Earth Syst. Dynam. Discuss., referee comment RC2
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Comment on esd-2021-35

Anonymous Referee #2

Referee comment on "Soil organic carbon dynamics from agricultural management practices under climate change" by Tobias Herzfeld et al., Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2021-35-RC2, 2021

This manuscript used a processed-based model to simulate the cropland SOC stocks change historically and in the future under different climate scenarios. The historical simulations of global and cropland SOC stocks are comparable with previous studies. The future projections with various agricultural practices show that residue management has a greater impact on SOC stocks as compared to tillage. This study provides important insight on preferred management to maximize cropland SOC storage under climate change. My main concern is that the future simulations did not include the impact of irrigation. Besides increasing temperature and CO2, climate change also has a strong impact on regional precipitation, in turn, the soil moisture and vapor pressure deficit. Studies have shown that soil moisture has a strong impact on the global carbon cycle (e.g. Humphrey, V., et al. (2021). "Soil moisture-atmosphere feedback dominates land carbon uptake variability." Nature 592(7852): 65-69.). In this study, the authors only mentioned croplands were separated into the irrigated and rain-fed areas in the historical simulations (lines 122-124). Did the future simulations use the same irrigation management as the year 2015? Can the authors at least clarify their method of determination of the irrigated and rain-fed areas and add discussion on the impact of irrigation practice and its interaction with other managements on cropland SOC stocks. I look forward to reading a revised version of this manuscript.

Specific comments:
1. The “SOC sequestration potential” in the title seems to be misleading. Sequestration indicates SOC accumulation even under climate change as long as we use proper management. However, the results of this study show that the global SOC stocks decrease under all climate scenarios and management. I think using something like “SOC stock dynamics” is more appropriate.
2. The impact of various agriculture practices, such as residue management, tilling, and irrigation should be described in the introduction to set up for the results and discussion.
3. Line 115: the potential natural vegetation data need a reference.
4. Line 237-238: this description of h_dLU_area05 is quite confusing. Can the authors describe this scenario in the method?
5. Line 240 - 243: the h_dLU_area05 scenario described here is more clear, but it still

should be described in the method and be listed as one of the scenarios in Table 1, because it is related to the main conclusion that cropland SOC stock decrease over history.

6. Line 248 - 249: this sentence needs some editing. Did the authors mean the calculation of the actual decrease in SOC stocks from LUC considered areas that were converted to cropland at any time over the entire period (1700-2018)?

7. Line 272: what lead to the sudden jump of SOC, turnover rate, and litterfall between 2000 and 2005 in all management scenarios?

8. Line 379-382: the mechanism of SOC forming should be better described and referenced here. The number of residues that can be retained on cropland also depends on both the quantity and quality of residues. The priming effect is not always positive. Since the authors discussed the compensating effect of higher productivity and turnover rates in the following paragraph, the effect of temperature on organic matter decomposition should be described here to set up the following discussion.