Leibniz Centre for
Agricultural Landscape Research
(ZALF)

Future Arctic soil nutrient availability and microbial community structure

P. Stimmler, J. Schaller

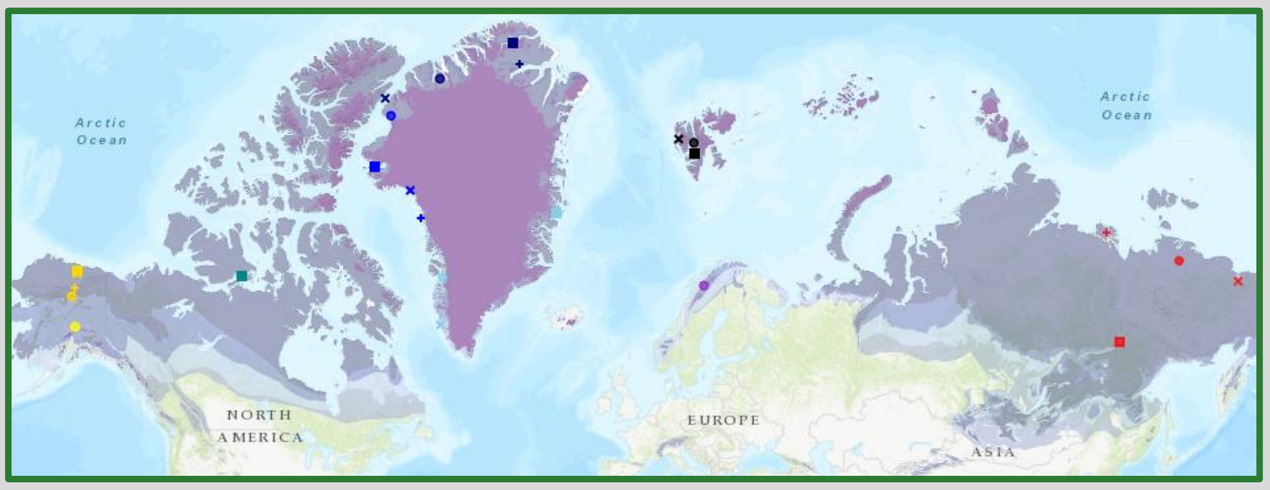

Fig. 1. Location of the 40 sampling plots over the whole Arctic.

Abstract

Permafrost soils are a large storage of organic carbon. The thawing of the arctic permafrost soils is a main issue for global warming and has the potential to intensify climate change. The release of this carbon is driven by many parameters like phosphorous availability and microbial community structure. Understanding these complex processes on a interdisciplinary level is an important attempt for future research. Phosphorus availability is known to be affected by silicon (Si) and calcium (Ca) availability. Here we show that Si and Ca availability in permafrost soils differs on large extend between sites and between active and permafrost layers, suggesting changes after permafrost thaw. Furthermore, we show that a change in Si and Ca availability alters the microbial community structure of these soils. Consequently, Si and Ca should be considered as factors affecting greenhouse gas emissions from the Arctic.

Research Question

How are element availabilities distributed over the Arctic?

How does the nutrient availability affect microbial community structure?

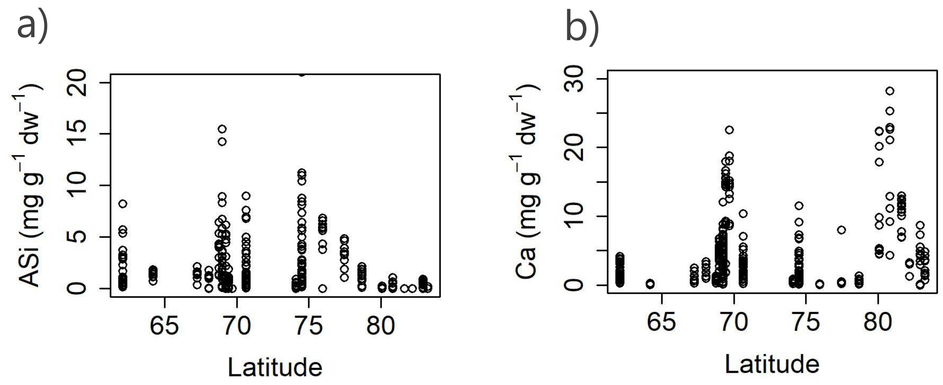

Fig. 2. Available element concentrations in the Arctic.
a) Biogenic available amorphic silicon b) Biogenic available calcium

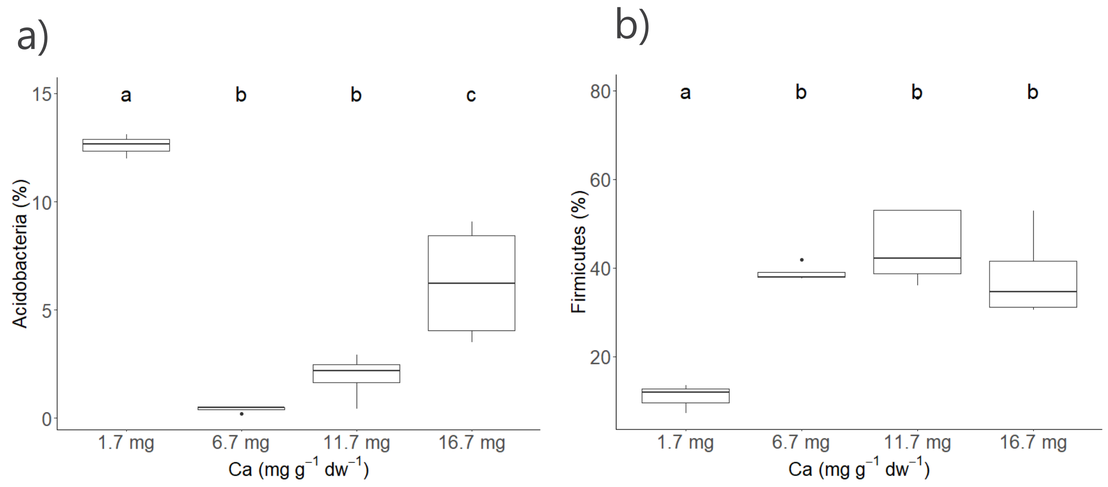

Fig. 4. Disko, Greenland: Response of microbial community structure to increasing Ca concentrations. a) Acidobateria b) Firmicutes

