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Inferring model structural deficits by analyzing temporal dynamics of model performance and parameter sensitivity

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We investigate the use of hydrological models as learning tools to help improve our understanding of the hydrological functioning of a catchment. With the model as a hypothetical conceptualisation of how dominant hydrological processes contribute to catchment scale response, we investigate three questions: 1) during which periods does the model (not) reproduce observed quantities and dynamics. 2) what is the nature of the error during times of bad model performance, and 3) which model components are responsible for this error.

To investigate these questions we combine a method for detecting repeating patterns of typical differences between model and observations (TIGER) with a method for identifying the active model components during each simulation time step based on parameter sensitivity (TEDPAS). The approach generates a time series of occurrence of dominant error types and time series of parameter sensitivities. A synoptic discussion of these time series highlights deficiencies in the assumptions about the functioning of the catchment.

The approach is demonstrated for the Weisseritz headwater catchment in the eastern Ore Mountains. Our results indicate that the WaSiM-ETH complex grid based model is not a sufficient working hypothesis for the functioning of the Weisseritz catchment, and point towards future steps that can help improve our understanding of the catchment.