Reply on RC2

Raúl Tapia et al.

Author comment on "Contrasting vertical distributions of recent planktic foraminifera off Indonesia during the southeast monsoon: implications for paleoceanographic reconstructions" by Raúl Tapia et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-329-AC2, 2022

Reviewer #2

General comments

The manuscript by Tapia et al. presented valuable planktic foraminifera dataset off Indonesia where the available data are currently limited. Their plankton net study along with published sediment trap and surface sediment records will form the basis for understanding planktic foraminifera ecology, seasonality, and foram-based paleoceanography in this important region. The manuscript deals well with the contrasting foraminifera distribution in upwelling sector and non-upwelling sector, and also includes implications for paleoceanography, which thus falls within the scope of BG.

However, the authors concentrates on six of 29 species, and do not show all of the species list. My concern is whether the taxonomic concept is consistent between plankton net, sediment trap, and surface sediments. The current form of the manuscript lacks the discussion of rare species. Another concern is the consideration of anthropogenic climate change. Plankton net and sediment trap are susceptible to recent climate change, though surface sediments likely hold pre-industrial state. I also felt that figures can be improved to better convey the results and discussion of the paper. I recommend major revisions of the manuscript.

We thank the reviewer for their positive comments and constructive criticisms. We agree that the clarity of the manuscript can be further improved. Below are our responses to their concerns.

Specific comments

- A total of 29 species were identified, but all the species never appeared in the manuscript. The authors tend to discuss the major 6 species, but rare species also hold important information of water column structure and thus implication for paleoceanographic reconstruction. Although the manuscript compared the number of species between plankton net, sediment trap, and surface sediments (Discussion 4.1), is the taxonomic concept the same? If any difference exist, the authors should care the consistency to discuss the diversity of foraminifera assemblage. Also, taxonomic identification rely on the works before 1989. But the genus Trilobatus should follow the paper by Spezzaferri et al. (2015 PLOS ONE). I would like to see all the species of plankton net, sediment trap, and surface sediments to infer seasonality and possible dissolution effect on both major and minor species.

We do agree with Reviewer #2 that the full assemblage may be useful for other studies that are more focused on the total assemblage. We will therefore present the complete assemblage data in the Supplementary Info for future consideration by the community. But we emphasize that the main focus of our study is not on the assemblages. Instead, we aim to (1) assess the habitat depth of species that are often used for geochemical analyses in paleoceanographic reconstructions (thus not assemblage), (2) compare the habitat depth of these species inferred from different sample types and approaches, (3) assess the implications for paleoceanographic reconstructions. To achieve these goals, we selected several species that are often used for geochemical analyses, for instance those used in sediment traps, surface sediment or downcore reconstructions (e.g., Mohtadi et al, 2007, 2009, 2011, 2014, 2017).

Adding more discussion on rare species and the full assemblage will not improve the clarity of the manuscript. The rare species are not suitable for the calculation of ALD as already outlined in the Methods section as a few specimens likely do not yield statistically significant estimates (Rebotim et al., 2017; Lessa et al., 2019).

As mentioned above, one of the main goals of this study is to compare the habitat depth inference from plankton net samples with the estimates based on surface sediments (Mohtadi et al., 2007) and sediment traps (Mohtadi et al., 2009). Therefore, we used the same taxonomic concept as these previous works, and the lead authors of those papers are in fact also contributing to this paper.

To clarify the above-mentioned point about taxonomic concept, we will add in the Methods section:

"We used the same taxonomic approach as in previous studies based on surface sediments (Mohtadi et al., 2007) and sediment trap (Mohtadi et al., 2009/11). The only exceptions are for G. elongatus and T. trilobus, as the names of these species have been updated recently by Aurahs et al. (2009) and Spezzaferi et al. (2015), respectively."

- Jonkers et al. (2019 Nature) paper presented modern plankton community driven by anthropogenic climate change. I'm wondering whether recent climate change affects plankton net and sediment trap data, which potentially alters the relationship of foraminifera assemblages between plankton net, sediment trap, and surface sediments. Coincidentally, Jonkers et al. paper includes one sediment trap data off Indonesia (Mohtadi et al., 2009) and categorizes apparent warming for this region (historical change is cooling but the species composition shows warming). What is the relationship between this study and Jonkers et al. paper?

