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Calibration validation revisited or how to make better use of available data: Sub-period calibration

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Parameter identification of conceptual hydrological models depends largely on calibration, as model parameters are typically non-measurable quantities. For hydrological modeling the identification of “realistic” parameter sets is a key objective. As a model is intended to be used for prediction in future it is also crucial that the model parameters be time transposable. However, previous studies showed that the “best” parameter set can significantly vary over time.

Instead of using the "best fit", this study introduces sub-period (SuPer) calibration as a new framework to identify the most “realistic” parameterization, although potentially sub-optimal in the calibration period. The SuPer calibration framework includes two steps. First, the time series is split into different sub-periods, such as years or seasons. Then the model is calibrated separately for each sub-period and a Pareto front is obtained as the “best fit” for every sub-period. In the second step those parameter sets are selected which minimize the distance to the Pareto front of each sub-period, which involves an additional multi-objective optimization problem with dimensions equal to the number of sub-periods.

The performance of the SuPer calibration framework is evaluated and compared with traditional calibration-validation frameworks for three consecutive years for the Wark catchment in Grand Duchy of Luxembourg, using the conceptual rainfall/runoff model HyMOD.

We show that besides being a calibration framework, this approach has also diagnostic capabilities. It can in fact indicate the parameter sets that perform consistently well for all the sub-periods and does not require subjective thresholds for defining behavioral parameter sets. For the parameters that show similar feasible ranges for the individual sub-periods, SuPer calibration focuses on the overlap range while for the parameters which vary significantly (although sometimes well identifiable in individual sub-period) SuPer calibration returns a wider range showing they are not time consistent, possibly indicating model structural deficiencies. Furthermore it shows the tradeoff between different parameter sets and performance for each sub-period which can be used as an indicator for model development as it helps to reduce type I and II errors. Finally the method retains hydrological information of a specific year or season while it calibrates each sub-period separately rather than a longer period which causes averaging of events and consequently loss of information.