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Geoscientific
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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 Short Comments by P.Jöckel

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

Comments

Comment: Some very important points, which need to be discussed, are missing:

1) An explanation or at least a summary, why the number of CPUs changes the results (on the same architecture!) is clearly required. Is it simply because MPI "all reduce" function are used? In this case it could be avoided.

Reply: Thank you very much for your valuable suggestion. According to the above suggestion, we insert one paragraph to discuss why the number of CPUs changes the model results in the Introduction. And we also reorganized the Introduction Section in order to express more clearly that the point of our research is the round-off error, not limited to the number of CPUs.

About the above question, in fact, it is indeed because of "MPI_ALLREDUCE". It arises out of the change in computation sequence when the "MPI_ALLREDUCE" is used in the model. Furthermore, the round-off error, which induced by the number of CPUs change, different compute system or computing environment etc., is the essence of model result difference. Although, the round-off error *change* due to "MPI_ALLREDUCE" could be avoided and the parallel model results keep consistent with the serial model, we cannot guarantee that the results of the serial model are more accurate than the results from the parallel model. Because the model results from serial model also contain influences of the round-off error. In addition, as we discussed above, the essence of the CPUs number change and different computing environment etc. is same, which is the round-off error, so 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) Other model system produce (on the same architecture!) binary identical results (for the same given initial and boundary conditions), independent on the degree of MPI parallelization. What is different here and could it be avoided? Is it not avoided, simply for the sake of a better run-time performance? If the latter is the case, on might ask the question: What is cheaper: the need to perform always (for each setup!) ensembles to assembles to assess the "implementation uncertainty" in addition to the desired "physically perturbed" ensembles, or to invest in a presumably slower setup which avoids the dependence of the results on the parallelization?

Reply: Firstly, to our knowledge, it indeed become slower after we modify the model to be independent on the degree of MPI parallelization, but the speed is not significantly

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slower. And as we discussed above, even the results of parallel model is the same with the serial model, it still does not mean the results are reliable, but only the effects of round-off error is hidden. So, it's hard to say which way is cheaper. Similarly, we also could not say the results simulated on one machine are more accurate than others. That's why we suggest diagnosing model results carefully. Of course, we need develop and setup some method to define and analyze the computational uncertainty more accurately in the future.

3) Why is there a need to modify the degree of MPI parallelization within the scope of a study (you mention this in the text as motivation)? Once the optimum decomposition is found for a given architecture, why can't it be kept?

Reply: The optimum decomposition is limited by the available computing resource. For instance, if only 100 CPUs are available, there is one optimum decomposition scheme. Meanwhile, if 200 CPUs are available, there may be another scheme. And the available computing resource may vary in integration, so we need to change the CPU configuration accordingly for continuing the task. Certainly, if there is always enough computing resource for running the model, we can keep the same decomposition scheme.

4) Do you expect different sensitivities (to the degree of the MPI parallelization) on different architectures?

Reply: Reply: Thanks for your suggestion. Actually, we have conducted similar numerical experiments. At first we compared the results simulated by IBM Power5 and HP Itanium2 when we ported the CCSM3 to HP Superdome (Fig. 1 in this comment). We noted that the difference between same architecture with different CPUs number (the degree of the MPI experiments on HP or IBM) or between different architectures with same CPUs number (same CPUs number experiment on HP and IBM) is quite similar (Fig. 1 in this comment). And the essence of them is the same, so we believe the conclusions are consistent with each other.

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

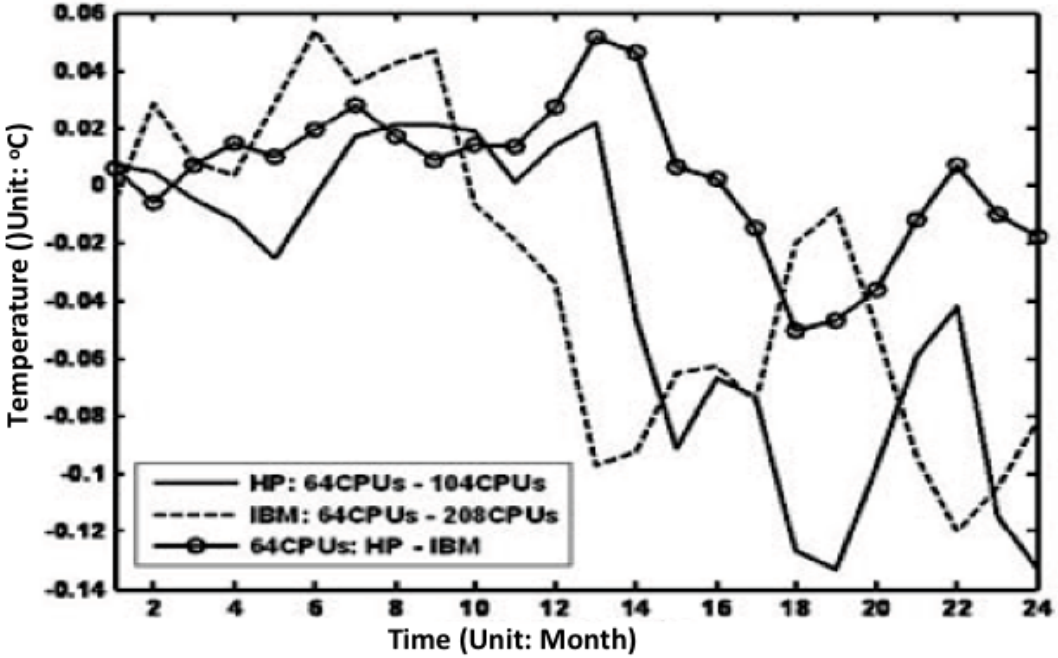

Fig. 1. The Global-SST difference

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