A flexible multi-model framework for catchment-specific calibration, and application to diverse European catchments

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If one accepts that a single model structure cannot accommodate the wide spectrum of catchment dynamics encountered in practice, the need for flexible hydrological models becomes evident. Here, we present SUPERFLEX, a hydrological modelling system that represent the catchment as a network of conceptual elements, including non-linear reservoirs and routing components, with connectivity, constitutive relations and parameterizations specified by the Hydrologist using a priori insights into the catchment of interest, and refined based on calibration results. The model equations are implemented using robust numerical approaches, and the entire SUPERFLEX system is integrated into a Bayesian inference suite, permitting hypotheses regarding forcing/response data to be evaluated and refined as part of the model inference. The application of the SUPERFLEX approach to a range of European catchments is presented, demonstrating how the ability to adjust the model structure to specific catchments allows improved representatation of its key hydrological processes, and consequently improved model performance.