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Organic Aerosol Nucleation and Growth at the CERN CLOUD chamber

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It is well known that atmospheric aerosols influence the climate by changing Earth's radiation balance (IPCC 2007 and 2013). Recent models have shown (Merikanto et al. 2009) that aerosol nucleation is one of the biggest sources of low level cloud condensation nuclei. Still, aerosol nucleation and growth are not fully understood. The driving force of nucleation and growth is sulfuric acid. However ambient nucleation and growth rates cannot be explained by solely sulfuric acid as precursor. Recent studies have shown that only traces of precursors like ammonia and dimethylamine enhance the nucleation rates dramatically (Kirkby et al. 2011, Almeida et al., 2013). Thus the role of different aerosol precursor needs to be studied not only in ambient but also in very well controlled chamber experiments. The CLOUD (**C**osmics **L**eaving **OU**tdoor **D**roplets) experiment enables conducting experiments very close to atmospheric conditions and with a very low contaminant background.

The latest CLOUD experiments focus on the role of organics in aerosol nucleation and growth. For this purpose, numerous experiments with alpha-pinene have been conducted at the CERN CLOUD chamber. Several state-of-the-art instruments were used to cover the whole complexity of the experiment. Chamber conditions were set to 40% relative humidity and 5˚C. Atmospheric concentrations of SO_2, O_3, HONO, H_2O and alpha-pinene were injected to the chamber. Different oxidation conditions were used, yielding different levels of oxidized organics: (1) OH radicals, (2) Ozone with the OH scavenger H_2 (pure ozonolysis) and (3) both. SO_2 was injected to allow for sulfuric acid production. Optical UV fibers were used to enable photochemical reactions. A high field cage (30 kV) can be turned on to remove all charged particles in the chamber to enable completely neutral conditions. Comparing neutral conditions to the beam conditions using CERN's proton synchrotron, the fraction of ion-induced nucleation can be studied. Using the beam, different ion concentrations can be simulated, from the planetary boundary layer to the upper troposphere (Kirkby et al. 2011).

Precursor concentration and oxidiation products were measured with one proton transfer reaction time-of-flight mass spectrometer (precursor concentration), two atmospheric pressure interface time-of-flight mass spectrometer (APi-ToF, charged cluster composition) and two chemical ionization APi-ToF (neutral cluster composition and concentration). Aerosol formation and growth rates were determined using particle size magnifier (size rage: 1-3 nm), neutral air ion spectrometer (size rage: 0.8 -30 nm), nano scanning mobility particle sizer (size rage: 5-80 nm) and several low cut-off condensation particle counters.

The presented results will include nucleation and growth rates depending on oxidized organics and sulfuric acid concentration. Another focus will be on the contribution of organics to aerosol growth. For this, different size ranges will be considered. The results will also include the influence of ions on nucleation and growth.

References:
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