



EGUsphere, referee comment RC2
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Comment on egusphere-2022-869

Anonymous Referee #2

Referee comment on "On the ocean's response to enhanced Greenland runoff in model experiments: relevance of mesoscale dynamics and atmospheric coupling" by Torge Martin and Arne Biastoch, EGU Sphere, <https://doi.org/10.5194/egusphere-2022-869-RC2>, 2022

This paper explores how the North Atlantic Ocean responds to enhanced Greenland melt, using a suite of ocean modelling experiments. The authors carefully explore this problem by using twin experiments, with and without Greenland melt, while also examining the role of resolution (through the inclusion of high resolution nests) and forcing (by considering coupled as well as forced ocean model experiments). The authors also run their experiments for a length (100 years) sufficient to allow signals and different behaviors between experiments to develop. Key results include a compensating temperature feedback in the coupled simulations, which also have greater stability. Additionally, mesoscale dynamics, represented in the nests, play a key role, including penetration of freshwater in the sub-tropics.

This is an important topic, and the study nicely examines many aspects. The paper is generally well written and clear, with high quality figures. Thus, it definitely deserves publication, with EGU Sphere being an appropriate journal. That said, there are some ways the manuscript can be improved. There are some minor wording issues (such as un-needed adjectives). The manuscript also feels long, and given that it covers so much space, there are times that it feels like the main big picture goals get lost in the many details. So it might be good to try to tighten up the manuscript and make sure the focus is always on the main ideas and results. There are also a few technical items that could use further discussion.

Salinity Restoring: This is first mentioned at line 102-103 when the authors mention they use a weak restoring. It would be good to explain why this is included. Also, given the authors are looking at salinity signals for Greenland melt, I have concerns about those signals being damped by this term. At the very least this is worth further discussion. Some comparison with other studies that don't use restoring, or have restoring of different strengths, would be good. Ideally, and even though the experiments with the nests are computationally expensive, it would be good to see what would happen if they were run without restoring, or at least compared to a 10 year integration period with the restoring.

Historical vs Pre-Industrial: This is first discussed for lines 110-112. I know the authors work to justify this choice later in the paper, but I think this choice needs greater justification and discussion.

Averaging Periods: The authors explain why they use different averaging periods, and add Appendix A as a justification. This still feels like a concern in the transient experiments, since a longer averaging period means more Greenland meltwater added to the ocean, and a longer period that potentially means it can propagate farther. I would like to see some comparison with averaging over the same period, to help confirm that the results are not being biased by the variable averaging periods.

Specific points:

L23-25: "leaving the ice sheet at a negative net mass balance" doesn't read well.

L38: Note sure exactly what "indicate robustly" means

L71: "most critical improvements by the grid refinement" doesn't read well.

L87: "including entire Greenland" is missing some words/explanation

L88: Might be worthwhile to clearly explain what is meant by a strongly eddy ocean

L92: McWilliams

L99: extended

L113: "much more" – much isn't needed, more pronounced says the same thing

L113: What exactly is "strongly meandering" compared to just meandering?

L117: height

L122-123: "promotes intensified, partly overly pronounced deep convection" doesn't read well

L131: by "data extending beyond Greenland is not considered though", do you mean you haven't included the other non-Greenland glaciers in the dataset? If so, say it directly.

L131: on the annual mean

L133: What does "over 62 and 100" mean?

Figure 3 caption: What is an "Exemplary improvements"?

L142: Half of the icebergs melting in fiords – this needs to be referenced.

L144-145: "we find the prescribed freshwater rapidly mixed over the depth of the Greenland shelf by the ocean model also shifting the seasonal peak by a month" – no idea what this statement is trying to say.

L155 "much more pronounced" – more pronounced is good enough – the additional adjective doesn't really add anything

L169-171: Reference each of the listed processes that the authors suggest the overturning is sensitive to.

L175: Would be good to compare the model overturning strengths to observations, such as RAPID and OSNAP. Even if the paper's focus is understanding responses in different model configurations, it helps to understand the realism of different results/measures.

