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JINAN UNIVERSITY

ABSTRACTS

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ABSTRACTS

Air quality in Ulaanbaatar, Mongolia: impact assessment of a residential heating stove replacement program

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ABSTRACT

Ulaanbaatar, the capital of Mongolia, is commonly ranked among the worst cities in the world for outdoor particulate matter air pollution. Air quality conditions are particularly poor during the wintertime because of the extreme climate and high demand for energy to satisfy space heating needs. A major source of pollution is coal combustion in residential heating stoves with these activities centered in the ger districts of the city. The U.S. Millennium Challenge Corporation, through a compact with the Mongolian Government, funded a subsidy program to replace traditional residential stoves with improved stoves. Within a few years more than 100,000 stoves were sold which represents about half of the stoves in the city. This presentation will focus on an impact assessment conducted to quantify the benefits of this investment. The assessment instruments included a household survey to determine fuel consumption and stove usage patterns, household stove emissions testing and indoor air quality measurements, and outdoor air quality measurements and modeling. Key findings included; 65% lower $PM_{2.5}$ emissions for improved stoves compared to traditional stoves; and for 2013, and a 30% reduction in population-weighted ambient $PM_{2.5}$ concentrations attributable to residential heating stoves.

KEYWORDS: $PM_{2.5}$; solid fuels; heating stoves

Air quality in domestic kitchens: cooking with gas or electricity?

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ABSTRACT

In our modernised world, people are spending increasingly large amounts of time indoors. Indoor air quality is thus important, and exposure assessments pave the way to measuring the risks to human health. In this pilot study, we investigated emissions in the domestic kitchen, as cooking is a main source of air pollutant exposure in the home.

Our before-and-after study aimed to compare the emissions in 16 home kitchens that first cooked using gas stoves, then switched to electrical induction cookers. Two evening field visits were conducted at each household, during which we would observe the family's dinner preparations. The same menu was prepared on both visits; hence, details on each dish, like ingredients and cooking times, were recorded. The only major change between visits would be in the cooker type.

Air sampling and monitoring methods were identical for both visits. Prior to cooking, we assessed each kitchen's ventilation rate. We then conducted real-time monitoring on the room temperature and the levels of air pollutants, including fine particulates ($PM_{2.5}$), carbon monoxide (CO), and carbon dioxide (CO_2). Measurements were started before cooking, to obtain background levels, and continued throughout meal preparations until after all cooking processes were completed. Air samples were also collected before, during and after cooking; these were analysed for pollutants such as nitrogen monoxide (NO) and NO_2 using a chemiluminescence analyser.

Our main findings showed that, by switching stoves from gas-fuelled to electric, cooking activities generated significantly less $PM_{2.5}$ (reduced by 95.39%), CO (reduced by 99.08%), and CO_2 (reduced by 59.64%), as well as substantially less NO (reduced by 79.83%) and NO_2 (reduced by 74.05%). It also became less hot (temperature reduced by more than 0.5 °C). Overall, the use of an electrical induction cooker seems preferable to a gas stove when aiming to reduce air pollutant emissions in the domestic kitchen.

KEYWORDS: Indoor air quality; air pollutant emissions; exposure assessment; domestic environment; kitchen; cooking; gas cooker; electrical induction cooker

Air quality response to street canyon geometry in urban area

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ABSTRACT

Being a small and rapidly developing city, land supply in Hong Kong can hardly meet her need, especially in commercial zones near the harbour. To entertain the commercial floor area need, buildings in Hong Kong would inevitably become taller and deteriorate air quality by hindering dispersion of pollutants in street canyon, which is the space over a street surrounded by two rows of buildings. Since pedestrian and vehicle activities are both happening on gourd level in a close distance, understanding pollution level due to vehicle emission in the street canyon (specifically nitrogen oxides (NO_x) and particulate matter (PM), which can induce serious health effect on the pedestrian) is essential to the health of the citizen.

In the study, the Atmospheric Dispersion Modelling System-Urban (ADMS-Urban) is employed to investigate emission of those pollutants and their dispersion in the urban setting. By changing the urban canopy flow parameters, including the average building height H, the average street canyon width G, and the ratio of plan area occupied by buildings λ_P and frontal area perpendicular to wind direction $\lambda_F(\theta)$, the effect of street canyon geometry change can be studied by simulations. It is hoped to provide an idea for urban planners on how air quality in street is affected by buildings.

KEYWORDS: ADMS-Urban; Street Canyon; Dispersion

Ambient air pollution and health impact in China: a review based on Chinese survey

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ABSTRACT

For the exposure-effect relationship of air pollution with health effect is non-linear, and the air pollution levels in developed countries were usually low ($PM_{2.5}$ mostly below 40 μg/m^3), the results from the developed countries may be not suitable in China where the $PM_{2.5}$ levels were usually more than 120 μg/m^3, and the country's toxic air pollution levels resemble something like a 'nuclear winter'. In order to evaluate the effects of ambient air pollution exposure on Chinese health, we have conducted four large epidemiologic investigations and one clinical case-control study in Chinese from a high pollution range area since 2007. We summary the results of our studies as following: 1) Air Pollution and Lung Cancer: To investigate the relationship between long-term exposure to ambient air pollution and mortality of lung cancer in a cohort of Northern China, a total of 39,054 participants aged 40-89 years were followed from 1998-2009; The results showed ambient concentrations of PM_{10} was positively associated with lung cancer mortality (HR per each 10 μg/m^3 = 1.65, 95% CI, 1.52-1.80), which was much higher than that the level reported by IARC (HR=1.08, 95%CI:1.00-1.07). **2)** Air Pollution and CVDs in Chinese: In order to examine whether the exposure to ambient air pollution was associated with the prevalence of stroke and CVDs among people living in a heavy industrial province of northeast China, we conducted a cross-sectional study of 24,845 Chinese adults, ages 18e74 years old, from 33 communities in the 11 districts of the three Northeastern Chinese Cities during 2009. The results showed that the adjusted odds ratio for stroke increased by 1.16 (95% CI, 1.03-1.30) per 19 μg/ m^3 increase in PM_{10}. The associations of air pollutants with blood pressure were much stronger in populations with prehypertension than in the hypertensives. Compared with the other circulations system diseases (CVD, Stroke, Hypertension, Diabetes, Metabolic syndrome, HDL-C, Triglycerides, etc.), diabetes is the most sensitive indicators for the impact of air pollutants on human health. 3) Air Pollution, Asthma, and Lung function in Children: Compared with the adults, children may be more sensitive to environmental pollution. To assess the association between air pollution and respiratory health in children, we studied 31,049 Chinese children, ages 2–14 years old, from 25 elementary schools and 50 kindergartens in the Seven Northeastern Cities during 2008–2009. We found that air pollution is particularly important in the development of respiratory morbidity among children. Compared with other air pollutants, the effects of PM_{10} on respiratory health was the largest, and a 10 μg/m^3 increase of PM_{10} resulted to a 38% (OR=1.35; 95%CI: 1.04-1.79) risk excess for

asthma in children. As for lung function, the increased odds of lung function impairment associated with exposure to air pollutants, ranged from 5% (aOR=1.05; 95%CI: 1.01, 1.10) for FVC < 85% predicted per 46.3 mg/m3 for O_3 to 81% (aOR=1.81; 95%CI: 1.44, 2.28) for FEV1 < 85% predicted per 30.6 mg/m3 for PM_{10} in children. Furthermore, other factors such as breastfeeding\pet keeping in home, and obesity also modified these associations. 4) Air Pollution and Mental Health in Children: Recently, we studied about 70,000 Chinese children, ages 3–17 years old, from 24 elementary schools and 24 middle schools in the Seven Northeastern Cities during 2012–2013. The aim of this study is to evaluate whether ambient air pollutants at levels typically found in China are related to increased rates of low birth weight, blood pressure, sleep disorder and mental health (ADHD) in children from Northeast of China. For example, among these Chinese children, higher sleep disorder was positively associated with PM_{10} (OR=1.31; 95%CI: 1.22-1.41), NO_2 (OR=1.23; 95%CI: 1.15-1.31), and O_3 (OR=1.04; 95%CI: 1.03-1.06). As for ADHD, an increased prevalence of doctor-diagnosed ADHD was significantly associated with PM_{10} (OR=1.26; 95%CI: 1.17-1.36), SO_2 (OR=1.15; 95%CI: 1.08-1.23), and O_3 (OR=1.19; 95%CI: 1.12-1.27). 5) Toxicological Evaluation of Components in PM: It is well known that the ability of particulate matter to induce adverse health effects in human may be associated with many factors. These factors includes not only concentration and density, but also size, shape, and components of ambient particles. Based on the clinical case-control studies, we have firstly reported the association between the PFAAS, a new type persistent organic pollutants, with the biomarkers of asthma. For example, adjusted odds ratios for asthma among those with the highest versus lowest quartile of PFC exposure ranged from 1.81 (95% CI: 1.02, 3.23) for the perfluorododecanoic acid (PFDoA) to 4.05 (95% CI: 2.21, 7.42) for perfluorooctanic acid (PFOA). Furthermore, we also found that club cell secretory protein (CC-16) negatively associated with PM10 (β=-0.18, p=0.002), indicating CC-16 may be a sensitive biomarker for effects of air pollutants exposure. In conclusions, all these studies may prove to be effective preventative measures that could save lives and improve its quality, while reducing the economic and public health burden that plagues China and other industrialized nations.

KEYWORDS: Ambient Air Pollution; Health Impact; Chinese; Components; Toxicology

Ambient fine particulate pollution associated with hypertension, blood pressure and stroke among older Chinese adults

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ABSTRACT

To examine the effects of long-term exposure to ambient fine particulate pollution ($PM_{2.5}$) on hypertension, blood pressure and stroke. Methods We interviewed 12,665 participants aged 50 years and older and measured their blood pressures. The annual average $PM_{2.5}$ concentrations were estimated for each community using satellite data. We applied two-level logistic regression models to examine the associations, and estimated burden of hypertension and stroke attributable to ambient $PM_{2.5}$. Significant associations of ambient $PM_{2.5}$ with hypertension, blood pressure and stroke were observed. For each 10 $\mu g/m^3$ increase in ambient $PM_{2.5}$, the adjusted odds ratio was 1.14 (95% confidence interval, 1.07, 1.22) for hypertension and 1.11 (95% CI: 1.00, 1.24) for stroke. We further estimated that 11.75% (95% confidence interval: 5.82%, 18.53%) of the hypertension cases and stroke cases could be attributable to ambient $PM_{2.5}$ in the study population. Findings suggest that long-term exposure to ambient $PM_{2.5}$ might be an important risk factor of hypertension and stroke, and is responsible for significant burden hypertension and stroke among adults in China.

KEYWORDS: Air pollution; $PM_{2.5}$; hypertension; stroke; disease burden

Analyses of circulation weather type and their impacts on $PM_{2.5}$ concentration in Beijing

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ABSTRACT

To investigate interannual variation of winter haze pollution, this paper analyzes winter circulation types and their impacts on local meteorological conditions and haze pollution during 38 winters from 1980 to 2017 in Beijing. Circulation types, classified by T-mode principal component analysis combined with the K-means cluster method using European Centre for Medium-range Weather Forecasts ERA interim sea level pressure data, can significant distinguish cold air process, a degeneration of cold air, and static weather. With large pressure gradient, cold air process is accompanied by low temperature, high relative humidity, large near-surface wind speed, deep mixing layer over Beijing. Cold air process facilitates pollutant dispersion and transport to outside, and forms low $PM_{2.5}$ concentration and frequency of haze days. Compared with cold air, the local meteorology and haze pollution are almost inverse for static weather. For degeneration of cold air, the local meteorological conditions and haze pollution are between previous circulation types. In recent years, the occurrence frequency of cold air is low in winter 2014 and 2017, which is mainly responsible for severe $PM_{2.5}$ pollution. High frequency of static weather (48.4%) is one of the reason for haze pollution, which reaches 37% during 38 winters from 1980 to 2017 over Beijing. The time series of haze frequency is negatively correlated with that of cold air frequency. During 38 winters from 1980 to 2017, the trend of haze days and cold air was not significant based on regression analysis.

KEYWORDS: circulation types; local meteorology; haze pollution; $PM_{2.5}$

An evaluation of implementing 3DVAR data assimilation on WRF

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ABSTRACT

Increase in the number of extreme weather events has raised the demand for more accurate numerical weather predictions (NWP) to an unprecedented high level. These predictions are generated through computer modeling which rely heavily upon the quality of the initial atmospheric condition. An initial condition that closer represents the true atmospheric state can minimize errors that propagate into the future, which leads to substantial improvements in the forecast. This study aims to reduce the initial errors by combining surface observations to generate a more accurate initial condition. We will apply the Three-Dimensional Variational (3DVAR) data assimilation method onto our background analysis which is generated by the Weather Research and Forecasting (WRF) model that covers China (Domain 1), Guangdong province (Domain 2), and the Pearl River Delta (PRD) region (Domain 4). 3DVAR is a data assimilation technique that aims at producing an initial condition by incorporating observation data into background state of a model in a specific time window. The adjustment towards the background field is dependent on the both the model error as well as the observation error and the improvements will be quantified in terms of temperature, horizontal and vertical wind, humidity and pressure. We selected a case on within the period of 1740 UTC 15/12/2015 to 0345 UTC 17/12/2015, where strong northerly monsoon signal was hoisted indicating in very exposed places, monsoon winds may exceed 70 Km/h. Conventional surface observation data such as SYNOP, METAR SHIPS and BUOYS are collected from the Environmental Central Facility (ENVF) of which temperature, pressure, relative humidity, horizontal and vertical wind field, are assimilated into the model which initialized on 1200 UTC December 14, 2015. Through generating a more accurate initial condition, we expect that the observation data will contribute significantly in the reduction of initial error, which will bring visible improvements on the numerical weather forecast in the PRD region.

KEYWORDS: 3D-VAR; Data Assimilation; PRD, NWP; WRF-ARW

A new air monitoring system assessment and application: a case study of source identification in a local area

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ABSTRACT

Community air minoring system Village Green Project (VGP) developed by U.S. Environmental Protection Agency (USEPA) was first time deployed in Hong Kong for school Based air monitoring purpose. The VGP system provided highly time resolved and long-term data for ozone, PM2.5 and meteorological data. It was powered by solar panels and included a wireless telemetry module that provided air quality in real-time. Meanwhile, the VGP system worked automatically without mains power and little maintenance. In the 16-months measurement period, the data completeness reached over 62%. The monitoring data were evaluated by comparison with a nearby Hong Kong Environment Protection Department (EPD) station exhibited good performance for 1-hour resolution (R^2 = 0.74 for PM2.5 and R^2 = 0.76 for ozone). Furthermore, a nonparametric regression (NPR) model was applied for identifying the pollution source direction, which combined with the air pollution and meteorological measurements. In addition, based on the high time-resolution meteorological measurements, the back-trajectory were calculated as an input for receptor-oriented model Nonparametric Trajectory Analysis (NTA), the result of the model can identify the location of a nearby pollution source and quantitative evaluated the source influence. The combination of the VGP air monitoring system and NTA model shows the ability of source identification in urban scale area.

KEYWORDS: Air monitoring; Trajectory analysis; Source identification

Application of traceability analysis for air pollution control grid monitoring system based on sensor

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ABSTRACT

Micro air quality monitoring instrument based on sensor, due to its advantages of low cost, miniaturization and real-time monitoring, is suitable for the deployment of air pollution control grid monitoring system, with high temporal resolution (10min) and high spatial resolution (500m), and suitable for urban, industrial parks and other small-scale range of emission levels in the air pollution prevention work. Air pollution control grid monitoring system can be achieved on specific-targeted management and control for the uncontrolled emission, illegal discharge of enterprises and sudden pollution incidents. This paper introduces the basic stationing principle of air pollution control grid monitoring system in different functional areas, such as cities, suburbs, chemical parks, key industrial enterprises, roads and transmission channels for pollution air, and successful application of the system in air pollution control in cities. Based on the high spatial and high temporal resolution air quality monitoring data, combined with meteorological and geographic information, the system could display how polluted air masses transmission in the air exactly, and have been used on unknown pollution source identification, location of suburban pollution transmission and positioning of polluting enterprises in the chemical industry park successfully, which provided effective support for pollution prevention and control management work.

KEYWORDS: air pollution control; sensor; grid monitoring; grid monitoring; traceability analysis

Application of lidar in atmospheric environment monitoring over Hubei province

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ABSTRACT

As a kind of advanced technique of active remote sensing, lidar remote sensing has been widely used in the research fields of environmental sciences, atmospheric science and so on. In this paper, we introduce the applicational achievements of remote sensing technology over Hubei Province. Based on the satellite remote sensing images, space-borne lidar, ground-based lidar and ground station monitoring equipment ,we monitor the pollution transportation process, and analysis the delivery of pollution and the influence degree for air quality at Wuhan and Xiangyan in Hubei province.Using the 3D lidar scanning technology and navigation monitoring technology, this paper also track the pollution sources in key areas, which provides a scientific basis for pollution control and refined environmental managements.

KEYWORDS: lidar, atmospheric; monitoring; pollution; remote sensing

Application of air parcel residence time analysis on emission control policy in Pearl River Delta

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ABSTRACT

Based on the idea that the longer residence time an air parcel stays in a certain area, the weaker the atmospheric diffusion capacity is, Air Parcel Residence Time (APRT) has been investigated to study its potential application in air pollution issues in the Pearl River Delta (PRD). The APRT in PRD is defined as the total period of an air parcel staying within the PRD region. Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model is employed to calculate the forward trajectory for APRT analysis in the whole year of 2015. Results show that air parcels travel with a start point in the PRD have a significantly higher APRT than those travel from the outer regions. For the seasonal cycle, air parcels with high APRT mainly distribute in northeastern and southern Guangzhou, which is related to the prevailing wind directions of the summer and winter monsoon. For diurnal cycle, the distribution of APRT is affected by sea breeze circulation as well as mountain-valley breeze circulation, which leads to a centralized pattern in the daytime and a patchy pattern in the nighttime. Furthermore, comparing the APRT distribution between mild pollution days and moderate pollution days, moderate pollution days are accompanied with air parcels with significantly longer APRT, and the air parcels are mainly sourced from Foshan, Dongguan, Guangzhou, and eastern Huizhou. While eastern Guangzhou and western Huizhou are the prominent air parcel sources in mild pollution days.

KEYWORDS: Air parcel residence time; emission control; HYSPLIT; Pearl River Delta Region; air pollution

Assessment and Improvement of MISR Angstrom Exponent and Single-Scattering Albedo Products using AERONET Data in China

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ABSTRACT

Mapping the components, size and absorbing/scattering properties of particle pollution is of great interest in the environmental and public health fields. Although the Multi-angle Imaing Spectro Radiometer(MISR) can detect a greater number of aerosol microphysical properties than most other spaceborne sensors, the Angstrom exponent (AE) and single-scattering albedo (SSA) products are not widely utilized or as robust as the aerosol optical depth (AOD) product. This study focused on validating MISR AE and SSA data using AErosol RObotic NETwork (AERONET) data for China from 2004 to 2014. The national mean value of the MISR data (1.08) was 0.095 lower than that of the AERONET data. However, the MISR SSA average (0.99) was significantly higher than that of AERONET (0.89). In this study, we developed a method to improve the AE and SSA by narrowing the selection of MISR mixtures via the introduction of the following group thresholds obtained from an 11-year AERONET dataset: minimum and maximum values (for the method of MISR_Imp_All) and the top 10% and the bottom 10% of the averaged values (for MISR_Imp_10%). Overall, our improved AE values were closer to the AERONET AE values, and additional samples (MISR_Imp_All: 28.04% and 64.72%, MISR_Imp_10%: 34.11% and 73.13%) had absolute differences of less than 0.1 and 0.3 (defined by the expected error tests, e.g., EE_0.1) compared with the original MISR product (18.46% and 50.23%). For the SSA product, our method also improved the mean, EE_0.05, and EE_0.1 from 0.99, 16.13%, and 56.45% (MISR original product) to 0.96, 40.32%, and 70.97% (MISR_Imp_All), and 0.94, 54.84%, and 90.32% (MISR_Imp_10%), respectively.

KEYWORDS: MISR; Angstrom Exponent; Single-Scattering Albedo; AERONET

Assessment of atmospheric pollutants compliance of thermal power industry in China based on big data

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ABSTRACT

Hourly concentration compliance, standard outlet based on percentile of standard compliance and average concentration of thermal power industry in China in 2015 were assessed by using statistical analysis, taking the CEMS data was study object and according to the GB 13223-2011 standard and special emission limits. The results show that for particulate matter, SO_2 and NO_x, average compliance rate of hourly concentration were 96.1%, 91.6%, 73.8%; and outlet radio of 100-percentile were 74.9%, 73.9% and 31.5%; average concentrations in different provinces were 5.86~53.93, 7.88~208.57, 40.33~238.2 mg/m^3. Expect Beijing, Tianjin and Shanghai, other provinces in China have not reached the ultra-low emission limits.

KEYWORDS: thermal power industry; percentile of standard compliance; atmospheric pollutants; China; CEMS (continuous emission monitoring systems)

A temporally and spatially resolved validation of source apportionment by measurements of ambient volatile organic compounds in central China

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ABSTRACT

Understanding sources of volatile organic compounds (VOCs) is essential for implementation of ground-level ozone and secondary organic aerosol (SOA) abatement measures. In this study, we conducted offline VOCs measurements at 9 sites and online VOCs observations at XX site in Wuhan city from July 2016 to June 2017. Ambient samples were synchronously collected at each site and were analyzed using GC–MS. An advance receptor model positive matrix factorization (PMF) was applied to identify VOCs sources and quantify the relative contributions of various sources. The results showed that the measured VOC mixing ratio in Wuhan was dominated by alkanes (38%) and oxy-organics (24%), followed by halocarbons (13%), alkenes (9%), aromatics (8%) and alkynes (6%). ThePMF model identified gasoline-related emission (the combination of gasoline exhaust and gas vapor) as the most important VOC source, with the relative contribution of 44%, significantly lower than the 32% estimated by VOCs emission inventory of 2015. The relative contribution of industrial source obtained from the PMF model was 37 %, in good agreement with the 39 % estimated by the emission inventory. The relative contribution of paint and solvent utilization obtained from the PMF model was 16 %, significantly lower than the value of 22 % reported by the emission inventory. Meanwhile, the relative contribution of biogenic emission was 3%. Based on these findings, controlling gasoline-related and industrial VOCs emissions is important to reduce VOCs emissions in Wuhan city.

KEYWORDS: VOCs; source apportionment; PMF; Wuhan

A vehicle emission monitoring and impact assessment system based on dynamic traffic state

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ABSTRACT

Vehicular emission serves as an important contributor to the domestic air pollution issue. Dynamic emission monitoring and impact assessment with highly temporal-spatial resolution is the foundation for relevant traffic and environmental control. This study established both a novel methodology and a comprehensive system for real-time dynamic emission monitoring and assessment by real-time traffic information from public traffic information system. The mapping rule from image pixel to real-time traffic states, the velocity-volume model, emission and diffusion simulation model were developed and applied, taking Chancheng District, Foshan as an example. The system can monitor dynamic activity level, emission level of each road segment in the experimental area, and is able to evaluate the vehicular emission impact on the surrounding area and especially on important Air Monitoring Site (AMS). Commissioning operation has been carried out for 3 months and can be directly apply for NO_2 control at AMS Huacaizhizhong.

KEYWORDS: real-time emission monitoring; impact assessment; velocity-volume model; diffusion model

Biomass burning impacts on fine particles at two megacities of North China during 2014 APEC summit

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ABSTRACT

Biomass burning activities in China are ubiquitous and the resulting smoke emissions may pose considerable threats to human health and the environment. To evaluate the influences of biomass burning on fine particles during 2014 Asia-Pacific Economic Cooperation (APEC) summit, typical biomass burning tracers including levoglucosan (LG), Mannosan (MN) and water-soluble potassium (K^+) in $PM_{2.5}$ were determined at two urban sites in Beijing (BJ) and Shijiazhuang(SJZ) in North China. The results show the biomass burning tracers as well as $PM_{2.5}$ dropped by around half during the APEC period and then increased to even higher levels during post-APEC than pre-APEC. Distinct linear regression relationships between LG and MN were found with lower LG/MN ratios from periods with much reduced open biomass burning activities. This was likely resulted from the reduced open crop residues burning and increased residential wood burning emissions, as was also supported by the simultaneous decrease in K^+/LG ratio. It provided observational evidences to present the changes of biomass burning aerosol types during APEC in North China. The primary biomass burning source resolved from the positive matrix factorization (PMF) model were estimated to contribute 16.5% of $PM_{2.5}$ at BJ and 23.8% at SJZ during the study period. It further suggested that $PM_{2.5}$ concentration produced from biomass burning sources was reduced by 22% at BJ and 46% at SJZ during the APEC period compared to pre-APEC period based on air quality model simulation analyses. This study not only suggested both open crop residues burning and indoor biomass burning activities could make substantial contributions to $PM_{2.5}$ in North China, but also indicated implementing biomass burning controls measures during APEC were helpful to reduce $PM_{2.5}$.

KEYWORDS: $PM_{2.5}$; biomass burning tracers; source-apportionment analysis; open burning; residential wood burning

Characteristics of carbon components in atmospheric particulate matter before and during the heating period in Shijiazhuang

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ABSTRACT

Atmospheric particles samples (PM_{10}, $PM_{2.5}$ and $PM_{1.0}$) were collected before and during the 2016 heating period in Shijiazhuang. The effects of different particle size atmospheric particles and their OC, EC and WSOC concentrations were studied. The correlation of particulate matter and carbon components, the ratio of OC/EC, and the characteristics of the eight carbon components were used to analyze the source of air pollution in Shijiazhuang. The results showed that the average concentration of PM_{10} and $PM_{2.5}$ increased by 26.4% and 32.1% than that before heating, while the average concentration of $PM_{1.0}$ was 12.2% lower than that before heating. PM_{10} and $PM_{2.5}$ have homology, the correlation of PM_{10} and $PM_{2.5}$ before heating is more significant than in heating. During the heating, the concentration of PM_{10} and $PM_{2.5}$ increased by coal combustion, motor vehicle limit and industrial shutdown caused $PM_{1.0}$ concentration decreased. Particles are weakly correlated with EC, and the correlation decreases with increasing particle size. The particles migrate from fine particles to coarse particles. Carbon components in the $PM_{1.0}$ accounted for the highest proportion. During the heating, OC, EC and WSOC concentration was significantly higher than before heating in the PM_{10}, $PM_{2.5}$. While in the $PM_{1.0}$ OC increase in smaller, and EC and WSOC concentration in heating is lower than before heating. SOC/OC is about 80%, indicating that the secondary pollution is serious in Shijiazhuang; The OC/EC ratio is about 4.5 before heating, the OC/EC ratio of PM_{10} and $PM_{2.5}$ is about 8.5, while the OC /EC ratio is 5.7 in $PM_{1.0}$. The exhaust emissions of motor vehicles before heating are the main sources of carbon aerosols, while the emissions of coal after heating are the main sources of carbon aerosols. The contribution of motor vehicle limit to EC_1 was significant, but the concentration of OC_2 increased significantly due to the increase of coal combustion during the heating.

KEYWORDS: PM_{10}; $PM_{2.5}$; $PM_{1.0}$; organic carbon; elemental carbon; water-soluble organic carbon; Shijiazhuang

Characteristics of secondary air pollutants in typical cities over the Beijing-Tianjin-Hebei region

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ABETRACT

Beijing-Tianjin-Hebei (BTH) region is one of the most developed city clusters in China, which however suffers from increasingly severe air pollution. In this study, the spatial-temporal characteristics of secondary air pollutants, *i.e.* secondary fractions in airborne particulate matter (PM) and ozone (O_3) were examined at four National Air Quality Monitoring Stations in the Beijing-Tianjin-Hebei Region. It was found that CO, NO_2, SO_2 and PM were generally higher in autumn and winter while O_3 had the highest concentration in summer. The strong photochemical production during summertime in relation to the high temperature, low relative humidity and strong solar radiation might be the main causes of elevated O_3 in summer. Spatial variations revealed that the level of primary air pollutants and PM in Hebei province dominated over those in Beijing, while O_3 was higher in Beijing in summer. This was likely due to the fact that Beijing was in the downwind direction of the sites of interest in Hebei province in summer, allowing more O_3 to be formed during the transport of air masses. Moreover, O_3 episodes usually occurred in summer and autumn, under the conditions of southerly winds and high temperature. In contrast, high PM events were generally observed in autumn and winter, as a result of intensive emissions and stagnant weather. During high PM events, the levels of primary air pollutants generally increased, on contrary to the decrease of O_3 concentration, which might be due to the weakened solar radiation on haze days. This preliminary study on secondary air pollutants in BTH region will be a reference for us to carry out comprehensive studies on secondary organic aerosols and O_3 in this region.

KEYWORDS: Secondary organic aerosol; Ozone; Regional transport; BTH region; North China Plain

Characteristic analysis and source identification of atmospheric pollution in Haizhu district of Guangzhou

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ABSTRACT

To make the optimal policies for improving air quality, the emission inventory method and the chemical mass balance (CMB) model were used to analyze the characteristics of atmospheric pollution and identify the main sources of atmospheric pollutants based on monitoring data of atmospheric pollutants in 2015 in four monitoring sites of Haizhu District. Results showed that NOx was the pollutant that exceeded the standard value most seriously in four monitoring sites of Haizhu District in 2015, followed by $PM_{2.5}$ and O_3. Among four monitoring sites, the overall exceeding standard rate of pollutants in Shayuan site was far higher than that in other sites. Among pollution sources, on-road mobile source was the main source of NOx, CO, VOCs and $PM_{2.5}$ emissions; SO_2 and PM_{10} emission were mainly from industrial source and dust source, respectively. Combined with the traffic flow data and technology level parameters of motor vehicle in Haizhu District in 2015, it was found that the proportion of buses was only 3.8%, but the NOx emissions was as high as 42.8%. The population of light trucks accounted for 14%, and the NOx emissions reached 22.9%. Meanwhile, light trucks were main vehicles for $PM_{2.5}$ emissions, which contributed to 45.8%. From the perspective of emissions standards, the total emissions of the three pollutants (NO_x, CO, VOCs) from European 0, I and II standard vehicles exceeded 30%, although the total amount of vehicles accounted for just 16.1%. The results implied that controlling the population of light trucks and strengthening the control of the yellow-label car could help to improve air quality in Haizhu District.

KEYWORDS: Atmospheric pollution; Emission inventory; Source apportionment; On-road mobile source

Characteristics and sources apportionment of atmospheric particulates during the Spring Festival in a coastal city in China

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ABSTRACT

Particulate matter has become serious pollution in the atmosphere. Characteristics and sources of $PM_{2.5}$ and its components have been analyzed in Xiamem in this paper for the first time. The results show that fine particulate was dominant in TSP, and the percentage of each component in $PM_{2.5}$ followed the order OC > EC > WSIIs > trace elements and WSIIs > OC > EC > trace elements before and during the Spring Festival, respectively. OC, EC and SOC concentrations were lower during the Spring Festival than before the Spring Festival, suggesting that the fossil fuel combustion, the biomass burning and the secondary processes of carbonaceous aerosol decreased during the Spring Festival. SO_4^{2-}, NO_3^- and NH_4^+ were top three ions of the WSIIs, and the increase of K^+ and Mg^{2+} concentrations was related to the discharge of fireworks during the Spring Festival. Anions and cations maintained a good neutralization before the Spring Festival, whereas the aerosol was acidic during the Spring Festival because of the decrease of SO_4^{2-}, NO_3^- and Cl^-. Most trace elements concentrations decreased during the Spring Festival except V, Sr and Ba. The principal component analysis shows that trace elements were mainly from coal burning, traffic, heavy fuel oil combustion, metallurgical, industrial and mineral substance before the Spring Festival, whereas they were influenced by fireworks besides the above sources during the Spring Festival. The normalized patterns and characteristic parameters of REEs indicate that REEs were influenced by more complex sources during the Spring Festival. The backward air mass trajectory shows that combined effects of long-time transportation and local human activities on $PM_{2.5}$ concentrations.

Characteristics of the concentration and size distribution of the total microorganisms in bioaerosols in QingDao

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ABSTRACT

In order to study the changes of Concentration and size distribution of microbes in bioaerosols, bioaerosol samples were collected continuously in Qingdao from February to September in 2017. The bioaerosol samples were collected on sterilized polycarbonate membranes using a six-stage microorganism FA-1 cascade impactor sampler. The concentration of total airborne microbes were measured using an epifluorescence microscope after staining with DAPI (4′,6-diamidino-2-phenylindole). The results showed that the particle sizes of the total microbes presented a bimodal distribution, the highest peak appeared in the particle size of> 7μm, the secondary peak appeared in the particle size of 2.1-3.3μm, the lowest value appeared in the particle size of 0.65-1.1μm. In general, the concentration of total microbes on coarse particles (> 2.1 μm) was significantly higher than that of fine particles. The concentration of total microbes was 2.54×10^6 cells • m^{-3} on February 25, and the lowest value appeared on April 6, 3.8×10^5 cells • m^{-3}**.** The correlation analysis showed that the concentration of total microbes was weak negative correlation with temperature (r=-0.936,n=11,**p<0.05) during the sampling period. However，the concentration of total microbes showed no significant correlation with the meteorological factors，such as relative humidity， wind velocity and UV intensity during the sampling period. Moreover，there was no significant correlation of microbial activity with air quality factors，such as AQI，$PM_{2.5}$，PM_{10}，CO，NO_2，O_3 and SO_2. In general, under different meteorological conditions, the concentration and size distribution of the total microorganisms showed different distribution.

KEYWORDS: bioaerosol; total microbial concentration; Qingdao

Characteristics of complex air pollution in the typical cities of North China

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ABSTRACT

The Beijing-Tianjin-Hebei urban agglomeration was currently facing severe complex air pollution. In this paper, simultaneous observations conducted in 2014 showed that the annual mean concentrations of $PM_{2.5}$ were (84±70), (86±60) and (118±95) $\mu g \cdot m^{-3}$ in Beijing, Tianjin and Shijiazhuang, respectively. The mean $O_{3\_8h\ max}$ in the summer were (171 ± 43), (147 ± 45) and (146 ± 44) $\mu g \cdot m^{-3}$, respectively. This research indicates that the $PM_{2.5}$ and O_3 showed a positive correlation when the temperature exceeded 20°C, and the urban agglomeration showed the characteristics of complex air pollution consisting of superimposed ozone and fine particles. In summer, when the humidity was less than 55%, the secondary particles and ozone also increased in coordination (y=1.35x+29.85, R^2=0.61), which showed severe complex pollution. However, the mean $PM_{2.5}$ (y) and the mean $O_{3\_8h\ max}$ (x) in summer showed a negative correlation [y = -1.3x + 245(R^2=0.61)] in the three regions, indicating that high concentrations of $PM_{2.5}$ pollution partially inhibited ozone generation.

Chemical characteristics and spatial distribution of submicron aerosols in Zhejiang Province

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ABSTRACT

Aerosol pollution have significant influence on air quality and human health. The rapid economic development and urbanization in Yangtze River Delta of China over recent decades resulted in severe atmospheric pollution, which characterized by high concentrations of fine particles ($PM_{2.5}$). Previous studies mostly focused on the chemical compositions and seasonal variations of ambient aerosols in urban area. In this study, we performed online aerosol measurement field campaigns at eight suburban sites in Zhejiang Province during winter in 2017 (Yongjia site: YJ; Tiantai site: TT; Jinhua site: JH, Zhuji site: ZJ, Qiandaohu site: QDH, Shaoxing site: SX, Hangzhouwan site: HZW, Jiashan site: JS). Aerodyne aerosol chemical speciation monitors (ACSM) were utilized to characterize and compare the chemical compositions and spatial distributions of regional background non-refractory particle matter (NR-PM_1). The campaign-average atmospheric PM_1 concentration was approximately 37.2 ± 7.5 μg/m^3 at all sites in this study, with the highest concentration was found at JH (51.0 μg/m^3), followed by SX (44.4 μg/m^3), JS (40.8 μg/m^3), HZW (39.7 μg/m^3), YJ (31.5 μg/m^3), QDH (31.3 μg/m^3), ZJ (31.2 μg/m^3), while the minimal mean concentration appeared at TT (28.0 μg/m^3). Organic aerosol (29.8%-41.6%), sulfate (23.3%-32.7%), and nitrate (16.1%-28.4%) contributed the most to atmospheric PM_1 in Zhejiang, while ammonia and chloride totally accounted for 14%-19%. The result of correlation and diurnal variations analysis of PM_1 chemical compositions indicated that regional transmission made great contribution to heavy aerosol pollution in Zhejiang during winter. In addition, it is also essential to control locally emission and gaseous precursors simultaneously to reduce organic aerosols.

