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Microzoo: assessing diversity of biological ice nuclei in rain and snow

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Biological ice nuclei (IN) are involved in initiating precipitation at temperatures between 0 and -12°C. More and more species of pollen, fungi and bacteria are being discovered to actively induce ice formation. Nevertheless, several questions remain unanswered: which organisms contribute the most to the IN activity in the atmosphere? What fraction of biological IN activity in precipitation samples is due to living cells, dead organic material or even macromolecules detached from cells?

As first approach to tackle these questions, we decided to separate biological IN by size and thermal stability, assessing the cumulative number of IN active at temperatures warmer than -12°C in precipitation samples processed via progressive filtration through different meshes (5 μm, 1.2 μm, 0.22 μm) followed by heating (40°C, 80°C or 100°C). This method was applied on a set of precipitation samples collected at two sites in Switzerland: Basel (260 m a.s.l.) and the High Altitude Research Station of Jungfraujoch (3580 m a.s.l.).

Results showed that each sample is characterised by a unique freezing profile and almost all ice nucleation activity in the temperature under study was due to proteinaceous structures (lost after heating at 80°C or 100°C). Interestingly, a significant part of the observed biological activity was always associated with the fraction > 5 μm and lost already after warming to 40°C. This suggests that biological IN activity depends also on easily denaturable molecular structures which can be in form of clusters rather than single floating airborne bacterial cells or molecules, or which are due to organisms that produce particles bigger than 5 μm (fungal spores, for example). Moreover, the storage of a sample can strongly change its freezing spectrum, emphasising the need to do measurements on freshly fallen precipitation.