1.003 Climatology of wintertime long-distance transport of surface-layer air masses arriving urban Beijing in 2001-2012.

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Abstract:

In this work, the FLEXPART-WRF coupled modeling system is used to conduct 12-year Lagrangian modeling over Beijing, China, for the winters of 2001-2012. Based on large trajectory tracking ensembles, the long-range air transport properties, in terms of geographic source regions within the atmospheric planetary boundary layer (PBL) and large-scale ventilation, and its association with air quality levels were quantified from a climatological perspective. The results show the following: (1) The air masses residing in the near-surface layer over Beijing potentially originate from broader atmospheric boundary-layer regions, which cover vast areas with the backward tracking time elapsed. However, atmospheric transport from northeastern China and, to a lesser extent, from the surrounding regions of Beijing is important. (2) The evolution of air quality over Beijing is negatively correlated with large-scale ventilation conditions, particularly at a synoptic timescale. Thus, the simple but robust backward ventilation (BV) index defined in this study could facilitate operational forecasting of severe air pollution events. (3) By comparison, the relatively short-range transport occurring over transport timescales of less than 3 days from southern and southeastern Beijing and its surrounding areas plays a vital role in the formation of severe air pollution events during the wintertime. (4) Additionally, an interannual trend analysis suggests that the geographic sources and ventilation conditions also changed, at least over the last decade, corresponding to the strength variability of the winter East Asian monsoon.

1.004 Aerosol aqueous phase oxidation of SO2 by NO2 in Chinese haze formation process.

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Abstract:

Sulfate aerosols exert profound impacts on human and ecosystem health, weather, and climate, but their formation mechanism remains highly uncertain. Atmospheric models consistently underpredict sulfate levels under diverse environmental conditions. From atmospheric measurements in two Chinese megacities and complementary laboratory experiments, we show that aqueous oxidation of SO_2 by NO_2 is key to efficient sulfate formation, but is only feasible on fine aerosols with high relative humidity and NH_3 neutralization or under cloud conditions. Under polluted environments, this SO_2 oxidation leads to large sulfate production and promotes formation of nitrate and secondary organic compounds such as dicarboxylic acids, keto-carboxylic acids and dicarbnyls on aqueous particles, exacerbating severe haze development. Effective haze mitigation is achievable by intervening in the sulfate formation process with enforced NH_3 and NO_2 control measures. In addition to explaining the polluted episodes currently in China and during the 1952 London Fog, this sulfate production mechanism is widespread, and our results suggest the way for tackling this growing problem in China and much of the developing world.

1.005 Characterization of aerosols and trace gases using MAX-DOAS measurements in Phimai, Thailand.

Early Career Scientist

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Abstract:

We performed Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) aerosol and trace gas measurements at Phimai, Thailand (15.18°N,102.56° E) from October 2014 to September 2016. The vertical distributions of aerosol and trace gases were retrieved using the Japanese MAX-DOAS profile retrieval algorithm version 2 (JM2), a multi-component profile retrieval algorithm based on the optimal estimation method. The components retrieved are Aerosol Extinction Coefficient (AEC) at 357nm and 476 nm and 6 trace gases (NO_2, SO_2, O_3, CHOCHO, HCHO and H_2O). The MAX-DOAS data of AEC and its vertically-integrated quantity, i.e., the Aerosol Optical Depth (AOD), were compared to those of the co-located AD-Net (Asian Dust and aerosol lidar observation network) LIDAR (Light Detection and Ranging) and SKYNET sky radiometer measurements, respectively. Aerosol measurements from all the three platforms showed clear seasonality with high AEC and AOD values during the dry season (October-May) and low values during the wet season (June-September). The observed seasonality agrees well with the pronounced biomass burning reported in the literature. This was further supported by satellite observations (MODIS), which show high correlations with MAX-DOAS data with an R^2 of 0.71. Enhanced concentration of trace gases (NO_2, SO_2, O_3, CHOCHO, and HCHO) was also observed during the dry season, consistent with the influence of biomass burning. In the dry season, the CHOCHO/HCHO ratio was estimated to be 0.025±0.017, which is in the range of the literature values reported for rural sites. The Ozone Monitoring Instrument (OMI) tropospheric NO_2 data also showed similar seasonal variations but tended to be biased high by 27%. It is thus expected that such unique results from multi-component observations with MAX-DOAS will be useful for evaluating satellite data and models for the Southeast Asia region.

1.006 Data assimilation experiment on SO2 initial conditions in the Pearl River Delta.

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Abstract:

Base on the WRF-CMAQ air quality numerical model,the pollutant SO_2 in the Pearl River Delta Region in December 2013 was assimilated to optimize the initial conditions using the optimal interpolation approach (OI) and the ensemble square root filter (EnSRF). The high value of the background error was mainly located in Jiangmen region in horizontal direction and was larger within the boundary layer in vertical direction. It was nearly constant blow 400m and decreased with height above 400m.Compared the SO_2 concentration field before and after assimilation with two methods, it showed that assimilation could adjust the distribution pattern of the pollutant and make it more consistent with the observation field. Both methods could offer an initial field more close to the true situation. Sensitivity test showed that the optimal horizontal scale of the optimal interpolation method was 20 km. The root mean square error decreasing percentage of the assimilation sites and verification sites reached 73% and 39%, respectively. With the number of the assimilation site increasing, the optimization of the assimilation site had a declining trend.

1.007 Impact of typhoons on the composition of the upper troposphere within the Asian summer monsoon anticyclone: the SWOP campaign in Lhasa 2013.

Early Career Scientist

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Abstract:

In the frame of the SWOP (sounding water vapour, ozone, and particle) campaign during the Asian summer monsoon (ASM), ozone and water vapour profiles were measured by balloon-borne sensors launched from Lhasa (29.66° N, 91.14° E, elevation 3,650 m), China, in August 2013. In total, 24 soundings were launched, nearly half of which show strong variations in the relationship between ozone and water vapour in the tracer-tracer

correlation in the upper troposphere and lower stratosphere (UTLS). 20-day backward trajectories of each sounding were calculated using the trajectory module of the Chemical Lagrangian Model of the Stratosphere (CLaMS) to analyse these variations. The trajectory calculations demonstrate that three tropical cyclones (tropical storm Jebi, typhoons Utor and Trami), which occurred over the Western Pacific Ocean during August 2013, had a considerable impact on the vertical distribution of ozone and water vapour by uplifting marine air masses to altitudes of the ASM anticyclone. Air parcels subsequently arrived at the observation site via two primary pathways: firstly via direct horizontal transport from the location of the typhoon to the station within approximately three days, and secondly via transport following the clockwise wind flow of the ASM within a timescale of one week. Furthermore, the interplay between the spatial position of the ASM anticyclone and tropical cyclones plays a key role in controlling the transport pathways of air parcels from the boundary layer of the Western Pacific to Lhasa in horizontal as well as vertical transport. Moreover, the statistical analysis shows that the strongest impact by typhoons is found at altitudes between 14.5 km and 17 km (365-375 K). Low ozone values (50-80 ppbv) were observed between 370 K and 380 K due to the strong vertical transport within tropical cyclones.

1.009 Export of black carbon and carbon monoxide from Asia: How far can they go?.

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Abstract:

Black carbon aerosols have substantial impacts on air quality and climate from regional to global scales. In the present study we implemented a tag-tracer scheme of black carbon (BC) and carbon monoxide (CO) into a global chemistry-transport model GEOS-Chem, and examined long-range transport of BC and CO from various sources to the Arctic and quantified the source contributions. We distinguished BC and CO tracers by source types (anthropogenic and biomass burning) and regions; the global domain was divided into 16 and 27 regions for anthropogenic and biomass burning emissions, respectively. Our simulations showed that BC and CO emitted from East Asia are up lifted and transported in the middle troposphere over Okhotsk Sea and East Siberia and can reach to the Arctic during winter and spring. We identified important region where a strong inflow from East Asia to the Arctic occurs (130–180°E and 4–7 km altitude at 66°N). The model demonstrated that the contribution from East Asia to the Arctic shows a maximum at about 5 km altitude due to the uplifting during the long-range transport in early spring. The efficiency of transport from East Asia to the Arctic is smaller than the other large source regions such as Europe, Russia and North America. However, the contribution of East Asia is most important to the middle troposphere (41 %) and BC burden (27 %) over the Arctic because of the large emission from this region. These results suggest that the main sources of the Arctic BC are different with altitude. The total contribution of anthropogenic sources to BC concentrations near the surface is dominant compared with that of biomass burning in annual mean.

1.010 Characterization of absorbing aerosol types using ground and satellites based observations over an urban environment.

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Abstract:

In this work, efforts have been made to seasonally characterize the absorbing aerosols into different types using ground and satellite based observations. For this purpose, optical properties of aerosol retrieved from AErosol RObotic NETwork (AERONET) and Ozone Monitoring Instrument (OMI) were utilized over Karachi for the period 2012 to 2014. Firstly, OMI AOD_{abs} was validated with AERONET AOD_{abs} and found to have a high degree of correlation. Then, based on this validation, characterization was conducted by analyzing aerosol Fine Mode Fraction (FMF), Angstrom Exponent (AE), Absorption Angstrom Exponent (AAE), Single Scattering Albedo (SSA) and Aerosol Index (AI) and their mutual correlation, to identify the absorbing aerosol types and also to examine the variability in seasonal distribution. The absorbing aerosols were characterized into Mostly Black Carbon (BC), Mostly Dust and Mixed BC & Dust. The results revealed that Mostly BC aerosols contributed dominantly during winter and postmonsoon whereas, Mostly Dust were dominant during summer and premonsoon. These types of absorbing aerosol were also confirmed with MODerate resolution Imaging Spectroradiometer (MODIS) and Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) observations.

1.011 Impacts of the East Asian monsoon on seasonal, interannual, and decadal variations of tropospheric ozone and aerosols in China.

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Abstract:

The changes in concentrations of air pollutants in China are coupled with the variations of the East Asian monsoon (EAM). We present in this talk a series of our studies that quantify the impacts of the EAM on seasonal, interannual, and decadal variations of tropospheric ozone and aerosols in China, by using a global three-dimensional Goddard Earth Observing System chemical transport model (GEOS-Chem) driven by assimilated meteorological fields. Sensitivity studies with no seasonal variations in emissions indicate that the East Asian summer monsoon can reduce aerosol concentration averaged over the domain of (110-120E, 20-45N) by 60-70%, as the averaged surface-layer aerosol concentration in July is compared with that in January. Interannually, simulated aerosol concentrations are found to have strong negative correlations with the strength of the EAM. Accounting for sulfate, nitrate, ammonium, black carbon, and organic carbon aerosols, the summer surface-layer PM2.5 concentration averaged over eastern China can be about 18% higher in the weakest monsoon years than in the strongest monsoon years. We also show that the decadal-scaling weakening of EAM has an effect of increasing aerosol concentrations over eastern China by the changes in atmospheric circulation (the convergence of air pollutants). Similar studies are carried out for tropospheric ozone. Interestingly, simulated ozone concentrations are found to have strong positive correlations with the strength of the EAM, and the interannual variations of tropospheric ozone are small (less than 5%). The mechanisms for the impacts of EAM on air pollutants will be discussed.

1.012 Enhancement of the lower tropospheric ozone over China: Comparison of Ozone Monitoring Instrument (OMI) and model simulations.

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Abstract:

Liu et al. (ACP, 2010) successfully derived ozone profiles from the surface up to 60 km in 24 layers, using ultraviolet spectra observed by the Ozone Monitoring Instrument (OMI). Hayashida et al. (ACP, 2015) assured the reliability of the 24^{th} lowermost layer of the OMI products, corresponding from 0 km to about 2.5–3 km. They reported O_3 enhancement observed in Central and Eastern China (CEC). This enhancement is most notable in June in any given year. In this study, to reveal spatial and temporal variation of O_3 distribution over CEC, we applied cluster analysis to the OMI O_3 data from the region. We focus on the anomaly of ozone (DO_3), which is defined as the difference between the retrieval values and the a priori values (DO_3 = O_3[retrieval] – O_3[a priori]). This analysis is effective in tracking the O_3 enhancement under polluted conditions, because our focus is the temporal O_3 enhancement from background levels, i.e., the climatological values. The DO_3 valuescan be interpreted as an indicator of the ozone enhancement from the background level. By this analysis, we can distinguish the areas (Cluster 1) where DO_3 has outstanding seasonality with high values in summer (June, in particular) and low values in winter over the North China Plain and Sichuan basin, which corresponds to the areas of high NO_2 concentration observed by satellite sensors. We compared the results with model simulations by the Meteorological Research Institute – Chemistry Climate Model (MRI-CCM2) (Deushi and Shibata, MRIpapers, 2011) as well as meteorological data. Cluster 1 corresponds to areas of high chemical production rates in June in the model simulation. Along the coastal area, DO_3 tends to drop to negative values temporarily in August, which can be interpreted as due to the inflow of oceanic clean air into the inland area.

1.013 Linking Atmospheric Pollution to Cryospheric Changes over “The Third Pole” Region.

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Abstract:

The Tibetan Plateau and surrounding mountains hold the largest aggregate of glaciers outside the polar regions and have been designated "the Third Pole" (TP). The long-range transport of atmospheric pollutants, including light absorbing impurities (LAIs) such as black carbon (BC) and mineral dust (MD), can significantly absorb the solar radiation in the atmosphere, and reduce albedo after being deposited onto the cryosphere, thereby promoting glacier and snow melt in the TP.

A coordinated atmospheric pollution monitoring network including 20 stations has been launched and operated covering the TP region with emphasis on trans-Himalayan

transects since 2013. Spatio-temporal distributions of atmospheric pollutants (e.g. BC, OC, typical persistent organic pollutants) revealed a decreasing trend from south to north across the Himalayas and a clear seasonal variation with higher values in pre-monsoon seasons. Integrated analysis of satellite images and air mass trajectories suggested that the trans-boundary atmospheric pollution could be transported across the Himalayas reaching to the inland TP. Simulation by a regional climate model coupled with a chemistry-aerosol module indicated that carbonaceous aerosols increased surface air temperatures by 0.1-0.5℃.

To estimate the impacts of LAIs on glacier and snow cover melt, surface snow/ice samples have been collected in-situ from five benchmark glaciers since 2013. Primary sensitivity analysis were conducted using the SNICAR model and a distributed energy-mass balance model, showing that contributions of BC and MD were 22% and 20%, respectively, to the summer melt of Laohugou Glacier No. 12 in the northeast of the TP. While MD (38%) contributed more glacier melt than BC (11%) for Zhadang Glacier in the southern TP. LAIs can be further accumulated in the surface of glaciers as glacier melting proceeds, representing a positive feedback. Accelerated glacier melt is expected due to albedo reduction by LAIs in the future.

1.014 Regional Chemistry-Climate Simulations in South Asia.

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Abstract:

To learn how future air quality and atmospheric composition may change in South Asia, we have conducted nested regional chemistry-climate simulations of the region for the 1995-2004 and 2045-2054 time periods. We examine the combined effect of changes in climate and air pollutant emissions projected by the Representative Concentration Pathways (RCP) 8.5 and RCP6.0 on the atmospheric composition in South Asia. We show that ozone and particulate matter ($PM_{2.5}$) will either increase significantly by mid-century in South Asia (RCP8.5) or remain similar to present-day conditions (RCP6.0). Under RCP8.5, the frequency of air pollution events is predicted to increase by 20-120 days per year in 2050 timeframe compared to the present-day conditions with $PM_{2.5}$ predicted to breach the World Health Organization (WHO) ambient air quality guidelines on an almost daily basis in many parts of South Asia. We find similar predictions in the Indo-Gangetic Plain of ozone and $PM_{2.5}$ when using coarse (Δx = 60 km) and fine (Δx = 12 km) grid resolutions, likely because the emissions occur throughout the region and do not have isolated urban centers, emphasizing the need to understand regional-scale air quality. We also analyze changes in ozone and PM in the upper troposphere during the summer monsoon season to learn if large-scale changes to ozone are evident.

1.015 Co-benefit Thinking to Link Atmospheric Chemistry Research to Pollution-Reduction Policy.

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Abstract:

Future Earth promotes solution-oriented transdisciplinary research in order to contribute scientific findings to sustainable development of our society. Nevertheless, in practice, how to conduct such a research still requires tremendous experience sharing and capacity building. In the field of atmospheric chemistry, the urgent and tangible problem should be solved is to reduce various air pollutant levels in the environment. This presentation emphasizes co-benefit thinking in linking atmospheric chemistry research to pollution-reduction policy.
In addition to climate-and-health co-benefits introduced in earlier publications, an expanded co-benefit thinking will be introduced. Suggestions on how to identify potential research gaps from the viewpoint of the progression of pollutants from emission to health effects will be given. Scientific challenges that atmospheric chemistry research may be able to tackle in order to contribute to actual air pollution reduction policies will be presented from human exposure perspectives, particularly pointing out air pollution exposure due to distinct features in Asian communities such as high population density and dense traffic/commercial/industrial pollution sources. Furthermore, successful experiences of guiding pollution reduction policies with scientific findings will be presented using incense-burning in Taiwan as an example. Studies focusing on controllable factors in incense-burning in a household indoor environment, temples, Goddess parade, and community settings will be briefly presented, emphasizing on how to design solution-oriented studies and use these scientific findings to promote changes in human behaviors and governmental policies. After more than ten years, temples nationwide have taken actions to reduce the numbers of incenses required per censer and even the number of censers. Contribution from atmospheric chemistry scientists are anticipated with similar strategic planning targeting controllable factors.

1.016 Increased atmospheric ammonia over the world's major agricultural areas detected from space.

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Abstract:

This study provides evidence of substantial increases in atmospheric ammonia (NH_3) concentrations (14-year) over several of the worlds major agricultural regions, using recently available retrievals from the Atmospheric Infrared Sounder (AIRS) aboard NASA's Aqua *satellite*. The main sources of atmospheric NH_3 are farming and animal husbandry involving reactive nitrogen ultimately derived from fertilizer use; rates of emission are also sensitive to climate change. Significant increasing trends are seen over the US (2.61% yr^{-1}), the European Union (EU) (1.83% yr^{-1}), and China (2.27% yr^{-1}). Over the EU, the trend results from decreased scavenging by acid aerosols. Over the US, the increase results from a combination of decreased chemical loss and increased soil temperatures. Over China, decreased chemical loss, increasing temperatures, and increased fertilizer use all play a role. Over South Asia, increased NH_3 emissions are masked by increased SO_2 and NO_x emissions, leading to increased aerosol loading and adverse health effects.

1.017 Satellite view of the widespread haze pollution in eastern China: formation, variation, and connection with atmospheric circulation.

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Abstract:

Satellite observations show that the air pollution in eastern China is characterized by extensive haze plumes with large spatial variations. The extreme pollution episodes in megacities such as Beijing is usually connected with regional transport under certain atmospheric circulation. Unlike local accumulation under stagnant weather conditions, the slow airflows within the boundary layer during winter usually make atmospheric pollutants wander in the North China Plain rather than be blown away. Daily variation of satellite estimated concentration of $PM_{2.5}$ show spatial oscillation phenomenon of particle pollutants in eastern China, which leads to two distinct patterns in change processes. In the other hand, integrated observation of A-Train satellites reveals strong influence of natural factors on anthropogenic pollution in eastern China. CALIPSO and OMI UV detection show very inhomogeneous vertical structures of the haze layers with dust aerosols in the upper part. It is found that transport of floating dust from the deserts of northwestern China downstream to eastern China is prevalent in winter. Decadal trends of the haze pollution China during 2000-2015 indicate evident impact of regional circulation on frequency and distribution of haze events, especially in summer. Besides the strength, the direction and location of circulation is also important. The coming geostationary satellites will provides new insights into the dramatic changes of air pollution in China as well as its interaction with regional climate.

1.018 Identification and impact of biomass burning on Monsoon Asia.

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Abstract:

This work presents a combined methodology analyzing simultaneous tropospheric measurements of AOD and trace gasses, and then using them to constrain multi-scale models. The goal is to constrain the extensive biomass burning and urban plumes found throughout the Asian Monsoon region.
Measurements from the past 11 years (2006-2016), over Southeast Asia and East Asia, a region characterized by rapidly changing emissions due to deforestation, increasing urbanization, and economic development. Additional complexity comes from the Monsoon meteorology, leading to very different atmospheric fate and transport mechanisms on inter-annual, annual, and intra-annual time scales. Specific measurements of both aerosol and related gas phase tropospheric measurements across different spectral, spatial, temporal, and passive/active sensors and properties, including: MODIS, MISR, OMI, CALIOP, and others. The modeling components are designed to address scales ranging from large-scale biomass burning plumes that originate in Myanmar, Thailand, Laos, Vietnam, and rural Southwestern China, where they are lofted and transported thousands of kilometers away from their source, eventually mixing with urban plumes.
High resolution models are required to compute the appropriate lofting, due to heat from the biomass burning and the changes in the radiative column induced by the high loading of aerosols. Detailed chemistry is required to compute the ultimate aerosol mixing and physical properties at high concentrations. Furthermore, to understand the impact of the large-scale Monsoon meteorology, mesoscale models are used to compute the transport thousands of kilometers downwind.
This work will demonstrate how the approach can constrain the emissions in 4 dimensions, as well as attempt to present what next needs to be done in terms of the physics and chemistry to reproduce the measured fields. Furthermore, a trio of new information, including a time-invariant urban signal, slowly-time-varying new-urbanization signal, and a rapidly time-varying biomass burning signal are described in detail.

1.019 Seasonal Changes in Molecular and Stable Carbon Isotopic Compositions of Dicarboxylic Acids and Related Polar Compounds in the Northeast Asian Atmosphere.

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Abstract:

Dicarboxylic acids and related polar compounds are abundant species in the atmosphere and account for a substantial fraction of the water-soluble organic aerosols. The water-soluble organic aerosols have serious impact on the Earth's climate system through indirect radiative forcing because of their hygroscopic properties and capability to act as cloud condensation nuclei. However, the seasonality of diacids and related compounds and their origins in Northeast Asia are not fully understood. We studied the aerosol samples collected from Sapporo, northern Japan (43.07°N, 141.36°E) during 2 September 2009 and 5 October 2010 for diacids, ketoacids, a-dicarbonyls and fatty acids and their stable carbon isotopic compositions ($d^{13}C$), using a capillary GC and GC-MS and GC-irMS, respectively. Molecular distributions of diacids were characterized by a predominance of oxalic acid (C_2) throughout four seasons followed by C_3 and C_4 diacids. Total diacids were found to contribute 1.22-3.03% of TC and 3.73-16.3% of WSOC. Saturated *n*-diacids (C_2-C_{11}, except for C_5 and C_6), long-chain ketoacids (C_7-C_9) and even-carbon numbered fatty acids (C_{14}-C_{24}) showed a seasonal pattern with a gradual decrease from autumn to winter and then a gradual increase from spring to summer. $d^{13}C$ of diacids showed an enrichment of ^{13}C in C_2 diacid than in C_3 and C_4 diacids. Average $d^{13}C$ of individual diacid species, except C_9 acid, were significantly higher than those of fatty acids. Based on the results obtained and their comparisons with the literature, we found that the Sapporo aerosols are mainly originated from biogenic sources and significantly aged during long-range transport and thus largely influenced by outflows from distant source regions rather than local emissions. However, relatively high concentrations of phthalic acid (Ph) and mass ratios of C_6/C_9 and Ph/C_9 diacids in winter suggest a significant anthropogenic contribution.

