

Dynamique microbienne dans les manteaux neigeux saisonniers

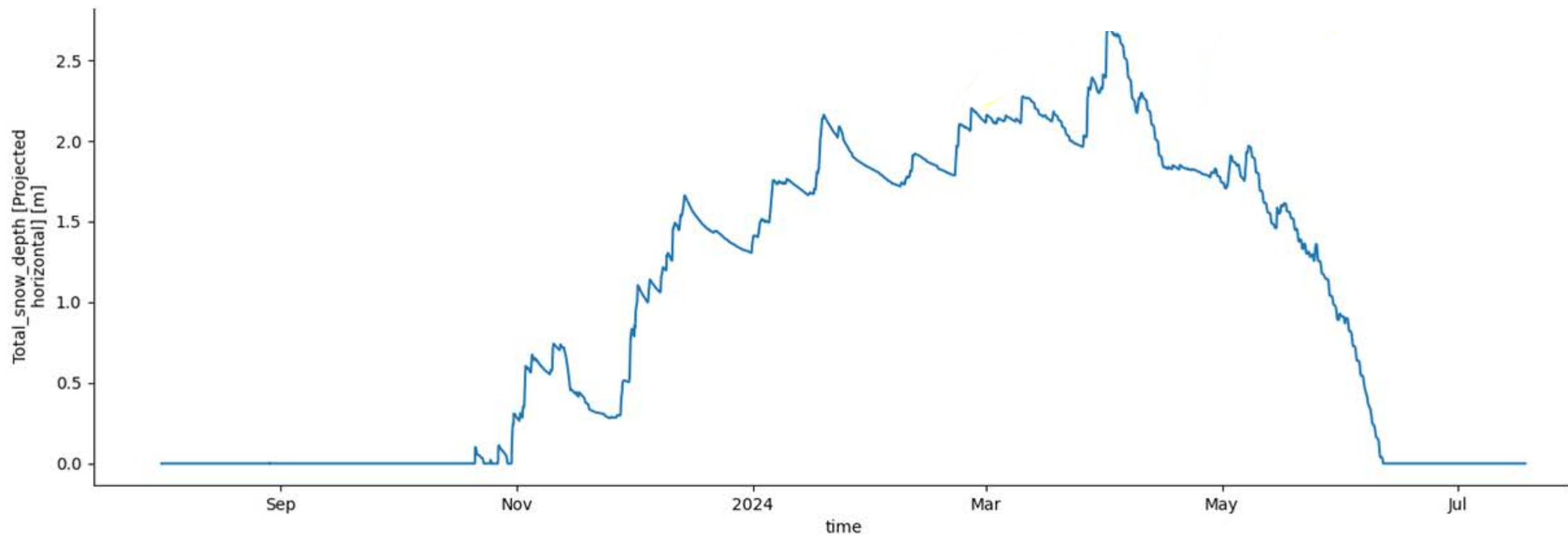


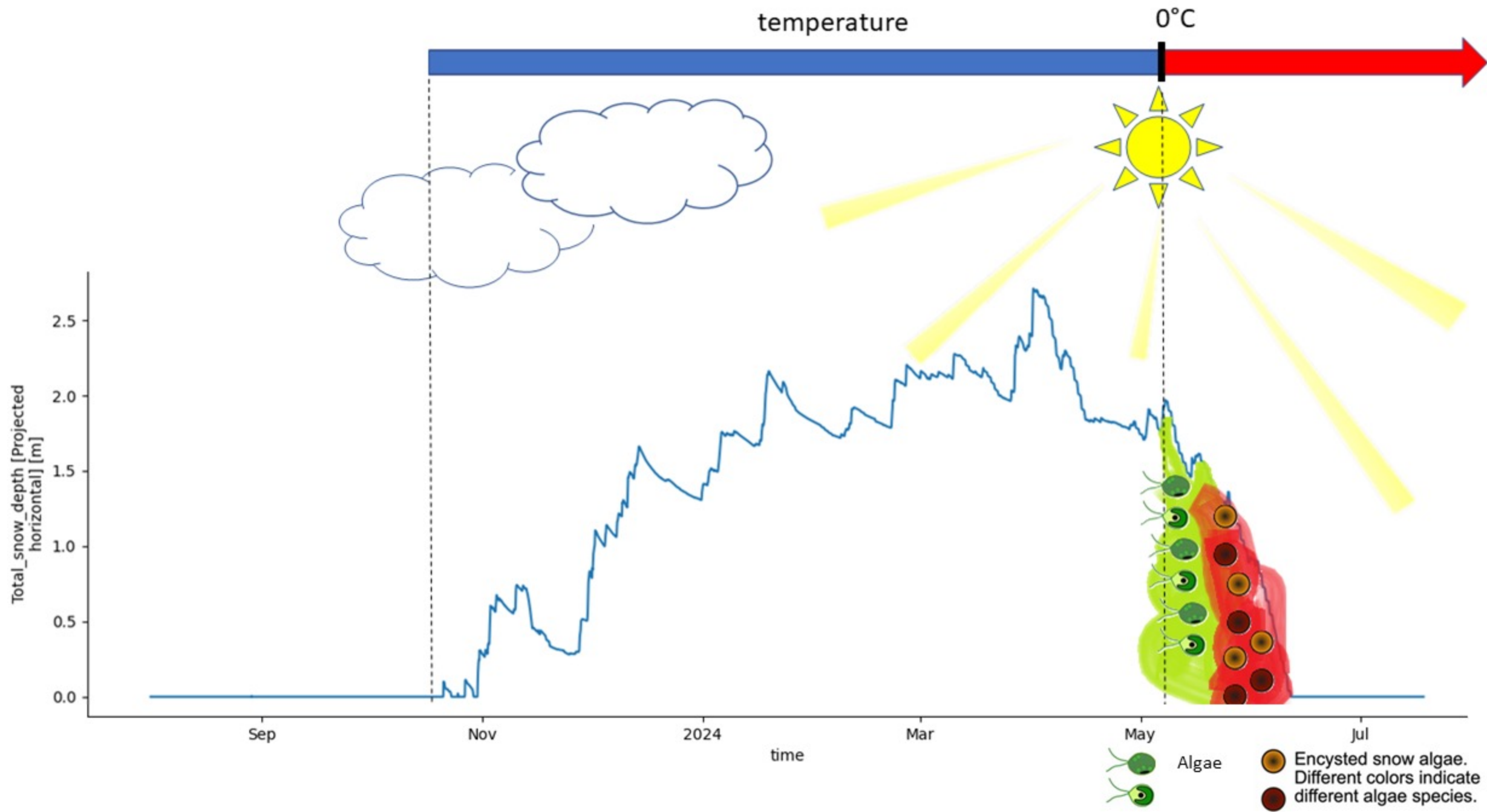
Catherine Larose

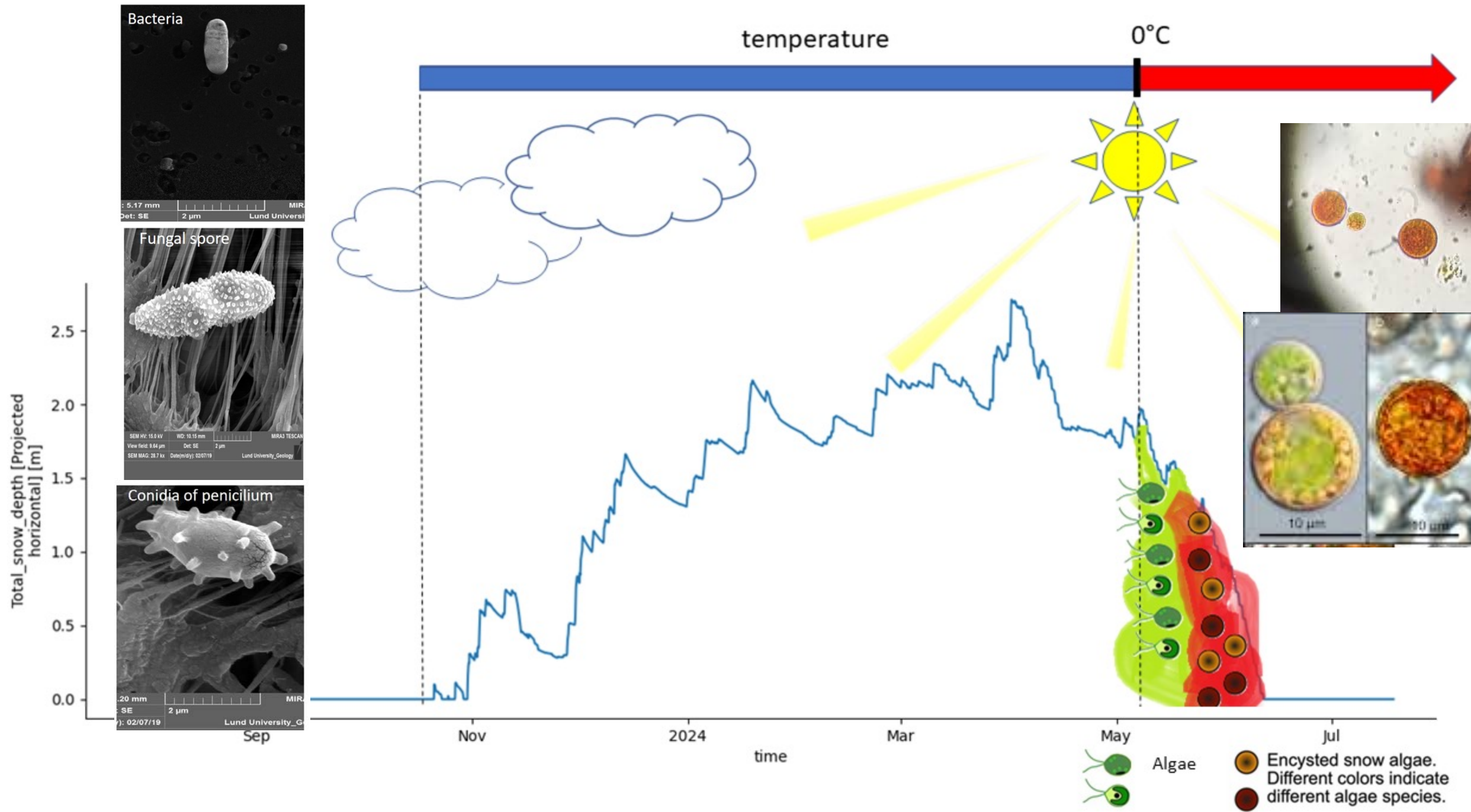


Institut des Géosciences de
l'Environnement

Atelier Neige, 30 septembre







Ecosystem :

Community of living organisms (plants, animals and microbes) in conjunction with the non-living components of their environment interacting as a system.
