

Author response to:

RC1: 'Comment on hess-2021-104', Anonymous Referee #1, 11 Apr 2021

This study applied the Markov Chain Monte Carlo algorithm to calibrate a simple water balance model using GRACE TWS observations. The posterior model parameters, model states and simulated TWS for one watershed were shown in this study. The results suggested the potential of using GRACE to constrain model parameters. The topic is relevant for reader of HESS. However, I believe some critical points need to be clarified and supported by additional results.

Thank you for your time spent reviewing our manuscript and for your valuable comments. We hope our notes below address your concerns about this paper.

1. It was mentioned that the ET in the model was derived from the satellite observations of precipitation and TWS and ground-based river runoff (L138). I assumed that it must be GRACE TWS here. If so, GRACE data has been used in the modelling and reused in the model calibration through MCMC. The GRACE data was not independent to the model simulations. Please clarify.

This is true. To clarify this more, there are 3 different derivations used for the TWS variable. These 3 estimates provide a sense of uncertainty for the TWS. The uncertainty from these different 'products' is used in the likelihood function of the MCMC algorithm when fitting the model simulated TWS to the GRACE derived TWS. Then, there is also 3 products used in the precipitation and the runoff driving variables that were used, to get a sense of the uncertainty in each variable. To estimate the ET driving variable in this work, we use the mean of the TWS, P, and Q products and create a water balance that will allow us to estimate a mean for the ET driving variable. Then by application of the ET scaling parameter, we try to estimate whether our initial calculation of ET required any scaling to match the data. Therefore, even though the GRACE TWS is somehow used in the derivation of the ET data, the uncertainty that is applied throughout the work allows us to still estimate ET that is not dependent on the GRACE data. We will provide these details in the new version of the manuscript to provide more clarity to the readers.

2. The results for one watershed is not convincing. In particular, it was mentioned that additional testing over other watershed has been done in L369. Results for few more watersheds can help supporting this study. Since the inputs for the model are satellite rainfall, TWS and in-situ river runoff, it would be surprise there is no other watershed has enough river runoff data over Amazon.

Thank you for this insight. We will include results of the model simulated TWS as well as the inferred parameter values from two other basins in the Amazon. By examining the differences in the parameter inference and resulting TWS simulations between the different basins, we believe we can better answer the questions laid out in the paper. We will choose two other watersheds with contrasting precipitation levels, to demonstrate how information content varies across precipitation gradients.

3. Results of model simulations without MCMC should be compared with the posterior TWS to demonstrate the improved performance.

We again agree with the comment here and will include the prior simulation of TWS to show the improved performance after applying MCMC.

4. L76: Is the model proposed by the authors for the first time? Or any reference for the model?

Yes, this is the first time this model is reported in the literature. We will clarify this in the revised manuscript

5. L138: Was the satellite precipitation from TRMM here as well?

Yes, the precipitation product is from TRMM. We will clarify this in the revised manuscript

6. L173: Spherical harmonic solutions here?

Yes, spherical harmonics solutions used here. We will clarify this in the revised manuscript

7. L260: The information about each variable for each subfigure has been included in the figure caption. More discussion about the results instead would be helpful.

Yes, we can replace these comments with additional discussion about the results. Specifically, we can provide more comments about the supplementary figures which show how the parameter posteriors correlate with one another. These results in the supplement indicate what parameters combinations are ultimately possible, and more discussion about these combinations can be useful for the reader.

8. L285-290: could you include the r^2 for the model simulated TWS and de-seasonalized TWS without MCMC as a comparison? Also plot the time-series together in Fig6?

Yes, we can add these to the figures. And we can combine the figures together in one. We will do this in the revised manuscript.

9. The sensitivity results from figure 8 would make more sense to mentioned in the beginning of the section since the results were summarised in Table1.

This can be moved to the beginning of the section. We will do this in the revised manuscript.

10. Changing x-axis to years Figure 4 and 8 like the other plots would be more reader-friendly.

We agree with this comment. We'll change the x-axis in all figures to represent years.