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.

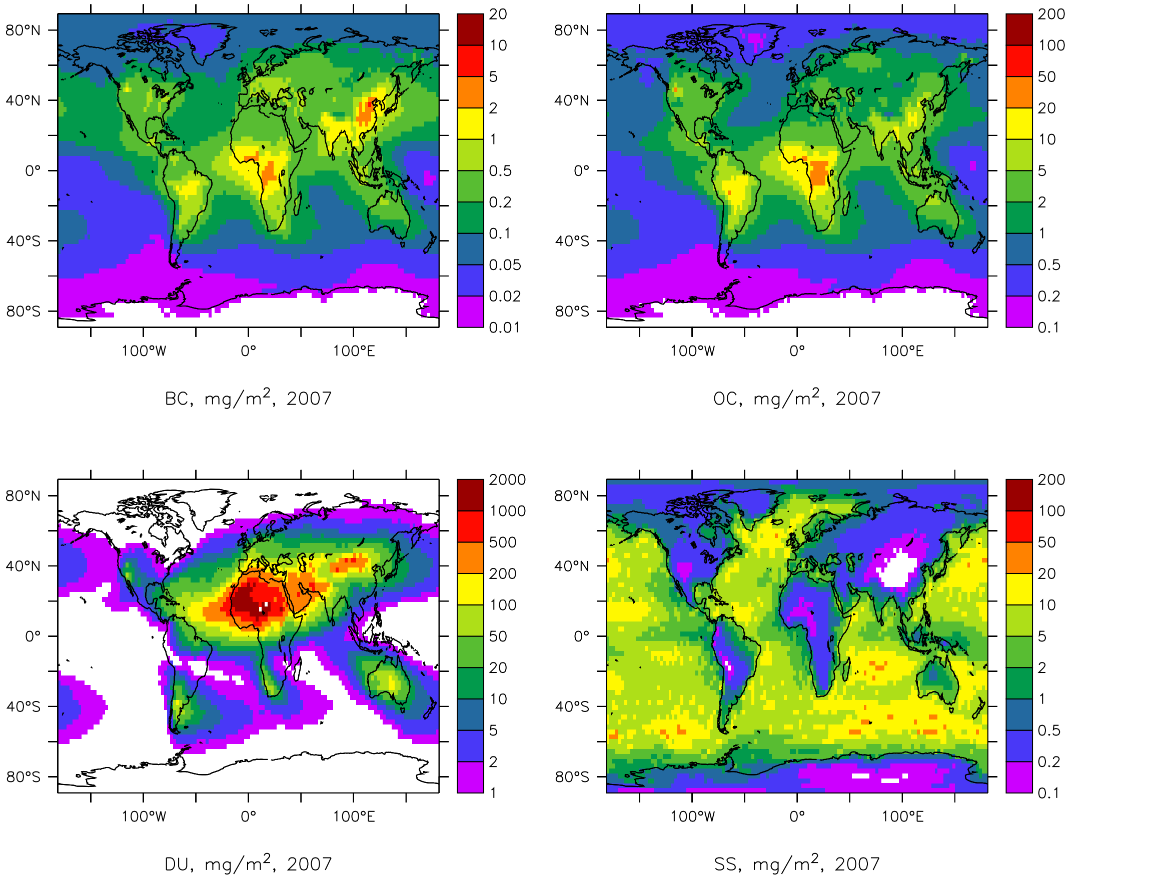

Fig. 1. Annual average tropospheric burden of black carbon (BC), organic carbon (OC), dust (DU) and sea salt (SS) aerosol, integrated from the surface to 14 km altitude

