Modelling the Pinatubo aerosols

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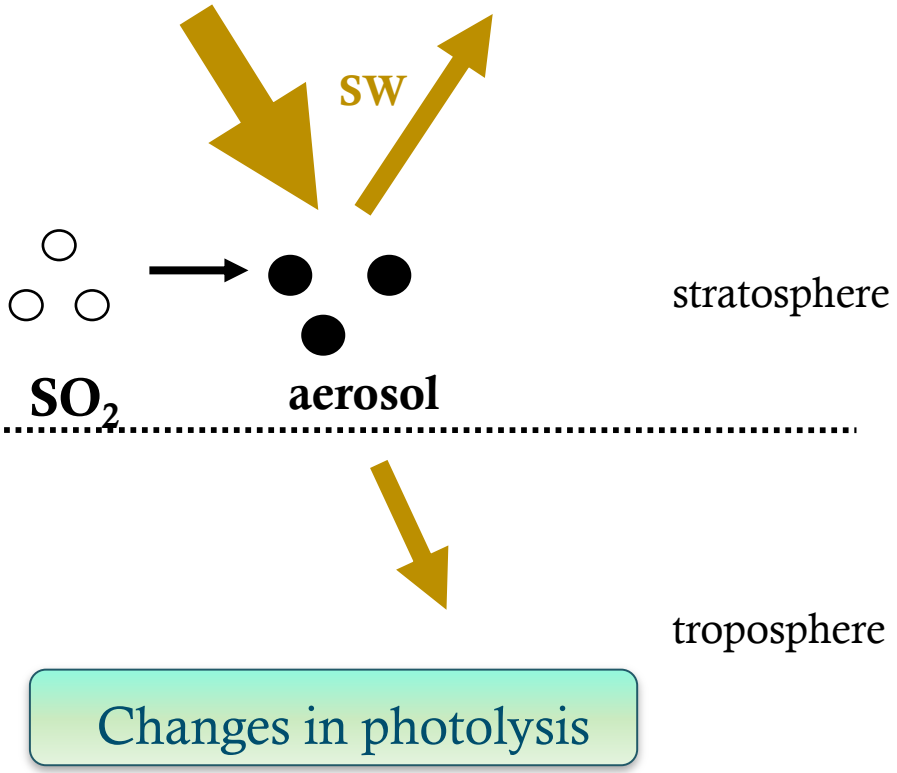
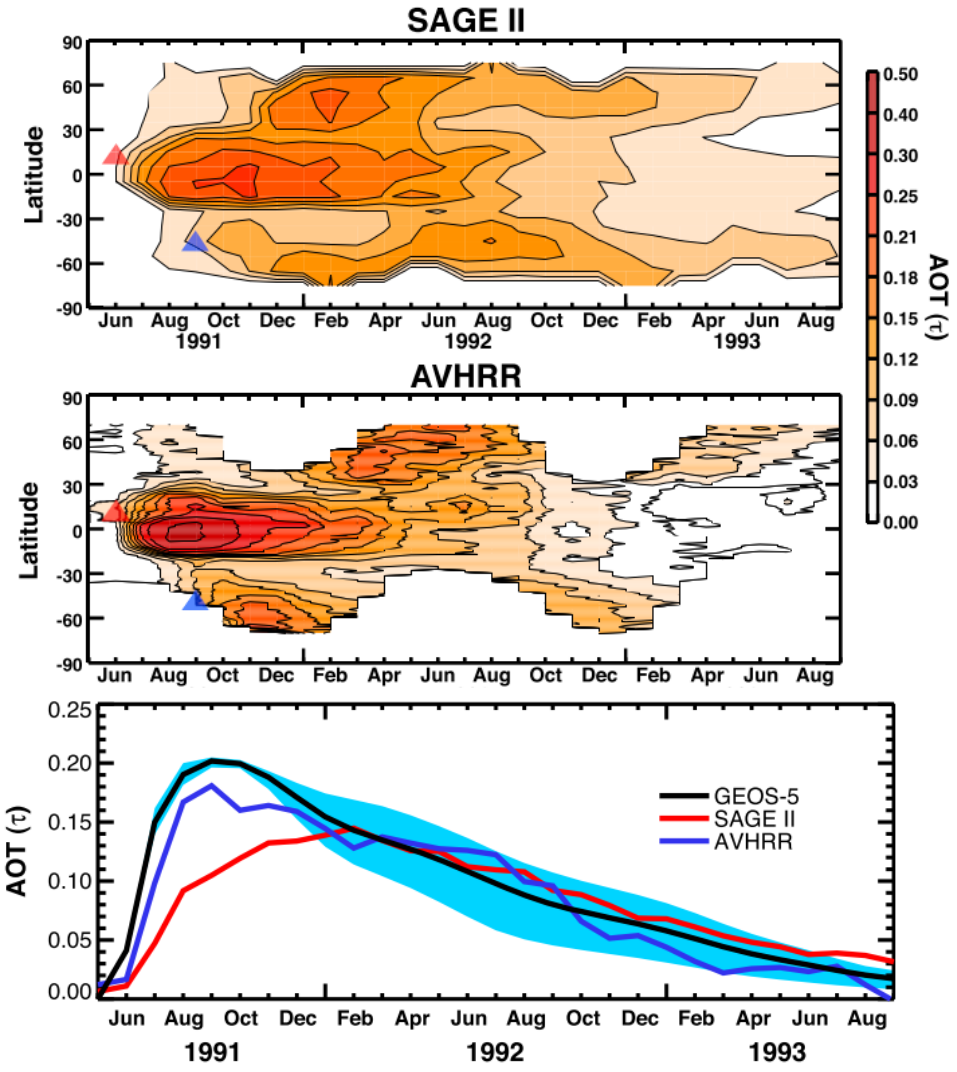


Changes in photolysis

SO_2 and Aerosol Observations

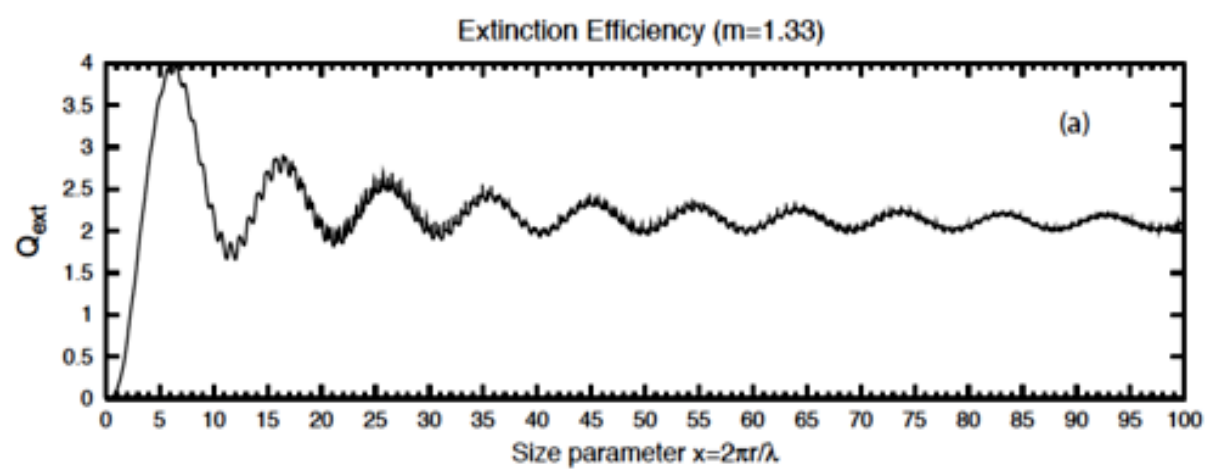
- **17-20 Tg SO_2 injected on 15th June 1991**
- **SO_2 oxidized to sulphate aerosols with lifetime:**
  - **23-25 (TOMS, TOVS),**
  - **33 days (MLS)**



