

Abstracts

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14th iCACGP Quadrennial Symposium
and
15th IGAC Science Conference

Atmospheric Chemistry:
From molecules to global impacts



25-29 September 2018
Takamatsu, Kagawa, Japan

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Keynote Presentations

Abstract ID	Abstract Title	Presenting Author & Affiliation
K.001	Going Through a Phase: Particulate Water in Atmospheric Aerosol	Margaret Tolbert, Dept. of Chemistry and CIRES, University of Colorado, Boulder CO USA
K.002	The science of atmospheric composition and chemistry: past, present and future	Ian Galbally, Climate Research Centre, CSIRO Oceans and Atmosphere, Aspendale, Victoria, Australia & Centre for Atmospheric Chemistry, School of Chemistry, University of Wollongong, New South Wales, Australia
K.003	Atmospheric Chemistry Research from Fundamentals to Policy Relevance – Recent Research Experience	Hajime Akimoto, National Institute for Environmental Studies, Center for Global Environmental Research, Tsukuba, Ibaraki, Japan

Invited Oral Presentations

Session 1: Atmospheric Chemistry & People

Abstract ID	Abstract Title	Presenting Author & Affiliation
1.044	Emissions, Air pollution, Health and Society in Africa	Laboratoire d'Aérodologie, Université Paul Sabatier Toulouse III CNRS, France
1.066	Atmospheric Chemistry: A quiet revolution helping people mitigate risks of air pollution	Rajesh Kumar, National Center for Atmospheric Research, Boulder, CO, USA

Session 2: Atmospheric Chemistry & Fundamentals

2.126	Linking theoretical kinetic studies with laboratory and chamber experiments	Luc Vereecken, Institute for Energy and Climate Research, IEK-8: Troposphere, Forschungszentrum Jülich GmbH, Jülich, Germany
2.145	First steps to uncovering molecular level interactions of organic aerosol and cloud droplets from direct observation using synchrotron radiation.	Nonne Prisle, Atmospheric Research Group, Nano and Molecular Systems Research Unit, University of Oulu, PO Box 3000, 90014 University of Oulu, Finland

Session 3: Atmospheric Chemistry & Ecosystems

3.038	Biogenic modelling activities in eucalypt-rich southeast Australia	Kathryn Emmerson, CSIRO Climate Science Centre, Aspendale, Victoria 3195, Australia
3.104	Contributions of commercial aircraft for researching atmospheric greenhouse gases	Toshinobu MACHIDA, National Institute for Environmental studies, 16-2 Onogawa, Tsukuba 305-8506, Japan

Session 4: Atmospheric Chemistry & Climate/Weather

4.062	How do short-lived climate forcers affect climate?	William Collins, University of Reading, Department of Meteorology, Reading, UK
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Session 5: Challenging the Future

5.011	Moving the full complexity of the ocean-atmosphere system into the laboratory for fundamental chemistry studies	Kimberly Prather, UC San Diego, Scripps Institution of Oceanography, La Jolla, CA, USA, 92093
5.029	Observing Air Quality from Geostationary Constellation	Jhoon Kim, Yonsei University, Department of Atmospheric Sciences, Seoul, Korea

Abstract ID	Abstract Title	Presenting Author & Affiliation
5.062	Atmospheric Chemistry: Future Directions	Guy Brasseur, National Center for Atmospheric Research, Boulder, CO, USA

Oral Presentations

Session 1: Atmospheric Chemistry & People

Abstract ID	Abstract Title	Presenting Author & Affiliation
1.031	A New Top-Down Approach to Quantifying the Spatial, Temporal, and Vertical Distribution of Urban and Biomass Burning Regions using Decadal Measurements from MOPITT and AERONET	Chuyong Lin, Sun Yat-Sen University, Guangzhou, Guangdong, China (Early Career Scientist)
1.055	Establishing Connections between Aerosol Chemical Composition and Possible Health Effects	Yinon Rudich, Department of Earth and Planetary Sciences, Weizmann Institute, Rehovot, Israel
1.093	Decadal changes of ozone-NO _x -VOC sensitivity over Japan estimated using satellite data and their impact on the effectiveness of surface ozone mitigation policies inferred from air quality simulations.	Kazuya Inoue, RISS / AIST, Tsukuba, Ibaraki, Japan
1.095	Forecast the shipping emissions and impacts in China	Huan Liu, Tsinghua University, Beijing, China
1.112	What level of air quality monitoring data is needed to support effective policy action to reduce pollution?	Aderiana Mbandi, South Eastern Kenya University (Early Career Scientist)
1.124	Recent changes of trans-boundary air pollution over Northeast Asia: Implications for future air quality in South Korea	Piyush Bhardwaj, Gwangju Institute of Science and Technology, School of Earth Science and Environmental engineering, Gwangju, 61005, Republic of Korea (Early Career Scientist)
1.146	Surface ozone variability in continental South Africa	Pieter Gideon van Zyl, Unit for Environmental Sciences and Management, North-West University, Potchefstroom, South Africa
1.157	Trends of PM pollution and health effects in Europe during the 1990s and 2000s: multi-model and observational assessment	Svetlana Tsyro, Norwegian Meteorological Institute, P.O. Box 43, Blindern, N-0313 Oslo, Norway
1.167	Towards improved quantification of Russian oil and gas extraction emissions based on analysis of YAK-AEROSIB aircraft data	Kathy Law, Laboratoire Atmosphères, Milieux, Observations Spatiales (LATMOS)-CNRS, Paris, France
1.185	Air Quality in Puerto Rico in the Aftermath of Hurricane Maria	Olga L Mayol-Bracero, Department of Environmental Science, University of Puerto Rico, San Juan, Puerto Rico
1.197	Detecting Human Emissions of Volatile Chemical Products in Urban Atmospheres	Brian McDonald, University of Colorado, Cooperative Institute for Research in Environmental Sciences, Boulder, Colorado, USA; NOAA Earth System Research Laboratory, Chemical Sciences Division, Boulder, Colorado, USA

Abstract ID	Abstract Title	Presenting Author & Affiliation
1.205	The Tropospheric Ozone Assessment Report (TOAR): A community-wide effort to quantify tropospheric ozone in a rapidly changing world	Owen Cooper, CIRES, University of Colorado/NOAA Earth System Research Laboratory, Boulder
1.208	Effect of Megacities on the Transport and Transformation of Pollutants on the Regional to Global Scales (EMeRGe): an overview of the HALO airborne campaigns in Europe and Asia.	Maria Dolores Andrés Hernández, University of Bremen, Institute of Environmental Physics, Bremen, Germany
1.218	Source apportionment of particulate matter using a low-cost multi-pollutant air quality sensor in an Indian megacity	David Hagan, Massachusetts Institute of Technology, Department of Civil & Environmental Engineering, Cambridge, MA 02139 (Early Career Scientist)

Session 2: Atmospheric Chemistry & Fundamentals

2.003	An updated isoprene oxidation and deposition scheme in the IMAGES model	Jean-François Müller, Royal Belgian Institute for Space Aeronomy
2.010	Reconciling organic auto-oxidation, new-particle formation, and chamber secondary organic aerosol formation	Neil Donahue, Center for Atmospheric Particle Studies, Carnegie Mellon University, Pittsburgh PA 15213 USA
2.028	Kinetics of Criegee Intermediates	Jim Lin, Institute of Atomic and Molecular Sciences, Academia Sinica, Taipei 10617, Taiwan
2.038	Aerosol formation and aging under atmospheric conditions in China's application of a quasi-atmospheric aerosol evolution study (QUALITY) chamber	MIN HU, State Key Joint Laboratory of Environmental Simulation and Pollution Control, College of Environmental Sciences and Engineering, Peking University, Beijing, 100871, China
2.051	Insight into the in-cloud formation of oxalate based on in situ measurement by single particle mass spectrometry	Guohua Zhang, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences
2.085	Role of Sulfate Radical Anion Chemistry in Heterogeneous OH Oxidation of Organosulfates	Man Nin Chan, Earth System Science Programme, Faculty of Science, The Chinese University of Hong Kong, Hong Kong
2.100	OH, HO ₂ and RO ₂ Radical and OH Reactivity Observations during Wintertime and Summertime in Beijing, and comparison with both steady state calculations and box model simulations.	Eloise Slater, School of Chemistry, University of Leeds, Leeds, West Yorkshire, United Kingdom (Early Career Scientist)
2.104	ROOOH: the Missing Piece of the Puzzle for OH measurements in low NO Environments	Christa Fittschen, University Lille / CNRS
2.113	Air/sea interfacial photochemistry is a global source of organic vapors and aerosol particles	Christian George, Univ Lyon, Université Claude Bernard Lyon 1, CNRS, IRCÉLYON, F-69626, Villeurbanne, France
2.119	Impact of temperature on molecular composition of secondary organic aerosols from anthropogenic and biogenic sources: from lab to field	Cheng Wu, Department of Environmental Science and Analytical Chemistry, University of Stockholm, Sweden (Early Career Scientist)

Abstract ID	Abstract Title	Presenting Author & Affiliation
2.141	The significant role of cloud chemistry in tropospheric NO _x and oxidant cycles	Christopher Holmes, Earth, Ocean, and Atmospheric Science, Florida State University, USA
2.152	A Comprehensive Test of the Recent Proposed HONO Sources in Field Measurements at Rural North China Plain	Yuhan Liu, 1. State Key Joint Laboratory of Environment Simulation and Pollution Control, College of Environmental Sciences and Engineering, Peking University, Beijing, China (Early Career Scientist)
2.159	Influence of Relative Humidity on the Heterogeneous Oxidation of Secondary Organic Aerosol	Christopher Cappa, Dept. of Civil & Environmental Engineering, University of California, Davis, CA USA
Session 3: Atmospheric Chemistry & Ecosystems		
3.044	Development of an aerosol reanalysis product - JRAero	Keiya Yumimoto, Research Institute for Applied Mechanics, Kyushu University, Kasuga, Fukuoka, Japan
3.059	Summertime observations of ultrafine particles and their growth to CCN sizes in the high Arctic marine boundary layer	Jonathan Abbatt, Department of Chemistry, University of Toronto, Toronto, Canada
3.066	Organic matter in marine aerosol particles: chemical characterization, transfer and sources	Nadja Triesch, Leibniz Institute for Tropospheric Research (TROPOS); Atmospheric Chemistry Department (ACD), Leipzig, Germany (Early Career Scientist)
3.071	Ammonia revealed from space: from industrial and agricultural point sources to global trends	Martin Van Damme, Université libre de Bruxelles (ULB), Spectroscopie de l'Atmosphère, Service de Chimie Quantique et Photophysique, Brussels, Belgium (Early Career Scientist)
3.092	Characterization of carbonaceous aerosols emitted from peatland burning in Central Kalimantan Indonesia	Puji Lestari, Faculty of Civil & Environmental Engineering, Institute of Technology Bandung (ITB), Bandung, Indonesia
3.102	Stress-induced biogenic organic emissions and atmospheric chemistry interactions	Alex Guenther, University of California, Irvine
3.127	Direct OH reactivity measurements show agricultural crop residue fires fuel large missing OH reactivity associated with rapid photochemical formation of reactive nitrogen organics	Vinayak Sinha, Department of Earth and Environmental Sciences, Indian Institute of Science Education and Research Mohali, Sector 81, S. A. S. Nagar, Manauli PO, Punjab, India 140306
3.145	The Mysterious Global Methane Budget	Lori Bruhwiler, NOAA Earth System Research Laboratory, Global Monitoring Division, Boulder, Colorado, USA
Session 4: Atmospheric Chemistry & Climate/Weather		
4.007	The influence of dimethyl sulfide produced by global coral reefs on the climate	Sonya Fiddes, ARC Centre of Excellence for Climate System Science, Australian-German Climate and Energy College, School of Earth Sciences, University of Melbourne, Parkville, Australia (Early Career Scientist)
4.018	Enhanced surface ozone during the heat wave of 2013 in Yangtze River Delta region, China	Tijian Wang, School of Atmospheric Science, Nanjing University

Abstract ID	Abstract Title	Presenting Author & Affiliation
4.021	The impact of climate variability on volatile organic compounds emissions assessed using spaceborne formaldehyde data from SCIAMACHY and OMI	Jenny Stavrakou, BIRA-IASB
4.023	Unraveling the influences of pollution and climate trends on radiation fog frequency using generalized additive models	Ellyn Gray, Environmental Science, Policy, and Management, UC Berkeley, Berkeley, CA, USA (Early Career Scientist)
4.028	Characterizing the climatological composition and intraseasonal and interannual variability of the Asian summer monsoon anticyclone using Aura Microwave Limb Sounder measurements	Michelle Santee, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA
4.052	Changing Conditions in the Arctic: An Analysis of Trends in Observed Surface Ozone Conditions	Audra McClure-Begley, University of Colorado - CIRES and NOAA Global Monitoring Division (Early Career Scientist)
4.054	Dust induced changes on the West African summer monsoon features	N'Datchoh Evelyne TOURE, Laboratoire de Physique de l'Atmosphere, University Felix Houphouet Boigny, Abidjan Cote d'Ivoire (Early Career Scientist)
4.059	Persistent La Niña-like climate in 2010s reduced export from China and suppressed ozone trend in the lower troposphere over Japan	Sachiko OKAMOTO, Center for Global Environmental Research, National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan
4.084	Spatial and temporal variation of haze in the Yangtze River Delta region from 1961 to 2015	Rui Han, National Meteorological Information Center, China Meteorological Administration, Beijing100081, China
4.098	Equilibrium climate and air pollution responses to greenhouse gases, anthropogenic emissions and ozone changes from 1970 to 2010 under different EDGAR emission scenarios	Alcide Zhao, School of GeoSciences, University of Edinburgh, Edinburgh,UK (Early Career Scientist)
4.163	Global scale variability of the mineral dust shortwave and longwave refractive index: a new dataset of in situ measurements for climate modelling and remote sensing	Claudia Di Biagio, LISA, CNRS, UPEC and UPD, IPSL, Créteil, France
4.179	Impact of particle size and mixing state diversity on estimates of black carbon mitigation	Hitoshi Matsui, Graduate School of Environmental Studies, Nagoya University, Nagoya, Japan
4.185	Impacts of Climatic and Land-Use Changes on Global Aerosol Burden	Alan Lim, Graduate Division of Earth and Atmospheric Sciences, Faculty of Science, The Chinese University of Hong Kong, Sha Tin, New Territories, Hong Kong (Early Career Scientist)
4.189	Impacts of drought on air quality	Yuxuan Wang, Department of Earth and Atmospheric Sciences, University of Houston, Houston, Texas
4.203	Deep Convective Transport, Lightning NO _x Production, and Wet-Scavenging in Mid-latitude Deep Convection: Combining Modeling and Observations from DC3	Kenneth Pickering, Department of Atmospheric and Oceanic Science, University of Maryland, College Park, MD USA

Abstract ID	Abstract Title	Presenting Author & Affiliation
4.246	Impact of reduction of ship-induced sulphur emission on climate and health	Mikhail Sofiev, Finnish Meteorological Institute, Atmospheric Composition Department, Helsinki, Finland

Session 5: Challenging the Future

5.005	Replacing the integrator: modelling atmospheric chemistry with machine learning	Mathew Evans, University of York, York, UK. National Centre for Atmospheric Sciences, York, UK
5.022	Spatial and Temporal Optimisation of Variable Density/Capability Air Quality Networks. Improving returns from emerging low-cost Air Quality Monitoring Networks	Mohammed Iqbal Mead, Centre for Environmental and Agricultural Informatics. Cranfield University.
5.025	Global, In Situ Measurements of New Particle Formation and Growth to CCN Sizes	Charles Brock, NOAA Earth System Research Laboratory
5.033	New perspectives on atmospheric chemistry from the Sentinel-5P TROPOMI sensor and the 23-year QA4ECV climate data record	Klaas Folkert Boersma, KNMI / Wageningen University
5.074	Challenging the future of air pollution in southern Africa	Roelof Burger, North-West University, South Africa
5.078	Challenges in Identifying Sources of PM _{2.5} in China	Mei Zheng, College of Environmental Sciences and Engineering, Peking University Beijing, 100871, China

Poster Presentations

Session 1: Atmospheric Chemistry & People

Abstract ID	Abstract Title	Presenting Author & Affiliation
1.003	Unexpected air quality feedback chains from implementation of green infrastructure in urban environments: a Kansas City case study	Yuqiang Zhang, Oak Ridge Institute for Science and Education (ORISE) Fellowship Participant at US Environmental Protection Agency, Research Triangle Park, NC 27711 (Early Career Scientist)
1.006	Air pollution near unpaved roads: An experimental and modelling study	Daniel Fernando Prato Sanchez, Instituto Tecnológico y de Estudios Superiores de Monterrey (Early Career Scientist)
1.007	Model Ready Emissions Inventory Conversion System: Central Mexico Base Case	Jose-Agustin Garcia-Reynoso, Universidad Nacional Autonoma de Mexico, Centro de Ciencias de la Atmosfera, Ciudad de Mexico, Coyoacan, México
1.009	An On-line Monitor of the Oxidative Capacity of Airborne Particulate Matter (o-MOCA)	Arantzazu Eiguren-Fernandez, Aerosol Dynamics Inc, Berkeley, CA, USA
1.013	Modeling Particulate Matter Dispersion in Metro Manila: Application of an Integrated MM5/CALPUFF Approach	Melliza Cruz, Manila Observatory, Ateneo de Manila Campus, Loyola Heights, 1108 Quezon City, Philippines (Early Career Scientist)
1.014	Characteristics of personal exposure to PM _{2.5} from household solid fuels burning in rural Guanzhong Plain, China	Hongmei Xu, Department of Environmental Science and Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi, China

Abstract ID	Abstract Title	Presenting Author & Affiliation
1.015	Mobile measurements reveal high NO ₂ and ammonia concentrations in German inner cities	Robert Wegener, Institute of Energy and Climate Research, IEK-8: Troposphere, Forschungszentrum Jülich GmbH, Jülich, Germany
1.016	Significant Recent Changes in Anthropogenic SO ₂ Emissions: Insights from Spaceborne Observations and Large Scale Implications	Can Li, NASA Goddard Space Flight Center & University of Maryland, College Park, MD, USA
1.017	Impact of ship emissions and port-industrial activities on the chemical characteristic of urban PM _{2.5} in southeastern China	Lingling Xu, Institute of Urban Environment, Chinese Academy of Sciences
1.020	Monitoring sulfur dioxide from space: How we can interpret satellite data	Vitali Fioletov, Air Quality Research Division, Environment and Climate Change Canada, Toronto, ON, Canada
1.022	Characteristics of PM _{2.5} in India Collected by High-volume PM _{2.5} Particle Sampler	Jiaxin Chen, Faculty of science and Technology, Keio University (Early Career Scientist)
1.023	Development of a small-sized cyclone to collect ultrafine particles in the air	TAKUYA KATORI, Keio University, Faculty of Science and Technology (Early Career Scientist)
1.024	Investigation of the factors controlling the variation of aerosol surface area concentrations in Fukuoka, Japan	Miho Kiriya, Faculty of Science and Technology, Keio University (Early Career Scientist)
1.025	Development of atmospheric particle concentrator with virtual impaction and condensation growth	Kazushi Inoue, Faculty of Science and Technology, Keio University (Early Career Scientist)
1.026	Cyclone collection of fine and coarse particles followed by exposure experiments	Daiki Shishido, Faculty of Science and Technology, Keio University (Early Career Scientist)
1.027	Measurement of the chemical components of aerosol particles with different electrostatic charging state	Keiichi Kurosawa, Faculty of Science and Technology, Keio University (Early Career Scientist)
1.028	Carbon Monoxide and Cities as Seen from the MOPITT Instrument	James Drummond, University of Toronto, Department of Physics, Toronto, ON, Canada
1.029	Chemical characterization of ultrafine particles in aircraft emissions observed in the Narita International Airport, Japan: Possible contributions of fuel and lubricating oil	Akihiro Fushimi, National Institute for Environmental Studies, Center for Environmental Measurement and Analysis, Tsukuba, Japan
1.030	Effects of Transboundary Peat-forest Smoke on Acidity of Receptor Urban PM _{2.5} in Maritime Continent	Yang Lan, Department of Civil and Environmental Engineering, National University of Singapore, Singapore (Early Career Scientist)
1.032	Spatial distribution of number concentration and characteristics of ultrafine particles in Roadside Atmosphere	Wada Masashi, Research Institute of Environment, Agriculture and Fisheries, Osaka Prefecture
1.034	Identification and implications of biomarkers related to transboundary peat-forest smoke in urban environment	Liya Yu, National University of Singapore, Singapore

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1.039	Seasonal Variability and Source Apportionment of Fine Particulate Matter in the Klang Valley Urban-Industrial Environment	Norhaniza Amil, Environmental Technology Division, School of Industrial Technology, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia (Early Career Scientist)
1.045	Pollution Characteristics and Formation Mechanism of PM _{2.5} at Ningbo During the G20 Summit in 2016	Yanru ZHANG, Center for Excellence in Regional Atmospheric Environment, Institute of Urban Environment, Chinese Academy of Sciences, Xiamen 361021, China (Early Career Scientist)
1.047	The journey of C ₂ -C ₅ alkane emissions from the oil and gas sector: atmospheric and air quality implications	Zitely Tzompa, Colorado State University, Department of Atmospheric Science, Fort Collins, Colorado, USA (Early Career Scientist)
1.048	Fine Particle Pollution and Acid Deposition in Bangkok Metropolitan Region: Project Overview and Policy Implications	Daiju Narita, University of Tokyo/JICA Research Institute, Tokyo, Japan
1.049	Microphysical and Chemical property of winter fog in highly polluted place in India	Rachana Kulkarni, Indian Institute of Tropical Meteorology, Pune, Maharashtra, India. (Early Career Scientist)
1.052	Surface ozone over the coastal Antarctica during Austral summer	Imran Girach, Space Physics Laboratory, Vikram Sarabhai Space Centre, Thiruvananthapuram 695022, India (Early Career Scientist)
1.053	On-line and off-line measurements of particle-bound reactive oxygen species (ROS) in Beijing	Sarah Steimer, Department of Chemistry, University of Cambridge, Cambridge, CB2 1EW, United Kingdom
1.054	Long term ground level ozone observations in Malaysia: Spatio-temporal variability and challenges in mitigation	Fatimah Ahamad, Centre for Tropical Climate Change System, Institute of Climate Change, Universiti Kebangsaan Malaysia, 43600, Bangi, Selangor, Malaysia. (Early Career Scientist)
1.056	Reaction of Limonene with HOCl and Cl ₂ in the Dark Followed by Particle Formation under Indoor Fluorescent Light	Chen Wang, University of Toronto, Department of Chemistry, Toronto, ON, Canada (Early Career Scientist)
1.057	Contribution of Natural Emissions to Air Quality in Korea	Louisa Emmons, NCAR, ACOM, Boulder, CO, USA
1.059	Nitrate Isotopic Signature of Rainwater in Singapore: Implications for nitrogen sources and transformation in tropical regions	Shaoneng He, Earth Observatory of Singapore, Nanyang Technological University, Singapore
1.060	An investigation of possible roles of atmospheric circulation on annual visibility in Pearl River Delta, southern China	RUN LIU, Institute for Environmental and Climate Research, Jinan University (Early Career Scientist)
1.061	Airborne Air Pollution Assessment around London UK, During EMERGE-EU	Will Stephen Drysdale, Wolfson Atmospheric Chemistry Laboratories, Department of Chemistry, University of York, Heslington, York, YO10 5DD, UK (Early Career Scientist)

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1.062	Characterization and comparison of organic tracers in five mega cities, China, 2013 and 2003	Meng Wang, Key Laboratory of Aerosol Chemistry & Physics (KLACP), Institute of Earth Environment, Chinese Academy of Sciences, Xi'an, Shaanxi, China (Early Career Scientist)
1.065	An Ozone Event During a High Pressure Episode in the North China Plain: Transport and Photochemistry	Sarah Benish, University of Maryland, College Park, MD (Early Career Scientist)
1.067	Development of Device Evaluating On-site VOC Emissions during Refueling Gasoline	Tatsuya KATORI, Tokyo Denki University Graduate School of Engineering, Mechanical Engineering, Adachi-ku, Tokyo, Japan (Early Career Scientist)
1.068	Volatile organic compound emissions in the South China Sea during the 2011 VASCO Cruise: sources, emission rates, and ozone formation potential	Gabrielle Leung, Ateneo de Manila University, Department of Physics, Quezon City, Philippines (Early Career Scientist)
1.069	Particulate Matters (PM ₁₀ , PM _{2.5} and PM _{1.0}) and Gaseous Pollutants Exposure to Indoor Environment and the Association of Fine PM with Lung Function in Dhaka city, Bangladesh	Tanzina Akther, University of Dhaka, Department of Chemistry, Dhaka, Dhaka-1000, Bangladesh (Early Career Scientist)
1.070	Trends of visibility in three regions of eastern China	SHAW CHEN LIU, Institute for Environmental and Climate Research, Jinan University, Guangzhou, China
1.071	Historical trends of air pollutant emissions in Asia: Development of Regional Emission inventory in ASia (REAS) version 3	Jun-ichi Kurokawa, Asia Center for Air Pollution Research, Atmospheric Research Department, Niigata, Japan
1.072	The characteristics of natural NO emission from soil and its effect on secondary pollution over China: modelling study	Weihua Chen, School of Environmental Science and Engineering, Sun Yat-Sen University, Guangzhou, China (Early Career Scientist)
1.073	Ship-based NO _x and O ₃ Measurements in the Marine Boundary Layer Around the Arabian Peninsula	Ivan Tadic, Max Planck Institute for Chemistry, Atmospheric Chemistry, Mainz, Germany (Early Career Scientist)
1.074	Ground-based measurements of gaseous air pollutants and PM _{2.5} in Taiwan during the joint campaign of EMerGe-Asia and ProACT3	Charles Chou, Research Center for Environmental Changes, Academia Sinica, Taipei, Taiwan
1.075	Measurement of stable carbon isotope ratios of VOC in the outflow of major population centres in Europe and Asia	Ralf Koppmann, Institute for Atmospheric and Environmental Research, University of Wuppertal, Wuppertal, Germany
1.076	A Global assessment of Ozone Trends relevant to Human Health: Results from the Tropospheric ozone Assessment Report IGAC activity	Ruth Doherty, School of GeoSciences, University of Edinburgh, UK
1.077	Nitrogen Oxides Emissions from Major population centers in Europe and Asia: First results from the EMerGe field mission	Helmut Ziereis, Deutsches Zentrum für Luft- und Raumfahrt, Institut für Physik der Atmosphären, Oberpfaffenhofen, Germany

Abstract ID	Abstract Title	Presenting Author & Affiliation
1.079	Chemical Composition and Health Risk Assessment of Atmospheric Fine Particulate Matters in Bangladesh	Abdus Salam, Department of Chemistry, University of Dhaka, Dhaka 1000, Bangladesh
1.081	Towards reduced human exposure to mercury: The need for near-term global action	HELENE ANGOT, 1. Institute for Data, Systems, and Society, Massachusetts Institute of Technology, Cambridge, MA, USA. * now at Institute of Arctic and Alpine Research (INSTAAR), University of Colorado, Boulder, CO, USA. (Early Career Scientist)
1.083	Source identification and health risk assessment of trace metals in suspended particulate matters collected in Dhaka, Bangladesh	Morshad Ahmed, University of Dhaka, Department of Chemistry, Dhaka, Dhaka-1000, Bangladesh (Early Career Scientist)
1.084	Regional shifts in the diurnal cycle of surface ozone	Sarah Strobe, Universities Space Research Association and NASA GSFC, Greenbelt, MD, USA
1.085	Sensitivity study for satellite observation of the lowermost tropospheric ozone using three different wavelength ranges, UV, TIR, and microwave	Tomohiro Sato, Big Data Analytics Laboratory, National Institute of Information and Communications Technology, Koganei, Tokyo, Japan (Early Career Scientist)
1.086	Physicochemical and bioreactive characterization of urban fine particulate matter during Asian dust storm	Hsiao-Chi Chuang, School of Respiratory Therapy, College of Medicine, Taipei Medical University, Taipei, Taiwan
1.087	Performance Evaluation of PM2.5 Micro-sensors in Taiwan	Wen-Cheng Wang, Research Center for Environmental Changes, Academia Sinica, Nankang, Taipei, Taiwan.
1.088	Toxicity and anti-oxidative response induced by carbon black particles in a co-culture system	Cheng Teng Ng, 1Department of Anatomy, Yong Loo Lin School of Medicine, National University of Singapore 2NUS Environmental Research Institute, 5A Engineering Drive 1, National University of Singapore (Early Career Scientist)
1.090	Nitrogen isotope of nitrate in Arctic ice core records past anthropogenic energy shift	Shohei Hattori, Tokyo Institute of Technology
1.091	Improvement on urban scale meteorological and air quality simulation: using local urban canyon parameters and models	Zhaofeng Lv, State Key Joint Laboratory of ESPC, School of the Environment, Tsinghua University, Beijing 100084, China. (Early Career Scientist)
1.094	Application of PM2.5 Micro-sensors in Taiwanese Communities	Shih-Chun Candice Lung, Research Center for Environmental Changes, Academia Sinica, Nankang, Taipei, Taiwan.
1.097	CHARACTERISTICS OF O3, NOX, CO, CH4, NMHCs AND PM2.5 NEAR THE ROAD SITE IN HO CHI MINH CITY, VIETNAM	Thi Hien TO, Faculty of Environment, University of Science, Vietnam National University - Ho Chi Minh City, Vietnam
1.098	Greenhouse Gas Emissions from Major Population Centers in Europe and Asia: Aircraft-borne CH4 in-situ observations during the EMerGe field missions	Theresa Klausner, German Aerospace Center (DLR), Institute of Atmospheric Physics, Oberpfaffenhofen, Germany (Early Career Scientist)

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1.099	Biomass Burning Contribution of Carbonaceous Aerosols at Suburban and Rural Sites in Indo-Gangetic Plain	MANISHA MISHRA, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India (Early Career Scientist)
1.102	Aircraft-based measurements of aerosol chemical composition in the outflow of Asian megacities during EMERGe-Asia 2018	Katharina Kaiser, Johannes Gutenberg University Mainz, Institute for Atmospheric Physics, Mainz, Germany; Max Planck Institute for Chemistry, Particle Chemistry Department, Mainz, Germany (Early Career Scientist)
1.104	Downscaling air quality data from global to local scales	Michael Gauss, Norwegian Meteorological Institute, Oslo, Norway
1.105	Pollution characteristics and source apportionment of volatile organic compounds in different functional zones in a coastal city of Southeast China	Baoye Hu, Center for Excellence in Regional Atmospheric Environment, Institute of Urban Environment, Chinese Academy of Sciences, Xiamen, 361021, China; Key Lab of Urban Environment and Health, Institute of Urban Environment, Chinese Academy of Sciences, Xiamen 361021, China; University of Chinese Academy of Sciences, Beijing 100086, China (Early Career Scientist)
1.116	Modeling the health impacts of PM2.5 exposure in China at 5 km resolution	Yuanlin Wang, The State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China (Early Career Scientist)
1.118	Impact of Indonesian fires on air quality in Equatorial Asia between 2002 and 2015	Laura Kiely, University of Leeds (Early Career Scientist)
1.121	Developing a new urban air quality model for Beijing	Michael Biggart, School of Geosciences, The University of Edinburgh (Early Career Scientist)
1.122	Urban-Coastal Environment: Particle Formation and Growth Mechanisms	Doreena Dominick, Centre for Atmospheric Chemistry, University of Wollongong, Wollongong, NSW 2522, Australia (Early Career Scientist)
1.125	NO2 vertical columns retrieved over Mexico City from ground and space a space.	Zuleica Ojeda Lerma, National Autonomous University of Mexico, Atmospheric Science Institute, Coyoacan, Mexico City (Early Career Scientist)
1.126	Insufficient representation of summertime surface ozone minimum in the East Asian maritime region by chemical transport models	Tatsuya Nagashima, National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan
1.127	Measurements of of HONO, NO2 and NH3 by a filter pack method in Ho Chi Minh City Vietnam and Osaka, Japan	Norimichi TAKENAKA, Osaka Prefecture University, Graduate School of Humanities and Sustainable System Sciences, Sakai, Osaka, Japan

Abstract ID	Abstract Title	Presenting Author & Affiliation
1.128	First results of VOC and ozone measurements in European and Asian Major Population Centers (MPC) during the research aircraft campaign EMERGe (2017/2018)	Eric Foerster, KIT - Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research, Karlsruhe, Germany (Early Career Scientist)
1.129	Observing the changing Anthropocene from satellites and from aircraft: SCIAMACHY/GOME/GOME-2/S5-P and EMERGe	John P. Burrows FRS, Institute of Environmental Physics, University of Bremen P.O, Box 330440, 28334 Bremen, Germany
1.131	Data mining of large air quality datasets to improve emission inventories, identify long-term trends, and characterize meteorological influences on pollutant concentration	Benjamin de Foy, Department of Earth & Atmospheric Sciences, Saint Louis University, St. Louis, MO, USA
1.132	Variability in the mixing state of black carbon aerosols observed in Asian outflow in the spring of 2016	Nobuyuki Takegawa, Graduate School of Science, Tokyo Metropolitan University, Tokyo, Japan
1.133	Seasonal Characteristics of Particulate Polycyclic Aromatic Hydrocarbons in Ulaanbaater city, Mongolia	Batdelger Byambaa, Graduate School of Natural Science and Technology, Kanazawa University, Kanazawa, Ishikawa, Japan and Department of Environment and Forest engineering, School of Engineering and Applied Sciences, National University of Mongolia, Ulaanbaatar, Mongolia (Early Career Scientist)
1.134	Mexico City Regional Carbon Impacts	Michel Grutter, Universidad Nacional Autónoma de México, Mexico City, MEXICO
1.135	Tropospheric ozone trend during 1994-2007 in subtropical southern China	Tao Wang, Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hong Kong, China
1.137	Unexpected slowdown of US pollutant emission reduction in the past decade	Zhe Jiang, School of Earth and Space Sciences, University of Science and Technology of China, Hefei, Anhui, China
1.138	Data assimilation of the cross-border transport of aerosols/PM2.5 using Himawari 8 data and NICAM-Chem model	Takeshi Kuroda, National Institute of Information and Communications Technology, Big Data Integration Research Center, 4-2-1 Nukui-Kitamachi, Koganei, Tokyo 184-8795 Japan.
1.141	Health Impacts associated with O3 and PM2.5 air quality episodes in the UK in 2006	Sara Fenech, School of GeoSciences, University of Edinburgh, UK (Early Career Scientist)
1.142	Trends in primary NO2 emissions and investigation into vehicle cold start effects from ambient monitoring data in the UK	VASILIS MATTHAIOS, SCHOOL OF GEOGRAPHY EARTH AND ENVIRONMENTAL SCIENCE, UNIVERSITY OF BIRMINGHAM, UK (Early Career Scientist)
1.143	EMERGe campaigns in Asia: Regional air pollutants prediction and simulation	Chuan-Yao Lin, Academia Sinica, Research Center for Environmental Changes, Taipei, Taiwan

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1.144	Impact of Air Pollution on School Children in Dhaka city, Bangladesh	Shatabdi Roy , University of Dhaka, Chemistry, Dhaka, Bangladesh (Early Career Scientist)
1.147	How effective are short-term emission controls for mitigating urban air pollution?	Oliver Wild, Lancaster Environment Centre, Lancaster University, Lancaster, UK
1.148	Toxicological and Chemical Characteristics of Fine Particles from Burning of Crop Residues in China	Kin-fai HO, The Jockey Club School of Public Health and Primary Care, The Chinese University of Hong Kong, Hong Kong, China
1.149	Influence of urbanization on the sources of atmospheric nitrate; Evidence from the triple oxygen isotopes of nitrate in dry and wet deposition	Fumiko NAKAGAWA, Nagoya University, Graduate School of Environmental Studies, Nagoya, Aichi, Japan
1.150	Indoor particulate matter, trace elements, and temperature variations: a case study in rural Giyani, Limpopo, South Africa	Brigitte Language, Unit for Environmental Science and Management, North-West University, Potchefstroom, South Africa (Early Career Scientist)
1.153	Recent trend of atmospheric emissions due to open crop residue burning in the central east China	Kazuyo Yamaji, Kobe University, Kobe, Hyogo, JAPAN
1.155	Air pollutants and GHGs monitoring project around Jakarta megacity	Masahide Nishihashi, Center for Global Environmental Research, National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan
1.156	Regional air pollution reaching Fukue Island, western Japan: Highlights during EMERGE-Asia/ KORUS-AQ and long-term variations during 2009-2018	Yugo Kanaya, Japan Agency for Marine-Earth Science and Technology, Yokohama, Japan
1.158	Analysis of trends in Chinese Air Quality: results from a new monitoring network.	Ben Silver, Institute for Climate & Atmospheric Science, School of Earth and Environment, University of Leeds, Leeds, UK (Early Career Scientist)
1.159	Sensitivity of tropospheric ozone formation in urban areas under changing climate, emissions and vegetation modeled with the city-scale chemical transport model CityChem-EPIISODE.	Martin Otto Paul Ramacher, Helmholtz-Zentrum Geesthacht, Chemistry Transport Modeling Department, Geesthacht, Germany (Early Career Scientist)
1.161	Ground-based and satellite remote sensing in Korea for the EMERGE-Asia mission	Ja-Ho Koo, Yonsei University, Department of Atmospheric Sciences, Seoul, South Korea
1.162	Airborne measurement of peroxy radicals during EMERGE	Midhun George, University of Bremen, Institute of Environmental Physics, Bremen, Germany (Early Career Scientist)
1.163	Lower tropospheric ozone variability and trend over the North China Plain derived from space for 2008-2016	Gaëlle Dufour, Laboratoire Inter-universitaire des Systèmes Atmosphériques (LISA), UMR7583, Universités Paris-Est Créteil et Paris Diderot, CNRS, Créteil, France
1.165	Temporal variability of polycyclic aromatic hydrocarbons and their oxidative derivatives in Beijing, China: wintertime observations.	Atallah El Zein, Wolfson Atmospheric Chemistry Laboratories, Department of Chemistry, University of York, York YO10 5DD, United Kingdom

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1.166	Health impacts and complex drivers of air pollution in the City of Johannesburg, South Africa	Rebecca Garland, Natural Resources and the Environment Unit, CSIR, PO Box 395, Pretoria, South Africa
1.178	Global Modeling Assessment of PM2.5 During Wildfires: Inferring the Impact of PM2.5 Exposure on Adverse Respiratory & Cardiovascular Conditions	Emily Saunders, Science Systems and Applications, Inc. (SSAI) / NASA Global Modeling & Assimilation Office (GMAO), Greenbelt, MD, U.S.A. (Early Career Scientist)
1.181	Surface emissions for global and regional atmospheric composition analysis	Claire GRANIER, Laboratoire d'Aerologie/CNRS-UPS and NOAA/CIRES, University of Colorado; Toulouse, France and Boulder, CO, USA
1.182	The improvements and application of XBAER derived aerosol properties for EMERGe campaign	Mei Linlu, Institute of Environmental Physics, University of Bremen, Otto-Hahn-Allee 1, 28359 Bremen, Germany
1.183	A decade of satellite-derived maritime NOx emissions over Chinese Seas	Ronald van der A, KNMI, The Netherlands
1.186	Trends in photochemical pollution in Central Chile	Laura Gallardo, Center for Climate and Resilience Research, Universidad de Chile
1.188	Using citizen science approach to assess personal exposure to air pollution in a low income neighborhood: The case of Nairobi.	William Apondo, Stockholm Environmental Institute, Sustainable Urbanization Programme, Nairobi, Kenya. (Early Career Scientist)
1.191	Odd oxygen budgets in a polluted winter boundary layer and its implication for wintertime oxidant formation	Caroline Womack, NOAA Earth System Research Laboratory / CIRES
1.192	A PROBABILISTIC APPROACH FOR ESTIMATING SOLID-FUEL BURNING EMISSIONS IN LOW-INCOME SETTLEMENTS A CASE IN KWADELA	Ncobile Nkosi, North West University, Faculty of Natural sciences, Department of geography and environmental management, school of Geography and spatial sciences, Potchefstroom, North West province, South Africa (Early Career Scientist)
1.193	Regional to Hemispheric Atmospheric Impacts of Oil and Natural Gas Development in the U.S.	Helmig Detlev, INSTAAR, University of Colorado, Boulder
1.194	Measurement and modeling of ground-level and column ammonia for improved health impact assessment in Southern California	William PORTER, University of California, Riverside, Department of Environmental Sciences, Riverside, CA, USA
1.196	Long-range transport of NH3 deduced from continuous observation at Tottori, Japan	Kazuo Osada, Nagoya University
1.198	Atmospheric greenhouse gas concentrations and carbon isotopic ratio in 2004-2017 at southwestern China	Shohei Nomura, National Institute for Environmental Studies
1.200	Rural Residential Energy Transition in China from 1992 to 2012: Implications on Emissions and Health Benefits	Muye Ru, Nicholas School of the Environment, Duke University, North Carolina, USA; College of Urban and Environmental Sciences, Peking University, Beijing, China (Early Career Scientist)

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1.203	Comparison between TD-GC/MS and HPLC on analyzing polycyclic aromatic hydrocarbons in PM _{2.5} from Ho Chi Minh City	OANH PHAM, Osaka Prefecture University, Applied Chemistry Department, Sakai City, Osaka, Japan (Early Career Scientist)
1.204	Study on strategies to reduce photochemical oxidant for each environmental receptor	Yuki Nakagawa, Department of Environment Systems, Graduate School of Frontier Sciences The University of Tokyo (Early Career Scientist)
1.206	Characterization of Asian emissions and chemistry utilizing the satellite, aircraft, and ground-based measurements and model simulations	Si-Wan Kim, Department of Atmospheric Sciences, Yonsei University, Seoul, South Korea
1.211	Pollution events observed by IAGOS aircraft in various location, with focus to Taiwan extreme pollution in November 2017 and March 2018.	Philippe NEDELEC, Laboratoire d'Aérodologie, Université de Toulouse, CNRS, UPS, Toulouse, France
1.212	Vertical Profile of Long Range Transport Aerosols Investigated by a Lidar Network in Taiwan during EMerGe-Asia	Wei-Nai Chen, Research Center for Environmental Change, Academia Sinica, Taipei, Taiwan
1.213	Estimation of NO ₂ Concentrations Within and Around three major cities of Pakistan by Using MAX-DOAS and Satellite observations.	Ahsan Ali, Institute of Environmental Sciences and Engineering, NUST, Islamabad, Pakistan. (Early Career Scientist)
1.214	Large-Eddy-Simulation of Pollutant Dispersion: Comparison with Tracer Gas Field Campaign and Effect of Topography	Yung-Chang Chen, Research Center for Environmental Changes, Academia SINICA, Taipei, Taiwan (Early Career Scientist)
1.216	First observations of light non-methane hydrocarbons (NMHCs) over an high altitude site in Southern India	Venkataramani Sethuraman, Physical Research Laboratory(PRL), Navarangpura, Ahmedabad, Gujarat, India and Physics Department, S.P. University, Vallabh Vidyanagar, Gujarat, India (Early Career Scientist)
1.217	Source apportionment of PM _{2.5} and analysis of long-range transport from Northeast Asia Continent to Niigata in Eastern Japan	Keiichi Sato, Asia Center for Air Pollution Research, Niigata, Japan
1.220	Characterization of a Thermal Denuder for the Estimation of Volatility Parameters of Laboratory Generated Aerosols	Zaeem Babar, Department of Environmental Engineering, Kyungpook National University, Daegu 702-701, Republic of Korea (Early Career Scientist)
1.221	Relationships between ground- and upper-level concentrations of gases and particles in Tokyo	HIROSHI HAYAMI, Central Research Institute of Electric Power Industry, Japan
1.222	Determination of composition and chemical structures of α -pinene SOA species	JUN-HYUN PARK, Department of Environmental Engineering, Kyungpook National University, 80 Daehakro, Bukgu, Republic of Korea (Early Career Scientist)
1.225	Determination on the triple oxygen isotopic compositions of tropospheric ozone in Asian Monsoon area	Yuto Mineno, Graduate School of Environmental Studies, Nagoya University, Nagoya, Aichi Prefecture, Japan (Early Career Scientist)

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1.228	Diagnostics of tropospheric oxidants using an ensemble data assimilation system and aircraft observations	Benjamin GAUBERT, NCAR-ACOM
1.229	Aircraft-based 2- and 3D Measurements of Trace Gases with the Heidelberger Airborne Imaging DOAS Instrument (HAIDI) during the Phase II Mission EMERGe	Katja Bigge, Institute for Environmental Physics, Heidelberg University, Heidelberg, Germany (Early Career Scientist)
1.232	Low-cost Sensors in the Study of Air Quality in San Juan Metro Area Following Hurricane Maria	Maité Morales Medina, Department of Environmental Science, University of Puerto Rico, San Juan, PR
1.235	Changes in air pollution-related mortality in the United States since 1990	J. Jason West, University of North Carolina
1.238	The global network of import and export of air-pollution related premature mortalities	Daven Henze, Department of Mechanical Engineering, University of Colorado, Boulder, CO, USA
1.239	Modelling roadside NO _x production and dispersion with a regional-scale coupled large-eddy simulation approach	Edward C. Chan, Institute of Advanced Sustainability Studies (IASS)
1.240	Cloud condensation nuclei (CCN) measurements with the HALO aircraft during EMERGe in European and Asian airspace	Ovid O. Krüger, Max Planck Institute for Chemistry, 55128 Mainz, Germany (Early Career Scientist)
1.242	Impacts of East Asian black carbon emissions on the Arctic climate and air quality: Contributions from anthropogenic and biomass burning sources	Kohei IKEDA, National Institute for Environmental Studies, Center for Global Environmental Research, Tsukuba, Ibaraki, Japan
1.243	10 years of IASI CO retrievals	Maya GEORGE, LATMOS/IPSL, UPMC Sorbonne Universités, UVSQ, CNRS, Paris, France
1.244	NICT priorities for observing the anthropocene from space	Yasko KASAI, Terahertz Technology Research Center, Big Data Integration Research Center National Institute of Information and Communications Technology (NICT), Tokyo, Japan
1.245	Using Short Term CO/CO ₂ ratios to assess air mass differences over the Korean Peninsula during KORUS-AQ 2016	Hannah Halliday, NASA Langley Research Center, Chemistry and Dynamics, Hampton, VA, USA (Early Career Scientist)
1.246	Application of multi-dimensional mass spectrometry methods for the characterization of urban PM _{2.5} samples in Chengdu, China	Yoshiteru Iinuma, Okinawa Institute of Science and Technology
1.247	Sources and atmospheric processing of PM _{2.5} carbonaceous and nitrogen aerosols in Northeastern China and the Yellow Sea during the KORUS-AQ campaign: Preliminary results of isotopic study	Saehee Lim, Dept. of Earth and Environmental Sciences, Korea University, 02841 Seoul, South Korea. (Early Career Scientist)
1.248	Flaring emissions in Africa: distribution, evolution and comparison with current inventories	Thierno Doumbia, CNRM/Météo-France, Toulouse, France

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1.249	Calibration of column-averaged dry-air mole fractions of atmospheric CO ₂ , CO and CH ₄ at the Burgos TCCON site in the Philippines	Voltaire A. Velazco, Centre for Atmospheric Chemistry, University of Wollongong, Northfields Ave., Wollongong 2522 NSW Australia & Oscar M. Lopez Center for Climate Change Adaptation and Disaster Risk Mgmt. Foundation Inc., Manila, Philippines
1.251	Seasonal Characteristics of High PM _{2.5} Episodes in Korea between 2013 and 2016	Yongjoo Choi, Department of Environmental Science, Hankuk University of Foreign Studies, Yongin, South Korea
1.252	Observations of Carbonaceous Aerosols at Nainital, a high altitude site in the central Himalayas	Priyanka Srivastava, Aryabhata Research Institute of Observational Sciences (ARIES), Nainital, India (Early Career Scientist)
1.254	Satellite Observed Variability of Aerosols and Carbon Monoxide in Southern Cities of South America	Sebastián Diez, Instituto Gulich, CONAE-UNC, Falda del Cañete, Córdoba, Argentina (Early Career Scientist)
1.256	Adverse health impacts associated with urban and rural air pollution in India	Alexandra Karambelas, The Earth Institute, Columbia University, New York, NY USA (Early Career Scientist)
1.257	Comparison of urban air pollution monitoring networks using low-cost sensors in fixed, mobile, and paired modes: Lessons for developing economies	Frank Hiroshi Ling, 1. Anthropocene Institute, Menlo Park, CA, USA 2. Policy Alternatives Research Institute (PARI), University of Tokyo, Tokyo, Japan

Session 2: Atmospheric Chemistry & Fundamentals

2.001	Photochemical formation of C ₁ -C ₅ alkyl nitrates in suburban Hong Kong and over South China Sea	Lewei ZENG, Air Quality Studies, Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hong Kong, China (Early Career Scientist)
2.002	Interfacial Criegee Chemistry in the Atmosphere	Shinichi ENAMI, NIES, Japan
2.004	AeroCom Phase III Nitrate model experiment: a process-level understanding	Huisheng Bian, Joint Center for Environmental Technology UMBC, Baltimore, MD, USA
2.006	An inter-comparison of methods for HO ₂ and CH ₃ O ₂ detection and kinetic study of the HO ₂ + CH ₃ O ₂ cross-reaction in the Highly Instrumented Reactor for Atmospheric Chemistry (HIRAC)	Lavinia ONEL, School of Chemistry, University of Leeds, Leeds, LS2 9JT, UK
2.007	Effect of condensed-phase photochemistry on the mass, composition, and properties of organic aerosols	Sergey Nizkorodov, University of California, Irvine
2.008	Aqueous-phase phenols nitration under mild environmental conditions	Irena Grgić, Department of Analytical Chemistry, National Institute of Chemistry, Hajdrihova 19, SI-1000 Ljubljana, Slovenia
2.009	A large ensemble based data assimilation experiment with a global aerosol transport model	KEIICHI KONDO, Meteorological Research Institute, Atmospheric Environment and Applied Meteorology Research Department, Tsukuba, Ibaraki, Japan

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2.011	Investigation of the oxidation of methyl vinyl ketone (MVK) by OH radicals in the atmospheric simulation chamber SAPHIR	Hendrik Fuchs, Institute of Energy and Climate Research, IEK-8: Troposphere, Forschungszentrum Jülich GmbH, Jülich, Germany
2.013	Aqueous-phase formation of nitrocatechols relevant for atmospheric nighttime conditions	Kristijan Vidović, Department of Analytical Chemistry, National Institute of Chemistry, Hajdrihova 19, SI-1000 Ljubljana, Slovenia (Early Career Scientist)
2.014	Reactive uptake of glyoxal by ammonium containing salt particles as a function of relative humidity	Chak K. Chan, School of Energy and Environment, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, China
2.015	Molecular investigation of bromide reaction on sea-spray aerosol proxy: temperature dependence and the effect of organics	Jacinta Edebeli, Laboratory for Environmental Chemistry, Paul Scherrer Institute, Villigen PSI, Switzerland (Early Career Scientist)
2.016	Rate Constants and C-C Bond Scission Ratios for Hydrolysis or Clay-catalyzed Degradation of 2,2,3-Trifluoro-3-(trifluoromethyl)oxirane (a Fluorinated Epoxide)	Shuzo Kutsuna, National Institute of Advanced Industrial Science and Technology (AIST), AIST Tsukuba West, Tsukuba, Ibaraki, Japan
2.018	Interactions at the aqueous aerosol surface	Lin Du, Environment Research Institute, Shandong University, Shanda South Road 27, Jinan, 250100, China
2.019	Iodide and ozone, an ongoing story: New insights from lab experiments in the ozone-iodide reactivity at the sea interface	Liselotte Tinel, Wolfson Atmospheric Chemistry Laboratory, Department of Chemistry, University of York, York, United Kingdom (Early Career Scientist)
2.020	Simulation on the similarities and differences of particle formation in winter and summer period in Beijing by NAQPMS+APM	Xueshun Chen, State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China (Early Career Scientist)
2.021	The atmosphere of a tropical forest simulated in a chamber: experiments, theory and global significance of OH regeneration in isoprene oxidation	Anna Novelli, Institute of Energy and Climate Research, IEK-8: Troposphere, Forschungszentrum Jülich GmbH, Jülich, Germany (Early Career Scientist)
2.022	Wintertime photochemistry in Beijing: Observations of ROx radical concentrations in the North China Plain during the BEST-ONE campaign	Zhaofeng Tan, Institute of Energy and Climate Research, IEK-8: Troposphere, Forschungszentrum Jülich GmbH, Jülich, Germany (Early Career Scientist)
2.023	Evolutionary process of winter haze in Beijing-Tianjin-Hebei: regional transport and heterogeneous reactions	Huiyun Du, State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China (Early Career Scientist)

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2.024	Hydroperoxide measurements in the marine boundary layer around the Arabian Peninsula during the AQABA ship-campaign	Bettina Hottmann, Max Planck Institute for Chemistry, Airchemistry Department, Mainz, Germany (Early Career Scientist)
2.025	Applications of total ozone reactivity analyzer to a trial observation in the ambient air and to a further experiment on kinetics of terpene-ozone reactions	Jun Matsumoto, Waseda University, Faculty of Human Sciences, Tokorozawa, Saitama, Japan
2.026	Laboratory studies on the aging of biomass burning emissions: chemical evolution and secondary organic aerosol formation	Christopher Lim, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, MA, USA (Early Career Scientist)
2.027	Contributions of condensable particulate matter to atmospheric organic aerosol over Japan	Yu Morino, National Institute for Environmental Studies
2.029	Particle phase state and viscosity in atmospheric secondary organic aerosols	Manabu Shiraiwa, University of California, Irvine
2.030	Studies on liquid-liquid phase separation in a-pinene secondary organic aerosol particles	Su han Ham, Department of Earth and Environmental Sciences, Chonbuk National University, Jeonju, Jeollabuk-do, Republic of Korea (Early Career Scientist)
2.033	Laboratory study for gaseous mercury uptake by atmospheric water	Satoshi Irei, National Institute for Minamata Disease
2.035	Extractive Electrospray Ionisation Mass Spectrometry (EESI-MS) for organic aerosol analysis	Peter Gallimore, University of Cambridge, Department of Chemistry, Cambridge, UK (Early Career Scientist)
2.036	Nitrous acid in the marine boundary layer	Liang Wen, Environmental research institute, Shandong University, Qingdao city, Shandong Province, China (Early Career Scientist)
2.037	An Evaluation of Global Organic Aerosol Simulations of Varying Complexity using Airborne Observations	Sidhant Pai, Massachusetts Institute of Technology, Department of Civil and Environmental Engineering, USA (Early Career Scientist)
2.039	Characteristics of atmospheric peroxyacetyl nitrate and its precursors at an urban site in Beijing, China	Wanyun Xu, Chinese Academy of Meteorological Sciences, State Key Laboratory of Severe Weather & Key Laboratory for Atmospheric Chemistry, Institute of Atmospheric Composition, Beijing, 100081, China (Early Career Scientist)
2.040	Investigating the relationship between physicochemical properties of fine particles and visibility impairment in central Taiwan	Ta-Chih Hsiao, Graduate Institute of Environmental Engineering, National Central University, Taoyuan, Taiwan
2.041	The Effects of Aerosol-Phase State and Chemical Composition on Multiphase Chemistry Leading to Isoprene-Derived Secondary Organic Aerosol Formation	Yue Zhang, Department of Environmental Sciences and Engineering, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, United States 27599 (Early Career Scientist)

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2.043	Numerical analysis of seasonal change of iodine-129 deposition in Japan using a global atmospheric iodine transport model	Masanao Kadowaki, Japan Atomic Energy Agency, Tokai, Ibaraki, Japan
2.045	Characterization and source apportionment of water-soluble organic aerosol with high resolution aerosol mass spectrometry in Beijing, China	Yanmei Qiu, State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China (Early Career Scientist)
2.046	New insight into the role of H ₂ SO ₄ seeds in SOA formation from toluene and isoprene	Yongfu XU, State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China
2.047	OH-, ozone-, and nitrate radicals-initiated aging of secondary organic aerosol formed from the ozonolysis of limonene	SATHIYAMURTHI RAMASAMY, National Institute for Environmental Studies, Japan (Early Career Scientist)
2.048	Hourly observation of PM _{2.5} components in the coastal area in Seto Inland Sea, Japan	Ryohei NAKATSUBO, Graduate school of Maritime Sciences, Kobe University, Kobe, Hyogo, Japan (Early Career Scientist)
2.049	A simplified approach for estimating cooking organic aerosol from Q-ACSM measurements in Beijing, China	Yao He, State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China (Early Career Scientist)
2.050	Pressure Studies of the Reaction of HO ₂ with NO ₂ using a mid-infrared Continuous Wave Quantum Cascade Laser	JUNTING QIU, Department of Environment Systems, Graduate School of Frontier Sciences, The University of Tokyo, Kashiwanoha 5-1-5, Kashiwa, Chiba 277-8563, Japan (Early Career Scientist)
2.053	Secondary Formation and Transformations of Organic Aerosols in Atmospheric Waters	Chandra Mouli Pavuluri, Institute of Surface-Earth System Science, Tianjin University, Tianjin 300072, China
2.055	Simulation of the ionization efficiency of evolved gas molecules from aerosol particles in a thermal desorption aerosol mass spectrometer	yu ide, Graduate School of Science, Tokyo Metropolitan University, Hachioji, Tokyo, Japan (Early Career Scientist)
2.056	The MAGNIFY project - Updated protocols for ozonolysis and photolysis of organic compounds	Peter Brauer, National Centre for Atmospheric Science, University of York, Wolfson Atmospheric Chemistry Laboratories, York, YO10 5DD, UK. (Early Career Scientist)
2.058	Observations of Ozone-Induced Potential Aerosol Formation at Deciduous Forest and Residential Sites near Tokyo	Tomoki NAKAYAMA, Nagoya University, Nagoya, Japan / Nagasaki University, Nagasaki, Japan
2.060	Measurement of atmospheric carbon dioxide using unmanned aerial vehicle for profiling vertical distribution over Akita	Makoto Inoue, Akita Prefectural University, Japan

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2.061	Comprehensive characterization of oxidation of organic compounds in the atmosphere	Abigail Koss, Massachusetts Institute of Technology, Department of Civil and Environmental Engineering, Cambridge, MA, USA (Early Career Scientist)
2.062	Outcomes of the Whiteface Mountain Cloud Chemistry Initiative: Model Intercomparison and Pilot Field Study	Mary Barth, NCAR, ACOM/MMM, Boulder, Colorado, USA
2.065	Urban particle phase state and its link with chemical composition, mixing state, and liquid water content	Zhijun Wu, College of Environmental Sciences and Engineering, Peking University, Beijing 100871, China
2.066	Probing the Role of Water in Criegee Chemistry Producing High Molecular Weight Compounds on Aqueous Organic Surfaces	Lijie Li, California Institute of Technology (Early Career Scientist)
2.067	Measurement of effective quantum yields for the photolysis of aqueous I ⁻ and estimation of atmospheric I ₂ emission rate	Akihiro YABUSHITA, Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, 6-1 Kasuga-koen, Kasuga, Fukuoka 816-8580, Japan
2.069	Laboratory Evaluation of the Particle Trap Laser Desorption Mass Spectrometer (PT-LDMS): Quantification of Ammonium Nitrate Aerosols	Cuizhi Sun, Graduate School of Science and Engineering, Tokyo Metropolitan University, Tokyo, Japan (Early Career Scientist)
2.072	Chemical characterization of submicron aerosols during the coal ban winter at Dezhou in the North China Plain	Wei Hu, Institute of Surface-Earth System Science, Tianjin University, Tianjin 300072, China; State Key Joint Laboratory of Environmental Simulation and Pollution Control, College of Environmental Sciences and Engineering, Peking University, Beijing 100871, China (Early Career Scientist)
2.075	Photocatalytic degradation of single, levitated organic aerosol particles containing iron nanoparticles or Arizona test dust.	Ulrich K. Krieger, Institute for Atmospheric and Climate Science, ETH Zurich, Switzerland
2.076	Vertical characterization of highly oxygenated molecules (HOM) below and above a boreal forest canopy	Qiaozhi Zha, Institute for Atmospheric and Earth System Research / Physics, Faculty of Science, University of Helsinki, 00014 Helsinki, Finland (Early Career Scientist)
2.077	Direct evaluation of photochemical ozone production regime	Yasuhiro Sadanaga, Department of Applied Chemistry, Osaka Prefecture University, Sakai, Osaka, Japan
2.078	Molecular Insights into NO-Promoted Sulfate Formation on Model TiO ₂ Mineral Dust with Different Exposed Facets	Weiwei Yang, Institute of Environmental and Applied Chemistry, College of Chemistry, Central China Normal University, Wuhan, Hubei, China. (Early Career Scientist)
2.080	The infrared signature of secondary organic aerosol from OH and O ₃ channel oxidation of isoprene and α -pinene	Long Jia, State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China

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2.081	Exploring the variations in atmospheric primary and secondary pollutants response to the stringent control measures during the 2016 G20 summit in Hangzhou	Gen Zhang, Chinese Academy of Meteorological Sciences (CAMS), China Meteorological Administration (CMA), Beijing, China
2.084	Assessment of Photo-stationary state of ozone over Delhi	Renu Masiwal, Environmental Sciences & Biomedical Metrology Division, CSIR - National Physical Laboratory, Dr. K. S. Krishnan Road, New Delhi -110012, India (Early Career Scientist)
2.086	Long-term observations of OH reactivity at the central European GAW station Hohenpeissenberg	Jennifer Muller, German Meteorological Service (DWD), Meteorological Observatory Hohenpeissenberg, Germany
2.088	17O-excess of atmospheric nitrous acid in urban area: quantification of its sources	Dong Ding, Graduate School of Environmental Studies, Nagoya University, Nagoya, Aichiken, Japan (Early Career Scientist)
2.089	Formation and chemical processing of spherical organic aerosol particles, or "tar balls," from biomass burning in the northwestern US	KOUJI ADACHI, Meteorological Research Institute, Japan
2.090	OH reactivity of primary tree emissions and their oxidation products using the atmosphere simulation chamber SAPHIR-PLUS	Thorsten Hohaus, Institute of Energy and Climate Research, IEK-8: Troposphere, Forschungszentrum Jülich GmbH, Jülich, Germany
2.091	Caught in the act: interfacial acid base chemistry	Thorsten Bartels-Rausch, Paul Scherrer Institut, Laboratory of Environmental Chemistry, CH-5232 Villigen PSI
2.092	Impact of C1-C5 alkyl nitrate chemistry on tropospheric ozone: box and global model perspectives	Maria Zamyatina, Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia, UK (Early Career Scientist)
2.093	Halogens role during the production of sulfate in tropospheric volcanic plumes	Tommaso Galeazzo, Sorbonne Université, Paris, France (Early Career Scientist)
2.094	The roles of volatile organic compound deposition and oxidation mechanisms in determining secondary organic aerosol production, a global perspective	Jamie Kelly, University of Edinburgh (Early Career Scientist)
2.095	Mechanistic Study of the Reactions of NO ₃ Radicals with C ₃ -C ₆ Alkenes	Freja F. Oesterstroem, Copenhagen Center for Atmospheric Research, Department of Chemistry, University of Copenhagen, Universitetsparken 5, 2100 Copenhagen, Denmark. Currently at: School of Chemistry, University of Leeds, LS2 9JT, Leeds, United Kingdom (Early Career Scientist)
2.097	Radiative properties of aerosols over central Indo-Gangetic Plain during variable monsoon scenarios	Manish Kumar, Institute of Environment and Sustainable Development, Banaras Hindu University, India (Early Career Scientist)

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2.105	Composition, Source Apportionment and Health Risk Assessment of PM _{2.5} in Kuala Lumpur City Centre in 2015-2016	Mohd Talib Latif, School of Environmental and Natural Resource Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
2.106	Studies on liquid-liquid phase separation in organic particles produced from the ozonolysis of α -pinene and β -caryophyllene products	Gwanggon Jo, Department of Earth and Environmental Sciences, Chonbuk National University, Jeonju, Jeollabuk-do, Republic of Korea (Early Career Scientist)
2.107	Heterogeneous uptake of N ₂ O ₅ in urban and sand dust plumes observed in spring in Beijing, China: implications for parameterizations and particulate nitrate formation	Men XIA, Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hong Kong, China (Early Career Scientist)
2.108	Kinetic study of OH radical uptake onto deliquesced NaCl particles with a combination technique of a laser flash photolysis and a laser induced fluorescence detection	Yosuke SAKAMOTO, Graduate School of Global Environmental Studies, Kyoto University, Japan
2.109	Viscosities of secondary organic aerosols derived from benzene, p-xylene, and diesel fuel: Measurements and predictions	Mijung Song, Department of Earth and Environmental Sciences, Chonbuk National University, Jeollabuk-do, Republic of Korea
2.110	Derivation of aerosol light scattering coefficient from absorption coefficient measured by a filter-based instrument at a metropolitan area	JEONGHOON LEE, Korea University of Technology and Education, School of Mechanical Engineering, Cheonan, Korea
2.111	Direct measurement of heterogeneous reactive uptake of N ₂ O ₅ on ambient aerosols in the polluted environment in China	Zhe Wang, Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hong Kong, China
2.112	Direct observation of new particle formation during ozonolysis of isoprene and ethene competing against the growth of preexisting particles	Satoshi Inomata, National Institute for Environmental Studies
2.114	Variation of Particle Numbers at Fukuoka, Japan in winter, 2018	Ayako Yoshino, National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan
2.115	Mixing State of Black Carbon in the Outflow of Urban Beijing: Implications for Light Absorption Enhancement	Tianyi Tan, State Key Joint Laboratory of Environmental Simulation and Pollution Control, College of Environmental Sciences and Engineering, Peking University, Beijing, CHINA (Early Career Scientist)
2.117	Formaldehyde over the Persian Gulf and around the Arabian Peninsula - marine boundary layer measurements during the AQABA campaign	Dirk Dienhart, Max Planck Institute for Chemistry, Atmospheric Chemistry Department, Mainz, Germany (Early Career Scientist)

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2.118	Halogenated organic compounds production by photosensitized reactions at the air/water interface	Marie ROVERETTO, Univ Lyon, Université Claude Bernard Lyon 1, CNRS, IRCELYON, F-69626, Villeurbanne, France (Early Career Scientist)
2.120	Increased volatility in cloud residuals compared to ambient aerosols	Emelie L. Graham, Department of Environmental Science and Analytical Chemistry (ACES) and Bolin Centre for Climate Research, Stockholm University, 11418 Stockholm, Sweden (Early Career Scientist)
2.124	Evaluation of the key factors in parameterization of HO ₂ uptake coefficient on atmospheric aerosols	Jia GUO, Department of Atmospheric Sciences, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing, China (Early Career Scientist)
2.125	Source attribution of tropospheric ozone in a chemistry-climate model using a novel tagging approach	Tim Butler, IASS Potsdam
2.127	An experimental study on carbocationic oligomerization processes of VOCs at acidic water surfaces	Shinnosuke Ishizuka, National Institute for Environmental Studies, Onogawa 16-2, Tsukuba, Ibaraki, Japan (Early Career Scientist)
2.128	Effect of Liquid-Liquid Phase Separation on the Heterogeneous OH Oxidation of Inorganic-Organic Aerosols	Hoi Ki Lam, Earth System Science Programme, Faculty of Science, The Chinese University of Hong Kong, Hong Kong, China (Early Career Scientist)
2.129	Composition of traffic emitted semi-volatile organic compounds at street canyon and urban background sites in central London, UK	Ruixin Xu, Division of Environmental Health and Risk Management, School of Geography, Earth and Environmental Sciences, University of Birmingham, Edgbaston, Birmingham. B15 2TT, U.K. (Early Career Scientist)
2.133	Reduced nitrogen species as observed in urban and rural areas in the North China Plain	Xiaobin Xu, Key Laboratory for Atmospheric Chemistry, Institute of Atmospheric Composition, Chinese Academy of Meteorological Sciences, Beijing 100081, China
2.134	Aqueous photo-oxidation of molecular size separated brown carbon	Rachel Hems, University of Toronto, Department of Chemistry, Toronto, Ontario, Canada (Early Career Scientist)
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2.137	Predictability of wildfires' impact on air quality: cas study of the summer 2016 in Europe	Solene Turquety, Sorbonne université, Laboratoire de Meteorologie Dynamique LMD-IPSL, Paris, France.

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2.139	How well can we assess atmospheric ozone changes? The OzoneSonde Data Quality Assessment (O3S-DQA)	David W. Tarasick, Environment and Climate Change Canada, 4905 Dufferin Street, Downsview, ON, M3H 5T4 Canada (Early Career Scientist)
2.142	Relative reactivity of stabilized Criegee intermediates from hydrocarbon ozonolysis toward carboxylic acids and water vapor	JUN HIROKAWA, Faculty of Environmental Earth Science, Hokkaido University, Sapporo, Hokkaido, Japan
2.143	Characteristics of Submicron Aerosols in 2013 summer of Beijing: Particle Size, Density, Hygroscopicity, and Mixing State	Song Guo, State Key Joint Laboratory of Environmental Simulation and Pollution Control, College of Environmental Sciences and Engineering, Peking University, Beijing, 100871, China
2.144	Towards comprehensive characterization of atmospheric VOC oxidation products	Mikael Ehn, Institute for Atmospheric and Earth System Research (INAR), University of Helsinki, Helsinki, Finland
2.146	Quantification and the Impact of SO ₂ on the New Particle Formation in the Ozonolysis of α -pinene	Hui-Ming Hung, Department of Atmospheric Sciences, National Taiwan University No. 1, Sec. 4, Roosevelt Road, Taipei, 10617 Taiwan
2.147	Origin of Soluble Iron from Low-emitting Automobile Exhaust	Joseph Salazar, University of Denver, Chemistry, Denver, Colorado, United States (Early Career Scientist)
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2.154	Measurements of HO ₂ uptake coefficient on mineral dust particles using aerosol flow tube with PERCA and LIF system	Qi Zou, State Key Joint Laboratory of Environment Simulation and Pollution Control, College of Environmental Sciences and Engineering, Peking University, Beijing, China (Early Career Scientist)
2.155	Highly Oxidized Organic Molecules (HOMs) Formation in the NO ₃ -Initiated Oxidation of Isoprene, Limonene and α -Pinene	Defeng Zhao, Institute for Energy and Climate Research, IEK-8: Troposphere, Forschungszentrum Jülich, Jülich 52425, Germany; Institute of Atmospheric Sciences, Fudan University, Shanghai, 200438, China
2.156	The impacts of VOCs on atmospheric chemistry: The Common Representatives Intermediates Chemical Mechanism in UKCA	Scott Archer-Nicholls, University of Cambridge, Department of Chemistry, Cambridge, UK

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2.160	1-Octanol Water Partition Coefficient as a Predictor of Liquid-Liquid Phase Separation in Mixed Organic/Inorganic Particles	Mikinori Kuwata, Nanyang Technological University
2.161	Condensable vapours from alpha-pinene oxidation: experimental characterization of formation processes and volatility	Otso Johannes Per��kyl��, University of Helsinki, Institute for Atmospheric and Earth System Research / Physics, 00014 University of Helsinki, Finland (Early Career Scientist)
2.162	New constraints on budgets of oxidized volatile organic compounds in the remote troposphere	Kelvin Bates, Harvard University, Cambridge, MA, USA (Early Career Scientist)
2.163	The bromine conundrum - Chemical coupling of halogens and OVOC over tropical oceans	Theodore K. Koenig, University of Colorado Boulder, Department of Chemistry and Biochemistry, CIRES, Boulder, CO, USA (Early Career Scientist)
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2.177	Field evaluation of low-cost PM sensor and results of network deployment in heavily polluted Kathmandu Valley, Nepal	Ashish Singh, Institute for Advanced Sustainability Studies, Potsdam, Germany (Early Career Scientist)
2.178	Determination of pathways in chemical reaction systems: an algorithm and applications to atmospheric chemistry	Ralph Lehmann, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Telegrafenberg A45, D-14473 Potsdam, F.R. Germany
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3.027	Spore emission of shiitake mushroom (<i>Lentinula edodes</i>) as one of bioaerosol particles: Shape and size characteristics	Masahide ISHIZUKA, Faculty of Engineering, Kagawa University, Takamatsu, Japan
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3.029	Investigating the global emission and transport of bioaerosols: combining modeling tools with ground-based and aircraft observations	Ruud H.H. Janssen, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge MA, USA
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3.032	Evaluating Global Biomass Burning Emission Inventories for CO in Australasia.	Maximilien Desservettaz, University of Wollongong & CSIRO Oceans and Atmosphere, Australia. (Early Career Scientist)
3.033	Variation in atmospheric CO ₂ and CO concentrations emitted from biomass burning inferred from GOSAT/TANSO-FTS and MOPITT data	SHINGO KOSAKA, Center for Environmental Remote Sensing (CEReS), Chiba University, Japan (Early Career Scientist)

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3.039	Seasonal variation of surface methane observed in North India: An investigation on the contributions of emissions and transport	Sachiko Hayashida, Nara Women's University, Faculty of Science, Nara, Japan
3.040	Carbonyl Sulfide: new ways of Observing the Climate System	Maarten Krol, Meteorology and Air Quality, Wageningen University, Netherlands,
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3.043	Bioaerosol emission and its role in re-emission of radioactive cesium from forest in Fukushima	Kazuyuki KITA, Graduate school of science and engineering, Ibaraki University
3.045	Primary and secondary biogenic organic aerosols in a midlatitudinal forest in Wakayama, Japan	Chunmao Zhu, Research and Development Center for Global Change, Japan Agency for Marine-Earth Science and Technology, Yokohama 2360001, Japan
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3.050	Long-term trend of tropospheric N ₂ O isotopic ratios in the Northern Hemisphere	Sakae Toyoda, Department of Chemical Science and Engineering, School of Materials and Chemical Technology, Tokyo Institute of Technology, Yokohama, Japan
3.052	Estimation of sulfur and nitrogen input/output budget on the small river catchment by long-term observations at Russian EANET Primorskaya station	Ekaterina Zhigacheva, Institute of Global Climate and Ecology (IGCE) Roshydromet & RAS, Environmental Pollution Monitoring Division, Moscow, Russian Federation/ Russian State Social University, Faculty of Postgraduate Studies, Moscow, Russian Federation (Early Career Scientist)

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3.062	Chemical transfer of dissolved organic matter from surface seawater to sea spray aerosol in the marine atmosphere	YUZO MIYAZAKI, Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan
3.063	Multi-component observations of biomass burning plumes by MAX-DOAS and sky radiometer at Phimai, Thailand in the dry season of 2016	Hitoshi Irie, Center for Environmental Remote Sensing, Chiba University, Chiba, Japan
3.064	Measurement Of Isoprene Sea-To-Air Fluxes At The Ocean- Atmosphere Interface	ROYSTON UNING, School of Environmental Sciences and Natural Resources, Faculty of Science and Technology, The National University of Malaysia, 43600 Bangi, Selangor, Malaysia. (Early Career Scientist)
3.065	Production of bromoform in sea ice and emission to the atmosphere	Daiki Nomura, Faculty of Fisheries Sciences, Hokkaido University, Hakodate, Japan.
3.068	Measurements of carbon and hydrogen isotope ratios of atmospheric methane in the northern North Pacific and the Arctic Ocean and interpretation of Arctic methane sources	FUJITA RYO, Center for Atmospheric and Oceanic Studies, Graduate School of Science, Tohoku University, Sendai, Japan (Early Career Scientist)
3.069	Longitudinal distributions of DMS and pCO ₂ in the surface seawater and atmosphere in the subarctic North Pacific during the summer cruise of 2007 (MR07-04)	Ippei Nagao, Graduate School of Environmental Studies, Nagoya University, Nagoya, Aichi, Japan
3.070	Iodide to feed the machine: a machine-learning built parameterization for sea-surface iodide using new observations, which impacts the ozone budget and iodine emissions	Tomás Sherwen, National Centre for Atmospheric Science, Wolfson Atmospheric Chemistry Laboratories, Department of Chemistry, University of York, York, UK (Early Career Scientist)

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3.077	Potential co-benefits of intercropping as a sustainable agricultural practice for both air pollution mitigation and global food security	Ka Ming Fung, Graduate Division of Earth and Atmospheric Sciences, The Chinese University of Hong Kong, Shatin, Hong Kong (Early Career Scientist)
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3.079	Sea-to-air flux of dimethylsulfide in the South and North Pacific Ocean as measured by Proton Transfer Reaction-Mass Spectrometry coupled with the Gradient Flux technique	Yuko Omori, Faculty of Life and Environmental Sciences, University of Tsukuba, Tsukuba, Ibaraki, Japan
3.080	The natural aerosol diffuse radiation fertilisation effect on global plant productivity	Alex Rap, School of Earth and Environment, University of Leeds, Leeds, United Kingdom
3.081	Influences on spring and summer-time tropospheric ozone in Western Siberia and the Russian Arctic: a model and satellite analysis	Tom Thorp, Institute for Climate and Atmospheric Science, School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK (Early Career Scientist)
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3.086	Towards a more comprehensive characterisation of biogenic volatile organic compounds in the greater Sydney region of southeast Australia	Elise-Andree Guerette, Centre for Atmospheric Chemistry, University of Wollongong, Wollongong, NSW, Australia (Early Career Scientist)

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3.093	Deposition velocity of nitric acid above a forest in suburban Tokyo using relaxed eddy accumulation	Kenta KASAHARA, Tokyo University of Agriculture and Technology, Graduate School of Agriculture, Fuchu, Tokyo, Japan (Early Career Scientist)
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3.095	Philippines TCCON Project: one-year measurement results and future	Isamu Morino, National Institute for Environmental Studies, Satellite Observation Center, Tsukuba, Ibaraki, Japan
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3.105	Characterization of organic aerosols at a forest site in Kii Peninsula, Japan, based on PMF analysis of aerosol mass spectra	Michihiro MOCHIDA, Graduate School of Environmental Studies, Nagoya University, Japan; Now at Institute for Space-Earth Environmental Research, Nagoya University, Japan
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3.112	Effect of atmospheric sulphur dioxide fumigation on photosynthesis by determination of ascorbic acid content in plants	Samaha Nahian, Institute : University of Dhaka, Department : Chemistry, City : Dhaka, Country : Bangladesh (Early Career Scientist)
3.113	A Ten-year Remote Sensing Based Estimate of Dust Deposition and Loss Frequency into Tropical Atlantic Ocean and Caribbean Sea	Hongbin Yu, NASA Goddard Space Flight Center, Greenbelt, MD, USA
3.114	Temporal variations of the atmospheric CO ₂ mole fraction, isotopic ratios of CO ₂ and $\delta(O_2/N_2)$ observed at Ny-Ålesund, Svalbard	Daisuke Goto, National Institute of Polar Research
3.115	The Behavior of Nitrogen Components in Atmospheric Aerosols at the Coastal Area of Seto Inland Sea in Summer	Tokuhiro Nakamura, Department of General Education, National Institute of Technology, Kagawa College, Mitoyo, Kagawa, Japan
3.119	Analysis of trends and seasonal variations of nitrogen dioxide, nitric acid and ammonia concentrations measured at six rural sites in Africa from 1998 to 2015.	Money Guillaume OSSOHOU, Laboratoire de Physique de l'Atmosphère et de Mécanique des Fluides, Université Félix Houphouët-Boigny, Abidjan, Côte d'Ivoire (Early Career Scientist)
3.121	Effects of African dust in the nutrient, radiation, and water budget of a tropical forest	Elvis Torres-Delgado, Department of Environmental Science, University of Puerto Rico, San Juan, Puerto Rico (Early Career Scientist)
3.122	Transported and local contributions to carbon monoxide in Australasia	Rebecca Buchholz, National Center for Atmospheric Research, Atmospheric Chemistry Observations & Modeling Laboratory, Boulder, CO, USA

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3.123	VERTICAL TRANSPORT OF PRIMARY BIOLOGICAL AEROSOLS EMITTED FROM THE AMAZON RAINFOREST	Cybelli Gonçalves Gregorio Barbosa, Environmental Engineering Department, Federal University of Paraná, Curitiba, Paraná, Brazil (Early Career Scientist)
3.124	Nitrogen wet deposition during El Niño 2015-2016: Effects in a Venezuelan tropical cloud forest	Stephanie Díaz López, Instituto Venezolano de Investigaciones Científicas (IVIC), Centro de Ciencias Atmosféricas y Biogeoquímica (CCAB), Caracas, Venezuela (Early Career Scientist)
3.125	Dry deposition of PM _{2.5} nitrate in a cool-temperate forest in northern Japan by vertical profile measurements	Akiyoshi Nakahara, Tokyo University of Agriculture and Technology, Graduate School of Agriculture, Fuchu, Tokyo, Japan (Early Career Scientist)
3.126	Relationship between bioluminescence-based ecotoxicity and water-soluble compounds of fine and coarse aerosol in Jeju, Korea	Joo-Ae Kim, Department of Earth and Environmental Science, Korea University, Korea (Early Career Scientist)
3.128	Determination of the triple oxygen isotopic compositions of tropospheric carbon dioxide	Shun Tsunekawa, Graduate School of Environmental Studies, Nagoya University, Nagoya, Japan (Early Career Scientist)
3.129	Marine organic carbon: simulating impacts on aerosol, clouds, and climate	Matt Woodhouse, CSIRO Climate Science Centre, Aspendale, Australia
3.131	Methyl chloride emissions from Bornean tropical tree species	TAKUYA SAITO, NIES
3.132	Observations of long-lived trace gases over the central Himalayas	Manish Naja, Aryabhata Research Institute of Observational Sciences (ARIES), Nainital, India
3.134	Urban pollution to the Andean cryosphere	Nicolas Huneeus, Department of Geophysics and Centre for Climate and Resilience Research, University of Chile, Santiago, Chile
3.136	Determination of $\delta^{18}O$, $\Delta^{17}O$, and $\delta^{15}N$ in atmospheric nitrates: First steps towards a deeper understanding of the nitrogen cycle over the Tibetan Plateau	Mang Lin, School of Materials and Chemical Technology, Tokyo Institute of Technology, 226-8502 Yokohama, Japan (Early Career Scientist)
3.138	Atmospheric Ammonia in the Summertime Arctic	Jennifer Murphy, University of Toronto, Department of Chemistry, Toronto, ON, Canada
3.139	The atmospheric reactivity of the NO ₃ radical	Jonathan M. Liebmann, Atmospheric Chemistry Department, Max Planck Institut für Chemie, 55128, Mainz, Germany (Early Career Scientist)
3.140	Studying Ammonia Sources Using Nitrogen Isotope in Beijing	Aohan Tang, College of Resources and Environmental Sciences, China Agricultural University, 100193, China
3.141	Spatial and temporal changes of atmospheric PM _{2.5} over the Seto Inland Sea observed on board the training ship Fukaemaru	Katsuhiko Kawamoto, Kobe University, Maritime Science, Kobe, Hyogo, Japan (Early Career Scientist)

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3.142	Biomass burning influence on ozone and precursors over the Amazon: trends and regional source contributions	Steve Arnold, Institute for Climate and Atmospheric Science, School of Earth & Environment, University of Leeds, Leeds, UK.
3.143	Ozone deposition at a rainforest site (ATTO) in the central Amazon Basin	Stefan Wolff, Multiphase Chemistry and Air Chemistry Departments, Max Planck Institute for Chemistry - Mainz, Germany (Early Career Scientist)
3.144	Temporal variations of the mole fraction and carbon isotope ratio of atmospheric methane observed at Ny-Ålesund, Svalbard	Shinji Morimoto, Graduate School of Science, Tohoku University, Sendai 980-8578 Japan
3.146	Sequential changes of airborne microbial communities emitted from forest ground surface in Fukushima	Teruya Maki, Kanazawa University, Kanazawa, Ishikawa, Japan
3.148	Measurements of hydrogen peroxide and formaldehyde concentrations at ground level and in the high-altitude atmosphere over a rural site in central Japan	Koichi Watanabe, Toyama Prefectural University, 5180 Kurokawa, Imizu, Toyama, Japan
3.149	The Influence of Biomass Burning on the Arctic: Pan-Arctic FTIR Observations and Model Results	Kimberly Strong, Department of Physics, University of Toronto, Toronto, Ontario, Canada
3.150	Analysis of Atmospheric Aerosol Optical Properties in the Brazilian Northeast Using Remote Sensing Data from the CALIPSO Satellite, AERONET Photometers and a Ground-Based Lidar	Judith Hoelzemann, Department of Atmospheric and Climate Sciences, Federal University of Rio Grande do Norte - DCAC/CCET/UFRN, Natal/RN, Brazil

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4.005	Modelling and remote-sensing based analysis of a dense haze event over Northeastern Pakistan	Muhammad Zeeshaan Shahid, Department of Environmental Sciences, GC University Faisalabad Pakistan & Qatar Environment and Energy Research Institute, Doha, Qatar (Early Career Scientist)
4.008	Characteristics and influencing factors of PM1 over Shanghai and its impact on visibility	Guangqiang Zhou, Shanghai Meteorological Service, Shanghai 200030, China
4.010	Reduced biomass burning emissions reconcile conflicting estimates of the post-2006 atmospheric methane budget	John Worden, JPL / Caltech Pasadena CA
4.011	Provincial & transported size distributed carbonaceous aerosols at Eastern Central India	MITHLESH MAHILANG, School of Studies in Chemistry, Pt. Ravishankar Shukla University, Raipur, Chhattisgarh, 492010, India (Early Career Scientist)

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4.012	Year-round in situ measurements of Arctic low-level clouds: Microphysical properties and relationship with aerosols	Makoto Koike, Department of Earth and Planetary Science, University of Tokyo, Tokyo, Japan
4.013	Abundance of light-absorbing anthropogenic iron oxide aerosols in the urban atmosphere and their emission sources	Sho Ohata, The University of Tokyo, Tokyo, Japan
4.014	Identifying air pollution sources in Beijing, Taiwan and Malaysia using air mass footprints	Marios Panagi, National Centre for Atmospheric Science, Department of Chemistry, University of Leicester, Leicester, UK (Early Career Scientist)
4.015	Global aerosol climatology with 14km grid spacing using a non-hydrostatic icosahedral atmospheric transport model	Daisuke Goto, National Institute for Environmental Studies (NIES), Tsukuba, Japan
4.016	Abundance and emission flux of the anthropogenic iron oxide aerosols from the East Asian continental outflow	Atsushi YOSHIDA, The University of Tokyo, Department of Earth and Planetary Science, Tokyo, Japan (Early Career Scientist)
4.017	Intraseasonal Oscillation of Tropospheric Ozone in the Summer Monsoon Region	Yuli Zhang, Key Laboratory of Middle Atmosphere and Global Environment Observation, Institute of Atmospheric Physics, Beijing, China (Early Career Scientist)
4.024	Sources and Removal of Springtime Arctic Aerosol	Megan Willis, Department of Chemistry, University of Toronto, Toronto, Ontario, Canada (Early Career Scientist)
4.025	Effects of aerosols on the precipitation of convective clouds: a case study in the Yangtze River Delta	Chong Liu, School of Atmospheric Sciences, CMA-NJU Joint Laboratory for Climate Prediction Studies, Jiangsu Collaborative Innovation Center for Climate Change, Nanjing University, Nanjing 210023, China (Early Career Scientist)
4.027	Agricultural fire impacts on ozone photochemistry over the Yangtze River Delta region, East China	Mengmeng Li, School of Atmospheric Sciences, Nanjing University, Nanjing 210023, China (Early Career Scientist)
4.030	Dust storms in the Middle East: An observational and modeling study of two events using in-situ and remotely sensed measurements and WRF-Chem-RTFDDA	Dorita Edelstein, IIBR
4.031	Water-soluble diacids and related compounds in PM2.5 aerosols in eastern central India: influence of biomass burning and atmospheric processing	Dhananjay Kumar Deshmukh, Chubu Institute for Advanced Studies, Chubu University, Kasugai 487-8501, Japan (Early Career Scientist)
4.033	The impact of long-range transport of African ozone on tropospheric ozone over Asia	Han Han, School of Atmospheric Sciences, Nanjing University, Nanjing, China (Early Career Scientist)
4.034	The impacts of long-range transport on the spatial and temporal distribution of black carbon in the Tibetan Plateau	Yue Wu, School of Atmospheric Sciences, Nanjing University, Nanjing, Jiangsu, China (Early Career Scientist)

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4.035	Aerosol radiative forcing of pyrogenetic iron oxides	ITO AKINORI, Yokohama Institute for Earth Sciences, JAMSTEC, Yokohama, Kanagawa, 236-0001, Japan
4.036	Measurements of Mie scattering of single optically-levitated aerosol particles in air	Maho Nakagawa, Department of Chemistry, Graduate School of Science, Hiroshima University, Hiroshima, japan (Early Career Scientist)
4.037	Variations of atmospheric CO ₂ and its isotopes in the upper troposphere/lower stratosphere over Siberia	Yoichi INAI, CAOS, Tohoku University, Sendai, Japan
4.039	Tropospheric column ozone variability from space: results from the first multi-instrument intercomparison	Audrey Gaudel, Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado; NOAA Earth System Research Laboratory, Chemical Sciences Division
4.040	Field observation and numerical simulation of ozone (O ₃) formation and accumulation in Pearl River Estuary, South China	Yangzong Zeren, Air Quality Studies, Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hong Kong (Early Career Scientist)
4.041	JMA aircraft observation for greenhouse gases over the western North Pacific	Kazuhiro Tsuboi, Meteorological Research Institute, Japan
4.042	Validation of GOSAT cloud determination by Himawari-8 data	Katsuki Kitamura, Center for Environmental Remote Sensing, Chiba University. (Early Career Scientist)
4.044	Insight into nitro-phenolics in organic aerosol during high pollution events in Beijing	William James DIXON, Wolfson Atmospheric Chemistry Laboratories, Department of Chemistry, University of York, York, UK (Early Career Scientist)
4.045	Evaluation of Radiative Effects during a Typical Wintertime Black Carbon Episode over the Yangtze River Delta in China	Yichen Li, School of Atmospheric Sciences, Nanjing University, Nanjing, China (Early Career Scientist)
4.046	Numeric modeling of plant ozone exposure and its effect on atmospheric CO ₂ in China	Xiaodong Xie, School of Atmospheric Sciences, Nanjing University, CMA-NJU Joint Laboratory for Climate Prediction Studies, Jiangsu Collaborative Innovation Center for Climate Change, Nanjing, China (Early Career Scientist)
4.047	An 8-year record of atmospheric trace gases and aerosols in Southeast Asia based on shipboard observation	Hideki Nara, National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki, 305-8506, Japan
4.050	UKESM1: A first assessment of the pre-industrial to present-day anthropogenic forcing	Fiona O'Connor, Met Office Hadley Centre
4.051	Fine particulate matter (PM _{2.5}) in the two largest cities in Vietnam	Huu Huy Duong, Faculty of Environment, University of Science, Vietnam National University - Ho Chi Minh City, Ho Chi Minh City, Vietnam (Early Career Scientist)

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4.058	Short-term variations in atmospheric constituents associated with local front passage over Fukuoka, an urban area in Japan, observed by a 3-D coherent Doppler lidar and in-situ tracer measurements	Hisahiro Takashima, Faculty of Science, Fukuoka University, Fukuoka, Japan
4.060	Case study of aerosol optical and radiative properties during a haze event over the northern Thailand region using WRF-Chem.	sherin Hassan Bran, National Astronomical Research Institute of Thailand (NARIT), Atmospheric Research Unit, Chiang Mai, Thailand & Chiang Mai University, Environmental Science, Thailand (Early Career Scientist)
4.061	Using Multi-model Intercomparison and Aircraft Observations to Advance Constraints on the Methane Lifetime	Julie Nicely, NASA Goddard Space Flight Center, Greenbelt, MD, USA; Universities Space Research Association, Columbia, MD, USA (Early Career Scientist)
4.063	Effect of transboundary transport of air pollution from the Asian continent for the new particle formation by aerial observation in Fukue Island, Japan	Yayoi Inomata, Institute of Nature and Environmental Technology, Kanazawa University, Kanazawa, Ishikawa, Japan
4.065	Resolving the Persistent CO Underestimate in Atmospheric Chemistry Models	Katherine Travis, MIT, Civil and Environmental Engineering, Cambridge, MA, USA (Early Career Scientist)
4.066	Seasonal variation of the wet deposition of black carbon at Ny-Ålesund, Spitsbergen	Yutaka Kondo, National Institute of Polar Research, 10-3 Midori-cho, Tachikawa, Tokyo 190-8518, Japan
4.067	Natural and Anthropogenic Aerosols in the UTLS in Recent Decade: Sources and the Role of Monsoon Transport	Mian Chin, NASA Goddard Space Flight Center, Greenbelt, MD, U.S.A.
4.068	Green House Gas Emission from Solid Waste Disposal Sites in Sri Lanka	Hiranthi Jansz, Central Environmental Authority, Laboratory Services ,Battaramulla, Sri Lanka
4.070	Climatological Study of Black Carbon Transport from European Major Population Centers.	Anna Beata Kalisz Hedegaard, Institute of Atmospheric Physics, German Aerospace Center (DLR), 82234 Oberpfaffenhofen-Wessling, Germany; Institute of Environmental Physics (IUP), University of Bremen, 28359 Bremen, Germany (Early Career Scientist)
4.071	Summertime upper tropospheric nitrous oxide (N ₂ O) over the Mediterranean as a footprint of Asian emissions	Philippe RICAUD, CNRM, Météo-France/CNRS UMR 3589, Toulouse, France
4.074	Southern Ocean Aerosols - a seasonal perspective from Macquarie Island	Ruhi S Humphries, Climate Science Centre, Oceans & Atmosphere, CSIRO, Aspendale, VIC, Australia (Early Career Scientist)
4.077	Analysis of the carbon dioxide in the upper troposphere and lower stratosphere by the data from GOSAT TANSO-FTS TIR	Akihiro Honda, Interdisciplinary Graduate School of Engineering and Sciences, Kyushu University (Early Career Scientist)
4.078	A study on aerosol transport into upper troposphere and lower stratosphere and their impact on radiative and chemical processes with a global climate model	kensei hokazono, Interdisciplinary Graduate School of Engineering Sciences, Kyushu University (Early Career Scientist)

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4.079	Seasonal and inter-annual variations of methane at the upper troposphere	Nawo EGUCHI, Research Institute for Applied Mechanics, Kyushu University, Kasuga, Fukuoka, Japan
4.082	Heterogeneous distribution of dimethyl sulfide (DMS) and dimethylsulfoniopropionate (DMSP) in melt pond and its impact to atmospheric sulfur compounds	Sohiko KAMEYAMA, Faculty of Environmental Earth Science, Hokkaido University, Sapporo, Hokkaido, Japan
4.083	Sources and processes driving pollution in the African upper troposphere between 2005 and 2013	Bastien Sauvage, Laboratoire d'Aérodologie, Université de Toulouse, CNRS, UPS, Toulouse, France
4.085	Ozone trend analysis from 1980-2015: Models vs Observations	Nikos Daskalakis, Laboratory for Modeling and Observation of the Earth System (LAMOS), Institute of Environmental Physics (IUP), University of Bremen, Bremen, Germany (Early Career Scientist)
4.086	OH and HO ₂ concentration observations in the upper troposphere inside and outside of Asian monsoon influenced air.	Daniel Marno, Max-Planck Institut für Chemie (Early Career Scientist)
4.088	Characterization of ozone in the middle troposphere over Japan from 6-year observation at the summit of Mount Fuji (3776m)	Yukitomo Tsutsumi, Meteorological Research Institute, Japan Meteorological Agency
4.089	What controls interannual variability and long-term trends in global tropospheric chemistry and aerosols in past and future?	KENGO SUDO, Graduate School of Environmental Studies, Nagoya University, Nagoya, Japan
4.090	Aerosol impact on present day climate	Maria Sand, CICERO Center for Climate Research, Oslo, Norway
4.091	Evaluation of MERRA-2-based Ozone Profile Simulations with the Global Ozone Network	Ryan Stauffer, Universities Space Research Association, Columbia, MD, USA (Early Career Scientist)
4.095	Decadal-scale attribution of ozone and methane radiative forcing	Kevin Bowman, Jet Propulsion Laboratory, California Institute of Technology
4.096	Cloud Condensation Nuclei Properties of Pollen Grains	Olga Ivanova, Saint-Petersburg State University, Atmospheric Physics Department, Saint-Petersburg, Russia (Early Career Scientist)
4.099	Analysis of high radon-222 concentration events in winter using multi-horizontal-resolution NICAM simulations	Kentaro ISHIJIMA, MRI-JMA, Japan
4.102	Vertical profiles of particle light extinction coefficient in the low troposphere in Shanghai in winter based on Tethered balloon measurements	Qingqing Wang, State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry, Institute of Atmospheric Physics, Chinese Academy of Sciences (Early Career Scientist)
4.103	Impact of biogenic emissions of organics from a cool-temperate forest on aerosol optical properties retrieved from a Sky Radiometer	Astrid Mueller, Institute of Low Temperature Science, Hokkaido University, Japan; Graduate School of Environmental Science, Hokkaido University, Japan (Early Career Scientist)

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4.105	Temporal variation of HCl related to the change of the meridional circulation in the northern lower stratosphere	Isao MURATA, Graduate School of Environmental Studies, Tohoku University, Sendai, Miyagi, Japan
4.106	Iodine monoxide variations observed by shipborne MAX-DOAS over the tropical Pacific Ocean	Saki Kato, Fukuoka University, Faculty of Science, Fukuoka, Japan (Early Career Scientist)
4.107	The surface aerosol optical properties in urban areas of Nanjing, west Yangtze River Delta of China	Bingliang Zhuang, School of Atmospheric Sciences, Nanjing University
4.108	Transmission electronic microscopy observations of aerosol mixing state in Japan - its relevance to CCN activity and air quality	Joseph Ching, Meteorological Research Institute, Atmospheric Environment and Applied Meteorology Research Department, Tsukuba, Ibaraki, Japan
4.114	Processes driving the chemical variability over the Mediterranean basin: results from the GLAM campaign as compared to chemical-transport models and analysis	REGINA ZBINDEN, CNRM, Météo-France/CNRS UMR 3589, Toulouse, France
4.115	Impact of densely populated area of Krakow (Poland) on CFCs and SF6 concentration in the atmosphere	Jaroslav Bielewski, Institute of Nuclear Physics Polish Academy of Science, PL-31342 Krakow, Poland
4.116	Transport of aerosols and trace gases into the upper troposphere during the peak Asian monsoon period in summer 2017	Tatsuo ONISHI, Laboratoire Atmosphères, Milieux, Observations Spatiales (LATMOS/CNRS/UPMC/UVSQ), Paris, France
4.117	Comprehensive changes of aerosol compositions and reactive gases during south-westerly summer monsoon in a Southeast Asian urban site	MD FIROZ KHAN, Centre for Tropical Climate Change System, Institute of Climate Change, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia
4.118	Investigation on the factors controlling new particle formation by long term observation in Noto peninsula	ATSUSHI MATSUKI, Institute of Nature and Environmental Technology, Kanazawa University, Kanazawa, Ishikawa, Japan
4.119	Using chemical and idealised tracers to investigate interannual variability and trends in Asian monsoon transport	James Keeble, University of Cambridge, Department of Chemistry, Cambridge, UK (Early Career Scientist)
4.120	Inaccuracies in meteorology within a regional air quality forecast	Kaja Milczewska, University of Reading, Department of Meteorology, Reading, RG6 6BB, United Kingdom (Early Career Scientist)
4.121	Effect of Diwali festival and stubble burning activities on the formation of Secondary Organic Carbon (SOC) in Delhi, India	SHIVANI SHIVANI, Indira Gandhi Delhi Technical University for Women, New Delhi-110006, India (Early Career Scientist)
4.124	Light absorption of PM2.5 in a coastal city Xiamen in Southeast China: temporal variations and implications for brown carbon	Yuqing Qiu, Center for Excellence in Regional Atmospheric Environment, Institute of Urban Environment, Chinese Academy of Sciences, Xiamen, China (Early Career Scientist)
4.125	Spatiotemporal distribution of anthropogenic aerosols in China around 2030	Shu Li, School of Atmospheric Sciences, CMA-NJU Joint Laboratory for Climate Prediction Studies, Jiangsu Collaborative Innovation Center for Climate Change, Nanjing University, Nanjing, China

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4.126	Annual variation of new particle formation at the summit of Mt. Fuji	Hiroki Igarashi, Tokyo University of Science, JAPAN
4.127	Analysis of aerosol transport route in East Asia	Takashi Maki, Atmospheric Environment and Applied Meteorology Research Department, Meteorological research Institute, Tsukuba, Ibaraki, Japan
4.129	The Aerosols, Radiation and Clouds in southern Africa (AEROCLO-sA) project: overview, research highlights and way forward	Paola Formenti, LISA, CNRS/UPEC/UPD/IPSL, France
4.130	Development of the MRI-ESM2 and evaluations of spatial distributions and radiative effects of black carbon	Naga Oshima, Meteorological Research Institute, Japan Meteorological Agency, Tsukuba, Japan
4.131	Short-term direct radiative effects of near-source biomass burning aerosols in northern peninsular Southeast Asia	Shantanu Kumar Pani, Department of Atmospheric Sciences, National Central University, Taoyuan 32001, Taiwan
4.132	The seesaw modulation of haze pollution in North China from the combined effect of El Nino and Arctic Oscillation	Ge Zhang, Key Laboratory of Marine Environmental Science and Ecology, Ministry of Education, Ocean University of China, Qingdao 266100, China (Early Career Scientist)
4.133	Atmospheric processes influence the light-absorption properties of brown carbon in haze particles from Indonesian peat and biomass burning	Sri Hapsari Budisulistiorini, Nanyang Technological University, Earth Observatory of Singapore, Singapore 639798, Singapore (Early Career Scientist)
4.135	Atmospheric Chemistry and Climate Trends in the North Atlantic Over The Period 1970-2017.	Alexander Archibald, University of Cambridge & NCAS-Climate
4.136	Long-term trends in oxidant budgets of the northern hemisphere constrained by alkanes and alkyl nitrate ratios	Marcus Oliver Köhler, Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia, Norwich, United Kingdom
4.139	Radiative impacts of wildfire smoke in the Arctic: perspectives from the Copernicus Atmosphere Monitoring Service	Mark Parrington, European Centre for Medium-Range Weather Forecasts, Reading, UK
4.140	Impacts of tropical land-use change on the atmosphere and the climate	Jamie Wilson, Institute of Climate and Atmospheric Science, University of Leeds (Early Career Scientist)
4.141	Benchmarking 9.6- μm ozone band top-of-atmosphere flux in chemistry-climate models using AURA TES instantaneous radiative kernel	Le Kuai, UCLA, Joint Institute for Regional Earth System Science and Engineering (JIFRESSE), USA
4.142	Air-sea exchange of acetone and acetaldehyde and the impacts on their global atmospheric budget	Siyuan Wang, National Center for Atmospheric Research (NCAR), Boulder, CO, USA (Early Career Scientist)
4.143	Important contributions of sea-salt aerosols to atmospheric bromine cycle in the Antarctic coasts	Keiichiro Hara, Fukuoka Univ.

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4.144	Aerosol Particle Size Distributions and Compositions over the Southern Ocean in the Austral Summer of 2017	Takuma Miyakawa, Research and Development Center for Global Change, Japan Agency for Marine-Earth Science and Technology, Kanagawa, Japan
4.145	The sensitivity analysis of airflow from local emission source using WRF and WRF-chem	Fumie Kataoka, Remote Sensing Technology Center of Japan, Tsukuba-city, Ibaraki, JAPAN (Early Career Scientist)
4.146	Evaluation of wet deposition process of black carbon in WRF/Chem model during MIRAI Arctic research cruise over high-latitude regions in 2016	Masayuki Takigawa, Japan Agency For Marine-Earth Science and Technology, Institute of Arctic Climate and Environment Change Research, Yokohama, Japan
4.149	Observed characteristics of precipitation timing during the hazes : Implication to aerosol-precipitation interactions	Hyewon Hwang, Department of Atmospheric Environmental Sciences, Gangneung-Wonju National University, Gangneung, Gangwon-do, Republic of Korea (Early Career Scientist)
4.150	Characterization of individual ice nucleating particles by the single droplet freezing method	Ayumi Iwata, Department of Applied Chemistry, Faculty of Science and Technology, Keio University (Early Career Scientist)
4.151	Characteristics of precipitation response to the severe hazes in Korea peninsula	SungMin Park, Department of Atmospheric Environmental Sciences, Gangneung-Wonju National University, Gangneung, Gangwon-do, Republic of Korea (Early Career Scientist)
4.152	Variabilities in CCN concentration and CCN activity related to SO ₂ emission reduction and new particle formation in Qingdao	Xin Wang, Key Lab of Marine Environmental Science and Ecology, Ministry of Education, Ocean University of China, Qingdao 266100, China (Early Career Scientist)
4.153	Analysis of Artificial Seeding Effects on Snow Using Snowflake Camera In the Mountainous Region of Korea	SuHyouon Kim, Atmospheric Environmental Sciences of Department, Gangneung-Wonju National University, Gangneung, Gangwon-do, Republic of Korea (Early Career Scientist)
4.155	Collective climatology and temporal analysis of air quality from measurement, observation and simulation over the Greater Bangkok area, Thailand	Vichawan Sakulsupich, National Astronomical Research Institute of Thailand (Public Organization) 260, Moo 4, Donkaew, Maerim, Chiangmai THAILAND 50180 (Early Career Scientist)
4.156	Boundary layer height determination from lidar for improving air pollution episode modeling: development of new algorithm and evaluation	Yang Yang , Institute of Atmospheric Physics, Chinese Academy of Science
4.157	A model study of atmospheric OCS; current understanding and geoengineering implications	Sebastian Danielache, Sophia University, Department of Materials and Life Science, Sophia University, Tokyo, Japan
4.159	Long-term variations of HCN in the lower stratosphere measured with ground-based FTIRs over Hokkaido, Japan	Tomoo Nagahama, Institute for Space-Earth Environmental Research, Nagoya University, Nagoya 464-8601, Japan

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4.161	Development of global high-resolution climate model and its application to the chemistry-climate study	Yashiro Hisashi, RIKEN Center for Computational Science (R-CCS), Kobe, Japan
4.162	Production of high potential temperature airmass just below the tropopause associated with the Asian monsoon	TORU TERA0, Faculty of Education, Kagawa University, Takamatsu, Kagawa, Japan
4.165	High Time Resolution Source Apportionment of PM2.5 in Beijing with Multiple Models	Yue Liu, College of Environmental Sciences and Engineering, Peking University, Beijing, China (Early Career Scientist)
4.169	Long-term climatology of aerosol optical properties measured at a South African site	Marcell Venter, Unit for Environmental Sciences and Management, North-West University, Potchefstroom, South Africa (Early Career Scientist)
4.170	Developing PM Source Profiles of Diesel Vehicles and Its Application on Source Apportionment of PM2.5 in China	Min Cui, College of Environmental Sciences and Engineering, Tongji University, Shanghai, China (Early Career Scientist)
4.172	The Southern European fire season 2017 as seen by the Copernicus Atmosphere Monitoring Service	Johannes W. Kaiser, Max Planck Institute for Chemistry, Atmospheric Chemistry Department, Mainz, Germany
4.173	Determining Polarity Distribution of Organic Matters by the 1-octanol-water Partitioning Method	Wen-Chien Lee, Department of Chemistry and Biological Chemistry, School of Physical and Mathematical Sciences, Earth Observatory of Singapore, Nanyang Technological University, Singapore (Early Career Scientist)
4.174	Quantitative analysis of the global dust emission using a data assimilation technique	Taichu TANAKA, Meteorological Research Institute, Japan Meteorological Agency, Atmospheric Environment and Applied Meteorology Research Department, Tsukuba, Ibaraki, Japan
4.175	The Impact of Carbon Mitigation Measures on Future Air Quality	Steven Turnock, Met Office Hadley Centre, Fitzroy Road, Exeter, Devon, UK (Early Career Scientist)
4.176	Direct ground-based observation of lightning-induced nitrogen oxides in the free troposphere	Ryuichi Wada, Teikyo University of Science
4.177	Black carbon concentrations and size distributions of surface snow at Antarctica from April to December in 2011	Kinase Takeshi, Meteorological Research Institute, Tsukuba, Japan (Early Career Scientist)
4.178	Size-resolved hygroscopicity of atmospheric aerosols in a mid-latitude forest in Japan	Yange Deng, Graduate School of Environmental Studies, Nagoya University, Nagoya, Japan. (Early Career Scientist)
4.187	Properties of Aerosol Particles Originated from Siberian Forest Fires over the Western North Pacific Ocean	Momoka Yoshizue, Tokyo University of Science, JAPAN (Early Career Scientist)
4.188	African biomass burning pollutes large parts of the south east Atlantic boundary layer - results from the CLouds and Aerosol Radiative Impacts and Forcing: Year 2017 (CLARIFY-2017)	Hugh Coe, University of Manchester, SEES, Manchester, UK

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4.194	Influence of seasonal mesoscale and microscale meteorological conditions in Svalbard on results of monitoring of long-range transported pollution	Alena Dekhtyareva, Department of Engineering and Safety, Faculty of Engineering and Technology (IIS-IVT), UiT The Arctic University of Norway, Tromsø, Norway (Early Career Scientist)
4.197	Lightning NO _x Production as Determined Using OMI NO ₂ Retrievals and WLLN Stroke data	Dale Allen, University of Maryland, Atmospheric and Oceanic Science, College Park, MD, USA
4.198	Improving Prediction of Aerosol and Ozone Formation from Wildfire Emissions in the Western U.S.	Megan Bela, CIRES University of Colorado Boulder and NOAA-ESRL Chemical Science Division, Boulder, CO, USA (Early Career Scientist)
4.201	Characteristics of Atmospheric Black Carbon Observed by R/V Mirai over the Bering Sea and Arctic Ocean	Fumikazu Taketani, JAMSTEC Institute of Arctic Climate and Environmental Research, Yokohama, Japan
4.202	Impacts on PM and O ₃ in urban areas of the Western U.S. due to wildfires	Daniel Jaffe, University of Washington, School of STEM, Bothell, WA
4.204	A study of 2016 Winter Fog Season in Islamabad, Pakistan	Farrukh Chishtie, SERVIR-Mekong, Asian Disaster Preparedness Center, Bangkok, Thailand
4.206	Temperature-dependent drivers of summer surface-level ozone: Insights from a chemical transport model within the Eastern United States	Gaige Hunter Kerr, Department of Earth & Planetary Sciences, The Johns Hopkins University, Baltimore, MD, USA (Early Career Scientist)
4.208	Probing the Asian Tropopause Aerosol Layer and North American Tropospheric Aerosol Layer during Summer Monsoons Using in situ Measurements	Shang Liu, University of Science and Technology of China, Department of Earth and Space Sciences, Hefei, Anhui, China
4.209	Recent changes and influences of the springtime circulations on the atmospheric chemistry in the lower free troposphere of coastal East Asia	Chang-Feng Ou-Yang, Department of Atmospheric Sciences, National Central University, Taoyuan 32001, Taiwan
4.210	Aerosol properties across the southern polar front in summer	Stephen Wilson, Centre for Atmospheric Chemistry, University of Wollongong, Wollongong, NSW 2522, Australia
4.211	Aerosol-cloud-radiation interaction along the western coast of southern Africa as simulated by a regional climate model	Nellie Elguindi, LA/CNRS, Toulouse, France
4.212	Indonesian fire history recorded in the upper tropospheric CO from the long-term CONTRAIL observation	Hidekazu Matsueda, Meteorological Research Institute, Tsukuba, Japan
4.217	Towards a global vectorial vehicular emissions inventory	Sergio Ibarra Espinosa, University of São Paulo (Early Career Scientist)
4.219	Role of Various Factors in the UV Photochemical Treatment of N-Nitrosamines Related to CO ₂ Capture	Aqeel Afzal, Department of Environmental Engineering, Kyungpook National University, Daegu 702-701, Republic of Korea (Early Career Scientist)
4.220	Regional model analysis of the source and transport pathways of black carbon aerosols over the Arctic Ocean on September 2016	Masahiro Yamaguchi, Japan Agency for Marine-Earth Science and Technology, Institute of Arctic Climate and Environment Research, Yokohama, Kanagawa, Japan

Abstract ID	Abstract Title	Presenting Author & Affiliation
4.224	Earth's Land Surface Temperature as a Tracer for Climate Change	Sarah Safieddine, LATMOS/IPSL, Sorbonne Université, Paris, France (Early Career Scientist)
4.226	An important mechanism of regional ozone transport over the Yangtze River Delta in East China	JUN HU, Collaborative Innovation Center on Forecast and Evaluation of Meteorological Disasters, Key Laboratory for Aerosol-Cloud-Precipitation of China Meteorological Administration, Nanjing University of Information Science & Technology, Nanjing 210044, China (Early Career Scientist)
4.227	The effect of El Nino Southern Oscillation on global CH4 concentrations.	Matthew Rowlinson, Institute for Atmospheric and Climate Science (ICAS), University of Leeds, Leeds, UK (Early Career Scientist)
4.228	Global distribution of lowermost tropospheric ozone pollution from multispectral synergism of IASI and GOME-2 satellite measurements	Juan Cuesta, LISA CNRS/UPEC/UPD, Créteil, France
4.230	A case study of spring haze in Beijing: characteristics, formation and regional transportation	Fengkui Duan, School of Environment, State Environmental Protection Key Laboratory of Sources and Control of Air Pollution Complex, Tsinghua University, Beijing 100084, China
4.232	Seasonal characterization of PM2.5 mass and its chemical composition associated with visibility reduction observed at IORS in the East China Sea	Jihyun Han, (1) Korea Environment Institute, Sejong-si, Korea, Republic of. (2) Earth & Environmental Sciences, Korea University, Seoul, Korea, Republic of. (Early Career Scientist)
4.233	The equilibrium response of climate and composition to lightning	Lee Murray, Dept. of Earth and Environmental Sciences, University of Rochester, Rochester, NY USA
4.237	The production of 20+ year height-resolved ozone data from GOME-class instruments for ESA-CCI and C3S	Barry Latter, STFC - RAL Space, Earth Observation, Didcot, Oxfordshire. UK
4.240	Cloud resolving simulations of the UTLS chemistry during the Asian Summer Monsoon	Brice Barret, Laboratoire d'Aérodologie, CNRS, Université de Toulouse, UPS, Toulouse, France
4.241	Sources of carbonyls and their contributions to photochemical O3 formation in the Pearl River Delta	Zhenhao Ling, School of Atmospheric Sciences, Sun Yat-sen University, Guangzhou, China (Early Career Scientist)
4.242	Upper tropospheric water vapour and its interaction with cirrus clouds - Insights from two decades of IAGOS in-situ observations	Andreas Petzold, Forschungszentrum Jülich, IEK-8 Troposphere, Jülich, Germany
4.243	Understanding Differences in Satellite Records of Tropospheric Ozone Over the Past Decade	Jessica Neu, NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, United States
4.244	Should we control aircraft NOx emissions?	Agnieszka Skowron, Faculty of Science and Engineering, Manchester Metropolitan University, Manchester, UK (Early Career Scientist)

Abstract ID	Abstract Title	Presenting Author & Affiliation
4.245	Urbanization of weather and climate simulations coupled with chemistry-transport modelling - Project URBI PRAGENSI	Tomas Halenka, Charles University, Dept. of Atmospheric Physics, Prague, Czech Republic
4.247	Upper stratospheric O3 recovery as observed by IASI over 10 years of measurements	Catherine Wespes, Spectroscopie de l'Atmosphère, Service de Chimie Quantique et Photophysique, Université Libre de Bruxelles, Bruxelles, Belgium
4.250	Source apportionment of the marine aerosol over Atlantic Ocean by combining particle chemical composition and number concentration	Shan Huang, Institute for Environmental and Climate Research, Jinan University, Guangzhou, Guangdong, China (Early Career Scientist)
4.251	Exploring the Atmospheric Composition in the Changing Climate Scenario of Pakistan	Muhammad Fahim Khokhar, Institute of Environmental Sciences and Engineering-NUST Pakistan
4.252	Measurement of the Electrostatic Charging State of Ambient Aerosol using a Parallel Electrode Plate Device	Ryoya Tabata, Faculty of Science and Technology, Keio University (Early Career Scientist)
4.253	Black carbon in snowpack over the different regions in the Arctic	Tatsuhiko Mori, Tokyo University of Science, Department of Physics, Faculty of Science Division I, 1-3 Kagurazaka, Shinjuku-ku, Tokyo (Early Career Scientist)
4.254	Dust storms in the Middle East: An observational and modeling study of two events using in-situ and remotely sensed measurements and WRF-Chem-RTFDDA	Yongxin Zhang, NCAR/RAL, Boulder, CO, USA
4.256	Large impacts, past and future, of ozone depleting substances on Brewer-Dobson circulation trends: A multi-model assessment	Lei Wang, Fudan University, Department of Atmospheric and Oceanic Sciences & Institute of Atmospheric Sciences, Shanghai, China

Session 5: Challenging the Future

5.001	What we have observed with GOSAT and which kind of instruments we will need for future satellite observations	AKIHIKO KUZE, Japan Aerospace Exploration Agency 2-1-1 Sengen, Tsukuba-city, Ibaraki, 305-8505, Japan
5.002	Automatic processing of essential climate variables (ECVs) recorded at different atmospheric observatories in the framework of the NextDATA project	Davide Putero, CNR-ISAC, 40129 Bologna, Italy (Early Career Scientist)
5.003	Assessing risk to human health for heavy metal contamination through street dust in the Southeast Asian Megacity: Dhaka, Bangladesh	Akash Talukder, Department of Chemistry, University of Dhaka, Dhaka-1000, Bangladesh (Early Career Scientist)
5.008	Seasonal variation and nighttime formation of particulate organic nitrates in South China urban atmosphere	Qiao Zhu, Key Laboratory for Urban Habitat Environmental Science and Technology, School of Environment and Energy, Peking University Shenzhen Graduate School, Shenzhen, 518055, China. (Early Career Scientist)

Abstract ID	Abstract Title	Presenting Author & Affiliation
5.015	First steps developing a tool to monitor city-wide air quality using Earth observations	KARN VOHRA, School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham, UK (Early Career Scientist)
5.016	Advanced services for the IAGOS users	Damien Boulanger, Observatoire Midi-Pyrénées, CNRS, AERIS, Toulouse, France
5.017	Development of National Land Use Regression Model and Estimation of PM2.5-related Premature Deaths in China	Jin Li, School of Environment, Tsinghua University, Beijing 100084, China. (Early Career Scientist)
5.018	Trends in air quality over the eastern US and China: Policy relevant science	Russell R. Dickerson, The University of Maryland
5.019	Improving constraints on the oxidative capacity of the atmosphere	Stijn Naus, Meteorology and Air quality, Wageningen University & Research, Wageningen, The Netherlands (Early Career Scientist)
5.020	Towards an ECMWF's CAMS near real-time global surface flux inversions.	Jerome Barre, ECMWF, Copernicus Atmospheric Monitoring Service
5.021	Evaluation of Selected Ion Flow Tube Mass Spectrometry for VOC concentration and emission determination in Beijing - Automation and Calibration considerations.	Marvin Shaw, Wolfson Atmospheric Chemistry Laboratories, University of York
5.024	Size-resolved source apportionment of particulate matter in the South China Sea/West Philippine Sea during the 2011 Vasco Cruise	Miguel Ricardo HILARIO, Department of Physics, Ateneo de Manila University, Quezon City, Philippines (Early Career Scientist)
5.026	Evaluation of surface emissions using the ECCAD database	Sabine DARRAS, CNRS / Observatoire Midi-Pyrénées, UMS831 / Sedoo, Toulouse, France
5.027	Ensemble dispersion simulation of tropospheric aerosol plumes using a perturbed meteorological reanalysis	Tsuyoshi Thomas SEKIYAMA, Meteorological Research Institute, Japan Meteorological Agency, Tsukuba, Japan
5.028	Shipping emissions in international trade between China and America	Zhihang Meng, State Key Joint Laboratory of ESPC, School of Environment, Tsinghua University, Beijing 100084, China (Early Career Scientist)
5.030	The importance of different global change processes for future air quality	Suzanne VAN ZUIJLEN, Lancaster Environment Center, Lancaster, United Kingdom (Early Career Scientist)
5.031	Modelling air pollution in the Pearl River Delta Region of China	Zhenze Liu, School of Geosciences, The University of Edinburgh, Edinburgh, UK (Early Career Scientist)
5.032	Comparing the stratosphere in Specified Dynamics (nudged) and free-running simulations from the Chemistry Climate Model Initiative model intercomparison	David Plummer, Environment and Climate Change Canada, Climate Research Branch, Montreal, Quebec, Canada
5.034	Spatio-temporal variations of 17O excess of sulfate over Antarctica: reconciling observations and modeling	Sakiko ISHINO, School of Materials and Chemical Technology, Tokyo Institute of Technology, Japan (Early Career Scientist)

Abstract ID	Abstract Title	Presenting Author & Affiliation
5.037	An advanced cross platform whole air sampling system to extend airborne Volatile Organic Compound (VOC) measurement capability	Stephen Joseph Andrews, Wolfson Atmospheric Chemistry Laboratories, Department of Chemistry, University of York, Heslington, York, YO10 5DD, U.K.
5.039	120,000 year record of sea ice in the North Atlantic inferred from ice core bromine and sodium	Niccolò Maffezzoli, Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen, Juliane Maries Vej 30, Copenhagen Ø 2100, Denmark (Early Career Scientist)
5.040	Deploying a low-cost, community-based air quality monitoring network in Hawai'i	Ben Crawford, MIT, Civil and Environmental Engineering, Cambridge, MA, USA
5.041	Space-based Constraints on the Terrestrial Variability of VOCs through Formaldehyde and Glyoxal	Sam Silva, Massachusetts Institute of Technology, Civil and Environmental Engineering, Cambridge, MA, USA (Early Career Scientist)
5.042	An updated global multi-constituent chemical reanalysis data set for 2005-2017 and its applications in atmospheric chemistry studies	Kazuyuki Miyazaki, Japan Agency for Marine-Earth Science and Technology
5.043	The GeoCarb Mission: A Tool in the Evolving Understanding of Methane and Carbon Monoxide Budgets	Robert Chatfield, NASA Ames Research Center, Atmospheric Science, Moffett Field, CA USA
5.044	Development of a statistical model for PM10 prediction	Hyun Soo Kim, Gwangju Institute of Science and Technology, School of Earth Sciences and Environmental Engineering, Gwangju, South Korea
5.045	Data assimilation for chemical transport model using an ensemble Kalman filter	Park Soon-Young, Gwangju Institute of Science and Technology, Gwangju, Republic of Korea
5.047	Validation of Brewer and Pandora measurements using OMI total	Jae Kim, Department of Atmospheric Science, Pusan National University, Busan, Korea
5.048	Using Wavelet Transform and Mobile Measurement of Air Pollutants to Evaluate Vehicle Emission Control Policies: a Case Study on the 2014 APEC summit in Beijing	Tong Zhu, Peking University, BIC-ESAT and SKL-ESPC, College of Environmental Sciences and Engineering, Beijing, China
5.050	Incorporating chemical interactions and co-emissions in top-down constraints on sources of NO _x , SO ₂ and CO	Zhen Qu, University of Colorado Boulder, Department of Mechanical Engineering, Boulder, CO, USA (Early Career Scientist)
5.051	Development and evaluation of a palm-sized optical PM2.5 sensor	Yoshifumi Watabe, Eco Solutions Company, Panasonic Corporation, Kadoma, Osaka, Japan
5.053	Development of accurate low-cost PM2.5 instruments and measurements in Asian countries	Yutaka Matsumi, Nagoya University, Japan
5.054	Assessment of calibration models for small sensor measurements of nitrogen dioxide and ozone using metal-oxide sensors	Sean Schmitz, Institute for Advanced Sustainability Studies e.v (IASS), Potsdam, Brandenburg, Germany (Early Career Scientist)

Abstract ID	Abstract Title	Presenting Author & Affiliation
5.057	Analysis of sulfate species and trace elements in aerosols collected at Noto Peninsula	CHIIRO MIYAMOTO, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, Tokyo, JAPAN (Early Career Scientist)
5.060	Combining modelling with satellite retrievals - reanalysis of global atmospheric composition by the Copernicus Atmosphere Monitoring Service at ECMWF	Johannes Flemming, ECMWF
5.061	ICOS atmospheric network Germany for long term monitoring of greenhouse gases	Dagmar Kubistin, German Meteorological Service (DWD), Hohenpeissenberg Meteorological Observatory, Hohenpeissenberg, Germany
5.063	Satellite observations of isoprene from the Cross-track Infrared Sounder	Dejian Fu, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, 91109, USA
5.064	Avoided and potential air pollution levels and health impacts: The 2003 European heat wave as an exemplar extreme event	Paul Young, Lancaster Environment Centre, Lancaster University, Lancaster, UK
5.065	Impacts of a New Multi-Satellite Constrained Aerosol Emissions Database: Missing Sources, Long-Range Transport, and In-Situ Chemical Processing	Jason Blake Cohen, School of Atmospheric Sciences, Sun Yat-Sen University, Guangzhou, China
5.066	Visualization Analysis on Uncertainties in the Global Greenhouse Gas Inventories	Richao Cong, National Institute for Environmental Studies, Center for Global Environmental Research, Tsukuba, Ibaraki, Japan (Early Career Scientist)
5.067	A 0.56°-resolution global data assimilation of multi-constituent satellite measurements for use in tropospheric chemistry studies	Takashi Sekiya, Japan Agency for Marine-Earth Science and Technology
5.068	Indoor Air Pollution exposure due to fuel burning in low income informal settlements in Umlazi Township, Durban, KwaZulu-Natal, South Africa	Sikhumbuzo Archibald Buthelezi, Department of Environmental Health: Mangosuthu University of Technology, Durban South Africa (Early Career Scientist)
5.071	Real time monitoring for NO ₂ /NO _x emission ratio from road vehicle	Yasuyuki ITANO, Osaka City Research Center of Environmental Science
5.072	Pan-Pacific observations of short-lived climate pollutants in marine surface air by voluntary cargoships	Hiroshi TANIMOTO, National Institute for Environmental Studies, Center for Global Environmental Research, Tsukuba, Japan
5.075	Ground-level ozone pollution in China: trends, influencing factors and abatement	MIN SHAO, Peking University, College of Environmental Sciences and Engineering, Beijing, China
5.079	An optimal specification of a micro-satellite for detection of NO ₂ hotspots with a km-order resolution	Tamaki Fujinawa, Environmental Chemistry and Engineering, Tokyo Institute of Technology, Tokyo, Japan (Early Career Scientist)
5.081	Designing an optimal observation network for monitoring carbon dioxide (CO ₂) emissions from megacity Osaka	Takayuki HAYASHIDA, Graduate School of Engineering, Osaka University, Suita, Osaka, Japan (Early Career Scientist)

Abstract ID	Abstract Title	Presenting Author & Affiliation
5.082	Techniques for the ensemble analysis of complex atmospheric mass spectrometric datasets	Jesse Kroll, MIT
5.083	Harnessing long-term meteorological satellite records for atmospheric composition and chemistry research	Vivienne Payne, Jet Propulsion Laboratory, California Institute of Technology
5.084	New perspectives for the air-sea interactions of bioactive trace metals: Applying X-ray spectroscopy and geochemical modeling to size-fractionated marine aerosols	Kohei Sakata, Center for Global Environmental Research, National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki 305-8506, Japan (Early Career Scientist)
5.085	Using chemistry observations to constrain sea-breeze transport	Robyn Schofield, School of Earth Sciences, University of Melbourne, Melbourne, Victoria, Australia
5.086	Global CO emissions inferred from assimilation of MOPITT, together with observations of O ₃ , NO ₂ , HNO ₃ , and HCHO.	Xuesong Zhang, Department of Physics, University of Toronto, Toronto, Ontario, Canada (Early Career Scientist)
5.087	Multi-Model Ensemble Forecasts of Air Quality in Eastern China	IDIR BOUARAR, Max Planck Institute for Meteorology (MPI-M), Environmental Modeling, Hamburg, Germany
5.088	Global Atmosphere Watch Training & Education Centre (GAWTEC) - Quality Assurance since 2001	Lena Careen Zoor, Environmental Research Station Schneefernerhaus, Zugspitze, Germany
5.089	Feasibility study of possible O ₂ abundances in the Martian atmosphere: line spectra simulations for Mars terahertz sensor missions	Takayoshi YAMADA, National Institute of Information and Communications Technology, Tokyo, Japan (Early Career Scientist)
5.090	Characterizing model errors in chemical transport modelling of methane: Using GOSAT XCH ₄ data with weak constraint four-dimensional variational data assimilation	Dylan Jones, University of Toronto, Department of Physics, Toronto, Ontario, Canada

K.001 Going Through a Phase: Particulate Water in Atmospheric Aerosol.

Presenting Author:

Margaret Tolbert, Dept. of Chemistry and CIRES, University of Colorado,
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Abstract:

The water content of atmospheric aerosols controls many properties including their ability to catalyze heterogeneous chemical reactions, their impact on climate and visibility, and their ability to form clouds. In the atmosphere, the water content of the particles depends on their composition as well as the relative humidity and temperature. As crystalline salt particles are exposed to increasing relative humidity, the deliquescence phase transition results in rapid formation of aqueous droplets at the deliquescence relative humidity (DRH). The DRH values of atmospheric salts are generally well predicted by theory. In contrast, decreasing relative humidity results in particle morphologies and water content that are difficult to predict theoretically, and must be measured in the laboratory. At sufficiently low relative humidity, the droplets may undergo efflorescence (at the ERH), resulting in recrystallization of the salt particles. Hysteresis in water uptake and loss is often observed and the DRH can be very much higher than the ERH. Thus atmospheric salt particles are often assumed to be aqueous throughout much of their atmospheric lifetime. Here we use a long working distance optical trap to measure the deliquescence and efflorescence phase transitions of individual levitated salt particles. In addition, we probe how efflorescence is influenced by collisions of the salt droplet with other particles and by immersion of solids within the droplet. We find that while both contact and immersion can promote efflorescence, contact-induced efflorescence is by far more effective. These laboratory experiments challenge our theoretical understanding of nucleation in microscopic salt particles. In addition, the experiments have implications for particle phase and water content of aerosols in the global atmosphere.

K.002 The science of atmospheric composition and chemistry: past, present and future.

Presenting Author:

Ian Galbally, Climate Research Centre, CSIRO Oceans and Atmosphere, Aspendale, Victoria, Australia & Centre for Atmospheric Chemistry, School of Chemistry, University of Wollongong, New South Wales, Australia,
ian.galbal@gmail.com

Abstract:

The science of atmospheric composition and chemistry is based on three essentials: fundamental knowledge, observations and modelling. The study of this has passed from mainstream physical research in the 18th century to an adjunct of meteorology in the 19th and early 20th century, and then to a recognised field of chemistry in the late 20th century. Today, in the 21st century, it is a core component of Earth systems science, the multidisciplinary study of the Earth in all its facets.

In the 18th century, eminent scientists investigated the composition of air identifying nitrogen, oxygen, carbon dioxide, hydrogen and other atmospheric gases. In the late 19th century William Ramsay identified Argon from the distillation of air.

The broader development of the science of atmospheric composition and chemistry included: the need for understanding of the nutrition of plants and the production of food by de Saussure, Liebig and others in the 19th century, the coupling of urban air pollution and health concerns by RA Smith in the 19th century and Haagen-Smit in the 20th century, the desire to probe the then inaccessible upper atmosphere by remote sensing and modelling by Dobson and Chapman in the early 20th century, and concerns about continental scale and global pollution including global warming and ozone layer depletion by Callendar, Keeling, Oden, Johnston, Crutzen, Rowland and Molina in the 20th century. This history will be reviewed and then a perspective on several questions relevant to the 20th and 21st Century will be presented:

How has the study of atmospheric composition and chemistry changed in the last 60 years?

What are the key features of atmospheric composition and chemistry science today?

How has the global distribution and gender balance of scientists in this area changed?

How will the future of atmospheric composition and chemistry science be realised?

K.003 Atmospheric Chemistry Research from Fundamentals to Policy Relevance - Recent Research Experience -.

Presenting Author:

Hajime Akimoto, National Institute for Environmental Studies, Center for Global Environmental Research, Tsukuba, Ibaraki, Japan, akimoto.hajime@nies.go.jp

Abstract:

The three-leg view on atmospheric chemistry research is widely accepted in the IGAC community (Melamed et al., 2015). I will propose an alternative slightly modified four-element view including "policy relevance" explicitly.

In my talk, I will cover the following three topics based on our recent research experience referring to the policy relevance in the above scheme.

1. Ozone prediction and control strategy based on chemical transport models

Tropospheric ozone chemistry mainly based on the homogeneous gas-phase chemical kinetics is thought to be matured in general. However, our recent studies in MICS-Asia III revealed that there exists substantial disagreement among the CTMs and between model simulation and observation, which may affect policy proposal.

2. Chemistry and physics of secondary organic aerosols

In contrast to O_3 , which has been investigated more than 40 years, atmospheric chemistry on tropospheric fine particles typified by $PM_{2.5}$ is still pre-matured, and the studies are going on most actively now. In order to obtain reliable source apportionment of $PM_{2.5}$, which is more policy relevant, studies to quantify atmospheric processes has to be established incorporating fundamental research.

3. Air quality-climate interaction and SLCP co-control strategy

In order to mitigate extreme events induced by global warming in next 30 years, co-control of SLCPs is the only way to achieve. Climate sensitivities of O_3 , CH_4 , BC and white aerosols per unit RF_{TOA} has to be evaluated more precisely in order to propose more solid co-control measures. Quantification of CCN activities of aerosols based on chemical structures has to be studied fundamentally also.

Melamed, M. L. et al., *Anthropocene*, 12,17-28, 2015.

1.044 Emissions, Air pollution, Health and Society in Africa.

Presenting Author:

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Mai-Lan Tran, RMCX, Université Paris Diderot, Paris, France

Veronique Yoboue, Université Félix Houphoët-Boigny, LAPA, VPV34, Abidjan 01, Côte D'Ivoire

Abstract:

Urbanisation is a strongly emerging issue in West Africa, for a number of factors: explosive population growth in sub-Saharan countries, urban concentrations of activities, lack of regulations... This has resulted in the rapid development of "urban ecosystems". In this context, the main West African emission sources are anthropogenic, such as domestic fires, unregulated traffic, savannah fires ... This results in an inordinate surge in particle and gas emissions within cities with unexpected high pollution levels extremely harmful to health with various clinical manifestations. Such questions have received very little attention in Africa unlike Europe, North America and Asia and were recently investigated in southern west Africa in the EU-funded project DACCWA. The main final objective is to produce spatial and temporal distribution maps of health impact due to particles and gases using numerical modeling, updated and revised combustion emission inventories and scenarios and dose-response functions measured during the project. For that purpose, four urban sites were selected in Abidjan (Cote d'Ivoire) and Cotonou (Benin) focusing on main specific regional combustion sources (domestic fires, traffic and waste burning). Long-term measurements occurred from January 2015 to March 2017 to determine dose response functions in terms of respiratory diseases and mortalities by linking gas and particulate mass measurements and census in hospitals. Intensive measurements took place during the dry and wet seasons 2016 and 2017 to characterize toxicological effects of size-speciated aerosol chemical composition and dose response functions in terms of lung inflammations. Note that in addition to DACCWA program and in the frame of SAREHA project, vulnerability due to air pollution of people working or living close to our sites has been evaluated through risk culture intensity index measurements.

Highlights on the acquired results on emissions, air quality, people health and vulnerability will be presented.

1.066 Atmospheric Chemistry: A quiet revolution helping people mitigate risks of air pollution .

Presenting Author:

Rajesh Kumar, National Center for Atmospheric Research, Boulder, CO, USA,
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Abstract:

Atmospheric chemistry emerged out of the societal need to mitigate health effects of deadly smog events that occurred in North America and Europe around the middle of 20th century. In less than 70 years, atmospheric chemistry has advanced so much that we are now capable of predicting air quality in short-term (1-3 days) and long-term (climate time scales), and assessing the implications of air pollution for public health and food security. This presentation will begin with a brief discussion of the evolution of atmospheric chemistry research. This will be followed by a discussion of the information provided by short- and long-term air quality predictions and how that information can help the public mitigate their risk to acute air pollution episodes and evaluate the response of air quality to projected socioeconomic development pathways. Finally, I will talk about the progress of a recent project called the Monitoring, Analysis and Prediction of Air Quality (MAP-AQ) that focuses on developing air quality prediction capabilities in the developing world where the frequency of acute air pollution events has been increasing dramatically.

2.126 Linking theoretical kinetic studies with laboratory and chamber experiments.

Presenting Author:

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Abstract:

Though much of our understanding of the chemistry of the atmosphere is derived from experimental studies, the elementary reactions that govern atmospheric chemistry are not always readily studied by experimental methodologies. Theoretical studies, combining quantum chemical characterization of the reaction properties with theoretical kinetic prediction of temperature- and pressure-dependent rate coefficients and product distributions, offer a highly complementary approach to experimental studies, able to investigate some intermediates and reaction conditions that are hard to access practically. A number of theoretical kinetic studies are presented where theoretical predictions contributed to the interpretation of experimental observations and/or the development of the kinetic model. The reaction systems touched upon includes H-migration in alkyl peroxy radicals, the catalytic conversion of fluoridated products, and the reactions of Criegee intermediates.

The reactivity trends discovered for a given reaction class from theoretical calculations, laboratory studies, environmental chamber studies, field data, and modeling, should ultimately be combined and summarized in Structure-Activity relationships (SARs). These allow kinetic model development for novel, complexly substituted compounds and intermediates without the need for direct studies of each reaction step. While SARs are available for many reaction classes, their field of applicability and their reliability is often not fully understood; e.g. existing SARs often struggle with multi-functionalized compounds. A brief overview of current SAR development, and the role of theoretical calculations therein, will be presented.

2.145 First steps to uncovering molecular level interactions of organic aerosol and cloud droplets from direct observation using synchrotron radiation..

Presenting Author:

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Abstract:

Advances in aerosol measurement techniques and model formulation have highlighted key features still lacking in our fundamental understanding and process description of especially the organic aerosol fraction. Discrepancies between experimental setups and between models and experimental results are evident in studies of new particle formation, aerosol growth and cloud activation, and atmospheric scale cloud effects. As a result, uncertainties in aerosol climate effects remain almost unchanged for decades. We explore the potential for emerging experimental methods using high-brilliance synchrotron radiation (SR) to shed light on molecular-level interactions between organic aerosol and atmospheric water. Using highly surface sensitive and chemically specific X-ray photoelectron spectroscopy (XPS) in combination with SR, we directly observe shifted protonation equilibria of organics with carboxylic acid functionalities in the aqueous surface. We also found isomer effects in the surface behavior of aqueous alcohols and used directly observed concentration-dependent surface compositions to evaluate a novel statistical mechanics based model for surface active organics. Using XPS on free-frying salt clusters with varying water content, we observed structural properties and solvation of sub-2 nm particles, including relative depth profiles and concentration dependence of ion solvation and cluster-size dependent phase transition of the salt crystal lattice structure.

