MODEL CALIBRATION WITH EXTERNAL ERROR MODELS

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One of the problems when modeling water fluxes in the unsaturated zone is to estimate the model parameters from observations. Due to heterogeneities of the soil, these parameters depend on length scale. Especially for flow models with large domain sizes it is often required to represent soil structure as simple as possible. This means that heterogeneous structures with strong effects on the flow behavior may become incorporated in larger homogeneous grids, requiring that a model is set up in such a way that the impact of the structure on averaged variables is still represented.
When calibrating a flow model for the unsaturated zone it is therefore important that the resulting effective parameters are independent of where measurements are taken. The calibration can become problematic if observation volumes are small compared to the modeling scale. Many approaches to deal with these problems have been suggested, including upscaling theory and geostatistics. This study looks at the use of explicit error models to guide a Markov Chain Monte Carlo (MCMC) calibration process towards sets of effective parameters for an upscaled model with good predictive power of the boundary fluxes.
To illustrate the problem of the model calibration, a virtual reality multi step outflow experiment is created using a strongly heterogeneous soil structure. An upscaled homogeneous model is then used to model the water flow in the column and spatially sparse measurements are used for the calibration. First it is shown how inconsistent a calibration can be if the measurements do not cover a representative volume of the structure. Second, three different external error models, that allows for a calibration that acknowledges soil structure by altering the likelihood functions, are implemented and tested. The three error models tested are all variable in space but constant in time and the difference between them is the amount of prior information about the soil structure.
The results indicate that the use of an error model can increase the consistency of the resulting models, improving the predictive capability of the calibrated upscaled model, when evaluating the fluxes over the lower boundary. The different error models tested show differently good performances depending on which amount and what type of measurement error is being considered. The result could be useful when calibrating large scale models where only local data is available.