

AGU press-presentation on AeroCom

San Francisco, Dec 2004

Panelists:

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AeroCom

an international collaboration

to improve aerosol modeling in climate models

Max Planck Institute for Meteorology



*Laboratoire des Sciences
du Climat et de l'environnement*

Outline

- some **background** information on aerosol and climate
- initial results about the uncertainty in global aerosol modeling as part of an international scientific status report (**IPCC 2001**)
- the **AeroCom** project: goals, first results and future plans

Background

S.Kinne

MPI-Meteorology

We change our atmosphere !

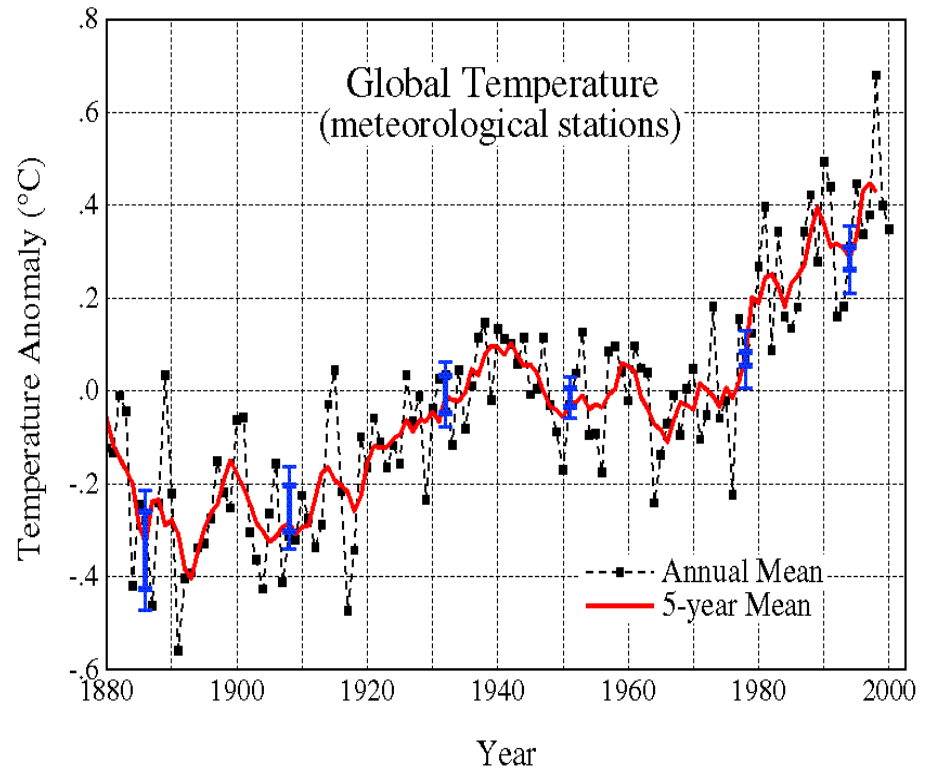
- **human 'footprints' from**
 - Industrialization
 - Urbanization
 - Changes in Farming
- **higher (*greenhouse*) gas concentration**
 - CO₂, CH₄, O₃, CFCs, ...
- **higher aerosol (*small particle*) concentrations**
 - direct emission of aerosol particles
 - indirect emission via the gas-phase (gas ⇔ particles)

Do we change our climate ?

since 1880

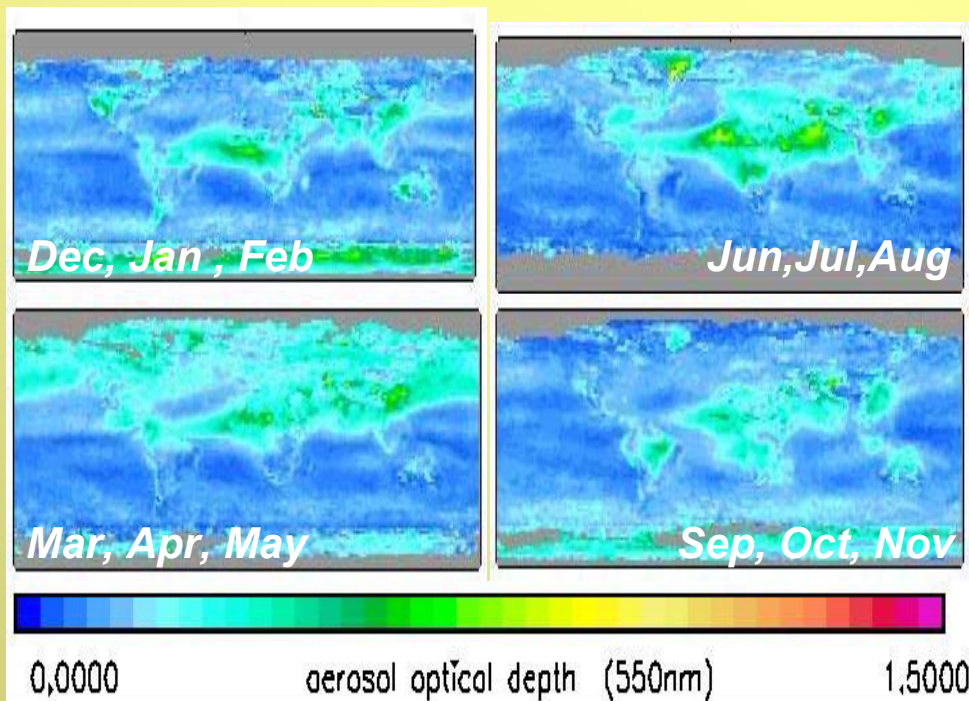
**temperature at
the earth's
surface has
increased by
0.75K**

**this exceeds
expectations
for natural
variability !**



what do we expect?

- more greenhouse gases \Rightarrow **warming $T +$**
- more aerosol \Rightarrow **generally a cooling $T -$**



generally because aerosol is highly variable in properties and distribution

e.g. aerosol optical depth
(= attenuation of visible sunlight due to aerosol)

based on MODIS and MISR sensor data on NASA's Terra platform for the four seasons of the year 2001

