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Interactive comment on "Large scale hydrological model river storage and discharge correction using satellite altimetry-based discharge product" *by* Charlotte Marie Emery et al.

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This review was jointly done by Rolf Hut and Zhenwu Wang.

This study applies Ensemble Kalman filter with two localization methods to assimilate discharge data into a relatively large scale hydrological model. As far as I can tell, this paper should the first case study in hydrology field to apply an EnKF with localization in such a high dimensional model. The academic value of this research is great and their exploration is valuable to the readership of HESS. After reviewing the entire paper, I have some concerns that need to be clarified and explained. Besides that, I have some minor suggestion and tips. 1. In the introduction, the third paragraph is about the

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resources of model errors. In my opinion, a description of the accumulation of model errors and other uncertainties in model's prediction which can lead to the collapse of the model should be added. I think this part can be regarded as a part of the explanation of the necessity of data assimilation. I recommend to shorten the section on model error sources and add some sentences on the impact of accumulation of uncertainties. 2. In Lopez Lopez (2016) discharge data was assimilated into a model for the Rhine basin. I think this paper should be added to the introduction. (López López, P., Wanders, N., Schellekens, J., Renzullo, L. J., Sutanudjaja, E. H., and Bierkens, M. F. P.: Improved large-scale hydrological modelling through the assimilation of streamflow and downscaled satellite soil moisture observations, Hydrol. Earth Syst. Sci., 20, 3059-3076, https://doi.org/10.5194/hess-20-3059-2016, 2016) 3. Page 3, in last second paragraph, the aim of this study only mentioned that EnKF is applied and also said something about the model and observations. From my point of view, the using of localization methods should be mentioned. The localization methods are the crucial key to this case study and without localization, the academic value of this research will mostly be as a case study of an otherwise known method into a new geographical area. 4. In section 2, I think the description of the CTRIP RRM is excessive. It would be better to make the context of this model shorter and simpler. Maybe the authors can reference one of their earlier papers on the model and point to that for the model description. 5. In section 3, it has the similar issue just like section 2, the explenation of the fairly standard EnKF is too long. 6. Section 3.2.4 (Localization) does not belong to "3.2 Generating the ensembles". In my opinion, the following structure of section 3 is better. Firstly, introduce the control variables and observations separately. And then, give a short introduction to EnKF theory. Following, present how to implement the EnKF with localization specifically. Last part includes diagnostics and experiment set up.

7. In page 14, section 3.2.4, the second paragraph, it said that there are three localization methods. I prefer to state that there are two common localization methods, namely local analysis (R localization) and covariance localization (B localization) . These two

methods can be found in following two papers. -Balance and Ensemble Kalman Filter Localization Techniques (doi:10.1175/2010MWR3328.1) -Relation between two common localisation methods for the EnKF (doi: 10.1007/s10596-010-9202-6) . 8. The names of the different localization schemes should align with the common names in the data assimilation field. I recommend the terms in those two papers in point 7, above. In table 3 and corresponding parts in the main body of this research should change “-local suffix” to “Local analysis” or “R localization” and also replace “-diagonal suffix” with “covariance localization” or “B localization”. 9. On page 16, the part before 3.3, it describes how to get the localization matrix. In this study, the author used localization matrix to multiply covariance matrix directly. This way is not wrong but it differs from the most common way to implement the localization methods. Can you use equations to display the formulation of localization matrix? This is helpful for readers to understand your localization methods. 10. In table 1, the size of the ensemble is 101. The authors do not justify the choice of exactly 101 ensemble members in the paper. It is not possible for the reviewer to see if the ensemble size represent the distribution of model states properly? Could the authors use some figures or the rank histogram of the ensemble to show the gaussianity of the ensemble? Otherwise, could the authors justify the choice for 101 ensemble members? 11. In data assimilation applications with localization usually a common localization function is used. Common example is a fifth order function of Gaspari and. I didn’t find the description of the localization function in this paper. If I missed it, please point out its location. If the authors didn’ t use it, could the authors explain reasons and considerations? 12. It is common that localization methods can cause imbalance. The analysis of imbalance can show the performance of localization method in specific application. I recommend adding the imbalance analysis. If the authors think it is unnecessary, could the authors explain the reasons? 13. I am a bit confused about the chosen localization scales. The “diagonal error covariance matrix” in this paper is to apply B localization method to form the localized covariance matrix. In this paper (Relation between two common localization methods for the EnKF, doi: 10.1007/s10596-010-9202-6), the author used a figure to

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show the influence of B localization (covariance localization) method to the error covariance matrix. The result of this localization method is mentioned in the paper. It said that “with non-zero elements centered around the matrix diagonal”(page 15, the first two lines). You only keep the elements in the matrix diagonal which means you only use the fixed localization scale. And also, in your “-local suffix ” case, if I understand correctly, this is the “Local analysis” or “R localization” in data assimilation. When you design and set the influenced areas, you still used the fixed localization scale. Could you explain the reasons why you only use a fixed localization scale in your experiment set-up? Can you also explain how this localization scale was chosen? In the results part, the “local” case has a better performance compared with the “diagonal” case. Can the authors collaborate on the impact of different localization scales on the performance of DA? 14. In page 24, the last paragraph, the authors state that there are two ways to improve DA. A more realistic ensemble method to generate ensemble and observation correction algorithms can help to get better performance. These two conclusions are right. But, in your analysis part, you didn’t compare the situation with specific ensemble generating method and the situation with generating ensemble randomly. In my opinion, no evidence in this paper can support this conclusion. Similarly, the second conclusion is not conclusive. Can you rephrase these two conclusions and make them open? In conclusion, after some modifications and additional explanations, I recommend accepting this paper.

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