Using hydrological signatures to improve the specification of parameters of a process oriented distributed hydrological model

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Key words: distributed model, hydrological signatures, diagnostic-evaluation, parameters specification.

Abstract:

Distributed hydrological models require the specification of a large number of parameters. Carrying out automatic calibration procedures on such models is most of the time a difficult task subject to equifinality issues. Aiming at simulating the right outputs for the right reasons [2], process-based or process oriented models can rely on more or less direct relations between some of the distributed parameters and measured spatial data (e.g. soil depth, land-use type, etc…) to infer the parameter values. However, in most cases, it is not enough to reach satisfying results.

We explore a novel approach to improve the parameters specification of process-oriented distributed model. This approach, first introduced by Gupta et al. [1], relies on hydrological signatures. Hydrological signatures are characteristic indices such as the runoff ratio or the slope of the mid-segment of the flow duration curve that can be related more or less directly to some of the hydrological processes occurring at various time and spatial scales (e.g. groundwater discharge, overland flow, etc…). As such they give insights into the characteristics and relative importance of the various hydrological processes at play for a given catchment. They can also be related to the model parameters using, for example, a sensitivity analysis.

Hydrological signatures can be extracted from both simulated and observed data. Comparison of simulated and observed signatures can be used in a model evaluation scheme. Their main advantage over traditional performance criteria is that discrepancies between simulations and observations are diagnostically meaningful, i.e. they allow identifying the processes that are badly modelled and pinpointing which parameters are at fault and should be modified to improve the model performance.

Focusing on widely available data (streamflow, precipitation and temperature time series), we detail the proposed methodology and illustrate its capabilities for the evaluation and diagnostic of the J2K [3]process oriented distributed model deployed on the 2250km² Ardèche catchment, that is part of the OHM-CV Observatory [4]. We focus our presentation on the selection of a relevant set of hydrological signatures and the relations between the signatures and the spatially distributed parameters of the model.

References:

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