A study of local circulation and their effect on air quality: a case study over Veracruz city, Mexico

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Veracruz city Harbor is the most important in Mexico. Recently an expansion project has result land cover changes, a population and vehicular fleet increase and major increment on emission rates. Therefore the meteorological condition information that favor or not the dispersion of pollutants is crucial to decision making. There are few studies about the pollution dispersion in this region; however the role of local circulations, the mixing height variability and particle trajectories emitted have not been examined yet. In this work, meteorological surface stations, buoys and the North America Regional Reanalysis data were used to characterize daily and seasonal variability of winds, temperature humidity. The CALMET model was also used to assess meteorological conditions for events with medium to high PM_{10} concentrations. The results show that a strong katabatic wind originates from radiational cooling of air atop the Central Mexican Plateau reaches the coast during the night transporting particles to Xalapa and Veracruz cities area. Also during daylight the sea breeze carries particles inland and at night the emissions are trapped in a shallow boundary layer near the coastline. Additionally PM_{10} concentration maxima occur during cold surges events due to wind erosion.

Keywords: dispersion of pollutants, local circulation, CALMET model

Regional contributions to primary and secondary inorganic components of particulate matter in India

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Source-oriented versions of the Community Multiscale Air Quality (CMAQ) model were used to estimate the contributions of different sources and regions to primary and secondary inorganic components (including elemental carbon, organic carbon, sulfate, nitrate, and ammonia) of particulate matter (PM) in India using Emission Database for Global Atmospheric Research (EDGAR) and Weather Research & Forecasting (WRF) model for meteorological inputs. The whole year 2015 was simulated with emissions grouped to seven sectors and nine regions. Seasonal variations in contributions of different sources and regions to major cities in Delhi were analyzed. Results indicate that while residential burning was the dominant source of PM during winter, open burning dominated during pre-monsoon. The source-region analysis indicates that Haryana-Punjab, Rajasthan, Haryana-Punjab and Uttar Pradesh regions were contributing to major fractions of primary and secondary inorganic PM in Delhi during winter, pre-monsoon and post-monsoon seasons.

Keywords: Particulate matter, Source apportionment, Regional transport, India

Regional transport of ozone and its precursors to Southeast Louisiana

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The Community Multi-scale Air Quality (CMAQ) model with modified photochemical mechanism is used to investigate the contributions of regional transport to ozone (O3) and its precursors to Southeast Louisiana in summer months from 2006 to 2015. Contributions from eight different source sectors and regions to the 8 hour average daytime O3 concentrations will be determined. The source types including residential wood combustion, on-road transportation, oil and gas, off-road, electric generating utilities (EGU), open burning, industry and other sources. After the local sources are quantified, transport of upwind sources is determined. Contributions of different source regions to direct O3 concentrations or its precursors will be obtained. Under favorable transport conditions, the maximum contribution to 1 hour O3 from each region will also be evaluated. Changes of the contributions of regional transport by comparing different years will show the effectiveness of previous control measures. The results would provide valuable information on controlling local and regional emissions of O3 precursors for improve O3 air quality in Southeast Louisiana.

Keywords: Ozone, Regional transport, Photochemical mechanism, CMAQ, Southeast Louisiana

A modeling study of effective radiative forcing and climate response due to increased methane concentration

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An atmospheric general circulation model BCC_AGCM2.0 and observation data from ARIS were used to calculate the effective radiative forcing (ERF) due to increased methane concentration since pre-industrial times and its impacts on climate. The ERF of methane from 1750 to 2011 was 0.46 W m^{-2} by taking it as a well-mixed greenhouse gas, and the inhomogeneity of methane increased its ERF by about 0.02 W m^{-2}. The change of methane concentration since pre-industrial led to an increase of 0.31 ˚C in global mean surface air temperature and 0.02 mm d^{-1} in global mean precipitation. The warming was prominent over the middle and high latitudes of the Northern Hemisphere (with a maximum increase exceeding 1.4 ˚C). The precipitation notably increased (maximum increase of 1.8 mm d^{-1}) over the ocean between 10˚N and 20˚N and significantly decreased (maximum decrease >−0.6 mm d^{-1}) between 10˚S and 10˚N. These changes caused a northward movement of precipitation cell in the Intertropical Convergence Zone (ITCZ). Cloud cover significantly increased (by approximately 4%) in the high latitudes in both hemispheres, and sharply decreased (by approximately 3%) in tropical areas.

