Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 9, 2035-2050, 2009
www.atmos-chem-phys.net/9/2035/2009/

Attribution of aerosol light absorption to black carbon, brown carbon, and dust in China – interpretations of atmospheric measurements during EAST-AIRE

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Abstract. Black carbon, brown carbon, and mineral dust are three of the most important light absorbing aerosols. Their optical properties differ greatly and are distinctive functions of the wavelength of light. Most optical instruments that quantify light absorption, however, are unable to distinguish one type of absorbing aerosol from another. It is thus instructive to separate total absorption from these different light absorbers to gain a better understanding of the optical characteristics of each aerosol type. During the EAST-AIRE (East Asian Study of Tropospheric Aerosols: an International Regional Experiment) campaign near Beijing, we measured light scattering using a nephelometer, and light absorption using an aethalometer and a particulate soot absorption photometer. We also measured the total mass concentrations of carbonaceous (elemental and organic carbon) and inorganic particulates, as well as aerosol number and mass distributions. We were able to identify periods during the campaign that were dominated by dust, biomass burning, fresh (industrial) chimney plumes, other coal burning pollution, and relatively clean (background) air for Northern China. Each of these air masses possessed distinct intensive optical properties, including the single scatter albedo and Ångstrom exponents. Based on the wavelength-dependence and particle size distribution, we apportioned total light absorption to black carbon, brown carbon, and dust; their mass absorption efficiencies at 550 nm were estimated to be 9.5, 0.5 (a lower limit value), and 0.03 m^2/g, respectively. While agreeing with the common consensus that black carbon is the most important light absorber in the mid-visible, we demonstrated that brown carbon and dust could also cause significant absorption, especially at shorter wavelengths.

Final Revised Paper (PDF, 507 KB) Discussion Paper (ACPD)

Citation: Yang, M., Howell, S. G., Zhuang, J., and Huebert, B. J.: Attribution of aerosol light absorption to black carbon, brown carbon, and dust in China – interpretations of atmospheric measurements during EAST-AIRE, Atmos. Chem. Phys., 9, 2035-2050, 2009. Bibtex EndNote Reference Manager