

Reply on RC1

Henry Zimba et al.

Author comment on "On the importance of phenology in the Miombo ecosystem: Evaluation of open-source satellite evaporation models" by Henry Zimba et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2022-114-AC1>, 2022

We appreciate your valuable insightful comments. This will definitely help improve the quality of our paper. We take note of your comments and hereby are our responses to the key issues raised.

- **"No eddy covariance measurements were available"**

What is also important to note is that there are currently no eddy covariance (EC) observations, at least known to us, focused on the Miombo forest/woodland region. There are extremely few, if any, flux observation sites in the Zambezi Basin. Furthermore, comparing remote sensing based evaporation with EC is also doubtful, although it's the common standard. However, one can question if this standard is a proper comparison due to non-closure of the energy balance, footprint issues and spatial heterogeneity (see e.g. **Miriam Coenders-Gerrits**, Bart Schilperoort, César Jiménez-Rodríguez "Evaporative processes on vegetation: an inside look" (2020). pp 35-48. Book chapter in "Precipitation Partitioning by Vegetation: A Global Synthesis", editors John T. Van Stan, II; Ethan D. Gutmann; Jan Friesen; Springer.)

We, nonetheless, have made point based observations using the Distributed Temperature Sensing (DTS) system. The DTS based observations are now available. We are more than glad to incorporate these results to enhance the quality of the paper should it be deemed necessary. What is important is that at basin scale the use of the water balance for validation is an acceptable approach especially in sparsely gauged basins like the Luangwa and the Zambezi Basin in general. This is affirmed by the point field observations we have made that give similar results as the general water balance.

- **"Authors used two different water balance models to compare the remote sensing evaporation products".**

In cases where spatially distributed measurements are not available as is the case with large basins and more importantly in the dominantly Miombo forest covered Zambezi Basin the use of the water balance approach is an acceptable approach (i.e., Weerasinghe et al., 2020; Liu et al., 2016). To this effect, we endeavoured to provide sufficient

references in our paper. As explain in our manuscript we use two water balance approaches to understand two aspects, these being annual variability and monthly variability.

- At annual scale we used the general water balance at basin level, as explained in the manuscript relies on remote sensing (i.e., precipitation) and field observations (i.e. discharge/runoff). This is a generally accepted approach noting that spatially distributed rainfall observations at basin level is practically impossible. Before selecting the precipitation product used in the study we made effort to compare various products with point based field observations.
- At monthly scale, we used two water balance models calibrated on observed discharge. Our reasoning behind the use of this approach is that observed discharge takes into account the influence of vegetation. The focus of our study as the title suggests is on the importance of phenology on model performance. As can be seen from our study model performance appear to be influenced by the phenological stages. For instance, the most notable discrepancy in model performance is during the dormant phenological stage. This is the major issue our paper is highlighting. However, it will be a valuable addition if models sensitivity to some parameters like precipitation, soil moisture and land surface temperature is done. This, however, is not the focus of the study.
- The lead author should at least read good papers before writing. Please check the paper of Trebs et al. (2021) (<https://www.sciencedirect.com/science/article/pii/S0034425721003229>) on how to do error analysis of evaporation models.

The papers you have provided are indeed high quality though have very different objectives compared to our submission. Furthermore, we believe the methods we used for understanding model performance are adequate and some of them similar if not the same as the methods used in the papers you have provided. However, we will always strive to do our best to raise the quality of submission to the standard of the journal.

- **“The paper just produced a huge list of figures and without any deep dive. Seeing the impact and prestige of HESS, the paper is inappropriate”**

We understand your view point. The novelty in our view is in highlighting the unique Miombo ecosystem characteristics and the influence on evaporation model performance. This has never been done before. As we have indicated in our manuscript, Pelletier et al. (2018) and Tian et al. (2018) postulated that the functional traits of the Miombo Woodlands vegetation species is different from other ecosystems. What is even more challenging is that there are extremely few, if any, flux observation towers in the Miombo region none in the Luangwa Basin. This makes it difficult to know the moisture feedbacks of the ecosystem from field observations. This is where our study and the use of the general water balance becomes necessary. The general water balance method has been used before in other regions as has been cited in our study. To this effect our study makes available information on the performance of evaporation models with regard to the

Miombo ecosystem that would otherwise be used without any form of validation. While we agree that field observations are needed, as we have indicated ourselves throughout the manuscript, the general water balance results at annual scale are still valid in our view. In our opinion the land cover specific field observations are needed though this is not likely to change the water balance results as our point observations using the Bowen ratio distributed temperature sensing system (BR-DTS) has shown for the Miombo forest.

Consequently, it would be helpful if the “**without any deep dive**” could be explained further so that we can adequately address the issues.

In summary

This study highlights difficulties in estimating evaporation by satellite-based evaporation models brought about by the unique physiological characteristics of the unexplored Miombo ecosystem in sub-Saharan Africa. We discuss the potential underlying factors to observed discrepancies in model performance across phenophases. We also suggest that understanding the Miombo woodland phenological characteristics and incorporating aspects that address these characteristics in the model structure and processes is likely to improve evaporation estimates. We believe our study, though not exhaustive, augments the scarcely available literature on evaporation in the Miombo ecosystem. Our study has potential to improve outcomes of climate, hydrological studies and water resources management which for example can benefit from improved estimates of evaporation in this vast unique ecosystem.

We have also responded to your valuable comments in the main document. We hope our responses will help clarify a number of issues.

Please also note the supplement to this comment:

<https://hess.copernicus.org/preprints/hess-2022-114/hess-2022-114-AC1-supplement.pdf>