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Cross validation of a multi-modal dataset describing temperature-induced rock slope dynamics

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Rock slope destabilization due to warming or thawing permafrost poses a risk to the safety of local communities and infrastructure in populated mountain regions. The analysis of fracture kinematics in the context of local temperature evolution in the longer-term is a common approach aiming to identify its forcing (e.g. Wegmann and Gudmundsson, 1999, Matsuoka and Murton, 2008, Blikra and Christiansen, 2014). Hasler et al. (2012) and Weber et al. (2017) analyzed fracture dilatation data measured at Matterhorn Hörnligrat at 3500 m a.s.l. and suggest thawing related processes, such as meltwater percolation into fractures to cause irreversible displacement. However, this finding so far has not been backed up by data from different instruments or analysis methods. Hence, misinterpretation of the existing data can not reliably be excluded. Based on further data consisting of surface displacements measured with D-GPS, inclinometers, ambient seismic vibrations and ground resistivity captured and compiled over a period of ten years, we apply a multi-data cross validation technique to detect and quantify temperature-induced rock slope dynamics and identify the components of derived process knowledge that predict behaviour across differing observation methods. The combined analysis of this multi-modal dataset allows to further develop and analyse our limited understanding of the dominant processes governing rock slope stability, in our case a steep bedrock mountain permafrost buttress.

Based on this evidence we conclude that the kinematics observed at the surface in the winter/re-freezing period is negligible compared to those observed during spring initiated by the thawing and mobilization of fluid water w.r.t. to destabilization and precursory signs of rockfall at a larger scale. Therefore, future research should focus on the quantification of water supply, distribution and mobility both in the frozen and fluid state.

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