We agree with Reviewer #2 that this is something interesting to add to the discussion. We will therefore add some text to mention the reported warm bias in the assemblage in

surface sediments due to anthropogenic effects and the likelihood that the water column may have changed over the last few decades, and discuss whether it has a bearing on our findings. Jonkers et al inferred the warming from changes in assemblage; higher proportion of warm species would lead to an assemblage that resembles that in a warmer region. The approach is based on the biogeography of planktic foraminifera, that each species occupies a specific thermal niche. For some tropical species the niche may span a temperature range of >10ºC. Our main findings about the habitat depth and implications for paleoclimate reconstruction are based on individual species, thus our results are likely not substantially affected by changes in foraminiferal assemblage. This is because the selected species are not dwelling at the limit of their thermal niche, thus as long as these species do not substantially shift their thermal niche over time (likely not as otherwise paleoclimate reconstructions would not be possible), we do not expect any large warming/cooling effect due to the anthropogenic effect.

- The authors stated that Ujiié (1968) paper is the only study using plankton net off Indonesia (L58). Then the author's study is consistent well with the Ujiié paper? Currently, there is only a general description (L252-254), and no comparison of species found and its standing stocks. Even though the Ujiié paper did not investigate the vertical distribution, at least surface distribution of foraminifera should be discussed.

We agree with Reviewer #2 that this is something worth discussing. We did not discuss the results of Ujiie because (1) his samples were collected in a different season (winter, whereas ours were collected in summer), and (2) he only looked at foraminifera that are > 300 micrometer (whereas the bulk of foraminifera in our samples come from the size fraction <300 micrometer). Despite the aforementioned disparities in sampling, comparing Ujiie's data with ours may shed light on seasonal differences in assemblage off Java, and further allows a comparison with the assemblage in surface sediments. We will add this discussion in section 4.1.

- Based on Figure 9, thermal gradient of plankton net in non-upwelling sector is 2 degrees C. However, the thermal gradient (delta T) seems much larger in the same sector in Figure 10. I couldn't follow the apparent difference in delta T between Figures 9 and 10. Please show absolute values of water depth and temperature in Figure 10, rather than relative values.

We thank the reviewer for pointing out this confusion. The temperatures plotted in Figure 9 are abundance-weighted temperatures (i.e., more weight is given to the depth interval with higher abundance). For Figure 10 we simply marked the ALD of selected species along the measured temperature profile without any calculation.

We will add detail of the calculation in the caption and Methods section, and provide absolute values of water depth and temperature in Figure 10.

- There are two discrepancies between plankton net data and surface sediment records. One is average living depths in Java-LSI (Figure 8). The other is thermal gradient in Sumatra and Java-LSI (Figures 9 and 10). What is the exact relationship between two discrepancies? If the discrepancy of the average living depths in Java-LSI is resolved, then the other discrepancy is also resolved?

Plankton net data off Java suggest a much deeper ALD compared to the calcification depth

inferred from geochemical data of foraminifera in surface sediments. Consequently, the abundance-weighted temperatures based on the plankton net mixed-layer species (red boxplot in the bottom right panel in Figure 9) with a greater-than-expected habitat depth are also lower than that suggested by surface sediment data (red boxplot bottom left panel in Figure 9). In other words, the discrepancy in the thermal gradient is due to the different calcification temperature / habitat depth of the mixed layer species in Java-LSI.

We agree with Reviewer #2 that the plots and associated discussion may be confusing. To improve clarity, we will add more detail about the temperature calculation in the caption, and also a few lines in the discussion to emphasize the difference in estimating the depth, i.e. geochemistry vs. observation.

Although the authors already pointed out the different temporal coverage of sample types, as the Referee (and as a reader), I expect the authors to discuss possible solution for the discrepancy. Please consider the above comments (specific comments 1 to 5) to utilize valuable dataset to tackle the discrepancies between plankton net and surface sediments (and sediment trap).

We find this suggestion very useful and will add a few suggestions for future work at the end of the discussion:

"To further shed light on the transfer of proxy signal from the water column to the sediment, longer sediment trap time series and repeated plankton net sampling in the same region will be useful to capture the seasonality of the vertical distribution of planktic foraminifera. Importantly, generating geochemical data on plankton net samples may help to verify the habitat depths and allow a direct comparison with the depth inference from the surface sediments. It would also be helpful to constrain the age of surface sediments to ensure that they are comparable to modern data."

Technical corrections

The manuscript uses the Ocean Data View and R software to plot and analyze the data. But no references and acknowledgements is presented. Please appropriately refer the ODV and R software.

We will add references for ODV and R.

L21 In addition to Katz et al., 2010, add seminal paper.

