

Clim. Past Discuss., community comment CC1
<https://doi.org/10.5194/cp-2021-171-CC1>, 2022
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Comment on cp-2021-171

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Community comment on "Do Southern Hemisphere tree rings record past volcanic events? A case study from New Zealand" by Philippa Ann Higgins et al., *Clim. Past Discuss.*, <https://doi.org/10.5194/cp-2021-171-CC1>, 2022

General comments

This paper led by Higgins examines the ability of eight New Zealand tree species to reflect volcanic dimming. As the authors point out, little is known of the impacts of past volcanic eruptions on Southern Hemisphere climate, and there is a discrepancy between models and palaeo-data. The authors found that there are differences across and within species in terms of their apparent reaction to dimming. The authors also present a summer temperature reconstruction from the tree-rings that reflects influence of dimming. This same response is detected in the 7-model ensemble response. Previous studies on Southern Hemisphere trees have not identified a volcanic impact. This study is therefore of considerable interest and importance. Overall, the manuscript is quite well written, although some work is required to improve clarity and succinctness, and to better emphasise main findings.

I wonder if a rearrangement of the material would help emphasise the key findings of this study a little better, better follow on from the introduction and also provide a basis for stronger and more substantial conclusions. One suggestion might be to start with showing a response in a new [more fully described] temperature reconstruction (or reconstructions) composed of a multi-species network of temperature sensitive chronologies to regional volcanic dimming, and a comparison with the CMIP ensemble before delving into the details of species used and species-level responses? The reason I suggest this, is that the introduction (l. 40 – 49, 65) seems to indicate that the model-palaeo discrepancy will be an important aspect of the paper, but this doesn't really come through (might the choice of a regional dimming index be relevant? – see below). I think that finding a volcanic response is the first 'big' result of the study. I am guessing the authors view it as more useful to build the case from the sites/species first and then to look at the temperature reconstruction but nevertheless ask that they carefully consider what aspects of their work deserve greatest emphasis.

The authors' use of a regional dimming index relevant to New Zealand latitudes/longitudes rather than a selection of events based on eruption magnitude may be a key reason for their results. I think this needs to be discussed in more detail – it seems to be the elephant in the room when the authors are focussed on reasons for differences in responses amongst species. The fact that a relationship with volcanic eruptions has been

identified in temperature-sensitive Southern Hemisphere trees is highly newsworthy. Why/how did the authors find this when other studies haven't? It would be good to place considerably more emphasis on this in the Discussion/Conclusions.

The authors rightly mention the moderate temperature response of the New Zealand species. This also applies to the ring widths of other Southern Hemisphere species. Do the authors consider that their use of the regional dimming index might 'compensate' somewhat for this moderate temperature response?

In relation to the more detailed analysis of species and sites, it would also be useful to show more information on the actual sites. It is not really sufficient to state that the meta-data for sites can be found in Palmer et al. 2015. It is difficult to adequately consider some of the points made by the authors in the discussion without having the sites put into context much earlier. For example, the information in Table 2 (along with references to the supplementary Figure 2) could be presented in Section 2.1. A summary (possibly pictorial and perhaps in the Supplementary?) of the various species' sites by altitude/location would also be very helpful to better guide the reader through the results/discussion. Would such a figure help when providing some detail on which sites within a species did not have a strong volcanic response (Section 3.1)? Are there common factors – like altitude for example – that play a role in nonsignificant response within species? Could it be linked in any way to the reason for previous studies not finding a relationship with volcanic eruptions? (e.g. the authors discuss elevation and latitude).

Also, the authors comment in the conclusions that only a subset of the temperature sensitive chronologies show a response to volcanic eruptions. Figures S2-6 show that a number of the chronologies that are not temperature sensitive. If the argument is that volcanic eruptions affect temperature and it is this that then impacts radial growth, why not use this information to exclude chronologies from the reconstruction and/or the analysis for a volcanic signal in the first place? Some better links between this information and discussion of which sites do and do not show a volcanic response (or show a range of responses – i.e. cedar) may be warranted. Ditto in terms of positive/negative responses – does a dominant current season [positive] temperature response equate to a negative response to volcanic eruptions? Does a dominant prior season [negative] temperature response equate to a positive response to volcanic eruptions? (for eg)? Any comment on seasonal window of temperature response and its relevance (or not) to volcanic response?

