

Authors' Response to Peer Review Comments on

Marginal reefs under stress: physiological limits render Galápagos corals susceptible to ocean acidification and thermal stress

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Authors' Response to Peer Review Comments on Original Version of Manuscript (2021AV000509)

Dear Dr. Thompson,

I will begin with an apology for the extended review time for your manuscript, "Marginal reefs under stress: physiological limits render Galápagos corals susceptible to ocean acidification and thermal stress" [Paper #2021AV000509], that was submitted to AGU Advances. It took 12 invitations to obtain two reviewers for the manuscript. One review was received, which is included at the end of this letter. The second reviewer has yet to provide a review. Because of the time that has elapsed and the nature of the one review, I am going forward with a decision for the manuscript. I have provided some review comments, which are also included at the end of this letter.

The reviewer indicated that the topic of the manuscript is important and represents an advance in understanding. However, the reviewer brings up points related to the methods that need clarification. The reviewer also requests additional explanations for some results and modifications for the figures. The reviewer also notes that Box 1/Figure 1 is not useful as presented and suggests that it be replaced with a simplified schematic.

My comments focus on revising the manuscript to more clearly highlight the advances made by the study. I also agree with Reviewer 1 that Box 1/Figure 1 is not useful. A simple schematic that illustrates the main processes that are the focus of the analysis would be helpful for the readers who are not experts in the subject area but have an interest in coral responses to environmental stressors.

I encourage you to submit a revised version of your manuscript by November 15, 2021, but this time can be extended if needed.

Along with the revised manuscript, please submit the following:

1. A response to reviewer file that lists each of the comments and describes how the manuscript has/has not been modified in response to those comments.
2. A copy of the manuscript with the changes noted (e.g., highlighted, "track changes," italics or bold changes). Please upload the article with tracked/highlighted changes as a response to reviewer file.
3. A copy of the revised manuscript with the changes incorporated which will be used for publication if the manuscript is accepted.
4. In addition to addressing the remaining important technical issues raised by reviewers, please also ensure that AGU data policy is addressed in the Acknowledgements section and that the key points report what is learned from the study.
5. All files in publication-ready formats.
***Publication-ready formats for article files are limited to Word and LaTeX (Excel is also acceptable for tables only). Figure files must be individually uploaded as .eps, .tif, .jpg, or .pdf files and all parts of the same figure need to be combined in one file.
6. AGU has officially joined with many other publishers in a [commitment](#) to include the [ORCID](#) (Open Researcher and Contributor ID) for authors of all papers published starting in 2016. Funding agencies are also asking for ORCID's.

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If you have not already created an ORCID or linked it to your GEMS record, please do so as soon as possible. This will need to be completed for us to accept your paper. You can both create and link and ORCID from your GEMS record.

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When you are ready to submit your revision, please login to your account (<https://advances-submit.agu.org/cgi-bin/main.plex>), and click "Revise 2021AV000509."

If you have any questions or require additional time to complete your revised manuscript, please contact the editor's assistant at advances@agu.org.

Thank you for submitting your manuscript to AGU Advances.

Sincerely,

Eileen E. Hofmann
Editor
AGU Advances

-----IMPORTANT INFORMATION-----

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Reviewer #1 Evaluations:

Recommendation: Return to author for minor revisions

Significant: Yes, the paper is a significant contribution and worthy of prompt publication.

Supported: Yes

Referencing: Yes

Quality: Yes, it is well-written, logically organized, and the figures and tables are appropriate.

Data: Yes

Accurate Key Points: Yes

Reviewer #1 (Formal Review for Authors (shown to authors)):

Review for AGU Advances

Thompson et al: Marginal reefs under stress: physiological limits render Galápagos corals susceptible to ocean acidification and thermal stress

The authors present boron isotope and trace metal geochemistry modern and fossil corals from the Galapagos that have experienced of extreme thermal stress and accelerated rates of acidification. The motivation for the paper is sound; it clearly of great importance to understand the biocalcification of corals, especially those already living "on the edge". I find the paper well written and easy to follow. I would recommend the manuscript for publication with minor revision.