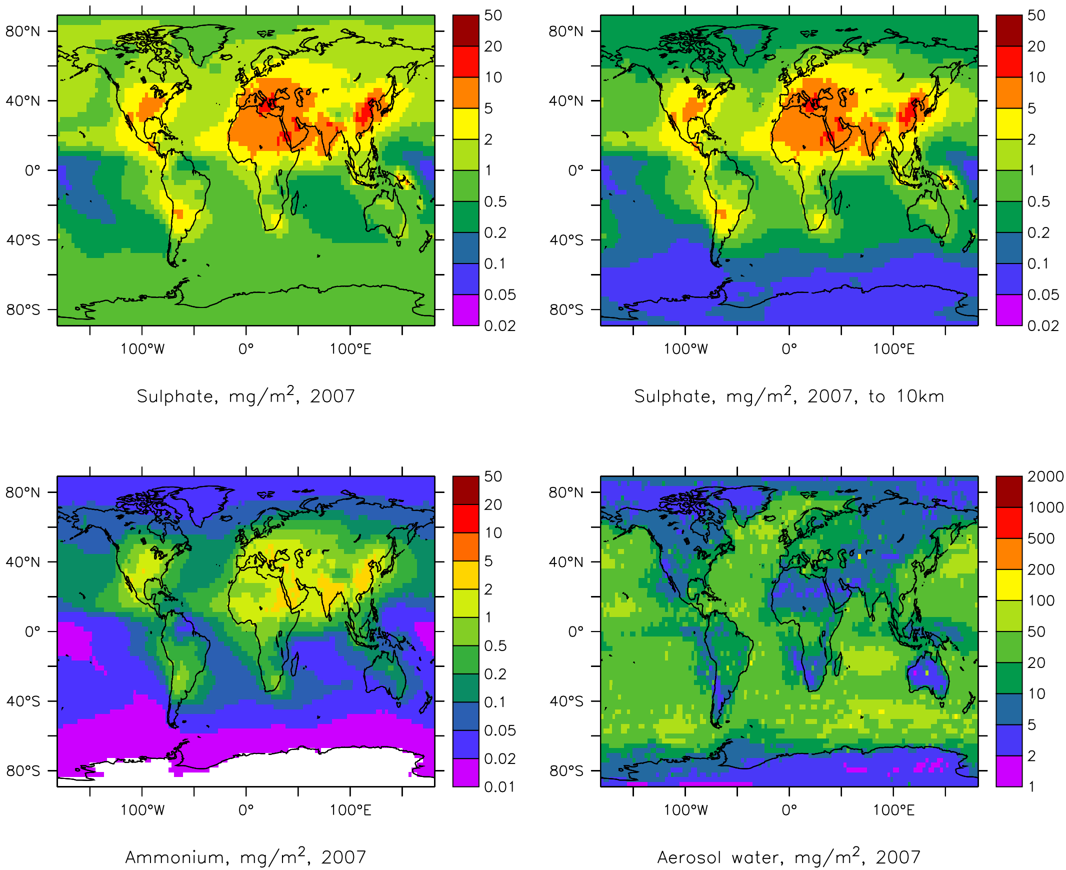

Fig. 2. Annual average tropospheric burden of sulphate (with and without lower stratospheric contribution), ammonia and aerosol water

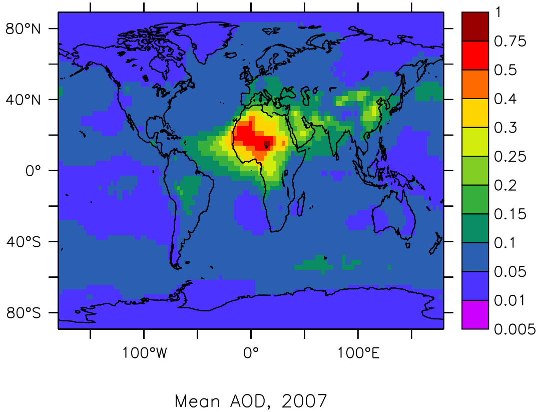

Fig. 3. Annual average tropospheric aerosol optical depth at 530nm for comparison with MODIS satellite data

4 Stratospheric 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

Heckendorn, P., D. Weisenstein, S. Fueglistaler, B. P. Luo, E. Rozanov, M. Schraner, L. W. Thomason and T. Peter: The impact of geoengineering aerosols on stratospheric temperature and ozone. Environ. Res. Lett. 4, 045108, 2009.

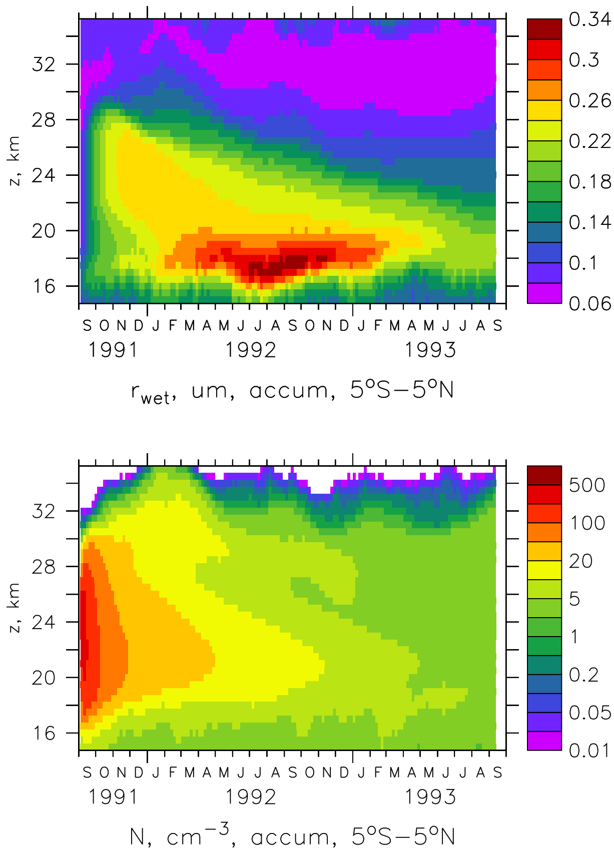

Fig. 4. Zonal mean effective wet radius and number concentration in the accumulation mode

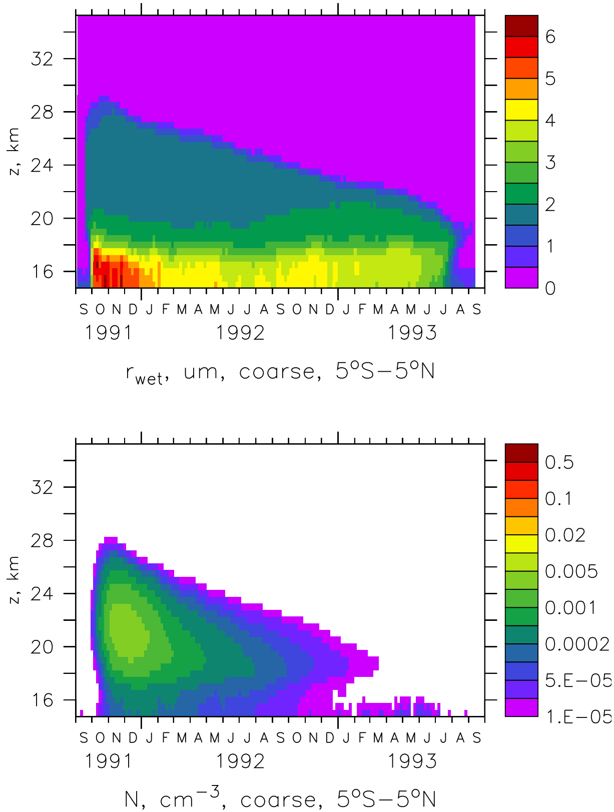

Fig. 5. Zonal mean effective wet radius and number concentration in the coarse mode

