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Reduction in biomass burning aerosol light absorption upon humidification: roles of inorganically-induced hygroscopicity, particle collapse, and photoacoustic heat and mass transfer

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Abstract. Smoke particle emissions from the combustion of biomass fuels typical for the western and southeastern United States were studied and compared under high humidity and ambient conditions in the laboratory. The fuels used were Montana ponderosa pine (*Pinus ponderosa*), southern California chamise (*Adenostoma fasciculatum*), and Florida saw palmetto (*Serenoa repens*). Information on the non-refractory chemical composition of biomass burning aerosol from each fuel was obtained with an aerosol mass spectrometer and through estimation of the black carbon concentration from light absorption measurements at 870 nm. Changes in the optical and physical particle properties under high humidity conditions were observed for hygroscopic smoke particles containing substantial inorganic mass fractions that were emitted from combustion of chamise and palmetto fuels. Light scattering cross sections increased under high humidity for these particles, consistent with the hygroscopic growth measured for 100 nm particles in HTDMA measurements. Photoacoustic measurements of aerosol light absorption coefficients revealed a 20% reduction with increasing relative humidity, contrary to the expectation of light absorption enhancement by the liquid coating taken up by hygroscopic particles. This reduction is hypothesized to arise from two mechanisms: (1) shielding of inner monomers after particle consolidation or collapse with water uptake; (2) the lower case contribution of mass transfer through evaporation and condensation at high relative humidity (RH) to the usual heat transfer pathway for energy release by laser-

heated particles in the photoacoustic measurement of aerosol light absorption. The mass transfer contribution is used to evaluate the fraction of aerosol surface covered with liquid water solution as a function of RH.

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