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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Time varying parameter models for catchments with land use change: the importance of model structure" *by* Sahani Pathiraja et al.

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The authors are performing data assimilation (DA), for a dynamical hydrological model with time-varying parameters. I fully agree that, in hydrology, time-varying parameters very often lead to a more realistic description of reality than constant ones, with the caveat that a good stochastic model for their dynamics is used. That being said, I have serious doubts about the validity of the method used in this paper.

First of all, there is no clear separation between the hydrological model assumptions and the numerical method that is used for DA. The model assumptions should not only comprise the deterministic hydrological equations and the observational error assumptions, but here also a precise definition of the assumed stochastic dynamics of the

model parameters. These assumptions have nothing to do with DA, but are part of our prior knowledge about the system. Together with prior probability distributions, e.g. for initial conditions, and measured data they completely define the posterior as well as predictive distributions of states and parameters. All DA methods must lead to the same distributions and the choice is only a matter of computational efficiency. If this separation is not clearly made, there is a risk that inference (here DA) and prediction is done under different model assumptions, which would be inconsistent and lead to a loss of interpretability of the results. I've been trying to do this separation and unveil the assumptions behind the dynamics of the parameters from step 1 of the numerical DA algorithm, but it is not obvious to me what these assumptions are. Without constraining data (i.e. in a predictive mode), what would be the dynamics of the parameter distribution?

Putting aside my concerns about these model assumptions, I have even more serious concerns about the chosen DA method, which seems to violate the assumptions behind Kalman filters in at least two ways: (i) Kalman filters assume normality of the distribution of the augmented state (incl. parameters). Is there any reason to believe that the non-linearity of the chosen hydrological model is weak enough for this assumption to be approximately valid? Given the dimensionality of the model and the data, respectively, I'm almost certain that it will be grossly violated. (ii) Updating the states, based on prior predictions that have been made with parameters that have already been updated seems to use the data twice. This again seems to violate model assumptions, or in other words, I have no idea what the model assumptions are, for which the proposed method is a valid DA.

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