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Geoscientific Model Development Discussions

Interactive comment on "Influence of parallel computational uncertainty on simulations of the Coupled General Climate Model" *by* Z. Song et al.

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Response to Referee #2

(Note: referee comments in black and our reply in blue)

Comments

Comment: This paper addresses an interesting question on how the MPI may induce the uncertainty in the climate simulations. This issue could be potentially very important for climate studies. I find the results are useful but the analysis needs to be improved. I would recommend it for publication after addressing following issues.

Reply: We would like to express our sincere thanks to the referee for providing all

valuable comments and suggestions. These comments and suggestions help us much to improve this manuscript.

General Comments

1) Experimental design: is there any scientific basis for the experimental design? For me, the CPU numbers seem to be too small. People are using much more CPUs in the real simulations. I am curious about the dependence of uncertainties on the total number of CPUs, and if the conclusions are the same with more CPUs, e.g. 24, compared to the small 2-12 CPUs in this study. Also, nowdays very few people run GCMs without using MPI. A discussion on MPI and OpenMP would be more useful.

Reply: Thanks for the above suggestion. The parallel computational difference is due to the round-off error induced by the change in computation sequence when the "MPI_ALLREDUCE" is used in the integration. So the results should be independent on the total number of CPUs. We could design numerical experiments to mimic the round-off error by changing the CPUs configuration based on the state-of-the-art AOGCM of CCSM3.

2)The authors draw their main conclusions based on one model, one set of CPU configurations and two spatially averaged variables. The conclusions do not necessarily represent other GCMs and variables.

Reply: We agreed to the above comments. Firstly, round-off error has the influence on the GCMs simulation, but the impact of it on different GCMs may be different. Secondly, the number or years of ensemble mean used to average for reaching convergence of Global-SST and Nino-SST is not exactly consistent in Figs. 3 and 5, which suggests that the results and conclusions may depend on the variable, spatial average, location etc. Because SST is one of the most important parameters to measure the coupled system, in the present paper we just mainly focuses on SST. And other regions or variables such as precipitation and radiative flux will be analyzed in the future.

3)Generally, the analysis of all the figures needs to be improved, with more detailed and more quantitative descriptions.

Reply: Thanks. The manuscript was refined following the referee's comments.

Specific comments

1) Page 3296, Line7-9: Is this 15 universal? Be precise especially in the abstract.

Reply: Thanks. The abstract and conclusion section of the revised manuscript was changed following the referee's suggestion.

2) Page 3296, Line 26- page 3297, Line 7: This paragraph is kind of unnecessary. It could be removed or merged the first paragraph.

Reply: Thanks. Following the above suggestion, we reorganize the Introduction Section, and insert a new paragraph of the discussions on the source of parallel computational uncertainty.

3) Section 3.1, Page 3300, Line 12-20. How different are these 16 cases, quantitatively or statistically? The authors showed the figure and mentioned that the difference is due to parallel computational uncertainty, but we really need some quantitative measure to figure out how big the difference is.

Reply: Thanks. Actually, the maximum STD deviations of 16 cases can reach 0.07 and 0.9 °C for Global-SST and Nino-SST, respectively. Since it maybe confuse people between "standard deviation" and "the deviation" used in the manuscript, we deleted this sentence in last manuscripts.

4) Page 3301, Line 9-13: Same as comment 1, the ensemble number threshold of 15 is only for the two variables chosen in this study, i.e., the SSTs averaged over the large area (global, and Nino). Other physical parameters should have much higher uncertainties, I guess. Nonetheless, the authors cannot claim "... the ensemble mean number of 15 is enough ...".

Reply: We added a new paragraph in the Discussion section. In revised manuscript, the new paragraph "The present paper uses CCSM3 to show the influence of the parallel computational uncertainty on simulations of the coupled system. Although we believe that the results can be applied to other models, a future study needs to be confirmed that the results are model-independent. In addition, the present paper mainly focuses on global and Nino3.4 average SST, and other regions or variables such as precipitation and radiative flux need to be investigated in the future." is added in Section 4.

5) Figure 4: The spectra for Nino-SST cases are certainly much more disperse than the global case. Why same conclusion? More detailed discussions are needed.

Reply: Thanks. Although the spectra for Nino-SST cases are much more disperse, the main characteristics, the periods and power intensity are quite similar, and more details and accurate descriptions are added.

In the revised manuscript, the analysis sentences "It should be mentioned that 16 power spectrums for Nino-SST are not identical although their main characters are quite similar. Maybe, it is because the global mean SST is quite steady, while Nino-SST normally has quite large variability." is added to figure4 in Section 3.2.

6) Section 3.3: Same issue as mentioned earlier, the authors only looked at tow SSTs. This may not apply for the climatological mean of other variables.

Reply: Thanks. Since SST is one of the most important parameters to measure the coupled system, the present manuscript just mainly focuses on SST. And other regions or variables such as precipitation and radiative flux need to be analyzed in the future. We add the above information as a new paragraph in Discussion Section.

In the revised manuscript, "The present paper uses CCSM3 to show the influence of the parallel computational uncertainty on simulations of the coupled system. Although we believe that the results can be applied to other models, a future study needs to

be confirmed that the results are model-independent. In addition, the present paper mainly focuses on global and Nino3.4 average SST, and other regions or variables such as precipitation and radiative flux need to be investigated in the future." is added in the discussion section.

Interactive comment on Geosci. Model Dev. Discuss., 4, 3295, 2011.