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Interactive comment on "Examining the sensitivity of the terrestrial carbon cycle to the expression of El Niño" *by* Lina Teckentrup et al.

Anonymous Referee #3

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Thank you for inviting me to review paper "Examining the sensitivity of the terrestrial carbon cycle to the expression of ElNino" by Teckentrup et al.

First, may I apologise for taking longer than the expected four weeks to return the review. I realise it can be unfair on the authors to have the Comments section closed, and then another further review appears. For that reason, I have tried to make the review a "light touch", and predominantly suggestions for better framing of the analysis in the future work part.

Possibly the most refreshing feature of this paper is that it actually has the confidence to present a "negative result". That is, for the processes investigated by factorial methods, these are likely to have a size that is relatively small compared to the overall impacts of on-going background climate change caused by fossil fuel burning. That is, though,

still really important to know, and it does not diminish from the paper.

However, by presenting the findings as unimportant also feels like a disservice to the paper findings? As so much recent research into the climate system illustrates, the simultaneous interannual variability of Earth System components does reveal much about potential long-term changes under global warming. Indeed the entire Emergent Constraint concept is based on such an approach. Hence, when placed in that context, the quite specific findings of this analysis become particularly important. I would encourage the authors to at least consider talking about this in the Future Directions part of the manuscript. When parts of ENSO are in a particular phase, what does it tell us about the terrestrial carbon store response, should general climate warming be in that state in a persistent way?

In the "Future Directions", the authors note that a more formal use of multiple DGVMs will help. The paper does not consider future projections, and it would certainly be interesting to see Figure 2d,e,f extended under the CMIP5/6 ensemble, maybe in a follow-on paper. Assessment of future findings will also have to be related to how well individual ESMs performing in projecting ENSO characteristics. The authors could also provide a couple of sentences on how others might be encouraged by this analysis to use data to assess the carbon cycle components of their analyses. Datasets do exist of the carbon cycle components, and for instance of NPP ("MODIS NPP"?). While some gridded datasets of terrestrial carbon do contain aspects of models in them e.g. to disaggregate from point to all locations, they still remain highly useful guides and are still "measurements" as such. What would comparisons show between the model-based findings of this paper and terrestrial carbon cycling measurements? The authors could then discuss in a short paragraph how data can constrain which aspects of land surface responses are performing well, and where there are deficiencies. Once constrained, the implications under future climates can be characterised. Although ecosystem acclimation effects might have to be accounted for, this would still offer an extra way to use current interannual variability to tell us about climate impacts. That

is the variations might tell us terrestrial carbon cycle response under a permanently adjusted near-surface climatic state. This paper provides a framework of which ENSO "expressions" to focus on, on the path to constraining future projections of land carbon cycle change.

The paper includes a particularly good introduction, and the broad literature search is undertaken well, capturing all the main recent papers on ENSO-Carbon cycle teleconnections.

I am happy to see any new paper version, and I will try and return any further comments much more promptly.

Small things

The word "expression" is used quite a bit e.g. in the discussion of the Central-Pacific and Eastern-Pacific features of ElNino. "Attributes" or "features" may be better words?

Can the diagrams could be tidied up a little more? To my eyes at least, some of the features of – for instance – Figure 2 are difficult to see. Slightly thicker curve linewidths might help, and without obscuring each other.

A better use of the colourbars would help in Figure B1 for instance, to understand better the geographical spread. To achieve this could be by including colour steps that are not all of identical amounts. Clustering of some colour bounds more around the zero value will reveal more information in the maps?

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