

EGU21-753

<https://doi.org/10.5194/egusphere-egu21-753>

EGU General Assembly 2021

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Volcanoes and ENSO: a re-appraisal with the Last Millennium Reanalysis

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The potential for explosive volcanism to affect the state of the El Niño-Southern Oscillation (ENSO) has been debated since the 1980s. Several observational studies, largely based on tree rings, have since found support for a positive ENSO phase in the year following large eruptions. Models of different complexities also simulate such a response, detectable above the backdrop of internal variability – though they disagree on the underlying mechanisms. In contrast, recent coral data from the heart of the tropical Pacific suggest no uniform ENSO response to all eruptions over the last millennium. Here we leverage paleoclimate data assimilation to integrate the latest paleoclimate evidence into a consistent dynamical framework and re-appraise this relationship. Our analysis finds only a weak statistical association between volcanism and ENSO, suggestive of either no causal association, or of an insufficient number of large volcanic events over the past millennium to obtain reliable statistics. While currently available observations do not support the model-based inference that tropical eruptions promote an ENSO response, there are hints of a response to hemispherically asymmetric forcing, consistent with the "ITCZ shift" mechanism. We discuss the difficulties of conclusively establishing a volcanic influence on ENSO given the many degrees of freedom affecting the response, including eruption season, spatial characteristics of the forcing, and ENSO phase preconditioning.