We thank the reviewer for their supportive and constructive review.

Minor points

Line 28: Aragonite supersaturation should be ($\Omega > 1$) rather than just Ω

Changed

Line 55: Just low coral diversity or all reef taxa?

Great point. We were referring to corals here, but have revised to say "species diversity and structural complexity" to denote that this is a broader issue among all reef species and the reef structure they (collectively) create.

Line 56: this "accelerated rate of OA" puzzling when, yes, figure 2b suggested Ω is low in the Galapagos, yet figure 2c suggests that the all-important change in Ω since the 1700s has been small in this region.
Great point. I have removed "accelerated rate" from the abstract. The rate here on line 56 is from 1997-2011, which is a later period than shown in figure 2c. This can account for at least part of the difference in rates between these two studies; nevertheless, we agree with the reviewer that the rate is not higher or accelerated here relative to other regions (in either study) and have removed this misleading text and added the time period of this acidification trend in the text. Nevertheless, the change is on the higher end of the range of equatorial Pacific sites with long-term buoy measurements (which range from -0.0010/year in the western central Pacific to -0.0026/year in the eastern central Pacific; Sutton et al. 2014).

Line 61: Suggest: "A critical question remains however:..."
Changed

Line 107: overuse of the work leverage
Changed to "allow us to assess"

Line 126: specify here "coral cores"
Specified here and on the previous line for clarity.

Line 128: Removed "m =". It has been established that these are gradients, the "m" is therefore redundant
Done.

Line 211: If inclusion/exclusion of this outlier makes no difference why flag it up at all?
Because one's eye is drawn to this outlier point, and we wanted to emphasize that this result is robust to the inclusion of this value (regardless of whether it is indeed an outlier). Nevertheless, we have removed this statement, as we agree with the reviewer that it is unnecessary.

Line 212: Citation needed for Suess effect
Added reference to Keeling 1979:
Keeling, C. D. (1979). The Suess effect: ^{13}C - ^{14}C interrelations. *Environment International*, 2(4-6), 229-300.

Line 213: data are needed
Great catch! Changed to "data are needed"

Line 260: This pH_{cf} drop due to El nino is very interesting!!
We think so too! We thank the reviewer for the shared enthusiasm on this result.

Line 264: Unclear how a regional increase in pH_{sw} would cause a decrease in pH_{cf}.
Thank you for catching this mistake. I have removed this statement from the list of possible causes.

Line 439: Samples were taken at 2mm intervals down core, but how much material was integrated laterally? Porites have small polyps so I'm guessing a specific sub-structure could not be targeted throughout.
That is correct, and we now note the width of the transects: "All cores were milled for geochemical analysis at continuous 2 millimeter increments in 5mm-wide transects along the maximum growth axis..." As the reviewer notes, this integrates across skeletal micro-structures, as is customary for *Porites* spp. with small polyps (where the impacts of smoothing across micro-structures is minimal relative to other species). Wide transects were necessary to obtain the large (10+ mg) samples required for boron isotopic analysis at sub-annual resolution.

Line 444: Something wrong with the wording here
Great catch. I have removed the extra words here. It now reads "this work significantly extends the network of long..."

Line 456: deionised is clearer than DI.
Changed.

Line 459: Errors assumed to be {plus minus} 50%? This seems rather large and doesn't match with {plus minus} 5yrs CE quoted

We apologize for the confusing statement. The statement “Errors were conservatively assumed to be +/- 50%” was referring to the initial, non-radiogenic $^{230}\text{Th}/^{232}\text{Th}$; it was defined here as the expected value for a material at secular equilibrium with bulk earth value, with errors of +/- 50% (thus the value $4.4\text{E}^{-6} \pm 2.2\text{E}^{-6}$ given in the previous sentence). These details were removed in the revised manuscript, as these details are already provided in Reed et al. (2021).

