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Evaluation of a semi-distributed model through an assessment of the spatial coherence of Intercatchment Groundwater Flows

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Semi-distributed hydrological models aim to provide useful information to understand and manage the spatial distribution of water resources. However, their evaluation is often limited to independent and single evaluations at each sub-catchment within larger catchments. This enables to qualify model performance at different points, but does not provide a coherent assessment of the overall spatial consistency of the model. To cope with these methodological deficiencies, we propose a two-step strategy. First, we apply a sequential spatial calibration procedure to define spatially consistent model parameters. Secondly, we evaluate the hydrological simulations using variables that involve some dependency between sub-catchments to evaluate the overall coherence of model outputs. In this study, we particularly choose to look at the simulated Intercatchment Groundwater Flows (IGF). The idea is that the water that is lost in one place should be recovered somewhere else within the catchment to guarantee a spatially coherent water balance in time.

The model used is a recently developed daily semi-distributed model, which is based on a spatial distribution of the lumped GR5J model. The model has five parameters for each sub-catchments and a streamflow velocity parameter for flow routing between them. It implements two reservoirs, one for production and one for routing, and estimates IGF according to the level of the second in a way that catchment can release water to IGF during high flows and receive water through IGF during low flows. The calibration of the model is performed from upstream to downstream, making an efficient use of spatially distributed streamflow measurements. To take model uncertainty into account, we implemented three variants of the original model structure, each one computing in a different way the IGF in each sub-catchment. The study is applied on over 1000 catchments in France. By exploring a wide area and a variability of hydrometeorological conditions, we aim to detect IGF even between catchments which can be quite distant from one another.