SOIL Discussions

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Comment on soil-2021-73

Anonymous Referee #3

Referee comment on "Additional soil organic carbon storage potential in global croplands" by José Padarian et al., SOIL Discuss., https://doi.org/10.5194/soil-2021-73-RC3, 2021

soil-2021-73
The manuscript addresses the potential of organic carbon storage in soils with respect to climate change mitigation. In particular, the effects of management practices are examined in a global study.

I have fundamental problems with the approach taken and the lack of any kind of validation.

Carbon sequestration in agroecosystems appears to be a significant way to offset some anthropogenic CO2 emissions, and no-till is generally considered an efficient and essential component for sequestering SOC. However, data comparing no-till and full tillage show large uncertainties, and not all studies found that SOC levels increased following a change in management to no-till. While there may be a significant change in C distribution in the soil profile, this does not necessarily translate into an increase in total SOC.

Since the most important management factor appears to have a limited impact, the hypothesis of this study is generally in question. So the main question is what management practices are we talking about that would result in significant SOC storage. I am assuming that what we are seeing are the effects of potential natural land cover, not the effects of human land use.

In this regard, land use history is also a very important factor. This is probably the most difficult part of the equation. It is likely to have a greater influence compared to changes in analytical methods over time. A common problem with global studies and modeling is spatial resolution. Land use and its history often vary on very fine scales, which cannot be accounted for with low resolution spatial data.

One factor controlling SOC distribution is soil erosion. Countermeasures may well cause SOC to accumulate in the soil. Colluvial soil can also store a lot of SOC. Estimates put the resulting global storage at 78 Pg C. Such effects are not considered in this study because neither terrain characteristics, soil properties, nor parent material are accounted for in the models.

That said, the results of the SHAP analysis become clearer at the 75th and 90th percentiles. This may indeed indicate some effect of management practices, but also the general potential to develop higher SOC levels in some terrain positions, as evidenced by the increase in importance of low elevations. Again, this may be an effect of small-scale (lower elevation) terrain and soil variability - rather than management practices.

All analyses and results are relatively worthless if they are not validated. And here, no validation of the hypothesis and no validation statistics for the modeling are presented. Therefore, the result is relatively meaningless.

The consideration of climate change impacts is generally a good point and the results (based on the hypothesis) are interesting. However, the steady state assumptions used as the basis for the space-time substitution are problematic, especially for cropland. The authors should consider discussing this in a separate publication when the hypothesis is better justified, explained, and validated.

Since the hypothesis is overly simplistic and the results obtained are most likely as uncertain as previous approaches, I am not sure it adds much to the discussion, which is thus rather counterproductive given the urgency of the problem.

References:
https://doi.org/10.1038/s41598-019-47861-7
https://doi.org/10.1016/j.still.2008.05.010
https://doi.org/10.1038/nclimate3263
https://doi.org/10.1016/j.agee.2010.08.006

Specific questions and comments:
The title and the abstract are not very clear.
Is it a "Quantile CNN model" as in the heading of section 2.2 or a "Quantile DL model"?
If I understand correctly, the global predictions are made based on cropland/pasture data only. The calculated SOC totals seem to be based on the global models. Here, however, at least the current forest areas would have to be removed, because otherwise the global storage capacity would be overestimated.