1.020 Networking in-situ ground measurements for validation of Korean GEMS (Geostationary Environmental Monitoring Satellite/Spectrometer) products.

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Abstract:

Considering that geostationary environment satellites(GEO) will be launched simultaneously in Korea(GEMS), the United States(TEMPO) and Europe(Sentinel-4) with the time frame of from 2019 to 2021, it is a very challenging research task to establish the validation strategy of GEO L2 products and to integrate *in-situ* ground measurements by making the linkage with each other. This work might be one of very important tasks that determines the success or failure of the development project for GEO because maintaining the high accuracy and consistency of its products is critical to achieve the scientific goals of the entire satellite development project. To evaluate the products of Korean GEMS, the GEMS Science Team will utilize the surface air quality monitoring data at more than 500 ground stations, the chemical composition information at 6 Supersites, the remote sensing data from Korean LIDAR network, the intensive aircraft campaign data, i.e., KORUS-AQ 2016 data and MAPS-SEOUL 2015 data within the Korean Peninsula. In addition, several ground measurement and remote sensing data over East Asia including China and Japan, for example, the MAX-DOAS network, NASA's PANDORA network and AERONET network, EANET data and WMO Global Atmospheric ozone monitoring data will also be used. Moreover, current operated LEO environmental satellite data can be also valuable for comparison to GEMS data.
Keywords: GEMS, in-situ ground measurements, L2 product

1.021 Impact of a new emission inventory on CAM5 simulations of aerosols and aerosol radiative effects in eastern China.

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Abstract:

Emissions of aerosols and gas precursors in China have increased significantly over the past three decades with the rapid economic growth. These increases might have a large climate effect. However, global aerosol-climate models often show large biases in aerosol distribution and radiative forcing in China, and these biases are often attributed to uncertainties and biases associated with the emission inventory used to drive the models. In this study, an energy-statics and technology-based emission inventory, Multi-scale Emission Inventory for China (MEIC), was compiled and used to drive the Community Atmosphere Model Version 5 (CAM5) to evaluate aerosol distribution and radiative effects in China against observations, compared with the model simulations with the widely-used

IPCC AR5 emission inventory. We found that the new MEIC emission improves the annual mean AOD simulations in eastern China by 12.9% compared with MODIS observations and 14.7% compared with MISR observations, and explains 22%-28% of the AOD low bias simulated with the AR5 emission. Seasonal variation of the MEIC emission leads to a better agreement with the observed surface concentrations of primary aerosols (i.e., primary organic carbon and black carbon) than the AR5 emission, while the seasonal variation of secondary aerosols (i.e., sulfate and secondary organic aerosol) depends less on the emission. The new emission inventory estimates the annual averaged aerosol direct radiative effect at TOA, surface, and atmosphere to be -0.50, -12.76, and 12.26 W m^{-2} respectively over eastern China, which are enhanced by -0.19, -2.42, and 2.23 W m^{-2} compared with the AR5 emission.Due to higher winter BC emission in MEIC, the atmospheric warming effect and the surface cooling of BC are twice as much as those using the AR5 emission. This study highlights the importance of improving the aerosol and gas precursor emissions in modeling the atmospheric aerosols and their radiative effects.

1.022 A new high resolution technology-based bottom-up emissions inventory for Nepal.

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Abstract:

In this study we have developed a high resolution (1km × 1km) present-day emission inventory for Nepal with a higher-tier approach to understanding the current combustion technologies in use and sectoral energy consumption. The emissions of aerosols, trace gases and greenhouse gases were estimated from residential, industry, transport, and commercial sources (i.e., non-open burning sources), as well as agro-residue and trash burning sources (i.e., open burning sources) for the base year 2013 using bottom-up methodologies. The estimates are based on (i) robust local knowledge such as local practices and activities, especially for dispersed sources like brick production, diesel generators, agri-residue burning and garbage burning, and (ii) newly-measured country-specific emission factors for several previously under-characterized sources. A GIS-based population density map was developed incorporating land-use and land cover data, settlement points, and topography for spatial distribution of emissions. Geospatial locations were assigned to point sources, while activity-based proxies, including population distribution, were used for other sources. The energy use estimates in the industrial and commercial sectors exceed the estimates provided in the governmental reports by a factor of two, whereas in the residential sector there is a good agreement (within 15%) with the government data. The national annual total $PM_{2.5}$, BC, OC, and SO_2 emissions estimated for the year 2013 from these three sectors were 86 Gg, 18 Gg, 37 Gg and 15 Gg, respectively. Emissions varied widely across grids, even within the Kathmandu Valley – for example, BC emissions varied between 0.5 and 20 tonnes per grid. These revised emissions will be used in analysis of atmospheric processes, impacts, and mitigation of air pollutants in Nepal and the Himalayan region.

1.023 Impact of summertime rainfall on PM levels over China.

Early Career Scientist

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Abstract:

Fine particulate matter ($PM_{2.5}$) is a significant threat to the public health over China. The Asian monsoon system brings a large amount of precipitation in summertime, but the effect on PM2.5 is not well quantified. We provide comprehensive analysis on the effect of monsoon precipitation on PM2.5 levels at daily and hourly scales. We found differences in removal efficiency between north and south China. This can be partly attributed to differences in pre-rain conditions and formation enhancement from heterogeneous reaction. Besides, rainy day meterological conditions act to enhance PM2.5 through secondary formation and unfavorable dispersion conditions, partly compensating the cleaning effect of monsoonal rainfall.

1.024 New observatories, new data, and new insights on air pollution in the Himalaya.

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Abstract:

Since hosting the first ACAM meeting in 2013, ICIMOD's Atmosphere Initiative has built research capacity, and strengthened government institutions in the Himalayan region to undertake atmospheric monitoring. During 2015 and 2016, we have brought into operation new state-of-the-art observatories and air quality monitoring stations at three locations in Bhutan and six locations in Nepal, extending from 100 meters above sea level in the Indo-Gangetic Plains (IGP), to 4900 meters above sea level, at the altitude of glacier snouts.

The stations provide real time data to the governments of the two countries, and will help in the design and evaluation of mitigation strategies as well as support public awareness about air quality, air pollution and mitigation options. The data collected also provide important insights about atmospheric processes, and potential impacts of air pollution on environment and health. We have discovered that unhealthy air pollution is not confined to cities, but that large areas of southern Nepal, and most likely major parts of the IGP, are extremely polluted. We have studied the influences of forest fires and agricultural burning on air quality as well as IGP winter fog. Furthermore, the importance of the condition of snow and ice for downstream communities have led us to study related atmospheric processes, and we now have a better understanding of the source areas for black carbon that contributes to the melting of snow and glaciers in different parts of the Himalayan region. Our overall efforts go beyond contributing to improved knowledge of the atmosphere among key stakeholders in the region, to building regional collaboration and working on mitigation and policy.

1.025 A new approach to modeling biomass burning emissions over the Southeast and East Asian Monsoon regions.

Early Career Scientist

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Abstract:

This study designs a new modeling methodology that simultaneously integrates measurements of AOD and some trace gasses to constrain emissions. This specific work looks at the model results of this effort, and reveals a trio of conclusions about the biomass burning in space, time, and magnitude. Additional information is gleaned from changes in urbanization.

Computing the physical and chemical properties of aerosols under the high loadings and complex meteorology of this Monsoon region is very complex. We employ WRF-Chem simulations using different constrained emissions scenarios in 4 dimensions and analyze the impacts that these have on the transport, chemistry, and physics of the aerosols over a two-month period in 2016. The column loadings of BC and OC are compared against measurements from AERONET and MODIS, while the column loadings and surface concentrations of CO are compared against measurements from MOPITT and surface stations where available.

Detailed analytics between the model results and the measurements show that the model performs better under the new emissions representations of biomass burning that the previous hotspot based approach. Some of the reasons include new source regions which are not found in either maps of urbanization or fire hotspots. The findings, however, are consistent with the current rapid economic development and movement of people throughout Southeast and East Asia. Additionally, this work supports other studies addressing the vertical and subsequent long-range transport of smoke throughout this region.

1.026 Exploring the relationship between meteorology and surface PM2.5 in Northern India.

Early Career Scientist

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Abstract:

Northern India is one of the most polluted and densely populated regions in world. Accurately modeling pollution in the region is difficult due to the extreme conditions with respect to emissions, meteorology, and topography, but it is paramount in order to understand how future changes in emissions and climate may alter the region's pollution regime. We evaluate a developmental version of the new-generation NOAA GFDL Atmospheric Model, version 4 (AM4) in its ability to simulate observed wintertime $PM_{2.5}$ and its relationship to meteorology over Northern India (23°N–31°N, 68°E–90°E). We perform two simulations of the GFDL-AM4 nudged to observed meteorology for the period (1980–2016) with two emission inventories developed for CMIP5 and CMIP6 and compare results with observations from India's Central Pollution Control Board (CPCB) for the period 1 October 2015 – 31 March 2016. Overall, our results indicate that the simulation with CMIP6 emissions has substantially reduced the low model bias in the region.

The AM4, albeit biased low, generally simulates the magnitude and daily variability in observed total $PM_{2.5}$. Ammonium nitrate and ammonium sulfate are the primary components of $PM_{2.5}$ in the model, and although not directly observed, correlations of total observed $PM_{2.5}$ and meteorology with the modeled individual $PM_{2.5}$ components suggest the same for the observations. The model correctly reproduces the shape and magnitude of the seasonal cycle of $PM_{2.5}$; but for the diurnal cycle, it misses the early evening rise and secondary maximum found in the observations. Observed $PM_{2.5}$ abundances within the densely populated Indo-Gangetic Plain are by far the highest and are closely related to boundary layer meteorology, specifically relative humidity, wind speed, boundary layer height, and inversion strength. The GFDL-AM4 reproduces the

observed pollution gradient over Northern India as well as the strength of the meteorology–$PM_{2.5}$ relationship in most locations.

1.027 Simulation of light absorbing aerosols' effects over the Tibetan Plateau and Himalayas .

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Abstract:

The majority light absorbing aerosols (LAAs) in atmosphere are composed from black carbon (BC), brown carbon and dusts. The LAAs have strong absorption in solar shortwave radiation and generate warming effects in the atmosphere. Once the LAAs deposit in the snow/ice through the dry and wet removal processes, the ground albedo is decreased and the absorption efficiency of solar radiation is increased. So the LAAs are considered as an important element that impact on the cryospheric environment and climatic change over the Tibetan Plateau and Himalayas. Here, we summarized our current studies focusing on the investigation of LAAs impacts on the climate change and water balance through the modeling method. A high resolution regional climate coupled with an aerosol-snow/ice feedback module was also used to simulate the effects of natural (mineral dusts) and anthropogenic (black carbon) LAAs over the TP and Himalayas. The climatic effects induced by LAIs were also assessed.

1.028 Sources of formaldehyde and their contributions to photochemical O3 formation at an urban site in the Pearl River Delta, southern China .

Early Career Scientist

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Abstract:

Identification and quantification of the contributions of primary emissions and secondary formation of formaldehyde (HCHO) are prerequisite for the formulation and implementation of control measures of HCHO, which play an important role in the atmospheric photochemistry and are hazardous materials having detrimental effects on human health. In this study, two models (the Positive Matrix Factorization (PMF) model and a photochemical box model with Master Chemical Mechanism (PBM-MCM)) were applied to analyze the HCHO data collected in July 2006 at an urban site (GPEMC) in the Pearl River Delta (PRD), southern China. Three major HCHO sources (secondary formation, vehicular exhaust, and solvent usage) were identified and they were found to contribute in average 53%, 31% and 16% respectively to the total HCHO loading in the PRD region. Among the identified secondary HCHO precursors, isoprene was the most important biogenic contributor, while the main anthropogenic counterparts were attributed to cis-2-butene, m-xylene, toluene, ethene and propene. Secondary HCHO contributed to 7 ppbv ground-based measured O3 at GPEMC, higher than those from the other two sources (vehicular exhaust, 4 ppbv; solvent usage, 2 ppbv). The contributions of HCHO to the HOx (HOx = HO2 + OH) radical loading were found to be more dominant from secondary formation (57%) than the others as well (vehicular exhaust, 30%; solvent usage, 13%). Our results highlight the importance of secondary HCHO formation for both photochemical formation of ozone and the oxidative capacity of the atmosphere in this region. It is hence critical for policy makers to propose strategies for controlling VOCs from biogenic and vehicular emissions in order to reduce secondary HCHO formation. Our results also have important implication for improving the understanding of the source apportionments of HCHO and their contributions to photochemical pollution in the PRD region in China.

1.030 The influence of urban open space and elevated buildings on building intake fraction and daily pollutant exposure.

Early Career Scientist

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Abstract:

Urban air pollution is becoming a more and more important environmental problem. Suitable city redevelopment is an effective way to improve urban ventilation and help pollutant dilution. This paper investigates the impact of urban open space and elevated buildings on pollutant (CO) exposure in 3-D urban canopy layer (UCL) models with medium packing density (plan area index and frontal area index l_p=l_f=0.25). Computational fluid dynamics (CFD) simulations are carried out under neutral atmospheric condition. The initial numerical UCL model consists of 55 cubic buildings (H=B=30m). In the first group, one of the 25 building models is removed to attain urban open space settings. In the second group, the first floor, or second floor or third floor of all building models are elevated respectively to create wind pathways through buildings. The standard *k-e* model is used to model the turbulence. CFD methodologies are successfully validated by wind tunnel data. Four wind directions are considered (0^0,15^0, 30^0, 45^0). The contribution of pollutant concentration reduction by urban open space and elevated building is quantified by two indicators: intake fraction (IF) and daily pollutant exposure (Et). The intake fraction represents the ratio of pollutant inhaled to the total pollutant emitted. The daily pollutant exposure represents the extent of a person contact with pollutants within one day. Results show that, urban open space and elevated building can effectively reduce pollutant exposure for urban residents. Wind directions of 15^0 and 30^0 experience better pollutant dilution capacity thus attain less pollutant exposure than 45^0 and 90^0.

1.031 A Multi-model Operational Air Pollution Forecast System for China.

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Abstract:

Every year, more than 3 millions people die prematurely from breathing air pollutants, which, according to the World Health Organization, trigger heart failures, strokes, pulmonary diseases and lung cancers. Children are particularly vulnerable to dirty air. Air pollution (back ground concentrations and acute episodes) has therefore become a global environmental problem that needs to be urgently addressed.
In order to better predict, and hence to avoid, the occurrence of high levels of particulate matter (PM), ozone, and other pollutants, a multi-model analysis and prediction system has been developed by combining 7 global and regional chemical transport models. The system has been applied in China as part of the European Panda and MarcoPolo Projects. The paper will describe the system, which is now operational, present some illustrative examples of air quality forecasts and discusses ways to downscale results to a city block scale in urban areas (statistical methods) and to reduce biases in the predictions. Perspectives for applying such systems in other parts of the world will be provided. A new international initiative, called “Monitoring, Analysis and Prediction of Air Quality (MAP-AQ) will be presented and discussed.

1.032 Analyzing the spatial and temporal changes of satellite retrievals of CO and AOD in polluted areas of Monsoon Southeast and East Asia.

Early Career Scientist

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Abstract:

This work presents a methodology and results from analyzing combined measurements of AOD from MODIS and CO from MOPITT from the past 17 years (2000-2016) over Southeast and East Asia. The results focus on those regions which are heavily influenced by large-scale biomass burning and intense urban pollution. It is observed that while there are some areas that are always polluted, there are other areas which are heavily polluted only during certain times of the year. There are other signals found in the data, corresponding to expanding urbanization, and differences on year-to-year scales.
Over the areas of significant changes, in space or time, we focus on analyzing how the changes are significantly different between the two measured datasets. Large differences are observed due to a few well known factors: different removal and in-situ atmospheric processes between the two species, leading to significantly different lifetimes; and different resolutions, with the higher resolution AOD measurements being able to replicate sudden changes more precisely. Additionally, information is obtained from the CO retrievals, which sometimes provide two vertical levels of information. When this is the case, we also observe the change of the vertical distribution, and use this piece of information to further understand the source profile.
These results are used to compare with measurements from the AERONET, NOAA, and Hong Kong government datasets, where available, and show consistent results. The results are then used to constrain model runs of WRF-CHEM to understand better the ability to fundamentally model the atmospheric loadings from first principles. We are able to conclude that presently the emissions of CO are underestimated from Southeast Asia, and further that they have a significant impact on the atmospheric loadings throughout both Southeast Asia and Southern China, as well as further afield.

1.033 Characterization of isoprene and its oxidation products at a subtropical forested mountain site of Southern China.

Early Career Scientist

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Abstract:

Isoprene has drawn attention as its pervasive biogenic sources and extremely high reactivity which potentially make a large impact on the global climate. In order to better understand the role that isoprene plays in the atmosphere, it is important to explore the relationship between isoprene and its photochemical products. However, this kind of information is lacking in subtropical forested high-altitude mountain-site in the north vicinity of Pearl River Delta (PRD) region where the air quality is significantly affected by local plant emissions and regional transport. Therefore, a field measurement study of isoprene and its oxidation products, methacrolein (MACR) and methyl vinyl ketone (MVK) was performed in July 15^{th} – Aug. 4^{th} 2016 at the summit of Mt. Tian Jing Shan in Southern China (1690 m a.s.l., 24°41′ N, 112°53′ E). Hourly sampling and analysis were achieved automatically by an online cryogen-free automatic GC-MS system. The average mixing ratios of isoprene, MACR, and MVK were 319, 89, and 341 pptv, respectively. The average daytime levels of isoprene and MVK were significantly higher than the average nighttime values, while for MACR, the daytime levels were slightly lower than the average nighttime values. Isoprene and MVK peaked at 16:00 LST, while MACR peaked at 22:00. The average daytime and nighttime MVK/MACR ratios were 2.4 and 1.9, both higher than the theoretical ratio (~2 and ~1, respectively). Regression analysis of total O_3 (O_3 + NO_2) versus MVK resulted in an estimated contribution of isoprene oxidation to ozone production of 27.8% and 14.7% in daytime and nighttime periods, respectively. The characteristics of isoprene, MACR and MVK during this study suggest we have a comprehensive understanding of the first few stages of isoprene oxidation in this forested mountain site.

1.034 How biogenic isoprene emission responses to vegetation variations globally?.

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Abstract:

Isoprene, as the predominant BVOCs component, is mainly emitted by forest and plays a vital role on atmospheric environment. This paper presents a study of the change in biogenic isoprene emissions that would result from vegetation variations between 2000 and 2015 based on the satellite vegetation data coupled with modeling isoprene data. The result shows that no significant change in isoprene emission is observed globally with the net change of -1.5%, but obvious changes in isoprene emissions were observed in some certain regions, with the largest decreases in isoprene emission are in mid-central USA, middle and southern Asia, Amazon basin, western Africa, and central Australia, and highest increases in east Brazil and Australia, Mexico, west Europe, and mid-Asia. The decreases of broadleaf and non-trees contribute 1.8% and 0.5% reduction of isoprene emission, while isoprene emitted by needleleaf has increased by 0.9%. Wildfires, logging, grazing and alternations in land use are the key reasons for the loss of forest and further decreasing isoprene emission, while afforestation and the implement of forest law cause the elevation of isoprene emissions.

1.035 Atmospheric heavy metals deposition in urban and suburban, the Pearl River Delta region, China.

Early Career Scientist

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Abstract:

The Pearl River Delta region suffers from severe atmospheric pollution in China, located in the subtropical monsoon climate area with abundant rainfall throughout the year. Spatial and temporal variabilities of wet and dry deposition constituents are examined based on soluble/insoluble of Cu, Pb, Cd, Cr and Zn in samples collected from 2010 to 2015 in Guangzhou and Dinghushan. Backward trajectories and PMF analysis are applied to investigate wet deposition source. Wet and dry deposition fluxes in Dinghushan is in the order of Zn > Pb > Cu > Cr > Cd while Guangzhou is Zn > Cu > Pb > Cr > Cd. Wet deposition fluxes of Cu, Pb, Zn in Dinghushan are higher than Guangzhou, while Cd and Cr fluxes are opposite; dry deposition fluxes in Guangzhou are all higher than Dinghushan. Wet deposition fluxes present seasonal variation: rainy season are higher than dry season; while dry deposition doesn't. Ratio of wet/dry deposition fluxes value indicates heavy metals deposition is governed by wet deposition. The solubility of heavy metals decrease in the order of Cd > Zn > Cu > Pb > Cr in Dinghushan; and Zn > Cd > Cu > Pb > Cr in Guangzhou. All heavy metals display a decrease of the solubility with pH increase, solubility of the heavy metals was higher at pH < 5. Cr exists more in insoluble fraction than soluble fraction in wet deposition, and higher insoluble fraction of 5 heavy metals are found in dry deposition. Air mass from the South China Sea brings abundant rainfall and relatively cleaner air-mass to both Guangzhou and Dinghushan, compared to the contaminated air-mass from the mainland of China and Taiwan island. Industries and vehicle are the dominated sources to the heavy metals in Guangzhou while ceramics industry, incense burning and vehicle in Dinghushan.

1.036 Evaluate dry deposition velocity of the nitrogen oxides using Noah-MP physics ensemble simulations for the Dinghushan forest, southern China.

