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Cloud Condensation Nuclei Activity, Droplet Growth Kinetics and Hygroscopicity of Biogenic and Anthropogenic Secondary Organic Aerosol (SOA)

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Recent field data and model analysis show that secondary organic aerosol (SOA) formation is enhanced under anthropogenic influences (de Gouw et al. 2005, Spracklen et al. 2011). The interaction of biogenic VOCs (BVOCs) with anthropogenic emissions such as anthropogenic VOCs (AVOCs) could change the particle formation yields and the aerosol properties, as was recently demonstrated (Emanuelsson et al., 2013; Flores et al., 2014). However, the effect of the interaction of BVOCs with AVOCs on cloud condensation nuclei (CCN) activity and hygroscopicity of SOA remains elusive. Characterizing such changes is necessary in order to assess the indirect radiative forcing of biogenic aerosols that form under anthropogenic influence.

In this study, we investigated the influence of AVOCs on CCN activation and hygroscopic growth of BSOA. SOA was formed from photooxidation of monoterpenes and aromatics as representatives of BVOCs and AVOCs, respectively. The hygroscopicity and CCN activation of BSOA were studied and compared with that of anthropogenic SOA (ASOA) and the mixture of ASOA and BSOA (ABSOA). We found that ASOA had a significantly higher hygroscopicity than BSOA at similar OH dose, which is attributed to a higher oxidation level of ASOA. While the ASOA fraction had an enhancing effect on the hygroscopicity of ABSOA compared to BSOA, the hygroscopicity of ABSOA cannot be explained by a linear combination of the pure ASOA and BSOA systems, indicating potentially additional non-linear effects such as oligomerization. However, in contrast to hygroscopicity, ASOA showed similar CCN activity as BSOA, in spite of its higher oxidation level. The ASOA fraction did not enhance the CCN activity of ABSOA. The discrepancy between hygroscopicity and CCN activity is discussed. In addition, BSOA, ABSOA and ASOA formed similar droplet size with ammonium sulfate in CCN at a given supersaturation, indicating none of these aerosols had a delay in the water uptake in the supersaturated condition. Our findings have important implications for the understanding of combined effect of AVOCs and BVOCs in SOA formation as well as on assessing their indirect radiative forcing.

References:

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