THE RELATIVE IMPORTANCE OF ACCURATE CATCHMENT-AVERAGED EVAPOTRANSPIRATION INPUTS VERSUS AUTOMATIC CALIBRATION PROCEDURES FOR OPERATIONAL FLOOD FORECASTING

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It is widely recognized that operational flood forecasting is a very important tool in the management of floods. Flood forecast models are usually based on two different kinds of meteorological inputs, more specifically the catchment averaged precipitation and evapotranspiration rates. These are related to the catchment discharge through a number of conceptual equations, of which the parameters are tuned through a comparison of the modeled discharge to the observations. Three different sources of errors thus influence the quality of the model results: 1) errors in the meteorological forcing data, 2) errors in the model structure, and 3) errors in the model parameters. The most difficult meteorological forcing to quantify is the catchment averaged evapotranspiration rate, since evapotranspiration rates are spatially very variable, are rather expensive to measure at small spatial scales, and up till now cannot be continuously observed at the catchment scale. The objectives of this presentation are to assess whether an automatic calibration procedure for operational flood forecast models can compensate for inaccurate evapotranspiration inputs, whether this depends on the model or not, and whether or not this depends on the construction of the calibration method. The relative importance of the three aforementioned sources of model errors is thus assessed.

This research is entirely conducted in the catchment of the Dender in Belgium. As a first step, a fully process-based spatially distributed water and energy balance model is validated using 1) observed discharge rates, 2) Bowen Ratio Energy Balance (BREB) observations of the net radiation and latent, sensible and ground heat fluxes, and 3) Boundary Layer Scintillometer (BLS)-based sensible heat fluxes. This allows a validation at three different spatial scales: at the point scale using the BREB data, across a large distance (approximately 10 km) using the BLS measurements, and at the catchment scale using the discharge observations. When the model is able to reproduce all these observations one can assume that it provides a reliable estimate of the catchment average evapotranspiration rate.

A second step then consists of calibrating two flood forecast models in two different ways. The models used are the well known Probability Distributed Model (PDM) and the HBV model. The first calibration procedure is the widely used Shuffled Complex Evolution (SCE-UA) method, which minimizes the Root Mean Square Error (RMSE) between the observed and the modeled discharge rates. A second method is the recently developed Multistart Weight-Adaptive Recursive Parameter Estimation (MWARPE) method, which uses the Extended Kalman Filter equations in an iterative Monte-Carlo framework. Unlike all other automatic calibration algorithms, MWARPE does not calculate one or more objective functions (usually the RMSE), but takes into account explicitly the mismatch between each observation and the corresponding model result in the parameter updating. Two different models and parameter estimation algorithms are used in order to assess whether the conclusions depend on the model or on the construction of the calibration method.

Both flood forecast models are first calibrated using potential evapotranspiration rates as input. These rates are obtained through two commonly used methods, more specifically the Penman and the Hargreaves methods, applied using point-scale observations. The observations at the point scale are thus assumed to be equal to the catchment averages. Then, both models are calibrated using the catchment averaged actual evapotranspiration rates from step one. For both models one less parameter needs to be calibrated as compared to when potential rates were used as inputs, more specifically the parameter required to convert the potential evapotranspiration rates into actual data.

The expected results of this study are an answer to the following questions, which are important for practitioners responsible for water management. First, how important are accurate catchment averaged evapotranspiration inputs for operational flood forecasting? Second, can an automatic calibration procedure compensate for errors in the evapotranspiration estimates? And third, does the answer to the previous question depend on the model or the construction of the calibration procedure?