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Observationally-constrained Estimates of carbonaceous aerosol radiative forcing

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Carbonaceous aerosols (CA) emitted by fossil- and biomass-fuels consist of black carbon (BC), a strong absorber of solar radiation, and organic matter (OM). OM scatters as well as absorbs solar radiation. The absorbing component of OM, which is ignored in most climate models, is referred to as brown carbon (BrC). Model estimates of global CA radiative forcing range from 0 to 0.7 Wm-2, to be compared with the net radiative forcing of about 1.6 Wm-2 required to account for the 20th century global warming. This study provides a model independent, observationally based estimate of the direct radiative forcing of CA. A ground based aerosol network is integrated with satellite based aerosol sensors to provide for the first time a decadal (2001∼2009) global view of the CA optical properties and direct radiative forcing. The estimated global CA direct radiative effect is about 0.75 Wm-2 (0.5∼1.0) for present day conditions. The study identifies the global importance of BrC, which is shown to contribute about 20% to CA solar absorption globally. The CA radiative forcing is estimated to be about 0.7 (0.43∼0.93) Wm-2, thus exceeding that of methane. Due partly to BrC absorption, CA have a net warming effect even over open biomass burning regions in Africa and the Amazon. The CA exert stronger tropics-to-extratropics forcing gradient than CO_2 and far greater surface forcing over the tropical Atlantic and the Indian Oceans. Thus this observational study strongly suggests CA as an important contributor, next only to CO_2, to global and regional climate changes.