In this manuscript, Karatsolis and Henderiks generated two calcareous nannofossil records from International Ocean Discovery Program (IODP) Sites U1463 and U1464, located in the NW Australian shelf, in order to reconstruct long-term changes in ocean circulation, seasonality and nutrient availability from ~ 6-3.5 million years ago (Ma). The authors characterised different periods of change in stratification and nutrient availability in the study area by analysing the shifts in the calcareous nannofossil dominant taxa and comparing them with palaeotemperature gradients between the NW Australian shelf and the eastern Indian Ocean.

Karatsolis and Henderiks found a marked regional change in the oceanographic conditions that affected the ecology of calcareous nannofossils across the Miocene to Pliocene boundary (5.4–5.2 Ma), which they attributed to an increase in seasonality and general intensification of the upper water column mixing. The authors also put the observed local variations in a more global context, considering events, such as the extinction of *Sphenolithus* spp. (~3.54 Ma) and the termination of the late Miocene to early Pliocene biogenic bloom in the eastern Indian Ocean (4.6-4.4 Ma).

General comments

This manuscript represents a substantial contribution to scientific progress within the scope of **Climate of the Past** and it is of interest for the coccolithophore, calcareous nannofossil, palaeoceanographic and micropalaeontological communities.

It is well written, logically structured, and presents a new calcareous nannofossil dataset.

The title reflects the contents of the manuscript and Karatsolis & Henderiks present an adequate summary of their work in the abstract. The state of the art and the main aims of this work are properly introduced in the first section.

The methods used in this piece of research seem adequate and are described section 2 of the manuscript. In my opinion, mathematical formulae, symbols, abbreviations and units are correctly defined and used through the text.

The interpretation and conclusions have been logically derived from their findings, and supported by the original data shown in section 3 (Results).

My main concern is that the authors should highlight more the variability between proxy types. They use different proxies, such as GDGT-based TEX86 temperature and alkenone-based U37k´ SST or Mg/Ca derived SSTs from *Trilobatus sacculifer.* I like that they use gradients, but in the manuscript, the uncertainty of working with different paleotemperature indicators need to be more clearly addressed. Perhaps adding some reference(s).

Figures and tables are in general clear (a very good example of this is Figure 7). I just have minor suggestions regarding the figures (see specific comments/technical corrections). I would recommend merging some of them (4 and 6).

I find that the references cited in the manuscript are adequate. I just found some typos.

The supplementary material is also adequate, but it could be improved (in some of the plots there are just too many wiggles). I would probably move some of the supplementary figures/plates to the main manuscript (see specific comments).

Specific comments:

Abstract:

Line (L.) 9-10: "and …and", replace by "as well as" to avoid repetition.

L.14: "and can therefore assist with more detailed reconstructions." sounds odd to me. Rephrase if possible.

L.14-25: In the abstract I would suggest to talk first about the general (more global) changes and the jump into the regional variations (or reword this part in a similar was as in the introduction). I understand the way that the authors try to "zoom out", but perhaps that makes more sense in the conclusions, rather than in the abstract. Therefore, my suggestion would be to reorganise this part.

L. 21: Could you provide more detail when you mention "Major changes"?

1. Introduction:

L. 28-34: It is confusing to the readers the way that the authors introduce the different terms "coccolithophores", "coccoliths", "nannoliths" and "nannofossils". Please rewrite this part.

L. 41: Please double check (here and elsewhere in the manuscript) that "equatorial warm water valve" is the right term. I have only encountered "equatorial valve" in the literature.

L. 48-49: Change to (/weaker)… (/El Niño)… (/3Sv)

L. 57-57: Sounds redundant. Double-check that sentence.

L. 61, 63: dot instead of circle

L. 63-64: Change to "The main surface oceanography of the Indo-Pacific region (dark red lines) and main path of the LC (lighter red line; adapted by (Auer et al., 2019; Gallagher et al., 2009) and the HC, which in this study are considered as one, are shown."

L. 65: The base map…

L. 71-76: Reword. Make it more concise.

L. 79: Mention somewhere what time Auer et al. (2019) previously covered.

L. 80: 100 km away

L. 92: Change to: (a) mixed layer and increased stratification (c) and SST…

L. 94: (b, d) there a space missing.

L. 103-105: As is Figure 2, I recommend putting (a), (b), etc before the description. E.g. (a) chlorophyll

2. Material and Methods:

L. 118: Specify seconds if possible.

L. 125, L. 135: Double-check the use of coccoliths /nannoliths etc here and elsewhere.

L. 129: Specify what is N (you do later in the text, but this is the first time).

L. 131: Make sure the comma is in the right place. It looks very close to the W, but I guess it is just a visual perception.

