Hydrol. Earth Syst. Sci. Discuss., 10, C6934–C6937, 2013
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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Improving streamflow predictions at ungauged locations with real-time updating: application of an EnKF-based state-parameter estimation strategy" *by* X. Xie et al.

Anonymous Referee #1

Received and published: 28 December 2013

Dear Authors, I enjoyed reading this manuscript, which I consider to be very interesting. The study addresses very important issues associated with the assessment of the streamflow prediction in ungauged locations transferring information (in terms of covariance matrix) from gauged locations. An Ensemble Kalman Filter, partitioned forecast-update scheme, was used to update the states and parameters of a distributed hydrological model, SWAT. The previous methodology was applied to the Zhanghe basin, in China, assuming different scenarios of gauged and ungauged locations. The results of this study showed how the assimilation of streamflow observations at gauged locations

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can improve the prediction of discharge at ungauged positions. The paper is generally well written and easily understandable by the readers. However, the introduction has to be better organized to focus on the main innovation of this study. The study is, in my opinion, of broad international interest and it can be considered worthy for publication after a minor revision. I list below some main comments which I sincerely hope can become useful.

A) As mentioned before, the novelty of this study it is not well presented in the paper. The section "Introduction" of this paper can be schematized in two different parts. In the first one, a description of the PUB initiative and a brief review of the regional methods used to propagate information from gauged to ungauged basins are proposed. Then, methods for data assimilation (Ensemble Kalman filter) with respect to the states-parameters estimation are reported. Honestly, I cannot see a connection between these two parts. Is this study the first one which deals with implementation of a data assimilation method in estimation of streamflow in ungauged sub-basins? My suggestion is to better explain if the proposed approach is actually new, by providing a better review of related publications about this issue (regional methods based on data assimilation techniques).

B) Another issue is related to the concept of gauged and ungauged locations. Sivapalan (2003) mentioned that ungauged case is the case in which observations of the variables we are trying to predict are short, of too poorly quality, or even nonexistent. My concern is that, in the framework of ungauged basin and streamflow estimation, the authors applied distributed hydrological model which usually require a significant amount of data. May the Authors explain this choice (in addition to the reasons described at line 13 of page 13451 of the manuscript)?

C) As described by the Authors, the correct estimation of the number of ensemble used in the EnKF is a delicate problem since the EnKF performances are directly connected with the model spread. The Authors provide a clear description of the method used to estimate the number of ensemble members but I could not find this last information in

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the paper. I think that an indication about the number of ensemble members (e.g. 10, 50 or 100) might be interesting for other researchers.

D) In the section "Assimilation setup and scenario design", the Authors proposed to assimilate observations in interior points of the basins (ASS_BD and ASS_AB) in order to improve the streamflow prediction in pseudo-ungauged location (location C). Assimilation of discharge data in interior points of the basin was already analyzed in other studies (Clark et al., 2008; Rakovec et al., 2012; Chen et al., 2012; Lee et al., 2012; McMillan et al., 2013;). My suggestion is to include these papers in the references of this manuscript.

E) In the section "Prediction in ungauged locations" the Authors state that "Adding an observed gauge (Gauge B) at the upstream in the basin, i.e. the ASS_BD scenario, provides better streamflow predictions in the pseudo-ungauged sub basins than the ASS_D scenario; the RMSE drops to 1.741m3 s−1" (around line 15, page 13456). On the other hand, in the section "Conclusions" it is reported by the Authors that "the downstream data have more important roles in the data assimilation than those from upstream" (line 5, page 13459). In my opinion the interior location B provides an improvement in the model performance in C and this can be related to the spatial correlation between the streamflow in B and C. The sentence in the conclusion should be rephrased and it should include the reason why, using a particular location of interior point, there is an improvement in the model performances.

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