Early Career Scientist

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Abstract:

There has been a rapid growth of reactive nitrogen (N_r) deposition over the world in the past decades. The Pearl River Delta region is one of the areas with high loading of nitrogen deposition. But there are still large uncertainties in the study of dry deposition because of its complex processes of physical chemistry and vegetation physiology. At present, the forest canopy parameterization scheme used in WRF-Chem model is a single-layer “big leaf” model, and the simulation of radiation transmission and energy balance in forest canopy is not detailed and accurate. Noah-MP land surface model(Noah-MP) is based on the Noah land surface model (Noah LSM) and has multiple parametric options to simulate the energy, momentum, and material interactions of the vegetation-soil-atmosphere system. Therefore, to investigate the improvement of the simulation results of WRF-Chem on the nitrogen deposition in forest area after coupled with Noah-MP model and reduce the influence of meteorological simulation biases on the dry deposition velocity simulation, a dry deposition single-point model coupled by Noah-MP and the WRF-Chem dry deposition module (WDDM) was used to simulate the deposition velocity(V_d). The model was driven by the micro-meteorological observation of the Dinghushan Forest Ecosystem Location Station. And a series of numerical experiments were carried out to

identify the key processes influencing the calculation of dry deposition velocity, and the effects of various surface physical and plant physiological processes on dry deposition were discussed. The model captured the observed V_d well, but still underestimated the V_d. The self-defect of Wesely scheme applied by WDDM, and the inaccuracy of built-in parameters in WDDM and input data for Noah-MP (e.g. LAI) were the key factors that cause the underestimation of V_d. Therefore, future work is needed to improve model mechanisms and parameterization.

1.037 SYNOPTIC SITUATIONS OF PM2.5 POLLUTED EPISODES AND TRANSPORTATION CHARACTERISTICS DURING A TYPICAL WINTER SEVERE POLLUTED EVENT IN ZHAOQING.

Early Career Scientist

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Abstract:

In order to investigate the occurrence and development of severe particle pollution process, two-years (2013-2014) of continuous observation data of $PM_{2.5}$ collected in Zhaoqing, Guangdong province were used and analysis in this study, further to explore the seasonal variation of air quality and $PM_{2.5}$ pollution processes. In addition, all the particle pollution processes combined with their weather condition during 2013 and 2014 were summarized and analyzed, and the air quality numerical model (WRF-Chem) was applied to simulate and study a typical winter heavy haze event. The result showed that, a total of 27 polluted episodes were found between 2013 and 2014, and the extremely polluted episodes mainly occurred in autumn and winter season. By analyzing the characteristics of $PM_{2.5}$ polluted episodes. Four typical weather conditions related to polluted episodes were summarized, including weak-high-pressure type (48%), tropical-depression type (22%), front type (19%) and strong-high-pressure type (11%). The prevailing wind direction was southeast and south under the influence of these weather conditions, and the atmosphere was in a steady state, resulting in the accumulation of pollutants and further leading to the occurrence of polluted episode. Model results revealed that the adverse meteorological conditions and local emission sources were the key reasons for the occurring of pollution processes. Four-dimensional Fluxes Model was employed to study the regional transport flux of atmospheric pollutants. Negative net flux was found for PM2.5, indicting the pollutants in Zhaoqing area were exported to adjacent

areas, especially for NO_3^- and NH_4^+, which presented a relatively higher negative flux. In addition, the transport pathway of pollutants in Zhaoqing mainly ran from southeast to northwest. The nonlocal pollutants tend to be transported through the pathway and further influence the air quality of Zhaoqing area.

1.038 Analysis of tropospheric ozone long-term changing trends and affecting factors over northern China.

Early Career Scientist

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Abstract:

The tropospheric ozone is an important pollutant composition and greenhouse gas, of which the generation process is often closely related to the photochemical reaction of pollutant gases discharged by human activities. In this paper, long-time series of tropospheric ozone datasets for the period of 1979–2013 are used to investigate the long-term trends of the tropospheric ozone in northern China, and quantitatively assess the influences of major impact factors on ozone changes, while combining the effects analysis of tropopause height change on the column of the tropospheric ozone during the same period. From the decadal scale, it can be seen that the tropospheric ozone long-term trends in northern China over 30 years showed significant differences in the different seasons. Among them, the summer tropospheric ozone presented a growth trend with the growth rate of 1.28 DU/10 a, while the winter data showed a downward trend with the decline rate of 1.46 DU/10 a, and spring and autumn showed volatility characteristics and downward trend in their fluctuations. In northern China the major impact factors of tropospheric ozone include solar, ENSO and QBO. The influence of the solar cycle from trough to peak can generally reach 5–6 DU, the effect of precipitation is 5–6 DU, and the effect of ENSO is 1–2 DU, while that of QBO in most cases is less than 2 DU. The NCEP tropopause height data are used to analyze the northern China tropopause height variation, and the results show that there is no significant change in the northern China tropopause height from the decadal time scale, only a significant variation in the different seasons of the year. It is shown that the changes in tropopause height and tropospheric ozone are closely related, and the correlation coefficient R=0.826.
Keywords: northern China, tropospheric ozone, solar, ENSO, QBO

1.039 17 years of MOPITT: A satellite perspective on decadal-scale trends in Asian pollution.

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Abstract:

Measurements Of Pollution In The Troposphere (MOPITT) on the NASA Terra spacecraft has been measuring the global atmospheric abundance of carbon monoxide (CO) since March 2000. CO is mainly produced by incomplete combustion from both natural fires and anthropogenic activities and is also a product of chemical reactions with other air pollutants. CO plays an important role in atmospheric chemistry and climate because it is a dominant sink for the hydroxyl radical (OH) and thus affects the abundance of greenhouse gases methane (CH4) and ozone (O3). Since CO is a pre-cursor to greenhouse gases, anthropogenic emissions of CO have a small but significant indirect radiative forcing of 0.22 W/m2. Satellite measurements of carbon monoxide are used to understand how pollution is emitted and transported globally, from large scale fires to urban sources. I will present an overview of the MOPITT mission with recent science results and then focus on changing CO distributions in Asia, including the impact of the 2015 ENSO on fires in Indonesia.

1.040 Numerical Simulation of Ozone and Secondary Organic Aerosols in Pearl River Delta and Different Sources' Contributions to Them.

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Abstract:

Secondary organic aerosols (SOA) and ozone are important components of the atmosphere, which can affect the atmospheric environment and human health. Through the simulations of the meteorological field and chemical field from 2008.12.01 to 2008.12.19 using WRF/CHEM, the optimal simulation schemes were selected. Then the sensitivity experiments were carried out to obtain the contributions of different pollution sources on SOA and ozone.

1.042 Seasonal Variation of Photochemical smog pollution in Metropolitan City of India in relation to Ozone precursor concentrations and meteorological conditions.

Early Career Scientist

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Abstract:

Monitoring of photochemical pollutants was performed at 4 selected sites during three different seasons viz. summer (Apr-June), monsoon (July – Sept) and winter (Nov-Feb) in metropolitan city, New Delhi, India from year 2009-2010. Monthly variations of secondary pollutant i.e. Ozone (O_3) were analyzed in relation to meteorological conditions as well as regional transport of pollutants related with the monsoon. The values of O_3 in New Delhi was found to be high in traffic intersection areas and lower in residential areas. High temperature, moderate relative humidity and low wind speed favours high ozone concentrations. Seasonal variation of O_3, though, were found to relate to the local transport linked with the Asian monsoon. Highest O_3 pollution was found in the months of January and May i.e. winter and summer months and lowest in mid-monsoon season i.e. August. Moreover, seasonal variations in NOx/NMHC ratios are reliable with respect to O_3 variations i.e. most favourable in summer (0.08), then in winter (0.06) and lowest during monsoon season (0.04).

1.043 Source apportionment PM10 in a respirable size fraction of PM10 during pre-monsoon season at a South Asian Mega City.

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Abstract:

In the present study, elemental composition of PM10 and its corresponding source apportionment was conducted in the urban atmospheric of Karachi Metropolitan area Pakistan, a South Asian mega city. The size segregated aerosol samples were collected on Quartz fiber filters using a high volume sampler during the months of March-April 2009. Trace elements such as Ni, Ba, Cd, Ca, Mg, Cr, Mn, Fe, Co, Cu, Sr and Ti were extracted by using 5% HNO_3 standard solution and Al, Pb, Zn, Se, P and S in 1% HNO_3 standard solution followed by analysis using ICP-AES spectrometer. The PM10 concentration ranged from 255 µg/m^3 to 793 µg/m^3 with an average of 438 ± 161µg/m^3. Among the various elements analyzed, concentrations of Ca, Al and Fe were highest (> 10 000 ng/m^3), followed by Mg and S (> 1000 ng/m^3). Elements like Zn, P, Cu, Pb, Mn, Ti, Sr and Ba demonstrated medium concentrations (> 100 ng/m^3), whereas lowest concentrations were measured for elements like Cr, Ni and Se (> 10 ng/m^3). The Positive Matrix Factorization model identified five possible factors contributing towards PM10, including biomass burning, coal combustion, re-suspended road/soil dust, vehicular emission and industrial dust. A strong positive correlation (R^2 = 0.98) was observed between the model predicted PM10 mass and gravimetrically measured mass collected on filters. The contribution from biomass burning to PM10 was found to be 23%. Vehicular emission was 22% and Industrial dust was also found to be 23%. This shows all sources have equal contribution towards bad air quality.

1.044 Multiple Regression approach for air quality assessment using integrated surface, satellite, and meteorological data over Jaipur, Rajasthan India..

Early Career Scientist

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Abstract:

Multivariable techniques based on the regression analysis between the satellite based AOD retrievals (MODIS Level 2.0 AOD at 550nm), meteorological variables (Temperature, Relative Humidity and Wind speed) and ground based daily averaged Respirable Suspended Particulate Matter (RSPM) were analysed over Jaipur, India. The air quality assessment was conducted for the period April, 2010 to March, 2013 over the study region.RSPM values were acquired from the Rajasthan Pollution Control Board (RPCB). To forecast RSPM, techniques used are simple linear, multi-linear regression and log linear regression. Model with logarithmic regression shows better statistical results in terms of statistical parameters like Normalised mean square error (NMSE=0.01), Correlation (R=0.59), Factor of Two (FA2=100%) and Fractional Bias (FB=0.00001) in comparison to observations. Meteorological conditions are found to influence the relationship between AOD and RSPM concentration. Same model is used to forecast the RSPM for the period Apr, 2013 to Mar, 2014. The statistical results indicates that this model has again performed better for forecasting RSPM (R=0.59, NMSE=0.01, FA2=100%, FB=-0.07). For most of the cases, predicted RSPM slightly overestimate than the observed value. The average RSPM obtained from RPCB observations is 119.6µg/m3 whereas the predicted average is 152.43µg/m3. These RSPM values over Jaipur come under the “Moderately Polluted” category as per National Air Quality Standards (NAAQS). During dust storms it can go in the range of 250-430 µg/m3 which comes under the severe quality of air pollution, which also brings serious human health impacts. So, this approach can be used to forecast RSPM in nearby surrounding areas where there are no ground stations for RSPM. The finding of these results illustrates the importance of satellite data in air quality assessment, which is broadly available over the world and may provide an important supplemental source of information of aerosols to determine surface RSPM concentrations.

1.045 A study on characterization, emission and deposition of black carbon over Indo-Gangetic Basin.

Early Career Scientist

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Abstract:

Atmospheric aerosol plays a significant role in the earth climate system. The northern part of India along with the Indo-Gangetic Basin is often influenced with dust transported from the Thar Desert of Rajasthan and long-range transported crop burning from northwest India. Black carbon (BC) is gaining considerable attention as a strong absorber of the solar radiation in the visible and near infrared wavelength and subsequently because of its ability to alter the monsoon pattern and its effect on human health. This paper deals with BC mass concentration and its characterization, source identification and deposition to natural surfaces at Agra over the Indo- Gangetic basin during January-December, 2016. The average mass concentration of BC was found to be 5.3 µg m^{-3}. The diurnal variation of black carbon shows the highest peak in night time than in day time due to low atmospheric boundary layer (ABL) and local sources from study region. The major sources of BC were found to be fossil fuel throughout the year while biomass combustion was dominated in the winter season. The estimation of direct dry deposition of BC on a natural surface has been carried out for the first time using surface washing method and dry deposition flux was found to be high. The mean estimated radiative forcing is -14 W m^{-2} at top of atmosphere while, at the surface net radiative forcing is -237 W m^{-2} and 223 W m^{-2} at the atmosphere. The radiative forcing without the BC has been estimated and subtracted from the radiative forcing due to the composite aerosol. Radiative forcing obtained due to BC over this region is in the reported range.

1.046 Air pollution caused by Volatile Organic Compound (Benzene, Toluene and Xylene) in Ho Chi Minh City and mitigation solutions.

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Abstract:

Since July, 2001, unleaded gasoline has been used through Vietnam. This helped to decrease the concentration of organic lead in the air. However, lead was replaced by other additives which contains high concentration of ring hydrocarbon lead to air pollution severely. These ring hydrocarbon, such as Benzene, Toluene, Xylene (BTX) cause cancer (a maximum of 5% Benzene in Vietnam Standards – NTR 2000). Therefore, Ho Chi Minh City (HCMC) government established many monitoring stations in some areas in HCMC. The monitoring results showed that these concentrations of Benzene, Toluene and Xylene were very high. For example, the concentration of Benzene was ten times higher than that of maximum permitted standard of WHO.
This report not only presents the monitoring results of the concentration of Benzene, Toluene, Xylene in the air of HCMC in many years but proposes measures to mitigate air pollution.
Keywords: air pollution; Benzene; Toluene; Xylene

1.047 Variation in aerosol optical properties and the sources of aerosols at Buddha's Birthplace, Lumbini, Nepal.

Early Career Scientist

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Abstract:

Aerosol optical properties were measured over Lumbini, Nepal with CIMEL sunphotometer of the Aerosol Robotic Network (AERONET) program. Lumbini, located near the northern edge of the central Indo-Gangetic Plains (IGP), is a sacred place- the birthplace of Lord Buddha and a UNESCO world heritage site. Average aerosol optical depth (AOD_{500}) was found to be 0.64±0.38 (0.06-3.28) over the sampling period (January 2013 - December 2014), with highest seasonal AOD during post-monsoon season (0.72±0.44). More than 84% of the daily averaged AOD values, during the monitoring period, were above 0.3, indicating polluted conditions in the region. Levels of aerosol loading observed in Lumbini were comparable to those observed at several sites in the IGP. Based on the relationship between AOD and Ångstrom exponent (α), urban/industrial and biomass burning, and mixed aerosols were found to be the most prevalent aerosol types. During all seasons the air mass reaching the study site traversed large distance across the IGP. The aerosol volume size distribution was bi-modal during all four seasons with modes centered at 0.1-0.3 μm and 3-4 μm. For both fine and coarse modes, the highest volumetric concentration of ~0.08 $\mu m^{-3}\mu m^{-2}$ was observed during post-monsoon and pre-monsoon seasons. As revealed by the single scattering albedo (SSA), asymmetry parameter (AP) and refractive

index (RI) analyses, Lumbini is dominated by urban-industrial and biomass burning aerosols.

1.048 Chemical Characterization of the Particulate Matters Emitted from Biomass Burning in the Traditional Rural Cooking Stove in Bangladesh.

Early Career Scientist

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Abstract:

The chemical characterization of seven commonly used biomasses species were done. The bioassess are rain tree- *Samanea semen*, mango tree - *Mangifera indica*, jackfruit tree - *Artocarpus heterophyllus*, albizia tree - *Albizia julibrissin*, mahogany tree - *Swietenia mahogany*, cow dung, and dry Leaf of mahogany tree. Particulate matters (PM) emitted from biomass burning at a typical rural cooking stove were collected on quartz fiber filters. PM loaded filters were characterized with Scanning Electron microscope (SEM) for surface morphology, X-ray Diffractometer (XRD) for chemical structure, Fourier Transform Infra-red (FTIR) to determine the functional group of organic compounds, and TOC analyzer to determine total organic carbon (TOC). Black carbon (BC) and brown carbon (BrC) concentrations were determined with Aethalometer. Δ-C value was calculated from the difference between brown and black carbon. Trace metals concentrations were determined with Atomic Absorption Spectrophotometer (AAS) among them higher concentration of K, Ca, Na, Pb, Zn, Fe, and Cu were observed. The average concentrations of BC, BrC, TOC, and Δ-C value were 5.85±4.75, 11.6±9.57, 152.9±89.6, and 7.16±5.33 μgm^{-3}, respectively. The emission factors of BC and BrC were 1.08±0.96 and 2.35±1.80 mgg^{-1}, respectively. The brown carbon was about 1.6 to 2.9 times higher than black carbon. The highest amount of BC was observed in mahogany leaf; whereas, the lowest was in mango tree. Mahogany leaf has the highest emission of trace metals, and jackfruit tree has the lowest. Mango tree has relatively lower emissions among these seven biomasses used in this study.

1.049 Absorbing Aerosol modulation of meso-scale summertime temperature maxima over India: a causality based approach.

Early Career Scientist

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Abstract:

From the mid-1970s, the Indian subcontinent, in particular the Indo-Gangetic plains, have witnessed large anomalies in summer time temperature maxima (Ratnam et al. 2016) along with an increase in frequency and intensity of heat wave events (Rohini 2016). Studies have related absorbing aerosols in lower tropospheric layers to increase in surface air temperature (Ban-Weiss et al. 2012; Hansen et al. 2005), which could extend several hundred kilometers around “hot-spots” of absorbing aerosol abundance. However, the ability of absorbing aerosols to modulate temperature on local and mesoscales has not been explored much.
Considering this, the current work investigates links between daily mean observations of columnar absorbing aerosol abundance, using absorbing aerosol index (AAI (Herman et al. 1997)), and temperature at surface and in elevated atmospheric layers, using ERA-interim reanalysis data (Dee et al. 2011) and gridded observations (Srivastava, Rajeevan, and Kshirsagar 2009), in MAMJ, during 1979-2013. Cross-correlations were examined between AAI and mean and maximum daily temperature at surface and at eleven layers between 1000-700 hPa. In each layer nearby and distant pixels (>250 kilometers) with high cross-correlations (>0.25) were identified using hierarchical clustering. Spatial clusters were identified where such cross-correlations were significant. Clustering was followed by causality analysis using Granger causality (Granger, 1969) on cluster averaged time series of AAI and temperature.
It was found that that AAI and temperature maxima shows statistically significant cross-correlations for co-located and distant pixels and more prominently over Indo-Gangetic plain. Further, it was found that as the altitude increased magnitude of the cross correlation decreased cross-correlations fades away. A causal influence of AAI on temperature was found with a lag extending upto 3-days implying that present AAI in IGP affects the temperature over north-western part 3-days later.

1.050 Comparison of black carbon and ozone variability at the Kathmandu “hot spot” and at the southern Himalayas.

Early Career Scientist

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Abstract:

Several studies have shown that the transport of short-lived climate pollutants (SLCP) from the highly polluted areas in south Asia (e.g., the Indo-Gangetic Plain and the Himalayan foothills) to the Himalayas may occur, with significant implications for the global and regional climate, crop yields, and human health. In this work, we perform a multi-year comparison (February 2013–October 2015) of simultaneous black carbon (BC) and surface ozone (O_3) measurements at two sites in Nepal, i.e.: Paknajol (1380 m a.s.l.) in the Kathmandu Valley, and the WMO/GAW global station Nepal Climate Observatory-Pyramid (NCO-P, 5079 m a.s.l.), near the base camp of Mt. Everest. The two sites are only 150 km apart, and are characterized by different situations: while the Kathmandu Valley is one of the regional urban “hot spots” for what concerns air pollution, NCO-P is representative of the background conditions of the high Himalayas and the free troposphere. This represents a good opportunity to investigate the possible role played by emissions occurring in the planetary boundary layer (PBL) of the Kathmandu megacity in influencing the variability of these two key SLCP in the southern Himalayas. BC and O_3 concentrations at NCO-P show linear correlation with the modelled PBL height over the Kathmandu urban area, providing evidence that the anthropogenic emissions occurring within the Kathmandu PBL could affect the variability of BC and O_3 at NCO-P. Furthermore, when introducing an additional constraint in the analysis (i.e., back-trajectories), we show that 40% and 52% of BC and O_3 variability at NCO-P can be explained by the PBL variations over the Kathmandu urban area, in days in which air-mass transport between the two measurement sites is observed.

1.051 FACTORS INFLUENCING AVIATION VISIBILITY IN NEPAL.

Early Career Scientist

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Abstract:

Visibility impairment is believed to create numerous direct and indirect hazards in various areas; ranging from health impact, tourism business to transportation and so forth. Role of atmospheric visibility in aviation is more crucial as evidenced by occurrences of many incidence and accidents which are attributed to low visibility. Like in other parts of globe; atmospheric visibility in Nepal plays most significant role for such occurrences as per aviation safety reports. In Nepal; seen causes of visibility impairment are:
· winter fog in winter season
· atmospheric haze in dry, winter and pre-monsoon season
· elevated cloud covers during monsoon period
· precipitation
The trends and occurrences of these atmospheric phenomena are irregular as observed. This study focus to address factors responsible for aviation visibility in Nepal through extensive use of ground observations data set (METAR, Biral SWS-100, Ceilometer etc.), remote sensing (AERONET,MODIS, CALIPSO) and numerical model tools(WRF-Chem.). Trend analysis of visibility is planned to be carried out using statistical analysis tools like **ridit** analysis, linear regression method, percentile computation etc. Through this study it is expected to find proper explanation for:
· regional and seasonal patterns
· magnitude and direction of change in visibility with time
· patterns and impact of associated variables like aerosol loading, fog formation, precipitation, relative humidity, occurrence of light wind episodes and other important meteorological variables.
· effects of lateral and vertical distribution of aerosols on visibility
· influence of trans-boundary propagation of pollutants
· correlation of visibility trend in between trend of Nepal and that of Indo- Gangatic Plain
· effect of changes in Asian Monsoon circulation pattern on the trend change of visibility

1.052 Smog choked the life in the city of Lahore, Pakistan as air pollution hits hazardous levels .

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Abstract:

Usually, urban smog is caused when favourable conditions like higher moisture content and lower temperature results in fog and is mixed with smoke. The sources of air pollutants in Lahore are the motor vehicles and medium and small scale industries. But, in this particular case, the onset smog was observed during the first week of November, very unusual to be winter fog. However, this smog event is believed to be caused by the burning of crop residue (rice paddies) in the Indian part of Punjab. These fires were also reported by NASA satellite images and MODIS fire observations. Smoke from the massive crop residue burning has caused the onset and prevalence of smog not only in Lahore but throughout Punjab province on both sides of the international border. This study focus on recent smog(smoke)episodes over Pakistan. Beginning from 1 November 2016, severe smog episodes were observed over Lahore and New Delhi, which continued for a period of one week. The car MAX-DOAS instrument was used for mobile monitoring of air pollutants along with other stationary measurements within the city of Lahore. Concentration levels of various air quality parameters were much higher than Pak-NEQS, so warnings were issued by the Punjab government in order to avoid adverse health impacts. For spatial and temporal distribution of aerosols over the study area, MODIS (Moderate Resolution Imaging Spectro-radiometer) observations were used and also validated with AERONET observations. The results showed that during smog period aerosol load was enormous high. Furthermore, HYSPLIT back trajectories were run to identify the pollutants' source. The results from mini MAX-DOAS showed that NO_2 and SO_2 were maximum along the busy roads and downwind areas. Especially, when the wind was coming from the eastern side.

