# Short-lived climate pollutant issues in the mitigation of the global warming

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The Paris agreement, adopted in the UNFCCC COP21 round, set the 2 degrees target and 1.5 degrees effort of global warming after the industrial revolution. These targets mean that the society has to pay significant efforts to reduce the long-lived greenhouse gases (LLGHGs) emission. Another problem is that the notable reduction of the surface temperature does not appear in the next two decades even with a substantial reduction of LLGHGs, because of the long lifetime of the LLGHGs. As one of other mitigation methods, a concept of the short-lived climate pollutants (SLCP), which include black carbon (BC) aerosols, tropospheric ozone, and methane, has been introduced by UNEP. According to the UNEP report for black carbon and tropospheric ozone, it will be possible to reduce the global surface temperature of about 0.5 degrees in a short period after substantial removal of SLCP emission. There are several mitigation initiatives along this idea, such as the UNEP Climate and Clean Air Coalition (CCAC), has been launched.
It is, however, there are several recent studies that the SLCP impact on the global surface temperature is not large, so that a careful analysis of the SLCP impact has to be made. We like to discuss this issue in this talk based on several past studies and results of the ERTDF S-12 project. Important subjects of the analysis are links between 1) air quality and SLCP emissions, 2) emission and mitigation technologies, and 3) SLCP concentration and the earth's climate change.

キーワード：地球温暖化、短寿命気候汚染物質、UNFCCC
Keywords: global warming, short-lived climate pollutants, UNFCCC

 

# Effects of snow-darkening by absorbing aerosols on early spring snow melt and summer heat waves over Eurasia.

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Using the NASA GEOS-5 Earth System Model, we have carried out a series of 10 x10 years ensemble experiments to explore the impacts of snow-darkening effect (SDE), *i.e.,* surface albedo reduction due to deposition of absorbing aerosols (BC and OC) and dusts on the surface energy and water balance, and on extreme heat waves over Eurasia. Comparing the model climate with SDE to a control climate without SDE, we find that a) desert dust contributes the strongest SDE over eastern Europe/Western Asia region, while BC has maximum SDE over southwestern Europe, and northern East Asia, b) over the above areas, the maximum surface warming induced by SDE is 3–5°C near the snowline, during the spring melting season, c) ground wetness increases due to accelerated snowmelt during early to late spring, but subsequently decreases due to enhanced evaporation as land warms, and more exposure of bare land areas, as the snowmelt accelerates, and d) following the retreat of the snowline, the maximum surface warming migrates to northern Eurasia, while the continental land region continues to dry up through the following summer.

The continued drying of land and surface warming over Eurasia reduce tropospheric humidity, and suppresses cloud formation, leading to atmospheric blocking conditions, with increased geopotential height and anomalous anticyclonic circulation over Eurasia. The aforementioned sequence of SDE induced changes in water and energy cycles, and associated land-atmosphere interactions from boreal spring through summer eventually lead to a doubling of the frequency of top 10% hot days, and 10-fold increase in the frequency of the top 1% hot days in the summer months over western and northern Eurasia. Impacts of snow-darkening effect of Himalayan snowpack on the Asian summer monsoon will also be discussed.

Keywords: absorbing aerosols, snow-darkening effects, early snow melt and summer heat waves over Eurasia

 

# Seasonal and interannual variation in aerosol outflow from Asia/China and its controlling factors

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This study reveals seasonal and interannual variability in aerosol outflow from Asia and China (as the major source regions) and its controlling factors using simulations with a global chemical climate model. In the simulations, anthropogenic emissions are kept constant at the 2008 level to easily detect effects of meteorological variation. The model simulations are validated with the satellite observations of aerosol optical depth (AOD) and column burden of carbon monoxide (CO). The distributions and seasonal variations of simulated AOD both show a good agreement with satellite observations over maritime regions, while the model overestimates AOD over China in winter. On the other hand, simulated burden of CO is largely consistent with the satellite observations in the Asian regions including China.
This study also reveals the regional budgets of aerosols within Asia and China, focusing on black carbon (BC), organic carbon (OC) and sulfur oxides (SOx; $SO_2$ and sulfate) as aerosol components. Basically, zonal flux of aerosol is much larger than meridional one. Aerosol outflow across the east boundary of the China region, which shows significant large aerosol fluxes in 30°N-45°N, and the inflow across the west boundary of it both peak in March regardless of components of aerosols. In terms of interannual variation of aerosol outflow, the year to year change of zonal flux plays central role in total variability of aerosol outflow. Of the emitted BC, OC, and SOx from China, about 38%, 20%, and 25% are fractionally exported outside of the region, respectively. The simulated aerosol outflow is validated with diagnosis based on the satellite observation of AOD following the method by Yu et al. (2008). The simulated aerosol outflow across the boundary at the eastern edge of China agrees well with the outflow derived from the satellite observation for both quantitative level and seasonal to interannual variations. The aerosol outflow derived by this study shows a positive trend of 1-2% per year for the period of 2000-2015, which suggests increasing anthropogenic emissions in East Asia during the recent decades.
In addition, to interpret interannual variability in regional aerosol burden over Asia and China, its controlling mechanism is separated into three independent factors of emission, deposition, and export outside the region using a multiple regression analysis for total aerosol burden. The result shows that burden variation of BC in Asia and China is principally controlled by export outside the region, whereas SOx variation is by regional deposition; to OC variation, export and regional deposition equally contribute. Therefore, the BC outflow from China can affect climate and atmospheric environment in both local and remote areas.
Furthermore, to assess the aerosol effects on climate and air quality in downwind region, this study investigates controlling factors of interannual variations of aerosol outflow from China. By a composite analysis for winter, it is shown that in the phase of relatively enhanced aerosol outflow from China, a dipole-like anomaly presents exhibiting negative/positive deviation in interior of China and its downwind regions including India and Southeast Asia, respectively. It is also suggested that aerosol outflow from China has a negative correlation with the strength of Asian monsoon. Accordingly, modulation of Asian monsoon associated with climate change can cause additional climate effects through varying aerosol outflow from the polluted area.

 

キーワード：エアロゾル、長距離輸送、アジアモンスーン、化学輸送モデル、化学気候モデル
Keywords: aerosol, long-range transport, Asian Monsoon, Chemical Transport Model, Chemistry Climate Model

 

# Winter monsoon variability and its impact on aerosol concentrations in East Asia

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Monsoons play a key role in synoptic weather patterns, which affect the frequency and longevity of pollution events. In East Asia, particulate matter (PM) pollution is particularly severe in winter. In this study, we investigate the relationship between winter aerosol concentrations and the East Asian Winter Monsoon (EAWM) variability using a global 3-D chemical transport model (GEOS-Chem) and ground PM observations. A strong relationship between aerosol concentrations and the intensity of the EAWM is found, but shows a different sign for northern and southern East Asia. Compared to the climatological mean aerosol concentrations in winter, changes driven by the EAWM variability are up to 25% in East Asia in the model. The EAWM variability is found to play a major role in interannual variations in aerosol concentrations; consequently, changes in the EAWM will be important for understanding future changes in wintertime PM air quality in East Asia.

