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Ocean Science
Discussions

Interactive comment on "A modelling study of the hydrographic structure of the Ross Sea" *by* M. Tonelli et al.

M. Tonelli et al.

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Response to referee # 2

I would like to thank Dr. Karen Assmann for her helpful and very constructive comments. I have accepted all of them and introduced the comments and suggestions in the text

The point-by-point response follows:

Specific Comments

"Introduction: 1) You motivate the work by pointing out the formation of AABW formation for global climate and its potential vulnerability under climate change, yet your

manuscript doesn't really address either point.

*dense water masses are indeed a key component of the role of the oceans in climate change through the MOC cold pathway. The AABW of special significance to climate change because of its ability to spread throughout the global ocean. The significance of this study is that ocean models dot always correctly represent this water mass because it is the shelf waters with temperatures near the freezing point (about -1.9°C), produced along the margin of the Ross sea that contribute to the formation of AABW and continuing ventilation of this water in the world's oceans (Whitworth et al., 1998). This was included in the text.

"Get rid of the "1.1 Ross Sea" heading"

This was eliminated from the text.

"The ACC does not flow East to West at any point, especially not along the Ross Sea continental shelf break. What flows along the Ross Sea continental shelf break is the southern limb of the Ross Gyre."

The reviewer is correct. It was miswritten and corrected to: "The southern limb of the Ross Gyre follows the continental slope carrying the CDW from east to west..."

"When talking about the different AABW sources, you need to mention the component formed along the Adelie Land coast as well, because it is as large as the Ross Sea. The thing about the Ross Sea BW is that it ventilates the entire deep Pacific."

The reviewer is correct. Adelie Land is now mentioned in the text: "Although the Weddell and Ross Seas have long been considered the major AABW sources, recent observational investigations suggest that the Adelie Land coast is a globally significant source of Antarctic Bottom Water [Rintoul, 1998; Orsi et al., 1999]".

"There are various points here and in the rest of the manuscript where you get a bit confused about how HSSW and ISW interact and which paths they take before flowing off the shelf to become AABW."

Revised in the text.

“Model description nice and comprehensive, but could potentially be shortened.”

Since ROMS is such a widely used numerical model and since this added ice-shelf implementation is significantly new, we believe that a comprehensive model description is needed to help other modelers to reproduce the present results.

“Define the variables you use in the equations in section 2.2.”

Equation 1 is re-writen the following way: The SWT contributions or fractions xi for each data point are obtained by finding the best linear mixing combination in parameter space defined by temperature (θ), salinity (S) and potential vorticity (PV) which minimizes the residuals in a non-negative least squares sense (R).

x_1θ_1 + x_2θ_2 + x_3θ_3 = θ_Obs + R_θ

x_1S_1 + x_2S_2 + x_3S_3 = S_Obs + R_S

x_1PV_1 + x_2PV_2 + x_3PV_3 = PV_Obs + R_PV

x_1 + x_2 + x_3 = 1 + R_mass

where the observed values of temperature TObs , salinity SObs and PVObs with their respective residuals R define the columns on the right-hand side. The values Ti , Si and PVi (i = 1, ..., 4) represent the predetermined (known) parameter values of the 3 source water types for each parameter. The last row expresses the condition of mass conservation.

“is the run stable?”

Yes, the run stabilizes around year 30.

Results - You don’t check water column structure in a TS-diagram, but water mass characteristics. - The density lines you show in your TS-diagram look like surface referenced density sigma0 not neutral density gamma_n that Orsi and Wiederwohl

(OW) use. That’s why your densities are all out compared to theirs. Your two choices are either to calculate neutral density for the model, or to take the OW data and plot it in a manner comparable to your Fig. 3 with lines of sigma_0 which is what I would suggest.”

The choice made was to use NODC data to calculate the reference T/S. Figure 2 is redrafted. NODC data were also used to produce salinity and temperature transects and to perform the OMP water masses investigation.

Why did you choose 165W? You should catch some of the ISW that way, but there isn’t really that much HSSW left that far East and it’s not the best place to see whether the model really does produce AABW or just retains it from the initialization.”

The referee is right. The 165°W transect was chosen to reach the southernmost extension of the water column under the RIS, but it was not be best region to look for the dense waters. A transect at 175°E (shown in Figure 1) is analyzed for the western RS for the modeled results and for NODC data.