Current efforts focus on enhancing the immediate atmospheric relevance of experimental design, including moving towards ambient pressures and single particle in-situ studies. The emergence of fourth generation SR facilities like MAX IV Laboratory in Sweden brings great promise in this respect. We are part of the consortium commissioning the Finnish-Estonian Beamline for Atmospheric and Materials Science (FinEstBeAMS). With a wide photon energy range, high brilliance and resolving power, and three complementary end-stations, the beamline enables studies of a wide range of systems, conditions and properties. We are furthermore developing mobile instrumentation to specifically enable atmospherically directed research at several beamlines at MAX IV.

3.038 Biogenic modelling activities in eucalypt-rich southeast Australia.

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Abstract:

With over 800 species of eucalypt trees, the south east coast of Australia is a global hotspot for isoprene emissions. Eucalypts are amongst the world's largest flowering plants. The first in-depth study of how the Model of Emissions of Gases and Aerosols from Nature (MEGANv2.1) performed in Australia, showed large discrepancies when compared with measurements in the Sydney region. The discrepancies were due to the use of incorrect emission factors, some of which were derived from measurements of emission factors from Northern Hemisphere sapling specimens in laboratory experiments. These discrepancies highlight the need for new measurements on in-situ eucalypt forests around the world.

Whilst trying to reduce the modelled uncertainties, our work began to uncover a series of unique behaviours not seen in other regions of the world. The isoprene to monoterpene carbon ratio is approximately one and suggests that neither isoprene nor the monoterpenes dominate. This is unusual, and could impact the rate of formation of biogenic secondary organic aerosol and its composition.

We also discovered that the values chosen for the light dependence of monoterpene

species in MEGANv2.1 may not be appropriate for Australian eucalypts. Switching off the light dependence entirely has improved the agreement between the predictions and the observations, particularly at night.

We are also quantifying the suppression of isoprene emissions by Australian drought conditions, by coupling soil moisture from the land-surface model CABLE.

There are still numerous unanswered questions. However, we are working towards constructing a more accurate emission inventory of biogenic hydrocarbons for Australia, and ultimately their incorporation into global atmospheric models.

3.104 Contributions of commercial aircraft for researching atmospheric greenhouse gases.

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Abstract:

Aircraft is one of the most promising platforms to investigate atmospheric chemical constituents (or physical parameters) in the upper air. Chartered aircraft plays an important role for atmospheric measurements especially for specific area and time according to research interests. In spite of the inflexibility in flight scheduling, observations based on commercial aircraft have great advantages such as 1) high frequency to find seasonal or more short-term variations, 2) wide coverage to elucidate inter-hemispheric or inter-continental differences in the upper troposphere, and 3) long continuity to detect decadal changes in the atmosphere. In addition to the above advantages, a lot of vertical profiles provide strong constraints for estimating global cycles of atmospheric trace gases .

The project named CONTRAIL (Comprehensive Observation Network for Trace gases by Airliner) is one of the noble project started in 2005, which have been observing atmospheric greenhouse gases by using the airliners operated by Japan Airlines (JAL). The Continuous CO₂ Measuring Equipment (CME) has been producing plenty of CO₂ data in the troposphere and those data have been used to estimate CO₂ fluxes at the earth surface, to understand atmospheric transport processes by utilizing CO₂ as an atmospheric tracer and to validate remote observation products such as ground-based FTS and satellite. The Automatic air Sampling Equipment (ASE) provides us data not only for CO₂ mole fractions but also CH₄, CO₂, N₂O, SF₆, CO and H₂ mole fractions and isotope ratios of CO₂ and CH₄ on the routes between Japan and Australia, Europe, Hawaii, Guam and Bangkok.

A number of studies have used the CONTRAIL data, but we believe the CONTRAIL data have more possibilities to contribute atmospheric sciences. We welcome researchers not only from the carbon-cycle community but also from other atmospheric chemistry research to use CONTRAIL data.

CONTRAI-CME data are available at <https://doi.org/10.17595/20180208.001>.

4.062 How do short-lived climate forcers affect climate?.

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Abstract:

Between now and the middle of the century the largest changes in forcing agents are likely to be in chemically reactive short-lived species such as ozone and aerosols, as emissions of these are expected to reduce dramatically due to air quality legislation. The relative importance of short-lived species is further increased if CO₂ emissions are reduced under Paris negotiations. Mitigation of some short-lived climate forcers is also needed to meet the Paris goals. However (unlike CO₂) the short-lived species are not uniformly distributed but are concentrated near the regions of highest emissions such as the northern mid-latitudes. The temperature effects of these uneven agents will also be uneven, with larger effects locally, but also remote implications.

I will explore the progress being made to quantify the overall effects of short-lived climate forcers through understanding how their forcing patterns induce rapid adjustments in meteorology either amplifying or dampening the forcing; and how these forcing patterns lead to temperature changes that may have a different climate sensitivity than that for CO₂.

The impacts of short-lived climate forcers on precipitation patterns are even more complex than the impacts on temperature. The latest research shows that on a global scale the precipitation effects, for instance from changes in tropospheric or stratospheric ozone, can be understood from the global atmospheric energy balance.

The science behind the effects of short-lived climate pollutants is relatively new and is advancing rapidly. Research to understand these, and to identify whether there are robust relationships that can be quantified, is at the cutting-edge of climate science. The experiments in the AerChemMIP project as part of CMIP6 will provide valuable data from a large number of chemistry-climate models to allow us find the answers to some of these important questions.

5.011 Moving the full complexity of the ocean-atmosphere system into the laboratory for fundamental chemistry studies.

Presenting Author:

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Abstract:

The oceans cover nearly three-quarters of our planet, yet our understanding of their impact on Earth's climate remains poor. The ocean represents a significant source of sea spray particles that play a vital role in the climate system as they serve as the essential seeds upon which water condenses and ice forms to create clouds. Understanding the ocean-atmosphere-system is critical for understanding the influence of this large, natural source on our climate. This presentation will describe the unique approach developed by scientists in the Center for Aerosol Impacts on Chemistry of the Environment (CAICE) to study the real-world complexity of the ocean-atmosphere-cloud system in a laboratory setting. To control the chemical complexity of the system, phytoplankton blooms are generated, inducing a myriad of biological processes and interactions between phytoplankton, viruses, and microbes in seawater. When waves break, bubbles rupture at the surface of the ocean, launching microbes and other biological species--as well as particles comprised of salts and organic species--into the atmosphere. The primary objective of CAICE is to use this "ocean in the lab" approach to control and better understand how chemical complexity, morphology, and interfacial composition control the climate properties and reactivity of atmospheric aerosols. In this presentation, I will highlight how a combination of lab and field studies is being used to better understand the influence of the chemical complexity on the cloud forming ability of aerosols. Results from experimental measurements will be presented along with new theoretical methodologies for molecular-level and coarse-grained simulations to explore the complex, heterogeneous and dynamic aspects of aerosol particles. Findings will be presented from detailed interdisciplinary studies and how they are advancing our understanding of the impact of aerosols on clouds and climate.

5.029 Observing Air Quality from Geostationary Constellation.

Presenting Author:

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Abstract:

Satellite remote sensing has played a significant role in providing a global picture of air quality, filling the gaps of ground-based networks. Monitoring of air quality is very important in understanding the globalization of air pollution, climate change, and assessing the public health impacts of air pollution. With the recent developments of spectrometers in UV-visible wavelengths with sub-nm spectral resolution and of retrieval algorithms, we now can generate estimates of the column amounts of atmospheric O₃, NO₂, SO₂, HCHO, CHOCHO and other constituents in the troposphere. To date, all the UV-visible satellite missions to monitor trace gas concentrations in the atmosphere have been in low Earth orbits (LEOs), usually allowing one observation per day. With the advent of new UV-visible instruments on geostationary Earth orbit (GEO) platforms, the diurnal variation of these components can be captured. By the early 2020s, the geostationary belt is expected to be occupied by three UV-visible spectrometers: The NASA Tropospheric Emissions: Monitoring of Pollution (TEMPO) over North America, the Copernicus Sentinel-4 ultraviolet visible near infrared spectrometer (developed by ESA) over Europe, and the KARI Geostationary Environment Monitoring Spectrometer (GEMS) over Asia, with the Tropospheric Monitoring Instrument (TROPOMI) and Ozone Mapping Profiler Suite (OMPS) flying underneath in LEO. Recognized by the Committee on Earth Observation Satellites (CEOS) Atmospheric Composition Virtual Constellation (AC-VC), the geostationary constellation of UV-visible spectrometers will enlighten us on the global distribution of ozone, aerosol, and their precursors. To integrate the dataset for global measurements, consistent data quality is very important, thus inter-calibration among the three different UV-visible satellite instruments and the standardization and harmonization of data products and data quality are now under discussion. Together with geostationary meteorological satellite programs, these three missions will contribute to monitoring global air quality, long range transport, and top-down emission sources.

5.062 Atmospheric Chemistry: Future Directions.

Presenting Author:

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Abstract:

Among the key issues with important societal impacts that have been addressed by the atmospheric community in the past decades are questions related to stratospheric ozone, acid deposition, global tropospheric chemistry, biogeochemical cycles. The US National Academy of Sciences has identified several priority areas for the next few years. One of them is to advance the fundamental atmospheric chemistry knowledge that enables predictive capability for the distribution, reactions and lifetime of gases and particles. The Academy calls for better quantitative estimates of emissions and deposition of chemical species in a changing earth system, and for the integration of atmospheric chemistry within weather and climate models. With the more advanced supercomputing facilities, satellites (including geostationary instruments) and small observing devices that can be deployed everywhere, it becomes possible to observe and simulate the global atmosphere at a spatial resolution of just a few kilometers or less. A new direction for our community is to measure, analyze and forecast air pollutants at the city block scale, and to better manage air quality in areas where human exposure is high. Inverse modeling should allow the attribution of pollutant sources which would help the development of mitigation measures.

1.031 A New Top-Down Approach to Quantifying the Spatial, Temporal, and Vertical Distribution of Urban and Biomass Burning Regions using Decadal Measurements from MOPITT and AERONET.

Early Career Scientist

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Abstract:

This work presents an upgraded result of our just introduced new methodology, based on an analysis of CO measurements from the MOPITT satellite over the past 17 years (from 2000-2016). The specifics presented here will cover the entire globe. We analyze the CO total column measurements, as well as the vertical mixing ratio profile (where the degree of freedom is sufficiently high). Since the goal is to characterize and then use this characterization to look into the emissions of CO at high frequency, we focus on those regions which are heavily influenced by large-scale biomass burning, intense urban pollution, or are rapidly urbanizing. The goal is to understand how the vertical, temporal and spatial distribution is changing over time, and the impacts of emissions, in-situ processing, and long-range transport, on the overall atmospheric loading.

Initial results indicate that biomass burning dominates the loadings in Southeast Asia, Africa, and South America, where the loadings are highly variable in time, with part of every year polluted, and another part of every year relatively clean. On the other hand, urban emission mainly dominate over East Asia, and parts of Europe and North America, where the loadings are almost always polluted. In addition to differences in space and time, there is a significant distributional difference in the vertical between these types of regions.

Given these differences, when we combine our a priori information with information from OMI, MISR, and AERONET, we also are able to differentiate local-sources from long-range transport. The results over Southeast Asia are described in detail with respect to long-range transport, from regions as far west as Bangladesh, and stretching as far east as the Western Pacific Ocean. Additional driving mechanisms are included for long-range transport in other regions of the world.

1.055 Establishing Connections between Aerosol Chemical Composition and Possible Health Effects.

Presenting Author:

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Abstract:

Exposure to ambient air pollution is the 4th highest-ranking risk factor for death globally. Most health effects measures and regulations use particulate mass (PM) as the indicator for the health effects due to exposure to ambient particles. However, atmospheric chemistry and chemical composition may play crucial roles in determining the biological and health-related effects due to exposure to PM from different sources. In addition, atmospheric aging and photochemistry change the chemical composition and may drive health effects. We will describe several direct examples where aerosol chemical composition can be linked to observed biological effects in in vivo and in vitro models. Specifically, we will show that seasonal variations in the chemical composition of aerosols from Beijing, poly-aromatic hydrocarbons (PAH and oxy-PAH) from coal and biomass burning during the winter months, lead to damage in the liver, a secondary organ of exposure. We will show that dissolved metals in resuspended urban dust drive oxidative stress and inflammation. Data from the new global SPARTAN network show that metals comprise an important component of the global aerosol composition. Finally, we will provide evidence that minor biological components found in desert dust, can induce mitochondrial dysfunction and cell death. These examples show that atmospheric chemistry and the specific chemical composition, and not only the mass, must be studied together with health effects in order to improve our understanding of how exposure to PM affects people's health.

1.093 Decadal changes of ozone-NO_x-VOC sensitivity over Japan estimated using satellite data and their impact on the effectiveness of surface ozone mitigation policies inferred from air quality simulations..

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Abstract:

It is crucial how surface ozone respond to emission reduction of its two main precursors, NO_x and VOC, for policymakers pursuing the effective ozone mitigation strategy. In the present study, I estimated decadal change of ozone-NO_x-VOC sensitivity over Japan utilizing HCHO/NO₂ column density ratio measured with Ozone Monitoring Instrument (OMI). Also, using the air quality model, ADMER-PRO, we estimated the effect on surface ozone concentration of some emission reduction scenarios, such as the NO_x reduction from diesel truck cars and the VOC reduction from evaporative point sources, which are considered as choices of the air pollution mitigation policies. The effect on surface ozone concentration of each emission reduction scenario was estimated using two kinds of emission inventory as the input to the base case simulation, one prepared for a decade ago situation (year of 2005) and the other simply adjusted for the current situation. The results from satellite data showed that surface ozone sensitivity has become more NO_x-sensitive over Japan during the last decade. Accordingly, the simulation results showed the scenarios with NO_x reduction are more effective for mitigating surface ozone when using the emission inventory adjusted for the current situation than using that for a decade ago situation. The above results suggest that the appropriate surface ozone mitigation policies should be selected on the basis of the current situation of ozone-NO_x-VOC sensitivity but not a decade ago situation, and also suggest that the emission data input to the base case simulation should be updated for the current situation in order to estimate correctly the effect of each emission reduction scenario. So, for the next challenge, we should develop the method of updating emission inventory for the current situation not just simply but also correctly, though preparing emission inventory is in general very time-consuming and with large uncertainty.

1.095 Forecast the shipping emissions and impacts in China.

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Abstract:

China established Domestic Emission Control Area (DECA) for sulphur since 2015 to constrain the increasing shipping emissions. However, future DECA policy-makings are not supported due to a lack of quantitative evaluations. To investigate the effects of current and possible Chinese DECAs policies, a model is presented for the forecast of shipping emissions and evaluation of potential costs and benefits of an DECA policy package set in 2020. It includes a port-level and regional-level projection accounting for shipping trade volume growth, share of ship types, and fuel consumption. The results show that without control measures, both SO₂ and particulate matter (PM) emissions are expected to increase by 15.3-61.2% in Jing-Jin-Ji, the Yangtze River Delta, and the Pearl River Delta from 2013 to 2020. However, most emissions can be reduced annually by the establishment of a DECA that depends on the size of the control area and the fuel sulphur content limit. Costs range from 0.667 to 1.561 billion dollars (control regional shipping emissions) based on current fuel price. A social cost method shows the regional control scenarios benefit-cost ratios vary from 4.3-5.1 with large uncertainty. Chemical transportation model combined with health model method is used to get the monetary health benefits and then compared with the results from social cost method. This study suggests that Chinese DECAs will reduce the projected emissions at a favorable benefit-cost ratio, and furthermore proposes policy combinations that provide high cost-effective benefits as a reference for future policy-making.

1.112 What level of air quality monitoring data is needed to support effective policy action to reduce pollution?.

Early Career Scientist

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Abstract:

Atmospheric pollution is a global problem which has taken on particular significance in Africa in recent years because of its growing impact on human health, climate and vegetation; this is likely to increase if steps are not taken to reduce emissions. Assessment of air pollution through measurement and modelling provides information on the degree of pollution, supports formulation of evidence-based policies for abatement and assessment of the effectiveness of these policies when implemented. In Africa, these country assessments are generally short term, sparse and infrequent, and therefore, provide little data on emission source, pollution levels or the extent of impacts on human health or ecosystems. In most African countries, the context relevant approach to mitigate emissions is absent in national environment planning and is generally not informed by robust analysis.

We present a framework for air pollution assessment relevant for African countries that integrates analyses at different scales to apply it in evaluating effectiveness of mitigation strategies. Firstly, at the macro-scale, national air quality monitoring for four countries- Botswana, Benin, Ethiopia and Kenya - are mapped and the institutional arrangements examined to assess the status of air pollution policy in national planning. At the meso-scale, urban air quality monitoring for Gaborone, Cotonou, Addis Ababa and Nairobi is mapped and major emission sources identified. Review of urban plans for these cities assesses the inclusion of these major emissions sources in historical and emerging air quality policies. At the micro-scale, emerging technologies for personal exposure to air pollution are assessed in the context of identifying local emission sources, trends and hotspots. Analysis from the distinct scales, illustrates the linkages from the local to the urban and national scale and the high temporal, spatial measurements provides new insights into the potential role and contribution that personal exposure monitoring can make towards mitigating air pollution.

1.124 Recent changes of trans-boundary air pollution over Northeast Asia: Implications for future air quality in South Korea.

Early Career Scientist

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Abstract:

The influence of Chinese pollution on air quality over South Korea is a major concern for the policymakers in South Korea. To investigate the inter-annual trends of the long-distance transport of air pollutants from China to South Korea, multi-year trend analysis was carried out for AOD (Aerosol Optical Depth, as a proxy of particulate matter) and gaseous CO (a water-insoluble air pollutant) and SO₂ (a partially water-soluble air pollutant) over the three regions in Northeast Asia. The Yellow Sea serves an ideal geographical situation where the inter-annual trends and the amounts of the trans-boundary air pollution from China to South Korea can be monitored. Decreasing trends of about 5-10%, 13-17% and 55-61% during the last decade were observed in surface CO, AOD and tropospheric SO₂ columns over North China Plain (NCP), Yellow Sea (YS) and South Korea (SK), respectively. Such decreasing trends were also found consistently during the last three, five, and seven years, indicating that the changes in the pollution levels are likely in response to recent policy measures taken by the Chinese and Korean governments to improve air quality over the regions. Due to these efforts, the amounts of air pollutants transported through the YS region from China to South Korea are expected to decrease in future years, at the likely rates of -5.1 % yr⁻¹, -16.9-21.8 % yr⁻¹, and -53.1-66.3 % yr⁻¹ for CO, AOD, and SO₂, respectively. Given the ambitious plans recently announced by the Chinese government for COP21 and its co-benefit effects, the suggested percentage rates may be even conservative numbers.

1.146 Surface ozone variability in continental South Africa.

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Abstract:

Although elevated surface ozone (O_3) concentrations are observed in many areas within southern Africa, few studies have investigated the regional atmospheric chemistry and dominant atmospheric processes driving surface O_3 formation in this region. Therefore an assessment of comprehensive continuous surface O_3 measurements performed at four sites in continental South Africa was conducted. The regional O_3 problem was evident with O_3 concentrations regularly being higher than 40 ppb, while O_3 levels were higher compared to other background sites in the Southern Hemisphere. The temporal O_3 patterns observed at the four sites resembled typical trends for O_3 in continental South Africa with O_3 concentration peaking in late winter and early spring. Increased O_3 concentrations in winter were indicative of increased emissions of O_3 precursors from household combustion and other low-level sources, while a spring maximum observed at all the sites was attributed to increased regional biomass burning. Source area maps of O_3 and CO indicated significantly higher O_3 and CO concentrations associated with air masses passing over a region with increased seasonal open biomass burning, which indicated CO associated with open biomass burning as a major source of O_3 in continental South Africa. The relationship between O_3 , NO_x and CO indicated a strong dependence of O_3 on CO, while O_3 levels remained relatively constant or decreased with increasing NO_x . The instantaneous production rate of O_3 calculated at Welgegend indicated that ~40% of O_3 production occurred in the VOC-limited regime. These relationships between O_3 and precursor species indicated that continental South Africa can be considered VOC-limited, which can be attributed to high anthropogenic emissions

of NO_x in the interior of South Africa. The study indicated that the most effective emission control strategy to reduce O_3 levels in continental South Africa should be CO reduction associated with household combustion and regional open biomass burning.

1.157 Trends of PM pollution and health effects in Europe during the 1990s and 2000s: multi-model and observational assessment.

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Abstract:

Particulate matter (PM) pollution in Europe has, during the last decades, shown a significant decrease, mainly due to emission reduction of its gaseous precursors as regulated by the Protocols under the Convention on Long-range Transboundary Air Pollution (LRTAP). In 2012 primary PM emissions were included in the revised Gothenburg Protocol. The Eurodelta-Trends multi-model experiment, coordinated by the Task Force on Monitoring and Modelling of EMEP (European Monitoring and Evaluation Programme), has a twofold objective: to assess the efficiency of emissions mitigation measures in improving air quality in Europe and to evaluate the ability of chemical transport models (CTMs) to reproduce observed pollution trends. Eight CTMs have performed harmonized simulations for the period 1990-2010. We focus on trend analyses of PM₁₀ and PM_{2.5} for the 2000-2010 period (for which EMEP measurements of PM are available), based on results from the EMEP MSC-W, CHIMERE, LOTOS-EUROS, MATCH, MINNI and Polair3D models and observed trends. In general, the models show a fair agreement and ability to reproduce measured trends; they identify significant PM trends at more sites though the mean modelled trends tend to be smaller than the observed trends, e.g. for PM₁₀ -2.0 vs -2.3 % yr⁻¹. Considerable differences are found in PM trends across Europe, and also in different seasons (largest in summer and smallest in winter). The models do not always agree about the relative contribution of individual components to PM trends. For the relatively short period of 2000-2010, the effect of inter-annual meteorological variability appears rather important compared to emission changes, resulting in non-significant trends in many European regions/sites. Finally, we present the trends in population exposure to PM_{2.5} and related health effects. According to our estimates, nearly 14000 premature deaths were avoided every year (or 20% reduction in health effects) between 2000 and 2010.

1.167 Towards improved quantification of Russian oil and gas extraction emissions based on analysis of YAK-AEROSIB aircraft data.

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Abstract:

The Arctic is undergoing unprecedented changes as a result of global warming due to long-lived greenhouse gases, notably carbon dioxide, and short-lived climate forcers (SLCFs) including black carbon (BC), ozone and methane. Whilst, pollutant climate effects in the Arctic are primarily due to long-range transport of aerosols, ozone and their precursors from mid-latitudes, it is now apparent that there are already important local anthropogenic emissions (e.g. resource extraction, shipping, domestic combustion) that can impact climate, ecosystems, local/regional air quality and human health. Local Arctic emissions are also likely to increase in the future as a result of global warming providing opportunities for increased industrial activity. However, large uncertainties exist about the magnitude and spatial/temporal variation of emissions of SLCFs and their precursors and their contribution to SLCF loadings and impacts. Here, we focus on improving understanding about BC emissions from oil and gas extraction activities in northern Russia. This source has already been identified as an important source of Arctic BC. We analyse the origins of polluted air masses sampled during French/CNRS-Norwegian/NILU-Russian YAK-AEROSIB flights over the Ob Valley, Yamal and Kara Sea regions during October 2014 using WRF-Chem BC tracer runs for emissions from different sectors (*Huang et al. (2015)* inventory). We also separate plumes originating from oil/gas flaring and venting using measured trace gas (e.g. CO₂, CH₄) and aerosol ratios together with examination of VIIRS (Visible Infrared Imaging Radiometer Suite) satellite data, providing information on daily variability of flaring hotspots, and high-resolution FLEXPART-WRF simulations. Results are used to make updated estimates of BC flaring emission ratios (relative to CO₂). We examine the sensitivity of modelled aerosol (BC) distributions to these results and to the use of daily varying flaring emissions, as opposed to annual

mean emissions, in full chemistry-aerosol WRF-Chem simulations over Russia and the eastern Arctic.

1.185 Air Quality in Puerto Rico in the Aftermath of Hurricane Maria.

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Abstract:

On September 20th, the category four Hurricane Maria made landfall on Puerto Rico, making it the most powerful hurricane to hit the island in almost 90 years. With catastrophic winds of 250 km h^{-1} , Maria devastated the island causing severe damages to homes, buildings, agriculture, and infrastructure. The electric grid was devastated leaving over 90% of the island without electricity. Six months after, there remained municipalities where up to 45% of residents did not have power. While the electric grid was repaired, backup generators started to be widely used as the main source of electricity and a waiver from ultra-low sulfur diesel (ULSD, <15 ppm-sulfur) requirements was granted to Puerto Ricans by the United States Environmental Protection Agency. The

hurricane also damaged the island's existing air monitoring network and our University of Puerto Rico's observing facilities. Therefore, we partnered with several institutions in order to monitor air quality in the aftermath of Maria. We deployed four, low-cost, Real-time Affordable Multi-Pollutant monitors (RAMPs) for SO₂, NO₂, CO, NO, O₃, and optical PM_{2.5}, a black carbon (BC) monitor, a microaethalometer, an optical particle counter, and a condensation particle counter (CPC) at different locations in the San Juan Metro Area. Results from the first month of sampling (November-December 2017) showed SO₂ concentrations often exceeding the EPA's daily maximum 1-h standard for SO₂. Very good correlations between SO₂, CO, and BC (CO and SO₂ $r^2 > 0.9$, CO and BC $r^2 \sim 0.8$) suggest a single source type, likely the widespread use of backup generators. The use of low-sulfur diesel (<500 ppm-S) is expected to increase particle number that should be observed with the CPC. At the conference, we will present results from about a year of collected data where we hope to be able to show how air quality improves as power is restored.

1.197 Detecting Human Emissions of Volatile Chemical Products in Urban Atmospheres.

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Abstract:

Recently it has been identified that everyday use of volatile chemical products (VCPs), including personal care products, cleaning agents, inks, coatings, adhesives, and pesticides account for around half of the petrochemical volatile organic compounds (VOCs) emitted in the Los Angeles basin. In addition to VOC measurements of Los Angeles in 2010, we show measurements made in 2015 and 2018 detecting VCP emissions in Boulder, Colorado and New York City. In the latter two cities, atmospheric measurements were made during wintertime when biogenic activity is low, and anthropogenic sources are expected to dominate urban VOC emissions. To detect VOCs in ambient air, we utilized a proton transfer reaction-time of flight-mass spectrometer (PTR-ToF-MS), and canister samples analyzed by gas chromatography-mass spectrometry (GC-MS). We demonstrate the utility of decamethylcyclopentasiloxane (D5-siloxane) as a chemical tracer of personal care product emissions, which is mainly found in antiperspirants and hair care products. In Boulder, ambient measurements suggest that the mass concentration of D5-siloxane is similar to benzene (primarily emitted from mobile sources). The emissions of D5-siloxane peak in the morning when most personal care products are likely applied. In New York City, using a mobile laboratory instrumented with the PTR-ToF-MS, we find that atmospheric concentrations of D5-siloxane correlate

strongly with population density ($R^2 \sim 0.70$). This suggests a population-dependence of D5-siloxane emissions, consistent with prior indoor air quality studies showing that D5-siloxane off-gasses from people. Lastly, we explore the presence of other highly reactive VOCs found in chemical products, such as terpenes, which can efficiently produce ozone and secondary organic aerosol. Terpenes are common fragrances, and found in cleaning agents and other consumer products. A challenge is distinguishing human terpenes from natural sources in the urban environment. However, the speciation of human terpenes will differ from natural sources, and be elevated in limonene.

1.205 The Tropospheric Ozone Assessment Report (TOAR): A community-wide effort to quantify tropospheric ozone in a rapidly changing world.

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Abstract:

Tropospheric ozone is a greenhouse gas and pollutant detrimental to human health and crop and ecosystem productivity. Since 1990 a large portion of global anthropogenic ozone precursor emissions has shifted from North America and Europe to Asia. This rapid shift, coupled with limited ozone monitoring in developing nations, left scientists unable to answer the most basic questions: Which regions of the world have the greatest human and plant exposure to ozone pollution? Is ozone continuing to decline in nations with strong emissions controls? To what extent is ozone increasing in the developing world? Where can researchers find the ozone metrics necessary for quantifying ozone's impact on human health and crop/ecosystem productivity? To answer these questions IGAC initiated the Tropospheric Ozone Assessment Report (TOAR). With over 230 member scientists and air quality specialists from 36 nations, TOAR's mission is to provide the research community with an up-to-date scientific assessment of tropospheric ozone's global distribution and trends from the surface to the tropopause. TOAR has also built the world's largest database of surface ozone observations and generated ozone exposure metrics at thousands of measurement sites around the world, freely accessible for research on the global-scale impact of ozone on climate, human health and crop/ecosystem productivity. Maps of these metrics show the regions of the world with the greatest potential ozone exposure for humans and crops/ecosystems at urban and rural sites, consistently and objectively classified according to high-resolution geodata. The results also highlight regions where air quality is improving and where it has

degraded. TOAR has also conducted the first intercomparison of tropospheric column ozone from ozonesondes and multiple satellite instruments, which provide similar estimates of the present-day tropospheric ozone burden. The TOAR report and its continuously evolving database can serve as a dynamic, interdisciplinary and cost-effective blueprint for future assessment reports.

1.208 Effect of Megacities on the Transport and Transformation of Pollutants on the Regional to Global Scales (EMeRGe): an overview of the HALO airborne campaigns in Europe and Asia. .

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Abstract:

EMeRGe (Effect of Megacities on the Transport and Transformation of Pollutants on the Regional to Global Scales, (<http://www.iup.uni-bremen.de/emerge/>)) is a research project coordinated by the Institute of Environmental Physics of the University of Bremen and funded by a variety of national agencies. Its primary objective aims to improve our understanding of the transport and transformation processes of pollution plumes originating from major population centres (MPC). With this purpose, two airborne measurement campaigns were carried out in summer 2017 and spring 2018 for the investigation of selected MPCs in Europe and Asia. The periods of study were selected as times where polluted flows are large in two regions with significantly different pollution

control strategies.

EMeRGe has exploited the long endurance capabilities of the **HALO** aircraft research platform (www.halo.dlr.de) by selecting a payload, which combines in situ and remote sensing instruments measuring O₃ and aerosol precursors, as well as a larger suite of related radical and trace gases, aerosol amount and composition. In combination with tracer releases, the photochemical evolution of selected megacity plumes, the lifetime of the emissions and the transport of the air masses have been investigated by following optimal transects and vertical profiling during ca. 180 HALO flight hours.

The outflows of London, Rome, Po Valley, Paris, Benelux/Ruhr, South France, Madrid and Barcelona were investigated over Europe. The second campaign in March-April 2018 had Bangkok, Manila, Taipei, Seoul, Tokyo, Beijing, Shanghai and Guangzhou as MPC targets over Asia.

In this presentation an overview of preliminary EMeRGe data with special focus on the HALO Asian campaign will be provided.

1.218 Source apportionment of particulate matter using a low-cost multi-pollutant air quality sensor in an Indian megacity.

Early Career Scientist

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Abstract:

The past several years have seen the emergence of many low-cost commercial devices for measuring particulate matter (PM) and gaseous species for the monitoring of indoor and outdoor air quality. Although our understanding of their operation and quantification of their performance has improved substantially over this period of time, they are mostly used only to measure the concentrations of individual pollutants, or to monitor air quality generally (and often in a qualitative sense only). However, other potential applications of such sensors, such as the identification of major pollutant sources, has received considerably less attention. Here, we use a new multi-pollutant air quality sensor (MPAQS) comprised of an optical particle counter (for measuring PM) and four electrochemical sensors (for measuring SO₂, NO_x, O₃, CO) to perform source apportionment of fine particulate matter in a megacity (New Delhi) and to enhance source apportionment efforts derived from real-time particle characterization instruments. Research-grade particle characterization instruments including an Aerodyne Aerosol Chemical Speciation Monitor (ACSM), an Aethalometer (BC), and a TSI Scanning Mobility Particle Sizer (SMPS) are used to validate results as well as to understand how the source apportionment abilities of such atmospheric-chemistry measurements can be enhanced through the addition of low-cost sensors. Various time-series deconvolution techniques (e.g., k-means clustering, Positive Matrix Factorization) are used to derive a meaningful source apportionment across a multi-season data-set (September 2017 - March 2018) in a complex urban environment using low-cost sensors.

2.003 An updated isoprene oxidation and deposition scheme in the IMAGES model.

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Abstract:

Our view of isoprene atmospheric degradation has dramatically changed in the last years, thanks to numerous laboratory and theoretical studies. We present a revised, thoroughly updated isoprene chemical mechanism relying on recent work, including the Caltech review (Wennberg et al., 2018). A special focus is the fate of hydroperoxy carbonyls generated at various instances in the oxidation of isoprene and other compounds, e.g. following the isomerisation of delta-hydroxyperoxys from isoprene+OH. We show that 1) the absorption cross sections of alpha- and beta-hydroperoxy carbonyls is considerably enhanced compared to monofunctional compounds; 2) the quantum yield of alpha-hydroperoxycarbonyl photolysis is of the order of 1; and 3) the reaction is shown to result for a large, likely dominant part, in the formation of an enol, whereas C-C scission is another viable channel. The pathway often believed to be dominant (O-OH bond breakup) is found to be negligible. The implications are important. The atmospheric fate of enols is still largely unexplored, except for a theoretical study (So et al., 2014) addressing vinyl alcohol. Based on their results, we propose updated chemical mechanisms for key hydroperoxycarbonyls formed in isoprene oxidation. An interesting aspect is a substantial production of formic and acetic acid, for which large missing sources have been reported over vegetated areas.

In addition, a new dry/wet scavenging scheme is presented, incorporating a new estimation method for the Henry's Law constants of oxygenated organic compounds (OVOCs). The dry deposition scheme is adjusted based on evidence of fast uptake of OVOCs by foliage. Extensive evaluation of the scheme against field measurements for O₃ and OVOC is presented. The impact of the updates in the chemical degradation and deposition schemes are assessed using a global model (IMAGES).

2.010 Reconciling organic auto-oxidation, new-particle formation, and chamber secondary organic aerosol formation.

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Abstract:

Auto oxidation of organo-peroxy radicals and the subsequent association of highly oxidized peroxy radicals to form covalently bound peroxides are two important new processes that govern new-particle formation following oxidation of both biogenic organic compounds (i.e. terpenes) and anthropogenic organic compounds (i.e. alkyl benzenes). We have developed a radical-centered representation of these processes within the framework of the volatility basis set (VBS), which we constrain and test with three complementary sources of data: traditional smog-chamber secondary organic aerosol formation experiments; new-particle formation experiments; and mixing experiments involving two distinct populations of particles. Because auto-oxidation vs termination is strongly temperature dependent, the temperature dependence of these processes is especially important. Formation of peroxides is a key rate-limiting step for new-particle formation and consequently competition for the peroxides represents an important branching point for secondary particle formation. Particle growth is less sensitive to this competition because many termination products have sufficiently low volatility to contribute to particle growth, even at very small particle sizes.

2.028 Kinetics of Criegee Intermediates.

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Abstract:

Ozonolysis of unsaturated hydrocarbons would produce very reactive Criegee intermediates, which are relevant in atmospheric chemistry, including OH radical formation, oxidation of atmospheric gases like SO₂, NO₂, volatile organic compounds, organic and inorganic acids, and even water. We have investigated the kinetics of Criegee intermediate reactions with UV and IR absorption spectroscopy. We found that there are strong structure dependences of Criegee intermediates in their thermal decomposition and reactions with water vapor (monomer and dimer), methanol, etc. Our results indicate that various Criegee intermediates have different fates in the atmosphere. Syn and dialkyl-substituted Criegee intermediates decompose quickly to release OH radicals; this reaction involves hydrogen atom transfer and has large isotope effect. Anti and simplest Criegee intermediates would be consumed by reactions with tropospheric water vapor.

References:

Jim Jr-Min Lin, and Wen Chao, *Structure-dependent reactivity of Criegee intermediates studies with spectroscopic methods*, Chem. Soc. Rev., 46, 7483-7497 (2017).

Wen Chao, Jun-Ting Hsieh, Chun-Hung Chang, Jim Jr-Min Lin, *Direct kinetic measurement of the reaction of the simplest Criegee intermediate with water vapor*, Science 347, 751 (2015).

2.038 Aerosol formation and aging under atmospheric conditions in China—application of a quasi-atmospheric aerosol evolution study (QUALITY) chamber.

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Abstract:

Secondary aerosol formation is the critical process for severe haze pollution in Beijing.

But the quantification of aerosol formation and aging from typical field measurements is affected by complex decoupling of the various processes. Here, a novel quasi-atmospheric aerosol evolution study (QUALITY) chamber is employed to mimic the aerosol formation and aging processes under ambient conditions. Several critical issues, i.e., aerosol nucleation, SOA formation from vehicles exhaust and aging of BC particles, are investigated by the corresponding well-designed QUALITY chamber experiments.

(1) Consistent aerosol nucleation and growth were revealed in the ambient atmosphere in Beijing. Organic species is dominantly responsible for both the nucleation process and the growth of the fresh nucleated particles. The photochemical oxidation of vehicular exhaust consisting of mainly organics play the key role in new particle formation under polluted ambient conditions.

(2) The impacts of gasoline vehicle type and fuel content on SOA production were investigated. A significant amplification factor of 3–6 for SOA productions from gasoline exhausts was observed as gasoline aromatic content rose from 29 to 37%. Much higher SOA production was found from the exhaust of the gasoline direct injection (GDI) vehicle than that from the port fuel injection (PFI) vehicle under high NO_x condition. Single-ring aromatic VOCs could explain only 25–53% of the measured SOA formation. More IVOCs and SVOCs were inferred as being emitted by the GDI vehicle.

(3) Aging and variation in the particle properties of BC particles were evaluated under atmospheric conditions. BC aging exhibits two distinct stages, i.e., initial transformation from a fractal to spherical morphology with little absorption variation and subsequent growth of fully compact particles with a large absorption enhancement. The timescales to achieve an absorption amplification factor of 2.4 for BC particles are estimated to be 2.3 h in Beijing.

2.051 Insight into the in-cloud formation of oxalate based on in situ measurement by single particle mass spectrometry.

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Abstract:

While ground-based works suggest the significance of in-cloud production (or aqueous formation) to oxalate, direct evidence is rare. With the in situ measurements performed at a remote mountain site (1690 m a.s.l.) in southern China, we first reported the size-resolved mixing state of oxalate in the cloud droplet residual (cloud RES), the cloud interstitial (cloud INT), and ambient (cloud-free) particles by single particle mass spectrometry. The results support the growing evidence that in-cloud aqueous reactions promote the formation of oxalate, with ~15% of the cloud RES and cloud INT particles containing oxalate, in contrast to only ~5% of the cloud-free particles. Furthermore, individual particle analysis provides unique insight into the formation and evolution of oxalate during in-cloud processing. Oxalate was predominantly (>70% in number) internally mixed with the aged biomass burning particles, highlighting the impact of biomass burning on the formation of oxalate. In contrast, oxalate was underrepresented in aged elemental carbon particles, although they represented the largest fraction of the detected particles. It can be interpreted by the individual particle mixing state that the aged biomass burning particles contained an abundance of organic components serving as precursors for oxalate. Through the analysis of the relationship between oxalate and organic acids ($-45[\text{HCO}_2^-]$, $-59[\text{CH}_3\text{CO}_2^-]$, $-71[\text{C}_2\text{H}_3\text{CO}_2^-]$, $-73[\text{C}_2\text{HO}_3^-]$), the results show that in-cloud aqueous reaction dramatically improved the conversion of organic acids to oxalate. The abundance of glyoxylate associated with the aged biomass burning particles is the controlling factor for the in-cloud production of oxalate. Since only limited information on oxalate is available in the free troposphere, the results also provide an important reference for future understanding of the abundance, evolution and climate impacts of oxalate.

2.085 Role of Sulfate Radical Anion Chemistry in Heterogeneous OH Oxidation of Organosulfates.

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Abstract:

Organosulfates are important organosulfur compounds present in atmospheric particles, but it remains largely unclear how they chemically transform in the atmosphere. To gain a fundamental understanding of how organosulfates evolve, this work investigates the heterogeneous OH radical-initiated oxidation of sodium methyl sulfate ($\text{CH}_3\text{SO}_4\text{Na}$) particles, the smallest organosulfate detected in atmospheric particles, using an aerosol flow tube reactor at a high relative humidity of 85 %. Aerosol mass spectra measured by an atmospheric pressure ionization source (Direct Analysis in Real Time, DART) coupled with a high-resolution mass spectrometer showed that neither functionalization nor fragmentation products are detected. Instead, the ion signal intensity of the bisulfate ion (HSO_4^-) increases significantly after oxidation. We postulate that sodium methyl sulfate tends to fragment into a formaldehyde and a sulfate radical anion ($\text{SO}_4^{\bullet-}$) upon OH oxidation. The formaldehyde is likely partitioned back to the gas phase. The sulfate radical anion can abstract a hydrogen atom from neighboring sodium methyl sulfate to form the bisulfate ion. Overall, we firstly demonstrate that the heterogeneous OH oxidation of an organosulfate can lead to the formation of sulfate radical anion and produce inorganic sulfate. Fragmentation processes and sulfate radical anion chemistry play a key role in determining the compositional evolution of sodium methyl sulfate during heterogeneous OH oxidation.

2.100 OH, HO₂ and RO₂ Radical and OH Reactivity Observations during Wintertime and Summertime in Beijing, and comparison with both steady state calculations and box model simulations..

Early Career Scientist

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Abstract:

We will present OH, HO₂ and RO₂ measurements made in central Beijing during the recent AIRPRO project which took place in November/December 2016 and May/June in 2017. Interference free OH measurements were made using the FAGE (Fluorescence Assay by Gas Expansion) technique, with the use of an inlet pre injector (IPI) which provides an alternative method to determine the background by injecting a scavenger (propane) to remove ambient OH. The chemical conditions varied vastly between the two campaigns, with NO concentrations exceeding 250 ppb in the winter, whilst O₃ levels over 100 ppbv were frequently observed during the summer. The average OH concentration during the winter campaign was high ($\sim 2.5 \times 10^6 \text{ cm}^{-3}$) even during haze events, and during the summer elevated levels of OH were observed, reaching up to $2.5 \times 10^7 \text{ cm}^{-3}$.

A comparison of OH observations with a steady state calculation, constrained to the total OH reactivity measurement and known OH precursors that were measured alongside OH, has been performed. The steady state calculation was able to reproduce the OH observations well during the winter, but highlighted a significant missing daytime source of OH under low NO conditions during summer. A comparison between the observed radicals and a box model constrained with the detailed Master Chemical Mechanism demonstrates that wintertime OH concentrations can be reproduced under low-NO_x conditions, but are underestimated at NO concentrations beyond 4 ppbv. This underestimation of OH under high NO_x correlates with an underestimation of HO₂ and RO₂ and highlights uncertainties in our understanding of the reactions and transformations of peroxy radicals in high NO conditions. The summer measurement-model comparisons also highlighted similar discrepancies during periods when NO was high. In agreement with the steady state calculation, the model-measurement comparison provides evidence of a missing source of OH under low-NO_x conditions.

2.104 ROOOH: the Missing Piece of the Puzzle for OH measurements in low NO Environments.

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Abstract:

Field campaigns have been carried out in remote biogenic environments in the last decade to quantify the *in situ* concentrations of OH, the main oxidant in the atmosphere. These data have revealed concentrations up to a factor of 10 higher than predicted by models and were interpreted as a major lack in our understanding of the chemistry of biogenic hydrocarbons.

In the following year, and until today, many experimental and theoretical studies have been carried out to improve the knowledge of the oxidation mechanism of biogenic VOCs under low NO conditions in order to bring into agreement model and measurement. Some new reaction paths have been found able to recycle OH radicals under low NO, especially for isoprene, but the strong disagreement between measurements and models still persists until today.

But interferences in the OH concentration measurements of unknown origin have also been discovered for some FAGE instruments, with the intensity increasing with decreasing NO concentration.

We will present here convincing experimental and modeling evidence that the disagreement between model and measurement is due to interference by the unexpected decomposition of a new class of molecule, ROOOH, during expansion within the FAGE instruments. ROOOH is the product of the reaction between peroxy radicals and OH radicals. Including ROOOH reflects the missing piece of the puzzle in our understanding of OH in the remote atmosphere.

2.113 Air/sea interfacial photochemistry is a global source of organic vapors and aerosol particles .

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Abstract:

The most prominent example of a surfactant-enriched surface is probably the ocean, covering more than 70% of Earth. Studies have shown that this air/water interface is almost ubiquitously covered by a thin film of amphiphilic compounds, which are enriched there with respect to the bulk water. Such sea surface microlayers (SMLs) were found to have significant effects on marine biogeochemical as well as climate related mechanisms by directly affecting processes such as exchange of trace gases (e.g., CO₂), heat, and aerosol particles. In addition, recent field studies confirmed for the first time previous laboratory observations suggesting that irradiation of this air/water interface by sunlight produces organic vapours, known to enhance particle formation in the atmosphere. These emissions were attributed to purely photochemical reactions occurring in the SML. However, current model calculations neglect this abiotic source of reactive compounds and account only for organic vapours that are produced directly by biological processes. Here, we combine for the first time results on the formation and presence of SMLs with observations of photochemical production of organic vapours from irradiation of surfactant-enriched air/water interfaces, to identify locations and time periods in which such photochemistry is of major importance for marine VOC levels. We show that interfacial photochemistry serves as a major abiotic source of volatile organic compounds (VOCs) on a global scale, capable to compete with emissions from marine biology. Our results indicate global emissions of 65.0–257 Tg yr⁻¹ (46.4–184 Tg C yr⁻¹) of organic vapors from the oceans into the marine atmosphere and a potential contribution to organic aerosol mass of more than 60% over the remote ocean. Moreover, we provide global distributions of VOC formation potentials, which can be used as simple tools for field studies to estimate photochemical VOC emissions depending on location and season.

2.119 Impact of temperature on molecular composition of secondary organic aerosols from anthropogenic and biogenic sources: from lab to field.

Early Career Scientist

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Abstract:

Secondary organic aerosol (SOA) can be of natural or anthropogenic origin. Most often, precursors from biogenic and anthropogenic sources mix and interact with each other during atmospheric transport and chemical aging, and contribute together to SOA formation. During these processes, temperature plays an important role in changing the phase state, morphology and chemical composition of SOA.

We firstly present chamber studies of SOA formation from toluene and α -pinene in the AIDA chamber of the Karlsruhe Institute of Technology. The experiments were performed at temperatures between 293 and 243K, thus covering conditions from the Earth's

surface to high altitudes. Organic compounds in both gas and particle phase were characterized on the molecular level with a chemical ionization mass spectrometer with filter inlet for gases and aerosols (FIGAERO-CIMS). Comparisons of SOA generated from individual precursor compounds and their mixtures for three different temperatures indicate that the temperature has a significant impact on the chemical composition. Overall, decreasing temperature leads to compounds with lower oxidation state, lower degree of oligomerization, but a higher gas-to-particle conversion. For mixed cases, the respective fingerprints of α -pinene and toluene enable us to distinguish between their contributions, while novel molecular tracers show potential interaction between these two sources.

The understanding obtained from the lab experiments is further used to interpret field observations. We show first results from a comprehensive field campaign (December 2017 - May 2018) conducted at the GAW station Chacaltaya in the Bolivian Andes, at 5240 m a. s. l.. This high-altitude site is influenced by the anthropogenic emissions from the nearby El Alto-La Paz metropolitan area, and the biogenic emissions from surrounding Eucalyptus forests as well as tropical rainforests through long-range transport. We focus on the results from the FIGAERO-CIMS and investigate relative importance of different sources contributing to new particle formation and growth processes.

2.141 The significant role of cloud chemistry in tropospheric NO_x and oxidant cycles.

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Abstract:

Aqueous cloud chemistry is generally thought to play a minor role in the tropospheric NO_x cycle, in contrast to aerosol, which is known to be an important NO_x sink through the hydrolysis of N₂O₅ and NO₃. This consensus view seems to originate with model studies in the 1990s reporting that most N₂O₅ is already consumed by ubiquitous aerosol so clouds have little additional effect. However, those studies assumed reactive uptake coefficients (γ) for N₂O₅ and NO₃ on tropospheric aerosol that we now know are much too high; they therefore overestimated the importance of aerosol. We reassess the role of cloud droplets as sites for heterogeneous NO_x loss and its effect on tropospheric O₃ and OH using a global chemical transport model. Simulating heterogeneous cloud reactions in regional and global models that do not resolve individual clouds requires accounting for cloud entrainment in addition to diffusion and reactive uptake constraints on chemical rates. We develop a simple and fast mathematical framework for doing this and show that other commonly used approaches generate large simulation errors. In the improved model, global NO_x loss through hydrolysis in clouds is about half of that hydrolyzed on non-cloud aerosol and 7% of global tropospheric NO_x loss. As a result, addition of hydrolysis on clouds lowers simulated tropospheric O₃ by 2.8% (0.5 ppb), OH by 3.3%, and increases the CH₄ lifetime by 3.1%. Despite the greater loss of N₂O₅ on aerosols, clouds and aerosol have similar impact on global tropospheric O₃ and OH, because clouds have greater influence on the tropics, where O₃ production is NO_x-limited. The old paradigm of neglecting cloud effects on NO_x chemistry should be discarded and this work provides efficient numerical methods to treat cloud chemistry in regional and global models.

2.152 A Comprehensive Test of the Recent Proposed HONO Sources in Field Measurements at Rural North China Plain .

Early Career Scientist

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Abstract:

As HONO photolysis is an important source of OH radicals, apportionment of the ambient HONO sources is necessary to better understand atmospheric oxidation. It was found in summer 2014 in the Wangdu campaign (a rural site in North China Plain) that the importance of the various HONO sources changed according to the variable atmospheric and surface conditions, even within the same site. Using current literature parameterizations for the different processes, NO₂ heterogeneous conversion, NO₂ photoenhanced conversion, photolysis of adsorbed nitric acid and particulate nitrate and direct emissions from soil were all included in a box model. The simulation results reproduced the observed HONO production rates during noontime in general. Using existing parameterizations of the uptake coefficient, NO₂ photoenhanced conversion, photolysis of particulate nitrate are the two major mechanisms of HONO formation, which accounted for 16% and 53% respectively. Soil emission is an important HONO source on fertilized days that accounted for 80% of simulation HONO during noontime. For some of the biomass burning periods, the NO₂ heterogeneous conversion to HONO were promoted significantly while the others not. In addition, the contributions from the other proposed production channels for HONO can be neglected for the conditions in Wangdu in general.

2.159 Influence of Relative Humidity on the Heterogeneous Oxidation of Secondary Organic Aerosol.

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Abstract:

While relative humidity (RH) has a substantial impact on particle phase, the impact of RH on heterogeneous oxidation of complex organic particles, such as secondary organic aerosol (SOA), is not well established. We have experimentally characterized how the heterogeneous oxidation by OH radicals of SOA produced from dark α -pinene ozonolysis depends on RH. At high RH ($\sim 89\%$) there is substantial loss of particle volume ($\sim 60\%$) at an equivalent atmospheric OH exposure of 3 weeks. In contrast, at low RH (RH = 25%) there is little mass loss ($<20\%$) at the same OH exposure. Mass spectra of the SOA particles were measured using a vacuum ultraviolet aerosol mass spectrometer (VUV-AMS). The mass spectra observed at low RH overall exhibit minor changes with oxidation and negligible further changes at high OH exposures, indicating limited impact of oxidation on the average particle composition. In contrast, the mass spectra observed at high RH exhibit substantial, rapid and continuous changes as a function of OH exposure. Further, at high RH clusters of peaks in the mass spectra exhibit unique decay patterns, suggesting different responses of various species to oxidation. We developed a model of heterogeneous oxidation that accounts for particle phase to understand the origin of the difference in aging between the low and high RH experiments. RH-dependent differences in diffusivity (i.e. phase) of the SOA alone can explain the difference in compositional change but cannot explain the difference in mass loss. Instead, the difference in mass loss is attributable to RH-dependent differences in the OH uptake coefficient and/or the net probability of fragmentation within the condensed phase, with either or both larger at high RH compared to low RH. These results illustrate the important impact of relative humidity on the fate of SOA in the atmosphere.

3.044 Development of an aerosol reanalysis product - JRAero.

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Abstract:

As well as meteorological reanalysis products (e.g., ERA, MERRA and JRA), reanalysis products for aerosol components are under development and ready for research use. A global aerosol reanalysis product named the Japanese Reanalysis for Aerosol (JRAero Version 1) was constructed by the Meteorological Research Institute (MRI) of Japan Meteorological Agency (JMA) and Research Institute for Applied Mechanics (RIAM) of Kyushu University (Yumimoto et al., Geosci. Model Dev., 2017). The reanalysis employs a global aerosol transport model developed by MRI (MASINGAR mk-2), a 2-dimensional variational assimilation method, and maps of aerosol optical depth (AOD) from the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard Terra and Aqua satellites. Reanalysis products, including global distributions of AOD (for total and each aerosol component), surface PM_{2.5} concentration, and deposition amounts etc. are now available through the JRAero web site (<https://www.riam.kyushu-u.ac.jp/taikai/JRAero/>), and will be useful for various applications (e.g., climatological analyses of aerosol and its climate effect, epidemiologic studies of PM_{2.5}, estimates of aerosol exposure and its health impact, and determination of the initial and boundary conditions of numerical models). In this presentation, we will overview setup of the reanalysis and indication of its quality as well as some research results with the reanalysis product.

3.059 Summertime observations of ultrafine particles and their growth to CCN sizes in the high Arctic marine boundary layer.

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Abstract:

The summertime Arctic atmosphere will experience considerable change as sea ice continues to melt in the decades to come. As a result, it is important to understand how the atmospheric aerosol in this region of the world responds to the switch from an ice-covered to an ice-free ocean. In 2014, a large-scale field campaign was conducted by the Canadian aerosol-climate research network (NETCARE) to assess the sources, properties, and potential climate impacts of Arctic aerosol particles. Aerosol particle, gas, and cloud measurements were conducted in the high Canadian Arctic from a research aircraft and an icebreaker, hoping to better connect emissions from the ocean to the overlying aerosol particles and their associated cloud and climate impacts. It was found that numbers of ultrafine particles are enhanced in the marine boundary layer relative to those in the free troposphere. As well, there is evidence for growth into CCN sizes, largely through the condensation of organic aerosol materials. Through assessing the composition of the aerosol and the nature of its growth, a local marine source of the condensing organic materials appears to be present. The implications of these novel experimental findings and their potential impacts on clouds and climate will be discussed.

3.066 Organic matter in marine aerosol particles: chemical characterization, transfer and sources.

Early Career Scientist

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Abstract:

The oceans are an important source for marine aerosol particles and the chemical composition of the particles determines their microphysical properties. However, there are few available field data of the composition of organic matter (OM) in the marine environment, especially on a molecular level.

This study presents measurements of organic compounds (free/combined amino acids (FAA/CAA) and proteins) in marine field samples as important subgroups of marine OM. Concerted measurements- the simultaneous sampling of bulk water (ULW), sea-surface-microlayer (SML) as well as marine aerosol particles (PM₁)- were performed at a remote atmospheric station in the tropical Atlantic Ocean, the Cape Verde Atmospheric Observatory (CVAO).

Analytical measurements of FAA and CAA (after hydrolysis) were based on derivatization with 6-Aminochinoly-N-hydroxy-succinimidyl-carbamate(AQC)-reagent and LC-MS analysis. Proteins were quantified as Coomassie stainable particles.

The results of the concerted measurements show that the analytes are present in all three measured marine compartments. Phenylalanine was quantified in SML samples with an enrichment factor (EF) up to 15 compared to ULW and an EF of Phenylalanine in the corresponding aerosol particles up to 944. These results are in the same order of magnitude compared to other field studies: The EF of FAA in SML of the western Mediterranean Sea is up to 26 (Rheinthaler et al. 2008) and the EF of total organic carbon in aerosol samples of the Atlantic ocean is up to 10⁴/10⁵ -depending on chlorophyll-a-concentration (van Pinxteren et al. 2017).

However, most studies focus on only one marine compartment: either aerosol particles or seawater investigations. The simultaneous determination of the analytes in aerosol particles and in SML/ULW presented here will allow a more comprehensive analysis of OM on molecular level in the marine environment including its sources in the oceans, enrichment in SML, transfer across the air-sea-interface and the chemical composition of marine aerosol particles.

3.071 Ammonia revealed from space: from industrial and agricultural point sources to global trends.

Early Career Scientist

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Abstract:

Ammonia (NH_3) is presently high on the political agendas, mainly because it severely deteriorates air quality through particulate matter formation, affecting human health by increasing mortality and morbidity. In this work, we use IASI satellite retrieved NH_3 measurement to identify, categorise and quantify world's NH_3 emission hotspots. In particular, using a spatial oversampling technique, we present a ten-year average, enabling us to identify over 200 agricultural and industrial hotspots with associated point sources. More than half relate directly to fertilizer industry, but also other industrial sectors emerge as major emitters of NH_3 . While calculated satellite-based emissions over large source regions are generally in line with what is reported in bottom-up emission inventories, our results suggest a drastic underestimation of point sources, in particular of industrial and agricultural origin. Using IASI to track NH_3 emission changes, temporal analysis revealed rapid shifts in anthropogenic activities, such as the opening or closure of industrial plants. These results demonstrate that using NH_3 satellite data will be hugely beneficial for improving conventional bottom-up emission inventories. We also derive trends on the region and global scales over the extended period covered by the IASI mission (from end of 2007 up to now) using a reanalysed dataset, in order to avoid the discontinuities identified in the near-real time dataset. Distinct patterns of emissions are extracted over the ten years of space measurements and these are analysed in light of anthropogenic activities occurring on ground.

3.092 Characterization of carbonaceous aerosols emitted from peatland burning in Central Kalimantan Indonesia.

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Abstract:

Peatland burning is a significant source of particulate matter ($PM_{2.5}$) and become the major source of transboundary haze pollution in Southeast Asia. However, only limited data exist on the emission characteristics from this source. An intensive field study was conducted at the burning site, Pulau Pisau, Central Kalimantan, during a peat fire episode in 2009. $PM_{2.5}$ samples were collected using two Mini Volume Samplers with Teflon and quartz fiber filters. Samples were also collected at a residential area in Palangkaraya city to provide an overview of the urban background site. The samples were analyzed to determine concentrations of $PM_{2.5}$, OC and EC. In this study carbon fraction of OC (OC1, OC2, OC3 and OC4) and EC (EC1, EC2, and EC3) were quantified at the DRI's Laboratory using a thermo-optical technique (Chow et al., 1993; 2001). $PM_{2.5}$ measured near the source were observed in high concentration of 504-12,406 $\mu g m^{-3}$, while average $PM_{2.5}$ concentrations at urban residential site were $69.7 \pm 38 \mu g m^{-3}$. The results indicated that the dominant chemical component of $PM_{2.5}$ from peat land burning were organic carbon (OC) which contributed about $69 \pm 9 \%$ of $PM_{2.5}$, and OC1 and OC2 were the primary compound of Total Carbon. OC1 accounted for $24.6 \pm 4.5 \%$ of TC in peat fire samples and only $2.5 \pm 3.4 \%$ in urban residential samples. OC2 accounted for $46.6 \pm 4.4 \%$ of TC and $28.1 \pm 4.3 \%$ of TC for Peat fire and residential area sites respectively. While EC contributed 1.5% to the total $PM_{2.5}$. In the urban residential site, contribution of OC and EC to $PM_{2.5}$ were 41% and 2% respectively. OC/EC mass ratio could indicate the origin of carbonaceous $PM_{2.5}$. In this study the ratio of OC/EC were 52 ± 22 and 9.6 ± 3.9 for burning site and urban residential site respectively.

Key words: $PM_{2.5}$, OC, EC

3.102 Stress-induced biogenic organic emissions and atmospheric chemistry interactions.

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Abstract:

Earth system model simulations have demonstrated that surface-atmosphere exchanges of mass, momentum and energy are fundamental processes that exert control over atmospheric chemical composition and climate. This includes the release and uptake of biogenic volatile organic compounds (BVOC) by terrestrial ecosystems. BVOC participate in chemical reactions that influence atmospheric distributions of air pollutants and short-lived climate forcers including organic aerosol, ozone and methane. These emissions are presently included in most earth system models as either static inventories or a simple model that responds only to a few variables such as temperature, solar radiation and vegetation foliage abundance. It is well known that at least some BVOC emissions are also highly sensitive to abiotic (temperature, drought, etc.) and biotic (fungi, herbivores, etc.) stresses but the complex relationships are typically omitted or are represented in models with highly simplified approaches. We describe efforts to assess the potential for stress-induced BVOC emissions to significantly impact atmospheric chemical composition and consider potential interactions and feedbacks. This was accomplished by synthesizing field and laboratory observations of stress-induced BVOC emission and incorporating the results into numerical algorithms suitable for regional and global numerical models. Model simulations using Model of Emissions of Gases and Aerosols from Nature (MEGAN), Community Earth System Model (CESM), and Weather and Research Forecasting model coupled with chemistry (WRF-Chem) are used to investigate the impact of stress-induced BVOC emission on atmospheric chemical composition and determine the potential for significant interactions and feedbacks. MEGAN simulations with and without stress are used to quantify the potential sensitivity of BVOC emission response. WRF-Chem regional model simulations are used to determine how the stress-induced changes can affect atmospheric chemistry. Finally, global CESM simulations are used to assess potential global interactions and feedbacks.

3.127 Direct OH reactivity measurements show agricultural crop residue fires fuel large missing OH reactivity associated with rapid photochemical formation of reactive nitrogen organics.

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Abstract:

Biomass fires impact global atmospheric chemistry. The reactive compounds emitted and formed due to biomass fires drive ozone and organic aerosol formation, affecting both air quality and climate. Direct ambient OH reactivity measurements provide a robust measure of the total reactive pollutant loading. Here, we quantified the magnitude and composition of total OH Reactivity in the north-west Indo-Gangetic Plain, where greater than 80% of the land use is agricultural in nature. We discovered greater than two-fold increase in the total measured OH reactivity (28 s^{-1} to 64 s^{-1}) of summertime air influenced by the open crop residue fires. Surprisingly, the missing OH reactivity fraction changed from no significant missing OH reactivity to 40 % missing OH reactivity, while accounting for the same set of OH reactants and oxidation products during the pre-harvest and post-harvest fire influenced periods. In particular, the biomass burning tracer compound of acetonitrile, primary emissions such as aromatic compounds and compounds with a strong photochemical source such as acetaldehyde, acetone, hydroxyacetone, nitromethane, amides, isocyanic acid exhibited enhancements ranging from 30 to 120% in their ambient mixing ratios between the two periods. We show that rapid photochemical formation of some rare organic compounds associated with reactive alkyl amine precursor compounds contributed majorly to the increased missing OH reactivity between the pre and post- harvest summertime periods. Currently, even the most detailed state-of-the art atmospheric chemistry models do not consider formamide, acetamide, nitromethane and isocyanic acid and their highly reactive precursor alkylamines (e.g. methylamine, ethylamine, dimethylamine, trimethylamine) in their parameterization schemes. We suggest that for improved understanding of atmospheric chemistry-air quality-climate feedbacks in biomass-fire impacted atmospheric environments, future studies should include measurements of these rare compounds and include them in models that investigate secondary pollutant formation across different scales in biomass fire impacted ecosystems.

3.145 The Mysterious Global Methane Budget.

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Abstract:

Atmospheric methane (CH_4) contributes 0.5 W m^{-2} to global radiative forcing, making it the second most important anthropogenic greenhouse gas after carbon dioxide. Over half of global CH_4 emissions is related to human activities that range from food and energy production to waste disposal. The largest natural source of atmospheric methane is microbial production in wetlands, which is difficult to quantify and potentially sensitive to changing climate and land use. Understanding the global CH_4 budget is essential due to the large human influence on the global CH_4 budget and possible climate feedbacks. CH_4 plays an important role in global atmospheric chemistry because it is an ozone precursor and an important sink of the hydroxyl radical (OH).

The OH sink of CH_4 approximately balances emissions globally. Until 2006 when observed CH_4 abundance started to increase again, atmospheric CH_4 had nearly reached equilibrium after rising from pre-industrial levels of ~ 800 ppb to ~ 1850 ppb. The reason for the recent increase is not currently well understood, and there remains considerable controversy about the causes of the period of stability in the late 1990s and early 2000s, and the recent growth. Some studies have argued that significant decadal trends in OH are behind the recent trends in global CH_4 , or that emissions from fossil fuel production have increased. Unfortunately, current data assimilation/inversion systems have difficulty attributing changes in atmospheric CH_4 to individual sources and results can be significantly biased by prior emissions, both natural and anthropogenic. We show that source attribution can be significantly improved if more observational constraints are introduced, namely methane isotopes that allow partitioning of sources between microbial and thermogenic processes, and that the recent CH_4 increase is mostly likely due to changes in low latitude microbial sources, especially wetlands.

4.007 The influence of dimethyl sulfide produced by global coral reefs on the climate.

Early Career Scientist

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Abstract:

Dimethyl sulfide (DMS), a chemical produced by marine organisms, contributes approximately one fifth of the global sulfur budget, providing an important precursor gas for aerosol formation. The current DMS climatology is predominantly made up of observations from phytoplankton and algae. Recent literature has suggested that coral reefs are able to produce as much or more DMS as some of the most highly productive regions in the ocean. Furthermore, there are suggestions that coral reefs may play a role in protecting their local environment via cloud formation. Coral reef derived DMS is currently unaccounted for in climate modelling. In this study, the Australian Community Climate and Earth System Simulator (ACCESS) - United Kingdom Chemistry and Aerosol (UKCA) global climate-chemistry model is used to determine if the contribution of coral reef derived DMS has an influence on global climate. Several simulations have been performed, comparing the current DMS climatology to one with enhanced coral reef DMS. The enhanced climatology was produced by adding an amount of DMS, constrained by observations, to the current DMS climatology. Results indicate that including coral reef derived DMS may influence cloud condensation nuclei, cloud droplet number concentrations, low cloud fraction and radiation fields in regions removed from the coral reefs. On a global scale, little impact is found. These results imply that whilst coral reefs may produce enough DMS to have an effect on cloud formation in some regions, these effects are not experienced locally. Whether corals are able to modify their local environment is an area of ongoing research.

4.018 Enhanced surface ozone during the heat wave of 2013 in Yangtze River Delta region, China.

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Abstract:

Under the background of global warming, occurrence of heat waves has increased in most part of Europe, Asia and Australia along with enhanced ozone level. In this paper, observational air temperature and surface ozone in the Yangtze River Delta (YRD) region of China during summer of 2013, and the regional chemistry-climate model (RegCM-CHEM4) were applied to explore the relationship between heat wave and elevated ground-level ozone. Ozone was found to increase at a rate of 4-5 ppb K⁻¹ within the temperature range of 28-38 °C, but decrease by a rate of -1.3~-1.7 ppb K⁻¹ under extremely high temperature. It was found that chemical reactions play the most important role in ozone formation during HW days, which result in 12 ppb ozone enhancement compared to NHW days. During heat waves, a more stagnant condition, controlled by anti-cyclone with sink airflow, led to less water vapor in YRD from south and contributed to less cloud cover, which favored a strong solar radiation environment and ozone significantly increasing. High temperature also slightly promote the effect of dry deposition velocity, vertical turbulence and horizontal advection, but the magnitude is much smaller than chemical effect. Our study suggests that the chemical reaction will potentially lead to substantial elevated ozone in a warmer climate, which should be taken into account in future ozone related issues.

4.021 The impact of climate variability on volatile organic compounds emissions assessed using spaceborne formaldehyde data from SCIAMACHY and OMI.

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Abstract:

Biogenic hydrocarbon emissions (BVOC) respond to temperature, solar radiation, leaf area index and other factors. Isoprene is the principal contributor to BVOC emissions and accounts for about half of the estimated global total emissions, whereas monoterpenes are also significant over boreal ecosystems. Due to their large emissions, their major role in the tropospheric ozone and aerosol formation, BVOCs are highly relevant to both air quality and climate. Whereas the short-term response of BVOC emissions to meteorological drivers is fairly well simulated by current emission models, it is yet unclear whether models can faithfully predict their response to climate change, given the scarcity of long observation records of BVOC fluxes. The objective of this study is to cast light on the interannual variability and trends of observed HCHO columns during the growing season, when BVOC emissions are dominant, and interpret them in terms of climate and emissions variability.

We use the MEGAN-MOHYCAN model driven by the ECMWF ERA-interim meteorology to calculate global BVOC fluxes (Muller et al. 2008, Stavrakou et al. 2014) over 2003-2015, satellite HCHO observations from SCIAMACHY (2003-2011) and OMI (2005-2015) (De Smedt et al. 2008, 2017) and the IMAGESv2 global model (Bauwens et al. 2016). We focus on mid- and high-latitude regions in summertime, as well as tropical regions during the wet season. We find generally a very strong temporal correlation (>0.8) between modelled and observed HCHO columns over temperate and boreal ecosystems and positive calculated BVOC emission trends associated to warming climate which are well corroborated by the observations. We show that 1) HCHO interannual variability is primarily driven by climate through its impacts on photochemistry, vegetation fire occurrence, and above all, biogenic emissions, and the HCHO record validates the interannual variability of biogenic emissions calculated by the MEGAN model in regions dominated by biogenic sources.

4.023 Unraveling the influences of pollution and climate trends on radiation fog frequency using generalized additive models.

Early Career Scientist

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Abstract:

Fluctuating trends in dense fog frequency remain a puzzling global phenomenon. In California's Central Valley, episodes of radiation fog increased as much as 92% from 1930-1970, followed by a 76% reduction since 1980. The dominant hypothesis suggests that the decline in fog can be explained by rising temperatures associated with climate change. We instead assert that changes in air pollution better explain California's historical upward-then-downward fog trend. As unregulated emissions increased pollution from 1930-1970, it directly contributed to the CCN formation necessary to create clouds and fog. With emission mitigation in the 1970s, pollutant concentration declined rapidly, thus reducing the CCN available for fog formation. Similar radiation fog trends have been observed in Italy's Po Valley - a location of comparable climatology and anthropogenic function - where a 50% fog reduction has also been observed over the past 40 years, concurrent with dramatic improvements in air pollution.

To identify the most significant variables affecting visibility, an indicator of dense fog, and compare the trends in these two analogous regions, we used a generalized additive model (GAM) to test the predictor variables (temperature, wind speed, dewpoint, sea level pressure, precipitation, and pollutant concentration). We ran the model for a range of sites in California and Italy with differing timescales (daily, monthly, annual, decadal) to elucidate the nonlinear relationships in the system. Over 60% of the variance was consistently explained by dew point depression, wind speed, pollution concentration, and precipitation. Trends in dewpoint depression, which incorporates both water availability and temperature, have greater influence on daily time scales, suggesting that short-term fog meteorology is primarily influenced by local weather patterns. The explanatory value of pollution concentration becomes more pronounced when analyzing on annual timescales, where CCN's influence on the probability of fog climatology is most clearly expressed independent of year-to-year meteorological variance.

4.028 Characterizing the climatological composition and intraseasonal and interannual variability of the Asian summer monsoon anticyclone using Aura Microwave Limb Sounder measurements.

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Abstract:

The Aura Microwave Limb Sounder (MLS), launched in July 2004, makes simultaneous colocated measurements of trace gases and cloud ice water content (a proxy for deep convection) in the upper troposphere / lower stratosphere (UTLS) on a daily basis. With its dense spatial and temporal sampling, extensive measurement suite, and insensitivity to aerosol and all but the thickest clouds, Aura MLS is well suited to characterizing UTLS composition in the region of the Asian summer monsoon (ASM) and quantifying the considerable spatial and seasonal variations therein. In addition, the 13-yr MLS data record is invaluable for assessing interannual variability. Here we examine MLS measurements of cloud ice and both tropospheric (H₂O, CO, CH₃Cl, CH₃CN, CH₃OH, HCN) and stratospheric (O₃, HNO₃, HCl) tracers, along with meteorological reanalyses, to investigate the impact on the UTLS (350–410 K) of the ASM over the course of its complete lifecycle, from April through October. Links between observed trace gas behavior and variations in various meteorological factors, climate indices, and surface emissions are explored. In particular, we use MLS measurements to place the 2017 ASM observed in detail by the StratoClim field campaign into the context of other recent monsoon seasons.

4.052 Changing Conditions in the Arctic: An Analysis of Trends in Observed Surface Ozone Conditions.

Early Career Scientist

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Abstract:

The Arctic is a region which has been experiencing rapid changes in the environmental and atmospheric conditions and is likely to continue to be influenced by climate change. In order to understand the implications of drastic changes to the Arctic climate system, it is imperative to understand the expected behavior and associated impacts of different atmospheric constituents. As an important greenhouse gas, tropospheric ozone contributes to Arctic surface temperature and drives the photochemical oxidation properties of the atmosphere. Formed from the reaction of volatile organic carbons (VOC's), oxygen, and nitrogen oxides in the presence of UV radiation, ozone has an integral role in the chemical composition and behavior of the atmosphere. In addition, at high levels surface ozone has a negative impact on ecosystem functioning and public health. Surface ozone has been monitored in the Arctic since 1973 (Barrow, Alaska) and measurements have expanded spatially since to the current 8 Arctic ozone measuring locations used for this investigation. Some measurement stations, such as Barrow, show a 12% increase in observed ozone mixing ratios over the 45 year measurement period, with the dominant increases occurring during the spring months - driven by the loss of sea-ice and associated reduction in ozone depletion events. Ozone conditions in the Arctic are strongly influenced by long-range transport of pollutants from populated regions of the northern mid-latitudes, sea-ice extent, meteorological conditions, and relative amounts of precursor species. Co-located measurements of temperature, wind direction, carbon monoxide, and aerosol composition are used in addition to climate models, back-trajectory analysis, and satellite imagery to interpret the dominant causes for observed trends in surface ozone conditions across the Arctic. The analysis of trends and seasonal distribution of ozone across the Arctic provides a valuable opportunity to

investigate the spatial and temporal extent of detected trends in the region.

4.054 Dust induced changes on the West African summer monsoon features.

Early Career Scientist

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Abstract:

Dust generation and transportation from North Africa are thought to modulate the West African Monsoon (WAM) features. In this study, we investigated the relationship between the Saharan Air Layer located above Atlantic Ocean (OSAL) and WAM features, including Monsoon flow, African Easterly Jet (AEJ) and Tropical Easterly Jet (TEJ) over West Africa using the RegCM4 regional model at 30 km grid resolution. Two sets of experiments with and without dust load were performed between 2007 and 2013 over the simulation domain, encompassing the whole of West Africa and a large part of the adjacent Atlantic Ocean. An intercomparison of the two simulations shows that dust load into the atmosphere greatly influences both the wind and temperature structure at different levels, resulting in the observed changes in the main features of the WAM system during summer. These changes lead to a westward shift with a slight strengthening of AEJ core over tropical Atlantic and weakening of both TEJ and monsoon flux penetration over land. In addition, despite running the RegCM4 with prescribed sea surface temperature, a correlation has been found between Aerosol Optical Depths in OSAL and WAM dynamics suggesting a mechanistic link between dust and WAM well reproduced by RegCM4.

4.059 Persistent La Niña-like climate in 2010s reduced export from China and suppressed ozone trend in the lower troposphere over Japan.

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Abstract:

Large increase in the springtime free tropospheric ozone over the western and eastern North Pacific has been linked to the increase in anthropogenic emissions in China. In the 2000s, a rapid increase of tropospheric ozone was observed at Mt. Happo, Japan. However, the increasing trend at Mt. Happo has been unexpectedly suppressed by 5–10 ppbv since 2008 before the reduction of Chinese emissions. After 2012, ozone levels were sustained at about 60 ppbv. In this study, we analyze the tropospheric ozone records at Mt. Happo, along with the decadal changes in climate and anthropogenic emissions. We find that persistent La Niña-like climate pattern during 2008–2013 has reduced continental outflow from China to the western Pacific via weakened westerly wind, even though Chinese emissions continued to increase until 2012. On the other hand, an El Niño-like climate pattern during 1992–1996 has enhanced continental outflow export from China via strengthened westerly wind, contributing to the accelerated ozone trends. In addition, enhanced storm track activity around Japan during 2000–2006 has also contributed to the ozone increase. These results indicate that the tropical forcing by El Niño and La Niña affected the long-term trend of springtime free tropospheric ozone in Japan. Without this climatic effect driven by persistent La Niña, the ozone trend would have been further upward over the western Pacific and possibly over the western North America in late 2000s to early 2010s. At Mt. Happo, the mean springtime ozone level might have exceeded 70 ppbv by the early 2010s.

4.084 Spatial and temporal variation of haze in the Yangtze River Delta region from 1961 to 2015.

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Abstract:

In recent years, the haze weather in the Yangtze River Delta region (YRD) has been increasingly severe, which has become one of the key problems restricting the sustainable development of the YRD. The meteorological conditions play an important role in the formation of haze. Therefore, analysing the temporal and spatial distribution of haze and the impacts of meteorological factors is important to understand the haze formation mechanism. The results of this study will provide scientific basis for regional air pollution control in the YRD region.

In this study, data quality control and quality assessment of haze weather in YRD were conducted. Based on the calculation, the interannual, inter-decadal trend of haze days, temporal and spatial distribution of haze weather in the YRD were analysed using Mann-Kendall method and sliding T-test method. In addition, the meteorological factors influencing the formation of haze were studied using correlation analysis of haze weather phenomena, surface and upper air meteorological factors, and air pollutant concentrations, under six types of topography.

The results show that the number of haze days in YRD have increased from 1961 to 2015, and the average haze days during 1961-2015 are about 21 days. The main reason for the interannual growth of haze days is the increase of anthropogenic pollutant emissions. Winter had the highest haze occurrence frequency in the YRD. The haze days gradually increase from September to December and next January, then it gradually decreases from March. Meanwhile, the haze coverage is also increasing in the YRD. The spatial distribution of haze in Jiangsu Province and Shanghai has been expanding to the whole provinces. The "isolated points" in Zhejiang province are increasing gradually.

4.098 Equilibrium climate and air pollution responses to greenhouse gases, anthropogenic emissions and ozone changes from 1970 to 2010 under different EDGAR emission scenarios.

Early Career Scientist

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Abstract:

Using the fully-coupled Earth System Model (CESM1), simulations were carried out to investigate climate response at equilibrium to Greenhouse gas (GHG), anthropogenic aerosol and ozone (troposphere plus stratosphere) changes from 1970 to 2010, with anthropogenic aerosol emissions from the Emissions Database for Global Atmospheric Research (EDGAR 4.3.1) retrospective emission inventory and tropospheric and stratospheric ozone prescribed from CMIP5. Each simulation was run for sufficient years to allow the model to reach equilibrium (typically ~150 years), and only the last 40 years of each run were analysed. Radiative forcings, from 1970 to 2010, from GHG, anthropogenic aerosol and ozone changes, were diagnosed to be 0.96, -0.20 and -0.03 W m⁻², respectively. The results indicate that the global mean temperature at equilibrium is much warmer than the reality in 2010, and especially the Polar Regions (e.g. 3 K more over the Arctic). Changes in thermal and hydrological fields feature large spatial variability due to anthropogenic aerosols and ozone, which are related to changes in atmospheric circulations, heat and moisture transport. In addition, significant changes in climate extremes (especially temperature extremes) in accompany with thermal and hydrological responses are found, and the underlying mechanism are still being investigated.

We have also performed further experiments with fully interactive chemistry (CAM5-CHEM) forced by the EDGAR retrospective scenarios that estimate emissions changes associated with technology advancements and increases in energy consumption over 1970-2010, to investigate how these drivers of emission change have affected climate extremes and air pollution. The full chemistry model allows us calculate how ozone responds in these scenarios, rather than using prescribed fields, and hence allow us to analyse changes in air quality, including extremes, associated with the emissions' drivers.

4.163 Global scale variability of the mineral dust shortwave and longwave refractive index: a new dataset of in situ measurements for climate modelling and remote sensing.

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Abstract:

Modeling the interaction of dust with short-wave (SW) and long-wave (LW) radiation is still a challenge because of the scarcity of information on the complex refractive index ($n-ik$) of dust and its variability as a function of the particle mineralogical composition, which depends on the specific emission source. As a consequence, to date, climate models and remote sensing retrievals use a spatially invariant value for the dust SW and LW refractive index.

In this study, the global variability of the mineral dust SW (0.37-0.95 μm) and LW (2-16 μm) refractive index as a function of its mineralogical composition is explored by in situ measurements in a large smog chamber. Investigated dust aerosol samples were issued from major desert sources worldwide, including the African Sahara and Sahel, Eastern Asia, the Middle East, Southern Africa, Australia, and the Americas.

Results from the present study provide a regional mapping of the SW and LW optical properties by dust and show that the imaginary part of the refractive index largely varies for the different source areas due to the change in the particle composition. In the LW k varies between ~ 0.001 and 0.92 due to changes in the clays, quartz, and calcite content in dust. In the SW range k varies in the range ~ 0.002 - 0.030 at $0.37 \mu\text{m}$ and 0.0005 - 0.005

at 0.95 μm in relation to changes of the iron dust content.

A linear relationship between the magnitude of k at specific wavelengths and the mass concentration of minerals absorbing at these wavelengths was found. Predictive rules could be thus established to estimate the SW and LW refractive index of dust in specific bands based on an assumed or predicted mineralogical composition. These rules can be used to implement regional-dependent SW and LW refractive indices in models and remote sensing retrieval algorithms.

4.179 Impact of particle size and mixing state diversity on estimates of black carbon mitigation.

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Abstract:

Post-industrial increases in atmospheric black carbon (BC) have a large but uncertain warming contribution to Earth's climate. Particle size and mixing state determine the solar absorption efficiency of BC and also strongly influence how effectively BC is removed, but they have large uncertainties. In this study, we use a multiple-mixing-state global aerosol microphysics model and show that the sensitivity (range) of present-day BC direct radiative effect, due to current uncertainties in emission size distributions, is amplified 5-13 times ($0.18\text{-}0.42\text{ W m}^{-2}$) when the diversity in BC mixing state is sufficiently resolved. This amplification is caused by the lifetime, core absorption, and absorption enhancement effects of BC, whose variability is underestimated by 45-70% in a single-mixing-state representation. We demonstrate that reducing uncertainties in emission size distributions and how they change in the future, while also resolving modeled BC mixing state diversity, is now essential for evaluating BC radiative effect and the effectiveness of BC mitigation on future temperature changes.

4.185 Impacts of Climatic and Land-Use Changes on Global Aerosol Burden.

Early Career Scientist

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Abstract:

Climatic and land use changes have been found to affect atmospheric aerosols and climate worldwide, but the mechanisms and pathways involved are not well understood. Here we use a global coupled aerosol-chemistry-climate-land model (CESM with CAM4 and CLM4) to investigate how aerosols respond to future climatic and land-use changes. Time-sliced simulations are conducted for the base year (2000) and a future year (2050). For the future year, three future projected scenarios driven by both climate and land-use projections following the Representative Concentration Pathways RCP8.5 are conducted. The first scenario considers future projected biogenic emissions, allowing us to investigate the effects of modified plant activities and emissions of biogenic volatile organic compounds. The second scenario considers future biomass burning emissions following future climate and land-use. The third scenario combines both sources, allowing us to look at combined effects of both emissions. The same three scenarios are repeated for the base year, but with 2000-level emissions, climate and land-use. In the first scenario, 2050-level biogenic emissions causes 0.7% increase in PM_{2.5} global aerosol burden compared to 2000-level biogenic emissions, with effects ubiquitous in many places globally. In the second scenario, 2050-level biomass burning emissions causes 8.7% increase in PM_{2.5} aerosol burden. Burning decreases in Central Africa and Southeast Asia, while increasing drastically in Northeast Europe. In the third scenario, the combination of both 2050-level emissions lead to 12.2% increase in PM_{2.5} aerosol burden compared to year 2000. The combined effect is more than the additive sum of the two individual effects, indicating a synergistic effect that reflects enhanced levels of biomass burning aerosol particles serving as nuclei for secondary organic aerosol formation from biogenic gases. These experiments show that contributions of biogenic and biomass burning emissions to PM_{2.5} increase in year 2050, with biomass burning emissions being a generally more significant contributor.

4.189 Impacts of drought on air quality .

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Abstract:

Drought is a recurring extreme of the climate system on the synoptic scale. The strong perturbation of drought to the land biosphere and atmospheric water cycle will influence atmospheric composition, the nature and extent of which are not well understood. In this work, we first present observational evidence that air quality is significantly correlated with drought severity. Severe droughts during the period of 1990-2014 were found associated with growth-season (Mar-Oct) mean enhancements in surface ozone and PM_{2.5} in the US by 3.5 ppbv (8%) and 1.6 $\mu\text{g m}^{-3}$ (17%), respectively. The pollutant enhancements associated with droughts do not appear to be affected by the decreasing trend of US anthropogenic emissions, indicating natural processes as the primary cause. We then use the observed drought-pollutant relationships as a diagnostic to evaluate the predictive ability of climate-chemistry models and chemical transport models. Model deficiencies identified are mostly related to the lack of drought-induced changes in land-atmosphere exchanges of reactive gases and particles and aqueous phase chemistry in the atmosphere. By applying the observed relationships between drought and air pollutants to climate model projected drought occurrences, we estimate a significant increase for ground-level O₃ (1-6%) and PM_{2.5} (1-16%) in the US by 2100 compared to the 2000s due to increasing drought alone. Drought thus poses an important aspect of climate change penalty on air quality, and a better prediction of such effects would require improvements in model processes.

4.203 Deep Convective Transport, Lightning NO_x Production, and Wet-Scavenging in Mid-latitude Deep Convection: Combining Modeling and Observations from DC3.

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Abstract:

Research aircraft sampled the low-level inflow and upper tropospheric outflow associated with thunderstorms over the central and southern United States during the Deep Convective Clouds and Chemistry (DC3) field program in May and June 2012. WRF and WRF-Chem simulations of selected storms were conducted at cloud-resolved and cloud-parameterized resolutions and used to examine convective transport, entrainment and detrainment in detail for a supercell, a mesoscale convective system, and an air mass storm. Analysis of vertical flux divergence showed that deep convective transport in the supercell case was the strongest per unit area. The cloud-resolved simulations constrained by aircraft chemical observations and flash rates from ground-based lightning mapping arrays were also used to determine the best methods for estimating lightning flash rates and lightning NO_x production for the supercell case. A flash rate parameterization scheme based on upward cloud ice flux provided the best representation of lightning activity. The observations and the cloud-resolved simulations were used to evaluate convective transport in simulations at 12- and 36-km resolution that employ parameterized convection. A key finding from the simulations at these resolutions is that convective transport of trace gases to the upper troposphere is best represented when the transport scheme for tracers is consistent with the scheme used for water vapor. The approach used to retain soluble species on frozen hydrometeors in the wet scavenging algorithm associated with parameterized convective transport was also investigated. Using the convective transport, wet scavenging, and lightning NO_x algorithms discerned to yield best results for the supercell storm, the model was run at 36-km resolution to estimate upper tropospheric ozone production downwind of this storm over the following day. Results were compared with aircraft flight data from the downwind region, which showed a 15-20 ppbv increment in ozone compared with the air exiting the storm.

4.246 Impact of reduction of ship-induced sulphur emission on climate and health.

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Abstract:

Ship emission constitutes ~13% of the global fluxes of SO_x into the atmosphere. New global standards of sulphur content in the ship fuels, in force on 1 January 2020, reduce the maximum permissible sulphur mass fraction by 7 times – from 3.5% to 0.5%, - which will cut the global annual SO_x ship emission from 11,5 Mt yr⁻¹ to 2.5 Mt yr⁻¹.

With this talk, the impact of this reduction on global distribution of aerosols, public health and radiative forcing is analyzed following Sofiev et al (2018). The effects are studied using STEAM (ship emission) and SILAM (atmospheric composition) models. We also present later findings referring to regional effects of the reduction.

STEAM provided SILAM with the 3-hourly emission fluxes from ships using their actual locations, speed and physical characteristics as described in (Jalkanen et al. 2016). Since ships, especially oceanic vessels, are strong point sources moving over pristine areas but sometimes passing by densely populated places, the simulations were performed at the resolution of 0.1° (~10km) over the whole globe for the full year of 2015.

The simulations produced high-resolution patterns of the pollution distribution, where one can distinguish dense routes, individual ships ceiling offshore, coastal effects, and concentrations over populated areas.

It was shown that the MARPOL-VI regulations result in substantial reduction of PM concentrations: up to 50% of PM_{2.5} can be shaved out in the vicinity of busy ship routes. We estimated that it can save up to 100,000 premature deaths, mainly in Africa and Asia (Europe and America already control fuel sulphur content).

From the other side, the measures will result in 50-100 mW m⁻² of lost cooling due to diminishing aerosol concentrations. The bulk of the effect comes from the first aerosol indirect effect: reduction of the cloud droplet number concentrations and cloud albedo.

5.005 Replacing the integrator: modelling atmospheric chemistry with machine learning .

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Abstract:

Atmospheric chemistry is a high-dimensionality, large-data problem and so may be suited to machine-learning algorithms. One application would be to replace the integration of the simultaneous ordinary differential equations that represent atmospheric chemistry with a machine learning representation. To explore this, the GEOS-Chem model is run for a year archiving the concentration of the transported tracers before and after each chemical time-step together with information about the physical state for each gridbox. For each tracer, a machine learning algorithm (regression forest) is created to predict the concentration of the tracer in the next time-step based on the training data. Running the model forward for a different year using the machine learning rather than the differential equations shows that the machine learning approach has significant skill compared to the standard differential equation methodology. Replacing the integration methodology with a machine learning one, allows a number of new options for solving atmospheric chemistry which have a range of advantages and disadvantages for air quality forecasting and for the exploitation of new computer hardware. These will be discussed and suggestions for future developments made.

5.022 Spatial and Temporal Optimisation of Variable Density/Capability Air Quality Networks. Improving returns from emerging low-cost Air Quality Monitoring Networks.

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Abstract:

Observational studies can now be undertaken at very high resolution as a result of the development of transformative minituarised low-cost sensor technologies. However the increasing use of dispersed networks has highlighted the need for network optimisation to maintain affordability (especially important in developing economies), avoid redundancy and identify areas of sub sampling.

Dense sensor networks have been deployed often to evaluate performance and utility, primarily in Europe and N America. Studies in Africa and SE Asia are limited, even though pollution problems are generally more severe with routine episodes of national and transnational very poor air quality and haze. Optimisation of networks is vital to maximise scientific and public good returns in often resource limited environments.

Based on high resolution training datasets (including the NASA DISCOVER-AQ missions) this work demonstrates a flexible approach to determining optimal temporal and spatial resolution within a variable density/capability network. Primary species investigated are CO, NO_x/O₃, and PM. **Temporal Optimisation:** Variogram parameters derived from fast data ($\leq 1/60$ Hz) were compared to parameters derived from the same data averaged over a range of time intervals. The optimal time interval for measurements without loss of information (including non-continuous data e.g. diurnal variability) was identified by the degree of similarity of the fitted variogram parameters for the fast and averaged data at each sampling location. **Spatial Optimisation:** The time interval identified plus estimated variogram ranges (i.e. the time length over which air pollution levels are correlated) were used to generate spatial predictions of change. Fitted variogram parameters for spatial predictions were used to assess appropriateness of sensor

locations as well as areas of redundancy and under-sampling identified. This presentation will describe this advanced network design concept as well as present preliminary results from the “High Density Air Quality Monitoring in the Klang Valley Malaysia” project based on this approach.

5.025 Global, In Situ Measurements of New Particle Formation and Growth to CCN Sizes.

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Abstract:

Global models show that new particle formation (NPF) in the free troposphere is the largest source of cloud condensation nuclei (CCN) in the remote marine boundary layer (MBL), where aerosol-cloud-climate interactions are particularly strong (e.g., Merikanto et al., 2009). New global-scale, in situ measurements of aerosol properties have been made using instruments on a continuously profiling DC-8 aircraft over the middle of both the Pacific and Atlantic Oceans between the Arctic and the Antarctic over four seasons as part of NASA's Atmospheric Tomography (ATom) mission. These airborne observations between 0.15 and 12.5 km, along with model results, show that the Earth is girdled by a region of NPF in the upper troposphere between approximately 30 °N and 30 °S in all seasons. This globally significant particle source is associated with deep tropical convection, which transports trace quantities of gas-phase aerosol precursors and removes the pre-existing aerosols that compete with NPF for condensing species. Particle sizes increase with decreasing altitude in the tropics and subtropics, likely growing from gas-phase oxidation and condensation in regions of net downward motion. ATom measurements in the MBL consistently show a mode of sub-0.1 micrometer particles that may originate from this free tropospheric particle source. Accurately simulating this globally important CCN source requires that models capture the origins, transport, and removal of precursor species and of aerosol particles that compete for condensing compounds with the newly formed particles that actually alter CCN abundance. The unique ATom dataset provides powerful constraints against global models that simulate these processes.

Merikanto, J., Spracklen, D., Mann, G., Pickering, S. and Carslaw, K.: Impact of nucleation on global CCN, *Atmos Chem Phys*, 9, 8601–8616, 2009.

5.033 New perspectives on atmospheric chemistry from the Sentinel-5P TROPOMI sensor and the 23-year QA4ECV climate data record.

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Abstract:

The TROPOMI spectrometer on board the Copernicus Sentinel-5P satellite was launched in October 2017 to measure atmospheric composition from space using ultraviolet, visible, and infrared spectroscopy (www.tropomi.nl). TROPOMI allows the retrieval of trace gases O₃, NO₂, SO₂, HCHO, CO, CH₄ and information on aerosols. With its global daily coverage and spatial footprint of 3.5×7 km², TROPOMI's observations are anticipated to be of great relevance for monitoring pollutant concentrations, emissions from small-scale towns, individual power plants, wildfires, and major infrastructures. In this presentation we will showcase some striking observations of various atmospheric constituents collected in the first months of operation.

TROPOMI is the successor-in-line of the suite of instruments initiated with the launch and operation of GOME (1995-2003), SCIAMACHY (2002-2012), GOME-2 (since 2007), and OMI (since 2004). Within the EU FP7 QA4ECV project (www.qa4ecv.eu), we developed an improved, quality assured retrieval algorithm for NO₂ that we applied for all five sensors, culminating in a consistent climate data record that now spans a period of 23 years, and is continued by TROPOMI. We will evaluate the quality of the TROPOMI NO₂ retrievals based on an evaluation with QDOAS spectral fitting retrievals, validation with independent MAX-DOAS measurements, and comparisons against the OMI QA4ECV NO₂ product.

We will then highlight some of the new and exciting benefits of the new datasets. In particular, TROPOMI NO₂ columns shows great potential to trace back distinct plumes of

pollution observed on a single clear-sky day to their hotspot origins. This allows the direct quantification of emissions and lifetime of nitrogen oxides on a daily basis. Analysis of the multi-year QA4ECV NO₂ record suggests that NO_x emissions have reduced substantially over Europe, but also that the economic ups and downs between 2008 and 2013 have left a clear imprint on the pollution levels.

5.074 Challenging the future of air pollution in southern Africa.

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Abstract:

Air pollution impacts in southern Africa are one of the region's largest environmental risks. However, other more immediate socioeconomic issues push efforts to address emissions into the background. The region is expected to see large growth in population and development in the foreseeable future and current global predictions of ambient air pollution trends estimates a bleak reality. This paper explores the results from a series of empirical and modeling studies done in the region that aims to characterize local drivers of air pollution. It further assesses available regulatory instruments to find solutions that could help challenge the future of air pollution in the region. With a coal-heavy energy mix, more than half the population living in poverty and a small stagnant economy, unique technological and regulatory solutions are needed. These regionally relevant strategies are being formulated using the best available methodologies to quantify and model source contribution. Poverty alleviation proves to be an important part of moving communities away from solid fuel and waste burning practices. A balancing act is required between addressing complex sources and poverty while honoring international agreements is needed. The most promising regulatory instrument seems to be a variation of air quality offsets. Scoping and auditing these projects remain a challenge. Results from this work show the benefit of close collaboration between scientific investigation to understand and policy-makers to address context specific sources. It highlights the importance of local context in managing air pollution. It demonstrates the benefit of high resolution global emission inventories that can illuminate regional priorities. Lastly, it illustrates the need of distributed ground based and remote sensing monitoring technologies that can help to detect and assess the success or failure of single strategies that could have marginal, but real impacts on ambient air pollution.

5.078 Challenges in Identifying Sources of PM_{2.5} in China.

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Abstract:

Identify sources of haze is very important in China due to frequent occurrence of haze in recent years. This study presents the current tools that are applied for studying sources of PM_{2.5}. These tools include receptor model, chemical transport model, emission inventory, isotopes such as ¹⁴C, satellite, and sensor network. Each tool could provide useful information to understand major source types and quantify source contributions. However, it remains a great challenge when results from different methods are compared and it is even more challenging when one tries to integrate results from different methods. In this study, using Beijing as an example, we are investigating and discussing how to effectively integrate results from different methods in studying PM_{2.5} sources.

Although PM_{2.5} source apportionment studies are actively ongoing in multiple cities in China, major challenges still exist and need to be addressed. These challenges are mainly in four areas including the accuracy of source apportionment results, distinguishing primary emissions from secondary formation, identifying local vs. regional contribution, and time resolution (Zheng et al., 2017). For the issue of accuracy, the key is whether the traditional tracers are specific for China such as levoglucosan and K for biomass burning source (Yan et al., 2018). As current source apportionment work relies heavily on receptor model, therefore, to clearly distinguish local from regional transport remains a challenge. The challenge in time resolution leads to active and wide application of online measurements in China. However, how to integrate online data from different instruments and automatically evaluate the accuracy of source apportionment results is also a challenge.

1.003 Unexpected air quality feedback chains from implementation of green infrastructure in urban environments: a Kansas City case study.

Early Career Scientist

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Abstract:

Field and numerical studies have demonstrated the benefits of green infrastructure (GI) implementation on lowering daytime temperature in urban environments due to shading and the role of evaporation and transpiration. Studies have also shown that through changes in dry deposition and atmospheric dispersion, the GI implementation could also reduce surface air pollutants and improve human health. However, few studies have systematically analyzed the feedback chains between atmospheric dynamic and chemical processes that are triggered by changes in the urban vegetation coverage. While lower temperatures could reduce the intensity of chemical reactions and subsequently secondary air pollutant formation (O₃ and secondary organic aerosols), the reduced ventilation of surface emissions in a stabler planetary boundary layer (PBL) resulting from the cooling, could potentially increase near-surface concentration of precursor species for

O₃ and particulate air pollutants (PM_{2.5}).

We use the state-of-the-art WRF-CMAQ coupled model to simulate the likely effects of a GI implementation strategy in Kansas City, MO/KS on regional meteorology and air quality changes. Two different land surface schemes (Pleim-Xiu and Noah) were implemented to characterize the differences in response estimated by different land surface schemes. A full year simulation was conducted for both the base case and GI scenario. Though the estimated magnitudes of the changes were different, both configurations showed consistently cooler surface temperatures and lower PBL heights in downtown areas. The CMAQ then predicted PM_{2.5} increases, arising mostly from the primary components, across the domain due to the decreased PBL. O₃ changes are complicated as a combination of competing effects from increased dry deposition, increased NO_x titration and decreased chemical reduction interact non-linearly. These results highlight the region-specific non-linear process feedback chains that must be accounted for in assessing the likely air quality benefits and dis-benefits associated with GI implementation.

1.006 Air pollution near unpaved roads: An experimental and modelling study.

Early Career Scientist

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Abstract:

Aiming to advance in the understanding of pollutant dispersion near roads, we measured, simultaneously, vehicle traffic, meteorological parameters, 24-hour average mass concentration of particulate matter (Total suspended particles-TSP, PM_{10} , and $PM_{2.5}$) at several locations downwind two unpaved roads, located on a flat region without any other source of pollutants. We also implemented a commercial software of computational fluids dynamics (ANSYS Fluent), an air quality model to simulate the dispersion of solid and gas-phase pollutants emitted from roads. Numerical results of long-term and daily averages of TSP, PM_{10} and $PM_{2.5}$ concentrations showed high correlation with experimental measurements ($R^2 > 0.76$). We found, analytically and experimentally, that the plots of 24h and long-term averages of pollutant concentrations vs distance to the road edge converge into a single curve when they are expressed in terms of non-dimensional numbers and that this curve is well described by a beta function. Profiles of vertical concentration sketch an exponential function at the road edge, an S shape downwind and a flat shape far from the road. Particle size distribution fits a Rosin Rammler function with an average diameter of $\sim 7 \mu\text{m}$. This distribution remains unaltered downwind from the road, which implies that at any location within 1.5 km from the road, PM_{10} and $PM_{2.5}$ concentrations are a constant fraction of TSP concentration. Experimental data confirmed this observation. Previous results can be used to determine the size of the area impacted by roads, identify mitigating and adaptive countermeasures, and to improve the accuracy of vehicular emission factors

1.007 Model Ready Emissions Inventory Conversion System: Central Mexico Base Case.

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Abstract:

This work presents the Central México Emissions Inventory 2013; Spatial Temporal and Speciation Distribution model (STSP2013). The methodology and information used to perform the temporal, geographical and chemical distribution of the emissions is described. The results and the validation procedure are shown using the 2013 Emissions Inventory.

The EI 2013 considers seven pollutants: ammonia (NH_3), carbon monoxide (CO), nitrogen oxide (NO_x), particles (PM_{10} and $\text{PM}_{2.5}$), sulfur dioxide (SO_2) and volatile organic compounds (VOC). Emissions are from fixed, area and mobile sources. They are further subdivided into different categories. A source classification code (SCC), from EPA, is used to identify each one. Temporal and chemical profiles are based on the SCC. The STSP2013 system can generate files for RADM2, RACM, CBM5 and SAPRC99, these can be used by WRF-chem.

With this work air quality studies, policy evaluation and decision making can be done with an updated emissions inventory.

1.009 An On-line Monitor of the Oxidative Capacity of Airborne Particulate Matter (o-MOCA).

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Abstract:

The chemical properties of airborne particles have been associated with the ability of aerosols to generate cellular oxidative stress. Thus, rapid changes in the chemical composition may result in a significant variation of the oxidative potential of these particles. To better understand the ability of particles to exert oxidative stress and identify the particle properties responsible, we have developed an on-line, field-deployable instrument for the time-resolved quantification of the capacity of airborne particles to generate reactive oxygen species (ROS). Our approach adapts the widely accepted dithioerythritol (DTT) redox assay to on-line analysis of concentrated samples of airborne particles collected directly into sub-milliliter volumes of liquid using condensationally-enhanced particle collection technology. The concentrated nature of the suspension allows measuring the oxidative potential of particulate matter with time resolution of a few hours. The on-line Monitor of the Oxidative Capacity of Airborne Particulate Matter (o-MOCA) consists of a liquid collector coupled to a chemical module where the DTT analysis is conducted in-situ. The standard DTT assay has been modified for fast (30 min) analysis and coupled to the liquid collector for programmed sample transfer.

The chemical module has been built using reliable and cost-effective components. A new detection system has been custom built using single wavelength light-sources for signal and reference measurements and an Ocean Optics spectrometer. The DTT module will be easily coupled with the particle collector for field deployment. The system performance and robustness has been tested in the laboratory using the 9,10-Phenanthroquinone (PQ) as our standard compound.

1.013 Modeling Particulate Matter Dispersion in Metro Manila: Application of an Integrated MM5/CALPUFF Approach .

Early Career Scientist

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Abstract:

More than fifteen years after the Clean Air Act, air pollution in Metro Manila, Philippines, continues to adversely affect the health of more than 12 million residents. Recognizing the importance of air quality and its effects on public health and the environment, a study was initiated to support the development of science-based air quality management policies. To further improve the understanding of particulate matter (PM) pathway in the megacity, an integrated MM5/CALPUFF modeling system was used to simulate PM dispersion and to determine the contribution of point, area, and mobile sources to ambient concentrations. Emissions from point sources were estimated using data from the Self-Monitoring Reports of industries while area source emissions were estimated from household cooking fuel usage. Emissions from mobile sources were estimated using the Cube Transportation Demand Modeling Software. This approach divided the megacity into more than 90 zones connected by roads and analysis was done on how different modes of transportation are used to convey people from one zone to another. Results show that 76% of ambient PM concentration comes from on-road mobile sources, 20% from household cooking, and 4% from industrial equipment. Comparison of model results with annual average PM_{10} from measurements shows that model results fall within the range of observed values when background concentrations are added. High concentrations coincide with the most densely populated areas of Metro Manila and along major highways and guidelines for 24 hours and 1 year averaging periods are exceeded in most areas. The number of people exposed to specific levels of particulates was also estimated by overlaying the gridded concentrations over the population density grid. Results show that about one-third of the population is exposed to exceedances of the 24-hour guideline and almost a quarter of the population is exposed to exceedances of the annual guideline for PM_{10} .

1.014 Characteristics of personal exposure to PM_{2.5} from household solid fuels burning in rural Guanzhong Plain, China.

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Abstract:

Household solid fuel combustion for heating and cooking in rural areas is an important source of air pollution in Northwestern China, which largely contributes to PM_{2.5} personal exposure concentrations during the cold winter. There is a general lack of understanding about the personal exposure to PM_{2.5} levels and its chemical components emitted from household heating in northwestern Chinese rural populations. In this work, personal PM_{2.5} sampling associated to indoor and outdoor fixed samplings were carried out in Guanzhong Plain in December 2016 for the purpose of characterizing personal exposure to PM_{2.5} as a function of different solid fuels used in rural households. Correlations among personal exposure, indoor and outdoor PM_{2.5} levels and their mutual ratios were computed to investigate how personal exposure to fine aerosols can be related to microenvironmental PM levels and to individual activities. Housewife's personal exposure to PM_{2.5} concentration was 1.4 times higher than both indoor and outdoor values, and was related to the ignition of solid fuels for heating. Overall, the results showed that households using electric power for heating and cooking divided personal exposure to PM_{2.5} by at least a factor of two. Solid fuel combustion products and related secondary formed species dominated PM_{2.5} mass in personal exposure, indoor and outdoor samples. Motor vehicle emission and various dust sources were another two main identified contributors. Our results proved that the use of clean energy could be an effective measure to reduce personal exposure levels of PM_{2.5} from winter heating in rural areas,, which implied that the state should speed up the upgrade of the heating equipment fleet to protect the respiratory health of rural residents in Northwestern China.

1.015 Mobile measurements reveal high NO₂ and ammonia concentrations in German inner cities.

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Abstract:

Despite a number of regulatory measures by the European Union, the air quality in Germany is only slowly improving. Especially the concentration of nitrogen dioxide (NO₂) remains hazardously elevated. Although the concentrations of pollutants are monitored by measurement stations, the spatial coverage of the data is poor. Our measurements in German inner cities with MobiLab, the mobile laboratory of Forschungszentrum Jülich, reveal high peak concentrations of nitrogen oxides and other pollutants.

NO₂ is either directly emitted from Diesel engines with oxidation catalysts or produced by titration of NO with the available ozone. The highly time resolved data also enable the determination of emission ratios by normalizing the values to CO₂. As cars have been identified as main NO_x sources in German cities, an increasing number of Diesel engines are equipped with selective reduction catalysts (SCR) to diminish NO_x emissions.

However, tunnel data obtained from MobiLab measurements show that ambient temperature impacts the traffic emission of nitrogen oxides (NO_x) and that the average emission ratio of a car fleet in winter is one and a half times the summer value. NO₂ contributes between 10% to 40% to the total NO_x emission. In addition, efforts to reduce nitrogen oxide emission in Diesel cars by means reduction catalysts (SCR) can result in the release of ammonia (NH₃) which was observed to reach concentrations of up to 1 ppm in inner cities. Taking account the increasing number of cars with SCR catalysts the importance of ammonia as pollutant in German inner cities is expected to increase.

1.016 Significant Recent Changes in Anthropogenic SO₂ Emissions: Insights from Spaceborne Observations and Large Scale Implications.

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Abstract:

Sulfur dioxide (SO₂) and its secondary sulfate aerosol product in the atmosphere have profound impacts on air quality, ecosystems, and the climate. SO₂ is predominantly emitted from anthropogenic sources such as coal-fired power plants and smelters, but also has sizable sources from volcanic activities. While the overall level of global anthropogenic SO₂ emissions has seen relatively gradual changes over the past few decades, there have been significant regional trends due to changes in energy consumption as well as pollution control measures. These regional emission trends likely have substantial effects on the environment in both source and downwind areas. Accurate, up-to-date emission inventories are critical for assessing and mitigating these effects, but are often challenging to obtain due to the lack of necessary information. Here, we present our efforts and recent progresses in deriving SO₂ emission information from satellite measurements. In particular, we focus on advances in space-based SO₂ observations enabled by high-quality measurements from the Dutch/Finish Ozone Monitoring Instrument (OMI) aboard the NASA Aura spacecraft. We show that new remote sensing techniques, combined with innovative data analysis methods, have helped to quantify and track SO₂ emissions from ~500 sources around the world on an annual basis: <https://so2.gsfc.nasa.gov/measures.html>. This new top-down emission inventory reveals significant reduction in SO₂ emissions from China in recent years due to more strict pollution control measures, as well as steady increase in emissions from India due to continued growth of coal consumption. We also investigate SO₂ pollution transport events observed over the North Pacific during the same period. We present evidence that SO₂ emission reduction in northern China since the early 2010s has led to decrease in the export of SO₂ pollution from East Asia. Finally, we discuss the large-scale implications of these recent changes in SO₂ pollution observed from space.

1.017 Impact of ship emissions and port-industrial activities on the chemical characteristic of urban PM_{2.5} in southeastern China.

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Abstract:

Port activities have become a substantial source of atmospheric particles due to the flourishing seaborne trade and have an important impact on air in and around major ports. In this study, daily PM_{2.5} samples were simultaneously collected at an urban site (UB) and the nearby port-industrial site (PI) on the coast of southeastern China from April, 2015 to January, 2016. PM_{2.5} concentration was $46.4 \pm 20.9 \mu\text{g m}^{-3}$ at the UB and significantly higher at the PI ($51.9 \pm 25.9 \mu\text{g m}^{-3}$, $P_{t\text{-test}} < 0.01$). Chemical components including organic carbon (OC), elemental carbon (EC), water-soluble inorganic ions and several elements were analyzed for PM_{2.5} samples. The concentration of V at the PI was 1.5 times of that at the UB and was moderately correlated ($p < 0.05$) between sites, implying that ship emissions have an impact on both the PI and UB, but a more significant impact on the PI. Six source factors were extracted from the positive matrix factorization (PMF) analysis; they were secondary aerosols, coal combustion, biomass burning, mixed sources of industry and ship emissions, traffic emissions, and fugitive dust. The contribution of industry and ship emissions to PM_{2.5} at the PI (26.1%) was approximately double of that of the UB (13.2%). The difference of each source contribution among the trajectory clusters that included significant difference and insignificant difference from the UB to PI, which gave an insight into the role of local impacts. Conditional probability function (CPF) further identified that ship emissions and port activities distributed in the NE-E-SSE wind sectors were responsible for the source contribution of industry and ship emissions and secondary aerosols. This study well assesses the impacts of ship emissions and port activities on the surrounding air environment using the land-based measurements.

1.020 Monitoring sulfur dioxide from space: How we can interpret satellite data.

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Abstract:

Satellite measurements of vertical column densities (VCD: the total number of molecules or total mass per unit area) of sulfur dioxide (SO₂), a criteria air contaminant, were analyzed to link them with reported SO₂ emissions.

Fitting Ozone Monitoring Instrument (OMI) SO₂ VCD data by a linear combination of functions, where each function represents the plume from an individual source, makes it possible to estimate emission from these sources or groups of sources. If the location of all sources is known, it is expected that the fitting results and the actual OMI data will agree within the noise level as was found to be the case for the eastern U.S. and Canada. The approach was also used in reverse; that is, VCDs were reconstructed from reported emissions. Such "reconstructed" VCDs demonstrated a good agreement with the fitting results and the actual OMI data. This suggests a simple way of interpreting satellite SO₂ VCD data: they should agree with VCD estimates based on available emission inventories. Moreover, the differences between satellite SO₂ VCD data and VCD estimates based on available emission inventories can be used to find sources missing from these inventories.

The method was also applied to Europe demonstrated the agreement between satellite data and reported emissions and showing that the countries where no decreasing trends are observed are non-EU member states surrounded by EU countries with decreasing emissions. Applications for anthropogenic and volcanic sources in other regions such as Middle East, Central America, India, Africa, and China are also discussed.

While this study is focused on SO₂, the methods can be applied to other species with relatively short lifetimes measured from space, particularly to NO₂ and NH₃.

1.022 Characteristics of PM2.5 in India Collected by High-volume PM2.5 Particle Sampler.

Early Career Scientist

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Abstract:

Compared with the coarser atmospheric particles, fine particulate matter (<2.5 µm in aerodynamic diameter; PM2.5) has characteristics of smaller particle size, easier to inhale in the respiratory system, so it has great influence on human health and atmospheric environment quality. The influence on human health ranges from minor upper respiratory irritation to chronic respiratory and heart disease to lung cancer. In addition, short- and long-term exposures have also been linked with premature mortality and reduced life expectancy. With the development of global industrialization and urbanization, the problem of PM2.5 in the atmospheric environment has become increasingly serious. However, the filter method, which is a conventional sampling method, cannot collect a sufficient amount of PM2.5 particles to carry out toxicity assays using cells. In addition, when PM2.5 particles collected by filter method were used in the cell exposure experiment, influence of contaminants derived from the filter material cannot be avoided. So we propose a new type of high-volume PM2.5 particle sampler using an impactor and a cyclone, which can also avoid the effect of filter material and the clogging of the filter. It has two parts to collect samples, cyclone and back-up filter. The 50% cut-points of the cyclone for ambient aerosols at 1,100 L/min of air flow was 0.3 µm. India, as an Asian country with rapid economic development, have a typical representation of air pollution. The annual mean concentrations of PM2.5 was found to be about 160 µg/m³ in 2013. In this study, samples have been collected by the cyclone and back-up filter to analyze the concentration of metal elements and oxidative potential of PM2.5 in India.

1.023 Development of a small-sized cyclone to collect ultrafine particles in the air.

Early Career Scientist

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Abstract:

Fine particles in the air is serious concern for human health such as cancer, lung damage and respiratory disease. However detailed mechanism of the cellular biochemical reactions associated with the toxicity of fine particles have not been revealed well so far. Generally, cell exposure studies for aerosol particles been conducted using particulate matter collected by vibrating aerosol-loaded filters. However, the particles used for the exposure study may not be the same as those present in ambient air because contamination from the filter material may be included. Therefore we developed an instrument that collects fine particles in the air without using filter. It consists of an impactor and a cyclone. Fine particles in the air would be collected with cyclone. However this method also has a problem that cyclone cannot collect ultrafine particles. The 50% cut off diameter of the particles was about 0.3 μm though there were much quantity of particles smaller than 0.3 μm in the air. We would like to collect particles smaller than 0.3 μm . Therefore we prepared a small-sized cyclone. If the size of the cyclone diameter becomes smaller, the centrifugal force to the particles in the cyclone would be larger. As a result, the small-sized cyclone showed much better separation characteristics than the initial one.

1.024 Investigation of the factors controlling the variation of aerosol surface area concentrations in Fukuoka, Japan.

Early Career Scientist

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Abstract:

Observation of the ambient aerosol surface area concentrations is important to understand the aerosol toxicity because an increased surface area may be able to act as an enhanced reaction interface for certain reactions between aerosol particles and biological cells, as well as an augmented carrier surface for co-pollutants. In this study, the concentration of aerosol surface area was measured from April 2015 to March 2016 in Fukuoka, Japan. We investigated the monthly and diurnal variations in the correlations between the aerosol surface area and black carbon (BC) and sulfate concentrations. Throughout the year, aerosol surface area concentration was strongly correlated with the concentrations of BC, which has relatively large surface area since BC particles are usually submicron agglomerates consisting of much smaller (tens of nanometers) sized primary soot particles. In June 2015, however, the coefficient of determination for this correlation between the aerosol surface area and BC concentration was lower than in other months, as a result of high sulfate concentrations. For June, the number of data points for which the hourly sulfate concentration was $\geq 15 \mu\text{g m}^{-3}$ and the aerosol surface area concentration was $\geq 150 \mu\text{m}^2 \text{cm}^{-3}$ was extremely large. That is, high sulfate concentrations increased aerosol surface area concentrations, which resulted in a

weakening of the correlation between the aerosol surface area and BC concentrations. In addition, the correlation between the aerosol surface area and BC concentrations was weakest in the afternoon because certain secondary formed aerosols increase. This may be also because Fukuoka is generally dominated by the land and sea breeze, and BC concentrations decrease under those conditions due to the afternoon inflow of a clean airmass.

1.025 Development of atmospheric particle concentrator with virtual impaction and condensation growth.

Early Career Scientist

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Abstract:

Analysis of PM_{2.5} is carried out with various devices. However, due to the low atmospheric particle concentration, sometimes it is difficult to detect its components correctly and it takes a lot of time to collect samples. Therefore, in this study, we investigated the method of increasing the number concentration of particles with a virtual impactor. The virtual impactor is a device used for the inertial separation in particles. In this impactor a jet of particle-laden air is directed. The large particles cross the air streamlines and enter the straight passage, while the small particles follow the air streamlines into the side passage. To remove the large particles from the side passage, a fraction of the total flow passing through the virtual impactor is allowed to pass through the straight passage. This flow will be referred to as the minor flow, while the flow through the side passage will be referred to as the major flow. As a result, the concentration of the larger particles in the minor flow has increased. However, small particles can't be concentrated well by this method. So in this study, we attempted to enlarge particle diameter by condensation growth. The principle is that when vapor surrounding small particles reaches a certain degree of supersaturation, the vapor begins to condense onto the particles. The vapor can condense onto particles that are larger than a critical size. By combining virtual impactor and condensation growth, both of fine and coarse particles can be concentrated. In this study, we compared the concentration before and after passing through the virtual impactor. It was increased by 4.7 times for particles with diameter of 20 to 400 nm when the particle diameter was enlarged by condensation growth.

1.026 Cyclone collection of fine and coarse particles followed by exposure experiments.

Early Career Scientist

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Abstract:

Exposure to atmospheric aerosols is a serious concern for human health. However, detailed mechanisms of the cellular biochemical reactions associated with the toxicity of aerosol particles have not been elucidated well so far. Generally, cell exposure studies for aerosol particles have been conducted using particulate matter collected by vibrating aerosol-loaded filters. However, the particles used for the exposure study may not be the same as those present in ambient air. Possible contamination from the filter material should also be considered. In addition, sample handling to obtain particles for exposure experiments is highly complicated and time-consuming. Besides, the amount of particles that are collected on a filter is often insufficient to perform an exposure studies. Hence, the development of techniques that allow researchers to collect a sufficient amount of aerosol particles for exposure studies without the use of filters is needed. In this study, we developed a high-volume simultaneous sampler for fine (PM_{2.5}) and coarse aerosol particles using the impactor and cyclone techniques. Approximately 100 mg of fine and coarse aerosol particles can be collected individually as powder form for 2-3 week sampling. The sampling device developed in this study allows researchers to collect a sufficient amount of aerosol particles for cell exposure studies without the use of filters. We collected fine and coarse aerosol particles in three cities (Yokohama, Saitama, and Fukuoka) in Japan under the CYCLEX (Cyclone collection of PM_{2.5} followed by Exposure

Experiments) project. Chemical analysis (about water soluble ion, metal, Carbon) of the collected particles has been carried out followed by cellular exposure experiment. We found particle size- and sampling location-dependent response in the results of exposure experiments. Therefore, in cellular exposure experiment, the results of PM_{2.5} collected by the new method (virtual impactor and cyclone) differ from that a conventional method (real impactor and filter).

1.027 Measurement of the chemical components of aerosol particles with different electrostatic charging state.

Early Career Scientist

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Abstract:

Several studies have reported that the particle deposition in human airways is strongly enhanced by its electrostatic charging state. These facts clearly provide that aerosol particles with electrostatic charge deposit greater on human airways than it is expected from the particle size. Therefore, electrostatic charging state of aerosol particles is one of the key parameters of the human health impacts caused by aerosol. Nevertheless, few studies have focused on electrostatic charging state of atmospheric aerosol particles. In this study, we measured the chemical components of aerosol particles with different electrostatic charging state, in order to find out the relationship between electrostatic charging state of atmospheric aerosol particles and its sources.

To separate aerosol particles by different electrostatic charging state, we developed an experimental equipment composed of parallel electrode plate of aluminum and exterior structure of acrylic resin. The device named K-MACS (Keio-Measurement system of Aerosol Charging State) is designed to separate the aerosol particles by means of electric mobility. The K-MACS can separate the introduced aerosol particles into three types of electric charging state; particles with positive charge, particles with no charge or a small number of charges, and particles with negative charge.

We separated ambient aerosol particles into 3 types of electrical charging states using the K-MACS and collected aerosol particles respectively on quartz-fiber filter. Collected aerosol particles with different electrical charging state were analyzed by energy dispersive X-ray fluorescence spectrometry (EDXRF). Then, we calculated the element components proportion of electrically separated aerosol to ambient aerosol. As a result, aerosol particles separated as particles with no charge or a small number of charges had largest proportion for all element components. Also, particles with negative charge had larger proportion than those with positive charge for most element components.

1.028 Carbon Monoxide and Cities as Seen from the MOPITT Instrument.

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Abstract:

On 18th December 1999 the Terra platform was launched from the Vandenberg Air Force base carrying the Measurements Of Pollution In The Troposphere (MOPITT) instrument. Although manifested for a 5-year mission, the Terra satellite and MOPITT have now completed more than 18 years of operation.

The 18-year continuous data series that MOPITT has provided (so far) affords a great opportunity to look at longer-term changes over the planet if sufficient care is taken to eliminate instrumental effects. Fortunately, the instrument has been more stable than originally predicted and care has been taken throughout the mission to ensure that the data are properly validated. The result is a well-characterised time record that can now be “mined” for a variety of phenomena charting decadal changes (or stability) in carbon monoxide (CO) and looking at the frequency of events that often drive anomalies in the carbon monoxide distribution.

Recent interest in megacities and their atmospheric chemistry footprint both within their boundaries and in the broader region has prompted a study using the MOPITT dataset of the changes in CO around megacities. CO is neither confined locally, nor globally distributed so it offers an interesting “medium life” pollutant with influence over a considerable area. This talk will present some studies of CO around large cities and industrial zones with the objective of looking for long-term trends.

MOPITT was built in Canada by COMDEV of Cambridge, ON, data processing is performed at the National Center for Atmospheric Research in Boulder, CO, the Terra instrument is funded and operated by NASA and the MOPITT instrument and operations are funded by the Canadian Space Agency.

1.029 Chemical characterization of ultrafine particles in aircraft emissions observed in the Narita International Airport, Japan: Possible contributions of fuel and lubricating oil.

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Abstract:

Aircrafts (jet engines) emit large number of ultrafine particles. However, the chemical composition and sources of aircraft exhaust particles (e.g. fuel, lubricating oil) are not well understood. To reveal them, we conducted a field measurement in the Narita International Airport, Japan. The measurements were conducted at 140 m west of the runway A in winter (February 2018). Size-resolved ambient particles were simultaneously collected with two cascade impactors (NanoMoudi-II, MSP, USA, from 10 nm to 10 μ m) using gold foils and polycarbonate filters as the collecting substrates. To differentiate the effect of aircraft emissions, the samples were collected during daytime (aircrafts fly) and nighttime (aircrafts do not fly), respectively. The particulate mass, elemental/organic carbon, organic compounds, and trace elements were measured. For comparison, organic components and elements in jet fuels (Jet-A1) and jet oils (Mobil Jet oil II and Mobile Jet oil 254, ExxonMobil, USA) were also analyzed. Based on these measurements, the chemical composition and sources of aircraft exhaust ultrafine particles are discussed.

1.030 Effects of Transboundary Peat-forest Smoke on Acidity of Receptor Urban PM_{2.5} in Maritime Continent.

Early Career Scientist

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Abstract:

This is the first multi-year study in the Maritime Continent, Southeast Asia demonstrating that transboundary peat forest (PF) burning smoke lessens acidity of PM_{2.5} in an urban receptor environment. Acidity of more than 450 urban PM_{2.5} (daily 24-hour) samples collected during 2011–2015 were investigated by coupling chemical characterization with thermodynamic Extended Aerosol Inorganics Model (E-AIM) simulation. The average in-situ pH (pH₁₅) increased by 30% from 1.2 in non-smoke dominant (NSD) PM_{2.5} to 1.6 in smoke dominant (SD) samples, and elevated up to 2.4 during an episodic smoke event in June 2013, demonstrating that transboundary PF smoke increased alkalinity of urban PM_{2.5}. Enhancement in particulate ammonium (1.7 – 2.1 folds), outweighing the increment in sulfate (1.2 – 1.6 folds), was the dominant factor increasing alkalinity in SD and episodic PM_{2.5}. The increased ammonium in PM_{2.5} was concurred by surged concentrations in gaseous ammonia during SD and episodic period; the concentration of NH_{3(g)} was enriched up to 8.5 folds of NSD periods, larger than the increment in other acidic gases (SO₂, HNO₃, and HCl). Statistical analyses demonstrate that a minimum of 86 NSD samples are required to show inorganic ionic concentrations differing from 117 SD samples at a power (confidence) of 90%. Nevertheless, such sample sizes remain insufficient, rendering biased lower pH₁₅ as if PF smoke acidified urban PM_{2.5}. Our results also show that >100 NSD PM_{2.5} samples are needed to represent local environment as a proper baseline, which is critical for assessing impact of transboundary PF smoke on receptor urban environment in the Maritime Continent.

1.032 Spatial distribution of number concentration and characteristics of ultrafine particles in Roadside Atmosphere.

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Abstract:

Understanding local-scale transport and dispersion of pollutants emitted from traffic sources is important for urban planning and air quality assessments. To understand the distribution of the ultrafine particles in the vicinity of urban roads, the number concentration distribution of ultrafine particles in the air was observed at road side and background area. Two portable SMPSs were used for measuring the particle number size distribution (NSD) according to the particle diameter. One SMPS was installed at the pavement to measure the roadside NSD (this observation point are called "Stationary site"), and another was moved vertically to the main street to measure NSD in various points away from the main street (this observation points are called "Mobile site"). The points of mobile site were set at the edge of the sidewalk, the end of the sidewalk, and also more behind of road side and the height was 1.5m. The wind direction / speed data by ultrasonic anemometer and the measurement result of VOC concentration distribution were used for examine the diffusion situation in more detail. In mobile site, there was large difference between winter and spring in NSD. Especially, the amount of <50 nm particles in winter was larger than that in spring. The number of <50 nm particles was considered to be decreased in spring, because higher temperature in spring compared to that in winter made it more difficult to form ultrafine aerosol. NSD in the road side, the changing with time and the diffusion to the background area were examined by comparing the number distribution of stationary site and mobile site. Depending on the conditions, attenuation at very short distances was observed. By comparing the distribution of particle number and the distribution of VOC, characteristics of attenuation of nanoparticles were discussed.

1.034 Identification and implications of biomarkers related to transboundary peat-forest smoke in urban environment.

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Abstract:

Concurrent peat-forest (PF) burning smoke in the Maritime Continent substantially degrades air quality affecting >75 million people in Southeast Asia, and imposes serious burden on global carbon footprint. Integrating laboratory mechanistic studies and field measurements, we investigate a suite of six organic markers in >150 PM_{2.5} (daily 24-hour) samples to quantitatively evaluate how transboundary PF smoke increases pollutant burden in an urban environment (Singapore). A tracer of pyrolysis of biomass, levoglucosan, and its photooxidation daughter compounds (ribonic acid lactone and malic acid) are identified in laboratory studies and quantified in field samples affected by transboundary PF smoke. Relative to ~60 non-smoke dominant (NSD) PM_{2.5} samples, the concentration of levoglucosan, ribonic acid lactone and malic acid during the longest smoke episode in 2015 increased by factors of > 10, 19, and 5, respectively. Our field measurements also quantify three secondary biogenic organic compounds (SBOCs, 3-hydroxyglutaric acid, 3-hydroxy-2,2-dimethyl glutaric acid, 2-methylglyceric acid) originating through atmospheric photooxidation of biogenic volatile organic compounds (BOVC, isoprene and alpha-pinene). On average, the three SBOCs together in the receptor urban environment increased almost 10 times during the smoky period, exhibiting temporal trends close to the "levoglucosan family" introduced by PF burning smoke. Nevertheless, unlike the abundant levoglucosan family, little SBOCs were found close to PF burning sites. Although these SBOCs can also be formed through photooxidation of PF smoke during atmospheric transport, preliminary statistical analyses suggest that they were more associated with local sources. This implies that increased SBOC concentrations at the receptor site could be yielded from transformation of surged BVOC released by local vegetation undergoing significant abiotic disturbance (e.g. transboundary PF smoke). Further statistical analyses and BVOCs measurements are needed to verify whether higher concentrations in the three SBOCs may serve as indicators of stronger "stress" experienced by the receptor environment.

1.039 Seasonal Variability and Source Apportionment of Fine Particulate Matter in the Klang Valley Urban-Industrial Environment.

Early Career Scientist

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Abstract:

This study comprehensively explores the characterization and source apportionment of fine particulate matter (PM_{2.5}) in the Klang Valley urban-industrial environment for a complete Malaysia's four seasonal perspectives. Two methods were employed: 1) gravimetric method using high volume sampler for PM_{2.5} mass and chemical composition; and 2) continuous monitoring on particle number concentration (PNC) using environmental dust monitor (GRIMM 365) covering particle diameter (Dp) between 0.265 and 34 µm. The results reveal that PM_{2.5} mass concentration for all seasons except north-east monsoon showed more than 50% exceedance of the international standards. Chemical compositions exposed that both primary and secondary pollutants of PM_{2.5} are equally important, albeit with seasonal variability. Four factors were identified from source apportionment analysis with varies relative contribution for different season. In particular, the PM_{2.5} was dominantly sourced from Indonesian peatland fire (IPF) during the south-west monsoon. Hotspot count and backward trajectory further support that transboundary sources could be crucial contributor during certain period. In relation to meteorological-gaseous parameters, PM_{2.5} at site was influenced by different parameters during different seasons. The PNC distribution showed that particles with Dp < 1µm dominated the particle number count, mass and semi-volatile compound (SVC) fraction at the site. The PNC source apportionment resulted with four factors, with biggest factor on particles with Dp range between 0.265 and 1.45 µm. Both daily and diurnal correlations

matrix showed that meteorological-gaseous influence significantly ($p < 0.05$) particles with $D_p < 1.45 \mu\text{m}$. Diurnal distribution strongly suggests an influence of traffic (motor vehicle emission). Size-segregated source apportionment discloses that particles with $D_p < 0.5 \mu\text{m}$ covers 95% or more of particle number for all factors. Overall, this study reveals that changes in the environmental conditions have been reflected sensitively in fine particles aerosol distribution patterns of the Klang Valley urban-industrial environment.

1.045 Pollution Characteristics and Formation Mechanism of PM_{2.5} at Ningbo During the G20 Summit in 2016.

Early Career Scientist

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Abstract:

In this study we investigate two episodes of PM_{2.5} at Ningbo during September 2016, which covered the G20 summit in 2016. Chemical components including water-soluble inorganic ions (WSII), black carbon (BC) and gaseous pollutants were measured. The mean hourly concentration of PM_{2.5} was (21.20±11.68) μg m⁻³ with 14.0% exceeded 35 μg m⁻³ during September. WSII was the major component of PM_{2.5} and accounted for (71.7±15.8) %. SO₄²⁻, NO₃⁻, and NH₄⁺ (SNA) were the dominating components of WSII. In the first episode (E1, Sep. 1-10), strict control measures were implemented during Sep.

1-5. Concentrations of pollutants were higher during Sep. 1-3, which could be attributed to stable weather. During Sep. 4-5, concentrations of $PM_{2.5}$ and most species were decreased except Na^+ . During this period, clean air mass coming from the ocean with higher wind speed was benefit for diffusion of $PM_{2.5}$ but contributed to the concentration of Na^+ . Increment of $PM_{2.5}$ occurred when the summit concluded (Sep. 6-10). Lower wind speed and more sources were responsible for this increment. The formation of SNA contributed much to the formation of $PM_{2.5}$, which could be attributed to the gas-phase transformation and the heterogenous reaction. As for the second episode (E2, Sep. 11-20), $PM_{2.5}$, SNA and gaseous pollutants had significant reduction influenced by typhoon during Sep. 14-16, while the proportions and concentrations of Na^+ , Ca^{2+} , and Mg^{2+} was higher for the sea salt and dust resulted by typhoon. Sep. 17-20 were still under the influence of typhoon, wind speed was still high while the wind direction changed to northwest, which brought some pollutants from the inland to Ningbo and lead to increasing of $PM_{2.5}$.

1.047 The journey of C2-C5 alkane emissions from the oil and gas sector: atmospheric and air quality implications.

Early Career Scientist

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Abstract:

Oil and gas extraction has undergone a dramatic increase over the past century and, more recently, the advent of hydraulic fracturing has opened up new regions to extraction, particularly in the United States. This oil and gas extraction, and associated infrastructure, emit a variety of compounds including light alkanes (C₂-C₅) that have been shown to contribute to air quality degradation. Further, there is an observed ubiquitous increase in the atmospheric abundance of light alkanes in the Northern Hemisphere. Given this, it is critically important that we develop methodologies to estimate light alkane emissions with a rapidly evolving oil and gas industry. This is currently a challenge for emission inventories. Here we present results from three recent papers that quantify the role of the oil and gas sector on light alkane emissions at local, regional, and global scales. Our work on the global budget of ethane (C₂H₆) suggests that emissions of light alkanes in several major anthropogenic source regions, including the central and eastern U.S., Europe, Russia, and the Middle East, should be revisited. A closer look into the U.S. with updated oil and gas emissions was done using a nested high-resolution (0.5 degree x 0.667 degree) simulation to examine the contribution of this sector to the abundance of C₂-C₅ alkanes. Our model largely reproduces observed C₂ and C₄-C₅ alkane abundances over the U.S., based on a comparison to a large suite of surface observations, column measurements, and aircraft profiles. In contrast, simulated propane (C₃H₈) abundances are low over the central U.S. and we suggest that emissions from this sector need to be revisited. We also found that emissions of C₂-C₅ alkanes from the oil and gas sector make the largest contribution to secondary species production (e.g., ozone, peroxyacetyl nitrate, and several ketones) over the central U.S. compared to other regions.

1.048 Fine Particle Pollution and Acid Deposition in Bangkok Metropolitan Region: Project Overview and Policy Implications.

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Abstract:

This presentation will give an outline of a JICA-RI research project on fine particle pollution and acid deposition in the Bangkok Metropolitan Region (BMR), with a particular emphasis on its policy context and implications. The research project, which was carried out with the participation of the Asian Institute of Technology (AIT) and the Asia Center for Air Pollution Research (ACAP), has been timed with a recent renewed global interest in the problem of air pollution as a development issue, as evidenced by explicit targets of air pollution set under the United Nations' Sustainable Development Goals (SDGs). The project, which began in summer 2014, has two components, the measurements of fine particulate matter (PM_{2.5}) in BMR and the case studies of PM_{2.5} problem and policy in selected countries. The first group of project activities consists of a long-term weekly sampling and analysis of PM_{2.5} and rainfall in two locations of BMR. Meanwhile, concerning the project's second component, we have so far published a set of working papers (JICA-RI Working Papers) on case studies of Japan, South Korea, and Mexico. Our results of BMR measurements confirm that the levels of PM_{2.5} fail to meet the Thai environmental standards and the benchmark of the WHO guideline. Observational data also reveal finer characteristics of the problem, such as the diversity of pollution sources composed of traffic, biomass burning and secondary formation. Thailand has already implemented air quality and emission standards, and it is also strengthening its institutions for monitoring and enforcement of regulation. However, more actions can be taken as well. What our case studies of northeastern Asian countries suggest is that effective pollution control would require a holistic approach combining a range of measures, including those affecting people's incentives on their behavior and those involving a transformation of an economic system.

1.049 Microphysical and Chemical property of winter fog in highly polluted place in India .

Early Career Scientist

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Abstract:

The fog Experiment was carried out in Delhi to characterize the chemical and microphysical properties of dense fogs occur in the winter season over the northern part of India. This study provides results on aerosol and fog water chemistry, and microphysical properties during dense fog (around 25 events) occurred during 2015 - 2018 winter seasons. Data from the aerosol and fog water chemistry so far indicate a highly polluted environment in which fog developed and dominance of combustion ,vehicular exhaust sources have been noted in aerosol samples. Rapid uptake of gaseous NH_3 in the fog droplets was observed, which was likely due to acidic aerosol solution of HNO_3^- observed during dense fog cases. Secondary inorganic aerosols (SO_4^{2-} and NO_3^-) were dominant ions (38%) in the chemical constituents of the fine particles, higher during all fog events. The chemical partitioning of fog water samples suggested that NH_4^+ (28%) and SO_4^{2-} (26%) dominates chemical composition. The pH of fog water indicates alkaline (6.91). The concentrations of NH_4^+ , SO_4^{2-} , Cl^- , Ca_2^+ and NO_3^- were found to be very high, indicating that fog water is highly polluted. Even though the acidic ions SO_4^{2-} and NO_3^- are very high, fog water is not acidic because of very high concentration of neutralizing ions NH_4^+ and Ca_2^+ in the samples. Mean particle size distribution was observed by Fog monitor FM-120. There were considerably high aerosol concentrations during the measurement period with an averaged aerosol number concentration of $1,00,000 \text{ cm}^{-3}$. a large amount of fog droplets ($>1000 \text{ cm}^{-3}$) with small size (5-6 μm) were observed during the fog period, resulting in extremely low visibility (less than 100 m). Hence it is most likely that the particles grew larger by vapor

deposition/collection processes. LWC excess of 0.4 g/m^3 has been observed, suggesting that very large particles are formed during dense foggy condition.

1.052 Surface ozone over the coastal Antarctica during Austral summer.

Early Career Scientist

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Abstract:

Surface ozone was measured at the coastal Antarctic station, Bharati (69.4°S, 76.2°E, ~35 m amsl) during the Austral summer (December-January-February) of 2015, 2016 and 2017. Average ozone mixing ratios ($\sim 18 \pm 3$ ppbv) at Bharati are comparable with other coastal stations of Antarctica but lower than those over inland Antarctic stations (20–25 ppbv). The Copernicus Atmosphere Monitoring Service (CAMS) model reproduces the observed levels of ozone (bias: 2–3 ppbv) and variability (correlation coefficient of ~ 0.4 – 0.5). Many events with an ozone enhancement of 4–8 ppbv were observed. The analysis of potential vorticity along with the vertical profiles of ozone from CAMS simulations shows that these enhancements are caused by the intrusions of stratospheric air into the troposphere and subsequent descend of ozone-rich air. The analysis of an event observed on 23 February 2016, using the airmass back trajectory in conjunction with in-situ measured vertical profile of ozone, showed that the high ozone levels, mostly located at around 3 km, descended (descent rate ≥ 250 m hr^{-1}) to the ground causing enhancement of ~ 4 ppbv in the surface ozone. A global chemistry-climate model ECHAM5/MESy Atmospheric Chemistry (EMAC) reproduces the mean levels with a bias of ~ 2 ppbv. Analysis of a stratospheric tracer in the EMAC model shows that stratospheric influences enhance surface ozone levels by 35–38% at Bharati station during austral summer. Computations of ozone production and loss using EMAC results show that the

study region acts as a net sink and indicating that the surface ozone levels are sustained by the influx from stratosphere.

