

## Reviewer 2

Climate model analyses have been limited to some extent by the scenarios used in projects such as CMIP6 and this study seeks to provide a framework for filling in some of the gaps left by the set of scenarios that exist. The authors perform a comprehensive evaluation of their framework primarily focussed on global mean temperatures and demonstrate its potential utility.

This study addresses an important issue and is a major contribution to the field. I only have minor comments for the authors to consider which I list below. I will admit that it took me a while to understand the methodology which isn't to fault the explanation given here, but I would suggest that the authors carefully read through the manuscript with a view to making the framework more easily understood where possible.

Thank you for the positive reaction, and we will definitely work on improving the readability, mindful of Reviewer 3's comments as well.

Minor comments:

L62-64: I agree that the SSP-RCPs span a range of forcings that probably covers the real-world outcome over this century but I think this sentence sounds a bit over-confident and could be dialled back a touch as "exhaustive" seems too strong a descriptor.

We have rephrased that as "well representative".

L71: Could also cite (Hawkins and Sutton 2009) as the paper where the method used in Lehner et al. originates.

We have added the citation.

L98: The focus on "transient" warming levels is introduced rather abruptly and I suspect the significance of this point may not be obvious to some readers. Perhaps a sentence or two explaining this could help. Papers that may be of use for an explanation include (Manabe et al. 1991; King et al. 2020; Callahan et al. 2021).

Thank you for the useful pointers. We have added a few words and the two more general studies as citations:

Here we extend this approach, which only produced isolated time windows, to the construction of entire transient scenarios, i.e., *a trajectory of greenhouse gases and other*

*anthropogenic forcings evolving continuously over the 21st century*—\citep{Manabeetal1991,Kingetal2020}.

L127: “dimension” should be “dimensions”

Thank you, corrected.

Figure 1: It might be worth reminding the reader either in the plot or caption that this is global mean temperature.

It is now specified (twice) in the caption, thank you for the suggestion.

L227-228: Technically there is a lower bound of the level of global warming at the start of the simulations too presumably.

Yes, also in accordance to the discussion of Reviewer 1’s comment we have more clearly described the range of applicability for STITCHES, considering the lower end challenge as well as the higher end, and overshoots and stabilization pathways.

L259: “do” should be “does”

Thank you, corrected.

L387-388: This sentence needs to be rewritten.

It now reads: In this case STITCHES is significantly challenged, and its performance *as measured by the  $E_r$  metric significantly diminished*.

L473-475: Remove “If” before “ENSO” and add “but” before “there exist”.

Thank you, corrected.

L501: “haven’t” should be “have not”

Thank you, corrected.

## References

Callahan, C. W., C. Chen, M. Rugenstein, J. Bloch-Johnson, S. Yang, and E. J. Moyer, 2021: Robust decrease in El Niño/Southern Oscillation amplitude under long-term warming. *Nat. Clim. Chang.* 2021 119, **11**, 752–757, <https://doi.org/10.1038/s41558-021-01099-2>.

Hawkins, E., and R. Sutton, 2009: The potential to narrow uncertainty in regional climate predictions. *Bull. Am. Meteorol. Soc.*, **90**, 1095–1107, <https://doi.org/10.1175/2009BAMS2607.1>.

King, A. D., T. P. Lane, B. J. Henley, and J. R. Brown, 2020: Global and regional impacts differ between transient and equilibrium warmer worlds. *Nat. Clim. Chang.*, **10**, 42–47, <https://doi.org/10.1038/s41558-019-0658-7>.

Manabe, S., R. J. Stouffer, M. J. Spelman, and K. Bryan, 1991: Transient Responses of a Coupled Ocean–Atmosphere Model to Gradual Changes of Atmospheric CO<sub>2</sub>. Part I. Annual Mean Response. *J. Clim.*, **4**, 785–818, [https://doi.org/10.1175/1520-0442\(1991\)004<0785:TROACO>2.0.CO;2](https://doi.org/10.1175/1520-0442(1991)004<0785:TROACO>2.0.CO;2).