L187 "much more sensitive" – more sensitive is fine. Also, given the declines in Sv, might it be worth mentioning the percentage changes?

Paragraph ending on L205: How does this propagation compare with other, previous, studies of Greenland melt.

L208: 'well' not needed, expressed is fine.

L211: What is meant by the 'very eastern side'?

L220: coupled experiments – should it be plural? I.e. Is this behavior occurring in all coupled experiments?

L223: "Averaged over the top 200 m representative for the upper ocean" doesn't read well.

L224: "in some areas on annual mean" doesn't read well.

L226: "This is except for" doesn't read well.

L230: Nordic Seas.
L236: What is meant by "the mixed layer rather shoals"?
L238: Local regions of warming – Is this significant? Or just a minor detail?
L243: sites
L243: "For simplification, we only show the spatial means for these areas and averaged over the top 200 m if not mentioned otherwise." Isn't clear and doesn't read well.
L244: Why does this comment about grid cell averaging suddenly appear? Is there any other way to compute averages on model grids where the area/volume spatially varies?
L247: remove "being"
L255: "the large scale we focus on" – be quantitative, which will help this discussion.
L260: "...have approximately the same..."
L264-265: Why is the overflow water warmer if the mixed layers are deeper in the Nordic Seas?
L280: "barely is a density change noticeable" doesn't read well.
L284: "presents with excessive freshening" isn't clear.
Figure 10: Why use a line a latitude (60N) instead of the observational OSNAP line – would be useful for readers to look at the model fields where observations exists.
L289: Would a reference to Behrens et al be useful here?
L294: "it does not become clear" doesn't read well.
Figure 11: Is MLD > 500 m appropriate for the ENA shelf? Additionally, can you try to estimate a formation rate in Sv, to help readers put the numbers in context compared to other studies? Also, how realistic are the areas of deeper MLs in the various simulations?
L307: "enabling properties of the initialization fields still visible" – not sure what the authors are trying to say here.
L312: "show large content of overflow water" doesn't read well.
L318: "without though the higher resolution is not quite sufficient" – some words or explanation is missing
L330: shown
L339: suffers is probably not the best word here.
L355: Irminger Rings entering the Labrador Sea interior – maybe add some references.
L357: are crucial
L366: dynamically active (highly not needed)
L371: What does "largely improved" really mean?
L375: "well seen" doesn't strike me as formal scientific wording
L388: In terms of imprints of the different Northwest Corner dynamics on meltwater tracer concentrations, are there any other studies that could be referenced/included in the discussion here?
L418: "the coupled-nested configurations" – plural or singular – I.e. are you meaning the control and melt experiments with this setup?
Figure 14 caption: States magenta lines but I see red and yellow.
L428: "over the entire but mostly eastern SPNA" almost feels contradictory.
L445: Other studies have looked at the role of Ekman transports around the sub-polar gyre. Would be good to reference them.
L450: Is this realistic. Is there a concern of the atmospheric scale being too coarse to look at processes around the narrow boundary currents. This comes up later in the paper, but would be good to mention here. Also, would be good to reference those works that have previously discussed Ekman transport's role in exchange from the WGC and LC.
L474: "explored in many model studies before" – add some references to those previous studies
L476: "passed decade already" – I think the authors may mean a previous decade?
L484: being
L487: "Potentially in consequence thereof" doesn't read well
L492: What is meant by "does neither cover"?
L494: the objective of whether...
L501: Don't like the wording "quite typical" for the salinity bias – maybe explain this in more detail and more clearly.

L503: remove also

L505: "doubting the importance" isn't a great choice of wording

L509: disagree may be a better word than oppose

L522: I think Schulze-Chretien and Frajka-Williams should also be referred to here.

L527: remove also

L535-540: Some other studies suggest resolutions up to 1/60th degree may now be needed.

L548: remove "a"

L548: Gillard et al, (2022) – Ocean Modelling – looks at the some impacts on this exchange when changing the vertical resolution

L585: Not sure what "presenting with the strongest weakening" is really saying

L636: "present with diverse sensitivity" doesn't read well.