Dear Andrew Dolman, Sze Ling Ho and Thomas Laepple,

Thank you for your interest in our manuscript and for your enthusiastic and encouraging words regarding our single foraminifera analysis.

We would be happy to address the concerns that you have raised in the open discussion forum. Let's start with the most straightforward one:

> *We noticed one other potential error. In figure 2, the calibrated ages in panel B appear to be about ½ the 14C ages in panel A, whereas calibrated ages should be older than their 14C ages (but not by 2x).*

Sorry for any confusion this may have caused. Something happened when scaling the figures to the correct paper size in Matlab when saving to PDF format. During this process, the tick labels (which had been manually converted from years to ka) on Fig. 2B became mislabelled when the figure was resized. The x-axis labels in Figure 2B should not read 0, 5, 10, 15, 20, 25 ka, but rather 0, 10, 20, 30, 40, 50 ka. A classic case of pre-upload figure fatigue. It's great that you informed us about this, because it would have been a shame if the figure had made it into the final version with incorrect tick labels.

Regarding your other comments:

> *Their figure 4 shows the results of the simulation. Using the observed sediment accumulation rate of 2.2 cm/ka, they estimate the standard deviation of movement required in order to obtain a SD of age of 4670 14C years as approximately 6 cm.*

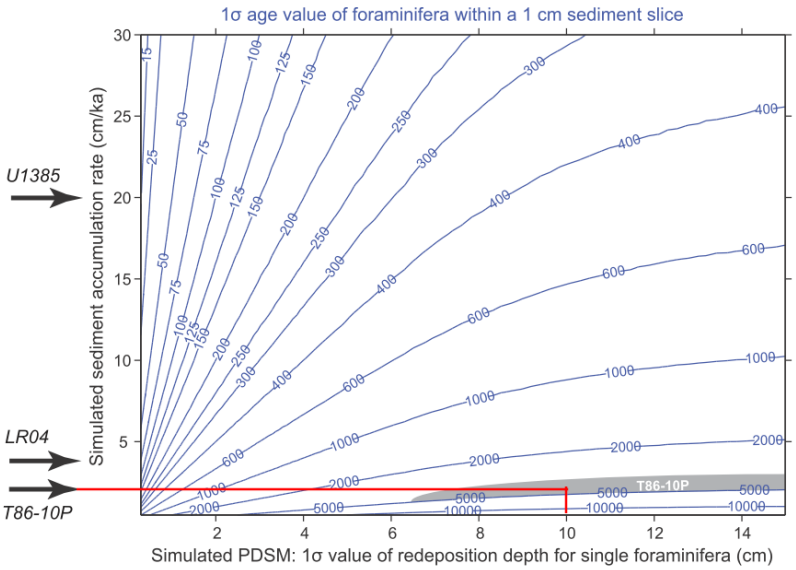
We must stress here that the exact words we used were "at least 6 cm" (Line 173 in the Discussion manuscript). We considered uncertainty when representing the intercept between the sediment accumulation rate (SAR) of 2.2±0.9 cm/ka and 4670 1σ age variation of a 1 cm slice, hence the intercept is represented by a grey area in Figure 4. This grey area begins at approximately 6 cm on the x-axis, so we have written "at least 6 cm". However, it occurs to us that we could have described this grey area of uncertainty more clearly in the text and figure caption, as it may have led to a misunderstanding. We will make things clearer for the reader and find a better way to graphically represent the intercept.

> *If a constant sedimentation rate is assumed, then is the SD in depth not simply the SD in time (4670 years) scaled by the sedimentation rate, i.e. 4670 * (2.2 / 1000) = 10.274 cm?*

If we follow your calculation, but also take into account the SAR uncertainty we reported (±0.9), then one would get a range of 6.1 – 14.5 cm, consistent with our interpretation of "at least 6 cm".

