Interactive comment on "SOC sequestration potentials for agricultural management practices under climate change" by Herzfeld et al. (2021)

Dear Editor and Referee,

We would like to thank the anonymous referee for the valuable and constructive comments that will help to improve the manuscript. In the following, we will address all the comments by referee #1 and respond to these. Line numbers in our response refer to the marked-up version of the manuscript, which we will upload as soon as the option is available.

Referee #1:

Preface: The manuscript describes a modelling study to analyse historical and future fluxes of soil organic carbon and its sequestration potential on global croplands. The authors describe in detail the various simulation steps to calculate historical SOC stocks and projected SOC changes under different management and climate scenarios. The estimated SOC stocks are compared to previous estimates. Model results are sensitive to assumptions about different amounts of residue remaining in the field, while different tillage and climate change scenarios have a small impact on estimated SOC stocks. The authors reach the conclusion that carbon sequestration potential as a climate change mitigation strategy is low and that SOC stocks are mainly declining by the end of the century. This article is of high scientific value and I recommend it for publication without any substantial revision. In general, this manuscript is well written and simple enough to understand. I have noticed some model input values whose origin I do not understand. It would improve the understanding of the model if the following were more clearly explained.

Response to preface: Thank you for the positive response to the manuscript and for suggesting it for publication after some edits and clarification.

Referee comment 1: Line 82-83 – What is the 40/60 ratio based on that determines how much C is released into the soil or emitted into the atmosphere?

Response to comment 1: This is a standard model assumption in LPJmL, originally set to 30/70 by Sitch et al. (2003) and changed to 40/60 when the nitrogen cycle was introduced (von Bloh et al. 2018). We have added the reference accordingly to line 99.

Referee comment 2: Line 87 – Similar to above, where does the 50% come from?

Response to comment 2: As the sentence states, this is an assumption made. Manure composition is highly variable across animal type, feed, storage, and treatment. Van Kessel and Reeves (2002) report 0.9 to 9.5 kg total N m^{-3} and 0.3 to 4.7 kg NH_4-N m^{-3} across different dairy manure types, which in principle supports a 50/50 split. In the model, the organic manure N in the litter pool quickly decomposes to NH_4 and this parameter is thus not too important for plant N availability or N losses. We have added a short sentence and the reference in the main text in lines 104-107.

Referee comment 3: Line 156 – What does tillage intensity set to 0.9 mean?

Response to comment 3: Thank you for pointing to this. This was falsely described as tillage intensity. It was meant to describe the mixing efficiency of tillage, which was set to 0.9. The tillage intensity in the model is a combination of tillage efficiency and mixing efficiency, as described in Lutz et al. (2019). A mixing efficiency for tillage management of 0.9 represents a full inversion tillage practice, also known as conventional tillage, as described in White et al. (2010).
We have now edited this section in the manuscript and briefly describe tillage efficiency and mixing efficiency and refer to Lutz et al. (2019) in lines 178-183.

Referee comment 4: Line 300 – “a third” instead of 1/3

Response to comment 4: We have changed this in the manuscript.

Referee comment 5: Finally, spelling out the management scenarios in the text would improve readability rather than using the abbreviations (T_NR, NT_NR, etc.), although I understand that this can be handled according to personal preference. In addition, spelling out the management scenarios in Table 3 would save time for the reader who may not have the abbreviations in mind.

Response to comment 5: For better readability, we have spelled out most of the abbreviations in the updated manuscript, as well as in Table 3.

References:

Lutz, F., Herzfeld, T., Heinke, J., Rolinski, S., Schaphoff, S., Bloh, W. von, Stoorvogel, J. J., and Müller, C.: Simulating the effect of tillage practices with the global ecosystem model LPJmL (version 5.0-tillage), 12, 2419–2440, https://doi.org/10.5194/gmd-12-2419-2019, 2019.

Van Kessel, J. and Reeves, J.: Nitrogen mineralization potential of dairy manures and its relationship to composition, Biol Fertil Soils, 36, 118–123, https://doi.org/10.1007/s00374-002-0516-y, 2002.

White, J. W., Jones, J. W., Porter, C., McMaster, G. S., and Sommer, R.: Issues of spatial and temporal scale in modeling the effects of field operations on soil properties, 10, 279–299, https://doi.org/10.1007/s12351-009-0067-1, 2010.