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An Integrated Analysis of Particulate Matter Episodes over Megacities using Multi-scale Modelling, Ground-based and Space-based Observations

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Particulate Matter (or aerosol) Episodes have significant effect on atmospheric composition and air quality. High levels of particulate matter (PM10 and PM2.5) concentrations are often observed over megacities. The cause of such episodes is not fully understood yet. In this study, we use the state-of-the-art CMAQ-WRF-SMOKE regional air quality modelling system to simulate the formation, evolution and dissipation of episodes over megacities and examine the dominant factors such as emission, meteorological and chemical processes. The simulations have been directly compared with ground-based and space-based observations.

We analyses the chemical composition of the particulate matter (PM10 or PM2.5) concentrations over megacities such as London and Paris from model simulations and ground-based measurements. The model simulations of major aerosol species including sulphate, ammonium, nitrate, black carbon and organics have been evaluated with ground-based measurements. The new boundary conditions generated from a global chemistry transport model (GEOS-Chem) are used to improve the CMAQ-WRF-SMOKE modelling results. In order to understand the emission, meteorological and chemical processes, the detailed emission sources and meteorological parameters simulated from WRF such as wind speed, pressure, and mixing height have been analyzed. The favourable meteorological conditions have been found to enhance the long range transport of air pollutants.

We synergically retrieve particulate matter concentrations from the measurements of multiple satellite sensors such as the Ozone Monitoring Instrument (OMI), the Moderate Resolution Imaging Spectroradiameter (MODIS) and the Multiangle Imaging SpectroRadiameter (MISR). The global model (GEOS-Chem) and regional model (CMAQ) are used to constrain the aerosol profiles. In particular, we use backscatter profiles from the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) measurements to explore the potential for improving the retrieval of surface PM2.5 and PM10 concentrations. Furthermore, we combine the network of ground-based measurements with the intelligent sensor retrievals to obtain the surface concentration of aerosols over urban area. The cause of particulate matter episodes over megacities will be analyzed with an approach of integration modelling and observation.