

# Aerosol modeling for variational data assimilation

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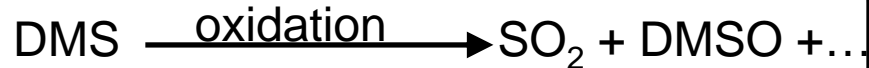
# FULL SCHEME

## • Tracers

**24 tracers:** DMS, SO<sub>2</sub>, H<sub>2</sub>S, DMSO, MSA, H<sub>2</sub>O<sub>2</sub>, SO<sub>4</sub>, Black Carbon, Organic Matter, Fly Ash, 2 bins for Dust and 10 bins for Sea Salt

Black Carbon and Organic Matter exist in model as hydrophilic and hydrophobic

## • Chemistry (Gaseous Phase)



Fixed oxidants but H<sub>2</sub>O<sub>2</sub> chemistry

Aqueous-phase oxidation of SO<sub>2</sub>

# REDUCED SCHEME

**Tracer 1:** Aerosol Precursors (DMS, SO<sub>2</sub>, H<sub>2</sub>S)

**Tracer 2:** Accumulation mode aerosol (SO<sub>4</sub>, Black Carbon, Organic Matter, Dust & Sea Salt)

**Tracer 3:** Coarse mode aerosol (Sea Salt)

**Tracer 4:** Coarse mode aerosol (Dust)

Sulphur chemistry is replaced by an equivalent chemical lifetime



No aqueous phase chemistry

# FULL SCHEME

## • Dry Deposition

	Tracer 1*	Tracer 2**	Tracer 3	Tracer 4
Vdep_oce	0.0 & 0.7	0.05 & 0.1	0.1, 1.2 & 1.5	1.2
Vdep_sic	0.0 & 0.2	0.25 & 0.1	0.1, 1.2 & 1.5	1.2
Vdep_ter	0.0 & 0.3	0.25 & 0.1	0.1, 1.2 & 1.5	1.2
Vdep_lic	0.0 & 0.2	0.25 & 0.1	0.1, 1.2 & 1.5	1.2

\*The value of SO<sub>2</sub> is taken for Tracer 1 in the simplified model, except for vdep\_oce where it is a weighted average of deposition velocities of SO<sub>2</sub> and DMS

\*\* The first value in the column represents the deposition velocity for SO<sub>4</sub> and all the other tracers grouped in tracer 2 have a value vdep of 1.2

## • Wet Deposition

## • Sedimentation

Sedimentation velocity is a function of size.

## • Aerosol optical properties

Size distribution. Mie theory.

# REDUCED SCHEME

	Tracer 1*	Tracer 2	Tracer 3	Tracer 4
Vdep_oce	0.28*	0.28	1.2	1.2
Vdep_sic	0.2	0.17	1.2	1.2
Vdep_ter	0.3	0.14	1.2	1.2
Vdep_lic	0.2	0.17	1.2	1.2

\*Weighted average between deposition velocities of SO<sub>2</sub> and DMS

Tracer 2 vdep correspond to weighted average between SO<sub>2</sub> and DMS

Equivalent size is used to adjust burden

Equivalent size distribution is used.

# FULL SCHEME

## • Order of calls

Gas & aqueous phase chemistry



Low level emissions



Dry deposition



Boundary Layer Mixing



Sedimentation



High level emissions



Hydroscopic to hydrophilic growth of BC/OM



Effect of Precipitation

# REDUCED SCHEME

Emissions (low + high level)



Dry deposition



Boundary Layer Mixing



Sedimentation



Gas to particle conversion



Effect of Precipitation

# FULL SCHEME

- **Effect of Precipitation**

In Cloud Scavenging (large scale precipitation)



Below Cloud Scavenging (large scale precipitation)



In Cloud Scavenging (convective precipitation)



Below Cloud Scavenging (convective precipitation)

# REDUCED SCHEME

In Cloud Scavenging (large scale precipitation)



In Cloud Scavenging (convective precipitation)



