

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.

Anonymous Referee #2

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This study demonstrates the use of a variant of the Ensemble Kalman Filter to assimilate streamflow measurements into a flow forecasting system. The topic is appropriate for the Hydrology and Earth System Sciences journal, but in some parts, the parts read like a user's manual (for example p. 9542, l. 2 or section 3.4); this is a scientific paper and should be written as such. The methodology followed is generally sound, although there are some issues that need to be addressed before publication (see below for details).

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- probably shorten the title by removing everything after “Filter”. - p. 9538 should be in an appendix. Perhaps adding a schematic for the REnKF would help. - It seems that the same observation is assimilated multiple times. Shouldn't the covariances developed by the model physics make re-running the model for each of the time steps before the observation time redundant? What does the pdf of the innovations look like? Can the authors add a comment on whether that pdf approximates a Gaussian since that will provide some insight on the optimality of the assimilation algorithm. - p. 9539, l. 12: I wouldn't use the term “directly”, isn't the optimality of the filter governed mostly from the Gaussianity and the linear model assumptions? - p. 9540: the adequacy of the ensemble size depends on the state vector size. Probably, a 50-member ensemble should be good enough, but adding that information would be helpful. - Section 2.2.2: why are the state variables perturbed along with precipitation? The correlations developed by the model itself will be physically consistent, however perturbing the state with additional noise could change the model error covariance significantly? Can the authors comment and demonstrate the consistency of the model states after perturbation? - p. 9541, l. 18: how were the parameters chosen for the other catchments? - p. 9546, l. 2-3: why aren't the results from the first and second type simulation shown on Fig. 5? - p. 9546, l. 9-15: how did each catchment's time of concentration relate to the chosen lag? Could that parameter have been estimated a priori (as was aforementioned in the text)? - p. 9546, l. 16-17: why was the median chosen and not the mean of the ensemble? - p. 9546, l. 20-27: it's not very clear whether the percentage of times the flow measurement fell within the ensemble for the EnKF and REnKF refer to a posteriori ensembles. If so, why wouldn't those numbers be 100%, shouldn't the filter nudge the model towards the estimates (I suspect a reduced ensemble spread is the reason, but it should be verified by the authors). - Fig. 8: please add a legend at the bottom of the overall figure. - p. 9548, l. 14-22: I'm having some difficulty understanding whether the change in the fractional error parameters improved the estimate because the filter did a better job or because the ensemble spread was wider and captured the observed streamflow values. - p. 9549, l. 10-12: the text seems to imply

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that a larger ensemble spread alone would improve the results, when in fact a better approximation of the spread would probably lead to better results. - Section 4.4: I think the Ensemble Kalman Smoother might have been a more appropriate comparison.

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

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