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Geoscientific Model Development Discussions
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Interactive comment on "A sub-canopy structure for simulating oil palm in the Community Land Model: phenology, allocation and yield" *by* Y. Fan et al.

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Response to Referee #2 (Line numbers added referring to the revised manuscript):

We acknowledge that the current MS is too long and includes lots of redundancy. In order to reduce the size, we follow the referee's recommendation to shorten the introduction and model description. The detailed phenology description is now moved to Supplementary materials and the discussions section is condensed to one section. Now the manuscript is largely reorganized and reduced (-30%) from 14,000 to 10,000 words (please see attached revision). We concentrated the validation with only LAI and yield because the sub-canopy structure and the phenology and allocation sub-

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routines we developed here are the base functions for simulating oil palm growth and yield. They are also the basis for simulating carbon, water and energy flux data in the next step. Our CLM-Palm model combines the abilities of an agricultural model, that is, growth and yield prediction, and a land surface model, i.e. energy, water and material cycles between land and atmosphere. We now add a validation with field measured NPP (see new Fig. 3). In a following paper we will focus on simulating carbon, water and energy fluxes and comparing with eddy covariance measurements.

We clearly stated the limitation of the model in the discussions: the difficulty to capture the small-scale site-to-site variation in yield and LAI, which is, however, tolerable with a land surface modeling approach, because our oil palm module developed within CLM is aimed to be run for large areas. In order to simulate small-scale variation, input data e.g. microclimate and site management at the same scale would be needed which are not available. Towards the general mission of a land surface model, this study demonstrates the ability of the new module to adequately simulate the average LAI, yield and NPP across sites in the Jambi region of Sumatra. This will allow simulating land use change effects driven by oil palm provided land cover data. We pointed out the possible reasons behind the limitation in the discussion and leave space for future improvement. (see Lines 507-519, Lines 534-538, and Lines 562-568 in revised manuscript)

A similar approach is taken by Drewniak et al. 2013 (doi:10.5194/gmd-6-495-2013) which uses CLM to simulate annual crops. They did not examine site-to-site variation of LAI and yield and validated LAI only with an individual site for each crop. They also did not show direct comparison of simulated yield with observation data. Another recent study by Bilionis et al. 2015 (doi:10.5194/gmd-8-1071-2015) validated the CLM-crop model at two AmeriFlux sites but they also indicated limited transferability of the calibrated parameters across sites.

We believe our CLM-Palm model development and validations with multiple oil palm sites are meaningful and provide a basis for future large-scale simulations.

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Answers to specific comments:

Comment 1: P4547L20-21: This is very subjective. To me, it should be something like 0% to call it perfectly.

Answer 1: We rephrased “perfectly” to “notably well” (see Lines 35-36).

Comment 2: P4549L1-2: and at fine time steps (e.g. half-hourly). A ref. is needed.

Answer 2: We revised this sentence to “Although a series of agricultural models exist for simulating the growth and yield of oil palm such as OPSIM (van Kraalingen et al., 1989), ECOPALM (Combres et al., 2013), APSIM-Oil Palm (Huth et al., 2014), PALMSIM (Hoffmann et al., 2014), these models did not aim yet at the full picture of carbon, water and energy exchanges between land and atmosphere and remain to be coupled with climate models.” (Lines 66-70). The references are already given for each agricultural model.

Comment 3: P4550L19-20: even for oil-palm-like plantations (e.g. coconut, date palm etc.). If you didn’t validate it, you should not state this.

Answer 3: We took the recommendation and deleted this sentence. However, the sub-canopy structure and phenology and allocation functions are developed with generic interest for other palm crops (e.g. coconut palm) because these palms share very similar canopy structure and phenology. We now formally name these new functions as the CLM-Palm model and its application for other palms would only require a calibration of the input parameters. (see revised sentences in Lines 22-24 and Lines 105-107)

Comment 4: P4551L20 (and other places): Don’t use “incl.”. This is not conventional.

Answer 4: We removed all the unconventional abbreviations.

Comment 5: P4558L17: What is mxlivenp? It is explained in Table 1 but not the main text.

Answer 5: The sentence is slightly revised to “Pruning is conducted at one time step if

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the number of expanded phytomers (including senescent ones) exceeds the maximum number allowed on a palm (mxlivenp)." Here "mxlivenp" refers to the maximum number of expanded phytomers allowed on a palm, which is pretty much self-explaining in the parentheses. This sentence together with detailed phenology description is now moved to Supplementary materials.

Comment 6: P4559L22: C:N ratios? The numbers are way too small in Table 2.

Answer 6: The C:N ratios were in Appendix Table B1, not in Table 2. Sorry for confusion. The C:N ratios are standard values shared by all PFTs in CLM. Table B1 is now renamed Table A3.

Comment 7: P4561L20: It's unclear how you derive NPPmon since it extremely challenging to estimate monthly tree NPP?

Answer 7: We revised the sentence to "where NPP_mon is the monthly sum of NPP from the previous month calculated with a run-time accumulator in the model." (see Lines 210-211). NPP_mon refers to modelled value, not that measured in the field. CLM calculates NPP (gC/m2/s) at every half-hour time step. We coded a run-time accumulator in the model to get monthly sum of NPP (gC/m2/mon) from the per second NPP flux. We now add a validation (new Fig. 3) with field measured monthly NPP which is an approximation through measurements of stem, root, leaf, and fruit growth in eight mature oil palm sites (see Lines 293-297 and cited paper).

Comment 8: P4564L23: What are the sizes of the sites?

Answer 8: The PTPN-VI site is 2186 ha. Pompa Air is 5.7 ha. Other 8 sites are 50m $\times$ 50m each (added in the text, Lines 275, 278, 287).

Comment 9: Figure 8b: A simple scatterplot field measures vs. simulated LAI would work.

Answer 9: We did not use scatterplot because the CLM-Palm model is mainly aimed to predict the average condition of LAI across sites in the study area. Furthermore,

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field measured LAI also has very large variation: “There are large uncertainties in field LAI estimates because we did not directly measure LAI at the plot level but only sampled leaf area and dry weight of individual phytomers and scaled the values up (Lines 460-462)”. With this data, it is hard to show the relationship between field measurements and simulated LAI by a scatterplot. The barplot can include error bars of measured LAI and also show that the average LAI of the eight sites from the model is comparable with field measurement (MPE = 10%) (now Figure 9, Lines 456-460). The limitation of a land surface model for simulating small-scale site-to-site variation is discussed before and more details are in Section 5.

Please also note the supplement to this comment:
http://www.geosci-model-dev-discuss.net/8/C1802/2015/gmdd-8-C1802-2015-supplement.pdf

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