Keywords: Aerosol, Winter monsoon, East Asia

 

# Satellite-based diagnostics of aerosol-cloud-precipitation-radiation interactions within a cloud regime framework

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Coincident multi-year measurements of aerosol, cloud, precipitation and radiation at near-global scales are analyzed to diagnose whether their apparent relationships are consistent with well-established paradigms. Specifically, we examine whether differences in aerosol loading in separate observations produce consistently different precipitation, cloud properties, and cloud radiative effects. Our analysis uses a cloud regime (CR) framework to dissect and sort the results. The source of the aerosol and CR information is the MODIS sensor, radiation iformation comes from CERES, while precipitation rates come from the TMPA-3B42 dataset. Our presentation will demonstrate that when global cloudiness is partitioned by cloud regime, apparent relationships emerge in many instances, and when they do, they can sometimes be clear and unambiguous, although they can differ between land and ocean. At the same time, there are numerous examples where the relationships are less straightforward and contrary to standard paradigms or prior modeling results and this was particularly the case for cloud regimes that contain ice and mixed phase clouds. These regimes are the most substantial precipitation producers, yet we were unable to find meaningful precipitation responses to aerosol. Radiative signatures for these clouds indicate greater cloud radiative effects with more aerosol loading. Results were clearer for liquid regimes and largely consistent with 1st and 2nd indirect effect predictions, but no precipitation suppression could be discerned. Our most populous cloud regime of low cloud fraction exhibited in most cases dramatic apparent responses to AOD with unambiguous increases in precipitation, cloud extent, cloud optical thickness, cloud top height, and radiative effect accompanying AOD increases. I will discuss why our rather ambitious near-global analysis confirmed once again that finding robust evidence of aerosol effects on clouds and precipitation from observations is a very challenging endeavor.

Keywords: Cloud regimes, Cloud Indirect effect, Cloud Invigoration, Precipitation, Aerosol, Satellites

 

# Assessment on the Atmospheric Impacts of Surrounding Fire Emissions: An Analysis on Malaysian Haze Episodes by Utilizing the Remote Sensing Satellite Information and Ground-Based Measurements

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The recurrence of forest fires in Southeast Asia and associated biomass burning, has contributed significantly to the problem of intense haze and the long-range movement of pollutants in the Malaysian region. Air pollutants, specifically particulate matter in the atmosphere, have received extensive attention, mainly because of their adverse effect on people’ s health. However, the haze episodes coincided temporally with the occurrence of hotspots detected at the surrounding area such as in Sumatra and Kalimantan, Indonesia. In this study, the spatial and temporal variability of the PM10 concentration over Malaysia were analyzed by utilizing the satellite remote sensing information, air quality dataset and meteorological condition associated with this episodes. This study objective is to provide an assessment on the effects of surrounding forest fire events on the Malaysian haze. In this study, severe haze episodes during 2000 until 2013 were reviewed. The nature of the haze episodes, their possible causes and their major features were discussed in this paper. In order to analyze and detect the occurrence of active fires in surrounding region, MODIS Active Fire Data was retrieved from NASA/LANCE –FIRMS while the air quality data across Malaysia was assessed based on PM10 concentration which provided by Malaysian Department of Environment (MDOE). The meteorological database including temperature, rainfall, and wind speed were gathered from NOAA’ s National Climatic Data Center (NCDC). The results of this study indicates most of the intense haze episode in Malaysia were caused by the transboundary pollution from Sumatra and Kalimantan area which brought substantial amounts of particulate matter into the Malaysian atmosphere.

Keywords: Malaysia , Haze, PM10, Forest fire

 

# Increases in wintertime aerosol concentrations and severe haze days in eastern China over the past decades: Roles of variations in meteorological parameters and anthropogenic emissions

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The increases in wintertime aerosol concentrations and severe haze days in eastern China over the past decades were quantified by using observed atmospheric visibility, observed $PM_{2.5}$ concentrations, simulated $PM_{2.5}$ concentrations from the Goddard Earth-Observing System (GEOS) chemical transport model (GEOS-Chem), as well as simulated climate change from 15 CMIP5 climate models. Observed winter haze days (defined as days with atmospheric visibility less than 10 km and relative humidity less than 80%) averaged over eastern China (105–122.5˚E, 20–45˚N) increased from 21 days in 1980 to 42 days in 2014. Averaged over eastern China, simulated wintertime surface-layer $PM_{2.5}$ concentrations from the GEOS-Chem model exhibited an increasing trend of 10.5 (±6.2) $\mu g\ m^{-3}$ $decade^{-1}$ over eastern China in the past decades, in which the changes in anthropogenic emissions and in climate contributed 87% and 17%, respectively. Observed severe haze days (defined as days with observed $PM_{2.5}$ >150 $\mu g\ m^{-3}$) occurred mainly over Northern China. Conducive weather conditions, such as reduced surface winter northerlies, weakened northwesterlies in the midtroposphere, and enhanced thermal stability of the lower atmosphere, were an important ingredient of severe haze episodes. Results from the 15 CMIP5 models showed that the frequency of weather conditions conducive to severe haze events in northern China increased substantially under greenhouse warming.

Keywords: air quality, aerosol, climate change, severe haze, eastern China

 

# Global simulations of tagged black carbon aerosols: Implications for Asian emissions and long-range transport to the Arctic

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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) into a global chemistry-transport model GEOS-Chem, and examined long-range transport of BC from various sources to the Arctic and quantified the source contributions. We distinguished BC 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 simulation showed that BC originating from Europe and Russia is transported to the Arctic mainly in the lower troposphere during winter and spring. In particular, BC transported from Russia extensively distributed over the Arctic in winter and spring, leading to the dominant contribution of 62 % to the Arctic BC near the surface in annual mean. In the middle troposphere, BC from East Asia is transported to the Arctic mainly through Okhotsk Sea and East Siberia 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. However, for total deposition of BC on the Arctic, the contributions of biomass burning from Siberia and Alaska and Canada that become large only during summer were estimated to be 15 % and 12 %, respectively.

