STRATOSPHERIC AEROSOLS

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° **WP_AER_1** : Implementation of the direct physical aerosol model in the ECMWF model

Task 1.2: Implementation of parameterisations for stratospheric aerosols

D_AER_1.1/2/3: Test simulations to be evaluated by WP_ AER_4

° **WP_AER_2** Refinement of aerosol emission sources

Task 2.5. Sources of stratospheric aerosols

D_AER_2.1: Global emission database of aerosols and its pre-cursors

° **WP_AER_3**: Aerosol data assimilation

Task 3.2b: Stratospheric (height-resolved) aerosol products

D_AER_3.2: Comparison of analyses without and with assimilation SAGE derived aerosol products

° **WP_AER_2** Refinement of aerosol emission sources

Task 2.5. Sources of stratospheric aerosols

D_AER_2.1: Global emission database of aerosols and its pre-cursors

OCS = 512 pptv (no seasonal or spatial variations initially)
+ lumped (SO2+H2S+DMS) gas-phase tracer (constant stratospheric lifetime initially)
+ volcanic SO2 injections (TOMS columns; vertical distribution?)

° **WP_AER_3**: Aerosol data assimilation

Task 3.2b: Stratospheric (height-resolved) aerosol products

D_AER_3.2: Comparison of analyses without and with assimilation SAGE derived aerosol products

SAGE data available (validation data, no real time)
CALIPSO?

Parameterisations of stratospheric aerosols (WP_AER_1, Task 1.2)

1-moment scheme (initial phase):

Assume log-normal size distribution of H_2SO_4/H_2O aerosols
= f (total number N_o, width σ , mode radius R_{mod}, composition WP_{H2SO4})

Prognostic variables: Total H_2SO_4 (gas-phase+condensed), WP_{H2SO4}
Processes: Transport + Chemistry + Aerosol microphysics
(sedimentation, no explicit treatment of nucleation and coagulation)

1/ **Photochemical production of H_2SO_4 from OCS/SO2 oxidation**
° *[weekly climatologies from full model]*
° WP_{H2SO4} = f(T, humidity) *[look-up table from full model]*

2/ **N_o derived from Total H_2SO_4, WP_{H2SO4}, and R_{mod}**
° σ and R_{mod} *[weekly climatologies from full model]*

3/ **H_2SO_4 partitioning between gas phase and aerosol phase**: N_o scaled
if P(Total H_2SO_4) < SVP(H_2SO_4) [=*f(activity, WP_{H2SO4}, T)]*
N_o=0
else
N_o= N_o * [P(Total H_2SO_4) - SVP(H_2SO_4)]/ P(Total H_2SO_4)
endif

4/ **Effect of sedimentation on Total H_2SO_4**
24 bins: $N_{aerosol}$= f (N_o, σ , R_{mod})

Full aerosol microphysical model in 1, 2 or 3-D CTM

Size distribution of H_2SO_4/H_2O aerosols

Prognostic variables: 26 size bins ($0.01 < R_i, < 2.5$ um), Number N_i, composition WP_{H2SO4}

Processes: Transport + Chemistry + Aerosol microphysics (nucleation, condensation/evaporation of H_2SO_4/H_2O, coagulation, sedimentation)

° Both (full and 1-moment) schemes inserted in the SA-UPMC global 2D CTM

° Full scheme has been fully assessed:
SPARC intercomparison (2D and 3D models)
comparison against satellite, balloon and lidar measurements.
(SPARC ASA report)
-> acts as a benchmark for the 1-moment scheme

