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Online Measurement of Aerosol Chemical Composition Classified by Black Carbon Mixing State using a LII-MS

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Aerosols have large influences on the radiation budget of the Earth's atmosphere by scattering or absorbing solar visible radiation (direct effect) and by altering cloud microphysical properties (indirect effect) (IPCC, 2013). These effects can significantly depend on the chemical composition and mixing state of aerosol particles. Specifically, the mixing state of sulfate, nitrate, and organics with black carbon (BC) is a key parameter for estimating the aerosol direct and indirect effects.

We have developed a new method to measure aerosol chemical composition classified by the mixing state with BC by combining laser induced incandescence (LII) and mass spectrometric (MS) methods (LII-MS, Miyakawa et al., AST, 48, 853-863, 2014). The purpose of this study is to further evaluate the LII-MS in the laboratory and also to understand the temporal variations of BC mixing state in a suburban area in Tokyo.

The LII-MS consists of a series of LII and MS. In the LII section, BC containing particles introduced into a near-infrared laser cavity can be efficiently vaporized and incandescence signals from the BC particles are detected. The sample air is then introduced into the MS section by a tandem nozzle to measure the mass concentrations of sulfate and nitrate (Takegawa et al., AST, 46, 428-443, 2012). The aerosol composition classified by the BC mixing state is obtained by alternatively switching on and off the LII laser.

Several modifications of the LII-MS hardware and additional experiments have been performed compared to the previous version presented by Miyakawa et al. (2014). First, the control electronics for switching the LII laser has been modified to achieve more stable operation. Second, the cycle of the LII laser on/off and zero-air modes has been modified to improve the quantification of the BC mixing state. Third, the performance of the tandem nozzle, which is one of the key components of the LII-MS, has been tested in the laboratory to investigate the stability and reproducibility of the particle transport efficiency. Ambient measurements have been conducted at the Tokyo Metropolitan University to test the overall performance of the LII-MS and to investigate the temporal variation of the BC mixing state in suburban air. Details of the laboratory experiments and ambient measurements will be presented and discussed.

Keywords: Aerosol, BC mixing state, Laser-induced incandescence, Mass spectrometer