

Biogeosciences Discuss., referee comment RC1  
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## Comment on bg-2021-266

Anonymous Referee #1

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Referee comment on "Marine CO<sub>2</sub> system variability along the northeast Pacific Inside Passage determined from an Alaskan ferry" by Wiley Evans et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-266-RC1>, 2021

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Review of Evans et al. "Marine CO<sub>2</sub> system variability along the Inside Passage of the Pacific Northwest coast of North America determined from an Alaskan ferry."

Evans et al. have prepared a massive manuscript detailing a suite of data collected opportunistically over two years in the Pacific Northwest. The core observations are temperature, salinity, and pCO<sub>2</sub>; however, the authors leverage a salinity-based estimate of total alkalinity (TA) to expand the analysis to other parameters of interest such as DIC, pH and  $\Delta\text{pH}$ . This approach is clever and allows for some novel analysis of anthropogenic influences on the marine inorganic carbon system in this region, but has drawbacks which are highlighted. Speaking from my own experience, I appreciate that continuous data records from ships of opportunity can be challenging to assemble into a coherent scientific analysis. I applaud the authors' work here in that regard, and think this work achieves that end. This manuscript is well-written, but some details in the Methods might be moved to the Supplementary Material. There is a huge amount of variability in study region conditions, so some specific sub-regions of interest are highlighted. This regional variability is presented in a series of nice figures, but some statistics around months/seasons might help to reinforce the presentation of the data, perhaps in a couple tables.

### MAJOR COMMENTS

-I am somewhat concerned with the length. For some journals this manuscript would be too long by perhaps 25%. The Methods section takes up more than 25% of the total manuscript text. These methods are important, but some of the description could be presented in the Supplementary Material. Perhaps Biogeosciences is a good fit, as being online-only the length is not a publication concern, but I do think readability would be helped with some length reduction and more concision.

-Many of the Figures (2-4, 8 and 9) follow the same presentation style, showing the cruise

track repeated over time and colored by data values. This is a style I haven't seen often before and overall I think it is really effective. However, I can't figure out the time component of these plots. For example, in Figure 2 each panel has dates listed along the x-axis (I'm going to ignore the longitude axis at the left side of these plots for now). The x-axis tick mark corresponds to Nov17, which agrees with the Introduction text as to when surveys began. However, as the ship travels 'north' (vertically along the y-axis), it also travels west, but seemingly back in time as well. Thus, the survey that departed Nov17 heading north appears to arrive at the northernmost point in Skagway a couple months earlier. This becomes confusing when seasonality is discussed: while the total north-south transit took one week, the northernmost data appear to precede the southernmost data by a couple months, even though the north-south total transit took one week. One solution might be to add a secondary x-axis on the top of each panel, corresponding to the date when the ship arrived at the northernmost point (basically the lower x-axis shifted to the left). These plots also seem to be done in a Matlab 3-D format (with short longitude z-axes appearing at the bottom), but I'm not sure the inclusion of the longitude adds much (although longitude is probably necessary to generate the plot). Can they be presented in a more 2-D format, or can the figure captions be expanded to provide more detail to the reader?

#### MINOR COMMENTS

-The title itself is long. Could it be something like "Pacific Northwest marine CO<sub>2</sub> system variability along the Inside Passage coast"?

-L41-42: is 1765-present considered the industrial era?

-L46: 0.1 decline over what period?

-L52-55: not sure what this is getting at

-L69: change in what?

-L71: was this mortality linked to upwelling of potentially anthropogenic CO<sub>2</sub>?

-L96-98: variability of what? This sentence may be so general as to be unnecessary.

-L117-118: awkward phrasing here

-Figure 1: the arrows are hard to see in some cases. Can they be outlined in white, or made wider? Also, can full location names (instead of acronyms) be used in the map itself?