Keywords: Methane, Effective radiative forcing, Climate change

Observationally constrained simulation of aerosol optical properties over East Asia

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Aerosol chemical composition over East Asia, a mixture of natural dust, sea salt, biomass burning, and air pollutants, is more diverse than other regions. There are still large uncertainties to simulate the aerosol composition and its associated optical properties in aerosol models. The aerosol optical properties simulated by a flexible high resolution global to regional air quality model (NICAM-Chem) are evaluated using the space-based and ground-based observations. The aerosol processes over East Asia including emission, transport, and deposition are compared between multiple aerosol models, and the general similarities and differences are found. Based on Local Ensemble Transform Kalman filter (LETKF) method, the aerosol assimilation system for the NICAM-Chem is further developed to improve the model performances. Assimilation leads to significantly positive effect on the simulated AOD field, improving agreement with all of the 12 AERONET sites over the Eastern Asia based on both the correlation coefficient and the root mean square difference (assimilation efficiency). Meanwhile, better agreement of the Ångström Exponent (AE) field is achieved for 8 of the 12 sites due to the assimilation of AOD only.

Keywords: Aerosol optical properties, LETKF, Aerosol assimilation

Correlation patterns and seasonal scaling behaviors of $PM_{2.5}$ concentration in China

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Recently China has been suffering from air pollution. Aerosols or particulate matters are an important component of the atmosphere, transporting under complex meteorological conditions. Here the data of $PM_{2.5}$ observations provided by the ministry of environmental protection, is first studied by a complex networks approach. We calculate the cross-correlation function for different seasons. The seasonal scaling behaviour of the probability distribution function of correlation can be observed. We report the two types of correlations, which correspond to the local and long-range interactions respectively. The local interaction is mainly caused by free expansion or transmission by wind. And a whole picture about the direction of transmission of $PM_{2.5}$ is given in China for different seasons. The long-range interaction is correlated with atmospheric waves.

A review on the local and inter-regional contributions to primary and secondary PM2.5 pollution in key regions of China

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Rapid economic growth and urbanization in China lead to increased primary air pollutants emissions and secondary particulate matter formation from power generation, industries, transportation as well as residential sectors. Primary and Secondary PM2.5 can be formed by local emissions and also can be transported over longer distances. Understanding the contributions of local and regional transport contributions to primary and secondary PM2.5 in key regions of China is necessary for designing effective emission control programs to reduce PM2.5 pollution in these regions. In this study, we reviewed the studies on the local and regional transport contributions of PM2.5 in China published in literature based on various methods including ambient measurements, trajectory analysis, and air quality modeling, etc. Contributions of different source regions to primary and secondary PM2.5 will be summarized quantitatively for the key regions under representative pollution episodes. The meteorological conditions that affect the formation, transport and gas-to-particle partitioning of PM2.5 will be analyzed.

Keywords: PM2.5, local emission, regional transport

A Modeling Study of Emission Control Strategies in Urban Cities in the Yangtze River Delta, China

