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A review of biomass burning emissions part II: intensive physical properties of biomass burning particles

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Abstract. The last decade has seen tremendous advances in atmospheric aerosol particle research that is often performed in the context of climate and global change science. Biomass burning, one of the largest sources of accumulation mode particles globally, has been closely studied for its radiative, geochemical, and dynamic impacts. These studies have taken many forms including laboratory burns, in situ experiments, remote sensing, and modeling. While the differing perspectives of these studies have ultimately improved our qualitative understanding of biomass-burning issues, the varied nature of the work make inter-comparisons and resolutions of some specific issues difficult. In short, the literature base has become a milieu of small pieces of the biomass-burning puzzle. This manuscript, the second part of four, examines the properties of biomass-burning particle emissions. Here we review and discuss the literature concerning the measurement of smoke particle size, chemistry, thermodynamic properties, and emission factors. Where appropriate, critiques of measurement techniques are presented. We show that very large differences in measured particle properties have appeared in the literature, in particular with regards to particle carbon budgets. We investigate emissions uncertainties using scale analyses, which shows that while emission factors for grass and brush are relatively well known, very large uncertainties still exist in emission factors of boreal, temperate and some tropical forests. Based on an uncertainty analysis of the community data set of biomass burning measurements, we present simplified models for particle size and emission factors. We close this review paper with a discussion of the community experimental data, point to lapses in the data set, and prioritize future research topics.

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