Anonymous Referee #1

Received and published: 22 July 2017

General Comments:

This paper makes some important contributions to the topic of how permeable carbonate sediments in a coral reef setting will response to a 2.4 C warming and to organic matter enrichment. The experiment was well designed, executed and adequately replicated. They found that the sediments were undergoing net dissolution during the night time hours under control and all treatment conditions despite the fact that the overlying water in the chambers was supersaturated with respect to aragonite (omega ar = 2.5- 4.0). This alone is noteworthy. It has been reported in field studies but it is helpful to confirm the observation under well constrained and replicated experimental conditions.

Response to General Comments:

We thank the reviewer for their detailed analysis of this manuscript. We agree that the continued compilation of data, such as the results contained herein, are helpful in shaping an ever-evolving understanding of coral reef permeable sediment carbonate chemistry. We have done our best to accommodate each comment and feel that the manuscript benefits from their suggestions. Please note, the referenced line numbers for each comment response refer to a new, revised version of this manuscript and may differ from the older version.

Specific Comments

Comment 1: *It is also interesting that during the daylight period they observed net carbonate precipitation under control and all treatment conditions. The authors should be encouraged to comment on what they think is contributing to this carbonate production. Forams possibly?*

Response 1: We agree with the reviewer that it is interesting the sediments exhibited net diurnal calcification under all treatment conditions. We have added some discussion as to why such behaviour may have been observed. (Lines 316 – 325)

Comment 2: *The main findings of the study are that elevated temperature (+2.4C) caused both R and GPP to increase by significant amounts. R increased more than GPP so that the GPP/R went for 1.3 to 0.9, i.e. from net autotrophic to net heterotrophic. This a reasonable result with many previous studies finding the dark respiration being more sensitive to temperature than photosynthesis. The Q10s for R and GPP are extremely high at 10.7 and 7.3, respectively. The authors need to discuss these results and put them in the context of the literature. Typically Q10 values are in the 2.0 to 2.5 range and this is consistent with the energy of activation for enzymatically mediated reactions which underlies the theory of why the rates are temperature dependent. Q10s are best computed on a C-specific basis, i.e. grams of C fixed or respired per gram C of*

organism biomass. I am not sure that a Q10 computed from R and GPP normalized to substrate area is meaningful. These high values are suggesting that something more than just a temperature effect on the energy of activation of the biological processes is at work. I think it would be better to simply report the temperature sensitivity on a mmol/m2/h per degree C basis and not suggest that that dependence might hold over a broader temperature range until there is data to support the claim.

Response 2: We thank the reviewer for their detailed analysis of the Q10 values in this manuscript and agree that the presented values are likely meaningless when normalized to substrate area. We agree with the suggested alternate approach and have therefore removed mention of Q10 calculations. In place, we have instead reported the temperature sensitivity on a mmol/m2/d per deg C basis in the methods and results. Please note this metric has been extrapolated to a total diel value over 24 hours (d-1) to provide explanative value for GPP/R in the discussion. (Lines 245, 288, 330)

Comment 3: *The reported effect of the temperature increase on Gnet varies between Table 3 and the text and this needs to be resolved. Table 3 says that Gnet is 0.2+/-0.2 mmol/m2/h under control conditions and -0.1+/-0.1 under the elevated temperature treatment. In the text Gnet under elevated temperature is said to be -0.2+/-0.1.*

Response 3: We thank the reviewer for their detailed overview of the results. The actual value for Gnet under elevated temperature is -0.15. To provide consistency, both Table 3 and the text will be rounded up to list the value as -0.2+/-0.1.

Comment 4: *It is hypothesized that the shift from net carbonate precipitation to net dissolution on a daily basis is caused by the shift in organic carbon metabolism from net autotrophic to net heterotrophic. This is supported by the observation that omega arag is lowest at dawn in the T treatments. The authors cite Yeakel et al in support of the connection between net heterotrophy and dissolution. It would be relevant to cite Muehllehner et al 2016 as another study that reported a clear relationship between reef sediment dissolution and a seasonal shift between community autotrophy and heterotrophy.*

Response 4: We thank the reviewer for this valuable additional citation. Muehllehner et al. 2016 has been added to the portion of the introduction where the coinciding seasonal shift to net respiration and dissolution is discussed. (Line 94)

Comment 5: *The observed responses to organic matter enrichment are among the most interesting of this study. They observed that the PD and CM enrichments resulted in increases in R and GPP, although the increase in GPP was greater than the increase in R. The effect of the organic matter enrichment also overwhelmed the effect of temperature such the GPP/R and Gnet were not significantly different from the control. The authors suggest that what happened is that first the organic matter was remineralized to its nutrient constituents. The small increase in R would be consistent with this. Then the released nutrients were immediately taken up of the autotrophs in the system resulting in the observed increase in GPP. The net autotrophy would result in a*

small elevation in pH which would in turn bump up saturation state and account for the shift from net dissolution to net carbonate precipitation. This scenario is reasonable to me. What is very interesting is that the system seems to be very closely poised at a tipping point. Day-night shifts in pH and temperature and organic matter augmentation are all able to shift the pore water saturation state sufficiently to shift the system between net carbonate production or dissolution. I would encourage the authors to include a table where they compare their daily rates of carbonate production and dissolution with the rates reported in the literature for other locations.

Response 5: We agree with the reviewer's synopsis regarding the mechanisms behind the observed trends in Gnet in response to organic matter enrichment and thank them for their detailed interpretation. We further agree that a comparison of carbonate sediment production and dissolution would be valuable in table form. It should be noted that the methodology employed and simulated advection rate varies greatly among past studies, therefore making comparisons amongst all described historical rates problematic. We would direct the reviewer and reader to consult the review paper in Nature Climate Change by Eyre et al. (2014) where these variations in methodologies and subsequent carbonate production and calcification rates are discussed in greater detail. Nevertheless, we have inserted a table into the discussion (Table 4) comparing studies that have specifically employed the same chamber methodology at the same simulated advection rate (sediment percolation rate ~ 43 L m^{-2} d^{-1}).

Comment 6: *As a small technical detail it would be nice if the authors employed the letter system to indicate in figures 4-6 which means are significantly different and which are not. The information can be obtained from the text but the figures would be more useful if the information was also supplied there.*

Response 6: We agree that such a notation would be valuable to indicate which means are significantly different from the control. When using the letter system to indicate significant difference between treatments, the figures quickly become crowded with information. For this reason, we have used an asterisk (*) notation to only indicate which means (GPP/R and 24-hour Gnet) were significantly different from the control. This was not necessary for Figure 4, as all treatments were significantly different for both GPP and R, but was necessary in Figure 5 and 6, where variations in significance existed. We feel this does an adequate job of satisfying the reviewer's request while maintaining a clear and informative figure.