

Review of “South Pacific Subtropical High form the late Holocene to the end of the 21st century: insights from climate proxies and general circulation models” by Flores-Aqueveque et al.

This study investigates changes in the South Pacific subtropical high (SPSH) using paleoclimate records, climate model simulations and ERA-Interim reanalysis data. The study is generally well designed and the methods and results are clearly described. The results are of relevance for understanding drivers of Southern Hemisphere circulation change, and evaluating model responses in past and future climates. I recommend publication subject to minor revisions as outlined below.

General Comments:

1. I am concerned about the use of such a small sample of models (4 models) to draw conclusions about changes in the SPSH. I cannot see why the authors could not use at least 6-8 models that have Last Millennium simulations, even excluding non-CMIP5 models HadCM3 and CSIRO Mk3L.
2. When comparing models for LIA, CWP and RCP8.5, it may not be informative to consider only the multi-model mean. If there is large model disagreement, the model mean change does not represent the changes of each model. Instead, calculating changes in a given variable for each model and then comparing these, e.g. using a scatter plot or box and whisker plot, may be more informative. The model spread also provides a measure of uncertainty. (See also specific comment for page 13 below).
3. The model evaluation compared with observations or reanalysis should be included earlier in the paper as it provides the justification for using the models to examine past and future climate. That is, swap the order of section 3.2 and 3.3. Then include a few sentences at the end of the model evaluation section about the strengths and weaknesses of models (also add a figure comparing observations and model climatologies).

Specific Comments:

Page 3, Section 1.1: It would be helpful to include a Figure or schematic showing the regional climatological circulation in austral summer and winter.

Page 3, line 12: “exceeding 45S” – does this mean extending poleward of 45S? It is not clear.

Page 4, line 25-28: There is reasonable evidence of a period of synchronous cooling between Northern and Southern Hemispheres, although this does not imply that the signal is synchronous on a regional scale. For example, Neukom et al. (2014) state that “simultaneous cold anomalies in both hemispheres are identified between 1571 and 1722”. Perhaps provide some qualification here, or explain the difference between Southern Hemisphere and South American scale responses.

Page 5, line 19: Why did you only use 4 CMIP5/PMIP3 models when there are many more (8+) models available with the required simulations? You should comment on the limitation of relying on such a small number of models.

Page 6, line 21: You could also cite the new PAGES2K study here (PAGES2K Consortium, *Nature Geosciences*, 2019).

Page 8, line 12: I am not sure what is meant by “increment”

Page 10, line 5: How can SLP fields move poleward?

Page 11, line 33: Do you mean the 4 models evaluated in this study, or a larger sample of CMIP models?

Page 12, line 18: “long-term trends”: do you mean spurious (incorrect) long term trends, or actual anthropogenic climate change trends?

Page 12, line 27: Denniston et al. (2016) is a study of the ITCZ in the Indo-Pacific region, so the position of the ITCZ in that study is not directly relevant to the ITCZ over South America.

Page 13, line 8 onwards: the lack of signal in the LIA and CWP comparison based on models may be due to model disagreement. If you are comparing the multi-model mean values only, you may be smoothing out changes in individual models. An alternative way to show the changes might be a scatter plot or box and whisker plot of changes for each individual model (for example, change in location of ITCZ or Hadley Cell edge versus area average change in precipitation). This would be even more informative if more than 4 models were used.

Page 15, line 1-5: How do the model biases impact on the simulated changes in past and future climate? Do they reduce confidence in the results?

Page 15, line 23: You could also comment on the need to improve model performance in the simulation of Southern Hemisphere circulation to provide more robust projections.

Figure 2: I found it difficult to distinguish the red and magenta lines. Perhaps use different colors?

Figure 3: These plots are quite small with very small labels and legends. It is also hard to see the overplotted contour lines. I suggest plotting the zonal mean precipitation and winds in a separate set of plots to make it easier to see (there should be space for more figures as the paper currently only has 4 figures).

Figure 4: In this study, you do not find a shift in the Atlantic ITCZ and find a southward shift in the Pacific ITCZ as temperatures increase (according to line page 15, lines 15-20) so I am not sure why the ITCZ is plotted south in both sectors during LIA compared with CWP?

Supplementary Figure 1: The green and magenta lines appear to be in the same location?

Supplementary Figure 2: The ERA-Interim climatology and the model climatology should be given in the main paper as this is an important part of evaluating model skill. Also, what are the stars? Also, the austral summer and winter lines appear to be swapped or wrongly labelled.

Technical Corrections:

Page 2, line 9: replace “interplays” with “interplay”

Page 2, line 16: replace “During last decades” with “During recent decades”

Page 2, line 25: delete “derived”

Page 3, line 6: replace “these evidences” with “this evidence”

Page 3, line 25: replace “to higher probability” with “with higher probability”

Page 5, line 2: replace “associated to” with “associated with” (and elsewhere)

Page 5, line 5: at the end of this line, I think “LM” is meant to be “LIA”?

Page 5, line 10: replace “several” with “numerous” or “many”

Page 5, line 12: replace “uniform period...” with “period of uniformly positive temperature trends” for clarity.

Page 6, line 6: replace “spanning time” with “time period”

Page 13, line 24: this sentence is unclear.

Page 15, line 12: figure 5 is actually figure 4.

References: Please indent or add space between references to separate.

References:

PAGES2K Consortium (2019), Consistent multidecadal variability in global temperature reconstructions and simulations over the Common Era, *Nature Geosciences*, 12, 643–649.