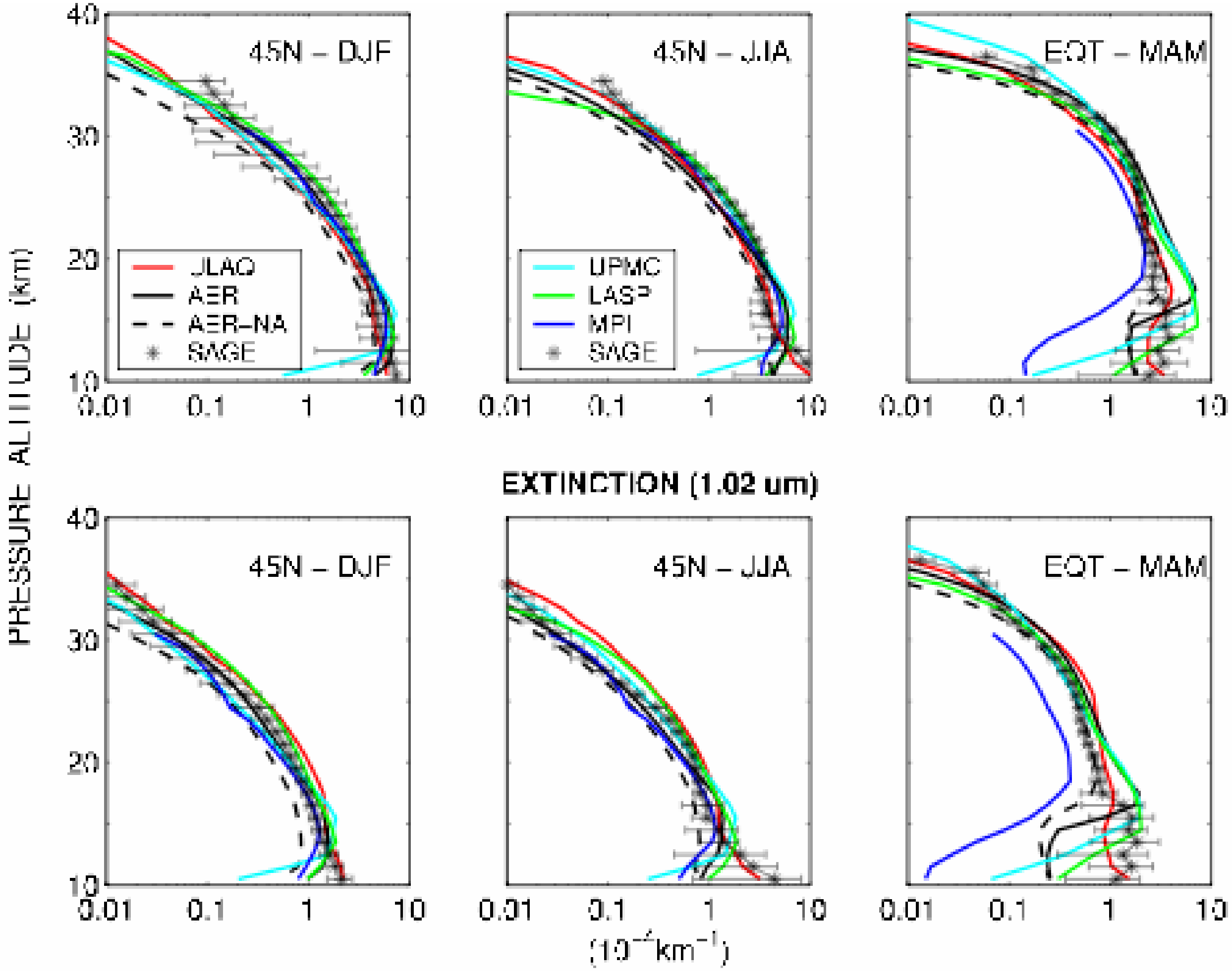


Figure 8.18: Aerosol extinction profiles (10^{-4} km^{-1}) at 0.525 and 1.02 μm for winter at 45°N, summer at 45°N, and March, April and May at the equator. SAGE II data for 1995-2000 are shown by symbols with error bars, model results by colored lines.

