Measurement of ambient particles using a newly developed polar nephelometer -Relationship between scattering angular distributions and chemical compositions-

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Angular distribution of scattering is one of the important optical properties contributing to the radiation balance in the Earth's atmosphere. Therefore, accurate description of the single-scattering properties of aerosol particles is required. The angular distribution of light scattering is an important optical property. In addition, because the angular distribution of scattering depend on size, shape, and refractive index of particles, the angular distribution for individual aerosol particles may provide useful information to estimate mixing state and type of particles. In the present study, applicability of the angular distribution for individual particles to the estimation of mixing state and type of particles was examined by comparing the temporal variations of the angular distributions with those of chemical compositions for ambient particles.
We have developed a new polar nephelometer, which can measure angular distribution of the optical light scattered by an individual particle.[1)] Laser beam at 532 nm from a 300 mW YAG laser was used as light source. The laser beam intersects with a stream of aerosol particles introduced with a sheath flow using a double pipe. There are 21 photodiode detectors arrayed in each plane, totaling 42. Detector apertures were placed to limit sensing angles and minimize background light scattered from walls. In this system, the angular distributions for an incident light polarized parallel and perpendicular to the scattering plane can be measured simultaneously.
Ambient particles were measured at the Higashiyama campus of Nagoya University (35°09¢N, 136°58¢E, 60 m above sea level) located in an urban area in Nagoya, Japan, from July 1st to 7th, 2015. After being dried by a diffusion dryer with silica gel, ambient particles were introduced alternately to a heated line (maintained at 300°C) or the bypass line to measure, respectively, ambient particles directly and after the evaporation of volatile materials under high temperature conditions. The lines were switched every 15 min using two-way ball valves. Then, the particles were passed through a differential mobility analyzer (DMA) and introduced into the polar nephelometer. The DMA voltage was switched to select the nearly monodispersed particle with a mobility diameter 300 or 500 nm every 30 min. Most of organics, sulfate, nitrate, and ammonium are expected to be vaporized at temperatures below 300°C.[2)] Therefore, black carbon (BC) particles are expected to be mainly measured when particles were passed through the heated line. During the observation, mass concentrations of BC were measured using a particle soot absorption photometer (PSAP) combined with a heated inlet (maintained at 300°C). The mass concentrations organics, sulfate, nitrate, and ammonium were measured using a time-of-flight aerosol mass spectrometer (AMS). In the presentation, relationship between the temporal variations of scattering angular distributions of individual particles and those of chemical compositions will be discussed.

Reference

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