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Molecular composition of biogenic secondary organic aerosols using ultrahigh resolution mass spectrometry: linking laboratory and field studies

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Biogenic volatile organic compounds (BVOCs) play an important role in atmospheric chemistry and give rise to secondary organic aerosols (SOA), which have effects on climate and human health. Laboratory chamber experiments have been performed during several decades in an attempt to mimic atmospheric SOA formation. However, it is still unclear how close the aerosol particles generated in laboratory experiments resemble atmospheric SOA with respect to their detailed chemical composition. To date, most laboratory experiments have been performed using a single organic precursor (e.g., alpha- or beta-pinene, isoprene) while in the atmosphere a wide range of precursors contribute to SOA, which results most likely in a more complex SOA composition compared to the one-precursor laboratory systems. The objective of this work is to compare laboratory generated SOA from oxidation of BVOCs mixtures and remote ambient samples using ultrahigh-resolution mass spectrometry (UHR-MS) that allows detection of hundreds of individual SOA constituents. We examined aerosol samples from a boreal forest site, Hyytiälä, Finland and determined that a dominant fraction of the detected compounds are reaction products of a multi-component mixture of BVOCs. In the subsequent smog chamber experiments, SOA was generated from the ozonolysis and OH initiated reactions with BVOC mixtures containing species (alpha- and beta-pinene, delta-3-carene, and isoprene) that are most abundant in Hyytiälä's environment. The laboratory experiments were performed at conditions (e.g., RH, aerosol seed, and VOC ratios) that would resemble those at the boreal sampling site during the summer period. The elemental composition of the complex mixtures from laboratory generated SOA samples were compared with field samples using statistical data analysis methods.