We will add seminal papers from Bemis et al. (1998) and Fairbanks et al. (1980).

L28 Abbreviation of SST should be in L27.

Agree.

L29 For transfer function, add seminal paper (e.g., Imbrie and Kipp, 1971).

Agree.

L34 Add oxygen isotope before "d18O", and add ratio after "Mg/Ca".

Agree.

L35 Rephase "popular".

We will replace it with "powerful".

L63 Add period after the end of sentence.

Will do.

L104 Both sensu stricto (s.s.) and sensu lato (s.l.) are not italic. See Wang (2000) paper.

Agree and will do.

L111 What is the approach of Mohtadi et al. (2009) to differentiate N. dutertrei from N. incompta? Please explain briefly.

We will add a brief description of the approach.

L140 Delete "psu". No unit for salinity.

Will do.

L173 Delete "sea".

Will do.

L184-L185 It is not clear that off Sumatra means transect 1-3, and Southern Sumatra and Java-LSI mean transect 4-7. Please clearly state which transect you mention, instead of area's name.

Agree and will add transects in the text.

L196-L197 I'm not sure these references for what reasons. Six species have been often used in paleoceanographic studies? Then describe so.

Agree and will rephrase the sentence to improve clarity.

L205 Typo, lysocline.

Will correct it.

L208 Not Fig. 5g, but Fig. 5f.

Will change it.

L211 Not Fig. 5f, but Fig. 5g.

Will change it.

L217 Delete ")" after G. menardii.

Will do.

L228 Any reference for the lysocline depth?

Will add two references.

L260 and L381 Change from planktonic to planktic.

Agree.

L263 Add "(white)" after G. ruber.

Will do.

L296 How to calculate habitat depth from surface sediments? Please explain.

Will add explanation in the Introduction when we describe the uncertainty associated with this approach.

L303 Delete "inclusion of".

Will do.

L308 Sort species name as in L286. Be consistent with the species order.

We will change the order of L286 so that it is consistent with the order of the species appearing in the discussion.

L332 Geochemical data of planktic foraminifera? It is not clear. Also, what is c of d18Oc? Calcite? State clearly.

We will spell out "Calcite".

L346 Rephrase "greater" to deeper.

We would like to keep "greater" because we find "deeper depth" a tad awkward grammatically.

L380 Delete "Possible". Implication itself includes possibility.

Agree.

L403 It is not clear the meaning of thermal gradient "of" mixed-layer and deep-dwelling species. Perhaps thermal gradient "between" mixed-layer and deep-dwelling species?

Agree.

L427 Does parentheses need for delta T?

We will remove the parentheses.

L466 Typo, LSI.

We will correct the typo.

Figure 1. Add the island names (Sumatra, Java, and the LSI) to Fig. 1a. Some readers are not familiar with this region.

Agree and will add the names.

Figure 2. I suggest to add horizontal lines (like error bars) on top of Fig. 2a showing each transect (1 to 7) corresponds what longitudes. In other words, 7 horizontal lines show

longitudinal extent of each transect, which helps readers to understand regional contrast of temperature, salinity and so on. This is also true for Figure 5.

Great idea! We will add these lines to improve accessibility of figures.

Figure 4. Add explanation for box plot. What is the meaning of box and bars? For stacked graph, legend is ascending order but the actual data is presented as descending order. I prefer ascending order also for the data.

We will add explanation for the boxplots and change the order of the legend.

Figure 5. The figure is currently shown up to 600 m. But the maximum water depth should be 500 m. Please limit the water depth.

We will change the axis limit to 500 m.

Figure 6. Similar to Figure 4, add explanation for box plot. Are the axis logarithmic? It is not clear, since no axis is shown between 100 and 200 m depth. Also, significant digits should be the same (1 or 2?) for the median of ALD. Add space between "species" and "T. trilobus" in the figure caption.

We will add explanation for the boxplots, change the significant digit to 1, and add the missing space.

Figure 8. Increase the font size of the species name. Remove italic from (white) for G. ruber.

Will do as suggested.

Figure 9. Add legend for red and blue colors, instead of stating in the figure caption.

Will do as suggested.

Figure10. In the figure caption, there are a and b. But a and b are not present in the figure. Be consistent with the caption. I prefer absolute values of water depth and temperature, rather than relative values.

We will label the panel and add absolute values of water depth and temperature.

Table 1. Put space after period for P. obliquiloqulata.

Will do.

Table A1. Add "dd.mm.yy" for Date.

Will do.