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Use of «MLCM3» software for flash flood forecasting

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Accurate and timely flash floods forecasting, especially, in ungauged and poorly gauged basins, is one of the most important and challenging problems to be solved by the international hydrological community.In changing climate and variable anthropogenic impact on river basins, as well as due to low density of surface hydrometeorological network, flash flood forecasting based on “traditional” physically based, or conceptual, or statistical hydrological models often becomes inefficient.

Unfortunately, most of river basins in Russia are poorly gauged or ungauged; besides, lack of hydrogeological data is quite typical, especially, in remote regions of Siberia. However, the developing economy and population safety make us to issue warnings based on reliable forecasts. For this purpose, a new hydrological model, MLCM3 (Multi-Layer Conceptual Model, 3rd generation) has been developed in the Russian State Hydrometeorological University.

MLCM3 is a "rainfall−runoff"model with flexible structure and high level of“conceptualization”.Model forcing includes precipitation and evaporation data basically coming from NWP model output. Water comes to the outlet through several layers; their number as well as two parameters (thickness and infiltration rate) for each of them, surface flow velocity (when the top layer is full of water) are optimized.

The main advantage of the MLCM3, in comparison to the Sacramento Soil Moisture Accounting Model (SAC-SMA), Australian Water Balance Model (AWBM), Soil Moisture Accounting and Routing (SMAR) model and similar models, is that its automatic calibration is very fast and efficient with less volume of information. For instance, in comparison to SAC-SMA, which is calibrated using either Shuffled Complex Evolution algorithm (SCE-UA), or Stepwise Line Search (SLS), automatically calibrated MLCM3 gives better or comparable results without using any “a priori” data or essential processor resources.

This advantage allows using the MLCM3 for very fast streamflow prediction in many basins. When assimilated NWP model output data used to force the model, the forecasts accuracy is quite acceptable and enough for automatic warning.

Also please note that, in comparison to the 2nd generation of the model, a very useful new option has been added. Now it is possible to set upvariable infiltration rate of the top layer; this option is quite promising in terms of spring floods modeling. (At the moment it is necessary to perform more numerical experiments with snow melting; obtained results will be reported later).

Recently new software for MLCM3 was developed. It contains quite usual and understandable options.

Formation of the model "input" can be done in manual and automatic mode. Manual or automatic calibration of the model can be performed using either purposely developed for this model optimization algorithm, or Nelder-Mead’s one, or SLS.

For the model calibration, the multi-scale objective function (MSOF) proposed by Koren is used. It has shown its very high efficiency when model forcing data have high level of uncertainty. Other types of objective functions also can be used, such as mean square error and Nash-Sutcliff criterion.

The model showed good results in more than 50 tested basins.