Responses to Anonymous Referee #4

RC5:

Within their manuscript: "*An 800-kyr planktonic δ18O stack for the West Pacific Warm Pool*" Christen Bowman et al. present a regional planktonic δ18O stack record that is created upon the basis of previously published δ18O records from the area by application of a novel dating and stacking software tool. The dataset might be useful for paleoceanographers in the future. Hence, I generally support its publication in ESSD, but find that the article has some flaws that should be remedied prior to publication. My concerns are outlined in more details below. The authors should also pay attention to a careful and precise wording/phrasing throughout the manuscript.

General comments:

Choice of records: I wonder, if the records chosen to be included in the stack are representative for the WPWP. There are apparently many more regional planktonic (*G. ruber*) δ18O records from the WPWP available, which are not considered in the stack record. The authors do however include two records from the Timor Sea. Strictly speaking, this is not part of the WPWP. What are the selection criteria to include / exclude records within / from the stack? The criteria should be stated clearly in the text.

Some planktonic d18O records from the WPWP were not included because the data did not extend past ~250 kyr. This age range criteria for core selection will be added within the text. We have also identified one new core to include, KX22-4 [Zhang et al., 2021] and more data from ODP site 806. Additionally, we are removing from the stack the Timor Sea cores SO18480-3 and MD01-2378. Collectively, these changes in the stacks' cores result in only minor changes to the stack and our estimates of glacial-interglacial amplitudes and orbital power.

Zhang, Shuai; Yu, Zhoufei; Gong, Xun; Wang, Yue; Chang, Fengming; Lohmann, Gerrit; Qi, Yiquan; Li, Tiegang (2021): Precession cycles of the El Niño/Southern oscillation-like system controlled by Pacific upper-ocean stratification. Communications Earth & Environment, 2(1), https://doi.org/10.1038/s43247-021-00305-5

Related to my previous point, I have another comment: Throughout the manuscript the authors refer to the "WPWP". I am wondering if it is reasonable here, because the authors include two core sites from the Timor Sea (SO18480-3, MD01-2378). Wouldn't it be more precise to refer to the Indo-Pacific Warm Pool (IPWP)? I however note that additional records from the tropical eastern Indian Ocean might be needed to cover the entire IPWP. If the authors use WPWP, shouldn't it be "Western Pacific Warm Pool" instead of "West Pacific Warm Pool" throughout the manuscript?

The WPWP name was updated to the Western Pacific Warm Pool. We agree that the Timor Sea cores are slightly outside the bounds of the WPWP and are more heavily influenced by the Asian monsoon system. We now exclude these Timor Sea sites from the stack and we have added one new site from within the WPWP as well as additional data from ODP 806. The new stack without these Timor Sea sites is quite similar to the previous one.

Section 3 – Data: There are radiocarbon dates of cores KX21-2 (Dang et al., 2020) and MD97-2141 (Oppo et al., 2003), which should be included in this study. The KX21-2 data are presented within the original publication, the MD97-2141 data can be found here: https://www.ncei.noaa.gov/pub/data/paleo/contributions_by_author/oppo2003b/oppo2003b.txt

Thank you for directing us to the additional data, they have been included in the new version of the stack used in the revised manuscript.

Please reference the original datasets, not only the original publications. If I regard it correctly, the original records are mostly deposited online and subsequent users should be able to cite the original datasets directly.

For datasets that have separate citations available, they will be added to the revision.

Comparison of the planktonic WPWP stack to the LR04 / LS16 benthic stacks: Why don't the authors compare planktonic and benthic δ18O records of the cores they are using to create the stack to get more direct assessments of the offsets between planktonic and benthic δ18O records? Benthic δ18O records are available for at least some of the cores.

The comparison of the new planktonic d18O WPWP stack to the timing of global average benthic d18O stacks provides justification for using LR04 as the initial alignment target for the WPWP stack. In the revised manuscript we will also add discussion of possible timing differences between WPWP planktonic and benthic d18O data based on 3 cores for which both proxies have been measured (MD05-2925, ODP 1143, and ODP 806). We will also add supplementary figures showing the planktonic and benthic d18O data from these cores plotted on their shared depth scales.

The authors present a stack record with a temporal resolution / time steps of 0.1 kyr, although the resolution of the individual records that go into the stack ranges between 0.33 and 2.3 kyr. The stack thus feigns a higher resolution than given, which should be avoided. The question is how this affects the statistical analyses presented in the article.

Our stack is produced with a temporal resolution of 0.1 kyr, but for spectral analysis the stack was first sub-sampled to have a 1 kyr resolution. This has been clarified in the methods section. Regarding other types of statistical analysis, the use of Gaussian process regression correctly reflects the relative uncertainty of stack values where data are relatively sparse compared to more densely sampled portions. This is why the stack's standard deviation is narrower in the more recent time interval (e.g., 0.15‰ for 0-60 ka) than for 500-800 ka, when fewer cores/measurements are available (as discussed on lines 234-238).

