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A mass spectrometric study of secondary organic aerosols formed from the photooxidation of anthropogenic and biogenic precursors in a reaction chamber

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Abstract. An Aerodyne Aerosol Mass Spectrometer (AMS) has been utilised to provide on-line measurements of the mass spectral signatures and mass size distributions of the oxidation products resulting from irradiating 1,3,5-trimethylbenzene (1,3,5-TMB) and α-pinene, separately, in the presence of nitrogen oxide, nitrogen dioxide and propene in a reaction chamber. Mass spectral results indicate that both precursors produce SOA with broadly similar chemical functionality of a highly oxidised nature. However, significant differences occur in the minor mass spectral fragments for the SOA in the two reaction systems, indicating that they have different molecular composition. Nitrogen-containing organic compounds have been observed in the photooxidation products of both precursors, and their formation appeared to be controlled by the temporal variability of NO_x. Although the overall fragmentation patterns of the photooxidation products in both systems did not change substantially over the duration of each experiment, the contribution of some individual mass fragments to total mass appeared to be influenced by the irradiation time. The effective densities of the 1,3,5-TMB and α-pinene SOA particles were determined for various particle sizes using the relationship between mobility and vacuum aerodynamic diameters. The effective density for the 1,3,5-TMB SOA ranged from 1.35–1.40 g/cm^3, while that for α-pinene SOA ranged from 1.29–1.32 g/cm^3. The determined effective densities did not show dependence on irradiation time. Results suggest that further chemical processing of SOA takes place in the real atmosphere, as neither the α-pinene nor the 1,3,5-TMB experimental results reproduce the right relative product distribution between carbonyl-containing and multifunctional carboxylic acid species measured at ambient locations influenced by aged continental organic aerosols.

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