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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Simultaneous estimation of model state variables and observation and forecast biases using a two-stage hybrid Kalman filter" *by* V. R. N. Pauwels et al.

Anonymous Referee #3

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In this manuscript, the Authors present a data assimilation (DA) framework that allows for i) the joint estimation of the state variables describing a hydrologic system, ii) the bias of the system observations and iii) the bias of the model used to simulate the system. The framework stems from a Discrete Kalman Filter (DKF) algorithm, which is used to identify and quantify the observation and the model biases, and an Ensemble Kalman Filter (EnKF), which is used to update the states of the system based on the biased and noisy field observations. The framework is applied to a synthetic test case based on a rainfall-runoff model developed by Lindstrom et al. (1997) and calibrated for a catchment located in the municipality of Zwalm, Belgium. Results show that

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the proposed framework has great potential in terms of applying DA to problems in which both field observations and simulations models are likely affected by significant systematic errors (bias), in addition to random errors (noise). Perhaps, one of the most attractive features of the combined DKF-EnKF approach is that models that already include unbiased DA algorithms may be more or less easily expanded to account for measurement and model biases. The topics of this paper are very interesting and aligned with the works typically published in Hydrology and Earth System Sciences (HESS). I found the manuscript innovative, scientifically sound and well written. The organization and presentation, however, require some significant improvements before the paper is ready for publication. One important concern is about some key operating hypotheses necessary to the formulation and the application of the two-stage DKF-EnKF approach devised by the Authors. These hypotheses require the covariance matrix of the model bias to be a fraction of the biased state error covariance matrix, and the covariance matrix of the observation bias to be a fraction of the biased state error covariance matrix projected onto measurement locations. These assumptions may seem quite far-fetched unless a reasonable physical basis is provided for them. From this perspective, the Authors need to critically address the validity of these hypotheses much more thoroughly, and explain when, in their view, they are valid and when they are not. Another important concern is about the quality of the presentation of the "Results". Several figures are low quality and unclear, which makes it very difficult to draw conclusions based on the application results. In several instances, these figures are not adequately presented and commented so that the reader is left to look into them on her/his own without adequate guidance. In broader terms, I suggest the Authors to expand Section 7 and make Sections 2 and 3 more concise. These and several other comments and questions are included in the attached annotated manuscript.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/10/C2647/2013/hessd-10-C2647-2013-supplement.pdf

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