Chemical composition, source, and process of urban aerosols during winter haze formation in Northeast China

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ABSTRACT

The characteristics of aerosol particles have been poorly evaluated even though haze episodes frequently occur in winter in Northeast China. OC/EC analysis, ion chromatography, and transmission electron microscopy (TEM) were used to investigate the organic carbon (OC) and elemental carbon (EC), and soluble ions in $PM_{2.5}$ and the mixing state of individual particles during a severe wintertime haze episode in Northeast China. The organic matter (OM), NH_4^+, SO_4^{2-}, and NO_3^- concentrations in $PM_{2.5}$ were 89.5 μg/m^3, 24.2 μg/m^3, 28.1 μg/m^3, and 32.8 μg/m^3 on the haze days, respectively. TEM observations further showed that over 80% of the haze particles contained primary organic aerosols (POAs). Based on a comparison of the data obtained during the haze formation, we generate the following synthetic model of the process: (1) Stable synoptic meteorological conditions drove the haze formation. (2) The early stage of haze formation (light or moderate haze) was mainly caused by the enrichment of POAs from coal burning for household heating and cooking. (3) High levels of secondary organic aerosols (SOAs), sulfates, and nitrates formation via heterogeneous reactions together with POAs accumulation promoted to the evolution from light or moderate to severe haze. Compared to the severe haze episodes over the North China Plain, the $PM_{2.5}$ in Northeast China analyzed in the present study contained similar sulfate, higher SOA, and lower nitrate contents. Our results suggest that most of the POAs and secondary particles were likely related to emissions from coal-burning residential stoves in rural outskirts and small boilers in urban areas. The inefficient burning of coal for household heating and cooking should be monitored during wintertime in Northeast China.

KEYWORDS: Northeast China; haze; POAs; coal-burning residential stoves

Chemical characteristics of brown carbon aerosols at a suburban site near Guangzhou, China

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ABSTRACT

Light-absorbing organic carbon (or brown carbon, BrC) in aerosol particles has received much attention because of their potential roles in global radiative forcing. While there are a number of field measurements on the optical properties of BrC, their relationship with the chemical characteristics are not well understood. In the study, we present co-located real-time aerosol light absorption and chemical composition measurements to relate the chemical and optical characteristics of BrC at a suburban site downwind of Guangzhou, China from November to December 2014. BrC and black carbon (BC) concentrations were estimated using a seven-wavelength Aethalometer, while chemical compositions of non-refractory PM1 were measured by a high resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS). Using the Absorption Angstrom Exponent (AAE) method, BrC contributed 21.1% of the total aerosol absorption at 370 nm, 15.2% at 470 nm, 9.6% at 520 nm, 7.4% at 590 nm and 7.2% at 660 nm. Biomass burning organic aerosol (BBOA) and to a lesser extent, low-volatile oxygenated organic aerosol (LVOOA), are major contributors to BrC. The ratio of mass absorption coefficient of BBOA to that of LVOOA at 370 nm was 9, but it decreases to 2 at 600 nm, suggesting the need to incorporate wavelength dependent analysis of BrC components. Analysis of N containing ion fragments from HR-ToF-AMS show that ions with high degrees of unsaturation and oxygenation (CxHyOzN+ and CxHyON+) are better correlated with the increase of light absorption by BrC than CxHyN+ ions. Furthermore, CxHyOzN+ ions give larger correlation coefficients with BrC as the degree of oxidation increases. More detailed molecular characterization of the BrC chromophores is warranted.

KEYWORDS: Brown Carbon; AMS; AAE

Chemical composition influences the toxicological responses elicited by size-segregated urban air particulate matter

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ABSTRACT

Air quality events and high urban particulate matter (PM) levels are a major concern for human health. PM exposure is associated with increased cardiorespiratory morbidity and mortality. PM sources include industry, traffic, construction and biomass burning. In this study, we assess how the atmospheric processes and local emission sources cause variations in the chemical composition of inhalable PM from Nanjing, China, and how this affects the toxicological responses of exposed human alveolar epithelial cells.

Day- and nighttime size-segregated urban air PM was collected in Nanjing, China during August and October 2013. The PM samples underwent extensive chemical characterization and toxicological profiling using human alveolar epithelial cell line A549. The cells were exposed to four particle size ranges ($PM_{10-2.5}$, $PM_{2.5-1.0}$, $PM_{1.0-0.2}$ and $PM_{0.2}$) at five doses (25, 75, 150, 200, 300 µg/ml) for 24 hours. Thereafter cellular metabolic activity (CMA), cell membrane integrity, oxidative stress, genotoxicity, inflammatory response and cell cycle state were measured.

$PM_{10-2.5}$ elicited very high oxidative stress, genotoxicity and inflammatory responses. For $PM_{2.5-1.0}$, the changes in CMA, cell cycle, and inflammatory response were high. $PM_{1.0-0.2}$ caused elevated genotoxicity and inflammatory responses, and moderate changes to CMA and cell cycle. $PM_{0.2}$ elicited great changes to CMA, cell cycle and inflammatory responses. Metals, especially Ca and Al, were the dominant constituents of $PM_{10-2.5}$. The level of metals diminished in the smaller size-ranges, whereas sulfate and nitrate increased significantly. Polycyclic aromatic hydrocarbons (PAHs) were most abundant in $PM_{2.5-1.0}$ and $PM_{1.0-0.2}$. $PM_{0.2}$ contained very low amounts of oxygenated PAHs, whereas they were prominent in the other size ranges.

We observed significant variations in PM chemical composition and toxicological responses between sampling campaigns and day to night. Thus, the chemical composition is influenced by atmospheric processes and emission sources. In turn, the chemical composition of PM affects the elicited toxicological effects.

KEYWORDS: Inhalation toxicology; Particulates; Chemical composition

Comprehensive study on the atmospheric degradation of α-phellandrene: detailed mechanism development and SOA characterisation

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ABSTRACT

Current atmospheric models are limited in their representation of BVOC, and given that the global burden of emitted VOC is dominated by BVOC, this is a key area of research to improve our understanding of the interaction of BVOC in the polluted atmosphere and on global climate, in particular with their high reactivity and prompt particle formation. Detailed atmospheric studies have to date only been on conducted on relatively few BVOC (e.g. isoprene, pinenes, limonene, β-caryophyllene). This study is the first comprehensive (computational, experimental and modelling) investigation of α-phellandrene, a BVOC primarily emitted from the ubiquitous Eucalypt species.

The computational study revealed novel pathways in the ozonolysis mechanism; 1,6-hydrogen shift in Criegee intermediates and dioxirane isomerisation to epoxides. The suite of chamber experiments has shown α-phellandrene to be one of the most reactive BVOC studied that generates higher levels of SOA than other BVOC. The levels of SOA were supressed on addition of a Criegee radical scavenger, demonstrating the importance of O_3 reactions in SOA formation. Analysis of filters collected, showed highly functionalised condensed products, with mass signals corresponding to acretion and dimer formation. The data rich experiments enabled the development of a degradation mechanism, with many of the postulated degradation products corresponding with masses observed in the mass spectra.

A model incorporating the constructed mechanism, of 1187 species and 3601 reactions, was used to simulate the experiments. 458 species were explicitly modelled as potential SOA precursors, with further mechanism construction to represent the aerosol partitioning. The initial model results highlight issues with experiments conducted in different campaigns, showing further experiments are needed. However, they also reveal for the first time changing aerosol composition under different VOC/NOx ratios.

KEYWORDS: Atmospheric Chamber; BVOC, SOA; ozonolysis; photooxidation

Concurrent observations of air pollution in Beijing and Jinan: implication on air mass interactions in North China Plain

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ABSTRACT

An intensive field measurement of air pollutants was conducted simultaneously at an urban site in Beijing (BJ) and a corresponding urban site in Jinan, Shandong (SD) province between 20 July and 11 August 2017. Ambient volatile organic compounds (VOCs) and $PM_{2.5}$ (particulate matters with aerodynamic diameters less than 2.5 μm) samples were collected during the sampling campaign, in addition to the continuous measurement of trace gases, *i.e.* ozone (O_3), nitric oxide (NO) and nitrogen dioxide (NO_2). During the sampling period, five and four O_3 episodes (the days with maximum hourly average O_3 exceeded 100 ppbv were defined as O_3 episodes) out of ten sampling days were captured at BJ and SD, respectively. The average mixing ratios of O_3 at SD (50.27 ± 7.81 ppbv) was significantly (p<0.05) lower than that (92.19 ± 5.57 ppbv) at BJ. However, the total VOC level at BJ (29.7 ± 0.2 ppbv) was lower (p < 0.05) than that at SD (34.4 ± 0.2 ppbv). At both sites, ethene was the most abundant species among all VOCs, with the mixing ratio of 3.4 ± 1.3 ppbv and 4.5 ± 1.5 ppbv at BJ and SD, respectively. To identify the interactions of air pollution between BJ and SD, the HYSPLIT backward trajectory model was adopted to simulate the potential transport of air masses between these two sites. It was found that around 48% of air masses arriving at Beijing were originated from or passed over Shandong province 72 hours ago. This might indicate the transport of air masses laden with primary and/or secondary air pollutants from the south (including Shandong province) to Beijing. Further studies will find evidences from the perspective of chemical compositions of VOCs and PM, and quantify the contributions of regional transport to air pollution in Beijing.

KEYWORDS: VOCs; Ozone; Backward trajectory; Regional transport

Concentration, source and activity of cloud condensation nuclei over western North Pacific in 2014

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ABSTRACT

In this study, we investigated concentrations, sources, and variations activities of cloud condensation nuclei (CCN) over Western North Pacific from 22 March to 18 April in 2014. Concentrations of CCN were 0.70±0.38 (mean ± standard deviation) and 1.13±0.71 in unit of $\times 10^3$ cm^{-3} at SS of 0.2% and 0.4% respectively, and the corresponding CCN activities of atmospheric particles were 0.29±0.11 and 0.46±0.20. Concentrations of CCN and CCN activities varied greatly with different regions. In the first-stage region (28°N~30°N，143°E~150°E), concentrations of CCN were relatively lower and they were mainly contributed by vertical transmission of terrigenous aerosols above the mixing layer and sea-salt aerosols caused by wave breaking. CCN activities were relatively lower due to the particle size distribution dominanted by the Aitken mode. In the third-stage region (33°N~37°N，145°E~148°E), concentrations of CCN were relatively higher and they were mainly contributed by transmission of terrigenous aerosols above or under the mixing layer, sea-salt aerosols as well as the primary aerosols from biogenic emissions. CCN activities were relatively higher due to the particle size distribution dominanted by the accumulation mode.

KEYWORDS: CCN; CCN activities; particle size distribution; Western North Pacific

Constant energy synchronous fluorescence detection of polycyclic aromatic hydrocarbons from polluted air

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ABSTRACT

The polycyclic aromatic hydrocarbons (PAHs) in the atmosphere are mainly derived from the incomplete combustion of organic matter such as fossil fuels, wood, tobacco and plastics. It is a persistent organic pollutant with mutagenic, carcinogenic and teratogenic effects and widely present in polluted air. And it is a serious threat to human health. In this paper, 14 kinds of PAHs in atmospheric particulates were qualitatively and quantitatively analyzed by constant energy synchronous fluorescence method combined with second order derivative constant energy synchronous spectroscopy. The developed method saves time and reagents, and has the advantages of reduced spectrum, reduced band overlap, simple sample processing method and so on. The constant energy synchronous fluorescence spectra and second - order constant energy characteristic spectra of each PAHs were established under different energy difference conditions, and the characteristic peak position was analyzed qualitatively. The quantitative analysis was carried out according to the standard equation. In a smoke chamber, the formation and decomposition of PAHs derived from exhaust gas of gasoline and/or diesel fuel combustion were researched. In the out-filed of Lanzhou, the source and transfer characteristics and mechanisms of PAHs in petrochemical enterprises, airport zone and vehicle exhaust gas along highway in the internal urban were investigated. The relationships between PAHs in polluted air and free radicals were also researched.

KEYWORDS: Atmospheric particles; Constant energy fluorescence; Polycyclic aromatic hydrocarbons; Polluted air; Source and sink

Characterization of NMHCs and their sources apportionment in Baoding, Hebei province

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ABSTRACT

Non-methane hydrocarbons (NMHCs) play an important role in the photochemical production of ozone (O_3) and secondary organic aerosols(SOA). Obtaining an accurate understanding on characterization and emissions of NMHCs is essential for predicting air quality changes and evaluating the effectiveness of current control measures. In this study, we observed NMHCs during September in Baoding based on online GC/MS-FID. The monitoring data showed that the sum of 57 measured VOCs (TVOCs) ranged from 3.50 to 168.75ppbv. The average mass concentrations of TVOCs were（43.85 ± 27.42）ppbv during the sampling period, including Alkanes (12.09 ± 9.76) ppbv, Alkenes (6.47±3.62) ppbv, Aromatics (22.91 ± 13.93) ppbv and Acetylene (2.38±1.47) ppbv, respectively. Alkanes and Aromatics were the most abundant VOCs species in atmospheric environment in Baoding. Some VOC species, such as Ethane Propane, Butane, Pentane, Benzene and m/p-Xylene had abnormally high values, which were possibly related to the local emissions. Positive matrix factorization model (PMF) will be used for further VOCs data analysis to identify the main sources.

KEYWORDS: Baoding; Volatile organic compounds (VOCs); Source apportionment; PMF

Comparison of secondary organic aerosol formation from toluene on initially wet or dry ammonium sulfate particles

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ABSTRACT

The formation of secondary organic aerosol (SOA) has been widely studied in the presence of dry seed particles at low relative humidity (RH). At higher RH, seed particles can exist as dry or wet particles. Here, we investigated the formation of SOA from the photooxidation of toluene using an oxidation flow reactor under a range of OH exposures on initially wet or dry ammonium sulfate (AS) seed particles at a relative humidity (RH) of 68%. At a low OH exposure of 4.66×10^{10} molecules cm^{-3} s, the ratio of the SOA yield on wet AS seeds to that on dry AS seeds was 1.31±0.02. However, this ratio decreased to 1.01±0.01 at an OH exposure of 5.28×10^{11} molecules cm^{-3} s. The decrease in the ratios of SOA yields may be due to the early deliquescence of initially dry AS seeds after coated by toluene-derived SOA. Initially wet AS seeds resulted in a higher oxidation state of the SOA than dry AS seeds did, likely due to the enhanced uptake of earlier-generation products containing carbonyl functional groups at low OH exposures and later-generation products containing acidic functional groups at high exposures. Our results suggest that the role of water uptake by SOA on the inorganic aerosols as well as the influence of initial physical state of seed aerosols on SOA formation should be considered in atmospheric models.

KEYWORDS: Secondary organic aerosol (SOA); toluene; phase state; ammonium sulfate

Characteristics of typical construction machinery exhaust emission in Sichuan

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ABSTRACT

According to the distribution of engineering machinery in sichuan province in 2015,13 typical engineering machinery, including excavators, forklifts, bulldozers, loaders, were selected to carry out the exhaust emission test study with portable emissions measurement system(PEMS),the test conditions include idle, walking and working, and the emission factors based on fuel consumption of PM, NO_x, CO and THC were obtained,the results showed that: (1) The emission factor of NOx and THC were higher in idle and walking conditions than in working condition,but the emission factor of PM were higher in working condition than in idle and walking conditions;(2)It was found that the emission factors of PM, CO, NOX and THC of stage 2 were significantly reduced in 3 test conditions;(3)A comprehensive emission factor was obtained by weighted average different working conditions,PM is about 0.36g/kg-26.26g/kg, NO_x is about 7.27g/kg-80.49 g/kg, THC is about 9.15g/kg-162.53 g/kg, CO is about 18.89g/kg-379.59g/kg, and the type,rate of work, utility time and executive standard have a significant influence on emission factor.

KEYWORDS: construction machinery; emission factor; actual measurement; test condition

Characteristics of radiation of China's three major economic regions and its relationship with O_3 and $PM_{2.5}$ in the past 10 years

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ABSTRACT

Based on the daily radiation datasets from 2007 to 2016 from the ground meteorological observation stations and the daily observation data from 2014 to 2016 from China's air quality online monitoring platform, the paper analyzes the annual and seasonal variations of global solar radiation(GSR) in recent 10 years and the monthly variation of GSR, the maximum 8 hour average ozone($O_{3\_8h\_max}$) and fine particles($PM_{2.5}$) in recent 3 years in Beijing-Tianjin-Hebei(BTH),the Yangtze River Delta(YRD) and the Pearl River Delta(PRD). The relationship among $PM_{2.5}$, $O_{3\_8h\_max}$ and GSR by the classification statistics of different factors and intensity grades are discussed. The results show that:(1) GSR in BTH has increased significantly in recent 10 years, Spring GSR in BTH and summer GSR in PRD have increased significantly meanwhile;(2) The annual frequency of $PM_{2.5}$ pollution process in the three major economic regions has been decreasing year by year, and decreasing from north to south. The annual frequency of O_3 pollution process has decreased first and then increased temporally, which in BTH is more than in YRD and PRD spatially; (3) The correlation coefficients between $O_{3\_8h\_max}$ and GSR in the three economic regions are all above 0.71, and which means a strong positive correlation.(4)The linear fitting effect of $O_{3\_8h\_max}$ and $PM_{2.5}$ under different GSR in the three economic regions is generally bad, and only shows a better positive correlation when GSR is more than 22MJ*m^{-2} in BTH and PRD. The linear fitting effect of $O_{3\_8h\_max}$ and GSR under different $PM_{2.5}$ concentrations in the three economic regions is good, reflecting a strong positive correlation. The goodness of fit reaches maximum and the correlation coefficient improves significantly when $PM_{2.5}$ concentration is more than 75 μg*m^{-3}. The tendency of the line fitting increases with the increase of $PM_{2.5}$ interval.

KEYWORDS: Global solar radiation(GSR); O_3; $PM_{2.5}$; Relationship; China's three major economic regions

Characteristics of $PM_{2.5}$ concentration and its relations with meteorological factors in typical cities of the Yangtze River Delta

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ABSTRACT

Based on the observational data of $PM_{2.5}$ mass concentration and meteorological elements from MICAPS data in Nanjing, Shanghai, Hangzhou and Hefei, four typical cities over the Yangtze River Delta region, from April 1, 2014 to March 31, 2015, the variation of $PM_{2.5}$ concentration and its relationship with meteorological factors were analyzed and discussed. The results showed that: The total standard-reaching rate of $PM_{2.5}$ concentration in the Yangtze River Delta was the highest in summer, and the lowest in winter. In four cities, Shanghai had the highest rate for the whole year, followed by Hangzhou and the lowest in Hefei. The monthly variation characteristics of $PM_{2.5}$ standard-reaching rate in Shanghai and Hangzhou were similar, and Nanjing and Hefei were similar. The diurnal variation curve of $PM_{2.5}$ showed a two-peak and one-grain distribution. The maximum values appeared in the morning and the lowest values appeared between 16 and 17 pm; The monthly averaged concentration had obvious seasonal variation characteristics, the highest value in winter, and the lowest in summer; $PM_{2.5}$ concentration was negatively correlated with wind speed and was affected by the wind direction. Pollutants can diffuse from the upstream pollution source to the downwind area under the dominant wind direction; There was a negative correlation between $PM_{2.5}$ mass concentration and temperature; $PM_{2.5}$ concentration in the Yangtze River Delta was negatively correlated with the relative humidity during the whole year, and the high humidity was more favorable for precipitation, which caused $PM_{2.5}$ wet deposition; The correlation between $PM_{2.5}$ concentration and pressure in each city was very weak, and the significance test was not passed. It can be seen that pressure was a minor factor affecting $PM_{2.5}$ concentration. Precipitation had obvious scavenging effect on $PM_{2.5}$. The variation of $PM_{2.5}$ in different cities and the influences of meteorological factors were also different. It was mainly caused by the geographical environment, industrial distribution and emission sources of different cities.

KEYWORDS: $PM_{2.5}$ concentration; variation characteristics; meteorological factors; Yangtze River Delta

Decrease of real-world vehicular VOC emissions in Hong Kong from 2003 to 2015: a tunnel study

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ABSTRACT

Vehicular emissions are one of major anthropogenic sources of ambient volatile organic compounds (VOCs) in Hong Kong. During the past twelve years, the government of the Hong Kong Special Administrative Region has undertaken a series of air pollution control measures to reduce vehicular emissions in Hong Kong. Vehicular emissions were characterized by repeated measurement in the same roadway tunnel in 2003 and 2015. The total net concentration of measured VOCs decreased by 44.7% from 2003 to 2015. The fleet-average VOC emission factor decreased from 107.1 ± 44.8 mg veh^{-1} km^{-1} in 2003 to 58.8 ± 50.7 mg veh^{-1} km^{-1} in 2015. The emission factor of ethene, which is one of the key tracers for diesel vehicular emissions, decreased by 67.3% from 2003 to 2015 as a result of the strict control measures on diesel vehicular emissions. Even though n-butane, i-butane, propane, and i-pentane had the highest EF_{NDV} in 2015, EF_{NDV} of n-butane, i-butane, propane, and i-pentane decreased by 62.3%, 60.6%, 78.4%, and 61.0%, respectively, from 2003 to 2015. Ethene had the highest EF_{DV} (25.70 ± 2.62 mg veh^{-1} km^{-1}) in 2003, but the EF_{DV} of ethene has been decreased by 76.8% in 2015. The contributions by VOC groups to total OFP were different in 2003 and 2015 with the large decrease of alkenes' contribution from 53.7% in 2003 to 45.1% in 2015. However, alkenes and hydrocarbon aromatics were always the two major contributors to total OFP from vehicular emissions in Hong Kong in both 2003 and 2015. The large decrease of VOC emissions from on-road vehicles demonstrates the effectiveness of past multi-vehicular emission control strategy in Hong Kong.

KEYWORDS: VOCs; vehicular emission; tunnel

Developmental cardiotoxic effects of ambient $PM_{2.5}$ on mouse P_{19} embryonic carcinoma stem cells mediated by AhR and Wnt signal pathways

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ABSTRACT

It is well-established that exposure to ambient fine particulate matter ($PM_{2.5}$) adversely affects cardiac functions in humans; however the influence of these particles on embryonic development remains to be determined. The aim of this study was thus to investigate the molecular mechanisms underlying $PM_{2.5}$ on cardiac development using P19 mouse embryonic carcinoma stem cell line. Extractable organic matter (EOM) was extracted from $PM_{2.5}$ and added into the culture medium of P19 cells. Results showed that EOM at concentrations of 10μg /ml or less did not induce marked cytotoxicity on P19 cells using MTT assay. However, P19 cells treated with EOM at 10μg /ml for 2 days significantly reduced both cardiac muscle troponin (cTnT) positive cells and spontaneously beating embryoid bodies, indicating an inhibition of cardiac differentiation. Immunofluorescence and qPCR data demonstrated that EOM increased expression of aryl hydrocarbon receptor (AhR) and its target gene Cyp1a1 and diminished the expression levels of mRNA and protein of β-catenin. Furthermore, $PM_{2.5}$ treatment significantly elevated the number of γH2A.X fluorescent stained positive cells indicative of DNA double strand breaks (DSB). Cell proliferation was also markedly increased following EOM exposure. Addition of AhR antagonist (CH223191) or Wnt activator (CHIR99021) was found to protect against EOM induced effects on AhR and β-catenin gene expression, cellular proliferation and DNA DSB. It is noteworthy that EOM did not markedly alter apoptosis. In conclusion, our data showed that the $PM_{2.5}$ induced adverse effects on cardiac development may be mediated via AhR and Wnt signaling pathway which are postulated to be associated with cardiomyocyte differentiation.

KEYWORDS: $PM_{2.5}$; cell cycle; DNA damages; AhR; Wnt; cardiac toxicity

Determination of volatile fatty acids in ambient air by gas chromatography-mass spectrometry

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ABSTRACT:

volatile fatty acids (VFAS) are a classs of odour polltants with very low sensory thresholds and potential adverse health effects, which will be probably listed in the new "Emission stantards for odor pollutants" of China. We have developed a smiple, rapid and sensitive method to determine C_2-C_5 VFAS in ambient air by gas chromatography with a mass selective detector in the selected ion monitoring mode preceding by adsorption by a comercial sodium carobonate-impregnated slica gel tube, desorption by pure water and partitioned by methyl tert-butyl ether (MTBE). To avoid time-consuming derivatisation preocess, a water-resistant free fatty acid phase capillary column was used to directly separate C_2-C_5 VFAs. The limits of detection ranged from 0.05 μg/m^3 to 1.67 μg/m^3. Using this method, all VFAs in blank spiked and actual ambient samples can be quantified with good repeatability and excellent recovery. This method will readliy meet the needs of relevant environmental protection standards for VFAs.

KEYWORDS: volatile fatty acids (VFAS); GC-MS; selected ion monitoring (SIM); methyl tert-butyl ether (MTBE); air

Detection and field measurement of acidic ultrafine particles based on standard acidic ultrafine particle generation system

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ABSTRACT

Acidic ultrafine particles (AUFPs) are ubiquitous in the atmosphere with significantly adverse implication to human health, visibility, and climate. However, no reliable measurement techniques are able to assess the existence of AUFPs and quantify the number concentration of AUFPs currently. In this study, our aim is to certify the existence of AUFPs in the ambient air and obtain the number concentration of AUFPs with the use of nano-iron film detectors and diffusion sampler (DS). Standard sulfuric acid (H_2SO_4)-coated particles were generated using the Standard Acidic Particles Generation (SAPG) system and deposited on the surface of nano-iron film detectors to generate reaction spots. The reaction spots, obviously different from those caused by non-acidic particles, were scanned using the Atomic Force Microscope (AFM) so as to obtain shapes and sizes of the acidic particles. To conduct field measurement, the nano-iron film detectors were deployed inside the DS at three different locations in a flat and rectangular channel to collect the ultrafine particles. The detectors were then scanned by the AFM to numerate and distinguish the acidic particles from the non-acidic particles according to the reaction spots. Based on the semi-empirical equation for the collection efficiency of particles at three different locations in the DS, the number concentrations of acidic particles and non-acidic particles were both quantified from AFM images. To validate this method, a field measurement was conducted from Jan 06 to Feb 19, 2017, on the rooftop of a 12-storey building (~36m height) on campus, and in total four sets of samples were collected and scanned. The results indicated that the method was a reliable tool for the measurement of AUFPs in the atmosphere.

KEYWORDS: Acidic ultrafine particles (AUFPs); Detection; Nano-iron film detector; Standard Acidic Particles Generation (SAPG) system; Diffusion sampler (DS)

Development of emissions inventory for energy production in Turkey

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ABSTRACT

The main purpose of this study is developing emission factors for electricity and heat production sector of Turkey with focus on Marmara Region of Turkey. According to Turkish Statistical Institute, Marmara Region is responsible from 31% of the produced electricity in Turkey. Unlike previous studies, not only public electricity and heat production plants were included, but also private sectors industrial energy production plants were considered, finally 123 plants from eleven cities were included.

The study is divided into two parts. The purpose of the first part is development of emission factors of the energy production industry of Turkey for SO_2, NO_x, CO, TSP and VOCs via stack measurements using well established and validated protocols. Totally 29 plants with 113 stacks were considered. Probabilistic analysis was conducted for emission factors by using facility level data. Generated emission factors were compared to literature values.

In the second part, emission inventory was compiled for electricity production sector of Marmara Region, which is the most industrialized region of Turkey. Inventory of SO_2, NO_x, CO, VOCs, PM_{10}, $PM_{2.5}$, BC, PAHs and POPs emissions were calculated. Benzo(a)pyrene, Benzo(n)(b)fluoranthene, Benzo(n)(k)fluoranthene, Indeno(1,2,3-cd) pyrene were considered as polycyclic aromatic hydrocarbons from energy industries where HCB, PCBs, PCDD and PCDF were considered under persistent organic pollutants. Uncertainty of the overall emission inventory was also quantified. Finally, emissions were mapped on pollutant basis and compared with former studies.

KEYWORDS: Emission factor; emission inventory; public electricity and heat production; Turkey, distribution fit; air pollution; uncertainty; primary pollutants

Diurnal and day-to-day characteristics of ambient particle mass size distributions from HR-ToF-AMS measurements at an urban site and a suburban site in Hong Kong

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ABSTRACT

Mass concentration based particle size distributions measured by a high-resolution aerosol mass spectrometer were systematically analyzed to assess long and short-term temporal characteristics of ambient particle size distributions sampled at a typical urban environment close to emission sources and a suburban coastal site representing a regional and local pollution receptor location in Hong Kong. Measured distributions were deconvoluted into submodes, which were analyzed for day-to-day variations and diurnal variations.

Traffic and cooking emissions at the urban site contributed substantially to particle mass in both modes, while notable decreases in mass median diameters were limited to the morning rush hour. Inorganic particle components displayed varying diurnal behavior, including nocturnal nitrate formation and daytime photochemical formation evident in both modes. Suburban particle size distributions exhibited notable seasonal disparities with differing influence of local formation, particularly in spring and summer, and transport, which dominated in the fall season leading to notably higher sulfate and organic accumulation mode particle concentrations. Variations in particle mixing state were evaluated by comparison of inter-species mass median diameter trends at both measurement sites. Internal mixing was prevalent in the accumulation mode in spring at the urban site, while greater frequency of time periods with external mixing of particle populations comprising different fractions of organic constituents was observed in summer. At the suburban site, sulfate and nitrate in the accumulation mode more frequently exhibited differing particle size distributions in all seasons signifying a greater extent of external mixing.

KEYWORDS: Aerosol mass spectrometry; particle size distributions; ambient $PM_{2.5}$ characterization

Does emission reduction activity dominant the variations of $PM_{2.5}$ concentrations in China during 2013—2017

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ABSTRACT

Fine particulate matter ($PM_{2.5}$) plays a key role in the atmospheric pollution in China. In order to decrease the $PM_{2.5}$ concentration and improve the air quality the Chinese government released a series of environmental policies since 2013. The monitoring data in China show a decrease trend from 2013 to 2016, with the national mean $PM_{2.5}$ concentrations decreased from 69.4±59.2 μg m^{-3} in 2013 to 48.9±32.9 μg m^{-3} in 2016. In this study, we investigate the dominant factor, i.e., the environmental policies induced emission reduction activities (ERA) or weather condition changes (WCC) for this $PM_{2.5}$ decrease by using the WRF-CMAQ model. The Multi-resolution Emission Inventory for China (MEIC) for 2012 was used for anthropogenic emissions and we assume that there was no change happened during 2013-2017. Biogenic emissions are generated using the Model for Emissions of Gases and Aerosols from Nature (MEGAN) model, which was driven by the WRF model. Evaluations show that the model successfully reproduces the weather conditions during 2013—2016, and the $PM_{2.5}$ concentration fields in 2013.

From 2013 to 2016, the observed national mean $PM_{2.5}$ concentrations were reduced by 29.5%, with annual reduction rates of 11.7%, 12.3% and 9.1% during 2013—2014, 2014—2015, and 2015—2016, respectively. Compared to observations, the simulated national mean $PM_{2.5}$ concentrations were reduced from 69.4 μg m^{-3} in 2013 to 61.0 μg m^{-3} in 2016 (i.e., 8.4%), with annual rates of 5.7%, 2.7%, and 4.2%, respectively. It indicate that the contribution of ERA (21.1%) to the decreasing of $PM_{2.5}$ is much greater than that of WCC (8.4%). In other words, view the satiation as a whole, the ERA dominant the variations of $PM_{2.5}$ concentrations in China during 2013—2017. For different areas, the satiations were different. For the most concerned and most polluted area of BTH, the WCC made the $PM_{2.5}$ decrease by about 3.0% every year, but actually, the $PM_{2.5}$ concentration in 2014 was basically the same as that of 2013, this means that in BTH, the emissions still keep increasing from 2013 to 2014, and the ERA was not significant. The benefits from ERA started from 2015, and became much higher than the WCC. In YRD, the actual $PM_{2.5}$ concentrations decreased by 24.5% from 2013 to 2016, in which the WCC only contributed by 2.2%. The paper give a full insight into the role of ERA and WCC on the variations of $PM_{2.5}$ concentrations in recent years, and the results show that the environmental policies are very fruitful.

KEYWORDS: $PM_{2.5}$; Air quality; Emission reduction activity; Weather condition change

Dual effects of the winter monsoon on haze-fog variations in eastern China

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ABSTRACT

Previous studies have revealed a negative correlation between the East Asian winter monsoon and wintertime haze-fog events in China. The winter monsoon reduces haze-fog by advecting away aerosol particles and supplying clean air through cold waves. However, it is found that the frequency of haze-fog events on subseasonal time scales displays no correlation with typical winter monsoon indices. The results show that the accumulating and maintaining effects of calm weather related to the Siberian High, which is also a part of the monsoon circulation system, are equally important for the development of haze-fog events during winter. Correlation analysis indicates that subseasonal variations in haze-fog are closely related to the intensity of the Siberian High (r=0.49). The Siberian High may increase the occurrence of haze-fog events by reducing the near surface wind speed and enhancing the stratification stability. To quantify the contribution of these diverse effects of the winter monsoon on the variations in haze-fog events, we analyzed haze-fog events during periods of cold wave activity and calm weather separately and contrasted the relative contributions of these two effects on different time scales. On the subseasonal scale, the effect of the Siberian High was 2.0 times that of cold waves; on the interannual scale, the effect of cold waves was 2.4 times that of the Siberian High. This study reveals the dual effects of the East Asian winter monsoon on wintertime haze-fog variations in eastern China and provides a more comprehensive understanding of the relationship between the monsoon and haze-fog events.

Effect of ecological restoration programs on dust pollution in North China Plain, China

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ABSTRACT

In recent years, Chinese government has taken great efforts in initiating large-scale ecological restoration programs (ERPs) to reduce the dust pollutions in China. Using a satellite measurement product of Moderate Resolution Imaging Spectroradiometer (MODIS), the changes in land cover are quantitatively evaluated in this study. We find that grass and forest are increased in berried lands and deserts in northwestern China, which locate in the upwind regions of the populated areas of the North China Plain (NCP) in eastern China. To assess the effect of ERPs on dust pollutions, a regional transport/dust model (WRF-DUST, Weather Research and Forecast model with dust) is applied to investigate the evolution of dust pollutions during a strong dust episode. The calculations are intensively evaluated by comparing with the measured data. Despite some model biases, the WRF-DUST model well captures the spatial variations and temporal evolutions of the dust storm event. The impacts of EPRs induced land cover changes on the dust pollutions in NCP are quantitatively assessed using the WRF-DUST model. We find that the ERPs significantly reduce the dust pollutions in NCP, especially in the heart area of NCP (BTH, Beijing-Tianjin-Hebei). Because the air pollution is severe in eastern China, especially in NCP, the reduction of dust pollutions has important effects on the severe air pollutions. This study shows that ERPs help to reduce air pollutions in the region, especially in springtime, suggesting the important contributions of ERPs to the air pollution control in China.