Loosely linked to this point, the authors make the case that lower elevation sites have a temperature response related to moisture stress (l. 432-434, 503). While this is not an unreasonable suggestion, the authors need to be more careful about how they state this – they have not shown data to support the statement, so comments should be more cautious when it is mentioned.

At face value, there seems to be an inherent contradiction in the authors' discussion around 'stress tolerators' and delayed responses and their later comments about the lack of a lagged response to volcanic eruptions in the temperature reconstruction. It is important to clarify this given that the memory in tree-rings has been found to be an issue in the response of Northern Hemisphere trees to volcanic eruptions. The authors should carefully consider what they are implying in their discussion of lagged response (as shown in Figure 3 and S1) as opposed to their comments about the 'lack of memory' in the temperature reconstruction. Why are there apparently lagged responses of varying magnitude across the chronologies that are not apparently reflected in the reconstruction? Some careful consideration needs to go into this.

Why were the specific 7 CMIP models selected (Table S2)? Why not other models?

There is quite a bit of repetition (almost the same sentences in some cases) between the Results and Discussion. This should be minimised, especially given that the authors are presenting a range of interesting results across and within species groups, and a temperature reconstruction and its response that is compared with a model ensemble. It is important to draw the threads together as coherently as possible.

A minor point: the title implies Southern hemisphere, but the study is focused on NZ. Perhaps it would be pertinent to include "A case study from new Zealand" or similar in the title.

Specific comments

Introduction

l.47-9 Might seasonality of signal matter?

- 52-5 "Tree growth...." Yes, but this almost sounds like the vast majority of the SH trees should be ruled out simply based on location and lack of serious elevation. It also seems to differ from what some of the results suggest (low elevation sites in mid-latitudes apparently sensitive).
- 66 – 7 – This sentence doesn't follow previous. Why would understanding whether a site is likely to have a volcanic response necessarily be relevant for studies of hydroclimate?
- 73-74. Reword a little – awkward to read.

Methods

- 104 maybe reword this first sentence slightly to improve clarity.
- 113 10 and 18 eruptions. On next page on l. 126 and also l. 118, 13 and 21 events? Seems to be an error here? In any case, this is confusing.

l.116 "Between 1900 and 1990, we selected the three largest.." Where these the largest based on the same criteria for selecting the historical eruptions? (ie. based on the regional

dimming index?)

- 128 "Species-level...". This again makes me wonder if it would be wise to first screen out those sites for each species that do not have a strong temperature response?

l.153 DJF Maybe point to Table 1 as justification – but include actual months of sensitivity in Table 1 – see below for comment.

- 165 – 169. Presumably for DJF so comparable with the tree-ring reconstruction?

Results

- 173 – 175 rewrite this a bit to be as clear as possible.
- 178 Which species had a neutral response? List here.
- 180 – 195 Include references to lagged responses shown in Figure...compare with later comments on the 'lack of memory' in the NZ trees compared to the NH trees. Maybe also better link this with the nature of the temperature responses (Figure S2-6).

Section 3.2 I am tempted to suggest that this could potentially go in Supplementary material (or even be omitted altogether) to simplify the paper and amplify the main points of the paper. I think it is useful to look at this, but not a key point. Also, the discussion here is a little confusing. In some cases it is the difference between the species at the various sites that is noted but not really described fully, but in other places, both species record a negative response. It would be useful to discuss both the nature of the responses of the individual species at these sites and then if they differ from the other species.

Section 3.3

- 218 It would be good to preface this section with some statement about why focus on cedar (why not do similar analyses for other species? – i.e. be explicit). One suggestion...begin with a comment about how the cedar average showed a generally muted response, but this masks very different individual site responses...and hence why this section of the results is useful. While it is certainly understandable that the authors

wish to consider this material in the main manuscript, it may be worth considering whether at least some of this information could go in the Supplementary? (so as not to distract too much from the bigger messages in the paper).

- 279 models – not CMIP models? Just be clear which models (reconstruction model or CMIP) is being referred to.
- 284 – 287 So there isn't a substantial issue with memory in the temperature reconstruction, but there are lags in the species-level responses. Be careful how this is discussed throughout the Results and Discussion.

Discussion.

As mentioned earlier, there is considerable repetition here (representation of Results) that clouds the text somewhat.

Section 4.1 – Compare with the above. Why doesn't this play out in the temperature reconstruction? Would be good to comment on.

