

Chemical insights into the ice nucleating ability of macromolecules in immersion freezing



@nadineborduas



Dr. Nadine Borduas-Dedekind

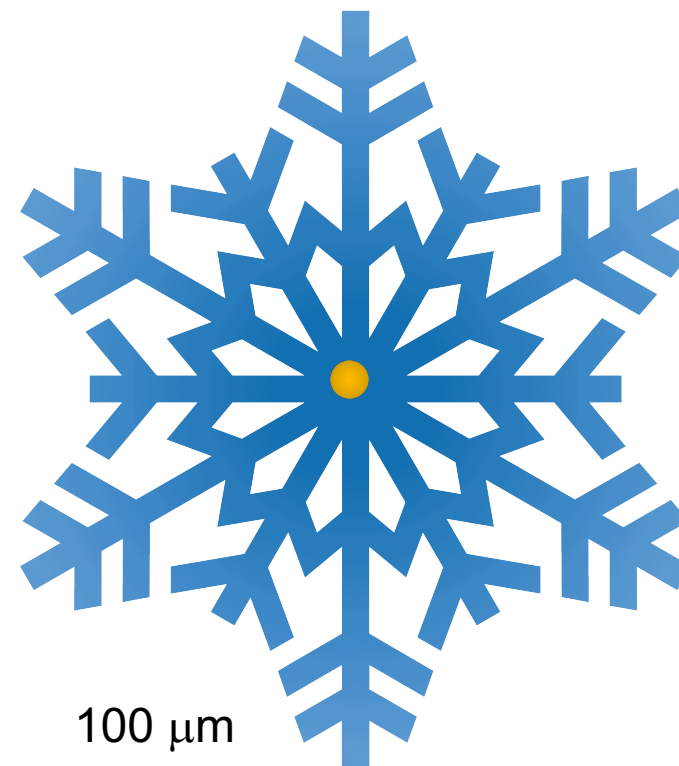
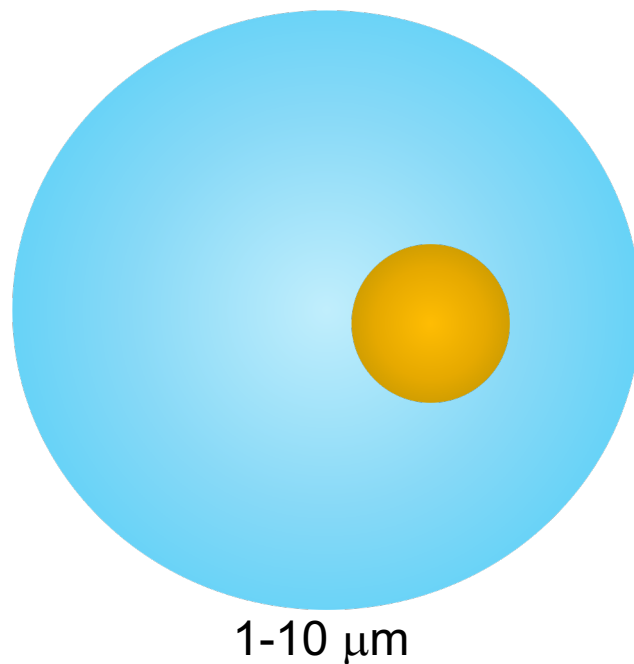
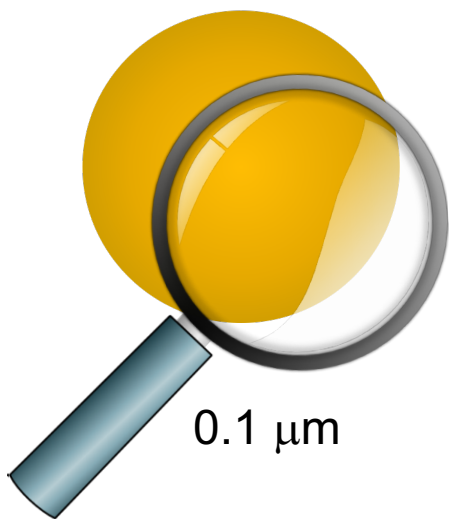
Swiss National Science Foundation Ambizione fellow

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Institute for Atmospheric and Climate Sciences, ETH Zurich



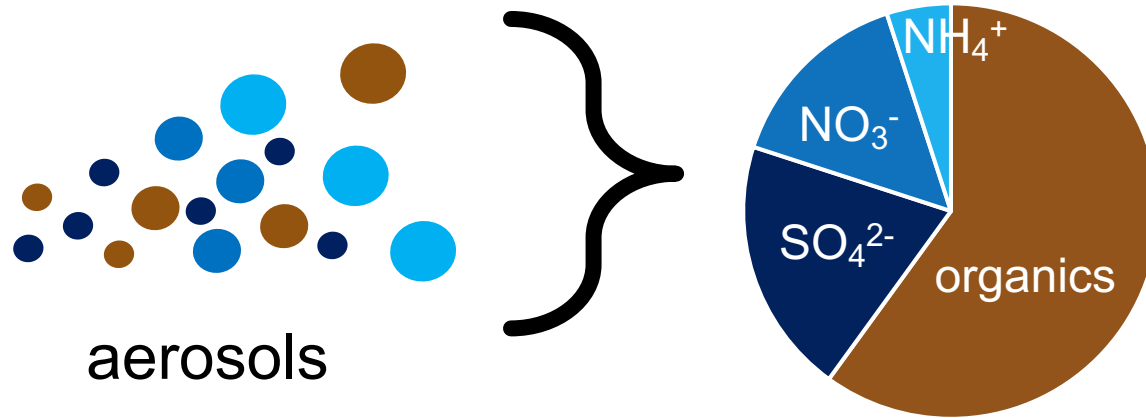
Can we identify molecular parameters of organic aerosols that will allow us to predict its cloud activation and ice nucleating ability for mixed-phase clouds?