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With fast advances in economy, most eastern Chinese cities are experiencing severe air pollution and in an urgent demand of stringent emission control strategies. The Community Multi-scale Air Quality model (CMAQ) and the Weather Research & Forecasting model (WRF) were applied to study the air quality and emission control strategies in two urban cities, i.e. Shanghai and Nanjing in the Yangtze River Delta (YRD), China. Multi-resolution Emission Inventory for China (MEIC) and the Model of Emissions of Gases and Aerosols from Nature (MEGAN) were used for anthropogenic and biogenic emissions, respectively. We evaluated model's performances against seasonal observations of O_3, NO_x, SO_2, $PM_{2.5}$ and PM_{10} at 10 monitoring sites in Shanghai and 11 monitoring sites in Nanjing during 2015. We further compared detailed $PM_{2.5}$ composition from the model and measured data at an urban monitoring site as an additional constraint. The model can well reproduce the spatial and temporal distribution of these chemical compounds. We then designed emission control strategies for $PM_{2.5}$ in Shanghai and Nanjing based on the modeling results. Sensitivity tests showed that long-range transport is mainly responsible for $PM_{2.5}$ pollution in both cities. Therefore, a collaborative emission control strategy in Nanjing/Shanghai and their surrounding regions is needed to effectively improve air quality. We also performed several sensitivity tests to study the response of $PM_{2.5}$ to different total controlled emission reductions as well as major primary emitted $PM_{2.5}$ precursors. This information is very useful for the government in policy making in the future.

Keywords: Emission control, CMAQ, WRF, China

Potential impacts of electric vehicles on air quality in Taiwan

Potential impacts of electric vehicles on air quality in Taiwan

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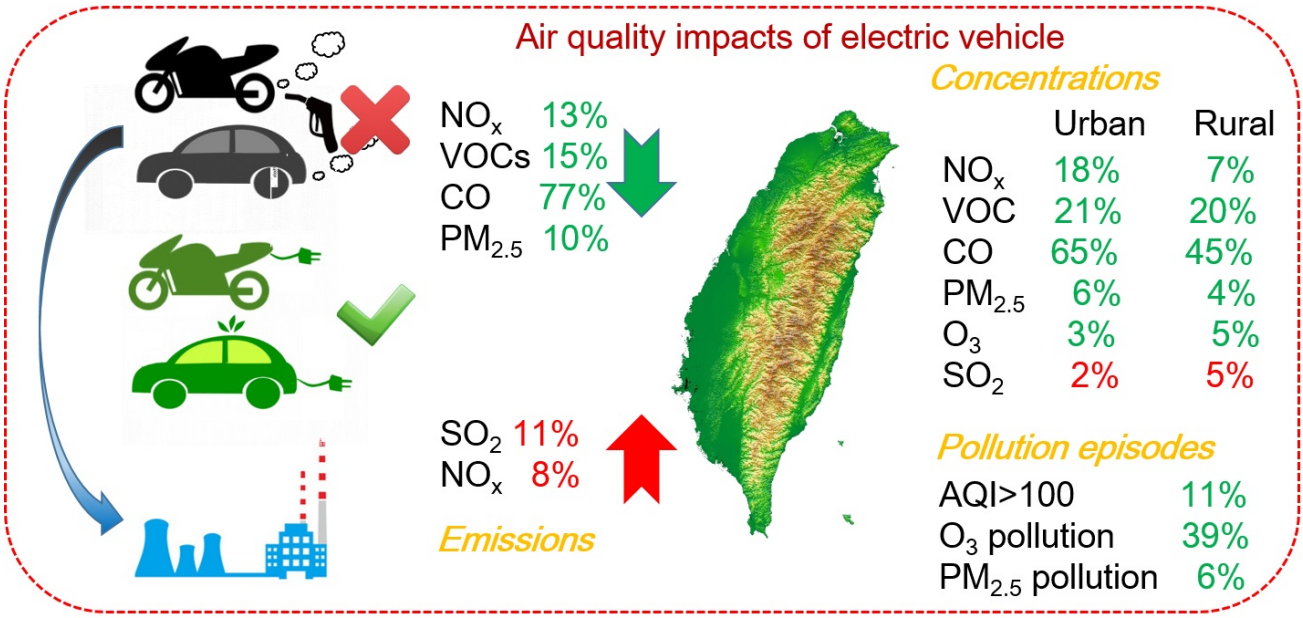
The prospective impacts of electric vehicle (EV) penetration on the air quality in Taiwan were evaluated using an air quality model with the assumption of an ambitious replacement of current light-duty vehicles under different power generation scenarios. With full EV penetration (i.e., the replacement of all light-duty vehicles), CO, VOCs, NO_x and $PM_{2.5}$ emissions in Taiwan from a fleet of 20.6 million vehicles would be reduced by 1500, 165, 33.9 and 7.2 Gg yr^{-1}, respectively, while electric sector NO_x and SO_2 emissions would be increased by up to 20.3 and 12.9 Gg yr^{-1}, respectively, if the electricity to power EVs were provided by thermal power plants. The net impacts of these emission changes would be to reduce the annual mean surface concentrations of CO, VOCs, NO_x and $PM_{2.5}$ by about 260, 11.3, 3.3 ppb and 2.1 μg m^{-3}, respectively, but to increase SO_2 by 0.1 ppb. Larger reductions tend to occur at time and place of higher ambient concentrations and during high pollution events. Greater benefits would clearly be attained if clean energy sources were fully encouraged. EV penetration would also reduce the mean peak-time surface O_3 concentrations by up to 7 ppb across Taiwan with the exception of the center of metropolitan Taipei where the concentration increased by ~2 ppb. Furthermore, full EV penetration would reduce annual days of O_3 pollution episodes by ~40% and $PM_{2.5}$ pollution episodes by 6–10%. Our findings offer important insights into the air quality impacts of EV and can provide useful information for potential mitigation actions.

