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Interactive comment on "Emulation of an ensemble Kalman filter algorithm on a flood wave propagation model" *by* S. Barthélémy et al.

Anonymous Referee #1

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Journal: HESS Title: Emulation of an Ensemble Kalman Filter algorithm on a flood wave propagation model Author(s): S. Barthélémy et al. MS No.: hess-2013-163

Review

This paper addresses a data assimilation problem related to flood forecasting. It shows that with a linear 1D flood wave propagation model, and under certain conditions of stationarity, a simplified EnKF can be used instead of a full EnKF, with almost no loss of performance. In the simplified EnKF, a surrogate of the (ensemble-based) covariance matrix is formed based on smart theoretical arguments. The paper is quite well written, although the abstract is a little bit too long and redundant with summaries given in the introduction and the conclusion sections. I strongly recommend to shorten the abstract

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and replace the summary in the introduction by more relevant material, see below.

My main concerns are related to the motivations and the novelty of this work.

The authors argue that the main motivation for this work is to reduce the computational burden of a full EnKF. This is surprising to me. First, as mentioned page 4, line 24, the ultimate models to be used for realistic flood forecasting are 1D or 2D shallow-water models. As far as I know, running an ensemble of O(10) members is not very challenging with such models. Also, the largest part of the computational complexity comes from the ensemble propagation, not from the analysis. The proposed method may help to reduce the computation time by a few percent, but this should be negligible. An argument, used page 16 line 1, is that for such problem a single forecast is carried out. That indeed answer the question. But this is again surprising, since such deterministic approach does not enable to identify the risks of extreme events, which floods are by nature. But if the assertion of the single forecast is actually true, it should be supported with scientific justification and appropriate references.

Most of the introduction is dedicated to the description of the work presented in the paper, missing the essential introduction of the context: How data assimilation and forecast are performed in other flood forecasting systems, with a particular emphasis on those using the EnKF; The usual methods to form covariance matrices in Optimal Interpolation systems - with an emphasis on the method chosen in this paper. Using the asymptotic behaviour of the covariance matrix to simplify the Kalman filter implementation is indeed not new. The lack of references to past works on this subject is astonishing, especially because it is at the core of the present work. I cite Fukumori et al (1993) and Gelb (1974) for example.

In fact, I wonder what the novelty of this paper is. Implementing an EnKF with a low dimensional linear model is not challenging, and the method described here to make it more efficient is not new. If the real novelty is the parametrization of the matrix, particularly using the diffusion operator, this must be put upfront in the abstract and

the introduction. The introduction must also describe what the other authors do to form their covariance matrix.

Other minor comments

Page 4 line 7: Localization can indeed help in reducing the computational complexity of the stochastic EnKF, but not the deterministic one. Saving time is not the main purpose of localization. And again, the analysis remains cheap compared with the ensemble propagation.

In section 2.2, the authors seem to discover that the linear wave model preserves Gaussianity. This fact is well known and is at the basis of the Kalman filtering theory. I do not say that this section is useless, because the derived formulas are necessary for the following sections, but it should be presented slightly differently.

Page 6 line 7, define U_m.

Page 6: I think recalling the Runge-Kutta 4 scheme is not essential here, since it is not at the core of the work.

Page 7, line 12: Explain that we switch to a spectral representation for the purpose of the theoretical derivation. Now, the reader expects the setup of an EnKF and may wonder why the authors do not simply sample the Gaussian distribution.

Page 9 and at other places: I think Lp should be written L_p. There are a few other typos of the kind throughout the text.

Beginning of section 2.2.2: Recall what N is.

Equation 17: Denominator should be N_e-1.

Page 12: I do not understand the point of the last sentence of Section 3.1.

References

Fukumori, I.; Benveniste, J.; Wunsch, C. & Haidvogel, D. B. Assimilation of sea surface

topography into an ocean circulation model using a steady-state smoother Journal of Physical Oceanography, 1993, 23, 1831-1855

Gelb, A. Applied optimal estimation M.I.T. press, 1974

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