Systematic errors in previous techniques to measure optical properties of aerosols: Simultaneous measurements with CRDS technique

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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. There are two components to aerosol optical extinction: scattering and absorption. Extinction coefficients of atmospheric aerosol have commonly been determined by measuring scattering coefficients using nephelometer and absorption coefficients using an aethalometer or particle/soot absorption photometer (PSAP). Both the aethalometer and PSAP rely on collection of the aerosol particles onto a filter substrate followed by a measurement of light reflectance and/or transmittance. Because of the temporal variations of the conversion parameter, these techniques may have relatively large uncertainties. Extinction coefficients can be measured using cavity ring-down spectroscopy (CRDS).

In this work, simultaneous measurements of extinction (alpha_ex), scattering (alpha_sc), and absorption (alpha_ab) coefficients of the ambient aerosols were performed in central Tokyo from 14 August to 2 September 2007 using a newly developed CRDS instrument, nephelometer, and PSAP, respectively. Gas phase ozone concentrations were also measured using a commercial instrument. Extinction coefficients measured using CRDS (alpha_ex(CRDS)) were compared with those determined from the sum of scattering and absorption coefficients measured by nephelometer and PSAP (alpha_ex(Neph+PSAP)). By comparing the single scattering albedo (SSA) calculated by three different combinations from extinction, scattering, and absorption, it is suggested that PSAP overestimates alpha_ab by a factor of 2. By taking the overestimation of alpha_ab(PSAP) into account, alpha_ex(CRDS) were in excellent agreement with alpha_ex(Neph+PSAP), except for the data on the days when high concentrations of ozone (more than 130 ppbv) were observed, with the ratio of alpha_ex(Neph+PSAP)/alpha_ex(CRDS) = 1.02. For the data when high concentrations of ozone (more than 130 ppbv) were observed, alpha_ex(Neph+PSAP) were 15-30 parcent larger than alpha_ex(CRDS). Using the corrected data, SSA during summertime in the central region of Tokyo are estimated.