- 340 – 345 This seems a little confused. Why separate silver beech from the other stress tolerators in this section? This section could probably be tightened up a bit.
- 350 – 354. So how does this relate to strong responses in years 0 and 3?
- 369 "...around 1000mm" This still seems relatively high, but how does it relate to the needs and distributional range (with respect to precipitation) of the species?
- 370 – 373. Again, mention of possible link to role of moisture. This seems to suggest that perhaps moisture-related variability should have been considered in this study? However, the low number of samples is of some concern, and perhaps this section should be shortened accordingly.
- 392 I'm not sure this is counter-intuitive response given the negative response to temperature (Supplementary). L. 397-99. This mention of seasonality of growth again makes me wonder if this should have been more fully described for all species much earlier (the longer climate response window of pink pine for eg is interesting)?

Section 4.2 Needs considerable tightening up. Reference to moisture-related responses is speculative (but not unreasonable), but it needs to be couched that way. Also, while the results and discussion for cedar in Section 3.3 are suggestive, I don't think they should be presented as being THE causes of differences. They may well be, but further work, and closer examination across all the species would provide more evidence for this. At l. 433, other factors are mentioned. This reference should perhaps come earlier in this section to better set up the discussion around the evidence presented in Section 3.3. Especially when the authors go on to discuss location in the landscape (l. 440 – 446). This isn't discussed in relation to the PCA results in Section 3.3. If these factors are so important, they should be mentioned in that section – do the PCA results reflect this?

- 422 "...sensitivity to temperature, including volcanic cooling..." So why include sites/chronologies not sensitive to temperature (or not at their limits)? This gets back to the locations of many of the SH tree-ring chronologies, and the relative lack of 'choice' compared to the NH.

- 450 "...large on site-related...". Only Elevation and latitude really mentioned.

- 450 – 452. While it is great that the authors produced this new reconstruction and tested it for volcanic response, I have two points to make about it:
 - The main features of this (these) new reconstruction are not really described in the study. How does it differ from earlier reconstructions? (Obviously the climate target may differ, but does it show similar features? If not/if so, where....?). Is it different enough to be the potential reason for volcanic dimming being detectable here but not in previous reconstructions?
 - If previous reconstructions were compared with the regional dimming index in the same manner would the same result be produced? Has it been the compilation of volcanic eruptions based on their magnitude which has been the problem in the past? Or is it the combination of chronologies used? The target season? The season of the eruptions vs seasonality of tree growth without due attention to regional and global circulation patterns?

Conclusions

I still think the big news is that a volcanic signal was identified. The 'next big news' is related to the species-level responses.

- 488 "...proxy selection...". This almost sounds like a choice amongst corals, trees, speleothems etc. Do you mean site selection?

- 492 "...plant life history traits...". What is meant by this? Not really discussed in the manuscript. Maybe just be explicit to avoid confusion.

- 500 “We found that....” Not convinced this is a major finding when it depends heavily on Section 3 and then later observations not related to the analysis in Section 3.3.
- 503 “ ...summer moisture...” I think this is too speculative to include in the conclusions.
- 513-515. But this study seemed to indicate that it didn’t matter so much whether a subset of the most sensitive sites was used or not (especially for the temperature reconstruction). Reword.
- 518 – 521. Yes, this applies to other types of reconstructions as well. Note that several large databases include composites that are then used by modellers who may not appreciate these types of nuances.

Figures and Tables

Figure 2. The orange and red are quite close to one another. Might it be useful to darken the red so there is a clearer visual difference between the two?

Figure 5 – colours for G4 and G5 difficult to tell apart for some. Change one of the colours.

Figure 8 – is it possible to use different symbols for the different species?

Table 1 Could this table be merged with Table 2 that simply summarises the nature of the response. Maybe also note which response is stronger, prior or current season?

Table 2 – I think this could be merged with Table 1, but in discussing Table careful references to Figures S2-6 should be made.

Supplementary

Figures S3 and S4. It is unclear why master chronologies are included just for these two species. Perhaps more could be made of the differences between 'master series' and individual series for all species in the main text? It would actually be good to see master series for all species included here given that species wide averages have been used in the main manuscript (Figure 3).

Technical comments

Abstract

- 28 "The has..." This has.

Introduction

- 88 amongst rather than between
- 89 Should "proxy" be "site"?

Methods

- 98 should "species depth" be "sample depth"?
- 133 "...two species.." Maybe insert 'different' between these words?

Results

- 175 "averaged across..." All sites of a species, not just all sites. Ditto in relation to sensitive chronologies.

Discussion

- 438 "...altitudinal range.." Altitudinal limit?
- 478 MDX – should be MXD?