

## ***Interactive comment on “Pathway dependence of ecosystem responses in China to 1.5 °C global warming” by Xu Yue et al.***

**Anonymous Referee #2**

Received and published: 27 November 2019

Anonymous Review of Yue et al., “Pathway dependence of ecosystem responses. . .”

In this manuscript, the authors use the YIBs model to simulate ecosystem productivity under two pathways to 1.5 C warming: and ensemble based on RCP2.6 and an ensemble based on RCP8.5. Overall, the 1.5 C warming is delayed by ~30 years in RCP2.6, and results in weaker carbon sink overall on this pathway to 1.5 C. But the authors demonstrate that reductions air pollution emissions from RCP2.6 (resulting in increased light availability and decrease surface O<sub>3</sub>) is better for land carbon uptake compared to RCP8.5. The slower warming scenario from RCP2.6 increases the allowable anthropogenic carbon emissions.

This is a very interesting study that replaces the more familiar “temporal” domain for a “temperature” domain. This results in some initial awkwardness, since the different

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carbon sinks are not being compared at/over equivalent time periods, but the authors make a clear argument in their introduction for why they have chosen this approach, and why this experiment is a useful exercise. In general, I think some points of clarification would help this manuscript, as I outline below. Overall, this is a sound and novel study with results that should be of interest to the ACP audience.

First, I would encourage the authors to explicitly describe how they have calculated NEE. While it is an obvious term to some, many of the readers in ACP may not find it as intuitive. If I have interpreted the authors work correctly (e.g. Figure 4 and its discussion), it seems like NEE is being calculated here as:  $NEE = - [GPP - Reco]$ , where the authors have taken the convention that a negative NEE means a net carbon sink. I’m not sure why this equation isn’t explicitly included somewhere, even if it might seem obvious. Actually, I couldn’t find where the authors even define the abbreviation “NEE” (presumably “net ecosystem exchange”). Nor would I necessarily even expect ACP readers to be so well acquainted with the term “gross primary production” that this doesn’t require an explanation/definition.

Without these definitions being explicitly laid out, things are in danger of becoming a bit unclear. For example, it might not be immediately obvious whether an “enhancement” in NEE is referring to a “more negative” value (and therefore a “stronger sink”). We run into confusing instances such as that found in Line 316, referring to an “enhancement” in NEE of “0.03 Pg”, which is somehow equivalent to a “-17%” difference. How can it be a simultaneously positive and negative difference, unless we know that enhancement refers to a more negative value? These instances could just use some clarification.

This clarification is especially important when the authors eventually start taking the differences in “NEE” between the two different pathways, further exacerbating the importance of keeping track of the sign convention. It isn’t immediately obvious whether the authors are taking the difference of two negative numbers (E.g.  $(-1.5 - [-2]) = 0.5$ ), or whether they are comparing absolute NEE values (i.e. so that in the hypothetical example above,  $(1.5 - 2) = -0.5$ ). The choice is important since these deltas have

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opposite meanings! It is also possible I have misinterpreted the authors' approach. I encourage the authors to explicitly define all conventions, and repeat them appropriately, to help guide the reader.

Nevertheless, despite some of this awkwardness, I suppose the implications of the results are usually clear to the reader: E.g. improvements in air quality result in more light availability and less ozone damage, which in turn drives a "better" land carbon uptake. (I would still encourage the authors to use clearer language than "better", see Line 399.)

Specific comments:

Line 107: "We further remove..." Why is the word "further" here? Have the authors removed some models based on other criteria that weren't mentioned above?

Line 138-139: "...apply the same protocols for anthropogenic and biomass burning emissions..." What do the authors mean by "same protocols?" Please be specific.

Line 141-142: I'm curious about the approach used to account for the temporal gaps in O3 in the various ACCMIP models. The authors state they fill gaps using a linear fitting approach. Does this ignore seasonality? Or is it accounted for? This also means that Figure 3b is a bit misleading, since the ozone concentrations at some of these timeslices were not actually from any model output at all, but from a very simple interpolation that might not capture multi-decade variability. For example, around the 2060 time slice of Figure 3b, I only see a couple of models in Table S3 that would actually have real output for this time slice. Most go from around 2030 to around 2090. It seems to me that drawing a straight line between two time slices that are 70 years apart is a bit dubious, even if it doesn't change the direction of the overall conclusions. I think this limitation could be more explicitly mentioned/discussed. [Also: I see there must be a typo in the first row of Table S3, which says "2100-2019".]

Line 284: "The YIBs simulations show variabilities of..." It wasn't immediately clear to

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me what the authors meant by "variabilities". It looks like they are referring to the full range of results from each YIBs ensemble?

Line 334-340: I would have liked to see a more detailed discussion on the role of changes in ecosystem respiration on the difference in NEE between the two periods for each pathway. I had to spend a lot of time with Figure 6b to wrap my head around the "net" difference between "net ecosystem exchange" at two different times, and how GPP and Reco must each play a role in this separately.

Figure 4: I wondered about also showing the YIBs future projections timeseries in this plot (or somewhere in the Supplemental material). I understand that the focus of this paper is in "temperature" space, instead of "temporal" space, but I just kept wondering what the projections actually looked like in the more familiar time x-axis. Obviously the RCP8.5 line would end earlier than the RCP2.6 line, but this might actually help clarify other points in the paper.

Figure 6: Should there be "delta" signs in the Y-axis label of these panels? This was a source of initial confusion for me.

Figure 8: Here the signs could potentially be confusing again (in this case, positive refers to a land sink), although I guess the meaning is clear overall. It just doesn't seem consistent with the choices elsewhere in the paper. Also, I would encourage panel b to include the word "net" somewhere, although perhaps this implicit in the word "accumulated" and would just add to the confusion?

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Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2019-641>, 2019.

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