Learning from the temperature sensitivity of biogenic and Arctic ice nucleating particles

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INP spectra obtained for the different examined samples

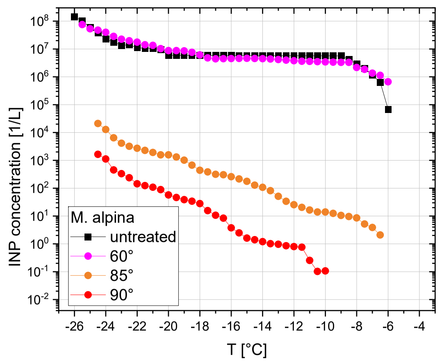
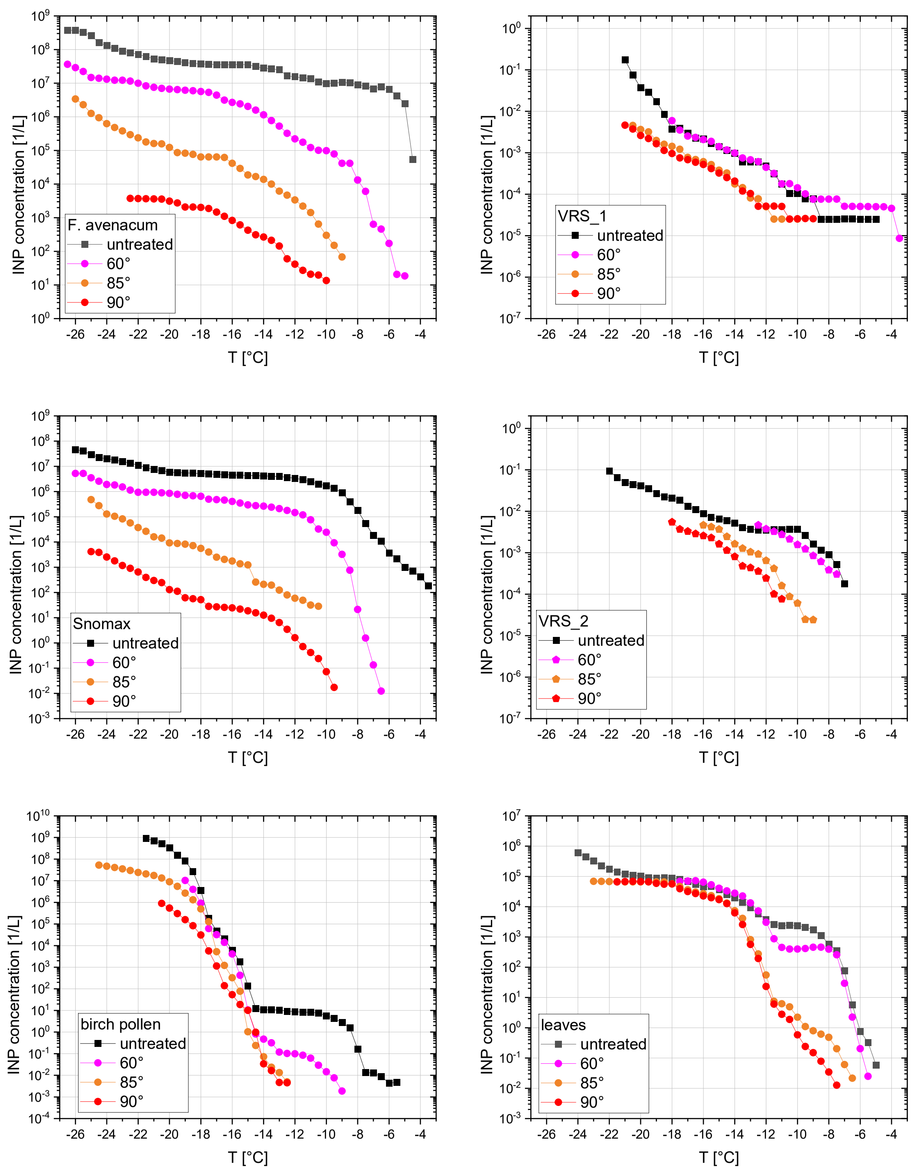


Fig. 1: Concentrations of INPs (such as ice active macromolecules) for purely microbial and environmental samples, shown in panels in the left and right column, respectively. Results are given for untreated samples as well as for samples after heating for 1 hour to different temperatures.



why and what

- **atmospheric INPs** (Ice Nucleating Particles) are important for the freezing of cloud droplets in the temperature (T) range between -38°C and 0°C, **influencing cloud radiative effects and precipitation formation**

- these INPs are mostly mineral dust particles (important at T < below -20°C) and **macromolecules formed by microorganisms** (important at higher T), of which **proteinaceous INPs** can be **destroyed by heat**

- detailed **sources and nature** of atmospheric INPs are **not yet well understood**

- we examined the following INPs with respect to their **heat lability**:

fungal spores (*Mortierella alpina*, *Fusarium acuminatum*), **bacteria** *Pseudomonas syringae* (from a commercially available SNOMAX sample), **birch pollen** (*Betula pendula*), freeze dried **aspen leaves** (from *Populus tremuloides*) [1] and **Arctic filter samples** from Villum Research Station (VRS) [2]

- examinations were done with the TROPOS offline INP measurement technique INDA [2] which is based on the use of PCR trays, washing off the Arctic filters [2] or else working with dilution series of the samples

- the goal was a subsequent comparison of the sample-specific patterns of ice activity reduction at different heating T

results

- *F. acuminatum* (fungal spores) and *P. syringae* (bacteria) showed similar losses of ice activity, with decreasing ice activity between each examined T and strong losses with less than 10^{-4} remaining INPs for heating to 90°C

- the ice activity of *M. alpina* was not decreased by heating to 60°C, but was similarly decreased as *F. acuminatum* and *P. syringae* for heating to higher T

- in *B. pendula,* highly ice active INP (active at > -12°C) were strongly affected by heating while less ice active INP were less affected

- Arctic samples and the leave sample showed no or only a small decrease in ice activity by heating to 60°C (similar to *M. alpina*), and no difference was observed between heating to 85°C and 90°C (different from *M. alpina*)

- our examinations cannot pinpoint the type of INP occurring on the leaves or in the Arctic, as a mixture of INP likely contributes, and as we may not have included all major microorganisms in our study which may be present in these samples

- but examinations like this may help to restrict the group of possibly important contributors to atmospheric INP

[1] Vasebi et al. (2019), Comprehensive characterization of an aspen (Populus tremuloides) leaf litter sample that maintained ice nucleation activity for 48 years, *Biogeosci.*, 16 (8), doi:10.5194/bg-16-1675-2019.
[2] Sze et al. (2023), Ice-nucleating particles in northern Greenland: annual cycles, biological contribution and parameterizations, *Atmos. Chem. Phys., accepted.*

fraction of INP remaining active after heating

Fig. 2: Fraction of INPs as shown in Fig. 1 still ice active after heating for 1 hour to different temperatures.