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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Identification of hydrological model parameters variation using ensemble Kalman filter" *by* Chao Deng et al.

Anonymous Referee #1

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In this manuscript, the authors investigate whether it is possible to infer the temporal variability of certain hydrological model parameters that are often assumed to be stationary. To that end, the method of ensemble Kalman (EnKF) filter is applied, which is known for its ability to account for time-varying state variables. The authors apply their approach first to a synthetic basin with varying degrees of uncertainty and then to two different real-world basins with different temporal variability of model parameters. Their results demonstrate the overall ability of EnKF for time-variant parameter identification.

The manuscript itself is very well written. The introduction gives an adequate overview on the relevant questions and properly motivates the study. The methods section provides the reader with the necessary information on the used model, the EnKF used for the inference and the criteria used for evaluating success. The results are presented in a way that it easy to follow and understand, and the discussion provides the necessary

context for these results. The data given through figures and tables is clear, well presented and sufficient to support the conclusions drawn by the authors. Furthermore, the presented conclusions are very relevant for the Scientific Community interested in model calibration and are well suited for the scope of HESS. I have to say that I really liked the study and the way it is presented in the manuscript. I can not see any major problems and I think the authors did a fine job throughout. In conclusion, I would strongly recommend publication.

In the following, I will list a number of minor concerns that could be easily fixed to improve the manuscript even further. None of them, however, affect the overall quality.

- Page 5, Line 62: The authors present two established methods to account for time-variant parameters: windowed assimilation (dividing the calibration set into smaller subsets) and parametric assimilation (assuming a parametric model for the time dependency) and contrast this with EnKF which is an non-parametric assimilation procedure (no form of the time dependency is assumed). I wonder how their approach might fare against parametric techniques. Typically, parametric estimation techniques are superior when the true form of the dependency is known but their performance quickly decreases when this condition isn't meet. Maybe, the authors want to elaborate where they see the strengths and weaknesses of their method vis-a-vis these other approaches. This may be relevant for paramters like C (the evapotranspiration paramter), where plausible paramteric models for the time dependency are possible. In fact, the authors use a paramteric model for C (for simulation and not for estimation, of course) in their synthetic basin. In such a situation, a parametric estimation scheme may outperform EnKF.
- Page 6, Line 82: The authors use the term data assimilation of which EnKF is a particular implementation. The term is introduced in the introduction together with its abbreviation and never used again. If you introduce a term, it better be

important later on. If not, I would propose to skip this term and start with EnKF right away.

- Page 8, Line 17: The authors say that EnKF is based on the Monte-Carlo method. I am not sure about the wording. First, Monte Carlo is not really a method but a buzzword for virtually any method that employs a random number generator at some point. Second, the randomness is only one element of EnKF, with others being the approximation of the covariance by the sample covariance and the assumption of Gaussianity for the PDF's.

- Page 8, Line 19: The authors care to mention that EnKF is applicable to a variety of non-linear problems. I am not an expert on the issue but I alway thought that EnKF assumes a linear forward model. I know that extensions of the Kalman filter to non-linear models exist. Is that what the authors talk about? If so, it's a little bit confusing.

- The authors consistently speak of uncertainty intervals (e.g., Page 19, Line 14). What do they mean by that? Credible intervals, confidence intervals, prediction intervals or something else? In my opinion, only credible intervals represent uncertainty, so the authors should elaborate on what they mean.

- Page 13, Line 97: If the authors care to explain that $NSE = 1$ is a perfect match, they should also explain that it starts at $-\infty$. People, who do not know about the NSE, may be lead to think that it varies between $0 < NSE < 1$, which is obviously not the case. On the other hand, people who do know about the NSE don't need that information.

- The authors diverge from the established IMRaD structure by splitting the Methods part into the 'Methodology' and 'Data and study area' section. This is nothing major, but it was a little bit disorienting when I first read the manuscript.

- The manuscript appears to have been typeset with a word processor like Microsoft Word and it shows. There are several major widows and orphans throughout the manuscript (e.g., Page 4, 7, 8, 11, and 24). I guess the publishing office takes care of it in the final version, but it was a drag while reading. In particular, section headings shouldn't be left dangling on a single page (see, e.g., Page 13 and 15).

- Similarly, the line numbering was confusing. Either use continuous line numbering or start anew every page.

- Punctuation is missing throughout all equations that aren't inline. Punctuation rules should apply to both inline and non-inline equations (see, e.g., Higham, Nicholas J. (1998), Handbook of Writing for the Mathematical Sciences, SIAM, ISBN 0-89871-420-6).

- Instead of acknowledging the contribution of the reviewers (who haven't done anything at this point), the authors may want to include the data providers (e.g., the China Meteorological Data Sharing Service System).

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