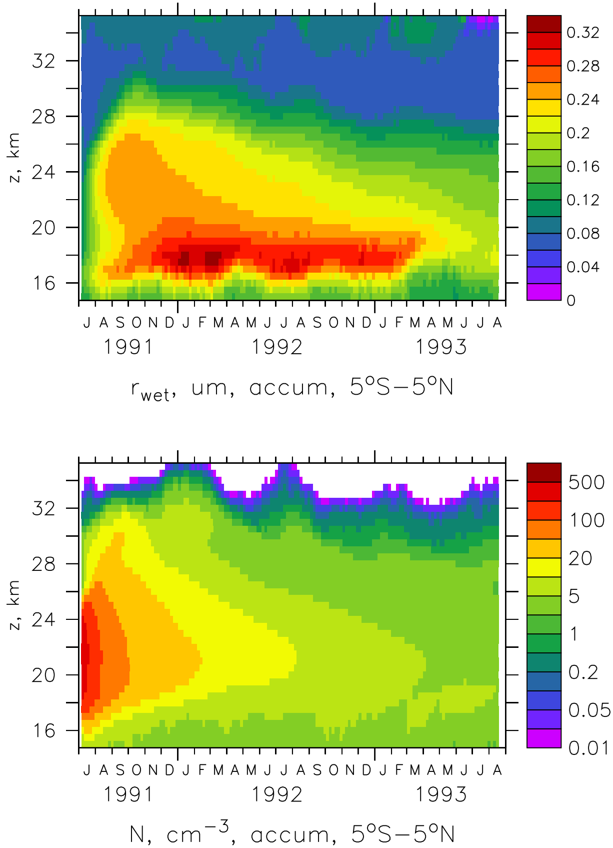

Fig. 6. Zonal mean effective wet radius and number concentration in the accumulation mode, detailed sensitivity study

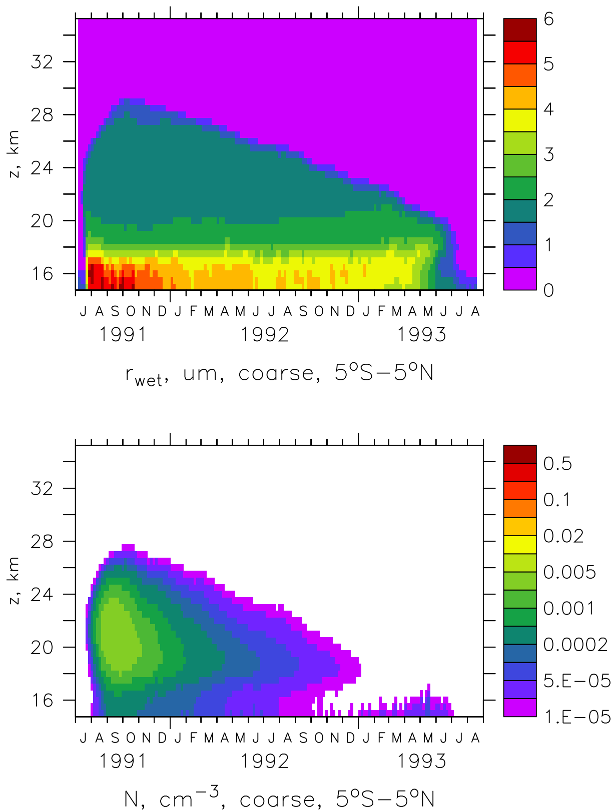

Fig. 7. Zonal mean effective wet radius and number concentration in the coarse mode, detailed sensitivity study