1.053 Spatio-Temporal and Seasonal Analysis of NO2 over Pakistan using Ozone Monitoring Instrument (2004-2016).

Early Career Scientist

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Abstract:

This study represents the emissions scenario of NO2 in Pakistan for the time period of 2004-2016. OMI (Ozone Monitoring Instrument) data sets are used to retrieve the total column densities. These Satellite Observations are then analyzed using a DOAS-base algorithm to figure out NO2 tropospheric column densities. Spatio-temporal analysis portrays strong emissions in well populace areas e.g., Punjab, Sindh and KPK. Along with Spatial analysis, seasonal studies also shows a regular pattern of emission, maximum in winters while relatively less in summers. As far the Province Baluchistan is concerned, reverse pattern of concentrations is observed. Anthropogenic exercises (Industrial sector emissions, Traffic congestion & aircrafts) are leading sources for intensified emissions but natural origins contributions are still holding a substantial percentage of emissions. For instance soil emissions are enhanced after the rain event due to boosted up Bacterial activities releasing more NO2 in the atmosphere. In addition to it, Lightening is also prime mover source for the emissions. These both phenomena account for almost 20% of total emissions in Punjab, Sindh and KPK while massive (~50%) addition is seen in case of Baluchistan. The one aspect for the abrupt discharge is high temperature which favors ideal conditions for NOx emissions. However ground based study is still needed to confirm the emission scenarios due to belittle results obtained from OMI.

1.054 Performances of two mesoscale meteorological models of WRF and MM5 in simulation of meteorology over Bangkok Metropolitan Region domain.

Early Career Scientist

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Abstract:

Air quality modeling (AQM) application requires accurate modeled meteorological fields input data. For the purpose, performances of 2 mesoscale meteorological models WRF and MM5 for the Bangkok Metropolitan Region (BMR) were evaluated and were comparatively analyzed. Models were simulated over 3 nested domains in 3 selected months (March, August and November) in 2010 to represent dry, wet and transition months. 3 sets of physical schemes were tested for both models and the best scheme set was used for model performance comparison. Simulated meteorological fields for first model layer (15 m) were compared to the observed temperature, wind speed, wind direction, pressure and relative humidity (RH) at two airport meteorological stations. The following physical schemes produced best performance for WRF: microphysics (WSM3), cumulus parameterization (BMJ), short-wave radiation (Dudhia), long-wave radiation (RRTM), planetary boundary layer (YSU), surface layer (Monin-Obukhov) and land surface layer (5-layer thermal diffusion). The best scheme set for MM5 performance was moisture scheme (Schultz), cumulus parameterization (Grell), planetary boundary layer (MRF), radiation scheme (RRTM) and surface scheme (5-layer soil model). The performance was further evaluated using the statistical criteria and the results showed better agreement for temperature and RH as compared to the observation. Overall, WRF simulation results showed better performance as compared to MM5 with critical parameter of wind which should be improved for both models. Further evaluation should be also conducted to evaluate mixing height parameter. WRF results can be used as meteorological input data for AQM application in BMR.

1.055 Variations of PM2.5-to-PM10 ratios in Bangkok Metropolitan Region, Thailand.

Early Career Scientist

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Abstract:

Hourly average data of PM_{10} and $PM_{2.5}$ monitored in Bangkok Metropolitan Region (BMR), Thailand from 2014 to 2016 were collected to analyze $PM_{2.5}$-PM_{10} correlations and $PM_{2.5}$-to-PM_{10} ratios for roadside and ambient air of BMR. The results showed that the annual averages of PM_{10} and $PM_{2.5}$ in the unit of microgram per cubic meter ($\mu g/m^3$) were 48-97 and 25-46, respectively. In BMR, annual averages of PM_{10} were reduced within the standard, while that of $PM_{2.5}$ were increasingly exceeding the standard. The annual average of PM_{10} and $PM_{2.5}$ at the northern area of BMR were the highest with nearly two times higher than the standard. The correlations between PM_{10} and $PM_{2.5}$ were the range of 0.33-0.84. A better correlation was obtained from ambient profile of Bangkok, while that of northern BMR (downwind area in wet season) was the lowest. $PM_{2.5}$-to-PM_{10} ratios in BMR ranked from 0.45 to 0.73 with annually increases. Higher $PM_{2.5}$-to-PM_{10} ratios were found in the areas of Bangkok, while lower $PM_{2.5}$-to-PM_{10} ratios were found in the vicinity. The HYSPLIT backward trajectory results and MODIS AOD showed the reasonable explanation of monthly variations in $PM_{2.5}$-to-PM_{10} ratios in relation to meteorology and emission sources. Despite, increases of $PM_{2.5}$-to-PM_{10} ratios might be the results from trans-boundary $PM_{2.5}$ and secondary PM2.5 formed in the atmosphere through chemical reactions in BMR.

1.056 Characterization of the atmospheric carbonaceous species (Organic and Elemental Carbon) in the PM2.5 and SPM fraction in Bangladesh.

Early Career Scientist

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Abstract:

Fine particulate matter samples (n=49) were collected from rural Bhola (Island of Bay of Bengal) on quartz fiber filters between December 2014 and February 2016 by using a Digital $PM_{2.5}$ cut-off high volume DH-77 samplers. EC and OC were analyzed using the NIOSH (National Institute of Occupational Safety and Health) 5040 thermal/optical transmittance method. The average concentration of $PM_{2.5,}$ OC and EC in Bhola were 107.8μgm^{-3}, 23±1.2μgm^{-3} and 8.2±0.5μgm^{-3}, respectively. Absolute concentrations of carbonaceous species indicate that the background site on Bhola Island is obviously affected by emissions from urbanized regions of Southeast Asia. The carbonaceous species were about 2.5 times higher in winter than summer in Bhola. OC/EC ratios ranged from 0.7 to 12.8 with an average of 3.25 indicating secondary organic carbon (SOC) formation due to the long range transport and/or photochemical activities. Total carbon concentrations accounted for 29% of the total $PM_{2.5}$, respectively. This indicates that, total carbon is a significant contributor to the total $PM_{2.5}$ concentration. Bhola is lying over the Indo-Gangetic Plain (IGP) and it is the outflow of wintertime haze layer which formed over the IGP. Hence much more particulate matter are formed during winter and increased the elevated level of carbon aerosols. Significant correlation was found between OC and EC during the whole period in Bhola ($r = 0.84$) indicating emissions by common sources. Bhola aerosol has a high fraction of OC, which can have serious implications for human health and also for climate change. The fraction of total organic carbon that was secondary organic carbon (SOC) was estimated using the OC/EC minimum ratio method. Based on this method the estimated SOC constituted about 73% of OC in Bhola indicating significant aging processes of the aerosols on a regional scale due to the long range transport.

1.057 Influence of Asian Monsoon on the Trend, Chemical Composition, and Emission Sources of PM2.5 in Bangladesh.

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Abstract:

Bangladesh is the highly polluted country in the World. About 37 thousand people were died every year due to the air pollution. The estimated cost for air pollution in Bangladesh is about 1% of its GDP (WBR 2014). Dhaka is a densely populated megacity with about 17 million habitants. Dhaka ranked number one in the World due to the per capita exposure of PM2.5 (SOGAR 2017). However, verities of sources are contributing to the worst air quality situation in Bangladesh, e.g., vehicles, brick and other industries, construction, and transboundary pollution. Emission from brick kilns and traffic vehicles are the two most important sources. About six thousand brick industries are in Bangladesh operating only in the dry season. Asian monsoon has a significant influences on the air quality in Bangladesh. The pollution level is the minimum during monsoon among the four seasons in Bangladesh.

In this workshop I will be presenting the influence of the Asian monsoon on the seasonal and annual trend of the PM2.5 and AOD, chemical composition (e.g., BC, PAHs, SO_4^{2-}, NO_3^-, trace elements, etc.), and emission sources in Bangladesh. Human health impact of the pollutants will also be presented. $PM_{2.5}$ samples were collected on filters with Digital $PM_{2.5}$ sampler (Switzerland) and Air photon, USA. BC was measured from filters (with thermal and optical method) and also real time with an Aethalometer AE42 (Magee, USA). Water soluble ions were determined from filters with ion chromatogram. Poly aromatic hydrocarbons (PAHs) were determined with GC-MS. AOD was continuously monitor with NASA AERONET sunphotometer. Positive matrix factorization (PMF) was used for sources apportionment study. NOAA, HYSPLIT was used for the contribution of transboundary air pollution. Health impact study was done with Geoaccumulation index (I geo), pollution load index (PLI), and health risk assessment (both carcinogenic and noncarcinogenic).

1.058 Evidence for high biogenic isoprene emissions in the north-western Indo-Gangetic Plain (NW-IGP).

Early Career Scientist

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Abstract:

Globally, isoprene (2-methyl-1,3-butadiene) is the dominant biogenic emission into the atmosphere with an annual budget of 500 to 750 Tg which is mainly controlled by biological, physical and chemical driving variables (Guenther et al.,2006). Measurement of isoprene and its oxidation products like MVK/MACR provide useful information in reference to location and magnitude of biogenic sources (Montzka et al,.1993; Dreyfus et al.,2002). This is necessary to help frame effective air quality management guidelines as natural emissions like isoprene are not subject to regulation, but do play a significant role in regional air quality and climate due to their chemistry and reactivity. The north-western Indo-Gangetic Plain (NW-IGP) is one of the most under-studied regions of the world in terms of atmospheric composition, though the large urban population and biogenic sources present a unique complex atmospheric environment with consequences for global atmospheric chemistry. Here, we will present observational evidence of high biogenic isoprene emissions in the NW-IGP, from multi-year in-situ measurements performed at the IISER Mohali atmospheric chemistry facility (30.667, 76.729E; 310 m, amsl). The facility consists of a high resolution proton reaction mass spectrometer (PTR-MS), an online ambient air quality station, a meteorological station (Sinha et al.,2014) and a newly added gas chromatography flame ionization detector.
The paper will show the strong seasonality of biogenic emissions and constrain the contribution of isoprene from urban emission sources (e.g. biomass burning), trees and vegetation in the region.

1.059 Regional heterogeneity of aerosol characteristics over the north-eastern part of India, a region in eastern Himalayan range.

Early Career Scientist

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Abstract:

The three-dimensional (3D) aerosol characteristics retrieved from Cloud Aerosol Lidar Infrared Orthogonal Polarization (CALIOP) on board Cloud Aerosol Lidar Infrared Pathfinder Satellite Observation (CALIPSO) satellite over the north-eastern region of India (Tawang (TWN) (27.6˚N,91.9˚E,2668 m AMSL), Shillong (SHN) (25.6˚N, 91.9˚E, 1496 m AMSL), Aizwal (AZL) (23.7˚N, 92.8˚E, 1001 m AMSL), Imphal (IPH) (24.82˚N, 93.95˚E, 790 m AMSL), Dibrugarh (DBR) (27.4˚N, 94.9˚E, 111 m AMSL), Guwahati (GHY) (26.1˚N, 91.6˚E, 55 m AMSL), Dhubri (DHB) (26.1˚N, 89.97˚E, 28 m AMSL) and Agartala (AGA) (23.9˚N, 91.2˚E, 14.9 m AMSL)) and in adjoining locations (Thimphu (THM) (27.5˚N, 89.6˚E, 2737 m AMSL), Banmauk (BNK) (24.24°N, 95.51°E, 279 m AMSL), Dhaka (DAC) (23.4°N, 90.2°E, 4 m AMSL)) have been investigated high biomass-burning episode seasons viz., pre-monsoon (March-April-May) for 2012-2016. The elevated aerosol layers (EALs) (~2-4.5km) is observed in all the locations during this season. The analysis of extinction coefficient (km^{-1}), particulate depolarization ratio (PDR) (at 532 nm) and the lidar ratio (at 532 nm) shows the different types of aerosols present in the EALs. In this region the polluted dust (dust mixed with smoke), biomass-burning and occasionally desert dust are present in EALs. The western locations of this regions (viz., DAC, AGA, DHB) shows the dominance of polluted dust while the biomass burning in case of eastern locations (viz., DBR, IPH, BNK). The elevated layers of aerosols are occasionally (~26%) present in DAC with low value of extinction coefficient to a height 4.5 km. These EALs are mainly produces by the desert dust/polluted dust. The high AOD in absence of EAL indicated the major contribution from surface aerosols in DAC. On the other hand the EALs of eastern locations like DBR, BNK are mostly due to either the biomass burning or the polluted dust.

1.060 Compositions and source apportionment of PM2.5 during haze and non-haze episodes in Kuala Lumpur, Malaysia and its potential impact to human health.

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Abstract:

This study aims to determine $PM_{2.5}$ concentrations and their composition during haze and non-haze episodes in Kuala Lumpur urban environment. Numerical Atmospheric-dispersion Modelling Environment (NAME) and Global Fire Assimilation System (GFAS) were applied In order to investigate the origin of the measured air masses. Source apportionment of $PM_{2.5}$ was determined using Positive Matrix Factorisation (PMF). The carcinogenic and non-carcinogenic health risks were estimated using the United State Environmental Protection Agency (USEPA) method. Samples were collected from the centre of the city using a high-volume air sampler (HVS). Inorganic compositions, including trace metals and water soluble ions, were determined using inductively coupled plasma-mass spectrometry (ICP-MS) and ion chromatography (IC), respectively. The results showed that the mean $PM_{2.5}$ concentrations collected during pre-haze, haze and

post-haze periods were 24.5±12.0 µg m^{-3}, 72.3±38.0 µg m^{-3} and 14.3±3.58 µg m^{-3}, respectively. The major trace metals identified were K, Al, Ca, Mg and Fe which accounted for approximately 93%, 91% and 92% of the overall metals' portions recorded during pre-haze, haze and post-haze periods, respectively. For water-soluble ions, secondary inorganic aerosols (SO_4^{2-}, NO_3^- and NH_4^+) contributed around 12%, 43% and 16% of the overall $PM_{2.5}$ mass during pre-haze, haze and post-haze periods, respectively. During haze periods, the predominant source identified using Positive Matrix Factorisation (PMF) was biomass burning. The NAME simulations indicate the importance of fires in Sumatra, Indonesia. The highest non-carcinogenic health risk was estimated among the infant group (HI = 1.06) while the highest carcinogenic health risk was estimated among the adult group (2.27×10^{-5}), both during the haze period.

1.061 Concentration and Chemical characterization of Particulate Matter (PM10 and PM2.5) in two megacities of Pakistan for the winter fog period 2016-2017 .

Early Career Scientist

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Abstract:

The issue of air pollution in the Asian region is emerging as a serious threat to the environment and public health. Increasing levels of air pollution are being cited due to rapid economic development along with urbanization, motorization and extensive energy use. It has been observed that hazardous impacts of air pollution become worse during winters, due to dense persistent fog in the Indo-Gangetic Plain (IGP), especially in the months of December, January and February (DJF). Pakistan in the region is among the various countries affected severely by air pollution. As such, many parts of Pakistan experienced severe fog and haze during the months of DJF in 2016-17, which lead to significant social and economic problems, especially disruptions of road and air traffic. To study the winter fog phenomenon, a three-month campaign was held in two megacities of Pakistan, namely Lahore and Faisalabad (which are also in the IGP region). The main objective of this study was to evaluate the concentrations and chemical characterization of particulate matter during the 2016-17 winter fog season. Aerosols were collected at different locations by using High/low volume samplers. It was observed that the average concentration of both PM10 and PM2.5 increased about two times during intense fog days. For elemental composition, Energy Dispersive X-ray Fluorescence (ED-XRF) was used and as a next step Atomic Absorption Spectroscopy (AAS) was used to quantify different metals detected by ED-XRF. Positive Matrix Factorization (PMF) model is an effective source apportionment receptor model that was used to find out the possible sources of PM10 and PM2.5. For further analysis and to validate sources, back trajectories were also calculated.

1.062 Winter fog experiment (WIFEX) over the Indo-Gangetic plains of India: Overview and initial results.

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Abstract:

The objectives of the Winter Fog Experiment (WIFEX) over the Indo-Gangetic Plains of India are
to develop better now-casting and forecasting of winter fog on various time- and spatial scales. WIFEX was carried out in the winter season of 2105/16/17 at IGIA, New Delhi through an initiative taken by Ministry of Earth Sciences, Government of India. Maximum fog occurrence over northwest India is about 48 days (visibility <1000 m) per year, and it occurs mostly during the December–February time-period. The physical and chemical characteristics of fog, meteorological factors responsible for its genesis, sustenance, intensity and dissipation are poorly understood. Improved understanding on the above aspects is required to develop reliable forecasting models and observational techniques for accurate prediction of the fog events. Extensive sets of comprehensive ground based instrumentation were deployed at the Indira Gandhi International Airport, New Delhi during 2015-2017 winter period. Major in situ sensors were deployed to measure surface micrometeorological conditions, radiation balance, turbulence, thermo-dynamical structure of the surface layer, fog droplet and aerosol microphysics, aerosol optical properties, and aerosol and fog water chemistry to describe the complete environmental conditions under which fog develops. In addition, Weather Forecasting Model coupled with chemistry is planned for fog prediction at a spatial resolution of 2 km. The present study provides an introductory overview of the winter fog field campaign with its unique instrumentation and initial results.

1.063 Microphysical and Chemical properties of winter-time fog in Delhi.

Early Career Scientist

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Abstract:

The winter fog Experiment (WIFEX) was carried out in the winter season of 2015/16 at IGIA, New Delhi through an initiative taken by MoES, GoI. The main aim of WIFEX was to characterize the fog events occurring in Delhi and monitor simultaneously associated dynamics, thermodynamics, microphysics and chemical composition of the gases, aerosols and fog water phases to understand factors responsible for their genesis, intensity and duration. This study provides preliminary results on fog microphysical properties dense fog events that occurred on 23 and 24 January, 2016.Mean particle size distribution (PSD) is observed from a cloud droplet probe (CDP) mounted inside an aspirator. The PSDs are characterized by broad spectra where particle concentrations are extended to drop diameter of D≈30 μm. This suggests that though the concentrations of large particles are less, the present result suggests that very large particles are formed during a dense foggy condition. We found that the fog particles grew larger and number concentration increased uniformly with time along entire diameter ranges (not shown here) when condition changes from the non-foggy to the foggy condition. Hence it is most likely that the particles grew larger by vapor deposition/collection processes. Data from the aerosol and fog water chemistry so far indicate a highly polluted environment in which fog developed and dominance of combustion and vehicular exhaust sources have been noted in the aerosol samples. Secondary inorganic aerosols (sulfate and nitrate) were the dominant ions (38%) in the chemical constituents of the fine particles and were higher during the fog events. The chemical partitioning of fog water samples suggest that NH_4^+ (28%) and SO_4^{2-}(26%) dominates the chemical composition. The pH of fog water indicates the alkaline (6.91) in nature and NH_4^+ and Ca^{2+} were found to be the major neutralizing components.

1.064 Study of gaseous pollutants and inorganic particulates in PM2.5 at an urban site of Delhi.

Early Career Scientist

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Abstract:

Study of gaseous pollutants and inorganic particulates in $PM_{2.5}$ at an urban site of Delhi
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The measurements of ambient NH_3 and related trace gases (NO, NO_2, CO and SO_2) and water soluble inorganic ionic species (Na^+, NH_4^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, NO^{3-}, and SO_4^{2-}) of $PM_{2.5}$ have been carried out during January 2013 to December 2015 to study the role of ambient NH_3 in the formation of secondary aerosol at an urban site of Delhi. The average mixing ratios of ambient NH_3, NO, NO_2 and SO_2, CO over the entire period were recorded as 19.6±3.5 (ppb), 20.4±6.2 (ppb), 19.7±5.3 (ppb) and 1.7±0.5 (ppb), 1.8±0.5 (ppm), respectively. The average monthly NH_3/NH_4^+ ratios varied from 0.28 to 2.56 with an average value of 1.46 in winter. The higher NH_3/NH_4^+ ratio (3.5) was observed in summer indicates the abundance of NH_3 in the atmosphere during summer. The higher fraction of particulate NH_4^+ observed in winter than summer attributes to conversion of gaseous NH_3 into NH_4^+.
Keywords: Air quality, Ammonia, Trace Gases, Particulates

1.065 The chemical composition characteristics of aerosol and its impact on the visibility in North China Plain.

Early Career Scientist

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Abstract:

To better understand the chemical composition and carbonaceous aerosol characteristics of aerosol and its impact on the visibility in North China Plain (NCP), four experimental sampling campaigns were carried out during Jun, 2013 to May, 2014. The sampling sites were located in Beijing, Xiangshan, Tianjin, Shijiazhuang, Qinhuangdao. In the sight of different particle size distribution, the ratios of anions to cations in the fine size (0.64) was greater than that in the coarse size (0.54) in NCP. The coefficient of divergences indicates that the aerosol pollution had a similar characteristic in the five cities of NCP and pollutants had a characteristic of mutual influence and regional transfer process. The increasing of $PM_{2.1}$, due to its hygroscopic growth in a higher RH, result in the decreasing of visibility. The IMPROVE method was used to estimate the light extinction coefficients (LEC) from the measured chemical species concentrations. Coarse matter, ammonium nitrate, ammonium sulfate were the three main LEC in Beijing, which had the highest proportion of total LEC in summer, accounting for 32.2%, 25.9%, 24.4%, respectively. The LEC of sea salts had not changed much in the full year, accounting for 4.1~5.3%(Beijing) and 4.8~7.4%(Tianjin). The increase concentration of NH_4NO_3, $(NH_4)_2SO_4$ and organic matter (OM) result in an increase of LEC in the NCP, which lead to the occurrence of low visibility events in autumn or winter. NH_4^+, NO_3^- and SO_4^{2-} mainly existed in the fine size in Beijing (73.5, 80.7, 78.0% on Pollutional Days (PD) and 63.3, 79.4, 72.5% on Attained Day (AD)) and Tianjin (81.0, 80.6, 82.1% on PD and 71.5, 44.3, 69.7% on AD). As PMF model, 33.21% and 54.43% of the LEC came from secondary aerosol in Beijing and Tianjin. In addition, Burning, sea salt and fugitive dust were also important compositions in LEC.

1.066 Geospatial Strategy for Adverse Impact of Urban Heat Island on air quality in the Haridwar region using LANDSAT ETM+ Sensors.