[Aerosols] > [CCN] >> [INP]

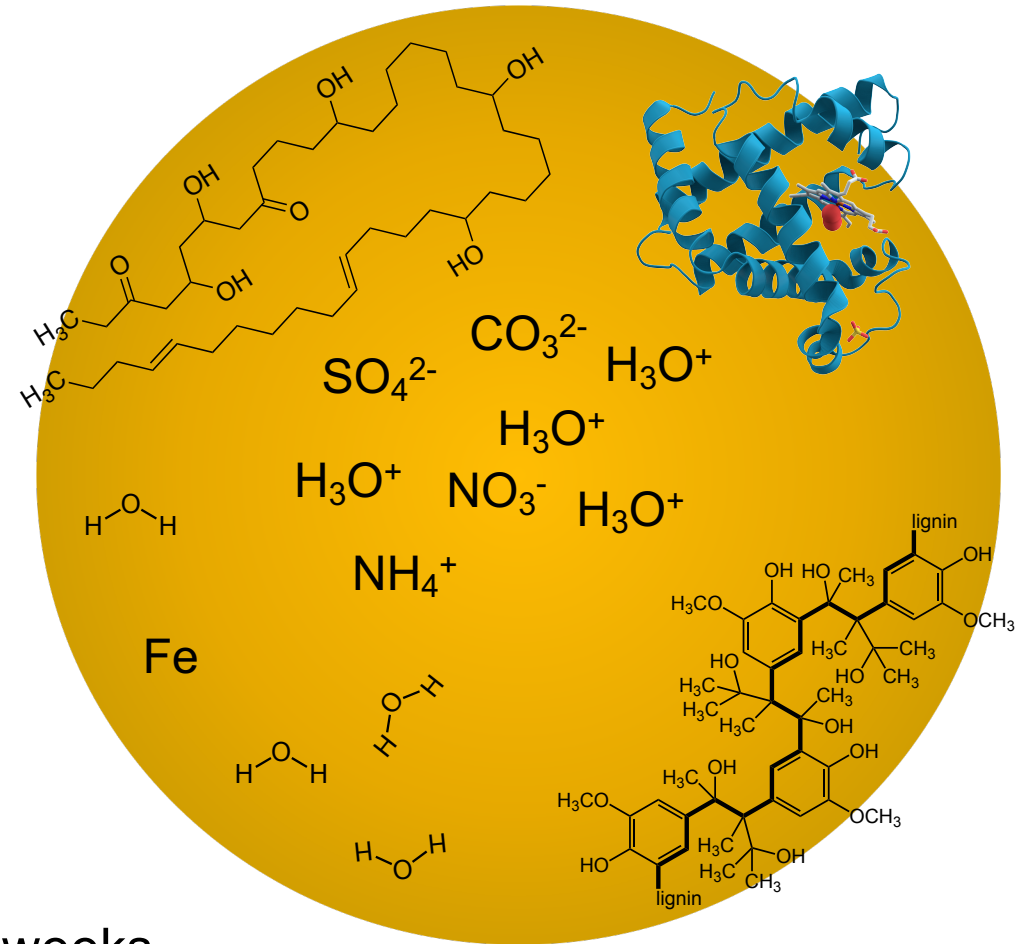


Chemical composition of an organic aerosol

3



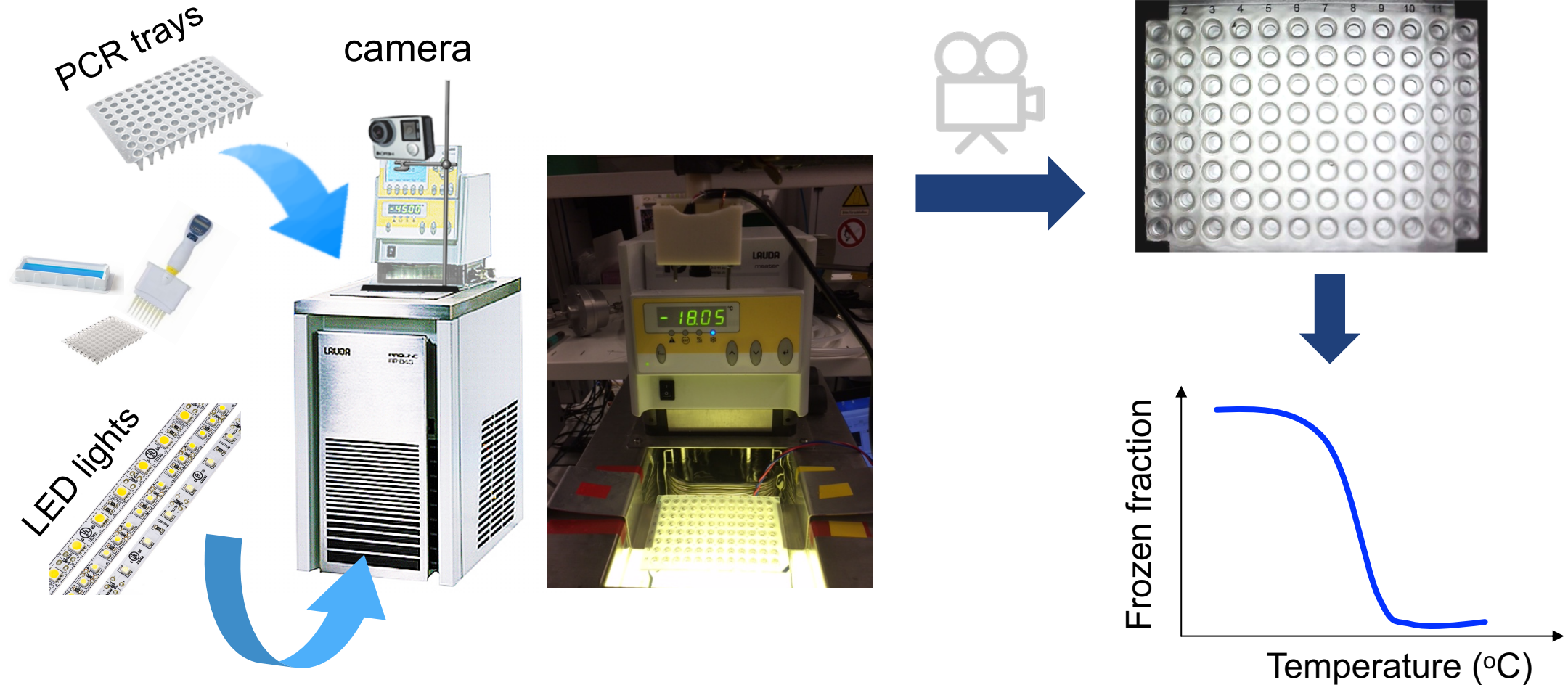
Jimenez et al.,
Science, **2009**, 326, 1525



