

Clim. Past Discuss., community comment CC1
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Comment on cp-2021-63: a well written and significant paper

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Community comment on "No evidence for tephra in Greenland from the historic eruption of Vesuvius in 79 CE: implications for geochronology and paleoclimatology" by Gill Plunkett et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-63-CC1>, 2021

This paper analyzes the glass geochemistry of tephra particles in a Greenland ice core, previously attributed to the 79 CE eruption of Vesuvius, and finds the attribution to be erroneous. The glass chemistry of the particles in the ice core differ significantly from 79 CE Vesuvius glass. Comparison with the geochemistry of volcanic glasses from several volcanoes in Central America, Kamchatka, western North America, and the Aleutians leads the authors to conclude that the tephra is most similar to that of Aleutian volcanoes and mostly likely came from a thus-far undiscovered Aleutian or Alaskan eruption around 88 CE. The change in time of this layer is significant because several ice-core chronologies are based on the 79 CE attribution. The study also uses several thousand model simulations to assess the likelihood that particles 32 or 64 microns in diameter would have reached Greenland from Central America, the Aleutians or Kamchatka under different assumed plume heights and locations of origin. It concludes that eruptions from the Aleutians or Kamchatka are more likely to reach Greenland than those from Central America, and that higher plumes are more likely to have delivered 32 or 64 μm particles.

Overall I find this paper well written and its results highly significant in their implications for the ice core record. My criticisms minor. For example,

- In the section on glass chemistry, it is not always clear which glasses are being plotted (e.g. in Fig. 4) or which are being referred to in the text. Specifics are given below. Also the caption to Fig. 5 incorrectly describes the contents of the sub-plots.
- In the modeling section, the plume heights and volumes used as input are not always consistent with the description of the VEI of these events. For example, a modeled event having a DRE volume of 0.5 km^3 is likely a VEI 5 rather than a VEI 4 (line 208).
- The model simulation use plume heights that range up to 35 km asl; but the NOAA NCEP Reanalysis 2 model output that provide the wind field extend only to about 30 km elevation. In order to accommodate higher plumes, Ash3d extends the wind vectors from the highest pressure level in the met. model to higher elevation. You may want to remove the runs with higher plumes.

Other comments are even more minor. I think this will be a significant contribution to the literature on ice core chronologies. It offers some important insights into the eruption size and plume height required from volcanoes in the West to deposit tephra in Greenland.

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Specific comments:

Line 18: Here, in the first two words of the abstract, you are stating the subject of the study. "volcanic signatures" is a little too vague to tell people what exactly you are studying. Trace deposits of past eruptions?

Line 41: consider changing "continuous flow processes" to more specific wording that might be understandable to non-specialists.

Lines 42-43: you note here that pinpointing the source of the eruption is a critical factor needed to determine the amount or aerosol emission and their lifetime. How so? Is finding the source critical because it would allow you to find other studies that estimate aerosol emission from that eruption? Do you assume that more distal eruptions were bigger and therefore had more climate impact?

Line 45: change "grain size analysis" to "isopleth analysis".

Lines 80-82: approximately what time period do these three core samples represent?

Line 84: add "which was placed" before "on a hotplate"

Line 89: add "electron microbe" after "6500F".

Lines 118-121: this description of the number of models run is a little confusing. You say that you ran 350 simulations for each volcano, but you randomly selected 1,000 start times between 1950 and 2011?

Line 121 (or thereabouts). Does Plunkett et al. (2021) include a table with model settings for these simulations? (e.g. model resolution, domain size etc.). If so, perhaps note that here.

Line 124: change "Cryptotephra was" to "Cryptotephra particles were"

Line 127: although one shard was microlite rich, it appears from the photos that most of the shards were almost completely aphyric. It might be worthwhile noting this.

Line 143: Cite Fig. 3a, b at the end of this sentence.

