Geophysical Research Abstracts
Vol. 13, EGU2011-12760, 2011
EGU General Assembly 2011

Balancing the model structure and spatial scheme using model sensitivity analysis and parameter identifiability

Stijn Van Hoey (1,2), Piet Seuntjens (2,3,4), Johannes van der Kwast (2), Jean-Luc de Kok (2), Guy Engelen (2), and Ingmar Nopens (1)

(1) University Ghent, Bioscience Engineering, Department of Applied Mathematics, Biometrics and Process Control, Gent, Belgium (stvhoey.vanhoey@ugent.be), (2) Flemish Institute for Technological Research (VITO), Mol, Belgium, (3) University Ghent , Department of Soil Management, Ghent, Belgium, (4) University of Antwerp

When modeling hydrological systems, one can choose between different aggregative or disaggregative spatial schemes. The spatial scheme can range from lumped models on the one side to high-resolution spatially-explicit models operating at many small entities on the other. Lumped models give rise to uncertainty due to the spatial aggregation into watershed average characteristics. Distributed models, on the other hand, suffer from uncertainty owing to limited calibration data. Hence, the choices regarding the aggregation level are not necessarily straightforward or transparent and are highly dependent on the objective of the modeling exercise and the availability of the data.

The choice of a spatial scheme is, however, not one that can be made independent of the other underlying processes that are taking place in the system. Also processes can be described by a range of “models”. One can use a single empirical (transfer) function, i.e. a conceptualization or a description of the underlying physics using the governing equations. On the other edge of the spectrum, one can distinguish physically-based models. The latter are assumed to be the best representation of the phenomena, but have the downside that (1) they require a lot of good quality data for proper calibration and, (2) they are overparameterised. It is, however, important to highlight that the choice of model will be influenced by the choice of spatial scheme and vice versa, in order to end up with the most appropriate overall model.

It is mentioned in literature that there is no general model structure for all resolutions used and goals set forth. Hence, in the overall model structure, the process descriptions must be consistent or “in balance” with the spatial resolution of the model. Nevertheless, lumped water balance models (SAC-SMA, hymod, HBV,...) are used on a large variety of scales and adapted versions are available where these models are grid-based calculated and linked with a certain distributed routing component (surface of subsurface). Process descriptions are generally similar among these scales and the overparameterisation is (mis)used to force the model to represent the hydrograph correctly. Such a suboptimal model structure wil lead to parameter identifiability problems, increasing uncertainty and significantly reduced model predictive power.

In this study an in-house developed tool is used to automatically produce varying model structures and identify their difference in performance among different spatial scales. By changing specific processes or spatial resolution, while maintaining the remainder of the model structure, rigorous testing of the model structure is possible. This allows identifying dominant processes for different levels of spatial integration. The identifiability of different model parameters is assessed and differences were found based on changing interactions between the scale and the different process descriptions. Sensitivity analyses were performed on all models. They give an idea of the most important processes involved and yield information about possible simplifications.