Early Career Scientist

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Abstract:

We are living in the age of rapidly growing population and changing environmental conditions with advance technical capacity. This has been resulting in wide spread land cover change. Among several human induced environmental and urban thermal problems are reported to be negatively affecting urban residents in many ways. Urban Heat Islands exist in many large cities especially metropolitan cities and can significantly affect the quality of life in affected areas. The adverse effect of urban heat island has become the subject of numerous studies in recent decades and is reflected in many cities in world. The built up structures in urbanized areas considerably alter land cover thereby affecting thermal energy flow which leads to development of elevated surface and air quality. The Urban Heat Island for the temporal period is estimated using geospatial techniques which are utilized for the impact assessment on climate of surrounding region and how it reduce the sustainability of the natural resources like air, vegetation Rapid growth of industries in peri-urban areas results in excessive warming and variations in weather conditions. Remotely sensed data of thermal infrared band in the region of 10.4-12.5 µm available from LANDSAT-7 Thematic Mapper and Enhanced Thematic Mapper (TM and ETM+) with 60 m resolution is proved to be very helpful to identify urban heat islands using surface topography. To ascertain the influence of land use and land cover categories and vegetation density on surface temperature LANDSAT 7 ETM+ and ASTER Advanced Space-borne Thermal Emission and Reflection Radiometer with 90 meters resolution data sets can be used. The present paper describes the methodology and resolution dynamic urban heat island change on climate using geospatial approach for Haridwar district,India. NDVI were generated using day time LANDSAT ETM+ image of different years. Temperature of various land use and land cover categories was estimated.

1.067 Dense Haze, Fog and Smog during Early November 2016: Associated with the Crop Residue Burning and Diwali Festival.

Early Career Scientist

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Abstract:

The burning of crop residue during winter season, influences the weather conditions of Delhi and also some of the major cities located in the Indo-Gangetic plains (IGP). The westerly winds (speed and direction) and meteorological parameters (RH and Temperature) play an important role in the transport of the plumes from the burning fields over the major cities in the eastern parts of IGP. These plumes mix with the local anthropogenic emissions of the urban areas and form the haze, fog and smog especially during winter season. We have carried out detailed analysis of satellite and ground data averaged for four weeks of October and November during 2006-2016 over the major cities of IGP. Our detailed analysis show that sometime the plume reaches far east in the IGP and sometimes the plumes reach over Nainital (located 2000m height in Himalaya). Thus, pronounced changes in the AOD and aerosol optical parameters (SIZ, SSA and AE) have been observed, that show the influence of air mass coming from burning fields. During 2016, crop residue burning coincided with the Diwali (light) festival, as a result, dense haze, fog and smog were persisted for long time during November 2016. The weekly mean AOD and angstrom exponent (AE) during October, 2016 in the north-western parts of India was 0.85 and 1.08 and during November the AOD and AE, respectively was 1.01 and 0.94. The average $PM_{2.5}$ and PM_{10} concentrationsenhancedin the first week of November showingalarming conditions of airquality in Delhi and surrounding areas. We will discuss Ozone concentrations and NO_2 levels measured in and around Delhi by CPCB. The alarming conditions of air quality and weather conditions clearly show mixing of emissions from crop burning and Diwali festival, such mixing is also reflected from lowering of SSA using AERONET stations data.

1.068 Modeling the Contribution of Wildfire Emissions to Air Pollution in Kathmandu Valley.

Presenting Author:

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Abstract:

Wildfire emissions can contribute a significant amount of atmospheric pollutants in Nepal. This study presents the quantification of the contribution of wildfire emissions to the total air pollution in the Kathmandu Valley, where the population is very dense. The wildfire emissions are quantified and assessed by conducting modeling experiments over Kathmandu Valley with the WRF-Chem model at high resolution. The modeling system analyzes the contribution of wildfire emission to AOD and other air pollutants in the Kathmandu Valley. For model simulation, the fire inventory from NCAR (FINN) fire emissions dataset, EDGAR-HTAP dataset for anthropogenic emissions and MEGAN dataset for biogenic emissions are used. The results will be presented during the workshop along with the spatial and temporal plots of the air pollutants. The modeling framework will allow the researchers to quantify the effect of wildfire emissions on the overall air pollution scenario in Nepal. In addition, the high-resolution modeling system can be applied to assess other several air pollution problems in Nepal.

2.004 The regional distribution characteristics of aerosol optical depth over the Tibetan Plateau.

Early Career Scientist

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Abstract:

The Tibetan Plateau (TP) is representative of typical clean atmospheric conditions. Different monthly variation patterns of AOD are observed over the southern and northern TP, whereby the aerosol load is usually higher in the northern TP than in the southern part. The aerosol load over the northern part increases from April to June, peaking in May. The maximum concentration of aerosols over the southern TP occurs in July. Aerosols appear to be more easily transported to the main body of the TP across the northern edge rather than the southern edge. This is may be partly because the altitude is lower at the northern edge than that of the Himalayas located along the southern edge of the TP. Dust is found to be the most prominent aerosol type on the TP. A dividing line of higher dust occurrence in the northern TP and lower dust occurrence in the southern TP can be observed clearly at altitude of 6-8 km above sea level, especially in spring and summer. The different seasonal variation patterns between the northern and southern TP are primarily driven by atmospheric circulation, and are also related to the emission characteristics over the surrounding regions. Aerosol optical properties at two Aerosol Robotic Network (AERONET) sites on the southern side of the Himalaya (Pokhara, 812 m above sea level (a.s.l.) and EVK2-CNR, 5079 m a.s.l. in Nepal) and one on the northern side (Qomolangma (Mt. Everest) station for Atmospheric and Environmental Observation and Research, Chinese Academy of Sciences (QOMS_CAS) in Tibet, 4076 m a.s.l. in China) are investigated. Seasonal variations of aerosols are profoundly affected by large scale atmospheric circulation. Diurnal variations are mainly influenced by meso-scale systems and local topography.

2.005 Impact of Chinese Urbanization and Aerosol Emissions on the East Asian Summer Monsoon.

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Abstract:

Impacts of urbanization and anthropogenic aerosols in China on the East Asian summer monsoon (EASM) are investigated using the Community Atmosphere Model (CAM5.1) by comparing simulations with and without incoporating urban land cover and/or anthropogenic aerosol emissions. Results show that the increase of urban land cover causes large surface warming and an urban frictional drag, both leading to a northeasterly wind anomaly in the lower troposphere over East China (EC). This weakens the southerly winds associated the EASM and causes a convergence anomaly in southern China (SC) with increased ascent, latent heating and cloudiness. The enhanced latent heating reinforces surface convergence and upper-level divergence over SC, leading to more northward advection in the upper-level into northern China (NC) and descending between 30^{O}N and 50^{O}N over East Asia. Cloudiness reduction, adiabatic heating and warm advection over NC all enhance the urban heating there, together causing anomalous tropospheric warming at those latitudes over East Asia. Anthropogenic aerosols cause widespread cooling at the surface and in the troposphere over EC, which decreases the summer land-ocean thermal contrast, leading to a weakened EASM circulation with reduced moisture transport to NC. This results in wetter and drier conditions over SC and NC, respectively. When both the urbanization and anthropogenic aerosols are included in the model, aerosols' cooling is partially offset by the urban heating, and their joint effect on the circulation is dominated by the aerosols' effect with a reduced magnitude. In the combined experiment, surface and tropospheric temperatures are also altered by the decrease (increase) in cloudiness over NC (SC) with most of the cooling confined to SC, which further weakens the EASM circulation.
Keywords: East Asian summer monsoon, China, urbanization, anthropogenic aerosols, climate model

2.006 Quantification of SO2 Oxidation on the Surfaces of Acidic Micro-Droplets: Implication to the Ambient Sulfate Formation.

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Abstract:

The oxidation of SO_2(g) on the interfacial layers of micro-droplet surfaces was investigated using a spray-chamber reactor coupled to an electrospray ionization mass spectrometer. In addition to the observed radical formation, the interfacial reaction rate was quantified based on the comparison of the liquid jet reacting with given H_2O_2 conditions. The relatively high signal intensities of $SO_3^{-\bullet}$, $SO_4^{-\bullet}$, and HSO_4^- compared to those of HSO_3^- as observed at pH < 3.5 without the addition of oxidants other than oxygen suggests an efficient oxidation pathway via sulfite and sulfate radical anions on droplets possibly via the direct interfacial electron transfer from $SO_2 \bullet H_2O$ to O_2. When H_2O_2(aq) was introduced into the spray chamber, HSO_3^- is rapidly oxidized to form bisulfate in the pH range of 3 to 5. Conversion to sulfate was less at pH < 3 due to relatively low HSO_3^- concentration caused by the fast interfacial reactions. The rapid oxidation of SO_2(g) on the acidic micro-droplets was estimated to be proportional to the collision of SO_2 molecules on the droplet surfaces with a pH dependent factor based on the comparison of sulfate production via the oxidation of SO_2(g) by H_2O_2(aq). In the presence of acidic aerosols, this oxidation rate is approximately two orders of magnitude higher than the rate of oxidation with H_2O_2 at a typical atmospheric H_2O_2(g) concentration of 1 ppb. This finding highlights the relative importance of the acidic surfaces for SO_2 oxidation in the atmosphere. Surface chemical reactions on aquated aerosol surfaces, as observed in this study, are overlooked in most atmospheric chemistry models. These reaction pathways may contribute to the rapid production of sulfate aerosols that is often observed in regions impacted by acidic haze aerosols such as Beijing and other mega-cities around the world.

2.007 Effects of monsoon variability on air quality in East Asia.

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Abstract:

Monsoons play a key role in synoptic weather patterns, which affect the frequency and longevity of pollution events. In this study, we investigate the relationship between air pollutant concentrations and the East Asian Monsoon (EAM) variability using a global 3-D chemical transport model (GEOS-Chem) and ground observations. We find a strong relationship between PM air quality and the intensity of the EAM, the sign of which differ for northern and southern East Asia. Compared to the climatological mean aerosol concentrations in winter when the PM air quality is typically bad, changes driven by the EAM variability are up to 25% in the model. Ozone also appears to be affected by the EAM variability especially for summer. By analyzing the results from the sensitivity simulations, we investigate important factors associated with the EAM variability for determining air pollutant concentrations in East Asia. The EAM variability is found to play a major role in interannual variations in pollutant concentrations; consequently, changes in the EAWM will be important for understanding future changes in air quality in East Asia.

2.008 Impact of El Niño on aerosol concentrations in East Asia.

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Abstract:

In order to examine the effects of meteorological variability on aerosol concentrations in East Asia during the El Niño periods, we used a 3-D global chemical transport model (GEOS-Chem) for the period of 1980-2014. First, we verified the model by comparing the observed and modeled aerosol concentrations from the Acid Deposition Monitoring Network in East Asia, the China Atmosphere Watch Network, the Chinese Ministry of Environmental Protection, and the Korea Ministry of Environment. The results indicated that the model well reproduces the spatial and seasonal characteristics of the observed surface aerosol concentrations. Analysis of the simulated results shows that the surface aerosol concentrations increase and decrease during the developing and decaying phase of El Niño periods, respectively, due to changes in the meteorological field. We also find that the EP- and CP-El Niño types have different impacts on the surface aerosol concentrations in East Asia, which means that the East Asian air quality is affected differently by the type of El Niño.

2.009 Surface solar radiation over East Asia and its interactions with the aerosols and clouds.

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Abstract:

Surface solar radiation plays a crucial role in surface energy and water budgets, and it is also an important forcing for land hydrological models. In this study, the downward surface solar radiation (DSSR) from two satellite products (FY-2C and FLASHFlux) and two reanalysis datasets (NCEP-DOE and ERA-Interim) was evaluated against ground-based observations (OBS) from 94 stations over mainland China during July 2006-June 2009. It is found that the mean DSSR derived from FY-2C is comparable to OBS, with small positive biases of (3.0 Wm^{-2} for daily data and 3.5 Wm^{-2} for monthly data), and moderate RMSEs of 49.3 Wm^{-2} (daily) and 31.9 Wm^{-2} (monthly). These results are comparable to those for FLASHFlux, which has the lowest RMSEs (43.2 Wm^{-2} and 30.5 Wm^{-2} for daily and monthly data, respectively) and the strongest correlations with OBS (r = 0.90 and 0.93 for daily and monthly data, respectively) among the four products. The DSSR from the four datasets over East Asia shows similar spatial patterns with large seasonal variations, but differs in magnitude. In summer, high DSSR is observed over western China, while low DSSR is seen primarily over South Asia and the Sichuan Basin associated with extensive cloud cover (CC) and large precipitable water (PW). In winter, the high DSSR center shifts to South Asia due to decreased CC and PW, and the DSSR decreases from the South to the North. Deficiencies in the parameterizations of clouds, aerosols and water vapor, as well as errors in atmospheric and surface properties for the retrieval algorithms contribute to the lower correlation of the DSSR derived from FY-2C (r=0.82 and 0.90 for daily and monthly data) with OBS than those from FLASHFlux product. Further improvements to the representation of clouds and aerosols in the FY-2C retrieval algorithm are needed.

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

Early Career Scientist

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Abstract:

In this paper, observational air temperature and 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. Observations indicated that YRD experienced severe heat waves with maximum temperature up to 41.1 °C, 6.1 °C higher than the definition of heat wave in China, and can last for as long as 27 days. maximum ozone reached 160.5 ppb, exceeding the national air quality standard (secondary level) as 74.7 ppb. Moreover, 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. A typical heat wave case (HW: 24/7-31/7) and non-heat wave case (NHW: 5/6-12/6) were selected to investigate the mechanism between heavy ozone and heat waves. mechanism difference It was found that chemical reactions play the most important role in ozone formation during HW days, in which 12 ppb ozone enhancement was found compared to NHW days. High temperature also slightly promote the effect of dry deposition velocity, vertical turbulence and horizontal advection, which beneficial to ozone remove, but the magnitude is much smaller than chemical effect.

2.011 Aerosol observations over India during summer by a light aerosol counter/sizer in the frame of the BATAL 2015 campaign.

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Abstract:

The LOAC Light Optical Aerosol Counter has been launched regularly since 2013 in various areas of the world in the free troposphere and in the stratosphere. Here we focus on flights conducted during the BATAL balloon campaign which occurred in India in 2015 during the monsoon season. The main objective of the campaign was to explore in situ

the tropospheric aerosol content and the Asian Tropopause Aerosol Layer (ATAL) which presence has been revealed in the UTLS region (~13-18 km) with a clear link with the Asian monsoon. Recent results reported in the literature seem to indicate the presence of carbonaceous aerosols (certainly mixed with sulfate) confined within the monsoon anticyclone but their microphysical properties are still unclear.
Three balloon launches of the LOAC aerosol counter were conducted from Varanasi (25.3°N, 82.9°E) well within the expected position of the ATAL. Our analysis focuses on the aerosol concentration evolutions along the vertical, on the particle size distributions and on their typology. The bottom of the ATAL has been probed and shows enhanced aerosol levels, thus corroborating satellite observations from CALIPSO reported in the literature. We show that the signature of these aerosols in the recorded size distributions is visible for particle sizes larger than 1 µm. LOAC typology indicates the presence of carbonaceous material in the ATAL and also throughout the troposphere, though we cannot conclude whether or not the particles are coated with water/sulfate. Also, icy particles have been detected and show very good agreement with other observations. Finally, we will give perspectives about operational improvements for future new campaigns, submitted national projects and simulations with Chemistry-Climate models to investigate the sources contributing to the ATAL

2.012 The role of pre-monsoon convection in trans-Himalayan pollution transport.

Early Career Scientist

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Abstract:

Episodes of high level aerosol pollutions have been observed over the Tibetan Plateau (TP) recently. Deposited and accumulated over the snow/ice surface, these pollutions accelerate snow melting and glacier retreat through the albedo feedback, thereby impacts the sustainable freshwater supplies for billions of people who reside downstream. The sources of the pollutions reaching TP have been attributed to local emissions from fossil fuel and biomass, to transport from lower lands facilitated by mountain/valley wind system. Here, we find that convection during the pre-monsoon season also contributes to the trans-Himalayan pollution transport. Our findings reinforce the process of pollution transport from South Asia into the TP. The complementary mechanism has important implications for quantifying the pollution transportation, thus would be helpful for planning adaptation strategies, managing water resources and establishing environmental protections over the TP.

2.014 Radiative and microphysical pathways of aerosol impact over Indian summer monsoon.

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Abstract:

Indian summer monsoon is the primary source of surface water in North India. North India is also one of the most polluted regions of this world. We have studied the associations between variability of aerosols, thermodynamics and surface energy balance within Indian summer monsoon region (ISMR). Observational analysis and radiative transfer modeling show that presence of elevated aerosol layers during monsoon onset period can reduce the lower tropospheric temperature by 2-3^{o}C and thereby increase atmospheric stability over ISMR. At the same time, a study of episodic increase in concentration of absorbing aerosols reveals close coupling between absorbing aerosols and Bowen ratio over Kanpur, located within ISMR during monsoon onset period. Aerosol associated changes in physical and biological properties determine the magnitude and pathway of partitioning of available energy at surface.

We have also investigated the aerosol-cloud-rainfall associations in mesoscale convective clouds over ISMR. Deep convective clouds sampled during Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX) over ISMR were simulated under high and low aerosol emission scenarios using WRF-Chem. Idealized supercell simulations of a typical heavy rainfall event initialized with different concentration of cloud condensation nuclei were also performed using spectral bin microphysics scheme on WRF platform (WRF-SBM). Further, satellite data and in situ measurements were analyzed to study association between aerosol loading, cloud macro- and microphysics, cloud radiative forcing and daily surface rainfall. Our analysis show that high aerosol loading induces delay in warm rain processes, which in turn, lead to increase in vertical transport of more water mass above the freezing level, thereby, enhancing formation of ice-phase particles. Lastly, using WRF simulations and in situ measurements we also found that aerosol microphysical effect coupled with the dynamic effect of urban land cover can influence the spatial distribution of surface rainfall over greater Kanpur.

2.015 Radiative and microphysical pathways of aerosol impact over Indian summer monsoon.

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Abstract:

Indian summer monsoon is the primary source of surface water in North India. North India is also one of the most polluted regions of this world. We have studied the associations between variability of aerosols, thermodynamics and surface energy balance within Indian summer monsoon region (ISMR). Observational analysis and radiative transfer modeling show that presence of elevated aerosol layers during monsoon onset period can reduce the lower tropospheric temperature by 2-3oC and thereby increase atmospheric stability over ISMR. At the same time, a study of episodic increase in concentration of absorbing aerosols reveals close coupling between absorbing aerosols and Bowen ratio over Kanpur, located within ISMR during monsoon onset period. Aerosol associated changes in physical and biological properties determine the magnitude and pathway of partitioning of available energy at surface.

We have also investigated the aerosol-cloud-rainfall associations in mesoscale convective clouds over ISMR. Deep convective clouds sampled during Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX) over ISMR were simulated under high and low aerosol emission scenarios using WRF-Chem. Idealized supercell simulations of a typical heavy rainfall event initialized with different concentration of cloud condensation nuclei were also performed using spectral bin microphysics scheme on WRF platform (WRF-SBM). Further, satellite data and in situ measurements were analyzed to study association between aerosol loading, cloud macro- and microphysics, cloud radiative forcing and daily surface rainfall. Our analysis show that high aerosol loading induces delay in warm rain processes, which in turn, lead to increase in vertical transport of more water mass above the freezing level, thereby, enhancing formation of ice-phase particles. Lastly, using WRF simulations and in situ measurements we also found that aerosol microphysical effect coupled with the dynamic effect of urban land cover can influence the spatial distribution of surface rainfall over greater Kanpur.

2.016 Role of Aerosol and its distribution over south Asian region.

Early Career Scientist

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Abstract:

The south Asian regions are one of the densely populated area in the globe. It is observed that there are five types of aerosols optical depth over the south Asian region. It is studied for the monsoon and winter seasons by using Regional Climate Model. The variations are found for the seasons as well as regions. In the monsoon season most of the part of the south Asian region shows decrease of precipitation due to anthropogenic and biomass aerosols. The climate model depicts that in the winter there are less aerosols compare to monsoon seasons. In the summer Sulphate (SO_4) is aggravated over India and the Bay of Bengal area. In the winter SO_4 is existing whole region over India. On the contrary, both the seasons dust is higher and dominating in the northwest region of south Asia.
Keywords: aerosols, south Asia, precipitation and SO_4.

2.017 Synoptic Variations of West Asian Dust Associated With Indian Summer Monsoon Precipitation.

Early Career Scientist

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Abstract:

Dust is known to influence the Indian summer monsoon circulation on seasonal timescales by
perturbing the atmospheric radiation. Aerosol optical depth retrieved by MODIS has been shown to be highly correlated with observed Indian monsoon precipitation on weekly time scales. This has been interpreted to show the effect of dust radiative heating on Indian rainfall.
However, we are able to reproduce this correlation in our simulations with the GISS Earth System ModelE2, where dust is present but its radiative effect is omitted. This shows that dust
radiative heating has limited influence upon monsoon rainfall on weekly time scales. Further
analysis on daily time scales suggests that the correlation results from the effect of precipitation
on dust. High monsoon precipitation over India induces higher emission over the dust sources in
North Africa and the Middle East. However, on seasonal time scales, dust is known to alter monsoon rainfall. There is a need to better understand the underlying physical phenomenon and
at what time scale dust modifies Indian precipitation.

2.018 Deviation of South-Asian Summer Monsoon Onset with associated Trends of Anthropogenic Black Carbon over Pakistan.

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Abstract:

The summer monsoon onset, inter-annual variability, and long-term present and future trends significantly impact the water resources and agriculture of Pakistan, thereby influence the entire socio-economic development. Using different observational datasets and methods, the monsoon onset is found to be on the 1st of July with the standard deviation of 12 days over Pakistan. The large-scale circulation characteristics and thermodynamic structure leading to monsoon onset are investigated in order to explore, and understand the precursory circulation signals affecting the year-to-year variations in the onset dates, which may provide useful information for short-term monsoon forecast over the region. A dipole-like pattern in seasonal (June – September) and monthly rainfall trends is identified over north of the Indo-Pakistan subcontinent, where significant increasing trends in the last 60 years are seen over the Core Monsoon Region of Pakistan (CMRP) and significant decreasing trends over the Central-North India (CNI) and adjacent areas. The Empirical Orthogonal Function analysis of Vertically Integrated Meridional Moisture Transport revealed that the positive trend of rainfall in the CMRP and negative rainfall trend over the CNI region is related to strengthening (weakening) of moisture transport in the Arabian Sea (Bay of Bengal) during the monsoon season. This is linked to the analysis of EDGAR-HTAP data for anthropogenic black carbon over Pakistan. The increasing trends are found along the foothills of Himalayas, the provinces of Punjab and Sindh. The summer monsoon rainfall trends using historical and future climate change (under RCP4.5 and RCP8.5 scenarios) simulations of different climate models from Coupled Model Intercomparison Project (CMIP5) show large variability across models. More refined study regarding the monsoon onset and long-term rainfall trends with associated mechanisms for the regional perspective using WRF-Chem is under investigation; the results will be presented at the ACAM workshop.