1.053 On-line and off-line measurements of particle-bound reactive oxygen species (ROS) in Beijing.

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Abstract:

Reactive oxygen species (ROS), present in particles or generated by particle components upon deposition of particles in the human lung, are widely thought to be one of the main contributors to particle-related toxicity. However, there is so far only little data available on their concentrations in ambient air, making it difficult to gauge their impact on air quality. Recent studies have shown that a large fraction of particle-bound ROS in secondary organic aerosol is relatively short-lived, with lifetimes of several minutes. Traditional off-line sampling with high-volume samplers will therefore likely severely underestimate ROS concentrations, showing the need for on-line instrumentation. We have recently developed a compact, high time-resolution, on-line instrument for the measurement of particle-bound ROS (OPROSI). To determine ROS concentrations, particles are continuously extracted and the extract is reacted with 2'-dichlorofluorescein (DCFH) in presence of horseradish peroxidase (HRP). This leads to formation of a fluorescent dye, which is detected spectroscopically. The instrument allows for up to 16 h of continuous measurement with a time resolution of around 10 min and a limit of detection of ca. 3 nmol [H₂O₂] equivalent per m³ air.

We used the OPROSI to continuously measure the concentration of particle-bound ROS in Beijing air during the Air Pollution and Human Health in a Developing Megacity (APHH-Beijing) campaign in November-December 2016 and May-June 2017. We observed seasonal variations as well as pronounced diurnal cycles, with maxima developing in summer in later afternoon whereas winter daily maxima usually occur around midday or early afternoon. On-line ROS data are compared with off-line ROS data from aerosol collected in parallel on filters, with other gaseous and particulate air pollution parameters and with meteorological measurements. This study is the first long-term, online ROS data set, enabling us to gain a better understanding of the factors influencing ROS generation and distribution.

1.054 Long term ground level ozone observations in Malaysia: Spatio-temporal variability and challenges in mitigation.

Early Career Scientist

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Abstract:

Long term (> 10 years) ground level ozone measurements from ambient air quality networks provide an opportunity to determine ozone behaviour over space and time. Coupled with precursor and meteorological data, these measurements can provide information on the relative influence of emissions and local meteorology on ozone concentration and identify potential mitigation challenges. Data from more than 40 ambient air quality stations that were deployed in stages by the Department of Environment Malaysia since 1996 to 2015 were analysed to determine the spatio-temporal variability of ozone. Peak ozone concentrations did not exceed Malaysian Ambient Air Quality Guideline of 100 ppbv for the duration of the study period at the Malaysian Borneo island while it was frequently exceeded in the Malaysian Peninsular. Within the Malaysian Peninsular, several hotspots were identified. The seasonal cycle, ozone weekend effect and diurnal ozone observations highlight the variability of ozone within a small geographical area as well as the influence of long range transport of pollutants. The mitigation challenges include the risk of ozone increasing at certain areas due to 'blanket' regulations of NO_x emissions. The current work is expected to provide an overview of ground level ozone variability and highlight potential challenges in ozone mitigation.

1.056 Reaction of Limonene with HOCl and Cl₂ in the Dark Followed by Particle Formation under Indoor Fluorescent Light.

Early Career Scientist

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Abstract:

Application of bleach solution (major component NaOCl) in indoor environments emits gaseous hypochlorous acid (HOCl) and chlorine (Cl₂), both of which are strong oxidants. In contrast to the outdoor atmosphere, where mixing ratios of HOCl and Cl₂ in marine air are low (10s to 100s of pptv), indoor HOCl and Cl₂ can reach high levels during cleaning activities (100s of ppbv). These gases may react with unsaturated organic compounds on indoor surfaces and in indoor air. In this study, we studied the reaction of limonene, one of the most common indoor volatile organic compounds (VOCs) arising from use of cleaning products, fragrance, air fresheners, with HOCl and Cl₂ in the dark and under indoor irradiation conditions in an environmental smog chamber. Experiments were conducted with indoor relevant concentrations of reactants (HOCl, Cl₂ and limonene), relative humidity and irradiation. A dark reaction was observed between limonene and HOCl/Cl₂. The gas-phase reaction products were investigated using chemical ionization mass spectrometry. With subsequent use of indoor fluorescent lights, a significant mass loading of secondary particles formed. Aerosol mass spectrometry measurements indicate a large contribution of particulate organochlorine species. This is the first study on the reaction of HOCl and Cl₂ with unsaturated organics relevant for indoor air chemistry. Results suggest that secondary particle formation may occur in indoor environments due to the use of common cleaning products.

1.057 Contribution of Natural Emissions to Air Quality in Korea.

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Abstract:

Measurements over Korea during May-June 2016 as part of the KORUS-AQ (Korea-U.S. Air Quality) campaign showed an increase in ozone mixing ratios from May into June, coincident with increasing biogenic emissions of isoprene and other compounds as temperatures increased. To quantify the impact of biogenic emissions on ozone pollution, model simulations at a range of scales have been used in combination with the airborne and ground-based measurements of the KORUS-AQ campaign. A global chemistry model (CESM/CAM-chem) has been run at different horizontal resolutions (1, 0.5, 0.25 degrees) with the standard chemical mechanism, as well as an expanded terpene oxidation scheme. The simulations are evaluated with the full suite of observed ozone precursors, including NO_x, hydrocarbons and oxygenated volatile organic compounds (OVOCs). Evaluations of the online biogenic emissions model MEGAN in CAM-chem will be presented through comparisons with observations of isoprene and terpenes, as well as OVOCs, such as methanol and acetone. Sensitivity to updated landcover and emission factors in MEGAN are also being investigated. Box model calculations initialized with observations, along with sensitivity studies (e.g., zeroing isoprene) will be used to illustrate the impact of biogenic emissions on ozone amounts for a range of anthropogenic pollutant levels. The KORUS-AQ Science Team is acknowledged for contributions to this work.

1.059 Nitrate Isotopic Signature of Rainwater in Singapore: Implications for nitrogen sources and transformation in tropical regions.

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Abstract:

Nitrate Isotopic Signature of Rainwater in Singapore: Implications for nitrogen sources and transformation in tropical regions

Cai Li, **Shaoneng He**, Siliang Li, Fujun Yue, and Nathalie

F. Goodkin

Globally increased emissions of nitrogen oxides (NO_x) in the atmosphere pose threats to global ecosystems and human health. The main sink of nitrogen oxides from the atmosphere to terrestrial systems is the wet deposition. Therefore, tropical regions with abundant precipitation are likely to experience greater impact from nitrogen pollution. To identify the nitrate sources in tropical rainwater, we collected daily rainwater samples in Singapore between May 2015 and July 2017 and measured coupled nitrogen and oxygen isotopes of nitrate in these samples. The results showed that the NO₃⁻-N concentrations range from 0.05 to 3.28 mg/L, with an average of 0.64±0.54 mg/L (±1SD), showing a higher level in the inter-monsoon (IM, April to May and October to November) period relative to the Northeast (NE) monsoon (December to March) and Southwest (SW) monsoon (June to September). The δ¹⁵N-NO₃⁻ values range from -6.5‰ to +8.2‰, with an average of -0.6±2.6‰, and the δ¹⁸O-NO₃⁻ values range from +38.9‰ to +71.7‰, with an average of +58.0±6.4‰. Similar to the seasonal pattern of nitrate concentration, higher isotopic values of nitrate are also observed during IM period, while the NE monsoon had more negative δ¹⁵N-NO₃⁻ values. In combination with back trajectory analyses, the wide range of δ¹⁵N-NO₃⁻ values suggests multiple nitrate sources, including anthropogenic activities (power plants, industry, transportation and biomass burning) and natural sources (lightning and biogenic soil NO_x). The seasonal pattern of δ¹⁵N-NO₃⁻ values implies proportional contributions from different nitrate sources. We believe that seasonal variability of δ¹⁸O-NO₃⁻ values is driven by the formation pathways, with lower δ¹⁸O-NO₃⁻ values resulting from the hydroxyl radicals and peroxy radicals, which compete with ozone.

1.060 An investigation of possible roles of atmospheric circulation on annual visibility in Pearl River Delta, southern China.

Early Career Scientist

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Abstract:

We investigate annual variations of visibility in Pearl River Delta (PRD) region from 1973 to 2017 and their relationship between atmospheric circulations based on daily records from Global Summary of the Day (GSOD) database and NCEP/NCAR reanalysis data. In general, the annual visibility in PRD has decreased from 1973 to 2017, however there is a significant improvement in visibility since 2007. According to the spatial distribution of correlation coefficients, six atmospheric circulation indices are defined from the key areas in sea level pressure, zonal and meridional winds at 850 hPa, geopotential height field at 500 hPa, zonal wind at 200 hPa, and air temperature at 200 hPa, respectively. These six circulation indices together can explain 79.1% variance of the visibility in the year-to-year variability, thus a statistical model is established between visibility and atmospheric circulation indices. Furthermore, the visibility in the future under different scenarios is calculated based on those indices derived from Coupled Model Intercomparison Project Phase 5 (CMIP5) model simulations. It is vital for government decision makers to take long-term action in dealing with the improvement in air quality in PRD indicated by the atmospheric circulation conditions.

1.061 Airborne Air Pollution Assessment around London UK, During EMeRGe-EU .

Early Career Scientist

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Abstract:

In July 2017, measurements were made using the UK's Facility for Airborne Atmospheric Measurement (FAAM) as a part of the Effect of Megacities on the Transport and Transformation of Pollutants on the Regional to Global Scales (EMeRGe) project. In a combined effort with the DLR-HALO aircraft, plumes from several cities across Europe were measured for a variety of chemical species relevant to air pollution. The FAAM aircraft's seven flights focused on measuring the inflow and outflow around London, and providing vertical structure of the plume.

We present these data, examining the structure of the London plume. Some of the flights lend themselves to mass balance calculations, in these cases this has been performed to quantify bulk emission. Through the comparison of measured data with air quality and transport models (GEOS-Chem and WRF-CMAQ) we gain an insight into the emission, transport and processing of air pollutants (NO_x , CO, O_3) in South East UK.

1.062 Characterization and comparison of organic tracers in five mega cities, China, 2013 and 2003.

Early Career Scientist

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Abstract:

A study focuses on the characterization of organic tracers in five mega cities in China, Beijing, Xi'an, Shanghai, Guangzhou, Hong Kong. Seasonal variations in OC, EC, organic tracers, and some ions are measured by using the offline analysis methods. Mainly introduced n-alkanes, PAHs, hopanes, sugars, n-alkanoic acid, n-alkanols, phthalates and so on in these regions. In 2003, the laboratory had made simultaneous observations of five cities. Ten years later, in 2013, the campaign was conducted in the same season and in the same locations. The results of 2003 observations have been published in Wang et al. 2006. This report provides detailed reports on observations and compares the differences in emissions of organic matter over a decade. The analysis can then lead to a decade of China Changes in urban emission source data. At the same time, the offline data source apportionment results discussed in this work were obtained from PMF analysis (Paatero and Tapper, 1994) of GC-MS using the Multilinear Engine (ME-2; Paatero, 1999). The Source Finder toolkit (SoFi; Canonaco et al., 2013, v.6.37) for Igor Pro (Wavemetrics, Inc., Portland, OR, USA) served as interface for data input and result evaluation.

1.065 An Ozone Event During a High Pressure Episode in the North China Plain: Transport and Photochemistry.

Early Career Scientist

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Abstract:

The Air Chemistry Research in Asia (ARIAs) field campaign flew 11 research flights collecting meteorological, trace gas, and aerosol measurements in Spring 2016 in the North China Plain (NCP). In May, the beginning of the ozone (O_3) season, the NCP experienced numerous violations of World Health Organization (WHO) air quality standards to protect human health. We present a case study of an O_3 event during a persistent and anomalous high-pressure episode on May 17 to May 21, 2016. The National Oceanic and Atmospheric Administration's (NOAA) Hybrid Single Particle Lagrangian Integrated Trajectory Model (HYSPLIT) forward trajectories show large recirculation during this period bringing pollutants from the Korean Peninsula to China. The anticyclonic circulation with weak winds at the surface, combined with the position of the Taihang Mountains, inhibited pollutant dispersion and allowed for development of a multi-day O_3 event. An observation-constrained box model simulation study using the called Framework for 0-Dimensional Atmospheric Modeling (F0AM) was used to study O_3 photochemical processes along the flight track and ground site in Xingtai. Preliminary results suggest O_3 production tends to be more VOC-sensitive in the morning with lower O_3 production compared to the afternoon rates (up to 20 ppb/hr). VOC OH reactivity will be used to quantify the potential of a VOC molecule to produce O_3 . Identification of reactive VOCs concerning O_3 formation has significant policy implications; isoprene was relatively unimportant while CO played a major role in HO_2 formation. O_3 during this anomalous high-pressure event was relatively constant and just as high as during other synoptic conditions. Additionally, 3 examples of transport from China to South Korea were identified. These events brought cleaner air into China where it was dispersed and diluted before continuing to the east. These transport events showcase O_3 exceedances in the NCP can occur with and without strong transport.

1.067 Development of Device Evaluating On-site VOC Emissions during Refueling Gasoline.

Early Career Scientist

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Abstract:

We have developed a new device which can evaluate amount of VOC emissions during refueling process to gasoline cars. This device vacuums an air surrounding fuel filler cap of refueling car and traps volatile organic compounds by a canister filled with activated carbon or silica. By measuring a growth of canister weight, we can evaluate the VOC emissions during refueling process.

Using the developed device, we have evaluated an effect of introducing most recent gasoline dispenser which is equipped with vapor collection liquified system (VLCS) in real world condition. VLCS is basically similar to stage II system used in California and Europe which vacuum refueling emissions and send them to underground tank. Difference of VLCS to stage II system is trapped VOC is not sent to underground tank as a gasoline vapor but trapped VOC is once liquified and sent to underground tank as a gasoline liquid.

1.068 Volatile organic compound emissions in the South China Sea during the 2011 VASCO Cruise: sources, emission rates, and ozone formation potential.

Early Career Scientist

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Abstract:

As part of the Seven Southeast Asian Studies (7SEAS) program, air sampling was conducted on the M/Y Vasco over a two-week research cruise in late September 2011 in the Northern Palawan region of the South China Sea (SCS) to observe the temporal behavior of atmospheric aerosol properties and their relationships to meteorology during the Southwest monsoon. Whole air samples from the cruise, with over 60 identified trace gases, were analyzed to identify potential sources, emissions and ozone formation potentials (OFPs). Based on HYSPLIT ensemble back-trajectories and MODIS Active Fire satellite data, the two periods of enhanced VOC concentrations observed are dominated by contributions from biomass burning. However, because the air masses were transported over long distances, this paper further discusses the influence of photochemical aging and other regional sources mixed into the plume. To identify the sources, positive matrix factorization (PMF) is applied. Six factors are identified with the following contributions: biomass burning (19.2%), urban emissions (48.4%), industrial emissions (8.5%), ships (7.9%), marine emissions (10.6%), and a mixed source (5.3%). Normalized excess mixing ratios (NEMRs) are calculated with respect to CO to isolate

combustion-related emissions. NEMRs for three VOCs (ethyne, benzene, 3-Methyl-2-BuONO₂) showed high correlation ($R^2 > 0.8$) and eight (CH₃I, ethane, CH₃Cl, 2-BuONO₂, 3-PenONO₂, 2-PenONO₂, CHCl₃, EtONO₂) showed moderately high correlation ($0.8 > R^2 > 0.5$) with CO. These calculations were robust, consistent using both linear regression and source-tracer-ratio (STR) methods. These NEMRs represent the integrated regional emissions attributed to combustion-related sources. Finally, the OFPs of individual VOCs and of each source are quantified using the maximum incremental reactivity (MIR) scale. Within the plumes, OFP is 2-3 times above background, even at a receptor point distant from large emission sources. This characterization of emissions, particularly combustion-related ones, offers insight into the long-range impact of biomass burning and other sources within the SCS region.

1.069 Particulate Matters (PM₁₀, PM_{2.5} and PM_{1.0}) and Gaseous Pollutants Exposure to Indoor Environment and the Association of Fine PM with Lung Function in Dhaka city, Bangladesh.

Early Career Scientist

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Abstract:

PM_{1.0} (particulate matter with an aerodynamic diameter $\leq 1.0 \mu\text{m}$), PM_{2.5} (particulate matter with an aerodynamic diameter $\leq 2.5 \mu\text{m}$) and PM₁₀ (particulate matter with an aerodynamic diameter ranging from 2.5 to 10 μm) were measured at indoor environment in various residential houses in Dhaka from August to October, 2017 using Aerocet 531S, and PM₁₀ were collected using dual channel dust sampler. Atomic Absorption Spectroscopy (AAS) was used for analyzing metals in PM₁₀ samples. Simultaneously, NO₂ and TVOC concentrations were measured using Aeroqual 500 series. Samples were collected from living room over 15 hours. Peak flow rate of the occupants was recorded using Peak expiratory flow meter. Mean PM_{1.0} concentration was found highest in houses of Khilkhet (62.75 $\mu\text{g}/\text{m}^3$) and lowest in Mirpur (34.88 $\mu\text{g}/\text{m}^3$). The average indoor PM_{2.5} concentrations for Khilkhet, Rampura, Mirpur, Dholaipar were 92.33, 66.60, 58.20, 86.80 $\mu\text{g}/\text{m}^3$, respectively. The average PM₁₀ concentration for houses of Dhaka was 203.94 $\mu\text{g}/\text{m}^3$ which is four times higher than the guideline limit value (50 $\mu\text{g}/\text{m}^3$). The I/O ratios of all the sampling sites were less than one, indicating that the outdoor PM originated from vehicular emissions directly enter the indoor environment of homes and thus increasing their concentration levels. Six metals Fe, Ni, Zn, Ca, Mg and Pb were quantified from PM samples. Enrichment factor showed that non-crustal sources are responsible for high concentration of Zn and Pb. Average NO₂ concentrations was found almost thrice than threshold values. A negative association between PM_{1.0}, PM_{2.5} and peak flow rate indicated the reduction of lung function with increasing exposure. This is the first-time study in Bangladesh about the exposure to fine particles and their relation with lung function. As fine and ultrafine particles can penetrate deeper into the lung, rapid actions should be taken by the government to reduce their emission.

1.070 Trends of visibility in three regions of eastern China.

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Abstract:

Trends of visibility in three major polluted regions of eastern China, namely Beijing-Tianjin-Hebei (BTH), Yangtze River Delta (YRD) and Pearl River Delta (PRD), are analyzed for winter and spring seasons during the period 1973-2017. Downward trends attributable to increases of haze are observed in all three regions. However, the values of trends reveal substantial regional and temporal differences. In addition, significant differences exist between the trends of visibility and those of emissions of air pollutants. Climate and meteorological conditions can be shown to be the primary driving force in determining the inter-annual variability as well as the trends of visibility in the three major polluted regions of eastern China.

1.071 Historical trends of air pollutant emissions in Asia: Development of Regional Emission inventory in ASia (REAS) version 3.

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Abstract:

Huge growths of emissions of air pollutants in Asia are affecting not only local air pollutions but also regional, inter-continental, and global air qualities. In addition, emissions of greenhouse gases and Short-Lived Climate Pollutants (SLCPs) in Asia are considered to have strong impacts on global climate change. On the other hand, historical trends of emissions in Asia vary with regions and are complicated especially recently. So, it is important to understand current status, past trends, and effectiveness of mitigation measures of air pollutant emissions in Asia. In order to provide fundamental information for these issues, we are developing Regional Emission inventory in ASia (REAS) version 3 and evaluating historical trends of Asian air pollutant emissions in these six decades. For NO_x emissions, Asia's share of global total increased to 45% in 2010, from 18% in 1970. In Asian countries, nearly half of emissions were from Japan in 1970, but more than half from China in 2010. For BC, Asia's share of global total emissions was relatively large even in 1970 due to residential sources and that in 2010 was increased to 65%. In 1970, majority of emissions was from residential biofuel combustion, but nearly half of emissions in 2010 were also from industry and road vehicles. Recently, air pollutant emissions in China are showing decreasing trends. On the other hand, those in India are increasing basically monotonically. So, relative importance of emissions in India is increasing. Development of REAS version 3 is still underway and at the conference, we plan to show updated results from 1950 to 2015. Also, evaluation of REAS version 3 using results of both inverse modeling and historical model runs in Asia will be reported and discussed.

1.072 The characteristics of natural NO emission from soil and its effect on secondary pollution over China: modelling study.

Early Career Scientist

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Abstract:

NO, as one of the most active precursors, plays a significant impact on secondary pollution, e.g., O₃ and SOA. Anthropogenic emissions (e.g. fossil fuel combustion, mobile) are the key NO emission sources in the urban area, while soil is considered to be the major natural source of NO in the suburban and remote area. A new algorithm, which has considered the controlling factor of soil temperature, soil moisture, precipitation, nitrogen fertilizer application and nitrogen deposition, has been coupled and improved in the WRF/Chem-MEGAN model, and used to estimate soil NO emission and further study its influences on secondary pollution over China in 2014. The results show that soil NO emission is 1.4, 10.4, 48.6 and 6.3 Tg N over China in Jan., Apr., Jul., and Oct. 2014, respectively. Highest soil NO emission is found during summer season due to the large amount of nitrogen fertilizer, and the impact of precipitation and higher soil temperature and moisture. Since the high load of nitrogen fertilizer and deposition, higher soil NO emission is distributed in North China. Soil NO affects O₃ and SOA more significantly in the summer season than that in the autumn season. During the summer season, soil NO decrease daytime O₃ concentration with a value of 5.0 ug·m⁻³ over north China, central China and southern China, where have higher concentration of anthropogenic NO_x and belongs to VOCs-sensitive region. While soil NO tends to increase daytime O₃ concentration in the rest of the region with the value of 5.0 ug·m⁻³ above. In general, soil NO weakens the formation of SOA with a value of 1.0 ug·m⁻³ in central and southern China due to the competition of oxidant with NO. Soil NO significantly increases SOA formation significantly in southwest China with a value of 2.0 ug·m⁻³.

1.073 Ship-based NO_x and O₃ Measurements in the Marine Boundary Layer Around the Arabian Peninsula.

Early Career Scientist

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Abstract:

The Arabian Peninsula is a hot and dry desert region between Africa and Asia that is exposed to intense solar radiation, pollution emissions from many anthropogenic sources, including on- and off-shore petrochemical industry. Although the environmental conditions are globally unique, recent studies show that the extreme weather conditions are intensifying. However, in-situ atmospheric gas phase measurements on and around the Arabian Peninsula remain sparse. We present ship-based NO_x and O₃ measurements obtained during the AQABA campaign (**A**ir **Q**uality and **C**limate in the **A**rabian **B**asin) onboard the 'Kommandor Iona' Research and Survey Vessel that sailed from Toulon to Kuwait and back in summer 2017 to investigate chemical processes in the Marine Boundary Layer (MBL) in the region.

We will present and interpret the conditions and differences observed in the various regions investigated during AQABA. Whilst background mean NO_x and O₃ abundances of 0.21 ppb_v and 24.2 ppb_v were observed over the Indian Ocean, a significant northeastward increase in pollution towards the Gulf of Oman was observed, with mean mixing ratios of NO_x and O₃ of 3.85 ppb_v and 38.4 ppb_v respectively. A further increase in O₃ could be detected entering the Arabian Gulf coinciding with a mean NO_x mixing ratio dropping below 1 ppb_v. In late summer, a strongly elevated mean O₃ mixing ratio of 65.4 ppb_v was detected over the Mediterranean Sea with NO_x < 0.3 ppb_v.

Daytime NO maximum mixing ratios of $\sim 30 \text{ ppt}_v$ were observed over the Indian Ocean. Concurrent NO_2 , O_3 and $\text{J}(\text{NO}_2)$ measurements enabled deviations from the Leighton Ratio to be estimated which indicated daytime maximum RO_2 mixing ratios of 40-70 ppt_v . Similarly low NO mixing ratios were observed in the Southern part of the Red Sea, with increases in both NO_x and O_3 observed in the northerly parts.

1.074 Ground-based measurements of gaseous air pollutants and PM_{2.5} in Taiwan during the joint campaign of EMeRGe-Asia and ProACT3.

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Abstract:

Urban air pollution is among the common issues that both the developing and developed countries are facing to. Due to the rapid industrialization in the last 20 years, the East Asia has become one of the major source regions of air pollutants in the world. The air pollutants originating in the East Asia can be transported on the general circulation to the downwind areas. Besides changing the atmospheric composition and thereby influencing regional climate, the transported air pollutants can have significant impacts to the air

quality in the downwind countries. In addition to the regional air pollution, the western Taiwan suffers also from the substantial emissions of air pollutants from local urban and industrial sources. The air pollutants from Taiwan could have also been transported to the areas of the East and/or South China Seas and, consequently, influenced the atmospheric chemistry in the marine atmosphere.

During the period from 12th March to 7th April 2018, a joint field campaign of the EMERGe-Asia and the ProACT³ has been performed. Besides the snapshots of atmospheric composition taken by the instruments on board the HALO research aircraft of the DLR, the mass concentration and chemical composition of fine particulate matters (PM_{2.5}) at ground level were also measured continuously at the CAFÉ, a background station at the northern tip of Taiwan, and also a network of 12 sampling sites in the central Taiwan. Moreover, the concentrations of criteria gaseous pollutants (CO, O₃, SO₂, NO_x) have been also reported from the official air quality monitoring stations of Taiwan-EPA. All the ground-based measurements will be investigated in this study, which will be integrated with the aircraft-based measurements later on and then contribute to a better understanding upon the variations in the air quality over Taiwan.

1.075 Measurement of stable carbon isotope ratios of VOC in the outflow of major population centres in Europe and Asia.

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and the EMeRGe-Team,

Abstract:

An automated high volume air sampling system has been deployed from 10th to 28th July 2017 on the German Research Aircraft HALO during the EMeRGe-Europe (Effect of Megacities on the transport and transformation of pollutants on the Regional and Global scales) campaign. The goal of this mission was the measurement of the pollution emitted, transported and transformed from the major European population centres (MPCs) London, Paris, Rhine-Ruhr-Area, Rome and Po Valley. The whole air samples were analysed for the mixing ratios and stable carbon isotope ratios of selected volatile organic compounds with GC-MSD-C-IRMS in the laboratory afterwards. One key experiment was the identification of the source of the air masses and the residence times of the VOC by collecting whole air samples on the ground in specific metropolitan regions. During 7 flights, mostly below 6 km altitude, 141 air samples in total were collected on HALO, and additional 28 samples at ground sites in London, Milan and Rome. We determined stable carbon isotope ratios and mixing ratios of several aldehydes, ketones, alcohols, and aromatics. With HALO's special characteristics of long endurance and long-range flights an extended area could be investigated. This allowed investigating air masses of different origin, characteristics, and atmospheric processing. Between March 10 and April 9, 2018, a similar campaign (EMeRGe-Asia) was conducted from Taiwan with the goal to investigate the pollution outflow from Asian megacities such as Taipei, Hongkong, Shanghai, Beijing, Manila, Seoul and Tokio. During 12 flights in total 144 whole air samples were collected, which again were analyzed for selected VOC. Additionally, for specific flights ground samples were collected in Taipei and Manila. In this contribution, we will give a data overview and show first exemplary results.

1.076 A Global assessment of Ozone Trends relevant to Human Health: Results from the Tropospheric ozone Assessment Report IGAC activity.

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Abstract:

We quantify present-day (2000-2014) global and regional trends for five ozone metrics relevant for short-term and long-term human exposure, calculated by IGAC's

Tropospheric Ozone Assessment Report. Most of these metrics are associated with regulatory standards to protect human health from ozone exposure, and are derived on the basis of clinical, epidemiological and cohort studies. The five metrics are: the 4th highest MDA8 (4MDA8); number of days per year with MDA8 > 70 ppb (NDGT70); annual sum of ozone means over 35 ppb (SOMO35); annual maximum of the 3-month running mean of daily 1-hour ozone (3MMDA1); and the warm season average MDA8 (AVGMDA8). We explore trends in these metrics at 2,600 ozone monitoring sites worldwide, which were classified as urban or non-urban based on population and nighttime lights data. Over this period we find significant positive trends in 4MDA8 and NDGT70, determined predominantly by peak ozone concentrations, at many sites in South Korea and Hong Kong, with mixed trends across Japan. In contrast, significant negative trends occur at many USA and some European sites. The other three metrics have similar, positive trends across much of East Asia, and negative trends for many non-urban North American and some European and Japanese sites. Generally, trends are unchanged at many sites when a 1995-2014 period is used; although some urban sites in Europe and Japan that have a non-significant 2000-2014 trend, have a significant 1995-2014 positive trend. We also examine 1970-2014 trends (much fewer sites) for two metrics: 4MDA8 and SOMO35. Over this longer period, more sites in North America have significant downward trends, whilst more urban sites in Europe show significant trends than in 2000-2014. For Japan, differences are more apparent, whereby most sites exhibit significant positive trends. Insufficient data exist to characterise trends for the rest of Asia and other world regions.

1.077 Nitrogen Oxides Emissions from Major population centers in Europe and Asia: First results from the EMeRGe field mission.

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Abstract:

Major Population Centers (MPCs) are substantial sources of trace gases and particles. In this context nitrogen oxides are of special interest. On the local and regional scale nitrogen oxides impact directly and indirectly on human health. On all scales they impact on tropospheric chemistry contributing to the catalytic formation of ozone and the oxidizing capacity of air masses. They also control the lifetime of short lived hydrocarbons and long lived greenhouses gases like methane.

Within the EMeRGe (Effect of the Transport and Transformation of Pollutants on the Regional to Global scales) - project, aircraft measurements have been performed with the German research aircraft HALO (High Altitude and Long Range Research Aircraft) in the summer 2017 and spring 2018. In July 2017 the aircraft was based in Oberpfaffenhofen/Germany, whereas in March 2018 Tainan/Taiwan was the base for

Asian mission flights.

During the summer deployment phase, the pollution plumes of European MPCs such as London, Rome, the Ruhr area and the Po valley were probed. During the spring deployment phase aircraft measurements have been conducted to study the emission plumes from Asian MPCs in China, Philippines, Taiwan and Korea.

HALO was equipped with a comprehensive set of in-situ instruments for the measurement of different trace gases and aerosol parameters. Here, the focus is laid on the observation of nitric oxide and the sum of all reactive nitrogen species. These unique observations are presented and discussed together with other related and relevant trace gas observations. It was found that MPCs emissions lead to substantial enhancements in the nitrogen oxides burden especially in the boundary layer. Above the boundary layer the local MPC emissions are mixed with contributions from other sources such as the long range transport of biomass burning. Differences in the nitrogen oxides emission characteristics of European and Asian MPC are analysed

1.079 Chemical Composition and Health Risk Assessment of Atmospheric Fine Particulate Matters in Bangladesh.

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Abstract:

Atmospheric particulate matters (PM) have significant impact on human health, climate change, agriculture, and ecosystem. Fine PM can easily enter into the human respiratory system, brain, and blood and can cause many diseases (respiratory infection, COPD, stroke, and cancer). Bangladesh is the top most country in the world for deaths due to environmental pollution accounted up to 25% of the total. Air pollution caused 2/3 of these deaths in Bangladesh. Particulate matters have both absorbing and scattering properties depending on their chemical composition and sizes.

PM_{2.5} samples and aerosol optical depth (AOD) have been collected at urban Dhaka and a rural Bhola since 2013. Dhaka is a highly polluted Southeast Asian megacity with a population of about 20 million. Coastal Bhola is an outflow location of the Ingo Gangetic Plain (IGP) to the Bay of Bengal. Black carbon, water soluble ions, trace metals and PAHs were measured in PM_{2.5}. PMF model for source apportionment and HYSPLIT model for trans-boundary pollution have been applied. Health risk assessment was estimated with US EPA model for non-cancer and cancer risks using Hazard Quotient (HQ), Health Index (HI) and Lifetime Cancer Risk (LCR).

The average PM_{2.5} is 62.0 μg m⁻³ with a winter high of 500 μg m⁻³ in Dhaka. BC in PM_{2.5} is 12.4 μg m⁻³ which is much lower than previous measurement in Dhaka for TSP, but still many times higher than the cities in developed countries. Five main sources are identified with PMF. Both urban and background locations have significant influence from IGP during winter, and also relatively clean air masses from the Bay of Bengal during monsoon. The LCR values of naphthalene, fluoranthene, chrysene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthrene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene are 1.14x10⁻², 8.06 x10⁻⁴, 9.29x10⁻⁴, 1.56x10⁻³, 4.8x10⁻³, 1.68x10⁻⁴, 7.04x10⁻³, 3.60x10⁻⁴, respectively. These values are higher than the safe limit value indicating potential carcinogenic risk of PAHs in Bangladesh.

1.081 Towards reduced human exposure to mercury: The need for near-term global action.

Early Career Scientist

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Abstract:

Toxic pollutants, such as mercury (Hg), are emitted into air worldwide by multiple natural and anthropogenic sources. The atmosphere provides both a route of exposure (via inhalation) and a means for the efficient long-range transport and transformation of such pollutants in the environment. Through a modeling approach, we aim to draw the link between global emissions and local impacts of Hg. Hg is of global concern owing to its long-range atmospheric transport, its persistence in the environment, its ability to bioaccumulate in ecosystems, and its negative effects on human health. The UNEP Minamata Convention on Hg, a global treaty to protect human health and the environment from adverse effects of Hg, entered into force in August 2017. Under this Convention and as a co-benefit of greenhouse gases mitigation policies, global Hg anthropogenic emissions are expected to decrease. Here, we investigate the consequences of delayed global action on global Hg atmospheric deposition and local contamination. Using a global multi-media Hg box-model, we find that, under a business-as-usual scenario, each 5-year delay in near-term peaking of Hg emissions in turns delays by additional extra 3 years the decrease of global Hg deposition to ecosystems under a given targeted threshold. In order to derive local-scale impacts, we use a combination of chemical transport modeling (GEOS-Chem) to predict local Hg deposition, and lake modeling to predict concentrations in fish. Here, we focus on remote tribal regions of Eastern Maine (USA) as Native Americans are particularly affected by Hg contamination due to their traditional dependence on subsistence fishing. We show that each 5-year delay in reducing global Hg emissions leads to a local 2% increase in atmospheric deposition to ecosystems. Consequences on fish contamination will also be discussed.

Overall, our results underline the importance of near-term action for limiting the Hg burden of future generations.

1.083 Source identification and health risk assessment of trace metals in suspended particulate matters collected in Dhaka, Bangladesh.

Early Career Scientist

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Abstract:

In order to investigate the human health risk of suspended particulate matter (SPM) in Dhaka, ambient air samples were collected weekly during August 2016 to January 2017. Trace elements were determined with Inductively Coupled Plasma Mass spectrometry (ICP-MS). Source apportionment study was done with correlation analysis, enrichment factor, positive matrix factorization (PMF). Air mass back trajectory analysis was carried out by NOAA HYSPLIT model. Human health risk assessment was conducted by US EPA model. The average mass concentration was recorded $329.16 \pm 89.29 \mu\text{g m}^{-3}$ with a range of 173.81-496.99 $\mu\text{g m}^{-3}$. Strong seasonal variation was noticed in the mass concentration with maxima during winter ($423.90 \pm 40.79 \mu\text{g m}^{-3}$) and minima during monsoon ($243.73 \pm 46.30 \mu\text{g m}^{-3}$). Thirty three trace elements (Li, B, Na, Mg, K, Ca, Al, Si, P, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Rb, Sr, Zr, Mo, Cd, Sn, Ba, W, Ag, Sb, Cs, Pb) were measured and was accounted for $\sim 7.0\%$ of particulate mass. High enrichment factors of Cd, Pb and Zn indicates anthropogenic source. The major source of PM were soil dust (39.0%) followed by road dust (31.2%), vehicle emissions (13.6%), industrial sources (9.4%) and mixed sources (6.8%) from PMF analysis. Back trajectory analysis revealed that particulate matters were greatly affected by Indo-Gangetic Plain (IGP) during winter, while from Bay of Bengal in monsoon and eastern part of India in post monsoon. The health risk of heavy metals (HMs) was evaluated by hazard quotient (HQ) and hazard index (HI) and the results showed that ingestion and dermal contact were the

major exposure pathways to human health. The HI values of Pb for children exhibited to be higher than 1 indicating that a non-carcinogenic health effect. The carcinogenic risks of Cd, Ni and Cr were all below the safe value.

1.084 Regional shifts in the diurnal cycle of surface ozone.

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Abstract:

Reductions in NO_x emissions have driven important decreases in peak summertime ozone concentrations in many parts of the United States and Europe. However, the magnitude and even sign of these trends can change when considering nighttime ozone, as lowering NO_x emissions can reduce nighttime ozone titration by NO_x . The shape of the ozone diurnal cycle has implications for human health and vegetation studies, since some ozone metrics depend on peak hourly ozone while others consider ozone concentrations over an 8 or 12-hour window. We use a high-resolution global atmospheric simulation constrained by MERRA-2 meteorology to investigate changes in the diurnal cycle of ozone for different seasons and regions of the world. The simulation reproduces the trends in tropospheric column NO_2 observed by the OMI instrument, as well as the reduction in the amplitude of the diurnal cycle of ozone in the northeast United States seen in CASTNET observations. The simulation shows an increase in the magnitude of the diurnal cycle in surface ozone over China in response to increasing NO_x , in contrast to the decrease in magnitude in regions with negative NO_x trends. We attribute the changes to shifts in the timing of net ozone production and loss.

1.085 Sensitivity study for satellite observation of the lowermost tropospheric ozone using three different wavelength ranges, UV, TIR, and microwave.

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Abstract:

Tropospheric ozone, one of the most harmful pollutants, has been increasing globally over few decades. Satellite measurement has an advantage of global monitoring coverage but also has a difficulty to obtain the amount of the lowermost tropospheric ozone. There are attempts to improve the vertical resolution of tropospheric ozone profile by combining the space-based measurements with different spectral ranges at ultraviolet (UV) and thermal infrared (TIR) such as Aura/OMI and TES or MetOp/GOME-2 and IASI. Our idea to further increase the sensitivity of the tropospheric ozone is adding microwave (MW) measurements to UV and TIR measurements. We simulated the sensitivities to the vertical distribution of the tropospheric ozone based on the optimal estimation method.

The degree of freedom for signal (DFS, i.e., how detail the vertical distribution of ozone is constrained), the pressure of maximum sensitivity, reduction rate of error from the a priori error, and the averaging kernel matrix were calculated using radiative transfer models. The DFS value was increased by 96, 23, and 30% in the upper troposphere (UT), middle troposphere (MT), and lowermost troposphere (LMT), respectively by adding the MW measurements to the UV and TIR ones. The MW measurement increased the DFS value of the LMT ozone; nevertheless, the MW measurement alone has no sensitivity to the LMT ozone. Adding the MW measurement made the pressure of maximum sensitivity value for the LMT ozone closer to the surface. These results indicate that the constraints on the UT and MT ozone, which are explicitly introduced by the MW measurements, attribute to the derivation of better information of the LMT ozone. The results of this study are applicable to the upcoming air-quality monitoring missions, APOLLO, GMAP-Asia, uvSCOPE and the NICT air-pollution prediction project.

1.086 Physicochemical and bioreactive characterization of urban fine particulate matter during Asian dust storm .

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Abstract:

The objective of this study is to investigate the physicochemistry and bioreactivity of fine particles ($PM_{2.5}$) during the Asian dust storm period. The $PM_{2.5}$ samples were collected in Xi'an and Beijing from 9th March to 7th April. $PM_{2.5}$ were collected by mini-volume air samplers. Anions (Cl^- , NO_3^- and SO_4^{2-}), cations (NH_4^+ , K^+ , Mg^{2+} and Ca^{2+}), organic carbon (OC) and elemental carbon (EC) were determined. Human alveolar epithelial A549 cells were exposed to the $PM_{2.5}$ at 50 $\mu g/ml$ for determination of cell viability. The average $PM_{2.5}$ concentration were 104.2 $\mu g \cdot m^{-3}$ and 85.7 $\mu g \cdot m^{-3}$ in Xi'an and Beijing, respectively. During the study period, Xi'an and Beijing were suffered with heavy pollution with $PM_{2.5}$ concentration emitted from anthropogenic emissions as well as dust storm. It was found that OC contributed more to $PM_{2.5}$ in Beijing, and the OC/EC ratio of Beijing was higher than Xi'an. The concentrations and contributions of NO_3^- , SO_4^{2-} and NH_4^+ in Xi'an were much higher than Beijing, which was mainly caused by the local emissions of fossil fuels combustion with photo-oxidation. It was also found that the contribution of NO_3^- was increased evidently in pollution days due to the combustion activities, while in dust storm period, NO_3^- and NH_4^+ contributions to $PM_{2.5}$ showed evident decrease trend. We observed that the cell viability was positively correlated with Mg^{2+} , Ca^{2+} , OC and EC ($p < 0.05$) in the Xi'an $PM_{2.5}$ samples, whereas cell viability was

positively correlated with Cl⁻, K⁺, Mg²⁺, OC and EC ($p < 0.05$) in the Beijing PM_{2.5} samples. The difference in bioreactivity induced by the PM_{2.5} could be resulted from the various emission sources during the dust storm period.

1.087 Performance Evaluation of PM_{2.5} Micro-sensors in Taiwan.

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Abstract:

Development of low-cost sensors has advanced rapidly in recent years. This provides tools for assessing air pollutant levels in high tempo-spatial resolution with much lower expenses. In this work, we assessed the performance of a sensor package, called AS-LUNG, short for Academia Sinica-Lung (the organ affected by air pollutants) to examine whether they are applicable in atmospheric chemistry studies.

AS-LUNG includes sensors for PM_{2.5} (Plantower PMS3003), CO₂, temperature, relative humidity, GPS, and motion. Performance evaluation was conducted in both laboratory and field. AS-LUNG-outdoor can operate under harsh weathers, especially in Taiwan where typhoons hit and hot ambient temperature up to 37 °C (99°F). More than 40 devices of AS-LUNG-outdoor were evaluated in the laboratory and 10 of them in the field. PM_{2.5} and CO₂ readings were compared to the observations of GRIMM and TSI7545 side-by-side. For laboratory evaluation, sensor devices were placed in the chamber (temperature and relative humidity (RH) ranged 18.1-34.9 °C and 56.3-97.4%) for 14 hours in the concentration ranges of 1-472 ug/m³ in a batch of 4 to 6 devices. In the field, 10 sets were placed for 3 days under the conditions of 3.9-30.1 ug/m³, 25.9-40.9 °C and 43.4-93.8% RH.

The mean concentration of 1-min PM_{2.5} of AS-LUNG was 2.33 (1.86-2.73) times than those of GRIMM in our laboratory test ($R^2=0.80-0.98$). We also got the similar result in the field (2.01 times higher than GRIMM with $R^2=0.68-0.97$). Regarding the CO₂ results, we found the 1-hr mean concentration from AS-LUNG was 1.12 (0.77-1.67) times than TSI7545 instrument ($R^2=0.75-0.91$). These PM_{2.5} sensors are good for research as long as consistent inter-comparison relationships of readings from sensors and sophisticated instruments were established for conversion. Our results indicating these sensor devices have great potentials for atmospheric chemistry research to assess PM_{2.5} in high tempo-spatial resolution with much lower costs.

1.088 Toxicity and anti-oxidative response induced by carbon black particles in a co-culture system.

Early Career Scientist

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Abstract:

Carbon black (CB) is among the most highly produced and utilized nanoparticles. However, their increased usage has led to health and environmental concerns. A human alveolar-capillary co-culture system using Small Airway Epithelial Cell (SAEC) and Human Umbilical Vein Endothelial Cell (HUVEC), was used to investigate the cytotoxic effects of CB in neighbouring endothelial cells that were not exposed to CB. Prior to the start of the study, characterization of carbon black was performed using transmission electron microscopy (TEM) and dynamic light scattering (DLS). Subsequently, SAEC cells were cultured with various doses of 0µg/ml, 10 µg/ml, 25 µg/ml, 50µg/ml and 75 µg/ml of CB for 24 h before trypan blue cytotoxicity assay was carried out. Next, colony forming assay, reactive oxygen species (ROS) assay and profiling of the antioxidant (CAT, SOD1, SOD2, PRDX1-3, 5-6), metallothionein (MT1A, 1E, 1F, 1X, 2A, 3, 4) gene expression in HUVECs by RT-PCR, after co-culture with CB-treated SAECs were investigated. TEM images confirmed the uptake of CB into the SAECs, as shown by the presence of many black particles, in the form of agglomerates, lying free in both the cytoplasm and vacuoles. SAECs directly treated with CB exhibited a concentration dependent decrease in cell viability. On the other hand, HUVEC cells co-cultured with CB pre-treated SAECs did not exhibit any decrease the cell or reproductive viability. There was no increased ROS in the co-cultured HUVEC cells, indicating an absence of early oxidative stress. This observation could be due to the cyto-protective effect by metallothionein (an antioxidant) as evidenced by the increased expression of metallothionein genes in HUVEC cells. Taken together, the data from this study suggests that HUVEC cells are able to mount an antioxidant response to mitigate the cytotoxic effects of CB particles, when co-cultured with SAECs pretreated with CB particles.

1.090 Nitrogen isotope of nitrate in Arctic ice core records past anthropogenic energy shift.

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Abstract:

Nitrate is one of the major anions found in snow. Nitrate (NO_3^-) deposition results from reactions between nitrogen oxides ($\text{NO}_x = \text{NO} + \text{NO}_2$) and atmospheric oxidants. Global main sources of NO_x are fossil fuel, biomass burning, biogenic soil emissions, and lightning. A recent increase in NO_3^- in ice cores has been associated with increasing anthropogenic emissions of NO_x . Based on the changes in NO_3^- concentration, however, it is not easy to identify specific sources of NO_x which takes into account for the changes in NO_3^- concentrations, hindering the development of mitigation policy of anthropogenic pollution and its effect on the environment. Nitrogen and oxygen isotopic compositions of NO_3^- provide information on changes in the nitrogen source and its formation pathways, but ice core records for NO_3^- concentrations and its isotopic compositions are problematic because of post depositional loss of NO_3^- via photolysis (e. g., [1]). In this study, we analyzed isotopic compositions of NO_3^- preserved in the high-accumulation dome ice core, South East Greenland, which has a dome with high accumulation rate (about 1 m yr^{-1}) in water equivalent [2]. In this study, $d^{15}\text{N}$ value of NO_3^- was measured by the bacterial method coupled with N_2O decomposition via microwave-induced plasma (MIP) [3].

The nitrogen isotopic compositions for NO_3^- were generally lower than those reported in Summit, Greenland [4, 5], suggesting that some extent of NO_3^- deposited in Summit is removed via photolysis. Based on the trend of reconstructed $d^{15}\text{N}$ values and NO_x emission inventory, switches from coal to oil combustion mainly in North America was likely a factor changing the nitrogen cycle in the Arctic environments.

1.091 Improvement on urban scale meteorological and air quality simulation: using local urban canyon parameters and models.

Early Career Scientist

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Abstract:

Urban meteorological conditions and air quality becomes more and more difficult to be accurately reproduced by modelling tools due to rapid and complex changes in land use and land cover induced by urbanization in recent decades. In this study, in order to define the detailed urban morphology, the Remote Sensing (RS) and Geographic Information System (GIS) techniques are combined to develop high-resolution gridded Urban Canyon Parameters (UCPs) in Beijing, China. Four different urban canyon schemes with or without UCPs, coupled with The Weather Research and Forecasting (WRF) model and the Community Multiscale Air Quality (CMAQ) model, are used to explore the best selection of appropriate urban parameters and schemes for climate and air quality simulation: (1) Bulk simple scheme; (2) a single-layer urban canopy (SLUCM); (3) a multilayer urban canopy scheme (BEP); (4) BEP coupled with a simple building energy model (BEP + BEM). The results show that, compared with observations, the application of local UCPs in all urban canyon models has obviously improved the accuracy of urban meteorological, especially for the 10-m wind speed, and air quality predictions. The best performances for PM_{2.5} and ozone simulation are obtained in BEP and BEP+BEM scenarios, where the underestimation in July is significantly reduced, mainly because of the higher prediction for PBLH. Our results proved that although more computation time is needed, the local UCPs database and urban canyon models are both necessary configurations for urban-scale modelling.

1.094 Application of PM_{2.5} Micro-sensors in Taiwanese Communities.

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Abstract:

Asian residential communities are usually dotted with various pollution sources, such as restaurants and home factories, resulting in higher intra-urban variability than western communities. Thus, it is important to characterize pollution spatial variability in order to assess accurately residents' exposures. The objectives of this study are to evaluate the applicability of low-cost PM_{2.5} micro-sensors in the field and to assess PM_{2.5} levels in high tempo-spatial resolution with micro-sensors.

PM_{2.5} micro-sensor devices, AS-LUNG, were used for this work, including sensors for PM_{2.5}, CO₂, temperature, relative humidity, and GPS. Wireless transmission plus SD-card is available to avoid data loss. AS-LUNG-outdoor (AS-LUNG(O)) with a solar panel and water-proof housing is suitable for outdoor usage. Ten AS-LUNG(O) devices were placed at 2.5 meters above ground in Taiwanese communities to assess spatial variability and one AS-LUNG(O) at 10 meters above ground to assess ambient levels (high-level site). The monitoring duration was July 1-28 (25.5-30.0°C) and December 1-31 (14.0-22.0°C), 2017, with one-minute resolution. In addition, sensor devices were evaluated against GRIMM in the laboratory and fields; the measurements were converted accordingly.

During the monitoring periods, the mean PM_{2.5} levels in near-by EPA stations were 16.3±8.9 and 40.7±17.5µg/m³ for July and December, respectively, showing higher ambient levels in the winter. Data of AS-LUNG(O) had R² of 0.81-0.99 with those from EPA stations, showing high consistence of AS-LUNG(O) observations. The monthly mean ratios of community observations over those at the high-level site ranged from 1.05-1.29 and 1.08-1.63 in July and December, respectively. Moreover, the highest 1-min level at a site near vendors and traffic was 100 times of that at the high-level site, with 5-min average 35 times higher than that at the high-level site. Our results demonstrated the applicability of PM_{2.5} micro-sensors in summer and winter and high spatial variability of PM_{2.5} levels due to community sources.

1.097 CHARACTERISTICS OF O₃, NO_x, CO, CH₄, NMHCs AND PM_{2.5} NEAR THE ROAD SITE IN HO CHI MINH CITY, VIETNAM.

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Abstract:

Continuous measurements of air pollutants including methane (CH₄), none methane hydrocarbons (NMHCs), oxides of nitrogen (NO, NO₂ and NO_x), ozone (O₃), carbon monoxide (CO) and fine particles (PM_{2.5}) near the road were conducted from May 2013 to April 2015 in Ho Chi Minh City, Vietnam. This study aims to investigate the temporal variations of the pollutants with the meteorological conditions in order to know the characteristics of the pollutants supporting for environmental management in the city. The diurnal trends of NMHCs, CO and NO_x increased two times a day, around 6h-8h and 17h-19h. The diurnal variations of PM_{2.5} increased slightly at daily traffic hours from 6h to 11h. The high O₃ concentrations were observed during the period of daytime from 8h to 14h. In contrast to the other pollutants, the CH₄ concentrations were high at nighttime from 18h. The CH₄ levels were similar for all months during the wet season and decreased in the dry season. For NMHCs, NO_x, CO, PM_{2.5} and O₃, the monthly averages in the dry season are higher than the wet season. The relationship between air pollutants and meteorological parameters showed that the concentrations of CH₄, NMHCs, NO_x and CO negatively correlated with temperature and solar radiation, while O₃ concentrations positively correlated with both factors. Humidity could increase the levels of CH₄, NMHCs and PM_{2.5}. Rainfall washed PM_{2.5} out of the atmosphere and dissolved NO_x through wet deposition. *Keywords:* CH₄, NMHCs, CO, PM_{2.5}, NO_x, O₃, meteorological conditions

1.098 Greenhouse Gas Emissions from Major Population Centers in Europe and Asia: Aircraft-borne CH₄ in-situ observations during the EMeRGe field missions.

Early Career Scientist

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Abstract:

Major Population Centers (MPCs) accommodate more than half of the world population but cover only 2% of the terrestrial Earth's surface. Thus industry, energy usage, air pollution, and enhanced greenhouse gas emissions agglomerate in narrow areas. About one third of global anthropogenic methane (CH_4) originates from urban agglomerations, i.e. from pipeline leaks, landfills, and sewage treatment plants. Emission inventories significantly underestimate these emissions by 7-15%. However, a more accurate quantification is needed to develop efficient mitigation strategies for reducing CH_4 . We report on aircraft-borne CH_4 in-situ measurements during EMeRGe, investigating the *Effect of Megacities on the Transport and Transformation of Pollutants on the Regional to Global Scales*. Mission flights were carried out with the German research aircraft HALO over Europe (July 2017 from Germany) and Asia (March-April 2018 from Taiwan) probing pollution plumes of various MPCs mainly at altitudes below 3 km. Individual CH_4 footprints are identified and the increase in CH_4 mixing ratio is quantified by using in-situ measurements downwind of selected urban hotspots to better understand the regional impact of urban CH_4 emissions. In addition to CH_4 further trace gases (e.g. CO_2 , NO_x , CO , O_3) are analyzed to identify different potential anthropogenic and natural emission sources. The probed air masses are traced back to their possible emission source area using numerical models. In-situ observations during EMeRGe-Europe show that CH_4 enhancements are most distinctive in the boundary layer, with highest mixing ratios encountered in the Po Valley, London and BeNeLux (up to 2.4 ppm). First analysis indicates that a clear apportionment to individual CH_4 sources is hampered by the agglomeration of heavy industry and small cities surrounding MPCs. Sampled emissions from Asian MPCs show similar maximum CH_4 concentrations (e.g. Tainan, Manila, Yangtze Delta; up to 2.1 ppm) but in general higher background values at low altitudes compared to Europe.

1.099 Biomass Burning Contribution of Carbonaceous Aerosols at Suburban and Rural Sites in Indo-Gangetic Plain.

Early Career Scientist

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Abstract:

For the past few decades, seasonal appearance of a thick blanket of aerosol particles all over North India from Southern edge of the Himalayas to the Bay of Bengal has been attributed to various anthropogenic emissions. Studies have revealed that unique topography of North India and meteorological conditions during winters further lead to the accumulation of pollutants in the lower atmosphere. Indo-Gangetic Plain (IGP) is among one of the most densely populated regions around the world, where 70% population is still residing in the villages. Growing energy demands have led to the increased pollutant emission from industrial and transport sectors. Biomass such as woods, dung cake, dry leaves and crop residues used for traditional cooking and heating purposes and open field burning in rural areas have further added to the aerosol loadings in the atmosphere over the IGP. The present work is an attempt to characterize the carbonaceous aerosols (Organic Carbon and Elemental Carbon) in the fine mode ($<2.5\mu$) particles. Sampling was conducted during winter months (November 2016 to February 2017) at a suburban and a rural site in IGP. Simultaneous analysis of major inorganic ions (Na^+ , NH_4^+ , K^+ , Ca^{2+} , Mg^{2+} , Cl^- , NO_2^- , NO_3^- and SO_4^{2-}) was also carried using re-fluxing mist chamber to find out the possible sources. OC and EC levels were found to be strikingly higher at the rural site (71.3 and $47.6 \mu\text{g}/\text{m}^3$, respectively) as compared to the suburban site (30.1 and $23.5 \mu\text{g}/\text{m}^3$, respectively). Correlation and factor analysis of data suggested that biomass burning for cooking, crop residues burning and emission from agriculture activities as significant sources at the rural site. However, vehicular exhausts, waste burning, construction activities and re-suspended dust were found to be primary contributing sources at the suburban site. Their dynamics in detail will be discussed in the conference.

1.102 Aircraft-based measurements of aerosol chemical composition in the outflow of Asian megacities during EMeRGe-Asia 2018.

Early Career Scientist

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Abstract:

The EMeRGe-Asia project investigates the atmospheric transport and processing of Asian megacity emissions. In March and April 2018, twelve scientific measurement flights were conducted with the German research aircraft HALO out of Tainan, Taiwan, covering the region between Thailand, the Philippines, South Korea and Japan.

We operated a compact time-of-flight aerosol mass spectrometer (C-ToF-AMS) to measure the composition of non-refractory submicron aerosol particles. Additionally, an optical particle spectrometer was used to measure number concentration and size distribution of particles between 250 nm and about 3 μm , the latter being determined by the transmission efficiency of the aerosol inlet.

The specific objectives of the individual research flights were chosen according to chemical weather forecast using a range of model prediction tools. Outflow from selected target regions, as for example the Pearl River Delta, the Yangtze River Delta, Manila, and Taipeh was successfully probed during several flights. Also, biomass burning outflow from South and East Asia was encountered, predominantly at higher altitudes (typically around 5 km). Although the research focus was set to lower altitudes (below 3 km), vertical profiles were conducted up to 12 km, where occasionally stratospheric influenced air masses (characterized by high ozone values) were found.

The aerosol was mainly dominated by sulfate, although organics and nitrate also contributed, depending on the air mass and the pollution source. For example, coal power plant emissions at Taiwan's west coast contributed more sulfate than organics to the submicron aerosol, whereas urban emissions from Manila were characterized by a higher organic content.

This poster will present first results on aerosol properties, emission types, and atmospheric processing especially of the organic aerosol.

1.104 Downscaling air quality data from global to local scales.

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Abstract:

Regional air quality models are regularly used for assessing health impacts over country or continental scales. However, these models lack sufficient resolution to represent pollution gradients near sources, particularly in the case of road traffic emissions, and are based mostly on top-down emission inventories. Local scale models on the other hand, often based on Gaussian plume parameterizations and using bottom-up emissions inventories, are also applied for health impact assessments but rarely beyond the city scale. In this paper a methodology for downscaling regional scale concentrations from the EMEP/MSC-W air quality model to local scales is presented. The EMEP/MSC-W model is used operationally in Europe and in China for air quality forecasts and analyses at regional scales, forced by global boundary conditions from the Copernicus Atmosphere Monitoring Service (CAMS). Currently the maximum operational resolution is 0.1x0.1 degrees but through downscaling this resolution is improved for exposure and exceedance applications. The method is referred to as *u*EMEP ('urban EMEP') and is made up of two parts: The first is a new scheme within the EMEP/MSC-W model for determining the local contribution from emissions within a rectangular area to each EMEP grid cell and its neighboring grids. This is valuable information for local air quality policy makers to decide on various emission reduction measures. The second part is based on a Gaussian plume model redistributing these local contributions at high resolution (250 to 50 m), resulting in fine scale air quality maps used as input to population exposure and health impact studies. The method also reveals differences between top-down/bottom-up and regional/local scale methodologies and thus provides a path for assessing the quality of urban emissions used in regional models. Successful applications are presented for Norway (population exposure to NO₂ and PM_{2.5}) and the problems encountered when regional and local scales meet are discussed.

1.105 Pollution characteristics and source apportionment of volatile organic compounds in different functional zones in a coastal city of Southeast China.

Early Career Scientist

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Abstract:

Volatile organic compounds (VOCs) are the key precursors of tropospheric ozone and the contributors to the formation of secondary organic aerosol. VOCs from six functional zones in a coastal city, China, were collected by Summa canisters and determined by gas chromatography-mass spectrometer (GC-MS). The annual average concentrations of total VOCs (TVOCs) were obtained as follows: background site ($36.00 \mu\text{g}\cdot\text{m}^{-3}$) < residential site ($48.71 \mu\text{g}\cdot\text{m}^{-3}$) < port site ($61.09 \mu\text{g}\cdot\text{m}^{-3}$) ~development site ($62.25 \mu\text{g}\cdot\text{m}^{-3}$) < traffic site ($73.82 \mu\text{g}\cdot\text{m}^{-3}$) < industrial site ($98.33 \mu\text{g}\cdot\text{m}^{-3}$). Concentrations of TVOCs in spring and summer were higher than those in autumn and winter. Ozone formation potentials (OFPs) were calculated in this study, and the results indicated that 1-Butene had the highest OFP in residential zone, while Toluene contributed most to the OFP in other functional zones. The ratio of Xylene to Ethylbenzene was used to analyze the aging of atmospheric VOCs in background site, which was affected by transport of air pollutants from anthropogenic activities in urban areas. VOCs sources were identified by the Positive Matrix Factorization (PMF) model, including vehicle exhausts, fuel evaporation, biomass burning, industrial processes, and coal combustion. The vehicle exhaust was the largest sources of atmospheric VOCs in all seasons, ranging from 22.41% to 38.95%, and the percentage of fuel evaporation was enhanced in summer, up to 25.94%. The contributions of biomass burning in autumn (21.11%) and winter (18.01%) were larger than those in spring (11.23%) and summer (16.94%), probably due to crop straw burning from local residents. The vehicle exhaust was the dominant source across all functional zones (30.04%-44.39%), while fuel evaporation was also the major contributor (36.20%) in residential site.

1.116 Modeling the health impacts of PM_{2.5} exposure in China at 5 km resolution.

Early Career Scientist

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Abstract:

Abstract: Due to rapid urbanization and industrialization, air pollution is becoming more and more serious in China. Fine particulate matter (PM_{2.5}) is one of the major air pollutants affecting human health. In this study, a nested grid air quality model system (NAQPMS) was used to simulate PM_{2.5}, and to study the long-term health impacts of PM_{2.5} exposure across China from 2013-2015 at a high resolution of 5 km. A comparison with observations demonstrates that NAQPMS is able to reproduce the temporal and spatial variation of pollutants in China reasonably well. The simulation shows that high levels of PM_{2.5} are concentrated in mid-eastern China and the Sichuan Basin, with highest annual mean concentrations of 120 µg/m³. Integrated exposure-response relationships were used to estimate the mortality attributable to PM_{2.5} exposure across China based on the simulated spatial PM_{2.5} concentrations, population data and disease-specific mortality baselines at provincial level. The results show that PM_{2.5} concentrations caused 1.44 million premature deaths in 2015, 1.5% higher than in 2013. The numbers of premature deaths were 0.40, 0.42, 0.38, 0.16, and 0.08 million for stroke, ischemic heart disease, chronic obstructive pulmonary disease, lung cancer and lower respiratory infection in 2015, respectively, which increased from 2013. We also explore the short-term health impacts of PM_{2.5} during heavy pollution episodes, and compare these to the long-term impacts using the same model.

Key words: NAQPMS, 5 km horizontal resolution, 3 years, PM_{2.5} exposure, mortality

1.118 Impact of Indonesian fires on air quality in Equatorial Asia between 2002 and 2015 .

Early Career Scientist

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Abstract:

Forest and peatland fires in Indonesia contribute to poor air quality across Equatorial Asia, with negative impacts on human health. Fires are common in Indonesia as they are used to clear forest and for agricultural management. Indonesia also contains large areas of peatland, which have become more susceptible to fire due to deforestation and drainage. Peatland fires typically emit larger amounts of particulate matter (PM) compared with vegetation fires.

Vegetation and peatland fires in Indonesia are strongly regulated by climate, with greater fire emissions occurring in drought years. Fire emissions therefore exhibit strong interannual variability, and years with higher emissions can result in severe air pollution events. Previous research has generally focussed on specific pollution events and few studies have compared the impacts of fire emissions across multiple years.

We combine fire emissions datasets and a regional air quality model (the Weather Research and Forecasting model coupled with chemistry; WRF-chem) to simulate pollution events across Equatorial Asia over the period 2002 to 2015. The Fire Inventory from NCAR (FINN) is used to identify years with high fire emissions. The years 2002, 2004, 2006, 2009, 2013 and 2015 contain months where fire emissions in Indonesia exceeded the long-term monthly mean by more than one standard deviation.

We use the WRF-Chem model to attribute air quality degradation to different fire sources, by comparing three simulations with (a) emissions from both peat and vegetation fires, (b) only vegetation fires, and (c) no fire emissions. The PM and aerosol optical depth (AOD) from the different simulations are evaluated using ground and satellite observations. We demonstrate that fire emissions, in particular emissions from peatland fires, contribute substantially to regional PM_{2.5} concentrations. We compare population-weighted PM_{2.5} concentrations across years to identify which fire events had the largest impact on regional air quality and human health.

1.121 Developing a new urban air quality model for Beijing.

Early Career Scientist

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Abstract:

Quantifying the impact of policies aimed at improving air quality, to reduce the risk to human health, requires numerical modelling that simulates the complex atmospheric processes occurring in the urban environment. We have performed air quality simulations for Beijing using the urban-scale Gaussian dispersion and chemistry model, ADMS-Urban. ADMS-Urban simulates dispersion as individual plumes emitted from explicitly modelled sources and is able to calculate air pollution concentrations at street-scale resolution. The model includes a simplified fast chemistry scheme (NO_x , O_3 and VOCs) and accounts for the influence of urban morphology (including street canyons) and the urban heat island (UHI) on atmospheric composition.

We use a high-resolution emissions inventory, derived from the new sector-based 1km x 1km Multi-resolution Emission Inventory for China (MEIC), and compare simulated and observed diurnal and seasonal concentration profiles for NO_x , PM and O_3 across 12 sites and during the recent Air Pollution and Human Health (APHH) field campaigns. Emissions and local meteorological conditions combine to control each species' profile, with rush hour traffic and domestic heating/cooking emissions interacting with boundary layer dynamics to produce morning and evening NO_2 and $\text{PM}_{2.5}$ concentration maxima. An afternoon O_3 peak is related to lower NO_2 concentrations and peak solar irradiance. However, diurnal NO_2 cycles show an earlier and stronger evening peak compared to measurements. By incorporating stability effects relating to Beijing's UHI, through replicating the release of heat stored in the urban fabric, we are generally able to reproduce the observed annual and seasonal NO_2 and O_3 diurnal cycles for 2014. $\text{PM}_{2.5}$ concentrations are underestimated at all sites, suggesting missing emission sources and we discuss the most likely of these.

Currently we are assessing the sensitivity of model results to underlying meteorology. We are further developing our model to include a more advanced urban morphology and to treat haze effects.

1.122 Urban-Coastal Environment: Particle Formation and Growth Mechanisms.

Early Career Scientist

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Abstract:

A field aerosol measurement campaign as part of the MUMBA (Measurements of Urban, Marine and Biogenic Air) campaign was conducted between 16th January 2013 and 15th February 2013 in the coastal city of Wollongong, Australia. The objectives of this research were to study the occurrence frequency, characteristics and factors that control particle behaviours and also new particle formation processes. Particle number size distribution ($14 \text{ nm} < D_p < 660 \text{ nm}$) was measured using a Scanning Particle Mobility Sizer (SMPS) was used in this study. Four Class I particle formation events were observed, equivalent to 13% of the total observation days. All events occurred during the day time, starting at 8:30 Australian Eastern Standard time approximately with an average duration time of five hours. The events also appear to be positively linked to the prevailing easterly to north easterly sea breezes that carry pollutants from sources in and around Sydney. This suggests that photochemical reactions and a combination of oceanic and anthropogenic air masses are among the factors that influenced these events. Relative humidity also appears to play a role in the Class II particle formation event.

1.125 NO₂ vertical columns retrieved over Mexico City from ground and space..

Early Career Scientist

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Abstract:

The Mexico City Metropolitan Area has a population density of almost 6000 inhab/km² amounting to well over 20 million people. This region concentrates the most important economic and industrial activities of the country (25% of the total) and has the highest vehicular fleet (around 9.5 million), resulting in the emissions of a huge amount of anthropogenic pollutants that participate in important photochemical episodes.

We emphasize here in NO, that comes directly from combustion processes as a primary gas and NO₂, that mainly comes from its oxidation and gives the yellow color to the smog. NO₂, besides being toxic to humans when exposed during prolonged periods, is a precursor in the production of tropospheric ozone.

We present NO₂ data from a monitoring network formed of six Multi Axis Differential Optical Absorption Spectrometers (MAX-DOAS), built at our university, that measure backscattered radiation in the UV/Vis range. The spectra are processed using QDOAS and the Mexican Maxdoas Fit (MMF) retrieval code, which is based on least square fitting and uses optimal estimation and Tikhonov regularization for trace gas and aerosol retrievals, respectively.

The time series of NO₂ vertical columns densities and the methodology used for the statistical calculation of the errors are presented and compared to in situ observations from the city's network of atmospheric monitoring (RAMA) and the tropospheric vertical columns from the Ozone Monitoring Instrument (OMI).

1.126 Insufficient representation of summertime surface ozone minimum in the East Asian maritime region by chemical transport models.

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Abstract:

Seasonal variation of surface O₃ observed in many locations in the maritime region in East Asia shows distinct springtime maximum and summertime minimum. The chemical transport models (CTMs) such as participated in several model inter-comparison projects (MIPs) have roughly simulated this seasonal transition, however, the summertime minimum has been overpredicted in many cases, although most of the models consider the processes essential to simulate the seasonal march of the concentration of surface O₃ such as the emissions, transport, chemical reactions, and deposition. Here, we compared the observations of surface O₃ in East Asian maritime region with the model output from several MIPs in order to describe the special and temporal features of the overprediction in summertime surface O₃ concentration in this region.

Comparison of monthly mean surface O₃ concentration observed at maritime remote sites around Japan and Korean Peninsula (observations from EANET and WDCGG database) with those simulated by models participated in a MIPs with global CTMs (HTAP2) revealed that the HTAP2 models overpredicted about 10-20 ppbv in summer particularly south of 40N including the sites like Ogasawara and Minamitorishima located in open ocean area far away from the Asian continent. From the comparison of one hourly O₃ concentration observed and simulated at Cape Hedo located in the southernmost part of Japan, it was shown that most of the HTAP2 models could simulate the temporal variations corresponding to the meteorological perturbations but tended to overestimate in the events that the observed O₃ concentration went below 20 ppbv. In the northern part (north of 40N), the O₃ concentrations in summer was relatively well simulated by HTAP2 models, but winter to spring O₃ concentration was clearly underpredicted about 5-10 ppbv which made the simulated summertime minimum quite unclear.

1.127 Measurements of of HONO, NO₂ and NH₃ by a filter pack method in Ho Chi Minh City Vietnam and Osaka, Japan.

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Abstract:

HONO/NO₂ ratios were measured at 3 points in Ho Chi Minh City, Vietnam by a filter pack method from 26 to 31 August, 2017. HONO was collected at 4.0 L/min with NaCl impregnated filter to remove HNO₃ gas, and two Na₂CO₃ impregnated filters to collect HONO and correct HONO concentration. NO₂ was collected at 0.1 L/min with two stages of triethanol amine impregnated filters. It is found that the ratios were 0.077 - 0.164 and much higher than those in Sakai, Japan (about 0.042 - 0.12). The particle concentrations in Ho Chi Minh were very high, and it is speculated that the HONO is formed efficiently on the particles from NO₂. The traffic volume were about 5,000 to 10,000 vehicles per hour on highly traveled road in day time, and more than 90 % were motor bikes. The differences in traffic volume and type of vehicle were possible to relate the high HONO/NO₂ ratio. Further, NH₃ concentrations were measured with phosphoric acid impregnated filters at 5 points by the filter pack method and about 50 points by the passive samplers. We found that average NH₃ concentrations in Ho Chi Minh in this period was about 40 ppb and were also very high compared to that in Japan.

1.128 First results of VOC and ozone measurements in European and Asian Major Population Centers (MPC) during the research aircraft campaign EMeRGe (2017/2018).

Early Career Scientist

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Abstract:

EMeRGe (Effect of Megacities on the transport and transformation of pollutants on the Regional and Global scales) aims to investigate the impact of MPC emissions on air pollution and chemical processing at local, regional and hemispheric scales by making dedicated airborne measurements using the German research aircraft HALO (Gulfstream G550). Optimized transects and vertical profiling for diverse MPCs (e.g. Rom, London, Paris, Taipei, Manila, Shanghai) were performed to determine the composition of various pollution plumes entering and leaving Europe and leaving Asia.

We contributed with two custom-made instruments for the measurement of volatile organic compounds (VOCs) and ozone, respectively. VOCs were measured with a Proton-Transfer-Reaction Mass Spectrometer (PTR-MS) and ozone with both an UV photometer and a fast (10 Hz) chemiluminescence sensor. The sophisticated set of detected tracers allowed to distinguish, identify and characterize different air mass types and their chemical fate. Examples are biomass burning affected air detected using acetonitrile or air imported by long-range transport with enhanced VOC concentrations (e.g. acetone) at high altitudes. Furthermore, we could sample high VOC concentrations in local pollution plumes, especially downwind of Asian MPCs. The air mass age is estimated based on the ratio of toluene to benzene, which allowed identifying freshly polluted plumes near the Taiwanese coast or chemically aged air masses from China due to long-range transport.

1.129 Observing the changing Anthropocene from satellites and from aircraft: SCIAMACHY/GOME/GOME-2/S5-P and EMERGe .

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SCIAMACHY and EMERGe Teams, Europe, Asia and America

Abstract:

Population grew from 4M at the Neolithic Revolution (10000 BC) to around 1 Billion at the beginning of the Industrial Revolution (1750-1800 AD). This growth then accelerated rapidly and population is now over 7.6 Billion with more than 50% living in megacities or urban agglomerations, known as Major Population Centres, MPC. The impact of pollution from anthropogenic activity of the MPC and related land use change now extends from the local to global scale. The world has entered a new geological epoch, the Anthropocene.

To assess accurately the evolving Anthropocene both space based and airborne measurement of atmospheric composition are a pre-requisite. The SCIAMACHY (SCanning Imaging Absorption spectrometer for Atmospheric CHartography) project was proposed in 1988 to begin to meet the need. The SCIAMACHY project led to SCIAMACHY on ESA Envisat (2002 to 2012), the smaller GOME (Global Ozone Monitoring Experiment) 3 GOME-2 on the ESA/EUMESAT operational Metop A B and C(2006-2026), OMI on NASA AURA (2004-present). The new EU/ESA/EUMETSAT Atmospheric Copernicus programme comprises Sentinel 4 on MTG (2021-2036) Sentinel 5-P (2017- present)) and Sentinel 5 (2 satellites 2021 - 2037) on Metop Second Generation.

Aircraft measurements are needed to provide measurements at high spatial resolution of trace atmospheric constituents to test our understanding of how natural and anthropogenic emissions are modified and oxidised. The EMERGe (Effect of MEgacities on the Transport and Transformation of Pollutants on the Regional to Global Scales) exploits the capabilities of the German HALO research aircraft and its sophisticated in situ and remote sensing payload. EMERGe synergistically exploits the observations from HALO, FAAM and smaller aircraft, together with data from ground based and satellite instrumentation. This presentation will provide highlights from 23 year of space based remote sensing and first results from the unique EMERGe campaigns in Europe in 2017 and Asia in 2018.

1.131 Data mining of large air quality datasets to improve emission inventories, identify long-term trends, and characterize meteorological influences on pollutant concentration.

Presenting Author:

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Abstract:

Large datasets of air quality monitoring data in the United States of America and in China contain a wealth of information about emissions of pollutants and atmospheric processes. We combine data mining tools such as inverse modeling, cluster analysis and multiple linear regression to extract detailed information from the datasets. The methods are able to merge weather data, meteorological simulations, particle trajectories and satellite remote sensing with surface concentration measurements to improve the estimates of emissions and to quantify factors impacting air quality. In the United States, the methods are used to characterize intra-urban variability of emissions as well as to obtain estimates of the diurnal profiles of emissions for different days of the week. The analysis was also used to identify factors leading to extreme pollution events as well as meteorological factors influencing atmospheric reactions, for example on the production and removal of secondary organic aerosols as well as reactive mercury. In both China and the USA there have been concerted policy efforts at improving air quality. The impacts of these can be evaluated on a regional to sub-urban scale in order to estimate the effectiveness of control policies and to keep emission inventories up to date with rapid changes.

1.132 Variability in the mixing state of black carbon aerosols observed in Asian outflow in the spring of 2016.

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Abstract:

Black carbon (BC) aerosols strongly absorb solar visible radiation and can affect the radiative balance of the atmosphere on regional and global scales. The mixing state of BC, which can be significantly altered by condensation, coagulation, and cloud processing, is a key parameter for estimating the radiative impacts of BC. We have developed a new method to quantify the mass of sulfate and nitrate aerosols internally and externally mixed with BC: the laser induced incandescence - mass spectrometric analyzer (LII-MS). The LII-MS is based on the tandem connection of a LII analyzer and the particle trap laser desorption mass spectrometer (PT-LDMS). The LII analyzer is used to selectively remove BC-containing particles by laser-induced evaporation and the PT-LDMS is used to analyze the chemical compositions of aerosol particles downstream of the LII analyzer. The LII-MS was successfully deployed during a field experiment conducted at a surface site in Gwangju, Korea in the spring of 2016. Backward trajectory analysis shows that air parcels observed at the site were frequently affected by regional-scale air pollution transported from the Asian continent. We have observed large temporal variability in the mass concentration of sulfate, nitrate, and BC aerosols and the mass fraction of sulfate and nitrate internally mixed with BC. The internally-mixed fraction for sulfate tended to be lower in highly polluted air masses (high sulfate concentrations) originating from the continent and higher in clean air masses (low sulfate concentrations) originating from the free troposphere. Possible mechanisms affecting the variability in the mixing state are discussed.

1.133 Seasonal Characteristics of Particulate Polycyclic Aromatic Hydrocarbons in Ulaanbaater city, Mongolia.

Early Career Scientist

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Abstract:

Ulaanbaatar is the capital city of Mongolia which is located at an altitude of about 1350 m and in a valley surrounded by the mountains. This city is known as the coldest capital city in the World due to its geographic features such as high altitude and landlocked location and prevailing wintertime Siberian high.

This work presents the concentrations of major polycyclic aromatic hydrocarbons (PAHs) found in suspended particulate matter in Ulaanbaatar City. These PAH concentration levels were determined by high-performance liquid chromatography (HPLC) with fluorescence detection. Fifteen polycyclic aromatic hydrocarbons (PAHs) were measured in particulate samples collected from different sites, such as the urban center, industrial, ger (traditional house), residential areas in January, March, and September 2017. Additionally, samples were collected at the townhouse area in September. The concentrations of total PAH at these sites were the highest in ger area, followed in descending order by residential, industrial, urban center, and townhouse areas. Moreover, the concentrations of total PAHs were high in winter and low in summer (January > March > September). PAH diagnostic ratio used for identifying and assessing pollution emission source showed that the impact of different degree of traffic emission

resulted in the spatial distribution of particular PAHs. The emission of diesel based vehicles significantly influenced the PAH concentrations. However, a dramatic seasonal change in atmospheric concentrations of PAHs in Ulaanbaatar suggests that the coal burning systems such as coal-heating boilers is considered to be the major contributors of PAH.

1.134 Mexico City Regional Carbon Impacts.

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Abstract:

Despite the lower concentrations of several air pollutants registered during the last few years in relation to the early nineties, air quality remains a challenging problem in the Mexico Megacity. In particular, CO₂ emissions, estimated in 44 Mt per year according to the 2014 emissions inventory, are densely distributed within the Mexico City Metropolitan Area and are known to have a fast growing-rate. Precise information about the emissions and their temporal evolution is important in order to understand how effective the adopted mitigation policies can be and how to plan, design and implement more effective actions to reduce greenhouse gas emissions. We present more than 4 years of continuous in situ and column-integrated CO₂ and CO measurements in and outside Mexico City in order to identify their seasonal and daily variability, as well as the trends detected at the regional and local scales. The data has been compared and complemented with the available observations from satellites. Details about a newly approved international project named "Mexico City Carbon Impacts" (MERCIC-_{CO2}), a collaboration between Mexico's National Autonomous University (UNAM), the French *Laboratoire des Sciences du Climat et de l'Environnement* (LSCE) and the Mexico City's Ministry of the Environment (SEDEMA), will be described. This initiative aims to adequately use all the information available in terms of bottom-up emissions, measurements and modelling to

derive a more refined and precise emission product with higher temporal and spatial resolution.

1.135 Tropospheric ozone trend during 1994-2007 in subtropical southern China .

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Abstract:

Ozone (O_3) is a greenhouse gas and air pollutant. Understanding its abundance and change and driving factors are of great importance to climate research and air quality management. However, there has been limited research of long-term (>20 years) trend of tropospheric O_3 in fast developing Asia. Here we present the measurements of surface O_3 from 1994 to 2017 carried out by the Hong Kong Polytechnic University at a coastal background site of Hong Kong. This is the longest and continuous record of surface O_3 in eastern China. Overall, ozone has shown statistically significant upward trend with a rate of 0.38 ppb/year, and the increase is shown in all four seasons. Hourly backward air trajectories are computed for the 24-year period, and the ozone data are classified into four air mass groups: aged continental, eastern China, central China, and marine origin. The ozone level exhibits a positive trend in all air groups. While the O_3 increase in continent-affected air masses is expected, the large increase in the maritime air (~2% per year) is interesting. The cause of the significant rise of maritime O_3 is discussed with an analysis of climate parameters (solar radiation, temperature, and relative humidity) and emission and satellite data on ozone precursors. The inter-annual variability of O_3 at this subtropical site are examined with the ENSO Index (Niño3.4) indicating enhanced surface O_3 during El Niño years. The rising surface O_3 is consistent with the trend of boundary-layer O_3 from monthly/weekly vertical profiles obtained by the Hong Kong Observatory. The increasing tropospheric ozone have important implications to air quality, ecosystem, and climate in the subtropical region of East Asia.

1.137 Unexpected slowdown of US pollutant emission reduction in the past decade.

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Abstract:

Air pollution regulations in the United States (US) have resulted in substantial reductions in emissions and correspondingly improvements in air quality. However, large uncertainties remain in evaluating the partitioning of emissions, and how recent regulations have affected these emissions. Here we show a significant slowdown in decreasing US emissions of nitrogen oxides (NO_x) and carbon monoxide (CO) for 2011 to 2015, by combining recent inverse modelling analyses, satellite and surface in-situ measurements, and emission estimation using a bottom-up approach.

1.138 Data assimilation of the cross-border transport of aerosols/PM2.5 using Himawari 8 data and NICAM-Chem model.

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Abstract:

We are making a forecasting system of air quality for human health from the distributions of aerosols including PM2.5, oxidants (tropospheric ozone), NO_x, SO_x and so on. A report by WHO estimated that the air pollution due to those species caused the health damage such as lung trouble and cerebrovascular disease corresponding to kill ~3.7 million people in the world during the year of 2012. In the case of Japan, about a half of the observed PM2.5 and tropospheric ozone originate outside of the country, and, especially in the western Japan, the cross-border transport of PM2.5 from the continent is significant. Therefore, in the prediction of air pollution there, the enough consideration of the global-scale transports of aerosols and oxidants is indispensable.

Himawari 8 observes the column distributions of aerosols covering the East Asia with very high resolutions for both time (10 minutes) and space (~5 km), and provide the open observational data sets within a day. We have derived the abundance of PM2.5 near the surface from the data sets assuming the bimodal size distribution of aerosols based on the algorithm by Higurashi and Nakajima (1999) and the vertical profile observed by CALIPSO, and assimilated the density data into the NICAM-Chem general circulation model (Goto et al. 2015). The method of assimilation is based on the optimal interpolation to be adaptable for the fast predictions with small computational resources. In the presentation we show the preliminary results of the assimilated PM2.5 distributions on Japan, and discuss the connection with the km-scale regional simulations to predict the urban air quality.

Acknowledgement: We thank Suuri-Keikaku Co., Ltd. for the support of this work.

1.141 Health Impacts associated with O₃ and PM_{2.5} air quality episodes in the UK in 2006.

Early Career Scientist

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Abstract:

We used a coupled chemistry-climate model (AQUAM) at a 12 km resolution to simulate maximum daily 8-hour (MDA8) O₃ and daily mean PM_{2.5} concentrations during two five-day air pollution episodes in summer 2006 (1-5 July and 18-22 July). Both episodes were driven by anticyclonic conditions with light easterly and south easterly winds and high temperatures that aided pollution build up. For each of these episodes we calculated the short-term exposure attributable to population-weighted MDA8 O₃ and daily mean PM_{2.5} concentrations.

Over the two episodes (totalling 10 days), the estimated total mortality burden attributable to short-term exposure to MDA8 O₃ was associated with 70 daily deaths brought forward, summed across the UK. The estimated health impact due to short-term exposure to daily mean PM_{2.5} concentrations differed during the two air pollution episodes with about 43 and 36 daily deaths brought forward during the first and second episodes, respectively. The corresponding percentage of all-cause (excluding external) mortality due to short-term exposure to MDA8 O₃ and daily mean PM_{2.5} during these episodes ranges from 5.2% to 3.4% and from 3.9% to 2.0%, respectively.

For all episodes, the regions having the highest number of deaths brought forward were the North West and the South East regions of the UK due to a relatively higher population density in these regions. However population-weighted pollutant concentrations varied depending on region and episode.

We estimate that the short-term exposure to MDA8 O₃ and daily mean PM_{2.5} during these episodes was between 36-38% and 39-56% higher, respectively than expected seasonal mean estimates. This highlights the potential of air pollution episodes to have substantial short term impacts on human health burdens.

1.142 Trends in primary NO₂ emissions and investigation into vehicle cold start effects from ambient monitoring data in the UK.

Early Career Scientist

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Abstract:

Nitrogen oxides (NO and NO₂) are key air pollutants and atmospheric chemical intermediates; exceedance of air quality limits for NO₂ is a significant policy challenge in many urban environments globally. Here, we investigate trends in measured ambient NO₂ and NO_x mixing ratios from urban (road traffic dominated) monitoring sites in the UK over the period 2009-2016. We apply an oxidant analysis approach to the ambient data to determine trends in primary NO₂ emissions, and introduce a methodology to examine evidence for enhanced vehicle "cold start" primary NO₂ emissions. Analysis of the trends indicates an overall reduction of 18 % (from 0.17 to 0.14) in the monthly mean primary NO₂ emission fraction in the UK from 2009 to 2016, with a significant median decrease of -0.32 per year. However, during cold weather (temperatures of 5 °C or below) overall NO₂ primary emissions are elevated from 6.2 (±0.4) % to 10.2 (±0.1) %, and from 5.6 (±0.4) % to 9.8 (±0.1) % for morning and evening rush hours respectively. For individual locations, cold weather primary emissions can be factors of 1.6 - 3.8 higher. Trends in ambient NO_x and NO₂ and in the primary NO₂ emission in general indicate that there is an improvement in urban air quality over the last decade. However, the cold weather results may indicate that the combination of recent vehicle driving history and ambient weather conditions, in conjunction with technological constraints on the operating temperature range of emission control systems in some vehicles, have a substantial impact upon NO₂/NO_x emissions and hence upon UK urban air quality.

1.143 EMeRGe campaigns in Asia: Regional air pollutants prediction and simulation.

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Abstract:

In the winter and spring times, the cold continental airs not only often outflow to Taiwan, but also bring air pollutants and dusts. Moreover, springtime happens to be the biomass burning season in Indochina. Under favor weather conditions, the products of biomass burning pollutants could be transported easily to Taiwan and even East Asia. Due to the unique geographic location of Taiwan, that allows us to receive more than just one source in spring. Actually, the complex interactions of these air pollutants and aerosols features in the boundary layer and aloft have resulted in complex characteristics of air pollutants and aerosols distributions in the lower troposphere over Taiwan and East Asia. The impacts are also essential and complex.

The project "Effect of Megacities on the transport and transformation of pollutants on the Regional and Global scales (EMeRGe)" aims to improve our knowledge and prediction of the transport and transformation patterns of European and Asian megacities pollutant outflows. In EMeRGe Asia, the composition of the plumes of pollution entering and leaving Asia measured by the new High Altitude and Long Range (HALO) aircraft research platform. The HALO aircraft performing optimized transects and vertical profiling in Asia during 12 March and 7 April in 2018. To design the measurement of aircraft flight paths and elevations, a high resolution, 9 km, numerical prediction by Weather Research Forecast (WRF) and WRF-Chem models were joined and performed during the campaigns. The EMeRGe Asia has successfully finished more than 10 missions during study period. Model performances and preliminary results will discuss in this meeting. Overall, this series of studies significantly fill the gap of our understanding on air pollutants transformation and transport to Taiwan and East Asia, and show the potential directions of future studies.

1.144 Impact of Air Pollution on School Children in Dhaka city, Bangladesh.

Early Career Scientist

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Abstract:

Impact of Air Pollution on School Children in Dhaka city, Bangladesh

Air pollution contributes a significant threat to health in worldwide. Atmospheric aerosol particulate Matters (smaller than PM 2.5) play an important role in air quality. Inhalation of fine particulate matter (PM 2.5) is associated with lung injury as they can enter into the human system. The aim of the present study is to investigate the mass contribution of particulate matter in different sizes (PM 1.0 to PM 10) and also gases (NO x , SO x , CO, TVOC) in schools campus and correlating with children health especially lung function. Sampling locations (Mughda bisso road, Kakrail, Fuller road, Jatrabari, Ahmadhbagh, Motijheel, Gulshan, Mirpur, Nilkhet and Khilgaon) were selected by covering the whole Dhaka City. In each school we have selected 20 children aged between 8-10 years. The lungs function of each student will be recorded using Peak expiratory flow meter . Other health conditions will also be recorded for understanding the total impact of air pollution. Real time PM 1.0 , PM 2.5 PM 4.0 , PM 10 and TSP concentrations will be measured using Aerocet 531S, and NO x , SO x , CO x , TVOC concentrations will measured using Aeroqual 500 series. After collection of particulate matters and health related information, we will analyzed data for concluding relation between the average peak flow rate and particulate matters in the school children. We can also suggest Government and school authority for the control measures.

1.147 How effective are short-term emission controls for mitigating urban air pollution?.

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Abstract:

Urban air pollution from fine particulate matter and atmospheric oxidants such as ozone poses serious health risks to residents of major cities across the world. Many cities are now experimenting with short-term emission controls, such as restrictions on private vehicle usage and temporary closure of polluting factories, when air pollution reaches or is expected to reach dangerous levels. Control of these local sources improves air quality, but often by a smaller margin than expected. This reflects the importance of atmospheric transport from surrounding regions and secondary chemical and microphysical transformation of pollutants from across a wider area. In this study we use a high-resolution, nested air quality model (WRF-Chem at 3 km scale) to investigate the effectiveness of the emission controls imposed in Beijing for the Asia-Pacific Economic Cooperation (APEC) forum in November 2014. The air quality during the forum was good, aided greatly by favourable meteorological conditions, and emission controls led to a reduction in PM_{2.5} of about 25% over Beijing, with daily mean concentrations averaging 50 ug/m³. While this was hailed as a success, we show that if the forum had been held two weeks earlier, the same emission controls would have led to a marginally smaller relative reduction in PM_{2.5} of 20%, and only brought mean particulate levels down to 130 ug/m³. This remains far in excess of current air quality standards. We investigate the controls needed to achieve good air quality under these conditions, and highlight the need for robust policy options that account for prevailing meteorological conditions.

1.148 Toxicological and Chemical Characteristics of Fine Particles from Burning of Crop Residues in China.

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Abstract:

Crop residue burning is a major source of fine particulate matter and arouses significant concern in China and worldwide due to its adverse impacts on environment and human health. Five types of crop residue (rice straw, wheat straw, corn straw, sugarcane straw and sorghum straw) were selected and burned in a laboratory combustion chamber to mimic the combustion process. Total 28 sets of PM_{2.5} samples were collected to determine their chemical and toxicological characteristics. Human lung alveolar epithelial A549 cells were exposed to PM_{2.5} at concentrations of 0, 20, and 150 µg/ml for 24 hours. Burning of wheat straw emitted the highest level of PM_{2.5} while sugarcane and sorghum straw emitted the lowest. Carbonaceous species, organic carbon (OC) and elemental carbon (EC), were the dominant components in all samples which contributed ~50% of PM_{2.5} in total. Potassium (K⁺) and chloride (Cl⁻) are dominant water-soluble ions from crop residues burning, with an average abundance of 6.4 ± 4.4% and 14.5 ± 8.2% in PM_{2.5}, respectively. Exposure to PM_{2.5} at the concentration of 20 µg/ml to 150 µg/ml decreased cell viability and increased LDH / IL-6 release. Strong negative correlations were found between cell viability and OC (R = -0.66) and some heavy metals such as Cr, Mn, Fe, and Ba (R < 0.65). Moreover, OC, Cr, Mn, Fe and Ba also showed strong positive correlations with LDH and IL-6 responses. In conclusion, our data indicate that PM_{2.5} emitted from biomass burning contained high concentrations of OC and toxic metals which were strongly correlated to cell viability and inflammatory responses. The findings suggest a need to control the burning of crop residues which can induce significant health impact on human being.

1.149 Influence of urbanization on the sources of atmospheric nitrate; Evidence from the triple oxygen isotopes of nitrate in dry and wet deposition.

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Abstract:

Atmospheric nitrate deposition resulting from anthropogenic activities negatively affects human and environmental health. Identifying deposited nitrate that is produced locally versus that originating from long-distance transport would help inform efforts to mitigate such impacts. However, distinguishing the relative transport distances of atmospheric nitrate in urban areas remains a major challenge since it may be produced locally and/or come from upwind regions. To address this uncertainty, we assessed spatiotemporal variation in monthly weighted-average triple oxygen isotopic compositions of wet and dry nitrate deposition during one year at urban and rural sites along the western coast of the northern Japanese island of Hokkaido, downwind of the East Asian continent. Triple oxygen isotopic compositions of nitrate in wet deposition at the urban site mirrored those of wet and dry deposition at the rural site, ranging between +23 and +31 permil with higher values during winter and lower values in summer, which suggests greater relative importance of oxidation of nitrogen dioxide by ozone during winter and hydroxyl radicals during summer. In contrast, triple oxygen isotopic compositions of nitrate in dry deposition at the urban site were lower (range from +19 to +25 permil) and displayed less distinct seasonal variation. These results suggest that, relative to nitrate in wet and dry deposition in rural environments and wet deposition in urban environments, nitrate in

dry deposition in urban environments forms from relatively greater oxidation of nitrogen monoxide by peroxy radicals and/or oxidation of nitrogen dioxide by hydroxyl radical. Given greater concentrations of peroxy radicals and hydroxyl radical in cities, these results imply that dry nitrate deposition results from local NO_x emissions more so than wet deposition, which is transported longer distances. These results illustrate the value of stable isotope data for distinguishing the transport distances and reaction pathways of atmospheric nitrate pollution.

1.150 Indoor particulate matter, trace elements, and temperature variations: a case study in rural Giyani, Limpopo, South Africa.

Early Career Scientist

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Abstract:

Indoor air pollution contributes significantly to the burden of disease as it has numerous associated health impacts. Here, the aim was to assess and compare respirable particulate matter (PM₄ - particles equal to or less than 4µm in diameter) in residential homes in 4 villages in rural South African community. The objectives were to i) investigate differences in mass concentration for particulate size fractions of PM₁₀, PM₄, PM_{2.5}, and PM₁, ii) assess seasonal variations of respirable PM and trace elements, and iii) investigate the association between respirable PM and temperature. Measurement campaigns were conducted during spring (6-15 September 2016), summer (6 February – 8 March 2017), and winter (3-31 July 2017). The spring campaign consisted of three randomly-selected households in one village, whereas summer and winter included two households (~7 days per household) from each of the four villages. Indoor PM was measured using the DustTrak II continuous monitoring instrument at a 5-minute average time as well as 24-hour gravimetric filter sampling. Temperature and relative humidity were measured both indoors and outdoors. A collocated experiment was conducted in a single household (during spring) to investigate the relationship between various size fractions. The collocated study showed that mass concentrations of PM₁₀, PM₄, and PM_{2.5} were closely related making it possible to compare PM₄ measurements to PM₁₀ guidelines and standards. The continuous measurements allowed for time-series analysis and the identification of seasonal and diurnal patterns. The trace element mass concentrations were obtained by subjecting the gravimetric filter samples to wavelength dispersive x-ray fluorescence (WD-XRF) analysis suggesting possible sources, such as soil dust, that contribute to indoor particulate matter. Results provide insight into the level of indoor particulate pollution experienced in a rural setting and help to identify possible interventions to reduce exposure and reduce indoor air pollution-associated health impacts.

1.153 Recent trend of atmospheric emissions due to open crop residue burning in the central east China .

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Abstract:

Serious open crop residue burning (OCRB) is held after harvest in the granary areas, and that has been well known as significant sources of atmospheric pollutants including primary aerosols and precursors of photo-oxidants and secondary organic aerosols. The atmospheric pollutants emitted from OCRB not only stagnate in the source areas but are transported downwind, therefore OCRB might largely affect on wider regional atmospheric environment and climate. The activities of OCRB over the central east China are highest in June, which associate with the harvest season of winter wheat. The next highest month is October after the corn harvest season. The annual amounts of both grain productions in China slightly increased until 2013, and then the production amounts had remained almost unchanged. The long-term record of the fire detection counts (FDCs) have been obtained from Moderate Resolution Imaging Spectroradiometer (MODIS), which can be connected with OCRB over the cropland especially. The monthly-accumulated FDCs in June over the central China indicated a significant increase during the period of 2007-2012, though accompanied by a large variability. Thereafter the FDCs from MODIS indicated a decreasing trend after 2012 and the FDCs in June 2016 reached approximately 17% of those in June 2012. The decreasing trend on the FDCs from MODIS may connect with the reinforced OCRB regulation employed by both central and local governments of China. We will also report recent trend of atmospheric emissions due to OCRB in the central east China coupling with fire counts detected from satellite.

1.155 Air pollutants and GHGs monitoring project around Jakarta megacity.

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Abstract:

We have conducted air pollutants monitoring around Jakarta megacity in Indonesia, in addition to greenhouse gases (GHGs) monitoring, to estimate the amount of those anthropogenic emissions from the urban area.

In order to achieve this purpose, we developed a ground-based comprehensive monitoring system of air pollutants and GHGs and installed it at three sites around Jakarta: Bogor (center of Bogor city), Serpong (Jakarta suburb) in 2016, and Cibereum (mountainous area, background-like site) in 2017.

The monitoring system consists of data acquisition/control units and the instruments for continuous measurements of CO₂, CH₄ (G2301, Picarro), CO (CO-30r, Los Gatos Research), NO_x (Model 42i-TL, Thermo), SO₂ (Model 43i-TLE, Thermo), O₃ (OA-787, Kimoto Electric), aerosol concentrations (PM_{2.5}, PM_{coarse}, black carbon (BC)) (ACSA-14, Kimoto Electric), and for flask sampling of air (Koshin-RS). The ACSA-14 also measures the chemical components of aerosols (NO₃⁻, SO₄²⁻, WSOC) automatically. We can monitor/control not only the monitoring instruments but also peripheral devices, such as vacuum pumps and valves, remotely through the Internet. We can also obtain all data in unified format even though we use the monitoring instruments produced by a number of different instrument manufacturers. In Indonesia, lightning frequency is relatively high, thus electric power failures sometimes occur. Hence the monitoring system has an automatic power control function.

We found that urban characteristics (i.e., high concentration) are shown in CO₂, CH₄, CO, NO, NO₂, SO₂, PM_{2.5}, PM_{coarse}, and BC observed at Bogor and Serpong, but background-like characteristics are shown at Cibereum. For instance, the average value of BC observed at Bogor was 4 times larger than Cibereum. We also found that the values of CO₂, CH₄, NO₂, SO₂, and O₃ observed in December and January were lower than the other months. We will present those temporal variability observed at three monitoring sites around Jakarta.

1.156 Regional air pollution reaching Fukue Island, western Japan: Highlights during EMeRGe-Asia/ KORUS-AQ and long-term variations during 2009-2018.

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EMeRGe team,

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Abstract:

At Fukue Island (32.75°N, 128.68°E), western Japan, we have been conducting long-term observations of NO₂ vertical profiles using MAX-DOAS (Multi-Axis Differential Optical Absorption Spectroscopy), other gases (e.g., O₃ and CO), and aerosols (BC and PM_{2.5}) since 2009. While long-term trends are all negative for PM_{2.5}, black carbon and CO, severe pollution episodes are occasionally encountered even in recent years, particularly for ozone. The observational data during KORUS-AQ period (April-June 2016) and EMeRGe-Asia (March-April 2018) were intensively analyzed. Tropospheric NO₂ vertical column density (TropoNO₂VCD) as measured with a MAX-DOAS instrument exceeded 10×10^{15} molecules cm⁻² when air mass traveled quickly from Japan and Korea, while O₃ and PM_{2.5} peaked at different timings when air mass originated from China. During KORUS-AQ, we found close match between the NO₂ mixing ratio (~270 pptv) at ~300 m altitude derived from MAX-DOAS and that of airborne observations from NASA DC-8 which flew just over the site on 10 June 2016. During EMeRGe-Asia, a heavy pollution episode occurred during 24-28 March 2018 covering wide region over Japan; maximum hourly ozone, CO, BC, and PM_{2.5} levels at Fukue were 97 ppb, 563 ppb, 1.39 μg m⁻³, and 79 μg

m^{-3} , respectively, on 24 March. The ozone level was highest in the recent 10 years for March, but for 6 hours in 2013. We will include observations at other locations, aircraft measurements, and model simulations, to discuss three-dimensional features of such pollution episodes and modeling capabilities.

1.158 Analysis of trends in Chinese Air Quality: results from a new monitoring network..

Early Career Scientist

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Abstract:

China's rapid industrialisation and urbanisation has led to poor air quality, which studies estimate causes over one million premature deaths per year. The Chinese government have responded by introducing regulations to attempt to reduce industrial emissions and setting ambitious targets for ambient NO_2 , $\text{PM}_{2.5}$ and SO_2 concentrations. Previous satellite and modelling studies indicate that concentrations of these pollutants have begun to decline within the last decade. However, many studies suffer from a lack of measurements to verify their estimates.

Prior to 2013, air quality measurement data from ground-based monitoring stations were difficult to obtain, limited to a few locations in major cities, and often unreliable. Since then, there has been a drive to establish a more comprehensive and reliable monitoring network, with over 1000 stations being established by the Ministry of Environmental Protection (MEP) across China.

We use a three-year (2015-2017) dataset consisting of hourly $\text{PM}_{2.5}$, O_3 , NO_2 and SO_2 concentrations that has been scraped from the MEP website, combined with similar data from Taiwan and Hong Kong. We have rigorously cleaned the data, detecting several anomalies, some of which have not been discussed in previous literature. Statistical techniques are used to derive estimates of trends across China, revealing that for the majority of stations, SO_2 and $\text{PM}_{2.5}$ have decreased significantly, while NO_2 is more mixed, and O_3 concentrations have increased significantly. O_3 has been identified as one of the atmospheric pollutants that is most harmful to human health, which is concerning as O_3 is not currently subject to government targets and control measures in China. We use the WRF-Chem model to explore potential drivers of these observed trends.

1.159 Sensitivity of tropospheric ozone formation in urban areas under changing climate, emissions and vegetation modeled with the city-scale chemical transport model CityChem-EPIISODE..

Early Career Scientist

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Abstract:

Tropospheric ozone is a major threat for human health but still 90% of Europe's urban citizens are exposed to ozone concentrations above air quality guidelines. Policy support by Air Quality Management (AQM) requires a deeper understanding of ground-level ozone formation in cities. Within AQM, the potential of biogenic volatile organic compound (BVOC) emissions from urban vegetation in combination with anthropogenic emissions to produce ground-level ozone has long been recognized. Higher temperatures in a future climate will increase chemical reactivity. Emission abatement regulations leading to less emissions of nitrogen oxides (NO_x) and higher BVOC emissions from vegetation in urban agglomerations might interact to generate enhanced ozone concentrations in densely populated areas. Only few regional chemical transport model (CTM) studies have investigated the role of biogenic emissions in future climate states and have shown that these can contribute significantly to ground level ozone production in urban regions. In this study, city-scale CTM simulations resolving the near-field dispersion of pollutants are used to investigate the sensitivity of ground-level ozone formation in a changed climate and urban environment. Specifically we study the sensitivity towards elevated temperatures, increased BVOC emissions due to urban vegetation, and reduced NO_x traffic emissions. We use the CityChem-EPIISODE model which includes detailed VOC-chemistry and a street-canyon module with a resolution of 100m for the urban agglomeration of Duisburg, Germany (1.000.000 inhabitants). Scenarios are performed to identify the influence of higher temperatures on photochemical ozone-cycle and the influence of changing the VOC/NO_x-ratio to more NO_x-sensitive regimes, by systematically raising BVOC emissions of vegetation and reducing NO_x traffic emissions. Based on these findings insights about the formation of ground-level ozone under future climate and urban development conditions as well as shortcomings of the CTM mechanisms are gathered, and will improve the capabilities of urban AQM systems to serve for policy support.

1.161 Ground-based and satellite remote sensing in Korea for the EMeRGe-Asia mission.

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Abstract:

During the EMeRGe-Asia campaign (from 12 March to 8 April, 2018), various ground-based and satellite remote sensing observations have been conducted for monitoring the spatiotemporal pattern of aerosols and trace gases in Korea. Several cases showing high aerosol amounts are detected: 12-13 March, 24-25 March, 28-29 March, and 7-8 April. Ground-based Aerosol Robotic Network (AERONET) indicates the regional difference of aerosol optical depth (AOD): generally high in all west coastal regions in Korea, but particularly higher AOD in Anmyon. The satellite Geostationary Ocean Color Imager (GOCI) and Advanced Himawari Imager (AHI) also illustrate the distinct movement of aerosol plumes from China to Korea for these cases. Interestingly, the high AOD plume is transported into the Korea with the low-level cloud for the 24-25 March case, implying the potential increase of atmospheric turbidity due to the particle growth. A case showing strong Asian dust transport was detected for 7-8 April, having the different vertical shape

of particle transport. Thus, comparison analysis using these multiple cases will suggest how the regional meteorology can differently influence to the advection of East Asian aerosol plumes. Ground-based Pandora spectrometers at Seoul and Busan measure the column density of O_3 and NO_2 to see the trace gas concentration related to the air pollution. Sudden high O_3 and NO_2 columns are found during 23 March, simultaneously at both Seoul and Busan. Considering the distance between two sites, there may be a large intrusion of upper atmospheric (free troposphere or stratosphere) air masses above the Korean peninsula. All these findings are useful to understand the role of regional meteorology to the air quality and composition.

1.162 Airborne measurement of peroxy radicals during EMeRGe .

Early Career Scientist

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, and the EMeRGe team

Abstract:

The amount, distribution and role of peroxy radicals, HO₂ and RO₂ (where R is an organic group) in tropospheric air masses are of key importance for the assessment and interpretation of the transformation and processing of polluted outflows from major population centres (MPC). This issue has been investigated within the EMeRGe project (Effect of Megacities on the Transport and Transformation of Pollutants on the Regional to Global Scales) for selected MPCs. The reactions of these radicals play a key role in the catalytic oxidation of hydrocarbons. Thereby they determine the O₃ budget and the oxidation capacity of the atmosphere (OCA).

Airborne measurements of the total sum of peroxy radicals, RO₂^{*} = (HO₂ + ∑ RO₂), have been conducted within EMeRGe by using PeRCEAS (Peroxy Radical Chemical Enhancement and Absorption Spectrometer), which is part of the EMeRGe payload in the HALO research aircraft (www.halo.dlr.de). PeRCEAS combines the PerCA (Peroxy Radical Chemical Amplification) measurement technique for the amplified conversion of radicals entering the reactor into NO₂ by a chain reaction, with the sensitive detection of NO₂ by a novel cavity ring down instrument. The instrument shares a common inlet for two identical measurement lines (reactor-detector) to improve time resolution and sensitivity. The amplification factor (chain length) and detection limit are determined by calibrations under controlled representative flight conditions.

PeRCEAS successfully participated in the EMeRGe HALO campaigns in Europe in summer 2017 and in Asia in spring 2018. Air masses of different photochemical activity and significant RO₂^{*} mixing ratios up to 100 pptv were measured.

This presentation will describe the preliminary findings of the RO₂^{*} mixing ratios observed upwind and downwind of the selected MPCs.

1.163 Lower tropospheric ozone variability and trend over the North China Plain derived from space for 2008-2016.

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Abstract:

China is a highly polluted region. Emission reductions have been applied starting with SO₂ emissions in 2006 and with NO_x emissions in 2010. Recent studies show a decrease of NO₂ concentrations or tropospheric columns since 2013 and attribute it to the NO_x emissions reduction. The question of the impact of such reduction on ozone is then arising. In this study, we use the capabilities of the IASI satellite instrument to retrieve 2

semi-independent columns of ozone in the lower and the upper troposphere – the lower tropospheric (LT) column having a sensitivity maximum at 3-4 km – to evaluate the variability and trend of LT ozone over the North China Plain (NCP) for 2008-2016. Deseasonalized monthly timeseries show two distinct periods: a first period (2008-2012) with no significant trend (< -0.1 %/yr) and a second period (2013-2016) with a highly significant negative trend of -1.2 %/yr. However, any negative trend has been reported from background surface measurements in this Chinese region. As well, recent work made within the framework of the TOAR (Tropospheric Ozone Assessment Report) initiative reveals discrepancies in the trends of tropospheric ozone derived from satellite instruments. A detailed analysis of the IASI retrieval stability and robustness, done by comparing with surface and ozonesonde measurements and other satellite instruments, does not show any specific issue. We use statistical regression models and simulations from global and regional chemistry transport models to explore the dynamical and chemical factors that could explain this negative trend. Primary results suggest that the negative trend observed from IASI could arise from a reduction of the stratosphere-to-troposphere transport combined with reduction of regional precursor emissions.

1.165 Temporal variability of polycyclic aromatic hydrocarbons and their oxidative derivatives in Beijing, China: wintertime observations..

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Abstract:

Polycyclic Aromatic Hydrocarbons (PAHs) are known to be produced directly by combustion and are mostly emitted from anthropogenic sources; some have a strong mutagenic effect on human health. PAHs undergo reaction with oxidants in the atmosphere leading to the generation of a range of airborne nitrated-PAHs and oxygenated-PAHs, that in some cases are more toxic than the parent-PAHs. The formation of oxy-derivative and nitro-derivatives is influenced by local/regional emissions of PAH and oxidation rates, although relatively little is known about the variability in concentrations between daytime and night-time.

This study shows the temporal distribution of 16 particulate phase parent-PAHs, 11 oxy-derivative (o-PAHs) and 5 nitro-derivative (n-PAHs) in Beijing - China. PM_{2.5} samples were collected using a high volume air sampler (80 m³ h⁻¹) every three hours during daytime and over 15h at night-time during 18 continuous days (22 November 2016 to 9 December 2017). Fifty-seven samples in total were collected and extracted using an accelerated solvent extractor and analysed by GC-Q-ToF-MS in electron impact mode.

A range of different PAHs and o-PAHs were observed on most days, however n-PAHs were not always detectable in the 3h day samples and for some days the detection limit of the n-PAHs provides an upper estimate of possible concentrations. The total daytime concentrations during high particulate loading conditions for PAHs, o-PAHs and n-PAHs were 665, 85, and 38 ng m⁻³, respectively, concentrations which were of the order ~ 4.7, 2.9, and 2.7 times higher than average night-time values. In addition, the most abundant PAHs during polluted day were Pyrene (82.49 ng m⁻³), Fluoranthene (85.34 ng m⁻³), Chrysene (81.19 ng m⁻³) and Benzo(b)fluoranthene (119.5 ng m⁻³). 6-Nitrobenzo[a]pyrene (28.27 ng m⁻³) was the most abundant n-PAH, while 9-Fluorenone (12 ng m⁻³), 1-Pyrenecarboxaldehyde (11.45 ng m⁻³) and Benzo[a]fluorenone (16.3 ng m⁻³) were the three major o-PAHs species.

1.166 Health impacts and complex drivers of air pollution in the City of Johannesburg, South Africa.

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Abstract:

Gauteng Province in South Africa is the smallest Province in South Africa, but contains the largest population (~14.3 million in 2017). The City of Johannesburg is the largest city in the Gauteng Province, and in fact, in South Africa. From available ambient measurements, it is clear that air quality is poor in the growing City, with many exceedances of the National Ambient Air Quality Standards measured.

The sources of air pollution that impact the City are complex, with impacts from anthropogenic sources (e.g. vehicles, industries, power station) and natural sources (e.g. biomass burning, biogenic, dust). In addition, transboundary sources are important, as the City is surrounded by other populous cities, as well as industrialized areas. Adding to this complexity are a range of community-based sources, such as waste burning and use of domestic fuel, the emissions of which are generally concentrated in vulnerable

communities.

We have used measurements and air quality modelling (CAMx) to assess air pollution and its impacts on health in the City. The modelling used a high-resolution, locally-derived emissions inventory. This assessment was used in the review and development of the City of Johannesburg's Air Quality Management Plan, with an aim to support effective evidence-based air quality management. The analysis found that ozone and particulate matter are major contributors to poor air quality in the City, though their concentrations and impacts on health are spatially highly variable. The assessment of potential public transport interventions found that current public transportation plans for the City would have minimal impact on air quality in the growing City; this highlights the need for ambitious, integrated interventions to improve air quality. This presentation will discuss the findings of the research, and highlight atmospheric chemistry research needs to work towards improving the air quality in South Africa's largest city.

1.178 Global Modeling Assessment of PM_{2.5} During Wildfires: Inferring the Impact of PM_{2.5} Exposure on Adverse Respiratory & Cardiovascular Conditions .

Early Career Scientist

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Abstract:

Exposure to fine particulate matter (PM_{2.5}) can aggravate pre-existing respiratory and cardiovascular conditions. When PM_{2.5} is inhaled it can cause damage to the lungs such as reduced lung function and shortness of breath. After being inhaled PM_{2.5} can enter the bloodstream and cause harm to the heart. One major natural source of PM_{2.5} exposure is from wildfire smoke. The particulates within the smoke from the wildfires can spread from the initial source region, potentially impacting communities both near and far. During and after wildfire events, PM_{2.5} levels can exceed the WHO air quality guidelines (10 [endof]--> annual mean; 25 [endof]--> daily mean), becoming hazardous to an individual's health.

Global models can be used to simulate the emission and transport of these particulates and subsequently they can be valuable to air quality forecasting in highly polluted areas. The NASA Goddard Earth Observing System (GEOS) version 5 Composition Forecast (GEOS-CF) system has been used to produce near-real time air quality forecasts of atmospheric composition at a high global resolution of 25 km. The GEOS-CF system utilizes the GEOS weather forecast model coupled with GEOS-Chem (version 11) chemistry module to provide analyses and forecasts of various toxic air pollutants, including PM_{2.5}. The GEOS-CF simulated high levels of PM_{2.5} (40 [endif]--> to 250 [endif]-->), exceeding the WHO guidelines, during multiple recent regional and global wildfire seasons, including the 2017 Seattle, WA and Los Angeles, CA wildfire seasons, and biomass burning events in India. Furthermore, the GEOS-CF simulated PM_{2.5} applied to a human health assessment model, BenMAP (The Environmental Benefits Mapping and Analysis Program, version 1.3), estimates the impact on adverse respiratory health conditions due to PM_{2.5} exposure from wildfires. The GEOS-CF predicted PM_{2.5} during the wildfire season with the corresponding BenMAP results provides an assessment of the human health impact of PM_{2.5} exposure.

1.181 Surface emissions for global and regional atmospheric composition analysis.

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Abstract:

In order to drive atmospheric models performing air quality forecasting and analysis of the atmospheric composition, an accurate quantification of surface emissions from anthropogenic and natural sources is required. As part of the European Copernicus Atmosphere Service (CAMS), diverse emission datasets are being developed. Global anthropogenic emissions for about ten sectors for a large number of atmospheric compounds, including speciated volatile organic compounds for the 2000-2018 period, are being made available to the community, at a 0.1x0.1 degree resolution. Regional anthropogenic emissions for Europe are also being developed for 2000-2015 at a spatial resolution of about 0.125° x 0.0625°, for twelve sectors. In addition, detailed emissions from ships based on ship identification systems are being developed. Different datasets providing natural emissions are being processed, such as the emissions of biogenic volatile organic compounds from vegetation, nitrogen compounds emissions from soils, emissions from the oceans and emissions from volcanoes. Methodologies for evaluating the emissions and their consistency at different scales are being generated. Temporal profiles, as well as algorithms to take into account the impact of meteorological conditions on emissions are being considered. The project is also supporting the AMIGO/IGAC project.

1.182 The improvements and application of XBAER derived aerosol properties for EMeRGe campaign.

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Abstract:

EXtensible Bremen AErosol Retrieval (XBAER) is a recent developed algorithm in University of Bremen to retrieve aerosol and surface properties from MEdium-Resolution Imaging Spectrometer (MERIS)/ Ocean and Land Colour Instrument (OLCI) and similar instruments. The XBAER algorithm is performed to support the Effect of Megacities on the Transport and Transformation of Pollutants on the Regional to Global Scales (EMeRGe) campaign. The current XBAER algorithm has been developed for the retrieval of global aerosol and surface properties and the global dataset is available on ICARE Data and Services Center (www.icare.univ-lille1.fr) under "CCI/MERIS_XBAER". However, the validation results show that further improvements are needed to retrieve aerosol over relative bright underlying surfaces with complicated aerosol types, for instance, over EMeRGe campaign area. The following aspects will be included in this paper:

1. An extension of XBAER cloud masking utilizing new haze/fog detection will be included in this paper, which is an essential step for the improvements of the retrieval for strong air pollution events.
2. A new surface parameterization method will be proposed over EMeRGe campaign area due to the complicated surface types and topography.
3. A comparison with the Geostationary Ocean Color Imager (GOCI) Yonsei aerosol retrieval (YAER) version 2 products will be performed during EMeRGe campaign period.

1.183 A decade of satellite-derived maritime NO_x emissions over Chinese Seas.

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Abstract:

Using the inversion algorithm DECSO version 5 we derived monthly NO_x emissions on a 0.25 x 0.25 degree resolution over East Asia for an 11-year period (2007 to 2017) based on OMI observations. We used these emissions to analyse trends and seasonal cycle of maritime emissions over Chinese seas. No effective regulations on NO_x emissions have been implemented for ships in China, which is reflected in the trend analysis of maritime emissions. The effect of maritime emissions on the air quality over land will be discussed. Simulations by an atmospheric chemistry transport model show a notable influence of maritime emissions on air pollution over coastal areas, especially in summer. The satellite-derived spatial distribution and the magnitude of maritime emissions over Chinese seas are in good agreement with bottom-up studies based on the Automatic Identification System of ships. We will further show how the new high resolution observations of TROPOMI on Sentinel 5p are expected to enhance the accuracy of maritime emissions in the future.

1.186 Trends in photochemical pollution in Central Chile.

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Abstract:

In this work, we assess in situ air quality data collected by environmental authorities in Central Chile, focusing on ozone and its precursors. Further, we calculate long-term trends (decadal) in average and maximum values. In lack of an adequate hydrocarbon characterization, we use satellite observations to identify NO_x-limited versus NO_x-saturated ozone formation regimes under current conditions. Recommendations regarding air quality collection and curbing measures to address ozone pollution are outlined.

1.188 Using citizen science approach to assess personal exposure to air pollution in a low income neighborhood: The case of Nairobi..

Early Career Scientist

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Abstract:

Air pollution is a major environmental and health challenge globally. The primary pollutant of concern for human health is fine particulate matter (PM). It is estimated that PM pollution is associated with 670,000 premature deaths annually in Africa, divided roughly equally between indoor and outdoor exposures (Forouzanfar et al., 2015). Scientific studies on environment in general and air pollution in particular rarely inform policy in developing countries, especially in Africa. Similarly, many studies on air pollution do not engage with local communities, both of which are necessary for research to inform policy action and promote citizen awareness. Our study was designed to deal with both of these challenges by creating a research-policy platform.

This study presents findings from a personal exposure assessment campaign conducted for a period eight weeks in a low income settlement in Nairobi. We use a citizen science approach working with trained local members of the community to collect data on PM pollution from indoor and outdoor sources using portable particle counter (The Dylos DC1700) while at the same time keeping a detailed journal of daily activity diary. We also present how our study engaged local communities to create awareness on the challenges of pollution, and how we have engaged with policy makers at the city and national level to inform policy actions and decisions.

Key Words

Air Pollution, Health, Particulate Matter, Citizen Science, Kenya,

1.191 Odd oxygen budgets in a polluted winter boundary layer and its implication for wintertime oxidant formation.

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Abstract:

The mountain valleys of the western US experience high levels of wintertime air pollution, with Salt Lake Valley and its surrounding valleys reporting PM_{2.5} levels that exceed the National Ambient Air Quality Standards on an average of 18 days each winter. These exceedances typically occur during persistent cold-air pools (PCAPs) which trap pollutants near the surface for days to weeks, forming PM_{2.5} with composition strongly dominated by ammonium nitrate. The Utah Winter Fine Particulates Study (UWFPS) was a ground- and aircraft based study which took place Jan – Feb 2017, with the goal of measuring the spatial and temporal distribution of pollutants and their gas-phase precursors, and better characterizing the chemistry that leads to elevated levels of PM_{2.5}. We present an analysis of the partitioning among odd-oxygen species ($O_x = O_3 + NO_2 + ClNO_2 + 1.5 HNO_3 + 3 N_2O_5 + 1.5 NO_3^-$) in a polluted winter boundary layer. We further show the vertical and horizontal distributions of total odd oxygen and its evolution during PCAP events to levels well in excess of that defined by background ozone and NO_x oxidation reactions. This evolution implies an uncharacterized photochemical or primary source of oxidant, which may be one of the key drivers of winter PM_{2.5} pollution.

1.192 A PROBABILISTIC APPROACH FOR ESTIMATING SOLID-FUEL BURNING EMISSIONS IN LOW-INCOME SETTLEMENTS A CASE IN KWADELA.

Early Career Scientist

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Abstract:

Relevant emission estimates remain one of the biggest uncertainties in air quality assessment. Emissions from distributed sources, like those from solid fuel burning households, represents a particular challenge. The variability observed in low income areas presents a challenge to reduce to a single emission estimates for a particular population. Estimating emissions using a probabilistic approach accounts for fuel use and burning device operation variability. This generates results that better represent the real world situation and improves air quality modelling. The study presents a methodology that quantifies emissions with their associated uncertainties using field derived emission factors. KwaDela low income residential area will be used as a case study to estimate fine particulate matter emissions from domestic burning of solid fuels. A Monte Carlo simulation model will be used to estimate uncertainty in the total fine PM emissions estimate at 95 % confidence interval and to show their diurnal emission distribution profiles. High emissions were recorded in winter, owing to more burning events per household, a greater average amount of fuel used and a larger number of households burning compared to summer. Total PM emitted from domestic burning per winter day in kwaDela ranges between 33.7 kg to 70.1 kg, with an average of 51.4 kg and a standard deviation of ± 5.3 kg. Summer emissions range between 16.6 kg and 35.5 kg, with an average of 25.1 kg and a standard deviation of ± 2.5 kg. This study informs efforts to better quantify emissions in order to design and implement air quality improvement projects in South Africa.

Keywords: Monte Carlo simulation, Particulate matter emissions, Residential area, Uncertainty

1.193 Regional to Hemispheric Atmospheric Impacts of Oil and Natural Gas Development in the U.S..

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Abstract:

The development of hydraulic fracturing drilling techniques ('fracking') for oil and natural gas (O&NG) extraction has triggered a steep rise in drilling activity and O&NG production in the United States. Atmospheric emissions from these operations, including those of methane, volatile organic compounds (VOC), and nitrogen oxides, have become a concern for local and regional air quality and climate forcing on regional, continental, and global scales. Data collected from a series of field campaigns and year-round continuous monitoring in and near O&NG basins has yielded a rich data set for characterizing O&NG related emissions. Large scale impacts are reflected in observations from the NOAA-INSTAAR global VOC monitoring program, as well as from continuous monitoring at remote sites, such as at Summit, Greenland. Observed regional and hemispheric changes in absolute O&NG VOC concentrations, of VOC ratios, and in the methane to ethane ratio (MER) are indicative of changes in the contribution of emission sectors and O&NG producing regions. In the Northern Hemisphere, declining trends of O&NG VOC halted during 2005-2010, reversed to increasing concentrations during the U.S. O&NG boom until 2014, and have since been more inconsistent, possibly due to fluctuations in new drilling and production driven by the global O&NG market. Increases in O&NG VOC emissions can have a profound impact on regional surface ozone, in part offsetting emission reductions of ozone precursors made in mobile source and power generation sectors. O&NG emissions can result in elevated ozone not only during the summer ozone season, but also in the winter, when emissions accumulate in the shallow surface layer, with upwelling solar radiation from the snow surface further facilitating ozone production. Through modeling research we assess the relative contribution of O&NG emissions to exceedances of the ozone air quality standard in and near O&NG basins and downwind regions.

1.194 Measurement and modeling of ground-level and column ammonia for improved health impact assessment in Southern California.

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Abstract:

The emissions, chemistry, and eventual health impacts of tropospheric ammonia (NH_3) are topics of increasing interest, but efforts to quantify and constrain them have been slowed by the scarcity of surface measurements and the difficulty of achieving quantitative, highly resolved remote sensing products. An important gas-phase precursor of fine particulate matter, NH_3 is a significant factor for environmental, climatological, and human health concerns. However, despite playing an increasingly important role in relative contributions to particulate matter formation in many regions, NH_3 emissions remain highly uncertain, with large discrepancies between measured and modeled concentrations in recent studies.

In this work we present initial results from a mobile measurement campaign focused on the integration of surface observations with aircraft retrievals towards the goal of improved emissions inventories and chemical transport model performance. We show surface NH_3 measurements from around the south coast air basin of southern California during the summer of 2018 and compare these observations to modeled predictions using the Weather Research and Forecasting model coupled with chemistry (WRF-Chem). Together with retrievals from the airborne Hyperspectral Thermal Emission Spectrometer (HyTES) instrument, these surface emissions and inventories will be used to develop improved quantitative flux estimates and inventories, leading to more accurate model inputs and better representation of ammonia's human health impacts in Southern California.

1.196 Long-range transport of NH₃ deduced from continuous observation at Tottori, Japan.

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Abstract:

Ammonia (NH₃), the dominant volatile base in the atmosphere, plays an important role in atmospheric chemistry. Considering changes in the balance of acidic gases and ammonia emissions in East Asia especially in China, ammonia concentration with phase partitioning in the leeward area, such as Japan, will also change with their emission balance. Concentrations of NH₃ and NH₄⁺ in fine particles were continuously monitored by micro-flow NH₄⁺ analyzer with denuder differential method (Osada et al., 2011) at the Arid Land Research Center, Tottori University, located near the coast of the Sea of Japan from September 2016 to October 2017. Hourly sampling of fine and coarse particles using a tape sampler and various auxiliary measurements (optical black carbon, SO₂, O₃, CO, HNO₃, NO_y) were also conducted at the site. The observation site is suitable to exclude domestic contaminations from Japan using sea and land breeze winds. NH₃ concentration was high in warm season (April to September) and low in cold season (November to February). NH₄⁺ concentration was high from November to July with large variability and low from August to October. The NH₃ concentration was higher in the sea breeze winds during the warm season. HNO₃ concentrations were also high in sea breeze condition during warm season (May to August) but low in the cold season. Although high HNO₃ concentration during sea breeze in the warm season is mainly caused by in-situ photochemical production in daytime, decomposition of NH₄NO₃ particles might also contribute to the increase. However, products of gaseous concentrations were constantly well below equilibrium to form NH₄NO₃ particles in warm season. Therefore, these results suggest possibility of long-range transport of NH₃ in gas phase during these months.

1.198 Atmospheric greenhouse gas concentrations and carbon isotopic ratio in 2004-2017 at southwestern China.

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Abstract:

China Meteorological Administration established the station for GHGs observation at Waliguan (WLG) in 1990s and Shangdianzi (SDZ), Lin'an (LAN), Longfengshan (LFS), Jinsha, Akedala and Shangri-La in 2000s in China. It found that GHGs concentrations of WLG in central China showed the data as the regional background site. While the concentrations of coast sites (SDZ, LAN and LFS) were influenced strongly by human activities but those concentrations were quite different by the region. The density of network for measuring GHGs concentration in China is low and they don't have the station in Southern China. To clarify the behavior of GHGs in Southern China we carried out weekly flask sampling at Guiyang (26.34N, 106.43E, 1598m) in southwest China which is blank area for GHGs observation from 2004 and analysed the concentrations of CO₂, CH₄, CO, H₂, N₂O and SF₆ and carbon isotopic ratio ($\delta^{13}\text{C-CO}_2$ and $\delta^{18}\text{O-CO}_2$).

In this report, we showed the characteristics of the concentrations and carbon isotopes in Guiyang (GUI) in comparison with the data of GAW stations in China (WLG, SDZ, LAN and LFS), Hateruma (HAT) on the southern end of the Japanese Archipelago.

The concentrations of all species of GUI in summer showed the similar levels with WLG as the regional background site, while the concentrations of GUI in winter higher than those of WLG and similar levels with other Chinese sites (SDZ, LAN and LFS) which are affected by the human activities. Because the concentrations of GUI in winter were influenced mainly from the emissions of India, Bangladesh. Annual amplitude for concentrations of CO and H₂ of GUI decreased 5-10% every years due to decrease of incomplete combustion of fossil fuel and change of the type for primary energy.

1.200 Rural Residential Energy Transition in China from 1992 to 2012: Implications on Emissions and Health Benefits.

Early Career Scientist

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Abstract:

Rural household energy use for cooking and heating is an important source of air pollutants in China, affecting both human health and climate change. However, the magnitude of rural household energy use, especially during the rapid socioeconomic transition period has not been well quantified. We present the first-hand nationwide data from a 34,489-household energy mix survey and a 1,670-household fuel weighing campaign. We discovered that the previous information from the International Energy Agency (IEA) and Food and Agriculture Organization (FAO) contained significant errors. The quantity of crop residue consumption in 2012 was overestimated by 200%. Consumption of wood and crop residue in rural China decreased by 61% and 57%, respectively, from 1992 to 2012, much more than the 15% and 8% reported by IEA and FAO, respectively. The fast residential energy transition in rural China over the two decades was primarily driven by the rapid socioeconomic development. The proportions of clean fuels and electricity used for cooking and heating were quantified at provincial level by regression models. The most significant independent variable is per-person income, which serves as an indicator of socioeconomic status. One important implication of this transition was the significant emission reduction of major air pollutants especially the incomplete combustion products. For example, the emissions of black carbon and organic carbon from rural residential sources reduced 49% and 51%, respectively due to the transition. Emission reductions have brought health benefits. We estimate that the relative contribution of the rural residential sector to

exposure to ambient PM_{2.5} decreased from 18.6±13.0 to 15.0±15.8 mg/m³, premature death decreased from 392 (360-421 as 95% uncertainty interval) to 222 (198-247) thousand during 1992 to 2012. Nonetheless, the dependency of rural residents in northern China on traditional biomass and coal for heating remains the most important factor contributing to ambient PM_{2.5} associated health outcomes.

1.203 Comparison between TD-GC/MS and HPLC on analyzing polycyclic aromatic hydrocarbons in PM_{2.5} from Ho Chi Minh City.

Early Career Scientist

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Abstract:

Thermal desorption coupled with gas chromatography/mass spectrometry (TD-GC/MS) has been applied to analyze semi-volatile organic compounds (SVOCs) including polycyclic aromatic hydrocarbons (PAHs) recently. This method using high temperature at TD equipment to extract PAHs from the matrix, in this case is glass fiber filter, requires no pretreatment step, which means less consuming time and solvent. This is an eco-friendly analysis method for PAHs compared to traditional solvent extraction (SE) based method. A comparison between TD-GC/MS and HPLC, conventional analyzing method for PAHs, was conducted to check their performance.

Vietnam is a developing country with major concern of air pollution. High density of mobile vehicles, mainly motorbikes, causes severe health problems to human, especially in Ho Chi Minh City, which is the business and financial hub of Vietnam. For controlling air pollution, observing its variation is very important. Air monitoring station was set in Ho Chi Minh City (HCMC) for that purpose, however, specific compounds like PAHs were not under investigation. PM_{2.5} samples collected during 2013-2014 from monitoring station set in Vietnamese National University in HCMC was provided and analyzed. The seasonal variation and distribution profile of PAHs in PM_{2.5} within one year in Ho Chi Minh City were displayed as well as their toxicity.

1.204 Study on strategies to reduce photochemical oxidant for each environmental receptor.

Early Career Scientist

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Abstract:

There is concern about adverse effects on human bodies and agricultural crops due to the increase of ozone concentration in the urban areas of Japan. It is considered the reason why the reduction of anthropogenic emissions of NO_x and VOCs, which are main two precursors of ozone, is not linked to the decrease of ozone concentration is because clear grasp of the condition of ozone sensitivity to each precursor is lacking. In this study, the ozone-NO_x-VOC sensitivity in the Kanto region was evaluated by air quality simulations with input emissions of each precursor changed from 0% to 100% by 10%. It was revealed that ozone-NO_x-VOC sensitivity is completely different between the urban areas and their suburbs. In addition, using population and crop yield data, it was also revealed that ozone-NO_x-VOC sensitivity is totally different whether ozone is weighted with population, crop yield, or not. These results suggest it is crucial to evaluate sensitivity of ozone concentrations weighted by each evaluation object and unify them as same indicator such as monetary value for policymakers to decide appropriate emission reduction strategy.

1.206 Characterization of Asian emissions and chemistry utilizing the satellite, aircraft, and ground-based measurements and model simulations.

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Abstract:

Substantial increases of nitrogen oxides (NO_x) emissions in China have been detected by satellite observations since the mid of 1990's. Recent studies reported that SO_2 and NO_x emissions in China tend to decrease, starting from the early 2010's. To accurately predict air quality in Asia and other parts of the world, it is important to understand the emissions of trace gases and aerosols in Asia. In this study, we integrate the observations from the multiple platforms and chemical transport model results to characterize the emissions and chemistry in this region. The model first adopts the most up-to-date bottom up emission inventory as *a priori* and develops an improved the emission inventory using the inversion method that incorporates satellite observations and in-situ aircraft and ground-based observations from the recent field campaigns. The model utilizing *a posteriori* emission in this study serves as an essential tool to explore atmospheric chemical processes that have caused serious air quality issues in Asia, in particular South Korea.

1.211 Pollution events observed by IAGOS aircraft in various location, with focus to Taiwan extreme pollution in November 2017 and March 2018..

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Abstract:

Since 2001, MOZAIIC-IAGOS (<http://www.iagos.org/>) instruments have been flown on daily flights by international airlines to observe pollution by measuring carbon monoxide (CO) at high spatio-temporal resolution, in different key areas around the world.

This study shows evidence of intense and persistent pollution from the surface to the upper troposphere in different regions highly affected by biomass burning pollution and anthropogenic activities. Contributions of surface emissions injected at different altitude levels and transported downwind are investigated with the SOFT-IO module (modelling approach using the Lagrangian FLEXPART model coupled with emission inventories: MACCITY, EDGAR for anthropogenic emissions, GFAS, GFED for biomass burning).

We focus on Taiwan where intense pollution events occurred in November 2017 and March 2018. Pollution levels largely overshoot the air quality standards, due to the lack of normal dispersion winds. Very high levels of pollutants were measured by the Taiwan air quality networks and by the two IAGOS aircraft operating from/to Taipei.

1.212 Vertical Profile of Long Range Transport Aerosols Investigated by a Lidar Network in Taiwan during EMerGe-Asia.

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Abstract:

East Asia has been characterized as huge anthropogenic emission of aerosols and traces gases resulting from rapid growing of population in this region. Taiwan is located in between the southeastern coast of the Asian continent and the East Asian islands distributed among the western Pacific Rim. In the spring, winter monsoon and summer monsoon will transport natural and anthropogenic pollutants from mainland China and biomass burning smokes from Indochina to Taiwan respectively. The vertical distribution and the columnar optical properties of aerosols were observed by a lidar network involves 4 aerosol lidars and accompanying sunphotometers installed in Cape Fuguei, Taipei City, Taichung City, and Dongsha Atoll (Pratas Islands) and one wind lidar installed in Taichung City. WRF/CHEM and HYSPLIT are used to study the transportation pathway of aerosols from different sources.

1.213 Estimation of NO₂ Concentrations Within and Around three major cities of Pakistan by Using MAX-DOAS and Satellite observations..

Early Career Scientist

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Abstract:

Air pollution is one of the emerging issues in most of the cities of Pakistan. According to US AQI, Lahore stands second among the most polluted cities of the world. So, there is an utmost need of air quality monitoring in the country. Increasing traffic load, industrial development and constructional activities are contributing to air pollution. Air quality standards are regulated to minimize air pollution based on criteria pollutants such as NO₂. NO₂ is a major contributor to form smog, acid rain, tropospheric ozone and several other polluting compounds. This study was designed to monitor NO₂ in three major cities (Lahore, Islamabad and Multan) of Pakistan. Lahore was selected as the key study area; fixed monitoring was carried out at two different locations at Lahore and single site fixed monitoring was done in Islamabad by using MAX-DOAS. Several field campaigns were also carried out within and around the (Lahore, Islamabad and Multan) cities by using Car MAX-DOAS. NO₂ diurnal, weekly and annual cycle were observed. Results shows NO₂ concentration was higher in morning and evening but lower in the noon due to photolysis of NO₂. It was also observed that NO₂ was lowest on Friday day (Business holiday) and annual cycle shows highest average concentrations in winters and lowest in summers over Islamabad. NO₂ concentrations were occasionally exceeding Pak-NEQS limit (42.5 ppb) over Lahore, whereas Multan and Islamabad were in permissible limit during Field campaign. NO₂ MAX-DOAS measurements were also compared with OMI satellite observations and found a similar spatial distribution of NO₂. A good correlation was observed when MAX-DOAS data average of 01-02 pm (PST) was compared with OMI observations, as the satellite passes over Pakistan between 01-02 pm (PST). However, OMI satellite underestimate the NO₂ concentration as compare to ground based MAX-DOAS observations.

1.214 Large-Eddy-Simulation of Pollutant Dispersion: Comparison with Tracer Gas Field Campaign and Effect of Topography.

Early Career Scientist

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Abstract:

Large-Eddy-Simulation of Pollutant Dispersion: Comparison with Tracer Gas Field Campaign and Effect of Topography

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Air pollutant becomes a serious issue for public health and also a political challenge in Taiwan in recent years. It is a tough challenge to derive the transport and dispersion paths of hazardous substances from the emission sources to suffering areas because of the complicated and interactive chemical mechanisms of air pollutants. This study applies a large-eddy-simulation model (PALM) to investigate the pollutant dispersion from three emission sources, Taichung coal-fired power plant, Mailiao coal-fired power plant, and downtown of Taichung, in central Taiwan. Two intensive PFC (perfluorocarbon) tracer experiments were proposed to collocate the computational study to clarify the dispersions of air pollutant in temporal and spatial scales of about 12 hours and 48*48 km². Hypothetical scenarios are implemented into PALM to investigate the influence of topography on transport of air pollutants.

