Geophysical Research Abstracts
Vol. 16, EGU2014-14608, 2014
EGU General Assembly 2014

Aerosol formation by ozonolysis of α- and β-pinene with initial concentrations below 1 ppb

Harald Saathoff, Karl-Heinz Naumann, and Ottmar Möhler

Karlsruhe Institute of Technology, Institute for Meteorology and Climate Research (IMK-AAF), Eggenstein-Leopoldshafen, Germany (harald.saathoff@kit.edu)

Secondary organic aerosols (SOA) from the oxidation of biogenic volatile organic compounds (BVOC) are a large fraction of the tropospheric aerosol especially over tropical continental regions. The dominant SOA forming compounds are monoterpenes of which pinene is the most abundant. The reactions of monoterpenes with OH radicals, NO_3 radicals, and ozone yield secondary organic aerosol mass in highly variable yields. Despite the various studies on SOA formation the influence of temperature and precursor concentrations on SOA yields are still major uncertainties in tropospheric aerosol models. In previous studies we observed a negative temperature dependence of SOA yields for SOA from ozonolysis α-pinene and limonene (Saathoff et al., 2009). However, this study as well as most of the literature data for measured SOA yields is limited to terpene concentrations of several ppb and higher (e.g. Bernard et al., 2012), hence about an order of magnitude higher than terpene concentrations even near their sources. Monoterpene concentrations in and above tropical or boral forests reach values up to a few tenth of a ppb during daytime decreasing rapidly with altitude in the boundary layer (Kesselmeier et al. 2000; Boy et al., 2004).

Therefore we investigated the yield of SOA material from the ozonolysis of α- and β-pinene under simulated tropospheric conditions in the large aerosol chamber AIDA on time scales of several hours and for terpene concentrations between 0.1 and 1 ppb. The temperatures investigated were 243, 274, and 296 K with relative humidities ranging from 25% to 41%. The organic aerosol was generated by controlled oxidation with an excess of ozone (220-930 ppb) and the aerosol yield is calculated from size distributions measured with differential mobility analysers (SMPS, TSI, 3071 & 3080N) in the size range between 2 and 820 nm. On the basis of the measured initial particle size distribution, particle number concentration (CPC, TSI, 3775, 3776, 3022), and trace gas evolution model calculations were done using the aerosol model COSIMA (Naumann, 2003; Saathoff et al., 2009) supplemented by an improved SOA module in combination with the master chemical mechanism (MCM 3.2).

As previously reported for higher SOA concentrations the overall SOA yields from ozonolysis of α- and β-pinene increase significantly with decreasing temperature. However, compared to the yields extrapolated from experiments done with higher terpene concentrations the SOA yields at ambient like concentrations are surprisingly high. They reach values of up to 20% at 243 K for organic aerosol mass concentrations of about 0.5 μg m-3 even without additional seed aerosol.

This paper discusses the temperature dependent SOA yields from the ozonolysis of α-pinene and β-pinene in comparison with data from literature.

Bernard et al., (2012) J. Aerosol Sci. 43, 14-30.
Boy et al., (2004) Atmos. Chem. Phys. 4, 657–678.
Kesselmeier et al., (2000) Atmos. Environ. 34, 4063-4072
Naumann (2003) J. Aerosol Sci. 34 (10), 1371-1397.
Saathoff et al., (2009) Atmos. Chem. Phys. 9 (5), 1551-1577.