(Tansley 1934)



Microorganisms adapted to environmental conditions



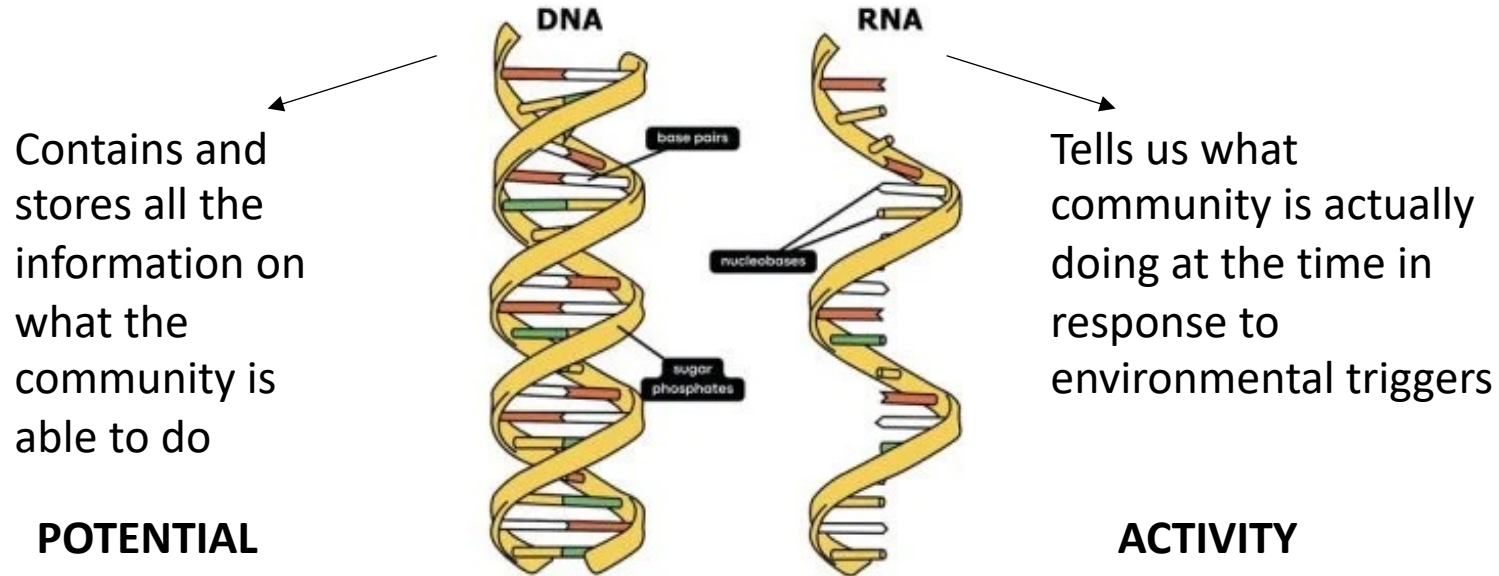
In interaction



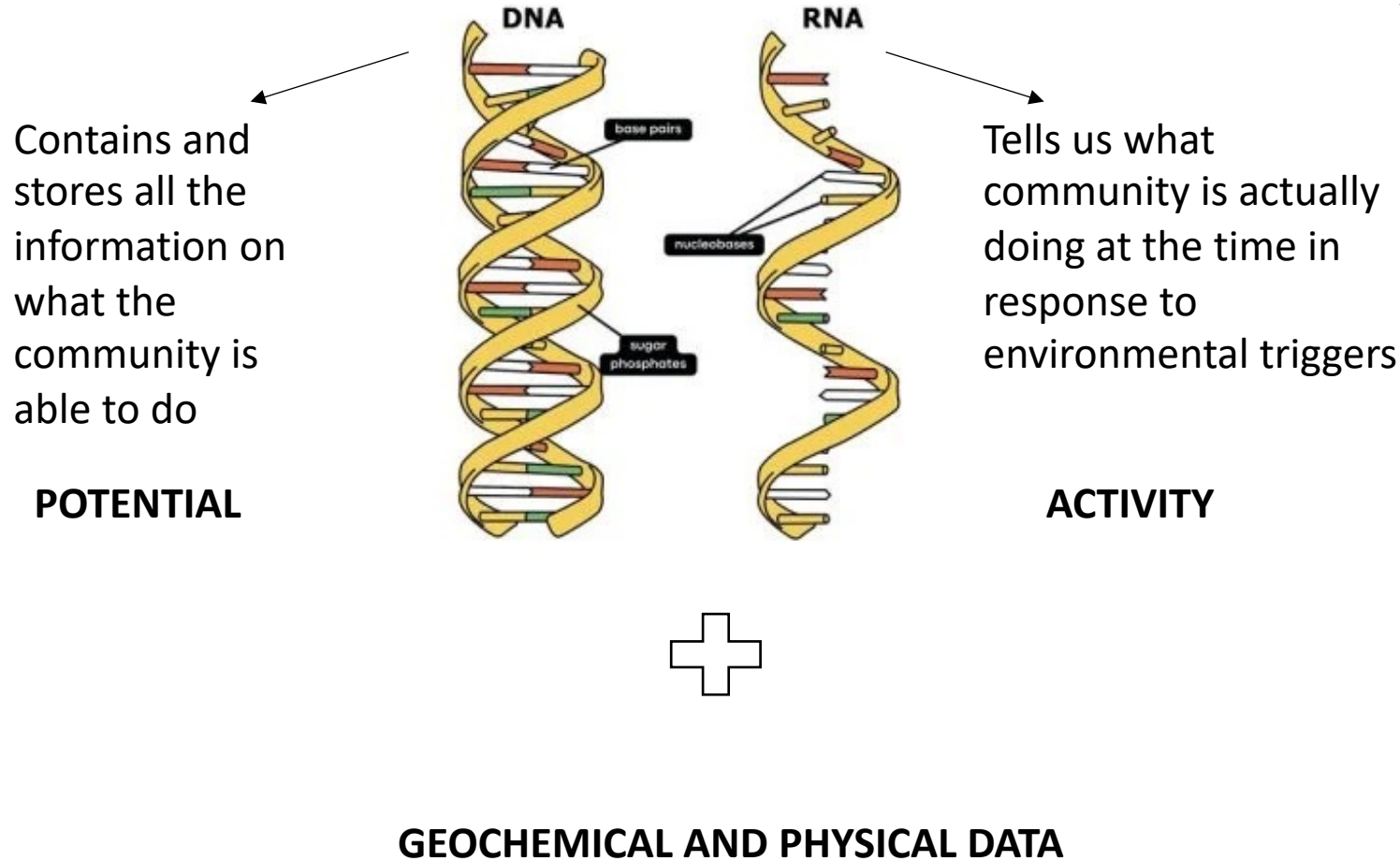
Active microbial community

Dynamic in response to fluctuations of environmental conditions

How do we study microbial communities in the snow?



How do we study microbial communities in the snow?



