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Analyzing the influence of Pre-Eruption Conditions on Post-Eruption ENSO Variability in the Pre-Industrial Millennium

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1. Introduction

- As one of the largest natural perturbations, volcanic eruptions inject sulfate aerosols and particulate matter into the stratosphere that reduces surface shortwave radiation, causing cooling anomalies and significant climate variability. These eruptions can influence oceanic responses and potentially disrupt the normal El Niño Southern Oscillation (ENSO) cycle in the central and eastern tropical Pacific Ocean.

- ENSO consists of three phases, the two opposites being "El Niño" and "La Niña" with "Neutral" being the middle of the continuum, in which El Niño is a warming of the ocean's surface or above average sea surface temperature (SST), while La Niña signifies the cooling of the ocean surface/below average SST.

- Climate anomalies and ENSO responses are compared in sea-surface temperature patterns shown during the pre- and post-eruption periods, categorized by their location: "Northern hemisphere", "Tropical region", and "Southern hemisphere" eruptions.

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Scan for more in-depth information on project.

3. Pre- and Post-Eruption Analysis

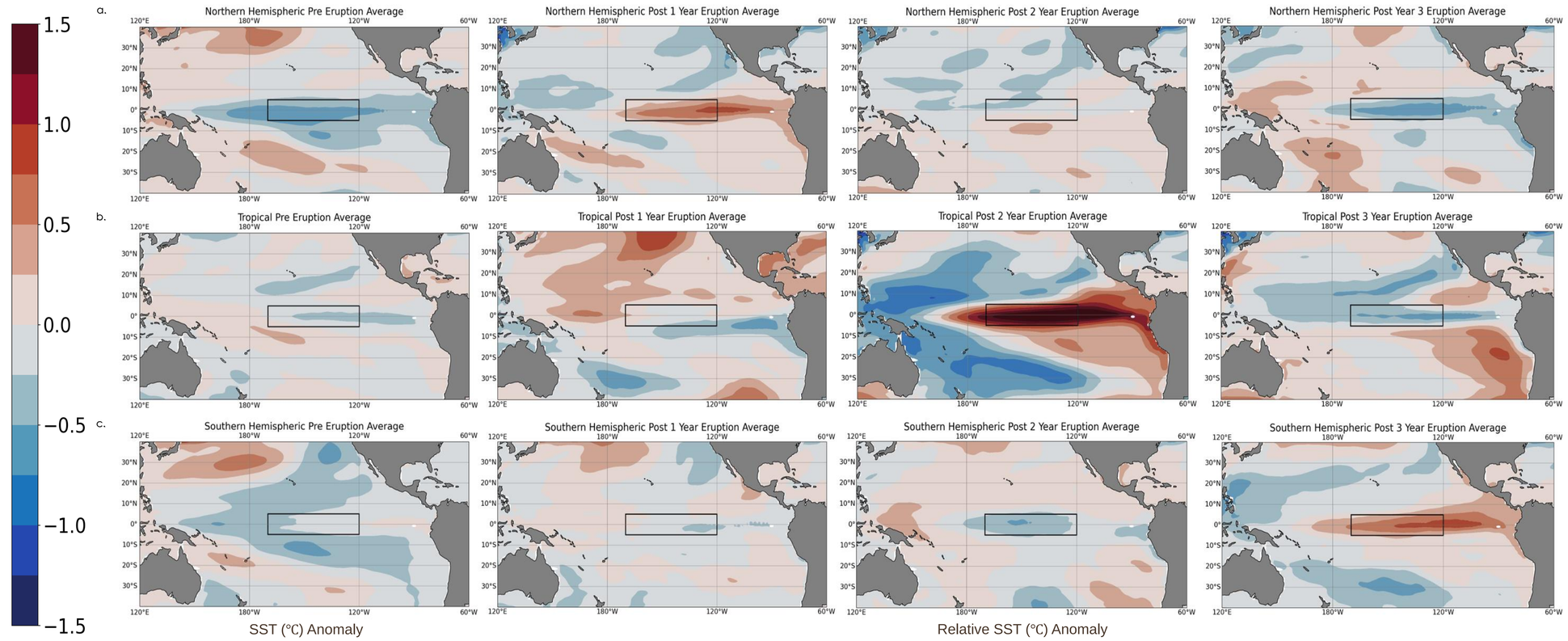

Figure 1: Averaged relative sea surface temperature (SST) anomalies for all chosen volcanoes from the pre-eruption year to the post third year of the eruption, using 5 month running mean in comparison to a monthly climatology. Volcanoes separated by **(a)** Northern hemispheric eruptions, **(b)** Southern hemispheric eruptions, and **(c)** Tropical region eruptions, focusing on Nino 3.4 (5ºN - 5ºS, 120ºW - 170ºW)

