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Biogeosciences Discussions

Interactive comment on "Calcium carbonate saturation in the surface water of the Arctic Ocean: undersaturation in freshwater influenced shelves" *by* M. Chierici and A. Fransson

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We are grateful for all the constructive comments made by three referees and in this final author response we reply and comment on all points that were of concern for the reviewers. We have focused on replying on the remarks and comments brought up by Referee #3 (C1129) and Are Olsen (C745), since they had some major points. Anonymous Referee #1 (RC C550)suggested minor corrections and clarifications which have been changed and the manuscript is updated accordingly.

Reply to comments made by C745:

1. We agree with A.Olsen that ODV surface plots are not always the best to use.

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Interactive Discussion

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However, they have advantages when showing data on maps with features that are important to explain the processes and variability in the data such as locations with physical upwelling. The color ODV plots are also quite commonly used in many scientific papers and posters and presentations and it is unfortunate that color figures in a few cases limit the availability for color blind people to view them, 4% of the male population. However, we have tried several other plots to avoid color figures. One major problem by using x-y plots with longitude on the x-axis as proposed by A.Olsen is that the last part of the leg (after Bering Strait) varies by latitude. That means that it is not possible to discern variability or features in that part of the data. We have also tried stacking data from the part of the track which varies mainly by longitude on top of each other with the result of a messy view. We found that the clearest way of showing the data is by using ODV surface plots with color. The information I found is that 4% of the male population is color blind and for 98% for red-green. Thus we tried to change the color setting to avoid red-green colors but with no success. We can only encourage that color blind people contact the first author and then we can send the data for them to study and/or plot it. Figure 10 works relatively well since that is a ratio between AT:DIC in for data in selected areas. It is not the complete data set, but also there it is difficult to discern the exact location of the AT:DIC ration around Wrangel Island for example. However, in the case of Fig 10 it is of less importance to know exactly where each data point is located.

2. Yes, we will include bathymetry on the Bering Strait figures and we will improve the resolution.

3. A major concern for RC C1129 and A.Olsen (C745) are the errors involved in the CO2 system calculations. We agree that it is of great importance and we have made new updates accordingly:

(i) and (iii) The appropriate equilibrium constants for different measurement parameter pairings when calculating fCO2 have been a subject of discussion for many years, which is likely to continue. Wanninkhof et al. (1999) and Johnson et al. (1999),came

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to the conclusion that the equilibrium constants of Mehrbach et al.(1973) were more appropriate when AT and CT were used to calculate fCO2, while the constants of Roy et al. (1993,1994) should be used when AT and pH are the source data. This agrees with what we found from a internal consistency check when comparing measured fCO2 (fCO2meas) from the same expedition (as proposed by Olsen) with calculated from AT and pH (fCO2ATpH). A new table summarizes the results from the internal consistency check using five different constants to calculate fCO2ATpH. We hope that this information will improve the knowledge regarding the CO2 system constants in cold waters. There have been few investigations made in cold waters as Olsen comment.

We have used the fCO2 data set that was collected on the same expedition to evaluate the internal consistency for 5 different CO2 system constants. From this we found that the Roy et al., 1993 constants give the best agreement between calculated fCO2 (from AT and pH) with the measured fCO2 data (median bias of 1.5 μatm versus -5 μatm for Mehrbach. Thus we use the Roy constants to estimate the Omega values. From a study of the difference between Omega from Roy and Mehrbach and 4 other set of constants we find that Omega from Roy et al, give highest values thus overestimate the Omega. Thus we know that the Omega values we present in this work is at the higher end. This strengthens the likelihood that we found undersaturation (<1) omega Ar values in the CAA and MS and that they are not due to CO2 system calculations and choice of constants. We will explain this in the new version and also add a boxplot and a new table showing the results from the internal consistency check based on measured fCO2. We have also updated references and used results from Chierici et al., 2004, Wanninkhof et al., 1999 and Clayton et al. 1995 (focus on AT and pH thermodynamic consistency which is of importance in this case). Most other references are given for errors/differences between CO2 calculations using AT and DIC.

(ii) We provided error connected to the omega values in the bg version. We will update the error in DIC.

4. We agree and we have included the standard error for AT linear regression($\pm$5

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μmol kg-1) and for pH regression: $\pm$0.028. Preliminary calculations show that the propagated error in calculated DIC is $\pm$ 6 μmol kg-1 and $\pm$ 0.15 in omega Ca and $\pm$0.1 in omega Ar.

5. We will improve the explanation about the use of the AT:DIC ratio to diagnose the processes involved in affecting the omega values.

6. We will add the sampling date in the Table 1. References will be added and checked again.

Reply to comments RC C1129:

Major comment was on the accuracy on the pH data and the referee propose that we use the fCO2 dataset from the same expedition. We direct the referee to the answer made to C745 under #3 (i) and (iii). We have used the measured fCO2 data set from the same cruise and performed an improved internal consistency check. We feel that this exercise have significantly improved the manuscript.

All minor comments have been changed accordingly.

Interactive comment on Biogeosciences Discuss., 6, 4963, 2009.