Constraining Climate Forcing by Black, Brown and Organic Carbon

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Accurate assessment of the radiative forcing by carbonaceous absorbing aerosols emitted by fossil energy use and fires that could be the 2nd largest warming agent but are also very most uncertain is a priority. We report the following validated parameterizations by integrating laboratory & field observations. (1) Single scattering albedo (ω) of fresh biomass burning (BB) aerosols produced from 92 controlled laboratory combustion experiments of 20 different woods and grasses was analysed to determine the factors that control the variability in ω. Results show that ω varies strongly with fire-integrated modified combustion efficiency (MCE_{FI})—higher MCE_{FI} results in lower ω values and greater spectral dependence of ω. A parameterization of ω as a function of MCE_{FI} for fresh BB aerosols is derived from the laboratory data and is evaluated by field observations from two wildfires. (2) We report the first direct evidence of substantial absorption enhancement for internally mixed black carbon (BC) at and around London. While the absorption enhancement is due to coated BC particles at emission in urban regions, the absorption enhancement increases with photochemical aging in rural areas, consistent with theoretical predictions and laboratory experiments. Our field results support parameterizations of enhanced light absorption by internally mixed BC in climate models and identifies mixed biomass and fossil combustion regions where this effect is large.