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Retention of secondary organic aerosols during riming experiments

Christine Borchers[1], Konstantin Dörholt[2], Alexander Theis[3], Alexander Lucas Vogel[2], and Thorsten Hoffmann[1]

[1]Department of Chemistry, Johannes Gutenberg-University Mainz, Germany (chborche@uni-mainz.de)
[2]Institute for Atmospheric and Environmental Sciences, Goethe-University Frankfurt am Main, Germany
[3]Particle Chemistry Department, Max Planck Institute for Chemistry, Mainz, Germany

The chemical composition of the upper troposphere and lower stratosphere (UTLS) region plays a major role in Earth's climate. Therefore, it is important to learn more about the transport mechanism of secondary organic aerosols (SOA) and their precursors into the UTLS region. One fast way of transport from the boundary layer to the upper troposphere is the deep convection. Organic vapors and particles, which get dissolved in cloud droplets, can take different pathways if the droplets freeze during the transport to the UTLS. Freezing occurs via different processes, for example riming which describes the freezing of supercooled liquid droplets upon the collision with ice crystals. During the riming the organic compounds could either revolatilise in the mixed zone of clouds or stay in the particles and get washed-out by precipitation or get transported to high altitudes and may revolatilise there if the cloud droplets sublimate. This partitioning between the ice and gas phase is given by the so-called retention coefficients.

Riming experiments in the worldwide unique vertical wind tunnel facility of the Johannes Gutenberg University of Mainz were carried out to derive retention coefficients for pinonoic and pinic acid. Both substances are formed during the monoterpene oxidation and represent SOA constituents. The simulated conditions were close to those prevailing in the mixed phase zone in convective clouds where riming is the predominant growth mechanism of ice particles. Artificial ice particles were captively floated at their approximate terminal velocity and exposed to a cloud of supercooled droplets containing the substance of interest. The cloud had liquid water contents between 1 and 3 g m^{-3} and temperatures ranging from -12 to -2 °C representing dry and wet growth conditions. From the concentrations of the substances before and after riming the retention coefficients for pinonic acid or pinic acid were obtained and compared to retention parameterizations available in literature.