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Stratospheric dynamics following the eruption of Mt. Pinatubo

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Large volcanic eruptions at low latitudes such as that of Mt. Pinatubo in June 1991 can lead to massively enhanced stratospheric aerosol loading for up to about two years. The enhanced aerosol loading leads to a global cooling in the troposphere as a result of the larger albedo. In the lower stratosphere, the enhanced aerosol leads to a warming of several Kelvins as a result of enhanced absorbed radiation. It has been argued that the characteristic temperature change from volcanic aerosols in the stratosphere - a warming of the low latitudes relative to the high latitudes - tends to induce a more stable polar vortex, and as such a reduced residual circulation. More recently, however, a number of studies have presented calculations of the residual circulation from meteorological reanalyses that suggest that the residual circulation may have been anomalously strong following the Mt. Pinatubo eruption. Similarly, unexpected ozone anomalies in the Southern Hemisphere stratosphere have been linked to a stronger residual circulation. Here, we will present General Circulation Model results, using models ranging in complexity from a primitive equation model to Chemistry-Climate Models, in combination with reanalysis data that aim to provide a mechanistic understanding of the anomalous stratospheric state following the eruption of Mt. Pinatubo. Of particular interest are the impact on model results of the relatively large differences in heating rate perturbations between different data sets of stratospheric aerosol, and the responses in atmospheric dynamics arising from, on the one hand, the specific sea surface temperature pattern of that period and, on the other hand, the response arising from the stratospheric radiative heating perturbation. Our model results suggest that the adjustment in the stratospheric state in response to the in-situ radiative heating perturbation from the volcanic aerosol is probably insufficient to explain the enhanced residual circulation seen in observations.