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# Identification of sparse set of performance criteria for hydrological model evaluation using principal components analysis

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Hydrological models are evaluated using multiple performance criteria. Thereby, a core challenge is the selection of appropriate performance criteria. In this study, we present an objective method to compress the main information provided by a set of performance criteria into a sparse selection of them.
Firstly, we carried out a large set of model simulations using a hydrological model in four contrasting catchments. Ten different performance criteria including typical performance measures (NSE, KGE) and signature measures based on the flow duration curve were calculated. Then, a principal component analysis (PCA) was computed for each data set of performance criteria. The number of principal components which explained 90% of the variability among the performance criteria was derived. Next, we selected for each considered component the highest correlated performance criterion. The principal components are by definition linear independent. Thus, the assigned performance criteria are approximately complementary to each other. By relating the selected performance criteria to model parameters, the most relevant hydrological components in explaining the model performance are derived. A joint analysis of all selected performance criteria provides suitable model runs which consider the most relevant hydrological components accurately.
In our study, the number of required performance criteria was reduced from ten to four or five. The number of selected performance criteria increases with higher process complexity in the catchments. In all catchments, one of the principal components is assigned to a specific performance criterion which is strongly related to water balance regulation, high or low flows, respectively. The ranking of the performance criteria corresponds with the relevance of the related hydrological behaviour in the respective catchments. Overall, this approach shows objectively how to select an adequate set of performance criteria to capture the process complexity in hydrological modelling.