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Hydrology and Earth System Sciences Discussions

Interactive comment on "The importance of parameter resampling for soil moisture data assimilation into hydrologic models using the particle filter" *by* D. A. Plaza et al.

Anonymous Referee #2

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Summary: This article compares the performance of three data assimilation techniques, the EnKF, the PF and the PF with parameter resampling. The three methods are applied to the CLM 2.0 model. The model parameters are optimized using the SCE-UA algorithm based on the ability to estimate streamflow. Parameter values differing from the optimized values are then used to create a synthetic truth for the soil moisture and baseflow values. This provides a truth that is biased in comparison to the model structure, as is normally the case in real experiments. All three techniques are used to estimate the soil moisture and baseflow by assimilating a synthetic observation. While both the EnKF and PF show improvements in the soil moisture estimation,

both methods poorly estimate the true baseflow. The PF with parameter resampling is shown to overcome this problem. The study also explores a sensitivity analysis based on different temporal frequencies of available observations.

Major Comments: The experimental setup and analysis of the results contain a major flaw. While the EnKF and PF both perform poorly, the PF with parameter resampling is suggested to overcome the problems of the EnKF and PF. This may be true but it is necessary to allow for parameter estimation in the EnKF as well to provide an objective analysis. As it stands, the manuscript overlooks the recent work by many authors to use the EnKF and also PF for state and parameter estimation. I would suggest adding a state-parameter estimation experiment with the EnKF, and providing a literature review on the works done on state-parameter estimation that have performed similar studies recently, to give a balanced analysis of the techniques and advancement made. Another key issue is the setup of the synthetic experiment. While using a different parameter set to create the synthetic truth than for state estimation experiments, a bias is created, which is often the case in real experiments, but it is difficult to say how realistic these errors are. This is especially important in looking at the somewhat conceptual parameters, such as the number of layers contributing to baseflow and surface runoff. By changing these parameters, the physics in the model may be altered to a point where soil moisture assimilation would not be expected to improve baseflow prediction. This is especially likely since the different parameter sets partition flow differently between surface runoff and baseflow (specifically parameter set 1 and 2). I suggest that there be more justification that the assimilation of soil moisture from the synthetic observation should improve the baseflow characterization in the model based on different parameterization. This is necessary to highlight the importance of parameter resampling as suggested by the title.

Minor Comments 1) Page 5853, Lines 16-18: The description of model setup to use individual "patches" as ensemble members could use further expansion. It is difficult from this explanation to understand exactly what the author means 2) Page 5855, Lines

1-2: “Depending on the algorithm, either an ensemble of synthetic observations is generated (for the EnKF) or only a single realization (for the PF).” While it is correct to perform this way (though an ensemble of observation can be used in the PF as well), this description is a little misleading and can give the reader the impression that the PF and EnKF must be treated entirely differently or are not applicable to the same situation. I suggest revising this sentence. 3) Page 5856, Line 6: I am unclear of what is meant by “optimal disturbance fraction”. I assume this is the relative error associated with the magnitude of the given value but an equation would help. Also, it seems that 0.01 for forcing data is quite low. Can you provide justification for this? 4) Page 5862, Line 28: “Residual resampling is an improved version of the SIR method” is not proven. Though it has been suggested, the literature does not support this statement. Also, if this was proven, by opting for SIR over residual resampling without justification degrades the quality of the paper. I suggest removing this comment or describing residual resampling as an alternate to SIR. 5) Page 5864, Line 5-10: These lines state that MCMC steps can “handle” particle degeneracy problems. Though this has been suggested in the literature, it is not a proven methodology in hydrologic modeling.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 5849, 2011.