Keywords: large eddy simulation, PALM, pollutant dispersion, topography, tracer gas

1.216 First observations of light non-methane hydrocarbons (NMHCs) over an high altitude site in Southern India.

Early Career Scientist

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Abstract:

Rapidly developing Indian subcontinent leads to higher anthropogenic emissions of ozone precursors. Over a longer period of time, these emissions invariably alters the regional background concentrations of many trace gases. The anthropogenic sources are relatively less in the Southern part of India largely due to the flushing by the monsoon winds from the relatively cleaner oceanic regions of the Bay of Bengal and Indian Ocean during winter and summer respectively. The emissions from the Indo-Gangetic belt can still affect South India during winter as the north-east monsoon winds carry the pollutants to this region through the northern Bay of Bengal.

Realizing the absence of the regionally representative trace gases observations in Southern Indian region, an environmental laboratory was set-up at Ooty (11.4 N; 76.7 E; 2520 m amsl), a hill station in the state of Tamil Nadu, in collaboration with Tamil Nadu Agricultural University, Coimbatore under the Atmospheric Trace Gases and Modelling (ATCTM) project of Indian Space Research Organisation–Geosphere Biosphere (ISRO-GBP) programme. Long-term measurements from this site can provide an insight to the background values present in this region.

Ambient air samples were collected for every two hours for 2 to 3 days continuously (once in 2 to 4 months) in glass sampling tubes using an air compressor. The samples are analysed for light NMHCs at PRL, Ahmedabad using a gas chromatographic system

equipped with a flame ionisation detector. These NMHCs over Ooty exhibit large variabilities. Ethane concentration is the highest among C2-C5 hydrocarbons over this site. These measurements are also compared with those observed at Nainital, a high altitude site in the Central Himalayan region. Further details will be discussed during the presentation.

1.217 Source apportionment of PM_{2.5} and analysis of long-range transport from Northeast Asia Continent to Niigata in Eastern Japan.

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Abstract:

Intensive measurement of PM_{2.5} mass and chemical composition was implemented for two weeks during each of four seasons from May 2015 to February 2018 at a rural site in Niigata, eastern Japan. Daily mean concentrations of PM_{2.5} ranged from 2.3 to 33.4 $\mu\text{g m}^{-3}$ during the observation period. All daily means were lower than the Japanese Environmental Quality Standard for PM_{2.5} (35 $\mu\text{g m}^{-3}$). The major chemical components of PM_{2.5} was SO_4^{2-} , NO_3^- , NH_4^+ , OC, EC. Compared with the data at other urban sites in Japan, lower concentrations of EC and NO_3^- and a higher OC/EC ratio were observed, which may result from no significant stationary source and low vehicular traffic around the observation site. PM_{2.5} source apportionment was conducted using positive matrix factorization (PMF) analysis, and the results inferred four major sources: sea salt (10.2%), biomass combustion (18.9%), soil dust (13.2%) and secondary aerosol (44.4%). The potential source contribution function (PSCF) analysis demonstrated that the major source regions for secondary aerosol and sea salts were domestic in southwest Japan and the Sea of Japan coast, whereas those for biomass combustion and soil dust were both domestic and the Northeast Asian continent (NEA) due to long-range transportation. Comparing with the previous source apportionment studies in western Japan, this study showed a larger domestic contribution of southwest Japan for secondary aerosol, while a

larger contribution of the NEA was observed in the previous studies. The central mountains in Japan which will hinder transportation from Tokyo metropolitan area is one of major reasons of the larger contribution of southwest Japan. Furthermore, the PSCF analysis for each season showed that significant contributions of biomass combustion in autumn and soil dust in winter were originated from the NEA, which is uniquely observed in this study.

1.220 Characterization of a Thermal Denuder for the Estimation of Volatility Parameters of Laboratory Generated Aerosols.

Early Career Scientist

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Abstract:

In this study, a new KNU thermal denuder was developed and characterized in detail. The temperature profile was uniform with relatively higher exit temperatures as compared to previous studies. Temperature ramping rate was $\sim 14.3^{\circ}\text{C min}^{-1}$ for a set value in the range of 25°C - 250°C . Particle losses in thermal denuder were due to diffusional and thermophoretic losses at room and higher temperatures, respectively. Furthermore, integrated volume method was used to determine saturation pressure (P_{sat}^0) at 25°C and enthalpy of vaporization (ΔH_v) of organic aerosols (single component and binary mixtures) using volatility profile data generated by coupling thermal denuder and scanning mobility particle sizer. For cis-pinonic acid, (1S)-(+)-ketopinonic acid, (1R)-(+)-nopinone, phthalic acid, catechol, benzoic acid, and o-cresol determined ΔH_v and P_{sat}^0 were 81.5 kJ mol^{-1} , 41.2 kJ mol^{-1} , 36.4 kJ mol^{-1} , 45.1 kJ mol^{-1} , 58.8 kJ mol^{-1} , 75.2 kJ mol^{-1} , and 39.8 kJ mol^{-1} and $0.24 \times 10^{-5} \text{ Pa}$, $0.65 \times 10^{-5} \text{ Pa}$, $1.67 \times 10^{-5} \text{ Pa}$, $1.15 \times 10^{-4} \text{ Pa}$, 6.55 Pa , 0.18 Pa , and 12.47 Pa , respectively. For the case of binary mixtures of benzoic acid and o-cresol, catechol and phthalic acid, cis-pinonic acid and nopinone, and ketopinonic acid and nopinone, the values of $P_{\text{sat},1}^0$ and $\Delta H_{v,1}$ and $P_{\text{sat},2}^0$ and $\Delta H_{v,2}$ for high and low volatile components were estimated using two product model and were within 10% to 38% of single component values. In addition, estimated ΔH_v and P_{sat}^0 using Thermal Denuder were also compared with those determined using Thermogravimetric Analysis.

1.221 Relationships between ground- and upper-level concentrations of gases and particles in Tokyo.

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Abstract:

Concentrations of gaseous and particulate species in the urban atmosphere have been monitored at about 320 m and 10 m above the ground in central Tokyo since 2016. Diurnal ozone concentrations behaved consistently at both levels in summertime. In wintertime, however, ground-level ozone varied diurnally with low concentrations in nighttime and high in daytime, although upper-level ozone kept mostly constant, corresponding with the daytime concentration of ground-level ozone. By taking oxidant, which is defined as $O_3 + NO_2$, the concentrations well agreed with each other between the ground and upper levels. SO_2 is generally higher at the upper level than at the ground level, particularly when winds come from the south, which brings SO_2 emitted from ships and large point sources inside and coasts along the Tokyo bay. Since 2017, monitors for $PM_{2.5}$ mass and chemical compounds were installed at both levels. Discrepancies in chemical compositions between both levels will be discussed on the poster.

1.222 Determination of composition and chemical structures of α -pinene SOA species .

Early Career Scientist

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Abstract:

The complex organic chemistry of atmospheric aerosols is still unclear. Secondary organic aerosols (SOAs) are formed by atmospheric reactions of primary organic aerosols (POAs) and organic gases (ROGs) with radicals such as O_3 , OH, and NO_3 . In general, SOAs have higher O/C ratios than POA. α -pinene ($C_{10}H_{16}$) is a representative biogenic compound of ROGs, accounting for ~45% of the total emissions. In this study, SOA formation experiments were performed using KNU flow reactor. The effect of NH_3 on the composition of α -pinene SOA products under ozonolysis and photooxidation was studied. UPLC/Q-TOF MS was used for detailed SOA speciation. An Orbitrap LC-MS / MS system was used to analyze the chemical structure of SOA species. 47mm SOA loaded Teflon filters were extracted using 5 mL of acetonitrile in 20 mL vials followed by sonication at room temperature for 30 minutes. Particulate impurities in the extract were removed using a 0.45 μm syringe filter. The extracted samples were passed through a Waters ACQUITY UPLC high-strength silica (HSS T3) column and analyzed at a temperature of 45 $^{\circ}C$. Methanol and water each containing 0.1% acetic acid were used as eluents. The flow rate and injection volume were 0.3 mL min^{-1} and 1 μL , respectively. Terebic and Pinonic acids were major species found among 54 species. Several other chemical species were also identified by MS/MS. During MS/MS analysis, cleaved structures were H_2O , CO, CO_2 , and CH_2CO_2 . Furthermore, SOA formation mechanism will be confirmed by the analysis of various other compounds.

1.225 Determination on the triple oxygen isotopic compositions of tropospheric ozone in Asian Monsoon area.

Early Career Scientist

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Abstract:

Tropospheric ozone (O_3) is important as a greenhouse gas, as well as having harmful effects on respiration and photosynthesis. In addition, O_3 is important as an oxidant in the tropospheric photochemical reactions. In recent years, tropospheric ozone have been increasing in Eastern Asia, and thus we must understand the origin and behavior of tropospheric ozone accurately.

In this study, we determined the oxygen isotopic compositions including the triple oxygen isotopic compositions ($\Delta^{17}O$), by passing air sample through nitrite (NO_2^-)-coated filters, which allows the reaction of O_3 with NO_2^- to produce NO_3^- . The oxygen isotopic composition of NO_3^- was then determined to estimate the oxygen isotopic composition of O_3 . Please note that the oxygen isotopic composition determined through this method is not the average isotope composition of oxygen atoms in O_3 ($\Delta^{17}O(O_3)_{\text{bulk}}$), but is of that in the terminal positions ($\Delta^{17}O(O_3)_{\text{terminal}}$) of O_3 .

Observation on the atmospheric O_3 was conducted from August to December, 2017, at Nagoya University. The $\Delta^{17}O$ values of ozone were between +32‰~+39‰ which coincided well with those previously determined for tropospheric ozone (35‰±4‰). Besides, the $\Delta^{17}O$ values of ozone were the lowest in August, and were the highest in November. The seasonal variation in the $\Delta^{17}O$ values is most likely due to the stratospheric influence on the tropospheric O_3 . We also found about 1‰ differences in

the $\Delta^{17}\text{O}$ values between day and night. We concluded that the formation of an inversion layer in night time was responsible for the lower $\Delta^{17}\text{O}$ values. That is to say, while the ^{17}O -depleted O_3 produced at ground level heights under the high pressure condition occupied major portion of O_3 in night time due to the inversion layer, the ^{17}O -enriched O_3 produced at the upper layers contributed to O_3 in day time through the active vertical convection.

1.228 Diagnostics of tropospheric oxidants using an ensemble data assimilation system and aircraft observations.

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Abstract:

The oxidative capacity plays a crucial role in the fate of greenhouse gases and air pollutants as well as in the formation of secondary pollutants such as tropospheric ozone. There is a non-linear chemical system that couple long (years for CH₄), intermediate (months for O₃ and CO) and very short lifetime (less than a second for OH). To understand the nature of those interactions and improve prediction capability, data assimilation allows to take fully advantage of satellite observations and global coupled model, such as the Community Atmospheric Model with Chemistry (CAM-Chem). In particular, the ensemble Kalman filter approach facilitates statistical estimation of error correlations between chemical states (CO and related species) and parameters (including sources). Within this context, we will investigate the role of initial conditions, emission perturbations and chemistry in the coupled CH₄-O₃-CO-NO_x-OH chemical system. We propose a set of tools such as emission tags, diagnostics of chemical regimes and emissions perturbations to estimate a regional budget of primary and secondary pollutants in East Asia and their sensitivity to data assimilation. Posterior fields will be evaluated using a set of non-assimilated measurements. We benefit from a large set of aircraft observations from the Korea-United States Air Quality (KORUS-AQ) campaign that occurred in South Korea in May-June 2016.

1.229 Aircraft-based 2- and 3D Measurements of Trace Gases with the Heidelberger Airborne Imaging DOAS Instrument (HAIDI) during the Phase II Mission EMerGe.

Early Career Scientist

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Abstract:

Remote sensing of atmospheric trace gases allows for a comprehensive probing of their distribution. Satellite instruments have excellent spatial coverage, but their spatial and temporal resolution is low. Also, vertically, no or very low spatial resolution is available. In contrast, aircraft-based remote sensing instruments can achieve a high spatial and temporal resolution during overflight and thus allows for an investigation of small-scale chemical and dynamical processes in the Earth's atmosphere. Sources of trace gases can also be identified and quantified.

The Heidelberg Airborne Imaging DOAS Instrument (HAIDI) has been developed to survey distributions of trace gases in 2D and 3D on the research airplane HALO. It was dispatched during the EMerGe (Effect of Megacities on the Transport and transformation of Pollutants on the Regional to Global Scales) missions in July 2017 in Europe and March 2018 in Asia to investigate the chemical composition of the outflow of megacities and the atmospheric impact of urban pollution. Target areas included Paris, London and the Po area as well as Manila, Taiwan cities and China outflow. A comprehensive set of mainly in-situ instruments was deployed to measure aerosols and many trace gases. HAIDI contributes remote sensing of a number of trace gases such as NO₂, SO₂, O₃, BrO and HCHO.

We will present first results of the HAIDI measurements during the EMerGe mission, as well as the overall instrumental concept and technical specifications of HAIDI.

1.232 Low-cost Sensors in the Study of Air Quality in San Juan Metro Area Following Hurricane Maria.

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Abstract:

After the impact of Hurricane Maria, the electric grid in Puerto Rico was devastated, with over 90% of the island without electricity. Still six months later, the service was unstable and more than 10% of the population was without grid electricity. The main objective of this project is to analyze how the air quality (AQ) of the island has been affected with the increase in the use of power generators post hurricane María and to evaluate how AQ changes when electrical power is restored. Four different sampling locations were selected in the San Juan Metro Area (SJMA). Low-cost sensors were key in monitoring air quality of the SJMA. Since November 2017, Real-time Affordable Multi-Pollutant monitors (RAMPs) were deployed at the four different locations to monitor CO, SO₂, and optical particulate matter (PM_{2.5}) concentrations. A microaethalometer to monitor black carbon (BC) and a Microtops sunphotometer to monitor aerosol optical thickness (AOT) were rotated among some of the locations. A black carbon monitor and a particle counter

(OPC) were deployed at the super site location of the University of Puerto Rico-Rio Piedras Campus. Results up to now show that, in the first weeks of sampling, SO₂ often exceeded the National Ambient Air Quality Standards (75ppb/hr). After four months of sampling and as the power is restored and fewer generators are used, concentrations of CO, SO₂ and BC were found ca. 50% lower. Detailed results regarding variations in the concentrations of BC, CO, PM_{2.5}, SO₂, and AOT during daytime/nighttime and for the different locations studied in the SJMA will be presented at the conference. We will also present the case study of January 1, 2018, which might have been affected by the excessive ignition of fireworks in this period.

1.235 Changes in air pollution-related mortality in the United States since 1990.

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Abstract:

Concentrations of ozone and fine particulate matter (PM_{2.5}) have decreased across most of the United States since 1990, as a result of air pollution standards, regulations, and shifts in energy resources and technologies. Annual average PM_{2.5}, averaged over EPA monitoring sites, decreased by 42% from 2000 to 2016, and the maximum daily 8-hr average ozone decreased by 22% from 1990 to 2016. Here we use three different concentration datasets to estimate air pollution-related deaths annually from 1990 to 2016. These datasets include a self-consistent simulation of air quality using CMAQ (1990-2010), the North American Chemical Reanalysis project that used CMAQ and assimilation of satellite and surface observations (2007-2016), and a combination of satellite AOD observations with surface observations and a model for PM_{2.5} for North America (1999-2011). We also use annual county-level population and baseline mortality data from the Centers for Disease Control. We attribute the overall mortality trends to changes in three factors: concentration, population, and baseline mortality rates. We find that PM_{2.5}-related deaths have decreased significantly since 1990, despite population growth. Ozone-related deaths have remained roughly constant, but would have likely increased without ozone concentration reductions due to increases in deaths from respiratory diseases. Inter-annual variability is greater for ozone-related than PM_{2.5}-related deaths, driven by the greater variability in concentration. Reductions in air pollutant concentrations in the US have very likely decreased the burden of air pollution on premature mortality.

1.238 The global network of import and export of air-pollution related premature mortalities.

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Abstract:

Quantifying the extent to which air pollution in any particular country is a consequence of that country's emissions is key to developing effective domestic air quality control policies. Further, understanding how much pollution emanating from any single country is affecting neighboring nations through long-range transport is critical for formulating international strategies to improve human health. Here we present first-ever calculations of national-scale source-receptor relationships for every country in the world for exposure to PM_{2.5} and O₃, quantifying the impact of each emitted precursor species and sector from each country on exposure in every other country. These calculations are possible through application of a global adjoint chemical transport model (GEOS-Chem) using satellite constraints to resolve PM_{2.5} exposures at ~10 km. Results are evaluated against source-receptor relationships calculated for large aggregate regions (i.e., Europe, South-East Asia) performed as part of the HTAP2 multi-model project. We then estimate the import and export of premature mortalities associated with long-term exposure to PM_{2.5} and O₃, identifying sectors in each country around the world that make the greatest contributions to premature deaths internationally and highlighting countries that are most subject to the influence of internationally transported pollution. Additionally, we

consider recent epidemiological evidence for O₃ health impacts being substantially (x2 - 4) greater than considered in previous assessments of long-range pollution health impacts; these revised estimates change our conclusions regarding the roles of PM_{2.5} vs O₃ in contributing to long-range health impacts in many cases. Lastly, we show how these source-receptor relationships have been incorporated into LEAP-IBC, a decision-support tool developed by SEI with support from US EPA, UNEP and the Climate and Clean Air Coalition (CCAC). LEAP-IBC connects policy-level decisions and related emissions (modeled in LEAP) to the impacts of those emissions on air pollution and associated health, crop, and climate impacts (modeled in IBC).

1.239 Modelling roadside NO_x production and dispersion with a regional-scale coupled large-eddy simulation approach.

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Abstract:

Traffic emissions account for over 40% of anthropogenic NO_x production in the European Union, and about 70% in urban environments. In addition, NO_x serve as precursors to tropospheric ozone and particulate matter, which have adverse effects on human health, ecosystems and climate change. Thus it is the main objective of the present study is to model production and dispersion behaviors of NO_x directly at the street level to better understand their formation and transport mechanisms. A representative set of road-side measurements obtained from the City of Berlin are used as the basis for the present study. Particular emphasis is placed on the period between June and August 2014, where corresponding meteorological and urban background concentration data are available from existing observations and regional model results as initial and boundary conditions. Detailed, seamless geometry of urban structures surrounding said measurement stations are constructed using building geographic information system (GIS) data. Using a large-eddy simulation (LES) approach, with a grid size of around 10 m at the finest level, complex flow structures in street canyons can be more effectively captured than, for instance, urban canopy models, hence providing a more accurate assessment of chemical dispersion behavior. The outcome of this work could be applied to the derivation of a more representative street canyon parameterization for regional models, or directly as guidance information for municipal- and region-level environmental policy makers.

1.240 Cloud condensation nuclei (CCN) measurements with the HALO aircraft during EMeRGe in European and Asian airspace.

Early Career Scientist

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Abstract:

During the EMeRGe campaign we employed a cloud condensation nuclei counter (CCNC) on board the high altitude and long range (HALO) research aircraft. The instrument was located in the CCN-Rack, together with a single particle soot photometer (SP2) and an aerosol multi-impactor for microspectroscopic aerosol particle analysis. The aerosol

particles were sampled by using the HALO aerosol submicrometer inlet (HASI). The scientific goal of EMeRGe has been to investigate the effect of megacities on the transport and transformation of pollutants on the regional and global scales. Therefore, measurements were taken in the European airspace in 2017, probing aerosol properties over cities like London, Paris, Barcelona and Rome. During March 2018, the same set of instruments was probing the outflows of Asian megacities like Taipei, Manila and transported pollution from China Mainland over the ocean. Furthermore, Japanese and South Korean airspace were probed. The measurements took place in altitudes between 0.3 km and 13 km ASL. Our scientific objective is to investigate the effect of different pollution states on cloud properties.

The measurements have been performed with a two column continuous-flow longitudinal thermal-gradient instrument (CCN-200) manufactured by DMT. The CCN-200 measures the CCN number concentration as a function of water vapor supersaturation (S). These measurements are carried out by changing S within one column from 0.10 % up to 1.00 % using 12 different supersaturations and keeping S constant within the second column ($S = 0.38 \pm 0.04$ %) to ensure baseline data. The different supersaturations are created by changing the flow while setting a fixed temperature difference.

The CCN properties will be compared with the total aerosol number concentration (CN) measured by a condensation particle counter and the black carbon measurements performed by the SP2. Supplementary, a comparison with ground based CCN and CN data from Cape Fuguei (Taiwan) will be conducted.

1.242 Impacts of East Asian black carbon emissions on the Arctic climate and air quality: Contributions from anthropogenic and biomass burning sources.

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Abstract:

Black carbon (BC) is one of key air pollutants that have great impacts on the climate and environment in the Arctic, where temperatures have increased more rapidly than the global average during the recent decades. East Asia is considered to be a major source region of anthropogenic pollutants with its BC emissions having a dominant contribution of 36 % in the northern hemisphere. Here we examined pathways and efficiency of transport of BC from various anthropogenic and biomass burning emission sources to the Arctic as well as quantified the source contributions, by Asia-specific tagged tracer simulations implemented in a global chemistry-transport model GEOS-Chem. The global domain was divided into 16 and 27 regions for anthropogenic and biomass burning emissions, respectively. We found that BC emitted from East Asia was transported mainly in the middle troposphere (~5 km) into the Arctic due to uplifting during the poleward transport. The East Asian contribution was dominant for BC in the middle troposphere (41 %) and the BC burden over the Arctic (27 %) because of its large emissions. This suggested that East Asia BC is important for radiative forcing at the top of the atmosphere. In contrast, BC emitted from Europe and Russia was transported to the Arctic mainly in the lower troposphere during winter and spring, i.e., the Arctic haze season. In particular, Russia BC had a dominant contribution of 62 % to the Arctic BC near the surface and 35 % to the deposition as annual mean. This suggested that BC from Russia and Europe is more important for surface air pollution and warming in the Arctic. These results suggested that East Asian and Russian sources play different roles in the Arctic climate and air quality.

1.243 10 years of IASI CO retrievals.

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Abstract:

Carbon monoxide (CO) is an important trace gas for understanding air quality and atmospheric composition. It is a good tracer of pollution plumes and atmospheric dynamics.

With two IASI instruments flying on the Metop-A and Metop-B satellites, any location on Earth is now observed at least four times per day in the infrared spectral range. All cloud free observations are analysed in near real time mode.

IASI CO concentrations are retrieved from the radiance data using the Fast Operational Retrievals on Layers for IASI (FORLI) algorithm, based on the Optimal Estimation theory. The operational production is performed at EUMETSAT and the products are distributed in NRT via EUMETCast under the AC SAF auspices.

We present here an analysis of 10 years of global distributions of CO. Improvements of the last FORLI-CO version (v20151001) will be shown. Updates in the auxiliary parameters (temperature, cloud information) have an impact on the retrieved product. Comparison with MOPITT CO data (v7T, record starting in 2000) was performed. IASI and MOPITT data are jointly assimilated in the Copernicus Atmospheric Monitoring Service (CAMS) to generate CO pollution forecasts. Harmonizing IASI and MOPITT CO products is

challenging: a method using corrective factors (developed in the framework of the QA4ECV project) will be presented.

1.244 NICT priorities for observing the anthropocene from space .

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Abstract:

Air quality in the atmosphere is strongly related with human health. The aim of NICT project is to provide a robust prediction system of air quality over Japan with km-class spatial resolution using satellite-based spectroscopic observation for atmospheric compositions, such as short-lived climate pollutant (SLCP), and NO₂. The system is assumed to use for health care, such as health tourism, by company and policy makers. Currently, we are developing 1. a forecasting modeling system including PM_{2.5}, oxidants (tropospheric ozone), NO_x, SO_x and so on with multi-modal area systems to realize both high- spatial resolution over Japan and wide coverage of Asian/global scales, since significant pollutions are coming from cross-border transport from the continent. 2. Health impact estimation using hospital data and air-quality data. 3. Feasibility study for satellite sensor to observe these air quality species with 1 or 2 km order spatial resolution. I will introduce overview, target, current status in detail in the presentation.

1.245 Using Short Term CO/CO₂ ratios to assess air mass differences over the Korean Peninsula during KORUS-AQ 2016.

Early Career Scientist

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Abstract:

The rapid industrial growth in East Asia over the past century has resulted in widespread prosperity, but has been accompanied by degraded air quality. These poor air quality can have both local and regional effects, and long range transport of pollution will increase the number of people affected. South Korea has a technologically oriented economy with vibrant urban regions, but suffers from poor air quality arising from both local emissions on the Korean peninsula and from the transport of pollution from mainland China. The KORUS-AQ field campaign was an international collaboration to measure the atmospheric composition over the Korean peninsula in the spring of 2016. We use the in situ data from the DC-8 aircraft to examine trace gas enhancement ratios over three major analysis regions: the Seoul metropolitan region, the South Korean peninsula, and the Yellow Sea. The ratios of the changes in CO and CO₂ abundance were calculated with a rolling correlation calculation, and the distributions of these calculated slopes were compared between different regions. These instantaneous slopes can be interpreted as a measurement overall combustion efficiency, and the distributions of the slopes show the ensemble of these combustion efficiency measurements. This technique allows us to compare the short term CO and CO₂ emissions signatures between different regions. Over Seoul, the surface layer shows a high efficiency signature in the $\Delta\text{CO}/\Delta\text{CO}_2$ ratios,

with 65% of the correlated short term slopes falling below 1 % $\Delta\text{CO}/\Delta\text{CO}_2$. However, this ratio shifts to a lower efficiency signature at higher altitudes, indicating that transport of Chinese emissions becomes more important with altitude. Comparisons of measurements collected over the Yellow Sea and over China confirm that Chinese-type emissions show a shift to higher $\Delta\text{CO}/\Delta\text{CO}_2$ ratios (lower efficiency), with approximately 70% of the correlated slopes having a CO/CO₂ ratio between 1 and 4%.

1.246 Application of multi-dimensional mass spectrometry methods for the characterization of urban PM_{2.5} samples in Chengdu, China.

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Abstract:

Qualitative and quantitative characterization of anthropogenic and biogenic secondary organic aerosols (SOA) were performed for PM_{2.5} samples collected in Chengdu, China. The samples contained a series of nitro-aromatic compounds and organosulfates, indicating a strong influence of anthropogenic emissions on SOA formation. In particular, organosulfates detected at the site contained a number of highly oxygenated organosulfates with carbon number smaller than eight and oxygen number greater than seven. In this study, we used a travelling wave ion mobility spectrometer coupled to mass spectrometer was used to obtain structural information of highly oxygenated organosulfates. The use of a large polarizable drift gas (CO₂) enabled us to separate small isobaric isomer compounds. The fraction of organosulfates in the PM_{2.5} was estimated by the subtraction of inorganic sulfur compounds determined by IC from the total sulfur amount determined by ICP-MS. In addition, GC x GC/TOMFS was used to obtain information about the precursors for highly oxygenated organosulfate compounds.

1.247 Sources and atmospheric processing of PM_{2.5} carbonaceous and nitrogen aerosols in Northeastern China and the Yellow Sea during the KORUS-AQ campaign: Preliminary results of isotopic study.

Early Career Scientist

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Abstract:

Most source apportionment studies in China using isotopic analyses have been carried out in cold season when severe haze events often occur. We measured the radiocarbon, stable carbon, and stable nitrogen isotopic composition of PM_{2.5} at two urban sites (Beijing; 40.04N 116.42E and Dalian; 38.51N 121.37E) and a background site (Changdao; 38.18N 20.74E) in China and over the Yellow Sea, between May and June in 2016 during the KORUS-AQ campaign. Fraction modern (f_M) of total carbon (TC) determined from ¹⁴C analysis was 0.48 ± 0.06 (n=31) and 0.51 ± 0.11 (n=9) in Beijing and Changdao, respectively, indicating equal contribution of both fossil and non-fossil sources. The $\delta^{13}\text{C}$ of TC in Changdao shows slightly higher values, probably related to its atmospheric processing during transport from source areas, while overall $\delta^{13}\text{C}$ of TC varied little with a mean of $-25.0 \pm 0.4\text{‰}$ in between sites. The largest site-by-site variability in isotopic composition was observed for $\delta^{15}\text{N}$ of total nitrogen (TN) with a mean of $7.8 \pm 3.6\text{‰}$. The $\delta^{15}\text{N}$ tended to decrease from Beijing ($10.6 \pm 1.8\text{‰}$) to the Yellow Sea ($1.0 \pm 2.3\text{‰}$), reflecting different emission sources, formation mechanisms and atmospheric processing of nitrogen species. Further results will be presented in the meeting.

1.248 Flaring emissions in Africa: distribution, evolution and comparison with current inventories.

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Abstract:

Flaring is a major concern due to large uncertainties in the amount of chemical compounds released into the atmosphere and their evolution with time. A methodology based on DMSP (Defense Meteorological Satellite Program) nighttime light data combined with regional gas flaring volumes from NOAA-NCEI has been developed to estimate flaring emissions. This method is validated in Nigeria where individual field company data are available.

A range of emissions due to flaring is estimated based on emission factors for each species. An average decrease in CO₂ emissions of about 30% is found over Africa from 1995 to 2010, with Nigeria being the largest contributor to this reduction (up to 50%). Changes in the spatial distribution with time indicate local increases, particularly at offshore platforms, which are attributed to a lack of regulations and aging infrastructures in oil/gas fields.

Comparisons with current inventories reveal differences in the location and magnitude of point source emissions. For chemical compounds such as NMVOCs and CH₄, the ECLIPSE and EDGAR country-level values are considerably higher than the highest estimation in this study for 2005. For species such as CO, OC, BC, SO₂ and NO_x, the emissions provided by the ECLIPSE and EDGAR inventories are generally within the same order of magnitude as the average values found in this study, with the exception of OC, BC and SO₂ in which EDGAR provides much lower emissions. These discrepancies are likely due to either differences in methodologies used to estimate the emissions, in the values of the emission factors considered, or in the definition of flaring sector. Our current estimations suggest that BC, CH₄ and CO₂ flaring emissions in Africa account for 1-15% (on average 7%), 0.5-8% (on average 2%) and 8-13% (on average 11%) of African total anthropogenic emissions, respectively, with large variability among countries.

1.249 Calibration of column-averaged dry-air mole fractions of atmospheric CO₂, CO and CH₄ at the Burgos TCCON site in the Philippines.

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Abstract:

The Total Carbon Column Observing Network (TCCON) is a network dedicated to the precise remote sensing measurements of the column-averaged dry-air mole fractions (DMF) of CO₂, CO, CH₄, N₂O and H₂O. Column-averaged DMF of gases (denoted as X_G for gas G) can be used in combination with in situ measurements to disentangle the effects of atmospheric mixing and surface exchange of greenhouse gases, providing a

better understanding of the regional-scale fluxes. However, TCCON measurements rely on spectroscopic parameters that are not known with sufficient accuracy. TCCON measurements of X_G must therefore be calibrated to World Meteorological Organization (WMO) in situ trace gas measurement scales. Here, we present a calibration of the Burgos TCCON data using WMO-scale instrumentation aboard the HALO aircraft that measured profiles during its transfer flight in the scope of the EMeRGe-Asia mission. Measurements of X_{CO_2} , X_{CH_4} and X_{CO} with a portable spectrometer (Bruker EM27/SUN) were also made, coincident with TCCON and the HALO measurements.

1.251 Seasonal Characteristics of High PM2.5 Episodes in Korea between 2013 and 2016.

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Abstract:

As the public interest in particulate matter increases, the Korean government has established intensive monitoring stations during the past decade to enhance the understanding of physical, chemical, and optical characteristics of PM_{2.5} in detail. We identified five episodes—two in winter and one in each other season—between 2013 and 2016, during which 24-h average PM_{2.5} exceeded 70 µg/m³ at a number of stations. We examined the variations in PM_{2.5} and chemical compositions during the episodes at four monitoring stations—Baengnyeong, Seoul, Daejeon, and Gwangju: Baengnyeong station is on the westernmost island of South Korea, while the other three stations are located in metropolitan areas on the western part of the Korean Peninsula. The contributions of emissions from China and Korea were estimated using a three-dimensional air quality modeling system, consisting of the Weather Research and Forecasting (WRF) model and the Community Multiscale Air Quality (CMAQ) model. In addition, the contributions by emission source categories were estimated using the Positive Matrix Factorization (PMF) method based on measurement data at each monitoring station.

1.252 Observations of Carbonaceous Aerosols at Nainital, a high altitude site in the central Himalayas.

Early Career Scientist

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Abstract:

Carbonaceous aerosols are currently the most important with respect to aerosol effect on climate as they have largest uncertainties. They can absorb or scatter solar radiation and hence have great contribution in determining the radiation budget of the earth's atmosphere. An important part of carbonaceous aerosols is BC that forms due to incomplete combustion of fuels containing carbon such as gasoline, diesel, natural gas, wood and other biomasses. Emissions from these sources are of major concern in many regions of the world. In this reference, extensive observations of aerosols and trace gases are initiated at a high altitude site in the central Himalayas (Nainital (India), 29.4° N, 79.5° E, 1958 m) and are supported by Indian Space Research Organization (ISRO). Here, we present observations of BC and OC/EC made using an Aethalometer and a Sunset analyzer, respectively. BC, OC and EC show maximum values in spring with a unimodal diurnal variation which indicates increased aerosol loading in the daytime. This has been attributed to rise in the boundary layer which could flush valley emissions to the observational site. Spring time values of EC and OC are observed to be about 15 $\mu\text{g}/\text{m}^3$ and 50 $\mu\text{g}/\text{m}^3$, respectively. Their lowest levels (5-10 $\mu\text{g}/\text{m}^3$) are observed in summer-monsoon. A nine particles back-air trajectory analysis showed greater (3-4 days) residence time over the defined region of Northern India during many days of higher BC levels. The major contribution in higher BC levels is found to be originated from the Indo-Gangetic Plain region. Observations of CO along with BC have also been used to identify the role of different emissions sources. A strong positive correlation between both signifies influence of fresh emissions while a poor correlation suggested role of aged emissions or scavenging of BC (in monsoon). Detailed analysis of this work will be presented.

1.254 Satellite Observed Variability of Aerosols and Carbon Monoxide in Southern Cities of South America.

Early Career Scientist

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Abstract:

Natural, but primarily anthropogenic atmospheric emissions, pose a threat to public health in two interconnected ways: the direct risk of air pollution and the indirect but merciless action of climate change. Natural fires and photosynthetic activity are important contributors to the quality of the air we breathe. However, levels of human activity such as transport, industry, agriculture, etc. are the main cause of air quality deterioration and of the indubitable climate disruption. In terms of air pollution, nearly 7 million people die each year, primarily of developing countries. Conversely, air quality monitoring in South America is still scarce, even in big cities in which there is a tendency to concentrate the economic resources of a country. For example, (i) Buenos Aires (Argentina) has 13 million inh. but only 3 air quality monitoring stations, (ii) Asunción (Paraguay) and Montevideo have more than 2 million inh. but no air quality monitoring and (iii) Córdoba (Argentina), with almost 2 million inh. since 2003 air pollution levels have not been monitored. In this work, we characterize the temporal and spatial variability, using satellites sensor information, of two contaminants relevant to public health: atmospheric aerosols and carbon monoxide (CO). We employed information from 2000 to 2017 covering the southern area of South America acquired by the EOS-TERRA satellite. The highest values of CO and Aerosol Optical Depth occurred in the period from August to October. The correlation between CO and active fires (AF) product was very high (0.89, $p < 0.05$), associated to biomass burning and the dominance of the dry season. However, it was not the case of AOD and AF, indicating the incidence of urban emission. Although it is necessary to have continuous measurements of air quality, the use of satellite data could be useful to establish causality when analyzing the degradation of air quality.

1.256 Adverse health impacts associated with urban and rural air pollution in India.

Early Career Scientist

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Abstract:

Ambient air pollution in India contributes to negative health impacts and early death. Ground-based monitors often used to quantify health impacts are located in urban regions, yet approximately 70% of India's population lives in rural communities. We simulate high-resolution concentrations of fine particulate matter (PM) and ozone from a regional air quality model over northern India, including updated estimates of anthropogenic emissions for transportation, residential combustion and location-based industrial and electrical generating emissions in a new anthropogenic emissions inventory. These simulations inform seasonal air quality and health impacts due to anthropogenic emissions, contrasting urban versus rural regions. We estimate 463 000 (95% confidence interval: 445 000–482 000) adults die prematurely each year from PM_{2.5} and that 38 000 (28 000–48 000) adults die prematurely each year from O₃. This translates to 5.8 deaths per 10 000 attributable to air pollution out of an annual rate of 72 deaths per 10 000 (8.1% of deaths) using 2010 estimates. We estimate that the majority of premature deaths resulting from PM_{2.5} and O₃ are in rural (384 000) as opposed to urban (117 000) regions, where we define urban as cities and towns with populations of at least 100 000 people. Further, we find that reducing emissions from predominantly urban transportation or predominantly rural residential combustion minimally mitigates future premature mortality despite increasing population and emissions over time. These findings indicate the need for rural monitoring and accompanying health studies to understand and mitigate the effects of ambient air pollution on this population in addition to supporting model evaluation.

1.257 Comparison of urban air pollution monitoring networks using low-cost sensors in fixed, mobile, and paired modes: Lessons for developing economies.

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Abstract:

In May 2018, the World Health Organization (WHO) announced that 90% of the global population are exposed levels of pollutions that are higher than deemed safe. Furthermore, 7 million people die each year due to exposure to fine particulate matter (PM) pollutants. In the last few years, low-cost sensors, which cost few hundred dollars or less, have been tested as complements to the existing official air pollution monitoring stations in North America, Europe, and Asia. While less reliable than government monitors, which can cost tens of thousands of dollars per pollutant, these devices open new potential in higher resolution monitoring, citizen engagement, and open data. They enable citizens to understand how pollution affects their health and what countermeasures they can take to protect themselves. Yet, the full costs of deploying and maintaining these low-cost sensors and analyzing their data have yet to be assessed. This paper aims to estimate and compare the advantages and costs of the three main modes of deploying urban air pollution networks using low-cost sensors: fixed, mobile, and paired phone systems using examples in the US and EU. We also discuss what these findings mean for cities in developing economies where staggering economic growth and energy consumption are accompanied by increased air pollution.

2.001 Photochemical formation of C1-C5 alkyl nitrates in suburban Hong Kong and over South China Sea.

Early Career Scientist

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Abstract:

Alkyl nitrates (RONO_2) are important reservoirs of atmospheric nitrogen, regulating nitrogen cycling and ozone (O_3) formation. In this study, we found that propane and *n*-butane were significantly ($p < 0.05$) lower at the offshore site (WSI) in Hong Kong, where C_3 - C_4 RONO_2 were comparable ($p > 0.05$) to the suburban site (TC). Stronger oxidative capacity at WSI led to more efficient RONO_2 formation. Relative incremental reactivity (RIR) was for the first time used to evaluate RONO_2 -precursors relationships. In contrast to consistently volatile organic compounds (VOCs)-limited regime at TC, RONO_2 formation at WSI switched from VOCs-limited regime during O_3 episodes to VOCs and nitrogen oxides (NO_x) co-limited regime during non-episodes. Furthermore, unlike the predominant contributions of parent hydrocarbons to C_4 - C_5 RONO_2 , the productions of C_1 - C_3 RONO_2 were more sensitive to other VOCs like aromatics and carbonyls, which accounted for ~40-90% of the productions of C_1 - C_3 alkylperoxy (RO_2) and alkoxy radicals (RO) at both sites. This resulted from the decomposition of larger RO_2 /RO and the change of OH abundance under the photochemistry of other VOCs. This study advanced our understandings on the photochemical formation of RONO_2 , particularly the relationships between RONO_2 and their precursors which were not confined to the parent hydrocarbons.

2.002 Interfacial Criegee Chemistry in the Atmosphere.

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Abstract:

Criegee intermediates (CIs) in the Atmosphere play fundamental roles in the HO_x cycles and new particle formations. The roles of CIs at the gas-particle interface, however, remain to be poorly understood. Here, we report the mass spectrometric study on the mechanisms of reactions of CIs with a series of atmospherically relevant compounds including carboxylic acids, alcohols, saccharides and water molecules on model surfaces of organic aqueous aerosol particles. CIs generated from prompt ozonolysis of beta-caryophyllene or alpha-humulene on the liquid surface preferentially react with surface-active and acidic species (e.g., *cis*-pinonic acid) to form larger mass, less volatile products. Unexpectedly, levoglucosan and other saccharides, major components of ambient biomass burning particles, very rapidly react with CIs at the gas-liquid interface. We infer that large gas-phase acidities of the multiple OH-groups of saccharides underlie their exceptionally large reactivities toward CIs. We also investigate how micro-heterogenous surface of internally mixed media (e.g., water/organics) influences on the CI chemistry. Based on these new findings, the atmospheric roles of interfacial CI chemistry will be discussed.

2.004 AeroCom Phase III Nitrate model experiment: a process-level understanding.

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Abstract:

Nitrate is an important aerosol component and impacts on atmospheric chemistry, radiative forcing, and ecosystem. A systematic multi-model experiment on the physical and chemical formation/loss processes for the atmospheric nitrate was proposed as a part of the AeroCom III study. We will present a process-level analysis of multi-model nitrate simulations and evaluate the results with various measurements from surface stations and aircraft measurements. Those studied processes include emission, dry deposition, wet deposition, thermodynamic chemistry, and heterogeneous chemistry. Such an analysis not only reveals diversity of nitrate simulation among the AeroCom models, but also helps us understand the reasons causing the diversity.

2.006 An inter-comparison of methods for HO₂ and CH₃O₂ detection and kinetic study of the HO₂ + CH₃O₂ cross-reaction in the Highly Instrumented Reactor for Atmospheric Chemistry (HIRAC).

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Abstract:

The hydroperoxy radical, HO₂, and methylperoxy radicals, CH₃O₂, participate in rapid chemical cycling at the heart of tropospheric oxidation. Laser-induced fluorescence (LIF) spectroscopy at low-pressure, known as the Fluorescence Assay by Gas Expansion (FAGE) technique, is most commonly used for the measurements of HO₂ in the atmosphere by conversion of HO₂ to OH by reaction with added NO followed by OH on-resonance LIF at 308 nm.¹ A new method has been developed for the sensitive and selective detection of CH₃O₂.² The method is similar to the FAGE method for HO₂ detection and consists in the titration of CH₃O₂ to CH₃O by reaction with NO followed by the detection of the resultant CH₃O by off-resonant LIF. Recently, the first near infrared CRDS measurements of HO₂ and CH₃O₂ in an atmospheric simulation chamber (HIRAC) were inter-compared against FAGE.^{3, 4} The good agreement between HO₂ and CH₃O₂, respectively concentrations measured using the two techniques at 1000 mbar of air provides a validation for the FAGE method for both HO₂ and CH₃O₂ detection.

The HO₂ + CH₃O₂ cross-reaction is important under clean, low NO_x levels, yet there are large uncertainties associated with its kinetics.⁵ The FAGE technique has been used to measure kinetic decays of HO₂ and CH₃O₂ radicals by the cross-reaction at 268, 295 and 323 K and 1000 mbar of air in the HIRAC chamber. The preliminary results have overlapping error limits at 1sigma level with the IUPAC preferred values at all three

temperatures.⁵

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2.007 Effect of condensed-phase photochemistry on the mass, composition, and properties of organic aerosols.

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Abstract:

Organic compounds in atmospheric aerosols are readily accessible to solar radiation and can participate in complex photochemical reactions occurring on surfaces and inside aerosol particles. This paper will discuss recent our results and on-going experiments on photochemical aging of organic aerosols. The specific topics will include: i) mass loss from organic particles driven by photodegradation processes; ii) the effect of UV radiation on absorption and fluorescence spectra of organic compounds in aerosols; iii) the effect of UV radiation on viscosity and volatility distribution of organics; iv) change in molecular composition of particles in response to UV irradiation. These projects involve multiple collaborators who will be acknowledged during the presentation.

2.008 Aqueous-phase phenols nitration under mild environmental conditions.

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Abstract:

Nitroaromatic compounds are ubiquitous in environmental systems, and known for their toxicity and secondary formation in the environment.¹ It has been shown that nitrophenols might be co-responsible for remote forest decline downwind from emission sources.² Atmospheric nitration of aromatic pollutants influences SOA formation closing the existing gap between field measurements and atmospheric models. Nitroaromatics significantly contribute to atmospheric brown carbon and directly contribute to climate forcing.³

Despite numerous efforts, understanding of (trans)formations of nitroaromatics in the environment remains insufficient. A generally accepted pathway of aromatic nitration proceeds via a radical mechanism, initiated usually by OH^\bullet . As it has been shown that nighttime production of nitroaromatics prevails over their daytime formation in the atmosphere, other radical (e.g., by NO_3^\bullet or NO_x) and nonradical pathways may be important sources of nitroaromatic compounds in the environment.

Nitration of 2-methoxyphenol, lignocellulosic biomass-burning pollutant, under mild aqueous-phase conditions was investigated by long-term temperature-dependent experimental modeling coupled to extensive quantum chemical calculations for obtaining the activation energies of modeled reaction pathways. The importance of dark non-radical reactions is emphasized, involving HNO_2 and HOONO . Oxidation by HOONO proceeds *via* a non-radical pathway, possibly involving NO_2^+ formation. By means of theoretical calculations, NO_2^\bullet is shown capable of abstracting the hydrogen from phenolic group on the aromatic ring, providing aryl radicals in acidic medium that can combine with HNO_2 and, after an oxidation step, yield nitrated aromatic products. Besides, HNO_2 is a mild oxidant capable of forming reactive quinone species from dihydroxyphenols and producing nitrophenols in the second reaction step. The demonstrated chemistry is especially important for the understanding of nighttime atmospheric deliquesced aerosol aging.

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2.009 A large ensemble based data assimilation experiment with a global aerosol transport model.

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Abstract:

Data assimilation methods are applied to various researches not only for atmospheric models but also for aerosol transport models to estimate more accurate analysis. In the ensemble based data assimilation methods, the background error covariance is estimated from ensemble forecasts. Sampling errors due to a limited ensemble size influence to the analysis accuracy, and covariance localization techniques are generally applied to remove the sampling errors. Although the covariance localization plays an essential role in the ensemble based filters, the covariance localization may remove important information between distant grid points or between different variables. Therefore, in this study, we apply the local ensemble transform Kalman filter (LETKF) known as one of ensemble based filters to a global aerosol transport model developed in Meteorological Research Institute and investigate the structure of covariance by increasing the ensemble size with 10 petaflops supercomputer named as K computer. This presentation will include the most recent results up to the time of the symposium.

2.011 Investigation of the oxidation of methyl vinyl ketone (MVK) by OH radicals in the atmospheric simulation chamber SAPHIR.

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Abstract:

The photooxidation of methyl vinyl ketone (MVK) was investigated in the atmospheric simulation chamber SAPHIR for conditions at which organic peroxy radicals (RO_2) mainly reacted with NO ("high NO" case) and for conditions at which other reaction channels could compete ("low NO" case). Measurements of trace gas concentrations are compared to calculated concentration time series applying the Master Chemical Mechanism (MCM version 3.3.1). Product yields of methylglyoxal and glycolaldehyde are determined from measurements. Direct quantification of OH radicals in the experiments shows the need for an enhanced OH radical production at low NO conditions similar to previous studies investigating the oxidation of the parent VOC isoprene and methacrolein, the second major oxidation product of isoprene. For MVK the model-measurement discrepancy is up to a factor of 2. Product yields and OH observations are consistent with assumptions of additional RO_2 plus HO_2 reaction channels as proposed in literature for the major RO_2 species formed from the reaction of MVK with OH. This study, however, shows that also HO_2 radical concentrations are underestimated by the model, suggesting that additional OH is not directly produced from RO_2 radical reactions, but indirectly via increased HO_2 . Quantum chemical calculations show that HO_2 could be produced from a fast 1,4-H shift of the second most important MVK derived RO_2 species. However, additional HO_2 from this reaction is not sufficiently large to bring modelled HO_2 radical concentrations into agreement with measurements due to the small yield of this RO_2 species. An additional reaction channel of the major RO_2 species would be required that produces concurrently HO_2 radicals and glycolaldehyde to achieve model-measurement agreement. A set of H-migration reactions for the main RO_2 radicals were investigated by quantum chemical and theoretical kinetic methodologies, but did not reveal a contributing route to HO_2 radicals or glycolaldehyde.

2.013 Aqueous-phase formation of nitrocatechols relevant for atmospheric nighttime conditions.

Early Career Scientist

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Abstract:

Almost all organic compounds in the atmosphere, either in the gas phase or in the particle phase are susceptible to secondary transformations. Recent studies have indicated that chemical processes in the atmospheric aqueous phase can also efficiently contribute to organic compounds aging.¹ One of the most important properties of ambient volatile organic compounds driving also the formation of secondary organic aerosol (SOA) is water solubility. Water-soluble organic species can dissolve in clouds and moist aerosol particles, where they can form low-volatility products.² Besides many short-lived radicals, non-radical oxidants such as nitrous acid (HNO_2) can also take an important part in atmospheric aqueous-phase transformation. The role of HNO_2 in the atmospheric waters is not yet clear, but its importance as a catalyst in condense-phase aromatic nitration has already been emphasized.³ Aromatic compounds, on the other hand, contribute significantly to the budget of atmospheric pollutants. In the present study, the intriguing role of HNO_2 (catalytic and oxidative) in the dark transformation of 3-methylcatechol under atmospherically relevant aqueous-phase conditions is emphasized. Three possible pathways of dark 3-methyl-5-nitrocatechol and 3-methyl-4-nitrocatechol formation, markedly dependent on reaction conditions, were considered. In the dominant pathway, HNO_2 is directly involved in the transformation of 3-methylcatechol *via* consecutive oxidation and conjugated addition reaction. Under very acidic conditions, the other two nitration pathways, oxidative aromatic nitration (electrophilic)⁴ and recombination of radical species, gain in importance. These results highlight the significance of catechol oxidation-conjugated addition reaction in nighttime secondary nitroaromatic chromophore formation.

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2.014 Reactive uptake of glyoxal by ammonium containing salt particles as a function of relative humidity.

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Abstract:

Reactions between dissolved ammonia and carbonyls, which form light-absorbing species in atmospheric particles, can be accelerated by actively removing water from the reaction system. Here, we examine the effects of relative humidity (RH) on the reactive uptake of glyoxal (Gly) by aqueous particles of ammonium sulfate (AS), ammonium bisulfate, sodium sulfate, magnesium sulfate, ammonium nitrate (AN), and sodium nitrate. In-situ Raman analysis was used to quantify particle-phase Gly and a colored product, 2,2'-biimidazole (BI) as a function of uptake time. Overall, the Gly uptake rate increases with decreasing RH, reflecting the "salting-in" effect. The BI formation rate increases significantly with decreasing RH or aerosol liquid water (ALW). Compared to that at 75% RH, the BI formation rate is enhanced by factors of 2.9×10 at 60% RH and 3.3×10^2 at 45% RH for AS particles and 6.5×10 at 60% RH, 2.1×10^2 at 45% RH, and 4.6×10^2 at 30% RH for AN particles. These enhancement factors are much larger than those estimated from increased reactant concentrations due to decreases in RH and ALW alone. We postulate that the reduction in ALW at low RH increases the Gly uptake rate via the "salting-in" effect and the BI formation rate by facilitating dehydration reactions.

2.015 Molecular investigation of bromide reaction on sea-spray aerosol proxy: temperature dependence and the effect of organics .

Early Career Scientist

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Abstract:

Tropospheric ozone reaction with halides has important implications on the oxidation capacity of and the fate of compounds in the atmosphere. Recent studies show that sea-spray aerosols, which contain both organic and inorganic species, may be significant in this halogen/ozone budget [1]. Recent studies have also highlighted the possibility of significant surface processes in bromide oxidation on aerosol proxies and salt solutions at environmentally relevant ozone concentrations. The presence of a surface process was recently observed in our kinetic study coupled with a liquid jet experiment presented in Artiglia et al.'s paper on the ozonide in bromide oxidation [2]. The liquid jet XPS aspect of the study showed the presence of Br•OOO complex as a surface intermediate driving the surface process [2].

Here, we tackle the question of the effect of organics on bromide oxidation in an aerosol proxy applying and extending the parameterization in Artiglia et al.'s paper. This is a first application of this parameterization, with modifications, to a wider temperature range, and including an organic species, citric acid, in this case. We apply this parameterization to evaluate the contribution of the surface and bulk processes to the observed uptake of ozone in the mixture. Our results indicate that the temperature and the composition of the mixture have effects on the solubility, diffusivity, and hence the uptake of ozone. These results show the importance of accounting for the aerosol composition in assessing the contribution of sea-spray aerosols in tropospheric halogen/ozone budget.

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2.016 Rate Constants and C-C Bond Scission Ratios for Hydrolysis or Clay-catalyzed Degradation of 2,2,3-Trifluoro-3-(trifluoromethyl)oxirane (a Fluorinated Epoxide).

Presenting Author:

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Abstract:

2,2,3-Trifluoro-3-(trifluoromethyl)oxirane (heptafluoropropene oxide, HFPO) is a versatile precursor of fluorinated chemicals. Much information about industrial use of HFPO has accumulated, but little is known about the fate of HFPO after it is released into the environment.

Rate constants for hydrolysis of HFPO were determined at 279–307 K. A reactor with a closed circulation system was used to measure the decrease of HFPO partial pressure while an HFPO-air mixture flowed over a stirred test solution under various experimental conditions. The rate of hydrolysis increased as the OH^- concentration increased in an aqueous NaOH solution but was almost independent of the H_2SO_4 concentration in aqueous H_2SO_4 solutions. Much C–C bond scissioning produced carbon monoxide and trifluoroacetate in aqueous NaOH, but similar scissioning did not in water or aqueous H_2SO_4 . The first-order rate constant for the pH-independent hydrolysis (k_{water} in s^{-1}) was estimated by simultaneously fitting equations based on a two-film model to the time series of HFPO partial pressures under different experimental conditions. The product of k_{water} and the Henry's law constant, K_{H} (M Pa^{-1}), at a temperature of T (K) was determined to be $k_{\text{water}} \times K_{\text{H}} = 3.7 \times 10^{-11} \exp[-3300 \times (T^{-1} - 1/298.2)]$. The tropospheric lifetime of HFPO estimated using this equation suggests that, in the absence of other atmospheric sinks, hydrolysis of HFPO should occur not in clouds but in the ocean (lifetime, some hundreds of years).

Furthermore, clay-catalyzed degradation of HFPO was examined at 283–313 K using the same reactor. The degradation produced carbon monoxide. The degradation rate in dry air was about a tenth times that reported for clay-catalyzed degradation of methyl chloroform under the corresponding experimental condition. The rate decreased with increasing relative humidity; however, the decrease in clay-catalytic activity was not so substantial as that for methyl chloroform.

2.018 Interactions at the aqueous aerosol surface.

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Abstract:

Atmospheric aerosols are commonly composed of a mixture of organic and inorganic compounds and constitute an important fraction of air pollutants. Adsorption of volatile species onto aqueous aerosol surface results in aqueous aerosols coated by organic films. Such organic coatings may affect the chemical and physical properties of aerosol particles, which in turn might have effects on different atmospheric processes. The role of surfactants in nucleating cloud droplets has acquired growing interest recently. In this study, the interactions of common atmospheric cations (Ag^+ , Zn^{2+} , Fe^{3+} , Ca^{2+} and Al^{3+}), anions (Br^- , Cl^- , NO_3^- and SO_4^{2-}) with lipid molecules (fatty acids and phospholipids) and the binary mixture of two lipid molecules at air-aqueous interface were investigated by Langmuir methods and infrared reflection absorption spectroscopy (IRRAS). In the presence of different ions, surface pressure-area isotherms showed the change of phase behaviors and the compressed or expanded characteristics of the organic monolayers. IRRAS spectra confirmed that the existence of inorganic ions in the lipid monolayer changes the surface properties of aqueous-phase aerosols. Formation of different coordination types of carboxylates at the air-water interface alters the dissolution and partitioning behavior. The miscibility and thermodynamic stability of mixed monolayer are dependent on the molar ratio of components. The surface organization of organic film and the change of surface to bulk partitioning may have significant impacts on the transport of volatile species, the evaporation of water vapor and nucleating cloud droplets. Our work displays the relationship between surface structure and properties for aqueous-phase aerosols and implies an efficient method for further understanding of their formation mechanism and potential atmospheric implications.

2.019 Iodide and ozone, an ongoing story: New insights from lab experiments in the ozone-iodide reactivity at the sea interface .

Early Career Scientist

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Abstract:

Ozone loss over the open ocean is governed mainly by mechanisms of dry deposition at the surface of the ocean and through homogeneous gas phase reactions. Observations have demonstrated the influence of atmospheric iodine as a sink for ozone (Read et al., 2008) and model studies indicate that iodine chemistry has significant impact on the global tropospheric ozone burden (Sherwen et al., 2016). It is believed that the main source for iodine in the atmosphere is the reaction of ozone with dissolved inorganic iodide (I^-) at the ocean's surface, but the factors influencing the surface reaction between ozone and iodide are not entirely understood (Carpenter et al., 2013). Uncertainties in the currently used interfacial model include the prediction of HOI/I_2 fluxes at ambient levels of ozone and iodide and the influence of organic material, because organics can compete for ozone or form a physical barrier for the transfer of iodine species to the atmosphere.

Here, a laboratory study using natural and spiked (I^-) seawater samples and relevant ozone concentrations (50 pbb – 130pbb) is presented using a flow reactor where molecular iodine (I_2) is measured *in situ* by BBCEAS (Ball et al., 2010), with high sensitivity, thus exploring this reaction around ambient conditions for the first time. I_2 emissions are compared to those from artificial seawater solutions using similar iodide and ozone concentrations, but without organics. Our results confirm that the overall effect of organics is to suppress the I_2 emissions and correspond well with the interfacial model. Furthermore, quantitative offline analysis by TD-GC-MS showed a novel production of different iodinated halocarbons in the gas phase. The qualitative high-resolution mass-spectrometry analysis of SPE-DOM extracts before and after ozonolysis provides supplementary insights in the changes of the organics. These experiments will be used to

validate and refine the current interfacial model.

2.020 Simulation on the similarities and differences of particle formation in winter and summer period in Beijing by NAQPMS+APM.

Early Career Scientist

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Abstract:

The NAQPMS+APM model was applied to simulating particle number size distribution evolution in two periods in summer and winter in Beijing. Both in summer and in winter, the new particle formation events usually occurred in relative clean atmosphere or followed a pollution scavenging process by strong north winds. The number concentration of nucleation-mode particles explosively increased in new particle formation events. In polluted periods, number concentration of accumulation-mode particles increased significantly while number concentration of nucleation-mode particles was at a low value. The diurnal variation of nucleation-mode secondary particles was opposite to the primary

particles while the accumulation-mode secondary particles diurnal pattern was in line with primary particles, which showed local features of nucleation-mode secondary particles and regional features of accumulation particles. The high concentration of condensable gas led to high frequency of new particles formation events in Beijing. Nucleation rates can be higher than $10 \text{ cm}^{-3}\text{s}^{-1}$. Nucleation events usually occurred before noon when pollutants concentration was low. In pollution episodes, the primary particles can grow rapidly due to coating secondary species through microphysics processes. Nucleation rates in winter was obviously higher than that in summer due to the higher temperature in summer was not favorable to nucleation despite the higher concentration of sulfuric acid and organic vapors. However, in summer the secondary particles can grow to a larger size as a result of the higher concentration of condensable gases produced by intense photochemistry.

2.021 The atmosphere of a tropical forest simulated in a chamber: experiments, theory and global significance of OH regeneration in isoprene oxidation.

Early Career Scientist

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Abstract:

New experiments focusing on the OH-initiated oxidation of isoprene over a broad range of NO concentrations were achieved in the atmospheric simulation chamber SAPHIR at Forschungszentrum Jülich, Germany. Measurements of VOCs, NO_x, O₃, HONO and photolysis frequencies were performed together with measurements of OH radicals (by both LIF-FAGE and DOAS) and OH reactivity. The NO mixing ratio was varied between 0.05 and 2 ppbv allowing the investigation of regeneration paths for OH radicals which originates from the isomerization of the RO₂ radicals, and the well-known NO+HO₂ mechanism. The observed radicals concentrations were compared with a state-of-the-art model (MCM 3.3.1) which includes isomerization reactions as described in the Leuven-Isoprene-Mechanism 1 (LIM1) [1]. The best agreement (within 10%) between measured and modelled OH radicals and primary oxidation products from isoprene was observed when the yields from the 1,6-hydrogen shift reaction in the MCM 3.3.1 were modified according to findings in recent laboratory studies [2]. The largest contribution to the OH production within the model for experiments with NO < 300 pptv originates from the 1,4-hydrogen shift of the di-HPCARP which is formed after the 1,6-hydrogen shift of Z isomers from the δ-hydroxy peroxy radicals (LIM1). Theoretical calculations confirm that the major degradation path for the di-HPCARP proceed via a 1,4-hydrogen shift with formation of OH radicals with a proposed rate coefficient of ~ 0.1 s⁻¹. This reaction path together with the modified yields of the products of the 1,6-hydrogen shift were included in a global chemistry model to assess the impact of the 1,4-hydrogen shift on the OH concentration throughout the troposphere. In light of this enhanced OH regeneration, the sensitivity of OH atmospheric levels to perturbation will be discussed.

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2.022 Wintertime photochemistry in Beijing: Observations of ROx radical concentrations in the North China Plain during the BEST-ONE campaign.

Early Career Scientist

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Abstract:

The first wintertime in-situ measurements of hydroxyl (OH), hydroperoxy (HO₂) and organic peroxy (RO₂) radicals (RO_x=OH+HO₂+RO₂) in combination with observations of total reactivity of OH radicals, k_{OH} , for the Beijing area are presented. The field campaign "Beijing winter fine particulate STudy - Oxidation, Nucleation and light Extinctions" (BEST-ONE) was conducted at the suburban site Huairou near Beijing from January to March 2016. It aimed to elucidate the mechanism of formation of secondary pollutants in the North China Plain (NCP) during wintertime. Unexpectedly high OH radical concentrations were observed during the campaign with noontime average concentration values of about $2.8 \times 10^6 \text{ cm}^{-3}$, with a slight difference in relatively clean ($3.6 \times 10^6 \text{ cm}^{-3}$) and severely polluted days ($2.4 \times 10^6 \text{ cm}^{-3}$). The Beijing winter OH concentration is nearly two-fold larger than what was observed in Birmingham, Tokyo, and New York City during wintertime. The simultaneous measurements of nitrogen monoxide NO and of the total reactivity of OH, k_{OH} , allows constraining the production and destruction rates in the radical chain reactions. During this campaign, the total primary production rate of RO_x radicals was dominated by the photolysis of nitrous acid accounting for 46% of the identified primary production pathways for RO_x radicals. Other important radical sources were alkene ozonolysis (28%) and photolysis of oxygenated organic compounds (24%). An observation based model was used to simulate the OH, HO₂ and RO₂ concentrations, which was capable of reproducing the observed RO_x concentrations during clean days. However, it largely underestimated HO₂ and RO₂ concentrations during pollution episodes. The HO₂ and RO₂ observed-to-modeled ratios increased with increasing NO_x concentrations, both during clean and polluted periods, implying that the current chemical mechanism has difficulties in the high NO_x regime.

2.023 Evolutionary process of winter haze in Beijing-Tianjin-Hebei: regional transport and heterogeneous reactions .

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Abstract:

Regional transport and heterogeneous reactions are both important processes that lead to severe haze pollution. The Nested Air Quality Prediction Model System (NAQPMS) with an online tracer-tagging module was used to investigate the formation of haze episodes in winter of 2016. The observational data shows that fraction and production rate of secondary inorganic aerosols increase a lot from clean to polluted level. A scheme of uptake coefficients considering aerosol properties and aerosol liquid water was incorporated in the model. The model shows high performance in simulating $PM_{2.5}$ with overall better agreements with the observations but still underestimation of SO_4^{2-} during sharp increase. And regional transport played an important role during episodes. Combining the Lagrange model with the Euler model, we investigate the evolution of source region during transport. Our results indicate that the efforts to control the air pollutants in Beijing and surrounding areas should be focused on controlling not only local and regional emissions, but also primary and precursors.

2.024 Hydroperoxide measurements in the marine boundary layer around the Arabian Peninsula during the AQABA ship-campaign.

Early Career Scientist

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Abstract:

The general goal of the AQABA (Air Quality and climate change in the Arabian BASin) campaign was to study the influence of air pollution on public health, climate and the natural environment. During the two-month expedition, AQABA encountered a unique variety of air masses, ranging from pristine conditions over the Arabian Sea and unpolluted but dusty air originating from Africa over the Red Sea, over moderately polluted conditions over the Mediterranean downwind from urban areas and the Middle East, to ship exhaust and petrochemical emissions in the Persian Gulf area.

For this purpose the hydroperoxides are of major interest. During the first leg the mixing ratios of the hydroperoxides decreased from the Red Sea (median H_2O_2 169 ppt, ROOH 182 ppt) southeastwards to the Gulf of Aden and the Arabian Sea (H_2O_2 111 ppt, ROOH 88 ppt). At the end of the leg in the Gulf of Oman and the Persian Gulf, the mixing ratios increased to 143 ppt for H_2O_2 (maximum 603 ppt) and 170 ppt for ROOH (maximum 1,995 ppt).

During the second leg the mixing ratios were slightly higher. In the Persian Gulf mixing ratios of 234 ppt for H_2O_2 and 182 ppt for ROOH were found. The lowest mixing ratios were observed over the Arabian Sea and the Gulf of Aden (H_2O_2 157 ppt, ROOH 67 ppt). In the Red Sea and the Mediterranean concentrations increased to 269 ppt for H_2O_2 and 224 ppt for ROOH.

Over the Mediterranean, the Red Sea and the Gulf of Aden we observed a diurnal variation with maxima between 12 a.m. and 3 p.m.. Over the Arabian Sea and the Persian Gulf no significant diurnal variation was found. The H_2O_2 /ROOH ratio varied from 0.03 (minimum, Persian Gulf) to 11.4 (maximum, Arabian Sea).

Further interpretation will be presented on the poster.

2.025 Applications of total ozone reactivity analyzer to a trial observation in the ambient air and to a further experiment on kinetics of terpene-ozone reactions .

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Abstract:

Biogenic volatile organic compounds (BVOCs) have been focused on as precursors of tropospheric ozone (O_3) and secondary organic aerosols. Various species of BVOCs have C=C double bonds and can react with O_3 . To capture BVOCs comprehensively, a total ozone reactivity (R_{O_3} , the sum of $k_i[VOC_i]$) analyzer has been developed [1-4]. R_{O_3} of sample BVOCs can be determined when decrease of O_3 due to BVOCs+ O_3 is precisely monitored. In our previous studies, the detection limit of the analyzer reached $2 \times 10^{-5} \text{ s}^{-1}$ (S/N=3, 60-s average, 50-s reaction) [4]. To demonstrate the validity and usefulness of the analyzer, measurement tests of R_{O_3} in the ambient air were conducted in this study. The observation was conducted at a suburban site in Japan (Tokorozawa campus, Waseda University) on July 6 and 7, 2016, and April 30, May 3, July 19, 20 and 21, August 9, 2017. Contribution of ambient NO on R_{O_3} was corrected with observed NO concentration and correction factor considered [5]. As a result, R_{O_3} was significantly captured when the temperature was high during daytime in summer. It was suggested that observed R_{O_3} could be explained roughly by temperature dependence of BVOCs emission from plants. Meanwhile, as another application of the sensitive analyzer, temperature dependence of rate constant, $k(T)$, for gas-phase reactions of BVOCs with ozone were explored experimentally. Consequently, $k(T)$ of beta-caryophyllene+ O_3 reaction decreased by 11 % and increased by 9 % when the temperature changed from 299 K to 323 K and to 283 K, respectively.

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2.026 Laboratory studies on the aging of biomass burning emissions: chemical evolution and secondary organic aerosol formation.

Early Career Scientist

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Abstract:

Biomass burning emissions represent a major source of fine particulate matter to the atmosphere, and this source will likely become increasingly important in the future due to changes in the Earth's climate. Understanding the effects that fire emissions have on air quality and climate requires understanding the composition of the particles emitted, since their composition is directly related to important properties such as absorptivity, toxicity, and cloud condensation nuclei activity. However, the composition of biomass burning particles in the atmosphere is dynamic, as the particles are subject to the condensation of low-volatility vapors, reaction with oxidants such as the hydroxyl radical (OH), and evaporation during transport. Previous studies have shown significant variability with respect to the net effect of aging on the amount of biomass burning organic aerosol (OA), with some studies showing a decrease in OA with age and other studies showing significant increases. Here, we present a series of laboratory chamber experiments on the OH-initiated aging of biomass burning aerosol performed at the Fire Sciences Laboratory in Missoula, MT as part of the Fire Influences on Regional and Global Environments Experiment (FIREX) campaign. We measure the evolution of biomass burning aerosol produced from a variety of fuels, monitored with a high-resolution time-of-flight aerosol

mass spectrometer (Aerodyne HR-ToF-AMS) and a proton-transfer reaction time-of-flight mass spectrometer (NOAA PTR-ToF-MS). Typical equivalent atmospheric aging times in the chamber range from 2 - 10 days of OH exposure, over which the mass and carbon oxidation state of the particles increase. OA production varies significantly from experiment to experiment, but we observe a strong correlation between the concentration of relatively high molecular weight gas phase compounds (C_5 and above) measured by the PTR-ToF-MS in the chamber before oxidation and the absolute amount of OA formed after aging.

2.027 Contributions of condensable particulate matter to atmospheric organic aerosol over Japan.

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Abstract:

In Japan, emission factors of particulate matters (PM) from stationary combustion sources have been measured without dilution or cooling, thus condensable PM were not included in the PM emission inventory. Recently, contributions of condensable PM were analyzed by comparing measured PM concentrations from stationary combustion sources before and after dilution. From these data, we modified emission inventory to include condensable PM from stationary combustion sources. Emission rates of organic aerosol (OA) increased by a factor of seven over Japan by considering condensable PM. Emissions of OA of this estimate became even higher than the total PM_{2.5} emissions of the previous estimate. In addition, road transport and biomass burning were the dominant OA sources in the previous estimate (filterable PM), while stationary combustion sources in industrial or power generation sector became the largest contributors to OA emissions over Japan in the revised estimate (filterable plus condensable PM). These results indicate that condensable PM from large combustion sources had critical contributions to total PM_{2.5} emissions. Contributions of condensable PM from combustion sources were also evaluated from simulations of a chemical transport model with a volatility basis set (VBS) module in winter, spring, and summer of 2012. Simulated OA concentrations drastically increased around urban and industrial areas, including the Kanto region, in all the seasons. On average, OA concentrations increased by a factor of 3.7, 2.5, and 6.1 in winter, spring, and summer, respectively, in the Kanto region. By considering condensable PM from stationary combustion sources, model performance of OA was improved in winter. However, in summer, OA concentrations were generally overestimated by considering condensable PM. Contributions of primary and secondary OA should be further evaluated from comparison with measurement data of organic tracers.

2.029 Particle phase state and viscosity in atmospheric secondary organic aerosols.

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Abstract:

Secondary organic aerosols (SOA) are ubiquitous in the atmosphere. SOA can occur in amorphous solid or semi-solid phase states depending on chemical composition, relative humidity (RH), and temperature. The phase state of SOA is important for their effects on climate and air quality, but its global distribution is poorly characterized. Our analysis of SOA phase state builds on the molecular corridor approach, which is a two-dimensional framework of volatility and molar mass of SOA components constrained by boundary lines of low and high molecular O:C ratio. We developed a method to estimate glass transition temperatures based on the molar mass and molecular O:C ratio of SOA components. We predict viscosity from the T_g-scaled Arrhenius plot of fragility as a function of the fragility parameter. We estimated viscosity of α -pinene and isoprene SOA as a function of RH by accounting for hygroscopic growth of SOA and applying the Gordon-Taylor mixing rule, reproducing previously published experimental measurements very well. Viscosity of toluene SOA was predicted using the elemental composition obtained by high-resolution mass spectrometry (HRMS), resulting in a good agreement with the measured viscosity. Further, we used the global chemistry climate model EMAC with the organic aerosol module ORACLE to predict the phase state of atmospheric SOA. For the planetary boundary layer, global simulations indicate that SOA are mostly liquid in tropical and polar air with high relative humidity, semi-solid in the mid-latitudes, and solid over dry lands. We find that in the middle and upper troposphere SOA should be mostly in a glassy solid phase state. Thus, slow diffusion of water, oxidants, and organic molecules could kinetically limit gas-particle interactions of SOA in the free and upper troposphere, promote ice nucleation and facilitate long-range transport of reactive and toxic organic

pollutants embedded in SOA.

2.030 Studies on liquid-liquid phase separation in α -pinene secondary organic aerosol particles.

Early Career Scientist

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Abstract:

Recent studies on liquid-liquid phase separation in several types of secondary organic aerosols free of inorganic salts have been investigated with a possible implications for the cloud condensation nuclei [1][2][3]. However, still limited studies have been carried out on liquid-liquid phase separation in secondary organic aerosols. To obtain additional insight into phase separation in organic aerosols free of inorganic salts, we studied liquid-liquid phase separation in secondary organic aerosol particles produced from α -pinene photo-oxidation and α -pinene photo-oxidation with a reaction of NH_3 . The results and implications will be presented.

2.033 Laboratory study for gaseous mercury uptake by atmospheric water.

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Abstract:

Mercury is a notorious pollutant causing severe nerve diseases. This metal has a semi-volatile nature under the STP condition, therefore, it is emitted to atmosphere as gaseous elemental mercury (GEM) from variety of sources. Because of the emissions and long atmospheric life time mercury spreads globally, consequently ubiquitous in our environment. The current global model for mercury cycle assumes that the atmospheric oxidation is a predominant pathway for the removal of GEM from the atmosphere. To the best of our knowledge, however, none of heterogeneous uptake of GEM by atmospheric water, such as cloud, fog, and rain droplets, has been evaluated to date. For more accurate understanding of the mercury cycle, the evaluation of this process is necessary. We conducted laboratory experiments to evaluate GEM uptake by atmospheric water. The experiments were carried out using a 3 L glass cell. 500 mL of acidified (pH 3-5) water by sulfuric acid, which represents atmospheric water, transferred into the cell. Approximately 50 ng m^{-3} of GEM gas mixture was then continuously introduced into the open space above the solution in the cell. After a definite time period the exposure was stopped and the solution was analyzed for mercury concentration. At this presentation preliminary results of these experiments will be presented.

2.035 Extractive Electrospray Ionisation Mass Spectrometry (EESI-MS) for organic aerosol analysis.

Early Career Scientist

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Abstract:

Organic compounds are ubiquitous in the troposphere and constitute a large fraction of aerosol mass. Characterising the composition of organic aerosols (OA) is key to understanding their formation, transformation and impacts on atmospheric chemistry and air quality. Here, we present a novel online technique for characterising OA, Extractive Electrospray Ionisation Mass Spectrometry (EESI-MS) [1]. EESI-MS employs gentle solvent-based capture and ionisation of aerosols. This generates molecular ions and allows individual aerosol species to be identified and monitored over time.

We will show that EESI-MS is an excellent tool for characterising OA generated in laboratory experiments, focusing on the quantitative abilities of the technique. Unlike related offline techniques, changes in EESI ion abundance provide a reliable measure of aerosol-phase concentration changes [2]. This “relative quantification” has been exploited in recent work to monitor composition changes during heterogeneous oxidation of oleic acid aerosols [3]. We extract previously unconstrained kinetic parameters related to condensed-phase reactions of Criegee intermediates using EESI-MS and process-based aerosol modelling.

Furthermore, we establish correlations between organic aerosol toxicity and chemical composition for OA formed from the prominent indoor pollutant and biogenic VOC, limonene [4]. We compare EESI spectra to complementary measurements of health-relevant reactive oxygen species (ROS). We find persistent levels of ROS are present in limonene OA, and hypothesise that the aerosol contains a reservoir of reactive species, including unsaturated compounds, which generate additional ROS over time.

[1] Gallimore and Kalberer, *ES&T*, 47, 7324-31, 2013.

- [2] Gallimore et al., ACP, 17, 14485-500, 2017.
- [3] Gallimore et al., JGRA, 122, 4364-77, 2017.
- [4] Gallimore et al., ACP, 17, 9853-68, 2017.

2.036 Nitrous acid in the marine boundary layer.

Early Career Scientist

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Abstract:

Nitrous acid (HONO) is a significant source of hydroxyl radical, plays a vital role in starting and promoting atmospheric photochemical processes, and indirectly affect the formation of secondary organic pollutants, hence, impacts regional air quality. HONO concentration measurements have been reported from different regions but rarely in the marine boundary atmospheric layer. Two in-situ campaigns were conducted at marine background atmospheric monitoring stations in Tuoji Island (China) and San Vicente (Cape Verde) in order to obtain a holistic understanding of HONO regional characteristics, formation mechanisms and implications for atmospheric oxidizing capacity in marine and coastal regions.

The obtained data showed enhanced ambient HONO concentrations during sunlight hours. Concentration peaks frequently appeared during noontime or early afternoon. The differences of daytime HONO patterns in the two areas may be attributed to different formation pathways or different environments in terms of pollutants concentrations and characteristics. However, light-enhanced heterogeneous reactions on Sea MicroLayer (SML) might be an important process involved in the concentrations trends of HONO observed. In this study, a sunlight conceptual model has been used to display the possible interactions between HONO and SML. The data obtained will be presented and discussed.

2.037 An Evaluation of Global Organic Aerosol Simulations of Varying Complexity using Airborne Observations.

Early Career Scientist

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Abstract:

Chemical transport models have historically struggled to accurately simulate the magnitude and variability of organic aerosol (OA), with previous studies demonstrating that models significantly underestimate observed concentrations in the troposphere. In this study we explore different model OA schemes using the GEOS-Chem chemical transport model and compare the simulations to a suite of globally-distributed airborne observations from 2008-2017. These include the recent Korus-AQ and ATom campaigns and provide broad coverage over a diverse set of regimes – anthropogenic, biogenic, fire and remote. The evaluated model schemes span a range of formation mechanisms – including a simple fixed-yield parameterization, a volatility basis set, and an explicit treatment of IEPOX aqueous uptake. We also use the observations to optimize the fixed-yield approach for the various precursor types. The result of this analysis is an improved parameterized OA scheme that significantly reduces bias and improves model skill when compared to ambient observations while maintaining the computational advantage of a parameterized approach.

2.039 Characteristics of atmospheric peroxyacetyl nitrate and its precursors at an urban site in Beijing, China .

Early Career Scientist

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Abstract:

Atmospheric peroxyacetyl nitrate (PAN) is an important secondary gas pollutant formed in photochemical reactions of volatile organic compounds (VOCs) in the presence of NO_x. PAN can act as a reservoir for NO_x and plays an important role in atmospheric photochemistry. Previous measurements of PAN in Asian megacities were mainly conducted for short periods in summer. Here we present a 1-year continuous measurements of PAN and its precursors (NO_x and VOCs) at an urban site (Chinese Meteorological Administration, CMA) in Beijing and focus mainly on their correlation during wintertime. No distinct seasonal variation pattern could be discerned, with the highest monthly average concentration occurring in Sep. 2016 and the lowest concentration in Feb. 2017. NO₂ reveals a clear seasonal variation with high concentrations during winter and lower ones in summer. Most oxygenated VOCs (oVOCs) displayed low concentrations during Feb. to Mar. 2017, while their peaks occurred during different times in the year. The variation of PAN is also governed by thermal dissociation, which peaks in May and can account for a loss of 10-30% during Apr. to Oct. 2017. Thermal dissociation was very weak during Nov. 2016 to Mar. 2017 and its effect on PAN concentrations is negligible. During summer, PAN shows relative good correlation to O₃, while during winter, the variation of PAN and O₃ are decoupled. Wintertime PAN is significantly positively correlated to the total concentration acetaldehyde, acetone and propanal and negatively to the ratio NO/NO₂. Additionally, PM_{2.5} during winter also displayed a significant correlation to the total concentration acetaldehyde, acetone and propanal, explaining 74% of its total variance, which may indicate that PM_{2.5} in Beijing has similar sources as these oVOCs, or that fine particle surface promotes the production of these oVOCs.

2.040 Investigating the relationship between physicochemical properties of fine particles and visibility impairment in central Taiwan.

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Abstract:

Air quality in Central Taiwan has improved gradually over the past decade, though the visibility has not changed much. From a scientific view, visibility is related to air quality or more specifically the fine particulate matter ($PM_{2.5}$), but not in a direct proportional relationship. With that in mind, this study evaluates the sources and formation mechanisms of $PM_{2.5}$ to elucidate the likely causes to the aforementioned bottleneck in improving visibility. Data from ground-level measurements, satellite telemetry and mathematic models will be combined, while two independent methods: physical and chemical extinction efficiencies (b_{ext}) will be estimated based on the measured aerosol physicochemical properties. The estimated b_{ext} will then be used to assimilate the b_{ext} from satellite data, with which further being used to reconstruct the spatiotemporal distribution of past b_{ext} for evaluating the impact of land use and microenvironment meteorology on visibility. The highly time-resolved aerosol physicochemical properties will be used for apportioning the contributions of sources and chemical-components on impaired visibility.

2.041 The Effects of Aerosol-Phase State and Chemical Composition on Multiphase Chemistry Leading to Isoprene-Derived Secondary Organic Aerosol Formation.

Early Career Scientist

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Abstract:

Multiphase reactions between gas- and particle-phase constituents are an important formation mechanism for atmospheric secondary organic aerosol (SOA). Aerosol phase state is thought to influence the reactive uptake and multiphase chemistry processes of gas-phase precursors by altering their diffusion rates within particles. This laboratory study systematically examines the reactive uptake probability of isoprene-derived epoxydiols (IEPOX) onto acidic ammonium sulfate particles with selected pre-existing SOA coatings by coupling a flow tube reactor with an iodide-adduct high-resolution time-of-flight chemical ionization mass spectrometer (HR-ToF-CIMS). A uniform layer of organics is coated onto the inorganic particles using a potential-aerosol-mass (PAM) oxidation flow reactor, confirmed via atomic force microscopy (AFM) and scanning electron microscopy (SEM). Results show that certain pre-existing SOA coatings could significantly reduce the reactive uptake probability of IEPOX, in some cases by nearly an order of magnitude when the coating thickness is only 10 nm.

Particle composition is also analyzed by online and offline analytical techniques, including an aerosol chemical speciation monitor (ACSM), ultra-performance liquid chromatography interfaced to electrospray ionization (ESI) HR-ToFMS, and ESI coupled to ion mobility spectrometry HR-ToF-MS. Results show that the oxidation state and composition of aerosol particles jointly change their phase state and reactive uptake coefficients. A box model combining experimental data with ambient measurements from the 2013 SOAS campaign is used to assess the effects of pre-existing organic coating on IEPOX-derived SOA formation. IEPOX-derived SOA within a diurnal cycle is estimated to be reduced by 16-27% due to pre-existing organic coatings.

Our study provides a potential explanation for the discrepancy between model predictions and field measurements of IEPOX-derived SOA from previous studies. The approach used in this study could be more widely applied to other multiphase chemical systems in regional and global scale models to better predict the impact of SOA their climate, human health, and visibility.

2.043 Numerical analysis of seasonal change of iodine-129 deposition in Japan using a global atmospheric iodine transport model.

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Abstract:

Iodine-129 (^{129}I) is a useful isotope for dating of water, tracing of marine sediments and investigating the geochemical cycle of iodine. Main sources of atmospheric ^{129}I are volatilization from ocean and discharge from nuclear fuel reprocessing plants. Although released ^{129}I is globally transported in the atmosphere and is deposited on the Earth's surface, the global cycle of ^{129}I are still not well understood. In this study, we focused on the deposition process of ^{129}I and investigated the seasonal change of ^{129}I deposition measured at Rokkasho in Japan by using a global atmospheric iodine transport model, GEARN-FDM developed by us. The simulation period was set to be from 2006 to 2010, and input meteorological fields to drive GEARN-FDM were calculated using WRF (Weather Research and Forecasting) model Version 3.6.1 with ERA-interim dataset. The model successfully reproduced the seasonal change of total deposition measured at Rokkasho. In summer, 85-90% of the monthly total deposition was attributed by wet deposition of the inorganic gaseous ^{129}I volatilized from ocean. In contrast, in winter, wet deposition of the inorganic gaseous ^{129}I discharged from European nuclear fuel reprocessing plants was the major contributor to the total deposition. The seasonal difference of contributor to total deposition at Rokkasho resulted from the atmospheric transport due to westerly wind in mid- and high-latitudes in the Northern hemisphere—strong in winter and weak in summer. Furthermore, over northern part of Eurasia where was estimated as the transport pathway of atmospheric ^{129}I from European nuclear fuel reprocessing plants to Rokkasho, the wet deposition in winter was less than that in summer, suggesting the rainfall over northern part of Eurasia plays an important role in determining the seasonal change of ^{129}I deposition at Rokkasho in Japan.

2.045 Characterization and source apportionment of water-soluble organic aerosol with high resolution aerosol mass spectrometry in Beijing, China.

Early Career Scientist

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Abstract:

Water-soluble organic aerosol (WSOA) constitutes a major fraction of organic aerosol (OA), and plays an important role in affecting aerosol hygroscopicity and cloud condensation nuclei formation. While real-time characterization of OA with Aerodyne aerosol mass spectrometer (AMS) has been widely conducted in Beijing during the past decade, our knowledge of the characteristics and sources of WSOA remains less understood. Here we analyzed filter extracts of fine particles using high resolution AMS that were collected at ground level and 260 m on the Beijing 325 m meteorological tower in winter 2016. The mass concentrations of WSOA were quantified and the sources were analyzed with positive matrix factorization (PMF). Our results show that WSOA on average contributed 47% and 52% to the total OA at ground and 260 m, respectively. PMF analysis identified five sources for WSOA, including three primary factors (coal combustion, biomass burning, and oxidized POA) and two secondary factors with different oxidation states. Our results suggest that WSOA in winter has considerable contribution from primary emissions which accounted for 44% and 42% at ground and 260 m, respectively. The sources and properties of WSOA also show some differences between ground and 260 m. For example, the average oxygen-to-carbon (O/C) ratio of WSOA at 260 m is 0.68, higher than that at ground (0.62), and the contribution of secondary sources is also higher (58% vs. 56%), especially the fraction of more oxidized organic OA account for 34% in 260m and 28% in ground level. These results indicate that WSOA at higher heights in the city is more oxidized. The offline source apportionment results were further compared with those of AMS online measurements, which provides more insights into the water solubility of OA from different sources.

2.046 New insight into the role of H₂SO₄ seeds in SOA formation from toluene and isoprene.

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Abstract:

In general, it is difficult to generate SOA through homogenous mechanisms. Preexisting seeds play a vital role in SOA formation. Chamber experiments have been used to demonstrate how background H₂SO₄ seeds affect SOA formation in toluene-NO₂ and isoprene-NO₂ irradiations. H₂SO₄ is generally formed from the gas-phase oxidation of SO₂ by OH. In toluene-NO₂ irradiations, the burst time of particles was delayed by 3 (2) hours in ultra-pure background air in which SO₂ concentrations were well below the SO₂ analyzer detection limit of 50 ppt as compared to that in background air in which SO₂ concentrations were around 1 ppb under dry (humid) conditions. The maximum number concentrations of particles were only 10²/cm³ in ultra-pure background air, compared to 10⁴/cm³ in background air. In addition, the maximum mass concentrations of SOA in ultra-pure background air were only about 8 μg/m³ under both dry and humid conditions after 6 hours of reaction, compared to the concentrations of about 75 μg/m³ (dry) and 165 μg/m³ (humid) in background air. In isoprene-NO₂ irradiations, both OH and O₃ are important oxidants. In isoprene-OH irradiations, background SO₂ had a great positive effect on SOA formation, which is similar to toluene-NO₂ irradiations. However, in the ozonolysis of isoprene particles were mainly formed by self-nucleation of organic products. It is concluded that background H₂SO₄ particles are the major seeds in the OH oxidation channel of toluene and isoprene, which enhance SOA formation through the acid-catalyzed particle-phase reactions, while they have little effect on the O₃ channel oxidation of isoprene due to self-nucleation of the stabilized Criegee intermediates-related products.

2.047 OH-, ozone-, and nitrate radicals-initiated aging of secondary organic aerosol formed from the ozonolysis of limonene.

Early Career Scientist

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Abstract:

Formation of secondary organic aerosol (SOA) from the reaction of VOCs with atmospheric oxidants (OH, O₃ and NO₃) and OH-initiated aging (OH reactions of secondary products) are included in the volatility-basis set model. However, night time aging by NO₃ and O₃ are not included. Significant nitrate aerosol formation was reported in recent field studies conducted in limonene abundant area, suggesting that the reactions of NO₃ with the secondary products formed from limonene oxidation as well as the direct reaction of NO₃ with limonene might contribute to nitrate aerosol formation. In a 6 m³ smog chamber we conducted light condition OH-initiated aging and dark condition O₃-, NO₃-initiated aging of limonene SOA to understand importance of daytime and night aging in SOA formation. Limonene SOA was produced from the ozonolysis of limonene. After SOA level became stable, OH-initiated aging was carried out by H₂O₂ photolysis and dark condition NO₃-, O₃- initiated aging were carried out by the injection of 1 ppm N₂ O₅ and O₃ respectively. Gas phase reactants and products were monitored by using FT-IR spectrometer and proton transfer reaction mass spectrometer. SOA formation was monitored by Aerodyne aerosol mass spectrometer (AMS) and SMPS. SOA particles formed before and during aging were collected on a Teflon filter and analysed by liquid chromatograph-mass spectrometer (LC-MS). AMS results showed that all three oxidants used in the experiments produced similar levels of SOA after one-hour aging, suggesting that NO₃- and O₃-initiated aging have comparable SOA formation potentials with OH-initiated aging. LC-MS results shows that ozonolysis of limonene produced monomeric and dimeric products in particle phase. Further, it shows that increasing of oligomeric products upon O₃ aging whereas several new monomeric and oligomeric compounds with higher mass range were produced upon NO₃ aging. This work was supported by JSPS KAKENHI Grant Numbers JP16H06305 and JP 17H01866.

2.048 Hourly observation of PM_{2.5} components in the coastal area in Seto Inland Sea, Japan.

Early Career Scientist

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Abstract:

We carried out a diurnal characterization of PM_{2.5} components using the continuous dichotomous aerosol chemical speciation analyzer (ACSA-14) at Kobe City in Hyogo Prefecture, a coastal area on the Seto Inland Sea. High concentration factors of the main components were estimated using the gaseous concentration data and the wind direction/wind speed data. The diurnal variation of the optical black carbon (OBC) increased in the morning. It is commonly affected by heavy-duty vehicles, and stable conditions of the atmosphere cause it to reach high concentrations. The diurnal variation of the NO₃⁻ was affected by a heavy-duty vehicle with a secondary generation at night. The diurnal variation of the water soluble organic carbon (WSOC) was affected by a secondary photochemical generation in the summer season and the stabilization of the atmosphere in the winter season. On the other hand, there was a time lag between the diurnal variation of WSOC and the diurnal variation of Ox in the summer, so additional consideration is necessary. The diurnal variations of the SO₄²⁻ and H⁺ were affected by exhaust gas from ships navigating on the surrounding sea. However, the time of the high concentration of SO₄²⁻ is later than that of SO₂ and requires greater consideration than other factors.

2.049 A simplified approach for estimating cooking organic aerosol from Q-ACSM measurements in Beijing, China.

Early Career Scientist

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Abstract:

Cooking organic aerosol (COA) constitutes a considerable fraction of total organic aerosol (OA) in megacities worldwide. However, it is very challenging to separate COA from traffic-related hydrocarbon-like OA (HOA) in summer through positive matrix factorization of unit mass resolution (UMR) spectra of quadrupole aerosol mass spectrometer (AMS) or aerosol chemical speciation monitor (ACSM). Here we present a simplified approach to estimate COA from the total primary OA (POA, mainly COA and HOA in summer) using black carbon as a tracer (BC). This assumption is rational because BC is dominantly from traffic emissions in summer in Beijing. By applying this approach to two ACSM datasets in summer in Beijing, we found that COA on average contributed 27 and 13% to OA in 2011 and 2012. These results agree reasonably well with previous PMF results from high-resolution AMS, and also those estimated using marker m/z 's of 55, 57 and 44. While this approach has the best accuracy for estimation of COA in summer, it can also be applied to other seasons although some uncertainties were observed due to additional sources of BC, e.g., biomass burning and coal combustion. Our approach has a significant implication in source apportionment of POA in urban areas considering the widely deployed Q-ACSM in the field during the past five years.

2.050 Pressure Studies of the Reaction of HO₂ with NO₂ using a mid-infrared Continuous Wave Quantum Cascade Laser.

Early Career Scientist

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Abstract:

The hydroperoxy radical (HO₂) is an important intermediate in both stratospheric and tropospheric chemistry. In polluted atmospheres, its reaction with NO₂ forms peroxy nitrates (HO₂NO₂), which is a reservoir of HO_x and NO_x. If the HO₂NO₂ lifetime is long enough they may act either as a sink, transporting NO_x, or may react with OH, effectively removing HO₂ radicals.

UV absorption spectroscopy has been the most commonly used method to detect the HO₂ radical in the range 220~230 nm, because of its strong cross sections ($\sigma \approx 10^{-18}$ cm² molecule⁻¹). However, the broad and structureless absorption of HO₂ in this region due to the predissociative B²A'' ← X²A'' transition leads to overlaps with the absorption of other species, such as hydrogen peroxide ($\sigma \approx 10^{-19}$ cm² molecule⁻¹), the main product of the HO₂ self-reaction.

Recently, the pressure dependency of the rate coefficient for HO₂ + NO₂ was studied with a time resolved laser-induced fluorescence (LIF). Based on the results of this research, the values of the rate coefficient for HO₂ + NO₂ ranged from 50~400 Torr at a temperature 298 K, are obviously higher than previous determined ones by the rate coefficient for HO₂ + NO₂.

In this work, we applied a mid-infrared cw quantum cascade laser as the spectroscopic light source, and measured the rate coefficients for HO₂ + NO₂ with the pressure varied in the range of 0~150 Torr at a room temperature 298 K, and supported the previous result decided by a LIF. The effect of HO₂ + NO₂ has been underestimated, especially in low pressures.

2.053 Secondary Formation and Transformations of Organic Aerosols in Atmospheric Waters.

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Abstract:

Organic aerosols (OA) have serious impacts on the Earth's climate system directly by absorbing solar radiation and indirectly by acting as cloud condensation nuclei. They can also play an important role in atmospheric chemistry and cause adverse effects on human health. The secondary OA (SOA), formed in the atmosphere, accounts for a large and often a dominant fraction of total OA mass. In recent times, much progress has been made in our understanding of SOA formation chemistry. However, most of the laboratory studies conducted so far represent idealized systems, which do not reflect the complex mixture of organic and inorganic aerosol constituents. The current atmospheric models underestimate the SOA mass and do not always capture the variability of the measured SOA loadings and distributions. In order to better understand the secondary formation and transformations of organics in the atmosphere, we conduct aqueous-phase experiments on atmospheric aerosol samples collected from Tianjin and Nanjing, China and at point sources as well under atmospherically relevant conditions for variant time periods. Both non-irradiated and irradiated samples are analyzed for the measurements of concentrations and stable carbon isotopic compositions of diacids, oxoacids, dicarbonyls and other compounds. Based on the results, we propose the secondary formation and transformations pathways of organics in atmospheric waters.

2.055 Simulation of the ionization efficiency of evolved gas molecules from aerosol particles in a thermal desorption aerosol mass spectrometer.

Early Career Scientist

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Abstract:

Thermal desorption aerosol mass spectrometers (TDAMSs) with electron ionization have been widely used to quantitatively measure chemical composition of aerosol particles. We have conducted laboratory experiments to investigate physical and chemical mechanisms affecting the ionization efficiency of evolved gas using a custom-made TDAMS. Sodium oxalate was selected as a test compound because the thermal decomposition products are expected to be simple (dominated by carbon monoxide (CO) and carbon dioxide (CO₂)). A numerical model for simulating the molecular dynamics in evolved gas plumes has been newly developed to interpret the experimental results. The simulation model consists of two main sections. The first section simulates elastic collisions of evolved gas molecules in a small region near the vaporization point where the mean free paths of molecules are much shorter than those in a surrounding high vacuum environment. The second section simulates the free-molecular dynamics from the vaporization to the ionization regions. The ionization efficiencies of CO and CO₂ are calculated by counting the number of CO and CO₂ molecules passing through the ionization region. Preliminary results suggest that the molecular collisions near the vaporization region could be an important mechanism affecting variability in the ionization efficiency. Details of the experiments and simulations are presented and discussed.

2.056 The MAGNIFY project - Updated protocols for ozonolysis and photolysis of organic compounds.

Early Career Scientist

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Abstract:

Atmospheric chemistry impacts on air quality, climate change, and a wide range of societal and economic issues such as effects on human health, including premature deaths, and reduced crop yields from air pollution. Chemical mechanisms are key to understanding the impacts of these effects and predicting future changes. However, owing to the large number of different compounds identified in the troposphere (currently $> 10^5$), it is impossible to develop the complex explicit chemical mechanisms needed

based solely on experimental information.

The MAGNIFY project (Mechanisms for Atmospheric chemistry: Generation, Interpretation and Fidelity) aims to address these pressing research issues by updating and extending the Master Chemical Mechanism (MCM, <http://mcm.leeds.ac.uk>) using state-of-the-art methods to predict missing mechanistic and kinetic data. With currently ~7,600 species and ~17,000 reactions, this open-access mechanism is one of the most widely used and cited benchmark mechanisms for atmospheric chemistry. A major focus of the current project is a complete overhaul of its construction rules so that future generations can be auto-generated using the GECKO-A expert system (Generator for Explicit Chemistry and Kinetics of Organics in the Atmosphere, <http://geckoa.lisa.u-pec.fr>), opening it up more to the community via the internet and assure a sustained provision and maintenance of future MCM versions.

Here, we focus on updates to the construction protocols for ozonolysis, including the chemistry of resulting Criegee intermediates, as well as photolysis, where the scarcity of experimental data has hindered the development of robust prediction methods for cross sections and quantum yields. Special attention is given to multifunctional compounds, which are expected to be ubiquitous in the atmosphere. However, kinetic and mechanistic measurements of multifunctional species chemistry are still needed for the development and implementation of robust protocol rules.

2.058 Observations of Ozone-Induced Potential Aerosol Formation at Deciduous Forest and Residential Sites near Tokyo.

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Abstract:

Secondary organic aerosol (SOA) particles, which are generated during oxidation of volatile organic compounds (VOCs), constitute a large fraction of submicron particles. However, formation processes of SOA remain largely uncertain. As a new approach to investigating their formation processes, ozone-induced potential aerosol formation was measured at a deciduous forest site in Tama during summer of 2015 and at a residential site in Tsukuba during summer of 2017. After passage through a reactor containing high concentrations of ozone, total particle volumes increased significantly by 17% (on

average) in the Tama site, especially during daytime when the concentrations of isoprene and oxygenated VOCs were high. In contrast, the increases in total particle volume were much less in the Tsukuba site, where concentrations of isoprene were relatively low throughout the observation period. These results suggest that isoprene and their oxidation products contribute significantly to the ozone-induced potential aerosol formation.

2.060 Measurement of atmospheric carbon dioxide using unmanned aerial vehicle for profiling vertical distribution over Akita.

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Abstract:

Atmospheric carbon dioxide (CO₂) is one of extremely important anthropogenic greenhouse gases, and which have effect on global warming and future climate change. This study presents a novel CO₂ measurement platform that is accommodated on an unmanned aerial vehicle (UAV). In situ measurements using an onboard non-dispersive infrared (NDIR) gas analyzer were conducted from the ground surface to a 500 m altitude over Akita. Before the UAV flight, CO₂ standard gas injections were made for the calibration of CO₂ concentration during flight examinations. Although UAVs have altitude limitations in the troposphere, our platform is useful for obtaining CO₂ vertical profiles under boundary layer easily and inexpensively. In the presentation, we will reveal measurement results obtained in 2017 and 2018.

2.061 Comprehensive characterization of oxidation of organic compounds in the atmosphere.

Early Career Scientist

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Abstract:

The oxidation of organic compounds in the troposphere is an important process controlling air quality and the formation of climate-active aerosols. These chemical species are diverse and participate in a wide range of reactions. Accordingly, challenges

remain with chemical modeling, detection of later-generation species, and predicting secondary organic aerosol (SOA) formation. In this work, we (1) identify and simplify major chemical pathways that species follow through multiple generations of oxidation, and (2) support how we process and interpret huge mass spectrometric data sets. The oxidation chemistry of six hydrocarbons + OH (isoprene, α -pinene, toluene, 1,2,4-trimethylbenzene, decane, and 1,4-dimethylcyclohexane) was studied under high-NO conditions in an environmental chamber. Resulting products were detected with a comprehensive analytical suite, including gas chromatography, two optical techniques, four mass spectrometric techniques for measuring gas-phase organics (TD-EIMS, VOCUS 2R PTR, PTR3, and I-CIMS), and three mass spectrometric techniques for measuring particle-phase organics (AMS, CHARON-PTR3, and FIGAERO I-CIMS). We first determine the extent to which all the product species of VOC oxidation can be detected and quantified, and highlight major gaps in our measurement capabilities. We use several recently-developed techniques to estimate instrument sensitivities to hundreds of compounds for which direct calibration is not possible, and show that this results in reasonable values of total measured carbon. We also examine the data set holistically, without interpreting mass spectra in terms of individual species. We identify the major groups of compounds and their chemical trajectories, and use these to identify overlaps and differences in the chemical space accessed by each instrument.

2.062 Outcomes of the Whiteface Mountain Cloud Chemistry Initiative: Model Intercomparison and Pilot Field Study.

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Abstract:

Clouds affect tropospheric composition by enhancing vertical transport of trace gases and aerosols, scavenging of soluble trace gases and hygroscopic aerosols, and supporting aqueous-phase oxidation reactions that contribute to increased aerosol mass. Many regional and global-scale models do not include detailed aqueous-phase chemical mechanisms due to the lack of complete understanding of the underlying aqueous-phase chemistry, but also due to the computational burden of adding more constituents. The cloud chemistry community has initiated an effort in connection with the Whiteface Mountain Observatory (WFM) in New York to evaluate the state of knowledge of current gas-aqueous chemistry 0-dimensional models.

The box model intercomparison utilizes meteorological and available gas-phase chemical composition data obtained during the 17-18 September 2016 cloud event at WFM to initialize the box models. It focuses on comparisons of oxidants, aldehydes, and organic acids. The participating models have different gas and aqueous phase mechanisms ranging from moderately complex appropriate for 3-d chemistry models to highly complex with thousands of reactions. Because of differences in the chemistry

represented and some Henry's Law coefficients, variability of up to an order of magnitude is seen among the different model predictions. While we can compare the model results to measured inorganic anions and water soluble organic carbon, we cannot evaluate the predicted oxidant concentrations.

The differences among the model results can guide the design of future field experiments. The Chemical Processing of Organics within Clouds (CPOC) pilot study, conducted in August 2017, provides an initial assessment for cloud chemistry research at WFM. During CPOC, upwind below-cloud aerosol composition was measured and compared to similar measurements at the summit, including cloud water composition. These observations are being analyzed in the context of airflow measured by wind LIDAR and radiosondes. A preliminary assessment of how well the CPOC sampling strategy worked will be discussed.

2.065 Urban particle phase state and its link with chemical composition, mixing state, and liquid water content.

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Abstract:

Particle phase state can be liquid, semi-solid and solid, and it has significantly influences on particle chemical and physical processes. In the present study, particle rebounding fraction, mixing state, chemical composition, and hygroscopicity were investigated in the urban atmosphere of China. The particle phase state and its link with particle chemical composition and aerosol liquid water content (ALWC) were studied. The particle phase state was sensitive to ambient relative humidity (RH). The particles changed from rebounding to adhering when RH increased above 60%, suggesting a transition from semi-solid to liquid state. This transition RH was below the deliquescence RH of both $(\text{NH}_4)_2\text{SO}_4$ and NH_4NO_3 . Sub-micrometer particles were in the liquid state during heavy haze episodes. This might be because the elevated RH and inorganic fraction in particles resulted in the enrichment of aerosol liquid water content. The transition to a liquid phase state, marking the beginning of the haze episode, might kick off a positive feedback loop. The liquid particles might readily uptake pollutants that then react to form inorganics, thereby further increasing water uptake. We propose that the liquid phase state facilitates the mass transfer and multiphase reactions of the particles, thereby accelerating secondary particle growth in haze over the North China Plain. We argue that the atmospheric particle phase state may be deeply influenced by the increasing global burden of nitrate aerosol in the century, and particles in liquid phase state may facilitate the formation of secondary inorganic salts and the VOCs transformed into SOA by aqueous reactions.

2.066 Probing the Role of Water in Criegee Chemistry Producing High Molecular Weight Compounds on Aqueous Organic Surfaces .

Early Career Scientist

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Abstract:

Ozonolysis of unsaturated organic emissions is a fundamental process in the formation and growth of tropospheric aerosols. $O_3(g)$ reacts with alkenes producing reactive carbonyl oxide Criegee (Cl) intermediates via chemically activated ozonides. The competition among Cls reaction pathways determines the nature of the products formed and, hence, their impact on aerosol processing. In the gas phase, the fate of gas-phase Cls is dominated by their reactions with $(H_2O)_2$ clusters. The role of H_2O on Cls chemistry on the surface of the aqueous organic aerosols typically found in the troposphere, however, is not known. In this work, we report the products of H_2O reactions with the Cls generated in the ozonolysis of oleic acid (OL) at the aerial interface of water/acetonitrile (W/AN) solvent mixtures.

We focused on the formation of high molecular weight (HMW) compounds. Surface specific online electrospray mass spectrometry, which probes in situ within 1 ms the composition of the interfacial layers where ozonolysis takes place, was used to search for the α -hydroxy alkyl hydroperoxides (HAHP) (detected as Cl^- adducts) that would result from H_2O addition to Cls in competition with channels leading to C_9 and HMW ($\geq C_{18}$) organic species.

Major products were: α -acyloxyalkyl hydroperoxides (AAHP) from Cls reactions with OL itself, and C_9 -carboxylic acids from Cls isomerizations. There was no evidence of significant HAHP formation, which was confirmed in experiments using D_2O and $H_2^{18}O$ instead of H_2O in W/AN mixtures. In W/AN mixtures richer in H_2O , the formation of AAHP decreases likely due to the more extensive dissociation of OL into its inert carboxylate, indicative of an indirect role of H_2O in this system. Summing up: our findings suggest that H_2O does not compete with the formation of HMW compounds in the ozonolysis of OL at air-aqueous organics interfaces.

2.067 Measurement of effective quantum yields for the photolysis of aqueous I⁻ and estimation of atmospheric I₂ emission rate.

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Abstract:

The chemistry of iodine plays an important role in the oxidizing capacity of the global marine atmosphere. However the sources of iodine are not well understood. Organoiodine compounds such as methyl iodide and inorganic compounds such as hypoiodous acid and molecular iodine (I₂) are considered to be the main source of atmospheric iodine in the marine atmosphere. These molecules undergo photochemical reaction and release I atoms. I₂ can be emitted from the reaction of gaseous ozone molecules (O₃(g)) with iodide ion in aqueous phase (I⁻_(aq)) on the sea surface. The photo-oxidation of I⁻_(aq) also have the potential to emit gaseous iodine molecules (I₂(g)) into the marine atmosphere. In this study, the values of the molar absorption coefficient and the photolysis quantum yields of I⁻_(aq) in the range of 290-500 nm were experimentally determined. Also, the influence of pH and dissolved oxygen on the photolysis quantum yields was investigated. Based on these obtained parameters, we estimated the rate of I₂(g) emission to the marine atmosphere. This result indicates that the photolysis of I⁻_(aq) could contribute to a significant part of the source of the marine atmospheric iodine compounds. This reaction has been implemented in a global chemistry-climate model, showing that it provides an additional oceanic source of inorganic iodine that can enhance the levels of reactive iodine in some oceanic regions. This study suggests that the formation of I₂(g) from the photolysis of I⁻_(aq) as well as the emissions of I₂(g) and gaseous hypoiodous acid (HOI(g)) from the reaction of O₃(g) and I⁻_(aq) on the sea surface must be considered to perform more exact model calculations for the impact of the atmospheric iodine compounds.

2.069 Laboratory Evaluation of the Particle Trap Laser Desorption Mass Spectrometer (PT-LDMS): Quantification of Ammonium Nitrate Aerosols.

Early Career Scientist

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Abstract:

Ammonium nitrate (AN) is one of the major inorganic compounds in ambient aerosols. The gas-particle equilibrium of AN aerosols shows strong temperature dependence near ambient conditions. Evaporation of AN particles during sampling and/or analysis could be an important issue for quantifying the mass concentrations of nitrate aerosols, especially for offline and semi-continuous methods. We have performed laboratory experiments to investigate possible effects of evaporation of AN particles in the particle trap laser desorption mass spectrometer (PT-LDMS). In the PT-LDMS, aerosol particles are collected on a particle trap in a vacuum chamber for 7 min and vaporized by a CO₂ laser for the detection by a quadrupole mass spectrometer (QMS). The sensitivity for AN aerosols, which is defined as the ratio of QMS ion signals at the mass-to-charge ratio (m/z) 30 to the mass of nitrate collected on the trap, was measured by altering the time interval between particle collection and laser vaporization. Effects of evaporation on the sensitivity and possible interaction with the surface of the particle trap are discussed.

2.072 Chemical characterization of submicron aerosols during the coal ban winter at Dezhou in the North China Plain.

Early Career Scientist

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Abstract:

A severe regional haze problem in the North China Plain has attracted much attention in recent years. In the winter of 2017, Beijing and surrounding areas banned the use of coal to switch to gas for heating to reduce pollution. An intensive campaign was conducted during that winter at Dezhou site (116.465°E, 37.146°N), 300 km south away from Beijing, to investigate the secondary formation and aging process of atmospheric aerosols in response to the coal ban. An aerosol chemical speciation monitor (ACSM) was used to measure chemical components of non-refractory submicron particulate matter (NR-PM₁) from 4 November to 4 December 2017. The results show that NR-PM₁ was mainly composed of organics (38%), nitrate (27%) and sulfate (18%). Compared to previous winters, NR-PM₁ was at a quite low level (42 mg m⁻³) and nitrate was more predominant in secondary inorganics, indicating that the coal ban was effective to alleviate air pollution to a certain extent, in addition to favorable meteorological conditions. Three primary organic aerosol (POA) factors from biomass burning (BBOA), coal combustion (CCOA) and traffic (HOA) emissions and one secondary OA (oxygenated OA) factor were resolved by positive matrix factorization of organic mass spectra. POA dominated OA (65% on average), with BBOA being the largest contributor (30%). The ratio of OOA to O_x (O₃+NO₂) largely increased under high humidity, implying that aqueous-phase process can enhance SOA production and oxidation states of OA in winter. In total, secondary inorganic and organic formation contributed the majority (~70%) of NR-PM₁, indicating that reducing regional emissions of secondary aerosol precursors is still needed.

2.075 Photocatalytic degradation of single, levitated organic aerosol particles containing iron nanoparticles or Arizona test dust..

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Abstract:

Iron (Fe(III)) carboxylate complexes in an organic aerosol particle absorb visible light below about 500 nm, with an inner complex electron transfer leading to the reduction of Fe(III) to Fe(II) and an escape of an organic radical from the complex followed by a fast decarboxylation reaction. When oxygen is present, ensuing radical chemistry will likely lead to further decarboxylation as well as peroxides and oxygenated volatile organic compounds production. The radicals (e.g., OH•, HO₂•, RO₂) in turn allow re-oxidation of Fe(II) to Fe(III), closing a photocatalytic cycle, in which the iron carboxylate complex acts as a photocatalyst.

Atmospheric aerosol particles may contain both, carboxylic acids and iron oxides, the latter being a component of mineral dust. Iron carboxylate complexes formed in these particles will promote photochemical degradation of the carboxylate ligands with an accompanying repartitioning of condensed phase mass to the gas phase.

We track mass and size changes of a single surrogate organic aerosol droplet levitated in an electrodynamic balance during photochemical processing under visible (473 nm) light irradiation. The surrogate droplets (radius ca. 5 - 10 μm) contain either Fe₂O₃ nanoparticles (< 50 nm) or Arizona Test Dust (ATD) particles (< 3 μm) in aqueous citric acid. As reference, we studied different concentrations of iron-citrate dissolved in aqueous citric acid droplets.

We observe substantial mass loss up to 80 % of the initial mass over 24 hours of irradiation for the reference droplets containing dissolved iron citrate, a similar loss for the droplets containing Fe_2O_3 nanoparticles and a smaller loss for the droplets containing ATD. Comparing the time needed for a 10% mass loss we conclude that Fe_2O_3 particles in the droplet lead to the same photocatalytic degradation as dissolved iron citrate whereas only 10% of the nominal iron in ATD becomes photochemically active.

2.076 Vertical characterization of highly oxygenated molecules (HOM) below and above a boreal forest canopy.

Early Career Scientist

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Abstract:

Highly oxygenated molecules (HOMs) play crucial roles in new particle formation (NPF) and secondary organic aerosol (SOA) formation, and hence strongly influence global radiation and climate. Besides the efforts that have been made in understanding HOM formation mechanism, more and more attention has been drawn to the interaction between HOM chemistry and changing atmospheric conditions.

During the Influence of Biosphere-Atmosphere Interactions on the Reactive Nitrogen budget (IBAIRN) campaign, vertical profile measurements of HOMs below and above the forest canopy were performed using two nitrate ion based Chemical Ionization Atmospheric Pressure interface Time-Of-Flight (CI-API-TOF) mass spectrometers, for the first time in the boreal forest SMEAR II station during September 2016. The HOM concentrations and composition distributions below and above the canopy were similar in the well-mixed boundary layer during daytime. However, during night, even though precursor monoterpene concentrations are elevated, much lower HOM concentrations were observed at ground level, as a result of the formation of a shallow decoupled layer below canopy. The results suggested that near ground HOMs were affected by the changes in the precursors and oxidants, and enhancement of the loss/deposition on surfaces in this layer, while the HOMs above the canopy top were not significantly affected.

One of the main novelties of our study is the detailed measurements of HOM below and above the canopy across a wide range of atmospheric stability conditions. The results highlight the significance of near-ground boundary layer dynamics and micrometeorological processes to the ambient HOMs, and the ground-based HOM measurement are not always representative for the entire boundary layer. This needs to be considered when interpreting measurements that are expected to be influenced by HOM, such as growth rates of new particles.

2.077 Direct evaluation of photochemical ozone production regime.

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Abstract:

In order to develop correct ozone control strategies, it is necessary to diagnose ozone production regime (i.e. NO_x -limited or VOC-limited) accurately. We developed direct evaluation system of the ozone production regime by applying a direct measurement system of oxidant ($\text{Ox} = \text{O}_3 + \text{NO}_2$) production rate ($P-L(\text{Ox})$) recently developed. The $P-L(\text{Ox})$ measurement system has “reaction” and “reference” chambers. The reaction and reference chambers are made of quartz and Pyrex, respectively. An outer wall of the reference chamber is coated with a UV-protection film. Both the chambers were exposed directly to artificial sunlight. Ambient air is introduced into both the chambers. Photochemical reactions proceed to generate Ox in the reaction chamber while Ox is not generated in the reference chamber. The difference of Ox concentrations (DOx) in air from the two chambers is the Ox produced photochemically in the reaction chamber. The $P-L(\text{Ox})$ is obtained by dividing DOx by a mean residence time of air in the reaction chamber. Ox concentrations were obtained as follows. O_3 in Ox is converted into NO_2 by the reaction of O_3 with large excess of NO, and then the NO_2 concentration is measured by a cavity attenuated phase shift spectroscopy technique. In addition, an automatic additional system of NO or propane was set before the reaction and reference chambers and NO or propane was added to ambient air perturbationally at regular intervals. The ozone production regime was diagnosed by investigating increase and decrease of $P-L(\text{Ox})$ from the addition of NO or propane. We performed an intensive observation of $P-L(\text{Ox})$, OH reactivity, and various trace species at National Institute for Environmental Studies in Tsukuba, Japan, in August 2017. The observation results are discussed in this presentation.

2.078 Molecular Insights into NO-Promoted Sulfate Formation on Model TiO₂ Mineral Dust with Different Exposed Facets.

Early Career Scientist

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Abstract:

Industry exhaust (such as that from coal-fired plants)-initiated, sulfate aerosol formation on man-made mineral dust has not received a great deal of attention despite having a possible impact on the local environment. Titanium dioxide (TiO₂) nanoparticle is one of the most widely used materials in the purification of industrial exhaust. Nowadays, there is a lot of efforts, such as through morphology control, have been made to improve the performance of TiO₂ in the application, thus leading to unanticipated release of nano TiO₂ inside the operational areas or outside the nearby atmosphere.

In this study, we choose the most available engineered TiO₂ nanomaterials with preferentially exposed (001), (010) and (101) facet as model oxides, to explore the possible reaction process and mechanism when they encounter NO and SO₂ under typical working conditions. DRIFTS spectra coupled with DFT calculations were used to investigate the dynamic adsorption behaviors of NO or/and SO₂ on the three facets while ion chromatography was adopted to quantify the surface products. Within the operational window of 100-400°C inside the coal-fired plants, an obvious promotion effect of NO on the formation of sulfate species was found on all the faceted samples. Active oxygen species present in those low-coordinated surfaces play a determinant role in the promotion process, which enabled the oxidation of NO into NO₂. Then the adsorbed nitrate species resulting from the disproportionation of NO₂ dimer (N₂O₄) or gaseous NO₂ oxidize adsorbed sulfite into sulfate species. The T101, as the most stable facet existing in nano anatase TiO₂ dust with over 90% fraction, obtained the highest normalized amount of sulfate in the presence of NO. The occurrence of NO-promoted formation of sulfate under simulated atmospheric conditions (30°C, 5 ppmv SO₂ and 10 ppmv NO) indicate that this promotion effect can be ubiquitous on well-engineered anthropogenic dusts.

2.080 The infrared signature of secondary organic aerosol from OH and O₃ channel oxidation of isoprene and α-pinene.

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Abstract:

The IR spectroscopy has great advantages in studying different functional groups in aerosols. It can provide a whole image of functional groups and bond information for secondary organic aerosol (SOA) without further treatment. In this study, the absorption ratio of O-H to C=O ($O-H/C=O$) was used to examine the difference between the O₃ and OH oxidation channels in the photochemical oxidation of isoprene and α-pinene. Our experiments show similar characteristics of IR spectra of SOA from both isoprene and α-pinene. The IR spectra of SOA from the OH channel are characterized by strong absorptions of hydrogen bonded O-H and weak absorptions of C=O (large ratio of $O-H/C=O$), while the absorptions of C=O are more abundant than O-H in the O₃ channel. The peak height ratio of $O-H/C=O$ is 0.36 (0.24) in the SOA from the isoprene-O₃ (α-pinene-O₃) system, while it is as high as 1.63 (2.19) in the SOA from the isoprene-OH (α-pinene-OH) system. This demonstrates that the major organic products from the O₃ channels are aldehydes, ketones and organic acid. In contrast to the O₃ channel, alcohols or polyalcohols are more abundant from the OH channel. Thus, the ratio of $O-H/C=O$ can be used to characterize SOA formation channels. In isoprene-NO₂ irradiations, the ratios of $O-H/C=O$ are 0.35, which are almost the same as the corresponding values in isoprene-O₃ but totally different from the values in isoprene-H₂O₂. It strongly supports that the O₃ channel plays a key role in the formation of SOA from isoprene-NO₂ irradiations.

2.081 Exploring the variations in atmospheric primary and secondary pollutants response to the stringent control measures during the 2016 G20 summit in Hangzhou.

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Abstract:

In September 2016, China hosted the Group of Twenty (G20) summit in Hangzhou, which is an international forum for the governments and central governors aiming at international coordination of economic policy. As the hosted city, Hangzhou, the second largest city located along the mid-Yangtze River Delta (YRD) in the eastern part of China, set rigorous control measures to reduce emissions of local air pollutants and adjacent regions from 24 August to 7 September. The target sources incorporated vehicles, paint and solvent use, steel factories, chemical factories, power plants. In order to evaluate the effectiveness of control measures, we conducted simultaneous measurements of atmospheric gaseous pollutants such as VOCs, PAN, O₃, and primary pollutants (CO, SO₂, and NO_x) and particulate matter (PM_{2.5} and PM₁₀) from 20 August to 15 September 2016. Our results show that significant reductions were found in most VOCs (e.g., alkanes, alkenes, and aromatics compounds), primary pollutants (CO, NO_x, and SO₂), and secondary photooxidants (PAN and O₃) during G20 compared to before G20, followed by apparent enhancements for all species after G20. Furthermore, a box model with MCMv3.3.1 was employed to elucidate the variations in the chemical processes of PAN and O₃ before, during, and after G20. The predominant primary precursors of PAN were acetaldehyde, MGLY, and followed by radical propagation for four episodes, and its secondary precursors were alkanes for the four episodes, aromatics before and during Phase I G20, and alkenes during Phase II and after G20, respectively. For O₃, its major precursors were aromatics, alkenes, and alkanes, respectively. In addition, we estimated the atmospheric oxidizing capacity by calculating their loss rates of CO and VOCs via reactions with OH, O₃, and NO₃ for these episodes and found that their corresponding average maximum AOC levels were up to 5.22×10^7 , 4.25×10^7 , 2.73×10^7 , and 4.71×10^7 molecules cm⁻³ s⁻¹.

2.084 Assessment of Photo-stationary state of ozone over Delhi .

Early Career Scientist

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Abstract:

The ozone (O_3) production in troposphere takes place via photo-oxidation of nitrogen dioxide (NO_2) and destruction via titration with nitrogen oxide (NO). When these two processes achieve equilibrium photo-stationary state (i.e. $\phi = 1$), it indicates that no additional processes are involved in ozone production. In moderately polluted or in the clean environment, the per-oxy (PO_2) radical can influence the photo-stationary state (PSS). Limited efforts have been made so far to assess the PSS over Delhi which is facing serious air quality issues.

This study presents the assessment of the photo-stationary state of ozone in Delhi's atmosphere based on the in-situ measurements of the surface ozone, oxides of nitrogen (NO_x) and non-methane hydrocarbons (NMHCs) carried out at Delhi. The highest values of ozone concentrations were observed during the period from 11:00 to 14:00 hours while the lowest O_3 concentrations were observed during night-time and early morning periods. The hourly averaged ozone values were found to vary from 4 to 170 ppb during the daytime. Whereas, the highest values of NO_x concentrations were observed during the morning and evening periods coinciding with the heavy traffic hours.

The ϕ values, calculated using the measured values of O_3 , NO, NO_2 and calculated values of NO_2 photolysis rate (JNO_2), were found to vary from 0.05-5.9 with the predominance of values ranging between 0.5 to 2.5. The PO_2 values, found to vary from 0.001 to 2.5ppb, were used to calculate the extended- ϕ (i.e. ϕ_1). The values of ϕ_1 have been found to vary from 0.02 to 0.9 with an average value of 0.3 ± 0.1 . The ozone production rate ($ppb \text{ min}^{-1}$) was calculated using the classical equations. The steady state time constant was also calculated for the ozone photo-stationary state which showed that the steady state was established over the study site for the duration of ~10-50 seconds.

2.086 Long-term observations of OH reactivity at the central European GAW station Hohenpeissenberg .

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Abstract:

The inverse of OH lifetime, i.e. the total OH loss rate also termed OH reactivity (s^{-1}), is being measured continuously on a long-term basis at the Meteorological Observatory Hohenpeissenberg which is a global station in the WMO Global Atmosphere Watch (GAW) programme. This site is situated on a hill surrounded by meadows and forests in a rural part of central Europe where OH reactivity typically is below $15 s^{-1}$.

Here we present long-term direct OH reactivity measurements made by a chemical ionisation mass spectrometer (CIMS). A novel method for OH reactivity measurements for CIMS was devised in 2009 and the instrument, already operationally running for OH and sulfuric acid concentration measurements, was adapted to include OH reactivity as part of the continuous measurement cycle.

The direct OH reactivity measurements are compared with OH reactivity calculated from concurrently measured trace gases. These reactive trace gases include inorganic species such as CO, NO, NO₂, SO₂ and about 80 organic species, including species with dominant single contributions to OH reactivity such e.g. methane, ethene, isoprene and acetaldehyde. OH reactivity changes, missing reactivity and their key drivers (such as dynamics, proximity to OH reactant sources etc.) are investigated over a range of timescales from diurnal, seasonal to annual. OH reactivity observations are also interpreted as part of a chemical climatology to demonstrate the potential use of these long-term measurements.

2.088 **¹⁷O-excess of atmospheric nitrous acid in urban area: quantification of its sources.**

Early Career Scientist

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Abstract:

Nitrous acid (HONO) is an important trace gas in the atmosphere because it plays an important role in tropospheric cycling of hydrogen oxides and nitrogen oxides due to the photolysis reaction. The sources of atmospheric HONO, however, are not well understood, especially during the daytime and need to elucidate the existing “unknown” sources, as well as estimating formations rates of the “known” sources precisely. The HONO sources can be divided into two categories: direct emission and secondary formation. The former includes vehicle or industrial exhausts, biomass burning and soil microbial activities, while the latter indicates photochemical/chemical reactions of atmospheric NO, NO₂ or nitrate (NO₃⁻). In order to estimate the relative importance of direct emission and secondary formation, we used ¹⁷O-excess of atmospheric HONO as tracer; Δ¹⁷O values of HONO produced via secondary processes should have positive values owing to part/all of oxygen atoms originate from ozone, while Δ¹⁷O value in directly emitted HONO should be zero because its oxygen atoms derive from H₂O or O₂.

In this study, automated systems for time-interval air sampling equipped with 6 four-stage-filter-packs were used to collect atmospheric samples every 4 hours, and verify diurnal variations in Δ¹⁷O value of atmospheric HONO. The Δ¹⁷O value of HONO was determined by combining sensitive determination method on isotopic compositions of NO₂⁻ with filter-pack method in which HONO was collected as NO₂⁻ on alkaline (K₂CO₃) impregnated filters.

Periodical sampling of atmospheric HONO was carried out at two sites; Nagoya and Sapporo, Japan. The daily mean Δ¹⁷O values of HONO ranged from +15‰ to +17‰

through the observation periods. The $\Delta^{17}\text{O}$ values of HONO showed large diurnal variation; maximum value was observed around noon, while minimum value was found at night. The increasing $\Delta^{17}\text{O}$ values observed after sunrise result from sunlight induced rapid production of HONO via secondary formation.

2.089 Formation and chemical processing of spherical organic aerosol particles, or “tar balls,” from biomass burning in the northwestern US.

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Abstract:

Biomass burning is a major source of atmospheric aerosol particles and gases and has important implications on regional and global climate. Smoke from wild fires contain extremely high concentrations of aerosol particles and the particle chemistry, viscosity, and volatility rapidly change within the few hours following their emission. Understanding these rapid processing is critical to accurately evaluating the influences of aerosol particles from biomass burning on the climate.

We measured aerosol particles, collected during the 2013 Biomass Burning Observation Project (BBOP) using an aircraft, from forest wild fires in North America [1-2]. Here we focus on individual particle properties using a transmission electron microscope (TEM) in samples with ages ranging < 1 hour to several hours from emission.

Most aerosol particles consist of organic matter with inorganic inclusions such as potassium salts and ns-soot. When fresh (<1 hour aging), these particles are characterized by low viscosity and spread over the substrate. Upon aging, they increased their viscosity on the substrate and became spherical particles called tar balls (TBs). We estimated the TB mass fractions in the smoke using a TEM and a single particle soot photometer (SP2) and showed that the TBs have weak light absorbance, with refractive index $m=1.56-0.02i$. We also measured volume changes upon heating and found TBs display low volatility upon heating. The chemical compositions of individual TBs, measured using an energy dispersive X-ray spectrometer (EDS) with a TEM, showed that TBs include nitrogen and potassium within the carbonaceous body. These findings will improve the evaluations of their inventory and climate influences.

1: Adachi, K., Sedlacek, A.J., Kleinman, L., Chand, D., Hubbe, J.M., Buseck, P.R. *Aerosol Sci. Technol.*, 52, 46-56, 2018.

2: Sedlacek, A.J., Buseck, P.R., Adachi, K., Onasch, T.B., Springston, S.R., Kleinman, L., *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2018-41>, 2018.

2.090 OH reactivity of primary tree emissions and their oxidation products using the atmosphere simulation chamber SAPHIR-PLUS.

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Abstract:

Biogenic volatile organic compounds (BVOC) contribute to about 90% of the globally emitted VOC. Intensive efforts in studying and understanding the impact of BVOC on atmospheric chemistry were undertaken in the recent years. However many uncertainties remain, e.g. field studies have shown that in forested areas, measured OH reactivity often cannot be explained by measured BVOC and their oxidation products (e.g. Noelscher et al. 2012). This discrepancy may be explained by either a lack of understanding of BVOC sources or insufficient understanding of BVOC oxidation mechanisms. Plants emit a complex VOC mixture containing likely many compounds which have not yet been measured or identified (Goldstein et al. 2007). The new extension PLUS (Plant chamber Unit for Simulation, Hohaus et al. 2016) coupled to the atmosphere simulation chamber SAPHIR provides the possibility to measure OH reactivity (LD-LIF) from complex plant emissions and to compare it with the OH reactivity calculated from the BVOC composition measured by GC-MS and PTR-ToF-MS. This comparison was

performed for both, primary emissions of trees typical of a Boreal forest environment (Norway spruce, Scots pine, Silverbirch) without any influence of oxidizing agents and using different oxidation schemes. The OH reactivity comparison was done for constitutive and stressed induced emissions for each tree species. For the trees investigated here, the overall discrepancies between measured and calculated total OH reactivity are low in the absence of an oxidizing agent while the discrepancies increase with increasing degree of oxidation. On average, signal detected with the PTR-ToF-MS but not assigned to specific BVOCs could account for the gap in OH reactivity when assuming OH reaction rates close to $1 \times 10^{-11} \text{ cm}^3 \text{ molecule}^{-1} \text{ s}^{-1}$.

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Hohaus, T., et al. (2016), *Atmos.Meas.Tech.*, 9(3): 1247-1259.

2.091 Caught in the act: interfacial acid base chemistry.

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Abstract:

Research over the past decades has provided an impressive observational basis of large scale effects that heterogeneous chemistry on ice has on Earth's atmosphere, such as substantial modification of the composition and of the chemical reactivity of the lowermost atmosphere in Polar regions. Here, we present fundamental details on the chemical mechanisms operating at the interfacial region of environmental snow and ice derived from laboratory based experiments.

The research is taking full advantage of X-ray excited electron spectroscopy to directly probe the chemical speciation of adsorbates and the hydrogen-bond structure at the air-ice interface in the temperature range of 230 - 255 K and at low surface coverage. The results confirm that surfaces are chemically unique from the underlying bulk and we interpret the data as

- a Janus-type character of physisorbed acids: Undissociated at the outermost ice surface and dissociation occurring upon solvation deeper in the interfacial region. This indicates that the classical concept of acid-base equilibria might not hold at interfaces.
- a non-uniform hydrogen bonding network along the depth of the interfacial region.

Even with a focus of this presentation on adsorption of acidic trace gases (HCl, HNO₃, formic acid, acetic acid) at the air-ice interface, the details on interfacial chemistry might be of high relevance to atmospheric and environmental science in general as it tackles two essential concepts in chemistry: acidity and hydrogen-bonds.

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2.092 Impact of C1-C5 alkyl nitrate chemistry on tropospheric ozone: box and global model perspectives.

Early Career Scientist

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Abstract:

Alkyl nitrates (RONO_2) are organic trace gases that are emitted from oceanic and biomass burning sources and produced photochemically from the oxidation of hydrocarbons (RH) in the presence of nitrogen oxides (NO_x). Their formation terminates the catalytic tropospheric ozone production by temporarily storing the active form of nitrogen. Due to a relatively long lifetime of a few days to a few months they can be destroyed far away from their sources by photolysis or OH radical oxidation, releasing NO_2 back to the local atmosphere. Given the right circumstances, this might change ozone concentrations on regional levels and alter the oxidative capacity of the atmosphere. The RONO_2 chemistry is currently under-represented in global chemistry-climate models. If present, they appear in a lumped form or only short-chained nitrates are considered explicitly. Here we extend the tropospheric chemical mechanism (CheT) of the UK Chemistry and Aerosols (UKCA) model to include the chemistry of C_2 - C_5 RONO_2 and C_4 - C_5 alkanes. The new mechanism is tested in a box model in a range of NO_x and RH conditions using the Master Chemical Mechanism (MCM) as a benchmark. Two types of box modelling experiments show that the inclusion of RONO_2 chemistry slows down the conversion of NO to NO_2 and leads to lower O_3 concentrations in all NO_x -RH conditions considered (lower by 2% at steady state). However, the reactions responsible for the change are slightly different in low and high NO_x environments. We implement the new mechanism into the UKCA model, validate the model with ground-based, ship and aircraft observations of RONO_2 and their parent alkanes and evaluate the impact of C_1 - C_5 RONO_2 chemistry on O_3 , HO_x and NO_x burdens and distribution.

2.093 Halogens role during the production of sulfate in tropospheric volcanic plumes.

Early Career Scientist

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Abstract:

Volcanic emissions are among the major natural sources of sulfur and reactive halogens in the atmosphere (i.e. chlorine and bromine). However, volcanic plumes are radically different environment compared to background atmosphere. Notably, reactive halogens can modify the budget of atmospheric oxidants via ozone depletion events (ODEs), thus they can affect dynamics of atmospheric oxidation. Moreover, there are still significant uncertainties pertaining to atmospheric oxidation of volcanic SO₂, while growing evidence suggests that halogens can influence the atmospheric sulfate budget. Mass independent fractionations (MIF) can be used as quantitative markers to detect atmospheric pathways of reaction. The majority of the oxygen isotopic anomalies observed in sulfates originate from ozone and it is transferred during tropospheric oxidation of SO₂. An oxygen isotopic chemistry scheme for sulfate is implemented into a photochemical box-model (CiTTyCAT) that contains a detailed description of tropospheric chemistry. The chemical scheme has been extended with heterogeneous chemistry of S(IV), S(VI) and halogen species, in both sulphate aerosols and cloud water droplets. The oxygen isotopes MIF scheme has been implemented to simulate the evolution of O-MIF of tropospheric sulfate. The model is used to determine pathways of sulfate formation during the oxidation of volcanic SO₂, during both erupting activity and passive degassing. Comparisons within isotopic compositions of sulfate from volcanic deposits and modeled O-MIF confirm that SO₂ is oxidized by O₂/TMI in the aqueous phase of condensing volcanic clouds. Finally, sulfate O-MIF suggests that during passive degassing volcanic SO₂ is oxidised by OH in the gas phase, and by H₂O₂ in the liquid phase of sulfate aerosols.

2.094 The roles of volatile organic compound deposition and oxidation mechanisms in determining secondary organic aerosol production, a global perspective.

Early Career Scientist

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Abstract:

Secondary organic aerosol (SOA) is important from both air quality and climate perspectives, yet the processes governing SOA production remain uncertain. Across modelling studies, treatment of SOA precursor deposition and oxidation mechanisms both vary substantially. In this study, we quantify the role of VOC deposition and oxidation mechanisms on the global SOA budget using a global composition-climate model. Including dry deposition of VOCs reduces global SOA production by 2–24 Tg (SOA) a⁻¹ (2–32%), with the range reflecting uncertainties in surface resistances. Including wet deposition of VOCs reduces global SOA production by 12 Tg (SOA) a⁻¹ (15%) and is relatively insensitive to changes in effective Henry's Law coefficient. The influence of oxidation mechanisms on SOA was explored by focussing on the anthropogenic and biomass burning VOC precursors of SOA (VOC_{ANT/BB}), which were varied in a) parent VOC reactivity, b) number of reaction intermediates, and c) accounting for differences in volatility between oxidation products from various pathways. The reactivity of VOC_{ANT/BB} was varied across a series of compounds, including aromatic hydrocarbons and monoterpene. The number of reaction intermediates for VOC_{ANT/BB} oxidation was increased by introducing the peroxy radical (RO₂). The difference in volatility between the products of competitive RO₂ reactions was accounted for by assigning different reaction yields to these pathways. We find that assuming the reactivity of monoterpene, undergoing a single step oxidation, and applying a single SOA yield, global SOA production from VOC_{ANT/BB} is 18 Tg (SOA) a⁻¹. Assuming the reactivity of aromatic hydrocarbons, global VOC_{ANT/BB} oxidation reduces by 3–66% compared to when using monoterpene. Introducing RO₂ alone does not affect SOA production. However, by accounting for the difference in volatility between RO₂ oxidation products, global SOA production increases by a factor of 2.5, to 45 Tg (SOA) a⁻¹.

2.095 Mechanistic Study of the Reactions of NO₃ Radicals with C₃-C₆ Alkenes.

Early Career Scientist

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Abstract:

The reactions of the nitrate radical, NO₃, with unsaturated volatile organic compounds (VOCs) are important tropospheric nighttime oxidative processes. The reactions act as sinks for VOCs and contribute to the partitioning and removal of NO_x from the atmosphere. In the case of larger alkenes (especially biogenic compounds, e.g. isoprene and terpenes), the reactions can lead to the formation of secondary organic aerosols (SOA). The reactions are initiated by NO₃ radical addition to the C=C double bonds that after addition of O₂ form nitrooxy substituted peroxy radicals. These peroxy radicals lead to substituted alkoxy radicals that will either decompose or isomerise in the atmosphere depending on the structure of the parent alkene (in some cases reaction with O₂ is also significant). Depending on the degree of alkyl substitution of the parent alkene the products formed may retain the nitrate group or release NO₂.

The reactions of several C₃-C₆ linear and branched alkenes with NO₃ radicals were studied using an environmental chamber coupled to an FTIR spectrometer at NCAR, investigating the end-products formed in the reactions. The focus of this study has been on developing predictive capability for the peroxy and in particular the alkoxy radicals formed in the alkene oxidation processes. Specifically, the structure-activity relationships of the alkoxy radicals formed in the NO₃ reactions with an array of alkene species will be useful in predicting product distributions for the NO₃ radical reacting with larger alkenes, such as terpenes. The products formed in the reaction of NO₃ radicals with trans-2-butene were quantified, and the fate of the nitrooxy alkoxy radical CH₃CH(O•)CH(ONO₂)CH₃ was determined. Our results are compared with previous findings for the species studied, when available, and are also compared with current structure-activity relationships and chemical mechanisms.

