

Review of: “The role of tides and sea ice on the carbonate chemistry in a coastal polynya in the south-eastern Weddell Sea” by Droste et al. submitted to *Ocean Sciences*

Summary

In this manuscript, the authors present two separate datasets (from January of two different years) documenting the evolution over a few days of physical and biogeochemical parameters measured in a coastal polynya near the Ekström Ice Shelf in the south-eastern Weddell Sea. They show that tides have a significant effect on fCO₂ in the polynya surface waters, and by extension on the air-sea flux of CO₂, which not only varies considerably, but can also change sign depending on the timing of sampling relative to the tidal cycle. In general, I found this a compelling study and well-written manuscript that succeeding in making its main point – that coastal polynyas near Antarctica are highly dynamic with respect to the carbonate system and that the tidal cycle has a profound influence on whether these features are strong/weak CO₂ sources/sinks. I particularly liked the thought exercise that the authors go through in section 4.2 to demonstrate the different answers one might get with regards to air-sea CO₂ flux if one did not appropriately account for the influence of the tidal cycle. Below, I have included a number of fairly minor comments and suggestions for the authors to consider, which I hope will help to improve the manuscript.

Title: Would it not be more correct to use “The role of tides and sea ice **in** the carbonate chemistry in a coastal polynya in the south-eastern Weddell Sea” or “The **influence** of tides and sea ice on the carbonate chemistry in a coastal polynya in the south-eastern Weddell Sea”? Additionally, the main message of this study seems to be about the tides (and not the sea ice). Of course, sea ice is inherent to the mechanisms the authors invoke to explain their observations, but I found it a little incongruous in the title.

L35-38: These two sentences are somewhat repetitive; can they be combined and made more concise?

L38-39: To what is this sentence referring? Everything outlined in the paragraph is important with respect to CO₂ flux estimates, no?

L40-45: I found this paragraph full of general statements that don't really say much – can the authors be more precise, for instance by giving examples or specifics?

L51: “...that has been exchanged with the atmosphere...” – do you mean **acquired from** the atmosphere?

L60: “separate and independent” – I think these two descriptors are redundant.

In general, I think the introduction would be strengthened with some more specific information on what has been shown previously with regards to CO₂/carbonate state variables (or even just biogeochemistry and/or hydrography that affects the carbonate system) in coastal polynyas even if the tides have not been considered.

L75-76: Given the subsequent sentence, it doesn't seem particularly informative to state the average area of polynyas.

L89: Sentence seems out of place.

LL92-93: Was the oxygen calibration good? And please can you clarify what you mean in the following sentence by “...malfunctioning on every other cast...”; what are the implications of this?

L99-105: Presumably these measured nutrient concentrations were used in the carbonate system calculations?

Figure 1 caption – where are the bathymetry data from?

Table 1 (and text): For PS117, is eight CTD casts really enough? For PS89, why were two casts conducted on 8 January not included in the case study?

L125: where is Syowa Station?

L135-136: How important might these discrepancies be?

Figure 2 caption – Towards the end of line 2, a space is missing between “The” and “u”.

L168: Why the choice of a density change of 0.02 kg m^{-3} to define the MLD when the standard is typically 0.03 kg m^{-3} (sensu de Boyer Montégut et al. 2004)?

L174: I don't think the amplitude of variability for salinity can really be considered “striking”

L190 (and elsewhere): The idea that physical processes such as mixing (rather than biogeochemical processes such as photosynthesis, respirations, and/or calcium carbonate formation/dissolution) are primarily responsible for the observed variability in DIC, TA, and $f\text{CO}_2$ is alluded to in numerous places in the manuscript. However, the reasoning behind this conclusion is never fully articulated. Since the readership of Ocean Sciences is going to include people not intimately familiar with the drivers of carbonate system variability, I suggest the authors more clearly lay out their logic in this regard, and here may be the place to do it.

