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Emissions of carbon species, organic polar compounds, potassium, and mercury from prescribed burning activities

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Biomass burning is an important emission source of pollutants to the atmosphere, but few studies have focused on the chemical composition of emissions from prescribed burning activities. Here we present results from a sampling campaign to quantify particulate-phase emissions from various types of prescribed fires including carbon species (Elemental Carbon: EC; Organic Carbon: OC; and Total Carbon: TC); polar organic compounds (12 different compounds and four functional classes); water-soluble potassium (K^+); and mercury (Hg). We measured emissions from the following types of prescribed biomass burning in the Lake Tahoe basin located on the California/Nevada border: (i) log piles stacked and dried in the field; (ii) log piles along with green understory vegetation; and (iii) understory green vegetation and surface litter; further emissions were collected from burns conducted in a wood stove: (iv) dried wooden logs; (v) green foliage of understory vegetation collected from the field; and (vi) surface organic litter collected from the field; finally, samples were also taken from (vii) ambient air in residential areas during peak domestic wood combustion season.

Results show that OC/EC ratios of prescribed burns in the field ranged from 4 to 10, but lower values (around 1) were observed in controlled stove fires. These results are consistent with an excess of OC emissions over EC found in wildfires. OC/EC ratios, however, showed clear separations between controlled wood stove combustion (higher EC) and prescribed burns in the field (lower EC). We attribute this difference to a higher combustion temperatures and dominance of flaming combustion in wood stove fires. OC positively and linearly correlated to the sum of polar organic compounds across all burn types (r^2 of 0.82). The most prevalent group of polar compounds emitted during prescribed fires was resin acids (dehydroabietic, pimaric, and abietic acids), followed by levoglucosan plus mannositol. Negligible contributions were observed for inositols, arabitols, and lignin derivates. Although some of these polar compound classes are linked to specific woody or green tissues, we found no significant differences of emission ratios between different types of fires. Water-soluble K^+, a common tracer for biomass combustion, showed a clear separation between understory burns (low K^+) and wooden pile burns (10 to 20 times higher), suggesting that K^+ can potentially be used for differentiating between green versus dry, wooden biomass combustion. Finally, Hg emissions were very low across all fire emissions collected, but were enhanced in urban air sampling which might allow for differentiating sources from biomass combustion from other urban sources.