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Centre for Microbiology and
Environmental Systems Science

ter:labs
TERRESTRIAL ECOSYSTEM RESEARCH



Effects of permafrost thaw on the global nitrogen cycle: the role of thermokarst systems

Nicolas Valiente Parra

24.11.2022

WG RICHTER

Andreas Richter



Victoria Martin



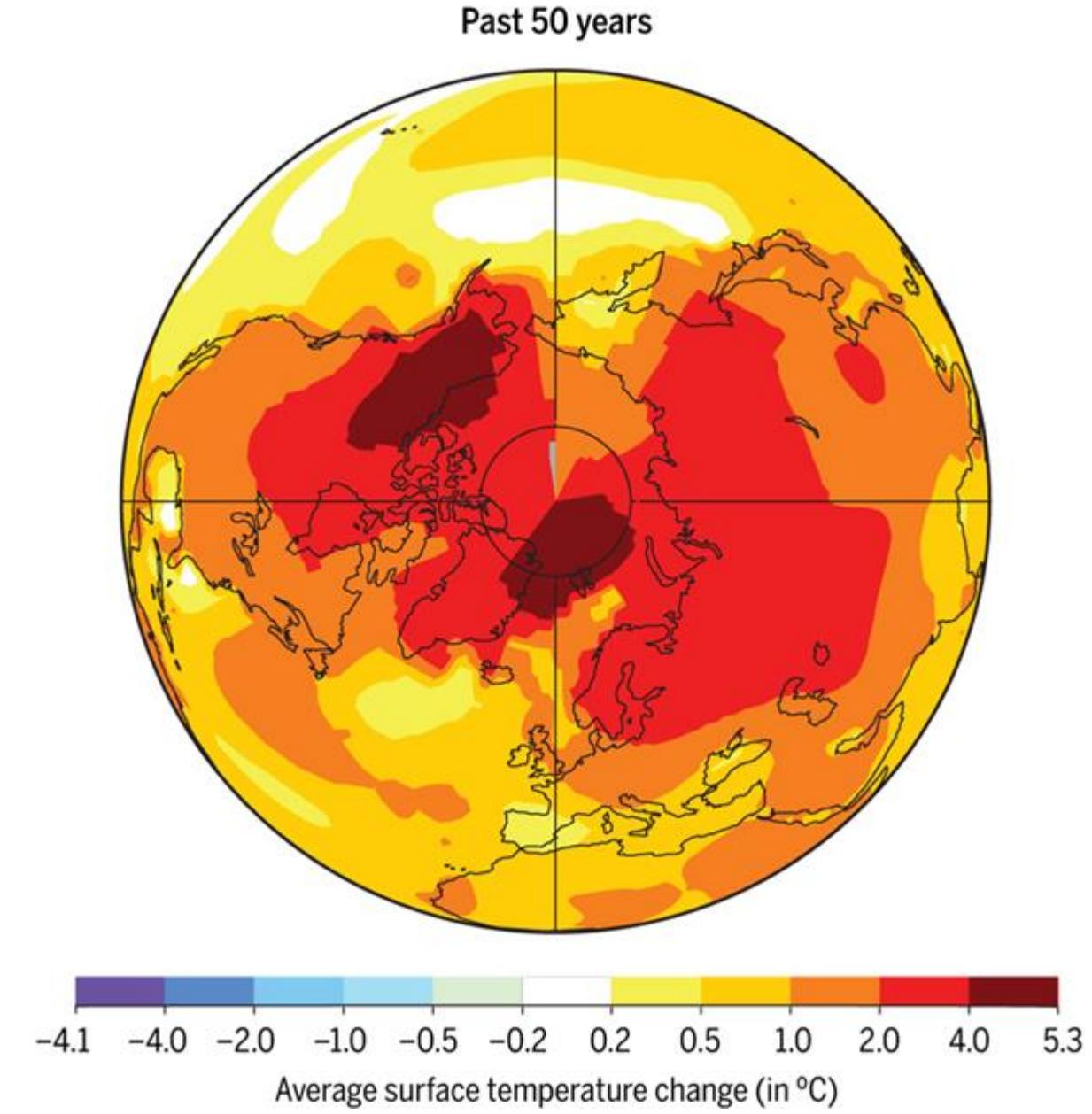
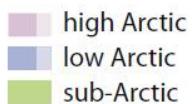
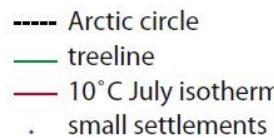
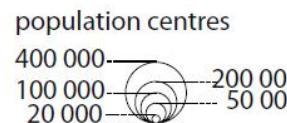
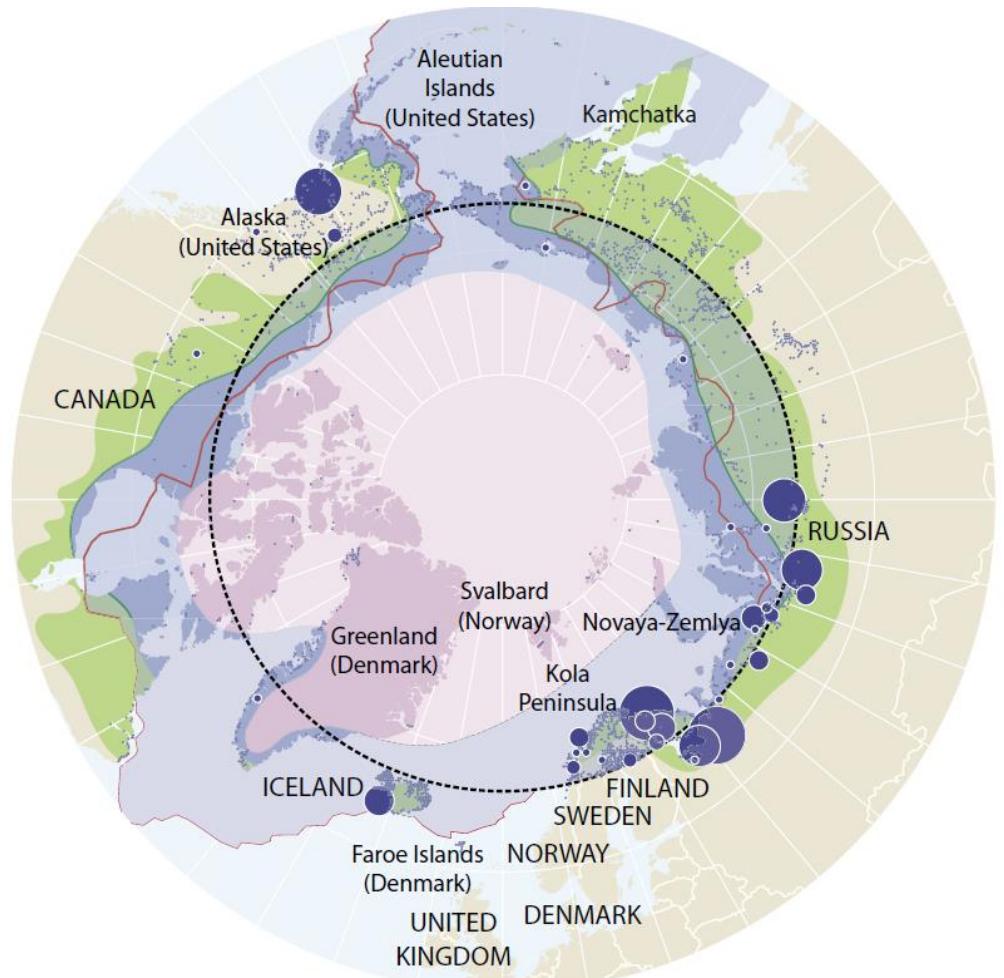
Cornelia Rottensteiner



