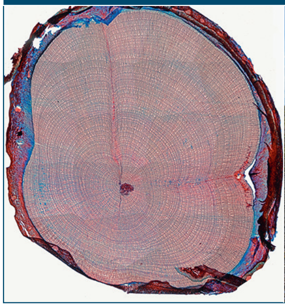
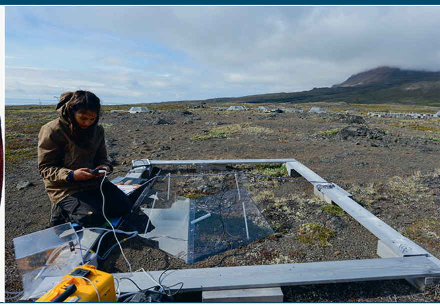
CENPERM HIGHLIGHTS 2015

Highlights of 2015 include intensive field work at 6 sites in Greenland and new snow fences being built and instrumented in South Greenland. It has also been a productive year in terms of scientific papers. The following four papers published in 2015 highlight two issues: that ecosystems across the ice-free Greenland are highly climate sensitive, and secondly that changes in ecosystem functioning should be considered over both short and long time scales.

1. Decomposition of organic carbon from thawing permafrost soils is considered a potentially critical global-scale feedback on climate change. The accompanying heat production from the microbial metabolism has been recognized as a potential positive feedback mechanism to enhance permafrost thawing and the release of soil carbon. This internal heat production is poorly understood but now Hollesen et al. (2015c) reported in *Nature Climate Change* that permafrost thawing in organic arctic soils can be accelerated by ground heat production. We quantified the variability of heat production in different types of organic permafrost soils across Greenland and documented that these soils produce enough heat to increase soil temperatures and accelerate the decomposition processes. We demonstrated that the impact of climate changes on organic soils could be enhanced compared to other soil types with crucial implications for the amounts of organic matter being decomposed and potentially emitted as greenhouse gases. We also showed that degradation of the uniquely well-preserved, organic archaeological artefacts in kitchen middens may be accelerated by internal heat production, with the risk of losing evidence of human activity in the Arctic.

2. Growing-season conditions are widely recognized as the main driver for tundra shrub radial growth, but the effect of winter warming and snow remains an open question. Hollesen et al. (2015a) reported in *Global Change Biology* that winter warming may have been an important co-driver for dwarf birch (*Betula nana*) growth in West Greenland during the past century. We presented a more than 100-year-long *Betula nana* ring-width chronology from the Disko Island that demonstrated a highly significant and positive growth response to both summer and winter air temperatures during the past century. The importance of winter temperatures for *Betula nana* growth was especially pronounced during the periods from 1910–1930 and 1990–2011 that were dominated by significant winter warming. In order to explain the strong winter impact on growth, we assessed the importance of different environmental factors by using site specific measurements from 1991-2011 of soil temperatures, sea ice coverage, precipitation and snow depths. The results showed a strong positive growth response to the amount of thawing and growing degree days as well as to winter and spring soil temperatures. These findings help to explain the recently observed "greening of the Arctic" which may further accelerate in future years due to both direct and indirect effects of winter warming.

3. The arctic climate is projected to change and expected to alter litter decomposition rates, which in turn could affect carbon and nitrogen (N) cycling rates in tundra ecosystems. However, little is known of seasonal climate change effects on plant litter decomposition rates and N dynamics. Based on the CENPERM snow fence experimental site on Disko Island, Blok et al. (2015a) tested the effects of snow addition, warming and shrub removal on mass loss and N dynamics of two shrub tissue types with contrasting quality. Field incubations of litter bags started in late fall and were harvested sequentially to study seasonal changes. We observed a significant positive effect of deeper snow on winter mass loss, which was considered a result of observed higher soil winter temperatures and corresponding increased winter microbial litter decomposition in deep snow plots. In contrast, warming reduced litter mass loss during spring, possibly because the dry spring conditions might have dried out the litter layer and thereby limited microbial litter decomposition. Our results support the widely hypothesized positive linkage between winter snow depth and litter decomposition rates in tundra ecosystems, but our results do not reveal changes in N dynamics during initial decomposition stages. The study also shows contrasting impacts of spring warming and snow addition on shrub decomposition rates that might have important consequences for plant community composition and vegetation-climate feedbacks in rapidly changing tundra ecosystems.

4. The future development of ground temperatures in permafrost areas is determined by a number of factors varying on different spatial and temporal scales. For sound projections of impacts of permafrost thaw, scaling procedures are of paramount importance. Westermann et al. (2015) reported in *The Cryosphere* the future permafrost conditions along environmental gradients in Zackenberg, Northeast Greenland. Numerical simulations of present and future ground temperatures were shown with 10 m resolution for a 4 km long transect. The work was based on stepwise downscaling of future projections derived from a general circulation model using observational data, snow redistribution modeling, remote sensing data and a ground thermal model. A comparison with measurements of thaw depths and ground temperatures showed a good agreement. Until the year 2100, modeled ground temperatures at 10 m depth showed a warming of about 5°C, and an increase in the active layer thickness of about 30%, in conjunction with a moderate climate scenario. Such changes imply potential changes on a landscape scale, with effects on ecosystem functioning.

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