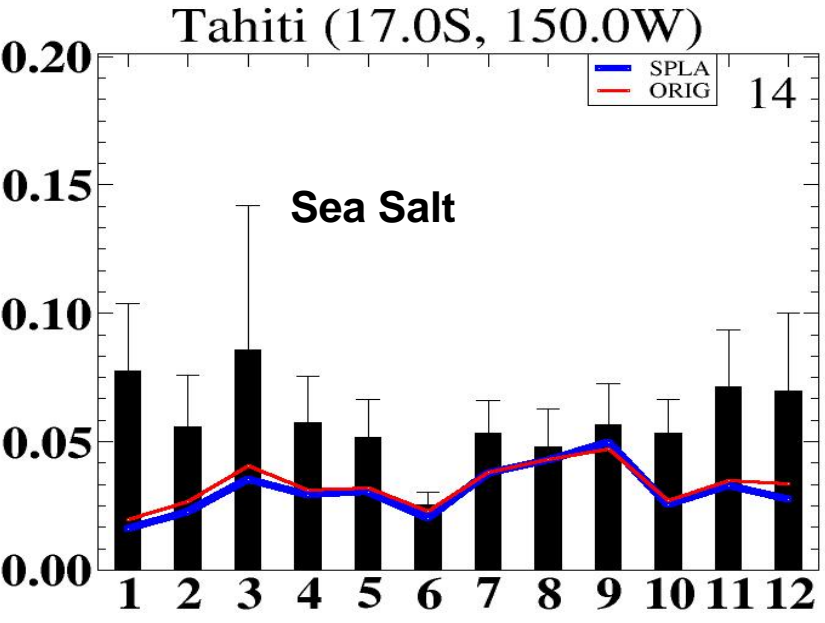
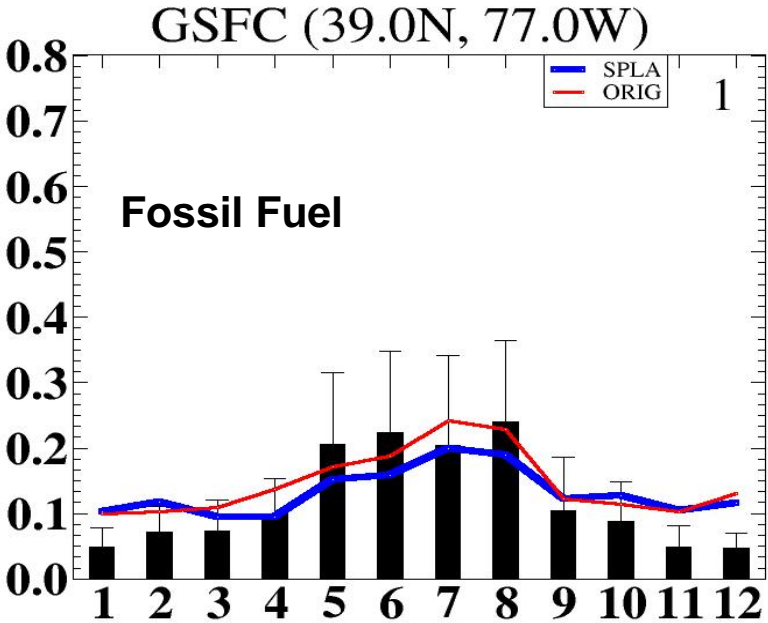
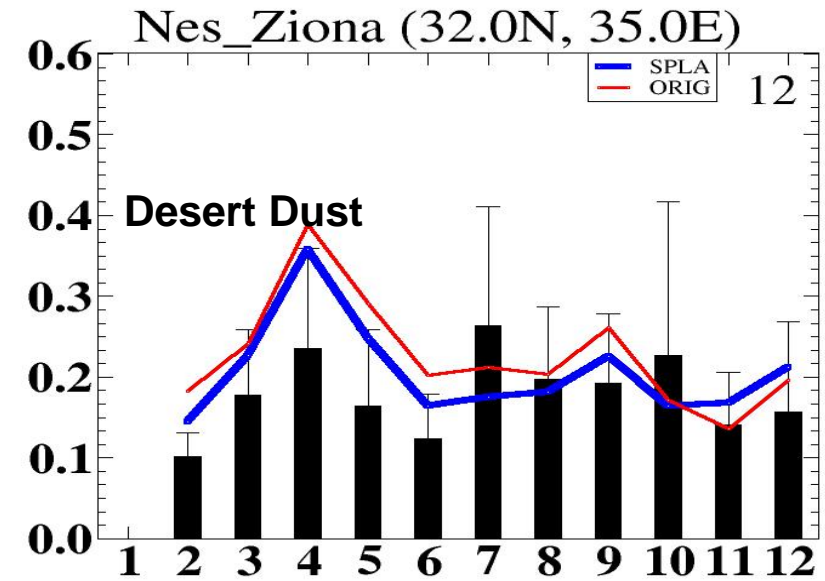
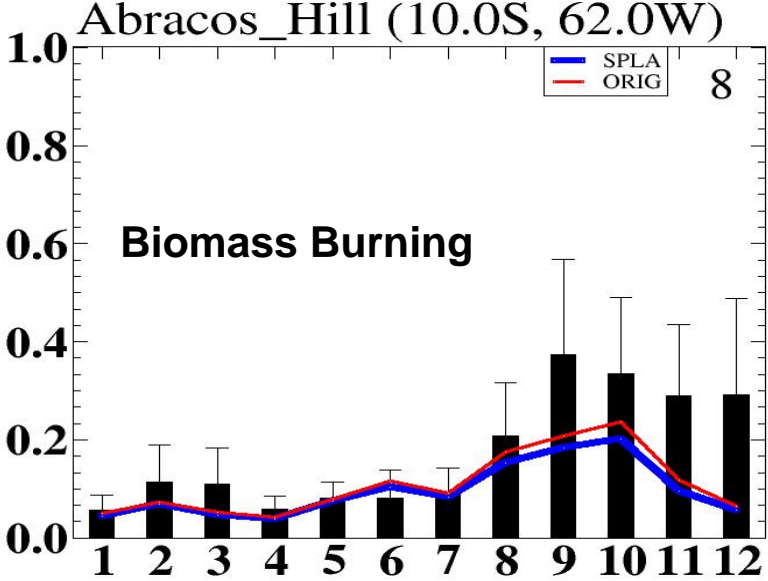
Below Cloud Scavenging (large scale precipitation)



Below Cloud Scavenging (convective precipitation)

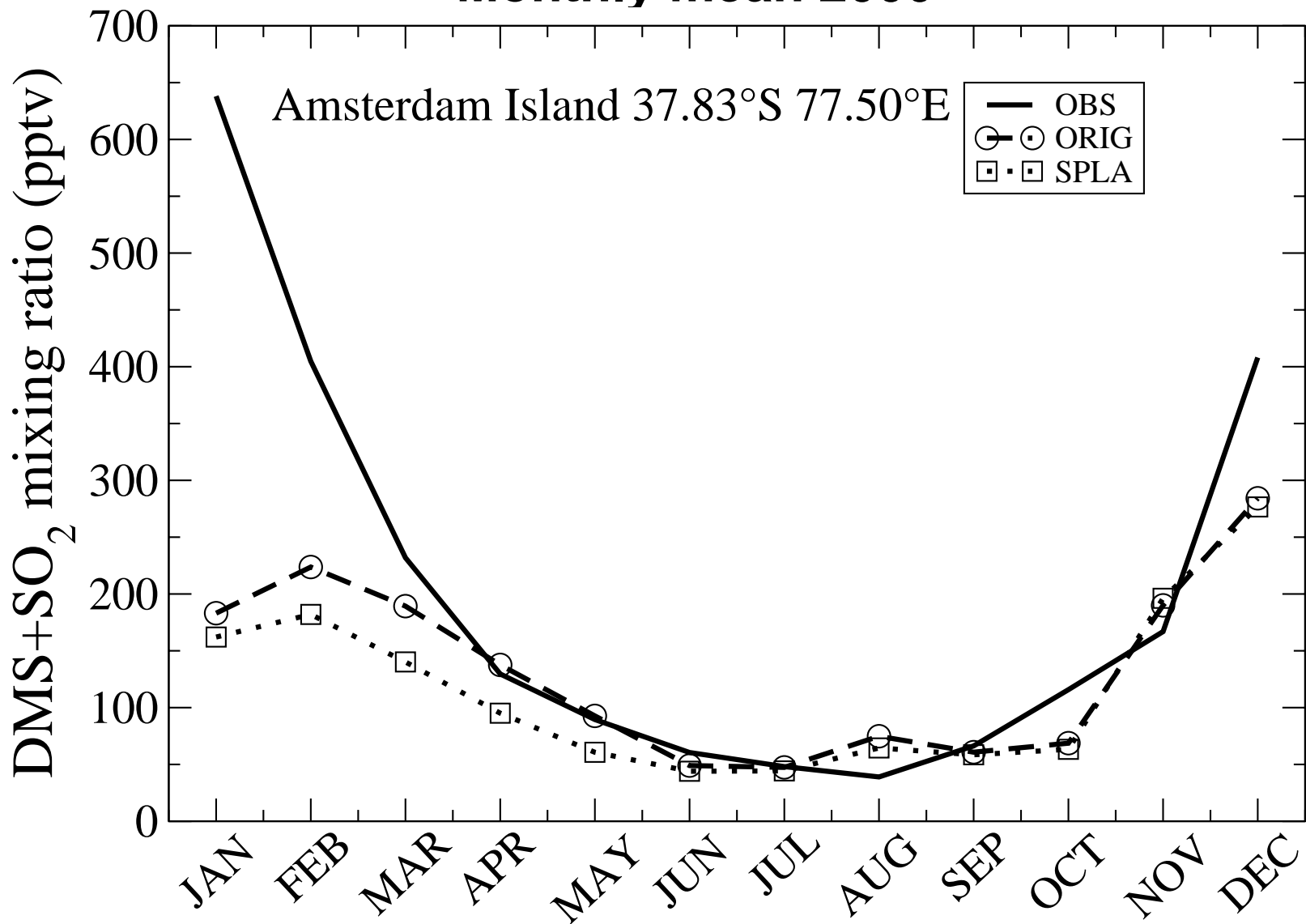
# Simplified aerosol model versus AERONET and Original aerosol model

