Geophysical Research Abstracts
Vol. 20, EGU2018-9811, 2018
EGU General Assembly 2018

From sensitivity analysis to calibration strategy in a hydrological semi distributed model.

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MORDOR SD is a conceptual hydrological model extensively used in Électricité de France (EDF, French electric utility company) operational applications: (i) hydrological forecasting, (ii) flood risk assessment, (iii) water balance and (iv) climate change studies. MORDOR SD is a semi-distributed, reservoir, elevation based model with hourly or daily areal rainfall and air temperature as the driving input data. The principal hydrological processes represented are evapotranspiration, direct and indirect runoff, ground water, snow accumulation and melt and routing. The model has been intensively used at EDF for more than 20 years, in particular for modeling French mountainous watersheds.

In this framework we introduce an alternative calibration strategy founded on a multi-criteria objective function, based on Kling–Gupta efficiency. This approach uses single-objective functions to quantify the good agreement between the simulated and observed runoff and fractional snow cover. Concerning runoff four hydrological signatures are taking into account: (i) the time series of flow, (ii) the long-term mean daily streamflow, (iii) the flow duration curve and (iv) the flow recessions during low flow periods. About fractional snow cover, the simulated time series are compared to gridded snow cover time series provided by the MOD10 satellite product.

Using a variance-based sensitivity analysis (Sobol method) we compare different calibration techniques in order to: (i) simplify the model structure, (ii) increase the calibration-validation performance of the model and (iii) reduce the equifinality problem of calibration process. We propose an alternative calibration strategy that reaches these goals. In other words, we significantly reduce the number of degrees of freedom of model (from 20 to 11 free parameters) and the parameter interaction during the calibration process, without losses in calibration-validation performance of the model. The analysis is illustrated by calibrating MORDOR SD model on an extensive hourly dataset composed of 10 watersheds located in French mountainous regions.