Comment on esd-2021-17

Anonymous Referee #2

The manuscript "*Parameter uncertainty dominates C cycle forecast errors over most of Brazil for the 21st Century*" by Smallman et al. presents projections of Brazilian carbon cycling using a model-data hybrid approach. A terrestrial ecosystem model with varying degrees of complexity is constrained by remote sensing data before being used to quantify the evolution of carbon stocks into the future. Overall, I think the methodology is robust and I commend the approach, in particular separating and quantifying parameter, structural, and climate uncertainty on future stocks. The paper is well written, flows well, and addresses an important topic with substantial and robust conclusions.

Therefore, I would recommend the manuscript to be published after the following comments have been addressed:

-

  In general, the paper has detailed reporting of results, however the explanations of model behaviour are sometimes incomplete. This lets down the previous good work that comes beforehand. For example:

  L406 - Can you explain why RT increased?

  L407 - I find it interesting that here the net flux correlates with GPP, but the long term net changes have low correlation with GPP. Can you explain?

  L414 - Can you explain why Amazon flux is overestimated?

It would help the reader if more insight was offered into what drives model responses.

- The introduction stresses the importance of land-use change and fire for the Brazilian carbon cycle, but there is little discussion on how these disturbances will influence future carbon stocks. Are they important? If not, why not? If they are, then how important? Also, it is not clear if/how land-use change is implemented in your future simulations. Is this implicit in the mortality parameter? It would be good to clarify this.
-

The writing style can be improved in places. There are a few dense paragraphs (that can sometimes read like a list), e.g. in Sections 3.3 and 3.4.3, there is often a detailed comparison between the five models that doesn't add much value. Can the values be moved to a table and then the text just discusses the most important parts? E.g. "Carbon allocation to wood as well as wood turnover rates determine future biomass stocks... Relative contribution of allocation and turnover varies across biomes…". Also, at times the paper sounds quite negative. E.g. in Section 3.4, I feel some value is lost when all your results are caveated with "uncertainty is larger than predicted changes" or (L299-305) - "...insufficient observational constraint to confidently determine the sign of NBE or soil C dynamics. The same was largely true for wood stock dynamics..". I appreciate the uncertainty is important (and the focus of the paper), and certainly needs to be addressed, but this large uncertainty seems to undermine any projections you make about future stocks.

- Can M1-M5 capture the full extent of model structural uncertainty? You start to discuss this (L467) but in my opinion, I don't think this is a strong enough justification. Further, you state "...limited sensitivity of C cycling to future soil moisture stress.", which is at odds with drought experiments that suggest increased mortality and reduced productivity (e.g. ACL da Costa et al., 2010 - New Phytologist).

Minor comments:

 - Looking at Figure A7, M5 looks like it still has a large fire bias similar to the other models, so can

Can M5 say anything about the role of fire on future C stocks in the future?

 - FLUXCOM-RS+METEO is known to underestimate IAV. One option would be to use FLUXCOM-RS which uses interannual satellite LAI as an input and generally shows large IAV and trends. This could improve the comparison in Figure 5.

L46-47 - Missing words?

L299 - "Carbon dynamics of wood, not soil, is the primary driver of net exchange." - Does this depend on timescales? Over the course of a century, won't slower (but potentially larger) soil C dynamics play a bigger role?

L394 - Missing words?

L395 - Increased from what? Due to increasing model complexity? Over time?

L394-402 - It would be good to place wood litter in the context of other drivers of fire. Is wood litter the most important variable if we want to correctly simulate fire? How about the local climate? Ignition sources?

L407 - Do you mean "GPP" instead of "net carbon uptake"?

L454 - Why is it important that NPPWood is the second most important determinant?

L456 - Don't some transient biomass maps exist already? e.g. ESA, or VOD based (Liu et al. 2015).

L533 - But don't we have transient AGB and atmospheric NEE available now?