4. Last Millennium El Niño 3.4 Index (n=10)

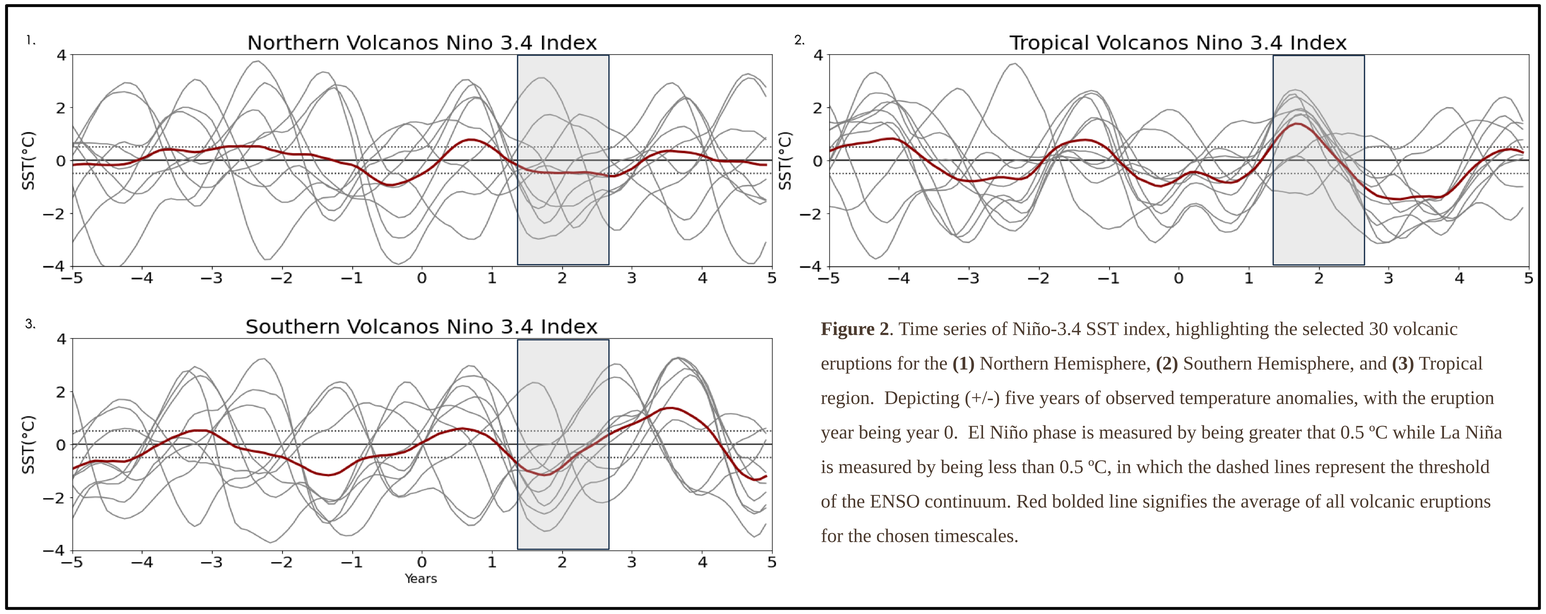

Figure 2. Time series of Niño-3.4 SST index, highlighting the selected 30 volcanic eruptions for the **(1)** Northern Hemisphere, **(2)** Southern Hemisphere, and **(3)** Tropical region. Depicting (+/-) five years of observed temperature anomalies, with the eruption year being year 0. El Niño phase is measured by being greater that 0.5 ºC while La Niña is measured by being less than 0.5 ºC, in which the dashed lines represent the threshold of the ENSO continuum. Red bolded line signifies the average of all volcanic eruptions for the chosen timescales.

4. Conclusion

- Analysis of our last millennium simulations indicate an averaged neutral to La Nina condition pre-eruption , followed by an El Niño response in year 1 of Northern hemispheric eruptions and a significant El Nino response in year 2 of tropical eruptions. After tropical eruptions, El Nino is triggered by the westerly anomalies induced by rapid surface cooling around the maritime continent.

- Both tropical and NH eruptions are found to have an increased probability of EL Nino occurrences on the first two years after eruptions, shown leading into a La Nina-like SST anomaly pattern on the post eruption third year.

- Compared to NH and tropical eruptions, the SST gradient over the Pacific is not as strong following southern eruptions, showing the warm SST anomaly lag with an La Nina-like response year two with the delayed EL Nino response on the third year.

5. Acknowledgments

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