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Climate response to the extremely large tropical volcanic eruption Los Chocoyos (84 ka BP): Simulations with the MPI-ESM

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Using an Earth System Model, we investigate the potential climate response to the extremely large volcanic eruption Los Chocoyos in Guatemala (84 ka BP, VEI>7) of the Central American Volcanic Arc (CAVA). The volcanic radiative forcing is calculated offline with a global aerosol climate model taken into account the formation and development of the volcanic aerosol size distribution from an initial stratospheric injection of petrologically estimated 700 Mt SO_2 (Metzner et al., 2012).

Due to the very strong radiative forcing, the stratosphere warms and the surface cools over almost the entire globe accompanied by a global reduction in precipitation. Focusing on coupled atmospheric-oceanic responses in the Southern Hemisphere (SH), whose complexity arises from the interactions between the radiative forcing and the ongoing broadband internal variability of the climate system, a significant positive phase of the Southern Annual Mode (SAM), persisting for at least 12 months, characterizes the simulated post-eruption SH atmospheric circulation. Significant changes of surface temperature, precipitation and wind fields result from a distinct increase in magnitude and poleward movement in position of the SH westerlies. This is associated with temporary modifications of the upper ocean circulation in the Antarctic Circumpolar Current region. Due to the propagation of the forced anomalies into the deep ocean layers, the anomalous oceanic state persists well beyond the atmospheric response timescale. Significant negative temperature anomalies in the SH ocean propagate down to ∼2000 m during the first ∼20-50 post-eruption years, and persist for the entire simulated 200 years. A multicentennial anomaly in the SH ocean heat content represents the longest lived volcanically-forced signal detectable in the simulated climate.