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Earth System Dynamics
Discussions

# *Interactive comment on* "The climate of a retrograde rotating earth" *by* Uwe Mikolajewicz et al.

**Anonymous Referee #1**

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Mikolajewicz and coauthors use the coarse resolution version of the Max Planck Institute Earth System Model to simulate a retrograde Earth, in which the sign of the Coriolis force is changed and the direction of the suns diurnal march is reversed (RETRO) and compare to an extension of a Pre-industrial control simulation developed for CMIP6. Some caveats include the use of PI fixed aerosol loading, GHG concentrations and ice sheet distribution.

I thought the manuscript was scientifically interesting and well written, however I had a couple comments/concerns with the analysis and therefore request a minor revision. Please see below.

Major comments:



I thought the expansion of sea-ice in the North Atlantic in the RETRO experiment was an interesting result that the authors link to the collapse of the AMOC and the associated reduction in northward heat transport. I also wondered if it was partly due to the reversal of the subpolar gyre and advection of colder Arctic air/water southward into the North Atlantic? It would be nice to plot the wind stress vectors on the sea ice images.

Does your thermodynamic sea ice model take into account brine rejection? This would surely impact the density (making it saltier and denser) of the North Atlantic circulation. If not, this would be a caveat of the current study and one possible theory for the discrepancy between this study and the Kamphuis et al. study that used the CCSM3 model, which I believe does reject salt, in which the Atlantic MOC did not shut down.

On page 17 you mention that both the Subtropical and Subpolar Gyres in the North Atlantic are weaker in the RETRO simulation and that it is a consequence of a weaker thermohaline circulation. Can you explain? I think of the gyres as being predominately wind driven. If there are weaker Atlantic gyres, then I assume net evaporation decreases substantially in the RETRO case compared to the control, which could be one of the drivers of the collapsed Atlantic overturning in RETRO. On this note, it would be very useful to show not only the mean precipitation and the difference but also Evaporation minus Precipitation and the difference.

Although the strength of the Pacific overturning circulation in RETRO is much stronger than the Atlantic overturning in the CNTRL simulation, the global net oceanic heat transport (Fig. 13a) shows less OHT in the RETRO compared to CNTRL. I expected a stronger MOC to result in more northward heat transport. Can you comment on this apparent discrepancy?

The dominance of cyanobacteria in the North Indian Ocean is one of the main conclusions of the paper, as mentioned in the abstract, however I think there is too much uncertainty in this conclusion since the dust loading is fixed in both simulations. Although the authors claim the change in upwelling rates is the driver, they write that cyanobacte-

ria is able to grow as long as there is sufficient phosphate and iron availability. I think a sensitivity test where you remove dust loading in the RETRO experiment is necessary to show that it is indeed a result of the increase in upwelled phosphate.

I would move the storm track analysis to the main paper – not in the appendix. I thought this was useful in understanding the precipitation changes in figure 2.

Technical comments:

Abstract: There are two instances of the word surprising. I would use a different word: unexpected?

Page 2 line 31: combine should be combined

Page 2 line 32: to provide should be provides

Page 3 line 8: around Africa

Page 3 line 16: limited northward extension (of what), the gyre circulation? I would be more specific.

Page 4 line 4: of which aspects

Page 4 line 13: vertical

Page 9 line 1: You write that cyclogenesis is shifted equatorward in RETRO. I don't see this in Figure 2d, e. Do you mean over the South Pacific? It seems the precipitation increase over western South America is related to the anomalous onshore flow and its interaction with topography.

Page 12 line 11: variety is spelled wrong

Page 17 line 4: what used to be

Page 17 line 14: the sentence structure is awkward here.

Page 20: In the caption to figure 13, Indian is spell wrong. Also, why not show the



global freshwater transport (black line) in panel b?

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