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Light absorption by organic carbon from wood combustion

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Abstract. Carbonaceous aerosols affect the radiative balance of the Earth by absorbing and scattering light. While black carbon (BC) is highly absorbing, some organic carbon (OC) also has significant absorption, especially at near-ultraviolet and blue wavelengths. To the extent that OC absorbs visible light, it may be a non-negligible contributor to positive direct aerosol radiative forcing. Quantification of that absorption is necessary so that radiative-transfer models can evaluate the net radiative effect of OC.

In this work, we examine absorption by primary OC emitted from solid fuel pyrolysis. We provide absorption spectra of this material, which can be related to the imaginary refractive index. This material has polar character but is not fully water-soluble: more than 92% was extractable by methanol or acetone, compared with 73% for water and 52% for hexane. Water-soluble OC contributes to light absorption at both ultraviolet and visible wavelengths. However, a larger portion of the absorption comes from OC that is extractable only by methanol. Absorption spectra of water-soluble OC are similar to literature reports. We compare spectra for material generated with different wood type, wood size and pyrolysis temperature. Higher wood temperature is the main factor creating OC with higher absorption; changing wood temperature from a devolatilizing state of 210 °C to a near-flaming state of 360 °C causes about a factor of four increase in mass-normalized absorption at visible wavelengths. A clear-sky radiative transfer model suggests that, despite the absorption, both high-temperature and low-temperature OC result in negative top-of-atmosphere radiative forcing over a surface with an albedo of 0.19 and positive radiative forcing over bright surfaces. Unless absorption by real ambient aerosol is higher than that measured here, it probably affects global average clear-sky forcing very little, but could be important in energy balances over bright surfaces.

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