Effect of mid-latitude cyclone frequency on fine particulate matter ($PM_{2.5}$) in Hong Kong and implications for $PM_{2.5}$ to climate change

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ABSTRACT

We applied extended empirical orthogonal function (EEOF) analysis on v wind component at 850 hPa in China to extract phase and amplitude information of mid-latitude cyclone. V wind data from NCEP/NCAR Reanalysis 1 in 2011-2012 winter and 2012-2013 winter were used in this study. A band-pass filter (2-15 days) was applied to v wind data before EEOF analysis which allows us to focus on synoptic scale variability. EEOF analysis shows that the first two dominant modes in each winter can explain about 40% of v wind variability in Southern China and represents a southward propagation signal. We further checked the phase time series of the propagation signal with corresponding weather maps, and it reveals that the propagation signal represents the passage of mid-latitude cyclone in Southern China. However, the frequencies of mid-latitude cyclone in two winters were quite different (8 days in 2011-2012 while 4 days in 2012-2013). Ground observation data of $PM_{2.5}$ concentration in Hong Kong shows that high frequency year has less mean concentration and less variation as mid-latitude cyclone comes more often to blow them away. As mid-latitude frequency is related to temperature gradient between tropical and polar region and the climate change tends to reduce the temperature gradient, our results demonstrate a possible effect of climate change on $PM_{2.5}$ concentration: a likely decrease in cyclone frequency implying an increase in $PM_{2.5}$ concentration.

KEYWORDS: air quality; $PM_{2.5}$; EOF analysis; mid-latitude cyclone; climate change

Effects of prenatal exposure to air pollution on preeclampsia in Shenzhen, China

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ABSTRACT

The impact of ambient air pollution on pregnant women concerns in China. However, little is known about the association between air pollution and preeclampsia; and that the modifying effects of meteorological conditions have not been assessed. This study aimed to assess risk effects of prenatal exposure to air pollution on preeclampsia, and to explore whether temperature and humidity modify the effects. We conducted a case-control study based on 1.17 million singleton births identified from birth registration system in Shenzhen, China, between 2005 and 2012. A total of 13,366 cases and 1,151,819 controls were identified. Daily average measurements of particulate matter <10 μm (PM_{10}), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), air temperature (T), and dew point (T_d) were collected. Logistic regression models were performed to estimate associations between air pollution and preeclampsia during the first and second trimesters, and during the entire pregnancy. In each time window, we observed a positive gradient of increasing preeclampsia risk with quartiles of PM_{10} and SO_2 exposure. When stratified by T and T_d categories ($<5^{th}$, 5^{th} -95^{th}, and $>95^{th}$ percentile), we found positive associations between preeclampsia and PM_{10}, SO_2 exposure that were solely apparent under extreme meteorological conditions. During the entire pregnancy, preeclampsia risk increased by 22% (95%CI: 19-25%) under $T<5^{th}$ percentile, 20% (17-23%) under $T_d<5^{th}$ percentile, and 26% (12-42%) under $T_d>95^{th}$ percentile per interquartile range (IQR) increment of PM_{10}. For SO_2 exposure, risk increased by 28% (25-32%), 26% (22-29%) and 16% (6-26%), respectively. This is the first study to address modifying effects of meteorological factors on association between air pollution and preeclampsia. Findings indicate that prenatal exposure to PM_{10} and SO_2 increase preeclampsia risk in Shenzhen, China, and the effects could be modified by air temperature and humidity. Pregnant women should limit air pollution exposure, particularly on extremely cold, dry and humid days.

KEYWORDS: Preeclampsia; Air pollution; Temperature; Humidity; Modification

Effects of plant-atmosphere interactions on ozone air quality under climate change

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ABSTRACT

Plant physiological functions such as photosynthesis, stomatal activity and terpenoid production play an important role in shaping the Earth's atmosphere. Changes in plant physiology in response to future warming, rising CO_2 and tropospheric ozone levels would therefore interfere with land-atmosphere exchange processes (e.g., evapotranspiration, dry deposition, isoprene emission), with ramifications for air quality. Here we develop and integrate several parameterization schemes for CO_2-ozone-vegetation coupling into the GEOS-Chem chemical transport model to examine how rising CO_2 and ozone damage on vegetation would influence ozone air quality via various pathways. We find that elevated CO_2 for year 2050 under the RCP8.5 scenario can significantly suppress isoprene emission (due to the CO_2 inhibition effect) and thus reduce surface ozone by up to 6 ppb, but can also reduce dry deposition velocity (due to reduced stomatal conductance) and thus increase surface ozone by up to 6 ppb. The effect of enhanced leaf area index (LAI) (due to CO_2 fertilization) is much smaller. The combined effect of elevated CO_2 via all three pathways is in the range of -1 to +4 ppb, reflecting compensating effects. On the other hand, ozone-induced damage on LAI can lead to an ozone feedback of -1 to +3 ppb, also reflecting compensating effects of reduced dry deposition and isoprene emission. Another model experiment using the Community Earth System Model further shows that simultaneously changing surface temperature arising from ozone-induced reduction in transpiration can further enhance ozone level by up to 6 ppb in total. These changes in surface ozone are comparable in magnitude with the effects of climate and land use changes per se. We therefore suggest that plant physiological changes arising from climatic and atmospheric ccompositional changes are important factors that should be accounted for in historical simulations and future projections of air quality, with ramifications for sustainable, integrated air quality, forest and agricultural management.

Effective radiative forcing and climate response due to short-lived climate pollutants under different scenarios

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ABSTRACT

An aerosol-climate online coupled model system BCC_AGCM2.0_CUACE/Aero, combined with the Representative Concentration Pathways (RCPs), was used to simulate the effective radiative forcing (ERF) and climate responses due to the change in the concentration of short-lived climatic pollutants (SLCPs), including methane, tropospheric ozone, and black carbon, from the year of 2010 to 2050 under different emission scenarios (RCP8.5, RCP4.5 and RCP2.6). It is indicated in our work that the global mean ERF will increase 0.12 W m^{-2} due to the change of SLCPs during the year of 2010 to 2050 under RCP8.5, which will lead to large increasing of surface temperature in the middle to high latitudes of Northern Hemisphere (NH). The precipitation will generally increase in the most areas between 60°N and 60°S, but decrease obviously in the Indian Peninsula and equatorial Pacific. The increased SLCPs will cause an increase in global mean temperature of 0.13 K and precipitation of 0.02 mm d^{-1}. Under RCP8.5, the global mean cloud cover will be almost unchanged, but some regional cloud cover will be affected obviously. The low cloud cover will be increased more than 1.0% in the high latitudes of NH and middle latitudes of Southern Hemisphere, and the high cloud covers will be increased more than 1.2% over the Mediterranean, South Pacific and North America. Under RCP4.5 and RCP2.6, the concentration reduction of SLCPs will cause a decrease in the global mean ERF by 0.29 W m^{-2} and 0.53 W m^{-2}, respectively. The surface temperature will be deceased in most areas of the globe, especially in northern Eurasia and North America. The global mean surface temperature will be reduced by 0.20 K and 0.44 K under RCP4.5 and RCP2.6, respectively. In most parts of the continents, the precipitation will have slight increases due to the reduction of SLCPs concentration; whereas in the tropic, the precipitation will have significant changes (from about -0.6 to 0.4 mm d^{-1}). The decreasing of SLCP concentration will lead to the southward movement of ITCZ. Under RCP4.5 and RCP2.6, the changes of SLCPs will cause the global average precipitation to reduce 0.02 mm d^{-1} and 0.03 mm d^{-1}, respectively. The global mean of low cloud cover will be almost unchanged as the same as RCP8.5, but the low cloud covers over East Asia will increase obviously. The high cloud covers will generally increase over northern Africa and southwestern Pacific. Under RCP4.5 and RCP2.6, the global average high cloud covers will increase by 0.2% and 0.3%, respectively.

Electrospray-surface enhanced raman spectroscopy (ES-SERS) of individual aerosol particles

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ABSTRACT

We present electrospray-surface enhanced Raman spectroscopy (ES-SERS)[1] as an analytical tool. ES-SERS has the potential to measure the surface chemical compositions of atmospherically relevant particles. The surface-sensitive SERS is realized by electrospraying Ag nanoparticle aerosols over analyte particles. Spectral features at *v*(SO42−), *v*(C-H) and *v*(O-H) modes were observed from the normal Raman and SERS measurements of laboratory-generated supermicron particles of ammonium sulfate (AS), AS mixed with succinic acid (AS/SA) and AS mixed with sucrose (AS/sucrose). SERS measurements showed strong interaction (or chemisorption) between Ag nanoparticles and surface aqueous sulfate [SO_4^{2-}] with $[SO_4^{2-}]_{AS/sucrose} > [SO_4^{2-}]_{AS/SA} > [SO_4^{2-}]_{AS}$. Enhanced spectra of the solid AS and AS/SA particles revealed the formation of surface-adsorbed water on their surfaces at 60 % relative humidity. These observations of surface aqueous sulfate and adsorbed water demonstrate a possible role of surface-adsorbed water in facilitating the dissolution of sulfate from the bulk phase into its water layer(s). Submicron ambient aerosol particles collected in Hong Kong exhibited non-enhanced features of black carbon and enhanced features of sulfate and organic matter (carbonyl group), indicating an enrichment of sulfate and organic matter on the particle surface.

KEYWORDS: SERS; Raman spectroscopy; Surface chemical compositions; Surface SO_4^{2-}; Surface-adsorbed water

Emission characteristics of heavy metals and their behavior during coke production in China

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ABSTRACT

Besides organic pollutants, coke production generates emissions of toxic heavy metals. However, intensive studies on heavy metals emission from coking industry are still very scarce. The current work focuses on assessing the emission characteristics of heavy metals and their behavior during coking. Simultaneous sampling of coal, coke, residues from air pollution control devices (APCD), effluent from coke quenching, and fly ash from different processes before and after APCD has been performed. The total heavy metal concentration in the flue gas from coke pushing (CP) was significantly higher than that from coal charging (CC) and combustion of coke oven gases (CG). Emission factors of heavy metals for CP and CC was 378.692 and 42.783 μg/kg, respectively. During coking, the heavy metals which were contained in the feedstock coal showed different partitioning patterns. For example, Cu, Zn, As, Pb and Cr were obviously concentrated in the inlet fly ash compared to the coke, among which Cu, As and Cr were concentrated in the outlet fly ash, whereas Zn and Pb were distributed equally between the outlet fly ash and APCD residue. Ni, Co, Cd, Fe and V were partitioned equally between the inlet fly ash and the coke. Understanding the behavior of heavy metals during coking processes is helpful to the effective control of these heavy metals and assessing the potential impact of their emissions on the environment.

KEYWORDS: Coking; Heavy metals; Shanxi

Emission factors and characteristics of size distributions for carbonaceous particulate matter from residential coal combustion in China

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ABSTRACT

China is thought to be the most important contributor to the global burden of carbonaceous aerosols, and residential coal combustion is the greatest emission source of black carbon (BC). Uncertainty in the emission factors (EFs) usually contributes largely to the overall uncertainty in the emission inventory. In the present study, based on domestic burning tests and a dilution sampling system, size-segretated particles emitted from burning of three kinds of honeycomb coals (in view of flaming and smoldering burning conditions) and four kinds of chunk coals included bituminous and lignite were collected by a cascade impactor (FA-3) that could segregate particles into nine fractions. Particulate elemental and organic carbon were analyzed by a thermal-optical (IMPROVE_A) method, emission factors of particulate matter (PM), organic carbon (OC), and elemental carbon (EC) are systematically measured, and the average EFs are calculated by taking into account our previous data. For flaming and smoldering burning conditions of honeycomb coals, EFs of OC, and EC in PM2.1 are 0.07 and 0.002 g/kg in flaming burning and 0.10 and 0.001g/kg in smoldering burning, respectively, carbonaceous particles emitted from flaming burning were higher than smoldering burning; and for chunk, they are 1.4 and 0.02 g/kg, respectively, more higher than honeycomb coals. The size-segregated results show that particulate matter and their carbonaceous components from coal combustion emissions distributed in fine particles mainly, and calculated mass median aerodynamic diameters (MMAD) of carbonaceous particles were under 2.5μm, size distribution of emission factor in total carbon (OC and EC) shows that the carbonaceous components distributed in Dp≤0.43μm of honeycomb coals and the range of 0.43 ~ 0.65μm of chunk.

Emission factor for atmospheric ammonia from a typical municipal wastewater treatment plant in South China

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ABSTRACT

Atmospheric ammonia (NH3), a common alkaline gas found in air, plays a significant role in atmospheric chemistry, such as in the formation of secondary particles. However, large uncertainties remain in the estimation of ammonia emissions from nonagricultural sources, such as wastewater treatment plants (WWTPs). In this study, the ammonia emission factors from a large WWTP utilizing three typical biological treatment techniques to process wastewater in South China were calculated using the US EPA's WATER9 model with three years of raw sewage measurements and information about the facility. The individual emission factors calculated were 0.15 ± 0.03, 0.24 ± 0.05, 0.29 ± 0.06, and 0.25 ± 0.05 g NH3 m3 sewage for the adsorption-biodegradation activated sludge treatment process, the UNITANK process (an upgrade of the sequencing batch reactor activated sludge treatment process), and two slightly different anaerobic-anoxic-oxic treatment processes, respectively. The overall emission factor of the WWTP was 0.24 ± 0.06 g NH3m3 sewage. The pH of the wastewater influent is likely an important factor affecting ammonia emissions, because higher emission factors existed at higher pH values. Based on the ammonia emission factor generated in this study, sewage treatment accounted for approximately 4% of the ammonia emissions for the urban area of South China's Pearl River Delta (PRD) in 2006, which is much less than the value of 34% estimated in previous studies. To reduce the large uncertainty in the estimation of ammonia emissions in China, more field measurements are required.

KEYWORDS: Atmospheric ammonia; Wastewater treatment plant; Emission factor; pH value; WATER9 model

Emission inventory of water soluble ions in fine particles from residential coal burning in China and implication for emission reduction.

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ABSTRACT

Emission factors (EFs) for 9water-soluble ions of Na^+, NH_4^+, Mg^{2+}, K^+, Ca^{2+}, F^-, Cl^-, NO_3^- and SO_4^{2-} in $PM_{2.5}$ from raw coal and honeycomb coal burning were obtained by dilution sampling system and domestic burning test. The total emission amounts of water-soluble ions from residential coal burning in 2013 of China were calculated and 1km×1km grid cell-based emission inventory was established. Result showed that the EFs of water soluble ions from honeycomb coal burning were higher than those emitted from the raw coal burning except for Ca^{2+} and Mg^{2+}. It is urgently to assess the emission reduction effect of hazardous chemical components of changing the raw coal into honey coal. The EFs of SO_4^{2-} were highest than other ions, which were 494mg/kg and 105mg/kg for honey coal and raw coal, respectively. The particles emitted from domestic coal burning were acidity, with ∑anion/∑cation ratios ranging in 2.0~2.5. For per capita emission, Shandong, Hebei and Beijing were the top three provinces with higher emission amounts, which were 520.16, 401.1 and 362.7gram per capita, respectively. For emission intensity, Shandong, Beijing and Shanghai hold the highest values, as 323.9, 287.3 and 197.9kg/km^2, respectively. The emission of ions from domestic coal burning in Beijing and Shandong should be paid more attention. For the high spatial resolution emission inventories of ions from domestic coal burning, they exhibited the following features: (1) eastern China exhibited higher values than those for western China; (2) they were higher in plains and basins than those in plateau and mountainous region; (3) they mainly constraint by the geographical environment factors and economic development level , which maybe related with the historical trend of population evolution. Human beings are mainly concentrated in the main plains, basins and river valleys, therefore from the view of alleviating heavy air pollution processes in winter, the water-soluble ions and their gaseous precusors should be strictly reduced.

Emissions prediction for on-road mobile sources in ShenZhen

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ABSTRACT

As one of the most developed metropolitan cities in China, the population of on-road mobile sources has dramatically increased with an annual increase rate of 15% of ShenZhen during the past decade. The total vehicle population has exceeded 3 million in 2014. Although the restriction policies have been implemented and the growth rate of vehicle population has slowed down in recent years, the vehicle exhaust emissions remain an important source of air pollutants. An accurate prediction of emission inventory is crucial for future decision making of vehicle exhaust pollution governance, which mainly depends on the vehicle population. Thus, the objective of this study is to evaluate the vehicle exhaust emissions in 2020 by predicting the population trends of motor vehicles in ShenZhen. Four types of on-road mobile sources were discussed, including passenger vehicles, ordinary trucks, other special motor vehicles and motorcycles. However, the population of vehicle will not increase linearly with the emission limits, which is usually influenced by the economy development and traffic situation, e.g., GDP, population density and road areas. In this study, a BP neural network method was used to predict the vehicle population and emissions. The methodology was showed a precise prediction for vehicle population. This will stimulate more reasonable strategies for vehicle emissions mitigation in ShenZhen.

KEYWORDS: On-road mobile sources; Population; Emissions prediction

Emission factor for atmospheric ammonia from a typical municipal wastewater treatment plant in South China

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ABSTRACT

Atmospheric ammonia (NH_3), a common alkaline gas found in air, plays a significant role in atmospheric chemistry, such as in the formation of secondary particles. However, large uncertainties remain in the estimation of ammonia emissions from nonagricultural sources, such as wastewater treatment plants (WWTPs). In this study, the ammonia emission factors from a large WWTP utilizing three typical biological treatment techniques to process wastewater in South China were calculated using the US EPA's WATER9 model with three years of raw sewage measurements and information about the facility. The individual emission factors calculated were 0.15 ± 0.03, 0.24 ± 0.05, 0.29 ± 0.06, and 0.25 ± 0.05 g NH_3 m^3 sewage for the adsorption-biodegradation activated sludge treatment process, the UNITANK process (an upgrade of the sequencing batch reactor activated sludge treatment process), and two slightly different anaerobic-anoxic-oxic treatment processes, respectively. The overall emission factor of the WWTP was 0.24 ± 0.06 g NH_3 m^3 sewage. The pH of the wastewater influent is likely an important factor affecting ammonia emissions, because higher emission factors existed at higher pH values. Based on the ammonia emission factor generated in this study, sewage treatment accounted for approximately 4% of the ammonia emissions for the urban area of South China's Pearl River Delta (PRD) in 2006, which is much less than the value of 34% estimated in previous studies. To reduce the large uncertainty in the estimation of ammonia emissions in China, more field measurements are required.

KEYWORDS: Atmospheric ammonia; Wastewater treatment plant; Emission factor; pH value; WATER9 model

Emission characteristics and health risk assessment of volatile organic compounds during the washing process in printing plant

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ABSTRACT

An abundance of volatile organic compounds (VOCs) was emitted during the washing process in the printing plant due to a great quantity of kerosene was used to wash the machines, which could cause harm to the workers in the printing plant. In this study, the samples of VOCs were collected by stainless steel canisters at working location during the washing process in the printing plant and measured by gas chromatography-mass selective detection/flame ionization detection (GC-MSD/FID). The characteristics of 44 VOCs were analyzed and health risk by inhalation of some selected poisonous VOCs were estimated. The results showed that the most abundant compounds emitted during the washing process were Xylene (including m-Xylene、o-Xylene and p-Xylene), Toluene, Ethyl-benzene, n-Nonane, Iso-pentane.The emission characteristics were similar with the composition of kerosene, since may be due to kerosene was the main solvent to be used for washing machine. For the health risk assessment of non-cancer risk, the hazardous quotient of Benzene, Ethyl-benzene, Toluene, Xylene was 47.52、1.79、13.04、31.36, respectively, which were greater than definite risk level of 1, indicating that aromatic hydrocarbons would cause non-carcinogenic health hazard to exposed population. The cancer risk values of Benzene (7.59×10^{-4}), Ethyl-benzene (1.66×10^{-3}) were much higher than the general acceptable risk level of 1.0×10^{-6}, suggesting that carcinogenic risks for these VOCs species were unacceptable. It was concluded that the emission of VOCs from washing process should be noted and the printing plant should provide more measures to reduce the exposure level of VOCs during the washing process for protecting the health of workers.

KEYWORDS: Volatile organic compounds; Emission characteristics; Health risk assessment; Washing process; Printing plant

Estimating spatiotemporal distribution of PM_1 and its health impacts in China

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ABSTRACT

PM_1 might be more hazardous than $PM_{2.5}$. However, studies on PM_1 concentrations and its health effects are limited due to a lack of PM_1 monitoring data. This presentation reports how to: 1) estimate spatial and temporal variations of PM_1 concentrations in China during 2005–2014 using satellite remote sensing, meteorology, and land use information; 2) compare the short-term health impacts of PM_1 and $PM_{2.5}$; and 3) assess the long-term impacts of PM_1 on birth outcomes. We find that: 1) generalized additive models with satellite-retrieved AOD, meteorology, and land use information has high predictive ability to estimate ground-level PM_1; 2) Exposure to both ambient PM_1 and $PM_{2.5}$ were significantly associated with increased risks of health outcomes. And most of the health effects of $PM_{2.5}$ come from PM_1; 3) long-term exposure to PM_1 air pollution has a significant impacts on preterm birth. In the future, more studies should be done to explore the spatial and temporal patterns of PM_1 and to assess its associations with health outcomes. These studies will also provide valuable information and evidence for policy makers when promulgating standards and guidelines for the control of PM_1 pollution both in China and other countries.

KEYWORDS: PM_1, $PM_{2.5}$, short-term effect, long-term effect, spatiotemporal model, remote sensing, health risk assessment

Estimating ground-level $PM_{2.5}$ concentrations in Hubei province using satellite-derived aerosol optical depth data and meteorological parameters

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ABSTRACT

Satellite-derived aerosol optical depth (AOD) from MODIS combined with appropriate auxiliary meteorological parameters, were used to develop statistical models and obtain ground-level $PM_{2.5}$ estimations during year of 2015 over Hubei, a province in central China. Limited ground monitoring stations with rather sparse spatial distribution obviously could not provide $PM_{2.5}$ observations at different locations to meet current requirements for pollution monitoring and forecasting. Fused AOD of two algorithms, Dark Target (DT) and Deep Blue (DB), from Aqua MODIS C6 Level 2 AOD product which could meet the demands of high accuracy and spatial coverage was utilized to retrieve $PM_{2.5}$ concentrations in regional scales using a rather advanced statistical model, day-specific linear mixed-effect model (LME). Developing particular and optimal models for 10 different cities using stepwise method, this study showed that day-specific LME have rather strong predictive ability for particulate matter. For the model fitting, the maximum and minimum values of R^2 are 0.97 and 0.86 in cities of JZ and SY, respectively, while the RMSEs were massively and least valued at 15.61 and 7.07 in WH and JZ, respectively. The statistical model for the city of JZ had the best performance overall. After being cross-validated against ground observations, the values of CV R^2 were basically more than 0.8 except 2 cities with R^2 of 0.78 and 0.67, which outperformed many results in previous studies using other statistical models. Gridded mean annual $PM_{2.5}$ concentrations map over province of Hubei was eventually obtained as a supplement for limited $PM_{2.5}$ observations from ground monitoring network.

KEYWORDS: $PM_{2.5}$; Aerosol optical depth; MODIS; Linear mixed-effects model

Evolution of fine particle number concentration, size distribution and chemical compositions under different dilution ratios from domestic coal combustion in China

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ABSTRACT

In this work, a dilution tunnel was explored to study the influence of dilution ratios (DRs) on the particle emission of six widely domestic coal in China. Measurements were conducted by scanning mobility particle sizer (SMPS, size ranges: 14.6-667.1nm) and single particle aerosol mass spectrometer (SPAMS, size ranges: 0.2-2.0μm), to obtain the particle size distribution (PSD), particle number concentration (PNC), and chemical compositions under two burning conditions. For flaming condition, there were three obvious burning stages, the evaporation and burning of volatile compounds, stable flaming combustion and last smoldering combustion, while the burning stages were not clear under smoldering condition. The PNC for flaming condition exhibited a single peak, and the smoldering condition showed a continuously decreasing trend of PNC along with the combustion process. DRs (100) affected the particle emission at flaming stage obviously. Along with the burning time, the particles in Aitken mode increased originally, then decreased; the Accumulation mode particle exhibited converse variation trend. It can be explained by the complex nucleation, condensation and coagulation processes. ART-2a results indicated that the particles emitted from domestic coal burning can be separated into eight parts: K-Rich(9.06%), K-EC(18.68%), K-OC(6.29%), K-ECOC(10.99%), K-OA(0.42%), K-PAHs(0.03%), K-Metal(53.90%) and others(0.44%), respectively. This research is helpful for understanding the emission and aging processes of aerosols emitted from domestic coal burning.

Evaluation of mesoscale numerical weather prediction WRF Model's performance by analyzing the kinetic energy spectra behavior

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ABSTRACT

Nowadays, for most of the scientists and researchers worldwide, improving the accuracy of numerical weather prediction models always remains a top-priority. For this, the grid resolution is often made finer and finer to obtain the weather forecast. However, reducing the grid spacing will only increase the computational cost, as doubling the horizontal grid density typically increases the integration cost by a factor of eight. Moreover, the model may not resolve eddies and important meteorological features at the chosen grid scale. Analysis of simulated kinetic energy spectra provides a better tool for finding out the optimum resolving capacity of the model. Generally, the model spectra starts to decay at the highest resolved wavenumbers compared with the observation spectra, which indicates the energy removal by the dissipation mechanism inside the model. This information of departure from the observed spectra is used for obtaining the effective grid resolution for running the model.

In this research, the kinetic energy spectra of the Weather Research Forecast (WRF) model are analyzed to find out its resolving capability over the Pearl River Delta (PRD) region in Southern China. The Fast Fourier Transform (FFT) is performed on the horizontal velocity output field data to obtain 1D spectra for further analysis. The spectra plotted over a period of a month have shown the slopes to be following k^{-3} wavenumber dependence for large scales and $k^{-5/3}$ dependence for the mesoscale similar to the observational spectra by Nastrom and Gage (1985). It is expected that analyzation of such spectra before obtaining the actual weather forecasts will help to obtain them with more accuracy which is beneficial for both the scientists and whole air quality research community which use the WRF model's meteorological data as a boundary condition to drive their models.

KEYWORDS: Kinetic energy spectra; Weather research forecast; Numerical weather prediction; Grid resolution; Pearl River delta; Fast Fourier transform; Air pollution

Evaluating the impacts towards meteorological variables between expanding urban area and increasing building height in Hong Kong

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ABSTRACT

Having an exceptionally high population density already, Hong Kong still requires to be further urbanised so as to accommodate the increasing population. As such, government may need to either develop new urban areas, or increase building heights by revitalizing the existing buildings. However, different type of developments will lead to respective changes in urban weather, and consequently affecting the thermal comfort and transportation of air pollutants. As a result, this study will investigate the impacts towards Hong Kong's weather under two development scenarios: either expanding urban area by 30% more, or increase the existing building height by 30% respectively.

To perform simulation between these scenarios, the urban Weather Research and Forecasting Model (uWRF) (Skamarock et al., 2008) is used. Building Environment Parameterization (Martilli, 2002) and the Building Energy Model (Salamanca et al., 2010) (BEP-BEM) are coupled with uWRF in order to include urban effects during simulation. The simulation period is chosen to be summer season in Hong Kong. Other than the two scenarios mentioned previously, a control run is also performed for comparison. Fundamental meteorological variables like changes in temperature and wind will be analysed and discussed in this study.

KEYWORDS: WRF; urbanisation; urban climate; urban morphology

Factors affecting variability in $PM_{2.5}$ exposure concentrations in a metro system

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ABSTRACT

The objectives of this study were to: (1) evaluate $PM_{2.5}$ inflow to metro train cabins when doors open at stations; (2) assess the spatial and temporal variability in $PM_{2.5}$ exposure concentration; and (3) quantify the relationship between in-cabin concentration versus outdoor and non-ambient $PM_{2.5}$. We measured in-cabin $PM_{2.5}$ concentrations using portable monitors at the door-side and center of a train cabin simultaneously on a Hong Kong metro line. In addition, platform and in-cabin pollutant concentrations near a train door were simultaneously measured. Short-term spikes in $PM_{2.5}$ concentrations typically occur near train doors when doors open, related to inflow of ambient air aboveground and tunnel air underground. In-cabin $PM_{2.5}$ exposure concentrations are typically lower away from the doors when the doors open. $PM_{2.5}$ concentrations inside train cabins and on station platform operating above-ground are more influenced, compared to underground, by outdoor $PM_{2.5}$. Moreover, non-ambient sources contribute approximately 50% of train in-cabin and station platform $PM_{2.5}$ concentrations during underground operation. The results help more accurately quantify commuting $PM_{2.5}$ exposure on a metro system, and can be used to improve population-based exposure simulation models.

KEYWORDS: $PM_{2.5}$; underground metro; above-ground metro; train in-cabin; station platform; Hong Kong

Fine particle pH in a central megacity of China: temporal variation and source attribution

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ABSTRACT

Aerosol acidity obviously affects atmospheric chemistry. A continuous measurement was done to obtain 1h resolution of water-soluble ions in fine particles, gases pollutants and meteorological parameters in September 2015-August 2016 at Wuhan, a megacity of central China. The aerosol acidity for different seasons, various pollution episodes and different air mass directions were calculated, with widely used E-AIM and ISORROPIA thermodynamic models. In general, aerosols in Wuhan was weak alkaline, with pH averaged as 8.2. The acidity in winter was slightly higher than that in summer. The pH values of aerosols were 7.82, 8.02 and 8.44 for polluted, transition and clean episodes, respectively. Aerosols for air masses originated from northwest Mongolia and northeast coastal regions of Yellow Sea (totally occupied by 40% of all the air masses) exhibited more alkali (PH averaged as 8.4 and 8.3, respectively), owing to the influence of dust and sea salt. However, the regional air masses from the south directions (57% of the total) held a little lower acidity as north. The abundant ammonia and excess ammonium were the most important influence factors to the low $PM_{2.5}$ acidity, which can be explained with the abundant agricultural activities in Wuhan (represented by higher primary industry proportion compared with other megacities). This study indicated that the atmospheric chemistry especially for the secondary inorganic ions formation in central China was quite different from those in Northern China where the aerosol acidity was acidic. The establishment of control measures for polluted episodes should be based on local representative atmospheric physical-chemical conditions.

KEYWORDS: acidity; secondary inorganic ions; air mass; weak alkaline; excess ammonia; neutralization

Forecasting real-time $PM_{2.5}$ in extreme-high-density city: an integrated neural network model framework in Hong Kong

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ABSTRACT

This presentation would introduce a hybrid model framework to predict air quality at Environment Protection Department (EPD) air quality monitoring stations in Hong Kong over the next 48 hours. This hybrid predictive model uses historical air monitoring records (SO_2, O_3, CO, NO_2, $PM_{2.5}$, PM_{10}), current meteorology data, weather forecasts in predicted time period from the station and other stations within a few kilometers. This predictive model consists of four parts: 1) a linear-regression-based temporal predictor to predict following hours PM for each station, 2) a neural network-based spatial predictor to model the impact from nearby regions, 3) a regression-tree-based dynamic aggregator combining the predictions of the temporal and spatial predictors according to the situation of meteorological and air quality observations, 4) an inflection predictor to capture sudden changes in air quality. To evaluate this hybrid model, first thing is to compare the traditional regression methods with neural network by feed all the features into one single model directly. Secondly, examine each part of model's necessity by controlling the components of the model to see the difference of results. Thirdly compare this hybrid model with some baseline methods, like Auto-Regression-Moving-Average, traditional air quality forecast model (CMAQ). After training this model with more data, this model is hoped to contribute in the platform of the HSBC project: Personalized Real-time Air-Quality Informatics System for Exposure- Hong Kong.

KEYWORDS: Urban computing; urban air; air quality forecasting; particulate matter; big data.

From O_2^--initiated SO_2 oxidation to sulfuric acid

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ABSTRACT

Aerosols remain the dominant uncertainty in predicting radiative forcing and future climate change, and also have adverse effects on air quality. A high proportion of aerosol particles is formed from SO_2 reactions in the gas phase, through the formation of sulfuric acid (H_2SO_4). While aerosol formation is related primarily to neutral clusters, state-of-the-art experimental methods measure only charged clusters, and there has also been strong evidence that the contribution of ions to aerosol formation is non-negligible. Motivated by this, many studies have investigated some mechanisms of ion-catalyzed SO_2 oxidation in order to find the connectivity between the missing H_2SO_4 and H_2SO_4 formed from ion-catalyzed SO_2 oxidation. For example, different combined theoretical studies showed that SO_2 oxidations initiated by O_3^- and the sulfate radical ion (SO_4^-) ultimately lead to the formation of H_2SO_4. One oxidation mechanism, initiated by the superoxide ion (O_2^-), is explored in this research. It is well established from previous studies that O_2^- reacts readily with SO_2 to form a peroxy compound, O_2-SO_2^-, whose atmospheric fate is currently unclear. Any atmospheric sulfur-containing compound is susceptible to significantly alter the formation mechanism of aerosol particles. The main objective of this study is to explore the chemical outcome of O_2-SO_2^- by collision with NO and NO_2, which will most likely terminate the oxidation of SO_2 initiated by O_2^- by ejecting SO_3 (a precursor for sulfates formation). We assess the importance of these reactions in aerosol formation, using quantum chemical calculations and statistical thermodynamics. Special focus is given to the mechanisms underlying the formation of H_2SO_4, hereby (partially) accounting for the missing H_2SO_4 needed to fully explain the observed atmospheric particle formation rates. Reaction mechanisms, thermodynamics and kinetics, including the effect of humidity, are determined under atmospherically relevant conditions.

KEYWORDS: sulfur dioxide; ionic oxidation; sulfuric acid; aerosols

Formation and evolution of aqSOA from direct photolysis of phenolic carbonyls: comparison between ammonium sulfate and ammonium nitrate seeded conditions

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ABSTRACT

We investigate the effects of sulfate and nitrate on the formation and evolution of secondary organic aerosol in aqueous phase (aqSOA) from the direct photooxidation of phenolic carbonyls that are typically emitted from wood burning. AqSOA formed efficiently from the photooxidation of both syringaldehyde ($C_9H_{10}O_4$) and acetosyringone ($C_{10}H_{12}O_4$) in either ammonium sulfate or ammonium nitrate solutions, with mass yields ranging from 30% to 120%. The aqSOA formed at the beginning of the reaction had similar oxygen-to-carbon (O/C) ratios and average carbon oxidation state (OS_C) as the precursors but much more oxidized aqSOA was formed over the course of photooxidiation, with O/C and OS_C reaching 1.2 and 1.1, respectively. Positive matrix factorization on the organic mass spectra revealed a combination of functionalization, oligomerization and fragmentation processes in the chemical evolution of aqSOA. Functionalization and oligomerization processes dominated the first 4 hours of reactions and phenolic oligomers and their derivatives significantly contributed to the aqSOA growth. Further oxidation of the first generation products led to the dominance of oxygenated ring-breaking products. Degradation rates of syringaldehyde and acetosyringone in nitrate solutions are 1.5 and 3.5 times of those in sulfate solutions; and nitrate experiments produce twice as much of the aqSOA mass as sulfate experiments. It is believed that nitrate promoted the reactions by generating OH radicals or through electron transfer reactions. This work highlights the importance of aerosol-phase nitrate in the formation of aqSOA from biomass burning products by facilitating the degradation of organic precursors and promoting the production of aqSOA reactions.

KEYWORDS: AqSOA; Sulfate, Nitrate; Yield, Evolution

Formation mechanism of tropospheric ozone and SOA from typical VOCs and attenuation of its precursors by photocatalytic technology

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ABSTRACT

Aromatic hydrocarbons, which are mainly produced from automobile and industrial emissions, account for 20-30% of the total volatile organic compounds (VOCs). The oxidation of aromatic hydrocarbons is commonly believed to form carbonyl compounds and contribute importantly to ozone and SOA formation in urban environments, profoundly impacting air quality, human health, and climate. Hence, it is necessary to clarify the transformation mechanism and then find cost-effective process to remove them from atmospheric environments. Photocatalytic technology is considered as a green cleaning method with excellent purification capability. To better controlling and removal these pollutants, a potential polluted mechanism to the formation of tropospheric ozone and SOA formation from these pollutants is needed. In this work, the experimental and theoretical studies was investigated to assess the mechanisms and the role of the oxidation of typical aromatic hydrocarbons and carbonyl compounds, and found that these pollutants play an important role in the formation of tropospheric ozone and SOA formation. And then, some effective photocatalysts are explored and developed. The adsorption and photocatalytic mechanisms of these typical pollutants was investigated in detail and a novel method was provide to removal and controlling of organic pollutants, especially for some high-level VOCs in urban city.

