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Phase state and humidity-induced phase transition studies of SOA particles from biogenic and anthropogenic precursors

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There is mounting evidence showing that tropospheric secondary organic aerosol (SOA) may exist in a phase state other than liquid, namely semi-solid or solid amorphous. The solid or semi-solid, high viscosity material may have significantly higher lifetime in an oxidizing atmosphere than low viscosity liquid due to mass transfer limitations in the particle bulk. In this work we report a systematic study of the phase state of SOA particles produced by photo-oxidation of several volatile organic compound (VOC) precursors in a potential aerosol mass (PAM) flow tube reactor. The phase state of the particles was studied by their bounce behaviour upon impaction on a polished steel plate in a low pressure impactor. The SOA oxidation level (O/C) was determined by an Aerodyne high resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS)

The phase state for several types of SOA from different surrogate anthropogenic and biogenic precursors, produced at a wide range of oxidation conditions, were studied at a range of relative humidities. We report the solid or semi-solid phase state of SOA produced from cyclic and terpene precursors used in the study up to at least 50 % relative humidity. Furthermore, adding sulfur dioxide into the reaction chamber yielded liquefied particles, while particles formed from oxidation of pure organic precursor were solid or semi-solid. For a long-chain alkane precursor a liquid-like SOA at low oxidation level was produced, but upon increasing the oxidation level, the formed particles became more solid. While the bounce behaviour of the particles had no single explaining factor for all experiments, the precursor molar mass was seen to correlate with more solid phase at higher humidities in cases with cyclic or terpene precursor.