キーワード：ブラックカーボン、北極、化学輸送モデル
Keywords: black carbon, Arctic, chemistry-transport model

 

# Overview of the studies of SOA in fogwater and proposal of field observational research in Asia

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It has been well known that reactions of carbonyl compounds in fogwater are important sources of secondary organic aerosols (SOA) in the atmosphere (Ervens et al., 2013). Specifically, dicarboxylic acids, organosulfates, organonitrates, and imidazoles are water-soluble chemical species are expected to be formed in cloud/fog water. Although fog water chemistry was historically focused on inorganic species such as $SO_4^{2-}$, $NO_3^-$, $NH_4^+$, $Ca^{2+}$, etc. related to acid deposition, recent interest has been directed toward organic species related to air quality and climate change. In this paper, field observations of organic species in fogwater are briefly reviewed trying to identify and quantify the importance of cloud/fog chemistry for aerosols formation.
Fog and ground based cloud sampling and analysis of organic compounds have been rather intensively performed in United States and Europe with a very limited occasion in Asia (Herckes et al., 2013). In most of these studies, the analyses have been made only for organic carbon mass (OC) rather than chemical species. For the evaluation of the importance of fog chemistry in aerosol formation, identification of organic compounds with high-resolution mass spectrometry (for example Mazzoleni et al., 2010) or other sophisticated instruments are definitely needed.
On the other hand, haze pollution is very serious in many cities in Asia, and it has been well known that they contain very high concentrations of $SO_4^{2-}$, $NO_3^-$, and $NH_4^+$, as well as organic aerosols. The concentrations of reactive carbonyl compounds and inorganic ions in fogwater are expected to be comparable in many areas in Asia. Thus, the formation of organic sulfates and organic nitrogen compounds would be much facilitated, and their concentrations in fogwater may be much higher than in US and Europe.
Field observational research to analyze organic chemical species in fogwater and aerosols simultaneously to quantify the importance of atmospheric aqueous phase reactions would be significant both for understanding fundamental science and quantification of $PM_{2.5}$ for air quality.

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Keywords: SOA, Fogwater

 

# Primary Biological and Biomass Burning Aerosols at the Northern Slope of Mt. Everest, Central Himalayas

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Organic aerosols from biomass burning and primary biological sources are ubiquitous in the Earth’s atmosphere. They affect the absorption and scattering of solar radiation, act as cloud condensation nuclei (CCN) and possibly influence ice and snow albedo in remote regions. Here we determined polar organic markers for biomass burning, plant debris and primary biological aerosols at a remote site (Qomolangma, 4276 m a.s.l.) of Mt. Everest, central Himalayas using a solvent extraction-BSTFA derivatization-GC/MS technique. Seasonal trends of biomass-burning aerosols are characterized by pronounced maxima in the pre-monsoon season and minima in the summer monsoon period, being consistent with aerosol organic carbon. However, concentrations of fungal spore tracers and pland debris peaked in both pre-monsoon and post-monsoon seasons, suggesting that primary bioaerosols and plant emission are important sources of organic aerosols over the Tibetan Plateau in the post-monsoon season when biomass burning emission is weak. With the consideration of primary bioaerosol particles as pontetial CCN and atmospheric ice nuclei and biomass burning as one of the significant sources of light-absorbing aerosols, our findings have potential implication for climate change in the Tibetan Plateau, a major concern in the Earth’s “Third Pole”.

Keywords: Biomass burning, Primary biological aerosols, The Tibetan Plateau, Secondary organic aerosols

 

# A study of the 2016 post-monsoon air pollution event over India using the GMAO GEOS system

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The countries in South Asia are particularly vulnerable to air pollution. With population of over 1.3 billion people (and high population density) India for example can be severely impacted by air pollution episodes amplified by the combination of the regional topography and winds, abundant natural aerosols and increased industrial growth and urbanization. In October-November 2016 a large scale pollution event that coincided with the post-monsoon burning of crop residue was observed from space over India. Predominantly clear sky conditions allowed the MODIS and CALIPSO instruments on board of NASA EOS satellites to reveal the scale and the duration of length of this air pollution episode and make aerosol retrievals. Characterization of the air pollution and the impact on the air quality and population was however impeded by the sparse PM and other air-pollutants observations.

The goal of this study was to analyze the post-monsoon air pollution episode by using observations from NASA satellites in conjunction with the GMAO GEOS system with emphasis on near real-time analysis and short term prediction capabilities. We examined and identified the major causes that lead and contributed to this event. Our analysis showed a clear link between the agricultural fires and the air pollution levels in India. In addition, we assessed the population affected by unhealthy pollution levels by using the air quality index derived from the standard model output.

Keywords: GEOS, aerosols, air quality

 

# Impact of biomass burning emissions on atmospheric aerosol burdens over the Sao Paulo Metropolitan Area

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Since the gases and particles ejected into the atmosphere from fire emission events can modify the atmospheric composition around and even far away from the sources, an accurate representation of fire emissions in atmospheric chemical transport models is very important to improve the current understanding on how these emissions impact the aerosol properties over urban areas. In this study, the Weather Research and Forecasting with Chemistry (WRF-Chem) model, a state-of-the-art coupled meteorology-chemistry modelling system, is used to describe the physicochemical processes involving the emission, formation and transport of gases and aerosols in order to characterise the main properties of atmospheric aerosol particles over the Sao Paulo Metropolitan Area (SPMA), in southern Brazil, focusing mainly on the impact of biomass burning source. The study period of August 19 –September 3, 2014 is selected due to the occurrence of biomass burning of agricultural residues and high values of pollutants concentration in SPMA. To evaluate the impact of biomass burning it is considered the experimental data collected during the last campaign from the Narrowing the Uncertainties on Aerosol and Climate Change in Sao Paulo State (NUANCE-SPS) project and a set of two 18-day WRF-Chem simulations including different emission settings: with (BASE) and without (NFE) fire emissions. Ground-based aerosol observations from NUANCE-SPS include mass and number size distribution and CCN, elemental carbon (EC), and $PM_{2.5}$ ($PM_{2.5}$; 2.5 $\mu$m in diameter) and $PM_{10}$ ($PM_{10}$; 10 $\mu$m in diameter) concentrations. In addition, lidar profiles complemented with satellite observations are used to assess aerosol optical properties. Despite the meteorological conditions during most of the period were not favourable for long-range transport into SPMA, comparisons of the two simulations BASE and NFE with observations show that the inclusion of fire emissions can raise the concentration of fine particles by up to 8 ug/$m^3$ which in turn reduces the bias hence improving the model performance. Lower predicted $PM_{2.5}$ concentrations are mainly related to underestimates on the calculation of emissions as well as the SOA concentration.

