Vertical distribution of aerosols and effects on radiation for different convective parameterisations in CCM-OSLO

Øyvind Seland

Department of Geosciences, University of Oslo, Norway

Acknowledgements

- Trond Iversen, Alf Kirkevåg and Jon Egill Kristjansson at the Dep. of Geosciences, UiO
- This work is funded by the Norwegian research council through the project AerOzClim and through a grant of computing time.

Outline

- Why is vertical distribution important
- Overview of CCM-Oslo
- Testing parameterisations of convective transport and scavenging
  - Changes in aerosol
  - Changes in direct and indirect effect

CCM-Oslo

- **CCM3:T42L18, semi-Lagrangian,**
- **Mass-flux deep-convection** (Zhang and McFarlane, 1995)
- **SW-radiation: 2-stream delta-Eddington**
- **18 spectral intervals, 11 bands for aerosol optics,**
- **LW-absorption by O3, H20, CO2, O2, cloud droplets, aerosols**
- **Parameterisation of transport and scavenging in deep convection**
    - **Standard: All tracers transported by deep convection. In-cloud scavenging parameterised by assuming all of the aerosol mass is subject to scavenging below level of maximum precipitation creation. Aerosols in updrafts and downdrafts completely mixed.**

CCM-Oslo

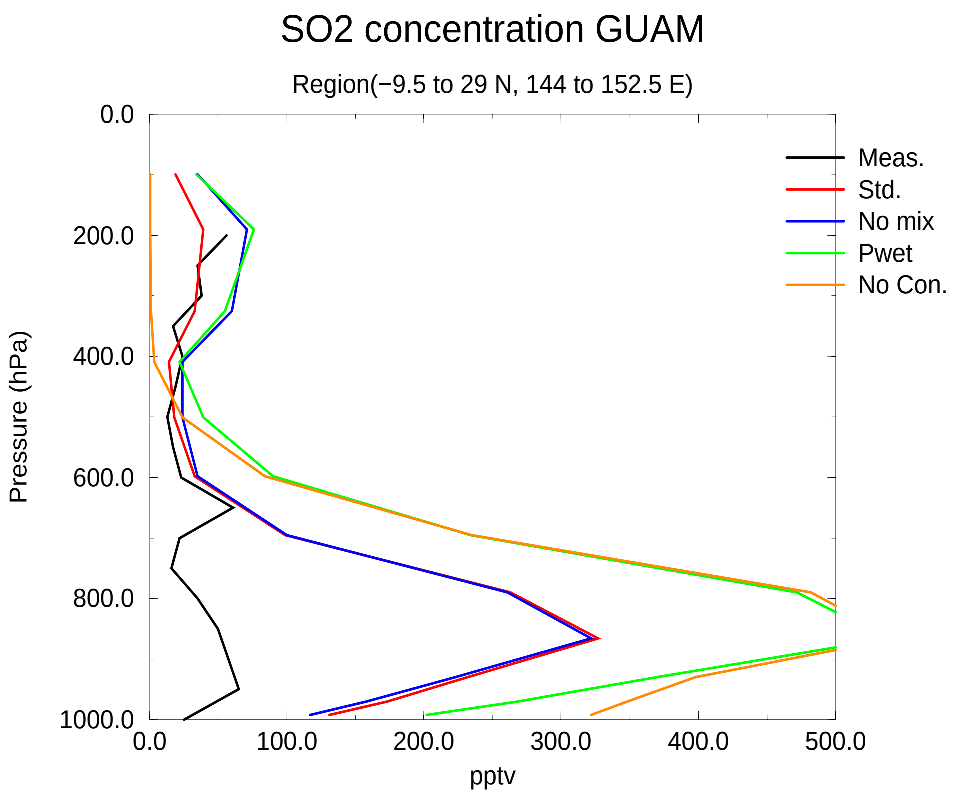
- Mechanistic treatment of the aerosol by production pathways
- Calculates transport, chemistry and deposition of DMS, SO_2, SO_4, BC and POM
- Aerocom B emissions
- Production pathways
  - Gas-phase production
  - Aqueous phase production
  - Condensation
  - Coagulation

Parameterisation of transport and scavenging in deep convection

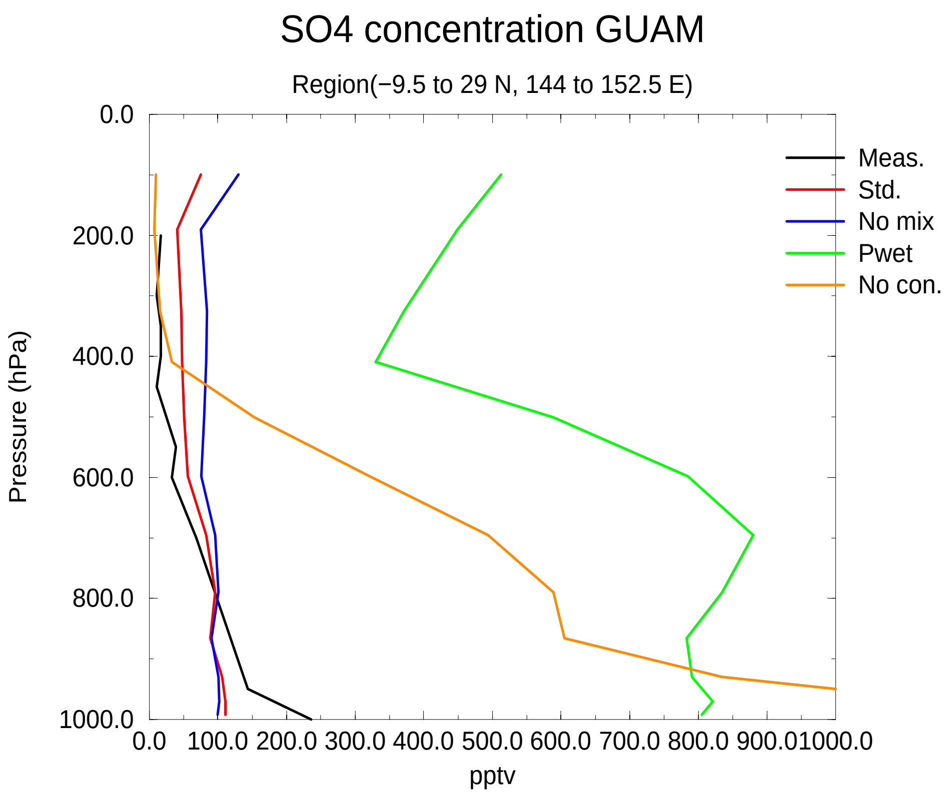
- **Standard: All tracers transported by deep convection. In-cloud scavenging parameterised by assuming all of the aerosol mass is subject to scavenging below level of maximum precipitation creation. Aerosols in updrafts and downdrafts completely mixed.**
- **No mixing between updraft and downdraft**
- **In situ scavenging only but full mixing of updraft and downdraft**
- **In situ scavenging only and no mixing**
- **No convective transport**