キーワード：Electric vehicle、air quality、AQI、CMAQ、Taiwan
Keywords: Electric vehicle, air quality, AQI, CMAQ, Taiwan



Investigating the feature and regional sources of urban $PM_{2.5}$ concentration over Central China in 2014

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In Central China, where Wuhan is a typical megacity, rapid economic growth has created numerous cities-clusters in recent years, which undoubtedly aggravates the regional and urban haze pollution in China attracting worldwide attention. In sight of recent works on observed particulate matter pollution, the feature and potential source regions of $PM_{2.5}$ concentration over Wuhan in the whole year remain highly uncertain. Based on analysis of observed data, the hazy days (average daily $PM_{2.5}$ 75 μgm^{-3}) in Wuhan accounted for 48% in 2014, and the annual concentration of $PM_{2.5}$ (84.1 μgm^{-3}) kept the same level with that of Beijing in 2013. Especially, $PM_{2.5}$ value in January was twice of that in Beijing over the corresponding period. Air pollution was severest in winter over Wuhan with hazy days of 18-30days in different month, followed by spring and autumn. Though the air quality was the best in summer, the days of $PM_{2.5}$ concentration averagely exceeding 75 ranged from 3 to 17days. We analyzed the impact of regional chemical transport of air pollutants throughout the year using a Nested Air Quality Prediction Model System (NAQPMS) with a source tagged tracer method. The monthly local contribution of Wuhan in winter is the smallest (less than 50%), which indicates regional transport is the dominant source of high $PM_{2.5}$ level. The local emissions play a determinant role in $PM_{2.5}$ formation in summer, while regional contribution could be 30%-40% approximately. The main reason is that prevailing strong winds in favor of regional transport from high-emission areas in winter, and strong local specificities and effective diffusion processes in vertical that decreasing $PM_{2.5}$ concentration in the local. Our results highlight the importance of the air pollutant transports in the formation of fine particulate matter over Wuhan. On a long term and durable perspective, regulating the regional trans-boundary environmental impact assessment in China appears to be an imperative for effectively mitigating urban $PM_{2.5}$ loading.

Keywords: PM2.5, Central China, regional transport, haze pollution, Wuhan

Investigation of relationship between air pollution formation mechanism and synoptic pattern based on three-years observations in megacity Beijing, China

