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Interactive comment on "Comparison of the $U^{K'}_{37}$, LDI, TEX^{H}_{86} and RI-OH temperature proxies in the northern shelf of the South China Sea" *by* Bingbing Wei et al.

Anonymous Referee #2

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This manuscript presents a comparison of four different molecular organic paleotemperature indices (Uk37, TEX86, RI-OH and LDI) from a suite of core-top sediment samples on the continental shelf of the northern South China Sea. They evaluate the spatial gradients across this coastal region and the influence of the Pearl River Estuary on the distribution of these biomarker compounds. Ultimately, they attempt to determine the seasonal preference of the source organisms for each of these proxies by comparing the proxy-derived SST with in situ SST from the WOA gridded data product. This data set is a potentially important contribution to understanding the influence of terrestrial and coastal processes on these marine proxies and could provide constraints on interpretations of downcore proxy-based paleotemperature reconstructions

from the South China Sea. Despite the potential value of this data set, the authors do an incomplete job of analyzing the data and putting it in the context of existing regional data and the body of literature from other near shore oceanographic settings. This manuscript would be suitable for publication in Biogeosciences after substantial revisions that address some of the points below.

One of the most substantive issues in this manuscript is the fact that the conclusions about seasonal bias or weighting of each proxy is based on a simple comparison of residuals between observed seasonal SSTs and proxy-derived SSTs, with an incomplete treatment using the full suite of available calibration equations. There is also only a cursory consideration given to the possible range of depth habitats that each proxy represents in the SCS. Below are some point-by-point comments meant to aid the authors in revising this manuscript with more in-depth analysis that should lead to more robust conclusions.

Comments:

Section 2.1: How as the sedimentation rate determined (1–2 mm/yr, stated in line 170)? The sediment accumulation rate is likely to vary across the offshore transect. Therefore, assuming that all core-top samples represent the mean conditions of a 7-year interval (from 2005–2012) is probably not appropriate. This assumption also does not account for bioturbation, which almost certainly has caused some mixing of material from the past few decades into the upper few centimeters. Making sure that the core-tops in this study are "calibrated" to observational temperatures from the appropriate time interval is especially important given the large SST trends observed over the past decade in the SCS (e.g., Yu, Y., Zhang, HR., Jin, J. et al. Acta Oceanol. Sin. (2019) 38: 106. https://doi.org/10.1007/s13131-019-1416-4).

Uk37-derived temperatures: A number of studies have pointed out the non-linearity of the Uk37-Temperature relationship at SSTs >24–26°C (e.g., Sonzogni et al., 1997, Conte et al., 2006, Tierney and Tingley, 2018). Since SSTs are >24°C for most of the year at these SCS core sites, it would be worthwhile to calibrate the Uk37 data in this study using BAYSPLINE (Tierney and Tingley, 2018), which accounts for the attenuation of the Uk37 signal at higher SSTs.

Supplemental figure 1. If the Uk37-derived SST ends up being significantly different using alternative uk37-SST equations, it will have implications for the inferred seasonality of the UK37 signal and needs to be addressed more thoroughly in the main body of the paper.

Lines 60–79: There is a substantial body of literature discussing sources of uncertainty and biases in these four biomarkers (especially TEX86 and Uk37) from sediment traps, surface sediments and culture studies. This section should be expanded to include some discussion of those factors. Just a few examples: lateral advection of sediments, light limitation, diagenesis (e.g., preferential degradation of C37:3 in sediments), sensitivity to redox conditions, etc.

Line 167: Why not use the latest WOA18 data?

Line 181–182: Looking at the local hydrographic data, the depth of the mixed layer appears to vary seasonally, with a much deeper winter mixed layer. This should be considered when discussing the potential seasonal and/or depth distribution of the biomarker source organisms.

Overall, there needs to be a much more thorough treatment of uncertainty in the manuscript. There are no error bars or uncertainties shown in any of the figures, nor are they discussed in the results or the supplementary data table. Uncertainty in the various transfer functions used to convert each of these indices to temperature needs to be considered. Analytical uncertainty could be addressed via replicate measurements of samples or standards. The analytical error and calibration error should be propagated and reported when converting proxy index to SST.

Lines 198–204: In order to maintain the organizational flow of the paper, this section

belongs in the Discussion. Also, instead of making the argument that you omit these 6 samples because of their large SST residuals, it makes more sense to omit them because the river input index (%C32 1,15) values are 4x higher than those of the other 19 samples.

