

Interactive comment on “JULES-crop: a parametrisation of crops in the Joint UK Land Environment Simulator” by T. Osborne et al.

Anonymous Referee #2

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The manuscript by Osborne et al. describes the JULES-crop model, an extension of the JULES land surface model to improve the representation of crops in there. The main focus of the manuscript is on global-scale application of the model (although the possibility for parameterisation at the local scale is discussed), and the model is evaluated against global yield data and site observations.

The manuscript is well-written and clear, and the strong focus on description of the model formulation and model structure is suited for Geoscientific Model Development. However, the manuscript needs a crucial improvement in two major aspects before it can be considered for publication:

(1) In general, the model is described well, but the origin of some important equations and their parametrisation is lacking (e.g., Eqs. 1, 2, 8, 10, 11). As these equations are

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crop-specific for most part, I presume that these are not based on the original JULES model, and the sources that these equations originate from (or were inspired by) should be provided. (If they originate from JULES, please state this explicitly.) Similarly, the origin of parametrisations could be documented better. Even when "tuned" (p. 6785, l. 6), there must be some understanding of the range of these parameters based on the literature.

(2) The evaluation of the model and discussion of its performance are very superficially, and do not add much information (or confidence) in their current form. Global simulations are performed, highlighting the discrepancy between potential yields as simulated by the model and actual yields as observed (yield gap), but the authors do not discuss whether the difference is realistic. There are estimates of the yield gap (e.g., Licker et al., 2010), which the model could be compared to at the global scale - there should be at least an attempt to a better comparison with the observations. Similarly, the site simulations (performed for a few crops and locations only) focus exclusively on the impact of the seasonally changing LAI on the energy balance, and ignore the model's performance in terms of crop growth characteristics (are yield, crop height, net carbon fluxes, seasonality, etc. simulated correctly?). The discussion of the model's abilities and shortcomings should be extended. E.g., the manuscript mentions the fact that spring wheat is not representative for large wheat-growing regions, but fails to discuss the implication of this for e.g. surface properties or surface fluxes. Similarly, the yield gap is acknowledged, but there is no discussion on the impact of this on the model's performance as a land surface scheme in a global model. What does this imply for the feedbacks to the climate system?

I would recommend the authors to improve the manuscript in these two aspects to make this an attractive article for publication.

Major comments:

Fig. 1: The figure seems to suggest that there is no accounting for belowground carbon

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pools in the model. Is this correct?

6781/6782: I am somewhat confused by the authors' estimate of the number of parameters needed to describe the allocation (not least by the statement " $2+(4-1)=6$ ", p. 6781, l. 19). I understand that there is no allocation to harvested compounds during the vegetative period (p. 6782, l. 12), but this would result in $(3-1)+(4-1)=5$ parameters, whereas the authors consistently talk about 6. Moreover, the parameter τ in Eq. 5 is not mentioned or described in further detail, whereas it will need an estimate (constant or temporally varying), adding to the parameters needed for the allocation description. Clarification would be appreciated.

6783, l. 16: Are the parameters κ and λ fitted for each crop separately, or do you derive a relationship valid for all crops? And how applicable is the relationship to the crops that are not grown at the FLUXNET site? Do you anticipate this relationship to be applicable at a global scale?

6788, l. 14: I do not agree with the statement that early season performance is crucial for future growth: Yes, there is a strong feedback from early assimilation and leaf growth to light interception, but this feedback decreases rapidly upon closure of the crop canopy.

Minor comments and technical corrections:

6778, l. 9: replace "know" by "known"

6779, l. 1: please refer to Table 1 for explanation of the subscripts b, o and m

6780, l. 15: add "with" (or equivalent) before "the following equation"

6781, l. 18: I take that " $2+(4-1)$ " should read " $2*(4-1)$ "

6784, l. 7: remove "being"

6784, l. 15: The mentioning of five plant functional types is somewhat confusing, as you talk about 9 surface types before. Upon rereading, I realized that 4 out of 9 are not

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plant-covered, which may explain the difference. Please clarify this.

6784, l. 18 (and elsewhere): please use subscripts for C3 and C4.

6784, l. 20: The mentioning of tropical oilseed confused me - do you consider this to be a cereal crop? What is the difference between crops and crop types in this sentence?

6785, l. 3: I presume that the comma is placed wrongly here and should go after "model" instead?

6785: "widely used in the literature": Why not add references for these?

6785, l. 19: replace "he" with "The"

6785, l. 21: Please specify the rough dimensions of an N96 grid for readers that are not familiar with climate modelling.

6785, L. 27: add "was" before "obtained"

6786, l. 3: What do these ratios between length of vegetative and reproductive period originate from?

6786, l. 15: replace "an" with "at"

6788, l. 8: replace "over estimated" with "overestimated"

6788, l. 28: replace "where as" with "whereas"

6790, l. 17: replace "over estimates" with "overestimates"

6790, l. 21: replace "over estimate" with "overestimate"

6791, l. 16: The feedbacks mentioned here are typically referred to as biogeophysical, not biogeochemical.

6791, l. 17: replace "parametrization" with "parametrisation"

6792, l. 20: replace "day length" by "daylength"

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Fig. 7: Please add units to the y-axes

References:

Licker, R., Johnston, M., Foley, J.A., Barford, C., Kucharik, C.J., Monfreda, C., Ramankutty, N.: Mind the gap: how do climate and agricultural management explain the 'yield gap' of croplands around the world? *Global Ecology and Biogeography*, 19, 769-782, 2010.

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