Positive feedback or stabilization following small-scale permafrost collapse after tundra shrub removal?

Heijmans MMPD[1], Nauta AL[1], Blok D[2], Limpens J[1], Li B[1], Wang P[1], van Huissteden J[3], Maximov TC[4, 5], Berendse F[1]

[1]Nature Conservation and Plant Ecology Group, Wageningen University, the Netherlands; [2]Center for Permafrost (CENPERM), University of Copenhagen, Denmark; [3]Earth and Climate Cluster, VU University Amsterdam, The Netherlands; [4]Institute for Biological Problems of the Cryolithozone, Siberian Branch Russian Academy of Sciences, Russia; [5]North-Eastern Federal University, Russia

Permafrost thaw and the resulting release of greenhouse gases from decomposing soil organic carbon has the potential to accelerate climate warming. In recent decades, arctic tundra ecosystems have changed rapidly, including expansion of woody vegetation, in response to changing climate conditions. For a better understanding of the response of permafrost to climate change, it is important to determine how observed vegetation changes, e.g. deciduous shrub expansion, contribute to stabilization or destabilization of the permafrost. In 2007, we set up a *Betula nana* (dwarf birch) shrub removal experiment at the Chokurdakh Tundra Research Station in Northeast-Siberia. Removing the shrub part of the vegetation initiated thawing of ice-rich permafrost, resulting in collapse of the originally elevated shrub patches into waterlogged depressions within five years. This thaw pond development shifted the plots from a methane sink into a methane source. The results of our field experiment demonstrate the importance of the vegetation cover for protection of the massive carbon reservoirs stored in the permafrost and illustrate the strong vulnerability of these tundra ecosystems to perturbations. Question now is whether the shallow thaw ponds in the removal plots develop further or whether increasing graminoid biomass is stabilizing the system.

Quantifying impacts of mosses and lichens on the C/H_2O/Energy balance with a process-based model

Porada P, Beer C

Department of Applied Environmental Science, Stockholm University, Sweden

Vegetation on the ground, such as mosses and lichens, plays a significant role in the C/H_2O/Energy balance at high latitudes. Moss, for instance, may contribute as much as vascular plants to the carbon budget of boreal forests. Moreover, the ground-based vegetation acts as an insulating layer for the soil below, thereby influencing active layer thickness and permafrost extent. Further connections between the moss and lichen cover and the C/H_2O/Energy balance include the storage of water at the surface, the interaction with vascular plants and the fire regime. Taking these processes into account, changes in the moss and lichen cover due to global warming might result in considerable feedbacks on the C/H_2O/Energy balance. To estimate the magnitude of these potential effects, however, it is necessary to quantify both the response of the moss and lichen cover to the climatic forcing as well as the effect of the cover on the relevant environmental factors, such as soil temperature, for example. For this purpose, we use a dynamical global vegetation model called JSBACH which can simulate the carbon dynamics of vascular plants and the soil at the global scale. The model also includes a water and energy balance as well as a representation of permafrost. We extend JSBACH by a process-based model of the moss and lichen layer, which simulates fractional cover and productivity as a function of climate and other JSBACH components, such as fire. By running the model with a transient scenario of climate change