



Applying the SNOWPACK model for permafrost investigations at Hoher Sonnblick, Austria

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The overarching aim of the ATMOperm project is to improve the understanding of the impacts of atmospheric extreme events on the thermal state of the active layer using a combined measurement and modelling approach as the basis for a long-term permafrost monitoring strategy. For this purpose, the Sonnblick Observatory at the summit of Hoher Sonnblick (3106 m a.s.l.) is particularly well-suited due to its extensive permafrost monitoring (i.a., three 20 m deep boreholes equipped with temperature sensors since 2007) and comprehensive long-term atmospheric monitoring network.

For the investigation of the impact of atmospheric extreme events on the active layer thickness (ALT), the one-dimensional physical based SNOWPACK model from the Swiss WSL Institute for Snow and Avalanche Research SLF (WSL/SLF) is used to determine the mass and energy exchange between the snow, the atmosphere and the soil. Manual snow depth measurements during 2016/2017 close to the location of the boreholes serve as basis for model calibration. For other years without snow depth measurements, the calibrated model will be evaluated in terms of snow disappearance date which can be inferred from borehole temperature measurements close to the surface. In a next step, the unknown soil properties will be calibrated based on the temporal evolution of error-corrected borehole temperatures in order to accurately represent the ALT. The calibrated model will then be driven by atmospheric input in order to investigate particular extreme cases such as the high summer temperatures in 2003.

As errors in the measured ground temperatures would further propagate into misleading modeling results, we will first highlight the importance of post-processing and correction of the borehole temperature measurements. In this respect, the quality and reliability of the measured ground temperature data at the study site is improved and a novel methodological framework for the post-processing of the borehole temperature data is developed and presented. Moreover, we will show first results concerning model calibration and its evaluation and further analyze the modelled active layer thickness for selected observed extreme cases. Finally, we will discuss our strategy in investigating long-term changes in the mean state of the active layer and associated extreme events.