Applied to time-series sampling in the Alps and Arctic

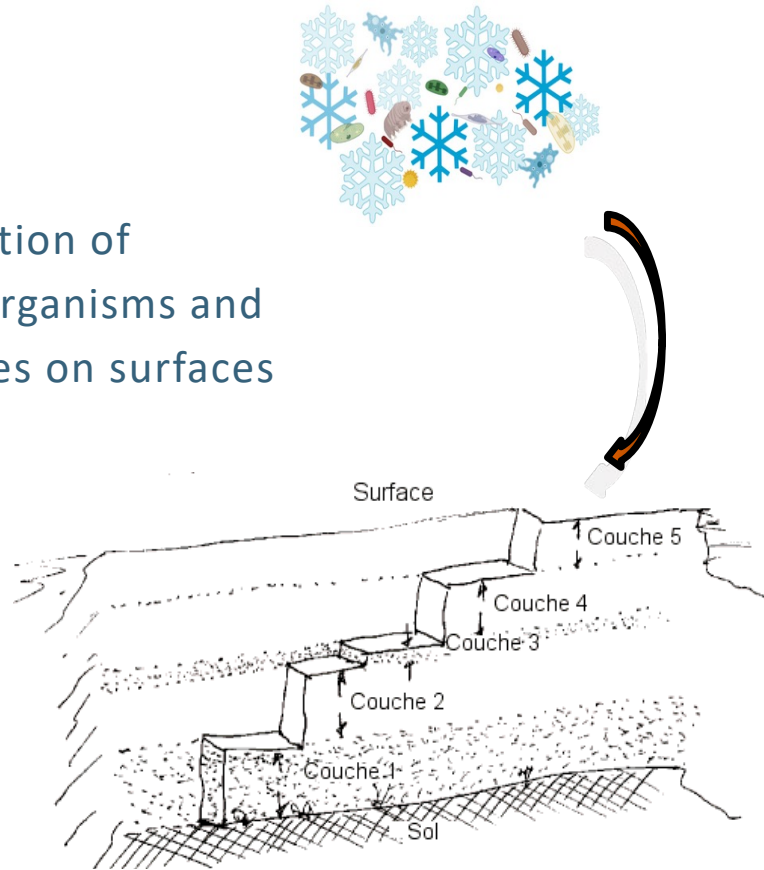


Experimental validation in the lab



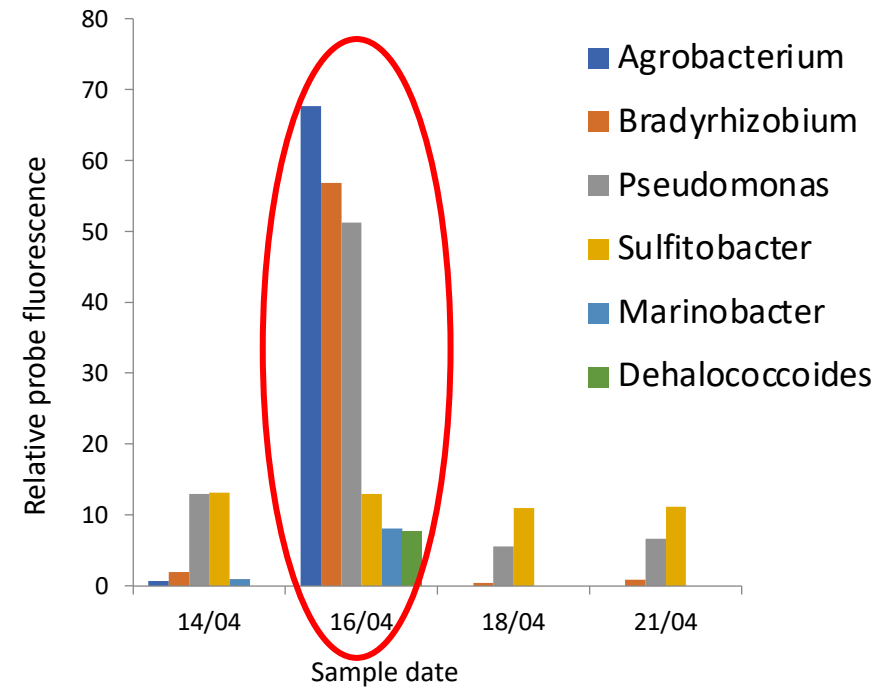
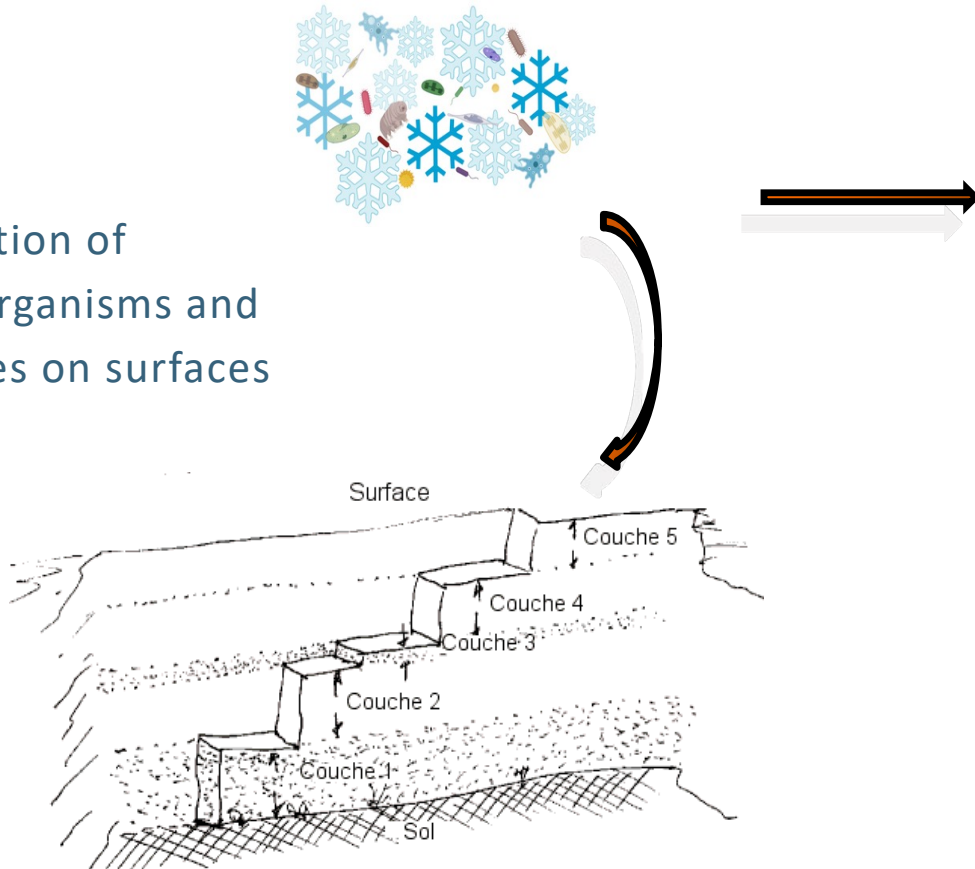
Microbial communities in snowpacks: initial colonization