“Regarding the water masses you define for your OMP: AASW is a hard water mass to define, because it is so variable in temperature and salinity both spatially and through a seasonal cycle which you alias by looking at an annual mean. I would leave it out in favour of MCDW or to split the shelf water into LSSW and HSSW.”

A different separation scheme including HSSW and LSSW is provided for the western transect. We first run OMP to separate ISW, HSSW and LSSW over de continental shelf. On a second run we separate SW, CDW and AASW along the 175°E transect up to 65°S. Many OMP runs were performed (considering other water masses such as MCDW) to reach this final separation scheme, which resulted in the best water masses visual identification.

“As far as I can tell your definitions of SW and ISW are too close together for the OMP to tell them apart, which is why you end up with 100% ISW and 100% SW at the bottom

on the shelf. This is where it would really help to see the actual temperature and salinity sections. Looking at a section along the ice shelf front would also help to work out how SW and ISW are distributed in the model"

We have actually used HSSW sea water types, but only shown ISW for this is the eastern RS. The new separation scheme will better characterize SW: HSSW and ISW. As cited above, we first separate ISW, HSSW and LSSW over de continental shelf and then we separate SW, CDW and AASW. This was performed for our modeled results and for NODC data for comparison. Figures 4 to 7 show the OMP results for both datasets.

"The 50/50 mixture of AASW and CDW just off the shelf looks like there might be spurious deep convection. Again it would be helpful to see the actual temperature and salinity sections. Depending on which area is covered by your TS-diagram that would explain why your CDW is too cold. Does your sea ice have holes in that area? Working out why the CDW at the Ross Sea shelf break is too cold in your model is quite important, because it will impact the conclusions you can draw from further studies done with it."

The reviewer is right, temperature and salinity sections were added. The TS diagrams cover the western continental shelf area and that is probably why CDW seems too cold, it is actually MCDW.

"You motivate the need to model the Ross Sea with AABW production and deep ocean ventilation, yet you only address this in a passing sentence and it remains unclear whether the model would be a good tool to address questions related to AABW formation and changes in it. A section further West might be better to look at this.

Yes, a section further West (175°E) is examined and included in the text.

Figure 1: was removed.

Figure 2: a new panel showing some of the RS features is added (now Figure 1).

Figure 3: NODC data were used for comparison.

Figure 4: Temperature and Salinity sections are included.

Interactive comment on Ocean Sci. Discuss., 9, 3431, 2012.

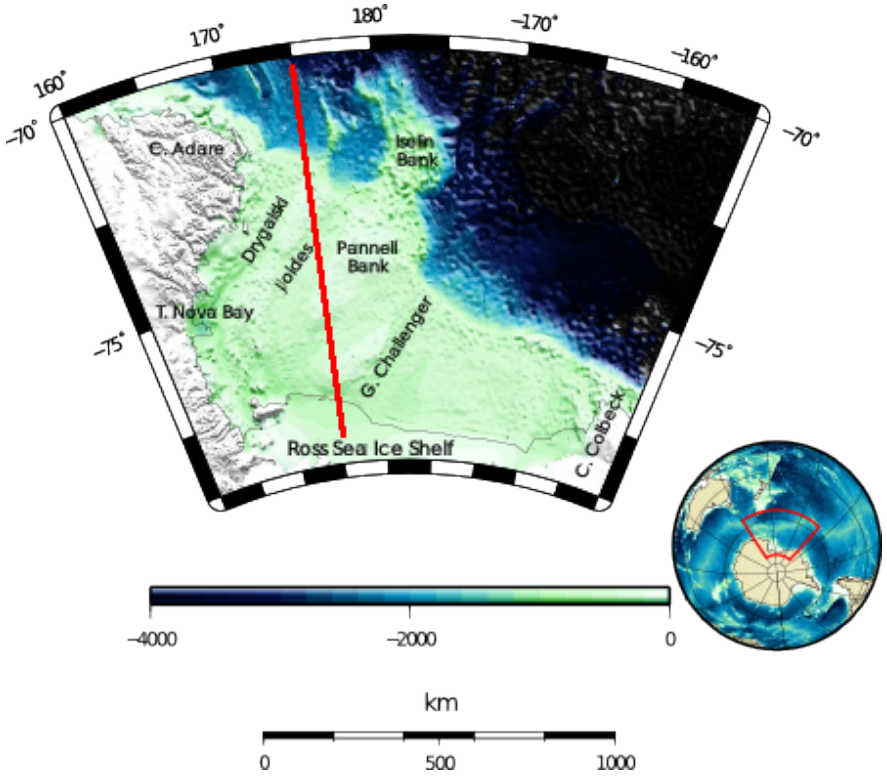

Fig. 1. Ross Sea bathymetry with the principal geomorphological features marked. The red line marks the analyzed section at 175°E.

