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Interactive comment on “Carbon-nitrogen interactions regulate climate-carbon cycle feedbacks: results from an atmosphere-ocean general circulation model” by P. E. Thornton et al.

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This is an interesting paper and the climate modeling community is eager to know what impact would inclusion of N cycle have on simulated future CO₂ concentrations. While this discussion paper does make the point that in the absence of C-N interactions land uptake is higher, the lack of results from a simulation with no nitrogen constraints makes it a little difficult to appreciate the results. In Figure 2a authors show simulated CO₂ from C4MIP simulations and their simulations with pre-industrial N deposition and anthropogenic N deposition. It would be useful to include results from a simulation where terrestrial photosynthesis is not constrained by N. That simulation can be directly

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compared with C4MIP simulations and its difference with authors' simulations would directly show the effect of C-N interactions in terms of CO₂ difference in year 2100.

In addition, like most earth system modeling studies this discussion paper lacks comparison with late 20th century observations of land and ocean carbon uptake and CO₂ concentration. Before assessing the response of the fully coupled model with C-N cycle interactions until year 2100 wouldn't it be useful to assess how the model reproduces land and ocean carbon uptake for the 1980s and 1990s and compare these to IPCC numbers. This can be done with and without C-N interactions and it would be extremely useful to see how the inclusion of C-N interactions affects this comparison. In regards to comparison with observed CO₂, unless I missed this I didn't see comparison of simulated CO₂ with observations for the 20th century.

In my opinion, an additional simulation and comparison with observations will make this interesting discussion paper complete and be able to make a compelling case for inclusion of terrestrial C-N cycle interactions, if they indeed improve the simulation of 20th century carbon budget, in other earth system models.

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