Aquila et al. (2012)

Effective radius

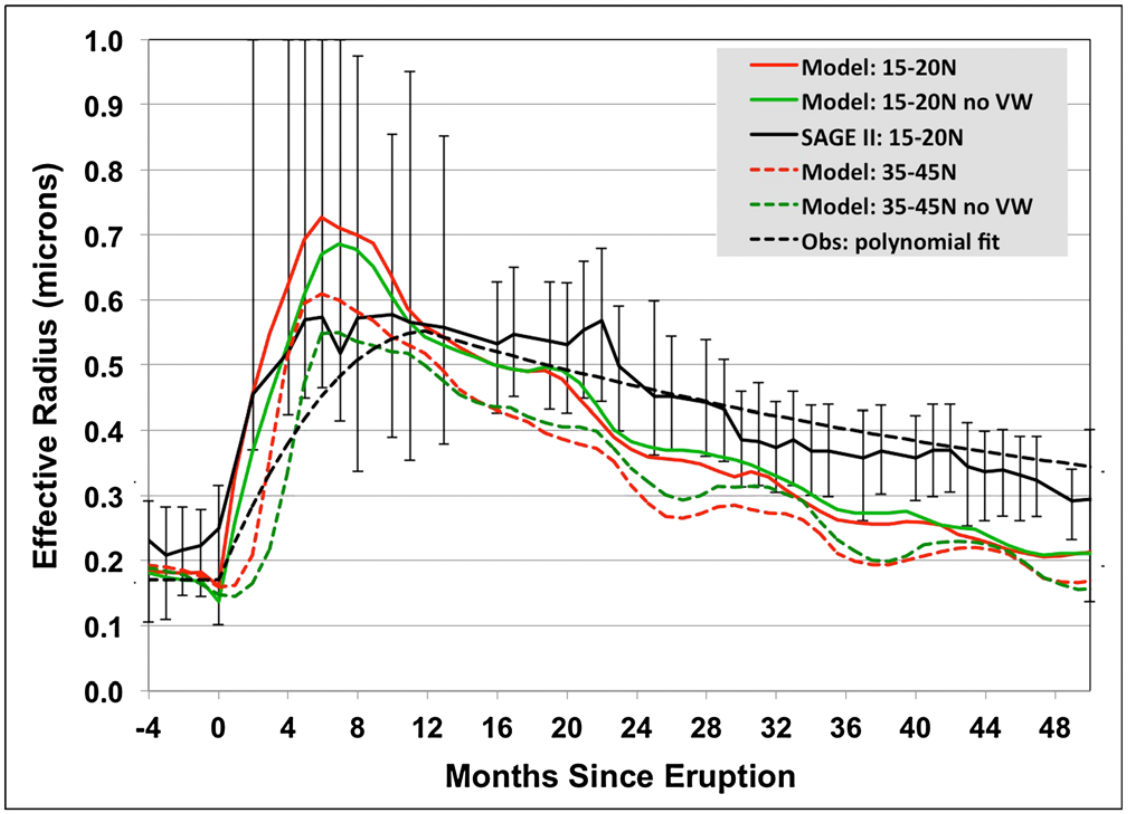
$$R_{eff} = \frac{3 \times V}{S} \qquad AOD = \int \pi r^2 N(r) Q_{ext} \, dr dz$$



Most efficient scattering: $\frac{2\pi r}{\lambda} \approx 6$

$$r \approx \lambda = 0.525 \mu m$$

Effective radius



English et al. (2013)

SO_2 bugs – fixed in new release

- Budget writing output
- SO_2+OH reaction rate
  - Was:

```
rates_lut(kso2oha,k)=3.3e-31*(temp/300.)**4.3
rates_lut(kso2ohb,k)= 1.6e-12*(temp/300.)
```

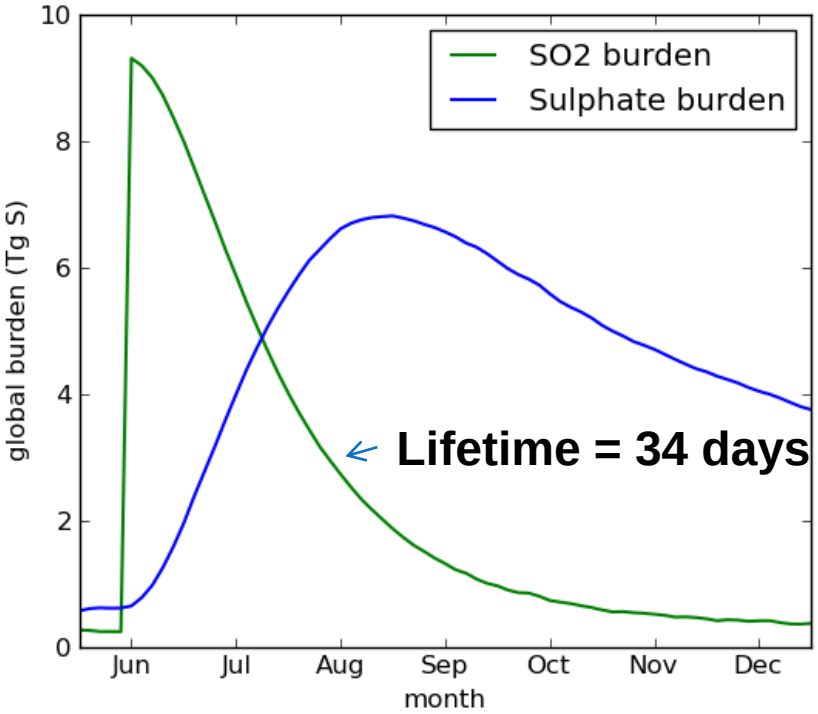
  - Is (JPL2006):

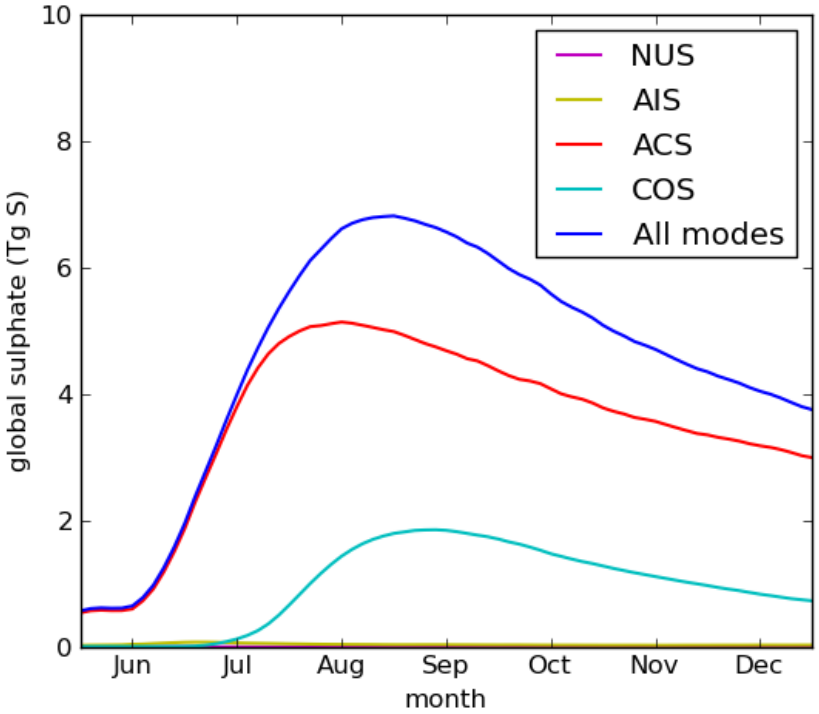
```
rates_lut(kso2oha,k)=3.3e-31*(temp/300.)**(-4.3)
rates_lut(kso2ohb,k)= 1.6e-12
```

