

Clim. Past Discuss., referee comment RC2  
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## Comment on cp-2022-33

Anonymous Referee #2

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Referee comment on "Leeuwin Current dynamics over the last 60 kyr – relation to Australian ecosystem and Southern Ocean change" by Dirk Nürnberg et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2022-33-RC2>, 2022

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Review of the paper : « Leeuwin Current dynamics over the last 60kyrs-relation to Australian extinction and Southern Ocean change» by Dirk Nürnberg, Akintunde Kayode, Karl J;F. Meier and Cyrus Karas.

This paper presents a number of high-resolution new data concerning hydrological changes South of Australia, since 60 kyr. Both oxygen isotopes and Mg/Ca of surface dwelling and deep dwelling planktonic foraminifera were measured, to reconstruct Sea surface and thermocline temperature and salinity evolution. The authors present the different currents and water masses influence along the last 60 kyrs and compare their result with different climatic records of the Southern Ocean. They also compare their data with the evolution of atmosphere circulation and South Australia precipitation, pollen and charcoal, to discuss the main factors that conduct to the Australia's megafaunal extinction. This interesting paper thus contains a lot of information, that is not really reflected in the title as not only the Leeuwin current evolution is considered for the oceanic circulation changes. The last part of the paper, dealing with the reasons of the megafauna extinction is well written and easier to follow than the oceanographic discussion.

I would suggest major revisions for two main reasons.

The first one concern the interpretation of the trace element concentration Mg/Ca of the foraminifera. The recent papers that improved a lot the knowledge concerning the factors playing a role in the incorporation of Mg/Ca in foraminifera tests are not taken into account. The authors should take into account those papers by W. Gray, and D. Evans, see Gray and Evans 2019 and reference therein. For the top core sample the temperature reconstructed for the SST for the eastern site is far from the climatologic one. It would be interesting to see the temperature reconstructed using the more recent temperature

equation. Taking into account that Mg/Ca will reflect not only temperature change but also salinity and pH changes will change the results. The origin of the surface waters coming mainly from the tropical area, changes in atmospheric CO<sub>2</sub> can be used to take into account pH changes, but for thermocline waters the influence of Subantarctic waters that probably underwent different pH changes due to their Southern Ocean origin might be of importance. The different salinity changes linked also to the changes of the water mass characteristics and the changes in currents strength might complicate the reconstruction.

The second reason is the fact that the main part concerning oceanic changes is quite difficult to read. It first relies on an analogy with a simplified description of the modern setting and finally consider much more complicate evolution of currents and influence of the different water masses. Some atmospheric considerations appear much later in the discussion as well as some currents and they have not been presented in the modern settings. For example, the subtropical ridge is not presented in the modern setting. It appears for the first time on page 22 where it is still not defined, it is defined on the next page, 23. On fig 6A and on page 32 STR appears but is not defined either. Does it correspond to the Subtropical Ridge? The West Australian Current could be also presented in the modern setting as well as the Est Australian current and the SIOC. The oceanographic area is quite complicated and the assumptions relating the changes in the isotopic and trace elements changes to evolution of water masses and currents influence is not always "direct". This part is thus sometime difficult to follow. A table presenting the implication of the different SST, TT and  $\Delta T$  and SST evolution for the different periods considered would be most welcome.

Following are some comments described along the text.

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Line 49 : ITW et EGC are not shown on fig.1 suppress fig.1 in this sentence.

Fig.1 SIOC : correct 2607/2609 by 2607/2611

Line 81 ivc not explained (Ice Volume corrected I suppose)

Line 326 : Records have been interpolated to calculate gradients. It would be nice to give the sedimentation rate and the resolution of the different records.

Line 347, 348. long term analytical precision: add « standards ». What is the reproducibility of *G. ruber*, *G. truncatulinoides* and *O. universa* oxygen isotopes in those cores ?

Line 361 correct ivf by ivc

Line 370 The notation -0.5-0.5‰ is not very clear. Change maybe for -0.5 to 0.5‰. Furthermore, in the GISS data base there are no values less than 0.25‰ (very few data points) for the first 400 m depth of the area.

Lines 371 and 374 Mean Holocene should maybe be corrected to Late Holocene if it is a mean of the most recent 5ka.

Lines 407-409 the link between temperature warming and saline conditions comes by the large temperature changes: the isotopes variations are mainly  $\leq 0.5\text{‰}$ , while Mg/Ca temperatures varies by 4 to 10°C. The Mg/Ca temperatures could be noisy.

Lines 413-427 : For the eastern site, the Mg/Ca temperatures are higher than the modern range but for MIS2. For the Holocene they are even higher than temperatures from the western site. Could the authors comment?

Fig.2 : The range 50-100 m water depth is indicated for *O. universa* in the legend, while 30-80 m is indicated on the graphs. Why not keep the usual colors for the two cores: green and red. And choose other colors for fig.2B, that is the longitudinal profile. Keeping the blue and red colors for 2A and 2B favor confusion.

Lines 446-472 and fig. 6 : Not easy to follow: In the text and on fig. 6A, from 60 to 37 kyr increasing La Niña is indicated, corresponding to a stronger Leeuwin current, while on figure C the trend for that period is a weakening of the Leeuwin current.

Fig.6: STR is not defined; it is not possible to read what is on fig. 6.B

Line 482 : The average looks closer to 20°C than 18°C at 60ka BP

Line 493 : 10-12°C is the modern range for the western site. For the eastern site, it is 9-10°C (WOA) maybe indicate cooler by 2-3°C than the core top.

Lines 493-495 : the  $^{18}\text{O}$  axis is reverse so the curve indicate more positive and not "more negative" conditions and during LGM the conditions are note fresher but more saline.

Lines 534-538: could be in the modern setting part.

Lines 543-545: strong stratification should be associated with high  $\hat{\Delta}T_{\text{SST-TT}}$  ?

Lines 553-567 : difficult to read, rephrase the English? What does the authors mean by "compare to the modern situation"? idem for "with a rather equalized vertical temperature gradient" and "The oceanographic setting as existent today was considerably different". Furthermore, the latest Holocene SST reconstructed from the two cores does not really look alike the modern situation as the reconstructed SST of the eastern site is  $\sim 21^\circ\text{C}$  instead of within the range 13-16°C. The atmosphere circulation has not been presented in the modern settings and as for STR, it would have been nice to read about the role of the "opposing winds" before.

Line 568: yes for TT waters not for the surface ones.

Line 575: is it really "dislocation" or shift?

Line 580 correct for "between core 2614  $\hat{\Delta}T_{\text{SST-TT}}$  and  $\hat{\Delta}T_{\text{west-east}}$ "

Line 625 similar would be more appropriate than equalized?

Line 652 again replace "equalized", that does not go well with gradient.

Line 722 the vertical  $\hat{\Delta}T$  gradient decrease at the west site linked to increased LC, it increases at the east site.

Lines 744-745 and following lines: for the late Holocene, in the core SST reconstruction the vertical temperature gradient and the SST is larger at the east site than at the west site. It does not correspond to the modern setting. What confidence in the east site reconstructed SST signal?

Supplementary :

- 182 : " $\delta^{18}\text{O}$  *G. ruber* values are on average higher by  $\sim 0.5\text{‰}$ " replace "higher" by "lighter"