General comments

The authors have taken advantage of repeat oceanographic measurements in the Kangilliup Sermia fjord region to examine the influence of glacial mélange meltwater on water column temperature and salinity. Along with discussing the event and its impact within Kangilliup Sermia, the authors compare with Kangerlussuup Sermia and consider possible alternative processes that could influence observed changes. Overall, the paper is nicely organized, provides complete analysis of the observations, and presents a variety of useful visuals in the primary manuscript and supplementary materials. The results will be of interest and use for researchers examining ice-ocean interaction, modeling glaciated fjord environments, and considering system connections from glacier/ice sheet to ocean properties and onto biogeochemical processes.

For all figures the authors should check compatibility with colorblind requirements. They might also consider introducing different symbol types when appropriate to help to distinguish datasets.

Finally, I've included a variety of mostly minor comments below. After completing my initial review, I also read through the comments from Benjamin Davison and overwhelmingly agree.

The authors thank Dr. Moon for reading our manuscript and providing a thorough and positive review, the suggestions in which will be beneficial to our paper. We have provided responses to Dr. Moon's comments and will modify our manuscript accordingly in the next submission.

Specific comments (by line number)

1. Consider shortening title to "Ice mélange melt changes observed water column stratification at Greenland tidewater glacier"

The authors will shorten the title to "Ice melange melt changes observed water column stratification at a tidewater glacier in Greenland". This will shorten the title, but also keep the focus of it on tidewater glaciers rather than Greenland specifically.

12. "brash ice" is only used twice in the manuscript – suggest using an alternative in both places and avoiding the phrase

The phrase brash ice will be removed from the manuscript in the abstract and on line 12.

30. correct to "marine-terminating"

This will be corrected in the new version of the manuscript.

31. Rather than use "these glaciers", suggest specifying the glaciers in question again. E.g., "The rapid retreat of Greenland marine-terminating glaciers...". It is easy for use of

“these/this” type of words to be confusing and I recommend checking this across the manuscript. I noted similar instances of confusion here: “where” in line 351, “This” in line 396.

Vague language such as the examples mentioned here will be changed accordingly throughout the manuscript.

32-34. The note in this sentence (and in the last sentence in the paragraph) feels out of place to me or perhaps a not-so-useful transition. The topic within this sentence is rigid mélange influence on ice dynamics/retreat. But this paper really focuses on mélange melt. This could link with other ice-ocean processes that influence ice dynamics/retreat (noted line 49), but I find the focus on mélange rigidity re: glacier dynamics perhaps unnecessary.

It does strike me that this connects with the comments from Benjamin Davison re: ~line 300. The authors might think more about how much or little to discuss mélange rigidity across the paper and edit accordingly.

We believe that some mention of rigidity is important here, as it highlights the difference between the impact of ice melange on water column properties as opposed to free floating icebergs from a typical calving event. The rigidity of the ice melange, even if only for ~12 hours, increases the residence time of icebergs in the glacier-adjacent water column. The authors plan to rephrase their focus on rigidity to remove the discussion of its impact on glacier dynamics, as that is likely minimal with the short-lived duration of the ice melange presented here. Instead, the authors will refocus the discussion of rigidity on how it prolongs the residence time of icebergs in the proglacial fjord.

45. remove “of”

This will be removed in the manuscript.

49-50. The sentence is easier to read and shorten when writing “increasing glacier and ice mélange submarine melting”. Consider if similar changes can help in other parts of the manuscript. (This is one of many excellent writing tips from the recommended Writing Science book by Joshua Schimel.)

This specific instance will be changed in the manuscript and we will look through the rest of the manuscript for additional examples of this.

69, 73, 76. Recommend adding information on the bathymetric uncertainties in this region. Those vary widely across Greenland and would be helpful context for the reader. Similarly, including information on maximum fjord depth in this paragraph.

We will add a statement on bathymetric uncertainty to this paragraph, which is +/- 10 m in this region. In addition, we will add the maximum fjord depth for both RNK and KAS to this paragraph, which are 1,100 m and 620 m respectively.

75. remove “-1,000 m;”

This will be removed in the manuscript.

86. It would be useful in this paragraph to introduce a clear definition/distinction between icebergs and ice mélange that can be used throughout the manuscript. This paragraph would also benefit from including mention of the time periods evaluated by Sulak et al. (2017) and any note on whether there’s an expectation of substantial change between that observation period and the one used within this paper’s research.

We believe that our definition of ice melange in the introduction section is sufficient, as we specify that ice melange is the frozen conglomeration of icebergs and sea ice.

Sulak et al. (2017) evaluated icebergs in the fjord of Kangilliup Sermia and Kangerlussuup Sermia in the summers of 2013, 2014, and 2015. This bookends the observations presented here, so we do not expect any change in iceberg distributions between our research and the observations presented in Sulak et al. (2017).