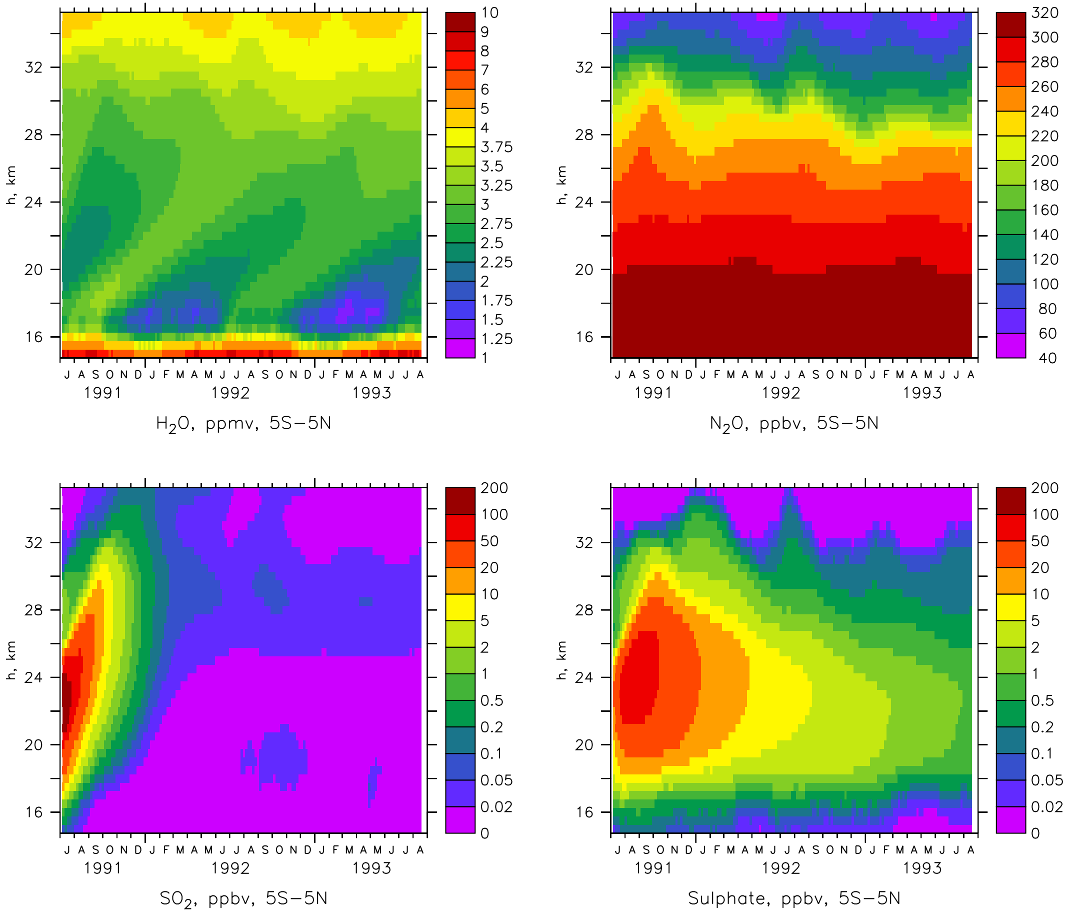

Fig. 8. Zonal mean water vapor (tropical tape recorder), N_2O, SO_2 and sulphate, lofting by enhanced tropical upwelling due to aerosol radiative heating

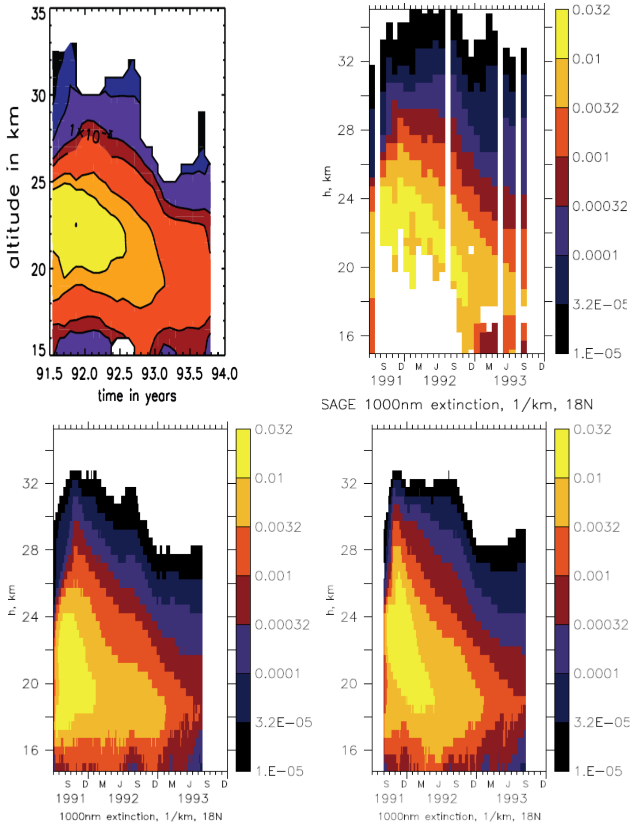

Fig. 9. Extinction at 1 μm at 18^{o}N, observed by lidar and SAGE (upper row) and calculated by EMAC (lower row, left sensitivity, right high scenario)

