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Distributed hydrological modelling in a permafrost catchment - on the value of geophysical information

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Alpine permafrost is prone to decrease in a warmer climate as a consequence of climate change which in turn may affect the runoff regime of high alpine catchments. In the presented case study detailed geophysical field investigations were performed in a 5 km2 large catchment in Western Austria to gain information about subsurface properties and permafrost occurrence. Ground penetrating radar, seismic refraction and ground-surface-temperature measurements were applied to map the spatial permafrost distribution, depths to the permafrost table and bedrock interface. This information was used to infer subsurface flow paths concepts for different geologic formations in the presence and absence of permafrost. The concepts were then used to set up a rainfall-runoff model and simulate the runoff response of the catchment for scenarios with and without permafrost. The results of the study show that geophysical information helps to improve the understanding of subsurface processes and to reduce the parameter identifiability problem. Subsurface model parameters are well constrained by the available field information and require little calibration. Furthermore, the simulations indicate that the melting of permafrost increases the available catchment storage which causes a reduction of flood peaks and an increase of runoff during recession. A reduction of extreme events is important since it may also affect flood events in downstream catchments.