First of all, we would like to thank Professor Lee Cooper for a thorough review of this paper. We have addressed all comments and suggestions. Please find our responses below

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.

--We agree that we need to discuss more about the winter AOU and its correlation to our reconstruction of CaCO₃ saturation state. A relatively constant positive AOU (~50 µmol kg¹) was observed over the winter for two years. As mentioned in the text, same level of AOU was also found in the hypersaline water that is formed in contact with atmosphere. This suggests that positive AOU in winter bottom water is not due to insufficient gas exchange but oxygen consumption. Although there is no year-round observation of sediment oxygen uptake in southern Chukchi Sea, it is known that oxygen uptake rate has a seasonal variation and is low in winter prior to initiation of biological production in spring. Previous studies in other Arctic waters have observed that sediment oxygen uptake rate in winter is not zero but is about half of that in summer in coastal area north of Pt. Barrow, Alaska (Devol et al., 1997), in Young Sound in Northeast Greenland (Rysgaard et al., 1998) and in Resolute Bay in Canadian high Arctic (Welch et al., 1997). Winter AOU observed by moored sensor in our study was about half of autumn AOU in 2012 and 1/4 in 2013. Therefore, we presume that the positive AOU in bottom water during winter can be explained by continued sediment oxygen uptake. This means that correlation between AOU and DIC should hold in winter bottom water. This assumption should be verified by winter observation of carbonate parameters by pCO_2 or pH sensors, automatic water samplers, or winter cruise observation in the future. These discussions have been included in the revised text as follows:

"Continued sediment oxygen uptake is a possible reason for the positive and constant AOU in bottom water during winter. Previous studies in shallow Arctic seas have found that sediment oxygen uptake rate is regulated by the availability of organic matter and macrofaunal biomass (Grebmeier and McRoy, 1989; Rysgaard et a l., 1998; Grant et al., 2002; Clough et al., 2005). Accordingly, oxygen uptake rate has a seasonal variation and is low in winter prior to initiation of biological production in spring (Cooper et al., 2002; Grant et al., 2002;). Nevertheless, winter sediment oxygen uptake rate is not zero but is about half of that in summer in coastal area north of Pt. Barrow, Alaska (Devol et al., 1997), in Young Sound in Northeast Greenland (Rysgaard et al., 1998) and in Resolute Bay in Canadian high Arctic (Welch et al., 1997). Winter AOU observed in our study was about half and 1/4 of autumn AOU in 2012 and 2013, respectively (Figure 4). This does not contradict observed seasonality in sediment oxygen uptake.

"Estimated low Ω in winter is likely due to continued oxygen uptake by benthic organisms during winter as suggested by positive AOU. Note that we applied the regression equation obtained from summer/autumn cruise observations to estimate winter Ω . We believe this is acceptable as because remineralization of organic matter should change AOU and DIC at a similar rate regardless. This assumption should be verified by winter observation of carbonate parameters by ship-based sampling, pCO₂ or pH sensors, or automatic water samplers in the future."

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.

--We have carefully checked data and calculations and found that there was a mistake in unit conversion (from saturation % to µmol/kg) in Nishino et al. (2016) for 2013 mooring data. This was the cause of the large difference of 69 µmol/kg between bottle and sensor measurements mentioned in their paper. With correct unit conversion, the difference was only 4 µmol/kg. In our original manuscript, we did not use calculations by Nishino et al. (2016) and used data correctly converted from original sensor output. Therefore, this mistake does not affect our results. This issue is now mentioned in the text to not cause same concern to readers: "Note that an offset of 69 µmol/kg found in sensor DO data for 2013 mooring in Nishino et al. (2016) was due to an artificial error in conversion of original sensor output to µmol/kg. With correct conversion, difference between sensor bottle DO data was only 4 umol/kg. Accordingly, we did not apply any correction to DO sensor data in the present paper."

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.

- --Our study is the first attempt to use this method to highly productive Arctic shelf sea. We agree that this should be confirmed in the future by using direct observations of carbonate parameters throughout the year. We have noted this in the revised text to read: "We should note this study is the first attempt to reconstruct seasonal variation of Ω using a method that has not been confirmed to work in Arctic shelf seas where seasonal changes in biological activity are extremely large. Direct observation of carbonate parameters in winter by using sensors or water sampler is desired to confirm our results.
- 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.
- --We agree that the maximum chlorophyll a was observed in May/June. However, our two shipboard samplings were made in two different period with high and low DO conditions. To be more accurate, text has been modified from "ship-based observations captured both higher and lower ends of seasonal variation in DO" to "ship-based observations captured both higher and lower parts of seasonal variation in DO", from "our ship-based observations in autumn 2012 and summer 2013 have captured the lowest and the highest Ω periods, respectively." To "our ship-based observations in autumn 2012 and summer 2013 have captured low and high Ω periods, respectively."
- 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.
- --We have revised the manuscript to describe results in an honest manner. Sentences have been changed to be more exact and fair, for example, "bottom water was kept at aragonite undersaturation for most of the winter" was changed to " Ω in bottom water was kept low during winter" and "intermittent undersaturation was found" was changed to "intermittent undersaturation was suggested".
- The title was also change from "prolonged undersaturation..." to "Seasonal variation of $CaCO_3$ saturation state in bottom water of a biological hotspot in the Chukchi Sea, Arctic Ocean".
- We hope the revised manuscript will meet the requirements for publication.

- 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.
- --We are sorry that we have submitted the manuscript with many typographical errors and really appreciate your kind editing. We will ask an English Language Service to edit our revised manuscript.
- 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

--The reference has been removed. The sentence has been modified to read "Because many benthic organisms have planktonic larval stages, timing and duration of $CaCO_3$ can be critical for their growth and populations".

- 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.
- --See response to the first comment above.

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

--The text has been changed as follows:

"In order to quantify the effect of anthropogenic CO₂ on our 2-year time series of Ω , we have estimated Ω for two cases: 1) preindustrial period case with pCO₂=280ppm, and 2) future case with pCO₂=650 ppm. Following previous studies (Gruber et al., 1996; Sabine et al., 1999; Yamamoto-Kawai et al., 2013; 2015), DIC concentration observed in year to obs is expressed as: DICt-obs = DICEQt-0 + (Δ diseq + Δ bio), where....".

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

--The sentence has been deleted.

Page 9. Line 25. Change "to" to "from"

- --We could not find "to" in this line and are not sure where the reviewer found this error. This will be corrected when we have the professional English editing.
- 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.
- --We agree that chlorophyll a was highest in June, though it is still high in July. The text has been changed from "under photosynthesis in early summer 2013" to "under an influence of photosynthesis".

All of following have been changed as suggested.

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 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 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 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 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 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. 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.