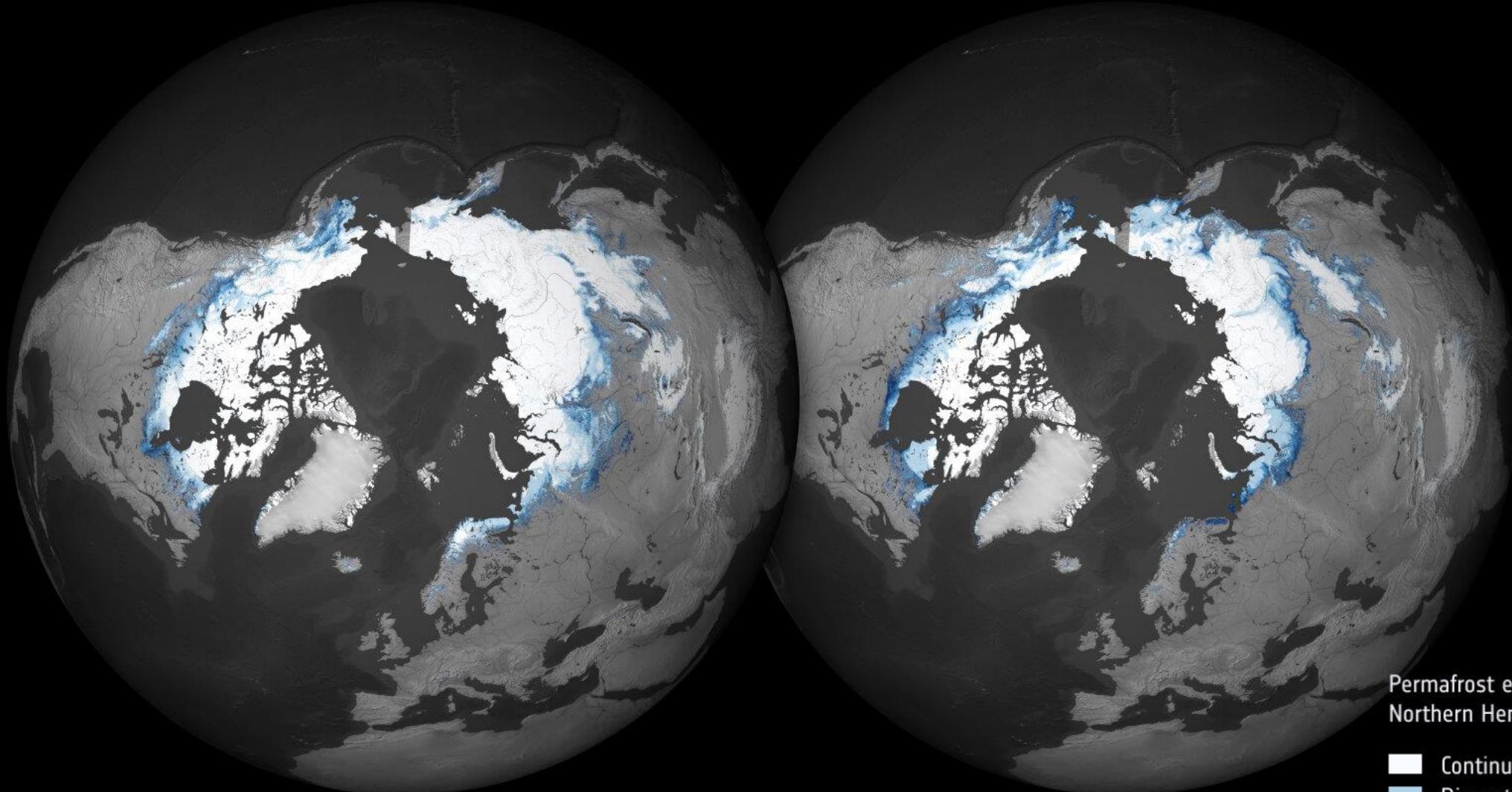
Nicolas Valiente Parra



THE ARCTIC



PERMAFROST



2003

2017

Permafrost extent for the
Northern Hemisphere

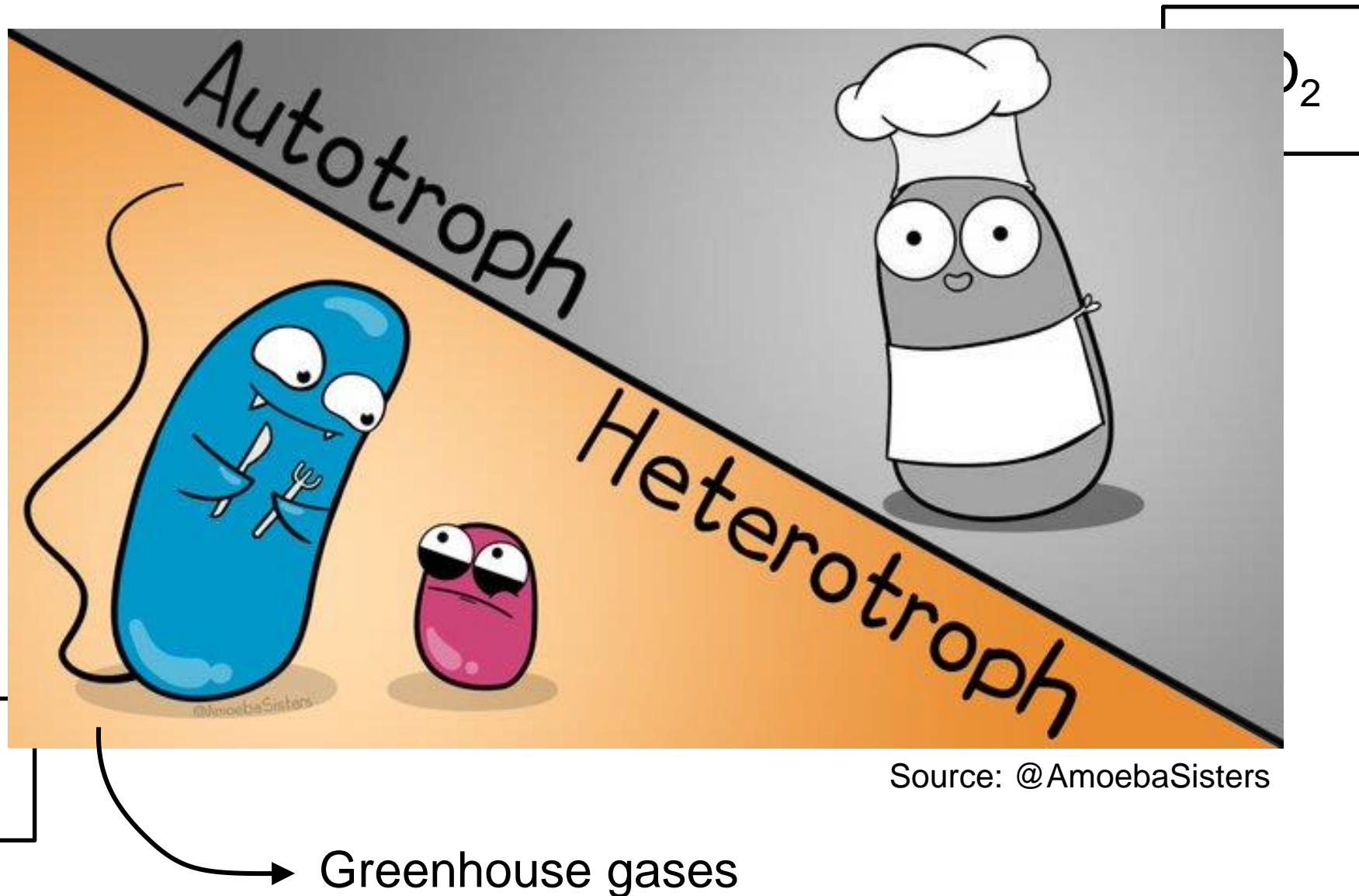
- Continuous
- Discontinuous
- Sporadic
- Isolated

