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Hydrological modeling of snow cover in forested mountain regions applying a canopy energy balance model in WaSiM

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Due to their ability to store large amounts of water as snow and ice, the Alps are often called Europe's water towers. Considering this key function of the Alps, it is obvious that the correct assessment of snow water equivalent (SWE) stored in mountainous snow covers is a crucial task for hydrological simulations of alpine regions. Montane areas of the northern Alps are characterized by their strong forest cover. To a large extent this vegetation cover consists of evergreen coniferous tree species, which effectively separate the sub-canopy space from the ambient meteorological conditions and therefore heavily affect the different energy fluxes to an underlying snow cover during winter. Besides snow-canopy interception processes these alterations to the prevailing energy fluxes imply the biggest impact of canopies to snow cover conditions in forests. As a result, accumulation and ablation periods in forested montane and subalpine areas differ strongly from non-forested alpine regions. Therefore the consideration of a canopy energy balance model leads to a more accurate computation of energy fluxes into underlying snow packs.

In order to model the energy balance of a snow cover under a canopy, the canopy temperature is of interest, as it determines the amount of incoming long-wave radiation and affects the sub canopy meteorological conditions. Energy balance models of snow covers, used in spatially distributed hydrological simulations usually consider the canopy temperature to be equal to the ambient temperature. While this approximation is suitable for catchments that are not dominated by snow processes, the modeling of catchments containing montane and subalpine forests should take into account the correct canopy temperature. The physical correct canopy temperature can be obtained by solving an energy balance for the forest canopy. The results lead to more realistic long-wave radiation input data for the snow cover energy balance. Physically based hydrological models, like WaSiM, feature snow cover energy balance methods as well as snow canopy interception processes, but the computation of a canopy energy balance for the assessment of a physically based canopy temperature is still neglected.

Within the scope of this presentation we demonstrate the impact of the application of a canopy energy balance on (snow)hydrological model results in WaSiM. The analysis is carried out utilizing measurements from the experimental catchment of the Dreisäulerbach in the Bavarian Alps.