Name of research institute or organization:

Departement Umweltwissenschaften, Universität Basel

Title of project:

Characterisation of biological ice nucleators at cloud height

Project leader and team:

Dr. Franz Conen, project leader
Ms. Claudia Mignani
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Project description:

The goal of this project is to clarify the impact that ice nucleating particles (INPs) of biological origin may have on clouds. At Jungfraujoch we sample snow and cloud droplets for analysis of INPs in so-called droplet freezing assays. In 2017 we have tested new samplers for these purposes which we will use more extensively from now on. We also continue to analyse – for interesting periods – PM_{10} filters routinely sampled by NABEL (Empa/BAFU). One of several insights gained that way is described in more detail in the report on our radon project (this volume). It shows that the rainfall-induced increase in biological INPs previously observed in the surface layer above vegetation sometimes extends to a height where such INPs may have an impact on moderately supercooled clouds. Another interesting period analysed includes three days at the beginning of September 2017, when smoke from large forest fires in North America had affected Jungfraujoch.

Towards the end of 2017, we started to experiment with analysing single snow crystals for embedded INPs. Dendrite-type snow crystals (example shown in Figure 1) are known to form within a temperature window from about -13 °C to -16 °C. They can grow within 20 min to a few mm in diameter, with an average deposition velocity during that time of about 0.2 m s^{-1}. Consequently, initial ice formation leading to dendrites may take place at perhaps slightly colder temperatures (i.e. at -14 °C to -18 °C). Melting a dendrite on a temperature controlled stage results in a tiny water droplet containing the (presumed) INP that had catalysed its formation. When cooled, the droplet will eventually freeze and reveal the activation temperature of the embedded INP. If the droplet does not freeze above -20 °C or so, the crystal has probably resulted from secondary ice formation, e.g. developed from a rime splinter, a collision fragment, a shattered droplet, or a sublimation fragment of ice. So far, about half of the crystals we analysed (n = 35) did contain an INP. Many more of such measurements in different locations and in various meteorological conditions will tell us about the importance of secondary ice formation between about -14 °C and -18 °C.

Figure 1. Example of a dendrite-type snow crystal collected at Jungfraujoch on 13th of December 2017. The habit (shape) of the crystal suggests that it had grown between -13 °C and -16 °C. The fragile structure (3.5 mm diameter) was placed with a fine paintbrush onto a temperature-controlled stage and melted into a tiny droplet, which was then cooled and froze at -17 °C. Therefore, we can conclude that this snow crystal was probably catalysed by an INP active at -17 °C and it was not a product of secondary ice formation.

Key words:

Primary biological aerosol particles, ice nucleation, sources, drivers of temporal variation

Internet data bases:

https://umweltgeo.unibas.ch/forschung/abgeschlossene-projekte/biological-nucleators/

Collaborating partners/networks:

Laboratory of Atmospheric Chemistry, Paul Scherrer Institute, Villigen, Switzerland
Laboratory for Air Pollution/Environmental Technology, Swiss Laboratories for Material Science and Technology (Empa), Dübendorf, Switzerland
Institut national de la recherche agronomique (INRA), Pathologie vegetale, Montfavet, France

Scientific publications and public outreach 2017:

Refereed journal articles and their internet access

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Magazine and Newspapers articles

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