

Interactive comment on “Ocean acidification accelerates dissolution of experimental coral reef communities” by S. Comeau et al.

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General comments: Comeau and colleagues have carried out a very nice experiment showing how net CaCO₃ sediment dissolution in coral reef communities accelerates under a potential ocean acidification scenario. The effect of OA on CaCO₃ dissolution has been largely ignored with a few exceptions; thus, this is a timely and important study. The study and the manuscript are nicely done and deserve publication in my opinion, but the manuscript needs significant clarification and expansion in several areas that I point out in the detailed comments below. The authors have also overlooked a few papers that have done similar work or discuss the issue of CaCO₃ dissolution and ocean acidification on coral reefs (e.g., Andersson et al., 2009; Andersson and Gledhill, 2013; especially the first one is relevant in the present context). With the risk

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of being self-promoting, I strongly believe the results and discussions of these previous papers will be beneficial to the authors. I hope the authors will find the following comments useful in order to improve the current version of the manuscript.

Detailed comments:

P12324, Line 15: I suggest change sentence to “. . . switch to net dissolution as pCO₂ increases and CaCO₃ saturation state decreases. . .” as dissolution is controlled by the seawater saturation state with respect to carbonate minerals and not the pCO₂.

P12325, line 7-8: See also papers by Andersson et al., 2009 and Jokiel et al. 2008.

P12325, line 20-22: Yes, dissolution is taking place at present conditions on coral reefs but mainly in sediment pore-waters or in microenvironments, where the seawater carbon chemistry is different compared to the overlying water column (see review by Andersson and Gledhill, 2013). Your interpretation of the Andersson et al. (2007) is somewhat incorrect. Yes, these observations reported net dissolution at present time but under elevated surface seawater carbon chemistry conditions, i.e. not conditions that are typically observed on coral reefs surface seawater today, but rather similar to conditions observed in sediment pore waters.

P12325, line 23-24: Several additional studies have proposed a threshold of when different benthic communities or coral reefs in general will switch to net dissolution (e.g., Yates and Halley, 2006; Andersson et al., 2005; 2007; 2009; Silverman et al., 2009; as well as others). The exact threshold obviously differs and depends on a number of factors discussed in Andersson et al. 2009 (see section 4.3).

P12326, line 1-2: what are these pCO₂ values? Mean pCO₂? It would be useful to show seawater saturation state with respect to aragonite and also the variability, e.g., +/- STD or SE.

P12326, line 23-25: What type of stratification are you referring to? Sediment stratification? Chemical gradients? Did the sample collection destroy the existing stratification

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and was this actual reestablished after 4 days. Please clarify.

P12327, line 14-16: This sentence needs clarification. I assume you refer to seawater pCO₂ and that the pessimistic scenario refers to surface seawater pCO₂ in the tropical(?) open ocean. However, coral reef seawater pCO₂ is currently significantly different than open ocean pCO₂ and will likely be different by the end of the century as well. See for example continuous seawater pCO₂ measurements at <http://www.pmel.noaa.gov/co2/story/Coral+Reef+Moorings> which shows that many reef experience seawater pCO₂ significantly higher than the atmosphere at present time. Thus, I think you need to clarify that the scenario you are referring to refers to the open ocean and that coral reefs can experience a radically different seawater pCO₂.

P12327, line 14-19: How did you maintain constant pH with your pH stat? What acids and bases were you using? What was the variability around the desired pH level?

P12327, line 17-19: Do you have data supporting that the diel variation is 0.1 pH units in the back reef of Moorea? From my own observations in other coral reef environments I have seen that the diel amplitude can be quite variable from day to day, but also vary greatly across space. Please clarify.

P12327, line 20-27: What were the accuracy and precision of your measurements and how did you verify it?

P12328, line 5-8: I am a little bit confused about how you used the alkalinity anomaly technique to estimate net calcification/dissolution since your experiments were done in a pH-stat. Doesn't the pH stat compensate any addition or reduction in total alkalinity? You could certainly use this compensation to estimate net calcification/dissolution, but it is currently not clear what you did and from the text it appears that you actually used the alkalinity anomaly technique. However, if this was the case and since the incubations were closed loops, TA must have been accumulating during net dissolution potentially producing a buffer effect, and the opposite could be true for times of net calcification. At some point in the ms you need to address this potential buffering effect and the effect

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on the seawater carbonate chemistry during the incubation. Also, when you refreshed the water every 6 hours, was this already equilibrated to the desired pCO₂ and pH levels?

P12328, line 14-16: What was the duration between the buoyant weight measurements of corals and coralline algae? Do you mean the entire 8 weeks incubation?

P12330, line 18-20: Please clarify what you mean by "...disproportionate surface area to planar area relationship in corals?"

P12330, line 22-25: This sentence needs clarification. What do you exactly mean by "...the effects of OA on coral reef communities are greater than estimates obtained by summing results obtained by incubating organisms in isolation..." Do you mean that the net community calcification decrease more than net calcification by individual organisms, which thus, is partly explained by increasing dissolution (which you demonstrate). However, this does not mean that the effect of OA on an individual coral is different than the effect on a group of the same corals, which would require a different set of experiments without the sediments.

P12331, line 17-19: I am aware of this statement, but must admit I am somewhat hesitant in my interpretation that this represents a dissolution signal. Increasing dissolution would favor dissolution of smaller grain sizes rather than larger grains as the surface to volume ratio increases with decreasing grain size. Also, this effect would probably only be apparent in the very small size fractions of silt and clay (see for example the work by Schmalz and Chave 1963; Neumann, 1965). However, increasing percentage of smaller grain sizes could certainly result from increased bioerosion, which also has been shown to increase under decreasing pH. Nonetheless, this comment is just a personal reflection of this statement, but perhaps something you want to consider.

P12337-P12339: The figures are nice and clear, but I would have liked to see a little bit more data and just not the mean results of seawater chemistry and net calcification results. In addition to the current figures I would have liked to see: 1. Seawater phys-

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ical and chemical properties over time that were measured, i.e., temperature, salinity, pH and TA, as well as your calculated aragonite saturation state and pCO₂ (Also, in the text of the results section when you talk about seawater pCO₂, I think you should also mention what the aragonite saturation state was). 2. The results for the alkalinity anomaly incubations and how chemistry changed over these incubations. This information could be provided either as a supplementary table or a figure.

As a final comment, one of my students pointed out the following that you may want to consider: There is a major assumption that is not discussed in the paper. Granted, I have much to learn regarding net calcification, but I would think that calculating the calcification by organisms is not as simple as $\text{Net} - \text{Sediment} = \text{Coral} + \text{Algae}$. The assumption they are making with this calculation is that the rate of calcification for the sediment is the same regardless of the presence of organisms. Won't the presence (or lack thereof) of coral and algae affect the calcification rate of the sediment? Again, this could be an ignorant observation, but I would assume that the calcification rate of the sediment is altered by the presence of organisms. If I am correct, it obviously doesn't negate their work, but an acknowledgement of the assumption needs to be clearly stated.

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