2.097 Radiative properties of aerosols over central Indo-Gangetic Plain during variable monsoon scenarios.

Early Career Scientist

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Abstract:

Observations on atmospheric aerosols were made to evaluate their radiative properties during typical monsoon season (June-September) from 2009 to 2011, and to recognize their impacts on aerosol radiative forcing. The entire Indian sub-continent experienced a drought year in 2009 before achieving a normal monsoon in 2010 and 2011. The ground station in Varanasi over central IGP experienced minimum monsoonal rain during 2009 drought year, which gradually increased during 2010 before achieving a normal monsoon in year 2011. The BC mass loading during drought year was relatively high compared to 2010 and 2011. The increase in BC aerosols especially during drought year was associated to lower wind speed and reduced rate of wet removal, which potentially enhanced BC loading in comparison to years with normal monsoon. Columnar aerosol loading in terms of aerosol optical depth (AOD) was retrieved from space-borne MODIS sensor on-board Terra satellite. It has revealed high AOD over Varanasi during drought (2009: 1.03 ± 0.15) and deficit monsoon (2010: 1.07 ± 0.53) before being reduced during 2011 (0.89 ± 0.20). Conclusively, a radiative transfer model was run to estimate the ARF for composite aerosols for both surface (SUF), atmosphere (ATM) and top of the atmosphere (TOA). The 2009 drought year was found to have reasonably higher ATM and SUF forcing (ATM: 105; SUF: -122 W m^{-2}) in comparison to deficit (ATM: 61; SUF: -88 W m^{-2}) and normal (ATM: 67; SUF: -89 W m^{-2}) monsoon scenarios. The lower atmosphere heating rates during 2009 monsoon was also recorded to be as high as 2.9 K day^{-1} in comparison to 2010 (1.7 K day^{-1}) and 2011 (1.9 K day^{-1}). Such findings provide meaningful outcomes in terms of climatic effects of BC aerosols and their associated inference on Indian summer monsoon.

2.101 Ionization Efficiency of Evolved Gas from Aerosol Particles in a Thermal Desorption Aerosol Mass Spectrometer.

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Abstract:

Abstract.

Thermal desorption aerosol mass spectrometers (TDMSs), including the Aerodyne aerosol mass spectrometer (AMS), have been widely used for quantitative analysis of aerosol chemical composition. The ionization efficiency of evolved gas from aerosol particles is a key parameter for the quantification. However, physical and chemical mechanisms affecting the ionization efficiency are not fully understood. We have performed laboratory experiments to investigate the ionization efficiency of selected compounds using the particle trap laser desorption mass spectrometer (PT-LDMS). Ammonium chloride (NH_4Cl) and ammonium iodide (NH_4I) are used as test compounds because the thermal decomposition products of these compounds are expected to be simple (dominated by ammonia (NH_3) and hydrogen halide (HX)). The ionization efficiency of NH_3 relative to HX (relative ionization efficiency) was measured by altering the geometric relationship between the ionizer and vaporization point. The relative ionization efficiency tended to increase with increasing the divergence angle of evolved gas plumes. This result suggest that spatial broadening of gas molecules could be an important factor affecting the ionization efficiency.

2.105 Composition, Source Apportionment and Health Risk Assessment of PM_{2.5} in Kuala Lumpur City Centre in 2015-2016.

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Abstract:

This study aims to determine the composition and health risk assessment of PM_{2.5} collected during seasonal cycles including haze episode in the Kuala Lumpur city centre. The samples were collected on quartz microfiber filter using a high volume air sampler (HVS) with the flow rate of 1.13 m³ min⁻¹ on a 24 h basis. The sampling campaign was conducted for a year, starting from June 2015 to May 2016. The composition of PM_{2.5} determined were water soluble ionic ions (WSII), trace metals, biomass tracers, black carbon and polycyclic aromatic hydrocarbons (PAHs). The possible sources of PM_{2.5} were apportioned using Positive Matrix Factorisation (PMF). The health risk was assessed according to United States Environmental Protection Agency (USEPA) methodology. The results showed that the annual PM_{2.5} concentrations was 30±26 µg m⁻³. About 38%,

19% and 7% of the daily samples exceeded the World Health Organization Guideline, USEPA Air Quality Standards and Malaysia Ambient Air Quality Standard (Interim I-2015), respectively. During haze episode, the $PM_{2.5}$ concentration measured was $72.3 \pm 37.8 \mu\text{g m}^{-3}$. From the inorganic compositions of $PM_{2.5}$, five factors were identified where the main source comes from mixed secondary inorganic aerosols (SIA) and biomass burning (37.9%). The source apportionment of the organic $PM_{2.5}$ revealed that the main source was released from gasoline emission (29.1%). The excess lifetime cancer risk (ELCR) and hazard index (HI) for trace metals inhalation exposure was the highest among the adult group ($4.56 \text{ E-}05$) and infant group ($\text{HI} = 2.128$), respectively. The incremental lifetime carcinogenic risk (ILCR) for PAHs inhalation exposure was the highest among the adult group ($1.42 \text{ E-}07$). Overall, this study revealed that more attention should be given to sensitive groups as they develop higher health risk than others.

2.106 Studies on liquid-liquid phase separation in organic particles produced from the ozonolysis of α -pinene and β -caryophyllene products.

Early Career Scientist

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Abstract:

Recently, some studies showed that liquid-liquid phase separation (LLPS) occurs in secondary organic aerosols (SOA) without inorganic salts at high relative humidity of ~95% (Renbaum-Wolff et al., 2016; Rastak et al., 2016; Song et al., 2017). More recently, Song et al. (2018) suggests using organic particles containing one and two organic species that the average O:C of the organic particles is important for occurrence of LLPS. In order to get additional insight into LLPS in organic aerosol particles, we investigated LLPS in particles containing pinonic acid, pinic acid, β -caryophyllonic acid, β -nocaryophyllonic acid, β -nocaryophyllene aldehyde, β -caryophyllinic acid and β -nocaryophyllinic acid which are ozonolysis products from α -pinene and β -caryophyllene. Moreover, we conducted LLPS in particles containing these products mixed with highly oxidized organic compounds such as polyethylene glycol 400, diethyl L-tartrate and pyruvic acid. The results and implications will be presented.

2.107 Heterogeneous uptake of N₂O₅ in urban and sand dust plumes observed in spring in Beijing, China: implications for parameterizations and particulate nitrate formation.

Early Career Scientist

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Abstract:

Dinitrogen pentoxide (N₂O₅) and its heterogeneous product on aerosol, nitryl chloride (ClNO₂), contribute to nocturnal nitrate formation and impact daytime oxidative capacity. However, ambient observations of N₂O₅ and ClNO₂ are still limited, which precludes full understanding of reactive nitrogen chemistry in various conditions. Here we present observations of N₂O₅ and ClNO₂ at a ground site in Beijing in 2017, focusing on the intercepted urban and sand dust plumes with abundant N₂O₅ and/or ClNO₂. High levels of N₂O₅ (up to 2.2 ppbv) were observed on May 1st night due to insignificant heterogeneous loss. In comparison, ClNO₂ mixing ratios of up to 3.3 ppbv were frequently observed in late May in humid and chemically processed urban plumes. Significant levels of ClNO₂ (up to 0.7 ppbv) characterized with very fast heterogeneous loss of N₂O₅ ($k(\text{N}_2\text{O}_5)$ up to 0.02s^{-1}) were observed in a sand storm event. N₂O₅ uptake coefficient (γ) is calculated for various air masses and found more variable than that suggested by parameterizations. The observed γ is mostly linked to the ratio of aerosol volume to surface area density (V_a/S_a) but less dependent on [H₂O] or water-soluble ions. Utilizing the derived uptake coefficient ($\gamma=0.027\pm 0.010$) along with related data, nocturnal nitrate production rates are calculated and found correlated to observed nitrate increasing rates. In the ClNO₂-rich urban plumes, heterogeneous uptake of N₂O₅ results in comparable or

higher nitrate formation potential than daytime OH+NO₂ reaction. Higher NO₃ production coupled with larger proportion of N₂O₅ lost in heterogeneous uptake is responsible for more significant nocturnal nitrate production. Overall, our results indicate notable nighttime chemistry of N₂O₅ in spring time of urban Beijing and its significant contribution to particulate nitrate formation.

2.108 Kinetic study of OH radical uptake onto deliquesced NaCl particles with a combination technique of a laser flash photolysis and a laser induced fluorescence detection.

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Abstract:

OH radical uptake onto sea salt particles is expected to be one of choline emission sources in the coastal region and marine boundary layer (MBL). However, its uptake coefficient has never been directly confirmed due to experimental limitation thus its contribution is still not unclear.

We developed a novel technique for kinetic measurement of OH uptake with a combination technique of laser-flash photolysis and laser-induced fluorescence detection (LP-LIF), which enabled us to measure the uptake coefficient directly. In the system, sample air containing aerosols, water vapor and ozone were introduced to a reaction cell, followed by pulsed laser irradiation to produce OH through the photolysis of O₃ and sequential reaction. A part of sample air is introduced into a detection cell and time variation of OH is monitored by laser-induced fluorescence detection. By analyzing OH decay, the uptake coefficient can be obtained.

In this study, we applied the LP-LIF to kinetic measurement of OH uptake onto deliquesced NaCl particles. The results showed higher uptake coefficient than those previously reported and suggested that the OH uptake onto sea salt particles has a significant contribution to the choline chemistry in the coastal region and MBL.

2.109 Viscosities of secondary organic aerosols derived from benzene, *p*-xylene, and diesel fuel: Measurements and predictions.

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Abstract:

In spite of importance for particle size distributions, mass concentrations, and chemical reactions, the viscosity of secondary organic aerosols (SOA) remain uncertain. In this study, we measured viscosities at 294 ± 1 K of SOA particles produced by photo-oxidation of benzene, *p*-xylene, and diesel fuel for relative humidities $\leq \sim 50$ % using a poke-flow technique combined with fluid simulations. Viscosity of benzene, xylene, and diesel SOA were also predicted based on the glass transition temperatures of SOA

compounds and compared with the measured viscosities. The results and atmospheric implication will be presented.

2.110 Derivation of aerosol light scattering coefficient from absorption coefficient measured by a filter-based instrument at a metropolitan area.

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Abstract:

For the quantification of black carbon concentration in the atmosphere, some filter-based techniques such as an aethalometer and a particle soot absorption photometry (PSAP) can be used with ease. However, those techniques have some issues about overestimation due to the multiple scattering and optical path-length change caused by the filter materials. To alleviate this issue, the aethalometer adopts correction method by considering the scattering effect. But, the aethalometer does not measure the scattering signal but assumes it as a certain value. In this situation, one filter-based technique called as a multi-angle absorption photometry (MAAP) has been developed and the MAAP actually measures the scattering signals at two different positions to compensate the scattering artifacts. Another filter-based technique, a tri-color absorption photometer (TAP), is less artefactual than the aethalometer in that it measures and displays only absorption coefficients rather than the black carbon concentrations which can contain artifacts. To convert the absorption coefficient into the black carbon concentration, mass absorption cross section should be assumed as a constant though the mass absorption coefficient is not a constant. By using the MAAP and the TAP, the black carbon concentration and the absorption coefficient in the atmosphere at Seoul, Korea were monitored for approximately one month. From the conversion scheme imbedded in the MAAP of the scattering signal into the absorption coefficient, one way to derive the scattering coefficient is to be introduced. One example includes that how the correction can be effectively done by scrutinizing the continuously measured data for the absorption coefficient. Discussion and an overview of the absorption coefficient obtained will be presented along with the conversion process applied to the MAAP in detail.

2.111 Direct measurement of heterogeneous reactive uptake of N₂O₅ on ambient aerosols in the polluted environment in China.

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Abstract:

Dinitrogen pentoxide (N₂O₅) is a reactive intermediate in the atmospheric oxidation of nitrogen oxides (NO_x), and its heterogeneous reaction on ambient aerosols play key roles in the atmospheric cycling of NO_x and photochemistry. Recent studies have revealed some knowledge gaps in the N₂O₅ reactivity on aerosol surfaces, which cannot be well characterized by parameterizations derived previously in lab studies based on aerosol compositions. To better understand the reactive uptake of N₂O₅ on the complex ambient aerosols, an in-situ experimental approach for direct N₂O₅ reactivity measurement was developed. The method utilizes an aerosol flow tube reactor coupled with an iterative chemical box model and can be used for the polluted environment with high and variable ambient precursors. Laboratory tests and model simulations have been performed to characterize the system, and the results demonstrated the applicability of this method under conditions of high NO₂/O₃ and fresh NO emission. This in-situ flow tube system was further deployed in the field to measure the N₂O₅ uptake coefficient in a suburban site in South China. During the observation period, ambient NO₂ and O₃ levels were in the range of 3~34 ppbv and 3~83 ppbv, respectively. The measured $\gamma(\text{N}_2\text{O}_5)$ ranged from 0.002 to 0.042. $\gamma(\text{N}_2\text{O}_5)$ showed positive dependence on aerosol water content and was suppressed by nitrate. Although these features generally follow the relationship suggested by lab studies, significant discrepancies exist between field-measured $\gamma(\text{N}_2\text{O}_5)$ and estimated values from different parameterizations. The results indicate that the complicated effects of some physicochemical parameters on the heterogeneous reactivity are still not well characterized, and further improvement of the parameterization is needed to account for the uptake variability in high-humidity and polluted conditions.

2.112 Direct observation of new particle formation during ozonolysis of isoprene and ethene competing against the growth of preexisting particles.

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Abstract:

Secondary organic aerosol formation during the ozonolysis of isoprene and ethene in the presence of ammonium nitrate seed particles (surface area concentrations = $(0.8-3) \times 10^7 \text{ nm}^2 \text{ cm}^{-3}$) was investigated using a 1 nm scanning mobility particle sizer. Based on the size distribution of formed particles, particles with a diameter smaller than the minimum diameter of the seed particles (less than ~6 nm) formed under dry conditions, but the formation of such particles was substantially suppressed during isoprene ozonolysis and was not observed during ethane ozonolysis under humid conditions. We propose that oligomeric hydroperoxides generated by stabilized Criegee intermediates (sCIs), including $\text{C}_1\text{-sCI}$ (CH_2OO), contribute to new particle formation while competing to be taken up onto preexisting particles. The OH reaction products of isoprene and ethene seem to not contribute to new particle formation; however, they are taken up onto preexisting particles and contribute to particle growth.

2.114 Variation of Particle Numbers at Fukuoka, Japan in winter, 2018.

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Abstract:

Particle numbers (PN) were measured using a scanning mobility particle sizer (SMPS) at Fukuoka University, Fukuoka, Japan in January - February, 2018. Variation of PN, whose particle diameter are about 25nm (hereafter called PN25), was observed under specific conditions.

When PN25 increased, carbon monoxide (CO) increased, but ozone decreased. When the wind from east prevailed, PN25 tend to be higher than that when the wind from west.

When the wind from west prevailed, the wind speed was higher, CO was higher and ozone was lower comparing with the wind from east.

Within one day (diurnal cycle), PN25 often increased in the morning and in the evening, when the wind blew from east and the wind speed was low. This is probably due to the combination of local emission and meteorological condition, ie, PN25 seems to increase with the low wind speed and the relatively large local emission.

2.115 Mixing State of Black Carbon in the Outflow of Urban Beijing: Implications for Light Absorption Enhancement.

Early Career Scientist

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Abstract:

Black carbon (BC) is the dominant aerosol absorber of solar radiation in the atmosphere. BC plays a major but highly uncertain role in both regional air pollution and global climate change, including light absorption and acting as ice and cloud nuclei. Previous researches demonstrated that the coatings on BC can enhance its light absorption, but the amplification depends on the mixing state, which is further influenced by emission sources and aging process in the atmosphere.

An intensive field campaign was conducted at Changping (40.14°N, 116.11°E), a regional

site approximately 45km northwest of downtown Beijing. In order to characterize the mixing state of BC in the urban outflow, a coupled system of Scanning Mobility Particle Sizer and Single Particle Soot Photometer (SMPS-SP2) was established to determine the refractory BC (rBC) core mass and accurate coating thickness in a wider range than SP2 only methods. The mass size distribution of rBC cores peaked at 172 nm, indicating a certain extent of biomass burning effect. The BC-containing particles were moderately coated, and the median coating thickness was 28 nm. During the pollution episodes, the coatings on BC were observed to become thicker as the level of pollution increased. This was proven to be efficient in enhancing the light absorption as large as a factor of 1.6, which substantially decreased the surface heat flux and depressed the development of PBL. This further enhanced the air pollution and established a positive feedback loop, which consequently accelerated the aging of BC. This study revealed the microphysical state of BC in the urban outflow and its effect on the light absorption, possibly providing some important constraints for models to evaluate BC's role in both regional air pollution and global climate change.

2.117 Formaldehyde over the Persian Gulf and around the Arabian Peninsula - marine boundary layer measurements during the AQABA campaign .

Early Career Scientist

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Abstract:

The AQABA (**A**ir **Q**uality and Climate Change in the **A**rabian **B**asin) measurements campaign characterized various trace gas and aerosol species in the Persian Gulf area and around the Arabian Peninsula. Starting in Toulon, France, the research vessel Kommandor Iona passed through Suez Canal, the Red Sea and the Indian Ocean into the Persian Gulf with Kuwait as the halfway point. In this field campaign air with different characteristics has been sampled, i.e. representing clean conditions combined with dust events, aged pollution, ship emissions as well as the unique air masses over the Persian Gulf - freshly emitted hydrocarbons and OVOCs mixed with hot dusty air coming from Kuwait under humid conditions, strong solar radiation and high ozone levels. Formaldehyde (HCHO) can be used, with its rather short lifetime, as a tracer for fresh pollution caused by the oil and gas industry near the Persian Gulf and in the Suez Canal. It is produced by the oxidation of VOCs, mainly methane, and by the combustion of fuels. Therefore, to avoid local contamination, the dataset was filtered to remove stack emissions caused by the own or passing ships thanks to simultaneous NO observations. HCHO mixing ratios in the Suez Canal reached a maximum of 7.6 ppb with a mean of 1.9 ppb during the first and 1.2 ppb during the second leg. The northern Red Sea (1.3 and 0.7 ppb) showed higher pollution than the southern part, where the lowest HCHO ratios were

detected (0.4 and 0.3 ppb). In the Persian Gulf area (4.5 and 2.3 ppb), two pollution events with values up to 12.1 ppb were probably caused by the emissions of oilrigs. The measurements have been compared to the global chemistry climate model (EMAC) showing a general good agreement, just overestimating the mixing ratios over the southern Red Sea.

2.118 Halogenated organic compounds production by photosensitized reactions at the air/water interface .

Early Career Scientist

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Abstract:

Air/water interfaces are omnipresent in the environment, and the largest one is clearly to be found at surface of oceans. The latter is generally enriched in organic compounds, as compared to the underlying bulk water, and this layer is called the sea surface microlayer (SML). Previous studies showed that dissolved organic carbon (DOC) leads to the emission of volatile organic compounds (VOCs) via photochemical processes¹. Halide anions (Cl⁻, Br⁻, I⁻) are massively present in the SML but also in marine aerosols, and they may be involved in these processes. However, an understanding of the associated chemistry is still missing.

Here, the photochemical reactions between 4-benzoylbenzoic acid, used as a photosensitizer and halides was investigated. Gas phase products were monitored by high-resolution mass spectrometry, more particularly by (+/-) means of an atmospheric pressure chemical ionization (APCI) source coupled with an Orbitrap. Under illumination simulating solar conditions, halogenated organic compounds were produced and detected in the gas phase. 4-benzoylbenzoic acid's triplet states lead to organics radical' formation but also halide radicals in the bulk water; together they can react and give gas halogenated VOCs. The presence of surfactant or proton donor affects also these formation processes.

This kind of photochemical reactions taking place at the interface can therefore be a source of halogenated compounds in the atmosphere, and participate in the tropospheric halogen cycle. Moreover, they could be also precursor for secondary organic aerosol formation like non-halogenated VOCs founded by Bernard et al.². This contribution will highlight our recent findings on these processes.

1 Ciararu, Fine et al., 2015, *Scientific reports*, 5, 12741

2 Bernard, Ciararu et al., 2016, *Environ. Sci. Technol.*, 50, 8678-8686

2.120 Increased volatility in cloud residuals compared to ambient aerosols.

Early Career Scientist

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Abstract:

Aerosols play a significant role in Earth's radiation budget, where the direct and indirect aerosol effects result mainly in a net cooling. An important parameter characterizing the aerosol properties is volatility. It provides information about the particle mixing state and composition, and can help to understand the ageing and other processes influencing the aerosol.

In this work, the volatility of ambient aerosols and cloud residuals was studied during the Cloud and Aerosol Experiment at Åre (CAEsAR 2014). A volatility tandem differential mobility analyser (VTDMA) connected to a counterflow virtual impactor (CVI) inlet was setup at Mt Åreskutan (1265 m a.s.l.) located in central Sweden. The station location and meteorological conditions provide a unique opportunity to study air masses of different origin, from clean Arctic to polluted European regions. The combination of VTDMA and CVI inlet enabled the distinction between ambient aerosols and cloud residuals.

Particle volatility was analysed for three different initial particle diameters, 100 nm, 200

nm, and 300 nm. The volatility of the ambient aerosols slightly decreases with increasing size, while cloud residuals do not show such trend and display higher volatility. One possible explanation is that smaller organic molecules, which are more volatile, tend to be more water soluble. However, the volatility of the smallest initial particle size did not reveal any changes for cloud residuals compared to ambient (non-activated) aerosol. The reason for this is still unclear, but it may be related to size-dependent chemical composition. This study will provide new information for resolving the chemistry and physics of aerosol – cloud processing, and for representing these processes in atmospheric models.

2.124 Evaluation of the key factors in parameterization of HO₂ uptake coefficient on atmospheric aerosols.

Early Career Scientist

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Abstract:

Heterogeneous uptake of atmospheric gaseous species on aerosols surfaces play important roles in determining the fate of trace gases and physic-chemical property of aerosols in the atmosphere. Previous studies suggest that the aerosol uptake is potentially effective sink for HO₂ radicals, thus an accurate evaluation of the uptake coefficient of HO₂ is of great importance in atmospheric radical chemistry studies and in regional/global air quality modeling. However, large variable values of HO₂ uptake coefficients have been used in pervious modeling and mechanisms studies. In the present work, we evaluate the HO₂ uptake coefficient with a comprehensive parameterization considering the gas phase diffusion, aerosols surface accommodation and aqueous phase reactions terms. The dominant factors controlling the HO₂ uptake onto aerosols with different physical and chemical characters are investigated, and the impact of HO₂ aqueous phase productions is also evaluated. In addition, we also assess the uncertainties on the determined HO₂ uptake coefficients from utilizing different HO₂ accommodation coefficients (α_{HO_2}), since large range of α_{HO_2} values were reported from lab studies and used in modeling studies (0.1~1). The dependence of HO₂ uptake coefficient on the factors including particles size, aerosols compositions, aerosols acidity, and the utilized α_{HO_2} value are comprehensively discussed. The results emphasize the necessity of carefully treating the HO₂ uptake coefficients in modeling and aerosols multiphase chemistry studies.

2.125 Source attribution of tropospheric ozone in a chemistry-climate model using a novel tagging approach.

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Abstract:

Tropospheric ozone is an important air pollutant, as well as a contributor to anthropogenic radiative forcing. Major sources of ozone in the troposphere are transport from the stratosphere, and photochemical production involving reactions of oxides of nitrogen (NO_x) and Volatile Organic Compounds (VOC), including methane. Model intercomparison experiments consistently show that ensembles of global chemistry-climate models produce a very wide spread in their simulation of present-day surface ozone concentration, and are not capable of reproducing observed historical trends in tropospheric ozone. Before these models can be reliably employed to make quantitative projections of future changes in tropospheric ozone, the shortcomings in their ability to simulate past and present ozone must be better understood. Improved diagnostic information about modelled ozone budgets is one way in which this understanding could be improved.

Here we describe and evaluate a novel approach to the attribution of tropospheric ozone to its emitted precursors and production in the stratosphere in a global chemistry-climate model using tagged tracers. We use this approach to attribute the modelled ozone in a number of “receptor regions” to NO_x and VOC precursors emitted in several major northern hemispheric “source regions” (East Asia, South Asia, North America, and Europe). Modelled summertime ozone maxima are shown to be due primarily to photochemistry involving locally emitted anthropogenic NO_x and biogenic VOCs. Anthropogenic VOCs play a minor role in modelled summertime ozone production, but become much more important in winter and springtime, when long-range transport of remotely-produced ozone becomes the dominant source of ozone in most receptor regions. Methane oxidation contributes to a consistent level of background ozone in all receptor regions. If implemented in more models, the deeper understanding of the provenance of modelled ozone provided by our tagging methodology could yield information about model-model differences, and point the way towards improvements.

2.127 An experimental study on carbocationic oligomerization processes of VOCs at acidic water surfaces.

Early Career Scientist

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Abstract:

Recent field and experimental studies show that atmospheric particles are sufficiently acidic to trigger carbocationic chain reactions at their surfaces. Electrophilic attack of interfacial H_3O^+ to volatile organic compounds (VOCs) induces carbocationic chain reactions including oligomerization at the surfaces, which are to play key roles in the evolution of atmospheric particles. Here we studied oligomerization abilities of various unsaturated hydrocarbons and competing chain reactions at the water surface as an analogue of atmospheric particles, by direct detection of carbocations using an experimental system equipped with online mass spectrometry of microjets. After ~ 10 us exposure of the reactant gases to the acidic water surface ($1 \leq \text{pH} \leq 5$), proton-transfer reaction from H_3O^+ to the reactant molecules were observed, initiating competing chain reactions of chain-propagation, chain-transfer and hydride(H^-)-abstraction. The oligomerization abilities of the monomers were varied with the relative efficiency of chain-propagation to competing reactions and are enhanced when (1) pi-electron at the reactive $\text{C}=\text{C}$ bond of a nucleophile is enriched by electron-donating functional group and (2) carbocation acting as an electrophile shows conjugative resonance. This resulted in the largest oligomer formation of isoprene up to the decamer, which is almost the limit of diffusion-controlled growth. Notably, conjugative resonance is known to restrain the oligomerization in the bulk organic solutions, implying that the water surface is a distinct reactor from the bulk. We found that even relatively unreactive monomers propagate to the oligomer, via hydride-abstraction and subsequent pi-alkylation. Furthermore, co-oligomerization is found to assist the chain-growth of the solely ineffective monomers when reactive species are co-existing (e.g., reactive isoprene and inert 1-pentene). These results consistently show that unsaturated hydrocarbons easily get protonated and form oligomeric-products at acidic water surfaces while the competition between chain-propagation, chain-transfer and hydride-abstraction determines the growth pathway of the interfacial carbocation.

2.128 Effect of Liquid-Liquid Phase Separation on the Heterogeneous OH Oxidation of Inorganic-Organic Aerosols.

Early Career Scientist

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Abstract:

Organic compounds and inorganic salts are found to coexist in a large fraction of tropospheric aerosols. Recent studies revealed that these aerosols may undergo liquid-liquid phase separation (LLPS), a result of non-ideal interaction between the dissolved salt ions, water molecules and organic molecules, which affects the morphology of aerosols. Despite the importance of aerosol morphology in governing many physical and chemical processes of the aerosols, whether the heterogeneous OH oxidation will be affected by LLPS physically or chemically still remains unknown. Therefore, the role of LLPS on the chemistry and kinetics of heterogeneous OH oxidation of 2-methylglutaric acid (2-MGA)/ammonium sulfate (AS) was examined in this study. Experimental data and molecular information of reaction products were obtained using an aerosol flow tube reactor and a soft atmospheric pressure ionization source, (Direct Analysis in Real Time, DART) coupled with a high-resolution mass spectrometer. Aerosol mass spectra reveal that same reaction products are formed independent of LLPS. The aerosol composition at a certain oxidation lifetime is also unrelated to LLPS, suggesting that LLPS may not significantly change the reaction mechanism of 2-MGA upon OH oxidation. In addition, a new reaction product with small relative abundance is found in the 2-MGA/AS system which does not exist in pure 2-MGA system. Therefore, it is likely that LLPS does not affect the chemistry of heterogeneous OH oxidation. For the kinetics, the rate constant are found to decrease as LLPS occurs, which may be explained by the increase in viscosity due to the higher concentration of organic at the surface.

2.129 Composition of traffic emitted semi-volatile organic compounds at street canyon and urban background sites in central London, UK.

Early Career Scientist

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Abstract:

This study collected atmospheric samples from a street canyon and the adjacent park in central London to evaluate the change in composition of SVOC during advection from the traffic to the cleaner atmosphere of the urban background. 24h duration ambient air samples were collected during the winter period 24 Jan to 18 April 2017 at four sites in central London, UK; a kerbside site on the south side of heavily trafficked Marylebone Road (M Road), an urban background site Eltham and simultaneous measurements on the roof of University of Westminster (WM) above M Road site and a roof of Regent's University (RU) located in Regent's Park, about 380m north of M Road. Samples were analysed using thermal desorption coupled to comprehensive two-dimensional gas chromatography time-of-flight mass spectrometry (TD-GC×GC-ToF-MS).

Groups of compounds identified and quantified in gas and particle phase include total alkanes (n-alkanes and branched alkanes), cyclic alkanes, bicyclic alkanes, monocyclic aromatics and PAHs. The chemical composition of SVOC is compared between different sampling sites and the influence of wind direction is discussed. As expected, M Road concentrations were the highest of all sites. The concentrations of hydrocarbons at WM were higher than RU as the particles were diluted with the increase distance away from the traffic emission source. The large SVOC concentrations in the gas phase can

contribute to secondary organic aerosol generation following reaction with atmospheric oxidants. These compounds may also contribute to increased OH reactivity. Gas-particle phase partitioning is also discussed and compared between sites. Pearson correlations between SVOCs and black carbon, and SVOCs and NO_x in multiple locations are compared to investigate the influence of traffic sources. While it is clear that traffic is a major contributor at the roadside site, the lower correlations at background sites are indicative of other source contributions and/or differential reactivity.

2.133 Reduced nitrogen species as observed in urban and rural areas in the North China Plain.

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Abstract:

Numerous trace gases exist in the atmosphere, some of which are nitrogen-containing species. Oxides of nitrogen (such as NO_x , HONO, etc.) play vital roles in atmospheric chemistry and have been extensively studied. However, less attention has been paid to reduced nitrogen species with the exception of NH_3 , which plays an important role in the formation of secondary aerosols and the acidification of ecosystems. So far, observational studies of reduced nitrogen species other than NH_3 have been extremely lacking, limiting our understanding of their roles in the atmosphere. Here we show observational results of ambient NH_3 and other nitrogen-containing gases from an urban site and a rural site in the North China Plain. Ambient NH_3 was observed at China Meteorological Administration (CMA) in Beijing from 1 December 2015 to 31 January 2016 and at Raoyang (RY) in central Hebei province from 19 June to 26 July 2016 using an off-axis integrated cavity output spectroscopy (ICOS) analyzer and a chemiluminescence analyzer, respectively. Other nitrogen-containing gases at both sites were observed using an IONICON proton transfer time of flight mass spectrometer (PTR-TOFMS). About fifty nitrogen-containing species showed average levels above the detection limit (10 ppt). The top eight reduced nitrogen species at both sites were NH_3 , H_4N_2 , CH_3N , CH_3NH_2 , CH_3NHNH_2 , H_2N_2 , HCN,

and CH_3CN , with average mixing ratios ranging from 0.45 to 52.6 ppb. Other nitrogen species with average levels over 0.10 ppb were HCCCN , $\text{C}_2\text{H}_6\text{N}_2\text{O}_2$, $\text{C}_4\text{H}_7\text{N}_2\text{O}$, $\text{C}_5\text{H}_5\text{N}$, and $\text{C}_5\text{H}_{10}\text{N}_2$. Although NH_3 was the most abundant nitrogen species, the sums of other reduced nitrogen species at CMA and RY were about 2.5 and 0.4 folds of the NH_3 levels, respectively. At both sites H_4N_2 was found to be the most non- NH_3 reduced nitrogen species, with average levels about 10 ppb.

2.134 Aqueous photo-oxidation of molecular size separated brown carbon.

Early Career Scientist

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Abstract:

Recent laboratory and field studies have shown that light absorbing organic aerosol particles, known as brown carbon, can be bleached of their colour by photolysis and photo-oxidation on the timescale of hours to days. However, there is evidence that light absorbing chromophores, suggested to be large molecular weight compounds, remain even after 48 hours of atmospheric aging. The lifetime of these chromophores will determine the extent of warming that brown carbon aerosol particles may cause, and therefore their impact on climate. The complex composition of brown carbon is still largely unknown, and most identified small molecule chromophores are reactive in the atmosphere, leading to short lifetimes. It is hypothesized that uncharacterized, oligomeric chromophores may be resistant to atmospheric degradation and have longer lifetimes. The molecular size dependence on absorption loss is investigated during aqueous photo-oxidation of primary brown carbon. Brown carbon aerosol particles were generated from smoldering wood in a heated flow tube (350 °C) and collected on supported Teflon filters. Molecular size separation and characterization was achieved by size exclusion chromatography, with the ability to separate molecules in the range of 100 to 5000 Da. Photo-oxidation was carried out in aqueous solution to simulate aqueous aerosol or cloud water processing. The UV-Visible absorption spectrum of the water-soluble brown carbon was investigated as a function of photo-oxidation time to understand the evolution of different sized chromophores.

2.135 Degradation of levoglucosan in atmosphere during transportation from West Siberia to northern Japan.

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Abstract:

Stability and degradability of levoglucosan, which is biomass burning tracer, in aerosols are key information for estimation of contribution of biomass burning aerosols. Degradation of levoglucosan in atmosphere is suggested by chamber experiment and chemical reaction studies. Validation of degradability of levoglucosan by different approach is necessary for better understanding the dynamics of levoglucosan in actual atmospheric conditions. We, therefore, investigated the degradation of levoglucosan during long transportation using combination of chemical analysis and model simulation techniques.

We measured hourly concentrations of levoglucosan at 7 stations located in northern part of Japan during July 25–August 1, 2014, when forest fire aerosols transported from West Siberia to Japan. Levoglucosan was quantified using high performance anion exchange chromatography with positive electrospray ionization mass spectrometry. The hourly concentrations of levoglucosan ranged from below method detection limit (0.48 ng m^{-3}) to 1120 ng m^{-3} . Backward trajectory analysis indicated that air mass was transported from West Siberia, when the levoglucosan concentration was remarkably high.

The measured concentrations of levoglucosan were compared with concentrations estimated by simulation model. Preliminary simulation was conducted by Weather Research and Forecasting (WRF, Ver. 3.7.1) model using NCEP Final Analysis (NCEP-FNL) data and Global Fire Emissions Database (GFED, Ver. 3.1) as boundary conditions and burned area, respectively. We hypothesized that degradation of levoglucosan is first-order kinetics with a half-life, and then the half-life was estimated by minimization of residues between measured and simulated concentrations of levoglucosan. We obtained half-life of 31–35 hour by preliminary analysis. Our result was within the atmospheric life time of levoglucosan estimated from previous experimental studies (0.9–3.5 day). In the future, chemical transport model and flux of wild fire emission database will improve our research.

Acknowledgement: Type II joint research of NIES of Japan and environmental research institutes of local government (1618AH003).

2.136 Primary Biological and Biomass Burning Aerosols at the Northern Slope of Mt. Everest, Central Himalayas.

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Abstract:

Organic aerosols from biomass burning and primary biological sources are ubiquitous in the Earth's atmosphere. They affect the absorption and scattering of solar radiation, act as cloud condensation nuclei (CCN) and possibly influence ice and snow albedo in remote regions. Here we determined polar organic markers for biomass burning, plant debris and primary biological aerosols at a remote site (Qomolangma, 4276 m a.s.l.) of Mt. Everest, central Himalayas using a solvent extraction-BSTFA derivatization-GC/MS technique. Seasonal trends of biomass-burning aerosols are characterized by pronounced maxima in the pre-monsoon season and minima in the summer monsoon period, being consistent with aerosol organic carbon. However, concentrations of fungal spore tracers and plant debris peaked in both pre-monsoon and post-monsoon seasons, suggesting that primary bioaerosols and plant emission are important sources of organic aerosols over the Tibetan Plateau in the post-monsoon season when biomass burning emission is weak. With the consideration of primary bioaerosol particles as potential CCN and atmospheric ice nuclei and biomass burning as one of the significant sources of light-absorbing

aerosols, our findings have potential implication for climate change in the Tibetan Plateau, a major concern in the Earth's "Third Pole".

2.137 Predictability of wildfires' impact on air quality: cas study of the summer 2016 in Europe .

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Abstract:

Wildfires are a significant source of atmospheric pollutants, altering air quality at local to regional scales, intercontinental in the most severe cases. Fire activity being highly variable both temporally and spatially, including this source into air quality forecasting systems requires daily reanalysis of emissions, as well as an estimate of their evolution during the forecast integration time, typically up to 5 days. In this presentation, the predictability of wildfires' impact on air quality will be discussed based on regional chemistry transport model simulations (CHIMERE), including hourly fire emissions (APIFLAME model), applied to the study of the summer of 2016 in Europe. The year 2016 was close to average for most regions except Portugal, where severe wildfires burned a total area twice larger as the average yearly area burned during the previous decade. Satellite observations are first used to evaluate the emissions (total and temporal variations) as well as the simulated transport pathways (IASI CO, MODIS AOD, CALIOP aerosol backscatter ratio). In particular, the dispersion of the fire plumes and its impact on the simulated influence on atmospheric composition is discussed depending on the resolution used. The predictability of the simulated impact on surface concentrations during a typical forecast integration time is then analysed using meteorological fire risk calculations.

2.138 The Impacts of Heterogeneous Reaction of N₂O₅ on Sea Salts on Concentration of Ozone and total nitrate.

Early Career Scientist

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Abstract:

High concentrations of nitrogen-contained gases and sea salts were concentrated over eastern coastal area of China. Heterogeneous reaction between them would lead to important impacts on ozone and nitrogen contained species, which will further influence atmospheric oxidation capacity and nitrogen deposition. We incorporated the heterogeneous reaction of N₂O₅ and sea salts into the Community Multiscale Air Quality model (CMAQv5.0) to analyze its impacts on O₃ and nitrogen across eastern China in summer (May 6 to 10, 2017) and winter (Jan 1 to 7, 2016). The results showed that the heterogeneous reaction of N₂O₅ on sea salt enhanced nitryl chloride (ClNO₂) levels by more than 3 orders of magnitude during both the winter and summer. In winter, ClNO₂ concentration can reach up to ~ 0.7 ppb over of Yangtze River area, Pearl River area and Yellow sea. ClNO₂ concentration in summer was 0.2 ppb lower than that in winter, and the highest daily mean concentration (0.5 ppb) appeared near Bohai Sea. Enhancements of ozone due to photolysis of ClNO₂ was in the range of 3 ~ 11ppb (8%-30%) in winter, which is approximately 2 ~ 4 times higher than that in summer (1.2-3 ppb). The increased O₃ showed a good corresponding relationship with the heterogeneous production of ClNO₂. In addition, model results suggested that this heterogeneous

chemistry reduced total nitrate ($\text{TNO}_3 = \text{HNO}_3 + \text{NO}_3^-$) by ~ 10%-18% in winter and 7%-11% in summer.

KEYWORDS

Heterogeneous reaction; N_2O_5 ; Ozone; Sea salt; total nitrate

ACKNOWLEDGEMENT

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2.139 How well can we assess atmospheric ozone changes? The OzoneSonde Data Quality Assessment (O3S-DQA).

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Abstract:

Ozonesondes are the backbone of the global ozone observing network, making inexpensive, accurate measurements of ozone from the ground to 30km, with high vertical resolution (~100 m), for more than 50 years. The data are used extensively for validation of satellite data products, and are also part of merged satellite data sets and climatologies that are used for trend analyses and as a priori data for satellite retrievals. The importance of ECC sondes for trend analyses and as a transfer standard and stable reference for satellite validation recommends research effort to better quantify uncertainties and changes in ECC data.

Comparison with UV-absorption measurements in a number of studies (e.g. JOSIE, BESOS) has shown that small changes in sensor type, preparation or sensing solution can introduce significant inhomogeneities in long-term sounding records. The major goal of the O3S-DQA is the homogenization of ozonesonde data sets. Essential aspects of this are the detailed estimation of uncertainties and documentation of the reprocessing.

Corrections to historical data for known issues may reduce biases but introduce additional uncertainties. We take a systematic approach to quantifying these uncertainties by considering the physical and chemical processes involved, and attempt to place our estimates on a firm theoretical or empirical footing. We discuss stoichiometry, sensing solutions, background current, humidity and temperature corrections to pump flow rate, altitude-dependent pump flow corrections, variations in radiosonde pressure offsets, and normalization of sonde total ozone to spectrophotometric measurements.

In the past 20 years ozonesonde precision has improved by a factor of 2, primarily through the adoption of strict standard operating procedures. We identify remaining quality assurance issues that can be better evaluated with further research. We present a "roadmap" for achieving a goal of better than 5% overall uncertainty throughout the global ozonesonde network.

2.142 Relative reactivity of stabilized Criegee intermediates from hydrocarbon ozonolysis toward carboxylic acids and water vapor.

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Abstract:

Criegee intermediates generated from hydrocarbon ozonolysis have potential importance in atmospheric oxidation and secondary organic aerosol formation. While Criegee intermediates with relatively simple structures have been extensively investigated by direct kinetic studies in recent years, there is limited information on chemical reactivities of more complicated and atmospheric relevant Criegee intermediates. Here, we report relative reactivity measurement studies of Criegee intermediates toward carboxylic acids and water vapor. Experiments were performed at atmospheric pressure using a glass flow tube, in which Criegee intermediates were generated from hydrocarbon ozonolysis and allowed to react with carboxylic acids and water vapor. Reaction products from the Criegee intermediate and carboxylic acid were monitored using a chemical ionization mass spectrometer as a function of the carboxylic acid or water vapor concentration. In studies on Criegee intermediates generated from isoprene ozonolysis, we found that the C₁ Criegee intermediate, CH₂OO, has high reactivity toward water dimer, (H₂O)₂, while most of the C₄ Criegee intermediates have low reactivity toward water vapor. The results are consistent with recent experimental and theoretical studies which suggest that the chemical structure of a Criegee intermediate strongly affects its reactivity toward water vapor.

2.143 Characteristics of Submicron Aerosols in 2013 summer of Beijing: Particle Size, Density, Hygroscopicity, and Mixing State.

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Abstract:

To characterize the air pollution of North China Plain of China, CAREBEIJING-2013 field campaign was conducted in summer of 2013. Submicron aerosols were measured at an urban site PKU from July 28th to September 31st 2013. A suite of integrated instruments was used to measure the size distribution, effective density and hygroscopicity of ambient particles. The chemical composition of submicron particles were measured by using an Aerodyne HR-ToF-AMS. During the measurement, the average particle densities are between 1.3-1.5 g cm⁻³, indicating organics and sulfate were dominant in the particles. The densities of smaller particles, i.e. 46 nm, 81nm, showed single peak at 1.3-1.5 g cm⁻³, indicating the particles are internal mixed sulfate and organics. While the 150nm and 240 nm particle densities exhibited bimodal distribution with an additional small peak at ~1.1 g cm⁻³, which is considered as external mixed organic particles or aged soot particles. The particle hygroscopic growth factor for all the measured sizes at RH of 90% showed bimodal distribution, attributing to external mixed organics (or aged soot) and internal mixed organics and sulfate. Both the density and HGF were higher than Tijuana, but similar to Houston. PMF (Positive Matrix Factorization) model was deployed to quantify the contributions of different mixing state particles. Internal mixed organics and sulfate were dominant in the ambient particles in Beijing.

2.144 Towards comprehensive characterization of atmospheric VOC oxidation products.

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Abstract:

Understanding the oxidation pathways of volatile organic compounds (VOC) in the atmosphere remains challenging for several reasons: the large number of different VOC, the vast amount of different processes they can undergo following reactions with various oxidants, and the perturbation of these processes under varying atmospheric conditions. Nevertheless, new insights are constantly being gained, through both theoretical and experimental efforts. For the latter, recent developments in chemical ionization mass spectrometry (CIMS) have been critical, especially for detecting and quantifying oxidized VOC (OVOC). These OVOC cover a wide range of species, from small volatile fragments (e.g. acetone and formaldehyde) to large highly oxygenated molecules (HOM) able to nucleate and form aerosol particles. No single instrument can map out this entire distribution, yet this is what needs to be done in order to understand OVOC formation processes and their ultimate impacts.

Here, we deployed five different mass spectrometers at our chamber facility to identify to what extent, and under which conditions, there was overlap between the OVOC detected by different instrument types. The system we studied was the oxidation of the monoterpene alpha-pinene, utilizing three CIMS instruments (using nitrate, iodide, and diethylamine as reagent ions) and two proton transfer mass spectrometers (a PTR-TOF and the newly developed VOCUS).

As in earlier studies, we found that two instruments detecting molecules with identical elemental composition is no guarantee for a good correlation between the two. This is also expected, since the selectivity of each instrument is different, and they may thus be measuring different isomers. However, we also found areas of good agreement: the most volatile species were detected by PTR-TOF and VOCUS, semi-volatile species often agreed

between iodide CIMS and VOCUS, and many HOM were identified by both nitrate and amine CIMS. More detailed results and conclusions will be presented during the conference.

2.146 Quantification and the Impact of SO₂ on the New Particle Formation in the Ozonolysis of α -pinene .

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Abstract:

The new particle formation from the ozonolysis of α -pinene as a function of initial ozone concentration ($[O_3]_i$) was studied using a scanning mobility particle sizer spectrometer (SMPS) to monitor the size distribution of the produced submicrometer particles at room temperature. The applied initial concentration of α -pinene (≥ 15.4 ppm) was much higher than $[O_3]_i$ (40 - 120 ppb), while RH was controlled at $< 1\%$, 36 % and 54 %. The generated particles showed a positive correlation to $[O_3]_i$ at $[O_3]_i \geq 50$ ppb in both number and mass concentration likely due to the produced low volatility products reaching the saturation point at $[O_3]_i \sim 50$ ppb. For a given $[O_3]_i$, the mass concentration of particles showed a slightly decreasing trend with RH likely due to a potential oxidant, HO₂, forming HO₂•H₂O to reduce the overall oxidation of the system. With the addition of 6.3 ppm of SO₂, a significant increasing of small particles in number concentration suggested a strong nucleation enhancement likely induced by the low volatile organic species with H₂SO₄ from the reaction of SO₂- with OH radical. By a model simulation, 0.35 ppb of H₂SO₄ was generated and had significant nucleation rate, faster than that estimated from the H₂SO₄-H₂O binary system. Overall, this study illustrated the new particle formation from the ozonolysis of α -pinene at different environments and suggested the importance of radicals, which can be applied to secondary organic aerosols derived from other biogenic organic species. The nucleation and condensation processes from the model simulations might provide the possible physical and chemical parameters required for the regional models to better estimate the number and mass concentration of aerosols generated from the interaction between the natural and anthropogenic sources in real atmosphere.

2.147 Origin of Soluble Iron from Low-emitting Automobile Exhaust.

Early Career Scientist

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Abstract:

Soluble iron has been found to be a limiting reagent for phytoplankton in most of the southern oceans. Phytoplankton is a vital part of the oceans ecosystem as it is involved in CO₂ uptake and nitrogen fixing. Thus, understanding iron geochemical cycle is essential to understanding the earth's oceans and atmospheric interactions. Previous field studies have linked soluble iron over the ocean to combustion sources. To directly test soluble iron emissions from automobiles, PM was collected from tail pipes of 22 low emitting gasoline vehicles at the CARB dynamometer facility using California Unified (UC) Drive Cycle. PM was collected from the exhaust pipe and analyzed for inorganic ions, EC/OC, total and soluble metals, functional groups, and GC-MS was used to quantify the class of 11 to 18 carbon intermediate volatility organic compounds (IVOC), ultimately categorized as alkane (ALK), single ring aromatic (SRA) and general (GEN) for each carbon number. Results showed that the tested automobile emissions have a high fraction of percent iron solubility ranging from 0% - 81.9% with an average of 26.7%, compared to crustal sources where the soluble iron is approximately 1% of total iron. Samples were analyzed by x-ray near edge absorption structure (XANES) spectroscopy, which confirmed that only Fe(III) was present in the samples and, thus, any increased solubility was not due to the emission of the more soluble Fe(II). Correlation of soluble iron to sulfate was insignificant ($R^2 = 0.157$), as was correlation to every measured chemical component, except one class. Soluble iron was highly correlated to the C11 - C18 IVOCs, with R^2 values as high as .981 for IVOC SRA-C14. These results imply the large driver in soluble iron from gasoline vehicle emissions is related to organic fraction of PM, suggesting that further studies are required to study metal-organic interactions in PM.

2.148 Optimization of the regional air secondary species monitoring network and source appointment of PM_{2.5} in Pearl River Delta of China.

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Abstract:

Abstract: The Pearl River Delta (PRD) region in South China is one of the most economically developed regions in China while also noted for its severe air pollution, especially in the urban environments. Since the characteristics of the air pollutants in the PRD region are distinct, and the regional transportation has a prominent influence on the region, single site monitoring can't meet the needs of the study and control of the secondary pollution of the regional atmosphere. This study established and optimized the regional air secondary species monitoring network of the PRD, and the technical route is as follows: Based on the pollution distribution characteristics, obtain the distribution of pollution zone and the special pollution area - combining the geographical location and climate characteristics of various places, determine the geographical area - combining with the previous research results of the formation potential of PM_{2.5} and O₃, subdivision zoning - Combined with the situation of urban and rural construction, we further subdivide the functional zoning - determine the monitoring area division, transmission channel, background and so on- determination of sites' position in combination with station building conditions. The result of PMF model of 62 monitoring sites and the function and significance of the environmental air quality monitoring site revised 10 sites as the sites of the secondary species monitoring network.

Based this network, the manual sampling and analysis of the atmospheric PM_{2.5} were carried out, by which we obtained the following main conclusions: (1) the average mass of PM_{2.5} in the PRD region was 34.8μg/m³, and the organic matter (OM) was the most abundant component. (2) the PMF model shows that the PM_{2.5} of the PRD is mainly from 10 sources of pollution, of which motor vehicle was the important source.

Key words: secondary species monitoring; The Pearl River Delta source appointment

2.151 Comparing and improving methane emissions estimates in the UKCA chemistry climate model.

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Abstract:

Methane is the second most important anthropogenic greenhouse gas after carbon dioxide and a major ozone precursor. Its relatively short lifetime allows any changes in the methane burden to have near immediate effects on global climate. However, large uncertainties exist in the estimates of methane sources and hence in the global methane budget.

The UM-UKCA has been modified to use both prescribed (offline) oxidant fields and interactively simulated oxidant fields in parallel. Thus, in one simulation, methane oxidation can be treated as both a linear first order process, removing the methane feedback onto itself, and a fully interactive process, using the same model OH field. The linear oxidation scheme allows methane emissions to be tagged by source type and region. An OH climatology can also be used as the offline OH field.

We use surface methane observations to assess the performance of the model. Using interactive chemistry, and an OH field which compares well with the ACCMIP multi-model mean, methane concentrations are found to be low biased with respect to observations at all latitudes but with an acceptable hemispheric gradient. The methane lifetime with respect to tropospheric OH loss is at the lower end of the ACCMIP multimodel mean. In contrast, when an offline OH field (North-South gradient 1.01, taken from Spivakovsky / TRANSCOM-CH4) is used, good agreement with is found in concentration but with too strong a hemispheric gradient. The lifetime agrees well with observational constraints.

We will present an analysis of the footprints of the different source types and regions, deployed in both linear and interactive schemes, which allows us to perform detailed comparison to observations, and to identify regions where methane emissions databases may under-represent methane emissions. We will show that these data allow a quantitative assessment of the speciated methane source strengths.

2.154 Measurements of HO₂ uptake coefficient on mineral dust particles using aerosol flow tube with PERCA and LIF system.

Early Career Scientist

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Abstract:

Field measurement studies imply that HO₂ uptake on aerosol is one of the most important sinks for HO₂ radicals. The uptake coefficient of HO₂ could significantly affect the budget of OH radicals and ozone regionally. However, the measurement results of HO₂ uptake coefficient on different aerosol are limited, while some have large discrepancies. Laboratory studies were carried out to investigate the heterogeneous reaction of HO₂ radical on TiO₂ and other mineral dust particles using aerosol flow tube (AFT). HO₂ concentrations were measured at room temperature using both peroxy radical chemical amplification (PERCA) system and the Laser-Induced-Fluorescence (LIF) system. For the PERCA system, HO₂ radicals were converted to NO₂, which was measured by a commercial instrument cavity attenuated phase shift (CAPS, Ecotech), in an amplified reactor using a chain reaction involving CO and NO. The amplification factor of HO₂, called chain length (CL), was calibrated at different relative humidity. The detection limit of NO₂ is 0.15 ppbv for an averaging time of 30s. The measurement was conducted under relatively high HO₂ concentration ($[HO_2] = 10^9$ to 10^{10} molecule cm⁻³). For the LIF system, atmospherically relevant HO₂ concentration was produced ($[HO_2] = 10^8$ to 10^9 molecule cm⁻³). The detection limit of HO₂ for LIF system is 10^7 molecule cm⁻³. The measurements of HO₂ uptake coefficient were conducted at relative humidity from 5% to 40% with a time resolution of 30s.

2.155 Highly Oxidized Organic Molecules (HOMs) Formation in the NO₃-Initiated Oxidation of Isoprene, Limonene and β-Pinene.

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Abstract:

Isoprene and monoterpenes are two important classes of biogenic volatile organic compounds. Oxidation of isoprene and monoterpene by NO₃ radical have significant impact on VOC loss, ozone formation, and secondary organic aerosol formation. The oxidation mechanism of isoprene and monoterpene by NO₃ radical is still unclear. Particularly, the formation of highly oxidized organic molecules (HOMs) during the oxidation of isoprene and monoterpene by NO₃ radical has not been reported in the literature. In this study, we investigated the oxidation of isoprene, limonene, and β-pinene by NO₃ radical in SAPHIR chamber (Simulation of Atmospheric PHotochemistry In a large Reaction chamber) at Forschungszentrum Jülich, Germany. The experiments were conducted at ambient relevant VOC and NO₃ concentrations. HOMs were measured using a nitrate chemical ionization mass spectrometry (NO₃⁻-CIMS). HOMs monomer, dimer and trimer were detected. The mechanism of the HOMs formation was attempted. A series of

HOMs compounds can be explained by the NO_3 addition to double bonds forming RO_2 , followed by auto-oxidation. Different HOMs were found to show distinctive time profile during the oxidation.

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2.156 The impacts of VOCs on atmospheric chemistry: The Common Representatives Intermediates Chemical Mechanism in UKCA.

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Abstract:

Ozone production in the troposphere is driven by the photo-oxidation of volatile organic compounds (VOCs) in the presence of NO_x. However, there are many thousands of VOC species in the atmosphere, and the simulation of all these species and their products is not feasible. In 3D models, various techniques for reducing complexity are used, but may introduce errors that are hard to identify. The Master Chemical Mechanism (MCM) is a near-explicit scheme, with several thousand species and 10s of thousands of reactions, but is almost exclusively used in box-model applications due to its high cost. The Common Representative Intermediates (CRIV2-R5) mechanism is an effective compromise, preserving the ozone forming potential of the MCM whilst reducing the number of species and reactions to be feasible in a 3D model (approximately 240 species, 650 reactions), whereby it can be used as a benchmark to assess simpler schemes in realistic, 3D modelling environments.

We present first results using CRIV2R5 in a global chemistry-climate model, the United Kingdom Chemistry and Aerosol model (UKCA) used in the Met-Office Unified Model. Detailed VOC speciation of emissions are required, so we utilise the new EDGAR v4.3.2 inventory with emissions of 25 VOC classes by 17 sectors. The CRI scheme is first implemented in a Box-Model version of UKCA, to test the scheme under a range of idealised chemical environments. It is further run in the full 3D modelling suite and evaluated against model runs using standard chemistry and routine observations used in chemistry-climate model inter-comparisons. Differences due to chemical mechanism for key chemistry-climate processes, such as tropospheric ozone production, the OH radical

burden and lifetime of methane, are discussed, as well as identifying errors which cannot be attributed to the chemical mechanism and are more sensitive to other model parameters.

2.157 Variability of Particulate Matter Concentrations During Dense Haze Period in Northeastern Pakistan.

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Abstract:

Persistent fog during winter has become a severe problem across the borders of South Asia in socio-economic context. It has caused severe health and visibility problems resulting in huge number of casualties and economic loss. Atmospheric pollutants, especially fine aerosol particles are responsible for the formation of intense fog. These aerosol particles result from combustion processes in vehicle, domestic and during industrial activities. Recently, the number of sources has increased thus contributing more towards increasing intensity and toxicity caused by the foggy conditions. Especially, the energy crisis across the South Asian countries has resulted in use of a mix of fossil fuels (biofuel, solid waste, coal, natural gas) with several question marks on their quality and renewability to deal with energy demands. The increased emissions of fine particles have provided more condensation nuclei. PM₁₀ and PM_{2.5} samples were collected at Lahore and Faisalabad sites during the winter 2015 /16 and 2016 / 17. At Faisalabad day time PM₁₀ concentrations were found to be ranged from 200 - 600 $\mu\text{g m}^{-3}$ while PM_{2.5} were 100 - 300 $\mu\text{g m}^{-3}$ while night time concentration of 790 $\mu\text{g m}^{-3}$ were observed for PM₁₀. While at Lahore due to high moisture contects night time concentrations of PM₁₀ were ranged from 500 $\mu\text{g m}^{-3}$ to 2500 $\mu\text{g m}^{-3}$. Correlation with ground based satellite AOD were also observed. Beside boundary layer / mixing height were studied during the study period, it was found that inversion layer at pressure level of 800 mb were formed during dense haze days and elevated concentration of particulate matter were found that shows the accomulation of pollution by mixing layer height.

Key words: particulate matter, inversion layer, haze, winter fog, aerosols

2.158 Isoprene Nitrate Chemistry in Beijing.

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Abstract:

An analytical system based on gas chromatography / mass spectrometry was deployed in Beijing to measure individual isoprene derived nitrates (IN). This was done as part of the AIRPRO project (An Integrated Study of AIR Pollution PROCesses in Beijing) under the NERC/NSFC Air Quality and Human Health in a Chinese Megacity programme. There were two field campaigns: one in the winter (November 2016) and one in the summer (May/June 2017).

Isoprene nitrates derived through different isoprene oxidation pathways were observed: 1) the hydroxynitrates (4,3)-IN and (1,2)-IN derived from hydroxyl radical (OH) oxidation; 2) the aldehydic nitrates E(1,4)-al-IN, Z(1,4)-al-IN, E(4,1)-al-IN and Z(4,1)-al-IN derived from nitrate radical (NO₃) oxidation; and 3) acetone nitrate (NOA) that can be derived via both OH and NO₃ oxidation of isoprene.

In winter the observed IN followed a similar pattern to many of the other observed pollutants, cycling between periods of highly polluted and cleaner days.

In the summer the hydroxynitrates, (1,2)-IN and (4,3)-IN, were found to exhibit a clear daytime maximum and to have a concentration ratio of about 4:1. Although we have previously measured the hydroxy nitrates E(1,4)-IN, Z(1,4)-IN, E(4,1)-IN and Z(4,1)-IN in simple photolysis experiments in the laboratory, we did not detect them in the field. The

aldehydic nitrates exhibited an evening/night-time peak, whilst NOA had a diel profile that was consistent with both a daytime and a night-time source.

The observed IN concentrations are assessed against observed OH, NO₃ and isoprene concentrations and compared to IN simulated by a box-model using the Master Chemical Mechanism (MCM), and by the regional WRF-Chem model using a chemical mechanism based on MOZART in combination with the Mainz Isoprene Mechanism (MIM2). In this way we evaluate understanding of the production and loss processes of the IN.

2.160 1-Octanol Water Partition Coefficient as a Predictor of Liquid-Liquid Phase Separation in Mixed Organic/Inorganic Particles.

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Abstract:

Aerosol particles interact with water vapor in the atmosphere, undergoing phase transitions and separations. One example is liquid-liquid phase separation (LLPS), which could impact the hygroscopicity and heterogeneous chemical reactivity of aerosol particles. Here, we propose to predict LLPS of mixed organic/inorganic particles using 1-octanol water partition coefficient (K_{OW}). LLPS data of single inorganic–single organic systems, including separation relative humidities (SRH), were compiled from literature. LLPS is found to occur for organic compounds with $\log K_{OW} > 0$, while it is inhibited for other cases (i.e., $\log K_{OW} < 0$). The threshold could be rationalized by change in the Gibbs free energy associated with partitioning. The positive correlation between K_{OW} and Setchenov coefficient (k_S) indicates that LLPS is driven by salting-out effect. K_{OW} explains the occurrence and suppression of LLPS for α -pinene and isoprene secondary organic aerosol (SOA). K_{OW} also implies that formation of organosulfates and organonitrates may potentially alter LLPS of SOA. Our data analysis further suggested the usefulness of solid phase extraction (SPE) in investigating LLPS of complex organic mixtures. As compared to the current predictor O:C, K_{OW} may introduce additional information on functional groups to facilitate LLPS prediction based on chemical composition. Experiments are conducted to examine the feasibility of this idea. To validate the rigorousness of K_{OW} as a LLPS predictor, deliquescence and efflorescence relative humidities (DRH and ERH) of organic mixtures after SPE are measured using Hygroscopic Tandem Differential Mobility Analyser (HTDMA).

2.161 Condensible vapours from alpha-pinene oxidation: experimental characterization of formation processes and volatility.

Early Career Scientist

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Abstract:

Atmospheric oxidation of volatile organic compounds (VOC) typically produces organic peroxy (RO₂) radicals. Their autoxidation can quickly lead to high oxygen contents and low volatilities (Ehn et al., 2014). These products, highly oxygenated molecules (HOM), can efficiently condense onto particles, producing secondary organic aerosol (SOA), a major component of tropospheric aerosol. Reactions of RO₂ radicals with each other can produce dimers (Berndt et al., 2018), which have been implicated in biogenic nucleation

(Kirkby et al., 2016). Presence of anthropogenic pollutants, such as nitric oxide (NO), can perturb the autoxidation process, suppressing the formation of dimers and forming organic nitrates (Ehn et al., 2014). To evaluate the aerosol formation potential from oxidation reactions in different conditions, it is essential to know the volatilities of the HOM formed. However, due to their exotic structures, estimating their volatility through commonly used group contribution methods is insufficient (Kurtén et al., 2016). Using state of the art instrumentation, we determined the relative volatilities of HOM formed in the ozonolysis of the monoterpene alpha-pinene. In line with previous research, we found dimers to be of very low volatility. In contrast, organic nitrates were of a relatively high volatility for their molecular mass. Due to the differing volatilities, understanding the detailed formation pathways of HOM is important in assessing their particle formation potential. However, our understanding remains limited: therefore, we tracked the behaviour of multiple RO₂ radicals and the respective dimer and other HOM products in high time resolution. As a result, we were able to map out the effect of RO₂ and NO loadings on the formed HOM, and hence particle formation potential, providing new insight on the anthropogenic impact on biogenic SOA formation.

References

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2.162 New constraints on budgets of oxidized volatile organic compounds in the remote troposphere.

Early Career Scientist

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Abstract:

Recent flight-based measurements of volatile organic compounds (VOCs) in the remote troposphere provide a unique opportunity to validate and improve the representation of these trace gases in global models, and to identify previously unknown or misunderstood aspects of their budgets. Here, we compare measurements of methanol, formaldehyde, acetone, and other oxidized VOCs from the Atmospheric Tomography (ATom) campaign to simulated mixing ratios of these compounds using GEOS-Chem, a global chemical transport model. Persistent model underestimates of formaldehyde and methanol in the remote marine troposphere suggest missing sources of these compounds, while acetone is typically overestimated in the model. Using a combination of tagged tracers, sensitivity studies, and correlations with additional trace gases, we identify potential factors in these model-measurement discrepancies, including air-sea exchange, biomass burning emissions, and photochemical reactions not previously included in the model, such as the reaction of the methyl peroxy radical with the hydroxyl radical. We further investigate the potential roles of these processes and others in the budgets of ubiquitous VOCs in the remote troposphere and discuss the extent to which these budgets remain unconstrained.

2.163 The bromine conundrum - Chemical coupling of halogens and OVOC over tropical oceans.

Early Career Scientist

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Abstract:

Tropospheric halogens are emitted from the ocean surface into the atmosphere in organic and inorganic form, and as sea-spray aerosols. Chemistry in aerosols and on aerosol surfaces releases bromide to the gas phase, leaving aerosols depleted in bromide relative to seawater. Bromine and iodine participate in catalytic cycles which destroy tropospheric ozone, impact oxidative capacity extending the lifetime of methane, oxidize mercury, modify aerosols, and can (iodine) form new particles which affect cloud cover and Earth's albedo. About 75% of global destruction of the greenhouse gases ozone and methane occurs at tropical latitudes.

Applying process-level representations of bromide liberation indicates sea-spray aerosol is the largest single source of atmospheric bromine. Such a source is particularly important near the sea surface. However, gas-phase bromine species are frequently found at low concentrations - most often below detection - in the marine boundary layer. This represents a conundrum for global models. State-of-the-art global models therefore often eliminate the sea-spray source in order to reproduce observations.

The sources of oxygenated volatile organic compounds (OVOC) over the ocean are an active area of research, significant concentrations over tropical oceans remain unexplained. Reactions of Br atom with OVOC, such as aldehydes, integrate gas-phase bromine into HBr, which is currently unmeasured. We have extended the set of known OVOC-Br reactions and represent these in the CABBA-MECCA box model along with the sea-spray aerosol bromine source to investigate bromine closure over the tropical eastern Pacific Ocean. The model is expanded to represent laboratory observations of Br+OVOC kinetics, which are currently not represented in global models, but which help reconcile field observations of BrO radicals, and size resolved aerosol bromide from a ship cruise over the tropical Pacific Ocean. Our insights provide a viable mechanism to explain the

long-standing bromine conundrum over remote oceans. The atmospheric implications are discussed.

2.164 Heterogeneous Photochemistry on Tropospheric Aerosols as an Alternative Pathway for HONO and NO_x formation.

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Abstract:

Nitric acid (HNO₃) and particulate nitrates have long been considered a sink for atmospheric NO_x. However, recent studies have shown that tropospheric aerosols provide a reactive surface for the uptake of atmospheric HNO₃, resulting in the renoxification of the atmosphere. Yet, little is known about the role of solar radiation in these atmospheric heterogeneous processes. Sunlight can excite photoactive components of atmospheric particulate matter, initiating indirect photochemical processes on nitrated particles. First, adsorbed nitric acid can undergo symmetry breaking, resulting in changes in its photochemical reactivity. Second, semiconductor components of atmospheric aerosols can induce photocatalytic decomposition of adsorbed HNO₃. Finally, chromophores within tropospheric aerosols can photosensitize nitrate particles and enhance its photodecomposition. In this work, we present the role of these three indirect heterogeneous photochemical pathways in the formation of HONO, N₂O and NO_x from chemisorbed nitric acid and nitrate particles. We present a combination of vibrational spectroscopy and quantum calculations for the study of nitrated tropospheric aerosols and gaseous products generated from its photodecomposition. First, insulator components of tropospheric aerosols, such as γ-Al₂O₃, are compared to semiconductor components (TiO₂, α-Fe₂O₃, ZnO) to contrast the heterogeneous photochemistry via symmetry breaking to that of a photocatalytic process. Photocatalysis of HNO₃ on TiO₂ was found to have the highest photochemical rate constant at $(7.6 \pm 0.6) \times 10^{-5} \text{ s}^{-1}$, almost doubling the second fastest rate constant observed, the photodecomposition of HNO₃ on γ-Al₂O₃. All heterogeneous photoreactions produced HONO, N₂O and NO_x. The effect on relative humidity on the HNO₃ photocatalysis was examined spectroscopically and computationally, with water participating in the photocatalytic reaction of HNO₃. Finally, we also present nitrate photodegradation by humic acids (HA), a proxy for humic substance in sea spray aerosol (SSA). We find that humic substances within SSA photosensitize nitrate particles and NO₂, opening an additional pathway for daytime HONO formation.

2.165 Assessing the spatial distribution and seasonal variation of atmospheric CH₂O column abundance using the GEOS-5 model and OMI retrieval.

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Abstract:

Formaldehyde (CH₂O) is a key atmospheric oxidation intermediate that is primarily formed when hydroxyl radical (OH) reacts with volatile organic compounds (VOC) and is removed by photolysis, reaction with OH or deposition. CH₂O is an important precursor for tropospheric ozone and PM_{2.5}. Therefore accurate abundance estimates and source attribution of CH₂O is of critical important for surface air quality assessments. Because its primary sources vary substantially from one region to the next and its short lifetime of just a few hours, CH₂O in the atmosphere features a highly inhomogeneous distribution. CH₂O is predominantly produced from methane oxidation in remote oceans, while nonmethane VOCs of biogenic and anthropogenic origins are primarily CH₂O sources in terrestrial and urban areas. CH₂O is detectable from satellite-based UV/visible spectrometers and global mapping of CH₂O column abundances are available from remote-sensing platforms, e.g., the Ozone Monitoring Instrument (OMI) and the Suomi National Polar-orbiting Partnership/Ozone Mapping and Profiler Suite (S-NPP/OMPS). For this work, we combine the modeled CH₂O from the NASA Goddard GEOS-5 full chemistry simulations (Nielson et al., 2017) with the OMI CH₂O retrievals (Li et al., 2015) to conduct a full evaluation of the geographic distribution and seasonal variation of CH₂O column abundances, focusing on the high CH₂O column abundance hot spot areas, e.g., the biogenic dominant Southeast U.S. and the Amazon region, the biomass burning dominant central Africa, and the anthropogenic emissions dominant East Asia region. We will conduct a suite of model sensitivity simulations to quantify the contribution of key VOCs and their emission sources to the atmospheric CH₂O abundance. The GEOS-5 CH₂O will be evaluated against OMI retrievals to assess whether the model provides a realistic representation of VOCs that are key to atmospheric air quality studies.

2.166 Atmospheric Chemistry of Nitriles (Cyano-Compounds).

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Abstract:

The atmospheric chemistry of organic nitriles is diverse and complex. Acetonitrile (CH_3CN) is found in Earth's atmosphere due to emissions from anthropogenic sources including vehicle exhaust, biomass burning, solvent use and tobacco smoke. Longer chain-length aliphatic nitriles have also been detected in interstellar space and in the atmosphere of one of Saturn's moons, Titan. Furthermore, $(\text{CF}_3)_2\text{CFCN}$ has recently been investigated as a potential replacement for the industrially important and potent greenhouse gas, SF_6 . Experimental and computational techniques were used to investigate the atmospheric chemistry of $\text{CH}_3(\text{CH}_2)_x\text{CN}$ ($x=0-4$), and $(\text{CF}_3)_2\text{CFCN}$. The oxidation kinetics and mechanisms were investigated with respect to reactions with Cl atoms, OH radicals and O_3 . Atmospheric processing yields multiple different oxygenated products. Trends in the reaction kinetics for the aliphatic nitriles follow the pattern of other substituted alkanes. The main atmospheric sink for $(\text{CF}_3)_2\text{CFCN}$ was determined to be reaction with OH radicals and the sole atmospheric degradation products of $(\text{CF}_3)_2\text{CFCN}$ appear to be NO, COF_2 , and $\text{CF}_3\text{C(O)F}$. The atmospheric lifetime of $(\text{CF}_3)_2\text{CFCN}$ is approximately 22 years resulting in an estimated Global Warming Potential of 1490, a factor of 15 less than that of SF_6 .

This presentation provides a detailed overview of the atmospheric chemistry of nitriles. The results are discussed in the context of the environmental impacts of nitriles on air quality and the radiative forcing of climate change.

2.169 Atmospheric fate of anthropogenic aerosols: Iron mobility, nitrite formation, and water uptake from fly ash particles.

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Abstract:

Combustion particles, such as fly ash (FA) aerosol from coal-fired power plants, may represent a source of bioavailable iron in the open ocean, with significant implications in global biogeochemical cycles. While FA's iron content and speciation depends closely on source region and combustion process, few studies have been made to compare the atmospheric processing and iron leaching from FA from multiple sources. We present here an investigation of iron dissolution in acidic aqueous solutions for fully characterized FA samples from three different sources: US Midwestern (USFA), European (EUFA) and Indian fly ash (INFA). To better understand their atmospheric fate, water uptake on these fly ash particles was also investigated.

Under the acidic atmospheric conditions, iron was found to mobilize primarily due to proton-promoted mechanisms. Suspensions of FA in HCl resulted in larger fractions of iron leached compared to suspensions on HNO₃. In general, dissolution showed a variability between source regions with a relative iron leach in the order USFA > INFA > EUFA. A similar order was also observed in the initial rate of iron leach, suggesting that source region is a determining factor in iron leaching from fly ash. While poorly combusted samples leached a larger fraction of bioavailable Fe(II) in HCl, in the presence of HNO₃ only Fe(III) was observed, as all leached Fe(II) was rapidly oxidized, reducing nitrates (NO₃⁻) into nitrites (NO₂⁻). Because of composition variability with source region, water uptake was studied at room temperature as a function of relative humidity (RH) on fly ash. Overall, water adsorbs on the fly ash particle surface in both an ordered (ice-like) and a disordered (liquid-like) structure. A discussion is presented on water monolayer coverage on each sample as well as a comparison between surface sites of fly ash samples the corresponding enthalpies of adsorption.

2.170 RO_x (OH, HO₂ and RO₂) uptake coefficients by ambient aerosols in Kyoto, Japan.

Early Career Scientist

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Abstract:

Atmospheric aerosols have multifaceted effects on climate and human health. The RO_x radicals (=OH+HO₂+RO₂) play the key roles in the oxidation of trace gases and the aerosol phase reactions in the atmosphere. Nevertheless, the discrepancies between the field measurements and the calculations from box modeling of RO_x radical have largely hindered our understanding of the overall RO_x recycling. The investigation of the RO_x produce and sink processes is thus important to reproduce its distributions in the atmosphere. To date, the RO_x heterogeneous uptake by the ambient aerosols, which is important for the assessment of its impact on tropospheric chemistry and the chemical evolution of particle composition through the heterogeneous reactions, and may also in part account for the RO_x sink processes, is sparsely investigated. In this study, a laser-flash photolysis and laser-induced fluorescence (LFP-LIF) detection technique is employed to measure the RO_x uptake coefficients by ambient aerosols in Kyoto (Japan) in real time. A versatile aerosol concentration enrichment system (VACES) is built to enrich the ambient particles to compensate the relative high limit of the detection (LOD) of the LFP-LIF instrument for ambient aerosol. Coupled with the additional measurement results from an aerosol mass spectrometer (AMS), a portable aerosol mass spectrometer (PAMS) and an Aethalometer, the main physical and chemical properties of the aerosol that determine the RO_x uptake coefficients will be presented.

2.171 Estimation of Volatility Parameters of Laboratory Generated α -Pinene SOA Using a Newly Characterized Thermal Denuder.

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Abstract:

This study presents the volatility of SOA formed from the ozonolysis and photooxidation of α -pinene by coupling KNU thermal denuder and KNU flow reactor. In case of ozonolysis, SOA formed in the presence of butanol (OH scavenger) showed more volatility and completely evaporated at temperature of 160°C as compared to SOA formed under ozonolysis in the absence of OH scavenger which completely evaporated at 200°C. The effect of NH₃ on the volatility of SOA formed under the conditions of ozonolysis and photooxidation was also studied. SOA formed under photooxidation was less volatile and completely evaporated at higher temperature of 220°C than 200°C observed in case of ozonolysis. SOA formed in the presence of NH₃ was less volatile as compared to the absence of NH₃ regardless of the ozonolysis and photooxidation. Furthermore, volatility profile data of SOA formed under the ozonolysis and photooxidation was utilized to estimate enthalpy of vaporization ($\Delta H_{v,2}$) and saturation vapor pressure (P^0) using two product model. For α -pinene SOA formed under ozonolysis and photooxidation, estimated values of $\Delta H_{v,2}$ and $P^0_{sat,2}$ were 21.2-29.9 kJ mol⁻¹ and order of 10⁻⁴ Pa, respectively and comparable with the previous studies.

Keywords: Thermal denuder, volatility, saturation pressure, enthalpy of vaporization, α -pinene, SOA.

2.172 Cloud processing of iron-containing particles at a mountain site, southern China.

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Abstract:

Cloud processing is a particular occasion for changing chemical property of the iron (Fe)-containing particles, and has an important application for bioavailable Fe. The potential increase of secondary species on Fe-containing particles by cloud processing may be expected to increase bioavailable Fe. In this study, a ground-based counterflow virtual impactor (GCVI) coupled with a real-time single-particle aerosol mass spectrometer (SPAMS) was used to characterize source and chemical composition of Fe-containing cloud residues (dried cloud droplets) at a mountain site, southern China for nearly one month during the autumn of 2016. Four Fe-containing particle types were obtained including Fe-rich, Fe-elemental carbon (Fe-EC), Fe-vanadium (Fe-V), and Fe-Dust. Among the Fe-containing cloud residues, the Fe-rich particles related with combustion sources, contributed to 84%, the Fe-Dust particles constituted 12%, while the remaining 4% consisted of the Fe-EC and Fe-V particles. The Fe-rich cloud residues were found to be internally mixed with the abundant sulfate and nitrate. The calcium-rich particles in the Fe-Dust cloud residues were found to enhance the in-cloud formation of sulfate, nitrate, chloride, and oxalate. The formation of these acids might promote Fe dissolution. A sharply reduction of oxalate in the Fe-containing cloud residues appeared during daytime, suggesting that photolysis of Fe-oxalate complexes occurred even in the presence of cloud events. This work provides the differences in cloud processing of the Fe-containing cloud residues from various sources and thus might further affect the solubility of Fe in the atmosphere.

2.173 Heterogeneous photochemical reactions on TiO₂ in the presence of UV irradiation.

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Abstract:

TiO₂ is an important component of mineral dust due to its efficient photochemical reactivity. Recent researches found the heterogeneous reactions on TiO₂ has a significant impact on the formation of secondary pollutions like HONO and sulfate. In this study, we used wall coated flow tube and in situ DRIFTS to study the heterogeneous reactions of SO₂ and NH₃ on TiO₂ at 298 K with or without irradiation. Both the reaction of SO₂ and NH₃ on TiO₂ under dark condition were very weak. The presence of UV irradiation was found to promote the adsorption of sulfur species and the formation of sulfate through the photo oxidation of sulfite/bisulfite species. However, UV irradiation exhibits slight effect on the initial uptake coefficient (γ_{BET}). Increase in relative humidity (RH in the range of 0-75%) led to the decrease in the γ_{BET} and uptake capacity of SO₂ both in the dark and the light reaction due to the competition effect. Adsorbed water can promote the formation of sulfate in dark reaction but decrease the conversion of sulfite to sulfate upon irradiation. It was found that NH₃ could be converted to NO_x in the presence of UV irradiation, while the presence of SO₂ inhibited the reaction of NH₃. In the presence of NH₃, formation of (NH₄)₂SO₄ species was observed during the heterogeneous reaction of SO₂ on TiO₂ under UV irradiation. These results suggest that under atmospherically relevant conditions the heterogeneous chemistry of TiO₂ can represent a potential source of sulfate and ammonium in the dust.

2.174 Sensitivity of biogenic volatile organic compounds (BVOCs) to land surface parameterizations and vegetation distributions.

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Abstract:

Current climate models still have large uncertainties in estimating biogenic trace gases, which can significantly affect atmospheric chemistry and secondary aerosol formation that ultimately influences air quality and aerosol radiative forcing. These uncertainties result from many factors, including uncertainties in land-surface processes and specification of vegetation types, both of which can affect the simulated near-surface fluxes of biogenic volatile organic compounds (BVOCs). In this study, the latest version of Model of Emissions of Gases and Aerosols from Nature (MEGAN v2.1) is coupled within the land surface scheme CLM4 in the Weather Research and Forecasting model with chemistry (WRF-Chem). In this implementation, MEGAN v2.1 shares a consistent vegetation map with CLM4 for estimating BVOC emissions. This is unlike MEGAN v2.0 in the public version of WRF-Chem that uses a standalone vegetation map that differs from what is used by land surface schemes. This improved modeling framework is used to investigate the impact of two land surface schemes, CLM4 and Noah, on BVOCs and examine the sensitivity of BVOCs to vegetation distributions in California. The measurements collected during the Carbonaceous Aerosol and Radiative Effects Study (CARES) and the California Nexus of Air Quality and Climate Experiment (CalNex) conducted in June of 2010 provide an opportunity to evaluate the simulated BVOCs. Sensitivity experiments show that land surface schemes do influence the simulated BVOCs, but the impact is much smaller than that of vegetation distributions. This study indicates that more effort is needed to obtain the most appropriate and accurate land cover datasets for climate and air quality models in terms of simulating BVOCs, oxidant chemistry, and consequently secondary organic aerosol formation.

2.175 A new reaction pathway other than the Criegee mechanism for the ozonolysis of a cyclic unsaturated ether.

Early Career Scientist

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Abstract:

Biofuels are considered to be an environmental friendly alternative to fossil fuels. Furanic compounds have been considered as second generation biofuels as they can be produced from non-food biomass. However, the atmospheric behavior of such compounds is required to evaluate their potential to be used as biofuels. The matrix isolation technique combined with infrared spectroscopy has been used to study the ozonolysis mechanism of 2,5-dihydrofuran. A new reaction pathway that is different from the widely accepted Criegee mechanism has been found. Experimental and theoretical results show the evidence of the formation of a furan–H₂O₃ complex through a dehydrogenation process. The complex is trapped in the argon matrix and stabilized through hydrogen bonding interaction. Meanwhile, the conventional ozonolysis intermediates were also observed, including the primary ozonide, the Criegee intermediate and the secondary ozonide. The present study highlights the cases in which the Criegee mechanism is not the dominant pathway for the reactions of cyclic alkenes with ozone. The cyclic alkenes that can form an aromatic conjugated system by the dehydrogenation process may follow the new mechanism when react with ozone in the atmosphere.

2.176 First observations of the aerosol vertical profiles in the Himalayan foothill region using an ultralight aircraft platform.

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Abstract:

Limited observational knowledge (especially from airborne measurements) on vertical properties of atmospheric aerosols in the Himalayan region prevents us from quantitatively assessing aerosol impacts in the sensitive Himalayan-Tibetan Plateau region. To quantify the vertical and horizontal variations of aerosol properties in this region, an airborne campaign with a single-engine, two-seater ultralight aircraft (IKARUS C 42) was carried out from the Pokhara Valley, Nepal (83.97°E, 28.19°N, 815 masl) in two phases: test flights in May 2016 (pre-monsoon) and intensive sampling flights in December-January 2017 (winter). The sampling flight plan included vertical profiling (between 1000- 4200 masl) at multiple points in mountain valleys and a horizontal south-north transect (>3000 masl) through the Pokhara Valley. A suite of aerosol instruments was deployed onboard which included a GRIMM OPC 1.108 (D_p : 300- 20000 nm), TSI SMPS (11-400 nm), TSI CPC 3375 and 3007 for the particle count, and two Magee Scientific Aethalometers (AE42 and AE 51) for BC and light absorption measurements. Sharp morning and afternoon gradients were observed in the vertical profile of aerosol number and size, mostly dominated by <400 nm particles. The gradient was much steeper in the winter than the pre-monsoon season. The elevated polluted layer was observed during the pre-monsoon season, associated with strong synoptic transport from the Indo-Gangetic Plain. The elevated layer was also observed in the winter season, only during the presence of high-pressure systems. Using the libRadtran model v2.02, the relationship of the radiative forcing (at 800 masl and 4000 masl) with the measured vertical profiles of aerosol size distribution and multi-wavelength aerosols absorption is explored. The diurnal and seasonal forcing variations, as well as the geographical variations (across different mountain valleys) are also evaluated. The aerosol radiative forcing estimates from aerial measurements are also compared with the columnar ground-based (AERONET) and satellite-based (CALIPSO) forcings.

2.177 Field evaluation of low-cost PM sensor and results of network deployment in heavily polluted Kathmandu Valley, Nepal.

Early Career Scientist

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Abstract:

Field evaluation of low-cost air quality sensors is critical in validating their performance for application in indicative and research monitoring. Notwithstanding sensing limitation and the required rigorous in-situ calibration and data quality check, such low-cost sensors could be one of the feasible means to determine air quality in developing countries. This study provides the first field evaluation of three PM sensors (Plantower PMS1003; Nova SDS011; Alphasense OPC-N2) in the Kathmandu Valley, Nepal which is one of the highly polluted urban areas in South Asia with strong seasonal emission variability. The field evaluation primarily focused on the Alphasense OPC-N2; a total of 15 identical units were locally configured and assembled into weatherproof systems and deployed in different parts of the valley after in-situ calibration for a year, from June 2017-May 2018. The results of the in-situ calibration and data validation will be presented. The influence of the relative humidity (RH) and concentration range in sensor's response (e.g., linearity) including the sensor's mean bias and error to reference measurements is also evaluated. The sensor performance with varying temperature, wind speed, and sample flow rate is also evaluated in order to determine the optimum operating condition for best sensor performance. Correction of the sensor response using multiple linear regression as well as supervised machine learning techniques will be shown. Using the network deployment in the valley the city-scale temporal and spatial variation of PM (mass/number, temperature, and humidity) and its association with local emission and meteorology will be discussed.

2.178 Determination of pathways in chemical reaction systems: an algorithm and applications to atmospheric chemistry.

Presenting Author:

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Abstract:

When a complex chemical system is analysed, a typical question is: How, i.e. via which reaction sequences (= pathways), is a certain species of interest produced or destroyed? An algorithm for the automatic determination of such reaction sequences is presented. Under the assumption that a chemical reaction system is given and reaction rates are known (from a chemical model run), the algorithm constructs all significant pathways and calculates a rate for each of them. Up to now the algorithm has been applied to analyse the chemistry in the stratosphere (ozone formation and destruction, methane oxidation, maintenance of elevated active chlorine levels through HCl null cycles), the mesosphere (HNO_3 formation by ion chemistry), the atmosphere of Mars (CO_2 formation), and the atmospheres of potential extra-solar planets.

2.179 Air quality sampling and analysis: Current and Emerging solutions for VOCs & SVOCs.

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Abstract:

Poor air quality can be linked to adverse human health effects and increased death rates, of sensitive individuals, during significant pollution events (1,2). Air quality is impacted by emissions from both anthropogenic and biogenic sources, and the understanding of the VOCs and SVOCs that are released is key to subsequent efforts to reduce these pollutants and improve air quality. This poster will highlight the current and emerging sampling and analytical technologies that are available for determining quantitatively VOCs and SVOCs concentrations in air, and their synergy with more routinely used environmental monitoring instrumentation.

Both online and offline sampling techniques will be discussed, including important validation techniques, sample security options and the importance of an inert system in the analysis of reactive species, such as monoterpenes, which are a crucial set of biogenic compounds for pollution events and key to increased ozone levels in the boundary layer (3).

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2. Stedman, J R (2004) The predicted number of air pollution related deaths in the UK during the August 2003 heatwave. *Atmospheric Environment*, 38 (8), 1087-1090
3. Lee, J.D., Lewis, A.C. and Monks, P.S. et al. (2006) Ozone photochemistry and elevated isoprene during the UK heatwave of August 2003. *Atmospheric Environment*, 40(39): 7598-7613.

3.003 Effects of ocean warming and coral bleaching on aerosol emissions in the Great Barrier Reef, Australia.

Early Career Scientist

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Abstract:

It is proposed that emissions of volatile sulfur compounds by coral reefs contribute to the formation of a biologically derived feedback on sea surface temperature (SST) through the formation of secondary organic aerosol and subsequent changes in local cloud cover. Yet the direction and strength of this feedback remains uncertain and constitutes a fundamental constraint on predicting corals ability to adapt to future ocean warming. We investigated the effects of elevated SST and coral bleaching on satellite-derived fine-mode aerosol (AOD) throughout the Great Barrier Reef, Australia (GBR) from 2000 to 2017, a period which included six mass coral bleaching events. AOD and SST were positively correlated, with AOD increasing up to 2-fold during spring and summer with high frequency variability. The correlation was strongest at low wind speed when advection of aerosol and the influence of non-biogenic aerosol was minimal, thus suggesting that the 2,300km stretch of coral reefs are a substantial, local source of aerosol under calm conditions. Importantly however, sharp declines in AOD were recorded during mass coral bleaching events. Recent evidence shows that corals shut down emissions of aerosol precursor gases when laboratory temperature perturbations exceed their physiological limits. It is thought that corals instead utilize these compounds intracellularly to cope with oxidative stress. This study agrees with those results and provides the first large-scale evidence of this phenomenon in the natural environment. We therefore posit that corals exhibit a two-stage stress response whereby elevated temperatures increase the production of biogenic aerosol and potentially lower SST through direct and indirect aerosol radiative effects. However, when continued SST rise pushes corals beyond their tolerance range, emissions of precursor compounds are shut down, resulting in a positive feedback on SST and potentially exacerbating coral bleaching.

3.004 Identification of Southeast Asian Biomass Burning from High Mountain of Taiwan.

Presenting Author:

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Abstract:

During springtime, trace gases and aerosols produced from biomass burning in Southeast Asia can be often observed in the high mountains in Taiwan. In this study, we present hourly meteorological data, trace gases, and daily aerosol samples collected at Mt. Lulin, Taiwan in 2010. Water soluble ions and trace metals of the aerosol samples are also analyzed. The indication of biomass burning from the high-mountain observations are discussed.

Results show that biomass burning emission from Southeast Asia peaked in March-April of 2010 when the collected CO and O₃ concentrations were approximately 1.8 times higher than the average concentrations obtained in other months. Biosmoke related water soluble ions, including K⁺, NH₄⁺, and NO₃⁻, were also elevated during these months. At the same periods, the total potassium showed a good correlation with Mn. All these indicate that biomass burning species were transported to the high mountain of Taiwan by the westerly winds.

The contribution of biomass burning to the background concentrations of Mt. Lulin is estimated. Our preliminary result shows that over 70% of total potassium in the high mountain is attributed to biomass burning. In addition, anthropogenic pollutants could mix with biomass burning species during their downwind transport.

3.005 Long term measurements of CO, O₃, and VOCs at Moshiri, Hokkaido in northern Japan.

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Abstract:

Atmospheric CO, O₃ and VOCs were observed at Moshiri, Hokkaido (N44.4, E142.2), a remote site in northern Japan from 2000. CO and O₃ were monitored by IR absorption and UV absorption instruments. VOCs were analyzed by GC-FID for C₂-C₁₁ hydrocarbons by weekly canister sampling. Clear seasonal cycles, high during winter-spring and low during summer, were observed for these trace gases. High concentration tended to be observed when Siberian forest fire periods. Average concentration of each VOC was related to the lifetime in the atmosphere. There was no significant long term trend for O₃ concentration. On the contrast, decreasing trend was observed for CO. CO and ethane have similar lifetime in the atmosphere, but no clear trend was observed for ethane and other VOCs. This difference would indicate that the CO decreasing trend would be caused by decreasing emission of CO, but not caused by increasing of removal process (global average OH concentration).

3.006 Strong sesquiterpene emissions from Amazonian soils as product of microbial activity.

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Abstract:

The Amazon rainforest is the world's largest source of reactive volatile isoprenoids to the atmosphere. It is generally assumed that these emissions are products of photosynthetically driven secondary metabolism and released from the rainforest canopy from where they influence the oxidative capacity through reaction with hydroxyl radicals (OH) and ozone (O₃). However, recent volatile organic compound (VOC) budgeting experiments (based on OH reactivity) show that further important sources remain to be discovered. Here we show that soil microorganisms are a strong, unaccounted source of highly reactive and previously unreported sesquiterpenes (C₁₅H₂₄; SQT). The emission rate and chemical speciation of soil SQTs were determined as a function of water and oxygen in the laboratory from soil samples. Based on these results a model was developed to predict soil-atmosphere SQT fluxes. Simulated results compared closely with SQT flux measurements in the field, so a two-year period (2014-2015) was modelled based on in-situ rainfall and soil moisture measurements. It was found that SQT emissions from a *Terra Firme* soil in the dry season were in comparable magnitude to current global model canopy emissions and that soil emissions dominated O₃ reactivity on the forest floor. SQT release and microbial activity were shown to be linked through 16S- and 18S-rRNA transcript abundances as a function of moisture in soils from a long-term forest fire experiment. Natural forest soil produces reproducible, strong emissions of SQTs, accompanied with a simultaneous increase in 16S-rRNA transcripts. In contrast, the burned forest soil generates minor SQT emissions accompanied by reduced microbial activity, establishing an important ecological connection between soil microbes and atmospherically relevant SQTs.

3.007 Biogenic New Particle Formation: Recent insights from lab and field.

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Abstract:

In this presentation, I will discuss recent laboratory and field measurements that elucidate the species and mechanisms responsible for the formation of new aerosol particles from biogenic volatile organic compounds (BVOCs). These studies were performed using instruments and facilities developed in my laboratory specifically for the study of nanoparticle composition and of low volatility gases that contribute to growth. Laboratory measurements have focused on two important aspects of biogenic new particle formation. The first is nitrate radical-initiated oxidation of monoterpenes – a process that shows remarkable variability in nanoparticle growth rates for many monoterpenes that are commonly emitted from plants, including α -pinene, which is found to contribute very little to nanoparticle growth, and β -pinene and Δ^3 -carene, which react to form readily condensable compounds. The second laboratory study focuses on the dependence of relative humidity in the formation of low volatility, highly oxidized multifunctional organic compounds from the oxidation of monoterpenes. Recent field observations have focused on the growth of nanometer-sized particles in the Amazon Basin of Brazil, where we compared the composition of nanoparticles during periods with clean background air with periods that were influenced by urban emissions. Finally, recent measurements from the Finnish boreal forest indicates that further attention should be given to the sources and role of non-terpenoid organics and the possible contribution of transported marine compounds in new particle formation.

3.008 Nitrate radical initiated atmospheric particulate matter formation in forests: Anthropogenically-triggered biogenic aerosol production .

Presenting Author:

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Abstract:

Vegetation supplies the majority of global non-methane volatile organic compounds (VOCs) emissions to the troposphere, which upon oxidation can yield secondary organic aerosol (SOA), a major component of fine particulate matter. This oxidation chemistry produces highly variable mass yields in the case of the anthropogenically controlled nitrate (NO_3) radical oxidant for different BVOC precursors, raising questions about underlying structural mechanisms. This talk will provide an overview of the complex NO_x -driven anthropogenic/biogenic interactions in aerosol formation, and will then describe recent studies that provide insight into mechanisms for NO_3 -initiated SOA formation.

3.011 Protection of higher plant from air pollution and acid rain by treatment with exogenous scavenging of reactive oxygen species.

Presenting Author:

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Abstract:

Air pollution significantly affects to physiological status and growth rate of higher plant. Ozone causes oxidative stress to plant and reduce photosynthetic activity. Acid rain damage cell walls of plant leaves. Protection of higher plant from air pollution and acid rain is important task but effective methods and skills for the plant protection have not been proposed so far. In this study we examined and developed methodology to protect plant from air pollution and acid rain by the use of exogenous scavengers of reactive oxygen species (ROS). We fumigated and exposed various air pollutants and acid mist to higher plant in greenhouse, with and without treatment with exogenous ROS scavengers such as mannitol, catechin, SOD and catalase. Mannitol has high reaction rate with OH radical, a most powerful ROS, as ascorbic acid does. After several months-fumigation and treatments with ozone, polycyclic aromatic hydrocarbons (PAHs) and sulfuric acid with the ROS scavengers, photosynthetic activities, visible injury and growth rates of leaves of trees and agricultural crops were measured and compared with the control treatment. The results showed that mannitol was most effective to mitigate the plant damage of plant by ozone, PAHs and sulfuric acid, whereas other ROS scavengers were also moderately effective. Mitigation mechanism of plant damage by the treatment with mannitol was not clarified yet in this study but this compound may act as an anti-oxidant through exogenous applications and eventually protect plant from air pollution and acid rain.

3.012 Investigating biomass burning aerosol in North America.

Early Career Scientist

Presenting Author:

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Abstract:

Fires and the aerosols that they emit have important implications for air quality, visibility, health, and climate, but the abundance and properties of carbonaceous aerosol (both black carbon and organic carbon) from biomass burning remain uncertain and poorly constrained. To explore this, we compare GEOS-Chem model simulations driven by a variety of fire emissions inventories (Global Fire Emissions Database version 4 (GFED4), Quick Fire Emission Dataset (QFED), and Fire INventory from NCAR (FINN)) to black carbon (BC) and organic aerosol (OA) concentrations observed during three fire-influenced aircraft campaigns in North America (ARCTAS, DC3, and BBOP). To constrain the optical properties associated with these emissions, we compare MODIS aerosol optical depth (AOD) observations with AOD simulated with GEOS-Chem both during the campaigns of interest and also globally in a longer, ten-year simulation. Comparing ten years of MODIS AOD against two chosen inventories - a bottom-up approach using fire counts, GFED4, and a top-down one employing fire radiative energy, QFED, brackets the uncertainty associated with emissions. This ten-year simulation provides additional insights on seasonal and interannual trends of emissions and AOD across the inventories.

3.013 Satellite evidence of substantial rain-induced soil emissions of ammonia across the Sahel .

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Co-Authors:

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Abstract:

In regions with distinct dry and wet seasons such as the Sahel, the start of the rainy season triggers a pulse of biogeochemical activity in surface soils known as the Birch effect. Field and lab studies have sometimes, but not always, observed pulses of NH_3 after the wetting of dry soils, but the potential regional importance of these emissions remains poorly constrained. Here we use satellite retrievals of atmospheric NH_3 using the Infrared Atmospheric Sounding Interferometer (IASI) in combination with satellite-based observations of precipitation, surface soil moisture, and nitric dioxide (NO_2) concentrations, to present evidence of substantial precipitation-induced pulses of NH_3 across the Sahel at the onset of the rainy season in 2008. In the Sahel, the highest concentrations of NH_3 occur in pulses during March and April, when biomass burning emissions estimated for the region by the GFED4s database are low. Changes in NH_3 concentrations are significantly correlated with changes in soil moisture during the period from mid-March through April, when the peak NH_3 concentrations occur ($r=0.28$, $p=0.02$). The correlation is also present when evaluated on an individual pixel-basis during April ($r=0.16$, $p<0.001$). Using a simple box model, average emissions for the entire Sahel are between 2 and 6 $\text{mg NH}_3 \text{ m}^{-2} \text{ day}^{-1}$ during peaks of the observed pulses, depending on the assumed effective lifetime. These early season pulses are consistent with surface observations from the INDAAF network, which show an uptick in NH_3 deposition at the start of the rainy season for sites in the Sahel. The NH_3 peaks also broadly correspond to peaks in tropospheric NO_2 concentrations, which have previously been attributed to the Birch effect. Box model results suggest that pulses occurring over a 35-day period in March and April are responsible for roughly one fifth of annual NH_3 emissions from the Sahel.

3.015 High- and low-temperature pyrolysis profiles describe volatile organic compound emissions from western US wildfire fuels.

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Abstract:

Biomass burning is a large source of volatile organic compounds (VOCs) and other trace species to the atmosphere. VOCs are precursors to secondary pollutants including ozone and fine particles, and also have direct effects on human and ecosystem health. Multiple complex processes take place in biomass burning, including distillation, pyrolysis of solid biomass, flaming combustion, and non-flaming processes. In a given fire, these processes occur simultaneously, but the relative importance of each process can change with time, which relates to the variability in integrated VOC emissions between different fires. Measurements collected with a proton-transfer-reaction time-of-flight mass spectrometer during the FIREX 2016 laboratory intensive were analyzed with Positive Matrix Factorization, in order to understand the instantaneous variability in VOC emissions from

biomass burning, and to simplify the description of these types of emissions. Despite the complexity and variability of emissions, we found that a solution including just two emission profiles, which are mass spectral representations of the relative abundances of emitted VOCs, explained on average 85% of the VOC emissions across various fuels representative of the western US. Importantly, the profiles were remarkably similar across almost all of the fuel types tested. For example, the correlation coefficient r of each profile between Ponderosa pine (coniferous tree) and Manzanita (chaparral) is higher than 0.9. We identified the two VOC profiles as resulting mainly from high-temperature and low-temperature pyrolysis processes known to form VOCs in the heating of biomass. The average atmospheric properties (e.g. OH reactivity, volatility, etc) of the two profiles are significantly different. The two pyrolysis processes differ significantly from the tradition “flaming” and “smoldering” categories that are based on modified combustion efficiency (MCE). This new framework may provide a more robust and widely applicable description of emissions composition and may lead to better prediction of SOA yield from wildfires.

3.017 The simulations of the long-range transport of aerosols emitted from the Siberian forest fire in September 2016.

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Abstract:

The large and continuous forest fire emission occurred around Lake Baikal in September 2016. The surface concentration of black carbon (BC) was observed at the “R/V Mirai” from August 2016 to September 2016 in Arctic Cruise (MR16-06), and the maximum BC concentration was detected in 25–26 September around Aleutian Islands. We perform aerosol transport simulations using the Nonhydrostatic Icosahedral Atmospheric Model (NICAM) - SPRINTARS with mesh size about 56 km to determine the forest fire impacts on the long-range transport of BC and organic carbon (OC) from Lake Baikal to Aleutian Islands. This model consistently calculates the emission, transport, and deposition of the aerosols, by relaxing the meteorological fields (horizontal wind, temperature) of the model to those of the reanalysis data. We use daily fire flux of BC, OC, and SO₂ of the CAMS Global Fire Assimilation System (GFAS). One noticeable advantage was achieved by replacing the model’s injection height of forest fire events by the observational injection height using GFAS dataset, while the emission scheme of previous model used constant injection height about 3 km. We successfully reproduce the maximum of carbon concentration in 25–26 September around Aleutian Islands, in agreements with the MR16-06 observation. Since the injection height of this events was about 2 km around Lake Baikal, the carbon concentration of new model is smaller than that of previous model (injection height about 3 km). In addition, we compared the simulated results with Himawari-8 data provided from JAXA, and found that the NICAM-SPRINTARS captured the high aerosol optical thickness (AOT) area moving from Lake Baikal (21 Sep.) to Aleutian Islands (25-26 Sep.) through Northeast China (22-23 Sep.) and the Sea of Okhotsk (23-24

Sep.) consistent with the observation. These results indicate that the NICAM-SPRINTAR is capable of simulating fine scales transport processes of carbon.

3.021 Past variations of atmospheric methane and its isotope ratios reconstructed from firn air and ice core measurements.

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Abstract:

Analyses of air occluded in polar ice cores and porous layers of ice sheets (firn) have shown secular increase of atmospheric CH₄ abundance at decadal and longer time scales over the industrial era, but our understanding of historical changes in CH₄ sources is still limited. Carbon and hydrogen isotope ratios ($\delta^{13}\text{C}$ and δD) of CH₄ are useful tracers of different CH₄ sources, which have their own characteristic isotope signatures. Earlier works have tried to reconstruct $\delta^{13}\text{C}$ and δD changes over the last decades from firn air analyses. However, precise reconstructions of $\delta^{13}\text{C}$ and δD in both polar regions and their inter-polar differences have been difficult because of limited sample availability and variety of uncertainties associated with the lack of atmospheric CH₄ concentration history before 1980s, large corrections for isotopic fractionation due to molecular diffusion in firn, and measurement offsets among laboratories who have contributed to Arctic and Antarctic datasets. We here analyzed CH₄ concentration, $\delta^{13}\text{C}$ and δD in firn air from YM85 and Dome Fuji in Antarctica and North GRIP (NGRIP) in Greenland, as well as two Antarctic ice cores (G15 and H15) based on the same analytical techniques and scales. In addition, we measured NGRIP firn air for halocarbons as strong constraints on diffusivity profile in our firn-air transport model. In our presentation, we address problems in reconstructing $\delta^{13}\text{C}$ and δD histories from ice cores and firn air, present the reconstructed $\delta^{13}\text{C}$ and δD variations in both polar regions, and discuss changes in CH₄

emissions from different source categories over the last decades using a chemistry transport model.

3.022 Rapid increase in N₂O emissions from continental East Asia estimated from the atmospheric observation at Hateruma Island.

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Abstract:

The National Institute for Environmental Studies (NIES) has been carrying out in-situ observations of the atmospheric greenhouse gases at Hateruma Island (HAT; lat. 24.1°N, long. 123.8°E) located off the coast of continental East Asia. Here, we present two-decadal (1996-2017) time series of the atmospheric nitrous oxide (N₂O) at HAT. The observed time series of N₂O mixing ratio show not only a steady increase and a seasonal cycle but also short-term enhancements with synoptic time scales especially during winter, when the air masses are often transported from the continental region due to the East Asian monsoon. We analyze the short-term variations to infer the temporal change in the N₂O emissions from East Asia, especially China. After removing the baseline of the N₂O mixing ratios, we compute the standard deviations of ΔN_2O^{obs} (observation - baseline) for the winter 5-month periods (Nov.-Mar.) during 1997-2016. The standard deviations gradually increase at an accelerating rate and are doubled in the two-decadal period. We simulate the short-term variations (ΔN_2O^{sim}) by using a Lagrangian Particle Dispersion Model (LPDM) and N₂O emission maps based on the EDGAR inventory. Since the LPDM simulation generally well explain the observed short-term variations, we compute the regression slopes ($\Delta N_2O^{obs}/\Delta N_2O^{sim}$) of the correlation plots between ΔN_2O^{obs} and ΔN_2O^{sim} for the winter 5-month periods. The regression slopes more than doubled during the two-decadal period when the N₂O emission map for a fixed year was repeatedly used for the entire period of the simulation. In addition, even when the N₂O emissions from China increase by about 40% during 1996-2012 according to the EDGAR v4.2 FT2012 estimation, the regression slopes still increase by about 30% during 1996-2012. These results suggest that the anthropogenic N₂O emissions from China increase more rapidly than the EDGAR estimation.

3.023 Air pollution over the North China Plain and its implication of regional transport: A new sight from the observed evidences.

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Abstract:

High concentrations of the fine particles (PM_{2.5}) are frequently observed during all seasons over the North China Plain (NCP) region in recent years. In NCP, the contributions of regional transports to certain area, e.g. Beijing city, are often discussed and estimated by models when considering an effective air pollution controlling strategy. In this study, we selected three sites from southwest to northeast in NCP, in which the concentrations of air pollutants displayed a multi-step decreasing trend in space. An approach based on the measurement results at these sites has been developed to calculate the relative contributions of the minimal local emission (MinLEC) and the maximum regional transport (MaxRTC) to the air pollutants (e.g., SO₂, NO₂, CO, PM_{2.5}) in Beijing. The minimal influence of local emission is estimated by the difference of the air pollutants' concentrations between urban and rural areas under the assumption of a similar influence of regional transport. Therefore, it's convenient to estimate the contributions of local emission from regional transport based on the selective measurement results instead of the complex numerical model simulation. For the whole year of 2013, the averaged contributions of MinLEC (MaxRTC) for NO₂, SO₂, PM_{2.5} and CO are 61.7% (30.7%), 46.6% (48%), 52.1% (40.2%) and 35.8% (45.5%), respectively. The diurnal variation of MaxRTC for SO₂, PM_{2.5} and CO shows an increased pattern during the afternoon and reached a peak (more than 50%) around 18:00, which indicates that the regional transport is the important role for the daytime air pollution in Beijing.

3.025 Methane emission from the stems of *Alnus japonica* in riparian wetlands within a temperate forest catchment.

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Abstract:

Methane (CH₄) is a strong greenhouse gas with more than 20 times the global warming potential compared to carbon dioxide. Understanding the sources and emissions of CH₄ is crucially important for climate change predictions; however, there are significant discrepancies between CH₄ source estimates derived via so-called bottom-up and top-down methods. Anoxic wetland ecosystems are considered to be the largest contributor to natural CH₄ emissions, accounting for more than 20% of the global CH₄ source. Recently, wetland-adapted trees have attracted a considerable attention because of its potential significance as a new emission source of atmospheric CH₄, in which CH₄ produced by methanogens in soil are believed to be transported upward inside the stem and diffused to the atmosphere through woody stem surfaces, yet the magnitude and controls of tree-mediated emission processes remain unknown. In our study, we have conducted measurements of CH₄ emission rates from the stem surfaces of *Alnus japonica* (*Alnus japonica* (Thunb.) Steud.) in riparian wetlands within a temperate forest catchment. A near-infrared laser spectroscopy instrument and closed chamber systems enables us in-situ continuous measurements of CH₄ emission rates, revealing that meteorological conditions and soil environment are associated with the spatio-temporal variations in the CH₄ emission rates.

3.027 Spore emission of shiitake mushroom (*Lentinula edodes*) as one of bioaerosol particles: Shape and size characteristics.

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Abstract:

Radionuclides were released to natural environment by FDNPP (Fukushima Dai-ichi Nuclear Power Plant) accident and those were deposited on forest and soil grounds. High volume air samplers were set in mountain area in Namie town, Fukushima prefecture. The atmospheric radiocesium concentration increased in summer. The genome analysis for the collected particles indicated the contaminated mushroom spores were one of the major causes of such seasonal variation of atmospheric radiocesium. Evaluations of the amount of emitted spore is important in order to assess the long-term effect of the contaminated suspended materials on human health. This study focuses on the emission mechanism of spore of shiitake mushroom (*Lentinula edodes*). Particle size and shape of the mushroom are measured by a digital microscope. The results show the area equivalent particle diameter of fresh spore and dry spore are 4.44 μm and 3.93 μm , respectively. The shape of fresh spore is oval and the length of long axis is about 1.5 times longer than that of short axis. In addition, PIV (Particulate Image Velocimetry) analysis measured the velocity of spore emission from the gills of mushrooms.

3.028 Top-down estimates of carbon monoxide fluxes from tropical biogenic emissions.

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Abstract:

Biogenic emissions in the tropics produce a significant portion (~25%) of the global carbon monoxide (CO) budget. We present results from a new top-down estimate of CO fluxes from these sources using a Markov Chain Monte Carlo (MCMC) Bayesian approach to re-partition CO fluxes following inversion of Measurements Of Pollution In The Troposphere (MOPITT) CO observations with the GEOS-Chem model. We compare these results to the prior information for CO from biogenic non-methane volatile organic compounds (NMVOCs) from GEOS-Chem, which uses the Model of Emissions of Gases and Aerosols from Nature (MEGAN) for biogenic emissions and to top-down estimates of isoprene emissions using Ozone Monitoring Instrument (OMI) formaldehyde observations. We find similar seasonality in the posterior CO and top-down isoprene estimates for equatorial West Africa, which both vary significantly from the MEGAN apriori. This method for estimating biogenic sources of CO has the potential for diagnosing decadal scale changes in emissions due to land-use change and climate variability.

3.029 Investigating the global emission and transport of bioaerosols: combining modeling tools with ground-based and aircraft observations.

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Abstract:

Bioaerosols are ubiquitous in the global atmosphere. They can influence cloud formation by acting as ice nuclei (IN) in their entirety or as cloud condensation nuclei (CCN) after rupturing into smaller particles when exposed to high humidity. Their presence in surface air can also have adverse effects on public health and agriculture. However, their concentrations are not well constrained, which inhibits our understanding of their impact on air quality and climate. We present simulations of global bioaerosol emissions, including fungal spores, pollen and bacteria, and their atmospheric transport using the GEOS-Chem chemical transport model. Emissions of fungal spores are described by a newly developed emission scheme, while we have implemented existing schemes for pollen and bacteria. The fungal spore emission scheme is developed by first deriving fungal spore fluxes from observed concentrations at various locations across the US, and by subsequently relating those fluxes to meteorological and land surface variables. We evaluate simulated concentrations of bioaerosols with ground-based and aircraft observations. We assess both the ability of the model simulations to represent seasonal variations in bioaerosol concentrations for various land use types, and the ability of the simulations to describe the vertical transport of biological aerosol particles to heights at which they can participate in cloud formation.

3.030 N₂O and NO processes in soil.

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Abstract:

Nitrous oxide (N₂O) is an important greenhouse gas and its atmospheric concentration is increasing as a result of increased use of nitrogen fertilizers in the world. However, its emission from ecosystems occurs sporadically and suddenly and prediction of the magnitude of emission is still quantitatively difficult because its production processes from soil are not fully understood. Furthermore, nitric oxide (NO) and nitrogen (N₂) are important in soil nitrogen processes and NO is a precursor of N₂O and N₂ is a product from N₂O during denitrification processes. Then, we are investigating N₂O production processes in soil with emissions of nitric oxide (NO) and nitrogen (N₂) in laboratory. We constructed a system to simultaneously measure NO, N₂O, and N₂ from soil in laboratory. And we are investigating emissions of these gases in relation with various parameters such as temperature, soil moisture, oxygen (O₂) concentration and so on. By making it possible to control O₂ concentration, the effects of O₂ and soil moisture can be separately considered. Denitrification processes are considered to be major in N₂O emission. In our experiments, during denitrification processes: a lot of NO was produced in soil; it is revealed that soil water is found to be important to process reactions from NO to N₂O and N₂O and N₂ by blocking gas transports in soil and giving longer residence time of NO and N₂O in soil.

3.031 Seasonal pattern of aerosol optical depth over Southern West Africa.

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Abstract:

This study investigates the seasonal pattern of aerosol optical depth (AOD) in Southern West Africa (SWA). From December 2015 to April 2017, a network of a new type of lightweight handheld sun photometer has been deployed at 4 sites located in Côte d'Ivoire and Bénin. Observations were acquired at two sites located at the seashore in Abidjan and Cotonou and 200 km northward inland at Lamto and Savè. AOD were measured daily at 465, 540 and 619 nm by local operators. The AOD follows a marked seasonal cycle with maxima observed during the winter dry period (December-March) when the Harmattan wind brings southward mineral dust and biomass burning aerosols. AOD can reach a maximum of 3.5 during mineral dust outbreaks in Cotonou, and 1.8 in Abidjan, which is located farther from the main dust sources. The analysis of the aerosol Angstrom exponent shows that mineral dust represents 35% of the observations with a mean AOD of 1.0 ± 0.4 . Biomass burning events are 15% of the observations with a mean AOD of 0.7 ± 0.2 . During the dry season, the AOD is well correlated ($R=0.7$) to the particulate matter (PM) surface concentration, highlighting the low altitude transport of aerosol in the Harmattan layer. The comparison between the sun photometer observations and the MODIS-derived AOD shows an excellent agreement for both urban and rural sites and is used to infer surface PM concentrations in SWA over the last decade.

3.032 Evaluating Global Biomass Burning Emission Inventories for CO in Australasia..

Early Career Scientist

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Abstract:

Knowledge about Australasian biomass burning emissions is under-represented in emission inventories. There was, therefore, a need to evaluate whether some of the mainstream global biomass burning emission inventories are suitable for the Australasian region. GEOS-Chem v10-01 was run, from 2008 to 2010, with three biomass burning emission inventories: FINN1.5, QFED2.4 and GFED4s; and an ACCESS-UKCA simulation with GFED4s was used as a comparison to also evaluate model variability. These four simulations were compared to a range of observations including surface mixing ratios, ground-based FTS total columns and satellite-based MOPITT total columns at five sites in Australasia: Cape Grim, Cape Ferguson, Lauder, Wollongong and Darwin. A previously documented high bias in CO levels was also found in both models, although it is slightly higher in GEOS-Chem. The three inventories were found to have up to an order of magnitude difference in their estimates of Australian biomass burning CO emissions, with FINN lowest and QFED highest. Bias aside, GEOS-Chem with GFED and QFED led to better correlation against measurements than either GEOS-Chem with FINN or ACCESS-UKCA with GFED. This poster demonstrates that GFED performs the best over the Australasian region and should, therefore, be used for this region. This study also highlighted that the FINN inventory requires improvements in its estimates of Australian savanna CO emissions.

3.033 Variation in atmospheric CO₂ and CO concentrations emitted from biomass burning inferred from GOSAT/TANSO–FTS and MOPITT data.

Early Career Scientist

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Abstract:

This study has focused on biomass burning in Africa and studied the relationship between carbon monoxide (CO) and carbon dioxide (CO₂) concentrations emitted due to the biomass burning by using CO₂ vertical profiles (Version 1) from the thermal infrared (TIR) band of Thermal and Near infrared Sensor for Carbon Observation Fourier Transform Spectrometer (TANSO–FTS) on board Greenhouse Gases Observing Satellite (GOSAT) [Saitoh et al., 2016] and CO vertical profiles (Version 6) retrieved from the combined use of the TIR and near infrared (NIR) bands of Measurement Of Pollution In The Troposphere (MOPITT) [Deeter et al., 2014].

In the latitude region around 10°N over Africa, TANSO–FTS CO₂ concentrations at 200–300 hPa were 2 ppm higher than a priori CO₂ concentrations taken from NIES–TM05 model [Saeki et al., 2013] from December to February when active biomass burning events occurred there frequently. MOPITT CO concentrations there were clearly higher in the lower troposphere from December to January and in the upper troposphere from February to March. We have compared monthly-averaged CO data from the MOPITT TIR/NIR bands with monthly-averaged detrended CO₂ data from the TANSO–FTS TIR band at 200–300 hPa in the northern low latitudes over Africa from 2009 to 2014. The comparison result showed that both TANSO–FTS CO₂ and MOPITT CO concentrations became higher almost at the same time. The periods of increase in the upper tropospheric CO₂ and CO concentrations were in January–March and in February–April, respectively, which slightly shifted from the periods of increase in their a priori concentrations. The amounts of the observed increase were larger compared to their a priori concentrations. We have analyzed backward trajectories of air masses with high CO and CO₂ concentrations observed by GOSAT/TANSO–FTS TIR band and MOPITT TIR/NIR bands to identify their sources.

3.034 Experimental study on motion characteristics of saltating grains under crusted soils related to the dust emission in drylands.

Early Career Scientist

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Abstract:

Desertification is spreading in the world, and environmental change on the global scale is occurring. One of the peculiar phenomena in drylands is dust. Dust generated by saltation not only decreases agricultural productivity due to loss of nitrogen and phosphorus contained in surface soil and increases health damage due to air pollutants such as PM_{2.5}, but also affects the global climate. Soil crust is one of the ground surface conditions that affect dust generation (Ishizuka et al., 2012).

In this study, wind tunnel experiments are conducted to clarify the mechanism of soil crust destruction and particle motions under crusted soils. Toyoura sand is used as saltating grains and Mongol soil which has relatively larger particles (Loam) is used as a target soil. In addition to the Mongol soil, Kasaoka soil which has relatively fine particles (Silty clay loam) was used.

As a result of the wind tunnel experiment, the lift-off angle of saltating grains is larger in the Mongol soil than that in the Kasaoka soil. The lift-off velocity decreases due to the loss of kinetic energy after saltating grains hit the ground surface for both the Mongol soil and the Kasaoka soil. As for the amount of soil erosion weight under non-aggregated condition, the Mongol soil is more eroded than the Kasaoka soil. PTV (Particle Tracking Velocimetry) analysis by using a high-speed camera (8000 fps) shows the reduction rate

of kinetic energy in the Mongol soil is larger than that in the Kasaoka soil. As for the amount of soil erosion weight of the Mongol soil under aggregated condition, the more moisture supplied, the less amount of soil is eroded by saltating grains.

3.035 Development of Online Continuous Relaxed Eddy Accumulation System Coupled with Ion Chromatographs.

Early Career Scientist

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Abstract:

A relaxed eddy accumulation system coupled with ion chromatographs (REA-IC) was constructed and optimized to capture the flux of ammonia and other water-soluble gases. The instrument assembly is based on the ambient ion monitoring ion chromatographs (AIM-IC) adapted following Markovic et al. (2012). The system uses wet parallel plate denuders to capture water-soluble gases, namely NH_3 , HNO_3 , HONO, HCl, and SO_2 followed by automated IC analysis every hour. Conditional sampling of up- and downdrafts is achieved using data acquisition system developed by Pattey et al. (1996) coupled with a sonic anemometer. REA fluxes are calculated using concentration difference between up- and downdraft reservoirs, standard deviation of the vertical wind speed, and a proportionality factor. Accurate flux measurements using this technique requires excellent precision between the respective reservoirs. Based on REA simulations that are informed by eddy covariance NH_3 fluxes over maize crops following fertilization, maximum fluxes of $\sim 50 \text{ umol m}^{-2} \text{ h}^{-1}$ leads to a concentration difference of less than 30% between the two reservoirs, emphasizing the need for high measurement precision. Preliminary lab tests showed a relative precision of $\sim 10\%$ for NH_3 and HONO concentrations measured in both up and downdraft reservoirs. Normalization based on a lithium bromide (LiBr) internal standard made an improvement on the precision. The use of LiBr also facilitates diagnosis of the instrumentation and background influence of the denuder assemblies. Preliminary field tests were carried out in an agricultural area during the growing season over maize crops that had been fertilized by urea. The ability to resolve NH_3 fluxes can help assess the utility of different agricultural management practices.

3.036 Biosphere-atmosphere exchange of nitrogen oxides: a study above a mixed hardwood forest during the 2016 PROPHET-AMOS campaign.

Early Career Scientist

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Abstract:

Nitrogen oxides ($\text{NO}_x = \text{NO} + \text{NO}_2$) are important constituents in the atmosphere because they can control ozone production and undergo oxidation reactions with other species. Deposition and transport of NO_x can impact the ecosystem by influencing the nitrogen cycle, vegetation health and forest carbon storage. Here, we present observations of nitrogen oxides mixing ratios and eddy covariance fluxes above a forest from the 2016 PROPHET-AMOS summer field campaign using a custom built AQD NO_{xy} instrument. This field site is in a mixed deciduous and coniferous forest located in northern Michigan, with a research tower PROPHET available for above-canopy measurements. Observations made at 29 m show that NO and NO_2 have median midday mixing ratios of 50 ppt and 500 ppt respectively. A maximum mixing ratio of NO resulting from photolysis of NO_2 is frequently observed in the early morning. HYSPLIT back-trajectory analysis was applied to identify flow regime, and hourly NO_x mixing ratio and flux data were separated into clean and polluted (transition periods included) conditions. The diurnal variations of NO_x (in particular that of NO_2) between clean and polluted periods showed distinct patterns, indicating that long-range transport of nitrogen oxides is important to the local budget. During the day we observed upward NO and downward NO_2 fluxes; an example of flux divergence driven by a large gradient in light above and below the canopy. Overall, NO_x fluxes were close to zero during clean periods indicating that the local ecosystem is not a source of NO_x to the atmosphere. During polluted periods, NO_x fluxes were consistently negative, and scaled with mixing ratios, indicating net deposition. The 1-D canopy model FORCAST was able to reproduce the patterns in mixing ratios and fluxes, including the observed flux divergence, which is associated with photochemistry and turbulent mixing occurring on comparable timescales.

3.037 The role of biomass burning and other natural sources affecting the Arctic summer atmospheric composition.

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Abstract:

The Arctic lower troposphere in summer time is generally characterized by relatively clean and pristine conditions, due to less efficient transport from lower latitudes and more efficient wet removal processes during this time of the year. As a result, local and regional natural/biological sources play a more important role in the Arctic under these conditions. In this study, we use GEM-MACH, an on-line chemical transport model, to investigate sources and processes influencing summertime atmospheric composition in the Canadian Arctic. Model simulations of an intensive field campaign conducted over the Canadian high Arctic during the summer of 2014 were carried out, and results were compared with in-situ measurements from multiple platforms. Here we focus on North American (NA) boreal biomass burning, emissions from seabird (guano) colonies, and the process of terrestrial bi-directional exchange of ammonia. We show that the episodes of relatively high aerosol concentrations observed in the Canadian high Arctic during transient periods are contributed by the NA wildfire emissions, either by direct impact of biomass burning plumes or indirectly through the accumulative impact of biomass burning emissions on the NA background concentrations. We also show that both NA boreal wild fires and emissions from seabird colonies are contributors to periods of high NH₃ concentrations observed in the Arctic. The impact of emission from seabird colonies is particularly important in the Arctic summer (due to its intensity and close proximity, and given the relatively short atmospheric lifetime of NH₃). In addition, NH₃ observed in the Canadian high Arctic can also be influenced by the terrestrial bi-directional exchange process.

3.039 Seasonal variation of surface methane observed in North India: An investigation on the contributions of emissions and transport.

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Abstract:

It is not straightforward to connect CH₄ emissions from the surface with the total column amount (XCH₄) that is obtained from passive nadir-sensors such as TANSO-FTS/GOSAT, as discussed in Chandra et al. (ACP, 2017). To reduce the uncertainty in CH₄ emissions on a regional scale from inverse analysis, information of CH₄ vertical distribution is critically important especially in North India where deep convection driven by Asian monsoon circulation lift atmospheric CH₄ to upper troposphere in summer (Xiong et al., ACP, 2009). For that reason, we started weekly flask sampling in North India at Karnal (29.7N, 76.9E) in 2014, which was later moved to Sonapat (29.0N, 77.2E) in 2015. The CH₄ mole fraction in the collected air samples was measured at NIES by gas chromatography with a flame ionization detector (GC-FID) with the NIES 94 CH₄ scale. Both of the sampling sites are situated in the middle of rice paddy fields where the local CH₄ emission should be the highest in the summer monsoon season (August-September). However, the 4-years long record at those stations indicate that the CH₄ concentration is in winter (December-January). This seasonality in surface observations is opposite to that has been reported from GOSAT, showing peak in summer. Comparison with model simulation by ACTM developed in JAMSTEC suggests that the CH₄ builds up at the surface during the winter because of the slow loss rate of CH₄ in the whole northern hemisphere, in addition to the weak vertical and horizontal transport (Patra et al., JMSJ, 2016). It is noteworthy that chemical analysis of the sampled air indicates clear positive correlation between CH₄ and CO. Besides, trajectories suggest significant air subsidence over Karnal/Sonapat in winter. Complete picture of sources and transport of the CH₄ will be presented by combined analysis of air-sampling data, trajectories and model simulations.

3.040 Carbonyl Sulfide: new ways of Observing the Climate System.

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Abstract:

The future climate of our planet strongly depends on the capacity of the biosphere to sequester atmospheric CO₂, and on the abundance of stratospheric sulfate aerosols (SSA). These aerosols form a layer that resides at about 16 km altitude that, contrary to CO₂, has a cooling effect on climate. These two climate-regulating mechanisms are intricately linked to the atmospheric trace gas carbonyl sulfide (COS).

COS is the most abundant sulfur compound in our atmosphere. The dominant COS source is biogenic activity in the ocean, while uptake by the terrestrial biosphere, and a small amount of destruction in the stratosphere, contribute to its removal. The COS loss to the biosphere could potentially be used to quantify photosynthetic CO₂ uptake, while its stratospheric destruction is an important precursor for the formation of SSA. A deeper understanding of atmospheric COS variations would therefore signal a major step forward in our ability to diagnose CO₂ uptake and SSA formation.

We recently started an ERC-funded research program (COS-OCS) to fundamentally improve our limited understanding of the COS budget. The program will combine innovative modelling and measurements, including air core and highly challenging analyses of COS isotopologues. In this overview, recent scientific insights will be presented concerning the exchange of COS with the biosphere. These insights include evidence of night-time uptake by vegetation, bidirectional COS exchange from soils, and isotopic fractionation during COS uptake by bacteria. Subsequently, I will highlight the main uncertainties in the COS budget, and prospects for combined modelling and measurement activities to reduce these uncertainties.

3.041 How regional to global biogenic isoprene emission responses to changes in vegetation from 2000 to 2015 .

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Abstract:

Isoprene, a dominant biogenic volatile organic compound that is mainly emitted by trees, has a significant impact on the atmospheric chemistry. Regional to global changes in biogenic isoprene emission associated with vegetation variations between 2000 and 2015 were estimated using the MEGAN model with satellite land cover data for inputs in this study. The satellite data estimates of land cover changes were compared to results from previous investigators that have either conducted regional studies or have used lower resolution land cover data. The analysis indicates that tree coverage increases of >5% occurred in 13% of locations including in central China and Europe. In contrast, a decrease of >5% was observed in about 5% of locations, especially in tropical regions. The trends in global tree coverage from 2000 to 2015 resulted in a global isoprene emission decrease of only 1.5%, but there were significant regional variations. Obvious decreases in tree coverage in some tropical areas (e.g. Amazon Basin, Western Africa, Southeast Asia) resulted in a ~10% reduction of regional isoprene emission due to agricultural expansion. Distinct increments of isoprene emission (5~10%) were mainly found in Northeast China and India and were associated with afforestation efforts. Deforestation and afforestation associated with managed plantations does not only affect the total forest coverage, but also impacts average isoprene emission capacity, which can result in accelerated isoprene emission variations. Consequently, isoprene variation assessments are needed that not only account for changes in vegetation fractions, but also consider the changes in plant species compositions of forests and other landscapes.

3.043 Bioaerosol emission and its role in re-emission of radioactive cesium from forest in Fukushima.

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Abstract:

Primary bioaerosols have recently been remarked by their possible roles in the environment, such as ice-nuclei formation and health influence. In this study, we show another role of bioaerosol in the environment: re-emission of radioactive cesium (radiocesium) from forests polluted by radiocesium.

Radionuclides emitted in the Fukushima dai-ichi nuclear power plant (FNDPP) accident in March 2011 have been deposited on the soil, ocean and vegetation. Re-suspension/emission of radiocesium from the soil and vegetation to the atmosphere may be one of significant paths in the diffusion of radiocesium after the accident. We have measured the concentration of atmospheric radiocesium activity at a heavily-polluted area in Fukushima, by sampling aerosols with high-volume air samplers. This observation showed that major part of the sampled coarse particles were carbonaceous, probably biogenic particles, such as spores and bacteria in summer and autumn, between June and October, indicating that a large amount of bioaerosol could be emitted from forest around Fukushima.

The atmospheric radiocesium activity concentration significantly increased in this period, and was positively correlated with amount of carbonaceous particles in these seasons. Bioaerosol sampling and genome analyses showed that major coarse particles in these seasons were probably spores of fungi and stain. We counted the spores collected on the sample filters to evaluate their number density, and found the number density was positively correlated with the atmospheric radiocesium activity concentration. We collected fungi near observation site to sample its spores to measure radiocesium activity per one spore. These results indicated that atmospheric radiocesium activity could be attributed to spores in the atmosphere. Water solubility of atmospheric radiocesium in

these seasons suggests possibility of its circulation between the atmosphere and biosphere.

3.045 Primary and secondary biogenic organic aerosols in a midlatitudinal forest in Wakayama, Japan.

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Abstract:

Both primary biological aerosol particles (PBAPs) and oxidation products of biogenic volatile organic compounds (BVOCs) contribute significantly to organic aerosols (OAs) in forested regions. However, little is known about their relative importance in diurnal timescales. We report biomarkers of PBAP and secondary organic aerosols (SOAs) for their diurnal variability in a temperate coniferous forest in Wakayama, Japan. Tracers of fungal spores, trehalose, arabitol and mannitol, showed significantly higher levels in nighttime than daytime ($p < 0.05$), resulting from the nocturnal sporulation under near-saturated relative humidity. On the contrary, BVOC oxidation products showed higher levels in daytime than nighttime, indicating substantial photochemical SOA formation. Using tracer-based methods, we estimated that fungal spores account for 45% of organic carbon (OC) in nighttime and 22% in daytime, whereas BVOC oxidation products account for 15 and 19%, respectively. To our knowledge, we present for the first time highly time-resolved results that fungal spores overwhelmed BVOC oxidation products in contributing to OA especially in nighttime. We also present the genetic diversity of fungal species contributing to OC. This study emphasizes the importance of both PBAPs and SOAs in forming forest organic aerosols.

3.046 Comparisons of XCO₂ data from SWIR and TIR bands of GOSAT/TANSO–FTS.

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Abstract:

This study has assessed the quality of CO₂ data retrieved from the thermal infrared (TIR) band [Saitoh et al., 2016] of Thermal and Near-infrared Sensor for Carbon Observation–Fourier Transform Spectrometer on board Greenhouse Gases Observing Satellite (GOSAT) by comparing the column-averaged dry-air mole fractions (XCO₂) calculated based on the TIR CO₂ data with aircraft XCO₂ data, XCO₂ data from Nonhydrostatic Icosahedral Atmospheric Model–based Transport Model (NICAM–TM) [Niwa et al., 2011, 2012, 2017], and XCO₂ data retrieved from the short-wave infrared (SWIR) band [Yoshida et al., 2011, 2013] of TANSO–FTS. Overall, TIR XCO₂ data agreed with SWIR XCO₂ data to within 1% on average over the ocean and the land except the Sahara in the Northern Hemisphere after applying TIR CO₂ bias-correction values proposed by Saitoh et al. [2017]. In the Southern Hemisphere, TIR XCO₂ data were slightly larger than SWIR and NICAM–TM XCO₂ data, which suggests overcorrection of the negative biases in TIR CO₂ data. In background regions without any strong CO₂ sources like Hawaii, bias-corrected TIR XCO₂ data agreed with SWIR XCO₂ data to within 0.2% on average and showed much better agreement with NICAM–TM XCO₂ data, which demonstrates a certain degree of consistency between CO₂ measurements by the two bands. We have evaluated the consistency between the two bands through comparisons of bias-corrected TIR and SWIR XCO₂ data with XCO₂ data obtained in the Comprehensive Observation Network for TRace gases by AirLiner (CONTRAIL) project [Machida et al., 2008] by applying TIR and SWIR CO₂ averaging kernel functions to the aircraft CO₂ data over airports. The results showed that there were some disagreements among the three XCO₂ data in some seasons and regions, which suggests the seasonal and regional dependence of quality of CO₂ data from the two bands of TANSO–FTS.

3.049 Long-term decline of stable carbon isotopic composition of oxalic acid in marine aerosols from the western North Pacific: Atmospheric implication for an enhanced emission of terrestrial organic matter.

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Abstract:

Oxalic, malonic and other dicarboxylic acids comprise an important fraction of water-soluble organic aerosols in various environments. A rapid industrial development in China and East Asian countries for last two decades may have caused a serious change in the air quality and atmospheric composition over the North Pacific. To better understand long-term atmospheric changes in the western North Pacific, we collected marine aerosol samples in 2001-2013 on weekly basis at a remote island Chichijima (27°04'E; 142°13'N), which is located in the boundary of westerly and easterly wind regimes. Here, we present distributions of dicarboxylic acids (diacids, C₂-C₁₁) and stable carbon isotopic composition (δ¹³C) of oxalic acid using a GC/combustion/isotope ratio monitoring MS (GC/IR/MS) technique.

We found a strong seasonal change in δ¹³C values of oxalic acid with summer maxima and winter minima, e.g., seasonal shift from -22‰ in winter to -4‰ in summer in 2006. The significant enrichment of ¹³C in oxalic acid with higher values in summer should be associated with photochemical aging of organic aerosols in the marine atmosphere; that is, kinetic isotopic fractionation during the photo degradation of oxalic acid in the presence of Fe (III), and/or gas/particle partitioning reaction of glyoxal and glyoxylic acid, potential precursors of C₂.

We also found a decadal decrease in the stable carbon composition of oxalic acid from 2001 to 2013 by ca. 3‰. The decadal decrease can be most likely explained by an enhanced input of continental organic matter (isoprene and biomass burning) from East Asia over the western North Pacific. An increased emission of CO₂ by fossil fuel combustion may potentially contribute to enhance the emission of isoprene, whereas the corresponding decline of δ¹³C (0.2‰) due to fossil fuel CO₂ may contribute to decrease in δ¹³C of terrestrial plants and their isoprene emissions.

3.050 Long-term trend of tropospheric N₂O isotopocule ratios in the Northern Hemisphere .

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Abstract:

Nitrous oxide (N₂O) is one of the increasing greenhouse gases and is the most important stratospheric ozone-depleting gas emitted in the present century. Isotopocule ratios of N₂O, which include not only elemental ¹⁵N/¹⁴N and ¹⁸O/¹⁶O ratios but also site-specific ¹⁵N/¹⁴N ratio in asymmetric NNO molecule, are regarded as useful parameters to infer the origin and production-consumption mechanisms of N₂O, and to estimate its global budget. Previous studies on the firn air in polar ice sheet revealed the secular trend of isotopocule ratios, but there have been only a few reports on long-term monitoring of atmospheric N₂O isotopocule ratios in the Northern Hemisphere.

We present up to 19-year record of monthly or biweekly mixing ratio and isotopocule ratios of N₂O obtained at three sites in the Northern Hemisphere: Hateruma, a southwestern island of Japan (24°N, 124°E) (since 1999), Novosibirsk in the western Siberia, Russia (55°N, 83°E) (since 2005), and Churchill, northern Canada (59°N, 94°W) (since 2011). Results show that the bulk nitrogen isotope ratio (d¹⁵N^{bulk}) are decreasing at the similar rate (about -0.04‰ yr⁻¹) as reported by firn-air analysis while the N₂O mixing ratio are increasing (about 0.8 ppbv yr⁻¹) at the three sites. This suggests isotopically light N₂O sources such as agriculture are still contributing to the increase in the atmospheric N₂O. Detailed analysis of the time series reveals that year-to-year variation of the mixing ratio and d¹⁵N^{bulk} has been enhanced since around 2010 at all the three sites, and that vertical gradient of the mixing ratio and d¹⁵N^{bulk} over Novosibirsk has been also variable recently. Cause of these findings will be discussed with respect to temporal change in N₂O flux and isotopic signature of surface sources and change in atmospheric circulation including troposphere-stratosphere exchange, with the aid of atmospheric model simulation.

3.052 Estimation of sulfur and nitrogen input/output budget on the small river catchment by long-term observations at Russian EANET Primorskaya station.

Early Career Scientist

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Abstract:

The ecosystems in Russian Far East is suspected to be under the changing transboundary air pollution and, hence, related effect of atmospheric compound loads is one of indispensable topics of environmental studies.

The present study is conducted for Komarovka river catchment at the Russian Far East where one of the EANET sites, Primorskaya, was established in 2002. For the first approach we used a simplified input-output budget calculation for pollutants. The budget calculation assumed: the input consists of total (dry and wet) deposition while the output is presented solely by the discharge with the river water. The budget was calculated for sulphur and nitrogen compounds for years 2005-2015 using monitoring data.

Firstly we calculated separately the chemical compound fluxes by wet deposition, dry deposition and river runoff. The trend analysis was also performed for annual concentrations and their fluxes. Notably declining trends with evident significance were disclosed in time series of dry deposition fluxes. Significant trend was found neither for the fluxes by wet deposition nor for those by river runoff.

We found that wet deposition is higher than dry one for most of the years at Primorskaya except for 1-2 years only. This proves more contribution of precipitation fall-out to the total deposition which depends on climatic patterns of this region.

Budget estimation demonstrates that the output of sulphur compounds (SO_x) were higher than the input for most of the years at river catchment. In opposite, for nitrogen compounds (NH_x and NO_x) the input exceeded the output.