Data source: Permafrost CCI, Obu et al., 2019
via the CEDA archive

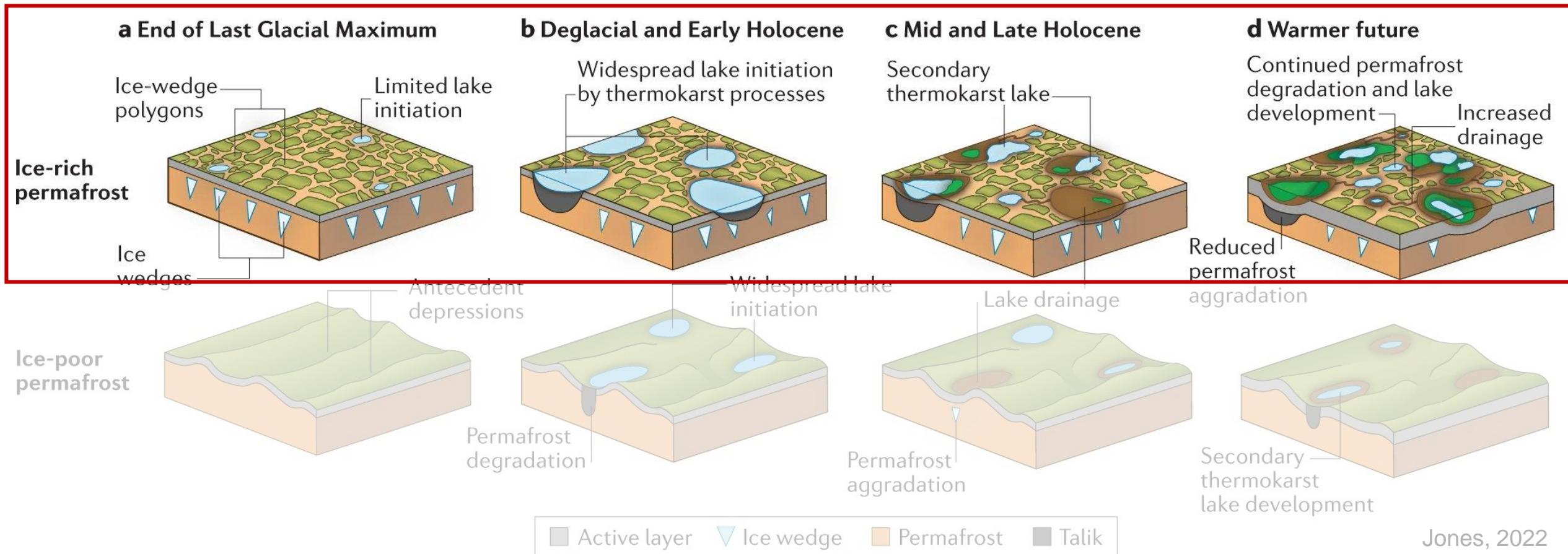
CURRENT STATE



MICROBIAL METABOLISM

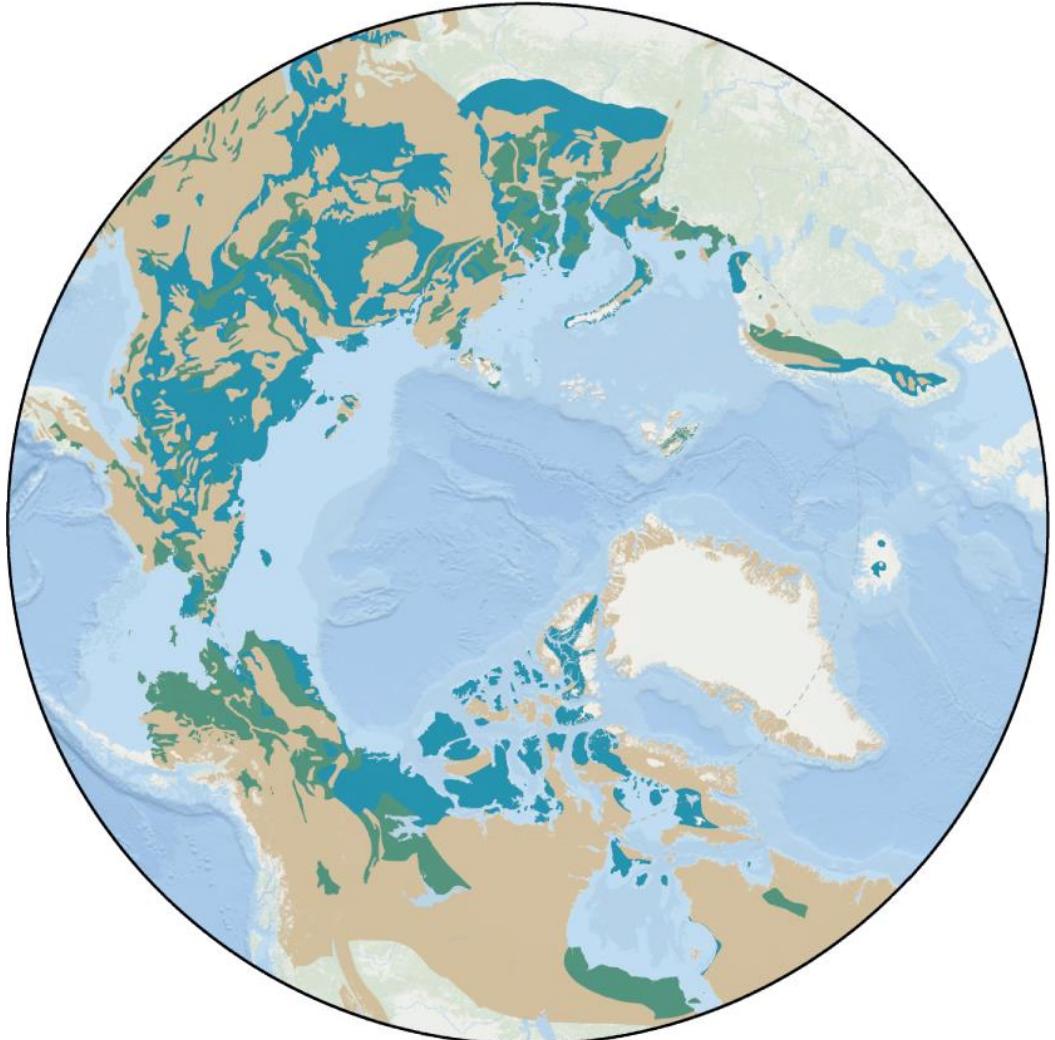


THERMOKARST LANDSCAPE DEVELOPMENT

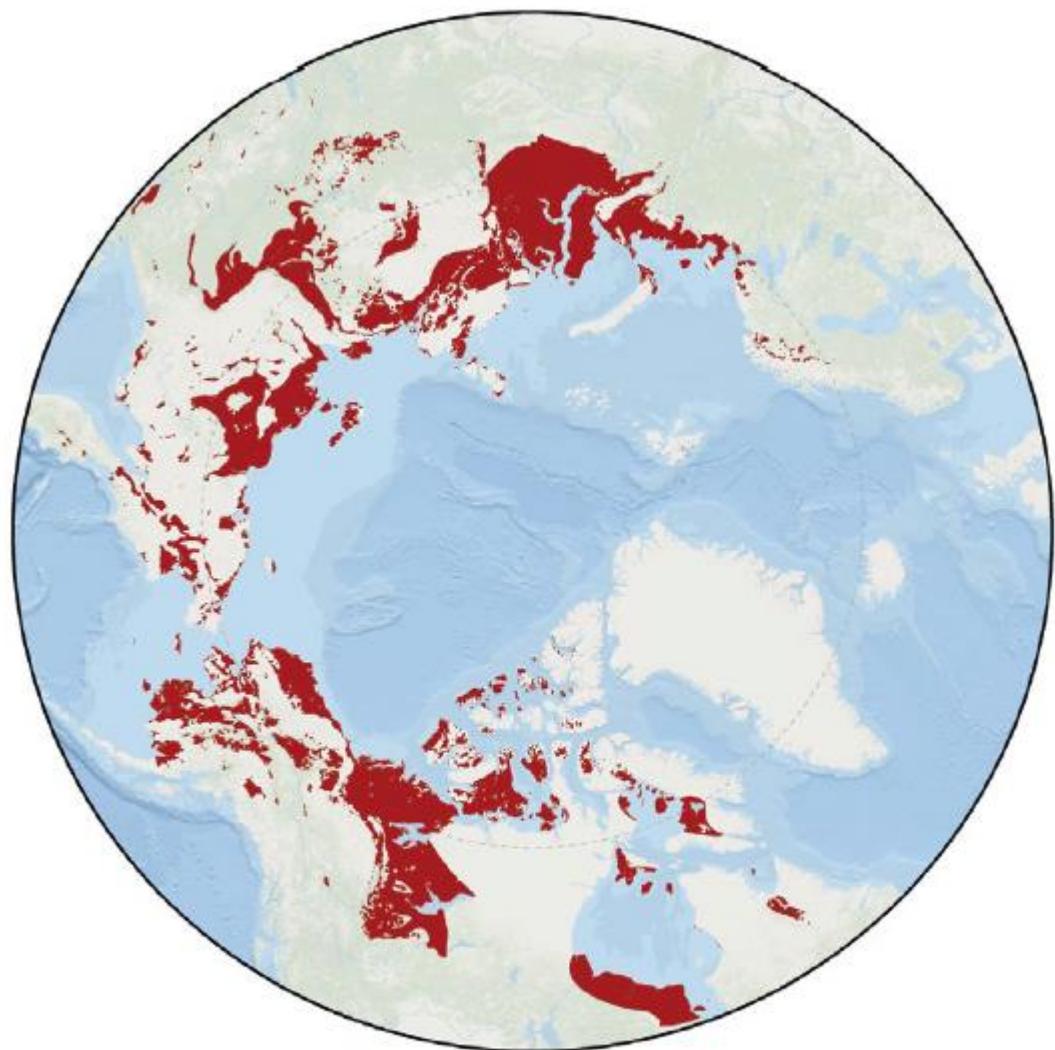


Jones, 2022

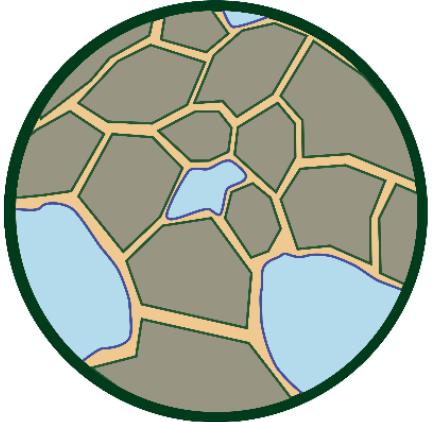
DISTRIBUTION OF THERMOKARST LANDSCAPES



Ground ice
■ High ■ Medium ■ Low



■ Thermokarst lake landscapes



NITROKARST

Project description

[DE](#) [EN](#) [ES](#) [FR](#) [IT](#) [PL](#)

The importance of thermokarst-affected permafrost soils in the global nitrogen cycle

