

Clim. Past Discuss., referee comment RC2
<https://doi.org/10.5194/cp-2021-151-RC2>, 2022
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Comment on cp-2021-151

Anonymous Referee #2

Referee comment on "Plio-Pleistocene Perth Basin water temperatures and Leeuwin Current dynamics (Indian Ocean) derived from oxygen and clumped-isotope paleothermometry" by David De Vleeschouwer et al., *Clim. Past Discuss.*, <https://doi.org/10.5194/cp-2021-151-RC2>, 2022

The focus of the manuscript "Plio-Pleistocene Perth Basin water temperatures and Leeuwin Current dynamics (Indian Ocean) derived from oxygen and clumped isotope paleothermometry" by De Vleeschouwer et al. is the calculation of planktonic foraminiferal $d^{18}O$ gradients between IODP Site 1459 located off the western coast of Australia and previously published records from more northern located sites. These gradients are intended to provide new insights into temporal changes in the Leeuwin Current strength during the time-period 4- 2 Ma. The authors present a new planktonic foraminiferal $d^{18}O$ record from IODP Site 1459 in orbital resolution that extends a previously published record from the same Site. Also, eight clumped isotope SST reconstructions are presented and compared to previously published TEX 86 SST reconstructions from the same Site.

While the data presented here are from an interesting location and time period the used methods, and interpretations are very uncertain, and claims are not well supported by the data. The manuscript is generally written well. Major comments:

- A planktonic $d^{18}O$ record is presented from core depths (55-105 mcd) where partly severe dolomitization was reported previously (*Proceedings of the International Ocean Discovery Program*, vol. 356). Further, all samples are from a shallow carbonate rich ocean region close to coral reefs where carbonate diagenesis is very common. It is well

known that diagenesis and recrystallisation at sea bottom alter foraminiferal $d^{18}O$ towards heavier values (e.g., Edgar et al., 2015, *Geochimica et Cosmochimica Acta*). It is also clear that these alterations (solution, recrystallisation) are not always visible in the crystal structure of the foraminifers (Kozdon et al., 2011, and refs. therein, *Paleoceanography*). The comparison to clumped isotope temperatures is not convincing to rule out diagenesis as there are only eight data points shown and it has been shown that clumped isotope temperatures from planktonic foraminifers are also biased towards colder temperatures by diagenesis (Leutert et al., 2019, *Geochimica et Cosmochimica Acta*). Hence, at least parts of the paleoclimatic interpretations with relatively high $d^{18}O$ during the warm Pliocene might be probably related to diagenesis.

- I see the method of calculating planktonic foraminiferal gradients to reconstruct changes in the paleo-Leeuwin Current (warmer-colder) very problematic. It is known that the $d^{18}O$ of planktonic foraminifers are dependent on local temperature changes, local salinity changes and the global ice volume. Even if the global ice volume is known from the past there are still two variables which are unknown for each site location (local temperature and local salinity). Also, the clumped isotope temperatures do not really support the presented $d^{18}O$ record from Site 1459 as a temperature signal. This is due to the very few (eight) data points over the whole time period studied, that makes it impossible to compare long-term trends in temperature. Additionally, these data points show a huge error bar of up to $10^{\circ}C$.
- It was not clear to me why the $d^{18}O$ gradient between sites at $29^{\circ} S$ and $19^{\circ} S$ reflect the evolution of the Leeuwin Current better than the difference between sites located northwards (sites 1463 and 763). Presented model simulations (Fig. 2b) show miniscule temperature changes at about $29^{\circ} S$ at Site 1459 between cold and warm stages but the gradients presented by the authors are mostly driven by huge changes in the planktonic foraminiferal $d^{18}O$ of Site 1459.
- A recent study by He et al., (2021, *EPSL*, mentioned by the authors) presented alkenone derived SST gradients from regions close to what the authors used to reconstruct their planktonic foraminiferal $d^{18}O$ gradients. However, the temporal development of these alkenone SST gradients is different from what the authors show from their $d^{18}O$ gradients.

Some more detailed comments:

Line 21: Here the authors should make clear that clumped isotopes are not in an orbital resolution. The reader might be confused.

Line 39: Clearly, the boundary currents facilitated the conditions for humans in Australia but that it is only habitable because of these is exaggerated.

Lines 81-86: The authors discuss here a point of the study of He et al., (2021) which focuses on a time period that is not covered by their data so it's not really relevant.

Lines 245- 255: This might be more suitable for the methods section

First paragraph of Chapter 3.2: Parts can be moved into the methods section

Lines 280-288: Unclear and confusing, please describe more clear

Lines 297-301: Not clear to me how the authors calculated $d^{18}O_{sw}$

Line 334: Indicate how much is "slightly warmer"

Lines 361-367: See mayor comments

Lines 372-388: Confusing paragraph about the habitat depth of sacculifer. The authors already mention that it is not a close surface dweller as *G. ruber*, but there is poor evidence of making it a subsurface water species.

Lines 460-461: Not very convincing for me.

Lines 464-471: I would like to see these comparisons in a figure. Which age models are used for these reconstructions?

Lines 472-473: This correlation is not really convincing for me.

Figure 1C:

The authors should clarify why the depth scale is from 100 to more than 500 m water depths if the present water depth of Site 1459 is only about 192 m.

Figure 3C:

It is not clear which data is new and which has been already published. I recommend indicating this with different colors.

Figure 4B:

I can't see a good "coherence" of the two records. Yes, the lowest clumped isotope temperature data point is at the same time when $d^{18}O$ values appear low. However, other data points don't really match, for instance the data point at 2.25 Ma. Also, the marks of the clumped isotope temperatures are too thick to really can correlate them to the $d^{18}O$ record.

Figure 7A:

Especially the long-term trends do not show a good correlation.

Figure 8B-D:

Colors of the records are difficult to distinguish. Scales are all different. Records do not show a good correlation.