2.019 Satellite retrieval of cloud condensation nuclei (CCN) concentrations for convective clouds.

Early Career Scientist

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Abstract:

Quantifying the aerosol/cloud-mediated radiative effect at a global scale requires simultaneous satellite retrievals of cloud condensation nuclei (CCN) concentrations and cloud base updraft velocities (Wb). Hitherto, the inability to do so has been a major cause of high uncertainty regarding anthropogenic aerosol/cloud-mediated radiative forcing. This can be addressed by the emerging capability of estimating CCN and Wb of boundary layer convective clouds from an operational polar orbiting weather satellite. Our methodology uses such clouds as an effective analog for CCN chambers. The cloud base supersaturation (S) is determined by Wb and the satellite-retrieved cloud base drop concentrations (Ndb), which is the same as CCN(S). Validation against ground-based CCN instruments at Oklahoma, at Manaus, and onboard a ship in the northeast Pacific showed a retrieval accuracy of ±25% to ±30% for individual satellite overpasses. This method open a new window for teasing out the aerosol effects on the convective clouds from dynamic effects in Asian Monsson region.

2.020 Understanding the coupling between aerosol chemistry and Indian summer monsoon: An Indian Perspective.

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Abstract:

Atmospheric aerosols, a ubiquitous component of atmosphere, remain the least understood in Earth's climate system for their microphysical and radiative processes, despite decades of demanding attention and extensive studies on a regional to global scale. Our studies from at a high-altitude site, Manora Peak, in the central Himalaya suggest that black carbon (BC) concentration varies between 0.14 to 7.6 μgCm^{-3} (range: 0.1% in summer to 7.6% of total suspended particulates (TSP) matter in winter) and has a large positive atmospheric radiative forcing (~ +28 ± 5 Wm-2) and high values of heating rate (0.80±0.14 $Kday^{-1}$). In contrast, scattering organic carbon (OC) constitute, on an average 15% of TSP at Manora Peak. The average contribution of OC and EC are ~30% and 5% respectively at Kanpur, an urban area in the Gangetic Plain. However, OC/EC ratios are much higher (in range of 6-8) over urban as well high-altitude locations in India. The understanding of the aerosol and Indian summer monsoon (ISM) link is driven primarily by the chemistry-climate models but the response of the ISM to aerosols in the models is found to be very sensitive to the partitioning of absorbing and scattering components of the aerosols. Therefore, an accurate representation of the absorbing and scattering fraction and optical properties of aerosols from India is crucial to understand the coupling among aerosol-chemistry, ISM and climate on a regional scale.

2.021 South-westerly monsoon impact on fine particulate matter in Malaysia: trend, source apportionment and health implication.

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Abstract:

Haze pollution in Southeast Asia (SEA) is a significant regional issue which needs to be addressed further, scientifically. Smog, a combination of smoke and fog, is contributed by the intensive burning of agricultural wastes, peat soil and forests in SEA and can trigger the $PM_{2.5}$ level. $PM_{2.5}$ poses deleterious impact on human health particularly on brain damage, cardiovascular and respiratory diseases. Several comprehensive projects on the compositions of $PM_{2.5}$ were accomplished at Universiti Kebangsaan Malaysia until 2015. A high volume sampler (HVS) was used to collect the filter samples. Water-soluble ions (WSI), trace species, rare earth elements (REE), and elemental and organic carbon (EC, OC, OC1, OC2, OC3 and OC4) and polycyclic aromatic hydrocarbons (PAH) were subjected to analysed in $PM_{2.5}$ samples using ion chromatography (IC), inductively coupled plasma mass spectroscopy (ICP-MS), a thermal/optical carbon analyser and gas chromatography (GC-MS), respectively. A database was characterized by the United States Environmental Protection Agency (US EPA) positive matrix factorization (PMF), a mass closure model and the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) based potential source contribution function (PSCF). A sensitivity test of the PAHs was also made to the frequency and the number of traffic types. Overall, the 24 h average values of $PM_{2.5}$ ranges from 6.64 – 68.2 μg m^{-3}. Motor vehicle, biomass burning and emission from a coal-fired power plant are the predominant sources of $PM_{2.5}$. PSCF and HYSPLIT Model clearly demonstrated that localized sources as well as biomass burning emissions originated from the Sumatra, can alter $PM_{2.5}$ concentration during the south-west monsoon. The associated lifetime cancer risk posed by the exposure of hazardous metals in $PM_{2.5}$ is 3-4 per 1 000 000 people at this location. However, the carcinogenic risk of the total PAHs

indicates an acceptable risk level in the present study area in Malaysia.

2.022 PM2.5 concentration and composition in Bandung area: comparison using different equipment.

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Abstract:

$PM_{2.5}$ is very critical air pollution because of its size, ability to transport long distances and the chemical-composition contained therein. With characteristic topography and population growth, Bandung is considered to have the potential dangers of high air pollution so that the necessary efforts in monitoring the quality of air pollutant, particularly $PM_{2.5}$ is very important. The measurement of $PM_{2.5}$ were carried out using AirPhoton® instrument on the roof of eight story Building at ITB which is considered to represent the ambient air quality in an urban area of Bandung. Measurements were carried out from July 18th 2014 to February 17th 2015. The $PM_{2.5}$ mass concentration were determined by gravimetric analysis while Ion Chromatography and ICP-MS are used to analyze the ions and elements respectively..
The results show that *$PM_{2.5}$ concentrations in Bandung urban area were still meet the Indonesia NAAQS which is 65 µg/m^3. The average PM2.5 concentration were 29.32±7.52 µg/m^3 and the peak concentration of $PM_{2.5}$ were occurred in morning (06:00-09:00) and afternoon (18:00-20:00) during rush hours. There is a good agreement (good correlation) between AirPhoton® instrument and Mini Vol sampler with R^2=0.67 . The highest component contribute to PM2.5 were sulfate, nitrate, ammonium and Black Carbon (BC) with the total contribution is 27% of the $PM_{2.5}$ mass concentration. The remaining may come from Organic Carbon which were not analysed in this study.*

Keywords: *$PM_{2.5}$, AirPhoton®, chemical composition, sulfat, nitrat.*

2.023 The role of snow-darkening effect in the Asian monsoon region.

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Abstract:

It is known from previous studies that snow-darkening is caused by deposition of light-absorbing aerosols such as dust, black carbon, and organic carbon and accelerating snow melting in spring. Our team mainly led by NASA Goddard Space Flight Center has worked on developing the snow-darkening module (called GOddard SnoW Impurity Module: GOSWIM) for the NASA's global model, GEOS-5. In this presentation, we introduce the summary of our studies so far including the published paper on the snow-darkening role in the northern hemisphere as follows and most of the data for this presentation were based on Yasunari et al. (2015, *J. Geophys. Res. Atmos.*, 120, 5485–5503. doi:10.1002/2014JD022977; also see at: https://svs.gsfc.nasa.gov/11899). Based on their data of 10-year x 10-ensemble with/without snow-darkening effect (SDE), they concluded that the existence of snow-darkening in spring would contribute to emphasize the water cycle in East Asia and dryness from Europe to Central Asia, where the contributions of black carbon and dust to the visible snow absorption are relatively larger, respectively. On their mentioned enhanced water cycles in East Asia, the water vapor mainly contributed the advection from the ocean and regional water recycling. In summer, their study also showed the significant advection from the Indian Ocean to the Himalayas and increased precipitation over the Tibetan Plateau and Himalayas. Over Western Eurasia, the spring precipitation increase due to the SDE was largely explained by water re-cycling. The changes of heatwave frequency over Eurasia due to SDE showed a boomerang shape in which two stronger regions were seen in Central Asia and China. The peak seasons of higher heatwave frequency at 40-60°N and 60-80°N were in spring and early summer, respectively. In this talk, we also intend to tell our updates of GOSWIM to the latest version of NASA GEOS-5.

2.024 The Roles of Anthropogenic Aerosols in Future Projection of Extreme Summer Precipitations over the Asian Monsoon Regions.

Early Career Scientist

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Abstract:

This study investigates the potential impacts of anthropogenic aerosols on future changes in summer precipitation extremes over the Asian Monsoon region. Data are obtained from the Community Earth System Model (CESM1) ensemble simulations under the Representative Concentration Pathway (RCP) 8.5 and the corresponding scenario with aerosol precursor emissions and atmospheric oxidants fixed at 2005 levels (RCP8.5_FixA). The model performs well in capturing the present-day precipitation climatology and extremes compared to observations. Under the RCP8.5 scenario aerosol emissions and burdens follow very different future trajectories over East Asia (EA) compared to SA. Specifically, aerosols over EA are projected to decline steadily while they are expected to increase to peak around the 2040s and then decline slowly to return to below 2005 levels after the 2080s over SA. From 2006-2100 surface temperature over Asia warms by about 5°C following the RCP8.5 scenario, compared to about 4°C under RCP8.5_FixA. Extreme precipitation indices were carefully selected and studied separately over EA and SA. Precipitation extremes increased under both scenarios, however we found that for the same degree of warming, the increase was significantly less when the aerosols are fixed. The difference is most significant in terms of consecutive wet days and extreme wet days. To interpret the underlying mechanisms driving these changes, the interactions between aerosols, clouds, radiation budget, as well as thermodynamics and dynamics were studied in detail. Generally, the patterns of precipitation were accompanied by evident weakening in the large-scale monsoon circulation with more aerosols. In conclusion, the aerosols levels have significant effects on the future precipitation extremes over Asia Monsoon Regions through interactions with cloud, radiation, and the large scale monsoon circulations.

2.025 Satellite remote sensing of snow albedo and snow grain size in the Himalayan cryosphere in relation with dust deposition events using Landsat and MODIS data.

Early Career Scientist

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Abstract:

Deposition of light absorbing impurities (LAI) such as mineral dust reduce the reflectance of snow/ice surface by enhancing solar absorption (Snow Darkening), which can lead to accelerated snowmelt and snow albedo feedbacks. The concentrations of LAI peak during the pre-monsoon season. This study focuses on the characterization of LAI deposited in the Hindu Kush-Himalaya-Karakoram (HKH) glaciers and seasonal snowpack using multi-spectral satellite measurements from the MODIS and Landsat-8 OLI, obtained for the year 2015. Spectral reflectance derived from MODIS and Landsat data for spatially and temporally overlapping periods are analyzed and inter-compared for the HKH region, using visible-nearIR (VIS-NIR) radiances after atmospheric correction. We use the VIS-NIR reflectance gradient approach to characterize dust LAI on snow associated with a positive gradient, resulting from the enhanced dust-induced absorption in the blue bands. The reflectance reduction during the dust-laden pre-monsoon season is found to be larger in Western-Himalaya (39%-48%) and Hindu-Kush (26%-58%) compared to Karakoram (10%-28%). In addition, snow grain size (SGS) and its temporal variation for the pre-monsoon months is estimated using red and NIR bands. The SGS was observed to increase with snow aging, melting and darkening during the pre-monsoon period. The mean SGS was found to be largest in western-Himalaya (236-298µm) followed by the Hindu-Kush (166–269µm) compared to Karakoram (110–216µm). We find that our satellite-based estimates of SGS are in close agreement with in-situ SGS measurements (130–340µm), based on limited available literature for the HKH. However, in-depth case studies of extensive dust deposition indicate significant temporal variations with satellite-based SGS exceeding 700µm, with implications to enhanced snow albedo feedbacks. Overall, the spatio-temporal variation of snow reflectance and SGS are found to strongly depend on desert-dust transport pathways and elevation gradients, with the Western-Himalaya and Hindu-Kush experiencing greater dust influx compared to the northern regions of Karakoram.

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

Early Career Scientist

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Abstract:

In this paper, observational air temperature and 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. Observations indicated that YRD experienced severe heat waves with maximum temperature up to 41.1 °C, 6.1 °C higher than the definition of heat wave in China, and can last for as long as 27 days. maximum ozone reached 160.5 ppb, exceeding the national air quality standard (secondary level) as 74.7 ppb. Moreover, 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. A typical heat wave case (HW: 24/7-31/7) and non-heat wave case (NHW: 5/6-12/6) were selected to investigate the mechanism between heavy ozone and heat waves. mechanism difference It was found that chemical reactions play the most important role in ozone formation during HW days, in which 12 ppb ozone enhancement was found compared to NHW days. High temperature also slightly promote the effect of dry deposition velocity, vertical turbulence and horizontal advection, which beneficial to ozone remove, but the magnitude is much smaller than chemical effect.

2.027 Decreased Dust loading in the Atmosphere and Indian Summer Monsoon Rainfall .

Early Career Scientist

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Abstract:

Dust aerosol is known to have a profound effect on the spatial distribution and intensity of rainfall over the Indian subcontinent with various time scales. In the present study using long-term (2000-2016) satellite (MODIS, MISR, and OMI) and ground based (AERONET) observations with reanalysis (MERRA) products, we have shown that in recent years dust aerosol in the atmosphere has decreased (up to 20 %). The major factors contributing to this decrease are pre-monsoon increased rainfall and slow down of circulation over the North-western part. In addition to that monsoon rainfall is found to have a positive correlation with pre-monsoon dust loading. Further, it is observed that more than 50 % of Indian-landmass having a decreasing trend in the rainfall in the month of June and July.

2.028 Spatial variability of aerosol - cloud interactions over Indo - Gangetic Basin .

Early Career Scientist

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Abstract:

Clouds are one of the major factors that influence the Earth’s radiation budget and also change the precipitation pattern. Atmospheric aerosols play a crucial role in modifying the cloud properties acting as cloud condensation nuclei (CCN). It can change cloud droplet number concentration, limit cloud droplet size and hence cloud albedo. Aerosols show large spatial and temporal variability due to various emission sources, resulting in significant spatial variation of aerosol – cloud interaction effects. In the present study, we investigate the effect of aerosol on cloud parameters during normal monsoon years and drought years over entire Indo – Gangetic Basin (IGB). IGB is one of the most polluted regions of the world and experiences significant heterogeneity in aerosol loading throughout the year. We divided the entire IGB in to six major sub regions based on aerosol loading. With this objective, fifteen years (2001 – 2015), daily mean aerosol optical depth, cloud parameters and rainfall data obtained from MODerate resolution Imaging Spectroradiometer (MODIS) on board of Terra satellite and Tropical Rainfall Measuring Mission (TRMM) is analyzed over each sub regions of IGB for monsoon season (JJAS : June, July, August and September months). Preliminary results show a negative gradient in aerosol loading as we move from northern IGB to north – eastern IGB. A strong correlation between cloud optical thickness and liquid water path is obtained with maximum in central IGB while minimum in western IGB region. Correlation between cloud optical thickness and rainfall is found smaller during drought years than the normal monsoon years over western IGB. Detailed results will be presented during the workshop.

3.001 Variabilities in greenhouse gases in South Asia due to monsoon.

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Abstract:

The concentration of atmospheric methane (CH_4) has more than doubled since pre-industrial times, and its radiative forcing is second largest after carbon dioxide (CO_2). The annual CH_4 emissions from South Asia are estimated at about 75 Tg/yr for 2010, which represents about 15% of the global total emissions (Patra et al., 2016). A significant fraction of methane emissions is attributable to ruminants and rice fields in South Asia. However, large uncertainty prevails in the sectorial CH_4 emissions because of the lack of measurements. To improve CH_4 emission estimates, a project entitled "Atmospheric Methane and Agriculture in South Asia (AMASA)" is funded by the Japanese Ministry of the Environment. Overarching goals of this project are: (1) to improve CH_4 emission estimates in South Asia using remote sensing and *in-situ* measurements, and (2) to develop an emission mitigation proposal based on local experimental studies in South India.

In this meeting, we will present an analysis of greenhouse gases observations from existing and newly established surface stations at Comilla, Bangladesh, and 4 sites in India (Nainital, Sonipath, Ahmedabad, Cape Rama). It is shown that the measurements of CH_4 are better explained when analysed in comparison with the variabilities in other species, e.g., CO_2, carbon monoxide (CO), nitrous oxide (N_2O). We also use the JAMSTEC's atmospheric chemistry-transport model (ACTM) for simulating the observed concentrations by varying surface emissions. The model-observation comparisons help us to elucidate the synoptic and seasonal variabilities in surface concentrations of greenhouse gases in relation with coupled monsoon meteorology and surface fluxes. Our results suggest, the west coastal regions of India are predominantly under the influence of southern hemispheric air during the south-west monsoon season, while an efficient transport of surface emission occur over the Indo-Gangetic Plane by strong upwelling

motion. The model-observation differences are used for correcting surface emissions.

3.002 Model calculations of the contribution of tropospheric SO2 to the stratospheric aerosol layer.

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Abstract:

The stratospheric aerosol layer is important for the radiative balance of the Earth and plays a significant role in stratospheric chemistry. Despite its importance, many processes forming the stratospheric aerosol layer are not well understood, including the magnitude of the contribution of tropospheric SO_2 to the non-volcanic background of the aerosol layer.
We examine the tropospheric chemistry of SO_2 and its transport to the stratosphere by running a chemical box model along trajectories ascending from the boundary layer to the tropopause. Numerous sensitivity runs are used to assess the range of uncertainty in the global SO_2 flux through the tropopause introduced by the limited knowledge of the involved process parameters. The trajectory model is based on the ATLAS model and is driven by ECMWF ERA Interim data. The chemistry model includes the gas phase reactions SO_2+OH and DMS+OH and the liquid phase reactions SO_2+H_2O_2 and SO_2+O_3 and uses background fields of OH, O_3 and H_2O_2 obtained from a GEOS-Chem CTM run. A model simulation in the monsoon season is compared with results of a simulation outside the monsoon season.

3.003 Intercomparison of vertical structure and formation mechanism between summer ozone valleys over Tibetan Pleateau and North America.

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Abstract:

The ozone valleys over the Tibetan Plateau (OVTP) and over North America (OVNA) occurred both in middle latitudes and in summer half year. Hence, to compare their structure and formation mechanism is an interest issue. We calculated ozone zonal deviation rate, using MLS data from 2005 to 2013. There are two centers of OVTP and only one center of OVNA. One center of OVTP is located in the upper troposphere and lower stratosphere (UTLS) with peak ozone zonal deviation rate of -0.3 and another center is located in the upper stratosphere with peak ozone zonal deviation rate of -0.01. The center of OVNA is also located in the UTLS region with peak value of -0.18. Then we analyzed the dynamic and chemical mechanism of ozone valleys. Summer circulation and ozone flux divergence from ERA-interim data show that domain of the anticyclone over the Tibetan Plateau is larger than that over North America. Moreover, corresponding ozone flux divergence over the Tibetan Plateau (1×10^{-12} kg·kg^{-1}·s^{-1}) is more robust than that over North America (5×10^{-13} kg·kg^{-1}·s^{-1}). That is the reason that UTLS center of OVTP is stronger than that of OVNA. However, the MLS data imply chemical reaction may play a role in the upper center of OVTP. Zonal deviation of chlorine monoxide and zonal deviation of hydrogen chloride are negative and zonal deviation of nitrogen dioxide is

positive at 10 hPa over the Tibetan Plateau. Higher chlorine monoxide and hydrogen chloride concentration implies that chlorine catalytic reactions which make ozone loss are stronger over the Tibetan Plateau. While lower nitrogen dioxide concentrations may slower the reaction that deactivates reactive chlorine into nonreactive chlorine and then may strengthen the chlorine catalytic reactions. Consequently, chemical processes may have an effect on the upper center of OVTP.

3.004 Trace gas studies in the UT/LS from recent airborne campaigns.

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Abstract:

Chemical composition of the air in the upper troposphere/lower stratosphere is controlled by a balance of transport, photochemistry, and physical processes, such as interactions with clouds, ice, and aerosol. The chemistry of the air masses that reach the upper troposphere can potentially have profound impacts on the chemistry in the near tropopause region. For example, the transport of reactive organic halogens and their transformation to inorganic halogen species, e.g., Br, BrO, etc., can have a significant impact on ozone budgets in this region and even deeper the stratosphere. Trace gas measurements in the region near the tropopause can also indicate potential sources of surface emissions that are transported to high altitudes. Measurement of trace gases, including such compounds as non-methane hydrocarbons, hydrochlorofluorocarbons, halogenated solvents, methyl halides, etc., can be used to characterize source emissions from industrial, urban, biomass burning, or even marine origins. Recent airborne research campaigns have been conducted to better characterize the chemical composition and variations in the UT/LS region. This presentation will discuss these measurements, with a special emphasis on the role of convection and transport in modifying the composition of the UT/LS.

3.005 What drives the seasonal cycle of stratospheric entrainment of oceanic halogenated very-short lived substances through the Asian monsoon?.

Early Career Scientist

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Abstract:

Halogenated very short-lived substances (VSLS) are naturally produced in the ocean and emitted to the atmosphere. When transported to the stratosphere, these compounds can have a significant influence on the ozone layer and climate. The Asian monsoon circulation provides an effective pathway for air masses from the atmospheric boundary layer to enter the global stratosphere during boreal summer. While most existing studies focus on pollution from Asia, the contribution and transport of oceanic trace gases on the atmospheric composition via the Asian monsoon circulation is still unclear. In order to better understand the role of natural and anthropogenic factors of the atmospheric composition and chemistry for the Asian monsoon, it is important to also investigate the role of oceanic trace gas emissions, such as VSLS. In previous measurement and model studies, we demonstrated that the subtropical and tropical West Indian Ocean is an important source of VSLS for the troposphere and stratosphere and shows a distinct seasonal cycle in the transport-driven stratospheric entrainment.
In this study, we simulate the seasonal transport pathways from the tropical Indian Ocean surface to the stratosphere based on seasonally resolved oceanic VSLS emissions using the Lagrangian transport model Flexpart with ERA-Interim meteorological fields. Monthly VSLS emissions fields will be created using new Indian Ocean observations, the HalOcAt data base and biogeochemical parameterizations. We will investigate the relative importance of the seasonal changes in the transport pathways versus the seasonal cycle in VSLS emissions for the stratospheric entrainment. With this approach the main oceanic source regions and seasons for natural contribution from the Indian Ocean to the stratospheric halogen burden can be determined.

