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Informing regionalization with a limited number of runoff measurements: a large-sample study

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Prediction of runoff in ungauged catchments often relies on some form of parameter regionalization. Alternatively, it has been demonstrated that a limited number of runoff measurements taken at strategic points in time in the ungauged target catchment can already be informative for parameter estimation. We therefore hypothesize that informing parameter regionalization with strategically taken runoff measurements could improve runoff predictions in otherwise ungauged catchments. The proposed approach was tested using the bucket-type HBV model and an extensive dataset of 579 gauged catchments in the U.S. spanning a wide range of hydroclimates and topographical characteristics. A set of 100 parameter sets derived for each catchment using a genetic calibration algorithm formed the basis of the subsequent regionalization analysis. In a first step, each catchment was once treated as ungauged and five donor catchments were selected based on either spatial proximity or catchment similarity. In a second step, the 100 calibrated parameter sets from each selected donor catchment were used to simulate runoff in the ungauged catchment. Finally, the mean square error was calculated between the simulated hydrographs and a limited number of observed runoff samples from the otherwise ungauged catchment. An ensemble mean hydrograph was computed by weighting each simulation based on the error performance. Results demonstrate that runoff samples added information to the regionalization in most cases with an improvement in model efficiencies in up to 90 % of the study catchments. In contrast, samples could be disinformative in many catchments when selected in suboptimal years. For these less informative years, the value of runoff samples for the regionalization increased with increasing number of samples. Overall, runoff samples tended to be especially effective in catchments with water-limited conditions, a high fraction of precipitation falling as snow, or a high fraction of wetlands.