Investigation of uncertainties in aerosol simulation using GMI : A complementary approach to AEROCOM

A modular approach to understand processing

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and More …

AEROCOM workshop, 17-19 Oct. 2006

Global Modeling Initiative (GMI)

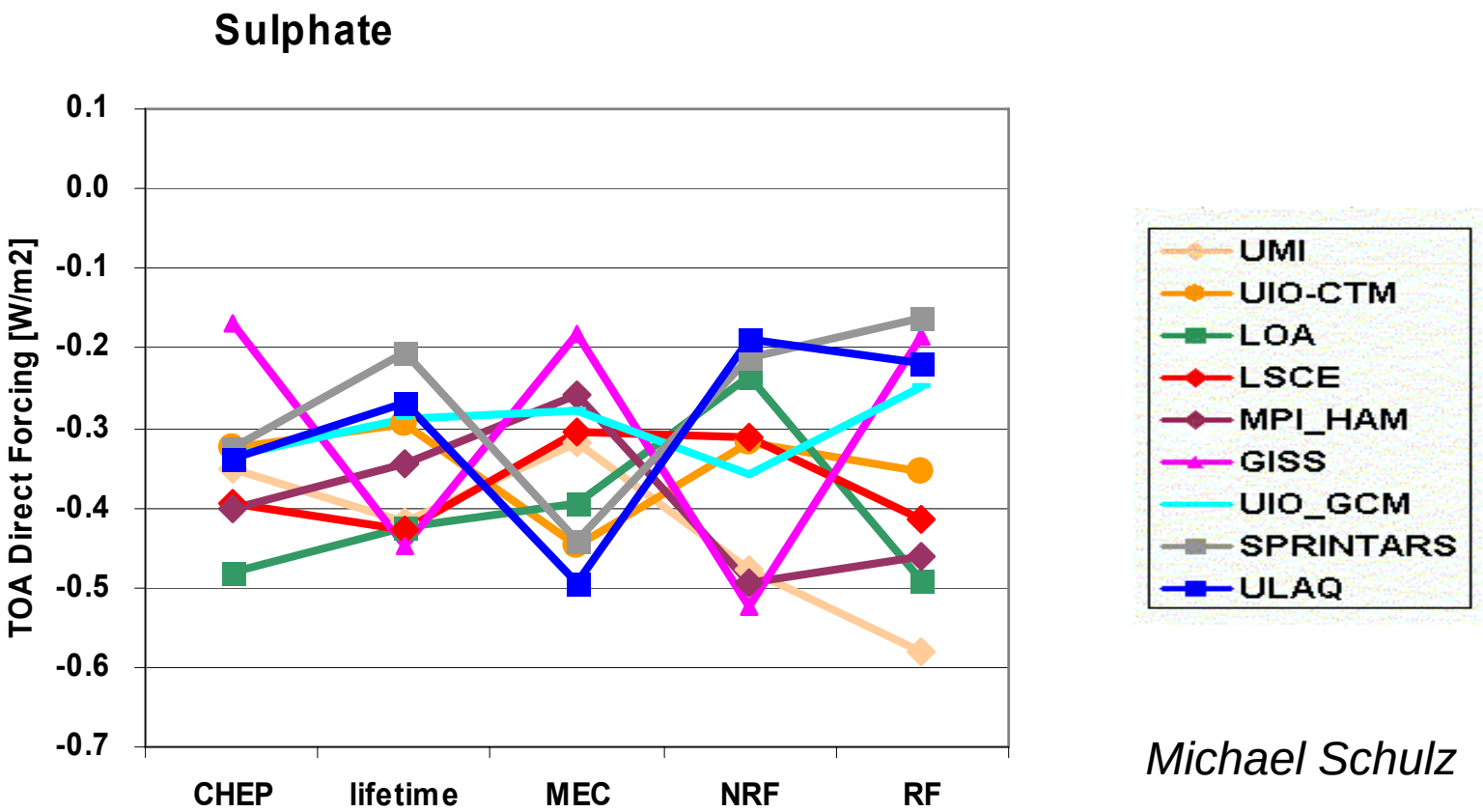
- **a modular 3D chemical-transport model to assess the impact of various natural and anthropogenic perturbations on atmospheric composition and chemistry**
- **a testbed for model improvements**

http://gmi.gsfc.nasa.gov/gmi.html

Different Properties on Forcing Estimate

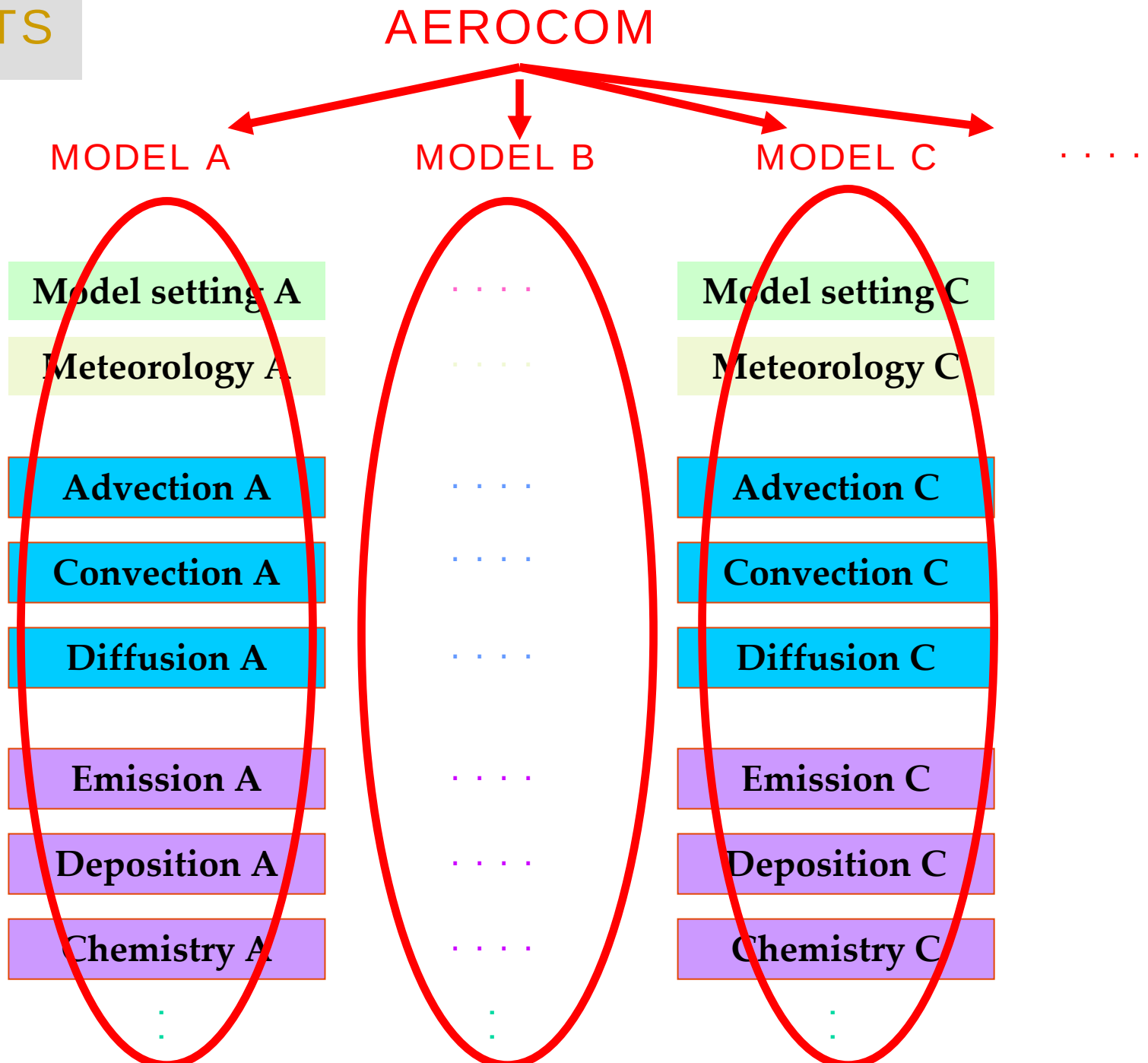
How much would simulated forcing vary
IF only one factor would be different between models

Forcing (RF) = chemical production (CHEP) x lifetime x extinction_coefficient (MEC) x forcing efficiency (NRF)

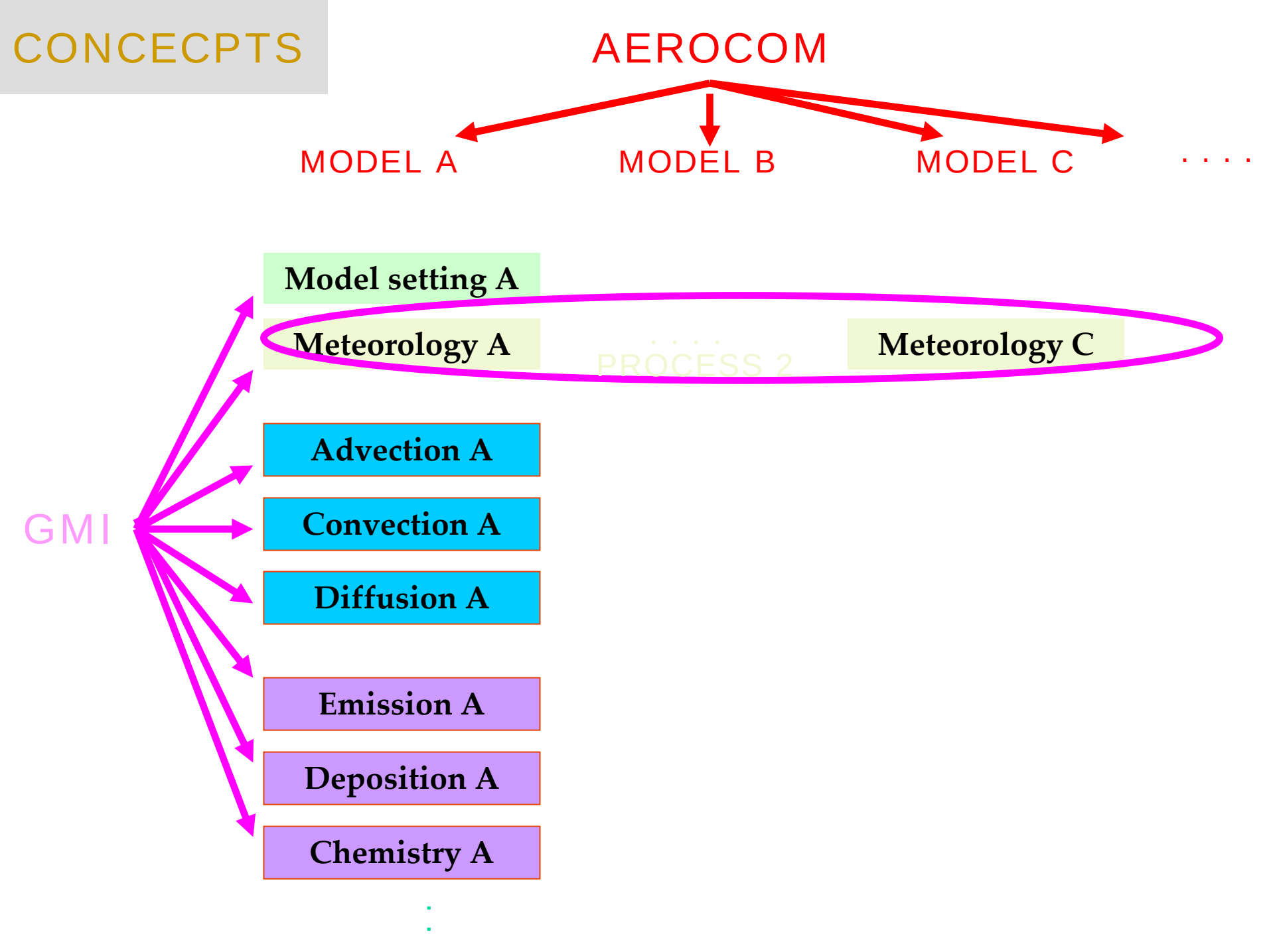


Michael Schulz

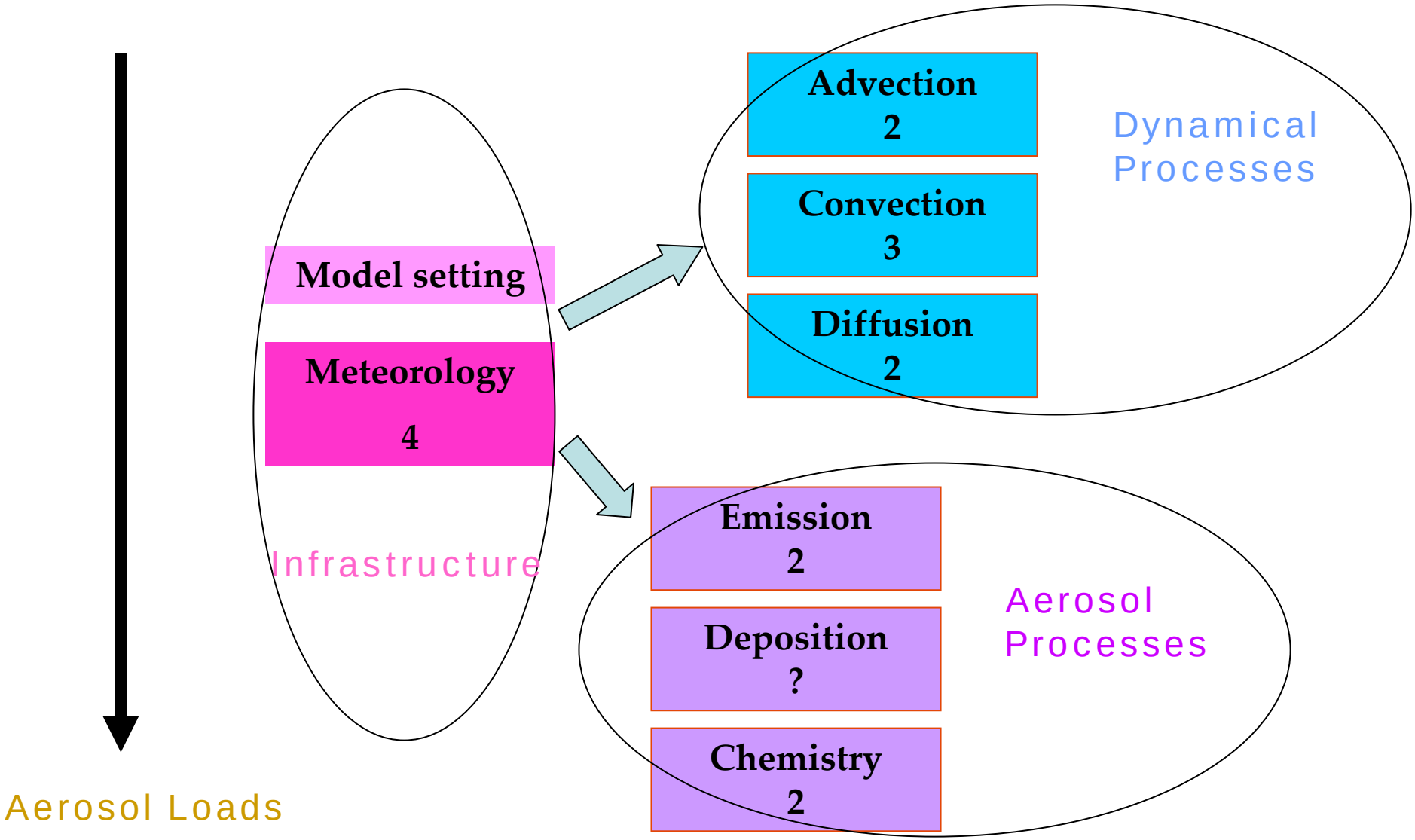
CONCECPTS


AEROCOM
MODEL A
MODEL B
MODEL C
. . . .
Model setting A
Meteorology A
Advection A
Convection A
Diffusion A
Emission A
Deposition A
Chemistry A
Model setting C
Meteorology C
Advection C
Convection C
Diffusion C
Emission C
Deposition C
Chemistry C

