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Multi-objective calibration of a distributed eco-hydrological model using several remotely sensed information

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Calibration of eco-hydrological models is difficult to carry on, even more if observed data sets are scarce. It is known that calibration using traditional trial-and-error approach depends strongly of the knowledge and the subjectivity of the hydrologist, and automatic calibration has a strong dependency of the objective-function and the initial values established to initialize the process.

The traditional calibration approach mainly focuses on the temporal variation of the discharge at the catchment outlet point, representing an integrated catchment response and provides thus only limited insight on the lumped behaviour of the catchment. It has been long demonstrated the limited capabilities of such an approach when models are validated at interior points of a river basin. The development of distributed eco-hydrological models and the burst of spatio-temporal data provided by remote sensing appear as key alternative to overcome those limitations. Indeed, remote sensing imagery provides not only temporal information but also valuable information on spatial patterns, which can facilitate a spatial-pattern-oriented model calibration.

However, there is still a lack of how to effectively handle spatio-temporal data when included in model calibration and how to evaluate the accuracy of the simulated spatial patterns. Moreover, it is still unclear whether including spatio-temporal data improves model performance in face to an unavoidable more complex and time-demanding calibration procedure. To elucidate in this sense, we performed three different multiobjective calibration configurations: (1) including only temporal information of discharges at the catchment outlet (2) including both temporal and spatio-temporal information and (3) only including spatio-temporal information. In the three approaches, we calibrated the same distributed eco-hydrological model (TETIS) in the same study area: Carraixet Basin, and used the same multi-objective algorithm: MOSCEM-UA. The spatio-temporal information obtained from satellite has been the surface soil moisture (from SMOS-BEC) and the leaf area index (from MODIS).

Even though the performance of the first calibration approach (only temporal information included) was slightly better than the others, all calibration approaches provided satisfactory and similar results within the calibration period. To put these results into test, we also validated the model performance by using historical data that was not used to calibrate the model (validation period). Within the validation period, the second calibration approach obtained better performance than the others, pointing out the higher reliability of the obtained parameter values

when including spatio-temporal data (in this case, in combination with temporal data) in the model calibration. It is also reliable to mention that the approaches considering only spatio-temporal information provided interesting results in terms of discharges, considering that this variable was not used at all for calibration purposes.