Coupling the models GEOtop (2-D surface) and COMSOL (3-D subsurface) in a case study for the Swiss borehole site Schilthorn

J. Noetzli (1), S. Gruber (1), M. Dall'Amico (2), and S. Endrizzi (2)

(1) University of Zurich, Department of Geography, Zurich, Switzerland (jnoetzli@geo.uzh.ch), (2) Department of Civil and Environmental Engineering, University of Trento, Italy

In mountain permafrost, temperature measurements are only feasible at a number of selected sites and their extrapolation in space and time is difficult because of high lateral variability of micro climate and ground conditions. The assessment of the distribution and evolution of ground temperatures in Alpine regions therefore relies to a large part on numerical modeling. Here, a sound calculation of the spatial distribution of near surface temperatures (including the simulation of the snow cover) and their coupling to a model for the deeper subsurface are key challenges. Both, the development of coupling strategies of corresponding models and their application to real topographies are currently subject to research.

At the Schilthorn Crest, one of the most prominent research sites for mountain permafrost in the Swiss Alps, a recent case study was performed to model the subsurface thermal field at the boreholes site: below ground temperatures were simulated based on measured near-surface temperatures and a heat conduction model using the measurements as upper boundary condition. The heat conduction equation was solved within the software package COMSOL Multiphysics. Comparison of modeling results to temperature profiles measured in two 100 m deep boreholes and electrical resistivity tomography profiles were encouraging. By continuing this case study and extending the modeling procedure applied, we do not use measured near-surface temperatures as upper boundary condition, but combine the subsurface heat conduction model with the 2-D version of the GEOtop model.

GEOtop is a distributed hydrological model, which solves coupled water and energy budgets. The model is currently under development for use in mountain permafrost research and its 1-D version has been validated and applied at several sites in the Swiss, Italian, and Austrian Alps. In this study, we use its 2-D mode and questions on how it performs to simulate spatially distributed have to be considered and tested. This can be achieved by validating against available near-surface temperature measurements and data from the boreholes.