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CCN activation and hygroscopic growth measurements of secondary organic aerosols from tree emissions

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Plant emitted volatile organic compounds (VOCs) are a major precursor of secondary organic aerosols (SOA), an important constituent of atmospheric aerosols. We used the Juelich Plant Atmosphere Chamber (JPAC) at the Research Center Juelich to investigate the microphysical properties of aerosols. SOA particles were produced from the ozonolysis and reaction of OH radicals with the complex VOC mixture emitted from trees typical for the boreal forest. Hygroscopic growth factors (GF) were determined with a humidity tandem differential mobility analyzer (HTDMA) for different particle sizes at RH = 2 - 97%. Cloud condensation nuclei (CCN) activation was measured with a continuous flow CCN counter (DMT). Additionally, the chemical composition, size distribution and number concentration of the particles were measured. The gas phase was monitored with GC-MS and PTR-MS.

Changing the emission pattern of the trees changed the measured GF and the diameter of the dry particles that were activated (D_{crit}). However, below 80% RH the GF changes are within the range of the measurement error. The GF (RH = 95%) are between 1.11 and 1.19 and the D_{crit}(SS = 0.4%) in a range of 93 - 100nm.

Koehler theory was applied to achieve closure between CCN activation and GF measurements. The κ parameter according to Petters and Kreidenweis (2007) was calculated for all SS (κ(CCN)) and RH (κ(GF)). The κ(GF) decrease with increasing RH but levels off at RH $>$ 95%. Assuming the surface tension of pure water, κ(GF, RH$>$95%) would be by a factor of 2 lower than κ(CCN). Closure between the HTDMA and CCN measurement requires the use of either a lower surface tension or a limited solubility of the organic material.

Reference: Petters, M. D. and Kreidenweis, S. M. (2007). Atmos. Chem. Phys., 7, 1961-1971.