

Interactive comment on “Implementation of dynamic crop growth processes into a land surface model: evaluation of energy, water and carbon fluxes under corn and soybean rotation” by Y. Song et al.

Anonymous Referee #1

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The BG Discussions paper by Y. Song et al. describes a set of developments in the land surface model ISAM that are performed to improve the representation of crops in this model. These developments are in (1) phenological development, (2) representation of vegetation structure, (3) root distribution and (4) crop senescence. Two eddy covariance measurement sites (Mead and Bondville) with maize-soybean rotations in central US were used for model calibration and validation, respectively.

The topic of this study fits the scope of Biogeosciences, and the description of the model is done comprehensively, with two appendix tables listing the model parameters

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and model equations, which I value. The separation of the two sites into a calibration and a validation set is done consciously, but could be highlighted somewhat more in the analysis of the results - expectations in terms of model performance would clearly differ between the calibrated set and the non-calibrated set (see my comment below). Moreover, the calibration process itself is not described; such a description should be part of this paper.

From the four developments described in section 2, only (2) and (3) from the list above are assessed in section 4. Of course, the model is generally evaluated, but it would be worthwhile to learn as well how important improvements (1) and (4) are for the model's performance. Finally, the authors do not discuss their results in a larger perspective, there is no critical assessment of the applicability of this model, or e.g. a comparison with other studies. It would be interesting to learn whether the authors expect the presented developments and parameterizations to work as well for other regions, or other crops.

I expect that these shortcomings can be overcome, and hope that the authors are willing to improve the paper accordingly. My detailed comments are provided below (with reference to page and line numbers in the discussion paper).

General comments:

The separation of the two sites into a calibration and a validation set does not appear in the analysis of the results. When analyzing these results, it should be kept in mind that the Mead simulation was calibrated, whereas the Bondville site was not. Even though it can be valuable to show results of both, they should not be compared directly. It would be preferable to see this distinction more explicitly in the Results section.

The use of a detailed description of crop development, as provided in section 2.2.1, could and should be addressed in the results. E.g., Fig. S1 from the supplementary material is interesting in this respect, and would be better placed in the main manuscript. It may be possible to extend this figure to show the effects of the new

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phenology scheme used.

The language is generally good, but the Results section uses a mixture of present and past tense, which is awkward to read.

9901 / 21: What does "hydrological and thermal inactive bedrock layers" mean? I presume that these layers are not hydrologically and thermally inactive, as there would be no need to include five of them in that case.

9905 / 16: The LAI dependence of development is unexpected (in most models, development is not linked to crop growth), and it would be good to explain this. Is there a reference for this effect?

9905 / 20: Is the cold temperature effect on yield limited to certain growth stages only?

9908 / 24: The claim that the two sites have "distinct climate and soil characteristics" is not supported by the conditions described in the section below. In fact, growing season average temperature conditions differ by 0.2 K only, and the sites have very similar precipitation amounts. If these sites are really distinctly different, e.g. in the seasonality, please specify in what respect. The similarity between the sites should be discussed in more general respect as well. To what extent do the authors expect this model and parameterization to be applicable to different parts of climate space?

9909 / 9: Which "site climate" parameters does the model require as input? It would be helpful to get this information, either here or in the beginning of section 2.

9909 / 10: How many years of spinup do you need to obtain a steady state?

9909 / 16: What are the summation signs for in Equation (1)? Is this a summation over time? And if yes, what is the time interval you perform the correction on? 9910 / 4: Please add brackets to the first line in Equation (2), so that the denominator cannot be misunderstood.

Fig. 1: Are the error bars on observations and simulations resulting from the individual

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days during the growing seasons? Describe the meaning (e.g. "Error bars indicate +/- 1 sd of variation between individual days"). The wording "diurnal averaged" is confusing: it is the annually averaged (or averaged over the growing season) diurnal cycle you are showing.

9913 / 16: There is reference here to the development stages, but it is impossible to read these stages from the figure. See my comment above on the description of these as well.

Fig. 2 and 5: It would be good to know which of these panels/graphs were maize and which were soybean years for each of the two sites.

9913 / 27: It is misleading to talk about "measured" H and LH, as these are not the true measured values, but the adjusted/corrected ones.

9916 / 8: How do you quantify water stress here? Or in other words, the 60% reduction is 60% of what?

9916: You discuss 2001-2003 here in detail, which show an increase for all parameters with the new dynamic description. How about Bondville 2004? Moreover, in your discussion of increased GPP and LH, it is good to separate increased amounts from improved data fit - see as well my comment on the abstract.

9918 / 14: The comparison between measurement bias and measurement uncertainty has not been discussed in the Results, which would be interesting (and necessary if you want this in your conclusions).

Table A1: What is the meaning of the two parameters in the "Value" column? Is this soybean and maize, respectively? Please clarify.

Minor remarks:

9898 / 23: "without dynamic case" is an awkward terminology and should be specified more clearly (same on l. 25)

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9898 / 24: Use "increased" instead of "improved" in this sentence. The increase in GPP and LH in most cases indeed improves the results, but expressing the improvement in percent would give rise different expectations in terms of the reference to which you improve.

9899 / 20: The statement that corn/soybean is the most common crop rotation world-wide needs a reference.

9902 / 21: remove "the"

9904 / 7: Add "the" in front of "hydrological cycle" and "energy cycle"

9904 / 14: Replace "with dynamic root distribution" by "with a dynamic root distribution"

9906 / 2: Remove "An"

9908 / 5: Replace "varies" by "vary"

9911 / 26: Replace "varies" by "vary"

9912 / 11: Please use SI units for the wind speed, i.e. m/s

9912 / 22: Remove "are"

9913 / 10: replace "that also add to discrepancy" with "which adds to the discrepancies"

9913 / 12: Replace "indicates" with "indicating"

9913 / 13: I think that dr_d would be better described with "seasonal pattern" than "daily pattern"

9913 / 26: replace "balanced" with "balance"

9914 / 13: replace "independent" with "independently"

9915 / 24: replace "moisture" with "moist"

9916 / 3: check spelling of "DynamicR"

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9916 / 8: remove "in"

9918 / 19: Check the sentence starting with "Since we..."

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