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Modelling mass movement on periglacial slopes

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Thawing of ice-rich soils leads to significant loss of strength associated with high moisture contents and raised pore pressures. In consequence, solifluction and more localised shallow slope failures are frequently the dominant mechanisms of sediment transport on periglacial slopes. Here we report on integrated field monitoring, physical modelling at full-scale in the laboratory, scaled physical modelling in the geotechnical centrifuge, and coupled thermal-hydraulic-mechanical (THM) numerical modelling designed to predict the nature and rates of solifluction and related periglacial mass movements. The numerical modelling is validated against two field monitoring stations, one in a non-permafrost site at Dovrefjell, Norway and the second in Svalbard, where permafrost is continuous. Model calibration is against ongoing laboratory slope simulations undertaken at full-scale in the CNRS Cold Laboratories, Caen, France, and at reduced scale in the Cardiff University Geotechnical Centrifuge Laboratory. Laboratory experiments are designed to simulate active layer freezing and thawing under non-permafrost and under permafrost thermal conditions. The physical models allow excellent control of boundary conditions and material properties that is not available under field conditions. In this paper we present results from the field and laboratory, and report briefly on numerical modelling approaches. In the longer term it is hoped that integration of environmental data with process-based numerical modelling of mass movement will allow prediction of sediment transport rates in the context of the interaction between changing climate and complex spatial variations in topographical, hydrological and geotechnical terrain parameters.