Global changes are modifying the Arctic regions' climate, where temperatures have risen faster than anywhere else on Earth. These regions store vast amounts of soil organic matter (SOM) in permafrost soils that rapidly release nutrients and greenhouse gases when they thaw. The thawing yields thermokarst processes that occur abruptly, leading to ground surface collapse and to the development of ecosystems (ponds and lakes) where anaerobic environments enhance microbial activity. With Arctic warming, permafrost thawing and thermokarst processes will increase, releasing soluble nitrogen (N) into the environment, thus enhancing microbial decomposition of SOM. The EU-funded NITROKARST project will explore the underlying mechanisms of the N cycle in thermokarst systems, examining how microbial pathways promote N transformation and how thawing controls the operation of these processes.

Project Information

NITROKARST

Grant agreement ID: 101024321

Start date

1 February 2022

End date

31 January 2024

Funded under

H2020-EU.1.3.

H2020-EU.1.3.2.

Coordinated by

UNIVERSITAT WIEN

Austria

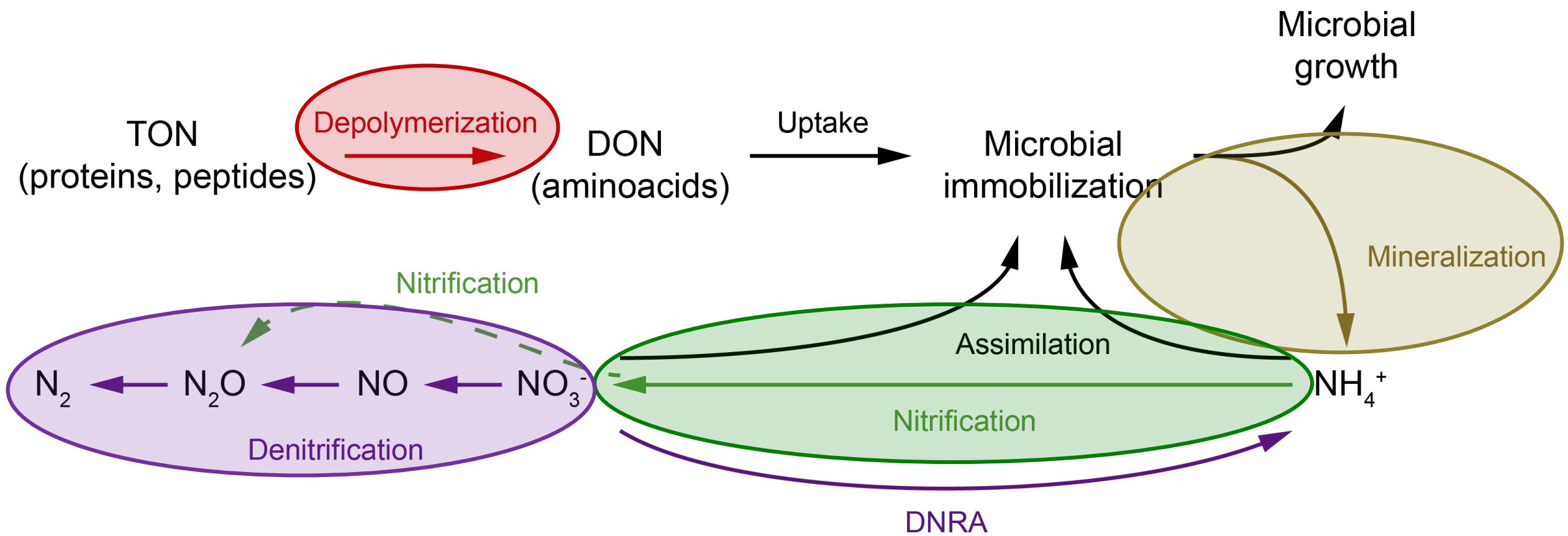


Goal: Understand how microbial pathways promote **N transformation** in response to permafrost thaw in thermokarst.

