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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 #3

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The paper describes the implementation and testing of a detailed crop module to an existing Land Surface Model (ISAM). Four main processes are implemented to ISAM: "(i) crop growth and biomass allocation in five phenology stages, distributing assimilated carbon among above and below ground parts depending upon both the accumulated heat and the resource availability, such as light, water, and nutrient (e.g., nitrogen); (ii) development of vegetation structure (LAI, canopy height and root depth) calculated based on accumulated carbon mass in leaf, stem and root pools; (iii) vertical and horizontal root growth in soil layers in response to available soil moisture; and (iv) different

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abscission rates for fresh and old dead leaves".

The model is calibrated using AmeriFlux flux-data (GPP, Latent Heat and Sensible Heat) as well as LAI, leaf carbon, biomass and yield data from one site (Mead) and compared against corrected fluxdata from another AmeriFlux site (Bondville) using Willmott's Index. Results show that the calibrated model well simulates the diurnal cycle of GPP, and latent heat for both crops and the seasonal cycle of GPP for both crops and latent heat for soybean comparing modeled against corrected measured data.

The paper is novel in the sense that it includes a detailed phenology and carbon allocation model to the existing ISAM model and model improvement of Land Surface Models in relation to including carbon and water fluxes of managed land is within the scope of Biogeosciences. The title reflects the content of the paper.

General Comments:

The paper is generally well written and clear albeit with some minor grammatical errors mainly related to the presence and absence of "the" and other articles. Some proof reading and corrections related to grammar is needed.

The abstract and introduction read well and are informative. In the introduction several earlier studies where crop modules have been added to existing models are mentioned but there is no mention of how the approaches used in this paper differ from previous approaches and also not how the ISAM model differs from other Land Surface Models.

In the methods section I find it hard to differentiate between what is the description of the "standard" ISAM model and what is new in this study. I would like to see a clearer separation of these two. The section describing the original ISAM model should be shortened leaving a stronger focus on "what is new".

Of the four main processes that are new to the model, there is a large focus on phenology and carbon allocation in the paper reflecting the number of equations for these

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processes in the Appendix. Even so, it would be nice to have some more information about the calculation of LAI, canopy height and root depth in the text.

No description of the calibration of the model is present in the paper. This is clearly needed. Also, it would be interesting to know which of the calibrated parameters that strongest influence the model fit in relation to the different variables (fluxes, LAI, leaf and plant biomass, and yield). An option would also be to perform a cross validation, by also tuning the model using the Bondville data (if all variables are available) and to test the result against the Mead data. Following this it would be interesting to see if the "best parameter values" would differ depending on the dataset used for the calibration.

The model is not benchmarked against other models and the effect the addition of various processes new to the model has on model fit is thusly not tested (with the exception of root dynamics). The phenology and carbon allocation approaches implemented in this study may have been compared against other approaches elsewhere but no justification of the selection of the approaches used in this paper is made. The same is true for canopy height and LAI.

An easy test of the phenology and leaf allocation, and also the calculations of LAI would be to compare simulated LAI against measurements (Figure S1) using both the crop version of ISAM as well as the original veriosn simulating soybean as C3 and corn as C4 grass (if these plant functional types are available in ISAM) (cf. Fig.5 in Lindeskog et al. 2013). It would also be interesting to compare the climate sensitivity of both modeled and measured fluxes in order to see how much of the variation in these fluxes can be explained by changes in input climate variables. This could also help explain the differences in model fit between GPP, and latent and sensible heat.

In the comparison between the DynamicR and StaticR submodels it is shown that using the DynamicR submodel generates the largest model fit. It is interesting to see that the model results differ depending on which submodel is being used. However, it is not clear whether the ISAM-StaticR model also has been calibrated using the same data

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as ISAM-DynamicR. If not, the comparison would be of a calibrated model against a non-calibrated model and thus not a fair one.

The discussion is focused on the results from the current study and these are not discussed in a wider context.

I suggest a major revision of the paper. To be accepted for publication I suggest the authors to:

* Improve the language of the manuscript

* Revise the methods section to increase the focus on the added processes to the existing ISAM model

* Include a description of the calibration process

* Redo (or better describe) the comparison of the DynamicR and StaticR submodules

* Include an evaluation of other submodules, or at least justify the selection of these submodules

* Expand the discussion to include a comparison with earlier studies mentioned in the introduction

Specific Comments:

9898, 6-13 A very long sentence. Revise

9901, 20-25 The seven vegetation pools are mentioned twice here which is a bit confusing

9904, 20-23 To me data description belongs to section 3.1 rather than here

9908 Section 3 From where was climate data obtained and which variables were used?

9910 3 The refined Willmott's Index is a relatively new measure and most people (including me) will not be familiar with this index. Therefore it is good that this is described

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in detail. But it would perhaps be useful to further warrant the selection of this index instead of other more commonly used indices (cf. Medlyn et al. 2005).

9942 Fig 2. Please caption rephrase for clarity

References missing in the text

Arora 2003

Climate Champaign 2003

Goulden et al. 1996

Jain et al. 2009

Sacks and Kucharik 2011

Willmott 1981

Zeng and Decker 2009

References missing in reference list

Chen et al. 2010

Arora et al. 2003

Sachs and Kucharik 2011

References

Lindeskog, M., A. Arneth, A. Bondeau, K. Waha, J. Seaquist, S. Olin, B. Smith (2013). Implications of accounting for land use in simulations of ecosystem services and carbon cycling in Africa, Earth Syst. Dynam. Discuss., 4, 235-278.

Medlyn, B. E., A. P. Robinson, R. Clement, and R. E. McMurtrie (2005), On the validation of models of forest CO2 exchange using eddy covariance data: Some perils and pitfalls, Tree Physiol., 25, 839–857.

Interactive comment on Biogeosciences Discuss., 10, 9897, 2013.