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Parameter values for ungauged catchments - comparing regionalization approaches using large-sample hydrology

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The parameterization of hydrological models in ungauged catchments remains challenging. However, the increased availability of large-sample data sets in recent years provides new opportunities for regionalization. In this study, we use the CAMELS dataset and the HBV model to simulate daily runoff in nearly 600 catchment areas in the United States. In a first step, a lower and an upper benchmark were derived to obtain an approximation for how poor or how good runoff simulation could get in each of the catchments. For the upper benchmark the HBV model was calibrated, and the calibrated parameter values were related to catchment characteristics. To account for parameter uncertainty, 100 independent calibrations were performed, and then median efficiency values were used for further analyses. For the lower benchmark the HBV model was run for 1000 randomly selected parameter sets, and median efficiency values were again used for further analyses. In a second step, each catchment was treated as ungaued and its parameter values were estimated by multiple regionalization methods. For each regionalization method donor catchments were selected based on a certain criterion including spatial proximity, similarity of hydrological signatures or attribute similarity. Additionally, we tested the added value of single discharge observations, which could be collected during short field visits. Furthermore, to analyze the theoretical limits of regionalization in general, the best three available donors of each receiver catchment were directly used to run simulations. All regionalization approaches were evaluated based on their relative performance with regard to the upper and lower benchmark.
First results indicated that the use of an ensemble of parameter sets calibrated in one of the gauged catchments leads to clearly better simulations than the use of randomly selected parameter values. Using the best three donor catchments resulted in nearly as good simulations as the upper benchmark, showing that regionalization has a high potential as long as we find a way to select these most suitable donors. The regionalization approach coming closest to the upper benchmark was based on a combination of spatial proximity and the use of single discharge measurements. Yet, there was still a considerable gap to the performance of using the best three donors. Despite the potential of regionalization demonstrated in this study, there still remains the challenge to find more reliable ways to link the hydrological functioning of catchments with the

similarity of model parameter values.