Biological ice nucleators at tropospheric cloud heights

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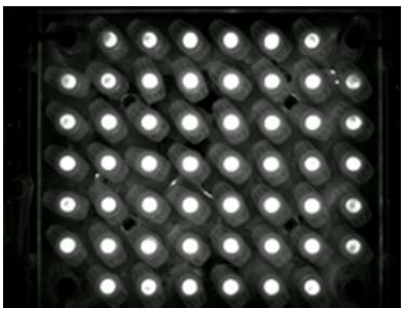
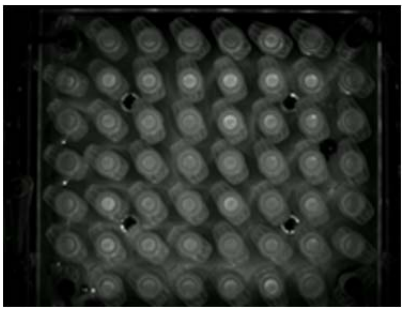
A matter of quantity or quality?

The presence of particles in the atmosphere is crucial for the formation of precipitations, since they provide a template for the construction of ice crystals. Biological ice nucleators (IN) are constituents of these particles and are active at relatively warm temperature (from -2°C to -12°C). Moreover, some bacteria isolated from precipitation are known to synthesize an IN protein under stressful conditions, in particular after exposure to low temperatures (+4°C).

Despite being effective at higher temperatures, the abundance of biological ice nucleators seems to be minor in comparison with other particles present in the atmosphere, like dust or salts. Thus, new evidence is needed to assess their potential role in conditioning precipitations on Earth, since they are quantitatively a minority but qualitatively really active.

New drop freezing apparatus, new possibilities





Different techniques are available to study ice nucleation phenomena. We are currently using the drop freezing method through a new apparatus, LINDA. In detail, the sample (rain or melted snow for instance) is distributed into vials immersed in a cooling bath. Freezing in closed tubes is detected automatically by a change in light transmission upon ice development. Thus, no contamination of the sample is guaranteed, allowing its preservation for further analysis.

Up in the clouds: field sampling at Jungfraujoch Research Station (3580 m a.s.l.)

One of our goals is then to study the abundance of biological IN in precipitations, its potential variation over time and whether this abundance is linked to meteorological, geographical or seasonal factors.

Monthly sampling campaigns have been carried out at the High Altitude Research Station of Jungfraujoch, in the deep heart of the Swiss Alps, as representative of tropospheric cloud heights. Thus, we try to be as close as possible to the formation of snowflakes. Meteorological data (METEOSWISS), concentrations of PM10 and trace gases (EMPA), and cloud modelling data (EMPA) available for this station are then combined with measurement of water stable isotopes (2H and 18O) and bacterial abundance (direct counting) to obtain a good set of information for each sample.

In the lab: behavior of samples through storage at low temperatures

With LINDA apparatus it is possible to analyse samples without contaminating them. This offers a new possibility to study the behavior of a sample over time. We are interested in understanding whether different classes of biological ice nucleators behave differently upon storage at low temperatures and whether it is possible to progressively isolate them. The final goal is to obtain a better understanding of the components determining the nucleation activity of samples.

Publications from our group on this topic

Describing and predicting abundance of bio INPs in precipitation

Ice nucleating particles in the Arctic

Ice nucleation active particles are efficiently removed by precipitating clouds

LINDA: a new freezing apparatus for IN analysis

Biological molecules on soil dust acting as ice nuclei

A new facet of soil organic matter

Atmospheric ice nuclei at Jungfraujoch

PM_{10} filters and IN quantification

Bioprecipitation: land-atmosphere feedbacks

Bacterial concentrations in the air above the Alps

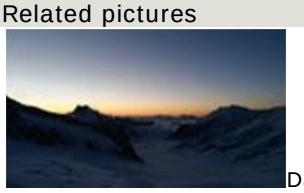
Related links

Biological IN forum
Drop freezing apparatus

News

2014/09/25: This project was selected to represent the departement DUW infront of the UniRat (Council of the University of Basel). Click here for the presentation.

Related pictures


Dawn on the Aletsch glacier


glacier


Jungfraujoch


sunset


atmosphere


precipitation sampling


Haldde- Norway


PM10 sampling


La Brevine