The authors align their planktonic δ18O stack to the LR04 stack. They argue that there is almost no time shift between the planktonic and benthic records. Considering this, and by looking at the two stack records in comparison (Figure 4), the question arises, why scientists should use the planktonic δ18O stack instead of the LR04 or more recent regional LS16 benthic stacks in the future. I think that should be pointed out more clearly within the article.

We agree that the manuscript needs to more clearly describe the usefulness of the new WPWP stack as a regional alignment target that will improve relative age models and alignments of other planktonic WPWP records. We want this intended purpose to be easily identifiable for readers.

The similarity in timing of d18O change between the planktonic and benthic stacks provides justification for our use of the LR04 stack as an initial alignment target. However, there are differences in the amplitude of d18O change between the planktonic and benthic stacks and local WPWP signals that make the WPWP planktonic stack a preferable regional alignment target. We will add an example to the manuscript that demonstrates how the aligned age model for core MD01-2378 (from the Timor Sea and, thus, excluded from the new version of the stack) is improved when the WPWP planktonic stack is used for the alignment target compared to using the LR04 benthic stack for alignment. We will also modify the manuscript's conclusion to clarify for which applications the WPWP planktonic stack is preferable to a benthic stack.

If the δ18O records are shifted and scaled "to better match the target stack" (line 114), how useful is it to compare amplitudes or spectral power of the WPWP and LR04 stacks?

The phrasing used here was inadvertently confusing, and the revision will explain this more clearly. (The BIGMACS "target stack" reflects planktonic values after the first iteration of alignments.) The mean and amplitude of the final WPWP stack match the mean and amplitude of the component planktonic records; therefore, comparison of the glacial cycle amplitudes and spectral power between the WPWP and LR04 are meaningful. The reported shift and scale factors indicate how much each individual record differs from the WPWP stack. (Thus, in Table 2 the shift values have an average of ~0 and the scale values average ~1.) This approach allows the amplitude of the stack to reflect variability in the common signal across sites although there are small constant offsets or amplification factors across the WPWP region.

The authors introduce that they "seek to characterize WPWP climate on orbital timescales and its differences from high-latitude climate, which can help test hypotheses about the sensitivity of the WPWP to orbital forcing, ice volume, and greenhouse gas concentration" (lines 20-22). Later on, they compare their regional planktonic stack to a regional benthic stack, to the LR04 stack and to a regional WPWP SST stack record. They however miss to draw conclusions from their results. What can be inferred from the comparisons? What is, for instance, the value of comparing spectral power and variability of the regional planktonic stack to the global benthic stack?

We intentionally omitted any interpretation of WPWP climate mechanisms based on our understanding of the aims and scope of this journal, which provides guidance that "Any interpretation of data is outside the scope of regular articles" (https://www.earth-system-science-data.net/about/aims_and_scope.html). Further guidance on data description papers says: "Although examples of data outcomes may prove necessary to demonstrate data quality, extensive interpretations of data – i.e. detailed analysis as an author might report in a research article – remain outside the scope of this data journal. ESSD data descriptions should instead highlight and emphasize the quality, usability, and accessibility of the dataset, database, or other data product and should describe extensive carefully prepared metadata and file structures at the data repository." (https://www.earth-system-science-data.net/about/manuscript_types.html)

Therefore, we confine our discussion/conclusions to (1) the strengths and limitations of the methods used to create the stack (to provide guidance on how the data should be used for future studies), and (2) a brief description of how this stack differs from other available stacks that researchers might consider using.

In the revised version of the manuscript we will edit the conclusion so that it ends by highlighting the primary message of the publication. Specifically, we will append to the last paragraph: "Differences in the glacial-interglacial amplitudes between the WPWP planktonic stack and benthic d18O stacks validate that these differences are characteristic of planktonic d18O throughout the WPWP. Furthermore, stratigraphic alignments of WPWP planktonic d18O will be more reliable when aligned to a WPWP planktonic stack than a benthic d18O stack."

This added conclusion will be supported by a comparison of results for aligning planktonic d18O from core MD01-2378 to the WPWP planktonic stack versus the LR04 benthic stack.

More specific comments:

Line 9: It should be "a smaller glacial-interglacial amplitude".

Updated.

Lines 19-20: "Thus, climate records of the WPWP region are expected to have features which differ from many other locations on Earth." This statement is rather general and should be more precise.

We agree that this sentence should make a more specific comparison. We revise it to say "Thus, the climate records of the WPWP region are expected to have features which differ from the high-latitude climate records often used to characterize global climate change (e.g., Lisiecki & Raymo, 2005; Past Interglacials Working Group of Pages, 2016)."

