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Temperature and humidity dependence of secondary organic aerosol yield from the ozonolysis of β-pinene

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Abstract. The temperature dependence of secondary organic aerosol (SOA) formation from ozonolysis of β-pinene was studied in a flow reactor at 263 K – 303 K and 1007 hPa under dry and humid conditions (0% and 26% – 68% relative humidity, respectively). The observed SOA yields reached maximum values of 0.18 – 0.39 at high particle mass concentrations (M_o). Under dry conditions, the measurement data showed an overall increase in SOA yield with inverse temperature, but significant oscillatory deviations from the predicted linear increase with inverse temperature (up to 50% at high M_o) was observed. Under humid conditions the SOA yield exhibited a linear decrease with inverse temperature. For the atmospherically relevant concentration level of M_o=10 µg m^{-3} and temperature range 263 K – 293 K, the results from humid experiments in this study indicate that the SOA yield of β-pinene ozonolysis may be well represented by an average value of 0.15 with an uncertainty estimate of ± 0.05. When fitting the measurement data with a two-product model, both the partitioning coefficients ($K_{om,i}$) and the stoichiometric yields (α_i) of the low-volatile and semi-volatile model species were found to vary with temperature. The results indicate that not only the reaction product vapour pressures but also the relative contributions of different gas-phase or multiphase reaction channels are strongly dependent on temperature and the presence of water vapour. In fact, the oscillatory positive temperature dependence observed under dry conditions and the negative temperature dependence observed under humid conditions indicate that the SOA yield is governed much more by the temperature and humidity dependence of the involved chemical reactions than by vapour pressure temperature dependencies. We suggest that the elucidation and modelling of SOA formation need to take into account the effects of temperature and humidity on the pathways and kinetics of the involved chemical reactions as well as on the gas-particle partitioning of the reaction products.

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