Investigation on temperature- and acidity-dependence of the formation of secondary organic aerosol from α-pinene ozonolysis

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Secondary organic aerosol (SOA) accounts for 20–90 % of submicrometer aerosol mass and is thus of great importance in affecting human health and the prediction of climate change. The formation of SOA in ambient atmosphere is influenced by both the environment temperature and the acidity of precursor reactants. However, these factors are not embodied in current atmospheric chemistry models mainly because our understanding on them is insufficient. In this study, a new Teflon atmospheric simulation chamber, in which reactions in atmospheric pressure conditions can be performed with controlled temperature, humidity, light, and seed particles (with/without, and different acidity), is developed. α-Pinene ozonolysis is simulated under temperatures of 278 K, 288 K, and 298 K with neutral/acidic seed aerosol particles. In each experimental run, excess ozone was introduced to the chamber and α-pinene was almost fully consumed by the end of the experiment. SOA were collected onto Teflon filters and were analyzed using negative electrospray ionization liquid-chromatography time-of-flight mass spectrometry (LC-TOF-MS). SOA yield increased with the decrease of temperature. While this could be caused by the shifting of the partition of semi-volatile organic vapors (SVOC) between gas and aerosol phases toward the aerosol phase at the low temperature, the low enthalpy of vaporization might indicate the large contribution of water to SOA yield at the low temperature. Volatility distribution of SOA components, which is represented by the vapor saturation concentration in logarithmic scale ($\log_{10}C^*$) in unit interval, was derived under different experimental conditions in order to see chemical changes macroscopically. Compared with neutral seed conditions, the mass fraction of SOA at $\log_{10}C^*$=-1 decreased and that at $\log_{10}C^*$=-4, -3 increased in the condition of acidic seed particles (~200 μmol m^{-3}) at 298 K. Chemical composition analyses indicated that the difference was probably caused by the formation of organosulfate, which could lead to increased SOA yield under acidic seed conditions. Under acidic seed conditions, mass fraction of SOA at $\log_{10}C^*$=-9, -8 (m/z range: 411-453) increased with the decrease of temperature, which might suggest that the formation of products by acid-catalyzed heterogeneous reactions were more effective at the low temperature.We thank Dr. Tomoharu Sano and Ms. Sumiko Komori for their technical supports. This research is supported by the NIES Research Funding (Type A).

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