Similar research is seldom in Russia due to the need of the whole range of monitoring

data. We do comparison of our results with data obtained from other published catchment studies. The uncertainties of applied approach for balance evaluation are simultaneously discussed

3.054 Surface Ozone Concentration Impacts on Agriculture From Stratospheric Sulfate Injection.

Early Career Scientist

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Abstract:

Solar radiation management using stratospheric aerosols has been proposed to reduce anthropogenic global warming, and studies have shown that its cooling effects, along with precipitation and solar radiation reduction, would influence agriculture production differently in different regions. However, surface ozone concentration change has not been considered in any previous agriculture studies. Simulated solar radiation management impacts the ozone budget. We use the G4 Specified Stratospheric Aerosol (G4SSA) scenario, in which 8 Tg SO₂ is injected into the stratosphere each year from 2020 to 2069 to counteract warming from RCP6.0 forcing. Under G4SSA, surface ozone would decrease over agricultural regions compared with RCP6.0. We assess how surface ozone changes under G4SSA impacts agriculture production, and whether this surface ozone change is as important as the cooling and precipitation changes. We use the crop model in the Community Land Model, version 5 (CLM5-crop) coupled with an ozone damage module and simulate rice, maize, winter wheat, soybean, cotton and sugarcane in the current planting regions. We perform two sets of crop simulations (with/without ozone damage) for G4SSA and for the global warming reference run RCP6.0. Agriculture practice (e.g., fertilizer usage and seeds) and planting area are fixed in both runs. With the ozone damage module turned on, regional ozone concentration changes would alter stomatal conductance and photosynthesis rate, and hence change crop production. With less ozone in most agriculture regions in G4SSA compared with RCP6.0, ozone changes show positive impacts on crop yields in most regions. The crop production increases due to reduced surface ozone under G4SSA are less than the benefit from cooling effect.

3.055 Quantifying the impact of African pollution on the Tropical Troposphere of the Atlantic.

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Abstract:

The population of Africa is expected to double to 2.5 billion people by 2050 (UN Population Division), with the population of mega cities, such as Lagos, Nigeria, reaching over 20 million people (from the current 11 million). In August 2016 and February 2017, flights of the Atmospheric Tomography (ATom) mission over the Atlantic and Pacific oceans (from 65S to 85N) intersected a zone of strong pollution extending across many degrees of latitude, emanating from Southern and Western Africa, respectively. The emissions from southern Africa were dominated by biomass burning and dust. However, the West African emissions indicated a mix of oil and gas, biomass burning and Saharan dust sources. Using the trace gases measured during ATom, including profiles of carbon monoxide (CO), we quantify the impact of these emissions on the tropical troposphere in the Atlantic sector.

3.056 Chemical characterization of wet deposition at a tropical urban city.

Early Career Scientist

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Abstract:

The chemical composition of rainwater has not been intensively studied in the urban area of Río Piedras, Puerto Rico. Through this research, we aimed to characterize the chemical composition of the wet deposition received in this region and contrast to the rainwater chemistry of a forested area located at El Verde Field Station in the National Forest El Yunque. Weekly sampling was conducted from 2014 to 2016 at the two sites. All samples collected were analyzed for pH, conductivity and concentrations of Ca^{2+} , Na^+ , Mg^{2+} , NH_4^+ , K^+ , SO_4^{2-} , NO_3^- and Cl^- . The highest records of conductivity were found in the Río Piedras station, with a mean of 48.64 $\mu\text{S}/\text{cm}$, while at El Verde the mean conductivity was 14.64 $\mu\text{S}/\text{cm}$. This notable difference could be due to the high concentrations of vehicles in the urban area, which emit many contaminants to the atmosphere capable of altering the chemical composition of rainwater. Cl^- was the dominant chemical species at both sites, but its concentration was higher at the urban station ($p < 0.01$). A comparison between the sea-salt and non-sea salt fractions for this species was made and a strong correlation ($r \sim 0.98$) was found between Cl^- and Na^+ at El Verde, which is different to what was found at Río Piedras, where there is a weak correlation between the two. The major source for Cl^- at El Verde appears to be mostly marine, which can be justified by its proximity to the ocean.

3.057 Simulation of carbon dioxide transport and variability with the NASA-Unified WRF regional model.

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Abstract:

Knowledge of carbon cycle science, especially spatial-temporal variability of carbon sources/sinks, is vital to understand the carbon-climate interaction that remains the major source of uncertainty in future climate prediction. Part of the problems arises that mechanisms and processes controlling CO₂ fluxes and variability occur at relatively small spatial and/or rapid temporal scales. Thus, a high-resolution regional model may help filling the knowledge gap and reduce the uncertainty. With the support of NASA's Modeling Analysis and Prediction program, the NASA-Unified Weather Research and Forecasting model (NU-WRF) has been coupled with the Carnegie-Ames-Stanford Approach (CASA) biogeochemical model and the Parameterized Chemistry Transport Model (PCTM) to simulate CO₂ transport and variability at fine spatial resolutions. The coupling model system (NU-WRF-CASA) was designed to operate in an internally consistent manner in which NASA's Goddard Earth Observing System Model, version 5 (GEOS-5) that included the production of NASA's Modern-Era Retrospective Analysis for Research and Applications, version 2 (MERRA-2) can be applied to drive each model component. A 3-year simulation was carried out to evaluate its performance under various landscapes, topographies, and environmental conditions. Observational CO₂ data from tower, flask, and flight measurements were used for model evaluations. The results show that NU-WRF-CASA can reproduce the spatial-temporal transport and variability reasonably well. The simulation demonstrates the model skills in resembling inter-annual, seasonal, daily, and diurnal variabilities in atmospheric CO₂ distribution under both drought and normal conditions.

3.060 How do warm-core eddies affect methane emission into the atmosphere in the southwestern Canada Basin? .

Early Career Scientist

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Abstract:

Methane (CH_4) is a potent greenhouse gas and plays major roles in both tropospheric and stratospheric chemistry. During the last two centuries, atmospheric CH_4 has increased by 1000 ppb and reached to 1834ppb in 2015 as a result of anthropogenic activities. Amount of CH_4 emission into the atmosphere is attractive to the scientists, due to remarkable changing in global warming. The ocean acts as one of the sources of atmospheric CH_4 , and the CH_4 flux can vary depending on the oceanic region owing to the difference in biological activities and physical condition. In the Arctic Ocean, a massive CH_4 hydrates from marine sediments release and/or methanogenic CH_4 producing in anaerobic environment with the presence of high organic matter on the seafloor and then diffusion into water column was examined. However, the vertical CH_4 distribution is still scarce, so it needs to be examined for comprehension of CH_4 dynamics.

A noted point is vertical CH_4 distribution inside/outside of the warm-core eddy (WCE), which had been observed. We consider that WCEs are generated as a result of instability of Alaskan Coastal Current through Barrow Canyon. A coherent mesoscale eddy is one of the possible mechanisms for transporting the shelf-water from Chukchi Sea into the Canada Basin (CB) interior. The existence of WCE implies that it would transport nutrients as well as CH_4 from the Chukchi Sea shelf-water to the CB. Seawater samples were collected to capture vertical CH_4 distribution in the CB during R/V Mirai (MR15-03) in summer 2015. We found that a broad spreading of sub-surface CH_4 peaks in depth inside the radius of eddy's velocity maximum has been compared to outside of WCE. A sinking mechanism inside of WCE is explained by vertical mixing associated with the velocity shear. Discussion of contribution of CH_4 emission between WCE and cold-core eddy will be shown.

3.061 Emissions of Biogenic VOCs from major tree species in Japan: Improvement of monoterpene emission algorithm.

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Abstract:

Biogenic volatile organic compounds (BVOCs) are emitted by vegetation. The annual global emissions of BVOCs are estimated to be several times greater than annual anthropogenic VOC emissions. Monoterpenes emitted from trees have important roles in atmospheric chemistry through the formation of secondary organic aerosols and photochemical oxidants. The emission rates and patterns can be affected by changing climate and air quality. We and our colleagues reported that monoterpene emissions from Japanese cedar and Japanese larch depended on temperature. However, several high monoterpene emission rates were observed after rain fall events. To improve a monoterpene emission algorithm, we performed a field experiment and investigated the relationship between monoterpene emission rates and volumetric soil water content (SWC) at Japanese cedar and Japanese larch. In addition, we measured monoterpene emission rates of Japanese cedar under different CO₂ concentrations (control: ambient CO₂ level, elevated CO₂: 1000 ppm). We found a high positive correlation between monoterpene emission rates and SWC at Japanese cedar and Japanese larch. The monoterpene emission rates estimated by considering temperature and SWC better agreed with the measured monoterpene emission rates, when compared with the emission rates estimated by considering temperature alone. Interestingly, degree of SWC effect on the monoterpene emission rates differed by CO₂ concentration. We suggest that the combined effects of SWC and CO₂ concentration are important for controlling the monoterpene emissions.

3.062 Chemical transfer of dissolved organic matter from surface seawater to sea spray aerosol in the marine atmosphere.

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Abstract:

It is critical to understand how variations in chemical composition in surface seawater (SSW) affect the chemistry of marine atmospheric aerosols, because this information is required for quantitative estimate of the atmospheric chemistry and climate impacts of sea spray aerosol (SSA). We investigated the sea-to-air transfer of dissolved organic carbon (DOC) by cruise measurements of both ambient aerosols and SSW during phytoplankton pre-bloom in the Oyashio and its coastal regions, the western subarctic Pacific. SSA was defined by stable carbon isotope ratio of water-soluble organic carbon (WSOC) ($\delta^{13}\text{C}_{\text{WSOC}}$) and the concentrations of organic molecular tracers (e.g., monosaccharides) in marine aerosol samples together with local surface wind speed data obtained during the cruise. For both SSA and SSW samples, excitation-emission matrices (EEMs) were obtained to examine chemical transfer of fluorescent organic material, specifically protein-like and humic-like substances. We found that ratios of fluorescence intensity of humic-like/protein-like substances in the submicron SSA were significantly larger than those in the bulk SSW ($53 \pm 24\%$). The larger ratio was also found for the supermicron SSA compared with the SSW. The result suggests significant decomposition of protein-like DOC on timescale of <12–24 h and/or preferential production of humic-like substances in the atmospheric aerosols regardless of the particle size. This study provides unique insights into the complex transfer of organic matter, mostly related to marine biological activity, from the ocean surface to the atmosphere.

3.063 Multi-component observations of biomass burning plumes by MAX-DOAS and sky radiometer at Phimai, Thailand in the dry season of 2016.

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Abstract:

The first intensive multi-component ground-based observations by multi-axis differential optical absorption spectroscopy (MAX-DOAS) and sky radiometer were performed at the SKYNET/Phimai site located around central Thailand (15.18°N, 102.56°E) from January to April 2016. The period corresponds to the dry season of 2016 associated with the intense biomass burning activity around the site. For the period, the ratio of glyoxal to formaldehyde concentrations (R_{GF}) near the surface was estimated from MAX-DOAS observations to be about 0.028, which was lower than that of wet seasons. In wet seasons, the volatile organic compound (VOC) emission was dominated by biogenic activities. This response of R_{GF} to VOC sources was found to be consistent with results from satellite observations reported in literatures. On the other hand, the sky radiometer observation with UV-VIS-NIR channels allowed us to retrieve wavelength (λ) dependent aerosol optical properties, including the absorption aerosol optical depth (AAOD). Strongly enhanced UV absorption (e.g., the mean AAOD of ~ 0.06 at 380 nm) as an approximate function of λ^{-2} over UV-VIS-NIR was observed, while most of current chemistry-transport models assume that organic carbon (OC) aerosols from biomass burning were purely scattering aerosols. Thus, our multi-component observations characterize intense biomass burning plumes around central Thailand, providing unique constrains of VOC-OC chemistry.

3.064 Measurement Of Isoprene Sea-To-Air Fluxes At The Ocean-Atmosphere Interface.

Early Career Scientist

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Abstract:

Sea surface microlayer (SML) as the ocean-atmosphere interface releases isoprene that effects the oxidative capacity of the atmosphere and act as a source for secondary organic aerosols. Estimating isoprene flux from the SML under *in situ* conditions is of prime importance in understanding the interactions between the ocean and the atmosphere for global climate models. Measuring isoprene flux from the SML remains a great challenge because the current sampling methods such as screens or glass plates are not practical for highly insoluble gases. A chamber coupled with sorbent tube as a solventless extraction method is suitable for flux measurement. The main objective of this study is to present a new approach to measure isoprene flux from the SML under *in situ* condition. A system consist of a floating flux chamber coupled with sorbent tubes have been developed, tested and optimized. Isoprene emitted from the SML was trapped in the floating chamber. Sampling of isoprene was performed during daytime by adsorption into 1TD sorbent tubes using low flow pump. Samples were analysed using thermal desorption unit coupled with gas chromatography mass spectrometry. Recent year 2017 measured isoprene fluxes located at the tropics region ranged from 8.3 to 34.3 ($\times 10^7$) molecules $\text{cm}^{-1} \text{s}^{-1}$ and mean 19.7 ± 7.3 ($\times 10^7$) molecules $\text{cm}^{-1} \text{s}^{-1}$. The measurement of isoprene flux from the SML under *in situ* conditions is expected to

improve the estimation of the ocean isoprene fluxes. This approach also have the capacity to measure fluxes for other type of trace gases emitted from the SML.

3.065 Production of bromoform in sea ice and emission to the atmosphere.

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Abstract:

Bromoform (CHBr_3) is one of the important bromine containing volatile halocarbons that are involved in ozone depletion in the atmosphere. Although the possible source of reactive bromine species from snow and sea ice has been discussed, mechanisms that control CHBr_3 production within sea ice and emission to the atmosphere remain unclear. Here, we show evidence of massive CHBr_3 production at sea ice surface-snow interfaces and its strong emission to the atmosphere from five field-campaigns to the Arctic Ocean, the Southern Ocean, and the Sea of Okhotsk in the winter and spring, in addition to supporting laboratory experiments. We found that the ice-related strong CHBr_3 emission was linked to the production of the CHBr_3 at the snow-sea ice interface through the haloform reaction. Our results suggest that sea ice acts as a strong CHBr_3 source for the atmosphere, indicating a significant contribution to the atmospheric bromine cycle.

3.068 Measurements of carbon and hydrogen isotope ratios of atmospheric methane in the northern North Pacific and the Arctic Ocean and interpretation of Arctic methane sources.

Early Career Scientist

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Abstract:

There are large and important natural CH₄ sources in northern high latitudes, but their emissions and spatial distribution are not well understood yet. Simultaneous measurements of carbon and hydrogen isotope ratios ($\delta^{13}\text{C}$ and δD) of atmospheric CH₄ would help us to separate contributions from different types of sources (e.g., biogenic or thermogenic) to atmospheric CH₄; however, the isotope data are still sparse, especially in boreal North America and Siberia. In this study, we measured atmospheric CH₄, $\delta^{13}\text{C}$, and δD on board the research vessel MIRAI in the northern North Pacific and the Arctic Ocean in summer to autumn in 2012–2016. We also estimated the representative CH₄ isotope source signatures in their surrounding areas. A clear latitudinal gradient is observed for atmospheric CH₄, $\delta^{13}\text{C}$, and δD from 36°N to 76°N; northward increase of CH₄ and decrease of $\delta^{13}\text{C}$ and δD are evident. This suggests that biogenic CH₄ sources are dominant in northern high latitudes in the summertime. By applying a single mixing equation to the data observed at latitudes higher than 55°N, the average isotope signatures over 2012–2016 are estimated to be $-65.6 \pm 1.6\text{‰}$ for $\delta^{13}\text{C}$ and $-361 \pm 45\text{‰}$ for δD . The results are similar to the values reported previously for boreal wetland CH₄ sources. A five-day backward trajectory analysis shows that air parcels with high CH₄ come mainly from land areas of Alaska and Northern Canada and partially from Siberia. CH₄ emissions from surface water in the Arctic Ocean would not be prominent in summer to autumn in 2012–2016.

3.069 Longitudinal distributions of DMS and pCO₂ in the surface seawater and atmosphere in the subarctic North Pacific during the summer cruise of 2007 (MR07-04) .

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Abstract:

In order to investigate the longitudinal distributions of major climate relevant gases, such as dimethylsulfide (DMS) and carbon dioxide (CO₂), in the subarctic North Pacific in the summer, continuous measurements of these gases in both the surface seawater and atmosphere were carried out during the transect cruise at 47°N from 160°E to 120°W in the summer of 2007 by R/V Mirai (MR07-04 cruise). Abrupt increases in the DMS concentration in both the surface seawater and atmosphere were observed between 180° and 160°W from 1-5 nM (160°E-180°) to 30 nM (180°-160°W) for seawater DMS and from several hundred pptv (160°E-180°) to 1-3.5 ppbv (180°-160°W) for atmospheric DMS. The sea-air DMS flux was estimated to be the highest (100-150 μmol/m²/day) between 180° and 170°W due to the high seawater DMS concentration and high wind speed associated with low-pressure systems. The atmospheric pCO₂ was approximately constant (370 μatm), and the seawater pCO₂ exhibited large variations, ranging from 320 to 400 μatm. While the seawater pCO₂ was lower than the atmospheric pCO₂ for most measurement positions at this latitude, the seawater pCO₂ was sporadically higher than that in air at 170°E and between 170°W and 160°W. At the latter longitude where a high DMS flux was calculated, CO₂ was emitted into the atmosphere, i.e., the ocean was a source of atmospheric CO₂ (2-10 mmol/m²/day). The concentration of bio-Ca in the suspended particles of seawater was high at this longitude, suggesting an increase in coccolithophores, which are known as high DMSP producers, and CO₂ was released into the seawater when forming coccoliths. From our discussion based on our measurement data and the literature, it can be said that the production of DMS and CO₂ in the seawater was likely to be enhanced between 170°W and 160°W due to increases in coccolithophores.

3.070 Iodide to feed the machine: a machine-learning built parameterization for sea-surface iodide using new observations, which impacts the ozone budget and iodine emissions.

Early Career Scientist

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Abstract:

Halogens (Cl, Br, I) in the troposphere have been shown to play a profound role in determining the concentrations of ozone and OH. Iodine, which is essentially oceanic in source, exerts its largest impacts on composition in both the marine boundary layer, and in the upper troposphere. This chemistry has only recently been implemented into global models and significant uncertainties remain, particularly regarding the magnitude of iodine emissions. Iodine emissions are dominated by the inorganic oxidation of iodide in the sea surface by ozone, which leads to release of gaseous inorganic iodine (HOI, I₂). Critical for calculation of these fluxes is the sea-surface concentration of iodide, which is poorly constrained by observations.

Previous parameterizations for sea-surface iodide concentration have focused on simple regressive relationships, mostly based on sea-surface temperature. The choice of parameterization used in global models leads to differences in iodine fluxes of approximately a factor of two, and substantial differences in the modelled impact of iodine on atmospheric composition.

Here we use an expanded dataset of oceanic iodide observations that incorporates new data that has been targeted at locations that had poor coverage. This is combined with a data-driven multivariate machine learning technique using climatological products (e.g. temperature, salinity) to generate a model that better captures the observations in both coastal and open-ocean regions.

This improves estimates of the global sea surface iodide spatial distribution, with a global average magnitude (3.2×10^{-6} kg/m³) between to the two parameterisations most commonly used in the literature (2.3×10^{-6} kg/m³, 5.0×10^{-6} kg/m³). We then use a global chemical transport model (GEOS-Chem) to show the atmospheric impacts compared to the previously used parameterisations, including increased iodine emissions (~40%) and a modest impact of decreasing tropospheric ozone burden (~1%).

3.073 Leaf uptake of atmospheric monocyclic aromatic hydrocarbons by plants.

Early Career Scientist

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Abstract:

Plants are reported to remove several species of volatile organic compounds (VOCs) from the atmosphere. The uptake of VOCs by plants contributes directly to the purification of the atmosphere and indirectly to suppression of the generation of photochemical oxidants such as ozone. Aromatic hydrocarbons including phenol and benzyl alcohol are ubiquitous VOCs in the atmosphere. We determined leaf uptake rate of these compounds by *Spathiphyllum clevelandii*, *Osmanthus fragrans*, *Quercus acutissima* and *Quercus myrsinifolia* at several part per billion by volume using a measurement system consisting of a proton transfer reaction mass spectrometer (PTR-MS), infrared gas analyzer, diffusion device and two leaf enclosure bags. One bag contained the plant leaf (sample bag) and the other bag was empty (blank bag). We calculated the VOC uptake rate, net photosynthetic rate and transpiration rate from the concentration differences of VOC, CO₂ and water vapor, respectively, between sample and blank bags. These uptake rates varied with VOC species and plant species. *S. clevelandii* absorbs phenol and benzyl alcohol more rapidly than low molecular weight ketones and aldehydes. We also found that the *S. clevelandii* leaves exposed to phenol emitted anisole. It might be produced by methylation of phenol inside the leaf.

3.075 PERIODIC AND CONTINUOUS MONITORING OF ATMOSPHERIC FORMALDEHYDE AROUND THE METROPOLITAN CITIES OF LAHORE, MULTAN, ISLAMABAD BY USING CAR MAX-DOAS.

Early Career Scientist

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Abstract:

An oxygenated Volatile Organic Compound (VOC), Formaldehyde, essentially contributes to the hazardous tropospheric ozone pollution in urban areas. Emissions from automobiles are the major contributors towards elevated formaldehyde concentrations in major urban cities of Pakistan, exposing the population to a polluted urban environment. This study was planned to quantify the formaldehyde concentration at two fixed places in the cities of Islamabad and Lahore for a period of two years and three months respectively. Besides Islamabad, the periodic mobile monitoring of HCHO over Lahore, Islamabad and Multan Pakistan was also included in the designed study. MAX-DOAS (Multi-Axis - Differential Optical Absorption Spectroscopy) instrument was used to measure the diurnal, weekly and annual cycle in HCHO concentration at fixed station and field campaigns. The diurnal concentration trend exhibited maxima in morning and evening and minima at the noon time. The weekly course reveals the higher values in working day and lesser values during the weekend, while the annual cycle shows the highest concentration in summer followed by spring, autumn and winter. During Field campaigns the maximum mean values of HCHO over Lahore were found to be 164, 108, 283 ppbv, meanwhile; the maximum mean value in Multan was 161 ppbv, exceeding the limit prescribed by WHO (83 ppbv). The suspected sources of HCHO along the route were gas stations, emissions from industries including brick kilns, steel mills, oil mills etc and vehicular emissions.

Upon comparing monthly OMI satellite observations with ground-based formaldehyde values, a good correlation was noticed within the time span of 1-2 pm (PST). The allocated time was selected as it was satellite passing time over Pakistan.

3.076 Measurements of total ozone reactivity and what they tell us about biogenic organic compounds in the troposphere.

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Abstract:

Biogenic volatile organic compounds (BVOC) are emitted through plant metabolism and account for a large fraction of the organic carbon loading in the atmosphere. Only a small fraction of the total atmospheric loading and potential species of BVOC have been identified and measured, but they are known to influence several atmospheric chemical processes. Of particular interest are the reactions of BVOC with ozone (O₃) which lead to the formation of secondary organic aerosol (SOA) and are significant sources of oxidant radicals, especially at night. These reactions can also represent a significant sink for tropospheric ozone.

Total ozone reactivity is a measure of ozone chemical loss rate that does not require prior knowledge of the detailed chemical composition of the BVOC pool. We report measurements of total ozone reactivity (TOR) made using a newly developed instrument designed to measure the decay of a known quantity of ozone caused by the presence of unsaturated hydrocarbons, such as BVOC. The instrument was extensively tested in the laboratory using nitric oxide (NO) and selected BVOC (isoprene, α -pinene). Together with a proton-transfer-reaction mass spectrometer, the TOR instrument was then used to study BVOC+O₃ chemistry in a chamber with lemonthyme plants (*Thymus citriodorus*) and in a tree branch enclosure. The results of these experiments demonstrate the validity of this approach and provide new insight into the importance of BVOC/O₃ interactions for the Earth's carbon budget and for the tropospheric ozone cycle.

3.077 Potential co-benefits of intercropping as a sustainable agricultural practice for both air pollution mitigation and global food security.

Early Career Scientist

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Abstract:

The fast-growing world population will impose a severe pressure on our current global food production system. Meanwhile, boosting crop yield by increasing fertilization comes with a cascade of environmental problems including air pollution. Globally, agricultural activities contribute up to ~90% of total ammonia (NH₃) emissions. Such emissions are attributable to ~20% of the fine particulate matter (PM_{2.5}) formed in the downwind regions, which could be a severe health risk to densely populated cities. Field studies of intercropping of legumes and non-legume crops have demonstrated its potential to enhance crop yield, lower fertilizer use, and thus reduce NH₃ emission by taking advantage of legume nitrogen fixation and enabling mutualistic crop-crop interactions. Our work employs a modeling approach to evaluate the effectiveness of large-scale adoption of intercropping in China on safeguarding food production and air quality. We revise the process-based biogeochemical model, DeNitrification-DeComposition (DNDC), to capture the belowground interactions of intercropped crops, and show that adopting intercropping nationwide can generate the same amount of maize plus an extra batch of soybean with only ~60% of fertilizer required by its monoculture counterpart, which can correspondingly reduce the NH₃ emission by more than 40% over China. Using the GEOS-Chem global 3-D chemical transport model, we estimate that such an NH₃ reduction can

lessen downwind inorganic $PM_{2.5}$ concentrations by up to 2.1%, saving the country up to US\$1.5 billion each year on air pollution-associated health damage costs. We further add to the Community Land Model (CLM) two new schemes for parametrizing intercropping and estimating soil NH_3 emission to further appraise the multifold benefits of a worldwide shift from the current practice to intercropping. This study can be used as a scientific basis to evaluate the costs and benefits of adopting intercropping as a means to maintain a sustainable global food supply while minimizing environmental impacts.

3.078 Development of a large volume sampling system for measuring stable isotope analysis of carbonyl sulfide.

Early Career Scientist

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Abstract:

Carbonyl sulfide (OCS) is the most abundant sulfur-containing gas in the ambient atmosphere, with an average mixing ratio of 500 parts per trillion (ppt) by volume in the troposphere (Chin and Davis, 1995) and possess great potential for tracer of carbon cycle. OCS is taken up by vegetation during photosynthesis like absorption of carbon dioxide but OCS is not able to emit by respiration of vegetation, suggesting possible tracer for gross primary production. However, current figures for tropospheric OCS sources and sinks carry large uncertainties.

Recently, our group developed new method measuring sulfur isotopic composition of OCS using fragmentation ions S^+ (Hattori et al., 2015). However, for applying our method to air, there is problem in collection over 8 nmol of OCS from air. Therefore, we developed OCS collection system in air and measured sulfur isotopic composition of OCS in air. For developing large volume collection system, we referred to the large volume collection system for carbon isotope measurement method for halocarbons (Bahlmann et al., 2011). The large volume sampling system were collected volatile organic compounds including OCS from up to 500 L in air for 100 min. At the presentation, we report that OCS collection efficiency by using our collection system and the OCS isotopic compositions in air were presented. Additionally, we introduce the collected volatile organic compound with OCS in this system and discuss the possibility of a new development to atmospheric chemistry.

3.079 Sea-to-air flux of dimethylsulfide in the South and North Pacific Ocean as measured by Proton Transfer Reaction-Mass Spectrometry coupled with the Gradient Flux technique.

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Abstract:

Exchange of dimethylsulfide (DMS) between the surface ocean and the lower atmosphere was examined by using Proton Transfer Reaction-Mass Spectrometry coupled with the Gradient Flux (PTR-MS/GF) system. We deployed the PTR-MS/GF system and observed vertical gradients of atmospheric DMS just above the sea surface in the subtropical and transitional South Pacific Ocean and the subarctic North Pacific Ocean. The DMS flux determined was in the range from 1.9 to 31 $\mu\text{mol m}^{-2} \text{d}^{-1}$ and increased with wind speed and biological activity, in reasonable accordance with previous observations in the open ocean. The gas transfer velocity of DMS derived from the PTR-MS/GF measurements was similar to either that of DMS determined by the eddy covariance technique or that of insoluble gases derived from the dual tracer experiments, depending on the observation sites located in different geographic regions. When atmospheric conditions were strongly stable during the daytime in the subtropical ocean, the PTR-MS/GF observations captured a daytime vs. nighttime difference in DMS mixing ratios in the surface air overlying the ocean surface. The difference was mainly due to the sea-to-air DMS emissions and stable atmospheric conditions, thus affecting the gradient of DMS. This indicates that the DMS

gradient is strongly controlled by diurnal variations in the vertical structure of the lower atmosphere above the ocean surface.

3.080 The natural aerosol diffuse radiation fertilisation effect on global plant productivity.

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Abstract:

Atmospheric aerosol from natural sources include primary emissions of biomass burning, sea-salt, and desert dust along with aerosol precursors from vegetation, ocean biology, and volcanoes that can subsequently form particles in the atmosphere. All these aerosol particles play an important role in the climate system through their direct and indirect radiative effects. In addition, through scattering of solar radiation these particles increase the fraction of diffuse radiation and the efficiency of photosynthesis. Here we quantify the impact of natural aerosol (e.g. biomass burning, secondary organic aerosol, volcanic aerosol) on plant photosynthesis via the diffuse radiation fertilisation effect. We use a methodology based on combining three models: (i) the Global Model of Aerosol Processes (GLOMAP), (ii) the SOCRATES radiation model, and (iii) the JULES land-surface scheme. Our results show how natural aerosol reduces the amount of total radiation reaching the surface, while increasing diffuse surface radiation. This leads to substantial enhancements of net primary productivity (NPP) over large tropical areas of the globe such as the Amazon and central Africa. We show for example that secondary organic aerosol (SOA) from biogenic volatile organic compounds (BVOC) emissions lead to a global NPP enhancement of $\sim 1.2 \text{ Pg C a}^{-1}$, which is twice the mass of BVOC emissions causing it. Hence, our simulations indicate that there is a strong positive ecosystem feedback between plant emissions and plant productivity. We also show that Amazon fires lead to an NPP increase in the Amazon basin equivalent to $\sim 50\%$ of the annual regional carbon emissions from biomass burning. While this NPP increase occurs primarily during the dry season, it actually counteracts some of the observed effect of drought on tropical production. Finally, we find that current levels of anthropogenic pollution aerosol suppress some of the natural aerosol diffuse radiation fertilisation effect.

3.081 Influences on spring and summer-time tropospheric ozone in Western Siberia and the Russian Arctic: a model and satellite analysis.

Early Career Scientist

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Abstract:

High latitudes have warmed disproportionately relative to mid-latitudes. This warming is predominantly controlled by radiative forcing from well-mixed greenhouse gases, amplified by efficient Arctic climate feedbacks. However, warming from changes in short-lived climate pollutants (SLCPs), such as tropospheric ozone precursors and aerosols, also contribute to Arctic warming. Arctic SLCP abundances are controlled by long-range transport from mid-latitudes, and by local sources within the Arctic. At present, high latitude emissions of SLCPs and ozone precursors are poorly quantified, particularly in Russia, where there is a paucity of in-situ observations. A full understanding of the impact of SLCPs on the Arctic is partly hampered by poor knowledge of processes controlling SLCPs in northern Siberia, which is home to large sources of anthropogenic and natural emissions. This region is also a key route for import of SLCPs to the Arctic lower troposphere from northern Europe and Asia.

In this study we use the regional chemistry transport model WRF-Chem, in conjunction with observations from ground sites and the Ozone Monitoring Instrument (OMI) satellite instrument, to evaluate processes controlling the regional ozone distribution during the Western Siberian spring and summer. Model sensitivity simulations are used to assess the influence of different ozone sources and sink processes in the region. We assess the influence of NO_x source sectors on ozone over Siberia and the Russian Arctic, including comparison between anthropogenic sources and wildfires. Model comparisons with OMI NO_2 observations are used to highlight potential emission biases in the region. We also assess the sensitivity of Siberian ozone to uncertainties in simulating dry deposition,

specifically with regard to parameters controlling ozone uptake to Boreal vegetation – an important ozone sink in the region. Our study provides insight into the relative importance of anthropogenic emissions compared with natural biosphere processes in controlling Siberian tropospheric ozone.

3.082 Air pollution in rural ecosystem: The issue being neglected so far.

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Abstract:

Currently, policy decision and actions on air quality mainly consider on mobile emissions resulting in urban air pollution. In Myanmar, the developing country, rural air quality becomes a challenge since several rural areas have exceeded the national air quality standard for one or more air pollutants. Rural ecosystem where a large percentage (70%) of the population depends on is being affected by air pollution in a number of ways. The objective is to raise understanding of policy makers, administrative personnel, developers and local community on the potential sources of the exceeding air quality standards. The perimeter air monitoring station has been 24hr continuously monitoring particulates and gases in the rural areas across states and regions of the country. These surveys were cross sectional studies being conducted as the scope of works for the Environmental Impact Assessment. Major findings were summarized that PM_{10} , $PM_{2.5}$ and SO_2 levels were higher than air quality standard while three transportation-related pollutants including carbon monoxide, ozone and NO_2 were below the standards. The five years data (2013-2018) provides the insight of rural air status and the notable findings were in the Mon State (2013), PM_{10} 123 (114-130) ± 5 , TSPM 212(145-256) ± 34 , in the Magwe region (2015) and (2016), SO_2 59 $\mu g/m^3$ (28-104) ± 8 , Methane 6 ppm (5-7) ± 0.2 , Ammonia 0.5 ppm (0-1) ± 0.1 and PM_{10} 124 $\mu g/m^3$ (96-207) ± 11 , $PM_{2.5}$ 45 $\mu g/m^3$ (13-72) ± 6 , SO_2 29 $\mu g/m^3$ (5-97) ± 9 , Methane 8 ppm (8-9) ± 0.1 , Ammonia 0.6 ppm (0-2) ± 0.2 respectively. Survey identified that major sources namely rice straw, crops residues open burning and forest fire are primarily responsible issues. A predominant view supported that particulates and SO_2 levels in rural areas become significant and furthermore, transportation-related strategies only did not help these areas to attain the national air quality standard.

3.083 Organic aerosols and their impact on biogeochemical cycles and climate.

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Abstract:

In the atmosphere organics are a complex mixture of compounds of variable chemical, physical and optical properties. Depending on their sources and their atmospheric fate, they also have variable content in C, H, O, N. Therefore, organics are involved in the biogeochemical cycles of trace elements and are recycled between the atmosphere, the terrestrial biosphere and the ocean.

In the present study we investigate the contribution of organics to the global burden of cloud condensation nuclei and of ice nuclei, as well as to the nutrients atmospheric global cycles, using a global 3-dimensional chemistry transport model able to account for multiphase chemistry in the atmosphere, the major aerosol components as well as the nitrogen, iron and phosphorus nutrients.

Uncertainties related to the chemical, biological and physical process understanding or to the process parameterizations in the models are discussed.

3.084 Relationship between anthropic pollution in the Santiago Metropolitan Region and the decrease of snow albedo on the Maipo river basin, Chile.

Early Career Scientist

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Abstract:

The snow melting in the Maipo River basin during the austral spring is one of the main water sources for the Santiago Metropolitan Region (SMR) and the decreases of snow albedo can be an indicator of the presence of atmospheric aerosols (e.g., black carbon, organic carbon and dust). Therefore, changes in the snow albedo from the upper Maipo river basin related to the aerosol atmospheric deposition potential in the spring were analyzed. Remote sensing data of snow cover, snow albedo, aerosol optical depth (AOD) and surface temperature were obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard NASA Terra satellite and precipitation from the TRMM satellite from the period 2000-2016. Only pixels with 100% snow cover were used to derive the average monthly value of the indicated data and daily for a case study. The statistical analysis showed that an average of 5% snow albedo reduction in the spring on this basin is linked to an AOD increase. However, daily data analyzed for the case study, showed that the AOD variations have a similar behavior to those reported by PM10 and PM2.5 measurements in the air quality network of this region with a maximum 0.23 AOD, 32.04 $\mu\text{g}/\text{m}^3$ PM2.5 and 61.60 $\mu\text{g}/\text{m}^3$ PM10. This may be related to an observed decrease of 30% of snow albedo. A retro-trajectory analysis using the HYSPLIT model, showed that the origin of these aerosols observed on the snow area came from the SMR. The results indicate that the anthropogenic aerosols are reaching the snowy areas, decreasing the albedo in snow and consequently increasing its rate of ablation during the spring on this area in this 16-year period.

3.085 Ammonia concentrations in East Asia assessed from near surface and satellite measurements.

Early Career Scientist

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Abstract:

Ammonia (NH₃) is an important component of nitrogen emissions to the atmosphere. Primarily it is emitted from agriculture and biomass burning. EANET (Acid Deposition Monitoring Network in East Asia) performs regular continuous monitoring of air pollutants in thirteen countries in East Asia since 2000. Among other species ammonia concentrations are included in the monitoring program and data from 25 stations are available.

However due to high variability of NH₃ in space and time, local point measurements are not enough for detailed understanding of the situation in the region of interest. For large spatial coverage satellite data may be used. In this study total ammonia amount retrieved from IASI/MetOp-A measurements since 2008 was used together with near surface measurements performed at EANET stations.

To understand limitations of using satellite data, the comparison of satellite and near-surface measurements for 25 stations for years from 2008 to 2015 was done in this study. Good agreement was found for monthly mean values and proved that satellite data may be used for regional air pollution monitoring and seasonal changes assessment for majority of stations. However number of differences between remote sensing data and near surface measurements was observed. The disagreement may be explained by several reasons and was considered for each station. Local features while comparison were taken into account in order to interpret satellite data in the correct way.

The assessment of ammonia concentrations for several regions in East Asia was done with use of both *in situ* and remote sensing data.

3.086 Towards a more comprehensive characterisation of biogenic volatile organic compounds in the greater Sydney region of southeast Australia.

Early Career Scientist

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Abstract:

Coastal southeast Australia is home to many of Australia's largest cities, and to large swathes of eucalypt-dominated forests. Despite the importance of biogenic volatile organic compounds (BVOCs) to the airshed of these cities, relatively few measurements of BVOCs have been conducted in the area. In the greater Sydney region, ambient measurements so far have mostly been made at urban or suburban sites in the context of short-term air quality campaigns. These campaigns provide useful snapshots but typically do not have BVOC characterisation as their focus.

Here we report on recent measurement efforts to provide a more comprehensive characterisation of BVOCs in the greater Sydney region. These include repeated spot sampling at forested sites over the 2017-2018 austral summer using absorption tubes followed by analysis using thermal desorption gas chromatography mass spectrometry (TD-GC-MS). The sampling program was designed to investigate differences in BVOC composition between sites and sampling periods (early, mid and late summer). We also describe the commissioning of a new online BVOC measurement system based on TD-GC-MS. This system will provide year-round characterisation of ambient BVOC levels at the

Australian Nuclear Science and Technology Organisation campus in Lucas Heights, ~40 km southwest of the Sydney CBD and adjacent to large forested areas. This deployment is part of the COALA-JOEYS campaign (see <https://www2.acom.ucar.edu/campaigns/coala>).

3.087 Observing ozone deposition velocity from an unmanned aerial vehicle.

Early Career Scientist

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Abstract:

Tropospheric ozone (O_3) is an air pollutant and key atmospheric oxidant. Global chemical transport models suggest as much as a third of tropospheric O_3 is lost by deposition to the Earth's surface annually. To predict O_3 variability in the troposphere, we require knowledge of O_3 loss processes; however, there are few direct measurements of the atmosphere-surface loss rate, known as the deposition velocity (V_d). Here, we describe a method for observationally-deriving the O_3 V_d using light-weight, low-power instrumentation from onboard an unmanned aerial vehicle (UAV) in combination with flux-gradient relationships. We present O_3 V_d derived from data collected over a variety of cultivated and natural plant canopies.

3.089 Seasonal variation in the triple oxygen isotopic compositions of atmospheric nitrate in the Asian monsoon area.

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Abstract:

The ^{17}O excesses ($\Delta^{17}\text{O}$) of nitrate in wet deposition ($n = 196$) were determined for three years at Sado-seki in Japan ($38^{\circ}14'59''\text{N}$, $138^{\circ}24'00''\text{E}$). The deposited nitrate showed large $\Delta^{17}\text{O}$ similar to those already reported for mid-latitudes: the $\Delta^{17}\text{O}$ ranged from +18.6‰ to +32.4‰ with a three-year average of +26.3‰. Both the annual average and the seasonal variation range of $\Delta^{17}\text{O}$ correlated strongly with those determined at Rishiri ($45^{\circ}07'11''\text{N}$, $141^{\circ}12'33''\text{E}$) in past. Moreover, the values also coincided with those reported for mid-latitudes. We concluded that the observed temporal variations in $\Delta^{17}\text{O}$ reflect variations in the atmospheric formation channels of atmospheric nitrate from NO .

Moreover, a clear normal correlation between $\Delta^{17}\text{O}$ and $\delta^{18}\text{O}$ was shown ($r^2 = 0.878$). A similar trend had been obtained in other areas of the world, implying that the linear correlation corresponds to the mixing line between ozone and H_2O , and thus OH radicals, with $\Delta^{17}\text{O} = 0\text{‰}$ and $\delta^{18}\text{O} = -5\text{‰}$. However, the NO_3^- in Sado-seki showed a somewhat different trend in the $\Delta^{17}\text{O}$ - $\delta^{18}\text{O}$ plot between summer and winter. Although the line fitted to the summer showed a slope of 2.21 ± 0.22 and an intercept of $+19.7 \pm 5.1\text{‰}$ in the $\Delta^{17}\text{O}$ - $\delta^{18}\text{O}$ plot, that of the winter showed a statistically significant larger slope of 2.89 ± 0.38 and a smaller intercept of $+3.0 \pm 9.2\text{‰}$. Although the winter data included an intercept of -5‰ as the end-member $\delta^{18}\text{O}$ value of the OH radical within the possible error range, the intercept of summer deviated strongly from the value. Because the monitoring station is located in the Asian monsoon area, the major air mass that arrived at the station was different seasonally. The present results imply regional changes in the $\delta^{18}\text{O}/\Delta^{17}\text{O}$ ratios of ozone and the OH radical in the Asian monsoon area.

3.090 Present and future mercury concentrations in Chinese rice: Insights from modeling.

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Abstract:

Rice consumption is more important methylmercury mercury exposure pathway to certain Chinese populations compared to fish consumption. However, little is known about the sources and biogeochemical processes governing rice mercury levels. We construct a rice paddy biogeochemical cycle model to simulate mercury sources and biogeochemical processes in rice paddies, and to understand factors influencing spatiotemporal variability in Chinese rice mercury concentrations. The rice paddy model takes atmospheric mercury deposition, simulated from a global atmospheric-chemistry-transport model (GEOS-Chem), and soil and irrigable surface water mercury concentrations obtained from literature to calculate rice inorganic (IHg) and methylmercury (MeHg) concentrations. We use future atmospheric mercury deposition--no-policy and strict-policy to regulate mercury emissions from Chinese coal-fired power plants under the Minamata Convention on Mercury -- to simulate future rice IHg and MeHg concentrations. Our rice paddy model suggests that a portion of IHg in rice comes directly from the atmosphere and via infiltration. The rate of internal methylation via microbial activity has the largest modeled influence on rice MeHg concentration. While atmospheric deposition is an important rice mercury source, we find that soil mercury and the rate of desorption explain observed spatial variability in rice IHg and MeHg concentrations and captures locations of rice mercury hotspots (> 20 ng/g; China National Standard Limit). Under our future scenarios, the Chinese median rice IHg and MeHg concentrations increase by 13% and decrease by 18% under no-policy and strict-policy, respectively. Central China exhibits the largest percentage decline in rice IHg and MeHg concentrations under strict-policy and demonstrates high rice mercury concentrations, rice production, and consumption. Our study suggests that addressing Chinese rice mercury contamination requires both soil remediation and regulation of anthropogenic mercury emissions.

3.093 Deposition velocity of nitric acid above a forest in suburban Tokyo using relaxed eddy accumulation.

Early Career Scientist

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Abstract:

Asian region has high risk of atmospheric deposition of reactive nitrogen. Estimations of dry deposition of reactive nitrogen by the inferential model still have large uncertainties, especially for the forest surface. Gaseous nitric acid (HNO_3), which is highly reactive and soluble in water, well deposits to land surfaces due to its highest deposition velocity. Therefore better understanding of the deposition velocity of HNO_3 on forest can contribute to improve the inferential model. In this study, we developed a direct measurement system for the fluxes of HNO_3 and $\text{PM}_{2.5}$ components based on relaxed eddy accumulation (REA) by improving previous REA system (Matsuda et al., Atmos. Env., 107, 255-261, 2015). The REA method is an alternative to the eddy correlation method that is the method to most direct measure flux. For the collection of HNO_3 in the REA system, we used annular denuder tubes coated with a solution of 9% NaCl and 1% glycerol is prepared by dissolving in 100ml of 50/50 (v/v) ethanol-water solution. We carried out the measurements from October 2016 to March 2017 and September 2017 to January 2018. We set the REA system at the top of 30m-high walk-up tower in a deciduous forest of the Field Museum Tamakyuryo (FM Tama) located in western suburb of Tokyo, Japan. Height of the forest canopy was about 20m. Weekly samplings were done continuously during the observation periods. We could obtain the dataset of directly observed HNO_3 deposition velocities covering leafy and leafless period. The HNO_3 deposition velocities were mostly higher in the leafy period than in the leafless period. In addition, we attempted to validate a resistance model by using the dataset obtained in this study.

3.094 PyrE, an interactive fire module within the NASA-GISS Earth System Model.

Early Career Scientist

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Abstract:

Fires directly affect the composition of the atmosphere and Earth's radiation balance by emitting a suite of reactive gases and particles. Having an interactive fire module in an Earth System Model allows us to study the natural and anthropogenic drivers, feedbacks, and interactions of biomass burning in different time periods. To do so we have developed PyrE, the NASA-GISS interactive fire emissions model. PyrE uses the flammability, ignition, and suppression parameterization proposed by Pechony and Shindell (2009), and is coupled to a burned area and surface recovery parameterization. The burned area calculation follows CLM's approach (Li et al., 2012), paired with an offline recovery scheme based on Ent's Terrestrial Biosphere Model (Ent TBM) carbon pool turnover time. PyrE is driven by environmental variables calculated by climate simulations, population density data, MODIS fire counts and LAI retrievals, as well as GFED4s emissions. Since the model development required extensive use of reference datasets, in addition to comparing it to GFED4s BA, we evaluate it by studying the effect of fires on atmospheric composition and climate. Our results show good agreement globally, with some regional differences. Finally, we quantify the present day fire radiative forcing. The development of PyrE allowed us for the first time to interactively simulate climate and fire activity with GISS-ModelE3.

3.095 Philippines TCCON Project: one-year measurement results and future.

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Abstract:

TCCON is dedicated to the precise measurements of the total column averages of greenhouse gases (GHGs) such as CO₂ and CH₄. TCCON measurements have been and are currently used extensively and globally for satellite validation, for comparison with atmospheric chemistry models and to study atmosphere-biosphere exchanges of carbon. With the global effort to cap GHG emissions, TCCON has taken on a vital role in validating satellite-based GHG data from past, current and future missions like Japanese GOSAT and GOSAT-2, NASA's OCO-2 and OCO-3, Chinese TanSat, TROPOMI, and others. The lack of reliable validation data for the satellite-based GHG observing missions in the tropical

regions is a common limitation in global carbon-cycle modeling studies that have a tropical component. The international CO₂ modeling community has specified a requirement for “expansion of the CO₂ observation network within the tropics” to reduce uncertainties in regional estimates of CO₂ sources and sinks using atmospheric transport models.

To address this challenge, we installed a newly-constructed TCCON FTS at a wind farm operated by the Energy Development Corporation in Burgos, Ilocos Norte, Philippines (18.5326° N, 120.6496° E), which followed rigorous site assessments and discussions at several TCCON and GOSAT-2 science team meetings. After installation and setup of the instruments in Mar. 2017, we started operations in the Philippines using TCCON protocols. Here, we will show results of one-year of measurements, some interesting phenomena such as CO and CH₄ enhancements, comparisons with GOSAT and OCO-2 soundings, and participation in aircraft observation campaigns such as EMERGe-Asia and NASA CAMP²Ex.

3.097 Evaluation of volatile property of ammonium nitrate on filter using denuder filter pack system.

Early Career Scientist

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Abstract:

In recent years, the air pollution of the fine particulate matter ($PM_{2.5}$) has been concerned in East Asia. In order to know the sources of $PM_{2.5}$, it is necessary to investigate not only mass concentration but also its chemical components. Acid Deposition Monitoring Network in East Asia (EANET) has accumulated long-term data of aerosol components observed by the filter pack method. The dataset possibly contributes the measures for $PM_{2.5}$. However, it is known that the filter pack method has a negative artifact by the volatilization of semi-volatile particles on the filter during the sampling. This study aims to develop the correction method of the artifact of ammonium nitrate (NH_4NO_3) that is one of main components of $PM_{2.5}$. We compared the filter pack with the denuder filter pack system, which can measure $PM_{2.5}$ components without the artifact, and evaluate volatile properties of NH_4NO_3 on the filter.

Parallel weekly measurements of the filter pack and the denuder filter pack system were carried out on an observation tower in the Field Museum Tamakyuryo (FM Tama) located in western suburb of Tokyo. Both methods measure NO_3^- , NH_4^+ and other inorganic ions in aerosols; gaseous HNO_3 and NH_3 . From the results, we calculated gas ratio ($HNO_3/(NO_3^- + HNO_3)$ and $NH_3/(NH_4^+ + NH_3)$). The gas ratio of the filter pack method was larger than that of the denuder system due to the artifact effect. Clear seasonal variation of the gas ratio was found in HNO_3 . Moreover the gas ratio of the denuder system correlated with some meteorological elements especially temperature and humidity. Therefore, the gas ratio was well reproduced by a multiple regression equation using these meteorological elements. The gas ratio calculated by the equation could be applied for the correction of the artifact of the filter pack method.

3.098 Factors determining the longitudinal distribution of biogenic sulfur compounds in aerosols over the subarctic North Pacific.

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Abstract:

Sulfur-containing aerosols are a significant source of cloud condensation nuclei (CCN). Biogenic sulfur compounds such as non-seasalt (nss-) sulfate and methanesulfonic acid (MSA) are formed by the oxidation of dimethylsulfide (DMS) which produced by marine phytoplankton. These compounds are important especially in the open ocean where are less impacted by anthropogenic pollutants. From a wide range of atmospheric observations over the subarctic North Pacific and chemical analyses of the aerosol samples, longitudinal distribution of atmospheric sulfur compounds were revealed. Furthermore, factors determining the distributions are discussed.

The concentrations of MSA in the eastern region of the international date line (IDL) were almost twice of those in the western region. The spatial variation of MSA concentration was similar to that of DMS in both seawater and atmosphere. The high concentrations of DMS in the atmosphere could be caused by high wind speed in the eastern region of IDL. Furthermore, composition of oceanic suspended particles including phytoplankton debris showed remarkable increase in coccoliths in the eastern region of IDL, indicating that dominant species of phytoplankton also influenced MSA formation.

Although about 80% of MSA was existed in fine mode aerosols, the coarse mode fraction of MSA were higher in the eastern region than the western region of IDL. On the other hand, size distribution of nss-sulfate was relatively constant regardless of oceanic regions, and their concentrations were lower in the eastern region of IDL. These results suggest that seasalts, which were mainly existed in coarse mode, increased due to the high wind speed, and a part of MSA and SO₂ adsorbed on the seasalt particles. Since the residence time of seasalt aerosols are much shorter than fine-mode aerosols, the contribution of biogenic sulfur compounds to CCN could be overestimated in the marine atmosphere with abundant seasalt aerosols.

3.099 Atmospheric CO, CH₄ and CO₂ observed over the Yellow Sea and the East China Sea in Spring 2017.

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Abstract:

Accurate measurements of the mole fractions of carbon monoxide (CO), methane (CH₄) and carbon dioxide (CO₂) were performed using a Cavity Ring-Down Spectrometer (CRDS) plus high pressure cylinder reference gas system during a cruise of the survey vessel Dongfanghong II on the Yellow Sea and the East China Sea in the spring of 2017. The spatial variations of the mole fraction of the three trace gases were very similar. The emission sources of these gases were divided into several regions by using the NOAA HYSPLIT model. Then we analyzed the variations of the ratios of the mole fraction enhancements between every pair of trace gases downwind of these source areas. The ratios showed that the distributions of these trace gases over the Yellow Sea and the East China Sea in the spring was mainly caused by the emissions from Eastern China. The much higher enhancement ratio of $\Delta\text{CO}/\Delta\text{CO}_2$ and the lower ratio of $\Delta\text{CH}_4/\Delta\text{CO}$ observed in the air parcels from big cities like Beijing and Shanghai indicated high CO emission from the cities during our time of observation. Compared with the values of NOAA's Marine Boundary Layer (MBL), the ratios of the averages in the air coming from the Northern sector (Russia) were on average closer to the MBL, and the air that stayed over the Yellow Sea and the East China Sea was a mixture of emissions from wide regional areas. The methods used to calculate the enhancement ratios and the uncertainties of the ratios of the enhancements of every pair of gases in this study can be used to compare with emissions inventories as a completely independent check. Moreover, the observation data and the results can be used for multi-species inverse estimates of the sources and sinks of greenhouse gases.

3.100 Bi-directional air-surface exchange of ammonia in a cool-temperate forest in northern Japan.

Early Career Scientist

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Abstract:

Atmospheric ammonia (NH_3) is one of the important components that affect nitrogen saturation of forest ecosystems and eutrophication of rivers and lakes. Since the NH_3 exchange over vegetated surface is known to be bi-directional as shown in a number of studies of flux measurements in Europe and North America, it is difficult to evaluate the dry deposition. On the other hands, there have been some studies in Asia. To investigate the air-forest NH_3 exchange process over the forest and the applicability of the previous knowledge to Japanese forest, we measured the vertical profiles of NH_3 and relevant components in a cool-temperate forest in northern Japan from 21 July to 5 August in 2017. The filter pack method was used to collect NH_3 and aerosols. NH_3 was collected on the phosphoric acid impregnated filters placed downstream of the quartz fiber filters for aerosols. During the observation period, we made the daily sampling using the filter holders at four heights of 0.1, 2, 8 and 16m at the observation tower over and within forest canopies and dwarf bamboo of 6 and 1.5m, respectively. At 0.1 m, 2 sets of filter holder were installed inside and outside of the dwarf bamboo, respectively. Both NH_3 emissions and depositions were found during the observation. Some variations between depositions and emissions were associated with precipitation events. From the measurements at 0.1 m in height, NH_3 concentrations inside the dwarf bamboo were almost always higher than that of its outside. Significant emissions were found when the concentration inside the dwarf bamboo was higher than the outside. Applications of a bi-directional NH_3 exchange model to the observations were attempted.

3.101 Variations in atmospheric CO₂ and its $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ observed at Minamitorishima Island in the western North Pacific.

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Abstract:

The station of Minamitorishima (MNM; 24°18'N, 153°58'E) is a unique monitoring site of background air at northern mid latitudes, which is situated on a remote coral island in the western North Pacific, about 1,950 km southeast of Tokyo. The Japan Meteorological Agency has made long-term continuous observations of atmospheric concentrations of major greenhouse gases at MNM. For better understandings of mechanism governing the CO₂ variation, systematic measurements of atmospheric CO₂ and its $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ have been carried out at MNM by analyzing discrete flask air samples since 2011. The CO₂ concentration shows a clear seasonal cycle with a decrease from summer to early autumn and an increase from late autumn to early spring, which is in opposite phase with the $\delta^{13}\text{C}$ cycle. Comparative analyses between both of the seasonal components suggest that the cycles are due mainly to a seasonal-dependent CO₂ exchange with C₃ plants in land biosphere. However, the variation from June to October is found to be related to CO₂ exchange with a significantly heavier $\delta^{13}\text{C}$ signal compared to the other period of the year. On the other hand, $\delta^{18}\text{O}$ shows a seasonal cycle with a decrease from summer to late autumn and an increase thereafter until early summer, due to influences of not only carbon but also hydrological cycles. Secular increase of the CO₂ concentration and decrease of $\delta^{13}\text{C}$ due to anthropogenic CO₂ emission are also observed, accompanied by year-to-year variations in opposite phase with each other,

while $\delta^{18}\text{O}$ shows a secular increase trend until 2016 and then a decrease trend. These secular trends may reflect variations in global carbon and hydrological cycles associated with the ENSO events.

In addition to these results, preliminary results of continuous measurements of the $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ using a laser spectroscopy initiated in March 2018 will also be presented.

3.105 Characterization of organic aerosols at a forest site in Kii Peninsula, Japan, based on PMF analysis of aerosol mass spectra.

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Abstract:

In the forest atmosphere, both of the local formation of biogenic aerosol and the inflow of regionally-transported aerosol may contribute to the burden of submicrometer organic aerosols, resulting in complex temporal variations of the compositional characteristics. We investigated the compositional characteristics of organic aerosols at a forest site in Kii Peninsula, Japan, based on an on-line aerosol mass spectrometry. The atmospheric observation was performed at Wakayama Forest Research Station, Kyoto University, during July-September 2014. The mass spectra of aerosol components were acquired using a high-resolution time-of-flight aerosol mass spectrometer. Black carbon was analyzed using a particle soot absorption photometer, and aerosol optical thickness was analyzed based on the measurement using a skyradiometer. Aerosol mass spectrum signals associated with ions from organics and signals of NO^+ and NO_2^+ were subjected to the PMF analysis. Three among five factors from the five factor solution show diurnal variation patterns with the enhancement in the daytime, suggesting the contribution of locally-formed biogenic secondary organic aerosol. The diurnal variations of the other two factors were not clear. One of these two factors shows a strong positive correlation with sulfate, suggesting the association with in-cloud processing and/or anthropogenic sources. The other of the two factors is characterized by strong signals of nitrogen containing ions, suggesting the association with nitrogen containing components. Based on the elemental analysis of the aerosol mass spectra and the estimate of the contributions of locally-formed and regionally-transported organic components to PMF

factors, the oxygen-to-carbon ratios of locally-formed organic components were estimated.

3.106 Measurements of atmospheric CO₂ column concentration using compact solar spectrometers.

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Abstract:

Carbon dioxide (CO₂) is the most important anthropogenic greenhouse gas and has been proved having a great influence on the changing of global temperature. The satellite observation of CO₂ has become an important approach to obtain CO₂ concentrations. As the main ground-based data source for validating satellite retrievals, the Total Carbon Column Observing Network (TCCON) sites are sparsely distributed globally with fixed positions. To increase the density of observations, low-cost and compact remote-sensing instruments are used as a promising complement to the current techniques.

In this research, we used two types of ground-based compact solar spectrometers to measure the column-averaged dry-air molar mixing ratios of atmospheric CO₂ (XCO₂), one consists of a portable scanning grating optical spectrum analyzer (Yokogawa Electric, OSA AQ6370, resolution 0.2 cm⁻¹), and the other consists of a low-cost array detector type grating spectrometer (Ocean Optics, NIRQuest, resolution 1.0 cm⁻¹).

We measured the XCO₂ using the OSA in the central area of Tokyo during Sep. 2014–Aug. 2016. The results show that the high XCO₂ values were attributed to the large local emission sources and the OSA can well capture the seasonal and daily changes of XCO₂ in Tokyo area.

Because the OSA takes several seconds to several minutes to scan the wavelength range around 1.6 μm, the passage of thin clouds can distort the spectrum. We have developed a low-cost, smaller observation system using NIRQuest. Since this system uses an array type sensor, there is an advantage that the entire spectral range can be measured instantaneously. We used this instrument to conduct continuous solar spectrum

observations at Nagoya University during daytime of one-month and calculated the XCO_2 concentration. The observational results will be presented. Finally, we are expecting that it is possible to analyze the dynamics of CO_2 from multipoint observations using the compact solar spectrometer.

3.107 Bioaerosol emissions during the summer precipitation in Fukushima forest revealed by radiocesium observations.

Early Career Scientist

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Abstract:

Aerosol particles have been thought to deposit on land surfaces by precipitation. However, our radiocesium observation showed the events that cannot be explained by a rain deposition.

We have carried out observations of aerosol and atmospheric precipitation in Namie, Fukushima to study the dynamics of radiocesium released by the nuclear accident. As a result, radiocesium resuspensions were observed. However, carriers of atmospheric radiocesium and their suspension mechanisms have not been fully understood. Previous studies have shown that the resuspension is active in summer and biogenic particles (bioaerosol) are important, but the mechanism is not clarified. Therefore, we investigated a fluctuation of the atmospheric concentration of radiocesium by precipitation. As a result, the concentrations of radiocesium during precipitation were higher than those during non-precipitation, and it is hypothesized that the bioaerosols, such as fungi, carries radiocesium during the precipitation.

To prove the hypothesis, we measured the radiocesium and bioaerosols in the air during August and September 2016. The air filter samples were observed by a scanning electron microscope (SEM) and an optical microscope (OM). The elemental composition was measured by SEM- energy dispersive x-ray spectrometry (EDS) analysis.

A large numbers of particles were found to contain carbon compounds and to be composed of fungal cells originated from Ascomycota and Basidiomycota, judging from their color and morphology. Molecular biological analysis also revealed that Basidiomycota members dominated in the air samples commonly. The number of colored bioaerosol and the radiocesium concentrations showed a positive correlation, and the slopes of the correlations were different between the precipitation and non-precipitation events. We thus conclude that the bioaerosol particles during rainfall and non-precipitation were different.

3.108 Decrease of Black Carbon Aerosol in air masses transported from China at Suzu, Noto Peninsula, Japan.

Early Career Scientist

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Abstract:

Black carbon aerosol (BC) is considered as one of major contributors to global climate change because BC strongly absorbs solar radiation to heat surrounding air. Coal and biofuel burning in China for industrial and residential use has been supposed to be significant BC emission source. Recent fuel conversion in China may reduce atmospheric BC concentration globally. In this study, we are trying to find change in BC concentration in air masses transported from China to Japan in winter.

BC concentration has been measured with light absorption photometry technique at Noto atmospheric monitoring observatory (37.5N, 137.4E, 10m ASL) in Suzu, Japan. Carbon monoxide (CO) concentration has also been measured with NDIR technique at this site. Both BC and CO frequently increased simultaneously at Noto in winter. Defining a high-BC event by measured BC concentration exceeding its lower 84 percentile value ($>0.3 \text{ mg m}^{-3}$), we calculated integrate excess BC value during each BC event, and compared the values in 2014-2017 winter (December, January and February). We selected high-BC events that occurred with the transport from China based on the backward trajectory analysis.

Both the number of high-BC events and BC peak values in the events tend to decrease between 2014 and 2018 winters. The central 50 % ranges of the integrated excess BC values during high-BC events are 1.2-5.9, 0.9-4.9, 0.7-2.6, and 0.9-2.5 ($\text{mg m}^{-3} \text{ hour}$) in 2014-2015, 2015-2016, 2016-2017, and 2017-2018 winters, respectively. This result shows that BC increase in air masses from China from 2014-2015 winter to 2016-2017 winter, but that difference between 2016-2017 and 2017-2018 winters was not clear. Variation of excess CO and excess BC/CO ratio will be also discussed.

3.109 Impacts of present-day and future shipping emissions in the Barents Sea region.

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Abstract:

The Arctic is undergoing unprecedented changes due to global warming which is intensified in the region leading to reductions in summer sea-ice extent opening up the possibility for increased shipping in particular along the North-East passage traversing the north coast of Norway and Russia. Shipping emissions may lead to the production of acidic compounds such as nitrate and sulphate aerosols which are highly soluble and can be deposited to land and marine ecosystems.

In this work, carried out as part of EU-FP7 project ICE-ARC (Ice, Climate, Economics - Arctic Research on Change), we focus on the Barents Sea where there is already quite significant shipping either in the form of transit shipping to Russia or related to fishing. We examine the impacts of present-day and future shipping on trace gases and aerosols which have the potential to impact human health and ecosystems, notably ozone, nitrate and sulphate aerosols.

The mesoscale model including chemistry, WRF-Chem, has been run at high resolution with recent shipping emissions for 2012 and 2050 for a variety of scenarios for a summer period (July/August). Present-day shipping emissions used real-time satellite AIS (Automatic Information System) ship positioning data for 2012 (Winther et al., 2014) and include pollutant emissions from fishing vessels that were not included in previous inventories. We take into account different future (2050) growth scenarios, such as CLE (current legislation) and HGS (high growth scenario), to investigate possible future changes in surface concentrations, total column burden and deposition fluxes. Results indicate that deposition of acidic compounds such as nitrate and sulphate aerosols from shipping to marine ecosystems could be significant with potential impacts on marine biogeochemistry and primary productivity, in particular in the Barents Sea during summer when surface waters are depleted of nutrients.

3.110 Chemical characteristics and deposition amounts of precipitation components in Bangkok metropolitan region.

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Abstract:

A comprehensive study on the chemical characteristics and deposition fluxes of precipitation components including pH, major ions (SO_4^{2-} , NO_3^- , Cl^- , Na^+ , NH_4^+ , K^+ , Mg^{2+} , Ca^{2+}), water insoluble organic carbon (WIOC), water soluble organic carbon (WSOC), elemental carbon (EC) were carried out from September 2015 to March 2017 at suburban site and urban site in Bangkok metropolitan region, Thailand. To study the scavenging effect of atmospheric particles by wet deposition, particulate carbonaceous components in $\text{PM}_{2.5}$ and Coarse particles were also observed simultaneously. Average pH of rainwater at suburban and urban sites were 4.7-7.0 and 4.6-7.1, respectively. The total annual wet deposition fluxes for different species at both sites ranged from 5.3 to 86.1 meq/m² with the following order: $\text{NH}_4^+ > \text{Ca}^{2+} > \text{NO}_3^- > \text{SO}_4^{2-} > \text{Cl}^- > \text{Na}^+ > \text{K}^+ > \text{Mg}^{2+}$. The deposition amount of carbonaceous components were also evaluated and compared with the observation results in Japan. The average concentrations of carbonaceous components were higher at suburban area than city center of Bangkok. The contribution of insoluble organic components to total organic carbon at suburban site is more important, the contribution of EC from vehicle exhaust was more important at urban site. The ions, and carbonaceous concentrations were higher in dry season, while the deposition amount was higher in wet season. The influence of scavenging process by precipitation was more important for OC than EC. The long range transport from inland (East direction) contributed significantly EC and anthropogenic ions to the rainwater from sites in Bangkok Metropolitan Region. The chemical species in rainwater at Bangkok metropolitan region were mainly composed of carbonaceous components from combustion sources, acid-base ions and marine species. This study is conducted within the JICA Research Institute's research project, "A Study on Urban Air Pollution Improvement in Asia," which focuses on $\text{PM}_{2.5}$ and other air pollution problems and analyzes relevant policies, primarily in Asian countries.

3.111 Long-term changes in biogenic VOC emissions due to changing land-cover.

Early Career Scientist

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Abstract:

Emissions of biogenic VOC emissions are closely linked to vegetation distribution and vegetation biomass. These factors have been changing in the past due to natural processes in the Earth's system. But significant changes can be observed as a result of human activities, such as deforestation in the tropical forest and its replacement with agricultural land. Such land use / land cover (LULC) transitions affect the amount and chemical composition of VOC emissions from vegetation. The paper will present impact of LULC changes on BVOC emissions over the last decades since 1980 up to present as calculated by the emission model MEGAN (Model of Emissions of Gases and Aerosols from Nature). Annual global maps of vegetation distribution are simulated by the Community Land Model (CLM) land use data tool called Thesis. The Thesis tool incorporates information about dynamics and agriculture from the Global Land Model (GLM). MEGAN model is driven by the ERA-Interim meteorological fields. We will present temporal and spatial distributions of BVOC emissions calculated with varying meteorology and land cover, as well as with fixed meteorology and changing land cover, in order to pinpoint impact on emissions solely due to vegetation changes.

3.112 Effect of atmospheric sulphur dioxide fumigation on photosynthesis by determination of ascorbic acid content in plants.

Early Career Scientist

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Abstract:

Well lighted plants contain considerable amounts of ascorbic acid (AA). AA is indispensable for photosynthesis and influences detoxification of plants like reducing SO_2 . If the concentration of SO_2 in atmosphere increases above $400 \mu\text{g}/\text{m}^3$, it can result in disruption of photosynthesis. SO_2 is emitted from fossil fuel combustion, roasting of sulphide ores, volcanic eruption, sea spray etc. SO_2 puts a serious threat to the ecosystem by forming other sulphur oxides and H_2SO_4 leading to acid rain and particulate matter pollution. As a phytotoxicant, SO_2 causes tissue damage, leaf chlorosis etc. It readily diffuses into the leaves and dissolves in the moisture available in mesophyll cells forming sulphite, free oxygen & hydroxyl radicals and H_2O_2 . These free radicals promote oxidation of ascorbic acid, thereby reducing the AA content in plants and obstructing photosynthesis. The main objective of this project is investigating the response of AA in plants to fumigation of SO_2 and finding out SO_2 sensitivity of plants. For this project, plants of three different species will be selected & subjected to continuous fumigation of SO_2 with 0.05, 0.1 and 0.2 ppm concentrations in a glass chamber for 2 hours daily for several weeks. The plants will be kept in both normal daylight & complete darkness for more than 80 hours. There will be three replicates for each treatment. The percentage reduction of AA in sun exposed and shaded leaves will be calculated from mean values of different replicates. The AA content will be determined colorimetrically by using 2,6-dichlorophenolindophenol method. I will present the result showing the distinct drop of AA content in plants under the influence of SO_2 and establish a positive correlation between concentration of SO_2 and reduction in AA content. The diminution of relative rate of photosynthesis will be graphically represented. The injury caused to the plants will also be observed.

3.113 A Ten-year Remote Sensing Based Estimate of Dust Deposition and Loss Frequency into Tropical Atlantic Ocean and Caribbean Sea .

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Abstract:

Massive dust emitted from North Africa can transport long distances across the tropical Atlantic Ocean, reaching the Americas. Dust deposition along the transit adds microorganisms and essential nutrients to marine ecosystem, which could increase the productivity of the ecosystem and CO₂ uptake, modulate biogeochemical cycle, and influence climate. Assessment of the dust-ecosystem-climate interactions has been hindered in part by the paucity of dust deposition measurements particularly in open oceans, and large uncertainties associated with representing dust processes in models. Over the past decades, satellite remote sensing capabilities of measuring aerosol optical depth (AOD) and particle size and shape properties have been significantly enhanced, which offers an opportunity of distinguishing dust from other types of aerosol and derive the dust deposition into ocean. In this study, we combine CALIOP 3-D distributions of dust extinction with dust optical depth (DOD) from MODIS, MISR, and IASI to quantify dust transport and deposition over the tropical Atlantic Ocean and Caribbean Sea from 2007 to 2016. On the basis of the ten-year average, the yearly dust deposition into tropical Atlantic Ocean and Caribbean Basin is 84-135 Tg. The dust deposition shows large spatial

and temporal (on seasonal and interannual scale) variability. The satellite observations also yield an estimate of annual mean dust loss frequency of $0.052 \sim 0.073 \text{ d}^{-1}$, which is higher in winter than summer. This satellite-based estimate of dust loss frequency is 2-8 times lower than model simulations of $0.16 - 0.42 \text{ d}^{-1}$, which is being used to constrain parameterizations of dust removal processes in the GEOS-5 model. Preliminary result shows that such constraint significantly improves agreement between the GEOS-5 simulations and aircraft observations of trans-Atlantic dust transport during the ATOM campaign.

3.114 Temporal variations of the atmospheric CO₂ mole fraction, isotopic ratios of CO₂ and δ(O₂/N₂) observed at Ny-Ålesund, Svalbard.

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Abstract:

To elucidate contributions of the terrestrial biosphere and the ocean to the CO₂ cycle on the earth's surface, we have maintained systematic observations of CO₂ mole fraction, the isotopic ratios (δ¹³C and δ¹⁸O) of CO₂ and oxygen to nitrogen ratio (δ(O₂/N₂)) in the atmosphere at Ny-Ålesund, Svalbard since 1991, 1996 and 2001, respectively. The CO₂ mole fraction shows a clear seasonal cycle superimposed on a secular increase with an average rate of 2.0 ppm yr⁻¹ for the period 1996–2013. On the other hand, δ¹³C and δ(O₂/N₂) decrease secularly at an average rate of -0.020 ‰ yr⁻¹ for 1996–2013, and -19.9 per meg yr⁻¹ for 2001–2013, respectively. Based on the observed secular trends of the CO₂ mole fraction and δ(O₂/N₂), the average CO₂ uptake during 2001–2013 was estimated to be 1.6 ± 0.8 and 2.3 ± 0.5 GtC yr⁻¹ for the terrestrial biosphere and the ocean, respectively. By using the observed CO₂ and δ¹³C, the corresponding CO₂ uptake of 1.3 ± 0.6 and 2.6 ± 0.5 GtC yr⁻¹ were obtained for the same period. The estimates from the two methods are in good agreement with each other. The terrestrial biospheric CO₂ uptake derived by the latter method showed large inter-annual variability in association with El Niño events. On the other hand, the oceanic uptake increased secularly with less inter-annual variability during 1996–2013. In this presentation, temporal variations of the CO₂ mole fraction, δ¹³C, δ¹⁸O and δ(O₂/N₂) observed at Ny-Ålesund up to 2017 will also be presented.

3.115 The Behavior of Nitrogen Components in Atmospheric Aerosols at the Coastal Area of Seto Inland Sea in Summer.

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Abstract:

Seto Inland Sea is located in west Japan, and semi-closed coastal sea surrounded by Honshu: the main island of Japan, Shikoku and Kyushu Island. The Seto Inland Sea area is one of the most industrialized areas in Japan, and also affected by anthropogenic and mineral substances transported from the Asian continent. It is necessary to understand the factors of high concentrations of atmospheric pollutants, and the influences to the marine ecosystems by atmospheric deposition. This study represents the chemical properties of atmospheric aerosols, especially nitrogen and phosphorus components, and the estimation of nutrients deposition to the ocean, during the summer of 2017. Atmospheric aerosols were collected in fine (<2.5 μm) and coarse (>2.5 μm) modes. These were analyzed ionic species and water soluble total nitrogen (TN_{WS}). The concentration of $\text{PM}_{2.5}$ was also measured.

The concentrations of TN_{WS} in fine mode and $\text{PM}_{2.5}$ co-varied well. During the observation period, the concentrations of TN_{WS} and $\text{PM}_{2.5}$ were often increased drastically. In particular, from 25 to 26 and 28 July, the concentrations of $\text{PM}_{2.5}$ were up to about 60 ug m^{-3} . This is because the study area in summer was also mainly affected by the air masses originating from the East Asian continent by back trajectory method, although it is necessary to take regional pollution into consideration comparing with the measurements of a neighbor observation station. The mean concentrations of TN_{WS} in fine and coarse modes were 1.0 ± 0.57 and 0.19 ± 0.083 (standard deviation) ug N m^{-3} , respectively. Total nitrogen existed mainly in fine mode, but coarse mode TN_{WS} affected the deposition to the ocean.

In the presentation, organic nitrogen and phosphorus components in atmospheric aerosols, and the estimation of nutrient deposition from atmosphere to the ocean will be discussed.

3.119 Analysis of trends and seasonal variations of nitrogen dioxide, nitric acid and ammonia concentrations measured at six rural sites in Africa from 1998 to 2015..

Early Career Scientist

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Abstract:

This work is part of the INDAAF (International Network to study Deposition and Atmospheric chemistry in Africa) programme. INDAAF is a long term monitoring measurement network since 1995 to document atmospheric chemistry and deposition fluxes in Africa. This programme is part of the IGAC/DEBITS (Deposition of Biogeochemically Important Trace Species) activity and a contributing network to the GAW/WMO programme. Data collected within the framework of INDAAF constitutes a unique long-term database in the major African ecosystems for gases concentrations, aerosols composition and rain chemistry.

We present for the first time an assessment of trends, on a monthly basis, of atmospheric concentrations of NO_2 , NH_3 and HNO_3 over the period 1998-2015. The various time series have been obtained at 6 monitoring stations geographically spread to represent the major African ecosystems in west and central Africa (dry savanna - wet savanna - forest). Two statistical techniques are used (1) to relate nitrogen gas concentrations to their potential emission sources and (2) to estimate trends of these gases over 18 years. Principal component analysis allowed us to analyse the data sets,

highlighting the influence of physical parameters on nitrogen gases concentrations. We found in the sahelian region (Niger, Mali) a well marked seasonal cycle with a maximum of NO_2 concentration at the beginning of the wet season (May) correlated to maxima of air temperature, soil temperature, NH_3 and HNO_3 concentrations, showing that soil biogenic emission is the main driver of nitrogen gases at the sahelian sites. Mann-Kendall tests are applied to determine monotonic trends of the gases concentrations data. This study allows to statistically highlight the physical parameters which influence the atmospheric gases concentrations and the seasonal variations, and to analyze for the first time gases concentrations trends in relation with of the major sources of nitrogen gases in western and central Africa.

3.121 Effects of African dust in the nutrient, radiation, and water budget of a tropical forest.

Early Career Scientist

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Abstract:

African dust travels thousands of kilometers and can reach the Americas and the Caribbean. Dust particles interact with radiation, by directly scattering and absorbing it, or indirectly by serving as cloud condensation nuclei (CCN) or ice nuclei (IN). These particles can also affect the water budget by altering the normal precipitation patterns of an ecosystem. Through dry and wet deposition, they can alter the nutrient budget of a system. As part of the Luquillo Critical Zone Observatory, field campaigns were held during the summers 2013, 2014, and 2015 at Pico del Este, a tropical montane cloud forest in the Caribbean island of Puerto Rico. Cloud microphysical properties, which include liquid water content, droplet concentration, and droplet size, were measured. Cloud and rainwater samples were collected and analyzed for chemical composition. Properties analyzed include pH, conductivity, the concentration of ions and trace metals, and concentration of total and dissolved organic carbon and nitrogen. Radiation, visibility, precipitation (total and intensity) and meteorological state variables (temperature, relative humidity, wind direction and wind speed) were also measured at this station. Samples were separated between high and low dust concentration samples using products from models and satellites. Results suggest that some African dust serves as a CCN, increasing by 44% the droplet concentration and by 33% the liquid water content under high dust events, which could be affecting the radiation and water budgets. Chemical analyses showed an overall increase in the concentration of ions, trace metals, and total and dissolved organic carbon and nitrogen under high dust influence (e.g., Ca trace metal in cloud water was 4x higher). An increase in the concentration of ions and trace metals could alter the nutrient budget of the ecosystem by injecting nutrients like nitrogen, phosphorous and calcium into the ecosystem.

3.122 Transported and local contributions to carbon monoxide in Australasia.

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Abstract:

Distinguishing the relative contribution of transported versus local sources of atmospheric pollution is fundamental to developing realistic air quality policies and providing accurate air quality forecasts. We study sources of atmospheric carbon monoxide (CO) by exploiting the complementary information provided by the different sensitivities of satellite and ground-based remote-sensing instruments. Total column amounts of CO are compared between the satellite-borne Measurements of Pollution in the Troposphere (MOPITT) and ground-based solar FTIR instruments in the Total Carbon Column Observing Network (TCCON) and the Network for the Detection of Atmospheric Composition Change (NDACC). We focus on three Southern Hemisphere stations: Darwin and Wollongong in Australia and Lauder in New Zealand.

CO timeseries anomalies from each instrument are discussed in relation to pollution delivery pathways of local, regional and long-distance origin. The ground-based spectrometer data capture small-scale urban pollution and fire events, and also record the long-range transported effect of biomass burning emissions from South America, southern Africa and Indonesia. While large-scale pollution events impact both instruments, only the satellite instrument can provide regional and global context. For example, MOPITT can be used to track the hemispheric impact of South American and southern African fires, as well as determine the regional influence of severe Australian fires. Finally, we quantify contributions to CO variability using the Community Atmosphere Model with chemistry (CAM-chem) using tagged tracers to distinguish relative contributions from different CO source regions and sectors. Modeling is also used to calculate the relative roles of emissions and meteorology.

3.123 VERTICAL TRANSPORT OF PRIMARY BIOLOGICAL AEROSOLS EMITTED FROM THE AMAZON RAINFOREST.

Early Career Scientist

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Abstract:

Primary biological aerosol particles (PBAP) are essential as a nutrient source and for dispersal of reproductive material. Pollen and fungal spores are potential giant cloud condensation nuclei over tropical rainforests. Thus, they likely influence local and regional scale precipitation processes. We analyzed the vertical distribution of coarse particles above a rainforest using tower-based measurements at the Amazon Tall Tower Observatory (ATTO) in Brazil. Sampling campaigns were conducted during both the wet and dry seasons from 2015 to 2017. A Recording Volumetric Spore Sampler (Burkard) was used to collect particles on the tower at 24, 40, 60, 80 and 300 m heights. Samples were imaged with optical microscopy, and time series of bioaerosol abundance were obtained based on morphological classification, quantification and identification, at least on family level. Pollen grains, fungal spores, fern spores and canopy debris, such as leaf and insect fragments, as well as plant waxes and glands, decreased in abundance from below canopy to 300m height. Precipitation, relative humidity, and wind speed had a strong influence on the vertical distribution of those PBAP. Large pollen grains, such as *Podocarpus*, were absent high above the canopy except during thunderstorm events. Pollen grains above the canopy often appeared ruptured, e.g., bamboo. The low rainfall across the 2015 dry season, recorded during an El Niño event, correlated with an increased number of suspended PBAP, due to an increased emission and/or decreased rain-related scavenging. For 60 and 80m, there were significant ($P < 0.01$) differences between day and night concentrations of pollen and fungi. The abundance of bioaerosols high above the Amazon rainforest was much lower than expected given the canopy emissions. Outside of storm events, coarse primary aerosols, especially pollen, might

generally undergo less atmospheric entrainment and have less influence on atmospheric processes than previously assumed.

3.124 Nitrogen wet deposition during El Niño 2015-2016: Effects in a Venezuelan tropical cloud forest.

Early Career Scientist

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Abstract:

Time series of nitrogen deposition give information on how reactive nitrogen (Nr) inputs to ecosystems change with climatic conditions and sources variations (natural and anthropogenic). This information is useful in identifying losses of biodiversity in natural ecosystems and potential changes in soil microbiology. To assess the impact of N deposition on different ecosystems in Latin America, the Latin American Network of Nitrogen (Nnet) arises (<http://www.iai.int/crn-3005/>). Nnet's Venezuelan component is monitoring N wet deposition at an Altos de Pipe Air Quality Station (APAQS-IVIC). Altos de Pipe ecosystem is a tropical cloud forest (10°23'N, 66°59'O; 1.670 m.a.s.l.), with mean annual precipitation and temperature of 1100 mm and 16.1 °C, respectively. A total of 105 wet deposition samples were collected from May 2015 until May 2017 using an only wet collector. Ionic composition of the samples was determined by ion chromatography. The results show that during 2015 and 2016 where precipitation was roughly half of the annual 30-year average, the NH_4^+ and NO_3^- volume weighted mean were 9.4 and 15.4 μM and 5.6 and 7.6 μM , respectively. The rain Nr concentrations were three times higher than historic values in this forest (Pacheco *et al*, 2004), these changes could potentially affect plant composition that has low tolerance to larger Nr concentrations (Erisman *et al*, 2015). The total Nr deposition rate range was 1.1 and 2.5 kg N/ha yr for 2015 and 2016, respectively. These values, although in the lowest range for natural ecosystems, show that during years of drought (such as El Niño years), Nr deposition will increase. Also, the fact that the Nr deposition rate is largely comprised as ammonium will favor soil nitrification. The NO_x and N_2O emissions derived from this process to the atmosphere could contribute to both a more reactive atmosphere and the enhancement of global warming.

3.125 Dry deposition of PM_{2.5} nitrate in a cool-temperate forest in northern Japan by vertical profile measurements.

Early Career Scientist

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Abstract:

In Asia, the significant emission of oxidized nitrogen from fossil fuel combustion has been concerned associated with air pollution, as well as the acidification and eutrophication of ecosystems. To better understand the process for removing the oxidized nitrogen from the atmosphere, we conducted vertical profile measurements of PM_{2.5} and coarse aerosol components and gaseous HNO₃ in a cool-temperate forest in remote area of northern Japan. Previous observations (e.g. Honjo et al., J. Jpn. Soc. Atom. Env., 51, 257-265, 2016) indicated the deposition velocities of PM_{2.5} nitrate were higher than those of PM_{2.5} sulfate above forests. In this regard, almost observations were done above forest canopies. To understand the removal mechanisms in forest, we measured the vertical profiles above and below the forest canopy using both the filter and the denuder-filter sampling method. We set filter holders at 4 heights (0.1, 2, 8 and 16 m) and denuder-filter systems at 2 heights (2 and 16 m) on an observation tower in the forest. Height of the forest canopy was about 6 m. During the period from 21 July to 7 August in 2017, the filter samplings to collect PM_{2.5} and coarse aerosols were done every day and the denuder-filter samplings to collect HNO₃ and PM_{2.5} without the effect of volatilization of ammonium nitrate on the filter were done every 2 days. Both sampling methods indicated the vertical gradients of PM_{2.5} nitrate were significantly larger than those of PM_{2.5} sulfate. The gradients of PM_{2.5} nitrate above the canopy increased with

the daytime temperature increase rate from 21 m to 4 m. That is because the steep gradients of the PM_{2.5} nitrate were associated with the volatilization of ammonium nitrate, as semi-volatile aerosols, near the leaf canopy layer due to the higher temperature. In this study, calculations of the gas-particle equilibrium were also attempted.

3.126 Relationship between bioluminescence-based ecotoxicity and water-soluble compounds of fine and coarse aerosol in Jeju, Korea .

Early Career Scientist

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Abstract:

An ecotoxicity test was conducted to determine the ecological effects associated with water-soluble composition of ambient aerosol from Jeju, Korea (Gosan Climate Observatory, GCO). The water-soluble components were extracted from PM₁, PM_{2.5}, and PM₁₀ collected on the filters, and water-soluble ions and WSOC, organic carbon species and ecotoxicity were measured. *Vibrio fischeri* was used to measure bioluminescence inhibition and the EC10 value, 10% effect concentration, was derived from dose-response curves of each sample. The aerosol ecotoxicity in Jeju, background area, was lower than other studies of urban areas. Overall, bioluminescence inhibition (%) is most related to the major components of the aerosol mass composition, such as SO₄²⁻, NH₄⁺, and WSOC. Higher ecotoxicity levels were increase NO₃⁻/SO₄²⁻ ratio or WSOC concentration in PM₁ and PM_{2.5} under nearby land outflows with stagnant condition. In several dust events, ecotoxicity was relatively well correlated with PM10 mass, and the ecological impact was significantly higher when elevated NO₃⁻ and NH₄⁺ levels than when the soil component was increased. Interestingly, we found the ecotoxicity levels were slightly increase with increase abundances of nitrogen-bounded compounds in organic carbon species analyzed by GC-Tof-MS. The relationship between nitrogen containing compounds and ecotoxicity will be verified through the case study of the winter haze and the spring yellow dust events in Aewol, Jeju.

3.128 Determination of the triple oxygen isotopic compositions of tropospheric carbon dioxide.

Early Career Scientist

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Abstract:

The triple oxygen isotopic compositions ($\Delta^{17}\text{O}$) of tropospheric carbon dioxide (CO_2) can be a useful tracer to quantify carbon cycle in terrestrial environments. Traditionally, CO_2 must be converted to O_2 to determine $\Delta^{17}\text{O}$ precisely. However, toxic and dangerous reagents such as BrF_5 must be needed for the reactions to convert CO_2 to O_2 . Alternative safer, more simple, and more easy techniques should be needed for the routine measurements on the $\Delta^{17}\text{O}$ of tropospheric CO_2 . In this study, we developed an alternative new method for the high precision measurements on the $\Delta^{17}\text{O}$ of CO_2 using Cavity Ring-Down Spectroscopy (CRDS) for H_2O . First of all, atmospheric sample with CO_2 was introduced into pre-evacuated line and separated from atmospheric nitrogen (N_2), oxygen (O_2) and water (H_2O) using the differences in the boiling points. Then, N_2O having the similar molecular weight and the similar boiling point with CO_2 was separated from CO_2 using a Porapak PS column under $-70\text{ }^\circ\text{C}$. By reacting the purified CO_2 with H_2 at $600\text{ }^\circ\text{C}$ under the existence of the nickel catalysts, CO_2 was converted to methane (CH_4) and water (H_2O). Subsequent to purify H_2O from CH_4 , $\Delta^{17}\text{O}$ of H_2O was measured in CRDS. The new system developed in this study has several advantages over the conventional methods, such as (1) safe and easy operations, (2) less than 50 min for the single sample analysis, and (3) comparable precisions with previous methods. By using the new system, we can determine $\Delta^{17}\text{O}$ of tropospheric CO_2 with precision better than $0.015\text{ }‰$ (1σ). By using the new system developed in this study, we determined the difference in the $\Delta^{17}\text{O}$ values between tropospheric CO_2 in Nagoya and that in car exhaust, and found that tropospheric CO_2 in Nagoya was $0.22\text{ }‰$ higher in $\Delta^{17}\text{O}$ than that in car exhaust.

3.129 Marine organic carbon: simulating impacts on aerosol, clouds, and climate.

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Abstract:

The marine aerosol burden is often thought of as being dominated by sulfate from phytoplankton-derived dimethyl-sulfide and sea salt. In the last decade, observations and laboratory studies have highlighted a significant contribution to the marine aerosol burden from emission of organic carbon. However, even the latest generation of aerosol schemes included in climate models often neglect these organic carbon emissions, introducing potential biases to the simulated clouds, precipitation, and radiative budget. Marine organic carbon emissions can be primary (direct release of organic carbon in particles) or secondary (organic carbon emitted in the gas-phase). The lifetime and fate of aerosol from the two distinct marine organic carbon source mechanisms are quite different, and require individual representation in an aerosol scheme to quantify their role in the climate system.

We have used the ACCESS-UKCA global composition-climate model (which includes the GLOMAP-mode aerosol microphysics scheme) to simulate the emission and fate of both primary and secondary organic carbon. We compare the model against detailed observations made during the Surface Ocean Aerosol Production (SOAP) ship campaign in the biologically productive seas east of New Zealand, and also against long-term observations from fixed stations (e.g. Cape Grim). We quantify the contribution marine organic carbon makes to aerosol mass and number, and the subsequent impacts on cloud optical properties and radiation, finding significant contributions from both primary and secondary sources of marine organic aerosol. In order to properly represent the critically important marine boundary layer in climate simulations, marine organic carbon emissions should be included, and may help to address long-standing climate model biases.

3.131 Methyl chloride emissions from Bornean tropical tree species .

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Abstract:

Methyl chloride (CH_3Cl), a volatile organic compound emitted primarily from natural sources, is the major carrier of chlorine to the stratosphere, where it contributes to chlorine-induced destruction of ozone. Among a variety of natural sources, tropical forest ecosystems are considered the single largest source of CH_3Cl . Previous studies reported that CH_3Cl emissions by tropical plants are species-dependent and tens of tropical plant species, mainly dipterocarp trees, have been identified as CH_3Cl emitters. However, little is known about what controls the emission rates. In this study, we screened ~15 species of trees for CH_3Cl emission by using a canopy crane to gain access to the canopy in a lowland tropical rainforest at Lambir Hills National Park, Malaysian Borneo. We analyze the leaf-level measurements to investigate the intra- and inter species variability in CH_3Cl emission and discuss possible drivers of the emission rates.

3.132 Observations of long-lived trace gases over the central Himalayas.

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Abstract:

The increase in anthropogenic emissions of greenhouse gases since industrial revolution have led to enhanced positive radiative forcing and thereby greenhouse gases are now widely recognized as a major driver of the climate change. The Asian continent is home to some of the fastest growing economies and consequently CO₂ emissions in the world. The 2015 UNFCCC (United Nations Framework Convention on Climate Change) Conference of the Parties (COP-21 and COP-22) discussed that the emerging economies have to play a significant role for reliable budget estimate and mitigation of greenhouse gas emissions and thereby keeping the global average temperatures rise below 2°C. India is the third largest CO₂ emitter (~0.61 PgC/yr) after China (~2.81 PgC/yr) and USA (~1.43 PgC/yr) in the world but the current estimates of greenhouse gases emissions based on both the top-down and bottom-up approaches show large uncertainty over south Asia compared to other developed countries. In view of this, observations of long-lived radiatively active trace gases have been initiated at a high altitude central Himalayan site (29.4°N, 79.5°E, 1950 m amsl) located in Nainital at the Aryabhata Research Institute of Observational Sciences (ARIES), in collaboration with National Institute of Environmental Studies (NIES), Tsukuba, Japan. Regular weekly air samples are collected in a flask (1.5 L glass) and are sent to NIES, where they are analyzed using non-dispersive infrared analyzer and a gas chromatograph. Here, we present the results of observations of CO₂, CH₄, CO, N₂O, and SF₆ for the period of 2006 to 2017. CO₂, N₂O and SF₆ show a very consistent increase in their levels, unlike those of CO and CH₄. Seasonal amplitude in CO₂ is observed to be reasonable greater than other observation sites. The contribution of different emission sources is also studied utilizing the correlation analysis. More details, including trend analysis will be presented.

3.134 Urban pollution to the Andean cryosphere.

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Abstract:

Large portions of South America's population live west of the Andes as well as in the Andean valleys and plateaus, with a strong dependence on water resources from the melting of Andean glaciers and snow. Various studies have shown that these glaciers have receded in the last decades in response to temperature and precipitation changes. However, absorbing particles such as black carbon (BC) and dust could potentially also contribute to the increase of melting rates. Important sources of these pollutants, such as cities and mining activity, are located on the slopes or vicinity of the mountain range. The study of the potential transport of urban pollutants to the Andean cryosphere is the focus of several projects and initiatives that have been started in the last few years in the region. Results of two winter campaigns measuring transport up into the Andes as well as model outputs simulating this transport will be presented.

3.136 Determination of $\delta^{18}\text{O}$, $\Delta^{17}\text{O}$, and $\delta^{15}\text{N}$ in atmospheric nitrates: First steps towards a deeper understanding of the nitrogen cycle over the Tibetan Plateau.

Early Career Scientist

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Abstract:

Over the past century, the budget of nitrate, a major component in the terrestrial nitrogen cycle, is greatly modified as a result of increased anthropogenic contributions. However, its interactions with the atmosphere and ecosystems remain poorly understood because of the complex physical and chemical transformation of nitrate within the atmosphere, cryosphere, hydrosphere, and biosphere. The atmospherically produced oxygen isotopic anomalies (quantified as $\Delta^{17}\text{O} = \delta^{17}\text{O} - 0.52 \cdot \delta^{18}\text{O}$) in nitrates provide valuable information that cannot be obtained from other techniques including the conventional isotopic measurements ($\delta^{15}\text{N}$ and $\delta^{18}\text{O}$). This unique isotopic signature has been utilized in understanding photochemistry of nitrogen (in the atmosphere, snow/ice, and their interface), tracing nitrogen sources for varying ecosystems, and reconstructing the atmospheric composition and climate in the past.

Tibetan Plateau, the world's highest and greatest plateau, strongly influences the regional circulation patterns, freshwater availability, and ecosystems. In addition, because of the unique location of the plateau (at mid-latitude and high-altitude), cryospheric records preserved in this region provide valuable paleo-climate information that cannot be obtained from polar regions. In this study, we measured $\delta^{18}\text{O}$, $\Delta^{17}\text{O}$, and $\delta^{15}\text{N}$ in size-segregated aerosols collected in the central Tibetan Plateau (Nam Co, 30.77°N, 90.98°E, 4730 m above sea level) for the first time to provide fundamental information of atmospheric nitrate isotopic composition and chemistry in this unique and climatically important region. Our study not only yields new insight into the present-day atmospheric nitrogen cycle over the Tibetan Plateau, but also allows for extended studies to define the role of nitrate in the atmosphere-cryosphere-hydrosphere-biosphere interaction in the modern- and paleo-environments using this novel and high-dimensional

isotopic technique.

3.138 Atmospheric Ammonia in the Summertime Arctic.

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Abstract:

The budget of atmospheric ammonia (NH_3) in the summertime Arctic is poorly understood, but ammonia can play a key role in new particle formation in this relatively pristine environment. Motivated by the lack of in situ NH_3 measurements in the Arctic, observations were made using online ion chromatography (AIM-IC) and laser spectroscopy (QC-TILDAS) techniques in both marine and terrestrial environments. The marine atmosphere in the eastern Canadian Arctic was investigated onboard the Canadian Coast Guard Ship Amundsen in the summers of 2014 and 2016. Median NH_3 mixing ratios measured from the ship were 220 pptv in 2014 and 140 pptv in 2016. Ocean-atmosphere exchange of NH_3 was quantified using measurements of sea surface water NH_4^+ concentrations, showing net deposition of NH_3 to the Arctic Ocean in both years. In summer 2016, NH_3 was measured at a tundra site in Alert, NU, revealing a median NH_3 mixing ratio of 230 pptv. Measurements of soil NH_4^+ content and pH showed that the tundra can also act as a source for atmospheric NH_3 under certain conditions. Additional sources that can be important in the region include colonies of migratory seabirds and boreal biomass burning. The loss of atmospheric NH_3 through wet deposition was quantified in both 2016 campaigns. The relatively high levels of atmospheric ammonia indicate a much larger flux of NH_x through the Arctic ocean/atmosphere/biosphere system than previously recognized.

3.139 The atmospheric reactivity of the NO₃ radical.

Early Career Scientist

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Abstract:

We describe the first direct measurements of the total reactivity of NO_3 in ambient air, in which cavity-ring-down spectroscopy is used to monitor the loss synthetically generated NO_3 after reacting with ambient trace-gases in a flow-tube. The instrument can measure NO_3 loss rate constants between 0.005 s^{-1} and 45 s^{-1} with an uncertainty of 16 % in the center of its dynamic range.

Results from the deployment of this instrument in a boreal forest in southern Finland and a rural mountain site in southern Germany are presented. In both cases, NO_3 reactivity was driven by local meteorology coupled with biogenic emissions and displayed a strong vertical gradient with the highest reactivity measured below canopy level in the boreal forest. Very low NO_3 reactivities were observed in the residual layer. Comparison of the measured NO_3 reactivity with measurements of Volatile Organic Compounds (VOCs) indicated that the reactivity is dominated by reaction with monoterpenes, though a significant fraction of reactivity remained unattributed. During daytime, at both sites, more than 25% of the NO_3 formed was removed via reaction with biogenic volatile organic compounds (BVOCs), implying a significant daytime loss of NO_x and formation of organic nitrates and secondary organic aerosol via NO_3 chemistry even though the nitrate radical is generally considered to be of importance at night.

3.140 Studying Ammonia Sources Using Nitrogen Isotope in Beijing.

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Abstract:

Atmospheric ammonia (NH_3) plays an important role in secondary particle formation, which is the most important component of haze in Beijing. It is critical to understand various emission source characteristics of NH_3 and quantify each source contribution to NH_3 in ambient atmosphere. However, it is still a challenging question in Beijing. Stable nitrogen isotope composition ($\delta^{15}\text{N}$) provides an effective tool to investigate NH_3 sources. Since NH_3 from different sources has distinct $\delta^{15}\text{N}$ values, it is very important to develop the local source isotope profiles of NH_3 . In this study, NH_3 samples were collected from March 2017 to February 2018 at six sites, which represent major and typical ammonia emission sources in Beijing. We find that there is a wide range in NH_3 mass concentration from different sources (ranging from $24 \mu\text{g m}^{-3}$ for traffic to over $5000 \mu\text{g m}^{-3}$ for livestock) with different $\delta^{15}\text{N}$ values (ranging from -68.2 to -7.7 ‰). The $\delta^{15}\text{N}$ value of traffic source (-15.1 ± 5.9) is significantly higher, which shows a clear distinction from other sources (-32.2 ± 7.5 ‰, -35.5 ± 9.6 ‰, -30.3 ± 9.5 ‰, -37.8 ± 14.2 ‰ and -35.9 ± 4.6 ‰, for waste water treatment, solid waste disposal, human excreta, livestock, and fertilizer respectively). Moreover, the NH_3 source apportionment is conducted using the IsoSource, an isotope mixing model, along with N isotope signatures of NH_3 for each source developed in this study. In March 2017, the average contribution of traffic, waste (including waste water treatment, solid waste disposal and human excreta), livestock, and fertilizer is $29.2 \pm 9.6\%$, $30.7 \pm 22.2\%$, $20.6 \pm 15.1\%$ and $19.4 \pm 14.2\%$, respectively. Our research suggests the important roles of traffic and waste sources, which are unexpected in urban Beijing. The NH_3 source apportionment in Beijing in other seasons will be compared and discussed.

3.141 Spatial and temporal changes of atmospheric PM_{2.5} over the Seto Inland Sea observed on board the training ship Fukaemaru.

Early Career Scientist

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Abstract:

Since the environmental quality standards for PM_{2.5} were established in Japan on September 9, 2009, the atmospheric monitoring network for PM_{2.5} have been expanded over land area and then the PM_{2.5} monitoring data have been accumulated. The data indicated that large numbers of monitoring stations recording higher PM_{2.5} concentrations existed around the Seto Inland Sea as compared with the other regions in Japan. The key factor for increased PM_{2.5} has not resulted to specify yet. To understand the factor, since 2016, we started to observe the ambient concentrations of PM_{2.5} and PM_{2.5} precursors over the Seto Inland Sea on board T/S Fukaemaru owned by Kobe University. In this paper, we will report the observation during the Fukaemaru spring research cruise on March in 2017 with round voyage (Kobe ⇄ Beppu). PM_{2.5}, SO₂ and NO_x concentrations in the marine air, which was intaken to the laboratory on the ship were measured by PM-712, SA-633, NA-623 (Kimoto Electric Co., Ltd). To remove the exposure from own exhaust gases, hourly concentrations were calculated using observed one-minute data after screening. On the out-bound cruise from March 15th to 16th, 2017, hourly PM_{2.5} concentrations were quite low from -1.9μg/m³ to 21.3μg/m³. On the in-bound cruise from March 20th to 22th, 2017, on the other hands, hourly PM_{2.5} concentrations were higher than those on the out-bound cruise. Considerably high PM_{2.5} concentrations, 29.1μg/m³ ~ 44.6μg/m³ were observed at Beppu Bay, Iyo Nada, and Aki Nada located in the western parts of the Seto Inland Sea on March 20th, 2017. At the same period, considerable high PM_{2.5} were recorded at some monitoring station around the Seto Inland Sea. Therefore it was suggested that high PM_{2.5} concentrations observed on board Fukaemaru was affected by regional pollution over Seto Inland Sea.

3.142 Biomass burning influence on ozone and precursors over the Amazon: trends and regional source contributions.

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Abstract:

Biomass burning is a large source of reactive trace gases and aerosol to the tropical atmosphere, with substantial impacts on the atmospheric radiation balance and surface air quality. In the Amazon, fires are mainly caused by human activity, being used as a tool for land clearance during conversion of forest to agricultural land. These fires produce smoke and trace gases, which are observed across widespread regions of the Amazon basin. A downward trend in deforestation over the Amazon has recently been shown, with associated reductions in biomass burning-sourced aerosol. The effects of fires and temporal changes in fire activity on ozone and precursors in the Amazon region may differ from those on aerosol, due to different emission dependencies on fuel type and fire regimes.

We use long-term satellite datasets (2005-2015) of tropospheric column NO_2 and sub-column (0-6 km) ozone from the Ozone Monitoring Instrument (OMI), to investigate biomass burning contributions to NO_2 and ozone concentrations over the Amazon region, and trends over the 11-year period. Large enhancements in Amazon region NO_2 and ozone are detected in the satellite data during the dry season. Our model simulations show these enhancements are sourced mainly from South American biomass burning emissions, with smaller ozone contributions over the eastern Amazon from easterly import of African biomass burning emissions. The 11-year satellite time-series shows statistically significant trends in observed NO_2 both in the deforestation region of the Amazon (negative trend) and in Eastern Brazil (positive trend). These trends appear to be related to trends in deforestation and savannah fire burned area in South America. We

use the TOMCAT chemical transport model to investigate the effects of these trends in NO₂ emissions on regional tropospheric ozone concentrations. We discuss implications of the observed NO₂ trends for ozone air quality in the Amazon region.

3.143 Ozone deposition at a rainforest site (ATTO) in the central Amazon Basin.

Early Career Scientist

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Abstract:

Several recent papers have highlighted the importance of ozone (O_3) dry deposition estimates for modelling global O_3 , especially over tropical forests. O_3 levels are expected to increase with ongoing deforestation: first, through release of O_3 precursors (NO_x) from biomass burning and secondly by reduced deposition as forest canopies (esp. tropical forest) efficiently remove O_3 .

The ATTO (Amazon Tall Tower Observatory) site is located in the Central Amazon ($02^{\circ}08'38.8''S$, $58^{\circ}59'59.5''W$), comprising a 325 meter and two 80 meter towers. The site is an ideal location to perform comprehensive long-term studies regarding forest-atmosphere interactions. The climate is characterized by a very rainy (350 mm in March) and a drier season (ca. 80 mm in September). During the wet season, the air quality shows almost pristine conditions, whereas strong pollution from regional scale biomass burning prevails in the drier season. Since 2012 vertical mixing ratio profiles of H_2O , CO_2 and O_3 have been continuously measured at multiple heights between 0.05 and meanwhile 325 meters. Ozone fluxes have been determined by means of gradient methods and eddy covariance.

Here we present O_3 deposition velocities from gradient and eddy covariance measurements with first results of a recent O_3 flux campaign aimed at disentangling the different O_3 deposition pathways. Fluxes were measured at two levels above and two levels within the canopy to address a) the chemical flux divergence above canopy, b) the total ecosystem flux and c) the partitioning of the flux between upper canopy and understory and soil fluxes. Based on parallel profile measurements of O_3 and NO_x the storage flux of O_3 and the loss by reaction of O_3 with NO will be calculated. The fluxes for the different canopy parts are analyzed by means of stomatal and non-stomatal fluxes based on estimates of stomatal conductance from water vapor fluxes and leaf-level measurements.

3.144 Temporal variations of the mole fraction and carbon isotope ratio of atmospheric methane observed at Ny-Ålesund, Svalbard.

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Abstract:

CH₄ is one of the most important gases for the atmospheric greenhouse effect and the atmospheric chemistry. To contribute to a better prediction of future climate change, great efforts have been conducted for characterizing variations in the CH₄ sources and sinks and their response to climate variability. The stable carbon isotope of atmospheric CH₄ (δ¹³C relative to V-PDB) provides us with additional constraints for understanding the CH₄ cycle, since the respective source categories, microbial, fossil fuel and biomass burning, have their own characteristic δ¹³C values of ~-60, ~-40 and ~-25‰. However, systematic and long-term observation data of δ¹³C are still limited. We have measured the CH₄ mole fraction and δ¹³C using air samples collected weekly at Ny-Ålesund, Svalbard (78°55'N, 11°56'E) since 1991 and 1996, respectively. In this paper, we will present temporal variations of the CH₄ mole fraction and δ¹³C at the site and discuss the causes of the atmospheric CH₄ variations based on the δ¹³C data.

3.146 Sequential changes of airborne microbial communities emitted from forest ground surface in Fukushima.

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Abstract:

The aerosols emitted from forest areas include not only abiotic particles but also airborne biological particles, such as fungal and bacterial cells, which act as ice nuclei and impact on ice-cloud formation processes. However, the detail sequential changes of airborne microbial communities in forest area are have not investigated in detail. Here aerosols were collected at the altitude of 1.5 m above the ground surface at the inside and outside sites of forest area in Fukushima from Spring to Autumns. Under the microscopic observation with DNA staining technique, the biological aerosols could be categorized to fungal spores and bacterial cells. The microbial particles in the air samples of outside and inside sites constantly fluctuated the similar densities ranging from 10^4 particles m^{-3} to 10^6 particles m^{-3} . Exceptionally, at one day after rain, the bacterial particles at the inside of forest area increased to 10^7 particles m^{-3} . High-throughput sequencing technology targeting 16S rRNA genes revealed that the bacterial communities in the both sites exhibited higher diversities and were frequently composed of plant-associated bacteria (Proteobacteria) and terrestrial bacteria (Actinobacteria). The organic aggregated bacterial members (Bacteroidetes) were also detected at the specific to spring and summer. Additionally, in the case of the analyses using internal transcribed spacer (ITS) sequences, the fugal community structures in the both sites were relatively dominated by the members of Basidiomycota, which were related to organic matters-degrading mushroom. The airborne microbial communities are thought to be mixed between the outside and inside of forest areas and would be originated from the forest environmental and/or organic-associated microorganisms.

3.148 Measurements of hydrogen peroxide and formaldehyde concentrations at ground level and in the high-altitude atmosphere over a rural site in central Japan.

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Abstract:

Measurements of H_2O_2 and HCHO concentrations were performed at ground level and in the high-altitude atmosphere using a helicopter over Toyama Prefecture, Japan. The H_2O_2 and HCHO showed clear seasonal variations with highest concentrations in the summer. The H_2O_2 was well correlated with the O_3 in July and August whereas there was no correlation between O_3 and H_2O_2 in May and June. There was a negative correlation between NO_x and H_2O_2 . Significantly high concentrations of H_2O_2 were observed in the summer when air pollutants were transported from the industrial regions in China. Trans-boundary air pollution may significantly affect harmful influence on vegetation. The concentrations of H_2O_2 and HCHO at high-altitude were analyzed by a HPLC system within 5-10 minutes after the sampling. The H_2O_2 over Toyama was lowest at the surface and highest H_2O_2 was detected at the altitudes of 6,000 and 8,000 ft. On the other hand, the HCHO was highest at ground level. The concentrations of H_2O_2 were higher than those of SO_2 at high-altitude in the summer, however the H_2O_2 was usually lower than the SO_2 ; this condition is called *oxidant limitation* during cold months. If H_2O_2 concentration rises in cold months, the acidification of cloud water may be accelerated at high elevations in central Japan where air pollution is actively transported.

3.149 The Influence of Biomass Burning on the Arctic: Pan-Arctic FTIR Observations and Model Results.

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Abstract:

Transport of biomass burning emissions into the Arctic can cause episodic enhancements of multiple trace gas species. We present a multi-year time series of the total columns of carbon monoxide (CO), hydrogen cyanide (HCN), and ethane (C₂H₆) measured using Fourier Transform Infrared (FTIR) solar absorption spectroscopy at six high-latitude sites: Eureka, Nunavut; Ny Alesund, Norway; Thule, Greenland; Kiruna, Sweden; Poker Flat, Alaska; and St. Petersburg, Russia, and at three mid-latitude sites; Zugspitze, Germany; Jungfraujoch, Switzerland; and Toronto, Ontario. For each site, the inter-annual trends and seasonal variabilities of the CO total column time series are determined and enhancements above ambient levels are used to identify possible wildfire pollution events. Correlations of HCN and C₂H₆ with CO, back-trajectories from HYSPLIT and FLEXPART, and fire locations from the Moderate Resolution Spectroradiometer (MODIS) confirm the detections and identify the source regions. The GEOS-Chem chemical transport model is run in tagged mode to determine the relative contributions to the observed enhancements from continental-scale biomass burning source regions.

Exceptional emissions of CO, HCN, C₂H₆, and ammonia (NH₃) from the 2017 North American wildfires were measured at Eureka and Thule, indicating that wildfires may be a major source of NH₃ in the summertime high Arctic. The enhancement ratios of the long-lived species HCN and C₂H₆ are found to be comparable between sites, but for NH₃, the enhancement ratios are strongly dependent on the transport patterns of the smoke plumes. Satellite measurements of NH₃ from the Infrared Atmospheric Sounding Instrument (IASI) and Cross-track Infrared Sounder (CrIS) are used to examine the spatial and temporal variabilities of NH₃. Comparisons to a high-resolution (0.25° × 0.3125°) nested run of GEOS-Chem using emissions from the Global Fire Assimilation System (GFAS) are performed to evaluate the emission inventories and assess the long-range transport of NH₃ to the high Arctic.

3.150 Analysis of Atmospheric Aerosol Optical Properties in the Brazilian Northeast Using Remote Sensing Data from the CALIPSO Satellite, AERONET Photometers and a Ground-Based Lidar.

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Abstract:

We present results of a 10-year analysis of atmospheric aerosols optical properties in Northeastern Brazil. This is the first study of its kind in the region. where we analyzed CALIPSO satellite (CALIOP-Lidar) data, which performs the vertical probing of fine clouds and aerosol properties, and data from the DUSTER Lidar system, that probes the atmosphere over the city of Natal-RN between 800 m and 20,000 m altitude. We also present an evaluation of the CALIOP Lidar Ratio (LR), considering the Aerosol Optical Depth (AOD) obtained from the AERONET network photometer in an inland city called Petrolina-PE. Analyses included determining the LR from the DUSTER and CALIOP, and interomparing AERONET and CALIOP Ångström coefficients versus AOD. Both Natal and Petrolina, apart from marine aerosols and continental pollution, presented dust and biomass burning aerosols that, according to the HYSPLIT model backtrajectories, originated from the Sahara desert and Tropical Africa, respectively. For Natal-RN, the highest concentrations of aerosols were observed in June 2008 (AOD 0.16) and April 2010 (AOD 0.15), indicating that the atmosphere over the city has a low aerosol burden. Both DUSTER and CALIOP level 1 local and time coincident data showed that most of the aerosol layers are located between 1 to 3 km altitude, while the cloud layers are at 1 to 2 km, indicating that both are suitable for initial verification of Cumulus or Stratus clouds and aerosols over the region. For Petrolina-PE, 54 coincident CALIOP and AERONET cloud-free measurements were identified. The Lidar Ratios from the CALIOP HERA algorithm and AERONET/CALIPSO technique (A/C) were compared and presented a percentage difference of $14.76 \pm 4.79\%$. For the 10-year study, CALIOP indicated an overall

underestimation of the Lidar Ratio values.

4.001 The properties and effects of new particle formation events on polluted days in the PRD region, China.

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Abstract:

New particle formation (NPF) events on polluted days at a regional supersite in the Pearl River Delta (PRD) region and its impact on the abundance and properties of cloud condensation nuclei (CCN) were investigated. Nucleation and subsequently significant growth of nanoparticles on a regional scale was observed and representative events on 2 and 6 October 2013 were chosen in this study. The measurements showed that the primary components of the particles were sulfate, ammonium, and organics as they were added continuously to secondary aerosol mass and that particles show inversion from growth to shrink if the particles comprise primarily of organics due to evaporation of semi-volatile species under favorable meteorological conditions. The effective hygroscopicity parameter κ of fine particles on 2 October composed of sulfate, nitrate and ammonium ($\kappa=0.26-0.42$) was larger than that of fine particles on 6 October containing more organics ($\kappa=0.19-0.36$). Particles in the nucleation mode were observed to grow rapidly to the CCN sizes and dominate the CCN number concentrations at a water vapor supersaturation (S) over 0.46%. At an S range of 0.26-0.86%, the CCN number concentrations reached maximum values of $(1.3-2.6)\times 10^4 \text{ cm}^{-3}$ after the NPF event on 2 October. The sulfate component in the particles was found to increase significantly, about 50% higher than that before NPF. Results from events on 6 October showed a significant increase of the organic component and the CCN number concentrations after the NPF event were comparable or slightly lower than those before the event. Nevertheless, the

average CCN number concentrations scaled with EC mass concentration with S over 0.46% in the daytime of 2 and 6 October were significantly higher than those on a non-NPF event day.

4.005 Modelling and remote-sensing based analysis of a dense haze event over Northeastern Pakistan.

Early Career Scientist

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Abstract:

Urban areas in Pakistan are experiencing escalation in haze episodes. Due to magnification in the economy, emissions of gaseous and aerosol components from automobiles, road constructions and industry have been growing in Pakistan that resulted in worst air quality during winter and post-monsoon season. Northeastern (NE) Pakistan (71–74.5°E, 28–34°N) is undergoing from haze (smog / mist) episodes because of magnification in aerosol pollution levels. In addition to anthropogenic emissions, the winter pollution over NE Pakistan is associated with unwonted meteorological conditions. In this article, predicated on model simulations, to examine the pollution levels before, during and after the heavily polluted episode in NE Pakistan. The Lahore, a metropolitan city in NE Pakistan experienced a dense haze event during the first week of November 2016. Particulate matter concentrations, AOD, and pollutants concentration incremented many folds than the mundane. Goal of this study to characterize sources and causes of this haze event especially over Lahore. Weather Research Forecasting model coupled with chemistry (WRF-Chem) and pertinent satellite data from MODIS are utilized towards validation as well. Additionally, the Vertical Feature Mask (VFM) results was presented from the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite that reveals thick layers of aerosol ranging from 2- 5 km in the study region and period.

4.008 Characteristics and influencing factors of PM₁ over Shanghai and its impact on visibility.

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Abstract:

The relative long-term continuous *in situ* measurements during Jan 1st, 2015 and Dec 31st, 2016 were employed to study the characteristics of submicron particles (PM₁) over Shanghai and investigate the influence of precursors and meteorological factors on PM₁ as well as the impact of PM₁ on visibility. A discretization method was introduced to emphasize the general regularity of PM₁ with related factors. The results show that Shanghai has a relatively high PM₁ level of $\sim 28 \mu\text{gm}^{-3}$ annually and accounts for 69% of PM_{2.5}. PM₁ concentration shows obvious temporal variation in year, month, week, and day. In discretized approach, PM₁ has good linear relationship with its precursor gases and meteorological variables in most conditions. Its concentration can be highly determined by SO₂, NO₂, and NO (<34 ppb) with increasing rate of 3.37, 1.17, and 1.08 μgm^{-3} per ppb precursor, respectively. It was validated by the comparison of PM₁ change in day of week. PM₁ is negatively related with precipitation intensity, relative humidity (RH, >35%), and wind speed (>1.5ms⁻¹) with rate of -3.3, -0.27, and -5.9 μgm^{-3} , respectively. Effect of ozone on PM₁ is in two linear relationships inflected at ~ 30 ppb. For other factors or situation, their relationship is not linear due to the indirect influence on transportation, formation, or accumulation. PM₁ concentration has distinct impact on visibility and PM₁/PM_{2.5} ratio is found to be a key indicator to represent the impact of particulate matter hygroscopicity on visibility. PM₁/PM_{2.5} ratio has a good exponent relationship with RH, $PM_1/PM_{2.5} = 0.76 [(1-RH)/(1-40\%)]^{0.11}$ with determination coefficient of 0.98. It well describes the impact of particulate matter and its hygroscopicity on visibility accompanying with PM_{2.5} concentration.

4.010 Reduced biomass burning emissions reconcile conflicting estimates of the post-2006 atmospheric methane budget.

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Abstract:

Several viable but conflicting explanations have been proposed to explain the recent ~ 8 p.p.b. per year increase in atmospheric methane after 2006, equivalent to net emissions increase of ~ 25 Tg CH₄ per year. A concurrent increase in atmospheric ethane implicates a fossil source; a concurrent decrease in the heavy isotope content of methane points toward a biogenic source, while other studies propose a decrease in the chemical sink (OH). Here we show that biomass burning emissions of methane decreased by $3.7 (\pm 1.4)$ Tg CH₄ per year from the 2001–2007 to the 2008–2014 time periods using satellite measurements of CO and CH₄, nearly twice the decrease expected from prior estimates. After updating both the total and isotopic budgets for atmospheric methane with these revised biomass burning emissions (and assuming no change to the chemical sink), we find that fossil fuels contribute between 12–19 Tg CH₄ per year to the recent atmospheric methane increase, thus reconciling the isotopic- and ethane-based results. The abnormally large ENSO in 2015 is associated with almost a doubling of the atmospheric methane growth rate. We use data from the AIRS and GOSAT record, along with the surface network, to contribution of biomass burning to these changes

4.011 Provincial & transported size distributed carbonaceous aerosols at Eastern Central India.

Early Career Scientist

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Abstract:

Carbonaceous components of atmospheric aerosols have taken greater attention of researchers because it takes part in aerosol dynamics and it can be directly from primary sources or product from secondary reactions, affecting human health and also bad environmental effects, like it can disturb earth radiation budget and promotes climate change. Present work reports carbonaceous aerosols in nine size fractions (10.0-0.01 μm) at eastern central India. Size-distributed carbonaceous aerosols (SDCA) were collected over a year from September 2016 to August 2017 using micro-orifice uniform deposit (MOUDI) Impactor air sampler at eastern central India and these samples were analyzed using thermal/Optical carbon analyzer. We have found that study site has high average mass loading of organic carbon (OC) in comparison with elemental carbon (EC) in $\text{PM}_{>9.0}$. The average mass concentration of OC and EC was found to be $24.5 \pm 9.3 \mu\text{g}/\text{m}^3$ and $4.1 \pm 1.2 \mu\text{g}/\text{m}^3$. For the interpretation of air mass trajectories, the air coming in the sampling site were categorized on the basis of their direction i.e., North West (NW), South East (SE), North-South (NS), South East (SE). Air mass trajectories suggest strong possibilities of long-range transport of fine & ultrafine particles. The large value of EC/OC ratio obtained in December to January 2017 which suggests strong biomass burning in study site or nearby areas. Also, the contribution of secondary organic carbon (SOC) is more pronounced in winter because of photochemical reactions and atmospherically favoured conditions. Interestingly we have found EC/OC ratio as 1.52 ± 0.43 in summer indicates study is under the influence of intense vehicular emission.

4.012 Year-round in situ measurements of Arctic low-level clouds: Microphysical properties and relationship with aerosols.

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Abstract:

Continuous in situ measurements of Arctic low-level clouds/fogs have been made at the Mt. Zeppelin Observatory (78°56'N, 11°53'E, 474 m above mean sea level), in Ny-Ålesund, Spitsbergen, since October 2013. The monthly median value of the cloud particle number concentration (N_c) showed a seasonal variation, reaching a maximum in May - July (60 - 70 cm^{-3}) and gradually decreasing in the following months. The median N_c values were 2 - 10 cm^{-3} between October and March. At temperatures of higher than 0°C, hourly N_c values correlated with the aerosol number concentrations with dry diameters of greater than 100 nm (N_{100}), a proxy of cloud condensation nuclei (CCN) concentrations measured at both observatories at Mt. Zeppelin and the mountain foot (Gruvebadet Observatory). When clouds were detected below 0°C, some of the data followed the summertime N_c to N_{100} relationship, while other data showed systematically lower N_c values. Lidar-derived depolarization ratios suggested that the former (CCN-controlled) and latter (CCN-uncontrolled) data generally corresponded to clouds consist of super-cooled water droplets and those contain ice particles, respectively. A fraction of the CCN-uncontrolled data increased with decreasing temperatures, yielding values of more than 0.3 at temperatures below -4°C and values of unity below -19°C. Because monthly averages of atmospheric temperature are between 5 and -16°C at Zeppelin, the CCN-controlled data persistently appeared throughout the year, indicating that CCN concentrations play an important role in controlling the cloud microphysics that affect the radiative properties of clouds and their various indirect effects.

4.013 Abundance of light-absorbing anthropogenic iron oxide aerosols in the urban atmosphere and their emission sources.

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Abstract:

Light-absorbing iron oxide (FeO_x) aerosols such as magnetite contribute to shortwave atmospheric heating and possibly affect the biogeochemical cycle. However, their atmospheric abundance and emission sources are poorly understood. In this study, we quantified the abundance and mixing states of FeO_x at two urban sites in Tokyo and Chiba, Japan, using a modified single-particle soot photometer and filter-based instruments. At both sites, the majority of the FeO_x were of anthropogenic origin in the form of aggregated magnetite nanoparticles, and their concentrations generally correlated with those of black carbon (BC) and carbon monoxide. In Chiba, where the observatory was located near an integrated steel plant, we observed distinctly high FeO_x concentrations and high FeO_x/BC concentration ratios when the air mass passed through the plant. From the observed FeO_x plumes with the mass equivalent diameter range of 170–2100 nm, we estimated their emission flux to be approximately 0.012% of the crude steel production. Meanwhile, in Tokyo, where the observatory was 20–40 km northwest of steel plants, the FeO_x concentrations and FeO_x/BC ratios showed clear diurnal variations and depended little on wind direction. This indicates that other human activities also locally produce FeO_x aerosols in Tokyo. Our data imply that, although steel plant activities emit a large amount of FeO_x , emissions from other anthropogenic sources, e.g., motor vehicles, have a major contribution to the abundance of FeO_x aerosols at the regional and global scales.

4.014 Identifying air pollution sources in Beijing, Taiwan and Malaysia using air mass footprints.

Early Career Scientist

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Abstract:

The UK Met Office's NAME dispersion model has been used to interpret air quality measurements from Beijing, China, Bachok, Malaysia and Taiwan, China. Depending on the season and meteorological conditions the air quality in Beijing, China, Bachok, Malaysia and Taiwan, China is affected by the transportation of particles from China. The NAME model produces footprints that depict the air mass residence time over the previous 5 or 10 days. These footprints show the passageway of the air arriving at the monitoring stations. Regional influences can be assessed by calculating the time the air masses have spent over each region before arriving at the stations. For example in Beijing there are distinct changes in Particulate Matter (PM), CO and NO₂ levels, according to whether the air has remained stagnant over Beijing or whether there are strong winds carrying it from much further afield. In addition, multiple techniques, such as cluster analysis of the footprints and combining the model with an emission inventory, can be used to enhance the interpretation of the air quality measurements.

4.015 Global aerosol climatology with 14km grid spacing using a non-hydrostatic icosahedral atmospheric transport model.

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Abstract:

A high-performance computing resource allows us to conduct numerical simulations with a horizontal grid spacing that is high enough to resolve cloud systems. The cutting-edge computational capability, provided by K computer at RIKEN in Japan, enables the authors to perform more than 1-year, global simulations of air pollutions and clouds with unprecedentedly high horizontal resolutions. In this study, we have developed a next generation model that is capable of simulating global air pollutions with O(10km) grid spacing by coupling an atmospheric chemistry model to Non-hydrostatic Icosahedral Atmospheric Model (NICAM; Tomita and Satoh, 2004; Satoh et al., 2008; 2014). The atmospheric aerosol-chemistry model is called NICAM-Chem (Suzuki et al., 2008; Goto, 2014; Goto et al., 2015, 2016, 2017). We have performed 3-year integrations with 14 km grid spacing on K computer (proposal numbers in 140046, 150156, 160004, 170017, and 180012). The simulated results of the basic meteorological fields, clouds, precipitation, aerosols and radiation fluxes are compared with various measurements including reanalysis data, in-situ measurements and satellite observations. Their global distributions of simulated parameters are generally agreement in the measurements and better performances compared to the other simulations with lower-resolved horizontal grid sizes. Around the polar areas, for example, the aerosol distributions with the higher-resolved horizontal grid spacing are much closer to the measurements than those with lower-resolution, as shown by Sato et al. (2016). The further model evaluation will be presented.

4.016 Abundance and emission flux of the anthropogenic iron oxide aerosols from the East Asian continental outflow.

Early Career Scientist

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Abstract:

Anthropogenic iron oxide (FeO_x) aerosols can affect atmospheric radiation, marine biogeochemistry, and human health. However, due to a lack of observational data, their atmospheric abundance and emission flux are not well understood. In this study, we observed size-resolved concentrations of FeO_x (170–2100 nm) and black carbon (BC, 70–850 nm) aerosols at a remote site in the East China Sea in March 2016 using a modified single-particle soot photometer (SP2). Light signals from individual particles obtained by the SP2 and morphology and compositions analyzed by transmission electron microscope revealed that most of observed FeO_x aerosols are anthropogenic magnetite-like particles. Clear correlations between mass concentrations of FeO_x and BC ($R^2 = 0.717$) and between FeO_x and carbon monoxide (CO) ($R^2 = 0.718$) in air masses from China were obtained, which indicates that their emission sources are spatially similar. Their correlation slopes of mass concentration (ng/m^3) are ~ 0.3 and 0.0015 , respectively. Based on the correlation slopes and reported emission inventories of BC and CO in China, we estimate emission flux of anthropogenic FeO_x aerosols from China to be $0.183\text{--}0.372$ FeTg/yr. Assuming that FeO_x/BC and FeO_x/CO emission ratios remain constant for anthropogenic sources, we also estimate global emission flux of anthropogenic FeO_x aerosols to be $0.669\text{--}0.935$ FeTg/yr. This value is comparable to that of the current emission inventories of total Fe ($\text{FeO}_x + \text{non-FeO}_x$) in PM_{10} from fossil fuel combustion ($0.51\text{--}0.87$ FeTg/yr), although our estimate limits only FeO_x particles with 170–2100 nm in mass equivalent diameter. Our results indicate that the current emission inventories of Fe aerosols from fossil fuel combustion are likely to be underestimated.

4.017 Intraseasonal Oscillation of Tropospheric Ozone in the Summer Monsoon Region.

Early Career Scientist

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Abstract:

Boreal summer intraseasonal oscillation (BSISO) of tropospheric ozone has been observed in Indian summer monsoon (ISM) region and South China Sea summer monsoon (SCSSM) region. There are two types of BSISO in tropospheric ozone: 30–60 days variation with northeastward propagation in ISM region, and 10–30 days variation with northwestward propagation in SCSSM region. The northward propagation of 30–60 days variations of ozone is blocked by Tibetan Plateau in ISM region, however in SCSSM region, the 10–30 days variations of ozone could propagate much further to 40°N without any topographic countercheck. With the northeastward propagation of enhanced/suppressed convections, these negative/positive tropospheric ozone anomalies successively pass through eastern Indian Ocean, Maritime Continent, Bay of Bengal, South China Sea and Western North Pacific.

Most of active (break) ISM events occur when suppressed (enhanced) 30–60 days convections appear over equatorial Indian Ocean and enhanced (suppressed) convections appear over India, Bay of Bengal and South China Sea. As a result, 30–60 days variation of tropospheric ozone shows significant positive/negative anomalies over eastern Indian Ocean and Maritime Continent in active/break period of ISM. Similarly, the most active (break) SCSSM events occur when 10–30 days enhanced (suppressed) convections are over Philippine Sea and South China Sea. Therefore, the negative and positive 10–30 days variation of tropospheric ozone is observed over South China Sea in active and break periods of SCSSM respectively. Both the 30–60 days intraseasonal variation of ozone in eastern Indian Ocean and Maritime Continent region and 10–30 days intraseasonal variation of ozone over South China Sea accounts for more than 30% of ozone anomaly in active and break periods of ISM and SCSSM.

4.024 Sources and Removal of Springtime Arctic Aerosol.

Early Career Scientist

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Abstract:

The sources, chemical transformations and removal mechanisms of pollution transported to Arctic regions are key factors in controlling the impact of short-lived climate forcing agents on Arctic climate, but insufficient knowledge of these factors limits our predictive capability. We present vertically resolved observations of aerosol physical and chemical properties in High Arctic springtime. While much previous work has focused on characterizing episodic events of high pollutant concentrations transported to Arctic regions, here we focus on measurements made under conditions consistent with chronic Arctic Haze, which is more representative of the pollution seasonal maximum observed at long term monitoring stations and possibly more indicative of the High Arctic troposphere in general. On six flights based at Alert and Eureka, Nunavut, Canada (largely north of 80°N), we observe evidence for systematic vertical changes in both aerosol sources and removal mechanisms. With support from model calculations using FLEXPART-ECMWF, we show evidence for sources of partially neutralized aerosol with higher organic aerosol (OA) and black carbon content in the middle troposphere, compared to lower

tropospheric aerosol with higher amounts of acidic sulfate. Our observations suggest that surface-based long term monitoring has underestimated the contribution of OA to aerosol transported to the High Arctic troposphere. Further, we show evidence for aerosol depletion relative to carbon monoxide, both in the mid-to-upper troposphere and within the Arctic Boundary Layer (ABL). Dry deposition, with relatively low removal efficiency, may be responsible for aerosol removal in the ABL while ice or liquid-phase scavenging was likely responsible for aerosol removal at higher altitudes during transport. Overall, we find that the vertical dependence of both regional and remote aerosol sources, and removal mechanisms, combine with long aerosol residence times to drive the properties of springtime Arctic aerosol.

4.025 Effects of aerosols on the precipitation of convective clouds: a case study in the Yangtze River Delta.

Early Career Scientist

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Abstract:

Using the Weather Research and Forecasting model with Chemistry (WRF-Chem) and changing different levels of emissions (original, 50%, 10% and 1%), we simulate a typical convective precipitation to evaluate the effect of aerosols on precipitation. In general, the differences are most obvious in 100%-case, with the strongest precipitation center of 39 mm/h cumulative rainfall at 12:00 on June 10th 2017. Furthermore, there was no clear evidence how many aerosols will promote or suppress precipitation, which is a nonlinear relation. All these results indicate that aerosols can change the microphysical process in the cloud and the structure of the convective cloud. In 100%-case, aerosols increase the rising velocity area and cloud water mixing ratio, but convection center is relatively weak. Accompanied by more CCN activation, the rest CCN number concentration at the height of the cloud is lower along with more ground precipitation. Evidence from the precipitation process of convective clouds indicates the excessive aerosols can produce more CCN, produce a large area and weak strength precipitation. To consider different microphysical processes, the production rate for accretion of rain by snow (PRACS) always keeps a high level. We need further develop microphysics schemes in order to more accurately predict the timing, distribution, and intensity of such an extreme event.

4.027 Agricultural fire impacts on ozone photochemistry over the Yangtze River Delta region, East China.

Early Career Scientist

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Abstract:

Agricultural fire could affect tropospheric photochemistry by emitting trace gases, interacting with solar radiation or providing reactive surfaces for heterogeneous reactions. We examine the effects of an agricultural fire event (8–13 June, 2012) on ozone photochemistry over the Yangtze River Delta (YRD) region, East China. The on-line WRF-Chem model is used, with the inclusion of a detailed agricultural fire emission inventory and seven heterogeneous reactions on soot surface. Comparisons with satellite and ground observational data indicate that the model is capable of reproducing the transport and evolution of this crop fire event. The precursor emissions from agricultural fire play a major role in modifying ozone photochemistry, with a maximal increase in ozone mixing ratio reaching 20 ppb (40%) near the fire zones in northern Anhui. The radiation feedback generates a small increase of surface NO_2 by 2% and less surface O_3 by 1% in the smoke plume. The effects owing to the heterogeneous uptakes on soot are quite small, with an average change value of +0.8%, -0.5%, -0.7% and +0.8% for O_3 , NO_2 , $\cdot\text{OH}$ and HO_2 .

4.030 Dust storms in the Middle East: An observational and modeling study of two events using in-situ and remotely sensed measurements and WRF-Chem-RTFDDA.

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Abstract:

The combination of WRF-Chem and RTFDDA (Real-Time Four Dimensional Data Assimilation), WRF-Chem-RTFDDA, provides an ideal modeling system for simulating and forecasting dust storms in the Middle East due to (a) WRF-Chem's capability of simulating the emission, transport, mixing, and chemical transformation of trace gases and aerosols simultaneously with the meteorology, and (b) RTFDDA's capability of continuously assimilating both conventional and nonconventional observations and thus providing improved initial conditions for dust analyses and forecasts. In this talk, we will present a study of two dust storms in the Middle East using WRF-Chem-RTFDDA and in-situ (AERONET and surface stations) and remote sensing observations (MODIS and SMAP imaging, and profiles retrieved from the CALIPSO mission). WRF-Chem-RTFDDA was run including mineral dust only without the inclusion of anthropogenic aerosols and chemical reactions.

The synoptic conditions for the two dust storm cases are characterized by a cold front at the low level and an upper-level low-pressure system over the Western Mediterranean. Strong westerly and southwesterly winds associated with the cold fronts and the low-pressure systems are behind the development and evolution of the dust storms. WRF-Chem-RTFDDA simulated synoptic weather conditions out to 48-h forecasts are largely consistent with the GFS analyses though some discrepancies in the system locations and intensities are noted. Simulated surface variables, wind speed, wind direction, temperature and relative humidity generally show small biases at all station locations. WRF-Chem-RTFDDA demonstrates its capacity in resolving the generation and evolution of the dust storms; however, model deficiencies are noted especially over the Saudi Arabia where the model fails to simulate the observed dust in the first period of one of the cases. We investigate various factors that may be responsible for the deficiencies, with too moist soil conditions in GFS, and subsequently WRF-Chem-RTFDDA, appearing to be the main one.

4.031 Water-soluble diacids and related compounds in PM_{2.5} aerosols in eastern central India: influence of biomass burning and atmospheric processing.

Early Career Scientist

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Abstract:

Water-soluble organic aerosols are important constituents of fine particles and have been recognized as unique fingerprints to identify atmospheric processes. Fine aerosol samples ($PM_{2.5}$) were collected at a rural site in eastern central India (Ambikapur: $23.12^{\circ}N$ and $83.20^{\circ}E$) during March to June 2017. The samples were analyzed for water-soluble dicarboxylic acids (C_2 - C_{12}), glyoxylic acid (ωC_2), glyoxal (Gly) and methylglyoxal (MeGly) as well as organic carbon (OC), elemental carbon (EC) and water-soluble organic carbon (WSOC). Oxalic acid (C_2) was detected as the most abundant species followed by succinic and malonic acids. The peak concentrations of C_2 and related compounds were observed during early to late April when biomass burning episodes prevailed in eastern central India. Fire images and strong positive correlations of C_2 and related compound with levoglucosan ($R = 0.83-0.99$) suggest that biomass burning is the main source of water-soluble organic aerosols in eastern central India. The mass ratio of malonic to succinic acid suggests a greater contribution of photochemically unprocessed aerosol particles derived from biomass burning over photochemically aged aerosols whereas phthalic to azelaic acid ratios implied the atmospheric processing of unsaturated fatty acids is more significant than that of aromatic hydrocarbons in the atmosphere of eastern central India. Water-soluble organic aerosols derived from biomass burning contribute significantly to the solar radiation balance as they can act as cloud condensation nuclei and may have an impact on the hygroscopic behavior of aerosol particles and the lifetime of clouds in the atmosphere. Intense biomass burning emission and atmospheric processing of biomass burning derived organic precursors in Ambikapur increased the atmospheric burden of water-soluble organic compounds in eastern central India and may affect the regional climate. Biomass burning in this region may also affect the air quality and climate in the outflow region of Indian aerosols.

4.033 The impact of long-range transport of African ozone on tropospheric ozone over Asia.

Early Career Scientist

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Abstract:

Regional tropospheric ozone is greatly influenced by ozone transport from upwind areas. Studies on ozone source-receptor relationships among the continents are significant in improving air quality and understanding climate change. Based on 20-year simulations from a global chemical transport model, GEOS-Chem, and a trajectory model, HYSPLIT, the contribution of ozone produced in the African troposphere to Asia is quantified and the possible transport mechanisms are analyzed. Governed by the Hadley circulation and subtropical westerlies, imported African ozone over Asia peaks in the middle and upper troposphere around 25°N, being the largest in Northern Hemisphere (NH) winter and early spring (15 ppbv). The seasonality of the influence of African ozone on Asia is resultant from the integrated impacts of ozone precursor emissions in Africa and the meteorology and chemistry in Africa, Asia, and along the transport pathways. Overall, imported African ozone can account for 2-18% of tropospheric ozone over Asia, varying with season and altitude. Ozone from the Northern Hemisphere Africa contributes over 80% of the total African ozone in most altitudes and seasons over Asia. The convective divergence in the upper troposphere over the Intertropical Convergence Zone (ITCZ) in NH winter and the Somali jet in NH summer are two important pathways for the interhemispheric transport of Southern Hemisphere African ozone to Asia. Greatly influenced by the proximity of the ITCZ, the uplift of ozone and its precursors from the surface to higher altitudes is most effective in NH winter than in other seasons. The interannual variation of the contribution of African ozone to Asia is found to be positively correlated to the intensity of the African ITCZ in NH winter.

