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Large-scale modelling permafrost distribution in Ötztal, Pitztal and Kaunertal (Tyrol)

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Permafrost is an important element of the global cryosphere, which is seriously affected by climate change. Due to the fact that permafrost is a mostly invisible phenomenon, the area-wide distribution is not properly known. Point measurements are conducted to get information, whether permafrost is present at certain places or not. For an area wide distribution mapping, models have to be built and applied. Different kinds of permafrost distribution models already exist, which are based on different approaches and complexities. Differences in model approaches are mainly due to scaling issues, availability of input data and type of output parameters. In the presented work, we want to map and model the distribution of permafrost in the most elevated parts of the Ötztal, Pitztal and Kaunertal, which are situated in the Eastern European Alps and cover an area of approximately 750 km2. As air temperature is believed to be the best and simplest proxy for energy balance in mountainous regions, we took only the mean annual air temperature from the interpolated ÖKLIM dataset of the Central Institute of Meteorology and Geodynamics to calculate areas with possible presence of permafrost. In a second approach we took a high resolution digital elevation model (DEM) derived by air-borne laser scanning and calculated possible areas with permafrost based on elevation and aspect only which is an established approach among the permafrost community since years. These two simple approaches are compared with each other and in order to validate the model we will compare the outputs with point measurements such as temperature recorded at the snow-soil interface (BTS), continuous temperature data, rock glacier inventories, geophysical measurements. We show that the model based on the mean annual air temperature ($\leq$ -2°C) only, would predict less permafrost in the northerly exposed slopes and in lower elevation than the model based on elevation and aspect. In the southern aspects, more permafrost areas are predicted, but the overall pattern of permafrost distribution is similar. Regarding the input parameters, their different spatial resolutions and the complex topography in high alpine terrain these differences in the results are evident.

In a next step these two very simple approaches will be compared to a more complex hydro-meteorological three-dimensional simulation (ALPINE3D). First a one-dimensional model will be used to model permafrost presence at certain points and to calibrate the model parameters, further the model will be applied for the whole investigation area. The model output will be a map of probable permafrost distribution, where energy balance, topography, snow cover, (sub)surface material and land cover is playing a major role.