

## ***Interactive comment on “Developing a sequential cropping capability in the JULESv5.2 land–surface model” by Camilla Mathison et al.***

**Anonymous Referee #1**

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The manuscript by Mathison et al., describes a model development in the JULESv5.2 land-surface model to include sequential cropping. While the JULES model already includes agriculture, multiple growing seasons of crops, which are common in many tropical regions, is not included. In fact, multiple cropping is generally not included in land surface models. The approach uses a site in Avignon, with intense observations, to demonstrate the model capability and then four sites in India (across a gradient of temperature and precipitation) as test cases. The specific crops grown in the sites aren't represented in JULES, so proxies are used. The model is evaluated against several variables, including carbon pools, LAI, GPP, NEE, and heat fluxes, but the most important feature is capturing the peak of the growing season of the different crop types. Although the results vary, the model does reproduce consistent crop seasons.

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Overall, I find the manuscript to be interesting and a good first step in the next generation of crop modeling. However, there are several areas where additional clarification is needed. The manuscript would benefit from editing (punctuation and grammar in particular).

My main concern with this manuscript is the focus in the results on comparing with observations. While I think that is valuable, most of the results and discussion center on parameterization of the crops in JULES causing under or over-estimated yields (or other variables), and not necessarily the results from the addition of sequential cropping. This includes soil moisture, VPD, carbon partitioning, temperature. Since this discussion never loops back to the sequential cropping relationship, it should be removed because it adds length to the paper without providing valuable discussion.

There are also a significant amount of discussion in the results section. I provide some examples in my General Comments. These discussions in the results section belong elsewhere (if at all) in the manuscript (see previous comment).

Finally, I think what should be addressed is how the authors plan to scale this work up to larger simulations. The method requires external data on sequential cropping that is generally not available, especially at large scales. I agree that incorporating sequential cropping into agricultural models is important, but the method requires data on planting, harvest, and the location and types of crops that are grown sequentially. What is the next step to provide this?

General Comments:

P 4, L 22-24: I believe there is a lot of discussion in section 6. Either the discussion should go in section 7 or relabel the sections to reflect that. Also, section 5 is not listed here and should be for consistency.

P 5, L 6: Can this be clarified to indicate air or leaf temperature?

P 5, L 23: Please include the reference for the dataset(s) that were used for the sowing

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and harvest dates when observations weren't available?

P 6, L 8-9: Is forcing a harvest before maturity is reached realistic? Did any of the model simulations need to use this constraint any year?

P 6-7, Section 3: The DVI discussion might be better in section 2 where the model description is provided.

P 7, L 6-7: What do you mean when you state the effective temperature differs "between models"?

P 7-8, Section 4: The authors should expand on how these specific variables are important for the crop model and how they influence the variables that are being compared with observations (e.g., GPP, latent heat flux, sensible heat flux).

P 8, Section 4.1: The authors mention that the Avignon site is in France in the introduction. Location information (including approximate latitude and longitude) would be good in this section.

P 10, Section 5: It would be useful to have some climate information for all the sites. While some information is provided for the India sites in Figure 2, Section 6.2 and Figure 6, similar information should be included for the Avignon site.

P 11, Section 6: There is a lot of discussion in this section, which should just be results.

P 11, L 5: I do not see AviJUL-grass results in Figure 3.

P 11, L 10-27: I do not think it is very surprising that the simulations do not capture the observed biomass and LAI. The crops in JULES are corn and spring wheat whereas the crops at the Avignon site are sorghum and winter wheat. The fact that the model did well for the 2009 sorghum season, which was an anomaly for that crop at the observed site, indicates the crop parameters need to be tuned for a true comparison. I'm not suggesting the authors need tune the model for this manuscript, however, the different crops could play a large role in the model performance, which should have a place in

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the discussion.

P 11 L 28- P12: The discussion for  $p_0$  comes completely by surprise. The authors don't explain how  $p_0$  affects GPP and what the different values represent. This part feels like a discussion and doesn't belong in the results section, considering these additional water sensitivity simulations weren't discussed previously. The additional simulations with modified  $p_0$  do not add value to the results and I suggest they be removed (along with Figure A5). Then suddenly, the paragraph changes gears, jumping to GPP. The GPP results includes a grass simulation comparison, which I find unnecessary. The focus should be comparing the crops simulations and observations to be consistent with the rest of the section 6.1. The paragraph needs some editing and is written sloppily. For example, in L 15, "...early the decline is very close to the observations" does not make sense. Finally, delete the last paragraph on page 12.

P 14 L4-5 – P 15: This paragraph is confusing. It is not clear how soil moisture availability factor (beta) is calculated for the model or observations, nor is it clear what the impact has on simulations, other than an early decline in GPP. What is not discussed is that part of the problem could be related to how irrigation is handled in the model. It was stated in the beginning of the manuscript that the irrigation for sorghum was included in the rainfall data, but it was not specified how. If the timing of irrigation is off, that could explain some of the water stress for sorghum that is seen in the model but not in the observations (figure 5). Regardless, I think this is taking away from the main point of the results and I do not feel it is necessary. If it is kept, it should be moved to section 7.

P 15, L6: Do the "four levels" refer to four soil layers in JULES?

P 16-17: "the aim of this simulation is to demonstrate the method rather than provide a perfect representation of either of these crops." Yes – I agree with this statement. This should be the focus of section 6.1 – how this method improves the crop simulations. All the discussion about soil moisture and water stress muddle this point. Highlight the

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positives of the approach and mention the tuning discussion for future work.

P 19, L 17: the decline in NPP for wheat is hard to see in the figure.

P 20, L 20-33: The VPD discussion here belongs in section 7, it is not results, but discussion. Furthermore, it is not known what the effect of VPD on is on the model yields. The discussion on the plant response to VPD is difficult to follow and clearly does not belong here.

P 21: It is unclear in this discussion how much of this is related to poor wheat parameterization in JULES or how much is related to the sequential cropping component.

Technical Comments:

Define all acronyms (for example, GPP is never defined; DVI is not defined until Appendix B)

P 7, L 4: switch the “,” to a “.”

P 19, L35: the sentence beginning “Therefore suggesting it is not water stress. . .” is a fragment.

P 20, L 11-12: “in the simulations” is used twice.

P 20, L 12 and L14: Use first and second rather than “firstly” and “secondly”

P 27, L2-3: The sentence beginning “In general the model produces. . .” is unclear.

Figures need consistent labeling. Put units on the y-axis. Some figures have the y-axis units in the title, others don't have any at all. Also, in Figures 3,4,5,A1,A2,A3,A4,A5 the label “modelled soil moisture and LAI” is confusing. Shouldn't it be `AviJUL_sqcrop`?

Figure A1: What four simulations are you referring to in the caption?

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Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2019-85>, 2019.