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Stratosphere-troposphere coupling: the influence of volcanic eruptions

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Stratospheric sulfate aerosols produced by major volcanic eruptions modify the radiative and dynamical properties of the troposphere and stratosphere through their reflection of solar radiation and absorption of infrared radiation. At the Earth's surface, the primary consequence of a large eruption is cooling, however, it has long been known that major tropical eruptions tend to be followed by warmer than usual winters over the Northern Hemisphere (NH) continents. This volcanic "winter-warming" effect in the NH is understood to be the result of changes in atmospheric circulation patterns resulting from heating in the stratosphere, and is often described as positive anomalies of the Northern Annular Mode (NAM) that propagate downward from the stratosphere to the troposphere. In the southern hemisphere, climate models tend to also predict a positive Southern Annular Mode (SAM) response to volcanic eruptions, but this is generally inconsistent with post-eruption observations during the 20th century. We review present understanding of the influence of volcanic eruptions on the large scale modes of atmospheric variability in both the Northern and Southern Hemispheres. Using models of varying complexity, including an aerosol-climate model, an Earth system model, and CMIP5 simulations, we assess the ability of climate models to reproduce the observed post-eruption climatic and dynamical anomalies. We will also address the parametrization of volcanic eruptions in simulations of the past climate, and identify possibilities for improvement.