The Effect of Temperature, Water Content, and Light Intensity and Quality on Nitrogen Fixation in High Arctic Vegetation

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Introduction
Nitrogen is a key controlling factor for terrestrial primary production in the Arctic. Due to general low precipitation in arctic regions, deposition of nitrogen is not sufficient. Thus, biological nitrogen fixation plays an important role and contributes up to 50% of the nitrogen. Due to lack of legumes in high arctic ecosystems, nitrogen fixation by free-living, epiphytic (moss-associated) (Fig. 6) or symbiotic (lichen) cyanobacteria is considered to be the main source of biologically fixed nitrogen. Models of future climate predict significant changes in the climate conditions in the Arctic. Changes in different climate factors may have either a stimulating or an inhibiting effect on the nitrogen fixation activity in high arctic environments. In this study we investigated the effect of temperature, soil water content, and light quantity and quality on nitrogen fixation in different types of vegetation on Svalbard, High Arctic.

Results
The vegetation samples showed a low, but detectable ethylene production already at 0°C. From about 10°C ethylene production rates rapidly dropped to zero (Fig. 5c). Nitrogen fixation capacity of moss-associated cyanobacteria was significantly reduced at enhanced UVB radiation (Fig. 5d). The results shown are after enhanced UVB during six growing seasons, but similar results were already observed after 2 and 3 years. (Error bars are omitted for better clarity)

Discussion and conclusions
- The results from the temperature gradient show that epiphytic cyanobacteria do not have a temperature optimum adapted to the natural conditions on Svalbard. Moreover, the nitrogen fixation activity is almost constant between 0°C and 15°C. This and the fact that mean temperature at 1 cm depth in the vegetation layer at the sampling sites during the growing season is between 0°C and 12°C indicate that nitrogen fixation is temperature-independent during most of the growing season.
- Taking the low annual precipitation in central Svalbard (below 300mm) into account, the response of nitrogen fixation on an increased water content of the vegetation shows that moisture are an important factor for nitrogen fixation in these environments.
- Since the light intensity through the 24h-photoperiod during the growing season on Svalbard is mostly well above the critical value (140 µmol photons m⁻² s⁻¹), this factor seems not to be limiting for nitrogen fixation in this area.
- The results from the UVB-experiments clearly show that the simulated enhanced UVB-radiation, which is well inside the predicted increase due to ozone depletion, has a dramatic effect on the process of nitrogen fixation.