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Measurements of optical properties of aerosols in Nagoya: Contributions of lensing effect and brown carbon

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Aerosol particles have an important role in radiation balance in the atmosphere by scattering and absorbing incident light. Black carbon (BC) particles are an important global warming agent with radiation forcing similar in magnitude to CO2. The light absorption of BC is generally considered to be increased by internal mixing with other compounds but the amount of absorption enhancement depends on factors such as refractive index of BC and coating materials, size and location of the BC core. In addition, recently light-absorbing organic carbon 'brown carbon', involving humic-like substance (HULIS), organonitrate, and nitro-aromatics etc., has been proposed as a source of significant absorption, particularly in the near-UV. However, observational studies of the enhancement of BC light absorption and brown carbon are still limited mainly because of the difficulty in the accurate measurement of light absorption of internally mixed BC particles without collecting on filter. In this work, by applying photoacoustic spectroscopy, light absorption enhancement of BC and contributions of light absorption by brown carbon is examined.

Simultaneous observations of optical and chemical properties as well as size and density distributions of ambient aerosols were conducted on August, 16-26, 2011 at the Higashiyama-campus of Nagoya University. Optical properties of PM1 particles were measured using the PASS-3 (DMT, PASS-3, absorption and scattering at 405 and 781 nm). Chemical compositions of the aerosol were measured by a time-of-flight aerosol mass spectrometer (Aerodyne, HR-ToF-AMS). The optical properties and chemical composition were measured after passing through diffusion dryers and one of the heaters controlled at 25, 100, and 300degree-C by switching ball valves every 30 min. Mass concentrations of elemental carbon (EC) and Organic carbon (OC) were also measured by thermo-optical technique using a semi-continuous EC/OC analyzer (Sunset Lab., model 4) every 90 min.

By comparing absorption coefficients at 781 nm with and without heating (300degree-C), increase in BC light absorption due to coating is estimated to be 20-30%. Relatively higher amplification factors are observed during the period when large SO_4/Org ratio is observed. Contributions of light absorption by OC are estimated by assuming that the enhancement of BC light absorption due to coating does not depend on wavelength. As a results, contributions of 405 nm light absorption by OC, which is vaporized at 300degree-C, are found to be small, at least, during summer in Nagoya ($<$5%).

Keywords: Aerosol optical properties, Ambient measurement, Lensing effect, Brown carbon, Photoacoustic spectroscopy