- SO_2+OH -> HO_2

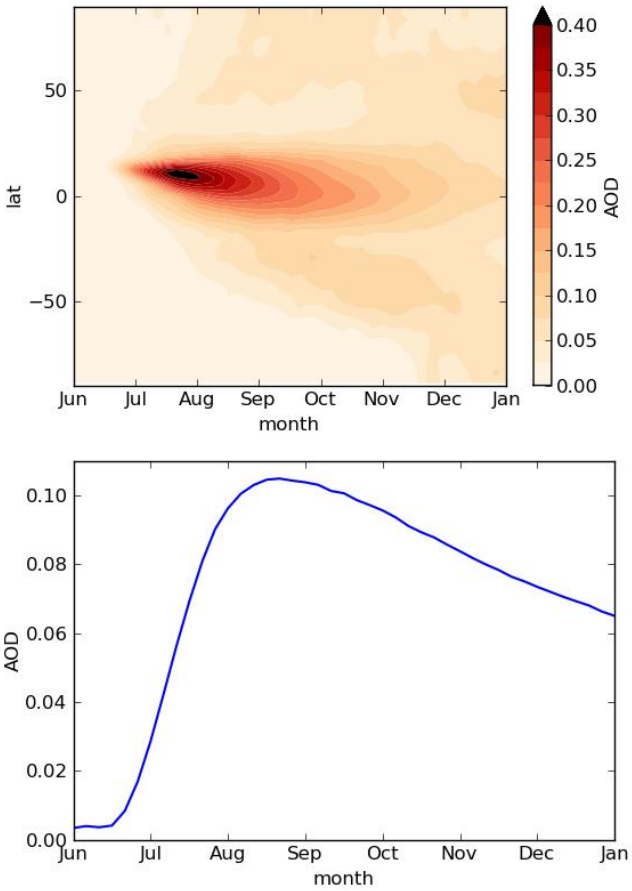
SO_2 and SO_4 global burden

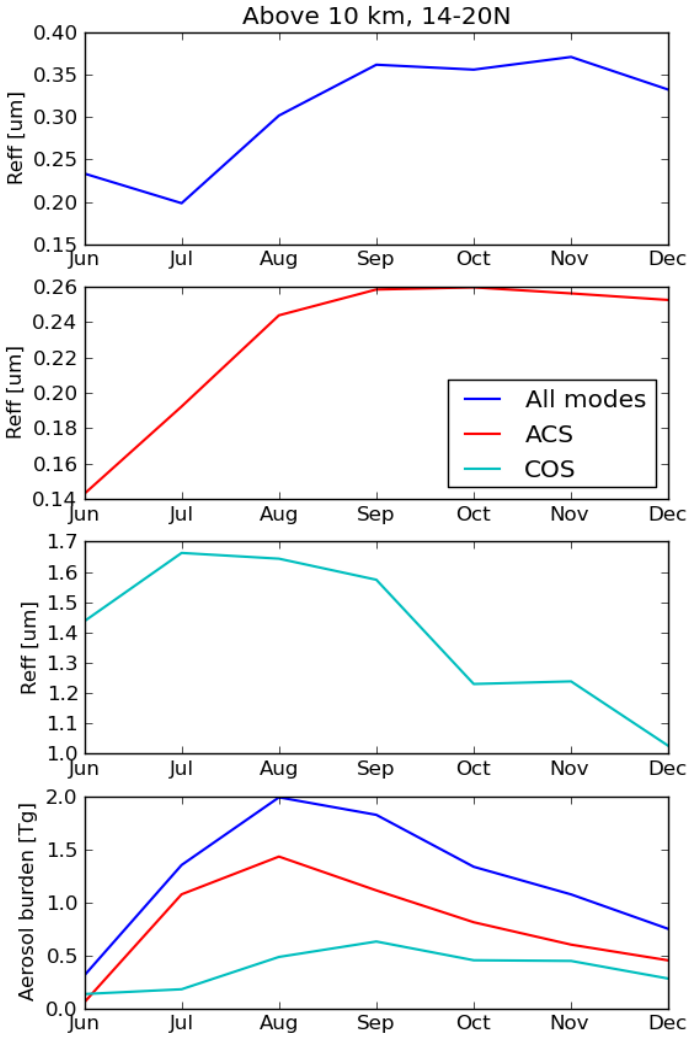
- TM5 chemistry, photolysis coupled to M7 ('new release')
- 18.5 Tg SO_2 injected during 15th June 1991 between 15-23 km (17-23 km)
- Simulation period: 1st Jun 1991 – 1st Jan 1992





