**Geoscientific
Model Development
Discussions**

Interactive comment on "Simulated pre-industrial climate in Bergen Climate Model (version 2): model description and large-scale circulation features" *by* O. H. Otterå et al.

Anonymous Referee #2

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General Comments

This is a model description/documentation paper. There is not much new science, if any. The paper is well written. It presents a standard set of analysis documenting the performance of a new AOGCM.

My only general suggestion is that the authors include more discussion of the impact of the Southern Ocean errors on the model oceanic heat and other tracer uptake in future climate change integrations. I think one can say that the Southern Ocean being too warm in the PI-control will lead to less oceanic heat and tracer uptake in a transient climate change integration than would otherwise be the case. This should lead to a

larger TCR (Transient Climate Response) due to less heat going into the ocean. If used as an ESM, this error would also lead to a larger amount of carbon staying in the model atmosphere. It would be helpful if the authors perform an analysis similar to that found in Russell et al. 2006. How bad is the Southern Ocean simulation relative to other models?

Russell, J L., Ronald J Stouffer, and Keith W Dixon, 2006: **Intercomparison of the Southern Ocean Circulations in IPCC Coupled Model Control Simulations**. *Journal of Climate*, **19(18)**, doi:10.1175/JCLI3869.1.

Specific Comments

1. Section 2.3, sea ice model – More details are needed here. What grid is the sea ice model on? Ocean grid – I assume. What scheme is used to advect the ice? Is there a ridging scheme? Etc.

2. P515, line 12 – According to Stouffer et al. 2004, 150 years is too short for the spin up. Comment?

3. P516, line 19 – How is the mass flux correction added into the model atmosphere? More is needed.

4. P517, lines 15-23 – Does the water budget close in the model? It is not clear from this discussion.

5. P517, line 25-29 – Mark observed values on figure 4.

6. P518, line 1-15 – This discussion is quite weak. It is written from the perspective of a model development process which is not fully discussed. This makes the discussion somewhat confusing. What is the authors' assessment of the Southern Ocean problems? Is the problem on the atmosphere or ocean side of things (or both)? I would guess the clouds are the problem but the authors should look at the AMIP runs and make this assessment. The top of atmosphere fluxes can be compared to satellite values.

Also, the phrase "albedo of low clouds in sea ice model" makes no sense. There are no clouds in most sea ice model components, by definition. If the phrase stays, much more is needed.

7. P519, line 8 – Add "and realistic" after "shallow". This change is a clear improvement.

8. P19, line 10 – Any peaks in spectrum of the AMOC index? The fact that this is a future study could be mentioned here.

9. P520, end of section 4.2.1 – Add discussion of the implications of the Southern Ocean errors on the ocean heat and other tracer uptake in climate change runs.

10. P520, lines 20-25 – Add the global RMS value for the SST error to the discussion.

11. P521, SLP figure – Show the model minus observation differences as a third panel.

12. P522, line 12 – Is there a reference for the gravity drag parameterization?

13. P523, precipitation figure – Why cut the figure at 60N?

14. P524, ENSO discussion – This discussion is not clear. My summary from looking at the figures is that the model has little or no power in the 3-7 year band as is found in observations. The model variability is very close to 2 years and is weak compared to the observations.

The regression pattern is as discussed but again too weak. I assume the combination of a slightly too weak ENSO and typical cold tongue error along the equator in the Pacific, means that the precipitation does not move much (or at all) during EL Nino events. Please if so, add to discussion. This will impact the teleconnection patterns.

15. P527 – Add discussion of the impact of the Southern Ocean simulation errors on ocean heat other tracer uptake in climate change simulations using this model.

16. P528, line 11 – No. XXXX- Fix the number.

17. Stouffer et al. 2004 Missing from reference list.

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Stouffer, Ronald J., A J Weaver, and M Eby, 2004: **A method for obtaining pre-twentieth century initial conditions for use in climate change studies**. *Climate Dynamics*, **23**, 327-339.