

Dear Luke,

We would like to thank to the reviewer for her/his comments that helped to improve the manuscript and sharpen our argument that habitat tracking deserves more attention from the paleoceanographic community. Below we respond to the comments in red. Line numbers refer to the version with tracked changes that we have appended to our response to your comment.

We hope that our revised manuscript now meets the criteria for publication in *Climate of the Past*.

Lukas Jonkers and Michal Kucera

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The manuscript of Jonkers and Kucera on “Quantifying the effect of seasonal and vertical habitat tracking on planktonic foraminifera proxies” reads good. However, the topic and the findings discussed in the manuscript are not new. Some of the newest findings on the seasonal production of species were possibly published earlier by another member of the same working group (Kretzschmer et al. 2016). Having said this, I still like the presentation of the results and new figures providing an interesting perspective of a familiar problem. I would guess that the manuscript can be published with minor revisions. Please find my comments below.

Before we respond in detail to the comments, we would like to shortly address the novelty issue of our manuscript. We realise that the phenomenon of habitat tracking appears familiar and unsurprising. Its existence has been invoked (or can be anticipated) from previous work on plankton tow and sediment trap samples. However, studies explicitly demonstrating the kind and size of the habitat bias in foraminifera proxies are rare and attempts to quantify the effect are – to the best of our knowledge – virtually non-existent. This observation is supported by the nature of the comments pertaining to the novelty of our study: the referees perceive the results as unsurprising and perhaps not novel, but do not provide references to previous work that used empirical data to investigate habitat tracking. We agree that the issue of habitat tracking is logical (and to be expected), but to the best of our knowledge it has not been given an explicit and quantitative treatment before. Indeed, this is the point where we believe the novelty of our study lies: not in the suggestion that habitat tracking affects foraminifera proxy records, but demonstrating that this occurs in a predictable manner and attempting to quantify the effect.

Line 68, seasonality, please refer Kretzschmer et al. (2016). *Will do.*

Line 140, *G. bulloides*, does include all genotypes and morphotypes in this case? Please clarify. In line 296, genotypes are mentioned and may be discussed here.

This is a valid point that applies not only to this species. All of the stable isotope data we analyse have been generated without considering the existence of multiple genetic types. We will add this information to the ‘Data and approach’ section of the manuscript. The section around line 140 of the original submission is a description of the first results and the information would not be best placed here. We also prefer to keep the

discussion about why *G. bulloides* may show a different pattern from the other species separate from the results section.

Line 160, Southern, in lower case. This is Copernicus policy.

Lines 224-229: Using a sine function is not imperative. Could this not be improved in the present manuscript, in comparison to Jonkers and Kucera (2015)?

Approximating flux seasonality by a sine wave is a simple and mathematically elegant solution, but we fully agree with the referee that it is not the only possible model of the reality (which may have a different underlying dynamics). We chose to use this notation, because in previous work we have demonstrated that seasonal flux patterns of foraminifera can be well described by a sine function (Jonkers and Kučera, 2015). Since it is not a priori clear that other approaches would yield better results, development of a new seasonality (or habitat) model goes beyond the scope of this study. We do take this suggestion as encouragement to continue ongoing research into the prediction of foraminifera habitat.

Line 243, Discussion: to my impression, the discussion has started long before. Reorganize chapters?

We agree with the reviewer that the sections preceding the discussion section do also contain some discussion and have therefore renamed the section headers.

Line 249-250, “role” of temperature and “dominant in controlling”: better replace “role” and “dominant in controlling” by “correlation” and “related to”. The effect of temperature is neither proven nor quantified, since it rather effects foraminifera indirectly through oxygen concentration, and other variables.

We agree with the suggestion to reword.

Lines 267, 310, 379: Referring as to “homeostatic . . . / homeostasy” in protists sounds wrong to me. Please delete in lines 267 and 379, and reword in line 310. Will do.

Line 314: “constant seasonality and depth habitat”, please give a reference.

Rather than arbitrarily singling out a few studies among the many that ignore habitat variability, we prefer to highlight one of the few studies that acknowledges the issue (lines 457-458).

Lines 319-325: This is not new, and the authors try to convince the choir.

Indeed, the assertion of this sentence is not new. It was not our intention to make it sound as if it were. As we note in the first comment, we realise that the existence of this issue is likely considered as well known and accepted by the community. It is here used as an opening statement for a section where we discuss the consequences of this phenomenon in view of the quantitative models we developed.

Line 328-329: “. . . because temperature change forces the foraminifera to live in a seasonal or vertical ‘window’ “. What is the difference to Kretzschmer et al. (2016)?

The difference is in the approach. Kretzschmer et al. (2016) and indeed the preceding studies by Fraile et al. (2008) and Lombard et al. (2011) are all based on numerical models, where the seasonal habitat of a species is the result of the parametrisation of its ecological preferences. If temperature preference is set to warm that the species in the model will grow only where and when “warm” is realised. This approach is powerful in testing the likely behaviour of the species under conditions that do not occur today. However, this approach provides no constraints on whether the species really behave in this way. In contrast, in this study, we provide empirical evidence that habitat tracking affects proxies and derived empirical estimates of the size of this effect.

Caption Fig. 10: Please explain: depth (z). In general, figures could need some more explanation.

We will replace z with depth to avoid confusion and expand on the figure captions.

Fraile, I., Schulz, M., Mulitza, S., and Kucera, M.: Predicting the global distribution of planktonic foraminifera using a dynamic ecosystem model, *Biogeosciences*, 5, 891-911, 10.5194/bg-5-891-2008, 2008.

Jonkers, L., and Kučera, M.: Global analysis of seasonality in the shell flux of extant planktonic Foraminifera, *Biogeosciences*, 12, 2207-2226, 10.5194/bg-12-2207-2015, 2015.

Lombard, F., Labeyrie, L., Michel, E., Bopp, L., Cortijo, E., Retailleau, S., Howa, H., and Jorissen, F.: Modelling planktic foraminifer growth and distribution using an ecophysiological multi-species approach, *Biogeosciences*, 8, 853-873, 10.5194/bg-8-853-2011, 2011.