KEYWORDS: Atmospheric reaction mechanism; SOA; Ozone; VOC; Photocatalytic technology

Formation of secondary organic aerosols from gas–phase emissions of heated cooking oils

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ABSTRACT

Cooking emissions can potentially contribute to secondary organic aerosol (SOA) but remain poorly understood. In this study, formation of SOA from gas-phase emissions of five heated vegetable oils (i.e. corn, canola, sunflower, peanut and olive oils) was investigated in a potential aerosol mass (PAM) chamber. Experiments were conducted at 19-20 ºC and 65-70% RH. The characterization instruments included a scanning mobility particle sizer (SMPS) and a high-resolution time-of-flight aerosol mass spectrometer (HR-TOF-AMS). The efficiency of SOA production, in ascending order, was peanut oil, olive oil, canola oil, corn oil and sunflower oil. The major SOA precursors from heated cooking oils were related to the content of mono-unsaturated fat and omega-6 fatty acids in cooking oils. The average production rate of SOA, after aging at an OH exposure of 1.7×10^{11} molecules cm^{-3} s, was 1.35±0.30 μg min^{-1}, three orders of magnitude lower compared with emission rates of fine particulate matter ($PM_{2.5}$) from heated cooking oils in previous studies. The mass spectra of cooking SOA highly resemble field-derived COA (cooking-related organic aerosol) in ambient air, with R^2 ranging from 0.74 to 0.88. The average carbon oxidation state (OS_c) of SOA was -1.51 – -0.81, falling in the range between ambient hydrocarbon-like organic aerosol (HOA) and semi-volatile oxygenated organic aerosol (SV-OOA), indicating that SOA in these experiments was lightly oxidized.

KEYWORDS: cooking emissions; heated cooking oils; secondary organic aerosol (SOA)

Formation of first-generation multifunctional products in the OH-initiated oxidation of isoprene

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ABSTRACT

Isoprene, with global emissions of about 500 Tg per year, is the largest source of nonmethane hydrocarbons to the atmosphere.[1] Due to its impact on the tropospheric species globally and its contribution to organic aerosols, photooxidation of isoprene has been studied extensively over past decades. Despite of all this, the details of the gas-phase chemical oxidation mechanism remain to be fully elucidated, as well as the source of missing HO_x regeneration. In this work, we proposed a comprehensive OH-initiated oxidation mechanism by quantum chemical calculations and mass spectrometric studies. Our calculations suggest that autoxidation steps can take place in isoprene hydroxy peroxy radicals formed from consecutive H-migrations, leading to formation of certain types of functional carbonyls and OH regenerations. Flow tube studies, coupled with Chemical Ionization Mass Spectrometers using with iodide and/or nitrate as the reagent ions, were carried out to characterize these multi-functional products and free radicals. The novel pathways presented in this work might account for unidentified species which have not been measured in the very recent study,[2] and would considerably contribute to the oxidizing capacity of the atmosphere and the formation of SOAs.

KEYWORDS: Oxidation Mechanism; Highly Oxidized Multifunctional Products; Mass Spectrometry; OH Regeneration

Green ferries for Hong Kong

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ABSTRACT

While ocean-going vessels remain the biggest source of ship emissions in Hong Kong, contributions from river and local vessels, especially passenger ferries, are also significant and should not be overlooked. It is estimated that the ferry sector, including in-harbour routes, outlying island routes, and cross-boundary routes, accounted for about 10 per cent of sulphur dioxide and particulate matter emissions, and 20 per cent of nitrogen oxides emissions from ships.

In terms of air quality control measures, the Hong Kong SAR Government has capped the sulphur content of locally supplied marine light diesel at 0.05 per cent since April 2014. Some ferry operators have also tested and applied different green technologies to their ferries, such as alternative fuel, propulsion systems, and ship-building materials, as well as after-treatment technologies. However, the use of green fuel and technologies in the ferry sector to date has remained sporadic, limited, and unsatisfactory.

In light of the above, the objectives of this paper are (a) to review the current use of green ferries in Hong Kong, (b) to identify and draw experience from overseas best practices in the use of green ferries, (c) to highlight the operational characteristics of local ferries in Hong Kong, and (d) to discuss the potential and challenges faced by Hong Kong in promoting and adopting green ferry technologies in the near future.

KEYWORDS: Ship emissions; ferries; green technologies; Hong Kong.

Health effects of ambient $PM_{2.5}$ air pollution: research findings from a longitudinal cohort study with 0.5 million participants

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ABSTRACT

Air pollution has become the world's largest single environmental health risk. Particulate Matter is the most important air pollutant which affects more people than any other pollutants. However, there is limited information on health effects of PM from the rapidly developing economic regions, where people are generally experiencing much worse air pollution. We therefore conducted research to investigate the health effects of ambient $PM_{2.5}$ air pollution using a longitudinal cohort study with 0.5 million participants. We developed a spatio-temporal model with high resolution (1×1 km) based on satellite AOD data to retrieve ground-level $PM_{2.5}$ concentrations. Appropriate statistical data analysis methods were adopted to assess the relationships of $PM_{2.5}$ air pollution with a range of health outcomes including mortality, cardiovascular risk, inflammatory markers, respiratory disease and reproductive health. Our results show: 1) Every 5 $\mu g/m^3$ increment in 2-year average $PM_{2.5}$ was associated with a 5% increased risk of all-cause mortality [hazard ratio (HR): 1.05, 95% confidence interval (CI): 1.03, 1.07]; 2) Every 5 $\mu g/m^3$ $PM_{2.5}$ increment was associated with 1.31% increase in CRP (95% CI: 1.00%, 1.63%) and 0.19% (95% CI: 0.17%, 0.21%) increase in WBC count; 3) Each 10 $\mu g/m^3$ increment in the 2-year average $PM_{2.5}$ concentration was associated with increases of 0.45 (95% confidence interval [CI]: 0.40 to 0.50), 0.07 (95% CI, 0.09 to 0.24) and 0.38 (95% CI, 0.33 to 0.42) mm Hg in SBP, DBP and PP, respectively; 4) Each 10 $\mu g/m^3$ increment in the 2-year average $PM_{2.5}$ concentration was associated with an increase of 3% in the risk of incident hypertension (hazard ratio, 1.03; 95% CI, 1.01 to 1.05); 5) Compared to the participants with exposure to the 1^{st} quartile of $PM_{2·5}$, participants with exposure to the 4^{th}, 3^{rd}, and 2^{nd} quartiles of $PM_{2·5}$ had a hazard risk of 1·23(95%CI: 1·09, 1·39), 1·30 (95%CI: 1·16, 1·46), and 1·39 (95%CI: 1·24, 1·56) in COPD development, respectively; and 6) Every increment of 5 $\mu g/m^3$ in 2-year average $PM_{2.5}$ was significantly associated with a decrease of 1.29% in sperm normal morphology and a 26% increased risk of being the bottom 10% of sperm normal morphology. In conclusion, we found that ambient PM2.5 air pollution has significantly adverse impacts on human health including mortality, cardiovascular disease, inflammation, COPD and semen quality in a Chinese population.

KEYWORDS: Air pollution; $PM_{2.5}$; health effects

Health effects of vehicular emissions control measures in China

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ABSTRACT

Road transportation is one major emission source contributing to ambient $PM_{2.5}$ pollution in China. Since the 1990s, China has adopted comprehensive control measures to mitigate vehicular emissions. However, the effects of these measures on reducing emissions, improving air quality and avoiding negative health impacts have not yet been comprehensively evaluated. In this study, we combine emissions inventory, air quality modeling, and IER model to evaluate the effect of various vehicle control measures on premature deaths attributable to ambient $PM_{2.5}$ at a spatial resolution of 36 km × 36 km across China. Our results show that, comparing to the no control scenarios, China's total vehicular emissions of NO_X, HC, CO, $PM_{2.5}$ have declined by 57%, 69%, 75% and 71% in 2010, respectively. The implementation of vehicular emissions control measures have reduced the national annual average concentrations of $PM_{2.5}$ by 2.5ug/m^3, and avoided 150,000 (95% confidence interval: 66,000~212,000) premature deaths. The geographic distribution of the avoided premature deaths presents distinct regional features and the most beneficial areas are mainly concentrated in Beijing and its surrounding urban areas. Our results have important policy implications on optimization of vehicular emission control strategy in China.

KEYWORDS: Air pollution; fine particulate matter; vehicle control measures; public health; China

Heterogeneous uptake of ammonia by secondary organic aerosol (SOA): effect of phase state and formation of organonitrogen species

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ABSTRACT

The physical state of atmospheric aerosol particles has an array of impact on particle hygroscopicity, volatility, as well as reactivity[1,2]. The reactivity of secondary organic aerosol (SOA) particles derived from six representative precursors and of variable viscosity was studied[3]. The SOA particles were produced in aerosol form from three terpenoid and three aromatic precursor species. The viscosity of the SOA particles was adjusted by exposure to various relative humidity (RH) from <5% to >90% RH at 293 ± 2 K. The SOA particles were subsequently exposed to 5 ppm NH_3 for ~370 s in a continuous flow reactor. The ammonium-to-organic mass ratio ($M_{NH_4^+}/M_{Org}$), as measured by high resolution time-of-flight aerosol mass spectrometry (HR-ToF-AMS), increased monotonically from <5% RH to a limiting value at a threshold RH, implicating a transition from a system limited by diffusivity within the SOA for low RH to one limited by other factors at higher RH. The transition RH values, however, differ among SOA from different precursors, and also differ from those in viscosity measurements. The production of light-absorbing organonitrogen (ON) species from ammonia exposure was also dependent strongly on the RH value. Production of ON species, as detected by aerosol mass spectrometry and characterized by ultraviolet-visible spectrophotometry, was kinetically inhibited for RH < 20%. The overall rate of "browning" reactions for <20% RH could be explained by the low diffusivity[4,5] of the large organic molecules from the interior region of the particle to the reactive surface region in the case of low Henry's law partitioning of the reactive gas (NH_3). The results of this study have implications for accurate modeling of ammonia uptake as well as brown carbon production that affects energy balance.

KEYWORDS: SOA; phase state; organionitrogen species

High-resolution sampling and analysis of air particulate matter in the Pear River Delta region of Southern China: source apportionment and health risk assessment

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ABSTRACT

Hazardous air pollutants, such as trace elements in particulate matters (PM), are known or highly suspected to cause detrimental effects on human health. To understand the sources and associated risks of PM to human health, hourly time-integrated major trace elements in size-segregated coarse ($PM_{10-2.5}$) and fine ($PM_{2.5}$) particulate matter were collected and examined in an industrial city of Foshan in the Pearl River Delta region, China. Receptor modeling of the dataset by positive matrix factorization (PMF) was used to identify six sources contributing to $PM_{2.5}$ and PM_{10} concentrations at the site. Dominant sources included industrial coal combustion, secondary inorganic aerosol, motor vehicles and construction dust along with two intermittent sources, biomass combustion and marine aerosol. The biomass combustion source was found to be a significant contributor to peak $PM_{2.5}$ episodes along with motor vehicles and industrial coal combustion. Conditional probability function (CPF) was applied to estimate the local source effects from wind direction using the PMF-resolved source contribution coupled with the surface wind direction data. Health exposure risk for hazardous trace elements (Pb, As, Cr, Ni, Zn, V, Cu, Mn, Fe) and source-specific values were estimated. The total hazard quotient (total HQ =HI) of $PM_{2.5}$ was 2.09, which is two times higher than the acceptable limit (HQ = 1). The total carcinogenic risk was $3.37*10^{-3}$ for $PM_{2.5}$, which was three orders higher than the acceptable limit (i.e. $1.0*10^{-6}$). Among the selected trace elements, As and Pb posed the highest non-carcinogenic and carcinogenic risks for human health, respectively. In additional, our results showed that industrial coal combustion source was the dominant non-carcinogenic and carcinogenic risks contributor, highlighting the need for stringent control of this source. This study can provide new insight for policy makers to prioritize sources in air quality management and health risk reduction.

KEYWORDS: Particulate matter; source apportionment; health risk assessment; PRD

Hourly measurement of carbonaceous aerosols in a roadside environment in Hong Kong

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ABSTRACT

Street level air pollution is one of the most concerned social issues in Hong Kong because of its detrimental impact on human health. Fine particulate matter ($PM_{2.5}$) is a ubiquitous and also the deadliest air pollutant in roadside environment, which in large part is from vehicular exhaust[1]. Indeed, both $PM_{2.5}$ and exhaust from diesel engines have been classified by the World Health Organization's International Agency for Research on Cancer as carcinogenic to humans. Carbonaceous aerosols including organic carbon (OC) and elemental carbon (EC) were determined to account for about half of the total $PM_{2.5}$ mass in Hong Kong[2]. In this presentation, results of hourly OC/EC measurement taken with a semi-continuous OC/EC field analyzer placed in Mong Kok Air Quality Monitoring Station, a roadside station in Hong Kong, will be discussed, with an aim to further our understanding of source contributions and formation mechanisms responsible for roadside particulates pollution. The measurement periods covered 12 selected months between July 2015 and June 2017. The monthly averaged OC and EC concentration were determined to be 2.25–5.88 and 1.80–4.34 μgC/m^3, respectively. They in total contributed to 17–49% (average = 30%) of $PM_{2.5}$ mass. Seasonal, weekday-holiday, and diurnal variations of OC and EC, which provided evidence to support the contributions from local vehicles and regional background pollutants, will be reported. Also, the inter-annual difference in OC and EC concentrations will be presented, which may help evaluate the effectiveness of recent control measures implemented by the Government.

KEYWORDS: Roadside air quality; carbonaceous aerosols; semi-continuous measurement

Identification of sink spots in two thermal desorption GC/MS systems for the analysis of polycyclic aromatic hydrocarbon

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ABSTRACT

Semi-volatile organic compounds (SVOCs) are chemicals that have a saturated vapor pressure of 10^{-4} to 10^{-14} atm at the ambient temperature of 25 ºC. Due to their low vapor pressure, SVOCs have a larger tendency than VOCs to be absorbed by surface materials [1], a phenomenon known as the sink effect in environmental chamber tests of SVOC emissions from materials. The sink effect is likely caused by the sink spots or insufficient heating in a TD system and results in the retaining of SVOC residues in the TD analysis, which could then be carried over to the next sample run. In thermal desorption GC/MS analysis of PAHs for example, such carry-over was observed, especially in cases of PAHs with lower vapor pressure [2]. Thermal desorption (TD) GC/MS has been used for the analysis of polycyclic aromatic hydrocarbons (PAHs) and other semi-volatile organic compounds. However, thermal desorption recovery of PAHs has not been well studied and the cause of PAH residues in a TD system has not been clearly understood. Our results showed that low volatility of PAHs can lead to their incomplete recovery in a TD system: for the PAHs with low vapor pressures, up to 10% and 3% could be lost in a two-stage (TS) TD system and a short-path (SP) TD system, respectively. Within the TSTD system, the majority of residues were found in the 4-port valve and in the spot where internal trap and the 4-port valve connects. Within the SPTD system, residues were largely confined to the tube needle connecting the sample tube and GC injection port as well as inside the injection port. Since the volatility of PAHs can represent the range typical of semi-volatile organic compounds (SVOCs), our results have a wide implication for the thermal desorption of SVOCs in general.

KEYWORDS: Thermal desorption; GC/MS; Deposition; Recovery; Polycyclic aromatic hydrocarbon

Impact of column-to-surface vertical correction method on the ambient $PM_{2.5}$/satellite AOD relationship in China

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ABSTRACT

As China is suffering from frequent severe haze pollution with dense industrialization and urbanization, satellite-derived aerosol optical depth (AOD) observations have been widely used to estimate fine particles with an aerodynamic diameter of smaller than 2.5 micrometers ($PM_{2.5}$). However, the relationship between satellite AOD and ambient $PM_{2.5}$ is affected by aerosol vertical distribution, as satellite AOD observations represent the total column, rather than ground-level concentrations. Thus, the optimal height section of column AOD has been explored to represent the ground-level concentrations, using ground-measured $PM_{2.5}$, satellite-derived AOD from Aqua/Terra Moderate Resolution Imaging Spectroradiometer (MODIS), and aerosol profile products from Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP). Moreover, a new column-to-surface vertical correction scheme is proposed to separate the near-surface and elevated aerosol layers, based on the ratio of the integrated extinction coefficient within the optimal height range. Furthermore, considering distinct differences in climate, meteorology, terrain, and aerosol transmission throughout China, the effectiveness of the new proposed vertical correction method and the classical vertical correction method via planetary boundary layer height (PBLH) have been compared and analyzed in different regions, combined with the original situation without vertical correction as reference. The results indicated that the vertical correction via PBLH showed best performance in northwest China; the vertical correction via CALIOP ratio performed optimally in northeast China, southwest China, Central China (except summer), North China (except Beijing), and the spring in the southeast coast; and the original situation without any vertical correction was better than other situations in Beijing and southeast coast (except spring). Through the suitable vertical correction process, the accuracy of estimating $PM_{2.5}$ by satellite AOD could been improved, which contributes to a more precise study of ecology and health.

Impact of dust haze on mortality: Epidemiological evidence from China

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ABSTRACT

In recent years, hazardous dust-haze has become one of the most catastrophic weather events in China. Reliable estimation of the burden of dust-haze on health has implications for implementation of mitigation measures. We did a time-series study to examine the health effects of dust-haze in China. A dust-haze day was defined as having daily visibility of less than 10 km, no rainfall, and relative humidity of less than 80%. A two-stage analysis was used to assess the effect of dust-haze on city-specific, cause-specific, sex-specific, and age-specific mortality in ten Chinese provincial capitals. Daily counts of deaths, further stratified by regions and individual characteristics, were obtained from Chinese Center for Disease Control and Prevention; daily meteorological data were obtained from the China Meteorological Data Sharing Service System. A distributed lag model was applied to estimate the city-specific delayed effects of dust-haze on mortality, after controlling for long-term trend, seasonality, day of the week, and weather conditions. The maximum lag was set to 14 days for the lagged effects of dust-haze. Pooled effects across cities were then obtained using the meta-analysis, based on restricted maximum likelihood estimation. We found that average number of days with dust-haze was 67 days [SD: 49] (18.36%) per year, ranging from 17 days (4.7%) in Guangzhou to 139 days (38.08%) in Hefei. Generally, the effects of dust-haze were immediate and limited to 7 days, with mortality displacement (harvesting effect) during lag 7–12 days. The relationships between dust-haze and mortality significantly varied by city (Cochrane's Q=40.725, I2=84.26% p<0.0001. The pooled relative risk of mortality associated with dust-haze over a lag time of 0–14 days was 1.05 (95%CI 1.01–1.09), 1.04(0.96–1.13), 1.03(0.98–1.09), and 1.15(1.03–1.29) for non-accidental, respiratory, cardiovascular, and diabetes-related mortality, respectively. Significant effects of dust-haze were found among females compared with males [relative risk: 1.07(1.02–1.14) versus 1.02(0.98–1.06)] and in people aged 75 years or above compared with younger people [relative risk: 1.05(1.00–1.09) versus 1.03(0.98–1.08)]. This study strongly supports the need for effective measures to reduce air pollution level and protective actions for vulnerable populations.

KEYWORDS: Dust haze; Air pollution; Mortality; Time-series method; China

Improved provincial emission inventory and speciation profiles of anthropogenic non-methane volatile organic compounds: a case study for Jiangsu, China

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ABSTRACT

Accurate estimation in emissions of non-methane volatile organic compounds (NMVOC) plays a crucial role in air quality simulation and policy making. We developed a high-resolution anthropogenic NMVOCs emission inventory for Jiangsu in eastern China from 2005 to 2014, based on detailed information of individual local sources and the field measurements on source profiles of chemical industry. Totally 56 NMVOCs samples were collected in 9 chemical plants, and then analyzed with a gas chromatography-mass spectrometry system (GC-MS). Various manufacturing technologies and raw materials lead to discrepancies in source profiles between our domestic field tests and foreign results for synthetic rubber and ethylene production. The provincial NMVOC emissions were calculated to increase from 1774 Gg in 2005 to 2507 Gg in 2014, and the estimates were larger than those from most other available inventories, due mainly to the complete inclusion of emission sources and to the elevated activity levels from plant-by-plant investigation in this work. Industrial processes and solvent use were the largest contributing sectors, and their emissions were estimated to increase respectively from 461 to 958 and from 38 to 966 Gg. Alkanes, aromatics and oxygenated VOCs (OVOCs) were the most important species, accounting for 25.9%-29.9%, 20.8%-23.2% and 18.2%-21.0% to annual total emissions respectively. Discrepancies in emission estimation were explored for chemical and refinery sector with various data sources and methods. Compared with Multi-resolution Emission Inventory for China (MEIC), the spatial distribution of emissions in this work were more influenced by the locations of large point sources, and smaller emissions were found in urban region for developed cities in southern Jiangsu. Besides, clear discrepancies were found between this work and MEIC in the speciation of NMVOC emissions under the atmospheric chemistry mechanisms CB05 and SAPRC99. The difference of species OLE1 resulted mainly from the updated source profile of building paint use, and the differences of other species from the varied sector contributions to emissions of the two inventories. CMAQ simulation was applied to evaluate the two inventories, and better performance (indicated by daily 1h-max O_3 concentrations in Nanjing city) was found for January, April and October 2012 when the provincial inventory was used.

Inclusion of the urban momentum and thermal drag effect within the ACM2 PBL Scheme in the WRF Model to obtain the wind profiles

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ABSTRACT

A realistic representation of the planetary boundary layer (PBL) structure and its periodic evolution is crucial for better numerical simulation and forecasting of the regional meteorological conditions and air pollutant dispersion. Various PBL schemes (local and non-local) have been integrated in the Weather Research and Forecasting (WRF) model to incorporate the governing turbulence within the PBL. In addition, these schemes are tied to the different land surface models to account the heat and moisture fluxes evolved from the earth's surface. A few years back, the urban models such as UCM (Urban Canopy Model), BEP (Building Effect Parameterization) and BEM (Building Energy Model) have been developed and included within the WRF model. The motive behind this was to enhance the representation of the urban surface phenomenon such as the heat island effect and the turbulence caused due to the complex built urban structures these days e.g. street canyons. This has improved the PBL structure creation over the urban cities worldwide. However, the widely used BEP-BEM model these days, which runs in parallel with the WRF model increases the computational requirements and the simulation time additionally.

In the recent years, the performance of the four PBL schemes, namely MYJ, Boulac, YSU and ACM2 has been analyzed over the Pearl River Delta (PRD) region in the Southern China. From the results, it was concluded that the non-local ACM2 scheme has shown good agreement with the observation of the meteorological field variables and the PBL height over the Hong Kong city. In this research, an attempt has been made to include the related governing urban physics within the ACM2 PBL scheme itself by modifying it. It is expected that performing simulations over the complex urban structure cities like Hong Kong with the newly modified ACM2 scheme will produce the vertical profile of the horizontal wind-speed as well as the urban roughness sublayer turbulence characteristics both of which are critical for the air pollutant dispersion within less computational time.

KEYWORDS: Weather research forecast; Pearl River delta; Urban; Air pollution; Asymmetric convective model; Planetary boundary layer

Indoor and outdoor air quality and carbonaceous characteristics of aerosols at residential homes in four cities: Hong Kong, Shanghai, Xi'an, and Guangzhou

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ABSTRACT

This study investigated the indoor and corresponding outdoor air quality, as well as the carbonaceous fractions in $PM_{2.5}$ particles at residential homes in Hong Kong, Shanghai, Xi'an and Guangzhou during winter/spring season from November 2016 to March 2017. Several different parameters including the mass concentration of $PM_{2.5}$ particles, mixing ratio of CO, CO_2 as well as TVOC have been investigated. Filter-based $PM_{2.5}$ samples were also collected for chemical analysis. During sampling, information of the residential homes, including the room area, number of occupants, and occupational activities has been recorded. The average mass concentrations (in $\mu g/m^3$) of indoor $PM_{2.5}$ were 34.0 ± 8.1, 50.1 ± 17.5, 78.7 ± 27.3, and 56.6 ± 18.4 in Hong Kong, Shanghai, Xi'an and Guangzhou, respectively. Average I/O ratios of $PM_{2.5}$ particles larger than 1 were observed in Hong Kong (1.02) and Shanghai (1.30), indicating the significance of indoor sources of air impurities. While the average I/O ratios of $PM_{2.5}$ particles in Xi'an (0.74) and Guangzhou (0.98) were less than 1, highlighting the influence of outdoor air quality. Occupational activities such as smoking, incense burning, and cooking were proved to be significantly affecting the indoor air quality. According to the thermal/optical carbon analysis, the carbonaceous aerosols contributed about one third of the total $PM_{2.5}$ mass for both indoor and outdoor. Among eight investigated carbonaceous fractions, OC2 and OC3, for which the major sources might be the indoor combustion activities, dominated in the mass concentration. EC1 fractions also counted for relatively high portion even in indoor samples, indicating the occurrence of particle infiltration and penetration from outdoor to indoor environment.

KEYWORDS: Indoor air quality; $PM_{2.5}$; Carbonaceous aerosol; Diurnal variation; Human influential factors

Inflammation responses to water-soluble fractions of fine particular matter ($PM_{2.5}$) in ten big cities of China during one year

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ABSTRACT

$PM_{2.5}$ exposure mainly induced the oxidative stress and inflammatory, but which kinds of fractions have significant correlation with their toxicity and possible mechanisms in different sites and different seasons in China are still unclear. $PM_{2.5}$ from ten big cities in China were collected during four seasons, and the water-soluble fractions of $PM_{2.5}$ were used to evaluated the potential of interleukin-6 (IL-6), and interleukin-6 (IL-8) release in A549 and Bease-2B cells. Water-soluble inos, water-soluble metal(loid)s, humic-like substances fractions (HULIS) levels, NMR (Nuclear Magnetic Resonance) characters were detected, principal component analysis (PCA)were carried out tried to find the most potent stimulator for pro-inflammatory. Results showed that during same volume air, water-soluble fraction had higher pro-inflammatory potential than organic-soluble fraction in human cells, and $PM_{2.5}$ water-soluble fractions from seaside cities induced lower pro-inflammatory than that from inland cities. Normally, pro-inflammatory potency resulted to be higher for spring and summer $PM_{2.5}$ with respect of winter and autumn, though higher $PM_{2.5}$ existed in winter and summer. In China, IL-6 was associated with PCA3 (mainly included NH_4^+, Pb, Ca, and V), NMR1, and NMR3. HULIS fraction might be the main fractions inducing pro-inflammatory release. Furthermore, hypomethylation of RASSF2 and CYP1B1, which were involved in these two gene expression increase might contribute to pro-inflammatory secretion, and these results were confirmed *in vivo*. Above all our study firstly explored the potential of $PM_{2.5}$ induced pro-inflammatory in larger area of China, and pointed that HULIS may be major toxic components in $PM_{2.5}$ in China, mechanisms results may help to novel therapeutic targets for $PM_{2.5}$ exposure in future.

KEYWORDS: $PM_{2.5}$; DNA methylation; CYP1B1; RASSF2; HULICS

Influence of interaction between marine and continental air masses on the ozone pollution in coastal region of South China Sea

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ABSTRACT

Marine atmosphere is usually considered to be a clean atmospheric environment, while this study indicates that air quality over the near-coast waters in the SCS was even worse than coastal cities. The analyses were based on concurrent field measurements of target air pollutants and meteorological parameters conducted at a suburban site (TC) and at a nearby marine site (WS) from August to November 2013. The observations showed that the levels of primary air pollutants (i.e., CO, SO_2, NO_x and VOCs) were significantly lower at WS than those at TC, while ozone (O_3) value was greater at WS. Higher O_3 levels at WS were attributed to the weaker NO titration and stronger O_3 production capacity because of much lower NO_x compared to TC. However, O_3 episodes were concurrently observed at both sites under certain meteorological conditions, such as tropical cyclones, continental anticyclones and sea-land breezes (SLBs). Driven by these weather systems, the interaction of continental and marine air masses had profoundly changed the atmospheric composition and subsequently influenced the formation and redistribution of O_3 pollution in the coastal areas. When continental air intruded into marine atmosphere, the O_3 pollution was magnified under the strong oxidative environment and wandered for hours - days over the SCS. Then, the exaggerated O_3 pollution over the SCS was re-circulated to the coastal inshore by sea breeze, leading to even aggravating O_3 pollution. The local governments should take this into account before enforcing measures to control O_3 pollution in the coastal areas of South China.

KEYWORDS: Continental air pollution; Maritime atmosphere; Mesoscale recirculation; Ozone photochemistry

Influence of synoptic condition and holiday effects on VOCs and ozone production in the Yangtze River Delta region, China

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ABSTRACT

In order to understand the influence of synoptic condition and holiday effects on ozone production in the Yangtze River Delta region, China, concentrations of speciated volatile organic compounds (VOCs) and O_3 as well as other relevant trace gases were simultaneously measured at the Station for Observing Regional Processes of the Earth System (SORPES) in Nanjing around the National day holidays of China in 2014. Different groups of VOC species and their chemical reactivities were comprehensively analyzed. The obvious enhancement of the VOC tracers during the National Day holidays (Oct. 1st-Oct. 7th) indicated that the holiday effect strongly influenced the distribution of VOC profile and chemical reactivity in the atmosphere. At the same time, two large-scale anticyclone processes were also observed during the measurement period. The integrated influences of synoptic and holiday effects were also analyzed with an Observation Based Model. The calculated relative increment reactivity (RIR) of different VOC species and groups revealed that during national holidays, this region was in VOC limited regime and the variation of RIR shows a close linkage to the development and elimination of anticyclones, indicating an in-negligible contribution of synoptic effect toward ozone production.

KEYWORDS: Yangtze River Delta region; synoptic condition; holiday effects; Observation Based Model; relative increment reactivity

Insights into the mechanism of severe haze formation in China: progress and challenges

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ABSTRACT

China has experienced severe haze pollution, with fine particulate matter (PM) reaching unprecedentedly high levels across many cities in recent years. In addition to their profound impacts on human health, fine aerosols interact directly and indirectly with the Earth's radiation budget, influencing weather and climate. An understanding of the PM formation mechanism is critical in the development of efficient mitigation policies to minimize its local, regional, to global impacts. The mechanisms leading to severe haze formation with exceedingly high $PM_{2.5}$ levels in China remain uncertain, and the abundance and chemical constituents of $PM_{2.5}$ vary considerably, depending on complex interplay between meteorology, emission sources, and atmospheric chemical processes. This talk will discuss the key aspects relevant to severe haze formation in China, including the fundamental chemistry and meteorological conditions. In particular, recent progress in the understanding of the complexed chemical processes leading to secondary PM formation will be emphasized. Future research needs relevant to the understanding of severe haze events in China will also be discussed.

Integrate analysis to differentiate impact of individual air pollution control policies

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ABSTRACT

The air quality in China now is mainly a regional and even a super-regional issue. Spatiotemporal variation in the concentration of air pollutants are influenced by various factors including meteorological conditions (e.g. wind speed and direction), and emissions of air pollution. To improve air quality and protect public health, different level of governments has implemented a range of intervention programmes to control the anthropogenic emissions (e.g. emission from industrial and powerplants), as well as closely works with different counterparts to implement a joint air quality management plan to tackle the regional smog problem. Since air quality changes caused by meteorological conditions and emissions are generally intertwined, to better ascertain the effectiveness of these intervention programmes, the contributions of meteorological conditions and regional impact should be distinguished. Because different analytical protocols have different strengths and limitations, it would be necessary to carry out a holistic study to look at the problem consistently with the use all assessments. In this study, take air pollution control polices applied on the traffic and marine vessel emission in Hong Kong since 2014 as an example, several approaches, including the PMF-based source apportionment, wind and non-wind decomposition analysis, as well as the numerical-based source apportionment are integrated to differentiate the impact of individual air pollution control polices. The results show a quite good agreement and consistency that reduction in NOx, PM_{10} and $PM_{2.5}$ concentrations between the pre-control and after-control periods, and the reduction was mainly driven by emission control. This study presents an integrated method for quantifying the effectiveness of control programmes on air quality.

Investigation on public's behavior to air pollution of Beijing subway commuters and the $PM_{2.5}$ exposure in the subway cars

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ABSTRACT

With the public awareness of air pollution increased significantly in recent years, during the haze days, the percentage of the public go out wearing masks and use air purifiers indoor has been significantly increased. However, the air quality in public places such as the subway, there are relatively limited research on the potential health risk of air pollution in the subway to the passengers. This study examines the public awareness, protection behavior, $PM_{2.5}$ exposure and willingness to pay for air pollution mitigation measures through questionnaire-based survey. The results show that the age, sex, income, educational level of the respondents and whether they have children are related to whether they are taking protective measures and whether they are buying protective equipment for air pollution. At the same time, $PM_{2.5}$ concentration in subway cars were also monitored while conducting the survey, the results show that during the project period the subway $PM_{2.5}$ concentrations were higher than the outdoor, with the average monitoring value of 143 $\mu g/m^3$, and among the monitored subway lines there is obvious difference in terms of the $PM_{2.5}$ level. The study estimates the long-term health risk of $PM_{2.5}$ exposure in Beijing subway commuters by applying the Exposure-response Functions and Pope's relevant empirical research data.

KEYWORDS: Air Pollution; $PM_{2.5}$ Exposure; Beijing Subway; Health Risk; Exposure-response Relationship

Kaohsiung Linhai special industrial park air quality monitoring system

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ABSTRACT

The Linhai Special industrial park is located at Kaohsiung of Taiwan, with the area of about 1560 hectare, including over 500 factories as well as some big industrial plants such as China steel and China Petroleum Company. It is in the transportation hub, with Kaohsiung Port and ShaoGan airport nearby and Tai17 express way crossing through. In addition, the Linyuan petrochemical industrial part and Dafa Industrial park are also near the area. 8 air quality monitoring stations (AQMS) were set up in 2015 to launch a 6.5yr programme to continuously measure the real time concentrations of ambient air pollutants of SO_2, NOx, CO, O_3, THC and PM_{10}, as well as 54 species of organic photochemical precursor by employing on-line monitors. Other gas samples are collected manually and once per 6 days, including 52 hazardous air pollutants, $PM_{2.5}$, odor substances and other air toxics of HCHO, CH_3CHO and Dioxin. Meteorological parameters such as wind direction, wind speed, temperature, rainfall, relative humidity, are also continuously monitored at each AQMS. All collected air quality and metrological data are simultaneously uploaded to the EPB system. The operation center office is also established to provide 24hr service to monitor the operation performance of all AQMS. QA/QC work for the online instrument at each AQMS are also completed in the operation office through remote control. All collected data will be used to examine the air quality status near the industrial part, analyze the air quality trend, and identify the potential sources that cause air quality deterioration or where the accident leakage come from.

KEY WORDS: Special Industrial Park, air quality monitoring

Key techniques for monitoring, forecasting and evaluating ozone in Beijing

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ABSTRACT

Beijing Municipal Environmental Monitoring Center(BMEMC) established an air quality forecasting and early warning system including numerical model, statistical prediction model and discriminate prediction system and this study introduced the key techniques for monitoring, forecasting and evaluating secondary air pollutant O_3 in Beijing. The average annual 90th percentile of daily maximum 8-h concentration from 2013 to 2016 was 183, 197, 203 and 199μg·m-3, respectively. Ozone concentration was lower in central urban area and higher in northern and western area with more vegetation. There were two pollution belts of ozone in Beijing and its surrounding areas. A pollution zone was mainly concentrated in Beijing-Baoding-northern Shanxi regions, the other was mainly concentrated in Beijing-Tianjin-Bohai areas. Compared with the temperature, the correlation between NO_2/NO and $O_3$1h is stronger (Rs=0.81), which can better indicate the change of ozone. For the parade on the 70th Victory Memorial Day for the Chinese People's War of Resistance against Japanese Aggression, we divided into four stages, S1 (August 1st, 2015 to August 19th, 2015), S2 (August 20th, 2015 to August 31st, 2015), S3 (September 1st to September 3rd, 2015) and S4 (September 4th to September 30th, 2015). The ozone peaks were sorted as S1>S4>S2>S3, indicating the most effective effects of enhanced version of the emergency emission reduction during S3 stage. From the experience of foreign governance, ozone governance is a more long-term, arduous and complex process. Ozone and PM2.5 pollution in Beijing are two aspects of a problem.

