**Climate
of the Past**
Discussions

CPD

Interactive
comment

Interactive comment on "Moving beyond the age-depth model paradigm in deep sea palaeoclimate archives: dual radiocarbon and stable isotope analysis on single foraminifera" *by* Bryan C. Lougheed et al.

Bryan C. Lougheed et al.

bryan.lougheed@geo.uu.se

Dear Philippa Ascough,

Thank you for your extensive review of our manuscript and for the many constructive suggestions. Apologies for the delayed reply. This manuscript generated a number of comment contributions in the discussion forum. Time had to be found to address them all.

We would be happy to address your main discussion points below:

"In a composite date, if the preponderance of measurements were representative of the age of the sediment (albeit with a long tail), this would increase the accuracy of the date, as the inaccurate ages would contribute proportionally less to the composite age. Can the authors comment on any statistical manipulation that could be used in this instance to improve accuracy? Also, how would one properly calculate (even semi-quantitatively) the uncertainties associated with composite measurements? Can the authors offer any suggestions for this? It would be good to see these points considered within the manuscript."

Our main suggestion for improving the accuracy of a multi-specimen date (e.g. existing conventional methods) would be to simply propagate extra uncertainty into the 14C determination in order to take into account the large intra-sample age heterogeneity. This could be done using our Figure 4 as a guide, or by considering bioturbation models suggested by you below or by the other contributors to the discussion panel. We will highlight this better in the revised manuscript.

"The addition of older material would have a proportionally smaller effect on the measured age than the addition of (much) younger material. Can the authors comment on how this would affect how the precision on measurements should be calculated (mass balance approach?)"

Very interesting comment. Indeed, it is additionally possible that multi-specimen foraminifera samples can be biased towards younger ages. We agree that researchers should additionally take this effect into account when considering uncertainty for multi-specimen foraminifera dates. We will mention this in the manuscript.

"One interesting point is that perhaps the changes in PDSM that could be identiïňĄed with this approach could tell us something about sediment dynamics. I appreciate this is a little outside the scope of the paper, but could be mentioned as a 'silver lining'. One reference that would be good to include is: Berger, W.H. and Johnson, R.F. 1978: On the thickness and the 14C age of the mixed layer in deep sea carbonates. Earth

and Planetary Science Letters 41, 223–27. The ïňА̧ndings in this support the authors results"

We didn't want to go too much into detail regarding sediment dynamics in this manuscript, but it does seem (as discussion contributors Dolman et al also subsequently suggested) that our data is in good agreement with the aforementioned bioturbation studies. We agree that it would indeed be a 'silver lining' if we were to go one step ahead and mention this in the manuscript. We will do so.

"How many samples would the authors advocate measuring in order to get a decent idea of the true amount of sample heterogeneity?"

The most straightforward method would be to date as many foraminifera as possible from the same 1 cm interval and analyse the age distribution from that interval. However, the problem with such an approach is that there is only a limited number of foraminifera of sufficient mass within any given sediment interval. Instead, we analysed as many as possible from multiple intervals and analysed PDSM by reconstructing the post-depositional ranking change of the single foraminifera (i.e. age ranking vs depth ranking). It is difficult to quantify the minimum number of necessary foraminifera to carry out a successful PDSM analysis using this method because the resulting age distribution of the foraminifera picked from the various levels is to a certain extent dependent upon luck (i.e. when PDSM is severe or SAR is low, one does not know the approximate age of the foraminifera that are being picked).

"Were the forams pretreated in any way? i.e. washing/ agitation with distilled water, or removal for surface C by preliminary acid dissolution?"

Acid pretreatment was only possible for select, larger foraminifera. In these cases, the 14C age of both the initial acid leach and remaining foraminifera was investigated. Foraminifera were washed during the wet sieving and subsampling process, but not again just prior to measurement. We are currently investigating various methods for pre-treatment on such small samples, project funding permitting.

You also asked about the blank correction. For extensive information regarding the blank correction process, we refer to our reply to Julia Gottschalk.

Thanks again for your helpful review. We look forward to using your input to improve the final version of our manuscript.

On behalf of the co-authors,

Sincerely,

Bryan Lougheed

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