

## ***Interactive comment on “Simulation Improvements of ECHAM5-NEMO3.6 and ECHAM6-NEMO3.6 Coupled Models Compared to MPI-ESM and the Corresponding Physical Mechanisms” by Shu Gui et al.***

### **Anonymous Referee #2**

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Recommendation: Accept pending minor revisions

General comments: The authors compared two new GCMs (ECHAM5-NEMO3.6 and ECHAM6-NEMO3.6) to MPI-ESM (ECHAM6-MPIOM), showing improvements and differences in biases in each model.

The paper is well written and only has a few issues that I would hope the authors would address before publication.

1) The authors compared mostly the Pacific ocean and concentrated on tropical Pacific.

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One of the stark improvements lie in the North Atlantic, especially where the cold bias in the subpolar region seen in MPI-ESM has been ameliorated. It would be extremely beneficial for the community to discuss this too, and show how the AMOC may be different between these different CGCMs.

2) Changes in mean state from changing component model provide simple but necessary information. However, it would benefit readers and the community if more information such as variability of the system is assessed, such as variance of variables that the authors have covered, and maybe even power spectrum of ENSO and SAM.

3) Section 6.2: Please be aware that correlation does not indicate intensity or magnitude of relationship. Fig. 13 shows that shortwave radiation has a much larger magnitude and can thus possibly have a greater effect on SST even though it has a smaller correlation value compared to sensible heat and longwave radiation. This does not change the proposed mechanism, but SW radiation should be incorporated into the explanation.

4) Along the lines of pattern correlation being used to rank the importance of contributing factors. Since the region of focus is the Pacific, the pattern correlation should be performed over the Pacific rather than globally. This should not change the concluding results, but it may provide some differences in the correlation and add robustness to your estimates.

5) Please state significance test for pattern correlation, particularly how the effective degree of freedom is computed or decorrelation length scale used. Having a significance at 99.9% level for a correlation at 0.018 is hard to reckon with.

6) Page 6, line 13: Which year of external forcing (like CO<sub>2</sub>, greenhouse gases, aerosol, etc.) was used for the piControl run to obtain equilibrated state? Is this the same (similar) forcing as seen during observation period? If the piControl uses forcing that is quite different from observations (e.g. excess of 100ppm of CO<sub>2</sub>), then one would have to account for these differences when computing biases with respect to

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observations.

7) page 12, line 7-8: Rather than inferring the relationship, the authors can easily compute the pattern correlation and quantify the correlation.

Minor comments: 1) page 6, line 11: please provide the actual websites.

2) page 8, line 31-32: Been staring at Fig. 4 but am not able to see “positive precipitation bias over the southern tropical Atlantic and negative bias on tropical South America”. Maybe you meant “negative bias over southern tropical Atlantic and positive bias on tropical South America”? Please indicate which specific figures you are referring to. 3) page 8, line 32: “. . . seems related to each other, because the values and scales of biases in . . . “ Please explain, it is not obvious how this is the case.

4) Fig. 5: Please provide magnitude difference in surface wind stress in colour. This would make it easier for readers to see extent of anomalies. 5) page 9, line 15: Change “sea water to across” to “sea water across”

6) page 10, line 13: Change “it turns out that three CGCMs” to “it turns out that all three CGCMs”

7) page 11, line 11: Change “,” to “.” 8) page 11, line 31: Change “In consistence” to “Consistent”

9) page 13, line 3: Change “it can be assumed” to “it would suggest”

10) page 15, line 22: None of the CGCMs used on this paper resolved mesoscale processes, so the subsentence “depending on mesoscale processes in the atmospheric and oceanic systems” cannot be concluded from this study and should thus be omitted.

11) Please state units for Fig. 5, 6, 8, 9, 10, 11.

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