Deposition of
microorganisms and
particles on surfaces

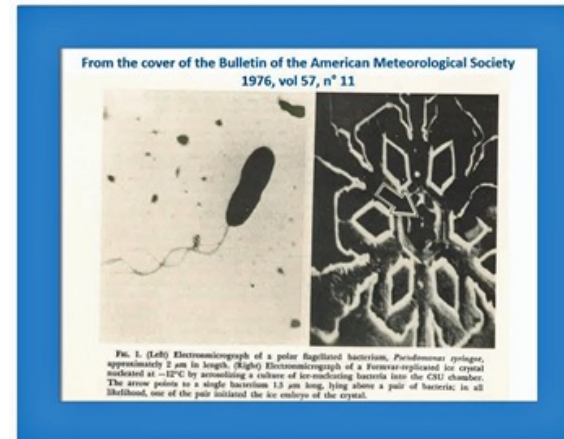
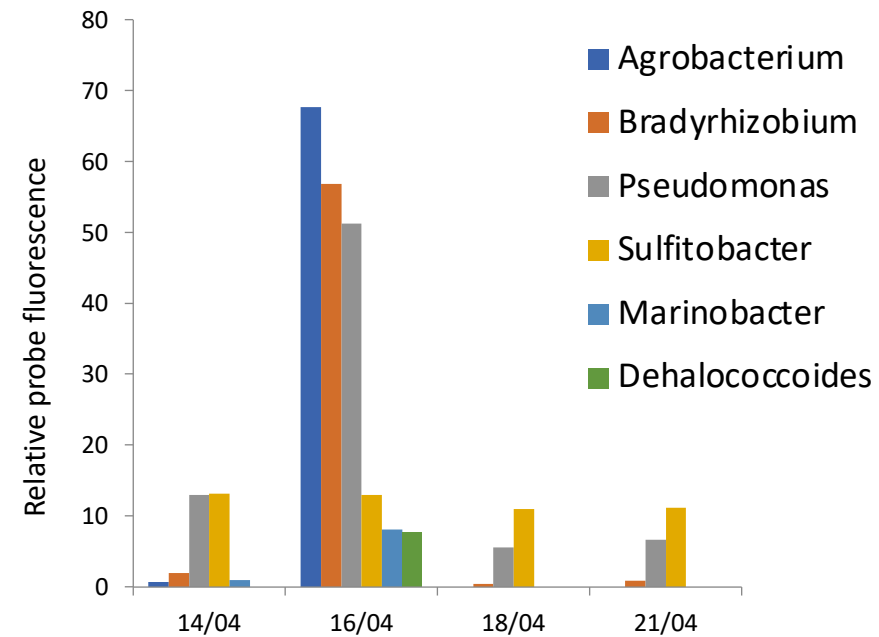
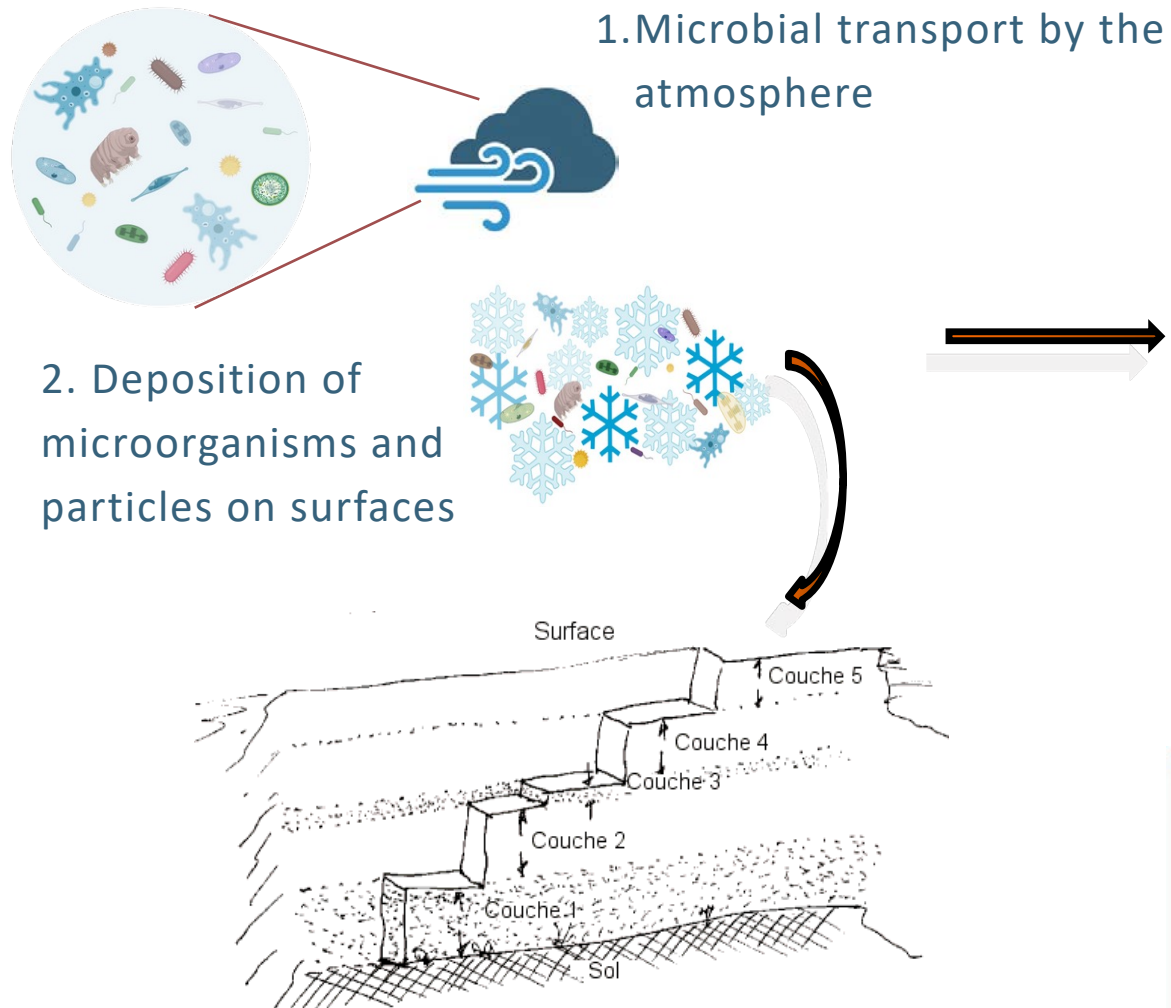


Microbial communities in snowpacks: initial colonization

Deposition of
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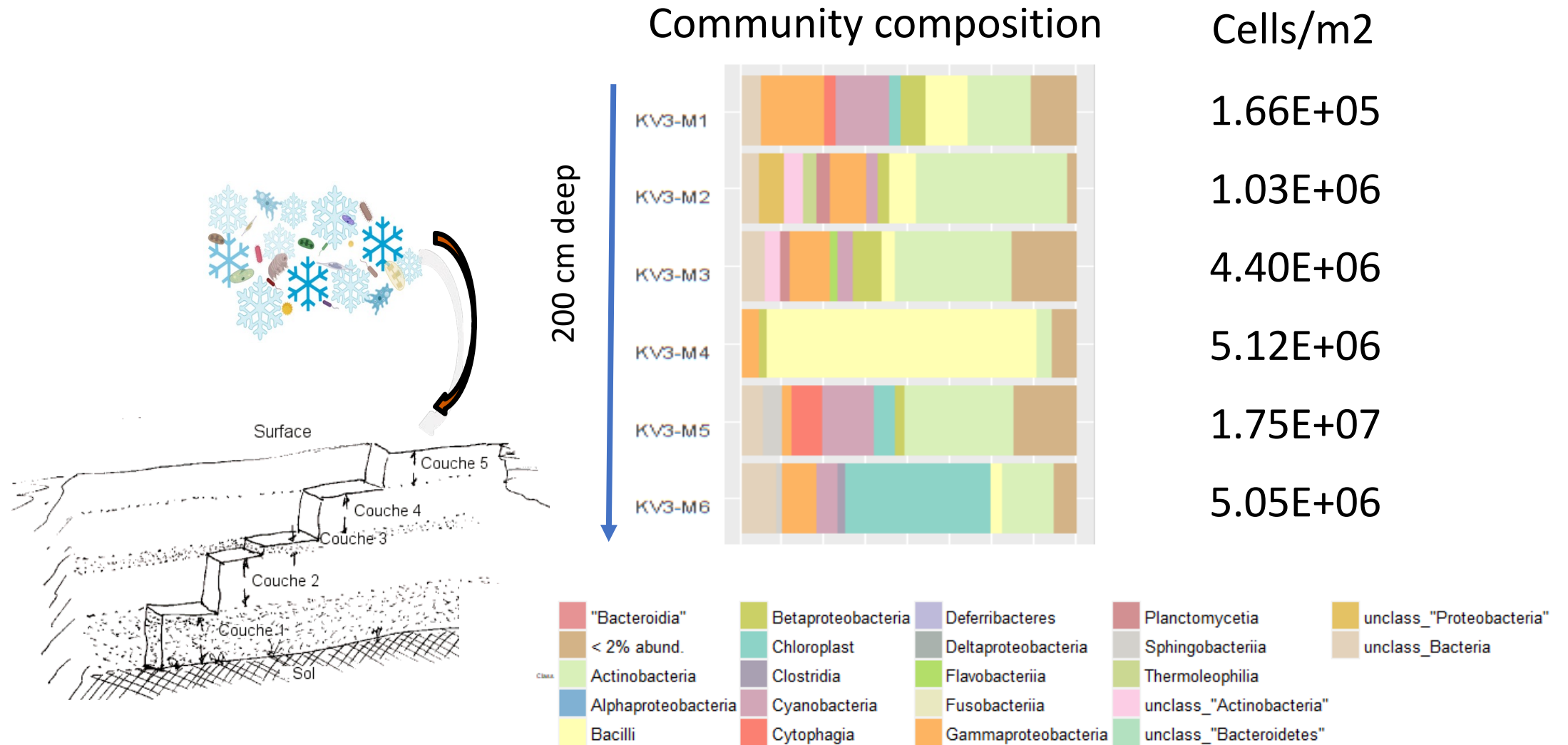


