AeroCom A

optical properties

an analysis of simulated fields

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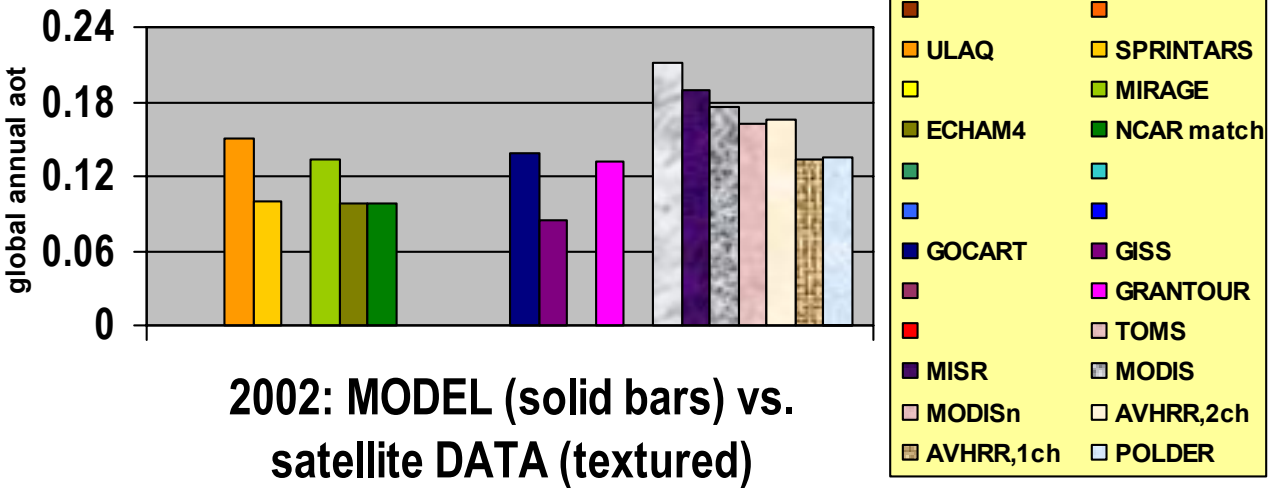
Overview

- column aot (aerosol optical thickness)
  - how are doing in global modeling ?
- beyond column aot in modeling
  - why there are other things to compare
- are there reliable constraints to modeling
  - why we need to understand that data have limitations
- the potential of data-synergy
  - how data actually can be useful to identify deficiencies

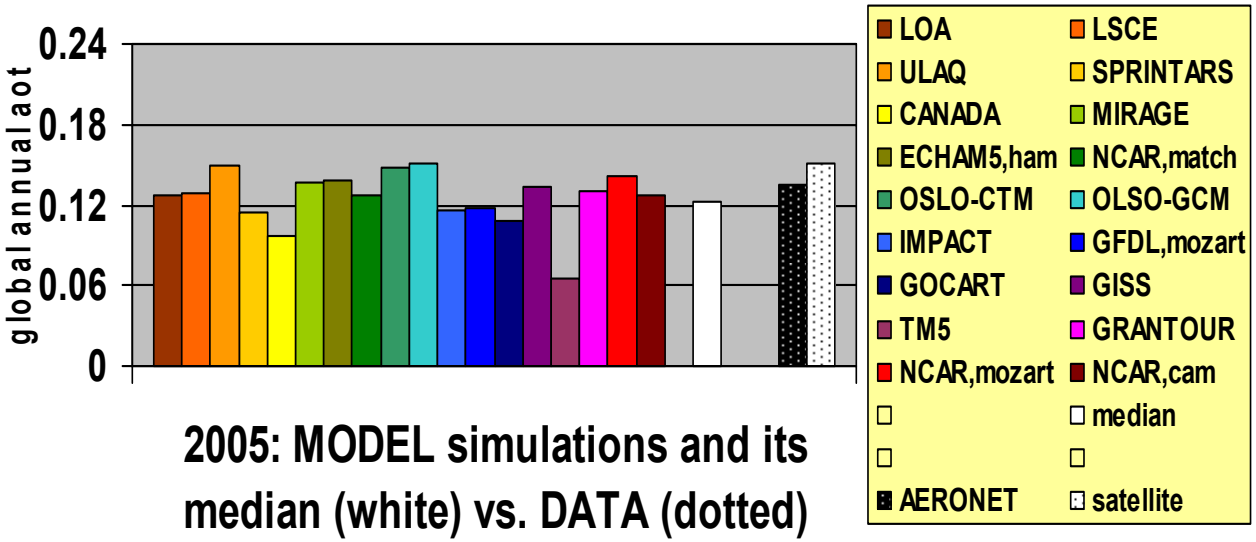
aot – *global annual average (the 1. test)*

within recent years:

- more component models appear
- better ‘aot’ agreement among models
- fair agreement to ‘aot’ data
- ***are we making progress?***



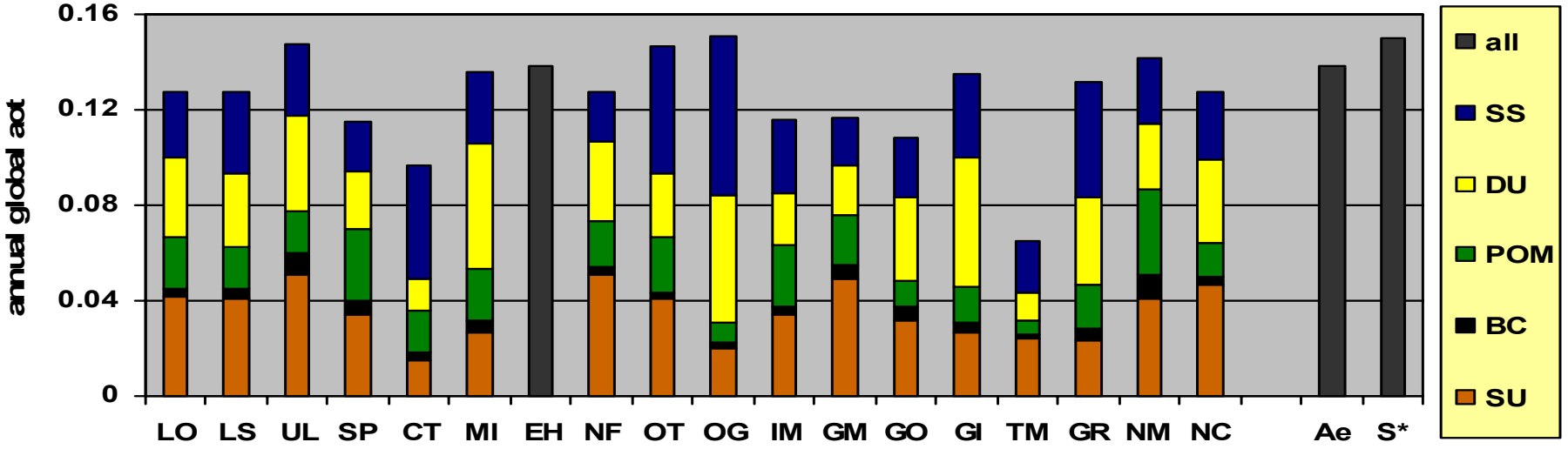
2002: MODEL (solid bars) vs. satellite DATA (textured)



2005: MODEL simulations and its median (white) vs. DATA (dotted)

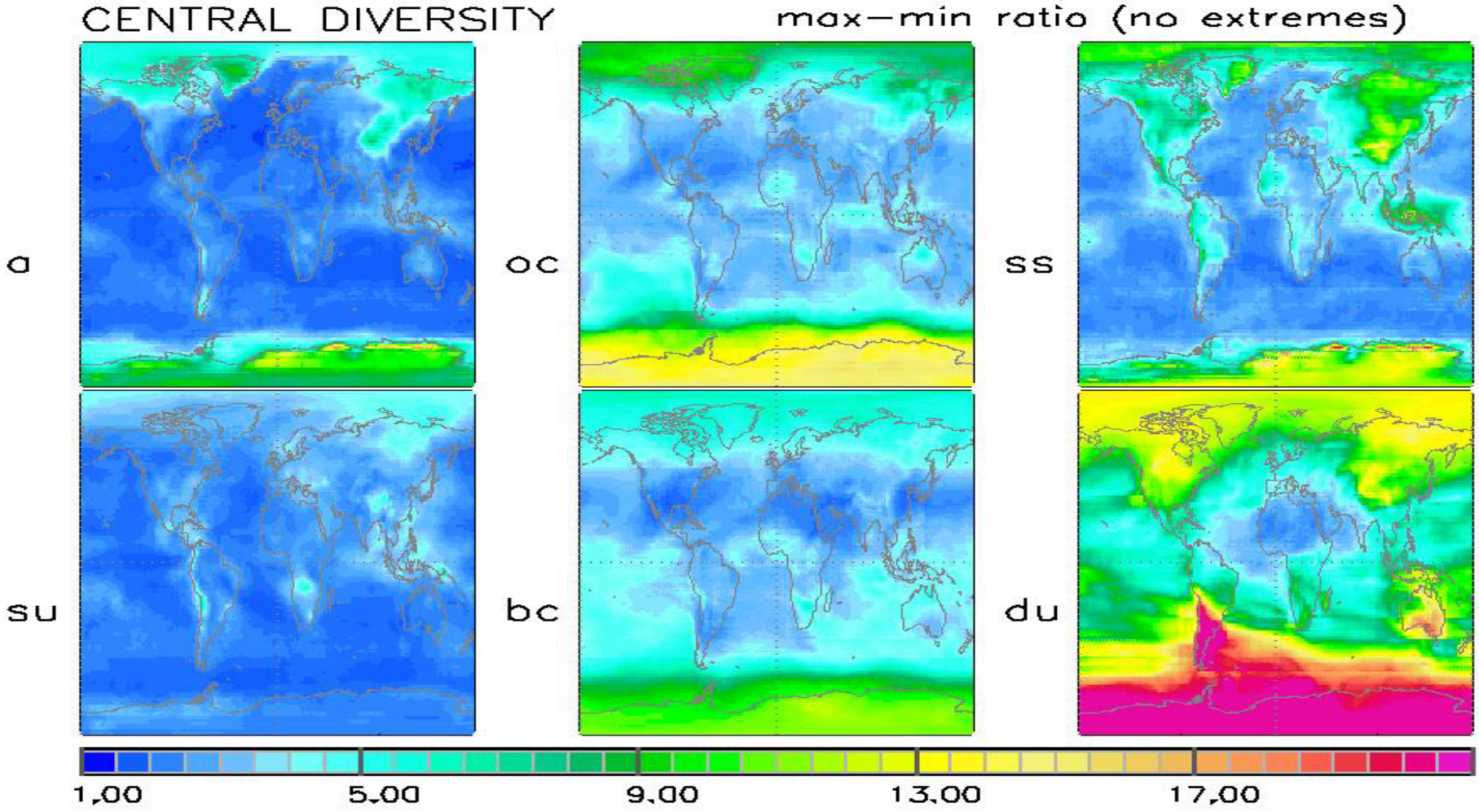
aot – *global, annual by component*

- less model agreement based on individual component !