4.034 The impacts of long-range transport on the spatial and temporal distribution of black carbon in the Tibetan Plateau.

Early Career Scientist

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Abstract:

Black carbon (BC) over the Tibetan Plateau can cause glacier melting and thus alter atmospheric circulations and global climate. In this study, we characterize the spatial and temporal distributions of black carbon over the Tibetan Plateau, using the simulations from a global atmospheric chemistry transport models, GEOS-Chem, from 1995 to 2004. We also use the NCEP/NCAR reanalysis data and back trajectory data from HYSPLIT to examine the effects of transport on BC distributions over Tibet. Our results show that surface BC concentrations in Tibet generally increase from the central Tibet to the borders of Tibet in the east, south, and southwest. Seasonally, BC concentrations are highest in spring and lowest in summer. In spring, BC is transported from India to the southern Tibet, resulting in high BC there. In summer, BC transport to the southwestern Tibet is enhanced so that BC can cross the Himalayas, resulting in a larger area that is with high BC and is expanded to the east. The direction of winds begins to change in fall. Consequently, BC concentrations in southeastern Tibet are influenced by BC transported from Southeast Asia in fall and by BC transported from central China in winter. The magnitude of transport is larger in winter than in fall. These results can enhance our understanding of the temporal and spatial variations of snow melting caused by BC over the Tibetan Plateau.

4.035 Aerosol radiative forcing of pyrogenetic iron oxides.

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Abstract:

Combustion aerosols affect the climate by absorbing and scattering radiation. Iron (Fe) oxides emitted from pyrogenetic sources largely reside in supermicron aerosols. Fe oxides on aerosols are known to absorb sun light and heat the atmosphere. However, supermicron aerosols from pyrogenetic sources are ignored for radiative forcing in climate models. Here, we use a global chemical transport model and a radiative transfer model to estimate the radiative forcing of Fe oxides from pyrogenetic sources. The model results suggest that Fe oxides from pyrogenetic sources significantly contribute to a warming effect at the top of the atmosphere over the air polluted regions in East Asia as well as biomass burning source regions. However, the estimates strongly depend on chemical speciation of Fe oxides. These nanoparticles are also important as bioavailable Fe for human health and external nutrient input to marine ecosystems. Our results highlight the need for improving the process-based understanding of the effects of emission sources and chemical transformation on both the optical properties and bioavailability. Since a rapid growth in energy consumption of iron and steel industry in upcoming developing countries is projected in the next decades, this is especially crucial for assessing the future impact of air quality changes on climate and ecosystems.

4.036 Measurements of Mie scattering of single optically-levitated aerosol particles in air.

Early Career Scientist

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Abstract:

Light scattering is one of the important properties of aerosol particles contributing to the radiation balance in the Earth's atmosphere. The aerosol particles are subject to many complex physical and chemical processes, which modify their morphology, chemical composition, and optical properties. To quantify the radiation balance, further understanding of changes in optical properties of aerosol particles due to heterogeneous reactions is urgently required. However, our current understanding of the effect of heterogeneous reactions on the optical properties of aerosol is not necessarily sufficient. It is necessary to investigate individually the optical properties of single particles as a function of its chemical compositions and morphology. Using a laser trapping technique, it is capable of measuring time-dependent changes in the chemical composition and morphology of an individual aerosol particle levitated in air ^[1]. The Mie scattering of individual aerosol particle provides useful information to determine its size and refractive index of particles ^[2]. Therefore, the Mie scattering measurements coupled with the laser trapping technique is a means to investigate change in the optical properties of aerosol particles during heterogeneous reactions in the atmosphere. We demonstrate in situ observation of Mie scattering of single aerosol particles levitated in air by means of the laser trapping technique.

Single micrometer-sized aqueous droplets containing sodium chloride or ammonium sulfate were levitated in air by a focused 532 nm laser beam. After trapping the droplets, 671 nm laser beam was irradiated to the droplets as scattering light source, and the spatial distributions of light scattering intensities of single optically-levitated aerosol particles were successfully observed with a CCD camera. The spatial distributions of light scattering intensities were analyzed to determine size and refractive index of the particles.

[1] S. Ishizaka et al., 2017, *Anal. Chem.*, **89.23**: 12866-12871.

[2] M. Nakagawa et al. 2016, *Aerosol Sci. Technol.*, **50.4**: 392-404.

4.037 Variations of atmospheric CO₂ and its isotopes in the upper troposphere/lower stratosphere over Siberia.

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Abstract:

Carbon and oxygen isotope ratios ($\delta^{13}\text{C}$ and $\delta^{18}\text{O}$) of atmospheric CO₂ provide us useful information on an understanding of the global carbon cycle owing to their dependencies on sources or sinks. To reveal temporal and spatial variations of $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ of CO₂ in the upper troposphere/lower stratosphere (UT/LS) over Siberia, we analyzed air samples collected on board commercial airliners between France/Russia and Japan by the Comprehensive Observation Network for TRace gases by AirLiner (CONTRAIL) project. The CO₂ mixing ratio and $\delta^{18}\text{O}$ show a secular increase during the observation period from April 2012 to May 2017. In contrast, $\delta^{13}\text{C}$ shows a secular decrease mainly due to isotopically lighter CO₂ emissions by fossil fuel combustion. The observed change rate of $\delta^{13}\text{C}$ with respect to CO₂ for the long-term trend (-0.02‰ ppm^{-1}) is, however, significantly smaller than that expected from fossil fuel combustion (-0.05‰ ppm^{-1}). This is ascribed to an isotopic disequilibrium of CO₂ between the atmosphere and the oceans or the terrestrial biosphere. The negative correlation between the CO₂ mixing ratio and $\delta^{13}\text{C}$ is also observed in the seasonal timescale variations in the UT. The change rate of -0.043‰ ppm^{-1} suggests that they are seasonally driven by the carbon exchange between the terrestrial biosphere and the atmosphere. On the other hand, those in the LS are primarily governed by seasonal cycle in stratosphere-troposphere exchange (STE) processes including the Brewer-Dobson circulation (BDC) in the stratosphere. A similar involvement with the STE process is also found in the seasonal relationship between CO₂ and $\delta^{18}\text{O}$; in particular, it is crucial that deeper stratospheric air masses with low CO₂ and high $\delta^{18}\text{O}$ influenced by stratospheric ozone are transported down to the UT/LS region in winter/spring in association with the BDC.

4.039 Tropospheric column ozone variability from space: results from the first multi-instrument intercomparison .

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Abstract:

Tropospheric ozone is a pollutant detrimental to human health and crop and ecosystem productivity. Tropospheric ozone is also the third most important greenhouse gas (after CO₂ and methane), responsible for ~17% of global radiative forcing since 1750. However, the lack of a comprehensive global ozone monitoring network means that ozone's radiative forcing must be estimated by chemistry-climate models with a large error bars

of $\pm 50\%$ due to model uncertainties ($0.40 \pm 0.20 \text{ W m}^{-2}$, according to the fifth IPCC assessment report). Improvements to this estimate require an accurate observation-based quantification of the present-day tropospheric ozone burden (TOB), and greater confidence in chemistry-climate model estimates of TOB in pre-industrial times. TOB is the total mass (Tg) of ozone in the troposphere, calculated by summing all of the tropospheric column ozone (TCO) values at every point on Earth. Presently there is one published observation-based estimate of TOB, which comes from the OMI/MLS satellite instruments on NASA's Aura satellite. Recently, four new satellite products have been developed for measuring TCO and TOB, with two based on the OMI satellite instrument and two based on the IASI satellite instrument. The first intercomparison of these products will soon be published as a component of the Tropospheric Ozone Assessment Report (TOAR). While all five products show the same general tropospheric ozone features across the globe, they differ in absolute TCO quantities and they also differ in terms of decadal trends. The next step is to evaluate all products against the exact same set of in situ ozone observations to gauge the performance of each product in different regions of the world. We will present preliminary results from this evaluation which relies on daily IAGOS commercial aircraft profiles above Frankfurt, Germany and weekly NOAA GMD ozonesonde profiles above Hilo, Hawaii; Trinidad Head, California; and Boulder, Colorado.

4.040 Field observation and numerical simulation of ozone (O₃) formation and accumulation in Pearl River Estuary, South China.

Early Career Scientist

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Abstract:

A field measurement was simultaneously conducted at a suburban site (Tung Chung, TC) in Hong Kong and a rural site (ZH) of Zhuhai city from September to November 2016 in the coast of Pearl River Estuary (PRE). Totally 9 ozone (O₃) episode events were captured (hourly maximum O₃ at ZH > 100 ppbv). The dry air, strong solar radiation and increase of CO, SO₂ were investigated during episodes. Higher NO_x was measured at TC but with less O₃. Typhoon and continental anticyclone mainly influenced PRE on episodes. A simulation model, the Weather Research and Forecasting coupled with Chemistry (WRF/Chem) was applied to understand those phenomena. Simulated results showed good performances with the observations. Higher NO_x was found on the surface and much O₃ in the upper air. Compared with non-episodes, elevated O₃ at both sites were attributed to increase of regional transport and photochemical reactions. More specifically, the vertical transport accounted major part for regional transport during typhoon influenced days, however, the horizontal transport was mainly responsible for it during days controlled by anticyclone. Photochemical reaction was the first contributor at ZH with higher elevations. The larger depletion by chemical consumption and vertical mixing were extracted at TC with more traffic effect and tough surface. From simulations, O₃ accumulation was always found in PRE. With the special topography, PRE is

surrounded by many continental cities. According to physical environment, the divergence wind field with low speed, mesoscale circulations over estuary and compressed planet boundary heights during episodes trapped air pollutants. With such effect, VOCs accumulation trend were also discovered in daytime. The results suggested PRE was a natural "pool" for O₃ and its precursors accumulation and reactions. This study is also significant for advance the knowledge of the O₃ accumulation phenomenon in other regions of the world with similar topography.

4.041 JMA aircraft observation for greenhouse gases over the western North Pacific.

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Abstract:

The Japan Meteorological Agency (JMA) and the Meteorological Research Institute (MRI) developed a flask air sampling system on a cargo C-130H aircraft, as well as a greenhouse gases (GHG) measurement system for the flask samples, as part of a new operational monitoring program of the JMA. Since 2011, the JMA has carried out an operational aircraft observation in the mid-troposphere at about 6km altitude over the western North Pacific. The C-130H cargo aircraft of the Japan Ministry of Defense flies from Atsugi air base near Tokyo to Minamitorishima (an island located nearly 2000 km southeast of Tokyo) once a month. Air samples are collected in flasks during a cruising flight at 6 km, as well as a descending over the Minamitorishima with the WMO/GAW global station. Mole fractions of CO₂, CH₄, CO, and N₂O in the flask air samples are measured using a high-precision analysis system with two laser-based instruments. In cooperation with National Institute of Advanced Industrial Science and Technology, we observe O₂/N₂ ratio using a high-precision MS analysis of flask air samples since May 2012. The 7-year GHG data could capture the geographical variations and their seasonal cycles in the mid-troposphere, as well as the climatology of their vertical profiles over the background station of Minamitorishima. We also found synoptic-scale events with the increased GHG due to Asian continental outflow through the mid-troposphere.

4.042 Validation of GOSAT cloud determination by Himawari-8 data.

Early Career Scientist

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Abstract:

The Greenhouse Gases Observing Satellite (GOSAT), which was launched on 23 January, 2009, is equipped with the Thermal and Near Infrared Sensor for Carbon Observation (TANSO)–Fourier Transform Spectrometer (FTS) for greenhouse gas monitoring and the TANSO–Cloud and Aerosol Imager (CAI) for cloud and aerosol detection. The retrieval processing of TANSO–FTS has been conducted under clear-sky condition, which is judged based on a cloud flag from TANSO–CAI in the daytime and on a TANSO–FTS thermal infrared (TIR) spectrum in the nighttime. Cloud contamination in the field of views (FOVs) of TANSO–FTS could degrade the greenhouse gas retrievals, and therefore the cloud detections should be validated. This study has compared the cloud detections in TANSO–FTS FOVs by TANSO–CAI or TANSO–FTS TIR spectra with cloud detections in coincident FOVs by the Advanced Himawari Imager (AHI) on board Himawari-8. We have first selected coincident Himawari-8 data obtained within one minute before or after TANSO–FTS observations and then conducted cloud determination tests on the selected Himawari-8 data in the TANSO–FTS FOVs following the cloud detection method applied to the Moderate Resolution Imaging Spectrometer (MODIS). We have applied several different sets of cloud determination tests to Himawari-8 reflectance and brightness temperature data obtained in the daytime or the nighttime over the land or the ocean, separately.

For the three days on 1–3 January in 2016, cloud detections by TANSO–CAI or TANSO–FTS and Himawari-8 agreed to each other by 61–80%. In the daytime over the ocean, the number of TANSO–FTS FOVs judged as clear conditions by Himawari-8 and cloudy conditions by TANSO–CAI was relatively large, which suggests that TANSO–CAI cloud determination tests are “clear conservative”. In the daytime over the land, cloud detections by TANSO–FTS TIR spectra possibly missed low clouds judging from the reflectance cloud determination tests by Himawari-8.

4.044 Insight into nitro-phenolics in organic aerosol during high pollution events in Beijing.

Early Career Scientist

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Abstract:

Air pollution, particularly from particulate matter of diameter, 2.5 microns or less (PM_{2.5}) has been linked to cardio-respiratory disease and cancer. The inhabitants of mega cities such as Beijing (with a population of over 20 million) are at high risk from exposure to PM_{2.5}, with official estimates of PM_{2.5} in Beijing at 86 µg m⁻³ for 2014. Nitro-phenolic compounds are known phytotoxins and are linked with cancer in humans, they also contribute to brown carbon and have impacts on climate.

In this study, we examine the composition of organic aerosol collected during winter and summer in Beijing during the Air Pollution and Human Health (APHH) project. An extensive mass spectra database was built from literature and secondary organic aerosol tracers from chamber experiments. High resolution (up to ½ hourly) filter samples were analysed using high-throughput ultra-high performance liquid chromatography and tandem mass spectrometry (UHPLC-MS²) analysis to determine the concentrations of nitro-phenolics. Modern data mining techniques were combined with meteorological measurements to determine the sources of nitro-phenolics in Beijing.

Thirteen commonly observed nitro-phenolic compounds were quantified across the campaigns and their time series used to determine preliminary source apportionment.

The nitro-phenolic compounds contributed on average 6.4% and 3.2% (for winter and summer respectively) of the total organic carbon (TOC) and displayed pronounced diurnal cycles during the two campaigns, peaking around 09:00, with minima overnight. An additional peak is observed in the summer diurnal cycle around 14:00, corresponding to photo-oxidation of aromatics. Of the thirteen compounds, dominant species observed include 2-Nitro-1-Naphthol and 4-Nitrophenol. The effect of structural isomerism of nitro-phenolics on the relative ionisation efficiency was investigated, with compounds with the nitro group in the ortho- position had 1-2 orders of magnitude lower ionisation efficiency. Outside of these compounds, the sources of all observed nitrogen containing compounds were investigated.

4.045 Evaluation of Radiative Effects during a Typical Wintertime Black Carbon Episode over the Yangtze River Delta in China .

Early Career Scientist

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Abstract:

Black Carbon (BC), an important aerosol component of regional haze pollution in eastern China, has been identified to impact the planetary boundary layer (PBL) structure and air quality effectively. In this study, a typical wintertime high black carbon pollution episode over the Yangtze River Delta (YRD) is analyzed using the fully coupled online Weather Research and Forecasting/Chemistry (WRF-Chem) model.

The episode is characterized by high anthropological emission and stable weather condition. The high BC concentrations (hourly value exceeded $20 \mu\text{g m}^{-3}$ in central YRD) corresponded closely to the appearance of inversion layer, low PBL height together with poor horizontal and vertical dispersions. The pollution formation mechanisms of this case are representative in eastern China during wintertime.

Analysis shows that in daytime BC increases the downward radiation in the upper boundary layer ($\sim 1200\text{-}1500$ m) by 5.6 W/m^2 , weakening the radiation incident on the surface by 8.4 W/m^2 , and radiative forcing on short-wave radiation is about 3 times that on long-wave radiation. The radiative effect leads to upper-level warming and surface cooling. The upper-level heating reaches its maximum (>1.0 °C) around afternoon, while surface cooling is strongest in the morning, contributing to a formation of inversion layer and a decrease in nocturnal PBL height by 20-200 m. Furthermore, the BC-boundary layer interaction could enhance the air pollution. BC radiative effect induced increases in $\text{PM}_{2.5}$ concentration by 4.4% in daytime and 8.1% in nighttime, averaged over the YRD during the pollution episode. The results indicate that although the radiative effect of BC is large during the daytime, its impact on the structure of PBL occurs mainly at night, which contributes to the nocturnal accumulation of air pollutants in winter haze events.

4.046 Numeric modeling of plant ozone exposure and its effect on atmospheric CO₂ in China.

Early Career Scientist

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Abstract:

Tropospheric ozone (O₃) is known to damage leaf photosynthesis through oxidizing plant cells. In consequence, carbon uptake by land ecosystem is suppressed and more carbon dioxide (CO₂) accumulates in the atmosphere. Recent studies have assessed the effect of O₃ on plant primary productivity and carbon storage, but the potential impact on atmospheric CO₂ concentrations has not been quantified. Here, we use the regional climate model (RegCM4) coupled with a terrestrial biosphere model (YIBs) to estimate the effect of plant O₃ exposure on atmospheric CO₂ in China. Results from experiments considering O₃ damage compared to simulations without O₃ effects show a considerable reduction (0.55 Pg C) in gross primary productivity (GPP), with a maximum of about 2.5 Pg C in summer. At the same time, O₃ increases land ecosystem CO₂ flux by a regional mean 0.29 Pg C due to the inhibited carbon sequestration. The effects of O₃ on CO₂ flux are strongest in east and central China, frequently suffer from high levels of O₃. Furthermore, we find a significant increase in atmospheric CO₂ concentrations as tropospheric O₃ damages plant productivity. The increases in CO₂ are much more evident in spring and summer, since plants grow vigorously in these period. The maximum increase in CO₂ concentration reaches about 12 ppm in Sichuan Basin and North China Plain. Our assessment indicates that the tropospheric O₃ has a detrimental impact on plant CO₂ uptake and leads to an indirect increase in atmospheric CO₂ concentrations, and should be taken into account in future carbon cycling and climate modeling.

4.047 An 8-year record of atmospheric trace gases and aerosols in Southeast Asia based on shipboard observation.

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Abstract:

The National Institute for Environmental Studies has performed long-term atmospheric monitoring over the Pacific Ocean using a commercial cargo vessel since 1994. Currently we conduct the monitoring work along three shipping routes: North Pacific (Japan–United States/Canada), Oceania (Japan–Australia/New Zealand), and Southeast Asia (Japan–Southeast Asian countries). The monitoring work was first implemented along the routes of North Pacific (Japan–United States/Canada) and Oceania (Japan–Australia/New Zealand), but was augmented by the monitoring work in the Southeast Asia region in September 2007. Along the Southeast Asia route, we observed climatically important trace gases and aerosols based on in-situ measurements (gases: CO₂, CH₄, CO, and O₃; aerosols: PM_{2.5}, SPM, and black carbon) and flask sampling (CO₂, CH₄, N₂O, CO, H₂, SF₆, and O₂/N₂) followed by the laboratory analysis. Here we present analysis of the 8-year record (2007–2015) of CO₂, CO, and O₃ based on the in-situ measurements, examining the time-series variation of these three gases in respective 7 defined areas: off the east and west coast of Indochina and Malay Peninsula, and off the coast of Philippines, Borneo, and Indonesia along the shipping route. The analysis revealed different distribution features of CO₂, CO, and O₃ in each area that were controlled by the seasonal change of transport patterns driven by the Asian monsoon with strong disturbance by large-scale tropical biomass burnings.

4.050 UKESM1: A first assessment of the pre-industrial to present-day anthropogenic forcing.

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Abstract:

A quantitative understanding of the role of different forcing agents in both historical and future climate change remains a key motivation and scientific question for the forthcoming 6th Coupled Model Intercomparison Project (CMIP6). Fundamental to this question is the impact of physical and chemical perturbations due to anthropogenic activities on the Earth's radiative balance. In this work, effective radiative forcings (ERFs) are quantified for different anthropogenic forcing agents with the UK's Earth System Model, UKESM1. By using a single modelling framework and adopting the protocol from the Radiative Forcing Model Intercomparison Project (RFMIP), pre-industrial to present-day ERFs are calculated consistently for all anthropogenic climate forcers. The forcing agents considered here are the long-lived well-mixed greenhouse gases (GHGs), stratospheric and tropospheric ozone (O₃), aerosols, and land use change. In particular, additional UKESM1 simulations are used to attribute the methane ERF, as an example, to forcing by methane, tropospheric O₃, aerosols, and stratospheric water vapour, and to attribute the tropospheric O₃ ERF to its individual precursors. The impact of pre-industrial to present-day oxidant changes on aerosol forcing is also

explored.

4.051 Fine particulate matter (PM_{2.5}) in the two largest cities in Vietnam.

Early Career Scientist

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Abstract:

Aerosol pollution is a serious problem in Vietnam. However, only few studies on the fine particulate matter (PM_{2.5}) have been reported so far, especially about long-term continuous and high temporal resolution (1 hour) data. This study presents one of the first long-term observations of PM_{2.5} obtained from two monitoring stations in Hanoi and Ho Chi Minh cities in Vietnam during one-year monitoring (2017). Ho Chi Minh City (HCMC) is the largest and most populous city, while Hanoi, the capital, is the second most populous in Vietnam. The average PM_{2.5} concentration of 42.8 µg/m³ in Hanoi is much higher than that of 29.7 µg/m³ in Ho Chi Minh City. Both of them could not meet the WHO air quality guidelines, indicating that high-risk potential related to PM exposure. A pronounced seasonal variation of PM_{2.5} is observed with the highest during the winter and the lowest during the summer in Hanoi. While in HCMC with the tropical region, the highest concentration is observed during the dry season compared to that during the rainy season. We also found that the diurnal variations vary from season to season which could be affected by daily variation of the meteorological conditions and anthropogenic emissions. Finally, the effect of air mass origins on PM_{2.5} observations is explored using the back trajectory and cluster analysis in HYSPLIT-4 model.

4.058 Short-term variations in atmospheric constituents associated with local front passage over Fukuoka, an urban area in Japan, observed by a 3-D coherent Doppler lidar and in-situ tracer measurements.

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Abstract:

Local fronts, such as sea-breeze fronts, play an important role not only in a meteorological aspect but also for pollutant transport/mixing, in urban areas in particular. Due to the difficulty of measurement of three-dimensional (3-D) wind fields, there are few studies focusing on spatial and temporal variations in aerosol and gas compositions associated with local front passage. At the end of November 2016, a 3-D coherent Doppler lidar was installed in Fukuoka city (33.55N, 130.37E), an urban area in Japan, and 3D-wind fields have been continuously measured since then. Two local fronts, having typical density current structure, were observed on 3 May and 29 June 2017. Ground surface atmospheric constituents (aerosol, black carbon (BC), carbon monoxide (CO), ozone (O₃), and sulfur dioxide) and meteorological parameters indicated a step-like change during the passage of fronts. Concentrations of BC and CO, supposed to be surface origin, were increased at the passage. However, O₃ content, which could be higher at higher altitude, decreased. Two case studies indicate that the temporal change of surface atmospheric constituents is strongly affected by vertical mixing as well as the vertical scale (depth) of the front.

4.060 Case study of aerosol optical and radiative properties during a haze event over the northern Thailand region using WRF-Chem..

Early Career Scientist

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Abstract:

Particulate matters (PM) has a crucial role in regional and global climate change by modifying cloud optical properties and radiative forcing. The climatic effect of aerosols is determined by their radiative forcing, which is a function of their optical properties, including scattering and absorption. The dynamical nature of PM causes direct and indirect effects on the radiation budget, circulation pattern and cloud albedo. In the present study, the temporal variation of aerosol optical and radiative properties are presented and discussed.

The model simulations were performed for 10 to 20 April, 2016, considered as a haze period over the northern Thailand region using Weather Research and Forecasting model coupled with Chemistry (WRF-Chem). The simulated optical and radiative effects of aerosol during the event are compared with AERONET (Omkoi, a semi-urban location in northern Thailand) and the aerosol mass concentration is compared with observation obtained from the Pollution Control Department (PCD) of Thailand. The correlation coefficient between simulated and observed AOD is found to be 0.66, associated rmsd (root mean square difference) is 0.2. The atmospheric short-wave radiative forcing estimated from the model is compared with observations and the correlation is 0.51, rmsd is 7.3 W/m². WRF-Chem showed an overestimation (10-30 %) in simulated AOD and atmospheric radiative forcing when compared to the observations. Substantial increase of AOD during dry season (March-April_May) are mainly due to the uncontrolled burning habit of agricultural waste and forest fires over the northern Thailand region, which is the predominant fuel during these haze conditions. Aerosol optical and radiative properties such as single scattering albedo, asymmetry parameter, short-wave radiative forcing at the surface and on top of the atmosphere are also studied over the study region and it will be presented and discussed.

4.061 Using Multi-model Intercomparison and Aircraft Observations to Advance Constraints on the Methane Lifetime.

Early Career Scientist

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Abstract:

Advances in methods using machine learning enable us to systematically quantify the factors that cause differences in tropospheric hydroxyl radical abundances and methane

lifetime between atmospheric models. We apply these methods to a larger group of models than ever before, 13 chemistry-climate models (CCMs) with free-running meteorology and 12 models that constrain their meteorological fields (i.e., specified dynamics or SD), using simulations conducted for the Chemistry-Climate Model Initiative (CCMI). Current analysis suggests the factors driving the largest differences in CH_4 lifetime within the free-running simulations are local O_3 concentration, the photolysis frequency of O_3 to $\text{O}(^1\text{D})$ ($\text{J}(\text{O}^1\text{D})$), and the abundance and partitioning of NO_x ($=\text{NO}+\text{NO}_2$). Analysis of the SD simulations for CCMI is currently underway, but past work showed that CO is also a top factor responsible for OH variations between models with constrained meteorology [Nicely et al., *JGR*, 2017]. In addition to sharing the latest results from the model intercomparison and compelling case studies of how these results can be applied, we also demonstrate how the machine learning approach can be adapted to include global-scale measurements. By incorporating observations from the Atmospheric Tomography Mission (ATom) aircraft campaign, we directly evaluate the impact of chemical and radiative biases within models that provide output at relatively high temporal frequency (30 minutes). Preliminary neural network analysis of the CAM-Chem and GEOSCCM models has been performed using data from ATom-1. Over the tropical Pacific ocean, differences in model versus observed local O_3 and CO drive the largest changes in OH from CAM-Chem, while $\text{J}(\text{O}^1\text{D})$ and CO differences have the most influence on OH within GEOSCCM. Quantification of these findings, examination of additional flights and ATom deployments, and synthesis of these results will be presented.

4.063 Effect of transboundary transport of air pollution from the Asian continent for the new particle formation by aerial observation in Fukue Island, Japan.

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Abstract:

Vertical distributions of atmospheric particles number concentrations (measured by CPC, model 3781, TSI Inc., USA; $D_p > 6$ nm; altitude of < 1.2 km) were investigated at Fukue Island (32.75°N, 128.68°E) by using a Kite-plane from April 13 to 16, 2017. Based on a comparison of those data, we characterized the event/non-event days into three cases: [Case 1] The strong new particle formation event (NPF) was observed on 13 April under the high-pressure systems and SO₂ rich condition. The maximum number of particle concentrations ($\sim 3.6 \times 10^3$ cm⁻³) was observed at an altitude of ~ 400 m, which was correspondence to the high RH layer. Ground based measurement indicated that NPF event occurred starting from 3 nm particles and subsequently observed growth of particle size to several tens nm. [Case 2] The weak NPF event was observed in the afternoon on April 14 by changing the air mass origin, which was due to the local domestic emission. An increase of particle number concentration was started from 20 nm under the higher SO₂ concentration. [Case 3] There was no NPF event and the particle number concentrations were almost constant ($\sim 2 \times 10^3$ cm⁻³) below 0.8 km. In this case, higher sulfate concentration in PM₁ was observed by Aerodyne Aerosol Chemical Speciation Monitor. Based on Aerosol Optical Depth data and air mass backward trajectory analysis, anthropogenic emissions from Shanghai region in China could affect high sulfate concentrations at ground-based site and suggesting that sulfates could be in the size range between 600 nm and 1 μ m and highly aged during transport over the East China

Sea. These results indicated that strong NPF could be occurred in the upstream region and high altitude before reaching to the ground-based site and NPF could affect vertical distribution of atmospheric nanoparticles over the Fukue Island.

4.065 Resolving the Persistent CO Underestimate in Atmospheric Chemistry Models.

Early Career Scientist

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Abstract:

Carbon monoxide (CO) is emitted from combustion and is the main sink of the hydroxyl radical (OH) in the troposphere. Observations of CO, combined with global chemical transport models (CTMs), can improve constraints on anthropogenic and natural combustion-related emissions with implications for greenhouse gas lifetimes and levels of background ozone. The long lifetime of CO makes it a useful tracer for identifying different sources of air pollution, but recent degradation of CO simulations hinders the use of CTMs for this purpose. Constraints on the global methane and methyl chloroform lifetimes indicate a general overestimate in modeled OH of up to 10 % across a suite of global CTMs (Naik et al., 2013) that may be the source of recent poor model CO performance. Similarly, models overestimate the ratio of OH in the Northern to Southern hemispheres (Patra et al., 2014) which may indicate poor understanding of OH drivers in the Northern hemisphere (Strode et al., 2015). Here, we use observations of CO and related species from the NASA Atmospheric Tomography Mission (ATom) combined with surface and satellite observations to improve our understanding of the persistent CO underestimate and OH overestimate in atmospheric chemistry models with the goal of improving confidence in model ability to assist in identifying sources of global pollution, simulate the lifetime of greenhouse gases, and estimate background concentrations of ozone.

4.066 Seasonal variation of the wet deposition of black carbon at Ny-Ålesund, Spitsbergen.

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Abstract:

Deposition (wet and dry) of black carbon (BC) in the Arctic lowers snow albedo, thus possibly contributing to warming in the Arctic. Wet deposition by snow and rainfall in the Arctic also influences BC concentrations in ambient air. We measured the size distribution of BC in snowpack and falling snow using a single particle soot photometer combined with a nebulizer. We sampled snowpack at two sites (11 m and 300 m above sea level) at Ny-Ålesund, Spitsbergen, in April 2013. The BC size distributions did not show significant variations with depth in the snowpack, suggesting stable size distributions in falling snow. The number and mass concentrations (C_{NBC} and C_{MBC}) at these sites agreed to within 19% and 10%, respectively, despite the sites' difference in snow water equivalence. This indicates the small influence of the amount of precipitation on these quantities. We also sampled falling snow near the surface during the same snow accumulation period. Average C_{NBC} in snowpack and falling snow agreed to within 15%. From the comparison of C_{NBC} and C_{MBC} in snowpack and falling snow, we estimated the relative contribution of dry deposition to total deposition to be about $22 \pm 6\%$. C_{NBC} and C_{MBC} in falling snow and BC concentrations in ambient air were highest in winter. We also sampled falling snow and rainwater near the surface during the extended period of 2012-2017. The C_{NBC} and C_{MBC} values in falling snow and rainwater showed significant seasonal variations. These variations, together with ambient BC concentrations, simultaneously measured, will be useful to improve the understanding of the processes of wet deposition of BC in the Arctic. The data will also be useful in constraining climate models used to estimate the effects of BC on the climate in the Arctic.

4.067 Natural and Anthropogenic Aerosols in the UTLS in Recent Decade: Sources and the Role of Monsoon Transport.

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Abstract:

We present a study of decadal variations of aerosols in the upper troposphere and lower stratosphere (UTLS) in terms of the origins and transport mechanisms through modeling and analysis of observations. We use the global model GEOS-5 that incorporates emissions from anthropogenic, biomass burning, volcanic, and other natural sources including dust and sea salt, to simulate the aerosols and track their origins. The model results are compared to satellite observations from CALIOP, OSIRIS, Envisat instruments, and OMPS as well as aircraft observations. It is evident that volcanic sources exert large, sporadic perturbation to the UTLS aerosol composition mainly due to the nature of volcanic eruptions and relatively high-altitude injections, but anthropogenic aerosols are the dominant sources in the UT and lowermost stratosphere that are transported from surface to high altitudes via the monsoonal convective transport with well-organized seasonal cycles. We estimate the relative contributions of natural and anthropogenic aerosols in the UTLS, analyze the chemical and physical processes, and discuss the implication of the continuous increase of Asian anthropogenic emissions.

4.068 Green House Gas Emission from Solid Waste Disposal Sites in Sri Lanka.

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Abstract:

Waste collection and disposal has become a serious problem in Sri Lanka with the expansion of urban population and rapid changes of the consumption patterns. Local authorities are responsible for municipal solid waste management in Sri Lanka. However the capacity of Local Authorities is not sufficient to manage all waste generated within the local authority limit. Only limited local authorities are running sanitary land filling practice currently and others open dump. In Sri Lanka there is no separation at the collection as biodegradable and non biodegradable.

The garbage mound located at Meethotamulla collapsed on 14th April 2017 destroying houses and infrastructure situated at the toe region of the south western side of the garbage mound. According to the situation report of "Meethotamulla MSW Dump Disaster" by the Disaster Management Centre, 60 houses have been completely destroyed, 27 partially damaged while 32 bodies have been recovered from the damaged area. The Meethotamulla waste dump site is located about 4.0 km east of Colombo which is the capital city of Sri Lanka. The spatial data obtained from the drone survey shows that at the time of collapse, the dump has occupied an area of 78000 m² having a maximum length of approximately 413m in the NW to SE direction and a approximate width of 189 in NE and SW direction. The maximum crest height of the mountain was in the range of 40 to 50m.

Presently, about 250 open dump sites in active operation out of which 25 are same as Meethotamulla garbage dump site. MSW disposal sites are one of the biggest CH₄ sources of the country and it is an acute problem. According to the second national communication on GHG inventory preparation, a total of 84.06 Gg of methane has released from MSW disposal in the country in 2002.

4.070 Climatological Study of Black Carbon Transport from European Major Population Centers..

Early Career Scientist

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Abstract:

The offline Lagrangian transport and dispersion model FLEXPART will be utilized to simulate the climatological dispersion characteristics of air pollution plumes produced by major population centers (MPCs) in Europe. The simulations will use black carbon emissions from the MACCity emission inventory forced by ECMWF ERA-Interim reanalysis data. The main scientific question to be addressed is the quantification of the impact of the emissions from the selected European MPCs on air pollution levels at local, regional and hemispheric scales. Black carbon has been chosen as a tracer because it plays a significant role as a positive radiative forcer, impacts notably human health, and is well suited for transport studies due to its linear chemistry. The black carbon aerosol-like tracers are modeled subject to removal processes by dry and wet deposition. The anthropogenic black carbon emissions from the chosen MPCs are treated separately to allow the investigation of their individual but also their cumulative impact, compared to other black carbon sources, on local atmospheric composition, and regional sites of pollution accumulation. As an outlook, the MPCs emission outflow to the Arctic regions will be discussed as well as consequences for human health of the exposure to elevated black carbon concentrations.

4.071 Summertime upper tropospheric nitrous oxide (N₂O) over the Mediterranean as a footprint of Asian emissions.

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Abstract:

The aim of this study is to analyse the transport of nitrous oxide (N₂O) from the Asian surface to the eastern Mediterranean Basin (MB) using N₂O measurements from the spectrometer TANSO-FTS on board the Greenhouse gases Observing SATellite (GOSAT) and the Infrared Atmospheric Sounding Interferometer (IASI) onboard the MetOp platform, and the outputs from the chemical transport model LMDz-OR-INCA. By comparing GOSAT and IASI upper tropospheric retrievals (~300 hPa) to aircraft measurements from the HIAPER Pole-to-Pole Observations (HIPPO), we calculated a standard deviation (std) error of 0.75% (~2.0 ppbv) for a single GOSAT pixel and 0.5-1.0% (1.6-3.2 ppbv) for a single IASI pixel. This std error can be reduced to ~0.1 ppbv by regionally and monthly averaging IASI and GOSAT N₂O over the MB. The use of nitrogen fertilizer coupled with high soil humidity during summer monsoon produces high N₂O emissions which are transported from Asian surfaces to the eastern MB. This summertime enrichment over the eastern MB produces a maximum in the difference between the eastern and the western MB N₂O at ~300 hPa (east-west difference) for July both in the measurements and the model. The analysis of IASI N₂O using results from

backtrajectories exhibits the capacity of these retrievals to capture long-range transport of air masses from Asia to northern Africa via the summer monsoon anticyclone on a daily basis. N₂O over the eastern MB can therefore be considered as a footprint of Asian summertime emissions. However, the peak-to-peak amplitude of the east-west difference observed by GOSAT ($\sim 1.4 \pm 0.3$ ppbv) is larger than that calculated by LMDz-OR-INCA (~ 0.8 ppbv). This is due to an underestimation of N₂O emissions and to a relatively coarse spatial resolution of the model that tends to underestimate the N₂O accumulation into the Asian monsoon anticyclone.

4.074 Southern Ocean Aerosols - a seasonal perspective from Macquarie Island.

Early Career Scientist

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Abstract:

Being so far from anthropogenic activity, the Southern Ocean region is a unique environment that experiences the most pristine atmosphere in the world. This makes it a perfect testbed for understanding pre-industrial conditions that are so vital for reducing the uncertainties inherent in global climate and earth system models today (Carslaw et al., 2013). Clouds are of particular interest in this region because of the large biases in shortwave radiation and sea surface temperatures that are present in most models. However, due to its remoteness and wild environment, the Southern Ocean is one of the most under-sampled regions of the Earth's atmosphere, making high quality observational data from the region invaluable.

The recently concluded Antarctic, Clouds and Radiation Experiment (ACRE) included a two-year intensive measurement campaign that began in March 2016 at Australia's sub-Antarctic research station at Macquarie Island (54.6°S, 158.9°E). Amongst the suite of instrumentation deployed are those for the measurements of condensation nuclei (CN₁₀) and cloud condensation nuclei (CCN) which are vital components in the formation of clouds and determining their properties. In this presentation, the first climatological analysis of the dataset is presented and compared to previous measurements in the region as well as other long-term datasets around the globe.

4.077 Analysis of the carbon dioxide in the upper troposphere and lower stratosphere by the data from GOSAT TANSO-FTS TIR.

Early Career Scientist

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Abstract:

It is said that the carbon dioxide (CO₂), which is a major greenhouse gas, causes the stratosphere cool. While, the concentration of CO₂ in the stratosphere is not well understood, nor are the exchange processes between the upper troposphere and lower stratosphere (UT/LS ; 300-100hPa). The present study investigated the seasonal and inter-annual variations of CO₂ to understand the concentration and exchange process between UT and LS. Analysis of seasonal and inter-annual variations in UT/LS was conducted by using vertical profile data of CO₂ derived from thermal infrared (TIR) region (Band 4: 5.5 - 14.3 μm) of the Thermal And Near-infrared Sensor for carbon Observation (TANSO) - Fourier Transform spectrometer (FTS) on board Greenhouse gas Observing SATellite (GOSAT). The data used for the analysis were Level 2 (version 01.xx ; latest edition), the analysis period is four years from January 2010 to December 2013. We adapted the correction values derived from Saitoh et al. [AMT, 2016] which validated the TIR CO₂ profiles at UT/LS region with the Comprehensive Observation Network for TRace gases by AirLiner (CONTRAIL). Detailed results of the seasonal and inter-annual variations of CO₂ in UT/LS are shown in the presentation.

4.078 A study on aerosol transport into upper troposphere and lower stratosphere and their impact on radiative and chemical processes with a global climate model.

Early Career Scientist

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Abstract:

Aerosols affect the radiation budget and chemical composition in the atmosphere. Among them, since the aerosols in the upper troposphere and lower stratosphere (UTLS) influence radiation, chemical and dynamical processes in the stratosphere, it is important for considering climate change. Recent satellite observations have shown an increase in the amounts of aerosols in the UTLS. The main reasons are considered to be due to deep convection by the Asian summer monsoon, volcanic eruption and large forest fires, but the transport processes from the aerosol sources and the climate impact of aerosols on the UTLS are not investigated quantitatively. This study examines the transport pathways of aerosols and its precursor gases to the UTLS using a global climate model, MIROC-SPRINTARS. Furthermore, we conduct sensitivity simulations with perturbing aerosol emissions from volcanoes, forest fires, fossil fuel to investigate the effects of aerosols on the climate through the radiative and chemical processes in the UTLS. These results will be shown in the presentation.

4.079 Seasonal and inter-annual variations of methane at the upper troposphere.

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Abstract:

To deeply understand climate change, it is important to understand the dynamical processes of transport in free-troposphere and stratosphere-troposphere exchange. We used the profile data (e.g., carbon dioxide (CO₂) and methane (CH₄) profiles) of GOSAT TANSO-FTS Level 2 (the latest version 01.XX [Saitoh et al., AMT, 2016]) and the other trace gases (e.g. ozone) to understand the above issues. These trace gases are long-lived in the troposphere and lower stratosphere, and are retrieved mainly from thermal infrared radiance (TIR) spectra of Band 4 of TANSO-FTS. The present study focuses on the seasonal and inter-annual variations of CH₄ in the upper troposphere and lower stratosphere. To compare, we used the model simulation data, NIES-Transport Model ver.5 [Saeki et al., GMD, 2013] and Nonhydrostatic Icosahedral Atmospheric Model (NICAM)-based Transport Model (TM) [Niwa et al., JMSJ, 2011]. The analysis period is from January 2010 to December 2013.

The spatial and temporal variations of CH₄ are similar with respect to the previous studies, for example, the seasonal march of latitudinal distribution, and the hemispheric contrast. The high concentration was seen over land at the high latitudes in the boreal winter and the central- and east-Asian during the boreal summer. At the south-central pacific, low concentration was seen during the boreal winter and spring. On the other hand, high concentration existed at the equatorial Indian Ocean and the western Pacific during the boreal summer and autumn. It was found that the CH₄ transports from the lower to the upper troposphere over the convective regions continuously. However the isolated maximum at the middle troposphere was seen in the low latitudes. The year-to-year variations removing the trend of CH₄ at the upper troposphere are larger than that of the simulation data, especially at the subtropical region.

4.082 Heterogeneous distribution of dimethyl sulfide (DMS) and dimethylsulfoniopropionate (DMSP) in melt pond and its impact to atmospheric sulfur compounds.

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Abstract:

The Arctic Ocean environment is experiencing rapid climate changes such as warming, ocean acidification and sea ice reduction, influencing ecosystem dynamics including biogeochemical cycling. Dimethyl sulfide (DMS) and its major precursor dimethylsulfoniopropionate (DMSP) are produced through physiological function of phytoplankton in marine environment. It has been suggested that oceanic DMS emissions could play a dominant role in climate regulation on a regional basis especially in the polar region. In this study, we investigated the characteristics of distribution of DMS and DMSP in melt pond during a cruise held in the Arctic Ocean. The increase of melt pond area in the Arctic has been documented over the past decade, but behavior of DMS and DMSP have rarely been studied in the melt pond. We collected water sample from the surface of 10 different melt ponds with different salinity conditions around an ice camp station (78.5°N, 179.2°E). We found large variation in both DMS and DMSP concentration among melt ponds, 0.1–18.6 nM and 0.5–5.1 nM, respectively, indicating heterogeneous distribution of DMS and DMSP in the melt ponds. There is no clear relationship between DMS and salinity or temperature, however, DMSP shows positive correlation with salinity ($r^2 = 0.58$). This relationship may indicate that the lower osmoregulation effect caused limitation of DMSP production in the lower salinity condition. This result shows that stratification of melt pond water and difference in biological activities in the stratified layer may induce the variation in DMS concentration. The concentration of DMS in melt ponds were relatively higher than those of ambient surface seawater (approximately 0.2 nM), suggesting that higher flux of DMS will occur when the whole sea ice will melt. We will discuss the impact of formation and spreading of melt pond and sea ice melting to the atmospheric sulfur amount.

4.083 Sources and processes driving pollution in the African upper troposphere between 2005 and 2013.

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Abstract:

We use IAGOS (<http://www.iagos.org>) aircraft measurements of ozone (O₃), carbon monoxide (CO) and relative humidity (RH), IASI spacecraft observations of O₃ and CO, to investigate the seasonal distribution variations and the inter-annual variability of the chemical species, over the African, the South Atlantic and the Indian Ocean upper troposphere. Between 2005 and 2013, daily Air Namibia flights equipped with onboard autonomous instruments, allowing sampling the atmosphere between Europe (London and Frankfurt) and Namibia (Windhoek) with high frequency (almost every day), while IASI observations provide additional measurements over the two adjacent Oceans. Using systematic Lagrangian simulations (FLEXPART) coupled with emission inventories (SOFT-IO module), we give a first quantification of the CO sources origin (anthropogenic, biomass burning, regions of the world) and of the transport processes (Hadley cells, tropical easterly jet, westerlies) driving the observed meridional gradients north and south of the Inter Tropical Convergence Zone over the three regions (South Atlantic, Africa, Indian Ocean) and zonal gradients East and West of the ITCZ. Thanks to the 7 years of regular measurements, a first assessment of the inter-annual variability of the

chemical species (O₃, CO and RH) is also presented.

4.085 Ozone trend analysis from 1980-2015: Models vs Observations.

Early Career Scientist

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Abstract:

Ozone (O_3), a secondary pollutant, is one of the main oxidant species in the atmosphere, affecting ecosystems and human health. Its secondary nature and the non-linear dependence of its production on nitrogen oxides (NO_x) and volatile organic compounds (VOC) concentrations challenges the accuracy of chemistry - transport model (CTM) simulations but also the definition of emission control strategies to reduce its concentrations in the troposphere. Thus, while for primary pollutants emissions reductions have been shown efficient to reduce pollutant levels for ozone concentrations the picture remains unclear.

Weather conditions and anthropogenic activities are shown to affect tropospheric ozone long-term and seasonal variability. Moreover, the air quality improvement strategies of the last decades also affect the ozone trends and seasonality by affecting its precursors. For this study the well documented TM4-ECPL model, with an analytical chemical scheme, is used to simulate the global ozone concentrations and the temporal and spatial trends of the past 35 years (1980-2015). The model is validated against near surface measurements from a vast collection of monitoring stations and independent studies, and against ozonesonde measurements where available.

Decadal changes in southern hemisphere surface ozone seasonality are calculated to be impacted by changes in the downward flux of stratospheric ozone. The importance of stratospheric ozone for the surface ozone seasonality changes in the southern

hemisphere is also investigated based on multi- year ozonesondes from several, mostly remote, sites.

4.086 OH and HO₂ concentration observations in the upper troposphere inside and outside of Asian monsoon influenced air..

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Abstract:

The Asian monsoon convectively transports pollutants like volatile organic compounds (VOCs), NO_x, and SO₂ from the boundary layer over South Asia into the upper

troposphere where they can potentially enter the stratosphere, or be dispersed globally throughout the troposphere. Therefore, it is crucial to understand the oxidizing capacity of this system and its impact on pollutant degradation and aerosol formation. The Hydroxyl radical (OH) plays a central role and is the most important oxidizing molecule in the atmosphere. During the OMO-ASIA campaign in the summer of 2015, HO_x (OH and HO₂) was measured onboard the High Altitude Long-Range Research Aircraft (HALO). Two laser-induced fluorescence instruments based on the fluorescence assay by gas expansion technique (LIF-FAGE) were installed, the AIR-LIF instrument from Forschungszentrum Jülich GmbH and the HORUS instrument from the Max Planck Institute for Chemistry, Mainz. To measure the chemical background of OH potentially produced inside HORUS from highly oxidized VOCs, an Inlet Pre-injector (IPI) system was used. This was the first time an IPI system was implemented within an airborne LIF-FAGE instrument measuring HO_x. Inside the Asian monsoon outflow total HO_x concentrations did not increase significantly compared to outside. However, OH concentrations were on average 37% higher inside the anticyclone. This is mainly attributable to increased NO_x levels within the anticyclone with a significant NO source from lightning. This strong shift of HO_x towards OH results in accelerated oxidation rates of pollutants, implying that the Asian monsoon anticyclone acts like an atmospheric purifier in addition to a pollution pump. The CAABA-MECCA box model was used to test our current understanding of HO_x chemistry in the upper troposphere. Constraining the model with measurements from OMO-Asia has provided insight into the extent of differences in the contribution and composition of HO_x sources, sinks and cycling in and outside the anticyclone.

4.088 Characterization of ozone in the middle troposphere over Japan from 6-year observation at the summit of Mount Fuji (3776m).

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Abstract:

The continuous measurement of tropospheric ozone was made at the summit of Mt. Fuji (3776 m a.s.l.) for 6 years (1992-1998). The observations suggest some characteristic features of ozone in the middle troposphere over Japan. The annual variation at the summit of Mt. Fuji shows a bimodal seasonal trend; May and October maxima and August and December minima. The summer minimum, which causes the bimodal seasonal trend, is resulted from the domination of the ozone-depleted maritime air at the summit. In June, however, the enhanced ozone (>60 ppbv) is occasionally observed at the summit in the air with low water-vapor mixing ratio and high potential vorticity (PV), suggesting that it has origins in the stratosphere or the upper troposphere. The small variance of ozone during the winter is suggested by the winter photochemistry on ozone and strong zonal winds. The infrequent ozone intrusions from the stratosphere are also thought to contribute to the small variance of ozone during the winter. The synchronization of the annual course of daily-mean ozone with the clear-sky solar radiation at the summit from late autumn to early spring and the coincident of the both minima in late December suggest that the solar radiation controls ozone observed at the summit during this period of time. In the spring, the daily-mean ozone simultaneously increases with the daily solar radiation besides the ozone concentrations do not correlate with PV, suggesting that the spring ozone maximum at the summit of Mt. Fuji is mainly resulted from photochemical ozone production. However, the possibility of partial contribution of indirect stratospheric ozone intrusions or aged stratospheric ozone to the spring ozone maximum cannot be ruled out. The 6-year observation of ozone at the summit shows the increase trend of $0.49 \text{ ppbv year}^{-1}$, but it is not significant at 95% significance level.

4.089 What controls interannual variability and long-term trends in global tropospheric chemistry and aerosols in past and future? .

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Abstract:

Global distributions and abundances of tropospheric constituents (O_3 , CH_4 , NO_y , CO , VOCs, NH_x , SO_x and aerosols) inter-annually change under the influences of meteorology (transport, temperature, water vapor, clouds, rain, etc.) and emissions from anthropogenic/natural sources and biomass burning. Since chemistry climate models are generally used for future projection of individual constituents, model validation against the observations and precise interpretation/understanding of changing processes in a model are essentially needed. In this study, we investigate the inter-annual variability and long-term trend of tropospheric constituents in a chemistry-aerosol coupled climate model CHASER (MIROC-ESM) focusing on the past reproduction (1960 to 2016) and future projection (2010-2100). In this study, we basically use our CHASER simulations for the CCMI multi-model experiment. Our results show that temporal variability (anomaly) in surface and lower tropospheric ozone and $PM_{2.5}$ very clearly correlates with that in CO , especially in NH ($r > 0.8$), indicating the principal importance of biomass burning emissions in determining near-surface O_3 and $PM_{2.5}$ variabilities. Changes in middle to upper tropospheric O_3 for the past decades and future, on the other hand, respond principally to variabilities/trends in water vapor, transport from the stratosphere (STE), and lightning NO_x production associated with climate trend (i.e., warming) and variability (inc. ENSO, PDO, etc.) and/or stratospheric O_3 change. It is also demonstrated that the inter-annual variability and long-term trend in tropospheric mean OH concentration (and hence CH_4 concentration) is largely controlled by tropospheric abundances of O_3 , NO_x , and water vapor. In the simulations, the emission-driven long-term increase in global mean CH_4 (~350 ppbv for 1980-2010) is nearly halved (~170 ppbv) by OH increases due to changes in climate and NO_x emission. Our simulations further suggest that this kind of complex interaction among O_3 -OH- CH_4 and climate plays key roles in future changes and radiative forcing of tropospheric constituents including aerosols (sulfate and nitrate).

4.090 Aerosol impact on present day climate.

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Abstract:

To keep within 2° of global warming, we need large reductions of greenhouse gas emissions. Since aerosols often are co-emitted with greenhouse gases, reducing greenhouse gas emissions will simultaneously reduce aerosol emissions, -compounded by present and future effort to improve air quality. Using idealized simulations with fully coupled climate models, we show how cleaning up aerosols, predominantly sulfate, may add an additional half a degree of global warming. The northern hemisphere is found to be more sensitive to aerosol removal compared to greenhouse gas warming, due to the location of the aerosol emissions. We find a higher sensitivity of heavy precipitation intensity and hot extremes to aerosol reductions, per degree of surface warming, over the major aerosol emission regions, which are also among the main populated regions of the globe. East Asia is a region where extreme precipitation is particularly sensitive to a reduction in aerosol emissions. Further, reducing sulphate and black carbon emissions over four separate emission areas (East Asia, South Asia, North America and Europe respectively) result in strong climate changes locally, but also remotely in areas such as the Arctic. The differences in spatial pattern between climate forcing and response due to greenhouse gases and aerosols mean that for low global warming scenarios, e.g., consistent with the 2° target, the realized climate impacts will depend significantly on the path we take toward a global temperature goal.

4.091 Evaluation of MERRA-2-based Ozone Profile Simulations with the Global Ozonesonde Network.

Early Career Scientist

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Abstract:

Chemical transport model (CTM) hindcasts of ozone (O_3) are useful for filling in observational gaps and providing context for observed O_3 variability and trends. We use global networks of ozonesonde stations to evaluate the O_3 profiles in two simulations running versions of the NASA Global Modeling Initiative (GMI) chemical mechanism. Both simulations are tied to the NASA Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) meteorological reanalysis: 1) The GMI CTM, and 2) The MERRA-2 GMI Replay (M2 GMI). Both simulations start in 1980, and are compared against >50,000 ozonesonde profiles from 37 global stations from the tropics to the poles. The comparisons allow us to evaluate how the Replay technique affects modeled O_3 distribution, how an updated chemical mechanism in the GMI CTM affects simulated tropospheric O_3 amounts, and how observed O_3 distributions compare to the full set of model output. In general, M2 GMI O_3 is ~10% higher than in the GMI CTM, and shows global near-surface and tropical upper troposphere/lower stratosphere (UT/LS) high biases. The updated chemical mechanism in the GMI CTM reduces these high biases. Both simulations show similar negative biases in tropical free-tropospheric O_3 , especially during typical biomass burning seasons. The simulations are highly-correlated with ozonesonde measurements, particularly in the UT/LS ($r > 0.8$), showing the ability of MERRA-2 to capture tropopause height variations. Both simulations show improved correlations with ozonesonde data and smaller O_3 biases in recent years. We expect to use the sonde/model comparisons to diagnose causes of disagreement and to gauge the feasibility of calculating multidecadal O_3 trends from the model output.

4.095 Decadal-scale attribution of ozone and methane radiative forcing.

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Abstract:

Methane and ozone are the 2nd and 3rd most important greenhouse gas in terms of radiative forcing (RF). Mitigation policies directed at controlling these short-lived climate pollutants (SLCP) as a means of avoiding "dangerous" climate change while simultaneously improving air quality have been proposed. In order to assess the effectiveness of these strategies at the scales in which they would be enacted, the complex interaction between emissions, transport, transformation, and radiation must be characterized. Concurrently, the last decade has seen a dramatic change in the landscape of emissions with Asian regions playing an increasingly prominent role. Here, we quantify and attribute the global impacts of these changes on climate forcing at unprecedented spatial scales using satellite observations from TES, OMI, and MOPITT in conjunction with advanced assimilation and adjoint modeling techniques from 2005-2015. The trajectories of satellite-constrained NO_x and CO emissions have divergent time rates of change leading to a net RF that changes in sign within country boundaries. The impact of the intra-continental variations in emissions along with the top 10% of sub-national drivers of decadal climate forcing is quantified revealing opposing regional balances between India and China. These results show the potential of an SLCP monitoring and attribution system as part of a broader effort to mitigate against climate change.

4.096 Cloud Condensation Nuclei Properties of Pollen Grains.

Early Career Scientist

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Abstract:

Atmospheric aerosol particles are known to have a direct effect on climate through scattering and absorbing incoming solar and planetary radiation. They also indirectly affect climate by acting as cloud condensation nuclei (CCN) and modifying cloud forcing and hydrological cycle. The least understood components include the primary biogenic aerosols (PBAs), such as pollen grains, which represent a significant fraction of the total aerosol component in the atmosphere. A number of prior studies have shown that PBAs have high ability to act as CCN and ice nuclei [1]. At the present time, pollen is not considered as one of the key parameters in climatic models due to the large size and short lifetime in the atmosphere. However, under high humidity pollen grains can rupture to form submicron subpollen particles (SPP) that as well can serve as CCN. A rather significant part of subpollen particles arising from fragmentation of the initial particles is not included in the latest climatic models: that leads to significant inaccuracy in estimations.

In this study the CCN ability of 3 different types of SPP typical for boreal forest biom in the size range 20-300 nm was analyzed. The CCN concentration of the size-selected particles and cloud condensation nuclei parameters in the water vapor supersaturation range of 0.1-1.1% were determined for birch (*Betula pendula*), pine (*Pinus silvestris*) and rape (*Brassica napus*) samples. Also the parameter κ which characterizes the chemical composition effect on the hygroscopicity of CCN-active particles has been determined.

Acknowledgments

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4.099 Analysis of high radon-222 concentration events in winter using multi-horizontal-resolution NICAM simulations.

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Abstract:

Atmospheric radon-222 (^{222}Rn) variability is analyzed and compared with model simulations made by the Nonhydrostatic Icosahedral Atmospheric Model (NICAM), with three horizontal resolutions (223, 56, and 14 km), for remote observation stations in the northern hemisphere; Minamitorishima (24°N, 154°E) (by Meteorological Research Institute, Japan) and Bermuda (32°N, 65°W) (by National Urban Security Technology Laboratory, U.S.), in order to understand high ^{222}Rn events predominantly caused by frontal activities. Seasonal variations of event frequency are well reproduced by the model, with correlation coefficients of 0.79 (223 km) to 0.99 (14 km). The frequency tends to maximize in winter for both observation and models, reflecting the fact that cold fronts most frequently occur in winter. Based on these results, we analyze composite mean of high ^{222}Rn events in winter in this study. All of the three horizontal resolutions can reproduce general features of observed temporal variation of ^{222}Rn during high ^{222}Rn events. The fact is also supported by the temporal variation of equivalent potential temperature, whose change is widely used to locate fronts. Equivalent potential temperature shows maximum decreasing rate at the time of or just before the ^{222}Rn peak, indicating high ^{222}Rn air is located behind the cold front. Peak height and width of ^{222}Rn are well reproduced by the 56 km and 14 km resolution models, while the 223 km resolution model shows much lower and broader peaks compared to those observed due to insufficient resolution. As a consequence of this study, it seems that model, with horizontal resolution of 56 km or finer grid spacing, can well simulate spatiotemporal variations of atmospheric components driven by frontal activities, while 223 km

resolution is not enough to reproduce them.

4.102 Vertical profiles of particle light extinction coefficient in the low troposphere in Shanghai in winter based on Tethered balloon measurements.

Early Career Scientist

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Abstract:

A state-of-the-art cavity attenuated phase shift single scattering albedo monitor (CAPS PM_{SSA}) was set up in a tethered balloon to study the vertical profiles of particle light extinction coefficient (b_{ext}) in the low troposphere (<1000 m) in Shanghai during 12-29 December 2015. In total, 90 vertical profiles of b_{ext} were obtained, 67 of which were measured continuously from ground surface to approximately 1000 m. 50 groups of b_{ext} at several fixed heights (e.g., 400 m, 500 m, 700 m, and 950 m) were also measured for about 70 h. A clear transition height (TH) was generally observed for vertical profiles of b_{ext} below 1000 m all day long. TH could be observed mostly at about 400-500 m, 100 m, 400-700 m during early night (18:00-20:00), late night, morning, respectively. During periods with PM_{2.5} at ground surface higher than 75 $\mu\text{g}/\text{m}^3$, stable TH were always formed below about 700 m and the average difference below and above the TH can be as high as 605 Mm^{-1} , about 9-fold higher. Detailed analysis of vertical profiles also revealed several higher b_{ext} at higher altitudes, which is mainly caused by regional transport at around 350 m and 500 m in winter in Shanghai. Comparatively, b_{ext} was relatively well vertically mixed below 1000 m during clean periods when PM_{2.5} < 75 $\mu\text{g}/\text{m}^3$ at ground surface. The transport of air masses could affect the general pollution level of PM concentrations and vertical profiles of b_{ext} . The study elucidates the vertical evolution characteristics of b_{ext} below 1000 m in winter in Shanghai, which will provide hints to aerosol optical model in the vertical direction. The study is also of importance to validate the retrieval algorithm of lidar measurements at the height range of 300-1000 m, and makes a good complement of the blind zone below 300 m.

4.103 Impact of biogenic emissions of organics from a cool-temperate forest on aerosol optical properties retrieved from a Sky Radiometer.

Early Career Scientist

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Abstract:

Terrestrial biogenic emissions of organics can affect the optical properties of atmospheric aerosols and thus impact climate change. Large uncertainties exist in how the abundance and chemical composition of biogenic organic aerosols affect the absorbing/scattering characteristics of aerosols. Filter measurements of submicron water-soluble aerosols were made within a canopy of Tomakomai Experimental Forest, a cool-temperate forest site in northern Japan. In order to elucidate the impact of biogenic emissions of organics on aerosol optical properties, the filter-based chemical data were compared with the aerosol optical depth (AOD) and single scattering albedo (SSA) retrieved from a Sky Radiometer at the same site simultaneously obtained with the filter-based samples from June to December 2015. In order to investigate a linkage between the filter-based aerosols and the Sky Radiometer data, the data were selected for periods when the vertical transport was dominant based on local wind data.

The AOD exhibited a distinct seasonal variation similar to that of the total soluble mass (TSM) in the filter-based submicron aerosols, which showed increase in summer and autumn. In summer, sulfate accounted for 60% of TSM, which was linked to an increase of SSA (>0.95) suggesting more scattering characteristics of aerosol particles above the forest canopy. On the other hand, the SSA in autumn decreased ($SSA=0.90-0.95$), suggesting more absorbing characteristics. The decrease of SSA was associated with the increase in the mass fraction of water-soluble organic matter (WSOM, 70% of TSM). The majority of WSOM in autumn is attributable to emissions of α -pinene from the forest floor, and the subsequent formation of biogenic secondary organic aerosols (BSOA). The result indicate that α -pinene-derived SOA, mostly originated from the forest floor, can decrease SSA in autumn, which has a potential to reduce the negative radiative effect on a regional scale.

4.105 Temporal variation of HCl related to the change of the meridional circulation in the northern lower stratosphere.

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Abstract:

HCl is a main chlorine reservoir species in the stratosphere. The amount of HCl is a good indicator for a potential of ozone depletion. Observed total column of HCl was decreasing in 2000s after the CFCs regulation but showed increase from 2007 to 2010. Mahieu et al. [2014] investigated that this increase is due to interannual dynamical variability in the northern stratosphere from Fourier Transform Infrared spectrometer (FTIR) observations at 8 sites including Tsukuba and 3D-chemical transport model simulations. In this study we extended the analysis of HCl total column observed with FTIR at Tsukuba to 2017. The temporal variation of HCl total column showed decrease again from 2011 to 2014 then increase from 2015 to 2017. Mass stream function was calculated from ERA-Interim meteorological data to confirm that these temporal variations are also due to stratospheric circulation change. The difference of the mass stream function between the average of 2003 - 2005 and the average of 2007 - 2009 shows negative values in the northern lower stratosphere. This means the deceleration of circulation and it is consistent with the result of Mahieu et al. [2014]. The difference between the average of 2007 - 2009 and the average of 2011 - 2013 shows positive values in the northern lower stratosphere that means the acceleration of circulation. The difference between the average of 2011 - 2013 and the average of 2015 - 2016 shows negative values in the northern lower stratosphere again. These changes correspond to the HCl temporal variation. Thus we confirm that the temporal variation of HCl after 2011 is also due to stratospheric circulation change.

4.106 Iodine monoxide variations observed by shipborne MAX-DOAS over the tropical Pacific Ocean.

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Abstract:

Iodine monoxide (IO) retrievals were performed by shipborne Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) on the Japanese research vessel *Mirai* during its expeditions from 2014 to 2017, to clarify the global IO variations over the world's remote oceans. During the expedition of Nov-Dec 2014, clear latitudinal variations in IO differential slant column densities (DSCDs) for an elevation angle of 3° were observed with maxima in the tropical Pacific ($\sim 2 \times 10^{13}$ molecules/cm²). We investigated ozone variations observed on the vessel and found that there were clear negative correlations with IO on a day-to-day time scale over the tropical Pacific. This result suggests that IO plays an important role in tropospheric chemistry over the tropical remote ocean.

4.107 The surface aerosol optical properties in urban areas of Nanjing, west Yangtze River Delta of China.

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Abstract:

Observational studies of aerosol optical properties are useful to reducing uncertainties in estimating aerosol radiative forcing and forecasting visibility. In this study, the observed near-surface aerosol optical properties in urban Nanjing are analyzed from Mar 2014 to Feb 2016. Results show that near-surface urban aerosols in Nanjing are mainly from local emissions and the surrounding regions. They have lower loadings but are more scattering than aerosols in most cities in China. The annual mean aerosol extinction coefficient (EC), single scattering albedo (SSA) and asymmetry parameter (ASP) at 550 nm are 381.96 Mm^{-1} , 0.9 and 0.57, respectively. The absorbing aerosol has smaller sizes than the scattering aerosols'. All the aerosol optical properties have substantial seasonality and diurnal variations. ASP has a good quasi-LogNormal growth trend with increasing SC when RH is below 60%. Atmospheric visibility decreases exponentially with increasing EC or SC, more sharply in spring and summer, and it could be further deteriorated with increasing SSA and ASP.

4.108 Transmission electronic microscopy observations of aerosol mixing state in Japan - its relevance to CCN activity and air quality.

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Abstract:

Aerosol particles are ubiquitous in the atmosphere, and their climatic importance is embodied in many ways. Acting as cloud condensation nuclei (CCN), promoting changes in cloud microphysical properties and therefore interfering the Earth energy budget, aerosols present one of the largest uncertainties in climate prediction. It is essential to understand how the role of aerosols as CCN evolves in various environments according to their physicochemical properties. In this study, we present the analysis of aerosols collected in three locations in Japan, with the technique of transmission electronic microscopy (TEM). (Electron microscopy particle database of Meteorological Research Institute can be accessed at <http://metemadb.kir.jp/>) Based on the TEM analysis, individual particles sizes and elemental compositions are revealed in great details and their hygroscopicity is derived. The TEM analysis of aerosol populations sampled at the three locations shows distinct composition, mixing state and CCN properties, indicating that the interactions between meteorology, atmospheric chemistry and local emissions differentiate the aerosol populations. In addition, the aerosol populations mixing state is characterized using an aerosol mixing state metric and the impact on cloud condensation nuclei (CCN) properties is quantified. This demonstrates that the CCN concentrations computed assuming internally-mixed aerosol populations are erroneous to various extent. Apart from their climatic importance, aerosol particles are closely related to air quality. Based on the information revealed by TEM, we compute the deposition efficiency of the transition metal content associated with the aerosols sampled in human respiratory tract using a deposition model and find that aerosol mixing state matters for the deposition efficiency. This research connects the valuable information of aerosols revealed by TEM to the investigation of aerosol impacts on air quality and climate.

4.114 Processes driving the chemical variability over the Mediterranean basin: results from the GLAM campaign as compared to chemical-transport models and analysis.

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Abstract:

The objective of the GLAM (Gradient in Longitude of Atmospheric constituents above the Mediterranean Basin) airborne campaign was to evaluate the summer impact of the Asian Monsoon Anticyclone onto the Mediterranean Basin (Ricaud et al., 2014, ACP). Performed during 6-10 August 2014, tropospheric pollutants, greenhouse gases and aerosols over the Mediterranean Basin were densely sampled along W-E transects at 5 and 9 km altitudes, with additionally vertical profiles (0-12 km) in the vicinity of Menorca, Lampedusa, Heraklion and Larnaca airports (Ricaud et al., 2018, BAMS). Considering the O₃, CO, CH₄, CO₂ and H₂O measurements sampled between 3°E (Menorca, Spain) and 33°E (Cyprus), the W-E gradient is atypical when compared to the climatology. Fine structures echoed consistently between species are interpreted as signatures of biomass burning, stratospheric intrusions and ozone depleted air masses with a remote maritime origin. We compared GLAM results against the Copernicus Atmosphere Monitoring Service (CAMS) models, the Météo-France MOCAGE chemistry transport model models, and the NASA Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2). The results with the evaluated biases are provided. Nevertheless, GLAM some anomalies are not echoed in the models/analysis and the tested MOCAGE downscaling

does not reduce bias significantly. The origin of the GLAM chemical species are determined using backward trajectories from Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT). These trajectories combined to chemical-transport model or analysis results are allowing to trace a chemical history of air masses.

The variability of the tropospheric chemical composition observed during GLAM is driven by the long-range transport (from Asia, from Africa through the North Atlantic and from North America), the downward motion of subsiding air aloft and a stratospheric intrusion, in which strong subsidence mechanisms interplay (Dayan et al., 2017, ACP) leading to an unexpected chemical W-E gradient.

4.115 Impact of densely populated area of Krakow (Poland) on CFCs and SF₆ concentration in the atmosphere.

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Abstract:

The concentrations of chlorofluorocarbons (CFCs) and sulphur hexafluoride (SF₆) in the atmosphere are on the ppt level. CFCs compounds are synthetic, stable, and they contribute to ozone depletion in the stratosphere. CFCs and SF₆ also participate in intensification of the greenhouse effect. Due to this fact, measurements of CFCs and SF₆ in air were started. They are usually carried out at places situated outside of urban areas influence ("clean stations"). In Europe such clean station is Mace Head (Ireland), which participates in AGAGE program since 1987 and in InGOS program till 2016. This kind of research is also conducted in Central Europe, in densely populated area of Krakow (Poland) since 1997. Within this work regression filtration of Krakow data was did, to pull the base line of individual compounds and to estimate its tendency. Then, the comparison with AGAGE data (Mace Head) was made. On this basis, it can be told that in Krakow, concentration of selected compounds is superposition of base line, typical for this part of Europe, and the local, incidental fluctuations. It is observed, that after 1.07.2002, when the Montreal Protocol legislations were implemented in Poland (The Journal of Laws No. 52), frequency of seasonal variability of CFCs concentration pollution events are diminishing. The concentration of CFC11 (CFCl₃), CFC12 (CF₂Cl₂), CFC113 (CCl₂FCClF₂), chloroform (CHCl₃), 1,1,1-trichloroetane (CH₃CCl₃), carbon tetrachloride (CCl₄) has a tendency to decrease, whereas sulphur hexafluoride (SF₆) tend to increase, which quite good agreed with data from Mace Head. Additionally, to show probable origin of these pollutants, meteorological characteristics of Krakow region was analysed.

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4.116 Transport of aerosols and trace gases into the upper troposphere during the peak Asian monsoon period in summer 2017.

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Abstract:

Deep convection associated with the Asian summer monsoon transports trace gases and aerosols into the upper troposphere and lower stratosphere (UTLS) and contributes to the Asian Tropopause Aerosol Layer (ATAL), a region important for the Earth's climate. This includes transport of anthropogenic emissions from Himalayan-Gangetic Plain and China as well as dust emissions from desert regions. As part of the EU StratoClim project, a high altitude aircraft campaign was carried out in summer 2017 using the Russian research aircraft M55-Geophysica making measurements of chemical and aerosol composition over Nepal, northern India and the Bay of Bengal in the UTLS up to 20km. In this study, we examine the relative contributions of different anthropogenic emission regions to the composition of the UT during the peak monsoon period in July-August 2017. The WRF-Chem model, ver. 3.8, was run at 25km horizontal resolution, nudged with meteorological analyses from GFS and using anthropogenic emissions from ECLIPSE and REAS v2.1 (Regional Emissions in Asia) inventories. Natural emissions are also included (e.g. dust). To investigate the role of convective uplift in enhancing pollutant levels in the Asian Monsoon Anticyclone (AMA) during the campaign period the model was run with CO/black carbon tracers from different sub-regions over south-east Asia and different cumulus convection parameterization schemes (Grell 3D, Betts-Miller-Janjic and Kain-Fritsch-Cumulus Potential (KF-CuP)). The model was also run with detailed gas phase and aerosol

treatments (SAPRC99 coupled with VBS and MOSAIC). Simulated spatial and vertical distributions of clouds as well as the convective available potential energy (CAPE) are examined and results compared carbon monoxide and ozone data measured onboard the M55. We also investigate the impact of convective uplift from different emission regions on the vertical distribution of aerosols in the ATAL through comparison with available observations (ERICA aerosol composition, aerosol backscatter and lidar).

4.117 Comprehensive changes of aerosol compositions and reactive gases during south-westerly summer monsoon in a Southeast Asian urban site.

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Abstract:

Southwesterly monsoon is a significant phenomenon on the variation of aerosol compositions, reactive gases and the strength of the sources contributed to aerosol. We have conducted a campaign on PM_{2.5} sampling in Universiti Kebangsaan Malaysia site during from 24 June 2014 to 14 September 2014 using a high volume sampler (HVS). Water-soluble ions (WSI), trace species, rare earth elements (REE) and mean eight thermally-derived carbon fractions, OC1, OC2, OC3, OC4, EC1, EC2, EC3 and OP were analysed using ion chromatography (IC), inductively coupled plasma mass spectroscopy (ICP-MS) and a thermal/optical carbon analyser, respectively. The characterization and data treatment by EPA's Positive Matrix Factorization (PMF) model version 5.0 determined the sources of PM_{2.5}. The 24-h mean concentration of PM_{2.5} during the sampling period was 18.3 µg m⁻³, which is lower than the US EPA National Ambient Air Quality Standard

(NAAQS) and WHO 24-h guideline. Correlation analysis indicated that EC emitted from the biomass burning-prone areas. Morning and evening rush hours coincided with the enhanced levels of CO and NO₂ which implied that traffic emission is a potential contributor to PM_{2.5} and its compositions. PMF 5.0 identified seven sources of PM_{2.5}. The identified factors were: i) biomass burning coupled with sea salt [I] (7%); ii) aged sea salt and mixed industrial emissions (5%); iii) road dust and fuel oil combustion (7%); iv) coal-fired combustion (25%); v) mineral dust (8%); vi) secondary inorganic aerosol (SIA) coupled with F⁻ (15%); and vii) motor vehicle emissions coupled with sea salt [II] (24%). The potential source contribution function (PSCF) and hybrid single particle Lagrangian integrated trajectory (HYSPLIT) suggest that biomass burning from Sumatra, maritime sea salt, local activities, point sources and the emission of traffic from local and transboundary areas were clearly affecting the concentration of PM_{2.5} in the tropical site.

4.118 Investigation on the factors controlling new particle formation by long term observation in Noto peninsula.

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Abstract:

The new particle formation (NPF) is an important initial process for the aerosols to nucleate and eventually act as Cloud Condensation Nuclei (CCN). It is therefore important in understanding the contributions of aerosols on the climate and air quality. During the last couple of decades, NPFs have been observed in many different environmental settings in the world. However, previous observations were mostly case studies that involved only several weeks to several months, and there have been few reports so far on seasonal characteristics of NPF based on long term observation in coastal East Asia. We observed particle size distributions, trace gas (SO₂) and meteorological parameters (solar radiation, temperature and relative humidity) at NOTOGRO (37.45°N, 137.36°E, acronym for NOTO Ground-based Research Observatory) located in Suzu City at the tip of Noto Peninsula along the western coast of Japan, from October, 2012 to June, 2017. In addition, hygroscopicity of particles were measured using a CCN counter. Based on 1,262 days' worth of long term observation, we observed in total 126 NPF events. A distinct seasonality was found in terms of the NPF event frequency and spring (May) and autumn (November) were found with the highest frequencies. In spring, cloud cover frequency was particularly low when NPF events occurred. These results suggested that spring events were most strongly affected by solar radiation (hence photochemistry). In order to investigate on the chemical compounds contributing to the particle growth, the chemical components involved in the NPF was inferred from the particle hygroscopicity measured simultaneously by the CCN counter. The hygroscopicity of particles was found to be highest in winter and lowest in spring and summer. This result suggested that chemical compounds involved in the growth of new particles may vary depending on the season.

4.119 Using chemical and idealised tracers to investigate interannual variability and trends in Asian monsoon transport.

Early Career Scientist

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Abstract:

The Asian summer monsoon acts as a transport pathway for anthropogenic surface pollution into the upper troposphere/lower stratosphere, and can have significant impacts on lower stratospheric composition. In this study, we investigate interannual variability and trends in Asian monsoon transport from 1960-2017 using an ensemble of UM-UKCA chemistry-climate model integrations. Modelled chemical species (CO, O₃ and H₂O) and dynamical quantities (PV, geopotential height) are used to explore the interannual variability in the strength of vertical transport; the extent to which vertical transport is confined within the core of the monsoon anticyclone; and to identify long-term changes in vertical transport associated with trends in the strength of the monsoon anticyclone. In addition, a number of idealised tracers have been implemented in the model to identify surface source regions of tropospheric airmass entrained in the monsoon circulation. These idealised tracers are emitted from selected surface regions, with two tracers with different prescribed lifetimes (5 and 30 days) emitted from each region. The use of these tracers allows us to separate airmasses which have undergone rapid and slow uplift, and to identify changes in contribution of different surface source regions to the composition of airmasses within the Asian monsoon anticyclone.

4.120 Inaccuracies in meteorology within a regional air quality forecast.

Early Career Scientist

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Abstract:

Correctly forecasting air quality (AQ) is of importance to public health on a daily basis, as exposure to elevated concentrations of pollutants can trigger health problems, particularly for people with existing heart, lung or breathing conditions. The accuracy of an AQ forecast is dependent on the forecast skill of the meteorology, as accumulation, dispersion and deposition of pollutants is highly dependent on regional weather conditions.

In this study we explore some of the relationships between inaccuracies in meteorological parameters (e.g. precipitation, surface sensible heat flux (SSHF), boundary layer height) and forecast levels of surface particulate matter (PM) and ozone (O₃) within the UK Met Office air quality model AQUM. We present some initial results for spatial correlations between modelled and observed PM and precipitation for a year-long period, quantifying the strength of their relationship with distance and explore how errors in precipitation modelling may influence PM forecasting.

We also present preliminary results from a study of how model temporal evolution of the urban boundary layer influences the observed peak in the model's positive O₃ bias. In this analysis, the influence of modelled SSHF on the dynamics of vertical transport and entrainment of O₃ from the night-time residual layer, and its subsequent impact on near-surface O₃ concentrations, is explored.

This study may lead to improvements in forecasting O₃ concentrations in urban areas and a greater understanding of the role of modelled precipitation on the surface PM forecast.

Key words: boundary layer, surface pollutants, regional forecasting, meteorology

4.121 Effect of Diwali festival and stubble burning activities on the formation of Secondary Organic Carbon (SOC) in Delhi, India.

Early Career Scientist

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Abstract:

Delhi is one of the most polluted megacities with respect to particulate pollution. Particulate matter levels in the ambient atmosphere exhibit seasonal variation. During post monsoon season, severe atmospheric pollution episodes were observed due to Diwali festival. Moreover, the existing pollution levels were accentuated by the crop residue burning practices in the adjacent states of Delhi, Punjab and Haryana during the post monsoon period. Ambient fine particulate matter (PM_{2.5}) was collected during post monsoon (October-November) period in two consecutive years 2015 and 2016. PM_{2.5} samples were chemically characterised for organic carbon (OC) and elemental carbon (EC). PM_{2.5} concentrations were higher than the prescribed NAAQS during the study period: $168.7 \pm 65.1 \mu\text{g m}^{-3}$ (2015) and $245.1 \pm 34.7 \mu\text{g m}^{-3}$ (2016). The westerly winds from adjacent states of Delhi carried smoke released from stubble burning towards Delhi during post monsoon season. Higher OC/EC ratios indicated the formation of secondary organic carbon during the study period. SOC was calculated and found higher during the Diwali period for both the years. This study concludes that the high PM_{2.5} levels during post monsoon season were due to contribution from fireworks, trans-regional movement of pollutants due to crop residue burning, low wind speed and high humidity. 5-day backward air mass trajectories revealed that pollutants were carried from the area of Indo-Gangetic plains (Uttar Pradesh, Punjab and Haryana and surrounding areas) towards Delhi during the post monsoon season.

The festival adds significantly to the existing air pollution problem in Delhi for a short period of time. The study highlighted the negative impact of these activities on environment. Therefore, there is a need to replace the firecrackers with environment-friendly alternatives. Farmers should also be made aware of the problems due to crop residue burning. Suitable mitigation options should be implemented by government to manage the waste after harvesting practices.

4.124 Light absorption of PM_{2.5} in a coastal city Xiamen in Southeast China: temporal variations and implications for brown carbon.

Early Career Scientist

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Abstract:

Light-absorbing carbonaceous aerosols including black carbon (BC) and brown carbon (BrC) play significant roles in atmospheric radiative. A one-year in situ measurements of aerosol light absorption at multi-wavelength were continuously conducted in Xiamen in 2014 to determine the light absorption properties including absorption coefficients (σ_{abs}) and absorption Ångström exponent (AAE) in the coastal city. Light absorption of BrC were further quantified. Mean σ_{abs} at ultraviolet wavelength (370 nm) and infrared wavelength (880 nm) were $56.6 \pm 34.3 \text{ Mm}^{-1}$ and $16.5 \pm 11.2 \text{ Mm}^{-1}$, respectively. Diurnal variation of σ_{abs} presented a double-peaks pattern with the maximum in the morning peak and the minimum in the afternoon. σ_{abs} and AAE showed obvious seasonality since it was low in warm seasons and high in cold seasons. AAE ranged from 0.26 to 2.58 with the annual mean value of 1.46, implying that both fossil fuel combustion and biomass burning influenced aerosol optical properties in Xiamen. σ_{abs} of BrC at 370 nm was $24.0 \pm 5.7 \text{ Mm}^{-1}$, contributing 42.1% to the total absorption. The highest AAE (1.52 ± 0.02) and largest BrC contribution ($47.4\% \pm 3.7\%$) in winter suggested the significant influence of biomass burning on aerosol light absorption. Long-distance air masses from the Beijing-Tianjin-Hebei (BTH) region and Yangtze River Delta (YRD) region led to high AAE and BrC contribution in Xiamen. High AAE value 1.46 in July indicated that intense biomass

burning in Southeast Asia affected aerosol light absorption in Southeast China. The study will improve the understanding of light absorption properties of aerosols and the impacts of BrC in China.

4.125 Spatiotemporal distribution of anthropogenic aerosols in China around 2030.

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Abstract:

In the context of global warming, the future spatiotemporal distribution of aerosols in China is a common concern of the government and the scientific community. In this study, the regional climate model RegCM4 is used to simulate the spatiotemporal distribution of anthropogenic aerosols including sulfate, black carbon and organic carbon in China around 2030 under the RCP4.5 and RCP8.5 scenarios and estimate the contributions of climate change, emission change and extra-regional transport change to the change of anthropogenic aerosol concentration in the study area. The results show that around 2030, the annual averages for sulfate, black carbon and organic carbon surface concentrations in the central and eastern parts of China will be 8.5, 1.7 and 3.7 $\mu\text{g m}^{-3}$, respectively, under the RCP4.5 scenario, whereas 10.0, 2.2 and 4.4 $\mu\text{g m}^{-3}$, respectively, under the RCP8.5 scenario. The surface concentration of sulfate is higher in summer and spring, while lower in winter and autumn. The surface concentrations of black carbon and organic carbon are higher in winter and lower in other seasons. The results of sensitivity experiments demonstrate that the future change in local emissions has the greatest impact on the anthropogenic aerosol concentrations throughout China, followed by the impact of future climate change, while the effect of extra-regional transport change is very small. For the column burdens of sulfate and black carbon, the future change in local emissions is the dominant influence factor. But for the column burdens of organic carbon, the effect of extra-regional transport change is close to that of the future change in local emissions. The results of this paper suggest that the future change in local emissions and future climate change may lead to further aggravated particulate pollution in China, thereby hindering the governmental effort to improve air quality.

4.126 Annual variation of new particle formation at the summit of Mt. Fuji.

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Abstract:

New particle formation (NPF) is the process creating particles by condensation with surrounding gases. The NPF process makes the number concentration of aerosols particles with a diameter < 25 nm (: a nucleation mode) increase, affecting the Earth's radiation budget by direct effect. However, the NPF mechanism and growth process are not sufficiently understood due to the limited observation data related with various chemical species and multi-step chemical reactions. Therefore, the long-term measurement of aerosol size distributions need to be done in various places. The top of Mt. Fuji is located at the area where has little effect on the local anthropogenic sources, and located within the free troposphere. Moreover, a direct observation of the aerosol particles transported from Asian continent is possible. In this study, we elucidate the annual variation and the diurnal change of NPF by the long-term measurement of size-resolved number concentration at the top of Mt. Fuji (35.360°N, 138.727°E, 3776 m a.s.l.) during summer (July to August) in 2011-2017. The measurement was conducted by using a Scanning Mobility Particle Sizer (SMPS) under dry condition (relative humidity $< 30\%$). The detectable diameter range was from 10 nm to 487 nm.

We defined the NPF event as an event that the size-resolved number concentration in the nucleation mode increased over 1 hour. We observed 176 NPF events for 217 days. Most events occurred at 8 o'clock (daytime) and 20 to 21 o'clock (nighttime) in local time. According to a back-trajectory analysis (NOAA HYSPLIT version 4), the observed airmasses were often transported from the Asian continent. Moreover, using the trajectories, we estimated the location and time where and when the NPF occurred. We found that the observed NPF events occurred mainly during the daytime (80%), and the events occurred mainly over Japan islands.

4.127 Analysis of aerosol transport route in East Asia.

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Abstract:

East Asia is a region of high natural and anthropogenic aerosol concentration. In Japan, various aerosols such as yellow sand and PM2.5 are transported by the westerly wind from sources on the continent. The qualitative transport routes of these aerosols are generally known, but quantitative assessment for long periods has not yet been made. For example, in recent years the number of yellow sand observation around Japan has been decreasing, but there are reports that the amount of dust generated at the source regions has not significantly changed, suggesting the influence of fluctuation of the transport route. We analyzed the transport route of the aerosol using global aerosol transport model MASINGAR mk-2 (TL159) developed by Meteorological Research Institute. The model was nudged towards global meteorological analysis of the Japan Meteorological Agency and conducted a 10-year simulation from 2007 to 2016. We calculated an integrated mass flux to study the transport route of aerosol. From the view of the monthly mean value for 10 years, most of the yellow sand that reaches Japan occurs in the Gobi Desert and northeastern China. The yellow sand has been transported mainly in the southeast direction in the winter (December to February), then advanced east of the Shandong peninsula and reached the vicinity of Japan. In the spring period (March to May), the transportation route shifts slightly north, and transportation to the northeastern part of China also increases. As a recent example, we analyzed aerosol transport routes for March 2016 when a small Kosa event was observed in Japan. Compared with the ten-year average in March, transportation to the southeastern part of China was observed as well as weakening transport of the aerosol plume to the southeast direction. On the day of the conference, we will introduce more detailed analysis results including other aerosols.

4.129 The Aerosols, Radiation and Clouds in southern Africa (AEROCLO-sA) project: overview, research highlights and way forward.

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Abstract:

The AEROCLO-sA project (Aerosol, Radiation and CLOUDs in southern Africa) investigates the role of aerosols on the regional climate of southern Africa, a unique environment where natural and anthropogenic aerosols encounter a semi-permanent and extended stratocumulus cloud deck.

The project aims to improve our understanding of aerosol-cloud-radiation interactions over coastal southern Africa in various landscapes and various meteorological conditions to investigate the dynamical, chemical and radiative processes involved in their life cycle. AEROCLO-sA is based on a field campaign conducted in August/September 2017 over Namibia. An aircraft equipped with active and passive remote sensors as well as aerosol in situ probes performed a total of 30 research flight hours over northern Namibia. The focus laid on terrigenous aerosol emission over land as well as biomass burning aerosol plumes which were advected from Angola, and their subsequent transport over the marine clouds over the Atlantic Ocean. Concomitantly, an instrumented mobile station was implemented over coastal Namibia in order to document the boundary layer aerosols at the ocean-atmosphere interface using a state-of-the-art suite of in situ aerosol probes as well as balloon-borne dynamics and thermodynamics observations of the lower troposphere. This article presents an overview of the AEROCLO-sA field campaign as well as first highlights from the airborne and surface-based observations.

We expect these observations to significantly contribute to the understanding of the fundamental processes of aerosol-cloud-radiation interactions in link with the atmospheric dynamics over the region and the improvement of their representation by climate models included into CORDEX exercises. They also will be instrumental in promoting regional capacity building and will support policies towards a more sustainable development for the region.

4.130 Development of the MRI-ESM2 and evaluations of spatial distributions and radiative effects of black carbon.

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Abstract:

The Meteorological Research Institute earth system model (MRI-ESM2) has recently been developed and the model participates in the Coupled Model Intercomparison Project Phase 6 (CMIP6). In this study, we perform the MRI-ESM2 calculations for the years 2008-2015 with nudging towards the meteorological data and prescribed sea surface temperatures and evaluate the spatial distributions of black carbon (BC) and its radiative effects. The MRI-ESM2 simulation with a new microphysical BC aging parametrization successfully reproduces the seasonal variations of BC observed by the surface measurements over the Arctic, although our previous approach with a constant conversion rate from hydrophobic BC to hydrophilic BC largely underestimates the BC mass concentrations throughout the years. Vertical profiles of BC observed by the aircraft measurements (e.g., A-FORCE, ARCTAS, and HIPPO) are successfully reproduced by the MRI-ESM2 simulation with a new consistent treatment of wet removal and vertical transport of aerosols in the spectral cumulus parameterization, although our previous wet removal approach largely overestimates BC mass concentrations particularly in the upper and middle troposphere over the tropical Pacific. These results suggest that the seasonal variations of BC over the Arctic are primarily controlled by the aging processes and the wet removal associated with cumulus convection plays an important role for the spatial distributions of BC in the upper and middle troposphere. The MRI-ESM2 simulation

underestimates the aerosol optical depths (AODs) and absorbing aerosol optical depths (AAODs) obtained from the Aerosol Robotic Network by 23% and 30%, respectively, on a global basis. The annually and globally averaged direct radiative forcing by BC at the top of atmosphere is estimated to be approximately 0.2 W m^{-2} for the global BC emission of 7.0 Tg year^{-1} in the simulation.

4.131 Short-term direct radiative effects of near-source biomass burning aerosols in northern peninsular Southeast Asia.

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Abstract:

Biomass burning (BB) is a major source of black carbon (BC) and organic carbon (OC) aerosols and very pronounced during the dry season (late February to April) over northern peninsular Southeast Asia (PSEA). BC aerosols, in the atmosphere, absorb solar radiation and may affect the hydrological cycle through changes in the surface-atmosphere radiation budget. However, OC aerosols have approximately the same lifetime as BC, but scatter sunlight to a much larger extent than BC, and therefore cool the atmosphere-surface system. The radiative effects of these particles have remained poorly quantified due to their diverse optical and cloud-activating properties. Regional variation in radiative forcing may have important regional and global climatic implications, which are not resolved by the concept of global mean radiative forcing. As a part of the Seven South East Asian Studies/Biomass-burning Aerosols & Stratocumulus Environment: Lifecycles & Interactions Experiment (7-SEAS/BASELInE) 2014 campaign, aerosol measurements were carried out at Doi Ang Khang (DAK; 19.93°N, 99.05°E, 1536 m above sea level), a near-source BB location in northern PSEA, where BB activities were densely distributed in the surroundings. The DAK is an excellent site for investigating the radiative impacts of near-source fresh BB aerosols. In this current study, direct aerosol radiative effects of BB-derived aerosols were assessed by synergizing the observed data set for aerosol physical, chemical, and optical properties along with their vertical distributions in a radiative transfer model. BC contributes up to 80% to the atmospheric forcing. Substantial atmospheric heating (as high as $+81 \text{ W m}^{-2}$) accompanying with the surface dimming (as high as -75 W m^{-2}) assessed over DAK can have a significant impact on atmospheric circulation prior to the onset of the Asian summer monsoon over northern PSEA.

4.132 The seesaw modulation of haze pollution in North China from the combined effect of El Nino and Arctic Oscillation.

Early Career Scientist

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Abstract:

By utilizing the recent observational $PM_{2.5}$ data in China, this study found that the $PM_{2.5}$ concentrations show distinct seesaw features with abnormally high and low in the adjacent two months of December 2015 and January 2016, respectively. This dipole $PM_{2.5}$ variations are modulated by the combined effect of El Nino and Arctic Oscillation (AO). In December 2015, the mature phase of super El Nino, accompanied by positive AO, induced weakened East Asian winter monsoon (EAWM), featured by positive anomaly of geopotential height at mid-troposphere (i.e., 500 hPa) and southerly wind anomaly at low level (i.e., 850 hPa) over the North China Plain (NCP), resulting in reduced Planetary Boundary Layer (PBL) height, abnormally warm temperature and substantial haze accumulation during this period. In the following month (January 2016) when El Nino starts to decay, the sharp reversal of AO from positive phase (in December 2015) to negative phase triggered enhanced EAWM, inducing more cold advection and low-level northerly wind invasion of the NCP, fostering the atmospheric dispersion and substantially reduction in haze formation. This abrupt turn of AO from positive to negative phase was robustly found during the same decay period (February 1983 and January 1998) after mature phase (January 1983 and December 1997) of the other two super El Nino, likely a modulation of the southward shift of upper troposphere jet at 200 hPa and weakened stratospheric vortex during the decay phase compared to the mature phase, which is also qualitatively identified through a model experiment by Geng et al. (2017).

Key words: El Nino, Arctic Oscillation, East Asian winter monsoon, haze

4.133 Atmospheric processes influence the light-absorption properties of brown carbon in haze particles from Indonesian peat and biomass burning.

Early Career Scientist

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Abstract:

Elevated fine aerosol concentrations in the Southeast Asia region due to wildfires influence the atmospheric and hydrological systems in the regional scale. Atmospheric observations of the wildfire haze in the region showed that aerosol particles are dominated by organic species. These organic aerosol species include brown carbon (BrC) which absorbs visible and near-ultraviolet (UV) light. Owing to its light-absorption properties, atmospheric BrC affects the radiative balance of the atmosphere. A laboratory study demonstrated that a notable fraction of BrC exists in aerosol particles emitted from combustion of Indonesian peat and biomass. On the other hand, atmospheric observation during a wildfire haze event revealed that concentration of BrC in the region is insignificant. We hypothesize that the difference in the existence of BrC in the fresh laboratory-generated organic aerosol and the ambient samples are induced by atmospheric processing.

In order to test the hypothesis, we are investigating impacts of atmospheric processes on the chemical composition and optical properties of BrC from Indonesian peat and biomass burning. We are oxidizing the primary organic aerosol and secondary organic aerosol precursors in a Potential Aerosol Mass continuous flow reactor. The residence time of particles in the reactor is approximately 150 sec. The oxidation experiments are conducted in dry (20–30% relative humidity/RH) and wet conditions (60–70% RH). Carbon monoxide and ozone levels are observed over the course of experiments. The chemical composition of particles is measured by a Time-of-Flight Aerosol Chemical Speciation Monitor and the optical properties of BrC are measured by a UV-Vis spectrometer and a fluorescence spectroscopy.

4.135 Atmospheric Chemistry and Climate Trends in the North Atlantic Over The Period 1970-2017. .

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Abstract:

Major changes are occurring across the North Atlantic climate system: in the ocean and atmosphere temperatures and circulation, in sea ice thickness and extent, and in key atmospheric constituents such as ozone, methane and aerosols. Many of the changes that are being observed here are unprecedented in the instrumental records and provide a vital test of coupled chemistry climate models.

In this presentation we will highlight the results from simulations with the UK community chemistry-climate model (UKCA). We will focus our analysis on evaluating the performance of the model over the North Atlantic basin over the period 1970-2017. A comparison of the performance of the model for 2010 shows that it agrees well with recent HTAP-2 and CCMI multi model mean data in terms of the global tropospheric ozone burden (325 Tg). A comparison against new observations generated as part of the NASA ATom and NERC ACSIS aircraft campaigns in the Atlantic have enabled improved insight into the models ability to simulate trends in key species such as carbon monoxide and ozone and an improved understanding of model biases in the North Atlantic. Whilst an analysis of 12 years of satellite data highlights strong anticorrelation between tropospheric ozone column and the North Atlantic Oscillation (NAO) index. A key determinant of this relationship is found to be the impacts of the NAO on changing the amount of STE of ozone in the region.

The combined analysis of satellite, aircraft and ground based data has enabled the most comprehensive evaluation of the UKCA model over the North Atlantic and provides new insight into the factors controlling the evolution of key trace gases in the region and how they are coupled to regional climate processes and trends.

4.136 Long-term trends in oxidant budgets of the northern hemisphere constrained by alkanes and alkyl nitrate ratios.

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Abstract:

Our study aims to understand how the concentrations of ozone (O_3) and hydroxyl radicals (OH), and as such the tropospheric oxidizing capacity, have changed since the mid-20th century, largely as a result of anthropogenic emissions. We do this through a combination of field observations and numerical simulations. Global emissions of O_3 precursors, such as volatile organic compounds (VOCs), oxides of nitrogen (NO_x) and carbon monoxide (CO), have changed substantially since preindustrial times, resulting in changes to the tropospheric budgets of O_3 and OH. However, the absence of long-term observational records of HO_x and NO_x results in large uncertainties associated with the current understanding of these past changes.

We use measured long temporal variations of alkane and alkyl nitrate concentrations from firn air to constrain global atmospheric model scenarios, because the formation of nitrates from alkanes is closely linked to chemistry involving HO_x and NO_x . This enables us to assess changes in the O_3 and OH radical budgets of the northern hemisphere troposphere. We have used the UK community global chemistry-climate model (UKCA) in its current configuration as part of the UK community Earth System Model (UKESM-1) to carry out transient model experiments from 1960 to the present day. We use global emissions data from the CMIP5 and also from the forthcoming CMIP6 model intercomparison projects. CMIP6 emissions show significantly higher NO_x and C3-C5 alkane fluxes compared to CMIP5, resulting in increased nitrate formation. The model is validated with surface and airborne observations of O_3 precursors, alkanes and alkyl nitrates, as well as with long-term trends for alkanes and nitrates obtained from firn air in Greenland ice cores.

4.139 Radiative impacts of wildfire smoke in the Arctic: perspectives from the Copernicus Atmosphere Monitoring Service.

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Abstract:

Recent years have witnessed significant transport of smoke pollution from wildfires in boreal forests to the high Arctic in the summer months. While Arctic smoke events are relatively short in duration, typically lasting a few days, aerosols in the smoke have a significant radiative impact (between 2-5 Wm^{-2} in net shortwave radiation at the top of the atmosphere) and can be deposited at the surface. The Copernicus Atmosphere Monitoring Service (CAMS), implemented by ECMWF on behalf of the European Commission, provides a unique perspective on the transport and impact of key pyrogenic pollutants, utilising near real-time satellite observations of wildfire locations and emissions of aerosols and trace gases. Five-day forecasts of global smoke aerosol and trace gases are produced operationally (initialised at 00 UTC and 12 UTC) with the ECMWF Integrated Forecast System (IFS), allowing prediction of pollution plumes up to several days ahead and the possibility to evaluate their impact on radiation and NWP. In addition to the operational forecasts a key product of CAMS is a reanalysis of global atmospheric composition from 2003 to the present day including satellite observations of

Aerosol Optical Depth and total columns and profiles of traces gases. Global wildfire emissions are estimated in CAMS with the Global Fire Assimilation System (GFAS) using satellite observations of Fire Radiative Power (FRP). We present a perspective on the occurrence and impacts of wildfire smoke aerosols in the high Arctic using: (i) CAMS real-time forecasts and their application to monitor a smoke plume from northern Canada and its radiative impact/surface deposition in August 2017; and (ii) 15 years of GFAS and CAMS reanalysis data to evaluate the inter-annual variability of boreal wildfire emissions, smoke transport and the potential impact on atmospheric radiation.

4.140 Impacts of tropical land-use change on the atmosphere and the climate.

Early Career Scientist

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Abstract:

Extensive land-use change has occurred over the past few decades across the tropics, with large areas of forest converted to agriculture and pasture. Such changes impact the climate through emissions of CO₂, but also through a number of biophysical and biogeochemical changes. Previous studies have demonstrated that changes in well-mixed greenhouse gases, short-lived climate forcers (SLCFs), such as ozone and aerosol, and surface albedo from deforestation directly affect the climate.

We combine data from different satellites to quantify the impacts of land-use change on surface albedo over the Amazon. Using data derived from Landsat satellite observations, we identify regions of significant deforestation between 2000 and 2014. We combine this with data collected with the Moderate Resolution Imaging Spectroradiometer (MODIS) and observations from the South American Biomass Burning Analysis (SAMBBA) campaign in 2012, to assess the impacts of changing forest cover on surface albedo.

The albedo changes we calculate (ranging from 0.008 to 0.034), are considerably less than previous observationally derived estimates and substantially lower than the values prescribed in model simulations found in the literature, which average 0.06.

We use a radiative transfer model to investigate the impacts of this reduced albedo change on top-of-atmosphere radiative forcing. Using an idealised Amazonian deforestation scenario, we calculate the associated global radiative forcing is reduced from -0.097 W m^{-2} using albedo values typically prescribed in models to -0.031 W m^{-2} using our observationally derived best estimate. Our findings suggest that model simulations are currently underestimating the warming effects from Amazonian deforestation.

4.141 Benchmarking 9.6- μm ozone band top-of-atmosphere flux in chemistry-climate models using AURA TES instantaneous radiative kernel.

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Abstract:

The IPCC chemistry-climate models estimate the tropospheric ozone (O_3) radiative forcing (RF) to the climate with large uncertainties, ranging from +0.2 to +0.6 Wm^{-2} . The previous studies show that about 80% of O_3 RF comes from O_3 longwave absorption and 97% of this longwave absorption is in the 9.6-micron O_3 band [Rothman et al., 1987]. The satellite observations of this O_3 band TOA fluxes by NASA AURA-TES, suggests strong geographic and seasonal variations globally. The variations in the fluxes highly depend on the distributions of ozone, water vapor, air temperature, and surface temperature. The biases of these quantities in the model are sources of the biases in both the O_3 band TOA flux and O_3 RF. Benchmarking present day O_3 band flux is the first step for understanding climate feedbacks from O_3 forcing.

The products of 9.6-mm ozone band IRK for ozone, water vapor, temperature, and etc., have been developed by AURA TES and this record could be extended by MetOP-IASI and SNPP-CrIS Fourier Transform spectrometer (FTS) measurements. In this study, we demonstrate the method of using the reanalysis data together with TES IRK to attribute the biases of the fluxes in a suite of CCMI models to these key parameters. In this way, we show the TOA flux biases differs significantly between models for different reasons. We find the principle contributors governing the variation for each model are under different processes or over different regions. We also provide quantitatively estimates of the influence from ozone, water vapor, and temperature bias in models. This study helps to understand the differences between the models and would provide the insights to reduce the spread of model estimates of ozone radiative forcing.

4.142 Air-sea exchange of acetone and acetaldehyde and the impacts on their global atmospheric budget.

Early Career Scientist

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Abstract:

Oxygenated volatile organic compounds (OVOCs) greatly affect the tropospheric oxidative capacity, which largely controls the chemical lifetime of methane (a greenhouse gas) and the self-cleaning capacity of the atmosphere. The ocean plays a key role in the budget of OVOCs in the atmosphere, especially in remote regions, yet the air-sea exchange of these OVOCs remains poorly understood. In this work, we present an online air-sea exchange framework newly developed for the Community Earth System Model (CESM). The model framework has been tested with previously derived ship-based measurements of seawater concentrations and fluxes. The oceanic influence on acetaldehyde and acetone in the remote marine boundary layer and free troposphere has been evaluated using airborne measurements obtained during the recent multi-year, nearly pole-to-pole airborne campaign, Atmospheric Tomography Mission (ATom). We show that the air-sea exchange module greatly improves the model-measurement agreements of acetaldehyde and acetone, leading to a better understanding of the global budget of these OVOCs.

4.143 Important contributions of sea-salt aerosols to atmospheric bromine cycle in the Antarctic coasts.

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Abstract:

Polar sunrise activates reactive bromine (BrO_x) cycle on the Antarctic coasts. BrO_x chemistry relates to depletion of O_3 and Hg in polar regions. Earlier studies have pointed out “blowing snow” as a source of atmospheric BrO_x . However, surface O_3 depletion and BrO enhancement occurs rarely under blowing snow conditions at Syowa Station, Antarctica. Therefore, trigger processes for BrO_x activation other than the heterogeneous reactions on blowing snow particles must be considered. This study shows that enhancement of sea-salt aerosols (SSA) and heterogeneous reactions on SSA are the main key processes for atmospheric BrO_x cycle activation. Blowing snow had Br^- enrichment, in contrast to strong Br^- depletion in SSA. In-situ aerosol measurements and satellite BrO measurements demonstrated clearly that a BrO plume appeared simultaneously in SSA enhancement near the surface. Results show that surface O_3 depletion at Syowa Station occurred in aerosol enhancement because of SSA dispersion during the polar sunrise. Amounts of the depleted Br^- from SSA were matched well to the tropospheric vertical column density of BrO and BrO_x concentrations found in earlier work. Our results indicate that SSA enhancement by strong winds engenders activation of atmospheric BrO_x cycles via heterogeneous reactions on SSA.

4.144 Aerosol Particle Size Distributions and Compositions over the Southern Ocean in the Austral Summer of 2017.

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Abstract:

Aerosol particles in the marine boundary layer, which are emitted from the ocean surface through the sea-spraying process, can affect the cloud formation over the ocean, resulting in their significance in the Earth's radiative budget. Southern Ocean (SO) is a unique region with rich ecosystems and without significant anthropogenic and continental natural impacts especially in austral summer (e.g., McCoy et al., 2015). The measurements of aerosol particles over the Pacific Ocean sector of SO are sparse and critically needed for understanding the concentration levels of aerosols to assess the role of aerosols as cloud condensation nuclei (CCN) and ice nucleating particles (INPs).

We conducted ship-borne aerosol measurements using our research vessel "*Mirai*" in a framework of the cruise "Trans South Pacific Project" between Japan and Chili (December 27, 2016-March 28, 2017). In the late austral summer of 2017 (February 10-March 3, 2017), RV *Mirai* was deployed over the SO (from Punta Arenas, CHL to Auckland, NZ). We performed in-situ measurements of size distributions of total and non-volatile (at 300°C) aerosol particles using a scanning mobility particle sizer (TSI, the combination of a differential mobility analyzer model 3080 and a condensation particle counter model 3010), black carbon aerosol using a single particle soot photometer (DMT), and fluorescent bioaerosol particle (FBAP) using a wideband integrated bioaerosol sensor (DMT) in the experimental room located on the top level of RV *Mirai*. We also performed aerosol sampling for the post-analyses of chemical composition, morphology (microscopy), and ice nucleation ability (a cold-stage-based immersion freezing technique; Tobo, 2016).

We will present the temporal variations of size-segregated aerosol concentrations, CCN-proxy (particles larger than Hoppel minimum, Hoppel et al., 1986), volume-fraction-remaining (a diagnosis of the sea-salt impacts), FBAP, organic carbon, and INPs to elucidate the atmospheric physics and chemistry of natural aerosols in this region.

4.145 The sensitivity analysis of airflow from local emission source using WRF and WRF-chem.

Early Career Scientist

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Abstract:

The Greenhouse gases Observing SATellite (GOSAT) was launched on January 23 2009 and GOSAT-2 plant to launch in this fall. GOSAT and GOSAT-2 carries the Fourier-Transform Spectrometer (FTS), which measure the global concentration of CO₂, CH₄ and other trace gases using with 10-km footprint. The FTS instrument has an agile pointing system. It is useful to target the local emission source and estimate the emission amount such as power plant, ground transportation, etc. To take advantage of an agile pointing system, it is important to understand the wind condition around target site and the airflow from emission source. In this work, we make sensitivity analysis to characterize of local emission source using WRF (Weather Research and Forecasting) and WRF-chem (WRF model coupled with Chemistry). The model simulates the emission, transport, mixing, and chemical transformation of trace gases with the meteorology. We simulated some target local emission sites throughout the year.

4.146 Evaluation of wet deposition process of black carbon in WRF/Chem model during MIRAI Arctic research cruise over high-latitude regions in 2016.

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Abstract:

Black carbon (BC), which is known as a component of PM_{2.5}, can change the Earth's albedo by changing the color of ice and snow via deposition into the surface. The impact of BC on the climate change seems to be larger at high-latitude regions than that at the rest of the world. The amount of anthropogenic emissions within the Arctic circle is relatively small, and the precise assessment of 1) impact of local source such as biomass burning, ship emissions, gas flares, 2) amount of BC transported from mid-latitude regions such as Asia, and 3) the removal process during the long-range transport, are quite important for the estimation of climate change in Arctic region. To tackle on this issue, we had conducted model simulations over the Pan-Arctic region using a regional chemical transport model (WRF-Chem version 3.8.1). The initial and lateral boundary conditions for the meteorology and chemical species were taken from NCEP-GFS and MOZART-4, respectively. RACM and GOCART modules were used for the gaseous and aerosol chemistry, with a slightly modification to include OH dependency for the aging and in-cloud wet deposition of BC process based on Liu et al. (2011). Calculated period was from August to October in 2016. Meteorological field was compared with the observational data from the ship-based observation on R/V Mirai at the Arctic Ocean and Bering Sea. Model generally succeeded to reproduce the temporal variations of meteorological field such as the passage of low pressure systems, though the model tends to underestimate the amount of precipitation. BC concentration in rainwater was also compared with the observed samples during the cruise, and it was found that the model tends to overestimate especially for snowing period.

4.149 Observed characteristics of precipitation timing during the hazes : Implication to aerosol-precipitation interactions.

Early Career Scientist

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Abstract:

Korea has suffered from largely domestic anthropogenic aerosols mixed with long-range transported pollutants from abroad. It is important to analyze general characteristics of different hazes in terms of time and space scales, and its relationship with precipitation. However, aerosol impact on weather has not much been investigated. First, we used ground aerosol observations at Seoul and Baengnyeongdo for 2011-2016 to classify severe haze episodes to Long-range transported haze (LH), Yellow sand (YS), Urban haze (UH) and Mixing haze (MH); after all, 40 LH cases, 23 YS cases, 29 UH cases and 35 MH cases classified. The ratios of the events accompanied with precipitation are 68%, 87% and 48% for LH, YS and UH respectively. Long-term analysis of the timing of aerosol and precipitation shows that precipitation tends to precede YS while it appears to coincide with LH event. We take statistics analysis to prove the reliability of these results. We also found out the differences between operational weather forecast and hourly observed precipitation in 41 cases among total 126 episodes examined. Interestingly light precipitation tends to last longer about within a day following enhanced aerosol loadings. Precipitation timing seems to be controlled by large scale synoptic forcing during the YS event. However, aerosols may be closely associated with precipitation through changes in

cloud microphysics during the severe long-range transported haze such that enhanced aerosols can increase smaller cloud droplets and further extend light precipitation at weaker rate. This result demonstrates active interactions between aerosols and meteorology such as probable modifications of cloud microphysics and precipitation, synoptic-induced dust transport, and precipitation-scavenging in Korea. In addition, we will demonstrate the precipitation characteristic on clear events for its comparison with the enhanced aerosol results mentioned above.

4.150 Characterization of individual ice nucleating particles by the single droplet freezing method.

Early Career Scientist

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Abstract:

Ice nucleation in clouds substantially affects the climate by having a significant impact on the radiation balance and precipitation process. Although the physical and chemical properties of ice nuclei play an essential role in the formation of ice crystals, a considerable uncertainty still exists as to the response of ice nucleation processes to the changes in the aerosol properties.

In order to better characterize ice nucleating (IN) atmospheric particles, we investigated the chemical composition, mixing state, and morphology of individual particles that nucleate ice under conditions relevant for mixed phase clouds. Standard mineral dust samples were compared with actual aerosol particles collected at Kanazawa City, Japan during Asian dust events in February and April 2016. Following droplet activation by particles deposited on substrate under supersaturated air, individual IN particles were located using an optical microscope by cooling the temperature to -30 °C. Then, both the IN particles and non-active particles were analyzed by Atomic Force Microscopy, micro-Raman spectroscopy, and Scanning Electron Microscopy coupled with Energy Dispersive X-ray spectroscopy.

The results showed that, most of the IN particles formed ice below -28 °C, but lower than the freezing temperatures of standard mineral dust samples of pure components. These IN particles were predominantly irregular solid particles that showed clay mineral characteristics (or mixtures of several mineral components). Moreover, sea salt particles were predominantly found in the non-active fraction, and internal mixing with sea salt clearly acted as a significant inhibiting agent for the ice nucleation activity of mineral dust particles. In this study, we demonstrated the capability of the combined single droplet freezing method and thorough individual particle analysis to characterize the IN particles. We also found that dramatic changes in the particle mixing states during long-range transport had a complex effect on the ice nucleation activity of the host aerosol particles.

4.151 Characteristics of precipitation response to the severe hazes in Korea peninsula.

Early Career Scientist

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Abstract:

The quantitative understanding of aerosol-cloud-precipitation interactions is still insufficient despite substantial efforts to solve this problem since it has inherent complexity. In East Asia, Korea is located in the downwind of China and likely to be vulnerable to long-range transported aerosols, which are expected have an inadvertent weather modification. With this regard, we used observed aerosol data of surface in Seoul (SL) and Baengnyeongdo (BN) from 2011 to 2016 to classify hazes types to long-range transported haze (LH), yellow sand (YS), urban haze (UH) and mixed haze (MH) (Lee et al., 2017). To demonstrate a possible evidence of aerosol impacts on precipitation with long-range transported hazes and yellow sand, we have analyzed the difference of precipitation timing between observational precipitation and forecasting precipitation when the weather forecast failed to catch the precipitation during classified hazes, especially LH and YS. We interestingly found that precipitation timing during LH tends to coincide with aerosol variations specifically in terms of temporal covariation, which is contrast to YS, such as YS following precipitation. Precipitation timing mostly seems to be controlled by large scale synoptic forcing during the YS event, whereas enhanced aerosol loadings in severe hazes are thought to impact clouds and precipitation in temporal scale

like timing of observed precipitation. So we briefly conduct numerical simulations to assess how LH could modify the clouds and precipitation. Simulated results show that cloud fraction with increased aerosol is increased, whereas precipitation rate is decreased. In spite of lacked cloud information of observed data and detailed cloud resolving simulation not represented, the results would prove aerosol-cloud-precipitation interaction in both observation and model. The quantitative evaluations of its results need more detailed modeling works using suitable cloud physical scheme to evaluate extended precipitation.

4.152 Variabilities in CCN concentration and CCN activity related to SO₂ emission reduction and new particle formation in Qingdao.

Early Career Scientist

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Abstract:

We measured concentrations of cloud condensation nuclei (CCN) and CCN activity at a suburb site of Qingdao in the North China during two heating periods from 6 November to 6 December 2013 and from 9 January to 24 February 2017, respectively. Concentrations of CN during the first heating period were $3.3 \pm 1.4 \times 10^4 \text{ cm}^{-3}$ (mean \pm standard deviation), While in the second heating period, CCN concentrations were $1.7 \pm 0.8 \times 10^4 \text{ cm}^{-3}$. The concentrations of CN decreased by about 48% from the first heating period to the second heating period because of the lower SO₂ concentration induced by the emission reduction. In first heating period, the peak particle diameter of aerosol particles was 86.6 nm, While in the second heating period, it was 138.9 nm. We speculate that this is the reason why haze events have occurred frequently in recent years. The adoption of sulfur dioxide emission reduction measures may affect the primary particulate matter emissions, particle size and chemical composition from the source; therefore, it will produce a climatic effect through the direct radiative forcing of a particulate matter and activation of the ability to cloud condensation nuclei. At present, the ammonia desulfurization and other wet desulfurization technologies in industrial desulfurization methods reduce SO₂, but liquid ammonia in ammonia desulfurization is volatile, part of the water vapor is taken away in other wet desulfurization processes, and sulfate is a hygroscopic property. The inorganic particulates increase the MMD of sulfur dioxide plumes and increase the peak aerosol particle size. According to the ternary nucleation mechanism of new particles, NH₃ and SO₂ are important precursors for the formation of new particles, and new particles are an important source of CCN. The growth of new particles will also increase the peak particle size of atmospheric aerosols.

Keywords: Cloud condensation nuclei; New particles formation; Particle number concentration

4.153 Analysis of Artificial Seeding Effects on Snow Using Snowflake Camera In the Mountainous Region of Korea.

Early Career Scientist

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Abstract:

Snowflake is a basic element of snowfall phenomenon in terms of various cloud physical processes such as density, fallspeed, scattering and absorption characteristics, etc. In spite of its importance, snowflake studies in Korea are still insufficient. Here morphological classification and quantitative analysis of snowflake of using multi-angle snowflake camera (MASC) in the Yeongdong region were investigated. Further some results of artificial seeding on snowflake in the mountainous site (Daegwallyeong) belonging to Yeongdong, where 2018 winter Olympic was held. In addition, qualitative analysis of snowflake had been done since 2014 using a smart phone with a magnifying lens, which will be also introduced here.

We had several snowfall episodes with MASC; a couple of typical ones are from Gangneung (coastal site) which will be compared to Daegwallyeong experiment. In general, the Yeongdong region tends to have sea-effect snowfall quite similar to lake-effect snowfall, which consists of largely dendrite aggregate and frequently riming

particles. The recent study claimed that snow crystal in this region heavily depends upon 850 hPa temperature, an usual height of cloud layer. Based on one (March 14 2017) of the experimental events, the snowflake modification by artificial seeding at Daegwallyeong shows the change of snow crystal habits from dendrite to riming particles. Interestingly the particle size distributions of riming-dominant crystals after the seeding become narrower with its size decreasing in comparison to dendrite-dominant crystals with larger particles before the seeding. This habit change by an additional supply of AgI is very consistent with the previous experiments at Daegwallyeong. More quantitative comparisons of seeding effect will be presented.

4.155 Collective climatology and temporal analysis of air quality from measurement, observation and simulation over the Greater Bangkok area, Thailand.

Early Career Scientist

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Abstract:

The problem of the intense, episodic aerosol events ('haze') has intensified in the last few years in Thailand, and has been a serious issue for northern Thailand for at least a decade. Very recently, in 2018, the Bangkok metropolis, which holds a population of 8.21 million, faced hazardous levels of PM_{2.5}, an exceedance of the WHO 24-hour standard, raising concerns for the impact of haze on human health.

Owing to extensive data Thailand has on air quality measurements which date back nearly ten years, this gives us the opportunity to look in some detail at the factors controlling air quality. Particularly, Bangkok is making increasing amounts of air quality data available to scientists for study. In this work, we present a climatology of air quality data for the Greater Bangkok area over this instrumented period. We will show an analysis of air quality and particulate loading over the Bangkok area using statistical tools and numerical weather simulation, with the aim of uncovering the cause of the prevalent haze. We use data from the most recent years, including sites which have recently begun operation, to determine the extent of the air quality event using MODIS fire hotspot counts, and examine the observed meteorological parameters and air quality data, such as the ozone, PM₁₀ and PM_{2.5}, to determine the overall temporal trend of the situation. We focus on the interannual variability of the haze events, and look at the comparison between interannual data, using back trajectory of analysis, and also statistically examine the correlation of meteorological parameters and the air quality. Finally, we use numerical weather simulation to simulate the atmospheric condition of the haze event.

4.156 Boundary layer height determination from lidar for improving air pollution episode modeling: development of new algorithm and evaluation.

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Abstract:

Predicting air pollution events in the low atmosphere over megacities requires a thorough understanding of the tropospheric dynamics and chemical processes, involving, notably, continuous and accurate determination of the boundary layer height (BLH). Through intensive observations experimented over Beijing (China) and an exhaustive evaluation of existing algorithms applied to the BLH determination, persistent critical limitations are noticed, in particular during polluted episodes. Basically, under weak thermal convection with high aerosol loading, none of the retrieval algorithms is able to fully capture the diurnal cycle of the BLH due to insufficient vertical mixing of pollutants in the boundary layer associated with the impact of gravity waves on the tropospheric structure. Consequently, a new approach based on gravity wave theory (the cubic root gradient method: CRGM) is developed to overcome such weakness and accurately reproduce the fluctuations of the BLH under various atmospheric pollution conditions. Comprehensive evaluation of CRGM highlights its high performance in determining BLH from lidar. In comparison with the existing retrieval algorithms, CRGM potentially reduces related computational uncertainties and errors from BLH determination (strong increase of correlation coefficient from 0.44 to 0.91 and significant decreases of the root mean square error from 643 to 142 m). Such a newly developed technique is undoubtedly expected to contribute to improving the accuracy of air quality modeling and forecasting systems.

4.157 A model study of atmospheric OCS; current understanding and geoengineering implications.

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Abstract:

Carbonyl sulfide (OCS) is the most stable and therefore abundant reduced sulfur compound in the atmosphere. OCS stratospheric oxidation is the main sink source and the source of a sulfate aerosol layer between 17 and 30 km. This stratospheric sulfur aerosol (SSA) also known as the Junge layer affects the planet's Albedo and catalysis the hydrolysis of N_2O_5 , promoting mid-latitude ozone depletion. While volcanic eruptions are an important source of stratospheric sulfate, they are sporadic and the source of sulfur in volcanically quiescent times has been a matter of debate. Application of sulfur stable isotopes has provided evidence for OCS as the main source of the SSA. Ice core studies show that of pre-industrial tropospheric levels of OCS were 372 ppt while current levels are 500 ppt. In this study, we created a new 1-D photochemical model that includes stable isotopes as an additional tool for model calibration and consider the historical variation of anthropogenic emissions of OCS and its tropospheric precursor CS_2 ^[1]. In order to calculate the OCS atmospheric vertical profile, the model that takes into account chemistry, transport, deposition, stable isotopes and high-resolution absorption spectrum. This last feature is important since the main isotopic imprint of the stratospheric oxidation pathway is produced by photo-dissociation. The application of stable isotopes not only confirm as OCS as the main source of SSA during volcanic quiescent times but also confirms the isotopic mixing ratio of tropospheric OCS measured by Hattori et al (2015)^[2]. Our findings show that about 33% of today's SSA is anthropogenic. Furthermore, the anthropogenic contribution to SSA means that an estimate of -0.16 Wm^2 of radiative forcing should be accounted in pre-industrial pollution free models.

[1] Aydin, M., et al., (2016), J. Geophys. Res-Atmos., 121(4), 1943-1954

[3] Hattori, S., et al., (2015), Anal. Chem., 87(1), 477-484.

4.159 Long-term variations of HCN in the lower stratosphere measured with ground-based FTIRs over Hokkaido, Japan.

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Abstract:

We report on long-term variations of hydrogen cyanide (HCN) in the lower stratosphere derived from solar-absorption spectra measured with ground-based high-resolution FTIRs over Rikubetsu (43.5°N, 143.8°E, 380 m a.s.l.) and Moshiri (44.4°N, 142.3°E, 200 m a.s.l.) in Hokkaido region, Japan. The stratospheric HCN are mostly transported from the troposphere where biomass burning on the surface is a major source of HCN. A major sink of the stratospheric HCN is transport to the troposphere, and therefore, stratospheric HCN is one of tracers of air-mass transport because there is no significant chemical process of source and sink (e.g. Glatthor et al., ACP, 2015). We have retrieved the vertical distribution of more than 10 trace gases in stratosphere and troposphere from the observed spectra measured in two decades as a part of the NDACC-certified measurements. The HCN climatology in the lower stratosphere over Hokkaido with the FTIRs shows a good agreement with satellite measurements such as ACE-FTS, MIPAS and AURA/MLS. In addition to the seasonal variations, significant enhancements of HCN in the lower stratosphere during 3 years from 1998 to 2001 and during 1 year from 2015 to 2016, respectively, are appeared. For the former event, the trajectory analysis and comparisons with the temporal variations of the other trace gases retrieved simultaneously from the FTIR spectra are carried out, and find that it may not be enough to be affected by transport of polluted air mass as a result of the huge biomass burning event in Indonesia, 1997, although the latter event is mainly caused by the intense springtime biomass burning in Indonesia under the condition of strong El Niño (Sheese et al. GRL, 2017). In the presentation, features of the two enhancement events as well as the climatology and the trend of HCN in the lower stratosphere are discussed.

4.161 Development of global high-resolution climate model and its application to the chemistry-climate study.

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Abstract:

We introduce the current status of the development of Non-hydrostatic Icosahedral Atmospheric Model (NICAM, Satoh et al., 2014) and a series of chemistry-climate simulations using NICAM. The uncertainty of convection and cloud process is a critical issue not only for the climate studies but also for the air quality studies. Vertical transport by the convective motion is essential for the long-range transport of aerosols and trace gases. Rain-out and wash-out processes are also critical but have large uncertainty in the global chemistry-climate models. One of the effective ways to reduce these uncertainties is a high-resolution simulation. The NICAM simulations with 14km-3.5km horizontal mesh, without using convection parameterization have shown good results, especially in the tropical weather predictions. Recently, aerosol simulations using NICAM revealed the importance of horizontal resolution and the simulation without parameterizations for the coarse grid spacing. Sato et al. (2016) showed strong resolution dependency of polarward transport of black carbon. Three-years simulation with 14km horizontal mesh showed a fairly good agreement with the observation at ground stations (Goto et al., 2017). For the aerosol effects on cloud water, the NICAM simulated observed results well, which is contrary to the result of traditional global climate models (Sato et al., 2018). The development efforts in computational aspects play an important role in the global high-resolution simulations. The high-resolution simulations require a huge amount of computational resources and the effective use of state-of-the-art supercomputers is

necessary. The code optimization and refactoring improved computational performance and scalability of NICAM (Yashiro et al., 2017). NICAM has been selected as one of proxy application for the evaluation of Japanese next flagship supercomputer, post-K. We will show the recent efforts of NICAM and NICAM-Chem development toward expanding the capability of global cloud-resolving chemistry-climate model simulation.

4.162 Production of high potential temperature airmass just below the tropopause associated with the Asian monsoon.

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Abstract:

In this paper, we will present the formation process of high potential temperature airmass just below the tropopause associated with the hydroclimatological aspects of Asian monsoon system. Huge amount of air mass with higher potential temperature accumulated in a gigantic anticyclone, Tibetan High, over the Tibetan Plateau over the period just coincide with the summer monsoon season, which is synclonized with the meridional temperature reversal over the Asian monsoon region. Such prominent accumulation of airmass and temperature reversal does not be found in other areas including southern hemisphere in austral summer.

Such huge amount of high potential temperature airmass (HPTM) over the Tibetan Plateau is attributed to the large amount of production of HPTM associated with the Asian monsoon system. Especially, the convective activity over the North and Northeastern Indian Subcontinent just to the south of the Tibetan Plateau plays important role in this process, which is supposed to carry the high equivalent potential temperature airmass (HEPTM) produced in the atmospheric boundary layer over the North and Northeastern Indian Subcontinent land surface to the upper troposphere. This is strongly supported by several findings from the field of atmospheric chemistry. However, from the view point of the atmospheric dynamics, it is not clarified yet.

In the present study, we firstly discuss about the climatological seasonal variation of the structure of upper tropospheric HPTM to show the special importance of the area just to the south of the Tibetan Plateau. Next, we analyze the seasonal and intraseasonal variability of HPTM and HEPTM over this region. Finally, we will discuss about the impact of the Post MAHASRI project, which will be launched within 2018, to the observational research on the hydroclimate process in the atmospheric boundary layer over the Asian monsoon region.

4.165 High Time Resolution Source Apportionment of PM_{2.5} in Beijing with Multiple Models.

Early Career Scientist

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Abstract:

As the capital of China, Beijing has been suffered from heavy local emissions as well as regional transport, resulting in severe atmospheric fine particles (PM_{2.5}) pollution. To better analyze the sources and regional transport of PM_{2.5} in Beijing, high time resolution datasets from online instruments together with multiple models should be applied together for identifying sources, which have seldom been used in previous studies. In this study, high time resolution online measurement of PM_{2.5} was conducted during winter in 2016 in Beijing. Major measured species included 20 metals, 11 water soluble ions, organic carbon, and elemental carbon. This study focuses on online source apportionment of PM_{2.5} in Beijing by positive matrix factorization (PMF) model, combining with other models such as chemical transport model (The Nested Air Quality Prediction Model System, NAQPMS), and the footprint model. The NAQPMS can distinguish local from regional contribution to air pollutants and the footprint model can identify potential source regions. PM_{2.5} source apportionment in Beijing in winter by PMF showed that secondary source was predominant (40~57%) in hazy episodes while traffic source more important in clean episodes (25~32%). The air mass transport by NAQMS agreed well with the temporal variation of PM_{2.5} with polluted southern air mass and stable meteorology resulting in the formation of haze episodes and clean northern air mass and high wind speed causing the rapid decrease of PM_{2.5}. The combination of PMF with footprint results indicated significant daily variation of PM_{2.5} sources, with coal and traffic source dominated when footprints located in local area and secondary source contribution increased with southwest footprints.

4.169 Long-term climatology of aerosol optical properties measured at a South African site.

Early Career Scientist

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Abstract:

Atmospheric aerosols affect the earth's radiative budget in two ways: firstly, particles that indirectly influence the lifetime and physical properties of clouds and, secondly, particles that directly absorb and scatter short- and long wave radiation. Due to the high spatial and temporal variability of aerosols, their climatic impacts are particularly important on regional scales. Consequently, high-resolution long-term, regional scale measurements are required in order to determine aerosol climatic impacts and to improve the uncertainty levels associated with these impacts. Although South Africa is the largest economy in Africa with numerous primary and secondary sources of aerosols, only few studies have been published on aerosol optical properties. In this study, aerosol optical properties, which include scattering and absorption coefficients, single-scattering albedo and Ångström exponent, are investigated based on in situ measurements conducted from September 2011 to November 2016 at the Welgegund measurement station - a regional background site situated in the interior of South Africa - with a multi-angle absorption photometer and a three wavelength light scattering nephelometer. The aerosol optical measurements conducted at Welgegund can be considered the most comprehensive in South Africa. The seasonal and diurnal trends of aerosol optical properties will be presented, which will also be related to possible sources of these species. It is foreseen that this study will make a significant contribution to improving the understanding of aerosol optical properties in South Africa and its associated impacts on climate change in this region.

4.170 Developing PM Source Profiles of Diesel Vehicles and Its Application on Source Apportionment of PM_{2.5} in China.

Early Career Scientist

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Abstract:

Vehicular emission is one of the most important sources of particulate matter (PM) in Beijing, China, which has significant adverse effects on air quality, human health and climate change. However, the estimate of contribution of vehicular emission to ambient PM_{2.5} is highly uncertain due to the lack of local source profiles in China and limited chemical species used for source apportionment. In order to develop local source profiles of diesel vehicles and evaluate the sensitivity of CMB (Chemical Matter Balance) model results to different vehicle source profiles, six excavators, and five trucks were tested. The average emission factors for PM (EF_{PM}) from excavator and truck emissions were 829 ± 806 and 498 ± 234 mg kg⁻¹ fuel, respectively. EF_{PM} and PM constituents were significantly influenced by fuel quality, operational mode, and emission standards of the vehicles. For example, a good and positive correlation ($R^2 = 0.79$, $p < 0.01$) was found between EF_{PM} for excavators and the sulfur contents in fuel. The highest average EF_{PM} for working excavators was 904 ± 979 mg kg⁻¹ fuel as a higher engine load was required in this mode. For trucks, the vehicle with higher emission standard exhibited lower emissions of PM. From China II to China III standard, the EF_{PM} for truck was decreased by 63.5% and it was decreased by 65.6% when switching from China III to China IV standard. The developed new source profiles are applied in the CMB model to test sensitivity of vehicle source profiles to source apportionment results of PM_{2.5} in Beijing-Tianjin-Hebei regions. In addition to source profiles, more organic tracers are also included in the model (polycyclic aromatic hydrocarbons, hopanes, steranes etc.) to test the sensitivity of source apportionment results to fitting species used in the model and improve the quantification of vehicular source contribution.

4.172 The Southern European fire season 2017 as seen by the Copernicus Atmosphere Monitoring Service.

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Abstract:

The 2017 fire season across southern Europe was extraordinary in terms of duration and intensity of individual events.

The operational Copernicus Atmosphere Monitoring Service (CAMS, <https://atmosphere.copernicus.eu>) is monitoring and forecasting global atmospheric composition and European air quality using, amongst others, a comprehensive set of satellite and in-situ observations, which yield information on the fire activity and emissions as well as the associated atmospheric smoke plumes. The Global Fire Assimilation System (GFAS) of CAMS uses satellite observations of fire radiative power (FRP) to estimate the emissions of forty smoke constituents.

The operational version of GFAS, shows an extraordinarily long fire season in Portugal and Spain with noteworthy burning in April, June, August and October, which lifted the total fuel consumption to 15 Mt in 2017. This is the largest value in the GFAS record 2003-17.

The fires in October are of particular interest because they were fanned by strong, hot and dry winds, which were part of the ex-tropical hurricane system Ophelia, which travelled a record distance to the north-east. Smoke from these fires was transported across Europe and affected the atmospheric composition in places as distant as Estonia.

A new version of GFAS has been developed, which allows for 1-hour time resolution and the assimilation of fire observations from the geostationary SEVIRI instrument alongside the two polar-orbiting MODIS instruments. It better represents the onset of the extreme fires and estimates a fuel consumption that is about half of the operational estimates.

We present simulations of the European atmospheric composition and air quality during the fire events based on the new GFAS version and the global and two European atmospheric compositions, resp. air quality, models. Furthermore, satellite observations of the smoke plumes and ground-based estimates of fuel consumption are used to validate the new emissions.

4.173 Determining Polarity Distribution of Organic Matters by the 1-octanol-water Partitioning Method.

Early Career Scientist

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Abstract:

Hygroscopic property of water-soluble organic matters (WSOM) has a crucial role in controlling cloud formation process and radiative balance in the atmosphere. Recently, the distribution of polarity, which regulates dissolution and phase partitioning processes in aerosol particles, has been regarded as one of the important properties of WSOM because it affects hygroscopic growth and cloud condensation nuclei activation. Techniques such as solid-phase extraction and high-performance liquid chromatography have been applied to classify WSOM by polarity. However, they only provide qualitative evaluations. To quantitatively conduct a liquid phase separation, we recently developed the 1-octanol-water partitioning method. Since 1-octanol-water partition coefficient is defined by polarity, the method is able to categorize organic compounds into different ranges of polarity by changing volume ratio of 1-octanol and aqueous phases ($V_{O/A}$).

We applied this method to WSOM in Indonesian biomass burning particles to quantitatively evaluate their polarity distribution. Sampled particles were dissolved in ultrapure water to extract WSOM. Subsequently, WSOM were classified into different ranges of polarity using the 1-octanol-water partitioning method with five sets of $V_{O/A}$ ranging from 0.01 to 10. The chemical composition of each fraction was measured by a Time-of-Flight Aerosol Chemical Speciation Monitor (ToF-ACSM) and a 3D fluorescence spectrometer. As the signal intensity of levoglucosan-like species derived from the ToF-ACSM mass spectra positively correlated with polarity, levoglucosan-like species were indicated to be highly polar. On the other hand, polarities of hydrocarbons and high molecular weight species were low. Regarding the fluorophores, humic-like substances and protein-like species were identified. The latter was classified into two types based on

the differences in polarity. In addition, polarity distribution of the Indonesian biomass burning particles was estimated by the established data inversion algorithm.

4.174 Quantitative analysis of the global dust emission using a data assimilation technique.

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Abstract:

Mineral dust aerosol plays several important roles in the Earth climate and the environment: it affects the Earth's energy balance directly by scattering and absorbing the radiation, darkening of snow/ice, indirectly by modifying the cloud properties, ocean carbon cycles. It also affects the atmospheric chemical cycles of other aerosols and gases. Numerical dust aerosol models have been developed and used for researches and operational dust weather forecasts with wind-driven dust emission schemes although there is still large uncertainty among models. To improve the dust emission flux calculation, accurate information of the surface erodibility is critical. Current global dust models commonly employ semi-empirical "dust source functions" to express the horizontal variability of surface erodibility to reduce disagreements with observations. Typical dust source function, specifies large dust emission to the topographic depression first proposed by Ginoux et al. (2001). In this study, we take another approach that utilizes a global aerosol model and its data assimilation system to derive empirical dust source functions. We used our global aerosol model called MASINGAR mk-2, which is used for the operational aeolian dust forecast in JMA, and the 2D-Var aerosol data assimilation system using satellite retrieved aerosol optical depth. In this method, calculated dust flux by the global model is inversely corrected by the AOD data assimilation. While the correction at one analysis time is limited over the dust emission area where satellite retrieval is available only, the correction factor map covering the globe can be created from a long-term analysis. We will show the results of the analyzed dust emission and discuss the implication from the empirical dust source function.

4.175 The Impact of Carbon Mitigation Measures on Future Air Quality.

Early Career Scientist

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Abstract:

Future policy measures to reduce air pollutants will improve air quality but policy measures aimed at reducing climate change could also inadvertently impact future air quality through changes to air pollutants co-emitted from carbon sources. Additionally, future changes in climate could also influence the concentration and spatial distribution of air pollutants. In this study, we quantify the impact on air pollutants from implementing measures to mitigate climate change, both in terms of their effect on air quality and climate forcing. Two consistent future emissions scenarios are used within the composition-climate model HadGEM3-UKCA: one is a reference scenario of future economic growth and development (REF), whilst the other (RCP4.5) assumes the same development pathway but stabilises anthropogenic radiative forcing at 4.5 W m^{-2} in 2100. Implementing carbon mitigation measures in RCP4.5 reduces the impact of a changing climate on air pollutants and can additionally reduce their emissions by between 15-30% in 2050. The change in emissions and climate from implementing carbon mitigation measures reduces annual mean surface concentrations of ozone and PM_{2.5} by 10-20% over different regions. Additionally, the total number of days that exceed the World Health Organization's (WHO) daily mean air quality standards for ozone and PM_{2.5} is reduced. In terms of climate forcing, the reduction in global mean effective radiative forcing (ERF) in 2050, relative to the present day, due to enacting carbon mitigation measures is enhanced by decreases in tropospheric ozone but is partially offset by a positive aerosol ERF from reductions in aerosols. This study demonstrates that carbon mitigation policies to mitigate climate change have added co-benefits for global and regional air quality. However, the effectiveness of the carbon policies in reducing climate forcing is lessened due to the combined changes in ozone and aerosols.