KEYWORDS: Ozone; Monitoring and forecasting Precursors; Grand Military Parade; Beijing；NO_2/NO

Long-term mortality benefits of air quality improvement during the Twelfth Five-Year-Plan period in 31 capital cities of China

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ABSTRACT

The severe air pollution across China in the past several years has made the Chinese government recognize its significant impacts on public health and society, and take enormous efforts to improve the air quality all over the country, especially during the Twelfth Five-Year Plan (12^{th} FYP) which started in 2011 and ended in 2015. However, the overall effectiveness of these policies remains unclear. Here, we selected the capital cities of all 31 provinces/municipalities in mainland China as study settings. We collected the annual average population size, mortality rates and concentrations of air pollutants (PM_{10}, $PM_{2.5}$, SO_2 and NO_2) in each capital city from 2010 to 2015 from national or local Statistical Yearbooks. The effect sizes of air pollutants on mortality were obtained from published meta-analyses or cohort studies. We first estimated the annual mortality rates attributed to the changes in air pollutant concentrations for every city in each year. Then, we further estimated the mortality benefits in the scenarios where the air quality had reached the grade 2 levels of Chinese Ambient Air Quality Standards (CAAQS) and World Health Organization (WHO) guidelines. In most capital cities, we observed dominant decreases in air pollutant concentrations during the 12^{th} FYP, particularly from 2013 to 2015, which has led to significant mortality benefits for the public. The morality benefits were larger in capital cities located in the key regions (the three main regions and ten city groups) than the other cities. In addition, more mortality benefits could be obtained in the future if the air quality reaches the grade 2 levels of CAAQS or WHO guidelines. We concluded that substantial mortality benefits have been achieved due to the improvements in China's air quality, which indicated its air pollution control policies implemented during the 12th FYP were significantly effective.

KEYWORDS: Air pollution; health benefits; total mortality; cancer mortality

Long-Term Observations in Hong Kong: $PM_{2.5}$ Speciation and Sources

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ABSTRACT

The Environmental Protection Department of Hong Kong SAR (HKEPD) included fine particulate matter ($PM_{2.5}$) mass in its air quality monitoring network as one of the criteria pollutants from 1999 onwards and promulgated the first air quality objectives for $PM_{2.5}$ mass in 2014. A few $PM_{2.5}$ chemical speciation studies were conducted during 2000-2010 and the regular monitoring operation of the $PM_{2.5}$ speciation network was started in 2011. In this study, the spatiotemporal variation patterns of $PM_{2.5}$ composition in Hong Kong were investigated based on six years' observations (2011–2016). Generally, the major components of $PM_{2.5}$ include sulfate (SO_4^{2-}), ammonium (NH_4^+), and carbonaceous material. Nitrate, formed from atmospheric oxidation of nitrogen oxides, contributed less than 10% to the total $PM_{2.5}$ mass. Elemental carbon, exclusively from combustion sources, exhibited a clear roadside-urban-suburban gradient pattern among the sampling sites. Throughout the year, higher $PM_{2.5}$ levels were usually observed during fall and winter months. The extra mass between the high and low $PM_{2.5}$ concentrations was mainly attributed to ammonium sulfate and organics which usually presented high concentrations simultaneously across all the sampling sites, suggesting that regional sources were the most probable $PM_{2.5}$ contributors on high PM days.

Source apportionment of $PM_{2.5}$ using the Positive Matrix Factorization (PMF) model was conducted and the identified contributing sources include vehicular exhaust, biomass burning, residual oil combustion, crustal dust, sea salt, industrial processes and secondary aerosol formation processes. The spatiotemporal variations of the source contributions suggest that local emission sources were largely responsible for the observed $PM_{2.5}$ level during summer months while sources in the regions outside Hong Kong (e.g. biomass burning, industrial processing, and secondary aerosols) made greater contributions in winter months, which were usually associated with northeast monsoons.

The comprehensive dataset has offered us a unique opportunity to study and track the changes in the contributions from different $PM_{2.5}$ sources and to monitor the effectiveness of the control measures. This continuous ground-level sampling effort is highly recommended so as to provide quantitative details for elucidating the formation mechanisms of PM and to provide sufficient data for adequate health impact assessments of specific PM components.

Mass spectra features of particles emitted by two burning boilers by single particle aerosol mass spectrometer

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ABSTRACT

Examining the size and chemical composition of particulate emissions are of tremendous importance in order to clearly identify and apportion the particles observed in ambient measurements. In this study, single particle mass spectra signatures of both coal burning boiler (CBB) and biomass burning boiler (BBB) emitted particles were studied. Particle samples were suspended in Resuspension Chamber, and analyzed by ELPI and SPAMS simultaneously. The size distributions of BBB and CBB particles were different, as BBB peaks at smaller size. Mass spectra signatures of two samples were studied by applying ART-2a to extract characteristic mass spectrum in different size ranges. In conclusion, CBB sample got higher fractions of Al_Silicate-containing particles than BBB as size increase. Part of the single particle mass spectrum signatures of two source samples in the same size are similar, which bring challenge to future source apportionment activity.

Methanol: meeting the 2020 challenge

Domlavigne

ABSTRACT

Methanol is an important chemical feedstock and alternative energy application that is being widely used on a global basis. The methanol industry is one of the world's most dynamic and vibrant. By producing a basic chemical molecule that touches our daily lives in a myriad of ways, the methanol industry has spanned the entire globe.

Worldwide, more than 90 methanol plants have a combined production capacity of about 100 million metric tons (90 billion liters). Each day, more than 100,000 tons (225 million liters) of methanol is used as a chemical feedstock or as a transportation fuel.

Methanol comes in liquid form and is primarily derived from natural gas or coal (China); ultra-clean, renewable methanol is also increasingly being developed from bio-waste and from carbon dioxide (CO_2). In recent years, demand has increased significantly for methanol's use in energy applications which include marine fuels and for land transportation.

In light of recent International Maritime Organization (IMO) policies which have capped sulfur (SOx) emissions in existing emission control areas (ECAs) to 0.1% from January 1, and with a global SOx cap of 0.5% on January 1, 2020 (as well as expected NOx and CO_2 maritime restrictions from 2021 onwards), governments and ship-owners globally are now looking at how best to address this. The Hong Kong government implemented legislation on July 1, 2015 limiting SOx emissions by ocean-going vessels (OGVs) berthing in Hong Kong to 0.5%. China established similar ECAs (0.5% SOx emissions) for ships berthing in the Yangtze River Delta and in Shenzhen from April 1, 2016 and October 1, 2016, respectively. China is expected to implement a country-wide ECA in 2019.

Methanol represents an important energy solution that can yield extremely low SOx, NOx, and CO_2 emissions, and will help ship owners meet the current and future IMO guidelines.

Globally, the Stena *Germanica* passenger ferry was converted in March to run on methanol. Methanex, the world's largest methanol producer, took possession in 2016 of seven MAN engine, dual-fuel methanol shipping tankers. MI is involved with several projects in the EU that include building of a large cruise ship running on methanol, as well as methanol's use in inland marine applications. The association is engaging with stakeholders in Singapore, Hong Kong, and China on development of similar methanol marine pilot projects in the next few years.

Mixing state of oxalic acid containing particles in the rural area of Pearl River Delta, China: implications for the formation mechanism of oxalic acid

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ABSTRACT

The formation of oxalic acid and its mixing state in atmospheric particulate matter (PM) were studied using a single particle aerosol mass spectrometer (SPAMS) in the summer and winter of 2014 in Heshan, a supersite in the rural area of the Pearl River Delta (PRD) region in China. Oxalic acid-containing particles accounted for 2.5% and 2.7% in total detected ambient particles in summer and winter, respectively. Oxalic acid was measured in particles classified as elemental carbon (EC), organic carbon (OC), elemental and organic carbon (ECOC), biomass burning (BB), heavy metal (HM), secondary (Sec), sodium-potassium (NaK) and dust. Oxalic acid was found predominantly mixing with sulfate and nitrate during the whole sampling period, likely due to aqueous phase reactions. In summer, oxalic acid-containing particle number and ozone concentration followed a very similar trend, which may reflect the significant contribution of photochemical reactions to oxalic acid formation. The HM type particles were the most abundant oxalic acid particles in summer and the diurnal variations of peak area of iron and oxalic acid show opposite trends, which suggest a possible loss of oxalic acid through the photolysis of iron oxalato complexes during the strong photochemical activity period. In wintertime, carbonaceous type particles contained a substantial amount of oxalic acid as well as abundant carbon clusters and biomass burning markers. The general existence of nitric acid in oxalic acid-containing particles indicates an acidic environment during the formation process of oxalic acid. The peak areas of nitrate, sulfate and oxalic had similar temporal change in the carbonaceous type oxalic acid particles, and the organosulfate-containing oxalic acid particles well correlated with total oxalic acid particles during the episode, which suggests the formation of oxalic acid is closely associated with the oxidation of organic precursors in aqueous phase.

KEYWORDS: Oxalic acid; Single particles; Mixing state; Photochemical process; Aqueous phase reactions.

Monitoring and analysis of $PM_{2.5}$ inorganic aerosols and water-soluble gases in Hong Kong

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ABSTRACT

Inorganic aerosols account for a large portion of $PM_{2.5}$ mass, and are composed of a variety of species including metal ions and ions formed from secondary formation. In addition, three water-soluble gases: nitric acid, ammonia and hydrochloric acid, can have a dramatic impact on the inorganic PM concentrations. Therefore, through studying inorganic aerosols and associated gases together with meteorological parameters and air mass trajectories, chemical analysis of inorganic aerosols can be explored. In this study, the abundance, diurnal pattern, and composition of $PM_{2.5}$ inorganic aerosols and water-soluble gases were investigated at an urban (Yuen Long) and suburban (HKUST) site in Hong Kong. The measurements were conducted from 3 October to 29 November 2016 using a Monitor for Aerosols and GAses (MARGA), an online measurement system with hourly time resolution for analysis of SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Ca^{2+}, Mg^{2+}, K^+ (aerosol) and HNO_3, NH_3, HCl, SO_2, and HONO (gas) at a low detection limit (0.01-0.09 μgm^{-3}). Among all the species, NH_4^+ and SO_4^{2-} were found to be the most abundant cation and anion, respectively at both sites, contributing 23% and 45% of the $PM_{2.5}$ mass at the Yuen Long site and 20% and 59% at the HKUST site on average. For the gas phase, NH_3 concentrations ranged from 0.056 – 10.694 μgm^{-3} (HKUST site) and 1.182 – 14.859 μgm^{-3} (YL site). Most of the time, the YL site had a higher NO_3^- concentration because of the higher concentration of the NH_3 available to react with HNO_3 in the YL site while the SO_4^{2-} concentration at HKUST was higher. NH_4^+ concentrations were similar at the two sites. Several high nitrate episodes were found at the YL site, indicating that a larger influence from local sources of nitrate compared to HKUST, where most nitrate has been regionally transported to the site.

KEYWORDS: MARGA, Inorganic aerosol, nitrate, $PM_{2.5}$

Modeling study on source contributions to an ozone pollution episode in Nanjing

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ABSTRACT

Rapid growth of industrialization, transportation, and urbanization has caused increasing emissions of ozone (O_3) precursors, enhancing the O_3 formation and increasing the frequencies of O_3 pollution events. A widespread and severe O_3 pollution episode from 22 to 26 May 2015 in Nanjing has been simulated using the Weather Research and Forecasting model coupled to chemistry (WRF-CHEM) to evaluate the contribution of biogenic and various anthropogenic sources to O_3 pollution. The model well simulated the temporal variations and spatial distributions of near-surface O_3 concentrations. Using the factor separation approach, sensitivity studies have demonstrated the relative roles of different sources in forming this episode. The results show that industry source plays the most important role in the O_3 formation for the severe O_3 pollution in Nanjing, accounted for about 48%. The transportation source contributes considerably to the O_3 formation with obvious daily variation, while the O_3 contribution of agriculture source is higher than transportation source in general. Besides, residential source contribution is not significant generally, and contribution of biogenic source can almost be ignored.

KEYWORDS: O_3; source; contribution; Nanjing

Modelling air pollutants including SOA during summer and autumn of 2014 in eastern China

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ABSTRACT

The Weather Research and Forecasting model and the Community Multiscale Air Quality model (WRF/CMAQ) were used to reproduce air pollutants including Secondary Organic Aerosols (SOA) during the summer (July and August) and autumn (October) of 2014. Observations of O_3, NO_2 and $PM_{2.5}$ based on the 357 monitoring network stations set up by the Ministry of Environmental Protection (MEP) were used to evaluate model performances. The simulated concentrations of air pollutants of WRF/CMAQ model showed good consistency in costal China provinces. The Mean Bias Error of O_3 and NO_2 ranged from -38.8 μg/m^3 to 34.9 μg/m^3 and from -21.0 μg/m^3 to 41.6 μg/m^3, respectively. Along with the change of monsoon season, high concentrations of anthropogenic Secondary Organic Aerosols (ASOA) varied from northern China in summer to southwestern China in autumn. While regions of high biogenic Secondary Organic Aerosols (BSOA) were mainly located in southern China during both seasons. The maximum monthly average concentrations of BSOA varied from 6.98 μg/m^3 in summer to 4.89 μg/m^3 in autumn with the changes of biogenic VOCs emissions between the two seasons. Compared to BSOA, ASOA showed less variations in concentration levels with the maximum of 1.61 μg/m^3 in summer and 1.64 μg/m^3 in autumn, respectively. The aqueous-phase-sourced aerosols (including aerosols originated from glyoxal and methylglyoxal) made important contributions to total SOA with the maximum of 5.1 μg/m^3 in an average of two seasons. Organosulfates was mainly produced in southwestern China during summer. The distributions of isoprene-derived-organosulfates (iOS) showed similar pattern with the southeastern USA.

KEYWORDS: WRF/CMAQ; SOA; eastern China; air pollutants

Multiplexed double imaging photoelectron photoion coincidence spectroscopy utilized to investigate free radical reactions in atmospheric chemistry: The CH_3 and O_2 reaction

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ABSTRACT

In this talk, we will present a multiplexed approach of double imaging photoelectron photoion coincidence spectroscopy (i^2PEPICO) coupled with a microwave discharge flow tube and tunable vacuum ultraviolet (VUV) synchrotron radiation to investigate free radical reactions in atmospheric chemistry. The i^2PEPICO scheme provides a novel strategy to obtain pure spectra of products without contamination of other byproducts and a multiplexed and universal detection with high sensitivity and selectivity is achieved. As a representative example, the CH_3 and O_2 reaction has been selected and investigated in detail in experiments. The products towards different reaction pathways, together with some minor products from subsidiary reactions occurred in the flow tube, have been simultaneously and definitely determined in the mass-selected threshold photoelectron spectra (TPES) and photoionization efficiency spectra (PIES), in both of which the isomeric or isobaric products have been successfully identified.

KEYWORDS: Free radical reaction; Double imaging photoelectron photoion coincidence; Threshold photoelectron spectroscopy; Photoionization mass spectrometry; Methylperoxy radical

Next-generation environmental compliance monitoring system and strategy

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ABSTRACT

Ineffective compliance monitoring leads to widespread environmental non-compliance in many developing countries. Next-generation environmental compliance monitoring technologies – many in the general category of Big Data – are rapidly emerging and evolving, including sensors, satellites as well as social media. They often have much lower costs per polluting source, but the accuracy is rarely high enough for legitimately issuing legal and administrative penalties. Based upon the economic theory of crime and punishment, this paper constructs a conceptual, computable model to simulate and evaluate a next-generation compliance monitoring system that utilizes these new technologies to screen polluting sources. The system could achieve greater cost-effectiveness in comparison with the traditional monitoring, reporting and verification system. With more resources that are available only for a short period, enforcement campaigns under the screening system could yield and more importantly sustain high compliance rates even after the campaigns are over, while under the traditional system, the short-lived campaigns will only generate short-term compliance. These new technologies and systems could trigger profound reform of environmental enforcement, governance and strategy.

KEYWORDS: Big Data; Next-generation compliance monitoring technologies; Environmental policy and governance; Enforcement and compliance

New particle formation and growth at a suburban site and a background site in Hong Kong

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ABSTRACT

Atmospheric nanoparticles have great impacts on human health and global climate change. The number concentrations and size distributions of nanoparticles in the size range of 5.5-350.4 nm were detected at a background site and a suburban site in Hong Kong from summer to winter in 2011 and in autumn of 2013, respectively. Significantly higher particle number concentrations in all modes were observed at the suburban site (p<0.05). The fraction of nucleation mode particles was higher at the suburban site (33.3±0.3%) than at the background site (16.0±0.2%), perhaps due to more frequent and intensive new particle formation (NPF) in suburban areas, as well as the growth/loss of nucleation mode particles during the transport of air masses to the background site. Particle number concentrations were much enhanced under northerly winds at both sites, resulting from regional transport of Aitken and accumulation mode particles, enhanced local NPF and occasionally low condensation sink. NPF was mainly limited by the precursors of condensable vapors and oxidative capacity of the atmosphere at the background site and the suburban site, respectively. In most cases, the formation rate of 5.5 nm particles was a function of sulfuric acid vapor to the power of 1.32±0.34 at the background site and 0.81±0.31 at the suburban site, abiding by the cluster activation theory. However, ozonolysis of monoterpenes (particularly α-pinene) might also drive NPF, particularly in the afternoon. These reactions also contributed to the growth of nucleation mode particles, which was largely explained by sulfuric acid vapor (73.6±10% at the background site and 60.4±9.8% at the suburban site). In contrast, the oxidations of isoprene, β-pinene and aromatics were found to participate in the growth of Aitken mode particles.

KEYWORDS: Atmospheric nanoparticle; New particle formation; Particle growth; Sulfuric acid vapor; Volatile organic compound

New particle formation during a spring cruise campaign across the South China Sea in 2017

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ABSTRACT

In this study, we investigated (new particle formation) NPF events in the marine atmosphere during a spring cruise campaign across the South China Sea using a Fast Mobility Particle Sizer and a Condensation Particle Counter (CPC) simultaneously. Seven NPF events were observed in 6 days out of 32 samping days. In 7 NPF events, 5 events occurred in daytime and 2 events occurred at nighttime. However, no apparent particle growth was always observed in the NPF events. The median mobility diameter of new particle mode was contant at ~10 nm. The formation rates (FR) of new particles (in the range of 5.6–30 nm) varied from 5.7 to 29.2 $cm^{-3}s^{-1}$, while the consendation sink (CS) ranged from 0.009 to 0.041 s^{-1} failed to explian the FR. The coefficient of variation (CV) was referred as a metric to distinguish horizontal and vertical transpot of aerosol particle. In this study, all the CVs of $N_{10\text{-}30}$ were higher than those N_{100} which suggested that NPF very likley occurred at aloft. Our study implied that the growth of newly formed particles with the diamter at 10 nm could be prevented under unfavoriable environmental conditons, but the mechanim needs more futher study.

KEYWORDS: NPF; marine atmosphere; no apparent growth

‘New’ reactive nitrogen chemistry reshapes the ozone relationship to its precursors

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ABSTRACT

Tropospheric ozone pollution has been a major environmental issue, and mitigation of this persistent problem requires comprehensive understanding of the sensitivity of ozone to its precursors, i.e., nitrogen oxides (NO_x) and volatile organic compounds (VOCs). Recent studies have proposed several ‘new’ reactive nitrogen chemical processes, including the additional sources of nitrous acid (HONO) and the heterogeneous uptake of dinitrogen pentoxide (N_2O_5) and production of nitryl chloride ($ClNO_2$). They have been shown to significantly affect the budget of the radicals and NO_x hence the formation of ozone. In present study, we aim to investigate to what extent these new chemical processes alter the relationship between ozone and the precursors and hence the precursor-control strategy. A revised Weather Research and Forecasting model coupled with Chemistry (WRF-Chem), incorporated with the ‘new’ nitrogen chemistry, was adopted to simulate the impact of nitrogen chemistry on the concentration of radicals and NO_x and prediction of ozone sensitivity regime in China during a summer season. The results showed that the nitrogen chemistry significantly increased the level of RO_x radicals and reduced the concentration of NO_x, and noticeably changed the ozone-sensitivity regime Forty percent of the simulated area, where ozone formation is influenced by anthropogenic emissions, changed the O_3 sensitivity regime due to the newly introduced nitrogen chemistry, mostly from VOC-sensitive to mixed-sensitive and from NO_x-sensitive to mixed-sensitive. Sensitivity tests indicated that the nitrogen chemistry changed the isopleth plots of the ozone peak values in the major cities in China, and implied different strategy in controlling the O_3 pollution. This study underscores the need to consider the unconventional nitrogen chemistry in air quality models which are used in design of ozone control strategies.

KEYWORDS: nitrous acid; nitryl chloride; ozone sensitivity; WRF-Chem

Numerical Simulation and Field Observation of Ozone Formation and Accumulation in the Pearl River Estuary

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ABSTRACT:

Sampling campaigns were simultaneously conducted at a rural site (Qi'ao) in Zhuhai and a suburban site (Tung Chung) in Hong Kong from 25 September to 29 November, 2016. An interesting ozone accumulation phenomenon was found in several high ozone episode events over the Pearl River Estuary. The Weather Research and Forecasting (WRF) coupled with Chemistry model was deployed to understand this phenomenon. The model simulation performances of meteorological variables and air pollutants agreed well with the observations. The index of agreement (IOA) for temperature, wind speed and ozone mixing ratio were 0.74, 0.54 and 0.82, respectively. It was found that the downdraft of peripheral typhoon as well as the high pressure system caused stable synoptic conditions with low wind speed, elevated temperature and low level of relative humidity. Specifically, a horizontal divergence wind field with very low wind speed was captured from 10:00 to 12:00 am in the estuary during those episode events, in which ozone as well as its precursors brought by upwind were trapped. In the afternoon of episode days, with the enhancement of sea breezes, the aged air masses with high ozone levels were brought back to coastal area. The simulated results showed that the estuary with horizontal divergence wind field provided a natural "pool" for ozone formation and accumulation during the morning hours on episode days. Besides, we also found that different directions of sea breezes could influence the ozone spatial distribution in surrounding cities of the estuary. The simulated planetary boundary layer heights on episode days also presented the characteristics of poor dispersion of air pollutants.

KEYWORDS: Ozone accumulation; WRF-Chem; Horizontal divergence wind field; Sea breezes; The Pearl River Estuary.

Numerical Study of Mobile Source Emission to Air Pollution in Beijing

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ABSTRACT

The major purpose of this article is to run the regional-scale emissions modeling-SMOKE-MOVES integration tool to estimate emissions for Beijing. MOVES2011b-the emissions model released by EPA, it allows MOVES users easily account for emissions under car and light truck energy and so on. MOVES default database was stored in the MySQL Workbench; users input the custom domain option to define separate zones, with separate Vehicle Miles Travelled (VMT) and some other activity inputs for each zone on MOVES Worker (GUI Program). We can obtain the inventory or Emission Rates in the MOVES Output of the custom domain based on the runspec it generated by custom domain options. The Sparse Matrix Operator Kernel Emissions (SMOKE) is an emissions processing system, it is a tool for converting emission inventory data (point sources, area sources, mobile sources) to the required data format by Air Quality Models, like CMAQ. For Mobile sources, SMOKE can generate an emission inventory from mobile-source activity data, using emission factors from the MOVES model. SMOKE-MOVES integration tool relies on the “reference county”, MOVES generates key emission rates for each county group, includes RPD (rate-per-distance), RPV (rate-per-vehicle) and RPP (rate-per-profile), and then these emission processes are treated as individual sectors in SMOKE. The innovation of this essay is that we use Multi-Model integration (MOVES-SMOKE-CMAQ) to simulate the air pollution in Beijing, the advantage of the attempt is that we utilizes the SMOKE-MOVES integration tool, we can have a precisely on-roadway emissions and off-network emissions to input the CMAQ Model, thus analyze the vehicle emissions contribution and forecast the air quality in Beijing.

KEYWORDS: mission; SMOKE-MOVES; air pollution; numerical simulation

Oscillation of Surface $PM_{2.5}$ Resulted from Alternation of Easterly and Southerly Wind in Beijing: Mechanisms and Implications

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ABSTRACT

Simultaneous measurements of surface $PM_{2.5}$ concentrations, profiles of aerosol, temperature and humidity in Beijing were used together with regional air quality model simulations to study an aerosol pollution episode during November 15-19, 2016. Potential effects of easterly and southerly winds on surface $PM_{2.5}$ concentration and its profile were investigated. Favorable easterly winds produced strong upward motion of air and thereby were able to transport surface $PM_{2.5}$ to the upper level of the atmosphere. The amount of surface $PM_{2.5}$ transported by easterly winds was determined by the strength and height of the upward motion of air produced by easterly winds as well as the initial height. More $PM_{2.5}$ was transported to the upper level by a lower initial height of upward wind. The pollutants are diluted by the easterly winds from the clean ocean air masses. The inversion layer was firstly destroyed by easterly wind. Surface pollutants and warm air masses were then lifted to the upper level and accordingly formed multi-layer inversion again. The inversion was strenghthened by southerly wind and thereby pollution was even worse. Positive vortex was produced by southerly winds that led to air convergence along the Taihang Mountains. Pollutants were transported from south-central Hebei province to Beijing in the boundary layer. Warm advection associated with southerly winds intensified the inversion produced by easterly wind and thereby a much more stable boundary layer was formed. The layer with high $PM_{2.5}$ got deeper as southerly wind with certain depth was persistent. The polluted air masses tended to climb over northern Taihang Mountains and moved to northern mountainous regions of Hebei province.

KEYWORDS: easterly wind; southerly wind; thermodynamic structure; $PM_{2.5}$; model simulation

Particulate nitrate in PM_1 and $PM_{2.5}$ at a suburban site in Hong Kong

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ABSTRACT

Pollution by atmospheric particulate matter (PM) is regarded as one of the most severe environmental problems in China[1]. Abatement measures have substantially reduced emissions of primary pollutants such as SO_2, and have eased the problem of secondary formation of sulfate to a certain extent[2]. Nevertheless, secondary nitrate formation still remains a key issue due to high NO_x emissions. Nitrate typically exists in fine mode as ammonium nitrate and in coarse mode as sodium or calcium nitrate[3,4]. In the present work, nitrate formation and partitioning behavior was investigated by measurements taken at Hong Kong University of Science and Technology (HKUST) during 2011 and 2012. Real-time mass concentrations measured by Monitor for Aerosols and Gases in ambient air (MARGA), which measures species in $PM_{2.5}$ (<2.5 μm), and Aerodyne High-Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS), which measures species in PM_1 (<1 μm), as well as mass size distributions measured by Micro-orifice Uniform Deposit Impactor (MOUDI). Thermodynamic model E-AIM[5] was also employed to estimate the particle acidity. Particulate nitrate formation is evaluated against temperature (T), relative humidity (RH), sulfate content, and particle acidity with respect to its seasonality, diurnal pattern and size distribution. Gas-to-particle partitioning of ammonium nitrate was generally favorable in winter and at night time as a result of low temperature and high RH as evidenced by attainment of thermodynamic equilibrium. Nitrate displayed bimodal size distribution in both fine mode and coarse code in winter with considerable elevation of nitrate concentration in fine mode (PM_1) compared to other seasons. Results from the current study might shed some light on the thermodynamic partitioning of particulate nitrate, which will affect both its abundance and size distribution.

KEYWORDS: nitrate; secondary; thermodynamic equilibrium

$PM_{2.5}$ mass, chemical compositions and sources in megacities in China

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ABSTRACT

To obtain a thorough knowledge of $PM_{2.5}$ chemical composition and its impact on aerosol optical properties across China, existing field studies conducted after the year 2000 are reviewed and summarized in terms of geographical, inter-annual, and seasonal distributions. Annual $PM_{2.5}$ was up to six times of the National Ambient Air Quality Standards (NAAQS) in some megacities in northern China. Annual $PM_{2.5}$ was higher in northern than southern cities, and higher in inland than coastal cities. In a few cities with data longer than a decade, $PM_{2.5}$ showed a slight decrease only in the second half of the past decade, while carbonaceous aerosols decreased, sulfate (SO_4^{2-}) and ammonium (NH_4^+) remained at high levels, and nitrate (NO_3^-) increased. The highest seasonal averages of $PM_{2.5}$ and its major chemical components were typically observed in the cold seasons. Annual average contributions of secondary inorganic aerosols to $PM_{2.5}$ ranged from 25% to 48%, and those of carbonaceous aerosols ranged from 23% to 47%, both with higher contributions in southern regions due to the frequent dust events in northern China. Source apportionment analysis identified secondary inorganic aerosols, coal combustion, and traffic emission as the top three source factors contributing to $PM_{2.5}$ mass in most Chinese cities, and the sum of these three source factors explained 44% to 82% of $PM_{2.5}$ mass on annual average across China. Biomass emission in most cities, industrial emission in industrial cities, dust emission in northern cities, and ship emission in coastal cities are other major source factors, each of which contributed 7-27% to $PM_{2.5}$ mass in applicable cities.

KEYWORDS: Fine particles; urban atmosphere; Source apportionment analysis

$PM_{2.5}$ Source apportionments and characteristics of different cities in Sichuan using a single particle aerosol mass spectrometer(SPAMS)

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ABSTRACT

The fine particulate matter characteristics dates during 2017 were collected by the single particle aerosol mass spectrometer(SPAMS), the monitoring location including Chengdu, Mianyang and Guangan in Sichuan province. In accordance with the source spectral library of atmospheric pollutant emissions in Sichuan, the main sources were distinguished and analyzed. The results showed that ① Most of the fine particulate matter were less than 1μm in both three cities. ② The peak of $PM_{2.5}$ number concentration in Guangan, Mianyang and Chengdu were 0.54μm, 0.5μm and 0.6μm respectively, which indicating that the mixed degree of $PM_{2.5}$ in Chengdu was higher than Guangan and Mianyang. ③ In term of chemical constituents, the proportion of carbon particles number in Guangan were higher than Mianyang and Chengdu, the proportion of OC and OCEC particles in Mianyang were the highest in three cities, the proportion of K-rich particles in Chengdu were larger than other two cities. ④ Coal combustion, vehicle emission and industry pollution were the major sources of $PM_{2.5}$ in three cities. ⑤ The contributing of vehicle emission and secondary sulfate in Chengdu were stand out compared to Mianyang and Guangan, Meanwhile, the contributing of biomass burning, dust and coal combustion in Mianyang were the highest.

KEYWORDS: Sichuan province; Fine particulate matter; SPAMS

$PM_{2.5}$ trends in China from 2001 to 2015 using satellite remote sensing

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ABSTRACT

Given the vast territory of China, the long-term $PM_{2.5}$ trends may substantially differ among the provinces. In this study, we aim to assess the provincial $PM_{2.5}$ trends in China during the past few Five-Year Plan (FYP) periods. The lack of long-term $PM_{2.5}$ measurements, however, makes such assessment difficult. Satellite remote sensing of $PM_{2.5}$ concentration is an important step toward filling this data gap. In this study, a $PM_{2.5}$ data set was built over China at a resolution of 1 km from 2001 to 2015 using satellite remote sensing. Analyses show that the national average of $PM_{2.5}$ concentration increased by 0.11 $\mu g \cdot m^{-3} \cdot yr^{-1}$ during the 10^{th} FYP period (2001 to 2005) and started to decline by -0.75 $\mu g \cdot m^{-3} \cdot yr^{-1}$ and -2.42 $\mu g \cdot m^{-3} \cdot yr^{-1}$ during the 11^{th} (2006 to 2010) and the 12^{th} (2011 to 2015) FYP period, respectively. In addition, substantial differences in the $PM_{2.5}$ trends were observed among the provinces. Provinces in the Beijing-Tianjin-Hebei (BTH) region had the largest reduction of $PM_{2.5}$ concentrations during the 10^{th} FYP period. During the 12^{th} FYP period, provinces in the BTH region and the central China (e.g., Hubei, Hunan) had the largest improvement in $PM_{2.5}$ concentrations. In contrast, $PM_{2.5}$ concentrations remained steady for provinces in eastern China (e.g., Shanghai) during the 12^{th} FYP period. In overall, great efforts are still required to effectively reduce the $PM_{2.5}$ concentrations in future.

KEYWORDS: $PM_{2.5}$; Satellite remote sensing; High resolution; Long-term trend; Provincial scale.

Pollution characterization and source apportionment of atmospheric fine particles in Wuhan city

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ABSTRACT

In order to research the forming reasons of atmospheric haze and control particulate matter pollution in Wuhan city, the analytical study of source apportionment of atmospheric fine particles in Wuhan was conducted during 2014-2015. This study was based on five representative sampling sites (Huangpi station、 Chenhu hotel, Qingshan station, Wu-jiashan station, Monitoring supersite) in Wuhan, which collected atmospheric fine particulate matter from January to December, 2014. Combined with air quality automatic monitoring data, the chemical composition of $PM_{2.5}$ was analyzed. The results showed that the annual average concentration of $PM_{2.5}$ in Wuhan was 82μg/m^3, which was standard by 1.34 times, the concentration was the highest in January and the lowest from July to September. Organic matter (OM) was the most abundant component in $PM_{2.5}$(30%), followed by sulfate (21%), nitrate (15%), elements (12%), ammonium (10%), EC (3%), and etc. By the method of Positive Matrix Factorization (PMF) to analyze sources of $PM_{2.5}$, which was combined with emission inventories of pollution sources, comprehensive source appointment result was obtained: industrial emission (32%), motor vehicle (27%), coal combustion (20%), dust (9%) and other sources (including biomass burning, domestic pollution and agricultural pollution, 12%). The contribution rate of industrial emission was significantly increased from secondary source apportionment, industrial emission source turned to be the primary source of $PM_{2.5}$ in Wuhan city.

KEYWORDS: Fine particles; source apportionment; chemical composition; PMF

Pollution characteristics of the water-soluble inorganic ions in $PM_{2.5}$ during the Spring Festival of 2015 in Beijing

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ABSTRACT

In order to investigate the impacts of fireworks on air quality in Beijing, highly time-resolved measurements of inorganic ions associated with fine particles ($PM_{2.5}$) were conducted at an urban site in Beijing from 10 February to 19 March, 2015. Three fireworks events, exerting significant and short-term impacts on $PM_{2.5}$, were observed on the days of Lunar New Year, Lunar Fifth, and Lantern Festival. The concentrations of water soluble inorganic ions during the three holidays were 84.97 ± 25.86 μg/m^3, 72.27 ± 23.82 μg/m^3 and 97.43 ± 16.70 μg/m^3, respectively, accounting for dominant fractions of 58.9 ± 6.0 %, 47.1 ± 9.3% and 48.3 ± 4.0% in $PM_{2.5}$, respectively. K^+ and Cl^- extremely enhanced on the Chinese Spring Festival eve and their peak values reached 63.32 μg/m^3 and 44.89 μg/m^3 at 00:00, accounting for 29.3 % and 20.8 % in $PM_{2.5}$, respectively. K^+ and Cl^- were mainly from fireworks with a good correlation (R^2 = 0.86) during the three episodes. Furthermore, the concentrations of SO_2 and NOx were more than 3 times higher than those observed in clean periods and also elevated simultaneously with K^+ and Cl^- when fireworks were burning. K^+-rich particles were transited to SNA (SO_4^{2-}, NO_3^-, NH_4^+) -rich particles after fireworks burning and the ratio of SNA in $PM_{2.5}$ varied from 0.25 to 0.61. The sulfur oxidation ratios (SOR) and the nitrogen oxidation ratios (NOR) were 0.40 and 0.23, which implied that sulfate and nitrate were mainly produced by the secondary oxidation. The conversion of SO_2 to SO_4^{2-} was observed to be sensitive to changes in RH. The SOR sharply increased at RH > 60% with the highest value of 0.91 at RH around 84% during the three holidays. However, nitrate formation was less consistent with rising RH compared to sulfate. The results suggested the need for control of intensive fireworks discharge to reduce the high levels of K^+, Cl^-, SO_2 and NOx, and the severe $PM_{2.5}$ pollution during holiday episodes.