Reference: Past Interglacials Working Group of PAGES (2016), Interglacials of the last 800,000 years, Rev. Geophys., 54, 162–219, doi:10.1002/2015RG000482.

Line 25: It might appear a bit old-fashioned, but don't foraminifers have tests instead of shells? Please correct.

Corrected.

Lines 24-35: Here, I clearly miss some references.

We agree with the reviewer that the introduction section does not have a sufficient amount of references. The revised manuscript will have additional references, including more modern oceanography papers pertaining to the region including the following:

Broccoli, A. J.: Tropical cooling at the Last Glacial Maximum: An atmosphere–mixed layer ocean model simulation, J. Clim., 13, 951–976, https://doi.org/10.1175/1520-0442(2000)013<0951:TCATLG>2.0.CO;2, 2000.

De Deckker, P: The Indo-Pacific Warm Pool: critical to world oceanography and world climate, Geosci. Lett., 3, https://doi.org/10.1186/s40562-016-0054-3, 2016.

Lo, L., Chang, S.-P., Wei, K.-Y., Lee, S.-Y., Ou, T.-H., Chen, Y.-C., Chuang, C.-K., Mii, H.-S., Burr, G. S., Chen, M.-T., Tung, Y.-H., Tsai, M.-C., Hodell, D. A., Shen, C.-C.: Nonlinear climatic sensitivity to greenhouse gases over past 4 glacial/interglacial cycles. Sci Rep, 7 (1), 4626, https://doi.org/10.1038/s41598-017-04031-x, 2017.

Mayer, M., Haimberger L., Balmaseda M. A.: On the energy exchange between tropical ocean basins related to ENSO. J. Clim., 27, 6393–6403, https://doi.org/10.1175/JCLI-D-14-00123.1, 2014.

Neale, R., and Slingo, J.: The maritime continent and its role in the global climate: A GCM study. J. Climate, 16, 834–848, https://doi.org/10.1175/1520-0442(2003)016<0834:TMCAIR>2.0.CO;2, 2003.

Rosenthal, Y., Oppo, D. W., Linsley, B. K.: The amplitude and phasing of climate change during the last deglaciation in the Sulu Sea, Western Equatorial Pacific, Geophys. Res. Lett., 30 (8), https://doi.org/10.1029/2002GL016612, 2003.

Line 78: There are calcification depth estimates from the study area (e.g. Hollstein et al., 2017). Why don't the authors consider these estimates? For instance, for G. ruber, the study indicates a calcification depth of 0-75 m, rather than the 30 m indicated by Wang et al. (2000).

Thank you for directing us to this additional publication. Additional information has been included within text which will read, "All but one core in the stack uses $\delta^{18}O$ values measured from the planktonic species *Globigerinoides ruber (G. ruber)* sensu stricto (s.s.), whose depth habitat in the WPWP ranges from the upper 45 m to upper 105 m of the mixed layer depending on how calcification depth is calculated (Hollstein et al., 2017). The average mixed layer depth of the WPWP is 50 m to 100 m (Locarini et al., 2018).

Line 79: Shouldn't it be *T. sacculifer*?

Updated in the revised manuscript to "One core, 180-1115B, has data from a different planktonic species, *Trilobatus sacculifer (formerly Globigerinoides sacculifer)* whose depth habitat is 20 m to 75 m or potentially as deep as 45 m to 95 m (Sadekov et al., 2009; Hollstein et al., 2017)."

Table 1: The reference of Chuang et al. (2018) is missing in the Reference list.

Corrected.

Line 119: The sentence is not complete.

Thank you for pointing out this error; “to have” should just be “have”. The corrected sentence reads: “Core sites with homogeneous planktonic δ^{18}O values have shift parameters close to 0 and scale parameters close to 1.”

Lines 119-121: A short explanation for the shift and scale parameters might be helpful.

Descriptions of the record properties related to the shift and scale parameters (i.e., vertical offset and amplitude) have been added to the revised manuscript. Clarification that the shift and scale are relative to the planktonic WPWP stack has also been included. The new text will read, “The shift/scale values represent how each core is adjusted optimize fit with the planktonic WPWP stack; the shift applies a constant d18O offset between the core and the stack, and the scale is a multiplicative adjustment to the amplitude of the core δ^{18}O data relative to the stack.”

Lines 129-130: The authors do not apply local reservoir age corrections and assume a reservoir age standard deviation of 0.2 kyr. What is the rationale behind these assumptions?

The Marine20 calibration curve includes a time-dependent reservoir age which is used in radiocarbon data calibration (Heaton et al., 2020). We set the reservoir age offset (ΔR) to 0, meaning we did not change the reservoir age from the Marine20 default of 400 yrs. Additional description has been added to clarify that a reservoir age is still being used, as well as added notation for the reservoir age offset (ΔR). We assigned a 1-sigma uncertainty of 200 yr to the reservoir ages to account for possible changes to the reservoir age through time.