AOD at 670 nm



# Surface measurements of tracer 2

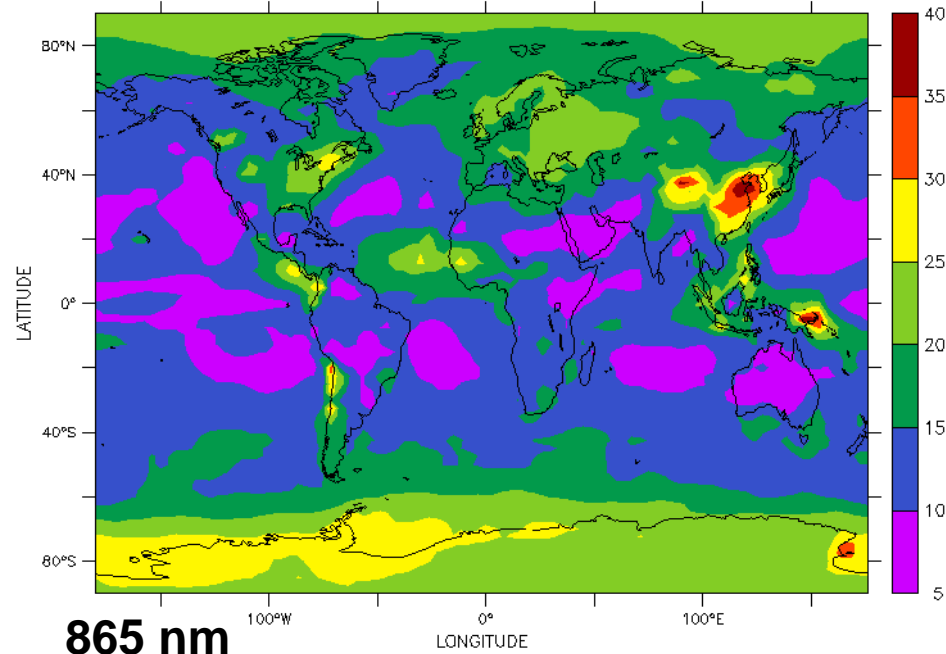
## Monthly mean 2000



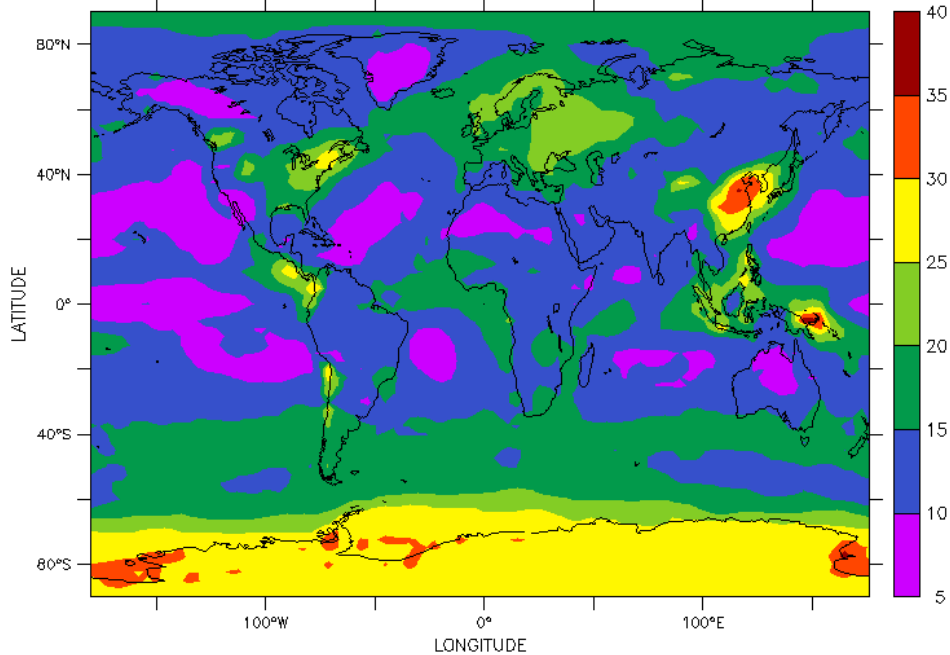
# Simplified Model versus Original

## RMSE (Reduced