3.006 Composition and transport in the Asian summer monsoon anticyclone: A case study based on in-situ observations during ESMVal and EMAC simulations.

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Abstract:

We present in-situ measurements of the trace gas composition of the upper tropospheric Asian summer monsoon anticyclone (ASMA) performed with the HALO research aircraft in

the frame of the ESMVal campaign. Air masses with enhanced O_3 mixing ratios were encountered after entering the ASMA at its southern edge at about 160 hPa on 18 September 2012. This is in contrast to the presumption that the anticyclone's interior is dominated by recently uplifted air with low O_3 during the summer monsoon season. Enhanced CO and HCl were also found in the ASMA, tracers for boundary layer pollution and tropopause layer or stratospheric air, respectively. In addition, reactive nitrogen was enhanced in the ASMA. Along the HALO flight track across the ASMA boundary, strong gradients of these tracers separate anticyclonic from outside air.

Our data represent the first in-situ observations across the southern and downstream the eastern ASMA flank, respectively. Back-trajectories starting at the flight track furthermore indicate that HALO transected the ASMA where it was just splitting into a Tibetan and an Iranian part.

A simulation with the EMAC model is found to reproduce the observations reasonably well. It shows that O_3-rich air is entrained by the outer streamlines of the anticyclone at its eastern flank. Back-trajectories and increased HCl mixing ratios indicate that the entrained air originates in the stratospherically influenced tropopause layer. Photochemical ageing of air masses in the ASMA additionally increases O_3 in originally O_3-poor, but CO-rich air. The interplay of entrainment from the tropopause region, photochemistry and dynamical instabilities can explain the in-situ observations, and might have a greater impact on the highly variable trace gas composition of the anticyclone than previously thought.

3.007 NO and NOy mixing ratios in an air mass affected by the Asian Monsoon Anticyclone during STRATOCLIM in the Eastern Mediterranean – airborne measurements on board the M55 Geophysica.

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Abstract:

A first phase of the STRATOCLIM (Stratospheric and upper tropospheric processes for better climate predictions) airborne field campaign took place in Kalamata/Greece in August/September 2016. The aim of the STRATOCLIM airborne field campaign is to improve our understanding of trace gas and particle distributions and transport in the upper troposphere/lower stratosphere (UTLS) Asian Monsoon Anticyclone. This anticyclone is one of the major regions of exchange of air masses between the troposphere and lower stratosphere. The research flights were conducted with the Russian high altitude research aircraft M55 Geophysica across the Eastern Mediterranean at flight altitudes up to 20 km. On board the Geophysica physical parameters, trace gas and particle concentrations were measured. High quality NO and NOy data were measured using chemiluminescence technique.
During a flight on the 30th of August 2016, enhanced mixing ratios up to 1.90 nmol/mol NOy and 0.55 nmol/mol NO were detected close to the tropopause at ~ 14 km altitude, compared to background values of around 1.1 nmol/mol NOy and 0.25 nmol/mol NO. We present the transport pathway of this air mass using HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectories) trajectory calculations. The trajectories show that the air mass of interest originates in the marine boundary layer in the south-west Pacific. Before transported to the Geophysica measurement site, the air mass was uplifted by a cyclone and circulated in the elevated Asian Monsoon Anticyclone.

3.008 Impacts of the Western Pacific Subtropical High on summertime ozone variability in East China from daily to interannual scales.

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Abstract:

The Western Pacific Subtropical High (WPSH) is one of the most important components of the East Asian summer monsoon (EASM) and a key factor that affects summertime weather conditions in east China. Here we characterize the influence of the WPSH on the day-to-day variability of surface ozone over east China using in situ observations at more than 100 cities in China during 2013-2016. An WPSH intensity index is found to explain about 30% of daily ozone variability, but the WPSH-ozone association is opposite in sign between North and South China. Preliminary analysis suggests this feature is related with the south-to-north march of the monsoonal rain band and convection. A three-dimensional global model of tropospheric chemistry, GEOS-Chem, is used to intepret the observed relationship between WPSH and summertime ozone. We employ the model simulation to develop a quantified estimate of the ozone-WPSH relationship in a longer time period (1990-2015) from daily to interannual time scales.

3.009 Impact of the monsoon on the self-cleaning capacity of the upper troposphere .

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Abstract:

The strong growth of the Asian economies during the past decades have led to an increasing level of air pollution in this region. The Asian monsoon transports this air pollution from the boundary layer over South Asia into the upper troposphere. In the upper troposphere the Asian monsoon forms an anticyclone in which these pollutants, including volatile organic compounds (VOCs), NO_x, and SO_2 are processed, potentially leading to the formation of aerosol and ozone. Air masses leaving the anticyclone can be transported globally and potentially also enter the stratosphere. In order to investigate the impact of this upward transported pollution a German research consortium from universities and research institutions equipped the HALO research aircraft with instrumentation to measure OH, HO2, VOC, CO, O3, NOx, SO2, photolysis frequencies and particles in the upper troposphere. Within the intensive field campaign ‘OMO’ the HALO aircraft probed air masses from 12 up to 15km within the Asian monsoon anticyclone. In addition air masses outside the anticyclone influenced by North American emissions, and also in very clean air originated from the southern hemisphere were probed, to contrast them with the measurements inside the anticyclone. The presentation will be focused on the OH and HO2 measurements.

3.010 Multi year’s balloon-borne ozone measurements and associated variabilities over the central Himalayas: Role of different processes.

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Abstract:

The tropospheric ozone is produced via photooxidation involving its different precursors and transport from the stratosphere. Emissions of various ozone precursor gases are shown to be increasing over several parts of Asia. Additionally, the downward transport of ozone from the stratosphere is another major factor to the springtime maximum in surface ozone. Generally, in the extra-tropical latitude regions, intrusion of stratospheric air takes place and it is also associated with tropopause folding events near the jet stream. It is also known that the Himalayas play an important role in regulating the transport of the pollution and moisture in the Asian monsoon region. In this reference, balloon-borne measurements of ozone (ECC ozonesonde, EN-SCI model 2ZV7) and meteorological parameters (InterMet GPS-radiosonde, iMet-1-RSB) were made from ARIES, Nainital (29.4N, 79.5E; 1950 m) in the Central Himalayas and so far, more than 250 flights have been conducted. The observations show large inter-annual variability in ozone during the period of years 2011-2017. The inter-annual variability changes with altitude and observed to be about 10-60%. Surface emissions of precursor gases and biomass burning appear to be major contributors in the lower tropospheric variability and emissions during biomass burning are observed to enhance ozone levels up to about 30 ppbv. Dynamical processes, including downward transport of ozone from the stratosphere, gravity waves etc. are suggested to be major contributors in the middle to upper tropospheric region. These observations indicate a weak negative trend in the lower troposphere and a positive trend in the middle-upper troposphere. Detailed analysis will be presented during the workshop.

3.011 Statistical downscaling using long-term trend preserving bias correction methods (DQM and QDM), for extreme climatic and hydrological events over Pakistan.

Early Career Scientist

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Abstract:

The reliability of climate models greatly depends on their validation and application for particular region. The projections of climate models are becoming increasingly relevant to policy makers; but their efficiency being criticized due to uncertainties and errors. To establish the confidence of policy makers in climate models, the scientific community has targeted to develop and use better models and minimize the uncertainty and errors in these models. Generally, simple bias-correction methods are used to minimize the errors gap between climate models output and observe data but the problem is that these bias-correction methods flat the extreme events and can't preserve the climate change signals in future projections. Here, we implement, Detrended Quantile Mapping (DQM) and Quantile Delta Mapping (QDM), which explicitly preserves relative changes in simulated models data. In this study, the future climatic extremes were projected for Pakistan under the RCP4.5 and RCP8.5 emission scenarios. Long-term trend preserving bias correction methods (i.e. detrended quantile mapping and quantile delta mapping), with 14 CMIP5 GCM climate projections for daily precipitation, minimum temperature, and maximum temperature over Pakistan. This long-term trend preserving data is used as input to hydrological model to project extreme events in respect of high inflow and flash flood.

The results show that QDM and DQM bias correction methods preserve the long-term trend of future extremes. It also clearly indicates of increasing risk in future extreme events in respect of intensity and frequency over Pakistan. The numbers of warm night are increasing and cold nights are decreasing may possibly due to global warming. Daily minimum, maximum temperatures and total rainfall are also increased. The results of hydrological extreme show there will higher inflow in the river and if add with precipitation extreme will cause flood in the region.

3.012 Insights into wet deposition of trace elements to central Himalayas: Spatial and seasonal variations.

Early Career Scientist

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Abstract:

Atmospheric pollution in the South Asia is serious and the precipitation chemistry studies in the region is limited. Therefore, in order to understand the concentration and variation of atmospheric trace elements in wet deposition, precipitation samples were collected for over 1-year period at four locations in the central Himalayas. The sampling was performed in urban, semi-urban, rural and remote locations in order to investigate the spatial distribution of the measured elements. Concentrations of 10 trace elements (Al, Cr, Mn, Fe, Co, Ni, Cu, Zn, Cd, and Pb) were examined. The highest elemental concentrations were found at urban site (Kathmandu) and lowest at remote background site (Gosainkunda). The seasonal differences of elemental concentrations in urban site was not clear between monsoon and non-monsoon seasons as local sources predominated over regional sources. On the contrary, the other three sites showed a distinct seasonal variation with higher loadings of trace elements during non-monsoon and lower during monsoon. EFs calculations at all sites showed that most of elements (Cr, Co, Ni, Cu, Zn, Cd and Pb) were from anthropogenic sources and some (Al, Fe and Mn) were originated from crustal sources. In addition, principal component analysis (PCA) also indicated that the precipitation chemistry was mostly influenced by crustal and anthropogenic sources in Nepalese Himalayas. The result from the present study is an indication that long-range transport of pollutants has a significant impact on the high altitude remote areas in the central Himalayan regions. In order to further understand atmospheric transport and deposition of trace elements in the region, long-term more studies at different sites on the Himalayan regions are necessary. This study of wet precipitation chemistry in the region can enhance the understanding of the atmospheric environment and create the dataset for further research of trace elements in the region.

4.001 Tropopause-following analysis of water vapour and deltaD for the monsoon systems and the tropics.

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Abstract:

MIPAS on Envisat has provided a 10-years global data set of water vapour and HDO. Here we analyse water vapour, HDO and delta D fields on tropopause-following coordinates for the Asian and American monsoon and the tropics. We contrast the enhancements/depletions for various seasons and regions and relate the findings to areas of increased convection. Besides the monsoon systems, the West Pacific area stands out with specific signatures.

4.002 Transport of carbonaceous aerosols emissions during Asian summer monsoon and its implications on the UTLS in aerosol climate model.

Early Career Scientist

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Abstract:

Recent satellite observations show efficient vertical transport of Asian pollutants from the surface to the upper level anticyclone by deep monsoon convection. In this paper, we examine the transport of carbonaceous aerosols including Black carbon (BC) and Organic Carbon (OC) into the monsoon anticyclone using of ECHAM6-HAM, a global aerosol climate model. Further, we investigate impacts of enhanced (doubled) carbonaceous aerosols emissions on the UTLS from sensitivity simulations.
These model simulations show that boundary layer aerosols are transported into the monsoon anticyclone by the strong monsoon convection from the Bay of Bengal, southern slopes of the Himalayas and the South China Sea. Doubling of emissions of black carbon and organic carbon aerosols, each, over the South East Asia (10°S-50°N; 65°E-155°E) show that lofted aerosol produces significant warming in the mid/upper troposphere. These aerosols enhance temperature by 1-3 K in the mid/upper troposphere and radiative heating rates by 0.005 $Kday^{-1}$ near the tropopause. They alter aerosol radiative forcing at the surface by -1.4 W m^{-2}; at the TOA by +1.2 W m^{-2} and in the atmosphere by 2.7 W m^{-2}over the Asian summer monsoon region (20ºN-40°N, 60ºE-120°E). In-atmospheric warming increases vertical velocities and thereby cloud ice in the upper troposphere. An anomalous warming over the Tibetan Plateau upshot the relative strengthening of the monsoon Hadley circulation and elicit enhancement in precipitation over India and north east China.

4.003 What control seasonal cycle of columnar methane observed by GOSAT over different regions in India?.

Early Career Scientist

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Abstract:

Asian summer monsoon strongly affect the vertical upward transport of air masses that are rich in short-lived climate forcers (SLCFs). Methane (CH_4) is one of the most important SLCFs as per the UNFCCC. In Asia, a significant fraction of CH_4 emissions is attributable to rice fields and ruminant animals, however quantitative estimates contain significant uncertainty due to sparse ground based measurement networks. Though the satellite observations have the advantage of providing continuous monitoring over a wide spatial range, the information is limited to total column dry-air mole fractions of methane (XCH_4), which involves the CH_4 densities at all altitudes along the solar light path. Thus the link of the enhancement in observed XCH_4 with the local/regional emissions will be ambiguous without separating the contributions of transport and chemistry to XCH_4 variability.

We analyze the variability of XCH_4 over different Indian regions by utilizing measurements from Greenhouse Gases Observation Satellite (GOSAT) and simulations from JAMSTEC's atmospheric chemistry-transport model (ACTM). The seasonal variation of XCH_4 (peak during southwest monsoon) is observed corresponds to the emission variation over the Indo-Gangetic Plain (IGP), which suggest that the seasonality of XCH_4 could be attributable to the emission variation. However, the

comparisons with ACTM simulations suggest only ~40% enhancement can be attributable to the surface emissions, as only ~40% enhancement is observed in the lower tropospheric layer (~1000-600 hPa) that is directly affected by surface emissions. The seasonality of XCH_4 over the semi-arid western India is, in contrast, attributable mainly (up to 88%) to CH_4 variations in the upper troposphere. This is because the CH_4 emitted from the IGP during the southwest monsoon season is uplifted by the deep convection, followed by a confinement by the anticyclonic wind in the upper troposphere (~200 hPa). These new findings will be discussed in details during the presentation.

4.004 CLaMS simulations of transport of young air masses to the top of the Asian monsoon anticyclone and beyond.

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Abstract:

Simulations with the Chemical Lagrangian Model of the Stratosphere (CLaMS) will be presented using artificial tracers of air mass origin. With this technique the impact of young air masses continuously released since the pre-monsoon season over the course of the simulation on the composition of the Asian monsoon anticyclone and above in the lower stratosphere can be determined. We found that young boundary emissions from India/China are trapped below the thermal tropopause, which is elevated over the Asian monsoon anticyclone. These findings are consistent with the concept that the Asian monsoon anticyclone constitutes a bubble of tropospheric air. The CLaMS model results are compared with global HCFC-22 measurements of the MIPAS instrument onboard the ENVISAT satellite for the monsoon season 2008. Because HCFC-22 is emitted in locally restricted regions, in particular in eastern Asia and therefore in the Asian monsoon region, this trace gas is very well suited for studying transport processes in the region of the Asian monsoon anticyclone. Further, we will show by CLaMS trajectory calculations that young air masses circulate clockwise, in an upward spiral, at the edge of the Asian monsoon anticyclone around the core of the anticyclone. Our model results show that these young air masses originating from outside the anticyclone contribute to the composition of air just above the anticyclone. Finally, we will analyze the transport pathways of young air masses to the top of both the western and eastern mode of the Asian monsoon anticyclone.

4.005 Characterizing the climatological composition and intraseasonal and interannual variability of the Asian summer monsoon anticyclone based on 12 years of Aura Microwave Limb Sounder measurements.

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Abstract:

Satellite measurements are invaluable for investigating the composition of the upper troposphere / lower stratosphere (UTLS) in the region of the Asian summer monsoon (ASM) anticyclone, which has been sparsely sampled by other means. 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 UTLS on a daily basis. Its dense spatial and temporal sampling, long-term data record, extensive measurement suite, and insensitivity to aerosol and all but the thickest clouds make Aura MLS uniquely suited to characterizing the climatological composition of the ASM region and quantifying the considerable spatial, seasonal, and interannual variability therein. Here we examine 12 years of version 4 MLS measurements of both tropospheric (H2O, CO, CH3Cl, CH3CN, CH3OH, HCN) and stratospheric (O3, HNO3, HCl) tracers, along with cloud ice, on four potential temperature surfaces in the UTLS (350–410 K) over the course of the complete ASM lifecycle, from April through October. In addition to describing the average evolution of the anticyclone during the monsoon season, we investigate intraseasonal and interannual variability in the UTLS response to the ASM. We explore the relationships between the observed trace gas behavior and variations in the strength or location of surface emissions as well as several meteorological factors and climate indices.

4.006 Quantifying pollution transport from the Asian monsoon anticyclone into the lower stratosphere.

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Abstract:

Pollution transport from the surface to the stratosphere within the Asian monsoon circulation may cause harmful effects on stratospheric chemistry and climate. Here, we investigate air mass transport from the monsoon anticyclone into the stratosphere using a Lagrangian chemistry transport model. We show how two main transport pathways from the anticyclone emerge: (i) into the tropical stratosphere (tropical pipe), and (ii) into the Northern hemisphere (NH) extra-tropical lower stratosphere. Maximum anticyclone air mass fractions reach around 5% in the tropical pipe and 15% in the extra-tropical lowermost stratosphere over the course of a year. The anticyclone air mass fraction correlates well with satellite hydrogen cyanide (HCN) and carbon monoxide (CO) observations, corroborating that pollution is transported deep into the tropical stratosphere from the Asian monsoon anticyclone. Cross-tropopause transport occurs in a vertical chimney, but with the emissions transported quasi-horizontally along isentropes above the tropopause into the tropics and NH.

4.007 Space-Time Variability of UTLS Chemical Distribution in the Asian Summer Monsoon Viewed by Limb and Nadir Satellite Sensors.

Early Career Scientist

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Abstract:

The Asian Summer Monsoon (ASM) creates a hemispheric scale signature in chemical trace gas distributions in the upper troposphere and lower stratosphere (UTLS). This work investigates the ASM driven sub-seasonal variability in UTLS tracer distributions from satellite observations. Day-to-day behavior of CO and O_3 in the UTLS from both nadir viewing (IASI and OMI) and limb viewing (MLS) instruments are analyzed to examine whether the sub-seasonal variability that is evident in dynamical fields is also evident in chemical fields and to analyze the response of chemical distributions to dynamical variability. The main focus is to assess the capability of available satellite data for resolving the UTLS chemical impact of the ASM anticyclone on sub-seasonal variations and how the data from nadir and limb viewing sensors may complement each other. Our result shows that both instruments agree on the enhancement (reduction) of CO (O_3) within the UTLS anticyclone and show variation in spatial distribution in response to

dynamical changes in the anticyclone. Despite the limited vertical resolution, tropospheric profiles from IASI are able to represent the upper tropospheric enhancement of CO in the region of ASM anticyclone. Similarly, the OMI ozone profile product is capable of distinguishing the tropospheric dominated air in the anticyclone from the stratospheric dominated background on daily scale. Contributed by higher horizontal sampling density, the IASI data show finer structures in the horizontal distribution of CO, including CO enhancement in the upper troposphere over the western Pacific resulting from the eastward eddy shedding of the anticyclone. The MLS CO and O_3 anomalies at 150 hPa and 100 hPa both display sub-seasonal westward migrations, mimicking the behavior found in anomalies of geopotential height (GPH). Westward anomaly migration is also evident in the nadir viewing data, but they occur less regularly than those of MLS and GPH anomalies.

4.008 The study on relationship between the Indian summer monsoon and East Asian summer monsoon and summer precipitation in southern China.

Early Career Scientist

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Abstract:

The study on relationship between the Indian summer monsoon and East Asian summer monsoon and summer precipitation in southern China

Abstract The paper analyzed the synergistic effect between the Indian summer monsoon(ISM) and East Asian summer monsoon(EASM) by using the monthly means reanalysis data of wind filed, geopotential height filed and temperature filed which are provided by ECMWF for the summers(June-July-August) of 1979-2014,and the nationwide gridded daily precipitation data from more than 2000 stations which are provided by China Climate Center during the period 1979–2014.Then,according the IIE(the interface between the ISM and EASM) index, analysis the relationship between the two monsoon and summer rainfall in southern China. The results show that there is strongly correlated with the seesaw variation between the ISM and EASM. When the index is larger than the normal, the EASM is stronger than the ISM, and the summer rainfall reduces in the middle and lower reaches of the Yangtze River, while the summer rainfall is enhanced in the coastal areas of Southern China. By contrast, When the index is smaller than the normal, the ISM is stronger than the EASM, the summer rainfall increases in Southwest China and Yangtze-Huaihe river basin, while the summer rainfall reduces in South China.

Key words: Indian summer monsoon; East Asian summer monsoon; monsoon interface index; rainfall; southern China

4.009 The HALO aircraft database.

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Abstract:

The observations made with HALO entail a large amount of data of relevance to various scientific communities (atmosphere & climate, earth observation, geoscience). The HALO database is a data retrieval and long-term archiving system with a web front-end [https://halo-db.pa.op.dlr.de/]. It allows users to access a wide range of data based on, or related to, observations of the HALO research aircraft. The database is also used for sharing data of scientific missions involving other DLR research aircraft, like the Falcon. It currently lists about 70 missions and holds more than 4000 data sets. This includes data relevant for the Asian summer monsoon, e.g. from the ESMVal and OMO missions.
Flight track data from the database are routinely provided immediately after a campaign as input for model simulations. The web front-end of the database offers tools for (meta-) data search, as well as for uploading, updating and downloading of primary data. Queries can be extended to include IAGOS data.
Some functionality of the HALO database is available to registered users only. The access to primary data is managed on a mission-by-mission basis. Additional functionality is available for the coordinators of a campaign to control access to and appearance of individual missions in the web portal. This presentation provides of brief overview of the HALO database and how to use it, e.g. as PI or member of a mission.
As an example of multi-campaign data composites using the data base we present sulfur dioxide (SO_2) data summaries from a large number of aircraft campaigns performed during the years 2004 to 2015 covering a geophysical range from 83°N to 65°S and 105°W to 135°E. The SO_2 data have been sampled by DLR from the Falcon and HALO research aircraft. We discuss SO_2 data sampled in the UT/LS influenced by the Asian Summer Monsoon.

