Response to reviewer comments on Kolås et al. EGUSPHERE-2023-2864*, The Polar Front in the northwestern Barents Sea: structure, variability and mixing.*

We thank the anonymous reviewer for the constructive comments and useful suggestions, which helped to improve the manuscript. Below we provide a point-by-point response to all comments. Reviewer comments are reproduced in *italic type in red* followed by our response in regular type in black color. The future tense refers to our plan to address the comments when preparing the revised version.

Response to Reviewer 1

Kolås and colleagues provide a detailed analysis of the oceanographic characteristics of the polar front in the northwestern Barents Sea (BS). The paper uses a comprehensive observational dataset (a subset of the companion paper submitted to JRL, as I understand it) obtained as part of the Nansen Legacy project with traditional and autonomous platforms (gliders), which is undeniably more detailed in terms of spatio-temporal variability, but also more complete in terms of physical variables than any previous dataset. To this end, the authors make a very valuable and serious contribution to the community. In addition, the writing and overall form are excellent and well streamlined, making life really easy for the reader.

We thank the reviewer for the positive comments on our manuscript and for recognizing the value of our data. We are glad the reviewer found the structure of our paper satisfactory.

This study is rather technical (which is fine!) and I find that the authors could discuss implications slightly more. The BS has long been thought a "hot spot" for marine productivity.... Due to strong vertical and/or cross-frontal mixing. However, this study confirms that the front is a place of "moderate turbulent mixing" (mainly at the surface and at the bottom) and that subsurface mixing occurs more along the isopycnals. And in fact, to the best of my knowledge, the front was never demonstrated as a significantly more productive area than the rest of the BS. The area studied is the only northern gateway to the western Barents Sea. As the front extends to the east, we might expect the same effect to occur here in the West. Interestingly, this is not the case seasonally, and from one year to another. The implications, both in terms of biogeochemical tracer and heat, are that the PF front acts more as a barrier to the AW domain (rather than a mixing machine) and to the ongoing "Atlantification". To go beyond, the AW have to subduct, transporting heat, salt and… carbon along isopycnals... which could eventually be sequestered further in the Nansen Basin.

Another interesting aspect of this study is that it provides the first very interesting evidence of the baroclinic structure of FP. This structure could favor baroclinic instabilities. So I can see why the authors took the time to study eddies (although they were created elsewhere). These vortices could temporarily tilt the isopycnals even further and provide additional mixing. It's fascinating that this physical feature has been studied for decades and still holds so many mysteries.

Thank you for providing useful reflections. We agree that we could discuss the implications of our findings more. When preparing the revised version, we will append the discussion on implications.

I found no major problems with the manuscript, which I recommend for direct publication. I recommend only very minor edits/additions for which (I think) it is not necessary to send the manuscript to the reviewers again:

Thank you for recommending our manuscript for direct publication. Below we respond to your minor comments individually.

- *Please specify somewhere that altimetry provides only surface geostrophic velocities. No need extra work but you could provide existing (very few) studies that evaluated those products for quality control in the region.*
  We agree and will include references to at least Carrere et al. (2016) and Pujol et al. (2016) who evaluated these products.
- *Figure 2: please provide brief information in the caption about transects A, D, F so that the reader so remains in the blue until Figure 9.*
  Agreed.
- *Figures 3 and 4: curious arrangement… panel labels at the bottom, colorbars squeezed in the middle. It would help to pop out the colorbars. Panels are un-scaled, you can notice through the y-axis which should be the same everywhere. This is okay and probably complex to fix, but I recommend to improve the visual. I would just use the same "frame" and leave blank where there is no data (no obligation, you probably tried already, just my suggestion).*
  Thank you for your suggestions. We agree these figures are complex and could be improved. The reason for "squeezing" the colorbars is that popping them out requires more of the width of the figure, resulting in the panels being more squeezed. The y-axis is scaled so that the height of 100m depth in one panel is equal to the height of 100m depth in all other panels. We insist that this uniform height in the vertical is a better representation when comparing different transects with varying maximum total depth. The y-axes between different panels have different heights because the individual transects differ. Some of the transects extended further south where the ocean is deeper, hence the height of that panel must be larger. We now include the following sentence in the caption: "The vertical-axis is scaled so that the height of 100 m depth is equal in all panels.".
- *Line 327, just say add "following" section, it helps to grasp the nice flow of the article. Nice transitions.*
  Agreed.
- *Figure 6: I recommend to draw some box, or arrow to describe the eddy position, structure, etc… because from isopycnals it looks like 2 eddies which are merging and it creates a bit of confusion when reading.*
  Thank you for suggesting this. We now draw a box around the eddy in panel (c).
- *In the discussion I would have liked a word on the intensity of the density gradient.*
  Agreed. The gradient across the average density front presented in our study is about one tenth of the surface density front observed by Parsons et al. (1996) (0.008 kg/m^3/km vs 0.05 kg/m^3/km). However, the surface and subsurface fronts are two different domains and are not directly comparable. Most frontal studies in the Barents Sea studied the subsurface temperature and salinity gradients individually as they tend to be density compensating (Oziel et al., 2016; Barton et al., 2018). However, estimated from Fig. 7 in Barton et al. (2018), the 1985-2016 average density gradient across the Ludlov Saddle in the Barents Sea, at 100m depth, is approximately 0.003 kg/m^3/km. We now include this in our discussion.

- *I would also like a comparison of magnitude of the dissipation rate with previous estimates and/or close-by regions, besides Fer and Drinkwater (2014).*
  Dissipation rate estimates in the region are sparse. We now added comparisons to estimates from Sundfjord et al. (2007) and Fer and Sundfjord (2007), and to relevant results from nearby regions such as north and west of Svalbard to give our measurements some context.

- *If the structure of the PF is baroclinic, then the use of altimetry must be at least questioned.*
  Thank you for pointing this out. We will include this in our discussion.