Microbial communities in snowpacks: initial colonization



Not everything survives in the snow

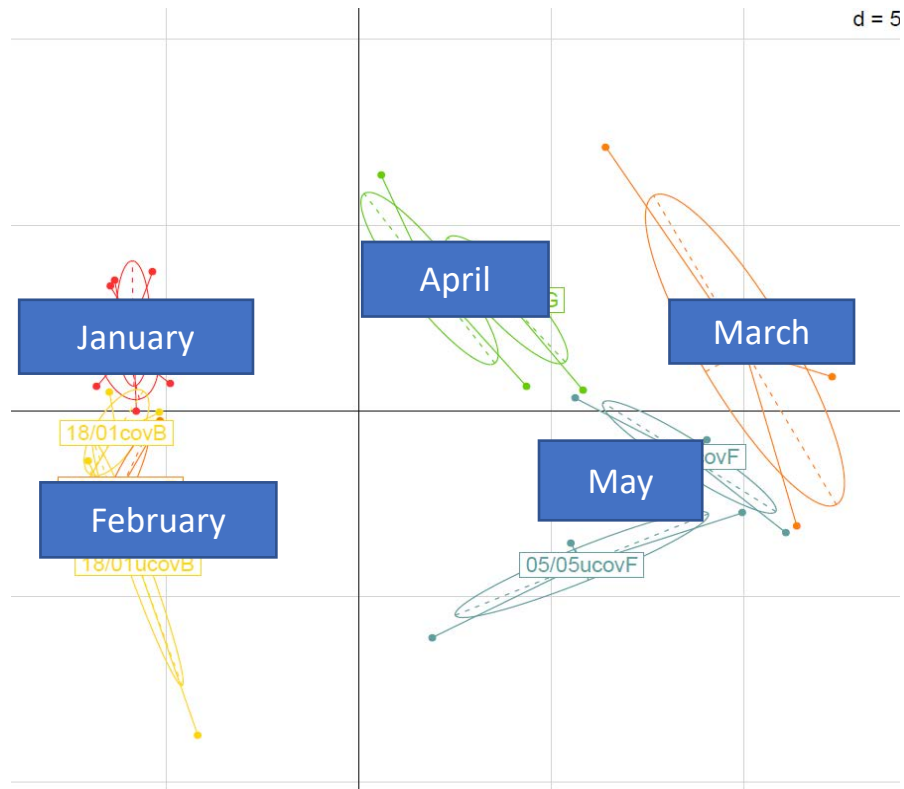
Microbial communities in snowpacks: vertical stratification



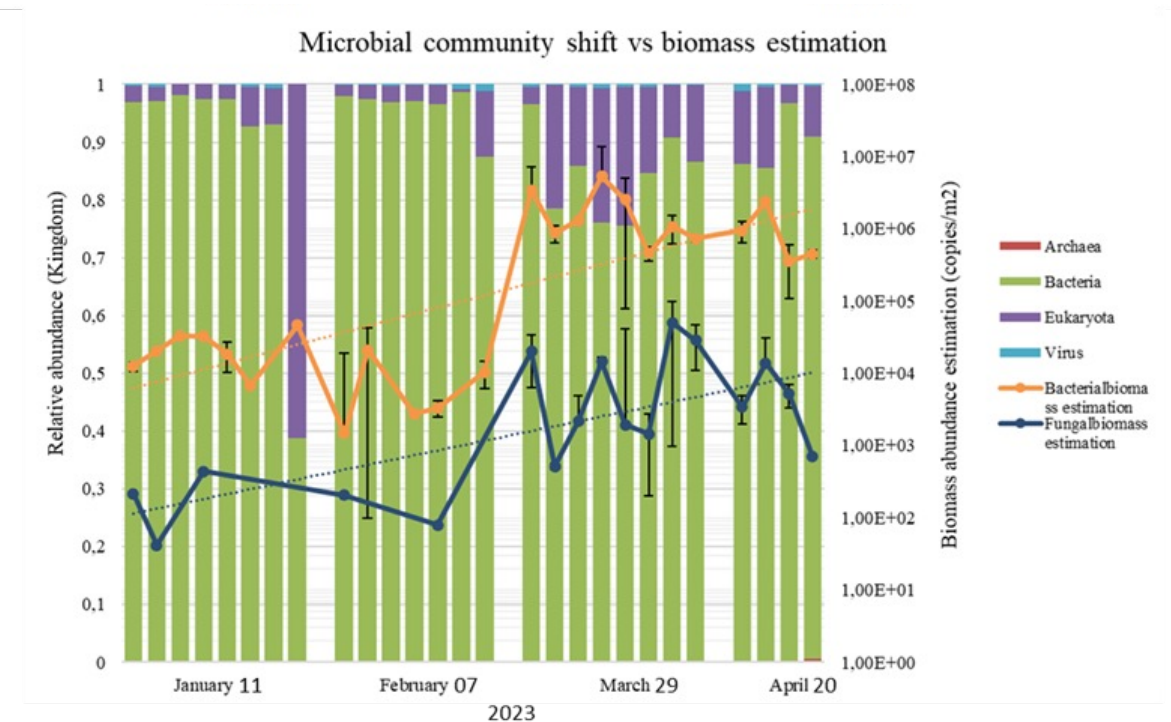
Snow layers characterized by different communities: correlated to chemical composition

Selection/adaptation?

Microbial communities in snowpacks: seasonal variability in community composition



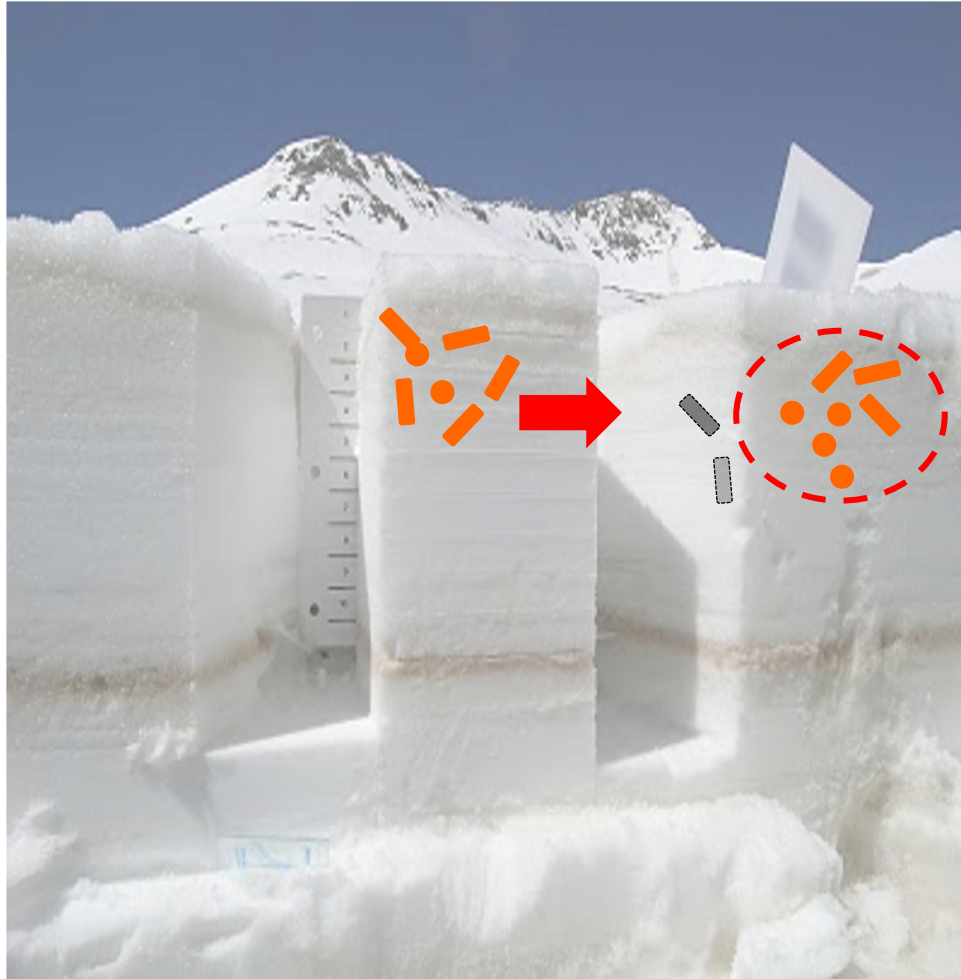
Arctic seasonal snowpack community shifts



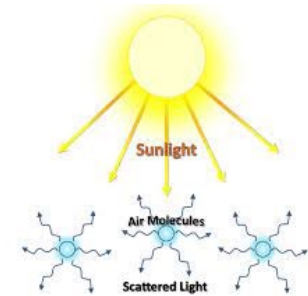
Alpine seasonal snowpack community shifts

What are the selection factors?

