

# ***Interactive comment on “Spatio-temporal variations in High-Salinity Shelf Water production in Terra Nova Bay polynya, Antarctica” by Seung-Tae Yoon et al.***

## **Anonymous Referee #1**

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Spatio-temporal variations in High-Salinity Shelf Water production in Terra Nova Bay polynya, Antarctica, by Yoon et al.

The authors use CTD and mooring observations from the Terra Nova Bay Polynya to investigate the temporal and spatial variation in HSSW production over a three-year period.

The most notable result, perhaps, is the marked increase in HSSW salinity seen over the time series. The authors also find a circulation of newly formed HSSW from near Nansen Ice Shelf, around the Drygalski Basin, to be observed a month or two later at one of their mooring sites in the eastern Terra Nova Bay, ie remote from the pri-

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mary HSSW production area. There is also some discussion about local production of HSSW at the eastern Terra Nova Bay site.

The data are very nice, and the underlying results deserve publication. There are, though, many presentational issues to be resolved before the manuscript is ready to be published. There are also one or two arguments that need more explanation, although my confusion is possibly language-related.

One of those is connected with the discussion about the idea of “Open ocean convection, which is led by wind-driven mixing” (L53-54, for example). There are a couple of points here, and, again, it is probably purely a matter of language. The implication of the sentence is that wind-driven mixing is a prerequisite for HSSW production via brine rejection. I suspect that was not what the authors meant. Probably just the use of the word “led”. Perhaps “preceded” would be better? But see below.

My understanding of the authors’ interpretation of the salinity evolution shown in figure 8(a) is that the summer stratification is eroded by wind-driven mixing, which gets the water column to 273 m depth to a salinity of between 34.5 and 34.6. The authors actually suggest that the increase in salinity at the mooring site might be a result purely of wind-driven mixing, presumably bringing up the more saline water from below the 273-m instrument, or an additional contribution might be from local brine rejection. The argument for local brine rejection, rather than advection of more saline waters from the east, is that those advected waters would actually have a lower, not higher salinity.

The confusion is in the use of the phrase “open ocean convection”, and the idea that HSSW can be formed by wind-driven mixing. Open ocean convection is a bit like a reserved word, and for polynyas, tends to be used only for (what used to be called) sensible heat polynyas, which are found off the continental shelf. They are found there because of the ready supply of heat at depth, which can be mixed up to keep the surface ice-free. As for the wind-driven mixing, I don’t believe that HSSW can be considered as being produced by mixing in this context. In this case, it seems that very

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high salinity water is being diluted to form a larger volume of a water mass that might still be classified as HSSW (depending on the definition adopted), but it strikes me as confusing to consider it “HSSW production by wind-driven mixing”.

Abstract: This needs some work. It seems a bit more detailed than necessary for an abstract.

L53-54 See comment above

L88 Low pass filtering by monthly averaging can lead to some spectral unpleasantness. It would be better to use a properly-constructed low-pass filter. I admit that it's likely that there will be no difference in the final conclusions.

L135 and 136 “Deep-ocean”. This is a bit confusing. For most oceanographers “deep ocean” refers to abyssal areas off the continental shelf. As this is on the continental shelf (even if it is a deep continental shelf basin) it might be best to leave out the “ocean” and just call it “Deep salinity variations in TNB”.

L143-144 A minor point. Do the authors mean that there is also evidence for active HSSW formation taking place “3 and 5 months later”, or that 3 and 5 months later, we can still see the evidence from the active formation that took place earlier? The next sentence points out an increased salinity seen in January, which implies additional brine rejection between October and January. It does not, though, tell us that HSSW was being formed in January. A similar point: how, from Figure 3, do the authors distinguish between the presence of HSSW and its active formation? How do we know when it formed? Vertical profiles of salinity would give a clue: if well-mixed from top to bottom, that would suggest active formation even if it doesn't prove it.

L153-154 Change “fewer amounts of”, to “less”.

