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Light absorption properties of carbonaceous particles in Nagoya

Tomoki Nakayama[1*], Yuka Ikeda[1], Yoshitaka Setoguchi[2], Yuki Sawada[1], Kaori Kawana[2], Michihiro Mochida[2], Yutaka Matsumi[1]

[1]Solar-Terrestrial Envieronment Laboratory and Graduate School of Science, Nagoya University, [2]Graduate School of Environmental Studies, Nagoya University

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 CO_2. 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 (e.g. Bond et al. 2006). In addition, recently light-absorbing organic carbon "brown carbon", involving humic-like substance (HULIS) and nitro-aromatics etc., has been proposed as a source of significant absorption, particularly in the near-UV (e.g. Nakayama et al. 2012). 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 (PAS), light absorption enhancement of BC and contributions of light absorption by brown carbon is examined.

Observations were conducted during summer (August, 2011) and winter (January, 2012) at the Higashiyama-campus of Nagoya University. Absorption and scattering coefficients at 405, 532, and 781 nm of PM1 particles were measured using the photoacoustic soot photometer (DMT, PASS-3), after passing through diffusion dryers and one of the heaters controlled at 25, 100, and 300 degC (summer) or 25, 300, and 400 deg C (winter) every 30 (summer) or 10 (winter) 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 (300 or 400 deg C), increase in BC light absorption due to coating was found to be small (<10 percent) both during winter and summer. The result is consistent with a recent observation by Cappa et al. (2012) conducted in California, USA. 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 300 (or 400) deg C, are found to be small during summer in Nagoya (<5 percent) but significant (˜20 percent) during winter. Larger absorption cross section of OC (MAC_{OC}) was observed especially when CO/delta-CO_2 ratio was higher. The result suggests that OC emitted from incomplete combustion processes such as biomass and coal burning for heating may contribute to the observed light absorption by OC during winter.

References
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Cappa et al., Science, 337, 1078-1081 (2012).
Nakayama et al., Earozoru Kenkyu, 27, 13-23 (2012).

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