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Hygroscopicity of secondary organic aerosols formed by oxidation of cycloalkenes, monoterpenes, sesquiterpenes, and related compounds

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Abstract. A series of experiments has been conducted in the Caltech indoor smog chamber facility to investigate the water uptake properties of aerosol formed by oxidation of various organic precursors. Secondary organic aerosol (SOA) from simple and substituted cycloalkenes (C_5-C_8) is produced in dark ozonolysis experiments in a dry chamber (*RH*~5%). Biogenic SOA from monoterpenes, sesquiterpenes, and oxygenated terpenes is formed by photooxidation in a humid chamber (~50% *RH*). Using the hygroscopicity tandem differential mobility analyzer (HTDMA), we measure the diameter-based hygroscopic growth factor (*GF*) of the SOA as a function of time and relative humidity. All SOA studied is found to be slightly hygroscopic, with smaller water uptake than that of typical inorganic aerosol substances. The aerosol water uptake increases with time early in the experiments for the cycloalkene SOA, but decreases with time for the sesquiterpene SOA. This behavior could indicate competing effects between the formation of more highly oxidized polar compounds (more hygroscopic), and formation of longer-chained oligomers (less hygroscopic). All SOA also exhibit a smooth water uptake with *RH* with no deliquescence or efflorescence. The water uptake curves are found to be fitted well with an empirical three-parameter functional form. The measured pure organic *GF* values at 85% *RH* are between 1.09–1.16 for SOA from ozonolysis of cycloalkenes, 1.01–1.04 for sesquiterpene photooxidation SOA, and 1.06–1.10 for the monoterpene and oxygenated terpene SOA. The *GF* of pure SOA (GF_{org}) in experiments in which inorganic seed aerosol is used is determined by assuming volume-weighted water uptake (Zdanovskii-Stokes-Robinson or "ZSR" approach) and using the size-resolved organic mass fraction measured by the Aerodyne Aerosol Mass Spectrometer. Knowing the water content associated with the inorganic fraction yields GF_{org} values. However, for each precursor, the GF_{org} values computed from different HTDMA-classified diameters agree with each other

to varying degrees. Comparing growth factors from different precursors, we find that GF_{org} is inversely proportional to the precursor molecular weight and SOA yield, which is likely a result of the fact that higher-molecular weight precursors tend to produce larger and less hygroscopic oxidation products.

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