Editor's Comments

The responses to the reviewers' suggestions are precise and substantial, both in form and content, and the manuscript has been greatly improved. The paper is more concise and clearer about the scope of the study.

We appreciate the helpful comments from the reviewers and editor. Thank you.

The following points have to be addressed before any publication:
- The integral, presented l.149, in the numerator of the FW density calculation is between z1 and z2 and not between z2 and z2.

Thank you. We have corrected that mistake in the revised manuscript (now line 144).

- Why are the values in Table 2 different from the original version?

The values in Table 2 are different from the original because Reviewer 1 pointed out that smoothing the climatological mean is recommended by Hobday et al. (2016), however, we did not apply smoothing to the climatological mean in our original submission. In our revised submission, we smoothed the climatological mean and, as a result, the MHW statistics presented in Table 2 changed slightly. In response to Reviewer's 1 comment, we described that the figures and tables had been updated to reflect the smoothing. We should have been more explicit to describe that Table 2 was modified and apologize for that oversight.

- Figure 3 (e,f) – how can the mixed layer depth be rigorously constant along the two transects?

This is an interesting observation and we agree that it is a surprising outcome. We analyzed the GLORYS12 mixed layer depth output over a larger region during July 2023 and we found that over the NL Shelf, the mixed layer depth is nearly uniform at approximately 10.5 m for the entire month (image below).

Time mean - July 2023 (left panel) and **Time std - July 2023** (right panel)
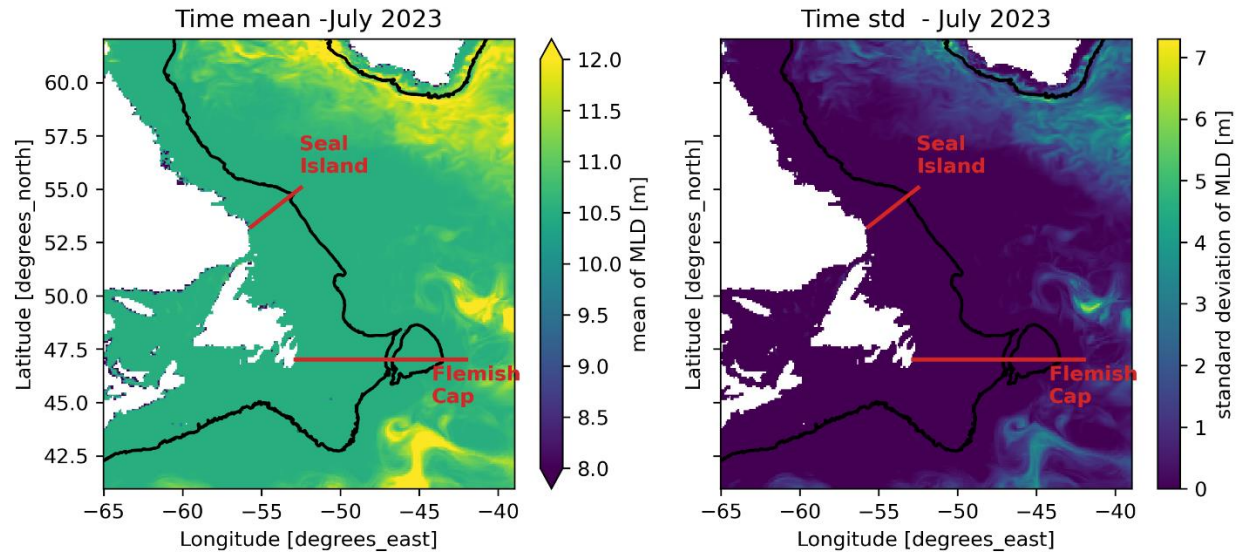
We suspect that the reason for the uniform value is related to the way the mixed layer depth is defined, where density differences are referenced to the density at 10 m.