KEYWORDS: $PM_{2.5}$; Firework; Festival; ions

Proteins and amino acids in fine particulate matter in rural Guangzhou, Southern China: seasonal cycles, sources, and atmospheric processes

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ABSTRACT

Water-soluble proteinaceous matter, including free and combined amino acids (proteins and peptides), is important to nitrogen cycle. For better understanding of the characterization and atmospheric processes of proteinaceous matter, one-year observation of proteins and free amino acids (FAAs) in fine particulate matter ($PM_{2.5}$) as well as air pollutants was conducted at Tianhu, Guangzhou. The annual averaged protein and FAA concentrations were 0.79 ± 0.47 μg m^{-3} and 0.13 ± 0.05 μg m^{-3}, accounting for 1.9 ± 0.7% and 0.3 ± 0.1% of $PM_{2.5}$, respectively. Sources of proteins and FAAs were investigated. Moreover, correlations analyses of proteins/FAAs and atmospheric oxidant (O_3) suggest that FAAs could be released upon the degradation of proteins and peptides under the influence of O_3.

KEYWORDS: $PM_{2.5}$; Protein; Free Amino Acids; Atmospheric Process

Potential impacts of electric vehicles on air quality in Taiwan

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ABSTRACT

Electric vehicles have been identified as a potential option for reducing air pollution, especially over urban areas. In this study, we used a regional air quality model to simulate gaseous and particulate pollutants in Taiwan, aiming at evaluating the prospective impacts of EV penetration on air quality. The simulations were parameterized using the best currently available emission inventories (TWEPA, 2015; Li et al., 2015), and the results were compared to the surface chemical measurements.

We assumed a 100% replacement of current light-duty vehicles in Taiwan. The burden of electricity supply (~58.1 billion kWh) was shifted to either coal-fired power plants or clean energy sources. With this ambitious EV penetration, CO, VOCs, NO_x and $PM_{2.5}$ emissions in Taiwan from on-road sources would be reduced by 1500 (85%), 165 (79%), 33.9 (27%) and 7.2 (27%) Gg yr^{-1}, respectively. On the other hand, electric sector NO_x and SO_2 emissions would be increased by up to 20.3 (29%) and 12.9 (29%) Gg yr^{-1} if all electricity were provided by thermal power plants. Overall, total emissions of most pollutants except for SO_2 (which increased by 11%) would be considerably reduced by EV penetration.

We further analyzed the consequent impacts of EV on the level of air quality. Replacement with EV would be effective in reducing annual mean surface concentrations of CO (by 260 ppb), VOCs (by 11.3 ppb), NOx (by 3.3 ppb) and $PM_{2.5}$ (by 2.1 μg m^{-3}), while SO_2 would increase slightly (by 0.1 ppb). The large reductions tended to occur at times and places with high ambient concentrations. Greater benefits would clearly be attained if clean energy sources were fully encouraged. EV penetration would cause widespread reductions in annual average O_3 peak values (up to 7 ppb) across Taiwan, except for a slight increase (< 2 ppb) in downtown Taipei.

Further analysis suggests that EV penetration would tend to be of significant benefit to the mitigation of high pollution episodes. Calculated regional mean pollution episode days (AQI > 100) in Taiwan would be reduced by 7–9 d yr^{-1} (11–15%), and the local reductions may reach 44 d yr^{-1} in highly-polluted Taichung city. We found O_3 and $PM_{2.5}$ to be the main causers of air pollution, and attributed at least 70% of the improvements to O_3 reduction. Our findings are important for understanding the potential effects of EV on air quality, and can provide useful information to local governments for use in air pollution strategies.

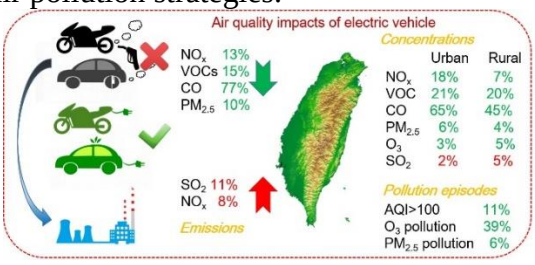

Figure 1. Air quality impacts of electric vehicle in Taiwan.

KEYWORDS: Electric vehicle; Air quality; AQI; CMAQ.

Predicting pollutant emissions from agricultural waste burning in Guangdong Province using neural network

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ABSTRACT

The trace gases and aerosols emitted from agricultural waste burning have large impacts on air quality in many parts of China, including in particular the Pearl River Delta. These seasonal emissions are variable in space and time, posing a challenge for air quality forecasts. Here, we used back-propagation neural network (BPNN) technique to predict the daily variability of agricultural waste burning. The BPNNs were constructed and trained using a decade (2003-2012) of daily assimilated meteorological data from NCEP FNL, including surface temperature, relative humidity, air pressure and wind speed, and fire pixels counts from the Moderate Resolution Imaging Spectroradiometer (MODIS). The data from the year 2013 to 2015 were used for validation. The correlations between the predictions and observations were from 0.41 to 0.83. The interannual change of fire counts can also be forecast by BPNN models. In forecast mode, we drove resulting BPNNs with NCEP FNL forecast to obtain daily fire pixel forecasts, which were in turn used to scale the monthly mean Fire Inventory from NCAR (FINN). The resulting BPNN successfully forecast fire emission inventory in Southern China in 2014 with an accuracy of 70%. We compared air quality forecasts driven by our daily-variable emission inventory, as well as forecasts driven by the monthly mean FINN using WRF-chem. We showed that our daily-variable inventory led to signifcant improvements in the forecasts of $PM_{2.5}$ concentrations in Southern China.

KEYWORDS: Back-propagation neural network; Fire emission forecast; $PM_{2.5}$ concentration

Pro-inflammatory effects of $PM_{2.5}$ from Beijing winter haze: revealing the role of individual external and internal microbiome

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ABSTRACT

China has experienced frequently serious haze weather in recent years, leading to a huge amount of research into the source and formation mechanism. Air pollution is widely recognized to be closely associated with respiratory and cardiovascular disease. Oxidative stress and inflammation is the most accepted mechanism that causes pollutants associated adverse health effects so far. However, the exact mechanism is still not fully clarifid. Human microbiome composes of microorganisms that is 10 times more than our own cells, has gained increasing attention in keeping individual healthy. In particular, components from our resident microbiome, i.e., lipopolysaccharide (LPS), play an important role in regulating immune homeostasis. This study aims to investigate the potential synergistic role of air pollutants and microbial components which will shed new light on the understanding of the mechanism.

Particulate matters smaller than 2.5 μm ($PM_{2.5}$) collected in Beijing during 2016 winter haze period were used to stimulate THP-1-derived macrophages. The cellular immune response was evaluated by measuring the cytokine production, including IL-1β, IL-8, TNF and IL-6. To simulate the internal body microenvironment exposure, extra LPS of different concentrations together with $PM_{2.5}$ water extractions was applied to study the cellular response. No toxicity was detected when 10 μg/ml $PM_{2.5}$ extractions were given to the macrophages. The pro-inflammatory immune effect of $PM_{2.5}$ collected on days of different pollution levels varies, however, it was not induced by the cytotoxicity. Chemical and biological characteristics of $PM_{2.5}$ indicates that this discrepancy in cellular inflammatory response was attributed to particle-borne LPS and metal levels (Fe and Ni). Furthermore, the pro-inflammatory cytokine secretion was augmented when macrophages were stimulated with $PM_{2.5}$ in the presence of extra LPS. Samples collected from heavily polluted weather show stronger magnifying pro-inflammatory effects when 100 pg/ml LPS was applied. Whereas, the magnification effect was weak in the presence of either 1 or 10 pg/ml LPS. PCR array assay results suggest that oxidative stress plays vital role in the magnifying effects of $PM_{2.5}$. Knowing the body internal microenvironment can be of great importance to evaluate the $PM_{2.5}$-associated health effects. The results obtained here provide evidence about the synergistic effects of $PM_{2.5}$ and microbial components LPS. Overall, this study highlights the growing significance of researches on the human microbial environment, especially respiratory microbiome, to unravel the underlying mechanism at cellular and molecular level.

KEYWORDS: $PM_{2.5}$; LPS; Microbiome; Oxidative stress; inflammation

Potential Exposure to Fine Particulate Matter ($PM_{2.5}$) and Black Carbon on Jogging Trails in Macau

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ABSTRACT

The health effects of atmospheric particulate matter (PM) has been a major environmental concern in urban areas. Most PM studies are mainly designed to measure the "ambient" or "emitted" concentrations of PM. Some studies are specifically designed to address exposure to PM for pedestrians, commuters on-board vehicles or at bus stops, but less attention is paid to the exposure during physical exercise[4] such as jogging. To this end, concentrations of both fine particulate matter ($PM_{2.5}$) and black carbon (BC) were measured along three jogging trails in the densely populated city Macau of China. The three jogging trails include the campus of University of Macau (UM), Guia Municipal Park (GP), and Saivan Lake (SL). In our measurements, $PM_{2.5}$ and BC ranged from 2.9 to 84.1 and 0.4 to 19.5 μg/m³, respectively. BC/ $PM_{2.5}$ ratio ranged from 0.02 to 0.4. Among all three jogging trails, the highest BC concentration was found at SL (19.5 μg/m³), and the highest $PM_{2.5}$ concentration was found at UM (84.1 μg/m³). On the contrary, the BC and $PM_{2.5}$ concentrations at the elevated GP trail were lower than at the other two jogging trails. BC and $PM_{2.5}$ concentrations were generally lower in the night loops (21:00 – 23:00) than those in the morning loops (7:00 – 9:00) which coincide with morning rush hours, with only a few exceptions. Difference in geographical locations also affect the BC and $PM_{2.5}$ concentrations measured, with locations near bus terminals, busy roads, or with congested street canyons having higher concentrations. Doses of BC and $PM_{2.5}$ after 60 min of exposure during typical jogging exercise are also estimated to evaluate the exposure to PM pollutions at these three jogging trails when exercising. The results from the current studies provide information both on personal choice for the time/venue for jogging exercise and on future abatement policy to mitigate such risks of exposure to BC and $PM_{2.5}$.

KEYWORDS: exposure; $PM_{2.5}$; black carbon; jogging

Relative humidity intensifying visibility impairment in wintertime haze pollution in Nanjing

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ABSTRACT

With the analysis of haze pollution in the wintertime of 2012-2015 in Nanjing, fine particulate matter ($PM_{2.5}$) is the leading factor affecting air quality in winter. Statistical analysis shows a significantly negative correlation between $PM_{2.5}$ concentration and visibility with $r = -0.58$, $p<0.001$. The atmospheric visibility is exponentially related to $PM_{2.5}$ mass, with a correlation coefficient of 0.61. The relative humidity (RH) is one of the important factors influencing the atmospheric visibility of winter. With the same $PM_{2.5}$ concentration, the visibility decreases with the increasing RH. Under different RH ranges, the fitting results of the visibility and $PM_{2.5}$ concentration accord with the power function distribution, the visibility is exponentially decreases with the increase of $PM_{2.5}$ concentrations. The goodness of the fitting and inflection point values decline with the addition of the RH. The influence of $PM_{2.5}$ on the visibility becomes weaker with increased RH. Accounting for this twofold effect of high $PM_{2.5}$ concentration and RH on visibility impairment in Nanjing, the multiple linear regression equation is constructed based on these two factors to quantify the relative contributions of the two factors to the visibility. It is identified that the contributions of $PM_{2.5}$ and RH respectively with the factors of 0.52 and 0.48 to the impairment of visibility in Nanjing wintertime is equivalent, reflecting both anthropogenic emissions and climate change exerting exhibiting impacts on air quality change.

KEYWORDS: Visibility; $PM_{2.5}$; Relative humidity; Nanjing

Real-world gaseous and particle emissions from individual city buses in Gothenburg

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ABSTRACT

Exhaust emissions of 221 individual city buses at Euro III, Euro IV, Euro V, Euro VI and EEV (Enhanced Environmentally Friendly Vehicle) emission levels were measured under real-world conditions at Linholmen bus station in Gothenburg. The buses represented different technologies from the viewpoint of engines, fuels, and exhaust after-treatment systems. Both gaseous (NOx, CO, HC and SO_2) and size-resolved particle number and mass emission factors were calculated for compressed natural gas (CNG), diesel, biodiesel, biodiesel-electric (HBY) buses equipped with diesel particulate filter (DPF), selective catalyst reduction (SCR) and exhaust gas recirculation (EGR) under acceleration driving mode. The emission factors were in the range of 5-22 × 10^{14} g (kg fuel)$^{-1}$, 2−52 g (kg fuel)$^{-1}$, 1.9-31.2 g (kg fuel)$^{-1}$, 0.6-3.2 g (kg fuel)$^{-1}$, 0.05-0.36 g (kg fuel)$^{-1}$, 0.07−0.25 g (kg fuel)$^{-1}$, for particle number (EF_{PN}), nitrogen oxides (EF_{NOx}), carbon monoxide(EF_{CO}), hydrocarbon (EF_{HC}), sulfur dioxide (EF_{SO2}) and particle mass (EF_{PM}), respectively. The on-road measurements results showed that Euro VI engine technology gave the lowest EF_{NOX}, EF_{CO}, and EF_{HC}. The highest EF_{PM} was obtained from the diesel buses without DPF and the lowest from the CNG buses and diesel buses equipped with DPF. The highest EF_{PN} was obtained from HBY buses which indicates some failure of the secondary power.

KEYWORDS: Vehicle emission; Emission factor; Biodiesel; Hybrid bus; Diesel Engine

Refined 2013-based vehicle emission inventory and its spatial and temporal characteristics in Zhengzhou, China

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ABSTRACT

Vehicle emission is becoming one of the most important pollution sources because of the increase in vehicle population and activity in China. A more reasonable and complete vehicle emission inventory in Zhengzhou for the year 2013 was developed in this study. This inventory is suitable for local emission factors and vehicle kilometers of travel. Estimates show that the total carbon monoxide (CO), hydrocarbon (HC), nitrogen oxide (NO_X), particulate matter ($PM_{2.5}$ and PM_{10}) and sulfur dioxide (SO_2) emissions were 291, 35, 106, 6, 7, and 3 kt, respectively. Approximately 55% of CO and HC emissions were from light duty gasoline vehicles and normal gasoline motor vehicles, whereas approximately 60.0% of NO_X, $PM_{2.5}$, PM_{10} and SO_2 were from heavy duty diesel vehicles, heavy duty diesel trucks, and medium duty diesel trucks. The spatial distribution of emissions was allocated in grid cells based on a road network and traffic flows with a resolution of 1 km × 1 km at different road types and locations, which shows that the six aforementioned air pollutants have similar characteristics in administrative districts. Emissions are mainly concentrated on the central grid cells of each part and in good agreement with line sources. The spatial characteristics were compared at a resolution of 3 km × 3 km and in a population-based approach. The network approach yields better level estimates in this study. Meanwhile, the preliminary temporal profiles were also established for on-road mobile source.

KEYWORDS: Vehicle; Emission inventory; Spatial distribution; Grid-based; Zhengzhou

Role of particulate organics in short-chain alkyl amine uptake by ammonium sulfate-organics mixed particles

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ABSTRACT

Short-chain alkyl amines (NR_3) are important alkaline gases beside ammonia (NH_3) in the atmosphere. Field measurements and thermodynamic modeling have revealed much higher short-chain alkyl aminium-to-ammonium concentration ratios in the particles than the corresponding concentration ratios of NR_3 to NH_3 in the gas phase, in large part due to heterogeneous uptake of NR_3 by ammonium-containing particles. The degree of NR_3 uptake has been thought to rely on the phase state of ammonium salts, while the influence of particulate organics on NR_3 uptake remains unknown. Here we investigated heterogeneous dimethylamine (DMA) uptake by ammonium sulfate (AS)-organic mixed particles using an electrodynamic balance coupled with *in situ* Raman spectroscopy. DMA was selected as the NR_3 representative owing to its ambient abundance. Sucrose and oleic acid were selected as surrogates for hydrophilic and hydrophobic organics, respectively. For AS-sucrose mixed particles, DMA uptake was generally effective except for the water-limiting and ultraviscous scenarios. Judging from the estimated DMA uptake coefficients, we propose that sucrose can accelerate DMA uptake by absorbing particulate water and inhibiting AS crystallization, or retard DMA uptake by increasing the particle viscosity and forming an ultraviscous coating. For AS-oleic acid mixed particles, oleic acid always forms a coating over AS because of its strong hydrophobicity. The oleic acid coating retards DMA uptake due to poorer accommodation of DMA gas molecules on the coating than on the uncoated AS surface. An intensively ozone-aged oleic acid coating further retards DMA uptake because of an increased viscosity of the coating. Heterogeneous DMA uptake by AS forms dimethylaminium sulfate in particles, which effectively enhances the hygroscopic growth of aerosol particles over AS. Findings from this work provide a deeper understanding towards the dependency of multi-phase chemistry on the phase state of aerosol particles with various compositions.

KEYWORDS: dimethylamine; heterogeneous uptake; viscosity; particle coating

Research on testing method of product docking technology for multi scale air quality forecast in China

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ABSTRACT

This study selected 17 units using the NAQPMS model forecast products and air quality forecast products, discussed and analyzed the forecast products' different effective utilization and the role of moderate conditions in heavy pollution processes in different units of national - regional – city. This study cleared different regions of city forecast operation needs and product deviation, in order to reduce the prediction error to improve the overall national prediction effect, provided daily work ideas, operation guidance and technical reference for different scale forecast. The results show that all kinds of products are made an important contribution to carry out provinces and cities air quality monitoring center daily forecast, the average accuracy rate of 52.33% for the capture of heavy pollution; guidance products can reflect the basic development and change of pollutant formation and trend, but in the $PM_{2.5}$ and O_3 prediction accuracy and prediction results of heavy pollution and low capture needs to be strengthened.

KEYWORDS: multi scale; forecast products; test evaluation

Review of $PM_{2.5}$ source apportionment results of 40 cities in China

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ABSTRACT

Due to the adverse effect of $PM_{2.5}$ on human health, climate change and air quality, $PM_{2.5}$ has attracted more and more attention of scientists and government. Source apportionment of atmospheric aerosols has been an important issue for pollution prevention and control strategies of the ambient particles in China. The aim of this study is to identify primary sources of $PM_{2.5}$ in different cities and areas. For the first time, based on the researches carried out by the Ministry of Environmental Protection since 2000 and other scientists, we summarized the spatial distribution of fine particulate matter concentration, pollutant sources and transport contribution in China from 40 cities. The results showed that coal combustion is an important source in Beijing, Tianjin, Hebei and surrounding areas; traffic emission is dominant contributor in Central China, South China and Southwest region while crustal dust (road dust, soil dust and construction dust) and industry contribute highest in South China and Northwest China respectively. These dominant sources contribute more than 25% to $PM_{2.5}$, and have obvious seasonal variation. The long-transport contribution is around 30%, and also plays a significant influence on $PM_{2.5}$. Suggestions for future research are provided including the need for standardizing protocols and methods for effective source apportionment.

KEYWORDS: $PM_{2.5}$; source apportionment; review; China

Seasonal Difference of PM_{10} Exposure In A Diesel Bus

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ABSTRACT

Bus passengers are easily/routinely exposed to the vehicular emissions. However, there is only limited information regarding the seasonal variation of particulate exposure along the entire bus route. Therefore, the present study investigated commuters' exposure to in-bus PM_{10} in a densely populated city, Macau. A busy route crossing the Macau peninsula and the Taipa island was chosen. The TSI DustTrak II 8530 aerosol monitor was used to measure the instantaneous PM_{10} concentration for a total of 56 bus trips with four groups of starting times (7:45AM, 8:15AM, 8:45AM, 9:15AM) during Feb.-Mar. and May-Jun. of 2012. The averaged duration of each trip was about 1.1 hour. A Holux M-241 GPS was used to record the bus position. It was found that the averaged concentration of each trip could vary significantly (28μg/m^3 to 189μg/m^3, mean: 64μg/m^3, standard deviation: 33μg/m^3). High averaged in-bus concentration occurred consistently during Feb.-Mar. (52μg/m^3 to 189μg/m^3, mean:87μg/m^3, standard deviation:33μg/m^3), while low concentrations were observed in May-Jun. (28μg/m^3 to 69μg/m^3, mean:42μg/m^3, standard deviation:8μg/m^3). In Feb.-Mar., traffic volumes could also affect the temporal pattern of instantaneous measurements. The in-bus PM_{10} level increased obviously when the bus passed through the high-density residential districts of Macau peninsula between 7:45AM and 8:45AM. However, similar pattern was not apparent in May-Jun.. The discrepancy was mainly caused by different ventilation modes (AC/non-AC) and higher background concentration in Feb.-Mar.. It was further supported by the higher correlation coefficient of 0.72 between the averaged in-bus concentration and the concentration measured at the Taipa ambient station (altitude: 110m above MSL) during Feb.-Mar. compared to the coefficient of -0.05 obtained in May-Jun.. Finally, the inhalation dose was used for the exposure assessment. It was found that the average inhalation dose ratio of different seasons was 0.43, which is comparable to those of Guangzhou (0.63) and Hong Kong (0.66).

KEYWORDS: bus; exposure; PM_{10}; seasonal difference

Seasonal and annual variations in atmospheric Hg and Pb isotopes in Xi'an, China

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ABSTRACT

We present a 3-year time series of lead (Pb) and mercury (Hg) concentrations and isotope signatures in total suspended particulate (TSP) matter and as total gaseous Hg (TGM) in Xi'an, Northwestern China. Mean concentrations of TSP (299 ± 120 μg m^{-3}), Pb_{TSP} (0.33 ± 0.15 μg m^{-3}) and Hg_{TSP} (0.64 ± 0.54 ng m^{-3}), and TGM (5.7 ± 2.7 ng m^{-3}) were elevated. We find that atmospheric Pb levels in Xi'an have decreased by 4.6% per year since 2003, yet remain elevated relative to air quality guidelines and therefore a major health concern. $\delta^{202}Hg_{TSP}$ and $\Delta^{199}Hg_{TSP}$ averaged -0.80 ± 0.30 ‰ (1σ) and -0.02 ± 0.10 ‰ (1σ) and $\delta^{202}Hg_{TGM}$ and $\Delta^{199}Hg_{TGM}$ averaged -0.08 ± 0.41 ‰ (1σ) and 0.00 ± 0.04 ‰ (1σ). Relative to raw coal from Shaanxi and surrounding provinces, $\delta^{202}Hg_{TSP}$ is enriched in the light Hg isotopes, while $\delta^{202}Hg_{TGM}$ is enriched in the heavy isotopes. TSP and TGM $\Delta^{199}Hg$ signatures are indistinguishable from raw coal, indicating little photochemical mass independent fractionation of atmospheric Hg in the near-field urban-industrial environment. $\delta^{202}Hg_{TGM}$ correlates significantly with TGM levels (r^2 = 0.3, p<0.01) and likely reflects binary mixing of local industrial TGM emissions with global background TGM.

KEYWORDS: heavy metals; lead and mercury isotopes; atmospheric emission; China

Sensitivity and Improvement of $PM_{2.5}$ simulation to the below-cloud washout schemes in atmospheric chemical transport models

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ABSTRACT

Below-cloud washout (BCW) is an important process of removing the ambient pollutants in the atmosphere. Many BCW parameterizations have been proposed for application in different 3D air quality models. This study analyzes the sensitivity of $PM_{2.5}$ simulation and source apportionment results by integrating different BCW schemes into the CAMx model during the rainy days. Furthermore, studies have considered the influence of different raindrop terminal velocity, raindrop mean diameter, and raindrop size distribution parameterizations on the simulation. $PM_{2.5}$ time series, spatial maps and the average concentration of each individual city with using different BCW schemes are presented. Our results show that some different BCW schemes and raindrop size distributions can cause large discrepancies in a $PM_{2.5}$ simulation. The influence from different raindrop terminal velocity and raindrop mean diameter parameterizations is limited. The source apportionment results for some cities (e.g. Hong Kong) are also sensitive to the choice of the BCW scheme. After implementing the self-calculated BCW coefficients and considering the effects of aerosol compositions, the $PM_{2.5}$ simulation performance is better than the methods in CAMx v6.00 and CAMx v6.40. The BCW coefficients for specific aerosol compositions and raindrop size distributions offer two possible directions that worth the further efforts in order to acquire reliable simulation results for the rainy season.

KEYWORDS: Precipitation; Below-cloud washout; raindrop parameterization; CAMx model; $PM_{2.5}$

Simulation on the radiative effects of aerosols and the interaction with boundary layer meteorology and haze pollution in eastern China

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ABSTRACT

China has been experiencing an economic boom featuring fast urbanization, growing industrial production, tremendous energy consumption in recent decades, which lead to increasingly severe air pollution, especially for particular matters, i.e. aerosols. Such concentrated aerosols would exert substantial impacts on radiation transfer through their extinction effects, thereby influencing regional climate. To quantify the radiative effect of multicomponent aerosol over china, a diagnostic iteration method is developed and applied. Among all the chemical compositions, light-absorbing black carbon (BC) has been identified as the largest positive radiative effect on long-term scale. For typical air pollution episode like biomass burning, this radiative effect due to BC could modify regional weather significantly. Intensive emission of BC from straw burning in mid-June 2012 trapped a considerable part of solar radiation in the atmosphere and reduced incident radiation reaching the surface on a regional scale. The energy re-allocation gave rise to substantial adjustments in vertical temperature stratification and led to precipitation redistribution. Increasingly frequent haze event has triggered extensive public panic in recent years. We found that the radiative effect of BC and its impact on planet boundary layer (PBL) evolution also played a vital role. Specifically, light-absorbing BC induces heating in the PBL and simultaneously decreases surface heat flux, which substantially suppresses the development of PBL and consequently causes extreme haze pollution episode. Further studies suggested that this effect is sensitive to altitude of aerosol layer and can be significantly intensified by aging process of aerosols. Besides, the effect is more substantial in rural areas. It is expected that China's air pollution would benefit from black carbon reduction from elevated sources and domestic combustion.

KEYWORDS: black carbon; aerosol-boundary layer interaction; haze pollution

Single particle analysis of amine-containing aerosols at a coastal roadside site in Qingdao

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ABSTRACT

Amines play a critical role in the atmospheric chemistry. Marine source has been known to be an important source of amine, yet most of previous studies have focused on the bulk measurements with poor time resolution. In comparison, individual particle analysis can supply sufficient high time resolution information on both the size and chemical mixing state. In the present study, we conducted single particle measurements of amine-containing aerosols at a coastal roadside site in Qingdao from 07 to 17Aug 2016. A total 679,541 particles with both positive and negative mass spectra were recorded during this campaign, while 39.58% of these particles were detected as amine-containing aerosols, including trimethylammonium (TMA), diethylamine (DEA), and triethylamine (TEA). The results showed 249,521 particles were identified as TMA (m/z 59[$N(CH_3)_3]^+$) , accounting for 36.72 % of total chemical characterized particles. While 14,065 particles were identified as DEA (m/z 74 [$(C_2H_5)_2NH_2]^+$ or 86[$(C_2H_5)_2NCH_2]^+$) and TEA (m/z 86[$C_3H_7NHC_2H_4]^+$). With the in-situ measured hourly particle number intensity, different diurnal variations were observed for TMA and DEA. A larger number of TMA particles was consistently observed during nighttime compared with that in the daytime, while the DEA showed a sharp peak in the early morning around 5:00 to 6:00am. Art-2a classification were conducted to classify the amines into 10 major groups, in order to understand the detail interaction between the marine source amine aerosols and the traffic emitted particles. Air-sea exchange and the abundance of ambient NH_3 play an important role in the aerosol processing and thus influencing the mixing state of amine particles. Overall, the present analyses could help to improve our understanding in potential roles of amine containing particles in the coastal site aerosols.

KEYWORDS: trimethylammonium (TMA); diethylamine (DEA); single particle analysis; marine source aerosols; amines

Source apportionment and aerosol pH

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ABSTRACT

Acidity (aerosol pH) plays a key role in the physical and chemical behavior of $PM_{2.5}$. In this work, the relationship between sources and aerosol pH were investigated. Our research in north cities in China indicated that the AE/CE was not strongly correlated with pH, and the emission of all sources could influence particulate acidity. Coal and dust were proved to be positive to pH while vehicle, secondary sulfate and secondary nitrate were not. The impact of specific source would play the dominant role in different ranges of pH. In addition, annual average aerosol pH in an arid atmosphere was higher than cities such as Beijing, Tianjin and Atlanta, reflecting the high dust contributions to particulate matter levels and low secondary sulfate concentration.

Source apportionment studies and instrumental comparisons with the on-line system MARGA in Melpitz, Germany

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ABSTRACT

A quantification of the inorganic gas and the particulate (PM_{10}) phase was performed with the Monitor for AeRosols and Gases in ambient Air (MARGA) since 2010. The MARGA is located at the TROPOS research station in Melpitz, Germany. This is a representative site for the measurements of the atmospheric background conditions in Central Europe.

The gaseous and the particulate phase can be separated with the combination of a Wet Rotating Denuder (WRD) (Wyers et al. 1993) and a Steam-Jet Aerosol Collector (SJAC) (Khlystov et al. 1995). Two ion chromatography systems allow to quantitate the water-soluble gases (HCl, HONO, HNO_3, SO_2, NH_3) and the particulate ions (Cl^-, NO^{3-}, $SO4^{2-}$, Na^+, $NH4^+$, K^+, Mg^{2+}, Ca^{2+}) with hourly time resolution.

For the validation of the MARGA several comparisons were performed. The comparison with the standard PM_{10} filter measurements, ACSM and the SO_2 gas analyzer show good agreements. With the hourly time resolution since 2010, a huge data set is available. A Potential Source Contribution Function (PSCF) was calculated by combining the MARGA data with 96h backward trajectories. This method leads to the identification of different sources for the particulate phase. Both the change of anthropogenic and natural sources and the shift of potential source areas between the seasons have been observed. Meteorological influences and temporal variations can give further hints of the source of the measured compounds especially for the gaseous compounds (Stieger et al. 2017).

KEYWORDS: air quality; instrumental comparisons; MARGA, source apportionment; atmospheric long-term measurements

Source apportionment of volatile organic compounds and the contribution to photochemical ozone formation in a typical heavy industrial city

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ABSTRACT

Heavy industries, like steel smelting, coking, coal chemical, etc., concentrate in the area of Taiyuan and its peripheral regions, which lead to the air pollution situation is not optimistic in the urban area of Taiyuan. In order to study the pollution characteristics of volatile organic compounds (VOCs), ambient air samples were collected by the stainless steel canisters in the urban area of Taiyuan in the winter and summer of 2016, and 56 kinds of VOCs were measured by gas chromatography-mass selective detector/ flame ionization detector (GC-MSD/FID). The results showed that the concentration of VOCs (137.42 g/m^3) in winter was 3.2 times as in summer, since the low temperature and wind speed could lead to pollutant accumulation. The dominant contributor to VOCs in winter and summer was aromatic hydrocarbons and alkane, according for 45.91% and 51.35%, respectively. The diurnal variation of VOCs showed obvious two peaks in both seasons, with the characteristic of the peak in summer appeared much earlier than winter. The diurnal variation trend of VOCs, NO_2, and O_3 showed that the concentration of VOCs was significantly influenced by vehicle emission and photochemical reaction. The evaluation of ozone formation potential by using maximum incremental reactivity showed alkene and aromatic hydrocarbons were the dominant contributors to ozone formation potential in summer. Source analysis conducted using the positive matrix factorization (PMF) model indicated that the vehicle emission and coal combustion were the two major contributors to atmospheric VOCs. Therefore, although the sampling sites was located in a typical heavy industrial city, the influence of vehicle emission on the air quality should be gotten more attention, indicating that controlling vehicle emissions is key to reducing the air pollution.

KEYWORDS: Volatile organic compounds; Photochemical ozone formation; Source apportionment; Typical heavy industrial city

Sources and atmospheric evolution of fine particulate matter in middle-size Chinese cities during haze pollution events

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ABSTRACT

Particulate air pollution in China is a serious environmental problem that is influencing visibility, air quality, regional and global climates and human health. Understanding of the chemical composition and sources of fine particulate matter, the mechanisms and atmospheric processes of substantial wintertime secondary aerosol production, and the constraint of sources and formation processes of secondary organic aerosol during haze pollution events are essential for effective mitigation of particulate pollution. The current studies mainly focus on megacities or city cluster. However, middle-size cities (with population of around 1 million) constitute the main portion (~70%) of Chinese cities and also suffer from serious aerosol pollution. Here, we present the results from recent field measurement campaigns in several middle-size Chinese cities. The non-refractory chemical composition was measured using an Aerodyne aerosol mass spectrometer. Our results show that coal combustion, biomass burning, cooking, and vehicle emissions are important contributors to primary aerosol, and they show spatial difference. Further, the formation and evolution of secondary aerosol have significant contribution for haze pollution. The effects of temperature, humidity, atmospheric oxidative capacity on secondary aerosol formation are discussed.

KEYWORDS: Particulate air pollution; source apportionment; middle-size cities; atmospheric evolution

Sources and photochemical formation of C_1-C_5 alkyl nitrates in suburban Hong Kong and over South China Sea (SCS)

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ABSTRACT

C_1-C_5 alkyl nitrates ($RONO_2$) and their parent hydrocarbons were concurrently measured at a suburban site (Tung Chung, TC) in Hong Kong and at an offshore site (Wan Shan Island, WSI) over South China Sea (SCS) from August to November 2013. While higher propane and *n*-butane were observed at TC ($p<0.05$), $RONO_2$ were comparable ($p>0.05$) between the two sites. Source apportionment and in-situ photochemical simulation both revealed much higher secondary formation of $RONO_2$ at WSI ($p<0.05$), likely due to the fact that the higher oxidative capacity (more abundant oxidative radicals) at WSI led to more efficient oxidation of the hydrocarbon precursors. Secondary formation of C_2-C_5 $RONO_2$ via the "RO_2+NO" pathway dominated $RONO_2$ formation at both sites. However, the pathway of "RO+NO_2" accounted for a considerable fraction of $MeONO_2$ formation, with greater contribution at TC (41.4 ± 3.7%), likely due to higher NO_2 level. The calculated relative incremental reactivity (RIR) was firstly applied to evaluate $RONO_2$-precursors relationship. At TC, $RONO_2$ formation was limited by VOCs. In contrast, it turned to co-limited by VOCs and NO_x during O_3 non-episodes at WSI, while VOCs were still the predominant limiting reagents during episodes. Interestingly, the productions of C_1-C_3 $RONO_2$ were more sensitive to non-parent hydrocarbons than their parent hydrocarbons. However, the C_4-C_5 $RONO_2$ were almost produced from the oxidation of *n*-butane and *n*-pentane. At TC, secondary formation of $MeONO_2$ was mainly attributed to aromatics (36-38%) and carbonyls (18-20%), while secondary $EtONO_2$ was largely derived from C_4-C_6 hydrocarbons (75%). For 1- and 2-$PrONO_2$, C_4-C_6 hydrocarbons (27-36%) were also the most important contributors, apart from propane (27-33%). Slightly different situation was captured at WSI that secondary $MeONO_2$ was contributed by CH_4 (29-31%), followed by aromatics (26-27%). Also, propane had higher contribution to 1- and 2-$PrONO_2$ (43-54%) than C_4-C_6 hydrocarbons (38-43%) at this site. It may be because of different VOC compositions between the two sites. The contribution of non-parent hydrocarbons to $RONO_2$ originated from their decompositions into smaller molecule RO_2 or RO radicals, as well as their regulations on OH production in the atmosphere. At the suburban site, reactive VOC species like aromatics, BVOCs and carbonyls would enhance OH production, further contributing to $RONO_2$ formation. However, aromatics and BVOCs suppressed OH production at the offshore site, which inhibited their contributions to $RONO_2$ formation through decompositions.