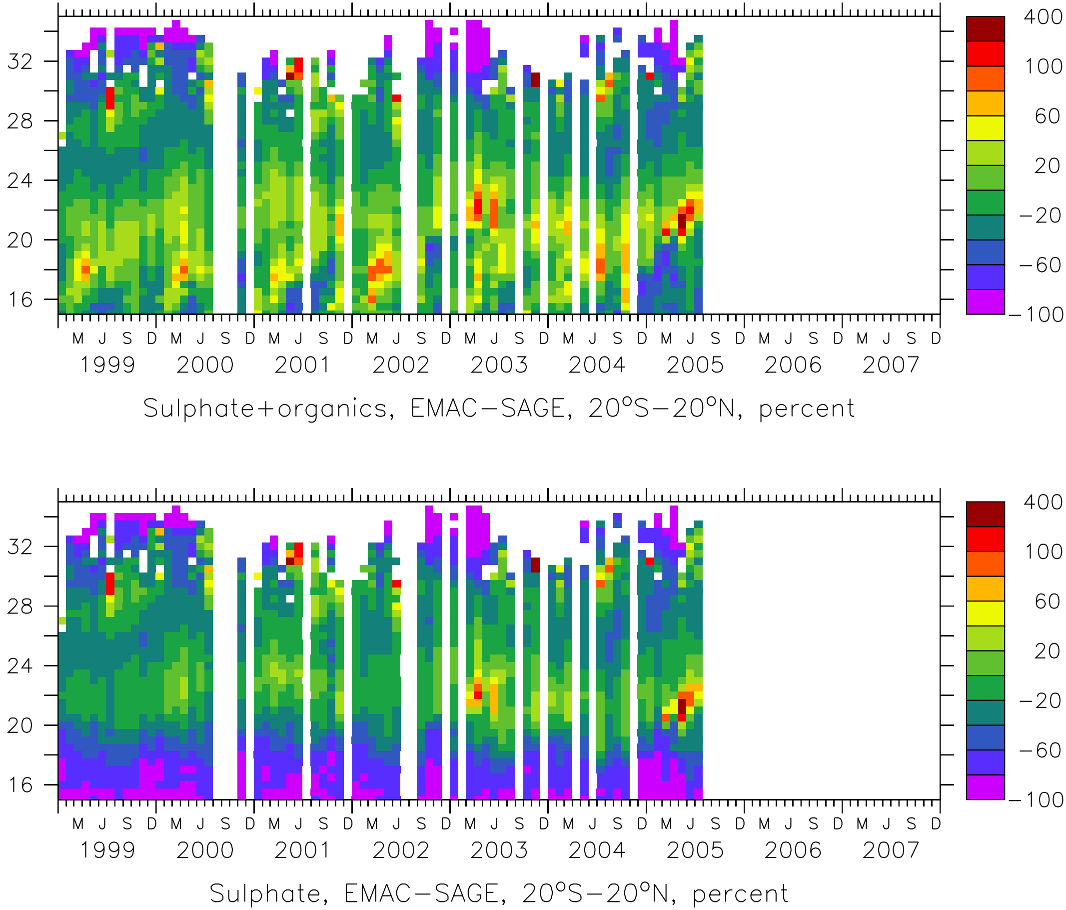

Fig. 10. Monthly mean percentage difference between EMAC and SAGE aerosol mixing ratio with and without organic carbon

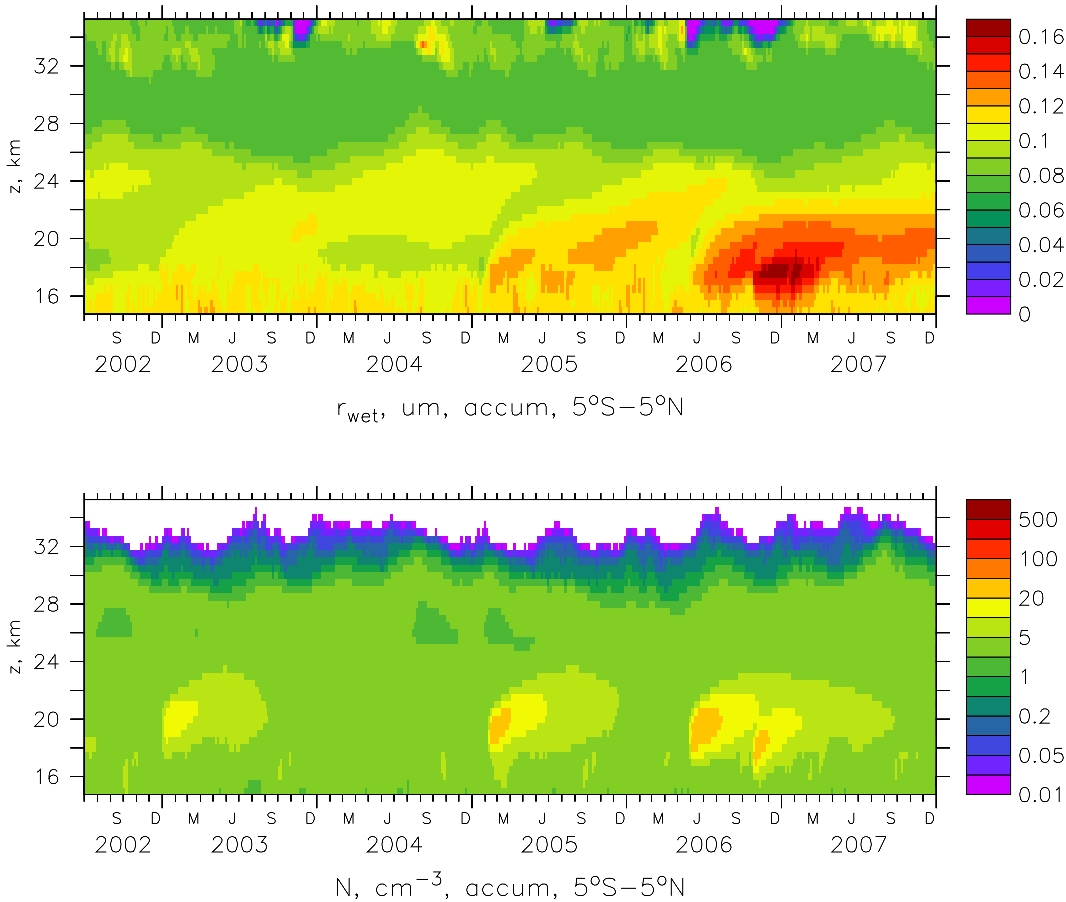

Fig. 11. Zonal mean effective wet radius and number concentration in the accumulation mode, background and medium tropical volcanoes

