Climate of the Past Discussions

Clim. Past Discuss., author comment AC3
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Reply on RC3

Jacob Jones et al.

Author comment on "Sea ice changes in the southwest Pacific sector of the Southern Ocean during the last 140□000 years" by Jacob Jones et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2021-107-AC3, 2021

RC3: We thank you for your time in reviewing our manuscript – your comments have been extremely helpful in the further development of our manuscript. We have considered and discussed your comments amongst the co-authors, which have sparked some productive exercises.

Because of the number of co-authors working on this project, we have opted to create a comment tracking table for ease of discussion and in-text references to other related comments. We have copied and numbered each comment received in your review and have provided our collective response to each.

Please feel free to follow up for any required clarity.

Sincerely,

Jacob Jones

Comment #	**Comment**	**Author's Response**
RC3-1	Sedimentation rate in core TAN1302-96 is much higher during interglacial/warmer period than during glacial period and MIS 2, 3 and 4 are represented by less than 30cm in that core from ~90 to 120cm. The period that the authors discuss as MIS 3 is	We appreciate the reviewer's deep engagement with the data provided in this manuscript. This comment has provided valuable discussion surrounding the robustness of the age model as currently outlined in the manuscript, and we welcome

part of MIS 5. The evidence comes first from the d^{18}O stratigraphy measured on N. pachyderma (senestre? should be indicated by the authors). The values measured between 120 and 170cm are clearly too low to represent MIS 3. They indicate that from 120 to 300cm the sediments were deposited during MIS 5. This is also indicated by the 14C data: measurements at both 130 and 170cm indicated dates undistinguishable from background because both are older than 70kyr. Further evidence of the "extended" MIS 5 and shrinked MIS 2, 3, 4 could come from the carbon isotopic record of N. pachyderma but they are not presented in the paper. The authors could/should compare their isotopic record to the isotopic record of core SO136-111 that they are also using in this paper if they want further evidence. Correcting the chronology for the studied core TAN1302-96 will make it possible to reconcile the sea ice record of this core with those of the 2 cores from the same area: core E27-23 and core SO136-111. It is not clear if MIS 6 is represented in the core. There is no corresponding isotopic value but it might be due to the low resolution of the isotopic data

discussions to improve the reliability of our data and interpretations.

Age model construction

To test the reliability of our age model, we have constructed 4 additional age models (5 total) and have set up a series of tests to determine their reliability. All age models use the youngest 5 radiocarbon samples outlined in the manuscript but use different tie points for the older portions of the core (incorporating comparisons with the EDC (dD as was done for SO136-111). The new age model versions also make different use of the 2 older, NDFB radiocarbon samples at 130 and 170cm. The 4 additional age models that we compare are as follows:

[1] **EDC 1**: includes both the 130cm and 170cm radiocarbon samples and is tied to the EDT temperature record (dD data from Stenni et al. (2010) on the AICC2021 timescale from Veres et al. (2013)). The NDFB radiocarbon ages used were 57.5 ka and 57.7 ka, respectively, as these were the lower bracket of the NDFB results supplied by the CAS laboratory.

[2] **EDC 2**: includes only the

130cm radiocarbon sample (using an age of 57.5 ka) and excludes the 170cm sample. This model uses the same tie points to the EDC SST record as were used for EDC 1.

[3] **EDC 3**: excludes both the 130cm and 170cm radiocarbon samples and uses the same tie points to the EDC SST record as were used for EDC 1.

[4] **R3**: based on the reviewer's comments, we attribute an age of 80 ka to the 130cm radiocarbon sample (reviewer suggests >70 ka) and a date of 104 ka to the 170cm sample. These date attributions are based on tying the TAN96 $d^{18}O$ record to the LR04 stack at the location of the radiocarbon samples. We then tie the TAN96 $d^{18}O$ record to the LR04 stack and assume that all sediment between 120 and 300cm accumulated during MIS 5, and that sediments between ~90 and 120 cm correspond to MIS 2, 3, and 4.

[5] **d18O 1**: original age model used in the manuscript, which uses 5 youngest radiocarbon dates, excludes the NDFB dates, and tie points between the TAN96 $d^{18}O$ record and the LR04 stack.

Age model comparison:

Following their selective tuning to EDC and d18O records, we compare these 5 age models based on:

[1] match of the $d^{13}C$ records between TAN 96 and nearby core SO136-111

[2] sensible behavior and magnitude of sediment accumulation rates relative to nearby SO136-111

[3] overall fit to d18O and EDC SST

Observations

Our comparisons suggest:

[1] Our current age model (d18O 1) fits very well with the d13C record from SO136-111 (Figure RC3-1), suggesting that it is consistent with the age model provided for SO136-111.

[2] R3, EDC 3, and d18O 1 all provide reasonable fits to the LR04 stack

[3] d18O-1 and EDC 3 provide the most sensible sedimentation rates when compared with SO136-111 rates.

