

Clim. Past Discuss., referee comment RC2
<https://doi.org/10.5194/cp-2021-82-RC2>, 2021
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Comment on cp-2021-82

R. Stockton Maxwell (Referee)

Referee comment on "The 1600 CE Huaynaputina eruption as a possible trigger for persistent cooling in the North Atlantic region" by Sam White et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-82-RC2>, 2021

Overview

The manuscript fits the scope of the journal well with integration of climate modeling, paleoclimatology, and historical climatology to address the effect of the Huaynaputina (Peru) eruption in 1600 CE on northern hemisphere cooling via the North Atlantic subpolar gyre and ocean-atmospheric feedbacks. The SPG is hypothesized to be the cooling mechanism that led to low temperature anomalies in Europe and Russia in the early 17th century. While the results are not conclusive, the authors have established a research course to investigate the relationship between volcanic eruptions and important climate shifts that have affected humans. The methods and assumptions of the work are clearly outlined and the authors' interpretation of the results is in accord with their analysis. The supplemental materials make the research reproducible with extensive presentation of the historical observations used in the methods. I found the paper well-structured and written with few technical errors.

General Comments

The cluster of volcanic activity in the late 1500s would seem to make it difficult to determine if the Huaynaputina eruption seeded the SPG slowdown or if the eruption was the final push over a threshold given the background state of the atmosphere after multiple VEI 4 eruptions. Perhaps this is why an SPG shift can occur in some simulations without a volcanic forcing in 1600. However, the combined use of model simulations, paleoclimate reconstruction, and historical climatology helped to better target an initial seed to the SPG slowdown but unfortunately the data are inconclusive at this point. That said, this is a fine contribution demonstrating how these data sources can be integrated to elucidate the mechanism driving climatic change circa 1600.

Further analysis and discussion of the North Atlantic Oscillation (NAO) and Arctic Oscillation

(AO) would be helpful to disentangle how the background climate state and internal variability might contribute to an SPG shift. Previous research suggests an interaction between NAO and volcanic eruptions (e.g., Ortega et al. 2015) with a positive NAO emerging after strong volcanic eruptions. NAO+ would lead to stronger westerlies in northern Europe resulting in warmer and wetter winters, meaning the SPG would likely not slowdown. Of course, there are many NAO reconstructions out there to choose from including several recent reconstructions from Ortega et al. 2015, Cook et al. 2019, and Hernandez et al. 2020. The research could benefit from a more comprehensive treatment of NAO/AO.

Specific Comments

L70 - North Atlantic Oscillation (NAO) was not significantly affected by the eruption but it could be foundation to understanding the background state of climate leading into an SPG shift.

L143-48 – Previous research is showing that no volcanic forcing is need to produce SPG shifts depending on the background climate state. Okay, so what was NAO, or the Artic Oscillation (AO), doing when the SPG shift occurred? How would you distinguish intrinsic variability from a volcanic forcing of an SPG shift?

L208 – Is the 1550-1590 baseline period suitable to calculate anomalies when it includes multiple eruptions?

L229- the reference period here changes from the reference period for the reconstructed anomalies. Please justify the change in reference period. Or is this a typo?

L275 – there also appears to be a lack of agreement between NTREND and the simulations. Why might this be?

L282- in Figure 6, it appears that the NVOLC reconstruction has much more annual variability and different spectral properties than the simulations. What is causing this discrepancy?

L297-301 – NAO does play a major role in setting winter conditions in Europe. So, what was the state of the NAO during the period of analysis?

L308 – Could the shifts in ice break of dates be connected to NAO and AO? Some of the

reconstructions of NAO (Cook 2019, Ortega 2015, Hernandez 2020, etc.) show shifts that might correspond to the ice break up regime shifts.

L376-385- If additional simulations do not result in determining what the initial seed for SPG slowdown is, what model improvements would be needed to better model what the climate proxies and historical records appear to show?

Technical Edits

L31 – add space between number and m - “4,850m”

L140 – missing hyphen “Moreno Chamarro”