Reply on RC3
Mario Hoppmann et al.

Author comment on "Mesoscale observations of temperature and salinity in the Arctic Transpolar Drift: a high-resolution dataset from the MOSAiC Distributed Network" by Mario Hoppmann et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2022-66-AC3, 2022

The authors present a dataset of upper ocean temperature and salinity from drifting buoys that were deployed as part of the MOSAiC Distributed Network. The dataset represents valuable observations from the central Arctic Ocean over a 10-month period, including the scarcely observed Arctic winter. Observational methods, data processing steps and the resulting dataset(s) are described in detail, and some preliminary analyses of the data to investigate the signature of an eddy in the distributed network are shown.

The manuscript is in general well written with mostly clear and useful figures. Some revisions could help to improve readability and avoid confusion in an otherwise highly relevant publication.
#We thank the reviewer for the positive feedback. We incorporated the comments into our revised manuscript, hoping to remove the confusion and improve the overall quality.

Main concerns:

There is a bit of repetition between the Methods and the Results section, esp. with 4.1. This is maybe not surprising given the nature of a data paper, but could still be avoided, and the manuscript could be more streamlined.
#We agree with this assessment, but this is somewhat intentional. This dataset as a whole is a little complicated, and there is great potential that a reader might get confused easily if only parts of the manuscript are read. We intentionally included some repetitions where appropriate to make individual sections (such as 4.1) better understandable on their own, when the other sections are not read in detail. There is absolutely a lot of room to cut information out, but we would prefer not to do so, even if it makes the overall manuscript longer. We hope for your understanding.

The introduction is quite lengthy about mesoscale and submesoscale features, but then there is nothing more these throughout the methods and the results section. First in the discussion, you pick up the topic again by describing the passage of an eddy. To show that the dataset is useful to investigate (sub)mesoscale features, which you explicitly present as an aim of the design of the DN and this manuscript, a bit more analysis in this direction would be useful. For example, more detail on the drift trajectories of the buoys relative to each other beyond just the map in Figure 3 (and the short sentence on Lines 267-269) could easily provided, such as a timeseries of the relative distance of the buoys to each
other or of the maximum diameter of the area covered by the buoys. That would link
nicely to the discussion around the size of the eddy and could indeed demonstrate that
this buoy network can capture (sub)mesoscale features.
#As also explained in our response to reviewer 1, we tried to improve the previous
mismatch between the intro and the analysis by moving some of the submesoscale
material to the discussion, alongside a new Figure 8 which shows TS diagrams for different
measurement intervals (which is a similar concept to the distance analysis suggested by
the reviewer). As there are currently 3 more manuscripts in preparation that use the
present dataset to look at (sub)mesoscale features, we would prefer not to give away to
many details. We therefore hope that this additional analysis is sufficient to make the
point.

Be more precise with the variable names – I have to assume that you talk about in situ
temperature and practical salinity but cannot know for sure, so please make this clear at
the start of the manuscript.
#This is correct. There are indications about this throughout the manuscript, but now we
state this explicitly at the beginning of the data processing section.

Many of the figures are not colour-blind (or greyscale friendly) – consider modifying them.
#Thanks for the suggestion, this will be fixed in the final version.

Other comments:

Line 21: “much greater than” – can you be more precise? E.g. give order of magnitude or
similar?
#Changed text to indicate that timescales are up to the order of months.

Line 21&22: “the vertical velocity” and “the horizontal velocity” – sounds odd (like there is
only one fixed vertical velocity and one horizontal velocity); suggest to change to “vertical
velocities are … weaker than horizontal velocities”.
#Done.

