

## ***Interactive comment on “Improving the representation of cropland sites in the Community Land Model (CLM) version 5.0” by Theresa Boas et al.***

### **Anonymous Referee #1**

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Boas et al. used ground data on three crops (two cash crops (sugar beet and potatoes) and winter wheat) to improve their representation in CLM5. Overall, I agree that the use of data is an important step for improving the predictions of crops in CLM5 and I like the idea of representing processes in the model that occur in real life in field. The main contribution from the authors end are: (1) implementation of the winter wheat subroutine (2) parameterizing for all three crops and (3) implementation of a method that allow rotation of crops within a year. After all these three changes, the authors compared modeled outputs of carbon cycling (leaf area index and net ecosystem exchange) and energy cycling (latent and sensible heat) processes of the above three crops with the measurements, and argue that their model perform better than the model (standard

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CLM5) that used default processes/parameters.

My main critique is that it is difficult to understand the impacts of (1) and (3) in particular. I tried to look into the code, but couldn't quite locate (1) and (3). I suggest the authors to make it clear in the code where these implementations are (perhaps mark it) so that I can follow how much the codes were changed relative to the standard. To gauge the impacts of (1), I would like to see a winter wheat simulation only at the “DE-RuS” site for with and without (1). You could show how much leaf area index, latent heat and sensible heat of winter wheat changes with this assumption. Similarly, to examine the impact of (3), you could do a simulation of sugar beet and Winter wheat at “DE-RuS” (in this case sugar beet will be rotated, which you already did) and a simulation of Winter wheat only at “DE-RuS”. You could also show how much leaf area index, latent heat and sensible heat of winter wheat changes if there was no rotation. Additionally, you can check whether rotation has any impacts on the modeled nitrogen leaching and fixation rates.

I list my specific comments as follows:

(1) While I appreciate some of the details in sections 2.1, and 2.2.1, it would be appropriate it put most of the text in the Appendix section. For example, the paragraph that starts with the description of the default crop phenology scheme (lines 139 to 152 and additional lines) is not new to this study but rather standard CLM5 documentation notes and therefore, they can be put in the Appendix. Similarly, the section about Winter cereal representation that begins with “Vernalization” is also not new to this study. The default phenology scheme of CLM5 has a Vernalization subroutine.

(2) The authors emphasize the importance of cash crops (e.g. sugar beets and potatoes). I would like the authors to comment on the spatial coverage of these crops in Germany and whether the farmers are smallholder or largescale holder plantation owners. Along similar lines, it would be good if the authors could comment on how they plan to carry out the large scale simulations or regional simulations for these crops

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given that you need time series information about the rotation of these crops and also that some crops might be planted every two years or so.

(3) A number of statements in the results section is difficult to follow. For example, in lines 407 to 412, there is no reference to any figures. What is green leaf area index in line 408? Do you mean before maturity, during maturity or after maturity?

(4) I think the poor seasonal dynamics and low magnitude of the leaf area index in Figures 2-5 of CLM-D could also be related to the parameter values rather than the winter wheat subroutine that was introduced in this study. There are at least 3 parameter values that are considerably different compared to the default parameters of CLM ('gddmin', 'hybgdd' and 'graincn'). For example, I see that the default gddmin is 50 in the default but 100 in the modified case (this study). Also hybgdd in the modified case is 30 more than the default. So couldn't these likely explain poor seasonal dynamics and low magnitude of the leaf area index in Figures 2-5 of CLM-D?

Some of the minor comments are as follows:

(1) In line 70, Bilinois et al. (2015) is cited but I think the reference is missing.

(2) Please provide fractions of sand, silt and clay in Table 2, maybe up to 5 cm or 10 cm?

(3) While I agree with the statement (line 289) that "CLM5 only permits land use changes at the beginning of every year", users can start a CLM5 simulation in any month the land use change actually happens in real life by performing a 'clear-cut' following spin-up, for example.

(4) At the "BE-Lon" site, the LAI curve of winter wheat from DOY= 0 to DOY = 100 seems to have a relatively gradual and smooth growth (Figure 2) while at sites "DE-RuS", "DE-RuM", "DE-Kli", the growth is relatively sudden and steep during the same period. I would like the authors to provide some explanations for this difference.

(5) In lines 602 to 603, the authors claim that CLM5 does not represent timing of

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fertilizer. Please provide a citation for this?

(6) In line 603, the authors state that CLM5 does not consider varieties of winter wheat. I agree with this statement but at the same time, many land surface models don't consider varieties or cultivars of crops. Crops can be genetically modified to boost productivity. This means there could large differences in the parameter estimates among varieties/cultivars. The authors could discuss the variation in the parameter estimates if they are measured at their sites.

(7) The authors mention in lines 626 to 629 the following: "There is a tool available for CLM5 that enables the simulation of transient land use and land cover changes (LULCC) (Lawrence et al., 2018). It was designed to simulate and study the effects of changing distributions of natural and crop vegetation, e.g. land use change from forest to agricultural fields (Lawrence et al., 2018), rather than inter-annual changes of agricultural management on crop vegetated areas." I'm confused about the last part "rather than inter-annual changes of agricultural management on crop vegetated areas". Please explain what do you mean by this? Do you mean you cannot change the Nitrogen fertilization rate from year to year in CLM5?

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