Climate of the Past Discussions

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Reply on RC1

Andrew L. A. Johnson et al.

Author 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-AC1, 2022

(RC1 comments in normal typeface; **responses in bold)**

The paper "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., aims at reconstructing the late Pliocene seasonal range of the seafloor and sea surface temperature in the southern North Sea Basin.

This topic is relevant for CP. The manuscript is clear and well-written, it presents new data, and substantial conclusions are reached.

The data used in the paper are primarily based on stable oxygen isotope analysis of growth increments in different bivalve species from formations in Belgium and in the Netherlands.

When using sub-fossil shells for climate reconstructions, there are several issues that need to be addressed when drawing conclusions about the seasonality of water temperature. These are the overall differences in d18O seawater between the Pliocene and today, possible seasonal variations in water d18O, uncertainties depth habitat (above/below the thermocline), aliasing of the d18O signal in relationship to ontogenetic decreases in growth, estimates of the changes in temperature between surface and bottom during the late Pliocene, and possible differences in the thermal niche between the late Pliocene and today.

The authors do a good job addressing the possible implications of these uncertainties on the reconstructed seasonal ranges in temperature. For the present paper, it seems likely that the biggest unknowns are the depth habitat and, for the calculation of absolute sea-surface temperatures, the estimate of summer stratification. However, the authors go through and reason around these uncertainties in detail. The authors also discussed briefly possible shifts in the thermal niche over time, which is an important point.

The interpretation of the 13C signal in the shells is not entirely necessary for the main story. However, given the complex interpretation of other isotopic data and sclerochronological analyses in the paper, I think that many readers will appreciate that the d13C data are also addressed, at least to some extent.

The referee is quite right that interpretation of the δ^{13}C data (obtained alongside

$\delta^{18}O$) is not essential to the main (temperature) story. In so far as atmospheric CO_2 influences global temperature we thought it worthwhile to make the point that the relatively low $\delta^{13}C$ values from Pliocene *Aequipecten opercularis* are rather doubtfully a reflection of the high atmospheric CO_2 (independently indicated) at that time, as had been suggested previously. In order to make this point we needed to show the more likely (local) controls on shell $\delta^{13}C$. We did so as concisely as possible to avoid a lengthy departure from the main story.

Some graphs (6 and 7) are tiny, and not entirely suitable for the aging eye. The same goes for the tables. Is it possible to present the comparison of temperature ranges (Pliocene vs modern) in a graph?

Figs. 6 and 7 were designed with a view to each occupying the full width of a page, like similar diagrams in Johnson et al. (2009, 2017, 2019, 2021). If reproduced in this way they will be considerably larger than they appear in the pre-print. It will also be possible to reproduce the tables at a larger size than in the pre-print, though Tables 1 and 3 might be best 'side on' (in landscape format), on their own pages. With the addition prompted by RC2, Fig. 8 now enables comparison of Pliocene with modern seafloor temperature ranges, and a new figure (Fig. 9) has been created in the same format to enable comparison of surface temperature ranges. Both figures are attached for perusal.

All in all, this is a nice paper that is an interesting read to many, especially sclerochronologists working on past warm climates.

References

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Please also note the supplement to this comment:
https://cp.copernicus.org/preprints/cp-2021-142/cp-2021-142-AC1-supplement.pdf