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A review of biomass burning emissions part III: intensive optical properties of biomass burning particles

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Abstract. Because of its wide coverage over much of the globe, biomass burning has been widely studied in the context of direct radiative forcing. Such study is warranted as smoke particles scatter and at times absorb solar radiation efficiently. Further, as much of what is known about smoke transport and impacts is based on remote sensing measurements, the optical properties of smoke particles have far reaching effects into numerous aspects of biomass burning studies. Global estimates of direct forcing have been widely varying, ranging from near zero to −1 W m^{-2}. A significant part of this difference can be traced to varying assumptions on the optical properties of smoke. This manuscript is the third part of four examining biomass-burning emissions. Here we review and discuss the literature concerning measurement and modeling of optical properties of biomass-burning particles. These include available data from published sensitivity studies, field campaigns, and inversions from the Aerosol Robotic Network (AERONET) of Sun photometer sites. As a whole, optical properties reported in the literature are varied, reflecting both the dynamic nature of fires, variations in smoke aging processes and differences in measurement technique. We find that forward modeling or ''internal closure'' studies ultimately are of little help in resolving outstanding measurement issues due to the high degree of degeneracy in solutions when using ''reasonable'' input parameters. This is particularly notable with respect to index of refraction and the treatment of black carbon. Consequently, previous claims of column closure may in fact be more ambiguous. Differences between in situ and retrieved ω_o values have implications for estimates of mass scattering and mass absorption efficiencies. In this manuscript we review and discuss this community dataset. Strengths and lapses are pointed out, future research topics are prioritized, and best estimates and uncertainties of key smoke particle parameters are provided.

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