We thank the referee for their constructive comments. We have provided detailed responses to each of their points below (author response is in bold).

My major concern on this MS are as follows:

- The conclusions of this study are heavily relied on model performance: the validation of ET, groundwater, streamflow are needed, although the authors directed readers towards other papers.

  The purpose of this study is to evaluate the influence of groundwater surface water exchanges on the shape of Budyko relationships given different approaches to quantifying evapotranspiration. We agree with the reviewer that the accuracy of local shape parameters for water year 1985 will be heavily dependent on the performance of the model. However, our goal here is not to predict shape parameters for our one-year simulation. Rather, we are using the model as a numerical testbed where we have fully defined precipitation, evapotranspiration, storage changes and runoff to evaluate the influence of different accounting methods on the resulting behavior. Thus, how well the model performs compared to observations is much less of a critical path toward the conclusions of this current work. Still, the model has been exhaustively validated to more than 1.2M observations [*Maxwell and Condon*, 2016]. As this appears in a 12,000-word, 20 figure document we feel directing the reader there is a much better approach than trying to replicate the validation in the current work. Of course the reviewer is correct that a better fit between the simulated results and observations for water year 1985 would improve our ability to use the Budyko relationships developed here to predict watershed evapotranspiration, but it would not change the findings of this paper.

  In response to the rest of the comments from this referee, as well as the other referees, we have significantly modified the manuscript to (1) more clearly emphasize the purpose of this analysis and (2) better explain our use of modeling as a numerical testbed and not a predictive framework. We hope that with these changes will more clearly emphasize the fact that the results presented here are general relationships that are not reliant on the underlying model which was only used as a means to sample the Budyko space within a controlled numerical framework.

- The judgements are too strong: one-year simulation data was used to judge long term assumption; at least the authors should mention that they only check shortcoming of the short-term application of budyko hypothesis; all of the words in abstract and conclusions should be constrained on this aspect (short term application).

  We agree with the referee that the one-year simulation used here does not prove or disprove whether it is appropriate to assume equilibrium conditions for long-term simulations. Our intention is not to predict when and where this assumption is valid, rather we seek to investigate the impact of storage changes when they are occurring. We intentionally chose to evaluate a one-year simulation because it is not in dynamic equilibrium and therefore captured a range of storage changes across the simulation domain. This allowed us to demonstrate the impact of variable groundwater storage changes on Budyko relationships. The intent here is only to demonstrate potential impacts given different approaches to evapotranspiration for a range of storage changes, this is not dependent on the time frame these changes occur over.

  As stated prior, we have refocused the purpose of our analysis and its intended applications in the revised manuscript in response to the reviewer comments. We have modified the introduction

and methods significantly to better clarify our goals and to be more explicit about the reason we selected a one-year simulation. Additionally, the conclusions and abstract have been refocused around these points to better highlight the intended use of these results.

- In the abstract, "trans-watershed lateral flow" (line 15) was mentioned, but only "groundwater surface water exchanges" are considered in this study as described in Methods section (2.4). If there exists "trans-watershed lateral flow", all the three methods should take it into consideration before comparison

  In response to other comments the abstract has been significantly revised to better reflect the purpose of this work. In the revised abstract we do not use this term. Additionally, we would like to clarify that the focus here is on the net exchange between groundwater and surface water so lateral groundwater fluxes are not explicitly analyzed for this work. However, they are simulated in the model and are an important drivers of exchanges. We have added the following text to the methods section to be more explicit about this point:

  "This approach is focused solely on the net contribution of groundwater to the surface water budget. Nested systems of local and regional lateral groundwater flow are simulated within the model and previous work has evaluated spatial patterns and physical drivers of lateral groundwater imports and exports across the domain [Condon et al., 2015; Maxwell et al., 2015] as well as groundwater residence times [Maxwell et al., 2016]. Here we focus only on net exchanges with the surface that are relevant to the Budyko formulation. We do not need quantify lateral exchanges in the subsurface directly for these purposes; however, it should be noted that the lateral redistribution of groundwater that occurs within the model is still vital to generating realistic groundwater configurations and supporting groundwater surface water exchanges."

- In addition, some text wring skills also need more efforts: The descriptions of the methods should all put into the Methods section: e.g. lines 412-414; lines 415-436; lines 481-484

  In response to this comment we created an additional sub-section in the methods that covers the three approaches to evapotranspiration calculations and we moved the description of Budyko calculations on lines 481-484 into the methods section on Budyko analysis (Section 2.5).

- Small errors: Line 13: "sized"? Line 342: "than"?

  Thank you, these have been corrected in the revised manuscript.

Works Cited:

Condon, L. E., A. S. Hering, and R. M. Maxwell (2015), Quantitative assessment of groundwater controls across major US river basins using a multi-model regression algorithm, Advances in Water Resources, 82, 106-123, doi: http://dx.doi.org/10.1016/j.advwatres.2015.04.008.

Maxwell, R. M., and L. E. Condon (2016), Connections between groundwater flow and transpiration partitioning, Science, 353(6297), 377-380, doi: DOI: 10.1126/science.aaf7891.

Maxwell, R. M., L. E. Condon, and S. J. Kollet (2015), A high resolution simulation of groundwater and surface water over most of the continental US with the integrated hydrologic model ParFlow v3, Geoscientific Model Development, 8, 923-937, doi: 10.5194/gmd-8-1-2015.

Maxwell, R. M., L. E. Condon, S. J. Kollet, K. Maher, R. Haggerty, and M. M. Forrester (2016), The imprint of climate and geology on the residence times of groundwater, Geophysical Research Letters, 43(2), 701-708, doi: 10.1002/2015GL066916.