Interactive comment on "Controls of terrestrial ecosystem nitrogen loss on simulated productivity responses to elevated CO$_2$" *by* Johannes Meyerholt and Sönke Zaehle

Anonymous Referee #3

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Overall, I really like the paper and I think it is worthwhile to publish. The paper highlights the different N loss routines in DVMs, and how this affects model performance in both N loss and C gain. Especially the experimental setup of running the model makes it useful and applicable for others. Also, the paper is well written and has good graphics.

However, I have some questions about the paper. First, while the N loss differences of the experiments are well explained and show with nice graphics, the C accumulation is more difficult to understand. Especially in the global simulation, the three different routines show quite different N accumulation (fig 5), while the C accumulation seems to be insensitive to the N accumulation. This is the same when the C:N ratio is constant

rather than flexible. The authors state that 'the exact mechanisms are difficult to discern', but that leaves me puzzled.. Did the authors look into more differences besides the C:N ratio's? How does this result link to the earlier 'experiments' in the paper? Where is most of the N that is accumulated stored and how does this relate to the C accumulation?

I have a few more questions and comments which I will go through one by one:

P1, line 37: the authors refer to figure 1, but this is confusing in this part of the paper. P4-5 & figure 1: the N loss formulations are well explained in words, but figure 1 is difficult to read on its own. Also, would it be possible to add N uptake somewhere in the methods? Since later in the paper we look at both N loss and C gain, it would be good to know the general N update scheme of O-CN, and how the Nloss routine of NL3 is altering the overall Nuptake routine in that formulation?

P4, line 17: is leaching of NH4+ equal to leaching of NO3-?

P6, line 27: just to be sure, in the global model run you use fertilizer application, but no N-deposition? What is the rationale?

P8, paragraph 3.1.3: This paragraph could use more explanation. Especially figure 2j is still unclear to me, as an example: why, with eCO2, is the leaching loss so much reduced? Is this because N uptake in mainly inorganic N and will happen before leaching? Why is the gaseous loss in NL2 so much reduced?

P10. Line 13: relative to 1850 values (285 ppm)?

P10, line 34: The 1 sentence for figure 4g is quite limited. Could this be extended? It is relative to control CO2 N loss? And how does it stand for N limitation?

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