

From the Geosphere to the Cosmos: ASPERA Workshop

Abstract

Cosmic Rays and Climatology: The CLOUD Project at CERN

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CLOUD is an acronym for Cosmics Leaving OUtdoor Droplets. The scientific objective of CLOUD is to investigate the influence of galactic cosmic rays (GCRs) on ions, aerosols, cloud condensation nuclei (CCN) and clouds, with the CLOUD facility at CERN, and thereby to assess the significance of a possible "solar indirect" contribution to climate change.

Aerosols and clouds are recognised as representing the largest uncertainty in the current understanding of climate change. The Intergovernmental Panel on Climate Change (IPCC) estimates that changes of solar irradiance ("direct solar forcing") have made only a small (7%) contribution to the observed warming. However, large uncertainties remain on other solar-related contributions, such as the effects of changes of GCR on aerosols and clouds. There are several plausible mechanisms that could link GCR flux and cloud properties. A leading candidate is the 'ion-aerosol clear-air mechanism', in which atmospheric ions created by GCRs act as nuclei for the formation of atmospheric particles. The nucleation of new nanometer-sized aerosol particles is observed frequently, and in many parts of the atmosphere, and is thought to be a major source of cloud-condensation nuclei (CCN) — particles large enough for cloud droplets to form around them.

To investigate the involved processes, a large aerosol chamber has been established in the beamline T11 at the CERN Proton Synchrotron accelerator, within which the atmosphere is recreated from ultra-pure air with added water vapour and trace gases under study. The chamber is equipped with a wide range of sensitive instruments to analyse their contents. The accelerator provides an adjustable and precisely measurable beam of "cosmic rays" that closely matches natural cosmic rays in ionisation density, uniformity and intensity, spanning the atmospheric range from ground level to the maximum around 15 km altitude. First results will be presented, which give new insight on the first step in the overall hypothesis of an influence of cosmic rays on clouds, i.e., ion-mediated nucleation of aerosol particles in the atmosphere.

For more information on the CLOUD project:

http://www.unifrankfurt.de/english/research/inter_projects/clouditn/index.html/
