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Interactive comment on "Field-warmed soil carbon changes imply high 21st century modeled uncertainty" *by* Katherine Todd-Brown et al.

Anonymous Referee #5

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This study was unusual in using a Q10 function derived from changes in soil C pools to model C fluxes. As such, it was a novel contrast with- and useful comparison to earlier studies based on respiration metrics. The modeling rationale is solid and the simplification of the various model formulations to aggregated responses was reasonable. Overall, I'm impressed with the logic and thoroughness of this study.

This work is important for a several reasons. First, it uses a novel derivation of Q10 to address the important topic of soil C dynamics. Second, the reduction in structural complexity of several different models demonstrated how such aggregations could be done comparably and generated a range of predictions based on existing ESMs. Finally, it suggested that more attention to underlying uncertainties in factors controlling C dynamics might improve outcomes – perhaps as a logical alternative to broad data

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integration projects.

Regardless of the novelty of this study, the variation associated with the final output is so large that mean estimates of soil C are not different from earlier work, considering the 95% CIs. This simple fact shifts the main focus from differences between these estimates to their similarities, and as the authors noted, reasons why the variation is so large.

The authors raise several points about their underlying assumptions, some also raised by reviewers, noting that uncertainties in soil C stock data, moisture variations, the assumption of steady-state C pool dynamics, uniform temperature sensitivity of various C pools, nutrient limitations, etc., likely all contribute to variations in prediction. Moreover, aggregations across time, space, and structural resolution of both the models and C pools sacrifice fine scale dynamics that are often non-linear and cannot be averaged across coarser scales, e.g., moisture responses of dry-land systems. So, it's not surprising that the variation in output was large.

I recommend publishing this article but given the large uncertainty in final predictions, I also recommend a more thorough discussion of the limitations of such broad scale approaches. I'd like to hear more from the authors about how different sources of variation could be elucidated and addressed to improve model performance.

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