Impacts of the Mount Pinatubo eruption on ENSO in the GEOS seasonal-to-subseasonal forecasting system

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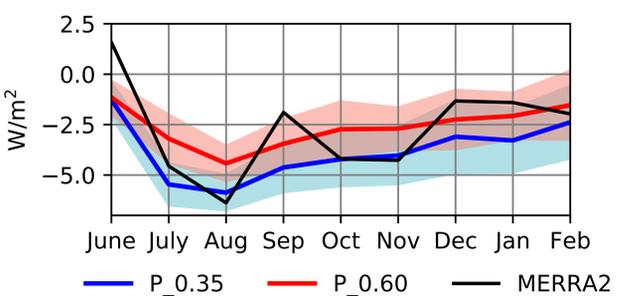[1]American University, Washington DC; [2]SSAI; [3]NASA GMAO; [4]USRA

BACKGROUND. Despite representing a major perturbation of the climate system, volcanic eruptions are generally not included in seasonal forecasting systems. Here, we show how the inclusion of the Mt. Pinatubo eruption in nine-month forecasts by the NASA GEOS-S2S forecasting system changes the forecast of the development of the El Niño Southern Oscillation (ENSO).

GEOS-S2S computes the interaction of aerosols with radiation and clouds. Aerosols are simulated with the GOCART bulk model. For this study, we introduced a stratospheric aerosol module to simulate volcanic aerosols.
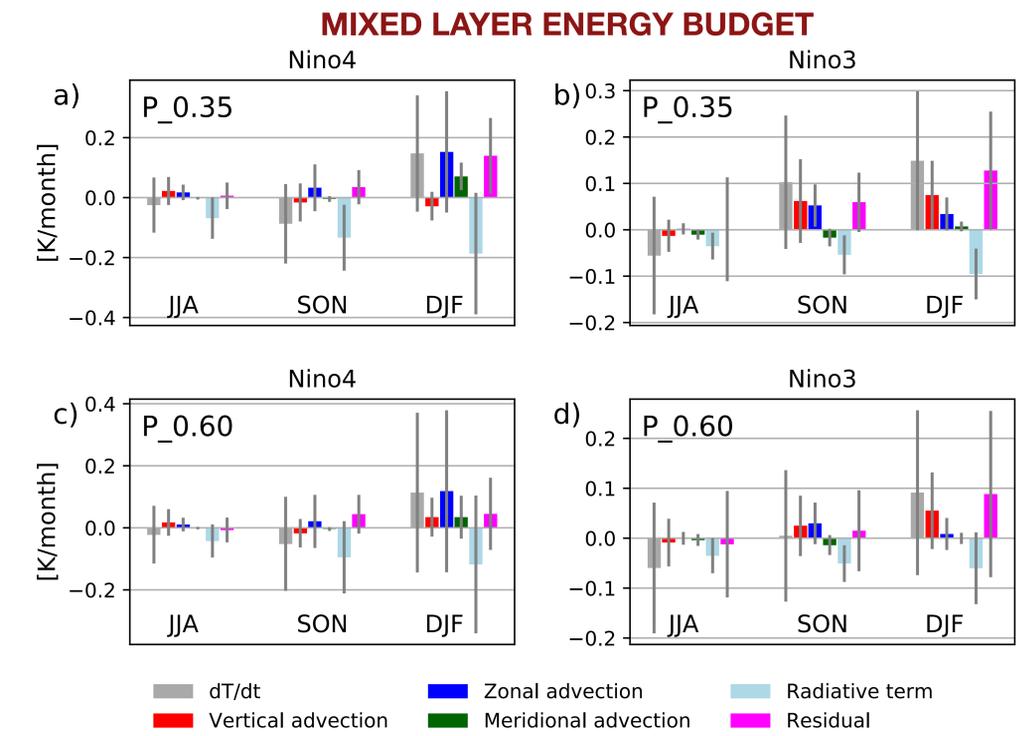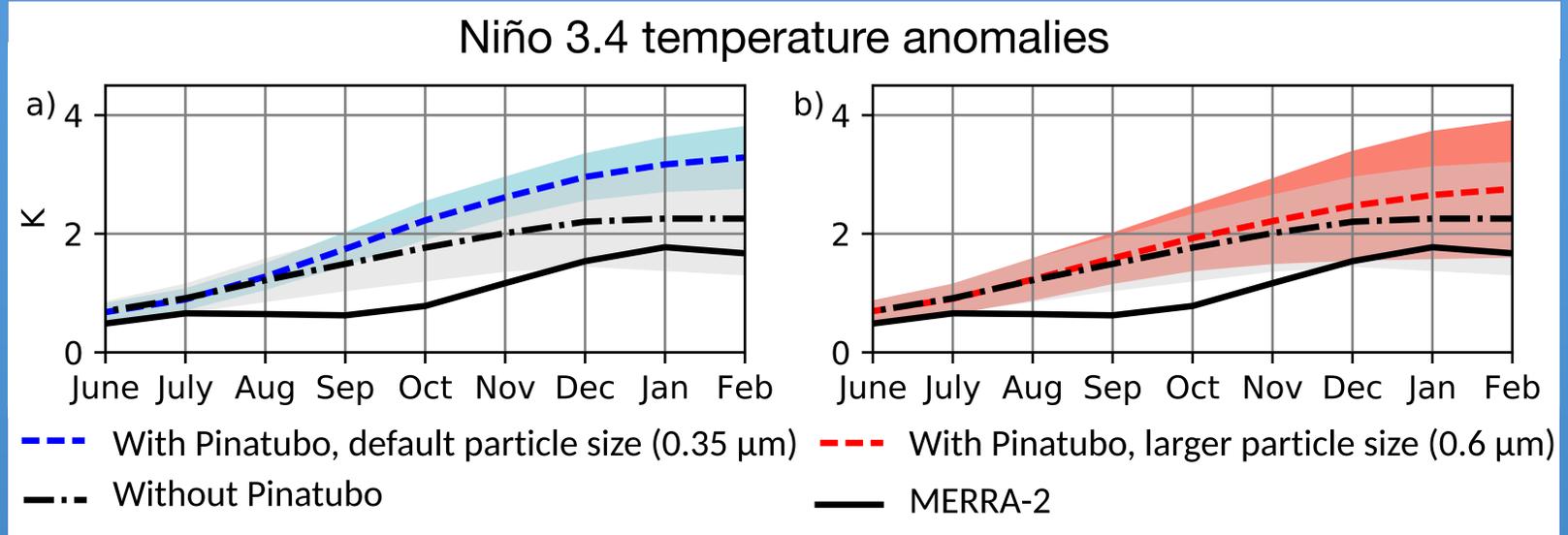
SIMULATIONS

