Replies to editor for:
Was the strengthening of the Northern polar vortex in 2024/2025 associated with the Hunga Tonga eruption?

ACP, Ales Kuchar et al.

Reply to Editor and Ref #3

Dear Editor,

We appreciate your very helpful comments! We revised the manuscript according to your suggestions and hope the revised version obtains your approval for publication in ACP. Please find our point-by-point answers to the comments below.

Best wishes

Ales Kuchar et al

Comments:

1. The article did not meet the reviewer evaluation criteria necessary for publication as an ACP letter. Furthermore, the readability of the article suffered from the imposed constraints on length and figure number. The manuscript will be reclassified as a research article, and the authors are asked to reformat the article, incorporating the appendix text and figures into the main text.

We reformatted the manuscript as a regular article incorporating the appendix text and figures.

2. In response to comments about the "statistic significance" of the results, the authors "therefore interpret the simulations as evidence for a forced tendency rather than deterministic grid-point attribution." This statement is not easy to understand: "tendency" is often used to refer to a time derivative (e.g., a temperature tendency), especially in contexts where heating rates are examined, but I guess this is not the meaning that is intended. (I would guess the intended meaning is more related to the probability of a strong or weak vortex?) Clear explanation is especially important given some recent works that have called into question the purported links between volcanic and solar forcing and the polar vortex (e.g., Polvani et al., 2019; Chiodo et al., 2019). Also, what is "grid-point attribution"? Some careful rephrasing here is essential, and the room afforded by the move to the research article format should be used to be more explicit about the authors' interpretation of the results.

We agree that the statement was ambiguous. We replaced the following sentence in Section 2.2: "Thus, the SOCOLv4 ensemble indicates a forced tendency toward stronger westerlies under HT forcing, not deterministic attribution of the full observed evolution." with "Thus, the paired SOCOLv4 simulations indicate that HT forcing shifts the ensemble-mean circulation response toward stronger polar westerlies. However, this ensemble-mean response does not imply that individual ozone, temperature, or wind anomalies, or the full observed evolution of OW3, can be uniquely attributed to the HT forcing."

Furthermore, we replaced the following sentence from the discussion paragraph: "Taken together, the observations and paired SOCOLv4 simulations support a forced tendency rather than deterministic attribution." with "Taken together, the observations and paired SOCOLv4 simulations support a probabilistic interpretation: HT-related WV and ozone anomalies increased the likelihood of a stronger polar vortex while internal variability remains too large to attribute the full evolution of the observed and simulated winters to the HT forcing."

3. Related to point 2, a main conclusion of the study is written that "the WV and ozone anomalies are, in combination, sufficient to generate substantial radiative cooling, which sharpens the meridional temperature gradient and strengthens polar stratospheric westerly winds". This statement (line 134 of revised document) answers the question set out in the paper's title, and is much more confident than the statement mentioned in point 2 above. However, there is no evidence shown in the manuscript to support the finding that the temperature gradient is sharpened. This seems to be inferred from the polar temperatures, but not shown explicitly. Please include information on the temperature gradient, or rephrase to be consistent with the evidence shown in the manuscript.

We added meridional temperature gradient daily anomalies as a new Fig. 14. This figure provides evidence that the polar cooling is accompanied by an enhanced meridional temperature gradient. We also revised the wording accordingly.

4. Concerning the article title, according to the ACP guidelines (https://www.atmospheric-chemistry-and-physics.net/policies/guidelines_for_authors.html), "ACP prefers titles that highlight the scientific results/findings or implications of the study". Using a question as a title is not explicitly forbidden according to the guidelines, but certainly it does not satisfy the intent of the guidelines to highlight the unique results/findings of the study. I would encourage the authors to choose a title which more closely aligns with the ACP guidelines, but also does not overstate the robustness of their results.

We changed the title to "Evidence for Hunga-Tonga eruption influence on the anomalously strong Northern-Hemisphere stratospheric polar vortex in 2024/2025".

The comments of Reviewer #3

Line, 86 How dependent are your results from the selection of the time interval?

Figure 9: The mean trajectory path in panel c) is difficult to read, maybe another color?

Figure 10: The red line lies with 50 hours so the test is a bit confusing

The comments above were ignored because they were apparently included by mistake.

line, 357 the link is not working anymore

We changed the Zenodo link once more and confirm that it is active.

line, 366 Kroll et al (2021) is not cited anymore

We added the reference again.

References