Geophysical Research Abstracts
Vol. 15, EGU2013-10701, 2013
EGU General Assembly 2013

Derivation of thermokarst distribution based on climate and surface characteristics

Thomas Schöngaßner and Stefan Hagemann
Max-Planck Institute for Meteorology, Hamburg, Germany (thomas.schoengassner@zmaw.de)

About one quarter of the northern hemisphere is covered by permafrost. Permafrost areas inherit a high amount of deposited soil organic carbon, which represents approximately 50% of the estimated global below-ground organic carbon pool and is more than twice the size of the current atmospheric carbon pool. A destabilization due to the expected amplitude of future Arctic climate warming would lead to a global-scale feedback mechanism. This feedback comprise interactions between snow, permafrost, hydrology, and ecosystems, which include altered energy and water fluxes between atmosphere and land surface.

The representation of permafrost related processes in GCMs and ESMs is still rudimentary and needs to be extended to improve the climate model performance in high latitudes. In this sense thermokarst processes should be included into JSBACH, the land-surface component of MPI-ESM. Initially, a 1-D scheme of thermal dynamics will be implemented into JSBACH, which fits into very recent developments with regards to permafrost melting and freezing (T. Blome; Ekici et al., in prep.) and a dynamical wetland scheme (Stacke and Hagemann, 2012). Structural improvements and new parametrization of the model are required with regard to heat and water flow (physical processes) and carbon and nitrogen dynamics (bio-geochemical processes). The implementation of a thermokarst module is one task within the EU project PAGE21 and is a joint activity between MPI-M Hamburg and MPI-BGC Jena.

Thermokarst changes are coupled thermal-hydrological processes, which lead to an enhanced thawing of ice-rich permafrost on local-to-regional scales, where the soil structure is characterized by segregated ice and ice-wedges. They result in severe consequences for soil structure, hydrology, and depletion of soil organic carbon. Thermokarst affected areas appear as a very uneven surface of hummocks and marshy hollows. The initial heat balance of the surface is disturbed by different trigger mechanisms, which cause the ground ice to melt and the soil to subside into depressions due to developing cavities in the interior. The depressions fill up with melting and precipitating water. Since deeper water bodies do not freeze up entirely, the annual mean surface temperature increases in the soil beneath. Therefore permafrost thawing is continued and depressions grow further due to soil subsidence and slope wash at the margins until a new soil surface heat balance is reached.

Here I'd like to give a short overview and an introduction into the ongoing thermokarst process in the Arctic tundra. The main focus will be on investigating the actual distribution of thermokarst lakes in the high northern latitudes. The development of thermokarst lakes depends on soil parameters like ice content, surface temperature, soil texture as well as on climate states like monthly mean temperature, precipitation, winter snow depth. They contribute to the surface heat balance and may serve as a measure for thermokarst potential. Since thermokarst mechanism is a small-scale process of 10-1000m in spatial extent, it needs to be parametrized for GCM applications on ESM grid scale. Thus, we want to derive the thermokarst distribution as a function of climate and soil parameters.