Our choices not to apply an offset from Marine20 and to use a 200-yr uncertainty are consistent with other WPWP studies. The originally published age model for MD05-2930 used the Marine09 calibration without a reservoir offset [Regoli et al., 2015]. Dang et al (2020) used the Marine13 calibration curve with offsets of <30 yr and an uncertainty of <100 yr for core KX21-2. Importantly, the main goal of this manuscript is to provide a record of orbital-scale variability in planktonic d18O, it is not intended to provide 1-kyr precision of absolute ages and the manuscript clearly describes the limitations of the stack’s age model (e.g., lines 211-218).

Lines 135-139: If I understand it correctly, the authors choose a standard deviation of 1 kyr for the alignment of the records to MIS 3 and 4, but a standard deviation of 4 kyr for the first and last δ18O measurements of each core. I think, this needs some explanation.

We agree that the revised manuscript would benefit from additional explanation here, and we will add it to the text. Specifically, the first and last additional ages with standard deviations of 4 kyr are age estimates taken from the core’s previously published age models and given to BIGMACS to help aid age model construction. The prescribed uncertainty of 4 kyr accounts for potential age model differences in the core start/end ages between the BIGMACS age model and the previously published age models. In cores MD97-2141 and ODP 1115B, tie points were added with a smaller age uncertainty of 1 kyr to provide additional guidance to the BIGMACS alignment of specific features within the records to the BIGMACS stack. We are essentially correcting the default alignment by forcing certain features in the d18O record (MIS 3 and 4) to have certain ages, so we reduce the age standard deviation to 1 kyr.

These tie points in MIS 3 and 4 are necessary largely because our initial alignment target is the LR04 benthic d18O stack, which has different amplitudes for the isotopic stages than the planktonic d18O records being aligned. The revised manuscript will include an example of an alignment error at the MIS 4/5 transition that occurs when planktonic d18O from MD01-2378 is aligned to the LR04 stack; in contrast, the correct alignment is found when the WPWP planktonic stack is used for the alignment target.

Line 150: “Present day”: Here the authors could be more precise, and indicate the year they are referring to.

The meaning of “present day” has been clarified in the revised manuscript to the time interval used for the World Oceans Atlas mean annual SST for the WPWP, which is 1955 - 2018 (Locarini et al., 2018)

Section 4.3: Please indicate, which software / tool was used to perform spectral analysis.

Updated in the manuscript methods and figure captions to indicate spectral analysis was performed using MATLAB’s pmtm( ) function. The revised manuscript will include this information and a citation for Matlab.

Line 185: “weaker the glacial-interglacial amplitude”. Delete “the”.

Corrected.

Line 254: “most negative”. Please rephrase.

Updated in the revised manuscript.

Line 261: “where glacial surface water δ18Osw was more positive at the LGM”. Please rephrase. I assume that the authors want to express that glacial δ18Osw was higher.

Updated in the revised manuscript.

Line 262: Which sites?

Thank you for pointing out the need to be more specific here. The revised text will read: “Previous studies show regional differences in $\delta^{18}O_{seawater}$ that may explain the reduced amplitude of planktonic $\delta^{18}O$ change at sites ODP-769A, MD97-2141, KX21-2 and ODP-806 in the Sulu Sea and eastern WPWP (de Garidel-Thoron et al., 2005).”

Line 333: It should be “which has a higher resolution”.

Corrected.

Tables 1 and 2: Could the authors maybe sort the entries of these tables?

This is an excellent suggestion. Cores will be sorted by longitude (west-to-east) in both tables and in Figure 2 for the revised manuscript.

References

Dang, H., Wu, J., Xiong, Z., Qiao, P., & Li, T. (2020). Orbital and sea-level changes regulate the iron-associated sediment supplies from Papua New Guinea to the equatorial Pacific. Quaternary Science Reviews, 239. https://doi.org/10.1016/j.quascirev.2020.106361.

Hollstein, M., Mohtadi, M., Rosenthal, Y., Moffa Sanchez, P., Oppo, D., Martínez-Méndez, G., . . . Hebbeln, D. (2017). Stable oxygen isotopes and Mg/Ca in planktic foraminifera from modern surface sediments of the Western Pacific Warm Pool: Implications for thermocline reconstructions. Paleoceanography. https://doi.org/10.1002/2017PA003122.

Oppo, D. W., Linsley, B. K., Rosenthal, Y., Dannenmann, S., & Beaufort, L. (2003). Orbital and suborbital climate variability in the Sulu Sea, western tropical Pacific. Geochemistry, Geophysics, Geosystems, 4(1), 1-20. https://doi.org/10.1029/2001gc000260.