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The El Niño response to tropical volcanic eruptions and geoengineering

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Following tropical volcanic eruptions and in response to geoengineering efforts in climate models, the occurrence of El Niño is notably enhanced. However, the precise mechanisms leading to the preference of the El Niño state remain a subject of ongoing debate. In this study, we explore the El Niño response within the context of stratospheric aerosol injection experiments using the Community Earth System Model version 1, with the Whole Atmosphere Community Climate Model atmospheric component (CESM1 WACCM). Our investigation is centered around the Stratospheric Aerosol Geoengineering Large Ensemble Dataset encompassing three distinct scenarios: a simulation of the RCP8.5 scenario as baseline climate change scenario, a geoengineering scenario, in which surface temperature increases are completely compensated and a scenario focusing solely on the stratospheric heating derived from the geoengineering approach. Our analysis reveals that the El Niño response is primarily linked to the heating in the tropical tropopause layer and lower stratosphere, and notably, it occurs independently of tropospheric cooling effects. We explain the increased occurrence of El Niño after volcanic eruptions and simulated geoengineering interventions by a slow down of the tropical atmospheric circulation, which is caused by increases in gross moist stability due to aerosol heating in tropical tropopause layer.