IPCC 2001

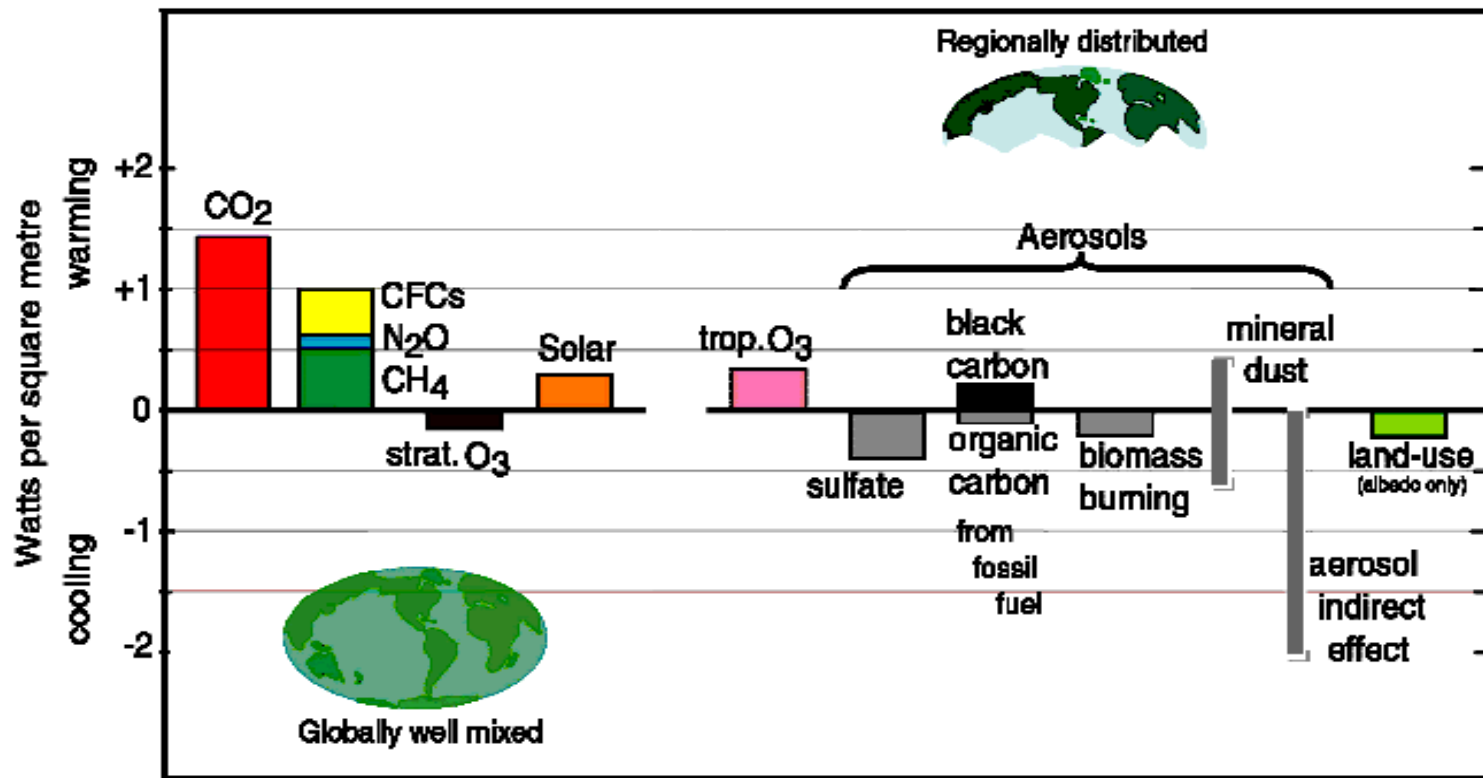
J. Penner

Univ. of Michigan

human influences on climate

our understanding is based on **MODELING**

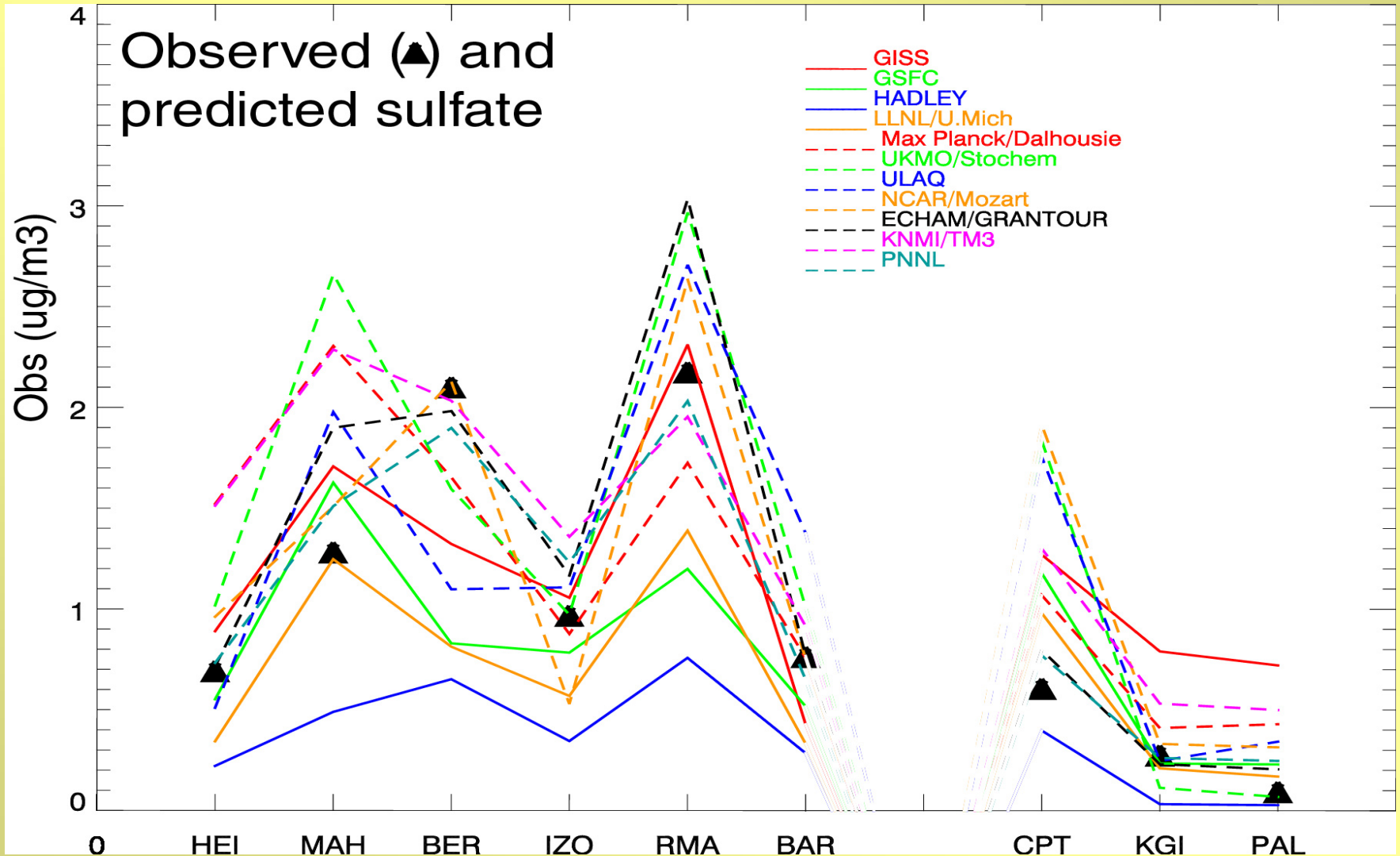
Global Mean Radiative Forcing of Climate for year 2000 relative to 1750



Level of scientific understanding: “ **Very low** ”