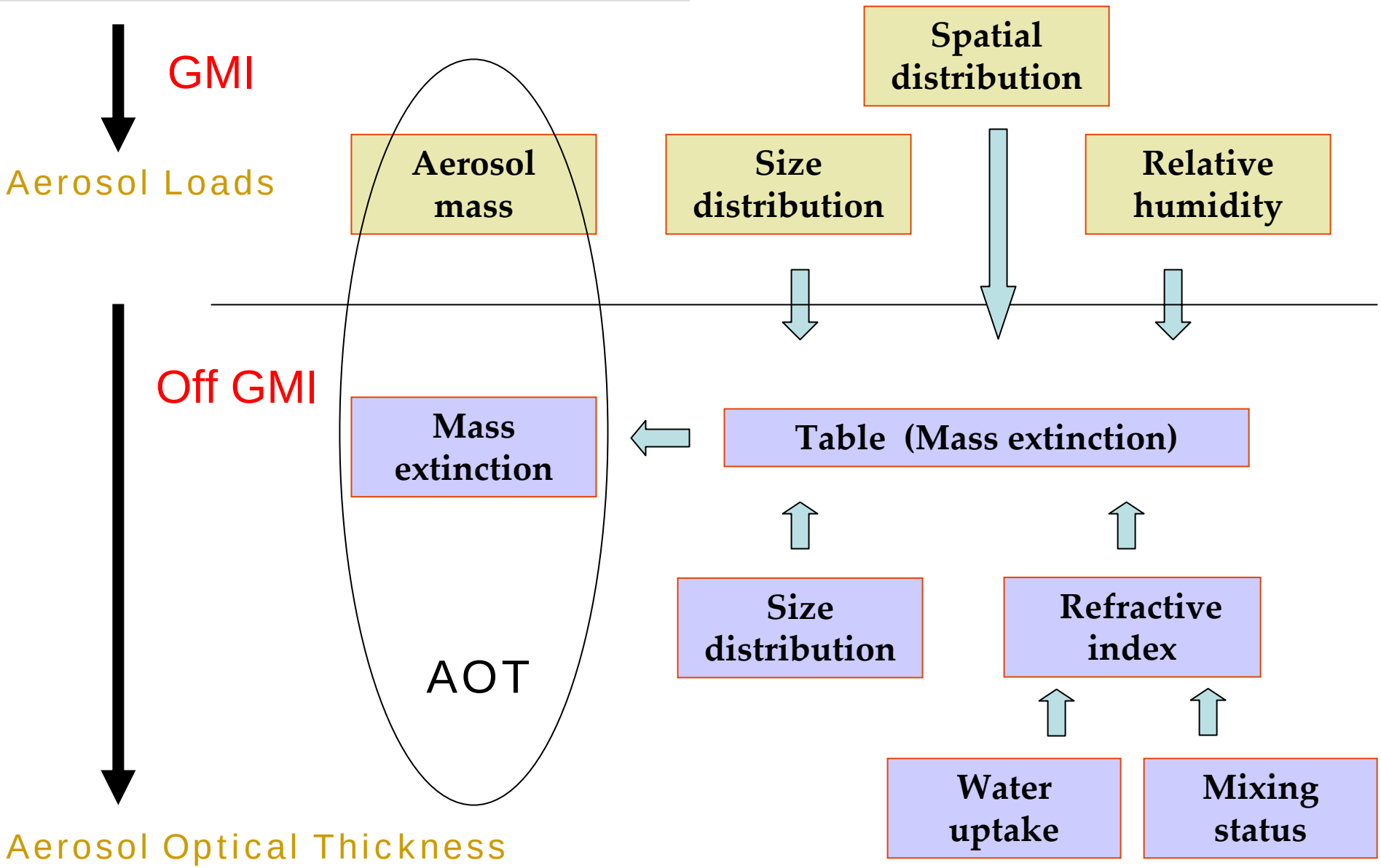
CONCECPTS


AEROCOM
MODEL A
MODEL B
MODEL C
. . . .
Model setting A
Meteorology A
. . . .
PROCESS 2
Meteorology C
GMI
Advection A
Convection A
Diffusion A
Emission A
Deposition A
Chemistry A

