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Coating of black carbon aerosols and increase of their light absorption coefficient observed in Tokyo

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Black carbon (BC) aerosols can influence the climate due to the heating the atmosphere by their strong light absorption (direct effect). Light absorption coefficient of BC is varied with their size, shape and mixing states. BC is often coated with other aerosol component such as organics and sulfate, and the coating is supposed to cause the increase of light absorption coefficient (lens effect). Lens effect has still not fully understood because the coating material and amount in the real atmosphere have not understood quantitatively. Therefore it is important to observe change of light absorption coefficient of BC and their shape and mixing state simultaneously. Our group conducted intensive observation of various parameters of BC, including light absorption coefficient and coating amount, in huge city, Tokyo. In this paper, variation of light absorption coefficient of BC in Tokyo and its relation with BC coating is studied.

Intensive BC observation named as Black Carbon / Carbonaceous Aerosol Removal Experiment (BC-CARE) were conducted from July 28 to August 15 in 2014. The atmospheric BC was sampled and observed at the sixth floor (20m) in Tokyo University, located central Tokyo city area. Light absorption coefficient was measured using the photoacoustic soot spectrometer (PASS). Amplification factor (FA) by coating of BC was evaluated from the ratio of light absorption coefficient in the unheated sampled air to that in the 300 ℃ heated air, where volatile coating materials were removed from BC. BC mass concentration and the ratio of coating thickness with BC diameter (Dp/Dc) was measured using single-particle soot photometer (SP2) simultaneously. During observation period, aerosol particle were regularly sampled and the BC size, shape and mixing states were observed using a transmission electron microscope (TEM).

The significant increase in BC light absorption coefficient with the BC coating was measured on 29th July. Maximum increase was about 80% in this period. In the early half of this period, FA and Dp/Dc values were increased correlatingly from about 1.0 to about 1.8. However, in the latter half of this period, FA values were gradually decreased although Dp/Dc values kept high. Observation with TEM showed that many coating BC particles larger than 1μm in the early half of this period. In the latter half, particle size of coated BC was generally less than 0.5μm. Because the measuring range of particle size of SP2 is less than 1μm and PASS can measure BC about 1μm or more, the difference between the two period may be cause by the contribution of these larger BC particles. However, both PASS and SP2 can measure BC particles less than 0.5μm, these results cannot fully explain the observed difference in FA and Dp/Dc behavior.

Keywords: Black carbon, Light absorption coefficient, Lens effect, Electron microscope