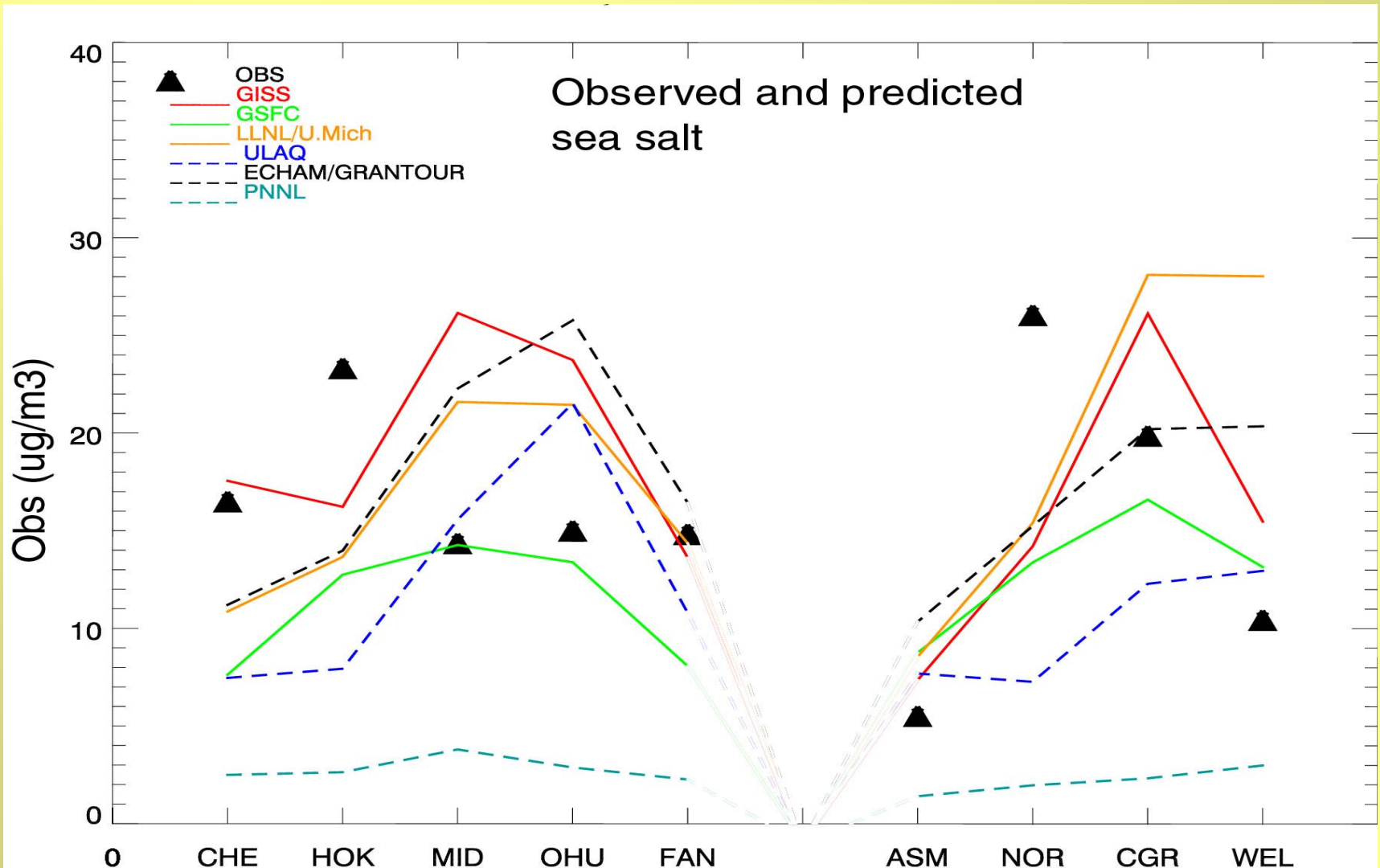
Sulfate Modeling

comparisons to ground data at 9 sites



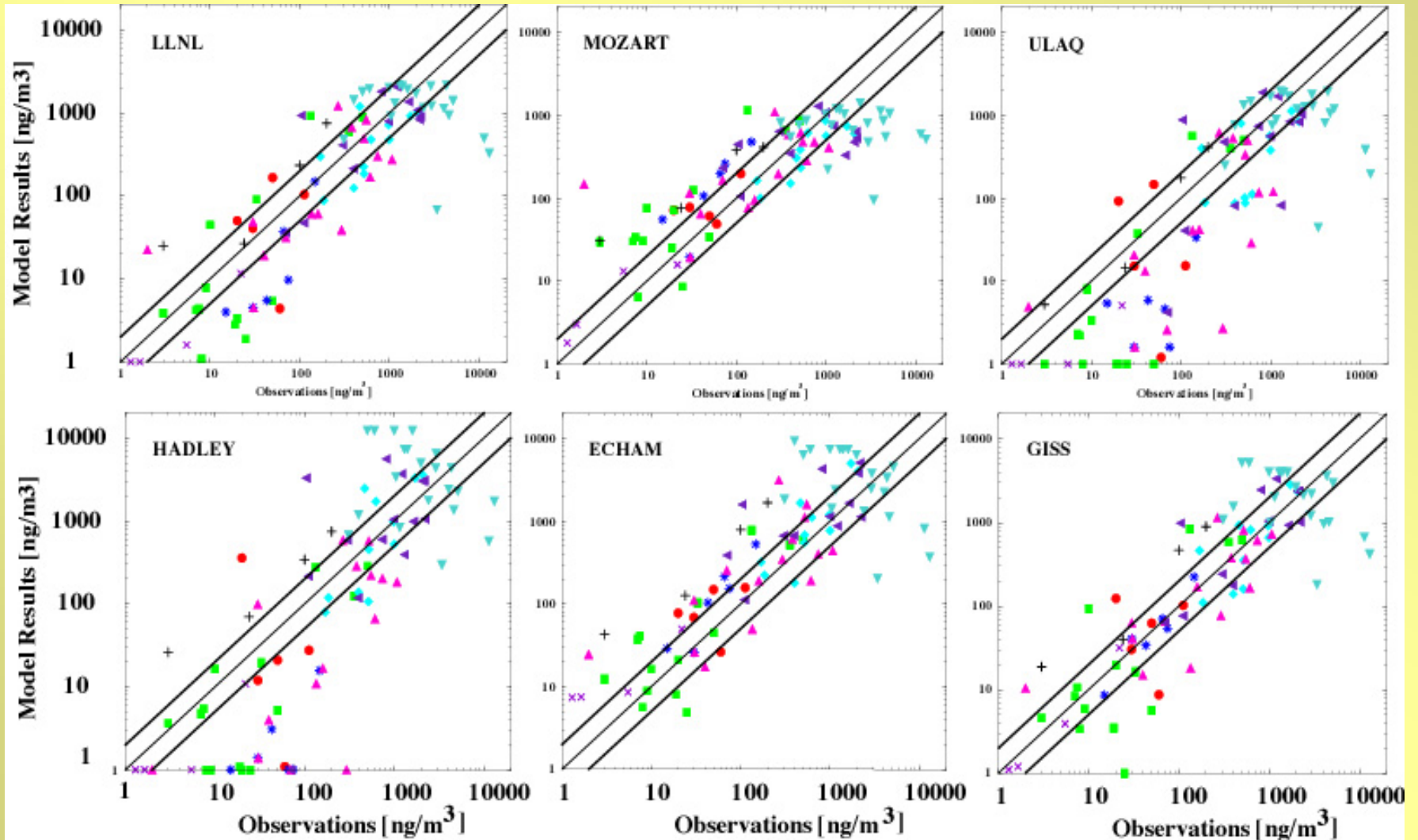
Sea-Salt Modeling

comparisons to ground data at 9 sites

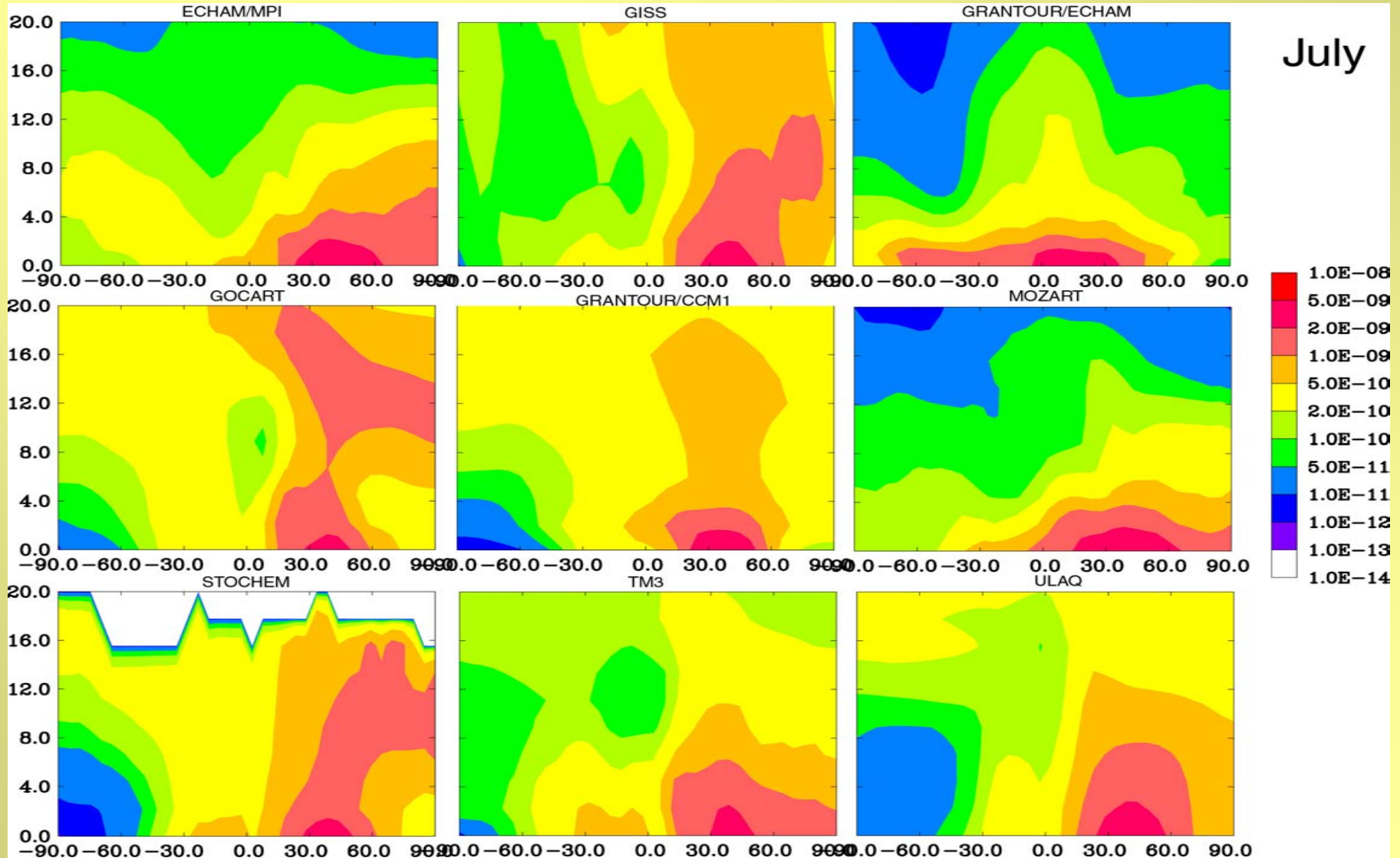


Black Carbon Modeling

comparisons to ground data

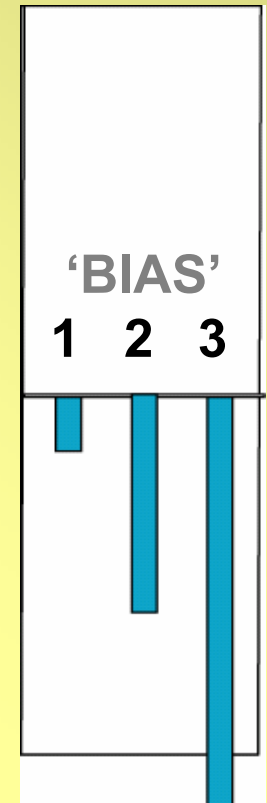
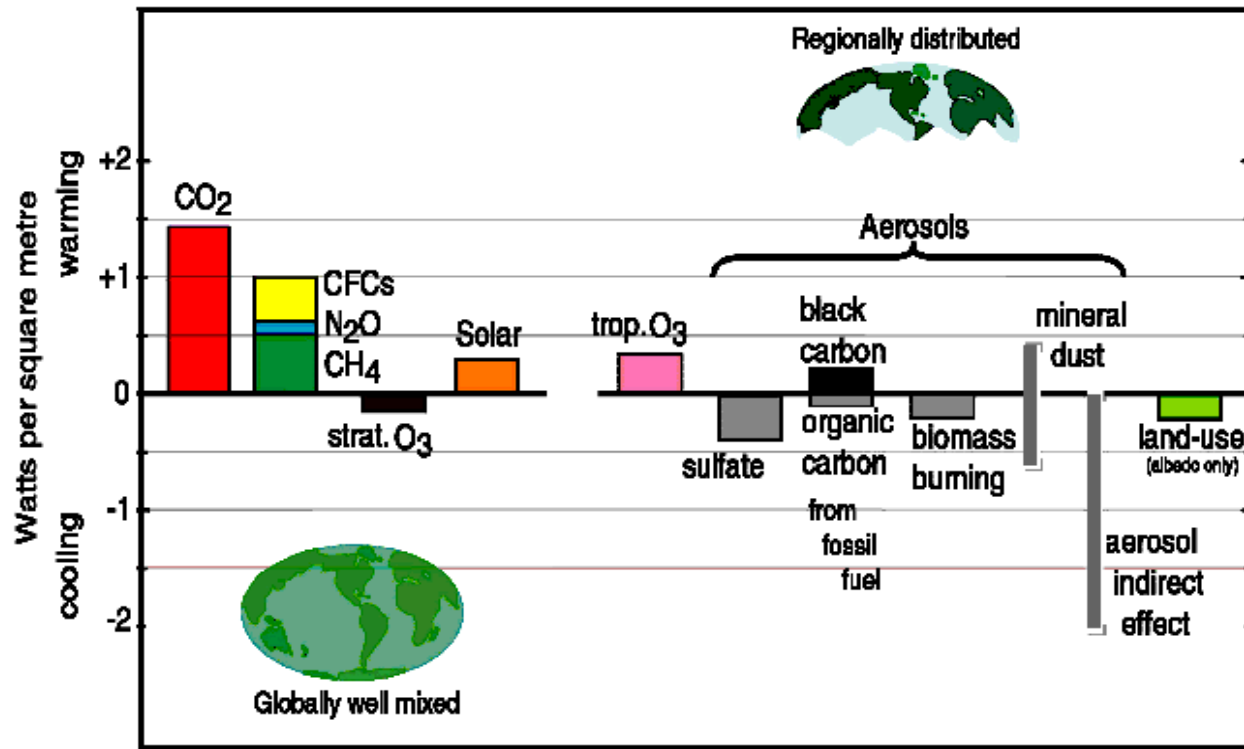


Modeling vertical distribution sulfate mix.ratios: latitude(x) vs height(y)



Modeling vs Satellite

Global Mean Radiative Forcing of Climate for year 2000 relative to 1750



AVHRR satellite analysis by:

1. Stowe
2. Nakajima
3. Mishchenko

Differently retrieved impacts based on identical satellite data-sets illustrate the quantification problem with data from space (non unique solutions)

AEROCOM: Why now?

- **Now we have better satellite data; more network observations**
- **Models are improved by being more physically realistic**
- **How good are they now for determining radiative forcing?**
- **Goal: Use comparisons to data to improve the models**

AeroCom

S. Kinne

MPI-Meteorology

AeroCom - Goals

- diagnose aerosol modules *of global models*
 - assemble useful data-sets *for evaluations*
- ⇒ identify (and eliminate) weak components
in aerosol modules of global modeling
- ⇒ reduce uncertainty in simulated forcing

'home' website

<http://nansen.ipsl.jussieu.fr/Aerocom>

(contacts: schulz@lsce.cea.fr or kinne@dkrz.de)

AeroCom - Participation

- **Modeling**

- **15 groups indicated their participation**
 - ... and more groups are expected to join
- **8 groups contributed to PHASE 1**
(‘best effort’ - if possible for the year 2000)
 - from US, Germany, France, Italy, Norway and Japan

