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Night-time chemistry of biomass burning plumes in urban areas: A dual mobile chamber study

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Biomass burning including residential heating, agricultural fires, prescribed burning, and wildfires is a major source of gaseous and particulate pollutants in the atmosphere. Although, important changes in the size distributions and the chemical composition of the biomass burning aerosol during daytime chemistry have been observed, the corresponding changes at nighttime or in winter where photochemistry is slow, have received relatively little attention. In this study, we tested the hypothesis that nightime chemistry in biomass burning plumes can be rapid in urban areas using a dual smog chamber system.

Ambient urban air during winter nighttime periods with high concentrations of ambient biomass burning organic aerosol is used as the starting point. Ozone was added in the perturbed chamber to simulate mixing with background air (and subsequent NO_3 production and aging) while the second chamber was used as a reference. Following the injection of ozone rapid organic aerosol (OA) formation was observed in all experiments leading to increases of the OA concentration by 20-70%. The oxygen to carbon ratio of the OA increased by 50% on average and the mass spectra of the produced OA was quite similar to that of the oxidized OA mass spectra reported during winter in urban areas. Good correlation was also observed with the produced mass spectra from nocturnal aging of laboratory biomass burning emissions showing the strong contribution of biomass burning emissions in the SOA formation during cold nights with high biomass burning activities. Concentrations of NO_3 radicals as high as 25 ppt were measured in the perturbed chamber with an accompanying production of 0.2-1.2 μg m^{-3} of organic nitrate. These results strongly indicate that the OA in biomass burning plumes can evolve rapidly even during wintertime periods with low photochemical activity.