Line 487: How did the average measurements of JCp-1 compare to the Harthorne et al 2013 G3 interlab values? Are there any systematic lab offsets to consider? It is also interesting that no oxidative cleaning was applied to coral powders. This is known to be important for Li/Mg (Cuny-Guirriec et al., 2019) and $\delta 11\text{B}$ measurements (Gutjahr et al., 2021) to remove organics.

We now report the long-term laboratory values for JCp-1 to show that they are well within the robust standard deviation reported by Hathorne et al. 2013, indicating that we do not need to consider any interlaboratory offset(s). The text now reads: “*The long-term laboratory values for JCp-1 are well within the robust standard deviation of reported values (Hathorne et al. 2013): Mg/Ca 4.211 +/- 0.024 mmol/mol (N = 173), Sr/Ca 8.848 +/- 0.0194 mmol/mol (N = 173), Ba/Ca 7.297 +/- 0.242 $\mu\text{mol/mol}$ (N = 159), U/Ca 1.194 +/- 0.0092 $\mu\text{mol/mol}$ (N = 165), Li/Mg 1.441 +/- 0.0325 mmol/mol (N = 144), and B/Ca 458.956 +/- 11.790 $\mu\text{mol/mol}$ (N = 144) (see also D’Olivo and McCulloch 2017).*”

Regarding cleaning: based on Cuny-Guirriec et al. (2019) figure 1, cleaning doesn't have a significant impact on the ratios for samples without green OM banding. As our samples do not have any green OM bands, oxidative cleaning should have little effect on the TE/Ca ratios reported here. Further, pre-treatment itself may cause artificial variability and reduce the reported analytical precision of JCp-1 for some TE/Ca ratios under certain conditions (Holcomb et al, Chem. Geol 2015; Sayani et al. 2021). Nevertheless, I have added a note that because samples were not pre-cleaned, any OM present in the samples could cause slight (1-4%) variations in TE ratios and add noise to our data. I have added the following text: “*While some recent work suggests that organic matter may bias TE/Ca values and increase analytical uncertainty (particularly for Li/Mg, Cuny-Guirriec et al. 2019), these issues were reported for green, organic-rich bands in the skeleton. As there were no green, organic-rich bands in our cores, we did not pre-treat the samples prior to geochemical analysis to avoid offsets and noise that can arise from oxidative cleaning under certain conditions (Holcomb et al. 2015, Sayani et al. 2021). Nevertheless, we note that the presence of organic matter in the samples could have caused small (1-4%) variations in trace elemental ratios and add noise to our data.*”

Line 492: equations should be written in full rather than m= and b=
The full equation has been added.

Line 509: What was the average lab $\delta 11\text{B}$ value for JCp. How does it compare to uncleaned JCp-1 compilation data by Gutjahr et al., 2021 GGR?

Great point. We have added the following text to address this issue: “*Further, the long-term laboratory JCp-1 value and reproducibility of 24.36 +/- 0.34‰ (2 σ ; n = 101; see also D’Olivo et al. 2017) agree well with reported values with and without oxidative pre-treatment (Gutjahr et al., 2021). Therefore, while the analytical uncertainty of our results may be slightly higher since the samples were not pre-cleaned (Gutjahr et al., 2021), the reported values are well within error of the pre-cleaned values from Gutjahr et al., (2021). The 2 σ uncertainties in this study are on par with that of pre-cleaned samples (n= 29), while the long-term average falls between that of published values with and without cleaning (n = 101). Finally, previous work suggests that $\delta 11\text{B}$ is relatively insensitive to sample cleaning methods (Holcomb et al. 2015).*”

Line 542: Define SODA

Changed to “Simple Ocean Data Assimilation (SODA)...”