CURRENT GMI STATUS



CURRENT GMI STATUS



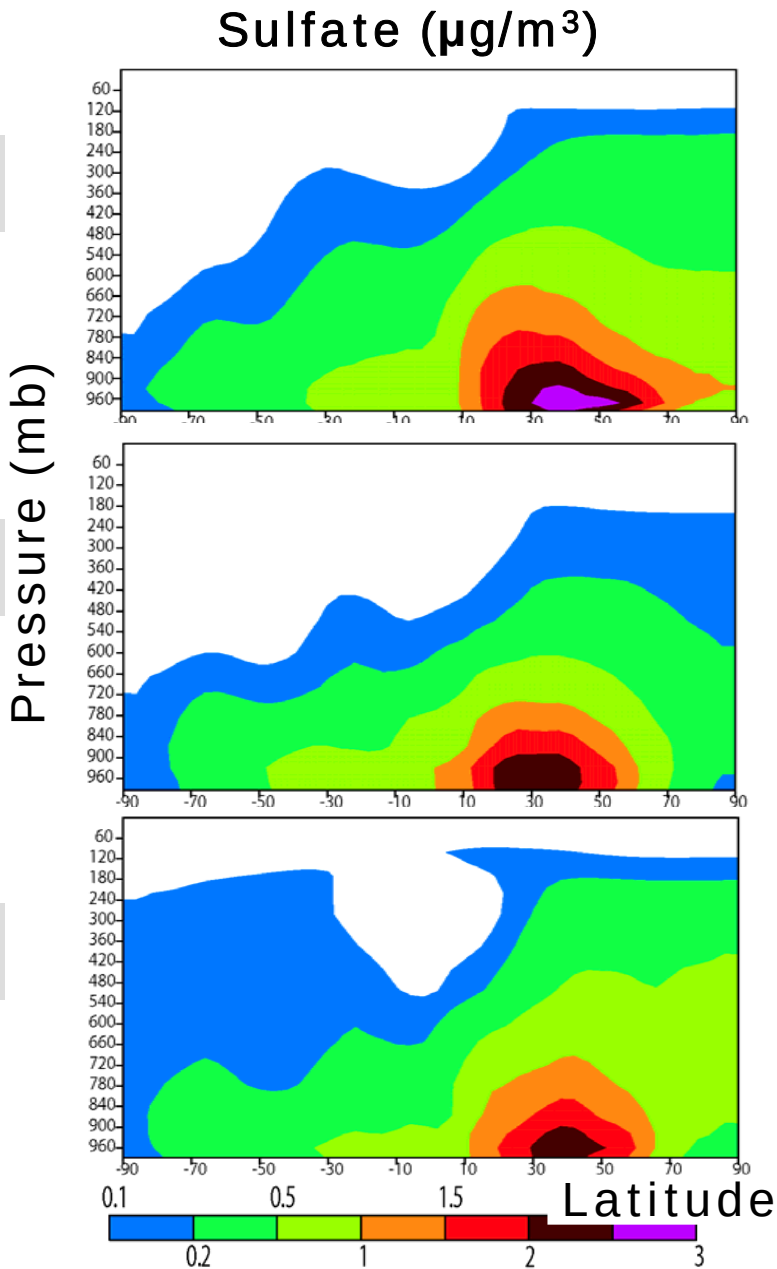
Impact of Meteorology

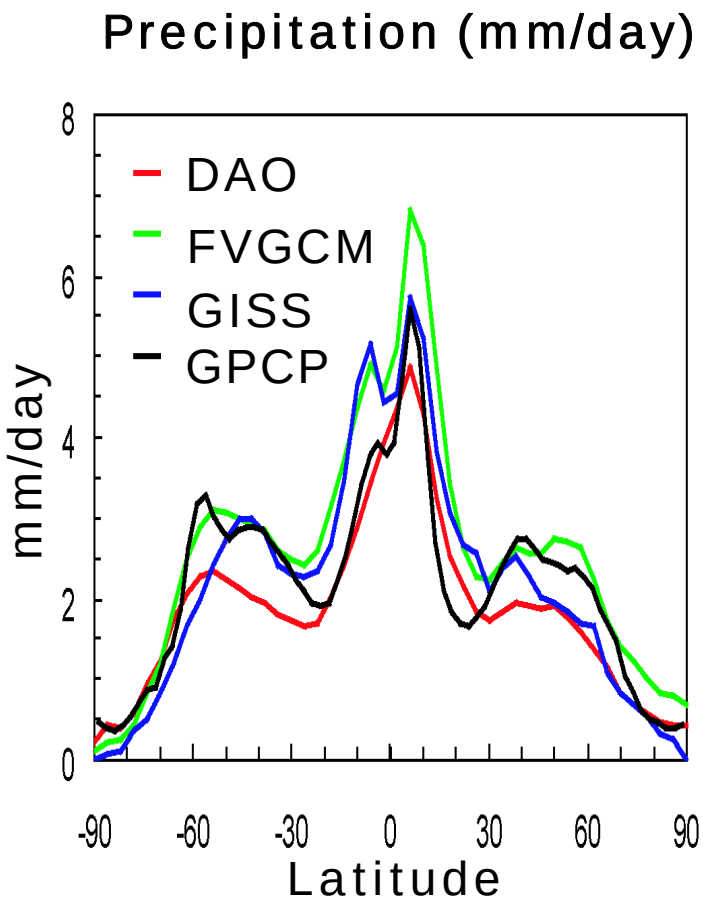
Annual and zonal mean

DAO

FVGCM

GISS

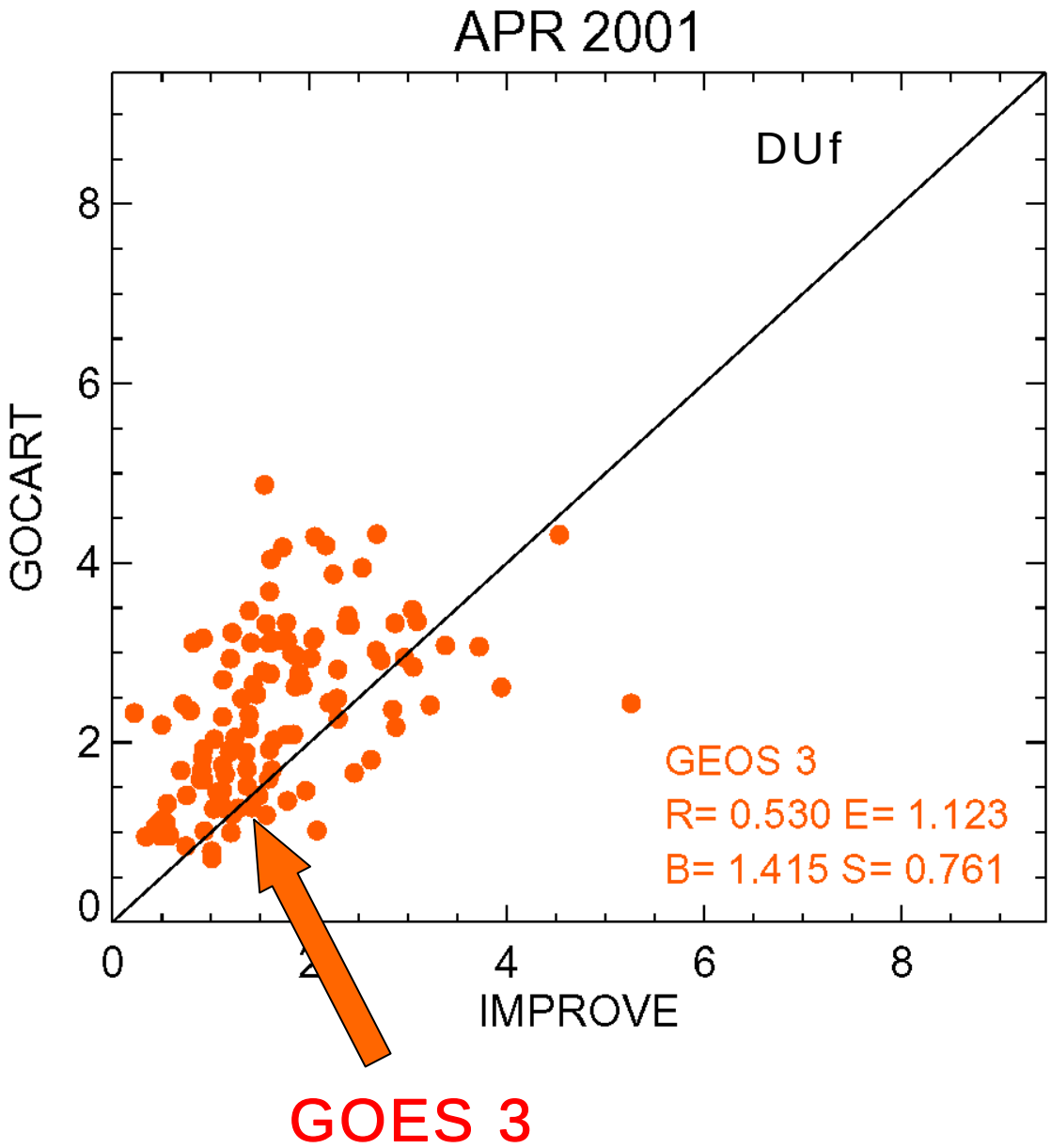




Xiaohong Liu et al. 2006

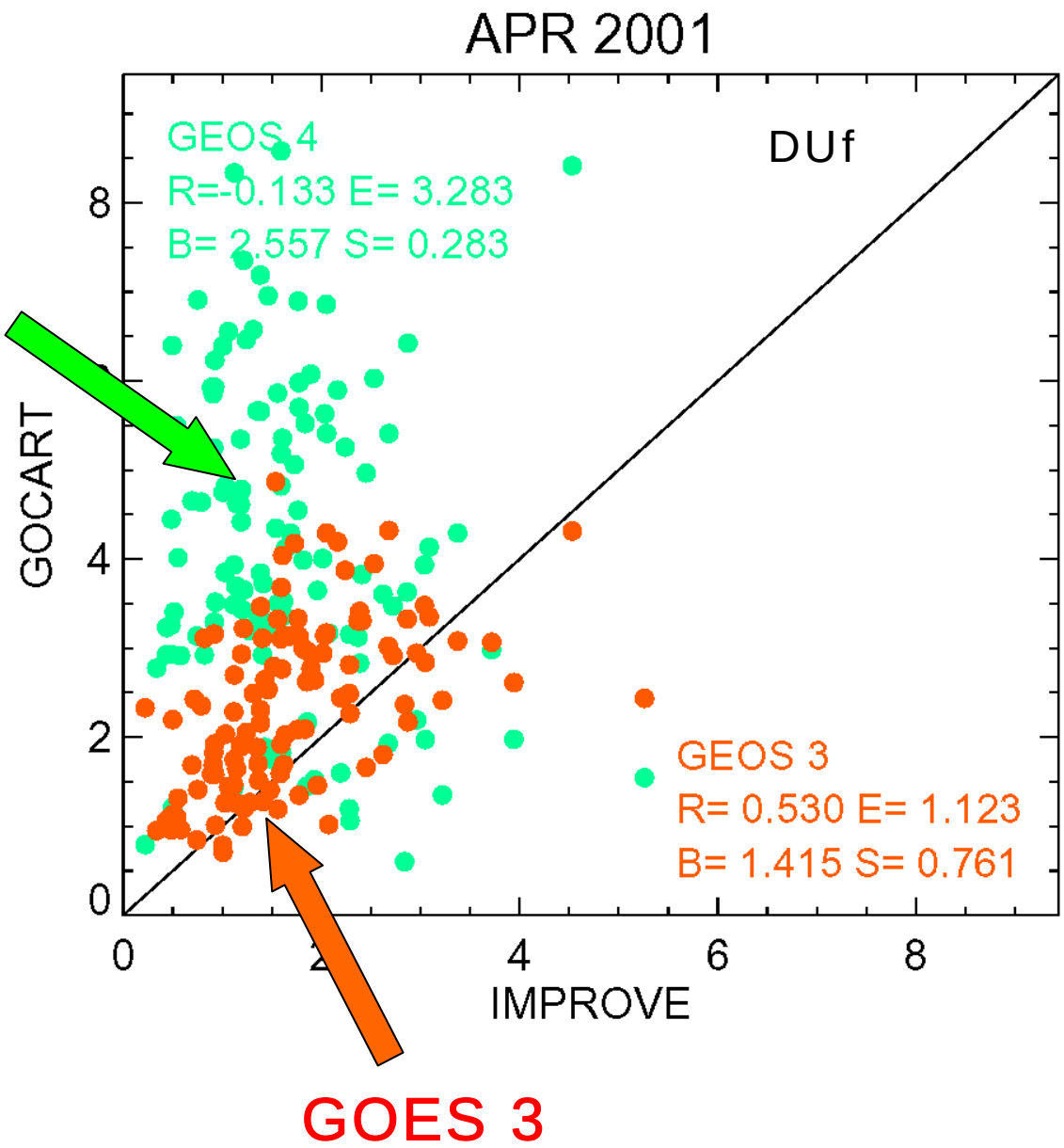
Impact of Meteorology

over U.S.



Impact of Meteorology

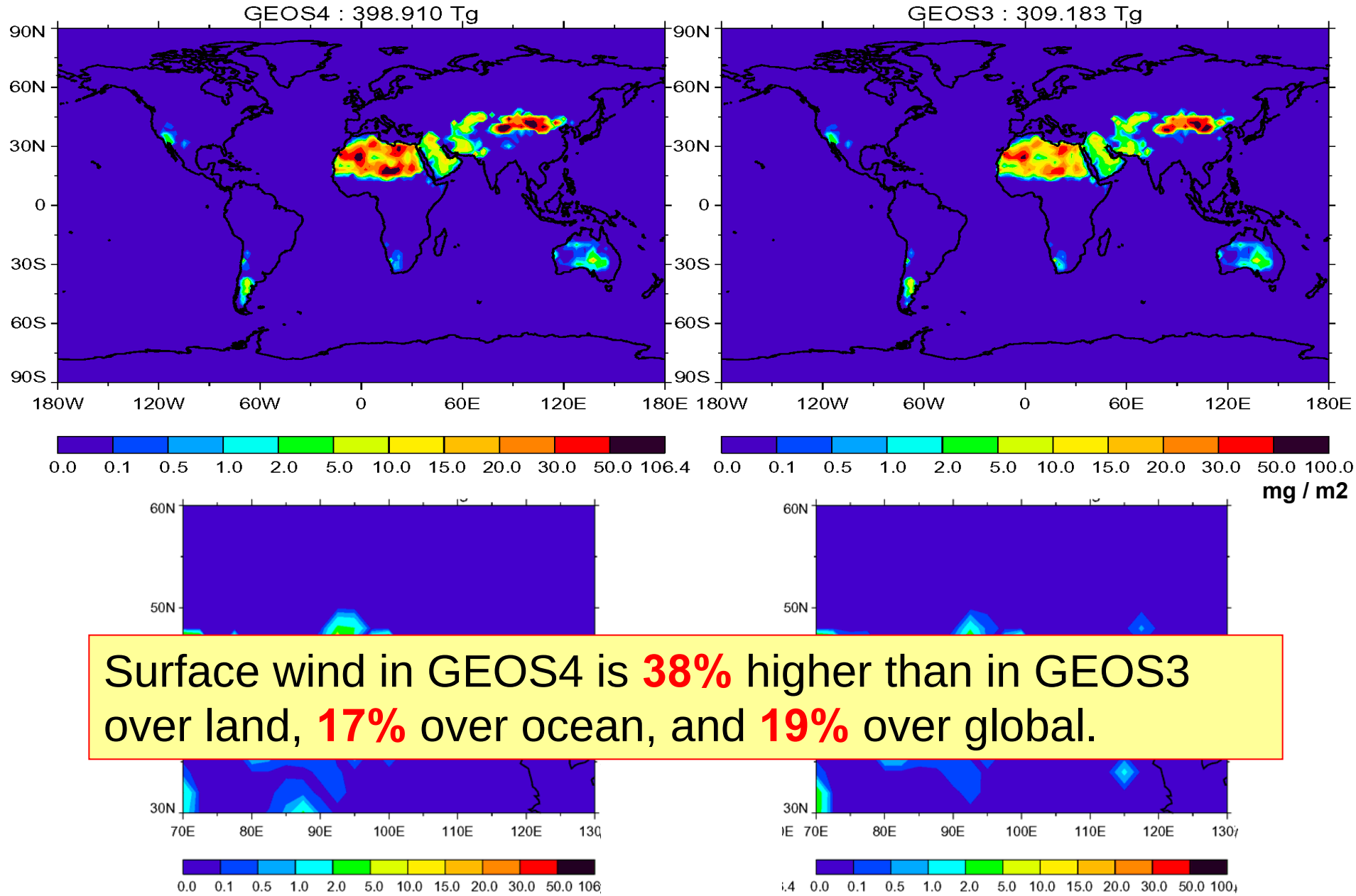
over U.S.



GEOS 4

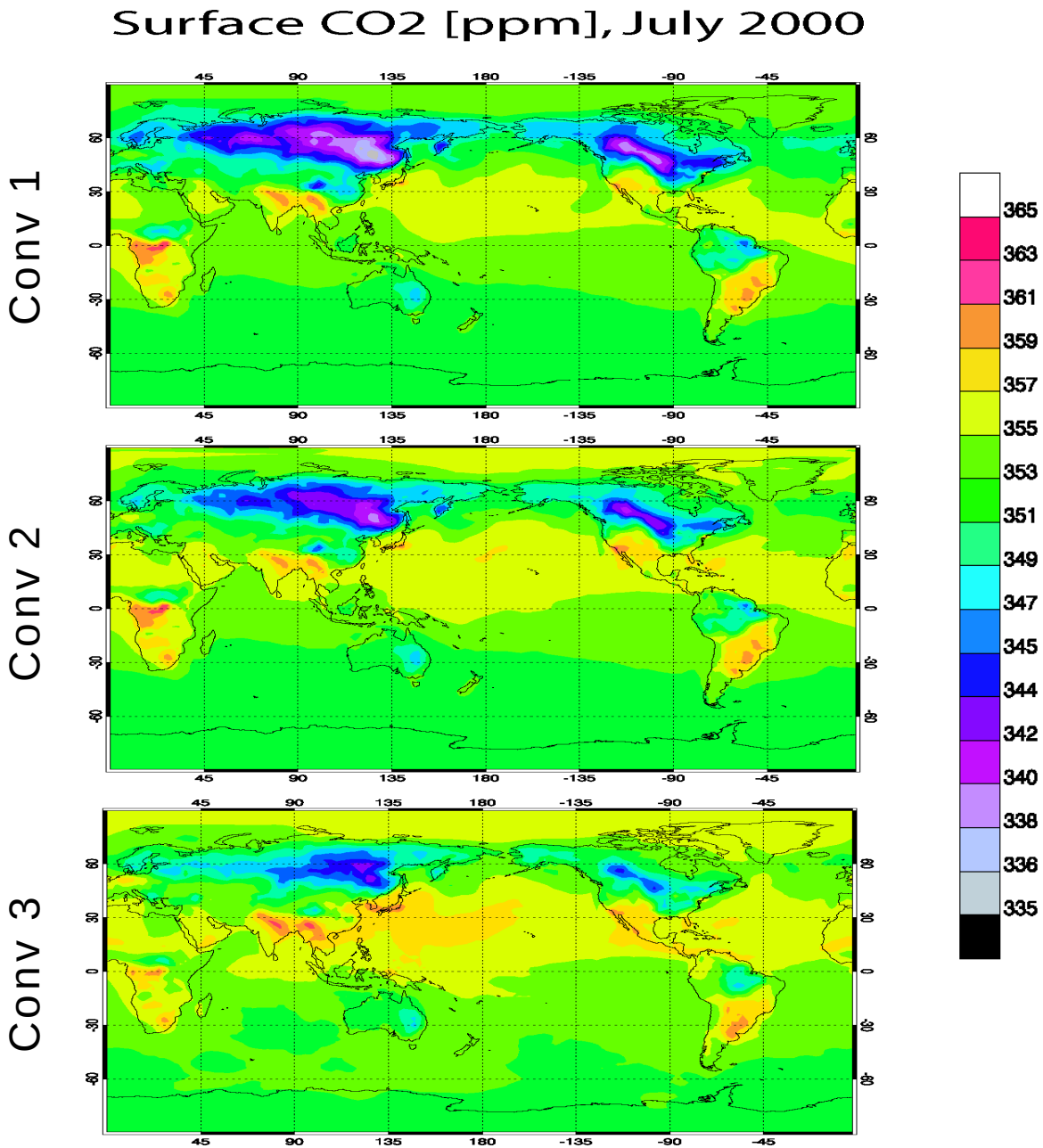
GOES 3

Dust Emission



Surface wind in GEOS4 is **38%** higher than in GEOS3 over land, **17%** over ocean, and **19%** over global.

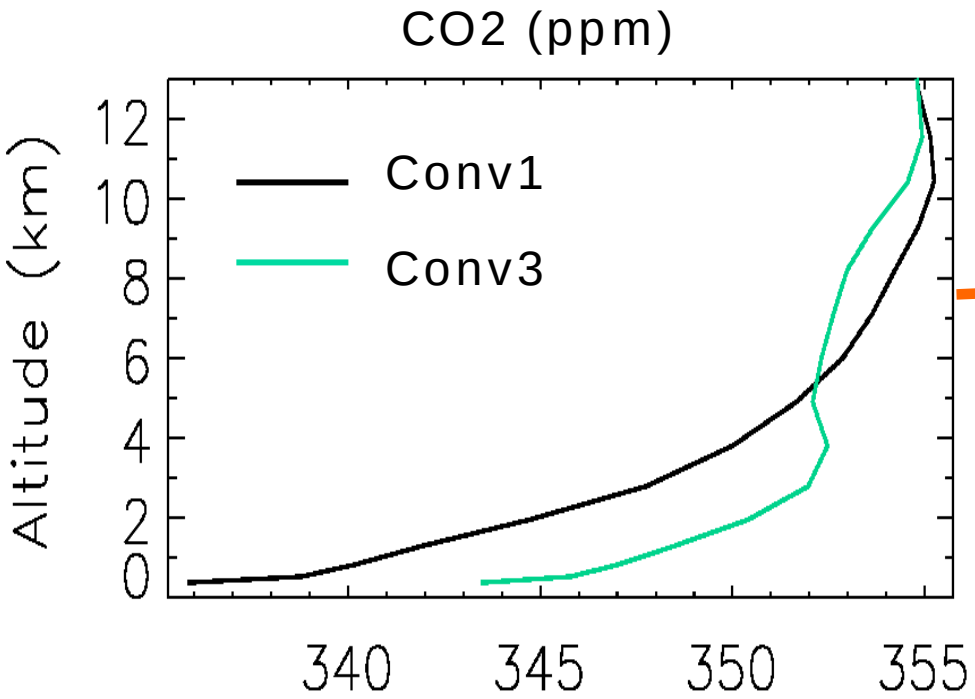
Impact of Convection

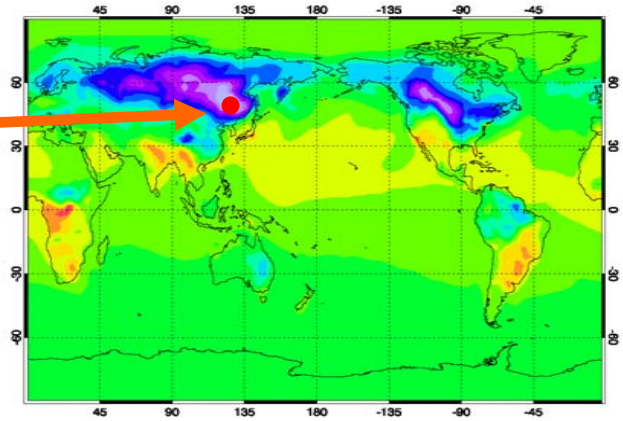


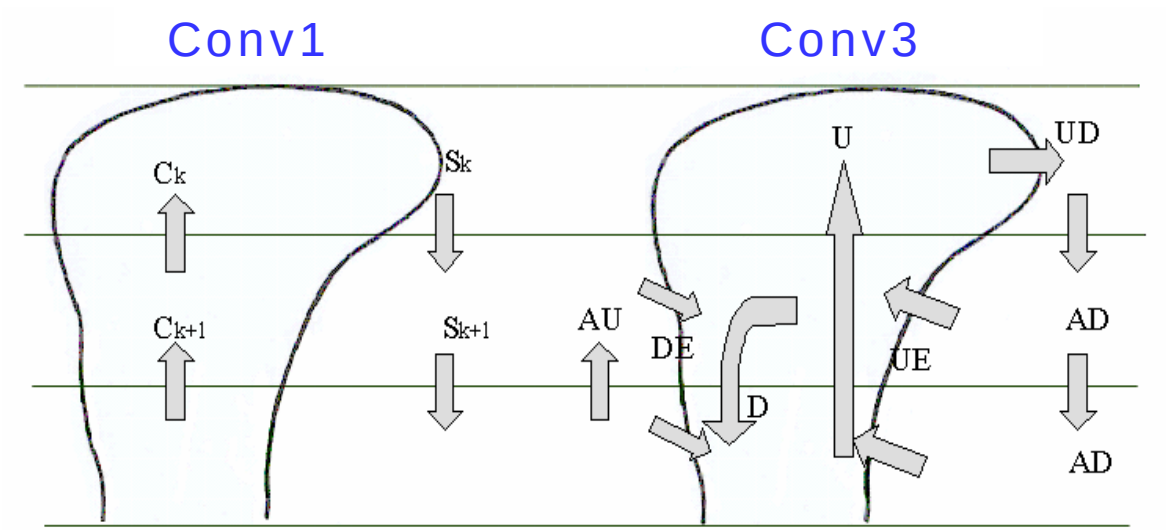
	Max.	Min.
Conv 1	363.8	335.4
Conv 2	363.4	339.1
Conv 3	363.1	343.1

