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Evaluation of a hydrological model based on Bidirectional Reach (BReach)

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Evaluation and discrimination of model structures is crucial to ensure an appropriate use of hydrological models. When evaluating model results by aggregating their quality in (a subset of) individual observations, overall results of this analysis sometimes conceal important detailed information about model structural deficiencies. Analyzing model results within their local (time) context can uncover this detailed information. In this research, a methodology called Bidirectional Reach (BReach) is proposed to evaluate and analyze results of a hydrological model by assessing the maximum left and right reach in each observation point that is used for model evaluation. These maximum reaches express the capability of the model to describe a subset of the evaluation data both in the direction of the previous (left) and of the following data (right). This capability is evaluated on two levels. First, on the level of individual observations, the combination of a parameter set and an observation is classified as non-acceptable if the deviation between the accompanying model result and the measurement exceeds observational uncertainty. Second, the behavior in a sequence of observations is evaluated by means of a tolerance degree. This tolerance degree expresses the condition for satisfactory model behavior in a data series and is defined by the percentage of observations within this series that can have non-acceptable model results. Based on both criteria, the maximum left and right reaches of a model in an observation represent the data points in the direction of the previous respectively the following observations beyond which none of the sampled parameter sets both are satisfactory and result in an acceptable deviation. After assessing these reaches for a variety of tolerance degrees, results can be plotted in a combined BReach plot that show temporal changes in the behavior of model results.

The methodology is applied on a Probability Distributed Model (PDM) of the river Grote Nete upstream of Geel-Zammel with 1 10^6 randomly sampled parameter sets for three separate years. Acceptable model results must fit in the 95 % uncertainty bounds of observed discharges and tolerance degrees of 0 %, 5 %, 10 %, 20 % and 40 % are applied. An evaluation of BReach results with regard to other variables, such as the magnitude and the rate of change of the observed discharges enables to detect recurring patterns in model errors. This results in an augmented understanding of the model's structural deficiencies, revealing the incapability of the PDM model to simulate both high and low flow simulations with a single parameter set for this catchment. As the methodology can be applied for different hydrological model structures, it is a useful tool to gain understanding of the difference in behavior of competing models.