

Biogeosciences Discuss., referee comment RC1
<https://doi.org/10.5194/bg-2021-66-RC1>, 2021
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Comment on bg-2021-66

Anonymous Referee #1

Referee comment on "Assessing the representation of the Australian carbon cycle in global vegetation models" by Lina Teckentrup et al., Biogeosciences Discuss.,
<https://doi.org/10.5194/bg-2021-66-RC1>, 2021

The authors present an analysis of the carbon cycle in Australia as simulated by 13 vegetation models. They show large differences in simulated carbon storage across the models and determine those differences are due to differences in carbon residence time, land cover fraction, response to CO₂, and fire. Assessing simulations of the carbon cycle at this scale is an important contribution to our understanding of how differences in model structure and assumptions translate into model biases. The greater importance of phosphorous as compared with nitrogen limitation in Australia is a good example of the need for this type of regional analysis to understand regional as well as global simulation biases. Detailing the effects of LUC implementation is another important contribution to our understanding of why models simulate drastically different outcomes. These contributions are highly relevant to the modeling community and the authors make a strong case for the need to improve the ability to simulate the Australian carbon cycle.

Additional analyses could increase the understanding of the interrelatedness of the separate factors discussed, and increase the strength and interpretability of some of the existing conclusions. I provide suggestions below.

General Comments:

Using the term "DGVM" is somewhat misleading because some of the models use prescribed PFT fractions. Explicitly identifying which models are truly DGVMs and which are not at the beginning instead of in the Future Directions section at the end might help a reader while digesting the figures.

Some additional analyses that bring the separate sections together will help disentangle the results. Most importantly, more detailed analyses of the effect of PFT fraction might allow for more informative conclusions. For instance, one conclusion is that differences in PFT fraction are largely responsible for differences in carbon storage and turnover time. Showing each model's NBP difference from the multi-model mean (and carbon storage and residence time) vs. the fraction of each PFT, either for every year or averaged over a number of years, would help understand the role of vegetation distribution on differences in the simulated response variables of interest. The discussion of inter-annual variability in precipitation would also benefit from assessing the model differences in terms of PFT fraction. This is alluded to in the Discussion but could be explicitly evaluated. Finally, analysis of differences in burned area relative to PFT fraction would be helpful.

Plotting annual average NBP vs. annual average area burned (or emissions), with error bars, could help understand the role of fire on differences in NBP.

It might help if the Results and Discussion presented the variables contributing to differences among models in the same order. PFT fraction is presented last in the Results, but addressed first in the Discussion.

The colors for each model are hard to distinguish in the time series plots. Maybe including different line types in addition to colors would help.

Specific Comments:

Lines 6-7: Is there a word missing in this sentence?

Lines 162-163: Plotting NBP anomaly vs ensemble spread would help make the point that years with extremely low or high NPB have large uncertainty more clear.

Figure 2: Plotting the differences between CO₂-only and the other two experiments (similar to Figure B7, except summed over the simulations) for each model would make it easier to see the effects of climate and LUC.

Figure 8. Showing observed land cover fraction would be helpful.

Line 297: Sentence "processes landcover/land use change" is missing "of".

Line 334: Change "an nitrogen cycle", to "a nitrogen cycle"

Line 359-360: These relationships, especially, between PFT fraction and residence time, could be checked relatively easily as suggested in my general comments.

Line 369: Change "was less important factor" to "was a less important factor"

Lines 441-456: Why not compare the parameterizations these 13 models used? That, in conjunction with the additional plots of NBP, carbon storage, and residence time by PFT fractions could allow for more comprehensive and informative conclusions as to why the models differ.