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A comparison between modeled and measured permafrost temperatures at Ritigraben borehole, Switzerland

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The area-wide distribution of permafrost is sparsely known in mountainous terrain (e.g. Alps). Permafrost monitoring can only be based on point or small scale measurements such as boreholes, active rock glaciers, BTS measurements or geophysical measurements. To get a better understanding of permafrost distribution, it is necessary to focus on modeling permafrost temperatures and permafrost distribution patterns. A lot of effort on these topics has been already expended using different kinds of models.

In this study, the evolution of subsurface temperatures over successive years has been modeled at the location Ritigraben borehole (Mattertal, Switzerland) by using the one-dimensional snow cover model SNOWPACK. The model needs meteorological input and in our case information on subsurface properties. We used meteorological input variables of the automatic weather station Ritigraben (2630 m) in combination with the automatic weather station Saas Seetal (2480 m). Meteorological data between 2006 and 2011 on an hourly basis were used to drive the model.

As former studies showed, the snow amount and the snow cover duration have a great influence on the thermal regime. Low snow heights allow for deeper penetration of low winter temperatures into the ground, strong winters with a high amount of snow attenuate this effect. In addition, variations in subsurface conditions highly influence the temperature regime. Therefore, we conducted sensitivity runs by defining a series of different subsurface properties.

The modeled subsurface temperature profiles of Ritigraben were then compared to the measured temperatures in the Ritigraben borehole. This allows a validation of the influence of subsurface properties on the temperature regime. As expected, the influence of the snow cover is stronger than the influence of sub-surface material properties, which are significant, however. The validation presented here serves to prepare a larger spatial simulation with the complex hydro-meteorological 3-dimensional model Alpine 3D, which is based on a distributed application of SNOWPACK.