

Interactive comment on “Soil carbon management in large-scale Earth system modelling: implications for crop yields and nitrogen leaching” by S. Olin et al.

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General comments

This is a comprehensive global modelling study into the effects of cropland management on crop yields, soil C sequestration, and nitrogen leaching. The authors used a state-of-the-art global ecosystem model which includes representations of N cycling and croplands to study trade-offs regarding these ecosystems services on a global scale.

I believe that the work is very innovative and the topic highly relevant. The study is also well executed to my mind. This is a challenging topic with numerous uncertainties,

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but most of these are discussed in an up-front manner. I find the paper generally well written and easy to follow. My comments are minor and mostly limited to the text which is in some places a bit difficult to understand. Particularly the description of the simulation experiments is somewhat unclear to me.

Specific comments

- I find the introduction, though interesting, a bit long and repetitive. On the other hand, the part on the current study is relatively short. Since many readers prefer to skip the methods section it is advisable to give a bit more information about what was done.

- p 1053, l 9-11: "Moreover, the conversion of N to plant-available forms is reduced in untilled soils and can thus lead to lower crop productivity, which could in the long run decrease the soil's ability to store water and nutrients because the reduced release is partly counterbalanced by a reduced input of new organic material." I find the second part of this sentence (from "which...") a bit strange and speculative, since (to my understanding) no-till farming is applied partially to *improve* water and nutrient retention. I also could not find this in the included reference (Lal, 2004a).

- p 1054, l 11-14: It took me several times before I understood this sentence. Please consider revising it.

- Section 2.1.1: please include a brief explanation of the term "developmental stage".

- p 1057, l 3: how was the manure application derived from the mineral N fertilizer? By assuring that the total amount of N is the same?

- p 1058, l 2: this section suggests that the effect of crop residues on soil evaporation is represented in LPJ-GUESS, while to my understanding it is not. Please make this clear.

- Section 2.2: 1) this section is somewhat unclear since descriptions for the different simulation experiments are mixed. Please include a brief but clear overview of the simulations that were performed, possibly identified by labels, which can be referred

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to later. 2) Please indicate briefly why the CMIP5 simulations started from 1850, while the CRU simulations started from 1901. 3) For the future simulations based on CMIP5 it is not clear if the GCM output was used for the complete simulation or for the future part only (with CRU being used for the historic part)

- p 1059, l 27 – p 1060, l 1: This sentence is not completely clear. Do you mean that a longer transition period for land use would reduce the spin up to such an extent that steady state is not reached for the natural vegetation?

- p 1060, l 10: The WISE dataset comprises both a collection of soil profiles around the globe and a global gridded product derived from this. It seems that here you refer to the latter, while in p 1060 l 14 you refer to the former. Please clarify this.

- section 2.2.1: 1) this section is somewhat unclear. I think a few introductory sentences about what was done would be helpful. Further: 2) Where results from a single simulation compared to both the the WISE soil carbon data and the data from Stockmann et al.? 3) Also, I do not understand the classification in to climate zones yields ~200 cells per zone (so 800 in total?), out of ~60,000 grid cells globally.

- p 1060, l 16: what does the "1000" in parentheses refer to? The number of columns per grid cell?

- Section 2.2.2: 1) The wording in this section suggest that some sort of optimization procedure was used to determine the management for optimal soil carbon sequestration for each grid cell. However, from what I understand, this is not the case; instead the results from the management experiments where combined by selecting for each grid cell the optimal management for soil C. Please indicate this clearly. 2) Please explain in this section the labels of the simulations as used in Table 1, and elsewhere in the text

- Table 1: what does "scenario" (last line) mean?

- Section 3: Unless I misunderstand, the correlation coefficient diagnostic used to eval-

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uate model fit to observations does not provide information about model bias (i.e. deviation from the 1:1 line). If this is the case please consider complementing it with another metric such as the (normalized) root mean square error.

- Fig 2. This graph is somewhat unclear. There's quite a few lines and the shading overlaps. I would suggest to replace the lines with bar graphs with errorbars for selected years. Also, I personally think an anomaly graph, i.e. the change in soil C relative to a specific year, is more informative than the rate of sequestration. However, I understand that this would complicate the comparison with the Stockmann et al. data.

- Section 3.2: The (long term) response of C sequestration to management options is much lower than wat is reported by Stockmann et al. However, this is not mentioned in the text nor could I find a discussion on this in section 4.

- p 1064, l 5-10: this is a quite remarkable result since croplands generally have lower soil C. I did not see this clearly discussed in the section 4 though. Further, could this also be related to the fact that the land use conversion in the simulations started only on 1750, thereby not giving the soil C in croplands enough time to decrease?

- Section 4: only three functional types are used to represent the full global spectrum of crops. I understand this was a necessary simplification but it likely adds considerable uncertainty to the results. However, it is not mentioned in the discussion. I'm sure it's possible to say something about the crops and regions for which this may lead to incorrect results (rice comes to mind).

- Section 4.1.1: could the low predicted response of C sequestration to management also be caused by the fact that soil C in croplands is over estimated due to the short period of land use conversion?

- p 1066, l 23-25: please consider revising this sentence

- p 1067, l 6-8: this sentence is difficult to follow. Please consider revising.

- Appendix: please include units of the allocation variables, and explain the DS

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acronym

Technical corrections

- In many places citations are completely (authors + year) enclosed in parentheses where only the year should be enclosed. I suspect that the authors used latex and wrote "`\citep{}`" where "`\citet{}`" was intended.
- p 1061, l 13: I assume you mean "Table 1" rather than "Table 2.1.1"
- p 1063, l 18: consider replacing "over" with "for" in "competition over available N"
- p 1064, l 12: please insert "in" before "1996-2005", or similar modification
- Table 4, caption: please remove comma in "Also listed are,"
- Fig 2, caption: do you mean "vertical", instead of "horizontal"?
- Fig 5, caption: consider replacing "on" with "of" in "response on"
- Table A2, caption: replace "atages" with "stages"

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