wrt Full) of Daily AOD

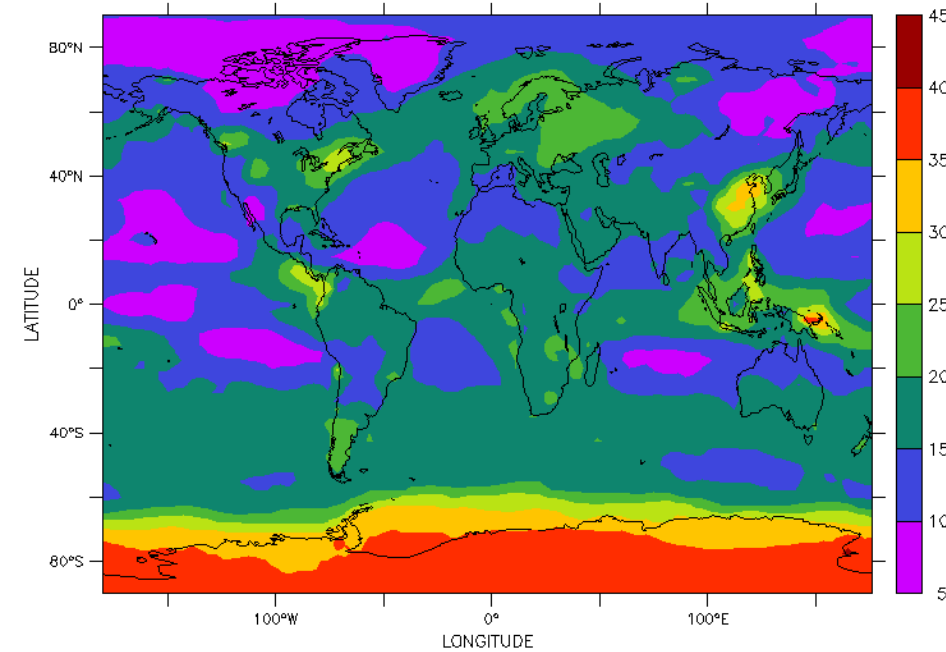
550 nm



670 nm



865 nm

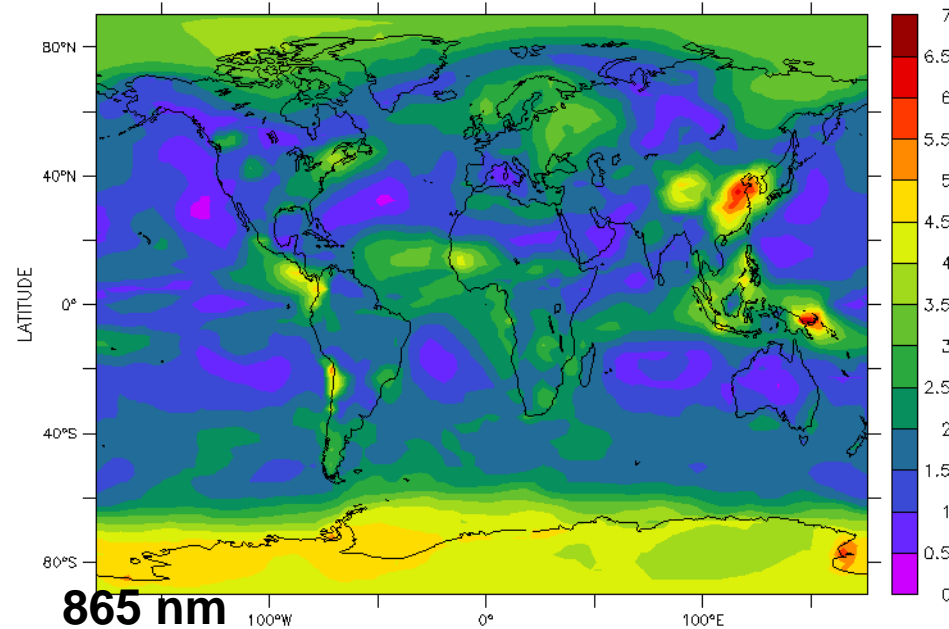




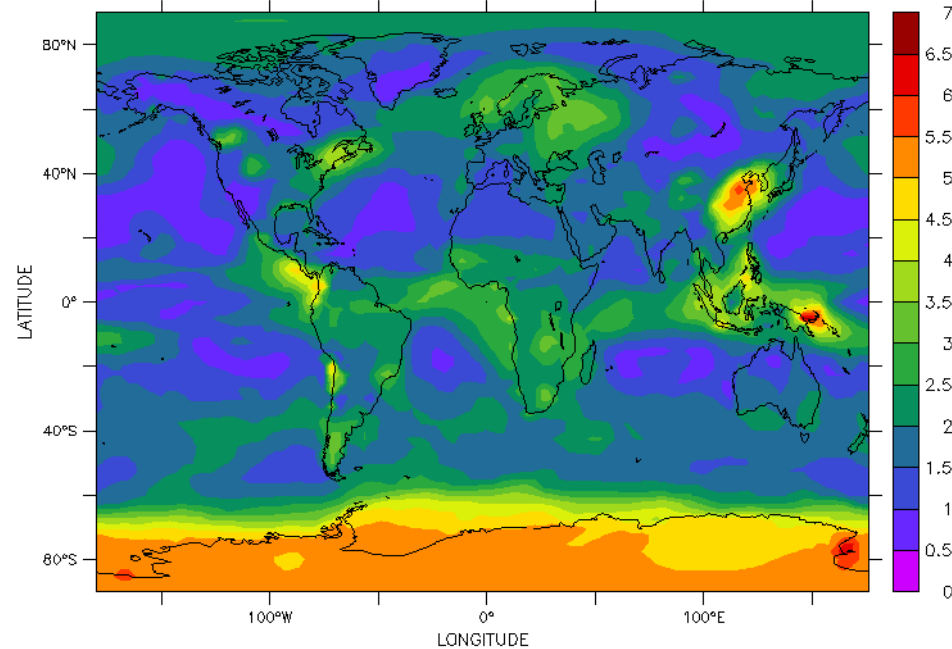
