Review of: "Eddy permitting simulations of freshwater injection from major Northern Hemisphere outlets during the last deglacial"

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Description: The authors investigate the impact of glacial freshwater runoff from realistic locations in the North Atlantic and Arctic in high-resolution, eddy-resolving simulations using the MITGCM ocean model under glacial boundary conditions. The locations of freshwater release include the Gulf of Mexico, the Gulf of St. Lawrence, a cite off Norway termed Fennoscandia, and the Mackenzie River in the high western Arctic. They conduct short transient simulations (decades) and observe the changes in salinity over different regions of the North Atlantic and the effect on the Atlantic Meridional Overturning Circulation, measured at 26°N to be consistent with contemporary measurements at the RAPID array. They find that freshwater released at realistic rates and locations has little effect on the AMOC, but that surface salinities are appreciably fresher in deep water formation regions when freshwater is released from Fennoscandia and the Mackenzie River.

Main Comments:

The major point of the paper is simple enough. Freshwater released in realistic locations, with realistic circulation and at realistic rates doesn't reduce deep water formation. This would suggest that despite glacial conditions and realistic release of freshwater during a strong meltwater pulse, the authors are showing that the AMOC has not reached a tipping-point for collapse in their model, which is an interesting result. However, the paper is somewhat difficult to read so we advocate for an improvement in the clarity of the paper. Clarity could be improved by improving the title, abstract and reporting of results. With respect to the title, it reads as methodology, not as a main finding. With respect to the abstract, we feel that it is much too long. With respect to the results, we feel that the important points are lost in very detailed reporting and confusing sentences.

Our main comment is therefore that the authors should improve the clarity of the manuscript. However, we also have some more specific comments too, some of which will likely be addressed by an improvement in overall clarity:

Other Comments:

- There are many acronyms in this paper. As it is a short paper, we think these should be spelled out more to ease the readability. https://www.natureindex.com/news-blog/science-research-papers-getting-harder-to-read-acronyms-jargon

Introduction:

- In the introduction, it is mentioned that there are "at least three common experimental design problems", but the authors only expand on two.

- It would be nice to have some information in the introduction for why the authors chose the sites they chose. Are these areas known to be the major outflows of freshwater during the glacial? Are there others that are not accounted for?
- It would also be nice for the introduction to talk more to why an AMOC collapse is thought to have occurred many times in the past. It is implied, but not clearly stated in the introduction. It is also not stated why we might be interested in AMOC collapse today, which may be obvious to the authors but would be worth stating.
- Another topic that is not mentioned is the bistability of the AMOC. There has been much work on the existence of "tipping-points" (e.g. most recently Lohmann & Ditlevsen, 2021, PNAS), whereby over a certain threshold of freshwater hosing the AMOC collapses, but underneath that threshold it does not. This is an important concept to include given that despite some significant freshening in your experiments there is little effect on the AMOC.

Results/Discussion:

- The ice extents in km^2 are quite low given that the record minimum in 2017 was 14.3 million km^2.
- Line 170 should read ". . down to 200 m depth. . ." [This comes of too much use by scientists of "high" instead of "large"]
- Line 186. Direct transport from FEN across the GIN seas is not clear in the figure, the proportion of fresh water shown is very small.
- Line 191 becomes clear looking at the figure but there has to be meridional transport to get from the Gulf of St. Lawrence to the Gulf Stream and it is curious to read "eastern . . North Atlantic"
- Lines 229-231. A curious statement. As though the meltwater is trying not to affect AMOC.
- It should also be noted that the authors did not complete a combined experiment where all sites received increased freshwater fluxes at the same time. This might have been sufficient to tip the AMOC into a collapsed state. At the very least, this should be discussed. At most, another simulation should be performed with all four release sites simultaneously releasing freshwater.

Figures:

- We suggest a change in the colour scheme of figures from jet to something more colour-blind friendly.
- Figure 1 is confusing and needs more details. We do not know how to interpret it.