Section 4.2.2: Is there any correlation between the BIT and diol river input index in this sample set?

TEX86: There is a large body of literature on the TEX86 proxy that is overlooked in this manuscript. Marine Thaumatchaeota are living throughout the water column in many locations, and it's likely that the TEX86 is integrating the entire water column in these shallow (<200 m) sites.

As with the Uk37-SST equations, I would suggest including BAYSPAR-derived SSTs in the TEX86-SST analysis (Tierney and Tingley, 2015).

Section 4.3.1: The Ring Index (RI), as defined by Zhang et al., 2015, could easily be calculated from the GDGT data used to calculate TEX86 in this study. This is another tool (in addition to the MI, [2]/[cren], and [0]/[cren]) that could be used to screen for non-thermal influences on iGDGT distribution in this sample set.

Figures:

The uncalibrated index values (uk37, LDI, RI-OH and TEX86) are not reported in your figures. I think there should be at least a table that shows the primary data from each of the core-top sites.

Figure 2: This figure is not a very effective way to present these data. I would consider presenting SST maps to show the mean annual, winter and summer SST distribution in the study area (showing spring and autumn is unnecessary in my opinion). Perhaps create separate panels for each of the SST indices. If the authors decide to keep this figure, the lines connecting WOA data points need to be removed, they are distracting. The use of the same colors for the WOA SST data and the proxy-SST data is confusing.

Figure 4: As with Figure 2, panels a and b are not a very informative. Dividing the samples into "inshore and offshore" as is done in Figure 5 and presenting the relative abundances and ratios/indices as bar graphs would be more effective. Again, if the authors chose to keep these panels, refrain from connecting data points with lines.

Figures 3 & 5: The inshore versus offshore comparison of the fractional abundances of diols in figure 5 illustrates the same point as the maps in Figure 3. Therefore, I think Figure 3 is unnecessary. It could be moved to the supplement or removed altogether without losing any information.

Figure 6: I would suggest adding panel d from figure 3 as a second panel in Figure 6 to better illustrate the elevated influence of terrestrially sourced diols in the PRE.

Figure 7: There is no reason to plot the residuals of 3 different calibrations versus the BIT index. If the purpose of the figure is to illustrate that there is no systematic relationship between BIT and SST residuals, then you need only illustrate this using one of the calibrated data sets. If the purpose of the figure is to illustrate the calibration equation that results in the smallest residuals, I would suggest a simpler way of showing the distribution of the data (e.g., box and whisker plots).

Figures 7b & 9: I don't think it's terribly informative to regress any of these indices over a <2 °C temperature gradient (as in the case of summer and autumn SST gradients), however, if you are going to make this plot, why not make a 4-panel figure that does the same for all 4 indices?

Figure 8: The source of the data from a "previous study" needs to be cited in the caption.

Figure 8: In the caption, the authors need to clearly state what "annual residuals" are. Also, "fitting lines" is not a mathematical term. Are these ordinary least squares regression lines? Something else?

Minor Comments:

Lines 49–50: This sentence is awkward to read. I would suggest changing to something like "Due to the distinctive ecology of their source organisms (e.g., depth habitat and seasonal preference), coeval temperature records from each of these proxies may differ substantially"

Line 51: Remove the "however" from this sentence.

Lines 57–59: Remove "while" from the beginning of the sentence. These two sentences seem to contradict each other. Also, what is the southeast Australian Ocean?

Line 60: This sentence doesn't make sense: "The accuracy of organic thermometers is also prone to be impaired by a low specificity of related biomarkers."

Line 83: Should be northeasterly and southwesterly winds

Lines 171–172: I believe WOA13 defines the summer and autumn as Jul–Sept and Oct–Dec, respectively (not Jul–Aug and Sept–Dec as stated here). Line 199: Instead of stating "three samples with low LDI values", it would be more descriptive to state, "three samples with LDI values lower than predicted from local SST".

Line 244: Explain what is meant by "complex sedimentation processes". If the authors are talking about lateral transport of the fine sediment fraction, or diagenetic alteration of the signal, this could be expanded on significantly here.

Lines 257–258: This sentence is confusing and should be rewritten for clarity.

Line 279: It is unclear what is meant by "an opposite response to ambient temperature of C30 1,15-diol to C28 and C30 1,13-diols".

Line 305: Change "methane-related" to methanotophic archaea

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