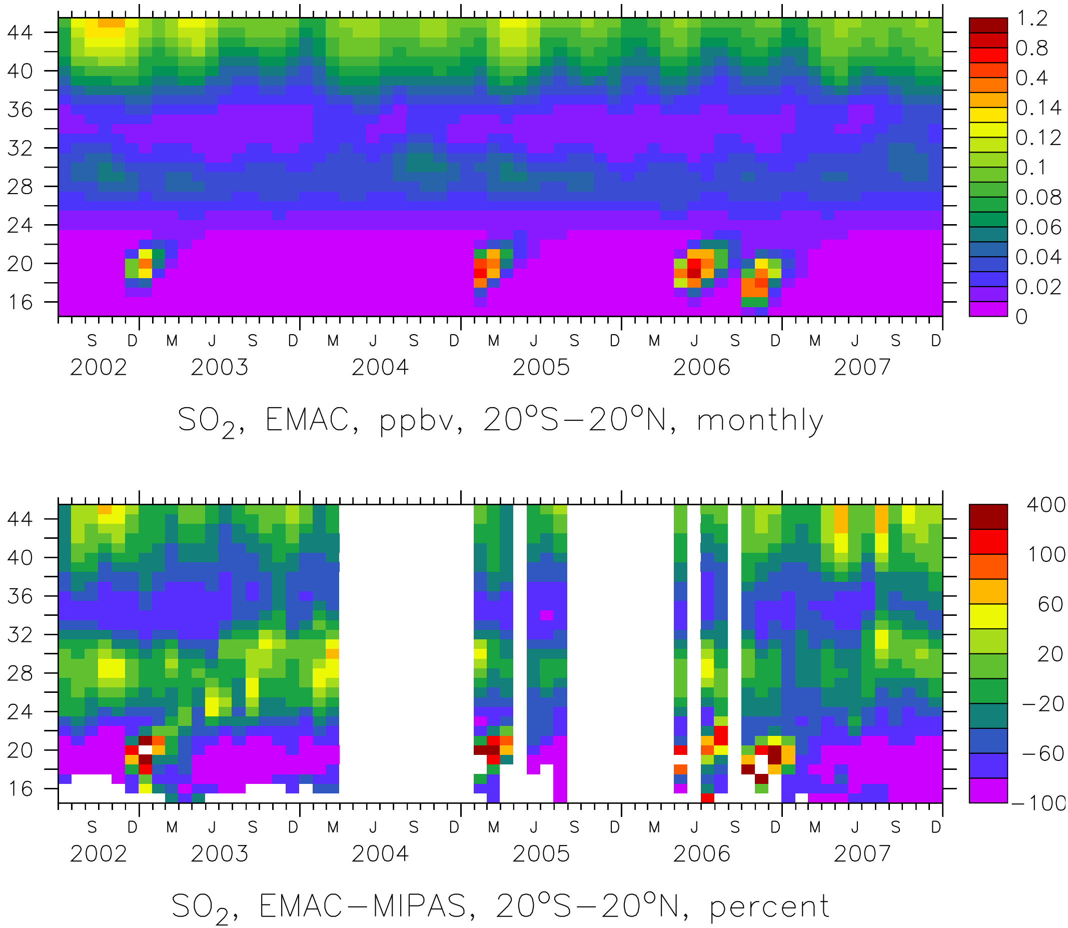

Fig. 12. Monthly mean simulated SO_2 in the tropics and percentage difference to MIPAS