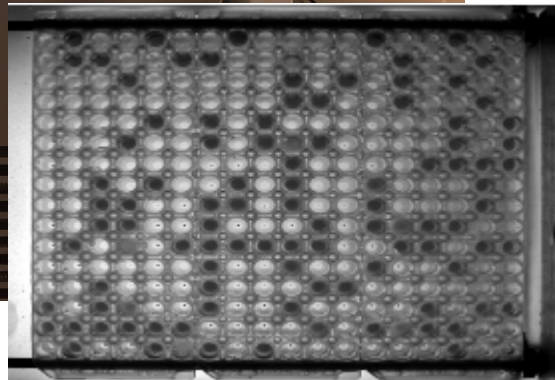
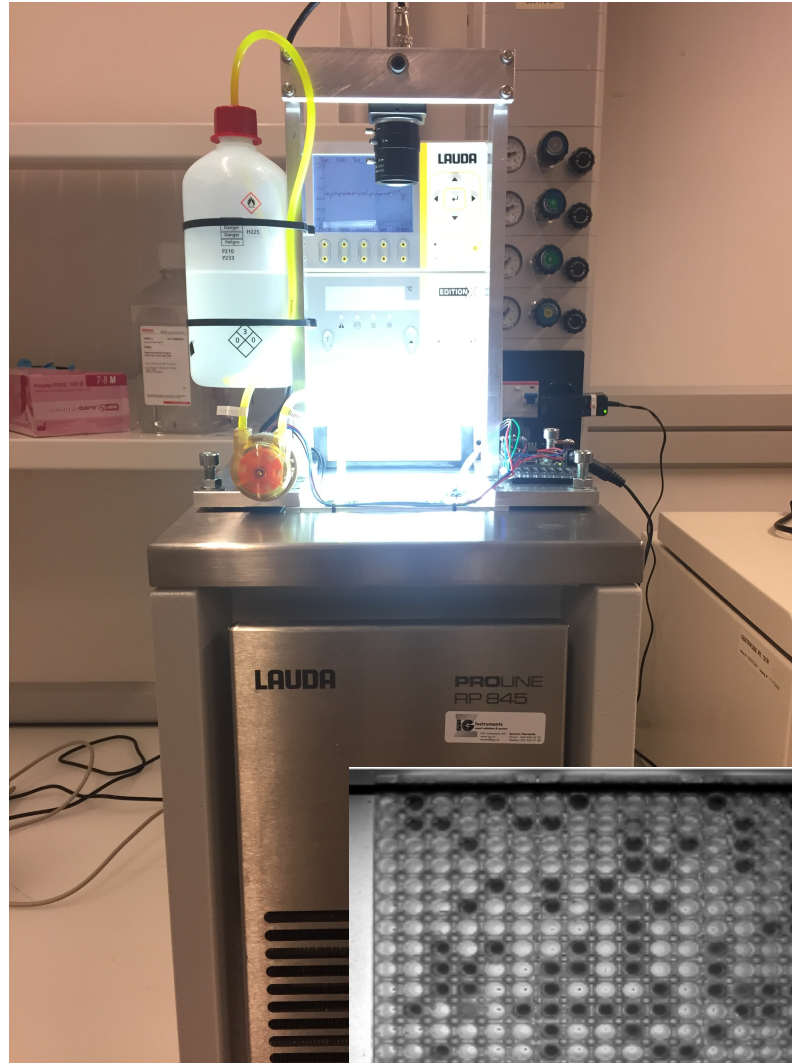
Lifetime ~ 1-2 weeks

Method: DRop Freezing Ice Nuclei Counter Zurich (DRINCZ)

