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Comment

Interactive comment on “Heat loss from the Atlantic water layer in the St. Anna Trough (northern Kara Sea): causes and consequences” by I. A. Dmitrenko et al.

Anonymous Referee #2

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The article analyzes observed sections through St. Anna Trough of 1996, 2008–2010 and ocean-ice model simulations. The eastern flank of the St. Anna Trough is identified as important regions for the heat loss of the outflowing Atlantic water coming from both Fram Strait and Barents Sea. Vertical velocity shear is suggested to be responsible for enhanced mixing and upward heat loss from the Atlantic Water. This study further shows a clear link of this heat loss to reduced ice thickness and concentration.

This study is important since it helps understanding processes leading to enhanced sea ice melt, which is particularly important in the light of the ongoing warming with a possible increased ocean heat transport from the Atlantic into the Arctic Ocean. The study is generally well written and structured.

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I miss some more discussion of uncertainties in the observational setup and I would urge the authors to draw their conclusions somewhat more carefully because they are only based on a few observations over a short time period (+ a short model period). Also, the effect of climate variability on the results should be discussed.

General:

1.) I miss a more detailed uncertainty discussion of the measurements and the quantities calculated from these measurements. It is argued that heat content of the outflowing water might be uncertain due to insufficient spatial resolution of the CTD-measurements. However, no numbers are named and it is not discussed what this means for the other observational results. Even though this insufficient spatial resolution might be most important for the outflowing water, it should lead to uncertainties for the other measurements as well. Please add such a discussion to the “Data and Methods” section.

2.) Related to the uncertainty issue: Given the fact that all observations are based on short time periods (compared to the climate time scale), a discussion of variability is necessary as well. Otherwise, it is very speculative to draw general conclusions from these observational based results. All conclusions should be drawn with some carefulness.

Specific points:

1.) Title: I do not like the brackets in the title. I would suggest either only “St. Anna Trough” or only “northern Kara Sea”

2.) Introduction: To stress the importance of analyzing the heat loss from the AW, it could be mentioned that observations indicate an increase of Atlantic water transport into the Arctic in the last 1-2 decades (e.g. Skagseth et al. 2008) and that this increase is related to recent sea ice reduction (e.g. Årthun et al. 2012, Schlichtholz et al. 2011) and simulated future ice reductions (e.g. Koenigk and Brodeau. 2013).

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3.) Page 545, line 7: I would suggest using another abbreviation for “St. Anna Trough” as “SAT” since SAT is widely known and used as abbreviation for “surface air temperature”. 4.) Page 546, line 23: Did you use the MIT version described in Marshall et al. 1997 or an updated version of this? If yes, which are the major updates compared to Marshall et al. 1997?

5) Page 546, line 26: “..initialized from rest..” What is “rest” – restart? Please explain more in detail how the model was started.

6) Page 546, line28: Is there any reference for the ETOPO2?

7) Figure 3: the model seems to show stronger interannual variations (particularly 3c) than the observations. Is there any explanation for this, e.g. different time steps or average intervals used in observations and model and thus smoothing short term variations, or is it just a model feature?

8) Page 548, lines 16-17: Please add a few words stating where and over which period Hanzlick and Aagard (1980) did measurements.

9) Page 548, line 25: Although the 1996 patterns (Fig. 4c) show clear similarities to the 2009 patterns (Figs. 4a,b), there are also clear differences, e.g T in the upper meters, different mixing depths and different vertical T and S gradients. These differences should be mentioned as well. Furthermore, July 96 values are compared to September 2009 values at slightly different positions: How comparable are these data? Please add some discussion on intra-annual and inter-annual variations? What part of the differences between the 1996 and 2009 values can be explained by these factors?

10) Page 550, line 11: Which 3 temperature maximums are meant here? Please specify.

11) Page 550, line 10-25: This part is quite speculative to me: this is fine since we lack clear observations showing exactly where which water masses takes it way but it should be marked as a speculation. I am also not convinced that the “diffusive staircases

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provide evidence”, I would prefer a weaker statement like “they indicate”. Also, in the introduction you write, FSBW is 2-2.5 C; where does the additional heat comes from to reach 2.74 C in the St. Anna Trough? This section needs some more explanations.

12) Page 552, line 6-11: Do you attribute the decrease of heat content between stations 25 and 77 to uncertainties in the measurements? If yes, these uncertainties are obviously quite large. Please add a more detailed discussion of the uncertainties in the measurements. If an increase of about 130MJm⁻² is due to error/ uncertainty in the observational setup (insufficient spatial resolution), the increase of 340MJm⁻² between stations 23 and 25 should be uncertain as well. According to your argumentation before, I would expect a reduction of heat content between stations 25 and 77, is that what you would expect as well and if yes how large would you expect that this reduction should be?

13) Page 553, lines 5-25: Also this section should include a discussion of uncertainties in the measurements/ observational based results. According to what is written on page 552, a 50 W/m² difference could be due to uncertainties in measurements. Furthermore, the measurement period is short while the model results are based on 7-year averages. Some more discussion here would be helpful as well, e.g. showing a time series of the modelled heat fluxes.

Typings and similar:

- 1.) Page 544, line 15 and elsewhere: Please write “sea ice” instead of “seaiice”
- 2.) Page 555, line 4: Stefan’s law
- 3) Fig. 4: Since you labeled the figures a, b, c, please use a, b, c in the caption as well instead of left, center, right.

Interactive comment on Ocean Sci. Discuss., 11, 543, 2014.

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