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Comment on egusphere-2022-734

Luke Skinner (Editor)

Editor comment on "Bayesian age models and stacks: combining age inferences from radiocarbon and benthic δ^{18}O stratigraphic alignment" by Taehee Lee et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-734-EC1, 2023

Now that a sufficient number of reviews have been submitted, I would like to invite you provide a point-by-point response to each of the review comments. I would like to underline the importance of addressing a key issue that has been raised in the reviews, namely: the 'empirically constrained' sedimentation rate prior that is applied in the matching algorithm. One issue is that the validity and applicability of this prior, across a range of sedimentary contexts, does not appear to have been fully assessed in a transparent manner in the manuscript – and indeed seems doubtful.

Below I add a few remarks of my own, in case these are helpful for considering what revisions you would undertake, and I invite your response to these too. I find your study of particular interest, and I hope that my comments will be seen as useful.

Title/general ethos:

In general, I think it might be useful to more clearly delineate the distinction between alignment and 'dating' at the core of the manuscript (even though the difference between relative and 'absolute/numerical' ages is indeed noted in the paper a few times). Creating a benthic d18O stack is one thing, aligning to a benthic d18O stack is another, and dating a sediment core is yet another. The only way that benthic alignment provides age constraints is if one proposes to have prior knowledge of how local/regional deep-water T and d18Osw relate to insolation, e.g. based on a hypothesis for how insolation paces ice volume, and how changes in ice volume are linked to deep water T changes and/or influence deep ocean d18Osw at a given location in the ocean. The latter sequence of hypotheses can give age constraints that are of ~millennial accuracy at best. In such a context, radiocarbon dates (even with ~centennial uncertainties in reservoir age offsets) obviously can provide a refinement. The inverse is unlikely to be true: age constraints on benthic d18O are unlikely to be precise enough, even to constrain changes in radiocarbon reservoir age offsets of order 100-1000 years. Alternatively, if the core notion of the manuscript and algorithm is the simple transferral of a radiocarbon chronology (or the pooling of radiocarbon dates) between sediment cores via a stratigraphic alignment of benthic d18O, then again it is not quite a case of 'combining age constraints from radiocarbon and benthic d18O'. Rather, it is one of radiocarbon dating of a stratigraphic alignment/stack.

As such, my own feeling is that the manuscript might more accurately be framed in terms of 'refining orbitally-tuned benthic d18O age models using radiocarbon constraints', e.g. in the title and through the text. In a similar vein, it seems to me that describing the age models as 'multi-proxy' is a little misleading: my own expectation was initially of something like that described in line 522. I would again suggest that the process tackled in the present study be described as something like 'radiocarbon-refined single proxy alignment'.

Line 25:

This line is not quite correct: the accuracy with which ocean sediment cores can reconstruct the *timing* of past climate events, depends on.. the.. age model. The accuracy of proxies is a separate (thorny) matter.

Line 48:

"Sedimentation rates are realistically constrained…."

As pointed out by the first Reviewer, it seems we must take this on faith, whereas there is burden of demonstration here.

Line 65:

In general, there is a need to be precise when describing radiocarbon procedures. Radiocarbon dates need to be calibrated to account for past changes in the initial radiocarbon concentration of the fossil entity's 'parent reservoir' (atmosphere, surface ocean, etc.), which may change due to 14C-production changes and/or other carbon cycle processes. This crops up again on Line 72: planktonic foraminiferal radiocarbon dates must be corrected for 'reservoir age offsets' (relative to the atmosphere) only if using a record of past atmospheric radiocarbon concentration/activity for the calibration. In principle, a 'marine calibration curve' might be used instead, with different potential corrections needed as a result.

Line 79:

"…requires simulating the core's sedimentation rate."

I think this might be more accurately phrased as: "…requires the assumptions/models of the core's evolving sedimentation rate between dated intervals."

Line 90:

I think this is a but unfair to Bchron: instead of 'resulting in extreme sedimentation rate variability', it simply posits the full range of possibility wherever there are no prior

constraints on sedimentation rates. This is arguably pretty sensible, and it represents a useful counter point to methods that assume a priori knowledge of sedimentation rates.

Line 109:

Again on the sedimentation rate prior issue: does a prior on sedimentation rate not 'beg the question' with regard to down-core changes in age, requiring simply a single point to be anchored in time? This seems like a very (overly) strong constraint to apply, does it not?

Line 138:

Is it worth noting perhaps that this shifts the problem of assuming 'instant ocean mixing' to one of a priori knowledge of past ocean hydrography and circulation?

Table 1:

note that the 14C dates for MD99-2334K are reported only by Skinner et al., G-cubed 2003 (Skinner & Elderfield 2003 does not exist, and was omitted from the references for this reason no doubt); Skinner and Shackleton 2004, and Skinner et al., Paleoc. & Paleoclim. 2021.

Figure 6: What is the reason for choosing this sediment core in particular? MD99-2334K is included in the present study, has various alternative stratigraphic age-models (aligned to the Greenland ice core event stratigraphy, and the Hulu speleothem record), as well as a reasonable 14C chronology, and a well resolved benthic d18O record. Would this not be an optimal target for testing the method? A comparison with MD95-2042 could also be made, since both also have 'alignable' planktic d18O records. Furthermore, these two cores were obtained using different coring devices resulting in very different 'apparent sedimentation rates' (due to compaction in the Kasten core and stretching in the Calypso corer), providing a useful basis for assessing the algorithm's sedimentation rate prior.

Line 537: again, I would propose that it might be more transparent to refer to 'radiocarbon-refined/guided d18O alignments, or similar. I wonder what the authors think.

I look forward to reading your views on these, and most importantly the reviewers', comments.

Sincerely

Luke Skinner