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Interactive comment on "Modeling the impact of agricultural land use and management on US carbon budgets" *by* B. A. Drewniak et al.

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We thank the reviewer for the comments on our manuscript. We believe these comments will significantly improve the manuscript. Our point-by-point response to the review follows.

The Drewniak et al. article is a modeling study of the effects of crop residue removal, as pertains to cellulosic biofuels, on soil organic carbon. The paper is well written and clearly presented. It is an interesting application of the CLM-Crop model. I suggest the following minor revisions (though the final suggestion could involve some more analysis of the existing model runs and would help enhance the article):

Comment: 1. Please cite Melillo et al. (2009) in the Introduction, which explored

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the effects of land use conversion due to cellulosic biofuels. (Melillo, J. M., Reilly, J. M, Kicklighter, D. W., Gurgel, A. C., Cronin, T. W., Paltsev, S., Felzer, B. S., Wang, X., Sokolov, A. P., and Schlosser, C. A. 2009. Indirect emissions from biofuels: how important? Science. 326:1397-1399.)

Response: Thanks for the suggestion, we have included the suggested reference to Melillo et al., in the Introduction (P. 13677, L. 10).

Comment: 2. The sentence "The use of crop residues for bioethanol production shows promise for meeting U.S. energy needs" in the Introduction needs some further clarification – what is meant by U.S. energy needs exactly?

Response: We have modified the text to reflect the renewable fuel goals, rather than energy needs (P. 13677 L. 16).

Comment: 3. Change the color bar in Figure 1c so the numbers match up to the divisions. " In most regions, the percent difference between the data set and the model simulation is < 5 %" – from Figure 1c, a large portion of the Central Plains appear to be > 5%, not just boreal regions.

Response: Thanks for the suggestion. We have updated the figure to scale more appropriately and to distinguish the 5% color change. There is a swath of the Great Plains where the percent difference is greater than 5%; however the percent difference is still less than 6% in this region.

Comment: 4. I do like the validation efforts, so I am not asking for more because I know how difficult it is to get models to look exactly like the data. However, the use of "r" rather than "r2" in Figure 3 is nonstandard and makes the correlation look better than it is. I really see no correlation between modeled and observed values – is there any better r2 value for clay, sand, or silt independently? I might instead comment that the overall range of values is captured by the model, in addition to the model underestimate. How does this figure show the model captures the variability?

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Response: The R-square values were small (0.057), even for individual soil textures (Sand R^2 = 0.03, Silt R^2 = 0.11 and Clay R^2 = 0.06). Given the difficulty comparing point field observations with model data, we have modified our comparison approach and created an alternate figure by plotting the mean and standard deviation of observed SOC stocks at the model grid cell resolution, which replaces Figure 3 in the manuscript. The coefficient of determination between observed and predicted values is still small. Our use of the term variability was to highlight that the model predicted large spatial variability in SOC, which is captured through a wide range of SOC values. We have updated the manuscript to clarify our meaning (P. 13684 L. 15-16). Our new approach using standard deviation demonstrates the large variability of SOC observations at the model grid scale.

Comment: 5. Sentence in discussion: "Currently, individual agricultural plots typically lose 33–51% of SOC, and that loss increases to nearly 90% when residue is harvested" and in abstract: "After long periods of cultivation, individual plots growing maize and soybean lost up to 65%.". Where do these figures come from? They are not apparent from Figure 4, so I am unclear if they are referring to individual grids, or individual "plots" – do these represent data rather than the model?

Response: Each modeled grid cell contains up to three crop types growing on independent soil columns. When we refer to "individual agricultural plots" we refer to the portion of the grid cell growing just one crop type as opposed to what is shown in the figures, which includes a weighted average of SOC of all the crop portions of the grid cell. We have revised the text to make this distinction more clear (P. 13687 L. 4).

Comment: 6. I thank the authors for pointing out the negative effects of adding too much fertilizer in the discussion. It can also be pointed out the fertilizer use and production also leads to more N_2O in the atmosphere, a powerful greenhouse gas.

Response: We have modified the text to include this important loss of nitrogen inputs (P. 13687 L. 23).

Comment: 7. Typo: Second to last paragraph, change “should a priority” to “should be a priority”.

Response: The text has been modified as suggested (P. 13688 L. 6).

Comment: 8. Ultimately this is a very simple analysis of the effect of residue on soil organic carbon. I would think the model would also track the effect of that additional SOC on nitrogen – it would add something to this analysis if the authors could easily pull out net nitrogen mineralization rates, or plant nitrogen uptake, to track more precisely how the decreased residue affects nitrogen limiting conditions, and ultimately, crop yield. I would also think they could pull out some actual numbers on crop yield for these different runs, rather than just make the qualitative statements that more SOC leads to better crop yields. However, I am not sure if these output are actually saved on their current history files.

Response: We do have data saved in our files for net nitrogen mineralization, plant nitrogen uptake, and crop yields. As suggested, we added two additional figures (Figs. 7 and 8) in the discussion section to highlight the decreasing nitrogen uptake and crop yields with increasing residue harvest. The major outlier was the simulation without fertilizer, which had much lower (∼60%) yield compared to the current residue simulation. This supports our conclusion that decreasing residue returned to the soil results in decreased nitrogen availability for future plant uptake and retards plant growth and productivity in subsequent growing seasons (P. 13687 L. 6+).

Interactive comment on Biogeosciences Discuss., 11, 13675, 2014.