KEYWORDS: Alkyl nitrate; Source apportionment; Photochemical formation; Pathway; $RONO_2$-precursors relationship

Spatical and temporal characteristics of absorbing aerosols during APEC based on OMI data

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ABSTRACT

Ozone Monitoring Instrument (OMI) data was used to analyze the optical properties of absorbing aerosols in the Jing-Jin-Ji region in the period before, during and after Asia-Pacific Economic Cooperation (APEC) and the respective value of the same three periods in the past decade in Beijing. The results showed that compared with pre-APEC and post-APEC period, AI (Aerosol Index), AOD (Aerosol Optical Depth), AAOD (Absorbing Aerosol Optical Depth) simultaneously decreased during APEC in Jing-Jin-Ji region and ASSA (Aerosol Single Scattering Albedo) increased. During APEC period in 2014, AI, AOD, AAOD in Beijing during APEC decreased by 10%, 49%, 30% compared with pre-APEC period, respectively; while compared with post-APEC, AI, AOD, AAOD during APEC decreased by 21%,23%,50%, respectively. All the results indicate the reduction of absorbing aerosols in APEC period in Jing-Jin-Ji region, and Beijing decreased more. Compared the respective value of the same three periods in the past dacade in Beijing, the variance of AI, AOD, AAOD and ASSA was without rhyme and random in some extent.

KEYWORDS: OMI; APEC; absorbing aerosol; Jing-Jin-Ji

Spatial and temporal characteristics of ozone formation sensitivity over PRD by ozone monitoring instrument

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ABSTRACT

Surface ozone pollution becomes more and more prominent in Pearl River Delta (PRD), which has been attributed to the emissions of nitrogen oxides (NO_x) and reactive volatile organic compounds (VOCs). This study characterizes spatial and temporal variations of ozone formation sensitivity over nine cities of PRD from 2013 to 2015 by analyzing the ratio (FNR) of formaldehyde (HCHO, a marker of VOCs) to nitrogen dioxide (NO_2), which was retrieved from the Ozone Monitoring Instrument (OMI). Based on previous researches, we use the indicator FNR to divide O_3 formation regimes. We regard FNR <1.0 as indicator of VOCs-limited regime, FNR> 2.0 as NO_x-limited regime, and FNR between 1.0 and 2.0 as transitional regime (where NO_x reductions or VOCs reductions will lead to O_3 reduction). A land cover classification (LCC) identifying urban, suburban and rural area of PRD cities was established and the sub-regional ozone sensitivity in nine cities in each month has been comprehensively analyzed. We found VOCs-limited regime is more likely to appear in central areas of PRD, NO_x-limited regime in the outermost, and the left is transitional regime, but these regimes vary distinctly in season and year. The study will provide data foundation and scientific basis for formulating sub-region and divided-period ozone control and management measures in PRD.

KEYWORDS: PRD; ozone sensitivity; OMI; FNR; land cover classification

Spatial and temporal pattern of surface ozone during the ninth BRICS summit: implication to control strategies

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ABSTRACT

The implementation of air pollution control measures during the ninth BRICS summit provided a good opportunity to study regional photochemical pollution in coastal area of Southeast China. Based on continuous observations at several air monitoring stations (including two supersites) from August 10 to September 10, 2017, the influences of emission reduction measures on ozone (O_3) pollution in Xiamen were investigated. The results indicated that the implementation of emission control measures decreased the concentrations of O_3 and its precursors, namely nitrogen oxide (NOx) and volatile organic compounds (VOCs). The concentrations of total VOCs in the urban and suburban area were reduced by 23% and 48%, while NO_2 concentrations were decreased by 62% and 65%, respectively. The daily average O_3-8h concentration was decreased by 13% and 25% in the central urban and suburban area. However, greater O_3 concentrations previously occurred during the nighttime with low NOx concentration. During the monitoring periods, the long-range transport of O_3 captured by ozone Lidar also resulted in high O_3 concentrations during the nighttime. The O_3 concentration in the suburban area was significantly higher than that in urban area, reflecting the influence of biogenic VOCs. The maximum O_3 concentration was frequently observed in distant mountain area, which was attributed to the contribution of NOx originated from vehicle emissions in the central urban with a particular wind direction. The empirical kinetic modeling approach (EKMA) curve showed the control region of NOx in the suburban area. So, the decreasing of NOx concentration resulted from traffic control altered the sensitivity of the O_3 production. Therefore, the reduction of non-point-source emissions, such as vehicles and anthropogenic VOCs, was potentially benefit to control regional photochemical pollution.

KEYWORDS: ozone; air pollution control; VOCs; ozone Lidar

Street canyon modelling in the urban areas of Hong Kong

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ABSTRACT

Hong Kong has one of the highest densities among mega-cities in the world. Seven and a half million inhabitants live on a group of islands that total 1,000 km^2. Tall and bulky high-rise building blocks with very limited open spaces in between, uniform building heights, and large podium structures have led to lower permeability for urban air ventilation at the pedestrian level. NO_2 and $PM_{2.5}$, well-known traffic-related pollutants, are currently one of the biggest causes of air quality problems in urban areas of the HK. High pollution levels have been often observed in urban street canyons.

In this study, the ADMS-Urban Regional Model Link (RML), which is an automated system specially designed for Hong Kong's routinely practical applications that couples the high-resolution local model (the ADMS-Urban) with the meso-scale regional model (the CMAQ) and the meso-scale meteorological model (the WRF), is used to model the pollutant concentrations within street canyons in the urban areas of Hong Kong.

In current study, the RML is applied to simulate the hourly NO_X, NO_2, PM_{10}, and $PM_{2.5}$ concentrations at three locations – Mong Kok, Central and Causeway Bay – where three Roadside Air Quality Monitoring Stations (RAQMSs) are installed, in the year of 2010. The agreements between the simulations from the RML and the observations from the RAQMSs are good with the acceptable error. Besides, the RML also performs better than the CMAQ. However, the RML has the tendency to under-predict the observations in most of the modelling periods, mainly due to the lack of traffic information for some minor roads in the vicinity of the RAQMSs and the rough calculations of emissions.

In future study, we are going to further refine the advanced street canyon model and investigate the impact of meteorological conditions and urban building morphology on the street-level pollutions through parametric studies on the quantified meteorological and urban morphology parameters respectively.

KEYWORDS: Pollutant Dispersion Modelling; Street Canyon; ADMS-Urban Model

Study on Reasoning the Factors of Ozone Pollution Events Over Western Taihu Lake Area in Summer

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ABSTRACT

Based on the analysis of the concentration of ozone, the concentration of Nonmethane hydrocarbon (NMHC), and the temporal and spatial characteristics of Algal Bloom in Taihu Lake basin in summer, combined with laboratory simulation experiment, we developed a study on reasoning the factors of ozone pollution events over Western Taihu Lake Area in summer. The western area (Yixing City) of Taihu Lake is the worst ozone pollution area in the whole of the Yangtze River Delta, and the concentration of Nonmethane hydrocarbon (NMHC) in this area is 3.3 times higher than it in Changzhou urban area, also its daily variation trend is according with the metabolism rule of algae. There are common temporal characteristics and meteorological conditions available among the algal bloom acreage of the western area of Taihu Lake, the concentration of Non-methane hydrocarbon (NMHC) in western Taihu Lake area and the pollution level of ozone. The experiment results show that the components of Algae-VOCs are complex, the alkenes and organic ammonia in their main components are highly reactive, and the concentrations of Algae-VOCs have the positive correlation with the concentration of ozone production. The area of Algal Bloom in Taihu Lake is a typical unorganized emission source, its volume is large, and its emitted Algae-VOCs is the critical factor causing the frequently occurred ozone pollution in Yixing City which locates on the downwind side.

KEYWORDS: Ozone; VOCs; Algal; Taihu Lake

Study on the roles of semi-volatile organic compound in the formation of secondary organic aerosol in East China

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ABSTRACT

Semi-volatile organic compound (SVOC) is of great importance for the formation of secondary organic aerosol (SOA). However, the knowledge on the contribution of SVOC to the formation of SOA via chemical conversion and gas-particle partition is still limited. The project will be aimed at the abundance, sources of SVOC and the physical and chemical behaviors of SVOC to the formation of SOA; 1. Establish the data base for the speciated SVOCs from typical anthropogenic sources based on the source-oriented and field measurements; 2. By considering the intermediate SVOC as the link between primary precursors and SOA, explore the physical/chemical evolution of SVOC and parameterize the relationship between SVOC and SOA; 3. Based on the above investigation, supplement the mechanisms for the evolution of SVOC, develop the SVOC-SOA modules and couple them into the regional air quality model (WRF-Chem), improve and optimize the WRF-Chem model by using the intermediate SVOC as constrain to conduct process analysis from SVOC emissions to the formation of SOA; 4. Using the improved regional air quality model to explore the roles of SVOC in the formation of SOA and the key impact factors. Through the above investigation, this study will perform a systematic analysis on the "source emissions-intermediate compounds-chemical conversion-impact factors", aiming to evaluate the contribution of SVOC to the formation of SOA, which could help to improve the model performance of the simulation of SOA, elucidate the detailed mechanisms of the formation of SOA in East China, and provide technique support for the implementation and formulation of control measures on SVOC, SOA and fine particles ($PM_{2.5}$).

Study on the characteristics and mechanisms of haze pollution during the heating period in Qingdao, China

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ABSTRACT

In recent years, China has achieved obligatory targets of emission control and urban SO_2 concentration has decreased significantly. However, the scope and extent of the impact of heavy pollution incidents have increased, causing widespread concern at home and abroad. By using the atmospheric monitoring data from 2013 to 2016 in Qingdao, this study analyzes the influence of meteorological factors, such as El Niño, and emission sources (e.g., heating period) on the air pollutant concentration. The results show that compared with 2013, the concentration of CO only slightly decreased from 2014 to 2016 (mainly in 2016). SO_2 concentration decreased significantly due to efficient emission control strategies. The magnitude of NO_x decrease is smaller than SO_2, likely a result of lower efficiency of denitrification compared to desulfurization and the offset of industrial coal denitrification by the increase in vehicle emission. In the past four years, $PM_{2.5}$ concentration generally showed a decreasing trend, however, the peak $PM_{2.5}$ concentration, occurring during the heating period of winter in 2015, was significantly higher than the other years. Through the combined analysis of meteorological factors, it was found that the heavy haze issue in 2015 winter was likely affected by the strong El Niño event during the same time.

KEYWORDS: El Niño; Emission sources; Heating period; Air pollution in Qingdao; $PM_{2.5}$

Study on the hematopoietic toxicity in mice induced by a combined exposure of PM2.5 and formaldehyde and its molecular mechanism

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ABSTRACT

Currently, the combined exposure to $PM_{2.5}$ and indoor formaldehyde has become a common situation in main cities of China. Both two pollutants have been reported to potentially induce hematopoietic toxicity (Wei et al. 2016; Jin et al. 2016), however, the molecular mechanism remains unclear. In order to explore the influence and the underlying mechanism of FA and $PM_{2.5}$ on hematopoietic toxicity, we conducted systematic research at three levels, which are toxicity induced in blood, hematopoietic organs (bone marrow, spleen) and myeloid progenitor. Male Balb/c mice were separately exposed to $PM_{2.5}$, formaldehyde respectively, and co-exposed to FA and $PM_{2.5}$ for two weeks. Similar effects were found in the FA-only group and $PM_{2.5}$-only group, including the significant reduction in both blood cells and myeloid progenitor (CFU-GM, BFU-E), the down-regulation in hematopoietic growth factors (GM-CSF, EPO) expression, the increase in oxidative stress (ROS, GSH) level and DNA damage (DPC, 8-OH-dG, γ-H_2AX), activation of the 'immune imbalance' pathway, promotion of the release of IL-4 and IL-17, leading to an imbalance of both Th1/Th2 and Treg/Th17 and inhibition of DNA damage repair by deregulating mTOR pathway, leading to an irreversible DNA damage of both bone marrow and spleen, the two hematogenic organs available for humans, thus resulting in the hematopoietic toxicity. Co-exposure to FA and $PM_{2.5}$ lead to more obvious result in several effects mentioned above, and these effects could be blocked by concurrent administration of Vitamin E. Our findings suggest that $PM_{2.5}$, FA may induce hematopoietic toxicity by reducing expression level of hematopoietic growth factors, increasing oxidative stress and DNA damages, inhibiting DNA damage repair, disordering immune system.

KEYWORDS: $PM_{2.5}$; formaldehyde; combined exposure; hematopoietic toxicity; molecular mechanism

Surface O_3 photochemistry over the South China Sea: application of a near-explicit chemical mechanism box model

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ABSTRACT

A systematic field measurement was conducted at an island site (Wanshan Island, WSI) over South China Sea (SCS) in autumn 2013. It was observed that mixing ratios of O_3 and its precursors (such as volatile organic compounds (VOCs), nitrogen oxides (NO_x=NO+NO_2) and carbon monoxide (CO)) showed significant differences on non-episode days and episode days. Additional knowledge was gained when a photochemical box model incorporating the Master Chemical Mechanism (PBM-MCM) was applied to further investigate the differences/similarities of O_3 photochemistry between non-episode and episode days, in terms of O_3-precursor relationship, atmospheric photochemical reactivity and O_3 production. The simulation results revealed that, from non-O_3 episode days to episode days, 1) O_3 production changed from both VOC and NO_x-limited (transition regime) to VOC-limited; 2) OH radicals increased and photochemical reaction cycling processes accelerated; and 3) both O_3 production and destruction rates increased significantly, resulting in an elevated net O_3 production over SCS. The findings indicate the complexity of O_3 pollution over the SCS.

KEYWORDS: Ozone; VOCs; Photochemical box model; Photochemistry; South China Sea

Synoptic situation, planet boundary layer and aerosol extinction properties associated to an air pollution episode over a coastal city

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ABSTRACT

With the fast development and urbanization, Xiamen, a national civilized city of China, was inevitable experienced frequent air pollutions in the past decade. Numerous studies have indicated that the air quality of Xiamen was worse than before. To investigate the impact of the Northwest Pacific subtropic high (NPSH) to the air quality of Xiamen, this study focused on the synoptic situation, planet boundary layer (PBL) and aerosol extinction properties during an air pollution episode from 16th to 28th Sep, 2017. Prebaratic charts were acquired from Korea Meteorological Administration. PBL height and aerosol extinction coefficients were obtained from a ground-based lidar at 532nm. The results showed that the NPSH basically controlled South China in this period and high temperature(30.9 3.2℃) and relative humidity (60.7 9.8%) were the requirements to the air pollution. The NPSH increased from 16th to 19th (stage 1), then eastward moved from 19th to 20th (stage 2). Since 21st, the NPSH tended to be stable until 26th when an anomalous westward extension occurred (stage 3). Precipitation at 18 o'clock in 28th weakened the air pollution (stage 4). PM_{10} and $PM_{2.5}$ concentrations were up to 121.1 μg/m^3 and 75.5 μg/m^3 at 11 o'clock in 20th in stage 1, and then decreased gradually in stage 2. In stage 3, particulate matters concentrations increased before 22nd then rapidly declined. From 26th to 28th, the concentrations were generally high. PBL and aerosol extinction coefficients were directly determined by particulate matters. Meanwhile, PBL was affected by downward streams of the NPSH center. When the NPSH pressure improved with the intensification of downward streams, PBL was compressed and further ascend particulate matter concentrations.

KEYWORDS: Northwest Pacific subtropic high; synoptic situation; planet boundary layer; particulate matters; aerosol extinction properties.

Stable mercury isotope compositions of $PM_{2.5}$ in four Chinese major cities

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ABSTRACT

Atmospheric pollution by fine particulates and mercury (Hg) in developing countries is a serious environmental concern. Here, we present Hg concentrations and isotope compositions in one-month (January, 2014) of 24-hour integrated $PM_{2.5}$ (particulates with aerodynamic diameter less than 2.5 μm) samples from four large cities (Beijing, Changchun, Chengdu and Hong Kong) of China to identify Hg sources and transformation processes. Mean concentrations of $PM_{2.5}$ (171±62 μg m^{-3}) and $PM_{2.5}$-bound Hg (1.3±1.1 ng m^{-3}) in Chengdu were highest among those cities. Overall, $PM_{2.5}$ samples were characterized by moderately negative δ^{202}Hg (-1.08±0.64‰, 1σ, n=64), slightly negative Δ^{199}Hg (-0.13±0.28‰, 1σ, n=64) and insignificant mass independent fractionated (MIF) of even Hg isotopes. On average, δ^{202}Hg of $PM_{2.5}$ was highest in Chengdu (-0.74±0.67‰, 1σ, n=29), followed by Beijing (-1.11±0.26‰, 1σ, n=17) and Changchun (-1.60±0.45‰, 1σ, n=18). $PM_{2.5}$ from Beijing showed the most negative Δ^{199}Hg (-0.31±0.40‰, 1σ, n=17) that was significantly lower than Changchun (-0.12±0.21‰, 1σ, n=18) and Chengdu (-0.02±0.15‰, 1σ, n=29). Coal combustion and cement production were identified to be the dominant sources of $PM_{2.5}$-bound Hg in these cities, with additional Hg source from non-ferrous metal smelting in Chengdu. Besides, Hg emissions from biomass burning were evident in short periods. The negative Δ^{199}Hg and near-unity slope of Δ^{199}Hg vs. Δ^{201}Hg in $PM_{2.5}$ from different cities indicate that the $PM_{2.5}$-bound Hg was extensively photo-reduced in the atmosphere after emissions from sources.

KEYWORDS: mercury isotopes; $PM_{2.5}$; $PM_{2.5}$-bound mercury; source identification; photoreduction

The characteristics of atmospheric phthalates in Shanghai: A haze case study

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ABSTRACT

While phthalates in indoor environments are extensively studied, reports on phthalates in outdoor air, particularly their associations with haze events are rare. Phthalates, especially dimethyl phthalate, are known to react with criteria air pollutants contributing to the formation of secondary organic aerosols. This study investigated phthalates levels in outdoor air in Shanghai with a focus on their associations with different air quality conditions. The air quality during the study period was classified into three levels: non-haze, light pollution and moderate pollution based on the Air Quality Index. Phthalates levels were found to be lower in non haze (236 ng/m^3) and higher in moderate pollution weather (up to 700 ng/m^3). Meteorological factors of relative humidity and wind speed had an inverse relationship with phthalates levels. Airborne particulate matter had a positive correlation with phthalates levels. Hydroxyl radical initiated photo-reaction of dimethyl phthalate was observed through its inverse relationship with total atmospheric oxidant (O_3 + NO_2), indicating that dimethyl phthalate could be one of the precursors of secondary organic aerosol causing haze. This is the first study demonstrating the relationship of phthalates and different air quality conditions. The knowledge contributes to our understanding on the cause of haze events in China and elsewhere.

KEYWORDS: phthalates; thermal desorption; gas chromatography/mass spectrometry; air quality; haze event; human exposure

The climate effect of heavy pollution over south China during the past 50 years

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ABSTRACT

The anthropogenic pollution in south China has led to the climate change including hazy days, cloud amount and light rain during 1960-2009. The total cloud cover (TCC) decreases in this period, whereas the low cloud cover (LCC) show the obvious opposite change with increasing trends. LCP defined as low cloud cover/ total cloud cover has increased and small rainy days (< 10 mm d−1) decreased significantly (passing 0.001 significance level) during the past 50 years, which is attributed to the enhanced levels of air pollution in the form of anthropogenic aerosols. The horizontal visibility and sunshine duration are used to depict the anthropogenic aerosol loading. When horizontal visibility declines to 20km or sunshine duration decreases to 5 hour per day, LCC increases 52% or more and LCP increases significantly. The hazy days in pearl river delta increased since the 1990s, which can be attributed to the anthropogenic pollution

KEYWORDS: Heavy pollution; South China; Climate effect; cloud; light rain x

The co-benefits of low carbon cities to asian air quality–proposed PhD work

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ABSTRACT

A rapidly urbanising global population has resulted in increased exposure to poor air quality, resulting in 3.3 million premature deaths per year, 70% of which are in Asia (Lelieveld et al., 2015). In addition, around two thirds of greenhouse gas emissions are attributable to urban sources (Satterthwaite, 2008). Previous work by Gouldson et al. (2014) has demonstrated the economic case for cities in both developing and developed countries to invest in low emissions development strategies (LEDS). Investments in energy efficient transport, building design and small-scale renewables could lead to significant reductions of urban energy use. In addition to the financial saving, there are co-benefits including a reduction in greenhouse gas emissions, as well as pollutants that are harmful to human health. Previous work has examined the air quality-climate co-benefits of controls on individual industry sectors (e.g. electricity generation, cement), and transportation (Liu et al., 2017). In this work, we will make the first assessment of the air-quality co-benefit from implementation of low-carbon city strategies in the Pearl River Delta region. We will present our strategy for using in-situ and remote sensed measurements alongside regional air quality modelling to better understand the emissions and processes that affect air quality in the region, and the impacts of LEDS. The aim is to identify realistic and effective measures to rapidly mitigate poor air quality, while also reducing climate impacts of cities in the region. This knowledge will then be communicated to policy makers, NGOs and the business sector.

KEYWORDS: Air Quality; Low-Carbon Cities; Co-benefits; WRF-Chem.

The balance of dispersion and deposition in reducing air pollutants close to urban roads

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ABSTRACT

Air pollutant concentrations decline rapidly with distance from busy roadways. This may be attributed to dispersion, deposition and transformation. The balance between these factors is not always carefully considered. In particular, the role of vegetation in air pollution prevention in metropolitan areas is sometimes over emphasized. Here we explore the example of declining concentrations of traffic derived pollutants into an urban park, assessing the balance between deposition to vegetation and dispersion. Dispersion is influenced by turbulence, which can also be affected by the presence of vegetation. There is a general view among those who manage urban infrastructure that the improved air quality in parks results from the uptake of pollutants by vegetation. However, measurements available from the literature offer little support for this view. In particular, VOCs, PAHs, fine particles show relatively slow rates of deposition to vegetation, with the picture for NOx and ozone complicated by an active chemistry. Our analysis of data from the literature, some new observations near roadside and modelling (ENVI-met) suggests that in many urban parks it is dispersion that dominates the reduction in pollutant concentrations rather than deposition to vegetation. This has important policy implications given the effort expended in modern park design on the choice of trees to be planted.

KEYWORDS: decay profile; ENVI-met; pollutant transformation; urban parks; vegetation uptake

The distribution dynamics of air pollution across Chinese cities: convergence, polarization, andstratification

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ABSTRACT

This paper employs a nonparametric distribution dynamics approach to examine the evolution behavior of air pollution ($PM_{2.5}$) in the 288 Chinese prefectural and above (PAA) level cities. We found evidence of convergence which is predicted by the Environmental Kuznets Curve (EKC) in the long-run distribution of air pollution. However, strong persistence in the transition process suggests that this convergence process takes a long time. In addition, the air pollution evolves into two distinct convergence clubs in the long-run rather than a normal distribution. In particular, poverty-environment trap exists in the long-run distribution. Conditioning analysis shows that geographical location can partially explain the bimodality in the long-run distribution. Environmental policies, such as Key City and Two Control Zones (TCZs) programs, are not stringent enough to make the air pollution converge to the average level. Thus more stringent policies and inter-regional technology spillovers are expected to reduce air pollutions in Chinese cities. The presence of multiple equilibria suggests that environmental policies should recognize the distinctive convergence paths associated with each cluster of cities.

KEYWORDS: Air pollution; Distribution dynamics; Chinese cities; Poverty-environment trap; Multiple equilibria

The effect of hydroxyl functional group on the viscosity of organic aerosol particles

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ABSTRACT

Secondary organic material (SOM) is formed via the oxidation of volatile organic compounds and frequently detected in ambient aerosol particles. However, physical properties, including viscosity, of SOM are poorly characterized. Viscosity of SOM is important because it influences the phase state, hygroscopic growth and heterogeneous reactions, thus the optical properties and climate forcing effects of aerosol particles. In this work, we determined the viscosities of 1,2,3-butanetriol and 1,2,3,4-butanetetrol using the bead mobility (BM) technique to investigate the effect of hydroxyl functional group addition on the viscosity of organic components. Tetrols have also been detected as the oxidation products of isoprene. The BM-measured viscosities of 1,2,3-butanetriol and 1,2,3,4-butanetetrol were 1.5–1.7 Pa and 5.7–240 Pa s, respectively. To test the accuracy of the measurements, we used a second technique, namely rectangular area fluorescence recovery after photobleaching (rFRAP), to measure the viscosity of 1,2,3,4-butanetetrol. The diffusion coefficient of the fluorescent probe species were converted to the viscosity using the Stokes-Einstein equation. The viscosity of 1,2,3,4-butanetetrol determined by rFRAP was 13–43 Pa s, consistent with that by BM, which confirms the accuracy of the BM technique. By combining our measurements with literature viscosity data of n-butane, butanol and butanediol, we show that the viscosity on average increases by a factor of 16–25 when one hydroxyl functional group adds to a linear C_4 organic molecule. Experimental results would be useful for predicting the viscosity of some components in secondary organic aerosols.

KEYWORDS: viscosity; bead mobility; rectangular area fluorescence recovery after photobleaching; Stokes-Einstein equation

The effects of inorganic seed aerosol on the oxidation state of secondary organic aerosol - α-pinene ozonolysis

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ABSTRACT

We compare the oxidation state and molecular composition of α-pinene-derived secondary organic aerosol (SOA) by varying the types and surface areas of inorganic seed aerosol that are used to promote the condensation of SOA-forming vapors. The oxidation state of α-pinene SOA is found to increase with inorganic seed surface area, likely a result of enhanced condensation of low-volatility organic compounds on particles versus deposition on the chamber wall. α-Pinene SOA is more highly oxygenated in the presence of sodium nitrate (SN) seed than ammonium sulfate seed. The relative abundance of semivolatile monomers and low-volatility dimer components that account for more than half of α-pinene SOA mass is not significantly affected by the composition of seed aerosol. Enhanced uptake of highly oxidized small carboxylic acids onto SN seed particles is observed, which could potentially explain the observed higher SOA oxidation state in the presence of SN seed aerosol. Overall, our results demonstrate that a combined effect of seed aerosol composition and surface area leads to an increase in the O:C atomic ratio of α-pinene SOA by as much as a factor of 2.

KEYWORDS: Seed particles; Oxidation state; ELVOC; Vapor wall loss

The effects of urban air particulate matter and farm dust particles on children's immune responses *in vitro*

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ABSTRACTS

Introduction: Air pollution, particularly ambient air particulate matter (PM), is considered as one of the most important environmental risks for human health. PM could potentially disrupt immune regulatory mechanisms and predispose exposed individuals to asthma. In contrast, children exposed to traditional farm environment have a natural resistance to asthma. This phenomenon seems to link with exposure to farm dust and subsequent immune regulatory mechanisms initiated in the airways. The comparable data on asthma-related immune responses induced by high risk and protective environments are needed for the risk assessment.

Objectives: Our aim was to investigate the effect of urban air PM (high risk environment) and farm dust (asthma-protective environment) on children' immune responses. Peripheral blood mononuclear cells (PBMCs) of 4-year-old children (N=18) were exposed to size-fractioned PM samples (75 µg/ml, $PM_{2.5-1}$, $PM_{1-0.2}$ or $PM_{<0.2}$, Nanjing, China) and farm dust particles (40 µg/ml, stable in Northern Savonia, Finland) for 18 hours. Expression of immune stimulatory CD80 and immune inhibitory ILT4 in circulating antigen-presenting cells, namely dendritic cells (DCs), was analyzed by flow cytometry. Cytokine production of PBMCs was analyzed by a multiplexed ELISA method.

Results: PM decreased the proportion of CD80+DCs, whereas farm dust stimulation increased cells positive for this marker. Similarly, PM reduced and farm dust increased the production of cytokines. DCs positive for ILT4 were decreased after PM exposure. Although PM samples induced parallel reactions, the strength of the effects was determined by the PM size-fraction.

Conclusions: Farm dust particles activate children's immune cells whereas PM seems to inhibit the expression of important receptors and the production of soluble mediators. This could potentially lead to atypical responses towards antigens in urban environment and at least partly explain differences in asthma prevalence between studied environments.

The establishment of emission Lab for aerosols and recent research progresses: from source emission to receptor monitoring of central China

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ABSTRACT

For source identification of atmospheric particulate matter by receptor models or emission inventory, it is the key to know the emission characteristic, such as the emission factors, source profiles, source marker and specific ratios of chemical components. In this report, we introduce the establishment of a lab for combustion sources including the dilution tunnel, combustion room, smoke hood and smog chamber as well as the online/offline monitoring equipment for aerosol and its gaseous pollutants. Then the recent research progresses of our group are briefly introduced as follows: (1) the establishment of emission inventory for stationary sources based on online monitoring data and enhanced atmospheric oxidizing capacity in simulating air quality was observed; (2) emission and aging of particles from domestic fuel burning; (3) 1*1 km emission inventory for key chemical components in fine particles of domestic coal burning; (4) the estimation of pollutant emissions Via open biomass burning in central and eastern China from 2003 to 2015 based on satellite observations; (5) a sampling campaign for sub-micro aerosol ($PM_{1.0}$) of straw burning emission and aging, in view of flume-source region-transport spot-megacity-human health; (6) aerosol acidity in Central China.

KEYWORDS: combustion sources; dilution tunnel; smog chamber; aging of particles; emission factors and inventory; Central China

The Growing Role of Portable Emission Measurement Systems in Answering Technical and Policy Questions About Vehicle Emissions

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ABSTRACT

There are estimated to be over one billion onroad motor vehicles globally. New vehicle sales during the 2017 model year vehicle were nearly 80 million worldwide. Most of these vehicles are either gasoline or diesel fueled, and produce emissions of carbon dioxide, nitrogen oxides, particulate matter, carbon monoxide, hydrocarbons, and a range of mobile source air toxins. Two decades ago, vehicle emissions estimates were largely based on cycle average rates from data measured in dynamometer laboratories. Now, the use of portable emission measurement systems (PEMS) has become more widespread in the U.S., Europe, and China. There are a growing number of PEMS-based studies that assess various aspects of the effect of vehicle technologies, fuels, operations, road infrastructure, traffic control, and emission standards on actual emissions under real-world driving conditions. Furthermore, high resolution (1 Hz) data measured with PEMS and in laboratories are being used to develop a variety of microscale energy use and emission models for coupling with traffic simulation models, to address a wide range of policy planning questions. This talk will briefly introduce the role of PEMS in empirical and modeling studies of real world vehicle energy use and emissions and address the following key questions: (1) What are the historic trends in vehicle technology, fuel efficiency, and emissions?; (2) How effective are fleet fuel economy and vehicle emissions standards?; (3) What are the current trends in vehicle technology and operation that affect energy use and emissions?; (4) Are real-world fuel economy and emissions consistent with fuel economy and emissions regulations, respectively?; (5) What are the emerging challenges and opportunities related to vehicle energy consumption and emissions?; and (6) What are the advances in measurement and monitoring of vehicle energy consumption and emissions, and what new capabilities do these advances enable? The role of PEMS for measurement of nonroad mobile sources will also be briefly discussed.

The Impact of Meteorological Factors on Ground-level Ozone Pollution

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ABSTRACT

In recent years, with the rapid development of China's economy and society, VOCs and other precursor emissions continue to increase, ozone pollution problems in Beijing-Tianjin-Hebei region, Yangtze River Delta, Pearl River Delta and other urban agglomeration and its surrounding areas become increasingly prominent, and gradually replaced traditional pollutants, become the most important major pollutants affecting ambient air quality in many cities. Ozone is mainly controlled by precursor emissions and atmospheric chemical processes, but changes in local ozone concentrations are often affected by various meteorological factors. Due to the limited monitoring data, the research about the impact of meteorological factors on ozone pollution is insufficient. The relevant research results from the influence of meteorological factors such as local meteorological factors, large-scale weather system, local circulation and climate change on near-surface ozone pollution was summarized in this paper and found that (1) meteorological factors in different seasons and different regions have different effects on ozone concentration; (2) the occurrence of high concentrations of ozone pollution is often associated with specific weather systems; (3) meteorological factors will affect the long-term trend of ozone concentration and affect the assessment of the effectiveness of historical environmental protection measures and affect the future development of pollution prevention and control strategies.

KEYWORDS: ozone pollution; meteorological factors; synoptic system; sea-land breeze; ozone trend

The interaction of inorganics with lipid monolayer at the sea surface

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ABSTRACT

Heavy metal ions as well as common anions in the seawater are known to be enriched in organic-coated marine aerosols. However, the impact of inorganics on marine aerosol generation and evolution is not well understood. Here the effects of heavy metal ions and common anions on the surface properties of a dipalmitoylphosphatidylcholine (DPPC) monolayer were investigated. Phase behavior of the DPPC film on inorganic salt solutions was probed with surface pressure–area (π-A) isotherms. Infrared reflection–absorption spectroscopy (IRRAS) was used to assess the impact of ions on the conformation order and orientation of alkyl chains. The isotherms show that Zn^{2+} and Fe^{3+} strongly interact with DPPC molecules, and induce condensation of the monolayers in a concentration-dependent manner. IRRAS spectra show that the formation of cation-DPPC complex gives rise to conformational changes and immobilization of the headgroups. Zn^{2+} ion causes dehydration of carbonyl group and binds to the phosphate group in a 2:1 bridging complex. The current results suggest that the enrichment of Zn^{2+} in sea spray aerosols is due to strong binding to the organic film. The interaction of Fe^{3+} with DPPC monolayers can significantly influence their surface organizations through the formation of lipid-coated particles. Phospholipids are preferred to combine with SO_4^{2-} relative to Br^-, therefore large quantities of sulfate salts coated by organics are enriched in the marine aerosols. These results suggest that the sea surface microlayer is capable of accumulating much higher amounts of these inorganics than the subsurface water. The organic and metal pollutants could transfer into the atmosphere by this interaction.

KEYWORDS: inorganics; sea surface microlayer; sea spray aerosol; pollutant transfer

The mechanism modulating the high ozone events in North China during the summer of 2017

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ABSTRACT

In the summer of 2017, strong heat waves swept most of China. During the period with high temperature, the observed data shows substantially elevated O_3 concentrations in particular over North China. The high level O_3 concentrations are likely a result of emissions and favourable meteorological conditions such as high temperature, low wind speed and high pressure system. In this study, we first use the observed ozone data and reanalysis meteorological data (i.e., ERA-Interim) to construct the relationship between these meteorological factors and high O_3 concentrations. Moreover, we use a regional air quality model WRF-CMAQ model to investigate how heat waves modulate the formation of high ozone concentrations. With the combination of process analysis, the impact of heat waves on ozone gas chemistry, diffusion and vertical advection was also explored.

KEYWORDS: Ozone; Heat waves; WRF-CMAQ; process analysis

The mechanism modulating the high haze events in China

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ABSTRACT

Recently, severe haze pollution has occurred frequently in China. By utilizing a large number of observational data including $PM_{2.5}$, NO_2, etc. from 2014-2016, we first examine the spatial and temporal distributions of haze in China, and identified two major pollution areas during winter season: one is the Beijing-Tianjin-Hebei (JJJ) area and the other one is the Northeast of China. The 3-year winter seasonal mean $PM_{2.5}$ concentrations over these two regions reach 100μg/m^3 or more, far exceeding the air quality standard. Favorable meteorological condition is one of the key factors driving the haze pollution, and atmospheric stagnation has been widely used as a major meteorological factor leading to severe haze. In this study, we found that the standard atmospheric stagnation index (i.e., combination of 500 hPa, 10-m wind speed and daily precipitation) only partly explains the occurrence of haze in Beijing. This study further investigates the meteorological mechanism over the JJJ and Northeast regions, and found climate variability such as El Nino is also a major driver of the recent haze event in particular over the winter of 2015.

KEYWORDS: haze; atmospheric stagnation; El Nino

Three-dimensional variational assimilation of Satellite AOD based on MOSAIC Multi-species and multi-size bins: Implementation and application to PM forecasting

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ABSTRACT

The accurate assessment of air quality, particularly in terms of $PM_{2.5}$ and its spatiotemporal variability, is currently a pressing issue.

In this article a three-dimensional variational data assimilation system for satellite AOD has been developed for WRF/Chem MOSAIC aerosol scheme. We also assess the role that assimilation of satellite AOD and surface PM measurements can play in improving the skill of aerosol forecasts. The MOSAIC aerosol scheme comprises 32 variables including eight chemical composition (4 size-bins in each chemical composition), in order to reduce the computational cost, we classify the aerosol species with similar optical properties. Then, the final control variable is set to 20 (5 kinds of aerosol composition, particle size of each component is divided into 4 sections). NMC method has been applied to construct the background error covariance. Based on Mie theory, satellite AOD observation operator and its adjoint operator for 20 MOSAIC aerosol variables has been developed. Furthermore, the AOD adjoint operator module passed the tangent and adjoint test. Finally, a three-dimensional variational data assimilation system for satellite AOD has been developed. A single point test show that AOD single point observation information can reasonably spread according to background error covariance structure.

