The Cryosphere Discuss., 7, C84–C87, 2013
www.the-cryosphere-discuss.net/7/C84/2013/

The Cryosphere Discussions

Interactive comment on "North Atlantic warming and declining volume of arctic sea ice" *by* V. A. Alexeev et al.

Anonymous Referee #3

Received and published: 21 February 2013

Review of Alexeev et al, North Atlantic warming and declining volume of arctic sea ice, submitted to Cryosphere Discussions.

Warm Atlantic Water enters the Arctic Ocean through eastern Fram Strait, flowing along the continental slopes of the Barents, Kara, and Laptev Seas in the southern Eurasian Basin and beyond. This water is in direct contact with the overlying sea ice cover, a well-known fact since at least Rudels et al. 1996 (if not earlier from Russian studies). Thus we expect sea ice melt (or reduced winter growth) in this area. These ideas are not new. What is new here is a specific study of the effect of this inflowing heat on the sea ice mass balance downstream of Fram Strait. In particular, the maps of sea ice thickness from Icesat that show a reduced ice thickness in this area are intriguing, especially given their geometry that strongly suggests forcing from Atlantic Water heat.

However, it is not rigorously proven here that the reduced ice thickness does not also have significant forcing from other factors, eg advection of thin ice from elsewhere, divergence of ice within the study area, or atmospheric thermodynamic forcing. It seems that more quantitative ice mass balance calculations should be performed before this manuscript can be accepted for publication in final form.

Shimada et al. 2006 do not propose that ice is melting because of increased PW inflow at Bering Strait, only that the changing pathways of PW circulation in response to sea ice retreat might cause enhanced sea ice retreat.

Figure 1: Please label geographic place names. How is fraction of multiyear ice calculated? How is the temperature time series constructed? Is it smoothed, are there gaps, over what space/time scales is it averaged? How were the data collected? What is the uncertainty in degC? Is it the temperature of the AW maximum, or some integrated value? Please label the vertical and horizontal scales of your temperature sections.

I do not see that "The warming accelerated in the 2000s. . ."

"Even though strong stratification in the eastern Arctic. . ." This is misleading. Most of the Nansen Basin is very weakly stratified, ie it is an extension of conditions in the Greenland Sea. Only in the eastern Nansen Basin, when riverine shelf water flows in, does a permanent winter stratification form (which is still weak compared to conditions in the Canadian Basin). The Amundsen Basin alternates between stratified and unstratified conditions, depending on the state of the shelf water inflow circulation.

"A series of transects. . .shows that AW in these sections is in actual contact with sea ice. . ." Probably this is true, but your transects do not explicitly show this, they only show very small-format temperature sections over a large vertical distance (500 m).

Why show Feb-March ice thickness in some years, and March-April in others?

You claim that your model has "reasonable high resolution" of 50 km but soon after you cite a width of the AW core of 5-15 km. Obviously you are nowhere near to resolve the

key physical phenomenon of interest in this study.

Your model uses isopycnal coordinates. Can you please comment then on its value in a region with very weak stratification, ie the AW inflow region near Svalbard?

Have you validated this model's ice thickness against any ice thickness observations?

"...melting in this sector is much higher than in other regions of the Arctic Ocean..." Is this true? It is hard to believe that it is higher than the tremendous melting seen in the Pacific areas of the Arctic Ocean in the past few years.

There are a number of qualitative associations made in this paper that are interpreted as "proof." An example is high melting in the model downstream of Svalbard "...that relates to the AW inflow." Probably you are right, but you offer no quantitative proof.

Perhaps you can cite Untersteiner "On the ice and heat balance in Fram Strait" (JGR, 1988) when discussing high melt rates in this area.

"...for an ocean layer under the ice that has a temperature of 0.09 +/- 0.01 K above the freezing point" Where do these numbers come from? IE are these values near Svalbard in your data, or from McPhee? I am confused. In fact why even cite a temperature, since Equation 1 has no temperature parameter?

"...suggests that the temperature directly underneath the ice in Sept'06 and Oct'08 could be..." This is confusing since Figure 1 shows a temperature section, ie why "could be?" Probably you should have a more detailed explanation earlier about the observational data set, which I am guessing does not have ocean data near the surface. In fact, at what depth does it begin?

Perhaps you can cite Steele and Morison "Hydrography and vertical fluxes of heat and salt northeast of Svalbard in Autumn" (JGR, 1993) when you discuss heat fluxes in this area of order 100 W/m2.

Pages 253 and 254 seem weakly argued and are probably not important to your paper.

Is Figure 2 necessary, given Figure 3?

What ice concentration data set did you use in Figure 3?

Figure 4b: The model shows enhanced melting to perhaps 40 E but not beyond. So why is there thin ice well to the east in Figure 3?

Interactive comment on The Cryosphere Discuss., 7, 245, 2013.