87. remove “similarly”

This will be removed from the manuscript.

Figure 1. (a) would benefit from slightly more satellite image viewable on the right and could be balanced by a small reduction on image left. It would also be useful to have the sill locations indicated in (a) and consider adding the tracks from (c) into the map-view in (a) (they could even have hash marks to help viewers align the data in (c)). In the caption, it would be helpful to add the rough time period for clearing at the end of the sentence noting formation over 6 hours (e.g., x hours or z days).

Figure 1 will be modified as suggested by shifting the focus of the satellite image towards the ice sheet, annotating the sill locations, and adding the location of the bathymetry profile from (c) into panel (a). The time period for ice melange clearing will be added to the caption.

106. change to “event discussed here”

This will be changed in the manuscript.

135-136. Why 250 m plume width? Also, why use the post-ice mélange CTD casts for the initial plume model stratification instead of pre-ice mélange? Can the authors also provide a note on uncertainty related to the plume model and what that implies for confidence on neutral buoyancy depth?

A 250 m plume width is used as work done by Jackson et al. (2017) focused on Kangerlussuup Sermia found that a line plume of ~200 m width best matched observations in this region. We quantify the uncertainty of different plume widths by varying the plume width between 100-500 m in our model (as discussed on Line 135) and presenting these results in the Supplementary Information (Figure S8). Despite the

large range of tested plume widths, the subglacial discharge plume always reaches neutral buoyancy at depth in the fjord (between 100 - 250 m deep).

We use the post-ice melange CTD casts so that we can more easily compare our predicted plume neutral buoyancy depth with the water column velocity observations from the ADCP presented in the main text of the manuscript.

163-166. The second sentence here is confusing re: varying the depth range – please edit for clarity.

We will change this from “We vary the depth range considered between 100-300 m…” to “We vary the maximum depth considered between 100-300 m…” to clarify that we are only testing the sensitivity of our results to the size of the control volume.

167. The authors note here that runoff/subglacial discharge don’t vary substantially. Looking at Figure S7, an initial read would suggest a notable reduction in runoff (~300 to 100 m3/s) during the mélange event when only looking at the runoff record. Providing comparative numbers (runoff vs mélange melt) or an alternative justification (e.g., line 284 about runoff vs subglacial discharge) could be helpful to convince the reader of the reasonableness of this approach.

We agree that there is a reduction in runoff during the ephemeral ice melange event investigated here, although the authors still believe it is negligible in the calculation of ice melange meltwater volume. As the rate of subglacial discharge decreases between the two hydrographic cast dates, the contribution of subglacial discharge to the control volume would be less in the second water column profile than the first. This would only increase the influence of the ice melange melt on the water column. We will highlight this impact in the new version of the manuscript by noting that the runoff does not substantially increase in between our two data collection dates.

180+. The authors note that the ice mélange broke up, moved down-fjord, and most of the ice mélange was transported out of the fjord. How much do you expect that freshwater is going to circulate and transport out along with mélange? In other words, what might you speculate about freshwater changes between August 9 (fjord cleared of ice) and August 11 (date of observations)?

This is difficult to quantify without observations during this time period, but we do expect that some of the freshwater from the ice melange event was likely transported out of the fjord during this gap in observations. We expect that the icebergs were likely exported from the fjord before the meltwater was, as icebergs are subject to both the variable ocean currents in the submarine environment, as well as strong katabatic winds that can clear the smaller icebergs in the fjord. In addition, numerical modeling results of fjords with geometries similar to Kangilliup Sermia have shown that ice melange meltwater is typically recirculated into the fjord at the sill, leading to a longer residence time of the meltwater in the fjord than the icebergs (Davison et al., 2022; Hager et al., 2024, The Cryosphere). While we don’t have direct observations of the water column during this time period, we would expect that the magnitude of cooling and freshening

observed here would have been even larger had they been taken directly after the ice melange breakup. A logical next step to further the research presented in this paper would be to do a focused study on water column change in a fjord with ephemeral ice melange by completing CTD casts before, during, and after events. This would help establish the exact timeline over which the water column is transformed.

Figure 2. I don't understand why the Aug 11 ~0-20 m water column is warmer than the Aug 4 0-20 m temperatures and this isn't explained in the text. Perhaps some of the information in the sentence at lines 206-208 is meant to help (noting freshwater surface input), but I was no less confused after reading this sentence. Or is the note at line 286-287 meant to address this?

