

Interactive comment on “Interactive Impacts of Fire and Vegetation Dynamics on Global Carbon and Water Budgets using Community Land Model version 4.5” by Hocheol Seo and Yeonjoo Kim

Anonymous Referee #1

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In the previous version of this comment, there were two errors in the table. (1) Cells with “Repeated 1901–2000 (CRU-NCEP)” have been replaced with “Repeated 1991–2000 (CRU-NCEP)”. (2) CO₂ row has been filled in.

General comments

In this manuscript, Seo and Kim present the results of a study designed to assess the relative and interactive effects of simulating fire and dynamic vegetation on carbon and water cycling in the Community Land Model. One especially interesting finding is that

C1

fire seems to increase net ecosystem productivity, but only when dynamic vegetation is turned off. Many of the other results are not very novel, but are appropriate for Geoscientific Model Development because they add evidence supporting existing findings, and could help to interpret future CLM experiments.

This work could be valuable for the large community of researchers using CLM, as well as for global vegetation and land system modelers in general. Unfortunately, certain experimental design choices, coupled with uncertain explanation of model run setups, render parts of this manuscript impossible to confidently evaluate. I thus recommend that this paper be **resubmitted with major revisions**.

Specific comments

The spinup and transient model runs need to be much better explained. Table 1 would have been a good place to clarify things, but as it is now that table does not really give any useful information. Here’s the information I would like to see in a revised Table 1, along with the gaps left by the Methods text (and a read through of the Methods for Qiu and Liu 2016):

C2

	CLM4.5BGC 1850	CLM4.5BGC 20th cent.	BGOnly	BGC-DV
Time	???	1901–2000	200 years	200 years
Climate forcings	???	1901–2000 (CRU-NCEP)	Repeated 1991– 2000 (CRU- NCEP)	Repeated 1991– 2000 (CRU- NCEP)
[CO ₂]	???	???	???	???
Biogeog. shifts?	Yes?	Yes?	No (constant map)	Yes
Initial veg.	No (bare soil)?	Yes (as resulting from “CLM4.5BGC 1850”)?	No (bare soil)?	No (bare soil)?
Initial soil	Uninitialized	As resulting from “CLM4.5BGC 1850”	As resulting from “CLM4.5BGC 20th cent.”	As resulting from “CLM4.5BGC 20th cent.”
Land use	???	???	At least crops?	No?
Fire	On?	On?	BGOnly-F: On BGOnly-NF: Off	BGC-DV-F: On BGC-DV-NF: Off

- It is unclear exactly which runs were initialized with no vegetation (i.e., bare soil) because it is unclear what is being referred to by “In these simulations” on L 141. The idea that the BGOnly and BGC-DV runs might be initialized with suddenly bare ground is concerning; this choice could have serious carbon cycling implications by itself. This should be justified, and well.
- If my interpretation is correct about the “Vegetation at beginning” row, how was the vegetation C present in 2000 removed for the start of the BGOnly and BGC-DV runs? Was it removed from the land system entirely, or was it all killed and left to decompose?

C3

- The use of climate forcings for 1991–2000 seems unwise. Generally, periods of at least 20–30 years are used in this sort of experiment, to better capture the full range of synoptic climate variability. It’s especially egregious to use the 1990s specifically, because the 1998 ENSO event resulted in an extreme fire year.
- It is only explained near the end of the manuscript (LL 299–300) that crops are not simulated in the BGC-DV experiments. This, along with the “CR” panels in Fig. 3 (although CR is not defined anywhere), leads me to understand that crops are simulated in the BGOnly experiments. But nowhere is there any information about (a) other land uses in those experiments, (b) land uses in the spinup and transient experiments, or (c) what is used instead of cropland in the BGC-DV experiments.

Unfortunately, the lack of clarity with regard to the model experiment setups makes confident appraisal of the rest of the manuscript impossible. I will attempt to assess what I can, couching my comments in the necessary uncertainty.

