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Plant-available N in soil solution in a Low-arctic tundra heath and a wet fen affected by snow addition (snow fences), shrub removal (clipping) and warming (OTC)

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Plant-available N in soil solution is a key parameter linking nutrient input, soil organic matter turnover and plant nutrient uptake and growth. This study investigates nitrate (NO_3^-), ammonium (NH_4^+) and dissolved organic carbon (DOC) availability in July-October 2013-2014 in a Low-arctic tundra heath and a wet fen in Western Greenland. The impact of up to four years of experimental field treatments simulating climatic change on DOC and plant-available soil N are reported here.

Peak concentrations of DOC and NH_4 were highest in the wet fen, whereas NO_3^- content was highest in the drier heath tundra, reflecting the soil moisture differences between the sites and inflow of drainage water from adjacent slopes to the wet fen. The availability of NO_3^-, NH_4^+ and DOC was highest during peak growing season in the wet fen, but highest before and after peak growing season in the mesic tundra heath.

2013 was a snow-poor year with average rainfall, whereas 2014 had average snow depth and experienced an extreme rain event in mid-August. The differences were reflected in the near-surface soil moisture content (SMC) of the tundra heath, which decreased below 40% vol. in mid-June 2013, but not until July in 2014. The soil was further saturated by the mid-August rain event. In 2013, NO_3^- in soil solution increased steadily from July to October, while NH_4^+ was stable. In 2014, NO_3^- and NH_4^+ concentrations peaked in mid-July, dropped to a minimum in late July-early August and increased in September-October. The wet fen SMC and seasonal nutrient pattern was not affected by snow depth or rain events, but might be indirectly influenced by tundra heath conditions due to inflow of water from surrounding tundra areas.

Two years after initiation of experimental warming with Open Top Chambers (OTC), a non-significant decrease in NO_3^- availability in the warmer and drier plots was observed. Warming in combination with shrub removal, however, increased the NO_3^- availability, reflecting lower plant demand. After four years of snow addition, DOC content in the upper 5 cm was significantly higher than ambient during whole growing season, and NO_3^- and NH_4^+ availability was higher in July, but not in August. In the wet fen, four years of snow addition increased DOC in 0-2 cm depth only.

The results suggest that nutrient availability in the Disko Island tundra heath in the early growing season is sensitive to a balance between SMC limitation (e.g. caused by warming) and oxygen limitation caused by a deep snow pack or extreme rain events. However, longer term snow addition increases DOC, NO_3^- and NH_4^+ availability in the early growing season while later growing season N availability is controlled by plant uptake, leaving no effect of snow addition. The wet fen was not affected by snow or warming, rendering it less directly sensitive to change.

Further studies will measure plant N availability from onset of ground thaw, measure and model the impact of nutrient inflow to the wet fen, and investigate how the active layer depth affects transport and distribution of plant-available N.