The notes in lines 206-208 and 286-287 are meant to help explain this, but the authors will make these points more explicit in the next version of the manuscript. While the upper 20 m are warmer after the ice melange event, we note that the water column remains much fresher in this layer after the event. Two main mechanisms could have contributed to this. First, as noted in the lines mentioned above, the waters at the surface of the water column are pulled back towards the runoff mixing line in the upper 20 m. This suggests that the iceberg melt-modified intermediate waters (50-100m) are being mixed with a surface input of freshwater, which is likely terrestrial runoff.

An additional mechanism that could have contributed to this warming is atmospheric heat flux. The cold and fresh meltwater layer is subject to heating from the atmosphere, which could have contributed to a warming of the upper 20 m of the water column. Unfortunately the glacier-adjacent weather station was recovered just before the ephemeral ice melange event investigated here, so we are unable to directly calculate the heat flux added to the water column during this time period. However, time-lapse video footage of the proglacial fjord shows that the weather was sunny for the duration of the ephemeral ice melange event.

We estimate that ~30 W/m2 of net heat flux would be needed to cause the observed warming in the upper 20 m of the water column using the equation Qnet = (dT/dt)*rho*Cp*Z, where dT/dt is the change in temperature in the upper 20m of the water column between our two observations, rho is the average seawater density, Cp is the heat capacity of seawater, and Z is the depth being examined. ERA5 Daily Averaged reanalysis data shows that the estimated solar radiation between our two observations is ~48 W/m2, suggesting that it is possible atmospheric heat flux contributed to the surface warming of the water column observed here.

Figure 3. In (a) it would be helpful to label some of the depth squares. At first the data I expected in (b) based on (a) and the caption note didn't seem to line up with (b) until I realized that I wasn't identifying the squares in (a) properly. They are very hard to see and it can be difficult to tell black from blue, so some help there would be nice. Please double check all the along-transect plots re: color/direction. For (c), it says that toward-glacier flow is positive (red) and that distance along fjord begins in the south at 0. These appear to mismatch – the top right corner of (c) should be southside toward-glacier flow, not northside toward-glacier flow (and based on line 217 sentence).

It does get confusing since the toward-glacier flow pattern is reversed between the surface and below 100 m. Consider if further editing can help keep this clear for the reader.

Depth markers in panel (a) will be labeled every 100 m to facilitate easier interpretation of the figure.

The authors appreciate the note about the along-transect plots, as this highlighted an error in the figure caption. Distance does indeed increase from north to south, so the figure caption should state that “Distance across fjord increases southward” rather than “Distance across fjord increases from southward”. This will be changed in the manuscript. The color scale remains correct, and with this change in the figure caption the recirculation gyre, where the ocean currents are away from the glacier in the north (i.e., negative velocities) and towards the glacier in the south (i.e., positive velocities) are shown in the blue and red currents respectively.

231. Clarify “highest at the ocean surface” (not subaerial)

This will be clarified in the manuscript.

279. Note the location/boundaries of the warm temperature anomaly

There is no specific warm temperature anomaly observed here. The authors are referring to work done by Carroll et al. (GRL, 2016), who showed that the subglacial discharge plume in deeply grounded systems, such as Kangilliup Sermia, will have higher temperature and salinity than the corresponding ambient ocean waters. This means that if the change in hydrography documented here was due to enhanced subglacial discharge, we would instead see an increase in temperature and salinity in our post-melange hydrographic profiles rather than the cooling and freshening observed.

298-300. This sentence does not read correctly – please rewrite.

This sentence will be rewritten to “While iceberg melt itself is responsible for the freshening and cooling signal observed here, the sea ice matrix holding the icebergs in place in the proglacial fjord supports this meltwater injection into the fjord by increasing the residence time of icebergs in the glacier-adjacent water column.”

300-301. Suggest using “facilitates” instead of “leads to”
Note: I agree with Benjamin Davison’s comments on this topic and that modifications to this explanation are warranted.

The wording in the text will be modified from ‘leads to” to “facilitates”. To address Dr. Davison’s concerns, the wording in this section will be changed to highlight that the limitation of our data at estimating the exact time period over which water column transformation occurs. However, we will still highlight that the formation of a briefly rigid ice melange increased the residence time over which the calved icebergs were able to inject meltwater into the glacier-adjacent water column, as this emphasizes the

difference between the results presented here and those surrounding free-floating icebergs.

394. Suggest specifying “Kangilliup Sermia fjord”

This will be specified in the new version of the manuscript.

Figure S4. Add information to understand north/south on these plots.

Similar to Figure 3 in the main manuscript, a statement indicating that “distance across fjord increases southward” will be added to the figure caption.

Figure S9. What are the black triangles in (a)?

The black triangles are the locations of the CTD casts used in this manuscript. This information will be added to the figure caption.

Table S1. Suggest stating the “full water column” depth range in the caption.

The full water column depth range (5-800 m) will be added to the table caption.