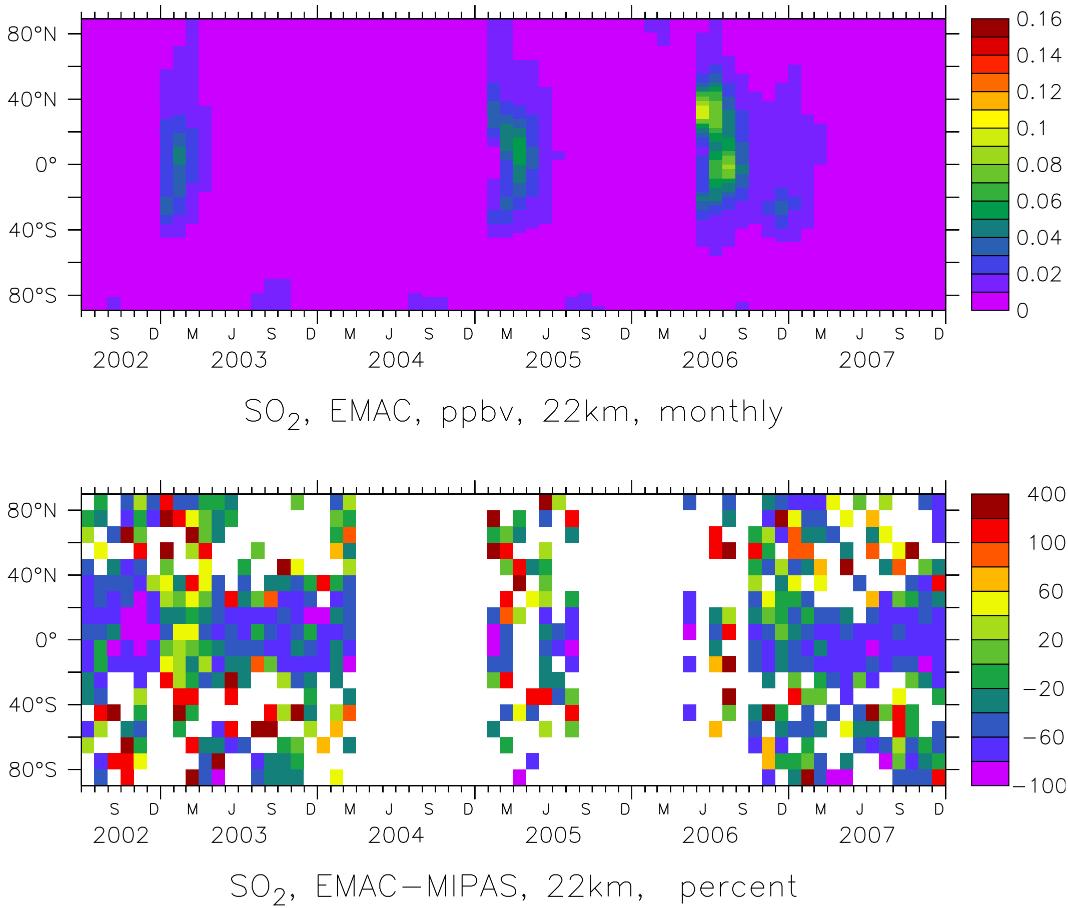

Fig. 13. Monthly mean simulated SO_2 at 22km and percentage difference to MIPAS

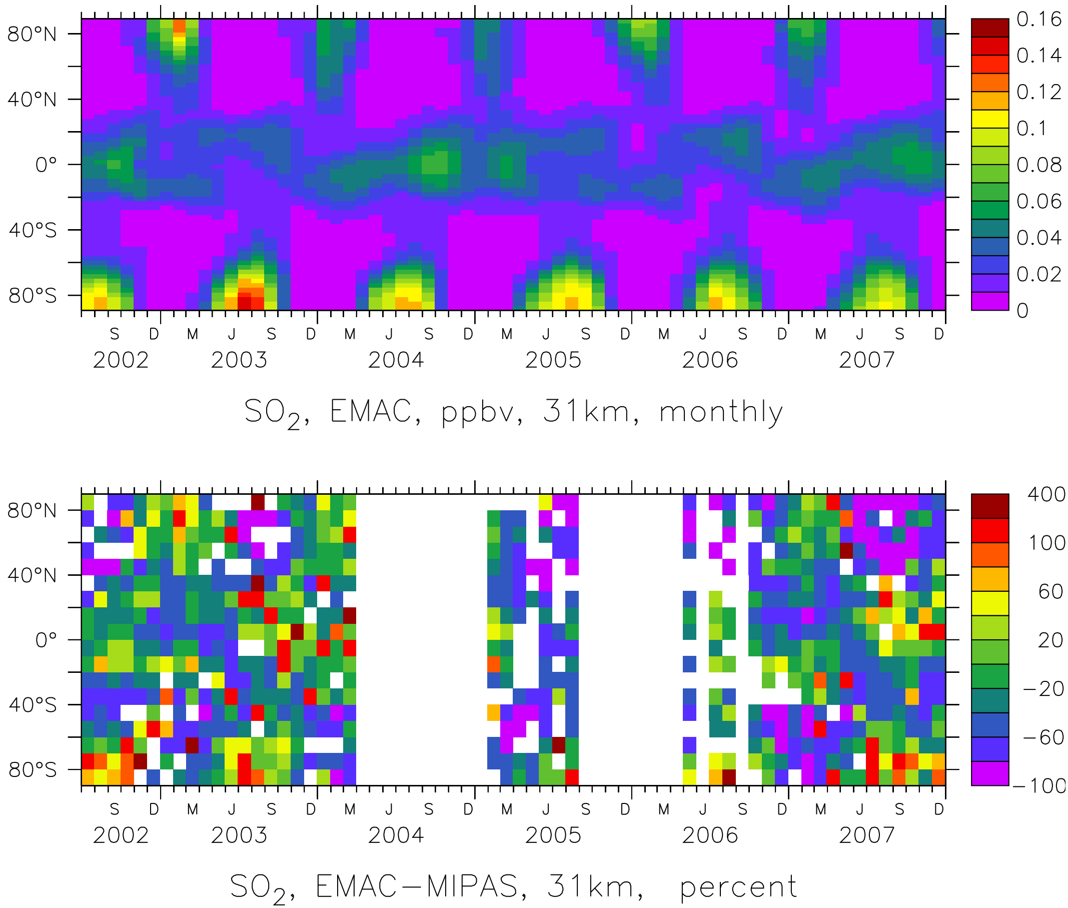

Fig. 14. Monthly mean simulated SO_2 at 31km and percentage difference to MIPAS

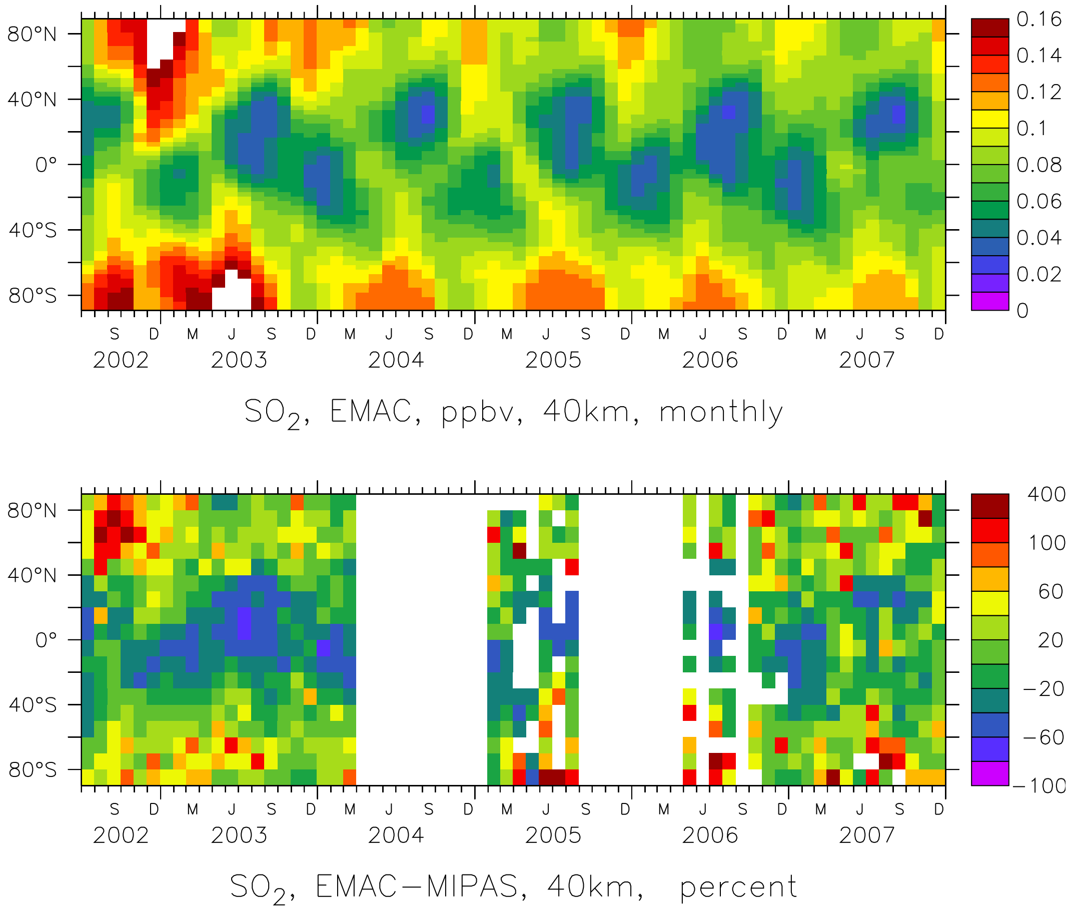

Fig. 15. Monthly mean simulated SO_2 at 40km and percentage difference to MIPAS

