Influence of water vapour during Secondary Organic Aerosol formation by alpha-pinene ozonolysis on chemical composition, hygroscopic properties and volatile fractions

POULAIN L.[1], Wu Z. [1], Petters M. D. [2], Hallbauer E. [1], Wex H. [1], Wehner, B. [1], Massling A.[3], Kreidenweis, S. M. [2] and Stratmann F. [1]

[1] Leibniz Institute for Tropospheric Research, Leipzig, Germany
[2] Department of Atmospheric Science, Colorado State University, Fort Collins, CO, USA
[3] National Environmental Research Institute, Aarhus University, Roskilde, Denmark

We present data on the impact of water vapour concentration on the hygroscopicity and volatility of the aerosol reaction products formed via alpha-pinene dark ozonolysis. The hygroscopic properties of the Secondary Organic Aerosol (SOA) were determined using the Leipzig Aerosol Cloud Interaction Simulator (LACIS) and a Cloud Condensation Nuclei counter (CCNc). In parallel, an Aerodyne High Resolution Time of Flight Aerosol Mass Spectrometer (AMS) was located directly downstream of a thermodenuder (TD) to determine the volatile and non-volatile fraction of the forming SOA. The hygroscopic properties of the SOA were correlated with the water vapour concentration inside the chamber. In contrast, the effective density of the SOA was found to be independent off both ozone and/or water vapour concentration. TD measurements show that the SOA was completely evaporated at temperatures slightly below 200°C. However, under humid conditions, the volatile fraction of the SOA, after being heated at 100°C, increased. Further, the volatile fraction is more hygroscopic than the non-volatile fraction. Chemical modification of the SOA resulting from differences in the reaction conditions was measured using the high resolution mass spectrometry analysis of the AMS data. The fragment CO_2^+ and the sum of $C_xH_yO_z^+$ (short name CHO) and $C_xH_y^+$ (short name CH) fragments were used to estimate the degree of oxidation of the SOA and here we use the ratios CO_2^+ to CH and CHO to CH as representative measures of the degree of oxidations. In the presence of higher water vapour concentrations, these ratios increased corresponding to the formation of more oxygenated compounds. Moreover, the thermodenuder analysis shows that the most oxygenated compounds (CO_2^+) are more volatile than CHO. Finally we interpret our result in the context of the alpha pinene ozonolysis mechanism.