We conducted the real case of December 15, 2015 by assimilating MODIS AOD data (referrer as DA_AOD). For the purpose of comparison, the control test (referrer as Control) was not assimilate any data. DA_AOD test of $PM_{2.5}$/PM_{10} forecasting improved significantly compared to Control test in terms of RMSE and CORR at the beginning of 8 hours. The RMSE of $PM_{2.5}$ and PM_{10} average reduction are 7.5μg/m³ and 10.1μg/m³, decreased by 18% and 13%, respectively; correlation coefficient of $PM_{2.5}$ and PM_{10} are improved by an average of 0.29 and 0.23, and the CORR were increased by 79% and 70%, respectively, indicating that MODIS AOD assimilation can effectively improve the $PM_{2.5}$ and PM_{10} forecast at the beginning of 24 hours, but the effect of improving the forecast over time decay rapidly with the forecast duration.

KEYWORDS: $PM_{2.5}$; MODIS AOD ; Data Assimilation; WRF-Chem; Air quality

UMAPS: A micro-scale model for urban wind field and air pollutant dispersion simulation

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ABSTRACT

A micro-scale air pollutant dispersion model system is developed for the emergency response purposes; it includes a diagnostic wind field model to simulate the wind filed and a random-walk air pollutant dispersion model to simulate the pollutant concentration with considering the influence of urban buildings. Numerical experiments are designed to evaluate the model performance with the CEDVAL (Compilation of Experimental Data for Validation of Micro-scale Dispersion Models) and FZ (carried out in Nanjing University) wind tunnel experiments data. The results show that the wind model can reproduces the vortexes trigger by urban buildings and the dispersion model simulates pollutant concentration around buildings well. Due to the complex shapes of buildings and their distributions, the simulation errors are usually caused by the simplification of the building shapes and the determination of the key zone sizes. The computational efficiencies of different cases are also discussed and the model can produce very high-resolution (~m) wind fields on the neighborhood scale (~km) in just minutes. This model has the potential for multiple applications: the predictions of air pollutant dispersion and evaluate environmental impact under urgent disasters; urban planning scenarios and assess for micro-scale air quality in urban area and so on.

KEYWORDS: numerical model; urban air pollution; air pollutant dispersion; emergency response model

Urban and industrial VOC emissions in Korea during KORUS-AQ:
Changing Signals from China and Comparison to Hong Kong

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ABSTRACT

The Korea-United States Air Quality Study (KORUS-AQ) took place in May and June, 2016 to better understand air pollution in Korea. During the campaign 2650 whole air samples (WAS) were collected using the NASA DC-8 research aircraft and analyzed for more than 80 C_1-C_{10} volatile organic compounds (VOCs), including alkanes, aromatics, alkenes, halocarbons and alkyl nitrates. Results from three different source regions are presented, each with distinct VOC signatures. (1) Urban air samples (n = 300) collected at low altitude over the Seoul Metropolitan Area (SMA) were rich in VOCs such as ethane, propane, toluene, ethyne and *n*-butane, reflecting a mix of source influences including compressed natural gas (CNG), liquefied petroleum gas (LPG), vehicle exhaust and industrial solvents. Aromatics (e.g., toluene, xylenes) and alkenes (e.g., isoprene) were strong contributors to OH reactivity in the SMA. Because public buses in Seoul use CNG whereas buses and taxis in Hong Kong use LPG, the air in Seoul is comparatively rich in ethane and propane as compared to the butanes and propane in Hong Kong. The toluene/benzene ratio was also much higher in Seoul than in Hong Kong. (2) Industrial air samples (n = 30) collected downwind of the Daesan industrial facility southwest of Seoul were rich in VOCs such as ethene, benzene and *n*-hexane. At least 25 VOCs showed their highest mixing ratios of the KORUS-AQ mission in these plumes. (3) Regional air sampled over the Yellow Sea showed that air masses arriving from China (n = 20) were elevated in CFC-113 and CFC-114 as compared to air from Korea. Unlike previous missions in Asia, these samples also showed that H-1211 is no longer a useful tracer of air from China. These and other results will be presented and discussed.

KEYWORDS: Volatile organic compound; emission, Korea; KORUS-AQ

Utilising COPERT Australia and CCAM-CTM to investigate air quality impact with improved fuel quality

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ABSTRACT

The study revealed how state-of-the-art models can influence environmental policy in an Australian perspective. This project is a joint effort by several government, research and private agencies in both Europe and Australia.

COmputer Programme to calculate Emissions from Road Transport (COPERT) is a globally used software tool for calculating air pollutant and greenhouse gas emissions produced by road transport. The development of COPERT is coordinated by the European Environment Agency (EEA), in the framework of the activities of the European Topic Centre for Air Pollution and Climate Change Mitigation.

COPERT Australia was a further development of this software in a joint effort of EMISIA and the Queensland Department of Science, Information Technology and Innovation (Smit, 2014). It includes algorithms that were developed from data collected in Australian vehicle emissions testing programs designed to

The aim of this study is to assess the emissions sensitivity and the effect on air quality due to the change in fuel quality.

Based on the proposed fuel specifications and projected vehicular fleet mix out to 2030, vehicular emissions were estimated using COPERT Australia (Marsden Jacob Associates & Pacific Environment Limited, 2016).

These projected vehicular emissions were used as an input parameter to the Commonwealth Scientific and Industrial Research Organisation (CSIRO) state-of-the-art regional photochemical transport model, i.e. CCAM-CTM (Cope et al., 2014, NSW Duc et al., 2016). CCAM-CTM was used to evaluate the impacts of the potential fuel legislation to air quality in New South Wales Greater Metropolitan Region (NSW GMR).

By adopting the new fuel quality standard, comparing to maintain the current fuel standard, the COPERT Australia model results demonstrate a quantifiable reduction in the mass of relevant pollutants emitted in the study region. The photochemical transport model also predicts the air quality outcome will be better. It is important to note that the model results represent a theoretical change to air quality based on changing motor vehicle emissions only, all non-motor vehicle sources emission remain constant.

KEYWORDS: COPERT; CCAM-CTM; Fuel Quality

Validation of the Air Quality Health Index

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ABSTRACT

We developed the Air Quality Health Index (AQHI) as a health risk-based air pollution index for Hong Kong.[1] Though modelled after the Canadian AQHI,[2] we used hospital admissions from cardio-respiratory diseases instead of mortalities, and also modified the method by which the AQHI bands were defined.[1] We derived the relative risks (RR) of hospital admissions for a unit increase in air pollutant concentrations, based on a 5-year time series study (2001–2005). We then calculated and added the percentage of excess risks (%ER) attributable to each of four air pollutants – nitrogen dioxide (NO_2), ozone (O_3), sulphur dioxide (SO_2), and respirable suspended particulates (PM_{10}) – to give a %ER for all four pollutants on a given day. Our AQHI banding made reference to the WHO's Air Quality Guidelines for each pollutant.[3] It also depended on the ratio of the median %ER for high risk groups (children under 5 years and the elderly over 65 years) to that of the general population. To assess the AQHI's performance, we studied the effects of changes in RRs, using a 10-year dataset (2001–2010). The RRs from the new model were similar to, but smaller than, those from the original model, excepting that for PM_{10}. In this validation study, the percentage of days exceeding the %ER at Band 7 (designated as 'high risk') was 36.8%, compared to 29.3% in our original study. 19.3% of days were at or higher than Band 8 ('very high risk'), compared to 18.7% in the original study. The AQHI is sensitive to changes in both RRs and %ERs. While the trends observed in the original model are consistent with those in the new, we conclude that the latter AQHI model, which uses a larger dataset, is more protective and likely more robust.

KEYWORDS: Air Quality Health Index; air pollutant; health impact; excess risk

Variabilities in CCN concentration and CCN activity related to SO2 emission reduction and new particle formation in Qingdao

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ABSTRACT

We measured concentrations of cloud condensation nuclei (CCN) and CCN activity at a suburb site of Qingdao in the North China during two heating periods from 6 November to 6 December 2013 and from 9 January to 24 February 2017, respectively. Concentrations of CCN during the first heating period were 3.3±1.3 (mean ± standard deviation), 6.4±2.3 and 8.5±2.6 in unit of $\times 10^3$ cm^{-3} at supersaturation (SS) of 0.2%, 0.4% and 0.6%. The corresponding CCN activities were 0.31±0.14, 0.35±0.15 and 0.37±0.15. While in the second heating period, CCN concentrations were 3.3±1.4, 4.9±2.1 and 5.5±2.3 $\times 10^3$ cm^{-3} and CCN activities were 0.22±0.11, 0.32±0.14 and 0.36±0.14. At SS ≥ 0.4%, the concentrations of CCN decreased by about 30% from the first heating period to the second heating period because of the lower SO_2 concentration induced by the emission reduction. The increased number of CCN-related new particle formation (NPF) events by 50% form the first heating period to the second one explains the increase of CCN activities in 2017. These results imply potential influences of SO_2 emission reduction and NPF on cloud processes and further on climate change.

KEYWORDS: Cloud condensation nuclei; SO_2 emission; New particle formation

Vertical variation of CO_2 and $PM_{2.5}$ under complex air circulation in high-rise urban environment

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ABSTRACT

Causing 7-million-deaths a year, air pollution is known as the single largest contributor of environmental health risk in the world according World Health Organization (WHO) in 2014. Almost the whole population (92%) in the globe suffered from poor air quality that exceed WHO limits. (WHO, 2016). However, the problem is even more severe in highly dense urban area owing to heavy traffic emission of air pollutants are trapped in the complex morphology and street canyons.

This case study examined whether and how ambient air quality varies with height in the urban environment. Rigorous field measurements were conducted in an 18-floor high-rise office building. The office building is located in a densely populated district in Tsim Sha Tsui, which is a popular place for tourism in Hong Kong. Taking the levels of outdoor air quality at the bottom part of the building as a reference, the normalized outdoor CO_2 concentrations ranged from 0.9 to 1.25 with no significant variation along the floors. While normalized concentrations of $PM_{2.5}$ at higher floors ranged from 0.78 to 2.88 with non-linear variation with height. This may suggest complex mixing of $PM_{2.5}$ outside the sampled building. To assess that possibility, a high-resolution computational fluid dynamics (CFD) analysis was used to gain insight on the wind circulation outside the building during the period of field measurement. Even though there is busy traffic at ground level, our result suggested that one should not assume better ambient air quality is guaranteed at higher position of a building. Also, this case study demonstrate more detailed analysis and simulations are needed to understand the air pollution problem in high-rise urban environment.

KEYWORDS: Indoor environmental quality; dense urban environment; street canyon; particulate matter; CO_2, concentration; $PM_{2.5}$

Wintertime nitrate formation during haze days in the Guanzhong Basin, China: a case study

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ABSTRACT

Nitrate aerosol constitutes an increasing amount of ambient $PM_{2.5}$ mass in China during recent years in the context of a stringent control strategy on air pollutants implemented since 2013. Here, as a case study, we simulate the formation of wintertime nitrate aerosol during the period from 16 to 24 December 2015 in the Guanzhong Basin, China using the WRF-CHEM model. The predicted near-surface O_3, NO_2, HONO, $PM_{2.5}$, and its major inorganic components are compared with hourly observations in the basin, presenting a reasonable simulation of atmospheric chemistry and aerosol. We find that the chemical competition between sulfate and nitrate could impact nitrate formation in the basin, which indicates that under current emission scenario, the continuous decrease of SO_2 emission would slightly aggravate current nitrate pollution. HONO plays an important role in nitrate formation; more than 10% or 4 μg m^{-3} in nitrate concentration within Xi'an is attributed to HONO enhancement. The study on nitrate sources demonstrates the predominated role of anthropogenic emissions in nitrate formation and ambient $PM_{2.5}$. When anthropogenic emissions are halved, the formed nitrate is reduced by 35.13% in mass. However, the contribution from any single sector of anthropogenic sources is much less. This probably suggests a synergistic effect among different anthropogenic sources, which enhances nitrate formation in the basin.

上海市臭氧污染现状和成因简析

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摘要

基于 2006-2016 年上海市臭氧（O_3）监测数据的统计分析，表明 O_3 存在逐年上升趋势，日 O_3 污染持续时长有所增加，O_3 污染持续时间延长，O_3 为首要污染物的比例逐年增加。O_3 浓度的上升导致 O_3 为首要污染物的比例有所增加，压缩了上海市优良率进一步提升的空间。

O_3 污染空间分析表明上海市 O_3 超标主要集中在西南部郊区，大致呈现从西南郊区向东北市区方向递减。市区 O_3 超标率较低，但 O_3-8h 年第 90^{th} 百分位浓度与西南郊区接近，市区的 O_3 超标潜势不容忽视。

根据上海市典型站点在 O_3 污染高发季节的臭氧污染玫瑰图以及 O_3-1h 浓度的后向轨迹分析，发现风向为偏南风时出现较多的 O_3 高值，利用数值模式开展的 O_3 源解析结果表明，上海市夏季 O_3 受区域输送影响较大，本地贡献占比约为 20~40%。总体而言，上海市中南部地区，乃至上海以外的杭州湾南岸地区是上海市控制 O_3 前体物排放的关键区域。

通过大气污染防治行动，影响上海 O_3 生成的关键前体物 NOx 和 VOCs 排放大幅减少。对于 NOx 减排的影响分析发现，NO_2 环境浓度在上海市区和北部郊区 NO_2 显著降低，内外环市区、西部郊区和东南部郊区也逐年改善，但下降幅度较小。根据上海市布设的 30 个 VOCs 网格化采样数据分析发现，上海市 VOCs 和 OVOCs 的空间分布趋势为西高东低，臭氧生成敏感性总体受 VOC 控制，东部沿海和西部郊区受 VOCs 和 NOx 双控。VOCs 源解析结果初步显示，化石燃料燃烧、溶剂使用和工艺过程及机动车排放占比分别为 32%、29%和 31%。上海市 O_3 污染控制在持续推进 NOx 减排的同时，更需同步推进 VOCs 的减排。

关键词：上海；臭氧；时空分布特点；成因；臭氧生成敏感性

华北地区臭氧时空分布特征及来源的模拟研究

韩霄，张美根

摘要

近年来，有研究表明我国大气环境氧化性逐年升高，区域臭氧污染呈加剧态势。随着对气溶胶污染物的治理措施逐渐取得成效，臭氧成为继 $PM_{2.5}$ 广泛引起关注后困扰城市空气质量改善的另一重要二次污染物。由于臭氧浓度的升高会对生态环境及人体健康带来直接的破坏影响外，还会加速 $PM_{2.5}$ 等污染物的转化形成进而影响大气重污染过程发生的频率和强度，臭氧污染控制是区域复合污染最重要的控制要素之一。因此急需在重污染背景下，对我国特定重污染地区的大气臭氧的时空分布特征、影响因子以及来源进行深入研究。为遏制臭氧污染加重的趋势，并寻找有效途径控制臭氧污染，实现空气质量根本改善提供可靠的科学依据。利用大气化学模式系统 RAMS-CMAQ 对中国华北地区臭氧质量浓度的时空分布特征进行模拟，并且利用 CMAQ-DDM 模块分析其来源，并对不同地区的贡献进行评估。CMAQ-DDM 可考察维持在同一个化学平衡下不同种类和地区的排放源贡献大小，因此很适合对不同地区之间的区域贡献开展模拟研究。模拟结果显示，华北地区臭氧浓度夏季较高、冬季较低。在冬季颗粒物污染较为严重的地区可使臭氧浓度明显低于周边地区。而夏季臭氧高值区主要集中在北京市南部至石家庄一带和山东省北部地区。通过 DDM 模块模拟分析，华北地区主要区域贡献来自山东省、其次为河北省中南部，其对自身的贡献可超过 40%，而对周边地区的贡献大致可达到 10-30%。北京市和天津市的贡献主要集中在本地，对外地的贡献很小，基本在 10%以下。

长三角东部雾霾形成机制及区域传输对空气污染影响

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摘要

长三角大气污染呈现一次污染与二次污染相耦合、局地污染和区域污染相叠加的态势，以 $PM_{2.5}$ 为代表的大气细颗粒污染问题仍较为突出。本研究基于长三角东部农村地区淀山湖超级站和上海城区浦东超级站监测数据，系统分析了2016 年 1 月~2 月冬季雾霾污染期间，颗粒物理化特性、形成机制及来源，并研究了春节假期效应对空气污染的影响；另外利用大载荷(200kg)系留气球在杭州湾北岸开展了 0~1000m 高度范围内的大气垂直观测，深入研究了 2015 年 12 月 14 日区域输送过程对地面空气质量的影响。

2016 年 1 月~2 月的观测研究发现：SO_4^{2-}、NO_3^-、NH_4^+、OC 等二次组分在长三角东部农村站点及上海中心城区站点均为 $PM_{2.5}$ 主要组分，占比超过 60%，二次颗粒物污染呈现区域性特征；春节假期效应导致了主要大气污染物呈现出显著的“V”字形变化特征，尤其是 NOx 和硝酸盐，机动车 NOx 排放是硝酸盐的主要来源；在富氨的大气环境下，较高的 NOx 排放会带来较多的 NH4NO3 形成，而 NH_3 在二次颗粒物形成过程中起到了促进作用；富集因子分析表明，该区域大气颗粒物中燃煤、机动车、钢铁冶炼等排放源贡献较大；PMF 源解析分析表明，机动车排放对 $PM_{2.5}$ 平均贡献达到 26.6%，位居各主要贡献源之首，春节假期期间机动车排放对 $PM_{2.5}$ 的贡献下降一半左右；PSCF 潜势源贡献分析表明，淀山湖超级站点位的 SO_2 以及 SO_4^{2-}主要来自长距离传输，而 NO_2 和 NO^{3-}主要来自于近距离区域的贡献。

2015 年 12 月大范围区域输送污染过程期间，大气边界层日变化过程对污染物的传输扩散有着重要影响：边界层内主要污染物浓度垂直分布较为均一，边界层以上颗粒物、SO_2 等迅速下降至接近于 0，但 O_3 总体呈现随高度升高而升高的趋势。拉格朗日污染物扩散模型（LPDM）分析表明：边界层打开前，边界层内主要来自上海及长三角周边近距离区域输送，边界层以上主要来自中远距离输送；边界层打开后，由于垂直混合作用，边界层内来自本地及外来输送的共同影响；外来输送路径主要是苏北到苏南一线，苏锡常近距离输送贡献较大。区域输送的污染物主要是硫酸盐、硝酸盐、铵盐、有机物等二次组分，同时还包含较高浓度的 SO_2。区域输送影响期间，硝酸盐在 $PM_{2.5}$ 中的平均占比可以达到 27.3%，为第一贡献组分，表明北方大范围区域输送影响长三角的过程已经逐步由硫酸盐输送型转变为硝酸盐输送型。

本研究对于深入了解掌握长三角东部区域雾霾污染成因机理提供了重要研究基础，并可进一步为长三角区域开展大气污染联防联控提供科学参考。

关键词： 长三角；雾霾；形成机制；区域输送

南京不同地区新粒子生成特性受 VOCs 的影响

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摘要

目前对于大气新粒子的生成机制还没有透彻的理解，需要从观测、实验室模拟和模型构建三方面进行深入的研究。大气中新粒子的形成（NPF）是二次气溶胶的重要来源。外场观察研究和模型模拟表明，NPF 对全球云凝结核（CCN）生产显著地贡献。大气中气-固转化形成颗粒物是由一个区域的光化学反应触发，并持续生成粒子。由于不同区域的大气成分受到各种因素（交通运输，工厂类型等）的影响，导致大气成分略有不同从而使得成核现象出现差异。无论是从单点还是多点观察，都发现新粒子生成的强度及后续的增长都与 VOCs 有较大的关系。

关键字： 大气新粒子生成；温度；湿度；实验室模拟

华南地区城市大气亚微米级颗粒物挥发性特征研究

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摘要

挥发性是大气颗粒物的非常重要的一个特征，大气颗粒物的挥发性特征能够影响其在气相和颗粒相之间的分配、不同化学组分在大气中的迁移转化以及气溶胶浓度的测量等，而饱和蒸气压是影响颗粒物中不同化学组分气-粒分布的主要因素。目前在国内进行了较多对大气颗粒物化学成分相关特性的研究，而对于其挥发性特征则研究较少。

TD-AMS（热扩散管-气溶胶质谱仪，Thermo-Denuder Aerosol Mass Spectrometer）系统广泛应用于颗粒物挥发性特征的研究，气溶胶在 TD 中的动力学特征受到其在 TD 中的保留时间的影响，相对较长的保留时间更适合于对于具有半挥发性特征的气溶胶研究[2]。

本研究中，利用 TD-AMS 系统对深圳冬季大气颗粒物中非难熔 PM_1 组分的挥发性特征进行了研究。在观测期间，PM_1 的质量浓度为 $42.7 \pm 20.1\ \mu g\ m^{-3}$，其中有机物（OA）含量最高，占比达 43.2%。AMS 测得的不同物种具有不同的挥发性，其中，硝酸盐挥发性最高（50℃时的质量保留分率 MFR 为 0.57）。OA 表现出了半挥发性特征，其 50℃是 MFR 为 0.88，并且在 TD 温度（50 到 200℃）范围内 OA 的 MFR 值与温度呈现显著的线性关系，其挥发速率为 $0.45\ \%\cdot°C^{-1}$。

通过 PMF 模型可以对 OA 进行源解析，得到五个不同的因子，包括：还原态有机气溶胶（HOA，占比 13.5%）、餐饮源有机气溶胶（COA，占比 20.6%）、生物质燃烧源有机气溶胶（BBOA，占比 8.9%）、较低氧化程度的氧化态有机气溶胶（LO-OOA，占比 39.1%）、较高氧化程度的氧化态有机气溶胶（MO-OOA，占比 17.9%）。不同的 OA 因子在 50℃的挥发性顺序为 HOA (MFR 为 0.56) > LO-OOA (0.70) > COA (0.85) ≈ BBOA (0.87)> MO-OOA (0.99)，可以看出 HOA 挥发性强于 BBOA 和 COA。因此，HOA 可能是通过“蒸发-气态氧化-凝聚”机理生成 LO-OOA 的重要的潜在源。本研究对于大气中气溶胶的形成和老化的机理以及模型研究都有着重要的意义。

基于 Himawari-8 的卫星云和雾霾检测算法的应用

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摘要

葵花－8 卫星上搭载的下一代气象观测遥感器（Advanced Himawari Imager，AHI）能够对地球进行多波段，高空间和时间分辨率的连续观测。其数据对研究我国大气污染的状况及传输有重要意义。我国污染背景下的云检测算法倾向于将雾霾识别成云或者晴空，且国际上云检测算法缺乏对雾霾的考虑。因此，开发基于 Himawari-8 的云和雾霾的识别算法是对我国环境监测和分析的前提。雾霾主要分布在海拔较低的平原地区，且分布均匀稳定，而云多产生于空中。依据这一特征，本文针对我国开发了同步识别晴空，云和雾霾的算法。算法使用 DEM 的高程数据来调整云和雾霾的识别阈值，从而针对不同高程利用不同的阈值。利用葵花－8 2016 年 4 个季节的不同月份的数据进行了算法测试，和激光雷达的定量对比结果表明本算法可以很好的识别中国中东部地区的云和雾霾的分布，晴空，云和雾霾的识别误差分别为 3.95%, 5.88%和 4.17%。

南京工业区夏冬季节二次有机气溶胶浓度估算及来源解析

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摘要

采用 2015 年 6 月 15 日~7 月 15 日及 2015 年 12 月 16 日~2016 年 1 月 15 日期间 GC5000 在线气相色谱仪得到的挥发性有机物(volatile organic compounds,VOCs)数据、DRI-2001A 热/光碳分析仪对膜采样分析得到的 EC(elemental carbon)、OC(organic carbon)数据，使用气溶胶生成系数法(fractional aerosol coefficient,FAC)、EC 示踪法及正矩阵因子分析(positive matrix factorization, PMF)对南京工业区二次有机气溶胶(secondary organic aerosol, SOA)浓度进行估算及来源解析。研究发现南京工业区 SOA 污染主要来源于芳香烃类物质，其对夏、冬季节 SOA 贡献率分别为 80.39%、94.63%，主要贡献者为苯、甲苯、乙苯、二甲苯（Benzene、 Toluene、Ethylbenzene、Xylene,BTEX）；对南京工业区 SOA 浓度进行估算，得到夏季 SOA 浓度值为 5.84~20.88 $g \cdot m^{-3}$，平均浓度为 12.15 $g \cdot m^{-3}$，冬季为 2.17~17.73 $g \cdot m^{-3}$，平均浓度为 6.91 $g \cdot m^{-3}$，冬季 SOA 浓度平均水平明显低于夏季。SOA 浓度值随风速及降水量的增大而减小；使用 PMF 受体模型对 VOCs 进行源解析分析得到夏季 SOA 污染主要来源于涂料使用、石油加工及石油化工源，SOA 贡献值分别为 0.65、0.21、0.18 $g \cdot m^{-3}$。冬季 SOA 污染主要来自于涂料使用，SOA 贡献值为 0.94 $g \cdot m^{-3}$。

关键词： VOCs；SOA 浓度；FAC 系数法；EC 示踪法；PMF 源解析

$PM_{2.5}$组分长期数据、高时间分辨率数据、多点位数据的特征对源解析影响研究

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摘要

颗粒物 $PM_{2.5}$ 污染受到国内外广泛关注，$PM_{2.5}$ 来源解析技术能识别大气颗粒物的主要源类，为颗粒物的高效防治提供科学依据。因子分析类模型（如正定矩阵因子分析模型 PMF）作为源未知类的受体模型在源解析工作中得到广泛应用，因子分析类模型根据受体数据自身变化规律进行解析。随着对 $PM_{2.5}$ 的重视，$PM_{2.5}$ 组分数据越来越丰富，如单点位长期观测数据，在线仪器观测获得的高时间分辨率数据、多点位同步观测数据等。不同数据具有不同的特征，而这些特征会影响源解析结果的准确性，因此需要研究 $PM_{2.5}$ 组分长期数据、高时间分辨率数据、多点位数据的特征对源解析结果的影响。本研究通过模拟实验和环境样品分析，研究长期监测环境样品数据、在线监测环境样品数据以及多点位数据特征对因子分析类模型影响，探讨模型对数据的要求。研究发现，多点位受体数据集应用于 PMF 模型的重要条件是点位间的源成分谱具有一致性，而点位间源贡献趋势的差异性对 PMF 模型的解析效果没有明显的影响；污染源类在单一受体点位的排放周期是 PMF 模型解析效果的重要因素，与样品量一起影响着模型的解析结果；针对高时间分辨率源解析，如果采样时期涵盖的源排放周期不足以反映源类变化特征，即使数据量很大，结果不确定也会较大；多点位受体样品的数据量也对 PMF 模型的解析有重要影响，为增加输入数据量而将多点位受体数据集应用于 PMF 模型不一定能够达到使模型解析稳定性更好的目的。本研究可以为高时间分辨率精细化源解析和高空间分辨率精细化源解析提供研究基础，有助于提高 $PM_{2.5}$ 常规和重污染过程防治的针对性、科学性和合理性，是大气环境保护研究领域的重要课题，具有重要的理论和实际意义。

关键词： 颗粒物；化学组分；源解析；长期源解析；高时间分辨率源解析；多点位源解析

有关气候变化与雾霾形成的思考

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摘要

通过对四川盆地城市群气候变化与雾霾污染进行相关性分析,提出有关气候变化与雾霾形成的几点思考。

一、四川盆地城市群出现雾霾的状况和历程

二、四川盆地气象和气候因素的变化历程

1、气温有所上升

2、风速有所加大，但也在微风和小风状态

3、日照和辐射有所增强

4、湿度降低显著

5、雾日数有所减少

三、气候变化与雾霾形成相关性分析

1、辐射与霾的相关性

盆地城市2009年后出现三日无雨即霾的现象,2015年以后该现象不再明显。

2、气温与霾的相关性

秋冬季节温度三日内无显著变化易出现霾，估计静稳天气过程造成。

3、风速影响

盆地城市群对风速不敏感，因为很少有起过三级的风，当然三级以上风速对空气质量改善有帮助。

4、湿度与霾的相关性分析

盆地城市群2008年的年平均湿度在85%左右，2016年年平均湿度降至65%左右，湿度降低的这十年，雾日数降低，但霾日数显著升高。

四、思考

1、假定污染物排放量不变，湿度由 85%降至 65%对霾的形成的机率大增。

2、辐射形成霾的影响不明显，主要是污染物排放和积累问题。

中国某城市大气中 $PM_{2.5}$ 主要化学成分的消光贡献解析

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摘要

大气能见度是城市环境空气质量的一个重要指标，能见度的大小主要取决于大气的消光作用。中国的灰霾主要由大气中细颗粒物（$PM_{2.5}$）的高污染造成。针对细颗粒物中不同成分的消光贡献，尤其是各种有机气溶胶的消光作用缺乏深入的研究，使得灰霾的控制管理缺少明确的目标。

本研究利用单颗粒黑碳光度计（SP2）、高分辨率飞行时间质谱（HR-ToF-AMS）、三波段光声黑碳仪（PASS-3）、氮氧化物分析仪（EC9841）等高时间分辨率的气溶胶观测仪器，测得了广东省东莞市冬季细颗粒物中不同化学组分的质量浓度，及颗粒物的消光系数。通过正向因子矩阵分析（PMF）与多元线性回归分析相结合，建立了拟合度较高（$R^2 = 0.953$）的细颗粒物中不同化学组分包括不同来源有机气溶胶与颗粒物消光系数之间的定量模型。

在整个观测期间，有机物占PM_1平均质量浓度的41%，其中二次有机气溶胶占总有机物质量的54%。其次是硫酸盐，硝酸盐，铵盐，黑碳和氯盐，分别占PM_1质量的23.2%，14.0%, 11.4%, 8.2%和2.2%。观测期间的大气消光系数为389 ± 192 Mm^{-1}，其中颗粒物消光占大气总消光的91.9%。

模型模拟结果显示，硫酸铵、硝酸铵、生物质燃烧有机气溶胶（BBOA）、二次有机气溶胶（SOA）和黑碳（BC）对颗粒物消光的贡献分别为48.1%, 20.7%, 15.0%, 10.6%和5.6%。二次气溶胶的贡献（79.4%）远高于一次气溶胶（20.6%），是造成能见度降低的主要因素。BBOA有较高的质量消光系数，具有较大的降低能见度的潜势，是某些重污染过程中最大的消光贡献者。更详细的分析表明，BC的混合状态造成的吸光增强约占颗粒物总吸光的37.7%，从而不容忽视。本研究量化了大气颗粒物中不同组分的消光贡献，为雾霾治理工作提供科学依据。

化工园区有毒有害气体预警监控及风险控制的探讨
——以高栏港化工园区为例

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摘要

化工园区聚集了大量化工企业，在化学品储存和生产等环节排放有毒有害气体，特别是在企业发生环境风险事故的情况下，大量有毒有害气体会对化工园区及周边环境造成严重影响。为有效控制有毒有害气体环境风险，需要建立快速反应的有毒有害气体预警监控体系。预警监控体系的建立主要包括几大任务，一是对化工园区开展有毒有害气体的环境风险排查，掌握园区企业排放的特征污染物并分析主要特征污染物排放的时空特征；二是结合园区的气候和气象条件和污染物排放特征，分析有毒有害气体迁移的时空分布规律，归纳有毒有害气体主要传输路径和影响范围；三是排查园区企业周边 5 公里范围内的环境敏感点，分析有毒有害气体对环境敏感点的影响；四是综合考虑污染物主要传输路径和重点区域，以保护人群健康为主要目的，提出预警监测的站点布设位置；五是根据园区污染物排放特征，选择优化组合多种有毒有害气体环境风险预警监测仪器，提出具体建设方案并构建化工园区有毒有害气体预警系统平台。在珠海高栏港化工园区预警体系建立的实例中，也发现预警体系需改进的地方，包括预警监测站点布设的完善；预警监测体系需进一步加强与企业排放口在线监测之间联动；另外建立环境行为控制的监控系统，根据企业环境行为判断和预警风险的发生。

关键词：化工园区；有毒有害气体；预警监控；风险排查；风险控制

武汉夏季大气臭氧及其前体物的污染特征

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摘要

2016 年 8 月，在武汉市市夏季主导风下风向监测点（吴家山站）、典型城区监测点（武昌紫阳站）和路边站进行 VOCs 样品的采集和检测。结果表明，吴家山站（9.71±1.32 ppbv）和武昌紫阳站（8.99±2.21 ppbv）的 VOCs 浓度水平相当，路边站（32.51±4.86 ppbv）由于紧邻交通主干道，受机动车影响较大，VOCs 浓度最高。利用 PMF 模型对三个站点的 VOCs 来源进行解析，得出机动车排放（汽油车、柴油车、天然气排放、汽油挥发）均为最大的 VOC 贡献源。吴家山站以机动车排放（49.53%）、石油化工（20.30%）和溶剂使用（17.28%）为主；紫阳站以机动车排放（59.71%）和石油化工源（24.93%）为主；汉口路边站以机动车源排放为主（81.53%），且机动车源贡献远高于其他两站。利用 WRF-CMAQ 模型对武汉地区臭氧生成及传输进行模拟。白天武汉地区高浓度的臭氧主要来自本地生成，而夜间主要来自区域传输。绘制臭氧生成的等浓度曲线，表明武汉市臭氧生成主要受 VOCs 控制，部分情况下，由 VOC 和 NO_x 共同控制，因此减少 VOCs 排放对武汉市臭氧控制非常有效。使用光化学反应箱式模型（PBM-MCM 模型）模拟并计算不同来源 VOCs 对臭氧生成的贡献。三个采样站点的机动车排放均为最大的臭氧贡献源。吴家山站臭氧生成的主要贡献源为机动车排放（33.57%）、植物排放源（28.71%）和溶剂使用（20.89%）；紫阳站臭氧主要贡献源为机动车源（37.75%）、植物排放（24.15%）和溶剂使用（21.11%）；路边站机动车源排放的 VOC 对臭氧的贡献最大，达到 58.68%。因此削减机动车排放的 VOCs 能有效减少武汉市臭氧的生成。

黑碳气溶胶老化程度的模拟

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ABSTRACT

黑碳气溶胶（Black Carbon, BC particles）是 $PM_{2.5}$ 的重要组成成分，主要来自化石燃料和生物质的不完全燃烧，占到城市大气 $PM_{2.5}$ 总质量浓度 120%。不同于其他颗粒物组分，BC 气溶胶具有很强的吸收太阳辐射的能力，对大气有很强的增温效应，进而可以改变地球辐射平衡，影响区域及全球气候。研究认为 BC 气溶胶对于地球的辐射强迫被认为仅次于二氧化碳。最近，Ding et al.研究发现，BC 气溶胶在我国灰霾污染期间起到“穹顶效应”，可以抑制大气边界层的发展，从而促进重污染的发生。

BC 气溶胶排放到大气后，会通过气固分配、非均相反应和凝结相反应等方式与其他气态污染物二次转化的产物发生相互作用，这一过程称为 BC 气溶胶的“老化”。BC 颗粒物在老化过程中自身的化学组成、粒径、密度、混合态和形貌等都会发生很大的变化，改变吸光能力和吸湿性，影响气溶胶的辐射强迫。本研究在源导向的 UCD/CIT 模型的基础上对 BC 气溶胶的区域老化程度进行追踪模拟。我们对美国休斯顿地区进行了模拟。

结果表明在休斯顿城区的 BC 70-90%是排放 0-3 小时内的 BC 组成的，而在偏远郊区，这个比例只占到 20-40%。同时 BC 的老化程度的分布具有明显的日变化规律，在早晚交通高峰时段，新鲜排放的 BC 的占比达到最大，而越接近排放源，这个比例越大。在该地区非常高比例的新鲜排放 BC 会对气溶胶的光学和吸湿性有重要影响，在气候模型模拟时需要考虑。