

Clim. Past Discuss., referee comment RC1
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Comment on cp-2021-87

Anonymous Referee #1

Referee comment on "Variability in *Neogloboquadrina pachyderma* stable isotope ratios from isothermal conditions: implications for individual foraminifera analysis" by Lukas Jonkers et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-87-RC1>, 2021

The manuscript by Jonkers and colleagues compares multiple samples of the stable isotopes from the shells of the planktic foraminifer *N. pachyderma* from the same sediment trap samples. They then use a combination of nearby hydrographic records, modeling, and statistical analyses to assess the variability within a population not attributable to environmental factors, primarily temperature. They find a substantial amount of variability in multiple samples from the same cups, which is used to illustrate the inherent "excess" variability of reconstructions using very few shells. With increasing use of high resolution instrumentation making use of small samples and individual foraminifera analysis (IFA) more frequent, the implications of these findings are important.

I have a few suggestions which I hope the authors will find useful. My primary suggestion for the manuscript is to do with framing. From line 1 of the abstract, the rationale of the study is laid out to be an estimate of excess variability in individual shells measurements and therefore utility of IFA. The catch is that the methodology used here is not IFA but rather multiple pooled samples. Several assumptions are required to make the leap from environmental data and pooled measurements to an estimate of excess variability by a theoretical IFA measurement, some of which require additional justification. My comments include a few specific suggestions of where this may be helpful. However, it is also my opinion that the framing of this manuscript as a quantification of IFA excess variability may be slight overreach drawing from this particular dataset. There are certainly implications for IFA, and the rough calculation done here are useful in illustrating that. However, given the number of assumptions required and the use of pooled rather than individual shells in the analyses, overemphasis on a quantification of "noise" in IFA analyses specifically, may do a disservice to the really important findings of large excess variability.

Minor/specific points:

111: Why were outliers removed? Points that deviate farther from the mean would seem particularly valuable for this dataset, unless there is specific justification for their removal. Perhaps there is a reason for this data treatment that just needs to be better explained?

146: The assumption of chamber formation over one day in *pachyderma* is a bit misleading. While initial chamber formation may occur over one day (as in the referenced studies), calcification is likely more prolonged in this species. A better model than the

spinose foraminifera observed in the Spindler and Be papers, might be congener *N. dutertrei*, where laboratory labelling experiments affirm that much of the calcite is added over a period of several days and nights as evidenced by banding and the apparently continuous uptakes of 'spikes' added in culture (see Fehrenbacher et al., 2017).

281: I am struggling with this calculation, on which so much of the interpretation relevant to IFA rests. While this estimation accounts for the N term, it makes two assumptions. The first is that the sample mean would have been the same if IFA had been carried out rather than multiple pooled analyses – this is probably a reasonable assumption, if one has on minimal instrumental error and near identical calcite contribution from all shells. However, the other assumption is that the stable isotope value of an individual shell would be the same as the value of the pooled analyses. This is a less robust assumption, belied by even the conclusions of this paper. Individual shells would be expected to represent a greater range of values, and therefore overall greater deviation from the sample mean. I think the argument for calculating excess of theoretical IFA as such could benefit from a statement of these underlying assumptions.

The obvious rebuttal to the caveat(s) raised above is that these are necessary assumptions given the sample set and/or that once again the estimate of unexplained variance is highly conservative. This might be the case, but if so perhaps there is too much emphasis on the quantification of this speculative 0.19 per mil (and therefore 0.11 per mil) number as a noise threshold.

333-335: My reading of Livsey et al. (2020) is that lamellar and crust calcite were indistinguishable in $\delta^{18}\text{O}$ space

Other minor points: I was curious about the lack of shell measurements here, as stable isotope values are well known to correlate with size, something that the authors discuss. I understand that this is a reanalysis and such measurements may no longer be available, but it is a point potentially worth addressing.

References:

Fehrenbacher, J. S., Russell, A. D., Davis, C. V., Gagnon, A. C., Spero, H. J., Cliff, J. B., ... & Martin, P. (2017). Link between light-triggered Mg-banding and chamber formation in the planktic foraminifera *Neogloboquadrina dutertrei*. *Nature communications*, 8(1), 1-10.

Livsey, C. M., Kozdon, R., Bauch, D., Brummer, G. J. A., Jonkers, L., Orland, I., ... & Spero, H. J. (2020). High-resolution Mg/Ca and $\delta^{18}\text{O}$ patterns in modern *Neogloboquadrina pachyderma* from the Fram Strait and Irminger Sea. *Paleoceanography and Paleoclimatology*, 35(9), e2020PA003969.