

# ***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 #1**

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The paper describes the effect of changing both the atmospheric and oceanographic components of a coupled general circulation model by trying to disentangle the different effects of upgrading the ocean model and upgrading/changing the atmosphere model.

I really like the paper. It is well-written and the underlying analysis of upgrading the components contribute to modify the coupled solutions is interesting and innovative. So, I am happy to recommend this for publications with minor revisions. Some of my comments below really more suggestions than required revisions.

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## 1 General questions/comments:

The authors should probably comment on how ocean (atmosphere) models might initially be tuned by running OMIP (AMIP) runs with fixed forcing fields (SST/sea-ice) to minimize biases etc in uncoupled mode. An existing coupled model could have been tuned to give a good coupled performance, so upgrading a component might require a retuning of the remaining component to get the best possible coupled performance. It could be good to discuss this briefly in the paper.

The authors briefly mention the sea-ice model in MPIOM but this is not mentioning of the sea-ice model in NEMO. Since there are large differences in biases between the different model combinations in high latitude on Figure 3 then it might be appropriate to at least mention those differences.

While I am aware that it is common in the climate modelling community to talk about reanalysis data as observations then it is not true. Both atmospheric and oceanographic reanalyses have errors due both lack of “real” observations until recent times and deficiencies in the data assimilation techniques used.

## 2 Detailed comments:

Page 3 line 24: The “Mogensen et al 2012b” reference is not relevant for data assimilation.

Page 3 line 26: ORCA2 is just one of many NEMO configurations, so it should be mentioned as a choice made by the authors and not all something all NEMO based system uses.

Page 3 line 27: The 31 levels of ORCA2 is unevenly distributed, so this should be mentioned for consistency with the MPIOM remark on page 4.

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Page 5 line 1 to 3 (and Figure): The authors should be more precise on all fields exchanged between ECHAM5/6 and NEMO.

Page 5 line 5: The 1200 seconds time step for NEMO quite short compared to the reference time step 5760 second time for ORCA2. Any reason for choosing this ocean time step?

Page 5 line 22: The grid specifications for MPIOM was already mentioned in section 2.1.1 on page 4 line 6, so this should not be repeated.

Page 6 line 18+24: Reanalyses are not observations as mentioned above.

Page 6 line 29: ORCA2 only has refinement in latitude from 2.0 to 0.5 degree, but not in longitude. The text seems to imply that ORCA2 has 0.5 degree resolution in both latitude and longitude which is not true.

Page 8 line 11: ECHAM5-NEMO3.5 should be ECHAM5-NEMO3.6.

Page 10 line 9-11: Would the fact that NEMO3.6st and MPIOM uses different grids contribute to the differences in SST biases?

Section 5.1+Figure 8: I assume that the MOC is compared with the SODA reanalysis? Maybe this should be I am aware of several inter-comparisons of reanalysis of the AMOC which show quite different results compared to the Rapid array, so I would expect quite some uncertainty in the SODAY reanalysis. Maybe this could be discussed briefly?

Section 5.2+Figure 9: Again, mention that this is against ERAI reanalysis and not observations. Also it might worth being very specific on which area the authors define as the SEC. Maybe a map on Figure 9 with a box could be useful.

Section 6: Unless I missed something then this section focus exclusively on JJA with no mentioning of DJF. There are some differences in SST biases on Figure 3 for all models, so maybe it would be worth mentioning if the authors would expect the conclusions

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to also be true for the boreal winter?

Page 14 line 12: “Cloud” should be “cloud”.

Figure 1: Please add all fields exchanged between the atmosphere and ocean model.

Figure 2: I am not sure that a Taylor diagram is the best way to present the data. Some of the data points are very small and difficult to see. Maybe the authors could think of alternatives for presenting the information?

All maps on Figure 3,4,5,6,7,9,10,13: I suggest moving the longitudes from 0 to 360 degrees to 20 to 380 degrees since it will mostly avoid cutting the Atlantic Ocean in two.

Figure 5+6+10: I suggest moving the legends with the arrow outside the plots.

Figure 8: Adding a colour legend might be useful since the minus sign on the contours are a bit hard to see.

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