Microbial communities in snowpacks: post-depositional selection



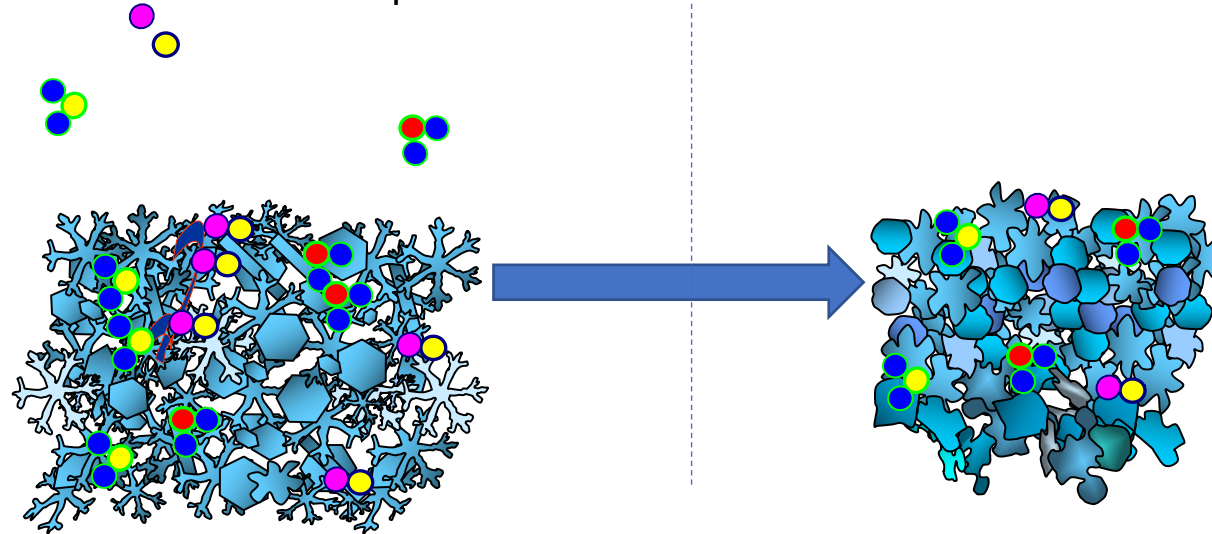
Physical-chemical constraints:



Shifts in activity: RNA can tell us what the communities are doing

What are they doing?

- ↑ Water acquisition
- ↑ Carbon starvation
- ↑ Nitrogen starvation
- ↑ Phosphorus starvation
- ↑ Genomic rearrangement/
Gene transfer/plasmids



Deep winter -15°C

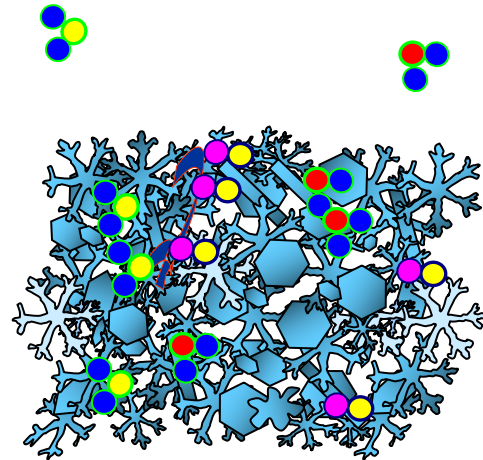
Spring -5°C < 0 °C

Shifts in activity: RNA can tell us what the communities are doing

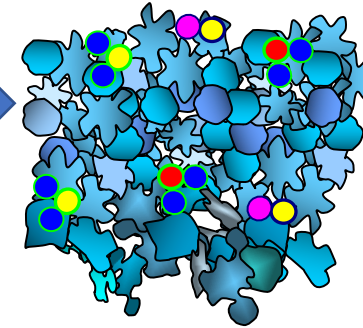
What are they doing?

- ↑ Water acquisition
- ↑ Carbon starvation
- ↑ Nitrogen starvation
- ↑ Phosphorus starvation
- ↑ Genomic rearrangement/
Gene transfer/plasmids

- ↑ Antibiotic production
- ↑ Photosynthesis
- ↑ Phage and Virus
- ↑ Symbiosis
- ↑ EPS/Biofilm production
- ↑ Degradation of complex
organic compounds



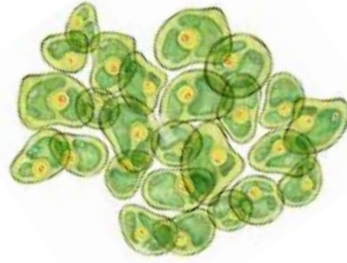
**Deep winter -15°C:
20% community activity**



**Spring -5°C < 0 °C:
50-75% activity**

Shifts in activity

Environmental and geochemical data

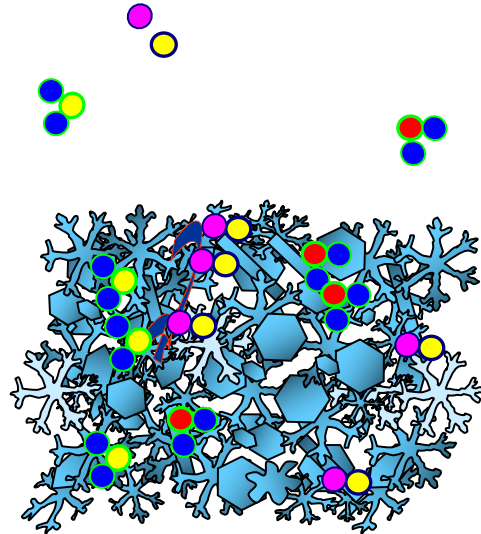


4-fold increase in organic carbon from 10 ppb to 40 ppb: algal exudates?

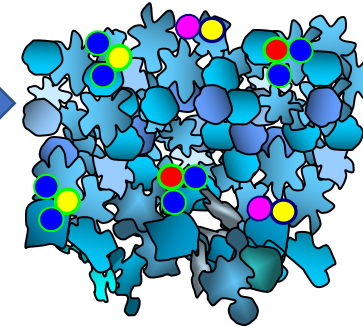
10°C average temperature increase from -15°C to -5°C



Significant increase in density and liquid water: increased contact rates and metabolic exchanges?