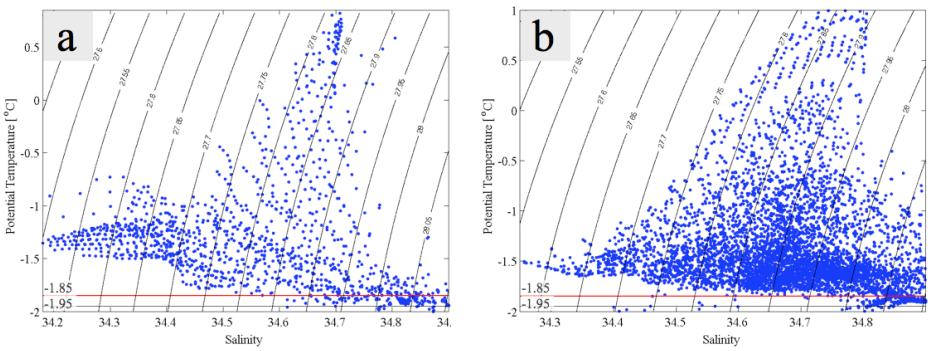

Fig. 2. TS diagrams with data from the western continental shelf of the Ross Sea. Diagram "a" represents NODC data and diagram "b" represents modeled data.

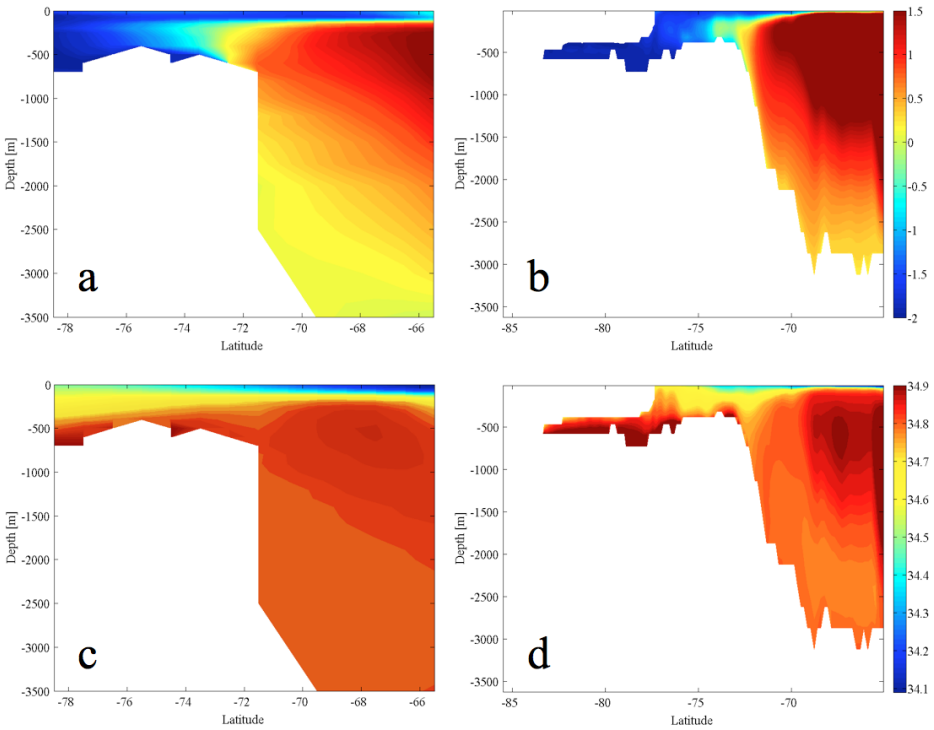

Fig. 3. Temperature and salinity cross sections at 175°E. “a” temperature from NODC; “b” temperature from modeled data; “c” salinity from NODC; “d” temperature from modeled data.