AeroCom - Participation

- **Measurements**

- numerous data-groups provided data

- remaining problems

- accuracy

- lack to long-term commitment

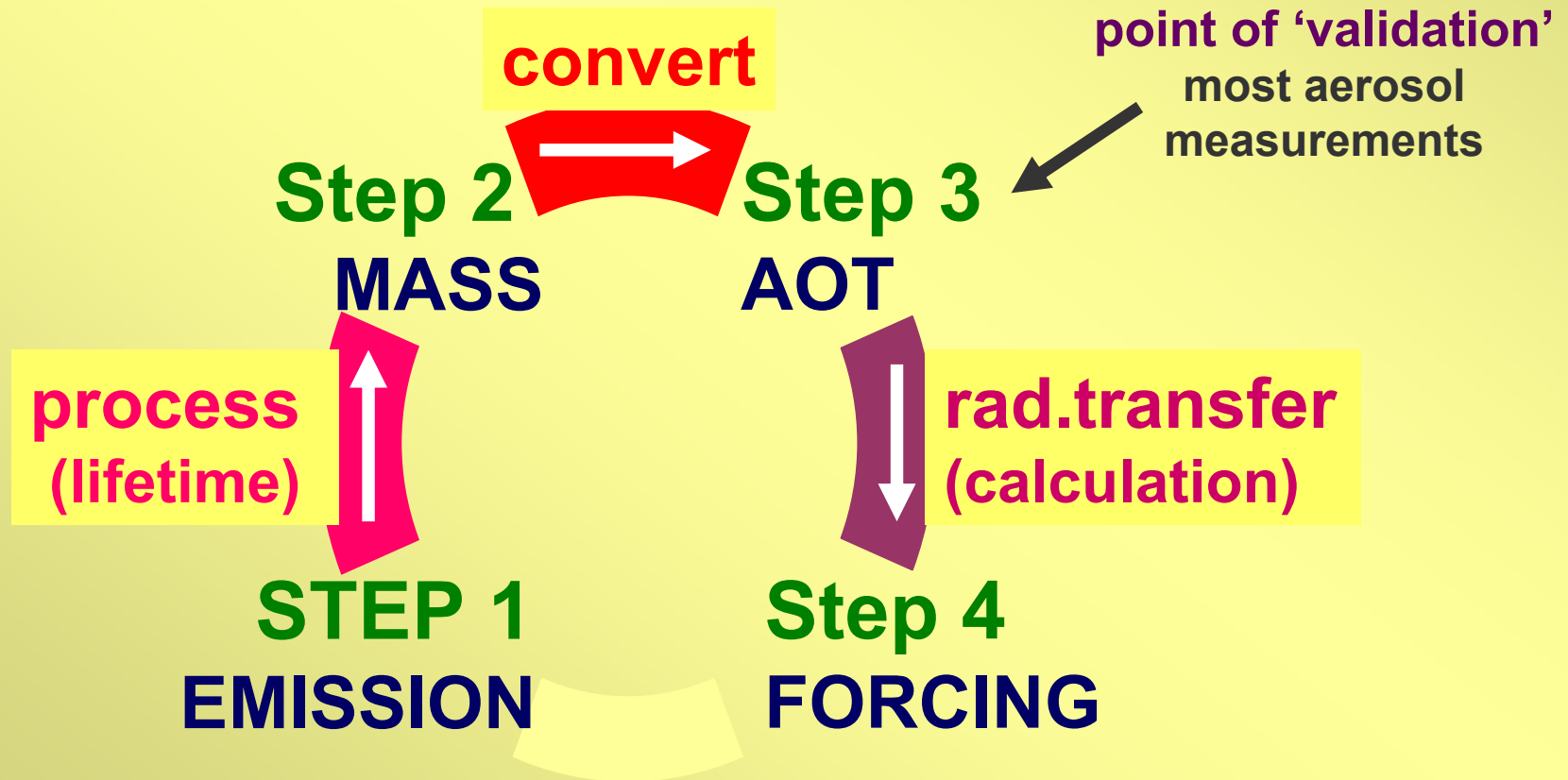
- scale issues (differences in space and time)

- **MODEL- and MEASUREMENT community interactions must be improved**

- **MODELING communities: to express NEEDS**

- **MEASUREMENT communities : to indicate, what is AVAILABLE – at what QUALITY?, to convey current CAPABILITIES**

Modeling - a 4 STEP process



Modeling: OLD vs. NEW

OLD

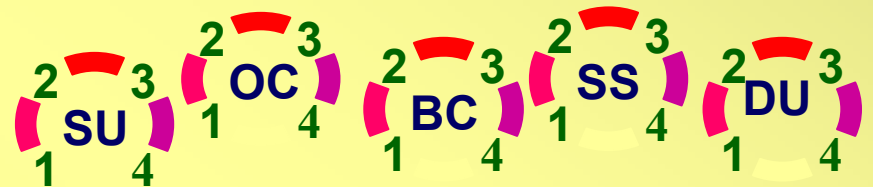
- aerosol = sulfate



- low absorption
- focus on industry
- globally incomplete

NEW

- aerosol = many types



- better characterization
- more processes

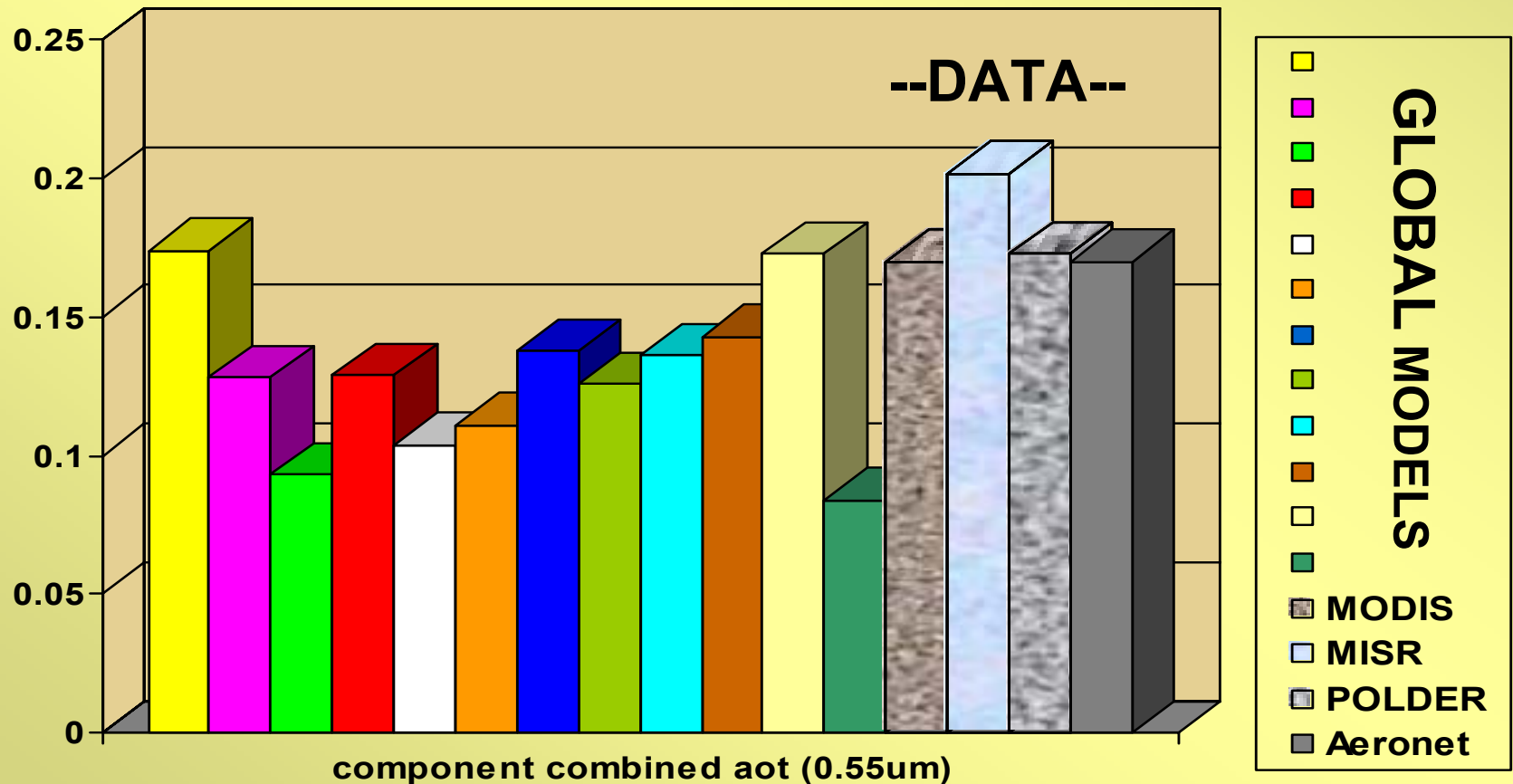
⇒ more errors ?!

despite better representation in new aerosol modules
... the associated climate uncertainties remain large !

