

Thank you to the reviewers for their time and consideration. Reviewer comments are in *blue italics*, and our responses are in plain black.

Reviewer 1

Specific comments

Lines 66-67: "As an additional check on the performance of the ESMs, we also looked at the BNF of a number of land surface models (LSMs) used in the ESMs presented here, and include this in the SI." Add explicitly that these runs are offline simulations performed with the set of LSMs.

Added.

Line 80: no reference for TaiESM1?

No reference was available at the time of writing, but has now been added.

Line 95: no reference for AWI-ESM?

No reference was available at the time of writing, but has now been added.

Line 141: "estimates is in" the "is" should be removed

Thank you, corrected.

Figure 4a,b: I don't see the AWI-ESM circles.

They aren't there because AWI-ESM did not have that simulation available.

Lines 195-196: ESMs taking part in the C4MIP effort should have used the same nitrogen deposition forcing coming from CCMI as described in Jones et al., 2016.

We have added this reference.

Lines 201-202: I don't see where these numbers are listed.

They are listed as changes to single number ratios in brackets on the next line.

Line 226: Discussion should be section 4 instead of 5

Fixed.

Line 249: "based Attempts" the "A" should be "a"

Fixed.

Figure 1, lines 502-503: inversion of low latitude and high latitude definition. Low latitude should be between 30°S and 30°N, while high latitude more than 60°N or 60°S.

Thank you for catching that, we have corrected it.

References:

*Jones, C. D., Arora, V., Friedlingstein, P., Bopp, L., Brovkin, V., Dunne, J., Graven, H., Hoffman, F., Ilyina, T., John, J. G., Jung, M., Kawamiya, M., Koven, C., Pongratz, J., Raddatz, T., Randerson, J. T., and Zaehle, S.: C4MIP – The Coupled Climate–Carbon Cycle Model Intercomparison Project: experimental protocol for CMIP6, *Geosci. Model Dev.*, 9, 2853–2880, <https://doi.org/10.5194/gmd-9-2853-2016>, 2016.*

Reviewer 2

It seems to me that the question about the scientific significance raised by Reviewer #2 was not adequately addressed in the revised manuscript. The article evaluates the ability of some CMIP6 ESM to reproduce the observed rates of biological nitrogen fixation and reports the results which are new and deserving publication.

We thank the reviewer for their time in reviewing and acknowledgement that these findings are new and deserving of publication.

The question is whether the results should be published in Biogeosciences or elsewhere. "Does the manuscript represent a substantial contribution to scientific progress within the scope of this journal (substantial new concepts, ideas, methods, or data)?" This question should be somehow answered in the article (preferably in an indirect way). The authors reply to Reviewer #2 comment does not look very convincing. I would recommend to highlight the conclusion that evaluated models "does not have explanatory power for variations in net primary productivity or the coupled nitrogen-carbon cycle" and therefore cannot be used for predicting biological nitrogen fixation response to global change.

We're grateful to reviewer for highlighting the potential for misunderstanding of the quoted conclusion from the abstract, and have amended the sentence appropriately to clarify that it means the variation within model ensemble. And while the reviewer is correct that the lack of relationship between NPP and BNF means that models with BNF based on NPP should not be used for projections of BNF response to global change, this conclusion does not hold for process-based models. This is a nuanced conclusion that indicates the importance of model structural uncertainty, and we have adjusted the text accordingly.

The title should be changed to convey the major result of the study. The current title forms a wrong impression that paper is not to report any new findings.

That is a wrong impression that we agree must be corrected. To that end, we have re-titled the paper: Assessment of the Impacts of Biological Nitrogen Fixation Structural Uncertainty in CMIP6 Earth System Models.

Perhaps, this can be done by minor revision if handling associate editor decides that the article is "appropriate to Biogeosciences status" in principle. (N.B. Do not forget to insert heading "3 Results" above the subheading "3.1 Present day BNF").

Our apologies if the lack of a Results heading made the paper more difficult to understand; it has now been added.