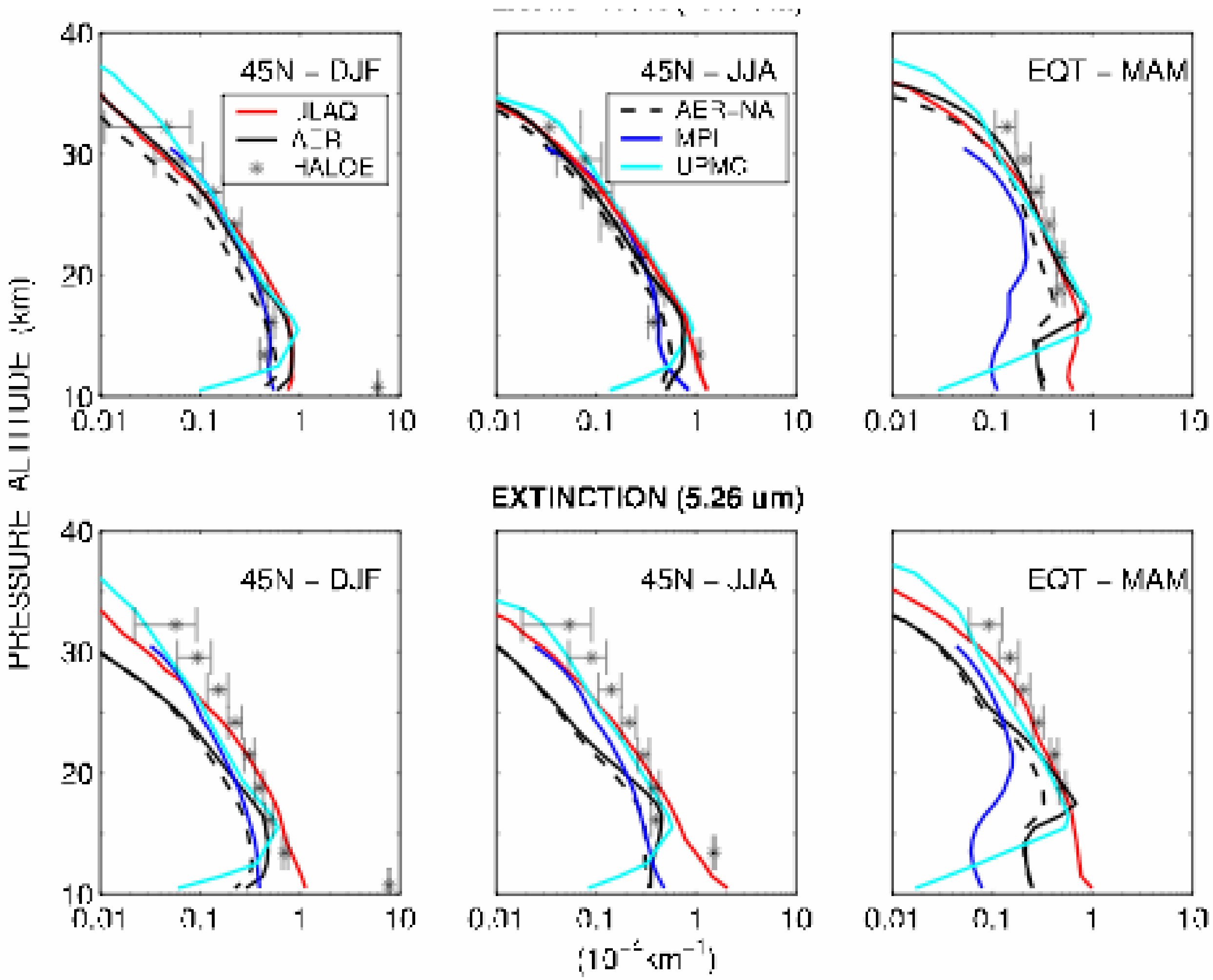


Figure 6.17: Aerosol extinction profiles (10^{-4} km^{-1}) at 3.46 and 5.26 μm for winter at 45°N, summer at 45°N, and March, April and May at the equator. HALOE data for 1996-2000 are shown by symbols with error bars, model results by colored lines.

