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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 capability of a hydrologic model to describe a subset of the data. 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 nonacceptable 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 nonacceptable model results. Based on both criteria, the outermost data points for which the model behaves satisfactory are assessed in each observation. These points are called the maximum left or right reach, depending on the direction of the investigation. 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 1 106 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. An analysis of the behaviour of model parameters within this methodology (throughout the year) provides additional information. 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.