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Climate of the Past Discussions

# *Interactive comment on* "Re-evaluating the link between the Laacher See volcanic eruption and the Younger Dryas" *by* James U. L. Baldini et al.

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We thank you very much for your in-depth, helpful, and interesting comments. We value you taking the time to comment on our manuscript. First, we would like to simply note that the goals of our submitted manuscript are straightforward: i) to highlight that the timing of the Laacher See eruption seems to be indistinguishable from the initiation of cooling associated with the Younger Dryas, ii) to highlight the possibility that the effects of volcanic eruptions can persist longer than just 1-3 years, and finally 3) that consequently the Laacher See eruption should be viewed as a viable trigger for the Younger Dryas Event. In other words, if the LSE occurred at the correct time (and it appears that it did), and if an eruption of this scale and sulphur content could catalyse extended cooling (and it appears that it could), then logically the LSE should be



considered a viable trigger for the Younger Dryas. Clearly more research needs to be conducted on this topic, but getting the idea out there is the key first step. We note that this is the only hypothesis where it is universally agreed that the proposed trigger actually occurred, so is not unacceptably speculative in our opinions.

We feel that an extended discussion of other proposed triggers is outside of the scope of the current submission, but we will include slightly more discussion with the revisions. There are reams of papers discussing the pros and cons of the Younger Dryas Impact Hypothesis specifically, and providing a thorough review of all the evidence for or against this hypothesis is not possible or necessary. For example, you are correct that the Laacher See Eruption would not account for the observed megafaunal extinctions across North America. However, recent papers [Cooper et al., 2015; Metcalf et al., 2016; Rule et al., 2012; van der Kaars et al., 2017] make an extremely strong case that this was caused by human migration, and that therefore the LSE (or an impact, or a meltwater pulse) would not have needed to cause any extinction. This perspective is also supported by the presence of other Younger Dryas-type events that apparently occurred during other Glacial terminations, e.g. TIII [Broecker et al., 2010] but that were not associated with megafaunal extinctions, implying that neither YD-type climate change nor a bolide impact were the cause of the megafaunal extinctions. The point though is that this has all been discussed before, and we do not feel that defending/rebuking other hypotheses in depth is the purpose of this manuscript, although we do mention the advantages and disadvantages of these competing hypotheses in order to put our hypothesis into context. Furthermore, we do not argue that a bolide impact did not happen near the YD boundary (it may have), so defending the presence or absence of a Pt spike, shocked quartz, black carbon, nanodiamonds, etc. is well beyond the scope of the manuscript. That being said, we will add some more detail in the revised manuscript.

In response to your comments that are specific to our hypothesis: 1) Comment: Our 'statement indicating that Laacher see eruption (LSE) effect could last for some 5 years

is in the contrast to surprisingly main conclusion not completely supported by own data and highly speculative that this event could trigger YD cooling.' 1) Response: We discuss a proposed ice/ocean feedback in detail in Sections 3.2, 3.3., and 3.4, and the concept of a positive feedback amplifying the original volcanic forcing is increasingly commonplace (see recent paper by Kobashi et al., Scientific Reports 2017 for example). There are now several papers that suggest the presence of a sea ice/oceanic circulation feedback that amplifies the initial short-lived aerosol cooling, and we will discuss these further in the revised manuscript as suggested by another reviewer. We therefore feel that the concept of a longer-term volcanic forcing is well-defended already by several pages of text as well as previously published papers (these will be included and discussed in the revisions); we do not feel that it is highly speculative if you are familiar with this most recent literature. Upon any revision, we will revise this text to ensure that this message is clear, and describe the positive feedback mechanism in more detail.

2) Comment: 'Resulting the title of msc starting with "Reevaluation" is inappropriate to the msc content.' 2) Response: The Laacher See eruption was one of the very earliest proposed triggers for the YDE, before it was discarded. However, the most recent lake core and ice core data suggest that the YD cooling occurred synchronously with the LSE, so we feel that 'Re-evaluating' is the correct word to use here. We were not the first to suggest the eruption as a trigger, although we are 're-evaluating' the eruption's climatological consequences in a modern context. Still, another reviewer raises this same issue, so although we feel that this is in fact the correct term, we will either change the title or better clarify why we chose to use this term in the title in the revisions.

We thank you for all the papers that you have provided. We will include these in any revisions, where relevant.

References: Broecker, W. S., G. H. Denton, R. L. Edwards, H. Cheng, R. B. Alley, and A. E. Putnam (2010), Putting the Younger Dryas cold event into context, Quaternary



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