Investigating the role of ions in new particle formation in the CLOUD chamber

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The CLOUD chamber facility (Duplissy *et al.* 2016) located at CERN enables the study of the effect of different levels of ionizing radiation on new particle formation. It is equipped with a high voltage field cage (clearing field) which can be used to remove all ions from the chamber. One of the key features of the CLOUD experiment is the extremely low level of contaminants, which allows the investigation of new particle formation in different chemical regimes under precisely defined conditions. While ion concentrations have been found to affect nucleation rates in previous studies (Almeida *et al.* 2013, Kirkby *et al.* 2016) the size resolved charge fractions were not yet subject to a detailed study.

In the most recent measurement campaign (CLOUD10, Sep-Dec 2015) we used a novel instrument setup to study the effect of charges on the formation of clusters. We operated two particle size magnifiers (PSM, Airmodus Ltd., model A11) in parallel, removing the ions from the sample for one of the PSMs (Kangasluoma *et al.* 2016). This way we were able to directly measure the charging state of the formed clusters. A sample experiment for the assessment of nucleation rates in the presence of ions is displayed in Fig. 1. Before the experiment, ions are removed from the chamber; only a small background concentration is detected and the concentration of total and neutral particles is the same (within error limits). When the clearing field was switched off and alpha pinene was injected into the chamber at 23:57, the concentration of ions increased and a strong signal of ion-induced particle formation was observed.

Besides particle counters and ion spectrometer (NAIS) a set of mass spectrometers and sensitive gas monitors were measuring the chemical composition of formed clusters and their precursors. The studied regimes include a mixture of monoterpenes (alpha pinene, delta-3-carene; 150–1200 pptv), sulfuric acid (<1e5–5e7 cm^{-3}), nitrogen oxides (0–5 ppbv) as well as ammonia (0–3 ppbv). With this broad set of experiments we aim to shed light on the significance of ion induced nucleation processes in different environments.

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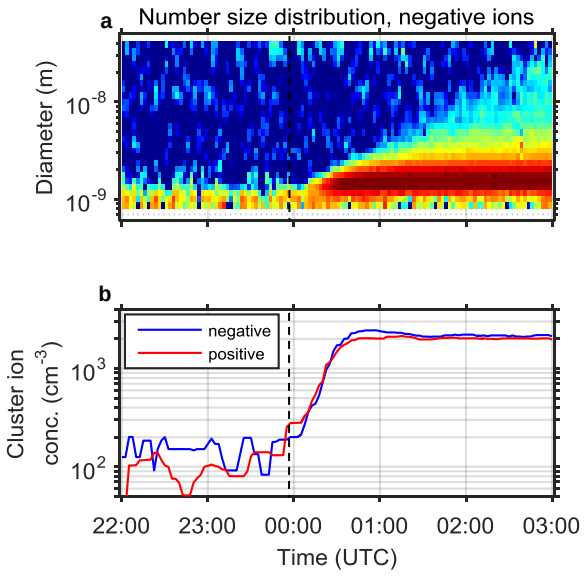

Figure 1. Ion-induced particle formation at 25°C from 900 pptv alpha pinene. The time evolution of a) number size distribution of negative ions, and b) cluster ion concentration (0.8–1.7 nm) in the NAIS are displayed. The clearing field is switched off at 23:57 (dashed line).

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