†

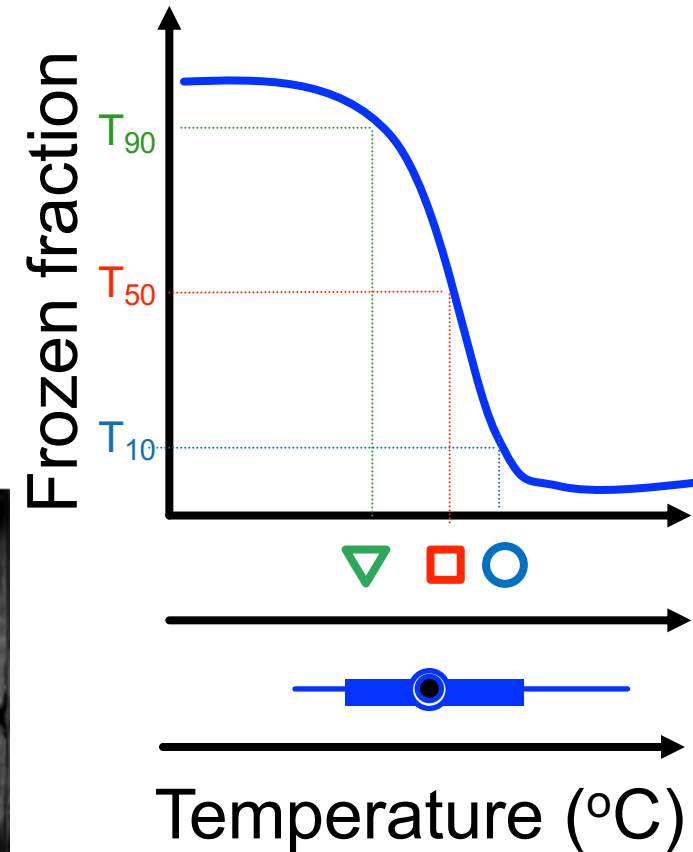


Introducing the new drop Freezing Ice Nuclei Counter (FINC)!



Upgrade:

- Lower temperatures ($-25\text{ }^{\circ}\text{C}$)
- More statistics



Killian Brennan



Anna Miller





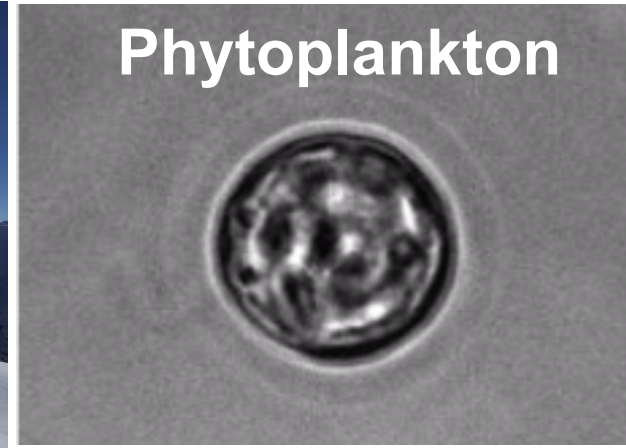
Dissolved organic
matter from rivers
& swamps



Alpine snowmelt
water



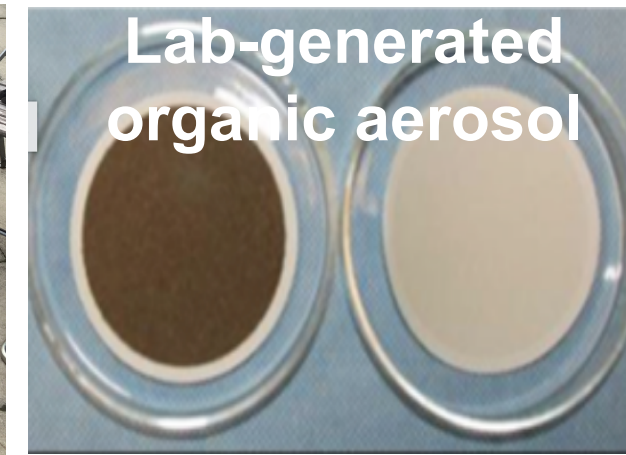
Phytoplankton



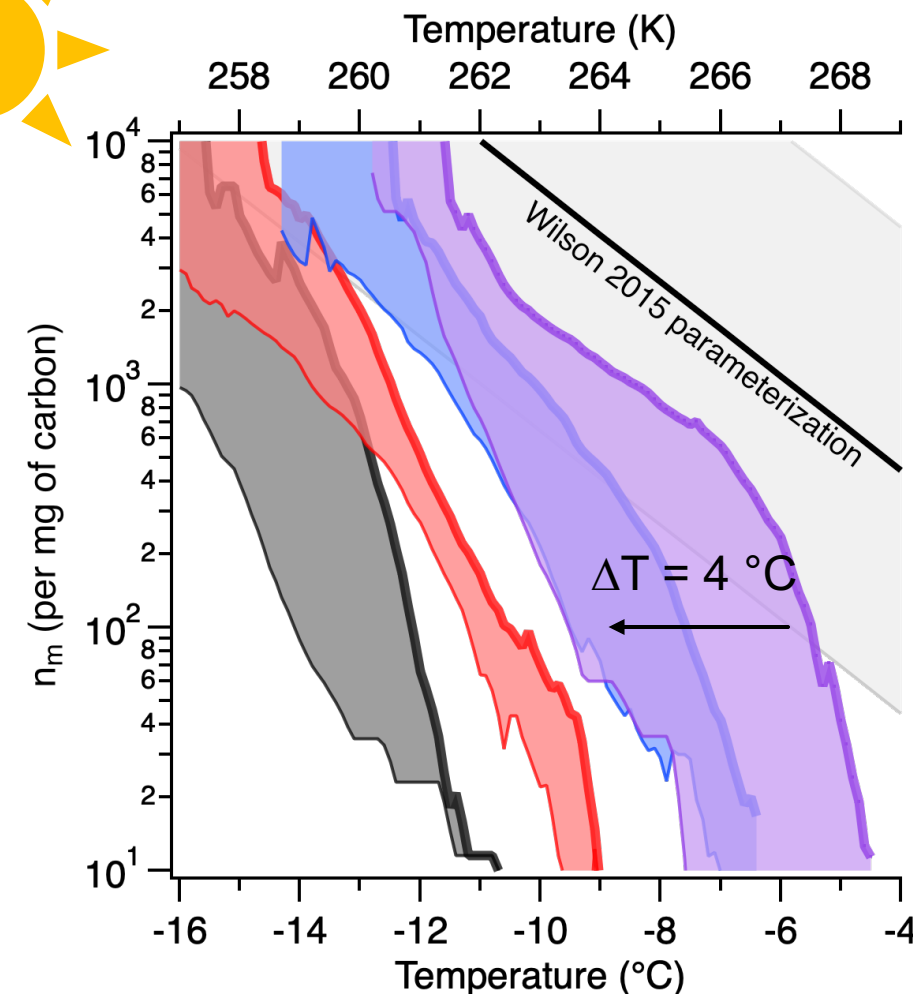
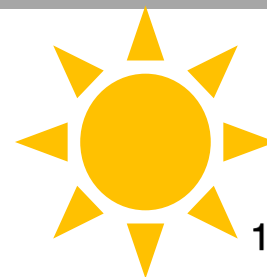
Firewood smoke



