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Dear Editor,

Thank you for your positive feedback on our revised manuscript. We are pleased that the reviewers are satisfied with the corrections and responses we have made.

We have now implemented the minor corrections provided by the reviewers, as detailed below.

We appreciate the opportunity to publish our work in GMD and we thank the referees for their constructive feedback.

Best regards,

Sofia Allende

Referee 1:

I thank the authors for addressing my questions and critical points well. I think the manuscript is now almost ready for the publication. I noted only three very small things:

- Would be good to mention that the upper limit of f_r is 0.1 for example in line 94.
We changed the phrase to: " Here, z is the depth, f_r is the fraction of the surface TKE e_{surf} that penetrates into the ocean, and it ranges from 0 to a maximum of 0.1."

- line 94: remove comma after f_r
Ok.

- line 188: 'Data are'
Ok.

- There is no discussion on the mean absolute error in lines 293-303, or elsewhere in the manuscript.
As previously discussed, Figure 11 illustrates the spatial distribution of differences in sea ice concentration and thickness between the sensitivity experiments and the control run for March and September. The differences were calculated as the difference between the experiment and control for sea ice concentration and sea ice thickness. For example, a positive difference indicates that the sea ice concentration in the control run is larger than in the experiment, while a negative value indicates the opposite. For instance, in the referenced lines, we write:
" The simulation with no TKE MLP ($f_r = 0$) displays a 7% increase in sea ice concentration relative to the control case, while simulations with more TKE MLP under sea ice ($\chi = 1$ and $\chi = 1 - f_i$) show a 10% and 7% decrease in September, respectively. A similar behavior is observed for sea ice thickness, with

the largest differences between experiments observed in the Canada Basin. In September, in the $f_r = 0$ experiment, sea ice thickness increases by 14 cm; in the $\chi = 1$ experiment, sea ice thickness decreases by 24 cm; and the $\chi = 1 = f_i$ experiment shows a decrease of 13 cm in the sea ice thickness, relative to the control case."

Referee 2:

This paper examines the impact of ocean vertical mixing on sea-ice and upper ocean properties in 1 degree NEMO-SI3 simulations. It looks like this paper has gone through several rounds of review previously and thus is in very good shape, even if this is my first look at it. At this stage, I only have minor technical comments as the latest version reads well, with good quality figures.

- L80: Define what you mean by the last version of NEMO. Given many groups use different versions, explicitly mention the version in question.
We thank the Referee for this remark. We have revised the phrase to avoid referencing the NEMO version, as it is explained later. The updated text now reads: " Madec et al. (2017) introduce significant modifications to this parameterization."

- L106: Given NEMO is a geopotential coordinate model, I think level thickness is a more appropriate term than layer thickness.
Ok.

- L108: What do the authors mean by "atmospheric forcing for the ocean"? Is it different for the sea-ice? Or do the authors just mean all the NEMO experiments in this paper are forced by ERA5?
Yes, this phrase simply means that all the NEMO experiments are forced by ERA5. We have changed the text to: " In our simulations, NEMO is forced by ERA5 reanalysis (hersbach et al. (2020))."

- Figure 2: The yellow dashed line for the Canada Basin box is near impossible to sea. Even the green for the Eurasian Basin is not very clear. Use other colours.
We have modified Figure 2 to provide a better visualisation of the three basins.

L216: MLD (not MDL).
Ok.

- Figure 8 caption: What does "maps difference" mean? Maybe an of is missing after maps?
Ok.

- L320: deep not depth.
Ok.

- L405: In the discussion, the authors mention other ice covered regions. I'd like to see some speculation about which parameterization to use for these areas. Additionally, as the climate warms, and sea-ice decreases, might that require changes to the parameterization in the future when there is less ice?
We thank the referee for this suggestion. We have added the following phrase: " In particular, the Arctic region has been significantly impacted by global climate change, resulting in a rapid decrease in sea ice extent. This phenomenon is expected to alter the exchanges between the atmosphere and ocean, thereby affecting the fully-coupled ice-air-ocean system in the Arctic, and consequently influencing the mechanisms driving the TKE MLP parameterization." (lines 416-419).