Geophysical Research Abstracts
Vol. 17, EGU2015-11471-1, 2015
EGU General Assembly 2015

Transient modeling of the hydro-thermal state of frozen ground in the sub-arctic catchment of Tarfala, Sweden.

Romain Pannetier and Andrew Frampton
Department of Physical Geography, Stockholm University, Stockholm, Sweden

A need for improvements in numerical models for the representation of permafrost and active layer dynamics has been highlighted. Initial efforts to address this have been made, in particular by coupling heat and multiphase flow equations under transient conditions. Implications of honoring the physical representation of such process includes an improved ability to model and analyze the effect of ongoing changes in hydro-climatic variables, as for example the change in permafrost's thermal regime and active layer's dynamic.
In this contribution, the recently developed frozen ground module of PFLOTRAN for fully coupled transient heat and water flow under partially saturated conditions is applied to the subarctic field site of Tarfala in Northern Sweden. Optimizing this model to reproduce subsurface temperature fluctuations in the ground, as recorded in two different boreholes over the last decade, allows to identify the respective roles played by heat diffusion, advection and convection in a changing permafrost environment.

Three simulation configurations are studied using 1D and simplified 2D representations of the subsurface. For each of them, different temperature forcing schemes are applied. Additionally, in the case where infiltration is represented, different snow-melt scenarios are implemented, hence allowing to discriminate between the effects of air temperature changes and shifts in hydrological patterns. The present study focuses on reproducing the site's documented permafrost warming and its active layer dynamics in order to find an explanatory mechanism to the near stagnation of the active layer's depth in a context of important increase in permafrost temperatures.

Preliminary results indicate the model's ability to successfully reproduce the ground temperature warming and show no clear trend in active layer's depth. Besides, a systematic underestimation of the simulated active layer's depth is observed, which likely originates from the advection of spring-flow related heat being delayed. This highlights the importance of heat advection by meltwater and soil's hydrological properties the accurate prediction of active layers depth.