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Interactive comment on "Assimilation of river discharge in a land surface model to improve estimates of the continental water cycles" *by* Fuxing Wang et al.

Anonymous Referee #2

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Review of "Assimilation of river discharge in a land surface model to improve estimates of the continental water cycles" by Fuxing Wang and co-authors.

The manuscript presents a calibration methodology to optimize a multiplicative factor on modeled surface runoff and deep drainage using river discharge observations. The study focus over Iberia using the ORCHIDEE land surface model, incorporating a river routing scheme and benefiting from the ORCHIDEE data assimilation system. This study is of general interest for the land surface and large-scale hydrological communities presenting a novel optimization/calibration methodology. The manuscript is well presented and organized, but there are a few points that require further attention before

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publication.

Comments:

1. “Data assimilation”: Data assimilation is normally associated with an “update” of the model state, e.g via improved initial condition. In this study, merging modelled river discharge with observations is used to “obtain optimized discharge over the entire basin” (as mentioned in the abstract). Therefore I fell that the term “data assimilation” could be a bit misleading for the audience, since this manuscript shows a model optimization or calibration. I suggest that the authors make this point very clear to avoid confusion.

2. River routing model: Since both references of the routing model are not published yet (Nguyen-Quang et al., 2017; Zhou et al., 2017) and this is a key component of this study it is important to have a bit more details on how the three linear reservoir are represented and which model parameters are used and were defined (e.g water residence time). For example the aquifer level is referred later in the text due to spin-up, but it is not clear from the model description how the aquifers are represented in the model.

3. How does the simple estimate of the correction factor used as prior (“xprior” compares with optimized values in figure 6 ? Are the changes significant for example in terms of improved correlation?

4. Role of forcing: To discard the role of precipitation forcing, the three datasets could be compared with a high resolution precipitation dataset (IB02, Belo-Pereira et al. 2011) also in terms of mean ratios : GPCC/IB02 CRU/IB02 NCEP/IB02 and compared with the “x” correction factor. I don’t see this as mandatory for the paper’s publication, but would make the results more robust.

5. Impact on evaporation: Section 3.4 compares the first guess evaporation by the land-surface model with the changes in evaporation resulting for the correction as a post-processing. Would it be possible to re-run the LSM applying just a constant cor-

rection factor to evaporation ? I understand that this might be difficult to do while conserving energy, but even if energy is not conserved, it could show the impact of "improving" evaporation, that would then be reflected directly in R & D and should, in principle improve the discharge simulations.

6. Comparison with GLEAM: It would be beneficial to also present the comparison between the original Evaporation and GLEAM in addition to the results in fig.12 (could be an extra panel). Considering the results shown, I find if difficult to understand the sentence " ln 473: "This result further confirms that .... And some processes are probably missing in GREAM v3.1" Please expand on this discussion to clarify the basis for this assumption.

Details:

Ln 21: "earth's water cycle"

Ln 324: The relative bias shown in figure 5 highlight the biases in the South since the absolute values are low. The absolute biases might be higher in the northern areas.

Ln 351: Should be: "Fig. 7 shows the annual mean" and not "annual cycle"

Ln 357: Looking that the stations distribution in Figure 2, the station Alcala Del Rio looks very close to Cantillana. If this is the case, the good results in Alcala Del Rio might be just a direct effect of the use of Cantillana observations, and it does not "validate the hypothesis that x is distributed homogeneously over the upstream basin". Please provide the distance between the stations and difference in upstream area and mean Qobs to show that Alcala Del Rio has other tributaries than just Cantillana to justify this sentence.

Ln 429: It is not clear the the simulations "underestimate the inter-annual variability". Could you provide the standard-deviation of the annual means of the observations and simulations?

Ln 436 (results in fig 10): If we assume that the increase in discharge is due to an increase of groundwater abstraction should we expect decrease of the correction factor since this is a process which is not represented in the model? The opposite sign with an increase of the correction factor, with higher corrections in in 1980 (around 0.2) and lower in 1989 (around 0.6) suggests that the correction factor is correcting for other processes and not human intervention? I think this is worth some discussion.

References Belo-Pereira M, Dutra E, Viterbo P. Evaluation of global precipitation data sets over the Iberian Peninsula. Journal of Geophysical Research-Earth Surface. 2011;116: D20101. doi:10.1029/2010jd015481

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