Why test convection

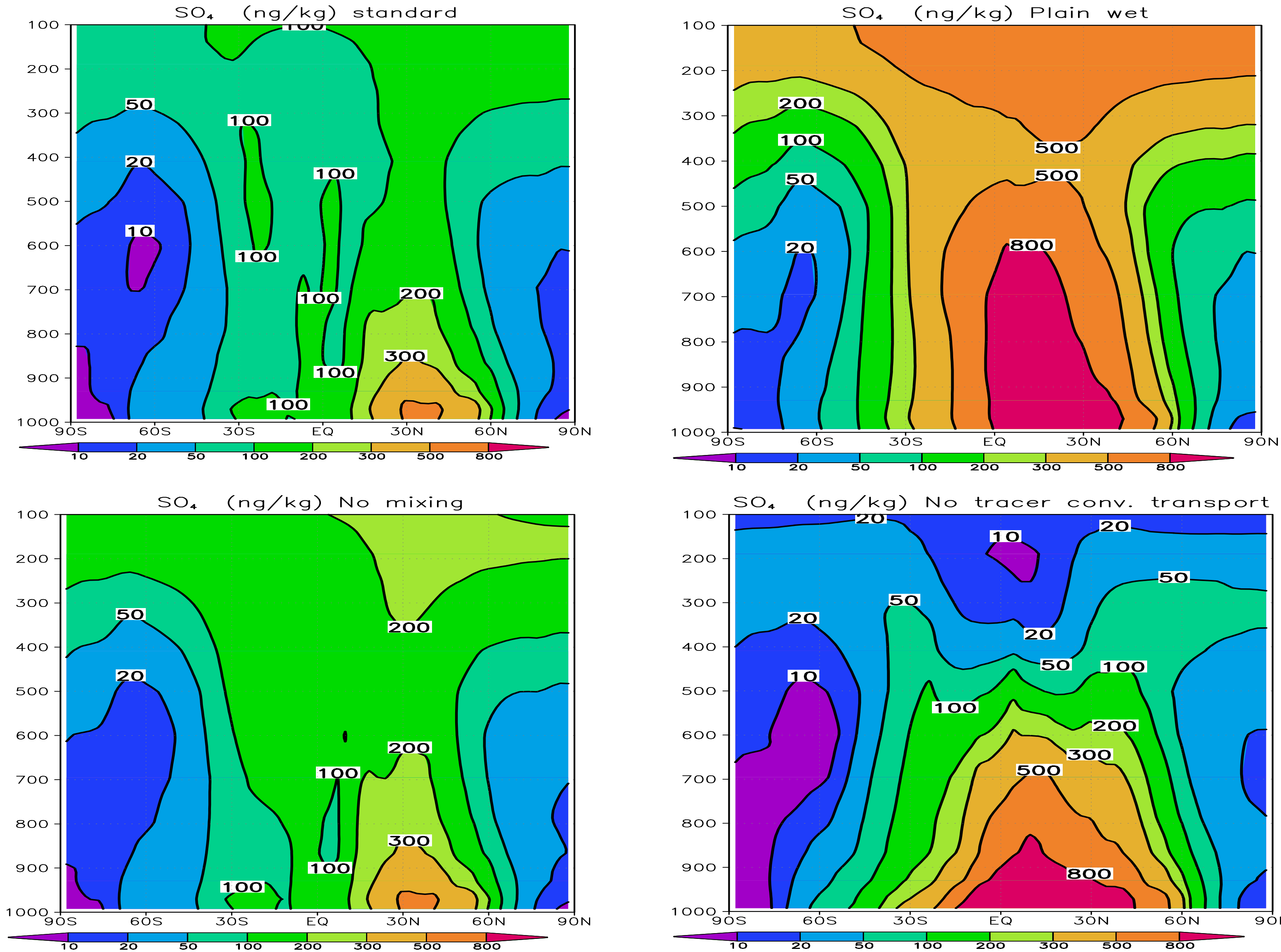
SO2, Guam



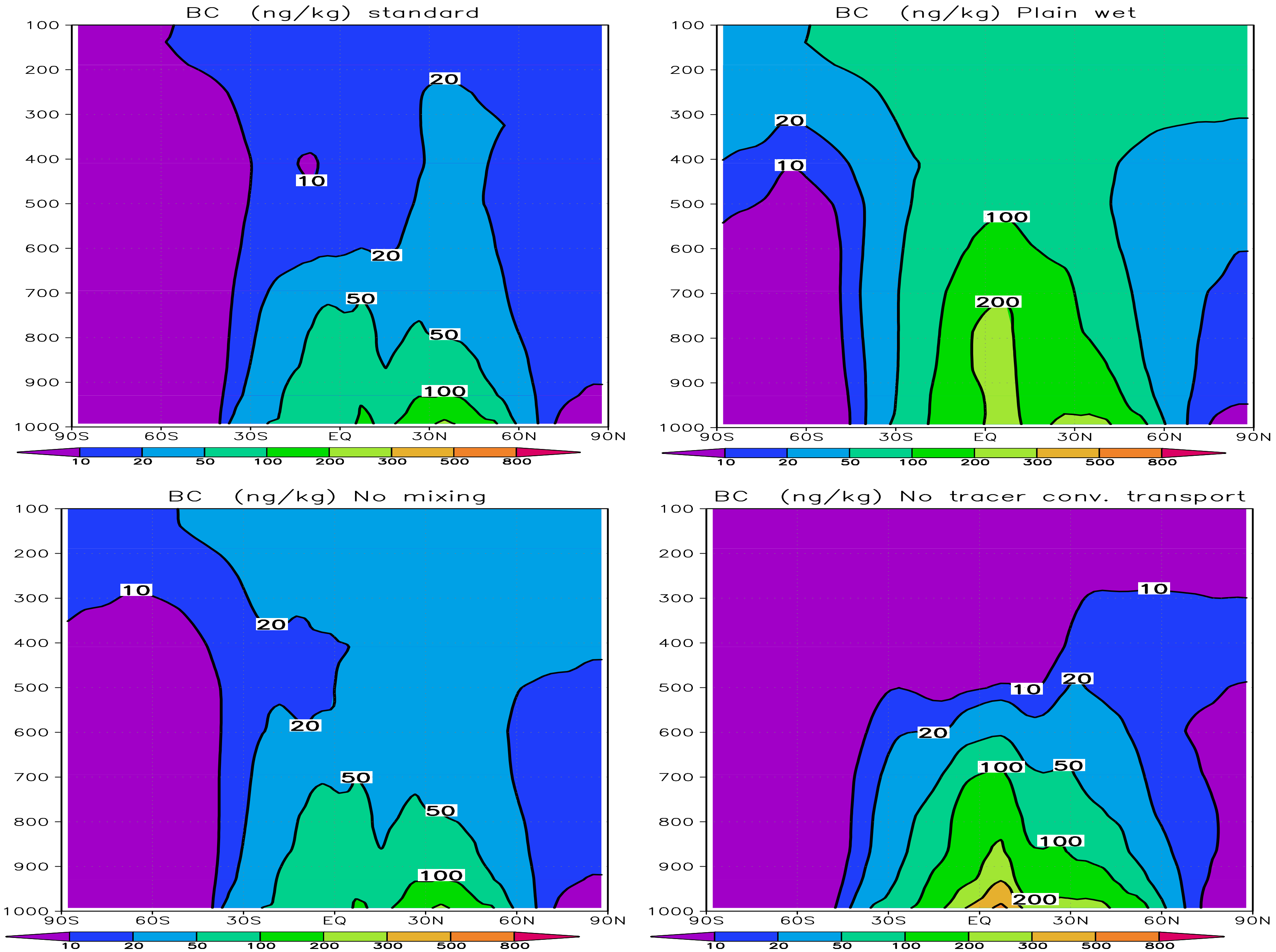
SO4, Guam



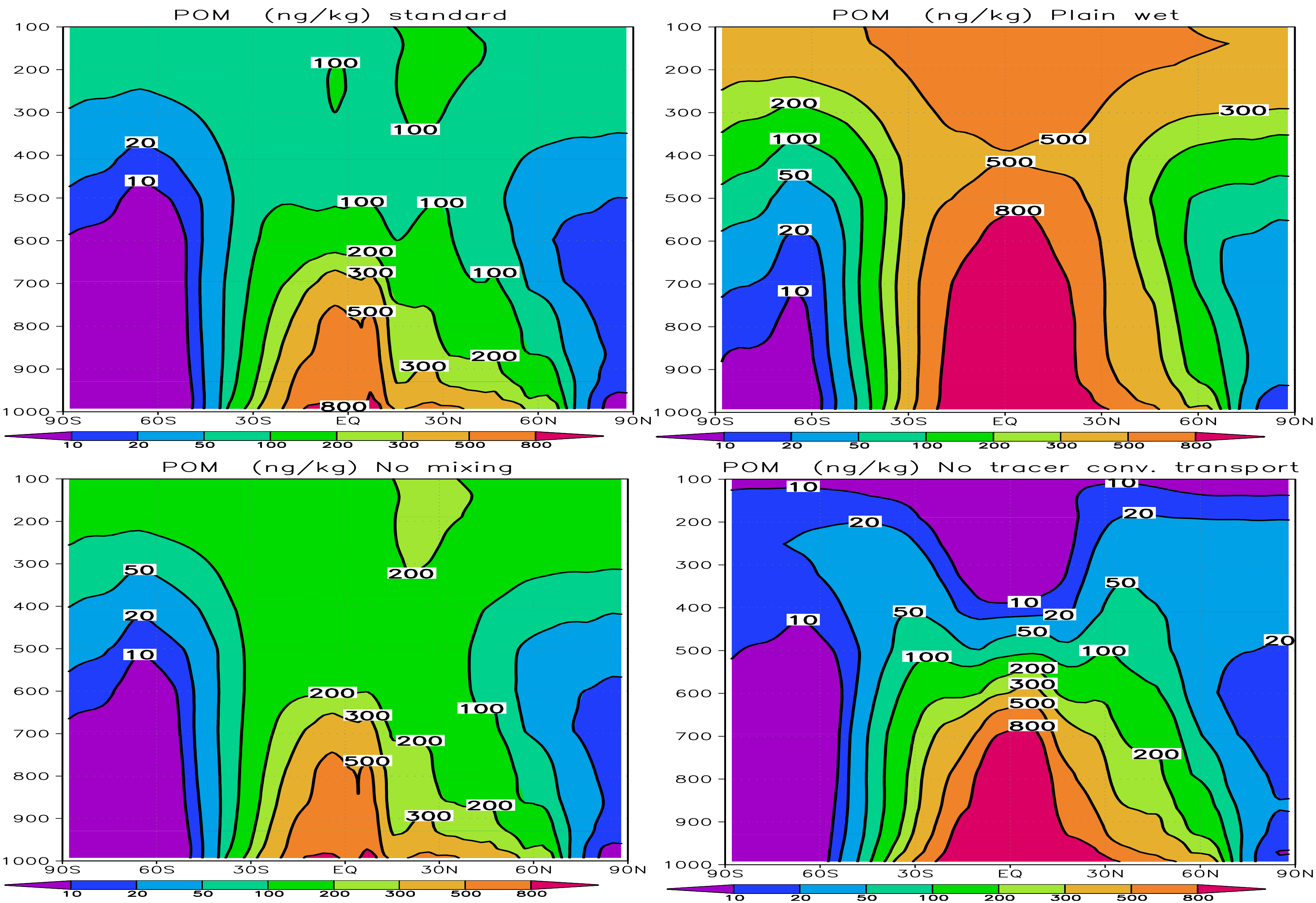
Vertical distribution sulphate



