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Evolution of an operational hydrological model: from global to semi-distributed approach

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MORDOR is a conceptual hydrological model extensively used in Électricité de France (EDF, French electric utility company) for operational applications: (i) hydrological forecasting, (ii) flood risk assessment, (iii) water balance and (iv) climate change studies. In its historical version, hereafter called MORDOR1996, this is a lumped, 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 and ice accumulation and melt, routing. The model has been intensively used at EDF for more than 25 years, in particular for modeling French mountainous watersheds.

In order to consider the spatial heterogeneity of the input data (rainfall and air temperature) and the hydrological characteristics within a basin, the structure of model has been updated. The new version of the model, named MORDOR SD, is a semi-distributed hydrological model driven by elevation. The basin is spitted into several elevation bands on which a simple global MORDOR model is implemented; i.e. only evapotranspiration, direct and indirect runoff, snow and ice accumulation and melt are computed. However ground water and routing processes remain global.

The primary purpose of this study is to present MORDOR SD model through a comparison with the historical version. The first result of this comparative study is that the new version provides better calibration-validation performances. Moreover the semi-distributed approach both allows to simplify the model structure (i.e. less degrees of freedom) and to reduce the equifinality problem in the calibration process. The model's parameters are calibrated at daily timestep with a genetic algorithm that uses a composed objective function. This complex function quantifies the good agreement between the simulated and observed runoff focusing on four different runoff samples: (i) time-series, (ii) annual hydrological regimes, (iii) monthly cumulative distribution functions and (iv) recession sequences. Results and discussions are here illustrated throughout with a dataset of 50 watersheds located in French mountainous regions.