Geophysical Research Abstracts
Vol. 16, EGU2014-1862-1, 2014
EGU General Assembly 2014

Biological ice nuclei at tropospheric cloud heights: potential conditioning of precipitation

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Different substances present in the atmosphere enhance the aggregation of water molecules into ice structures, but particularly effective seem to be aerosols of biological origin, active at temperatures up to -2°C. Yet, the relevance of biological ice nucleation for cloud processes, such as initiating precipitation, remains ambiguous.
We try to understand the meteorological conditions and the environmental factors controlling the abundance of biological ice nuclei (IN) in precipitation. One full year of observations has been carried out at the High Altitude Research station of Jungfraujoch, in the Swiss Alps, 3580 m a.s.l. Fresh snow was collected each month and analysed immediately on site for the concentration of IN active at temperatures warmer than -12°C. For this purpose we had developed an innovative system automatically recording freezing events of samples in closed tubes. Additional information was gained through the recording of meteorological parameters associated with the precipitation events, and the determination of stable isotopes (2H and 18O) and of bacterial concentrations (direct epifluorescence microscope counting, live/dead staining) in precipitation.
Our analysis of the data suggests that the abundance of ice nuclei in snowfall is characterized not only by seasonality, but also by the geographical origin of precipitating air masses. Further, it seems that the more water an air mass has lost through previous precipitation, the smaller is the biological IN abundance in the remaining precipitation. Moreover, the loss of biological IN with precipitation seems to be much faster than that of other suspended particles in the same air mass, pointing towards a role of biological IN in conditioning the development of precipitation at its early stages.