THE CLOUD EXPERIMENT AT CERN: NEUTRAL AND ION-INDUCED NUCLEATION AT FREE TROPOSPHERIC CONDITIONS

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Aerosols influence climate indirectly by providing the seed particles for cloud droplets. A large fraction of these so-called cloud condensation nuclei (CCN) originates from nucleated vapors, i.e. the particles form by nucleation of gas-phase precursors. Currently it is not well understood what vapors are responsible for new particle formation (NPF) and if ions from galactic cosmic rays (GCR) have a significant influence on NPF and therefore on climate.

The CLOUD experiment at CERN is designed to answer these questions. The 26 m^3 stainless steel CLOUD chamber provides an environment where nucleation experiments can be conducted under essentially contaminant free conditions. It further can be used to study nucleation under pure neutral conditions, where the influence of GCR is completely suppressed, or under ion-induced conditions using natural GCR and optionally an adjustable pion beam for enhancing the ionization rates.

Different chemical systems and varying conditions, e.g. regarding the ion concentration and temperature, have been tested so far. These include the binary sulfuric acid–water system and the ternary sulfuric acid–water–ammonia system presented by Kirkby et al (2011 *Nature* **476** 429), the ternary system involving sulfuric acid, water and dimethylamine presented by Almeida et al (2013 *Nature* **502** 359) and Kürten et al (2014 *P. Natl. Acad. Sci. USA* **111** 15019), and the ternary system with sulfuric acid, water, and oxidation products from α-pinene, a natural organic product emitted from coniferous trees, presented by Riccobono et al (2014 *Science* **344** 717).

Whereas the above-mentioned studies mainly aimed at explaining atmospheric boundary layer nucleation, there is also a strong interest in evaluating the role of ion-induced nucleation at conditions relevant for the higher altitudes. Therefore, this presentation focuses on measured new particle formation rates in the binary system and the ternary system with ammonia, which could dominate the nucleation at low temperatures as present in the free troposphere. Consequently, measurements were made at temperatures as low as -65 °C.