The Effect of Background ENSO and NAO Conditions on the Climatological Response to a Pinatubo Sized Volcanic Eruption

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Strong volcanic eruptions are a significant, intermittent source of natural climate variability throughout Earth's history. Here, the effect of atmospheric and oceanic background conditions on the interannual climatological response to a Pinatubo-type (simulated 18Tg injected at 24-26km height) eruption is examined using GISS ModelE2.1-R coupled atmosphere-ocean with specified volcanic aerosols (NINT) in accordance with the 'volc-pinatubo-full' Volcanic Model Intercomparison Project (VolMIP) experiment. ENSO and NAO conditions are sampled from a 300-year pre-industrial control run and 27 ensemble members are constructed with nine members in the positive, negative, and neutral phases for each condition (3 ensemble members for each co-condition.) A uniform aerosol forcing is prescribed for each ensemble to account for variations in global and regional climate responses, including northern hemisphere winter warming and changes in ENSO and NAO conditions. In particular, a strong (5-10 degree) post-eruptive winter warming anomaly in the Northern Hemisphere is examined for negative NAO ensembles. This surface temperature anomaly coincides with a decrease in 500 mb geopotential height and sea level pressure and an increase in westerly winds indicative of a strengthening polar vortex. The opposite signal for positive NAO ensembles suggests that the response is sensitive to the initial condition of the North Atlantic. ENSO phase, on the other hand, causes significant differences in the magnitude of the global surface temperature anomaly and impacts the evolution of ENSO in the year after the eruption. Positive and negative ENSO phase conditions relax the ENSO anomaly in the first post-eruption Boreal Winter while neutral-phase ensembles are variable and show no clear response. Thus, in GISS ModelE2.1-R we find that initial NAO phase to cause a significant atmospheric response in the first post-eruptive Boreal winter while initial ENSO phase causes a small perturbation in the ocean response.