Reply to Editor

Dear Dr. Nkwasa,

Thank you for the revision of the manuscript. The reviewers were very positive with the new version. There were only some minor aspects that one reviewer brought up (see below). Please respond to these comments.

Sincerely,

Christian Stamm, Editor HESS

General authors' note: Thank you for a positive evaluation of the revised manuscript. We appreciate all the feedback and we are glad that the clarity of the manuscript has greatly improved.

Comments Reviewer 1:

The authors have done a very serious and good job in addressing the issues raised in the review. The manuscript reads much better now. The methods and approach are well described and one can easily grasp the rationale. The authors have also added additional data and results and expanded on the discussion where necessary. This substantially helps to fully understand the findings.

I still have some comments but they are mostly suggestions for issues that might be (briefly) discussed in the paper:

Specific comments:

-Fig. 1: What is the data source for the map? Shouldn't that be indicated?

Response: Thank you for your positive evaluation of our revised manuscript. As regards to Fig.1, the map is as a result of the delineation done in this study. The source of the DEM used in the delineation has already been provided in the text in Table 1.

-Fig-7: if I interpret correctly, the actual LAI in the Victoria basin is most of the time much higher than the calculated LAI. One explanation could be the small-scale farming in the region where farmers cultivate on very small crops and often have intercropping of many different crops. Therefore, the spatial assignment of one single crop (with its easonal growth patterns driving the LAI in the model) may be only a poor representation of reality. So in addition to lack of a second crop that is mentioned in the manuscript (a limitation of the existing data in a temporal sense), there would also be a limitation in a spatial sense. Please comment on that aspect. It indeed supports your conclusion that local knowledge is required to grasp the complexity of the cropping patterns.

Response: Yes indeed, by using a single crop to represent a pixel, we have a limitation in a spatial sense. Especially, in the Victoria basin that has several combinations of intercropping and sequential cropping at plot scale. This has been highlighted in the text as a limitation that needs addressing especially at local scale application by considering the heterogeneity of cropping patterns in a pixel. [Lines 367 – 371]

I assume that LAI underestimation by the model has also consequences for the ET estimates. Could the widespread presence of "minor" crops be one of the reasons for the underestimation of ET in the Victoria basin? Can you comment on that?

Response: Yes, this has been mentioned as a possible cause of ET underestimation. However, instead of using "minor crops", we have used "crop heterogeneity" in a pixel. The simplification of using a single crop per pixel could have effects on the ET fluxes due to the simplifications in the variations of the physical characteristics (e.g LAI, root depth, stomata conductance) of the heterogenous crops (Burakowski et al., 2018). Additionally, this

simplification alters the partitioning of sensible heat fluxes to latent heat fluxes (Eltahir, 1998) that in turn affect the ET estimates [Lines 367 – 371]

-General comment: By relying on observed data for crop phenology, I'd assume that limits the application of the approach to the past, hence periods when such observations exist. Can you comment on how to deal with forecasting or using such models for prospective climate change studies? Do you see potential get better phenology data also for such purposes?

Response: We are glad that you raised this comment. We believe there is potential to get better phenology data for future impact studies. As highlighted in the manuscript, Waha et al. (2020) mapped global areas of different multiple cropping systems. This can potentially be combined with global phenology datasets to generate crop calendars with different cropping systems. Additionally, as suggested by Kim et al. (2021), future research should be directed towards hybridization of multiple sources of information (e.g satellite data products, model-based products and census-based data), improvements to temporal coverage and resolution, enrichment of management variables and exploration of new sources of information to achieve better phenology datasets.

We have shifted text from line 336 – 338 to the conclusion and recommendation section (Line 454 – 456) as a recommendation for future research to get better phenology data.

Note: We have updated the citation (Jägermeyr et al., in revision) to (Jägermeyr et al., 2021) and updated the reference list.

References

Burakowski, E., Tawfik, A., Ouimette, A., Lepine, L., Novick, K., Ollinger, S., Zarzycki, C., Bonan, G., 2018. The role of surface roughness, albedo, and Bowen ratio on ecosystem energy balance in the Eastern United States. Agric. For. Meteorol. 249, 367–376. https://doi.org/10.1016/j.agrformet.2017.11.030

Eltahir, E.A.B., 1998. A Soil Moisture–Rainfall Feedback Mechanism: 1. Theory and observations. Water Resour. Res. 34, 765–776. https://doi.org/10.1029/97WR03499

Jägermeyr et al., in revision. Climate change signal in global agriculture emerges earlier in new generation of climate and crop models. Nat. Food.

Jägermeyr, J., Müller, C., Ruane, A.C., Elliott, J., Balkovic, J., Castillo, O., Faye, B., Foster, I., Folberth, C., Franke, J.A., Fuchs, K., Guarin, J.R., Heinke, J., Hoogenboom, G., Iizumi, T., Jain, A.K., Kelly, D., Khabarov, N., Lange, S., Lin, T.-S., Liu, W., Mialyk, O., Minoli, S., Moyer, E.J., Okada, M., Phillips, M., Porter, C., Rabin, S.S., Scheer, C., Schneider, J.M., Schyns, J.F., Skalsky, R., Smerald, A., Stella, T., Stephens, H., Webber, H., Zabel, F., Rosenzweig, C., 2021. Climate impacts on global agriculture emerge earlier in new generation of climate and crop models. Nat. Food 2, 873–885. https://doi.org/10.1038/s43016-021-00400-y

Kim, K.-H., Doi, Y., Ramankutty, N., Iizumi, T., 2021. A review of global gridded cropping system data products. Environ. Res. Lett. 16, 093005. https://doi.org/10.1088/1748-9326/ac20f4

Waha, K., Dietrich, J.P., Portmann, F.T., Siebert, S., Thornton, P.K., Bondeau, A., Herrero, M., 2020. Multiple cropping systems of the world and the potential for increasing cropping intensity. Glob. Environ. Change 64, 102131. https://doi.org/10.1016/j.gloenvcha.2020.102131