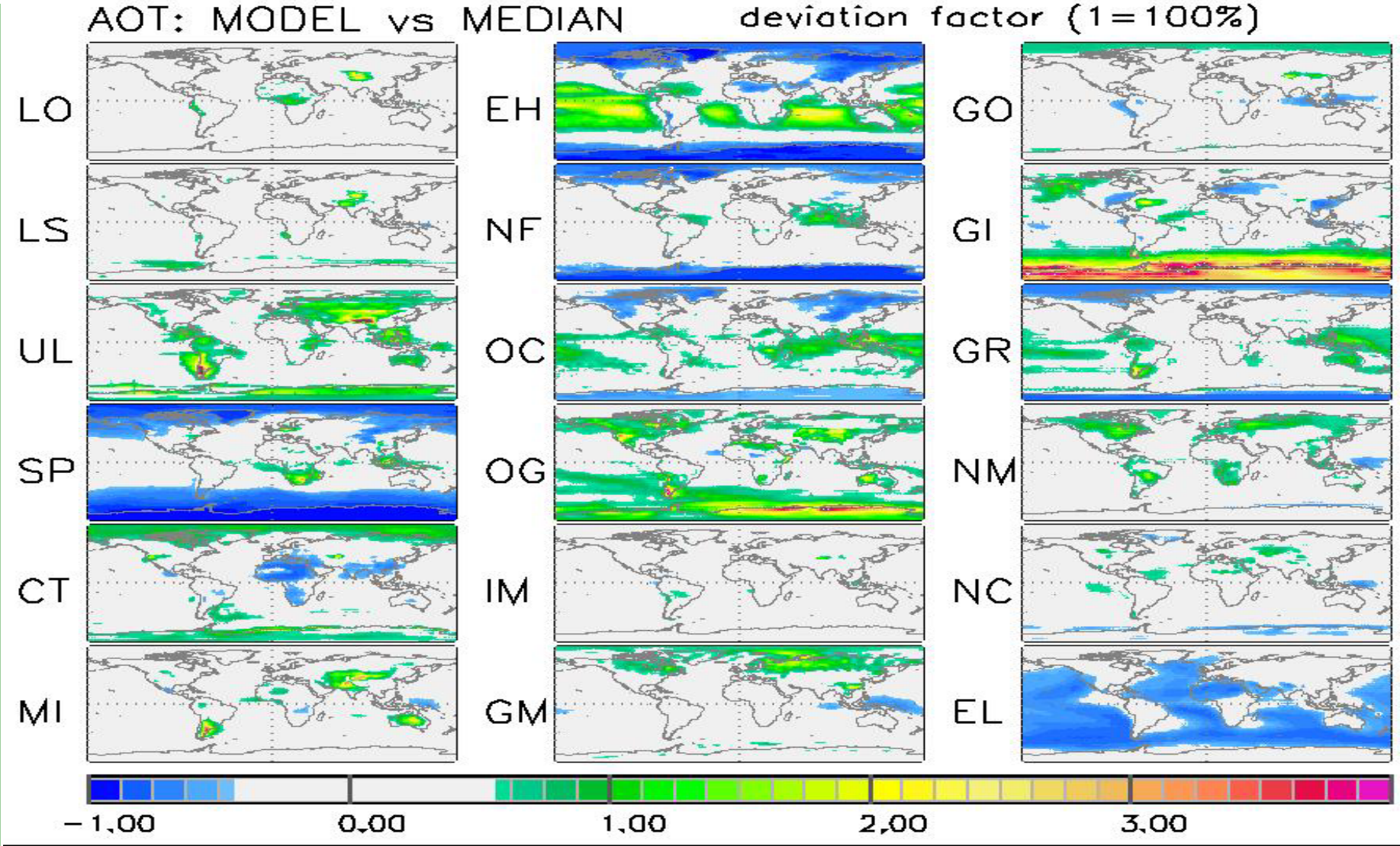
- let us introduce **'central diversity'**
  - regrid each model to 1*1 deg resolution
  - rank all models at each grid for each month
  - find models representing 83% and 17% of the prob. den. function
  - determine the 83% to 17% ratio (diversity without 'extremes')

aot – *uncertainty in modeling*



- (total) aot diversity < aot sub-component diversity WHY?

aot – *indiv. tendencies [(M-med) /med]*



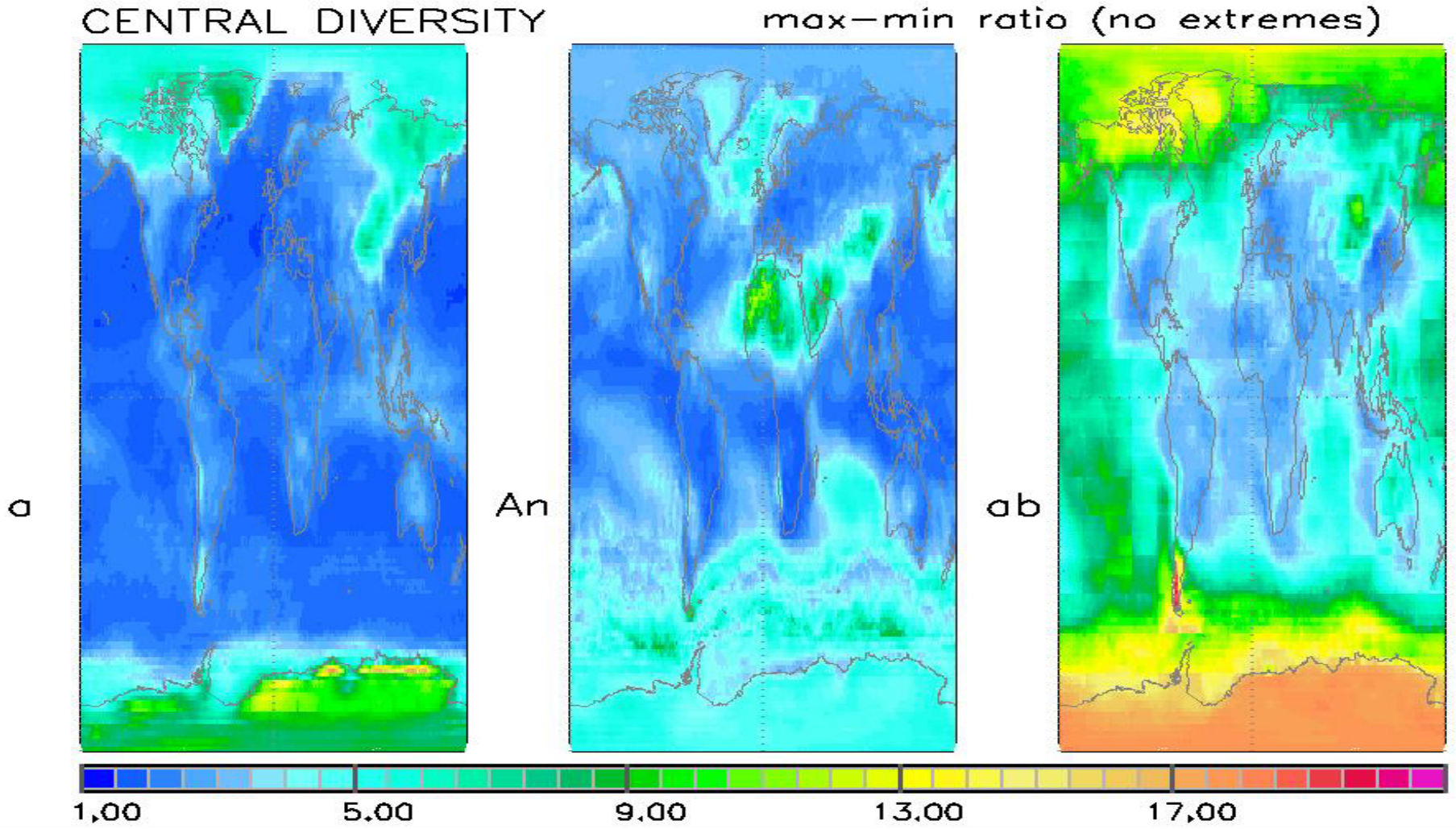
… lets take a break

component *aot diversity* ***exceeds total*** *diversity means*

- differences among models are larger than total aot comparisons might suggest *(note: data usually give only contraints for total aot)*
  - **there IS a necessity to explore model behavior**
- differences in composition mean differences in absorption *(absorption also influences the forcing thus aot agreement does not guarantee agreement for forcing)*
  - **other (than aot) aerosol properties matter as well**