Vertical distribution BC



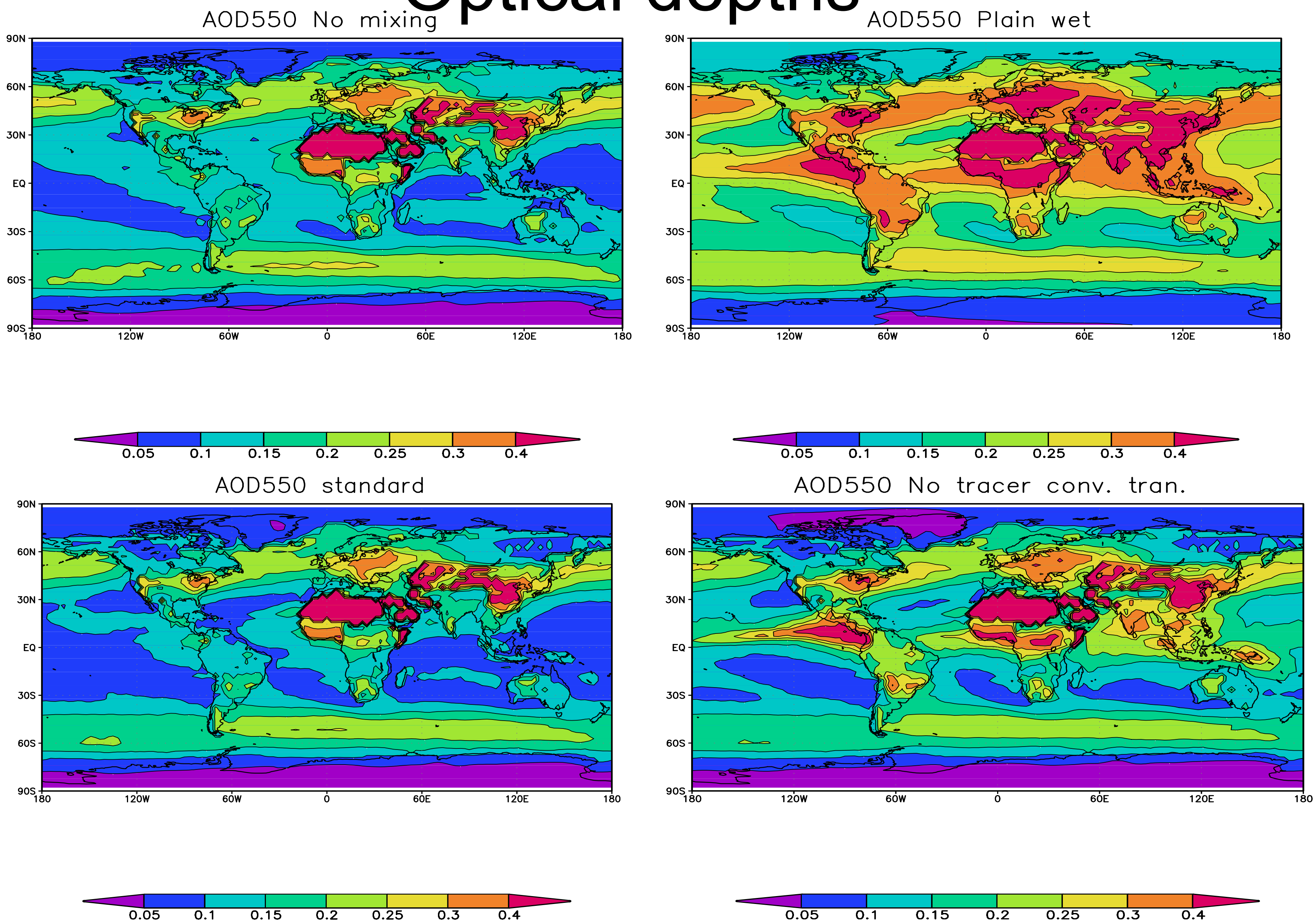
Vertical distribution POM



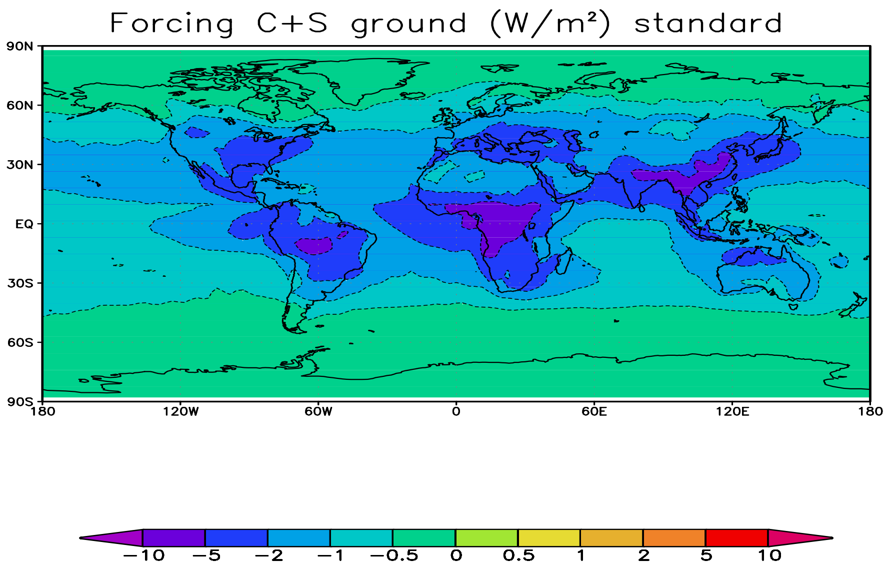
Column burdens (mg S/C /m2)