Keywords: biomass burning emissions, atmospheric aerosols, WRF-Chem model

 

# The solar absorptivity of organic carbon and its impact on Asian summer monsoon

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Light absorbing aerosols not only contribute to Earth’s radiative balance but also influence regional climate by cooling the surface and warming the atmosphere. Despite growing evidence of light-absorbing organic aerosols (OAs), their contribution to the Earth’s radiative budget is still poorly understood. In this presentation, we will show an evidence of solar absorption of OA and its impact on Asian summer monsoon. In the first part, we derive an algorithm that empirically determine OA solar absorptivity in terms of single-scattering albedo (SSA) mostly using the ground-based Aerosol Robotic Network (AERONET) observation over biomass burning regions. Our best estimate of OA SSA over the tropical biomass burning regions is 0.91 at 550 nm. The results imply that most aerosol models as well as climate models, which commonly use OA SSA of 0.96–1.0, have so far ignored light absorption by OAs. In the second part, we examine the role of light absorbing properties of OA on Asian summer monsoon rainfall redistribution using observational data and an atmospheric general circulation model (AGCM) experiment. Both observation and the model experiment suggest that the enhanced light absorption by OA in Southeast Asia and Northeast Asia are associated with the advance of the Indian summer monsoon in May and the southward shift of East Asian summer monsoon rainband in June. We further find that the rainfall redistribution of the Indian summer monsoon is induced by a so-called “elevated heat pump (EHP) effect” with formation of a warm-core upper-level anticyclone and surface warming of 1-2°C over the Tibetan Plateau whereas that of the East Asian summer monsoon is formed by stable conditions associated with surface cooling and atmospheric warming around 30°N.

Keywords: Organic aerosol light absorption, light absorbing aerosol, Asian summer monsoon and aerosol interaction

 

# *Carbonaceous Aerosols: a View from GLI's near-UV Data*

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Global Land Imager (GLI) onboard of ADEOS !! platform provided about 9 months of data in 2003. GLI design was remarkably close to MODIS, but also contained two additional shortwave channels at 400 nm and 388nm. Within NASA GeoCAPE project, we have adapted the Multi-Angle Implementation of Atmospheric Correction (MAIAC) algorithm for GLI processing, and enhanced it to derive aerosol spectral absorption information from 400nm and 388nm bands. The aerosol retrievals are performed at high 1km resolution which gives a unique picture of dynamic evolution of carbonaceous aerosols from the centers of fires. We will show different examples of fresh smoke as well as aged/transported smoke bringing insights into black/brown carbon dynamics.

Keywords: aerosol, brown carbon

 

# NASA/GSFC SMARTLabs Mobile Facility: Probing air quality and aerosol-cloud effects on the environment

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Air quality, as a measure of natural and anthropogenic emissions of pollutants (particulate matter and trace gases) into the atmosphere, is receiving increasing global attention. It correlates with the health of humans and ecosystems and is also a reflector of meteorological processes occurring predominantly on local to regional scales. In support of the NASA Earth Observing System (EOS) and future Decadal Survey endeavor, GSFC's mobile SMARTLabs (Surface-based Mobile Atmospheric Research & Testbed Laboratories; *cf.* http://smartlabs.gsfc.nasa.gov/) were conceptualized, built and have participated in numerous field campaigns. The overarching goal of the SMARTLabs mobile facility is to enrich NASA Earth Sciences by (1) contributing to NASA satellite missions in providing calibration/validation of data products, (2) piloting innovative science research through the mobility, flexibility and rich suite of complementary instruments offered in these test-bed platforms, and (3) promoting NASA Earth Sciences through educational and public outreach activities.

The sizes of atmospheric constituents vary by several orders of magnitude (e.g., *gas molecules on the order of* $10^{-10}$ *m to solid hydrometeors of* $10^{-2}$ *m)* and their compositions, from simple substances to complex compounds. SMARTLabs integrates a unique suite of remote sensing and *in-situ* instruments for observing the properties of atmospheric components including clouds, aerosols, and precursor species. Two different kinds of data products arising from SMARTLabs are those directly measured/retrieved (spectral optical thickness, *in-situ* properties near surface, etc.) and those derived from combining products (e.g., aerosol hygroscopic growth factors). These data products reflect advances in methods of observations and technological progresses in instrumentation. As model simulations inevitably become more detailed (reflecting increased understanding of atmospheric processes), they will use and rely increasingly on such data products and, as must be expected, will feedback new instrumental requirements and observational strategies. Indeed, such refinements have made possible predictive capabilities that describe how future changes in atmospheric composition affect air quality and climate. SMARTLabs measurements and data products are uniquely poised to address these challenges. Additionally, in light of the expected hiatus in satellite observations between the conclusion of EOS flagship and the Decadal Survey missions, the mobility, flexibility and rich suite of complementary instruments offered by SMARTLabs can be utilized to probe atmospheric phenomena of interest, thus providing a test-bed platform and a *partially* gap-filling measure. We will present, as an example, results from the 7-SEAS/BASELInE (Seven SouthEast Asian Studies/Biomass-burning Aerosols & Stratocumulus Environment: Lifecycles & Interactions Experiment) conducted in spring 2013–2015 over northern Southeast Asia.

Keywords: Ground-based, Aerosol, Cloud

 

# *Carbonaceous Aerosols in Foggy Days During Episodic Fireworks Event*

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The present study deals with the variation of organic carbon (OC) and elemental carbon (EC) on foggy days during fireworks of Diwali festival in New Delhi. The samples were collected at different selected sites viz. JNU (dense vegetative), VN (residential) and AN (industrial) in Delhi, India. In this study, average OC and EC concentrations were found to be higher at VN i.e. 99.24 $\mu g/m^3$ and 24.31 $\mu g/m^3$ respectively as compared to AN (90.93 and 19.85 $\mu g/m^3$ respectively) and JNU (19.59 and 5.55 $\mu g/m^3$ respectively) indicating more influence of burning of fireworks during Diwali and also relatively dense populated area which favours more vehicle density as compared to rest of the sites. EC concentrations were found to be OC/EC ratios found to be 2.69, 3.85 and 4.16 in case of Pre-Diwali days, 3.30, 4.06 and 4.80 in case of Diwali and 2.33, 3.87 and 4.21 in case of Post Diwali days respectively at sites JNU, VN and AN. These ratios clearly indicate that during sampling period (covering in and around Diwali) at VN and AN sites, sufficient formation of SOA is favoured. Another reason can be, the sampling period month is November which is pre-existing winter month that involves wood burning and ultimately increase emission of volatile secondary organic compounds which condensed to form aerosols under low temperature. In addition to that, fog is also a triggering factor which occurs during winter and recorded in all days of sampling period that would increase the SOA formation and favours gas-to-particle conversion mechanisms and ultimately adsorb gaseous pollutants. Another interesting finding is that high concentrations of OC and EC were found during Diwali period but gradually declined during Post Diwali periods at all the sites. High amount of charcoal used in crackers might be the reason for high EC especially during Diwali day, but, gradually the concentrations of carbonaceous aerosols goes down during Post Diwali period because fog is a factor which act as scavenger and during Diwali, fog was observed but it doesn't affect the chemistry of carbonaceous aerosols because fresh emission from local sources like firework activities, are generally less hydrophilic, but after 2-3 days of fresh emissions, these particles become aged particles and fog can scavenge them and gradually long-lived species would give rise to the formation of SOA. In comparison to OC, EC has relatively shown less decline because due to thick coatings and less soluble properties, it scavenge less as compared to OC. Hence, fog play a significant role as a scavenger which can reduce the concentration of OC and EC with respect to freshly emitted and aged particles.