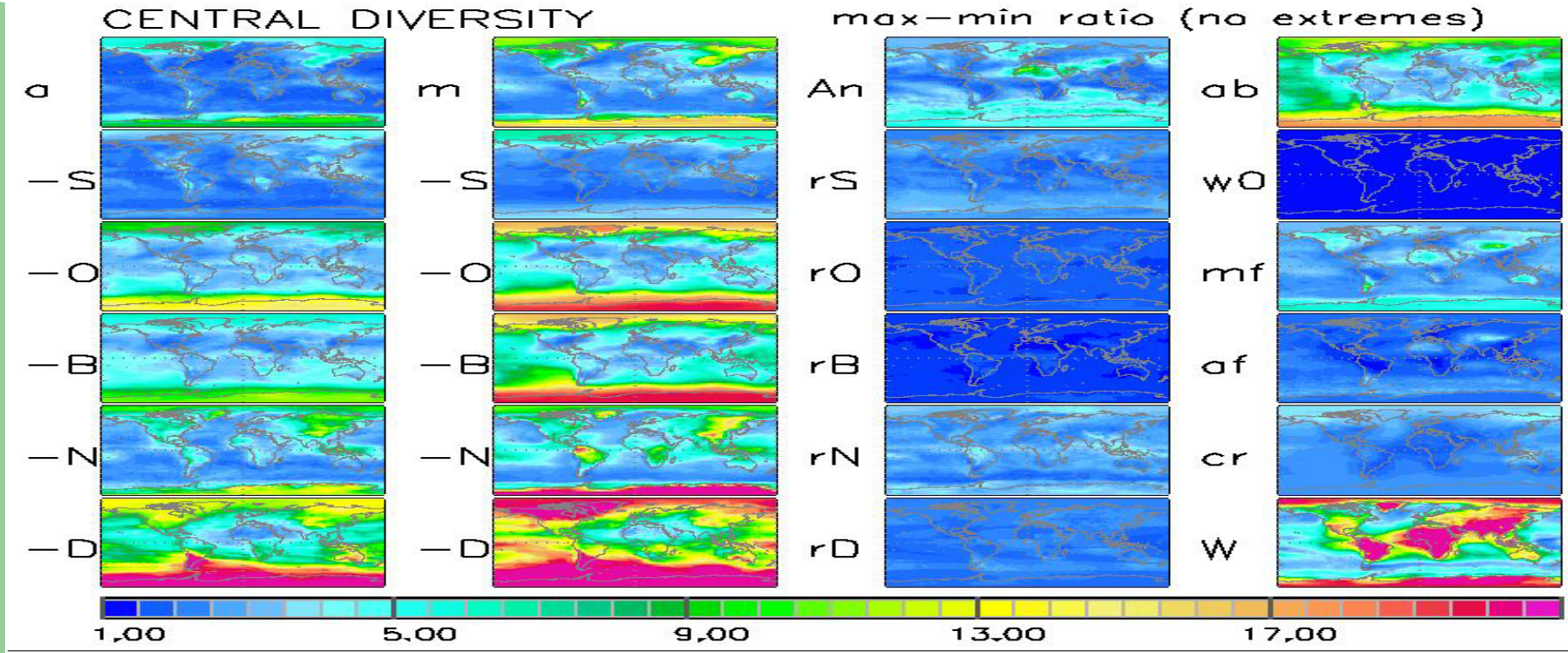
1. AMOUNT
2. **SIZE**
3. **COMPOSITION**

aerosol – uncertainty in modeling



… of 16 simulated annual averages (**a**ot, **An**gstrom, **ab**sorption) [83%PDF - 17%PDF]

Aerosol – *even more simul. properties*

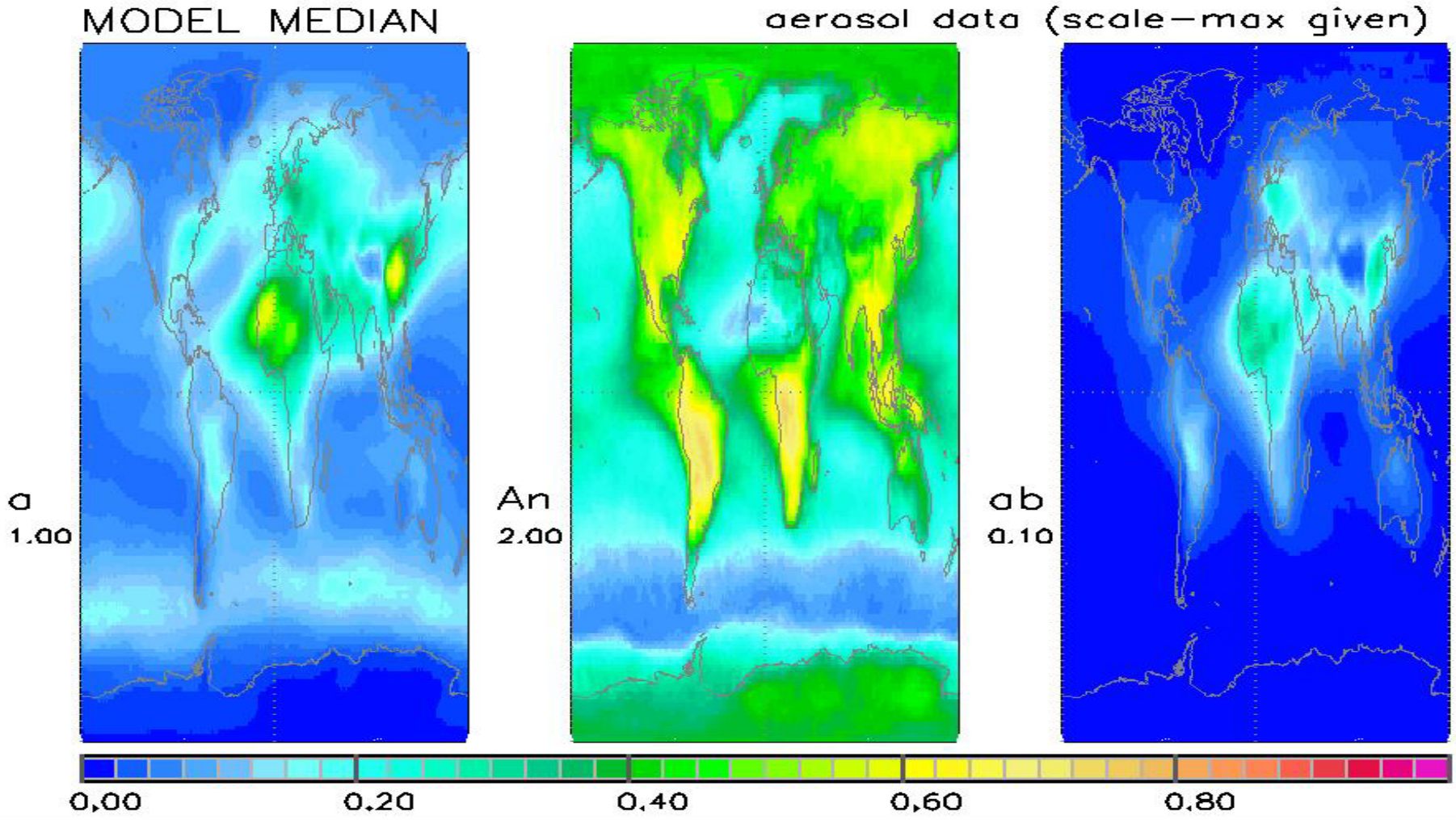


a	*aot (total)*	*-S*	*sulfate*	*ab*	*absorption aot*
m	*dry mass [g/m2]*	*-O*	*org. carbon*	*w0*	*ss-albedo*
r	*mee (=a/m)*	*-B*	*black carbon*	*cr*	*bc/oc ratio*
An	*Angstrom value*	*-N*	*seasalt*	*-f*	*accumulation mode fraction*
W	*aerosol water mass*	*-D*	*dust*		

given this diversity …

- Can we trust aerosol modeling ?
- What aspect in modeling can be trusted ?
- Is there a superior model ?
  - **data are needed**
    - for evaluations
    - to provide constraints
  - to be on the ‘safe’ side ⇨ start with the **model median**

aerosol – *the median in modeling*



… based on simulated monthly averages of 16 models (**a**ot, **An**gstrom, **ab**sorption)

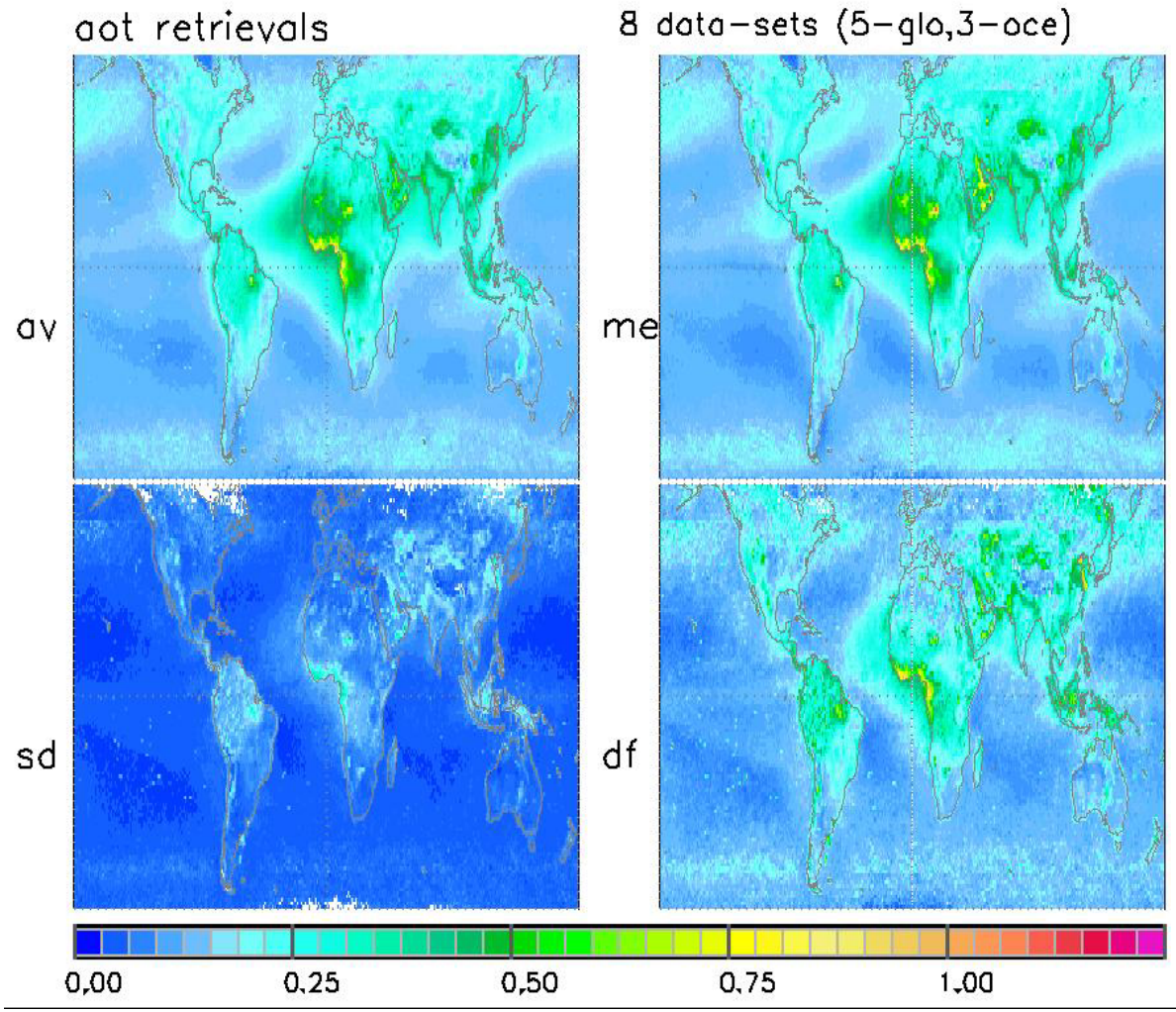
data ? – *we have a problem*

- **are there data to validate aerosol modeling?**
  - a few (and even many for some properties) … but
    - often of suspect quality ***(need comparisons)***
    - often no context to other data ***(need networks, long t.series)***
- **1.** satellites … ***can provide global data***
  - many 'aot' data-sets exist … but
    - usually at limited accuracy, especially over land ***(useful ?)***
    - no data on absorption … ***(assumptions required !)***
- **2.** ground networks … ***can provide column detail***
  - only few ground networks exist
    - just column properties ***(need vertical profiles)***
    - uneven and sparse ***(need denser coverage)***