-L134: I know I've mentioned the length of the manuscript, but a section here laying out the basic geography of the study area would be useful, especially since the discussion leans heavily on some specific geographic/oceanographic characteristics like areas of stronger tidal mixing and freshwater input.

-L157: what is the water jacket for? Temperature control?

-L170: "a LI-COR"

-L175: "calibrating a LI840A using the Praxair gases, then using...."

-L184-186: So was CO<sub>2</sub> measured at about a 2-minute interval? Were other data (SST, salinity) also measured or recorded at 2 minutes?

-L229-230: I'm not sure if the statement about the Alk composition is true, or even needed. CO2SYS certainly uses Alk contributions from sulfate and fluoride in the determination of total Alk. A sentence about the possible effects of the presence of organic alkalinity, P or Si could illustrate the potential uncertainties from leaving these potential contributors out. I believe modified versions of CO2SYS are available that can model organic alkalinity inputs.

-L233: what compromised the pCO<sub>2</sub> data?

-L234: "pCO<sub>2</sub> was estimated indirectly..."

L248-255: Not sure the weather vs. climate distinction matters much, as the authors clearly present the actual uncertainty estimates

-L256-260: Could there be seasonal bias in the gridded means, CVs etc? For example, there were observations in March 2018 and March 2019, but only in November 2017 (not 2018)? Are the spring and summer months overrepresented relative to the fall and winter months, given the data gap between October 2018 and March 2019? Also, I think some

explanation of the largest data gaps is warranted- what happened?

-L278: "three terms in Equation 1..."

-L288-291: these buffer factors should be defined and explained, and the global values provided. This would be a good job for the Supplementary Material.

-Section 2.3.2: I wonder if this whole section could go in the Supplementary. It's important, but does not directly tie into the results presented, and a small subset of this section referenced to the Supplementary might be able to orient the reader to the big picture (thermodynamic vs. biophysical  $p\text{CO}_2$  drivers).

-L310: where did this growth rate come from?

-L310: or  $p\text{CO}_2$  growth in coastal zones may not be apparent at all (i.e. Salisbury and Jonsson 2018)

-L351-353: this sentence can be removed

-L354: the Alexander Archipelago isn't shown in Figure 1, as far as I can see

-L393: can you estimate the relative strengths of the seasonal blooms in each year from satellite data?

-Figure 4 caption: these pHT values are at in-situ temperature, correct? In general, I think the figure captions can be expanded to explain the plots more, and perhaps even take some of the explanation out of the text itself

-L449: were temperature and salinity the same between years?

-L465-466: I think this is repeated from earlier.

-L548: Serguis Narrows and Wrangall Pass are not on the map in Figure 1

-L590: do previous studies indicate that seater  $pCO_2$  in this area is increasing at the rate of the atmospheric increase?

-L600: "additional change might be anticipated is greenhouse gas emissions are reduced to reach..."

-L626-644: this section had me a little confused. What do the changes in Figure 8 over time indicate? Different surface water sources? Direct addition of anthropogenic  $CO_2$  via summer  $pCO_2$  drawdown vs. longer time scales for mixing/advection?

-L650 "limit"

-L663: the analysis of 2035 acidification levels don't consider temperature increase, correct?

-L669-671: I wonder if averages are the best indicator here. What about a median with range, or one standard deviation? There is surely some variability that these averages are not capturing.

-L673: "have been"

-L673: should pH change values be negative?

-L725-727: I think the freshwater alkalinity variability is discussed, but could be highlighted more.

-L728: "dominant"

-L740: large portions of the Inside Passage show  $\omega < 1$  beyond 2035, right?

-This conclusions section summarizes the paper well, but doesn't do much to point the way forward from here. Some of that is done in the Discussion, which could be moved here instead.

Supplementary Figure S2: Could the bottle alk here below salinity 22 be used to refine the Alk(S) relationship, by basically developing a different relationship at  $S < 22$ ?

Supplementary Figure S11 caption: "therefore"