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Comment on bg-2021-215

Anonymous Referee #2

Referee comment on "The role of cover crops for cropland soil carbon, nitrogen leaching, and agricultural yields – A global simulation study with LPJmL (V. 5.0-tillage-cc)" by Vera Porwollik et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-215-RC2, 2021

This study adds representation of cover crops to LPJml, in order to enable simulations of soil C, N and yield responses to cover cropping, tillage, and both (Conservation Agriculture). The development, spin-up and model runs of the new model version are valuable developments and sufficiently described in the methods and supplement. The authors compare the soil C, N and crop yields of four crops (maize, rice, wheat, and soybean) to literature values, and as they discuss, the model tends to overestimate the soil C sequestration rate and underestimate N leaching and predict larger yield losses. Nevertheless, they find potential for using cover crops in conjuction with no till management to both increase soil C stocks and mitigate water and nutrient losses.

My main comment is with the presentation/organization of the paper. There are three main model simulations: 1) cover crops, 2) no till, and 3) both. Yet, these three simulations could be presented in a more consistent way. For example, Table 1 describes the soil C sequestration of cover crops only. I was also expecting to see analogous tables for tillage and CCNT. If similar literature estimates have already been provided in previous work on LPJml-tillage2, then perhaps the authors could refer to that, but CCNT is a new interaction that has not yet been modeled with LPJml, so I think that it merits a comparison to observed values. Again, Figure 4 only shows productivity response to cover crops, while all of the other figures show all three model simulations.

I would also be interested to know if LPJml predicts a similar total C stock (and maybe yield, veg C, GPP, NPP..) as LPJml-tillage2 from Herzfeld et al. (2021) or LPJml4 (Schaphoff et al. 2018b), basically to show if the model is indeed similar except for these new features.

Minor comments:

L54: A word is missing, maybe: “by this [method] may”

L67: Change “glass” to “grass”

Mention somewhere in the methods that LPJml simulates all of the crops mentioned in TablS1.1 but that in this paper, you only focus on maize, rice, wheat and soybean. I think it is fine to focus on the four major crops, but it is worth highlighting to readers that there

are others. It is also worth noting if they are included in any crop averages or totals reported in the paper.

Figure 5: It would be useful to know the number of grid cells (or whatever spatial unit is being used) in Figs 5, S2.4.1, and S2.4.2. From looking at the three graphs together, it looks as though most locations are rainfed rather than irrigated, and that the small response and variability of the irrigated locations could also be due to the lower sample size.

L315: Here the authors mention that there is a time lag in response of soil C sequestration rates, and while perhaps one could detect a change in soil C using a model, I would not expect field measurements to reflect soil C changes for at least a few years, due to the relatively small signal in such a large pool.

L335: Could be useful to know how you define equilibrium.

L463: I would say "model prediction" instead of "quantification" here. In general, it would be good to use language recognizing that these are model predictions and not measurements.

L484: Perhaps "conclude" instead of "resume"?

Table S2.1: It is interesting that yields tend to increase with CC for specific crops, but in non-legume averages, yield losses tend to be larger than the modeled losses. Why do you think the meta-analyses disagree with the national statistics?

Figure S2.5: I know there are already a lot of figures in the main manuscript, but this one seems as important as cover crops to the paper's main conclusions.

Optional, just a thought: It would be interesting to see if the C that is "lost" as a result of a reduction in yield is proportional to the C gained in the soil. It seems for example, that land management practices with less yield loss (like NT) also have less soil C gain.