Line 565: bracket position. Should read "...formulation of McCulloch et al., (2017)". Check for other citations where the reference is part of the sentence like this rather than just added on the end.

We thank the reviewer for catching this. We have changed the citation accordingly, and have fixed the formatting of other in-line references and references with preceding or following text (according to the latest LaTeX conventions).

Line 588: TE is unnecessary shorthand. Just say trace element chemistry
Changed.

Box 1:

I see why the authors have chosen this "Box" approach that keeps words out of the main text word count, but I'm not sure that this is the best approach or if this complies with the journal guidelines. A Figure within Box is confusing; either call it a box or a figure, not both. I suggest that this is revised, making the figure more schematic and with short bullet point labels rather than large blocks of text.

Unclear what is the difference or the need for separate 1,2,3... a, b,c... and a*, b*, c*... lists. Why can't these points be merged and made more concise?

Calcifying fluid "exaggerated". Does this mean the schematic changes in chemistry are exaggerated, or the size of the layer? If it is the size the extra label is unnecessary as you already state it is not to scale.

As this diagram is now published in the review Thompson (2021), we have significantly revised this figure following the suggestions (by both reviewer 1 and editor below). This figure has been replaced by a schematic depicting the change in calcifying fluid geochemistry we observe between seasons, as well as between the pre-industrial and modern periods.

Figure 2. Labels of Wolf (This Study) and GBR McCulloch could be added to the figure panels to make this visually clear.

A legend has been added to figure 2.

Figure 3: GBR data should be less prominent (slightly greyed out or smaller points) to make the new data in this study clearer.

We thank the reviewer for this suggestion, and have made the GBR data partially transparent, to emphasize the new data.

Editor Comments

1. I found this manuscript confusing and the results seem to confirm what is already known about coral responses. The structure of the manuscript is part of what contributes to this confusion. The combined Results and Discussion section for each topic makes it difficult to extract the advances made by the study and to see linkages between the different topics covered in the manuscript. The new results/advances are lost in the details. A recommendation is that the results and discussion be separated into individual sections with subheadings. Perhaps it is possible to develop a summary schematic that shows how the different factors/stressors interact and structure the discussion section around such a figure. Also, a summary section that places the results into context would be helpful in showing what is new.

We thank you for the excellent suggestion. We have now created a revised schematic, which we use throughout the results and discussion. Given the complexity of the results and interpretation, we feel that separating the "what it all means" from each significant result would actually make the paper harder to follow. Nevertheless, we have emphasized throughout these sections what is new from what has been published previously, and used this revised schematic as the backbone of the section. We have also added a summary section to place the results in context, and emphasize what new insights were gained from this study.

2. For AGU Advances, the Data and Methods section is included in the main manuscript text, rather than at the end, as is done for some other journals. Some of the Data and Methods section can be included as supplementary materials, if appropriate. Please look at recent AGU Advances articles for examples.

We apologize for missing this formatting difference, and have moved the methods accordingly.

3. Box 1/Figure 1: I understand that the authors are trying to provide considerable technical information in a succinct manner. However, Box 1/Figure 1 is not useful. The text and figure are too condensed and as a result are confusing and distracting. For example, does every reaction for multiple cations and anions need to be shown along with detailed explanations? My knowledge of coral responses to stressors would not be increased by Box 1/Figure 1. In fact, the opposite would happen. This Box/Figure should be removed from the main text and replaced with a simpler schematic/conceptual diagram that can be understood without assuming detailed knowledge of the subject and will engage the reader. If the current Box 1/Figure 1 is retained, it should be moved to supplementary materials.

We thank the editor for the feedback on figure 1. We have completely revised the schematic to focus on the changes we discuss in the manuscript, namely, between seasons and between pre-industrial and modern periods. As the editor notes, this provides a foundation for the results and discussion, and significantly improves the clarity of the paper.

4. Line 72, define pH_{cf} at first use in manuscript

Added.