AOD and R_{eff} evolution





- AOD above 10 km height

SO_2 and Aerosol Observations

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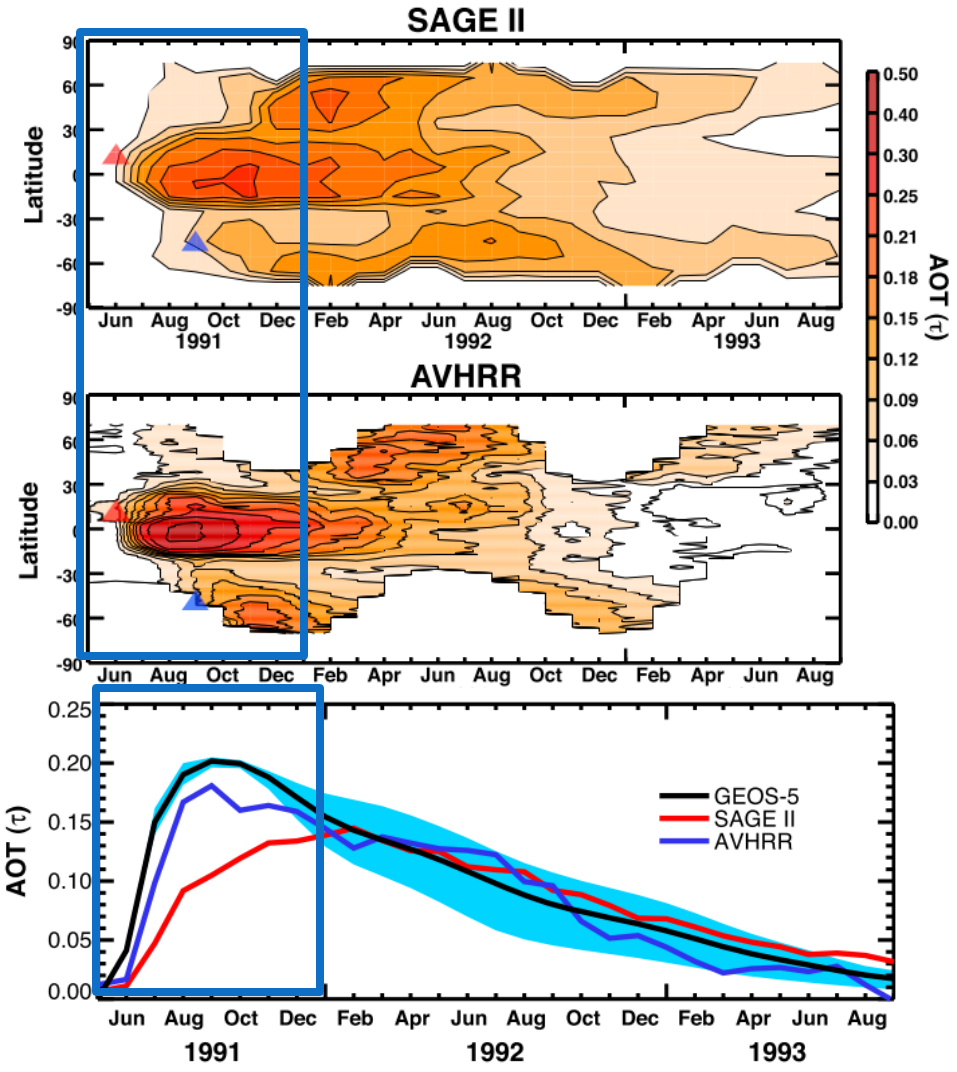
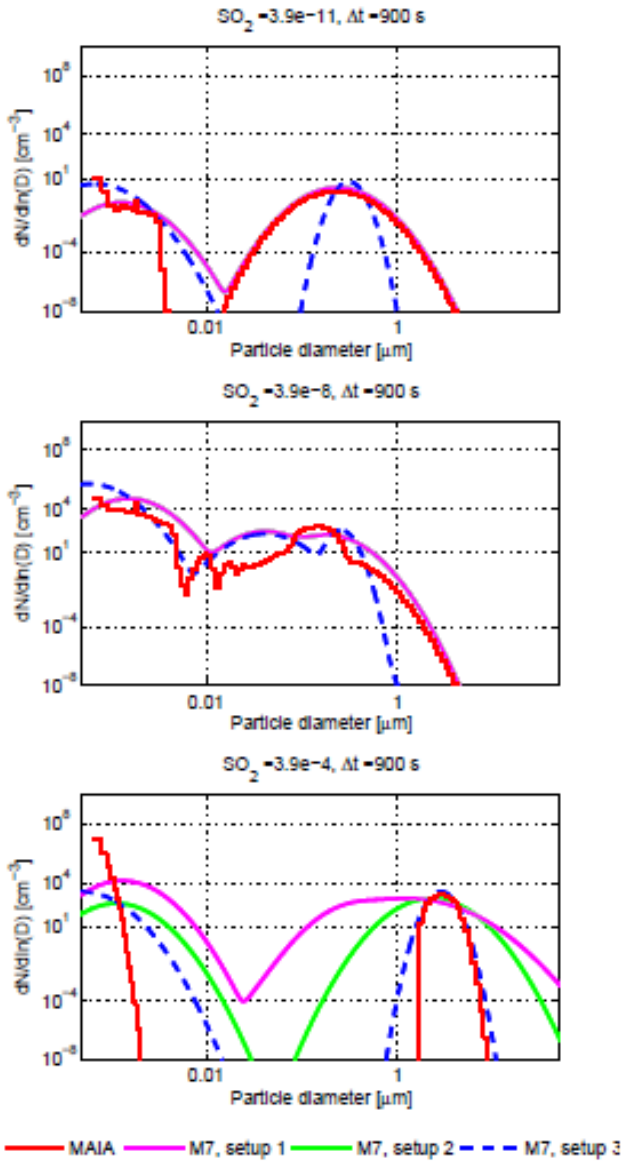


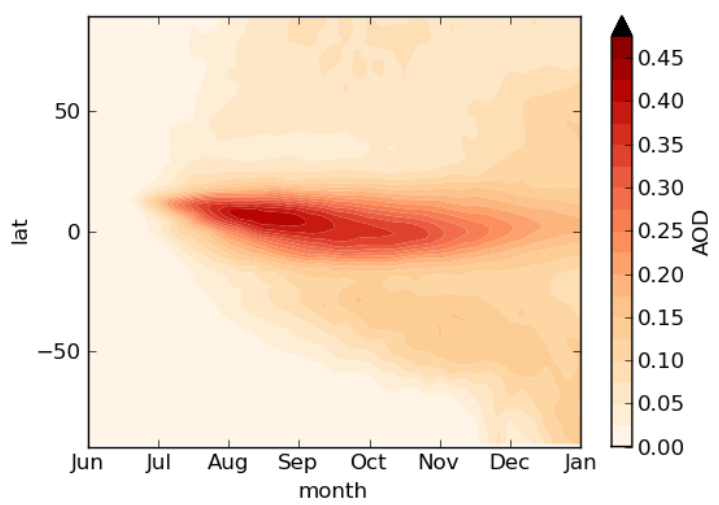
Aquila et al. (2012)

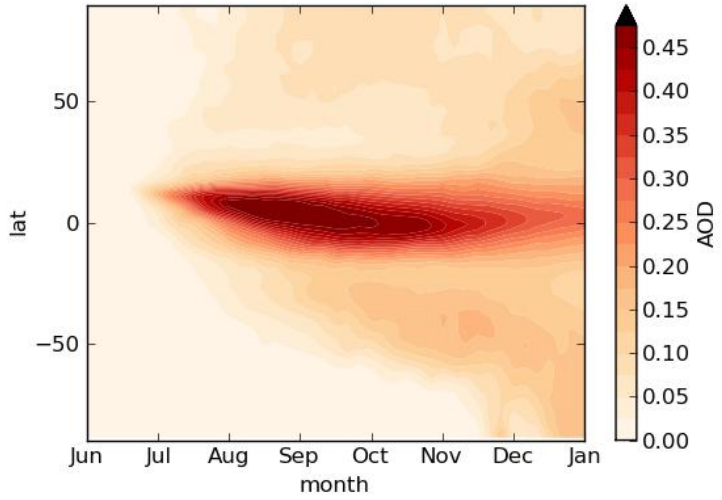
ECHAM papers

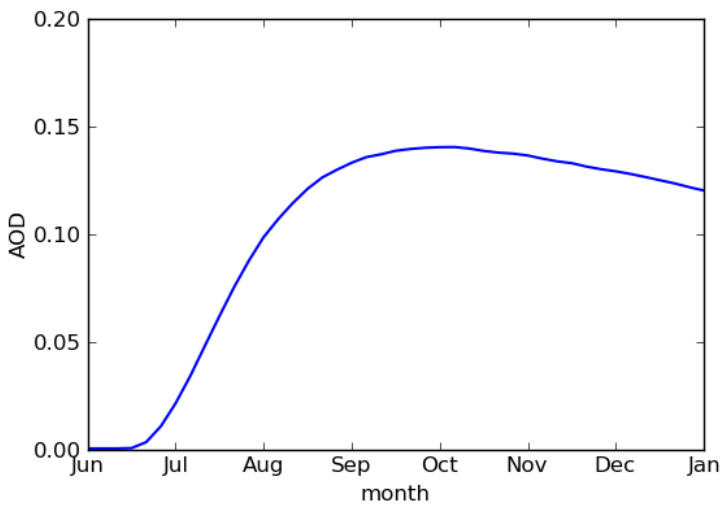
- Kokkola et al.: *Aerosol microphysics modules in the framework of the ECHAM5 climate model – intercomparison under stratospheric conditions*, GMD 2009.
  - M7 setup 1: standard M7
  - M7 setup 2: no soluble coarse mode
  - M7 setup 3: no soluble coarse mode, accumulation mode σ=1.2 instead of 1.59
- Niemeier et al.: *Initial fate of fine ash and sulfur from large volcanic eruptions,* ACP 2009
  - Pinatubo eruption in ECHAM using setup 3, no tropospheric aerosols

