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Biogeosciences Discussions

Interactive comment on "Prolonged aragonite undersaturation in bottom water of a biological hotspot in the Chukchi Sea, Arctic Ocean" *by* Michiyo Yamamoto-Kawai et al.

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Review of Yamamoto-Kawai et al. Biogeosciences Discuss., doi:10.5194/bg-2016-74, 2016

This is a short paper that uses shipboard observations of aragonite undersaturation (via alkalinity and DIC measurements) in the Chukchi Sea in 2012 and 2013 to describe regions of the Chukchi Sea where undersaturation was present during summer and autumn measurements. The authors also use data on oxygen utilization, temperature and salinity from those two cruises to see how well those measurements can predict the estimated Ω value of carbonate saturation. They then use these empirical corre-

lations to estimate the degree of undersaturation of calcite and aragonite at a moored location where dissolved oxygen, salinity, temperature, and chlorophyll measurements were also made over a two-year period. They find that in this moored location with high productivity that undersaturation is likely widespread and lengthy over the course of the year, although the actual impacts of calcium carbonate dissolution on benthic communities in this area do not seem obvious, based upon sampling of clam communities on the bottom. Obviously the organisms that inhabit this area and take advantage of the abundant food supplies have resiliency with respect to ocean acidification.

The observational portions of the study showing undersaturation during the summer and fall sampling periods are not surprising given other published work in the Chukchi Sea, but still add to our understanding of widespread undersaturation impacts. I have more misgivings about the extension of using the moored data and apparent correlations developed between AOU and ocean acidification to estimate undersaturation of calcite minerals over the course of the year. While I am not surprised that undersaturation is probably common due to mineralization and high productivity, the conclusions are based upon the assumption that oxygen utilization continues at fairly constant rates over the winter, and I think the small published set of sediment oxygen utilization measurements available from arctic shelves does not strongly support this assumption. Only one study (Devol et al. 1997) is cited to support this assumption, and it sampled in the winter in unproductive waters much different from the moored site. The moored data used (Nishino et al. 2016) also had to be managed—corrections undertaken for AOU data that were corrected because of apparent issues with the data that are mentioned in Nishino et al. 2016. Finally, the use of this correlation method for estimating calcium carbonate dissolution potential was initially demonstrated in California and Oregon, so it really hasn't been confirmed to work in the Arctic where there are much more extreme seasonal changes in biological activity. The authors defend their approach by stating that their shipboard sampling bracketed both high productivity in July and high oxygen utilization in October although my examination of the Nishino et al 2016 results suggest that sampling in July may have missed the highest primary

productivity.

I don't think this is necessarily a flawed paper because the available evidence suggests that widespread undersaturation with respect to carbonate minerals on productive arctic shelves is probably correct, but I don't think the evidence provided here is strongly convincing either. The manuscript is also unevenly written, and would benefit from efforts of a native English language editor. A number of mistakes in spelling, in the references, and even in the spelling of the author names suggest a hasty assembly of the manuscript. I have provided some editing suggestions below and posed a few additional questions and concerns, but this is not a comprehensive editing effort.

Page 1: Line 3. I think Dr. Nishino's name is misspelled.

Page 1: Line 26. Change "to affect" to "which affects"

Page 2: Line 3. Salisbury et al. reference misspelled.

Page 2: Line 7. Change "Nutrients. . ..is carried" to "Nutrients. . ..are carried"

Page 2: Line 8. Change "making the sea to have very high primary productivity" to "promoting very high primary productivity"

Page 2: Line 9. Add the article "A" before "proportion"

Page 2: Line 14. Change spices to species

Page 2: Line 22. Lower case 3 needed for calcium carbonate molecular symbol.

Page 2: Line 24. Change "difficulties in" to "the lack of"

Page 2: Line 25. I don't follow why the reference to Talmange and Gobler, 2009 needs to be made here. This reference has already been made (prior page, Line 29) to document larval stage vulnerability, although that reference is about non-polar invertebrates. The statement and reference repeated here is redundant

Page 3: line 2. Change was to were

Page 3: line 15. "the" before maintenance not necessary

Page 3: line 27. Delete "that" and change "is" to "as"

Page 3: Line 29. Insert a "the" before "two visits"

Page 4: Line 10. Change "kept at near" to "remained at a near"

Page 5: Line 23. Change kept to remained

Page 5: Line 31. Change captured to sampled

Page 5: Line 27-30. Most of the published data for sediment oxygen utilization rates for the northern Bering and Chukchi seas indicates that there is significant seasonal variation and it is lower in the late winter prior to initiation of the sea ice edge bloom. I think the Devol et al. paper is dubious to cite here because the winter sampling was done in nutrient-poor, near-shore waters that do not have high AOU at any time of year.

Page 6: Line 26. Change "in" to "to a"

Page 7: Line 15. Remove "of" The sentence would also read better if it starts with the article "the"

Page 7: Line 25. Suggest should be suggests.

Page 7: Line 28. Devol reference should be 1997, not 1996.

Page 7: Line 30 persisted should be persistent.

Page 8. Line 16. This really isn't a complete sentence.

Page 8. Line 31. Change "process" to "processes" and "is" to "are"

Page 9. Line 1. Change is to are

Page 9. Line 2. Add "the" between that and primary production.

Page 9. Line 3. There is a Grebmeier, 2012 reference in the literature cited, but not a

Grebmeier et al. 2012.

Page 9. Line 6-7. The sentence is not grammatically correct and I am not sure what the authors are trying to say.

Page 9. Line 9. Change “even with half productivity than today” to “even with half the productivity occurring today”

Page 9. Line 15. Change “it is indicated” to “it suggests”

Page 9. Line 16. Change “occupation” to “the proportion of”

Page 9. Line 17. Change “occupies” to “increases to”

Page 9. Line 18. Change These to This and indicate to indicates; add the article “a” has and significant.

Page 9. Line 22. I suggest changing Horizontal to Spatial

Page 9. Line 25. Change “to” to “from”

Page 9. Line 26. The mooring observations are presented in Nishino et al. 2016, so I think it is more accurate to state that the authors used the data from Nishino et al. 2016 to estimate calcium carbonate undersaturation.

Page 9. Lines 27-29. The Nishino et al. 2016 paper appears to show that the maximum chlorophyll a bloom can occur prior to July, so the early summer sampling may not have successfully sampled the most productive period.

Page 9. Line 33. Change “Occupation of calcite” to “The period of calcite”

Page 10, Line 2. Insert “subject to” between “been” and “aragonite”

Page 10. Line 5. Change two-hold to two-fold; change “occupation” to “the period of”

Page 10. Line 6. Change “year-long occupation under highly stratified condition. Occupation. . .” to “year-round periods under highly stratified conditions. Periods of

”

Page 10. Line 8. I suggest changing “surely” to “clearly”. It is less colloquial and more specific

Page 10. Line 10. Kroeker’s name is misspelled.

Page 10. Line 12. Change “may be conflicting the fact” to “is not consistent with the fact”

Page 10. Line 29. Since there was no formal presentation of oxygen isotope data, I don’t think an acknowledgement is necessary.

Page 12. Line 17. Global Change Boil should be Global Change Biol

Page 13, line 25. Raven reference is not in alphabetical order.

Figure 1. The arrows identifying the mooring sites are not clear.

Figure 8 caption. Corrected should be collected. Also trawl is misspelled.

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