Aerosol Optics, Direct Radiative Forcing, and Climate Change

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Aerosols influence the earth's direct radiative forcing and climate largely through modifying the planetary albedo, which is the whiteness of the planet as seen from the sun. If aerosols are whiter than the underlying scene, as seen from space, they increase the planetary albedo, have a negative radiative forcing and cause cooling (more solar energy is scattered back into space); otherwise if they appear darker, they decrease the planetary albedo, have a positive radiative forcing and cause heating (more solar energy is retained by earth). In addition, aerosols can continue to cause radiative forcing after deposition. In particular, dark aerosols can strongly decrease surface albedo after deposition on high-albedo surfaces such as snow and ice.

The dominant aerosol optical property that determines radiative forcing is their single scattering albedo (SSA) integrated over the solar spectrum with an additional contribution from the asymmetry parameter or hemispherical backscatter ratio (Chýlek and Wong, 1995}. The SSA is the ratio of scattering to extinction coefficient, with the extinction coefficient being the sum of scattering and absorption coefficient. To determine the SSA, two of these three coefficients need to be determined, preferentially one small one and one large one, absorption and scattering or extinction coefficient for the fairly white (SSA near 1) aerosols.

The ambient aerosols with the most uncertainty in their SSA spectrum are carbonaceous aerosols emitted by combustion processes and entrained mineral dust. Here, we discuss multi-wavelengths measurements of scattering and absorption coefficients for these aerosols with a focus on the dominant biomass burning aerosols containing light absorbing black and brown carbon and mineral dust aerosols whose light absorption is generally dominated by iron oxides strongly absorbing in the blue-green spectral region. Spectral properties are discussed in terms of the Ångström coefficients of absorption, scattering, extinction, and SSA.

References:

Chýlek, P., and J. Wong (1995). Effect of Absorbing Aerosol on Global Radiation Budget. *Geophys. Res. Lett.*, **22**, 929-931.