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Black carbon or brown carbon? The nature of light-absorbing carbonaceous aerosols

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Abstract. Although the definition and measurement techniques for atmospheric "black carbon" ("BC") or "elemental carbon'' ("EC") have long been subjects of scientific controversy, the recent discovery of light-absorbing carbon that is not black ("brown carbon, C_{brown}") makes it imperative to reassess and redefine the components that make up light-absorbing carbonaceous matter (LAC) in the atmosphere. Evidence for the atmospheric presence of C_{brown} comes from (1) spectral aerosol light absorption measurements near specific combustion sources, (2) observations of spectral properties of water extracts of continental aerosol, (3) laboratory studies indicating the formation of light-absorbing organic matter in the atmosphere, and (4) indirectly from the chemical analogy of aerosol species to colored natural humic substances. We show that brown carbon may severely bias measurements of "BC" and "EC" over vast parts of the troposphere, especially those strongly polluted by biomass burning, where the mass concentration of C_{brown} is high relative to that of soot carbon. Chemical measurements to determine "EC" are biased by the refractory nature of C_{brown} as well as by complex matrix interferences. Optical measurements of "BC" suffer from a number of problems: (1) many of the presently used instruments introduce a substantial bias into the determination of aerosol light absorption, (2) there is no unique conversion factor between light absorption and "EC" or "BC" concentration in ambient aerosols, and (3) the difference in spectral properties between the different types of LAC, as well as the chemical complexity of C_{brown}, lead to several conceptual as well as practical complications. We also suggest that due to the sharply increasing absorption of C_{brown} towards the UV, single-wavelength light absorption measurements may not be adequate for the assessment of absorption of solar radiation in the troposphere. We discuss the possible consequences of these effects for our understanding of tropospheric processes, including their influence on UV-irradiance, atmospheric photochemistry and radiative transfer in clouds.

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