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Ocean Science
Discussions

Interactive comment on "Ventilation of the Northern Baltic Sea" *by* Thomas Neumann et al.

Anonymous Referee #2

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This discussion paper presents ocean and sea ice observations from a cruise to the Northern Baltic Sea.

While there is nothing controversial and the discussion and conclusions are somewhat based on the observations, there is a quite modest set of findings. Very little evidence can be provided for how the ventilation is actually taking place. There is one profile that shows ventilated water, and very limited testing of mechanisms or modelling. As it stands now there is no use for all the sea ice observations, as the authors are suggesting the ventilation happens through advection.

The paper is in my view below the minimum of what should be published in an international scientific journal, and appears at present like a cruise report. Until further observations or simulations can be provided, it does not appear like a proper scientific paper. The oceanographic handwork done is of a good quality though, but the authors

have drawn the conclusions based on a very limited set of observations.

The paper largely ignores earlier literature on Baltic sea in special, and on the other relevant processes in question.

There are in my view a number of substantial improvements to be made if the paper should be accepted beyond the "Discussion" part of the journal – as outlined below.

General comments:

- The layer close to bottom at one station (station 9) is marginally interesting. Clearly one would have wanted more than one station to show the persistence of any suggested process. This water is high in oxygen, but also 0.5 deg C above freezing. This indicates that it is not related to sea ice formation, or brine driven convection. So why is all the sea ice observations included? Really – it has no use as the paper is written at the moment. Obviously the authors would have liked to find evidence for the "brine hypothesis" – but they have not.

- There is generally a small number of citations given. While it is good practice not to overflow with too many, here it is on the sparse side. And one suspects that the authors have spent a limited effort on finding relevant studies. A good example is for the experimental studies in polynyas (Page 2, line 5). Clearly there are many more observations available from polynyas, both in the Arctic and Antarctica. As noted by the other reviewer are also some literature on the down-flow required. Examples on earlier polynya studies are given at the end. In general is there also much more available studies of Baltic sea ice available, where the few seas ice samples could be compared to.

Specific Comments:

Page 2, line 7. The Arcic is a name, should always be spelled with capital A. Correct throughout.

Page 3, line 6: Use of "Fast ice" is wrong. Fast ice means sea ice frozen onto the

shore. Here I think you mean pack ice?

https://www.jcomm.info/index.php?option=com_oe&task=viewDocumentRecord&docID=145

Page 3, line 11 It is not clear how you sample the brine. You state that:" holes approximately half the depth of the ice thickness were drilled to collect brine". Do you mean that you take out the core, and wait for water to drain back into the whole? How do you know this is the brine? The brine salinity is very tricky to sample, and conditions here are very special with the super low surface salinities.

Page 4 – lower 4 lines. You simply state you used the (standard) Guildline's Autosal 8400B and the accuracy. It is a standard procedure in the field.

Page 4 –line 8: Are you sure you closed the bottles on the way down? With higher pressures this would lead to the bottles imploding, so the standard is to do this on the way up.

Page 6 –line 7: What do you mean by; "CTD and salinometer measurements of the melted ice core water are very close and, therefore, the CTD measurements appear to be reliable"? How can you take a CTD measurement of the melted ice core? A CTD needs to be fully submerged in ocean water to work, and measures the conductivity over a much larger volume of water that is inside the conductivity cell. . .

Page 6 – line 12; "The mean sea ice bulk salinity in the Bothnian Sea is about 0.6g kg-1". This is a very strong claim when you have ice cores from 3 locations. . ...

Page 8, Figure 4 caption: ice sheets – this means the large piece of ice on Greenland and Antarctica. You may mean "ice core"?

Page 10. Figure 7. The mini CTD observations appear close to the ship-born CTD. If they are plotted in the same figure – then one could see if there are any differences – but this appears not to be the case. This figure is not valuable – unless there are some significant differences – and then these should be shown in Figure 6.

Figure 8: Is this the ship CTD data? Why then is not the warmest water on Station 10 and 12 about +3 deg C visible? And

Page 12 – line 10. Please use one temperature throughout a paper. It is fine to use the new conservative temperature, but then you should use it throughout.

Page 13 – line 1: "we do not have information on surface salinity or currents." This is exactly the main problem. Very little data is available, and then one cannot really conclude on the suggested processes either. A numerical model could have amended this in a nice way.

Page 13 – line 6: Also here; "there are some indications that surface water from the Bothnian Sea have been mixed with Bothnian Bay water forming the observed bottom water at station 9". Some anecdotal indications are not really enough to claim that one has new findings worth publishing in an international journal.

Page 14, line 11-16: While I am no expert in biological processes it is clearly possible that there is growth of organic mater in sea ice, and this should be discussed. A fairly new paper (Assmy et al 2017) also finds that phytoplankton can also grow below a snow cover.

Page 14, line 18: polyniyas is spelled wrongly.

Page 14, line 17 – Page 15, line 7. While this is possible in the Bothnian Bay – you do not have any observations that indicate that this is going on. IF you added some simulations that this is likely, then this text could remain – otherwise it should be deleted.

Page 15, line 8 – 20. This section finally contains some calculations about the brine water "hypothesis". The calculations appear OK - but does not use a proper range in forcing and boundary conditions. How representative is the 0.2 m of ice thickness? Is there any freshwater discharge during winter?

Suggested citations – there are many more:

Assmy et al (2017) Leads in Arctic pack ice enable early phytoplankton blooms below snow-covered sea ice, Scientific Reports, 7:40850, 2017, doi: 10.1038/srep40850

Cavalieri, D. J., and S. Martin (1994), The contribution of Alaskan, Siberian, and Canadian coastal polynyas to the cold halocline layer of the Arctic Ocean, J. Geophys. Res., 99, 18,343– 18,362.

Gordon, A. L. (2014), 'Southern Ocean polynya', Nature Climate Change 4(April), 249–250.

Winsor, P., and Björk, G. (2000), Polynya activity in the Arctic Ocean from 1958 to 1997, J. Geophys. Res., 105(C4), 8789– 8803, doi:10.1029/1999JC900305.

Humfrey Melling, Yves Gratton & Grant Ingram (2001) Ocean circulation within the North Water polynya of Baffin Bay, Atmosphere-Ocean, 39:3, 301-325, DOI: 10.1080/07055900.2001.9649683

Granskog et al (2006) Sea ice in the Baltic Sea – A review, Estuarine, Coastal and Shelf Science, Volume 70, Issues 1–2

Granskog et al (2005). Characteristics and potential impacts of under-ice river plumes in the seasonally ice-covered Bothnian Bay (Baltic Sea). Journal of Marine Systems 53,

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