We've opted to use a different definition for the mixed layer depth, which we now define as the depth of the maximum squared-buoyancy frequency. This definition better reflects the highly stratified nature of the water column in the shelf region at this time of year. The new Figure 3 is shown below and we have made the following revisions to the text:

"Furthermore, we defined the mixed layer depth as the depth of the vertical maximum of $N^2(z)$." (Lines 136-137)

Figure 3 Caption: "In the bottom panels, the solid gray line represents the mixed layer depth defined as the depth of the maximum squared-buoyancy frequency." (Lines 215-216).
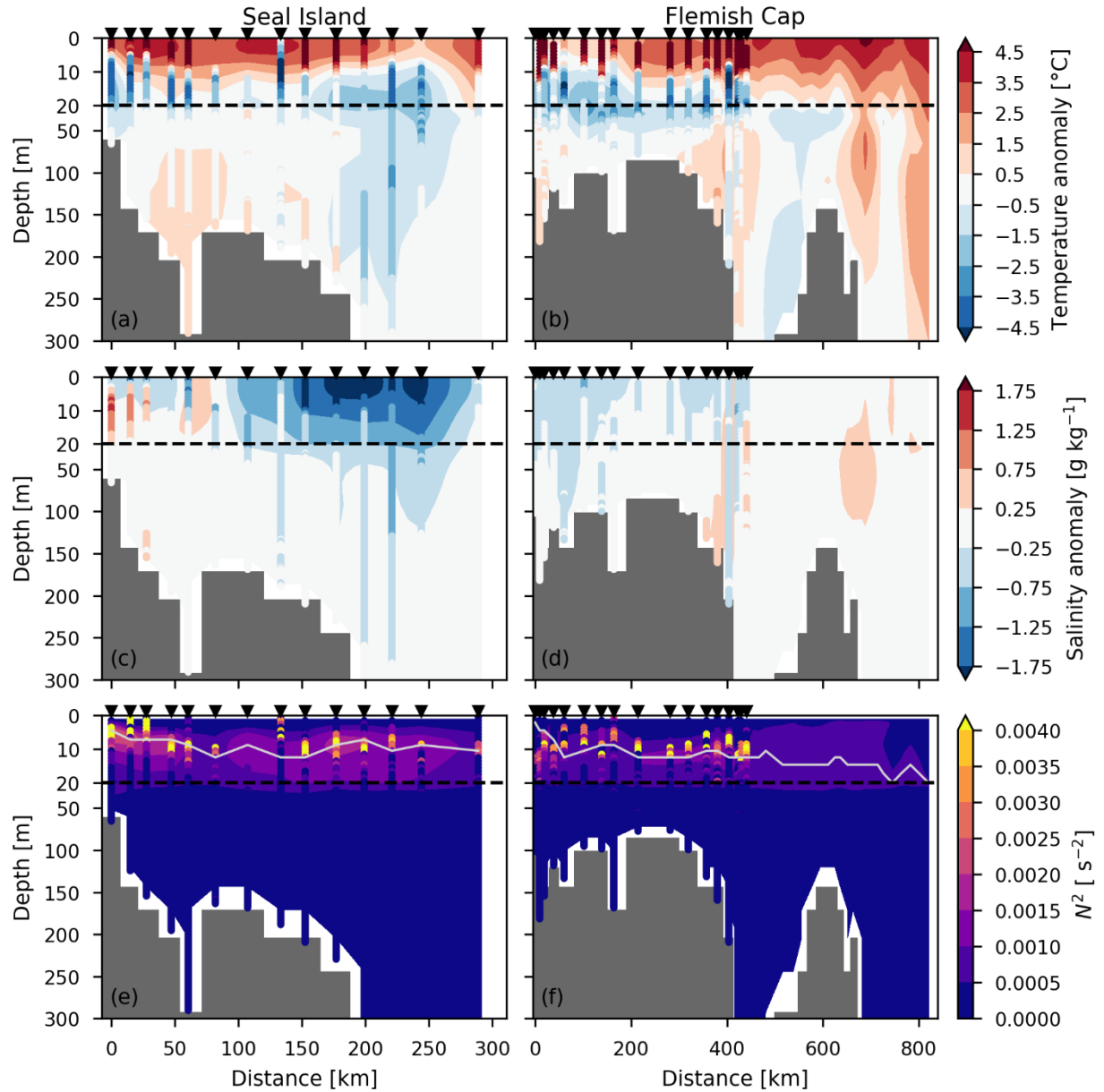
Figure 3: Vertical cross section of temperature anomalies (top), salinity anomalies (middle), and squared-buoyancy frequency (bottom) along the Seal Island (left) and Flemish Cap (right) transects shown for AZMP July 2023 occupation dates. For Seal Island, the AZMP occupation occurred on July 25. For Flemish Cap, the stations inshore of 200 km were sampled on July 20 and the others were sampled on July 30. GLORYS12V1 data (product ref. no. 1) matched to the AZMP sampling dates are shown in shaded contours, and AZMP data (product ref. no. 2) are shown in the coloured circles which appear as lines extending from top to bottom. **In the bottom panels, the solid gray line represents the mixed layer depth defined as the depth of the maximum squared-buoyancy frequency.** For Flemish Cap, GLORSY12V1 data at locations offshore of approximately 400 km, which were not sampled by AZMP in July 2023, are taken as the mean of July 20 and July 30. A reference period of 1993-2022 is used to calculate climatologies for both GLORYS12V1 and AZMP. For AZMP, all July and August occupations in the reference period were used to construct the climatology. The black triangles represent the positions of the AZMP stations sampled in July 2023. Note the difference in vertical scale above and below 20 m (black dashed line).