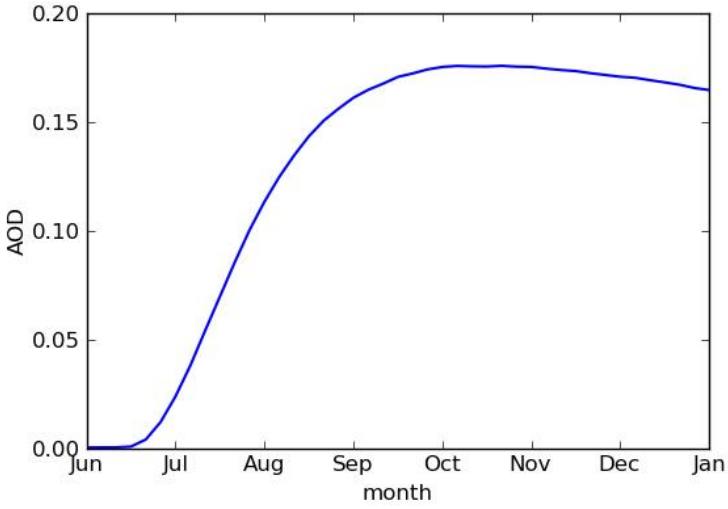


AOD setup 2 vs setup 3

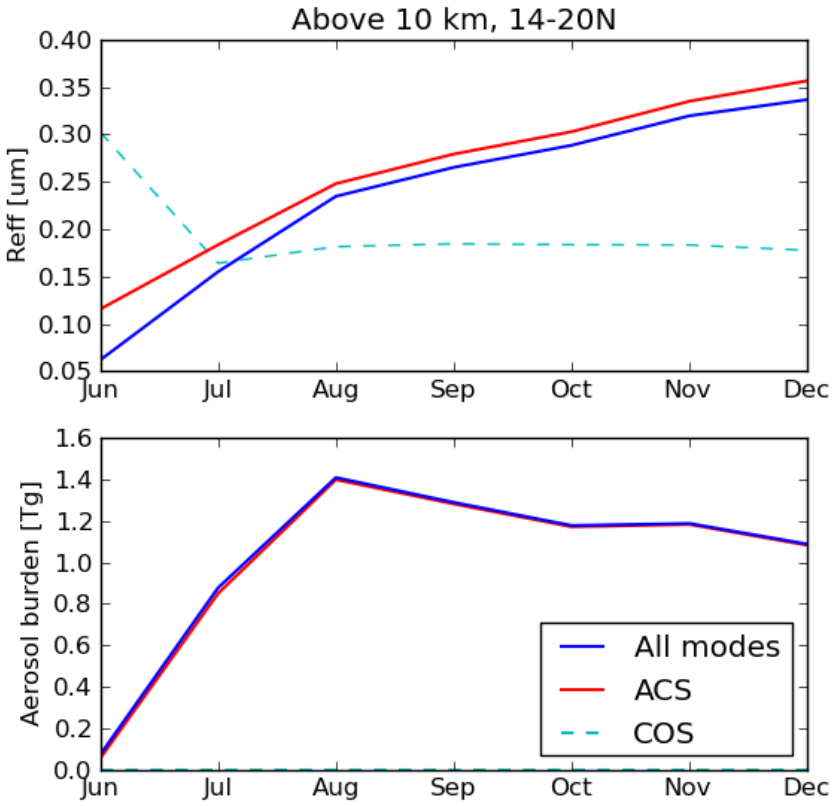


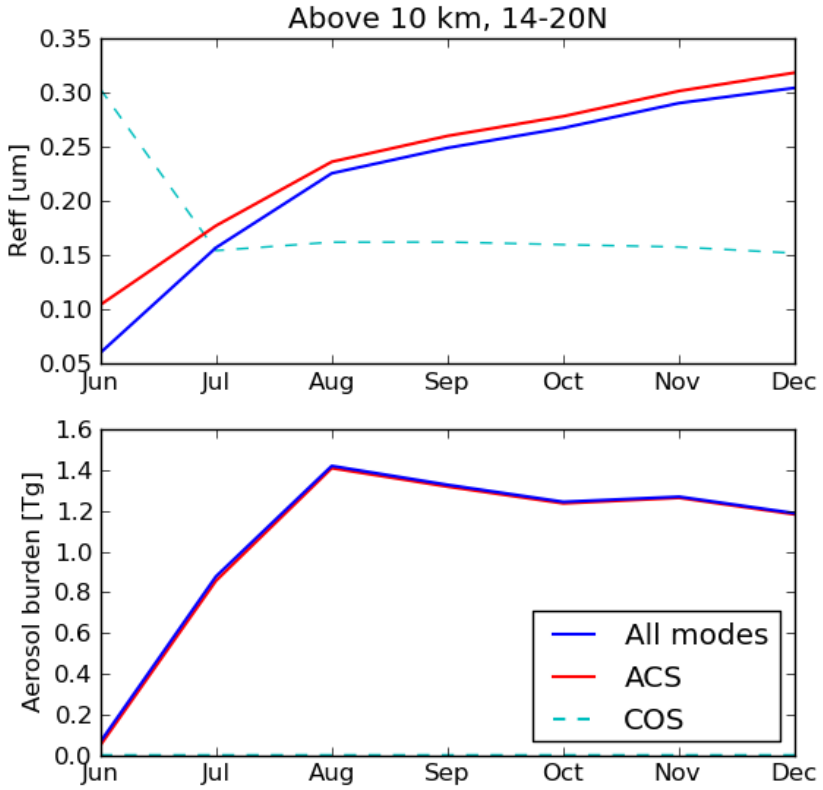




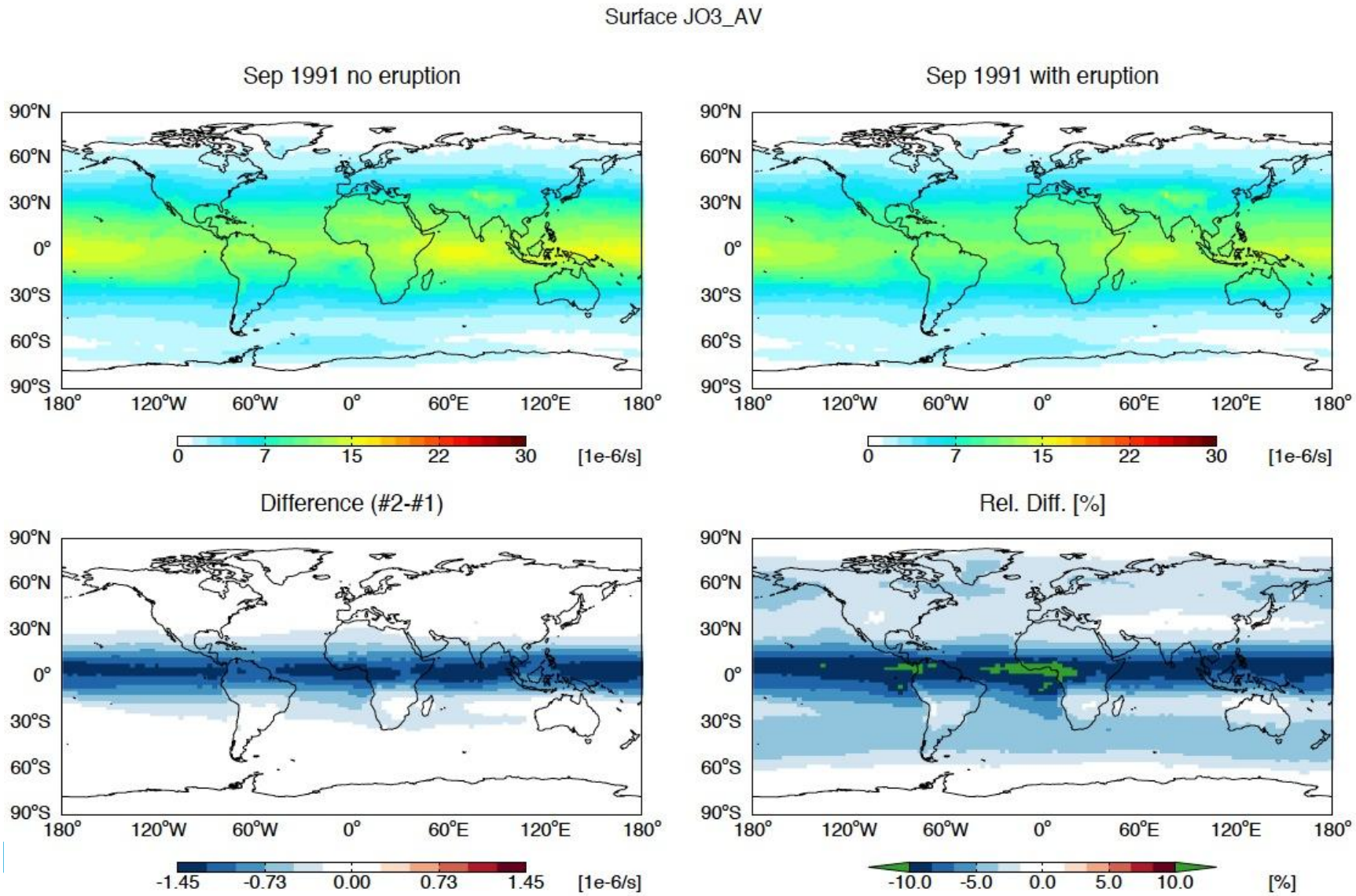


Effective radius