- **noP**: no Pinatubo eruption
- **P_0.35**: default configuration. Radius of volcanic sulfate 0.35 μm.
- **P_0.60**: new configuration. Radius of volcanic sulfate 0.60 μm.

Each experiment consists of 10 ensemble members starting between June 1, 1991 and March 1, 1992. Pinatubo is simulated as an injection of 16 Tg of sulfur dioxide (SO_2) between 18-22 km on June 15, 1991.
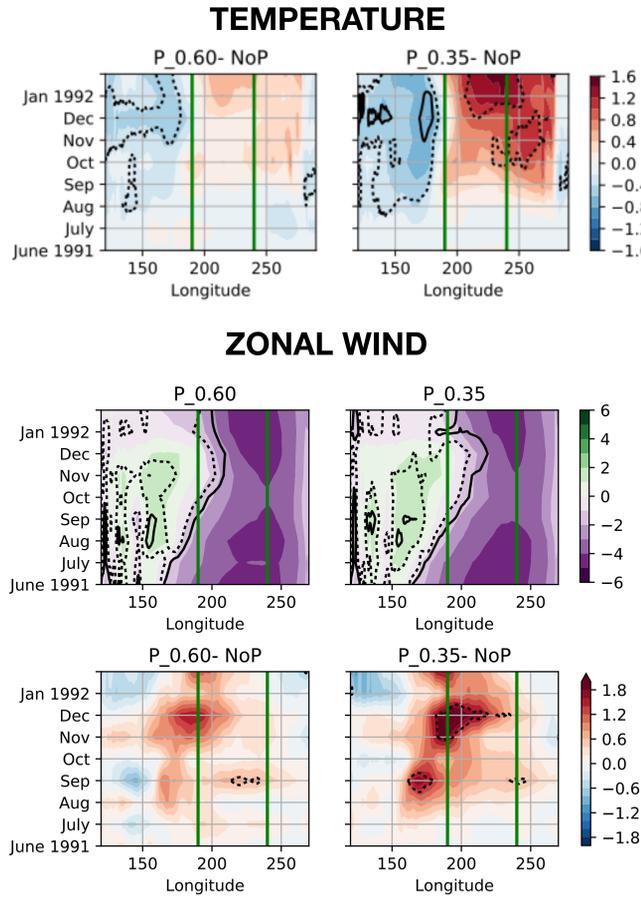
Tropical (20°S-20°N) mean change in surface net shortwave radiation.

P_0.35   P_0.60   MERRA2

The Mt. Pinatubo eruption does not significantly intensifies the seasonal forecasts of El Niño.

IMPACTS OF PINATUBO IN THE EQUATORIAL PACIFIC (5°S-5°N).

Significance: dotted = 1-σ; solid = 2-σ. Difference between simulations with and without Pinatubo

TEMPERATURE

ZONAL WIND

Upper panels: winds in the runs with Pinatubo. Green = westerlies.
Lower panels: anomalies from noP. Red = weaker easterlies or stronger westerlies.

MIXED LAYER DEPTH

Blue: mixed layer is deeper in the simulations with Pinatubo.

Niño 3.4 temperature anomalies

a) b)
June July Aug Sep Oct Nov Dec Jan Feb   June July Aug Sep Oct Nov

- - - With Pinatubo, default particle size (0.35 μm)   - - - With Pinatubo, larger particle
- · - Without Pinatubo   —— MERRA-2

MIXED LAYER ENERGY BUDGET

a) P_0.35 Nino4   b) P_0.35 Nino3
c) P_0.60 Nino4   d) P_0.60 Nino3
[K/month]   JJA SON DJF

dT/dt   Zonal advection   Radiative term
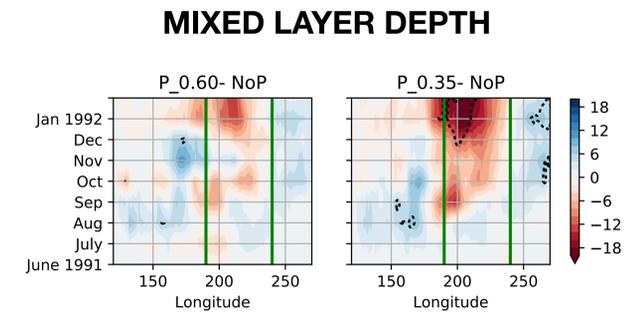Vertical advection   Meridional advection   Residual

The western Pacific Ocean SSTs, driven by radiative balance, cools faster in response to Pinatubo than the eastern Pacific, where the cooling is partly offset by advection. This flattens the temperature gradient, weakens the easterlies, and limits upwelling in the eastern Pacific (ocean dynamical thermostat). While this mechanism leads to a strengthening of El Niño, **the results are only weakly significant in the default GEOS-S2S configuration, and not significant in the update configuration.**