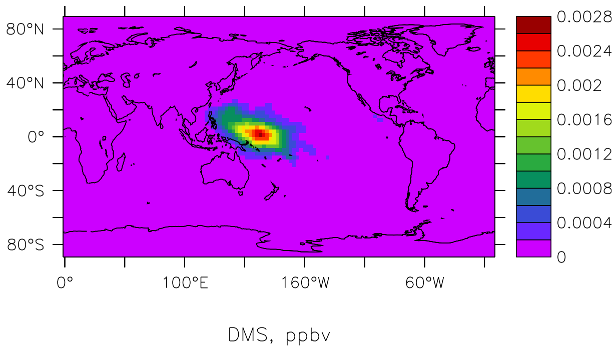

Fig. 16. Annual average calculated DMS mixing ratio at altitude of the tropical tropopause

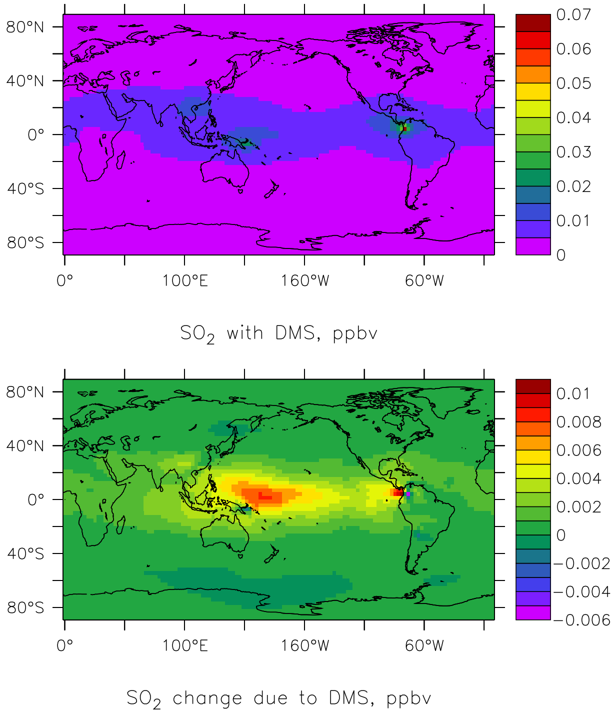

Fig. 17. Upper: SO_2 at altitude of the tropical tropopause with DMS and tropospheric volcanoes (peaks at Andes and Papua Guinea). Lower: Annual average SO_2 from oxidation of DMS