

Interactive comment on “Ventilation of the Northern Baltic Sea” by Thomas Neumann et al.

Thomas Neumann et al.

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First of all, we would like to thank the anonymous referee for the thorough review of our manuscript.

The common concern of all referees is that the amount of data collected during a cruise in the sea ice covered northern Baltic Sea is not sufficient to justify any of the hypotheses raised in the manuscript. Indeed, only three stations could be explored and we hardly can increase the number of in-situ observations. However, the referees proposed an option to save the manuscript by a complementary modeling approach.

We decided to follow this line and will perform a model simulation for the winter season 2016/2017. We will set up a model for the Baltic Sea with earmarked water masses allowing us to identify the origin of water which eventually arrives in the deep water of the Bothnian Bay. Nevertheless, we want to stress that recent ocean models are

not able to reproduce a possible haline convection due to brine release. However, this approach will prolong a revised version of our manuscript and will include substantial changes.

In the following, we respond to the referee's specific remarks. Remarks are shown and followed by our response.

Review #3:

1.) This paper tries to justify that oxygen rich bottom water found in one profile collected in the Bothnian Bay, may have been formed by inflowing water from the Bothnian Sea mixed with surface water in the Northern Quark, and not by salt release from sea ice. The data set is very small, and the processing done poorly explained. It is also hard from the discussion to grasp that the above explanation is what the authors want to say. To make this manuscript more readable they should state more clearly in the discussion whether each explanation they try own ends up with a plausible explanation. I do not suggest any places where to do this in particular, but both the abstract and discussion and conclusions should become clearer. Perhaps add your hypotheses at the end of your introduction. Then it would be easier to state of your data support or do not support each of the hypotheses.

We thank the referee for the useful suggestions. In a revised manuscript, we will include model simulations and formulate hypotheses and their acceptance/rejection more clearly.

2.) Page 3, line 12: Explain how you collected the brine.

We will do it in the revised manuscript.

3.) Page 4, Figure 3 caption: at (red crosses) to stations 7-10.

We will do it in the revised manuscript.

4.) Page 4, lines 1-2: Explain more elaborate how you measured salinity in both ice

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core samples (Table 1) and brine samples (Table 2). For instance how big did the samples have to be to measure salinity with the CTD. Also, with the low number of samples you collected, why not measure all with the Guildline?

We have analyzed one ice core from each station and the brine samples with the Guildline and all samples with the mini CTD. A detailed description of the procedure will be given in the revised manuscript.

5.) Page 4, lines 2-7: The Guildline Autosal is a standard instrument used with a standard procedure, so this procedure does not need elaborate description. How you collected ice samples and brine and measured their salinity is on the other hand not standard procedure and needs better description.

See above comment.

6.) Page 5, line 10: Justify how you can assume that 'upper 5m are well mixed and saturated with oxygen'. This might be ok for late winter, although I do not have any reference to recommend.

The only justification is that density and oxygen profiles are homogeneous in the 5m surface layer and do not show any stratification. The assumption is that in winter oxygen production/consumption is negligible compared to surface flux.

7.) Page 6, lines 13-14: Can you justify the assumption that all the rejected salt is trapped in brine pockets inside the ice? Some of it can be released into the water column.

Most of salt is released into water already. (2.4g of 3.0g salt in 1kg frozen sea water)
We will make it more clearly in the revised text.

8.) Page 6, line 14: You can hardly regard an average of two brine samples an average (14.7g/kg). At least, remove the decimal.

The referee is right; we will present the result more conservative.

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9.) Page 7, line 2: from where and to where is the water 'out-flowing'. I would find the term 'in-flowing' more appropriate if it flows from the Bothnian Sea into the Bothnian Bay.

Here we mean low saline water from the Bothnian Bay layers above Bothnian Sea water. In the revised manuscript, we will describe it precisely.

10.) Page 7, line 2, last words: Change to 'A weak stratification'

Will be done in the revised manuscript.

11.) Page 9 and 10, Figures 6 and 7: Try to use colors that are more easy to separate from each other. Especially Stations 9 and 10 with purple colors.

We will improve the figures clarity.

12.) Page 9, line 6: Mixing lines do not 'show' water masses. They indicate along which line a mix between two source water types can be placed.

We will improve our sloppy formulation.

13.) Page 10, Figure 8: It is confusing when the end points of the mixing lines go beyond the source water masses. It is clear where the end water mass is, but not the source water masses. You should also indicate better which 'greenish dashed and dash-dotted' lines you are referring to in each case. Where is the brine in this figure, having which temperature? Etc.

We will rework the figure and probably split into two.

14.) Page 11, Figure 9: in this figure, the colors of stations 10 and 12 are difficult to distinguish.

The referee probably means stations 7 and 10. As for Fig 8, we will improve the clarity.

15.) Page 11, line 3: The brine must be way beyond the axis in Figure 8. Again, which TS characteristics do you assume in the brine?

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Yes, brine is outside the figure. We used our observations as TS characteristics and will give the numbers explicitly in the description of the TS diagram in the revised manuscript.

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