Lab-generated
organic aerosol



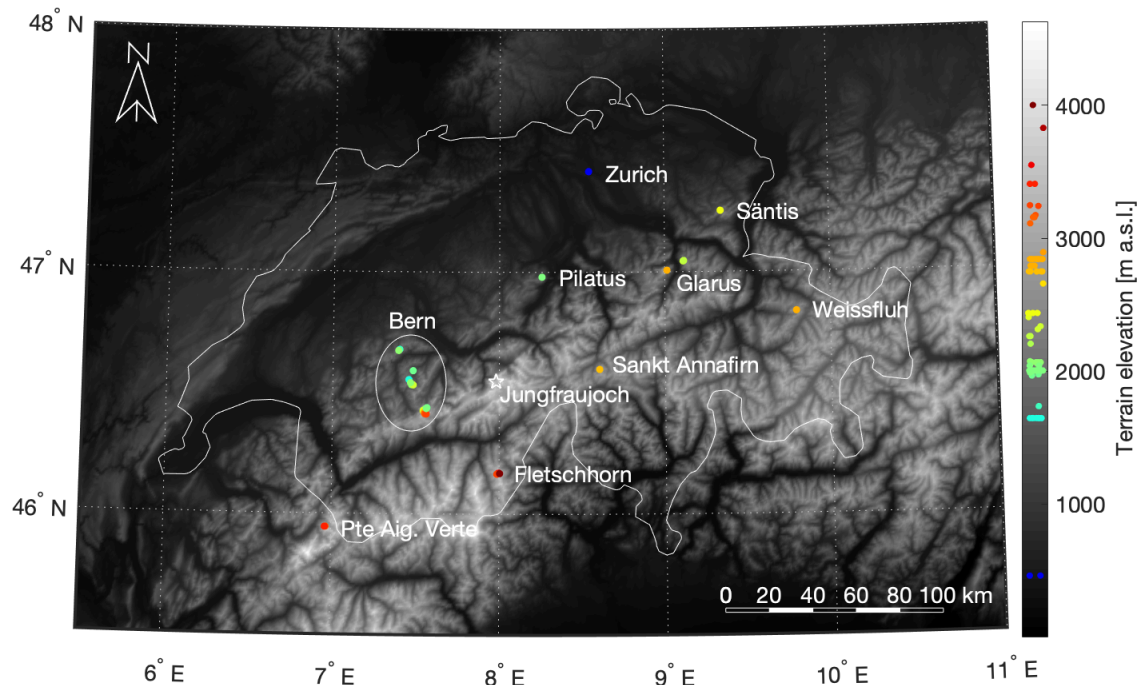
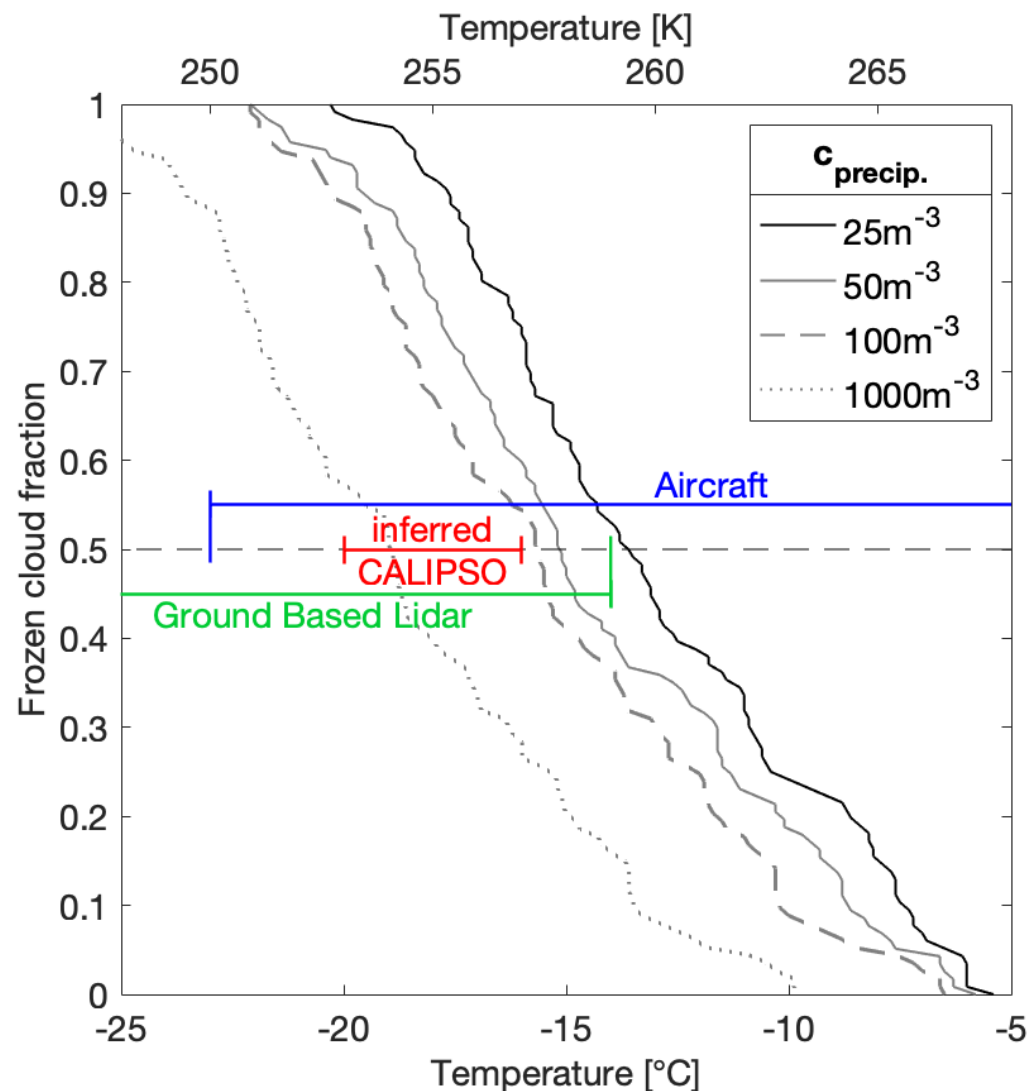
- The aerosol-cloud interactions of dissolved organic matter under UVB exposure equivalent to 4.5 days in the atmosphere:
 - Decrease IN ability
- Impacts for regional and global models?
 - Liquid water to ice fraction
- Caveat: use of aquatic DOM



