Global microphysical simulations of stratospheric sulfate aerosols after explosive volcanic eruptions

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Large-scale volcanic eruptions can directly inject large amounts of sulfur dioxide (SO_2) into the stratosphere, where the SO_2 is oxidized to form sulfate aerosols. These aerosols have significant impacts on climate by scattering visible radiation and by absorbing near-infrared radiation. Aerosol microphysical properties are a major source of uncertainty for volcanic effects on stratospheric aerosol residence time, temperature anomalies, and ozone anomalies. Previous observation studies have reported a shift to a larger stratospheric aerosol size distribution following large volcanic eruptions. We performed global microphysical simulation of stratospheric sulfate aerosols after the 1963 Mt. Agung and the 1991 Mt. Pinatubo eruptions. The model-observation comparisons demonstrated that the model generally captured well spatial and temporal variations in stratospheric aerosol optical depth (SAOD) derived from the IACETH stratospheric aerosols forcing data set for CMIP6 simulations. The model simulation also showed an increase in effective radius by up to 0.5 μm at Laramie, Wyoming (41˚N, 105˚W) after the 1991 Mt. Pinatubo eruption. In addition, we compared temperature anomalies in the stratosphere after the eruptions between JRA-55 re-analysis data and the model simulations. The model simulations and re-analysis data showed a comparable increase in temperature by about 2 K after the Agung eruption and by about 3 K after the Pinatubo eruption at 50 hPa over the tropics (15˚S-15˚N).

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