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Hydrology and Earth System Sciences Discussions

Interactive comment on "Estimating geostatistical parameters and spatially-variable hydraulic conductivity within a catchment system using an ensemble smoother" *by* R. T. Bailey and D. Baù

Anonymous Referee #2

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The paper presents the numerical application of an inverse parameter estimation scheme (called the Ensemble Smoother) to a hypothetical surface/groundwater example. The ES is not a new idea; it was first developed by van Leeuwen and Evensen (1996). In this paper, the influence of different factors such as the number of observations, the type of data (water table or stream flow), data errors, and the uncertainty of prior information about geostatistical K model, is investigated. Particularly, the original ES is modified into an iterative procedure in order to estimate the mean and variance of geostatistical K model. The numerical results indicate that the ES scheme can provide a reasonable estimation of the K field when there is sufficient water level data. Overall,

the reviewer believes that the paper makes a nice contribution to the hydrologic modeling community by presenting a detailed numerical study of ES and demonstrating its efficacy in the example problem.

The main comment is about the computational limitation of ES, as compared to other Kalman filter techniques such as EnKF. As pointed out by the authors, ES assimilates all previous model state and observation data up to the ïňĄnal data sampling time. This means the sizes of all the matrices involved in the calculation are increased by a factor of the number of measurement times, which will make the ES computationally difficult to apply if the real-world problem is large (millions of nodes are common in modeling practice). The authors should thus offer some remarks on the computational aspect of ES.

Other secondary comments about the paper:

1) page 9598 – lines 1 to 3. Clarify the connection between matrices E and D.

2) page 9599 – lines 13 to 14. Clarify "off-line". Isn't it the case that in all other Kalman filter techniques, the forecast and update are sequential and thereby separable?

3) page 9603 – line 14. Change "depth" to "rate". Also, it does not appear the precipitation is used as an input to CATHY. Rather, the net infiltration rate is used as input. If this is the case, please change the precipitation graph into infiltration rate graph. The precipitation graph makes people think that precipitation is a model input – then you need to consider evapotranspiration etc. in order to estimate the net infiltration rate.

5) page 9608 – line 9. The iterative approach is applied here only to estimate the geostatistical K model parameters. The reviewer thinks it might be worthwhile to apply the iterative approach for all the scenarios in section 3.2. Further improvement of K estimate might be possible by using the iterative approach there – instead of regenerating a new set of K realizations, the updated K fields from previous iterations can be used as initial K realizations for iterative updating.

6) page 9620. Figure 2 – precipitation graph. The precipitation rates are impractically large. The number of elements shown on the figure is not consistent with table 1.

7) page 9621 – figure 3. The font size of label too small to read. Similar suggestion for figures 5, 6 and 15.

8) page 9622 – figure 4B. The resolution needs to be improved.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 9587, 2011.