

This work provides valuable long-term carbonate observations and guidance on instrument setup, data processing and quality control for the coastal ocean measurements of carbonate species. The dataset would be a great contribution to the Arctic carbon cycle community and the method will be well-welcomed by the coastal ocean community. I think it is suitable to be published in ESSD upon resolving the minor corrections below.

By the way, my expertise mainly allows me to comment on the pco₂ and CO₂ flux-related contents. Please refer to the other reviewer's comments for the remaining parts. Also, I am not a native English speaker, but the writing looks good to me.

General and specific comments:

Line 6: Is it possible to use the data present in this study to back-calculate the dissociation constants?

Line 7: '...remains unsettled for Arctic waters'. How representative the water at the measured location for the entire Arctic waters?

Line 7: Does the stratification related to the ocean depth? If no, suggest removing 'despite the shallow depth'. Also, I did not see any discussion about this in the main text.

Line 10: in the main text, the value is 17. Keep consistency.

Line 12: 'are understood the least'. Why the least? Any reference for this?

I was thinking the Antarctic and Southern Ocean are less understood because of the remote and limited measurements.

Line 20: I am curious why the Arctic SST increasing rate right now is not significantly higher than other regions considering the greatest future warming?

Line 48-49: Fig. 1 A, B, C. The figure caption uses the capital A, B, C to represent the subplots. Keep consistency.

Line 50-51: I am wondering if this sulfuric acid will influence the pH and carbonate measurements. May quickly dilute by the water mixing?

Figure 1: worth to check all the figure captions. Here a, b, c, d should be 1, 2, 3, 4 I think. In addition, add (C): Svalbard (A), Kongsfjorden and Ny-Ålesund (B), and (C) observational set-up...

Line 63: ‘The number of outliers discarded was 38 and 41’. How many observations are in total?

Line 98: consider removing ‘...’ in the bracket.

Line 114: ‘The gas exchange parameterization as a function of wind speed of Ho et al. (2006) was used’. I like Ho et al. (2006), but not sure if Ho et al. (2006) parametrization is the best here at a coastal environment. First, the (Ho et al., 2006) was derived from the open ocean (Southern Ocean) environment, while the (Nightingale et al., 2000) was derived from the coastal sea (the North Sea), which may be better here. Second, the K in the very coastal area (very shallow seawater) might be different from the K in a relatively open ocean (see (Yang et al., 2019)). May not need to change the K parameterisation here, but worth to add this information.

Line 125: not clear to me which time-series data is mentioned here.

Figure 2: B: Monthly; C: Monthly

Figure 4: Here I did not see pCO_2 plot. Does the middle panel represent pCO_2 ? In addition, ‘aragonite Ω_a calculated from AT and AT’, two AT, should be a typo.

Line 173-175: Looks to me that the performance of Papadimitriou et al. (2018) and Lueker et al. (2000) is similar. Worth to explain why ‘the formulations of Papadimitriou et al. (2018) performs better on our data set’.

Line 175: remove one right bracket.

Line 195: ‘The relationship between the measured and calculated pCO_2 (blue line) is relatively poor’. What is the reason of this?

Figure 5: add **A** after 5.

Figure 6: explain the blue and red dots in subplots A-E. In addition, please check here ‘In panels F-J, the orange lines [to add] indicate the medians, boxes show the first and third quartiles and the interquartile range’. Some typos.

Line 222-223: ‘Temperature is lower by up to 2 °C in the deep layer from January to October and higher by up to 0.3 °C in November and December.’ Lower than the surface layer, higher than the surface layer?

Figure 8: Any thoughts on why the salinity and temperature at surface is higher than at deeper water in December? Caption: A, B, C, not a, b, c.

Line 232: Figure 5B shows that the calculated p_{CO_2} disagree with the directly measured p_{CO_2} . Not sure how good the calculation here is. Consider providing the uncertainty of the calculated p_{CO_2} .

Line 236 & Figure 10: here in the text, surface $p_{CO_2} < \text{deep } p_{CO_2}$, but figure 10 shows opposite. Please check and revise.

Line 239: It would be interesting to include some discussion about the surface $p_{CO_2} > \text{deep } p_{CO_2}$

scenario in December.

Line 240-242: Here is quite confusing. Does the value 20 missed a '-' (i.e., -20)? 'Correcting for the underestimation of $17 \mu\text{atm}\dots$ ', I think it is overestimation? But if the uncorrected flux is $-20 \text{ mol m}^{-2} \text{ yr}^{-1}$, after the $17 \mu\text{atm}$ correction, the flux should be higher than 20 in magnitude. Please double check and clarify carefully, because this is quite important for the conclusion.

Line 243-245: I guess here try to mention the entire Arctic Ocean carbon uptake. But I am wondering how representative for the Arctic Ocean this location is? I feel like this is just a coastal ocean, which is likely different from the relatively open seawater and also different from other coastal oceans.

-Yuanxu Dong