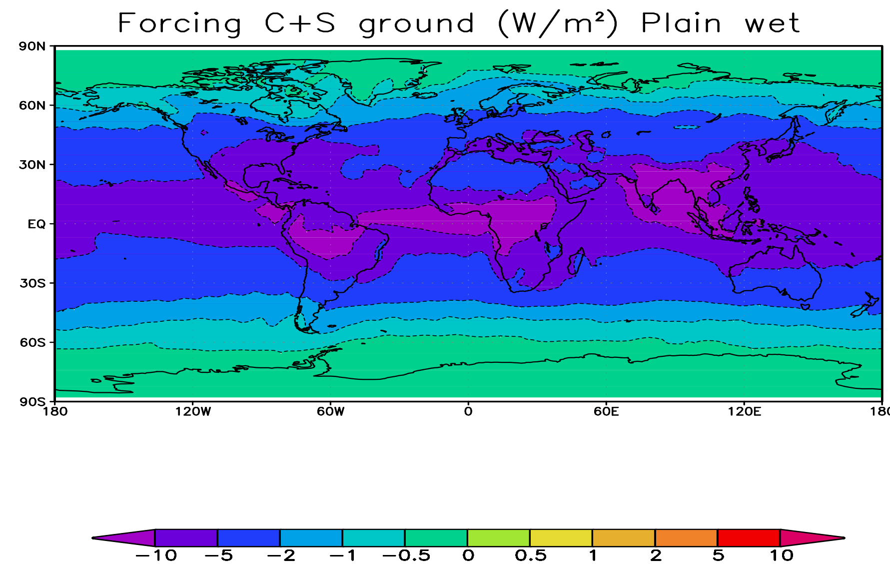
	SO2	SO4	BC	POM
TOT; Standard	0.71	0.99	0.22	1.30
TOT; No mixing	0.77	1.35	0.28	1.70
TOT; Plain scav.	0.88	4.56	0.70	5.05
TOT; No conv. transport	0.76	1.71	0.30	2.10