Aerosol Optical Depth (STEP 3)

global yearly average

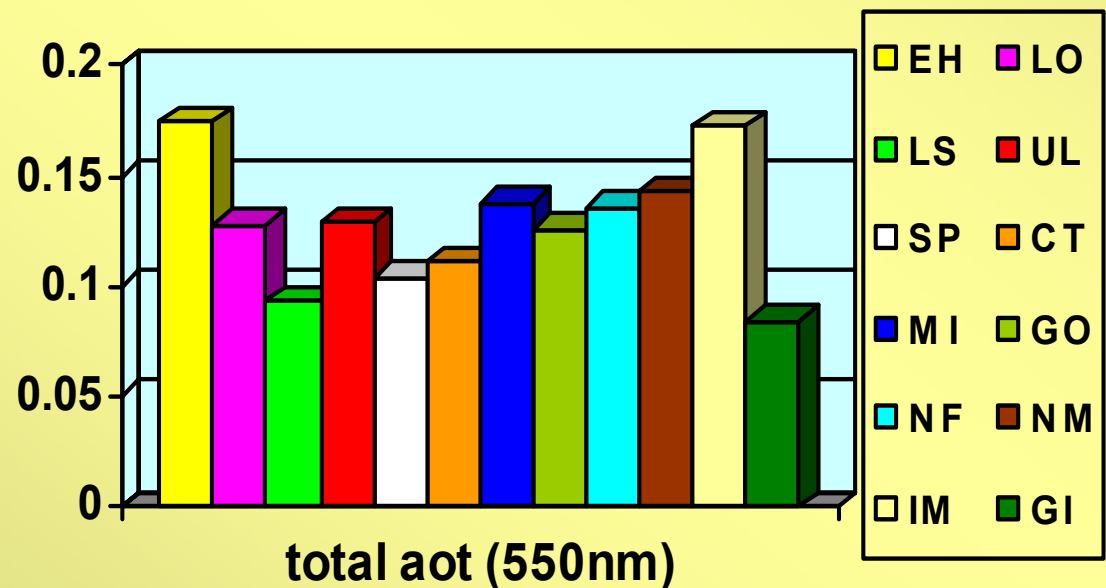
- model simulations vs data



aerosol optical depth (STEP 3)

- let us look just at models
- let us explore the details behind differences in simulated aerosol optical depths

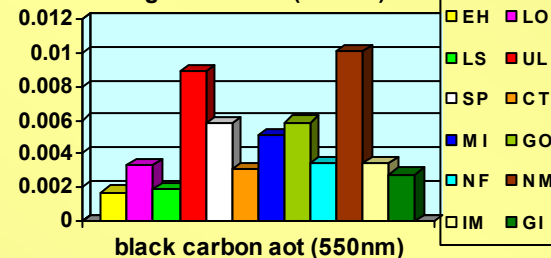
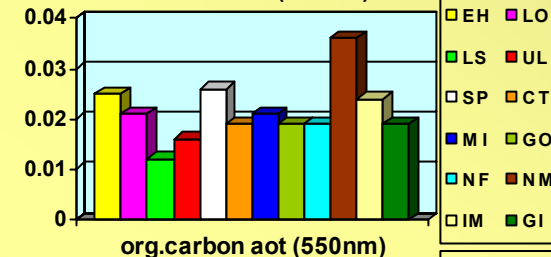
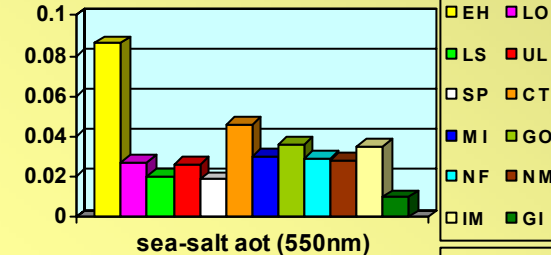
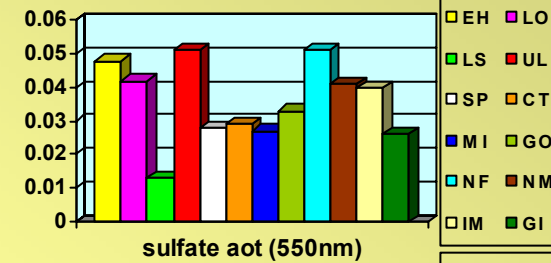
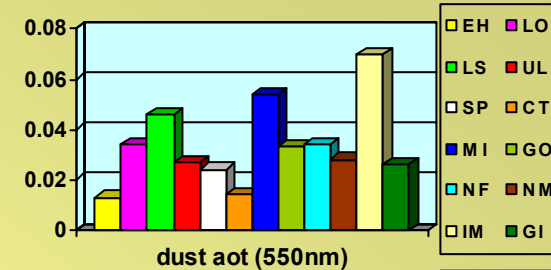
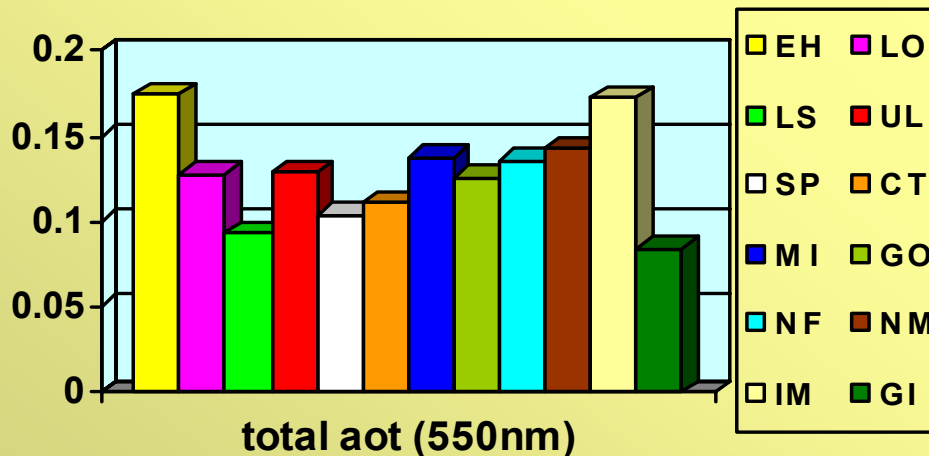
12 models:
simulated global
yearly averages
for visible aerosol
optical depth



