

Interactive
Comment

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

Anonymous Referee #3

Received and published: 10 July 2009

The authors have collected a wonderful dataset from a very hard-to-sample region. Because of ice-cover, weather and other logistical difficulties there is rather little carbonate chemistry data available from the Arctic. And yet it is thought that ocean acidification will lead to undersaturation of surface waters occurring first in the Arctic, before anywhere else. There is therefore a pressing need for more data in order to constrain models and improve our understanding of the ongoing shift to CaCO_3 undersaturation in the Arctic, and this paper helps meet that need with data collected right across the Arctic, from the Atlantic to Pacific sides via the Canadian Arctic Archipelago.

Major Comment:

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Data was collected at frequent intervals by taking discrete samples from the underway supply. Alkalinity and pH were measured. It is more normal to measure DIC and alkalinity because certified reference materials are available for both. A weakness of this study as presented is the uncertainty about the accuracy of the pH data. This accuracy is discussed in the methods section, but is only an inferred (optimistically expected?) accuracy. There is no information from actual pH measurements; for instance there is no data from inter-comparisons or from measurements of CRMs. This leads to uncertainty about exactly how robust the derivations of carbonate ion and saturation are, because they depend on the accuracy of the pH data.

Fortunately there is an obvious solution because pCO₂ was also measured on the cruise (Fransson et al., in press, CSR). The authors must present a comparison of pCO₂ calculated from Alk & pH against their measured pCO₂. If pH (and other) data are accurate then there will be good agreement. The comparison will help readers evaluate the quality of the data in different regions.

Minor Comments:

1. Terminology should be standardised throughout (AT and CT, or DIC and Alk).
2. The standard of the English is generally good but would benefit from some further attention, e.g. “due to” not “due from” (pg 4964), “control over” not “control of” (pg 4965), remove “the” before “aragonite” (line 20, page 4965), etc.
3. Spellings of locations should also be looked at (e.g. Cape Farwell and Wrangler Island (pg 4967).
4. More elegant not to say that saturation state depends on both carbonate ion and pH (lines 22-23, page 4965).
5. Remove “2” before H₂O (equation 1, pg 4966).
6. It seems contradictory to say both (1) that there is upwelling near Cape Bathurst where there is a polyna, and (2) polynas are sites of dense water production (leading

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therefore to downwelling?) (page 4968).

7. Elaborate and/or justify the phrase “which provided reliable samples” (page 4969).

8. “Hydrate ion” to “hydroxyl ion” (page 4971).

9. The error in calculated $[\text{CO}_3]$ relates to the accuracy of AT and pH data, not to their precision (page 4971).

10. Surely the most obvious pattern, that is not explicitly mentioned, is that nearly all variation in alkalinity is associated with variation in salinity (as shown in figs 4, 2a & 5a) (top of page 4972).

11. Also river inputs (line 15, page 4973)

12. Explain why you have chosen to use the ratio of AT:CT (e.g. because $[\text{CO}_3] \approx [\text{Alk}] - [\text{DIC}]$).

13. Insert 2 before HCO_3 (equation 3, page 4975).

14. A talk is not citeable (Azetsu-Scott et al., 2008) unless accessible to others.

15. Explain what the lines are in the caption to fig 4 (expand on the single word “For”)

The manuscript deserves publication following attention to the points above.

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