

## ***Interactive comment on “Arctic Ocean outflow and glacier–ocean interaction modify water over the Wandel Sea shelf, northeast Greenland” by Igor A. Dmitrenko et al.***

### **Anonymous Referee #2**

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The authors present a unique dataset of CTD profiles in the Wandel Sea, a previously unsampled region of Northeast Greenland that is subject to a complicated mixture of influences including Arctic ocean outflow (with traces of both Atlantic and Pacific water), ocean-glacier interactions, and irregular ocean-atmosphere interactions (based on the spatially variable history of open water and landfast sea ice).

The largely qualitative description of the various observed water masses in terms of sources and physical processes is plausible, however I found that the organization and description of the various clusters, regions, and processes difficult to follow and at times confusing. Additionally, several of the figures are overly complicated and therefore

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difficult to connect with the conclusions in the text, without a great deal of interpretive effort. To be accepted for publication, I believe that a clearer organization of the results (and figures) would greatly improve the readability.

More importantly, I think that the section dealing with the signatures of ocean-glacier interactions needs to be clarified through a more quantitative description of the processes and expected mixing lines and deviations. The calculation of  $\Delta S$ , along with the vague descriptions of how seawater will cool when it comes into contact with ice are disorganized and not well connected to the current literature of ocean-ice models that are currently in use in many recent manuscripts (e.g. Jenkins, Wilson and Straneo, Mankoff et al 2016, etc). In this treatment, the meltwater mixing line is defined by an end-member corresponding to the "apparent" temperature of a water parcel after losing heat to the ice to overcome the latent heat of melting (and zero salinity). Typically this has a value of approximately  $-90$  degC, and defines a slope against which water properties can be compared to determine e.g. meltwater fractions. No explicit discussion of this approach is made in the manuscript (e.g. by directly applying the model to the properties observed in the CTD profiles), however some discussion of temperature and salinity changes are made in terms of the transfer of heat and salt into the water column (e.g. lines 310). The authors should also clarify how they arrived at the meltwater mixing lines presented in Figures 5 and 6 – is it a result of a derivation of the "virtual temperature" end member, or simply a fit to the observed properties of the near-glacier CTD profiles?

There are also some citation issues, with citations given in the text not matching the bibliography (Jenkins 1998 vs 1999), as well as some citations not present in the bibliography that are cited in the text (Stevens 2015). The bibliography and all citations should be carefully checked for consistency (in addition to the two examples I noted), or managed with a reference manager of some kind.

## Minor corrections

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L131: Isn't region 3 located Northeast of Station Nord?

L185: No Stevens et al in bibliography

L189: I think this "new mixing end member" is the thermodynamic "meltwater" end member discussed above? Why is it referred to so cryptically here?

L225: The use of a "division" symbol is confusing here. Normally it would be a dash, but of course the negative signs would make that even more confusing. Why not use "to"?

L265+: This relates to the qualitative vs quantitative discussion of ocean-ice interaction I discuss above. Do we expect that water should cool to the ambient glacier temperature, or to something reflecting the thermodynamic processes involved (e.g. melting, etc)?

L276: Jenkins 1999?

L280-282: This discussion of the cool/turbid water and the lower boundary of the tongue is confusing and overly qualitative. Is it known that the glacier terminus is floating and not grounded? If so, why would the authors expect that cold/turbid meltwater released from the terminus would be at a neutral density level at the bottom of the glacier? I would expect that typically the salinity reduction due to the meltwater input, followed by turbulent entrainment during buoyant rising would determine a neutral density level somewhere above the depth that the meltwater was released. This is another point that would be clarified by a more rigorous discussion of the ocean-ice interaction processes and models as pointed out previously.

L304: Related – where exactly \*is\* the neutral density level for this water?

L309: the  $\Delta S$  equation – what is the source/citation for this? How is it derived?

## Figures

Figure 2 - L800: "rectangle"

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Figure 3: This figure contains many aspects that are nearly impossible to read, including: the red overlying text, the color scale for station depths, and the white/black circles. It appears that some points are larger than others, which is not discussed in the caption (and may just be a visual trick owing to the white/black borders).

Figure 4: In general, I find the profile (and TS) figures with many profiles overlain with different colors, line styles, and x-axes very difficult to interpret (see main review). I recommend either separating out the different plot types, or perhaps making subplots for the different groups of profiles that overlay the group of interest over the other lines which are colored in grey (so that the relative differences can be seen, but without the visual confusion).

Figure 5 - L830: Should the reference be to Figure 6a?

Figure 5 - L835: Is the meltwater mixing line "derived" from the theory/model, or simply from fitting the data in TS space?

Figure 7: The colors of clusters III and IV are indistinguishable.

Figure 8: Like Figure 4, the combination of colors, line types, and x-axes makes this plot difficult to interpret. Again, I recommend trying to separate out into subplots.

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