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Multiscale Parameter Regionalization for consistent global water resources modelling

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Due to an increasing demand for high- and hyper-resolution water resources information, it has become increasingly important to ensure consistency in model simulations across scales. This consistency can be ensured by scale independent parameterization of the land surface processes, even after calibration of the water resource model. Here, we use the Multiscale Parameter Regionalization technique (MPR, Samaniego et al. 2010, WRR) to allow for a novel, spatially consistent, scale independent parameterization of the global water resource model PCR-GLOBWB. The implementation of MPR in PCR-GLOBWB allows for calibration at coarse resolutions and subsequent parameter transfer to the hyper-resolution.

In this study, the model was calibrated at 50 km resolution over Europe and validation carried out at resolutions of 50 km, 10 km and 1 km. MPR allows for a direct transfer of the calibrated transfer function parameters across scales and we find that we can maintain consistent land-atmosphere fluxes across scales. Here we focus on the 2003 European drought and show that the new parameterization allows for high-resolution calibrated simulations of water resources during the drought. For example, we find a reduction from 29% to 9.4% in the percentile difference in the annual evaporative flux across scales when compared against default simulations. Soil moisture errors are reduced from 25% to 6.9%, clearly indicating the benefits of the MPR implementation. This new parameterization allows us to show more spatial detail in water resources simulations that are consistent across scales and also allow validation of discharge for smaller catchments, even with calibrations at a coarse 50 km resolution.

The implementation of MPR allows for novel high-resolution calibrated simulations of a global water resources model, providing calibrated high-resolution model simulations with transferred parameter sets from coarse resolutions. The applied methodology can be transferred to other global hydrological models to allow for improved consistency across scales in water resources simulations.