Report #2
Reviewer #1

In this revision, the authors have addressed most of the issues raised by reviewers in an appropriate way. Results of this study provide an interesting delineation between temperature-dominated and salinity-dominated parts of the North Atlantic. There remain a number of minor issues. New material incorporating the PWP model raises some questions that should be addressed carefully in the text.
We thank the reviewer for their positive assessment and for the constructive comments that have helped improve the manuscript.

1. line 273. "thus, we prefer to not to consider this". The fact that the two-year lag is statistically significant but not explained does not really justify a preference not to discuss the two-year lag. It's possible that the number of degrees of freedom is reduced for the 2-year lag, and its not actually significant. Even in the event that it is statistically significant, an alternative approach would be to explain, "However, we have not identified a physical explanation for a 2-year lag and will not explore this correlation further in this paper." That leaves open the opportunity for a future study to delve further into the matter.
We agree with the reviewer, that sentence is misleading and we used a slightly modified version of the suggested sentence, which in the revised manuscript reads: “However, in our assessment, the 2-year lag lacks a plausible physical explanation; therefore, we do not consider it a reliable correlation.”

2. Table 1. Do the numbers in Table 1 represent zero lag? I'm confused by the text at line 271-272, which talks about lagged correlations, while the table doesn't specify lags. More detail is needed in the table caption and probably also in the main text.
We apologize for the confusion regarding zero-lag and lagged correlations. The correlations between NAO and MLD/MLT/MLS are indeed lagged. In contrast, the correlations among the mixed layer variables (MLT, MLS, and MLD) are computed at zero lag, as no lag is expected between these variables.

3. lines 337-338. "It is worth mentioning that the 1D model estimates the MLD from temperature-based profiles while ..." If the PWP model estimates MLD from temperature, then how does it allow you to evaluate the impact of alpha vs beta oceans. I found online information that implies that PWP was originally written for temperature only but that newer versions incorporate freshwater fluxes, which should allow assessment of temperature and salinity effects. https://uop.whoi.edu/techdocs/technote/9701tn.html

Very well spotted, we thank the reviewer for this comment. We agree that the previous wording was incorrect and therefore misleading. In our implemented PWP configuration, MLD is diagnosed from density profiles computed from both temperature and salinity. To avoid confusion, we have removed the sentence in question and clarified the model description accordingly.

4. lines 341-342. "The choice of PWP model was made to support the idea that β- and transition oceans do not develop deep mixed layers, which ..." The PWP model should not be selected to support an idea---that sounds like circular logic. Rather it should be selected if it is the right tool to test a hypothesis. I'd suggest revising this to say, "The PWP model was chosen to test the idea that β- and transition oceans do not develop deep mixed layers, which ..." I also think this sentence looks like it should appear in line 336, just after the statement saying that the Price et al (2986) one-dimensional model is used.

We thank the reviewer for this comment. We agree that the original phrasing could be interpreted as implying circular reasoning. We have revised the sentence to clarify that the PWP model is used to test the hypothesis that β- and transition oceans do not develop deep mixed layers. In addition, we have moved this statement earlier in the manuscript (line 336) to improve the flow and presentation.
The new sentence now reads: “The PWP model was chosen to test the hypothesis that β- and transition oceans do not develop deep mixed layers.”

5. lines 409-411. "Even if the α-ocean area is warming, it is not expanding northwestward. Hence, the EGC is acting as a barrier bringing PSW in the area and maintaining the β-ocean state on the northwesternmost side of the Strait." Some precision in language is warranted. The fact that the alpha ocean is not expanding does not prove that the EGC is a barrier, but rather is consistent with the hypothesis that the EGC acts as a barrier. Or it implies that the EGC might be acting as a barrier.
We agree with the reviewer that this statement required clarification, and we have revised it accordingly. The sentence now reads: “Even if the α-ocean area is warming, it is not expanding northwestward. This suggests that the EGC may act as a barrier, bringing PSW into the region and maintaining the β-ocean state on the northwesternmost side of the strait.”

