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Interactive comment on "CO_3^{2-} concentration and pCO_2 thresholds for calcification and dissolution on the Molokai reef flat, Hawaii" *by* K. K. Yates and R. B. Halley

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Accurate measurements of community level metabolism and carbonate system parameters in the field are very logistically difficult and costly to acquire. This is, in part, why so few data are available from in situ field studies. We have presented the first available field data that estimate pCO2 and CO32- thresholds for calcification and dissolution. Thus, we are not at all embarrassed by the number of data points we have, nor the first approximations we present with respect to pCO2 and CO32- thresholds. Additionally, in the manuscript we have cautioned the readers on the limitations of the data set and fully expect that the ranges of thresholds and implications will be refined as additional data sets become available.

The low number of data points that we have results in relatively high p-values for the linear regressions of many of the sites (see table below). As we point out in the paper, different substrate types (and similar substrate types measured during different time periods) respond differently to pCO_2. The slopes of the regression curves are different for each location reflecting the variability in response from each substrate type. We have not yet sorted out or quantified the causes of this variability (which may include difference in metabolism due to different community compositions on each substrate type, seasonal variations in G, differences in sediment composition, degree of biologic control on G, mixing rate of water masses, rates of pore water/surface water interactions, etc.). However, as a result of this variability, you cannot create a composite data set and expect to see a significant correlation. This is why we have examined each substrate individually.

If we plot 4-hour calcification rates over 24-hour time periods, pCO_2 and CO_3^{2-} versus time for each substrate type (not only for the Molokai reef flat, but in many other reef ecosystems in which we have made similar measurements), it is very evident that correlations exist among these parameters despite the high p-values due to low sample number. We can plot all of the calcification data from all of the substrate types versus pCO_2 or CO_3^{2-} on the same set of axes. However, due to the variability among substrate types, the r^2 is lower, but the p-values improve ($r^2 = 0.17$, $p = 0.01$ for pCO_2; $r^2 = 0.32$, $p = 0.001$ for CO_3^{2-}). Nonetheless, whether you calculate the dissolution thresholds using the average of thresholds calculated for each individual substrate type (with relatively high r^2 and less significant p), or from the composite graphs (with lower r^2 and more significant p), you essentially get the same numbers (640 versus 654 microatm for pCO_2 threshold, and 153 versus 152 micromol kg^{-1} for the CO_3^{2-} threshold). For this particular set of data, you can have a high r^2 and less significant p, or a low r^2 and more significant p (take your pick) depending upon whether you examine the data sets individually or as a combined set, but you get the same average thresholds either way. Bottom line is, we need more data, and we have expressed this in the paper. We believe that many readers will find the data sets, comparisons, and discussion that we have presented valuable, thought provoking, and a good starting point for others to compare similar studies and improve upon. We will include the p-values and provide readers with enough information to decide for themselves the relevance of these relationships. It is also very well-established through numerous other lab and modeling studies (as referenced in the introduction of our manuscript) that calcification is dependent upon saturation state, CO32-, and pCO2. Thus, we are comfortable using these linear correlations as a first approximation.

Table of CO32- and pCO2 thresholds for individual substrate types and linear regression parameters.

Description; CO32- Threshold; R2, p; pCO2 Threshold; R2, p

(micromol kg-1); (microatm);

Sand Bottom 2000; 157; 0.81, 0.01; 562; 0.65, 0.03

Coral Rubble 2000; 164; 0.69, 0.04; 537; 0.63, 0.06

Patch Reef 10% 2000; 184; 0.50, 0.12; 467; 0.51, 0.11

Patch Reef 20% 2000; 155; 0.63, 0.06; 605; 0.66, 0.05

Sand Bottom 2001; 138; 0.56, 0.15; 748; 0.66, 0.10

Patch Reef 10% 2001; 113; 0.51, 0.11; 1003; 0.57, 0.08

Avg. plus/minus 1 std. dev.; 152 plus/minus 24; 654 plus/minus 195;

The benthic chamber procedure that we use in our study has been previously described in great detail in Yates and Halley 2003 (referenced in our methods section). It is redundant to repeat this discussion again in this manuscript.

Specific comments: We prefer to keep equation 1 as is. In our study we calculated deltaTA as TAinitial - TAfinal for each 4-hour incubation period. Thus, calcification is a positive value, and dissolution is negative. We will clarify this in our revised manuscript. I can find only very few papers that do not represent calcification as a positive value and dissolution as negative. We prefer to remain consistent with the majority of the literature.

Our data showed a best fit line for the relationship between calcification rate and CO32- or pCO2 using a linear function as opposed to the hyperbolic tangent function defined in the experiments of Gattuso et al. (1998). Our observation of a linear relationship between calcification rate and CO32- is consistent with the observations of Leclercq et al. (2002), Langdon et al. (2000), and data from Boucher et al. (1998). There is still uncertainty as to why some corals and reef communities show a linear relationship while others show a non-linear relationship between calcification and saturation state or CO32-. It is possible that this may result from the combined effect of light and CO32- on calcification rate. Calcification rate has been shown to correlate to irradiance with a hyperbolic tangent function indicating that calcification can become light saturated. It is possible (although unproven) that light saturation of calcification may have occurred in some of the experiments showing a non-linear fit between calcification and CO32-. Future experiments are needed to tease out the combined effect of these two parameters.

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