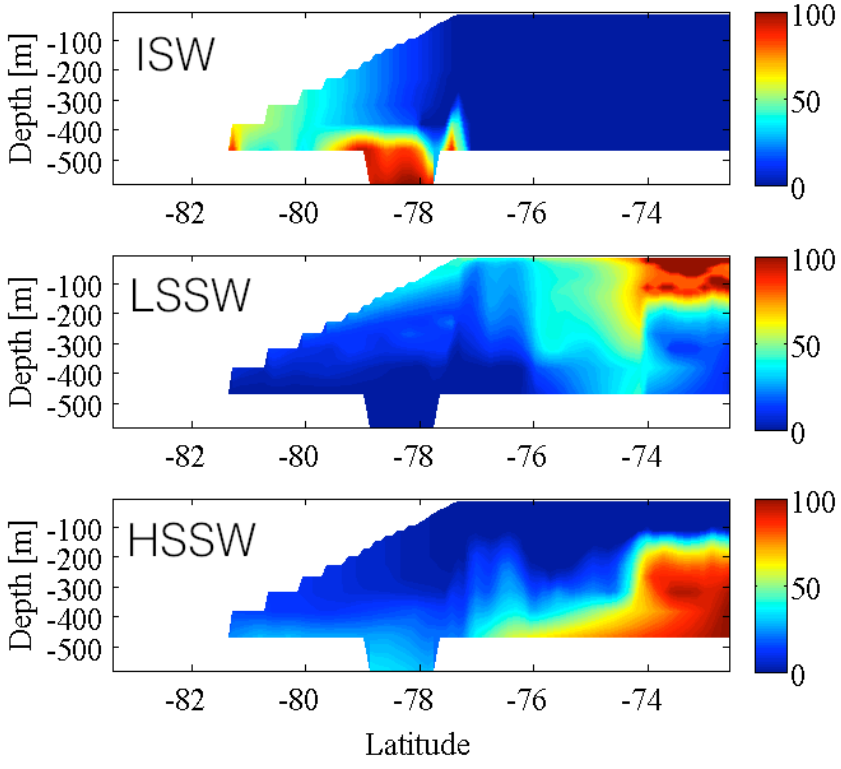

Fig. 4. Water masses spacial contribution (%) over de continental shelf at the meridional section along the 175°E from modeled data. Ice Shelf Water (ISW); Low Salinity Shelf Water (LSSW) and High Salinity Sh

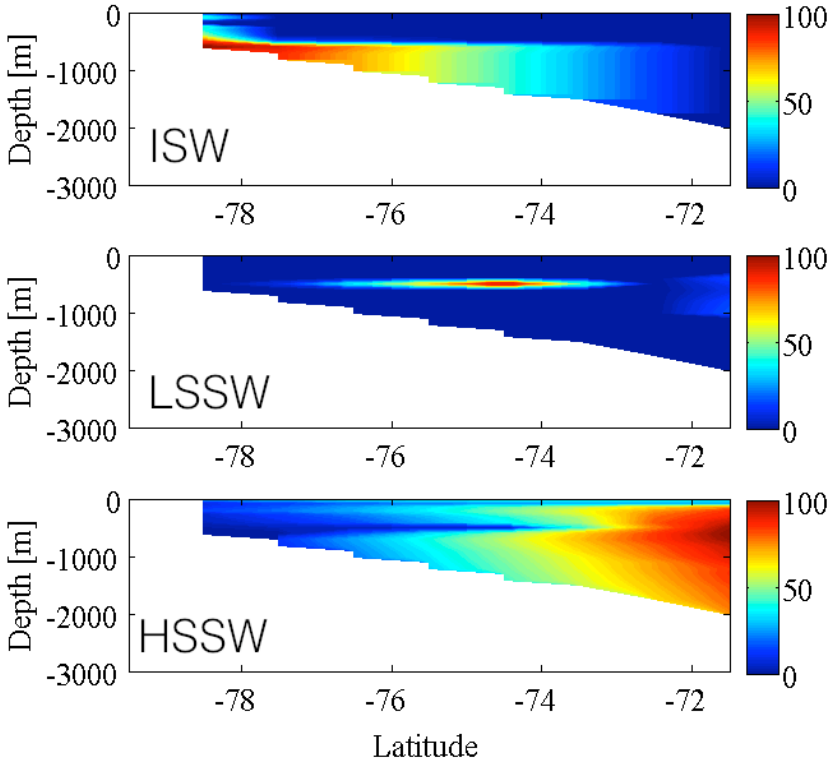

Fig. 5. Water masses spacial contribution (%) over de continental shelf at the meridional section along the 175°E from NODC data. Ice Shelf Water (ISW); Low Salinity Shelf Water (LSSW) and High Salinity Shelf

