Review of Baldry et al., "Estimating total alkalinity for coastal ocean acidification monitoring at regional to continental scales in Australian coastal waters"

## Summary

This manuscript uses in-situ total alkalinity and physical/biogeochemical measurements (temperature, salinity, chlorophyll fluorescence, and nitrogen) to both test a global equation for alkalinity retrievals (Lee et al. 2006) and to develop localized equations for nine coastal sites. I think this topic is potentially of significant interest to others, and I think the authors have a very nice data set to exploit. However, I think the analysis is somewhat superficial, and I finished the paper wanted a lot more analysis and discussion that what is provided. I will address these points below, but I encourage the authors to further expand their work. The paper is generally well-written, but I list some specific comments which may improve readability.

## Major Comments

My major reservation about this work is the depth of analysis. This mostly relates to the results from the nine study sites. As noted in the manuscript, these sites are scattered along a very long coastline, distributed across a wide range of latitudes, and presumably represent contrasting conditions from the interactions of offshore ocean water and unique terrestrial and estuarine inputs and transformations. However, except for the discussion of the Yongala site (where the regression results were weakest), little to no information is presented to describe how these sites differ. The one citation referencing the sites (Page 5 Line 5, "Lynch, Morello et al. 2014) appears to be missing from the References.

The reason I am left wanting more information about the physical settings is that a number of the regression coefficients are quite similar. By eye, it seems that under Base Model 2 the sites Kangaroo Island, Maria Island, and North Stradbroke Island have nearly the same regression line: is this true? If so, is this coincidence, or are there commonalities between these sites that might explain their similar results? Interestingly, the Ningaloo and Port Hacking Bay Base Model 2 results seem similar to each other, and they are on opposite sides of the continent! Considering Base Model 4, one might group Kangaroo Island, Ningaloo, and Rottnest Island, which is a much different cohort. Is there a statistical way to cluster the sites together to look for spatial trends?

The authors describe the site-by-site results as 'regional', but how far might that region extend around each site? How can these results be applied to locations between the study sites? One recent paper by Carter et al. discusses a method for interpolating alkalinity data between station which may be helpful. Again, some understanding of what makes the study sites alike or different would help me understand how applicable these equations may be in other places.

I also think the authors should read the paper by Alin et al. (2012), which may provide more insight for this work. Those authors also used multiple linear regression techniques to model alkalinity (and other carbonate system parameters) from physical/biogeochemical data at coastal sites.

Specific Comments

P2L9-10 the word “threatens/threatened” is repeated in one sentence.

P2L12 what are the synoptic scales of interest?

P3L2- Define $CO_2$ (and format the subscript)

P3L21-22- the phrase “contribute a significant calcifying fauna” seems pretty awkward

P3L26- This line is also pretty awkward

P3L29-30- “TA is conservatively related to salinity”- this is an overstatement

P3L36- don’t forget organic matter respiration too

P4L24- again, what are the synoptic scales of interest?

P5L23-24- how useful is an integrated phytoplankton biomass over the entire water column, if discrete alkalinity/salinity/temperature pairs are used? Will this affect the statistics, if the same CHL value is used for multiple alkalinity samples? This seems risky.

P5 and P6: the Sections “Linear Regression (LR) Analysis”,”Open ocean model”, and “Statistical analysis” are all numbered 2.2- shouldn’t they be 2.2, 2.3, and 2.4?

P6L3- these equations are listed with little in the way of introduction. Can the authors set them up more in the text before listing them?

P7L10- the term “minimum model” is a little confusing to me. It makes me think this is the minimum set of input parameters needed to accurately estimate alkalinity. Perhaps this is a statistical term I am not familiar enough with, but it seems the minimum model is just the one with the lowest AIC numbers- correct? But it may be perfectly reasonable to still use the other regression models, depending on the input data available and the user’s goals.

P8- This section is so brief, it feels somewhat like an afterthought. Have the authors considered combining this with the next section into a dual Results and Discussion section? This might result in better flow from topic to topic.

P9L10- again, the paper by Alin et al. (2012) and other related works undermine this argument that little coastal regression work has been done.

P9L14-29- much of this material seems like it should be in the Introduction or perhaps Data and Methods sections- it seems out of place here.

P9L39- are the “decreases” described here decreasing AIC values? Unclear from the text.

P10L37-40. This argument seems a little shaky. Seasonality in river discharge would also result in a salinity seasonality as well, not just in alkalinity. Are the authors implying that the alkalinity concentrations in river discharge vary seasonally? If so, what is the mechanism for this? Also, the authors state that this seasonality cannot be measured by remote sensing, but isn’t one of the prospects held out by this paper the potential of new remotely-sensed salinity products? Why would remotely sensed salinity not show this seasonality?

P11L18- change to “in the future”

P11L23-38- Figure 6 might undermine several of this paper’s points. For one, it only uses the general coastal model, since the authors did not attempt to interpolate their regional results over the entire domain. Also, Figure 6 shows that the actual locations of the stations where data were collected are masked out by a land mask. How sure are the authors that applying this coastal model is appropriate, given that the model data were collected in an area where remotely sensed measurements are not even available. I acknowledge that it is good to show the potential application of these relationships, but this raises the question of site selection in this study.

P13L2- Again, I am confused about the use of the term “minimum” Previously the authors state that at least temperature should be included with salinity in these equations. However, this seems to contradict that recommendation by saying that the inclusion of salinity, temperature, and CHL or N are the minimum. Also, can the authors quantify, perhaps in terms of umol alkalinity error, how much better it is to include CHL or N?

Figure 1- what is the inclusion of the 1000m isobath intended to show? Why 1000m?

Figure 2- the text in this figure is very small, and might not show up well in the final version

Figure 3 and Figure 5- please insert a space into the μmol $kg^{-1}$ labels

Figure 5- the caption says results from four models are shown, when only three are shown

Table 1- I’d appreciate another table, perhaps describing the salinity, temperature, alkalinity, CHL and N data for each site. Perhaps just some basic statistics such as range, mean, standard deviation etc.

Figure S1- Might this be better shown in a table? Or at least could this information be briefly described in the text? This figure seems a bit superfluous to include.

Table S1-S4- while these tables contain a lot of information, they are also really the heart of the paper’s analysis. Seems a little strange to bury them in the Supplementary Information. Also, do the terms Intercept, S, T etc. in these tables refer to the terms d, a, b respectively in the model equations listed on Page 6 of the main text? If so, please use consistent terms between the two.

Alin, S. R., R. A. Feely, A. G. Dickson, J. M. Hernández-Ayón, L. W. Juranek, M. D. Ohman, and R. Goericke. 2012. Robust empirical relationships for estimating the carbonate system in the southern California Current System and application to CalCOFI hydrographic cruise data (2005–2011). J. Geophys. Res. 117: C05033. doi:10.1029/2011JC007511

Carter, B. R., N. L. Williams, A. R. Gray, and R. A. Feely. 2016. Locally interpolated alkalinity regression for global alkalinity estimation. Limnol. Oceanogr. Methods 14: 268–277. doi:10.1002/lom3.10087