# Simulating new particle formation in boreal forest conditions in the CLOUD chamber

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The CLOUD experiment has previously studied new particle formation from sulphuric acid and water, together with ammonia (Kirkby *et al* 2011) and dimethylamine (Almeida *et al* 2013). The organic precursors studied so far are pinanediol (Riccobono *et al* 2014) and alpha-pinene (Kirkby *et al* 2016). These studies, however, did not fully investigate the interactions between these systems, which could be important in the atmospheric boundary layer.

Last fall, during the CLOUD10 campaign, we took a big step towards simulating new particle formation in conditions resembling daytime boreal forest, in the simultaneous presence of multiple precursor vapors and oxidation pathways. The main aim of the 12-week intensive campaign was replicating the new particle formation process observed at the Hyytiälä SMEAR II station, which is one of the most studied field sites. At the same time, we maintained a high degree of control and a low level of contaminants, which has made the CLOUD experiment so successful in the past.

Particle formation in the CLOUD chamber was started from a mixture of the two most abundant monoterpenes found in Hyytiälä: alpha-pinene and delta-3-carene. The total monoterpene volume mixing ratios varied from about 150 to 1200 ppt. The experiments were conducted at varying levels of sulphuric acid (from less than 1e5 $cm^{-3}$ up to 5e7 $cm^{-3}$) and $NO_x$ (from 0 to 5 ppb). The first experiment series were carried out without ammonia to ensure clean conditions, and later ammonia (up to 3ppb, but mostly at the level some hundreds of ppts) was added to the chamber. All the experiments were done first in neutral conditions (without ions present) and then repeated with ionization from galactic cosmic rays (GCR) and/or with additional ionization from the CERN pion-beam to study the fraction of ion-induced nucleation.

A comprehensive suite of instruments including state-of-the-art particle counters and mass spectrometers were used to detect the forming particles and their precursors. We will present the first results from the "Hyytiälä simulation" in CLOUD and show how new particle formation can proceed simultaneously by pure biogenic pathway and by acid-base mechanism.

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Kirkby, J. *et al.* (2011) *Nature* **476**, 429-433.
Kirkby, J. *et al.* (2016) *Nature* in review.
Riccobono, F. *et al.* (2014) *Science*, **334**, 717-721.

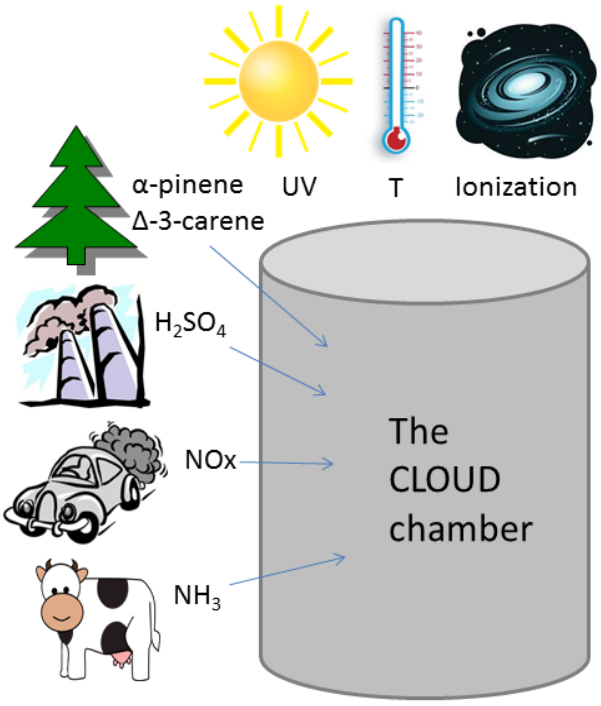


**Figure 1.** Conceptual picture of the CLOUD10 experiments simulating particle formation in Hyytiälä.

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