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Measuring and mapping rock wall permafrost across Norway

Florence Magnin (1,2), Bernd Etzelmuller (1), Paula Hilger (3), Sebastian Westermann (1), Ketil Isaksen (4), and Reginald Hermans (3)

(1) Department of Geosciences, University of Oslo, 0316 Oslo, Norway (florence.magnin@geo.uio.no), (2) Université de Savoie, EDYTEM Lab - CISM - Pole Montagne, Le Bourget du Lac, France , (3) Geohazard and Earth Observation Group, Geological Survey of Norway, 7491 Trondheim, Norway, (4) Norwegian Meteorological Institute, 0313 Oslo, Oslo, Norway

The investigation of rock wall permafrost is of high relevance for geohazards assessment and for understanding cold-climate landscape evolution since its changes over time can cause slope instability and trigger rock falls. The destabilization of steep slopes is a serious threat to human activities and lives in Norway, especially because most of rock walls lie directly above houses, infrastructures and large water bodies with potential of high-energy displacement waves.
Rock wall permafrost has been investigated since the early 2010s in alpine massifs of western Norway thanks to the CryoLINK project (2008-2011). The CryoWALL project (2015-2019) aims at extending this preliminary study to the nation-wide scale. It consists in systematic measurements of rock surface temperature (RST) in order model and to map the spatial distribution of rock wall permafrost. In between August 2015 and August 2016, 20 RST loggers (Geoprecision mini data loggers, accuracy $\pm$ 0.1°C, precision 0.01°C, sensors PT1000) were installed at 10 cm depth of 7 selected sites. These loggers are distributed along a latitudinal transect (from 60°50'N to 69°46'N), cover various elevations and sun-exposures, and are completed by 4 other loggers installed in Jotunheimen in 2009 and 2010.
The RST time series are used for (a) characterizing the distribution of rock wall permafrost across Norway, (b) running steady-state and transient numerical models of rock wall permafrost at selected sites, and to (c) calibrate a general linear regression model that will be used to (d) predict the spatial distribution of rock wall permafrost at the national scale.
In this communication we will introduce the RST measurement installations and sites, as well as the first RST records that encompass 6 years of continuous measurements in Jotunheimen, and 1 year of record for 13 other loggers. The preliminary analysis shows that RST differs by 3°C between N and S faces in Southern Norway, with mean annual RST as low as -1.9°C at 1700 m a.s.l in a N face (Nordfjord, Sogn of Fjordane) during the measurement year which was about 0.8°C above normal (1981-2010). In Northern Norway, the RST difference between N and S faces is rather around 1.5°C due to the midnight sun and polar night effects, inducing similar RST in both aspects during December, January, May and June. Negative mean annual RST is found as low as 1200 m a.s.l in S-exposed faces (Kåfjorden, Troms) during the measurement year which was 1.1°C above normal in this area. The ice and snow coating the rock faces during winter appears as a significant warming factor that can raise the mean annual RST up to at least 1°C compared to bare rock conditions. This first data set is shown to be of high relevance for predictive modelling.