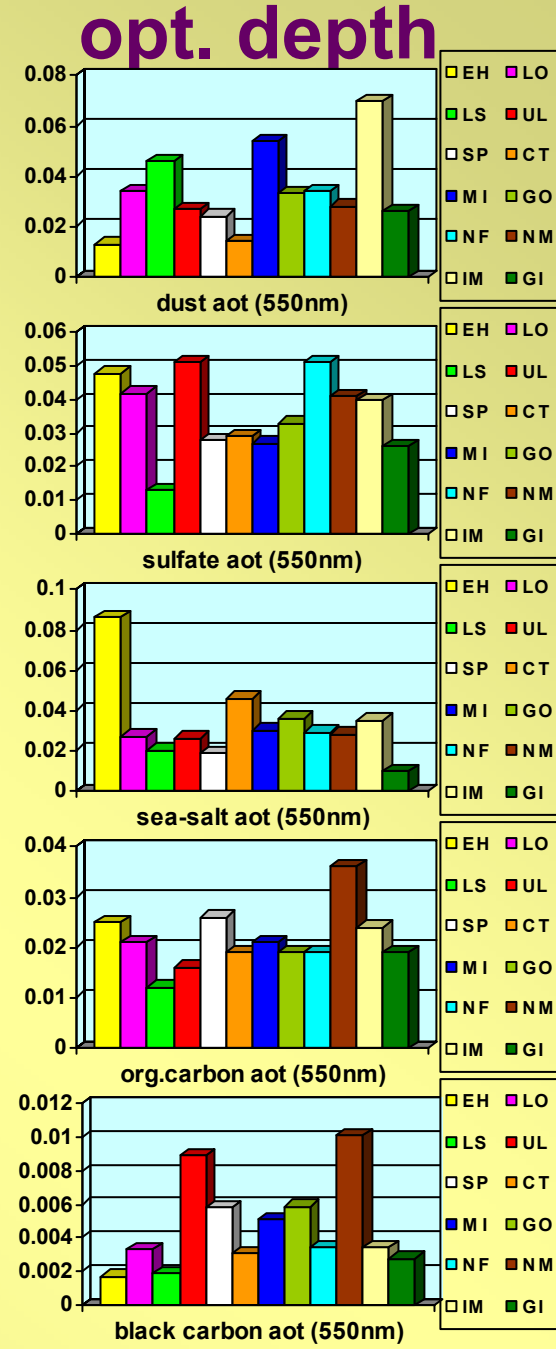
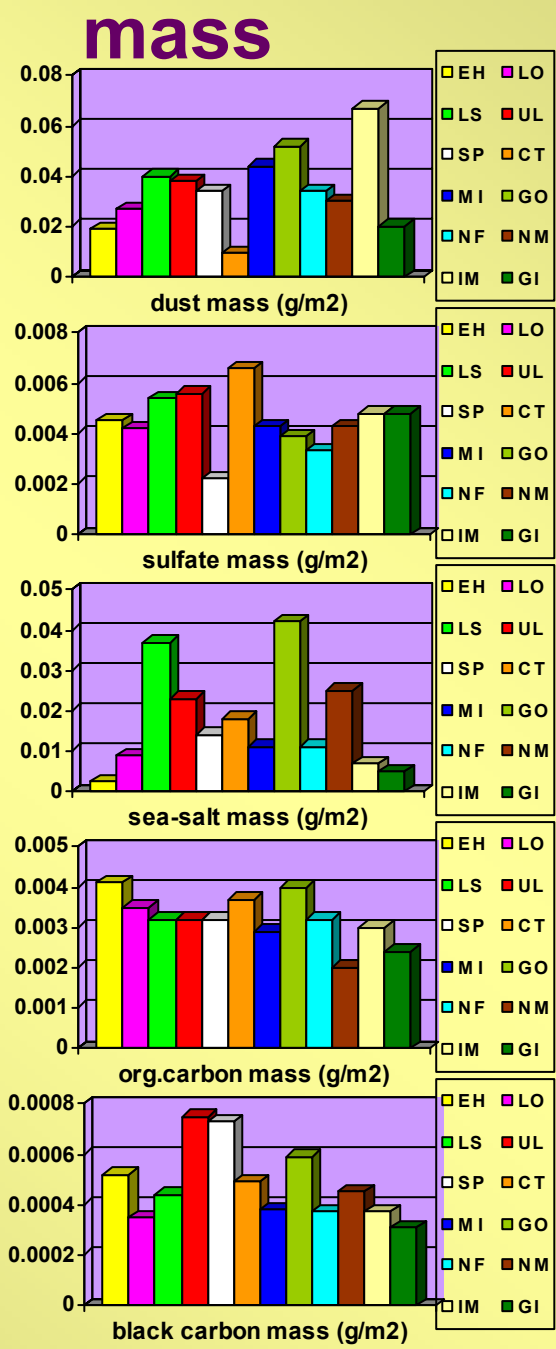
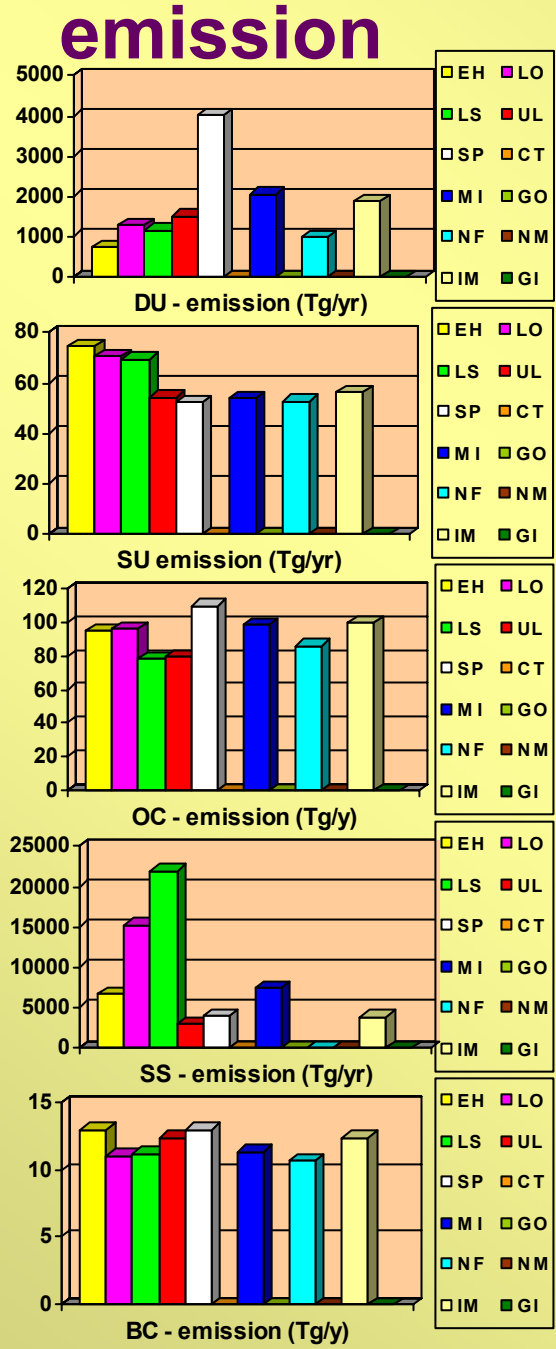
opt. depth (STEP 3)

by type ⇒

- notice the different ‘make-up’
 - different aerosol properties mean
 - differences in size (e.g. water uptake)
 - differences in absorption
- ⇒ differences in aerosol forcing !



simulated aerosol - by type



differences in 'aot' do not correspond to differences in 'mass' or 'emission !

Aerosol by type

Trans-
formations:

lifetime

STEP 1 \Rightarrow STEP 2
emission \Rightarrow mass

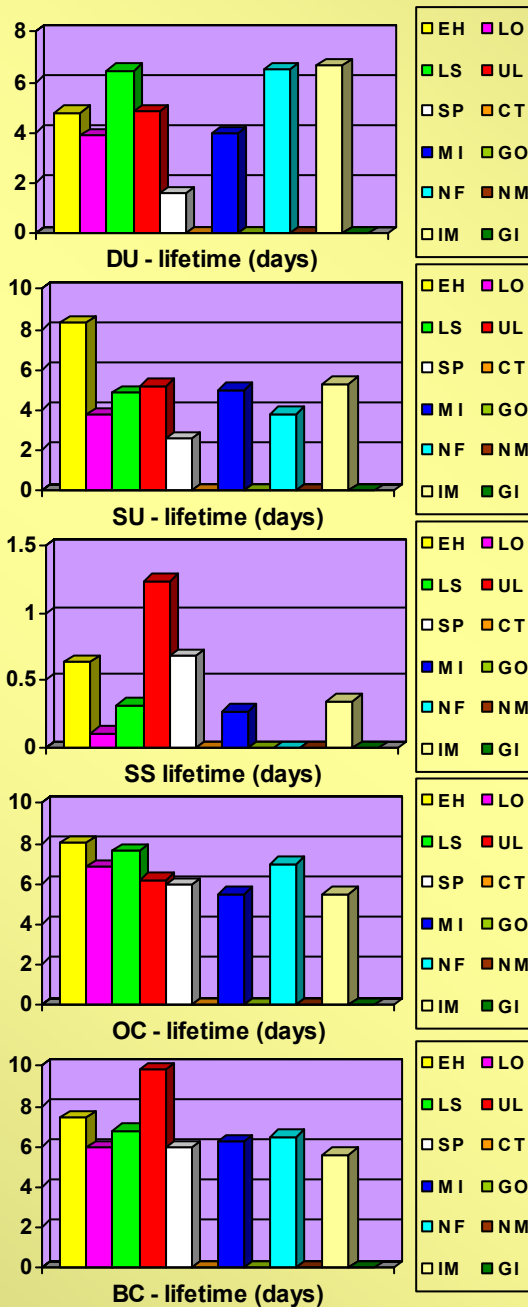
mass ext. eff.

