Variation of secondary organic aerosol in Kanto-area using a three-dimensional model

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Organic aerosol consists of primary organic aerosol (POA), which is emitted directly in particulate form, and secondary organic aerosol (SOA), which is formed through the oxidation of precursor gases in the atmosphere. Since SOA is considered to be one of the dominant forms of atmospheric aerosols, an understanding of processes controlling SOA amount in the atmosphere is important in evaluating various aerosol impacts on atmospheric environment and climate. The purpose of this study is to understand processes to control SOA levels in Kanto-area, using mechanistic (explicitly predict) SOA model.

In this study, MM5 and CMAQ-MADRID2 were used as a regional meteorological model and three-dimensional chemical transport model, respectively. To evaluate the performance of model calculations, we used measurements of aerosols and gaseous species made at Komaba, which is close to the center of Tokyo, in July and August 2003 and the regional network measurement of gaseous species in and around Tokyo metropolitan area. The period of model calculation was 10 days from 26 July to 5 August 2003.

In this study, meteorological field in Kanto-area and behaviors of various gaseous (ozone, VOCs, and others) and inorganic aerosol species were generally well reproduced by model calculations. Various observed features of temporal SOA variations, such as diurnal, day-to-day, and seasonal variations were also reproduced by model calculations reasonably well, however, model calculations underestimated that of observed by a factor of 3 to 6. A flaw of the current emission data, such as a lack of high-molecular-weight alkanes, and missing mechanisms to produce SOA, such as unknown liquid phase and heterogeneous reactions, can be possible causes for this underestimation.

Since calculated SOA roughly reproduced various observed features, one of the factors controlling these variations in Kanto-area is examined by comparing their effects on variations of ozone. When spatial distributions of maximum SOA and O3 concentration regions in Kanto-area are examined, it is found that SOA and O3 were photochemically produced concurrently during the transport to the suburbs. This is considered that SOA and O3 have common and similar precursor gases and formation processes. Transport paths are different day-to-day depending on sea-land breeze circulation, and this process is found to be one of the most important factors in controlling SOA levels in the suburbs (west and north part of Kanto-area). Similarities and differences of SOA and ozone photochemistry, such as dependence on precursor gases are also discussed.