Global Impact of Direct Solar Absorption due to Brown Carbon

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Recent observational studies have shown the absorbing part of organic aerosols, referred to as "brown" carbon (BrC), to be a significant source of absorption of solar radiation. We derived an optical treatment to account for BrC, based on spectral measurements of aerosol absorption, and conducted global calculations of aerosol optical properties and radiative transfer, with non-absorbing OC, moderately absorbing BrC, and strongly absorbing BrC. The simulated wavelength dependence of aerosol absorption, as measured by the absorption Ångström exponent (AAE), increases from 0.9 for non-absorbing organic carbon to 1.2 (or 1.0) for strongly (or moderately) absorbing BrC. The AAE calculated for the strongly absorbing BrC agrees with AERONET spectral observations at 440–870 nm over most regions but overpredicts for the biomass burning-dominated South America and southern Africa, in which inclusion of moderately absorbing BrC exihibits better agreement. In the presentation, we will also show the model comparison with the DOE/ARM absorption spectral measurements.

The main findings from this study are:

BrC absorption results in a global radiative forcing of +0.04 to +0.11 W m^{-2}, about 10% to 25% of the black carbon (BC) forcing (+0.45 W m^{-2}) at the top of the atmosphere;

Strongly absorbing BrC contributes to 19% of solar absorption by anthropogenic aerosols, while 72% is attributed to BC, and 9% due to non-absorbing coatings;

Regional effect of BrC contributes up to 50% of aerosol absorption over biomass burning and bio-fuel regions;

BrC absorption changes the direct radiative forcing of organic carbon aerosols from cooling (–0.08 W m^{-2}) to warming (+0.025 W m^{-2}), particularly over source regions and above clouds.