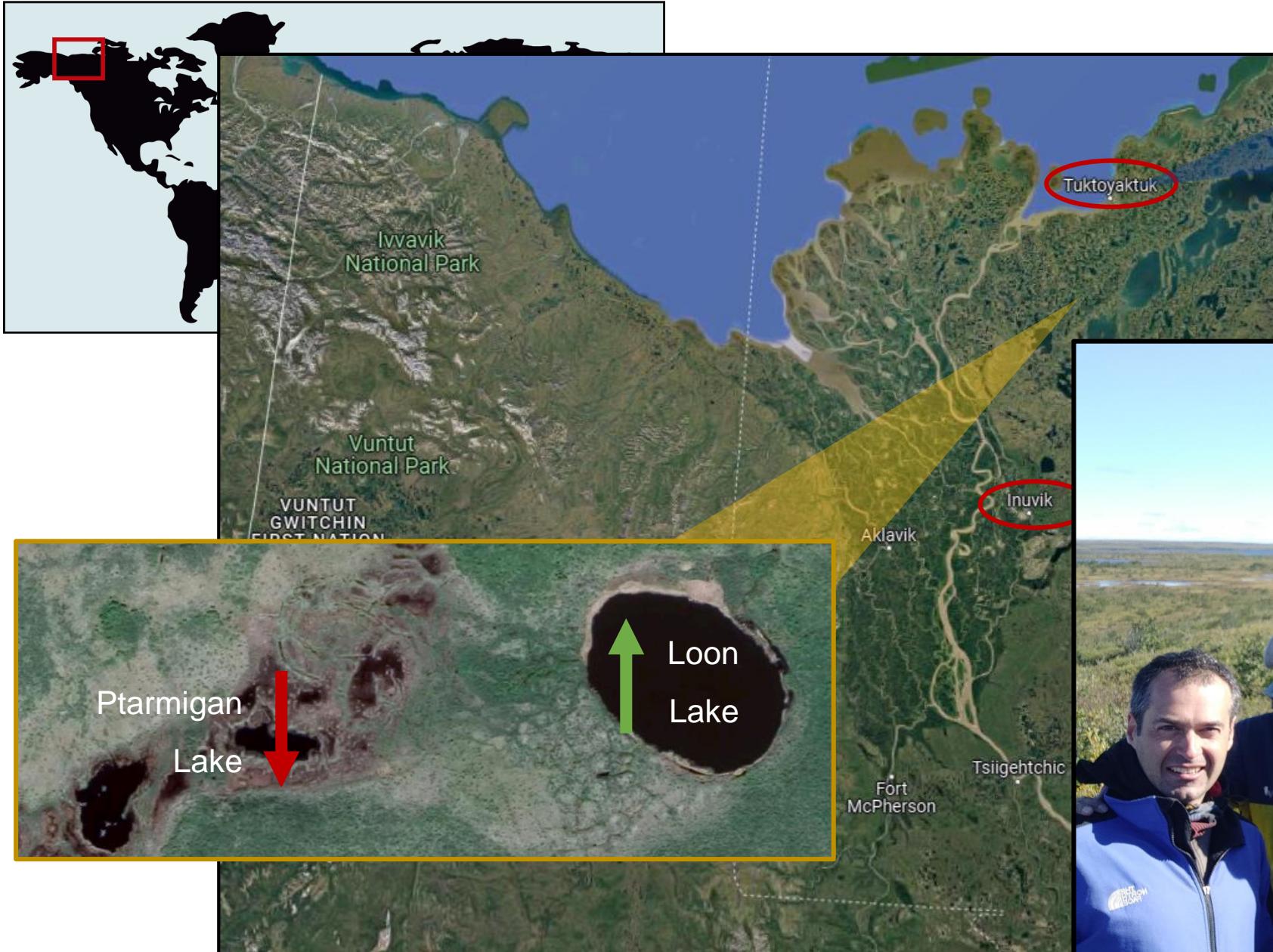
Hypothesis: Thawing increases SOM decomposition and **N availability**, and thus modifies microbial community composition.

Expected results: Differences in N transformation rates and microbial community composition along thermokarst transects.

NITROGEN CYCLE



STUDY AREA: Inuvialuit Settlement Region



SAMPLING

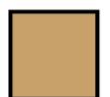
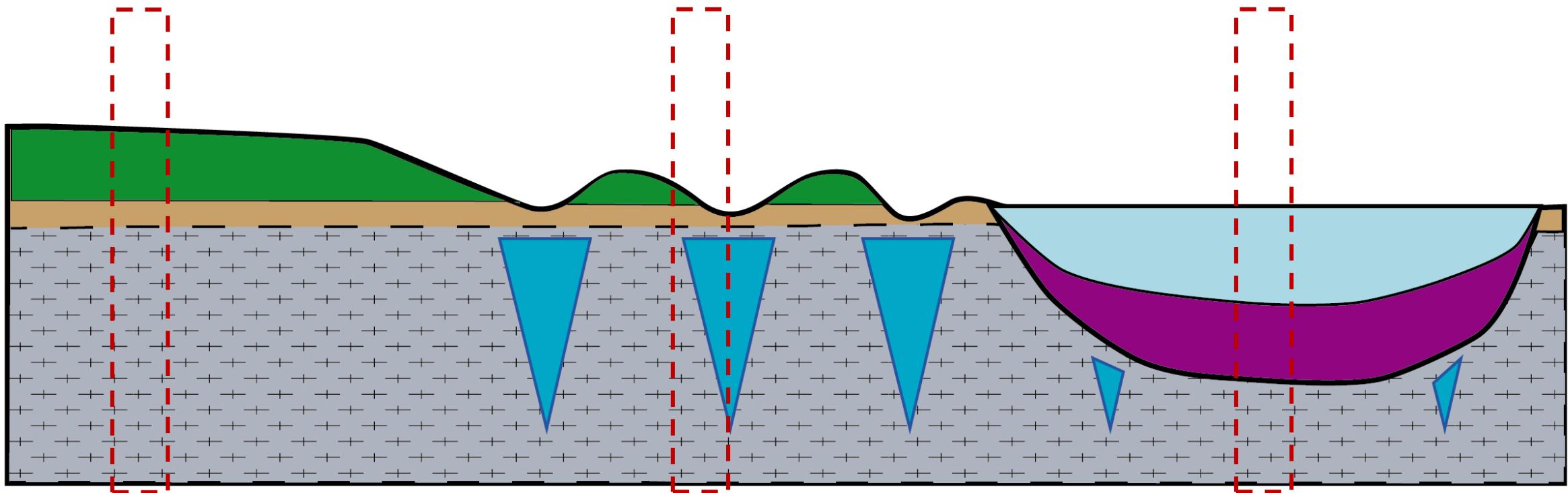
Thermokarst transect