STEP 2 \Rightarrow STEP 3
mass \Rightarrow opt.depth

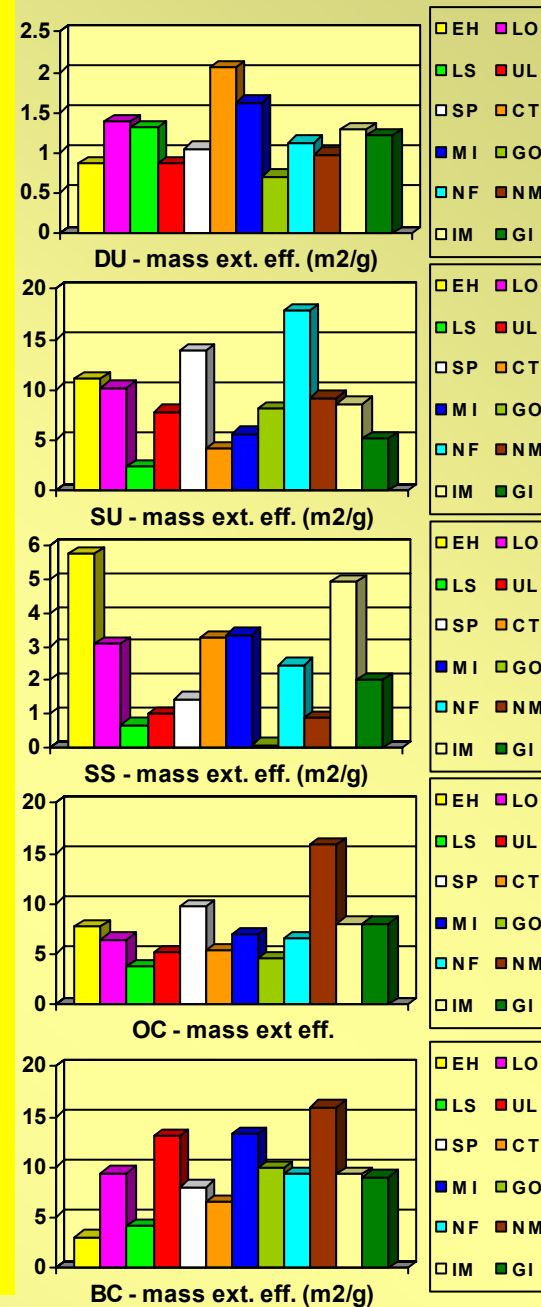
... control
experiments
to understand
differences ...

STEP 1
EMISSION

lifetime



mass ext. eff.



STEP 2
MASS

STEP 3
AOT

AeroCom – First Results

- **comparisons of aerosol optical depth are NOT 'validations' of models**
 - **one bad parameterization can kill an overall good effort**
 - **offsetting errors (and/or tuning) can elevate poor efforts**
- ⇒ **only a look at detail can provide answers !**
- ⇒ **identical input will help understanding model assumptions and deficiencies**

AeroCom - Plans

- **unify model input**
 - common emission data (*just established*)
 - amount, horiz. distribution, size, injection height
 - common met-data (use year 2000 data)
- **examine detailed model-output**
 - identify problem areas, give recommendations
- **acquire relevant data to test models**
 - reach out to the measurements community
- **establish an aerosol climatology data-base**

AeroCom - Activities

- **organize workshops**
 - present model evaluations / highlight problems
 - discuss future strategies
 - forum to connect model and data communities

– next meeting at ISRPA, Italy, Mar 10-12, 2004
- **provide community support via the web**

Extra Slides

AeroCom facilities (*websites*)

- <http://nansen.ipsl.jussieu.fr/Aerocom>
 - data request (*volume and format*)
 - performance feedback
 - (help) evaluate your model to other model and to data !
 - results (*workshop summaries /publications*)
- <ftp://ei.jrc.it> ... cd pub/Aerocom
 - prescribed emission sources (+sizes +heights) for nudged simulations of year 2000
(overview in an 'aerocom...ppt' [powerpoint] file)

Aerosol is complex

global differences in aerosol concentration
global differences in aerosol absorption
global differences in aerosol size

⇒ **aerosol impact varies by region and season !**

the aerosol impact on climate has many faces:

- *aerosol only effect “direct effect”*
- *aerosol associated **feedbacks** “indirect effect”*
 - *modifications to clouds (particles, lifetime, water content)*
 - *modifications to dynamics (cloud convection)*
 - *Modifications to precipitation*

anthropogenic radiative forcing

magnitude and uncertainties

- aerosol introduces one of the largest uncertainties
- results are based on MODEL –simulations
- ‘low understanding’ reflects deficiencies in modeling: aerosol modules in global models

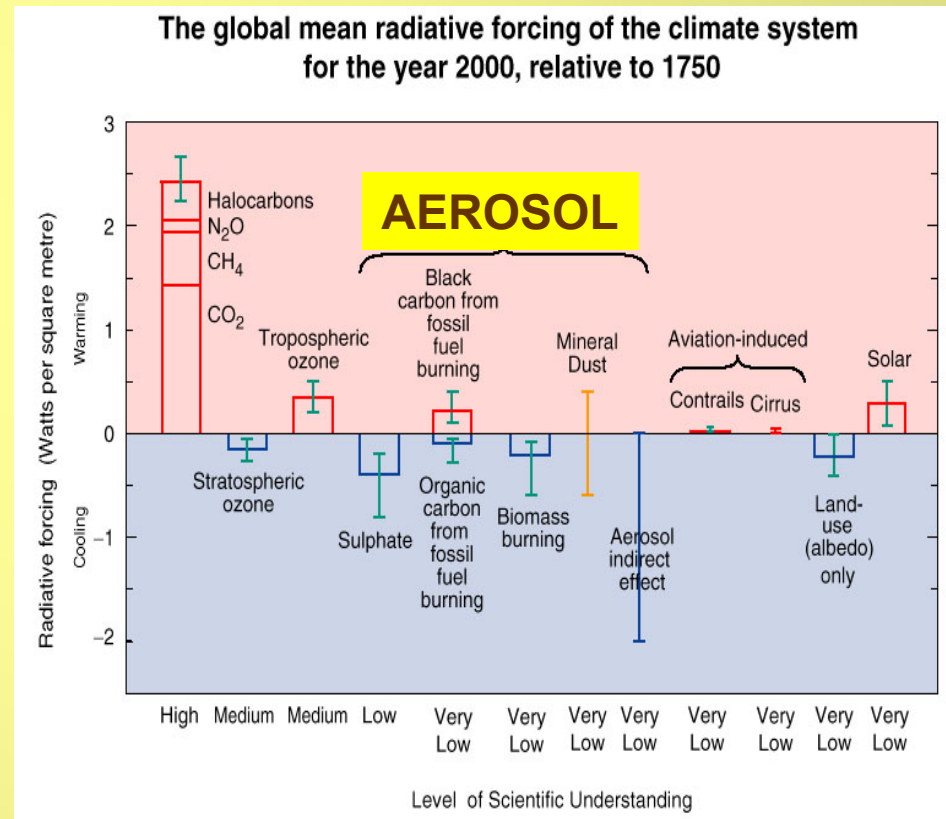


illustration of changes to the radiative energy budget at the top of the atmosphere

Aerosol Optical Depth (STEP 3)

global yearly average

SUMMARY

- **simulations tend to underestimate aot**
 - newer models underestimate less than older models
 - **global yearly totals smear deviation detail**
 - regional deviations
 - seasonal (and inter-annual) deviations
 - deviations by aerosol type
 - **limited relevance to aerosol processing**
 - one bad parameterization can kill an overall good effort
 - offsetting errors (and/or tuning) can elevate poor efforts
- ⇒ **only a look at detail can provide answers !**