

## **Author's response point-by-point on *Impact of mesoscale eddy parameterization on Arctic Atlantic Water circulation and heat transport in the eddy-permitting grey zone***

We have substantially revised our manuscript to meet the reviews of the two anonymous reviewers. Below follows a point-by-point response on the changes introduced in the revised manuscript as produced by the latexdiff with the initial submission.

### **Abstract**

L12: Changed to reference simulation in response to Reviewer 1 concern that the high resolution mode is not fully eddy resolving.

L13-L23: Updated with new main analysis and conclusions.

### **Introduction**

L38: Introduced Arctic Mediterranean.

L40: Use `\mbox` on word that contains hyphen to avoid breaking it at line end.

L44: Grammatical change from Reviewer 1.

Figur 1 text: Same changes as at L38 and L40.

L68: Grammatical change from Reviewer 1.

L85: Added references describing the GM scheme.

L105-L108: Added additional motivation why studies of response in realistic models are needed.

L109-L120: Added hypothesis based on suggestion from Reviewer 2.

L121: Stylistic change.

L122-L123: Same as L12.

Figure 2 text: Stylistic changes suggested by Reviewer 1.

L128-L132: Updated with the new diagnostics.

### **Methods and data**

L137: Added model reference, suggested by Reviewer 1.

L147: Changed to math mode text.

L148-L149: Stylistic changes suggested by Reviewer 1.

L151-L155: Clarified how lateral diffusivity and viscosity coefficients are computed in response to question raised by Reviewer 1.

L162: New coefficient values for the GEOMETRIC scheme

L164: Same as L137.

L166-L168: Clarified how minimal vertical diffusivity values are used in NEMO, in response to question by Reviewer 1.

L170-L173: Added more details on how the model time stepping is setup.

L179: Same as L137.

L182: Same as L137.

L187: Same as L12.

L189-L196: Describe how the new ARCTIC025-lowGM experiments is setup.

L197: Corrected the reference.

L201: Updated text based on retuned GEOMETRIC scheme.

Figure 3 text: Same as L197.

Table 1: Same as L189-L196.

L202: Same as L201.

L203: Stylistic change.

L215-L216: Added GLORYS reference + grammatical change.

L227-L231: Updated with new observational datasets.

L232: Updated reference.

L242-L287: Removed meridional overturning metrics and introduced new metrics for topostrophy, baroclinic transport function and tracer trend terms. Plus described how heat transport now is computed over a closed region.

## **Results**

L290: Grammatical changes suggested by Reviewer 1.

L291-L294: Updated introduction to results with new analysis.

L298: Changed the depth of the analysis suggested by Reviewer 1.

Figure 4 text: Change to new analysis depth and general improvements.

L305: Stylistic change suggested by Reviewer 1.

L306: Stylistic change.

L312: Stylistic change.

L313-L313: Changes due to updated experiments and analysis.

L317-L320: Same as L12.

L321: Stylistic change.

L323: Stylistic change.

L324-L326: Seems to be a misplaced figure text by the latexdiff command.

L327-L328: New structure with subsections and subsubsections.

L337: Stylistic change.

L342: Grammatical change.

L355-L400: Removed meridional overturning section and added section with analysing the topostrophy and baroclinic transport function, see motivation in reviewer responses.

Figure 6 text. New figure of topostrophy with new text.

L401-L402: New structure with subsections and subsubsections.

L403-L406: Additional text describing Greenland-Scotland ridge plus change density to  $\rho$  from  $\rho_0$ .

L406-L428: Updates of the text based on new experiments and analysis; plus use `\mbox` on word that contains hyphen to avoid breaking it at line end.

Figure 7 + text: New figure with baroclinic transport function

Table 2 text: Use `\mbox` on word that contains hyphen to avoid breaking it at line end.

Table 2: Updated based on new experiments plus corrected round off errors in analysis.

L429-L431: Clarification in response to question raised by Reviewer 1.

L435-L461: Updated text based on new analysis using heat computations over region with closed volume flux; added comparison to Mayer et al (2023); use `\mbox` on word that contains hyphen to avoid breaking it at line end.

Table 3 + text: New computation of heat transport over region with closed volume transport.

L463: New structure with subsubsection.

Table 4: New numbers based on new analysis and corrected round off error in analysis.

L469-L517: Updated text based on new experiments and analysis; plus some stylistic changes.

Figure 9 + text: Change location to 78 deg N and added comparison to observational estimates based on inverse model. Also introduce salinity in the plots. Suggested by Reviewer 1.

L519-L520: New structure with subsection and subsubsection.

L523: Included salinity.

L528-L558: Updated text based on new experiments, changed location of Fram Strait section to match the new observational estimates suggested by Reviewer 1.

L559-L563: New structure with subsubsection.

L564: Stylistic change.

L568-L597: Updated text based on new experiments and analysis; plus we now compare simulations to two climatologies and two reanalysis products to cover for uncertainties in observational-based products. Basin-average temperatures are also computed.

Figure 10+text: Updated figure with new experiments, two climatologies PHC3.0 and WOA201, two reanalysis products GLORYS12 and SODA4; and basin-average temperatures.

L598-L638: New subsection on analysis of the lateral eddy temperature flux divergence.

Figure 11: New figure showing the lateral eddy temperature flux divergence for the resolved eddy and parameterized (GM) temperature fluxes.

L639-L715: New subsection with analysis of the horizontally averaged temperature trend terms comparing the major terms to show what role the advective component plays, partly in response to concerns raised by Reviewer 1.

Figure 12: New figure showing the horizontally averaged temperature trend terms for the Norwegian Sea and Nansen basin.

Figure 13: New figure showing a further decomposition of the advective components (in Figure 12) into resolved mean, eddy and parameterized eddy contributions.

## **Summary and conclusions**

L719-L844: This section is almost entirely rewritten partly because of new conclusions based on the new analysis introduced and partly to connect to the concerns the reviewers had that our study lacked a physical interpretation and to make it more hypothesis-driven.

## **Appendix**

L1086: Change to Arctic Mediterranean

L1091-L1094: New Appendix B describing the further decomposition of the advective component into horizontal and vertical contributions.

Figure B1 and B2: New figures showing a further decomposition of the advective components (in Figure 13) into horizontal and vertical contributions.

Per Pemberton,

On behalf of the other co-authors