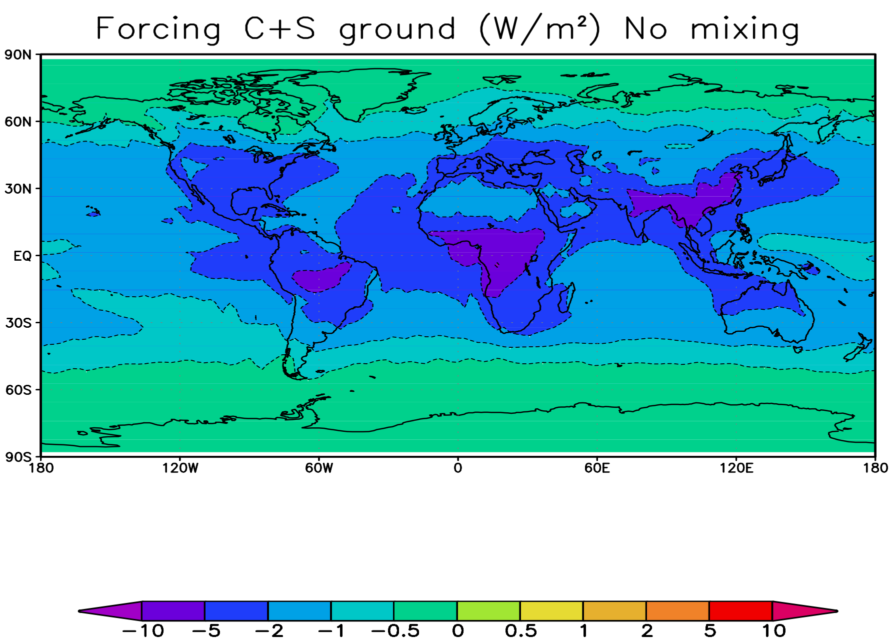
Optical depths

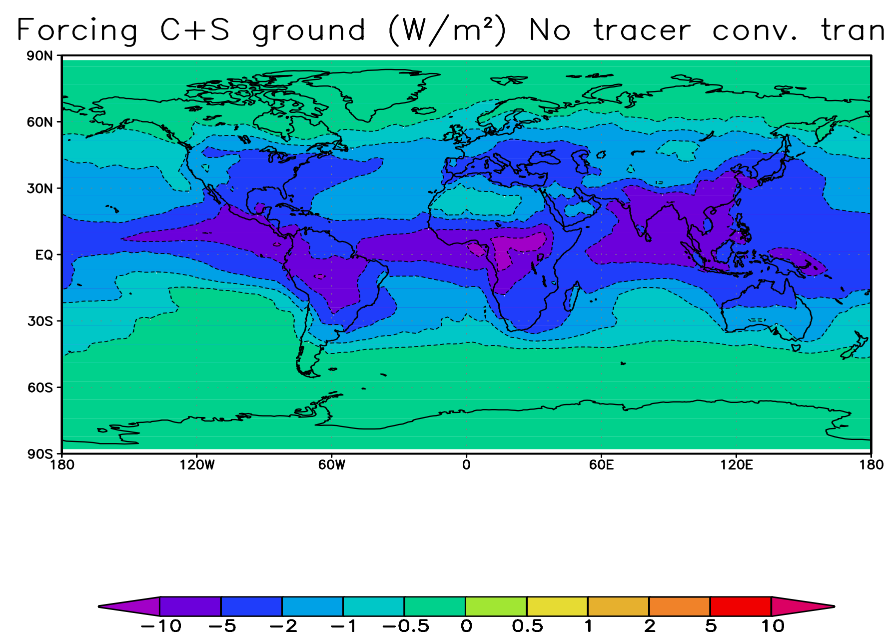


Total – preindustrial

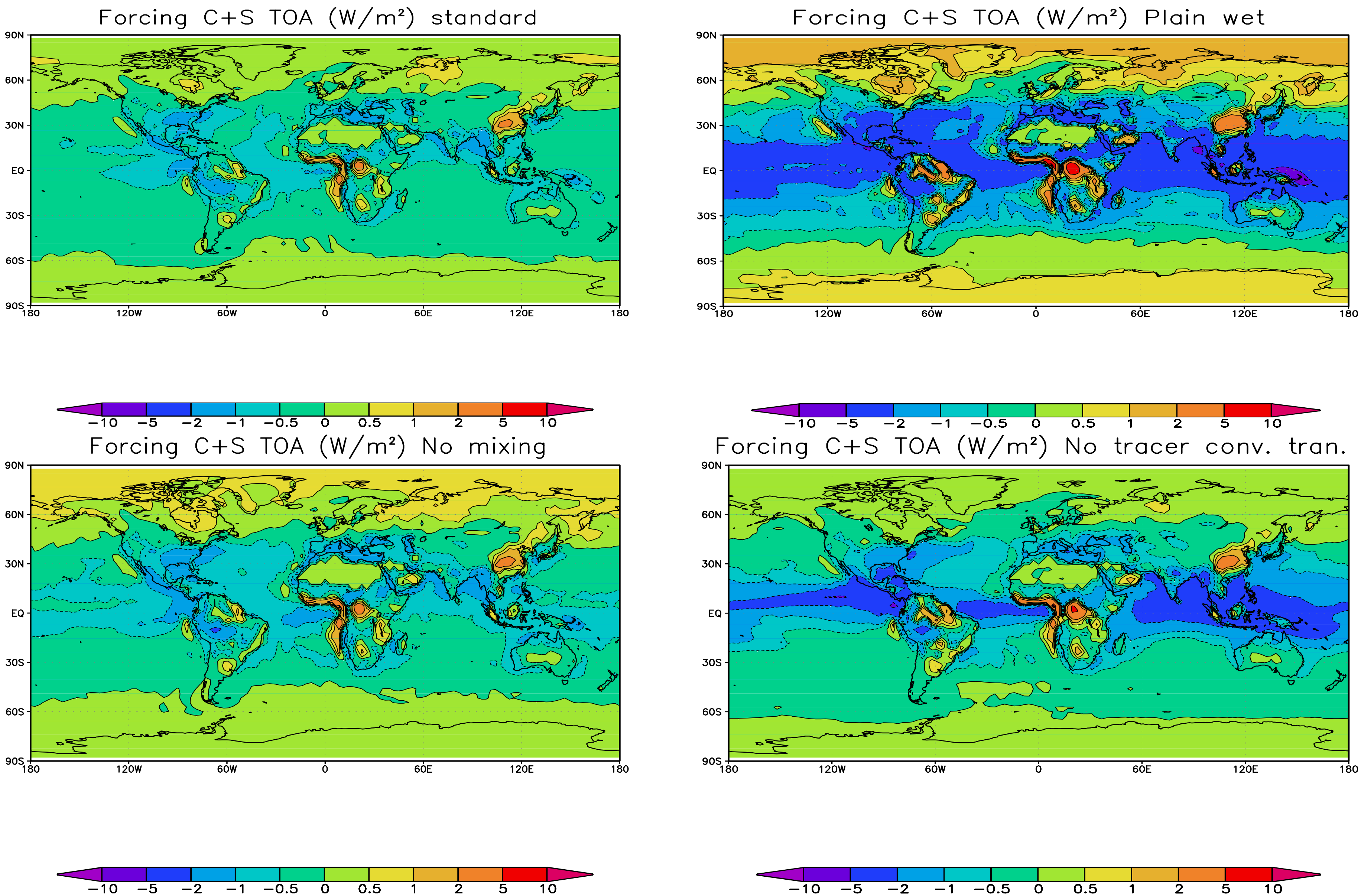








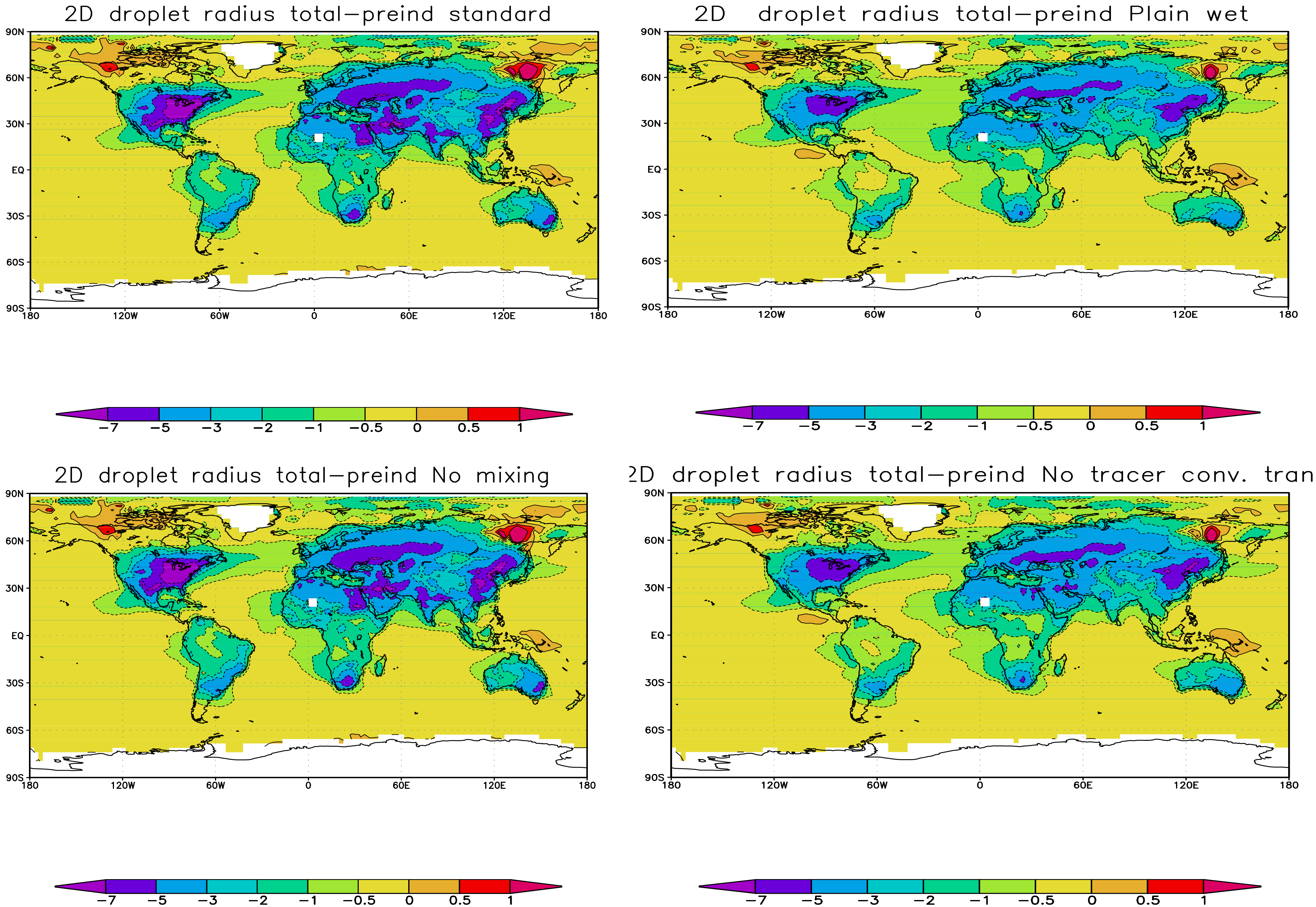
Total – preindustrial



DRF due to anthropogenic S+C(W/m2)

