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Assessment of Noah model physics and various runoff parameterizations over a Tibetan River

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Noah model physics options validated for the source region of the Yellow River (SRYR) are applied to investigate their ability in reproducing runoff at the catchment scale. Three sets of augmentations are implemented affecting the descriptions of i) turbulent and soil heat transport (Noah-H), ii) soil water flow (Noah-W) and iii) frozen ground processes (Noah-F). Five numerical experiments are designed with the three augmented versions, a control run with default model physics and a run with all augmentations (Noah-A). Further, runoff parameterizations currently adopted by the i) Noah-MP model, ii) Community Land Model (CLM), and iii) CLM with variable infiltration capacity hydrology (CLM-VIC) are incorporated into the structure of Noah-A, and four additional numerical experiments are designed with the three aforementioned and the default Noah runoff parameterizations within the Noah-A. Each experiment is forced with 0.1o atmospheric forcing data from Institute of Tibetan Plateau Research, with vegetation and soil parameters adopted from Weather Research and Forecasting dataset and China Soil Database. In addition, the Community Earth System Model database provides the maximum surface saturated area parameter for the Noah-MP and CLM parameterizations. Each model run is initialized using a single-year recurrent spin-up to achieve the equilibrium model states. The results highlight that i) a complete description of vertical heat and water exchanges is necessary to correctly simulate the runoff at the catchment scale, and ii) the soil water storage-based parameterizations (Noah-A and CLM-VIC) outperform the groundwater table-based parameterizations (Noah-MP and CLM) in the seasonally frozen and high altitude SRYR.