Climate of the Past Discussions

Clim. Past Discuss., referee comment RC2
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Comment on cp-2022-52

Anonymous Referee #2

Referee comment on "Causes of the weak emergent constraint on climate sensitivity at the Last Glacial Maximum" by Martin Renoult et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2022-52-RC2, 2022

Review of "Causes of the weak emergent constraint on climate sensitivity at the Last Glacial Maximum" by Martin Renoult and coauthors for Clim. Past

Summary

Renoult and coauthors examine the potential for constraining the equilibrium climate sensitivity (ECS) from Last Glacial Maximum and Pliocene in different PMIP generations, radiative perturbation experiments, and perturbed parameter ensembles of two climate models. They find that extratropical processes are largely responsible for the inter-model spread (e.g., sea-ice and ice sheet forcing), and they conclude that the strength of emergent constraints could be improved by including models with higher and lower ECS.

Recommendation

In general the paper is well written, thought through and timely. Assuming the comments below are addressed I would recommend acceptance after minor revisions.

General comments

- Generally the text reads well, but the flow and structure can be improved. The paper is quite long (the draft has 55 pages!), and the introduction does not place the sections well into context. The different datasets are dropped in without much context. After "1 introduction" comes "2 methodological consideration", "3 regional correlations", "4 Investigation of LGM climate physics", "5 Comparison of the sources of noise" "6 Statistical view on outlier models and generational issues", " 7 Prospects from single-model ensembles" and finally "8 Conclusions", the text meandering along and surprising with nice graphics and well thought-out sections. Please condense structurally and provide more overview in the beginning.

- Enhance the discussion on limitations. Given that one aim is to "provide a framework for future development of palaeo-emergent constraints" a brief discussion (or at least acknowledgement) of the data/model setup based limitations should be included. One can wonder to what extent ECS is a useful metric in palaeoclimate, given that the system is rarely in equilibrium. The Earth system at beyond-millennial timescales is evolving and feedbacks act across timescales which cannot (yet) be considered with PMIP models. The distinction between "Earth System Sensitivity" and "Climate sensitivity" is not explicitly made, yet it is shown that ice sheet forcing contributes substantially to the radiative forcing and sensitivity.

- Pliocene/LGM. Given that the LGM is in the title, once conclusion is that the Pliocene may be a better target to derive emergent constraints. So perhaps the title is not appropriate, and the framing should be adjusted.

Detailed comments

- p2 l32: last ice age --> correct to last Glacial period (we are still in an ice age)
- correct citation Rohlin et al., 2012 should be PALAEOSENS Project Members. 2012.
- Table 7 there are no parentheses (or rather, only two lonely ones)

References

ESS: Lunt, D. J. et al. Earth system sensitivity inferred from Pliocene modelling and data. *Nature Geosci.* **3**, 60–64 (2010);
PALAEOSENS Project Members. Making sense of palaeoclimate sensitivity. *Nature* **491**, 683–691 (2012). https://doi.org/10.1038/nature11574 (incorrectly cited as Rohling et al. 2012)