L192-194: Can you estimate how much of an effect the increase in atmospheric CO_2 might have had? Since the sampling weren't conducted that far apart in time.

L196: Fluorescence is presented here almost as an afterthought, and only for PS117; if these data are going to be shown in the manuscript, the authors should elaborate. I additionally found the text here about silicate to be confusing – why is this meaningful? I feel that if the authors want to draw so much attention to what they consider anomalous or unexpected observations with regard to silicate, they should probably offer an explanation for these observations.

L199: What is meant by “salinity-normalized” nutrient concentrations?

Figure 4 caption – why the choice to highlight $\text{pH} = 8.05$? Similarly, the $\Omega_{\text{aragonite}} = 1.3$; what is the significance of this isoline?

L216: What is meant here by “induced”?

Figure 5 caption – on the second line, remove “or” between “during” and “ebbing”

L227: What was the wind here? In general, I think a more systematic treatment of the winds is required. The values seem to be presented for the first time at random places in the Discussion, which makes it confusing. These values could perhaps be presented in the results?

L232: The idea of a “salinity front” is an important one that crops up throughout the Discussion. However, I don't think it is introduced and explained in a systematic way (unless I missed something). The authors should introduce this idea clearly early on in their Discussion so that its later significance is obvious to the reader.

Figure 6: Is the lack of fluorescence variability during PS117 the result of the colour scale chosen? Also, why are some of the data missing from panel C? Finally, the fluorescence data in panel E seem to me to support the authors' arguments about tidal mixing but they're not discussed at all, nor integrated into the authors' arguments – I think they probably should be.

L240: See above about “salinity front”.

L258: And presumably also due to a lack of exchange with the atmosphere?

L260: What do you mean here by “drill sites”? I think this is another example of an idea that needs to be better introduced.

L281-282: Here again, it is not apparent to anyone not deeply familiar with the carbonate system why the nDIC and nTA data suggest that physical processes explain the observed variability. The rationale either needs to be explained here, or explained earlier (see my comment above) and then alluded to here. This is a pretty concept in support of the arguments made in the paper. Additionally, I got to the end of this paragraph as a whole (L293) and wasn't really sure what I should take away from it.

L297: Please explain the significance of the nTA:nDIC ratio.

L299: The word “data” is plural.

L313: What do you mean by “light stability” in this context?

L334: I think this section might benefit from a sentence at the end here summing up what we have learned from the new data presented here rather than simply ending the section after outlining everything we don't know.

L345: “...fluctuates between the bottom (incoming tide) and... (outgoing tide)” – the meaning of this sentence is unclear.

L351: In general, I think it's better to avoid hyperbolic terms such as “drastic”.

Figure 7 – I believe that the use of PSU for practical salinity and outdated and such data should be presented with units. Alternately, absolute salinity should be used. Additionally, what is AB? And finally in the 5th line of the caption, should the reference to “single purple markers” actually be to “single white crosses”?

L378: There's some odd repetition here that makes the sentence confusing – please revisit for clarity.

Figure 8 – where is the “dotted line” referred to in the 3rd line of the caption? And if the filled shading indicates the range, does the black line indicate the average wind speed?

L414: What do you mean by “mediating effects”?

L415: What is meant by “repeats are required”? Also, I found the inclusion of “carbonate chemistry” a little incongruous here since that is what is presented in this manuscript. Can you clarify your meaning?

L424: Please see my comments above about the “salinity front”.

Data availability: is it acceptable to the journal for the data to only be accessible by contacting the corresponding author? This seems unusual.

Figure A1-A4 – what does the pink star denote? This information should be included in the caption.

Figure G4 – I think the authors should offer a reason for the anomalous silicate data from PS117. Are they certain it's not an analytical error? If not, might it shed some light on the water mass encountered during PS117? I found it a little odd that all these data were presented, the inconsistency highlighted, and then no discussion/explanation offered. Same comment applies to Figure G6.