Additional thoughts:

Overall, we find it unlikely that the TAN96 sedimentation rates would be reduced to near-zero (~0.2 cm/ka) during glacial periods (i.e., ~13cm (117 to 130cm) deposited over >60 ka for MIS 2, 3, & 4), as was suggested by Reviewer 3. While it makes sense that polar cores with >80% sea ice cover would experience greatly reduced sedimentation rates, the wSIC estimates for TAN 96 are 40-50% during glacial periods, suggesting that the study area would experience some productivity during glacial times. Furthermore, the proximal site SO136-111- which has comparable wSIC estimates during glacial periods - does not exhibit this behavior, as sedimentation rates are between 2-3 cm/ka during glacial periods.

Conclusion:

Our final response to reviewer document will provide the

		details of these comparisons, and our revised manuscript will provide a more comprehensive explanation of our age model determination including all supporting information.
RC3-2	Chronology: As the authors indicate , significant MRA variability occurs over a glacial cycle, specifically in the southern high latitudes. They should use as a minimum ±100 years for the uncertainty on the MRA as it is the variation indicated by Paterne et al., 2009, for the last century. The authors do not indicate the uncertainty they evaluate for the tie points used to correlate the planktic isotopic record to the LR04 benthic record. From figure 3 it seems that they also choose a too small uncertainty. Anyway the authors should give more details. Furthermore as they present a planktic isotopic record and a SST record and as their goal is to discuss the impact of sea ice extent on atmospheric CO_2, it would make more sense to establish the chronology of MIS 5 comparing their records to EDC deuterium record, following Govin et al., 2015, Capron et al., 2014. Anyway the record resolution is pretty low (partly due to the low sedimentation rate of the core) so the real uncertainties are large and this comment is not that important.	We have taken this comment into consideration and are in the process of comparing alternative age models that use the EDC deuterium record. As noted above, we will also provide more information on the age model that is selected, including a minimum ±100 year uncertainty for the MRA and more information on tie point uncertainty.

RC3-3	SST and wSIC: the authors should give more details: how many analogues have been used for reconstructions? Is the error indicated on the figure the standard deviation between the different analogues? The tables should be available to reviewers.	In this version, the MAT has a ~1°C RMSEP for SSST and a 10% RMSEP for WSIC on the modern validation step. These errors are generally applied downcore as other TF (IKM, WA-PLS…) and geochemical proxies (TEX86, UK37, Mg/Ca) only provide a mean error on the calibration. However, MAT allows for a sample-only error, calculated as the standard deviation of the chosen analogs. In core TAN96, SSST standard deviation varies between ~0.2°C and ~2°C (mean of 1.28°C, in good agreement with the modern calibration) (Figure RC3-2). WSIC standard deviation varies between 0% during interglacials to ~30% in glacials (mean of 8%). In SO136-111, SSST standard deviation varies between ~0.5°C and ~2°C (mean of 1.14°C) (Figure RC3-2). WSIC standard deviation varies between 0% in interglacials to ~25% during glacials (mean of 9.96%). All these data are provided in the appendix table. In TAN96, the dissimilarity of the fifth analog varies between ~0.15 and ~0.4 (mean of 0.23), far below the threshold of the first quartile (0.7). All five analogs are always preserved and estimates & SD are done on 5 analogs. In core SO136-111, the dissimilarity of the fifth analog varies between ~0.05 and ~0.3 (mean of 0.14), far below the threshold of the first quartile (0.7). All five analogs are

		always preserved and estimates & SD are done on 5 analogs. These data are not pivotal to the manuscript but a mention to the good dissimilarity and to the calculation on 5 analogs will be added to the revised manuscript.
RC3-4	Results: what is indicated in the text is not what is presented on the figures. Some examples: line 253, the SST increase seems to be ≤3°C on the figure. Taking into account uncertainties ~1 to 4°C would be precise enough. Line 254: on the figure the 2 methods indicate ~22 to ~33% wSIC for the oldest point. Where does the 48% comes from? Line 256: I do not see a rise in SST during MIS 5e, only variability.	This is a good catch – after looking through the datafile, an additional blank line of data was accidently added causing some of the data points to be shifted and/or not included in the figure. An updated figure is provided below (Figure RC3-3) which shows the wSIC of 48% at 140 ka. We note that the SSST value at the MIS 5e/6 boundary is 4 °C in the updated figure, and the text will be updated to reflect the corrected value. Finally, we do not disagree with your observations regarding SSTs during MIS 5e. We will change the wording to something like: "Reconstructed SSSTs were variable throughout MIS 5e, reaching a maximum…"

Figure RC3-1 (attached): d13C comparison between SO136-111 (shaded blue) with all 5 new TAN130-296 age models (coloured dotted lines).

Figure RC3-2 (attached): SSST in TAN1302-96 reconstructed through MAT (*this study*) in blue and their associated standard deviation (SD) in orange.

Figure RC3-3 (attached): This figure is updated from the original manuscript and the additional blank line of data has been removed.

Please also note the supplement to this comment:
https://cp.copernicus.org/preprints/cp-2021-107/cp-2021-107-AC3-supplement.pdf