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Comparison of complex and parsimonious model structures by means of a modular hydrological model concept

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A plenty of hydrological model types have been developed during the past decades. Most of them used a fixed design to describe the variable hydrological processes assuming to be representative for the whole range of spatial and temporal scales. This assumption is questionable as it is evident, that the runoff formation process is driven by dominant processes which can vary among different basins. Furthermore the model application and the interpretation of results is limited by data availability to identify the particular sub-processes, since most models were calibrated and validated only with discharge data. Therefore it can be hypothesized, that simpler model designs, focusing only on the dominant processes, can achieve comparable results with the benefit of less parameters.

In the current contribution a modular model concept will be introduced, which allows the integration and neglection of hydrological sub-processes depending on the catchment characteristics and data availability. Key elements of the process modules refer to (1) storage effects (interception, soil), (2) transfer processes (routing), (3) threshold processes (percolation, saturation overland flow) and (4) split processes (rainfall excess). Based on hydro-meteorological observations in an experimental catchment in the Slovak region of the Carpathian mountains a comparison of several model realizations with different degrees of complexity will be discussed. A special focus is given on model parameter sensitivity estimated by Markov Chain Monte Carlo approach. Furthermore the identification of dominant processes by means of Sobol's method is introduced.

It could be shown that a flexible model design – and even the simple concept - can reach comparable and equivalent performance than the standard model type (HBV-type). The main benefit of the modular concept is the individual adaptation of the model structure with respect to data and process availability and the option for parsimonious model design.