



Supplement of

Impact of major volcanic eruptions on stratospheric water vapour

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This supplement provides the results of additional sensitivity simulations, of which the model setups are summarised in Table S1. Details about the model setups are described in Section 2.2 of the main manuscript, and the results are discussed in Section 3 of the main manuscript.

Table S1: Description of simulation pairs, one including the stratospheric aerosol extinction and one excluding it.

simulation pair	description of setup
FC	original (nudged) simulations with full chemistry
RE	remake simulations (nudged) with prescribed monthly average chemistry
\mathbf{QF}	quasi free running simulations with prescribed monthly average chemistry
	and nudging of (logarithm of) surface pressure, only
LA	low a erosol (nudged) simulations with prescribed monthly average chemistry
	and by a factor of 0.5 reduced aerosol optical depth



Figure S1: Zonally averaged heating rates $[K d^{-1}]$ as differences (VOL-NOVOL) in the tropics (5°S–5°N) for the Mount Pinatubo eruption. Upper left panel: original simulation (nudged) with full chemistry (FC), upper right panel: "remake" simulation with prescribed chemistry (RE), lower left panel: "quasi free" running simulation (QF), and lower right panel: "low aerosol" simulation (LA). Contours indicate absolute temperature changes (interval 0.5 K) due to the heating rates.



Figure S2: Temperature [K] differences (VOL-NOVOL) for the tropics $(5^{\circ}S-5^{\circ}N)$, zonally averaged after the June 1991 Mount Pinatubo eruption for 20 hPa (upper panel), 30 hPa (middle panel) and 50 hPa (lower panel). The different simulation pairs are coloured as labelled in the upper panel.



Figure S3: Zonally averaged differences (VOL-NOVOL) in temperature (upper panel), pressure (middle panel) and specific humidity (lower panel) at the cold point in the tropics (5°S-5°N), zonally averaged for the Mount Pinatubo period. The different simulation pairs are coloured as labelled in the upper panel.



Figure S4: Differences (VOL-NOVOL) in water vapour [ppmv] for the tropics (5° S- 5° N), zonally averaged after the June 1991 Mount Pinatubo eruption for the 80 hPa level. The different simulation pairs are coloured as indicated.



Figure S5: SWV [ppmv, colours] as absolute differences (VOL-NOVOL) zonally averaged near the 90 hPa level for the Mount Pinatubo period (1991–1995) for the different simulation pairs as indicated. Contours indicate relative changes in water vapour (interval 5%) compared to the background value of NOVOL. The different simulation pairs are labelled according to Table S1.



Figure S6a: Left column: SWV [ppmv, colours] as absolute differences (VOL-NOVOL), zonally averaged as a near global (60° S- 60° N) vertical cross-section at a height between 120 and 20 hPa for the months of June, July and August in the year following the eruption of Mount Pinatubo. White contours indicate the relative increase in SWV (intervals 5, 10, 20 and 50 %) compared to the background value of NOVOL. Right column: SWV [ppmv, colours] as absolute differences (VOL-NOVOL) as a near global (60° S- 60° N) horizontal cross-section at 75 hPa for the month of August in the year of the eruption and in the following two years. White contours indicate the relative increase in SWV (intervals 5, 10, 20 and 50 %) compared to the background value of NOVOL. Shown are the results of the simulation pair FC.



Figure S6b: Shown are the results of the simulation pair **RE**.



Figure S6c: Shown are the results of the simulation pair QF.



Figure S6d: Shown are the results of the simulation pair LA.



Figure S7: SWV [ppmv, colours] as absolute differences (VOL-NOVOL) in the tropics ($5^{o}S-5^{o}N$), zonally averaged for the 1991 Mount Pinatubo eruption. Contours indicate relative changes of water vapour (interval 5 %) compared to the background value of NOVOL. The different simulation pairs are labelled according to Table S1.



Figure S8: Upwelling $[10^{-6} \text{ Pa s}^{-1}]$ as absolute differences (VOL-NOVOL) in the tropics $(20^{\circ}\text{S}-20^{\circ}\text{N})$ for the 1991 Mount Pinatubo eruption. The different simulation pairs are labelled according to Table S1.