# Simplified Model versus Original

## RMSE (Reduced wrt Full) of monthly AOD

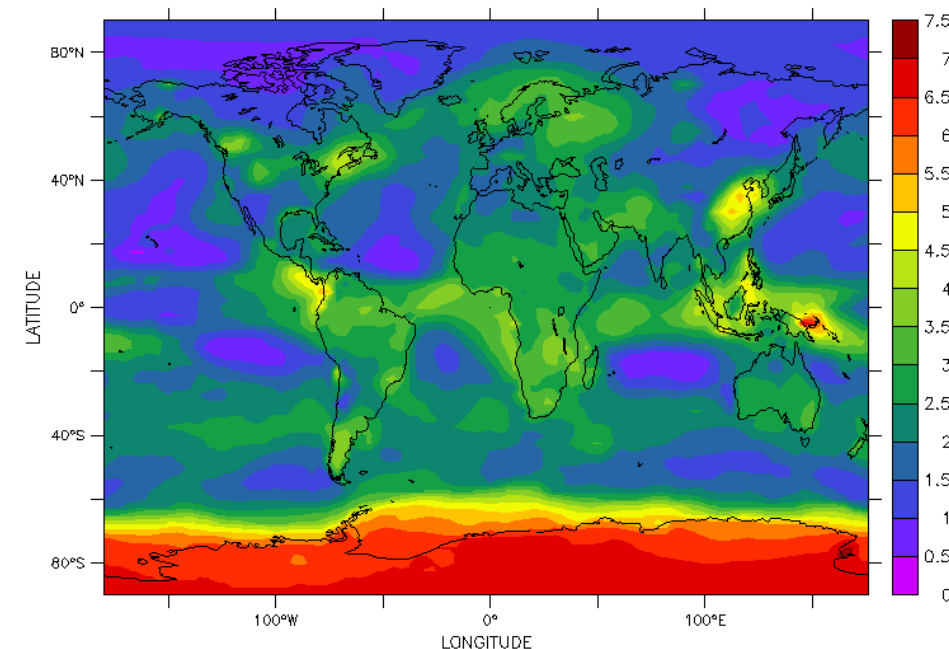
550 nm



670 nm



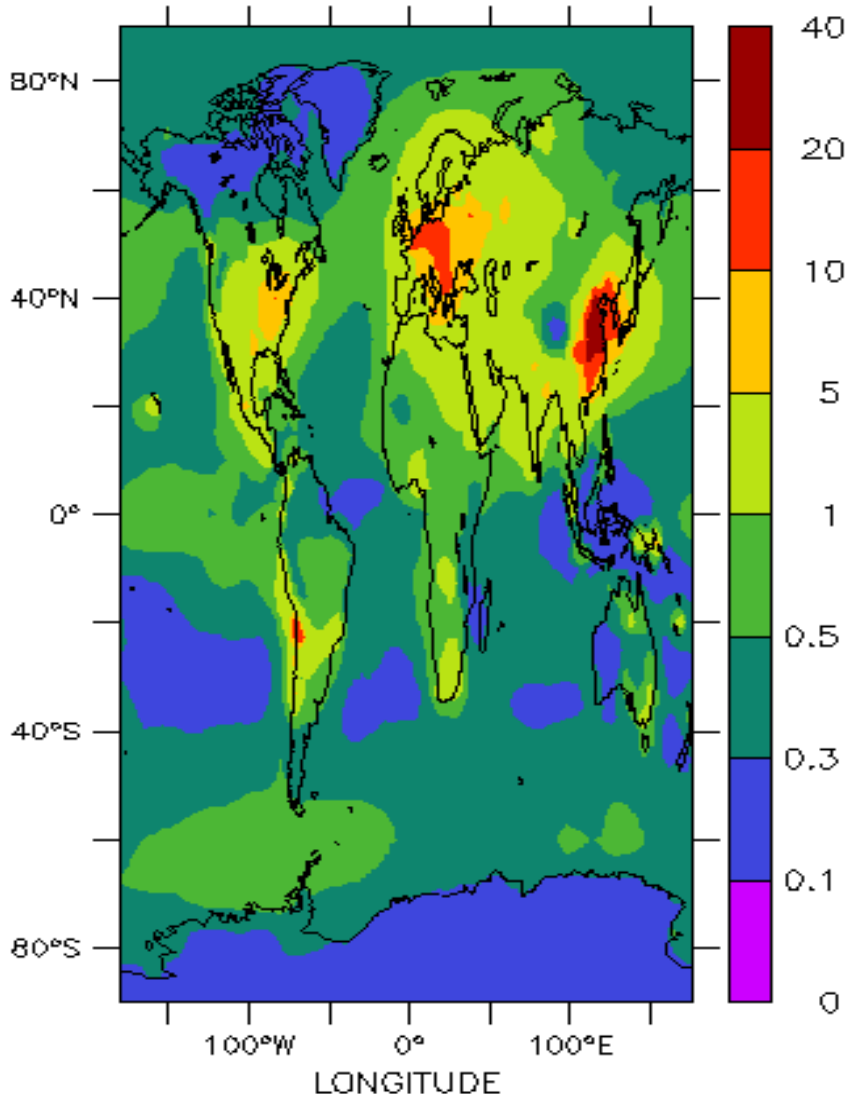
865 nm



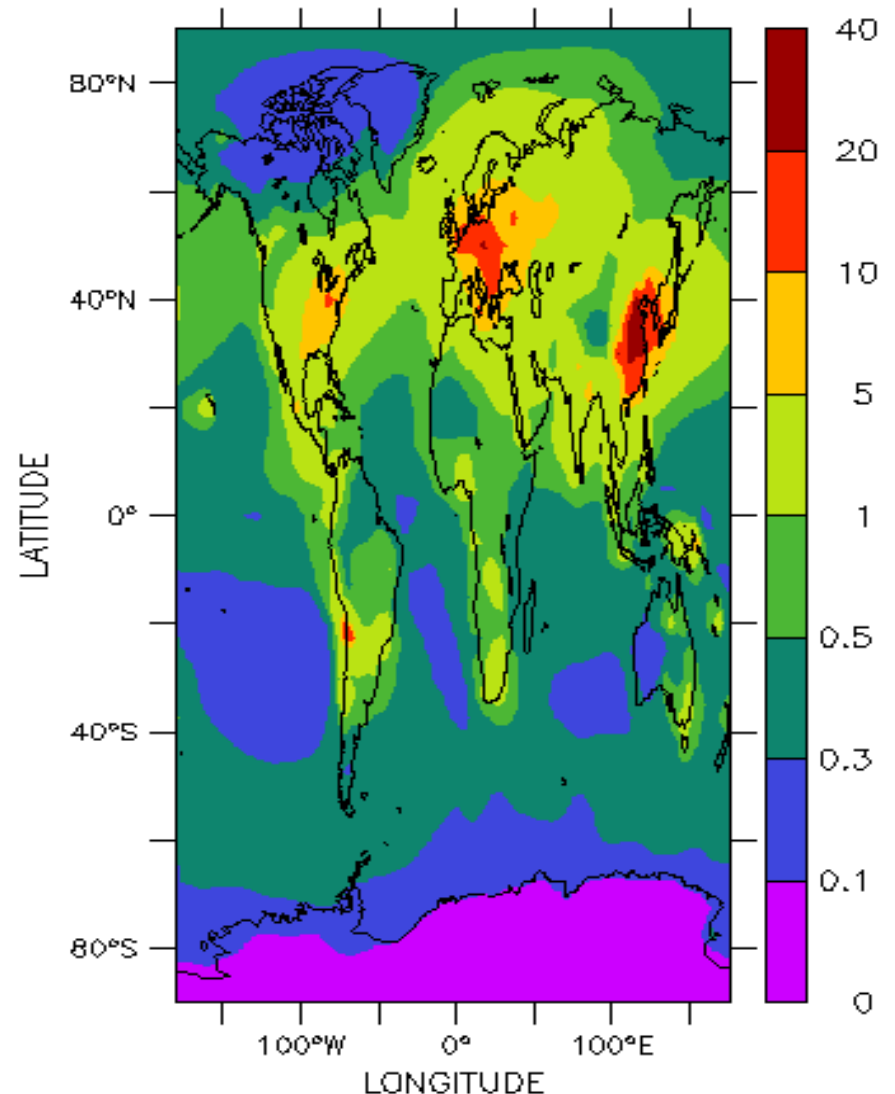
