EGU21-11704
https://doi.org/10.5194/egusphere-egu21-11704
EGU General Assembly 2021

Can hydrological model identifiability be improved? Stress-testing the concept of stochastic calibration

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Hydrological calibrations with historical data are often deemed insufficient for deducing safe estimations about a model structure that imitates, as closely as possible, the anticipated catchment behaviour. In order to address this issue, we investigate a promising strategy, using as drivers synthetic time series, which preserve the probabilistic properties and dependence structure of the observed data. The key idea is calibrating a model on the basis of synthetic rainfall-runoff data, and validating against the full observed data sample. To this aim, we employed a proof of concept on few representative catchments, by testing several lumped conceptual hydrological models with alternative parameterizations and across two time-scales, monthly and daily. Next, we attempted to reinforce the validity of the recommended methodology by employing monthly stochastic calibrations in 100 MOPEX catchments. As before, a number of different hydrological models were used, for the purpose of proving that calibration with stochastic inputs is independent of the chosen model. The results highlight that in most cases the new approach leads to stronger parameter identifiability and stable predictive capacity across different temporal windows, since the model is trained over much extended hydroclimatic conditions.