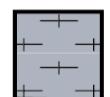
Stable conditions

Disturbed conditions

Thermokarst lake/pond



Active layer



Permafrost



Water

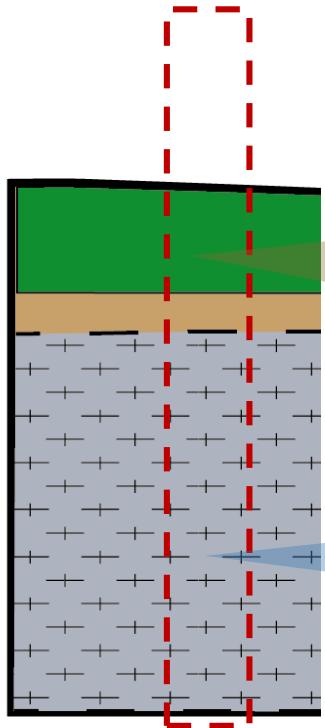


Talik



Vegetation

SAMPLING



Active layer

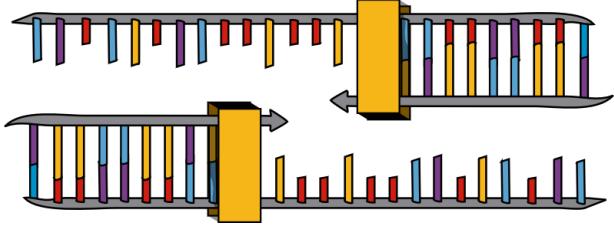


Permafrost



15N INCUBATIONS

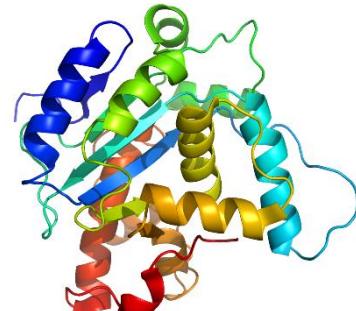
Amplicon sequencing



Metagenomics



Protein 15N-labelled



Depolymerization $^{15}\text{N-AA}$

N mineralization $^{15}\text{N-NH}_4^+$

Nitrification $^{15}\text{N-NO}_3^-$

Denitrification* $^{15}\text{N-N}_2\text{O}$

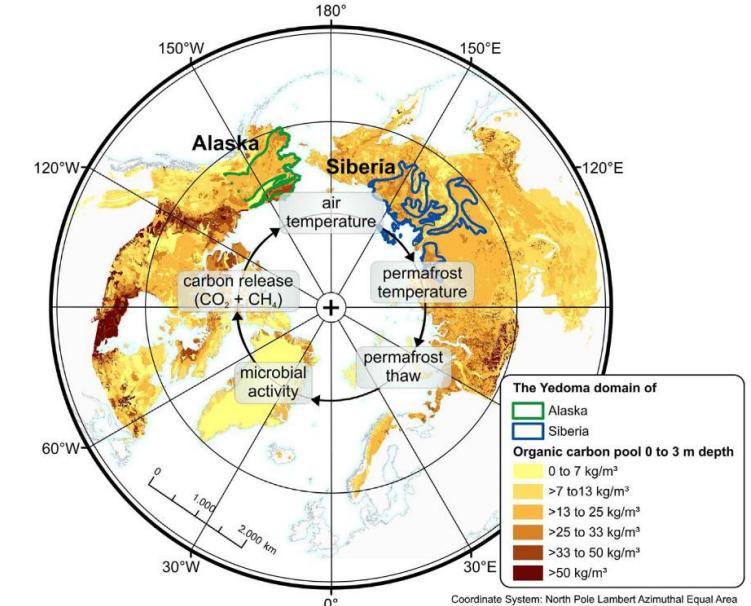
Subjecting permafrost microbes to short-term warming

V. Martin¹, J. Wagner², N. Speetjens³, R. Lodi⁴, J. Horak¹, C. Urbina-Malo¹, M. Mohrlok¹, C. Rottensteiner¹, W. a' Campo², L. Durstewitz², G. Tanski³, M. Fritz⁵, H. Lantuit⁵, G. Hugelius², and A. Richter¹

Activity of permafrost microbes is key to estimate extent of feedback to global climate.



This project is funded by
the European Union



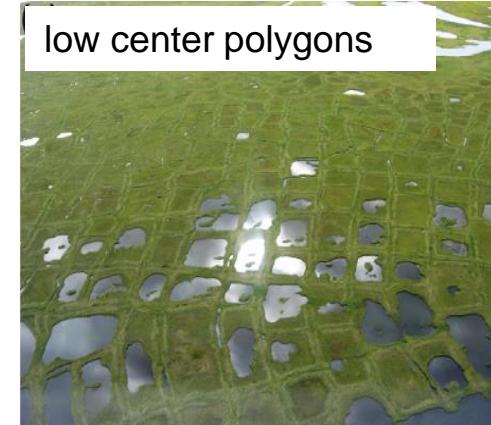
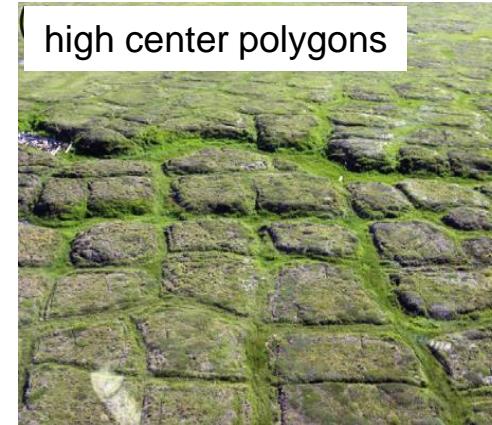
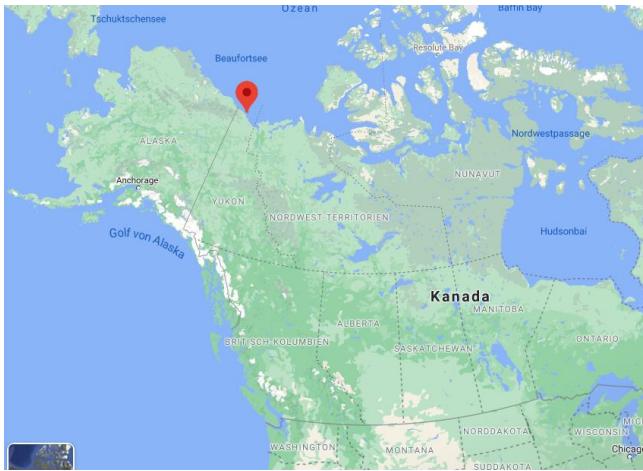
Strauss et al., 2017



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Lowland Ice-Wedge-Polygonal Tundra – Yukon Coast

© Fritz et al., 2016

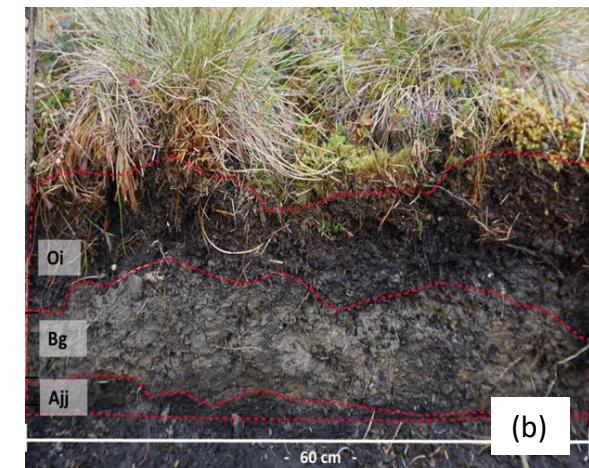


Does structural heterogeneity in lowland tundra ecosystems affect **microbial processes** and how soil microbes react to warming ?