# Simplified Model versus Original

## Annual burden of tracer 1

### FULL SCHEME



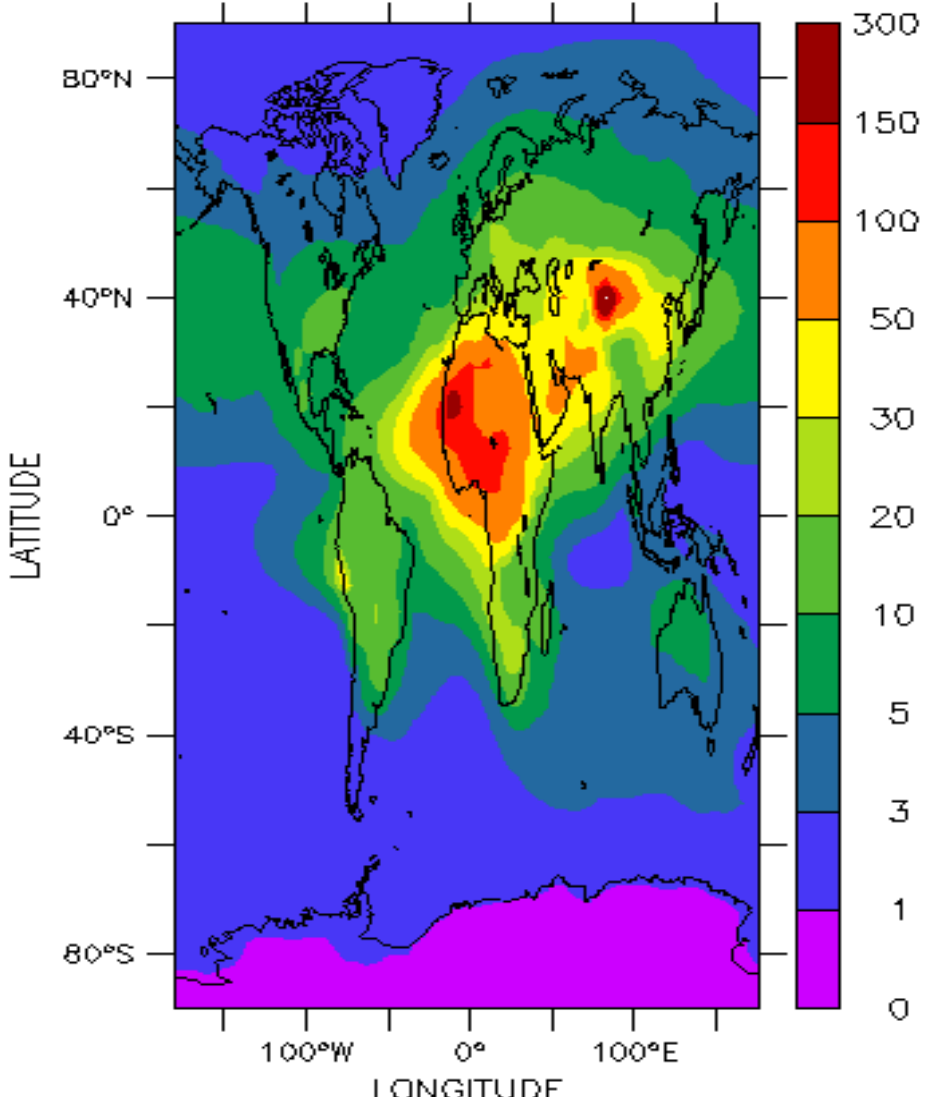
### REDUCED SCHEME



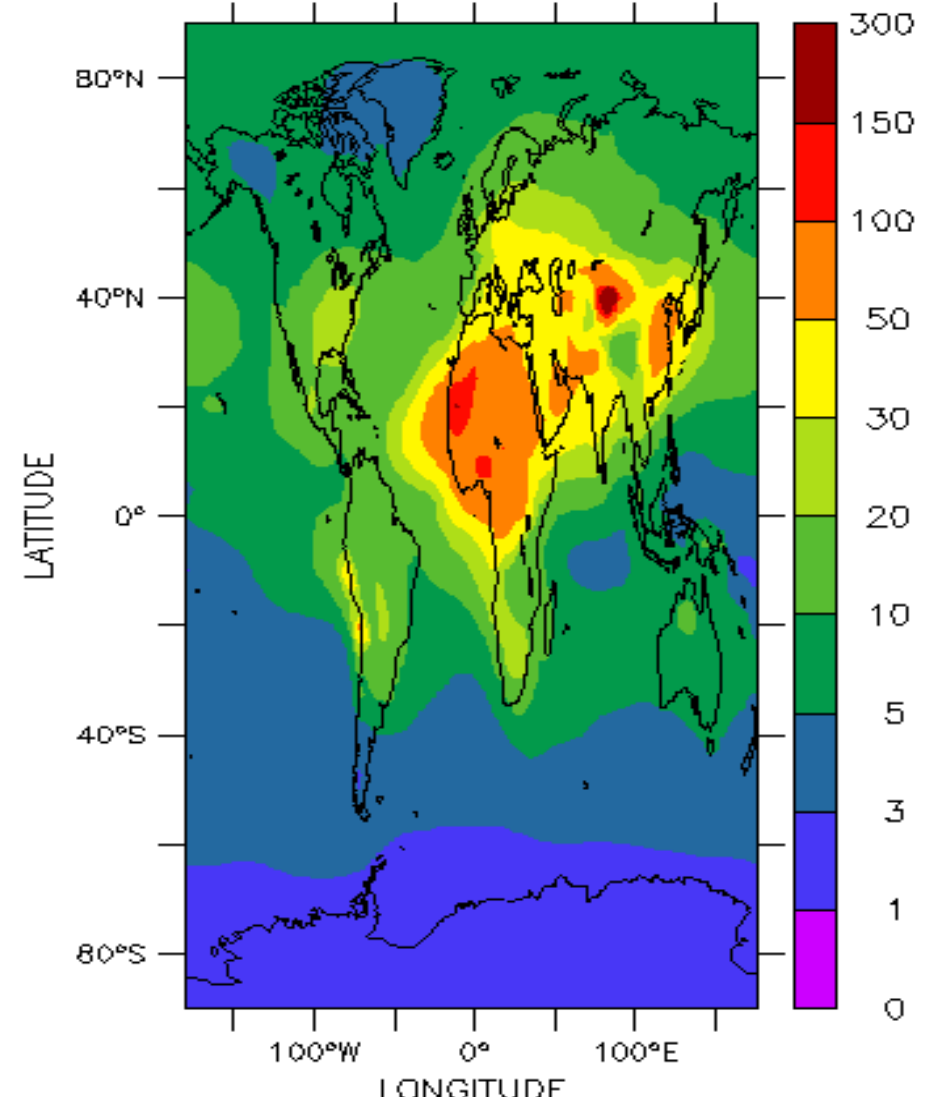
