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# ENSO Sensitivity to Volcanic Eruption Magnitude and Season

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Recent studies show that the impacts of Pinatubo-size low-latitude volcanic eruptions on ENSO depend on the timing of the eruption relative to both the seasonal cycle and ENSO. La Niñas and strong Eastern Pacific (EP) El Niños appear to be less sensitive to volcanic forcing than weaker Central Pacific (CP) El Niños and ENSO-neutral conditions. Moreover, the ENSO response comprises both deterministic and stochastic components, with the latter being more important for eruptions occurring early in the calendar year.

To better understand these stochastic and deterministic responses, and how they depend on the initial state of the Equatorial Pacific, we conduct numerical experiments using the GFDL CM2.1 global coupled ocean-atmosphere model, using initial conditions spanning the full spectrum of simulated ENSO phases – including La Niña, ENSO-neutral conditions, and El Niños of various amplitudes. The simulations are then perturbed by either Pinatubo-size volcanic aerosol forcings or Tambora-size forcings that are about three times stronger. For each experiment we use ten different initial conditions, and also slightly perturb the volcanic forcing to generate 100 ensemble members total, in order to discriminate between the deterministic and stochastic responses.

We find that for a given initial condition, a stronger volcanic forcing produces stronger El Niño-like responses in the second year after the eruption. For both Pinatubo- and Tambora-size forcings, the ENSO-neutral cases and weak (CP) El Niños show a larger response to the eruption than do the strong (EP) El Niños. However, compared to the Pinatubo forcing, the larger Tambora forcing is able to affect stronger El Niños. For eruptions occurring in boreal winter or spring, there is a significant stochastic component of the ENSO response, even relative to Tambora-size forcing. Thus a June Pinatubo-size eruption tends to affect the evolution of El Niño more than a February Tambora-size eruption.