- periglacial landform units (a)
- soil horizons (b)



(a)



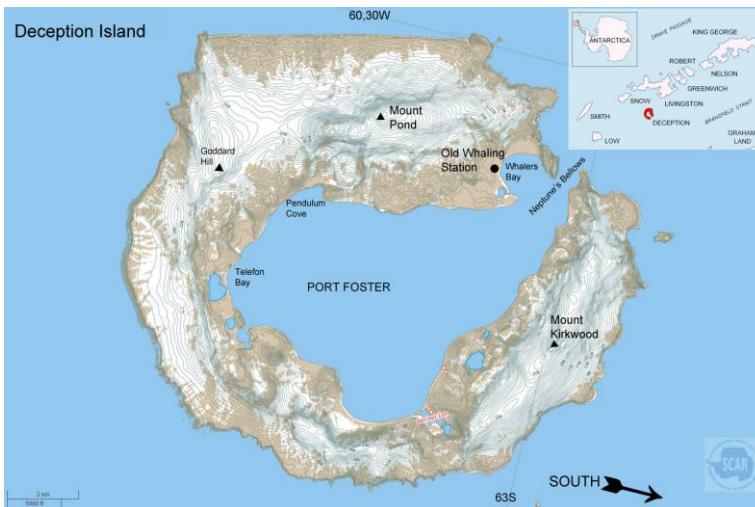
(b)

Cryptogam identity shapes microbial communities and organic matter pools in soils of maritime Antarctica

Victoria Martin¹, Hannes Schmidt¹, Alberto Canarni¹, Lucia Fuchslueger¹, Carsten W. Müller², Andreas Richter¹

¹ University of Vienna, Centre for Microbiology and Environmental Systems Science, Austria.

² University of Copenhagen, Department of Geosciences and Natural Resource Management, Denmark



Mosses \leftrightarrow Soil Crusts



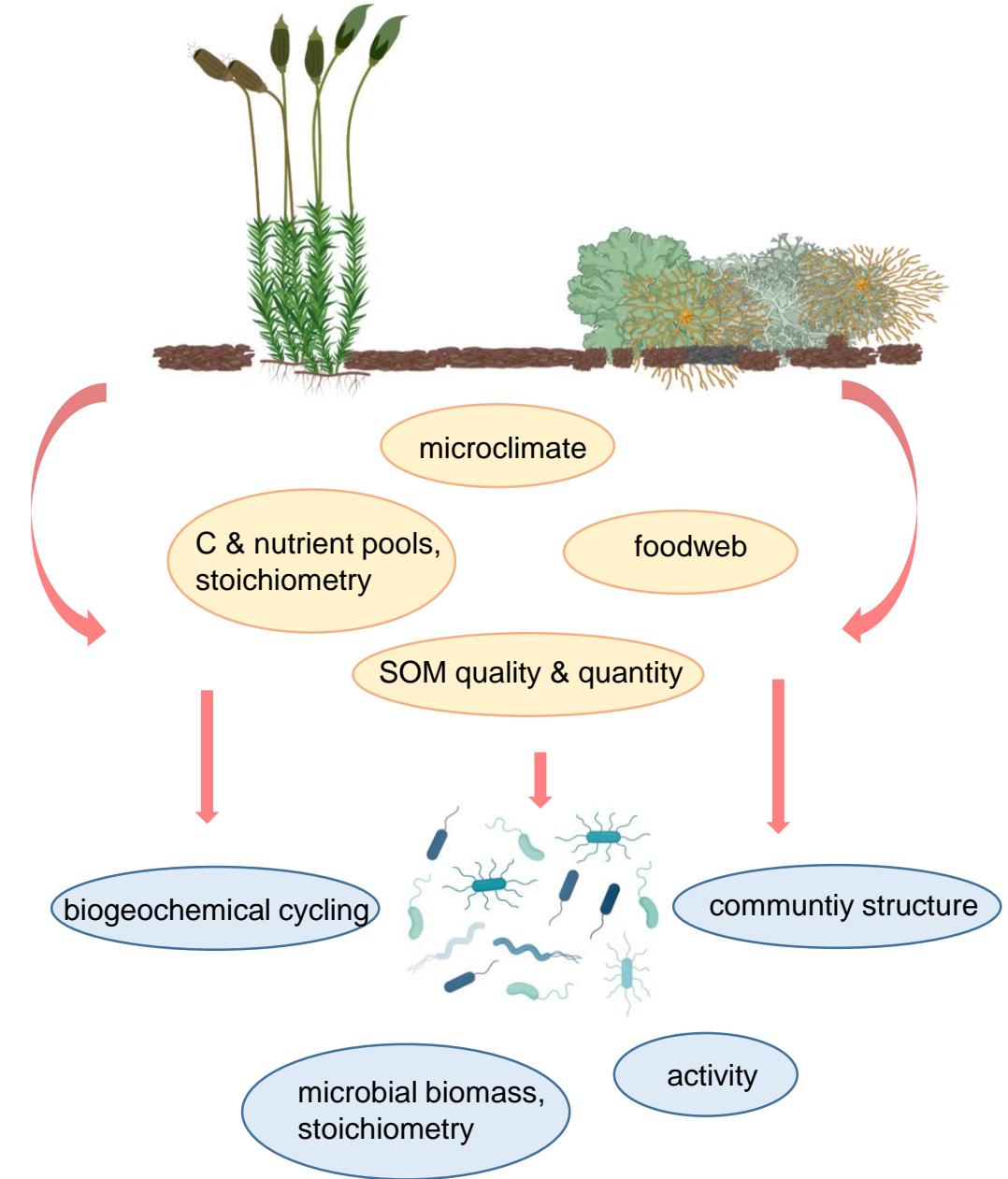
© A. Richter & C. Müller



Characterize the difference between the two major cryptogamic soil cover types in the little developed Antarctic soils

(mosses & soil crusts) as „hotspots“ for:

- subjacent soil microbial communities,
- soil biogeochemical processes, &
- SOM quality/quantity/build-up



THANKS FOR YOUR ATTENTION

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