data – *be careful !*

- understand limitations
- be suspicious on given errors
- compare and compare again
- *remember:*

only quality data help improve modeling



- **av**erage, **me**dian, **s**td.**d**eviation, **dif**ference

composite – *combine (reg.) strengths*

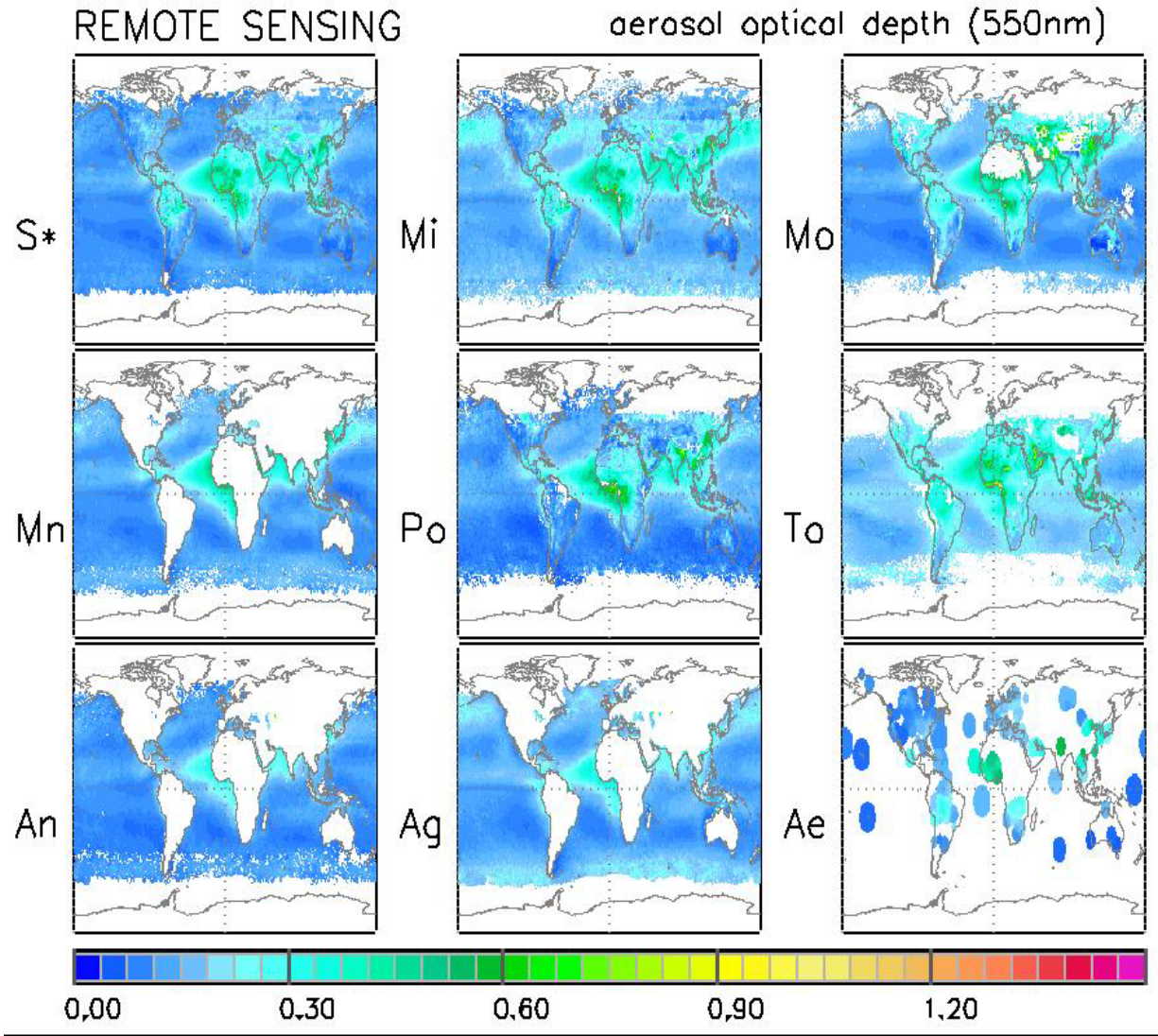
from space

- ***S* composite***
- Mn MODIS,noaa
- An AVHRR,noaa
- Mi MISR
- Mo MODIS
- Po POLDER
- To TOMS
- Ag AVHRR,giss

