Processes destabilising recently deglaciated rockwalls, driving cirque headwall retreat, and putting high alpine infrastructure at risk are poorly understood due to a lack of in situ monitoring data. Here we present quantitative data from an unstable, recently deglaciated cirque headwall at the north face of the Kitzsteinhorn (3203 m a.s.l.). Based on 2.5 years of monitoring fracture dynamics, this study aims to decipher and quantify stability-relevant processes and their temporal occurrence, and addresses the following research questions:

(i) Are fracture dynamics dominated by thermomechanical expansion/contraction of the inter-cleft rock mass?
(ii) Do cryogenic processes, i.e. freeze-thaw dynamics and ice segregation, affect fracture opening/closing?
(iii) Can irreversible crack deformation patterns and destabilisation be observed?

Conclusions

(i) Fracture dynamics are dominated by thermomechanical expansion and contraction of the inter-cleft rock mass during snow-covered and snow-free periods. Thermal expansion coefficients of 7 x 10^-6°C along and 14 x 10^-6°C perpendicular to foliation highlight strong anisotropy of the calcareous mica-schist.

(ii) Significant deviations from the thermomechanical deformation regime occur mainly during spring and autumn zero curtain periods due to freeze/thaw action. Lower magnitude deviations arise in autumn and early winter probably due to segregation ice growth. Besides cryogenic processes, other mechanisms may affect fracture dynamics such as wedged rock fragments impeding maximum fracture-closing during snowfree periods.

(iii) Irreversible fracture opening as precursor of high magnitude rock slope instability was not observed. Instead, enhanced cryogenic deformation in spring and autumn may lead to shallow, lower magnitude rock slide detachments.

Our results highlight the importance of liquid water intake in combination with subzero-temperatures on the destabilisation of glacier headwalls. Rockfall systems may favour intense frost action and ice segregation, serving as important preparatory factors of paraglacial rock slope instability.

References