4.010 Improved IASI Ozone retrievals in the tropical troposphere and UTLS.

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Abstract:

The IASI sensor documents the atmospheric composition since 2007. The Software for a Fast Retreieval of IASI Data (SOFRID) has been developped to retrieve O3 and CO profiles from IASI in near-real time on a global scale. Information content analyses from SOFRID and other IASI retrievals have demonstrated that IASI enables the quantification of O3 independently in the troposphere, the UTLS and the stratosphere. Validation studies have also shown that the variability of tropospheric and UTLS O3 was well captured by IASI especially in the tropics. Moreover, IASI data have been used to document the tropospheric composition during the Asian monsoon. Nevertheless, IASI O3 is biased high in the UTLS and in the tropical troposphere. Moreover, in the tropical UTLS, the O3 profile S-shape is accentuated by the IASI retrievals with anormally low values.
The IASI retrieval softwares and in particular SOFRID are based on the Optimal Estimation Method that requires a priori information to complete the information provided by the infrared radiances. This a priori information is supposed to represent the best knowledge of the retrieved quantity prior to the measurement In SOFRID-O3 v1.5 the a priori consists of a single O3 profile and associated covariance matrix based on one year of global O3 radiosoundings. Such a global a priori is caracterised by a very large variabilty in the UTLS because it encompasses the pole-to-pole tropopause variability and hence it does not represent our best kowledge of the O3 profile and variability at a given time and location. We have therefore implemented the use of a variable a priori information in SOFRID and performed experiments using O3 climatological data and MLS O3 analyses. We will present O3 distributions and comparisons with O3 radiosoundings from the different SOFRID-O3 retrievals focusing on the tropics and the Asian monsoon.

4.011 Impacts of surface emissions from Asia on the distribution of CO associated with the Asian summer monsoon anticyclone.

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Abstract:

The Whole Atmosphere Community Climate Model (WACCM) is used to investigate the impacts of CO surface emissions from Tibetan Plateau, East China, India and Mainland Southeast Asia on a persistent maximum associated with the Asian summer monsoon anticyclone and the spatial-temporal variations of the tropical CO in the UTLS. The model simulations show that the CO emissions from Tibetan Plateau and India can eventually lead to high CO values inside the Asian summer monsoon anticyclone, with the maximum in July and May, respectively. The CO emissions from East China and Mainland Southeast Asia tend to cause high CO along the Asian summer monsoon anticyclone, with the maximum appeared in August and May, respectively. The model simulations also show that the CO from the four regions can all lead to an increase in the tropical CO in May-September through the horizontal transport from the extratropics into the tropics driven by the Asian summer monsoon anticyclone, but the maximum CO in the tropical UTLS which originate from Tibetan Plateau, East China, India and Mainland Southeast Asia appear in July, Augest, June and June, respectively. In addition, the results show that the CO surface emissions from Mainland Southeast Asia make the largest contribution to CO increases in the tropical UTLS in May-September, if the surface emissions from Tibetan Plateau, East China, India and Mainland Southeast Asia are same.
Funded by National Natural Science Foundation of China (Grants 41575038) and Central Leading Local Development of Science and Technology Project in China (grant no. HN 2016-149)

4.012 UTLS Composition Variability Associated with Modes of the Asian Monsoon Anticyclone.

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Abstract:

Yan et al. 2011 composited MLS 100-hPa composition measurements into a Tibetan mode and an Iranian mode using a bimodal index of the location of the Asian summer monsoon anticyclone derived from NCEP reanalysis, after Zhang, et al. 2002. However, Nützel et al. 2016 have shown that the striking bimodality of the UTLS monsoon anticyclone location that is seen in NCEP/NCAR geopotential height (GPH) is not as clearly reflected in modern reanalyses such as MERRA, ERA-I and JRA-55. Here, we extend the analysis of Yan et al. 2011, determining modes of anticyclone variability from MERRA-2 and relating them to associated variability in version 4.2 MLS composition measurements on isentropic surfaces. Use of Montgomery stream function or potential vorticity on isentropic surfaces will provide a more natural means of examining the advection of tracers than does GPH on isobaric surfaces.

4.013 Characterizing the Asian Tropopause Aerosol Layer using in situ balloon measurements: the BATAL campaigns of 2014-2016.

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Abstract:

We present in situ balloon observations of the Asian Tropopause Aerosol Layer (ATAL), a summertime accumulation of aerosols in the upper troposphere and lower stratosphere (UTLS), associated with Asian Summer Monsoon (ASM). The ATAL was first revealed by CALIPSO satellite data, and has been linked with deep convection of boundary layer pollution into the UTLS. The ATAL has potential implications for regional cloud properties, and chemical processes in the UTLS. The “Balloon measurements of the Asian Tropopause Aerosol Layer (BATAL)” field campaigns to India and Saudi Arabia in 2014-2016 were designed to characterize the physical and optical properties of the ATAL, to explore its composition, and its relationship with clouds in the UTLS. We launched 55 balloon flights from 4 locations, with payloads ranging from 500g to 50 kg to measure meteorological parameters, ozone, water vapor, aerosol optical properties, concentration, volatility, and composition in the UTLS region. This project represents the most important effort to date to study UTLS aerosols during the ASM, given few in situ observations. The BATAL project has been a successful partnership between institutes in the US, Europe, India and Saudi Arabia, and continues for the next 3-4 years, sponsored by the NASA Upper Atmosphere Research program. This partnership may provide a foundation for potential high-altitude airborne measurement studies during the ASM in the future.

4.014 Seasonal and interannual variability of upper tropospheric aerosols: Sources and the role of Asian monsoon transport.

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Abstract:

We use a global model and satellite/aircraft observations to analyze the seasonal and interannual variability of the upper tropospheric (UT) aerosols in recent decade. We investigate the roles of deep convective transport and removal processes associated with Asian monsoon system in determining the UT aerosol variability, and attribute the UT aerosol composition to anthropogenic, biomass burning, and volcanic sources.

4.015 Evaluation of the climatology and variability of the Asian summer monsoon anticyclone in chemistry-climate models using Aura Microwave Limb Sounder measurements.

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Abstract:

We present a preliminary evaluation of the climatology and spatial, seasonal, and interannual variability of a range of trace gas species in the Asian summer monsoon anticyclone and surrounding region in specified-dynamics and free running versions of chemistry-climate models taking part in the IGAC/SPARC Chemistry-Climate Model Initiative. We compare the model output against more than 10 years of observations from the Aura Microwave Limb sounder (MLS) satellite instrument. We examine whether the models correctly reproduce the observed trace gas distributions and variations, as well as whether they capture the observed relationships of these trace gases to meteorological variations such as tropospheric jet position and strength and deep convective intensity. Using the Whole Air Chemistry-Climate Model (WACCM), we analyze additional simulations to assess the role of emissions in determining the composition within the anticyclone.

4.016 Role of resolution and stochastic physics parameterisations in climate simulations of the UTLS variability in the Asian Summer Monsoon region.

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Abstract:

Over the past few decades, climate models have developed considerably - increasing both in complexity and resolution - as computational power has increased. Recent studies with global high-resolution climate models have demonstrated the added value of enhanced horizontal atmospheric resolution, showing significant improvement in the simulation of aspects of the large-scale circulation. However, it is unlikely that climate integrations at very high feasible in the near future. Instead of explicitly resolving small-scale processes by increasing the resolution of climate models, it is possible to use stochastic parameterization schemes. These schemes introduce an element of randomness into physical parameterisation schemes to account for the impact of unresolved processes on the resolved scale flow. We evaluate in a set of a comprehensive set of ensemble simulations, aimed at evaluating the sensitivity of present and future climate to model resolution and stochastic parameterization, the ability of the EC-EARTH climate model to simulate variability of the large-scale anticyclone occurring in the UTLS and link it to improved physics and resolution.

4.017 Transport in the Asian Anticyclone at the synoptic and intraseasonal scale.

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Abstract:

Asian Anticyclone (AA) contains air from the troposphere that can enter directly in the lower stratosphere with observational evidence of low ozone / high water vapor and enhanced pollutants or precursors. We focus on the dynamics and variability for transport in the AA from the Monsoon region to the lowermost stratosphere from the synoptic to the intra-seasonal scale, making use of regional scale modelling, lagrangian analysis, the MLS (Microwave Limb Sounder) and MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) and convection proxies. This to identify the impact of processes acting at these scales (Monsoon break-up, stronger convection phases) on the injection of pollutants and water vapour in the Asian Anticyclone region. Concerning the synoptic variability, it is known that specific convection patterns and episodes as for instance those occuring at the flanks of Himalayan foothills, may generate a substantial flux of pollutants and water vapour in the AA, an estimate of their impact on the seasonal overall transport budget is still missing. This information is also particularly important to optimize in-situ observations in terms of expected variability, target regions, expected concentrations and to develop focused diagnostics for evaluation of Climate Models such as CCMs.

4.018 The Asian Summer Monsoon – A Smokestack to the Northern Hemisphere Stratosphere.

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Abstract:

An enhanced aerosol layer near the tropopause over Asia during the June-September period of the Asian Summer Monsoon (ASM) was recently identified using satellite observations. Its sources and climate impact are presently not well characterized. To improve understanding of this phenomenon, we conducted in situ aerosol measurements during summer 2015 from Kunming, China, then followed with a modeling study to assess its global significance. The *in situ* measurements revealed a robust enhancement of aerosol concentrations that extended up to 2 km above the tropopause. A climate model simulation shows that the abundant anthropogenic aerosol precursor emissions from Asia coupled with rapid vertical transport in monsoon convection leads to significant particle formation in the upper troposphere within the ASM anticyclone. These particles are subsequently spread throughout the entire Northern Hemispheric lower stratosphere, where they account for ~15% of the column stratospheric aerosol surface area annually. We find that this region is about 6 times more efficient per unit area and time in populating the Northern Hemisphere stratosphere with aerosol than the tropics, the largest sources of aerosol to the lower stratosphere. The ASM anticyclone region's contribution to Northern Hemisphere aerosol surface area (~15%) is comparable to that from the sum of the small volcanic eruptions between 2000 and 2015, while smaller than that pumped from the inner tropics (~35%). With a substantial amount of organic and sulfur emissions in Asia, the ASM anticyclone serves as an efficient smokestack venting aerosols to the upper troposphere and lower stratosphere. As economic growth continues in the Asian region, the relative importance of Asian emissions to stratospheric aerosol is

likely to increase.

4.019 Linkages of subtropical stratospheric intraseasonal intrusions with Indian summer monsoon deficit rainfall .

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Abstract:

Linkages of subtropical stratospheric intraseasonal intrusions with Indian summer monsoon deficit rainfall

The authors investigate the life cycle of a strong subtropical *stratospheric intrusion event* and document the mechanism through which it influences the Indian-summer-monsoon rainfall (ISMR) after the monsoon onset during June 2014. The diagnostic analysis of ERA-INTERIM data revealed that stratospheric intrusions occur in the regions of Subtropical Westerly Jet (SWJ) due to Rossby Wave Breaking (RWB). The RWB event is associated with eddy shedding. These eddies transport extratropical stratospheric mass and energy fluxes downward and southward to North India (NI). As a result, the intrusions spread dry, cold and ozone rich air deep into the troposphere (~500hPa) over the NI. It enhances the static stability and weakens the North-South upper tropospheric temperature gradient. The intrusion of cold and dry air persisted for the entire June, which might have inhibited northward propagation of ISM convection. Our study provides an evidence and proposes a hypothesis that the intrusion of stratospheric air in the region of SWJ could be responsible for prolonged hiatus in northward phase propagation of the ISM after onset.

We also investigate the relation between stratospheric intrusion events and ISMR during 1979-2007. Our analysis shows that the stronger negative anomalies of rainfall are associated with stratospheric PV (Potential Vorticity) in the upper troposphere, indicating an influence of stratospheric intrusions on ISMR deficit during break spells. Thus study reveals that stratospheric intrusion is an important factor that may influence ISMR deficit.

4.020 Influence of enhanced Asian NOx emissions on ozone in the Upper Troposphere and Lower Stratosphere (UTLS) in chemistry climate model simulations.

Early Career Scientist

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Abstract:

The Asian summer monsoon (ASM) anticyclone is the most pronounced circulation pattern in the Upper Troposphere and Lower Stratosphere (UTLS) during Northern Hemisphere summer. Asian summer monsoon convection plays an important role in efficient vertical transport from the surface to the upper-level anticyclone. In this paper we investigate the potential impact of enhanced anthropogenic nitrogen oxide (NO_X) emissions on the distribution of ozone in the UTLS using the fully-coupled aerosol chemistry climate model, ECHAM5-HAMMOZ. Ozone in the UTLS is influenced both by the convective uplift of ozone precursors and by the uplift of enhanced NO_X induced tropospheric ozone anomalies. We performed anthropogenic NO_X emission sensitivity experiments over India and China. In these simulations, covering the years 2000-2010 anthropogenic NO_X emissions have been increased by 38% over India and by 73% over China with respect to the emission base year 2000. These emission increases are comparable to the observed linear trends of 3.8 % per year over India and 7.3% per year over China during the period 2000 to 2010. Enhanced NO_X emissions over India by 38 % and China by 73 % increase the ozone radiative forcing in the ASM Anticyclone (15º-40°N, 60º-120°E) by 16.3 mW m^{-2} and 78.5 mW m^{-2} respectively. These elevated NO_X emissions produce significant warming over the Tibetan Plateau and increase precipitation over India due to a strengthening of the monsoon Hadley circulation. However increase in NO_X emissions over India by 73% (similar to the observed increase over China), results in large ozone production over the Indo Gangetic plain and Tibetan Plateau. The higher ozone concentrations, in turn, induce a reversed monsoon Hadley circulation and negative precipitation anomalies over India. The associated subsidence suppresses vertical transport of NO_X and ozone into the ASM anticyclone.

4.021 Appearance of the persistently low tropopause temperature and ozone over the Asian monsoon region..

Early Career Scientist

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Abstract:

This paper reports the observation of persistently low tropopause temperatures (100 hPa temperatures, T_{100}) and ozone throughout the year as compared to the corresponding zonal mean values over the Bay of Bengal (BOB). The long term mean T_{100} is ~2.2 K lower than the zonal mean values over the BOB. Despite the occurrence of most intense convective activity, the water vapour near the tropopause is observed to be relatively low over the BOB. The low ozone mixing ratios contributes ~1.2 K to the persistently low T_{100}. The convective activity also contributes to the persistently low T_{100}, but its contribution is relatively less (~0.35 K).

4.022 Transport of carbonaceous aerosols emissions during Asian summer monsoon and its implications on the UTLS in aerosol climate model.

Early Career Scientist

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Abstract:

Recent satellite observations show efficient vertical transport of Asian pollutants from the surface to the upper level anticyclone by deep monsoon convection. In this paper, we examine the transport of carbonaceous aerosols including Black carbon (BC) and Organic Carbon (OC) into the monsoon anticyclone using of ECHAM6-HAM, a global aerosol climate model. Further, we investigate impacts of enhanced (doubled) carbonaceous aerosols emissions on the UTLS from sensitivity simulations.
These model simulations show that boundary layer aerosols are transported into the monsoon anticyclone by the strong monsoon convection from the Bay of Bengal, southern slopes of the Himalayas and the South China Sea. Doubling of emissions of black carbon and organic carbon aerosols, each, over the South East Asia (10°S-50°N; 65°E-155°E) show that lofted aerosol produces significant warming in the mid/upper troposphere. These aerosols enhance temperature by 1-3 K in the mid/upper troposphere and radiative heating rates by 0.005 $Kday^{-1}$ near the tropopause. They alter aerosol radiative forcing at the surface by -1.4 W m^{-2}; at the TOA by +1.2 W m^{-2} and in the atmosphere by 2.7 W m^{-2}over the Asian summer monsoon region (20ºN-40°N, 60ºE-120°E). In-atmospheric warming increases vertical velocities and thereby cloud ice in the upper troposphere. An anomalous warming over the Tibetan Plateau upshot the relative strengthening of the monsoon Hadley circulation and elicit enhancement in precipitation over India and north east China.

4.023 Linkages of subtropical stratospheric intraseasonal intrusions with Indian summer monsoon deficit rainfall .

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Abstract:

The authors investigate the life cycle of a strong subtropical *stratospheric intrusion event* and document the mechanism through which it influences the Indian-summer-monsoon rainfall (ISMR) after the monsoon onset during June 2014. The diagnostic analysis of ERA-INTERIM data revealed that stratospheric intrusions occur in the regions of Subtropical Westerly Jet (SWJ) due to Rossby Wave Breaking (RWB). The RWB event is associated with eddy shedding. These eddies transport extratropical stratospheric mass and energy fluxes downward and southward to North India (NI). As a result, the intrusions spread dry, cold and ozone rich air deep into the troposphere (~500hPa) over the NI. It enhances the static stability and weakens the North-South upper tropospheric temperature gradient. The intrusion of cold and dry air persisted for the entire June, which might have inhibited northward propagation of ISM convection. Our study provides an evidence and proposes a hypothesis that the intrusion of stratospheric air in the region of SWJ could be responsible for prolonged hiatus in northward phase propagation of the ISM after onset.

We also investigate the relation between stratospheric intrusion events and ISMR during 1979-2007. Our analysis shows that the stronger negative anomalies of rainfall are associated with stratospheric PV (Potential Vorticity) in the upper troposphere, indicating an influence of stratospheric intrusions on ISMR deficit during break spells. Thus study reveals that stratospheric intrusion is an important factor that may influence ISMR deficit.

4.024 Preliminary study about the characteristics of convective gravity wave generated over Asian Summer Monsoon region and its effect on polar mesospheric clouds .

Early Career Scientist

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Abstract:

Gravity waves constitute a ubiquitous component of atmospheric motions, with horizontal scales ranging from a few kilometers to more than a thousand kilometers and it is an important factor in the Asian Summer Monsoon.In this study,we investigated the characteristics of convective gravity waves (CGWs) in Asian Summer Monsoon region from troposphere to stratosphere using 1-hourly NCEP Climate Forecast System Reanalysis (CFSR) data.we found CGWs existed diverse characteristics at different latitudes.In 0-30°N, zonal cloud-top momentum flux (CTMF) shows its maximum value at phase speed of 10 m/s, eastward component of the CTMF is much bigger than westward component,which is similar to the result of other scientists.On the other hand, peak of the zonal CTMF is at -6 ~ -5 m/s in 30°N-40°N,it means that the westward component is bigger than eastward component. Besides, the result shows that Gravity Waves (GWs) play an important role in both the formation and destruction of polar mesospheric clouds (PMCs). So we investigate the possible effect of GWs generated over the monsoon region on PMCs, during the northern hemisphere in recent PMC season.We find a significant positive correlation between the GWs over the monsoon region at 40~50 km and PMC frequency of occurrence over the polar region at 70~80 km suggesting a possible source of high latitude middle atmospheric GWs that can influence PMC.

4.025 Primary research of the characteristics and influencing factors of stratospheric quasi zero wind layer in the tropics..

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Abstract:

The data employed for this study come from the ERA-Interim reanalysis provided by ECMWF for the period from 1985 to 2014. We used the statistical wind analysis for near-space altitudes between 30 and 100hPa. The analysis shown that the distribution of quasi zero wind layer(QZWL) is most affected by seasonal change of circulation. Additionally, the tropical QZWL is also closely related to QBO. The QZWL mainly exists in lower stratosphere between 50 and 70hPa. At the QBO west phase, QZWL is mainly located in the area from 14 to 26°N(winter) or 24 to 28°N(summer) at 70hPa. And at the QBO east phase, QZWL is only located in the area nearby 10°N in winter. The QZWL frequency of occurrence at 50hPa slightly higher than 70hPa at QBO east phase. And we used the observational wind data between 30 to 100hPa at two location, Haikou, China and Xisha, China. The yearly and monthly statistical modeling indicated that Weibull distributions were a reasonable model for the data. The Weibull distribution and cumulative function were used to predict the 50%, 95% and 99% winds, which can help us find the suitable for airship to fly.

4.026 Balloon-borne measurements of water vapor, aerosol backscatter and ozone in Nainital (India) in August and November 2016.

Early Career Scientist

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Abstract:

The Asian summer monsoon anticyclone (ASMA) is a major meteorological feature of the Northern hemisphere’s upper troposphere-lower stratosphere (UTLS). It is known to exhibit anomalous maxima in the concentration of water vapor, aerosols (the Asian tropopause aerosol layer, ATAL) and other tropospheric tracers, due to the strength of the anticyclonic circulation, and of the monsoonal convection transporting boundary layer air to the upper troposphere. Despite uncertainties about what are the most effective pathways for surface-to-ASMA transport of pollution, convection over the southern slopes of the Himalayan plateau is generally thought to play an important role.
To investigate this aspect, balloon-borne measurements of water vapor (CFH), aerosol

backscatter (COBALD) and ozone (ECC) were conducted in Nainital, Uttarakhand, India (29.4°N, 79.5°E), within the activities of the EU-project StratoClim. Respectively, 30 and 5 soundings were performed in August and November 2016, during and after the monsoon season. In August, the troposphere above Nainital was very moist and ice supersaturation and cirrus clouds were very frequently observed near the tropopause. In contrast, the November flights showed much drier conditions and no clouds in the upper troposphere. In the UTLS, water vapor mixing ratio was found to be higher by about 5 ppmv in August compared to November (around 100 hPa). UTLS clear-sky aerosol backscatter was also higher in August than in November, showing clear evidence of ATAL occurrence above Nainital during the monsoon-time. In addition, three of the flights were balloon-balloon match measurements in collaboration with the SWOP campaign in Lhasa (China), which will be also presented. This dataset will contribute to the improvement of the current understanding of ASMA’s composition and processes, through dedicated process and global modeling studies that are ongoing.

4.028 Where is the pathway from atmospheric boundary layer to upper troposphere during the Asian summer monsoon?.

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Abstract:

Previous satellite measurements and model simulations have show that the Asian summer monsoon (ASM) anticyclone is colocated with higher concentration pollutants, which are emitted in the continent atmospheric boundary layer (ABL). Backward trajectory calculations show that the 150 hPa level air has the maximum frequency of ABL sources within 30 days over the most intensive convection regions and their downwind areas, which are not located within the ASM anticyclone, but rather at the southern flank or periphery of the ASM anticyclone. The upper tropospheric airs originated from the ABL sources include two parts, one from the ocean, which has the dominant impact to the south of 20°N, particularly over the south China Sea (SCS) and the west tropical Pacific Ocean; another from the continent, which is dominant in between 10-30°N, particularly over the Bay of Bengal (BoB), the India Continent (IND), the Arabian Sea, and the Arabian Peninsula. It's the latter part that forms the higher pollutant concentration within the ASM anticyclone as shown by satellite measurements. Air in the ABL sources (both polluted and unpolluted) converges to the intensive convection region in the lower troposphere, and then traverses the middle troposphere through a wide group of upward pipes, and finally to the upper troposphere. These pipes in the middle troposphere are defined by the ASM intensive convections and covers the southern IND, the BoB, the Tibetan plateau, the Indochina Peninsula, the SCS and the Philippine sea.