from ground

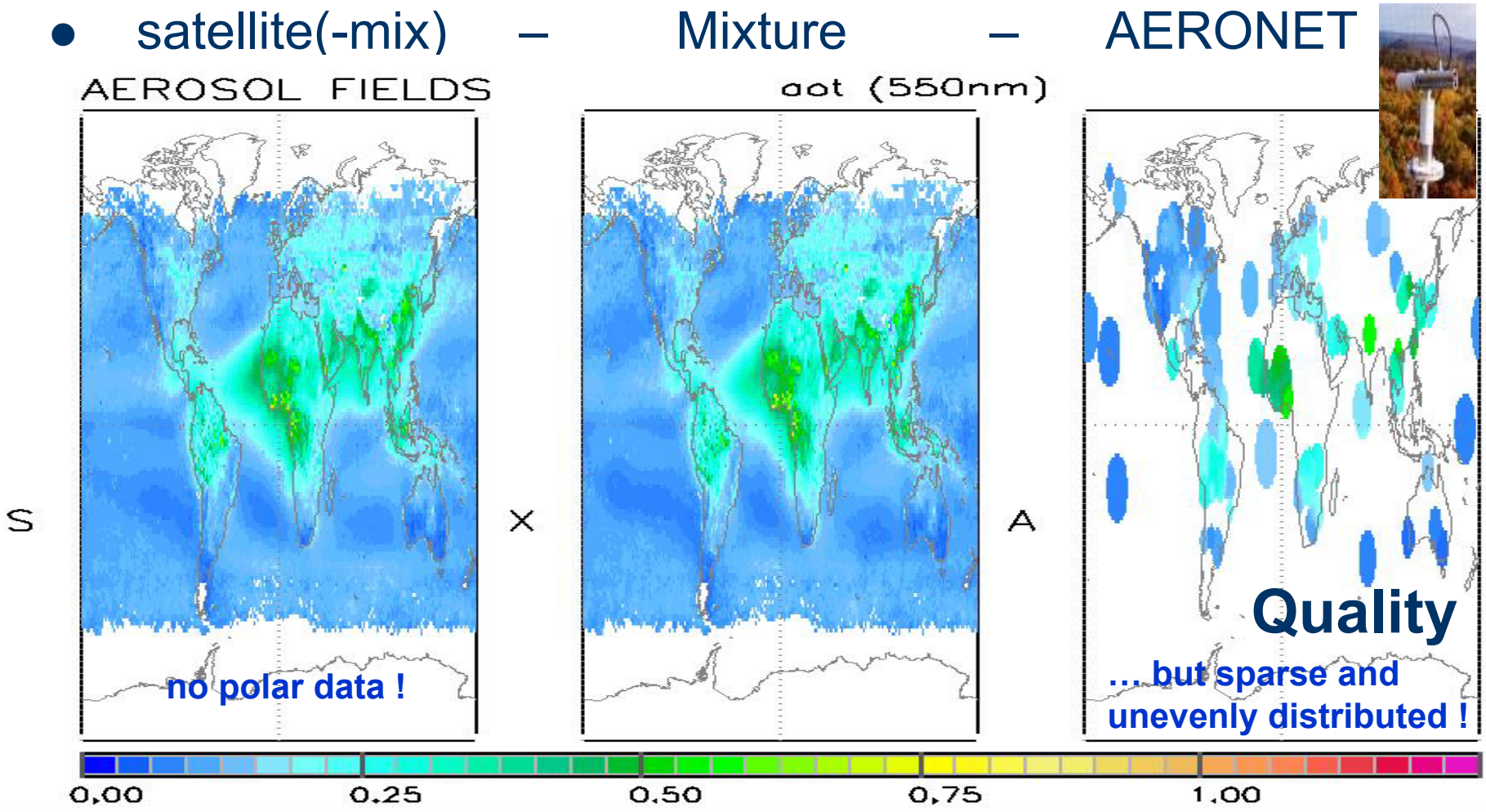
- ***Ae AERONET***

used for asessements



satellite **aot** – *improvement by AERONET*

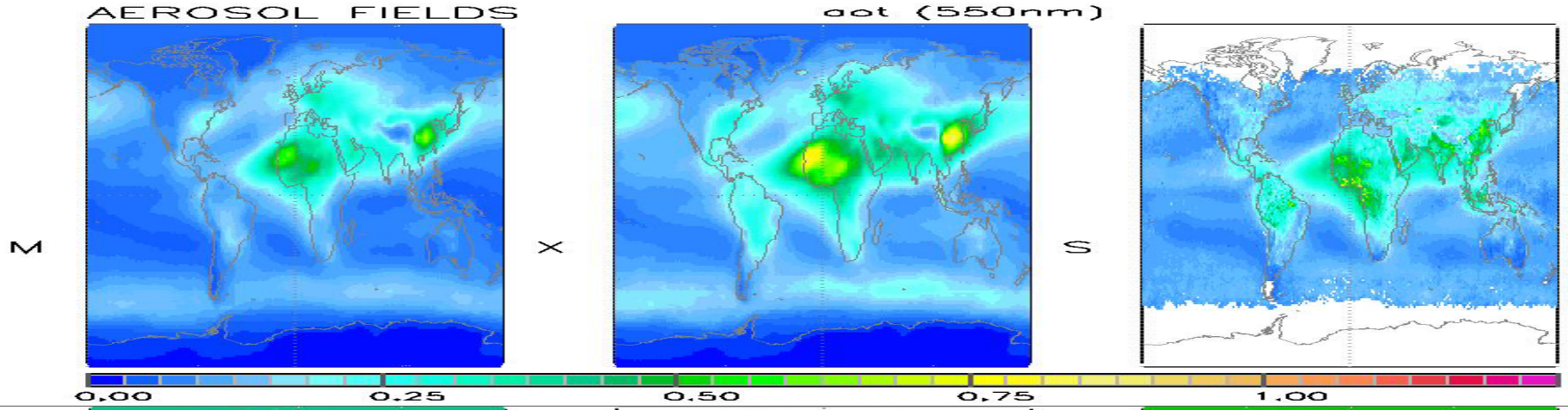
- satellite(-mix) – Mixture – AERONET

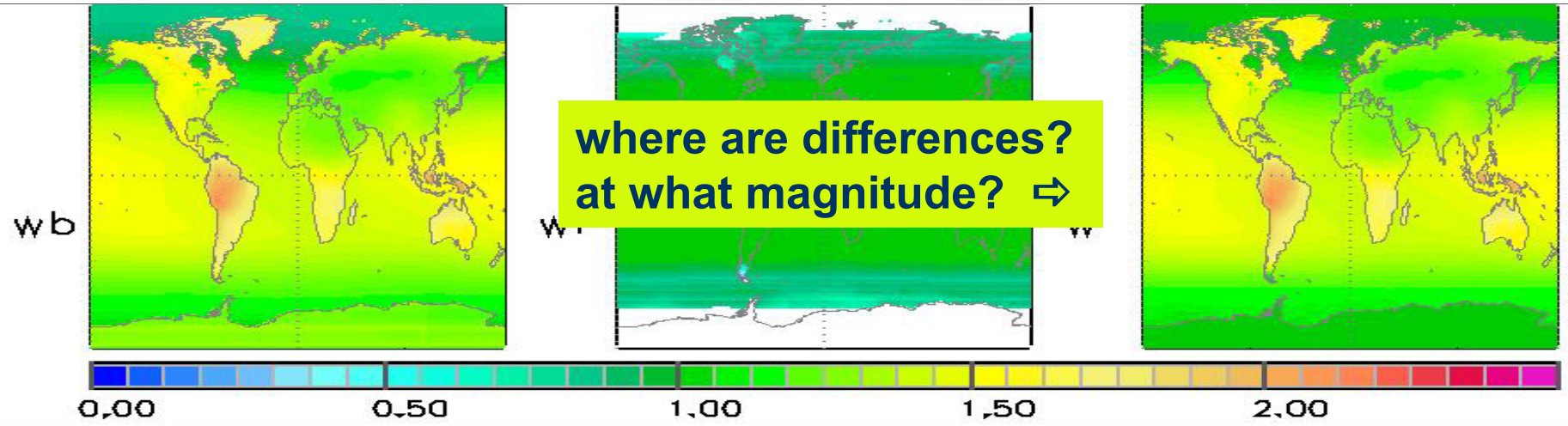


this ‘data merging’ only works if there is **sufficient statistics**!

Model aot - *twisted by SAT + AERONET*

- Model – Mixture – satellite / A-NET





where are differences?
at what magnitude? ⇨

- backgr. weight - weight factor - total weight

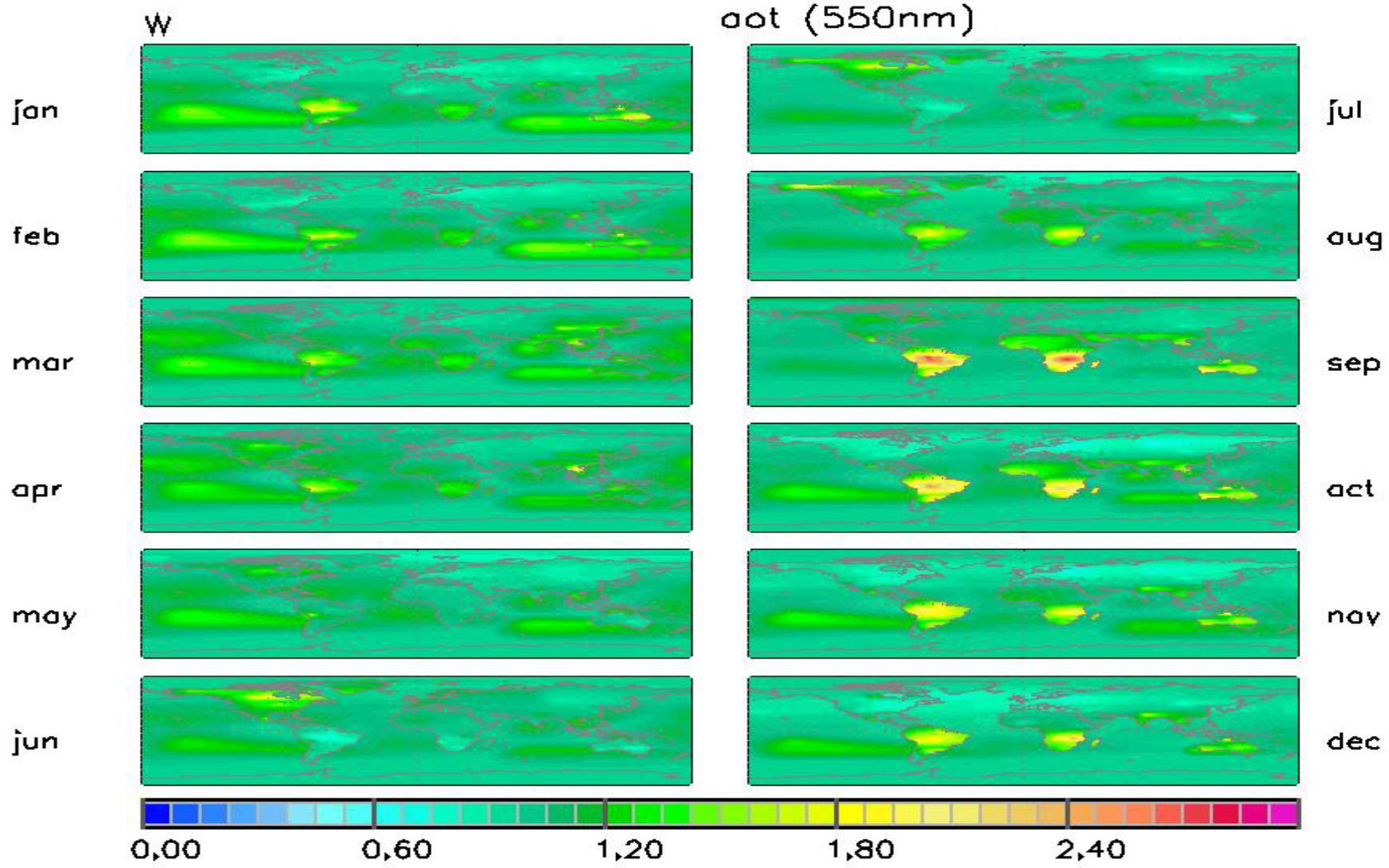
AERONET – *why?*

- **intercomparable** *(quasi-global)*
- **long time-series** *(good statistics)*
- **frequent sampling** *(only GEO matched)*
- **quality aot data** *(no surf. contamin.)*
- **size-distribution** *(even coarse sizes)*
- **absorption** ***(better only at larger aot)***

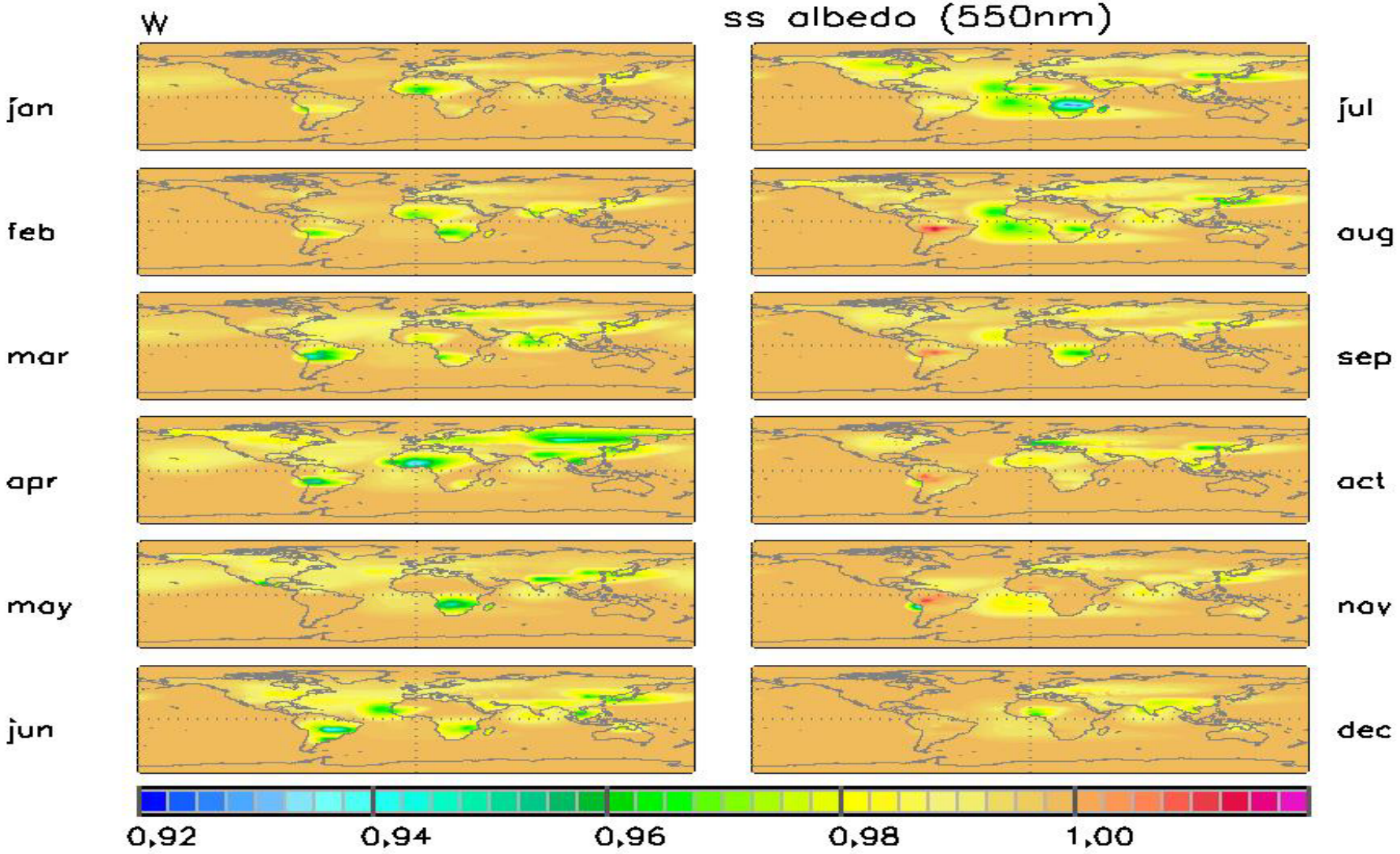
- What can these data tell us about modeling ?

