

Interactive comment on “Role of cabbeling in water densification in the Greenland Basin” by Y. Kasajima and T. Johannessen

Anonymous Referee #1

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Role of cabbeling in the water densification in the Greenland Basin

The manuscript submitted by Kasajima and Johannessen is a thorough analysis of CTD data taken from the Greenland Basin in terms of the processes and potential for water mass modification through the cabbeling process. This is a useful contribution to the literature of the oceanography of the Greenland Basin, but also fulfils an important role in the techniques of interpreting classical hydrographic sections. Consequently, I would like to see this manuscript published after minor revisions as indicated below.

General comments.

My biggest criticism of this paper, but one that I believe the authors can remedy, is one of clarity; particularly clarity in derived quantities and what they relate to physically. For

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example, in the abstract you refer to a production of NAW of 123 m³/day. I presume that this is per m² surface area. How does this then scale up geographically?

In general the manuscript reads very easily though it becomes more difficult to follow in the later stages - particularly sections 4.2 and 4.3. I urge you to edit your manuscript critically in these sections to aid clarity.

Detailed Comments:

Hydrography: p512 l11-14. I'm a little puzzled by your comparison of fronts between the 1989 section and your section. It would appear that your Eastern most front in Figure 2 is at approx. 17E which puts it to the east of that obtained in 1989. Please check this or modify the figure to indicate more precisely where your fronts are located.

Section 4.1 P517 line 24. You use stratification arguments to explain the lack of high velocity patches above 27.7. Looking at figures 5 and 7 it would appear that there is no significant vertical velocity above 27.9. Further, the 'sharp lateral interface'; caused by presence of sea ice is an interface in what parameter?? It is difficult to conceive that processes at the sea ice edge will have much effect at depth. Finally, what do the black markers indicate in Figure 7. From the caption and from Fig 5 they would appear to represent cabbeling velocities >1m/day - however their size and shape is a mystery.

P518 line 17. Discussion of the cabbeling parameter does not appear convincing. Yes, in region SB where there are significant vertical velocities, there is a substantial lateral change in cabbeling parameter. However, between 8W and 11W at neutral surface 28.05, there appears to be rather minimal lateral change in cabbeling parameter, though from figure 5 one notes the enhanced vertical velocity. Please reconsider your analysis here and provide a more robust assessment of cabbeling parameter in the context of vertical velocities.

Section 4.2 P518 line 21: The first sentence requires a reference.

Equation 5: Please define the terms more carefully paying particular attention to their

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units.

P519 line 3: I presume you mean that there is a change in water mass volume due to cabbeling.

P520 line 10. When discussion the resultant waters, is there an assumption that there is an equal mix of parent water masses? If so, please state this and provide some justification for the assumption.

P519 and 520: In your discussion of the overall formation rates, are you able to able to determine that rates of order 10-11 m³/day are significantly different from zero? If not, then these should be interpreted as an overall formation rate of 0; unless I have mis-understood you arguments. In which case, you need to clarify your position.

P520 line 22: I don't know what you mean by 'at different depths accompanying high pressure gradient in some areas.' Please clarify.

Section 4.3 P521: the first paragraph is very difficult to follow your explanation and arguments. Please revise this paragraph, and if necessary refer back to figures, particularly in the discussion of the relationship between vertical velocity and density anomaly.

P522 line 15. It is not clear where the areal calculation for each front is derived from. The final calculation of total density gain is not clear.

Conclusions:

The final sentence is a very weak end to very thorough and detailed piece of analysis.

Editorial comments:

P517 line 23: suggest the word 'suppresses' rather than 'prevents' P518 line 3: suggest 'indicates that high velocity is primarily due to the high temperature gradient' 518 line 25: should this be 'water mass formation rate' 520 line 5: perhaps 'cabbeling mixing increases the density of NAW without changing&...' Fig 4: '...outcrops to the west of 10.7W and therefore does not appear in the figure.' Table 3: Should this read 'The

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areas of high cabbeling ...' also suggest 'Depth variation' be replaced by 'Depth range'.
Table 3: What does vertical expansion mean? This parameter is not intuitive in the context of the manuscript. Please take the time to introduce it fully. Table 4: Please change layout so that it differentiates SB, AFZ etc properly.

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