The Influence of Relative Humidity on the SOA-Formation at Various Temperatures

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Monoterpenes represent a significant fraction of biogenic originated volatile organic compounds in the atmosphere. The oxidation of monoterpenes by ozone, OH and NO_3 radicals has been identified as a significant source for secondary organic aerosols (SOA) in the atmosphere. SOA yields can depend on relative humidity, temperature and pre-existing particulate organic mass for the absorption of the respective oxidation products.
In this study, we investigated the SOA-yields of the ozonolysis of a-pinene and limonene under dry and humid conditions in the aerosol chamber AIDA at temperatures of 303 and 243 K. All experiments were carried out in the presence of 500 ppm cyclohexane to scavenge OH-radicals produced during the reaction. In excess of ozone, the monoterpene was added to the chamber in steps. From this procedure the SOA yield, using the increasing organic aerosol mass, was determined. The monoterpenes and their oxidation products in the gas phase were measured by proton-transfer-reaction mass-spectrometry. The aerosol phase was characterized by means of an aerosol mass spectrometer (AMS). Size distributions of the organic aerosol were measured with differential mobility particle sizer.
The resulting SOA mass concentrations were related to the consumed monoterpene mass on a basis 5 min. time resolution, which provided time dependent growth functions. We observed significant lower SOA yields under dry conditions especially at lower temperatures. The AMS measurements revealed that partitioning of water to the aerosol phase is small and cannot account for the increase in SOA yields in the humid case. Molar yields of the a-pinene oxidation products pinonaldehyde and acetone increase with humidity. At temperatures below 253 K pinonaldehyde is exclusively found in the condensed phase and contributes then significantly to the SOA mass. In addition the water vapor dependent channels in the mechanism lead to other low volatile products resulting in higher SOA yields under humid conditions.