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Monitoring Permafrost at Hoher Sonnblick, Hohe Tauern, Austria

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Abstract

The Sonnblick Observatory at the summit of Hoher Sonnblick is an outstanding research station established in 1886. The initial motivation for permafrost monitoring at the summit of Hoher Sonnblick was the instability due to permafrost degradation that threatened local buildings and the associated stabilization work. The distribution of permafrost and its changes are under constant investigation at the Sonnblick and on the adjacent hill slope Wintergasse.

An extensive observation network for ground surface, shallow and deep borehole temperatures and geophysical measurements is established.

Keywords

Permafrost monitoring, borehole measurements, mountain permafrost, Hoher Sonnblick, geophysics

Introduction

Permafrost is soil, rock or sediment that is frozen for more than two consecutive years. In areas not constantly covered by ice, it exists beneath a layer of soil, rock or sediment, which freezes and thaws annually and is called the 'active layer'.

The distribution of permafrost and its changes are under constant investigation at the Sonnblick and on the adjacent hill slope Wintergasse since 2006. An extensive observation network for ground surface, shallow and deep borehole temperatures, snow monitoring and geophysical measurements is established (SCHÖNER 2012).
The main research questions are:

- spatial and seasonal distribution of the permafrost depending on altitude, slope inclination and exposition and subsoil
- changes in permafrost and possible impacts on the rock stability
- influence of mainly topographic parameters (altitude, slope inclination, exposition, vertical and horizontal curvature) as well as the lithological characteristics on the permafrost body
- effects of permafrost degradation on changes of rockfall events

Due to the heterogeneity and complexity of the surface and the subsoil characteristics of the alpine permafrost a multiple method approach is needed to determine the current permafrost distribution. To provide an accurate picture of the underlying processes and changes in the frozen soil the combination of different measurement methods from the projects PERSON-GCW, ATMOperm and SeisRockHT (Seismic Rockfall Monitoring in the Hohe Tauern Region (ÖAW ESS)) is applied.

Methods

Continuous temperature recordings from three 20 m deep boreholes located at the southern slope of Hoher Sonnblick are available since 2007, which represent the longest series of its kind in Austria. The 20 m deep boreholes are equipped with thermistor chains and geophones.
Within the investigation area 'Wintergasse' measurements of 'Near Surface Temperature' (NST) 'Ground-Surface Temperature' (GST) and 'Bottom Temperatures of the Snow cover' (BTS) are measured. NST and GST are measured with different kinds of temperature data loggers (e.g. UTL1, iButton, onset) and in order to measure temperatures in the uppermost layer of the ground and avoid heating by direct solar radiation the loggers were buried a few centimetres into the ground or installed in boreholes at depths between 2 cm and 140 cm. Each of the NST borehole openings is closed up with insulating foam to protect the measurements from atmospheric influences.
Furthermore, data from seismic and geoelectric measurements, terrestrial laserscanning and extensive meteorological observations are available at the Sonnblick Observatory.

Results

Results of our measurements are available at: www.sonnblick.net

Conclusion

The measurements in a high alpine terrain are posing a great challenge due to harsh weather conditions. Improving the data quality is still work in progress, requires man power for repairing the instruments around the observatory and for the correction of the measured data. An innovative method for the correction of the measured temperature of the active layer was developed within the ÖAW ATMOperm project (HEINRICH 2017).

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