Bian et al., 2006

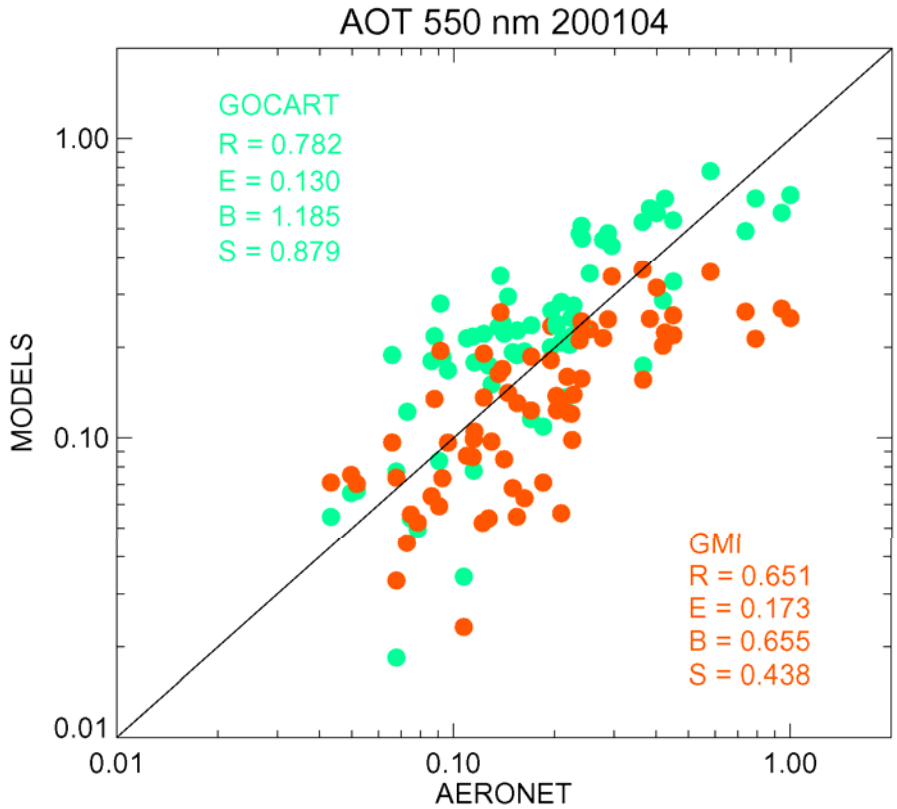
Impact of Convective transport







Masses vs Optical Properties ?

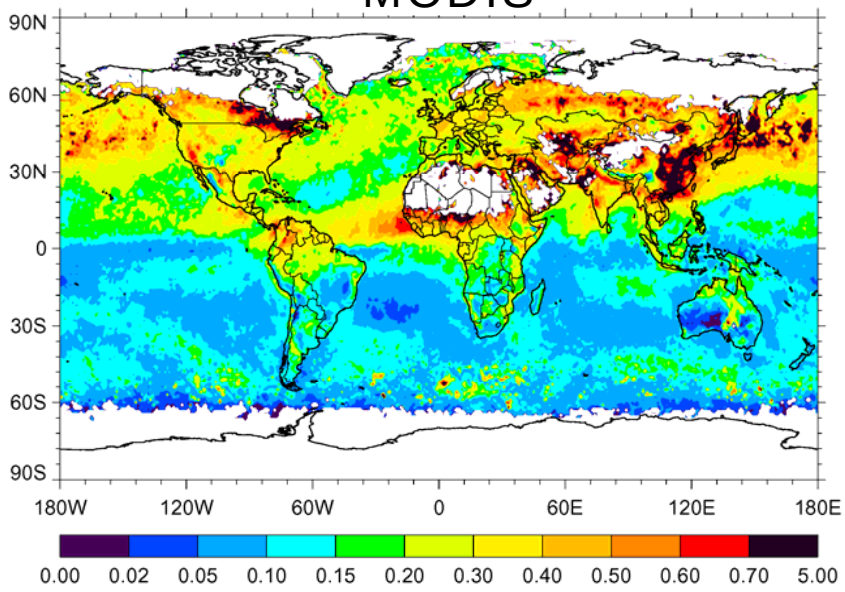


Compared with AERONET measurement, model AOT is globally higher for GOCART and lower for GMI.

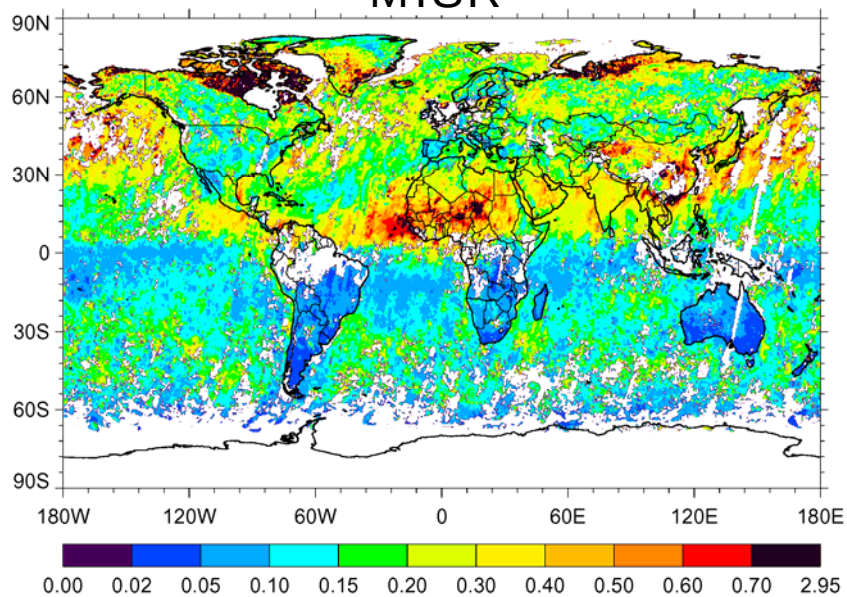
Masses vs Optical Properties ?

AOT (550nm)

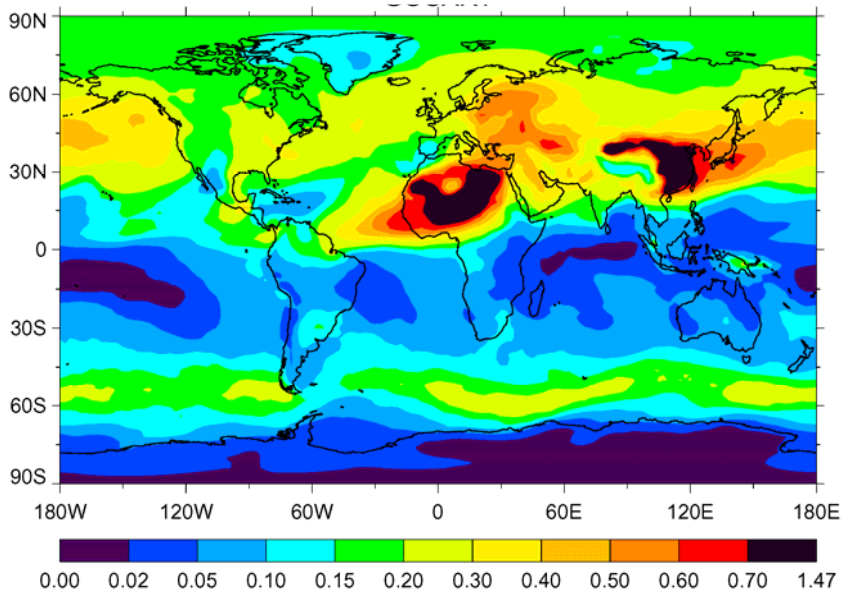
MODIS



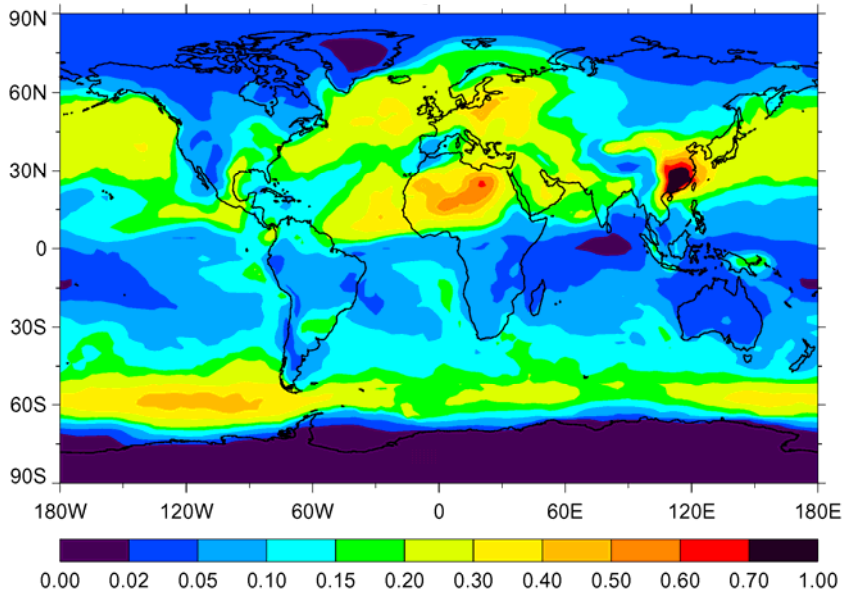
MISR



GOCART

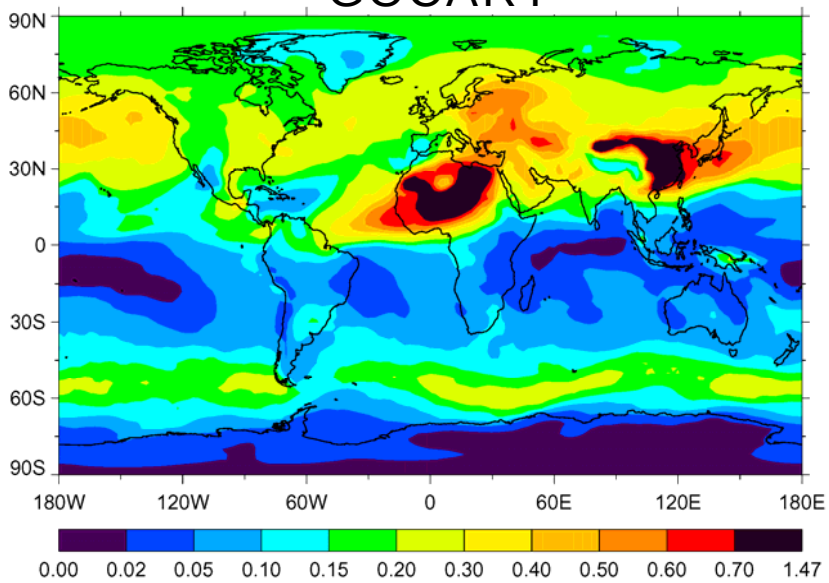


GMI

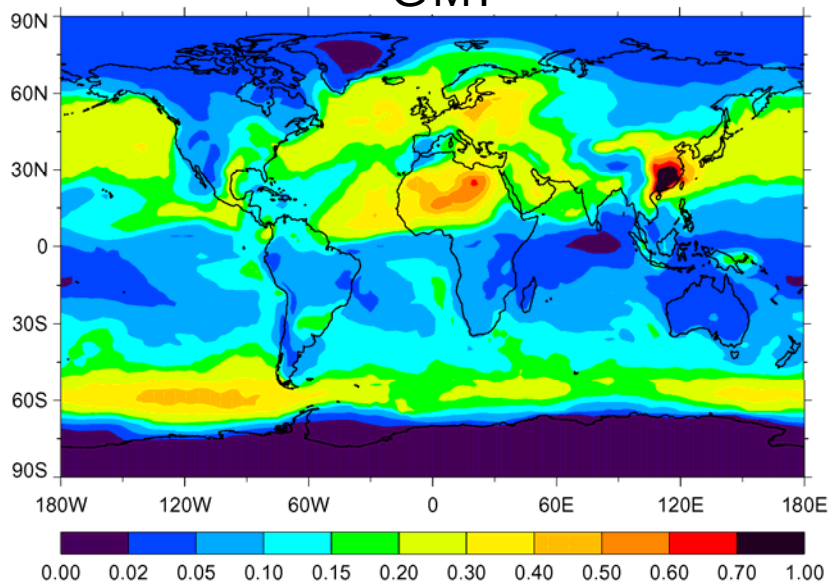


Masses vs Optical Properties ?

GOCART



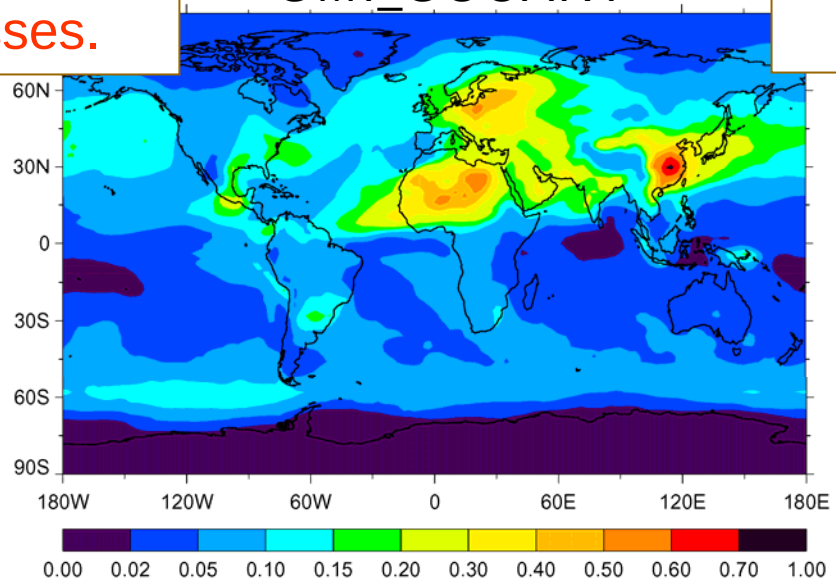
GMI



dAOT due to different aerosol masses.

dAOT due to different aerosol optical properties.