- Sea ice volume is implemented in figure 4 (e) but not discussed.

We acknowledge that sea ice volume was not discussed in great detail in the revised manuscript. We have added the following line to the methods section:

"Sea ice volume, defined as the product between the GLORYS12V1 sea ice concentration, sea ice thickness, and grid cell area, summed over the NL Shelf was also calculated and analysed." (Lines 79-81)

We have also added a few sentences describing the GLORYS12V1 sea ice conditions in 2023:

"Fresh water input due to sea ice melt from both local and remote areas is a possible explanation. Unfortunately sea ice in GLORYS12V1 may not be helpful to describe this as its sea ice cover doesn't appear to match observations very well, with no sea ice present in July 2023 or even in the 90th percentile of the 1993-2022 climatology (Fig. 4 (e))." (Lines 231-234)

We have also clarified in the text that observational results from other studies found a rapid decline in sea ice in July 2023:

*"In 2023, sea ice conditions on the Labrador Shelf were above normal in June leading to late last occurrence on **the southern Labrador Shelf and decreased very rapidly to zero prior to mid-July (Cyr et al., 2024c, Galbraith et al., 2024)."** (Lines 291-293)*

Finally, we revised the units on Figure 4e from m^3 to km^3 to improve readability.

- The caption of figure 4 has to be revised: the answer to reviewer 2's comment is not in accordance with the revised manuscript.

Following the response to Reviewer 2 submitted during the interactive discussion, we did revise the caption to Figure 4 in an attempt to make the caption more streamlined and clear. In the process of that revision, we neglected to describe the grey shaded boxes that represent the MHW periods. As a result, we have added that missing element to the new caption in Figure 4 which now reads as follows, with the new line in bold:

"Figure 4: Time series plots for 2023 in blue, the 1993-2022 climatology in black, and the 1993-2022 10th and 90th percentiles in grey dashed lines. Variables from GLORYS12V1 (product ref. no. 1) are (a) sea surface temperature averaged over the NL Shelf, (b) maximum squared-buoyancy frequency at Station 27, (c) depth-averaged temperature from 0-20 m averaged over the NL Shelf, (d) freshwater density from 0-20 m averaged over the NL Shelf, and e) sea ice volume over the NL Shelf. ERA5 (product ref. no. 3) variables include (f) 10-metre wind speed at Station 27, (g) net daily average surface heat flux averaged over the NL Shelf (where positive indicates a downward flux), and (h) 2-metre air temperature averaged

over the NL Shelf. Maximum squared-buoyancy frequency data at Station 27 from AZMP (product ref. no. 2) are shown in b) for 2023 in large dark brown dots and for 1993-2022 in small light brown dots. **Heat wave periods are indicated by the grey shading."** (Change on Line 262)

Besides that oversight, we have checked that the caption is accurate and believe it to be clearer, despite some minor differences with the original response to Reviewer 2.

Please, submit together with the revised version, a copy of your manuscript where the changes made as a result of the above points are annotated and the list of your answers to these above points.
Looking forward to receiving your revised manuscript
We have included in our submission a difference between the most recent changes and the last revision. Thank you again for your comments.