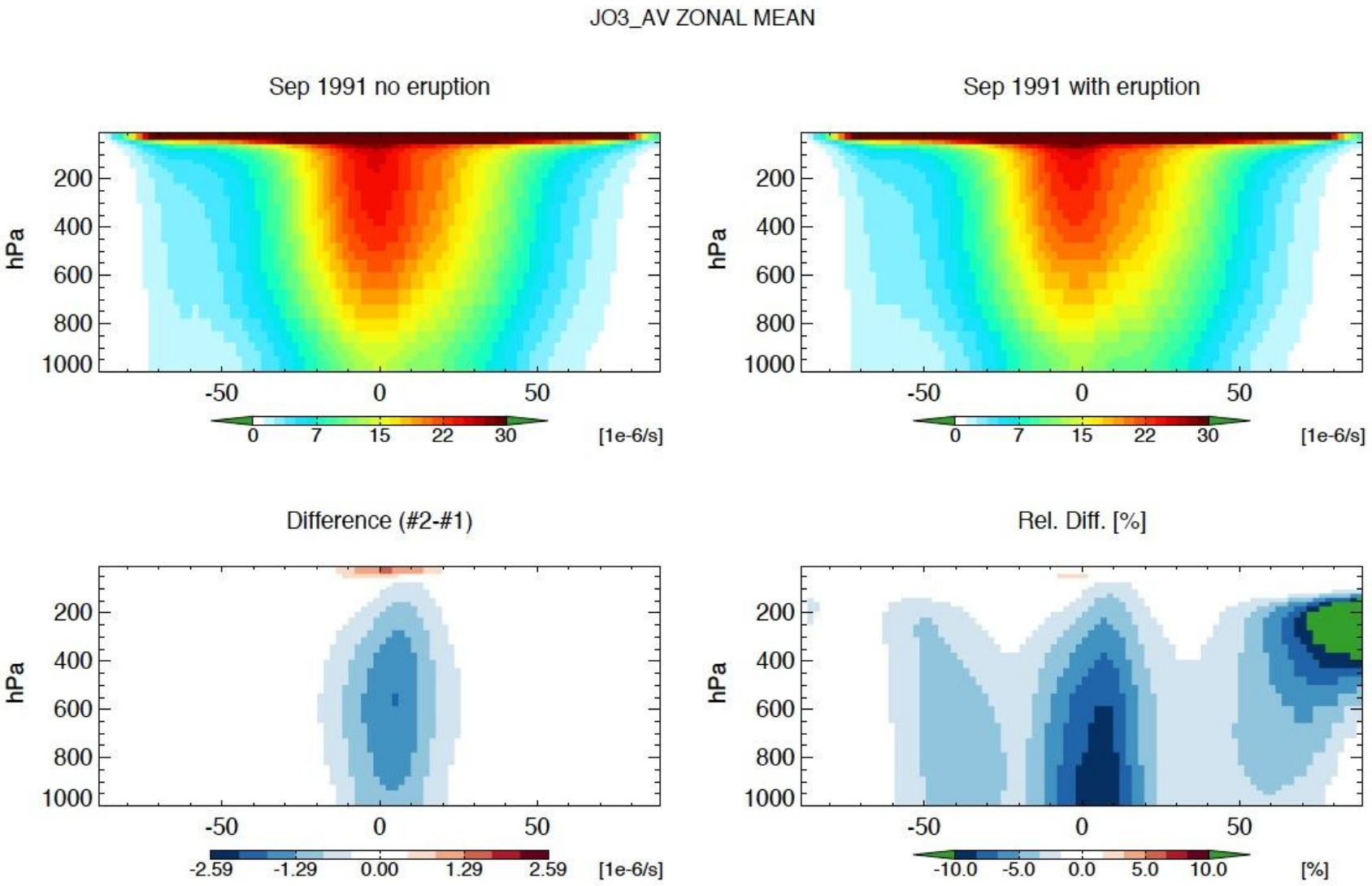




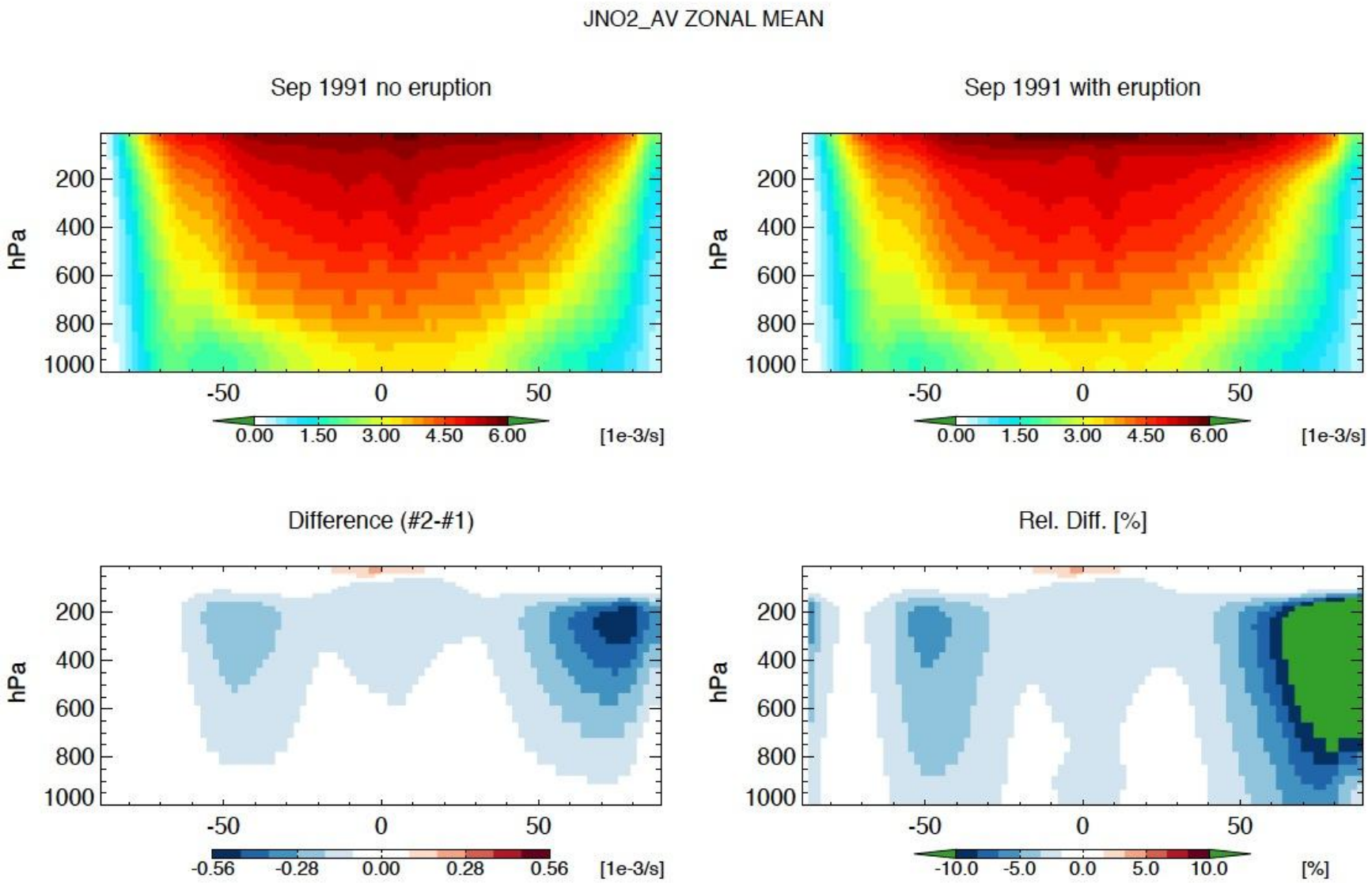
Impact on Jozone



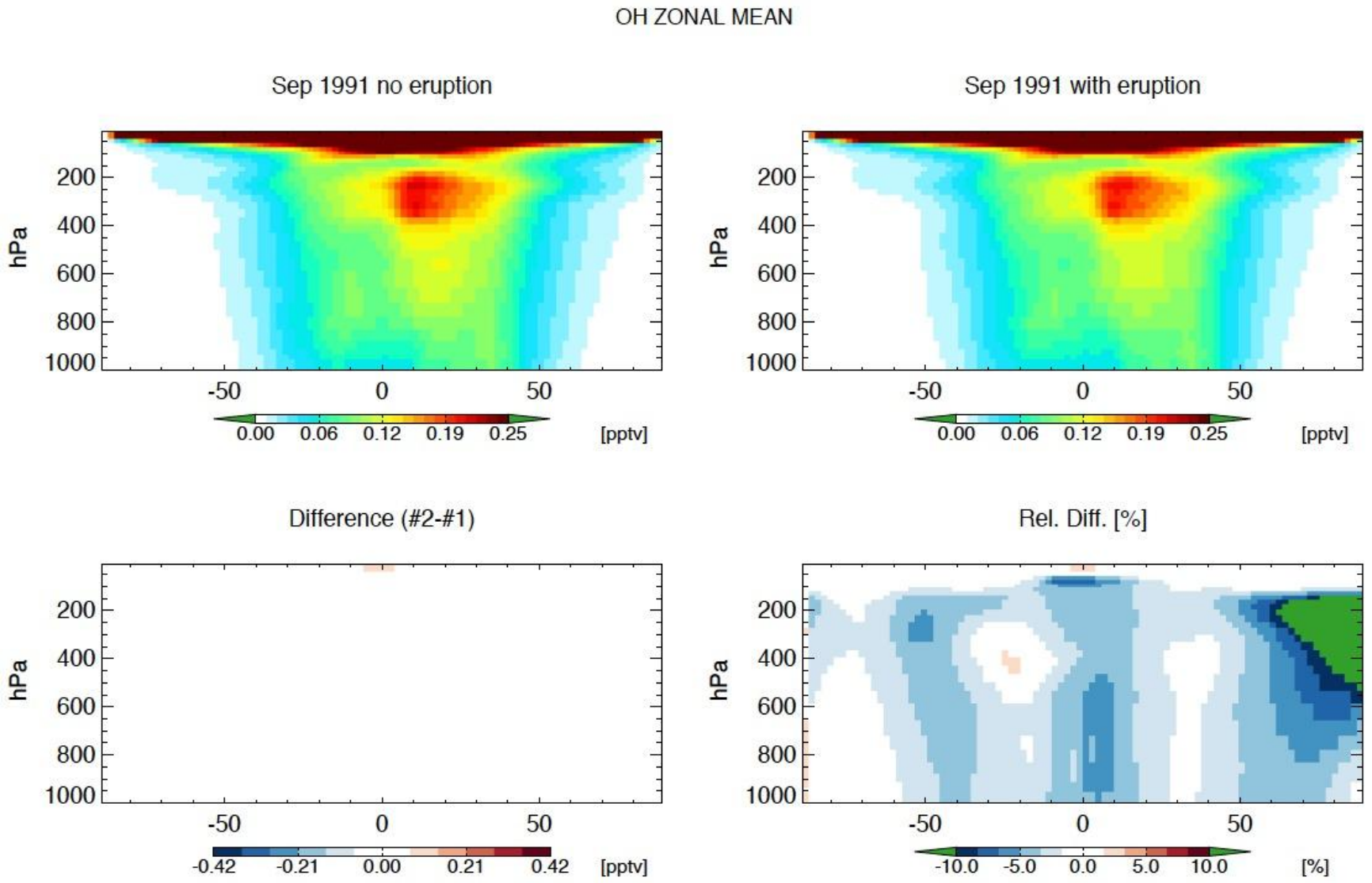
Impact on Jozone



Impact on JNO2



Impact on OH


OH ZONAL MEAN
Sep 1991 no eruption
Sep 1991 with eruption
Difference (#2-#1)
Rel. Diff. [%]
hPa
200
400
600
800
1000
-50
0
50
0.00
0.06
0.12
0.19
0.25
[pptv]
-0.42
-0.21
0.00
0.21
0.42
-10.0
-5.0
0.0
5.0
10.0
[%]