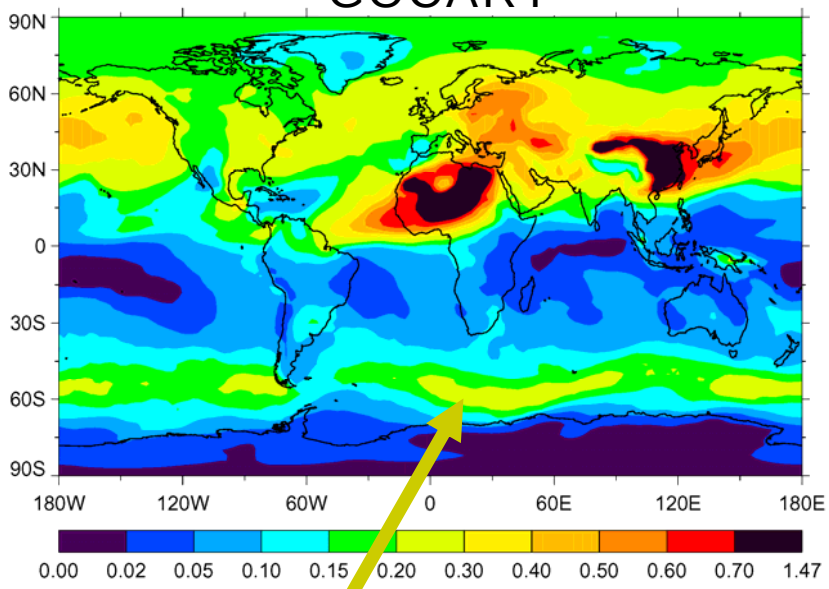
GMI_GOCART



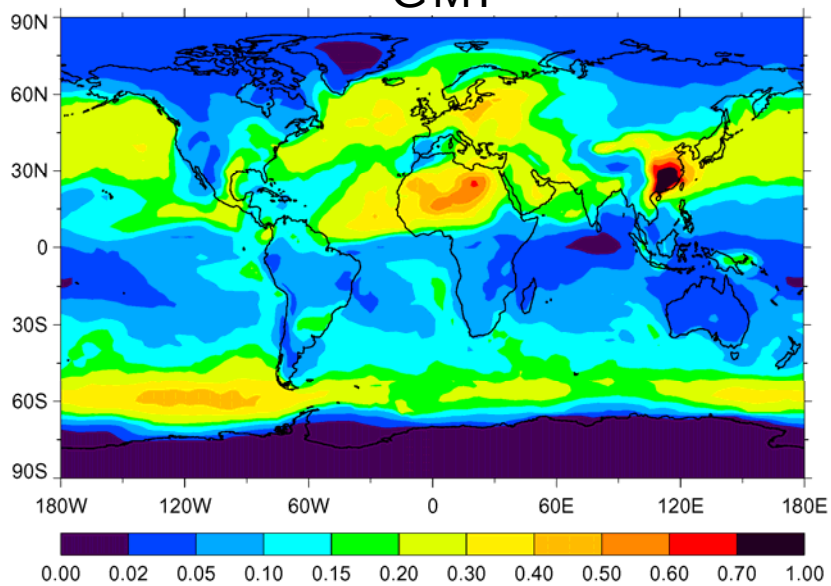
GMI_GOCART: AOT calculated using GMI aerosol mass and GOCART aerosol optical properties.

Masses vs Optical Properties ?

GOCART



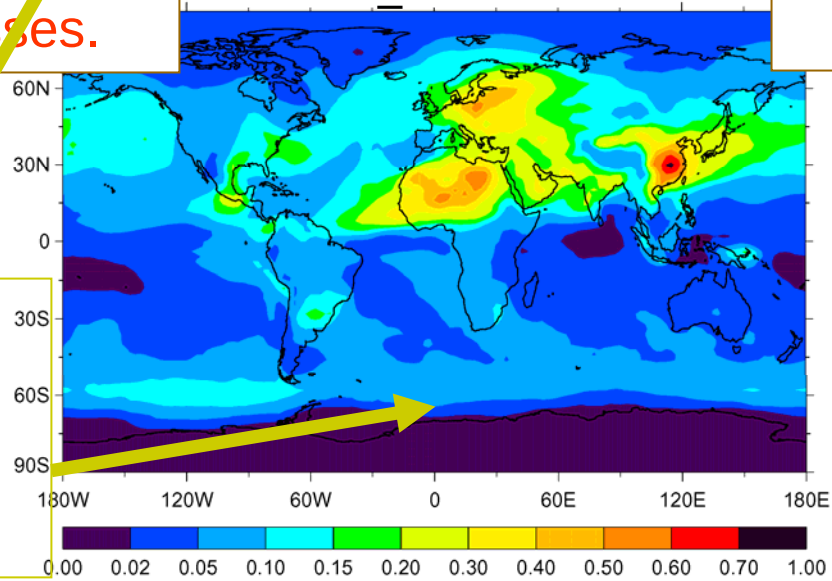
GMI



dAOT due to different aerosol masses.

dAOT due to different aerosol optical properties.

GMI_GOCART

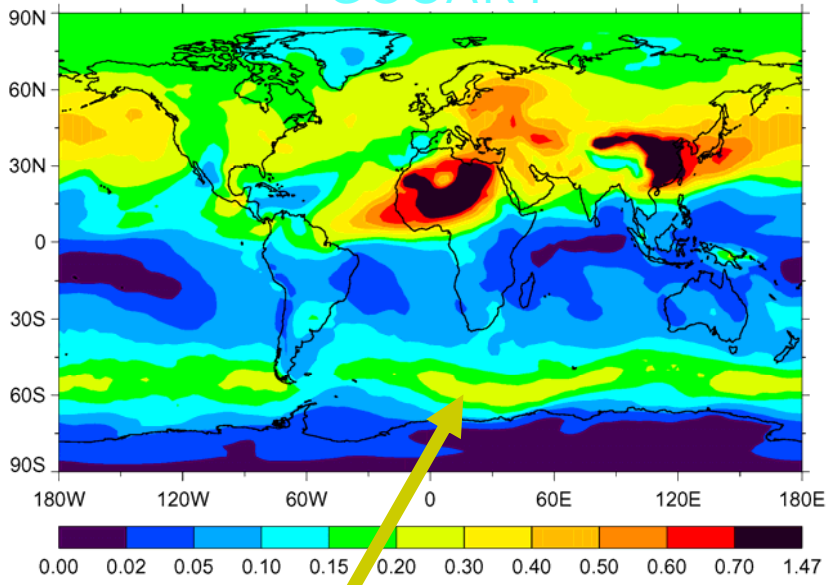


Sea-salt burden (Tg)	
GOCART	**18.1**
GMI	**4.8**

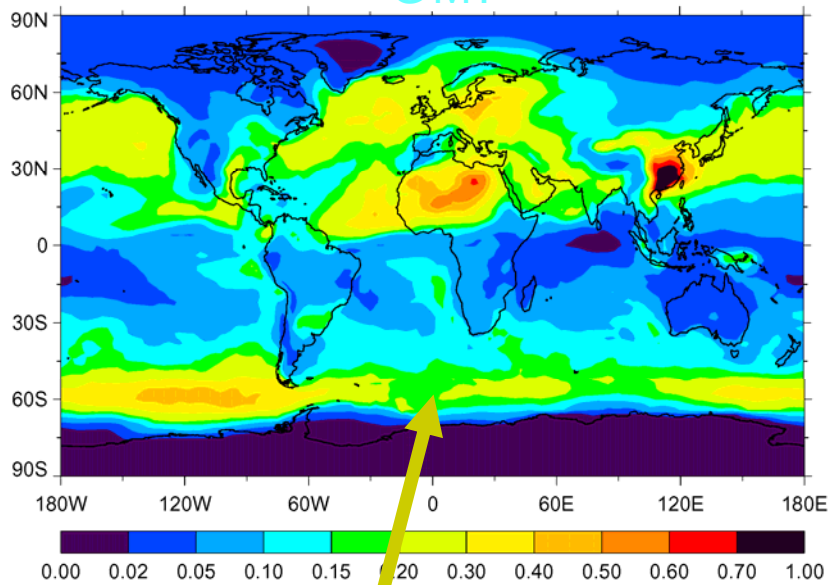
GMI_GOCART: AOT calculated using GMI aerosol mass and GOCART aerosol optical properties.

Masses vs Optical Properties ?

GOCART

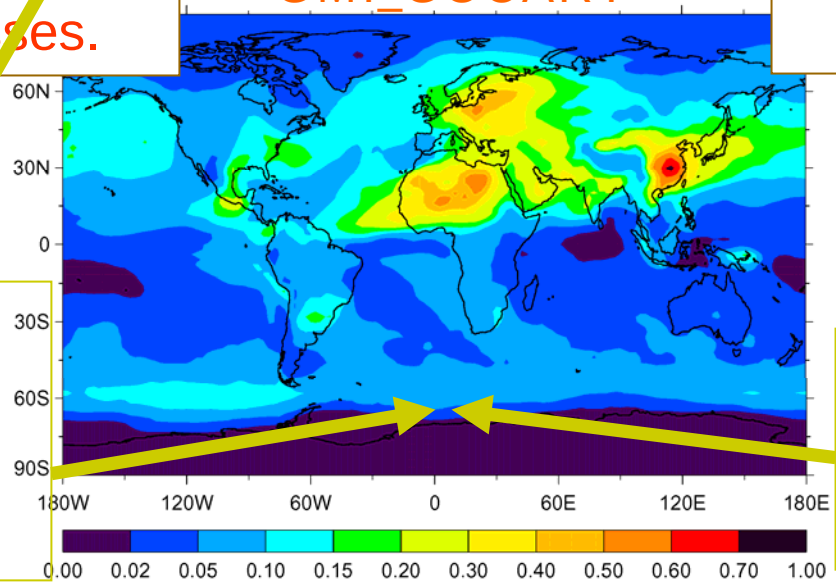


GMI

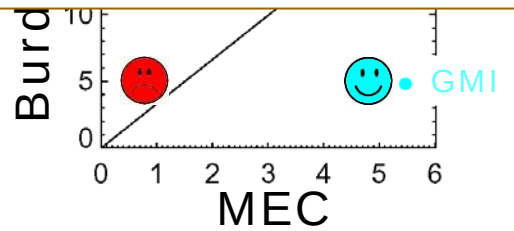


dAOT due to different aerosol masses.

GMI_GOCART



dAOT due to different aerosol optical properties.



Sea-salt burden (Tg)

GOCART 18.1

GMI 4.8

Sea-salt mean MEC (m2/g)

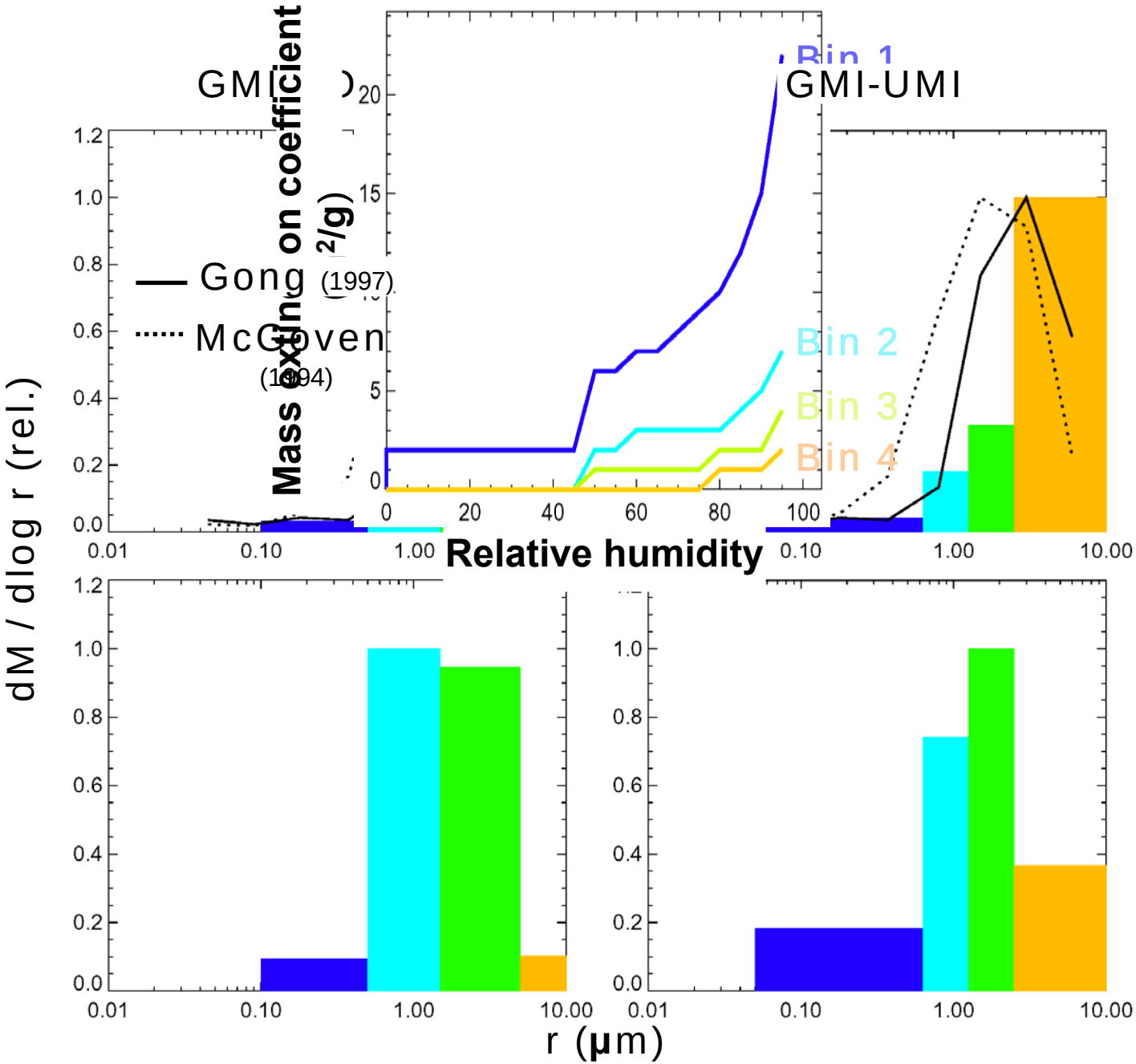
GOCART 0.90

GMI 5.47

Sea-salt Mass Size distribution

EMISSION

BURDEN



Summary

GMI provides a complimentary approach to AEROCOM !

- AEROCOM assessment involves multi-models with differences in physical and chemical processes, model settings, meteorological fields, etc.