	Standard	No mixing	Plain scav	No conv. transport
TOA	-0.01	0.04	0.06	-0.20
Ground	-0.83	-1.12	-2.53	-1.31

Cloud droplet radius as seen from space



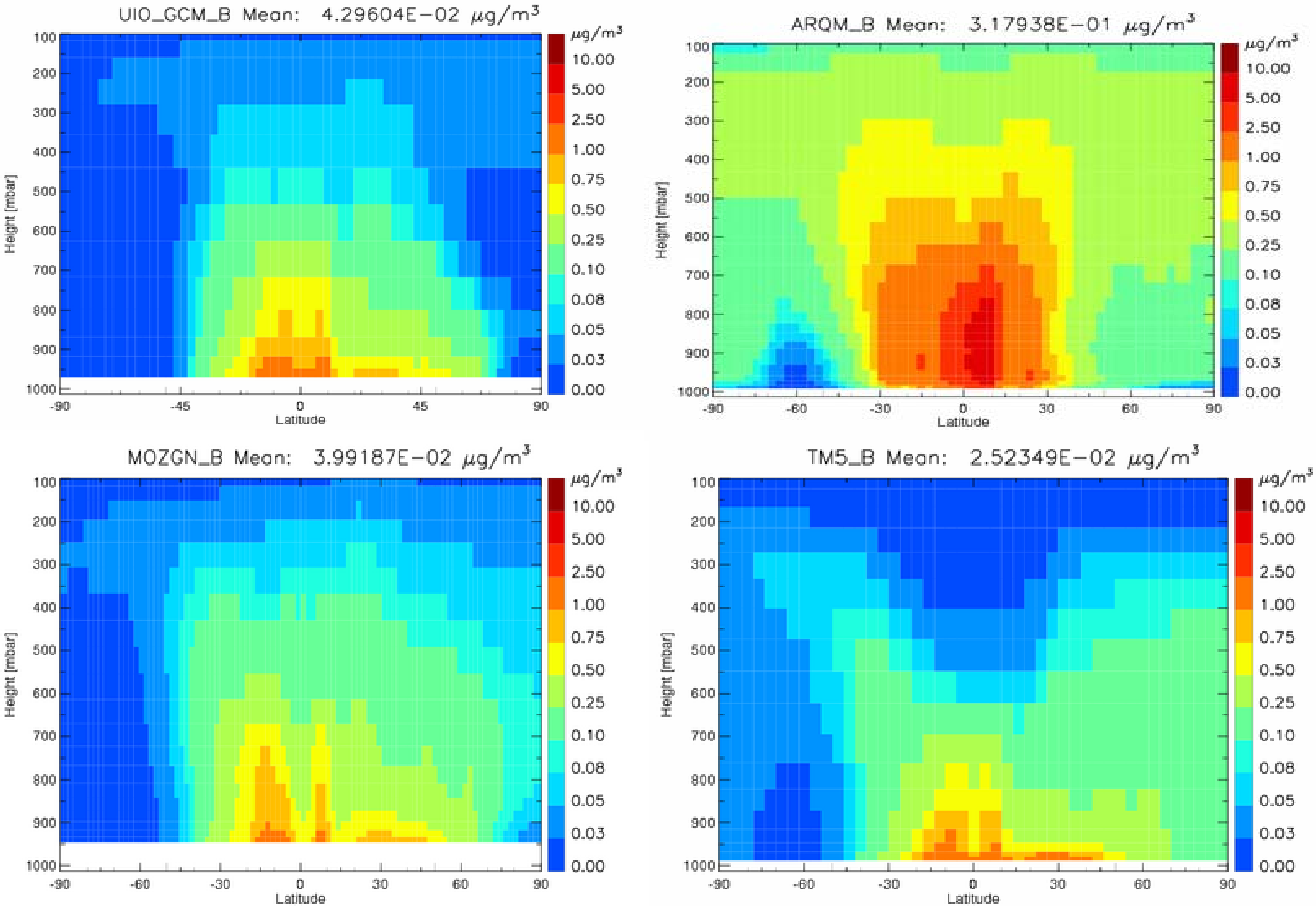
Change in SWCF due to anthropogenic S+C (1. indirect effect) (W/m2)