Keywords: OC, EC, Fireworks, Foggy Days, Delhi, Diwali

 

# Understanding the efficacy leading to high concentration of PM2.5 in a changing climate

# Understanding the efficacy leading to high concentration of PM2.5 in a changing climate

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We investigate the efficacy leading to high concentration of PM2.5 in a changing climate. To obtain the meteorological variables to the global chemical transport model (GEOS-Chem), we first conduct the historical run (1996-2005) and the four RCP runs (RCP2.6, RCP4.5, RCP6.0 and RCP8.5) in the two periods, 2016-2025 and 2046-2055, using the Community Earth System Model (CESM). With the same emission dataset used in the CESM, the GEOS-Chem assimilated by the meteorological variables from the CESM simulates produces a number of aerosol species in the present climate and future climate. We pay attention to the changes in the PM2.5 concentration simulated by the GEOS-Chem from the present climate (1996-2005) to the future climate (2016-2025 and 2046-2055). It is found that the PM2.5 concentration in the future climate is largely regulated by the emission scenario. Therefore, it is crucial to correctly know the emission scenario to predict the PM2.5 concentration in future climate. And then, we analyze the ratio of emission and concentration of PM2.5 in the present climate and future climate to examine the efficacy leading to high concentration of PM2.5. It is found that the efficacy increases in different RCP scenarios in each period (2016-2025 and 2046-2055) when the La Nina-like SST cooling occurs. The atmospheric conditions associated with a La Nina-like SST cooling provides more favorable condition to increase the efficacy leading to high concentration of PM2.5 in East Asia. We also compared with the two periods (2016-2025 and 2046-2055) in the four RCP scenarios in terms of the efficacy leading to high concentration of PM2.5 and we found that the efficacy for 2046-2055 is higher than that for 2016-2025 in spite of a reduction of emission.

キーワード：PM2.5、emission、La Nina-like SST
Keywords: PM2.5, emission, La Nina-like SST

 

# The top and bottom 10 monthly light-absorbing aerosol deposition anomalies over the Greenland ice sheet during 2003-2016 and their corresponding changes in atmospheric aerosol pattern

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Nowadays, the melting of the Greenland ice sheets (GrIS) along the ongoing climate change is one of large concerns for many people. It is well known from previous studies (e.g., Qian et al., 2015, and references therein; Yasunari et al., 2015) that the snow-darkening by deposited light-absorbing aerosols (i.e., LAA: dust, black carbon, and organic carbon) is one of the factors for accelerating melting. In this presentation, we examine the top and bottom 10 monthly LAA deposition flux anomalies over GrIS during 2003-2016 and associated changes in atmospheric circulations and LAA loading patterns, using the NASA’s MERRA-2 re-analysis data (Bosilovich et al., 2015; Randles et al., 2016).

Here we define the areas for the LAA deposition anomalies over GrIS as the grid points where the monthly mean snow mass (i.e., snow water equivalent, SWE) over glaciated surface is greater than 500 kg $m^{-2}$ within a domain including GrIS (287˚E-339˚E; 59˚N-85˚N). The monthly LAA deposition flux anomalies were calculated from the their monthly climatologies for 2003-2016. Then, we selected the top and bottom 10 months of dust, BC, and OC deposition flux anomalies for higher and lower cases of the LAA depositions over GrIS, respectively. To discuss the atmospheric LAA conditions for the higher and lower LAA deposition time periods, we also used column mass densities of dust, BC, and OC and calculated the composites of their column mass densities for the top and bottom 10 LAA deposition months. The differences of the composites for each LAA component can tell us the possible LAA source information which could contribute to generate higher LAA deposition flux anomalies over GrIS during 2003-2016.

For dust, higher atmospheric dust amount changes over Middle East and North Africa were seen for the composite difference of the column mass density of dust between the cases of the top and bottom 10 dust deposition anomalies over GrIS. This implies that these two sources could mainly contribute to make the higher dust deposition months over GrIS during 2003-2016. For OC, some hot spots were seen over the eastern part of the Lake Baikal, Eastern Siberia, and Canada. Probably smokes from biomass burnings over these areas significantly had responsibilities to highly increase OC depositions over GrIS. For BC, although increased BC column mass densities were seen over Eastern Siberia and Canada as were seen for the OC case, broadly increased BC were also seen over Alaska, the Indo-Gangetic Plains, South East Asia, and Central Africa. This implies that the source attributions of higher BC deposition months over GrIS are more complicated, compared to dust and OC source attributions.

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キーワード：グリーンランド、エアロゾル沈着、ダスト、ブラックカーボン、オーガニックカーボン、雪
Keywords: Greenland, aerosol depositions, dust, black carbon, organic carbon, snow

 

# Potential impact of snow darkening effect by light-absorbing aerosols on the hydrological cycle over Eurasia

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In this study, we present the possible impact of snow darkening effect (SDE) on the hydrological cycle over Eurasia by light-absorbing aerosols using the NASA GEOS-5 Model experiments with aerosol tracers and a state-of-the-art snow darkening module, Goddard SnoW Impurity Module (GOSWIM) for the land surface. Results show that SDE can have a significant regional dependency in partitioning the role of evaporative and advective components on the hydrological cycle, especially during spring and summer season. Over the western Eurasia (40-60˚N, 20-60˚E), SDE-induced rainfall increase during early spring can be largely explained by the increased evaporation from snowmelt. Rainfall, however, decreases in early summer due to the reduced evaporation as well as moisture divergence associated with the development of anticyclonic circulation. On the other hand, in the East Asian region, the moisture advection from adjacent ocean is a main contributor to rainfall increase in the melting season. Warmer land-surface due to earlier snowmelt further increases moisture convergence and significantly increases rainfall over the region. This finding suggests that the SDE may play an important role in advancing and strengthening monsoonal circulation in East Asia, while it may lead to dry and hot summer by intensifying blocking high over the mid-western Eurasia

Keywords: Snow darkening effect, Light-absorbing aerosol, Hydrological cycle, Asian summer monsoon, Heat wave

 

# Impacts of snow darkening by absorbing aerosols on South Asian monsoon

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North-south temperature reversal caused by the seasonal heating over the Tibetan Plateau is a main driver of the onset of the South Asian Monsoon. Aerosols can play an important role in pre- and early monsoon seasonal heating process over the Tibetan Plateau by increasing atmospheric heating in the northern India, and by heating of the surface of the Tibetan Plateau and Himalayan slopes, via reduction of albedo of the snow surface through surface deposition –the so call snow-darkening effect (SDE). To examine the impact of SDE on weather and climate during late spring and early summer, two sets of NASA/GEOS-5 model simulations with and without SDE are conducted.

