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Comment on hess-2021-247

Anonymous Referee #2

Referee comment on "Improved Representation of Agricultural Land Use and Crop Management for Large Scale Hydrological Impact Simulation in Africa using SWAT+" by Albert Nkwasa et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-247-RC2, 2021

Review

Improved Representation of Agricultural Land Use and Crop Management for Large Scale Hydrological Impact Simulation in Africa using SWAT+ (hess-2021-247)

By A. Nkwasa et al.,

General comments

The manuscript describes how the incorporation of crop specific phenology data improves ET and soil erosion estimates for large-scale simulations using SWAT+ throughout the Nile basin as compared to the default phenology implemented in the model. The simulated LAI and ET values agree much better with validation data obtained from remote sensing. The estimated erosion rates are substantially lower as compared to the default model.

The topic of the manuscript fits the scope of HESS. The results are relevant because they demonstrate the how important it may be to account in an adequate manner for regional differences of crop-specific phenologies.

Unfortunately, the method section is not very well written and is often rather confusing. The key element for the improved model set-up is the use of a global data set on plant and harvest dates for specific crops (Global Gridded Crop Model Intercomparison (GGCMI), see Tab. 1, L. 164 - 168) instead of using the default heat unit approach implemented in SWAT+ by default. It is pointed out in the Abstract and the Introduction that this default approach often fails in tropical regions because crop development is strongly affected by precipitation (e.g., L. 17, 47) while temperature is well suited for temperate regions. However, it remains obscure how the GGCMI data account for this deficiency. It is not explained whether these phenology data are based on observational reference data or on model simulations. If they were model based, one should know how the model accounts for precipitation and temperature compared to the SWAT+ concept. Irrespective of whether the dataset is observation or model based, one should know whether the data represent long-term averages or account for yearly variations. It remains also obscure what the spatial resolution of the dataset is.

These temporal aspects are also neglected in the analysis of the results. The authors used seven years of data for model validation (L. 173). However, they only present results averaged across the entire study period (2009 – 2015). They don't present any data on inter-annual variability (e.g. of precipitation) that might have affected the results. At least in some regions, rainfall varied affecting also the crops simulated in the manuscript (e.g., Epule, Dhiba et al. 2021). Such inter-annual differences can also be expected for erosion, which is very much triggered by few events.

Detailed comments:

- L. 87 – 88: Please describe more precisely (in the Method section) what these tables and datasets provide.
- L. 97: Study area: Please describe the study period as well.
- L. 146: "approached suggested by Chawanda": Approach for doing what?
- L. 152 (Table 1): Confusing: what is used for model set-up and what for comparison between the default and the revised model. Also linguistically. the sentence is strange (data sets are not used for crop management). GGCMI: please provide more details to address the questions mentioned above (general comments).
- L. 153: Section 2.5: It is not clear whether this section presents the revised SWAT version only or the land use for both the default and the revised version. If it's only about the revised version describe how land use was established for the default version. Otherwise, clearly indicate which part only refers to the revised version.
- L. 164: crop phenology data: please provide more information (see above).
- L. 191: What is a scientific validation? As it reads later in the manuscript it seems to be a plausibility check.
- L. 194: What's the meaning of "moreover" at that point?
- L. 197 – 200: These two sentences are not clear.
- L. 204 – 207: How has the model be parameterized? No information is provided. How well did the model perform e.g., when compared to discharge? The water balance information provided are not very conclusive since L. 254 demonstrates that the model can be quite off for one component (ET) while still closing the water balance well (compensating errors).
- L. 208: Results: Please provide a short description of the hydro-climatic characterization of the study period (2009 – 2015) including metrics of temporal variability.
- L. 210 – 220: Provide information about variability and model performance across years as well.
- L. 224: Fig. 4: Indicate in the caption whether the data represent average values. If they are provide standard deviations in the figures.
- L. 226: Fig. 5: Same comment as above. Additionally: the LAI of both models are rather similar. How does it come that the erosion rates differed so strongly? Explain.
- L. 230: The situations are probably denoted by Cases 1 and 2 in Fig. A2. However, this is not explained. How could one differentiate between the two cases in the spatial data?
- L. 240: Same comment as for Fig. 4; Additionally: Why is LAI for the default so low? Was there an underestimation of irrigated wheat (acreage)? If yes, this would imply that not only phenology but also land use differed between model versions. This was not made explicit so far. Clarify.
- L. 260 – 263: Would one not expect an overestimation of irrigation and therefore ET from an ideal unlimited water source for irrigation?
- L. 266: Fig. 7: A difference map between model predictions and remote sensing observations would be more instructive. How can one distinguish between agricultural and non-agricultural ET? Units: correct to mm y^{-1}.
- L280 – 283: Below, a specific comparison is presented for the Blue Nile region. Please provide also the relative change for this area to help the reader linking the two aspects.

- L. 297: On L. 295 a max of 20500 t km^{-2} y^{-1} is mentioned. Can you explain?

Recommendation

The manuscript requires substantial improvements regarding

- the presentation of the methods
- the temporal aspects of the data series that have been analysed.
- the issues listed in the detailed comments

References:

Epule, T. E., D. Dhiba, D. Etongo, C. Peng and L. Lepage (2021). "Identifying maize yield and precipitation gaps in Uganda." SN Applied Sciences **3**(5): 537.