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Interactive comment on "Multi-trace element sea surface temperature coral reconstruction for the southern Mozambique Channel reveals teleconnections with the tropical Atlantic" *by* Jens Zinke et al.

Anonymous Referee #1

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General comments: Overall, this is an excellent, well-written study by a group of experts in the field of coral-based paleoclimatic reconstructions. The study reports on a new study site on the southeastern coast of Africa, a place with limited instrumental records, thus adding a valuable site to the suite of subannual reconstructions in the Indo-Pacific region. The authors test trace elemental SST proxies, one that is more established (Sr/Ca) and two that are relatively new (Li/Ca and Li/Mg), in two Porites corals of different species. Some studies have criticized coral Sr/Ca as being problematic due to vital effects, yet the direct influence and attribution of these vital effects

remain elusive but some suggest growth-related effects are the source of the problem. Other studies have pointed out that improperly sampling a coral, not along a continuous time growth structure, could be a major reason some studies have problems with the coral Sr/Ca-SST proxy. This study examines these issues in coral-based trace elemental ratio proxies and assesses which is the better SST proxy for their site. They use a careful sampling of the coral skeletal to eliminate any potential suboptimal sampling problems. They also use several different types of temperature data for their proxy assessment including in situ and local air temperature records. They find coral Sr/Ca is the best-performing proxies in their two corals. My only wish is that this study would have also included another newly suggested proxy coral Sr-U for SST proposed by De Carlo et al., 2016, which could be performed simultaneously with their ICP-MS analysis, to assess this other suggested proxy along with the others. The method section (line 190) mentions the precision of U/Ca analysis so it seems U/Ca was measured. Why not add Sr-U to the proxy suite that was assessed?

Specific Comments: I do not have any major issues with this study that would significantly change the overall results. There are a few items that need clarification, suggestions to improve the manuscript, and ways to improve their data analysis.

Move the paragraph in section 3.3 Coral growth parameters and SST to the first section in the Results. I was looking for the extension results to understand why your record is bimonthly with your sampling method. Please give the average annual linear extension for the two corals in this section. In the methods section (lines 167–170) clarify if Coral XDS was performed on a single transect or replicate transects. Were these CoralXDS transects the same as your micro-sampling for geochemical analysis? CoralXDS software should have a reference to the original paper (Helmle et al., 2002, 2011). What were the lowest extension years? Any fall below the Porites threshold of 5 or 6 mm/year? If not, vital effects should not be a problem.

Looking at the X-rays in Supplemental material, I see why you did not sample back further than 2003, shame this coral has such wandering corallite fans. Nice example

of suboptimal corallites. Is this typical of P. mayeri or was this just a small colony?

Methods Line 190-191 The normalization of Sr/Ca with JCP-1, what about Li/Ca and Li/Mg? What is the precision for Li/Mg and Li/Ca?

Figure 4 and Figure S3 Time assignment. There seem to be three clusters of data in all the plots. This is odd, there should not be clusters of data. Double check your Analyseries time assignment, something is off, see next item.

Looking at the residuals plot (Figures 5 and 6) and the methods lines 197–200, I see there is a sinusoidal character in the residuals. This means your error (the residuals) have autocorrelation, which violates the assumptions of Ordinary Least Squares Regression (Durbin and Watson, 1951; Draper and Smith, 1998). Furthermore, the authors assume SST has no error, which in fact it does whether it is bimonthly averaged in situ SST, air temperature, or data products (ERSST and AHVRR SST), thus violating another assumption of OLS regression. I do not see any major issues with your linear regression plots (Figure 4) but if you reverse the regressors, you get a different solution. OLS will either over fit or under fit the proxy data to SST, depending which regressor is the independent regressor. Reduced Major Axis regression is better and takes error in both regressors into account. Weighted least squares regression is even better (York and Evensen, 2004; Thirumalai et al., 2011) since you can vary the error for each data point. However, this switch in regression method should not change your slopes greatly but should reduce your RSME results. The bigger issue is the serial correlation. WLS can take this serial correlation into account in the regression and it increases your confidence intervals, but it would be better to just remove it. The reason the residuals have sinusoidal character is the time assignment was performed with just one point per year (lines 197–200). Another study had this problem was Williams et al. 2012 (see their figures with residuals) where they used one point per year for their time assignment. Williams justified their use of one point per year due to their archive not growing constantly during the year and pausing growth in the winter. Corals should not have this problem in your location. If you use two points per year, this will help remove