# Simplified Model versus Original

## Annual burden of tracer 2

### FULL SCHEME



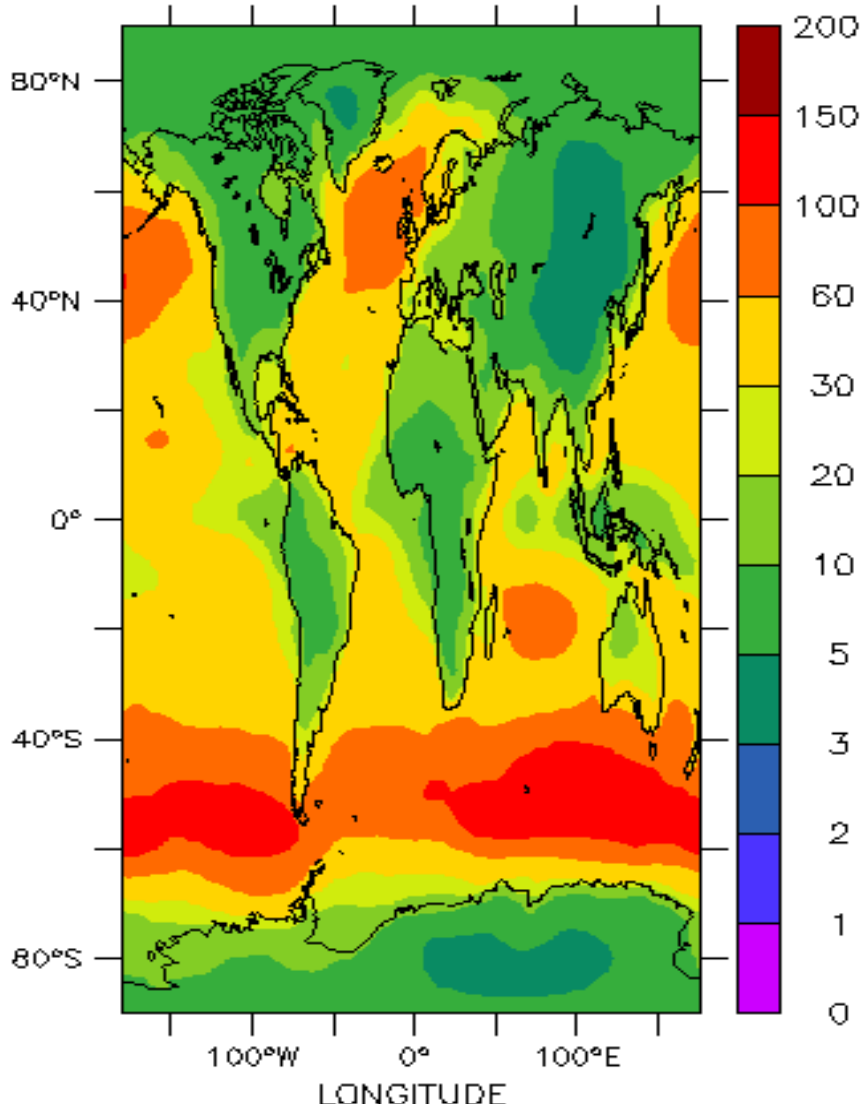
### REDUCED SCHEME



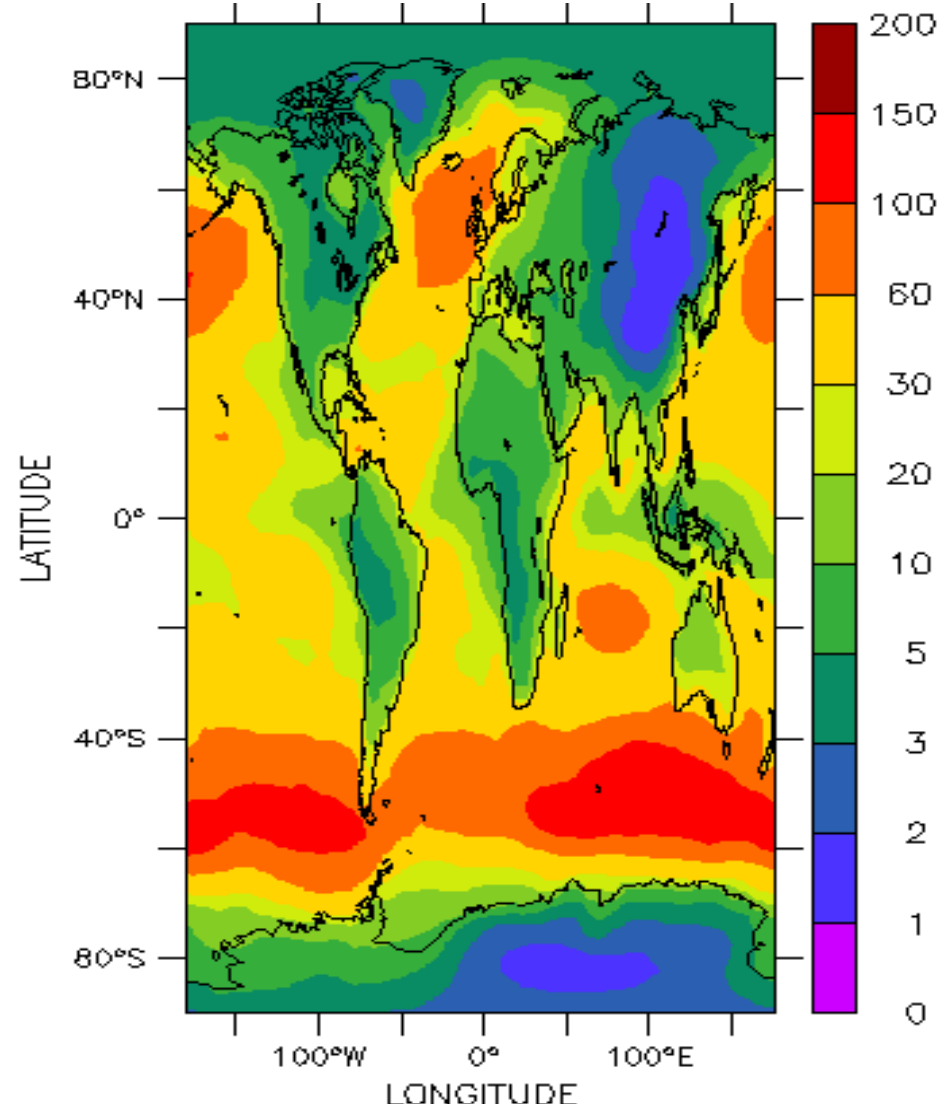
# Simplified Model versus Original

## Annual