Additional material to “Stratospheric SO$_2$ and sulphate aerosol, model simulations and satellite observations” by Brühl et al.

1 Tropospheric aerosol

Provided are integral quantities of the actual simulation from 2002 to 2007 with the adjusted settings for the mode boundaries like tropospheric burdens (Figs. 1 and 2) and aerosol optical depth (Fig. 3) for comparison with results and observations shown in Pringle et al. (2010, their figures 6, 7 and 15).

2 Pinatubo aerosol

Provided are the microphysical properties of the simulation initialized with zonal average SO$_2$ at the beginning of September (after most of lofting, Figs. 4 and 5) and of the sensitivity simulation initialized at the beginning of July (before lofting, Figs. 6 and 7) locally. Further simulated enhanced upward transport of gas and aerosol tracers in the aerosol plume is shown (Fig. 8) and the extinction as observed by lidar (Heckendorn et al., 2009) and SAGE, and simulated by EMAC (sensitivity and high scenario, with feedback to dynamics, Fig. 9).

3 Background aerosol and medium volcanic eruptions

Figure 10 depicts the monthly mean percentage difference between EMAC and SAGE aerosol mixing ratio with and without organic carbon. The large values at the times of volcanic eruptions are due to slight temporal and vertical shifts. Figure 11 shows zonal mean effective wet radius and number concentration in the accumulation mode. Here coarse mode is not present in the stratosphere.
Fig. 1. Annual average tropospheric burden of black carbon (BC), organic carbon (OC), dust (DU) and sea salt (SS) aerosol, integrated from the surface to 14 km altitude.
Fig. 2. Annual average tropospheric burden of sulphate (with and without lower stratospheric contribution), ammonia and aerosol water.
Fig. 3. Annual average tropospheric aerosol optical depth at 530nm for comparison with MODIS satellite data

4 Stratospheric \(\text{SO}_2\)

Monthly average simulation results and percentage differences to MIPAS are given in Figs. 12 to 15. Figures 16 and 17 show results of the sensitivity study with DMS (Dimethylsulfide).

5 References

Fig. 4. Zonal mean effective wet radius and number concentration in the accumulation mode.
Fig. 5. Zonal mean effective wet radius and number concentration in the coarse mode
Fig. 6. Zonal mean effective wet radius and number concentration in the accumulation mode, detailed sensitivity study
Fig. 7. Zonal mean effective wet radius and number concentration in the coarse mode, detailed sensitivity study
Fig. 8. Zonal mean water vapor (tropical tape recorder), N$_2$O, SO$_2$ and sulphate, lofting by enhanced tropical upwelling due to aerosol radiative heating
Fig. 9. Extinction at 1 μm at 18°N, observed by lidar and SAGE (upper row) and calculated by EMAC (lower row, left sensitivity, right high scenario)
Fig. 10. Monthly mean percentage difference between EMAC and SAGE aerosol mixing ratio with and without organic carbon
Fig. 11. Zonal mean effective wet radius and number concentration in the accumulation mode, background and medium tropical volcanoes
Fig. 12. Monthly mean simulated SO₂ in the tropics and percentage difference to MIPAS
Fig. 13. Monthly mean simulated SO$_2$ at 22km and percentage difference to MIPAS
Fig. 14. Monthly mean simulated SO$_2$ at 31km and percentage difference to MIPAS
Fig. 15. Monthly mean simulated $SO_2$ at 40km and percentage difference to MIPAS
**Fig. 16.** Annual average calculated DMS mixing ratio at altitude of the tropical tropopause
Fig. 17. Upper: \( \text{SO}_2 \) at altitude of the tropical tropopause with DMS and tropospheric volcanoes (peaks at Andes and Papua Guinea). Lower: Annual average \( \text{SO}_2 \) from oxidation of DMS