Submitted Abstract

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Abstract

The increased rockfall activity in high Alpine ranges observed during the last two decades is commonly attributed to permafrost degradation associated with atmospheric warming. Although the connection between mountain permafrost thawing and rockfall initiation is intuitive and supported by field and lab observations, the physical processes behind it are still poorly understood. In this study, we focus on the role of hydrologic and thermal processes acting in fractures of steep Alpine permafrost-affected bedrock.

We use a unique set of decadal field measurements which include subsurface and borehole temperatures and snow depth time series, from a high elevation Alpine site in the Mont Blanc massif (Aiguille du Midi, 3842 m a.s.l) to calibrate a permafrost surface energy balance model that is coupled with snow pack simulations (CryoGrid), and apply it to the complex topographic settings on a steep rock slope. The model provides first-order quantification of the potential water equivalent snow melt that is available for infiltration in rock fractures.

Preliminary results from a south facing slope show 3 orders of magnitude of variability in annual excess water amounts, with maximum amounts approaching 100 mm/yr. In addition, snow melt volume is predominantly produced between April to June (>95%).

The new snow melt data, together with available meteorological data will be used in a coupled thermal and hydrologic model (FEFLOW) to simulate groundwater flow and heat transport in fractured rock. We expect that our findings will give better understanding of how hydrological processes affect subsurface temperature patterns, which are commonly simulated using simple thermal conduction processes and ignore water flow, as well as its influence on the local stress field and slope stability.

The results of this study will help us decipher the governing processes in the degradation of high mountain permafrost and its link with rockfall occurrence.