Results show that SDE-induced surface heating accelerates snow melts and increases surface temperature over 4K in the entire Tibetan Plateau regions during summer. Warmer Tibetan Plateau further accelerates seasonal warming in the upper troposphere and increases the north-south temperature gradient between the Tibetan Plateau and the equatorial Indian Ocean. SDE-induced increase of the meridional temperature gradient drives meridional circulation and enhanced upper tropospheric easterlies and lower tropospheric westerlies, and intensifies monsoon circulation and rainfall. This pattern enhances the EHP-like circulation anomalies induced by atmospheric heating of absorbing aerosols over the northern India. The results suggest that SDE-induced early snow melting over the Tibetan Plateau may cause early and stronger monsoon in early summer.

Keywords: Aerosol, Snow darkening, Summer monsoon

 

# JMA/MRI Aerosol Reanalysis Product

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A global aerosol reanalysis product covering the period 2011–2015 was constructed by the Meteorological Research Institute (MRI) of Japan Meteorological Agency (JMA). The reanalysis employs a global aerosol transport model developed by MRI (MASINGAR mk-2) and a 2-dimensional variational method, assimilates maps of aerosol optical depth (AOD) from the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard Terra and Aqua satellites every 6 hour, and has horizontal resolution of TL159 (approximately 1.1˚× 1.1˚). In this presentation, we overview setup of the reanalysis as well as indication of its quality.
Comparing with the MODIS AOD shows that the reanalysis improved the under- and overestimates in the free run and exhibits much better agreement than the free run of the aerosol model confirming a sanity of the data assimilation system. The reanalysis obtains root mean square error (RMSE) = 0.05, correlation coefficient (R) = 0.96, mean fractional error (MFE) = 23.7%, mean fractional bias (MFB) = 2.8%, and index of agreement (IOA) = 0.98. The better agreement of the first guess comparing with the free run indicates that aerosol fields obtained by the reanalysis can improve the short-term forecasting.
AOD fields from the reanalysis agree well with monthly averaged AODs from the Aerosol Robotic Network (AERONET) with RMSE = 0.08, R = 0.90, MFE = 28.1%, MFB = 0.6% and IOA = 0.93 over the globe.
Site-by-site comparison shows that the reanalysis is considerably better than the free run and achieves RMSE < 0.10, R > 0.90, and IOA > 0.90 at 86.4%, 40.7%, and 43.4% of the 181 AERONET sites, respectively. However, the reanalysis tends to have negative bias at urban sites (particularly megacities in industrializing countries) and positive bias at mountainous sites possibly due to insufficient anthropogenic emission, the coarse model resolution, and difference of representativeness between the satellite and ground-based observations.

キーワード：エアロゾル、再解析、データ同化
Keywords: aerosol, reanalysis, data assimilation

 

# Near-real-time aerosol forecast experiment with Himawari-8 aerosol product

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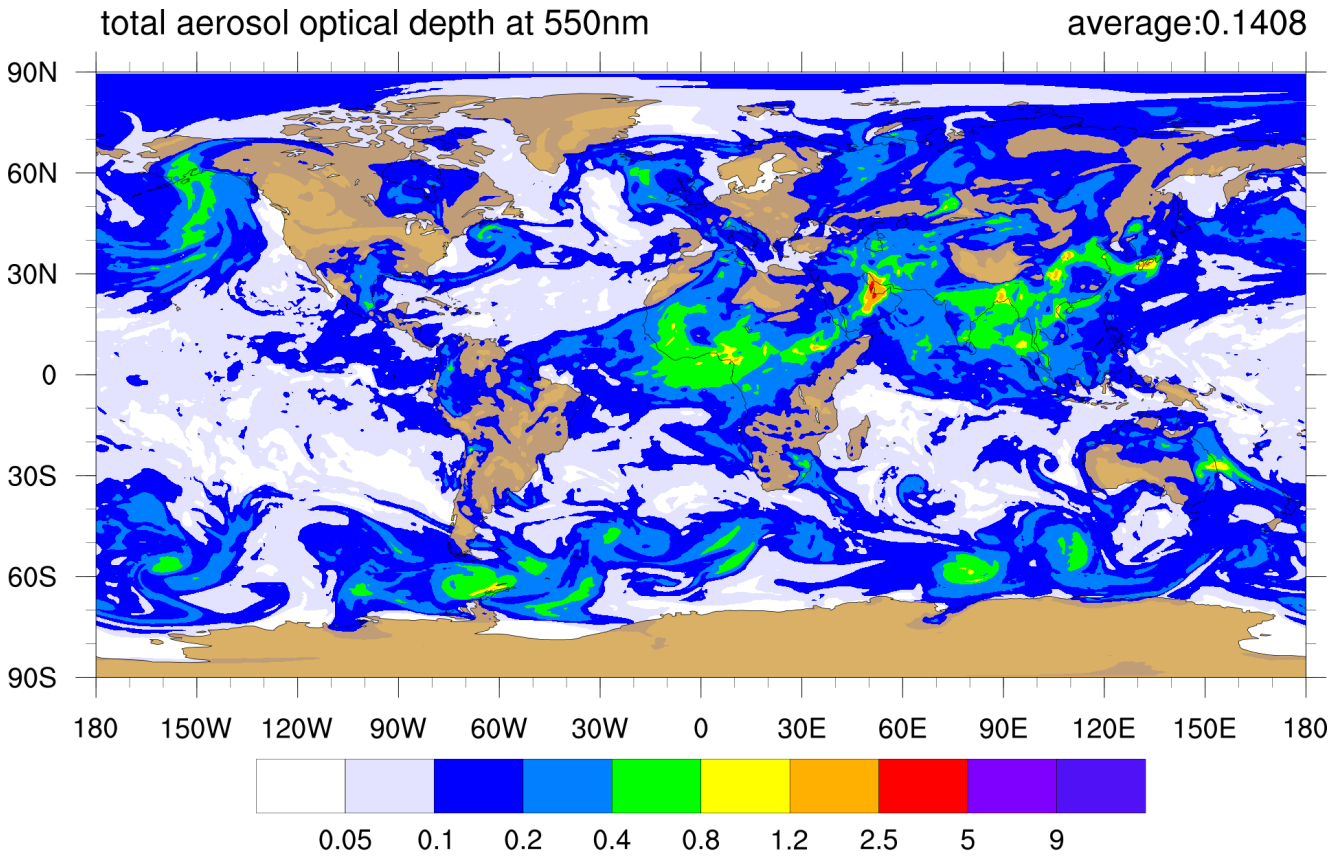
Japan Meteorological Agency has been providing Aeolian dust aerosol prediction over East Asia since January 2004. To obtain a better initial condition for the dust aerosol forecast, we are developing a near-real-time forecasting system of global aerosol distribution with data assimilation system. The prediction is calculated using a global aerosol model called MASINGAR mk-2 that is coupled to a general circulation model MRI-AGCM3. The data assimilation system uses a two-dimensional variational method (2D-VAR) and assimilates aerosol optical depth (AOD) observations by the Himawari-8 geostationary meteorological satellite and the Moderate Resolution Imaging Spectroradiometer (MODIS) on Terra and Aqua satellites. Himawari-8 AOD retrieval is developed by Japan Aerospace Exploration Agency (JAXA) Earth Observation Research Center (EORC). We will show the impact of using Himawari-8 aerosol product for data assimilation and discuss the necessary quality control of the Himawari-8 AOD.