	Standard	No mixing	Plain scav	No conv. transport
TOA	-1.06	-1.09	-1.08	-1.16

Conclusions

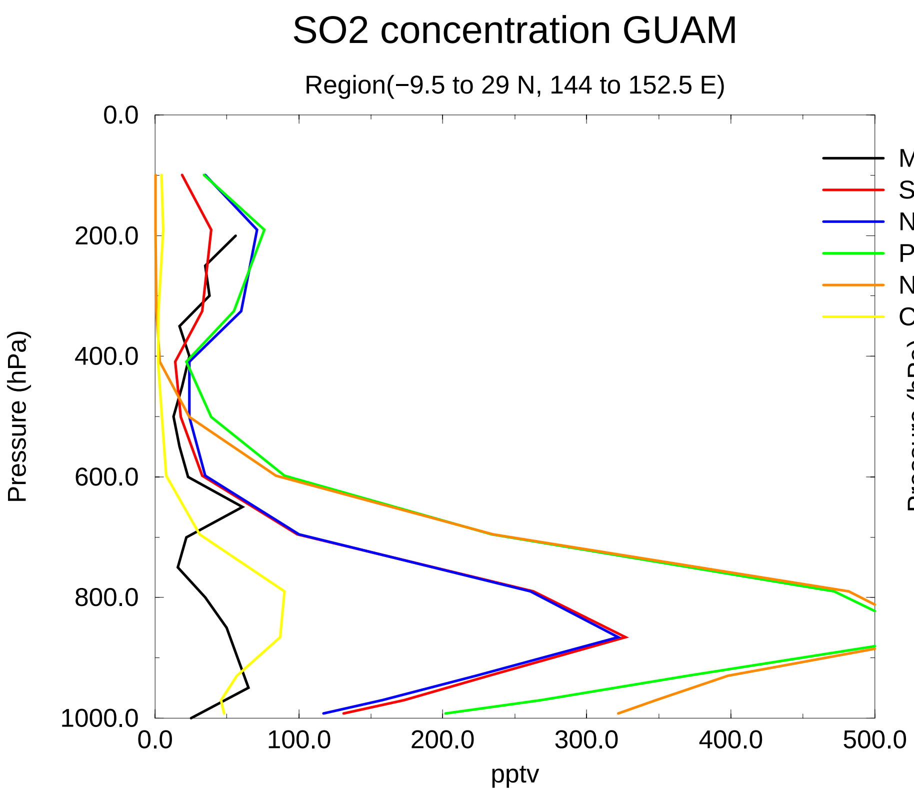
- Total aerosol burden very sensitive to parameterisation of convective transport
- Vertical distribution of aerosols, in particular absorbing aerosols above or below clouds may change the sign of the direct effect
- The in-direct effect is mostly affected by the amount of aerosols in the lower part of the atmosphere, so a high column burden does not necessarily mean a stronger in-direct effect

