4.082 Estimation of light absorption of brown carbon in PM2.5 with an improved AAE method.

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Abstract:

The strong spectral dependence of light absorption of brown carbon (BrC) aerosol is regarded to influence aerosol's radiative forcing significantly. The Absorption Angstrom Exponent (AAE) method has been widely used in previous studies to attribute light absorption of BrC at shorter wavelengths for ambient aerosols, with a theoretical assumption that the AAE of “pure” black carbon (BC) aerosol equals to 1.0. In this study, the AAE method was applied to both urban and rural environments in the Pearl River Delta (PRD) region of China, with an improvement of constraining the realistic AAE of “pure” BC through statistical analysis of on-line measurement data. A three-wavelength photo-acoustic soot spectrometer (PASS-3) and aerosol mass spectrometers (AMS) were used to explore the relationship between the measured AAE and the relative abundance of organic aerosol to BC. The regression and extrapolation analysis revealed that more realistic AAE values for “pure” BC aerosol ($AAE_{\_BC}$) were 0.86, 0.82, and 1.02 between 405 and 781 nm, and 0.70, 0.71, and 0.86 between 532 and 781 nm, in the campaigns of $urban_{\text{-winter}}$, $urban_{\text{-fall}}$, and $rural_{\text{-fall}}$, respectively. Roadway tunnel experiments were conducted and the results further confirmed the representativeness of the obtained $AAE_{\_BC}$ values for the urban environment. Finally, the average light absorption contributions of BrC (± relative uncertainties) at 405 nm were quantified to be 11.7%(±5%), 6.3%(±4%), and 12.1%(±7%) in the campaigns of $urban_{\text{-winter}}$, $urban_{\text{-fall}}$, and $rural_{\text{-fall}}$, respectively, and those at 532 nm were 10.0%(±2%), 4.1%(±3%), and 5.5%(±5%), respectively. The relatively higher BrC absorption contribution at 405 nm in the $rural_{\text{-fall}}$ campaign could be reasonably attributed to the biomass burning events nearby, which was then directly supported by the biomass burning simulation experiments performed in this study.