キーワード：エアロゾル、データ同化、衛星観測
Keywords: aerosol, data assimilation, satellite observation




00UTC 14 Feb 2017

# Intercontinental transport of aerosols: Results of source attribution and source/receptor relationship from HTAP2/AeroCom III model experiments

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Aerosol, also known as particulate matter (PM), is one of the major air pollutants determining ambient air quality. It also affects weather and climate through the aerosol-radiation-cloud interactions. Although its lifetime is relatively short (a few days), aerosol originated from one region can be transported to downwind regions and high altitudes to impose large scale to global influences. In this study, we will present results from multi-model experiments coordinated by the United Nations' Task Force on Hemispheric Transport of Air Pollution (HTAP) in its Phase 2 study. We first evaluate simulations by eight participating global models on (a) surface aerosol concentrations over North America, Europe, and Asia with available measurements and (b) AOD over the world with AERONET data, then we estimate the source attributions in the northern hemispheric regions of North America (NAM), Europe (EUR), South Asia (SAS), East Asia (EAS), and the Arctic (ARC), and finally we estimate the "Response to extra-regional emission reduction (RERER)" in the above regions.tr

Keywords: Transport, Aerosols, model

 

# Impact of air pollutants on East Asian summer monsoon over China-Korea-Japan under SSP2 and RCP8.5 scenario

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We have compared two long-term simulations of SSP2 and RCP8.5 scenarios conducted using the Community Earth System Model (CESM), focusing on the changes in East Asian summer monsoon. The SSP2 scenario was applied to only China-Korea-Japan region in order to explore the impact of air pollutants on the monsoon rainfall and circulations. Results show that in the early 21$^{st}$ century the surface warming over the Asian continent was greater than over the North Pacific Ocean, providing greater land-sea thermal contrast in the SSP2 compared to the RCP8.5; which may intensify the East Asian monsoon system. The location of major rainfall region shifts to the north with a reduction in East Asia and an increase in subtropics. Notice that the land-sea thermal contrast has decreased in the late 21$^{st}$ century and the associated rainfall anomalies between the SSP2 and RCP8.5 also become reverse compared to the early 21th century. This is consistent with the reduction of 10% of $CO_2$ concentration and two fold increase of atmospheric aerosols over the China-Korea area in the SSP2 relative to the RCP scenario. Physical mechanisms are discussed based on the diabatic heating, adiabatic heating, and associated secondary circulation around the jet stream.

This study was financially supported by National Institute of Environmental Research (NIER)

Keywords: East Asian summer monsoon, climate pollutants, SSP scenario, CESM

 

# Simulation of global distribution of temporal and spatial variation of $PM_{2.5}$ concentration in the future

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According to the emission scenarios of aerosols and their precursors, RCP2.6(low emission), RCP4.5(medium emission) and RCP8.5(high emission) scenarios given by the Fifth Assessment Report of Intergovernmental Panel on Climate Change (IPCC AR5), the temporal and spatial variations of the concentrations of total $PM_{2.5}$(the sum of anthropogenic and natural aerosols),anthropogenic and natural aerosols in $PM_{2.5}$ over the globe from 2010 to 2030 and 2030 to 2050, as well as the contributions of anthropogenic and natural aerosols to these variations under the green emission scenario (RCP4.5) over China are simulated in this work, using an aerosol-climate online coupled model from National Climate Center. Results show that from 2010 to 2030, the spatial variations of the column concentrations of $PM_{2.5}$ under the three emission scenarios are basically similar to each other. The column concentrations of $PM_{2.5}$ increase over Europe, North Africa, and the ocean to the west of North Africa, but the increase over North Africa and the ocean to the west of it is more significant than that over Europe. However, the column concentrations of $PM_{2.5}$ decrease over the Arabian peninsula. The annual mean surface concentrations of $PM_{2.5}$ over China decrease approximately by 2.55 $\mu g/m^3$, with the anthropogenic aerosols accounting for about 28% and the natural aerosols accounting for about 72% under RCP4.5 scenario. From 2030 to 2050, the spatial variations of the column concentrations of $PM_{2.5}$ differ greatly under the three different emission scenarios. The column concentrations of $PM_{2.5}$ increase apparently over North Africa and ocean to the west of it, while decrease over East Asia under both RCP4.5 and RCP8.5 scenarios. Whereas, the results under RCP2.6 scenario are quite different from RCP4.5 and RCP8.5 scenarios. In China, the column concentrations of $PM_{2.5}$, as well as the anthropogenic and natural aerosols in $PM_{2.5}$, are reduced further than the previous period under RCP4.5 scenario, with the contributions(about 34%) of anthropogenic aerosols increasing.

