Simultaneous measurements of optical and chemical properties of aerosols in central Tokyo during summer 2008

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Aerosol particles have an important role in radiation balance in the atmosphere by scattering and absorbing incident light. Therefore, accurate determination of the optical properties of atmospheric aerosols is essential. The optical properties of aerosol strongly depend on chemical composition, diameter, shape, and mixing state. In this work, we focused on the relationship between optical and chemical properties of ambient aerosol.

Simultaneous measurements of extinction, scattering, and absorption coefficients of the ambient aerosols were performed in central Tokyo from 31st July to 28th August 2008 using an originally developed cavity ring-down spectrometer (CRDS) (extinction at 355 and 532 nm), a nephelometer (TSI, scattering at 450, 550, and 700 nm), a photoacoustic spectrometer (PASS) (Droplet measurement technologies, absorption at 532 nm), and a PSAP (Radiance Research, absorption at 462, 526, and 650 nm). Chemical compositions of the aerosol were measured by a time-of-flight aerosol mass spectrometer (TOF-AMS) (Aerodyne). Carbonaceous particles were measured using a EC(elemental carbon)/OC(organic carbon) analyzer (Sunset Laboratory). Using the obtained extinction, scattering, and absorption coefficients, single scattering albedo (SSA) and aerosol angstrom exponents (A), were calculated. These optical parameters are compared with chemical properties.

First, SSA values at 532 nm were calculated using the CRDS and PASS data. SSA values were found to be close to unity when the extinction coefficients and AMS sulfate mass fractions are higher. On the other hand, SSA values frequently have values lower by 0.4 when the extinction coefficients are lower and AMS organics mass fractions are higher. Since mass concentrations of EC and OC measured by a carbon analyzer have a positive correlation, the results imply that sulfate aerosols contribute to the higher SSA for the airmass with high extinction coefficients, while EC contribute the lower SSA especially for the airmass with low extinction coefficients.

Second, extinction and scattering angstrom exponents between 355 and 532 nm, A(ex) and A(sc), were calculated using CRDS and TSI nephelometer data. The obtained A(ex) are often found to become larger than A(sc). The result suggests that the wavelength dependence of absorption contributes to the A(ex). Since absorption angstrom exponents calculated using PSAP data are small (close to 1), the aerosols which have large absorptions in the wavelength region shorter than that the PSAP used (462 nm) may exist. The difference between A(ex) and A(sc) have a good correlation with the organic mass fractions measured by AMS. This fact implies that the organic aerosols, which have a large absorption in the short wavelength region, brown carbon, may contribute to the A(ex) observed in the urban area of Tokyo.