Interactive comment on "Decadal impacts of nitrogen additions on temperate forest carbon sinks: A data-model comparison" *by* Susan J. Cheng et al.

Anonymous Referee #3

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This is a well written manuscript that presents an important model-data comparison exercise to identify model failures and successes in CLM5. The author's assembled an impressive data set and use this to test CLM5's ability to capture 15N tracer recoveries and dC/dN ratios across a suite of forested ecosystems. Both reviewers have provided extensive key insights and areas for improvement for this manuscript. As such, I will keep my comments brief to not duplicate their efforts.

Major Comments

Both Reviewer 2 and the authors in the discussion (Page 15 Line 19) suggest that adding the "tracer" N to the mineral soil pool may make it too accessible to plants. Why

not perform this experiment at one of the sites at least? This would allow you to identify whether the mode of N delivery is driving the high recovery seen in plants.

Both Reviewer's highlighted that turning denitrification off may make the adjusted model simulation unrealistic. I am not an expert in gaseous losses from forested ecosystems but from my understanding I believe they dwarf those of leaching losses particularly for aerobic well drained soils that are N limited. Maybe an empirical reference to support low rates of denitrification would help here. Similarly, most readers are not actively aware of reasonable values in N residence times. Can you put the differences between the default and adjusted CLM into context with literature values?

On aside here: The use of default and adjusted combined with direct and indirect make the results difficult to digest. Why not call them open and closed N cycles or observed C:N vs. modeled C:N or some similar variant that makes sense.

What is driving the variability in wood C:N in both CLM5 versions? Is this due to LUNA? How robust is the overall observed dataset in C:N ratios. Is there only a few observations per site or are there more?

The discussion highlights reasons why the default and adjusted CLM5 can capture 15N recovery rates and dC/dN ratios but fails to address whether CLM5 needs to remain as is or have a more closed N cycle. This is almost a bigger issue than where the tracer is going given that the model is somewhat able to get the right answer for the wrong reason there.

I disagree slightly with Reviewer 2 in regards to the idea that identifying model failures that could be addressed by adding in new processes is not fruitful. Many of the efforts the authors have raised to increase plant-microbial competition by adding in explicit microbial representations and interactions between plants and microbes have proven feasible in models at the ecosystem and global scale.