for general trends let us start with the model median

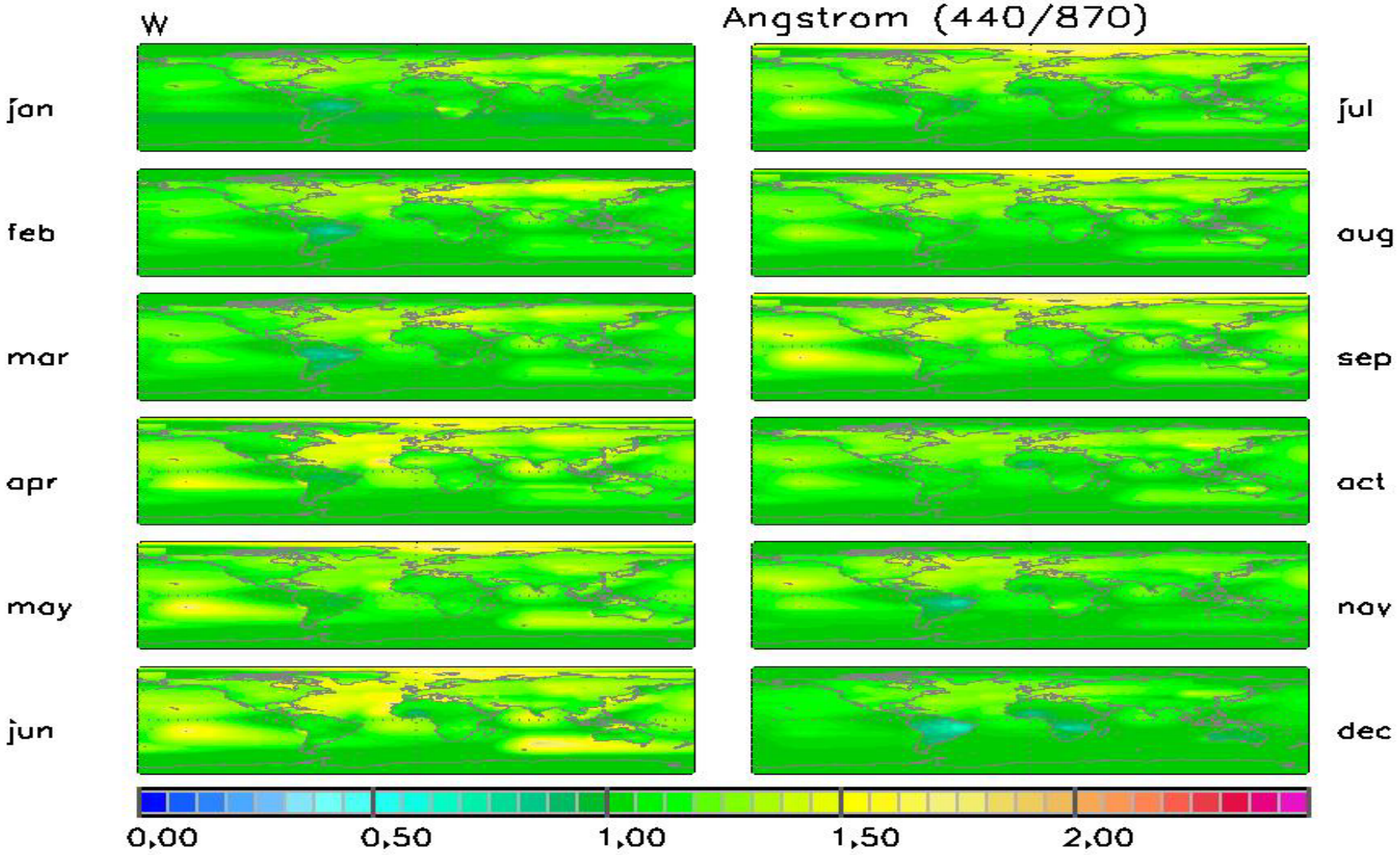
aot – *monthly deviation [(Anet-M) / M]*



ω_0 - *monthly deviation [(Anet-M) / M]*



Angstrom *mon. deviation [(Anet-M) / M]*



Summary

- only **quality** data can point to model deficiencies
- combining of strength of individual data sources multiplies to usefulness to (global) modeling
  - **satellite data need ground net-works**
  - **ground networks need satellite data**
- **simultanous deviations** for properties **in space and time** can provide (component) detail

extras

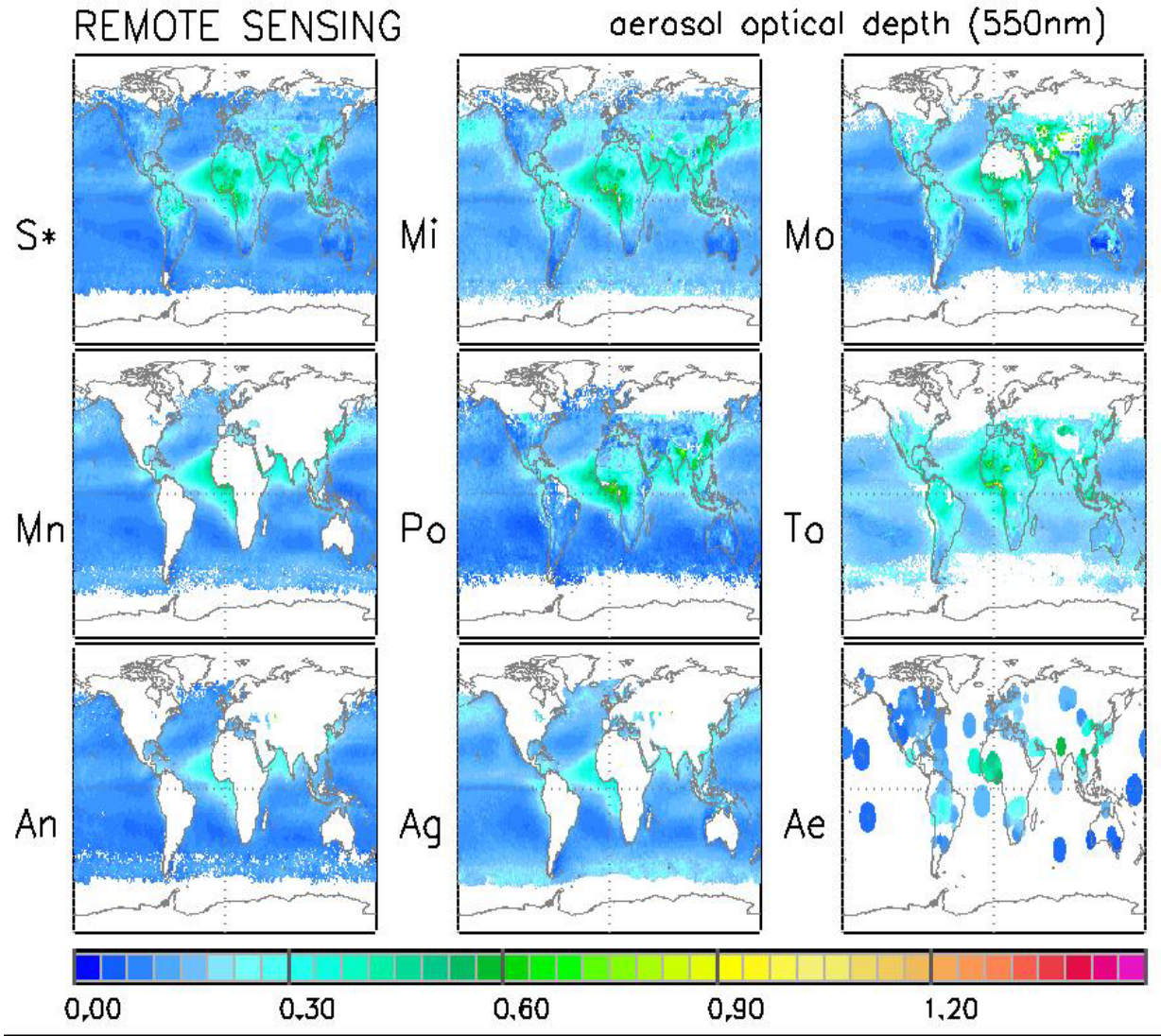
satellite aot – *why use a composite?*

from space

- ***S* composite***
- Mn MODIS,noaa
- An AVHRR,noaa
- Mi MISR
- Mo MODIS
- Po POLDER
- To TOMS
- Ag AVHRR,giss