Section 3.1 (comparing simulated burned area with GFED3) is extremely problematic. Although I’m uncertain about the specifics of the experimental design, it seems clear that the runs are not intended as a way of reflecting reality but rather as an exploration of model mechanics. This is suggested by the use of equilibrium runs using 1991–2000 climate—a period in which the land system was certainly not in equilibrium, because of (among other factors) the continued recovery of forests in the northern hemisphere. Perhaps that’s not an issue in these runs: It’s possible that land use was turned off (there’s no way to know, because it’s not described in the Methods), but if that’s the case, that’s just another reason why a comparison of the model outputs to observations makes little sense. And even if one ignores all that, there’s the problem that the simulations use 1991–2000 climate but the comparison is to burned area data from 1999–2011. The 1998 ENSO event resulted in an extreme fire year, which would be captured in the climate forcing (and ideally thus in the model

C4

output) but not the observational data. The third paragraph of Sect. 3.3 (LL 213–218) is problematic for the same reasons.

Figure 3 (land cover comparisons between BGC-DV-F and BGConly) is confounded by the fact that crops were not simulated in the BGC-DV runs. What land cover is being simulated instead? Unless there is some kind of adjustment going on, the area that should be cropland is instead in some other land cover category in BGC-DV-F.

In Figure 5 and the discussion thereof (LL 184–192), it is unclear what is meant by “changes in the vegetation distribution.” Does that refer to BGC-DV-F vs. BGConly-F, or BGC-DV-F vs. BGC-DV-NF? This makes it unclear how to interpret the results presented in the figure and text: Are we looking at an effect of including dynamic vegetation or of including fire?

The following, in Sect. 3.4, is incomplete: “Changes in ET and runoff do not differ markedly between BGConly and BGC-DV, despite differences in the vegetation canopy and height, and soil moisture. This result could be attributed to the fact that an offline CLM was used, which does not allow for land-atmosphere interactions.” It actually also indicates that including dynamic vegetation doesn’t make much difference for the physiological and physical processes of the land system governing evapotranspiration and runoff.

Other comments:

- The spinup and 20th century runs were performed with CLM4.5BGC, not CLM4.5BGC-DV. What input data were used for land use and vegetation?
- If changes were to be made to make Sect. 3.1 justifiable (see above), why would GFED3 be used instead of the more recent GFED4, or even better, GFED4s? This could change the interpretations in Sect. 3.1, for instance, since GFED4s

C5

gives global burned area of 476 Mha/year—much closer to BGConly-F instead of BGC-DV-F.

- Tables 3 and 5: It is not clear what the t-tests are actually testing. Are they testing the difference of each experiment’s mean difference from zero (i.e., the effects of including fire), or the difference between the two models’ mean differences (i.e., the interactive effect of including dynamic vegetation and fire)?
- Throughout the paper, more effort should be made to distinguish the discussion of fire effects vs. dynamic vegetation effects.

Technical corrections

- L 58: Since the first FireMIP results paper has not been published, it would be more accurate to say “is evaluating” rather than “evaluated”.
- L 64:
 - The most recent version of GFED is v4, not v3.
 - Because it’s the name of a specific sensor rather than a general technology, Moderate Resolution Imaging Spectroradiometer should be capitalized.
 - In addition to MODIS fire counts, GFED also considers MODIS burned area.
- L 81: Period missing after “1.2”.
- LL 301–302: “Thresholds used” should be “Thresholds are used”.
- Fig. 3:
 - “Plant cover” should be simply “Coverage” or something similar, because bare ground by definition has no plants.

C6

- "BGOnly" should be "BGOnly-F".
 - L 512: "bare ground (BE)" should be "bare ground (BG)". CR is not defined.
 - L 513: "BGOnly" should be "BGOnly-F".
 - L 515: "bare ground (BE)" should be "bare ground (BG)".
- Fig. 6: "Differene" should be "Difference".