Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2018-74-RC2, 2018

Hydrology and Earth System Sciences
Open Access
Discussions

Interactive comment on "Inflation Method for Ensemble Kalman Filter in Soil Hydrology" *by* Hannes H. Bauser et al.

Anonymous Referee #2

Received and published: 8 April 2018

General remarks

This is a well written paper that can be of interest for the hydrological modeling community using data assimilation. It presents the development and application of an adaptive inflation method specifically designed to counteract filter inbreeding in soil hydrology, when increasing the ensemble size is too computationally expensive. The method is applied and proved to work well in a small synthetic test case.

I used to think that inflation methods are not a good way to improve the ensemble Kalman filter, because in principle they are numerical tricks that, in my opinion, depart from the correct theory. When filter inbreeding occurs, the only mathematically consistent way to prevent it would be to increase the ensemble size, thus approaching the limit of an infinite ensemble for which the EnKF is demonstrated to converge to the

Kalman filter. However, I recognize that in some cases this is not practically feasible and in this specific case I like the idea of an adaptive inflation factor that is estimated based on the difference between measurements and mean forecast state, i.e., based on physical considerations and that can give useful insights about the dynamics in the unsaturated zone.

Other than relatively minor edits and comments, reported below, I think there is one main flaw in this paper: the method is demonstrated only in a fairly simple synthetic test case and it does not provide insights on possible issues in more realistic applications. I think an additional test case would make the paper more interesting and its conclusions more robust. The Authors themselves claim that the method has already been tested in a real-world application taken from Bauser et al. (2016): I strongly recommend that such an application be added to this paper and its results discussed in details.

Specific comments

Page 2, line 7: Another relevant reference is Botto et al. (2018) "Multi-source data assimilation for physically-based hydrological modeling of an experimental hillslope", still under discussion in HESS but already fully citable.

Page 3, Eq. 3: Strictly speaking, this is a scaled covariance matrix. The real one should be estimated dividing this by (N-1). Same for the matrix R in Eq. 4.

Page 5, lines 5-6: This statement requires an appropriate reference. Does it refer to a previous study by the same research group?

Page 6, lines 18-19: This is a potentially important issue that is worth of further investigation. Why not repeating the analyses with one or two different values of the seed to actually show this sensitivity?

Page 7, lines 4-8: Please add appropriate reference and explain exactly how the spatial variability is taken into account. Is the parameter ξ a function of space?

Page 10, lines 2-3: This statement is not clear. Can you please clarify, considering also the additional details required in the previous point?

Page 11, lines 28-30: As suggested above, this should be significantly expanded as a new section of the paper, where to show how the method works in a real-world application.

Page 13, lines 8-12: Why would one want to use a multiplicative parameter in the boundary conditions? Maybe use a different example to illustrate this point.

Page 13, lines 13-20: Similar to the previous one, also this paragraph is not very clear. Please rephrase and give practical examples of errors that can and cannot be represented with the augmented state.

Page 14, line 11: Please see previous point.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2018-74, 2018.