Line 41: “submesoscale processes are responsible for … restratification” – suggest to
change to “contribute to”. Du Plessis et al. (2019) still state that the main driver for
springtime restratification is surface heating.
#We have changed the text to "contribute to". There are many processes driving mixing
and restratifying the water column, dependent on season, region etc. Du Plessis et al.
(2019) name submesoscale processes as strongly influencing seasonal restratification
processes, e.g. their abstract states: "An increase of stratification from winter to summer
occurs due to a seasonal warming of the mixed layer. However, we observe transient
decreases in stratification lasting from days to weeks, which can arrest the seasonal
restratification by up to two months after surface heat flux becomes positive. This leads to
interannual differences in the timing of seasonal restratification by up to 36 days." The
point of the citation in our manuscript is to put forward the importance of submesoscale
processes for the upper ocean, not to give an accurate account of seasonality in the
southern oceans. In the Arctic, horizontal density gradients can lead to submesoscale
adjustment in the mixed layer, effecting restratification in the formerly well-mixed upper
layer (e.g. Timmermans et al., 2012).

Line 66: Is “synopticity” really a word? (Or rather, a word in this context?) Suggest to
rephrase.
#This has been changed and now refers to the design of hydrographic surveys.

Line 84: Which feedback? Sounds like there is only one...
#This has been changed to reflect that there are manifold feedbacks, without going into
further details though.
Line 93: Do you mean upstream IN or OF the Transpolar Drift?
We added an "in".

Line 101: Same issue: upstream in or of the TPD?
We added an "in" as well.

Line 109-110: "the ice relative drift across the liquid ocean" – weird formulation.
Rephrase?
This has been rephrased to just "ice drift"

Line 117: “ensued” – is this the right word? Or should it rather be something like “took place” or “were done”? I assume there was a degree of planning involved in the location of the DN.
The intro has been changed extensively, and the wording mentioned here was changed in the process.

Line 135-138: This part is confusing. So the CTDs are measuring every 2 minutes regardless of what the buoy is doing. Then there’s an extra measurement when the buoy is polling – so "its measurement interval" means the buoy’s measurement interval? And the data the buoy sends back via iridium – that’s only those extra measurements or all of them?
This paragraph has been strongly modified, as reviewer 1 had the same problems understanding it. We hope it is much clearer now. You are generally right, the buoy wakes up every 10 minutes and lets the CTDs take a separate measurement, regardless of the CTD internal recording interval. Only this one is transmitted.

Following on from that, on line 142 you write “All data” – is that now the data from the measurements polled by the buoy or indeed “all” data??
"All data" in that case refers to the CTD readings as a result of the "extra" measurement, along with GPS, surface temp and submergence. The buoy does not have any means to access the internal storage of the CTDs.

Please rework this part to clarify.
The part was reworked.

Line 145 and throughout: when you write “temperature”, is that in situ temperature? Please clarify in the text.
We added a general sentence at the beginning of the data processing section: "In this paper, we are exclusively referring to in situ temperature (T in $^\circ$C) and practical salinity (S in PSU), if not stated otherwise." We hope this makes it clearer.

Line 147: “the other variables” – I assume that’s conductivity, (in situ?) temperature and pressure?
Yes, this has been made clearer now.

Line 147 (and throughout the manuscript) provide version numbers of software and toolboxes used.
Version numbers have been added where relevant.

Line 169: Protection from what? Towels don’t strike me as the best protector from freezing in -15deg C.
Haha, you might be right, I guess towels are not the best protection against cold air temperatures. There were significant constraints on logistics and everything was quite hectic, which led to us not having any good means to keep the instruments heated pe-deployment. It might be embarrassing, but in the end we had to use towels to at least provide some sort of protection while handling the CTDs on the ice and in the snow. We
deployed the tether manually with 2 persons without the help of a tripod, so the instruments had to be placed on the ice/in the snow for up to an hour while we attached them to the cable. This also means that there were no 5 persons to handle every instrument while lowering the tether in the hole, so we actually had to drag them over the ice. To make a long story short, we did only have towels, which is better than nothing, and next time it should probably be done differently.

Line 171: What do you mean by "hydrohole"?
#This is the term for an access hole through the ice into the ocean, and is regularly used in the literature. We changed this now to "hole in the ice" though.

