

Comment on bg-2021-57

Anonymous Referee #2

Referee comment on "Quantifying the role of moss in terrestrial ecosystem carbon dynamics in northern high latitudes" by Junrong Zha and Qianlai Zhuang, Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-57-RC2>, 2021

General comments

This study addresses a critical gap in the Terrestrial Ecosystem Model by including mosses as a plant type at northern latitudes (>45 degrees). The authors do a good job of establishing the key role of moss in these ecosystems and show an improvement in model-data assimilation from the previous iteration of the model through the inclusion of mosses. In general, this is an important contribution to improving these models. However, some non-trivial caveats may have large effects on the future carbon storage potential of high latitude ecosystems, particularly the expected decreases in moss biomass with climate warming.

Specific comments

1. Throughout the manuscript, I would suggest replacing "higher plants" with a more appropriate terminology, such as "vascular plants". For a discussion on why (and how) to implement this change, please see McDaniel 2021 in New Phytologist (Title: Bryophytes are not early diverging land plants)
2. In order to support the claim that this paper quantifies the interaction between vascular plants and mosses as mentioned in the abstract and introduction, I would like to see a more explicit explanation of how that interaction was included within the model.
3. In the discussion, the authors say their simulation confirms that that mosses and vascular plants respond similarly to climate change in terms of productivity. He et al. 2016 (Title: Will bryophytes survive in a warming world?) finds an expected divergence between vascular plants and bryophytes in response to climate change, as do many experimental

manipulations (see below). It seems like the authors set up the model to have vascular plants and mosses respond similarly, rather than the model proving that they do? It may also be worth considering the higher CO₂ concentration at the moss carpet—is it appropriate to use mean atmospheric CO₂ concentration?

4. I think the potentially large decreases in moss biomass expected with warming are a non-trivial concern for future carbon storage expectations found in this model. I would recommend papers such as Elmendorf et al. 2012, Lang et al. 2012, and Alatalo et al. 2020 as sources on changes in moss biomass in response to simulated warming.

5. Soil uptake is only one pathway for mosses to access N. Studies have shown that they receive nitrogen from associations with nitrogen fixers (see Bay et al 2013 and Berg et al 2013 for examples in various types of host mosses). Mosses can translocate N from within the senescent moss body to incorporate new growth (Aldous 2002). Mosses also acquire nitrogen via deposition. The cited studies (Ayres et al. 2006 and Fritz et al. 2014) show that mosses can acquire nitrogen from soil (a previously unexpected N source due to the lack of roots and vasculature), but in Ayres et al. mosses incorporated more nitrogen via wet deposition.

Technical corrections

L22 ""which do not" instead of "without" moss

L27 "nutrient" should be nutrients

L41 "hold" instead of occupy, perhaps?

L59 Rephrase for clarity

L69 "nutrient" should be nutrients

L81 Since the degree to which mosses facilitate nitrogen fixation is not well-studied across the broad array of host mosses, rephrase to say "because of their associations with microbial nitrogen fixers" or similar

L83 "of" not "on"

L84 “being” recognized

L90 “exceeding” instead of “exceed”

L98 “higher plants” <- but also, see comment above

L103 Rephrase—perhaps exclude interaction?

L210: This sounds like a great feature of the model!

L307-308 Very cool result. I think this is a major take-away of this study.

L403 Please refer to a table or figure here to direct audience to that finding

L422-424 Past tense for past estimates?

L458 “which have their own functional traits” I would like to see a couple key traits enumerated—perhaps differing levels of insulation provided for soil, perhaps different associated microbiomes? Whichever may be most relevant to the assumptions within the model. Also remove next sentence that starts “In our model,...”

Figure 1: Since Moss as a category was added in this model, perhaps the Moss boxes should also be green? I would find that helpful in interpreting the figure.

Figure 3: Include a map as an inset or separate figure to show the location of these sites. I was surprised to see that half were on the southern end of area included in TEM_Moss, would you expect this to impact your results in any way?

Follow-up question: Why was 45 degrees N selected as the cut-off point? This includes temperate, boreal, and Arctic ecosystems--though the introduction and discussion seem tailored more to the Arctic and boreal ecosystems.