Lines 147-148: can you cite the source of Icelandic glass chemistry when stating that QUB 1832/33 glass chemistry doesn't correlate with any Icelandic glasses from this period? I see four Icelandic tephtras plotted in Fig. 3. Are these the only ones you compared with?

Lines 170-171: here you note the homogeneity of the Popo Pink and Lorenzo pumice compositions. On Figure 4 I see a light green field labeled "Popo matrix glass", and green hexagons labeled "Popo". Do these represent the same analyses? Are the Pink and Lorenzo glass analyses part of these? If you cite their homogeneity, it would nice to see which data you're talking about. You also describe the chemistry of the Smithsonian Popo samples but it's not shown on Fig. 4 which points these are.

Lines 158-159: Change "Point data" to "Microbeam data".

Line 208: what do you mean by "a VEI 4 event erupting 0.5 km³ dense rock equivalent (DRE) volume of tephra"? Is the volume 0.5 km³ DRE, or 0.5 km³ tephra? An eruption with a DRE volume of 0.5 km³ would likely produce 1-2 km³ tephra. It would be a small VEI 5, since VEI 4's are defined as having tephra volumes of 0.1 to 1 km³. A plume height of 12 km asl is also a bit on the low side for a VEI 4, which is defined as having plume heights of 10-25 km.
(https://en.wikipedia.org/wiki/Volcanic_Explosivity_Index) (Newhall & Self, 1982)

Line 217: add a comma after "century".

Line 220-221: "In none of the Ash3d simulations did tephra reach Greenland". Remind us how many simulations were run. 350 for Chikurachki? As above, an 11 km plume height is rather low for a VEI 4 event.

Line 227: an eruptive volume of 1 km³ DRE would translate into a bulk volume of about 2-3 km³, putting this eruption into the VEI 5 category (1-10 km³ bulk). Not a VEI 6.

Line 235: change "1,000 events" to "1,000 start times".

Line 236-237: delete "from a uniform distribution". If the start times were randomly selected, then the distribution should be uniform.

Line 238-239: I think you can directly note the best-fit relationship between plume height and erupted volume that you used. If it's the one I'm thinking of (Mastin, 2009, Eq. 2), it's $H = 25.9 + 6.64 \cdot \log_{10}(V)$, where V is erupted volume in DRE, and H is height above the vent (km). Also, add "empirical" before "best-fit"

Line 240: cite "Mastin et al., 2009, eq. 1)" after "plume height"

Line 243: You are using plume heights that extend to 35 km asl, but NOAA NCEP Reanalysis 2 data extend only to a pressure level of 10 mbar, which corresponds to about 30 +/- 1 km in the atmosphere. Ash3d accommodates higher plumes by using wind vectors at the highest altitudes that are the same as the wind vectors in the highest meteorological pressure level. If you don't want to add this caveat, it might be best to delete the plumes with heights of 31-35 km.

Line 257: At the end of this paragraph, you should add a couple of sentences noting that the rate of fall and deposition of distal fine ash are controlled by many factors that are not well understood. Rates of tephra aggregation, particle interaction, and local fluid instabilities could all affect whether fine ash makes it this far; and if so, whether it is deposited or simply continues airborne to greater distance. These model results are crude attempts to see what is possible. Small differences in probability are unlikely to be meaningful.

Line 267: what do you mean by the "validity" of small ash particles in polar ice cores? You are questioning whether fine particles seen in ice cores are actually volcanic ash?

Line 279: add "the" before "potential"

Line 298: change "Antarctica" to "Antarctic"

Line 308: change "independently" to "independent"

Line 348: change "with the eruption" to "with the 88 CE eruption" (I assume that's the one you're referring to).

Line 355: change "implicate" to "imply"

Line 948: I don't know what "field glass analyses" are. Is there a more widely understood term?

Line 975: change "for in the winter months" to "for the winter months"

Figure 5: The description of the subplots doesn't correspond with their content. (b) is said to be Japanese volcanic zones but the plot legend gives data points for Turrialba and Tacana, for example.