Referee #1

This manuscript analyses results from a high-resolution (1/12°) regional ocean model of the NW Atlantic forced by fluxes and boundary conditions from a lower-resolution fully-coupled earth system model. Specifically, four CMIP scenarios for different future warming levels are integrated out to 2100, and the work focuses on changes to currents, surface temperature, salinity, and sea-surface height (SSH). While others have already studied the resulting future reduction to the current systems (Atlantic Meridional Overturning Circulation (AMOC) and Western Boundary Current (WBC)) for the highest warming scenario (RCP8.5 and SSP585) in fully-coupled climate models (for CMIP5, ~1° ocean models, Beadling et al., 2018; and for CMIP6, ~1/4 – 1/12° ocean models, Roberts et al., 2020), the present investigation focuses on changes in the societally important near-coastal and shelf regions (Gulf of Mexico/America, West of Florida, South Atlantic Bight, Mid Atlantic Bight and Gulf of Maine), and investigates the range of possible conditions for the four different warming scenarios. These regions are found to become warmer and saltier in the future (changes which could affect the marine ecosystems) and also to have higher sea-levels. This near-coastal/ shelf focus examined across multiple future warming scenarios has not been studied before to my knowledge, and could provide useful information about future conditions for marine planners and societal uses.

The revised version of the manuscript is now improved, and would be suitable for publication after further minor revision as described below.

We appreciate the insightful and constructive comments in the previous round of review. As suggested, we have moved Supplementary Figure S6 (in the original manuscript) to the main text as Figure 18. We have also addressed all minor comments in the revised manuscript. Our manuscript has been much improved following the modifications made based on the reviewers' comments. Our replies are provided below in blue font for each of the general and specific comments.

The main issues from my first review concerned the impact of the flows from the north, and questions about the representation of sea-surface height (SSH), and these are addressed as follows:

1. Northern Inputs. The authors have added new text about the impact of the northern inputs in lines 539-554 (not lines 580-595 as they say in their response, which initially confused me). This is: “In addition, as discussed in New et al. (2021), the MAB and the Gulf of Maine are also strongly influenced by the Labrador Current and the Labrador Slope Water (LSLW). The Slope Current in MOM6-NWA12 shows a large bias in its position and the strength. More specifically, it is much weaker compared to that in GLORYS12, and is replaced by northward flow in the upper 400m or so (Supplementary Fig. 6). Another core of southward flow appears immediately shoreward of the Gulf Stream in MOM6-NWA12. Since it is positioned away from the continental slope (near 73°W), it is referred to as the northern recirculation flow of the Gulf Stream. In the future scenarios, both the northern recirculation flow and the Slope Current (below 600m) drastically weaken. The Gulf Stream also weakens and its core shifts shoreward. In the SSP370 and SSP585 scenarios, the Gulf Stream core is positioned along the continental slope. Thus, both the northern recirculation flow and the Slope Current (below 600m or so) completely disappear in those high emission scenarios. Therefore, despite a large bias in the location and strength of the Slope Current in MOM6-NWS12, we can still conclude that the future warming and saltening in the MAB, shown in Fig. 17, are the result of a compounding effect - a weakening and

shoreward shift of the Gulf Stream combined with reduced advection of cold, fresh Labrador Sea waters." So, while it is clear that the model does not reproduce the southward-flowing shelf-break jet in the upper 400 m (which should appear at the top of the shelf slope as part of their "slope current"), and this is a serious limitation to the realism of the model, there is a weakening of the deeper flows (500-1000m), and the role of these changing currents in the warming and salinification of the region is now reasonably discussed as suggested.

However, as the new text is quite substantial, I strongly recommend that their new figure (Supplementary figure 6, or R1) in association with this new text, is added as figure 18 to the main text, rather than being "relegated" to the supplementary material.

As suggested, we have moved Supplementary Figure S6 (in the original manuscript) to the main text as Figure 18 in the revised manuscript.

2. Sea-surface height (SSH). Following Steinberg et al. (2024), it is clear that the model does allow for local or regional changes in SSH due to steric effects (i.e. due to warming of the water column), which answers my question here, and this is now adequately discussed in the revised text, lines 225-235. In addition, it appears that changes in the Global Mean Sea Level (GMSL) cannot be properly represented in this regional model (forced by boundary conditions) so explaining why the model is constrained to maintain its overall sea-level as constant, with the GMSL being added on later to simulate the full effects.

Thank you for your previous comments, which have helped improve our manuscript.

Further minor issues

l. 156: insert the degree symbol, °, after "1/2".

