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Mapping model behaviour using Self-Organizing Maps

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Abstract. Hydrological model evaluation and identification essentially involves extracting and processing information from model time series. However, the type of information extracted by statistical measures has only very limited meaning because it does not relate to the hydrological context of the data. To overcome this inadequacy we exploit the diagnostic evaluation concept of Signature Indices, in which model performance is measured using theoretically relevant characteristics of system behaviour. In our study, a Self-Organizing Map (SOM) is used to process the Signatures extracted from Monte-Carlo simulations generated by the distributed conceptual watershed model NASIM. The SOM creates a hydrologically interpretable mapping of overall model behaviour, which immediately reveals deficits and trade-offs in the ability of the model to represent the different functional behaviours of the watershed. Further, it facilitates interpretation of the hydrological functions of the model parameters and provides preliminary information regarding their sensitivities. Most notably, we use this mapping to identify the set of model realizations (among the Monte-Carlo data) that most closely approximate the observed discharge time series in terms of the hydrologically relevant characteristics, and to confine the parameter space accordingly. Our results suggest that Signature Index based SOMs could potentially serve as tools for decision makers inasmuch as model realizations with specific Signature properties can be selected according to the purpose of the model application. Moreover, given that the approach helps to represent and analyze multi-dimensional distributions, it could be used to form the basis of an optimization framework that uses SOMs to characterize the model performance response surface. As such it provides a powerful and useful way to conduct model identification and model uncertainty analyses.

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