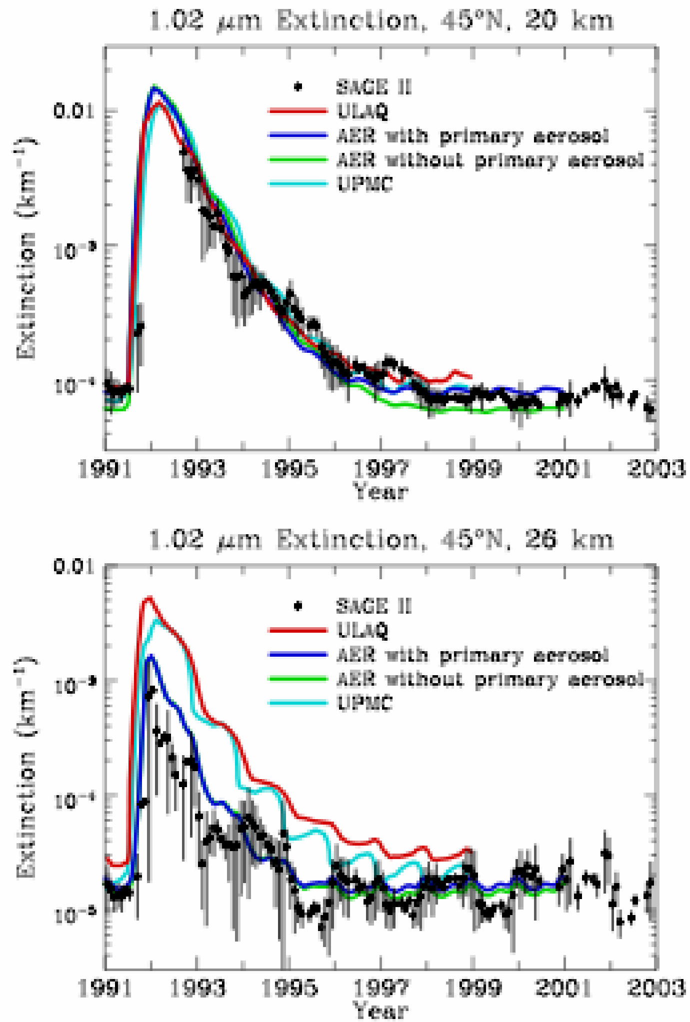
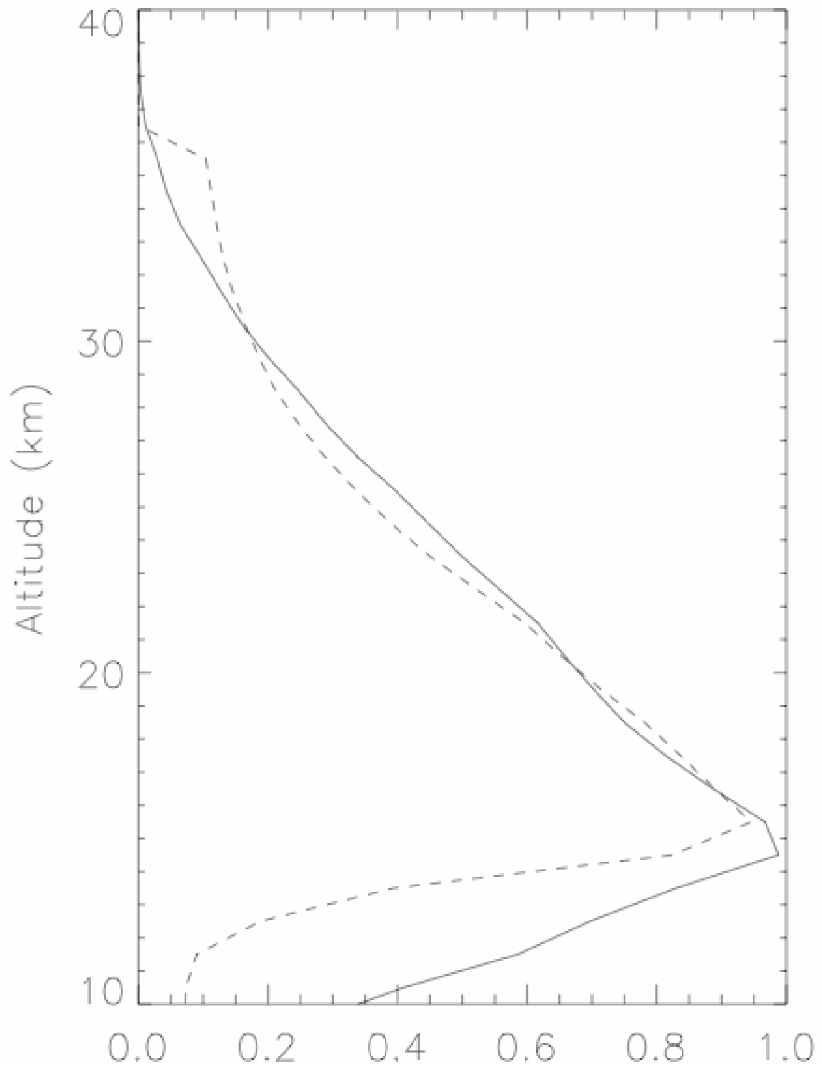