from ground

- ***Ae AERONET***

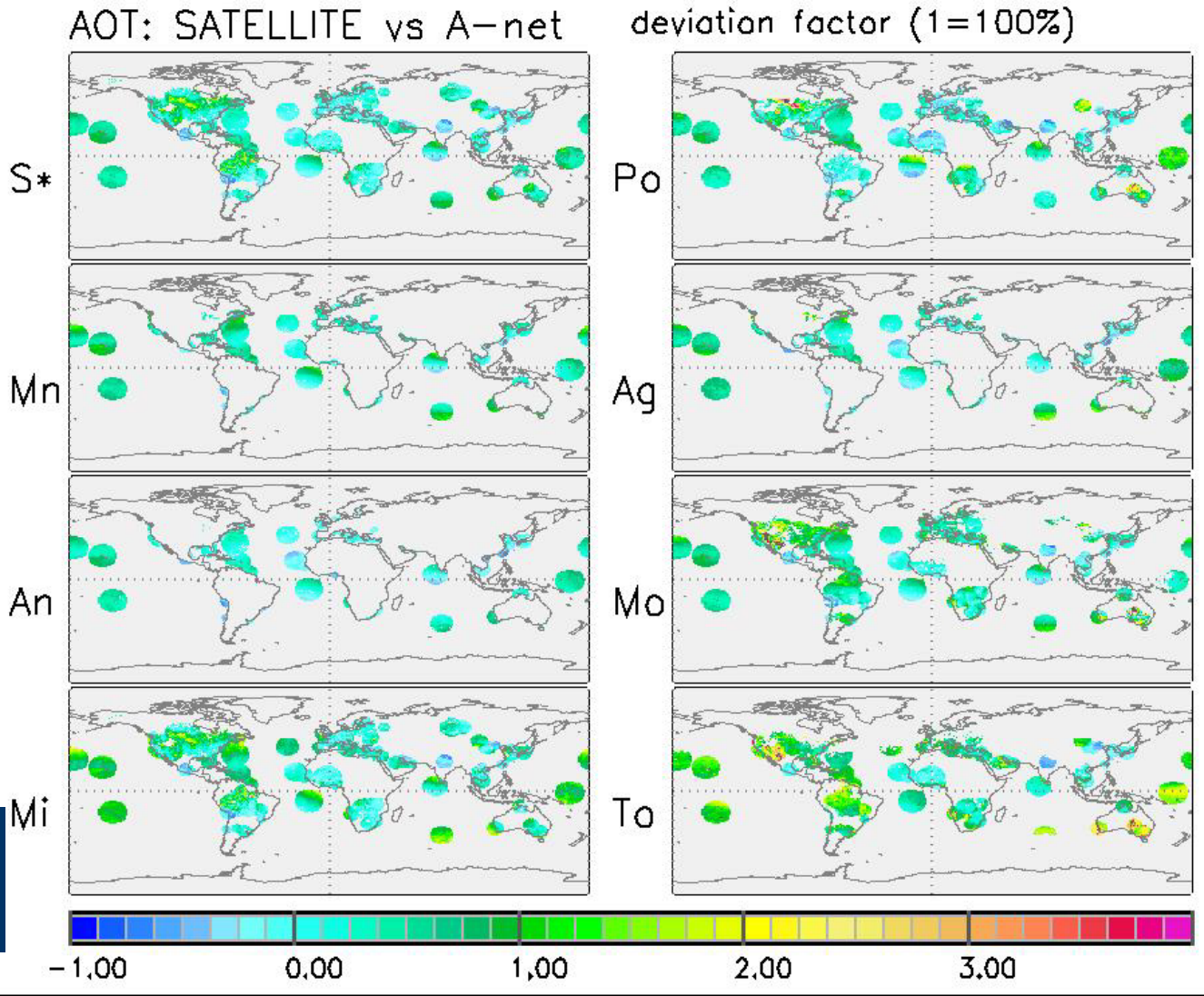


(Satellite-Aeronet) / Aeronet

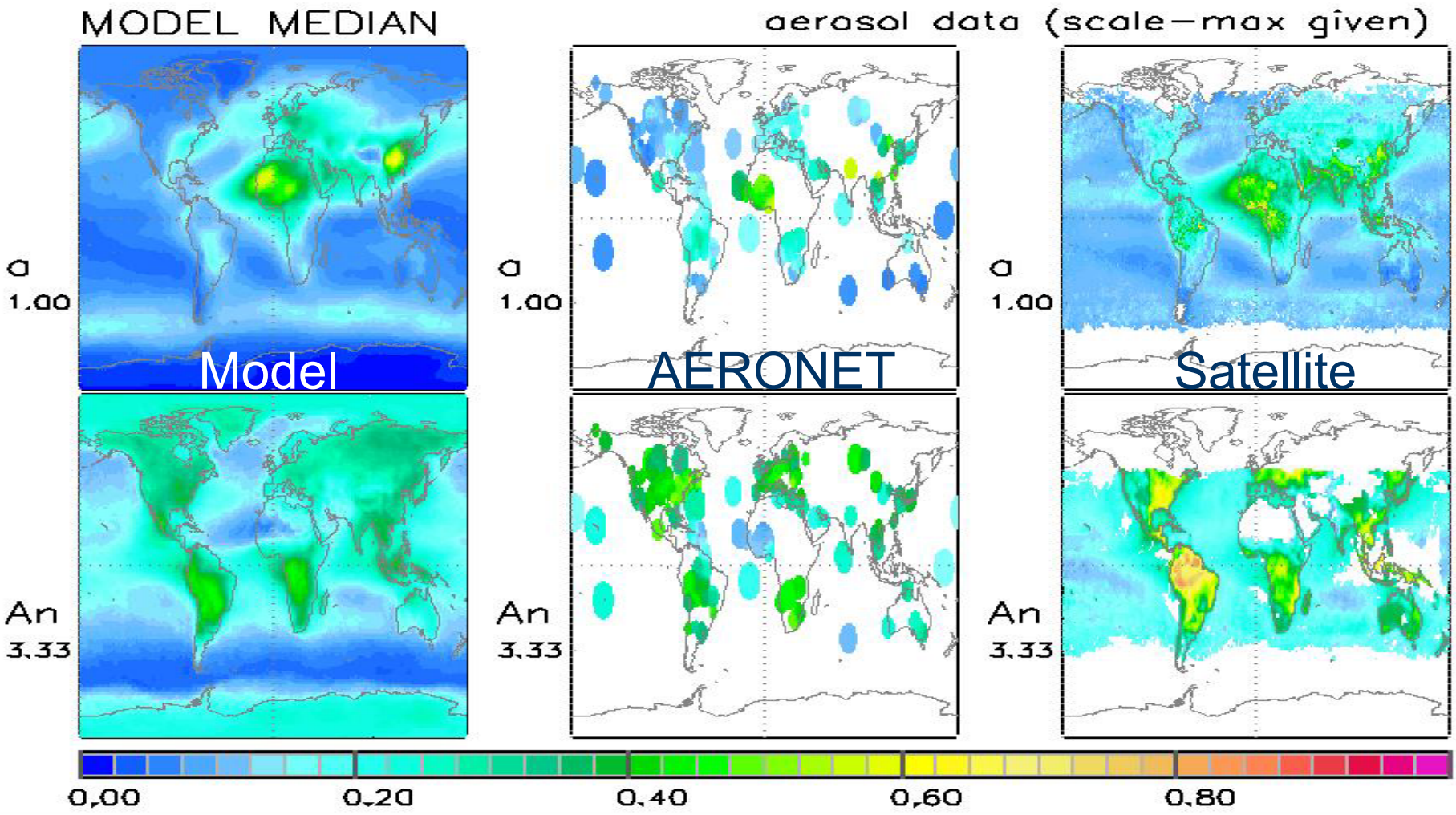
choices for composite

- ocean:
  - **An**: high lat.
  - **Mn**: low lat.
- land:
  - **Mo**: tropics
  - **Mi**: other