4.176 Direct grand-based observation of lightning-induced nitrogen oxides in the free troposphere.

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Abstract:

An important source of NO_x is lightning (LNO_x). Lightning occurs in the troposphere and LNO_x has generally been observed from aeroplanes. Recently, satellites have also been used to detect LNO_x , and the amount of LNO_x has been estimated with laboratories based on the available data; however, there is a large uncertainty around the actual amount of LNO_x . One of the reasons for this uncertainty is that the available observation data are limited (Schumann and Huntrieser, 2007). LNO_x could not be effectively detected using grand-based observation. If the LNO_x data can be obtained by grand-based observations, the uncertainty of the estimated amount of LNO_x can be minimised. In this study, we did our observations at the Mt Fuji Research Station (MFRS) which was located at the top of Mt. Fuji (3776 m a.s.l.). Since the mountain top is located in the free troposphere, the influence of NO_x emission based on human activities from the ground is insignificant. We obtained the concentrations of nitric oxide (NO), nitrogen dioxides (NO_2) and NO_x oxidation products (NO_y) during the summer of 2017. NO_2 concentrations were measured using laser induced fluorescence spectroscopy, and NO and NO_y concentrations were measured using the chemiluminescence method. The NO_2 peaks were observed at 12:45 and 13:18 on 22 August 2017 (GMT). These peaks corresponded to maximum concentrations of 0.90 ppbv and 0.96 ppbv over durations of 32 min and 34 min, respectively. These NO_2 peaks unaccompanied CO enhancement, which suggested that the air mass did not contain emissions from combustion sources. The air mass backward trajectories at the above times came across the area lightning occurred. We have discussed the direct LNO_x measurement made by grand-based observation in detail.

4.177 Black carbon concentrations and size distributions of surface snow at Antarctica from April to December in 2011.

Early Career Scientist

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Abstract:

Black carbon (BC) has a significant positive radiative forcing effect because 1) atmospheric BC absorbs the solar radiation strongly and 2) BC deposited on snow/ice packs reduces the snow/ice albedo. Reduction of the snow/ice albedo depends not only on the amount of BC in snow/ice (hereafter, BC-Snow) but also on its size distribution. In this study, we measured 30 of the BC-Snow concentrations and size distributions in surface snow samples collected at Syowa station (coastal station) and along traverse route between Syowa and Mizuho station (inland station), Antarctica with the 52nd Japanese Antarctic Research Expedition (2010–2012). We measured BC-Snow concentrations and size distributions by a wide-range Single Particle Soot Photometer (WR-SP2), ion concentrations, and pH in each melted water sample. Atmospheric BC concentrations were also monitored by an Aethalometer with ~300°C heated air inlet during the sampling period.

The averaged BC-Snow concentrations in the melted water samples were 591.6 (ng L⁻¹) with minimum and maximum values of 49.9 (ng L⁻¹) and 2681.2 (ng L⁻¹), respectively. The BC-Snow concentrations were lower in winter (May to September) than those in other

seasons at Syowa station. The BC-Snow concentrations in Mizuho route were higher than those at the Syowa station. The BC-Snow size distributions showed an increase in small particles (~100-200 nm) for winter samples, whereas large particles (>600 nm) were also detected in summer samples. The atmospheric BC concentrations increased around August, the result differs from the snow samples. Concentrations of ions and pH in snow samples had no seasonal variations. These results firstly showed detailed BC-Snow concentrations and air as well as their size distributions in the Antarctica and provide useful information to evaluate the BC transportation in this region and its radiative forcing effect.

4.178 Size-resolved hygroscopicity of atmospheric aerosols in a mid-latitude forest in Japan.

Early Career Scientist

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Abstract:

The hygroscopicity of aerosol particles is governed by their chemical composition, which can be size-dependent because of their different origins and/or atmospheric processes. The resulting size dependence of the hygroscopicity is not characterized well. The size-resolved aerosol hygroscopic growth at 85% relative humidity (30, 50, 70, 100, 200, 300, and 360 nm) and size-resolved aerosol composition (>70 nm) were measured using a hygroscopic tandem differential mobility analyzer and an aerosol mass spectrometer, respectively. The size-dependence of the hygroscopicity of aerosol particles (k_t) and organic components therein (k_{org}) were characterized. The k_t increased with the increase in the particle dry diameters. This can be explained by the size-dependence of fractions of inorganic salts, for super-100 nm particles. The k_{org} increased with the increase in the particle diameters in the range of 70–200 nm. Positive matrix factorization analysis of the mass spectra of bulk organics resolved a less-oxygenated organic aerosol component (LOOA) and a more-oxygenated organic aerosol component (MOOA). The size-resolved organic mass spectra were also attributed to those two factors using the least squares regression method. The volume fraction of LOOA was inversely correlated with k_{org} . The hygroscopicity parameters of LOOA and MOOA were estimated to be 0.06 and 0.27, respectively. Organics accounted for more than 50% of the water uptake by ≤ 100 nm particles. LOOA was estimated to account for 70% of biogenic secondary organic aerosol (BSOA). BSOA is estimated to contribute to 20% of water uptake by 70 and 100 nm particles and 13%–9% for larger particles. The result indicates a small contribution of

fresh BSOA to the aerosol water uptake on average under the studied conditions. However, the large mass fraction of BSOA (67% for 100 nm particles) suggests its importance to the particle hygroscopicity after aging.

4.187 Properties of Aerosol Particles Originated from Siberian Forest Fires over the Western North Pacific Ocean .

Early Career Scientist

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Abstract:

Atmospheric aerosol particles play an important role in the radiation budget by scattering and absorbing solar radiation. Recently, tar balls (TBs), originated from biomass burning such as forest fires and biofuel combustion, have been known as the particles absorbing solar radiation, contributing to global warming. However, the quantitative understanding of the lifetime and removal process of TBs are not sufficient. In this study, the morphology and chemical compositions of aerosol particles including TBs collected over the Western North Pacific Ocean were characterized by individual particle analyses. Observation and samplings of atmospheric aerosol particles were carried out during R/V MIRAI arctic cruise (2016/8/22-10/5). The ambient BC mass concentrations were measured by a single particle soot photometer (SP2). In this study, we focused on the relatively high BC mass concentration event over the Western North Pacific Ocean at 46.05°N, 159.32°E on 29 September 2016. The collected aerosols were analyzed using a transmission electron microscope and an energy dispersive X-ray spectrometer. In the sample collected at 29 September, the number fractions of S- and C-rich particles were about 30% and 70%, respectively. C-rich particles were mostly identified as TBs judging from their compositions and shapes. The backward trajectory analyses with the fire emission data suggested that the air masses were affected by Siberian forest fires. This observation found that TBs were transported over the Western North Pacific Ocean from Siberian forest fires. The internal mixing of TBs in this sample will be discussed. Our results are important to understand the long-range transport of TBs originated from Siberian forest fires.

4.188 African biomass burning pollutes large parts of the south east Atlantic boundary layer - results from the CLOUDS and Aerosol Radiative Impacts and Forcing: Year 2017 (CLARIFY-2017).

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Abstract:

The African continent is the largest global source of BBA (around 50% of global emissions) which is transported offshore over the underlying semi-permanent cloud decks

making the SE Atlantic a regional hotspot for BBA concentrations. While global climate models agree that this is a regional hotspot, their results diverge dramatically when attempting to assess aerosol-radiation-interactions and aerosol-cloud-interactions. Hence the area presents a very stringent test for climate models which need to capture not only the aerosol geographic, vertical, absorption and scattering properties, but also the cloud geographic distribution, vertical extent and cloud reflectance properties. Similarly, in order to capture the aerosol-cloud-interactions adequately, the susceptibility of the clouds in background conditions; aerosol activation processes; uncertainty about where and when BBA aerosol is entrained into the marine boundary layer and the impact of such entrainment on the microphysical and radiative properties of the cloud result in a large uncertainty.

The CLARIFY-2017 experiment sought to address these major challenges since measurement methods and high resolution model capabilities have developed rapidly over the last few years and are now sufficiently advanced that the processes and properties of BBA can be sufficiently constrained. The UK Facility for Airborne Atmospheric Measurements (FAAM), was operated from Ascension Island in August and September to measure in-situ and remotely sensed aerosol and cloud and properties while advanced radiometers measured aerosol and cloud radiative impacts. The aircraft measurements took place at the same time as the NASA ORACLES programme, the DoE-funded LASIC programme, and the CNRS AEROCLO-sA project.

We present an overview of the data and discuss the physical, chemical, optical and radiative properties of biomass burning aerosols and the physical properties of stratocumulus clouds and discuss initial model results of aerosol-radiation interactions in weather and climate models and the representation of aerosol-cloud interactions across a range of model scales.

4.194 Influence of seasonal mesoscale and microscale meteorological conditions in Svalbard on results of monitoring of long-range transported pollution.

Early Career Scientist

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Abstract:

The Zeppelin Observatory is an atmospheric monitoring station located on the north-west coast of Spitzbergen island, in the Svalbard archipelago. The station provides background air composition, meteorological and climatological data for numerous research projects including the Global Atmosphere Watch, the European Monitoring and Evaluation Programme and the Arctic Monitoring and Assessment Programme. The observatory is located on a mountain ridge in a region with complex topography that affects local atmospheric circulation processes. Seasonal change in the position of the Arctic front plays key role in long-range transport of atmospheric pollutants to the site. Due to this, long-range transported pollution prevails in autumn, winter and spring. In contrast, in summer, the ship traffic intensifies and becomes a significant local source of pollution in Ny-Ålesund, a small settlement near the station. The present study investigates influence of micrometeorological conditions, mesoscale dynamics and local air pollution on the data collected at the Zeppelin observatory and at a temporarily station in the settlement. Daily filter measurements of sulphur dioxide and non-sea salt sulphate and meteorological data from both stations have been analysed along with the data from radiosonde soundings and ERA-Interim reanalysis dataset. The statistical assessment of the influence of different micrometeorological phenomena, namely directional and speed wind shear, temperature and humidity inversions, and local pollution from ships on the data at both stations has been made. The reasons for seasonal variation of the correlation between the data from the two stations have been revealed, and the importance of different factors of influence has been examined statistically. The modelling of environmental factors, which are described in the current work, is still challenging, and it needs to be considered when one compares modelling results with in-situ measurements taken at

different heights in the area with complex topography.

4.197 Lightning NO_x Production as Determined Using OMI NO₂ Retrievals and WWLLN Stroke data.

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Abstract:

Nitrogen oxide (NO_x) production by lightning is estimated using Ozone Monitoring Instrument (OMI) nitrogen dioxide (NO₂) slant columns and detection-efficiency adjusted flashes from the ground-based World Wide Lightning Location Network (WWLLN) during the boreal summers of 2007 to 2011. Utilizing an algorithm that includes air mass factors appropriate for grid boxes affected by convection, NO₂ slant columns are converted to vertical columns of tropospheric NO_x ($V_{\text{LNO}_x^*}$), which are then converted to vertical columns of tropospheric NO_x due to recent lightning (V_{LNO_x}) by subtraction of a tropospheric background that is given by the mean $V_{\text{LNO}_x^*}$ at the same locations on non-flashing days. Estimates of LNO_x production efficiency (PE) per flash for the tropics and midlatitudes are obtained using summation- and regression-based approaches. In the summation approach, mean V_{LNO_x} over flashing grid boxes is divided by mean flashes during a flash window prior to the time of the OMI overpass. In the regression approach, mean daily $V_{\text{LNO}_x^*}$ values over a region are regressed against mean daily flashes during the window. LNO_x PE is determined to be greater over marine locations than over continental locations possibly because marine flashes are more energetic. LNO_x PE is found to be greater over the tropical Pacific where flash rates are low than tropical Africa where flash rates are high. Overall, the PE decreases by an order of magnitude for a two-order of magnitude increase in flash rate. The mean LNO_x PE for the midlatitudes and tropics are inferred to be 321 ± 170 and 161 ± 74 moles per flash, respectively, which corresponds to a global source of 4.1 ± 1.9 Tg N per year. The main contributors to uncertainty in approximate order of importance are uncertainties in WWLLN detection efficiency, upper tropospheric NO_x lifetime in the near field of convection, tropospheric background, and flash window.

4.198 Improving Prediction of Aerosol and Ozone Formation from Wildfire Emissions in the Western U.S..

Early Career Scientist

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Abstract:

In 2017, wildfires burned one of the largest areas on record in the western U.S. Fire risk and property damage and loss of life due to fires are expected to continue to grow in the western U.S. along with population and longer, warmer, and drier fire seasons. Air quality forecasts utilizing regional chemical models provide key information for affected communities and firefighting efforts, yet many models fail to accurately predict ozone and particulate matter levels during fire events. This study examines fire case studies from recent years for which in-situ observations are available, including smoke transported across the U.S. and to Europe from numerous wildfires in the Pacific

Northwest in Sept. 2017, and the Santa Rosa fires in Oct. 2017. We conduct meteorology-chemistry simulations with WRF-Chem and evaluate the model against aircraft, ground-based, and satellite observations of aerosols, trace gases, and radiation. Next, we include fire diurnal cycle information obtained from Geostationary Operational Environmental Satellite (GOES)-16 Fire Radiative Power (FRP) observations in FRP-based emissions estimates, compare the FRP-based emissions with bottom-up approaches, and evaluate the sensitivity of air quality prediction to the emissions. We also develop a meteorology-driven fire emissions parameterization for WRF-Chem. We use the simulations to identify dominant ozone and aerosol formation chemical pathways and missing mechanisms in the model. Finally, we discuss plans for modeling analysis for the 2018 NSF Western wildfire Experiment for Cloud chemistry, Aerosol absorption and Nitrogen (WE-CAN) and CU Trace Gas Emission Fluxes from Biomass Burning Sources (BB-FLUX) and 2019 NOAA-NASA *Fire* Influence on Regional and Global Environments Experiment - Air Quality (Fire-X-AQ) field campaigns. This study will help to focus and prioritize measurements collected in the upcoming field experiments. The field observations will be used to constrain model parameterizations of emissions, plume rise, chemistry, and aerosol-cloud and aerosol-radiation interactions.

4.201 Characteristics of Atmospheric Black Carbon Observed by R/V Mirai over the Bering Sea and Arctic Ocean.

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Abstract:

Atmospheric aerosol particles play an important role in Arctic climate through the absorbing and scattering of solar radiation. Also, the deposition of light-absorbing particles on the surface reduces the Earth's albedo and accelerates snow/ice melting by absorbing the sunlight. Black carbon (BC) is a major component of light-absorbing particulate matter in the atmosphere, causing positive radiative forcing. Therefore, the impact of BC on the Arctic climate needs to be assessed; however, observational information has been still insufficient. Over the Arctic Ocean, we have been conducting ship-based observations for BC using a single particle soot photometer (SP2) at September on R/V Mirai every year since 2014. To estimate the transport pathways of BC, we have also conducted model simulations during the period of cruise using a regional transport model (WRF-Chem 3.8.1).

Observations were continuously conducted along the ship track between Japan and Arctic Ocean via Bering Sea. Analyzed Data were employed after eliminating data influenced by ship exhaust. The observed average mass concentration in $>70^{\circ}\text{N}$ at September during the cruises on 2014 - 2017 was $\sim 2 \text{ ng/m}^3$. This value was lower than the levels ($\sim 10 \text{ ng/m}^3$) recorded at the ground-based observation site of Barrow (Alaska ($71^{\circ}\text{N}, 156.6^{\circ}\text{W}$))

on September [Sharma et al. 2013 JGR]. We captured relatively high BC mass concentrations over Bering Sea and Arctic Ocean during the cruises in 2014 - 2017. The regional transport model indicated the biomass burning at Siberia should be possible source in most cases. We will present further analysis on the BC mixing state, and comparison with other measured gases.

4.202 Impacts on PM and O₃ in urban areas of the Western U.S. due to wildfires.

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Abstract:

Over the last several decades wildfires in the western U.S. have increased in size due to climate and other human factors. As a result, PM concentrations have increased significantly in large parts of the western U.S. While exceedances of both the particulate matter (PM) and ozone standards can occur due to smoke, it is much harder to identify and quantify the contributions to ozone. While PM is nearly always present in downwind fire plumes, it is also ubiquitous in urban areas from normal industrial sources. So separating out the effects of smoke PM from normal urban PM can be challenging at relatively low concentrations. At present we have a few tools to identify the presence of smoke in urban areas including in-situ PM measurements, enhancement ratios, models and the satellite derived HMS smoke product. We have also developed tools to identify the impacts from wildfires on O₃ in urban areas, including enhancement ratios and statistical modeling. Combined, these tools can provide ways to quantify the contributions of wildfire smoke to urban photochemical production of O₃. Impacts on O₃ in urban areas appears to be greatest during periods of light to moderate smoke (between 15-60 ug/m³) and fall off at higher concentrations. Because identification of smoke in urban areas is challenging at low to moderate concentrations, new tools are needed to identify smoke contributions in urban areas. I will discuss the use of other tracers, particularly some that could be routinely measured to indicate the presence of smoke in urban areas.

4.204 A study of 2016 Winter Fog Season in Islamabad, Pakistan.

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Abstract:

PM₁₀ samples were collected during intensive fog days in Islamabad, Pakistan, to investigate the impact of particulate matter on fog formation. The PM₁₀ concentrations were monitored at the Institute of Space Technology site using a highvolume air sampler and its elemental composition was studied using Scanning Electron Microscopy-Energy Dispersive Spectroscopy (SEM-EDS). Sampling was done for a duration of 24 hours on selected days, including all foggy days in a period from January 2016 to February 2016. The concentration of PM₁₀ varied from 123 $\mu\text{g m}^{-3}$ to 202 $\mu\text{g m}^{-3}$ with an overall mean concentration of 177 $\mu\text{g m}^{-3}$. On most occasions, PM₁₀ levels were considerably high as compared to permissible limits of both Pak-NEQS and WHO guidelines. It has been observed that the air quality during fog days was much worse, with elevated levels of particulate matter observed during foggy days. The SEM-EDS revealed the presence of different elements including some metals Si, K, Ca, Mg, Zn, Fe, Cr, Pb, Al etc. The morphological studies suggest that most of the particles are crystalline in shape, suggesting their main source as soil. Some samples also showed round spherical shape which refers their anthropogenic source. The sun photometer observations of aerosol optical depth (AOD) and satellite observations from Aqua's Moderate-resolution Imaging Spectro-radiometer (MODIS) showed significant correlation. Moreover, elevated level of AOD were found during heavy fog days. The validated high satellite AOD were associated with high PM₁₀ concentration during heavy fog days.

4.206 Temperature-dependent drivers of summer surface-level ozone: Insights from a chemical transport model within the Eastern United States.

Early Career Scientist

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Abstract:

Temperature is an important and well-documented driver of extreme ozone (O₃), and over the Eastern United States, regional-scale O₃ responds nearly linearly to temperature changes by 1.48 ± 0.34 ppbv K⁻¹ during the summer. What is unclear, however, are the relative roles of temperature-dependent processes such as emissions and photochemistry. For instance, on hot summer days, anthropogenic NO_x emissions from power plants increase with greater air conditioning demand, and biogenic emissions of isoprene and other VOCs also increase. At the same time, high ambient temperatures alter chemical lifetimes and increase photochemical reaction rates.

In this study we first compare modeled O₃-NO_x-VOC chemistry from a control run of NASA's Global Modeling Initiative (GMI) chemical transport model (CTM) with *in situ* measurements of trace gases from the U.S. Environmental Protection Agency (EPA) Clean Air Status and Trends Network (CASTNet) and Air Quality System (AQS). In doing so, we establish a baseline for model performance.

We then present the results of sensitivity simulations aimed at disentangling the roles of the aforementioned temperature-dependent processes. The first such simulation uses observed industrial emissions from the EPA's Continuous Emissions Monitoring System (CEMS) to derive the sensitivity of industrial NO_x emissions to temperature (5.4% K⁻¹) and thereafter introduces daily-varying emissions to the CTM to isolate the role of temperature-dependent emissions. An analysis of this simulation indicates that the implementation of daily-varying emissions results in only nuanced changes to daily O₃ variability. Finally, our second simulation fixes time-varying temperatures to monthly mean values within the CTM's chemical mechanism to isolate the role of temperature-dependent photochemistry.

Our work clarifies the pathways that link temperature with O₃ and suggests the ways in which increasing global temperatures could impact surface-level O₃. Moreover, our work provides the strengths and limitations of sensitivity simulations of a global CTM on surface-level trace species.

4.208 Probing the Asian Tropopause Aerosol Layer and North American Tropospheric Aerosol Layer during Summer Monsoons Using in situ Measurements .

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Abstract:

The monsoon deep convection provides a potential pathway for the transport of surface-emitted pollutants to the upper troposphere and lower stratosphere (UTLS). These pollutants are then trapped by the anticyclone forming a sustained pollution layer. Recent satellite studies have revealed enhanced aerosol mass in Asia (Asian Tropopause Aerosol Layer, ATAL) and North America (North American Tropospheric Aerosol Layer, NATAL) during the monsoon season. The enhanced aerosol layer, however, has not been extensively measured by in situ measurements, in part due to the limitation of instrumentation that is capable to be deployed on balloons. With the development of a light-weight, high-sensitivity particle counter (printed optical particle spectrometer, POPS), we are able to measure the vertically-resolved aerosol number density and size distribution in real time. We deployed the POPS on balloons in August of 2016 in Lhasa on the Tibetan Plateau, a site within the Asian summer anticyclone region. Additional balloon-borne and aircraft measurements were conducted in Houston in September of 2016 to probe the NATAL. The measurements showed an ATAL spanning from 14 to 19 km vertically. The particles in the ATAL were dominated by submicron particles, with their total number concentration reaching 50 cm^{-3} for aerosols with diameter of 140 nm to 3 μm . In contrast, the particle number concentration in the NATAL ranged from 10 to 15 cm^{-3} , consistent with satellite measurements showing that NATAL is weaker than ATAL. A global sectional aerosol model coupled with the Community Earth System Model is being conducted to simulate the aerosol properties of ATAL and NATAL. Initial results show

reasonable agreement between modeled and measured aerosol vertical profiles. The sources and composition of the ATAL and NATAL will be discussed.

4.209 Recent changes and influences of the springtime circulations on the atmospheric chemistry in the lower free troposphere of coastal East Asia.

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Abstract:

The biomass burning emissions from the Southeast Asia as well as the Asian continental outflow are believed to remarkably influence the regional air quality and atmospheric chemistry over the western North Pacific. In this study, we report the measurement results at the Lulin Atmospheric Background Station (LABS, 23.47°N, 120.87°E, 2862 m a.m.s.l.) as a regional representative site for the baseline atmospheric compositions in the East Asia. Since the establishment of the LABS in April 2006, the seasonal maximum of most air pollutants observed in March-April was most likely caused by the long-range transport of biomass burning emissions from the northern Indochina peninsula, which was mainly driven by the westerly winds (group WWZ) in the lower free troposphere. However, the springtime air masses arriving at the LABS became much more contributed to the Asian continental outflow originated from the coastal China area (group C) since 2015. Based on the cluster analysis of four-day backward trajectories, the percentage of the group C increased from about 6% to 48%. By contrast, the WWZ groups decreased from about 51% to 14%. As a result, the mean O₃/CO ratio in March and April increased for approximately 37% from 0.21±0.08 ppb ppb⁻¹ during 2007-2011 to 0.29±0.10 ppb ppb⁻¹ during 2015 to 2017, implying a signature of aged urban pollution. The seasonal variation of CO and O₃ remained similar to the previous pattern with a maximum and a minimum in spring and summer, respectively.

4.210 Aerosol properties across the southern polar front in summer .

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Abstract:

In a study of aerosols both north and south of the polar front in the Austral spring of 2012 Humphries et al. (2016) have reported an order of magnitude step change in aerosol number concentrations across the Antarctic polar front, with those south of the front averaging over 1000 cm^{-3} . They postulated that this was due to the region being influenced by aerosols generated in the free troposphere that were being advected down. A return voyage to this region was made in the summer (February) of 2017 on the RV Investigator, with a more extensive range of aerosols measurements, including aerosol number concentrations and submicron size distributions. These measurements were augmented with a number of other instruments measuring trace gas species, including radon, an important tracer for atmospheric transport.

The results show interesting seasonal differences, with the step change in number concentrations virtually absent across the proposed frontal boundary. Despite this, there was evidence of free-tropospheric composition while crossing the atmospheric boundary. The dataset also shows some evidence of the modification of cloud behavior by ships emissions.

References:

Humphries, R. S., Klekociuk, A. R., Schofield, R., Keywood, M., Ward, J., & Wilson, S. R. (2016). Unexpectedly high ultrafine aerosol concentrations above East Antarctic sea ice. *Atmospheric Chemistry and Physics*, 16(4), 2185–2206. <http://doi.org/10.5194/acp-16-2185-2016>

4.211 Aerosol-cloud-radiation interaction along the western coast of southern Africa as simulated by a regional climate model.

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Abstract:

Atmospheric aerosol particles are known to influence the radiative balance at regional and global scales through their interactions with clouds (first and secondary aerosol indirect effects) and solar/infrared radiation (direct radiative forcing). In addition, the feedback mechanisms associated with the absorption of solar radiation due to absorbing particles (especially smoke) on cloud microphysical properties (semi-direct effect) is also recognized as an important radiative perturbation. In this context, the western coast along southern Africa is an ideal region to study these processes because it is characterized by both the presence of anthropogenic smoke particles and persistent stratocumulus clouds, both of which are known to be essential in the global radiative budget. This has been the main motivation for the development of the AEROCLO-SA project (FR), in collaboration with the ORACLES (US) and CLARIFY (UK) programs. Within the framework of AEROCLO-SA, we evaluate the capacity of a regional climate model (RegCM) to represent aerosol stratocumulus interactions and their impact on regional climate by comparing simulations performed with and without explicit biomass burning aerosol. Here we present preliminary results of simulations performed at a 30 km horizontal resolution, focusing on shortwave aerosol optical depth, absorbing properties (AAOD and SSA), heating rate, as well as the representation and changes in Sc cloud macrophysical/microphysical and optical properties.

4.212 Indonesian fire history recorded in the upper tropospheric CO from the long-term CONTRAIL observation .

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Abstract:

CONTRAIL (Comprehensive Observation Network for TRace gases by AirLiner) is a Japanese airliner observation project that measures atmospheric carbon dioxide and other trace gases during intercontinental flights of Japan Airlines. We analyzed temporal variations of carbon monoxide (CO) in the upper troposphere at about 10-km altitudes from the CONTRAIL datasets of flask air sample measurements taken between Japan and Australia. Here we present a long record of CO in the upper troposphere between 30°N and 30°S over the western Pacific from 1993 to 2016. This study focuses on the CO variations in the Southern Hemisphere (SH) with unique seasonal cycles with CO peaking around October-November. Transport model experiments indicated CO emissions from Indonesian fires being transported into the upper troposphere of the southern tropics. The seasonal CO peak in the SH was largest around 20°S, and the peak significantly varied year by year. This interannual variation is found to be highly correlated with yearly changes in Indonesian fire emissions of CO estimated from the satellite-based inventory database. We also found that the interannual variation of CO seasonal peak is tightly related with the El Niño-Southern Oscillation (ENSO) events, indicating the enlarged Indonesian fires during the dry-condition El Niño years. In particular, anomalously large amount of CO was injected into the upper troposphere during the strong El Niño year 1997. We examined the relationship between the CO peak and Southern Oscillation Index, and found that the 1997 anomaly was exceptionally greater than those expected for all other years. This strongly suggests that fire emissions in 1997 were intensified not only by severe drought due to climate change but also by human amplification due to increased agricultural practices in Indonesia.

4.217 Towards a global vectorial vehicular emissions inventory.

Early Career Scientist

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Abstract:

Air pollution modelers usually do not take too much care about the emissions input data. The principal justification is that EDGAR/MACCITY/GAINS emissions are better than nothing. Despite that this approach is understandable because they prefer to go into the deeper knowledge of air pollution modeling process, this limits the capacity of explaining its own predictions. It is been shown that vehicular emissions is the main source of pollution in cities, and also that vehicular emissions shape the daily cycle of air pollutant concentrations. Therefore, improving the vehicular emissions in any part of the world will improve the air quality simulations and capacity of explaining the air quality predictions. In this abstract, I'm presenting the basis and initial results of a global vectorial vehicular emissions inventory. Vectorial means street by street. We will develop a model to predict the distribution of age of use of vehicle-based on regional GDP. Traffic data comes from regional statistics and emission factors used in own territory, for instance, in North America emission factors from MOVES, Europe from Copert, Brazil from local source and the rest of the world from Copert. Emissions will be calibrated with fuel consumption from the energy balances from International Energy Agency, to ensure that the fuel consumed in each region/ country is representative. We believe that this work will produce a significant improvement on air quality simulations globally. As the output will be street, this will allow producing air quality input for any regions in the world and for any model. The emissions will be estimated using the VEIN model, developed by the author.

4.219 Role of Various Factors in the UV Photochemical Treatment of N-Nitrosamines Related to CO₂ Capture.

Early Career Scientist

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Abstract:

Post-combustion CO₂ capture using amine solvents is the most feasible method of reducing anthropogenic CO₂ emissions, which are the largest contributor to global warming. The formation of carcinogenic *N*-nitrosamines (i.e., by-products) can hinder the industrial application of this technology. In this study, the effects of the *N*-nitrosamine concentration, amines, H₂O₂, and O₃ on the UV photolysis of three specific *N*-nitrosamines that are commonplace in amine-based CO₂ capture (i.e., *N*-nitrosodiethylamine (NDEA), *N*-nitrosodiethanolamine (NDELA), and *N*-nitrosomorpholine (NMOR)) were examined. The *N*-nitrosamine photodegradation experiments were conducted in a cylindrical water-jacketed glass batch reactor (i.d. 8.5 cm x L 15 cm), exposing a 700 mL solution to UV irradiation from a 4 W low-pressure Hg lamp (GL4WP, UV Nature, Korea). The working solution was heated using a hot plate coupled with a magnetic stirrer (HMS100, Yhaha, Korea) and a temperature controller (TZ45T, Autonics, USA) with a K-type thermocouple to control the temperature (40°C) and ensure even mixing. A peristaltic pump (BT 100-2J, Longer Pump, China) was used to transport the reaction solution to the fraction collector (2110, Bio-Rad, USA) at predetermined time intervals. A significant decrease in the photodegradation rate constants was observed for NDEA (1.02×10^0 to $2.94 \times 10^{-1} \text{ min}^{-1}$), NDELA (1.52×10^0 to $3.32 \times 10^{-1} \text{ min}^{-1}$), and NMOR (1.93×10^0 to $2.20 \times 10^{-1} \text{ min}^{-1}$) as their concentrations increased within 1–50 mg/L. This is the first report of a significant increase in the degradation rate constants of *N*-nitrosamine with an increase in amine concentrations (i.e., monoethanolamine (MEA), diethanolamine (DEA), and morpholine (MOR)) within 10–200 mM. The photodegradation rate constants increased as the molar ratio of H₂O₂ to *N*-nitrosamine increased to 20, but then decreased at molar ratios beyond this. O₃ had a negligible effect on the photodegradation of *N*-nitrosamines.

4.220 Regional model analysis of the source and transport pathways of black carbon aerosols over the Arctic Ocean on September 2016.

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Abstract:

Black carbon (BC) aerosols emitted from incomplete combustion processes such as fossil fuel and biomass burning is recognized as one of factors affecting the climate change. However, since the information of atmospheric BC behavior is still limited, their influence on the climate change has large uncertainty. Furthermore, it is suggested that the impact of BC on the climate change at high-latitude is large. Therefore, the information of atmospheric BC such as transport pathway, source, and removal process etc. is required. In this study, we investigated the sources and pathways of BC at the arctic and Pan-arctic regions using a regional chemical transport model. Also, we compared with the model simulation results with ship-based observation data by R/V Mirai at the Arctic Ocean and Bering Sea cruise on 2016.

We conducted model simulations for the BC mass concentration over the Pan-Arctic region using a regional chemical transport model (WRF-Chem version 3.8.1). The initial and lateral boundary conditions for the meteorology and chemical species were taken from NCEP-GFS and MOZART-4, respectively. RACM and GOCART modules were used for the gaseous and aerosol chemistry, with a slightly modification to include OH dependency for the aging and in-cloud wet deposition of BC process based on Liu et al. (2011). To estimate the impact of BC from Siberian forest fire emission on the arctic BC concentration, we have conducted sensitivity experiment of biomass burning emission over Siberia from August to October in 2016.

The model generally captured the variation of BC mass concentrations by ship-based

observation data.. High contribution of Siberian forest fire emission for BC was suggested especially in late September through the sensitivity analyses.

4.224 Earth's Land Surface Temperature as a Tracer for Climate Change.

Early Career Scientist

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Abstract:

While long-term temperature time series mostly rely on weather stations, only satellite data are able to provide systematic global temperature data, from pole to pole on a regular basis, over both land and sea. Satellites do not measure the near-surface air temperature; instead they measure the land's surface or "skin" temperature (LST) derived from upwelling radiation at the Earth's land surface. The evolution of skin temperature is not yet fully exploited as its measurement is fairly recent.

One of the IASI-Flux and Temperature ERC project tasks aims at providing new climate benchmarks by using skin temperature observations from the calibrated radiances measured twice a day at any location by the IASI thermal infrared instrument on the suite of MetOp satellites (2006-2025). The uniqueness of this project is that the IASI-data record will be absolutely "clean", with no other data from observations or models used, and can therefore serve as an independent reference to e.g. reanalysis, or other climate data records.

In order to derive independent temperature time series, we use an iterative method combined with neural networks to construct a consistent skin temperature record over the period 2007-present.

In this presentation, we compare and validate our novel and simple method with far more complicated datasets (e.g. EUMETSAT and ECMWF reanalysis). We then show the increase/decrease in skin temperature, over land and sea, and in different regions in the world. The observed trends are analyzed at seasonal and regional scales in order to disentangle natural (weather/dynamical) variability and human-induced climate forcing. Finally, we show how expanding cities are hotspots for skin temperature reflecting the usefulness of skin temperature as a tracer for human-induced land use and climate change.

4.226 An important mechanism of regional ozone transport over the Yangtze River Delta in East China.

Early Career Scientist

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Abstract:

A severe summer smog extended over the Yangtze River Delta (YRD) in China from east to west during August 24-25, 2016, with hourly surface O₃ concentrations exceeding 300 µg m⁻³ in Nanjing of western YRD on August 25. By combining air quality modeling with environmental and meteorological observation analyses, this serious O₃ pollution episode over the YRD is investigated. The weather pattern during this episode was characterized by eastern prevailing near-surface wind and continuous high air temperature. The features of this episode was generally well simulated by using the air quality model WRF-Chem. According to the observational and WRF-Chem modeling, an important mechanism of regional O₃ transport for summer smog in East China is revealed as follows: On August 24, the high surface O₃ levels in daytime over the eastern cities of YRD with peak value of 250 µg m⁻³ resulted in high O₃ concentrations within the residual layer over the eastern cities of YRD at night, and then under the guidance of eastern prevailing wind, the center of high O₃ concentrations shifted in the nocturnal residual layer westwards to Nanjing, where O₃ concentrations in the residual layer accumulated up to 170 µg m⁻³ due to the cyclonic convergence in the wee hours of August 25. With the disappearance of the residual layer after sunrise, the enhancement of vertical mixing in the convective boundary layer drove the accumulated O₃ from the upper levels downwards to the ground with the maximum transport flux reaching 40 µg m⁻³ h⁻¹, which contributed considerably to the O₃ pollution episode in Nanjing. This mechanism of regional O₃ transport through the residual layer is of great implication for the research of the regional transport of air pollutants and air quality change.

4.227 The effect of El Nino Southern Oscillation on global CH₄ concentrations..

Early Career Scientist

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Abstract:

The growth rate of global methane (CH₄) concentrations has a strong interannual variability driven largely by fluctuations in CH₄ emissions from wetlands and wildfires, as well as changes to the atmospheric sink. The El Niño Southern Oscillation (ENSO) is known to have a strong influence on these drivers; however, there are still uncertainties associated with the exact mechanism and magnitude of this influence. Here we use a modelling approach to investigate how ENSO events affect global CH₄ concentrations via changes to wildfire emissions and dynamical transport.

Wildfire emissions have large interannual variability and enhanced fire events are known to occur during El Niño (positive ENSO phase), leading to larger CH₄ emissions. Wildfires also emit large amounts of carbon monoxide (CO), which may indirectly increase CH₄ concentrations by suppressing the hydroxyl radical (OH[•]) - the primary sink for both species. ENSO events also affect meteorology and atmospheric circulation which influence CH₄ variability by changing the CH₄ sink efficiency and lifetime.

Using a three-dimensional chemical transport model (TOMCAT) coupled to a sophisticated aerosol microphysics model (GLOMAP) we simulate the 1997-2014 period, capturing several El Niño and La Niña (negative ENSO phase) events. The model has been recently developed to include ECMWF clouds and extensive evaluation against observations demonstrate very good skill at capturing global CH₄ and oxidant species. Using

experiments with the fixed year 2013 ('ENSO-neutral' control year) fire emissions and/or meteorology we examine the simulated ENSO impacts on CH₄ and OH concentrations, analysing their relative importance. A series of sensitivity experiments for fire emissions is then used to investigate the importance of the chemical effect induced by CO emissions relative to the direct impact of increased CH₄ emissions from fires. Finally, we present a comprehensive analysis of the dominant mechanisms responsible for the connection between ENSO and CH₄ concentration growth rates.

4.228 Global distribution of lowermost tropospheric ozone pollution from multispectral synergism of IASI and GOME-2 satellite measurements.

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Abstract:

Tropospheric ozone is the most hazardous gaseous pollutant. Monitoring and understanding the spatiotemporal evolution of ozone pollution is therefore a crucial societal issue. Observation of tropospheric ozone at continental and global scales is only possible by spaceborne remote sensing. However, standard spaceborne observations using single-band approaches using either UV or IR measurements show limited sensitivity to ozone in the atmospheric boundary layer, which is the major concern for air quality.

A new capacity to observe the daily distribution of ozone located at the lowermost troposphere (below 3 km of altitude) is now offered by an innovative multispectral synergism of IASI and GOME-2 measurements at the IR and UV respectively (Cuesta et al., 2013; 2017). This novel method called IASI+GOME2 retrieves ozone at the lowermost troposphere with a low mean bias, a linear correlation of 0.86 and a mean precision of 16% as compared to reference ozonesonde measurements around the world during all seasons. The retrieval sensitivity peaks down to 2 to 2.5 km over land during summer. This multispectral product is available at the IASI spatial resolution (pixels spaced by 25x25 km²) and for cloud fractions below 30%. IASI+GOME2 retrievals also show a good and currently unique agreement with respect to in situ measurements of ozone at the surface, over East Asia and Europe, for both ozone outbreak events and the seasonal evolution. IASI+GOME2 data is publicly available at the French data centre AERIS/ESPRI (<http://cds-espri.ipsl.fr>).

The current presentation focuses on the analysis of global observations of lowermost tropospheric ozone from IASI+GOME2. We study the main global hotspots of ozone at the

lowermost troposphere at the tropics and mi-latitudes (e.g. over South and East Asia). We provide a new observational characterisation of the evolution and transport pathways of these ozone hotpots, in link with meteorological and dynamical conditions.

4.230 A case study of spring haze in Beijing: characteristics, formation and regional transportation.

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Abstract:

Continuous haze monitoring was conducted from 3 April to 8 April, 2017 in Beijing, China to develop a more detailed understanding of spring haze characteristics. The $PM_{2.5}$ concentration ranged from 6.3 to 164.6 $\mu\text{g m}^{-3}$ with an average of 63.8 $\mu\text{g m}^{-3}$. Nitrate was the most abundant species, accounting for 36.4% of $PM_{2.5}$, followed by organic carbon (21.5%), NH_4^+ (19.3%), SO_4^{2-} (18.8%), and elemental carbon (4.1%), indicating the key role of nitrate in this haze event. Species contribution varied based on the phase of the haze event. For example, sulfate concentration was high during the haze formation phase, nitrate was high during the haze, and secondary organic carbon (SOC) had the highest contribution during the scavenging phase. The secondary transition of sulfate was influenced by SO_2 , followed by relative humidity (RH) and O_x ($\text{O}_3 + \text{NO}_2$). Nitrate formation occurred in two stages: through NO_2 oxidation, which was vulnerable to O_x ; and by the partitioning of N (+5) which was susceptible to RH and temperature. SOC tended to form when O_x and RH were balanced. According to hourly species behavior, sulfate and nitrate were enriched during haze formation when the mixed layer height

decreased. However, SOC accumulated prior to the haze event and during formation, which demonstrated the strong contribution of secondary inorganic aerosols, and the limiting contribution of SOC to this haze case. Investigating backward trajectories showed that high speed northwestern air masses following a straight path corresponded the clear air periods, while southwesterly air masses which traversed heavily polluted regions brought abundant pollutants to Beijing and stimulated the occurrence of haze pollution. Results indicate that the control of NO_2 needs to be addressed to ameliorate spring haze. Finally, the correlation between air mass trajectories and pollution conditions in Beijing reinforce the necessity of inter-region cooperation and control.

4.232 Seasonal characterization of PM2.5 mass and its chemical composition associated with visibility reduction observed at IORS in the East China Sea.

Early Career Scientist

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Abstract:

There are often decreasing dramatically visibility represented by intense haze in the early summer over East Asia despite reduced aerosol mass. We conducted the measurements of PM_{2.5} mass and its chemical compositions during December 2004 ~ June 2008 at Ieodo Ocean Research Station (IORS, 32.07N, 125.10E) where represents background air quality in East Asia. The mean concentration of PM_{2.5} mass during experimental period was 21.8 $\mu\text{g}/\text{m}^3$ with the maximum of 35.3 $\mu\text{g}/\text{m}^3$ (March) and the minimum of 11.2 $\mu\text{g}/\text{m}^3$ (September). The seasonal variation of PM_{2.5} mass shows the similar pattern of O₃ owing to synoptic scale meteorological conditions, which seasonally causes Chinese outflows containing air pollutants including SO₄²⁻, OC, and EC. The major chemical components of PM_{2.5} shifted from SO₄²⁻ in winter to OC and SO₄²⁻ in early summer in seasonal variations. In summer, the PM_{2.5} mass starts to decrease due mainly to the enhanced impact of the aged marine air masses and the vigorous wet scavenging during the Asian monsoon. Due to the synoptic air transition, the poorest visibility with the most intensive haze occurred in June (early summer), which is also supported by maximum MODIS AOD (June). We found that OC concentration was distinctively high with high OC/EC ratio (~9.5) in June. In this period, the clearing fire of agricultural residues is common in China and is a major source of aerosol. These results show that one of the leading source of high OC in early summer is the managed agricultural fire in China as well as the continental fossil fuel combustion.

4.233 The equilibrium response of climate and composition to lightning.

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Abstract:

Climate change can affect atmospheric composition through perturbation of natural processes, leading to complex feedbacks. The primary atmospheric oxidants OH and ozone are highly sensitive to emissions of nitrogen oxides (NO_x) from lightning, and therefore so are the subsequent chemical perturbations to reactive greenhouse gases (e.g., methane) and aerosol chemistry and physics. Meanwhile, cloud electrification responds to both meteorology and composition (aerosol particles). Key to understanding the ultimate impact of lightning on air quality and climate is the long-term methane feedback. Here, we present simulations from the GISS ModelE2 chemistry-climate model in which we isolate the response of Earth's radiative budget and composition to lightning NO_x in the present day and future by allowing the model to re-equilibrate following removal of the source. Whereas lightning initially contributes to surface ozone enhancements, longer-term feedbacks via methane reduce surface ozone on multi-decadal time scales in the northern midlatitudes. These methane feedbacks lead to a strong negative radiative forcing (-0.6 W m^{-2}), reflecting the higher chemical efficiencies and efficacy of longwave absorption in the free troposphere. In addition to influencing tropospheric composition, we find significant changes in stratospheric dynamics and composition driven by changes in the tropical tropopause height. We test the sensitivity of our results to multiple parameterizations for global lightning activity, which remains a key uncertainty for future forecasts.

4.237 The production of 20+ year height-resolved ozone data from GOME-class instruments for ESA-CCI and C3S.

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Abstract:

RAL's ozone profile retrieval scheme for the GOME-class of solar uv/vis backscatter spectrometer has unique sensitivity to tropospheric ozone, which led to its selection for nadir ozone profile retrieval from this class of sensor in ESA's Climate Change Initiative (CCI) and inclusion in the Tropospheric Ozone Assessment Report (TOAR). The JASMIN computing facility at RAL has enabled the production of full-mission global data sets from GOME-1, SCIAMACHY, OMI and GOME-2A & 2B, resulting in over 20 years of height-resolved dataset for ozone from 1995-2016, spanning both stratosphere and troposphere. A reprocessing of data has been enabled under the Copernicus Climate Change (C3S) project and work is underway to reconcile these data time series. We present some of the retrieval scheme advancements and highlights of the latest version of the dataset, including comparisons with coupled chemistry climate models, chemical transport models and MACC/CAMS analyses.

4.240 Cloud resolving simulations of the UTLS chemistry during the Asian Summer Monsoon.

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Abstract:

During the Asian Summer Monsoon, the circulation of the UTLS is characterized by the large scale Asian Monsoon Anticyclone (AMA) extending from the Mediterranean sea to the Pacific Ocean. Monsoon convection is impacting the composition of the UTLS through the accumulation of pollutants within the AMA and the formation of the Asian Tropopause Aerosol Layer (ATAL). The StratoClim airborne campaign took place in July-August 2017 in order to document the composition of the AMA, the chemical processes responsible of the formation of the ATAL and the transport of water vapor to the stratosphere during the monsoon.

High resolution simulations with the Meso-NH cloud resolving model in the Asian monsoon region will be performed to represent convective clouds and associated processes (scavenging of particles, aerosol-cloud interactions and in-cloud chemistry). Analyses of the distributions of long-lived tracers (such as CO) will provide information about the transport processes (fast convective uplift versus slow diabatic heating) and the origin of the pollutants. The simulations will include detailed aerosol chemistry to discriminate between the different types of aerosols (black carbon, primary and secondary organic aerosols, sulfates and nitrates) and determine their formation pathways (convective uplift of boundary layer particles, taking into account scavenging and chemical processing, vs. nucleation of small particles from convectively uplifted gases oxidized within the cloud).

The Meso-NH simulations will be performed for case studies corresponding to observations from the StratoClim campaign. Airborne observations from StratoClim provide detailed and unprecedented information about the properties of the ATAL. In particular, mass spectrometer data that have documented the chemical speciation of the particles and size distributions from particle counters will be used to discriminate the formation pathways. The simulated CO distributions will be evaluated with satellite observations from the IASI sensor.

4.241 Sources of carbonyls and their contributions to photochemical O₃ formation in the Pearl River Delta.

Early Career Scientist

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Abstract:

Formaldehyde (HCHO) and acetaldehyde (CH₃CHO), key components of airborne carbonyl compounds, play important roles in atmospheric photochemistry and air quality because of their abundance and photochemical reactivity. Sources of HCHO and CH₃CHO in the Pearl River Delta were investigated by using the positive matrix factorization (PMF) and a photochemical box model with master chemical mechanism (PBM-MCM) based on the data collected at a rural (TMS) and urban site (TW) in Hong Kong, and an urban site (GPEMC) in Guangzhou. In Hong Kong, the PMF and PBM-MCM results showed that in-situ formation and vehicular emissions were the major contributors to both HCHO and CH₃CHO at the urban site, while the in-situ formation and the transport of photochemically formed HCHO and CH₃CHO were the most important source of HCHO and CH₃CHO at TMS, followed by vehicular emissions, biogenic emissions, biomass burning and solvent usage. On the other hand, secondary formation contributed the most significant fraction to ambient HCHO in Guangzhou urban environment, followed by vehicular exhaust (31%) and solvent usage (16%). For the secondary formation, in-situ formation of HCHO and the transport of photochemically formed HCHO contributed $45 \pm 4\%$ and $8 \pm 3\%$ to the observed HCHO, respectively. Among all the precursors, trans-2-Butene had the largest contribution to secondary HCHO formation, followed by *i*-butene, *cis*-2-butene, propene, isoprene and *m,p*-xylene. Furthermore, the sensitivity analysis from the PBM-MCM model suggested that secondary HCHO and HCHO emitted from vehicular emissions contributed comparably to ground-based measured O₃ and HO_x radical in the urban environment of Guangzhou.

4.242 Upper tropospheric water vapour and its interaction with cirrus clouds - Insights from two decades of IAGOS in-situ observations.

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Abstract:

IAGOS (In-service Aircraft for a Global Observing System; www.iagos.org) and its predecessor programme MOZAIC perform long-term routine in-situ observations of atmospheric chemical composition, water vapour, aerosols, clouds and temperature on a global scale by operating compact instruments on board of passenger aircraft. The unique character of the IAGOS data set originates from the global-scale sampling on air traffic routes with similar instrumentation such that the observations are truly comparable and well suited for atmospheric research on a statistical basis. The programme started in 1994 and emerging data records cover more than 20 years for ozone and water vapour, whereas ice cloud particle data are available since 2011. Two decades of data on water vapour mixing ratio and relative humidity over ice have been re-analysed with an advanced in-flight calibration technique to improve data precision, particularly for regions in the atmosphere where ice supersaturation occurs. The high-resolution vertical distribution of ice-supersaturation across the tropopause layer at mid-latitudes indicates a distinct layer of supersaturated air masses right below the thermal tropopause which favours formation of ice clouds (cirrus) and persistent contrails from aviation. The record of ice-supersaturation probability distribution for the highest upper tropospheric layer demonstrates a strong inter-annual variability of occurrence probability; e.g., over the North Atlantic region, this value varies between 20 and 40%.

The shorter record of collocated observations of water vapour and ice crystals is used for further analyses of properties of natural and anthropogenic ice clouds forming in the uppermost troposphere, and their link to relative humidity over ice. Of particular interest is the fraction of ice-supersaturated regions which exist outside of cirrus clouds.

Combining both data sets will allow conclusions on the long-term evolution of cirrus cloud coverage over the regions sampled by IAGOS aircraft and can be linked to satellite observations of cirrus coverage.

4.243 Understanding Differences in Satellite Records of Tropospheric Ozone Over the Past Decade .

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Abstract:

Given the importance of tropospheric ozone as a greenhouse gas and a hazardous pollutant that impacts human health and ecosystems, it is critical to quantify and understand long-term changes in its abundance. Satellite records are beginning to approach the length needed to assess variability and trends in tropospheric ozone, yet an intercomparison of time series from a joint TES/IASI dataset, the IASI standard product, and the OMI/MLS tropospheric column undertaken as part of the Tropospheric Ozone Assessment Report shows substantial differences in the net change in ozone over the past decade. We discuss the possible sources of differences in these datasets and describe a methodology for quantifying expected differences in the ability of each product to capture long-term variations in ozone. We also discuss the role of changes in the magnitude and distribution of precursor emissions and in downward transport of ozone from the stratosphere in determining tropospheric ozone abundances over the past decade.

4.244 Should we control aircraft NO_x emissions?.

Early Career Scientist

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Abstract:

Aviation emissions of nitrogen oxides (NO_x) alter the chemistry of the atmosphere, perturbing the greenhouse gases ozone and methane, resulting in positive and negative radiative forcing (RF) effects, respectively. We examine the changes in the tropospheric composition and the net RF from aviation NO_x emissions for 30% reductions in the present-day (2006) ozone precursor emissions (NO_x, CO, NMVOC) and for a future (2050) range of RCP scenarios together with ICAO CAEP aviation emission projections using the global chemistry transport model MOZART-3.

Any of the reduction in surface anthropogenic emissions results in the decrease, ranging from -8% to -20%, of the global aircraft net NO_x RF, where CO and NO_x emissions lead to the smallest and greatest decreases, respectively. Moreover, the surface NO_x emissions are 70% more efficient in affecting aviation net NO_x RF than aircraft NO_x emissions; any 1% reduction of background anthropogenic NO_x emissions decreases aircraft net NO_x RF by 0.9%. Thus, the ongoing efforts in cutting ground-level air pollution serve not only the air quality improvements but it is also beneficial for reducing the climate impact of aviation NO_x emissions.

Conversely, any reduction of aircraft NO_x emission *increases* the global aviation net NO_x climate impact. The global net NO_x RF in 2050 is ~23% smaller than RF in 2006, per any 1 Tg of emitted N, despite the fact that the ~200% increase of aircraft NO_x emissions is predicted. It is rather counterintuitive to suggest to *increase* aircraft NO_x emissions in order to reduce aviation net NO_x climate impact. As technology trade-offs exist: improving the fuel performance of engines at the cost of NO_x or concentrate on combustor modification at the cost of CO₂, this study suggests that efforts that will lead to better fuel efficiency might turn out to be a better option for the climate.

4.245 Urbanization of weather and climate simulations coupled with chemistry-transport modelling - Project URBI PRAGENSI.

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Abstract:

To assess the impact of cities and urban structures on weather, climate and air-quality, modelling approach is commonly used and the inclusion of urban parameterization in land-surface interactions is of primary importance to capture the urban effects properly. This is especially important when going to higher resolution, which is common trend in operational weather forecast, air-quality prediction as well as regional climate modeling, and which is necessary for proper assessment of impacts within the cities and of the effectiveness of adaptation and mitigation options applied in cities. It is valid not only for extreme heat waves impact prediction, but as well in air-quality prediction and in long term perspective in connection to climate change impacts. This provides the background for the new project within Operational Program Prague - The Pole of Growth "Urbanization of weather forecast, air-quality and climate scenarios for Prague", shortly URBI PRAGENSI. There are main objectives of the project: i) the urbanized weather forecast for Prague in very high resolution of 1 km, ii) the urbanized air quality prediction for Prague in that resolution, i.e. air quality prediction using chemistry-transport model coupled to the urbanized weather model, iii) climate change and its impacts for Prague in high resolution of 3 km, i.e. downscaled scenarios runs for Prague region, with coupled air quality model option, and iv) microscale studies for hot-spots, using LES to test eventual measures to solve the critical local problems

The preliminary results show that while urban heat island effect is captured reasonably well using even the simplistic bulk setting (especially in summer), to assess properly some parameters important for air pollution dispersion like mixing layer and wind velocity, more complex parameterizations provide better results. Some effects of the urban schemes on the concentrations of pollutants in cities and around will be presented as well.

4.247 Upper stratospheric O3 recovery as observed by IASI over 10 years of measurements.

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Abstract:

In this study, we assess how daily ozone (O₃) measurements from the first ten years of the Infrared Atmospheric Sounding Interferometer (IASI/MetOp-A) operation can contribute to the determination of the processes driving O₃ variability and to the monitoring of long-term trends in the stratosphere. To that end, we rely on the IASI ozone profiles retrieved from ground to 40 km with the Fast Optimal Retrievals on Layers for IASI (FORLI) software set up at ULB for near real time and large scale processing of IASI data.

We present the global fingerprints of recent changes in the stratospheric O₃ measured over January 2008 – December 2017. Using a dedicated regression model applied on gridded daily mean O₃ time series, we discriminate anthropogenic trends from various modes of natural variability which are accounted for in the regression model by a series of geophysical parameters (namely solar flux, quasi biennial oscillations, El Niño/Southern Oscillation, North Atlantic Oscillation ...). The spatial structures of the resulting covariates and trends are analyzed. The results show that the effectiveness of the Montreal Protocole is measurable by IASI in the upper stratosphere where the trend reaches +1.5 DU/yr at mid-high latitudes of both hemispheres, while a decline in O₃ levels (up to -1.5 DU/yr) is observed in the middle-low stratosphere. Nevertheless, we calculate that additional years of measurements are required to detect unequivocally such an upper stratospheric O₃ recovery or a middle-low stratospheric decline at a global scale.

4.250 Source apportionment of the marine aerosol over Atlantic Ocean by combining particle chemical composition and number concentration.

Early Career Scientist

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Abstract:

The marine aerosol plays an important role in global climate regulation and marine biogenic system. However, aerosol particles in the marine boundary layer (MBL) are seldom from exclusively marine origins. In this study, chemically distinct groups are identified by k-means clustering, in an exploratory way, on chemical composition (provided by a High Resolution Time of Flight Aerosol Mass Spectrometer, HR-ToF-AMS) and particle number concentration (PNC) of MBL aerosol particles, and linked to the air mass origins. The analysis is based on a unique dataset derived from 4 research cruises over the Atlantic Ocean in 2011 and 2012, covering spatial range from 53°S to 53°N in spring and autumn. In total 12 variables were used for clustering, including PNC of aerosol particles and 11 chemical components. With this algorithm, 4 clusters were identified based on the distinct chemical composition corresponding to 2 marine types and 2 continental types. Moreover, when compared to air mass back trajectories, each cluster can be attributed to a specific air mass type and/or influenced by location. The marine 1 cluster was characterized by dominating contribution of dimethyl sulfide (DMS) oxidation products, coincidentally with air masses from the ocean. The marine 2 cluster containing significant nitrogen products, which could be attributed to biogenic amines sources, was found mainly in autumn (especially over the Southern Atlantic) within marine air masses. The continental cluster appeared only in the Northern Hemisphere, in most case associated with air masses from the Europe. The combustion cluster occupied a wide area between 15 °S and 15 °N in autumn (November), influenced by the seasonal continental outflow (e.g. biomass burning). The resulting clusters are repeatable in the same season along the similar ship tracks, which makes the method useful for modelization on predicting physicochemical properties of MBL aerosol.

4.251 Exploring the Atmospheric Composition in the Changing Climate Scenario of Pakistan .

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Abstract:

Although, Pakistan is not contributing much to GHG emissions (ranked 135) as compared to other industrialized nations, however, it is listed among nations that are most vulnerable to the global warming and extreme weather events. The impacts of climate change/global warming can be copped by having better understating of the mechanisms, identifying the sector of most vulnerability, and controlling the emissions of GHG and short-lived climate pollutants (SLCPs)contributing directly and/or indirectly to climate change.

Pakistan is facing challenges due to observed changes in temperature, precipitation and other climatic abnormalities such as droughts and torrential rains. In this work, we assess and identify the extent of temperature and precipitation changes over Pakistan, by dividing the whole region into five climatic zones, which range from very cold to hot and dry climates. An absolute increase of 0.07 °C is observed in the mean temperature over Pakistan during the time period of 1980-2016. An interesting feature of both spatial and temporal shift in monsoon pattern is identified. This study further emphasises on the formation of the first database of tropospheric ozone, CO, HCHO, NO₂ and SO₂ distribution over Pakistan during the time period of 2004 to 2016.

Efforts are made to track the spatial and temporal changes in trace gas concentrations over Pakistan in the changing climate scenario. Seasonal cycles of all listed trace gases are identified over four provinces of Pakistan. A further focus is made on the comparison of satellite-born and ground-based measurements. Although the validation of tropospheric trace gas products from satellite observations is a challenging task for several reasons e.g. vertical sensitivity of satellite instruments, the spatial extent of the satellite ground pixel, cloud coverage etc. The efforts are made to validate satellite observations by using mini MAX-DOAS observations at fixed locations and at a moving platform.

4.252 Measurement of the Electrostatic Charging State of Ambient Aerosol using a Parallel Electrode Plate Device.

Early Career Scientist

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Abstract:

In recent years, the influence on health by fine aerosol particles such as PM_{2.5} has been concerned. Especially regarding the particle deposition in a human airway, some previous researches showed that charged particles were deposited to airway surface several times as much as uncharged particles. In other words, when we inhale an aerosol particle, it is deposited on the airway more than expected from its particle size if the particles are charged. However, little knowledge on the electrostatic charging state of atmospheric aerosols has been obtained so far. Therefore, in this study, we measured the electrostatic charging state of atmospheric aerosols from April 2017 using a parallel electrode plate device utilizing the principle of electric mobility. The results varied depending on the measurement day, and the proportion of charged particles was about 75~88%. By investigating the relationship between the electrostatic charging state and the weather condition at the time of measurement, it was found that there was a strong positive correlation between the proportion of charged particles and the absolute humidity. In order to investigate the relationship between the proportion of charged particles and the absolute humidity in detail, continuous measurement of the electrostatic charging state was conducted at the time of rainy weather in which the absolute humidity easily changed.

4.253 Black carbon in snowpack over the different regions in the Arctic.

Early Career Scientist

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Abstract:

Black carbon (BC) deposited on snow lowers snow albedo, potentially contributing to the warming in the Arctic. It is critically important to measure the spatial distributions of BC in snowpack in different regions of the Arctic to quantify this effect. However, accurate measurements of BC in snowpack are very limited because of the large uncertainties in the previous measurements. We measured size-resolved BC mass concentrations (C_{MBC}) in snowpack sampled over Alaska, Finland, Siberia in Russia, Greenland, and Ny-Ålesund in Spitsbergen in early spring between 2012 and 2016 by using a single-particle soot photometer. In total, 102 samples of surface snow, 77 samples of subsurface snow, and 116 columns of snowpack were collected in these regions. The amounts of BC deposition (DEP_{MBC}) over the major snow accumulation periods were derived from C_{MBC} and snow water equivalent (SWE). The average C_{MBC} in each region was well correlated with the average anthropogenic BC emission flux ($r^2 = 0.64$), suggesting significant influences of anthropogenic BC emissions on C_{MBC} on regional scales. The average size distributions of BC in snowpack shifted to smaller sizes with the decrease in C_{MBC} , suggesting an increase in the wet removal efficiency of BC with the increase in BC diameter during transport from major sources. The previous C_{MBC} values obtained by using an Integrating Sphere/Integrating Sandwich spectrophotometer were generally much larger than our values in the overlapping regions. The present data of C_{MBC} , SWE, and DEP_{MBC} will be useful in constraining climate model, used to estimate the effect of BC on the climate of the Arctic.

4.254 Dust storms in the Middle East: An observational and modeling study of two events using in-situ and remotely sensed measurements and WRF-Chem-RTFDDA.

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Abstract:

The combination of WRF-Chem and RTFDDA (Real-Time Four Dimensional Data Assimilation), WRF-Chem-RTFDDA, provides an ideal modeling system for simulating and forecasting dust storms in the Middle East due to (a) WRF-Chem's capability of simulating the emission, transport, mixing, and chemical transformation of trace gases and aerosols simultaneously with the meteorology, and (b) RTFDDA's capability of continuously assimilating both conventional and nonconventional observations and thus providing improved initial conditions for dust analyses and forecasts. In this talk, we will present a study of two dust storms in the Middle East using WRF-Chem-RTFDDA and in-situ (AERONET and surface stations) and remote sensing observations (MODIS and SMAP imaging, and profiles retrieved from the CALIPSO mission). WRF-Chem-RTFDDA was run including mineral dust only without the inclusion of anthropogenic aerosols and chemical reactions.

The synoptic conditions for the two dust storm cases are characterized by a cold front at the low level and an upper-level low-pressure system over the Western Mediterranean. Strong westerly and southwesterly winds associated with the cold fronts and the low-pressure systems are behind the development and evolution of the dust storms. WRF-Chem-RTFDDA simulated synoptic weather conditions out to 48-h forecasts are largely consistent with the GFS analyses though some discrepancies in the system locations and intensities are noted. Simulated surface variables, wind speed, wind direction, temperature and relative humidity generally show small biases at all station locations. WRF-Chem-RTFDDA demonstrates its capacity in resolving the generation and evolution of the dust storms; however, model deficiencies are noted especially over the Saudi Arabia where the model fails to simulate the observed dust in the first period of one of the cases. We investigate various factors that may be responsible for the deficiencies, with too moist soil conditions in GFS, and subsequently WRF-Chem-RTFDDA, appearing to be the main one.

4.256 Large impacts, past and future, of ozone depleting substances on Brewer-Dobson circulation trends: A multi-model assessment.

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Abstract:

While multidecadal increases in carbon dioxide concentrations have long been known to cause an acceleration of the Brewer-Dobson circulation (BDC) by the end of the 21st century, the impact of ozone depleting substances (ODS) on the BDC has received little attention. A few recent studies have suggested that ODS might be important drivers of BDC trends, but these studies were conducted with individual models. Here we take a multi-model approach, and analyze BDC trends for the past (1960-2000) and for the future (2000-2080) in the models participating in both the CCMVal2 and CCMI intercomparison projects. Examination of both age-of-air and vertical velocity, using 20 different stratosphere-resolving models, reveals that ODS are very important drivers of BDC trends. First: we find that in the last few decades of the 20th century ODS have contributed roughly half of the modeled trends. Second: owing to present and future ODS reductions as a consequence of the Montreal Protocol, BDC trends in the next several decades are projected to be much smaller (roughly by a factor two) than trends in the late 20th century. Our multi-model study, therefore, robustly establishes the major impact of ODS on BDC trends, and highlights how the Montreal Protocol will be altering the stratospheric circulation until the end of the 21st century.

5.001 What we have observed with GOSAT and which kind of instruments we will need for future satellite observations.

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Abstract:

GOSAT has measured solar reflected light that passes through troposphere and reaches earth surface with a high resolution spectrometer since 2009. It has provided decade long and global carbon data of dioxide and methane. In order to estimate global flux and local emission from various source sectors more accurately, imaging capability and sampling optimization are needed.

5.002 Automatic processing of essential climate variables (ECVs) recorded at different atmospheric observatories in the framework of the NextDATA project.

Early Career Scientist

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Abstract:

The aim of the Project of Interest NextDATA (2012–2018, <http://www.nextdatapoint.it/?q=en>) is to favor the integration of an observational network in Italy, based on measurement stations located in mountain, background and rural regions, for the monitoring of essential climate variables (ECVs). In this framework, we developed and implemented a system for centralized automatic data processing, able to support station personnel towards a more efficient adoption of QA/QC procedures. The system, which could be adopted also outside of the NextDATA project, is composed of several levels. First, raw data (typically collected at 1-min time resolution) from all instruments from different measurements stations (often recorded with acquisition systems that are not standardized between each other) are transferred to the NextDATA server, where they are automatically processed for the harmonization of format and flagging, according to WMO/GAW data-centers guidelines (i.e., creation of level-0 data). Then, all necessary checks for data validity and corrections (e.g., automatic calibration) are applied to the ECVs datasets. Within this phase, also a preliminary automatic data validation process is performed, leading to the creation of level-1 data. Basing on these data screening procedures and corrections, data at native time resolution are then aggregated to hourly averages, to obtain level-2 data. To support the station personnel in the daily QA/QC checks as well as data reporting and interpretation, also a suite of graphic products, based on R codes, is automatically generated. For each ECV, on a daily basis, together with plots reporting the time series of instrumental diagnostic parameters, a suite of elaborations showing time series or time averages over different reference periods (i.e., month, season, year) are produced.

5.003 Assessing risk to human health for heavy metal contamination through street dust in the Southeast Asian Megacity: Dhaka, Bangladesh.

Early Career Scientist

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Abstract:

Abstract: Heavy metal contaminations in street dust due to high traffic sites and industrial areas in the Southeast Asian Megacity (Dhaka City, capital of Bangladesh) were investigated in 88 street dust samples from 22 sampling sites. This study revealed the maximum Pb, Cd, Zn, Cr, Ni, As, Mn and Cu contents in the street dust samples. The spatial distribution of heavy metal concentrations in street dust samples of Dhaka City was determined using geographical information systems. The risk assessment strategies were used for this study for identifying the routes of exposure through oral ingestion, inhalation, and dermal contact by the fine particles ($\sim 75 \mu\text{m}$) of street dust, especially for children based on the US EPA health risk models. Both non-carcinogenic and carcinogenic risks of heavy metals were characterized in street dust samples. Results based on the hazard index (HI), in the case of non-cancer effect, the ingestion of dust particles of children and adults in Dhaka City appeared to be the route of exposure to street dust that results in a higher risk for heavy metals, followed by dermal contact. This study revealed that the inhalation of re-suspended particles through the mouth and nose were almost negligible. It was also noticed that children were experiencing the potential health risk due to HI for Cr (1.04), which was slightly higher than the safe level 1 and Cd (0.69) was close to the safe level 1. Reversely, cancer risk for Cr (i.e. 4.27×10^{-6}) was fallen within the range of threshold values (10^{-4} - 10^{-6}) and As (i.e. 9.59×10^{-7}) was close to the upper limit of threshold values (10^{-4} - 10^{-6}).

Keywords: Street dust, pollution, toxic elements, health risk assessment

5.008 Seasonal variation and nighttime formation of particulate organic nitrates in South China urban atmosphere.

Early Career Scientist

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Abstract:

Organic nitrates, which are mainly formed via NO_3 radical addition to alkene (especially biogenic VOCs) or in a minor branching pathway through peroxy radicals reacting with NO , are important atmospheric species as they affect the cycling of NO_x and the ozone production. With relatively high biogenic VOCs and anthropogenic NO_x levels, South China is an ideal region to investigate organic nitrates. In this study, an Aerodyne High-Resolution Time-of-Flight Aerosol Mass Spectrometry (HR-ToF-AMS) was deployed at an urban site in South China from 2015 to 2016 to characterize the submicron aerosols. Based on the measurements, we estimate that 41-64% of the total measured nitrates are from organic nitrate in summer and 16%-25% in autumn, while in winter and spring, most measured nitrates are inorganic. Furthermore, the contribution of organic nitrates to total organic aerosols (OAs) is estimated to be 12%-29% in summer and 8%-14% in autumn. The diurnal pattern of organic nitrate in summer and autumn both show pronounced increase during nighttime (18:00-7:00), which is quite different from that of the total measured nitrates. This observation implies that the organic nitrates are formed from NO_3 -initiated reaction with BVOCs. In addition, the good correlation ($R=0.91$ in summer and 0.78 in autumn) between organic nitrates and less-oxidized oxygenated OA (LO-OOA) factor using PMF method during nighttime indicates LO-OOA is closely related to nighttime NO_3 radical chemistry. Therefore, we estimate the NO_3 radical concentration and secondary organic aerosol (SOA) formation from some of the key BVOCs during the nighttime. The results show that the estimated SOA concentration correlates well with LO-OOA and organic nitrates. Consequently, the monoterpene reacts with NO_3 radical, which is the potential formation pathway of the organic nitrates in the South China urban region.

5.015 First steps developing a tool to monitor city-wide air quality using Earth observations.

Early Career Scientist

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Abstract:

Air pollution has adverse effects on human health, but is challenging to routinely and effectively monitor in cities. Satellite observations of atmospheric composition provide complete coverage of cities, but are cumbersome and challenging to use. We present first steps to develop a tool that end users can use to monitor city-scale air quality with Earth observations. We use surface observations of NO₂ for 2011-2016 from six monitoring sites in Birmingham (UK), a post-industrial city undergoing urban renewal, to validate that tropospheric column NO₂ observations from the Ozone Monitoring Instrument (OMI) accurately represent temporal changes in NO₂. Surface concentrations of monthly mean NO₂ averaged around the satellite overpass (12h00-15h00 local time) decrease by 1.5-4.2% a⁻¹ across the monitoring sites. Sites are spatially correlated ($R > 0.55$) and so are combined to obtain a representative city average decline in NO₂ of 3.1% a⁻¹ (95% confidence interval (CI): -6.2 to +1.1% a⁻¹). Monthly mean NO₂ from OMI is temporally correlated with city average surface NO₂ ($R = 0.69$) and gives steeper decline in NO₂ of 4.1% a⁻¹ (95% CI: -8.0 to +0.6% a⁻¹) for 2011-2016. All trends are not significant due to large temporal variability and a short period of overlap. Decline in OMI NO₂ becomes very significant (p -value < 0.001) over the long OMI record (2005-2017) and is 3.4% a⁻¹ (95% CI: -4.3 to -2.5% a⁻¹), similar to the reported UK-wide decrease in NO_x emissions of 3.9% a⁻¹. In Birmingham, tropospheric column NO₂ equivalent to the EU standard and WHO guideline of 40 μg m⁻³ is 6.1 × 10¹⁵ molecules cm⁻² and could be used to assess whether city-wide NO₂ concentrations exceed levels safe for human health.

5.016 Advanced services for the IAGOS users.

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Abstract:

IAGOS (In-service Aircraft for a Global Observing System) is a European Research Infrastructure that aims to provide long-term, regular and spatially resolved in situ observations of the atmospheric composition. IAGOS observation systems are deployed on a fleet of commercial aircraft and perform uninterrupted measurements, from take-off to landing, of aerosols, cloud particles, greenhouse gases, ozone, water vapor and nitrogen oxides, from the surface to the lower stratosphere. The IAGOS database is an essential part of the global atmospheric monitoring network.

The IAGOS Data Portal (via www.iagos.org) is part of the French atmospheric chemistry data centre AERIS (www.aeris-data.fr). In addition to the observations, the portal already provides (i) added-value products such as back trajectories and origin of air masses and (ii) web services such as the download in standardized formats (NetCDF or NASA Ames) and plotting tools (maps, time series and vertical profiles). A particular attention has been paid to standardized metadata which improve the data discovery but also provide information to the users such as the data provenance and QA/QC. DOI have been implemented in order to improve IAGOS data citation.

Thanks to future collaborations in the frame of H2020 projects, advanced interoperability will be setup with other airborne programs such as EUFAR and with other Research Infrastructures from the Atmospheric domain and more generally from the Environmental domain in the frame of the ENVRI community. In this context, an emphasis will be made on the link with satellite-based data in order to provide services for the satellite community.

Through these new services it will be possible (i) to combine products from different sources with satellite data and models, (ii) to have access to sophisticated statistical analysis tools (e.g. frequency distributions, interpolation, averaged/gridded data, complex extractions and aggregations) and (iii) to use advanced web-processing services (e.g. visualisation capabilities, modelling services).

5.017 Development of National Land Use Regression Model and Estimation of PM_{2.5}-related Premature Deaths in China.

Early Career Scientist

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Abstract:

Accurate estimation of PM_{2.5} related mortality is important but previous studies showed diverse results mainly caused by different selections of methods for PM_{2.5} exposure assessment. National Land Use Regression (LUR) model can predict long-term air pollution exposure at finer spatial scale over large geographic area but it has not yet been reported in China. In this study, we utilized PM_{2.5} data from Chinese national monitoring network and several classes of predictor factors to develop a national LUR model and generate Chinese PM_{2.5} exposure mapping in 2013-2015 at the resolution of 1km×1km. Our model has relatively better performance with cross-validation R² 0.70 than other national LUR for PM_{2.5} due to extensive monitoring network and wide selection of predictor variables. Population-weight concentration in China declined from 72.52 µg/m³ in 2013 to 57.18 µg/m³ in 2015.

C-R function is also another important progress in healthy effect assessment. Most previous studies used IER function which could yeild sensible results in the risk analysis over the range of concentrations that prevail in China. In this study, we adopted a new SCHIF function developed from a national cohort of 189,793 Chinese men to estimate the PM_{2.5}-related premature deaths in China. Results shows that almost 2.19 million (2013), 1.94 million (2013), 1.65 million (2014) premature deaths were attributable to PM_{2.5} long-term exposure and the propotion for specific disease is 53.2% for stroke, 20.5% for ischemic heart disease, 16.8% for chronic obstructive pulmonary disease and 9.5% for lung cancer. We also adopted IER function and the comparison indicates IER obviously underestimates the PM_{2.5} related premature deaths, especially in high concentration interval. Our study take advantage of national LUR-based PM_{2.5} exposure at fine

resolution and Chinese cohort-based C-R function to renew the health burden attributable to PM_{2.5} in China.

5.018 Trends in air quality over the eastern US and China: Policy relevant science.

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Abstract:

Over the past few decades, the eastern US has seen remarkable improvements in air quality, driven by policies guided by numerical simulations constrained by observations. Can these success stories be useful to Asian air pollution problems? This talk will briefly review progress of controlling ozone through NO_x emissions reductions and controlling particulate matter through SO₂ emissions reductions, with evidence from in situ and remotely sensed data. The current state of the science involves renewed focus on emissions inventories – evaluated through field experiments such as aircraft mass-balance analyses and ratios of short lived pollutants such as NO_x to greenhouse gases. Emissions from both power plants and vehicles were discovered to be sensitive to ambient temperature, but with opposite sign. State emphasis has shifted to include smaller NO_x sources, anthropogenic VOCs in urban areas, as well as the interplay of photochemistry with air/water interactions (the sea breeze) that can create hot spots of ozone. Comparison to the atmospheric chemistry of China, reveals that the emissions of SO₂ have improved substantially, but PM loading remains high due to SOA, BC, and mineral dust. Transport both to and from China was observed. The precursor mix in Hebei is dramatically different from that of the US with CO and anthropogenic alkenes playing a greater role and biogenic isoprene less important. NO_x, CO, and VOC controls will be necessary to control ozone formation.

5.019 Improving constraints on the oxidative capacity of the atmosphere.

Early Career Scientist

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Abstract:

The hydroxyl radical (OH), dubbed the cleansing agent of the atmosphere, is a gas at the centre of atmospheric chemistry. It is involved in the oxidation and removal of a wide variety of pollutants, which contribute to global warming (CH₄), stratospheric ozone depletion (H-CFCs) and air quality issues (NO_x, CO). However, due to its short lifetime of seconds, combined with a low atmospheric abundance (< 1 pptv), it is difficult to obtain reliable constraints on metrics such as abundance, global trends and interannual variability. Currently, the most stringent constraints are derived indirectly from the effect OH has on methyl chloroform (MCF): a gas rapidly disappearing from the atmosphere due to restrictions placed on production through the Montreal Protocol.

However, interpretation of the MCF record is tricky, and recent studies using two-box models have found even these most stringent constraints lacking, when derived OH is propagated to the CH₄ budget. Currently, limited constraints on OH are one of the key uncertainties in many pollutant budgets: without better constraints on pollutant sinks, it is difficult to get to improved emission estimates.

Here, we present a parametrization of a two-box model, using output of full 3D simulations of MCF, CH₄ and SF₆. The parametrization reveals how the loss of information from a 3D to a two-box model can affect the outcome of a two-box inversion. Due to varying 3D distributions of sources and sinks, complicated species-dependent corrections to the parameters of the two-box models are required. Thus, though two-box models seem deceptively simple, correct usage actually requires a complex 3D model analysis for each species involved. Incorrect usage can bias the results and can contribute to the already significant uncertainties on derived OH.

5.020 Towards an ECMWF's CAMS near real-time global surface flux inversions..

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Abstract:

The European Union's Copernicus Atmosphere Monitoring Service (CAMS) operationally provides daily forecasts of global atmospheric composition and regional air quality. It uses the ECMWF Integrated Forecasting System (IFS), that includes meteorological and atmospheric composition variables, such as reactive gases, greenhouse gases and aerosols. There is a strong need to monitor surface fluxes in addition to the 3D representation of atmospheric composition. In this presentation, we will show plans and advances on implementation of the surface flux inversion suite to provide real-time surface flux updates jointly with the current atmospheric updates (i.e. tracers and NWP variables), given constraints on the IFS and the observation stream available.

Firstly, we will emphasize the efforts to update the CAMS system to an Ensemble of Data Assimilation (EDA), i.e. running an ensemble of 4D variational analysis updates and subsequent forecasts. We will show how the ensemble information in a variational framework can be used to infer surface fluxes and potentially provide sectoral inversion. Additionally, we will compare the benefits and deficiencies of the ensemble formulation with the adjoint formulation for this particular application within the IFS.

5.021 Evaluation of Selected Ion Flow Tube Mass Spectrometry for VOC concentration and emission determination in Beijing - Automation and Calibration considerations..

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Abstract:

Volatile organic compounds (VOCs) are emitted from a variety of anthropogenic and natural sources to the earth's atmosphere with their concentrations in air being affected by numerous chemical and physical processes. An ability to selectively quantify VOC concentrations and emissions in both urban and rural environments is of importance to understand and characterise the sources and sinks for individual VOCs.

To provide a real-time analytical method for the detection of a wide range of VOCs, Spang and Smith pioneered the analytical application of a portable selected ion flow tube mass spectrometry (SIFT-MS) in 1996. SIFT-MS utilizes known ion-molecule reactions of mass-selected reagent ions with an analyte. The mass-selected reagent ions (H_3O^+ , NO^+ , and O_2^+) are introduced into a flow tube at low energy into a carrier gas where they undergo chemical reactions with analytes in the gas sample that is drawn directly into the SIFT-MS flow tube. The availability of NO^+ , and O_2^+ enables the measurement of compounds that do not react with H_3O^+ (e.g., light hydrocarbons, halogenated and inorganic species) and also facilitates the identification of compounds that cannot be differentiated on the basis of H_3O^+ reactions alone. The switching time of the reagent ion mass filter is sufficiently fast that essentially simultaneous measurements with all three of these reagent ions can be carried out. The ensuing reagent ion-analyte ion-molecule reaction enables identification of the analyte in seconds and provides quantitation from the ratio of counts of the analyte product ion(s) relative to the reagent ion.

In this research we describe the development, optimisation and evaluation of an experimental autonomous air quality monitoring system based upon the Voice 200 Ultra Selected Ion Flow Tube mass Spectrometer (SIFT-MS), and subsequent VOC compound mixing ratio and eddy co variance flux determination during its deployment in Beijing.

5.024 Size-resolved source apportionment of particulate matter in the South China Sea/West Philippine Sea during the 2011 Vasco Cruise.

Early Career Scientist

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Abstract:

The South China Sea/West Philippine Sea (SCS/WPS) is a receptor of various natural and anthropogenic aerosol species. In combination with its archipelagic/peninsular terrain and strong Asian monsoon climate, the SCS/WPS hosts one of the most complex aerosol-meteorological systems in the world. However, aside from the well-known biomass burning emissions from Indonesia and Borneo, the current understanding of aerosol sources is limited. In September 2011, a 2-week research cruise was conducted near Palawan, Philippines. Size-segregated aerosol data was collected using a Davis Rotating-drum Uniform size-cut Monitor sampler and analyzed for concentrations of 28 selected elements. Positive Matrix Factorization (PMF) was performed separately on the coarse, fine and ultrafine size ranges to determine possible sources and their contributions to the total particulate matter mass. Additionally, size distribution plots, time series plots, back trajectories and satellite data were used in interpreting factors. Using tracers of various sources, a linear regression analysis of key species showed the presence of biomass burning, oil combustion, sea spray and soil dust. For comparison, the PMF analysis resolved five sources across the three size ranges: biomass burning, oil combustion, soil dust, a crustal source/sea spray and a background factor largely composed of heavy metals. The agreement between the PMF analysis and the linear regression shows the robustness of the factors. In both analyses, anthropogenic and biomass burning sources were identified solely in the ultrafine and fine size ranges while biogenic sources such as

soil dust were found in the coarse and fine ranges. While biomass burning is indeed a key source of aerosol, the study shows the presence of other important sources in the SCS/WPS. Understanding these sources is key to characterizing the chemical profile of the SCS/WPS and, by extension, developing our understanding of aerosol-cloud behavior in the region.

5.026 Evaluation of surface emissions using the ECCAD database.

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Abstract:

The evaluation of surface emissions and the quantification of their uncertainties is a difficult task, since most of the emission datasets currently available are generally not provided with information on the data used to generate the emissions, and no uncertainties on these quantities are available.

As part of the Global Emissions Initiative (GEIA/IGAC) project, the ECCAD (Emissions of atmospheric Compounds and Compilation of Ancillary Data) database has been developed. It provides an easy access to a large number of datasets of anthropogenic, biomass burning and natural global and regional emissions. The datasets available in ECCAD cover the 1750-2100 period, and different spatial and temporal resolutions are provided. Tools for displaying the emissions and for their analysis are available, together with download capabilities. The most recent developments of ECCAD will be discussed. Using the data available in ECCAD as well as other published data, a comparison of global and regional emissions for the 1990-2015 period has been performed, for different types of emissions and sectors. The results of this analysis, which also include the use of emissions optimized through inverse modeling, will be discussed.

5.027 Ensemble dispersion simulation of tropospheric aerosol plumes using a perturbed meteorological reanalysis.

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Abstract:

We conducted a single-model ensemble simulation for the dispersion and deposition of point-source aerosol particles emitted from the Fukushima Daiichi nuclear power plant (FDNPP) in March 2011 using a perturbed meteorological reanalysis field. The 60-member meteorological ensemble reanalysis was prepared using an ensemble-based data assimilation system that consisted of the Japan Meteorological Agency's non-hydrostatic weather-forecast model (JMA-NHM) with a 3 km horizontal resolution, a local ensemble transform Kalman filter (LETKF), and the JMA operational observation datasets. The ground-surface wind velocity and aerosol concentration were validated with in-situ measurements of the JMA AMeDAS network (at approximately 70 observatories) and the radioactive Cs-137 concentration retrievals (at approximately 100 observation stations) in eastern Japan. The Brier skill score (BSS) of the radioactive aerosol plume arrivals at each Cs-137 observation station was significantly improved from the deterministic simulation (by a single run) to the probabilistic simulation (by ensemble runs). In this radioactive aerosol concentration experiment, the ensemble spread was almost comparable with the root mean square error (RMSE), which means that the ensemble simulation properly yielded the information on the model simulation error. An ensemble simulation can provide more accurate estimation than a single simulation and additionally multiple possible scenarios for atmospheric species dispersion. The probabilistic information derived from an ensemble simulation exhibits great potential for the analysis and prediction of atmospheric species.

5.028 Shipping emissions in international trade between China and America.

Early Career Scientist

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Abstract:

China and America are major trading nations with top 3 total volume of trade in the world. In 2016, Canada, Mexico and China are the three biggest trade partner of America and only China has no land connection with America, Which means most of cargo will be transported by vessels, resulting severe shipping emissions.

To estimate the shipping emissions in trade between China and America, a ship routes identification model was established based on Automatic Identification System (AIS) data in 2016.

We identified 1318 vessels with 2451 vessel calls in the export from China to America, and 1214 vessels with 2078 vessel calls in the import from America to China in 2016. The total deadweight ton (DWT) from China to America were 185 and 154 million tons from America to China. The total tonnage of cargo trading between China and America were used to verify the identification results, which was about 67% of the DWT of identified vessels.

The emissions of the identified vessels were calculated. The vessel emissions of PM, NO_x, SO_x and CO₂ were 23.9, 268.6, 188.3, 13791.8 kt in the export from China to America and 17.0, 183.9, 133.8, 9298.1 kt in the import from America to China in 2016. In both import and export from China to America, about 80% of the vessel emissions were from container ships and about 15% were from bulk carriers.

A link of trade cargos and vessel fleets was established and the trade cargos were distributed into 22 sections based on Harmonized Commodity Description and Coding System code (HS-code). In the export to America, Electrical machinery and equipment and parts contributed the most emissions which was 25%, in the import from America, Vegetable products contributed the most emissions which was 47.49%.

5.030 The importance of different global change processes for future air quality.

Early Career Scientist

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Abstract:

Poor air quality is a global threat to human and ecosystem health and crop yield. Over 3.5m deaths each year result from air pollution and between 2005 and 2010 the global death rate from this threat increased by 5%. Moreover, air quality (AQ) pollutants are also climate forcing agents and therefore contribute to climate change.

Understanding the future trajectory of AQ depends not only on projecting AQ pollutant emissions, but also on how climatic and meteorological factors will change. Factors such as the future occurrence of heatwaves and stagnation events, the passage of fronts, and the input of ozone from the stratosphere will likely change, linked with changes in the global atmospheric circulation patterns. These are expected to affect the occurrence, strength and length of polluted events.

We will present the results from a set of global chemistry climate model simulations. We explored and quantified the change in the risk of AQ extreme events, isolating different drivers of AQ change: climate change based on different scenarios, anthropogenic emission changes, and stratospheric ozone recovery. This is to better understand the links and impacts on AQ from climate change, and to understand which processes are the most important for given locations/given times of the year.

This project is in collaboration with the JBA Trust and its main sponsor, who have expertise in communicating with decision makers about future climate risk, particularly relating to flooding and also health issues. The goal of this research is to use JBA's expertise to deliver information on future AQ in a formal risk framework, such that it can be more readily used by decision makers in their policy planning (e.g., mayors of large cities).

5.031 Modelling air pollution in the Pearl River Delta Region of China.

Early Career Scientist

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Abstract:

The Pearl River Delta (PRD) in southern China, often referred to as “the factory of the world”, has high emissions of volatile organic compounds and is one of the fastest growing economic areas within China.

Like the North China Plain and the Yangtze River Delta, rapid economic growth has led to poor air

quality dominated by high ozone and PM_{2.5} levels. However, the difference in emissions, location and

terrain causes atmospheric composition to differ substantially between these three regions.

We use the state-of-art UKCA (UK chemistry and aerosol) model to simulate the atmospheric chemical

environment in these regions of China, focussing on six megacities. Our results show clear seasonal

and diurnal cycles of pollutants, with low O₃ and very high NO₂ concentrations in winter but relatively

high O₃ in summer. They also show the very low O₃ (< 1ppb) and extremely high NO₂ (> 300ppb)

concentrations in winter in Beijing. Diurnal cycles for six megacities across China show a strong NorthSouth gradient with the highest levels of O₃ in Hong Kong. The second highest levels of isoprene are

found in the vicinity of Hong Kong in winter months but isoprene levels here are the lowest in summer.

In addition, diurnal cycles of PM₁, PM₁₀ and NO₂ show a single peak at about 7 am in these locations

and the highest PM₁ is found in Shijiazhuang in winter (>180 ug/m³). Since huge differences exist in

the simulated atmospheric environment in these economic regions, we explore how different emission

controls are needed to effectively mitigate the air pollution impacts.

5.032 Comparing the stratosphere in Specified Dynamics (nudged) and free-running simulations from the Chemistry Climate Model Initiative model intercomparison.

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Abstract:

The Specified Dynamics (SD) experiment specified for the first phase of the Chemistry Climate Model Initiative (REF-C1SD) is the first time a large group of chemistry-climate models have run a coordinated experiment where the evolution of the atmospheric dynamics is constrained by reanalysis. Constraining the dynamics is typically done by the addition of an additional tendency to the dynamical fields (nudging) and it is an open question how the model responds to this additional forcing. The existence of freely-running simulations covering the same time period and with identically specified forcings, the REF-C1 experiment, allows for a fairly direct comparison of the SD and freely-running simulations. Here we focus on the stratosphere and compare the climatology and long-term trends of dynamical and chemical fields in those CCMI models that have provided output for both the REF-C1SD and REF-C1 experiments. Comparisons of diagnostics of the Brewer-Dobson circulation, including upwelling mass flux and age of air, show that the stratospheric residual circulation in the models do not all respond in a similar fashion to the addition of an extra tendency to constrain the dynamics. While the different SD simulations show a strong correlation for the interannual variability in tropical upwelling, a large spread in the magnitude of the upwelling is not reduced as compared to the set of free-running simulations. The SD simulations do, however, show a greatly reduced spread in mixing between the tropics and extra-tropics in the lowermost stratosphere, as evidenced by the age of air, and a greatly reduced model-to-model spread in the climatological mean total column ozone. The effects of temperature and mixing on the model representation of ozone are considered as possible factors to explain differences in ozone across the free-running simulations.

5.034 Spatio-temporal variations of ^{17}O excess of sulfate over Antarctica: reconciling observations and modeling.

Early Career Scientist

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Abstract:

^{17}O excess of sulfate ($\Delta^{17}\text{O}(\text{SO}_4^{2-})$) in aerosol samples reflects relative contribution of different oxidation pathways towards sulfate formation, which can be a diagnostic tool to constrain atmospheric chemistry models. In addition, it has been proposed that the application of $\Delta^{17}\text{O}(\text{SO}_4^{2-})$ to Antarctic ice cores potentially provides past information on oxidant chemistry. Extension of its applicability requires precise understanding of the spatio-temporal variability and the controlling factors of the signature over the present Antarctic atmosphere. In this study, we perform seasonal observations of $\Delta^{17}\text{O}(\text{SO}_4^{2-})$ for aerosol samples collected at both coastal (Dumont d'Urville, 66°40'S, 140°01'E) and inland Antarctica (Concordia, 75°06'S, 123°33'E). At Dumont d'Urville, $\Delta^{17}\text{O}(\text{SO}_4^{2-})$ exhibits a clear seasonal pattern characterized by summer minimum (December) and winter maximum (June), with the range of 1.0 to 3.4‰. This trend is generally caused by sunlight-driven changes in the relative contribution of S(IV) oxidation by O_3 versus other oxidants (e.g., OH radicals and H_2O_2). On the other hand, at Concordia, $\Delta^{17}\text{O}(\text{SO}_4^{2-})$ reaches minimum in late summer (February) and maximum in spring (October). This regional difference implies the existence of S(IV) oxidation processes that results in high $\Delta^{17}\text{O}$

$\delta^{34}\text{S}(\text{SO}_4^{2-})$ values during spring to early summer in the inland site relative to the coastal site. To discuss the possible processes, we evaluate the relative importance of different S(IV) oxidation pathways (i.e. gas phase oxidation by OH radicals, in cloud oxidation by H_2O_2 , O_3 , hypohalous acids (HOX = HOCl, HOBr), and metal-catalyzed O_2) using the GEOS-Chem 3-D global chemical transport model and simulate the $\Delta^{17}\text{O}(\text{SO}_4^{2-})$ over Antarctica.

5.037 An advanced cross platform whole air sampling system to extend airborne Volatile Organic Compound (VOC) measurement capability.

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Abstract:

In comparison to the extensive airborne measurement programme in Japan and the United States (e.g. at NIES, NCAR, NOAA and NASA), VOC observations made from aircraft in whole air samples (WAS) across Europe are relatively limited. Regular routine sampling into glass canisters is on going as part of the IAGOS-CARABIC project, analogous to the Japanese CONTRAIL project, but other air sampling systems are generally limited to single campaigns or specific to individual measurement platforms. For example, the large UK aircraft (FAAM BAe146) has dedicated WAS, used by multiple institutions but bespoke for that aircraft and unavailable for use in other platforms within the European fleet.

A new, universal WAS system has been developed to meet the requirements of multiple platforms, accessible to any downstream analytical system and that is lightweight, robust and portable. This greatly enhances the scope of future measurements as the system can be operated on almost any measurement platform, easily transported globally and the analysis of samples carried out at any appropriate facility without geographic limitation. The system is a modular design of 6U, 19" rack mountable units with stand-alone electronic control and basic operating requirements. Each 20 kg unit houses 16 bellows valve (Swagelok) actuated Entech Silonite coated 1.4 L canisters (as per NASA Global Hawk) optimised to preserve VOC integrity.

To test the system cross-platform, it has been deployed on the BAS DHC-6 Twin Otter during oil and gas emission monitoring flights (small aircraft experiments), the University of York mobile laboratory for the quantification of exploratory 'fracking' activities (on-road mobile experiments) and it will replace the current WAS system aboard the FAAM BAe146 (large airborne) for future aircraft atmospheric chemistry experiments, providing 96 canisters per flight with fully automated event driven sampling, synchronised via data

links with other networked aircraft systems/instruments.

5.039 120,000 year record of sea ice in the North Atlantic inferred from ice core bromine and sodium.

Early Career Scientist

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Abstract:

Although it has been demonstrated that the speed and magnitude of recent Arctic sea ice decline is unprecedented for the past 1,450 years, few records are available to provide a paleoclimate context for Arctic sea ice extent. Here we present a 120 kyr record of bromine enrichment from the RECAP ice core, coastal East Greenland, and reconstruct past sea ice conditions in the North Atlantic ocean as far north as the entrance of the Arctic Ocean (50-85 °N). Bromine enrichment has been previously employed to reconstruct first-year sea ice (FYSI) in the Canadian Arctic ocean over the last glacial cycle. We find that during the last deglaciation, the transition from multi-year sea ice (MYSI) to FYSI started at ~17.6 kyr, synchronous with sea ice reductions observed in the eastern Nordic seas and with the increase of North Atlantic ocean temperature. FYSI reached its maximum extent at 12.4-11.8 kyr, after which open-water conditions started to dominate, as supported by sea ice records from the eastern Nordic seas and the North Icelandic shelf. Our results show that over the last 120,000 years, sea ice extent was greatest during Marine Isotope Stage (MIS) 2 and MIS4, with decreased levels during MIS3 and the onset of the last glacial period (late-MIS5). Sea ice extent during the last 10 kyr

(Holocene/MIS1) has been less than at any time in the last 120 kyr.

5.040 Deploying a low-cost, community-based air quality monitoring network in Hawai'i .

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Abstract:

Poor air quality is the single largest environmental risk factor for premature death globally, but the lack of widespread observations has traditionally limited our understanding of air pollutant sources and impacts. However, with recent advances in low-cost sensor technology, it is now possible to deploy dense networks of air quality monitoring stations in a wide range of environments. Such networks have several advantages over traditional, more costly systems: i) they enable higher resolution monitoring for health and regulatory purposes, ii) novel network configurations have potential for meteo-chemical model evaluations, and iii) the sensors are a means to interact with the public in new ways.

Despite these advantages, there have been relatively few rigorous evaluations of low-cost sensor characteristics and thus the value of low-cost networks remains largely unknown. Here, we present initial results from a sensor network on the Island of Hawai'i to measure levels of volcanic air pollution ('vog' composed of sulfur dioxide [SO₂] and particulate matter [PM]). Vog is a significant public health concern on the Island and exposure levels have been linked to negative health and respiratory symptoms in the community. Hawai'i Island's Kilauea volcano is the world's most active volcano and the single largest point source of SO₂ in the United States. This makes for a unique location to test a low-cost air quality sensor network because pollutants are injected into clean background air from a known source. Preliminary results include i) PM and SO₂ sensor evaluations using field co-location and laboratory tests and ii) spatial and temporal vog patterns from trial network deployments.

5.041 Space-based Constraints on the Terrestrial Variability of VOCs through Formaldehyde and Glyoxal.

Early Career Scientist

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Abstract:

Atmospheric volatile organic compounds (VOCs) are important contributors to the oxidative capacity of the atmosphere and are precursors to many surface pollutants and climate forcers. Despite their substantial influence on the composition and chemistry of the atmosphere, VOCs remain poorly observed at the global scale. Recent developments in the retrieval of VOC concentrations from the OMI instrument allow for improved terrestrial characterization of two common VOCs, glyoxal and formaldehyde. Both glyoxal and formaldehyde are chemically formed and directly emitted, but the rates of formation and emission vary by region and source. Taking advantage of the differential formation properties of both chemicals can lead to constraints on the speciation of many VOCs, not just glyoxal and formaldehyde. In this work, we explore the magnitude and variability of VOCs across the globe using these satellite retrievals and the chemical transport model GEOS-Chem. We assess the value and explore challenges of inferences of total VOC speciation using only observations of glyoxal and formaldehyde. Finally, we provide recommendations for future observing systems, including the potential value added from geostationary satellites.

5.042 An updated global multi-constituent chemical reanalysis data set for 2005-2017 and its applications in atmospheric chemistry studies.

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Abstract:

An updated global chemical reanalysis data set of multi-constituent concentration and emission fields (TCR-2) was produced from an assimilation of the updated multiple satellite retrievals of ozone, CO, NO₂, HNO₃, and SO₂ from OMI, SCIAMACHY, GOME-2, TES, MLS, and MOPITT, for the years 2005-2017 at a 1.1-degree spatial resolution. Surface emissions of NO_x, CO, and SO₂, lightning NO_x sources, and the concentrations of various species were simultaneously optimized. The consistent concentration and emission data products provide unique information on decadal changes in the atmospheric environment that can be used for various applications in air-quality and climate research. We used the DC-8 aircraft measurements in East Asia during the KORUS-AQ campaign to evaluate the performance and efficiency of the data assimilation in East Asia. The evaluation of the data assimilation fields showed improved agreements in ozone, CO, NO₂, SO₂, PAN, and OH profiles. Significant improvements in the free tropospheric OH profile confirm the usefulness of multiple-species assimilation in tropospheric chemistry analysis and to improve emission inversions. Our results suggest that combining precursors' emission optimization and direct concentration assimilation is an effective method for obtaining sufficient correction of the entire tropospheric ozone profile, and to adjust various tracers chemically linked to the species assimilated. The reanalysis fields have also been used to investigate detailed distributions of emissions for all major regions, their diurnal and seasonal variability, and their evolution over the 13-

year period, such as strong positive trends over India and negative trends over China, with substantial differences between the variations in NO_x, CO, and SO₂ emissions, and to evaluate bottom-up emission inventories and chemistry-climate simulations.

5.043 The GeoCarb Mission: A Tool in the Evolving Understanding of Methane and Carbon Monoxide Budgets.

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Abstract:

NASA plans to operate an instrument in geostationary orbit over the Americas beginning in 2022. This mission allows a coordinated study of climate-determining carbon species. Prime focus is on CO₂ fluxes, but the reactive species CO and CH₄ are particularly relevant to IGAC. Measurements of solar-induced fluorescence will describe plant photosynthesis contemporaneous with emissions.

To outline the technology: Grating mapping spectrometry, using a single slit and four focal planes set at 0.76, 1.60, 2.07, and 2.32 microns and ~17000 resolving power.

Retrieval profiting from the rich heritage of OCO-2, GOSAT, TropOMI, and GOME/SCIAMACHY. Column concentrations of CO₂, CH₄, and CO, with finest resolution at 3 km x 6 km. A selection of scans allowing appreciable refinement in fluxes of CO₂ and CH₄. Rapid re-pointing allowing at least one synoptic observation of all North and South America daily, and 3 observations through the day for selected areas.

This presentation is an appeal to IGAC community to use GeoCarb to help improve the attribution of fluxes by sector and by geography. Cost constraints allow GeoCarb only limited listed goals. For example, GeoCarb aspires to constrain CH₄ emissions for the whole US, closing the ~60% gap between US EPA estimation and 3-d models. Detailed CO measurements should also aid photochemical and aerosol studies. NASA's TEMPO (UV-Vis geostationary) instrument will overlap GeoCarb. Consequently, HCHO, NO₂, aerosol, and CO may be intercompared, allowing elucidation of chemical sources and also transformation timescales. We expect that Sentinel-5P's TropOMI will lead the way here; geostationary imaging will allow diurnal views and reduced cloud obscuration of interesting areas.

Analysis of current data suggests interesting questions: (a) puzzling XCH₄ diel variations in the Amazonian rainforest; (b) time-varying CO/NO₂ relationships in urban plumes. We also urge the suite of airborne and small-sat measurements needed to complete the story at fine scales.

5.044 Development of a statistical model for PM₁₀ prediction.

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Abstract:

A statistical model was developed to predict mixing ratios of PM₁₀ by embedding deep LSTM (Long Short-Term Memory) layers. Information of atmospheric pollutants and meteorological parameters over Seoul Metropolitan area was collected and pre-processed to train and validate the developed model from 2014 and 2016. The modeled PM₁₀ mass densities show reasonable agreements with those for observed, with Pearson correlation coefficient (R) of 0.736. More detailed results of PM₁₀ forecasting were also discussed together with some limitation of current PM₁₀ prediction model.

5.045 Data assimilation for chemical transport model using an ensemble Kalman filter.

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Abstract:

Data assimilation provides a consistent physical state, which aims to present the truth-value by blending imperfect model predictions and noisy observations. This technique has been mainly applied to numerical weather prediction and ocean modeling. As more chemical observations are becoming available, data assimilation is expected to make more contributions to air quality problem.

In this study, we investigate the feasibility of data assimilation for chemical transport model using the ensemble Kalman filter (EnKF), which is easy to implement on an existing system and gives flow-dependent corrections. The observations used in this study were from hourly collected data in ground-based stations. Various numerical tests were conducted to optimize the ensemble system. One of the most important parameters in EnKF system is the number of ensemble, which should be large enough to represent the model error statistics. Since the calculation time, however, almost linearly increases with that number, it is important to find an optimum size of the ensemble considering its efficiency. Other parameters such as the emission factor, the deposition rate, and the photolysis rate were also optimized by means of the spatial distribution. We confirmed that EnKF data assimilation leads to significantly positive effects on the quality of forecasts, but also found that a more precise construction for the model error is needed in the future studies.

5.047 Validation of Brewer and Pandora measurements using OMI total.

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Abstract:

Korea will launch the GEMS instrument in 2019 onboard the geostationary satellite to monitor atmospheric constituents with high spatial and temporal resolutions. The purpose of this study is to examine the performance of total ozone from ground-based Pandora and Brewer instrument that will be used for validation of the GEMS ozone product. Satellite retrieval algorithm is used to process the entire satellite dataset, and instrument characteristics typically change slowly over the life of the satellite. Thus, the short-term stability of satellite measurements can be used to estimate the performance of the ground-based measurement network as well as to identify potential problems at individual stations. As a reference for satellite ozone measurements, we have selected total ozone data from OMI-TOMS V8.5 algorithm, because it is a robust algorithm that has been well studied to identify its various error sources. We validated ground-based Pandora and Brewer total ozone measurements using OMI total ozone data collected over South Korea from March 2012 to December 2014. The Brewer ozone measurements at Pohang showed significant deviation from overall seasonal variation during the study period. In addition, in the presence of clouds, Pandora ozone measurements are usually ~7% higher than OMI total ozone data. To filter out these cloud-contaminated data, we applied a Kalman filter to the Pandora measurements. The diurnal variation in the Kalman-filtered Pandora data agrees well with the Brewer data, and the correlation of Kalman-filtered Pandora data with TOM-TOMS total ozone is significantly improved from 0.89 to 0.99 at Seoul and from 0.93 to 0.99 at Busan.

5.048 Using Wavelet Transform and Mobile Measurement of Air Pollutants to Evaluate Vehicle Emission Control Policies: a Case Study on the 2014 APEC summit in Beijing.

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Abstract:

Vehicular emission is a major source of air pollution in global cities, such as megacity Beijing. Various policies have been introduced to control vehicular emission, but there is lack of proper method to evaluate the effectiveness of these policies. Based on Wavelet Transform (WT) of on-road mobile measurement, we developed a method to decompose the high and low frequency components of the concentrations of air pollutants. Using the

high-frequency components of the concentrations of air pollutants to represent the immediate vehicular emissions, we are able to evaluate the vehicular emission control policies during the 2014 Asia-Pacific Economic Cooperation (APEC) summit in Beijing. The on-road mobile measurement was conducted during the periods of Pre-APEC (28 October to 2 November 2014), APEC (3 to 12 November 2014) and Post-APEC (13 to 22 November 2014) along the 4th Ring Road of Beijing to obtain the concentrations of NO, NO_x, BC, CO, SO₂, and O₃ with high time-resolution. Then WT was used to decompose the on-road mobile measured concentrations of pollutants to the low- and high- frequency components. Through comparing the WT results with other methods, we validated that the WT method is feasible and stable to assess vehicular emission control policies. We found in day time, the high-frequency components of the concentrations of NO, NO_x, BC, CO during APEC were 19.4 %, 17.7 %, 0 %, and 50 % lower than that during Pre-APEC, and were 50 %, 47.3 %, 62.5 %, and 50 % lower than that during Post-APEC, respectively. In nighttime, the high-frequency components of the concentration of NO, NO_x, BC, CO during APEC were 65.3 %, 65.4 %, 14.3 %, and 50 % lower than that during Post-APEC. The results indicate that the vehicular emission control policies were effective during APEC period.

5.050 Incorporating chemical interactions and co-emissions in top-down constraints on sources of NO_x, SO₂ and CO .

Early Career Scientist

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Abstract:

Accurate estimates of air pollutant emissions from each human and natural activity are important for understanding atmospheric chemistry and implementing emission control strategies. Previous top-down estimates have inferred NO_x, SO₂ and CO emissions individually using observations of each species separately. With more common use of finer grid (< 10 km) air quality models and pending availability of higher resolution satellite measurements in the coming decade (e.g., TROPOMI, TEMPO, GEMS), opportunities and challenges exist for more effective usage of a broader suite of observations to better understand the sources of these pollutants. First, computationally quick approaches to constraining emissions based on the ratio of observed to modeled column densities are less accurate at the spatial scales of cutting-edge high resolution models, as column concentration are no longer governed by emissions in each grid cell. Second, the impacts of NO_x and CO emissions on OH and O₃ concentration are often overlooked in inversions using single species observations, degrading emission estimates for species oxidized by OH and O₃. Third, co-emitted pollutants and their uncertainties have correlations that should not be neglected in order to consistently invert different species emissions from the same sector and to analyze changes in activity and fuel types. Given these challenges, we develop a novel multi-species sector-based (e.g., industry) 4D-Var data assimilation framework (built on GEOS-Chem adjoint) to constrain emissions according to activities. We start with quantifying NO_x, SO₂ and CO emissions at global and regional scales using measurements from OMI and MOPITT (and TROPOMI, pending data availability). Posterior emissions from sector-based and traditional species-based inversions are compared. Simulated NO_x, CO, SO₂, PM_{2.5} and O₃ concentrations are evaluated against surface and aircraft measurements. This sector-based inversion can be further applied to other species to investigate the impact of emission sources on human exposure, climate and ecosystems.

5.051 Development and evaluation of a palm-sized optical PM2.5 sensor.

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Abstract:

A new palm-sized optical PM2.5 sensor has been developed and its performance evaluated. The PM2.5 mass concentration was calculated from the distribution of light scattering intensity by considering the relationship between scattering intensity and particle size. The results of laboratory tests suggested that the sensor can detect particles with diameters as small as 0.3 μm and can measure PM2.5 mass concentrations as high as 600 $\mu\text{g}/\text{m}^3$. Year-round ambient observations were conducted at four urban and suburban sites in Fukuoka, Kadoma, Kasugai, and Tokyo, Japan. Daily averaged PM2.5 mass concentration data from our sensors were in good agreement with corresponding data from the collocated standard instrument at the Kadoma site, with slopes of 1.07–1.16 and correlation coefficients (R) of 0.90–0.91, and with those of the nearest observatories of the Ministry of the Environment of Japan, at 1.7–4.1 km away from our observation sites, with slopes of 0.97–1.23 and R of 0.89–0.95. Slightly greater slopes were observed in winter than in summer, except at Tokyo, which was possibly due to the photochemical formation of relatively small secondary particles. Under high relative humidity conditions (>70%), the sensor has a tendency to overestimate the PM2.5 mass concentrations compared to those measured by the standard instruments, except at Fukuoka, which is probably due to the hygroscopic growth of particles. This study demonstrates that the sensor can provide reasonable PM2.5 mass concentration data in urban and suburban environments and is applicable to studies on the environmental and health effects of PM2.5.

5.053 Development of accurate low-cost PM_{2.5} instruments and measurements in Asian countries.

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Abstract:

We have developed a new palmtop-sized optical PM_{2.5} sensor. For accurate measurement of PM_{2.5} mass concentrations, the sensor is designed to be able to estimate particle sizes from the distributions of light scattering intensities from single particles. The validation of the compact PM_{2.5} sensors was performed by simultaneous measurements with large beta-attenuation monitor (BAM) instruments and good correlation factors were obtained. Even when the PM_{2.5} concentrations were high than 1000 mg m⁻³ in New Delhi, India, good correlation was obtained.

We are planning many applications of the compact, low-cost and simple PM_{2.5} instruments. In urban areas, many instruments can be installed with high densities. Local PM_{2.5} sources in the urban areas can be detected with the PM_{2.5} instruments. We have also developed personal exposure measurement system for PM_{2.5}. The system consists of the PM_{2.5} sensor and a smartphone. The measured PM_{2.5} and GPS position data are automatically transmitted to a cloud server.

The new PM_{2.5} instruments are especially suitable for the measurements in Asian countries. Many Asian countries suffer from serious environmental problems of extremely high PM_{2.5} concentrations and their health effects. The PM_{2.5} observations in rural areas of the Asian countries have difficulty to install valuable and delicate PM_{2.5} instruments such as BAM because of many serious difficulties about space, electric supply, dust, temperature, roof leaks, insects, transportation, maintenance access, standard-gas supply and so on. The new low-cost PM_{2.5} instruments can be installed and operated in those conditions. The PM_{2.5} instruments widely distributed in high PM_{2.5} concentration area are suitable for epidemiological studies.

In this presentation, we will present the features of the compact PM_{2.5} instruments, and also present the measurement results in India, Vietnam, and Mongolia for more than one year.

5.054 Assessment of calibration models for small sensor measurements of nitrogen dioxide and ozone using metal-oxide sensors .

Early Career Scientist

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Abstract:

Air pollution is linked to about nine million premature deaths worldwide in 2015 according to the last Lancet commission report. The classical view of urban air pollution monitoring is based on well-established and expensive reference methods installed in scarce and static monitoring stations. The use of small sensors as a complementary tool for air quality monitoring could give us high spatial density and temporal resolution relevant for city scale measurements and more information related to air pollution exposure of the population. This potential is however associated with challenges, such as interferences and the impact of environmental influences that require significant evaluation and calibration of the sensors to ensure data quality.

In summer 2017, in the framework of the project "Urban Climate Under Change", a field campaign was carried out in Berlin, Germany where nitrogen dioxide (NO₂) and ozone (O₃) were measured using low-cost, small air quality sensors (Earthsense prototype Zephyrs). As part of the deployment, the sensors were co-located with reference instruments to develop calibration models. The co-locations took place before and after deployment for measurement experiments, such as the vertical distribution of pollutants in a street canyon. A number of calibration models were explored to assess the fits for the metal-oxide sensors, including simple univariate regression, multivariate linear regression, and a machine learning technique. Differences in the model performance will be presented, as well as their application to and the results from the vertical profile

experiments.

5.057 Analysis of sulfate species and trace elements in aerosols collected at Noto Peninsula.

Early Career Scientist

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Abstract:

The Asian continent is one of the most significant source regions of anthropogenic emissions in the world (Street et al., 2003). Sulfate (SO_4^{2-}) aerosol concentration around the area has been high in recent years because of large energy consumption in China and influences various problems such as air quality, human health, and climate change, and its influence will differ depending on their chemical species. In this study, to understand sulfate species in aerosol and their chemical process during transportation, we collected size-fractionated aerosol samples (seven fractions) at Suzu, the Noto Peninsula which is isolated from major anthropogenic source in Japanese main island. The site is appropriate to focus on materials emitted from Asian continent and their long-range transportation to Japan and the Pacific. Then, concentration of sulfate and other soluble ions were measured using ion chromatography. Sulfate chemical species were determined by X-ray absorption fine structure spectroscopy. Concentrations of trace elements were measured using inductively coupled plasma mass spectrometry.

When air mass came from Asian continent, major sulfate species were gypsum in coarse particles, while fine particles consisted of ammonium sulfate, ammonium hydrogen sulfate, and hydrated sulfate. When air mass did not pass through Asian continent and was mainly transported from Japan sea, however, fraction of gypsum to sulfate in coarse particles was small, and hydrogen sulfate fraction in fine particle was larger than the former samples. In addition, size-distribution of trace elements such as zinc, lead, nickel, and vanadium, which are emitted by combustion process similarly to sulfur dioxide and used as markers of flue materials, was different between the samples. These results suggested that (i) sulfate species in aerosols collected at Noto differed depending on the influence of Asian continent and that (ii) trace elements are useful to estimate emission source and/or materials of sulfate.

5.060 Combining modelling with satellite retrievals - reanalysis of global atmospheric composition by the Copernicus Atmosphere Monitoring Service at ECMWF.

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Abstract:

Meteorological reanalyses data sets such as ERA-interim are widely used to represent the state and trends of the climate system. During the last 10 years, ECMWF has extended the scope of the reanalysis to atmospheric composition by additionally assimilating satellite retrieval of ozone, carbon monoxide, nitrogen dioxide and aerosol optical depth as well as carbon dioxide and methane with the Integrated Forecast System of ECMWF. The latest reanalysis, which covers the period 2003-2017 is currently being produced as part of the Copernicus Atmosphere Monitoring Service (CAMS). The CAMS reanalysis will be made available to users by the end of 2018.

We discuss the impact of the assimilation of the satellite retrievals, which is species specific, by comparing the reanalysis with a control model run. We demonstrate progress made in the composition re-analysis efforts at ECMWF by inter-comparing the latest composition reanalysis with the previous MACC and CAMS interim reanalysis with focus on temporal consistency, which is important for the robust identification of trends from the composition re-analysis. In more detail, we will discuss the decreasing trends in global carbon monoxide since 2003 found in the CAMS reanalysis and relate them to regional trends in the anthropogenic and biomass burning emissions.

Finally, we will suggest to inter-compare the composition reanalyses produced by research centres worldwide.

5.061 ICOS atmospheric network Germany for long term monitoring of greenhouse gases.

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Abstract:

Due to its central location within Europe, the German atmospheric network forms an important constituent of the recently established European research infrastructure ICOS (Integrated Carbon Observing System) for long term monitoring of greenhouse gases. Routine measurements of CO₂, CH₄, N₂O as well as CO are going to be continuously performed at three heights on eight tall towers and one marine station, with ancillary measurements of meteorological parameters, combined with flask samples, radiocarbon sampling and ²²²Rn. The network was designed to account for the typical European environment and will be utilised for inverse models to derive high spatial and temporal resolutions of the greenhouse gas fluxes in Germany. Started in 2015 with the Global Atmosphere Watch (GAW) station Hohenpeissenberg, the towers have become subsequently operational with a planned completion at the end of 2018. Here we present the design of the network together with its first observations. Data are shown for stations located from east to west of Germany, including rural stations as well as stations in proximity of a city. Vertical gradients are analysed depending on environmental conditions and seasons.

5.063 Satellite observations of isoprene from the Cross-track Infrared Sounder.

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Abstract:

Isoprene (C₅H₈), the most important of the non-methane biogenic volatile organic compounds, plays a crucial role in atmospheric chemistry: by affecting the oxidative capacity of the atmosphere through reaction with OH, and as an important precursor of O₃ and secondary organic aerosols. Its annual emissions have been estimated at 270–1000 TgC (overwhelmingly from terrestrial plants), which is equivalent to the size of the annual biogenic CH₄ source. Accurate isoprene measurements from airplane and surface sites are sparse. Top-down constraints on the global distribution of isoprene sources have relied on an indirect approach using its oxidation product formaldehyde (HCHO). However, such estimates suffer from errors due to (1) the fact that HCHO is also derived from other volatile organic compounds, and (2) uncertainty in the isoprene-formaldehyde relationship and spatial smearing between the two. This has led to an ambiguous understanding of the various factors controlling the spatial and temporal distribution of isoprene.

Direct measurements of global atmospheric isoprene are needed to improve quantification of isoprene's roles in atmospheric chemistry and the carbon cycle. We have recently simulated the spectral signals of atmospheric isoprene for its strongest absorption band in the ~900 cm⁻¹ region based on the environmental conditions over Amazonian forest. We will present retrievals of atmospheric isoprene directly from existing CriS satellite observations, as well as an evaluation of the results using a combination of in-situ measurements, GEOS-Chem modeling, and retrieval simulations.

5.064 Avoided and potential air pollution levels and health impacts: The 2003 European heat wave as an exemplar extreme event.

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Abstract:

Over 70,000 people died in Europe during the 2003 heat wave, as a result of both elevated air pollution levels, due to the stagnant atmospheric conditions, and extreme temperatures. By the end of this century, heat waves over Europe are expected to increase in intensity and duration. Given a "business as usual" scenario, the number of hot days in central Europe are projected to be similar to those recorded in southern Europe in the present day.

Such extreme events present a challenge for policy efforts to limit poor air quality. If their likelihood does indeed increase they could result in more days with air quality in exceedance of health limits, even if pollutant emissions do not change (the "climate penalty"). We will argue that historical extreme events provide an excellent test for the effectiveness of air quality policies on the air pollution levels they seek to control. These events are both a putative "worst case scenario" as well as being tangibly grounded in lived experience, unlike using climate model projections.

We will present results from a set of global chemistry climate model (CCM) simulations to explore the European air quality levels in the meteorological background of the 2003 European heatwave. Our simulations estimate the beneficial impact of air quality policy between 1970 and 2003 (the "world avoided"), and consider two alternative future pollution emission scenarios.

5.065 Impacts of a New Multi-Satellite Constrained Aerosol Emissions Database: Missing Sources, Long-Range Transport, and In-Situ Chemical Processing.

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Abstract:

We have applied a variance maximization technique to simultaneous remotely sensed measurements of AOD, Aerosol Size, CO, and NO₂, from MISR, OMI and MOPITT. The resulting products are emissions at high frequency and global scale, containing different “annual average values” in space and time from existing emissions. These changes are significant in magnitude, spatial, and temporal distribution.

Some of the changes have been “relatively slow”, reflecting urbanization. Other are rapid and sharply peaked, associated with biomass burning. In addition there are strong linkages with El-Nino and other decadal scale phenomena, particularly in regions of biomass burning, where inter-annually and intra-annually variations are both important. In particular, many of these changes are located in South Asia, Southeast Asia, East Asia, Central Africa, Southern Africa, and South America.

These new emissions have then been used in a set of runs covering the period from 2000 to the present, using the CESM-AERO model, and in more detail over specific regions and times using WRF-CHEM. In addition to the standard aerosol routines, we introduce a core-shell trained MIE based aerosol algorithm, constrained by Asian AERONET measurements. Comparisons between the model results, MODIS and CALIOP find an improved aerosol connection between the emissions and both the mean and variability of the system. Also included in the findings is some amount of “chemical speciation” and vertical structure, although far more is still required.

This has led to a few conclusions. First, the emissions and impact of biomass burning are both currently underestimated. Second, that urban emissions are underestimated in some regions and overestimated in others, leading to large changes in the profiles and resulting radiative effects. Third, that the impact of long-range transport is more prevalent than previous thought.

5.066 Visualization Analysis on Uncertainties in the Global Greenhouse Gas Inventories.

Early Career Scientist

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Abstract:

Greenhouse gas (GHG) inventories document a country's GHG sources and sinks over the course of a year, and are considered as a useful tool for policy making and scientific use. To support the global policy making effectively, various global carbon dioxide (CO₂) emissions maps are developed basing on the inventory databases such as emissions maps from the Carbon Dioxide Information Analysis Center (CDIAC) at a resolution of 1° × 1°, Open-source Data Inventory of Anthropogenic CO₂ emission (ODIAC) at 1° × 1°, Emissions Database for Global Atmospheric Research (EDGAR) at 0.1° × 0.1°, and Fossil Fuel Data Assimilation System (FFDAS) at 0.1° × 0.1°. To explore the distribution of uncertainties between these inventories on map, we try to make a synthetic global CO₂ emissions map at a resolution of 1° × 1° in 2010 to extract the gridded emissions values from these four source maps and make cross analysis on uncertainties grid by grid. The whole resolution process is conducted by ArcGIS. From the synthetic map, the global total emissions summarized as the source maps are about 33857 (CDIAC) ~ 41906 (ODIAC) teragram (Tg) CO₂ yr⁻¹. The largest emissions grid (locates in China domain) is about 299 Tg CO₂ cell⁻¹ yr⁻¹ and the mean global total is about 38388 Tg CO₂ yr⁻¹ that is much closer to FFDAS's estimation. Through cross analysis, we clarified the detailed distribution for the discrepancies between each source map and the synthetic map. Furthermore, we made the distribution for the standard deviation (SD) of gridded values between four maps by 1° × 1°. The areas with larger gridded SD values reflect where more uncertainties exist in the emissions estimation. This effort could detect the uncertainties distribution on map for these global GHG inventories at a resolution of 1° × 1°.

5.067 A 0.56°-resolution global data assimilation of multi-constituent satellite measurements for use in tropospheric chemistry studies.

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Abstract:

Detailed information on tropospheric ozone and its precursors are important for human health, ecosystem, and climate studies. The combined use of satellite measurements of ozone and its precursors has great potential to provide comprehensive constraints on the tropospheric chemistry system from regional to global scales. Several studies have demonstrated the capability of data assimilation of multi-species satellite measurements to simultaneously optimize concentration and emission fields at relatively low resolutions (at 1°–4° resolutions; e.g., Miyazaki et al., 2015). In this study, we present results from a high-resolution global data assimilation at a 0.56°-resolution using an ensemble Kalman filter approach and a high-resolution global CTM (Sekiya et al., 2018) towards better use of satellite measurements. We assimilated multiple chemical species measurements (ozone, NO₂, CO, HNO₃, and SO₂) from multiple satellite sensors (OMI, GOME-2, SCIAMACHY, TES, MOPITT, and MLS) for simultaneous optimization of concentration and emission fields, and evaluated the analysis fields using independent measurements. The global root mean square error of tropospheric NO₂ column against OMI was smaller by 56% in the high-resolution data assimilation compared to that in a low-resolution data assimilation (at 2.8° resolution). The high-resolution data assimilation also improved agreements with world-wide surface NO₂ monitoring networks (AirBase, AQS, and Asian networks) and various ozone measurements (ozonesonde, aircraft, and surface measurements), attributing to corrections made to both concentrations and precursor's emissions. The global total surface NO_x emission was increased by 35% from the a prior emissions (HTAP_v2.2, GFED4s, and GEIA inventories), with large emission increments at megacities and biomass burning hotspots, providing substantially different emission fields from low-resolution data assimilations. These results suggest the potentials of using the high-resolution data assimilation for studying the processes controlling the atmospheric environment at various spatial scales and for making better use of future satellite measurements such as TROPOMI and geostationary satellites.

5.068 Indoor Air Pollution exposure due to fuel burning in low income informal settlements in Umlazi Township, Durban, KwaZulu-Natal, South Africa .

Early Career Scientist

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Abstract:

Title: Indoor Air Pollution exposure due to fuel burning in low income informal settlements in Umlazi Township, Durban, KwaZulu-Natal, South Africa

Abstract

This study was aimed at investigating indoor air pollution exposure due to fuel burning in low income informal settlements in Umlazi Township, KwaZulu-Natal which is the second largest township in South Africa following Soweto in the Gauteng Province and occupies approximately 4500ha with an estimated population of 388 696. We measured indoor air quality (IAQ) and ambient air quality as well as meteorological variables, documenting and analysing individual indoor exposure and house characteristics using self-report questionnaires and walkthrough surveys in 243 low income and informal households from May to August 2017. Environmental and health questionnaire data from questionnaires were aggregated and analysed at household level. IAQ samples were obtained by direct monitoring using Microdust Pro Real-time Dust Monitor and the IAQ Monitor. Ambient air quality data were obtained from South African Air Quality Information Systems website. Households predominantly used electricity, wood and paraffin for cooking and heating. The Microdust Pro for IAQ showed an average range in particulate matter from 0.001-0.078 mg/m³ with a maximum value of 2.88 mg/m³ and carbon dioxide concentrations that ranged from 332-660 ppm. Indoor temperatures during the autumn/winter months ranged from 25 to 30 °C. We noted that when the temperature of the room was high (i.e. too much discomfort) the amount of carbon dioxide was also high. Since temperature with the room is likely a major factor affecting IAQ this will be explored in more detail and in relation to household variables, including human health impacts. Findings will be useful to inform development of household-level interventions for improved IAQ and thermal comfort.

Key words: Fuel burning, exposure, low income informal settlements.

5.071 Real time monitoring for NO₂/NO_x emission ratio from road vehicle.

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Abstract:

As a result of the promoted low-emission vehicles, the air concentrations of NO_x are in decreasing trend in Osaka City, Japan. Besides, the NO₂/NO_x emission ratios are increasing, seemingly because of the onboard after-treatment of vehicular exhaust. Drastic change in these amount and composition in vehicular exhaust are expected for the next decade, which may affect NO_x and O₃ air pollution in the city.

A procedure to estimate the NO₂/NO_x emission ratio in near real-time was considered in this paper to assess the variation in the ratio and its impact. Traditionally, the emission ratio was estimated from routine monitoring data for NO₂, NO_x, and O₃ in a roadside and the background site. The increments of NO_x and PO (NO₂ + O₃) concentrations at the roadside site over the background site were calculated, and the emission ratio was estimated from there ratio ($\Delta[\text{PO}]/\Delta[\text{NO}_x]$). The presented procedure is based also on the continuous monitoring of NO, NO₂, and O₃ by commercial instruments, just at a road side site, with 1-minute time resolution. The emission ratio was estimated in hourly basis by some statistical analysis of NO_x and PO temporal variations. Thus one can estimate the ratio from a single monitoring site, with existing monitoring instruments, with higher time resolution. The preliminary investigation for temporal variation of the ratio, and its impact on NO₂ and O₃ air pollution, were presented in this paper.

5.072 Pan-Pacific observations of short-lived climate pollutants in marine surface air by voluntary cargoships.

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Abstract:

The National Institute for Environmental Studies (NIES) has been operating a long-term program for monitoring trace gases of atmospheric importance over the Pacific Ocean since 1995. The NIES Voluntary Observing Ships (VOS) program currently makes use of three commercial cargo vessels that are in regular operation in constant routes for long periods and sail over a wide area between various ports (e.g., between Japan and the United States, between Japan and Australia/New Zealand, and between Japan and southeast Asia). These routine platforms offer the advantage of systematic measurements of trace gases and aerosols, providing long-term datasets for pristine background air over the Pacific Ocean and regionally polluted air around Southeast Asia. Ambient measurements are made by combination of continuous instruments onboard ships and flask sampling apparatus followed by laboratory analysis. We observe both long-lived greenhouse gases (LLGHGs, e.g., carbon dioxide, methane, nitrous oxide, etc) and short-lived climate pollutants (SLCPs, e.g., tropospheric ozone, black carbon, carbon monoxide) on a continuous basis. Cavity ringdown spectrometers were installed for high-resolution measurement of carbon monoxide, methane and carbon dioxide to capture their highly variable features in regionally polluted air around southeast Asia, which is now thought to be a large source due to expanding socioeconomic activities as well as biomass burnings. Contrasting the Japan-Australia/New Zealand and Japan-southeast Asia

cruises revealed remarkable characteristics of spatial and temporal variations that reflect regional characteristics of emissions, suggesting additional sources for methane, nitrous oxides, and carbon monoxide in this tropical Asian region. We will present long-term trends and interannual variations of multiple species at different latitudinal bands and different geographic regions.

5.075 Ground-level ozone pollution in China: trends, influencing factors and abatement.

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Abstract:

In the course of fast development of China, grave efforts have been placed on air pollution control, with the foci on fine particles (PM_{2.5}) problems. As the results of these efforts, the ambient concentrations of PM_{2.5} dropped evidently, achieving more than 30% in almost all cities in recent 5 years. However, the ground-level ozone levels kept on rising at the growth rate of 3-5% per year from limited long-term observation. This work, based on evaluating the data of ozone concentrations as well as NO/NO₂, and VOC species, the spatial pattern and temporal trends of ozone and its precursors were evaluated. The role of NO_x-VOCs chemistry, the influence of meteorological parameters, regional background and the effects of PM_{2.5} decline were investigated and compared. Furthermore, by using the case studies in several cities, such as Chengdu, Hangzhou and Pearl River Delta, the pathway for efficient control measures were analyzed for the co-benefit abatement of PM_{2.5} and ground-level ozone in China.

5.079 An optimal specification of a micro-satellite for detection of NO₂ hotspots with a km-order resolution.

Early Career Scientist

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Abstract:

We have investigated a concept of a micro-satellite for the observation of tropospheric NO₂ with a spatial resolution of 1x1 km² using the UV/visible wavelength range. Our aim is to find an optimal specification for the sensor concept. SCIAMACHY, GOME-2 and OMI have successfully provided the global distributions of tropospheric NO₂ (Hilboll et al., 2013; Duncan et al., 2016) with a horizontal resolution of 13-80 km, and satellite instruments having a resolution of 3-8 km (e.x. GEMS, TEMPO, Sentinel-4 and Sentinel-5P) are now being developed or have been launched. Here, we assumed an instrument with a 2D-CMOS array sensor and a compact optical system dedicated to the detection of NO₂ hotspots. The scientific requirement used in this study is to observe the tropospheric NO₂ column with a measurement error of less than 10%. The SCIATRAN was used for radiative transfer calculations. Considered areas were Beijing in China as a strongly polluted region and Hokkaido in Japan as a clean region. Calculated seasons were winter (January) and summer (July) on 2010 and 2012. The vertical profiles of NO₂, SO₂, O₃, BrO and HCHO for the troposphere and the upper atmosphere (up to 100 km) were taken from monthly mean values from the CHASER model, and annual mean values from the SOCRATES model, respectively. A Lambertian surface was assumed and a variability of albedo (0.05-1.0) was taken into account. The synthetic spectra were convolved with a Gaussian slit function with a FWHM of 0.4 nm and random noise was added corresponding to the signal-to-noise ratio (SNR) derived from the defined SNR equation using a given sensor specification. One thousand spectra were analyzed by the DOAS method for each of the different geometries and fitting windows. Finally, we statistically evaluated the measurement errors as the 1-sigma standard deviation of the 1000 retrieved SCDs.

5.081 Designing an optimal observation network for monitoring carbon dioxide (CO₂) emissions from megacity Osaka.

Early Career Scientist

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Abstract:

Cities are responsible for more than 70% of global greenhouse gases (GHGs) emissions. The Paris Agreement recognizes their key role in combating climate change. Many of global cities have signed up for local climate actions (e.g. Global Covenant of Mayors) and set their own emission reduction targets. Several cities have started compiling their emission inventories to monitor their progress: However, achieving robust emission estimates at a subnational level is a real challenging due to technical difficulties. The science community has been examining the use of atmospheric measurements to directly quantify emissions in order to support GHG emission management.

We as a team local at Osaka, have been prototyping a science-based framework to support emission management for megacity Osaka (population: 2.7 million). We have

developed a multi-resolution, spatially-explicit carbon dioxide (CO₂) emission inventory framework in order to better quantify Osaka emissions with an updated information. Compared to an existing 1km emission inventory for Japan, we confirmed shifts in major emission hotspots that are largely attributable to our unique emission disaggregation with detailed source geolocation and census-block level geographic data. Given the lack of operational ground-based atmospheric CO₂ observation in the Osaka area, we are currently developing an observation system simulation experiment capability to study an optimal observation network for emission monitoring.

We have completed an evaluation of the meteorology simulated with the WRF-Chem model and started simulating atmospheric CO₂ with our emission inventory. We will present simulations of observation system sensitivities (in situ and satellites) to arbitrary, but yet realistic emission changes (e.g. 30% emission reduction) and discuss future possibilities for Osaka observation network under a certain budget constraint.

5.082 Techniques for the ensemble analysis of complex atmospheric mass spectrometric datasets.

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Abstract:

The last several years have seen an explosion in the amount of data collected by individual atmospheric chemistry instruments. This has been driven in part by the development of new time-of-flight mass spectrometric techniques, which can provide real-time measurements of a large number of different atmospheric organic compounds. While such instruments provide substantial opportunities for gaining new insights into atmospheric composition and chemical processes (from field and laboratory studies), the extreme complexity of the datasets also introduces major challenges in the analysis and interpretation of the measurements. For example it is unclear how such datasets, involving hundreds or thousands of chemical species that each vary with time, can best be used to develop new chemical mechanisms or inform models. Here we investigate the use of advanced analysis approaches for examining such datasets holistically (with species treated together as ensembles rather than individually) for the extraction of useful chemical information. Our focus is on the laboratory (chamber) oxidation of organic compounds, using a number of mass spectrometric instruments to monitor evolving mixtures of reaction products. The datasets (concentrations or intensities as a function of time, from individual instruments or from the combined instrument suite) are analyzed using various ensemble methods (factorization techniques, machine learning approaches, etc.) in order to describe the overall evolving chemistry of the system. A specific objective is to help identify approaches by which results from such laboratory studies can be translated to mechanism or model development.

5.083 Harnessing long-term meteorological satellite records for atmospheric composition and chemistry research.

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Abstract:

Space-borne thermal infrared sounding spectrometers such as the NASA Atmospheric Infrared Sounder (AIRS), the NASA/NOAA Cross-track Infrared Sounders (CrIS) and the European Infrared Atmospheric Sounding Interferometers (IASI) have been shown to provide a wealth of information not only on atmospheric temperature and humidity but also on a range of trace gases. Trace gas products available or under development for these meteorological sounders include ozone, carbon monoxide, methane, carbon dioxide, deuterated water vapor, ammonia, methanol, formic acid, peroxyacetyl nitrate and isoprene. The value of thermal infrared radiances for Numerical Weather Prediction has ensured a long-term commitment to resources for these measurements. The AIRS record starts in 2002 and there are commitments in place to continue thermal infrared sounding measurements to 2035 and beyond. Together with previous and ongoing measurements from the Earth Observing System era, the meteorological sounders will provide a multi-decadal record of global atmospheric composition.

It is increasingly necessary to draw on multiple datasets to address key questions at the forefront of atmospheric research. Our atmosphere and its interactions with the anthroposphere, biosphere and lithosphere are sufficiently complex that no one instrument or measurement technique can provide all the answers. In addition to providing an overview of sounder trace gas products, we show examples of ways in which retrievals of trace gases from thermal infrared meteorological sounders are currently being used in combination with other measurements to advance knowledge of the Earth system. We will discuss the use of multi-spectral or multi-satellite retrieval approaches,

including tropospheric ozone retrievals combining information from AIRS and the Ozone Monitoring Instrument (OMI) and retrievals of carbon monoxide information from CrIS and the TROPOspheric Monitoring Instrument (TROPOMI). We will also discuss efforts involving assimilation of sounder trace gas products into chemical transport models.

5.084 New perspectives for the air-sea interactions of bioactive trace metals: Applying X-ray spectroscopy and geochemical modeling to size-fractionated marine aerosols.

Early Career Scientist

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Abstract:

Air-sea interactions of bioactive trace metals (BTMs, e.g.: Fe, Zn, and Cu) in marine aerosols have great impacts on carbon/sulfur cycles and global climate via the promotion of primary productions in the surface ocean. Although dissolved BTMs in the surface ocean act as nutrients for microorganisms, little is known about the factors controlling BTMs solubility in marine aerosols. One of the reasons for the uncertainties in controlling the BTMs solubility is a lack of speciated BTMs data. We applied X-ray spectroscopy to directly determine BTMs analysis in size-fractionated aerosols without any sample treatments including solvent-extraction. Furthermore, we utilized a geochemical model for the BTMs speciation in marine aerosols for the first time. We found excellent agreement between the X-ray spectroscopy and the geochemical model. This is the critical methodological development in speciating BTMs in marine aerosol because this model is able to calculate BTMs species based only on the concentrations and stability constants. In addition, we revealed that the formation of Fe(III)-organic complexes with siderophore (Fe(III)-siderophore) plays an important role in controlling atmospheric Fe solubility. Siderophore is the representative of Fe-ligand in seawater and Fe(III)-siderophore has substantially high solubility. The X-ray microscope indicated that Fe(III)-siderophore was formed by heterogeneous reactions of Fe with siderophore in sea spray aerosol. Therefore, the air-sea interactions of BTMs are important in the promotion of primary productions via atmospheric deposition as well as the control of atmospheric BTMs solubility. We believe that further applications of this novel method to other BTMs drastically develop our understanding of air-sea interactions of BTMs and its impacts on climate regulation.

5.085 Using chemistry observations to constrain sea-breeze transport.

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Abstract:

Sea and land breezes influence temperature, humidity and visibility in our coastal regions. Near coastal areas making up ~4% of the land area disproportionately host ~40% of the world's population and with urbanization increasing this number is likely to grow in the future. Most of the world's megacities are found within these near coastal zones. Understanding the complexities around sea breezes and atmospheric chemistry is a challenge for the resilience of our future cities. Measurements of atmospheric composition combined with physical atmospheric properties and aerosol observations provide a means of determining the ability of models to simulate the timing and intensity of sea and land breezes. These sea-breeze effects are not currently incorporated in climate models, but can be simulated by mesoscale models. Here we test the model parameterizations and boundary layer dynamics with atmospheric chemical observations made in the coastal zone.

