

Disentangling the effect of ocean temperatures and isotopic content on the oxygen - isotope signals in the North Atlantic Ocean during Heinrich Event 1 using a global climate model: a review

This study examines how the simulated $\delta^{18}\text{O}$ of calcite varies in a climate model when different time durations of Heinrich Events are simulated. Its results are interesting and present a novel way to think about the signal that is in the available data. It was let down, however, by its poor figures and rather superficial analysis.

I had to work really hard to relate what was going on in the text with what was shown in the figures. Many of the figures (e.g. fig. 10) don't really support the claims that are made in the text: the claims may be true, but I can't satisfy myself that they are from the figures. There are more detailed criticisms later but I urge the authors to think when preparing their figures: how can I make it as easy as possible for a reader to understand my figures. At present I feel that the figures have been prepared with what is easiest for the authors in mind. If your figures are hard to decipher readers won't bother to read the paper, so it really is in your interests to think about this.

There are a number of times in the text (for example the last line of the m/s) where claims are made that the simulated calcite is a "reasonable" fit or other such vague phrases. Simple statistics do exist that can quantitatively define how well series relate to one another. These should be used rather than qualitative claims of "reasonableness". That palaeoclimatology is rife with such vagueness is no excuse for this.

Dear reviewer,

Thank you for taking the time to thoroughly comment on our paper. We have changed the figures so that they are now hopefully easier to follow and better support the text. Moreover, we have revised the model - data comparison substantially, as mentioned in the general comments.

Specific Comments/questions:

Motivation:

It would be good to see the motivation for why it was chosen to test the sensitivity of the model to the duration of the simulated Heinrich Events rather than the size. Why vary the duration of the events and not the size? The size (that is flux of ice) and duration are to a certain extent constrained by the total volume of ice that can be released from the Laurentide Ice Sheet, therefore would not a better test to have been to keep the total ice volume constant and thus for the longer duration events have a small flux of ice?

We focused on the impact of the duration of the Heinrich Event because the impact of the amount of freshwater released over a certain amount of time has already been tested by Roche et al., 2014 using the same model. In their study the authors applied the various freshwater fluxes (e.g. 0.12, 0.18, 0.2) for 300 years and found that a freshwater forcing of 0.2Sv yields the best agreement with data. Therefore, we chose to apply 0.2Sv, but in the current study in the form of icebergs and to investigate the impact of the duration.

Model description:

Unless I have missed it there is no description of how $\delta^{18}\text{O}$ calcite is calculated within the model. This needs to be included along with discussion on how this model quantity relates to the calcite that you might find in forams. For example, is calcite calcuated in a water depth in which *bulloides* lives?

We have added a short description of the computation of $\delta^{18}\text{O}_{\text{calcite}}$.

In our results we display the calcite at the ocean surface, but we tested the impact of the different ocean depths (surface, 45m, and 90m depths) on the results and found that they were very small.

Section 4:

Section 4 could be a very nice section but is currently weak. More effort to link the observations back to the model runs would strengthen this. You are, I think, hindered by the currently horrible figure 10 in doing this.

It would be helpful to make some comments on how well you feel your model could in a perfect world simulate the calcite in forams (see above).

Please see general comments.

Line 402: "Overall, we see some similarities between the simulated and measured $\delta^{18}\text{O}_{\text{calcite}}$ curves and we find that the set-up of an iceberg forcing of 0.2 Sv over 300 years yields the most reasonable results compared to the proxy data considered"

If I am honest I do not think that I can judge this because comparing the simulated and proxy calcite is near impossible. See my comments on fig. 10.

The phrase "most reasonable" is unacceptably vague.

The regional abbreviations e.g. stNA, neNA, BB etc. are not necessary and detract considerably from the clarity of the manuscript. Please just use the full description.

We have deleted these abbreviations from the text, but kept them in Figure 7f.

Other comments

line 475: "From the comparison of simulated sea surface temperatures and $\delta^{18}\text{O}_{\text{calcite}}$ with proxy data, we find the best agreement between model output and data is reached when the iceberg discharge is stopped after 300 years."

I'm not sure I know what figure/metric shows this.

Please see revised discussion.

Figure comments.

Fig 1. Are the calving locations really those weird shapes? Why not use a pseudocolour plot rather than a contouring one to show the location, then one will be able to see what the model grid resolution is.

Yes, this is the model resolution.

Figs 5/6/7. These figures should be split up so that all of the panels (a) are on one figure all the (b)s on another etc. In the text the comparisons are always framed in terms of the variable (e.g. SST) not the model run (e.g. ICE 600). At present you have to flip between 3 figures for each variable. This is really difficult to do. You should also make the panels larger: the numbering on the colour scale is invisible.

We have changed the figures as suggested.

Fig 8 please put the names of the core on the map.

We have added the names.

Fig 9/10. In figure 9 time goes from left to right, in 10 it goes from right to left. So when trying to relate the modelled delta 18O calcite to the proxy delta 18O, not only do you have to flip between figures but you also have to mentally flip them through 180 degrees. Please chose one direction for time and stick to it.

Yes, this was an unfortunate mistake, thank you for pointing it out.

The panels in fig 9 are tiny. On full zoom my nose is about 2cm from the screen when I look at them!! Please make them bigger. The axes are also missing from the leftmost panels.

We have changed figure 9 – now figure 7 so that it is easier readable.

You must add the simulated calcite $\delta^{18}\text{O}$ curves into fig. 10 so that it is easier to follow the text. Again I have to flip between figure to work out what is happening: this is really hard.

We decided against adding the simulated $\delta^{18}\text{O}_{\text{calcite}}$ to the data because we think it will make the figure even more complicated. The revised figure 7 and figure 8 allow for an easier comparison than in the previous version.

Fig 10. The core that is in panel (a) is the core that is numbered 2 in fig.8. Panel (b) has core one. This is random. Please have panel (a) as core 1, panel (b) core 2 etc. Also as well as the core name put the number in the title.

Thank you for pointing it out, we have changed it.

To correctly interpret fig 10, I have to:

- (1) Look at fig8 to work out the number/location of the core,
- (2) read the caption to work out what the core name is.
- (3) look at fig 9 to find the modelled calcite
- (4) look at the title of the plot to find the region
- (5) refer back to fig 8 caption because the region names on the fig8 map and in fig9 are different
- (6) mentally flip the time axis of the panel in Fig.9
- (7) refer back to caption of fig. 10 because I have forgotten which core was which.....

This is **7 steps** before I can even look at what the data says.

On the axis in Fig 10 please change the axis label txt to be the same colour as the line to which it refers.

We have changed figure 10, now figure 8, as kindly suggested by the reviewer. Moreover, we have added the map with the regions and the core locations to the model results so that now only two figures have to be compared, instead of three.