Hydrol. Earth Syst. Sci. Discuss., 9, C4897–C4899, 2012
www.hydrol-earth-syst-sci-discuss.net/9/C4897/2012/
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Hydrology and Earth System Sciences Discussions

Interactive comment on "Operational hydrological data assimilation with the Retrospective Ensemble Kalman Filter: use of observed discharge to update past and present model states for flow forecasts" *by* H. K. McMillan et al.

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Received and published: 18 October 2012

I like to thank the authors for the response to my comments/remarks

The example provided about the physically based modeling of the routing process was not to give criticism on the model used in the manuscript. It is clear that the model implements a similar description for routing as Rakovec et al. (2012). It was only an attempt to get clear where the strange/erroneous behavior when using the Kalman

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Interactive Discussion

Discussion Paper

Filter in Clark et al (2008), Menodoza et al. (2012) and this manuscript is coming from. In the reply it is states that "The first is through a delay introduced to surface storage, which depends on the distribution of distances to the stream, and the overland flow velocity." How is the updating (when using EnKF) affecting this part of the model states? Could the strange behavior when applying the EnKF be a result of the way this process is being modeled (state t does not only depend on state t-1?)?

Ideally, when applying EnKF (or any other algorithm) all model states are updated. I assume that focus of applying the data assimilation is providing accurate forecasts mainly for the short term (48 hours)? Rakovec et al (2012) showed improvement in accuracy over 48 hours of leadtime for a catchment of +/- 1600 km2 (which indicates that other stores than the routing stores are updated as well).

I am not sure what is meant by the remark/comment "We also note the HESSD comment to the Rakovec paper which questions their approach which does not include the physically realistic lagged relationship between hydrological model states and runoff at the catchment outlet."? In the reply and final paper this comment is adequately addressed. Moreover, in the paper a twin experiment was carried out to show the correct working of the DA setup followed by a real world experiment. . .....

I am not sure what is meant by "In all, we believe that our method provides a more physically realistic and sustained correction to model states" compared to which method/application are the author's referring (REnKF vs EnKF in the application described in the manuscript?)?

"It is not easy to interpret the exact cause of the artefacts under the EnKF, although we believe we already provided physically realistic representations of time delay (kinematic routing) and time/space correlated perturbations, so these are less likely to be the cause. In Figure 13 we showed that the oscillations in the ensemble median flow under the EnKF were due to water being added/removed from the water table in that case (and this was replicated in other cases; not shown). Since the problem is cor-

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Interactive Comment

rected by use of the REnKF, we interpret that the artefacts are removed due to explicit representation of the lag time, and the iterated application of the EnKF. However, we agree that this is a likely explanation rather than a proof of the cause of the artefacts, and we will change the wording to reflect this." I am happy that the authors will rephrase the wording (no guessing!). However, I still feel this should be fully clarified before publishing the final results (and I think this could be clarified by carrying out a twin experiments).

The comment with regard to variational algorithms (for instance Maximum Likelihood Ensemble Filter) was an indirect way to ask if you considered those variational algorithms as they might be less computational demanding and maybe some even more suitable for hydrological models than EnKF (as was recently discussed at the HEPEX DA workshop in Korea) .

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 9533, 2012.