burden of tracer 3

### FULL SCHEME



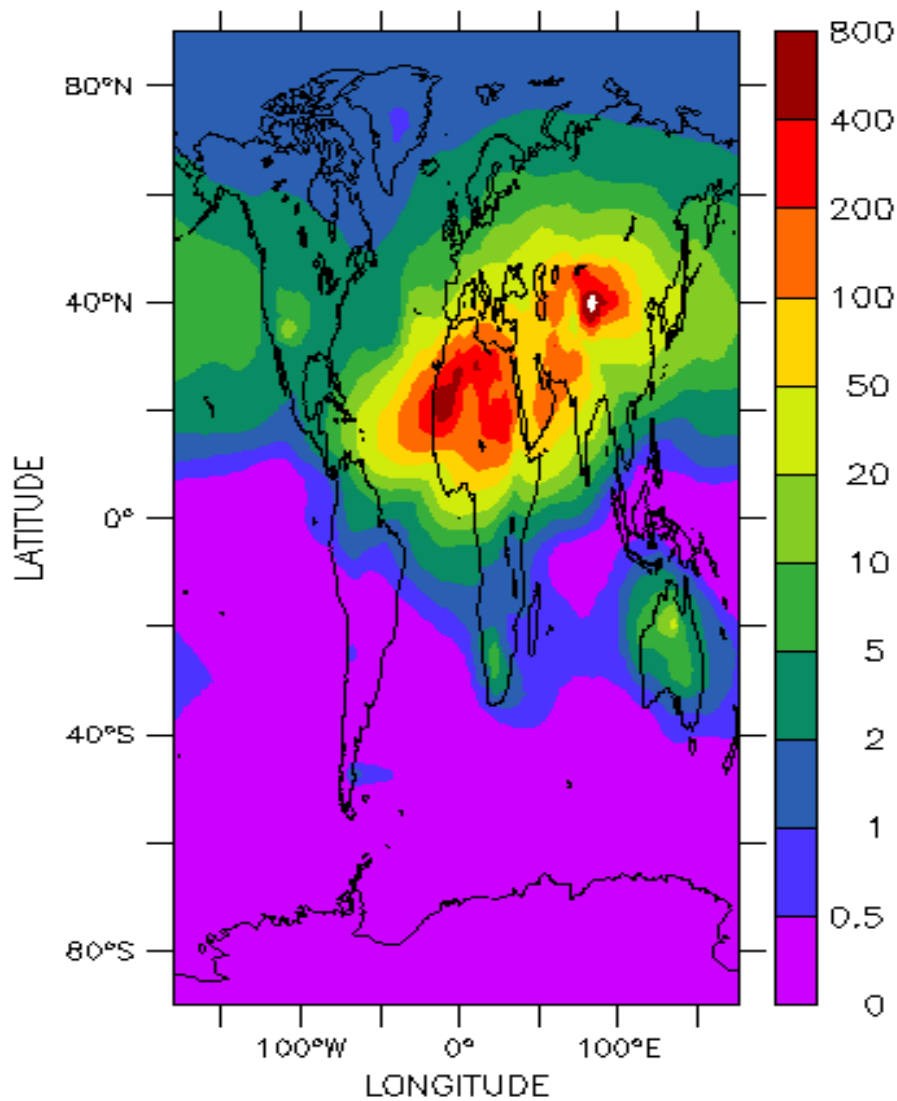
### REDUCED SCHEME



# Simplified Model versus Original

## Annual burden of tracer 4

### FULL SCHEME



### REDUCED SCHEME

