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Snow cover dynamics and water balance in complex high alpine terrain

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The water balance in high alpine regions in its full complexity is so far insufficiently understood. High altitudinal gradients, a strong variability of meteorological variables in time and space, complex hydrogeological situations, unquantified lateral snow transport processes and heterogenous snow cover dynamics result in high uncertainties in the quantification of the water balance.

To achieve interpretable modeling results we have complemented the deterministic hydrological model WaSiM-ETH with the high-alpine specific snow model AMUNDSEN. The integration of the new snow module was done to improve the modeling of water fluxes influenced by the dynamics of the snow cover, which greatly affect the water cycle in high alpine regions. To enhance the reproduction of snow deposition and ablation processes, the new approach calculates the energy balance of the snow cover considering the terrain-dependent radiation fluxes, the interaction between tree canopy and snow cover as well as lateral snow transport processes.

The test site for our study is the Berchtesgaden National Park which is characterized by an extreme topography with mountain ranges covering an altitude from 607 to 2713 m.a.s.l. About one quarter of the investigated catchment area, which comprises 433 km^2 in total, is terrain steeper than 35°. Due to water soluble limestone being predominant in the region, a high number of subsurface water pathways (karst) exist. The results of several tracer experiments and extensive data of spring observations provide additional information to meet the challenge of modeling the unknown subsurface pathways and the complex groundwater system of the region. The validation of the new snow module is based on a dense network of meteorological stations which have been adapted to measure physical properties of the snow cover like snow water equivalent and liquid water content.

We will present first results which show that the integration of the new snow module generates a considerable improvement in modeling the spatial and temporal distribution of the snow cover and an enhanced reproduction of the runoff dynamics influenced by melting snow.