Biogeosciences

Discussions

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# *Interactive comment on* "Spatial variations of CO$_2$ fluxes in the Saguenay Fjord (Québec, Canada) and results of a water mixing model" *by* Louise Delaigue et al.

**Anonymous Referee #1**

This paper uses an extensive dataset of physical and biogeochemical observations to identify water source contributions to a unique Canadian fjord-type system and evaluate the results in relation to the fjord's air-sea CO2 flux characteristics. Overall, I found this manuscript very well-written, with good explanations of methods used (with one exception I will discuss below), excellent descriptions of data analyses, and clear presentation of results. Also, the paper is concise! While this is very welcome overall, the Introduction and Summary may actually benefit from some additional content.

-The Introduction is a little light. Can more detail be added on coastal CO2 emissions? While there may be little information on CO2 emissions from fjord-like systems, there

have certainly been studies on a variety of other coastal system types which might provide context for this study.

-Similarly, the Summary and Conclusions section is pretty brief. At the very least, what do the authors see as the impacts of this work beyond the studied system. What future work might stem form these findings?

-One very interesting finding of the paper is the negative Org-Alk of the Saguenay River and the fjord waters (Figure 2, manuscript lines 383-388). I am familiar with work detailing positive Org-Alk findings (i.e. calculated TA lower than that measured directly), but I can't think of another example of negative Org-Alk. Negative total alkalinity is common in very acidic waters, but the total alkalinity in this river is positive (although low). This implies to me that in the total alkalinity titration, there is some excess of acid that is not reflected in the pH and DIC measurements. What could this be? This leads me to wish there were more description of the TA measurement method. At which pH range was the titration carried out? What is a shallow end-point detection algorithm? Where might the excess acidity be coming from? A short discussion of the factors that could explain the negative Org-Alk would be a welcome addition.

-The air-sea CO2 flux calculations were based on discrete measurements of DIC and pH at individual stations. However, to produce the overall fluxes for the system, the estuary must have been divided up spatially into segments, as implied by equation 5. However, these segments are not discussed or shown on the map (Figure 1), and should probably be included and delineated in the map.

-Also, pH data were important to this study, but are never shown. At the least it seems that the pH data should be shown in the Appendix figure, but really there should be a discussion of the pH findings before they are used to calculate pCO2.

-In Figure 2, the SRW and CIL TA data are plotted against salinity. It's unclear to me where exactly these data were collected, or how they were selected. The SRW data fall into the salinity range of 0 to ∼18 while the CIL data are saltier, from salinity ∼22-35.

A regression line is included (although I am skeptical of the R2 of 1.0 shown, given that there is at least some scatter in the data). However, to my eye it seems that the regression line of just the CIL data would produce a different (shallower) slope and (higher) y-intercept that that of the combined SRW and CIL data. If the CIL endmember TA:salinity regression were different, how would that affect the water mass mixing results?

Specific Observations: -L13-L15: this sentence is pretty awkward, can it be simplified? -L26: is there a newer citation for atmospheric CO2 levels than this 2008 work? -L77: the terms "Tmax" and "Sp" have not been defined -L90: the St. Lawrence River and Estuary frequently appear in this manuscript, but it's unclear where these features begin and end in relation to the Saguenay system. -L99: were samples from the St. Lawrence estuary included in the Appendix plot? There seem to be data in this plot that are quite different than those in Figure 2. If so, the locations of the St. Lawrence stations should be shown in Figure 1, and the difference between data from inside and outside the fjord should be clearer. -L110: what is the distinction between "TA" and "TA/DIC" samples? -L124: what is "Rio Tinto Alcan"? -L275: can the location of the weather station be included on the map? What was the measurement height for the wind speed? -L276-277: this is a really nice, concise description of the Schmidt number -L284: specify water temperature here -L298: is there a way to cite or list the conversion formula from NOAA-NWS? -L336: How was the correction for organic alkalinity performed? -L414-424: this correlation analysis assumes that the sensor pCO2 measurements are totally correct; however, there is a fair amount of uncertainty associated with these sensors. Error bars in both the x- and y-directions would be helpful in Figure 5. -Figure 1: the color scale needs a label ('Salinity' etc) -Figure 6(a): the line is dashed-black in my copy, not red as described in the caption -Figure 8: can the mean temperature used to normalize the data be listed somewhere in this figure, for ease of reference?

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Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2019-296, 2019.