The Climate Response due to Violent Volcanic Eruptions and the Limits of its Estimation for Middle and High Latitudes

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The combination of model experiments, data assimilation and the analysis of the increments from the reanalysis project allows a more detailed view into the dynamical feedback of violent volcanic eruptions. As an example the year after the Pinatubo eruption was studied. The analysis was partly extended for the year after the El Chichon eruption.

The circulation response in the lower stratosphere is consistent with earlier studies. But it is more local and restricted more to the tropics and subtropics near the instantaneous heating source than expected. The QBO will modify the signature of the heating in the lower tropical stratosphere, but the subtropical part of the volcanic aerosol signature is well visible.

Independent from the boundary conditions the meridional circulation response in the lower stratosphere was build up with the additional aerosol loading. The adiabatic warming in the upper troposphere over the subtropics and the increased westward flow on the equatorward side of the subtropical jet streams are a stable signature in the zonal mean flow field.

In the tropics the lower stratospheric aerosol heat source controls the strength of the upward branch of the Walker circulation but not its regional position, which is strongly correlated to the Pacific sea surface temperature (SST) as shown in the simulation results. The SST is modifying the transformation of the aerosol signal to higher latitudes. Due to differences of the circulation regime in middle latitudes between the real world and the model the simulated response in high latitudes is uncertain and non-deterministic.