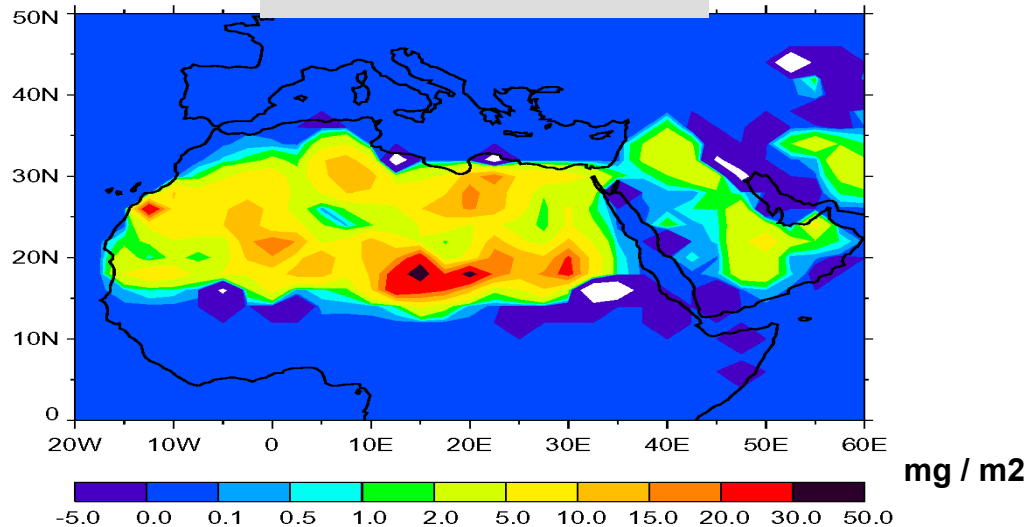
- GMI allows testing of a particular process within a single model framework and hold all others fixed.

- The advantage of such GMI investigation is that it eliminates all compounding perturbing factors and helps to identify the determining factors that cause the difference.

Experiment ?

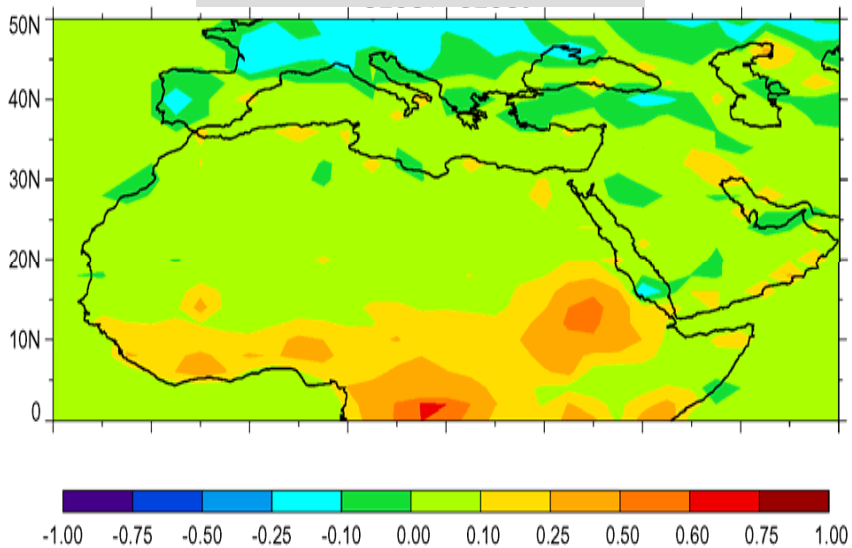
GEOS4 – GEOS3 over North Africa

Dust Emission

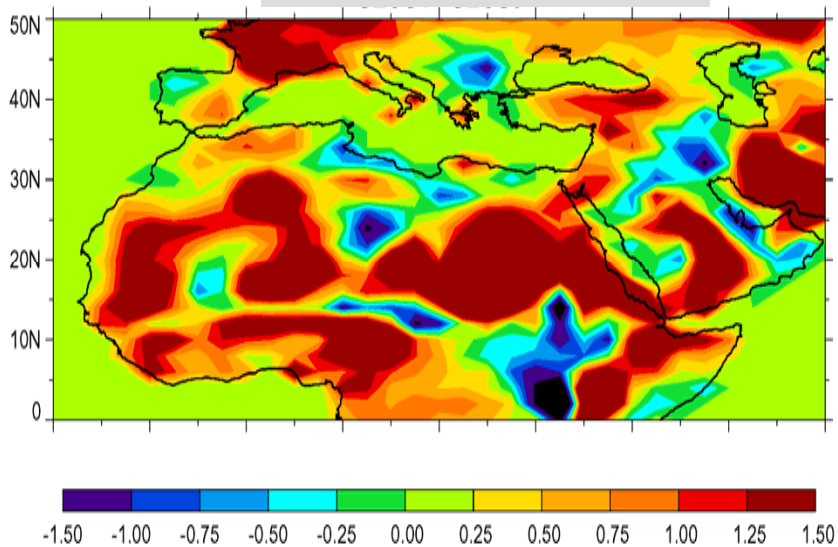


mg / m2

gwet



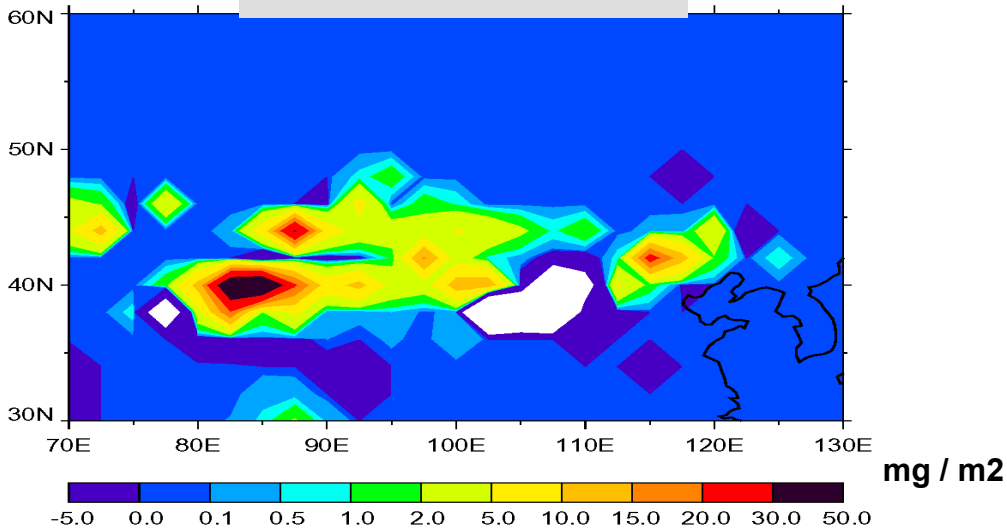
wind



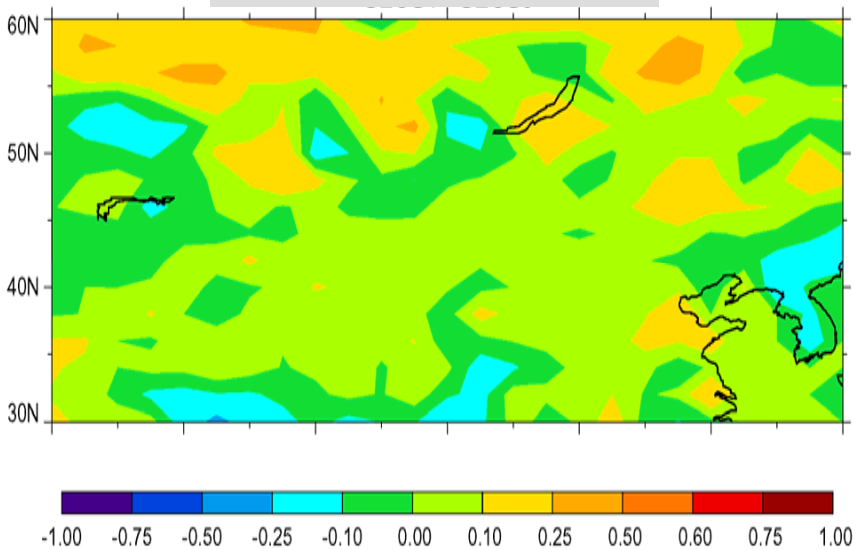
m / s

GEOS4 – GEOS3 over Asia

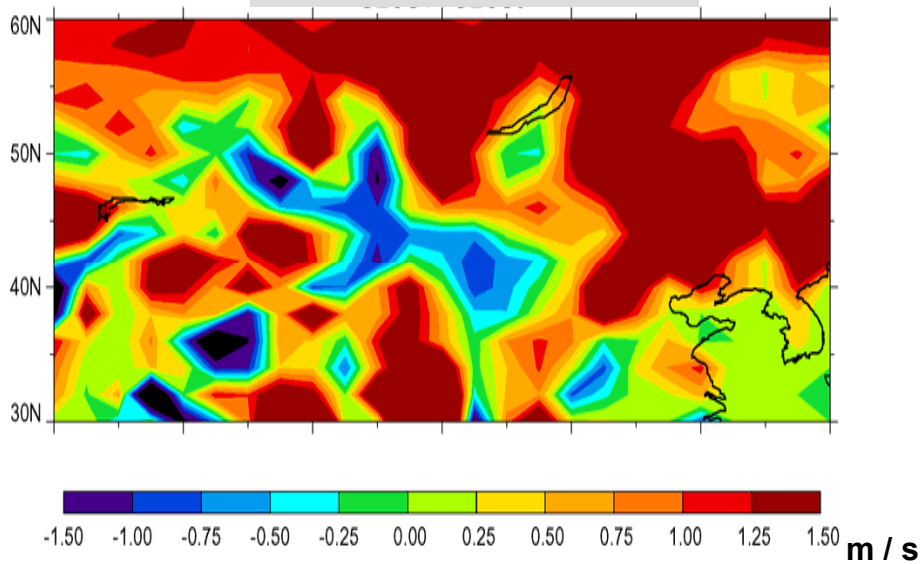
Dust Emission



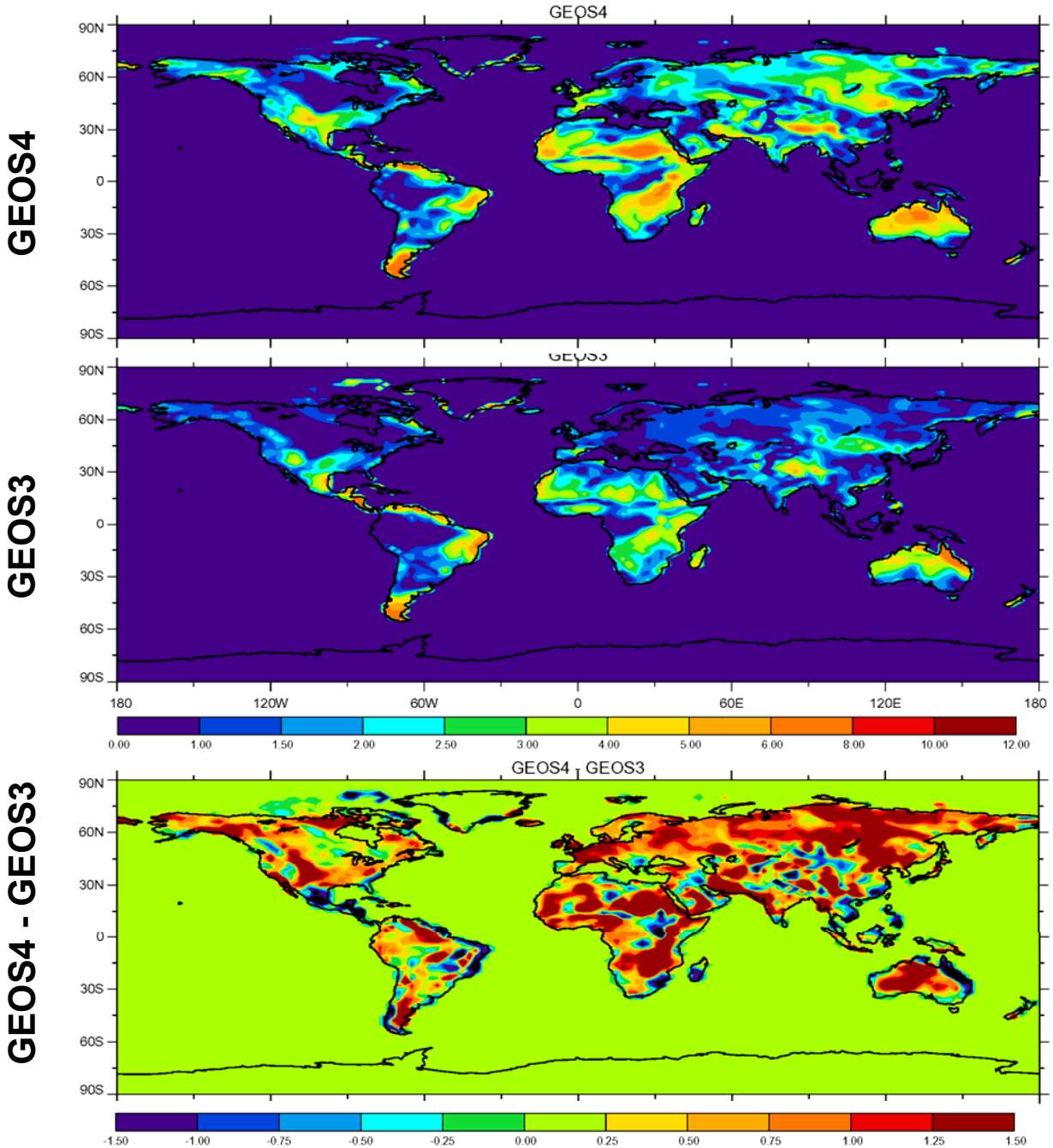
gwet



wind



Land Wind (sqrt(u**2+v**2))



Max: 8.5 m/s

Avg: 2.4

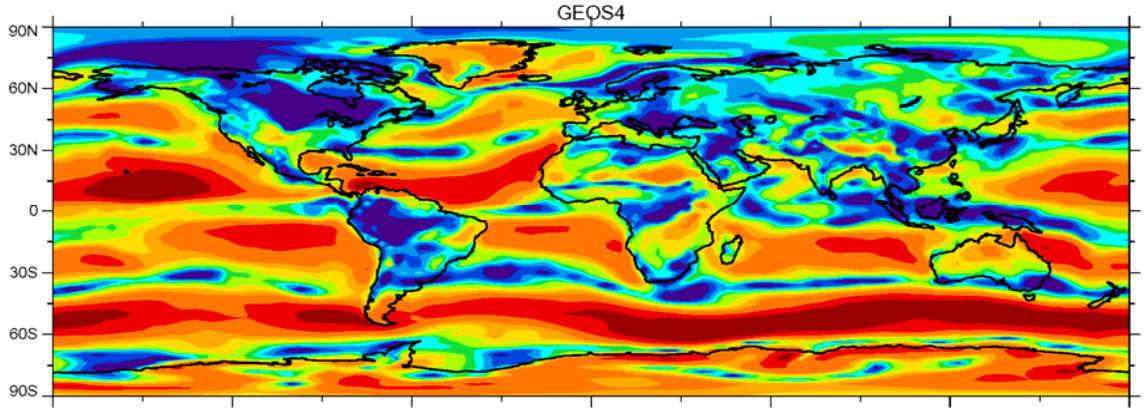
Max: 8.1

Avg: 1.7

GEOS4 is 38% higher than GEOS3

Global Wind (sqrt(u**2+v**2))

