Chemistry, morphology, and cloud activation: Chemical composition measurements of α-pinene SOA at low temperatures with a FIGAERO-CIMS

C. Mohr[1], H. Saathoff[1], A. Pajunoja[2], A. Virtanen[2], R. Wagner[1], W. Huang[1]

[1]Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, 76344, Germany

[2]Department of Applied Physics, University of Eastern Finland, Kuopio, 80101, Finland

Keywords: SOA, phase state, chemical composition, CIMS.

Presenting author email: claudia.mohr2@kit.edu

The formation of secondary organic aerosol (SOA) via ozonolysis of α-pinene has been studied extensively in the laboratory. Among the main motivations for these studies is the potential of organic aerosols to influence climate via cloud formation, which has not been established conclusively. During transport of SOA from the lower troposphere to the upper troposphere temperature and relative humidity (RH) variations can induce changes in phase state and morphology of the particles, which in turn both influence and are influenced by the particles´ chemical properties (Virtanen *et al*, 2010, Bateman *et al*, 2016). Little is known about such interactions.

We conducted cloud chamber experiments in the temperature range 208-298 K to study the role of chemical composition and phase state on SOA cloud interactions. We used 2 simulation chambers at the Karlsruhe Institute of Technology (KIT). α-pinene SOA was generated by ozonolysis in a 3.7 m^3 stainless steel chamber at room temperature and then transferred into the 84.5 m^3 aluminum chamber AIDA kept at temperatures between 298 and 208 K. For each temperature the RH in AIDA was then gradually increased from ~ 30% to ~95% followed by droplet or ice cloud formation induced by adiabatic expansion. The composition of the organic aerosol and its surrounding gas phase was measured with a Chemical Ionization Mass Spectrometer with a Filter Inlet for Gases and Aerosols (FIGAERO-CIMS) using I- as reagent ion (Lopez-Hilfiker et al, 2014, Lee et al, 2013). Viscosity of particles as a function of water uptake was investigated by the Aerosol Bounce Instrument (ABI, Pajunoja et al, 2015).

We observed differences in chemical composition as well as water uptake behavior for organic particles under different temperature and humidity conditions. For semi-volatile compounds, thermograms from the FIGAERO-CIMS show a shift towards larger maximum desorption temperatures with increasing AIDA RH at warm temperature, indicative of matrix effects or accretion reactions (Fig 1). Bounce measurements in the ABI indicate irreversible changes in the particles' physicochemical properties with increased humidity. Such effects were not observed at cold temperatures (Fig. 1). The results show the importance of meteorological conditions during SOA processing on their physicochemical properties and consequently their climate effects via cloud formation.

We will present detailed chemical analysis of gas and particle phase components as a function of temperature, RH, and particle phase state and morphology.

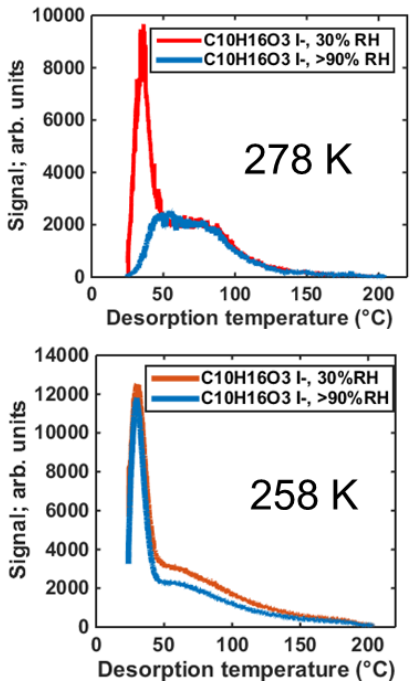

Figure 1. FIGAERO thermograms for $C_{10}H_{16}O_3I^-$, likely pinonic acid, at dry (30% RH) and humid (90% RH) conditions for 278 and 258 K in AIDA. Obvious is the loss of the first mode of the thermogram under warm and humid conditions.

Virtanen, A., et al. (2010) *Nature*, **467**, 824–827.

Bateman, A. P., et al. (2016) *Nature Geoscience*, **9**, 34-37.

Lopez-Hilfiker, F. et al. (2014) *Atmos. Meas. Tech.* **7**, 983-1001.

1001.

Lee, B. et al. (2013) *Environ. Sci. Technol.*, **48**, 6309-6317.

Pajunoja, A., et al. (2015) *Geophys. Res. Letter*, **42**, 3063-3068.