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Do internal flow measurements improve the calibration of semidistributed rainfall-runoff models?

Julien Lerat (1), Vazken Andréassian (2), Charles Perrin (2), Jai Vaze (1), and Jean-Michel Perraud (1)
(1) CSIRO, Land and Water, Canberra, Australia (julien.lerat@csiro.au), (2) Cemagref, HBAN, Antony, France

The calibration of rainfall-runoff models is commonly carried out on a single gauging station to reproduce streamflows only at this catchment outlet. Unfortunately, the use of a single site is usually not sufficient to derive robust parameter sets for distributed or semi-distributed models, which leads to large uncertainties in the parameter values and therefore limits model performance. This uncertainty may be reduced by using other gauging stations upstream on the catchment as complementary calibration targets.
To test this assumption, a semi-distributed model was applied to 195 catchments in France where streamflow is measured at the main catchment outlet and at one upstream station. This dataset is quite varied in terms of catchment characteristics and, hydrometeorological conditions and ratios between the upstream and downstream catchments areas.
Three different calibration strategies were compared:
1. In the benchmark strategy, the parameters are optimized to reproduce the streamflow at the main outlet only, without using internal streamflow measurements.
2. In a second approach, the model is calibrated sequentially: first, on the internal subcatchment against the internal streamflows, then on the remaining area against the streamflow at the outlet.
3. The last approach is a multiobjective optimization using simultaneously the streamflows at the two locations with the Multiobjective Shuffled Complex Evolution Metropolis algorithm (MOSCEM).
Surprisingly, the results show that, on average, the use of internal streamflow measurements for model calibration did not provide substantial performance improvement compared to the benchmark strategy at the main outlet.