UNIVERSIDADE DE SÃO PAULO

Instituto Oceanográfico

March 10, 2014

Dear Dr. U. Mikolajewicz (Editor)

We are responding to the reviews on our manuscript "*The impacts of Meltwater Pulse-1A in the South Atlantic Ocean deep circulation since the Last Glacial Maximum"* which we have considered very carefully. The point-by-point reply to each reviewer is enclosed. We have substantially re-written the manuscript, which is also enclosed, carefully detailing the description of the experimental set up.

Our investigation of the modern day NADW based on salinity changes in this transient paleoclimate run was broadened to acknowledge not only the impact of the southern contribution of MPW-1A but also all the Northern Hemisphere freshwater discharge events since the LGM. We had access to a single run with the transient paleoclimate version of the NCAR-CCSM. There was no possibility to run sensitivity simulations with prescribed individual freshwater events. Considering that in this single simulation all the known meltwater events are prescribed, isolating the spreading of the Southern Hemisphere source of freshwater (like reviewer #2 suggests) is not feasible. We discuss the limitations of a single run and the associated uncertainties inherent to the model results.

We believe that we fulfill the purpose of the paper, which is to understand the evolution of the structure of the NADW since the LGM in this transient run. However, our discussions and conclusions were expanded beyond considering just MPW-1A. In other words, the role of all freshwater events from LGM to the Holocene was taken into consideration.

We have also included a list of the specific modifications (below). We sincerely hope that it is now suitable to be accepted for publication in Climate of the Past.

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1. Inclusion of a new figure with the location of the meltwater rates (Figure 1b).
2. Better explanation of the meltwater fluxes and rates, listing the proxy data used.
3. More detailed LGM run that was used to initialized the transient experiment analyzed (TraCE-21K), based on the descriptions of Otto-Bliesner et al. (2006) and Clauzet et al. (2005).
4. Explanation about why our results/objectives are different than Liu et al. (2009) and He et al. (2013).
5. Clarification that the salinity barrier mentioned in the text is a characteristic of the highly stratified and dense LGM ocean.
6. Clarification that because of the SH freshening of MWP-1A, AABW formation is inhibited, allowing the less dense water to spread and mix. This helps erode the sub-surface salinity barrier that blocked the spreading of the NADW into the SH.
7. Inclusion of new figures on the Discussion section: time average for the AMOC streamfunction; northward heat transport as a function of latitude; northward ocean salt transport as a function of latitude; differences in the vertical salinity profiles. All new figures stand for the averages of the key periods (i.e. LGM, H1, BA, MWP-1A, YD, and Holocene).
8. Redraft of the heat and salt transport time series figure, changing the anomalies by the absolute values.
9. Redraft of the figure for the salinity profiles. Instead of instantaneous time-slices, it considers the mean of the key periods (i.e. LGM, H1, BA, MWP-1A, YD, and Holocene).
10. Inclusion of a paragraph about the lack of control and/or sensitivity experiments, which requires the consideration of all prescribed meltwater pulses in the interpretation of the changes in the Atlantic deep circulation.

11. Clarification of the work of Carlson et al. (2012), which attributes 37% of meltwater contribution to the Laurentide Ice Sheet (LIS).
12. Discussion about previous meltwater modeling studies that address the weakening of the NADW.
13. Addition of a discussion about the uncertainty of the ocean response to H1 meltwater inflow in function of its magnitude and location.
14. Substantial changes in the Discussions and Conclusion sections, now including the importance of the H1 continuous (and long) freshening. We believe that this freshwater sets the stage for the MWP-1A impact in establishing modern-day NADW structure.
15. Discussion that both (southern and northern) origin of the MWP-1A in the model are important for the shaping of the NADW.

Sincerely

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