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Improving Snow Process Modeling with Satellite-Based Estimation of Near-Surface-Air-Temperature Lapse Rate

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In distributed hydrological modeling, surface air temperature (Tair) is of great importance in simulating cold region processes, while the near-surface-air-temperature lapse rate (NLR) is crucial to prepare Tair (when interpolating Tair from site observations to model grids). In this study, a distributed biosphere hydrological model with improved snow physics (WEB-DHM-S) was rigorously evaluated in a typical cold, large river basin (e.g., the upper Yellow River basin), given a mean monthly NLRs. Based on the validated model, we have examined the influence of the NLR on the simulated snow processes and streamflows. We found that the NLR has a large effect on the simulated streamflows, with a maximum difference of greater than 24 % among the various scenarios for NLRs considered. To supplement the insufficient number of monitoring sites for near-surface-air-temperature at developing/undeveloped mountain regions, the nighttime MODIS LST is used as an alternative to derive the approximate NLR at a finer spatial scale (e.g., at different elevation bands, different land covers, different aspects, and different snow conditions). Using satellite-based estimation of NLR, the modeling of snow processes has been greatly refined. Results show that both the determination of rainfall/snowfall and the snow pack process were significantly improved, contributing to a reduced summer evapotranspiration and thus an improved streamflow simulation.