Cloud frozen fraction estimated using snow meltwater



Killian Brennan



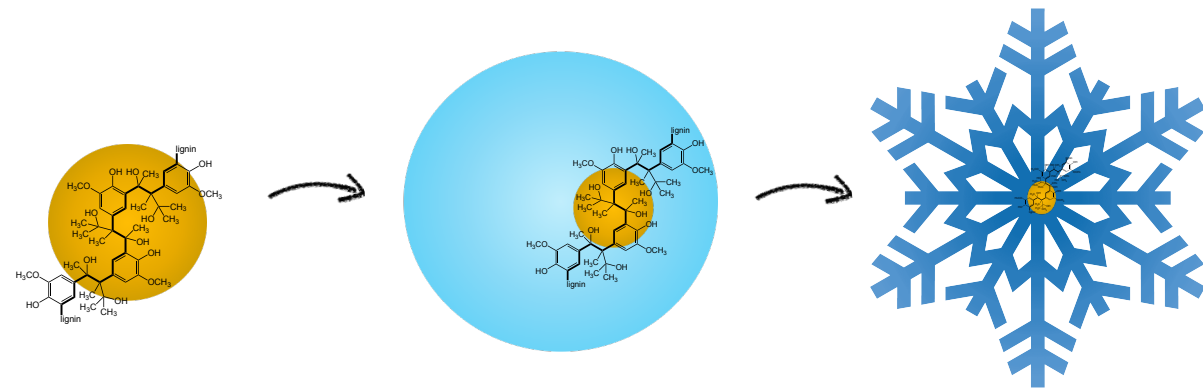
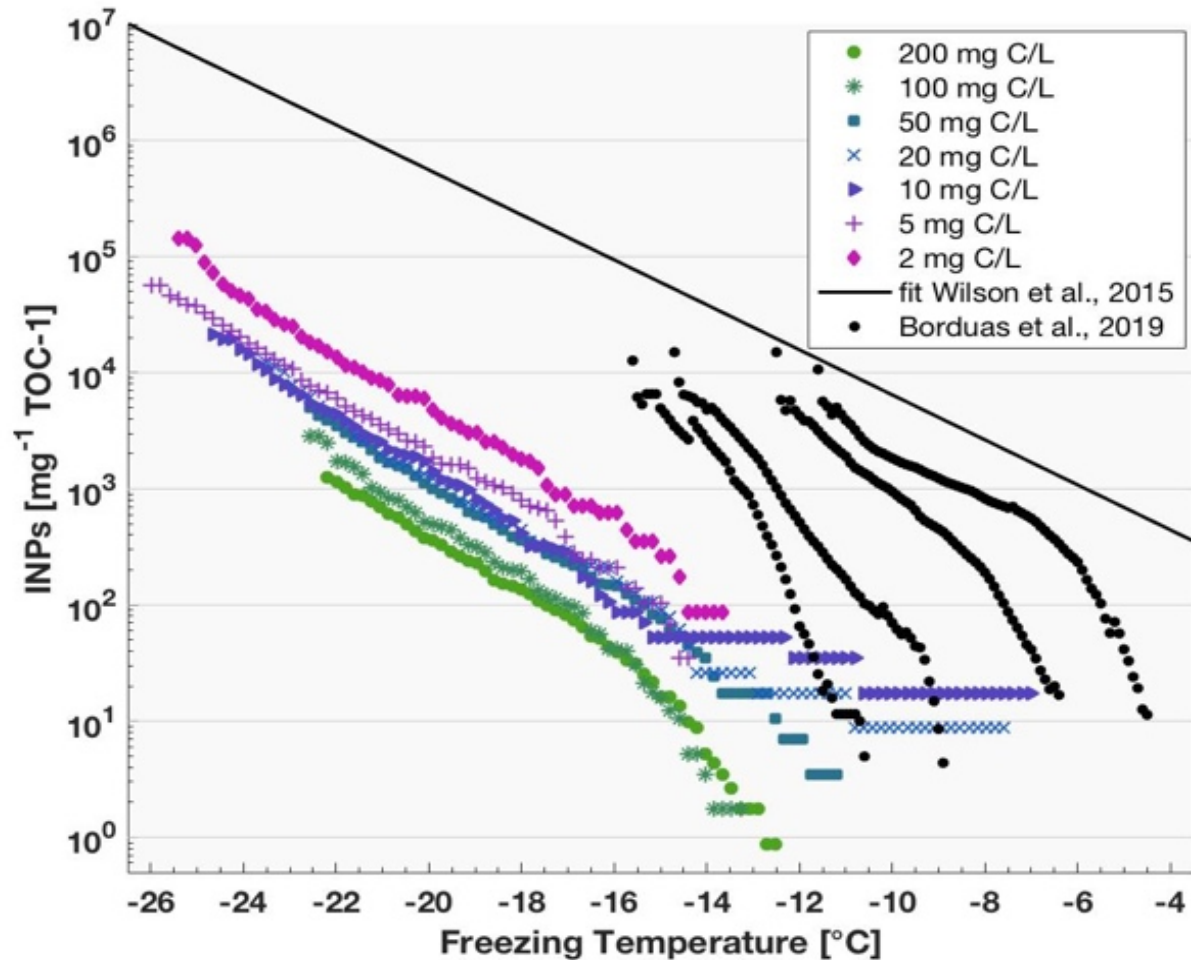
- Sampling took place across the Swiss Alps (88 samples over 17 different locations) over winter 2018.
- Immersion mode INP concentrations were measured.
- Snow meltwater samples are used to estimate frozen cloud fraction.