L155, and 9 other locations. The use of the phrase “upper depth(s)” should be changed. An upper depth is either a depth that is larger (ie deeper) or a depth that is ‘up above’ (ie shallower). The authors mean the latter, but it is ambiguous and needs

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changing in each of the 10 cases.

L156-157 ISW is usually defined as water with a temperature below the surface freezing point. So is the idea that TISW is characterised as having a temperature below the freezing point at 50 m depth a way of distinguishing it from ISW with a different source? As this is 'Terra Nova Bay' Ice Shelf Water, it refers to any ISW found in this area, so I would prefer the normal definition to be used. If the authors wish to continue with their definition, they need to explain why.

L160 "mooring D" This is the first mention of mooring D, although it is marked in Figure 1. Please give a sentence to introduce it, rather than relying on the readers tracking down the reference. It would be worth at least mentioning the time period over which the mooring was active, as it ended in 2008 according to the referenced paper, well before the present datasets. If data from mooring D are available from the time period of the authors' measurements, then the data from the overlapping period should be included here.

L191 Should "shorter" not be "longer"?

L203 "compared to" should be "compared with"

L211-212 It would be more useful to quote the draft, not the thickness, of Drygalski Ice tongue.

L223 "since" should be "in".

L229 "nearly as large as" should be "only a little higher than"

L233 Delete "current"

L236 "easterly" should be "westerly"?

L237 Delete "a"

L238 Was it 0.46 for each year? Or is there a different r value for each year? Or is this

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an average across the three years?

L248 Would it be possible to quote the mean wind speed during these events as a check? If the mean wind speed also correlates with the length of time the polynya is open, it draws into question the assertion that the duration of the katabatic is key.

L251-253 This is now a more positive assertion that wind-driving created a mixed layer, followed by brine release that forces convection. If this is the authors' interpretation of Figure 8(a), a statement to that effect at the end of section 3.2 would be helpful. At the end of section 3.2, this was left only as a possibility.

L255-258, and Fig 10. The monthly salinity differences shown in Figure 10 seem a very weak way of showing the correlation with wind and open water. Is there no way of improving on this?

L264 This is not very convincing in Figure 10b. In fact, the entire second half of section 3.4 needs rethinking. Attempts to demonstrate correlations between salinity change, wind speed and duration and sea-ice coverage are very unconvincing, based on the time series of those quantities. It would be better to find a stronger way of finding the correlations, rather than simply picking out short sections. Figure 10 is particularly weak and unconvincing. I'm sure there must be a better way of demonstrating the relevant correlations.

L291-292 Same concern as above about HSSW being formed by mixing.

L297 Change "with" to "from".

L300-305 I think this paragraph can be deleted, or possibly moved to the Conclusions?

L319 "HSSW flowing under greater depths is circulated over the DB." Should this be "HSSW flowing at greater depths circulates around the DB"? And, why "Despite this"? Despite what?

L330 "slower" should be "lower"

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L331 “deepest” should be “greatest”

L335 The ratio between vertical and horizontal velocities: is there a citation for this? I’m unaware of this rule of thumb.

L336 “similar with” should be “similar to a”

L341 Change “due to” to “by”

L345 Should “June or July” be “March to May”?

L349 Delete “Therefore”

L365 Change “depths” to “parts”. Change “deepest” to “greatest”. Change “since” to “from”

L366 Change “Due to this” to “As a result”

L378 Change “becomes increases” to “is increasing”

L379 Delete “although not an absolute salinity”.

L383 to 385 Delete from “which is yet another. . . .changes in TNBP”.

Figure 2. It would be helpful to add years (not just leg numbers).

Figure 3. Move the 50-m freezing point line to the surface freezing point, (unless there is a good case for defining TISW as water with temperatures below the 50-m freezing point).

Why is there a -1.85 degree C isotherm in the inset figure?

Figure 10. I don’t like this figure. In particular, the monthly salinity changes.

Figure 11. Is there a particular reason for interpolating the LADCP data onto a grid? Until we can see it we won’t be sure, but I think I would much prefer to see the vectors at the locations they were measured. Data from stations that close together could be spatially averaged, perhaps?

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