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Comment on cp-2021-142

Anonymous Referee #2

Referee comment on "Sclerochronological evidence of pronounced seasonality from the late Pliocene of the southern North Sea basin and its implications" by Andrew L. A. Johnson et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2021-142-RC2, 2021

General Comments

Johnson and co-authors discuss seasonality, an under-investigated but essential dynamic in palaeoclimatology, from the southern part of the North Sea Basin (SNSB) during the last episode in Earth History when global climate was consistently warmer than today. They use stable isotope measurements on benthic marine molluscs (*Aequipecten opercularis*, *Pygocardia rustica, Arctica islandia* and *Glycymeris radiolyrata*) sourced from the Luchtbal, Oorderen and Merksem Members (and their lateral equivalents) from the Lillo Formation in North Belgium and the Southern Netherlands. The authors use the extreme inflection points of the $\delta^{18}O$ ontogenetic profiles from the recovered molluscs to compute summer and winter seafloor temperatures using various equations against an assumed background of 0.0–0.4‰ average $\delta^{18}O_{sw}$ in the SNSB. The derived temperature difference taken at these inflection points is interpreted as a seasonality signal. Johnson et al. conclude that seasonality of the late Pliocene SNSB was on average more pronounced than it is now (3°C higher). Summer temperatures were found to be higher in the late Pliocene while winter temperatures were comparable to today.

I believe the subject matter is relevant to the diverse readership of Climate of the Past and closely matches the scientific remit of the journal. The manuscript is well-structured, underpinned by clear, objective and very precise writing. As a result, it is easy to follow the employed methodology, the authors' interpretation of the results and how the conclusions were reached. The text is supported by a set of informative figures which are, despite the complexity of the incorporated data, kept simple and straightforward to interpret.

The authors present a very honest assessment of their results, easily exceeding what can be reasonably expected as the baseline for scientific scrutiny. This is exemplified by Figure 8 where the authors compare different computation methods in the literature and select the most suitable algorithm for their specific case.

Specific comments

*The age of the different members of the Lillo Formation was constrained using biostratigraphy and sequence stratigraphy: Luchtbal Member (3.71–3.21 Ma), Oorderen Member (3.21–2.76 Ma) and the Merksem Member (3.21–2.76) (Figure 3 and De Schepper et al., 2009). This covers the mid-Piacenzian Warm Period, but also includes glacial events like MIS M2 (De Schepper et al., 2013), with a total fluctuation of 0.89‰ in the orbitally-tuned global stack of benthic $\delta^{18}O$ (Lisiecki and Raymo, 2005) over this period. Evidence suggests that seasonality in proxy records is more pronounced in colder, glacial conditions (Crippa et al., 2016; Hennissen et al., 2015 and references therein). Is there a way of tying the seasonality results from the current study into the global climatic picture or should they be viewed as endemic snapshots of seasonality of the late Pliocene (which may be against a background which could range from MIS M2 to MPWP)? Are the reported seasonality values to be viewed as an average seasonality signal for the late Pliocene or is it more of a minimum estimate?

*Sclerochronologically derived temperature estimates offer an invaluable window into the (sub)annual temperature fluctuations that the biotic carriers were exposed to. Other techniques (e.g. foraminiferal Mg/Ca, alkenones and TEX_{86}) offer estimates that are averaged over much longer time periods. Do these differences in temporal resolution complicate cross-proxy comparison? Can the sclerochronologically derived results be viewed as a tool to set the true range of seasonality recorded in other proxies that cannot capture this accurately but have the advantage of stretching observations over larger intervals?

Technical corrections

Line 460: measurements were made in two different laboratories and analytical errors were reported. Were replicate samples run to assess the inter-laboratory variation?

Line 532: insert comma after 'cycle'.

Line 573: is there a way of quantifying the covariation?

Figure 8: it may be informative to put in a vertical line (grey in background maybe) to indicate current summer and winter temperatures as a direct comparison to the measurements and calculations in each panel.

Table 3: the text is rather small and it may be better to put the entire table in landscape format.

In conclusion, I believe this paper is an example of how ecological uniformitarianism can be employed to evaluate palaeoclimatological conditions and offer invaluable constraints for climate models.

References

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