Lignin is recalcitrant in the atmosphere

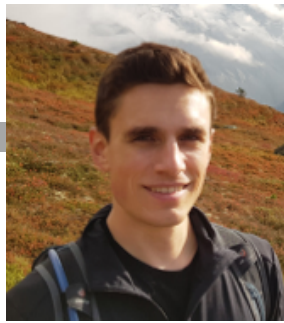
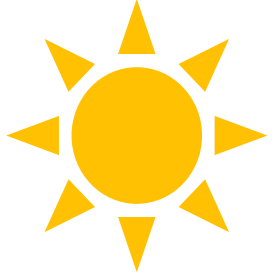


Sophie Bogler

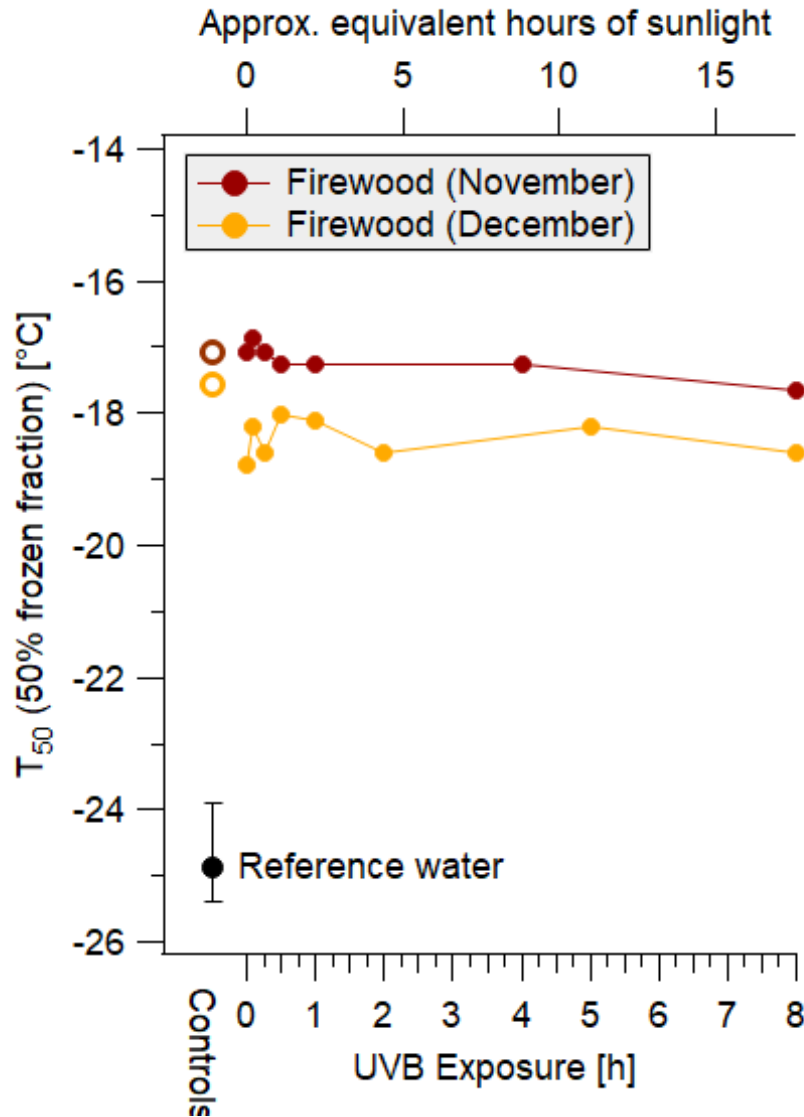


- Lignin can nucleate ice at atmospherically relevant ice and concentrations.
- Lignin is recalcitrant towards atmospheric processing.