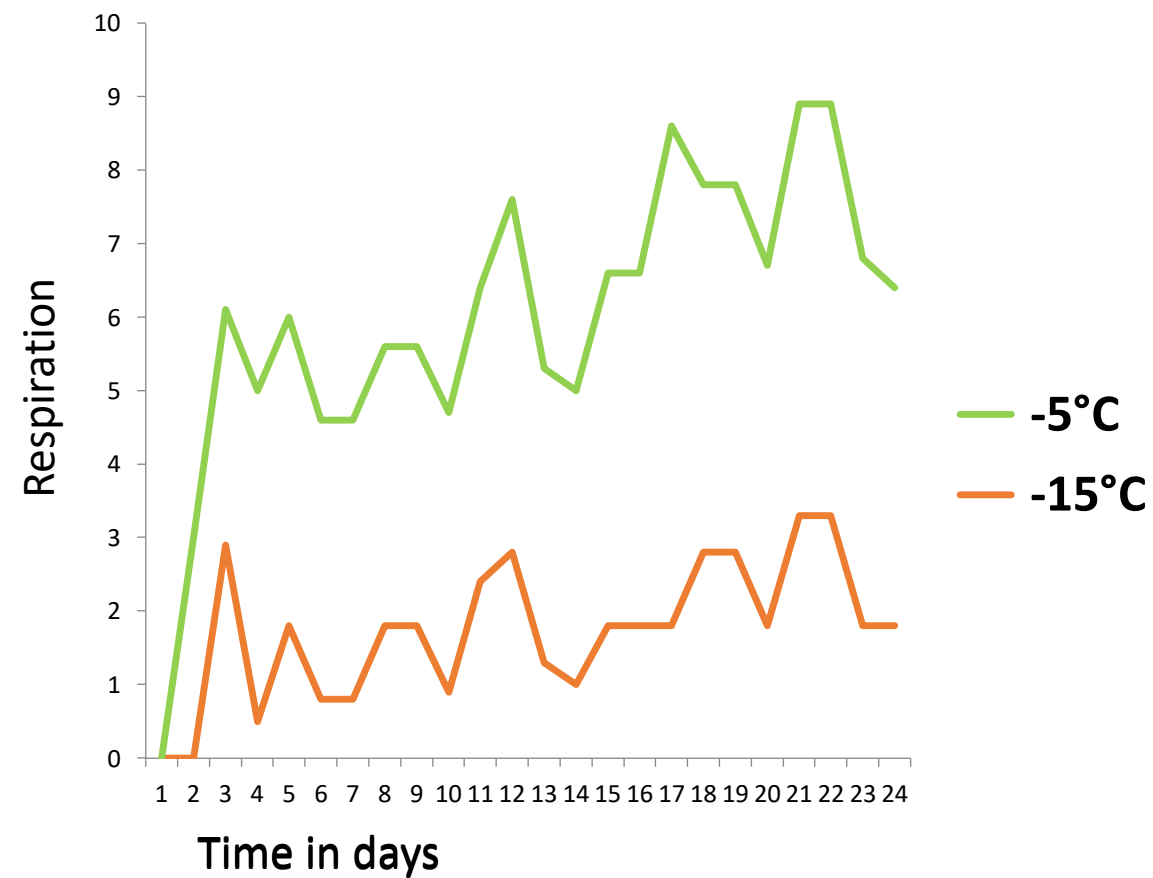
Deep winter -15°C



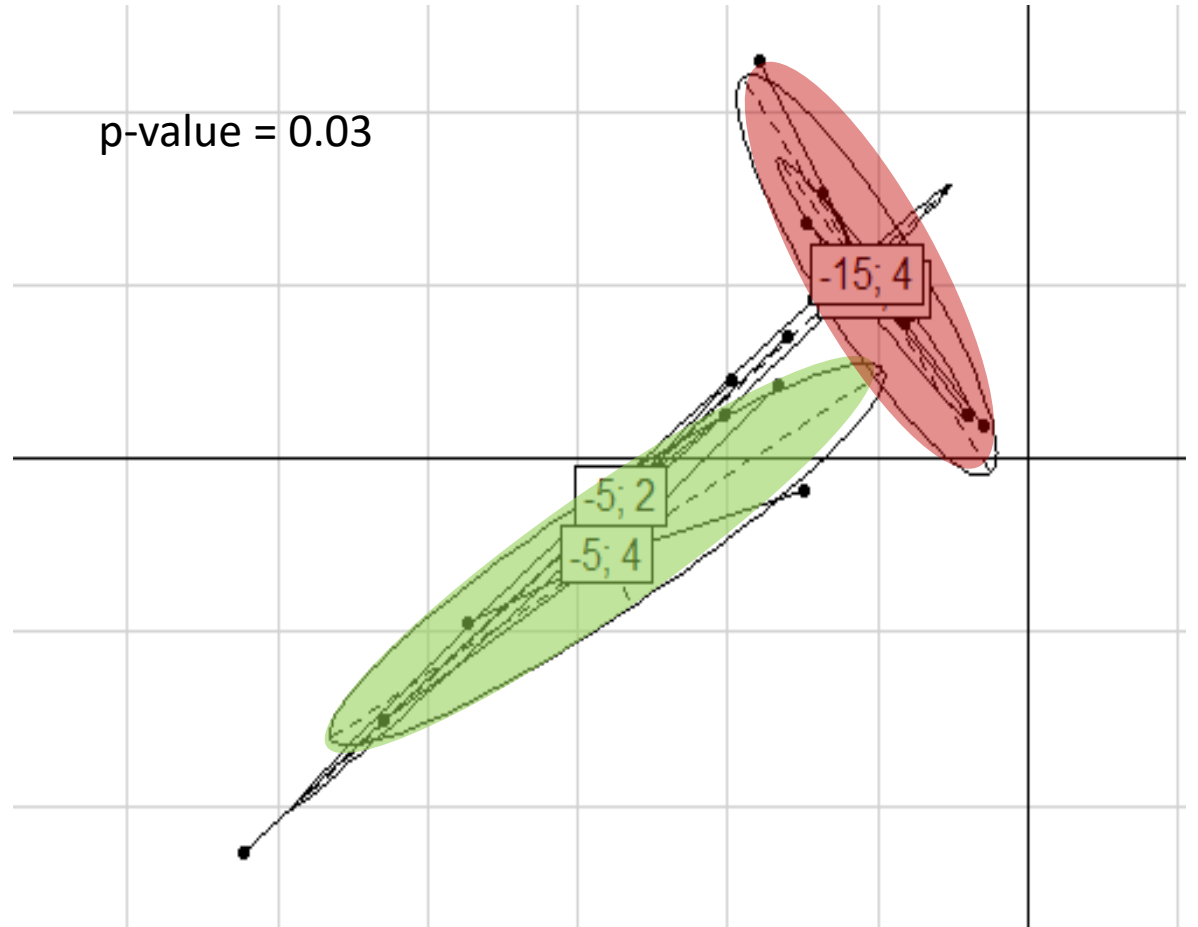
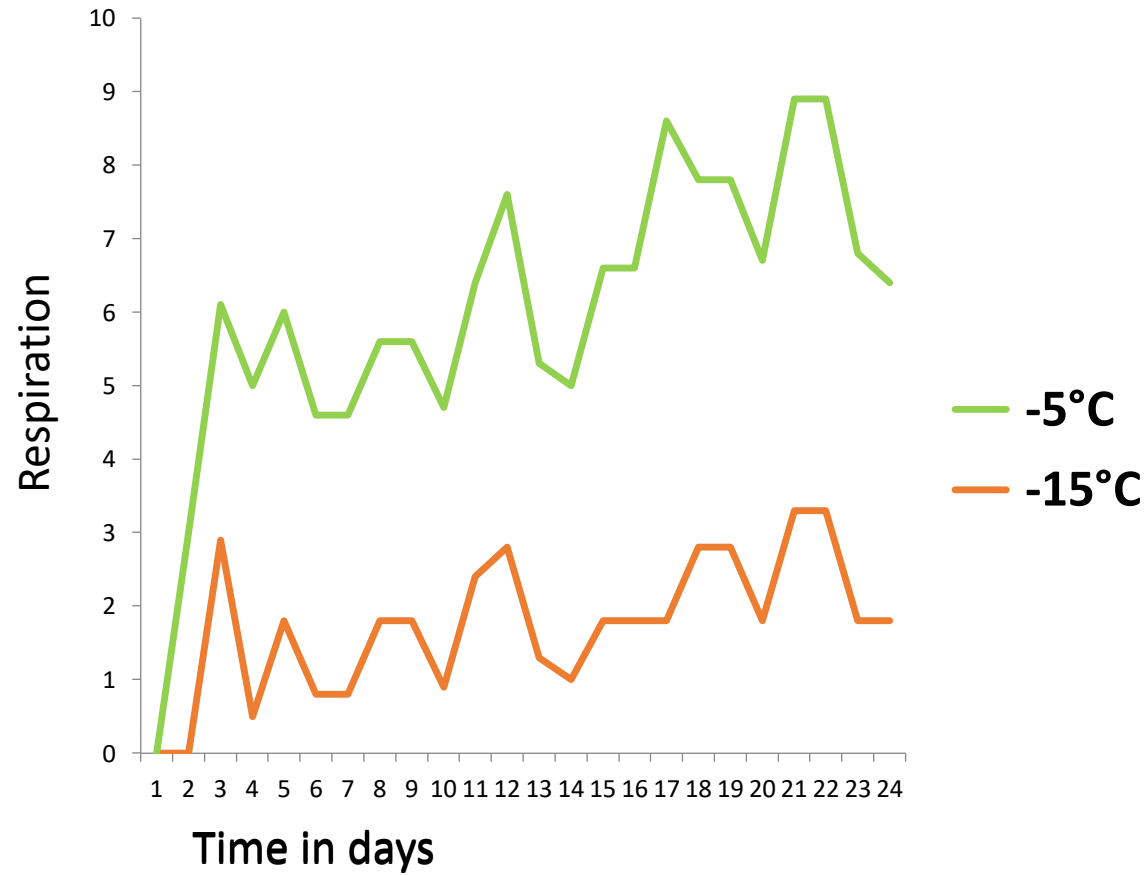
Spring -5°C < 0 °C

Potential drivers: liquid water, temperature and nutrients

Effect of winter warming on microbial communities



Effect of winter warming on microbial communities



Sub-zero temperature warming increases activity and changes microbial communities, similar response with organic carbon additions

Conclusions and Perspectives

- **Snowpacks are active, functional ecosystems, even at temperatures below zero**
- **Abiotic triggers like temperature likely trigger successional shifts in community composition**
- **Future work will focus on the impact of water availability and biotic interactions**



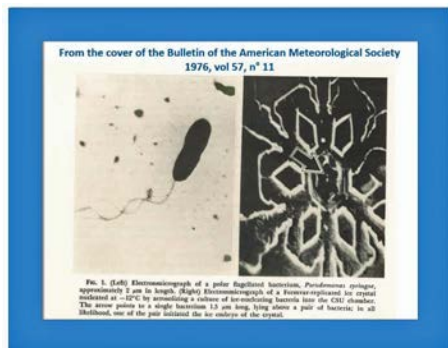
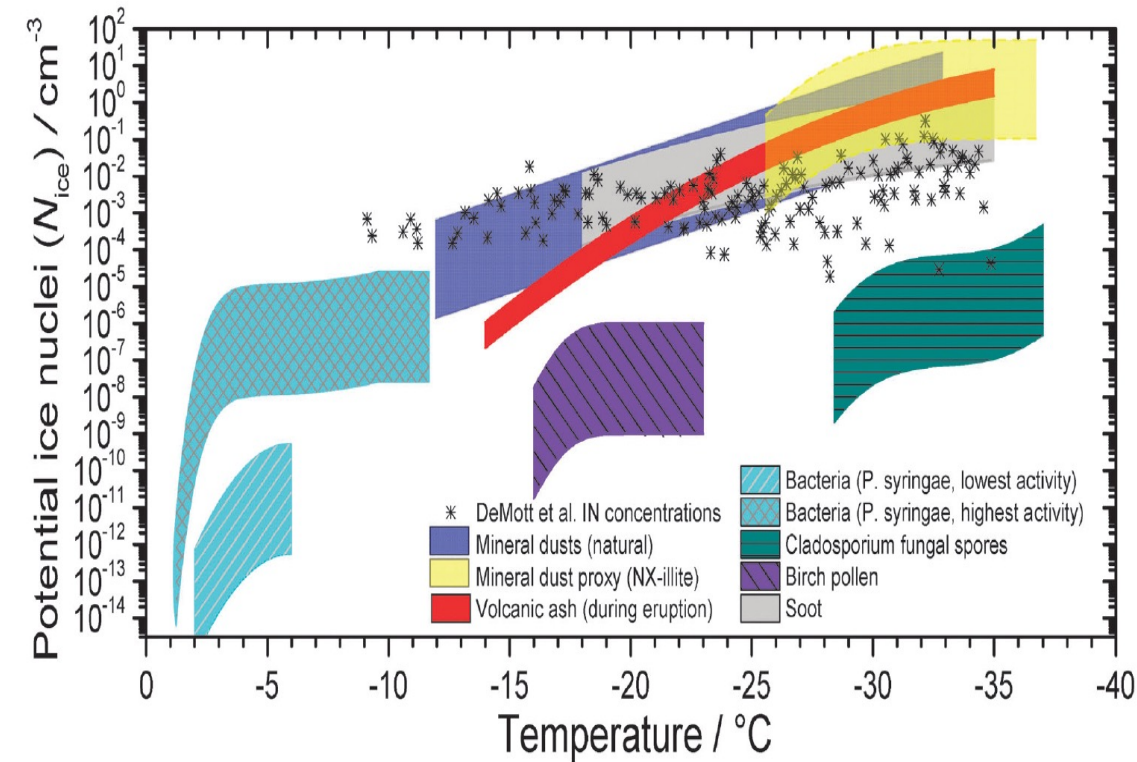
Thanks for your attention!