Keywords: PM2.5, anthropogenic aerosol, natural aerosol, BCC_AGCM2.0_CUACE/Aero

 

# Potential impacts of climate variability on transpacific transport of springtime Asian aerosols

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The potential impacts of large-scale circulation associated with western Pacific (WP) and Pacific-North American (PNA) patterns on transpacific transport of springtime Asian aerosols are examined using aerosol optical depth (AOD) from the Moderate-resolution Imaging Spectroradiometer (MODIS) and reanalysis data. Composite analyses reveal that the increased westerly winds are evidently observed to the north and south of the North Pacific, respectively, during WP positive (WP+) and PNA positive (PNA+) phases. Along the favorable pathways during WP+, the large amount of aerosols are more efficiently transported over the north of 40˚N, producing the increased transport probability by about 36% compared to the opposite phase (WP−). Similarly, the distinct route over the south of 40˚N during PNA+ associated with more frequent high aerosol loading days as compare to PNA−. Concurrent with these reinforcements during WP+ and PNA+, the long-range transports of aerosols emitted from northeastern and southeastern Asia can be effectively controlled by respective patterns.

Keywords: Asian aerosol, transpacific transport, MODIS AOD, western Pacific pattern, Pacific-North American pattern

 

# Peculiarities of the vertical and geographical distribution of particulate organic matter over West Siberia

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In recent years, we have performed aerosol sampling in the atmospheric surface layer (ASL) over different regions of West Siberia in order to reveal peculiarities of the geographical distribution of particulate organic matter. Investigation of the vertical distribution in the troposphere was undertaken by means of aerosol sampling from Optik TU-134 aircraft laboratory in the atmospheric layer from 2 to 8 km during three YAK-AEROSIB campaigns (2012, 2013, and 2014). Aerosol samples were collected onto Teflon filters (PTFE membranes, GRIMM). Hydrocarbons were identified using mass spectral library databases NIST, Wiley, as well as by comparing retention times of reference compounds in model mixtures (Alkane Standard Solutions by Sigma –aldrich).
Total organic matter varied from 244.56 ng $m^3$ in aerosol samples collected in the ASL to 0.08 ng $m^3$ in the free troposphere (FT) over the Kara Sea. Significant differences were also found in the geographical distribution of POM due to different volatile organic compounds emitted by vegetation in specific regions. Differences between concentrations of POM sampled in the free troposphere over the continent and ocean can exceed an order of magnitude. Average concentration of organic compounds in the ASL is close to 30 ng $m^3$ and it decreases exponentially with height down to 14 ng $m^3$ at the top of the atmospheric boundary layer and 5 ng $m^3$ in the FT.

Keywords: Aerosol, Atmospere, Chemical, Organic matter

 

# Impact of Dust Direct Radiative Effect on African Easterly Waves

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The effects of dust on African Easterly Waves (AEWs) has caught scientific attention for the last few decades, primarily because of close proximity of dust sources and AEW’ s pathways. Being the predominant synoptic-scale disturbances over tropical Africa and Atlantic during summer, AEWs act as the major weather-producing mechanism over tropical Africa and often could play a role of precursors for Atlantic tropical cyclones. Dust radiative effect can potentially influence the structure, dynamics and the periodicity by altering the temperature profile, stability, CAPE and by modifying the environmental wind shear. However, studies in the past suggest a contrasting response of AEW to dust direct radiative effect. The present study investigates the role of dust direct radiative effect on AEWs and their sensitivity to the dust induced heating as an effort to demystify the contrasting results in the past. Ensembles of high resolution global simulations have been conducted at a spatial resolution of ~25 km, using High Resolution Atmospheric Model (HiRAM) developed at GFDL, with and without dust radiative effect. To elucidate the sensitivity of AEW to shortwave heating by dust, the experiments with dust assumes three different hematite contents (Balkanski et al., 2007), 0.9%, 1.5% and 2.7% by volume, which corresponds to inefficient, standard, and very efficient dust shortwave absorption, respectively. Comparisons among various simulations suggest that the dust radiative effect enhances the AEWs intensity and changes their periodicity. It has also been shown that AEWs strength and periodicity is sensitive to shortwave absorption by dust.

Reference: Balkanski, Y., M. Schulz, T. Claquin, and S. Guibert (2007), Reevaluation of mineral aerosol radiative forcings suggests a better agreement with satellite and AERONET data, Atmos. Chem. Phys., 7, 81 - 95.

Keywords: Dust Radiative Impact, African Easterly Waves, HiRAM

 

# 酸化鉄エアロゾルの単一粒子測定法の確立と放射影響の評価
# Single-particle measurements of light-absorbing iron oxide aerosols and their radiative effects

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Iron oxide (FeOx) aerosols efficiently absorb solar radiation, causing a perturbation of radiation balance. A well-known FeOx aerosol is mineral dust, emitted from the erosion of arid and semi-arid soils. In addition to dust (natural FeOx), anthropogenic FeOx aerosols generated through combustion process have been reported recently. However, the size-resolved concentration of FeOx aerosols are not well understood because of the technical difficulty of single-particle measurement of FeOx particle. Furthermore, the importance of anthropogenic FeOx aerosols to climate has never been focused on. In this study, we performed ground observation of FeOx aerosols at Cape Hedo Atmosphere and Aerosol Monitoring Station (CHAAMS), Japan. We used a modified single-particle soot photometer (SP2) and transmission electron microscopy (TEM). Although the SP2 is conventionally used to measure individual black carbon (BC) particles, we applied it to measure FeOx aerosols using a new method (Yoshida et al., 2016). Optical properties of FeOx aerosols obtained by the SP2 and TEM show that the majority of FeOx aerosols were of anthropogenic origin. The mean mass concentration was 40.4 ng/m$^3$, approximately one third of that of BC (132 ng/m$^3$). We also theoretically estimated shortwave absorption of these aerosols using the size-resolved concentration observed by the SP2. The absorbing heating power of FeOx aerosols is estimated to be 2.3–6.4% of that of BC. This result indicates that anthropogenic FeOx aerosols, which has thus far not received attention, can have non-negligible light-absorbing ability comparting with brown carbon and mineral dust, well known light-absorbing aerosols.

キーワード：エアロゾル、酸化鉄、大気放射、観測
Keywords: aerosol, iron oxide, atmospheric radiation, observation

 

# 微量金属のICP-MS直接観測を利用したBCの起源判別の試み
# Trial for the BC source identification by using direct observation of trace metals with ICP-MS

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Direct mass spectrometric analysis for inorganic elements of atmospheric aerosols has become possible by using a gas converter (GED) coupled with inductively coupled plasma mass spectrometry (ICP-MS). This versatile and novel analysis technique would make us possible to assess more about source, transport, mixing and modification of the atmospheric aerosols. In this presentation, trials of BC source identification was carried out by using tracers of many metalic elements determined by the GED-ICP-MS in the actual field. Black carbon was observed by using Aethalometer along with GED-ICP-MS measurement. With PMF statistical analysis as well as meteorological analysis gave major sources of BC during a week of the observation campaign.

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