The impact of diverse types of biomass burning in a tropical country

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We couple laboratory work, airborne and ground-based field measurements, remote sensing of fires, and modeling to assess the impact of diverse types of biomass burning (BB) in Mexico as a model tropical country. About 70-80% of open BB occurs in the tropics along with large amounts of biofuel use and garbage burning (GB); both in rural and urban areas. During the Mexican dry season two instrumented aircraft measured emission factors (EF) from 57 fires including crop residue, tropical forest deforestation, pine forest, and savanna fires and GB. A mobile ground-based lab sampled 22 fires including GB, crop residue and cooking fires, and brick/charcoal-making kilns. The Fire INventory from NCAR (FINN) model calculates that open BB consumes 96 Tg of biomass in Mexico in a typical year and an estimated 68 Tg of biofuel is also consumed in Mexico in an average year. The fuel consumption estimates, coupled with our field-measured EF, indicate that the total BB emissions of CO and primary PM2.5 exceed those from fossil fuel (FF) use in Mexico by factors of about 1.4 and 40-50, respectively. Coupling recent laboratory measurements of the amount of unidentified non-methane organic compounds (NMOC) emitted by BB with our field measurements of identified species suggests that the mass ratio of gas-phase NMOC to PM2.5 is > 5 in fresh BB plumes. This indicates high potential for secondary organic aerosol (SOA) formation. Rapid formation of both SOA and ozone was observed in the one plume that could be sampled both at the source and downwind in the airborne measurements. The SOA production may be common since visual observations and forward trajectories suggest that the plumes from most open BB in Mexico dilute in the boundary layer; which often has high levels of organics and high RH. Mexico City may be most frequently affected by open BB in the surrounding pine-oak forest, which may have enhanced NOx emissions due to deposition of urban pollutants. Mexico City is also commonly downwind of savanna fires on the west coast. Comparing Mexican early dry season savanna fires to African late dry season savanna fires showed EF for smoldering compounds, PM2.5, and NOx were ~2-3 times higher, which could impact ozone formation. GB emitted high levels of PM2.5, NOx, and HCl, which could promote interaction between the latter species on surfaces. GB was also a source of species commonly used as BB tracers (e.g. levoglucosan). Charcoal kilns produced very low elemental carbon (EC) emissions, while brick-making kilns produced very high EC. The emissions from brick-making kilns may be a significant black carbon source. Finally, our full set of emission factors is being integrated with other recent work into a compilation of BB emission factor measurements.

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