Added. Thanks.

l. 188: remove the space between "2" and "4".

Removed.

l. 200: "period" not "frequency".

Changed.

Fig 4 caption: use (c) not (C).

Changed.

Formatting error: starting in section 3.1 and continuing throughout the manuscript: please close the gaps in all references to the component panels of the figures (e.g. not Fig. 2d, rather use Fig. 2d, etc). This also occurs in the text as well, e.g lines 352, 355, 394 etc etc.

In the previous version, there were some discrepancies caused by converting the file from google docs to MS word. We have checked and corrected all of the formatting in the revised manuscript. Thank you for pointing out this error.

ls. 342-344: Figure 6 shows the reduction in the loop current and Gulf Stream but where is the evidence that the increased SST and SSS in the SAB and West Florida comes from reduced upwelling. This is just an arbitrary statement which needs to be justified.

We toned down this sentence (L343): "The large increases in SST and SSS on the West Florida Shelf and the SAB appear to be linked to the projected weakening of the Loop Current and Gulf Stream (Fig. 6)."

ls. 349-350: After "Warming via this mechanism is fortified by commensurate mean reductions of the advection of cold high-latitude waters from the Labrador Sea" add "as described further in the Discussion".

We changed this (L350-351): "Warming via this mechanism is fortified by commensurate mean reductions of the advection of cold high-latitude waters from the Labrador Sea as described further in the Discussion section."

Figure 6: where is panel f?

Thank you for pointing this out. We corrected the captions for Figure 6 and 8.

l. 359: there is warming in the Gulf of Maine, so change "almost completely absent" to "much reduced".

Changed.

ls. 407-408: rather than saying the AMOC is a contributor to the modulation of the WBC system, it's the other way around i.e. the WBC components contribute to the AMOC.

We changed the sentence (L406-409): "The insensitivity of the Northwestern Atlantic WBCs to emission scenarios before the 2070s is consistent with the AMOC decline in GFDL-ESM4.1, given that the WBCs are key contributors to the AMOC (Fig. 10)."

No panel (f) in fig. 11 or fig. 12?

We corrected the captions for Figure 11 and 12.

ls. 436-437: use “MAB” not “north of Cape Hatteras” etc for consistency with the surrounding sentences.

Changed.

ls. 489-490: presumably the mass redistribution from the open ocean to the coast is in the upper layers, as the opposite would be occurring deeper down?

That is exactly what we see. As shown in Figure 15 and Figure S6, the SAB ocean exhibits vertically coherent warming. Consistently, the isotherms flatten, driving a baroclinic mass redistribution between the coast and the open ocean across almost the entire water column. Therefore, the mass redistribution occurs from the open ocean to the coast in the upper layers while the opposite mass redistribution from the coastal region to the open ocean occurs in the deeper ocean.

We revised this sentence (L489-492): “This baroclinic mass redistribution between the open ocean and the coastal region is also directly responsible for the large projected increase in dynamic SSH across the SAB, which is consistent with the historical analysis of Steinberg et al. (2024)”

l. 503: Say that “dynamic” ssh is that arising from changes in the currents.

We change this (L503-505) “Finally, we emphasize that the dynamical SSH changes driven by changes in ocean currents would occur in addition to the GMSL rise associated with ocean warming and glacial and ice-sheet melt.”

l. 504: Specify that GMSL is “Global Mean Sea Level”.

Global mean sea-level (GMSL) is defined in L228.

l. 506: say “even though GMSL ….”

Added “even though” in this sentence.

l. 509: say “projected GMSL …”

Added “projected” in this sentence.

l. 551: “NWA12” not “NWS12”.

Corrected.

l. 575: say “drive” not “drives”

Corrected.

Referee #2

I like to thank the authors for their detailed answers to my querries. I found them mostly addressed well.

We appreciate the insightful and constructive comments in the previous round of review. Our manuscript has been greatly improved following the modifications made based on the reviewers' comments.

As a further remark to the answer to question about the stream function (L442-445). I would like to note that the barotropic stream function can easily be calulated by integrating from the western bounday. Only Sverdrup transports need to be integrated from the eastern boundary.

We agree that the depth-integrated transport from the MOM6-NWA12 can be integrated from the western boundary to compute the barotropic stream function. However, the derived stream function would reflect the weakening of the Gulf Stream and the DWBCs driven by the future decline of the AMOC. Therefore, we believe this does not represent a purely wind-driven gyre circulation change. To avoid confusing the readers, we chose not to include this in the manuscript.