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Glacier melt contribution to the runoff in Alpine catchments

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Water availability of glacierized catchments significantly depends on glacier retreat and snowmelt. Consequently, downstream activities of glacierized catchments (e.g., hydropower production, agricultural management, and recreational activities) are controlled by runoff from snow- and ice-melt. A glacio-hydrological model, however, is needed to correctly predict the runoff amount and timing. In this study, we added a glacier module to the gro-hydrologic Soil and Water Assessment Tool (SWAT) program. The glacier module consists of ablation, accumulation, and glacier evolution components. We examined the improvements in the simulated runoff using the coupled glacier-SWAT model by testing it at the Gorner and Aletsch glacierized catchments in the Swiss Alps. We showed that by calibrating precipitation and temperature lapses as well as snow parameters such as snowpack temperature lag factor and snowfall temperature, SWAT could produce very acceptable discharge simulations (NSE=0.92). This, however, came at the expense of greatly overestimating precipitation lapse (a range of 180 to 195 mm/km was obtained). Using glacier-SWAT model we obtained reasonably simulated discharge (NSE=0.92) with realistic precipitation lapse rate of 1 to 5 mm/km. We also investigated the ice loss in the two catchments. For the Gorner catchment, we found a loss of 1.52 ckm in ice volume from an initial volume of 5.68 ckm in 1982 accounting for a 24% loss in 26 years. For the Aletsch catchment, the glacier-SWAT model simulated a 1.84 ckm ice loss from the 1982 volume of 18.7 ckm.