Photomineralization is not clearly impacting IN abilities



Silvan Müller



Preliminary data

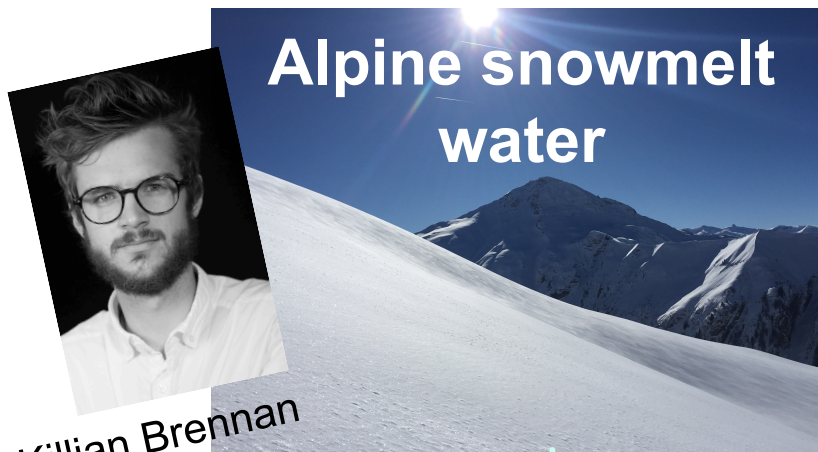
- Firewood smoke aerosols were collected by a Coriolis air sampler.
- IN abilities of the solutions did not change over photochemical exposure.
- We are revising our photomineralization hypothesis:
Photomineralization is clear in all samples, but the impact on aerosol-cloud interactions is more difficult to predict than we originally thought.

Dissolved organic matter from rivers & swamps



Borduas-Dedekind et al, *Atmos. Chem. Phys.* **2019**, 19, 12397

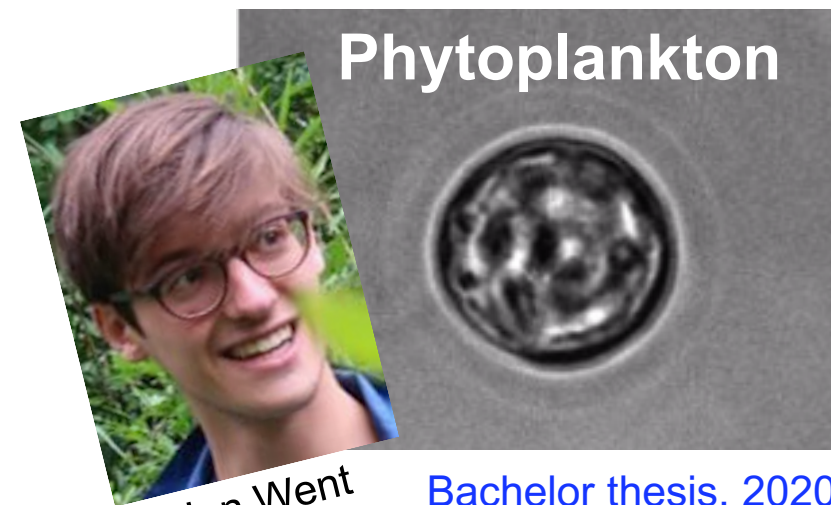
Alpine snowmelt water



Killian Brennan

Brennan et al., *Atmos. Chem. Phys.*, **2020**, 20, 163

Phytoplankton



Jon Went

Bachelor thesis, 2020

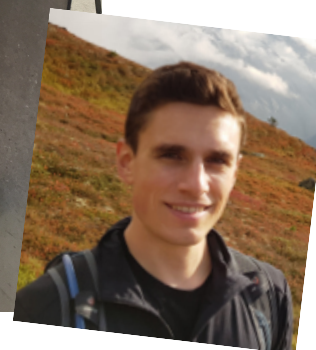
Lignin



Sophie Bogler

Bogler & Borduas-Dedekind, **2020**, to be submitted

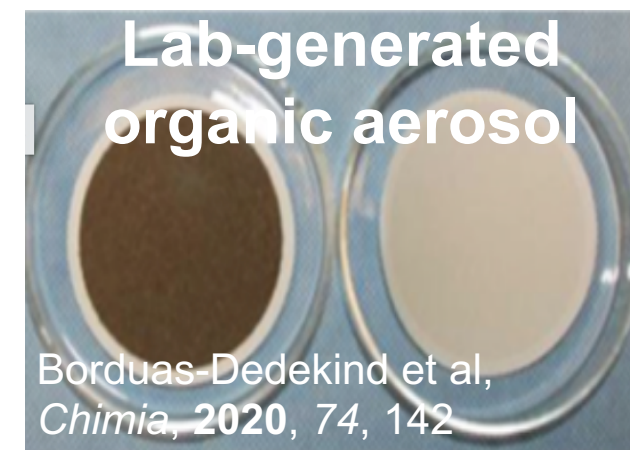
Firewood smoke



Silvan Müller

Müller & Borduas-Dedekind, **2020**, in preparation

Lab-generated organic aerosol



Borduas-Dedekind et al, *Chimia*, **2020**, 74, 142