Biogeosciences
Discussions

Interactive comment on "Variability of projected terrestrial biosphere responses to elevated levels of atmospheric CO_2 due to uncertainty in biological nitrogen fixation" *by* J. Meyerholt et al.

Anonymous Referee #1

Received and published: 11 January 2016

The paper addresses the effect of different implementation of biological nitrogen fixation (BNF) in terrestrial biosphere model. The authors capture different model families and test their effects on estimations of current rates, and as a response to increasing atmospheric CO2, that causes increased C availability to plants in TBMs and a potential N deficiencies. With BNF as the single largest source of new N to terrestrial systems, it is important to constrain these inputs in TBMs. The paper summarizes and categorizes the different philosophies nicely. It also carries out very sensible experiments to highlight the differences (current rates, vs response to perturbation). Since these experiments are carried out with a single TBM, effects of other processes in the nitrogen cycle do not blur the picture, as it would in a broad multimodel comparison.

Overall, I think this is a very important study.

Perhaps what is missing, is the answer to the question what of these outcomes can really be attributed to the specific models or whether it is just caused by a particular selection of parameter. In other words, how robust are these differences, given that the parameter space can be changed? I think a total sensitivity analysis is beyond the scope of this neat (!) paper. However, having worked with all the formulations the author will have a feel, what parameters in the different models are important. To demonstrate this in some way would further improve the paper. This could be done through a few key additional experiments in the best case, or through a conceptual walk through of the formulation in the discussion, and explain in a what-if scenario. Overall, I think what I am looking for is a subsection teasing out effects parameterization vs. model formulation on the model outcome.

Further, in the discussion of the current map of BNF it might be interesting to discuss the need of BNF in NDT, NDS and OPT. For example, high losses, over which plants do not have control for, can increase BNF in these the formulations that include plant status or invoke the optimality approach. Hi uncontrollable losses (Thomas et al., 2015) would create N limitation and thus induce N fixation in these model formulations. Can hot spots of BNF for these formulations be explained by high "uncontrollable" losses in OCN?

Minor:

P19431 L16: Zaehle unpublished. Perhaps the authors can explain a bit more instead of adding this reference?

P19432 L7: This sentence is long and awkard, and thus hard to understand. Can you rephrase?

P19434 L7: Gradually increasing CO2 concentration. This also occurs in A, doesn't it? Perhaps just state that the gradual increase in CO2 is higher in B compared to A.

P19438 L 17: Although the author state "long-term" it would be helpful to say somewhere in this paragraph that the discussion here refers to simulations B and C.

Table 2: It would add some information, if the N budget could be closed in Table 2. I feel the only budget terms would be N2 and NO loss (the remainder of the gaseous losses from nitrification-denitrification), fire and inputs via fertilizer deposition and accumulation. The question of N budget is hinted already via N leaching losses, see authors' note on P19437 L6:10. But a more thorough discussion about the "openness" of the N cycle would be a helpful and important insight. For example, for 2000-2013, one can then see how much of the N is accumulated (since this is transient), vs. lost via the different loss pathways.

P19439 L 3-6: I am not sure that NDT and NDS formulation would allow "excessive" fixation, given their formulation where BNF only occurs if it is really beneficial. Perhaps one could say that BNF may remove strong constraints and restore (?, not sure if it's the right word) pre-eCO2 N levels of N limitation?

P19441 L6: typo "dynamics"

P19448: L 21: I have trouble with the units NPP_pot*fcost/CN_Leaf would be [gC y-1 * gC gN-1 / (gCgN-1] = gCy-1?. However shouldn't demand be in gNy-1 Table A1: I think this is a very valuable table. Would it also be possible to add the PFT specific parameter values?