Vertical distribution POM

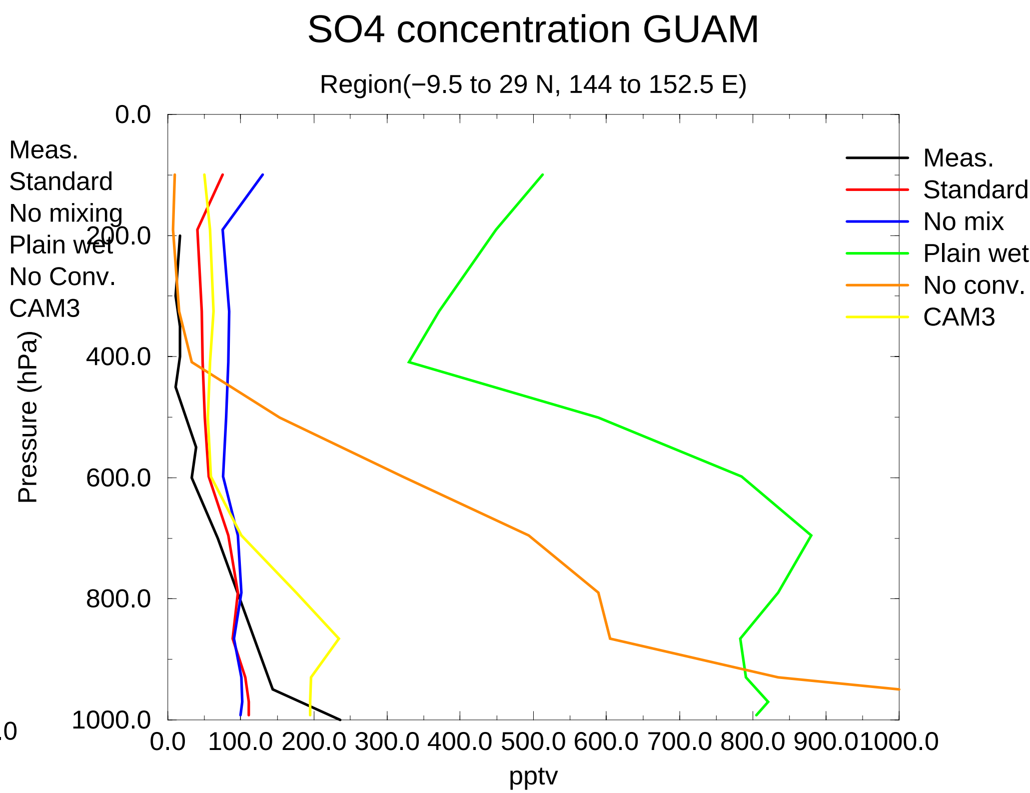


Why test convection

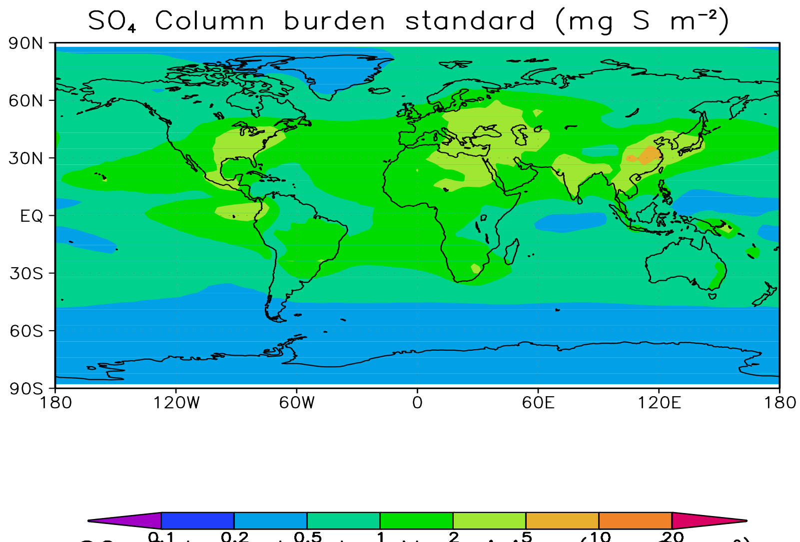
SO2, Guam

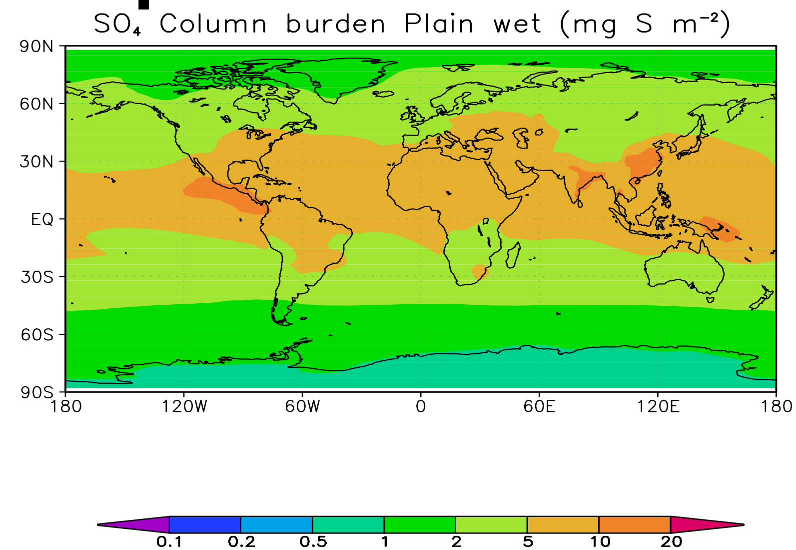


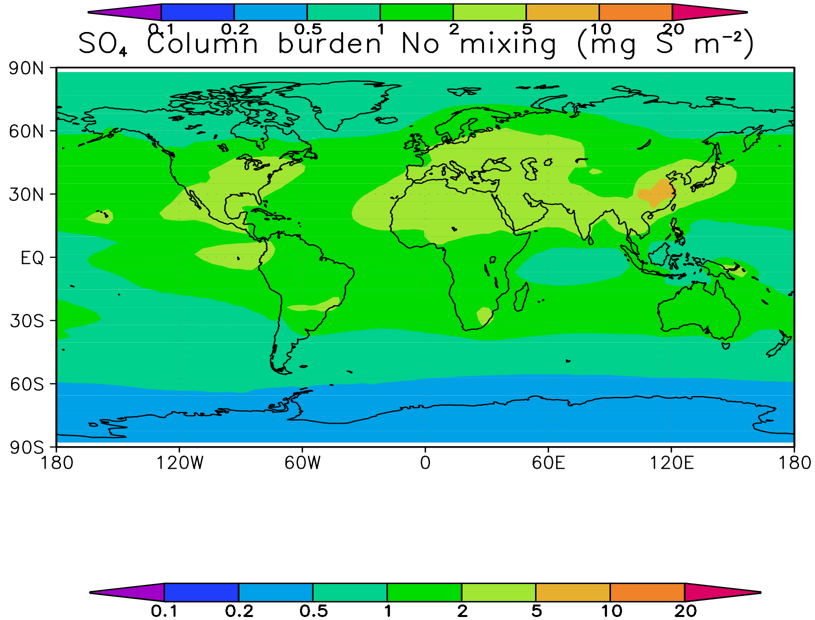
SO4, Guam

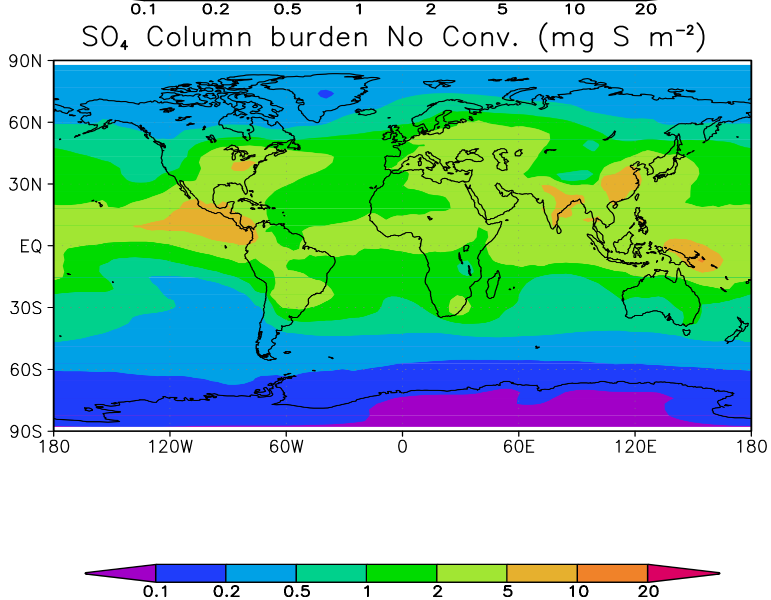


Column burden sulphate









Column burdens (mg S/C /m2)

	SO2	SO4	BC	POM
PRE; Standard	0.28	0.42	0.036	0.64
PRE; No mixing	0.31	0.55	0.043	0.85
PRE; Plain scav.	0.38	2.24	0.14	2.44
PRE; No conv. transport	0.30	0.76	0.063	0.99