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Earth System Dynamics
Discussions

Interactive comment on "Divergent predictions of carbon storage between two global land models: attribution of the causes through traceability analysis" *by* R. Rafique et al.

Anonymous Referee #1

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This manuscript examines the carbon cycle of two models, CLM-CASA' and CABLE, using a framework to trace carbon through the system. The traceability framework has been used and published previously – it is useful for comparative studies of the simulated carbon cycle in ecosystems. I appreciate the utility of the traceability analysis for identifying structural or parameter uncertainties in the models, and I think this paper provides a clear comparison between two widely used models. However I have two main concerns with the manuscript as it stands now. These are given below, followed by some specific comments/questions for the authors.

First, for a fair comparison between the models the same climate forcing should be used. Even if the mean values of temperature and precipitation are the same, it's more

likely the extremes of these that have the largest impacts on the NPP and residence times. I am not convinced that some of the differences between the models is not due to the different climate data sets used.

Second, the diagnosis that the differences in NPP are due to differences in Vcmax and SLA is speculative (at least as it appears in the text). External factors can affect the NPP such as temperature, radiation, or precipitation, and as I stated above I am not convinced these differences are not important. Also, internal model differences can affect NPP such as how canopy radiation and moisture stress are handled. Last, five biomes have either a lower SLA (ENF, EBF) or a lower Vcmax (DBF, C3 grass, Tundra) in CLM-CASA' despite that model having a higher NPP – so it is not clear to me the role of these parameters in determining the relative NPP.

Specific Comments: 1. I think some clarification on the role of PFTs and biomes in the carbon pools would be helpful. I have a few specific questions: - I am curious how you handle multiple PFTs within a gridbox in the traceability framework. How many pools does each model have in total (what is n in the equations)? For example, does each PFT in CLM-CASA' have 3 plant carbon pools? Are the litter and carbon pools shared between PFTs? - How is the translation from PFTs to biomes done? A table showing the 16 PFTs of CLM-CASA' and which biome each fits into would be useful. - Please provide the full names of the pools in the caption of Figure 3.

2. At the end of Section 2.1, the q10 values are given but not their context – do these apply to soil respiration?

3. What determines the baseline residence time? Why do deciduous needleleaf and evergreen needleleaf forests have the highest baseline carbon residence times? And why is there such a large difference in the baseline residence time for tundra between the models?

4. The residence time is higher in CABLE – and this is attributed to higher residence times in wood and a higher allocation of NPP to wood. Could another reason be that

once carbon enters the passive SOM pool in CABLE, it does not interact with the slow pool? What is the effect of the more complicated interactions between soil pools on the residence times in CLM-CASA'?

5. At the beginning of Section 3.5, I think it should be reiterated that a lower environmental scalar limits decomposition and turnover and therefore increases the final ecosystem residence time of carbon.

6. What is meant by the last sentence in the first paragraph of the Discussion: "Longer ecosystem residence time in CABLE was mainly attributed to higher environmental limitation of the organic matter decomposition." This seems to be in contrast to what is shown in Figure 6 – which shows a larger difference in the baseline residence time than in the environmental factors.

7. In general the abstract and Discussion/Summary sections communicate the main results of the study very well. I have one suggestion: the Discussion mostly addresses the 3 objectives given in the Introduction, but it could improve the paper to more explicitly address these objectives and the main conclusions pertaining to each.

Interactive comment on Earth Syst. Dynam. Discuss., 6, 1579, 2015.