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Influence of aerosol composition on the optical properties of soot during photochemical smog episodes in Beijing, May-June 2016

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The optical properties of Black Carbon (BC) or commonly called "soot" can significantly be influenced by its interaction with other type atmospheric particles including organic, sulfate, nitrate and ammonium aerosol. Condensation of semi-volatile vapors on the soot surface can act as a lens resulting in an overall enhancement of light absorption by BC. However, the influences of the chemical composition of this aerosol-led-lens around the BC core remain unclear. In this study, the aim was to investigate the light absorption (Babs) enhancement (Eabs) of black carbon due to lensing effect for photochemical smog in China. The effect of aerosol phase chemical composition on the absorption enhancement of BC core during photochemical smog episodes in Beijing was explored. As part of an inter-collaborative project to assess the photochemical smog in China, field measurements were carried from 15th of May to 22 June, 2016 at the campus of Peking University located in Changping (40.14° N, 116.11° E), Beijing, China. The light absorption by ambient PM1– particulate matter less or equal to 1 micrometer, and pure BC –obtained by thermally denuding the ambient aerosol at 380oC, were measured by Three-wavelength Photo Acoustic Soot Spectrometer (PASS-3). The chemical components were measured by Aerosol Mass Spectrometry (AMS) and Molecular level information of aerosol phase chemical composition was obtained using the High resolution Time-of-Flight Chemical Ionization Mass Spectrometer (HR-T-o-F-CIMS). Light absorption enhancement by BC (Eabs) was estimated as a ratio of light absorption by ambient aerosol/ light absorption by pure BC.

Higher light absorption enhancement by BC was observed during the days with heavier ambient loading of aerosol (polluted days) largely composed of organics, sulfate, nitrate and ammonium, compared to the cleaner days – low ambient particulate matter loading. The Clean and polluted days aerosol were distinctly different from each other in respect to their ambient loading and chemical composition. During the clean days, the average absorption enhancement of BC ranged from 1.18 – 1.33, 1.11 – 1.23, and 1.07 – 1.42 under the wavelength of 405 nm, 532 nm and 781 nm wavelength, respectively. During the polluted episodes, the light absorption enhancement of BC has ranges from 1.35–1.60, 1.18–1.64 and 1.45–1.62 under wavelength of 405 nm, 532 nm and 781 nm respectively. The presence of relatively higher nitrate in the aerosol-led-lens was found to associate with greater enhancement of BC at 405 nm.

In this study, the detailed assessment of the data linking the light absorption enhancement of BC and the oxidation state of organic aerosol and the molecular markers in the aerosol phase composition using the high resolution measurements from the combination of PASS3, AMS and HR-T-o-F-CIMS will be presented.