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Developing a distributed hydrological model driven, calibrated, and validated primarily by multi-source remote sensing data in high-mountain regions of the Tibetan Plateau

Di Long, Mingda Du, Pengfei Han, Wenting Yang, Qi Huang, and Xingdong Li
Tsinghua University, Department of Hydraulic Engineering, Beijing, China (dlong@tsinghua.edu.cn)

Distributed hydrological models are powerful tools to understand hydrological processes in high-mountain regions with marked cryospheric processes. Use of distributed hydrological models over most of cryospheric basins is, however, largely subject to uncertainties in forcing data and model parameters due to lack of in situ measurements to well calibrate and constrain the models. In particular, in situ river discharge measurements are traditionally indispensable for model calibration in most of gauged basins, but it is really challenging to do so over ungauged or poorly gauged basins. We developed a distributed hydrological model that uses primarily multi-source remote sensing data, including passive microwave remote sensing-based snow depth, optical remote sensing-based snow cover, Gravity Recovery And Climate Experiment (GRACE)-derived total water storage (TWS) changes, and radar altimetry-based water level heights, in combination with partial in situ measurements of snow density and river discharge to jointly calibrate the developed hydrological model. Simulations of river discharge, snow water equivalent, and glacier mass changes were evaluated using the remote sensing-based observations during the model validation period. This model was applied to the entire Brahmaputra River basin originating on the Tibetan Plateau (TP), with the contributions of snow and glacier meltwater to the total runoff quantified thoroughly. The developed multi-source remote sensing-based hydrological model is valuable in improving our understanding of cryospheric processes over transboundary river basins originating on the TP and potentially other poorly gauged basins globally.