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How to Tailor my Process-based Hydrological Model? Dynamic Identifiability Analysis of Flexible Model Structures

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In the field of hydrological modeling, many alternative mathematical representations of natural processes exist. To choose specific process formulations when building a hydrological model is therefore associated with a high degree of ambiguity and subjectivity. Identifiability analysis may provide guidance by constraining the a priori range of alternatives based on observations. In this work, a flexible simulation environment is used to build a process-based hydrological model with alternative process representations, numerical integration schemes, and model parametrizations in an integrated manner. The flexible simulation environment is coupled with an approach for dynamic identifiability analysis. The objective is to investigate the applicability of the coupled framework to identify the most adequate model structure. It turned out that identifiability of model structure varies in space and time, driven by the meteorological and hydrological characteristics of the study area. Moreover, the most accurate numerical solver is often not the best performing solution. This is possibly influenced by correlation and compensation effects among process representation, numerical solver, and parametrization. Overall, the proposed coupled framework proved to be applicable for the identification of adequate process-based model structures and is therefore a useful diagnostic tool for model building and hypotheses testing.