the serial correlation from the residuals, 4 points per year are even better. Additionally, make sure you are using the option “select data points” and not default “select interpolate points” in Linage in Analyseries so that not too much interpolation occurs to your data during time assignment (check before and after graphs of your data). This may be why you have data clusters in your scatterplots. This will improve your correlation values and may slightly change your regression equations. Most importantly, the RSME values will change (should be less) and may change proxy performance results. In line 200, mention that the Sr/Ca was used for the time assignment. Was this time assignment applied to the other trace elemental ratios? If so, mention this in your methods section. In your discussion, you should also note using Sr/Ca for the time assignment (whether you use 1, 2, or 4 points per year). Using Sr/Ca for time assignment results in lower RSME values for Sr/Ca compared to the other trace elements. You can convince yourself of this by using Li/Mg or Li/Ca for time assignment and then apply it to Sr/Ca, the Li series should have a lower RSME compared to the other series. This makes it harder to assess which proxy is better since the proxy used for time assignment should have the lowest RSME. You can use another statistic to assess differences between a proxy and temperature, average absolute differences (AD) between the two, which is a robust assessment that does not require the errors to free of autocorrelation or have a normal distribution. The proxy used for time assignment should still have a lower AD but is another test you can perform to assess proxy’s performance in reconstruction SST.

Line 192 After doing your own very nice and comprehensive calibration study, why use Correge’s –0.0607? Your slopes are lower than his and in my assessment, a better calibration study than Correge’s that was just the average for all published studies to date (2006), regardless of the calibration method, SST data used, the possibility of using sub-optimally sampled corals for calibration, etc. Things have vastly improved from 2006 and I would not trust a community average value anymore. See recent paper by (Murty et al., 2018).

Line 464–468, Figure 2 and Methods. It is not mentioned if you cleaned the corals to remove any endolithic algae, tissue layer or biological residue. Corals for Mg analysis are generally cleaned with bleach since Mg is present in biological tissues. In Figure 2, the Mg/Ca is high in the tissue layer, this section should be excluded from the Li/Mg and Mg/Ca data and analysis. Is there any dirty or algae present in the coral skeletons that could be influencing the Mg?

For your regression analysis, why not combined the two corals to see if the results improve?

Table 2 How were degrees of freedom determined? Was if adjusted for serial correlation? For EU3 it seems the Sr/Ca and Li/Mg are repeated in rows 9–12 or is this the average of EU2 and EU3 with the label missing in column 1?

Table 3 What is the second row for EU3 for? Is this EU2 and EU3 averaged together? Table 3 Why are you reporting a standard deviation for RSME? RSME does not have a standard deviation, it is a version of deviation itself between the calculated and measured. RSME is reported as $\pm$ since you take the square root of the sum of the deviations divided by the number of pairs.

Table 4 and all correlations. Give the degrees of freedom (adjusted for serial correlation), # of pairs, and p-values for all correlations.

Figure 2 Can you add the raw trace elemental ratios to the supplemental figures so time assignment can be verified?

Technical Corrections I am not sure the style guide this journal uses, so this may not be an issue, just a British vs. American spelling issue. Dataset is normally two words, data set. Database is one word.

Line 59 Add a reference for trade route statement. I believe the southeastern coast of Africa was part of trade routes before the mid-19th century. ICOADs (V3.1) now goes back to the 1600s (Freeman et al 2017, doi:10.1002/joc.4775) but ERSST stops at

1854. Additionally, there is a newer version of ERSST (V5) that includes new ICOADS data (Huang et. al, 2017 doi: 10.1175/JCLI-D-16-0836.1). Does this version give you any better data coverage for your study site and improve the assessment?

Lines 87–94 There is another coral Li/Mg study (Fowell et al., 2016) that looked at intra-reef variability with a different coral species from the Atlantic and combine Sr/Ca and Li/Mg. That study should be included here but examine the coral sampling in their figure carefully, there were some sub-optimal sampling issues with their corals. The study Montagna et al., 2014 did look at several species of corals, but not the one used by Fowler 2016, so it worth including the Atlantic study in your discussion of previous Li/Mg studies.

Line 154–156 Please give the interval for the air temperature records.

Line 161 Please clarify, is the depth of 12 and 13 m the water depth of the top of the coral colony where the cores were removed, or the water depth of the base of the coral? Did you sample the whole colony? Just trying to see how big these colonies were. Table 1 Add units for Length

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