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Hydrology and Earth System Sciences Discussions

Interactive comment on "Advancing data assimilation in operational hydrologic forecasting: progresses, challenges, and emerging opportunities" *by* Y. Liu et al.

Anonymous Referee #1

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General comments HESS 9, 3415-3472, 2012-07-09

This paper is an outcome of the 2010 Workshop on Advancing Data Assimilation in operational hydrologic forecasting and water resources management. It reviews the current status of data assimilation for hydrology and hydraulics with a focus on the challenges to transition to operational use. A complete and relevant overview of the recent and major research work on the advanced DA techniques is presented along with a rich bibliography .

The authors conclude that efforts should be made on the high non linearity, ensemble

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sizes, characterisation of uncertainties on both observatons and models. The use of a generic (OpenMI) tool and newly emerging observations should be investigated and that the expertise in DA for hydrology should be transferred to the field of water resources and hydraulic structures control.

Generally speaking, the paper is well writen and it the nicely summarizes the major research works on advanced data assimilation citing numerous papers. Still, I suggest the authors give more details on the most innovative ones (see point 2).

1- In the introduction of Section 2, the authors distinguish 3 types of DA problems : state correction, parameter calibration and error updating problem. The literature described in Section 2.1 deals with both state and parameter correction (p3424 l4, p3425 l1), I then recommend that the title would be modified and the definition of the vector x be extended to state plus parameters. For sequential algorithm, the dynamics of the model parameters is usually prescribed by a random walk process. This should be added as a coment to Eq (1). In addition, the question of non linearity between the control and the observation space is even more relevant when the model parameters are controled.

2- The description of innovative methods of EnkF for non Gaussian pdfs should be more detailled, especially the bimodal example from Zhou et al (p3426 l14). This seems particularly relevant for precipitation errors distributions.

3- I agree that the computational cost for EnKF and PF can be to high for operational application (p3426 l5), some ideas on how many members are usually needed for these methods and up to which control size they can be applied should be given. Also, please quantify what is meant by Âń large Âż on p3427, l28 when refering to variational methods and their advantages versus filtering and stochastic algorithms.

4- The Section on error and noise updating should be related to the notion of propagating the covariance matrices. This section should be revised with a proper distinction between describing the model error and how to update them along the assimilation

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procedure. I suggest to merge this section with 3.1.

5- Please define Âń Conditional simulation Âż on p3432 l10.

6- Why is the sentence 3433 l7-10 in italics ?

7- In 3.2, it is not clear how the 4 different approaches in p3433 l12 relate to the mathematical framework of data assimilation algorithms and covariance matrices, especially the second approach.

8- Several studies could be cited here on the use of remote sensing data (p3440 l4) :

Biancamaria S., M. Durand, K. M. Andreadis, P. D. Bates, A. Boone, N. M. Mognard, E. Rodriguez, D. E. Alsdorf, D. P. Lettenmaier and E. A. Clark, "Assimilation of virtual wide swath altimetry to improve Arctic river modeling." Remote Sensing of Environment, 115(2): 373-381

Durand, D., K.M. Andreadis, D.E. Alsdorf, D.P. Lettenmaier, D. Moller, and M. Wilson, "Estimation of bathymetric depth and slope from data assimilation of swath altimetry into a hydrodynamic model." Geophysical Research Letters, v.35, L20401, doi:10.1029/2008GL034150, 2008.

Studies from Balsamo et al. on the assimilation of SMOS data for the initialisation of soil moisture hydrology should also be cited :

Balsamo, G., J-F. Mahfouf, S. Bélair, G. Deblonde, 2007: A Land Data Assimilation System for Soil Moisture and Temperature: An Information Content Study. J. Hydrometeor, 8, 1225–1242. doi: http://dx.doi.org/10.1175/2007JHM819.1

Reichle, Rolf H., Randal D. Koster, Jiarui Dong, Aaron A. Berg, 2004: Global Soil Moisture from Satellite Observations, Land Surface Models, and Ground Data: Implications for Data Assimilation. J. Hydrometeor, 5, 430–442. doi: http://dx.doi.org/10.1175/1525-7541(2004)005<0430:GSMFSO>2.0.CO;2

9- The connection between the MPC method and the DA applications for dual state-

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parameters estimation and SODA approach (p3445, l25) should be clarified as well as the notion of error covariance matrices. Studies on DA for operationnal hydraulics structures and water resources from Jean-Baptiste and Malaterre should also be cited :

Jean-Baptiste Nelly, Malaterre Pierre-Olivier, Dorée Christophe and Sau Jacques, 2011. "Data assimilation for real-time estimation of hydraulic states and unmeasured perturbations in a 1D hydrodynamic model". Journal of Mathematics and Computers in Simulation. June 2011. Vol. 81, Issue 10, pp 2201-2214. DOI=http://dx.doi.org/10.1016/j.matcom.2010.12.021.

10-In Section 5.3, a description of the use of DA methods and other control methods for real-time flood forecasting by national and regional centers is missing (cite for example the EFAS project from the EU at the medium range scale and studies from Ricci et al. on operational flood forecasting in France).

Ricci et al. : Correction of upstream flow and hydraulics state with a data assimilation in the context of flood forecasting. Hydrol. Earth Syst. Sci. Discuss., 7, 9067-9121, 2010 www.hydrol-earth-syst-sci-discuss.net/7/9067/2010/ doi:10.5194/hessd-7-9067-2010

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