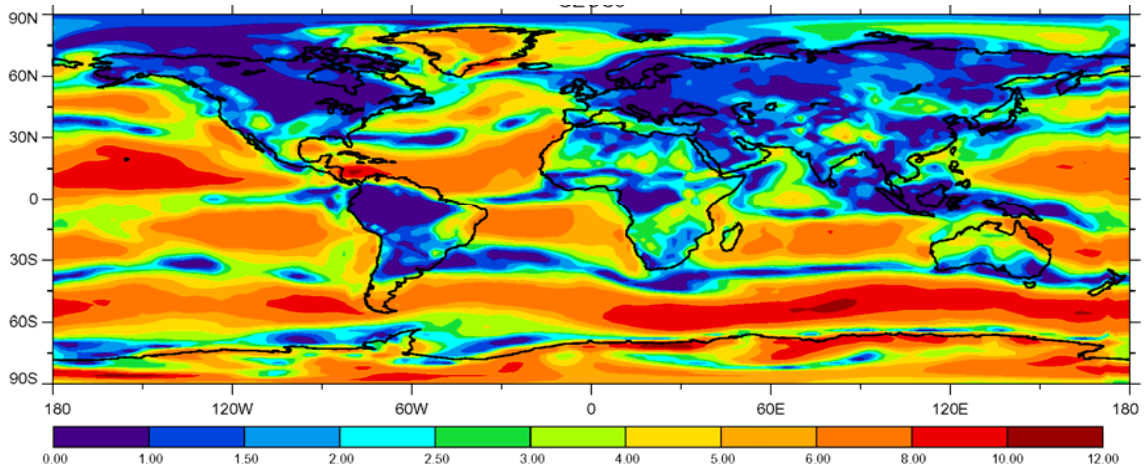
GEOS4



Max: 12.5 m/s

Avg: 4.4

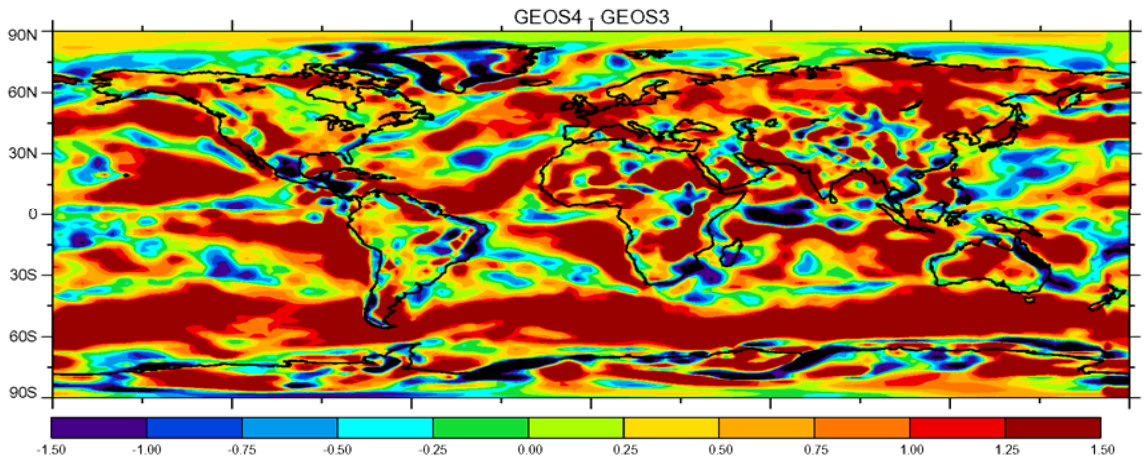
GEOS3



Max: 11.8

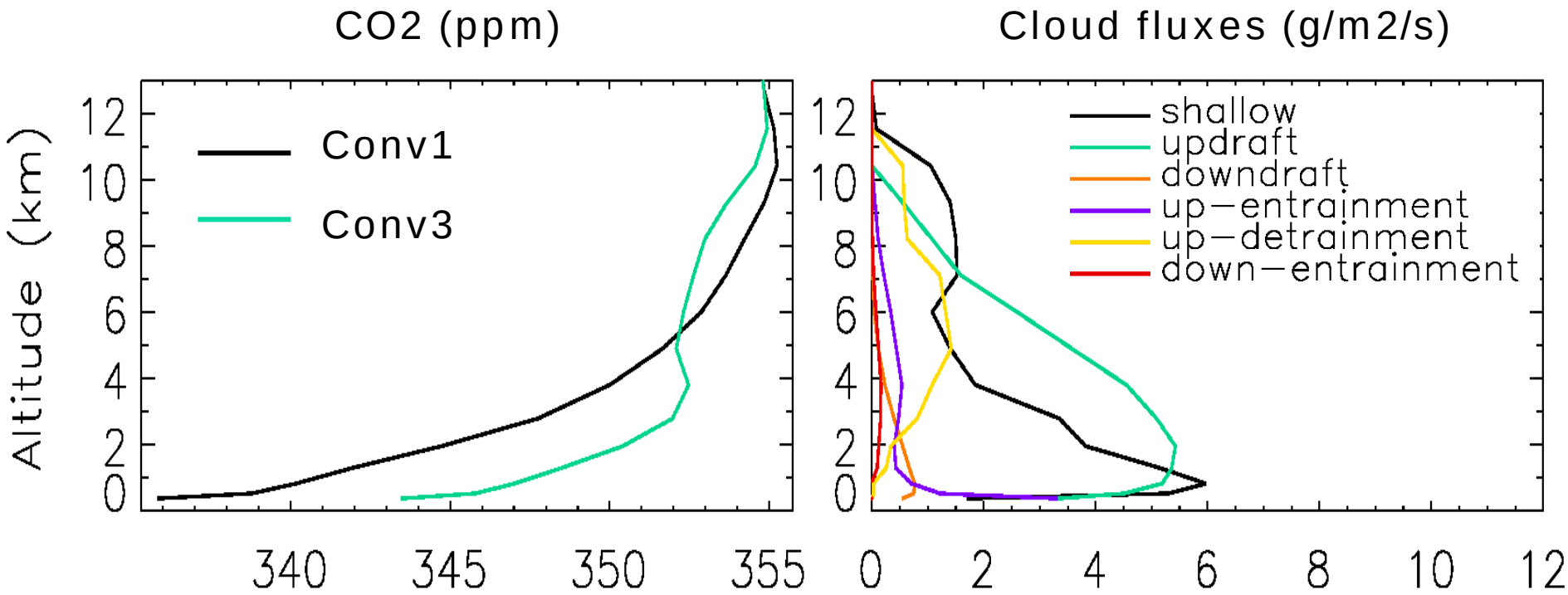
Avg: 3.7

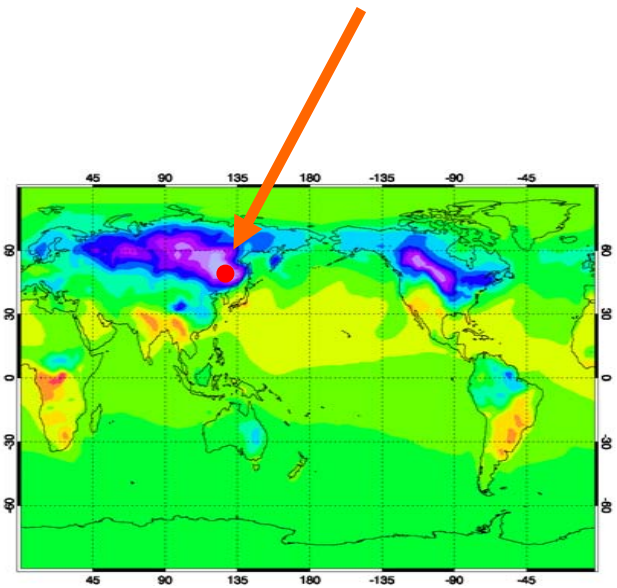
GEOS4 - GEOS3

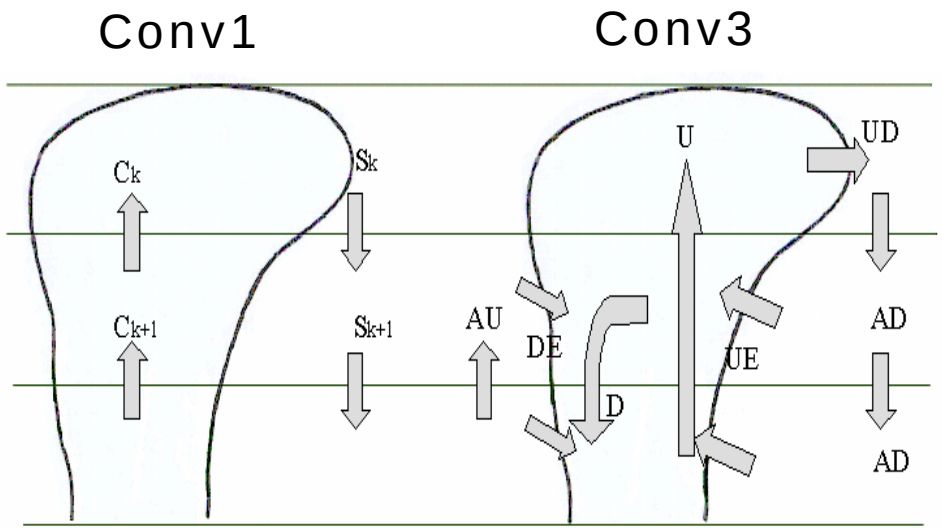


GEOS4 is 19% higher than GEOS3

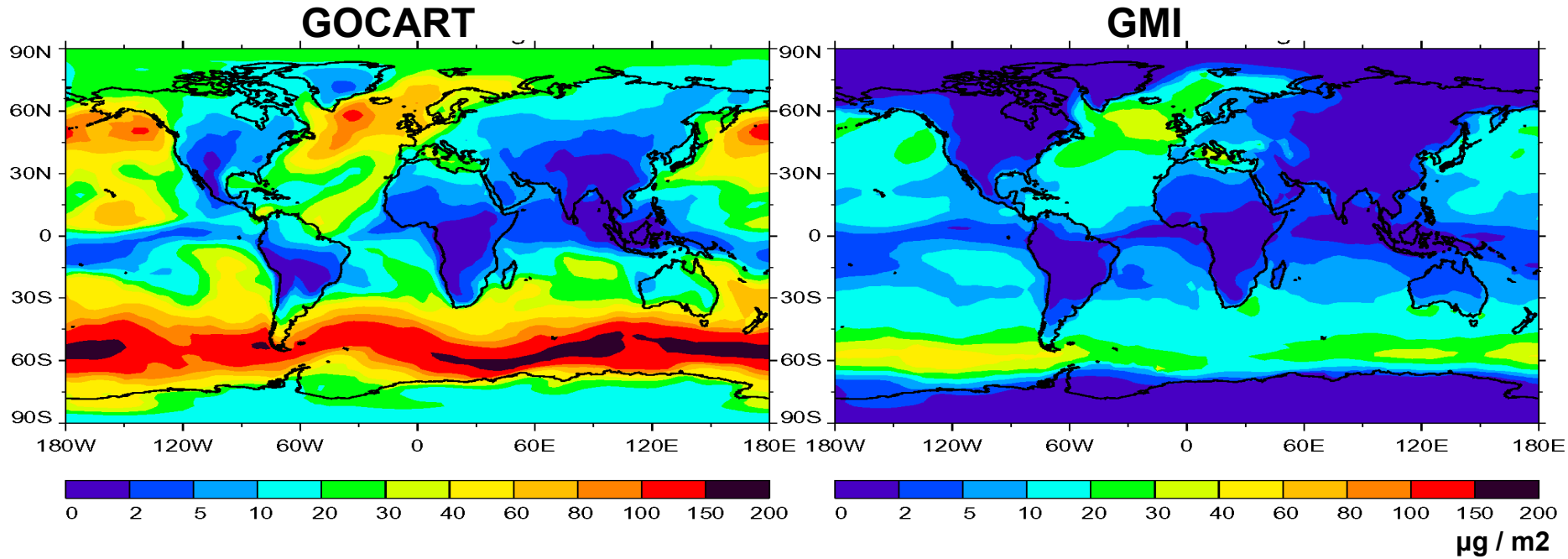
Impact of Convective transport







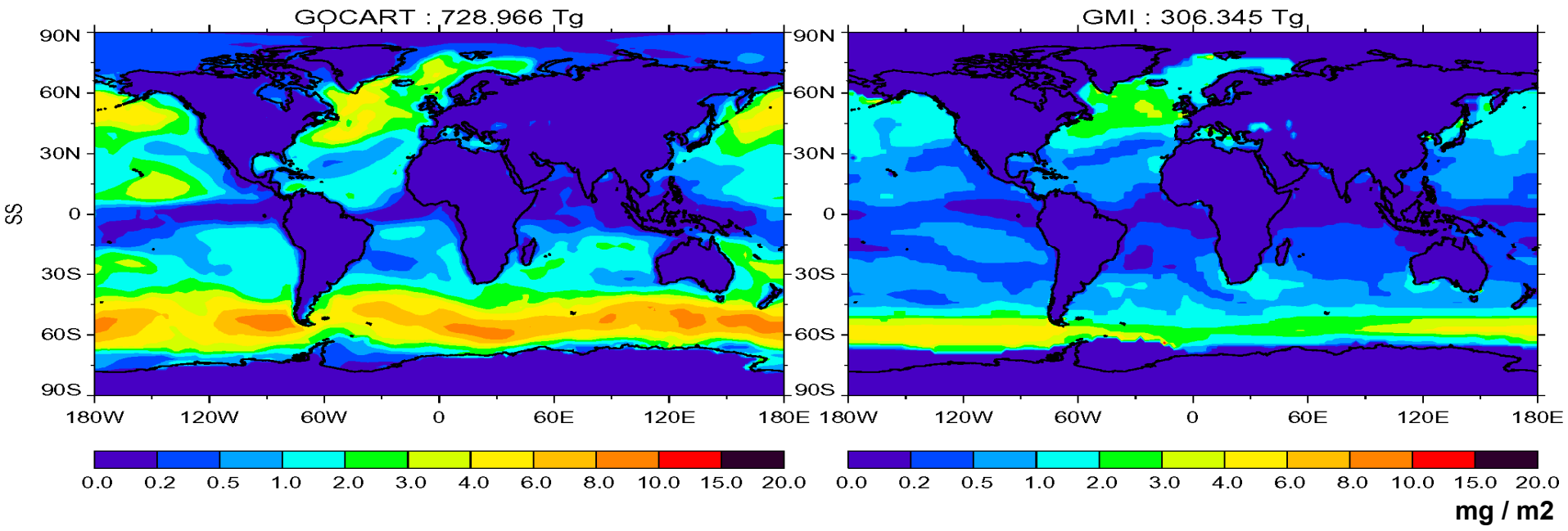
Column Sea Salt



	burden (Tg)	lifetime (days)
GOCART	18.1	0.74
GMI	4.8	0.47

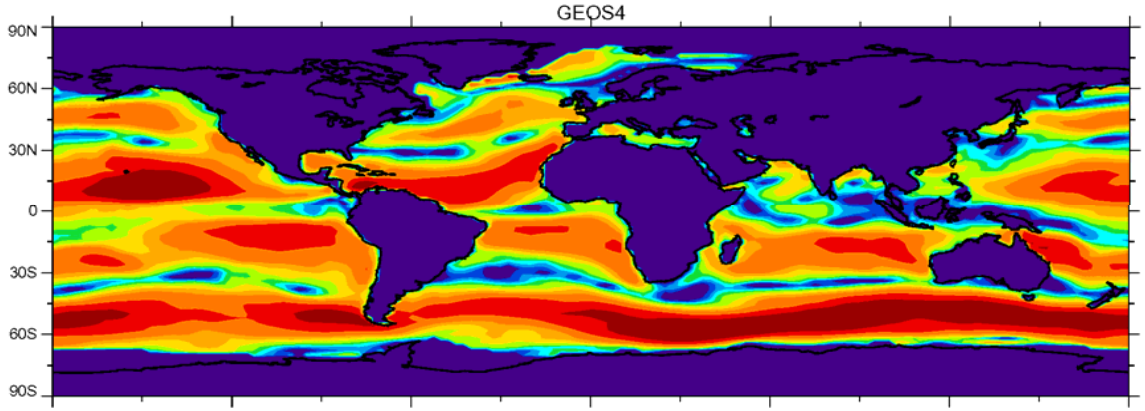
Emission

GOCART	GMI
Gong [1997] and Monahan [1986]	Same
Online calculation	Read in Gong's dataset
(from archived winds)	(monthly)



