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Climate of the Past Discussions

Interactive comment on "Comparison of past and future simulations of ENSO in CMIP5/PMIP3 and CMIP6/PMIP4 models" *by* Josephine R. Brown et al.

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General response: We thank the reviewer for their thorough analysis of our research.

Comment: Overall opinion: This is an interesting and well structured study. The results are well elaborated and convincing. My major concern is the presentation of some SST Figures, as relative SST highlights in many cases the relation between SST change and precipitation/atmospheric circulation changes much better (see major point). A more detailed discussion of the presented results to the changes in the Walker Circulation would also allow a deeper insight into the cause of the precipitation and ENSO amplitude changes. Response: We recognise that this work is predomi-

nantly descriptive which is unfortunately necessary given the large quantity of models and simulations being analysed here. We intend to include figures of changes in relative SST in a revised document, in addition to the existing figures of absolute SST change. We would prefer to leave evaluation of the changes in the Walker circulation for future studies as this is a substantial additional body of work that would greatly increase the size of the current manuscript.

Major comments:

Comment: Introduction: You don't say anything about ENSO in the Interglacial. Please add. Response: A revised manuscript will Include discussion of ENSO at the Last Interglacial, although there is not a large amount of research on the topic.

Comment: Fig. 1: As for the tropical circulation the relative SST reveals the relation to precipitation and atmospheric circulation much better, please show the relative SST bias in Fig. 1c-f) and give the area mean temperature in the header (Johnson and Xie 2010; Johnson and Kosaka 2016; Bayr et al. 2018; Izumo et al. 2019). Response: We will add an additional figure showing ensemble mean relative SST changes. We feel it is also important to include the absolute SST change, as they demonstrate the cooling/warming and therefore any Clausius-Clapeyron effects.

Comment: Fig. 6: As for Fig. 1 I would strongly suggest to show the relative SST change (and area mean SST change in the header), as this indicates the change in Walker Circulation (Bayr et al. 2014, 2020), which would be helpful to understand the precipitation change and ENSO amplitude change. Response: We will add an additional figure showing ensemble mean relative SST changes.

Comment: Further, the change of Walker Circulation under different global mean temperatures is partly driven by the overall (homogeneous) warming (weakening under warmer and strengthening under colder mean climate, (Held and Soden 2006; Vecchi et al. 2006; DiNezio et al. 2011) and partly by the inhomogeneous warming (depends on the change of the SST gradient, Bayr and Dommenget 2013; Bayr et al. 2014). The

best would be a more detailed analysis of the Walker Circulation changes to understand the ENSO amplitude change and precipitation change. But maybe you already get a clearer picture, when looking at the relative SST change. Response: As outlined above, we intend to include figures of changes in relative SST in a revised document. We would prefer to leave evaluation of the changes in the Walker circulation for future studies.

Comment: Fig. 8 & 9: can you please show the multi model ensemble mean for each subfigure and the spread around as box plot. Response: We will include the ensemble summary values in the bar charts, as this is a helpful addition.

Comment: Fig. 13: Please give the correlation values for each scatter plot. Response: We will include the correlation coefficient for the scatterplot figures.

Comment: Further, I suggest to also look on how the wind-SST feedback changes in the scenarios, as from my experience and the study of (Vijayeta and Dommenget 2018) the change in the wind-SST feedback explain a large part of ENSO amplitude change. The change in wind-SST feedback is strongly influenced by the change in the Walker Circulation (Bayr et al. 2018, 2020). Response: We would rather defer the analysis of the wind-SST feedback for future research which is planned on the Bjerknes Index.

Minor comments:

Comment: 75: mid-Holocene – please give the years BP. Response: This will be added.

Comment: 120: "was replaced by the Central Pacific-type El Niño" When? At the beginning of 21st century? Please make clearer. Response: This will be clarified.

Comment: 132: You should also cite here (Latif and Keenlyside 2009). Response: This will be added.

Comment: Fig. 1 & 2: What is the stippling? It is not mentioned in the figure caption. Response: The stippling will be defined in the Figure caption.

Comment: 255: "The Intertropical Convergence Zone (ITCZ) is generally shifted to the north". But also the rising branch of the Walker Circulation is shifted to the west (Bayr et al. 2018, 2020). This weakens the atmospheric feedbacks and hampers simulated ENSO dynamics. This should be discussed somewhere in the paper. Response: This will be added to the discussion.

Comment: 429: "must consist of several processes." An other explanation is the non-linear behavior of ENSO amplitude and SST gradient/thermocline slope as shown in Fig. 6 in (Hu et al. 2013). Response: This will be noted.

Comment: 460: "increase of the negative feedback by the mean current thermal advection" Another possible factor can be an increase of the negative heat flux damping as found in (Prigent et al. 2020) for the Atlantic Nino reduction since the year 2000. Response: This will be added.

Comment: 498: you should also mention here the bias ENSO dynamics due to the error compensation of the underestimated wind-SST and heat flux-SST feedback (Bayr et al. 2019) and weaker oceanic response (Kim et al. 2014). Response: This will be mentioned.

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