Biological availability of elements differs from total contents. The composition modifies the release of carbon. We found variations analyzing 700 soil samples from 40 locations in the Arctic.

How do calcium and amorphous silicon affect carbon release?

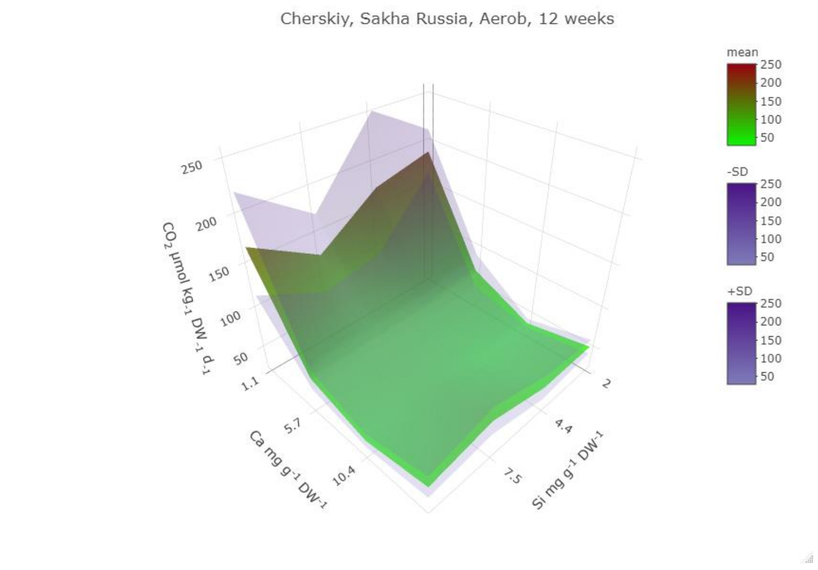

Fig. 3. Soil respiration rates of a Yedoma soil form NE-Sibiria at different Si and Ca concentrations. Quantification in headspace after 12 weeks with GC-FID.

Calcium decreases the phosphorus release in the soil and soil respiration. However, amorphous silicon increases phosphorus availability and carbon release.

Calcium increases salinity in the soil pore water and leads to additional drought stress in temporarily frozen ground. Higher Ca concentrations leads to more gram-positive bacteria and decreases gram-negative bacteria. We found an significant linear correlation between both.

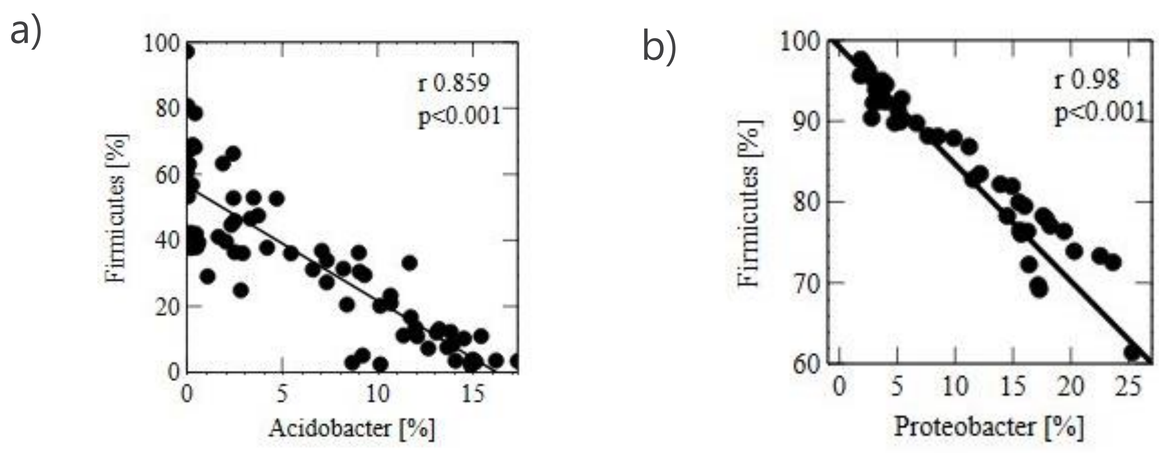

Fig. 5. Response to increasing Ca concentrations: Linear correlation of abundances of gram-positive Firmicutes and a) gram-negative Acidobacteria b) gram-negative Proteobacteria.

Conclusion

- Soil respiration in Arctic permafrost soils is driven by Ca and Si availability
- Elemental availability differs widely over the Arctic
- Ca and Si affect soil respiration by P mobilization and microbial community change

Contact person: Peter Stimmler
Leibniz Centre for Agricultural Landscape Research (ZALF) · Eberswalder Straße 84 · 15374 Müncheberg · Germany
www.zalf.de · peter.stimmler@zalf.de · +49 921 55 2319· Date: [May 05, 2020]