Ocean Wind (sqrt(u**2+v**2))

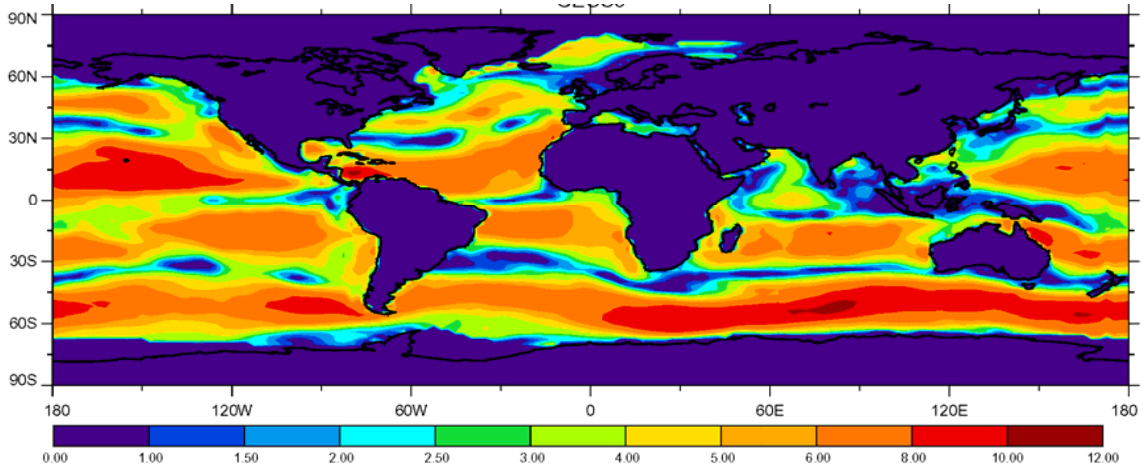
GEOS4



Max: 12.5 m/s

Avg: 5.5

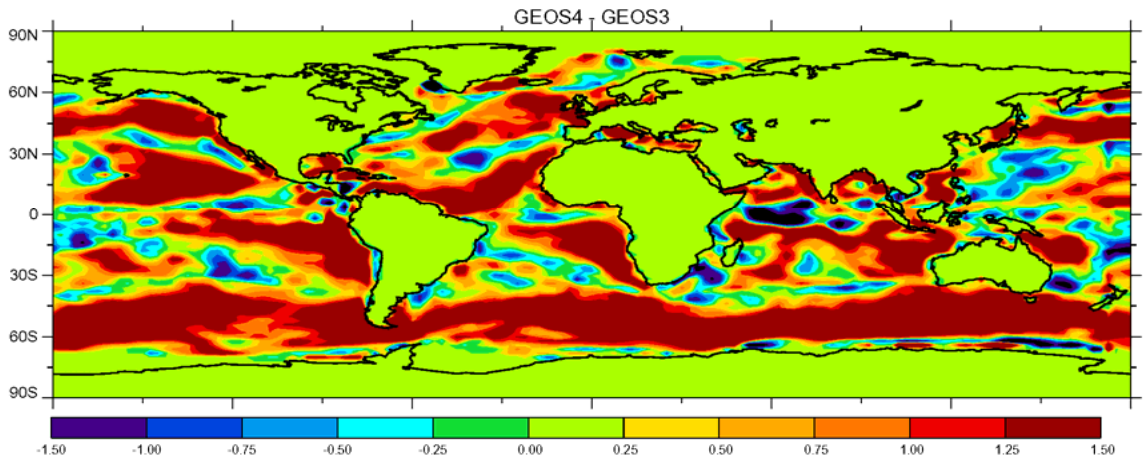
GEOS3



Max: 10.4

Avg: 4.7

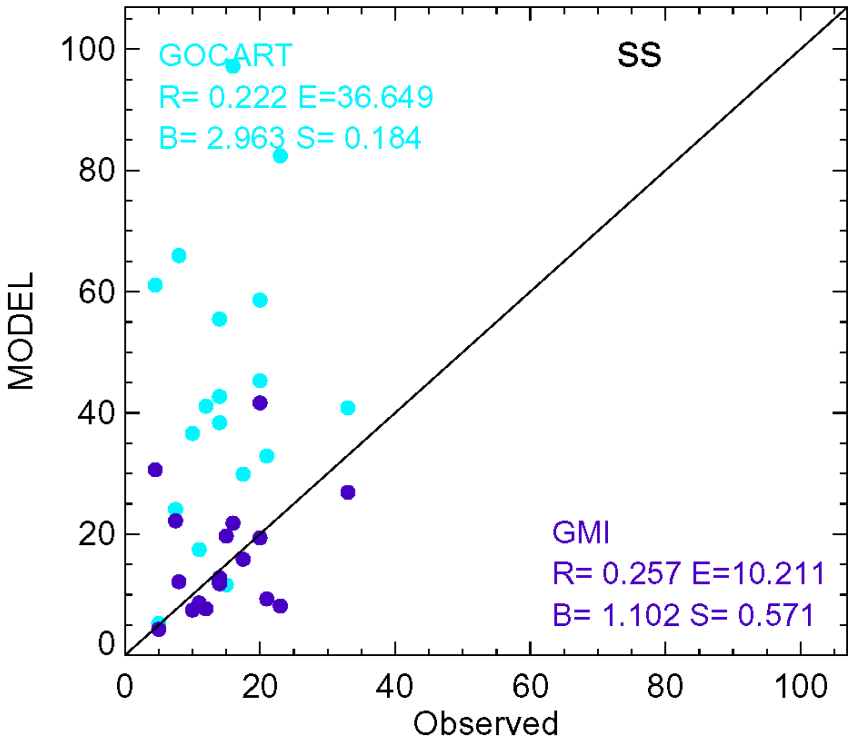
GEOS4 - GEOS3



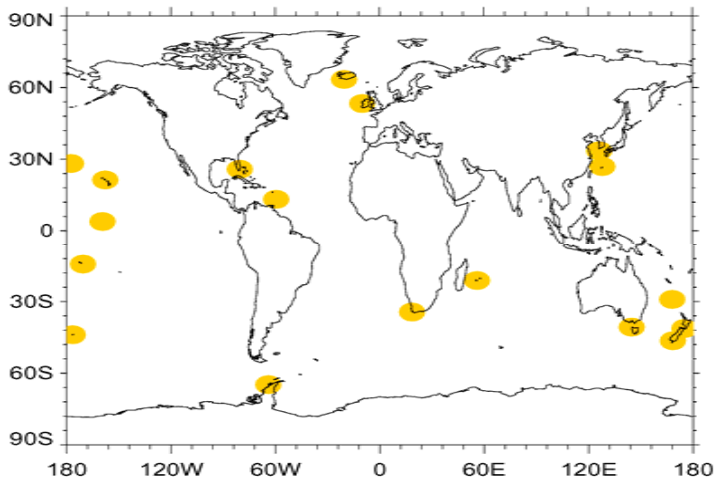
GEOS4 is 17% higher than GEOS3

Model and observation comparison (Sea-salt surface mass)

Global



Station sites



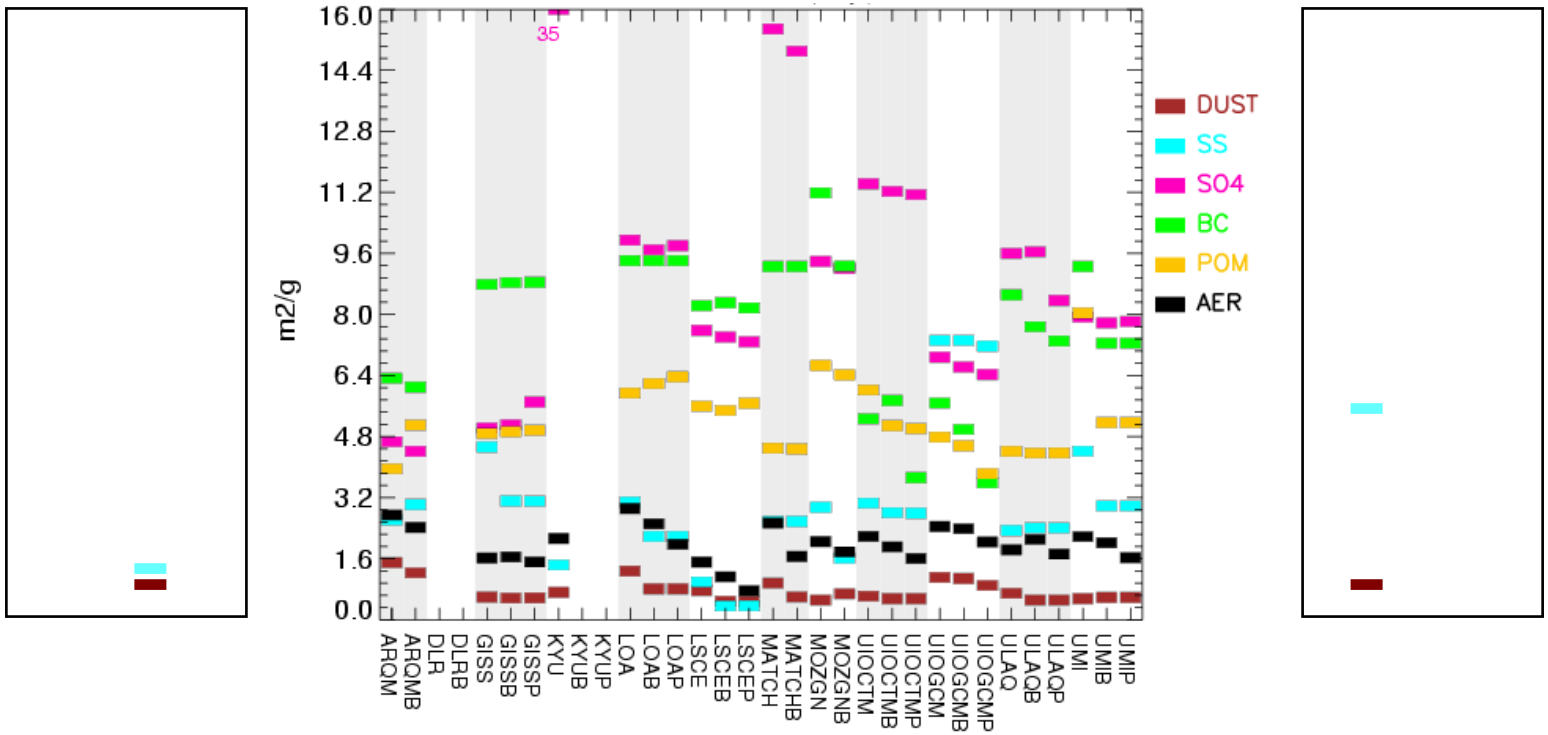
Mass extinction coefficients (m²/g)

GOCART

AEROCOM

GMI

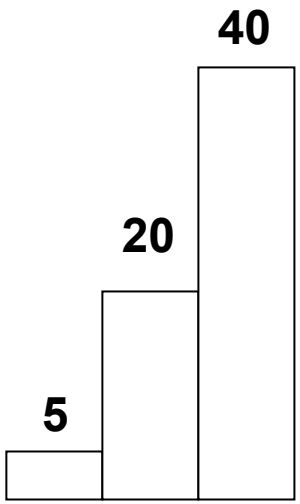
in Experiment A + B + Preindustrial



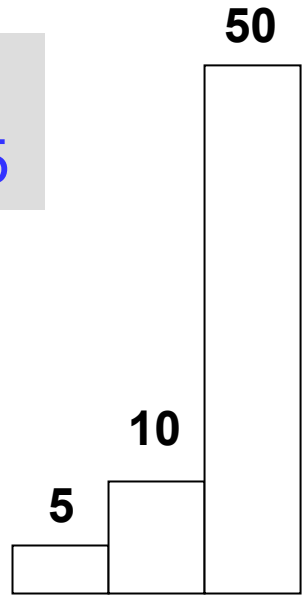
Michael Schulz

Fraction in bin 1

Before

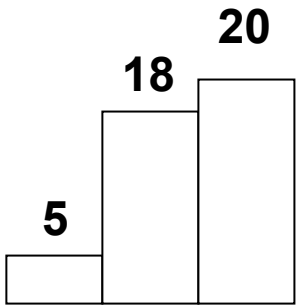


Total: 65
Fraction: 5 / 65

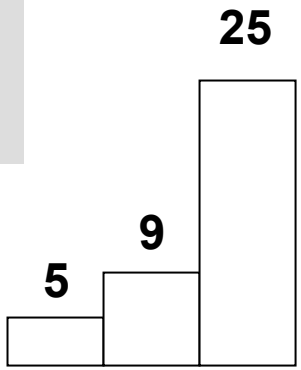


Total: 65
Fraction: 5 / 65

Settling



Total: 43
Fraction: 5 / 43



Total: 39
Fraction: 5 / 39

After