Figure 6.32: Aerosol extinction at 1.02 μm for 1991 to 2002 at (a) 45°N and 20 km and (b) 45°N and 26 km. SAGE II data are shown by symbols, model results by colored lines.

45N, August



Surface area density (um^2.cm^{-3})

Full scheme:

1-moment scheme:
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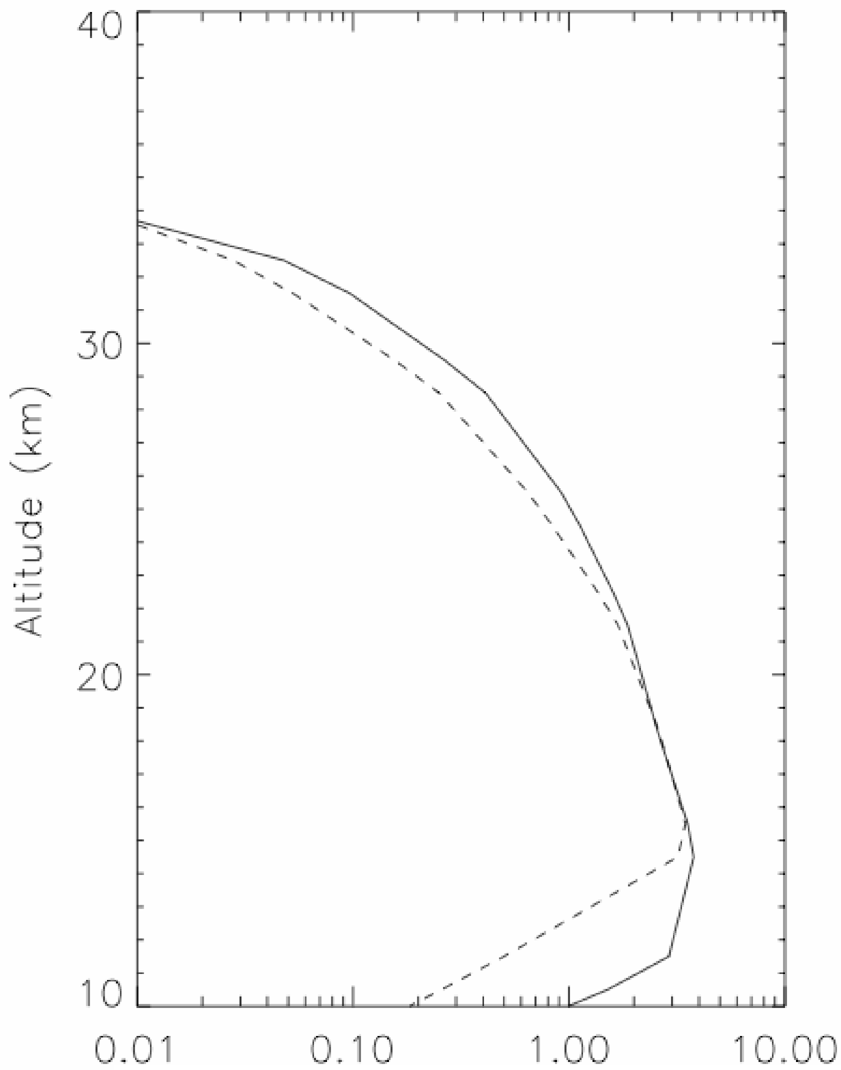
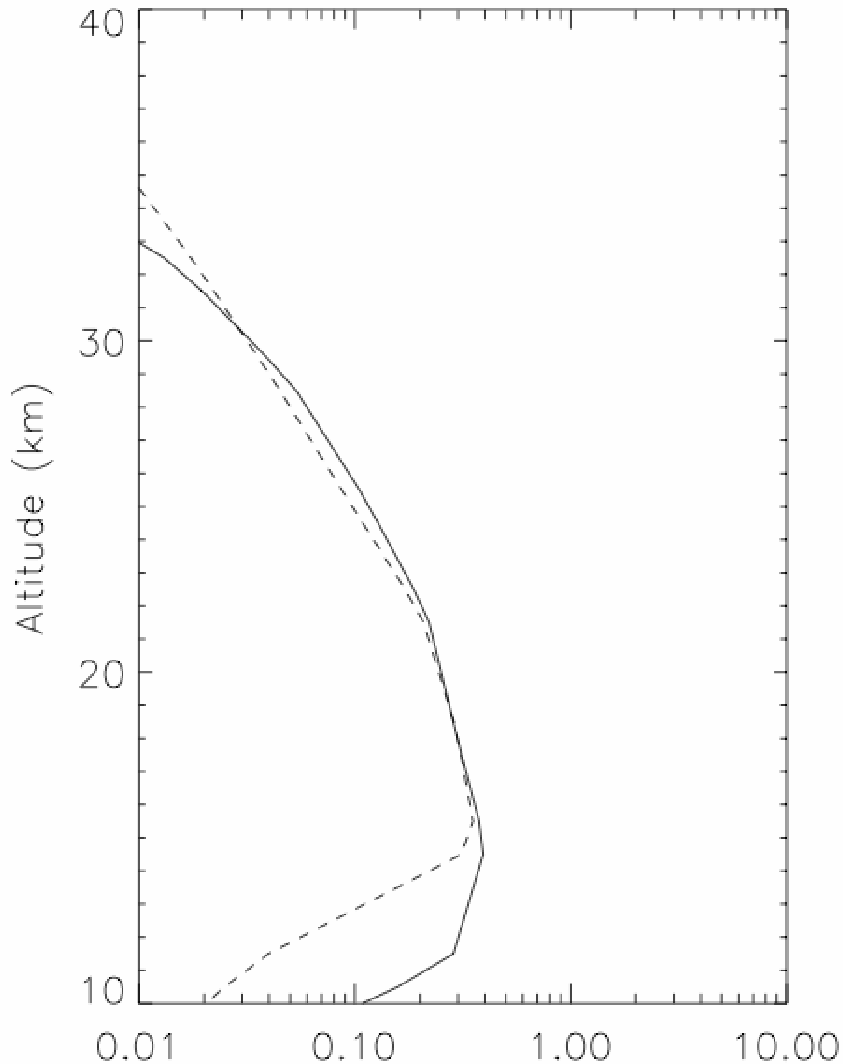
45N, August



Extinction ($10^{-4} km^{-1}$) at 0.52 um (SAGE)

45N, August



Extinction ($10^{-4} km^{-1}$) at 3.4 um (HALOE/UARS)

ON-GOING/FUTURE WORK

° A 2-moment scheme is being coded and tested
(more degrees of freedom, more problems)

° Can the scheme be coupled, or even merge, to the tropospheric aerosol scheme, perhaps outside the ECMWF model (in LMDz)?