

Clim. Past Discuss., referee comment RC2
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Comment on cp-2021-49

Anonymous Referee #2

Referee comment on "Was there a volcanic-induced long-lasting cooling over the Northern Hemisphere in the mid-6th–7th century?" by Evelien van Dijk et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-49-RC2>, 2021

This is an interesting paper showing new model based information on seasonal climate response following major volcanic events during the 6th and 7th century. In addition, the paper shows also proxy based reconstructions for different regions of the NH and a few simple model/reconstruction comparisons.

There are a couple of shortcomings, gaps and weak parts of the manuscript that need to be revised, I thus recommend major revisions

Comments (in no particular order):

Abstract

The abstract needs a major revision, currently it is a compilation of individual results without a clear statement. There are statements about proxy reconstructions, model output and model-data comparison, but there is no connection between the sections and also no dynamic explanations of what was found and new conclusions about climate during the 6/7 century. The first sentence is confusing as there is no actual detection/attribution study (yet) to support the finding that volcanoes are the main cause of cooling and not natural variability or a combination thereof. Further, several palaeoproxies are mentioned, but it is not clear what they refer to, whether they are used to date volcanic eruptions or to derive past climate.

General manuscript

It would be interesting and valuable to have a paragraph on the socio-economic impact of the cooler and more variable climate during this period. This would be a nice link to the other sections of the paper.

The paper is not up to date with the latest publications and the introduction needs to be revised accordingly. The first paragraph of the introduction is incomplete, confusing and needs better focus and the inclusion of more appropriate and new references to the state of the art in palaeoreconstructions for the study period. In general, the paper needs to be updated with recent findings related to reconstructions, post-volcanic responses in the palaeocontext, regional interpretations, and data/model comparison studies. Furthermore, the paper also needs considerations on uncertainties. In addition, two studies from 10 years ago on the onset of the LIA are cited (lines 39 ff). They are superseded by new findings.

It is not clear why Stoffel et al., Büntgen et al. and Esper et al. are used for comparisons with the model (Fig. 5). New reconstructions are available (see Büntgen et al. 2021 Nat. Comm for a review) and possibly an ensemble series could have been used instead of single reconstructions, which do not reflect the true NH conditions but are locally biased. It is also not clear why the authors compare the grid-based model output with local tree-ring-based reconstructions for three regions. In lines 390ff. they mention that such a comparison can be misleading, so they might reconsider this section. A more appropriate comparison could be made with continental reconstructions for Europe (Luterbacher et al. 2016, Env. Res. Lett) and for Asia (Zhang et al. 2018 Nat. Sci. Reports, 8, 7702).

The *methods* and associated measures to compare reconstructions and model output need to be explained in more detail.

The authors report on the summer precipitation behaviour in the Mediterranean region in the model world. This part needs to be revised, as in reality there is hardly any precipitation in the warm season and if there is, it is mostly on the northern rim. Even in post-volcanic summers there is no clear signal in observations and reconstructions of the last centuries (Wegmann et al. 2014; Fischer et al. 2007, CRL). Please note that there are hydroclimate reconstructions from different areas of the Mediterranean with which the model output can be compared.

In general, the work has a bias towards summer, which is not surprising as the tree-ring reconstructions resolve summer conditions. However, it would be important to provide some more insight into the conditions during the cold season and how the volcanic influence could change the annual cycle after the short and decadal volcanic influence.

Section 3.1. volcanic response:

It seems that the Figures 2,a, c and d are not commented and interpreted in the main text. Are the time series in Figure 2 referring to summer? The plots are small and details cannot be seen. Please could you increase the readability of the figures in general, thank you.

It is not entirely clear what Figure 3 shows. Are all post-volcanic years during the study period averaged and shown in relation to pre-volcanic non-volcanic conditions? Please state this more clearly in the caption and main text. Also, please provide more explanation of the multi-decadal analysis and how it is carried out.

In Figure 3b I see a strongly negative NAO with higher absolute pressure in the subpolar regions and lower pressure in the subtropics. This does not seem correct given the independent evidence of a strongly positive NAO following strong tropical volcanoes.

It might be good to show the statistically significant areas and instead use a field sign test

to show which areas are different compared to the reference period.

Please consider the interesting paper by Moreno-Chamarro, et al. 2017 re: Winter amplification of the European Little Ice Age cooling by the subpolar gyre. *Nature Sci. Reports*, 7, 9981. It is not about the 6/7th century, but about an active period during the Maunder Minimum and the role of internal variability versus forced influence on European seasonal climate. It might be worthwhile to review this publication as well to see whether similar processes might have been in effect and to include it in the interpretation.

Summary and conclusions

This part needs to be shortened and cleared of duplications. It is more a listing of some results without clear connection and explanation and what the main conclusions are from this study.

Fig. A2: Please provide the units of a) and also how the NAO indices have been calculated