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An approach for distributed parameter optimization of LISFLOOD hydrological model using efficient hybrid optimization procedure

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LISFLOOD is a grid-based, distributed hydrological model that has been developed at the Joint Research Centre of the European Commission (De Roo et al., 2000) to simulate: rainfall-runoff processes, flood events, and real-time hydrological forecasting in large European catchments. Although the LISFLOOD model contains some physical-based approaches, which mainly operate using empirical relations, and a few processes are represented by lumped models only. Regardless of the fact that the model can be controlled by a numerous of empirical parameters, we assumed that a subset of them are uncalibrated constant with “given” value. Thus there remain six parameters which need to be estimate by calibration procedure against historical discharge records. The parameters which have to be determined by calibration are:

1. The so called Upper/Lower Zone Time Constant (UZTC/LZTC) reflect to the

resident time of water in the upper (faster) and lower (slower) groundwater zone, respectively;

2. The Groundwater Percolation Value (GWPV) controls the volumetric flow from the upper to the lower groundwater zone;

3. The empirical shape parameter of Xinanjiang model (Xb) that is used to model the infiltration process;

4. The Power Preferential Bypass Flow parameter (PPBF) is also an empirical shape parameter of the function describing the flow that bypass the soil-matrix and drains directly to the groundwater and;

5. The empirical parameter of the simple degree-day factor model (Cm).

Basically there are two alternative possibilities to explain the distribution of empirical parameters listed above. Calibrating values of the parameters over the entire subcatchment are applied either: as a uniform value (*lumped calibration*) or considering their spatial variation (*distributed calibration*). As a rule in the case of *lumped calibration* the parameters are vary between their upper and lower bounds, whereas during *distributed calibration* it is supposed that those values vary indirectly through a function or some spatial properties. With reference to the *distributed calibration* in this work for the first five parameters it is roughly supposed that those values vary linearly with the *slope* of the grids, and for the last (Cm) it is supposed that it varies linearly with the *elevation* of the grids

As a rule, the optimality criterion is expressed by a nonlinear goal (loss) function, whereas the feasible domain for parameter selection – as usually – is given by a closed interval of real numbers (the lower and upper bound of the parameters). Hence, the task of model-calibration frequently leads to solve a multiextremal global optimization problem. In order to solve this calibration problem, an efficient deterministic hybrid method (Szabó, 2008) combining a derivate-free, globally convergent adaptive partition-based search and downhill simplex algorithm has been applied. The advantage of this combined algorithm is that it does not require derivative information and the solver operations are based exclusively on the computation of goal function values at each algorithmically selected search point.

In this presentation, a lumped and a distributed parameter calibration of LISFLOOD model is compared on three different pilot river basins using a grid resolution of 1x1 km: Upper-Tisza (9700 km^2, from Ukraine to Hungary), Raba (3200 km^2, from Austria to Hungary), and Mulde (4970 km^2, Germany). Following a brief description of the LISFLOOD model and the applied calibration procedure, the detailed comparative calibration results are presented on the selected basins.

Most important References:

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