

## ***Interactive comment on “Earth System Models that simulate crops underestimate CO<sub>2</sub> emissions from land use by neglecting soil disturbance due to cultivation” by S. Levis et al.***

**S. Levis et al.**

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Dear Dr. Anderson,

Thank you for your helpful comments. Our point-by-point response follows:

1) You wrote: "Selecting sites solely on model-data agreement may over-represent improvement in CLM..."

To clarify, we selected the eight sites based on DayCent-to-data agreement rather than CLM-to-data agreement. The manuscript includes the following sentences in Section 2.1, p. 6643, lines 12 and 15: "...we treat the DayCent model as a baseline for com-

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parisons with the CLM at the eight sites."

and

"...we select the eight sites where DayCent performs best against observations."

Right after, we now add this sentence for clarification: "We do not expect this selection approach to bias the CLM simulations."

We also modify an existing sentence on p. 6642 line 6 to say: "We perform simulations at eight sites distributed across the Great Plains of the American Midwest that span much of the region's climate variations:"

2) You wrote: "Winter wheat and spring small grains are much more common non-irrigated crops in your 8 counties (and thus representative of actual conditions)."

We do not have a working winter wheat parameterization in the CLM, yet. We agree with your comment as pertains to actual conditions. We expect that the first order effect of cultivation on the soil carbon decomposition would not change by replacing rainfed corn with rainfed spring small grains. So, for clarification, we add the following sentence to p. 6642 line 26: "We expect that the first order effect of cultivation on the soil carbon decomposition will not depend on the crop type present in the simulations (rainfed corn rather than the more common at these sites rainfed winter wheat and spring grains."

3) We add this reference at the end of the sentence on p. 6643 line 19: Bonan, GB, Hartman, MD, Parton, WJ, Wieder, WR, Evaluating litter decomposition in earth system models with long-term litterbag experiments: an example using the Community Land Model version 4 (CLM4), GLOBAL CHANGE BIOLOGY, 19, 957-974, DOI: 10.1111/gcb.12031, 2013

This article describes another CLM to DayCent comparison where the CLM (designed for coupling to an Earth System Model) is evaluated against the more complex DayCent ecosystem model at a series of sites.

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4) We do not show global DayCent simulations because M. Hartman has performed such simulations only WITH the effect of cultivation on soil carbon decomposition; this would not add useful information to the manuscript.

5) We add this explanation to the figure legend: "Soil carbon increases by about 120 g/m<sup>2</sup> in both the U.S. and globally in the CROP simulation. Soil carbon decreases by about 900 g/m<sup>2</sup> in the Central U.S. and by about zero globally in the CLTV simulation. This difference in simulated trends is because the enhanced soil carbon decomposition due to cultivation applies to a much larger fraction of the total land area in the Central U.S. than on the global scale."

6) We now include three references that support our statement:

Pongratz, J., Reick, C.H., Houghton, R.A., and House, J., Terminology as a key uncertainty in net land use flux estimates, *Earth Syst. Dynam. Discuss.*, 4, 677-716, DOI: 10.5194/esdd-4-677-2013, 2013

Gasser, T., and Ciais, P., A theoretical framework for the net land-to-atmosphere CO<sub>2</sub> flux and its implications in the definition of "emissions from land-use change", *Earth Syst. Dynam.*, 4, 171-186, DOI: 10.5194/esd-4-171-2013, 2013

Houghton, R.A., Keeping management effects separate from environmental effects in terrestrial carbon accounting, *Global Change Biology*, 19, 2609-2612, DOI: 10.1111/gcb.12233, 2013

7) We reword as follows: "The Community Land Model (CLM) underestimates the global land use and land management (LULM) C flux to the atmosphere, compared to the Houghton (2003) estimates, in large parts of the 19th and 20th centuries in simulations coupled to the Community Earth System Model (CESM) (Lawrence et al 2012)."

8) We will make all text in the figures larger and will consider using color.

9) Thank you for the suggestion. To preserve information included in the original title  
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and in response to a comment by your co-reviewer, we came up with this alternative:  
"The Community Land Model underestimates land-use CO<sub>2</sub> emissions by neglecting soil disturbance from cultivation."

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Interactive comment on *Geosci. Model Dev. Discuss.*, 6, 6639, 2013.