Hydrol. Earth Syst. Sci. Discuss., 12, C1793–C1796, 2015
www.hydrol-earth-syst-sci-discuss.net/12/C1793/2015/
© Author(s) 2015. This work is distributed under
the Creative Commons Attribute 3.0 License.

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Data assimilation in integrated hydrological modeling using ensemble Kalman filtering: evaluating the effect of ensemble size and localization on filter performance" *by* J. Rasmussen et al.

J. Rasmussen et al.

jr@geo.ku.dk

Received and published: 27 May 2015

Thank you for your comments. We have here tried to answer these point-by-point.

- Comment: 1) Figure 4 shows the effect of different localization methods. It is not explained why we see the differences that we see. It is noted that 10 km is producing worse results but no satisfactory explanation is given. The lower graph (discharge) cannot be interpreted by the readers (I see only two colors);

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

Response: We agree that the discussion of the distance-based localization methods is incomplete.

Modifications: A short discussion on the results of the distance-based localization is added to section 3.1: "[Increases in head RMSE] ... may be explained by true correlation (at a distance of more than 20 or 10 km) being removed from the filter. Simultaneously, spurious correlation occurring within the specified radii of the observations is not removed by this type of localization, which may lead to increases in head RMSE". Furthermore, figure 4 has been redesigned to improve readability.

- Comment: 2) I wondered if the cross-process correlation issues etc that are being mentioned/discussed is also something that is seen/studied in other manuscripts already published on (integrated) hydrologic models (http://www.hydrol-earth-syst-sci.net/18/2343/2014/hess-18-2343-2014.html, http://onlinelibrary.wiley.com/doi/10.1002/wrcr.20169/abstract) or in discussion (http://www.hydrol-earth-syst-sci-discuss.net/12/3169/2015/hessd-12-3169-2015.html).

Response: Cross-process correlation issues are likely to occur in all models where several processes are coupled and updated in a data assimilation scheme, and the issues in the manuscripts mentioned appear related to the ones of the present paper. The main problem with the cross-correlation presented in the present paper is the difference in the dynamics between stream flow and groundwater head, and the same difference is present in the manuscripts mentioned even if the processes observed and updated are different.

Modifications: References to Li et al. (2013) and Wanders et al. (2014) have been added to the paper.

- Comment: 3) The manuscript makes a lot of assumptions, for instance about noise (SD, correlated/uncorrelated, etc) on forcing and parameters and it remains unclear what the effect of these choices is on the final outcome; I would appreciate a discussion

HESSD

12, C1793–C1796, 2015

on the effect of such choices on the final outcome;

Response: We agree that the paper would benefit from a more broad discussion of the assumptions.

Modifications: The following is added to section 2.5: “The noise added to both forcings and parameters is based on experience with uncertainty in real data and parameters. The magnitude of parameter uncertainty is for many parameters well understood, as sensitivity analysis and calibration has been performed on several hydrological models, including the Karup catchment model (Refsgaard, 1997). Correlation in parameter values is only included where this is widely accepted to exist and easily quantifiable (i.e. horizontal and vertical hydraulic conductivity). The noise added to the forcings represents a significant simplification of the understanding of forcing uncertainty, which is likely to be highly correlated both temporally and spatially. A better description of the correlation in forcing noise would most likely have resulted in better description of the error covariances, and thereby better filter performance in terms of distributing the state updates. However, spatially and temporally correlated ensembles of forcings are difficult to generate, and outside the scope of this study“. Also, the following is added to section 2.6: “The assumption of head observations being uncorrelated in time is a simplification, as systematic error due to poor representation of the observation location in the model (i.e. the model grid point does not coincide with the observation location) is common in real head observations. The biases in head observations could potentially impact the filter performance, but accounting for bias is outside the scope of this study“.

- Comment: 4) Finally, the paper is a theoretical study. No observed discharge or head measurements are being used as far as I could see. Adding a comparison with measured data to the manuscript is needed and would overcome the issue regarding this manuscript mentioned by the authors in their last sentence of the conclusions.

Response: We agree that a natural extension of the study is to use real data. However,

HESSD
12, C1793–C1796, 2015

using real observations is not straight forward, particularly due to the significant biases present in groundwater head observations. The bias differs strongly from grid point to grid point, which often leads to very poor performance of the filter. Furthermore, the disconnect between the strongly biased head observations and the less biased discharge observations means that it is very difficult to assimilate both types simultaneously. We are aware of the methods that exist for bias correction in data assimilation, and are currently testing these. The bias issue is however so complex that we consider it outside the scope of this study.

Modifications: None.

- Comment: minor Figure 5 subtitles not in right places

Modifications: Corrected.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 2267, 2015.