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Transient modelling of ground temperatures in idealised high mountain topography

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During the past century, Alpine permafrost in Europe has warmed by 0.5 to 0.8 °C in the upper tens of meters. Permafrost degradation is regarded as a crucial factor influencing the stability of steep rock faces, and calls for the localisation of zones that exhibit critical temperature changes or are subject to thaw. However, knowledge about the temperature distribution and evolution at, and particularly below, the surface of steep rock still remains limited.

Due to the complex and highly variable conditions in high mountain topography, the project presented concentrates on numerical experimentation using typical idealised geometries such as ridges, peaks or spurs. The investigation of ground temperatures beneath such topography needs to account for 2- and 3-dimensional effects, since strong lateral components of heat fluxes exist that are caused by geometry and variable surface temperatures. The experimentation is conducted applying a surface energy-balance model (TEBAL) to determine surface temperatures, together with a 3-dimensional ground heat-conduction scheme (FRACTure), both especially designed for use in complex topography. Following investigations of the subsurface temperature distribution under influence of complex topography in steady state conditions, the energy balance model is forced with temperature scenarios to investigate the impact of changing atmospheric conditions. Transient effects of the subsurface thermal state, as well as depth scales involved, are examined therewith.

Results may contribute to indentifying areas especially sensitive to permafrost degradation and will be also beneficial for the assessment of hazards, as well as the interpretation of temperature profiles from deep boreholes in ongoing permafrost monitoring programmes.