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Air pollution is a severe problem in China especially in winter season for the decade years. To investigate the formation mechanisms of air pollution in winter, the relationship between air pollution and synoptic pattern was explored by employed three years (2013-2015) high resolution $PM_{2.5}$ concentrations, synoptic charts, satellite images, radiosonde data, wind pattern observation, and HYSPLIT Trajectory Model in megacity Beijing, China. The results indicated that haze days (daily $PM_{2.5}$ concentration > 150 $\mu g/m^3$) in winter season Beijing is 36, 28 and 35 for 2013, 2014 and 2015, respectively. Consistent air pollution episodes always accompanied with the following synoptic patterns: 1) at 500 hPa, cold air forces were located in the north part and north china Plain was controlled by western wind; 2) at 850 hPa, warm advection frequently occurred above North China plain and Bohai bay, which favored stable synoptic pattern and transportations of air pollutants to Beijing; 3) On surface, Beijing was controlled by back of anticyclone, low pressure or uniform pressure situation, which accounted for 47.3%,18.2% and 34.5% of the serious haze episodes, respectively. The above results also illustrated that air pollution episodes accompanied with anticyclone arose most frequently with maximum daily $PM_{2.5}$ concentration 258.8 $\mu g/m^3$. The results will offer beneficial environmental implications for the air pollution forecasting.

Keywords: air pollution, synoptic pattern, anticyclone, formation mechanisms

Outstanding seasonality of the lower tropospheric ozone over central China observed by Ozone Monitoring Instrument (OMI)

Outstanding seasonality of the lower tropospheric ozone over central China observed by Ozone Monitoring Instrument (OMI)

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Recent study by Cooper et al. (2016) reviewed global ozone (O_3) measurements, and showed a significant positive trend of the surface O_3 over East Asia after 1990’s. However, as the number of ground-based stations in East Asia is limited, a whole picture of the spatial distribution and its interannual variability of the boundary layer O_3 over East Asia is not yet well captured by observations. On the other hand, recent technological advances have made it possible to observe atmospheric concentrations of O_3 from space. However, almost 90 % of O_3 is available in the stratosphere while the amount of O_3 in the boundary layer is usually only several percentage of the total amount. Therefore, the vertical discrimination of O_3 in the lower troposphere is a big challenge in satellite-borne measurements. In spite of the difficulty, substantial progress has been made on this problem. Liu et al. (2010) successfully derived the ozone profiles from the surface up to 60 km into 24 layers using the ultraviolet spectra observed by Ozone Monitoring Instrument (OMI). The lowermost layer corresponds to a layer from 0 km to about 2.5~3 km above the surface. Hayashida et al. (2015) examined the 24th layer of their products and assured the reliability of the O_3 in the lower troposphere under enhanced O_3 conditions. They reported O_3 enhancement observed in Central and Eastern China (CEC), with Shandong as its center, and most notable in June in any given year.

In this study, to reveal spatial and temporal variation of ozone distribution over CEC, we applied cluster analysis to the OMI O_3 data over the regions. We focus the anomaly of ozone (DO_3), which is defined as the difference from the a priori values ($DO_3 = O_3$[retrieval] $-O_3$[a priori]). This analysis is effective to follow O_3 enhancement under polluted condition, because our focus is the temporal O_3 enhancement from the background level, i.e. climatological values. The DO_3 values can be interpreted as an indicator of the ozone enhancement from the background level.

Before cluster analysis, we applied the screening as described in Hayashida et al. (2017) for all OMI retrievals during the period from October 2004 through December 2013 to remove any doubtful data that might be affected by the UT/LS ozone variability.

We divided all of the grids in the range of 25˚- 40˚N, and 100˚-135˚E into some clusters according to the similarity of the seasonal variation of DO_3 at the 24th layer. The function used for the analysis is based on the complete linkage method for hierarchical clustering implemented in the statistical tool R (R Core Team, 2012). The number of the cluster was given from 4 to 11. By this analysis, we can distinguish the areas where DO_3 has outstanding seasonality over the North China Plain and Sichuan basin (named as Cluster 1). The Cluster 1 corresponds to the areas of high NO_2 concentration observed by satellite sensors. The values of DO_3 as well as O_3 in Cluster 1 show high in summer (in June in particular) and low in winter. We compared those clustered areas with the model simulations by Meteorological Research Institute –Chemistry Climate Model (MRI-CCM2) (Deushi and Shibata, 2011). The Cluster 1 corresponds to the areas of high chemical production rate in June in the model simulation. We also compared the

results of cluster analysis with meteorological data. Along the coastal area, DO_3 tends to drop to negative values (less than climatology) temporarily in August, which can be interpreted as the inflow of oceanic clean air into the inland area.