Next steps

- Small R_{eff} problem unsolved:
  - Bugs in sedimentation?
  - Water uptake?
  - Missing stratospheric background?
- Combine M7 tropospheric (default) with the stratospheric setup
- Aerosol lifetime in the stratosphere

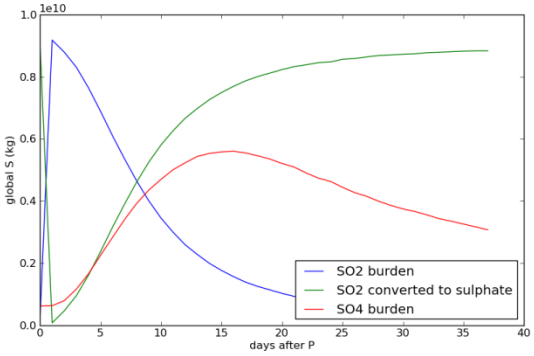
SO2 injection height

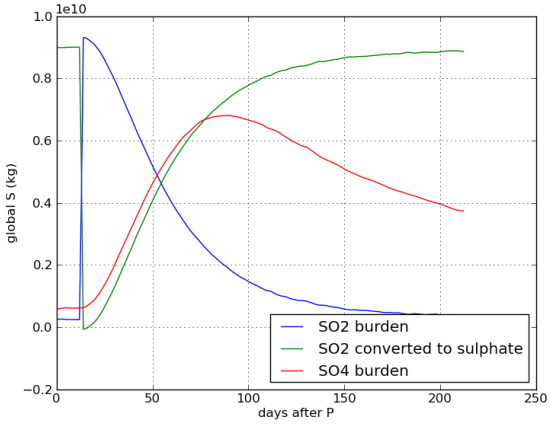
- LIDAR June: peak at 22 km
- MLS September: peak at 25 km

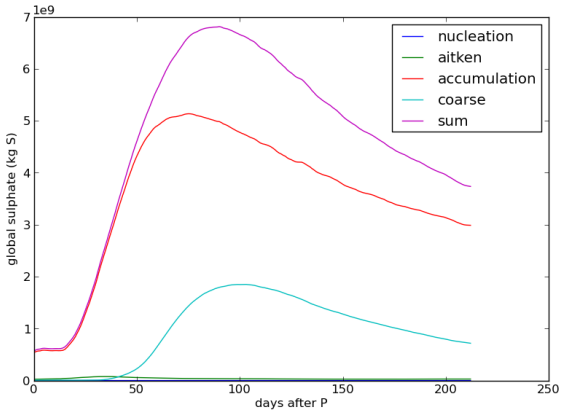
- Niemeier et al. (2009): at 24 km
- English et al. (2013): 15-28.5 km with peak at 21 km
- Aquila et al.(2012):
  - 16-18 km with plume self-lifting effect due to IR absorption
  - 17-27 km without self-lifting

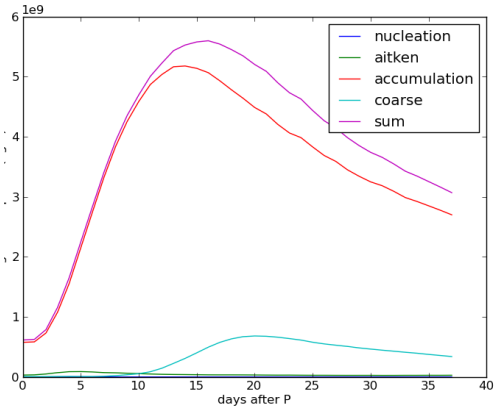
- My setups:
  - Low injection: 16-18 km
  - High injection: 17-23 km
  - Mixed: 10% 15-17 km, 80% 17-21km, 10% 21-23 km

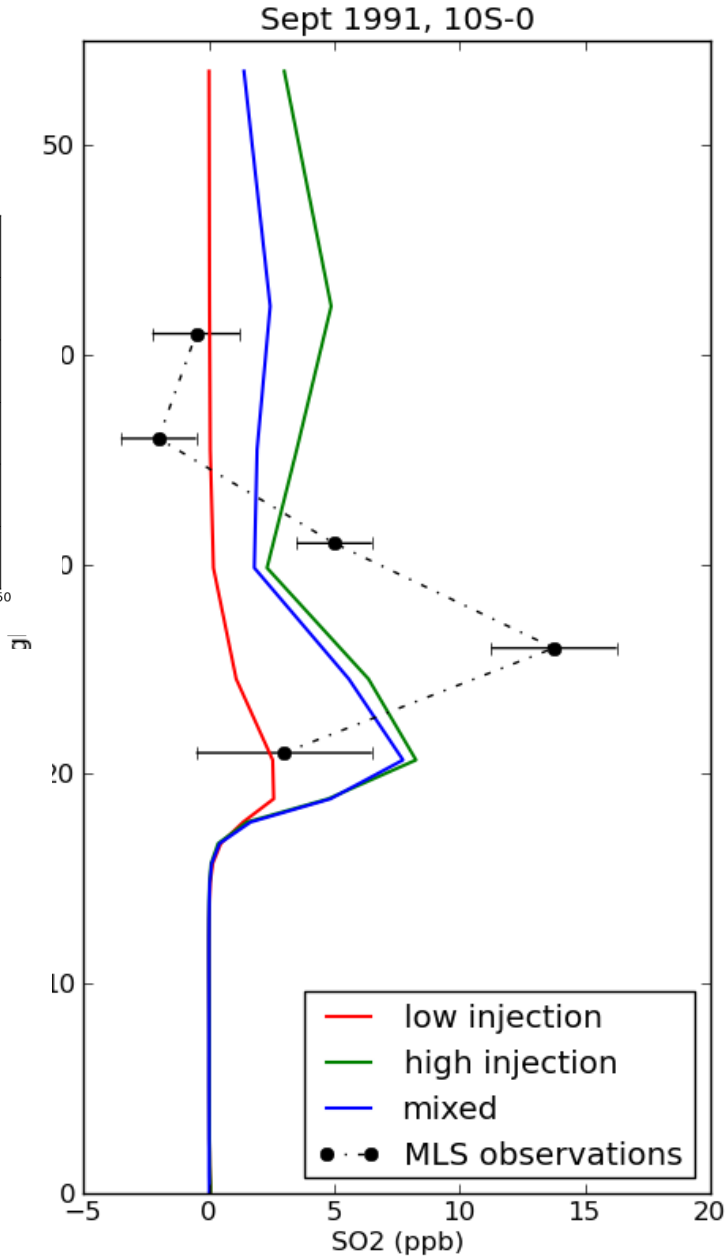
SO2, SO4 results











Low injection height