Results from the CERN pilot CLOUD experiment - DTU Orbit (16/12/2018)

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During a 4-week run in October-November 2006, a pilot experiment was performed at the CERN Proton Synchrotron in preparation for the Cosmos Leavinf OUtdoor Droplets (CLOUD) experiment, whose aim is to study the possible influence of cosmic rays on clouds. The purpose of the pilot experiment was firstly to carry out exploratory measurements of the effect of ionising particle radiation on aerosol formation from trace H2SO4 vapour and secondly to provide technical input for the CLOUD design. A total of 44 nucleation bursts were produced and recorded, with formation rates of particles above the 3 nm detection threshold of between 0.1 and 100 cm(-3) s(-1), and growth rates between 2 and 37 nm h(-1). The corresponding H2SO4 concentrations were typically around 10(6) cm(-3) or less. The experimentally-measured formation rates and H2SO4 concentrations are comparable to those found in the atmosphere, supporting the idea that sulphuric acid is involved in the nucleation of atmospheric aerosols. However, sulphuric acid alone is not able to explain the observed rapid growth rates, which suggests the presence of additional trace vapours in the aerosol chamber, whose identity is unknown. By analysing the charged fraction, a few of the aerosol bursts appear to have a contribution from ion-induced nucleation and ion-ion recombination to form neutral clusters. Some indications were also found for the accelerator beam timing and intensity to influence the aerosol particle formation rate at the highest experimental SO2 concentrations of 6 ppb, although none was found at lower concentrations. Overall, the exploratory measurements provide suggestive evidence for ion-induced nucleation or ion-ion recombination as sources of aerosol particles. However in order to quantify the conditions under which ion processes become significant, improvements are needed in controlling the experimental variables and in the reproducibility of the experiments. Finally, concerning technical aspects, the most important lessons for the CLOUD design include the stringent requirement of internal cleanliness of the aerosol chamber, as well as maintenance of extremely stable temperatures (variations below 0.1 degrees C).

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