Line 179: The CTD data from recovered instruments then also provide higher accuracy pressure data?
#This is correct. As described further down in the data processing section, we even used the more accurate recovered CTD data to increase the accuracy of the corresponding transmitted buoy data.

Line 186: Replace "using" with "indicated by" or something similar (you didn't "use" the flag to modify the data).
#Changed as suggested.

Line 190: How did you fill the gaps in the GPS record after removing outliers?
#The gaps were filled by linear interpolation. This has been added. (It was just a handful of outliers.)

Line 191: What was the consequence of applying the threshold? A different flag? Or removing data points?
#The data points were removed. This has been added.

Line 192: How did you determine "plausibility"?
#We just did a general range check and looked at the seasonal evolution. We did not compare or validate against other meteorological data, since this parameter is not in the focus.

Line 220: What do you mean by "sim"?
#This should have been \sim, which is the LaTeX code for ~. It is fixed now.

Line 223: How big was the drop in conductivity?
#The drop in C was from ~34.1 to ~33.5 PSU, and not accompanied by a temperature change. This has been added.

Line 229: Capital O in the buoy name.
#Done

Line 240: Add “practical” to salinity.
#Done

Line 243: Is the closing bracket in the right place? Bit confusing at the moment.
#The comma was in the wrong place, and it should be clearer now.

Line 253-254: It would be useful to include this information in one of the tables, e.g. Table 1. If you explicitly state here all buoy numbers of the ones you can provide a merged product from, then also provide the numbers of the ones with buoy data only.
#Good point. This information has been added to Table 3, where it is most relevant. Also, we included a detailed overview to the part this comment refers to.
Line 255: I guess the measured temperature is in situ temperature? And the derived salinity practical salinity (and not absolute salinity)?
#This is correct, and has been added here. We also added a general sentence as suggested in another comment.

Figure 2: Nice schematic! You could mark which of the steps were not included in the processing for buoy-only datasets.
#Actually this is the purpose of the steps that have a similar grey background as the SBE37 field at the top. Those have not been applied to the buoy-only datasets.

Table 2: In situ temperature?
#Yes, this has been added.

Figure 5d: axis labels in the salinity panel are missing. If they are not included because of the icing issues, why show the data at all?
#Thanks for catching that, the labels should be there. The graph shows the reasonable data. This will be corrected in the next version.

Presentation of the timeseries starting Line 274: Refer to the respective figures/panels.
#References have been added to the time series description.

Line 276: delete “a”
#Done

Line 276-277: Isn't 2.5 weeks a pretty long time for ice in the conductivity cell to disappear? Was the water at freezing point at 50 m depth throughout this period?
#We tend to agree, but we don't have any other explanation for that effect. It's not that there was an ambiguous adjustment, the salinity was completely off track. We included a sentence that this is rather unexpected, as you suggested.

Line 318-319: Is a drop in pressure not equivalent to instruments rising? “... causing the surface buoy to drop” => shouldn't that then lead to an increase in pressure? I can't follow your argument here.
#Thank you for catching this. Of course we meant that the pressure increased. this has been corrected.

Line 323-324: How long did this issue last? The entire record?
#Yes, this issue lasted the until the end of the operational period, which for this buy was anyways only two weeks. This information has been added.

Line 329: Replace “in” by “the”.
#Done

Line 338: Where below? Provide section/section number.
#Reference to Section with description of cross-validation has been added.

Line 374: What is the stated accuracy?
#The stated accuracies have been added.
Figure 7: I’m confused by the shading in panels c and d – please provide a clearer description in the caption.
#This has been clarified.

Line 472: Publish the code together with the dataset or place it on e.g. github or similar sites.
#Reviewer 1 had the same comment. We did consider it, but since the processing code doesn’t include any particularly innovative techniques and is only tuned towards this particular data set, we decided that there is not enough added value to putting the project on Github or similar repositories. If this is a requirement for the journal though, we will of course reconsider this.

Figure A1 is not referred to in the text.
#This figure has now been referred to in the Results section.