L. 139: Was the DBD calculated or downloaded from a specific site? Specify.

L. 139: considered for…specify

L. 141: were instead of " can still be"

L. 148-149: (column principal with ages representing distinct columns) is unclear to the reader.

L. 156: I would suggest using the whole name, Nannofossil Stratification Index.

L. 157: Write the whole name of the ratio and add (NSI) to introduce this term somewhere.

L. 160: Add a reference for that datum.

L. 182: I would delete or reword "Similarly, a ratio between *Reticulofenestra* species and *Florisphaera* has been used to monitor changes in the nutricline and thermocline during the Pleistocene (Flores et al., 2000)." This ratio is a bit different from what was previously mentioned…

L. 189: The authors should acknowledge the existing differences among different proxies to reconstruct the same environmental parameter (.e.g., SSTs) and reference it. Part of the last sentence (L. 200) should be moved up in this subsection.

This needs to be discussed further in the (sub-)section 3.4.

3. Results:

L. 205: How did the authors assessed the preservation? Expand or add a table in the supplementary material summarizing the ranking used. If it applies, reference it.

L. 228-229: Unclear to the reader. Rephrase, please.

L. 234-235: "NAR of *Sphenolithus* spp. bounced back to higher values, especially at IODP Site U1463" This is impossible to see in Figure A2. I would recommend the authors to space out the different taxa data in Figures A1 (especially in b and d) and A2 (all of them) using different Y-axes.

L. 241-242: Delete "As is the case for the nannofossil assemblage compositions", and change to: "Changes in NSI covary throughout the studied interval and correlate well between the two sites (Figure 4)."

L. 245: change demonstrates for shows?

L. 249. I suggest merging Figure 4 and 6.

L. 249-250: (light blue squares)… (orange triangles)

L. 255-257. I am not fully sure I understand this sentence. Are not assemblage and species composition the same? This sounds like circular thinking, but it is probably just a matter of rewording.

L. 278: Please use different symbols for the different sites.

L. 280: What does PP account for? I think it has not been introduced in the manuscript.

L. 285: "…Karas et al., 2011, upper…" (delete parenthesis)

4. Discussion:

L. 326-329: Is it possible for the authors to elaborate more in these higher and lower phases?

L. 345: "shelf area due to…" (I would mention it in the first sentence or merge L. 344-347).

L. 360: What about a combination of two or three of the 3 proposed mechanisms? Would that be an option? If so, perhaps add a sentence.

L. 371-372: "Shift" is mentioned twice in a sentence. Find a synonym.

L. 420-470. The reference Stuut et al. (2019) (https://doi.org/10.1029/2019GL083035) could be useful in the section 4.3 from the discussion because that study (in the continental margin of NW Australia) covers the last 5.3 Ma.

L. 423: Make sure PP is introduced before (not just in the figure captions), I guess the first time is in L. 67.

L. 478: *Trilobatus sacculifer*

L. 534-547: Figures A1 and A2. I already mentioned it, but I think it is difficult to see the data in some of the plots from these figure (especially if you print it in black and white). I would suggest using different Y axis.

When referring to a specific taxa, please add the symbol in the caption on top of the colour, as it was done for example in Figure C1. E.g., (<5µm *Reticulofenestra* and <3µm *Gephyrocapsa*; green circles).That will help colour-blind readers.

Also, I would probably include them as main figures (not as appendix), but this is up to the authors.

L. 537: Rather than error bars, I would use "shaded areas"

L. 545: 15%; Bordiga … (delete parenthesis).

In Figs. B1 and C1 the symbols of the legend do not match with the ones in the plot.

References:

There are several typos in the reference list. I spotted few, but the authors need to carefully check all the references.

L. 589: 2.45 Ma (space missing)

L. 594: (80-.)., (revise, something is missing here)

L. 595: K.-H.

L.598: CO_2 (subscript)

L. 606: 7(May) Double check

L. 614: Holloway

L. 626: 925, and… (delete comma?)

L.631: (August) Double check

L. 633: (80-.)., (revise, something is missing here)

L. 653: ,, (delete one comma) (February) Double check

L. 657: Species names' in italics

L. 665-666: Add doi

L. 672: PAST

L. 675: CO_2 (subscript)

L. 684-686: Add doi

L. 693-694: Add doi

L. 695: Nye, H. .: (delete one dot)

L. 707-714: B-Th, B. –. T. or B. T.? The name of the main author is written in 3 different ways.

L. 756: Page numbers or number of pages?

L. 769: (80-.)., (revise, something is missing here)