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キーワード：オゾン、中国、OMI
Keywords: ozone, China, OMI

High Resolution vehicular emissions inventory in Shanghai China: Application of REMI model

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Accelerated industrial development of Shanghai, China, lead to a large number of vehicles into the streets, generating critical levels of pollution that remains high nowadays. This is the biggest city in China, in commercial and industrial aspects, with more than 20 millions urban habitants, which produced an intense demand of public and private transport. Air pollutant concentrations persistently remains high with risk to health of population (http://semc.gov.cn/aqi/home/English.aspx, Environmental Service of Shanghai). This study presents a bottom-up vehicular emissions inventory with the R EMission Inventory (REMI) Package (Ibarra *et al*, 2017a) for the mega city of Shangai. REMI is package wrote in R language that estimates vehicular emissions inventory considering exhaust, cold-start, evaporative, dust resuspension and wear emissions. The road network (Figure 1) of Open Street Map is used as input, identifying the type of street, to perform a spatial traffic interpolation as shown by Ibarra *et al* (2017b). This approach assumes high density of light duty vehicles in downtown, and in contrast, less density of trucks in downtown. The emission factors used are COmputer Programme to calculate Emissions from Road Transport (COPERT) with an euro equivalency as shown by Wang *et al* (2010). Nevertheless, REMI offer the option to use local emission factors or a merge between local and COPERT emission factors. The age distribution is very important, so it was assumed that all vehicles were in circulation till 40 years of use. REMI is also suitable for cities with limitation of data, as showed by Ibarra *et al* (2017b) because it interpolates traffic and assign it into the road network directly. REMI outputs consists in vehicular emission with high spatial and temporal resolution, with hourly emissions at street level. This study will consider a detailed perspective of vehicles, including the use of motorcycles and it will be compared with Wang *et al* (2008). The resulting estimation will give detailed pollutant for each road, hour of the day and day of the week, allowing investigation of vehicular emissions for the biggest city of China.

