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Potential of natural seeding by ice clouds over Switzerland

Ulrike Proske, Verena Bessenbacher, Zane Dedekind, Ulrike Lohmann, and David Neubauer
Institute for Atmospheric and Climate Science, ETH Zürich, Zürich, Switzerland

The ice phase in clouds determines many of their key properties and influences the water cycle, since most precipitation globally originates from the ice phase. Ice crystals falling as seeds from an ice cloud into a lower lying mixed-phase or liquid cloud can influence ice and precipitation formation. In the lower lying cloud, the ice crystals feed on the liquid, grow and enhance precipitation (seeder-feeder mechanism) or trigger glaciation (natural cloud seeding). The seeder-feeder mechanism has been associated with the intensification of extreme precipitation and flooding.

Even though there have been multiple case studies of the seeder-feeder mechanism and a few on natural cloud seeding, estimates of the occurrence frequency of these processes are lacking.

We derived the frequency of possible seeding situations (ice-layer above liquid or mixed-phase cloud layer) from radar/lidar satellite observations over Switzerland. We found an ice layer to be present above another cloud layer about 20% of the time. The distance between the cloud layers was uniformly distributed between 100m and 10km. In sublimation calculations we used the mean effective ice crystal radius from the satellite observations and calculated the crystals' sublimation height, assuming a spherical shape. In a significant number of cases ice crystals would survive the fall between the two cloud layers. We investigated the effect of the falling ice crystals on the lower lying cloud layer and on precipitation formation in sensitivity studies of selected situations with the regional climate model COSMO.

The high occurrence frequency of seeding situations and the survival of the ice crystals indicate the seeder-feeder process and natural cloud seeding as widespread phenomena. To infer their importance, the magnitude of the seeding ice crystals' effect on lower lying clouds and precipitation needs to be established.