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Benchmarking Automatically Identified Model Structures with a Large Model Ensemble

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Recent studies have introduced methods to simultaneously calibrate model structure choices and parameter values to identify an appropriate (conceptual) model structure for a given catchment. This can be done through mixed-integer optimization to identify the graph structure that links dominant flow processes (Spieler et al., 2020) or, likewise, by continuous optimization of weights when blending multiple flux equations to describe flow processes within a model (Chlumsky et al., 2021). Here, we use the combination of the mixed-integer optimization algorithm DDS and the modular modelling framework RAVEN and refer to it as Automatic Model Structure Identification (AMSI) framework.

This study validates the AMSI framework by comparing the performance of the identified AMSI model structures to two different benchmark ensembles. The first ensemble consists of the best model structures from the brute force calibration of all possible structures included in the AMSI model space (7488+). The second ensemble consists of 35+ MARRMoT structures representing a structurally more divers set of models than currently implemented in the AMSI framework. These structures stem from the MARRMoT Toolbox introduced by Knoben et al. (2019) providing established conceptual model structures based on hydrologic literature.

We analyze if the model structure(s) AMSI identifies are identical to the best performing structures of the brute force calibration and comparable in their performance to the MARRMoT ensemble. We can conclude that model structures identified with the AMSI framework can compete with the structurally more divers MARRMoT ensemble. In fact, we were surprised to see how well we do with a simple two storage structure over the 12 tested MOPEX catchments (Duan et al.,2006). We aim to discuss several emerging questions, such as the selection of a robust model structure, Equifinality in model structures, and the role of structural complexity.

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Chlumsky et al. (2021). https://doi.org/10.1029/2020WR029229

Knoben et al. (2019). https://doi.org/10.5194/gmd-12-2463-2019

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