6. Minor style/grammar issues.
Thanks a lot for the careful revision of the style and grammar mistakes. We have now addressed all of the comments.
a. line 18. "the north and northeast regions" -> "the north, and the northeast."

b. line 22. "that, the" -> "that the"

c. line 22. "south, by" -> "south and by"

d. line 39. "play" -> "playing". (Or alternatively put a comma after "circulation".)

e. lines 54-55. Change hyphens to em dashes.

f. line 56. "retreat and" -> "retreat, and"

g. line 56. "drives" -> "drive"

h. line 57. Sentence too long. I'd suggest starting a new sentence with "Sea-ice retreat"

i. line 81. "IPCC" acronym is not defined, and the relevant citation needs to be clear about the specific IPCC report that is being cited.

j. lines 85-86. "on Climate Change" looks to be an erroneous citation for the IPCC report. Correct citation.

k. line 96. "supply and" -> "supply, and"

l. line 137. Missing parentheses around (2018).

m. line 138. "was" -> "were"

n. line 142. "where" should not be indented after equation (1).

o. line 151 and following. Paragraph appears to be erroneously indented relative to equation.

p. line 155, line 158. N should be italicized to match notation in equation (2).

q. line 156. "any" -> "either"

r. line 158. "stratified" -> "stratified,"

s. line 160. "MLD we" -> "MLD, we"

t. line 160. Remove "one-dimensional" since the same information is repeated in the next sentence.

u. lines 167, 168. Mathematical terms should be in the same font used for mathematical terms in equations.

v. line 169. "0.25 local" -> "0.25, local"

w. line 169. "with ERA" -> "with the ERA"

x. line 171. "allows to" -> "allows us to"

y. line 179. "positive (negative)". This structure is hard for readers to parse and can easily be avoided by slightly stretching out the sentence: "is positive in alpha oceans and negative in beta oceans."

z. line 183. "seasonal" -> "seasonal,"

aa. line 184. "are shown in Figure 2" -> "(Figure 2)"

bb. line 204. "summer but" -> "summer, but"

cc. line 261, line 264. "West" -> "west"

dd. line 268. "where": Should this be "when"? The phrasing appears to refer to timing rather than geographic location.

ee. line 270. "is average" -> "is near its long-term average".

ff. line 273. "we consider that a 2-year" -> "in our assessment, a 2-year

gg. line 283. "2016) but" -> "2016), but"

hh. line 293. "except the last decade where" -> "except during the last decade, when"

ii. line 334. "summer stratification" -> "stratification"

jj. line 357. "soobtained" -> "so obtained"

kk. line 358. "roughly with" -> "is roughly"

ll. line 370. "Icelan" -> "Iceland"

mm. line 379. "Then in " -> "In "

nn. line 381. "Then in" could remain as is, but this also might be smoother if changed to "In"

oo. line 428. "north and" -> "north, and"

pp. lines 429-431. Change to "of both the increase in surface temperatures, i.e., northward shift of warmer isotherms over the Iceland Faroe Ridge (de Marez et al., 2025) and the"

qq. line 434. "subjected" -> "subject"

rr. line 435. "variability (ii)" -> "variability. (ii)"

ss. line 438. "and accounting for" -> "and experience" (I'm not sure what you mean, so this is my guess.)
tt. line 433 and line 443. "Four main" seems to be undermined by point (v) at the end of the paragraph.

Report #1
Referee #2

I think that the authors have responded well to my comments and that the manuscript is ready for publication. I have only a few minor, editorial comments.

We acknowledge the effort from the reviewer to help this manuscript improve. We have attended all your minor comments below.

Detailed comments:

Line 112:
Niskin bottle is misspelled.

Fixed.

Line 142:
There's one comma too many on this line.

Thanks, we have rephrased the sentence.

Line 167:
The bulk and gradient Richardson numbers should be consistently capitalized.

Fixed.

Line 275:
There's at least one comma missing in "...deeper, colder, and fresher MLS...".

Fixed.

Line 305:
It would probably be more correct to write "The Pearson correlation coefficient...".

Thanks for your suggestion, we have now modified the text in Table.

Line 362:
There's a mismatch between the legend and the description in the figure caption regarding the colors of the different lines. Also, the black dots and lines represent the mean fall, winter, and summer MLDs and standard deviations, not just from winter and summer.

Thanks for pointing this out, we have now fixed the caption in Figure 8.

Line 370:
Iceland is misspelled.

Fixed.

Line 370:
Northern is misspelled.

Fixed.

Supplementary Figure S4:
It is interesting to see the various combinations of forcing mechanisms, but I don't fully understand the text introducing the figure. Do you mean that you use summer profiles to initialize the simulations? In that case, shouldn't the time along the x-axis be adjusted with start in summer rather than fall? If you show the same simulations, there seems to be a mismatch between the MLD evolutions in Figures 8 and S4 that I can't account for. Please clarify the text.

Thank you for your observations. We had rewritten the text introducing the figure to ensure consistency with the Figure S4 and the actual study. The new analysis is now initialized in the fall. The new text now reads "The summer stratification around Iceland is an order of magnitude higher than in winter and hence summer MLDs are very shallow for all stations. Figure S4 shows the PWP 1D model initialized in the fall (excluded from the manuscript) showing the evolution of the ML over the fall, winter, and summer (the shallowest of all)."