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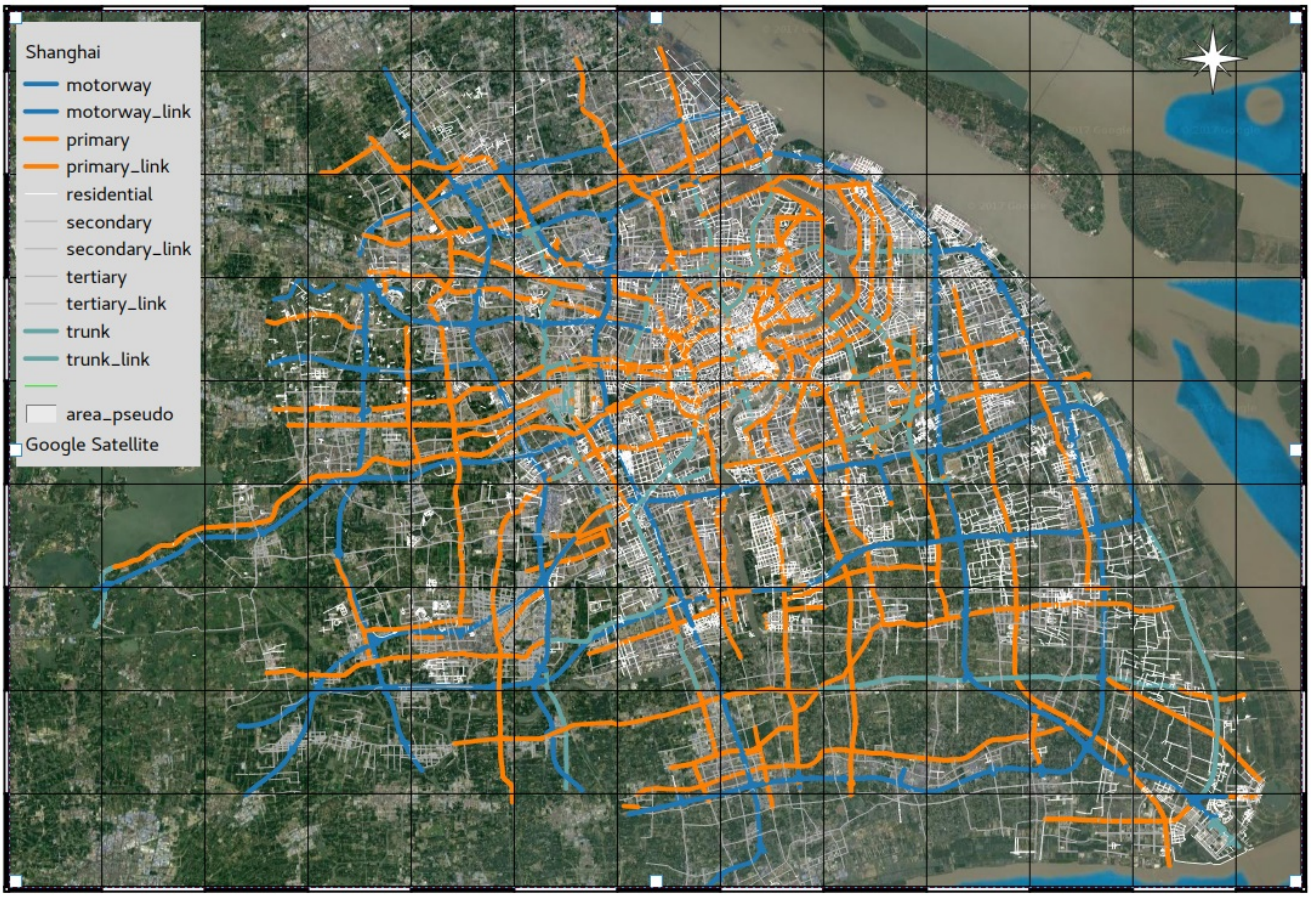
Keywords: REMI, Emissions Inventory, Air Pollution



Emissions of fine particulate nitrated phenols from the burning of five common types of biomass

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Nitrated phenols are among the major constituents of brown carbon and affect both climates and ecosystems. However, emissions from biomass burning, which comprise one of the most important primary sources of atmospheric nitrated phenols, are not well understood. In this study, the concentrations and proportions of 10 nitrated phenols, including nitrophenols, nitrocatechols, nitrosalicylic acids, and dinitrophenol, in fine particles from biomass smoke were determined under three different burning conditions (flaming, weakly flaming, and smoldering) with five common types of biomass (leaves, branches, corncob, corn stalk, and wheat straw). The total abundances of fine nitrated phenols produced by biomass burning ranged from 2.02 to 99.52 μg m^{-3}. The compositions of nitrated phenols varied with biomass types and burning conditions. 4-nitrocatechol and methyl nitrocatechols were generally most abundant, accounting for up to 88–95% of total nitrated phenols in flaming burning condition. The emission ratios of nitrated phenols to $PM_{2.5}$ increased with the completeness of combustion and ranged from 7 to 45 ng mg^{-1} and from 239 to 1081 ng mg^{-1} for smoldering and flaming burning, respectively. The ratios of fine nitrated phenols to organic matter in biomass burning aerosols were comparable to or lower than those in ambient aerosols affected by biomass burning, indicating that secondary formation contributed significantly to ambient levels of fine nitrated phenols. The emission factors of fine nitrated phenols from flaming biomass burning were approximately 0.75–11.07 mg kg^{-1}. According to calculations based on corn and wheat production in 31 Chinese provinces in 2013, the total estimated emission of fine nitrated phenols from the burning of corncobs, corn stalks, and wheat straw was 670 t. This work highlights the apparent emission of methyl nitrocatechols from biomass burning and provides basic data for modeling studies.

Keywords: Nitrated phenols, emission, biomass burning, fine particulate matter, smoke

