

Reviewer #4 Comments and Responses:

Comment #1: The subject of the Younger Dryas cooling is one of considerable interest and fascination in the scientific community. Here, most research has been dominated by one theme that the cooling was triggered by a freshwater flood, or rerouting of meltwater, to the North Atlantic ocean. The idea that the YD cooling might have been triggered by a volcanic eruption has received much less attention and is very interesting.

Response #1: As the reviewer notes, there has been essentially no modern research on whether or not the Laacher See eruption could have triggered the YD, largely because the evidence available suggested that the LSE predated the onset of YD cooling (GS-1) by ~200 years. Given that the last few published review papers on the YD do not even mention volcanism, we feel that this is a valuable (and novel) contribution, and we are glad that the reviewer finds it interesting.

Comment #2: Overall, I really enjoyed the paper. It's very well written, easy to follow, and provides a nice break from the more typical meltwater-trigger hypothesis. Indeed, I found the discussion about the sensitive of climate to intermediate ice volume conditions, and the alignment of this 'ideal' configuration, to the timing of the YD very enlightening.

Response #2: We thank the reviewer for these supportive comments.

Comment #3: But whether a volcano actually triggered the YD is hard to tell from this paper. Yes, there was an eruption around the time of the YD cooling, but did it really produce a 1000-yr cooling? As such, the manuscript would have been vastly improved if the authors had done their own climate modeling. I think it would have been fantastic to try and see whether a volcano could have triggered a YD-like cooling. Indeed, the authors note that previous studies (fig 2) released 10-time LESS SO₂ to the atmosphere than what is estimated here. Whether these experiments should be undertaken, I will leave that up to the authors, but I'm not going to rejecting this paper simply because they were not carried out.

Response #3: We really appreciate the reviewer's perspective on the inclusion (or not) of modelling. Although we agree that modelling is important, we feel that this is outside the scope of the current submission, and best left for future research. The reason is outlined at length in our response to Reviewer #2's comment #2, as well as in new text that we have added to discuss relevant models. Essentially, model simulations of the response of AMOC to volcanic forcing over the last 1000 years have yielded ambiguous results, with some models predicting that eruptions strengthen AMOC, and others predicting a weaker AMOC. Still others suggest initial strengthening, followed by long-term weakening. We strongly feel that under the considerably less-well constrained deglacial conditions, modelling results would be even more ambiguous, and results would not necessarily be robust. We hope that this manuscript would provide the motivation for substantial future modelling work on the triggering of the YD by the LSE, and we feel that modelling support (or not) would need to come from multiple climate studies conducted over several years.

Comment #4: Finally, I wasn't sure if the MWP-1b discussion was really needed. The existence of this period of rapid sea level rise is still very much debated, as is its source, with various camps arguing back-and-forth over an Antarctic or Laurentide contribution.

Response #4: We have toned down the MWP-1b discussion, and included more text, to emphasise that the provenance of the meltwater is still uncertain.

Comment #5: Anyway, my overall opinion is that this is a very interesting paper and it should be published with minor corrections/edits.

Response #5: We thank the reviewer for this opinion, and for their comments. We have taken on board their suggestions, as well as those from the other reviewers, and we feel that our revised manuscript is substantially improved from the last submission.