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Parsimonious rainfall-runoff model construction supported by time series processing and validation of hydrological extremes

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During implementation of lumped conceptual rainfall-runoff models, different problems may arise that make model calibration highly time consuming. Because of assumptions in the model structure, model performance may be insufficient in a specific application. When a more general model structure is implemented, the model often becomes overparameterized and, as a result, not identifiable.

To solve these problems, a procedure is presented that starts from a generalized model structure framework that is adjusted in a case-specific parsimonious way. The model-structure building is done in a transparent, step-wise way, where separate parts of the model structure are identified and calibrated based on multiple and non-commensurable information derived from river flow series by means of a number of sequential time series processing tasks. These include separation of the high frequency (e.g., hourly, daily) river flow series in subflows, split of the series in nearly independent quick and slow flow hydrograph periods, and the extraction of nearly independent peak and low flows. The model building and calibration account for the statistical assumptions and requirements on independency and homoscedasticity of the model residuals, significantly advanced through the use of nearly independent flow values extracted from the flow series. Next to the separate identification of the subflow recessions, the quick and slow runoff peak and low values and event volumes, also the performance of the model in predicting extreme high and low flow statistics is validated.