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Optical properties of light-absorbing organic carbon from primary and aged coal combustion emissions

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Light-absorbing organic carbon (OC), also termed brown carbon (BrC), affects the Earth's energy budget by contributing to the visible light absorption budget, particularly at shorter wavelengths. However, relatively few measurements have been conducted to examine BrC from residential coal combustion and even fewer measurements have examined absorption properties of aged BrC.

We conducted 12 individual burns in a traditional Chinese stove used in residential sector using five different coals collected from major coal producing area in China. Optical properties of BrC from coal combustion emissions are investigated as a function of aging during smog chamber experiments. Optical absorption measurements were made offline by UV-Vis spectrophotometric analysis of water and methanol filter extracts. Methanol has a higher extraction efficiency than water and can extract a greater range of compounds than just polar compounds dissolved by the water extraction process. The light absorption of water and methanol extracts for both primary and aged aerosols showed a strong wavelength dependence. Light absorption drops off with increasing wavelength, with little to no absorption above mid-visible wavelengths. Light absorption of water extracts is always smaller than methanol extracts, suggesting a large portion of BrC absorption comes from OC insoluble in water. Bulk mass absorption cross sections at 365 nm (MAC_{365}), used as a measurement proxy for BrC, were determined for the primary and aged aerosol by normalizing absorption coefficients (b_{abs}) measured at 365nm to the organic aerosol (OA) mass measured by aerosol mass spectrometer. The averaged MAC_{365} of primary and aged aerosols from water extracts was found to be 0.04 m^2 g^{-1} and 0.03 m^2 g^{-1}, respectively. Higher averaged MAC_{365} of primary and aged aerosols was found in methanol extracts (0.8 m^2 $g^{-1}$and 0.2 m^2 g^{-1}, respectively). $MAC_{365}$was found to correlate with elemental carbon(EC)/OA ratios (i.e., indicator of combustion conditions), and changed with OH exposure (indicator of aging). Decreasing trends were observed for MAC_{365} for both water and methanol extracts with increasing OH exposure, related to the destruction of BrC with aging. Our results suggest that coal combustion is an important BrC source.