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Alpine karst and its influence on the water balance at regional scale. A case study: Modeling the water balance in the Berchtesgaden National Park

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Alpine catchments at regional scale as water recharge areas are important for ecology, agriculture, economy, water supply and lowland river flow dynamics. In the context of integrated water resource management, it is important to gain information about water availability and dynamics to be prepared to find adequate measurements in case of shortages or climate change impact.
However, the water balance in high alpine regions is often affected by a significant variation of meteorological variables in space and time, a complex hydrogeological situation and a heterogeneous snow cover dynamics. If the rock composition is dominated by soluble limestone, the system is even more complex as various unknown underground flow conditions – low diffuse flow and fast matrix flow- and underground flow directions lead to unknown storage quantities. Missing parametrization in karst catchments at regional scale prevents reliable hydrological modeling of subsurface (unsaturated and saturated) water fluxes and consequently, climate impact modeling in karst dominated catchments is until today unssufficient.
The current research project aims to describe the water balance in the alpine catchment of the river “Berchtesgadener Ache” with the deterministic model WaSiM-ETH to determine and generally quantify karst impact on the hydrological processes within the watershed. The test site for our study covers 430 km2, is situated within the Berchtesgaden Alps, Germany and is characterized by extreme topography with mountain ranges covering an altitude from 607 to 2713 m a.s.l..
In a first step, several tracer and isotope experiments of the area were evaluated to gain information about the impact of the karst aquifer and its main subsurface drainage channels on the hydrology of the Berchtesgaden Alps. Furthermore we found, that measured runoff within the watershed differs significantly in between head -subcatchments, which may be a result of water inflow or outflow due to karst impact. Consequently, model runs with WaSiM-ETH show systematic over and underestimation of discharge at subcatchment-scale. By evaluation of the model bias, the assumed water inflow and outflow can be quantified with the distributed model in different time and space scales. This knowledge helps to deepen system understanding and to improve in a next step the distributed model WaSiM-ETH for alpine karst-dominated catchments. The final step is to force the model with scenario data of regional climate models to predict future changes in the water balance.