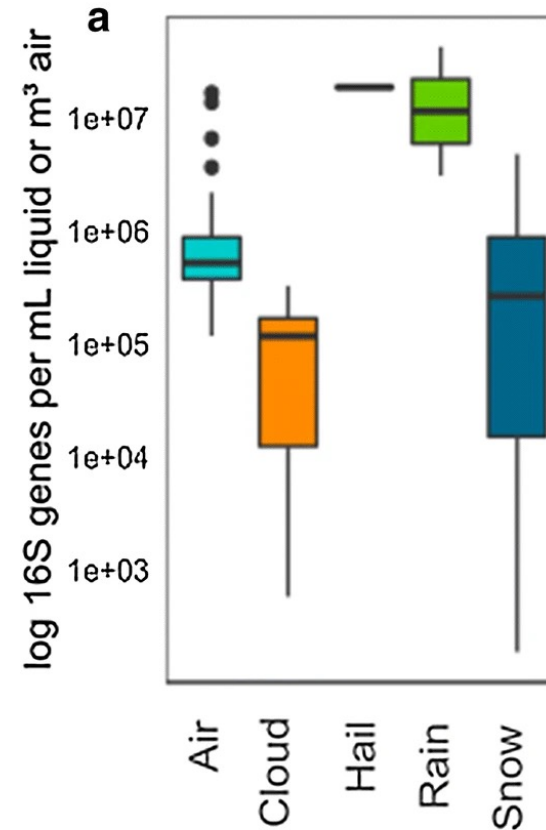
Collaborators:
University Aix-Marseille,
ISTerre, LECA



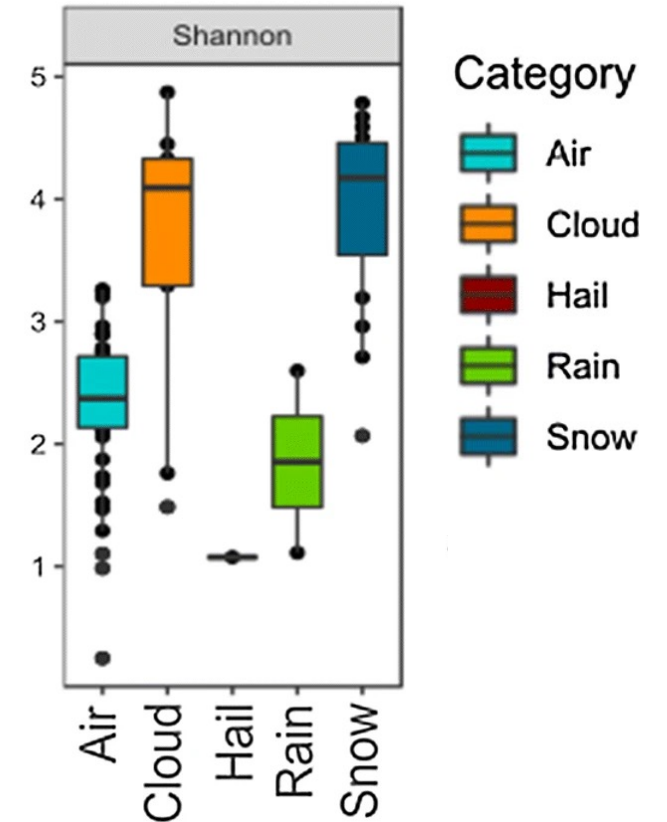
Microorganisms in the atmosphere



Abundance



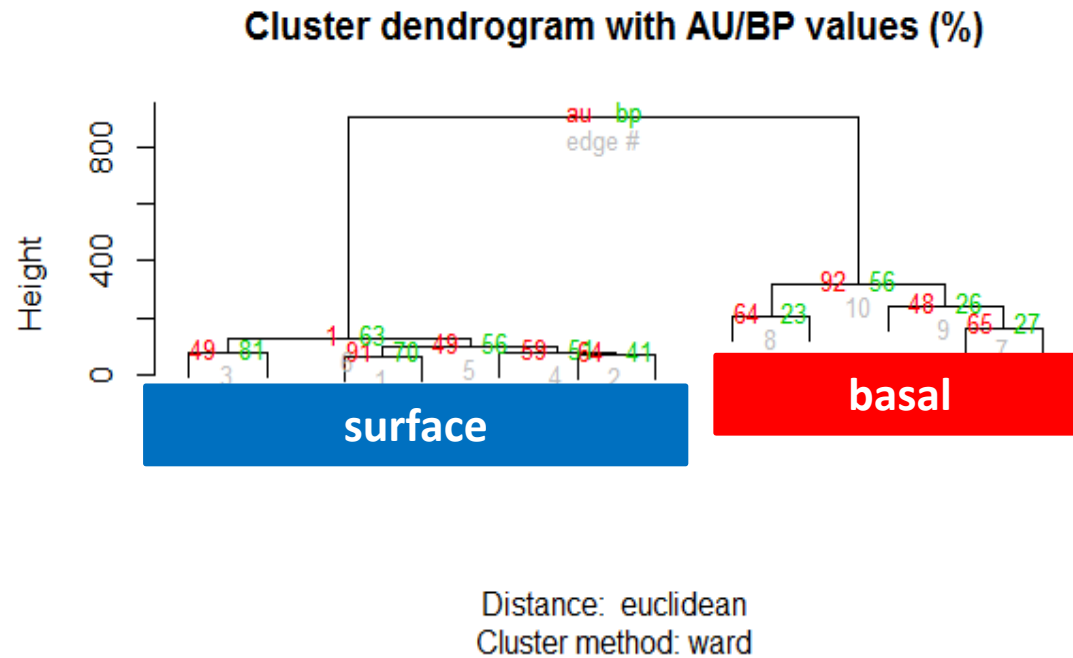
Diversity



Modified from Els et al., 2019

Microorganisms initiate ice nucleation, community abundance and diversity varies with precipitation type

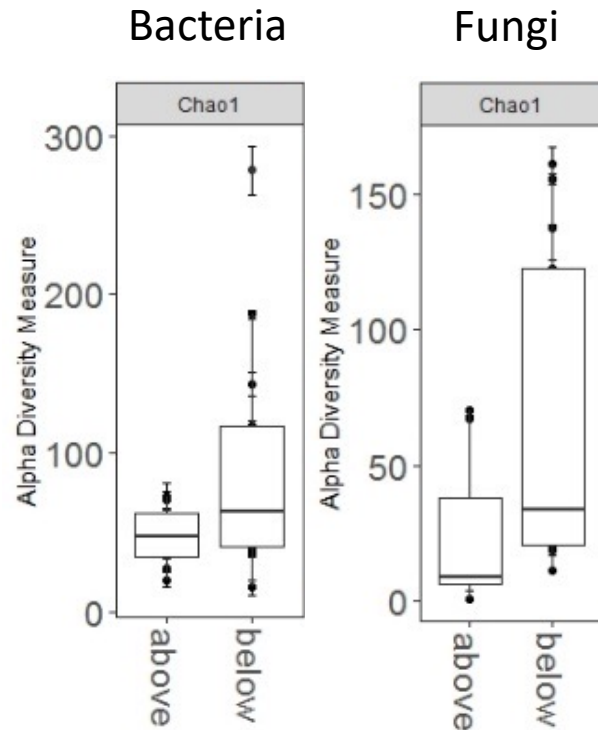
Snowpack homogeneity?



- Replicate samples cluster together based on 16S data and chemistry
- Snow layers separate based on depth

SAME DAY SAMPLING: horizontal homogeneity, but vertically stratified

Air vs snow compositional changes



Els et al., 2019, Mount
Sonnblick, Austria