> *We think this paper could be improved by instead considering a well established physical model of bioturbation in which there is a well-mixed surface layer of sediment of a fixed depth (Berger & Heath, 1968). Assuming a constant sedimentation rate, and a fixed mixing depth, the time integrated solution to this simple model predicts that the ages of material at a given depth follow an exponential distribution (Berger & Heath, 1968). The scale parameter of this exponential distribution is simply the mixed layer depth divided by the sedimentation rate (alternatively parameterised by rate = 1/scale). Both the mean and the standard deviation of the exponential distribution are equal to the scale, and so the ratio of the mixed depth and sedimentation rate give a prediction of the standard deviation of ages according to this model. Using a typical mixing depth of 10 cm (Boudreau, 1998) and the observed sedimentation rate*

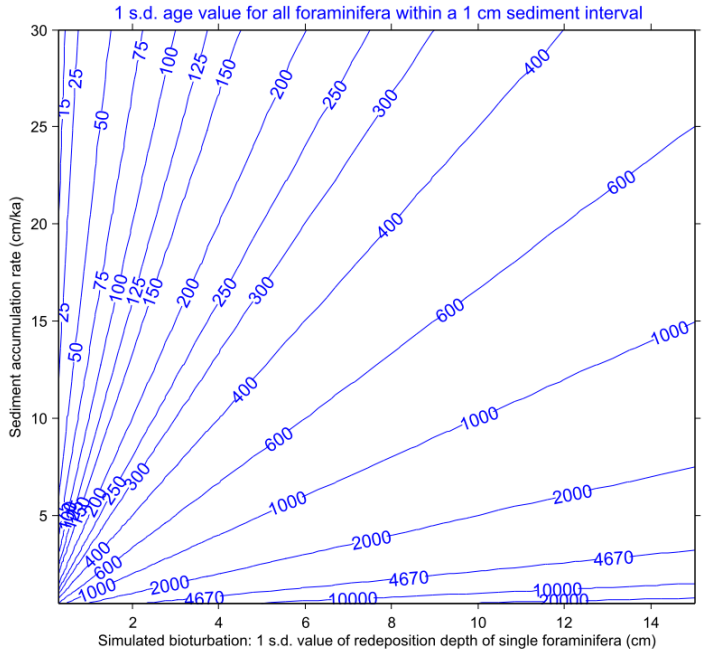
of 2.2 cm/ka, we obtain a standard deviation of 10 / (2.2 / 1000) = 4545 14C years, remarkably close to the 4670 14C years from the simulation.



Our Fig. 4 in the discussion paper is consistent with the method you describe for our sediment core. Your calculation using a mixing depth model approach yielded *10 / (2.2 / 1000) = 4545 yrs* when uncertainties are not considered, which you note is similar to our calculated 1 SD single cm age value of 4670 yrs. Our own simulation shows similar behaviour for our sediment core: Above we have drawn on our Fig. 4 the intercept lines (in red) for 2.2 cm/ka on the y-axis and 10 cm on the x-axis, momentarily also not considering uncertainty. The contour region where the two lines intercept is between 4000 and 5000 yrs. So in this case there is very good agreement. However, we investigated other x-axis and y-axis values against the Berger and Heath (1968) equation, and the agreement was not quite as consistent for regions in Fig. 4 where the contour lines bend towards horizontal, so we became curious, which brings us back to another comment you made:

> *We note that in the region of the observed sediment accumulation rate for this core, the contour line for a SD of ~5000 14C years is more or less parallel to the PDSM axis and therefore there is little power to constrain the strength of PDSM.*

After your interesting comment above we also became curious as to why our contour lines in Fig. 4 'bend' towards horizontal. After looking through the simulation it was discovered that the bending of the lines was because the simulation was originally not provided with enough synthetic core lengths to accurately reproduce more intense redeposition of single foraminifera (i.e. further to the right on the x axis). After we reran our simulation with the necessary synthetic core lengths, we produced a new Fig. 4 (now without bending lines, see below) that is entirely consistent with the Berger and Heath (1968) equation that you describe for all regions of the figure. We will use this updated figure in the new manuscript and also mention that it fully agrees with Berger and Heath (1968).



We will now also mention in the conclusions that our single foraminifera post-depositional movement simulation using Gaussian noise is consistent with existing bioturbation models and also consistent with the single foraminifera ^{14}C age variation we have measured for our core. The use of Gaussian noise is also supported by the fact that the single foraminifera ^{14}C results in our study suggest a normal distribution in post-depositional movement of single foraminifera. In other words, our approach reconciles both existing models of bioturbation and our single foraminifera data.

Regarding mixing depths: We didn't really want to talk about mixing depths in this manuscript, because we thought that would be overinterpretation of the data. However, we will add a couple of sentences and references for the benefit of the reader.

Hopefully we have been able to fully address your concerns. Thanks again for your helpful comments in the open discussion forum and for the interesting references for us to cite. Your input will help us to better communicate our method and results and to strengthen the manuscript.

On behalf of the co-authors,

Sincerely,

Bryan Lougheed