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Hydrology and Earth System Sciences Discussions

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Interactive Comment

Interactive comment on "Simultaneous estimation of land surface scheme states and parameters using the ensemble Kalman filter: idealized twin experiments" *by* S. Nie et al.

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This paper presents another interesting implementation of the EnKF for state and parameter estimation in an Atmosphere-Vegetation Interaction Model using synthetic soil moisture data. The study examines the ability of the EnKF to estimate three soil moisture parameters individually and simultaneously. The paper concludes that in order to accurately perform simultaneous estimation of all three parameters in the AVIM model using the EnKF, a constraint based update must be used. While this paper presents an implementation of the novel approaches reported in previous studies, some justifications of the results and also major edits are required given pervasive grammatical

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errors and typos. Furthermore, not an appropriate literature review is provided to reflect the state of the art in the topical area. My evaluation is that the paper is publishable and could be a good contribution to data assimilation community (given the encouraging results provided), however, a moderate revision is needed while the following issues should be resolved for the paper to be fit for publication.

1. Page 1436 line 19 cites Vrugt et al. (2005) as using the EnKF for state and parameter estimation but this study used the EnKF for state estimation and SCEM-UA for parameter estimation.

2. The listing of studies using the EnKF for state-parameter estimation is quite limited and should include Moradkhani et al., (2005a), Franssen and Kinzelbach (2008), Wang et al., (2009), DeChant and Moradkhani, (2010), Leisenring and Moradkhani, (2010), Montzka et al., (2011).

3. The idea of state-parameter estimation using the EnKF and also Particle Filtering (PF) in hydrologic modeling were first introduced by Moradkhani et al., (2005a and 2005b). Considering that the contribution of the current paper is exactly on the same topic but with the focus on soil moisture, the authors need to acknowledge the earlier research in this area that directly relates to their work. Particularly, the work by Moradkhani et al., (2005a) on state-parameter estimation using the EnKF is missing in the literature review provided by the authors. Given the similarity of some the fundamental equations (4-10) with those of Moradkhani's (2005a). The authors need to highlight the enhancement they have made in their work which distinguishes it from the others.

4. Similar to previous comment, in the context of soil moisture and state-parameter estimation, I suggest that the authors look at the recent work by Montzka et al., (2011). Although the particle filter was used in that work, the topic seems to be very relevant to the current work.

5. Page 1437 lines 5 through 8 explain that a constraint based EnKF is examined in this study but this was previously proposed by Wang et al. (2009). This previous work

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should be acknowledged. Also at the top of page 1444, it would be beneficial to this paper to explain how the constraints in this paper differ from Wang et al. (2009).

6. Page 1445 lines 20-24 explain that the ksat and b parameters converge faster than the si (sat) . This is used as justification to state that the si (sat) variable is more difficult to identify than the other parameters but I would argue that this is not necessarily true. The parameter converges quickly with the highest soil moisture observation values, which suggests that this parameter has a strong effect under high soil moisture values. Further, it is possible that the prior distribution of parameters affects the necessary time for convergence. There is little explanation of the reasoning for initial parameter distribution and how this may possibly affect the assimilation, but this is an important factor in the behavior of data assimilation techniques.

7. Figure 3 shows the RMSE of the “one-day-ahead” soil moisture prediction but it is unclear of how this is calculated. Is a set number of predictions and observations used to calculate this error? As the description stands, it seems that the error is only calculated for the one day prediction but I believe my understanding is incorrect.

8. Page 1447 describes the multi-parameter case and the reasons for using a constrained filter. Line 13 attributes a lack of convergence to the increased dimensionality and explains that constraints must be used to overcome this problem. While the increased dimensionality makes the estimation more difficult, experiments with higher dimensionality have been performed and not required constraints (e.g. Moradkhani et al., 2005a 2005b; Franssen and Kinzelbach, 2008; DeChant and Moradkhani, 2010; Leisenring and Moradkhani, 2010). What complicating factor in this study leads to a requirement of constraints in this study as opposed to previous studies? Have you examined the effects of creating a wider prior distribution of parameters? As it stands, your initial parameter distribution does not accurately reflect the uncertainty in the parameter.

9. Building on comment 6, lines 19 -22 of the conclusion attributes the failure of the

multi-parameter estimation experiment to independent perturbations of the parameters but this is not completely proven in light of repeated results in previous studies. Why is it necessary for this specific application to use constraints while previous applications converged without constraints?

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Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/8/C752/2011/hessd-8-C752-2011-supplement.pdf

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 1433, 2011.