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Black carbon aerosol properties measured by a single particle soot photometer in emissions from biomass burning in the laboratory and field

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We present SP2 observations of BC mass, size distributions and mixing state in emissions from laboratory and field biomass fires in California, USA. Biomass burning is the primary global black carbon (BC) source, but understanding of the amount emitted and its physical properties at and following emission are limited. The single particle soot photometer (SP2) uses a laser-induced incandescence technique to measure the mass and mixing state of individual BC particles. Its BC mass response does not depend on the BC mixing state, unlike optical and/or filter-based methods. The SP2 took part in a large, multi-investigator laboratory fire study at the US Forest Service Fire Science Laboratory in 2009. It was used to measure the emissions of ~20 burns of North American fuels, including fuels from California. The SP2 also participated in airborne sampling of prescribed fires in central California in November 2009. BC mass concentrations measured in both studies were converted to emission factors (EF, gBC/kg dry fuel burned). The EF varied between 0 and 2 g/kg dry fuel, shown in Figure 1. We observed a similar correlation between EF and combustion conditions in the lab and field. The SP2 measurements were 15-30% higher than elemental carbon observations made with a commonly used thermal-optical analysis method. The discrepancy was largest (200%) for emissions dominated by organic material. Early indications are that emission estimates may need to be revised upward by 15-30%, since most emission inventories are based on thermal-optical methods. We also examine light absorption measurements made using a 3-wavelength photoacoustic spectrometer during the laboratory experiments. The wavelength dependence of absorption decreased sharply with increasing BC mass fractions of total carbonaceous aerosol. The mass absorption efficiency depended on the mixing state of the BC and decreased after the sample passed through a thermal denuder. BC was also sampled following photo-chemically ageing in a portable smog chamber and 10:1 and 100:1 dilutions.

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