Modeling study on spatial and temporal variations of aerosols around Beijing

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In East Asia, recent rapid growth of industrial activities has been causing large increases in emissions of pollutants such as aerosols and their precursor gases. The increase in aerosols in the atmosphere potentially has significant impacts on regional climate and air quality (e.g. human health). Recently, mega-city regions have been attracted considerable attentions due to its large emissions and potential regional impacts. In August and September 2006, an intensive campaign, CAREBEIJING-2006 campaign, was conducted around Beijing (Peking Univ. campus site (PKU site) and Yufa site, which is located 50 km south of Beijing), which is one of the largest mega-cities in East Asia.

In this study, we made 3D regional modeling calculations (WRF-CMAQ and WRF-chem) to study temporal and spatial variations of aerosols around the Beijing region for a period in which the CAREBEIJING-2006 campaign was conducted. At both the PKU and Yufa sites, enhancements in concentrations of various aerosol species were observed five times during one-month observation period. Features of these temporal variations of aerosols as well as meteorological fields were generally well reproduced by model calculations. Aerosol optical depth (AOD) observations made by the AERONET surface network show that AOD values also increased when high aerosol events were observed at the PKU and Yufa sites. Furthermore, the MODIS satellite observations show that the increase in AOD extended further south over several hundred to a thousand kilometers. Features of these temporal and spatial variations in AOD were also generally well reproduced by model calculations. These results suggest that some important factors, which control aerosol concentrations, such as emissions, transport, and aerosol formation processes are reasonably well reproduced in the model calculations.

In this study we also estimated contributions of emissions at various locations to aerosol concentration at Beijing by changing emissions at individual locations. As a result, it was found that gaseous and primary aerosol species in Beijing were mostly controlled by emissions within 100km, while secondary aerosols, such as sulfate, were influenced also by emissions further than 100 km, reaching 500 km under stable atmospheric conditions.