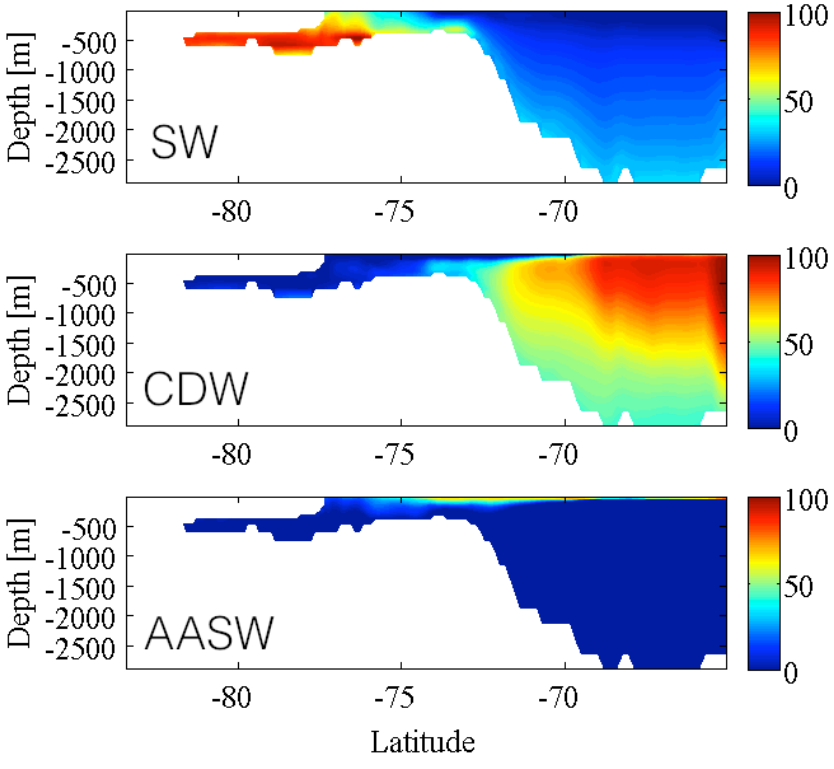

Fig. 6. Water masses spacial contribution (%) along the meridional section at 175°E from modeled data. Shelf Water (SW); Circumpolar Deep Water (CDW) and Antarctic Surface Water (AASW).

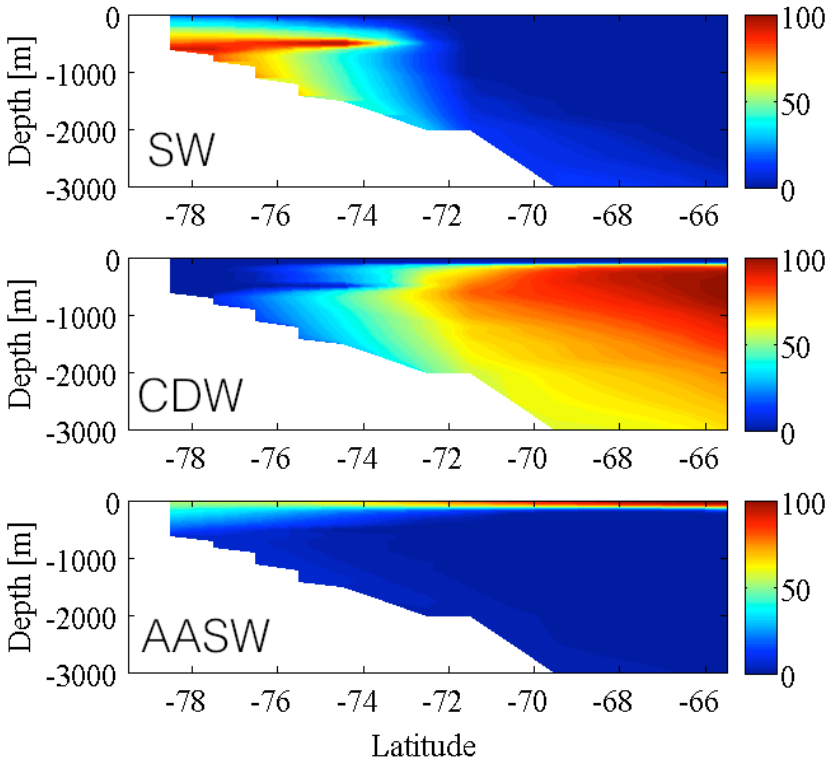

Fig. 7. Water masses spacial contribution (%) along the meridional section at 175°E from NODC data. Shelf Water (SW); Circumpolar Deep Water (CDW) and Antarctic Surface Water (AASW).