Influence of the Mt. Pinatubo eruption on the stratospheric circulation

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On June 15th, 1991 the eruption of Mt. Pinatubo in the Philippines injected about 20 Tg of sulfur dioxide in the stratosphere, which was transformed into sulfuric acid aerosol. Even though stratospheric winds climatologically tend to hinder the air mixing between the two hemispheres, observations have shown that a large part of the SO_2 emitted by Mt. Pinatubo have been transported from the Northern to the Southern Hemisphere. We show how the absorption of radiation by sulfate aerosol is responsible for the spreading to the southern hemisphere through a middle stratospheric channel.
We simulate the eruption of Mt. Pinatubo with the Goddard Earth Observing System (GEOS) version 5 general circulation model, coupled to the aerosol module GOCART and the stratospheric chemistry module StratChem. Our simulations are in good agreement with SAGE-II and AVHRR data. We perform two ensembles of simulations: the first ensemble consists of runs without coupling between aerosol and radiation. In these simulations the plume of aerosols is treated as a passive tracer and the atmosphere is unperturbed. In the second ensemble of simulations aerosols and radiation are coupled. We show that the set of runs with interactive aerosol produces a larger cross-equatorial transport of the Pinatubo cloud, in agreement with the observations. At first, the volcanic cloud is transported from the latitude of the eruption to both hemispheres through a lower stratospheric pathway. Additionally, in the interactive simulations the absorption of long wave radiation from the volcanic sulfate induces a lofting of the cloud to the middle atmosphere and, at the same time, a divergent motion from the center of the cloud. Such motion spreads the volcanic cloud across the equator and to the tropics, where the background circulation carry it to higher latitudes.