light blue indicates agreement ⇨

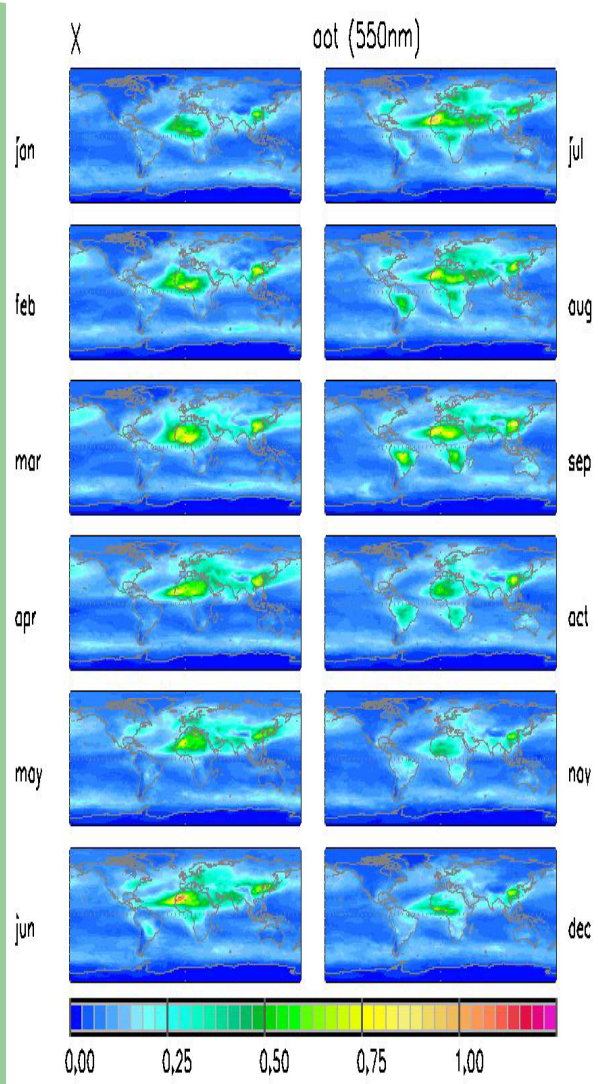


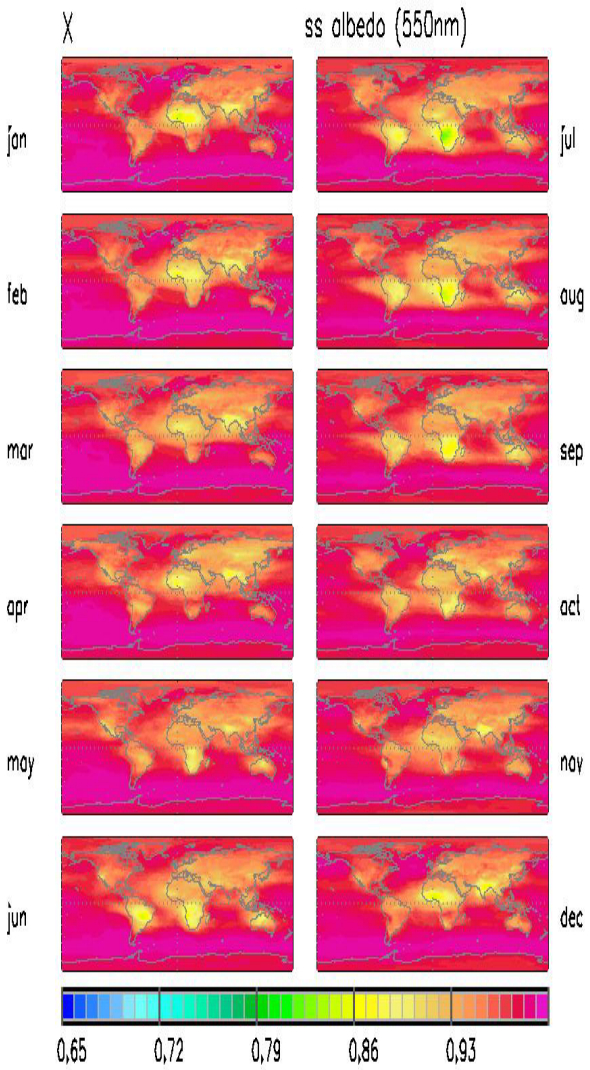
Model - AERONET - Satellite

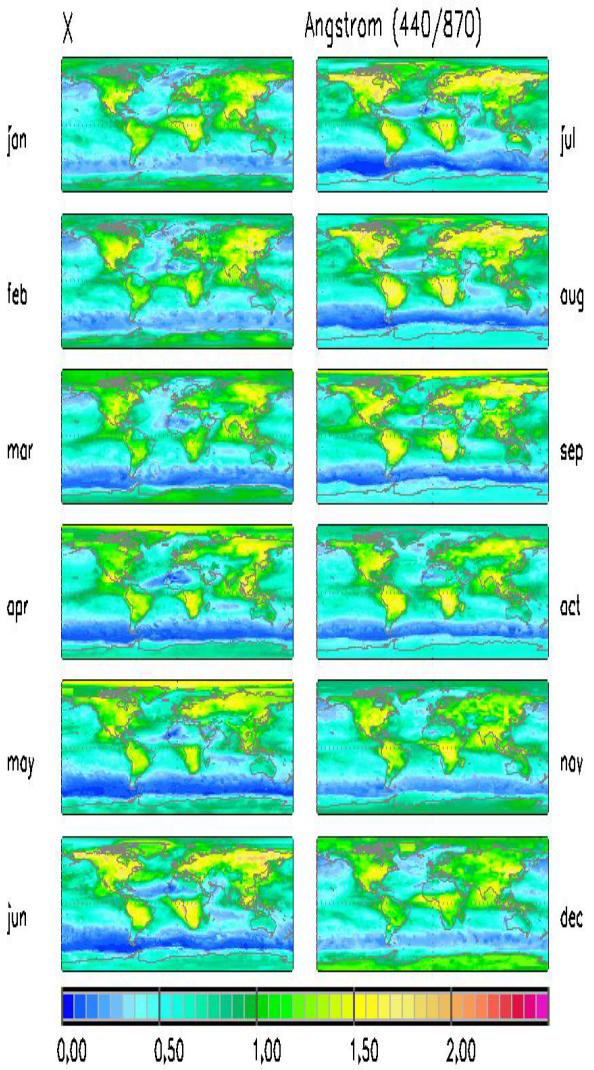


- **a**ot and **An**gstrom parameter

climatology - aot / ω_0 / Angstrom

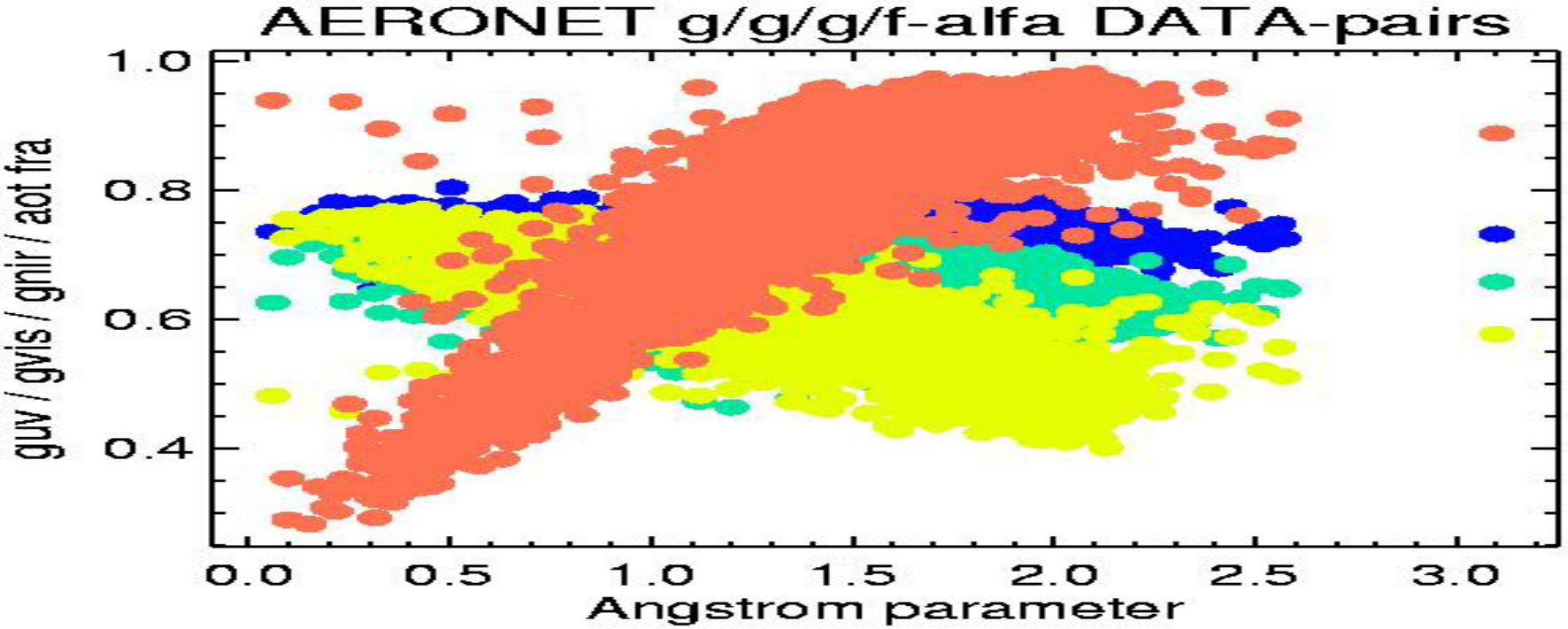






climatology – AERONET support

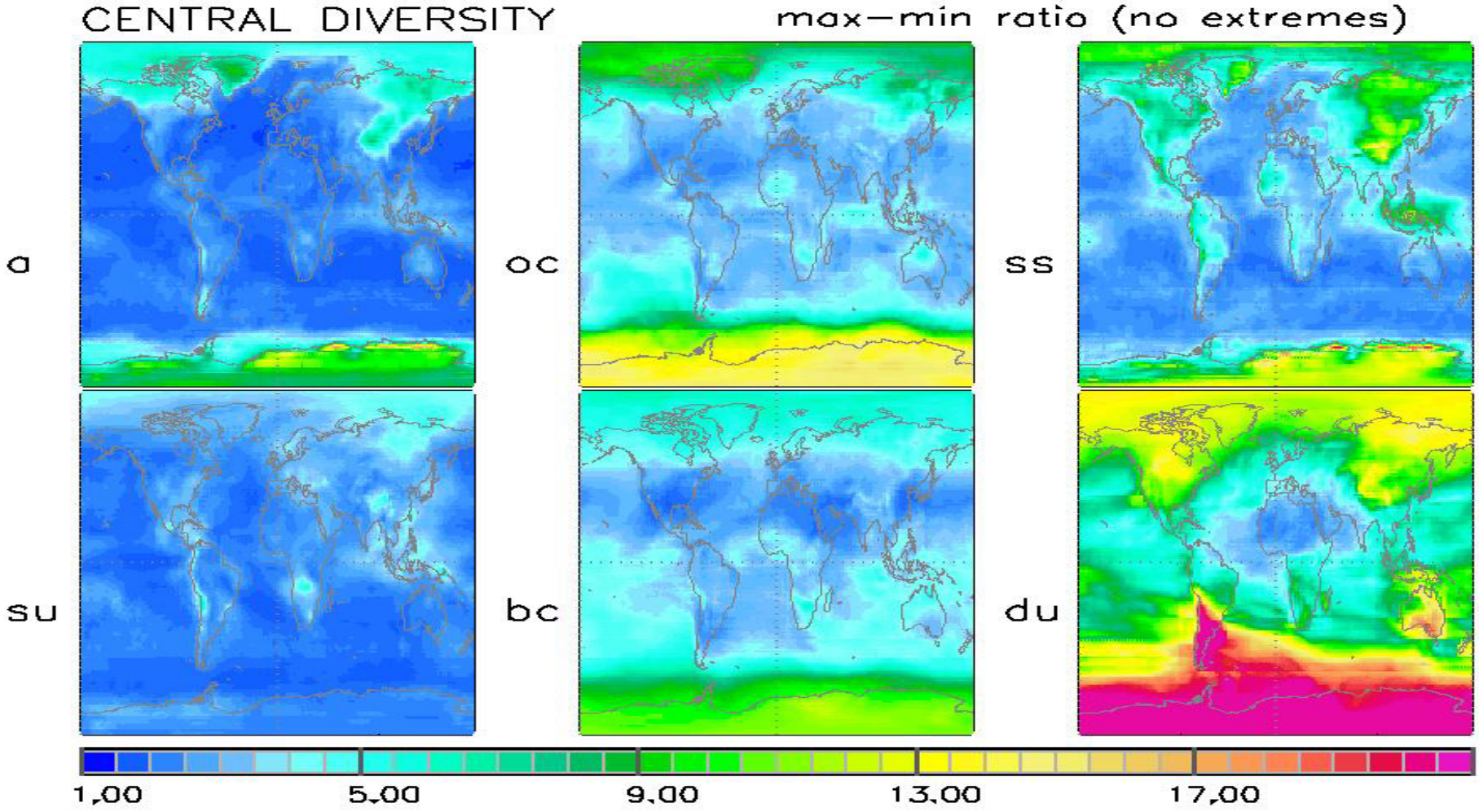
- Model / (satellite- /) AERONET composites at 550nm
- AERONET Angstrom relationships
  - the asymmetry-factor, in the **UV**, **VIS**, **n-IR**
  - the aot **fraction f** in accu-mode [f=.19+.687*ln(An+1)]



climatology … but

- model adjustments (with good data)
  - a quick fix
  - not satisfying from a modeling perspective
    - proper representation
    - including all relevant processes
    - … etc
- questions to be answered:
  - how to explain (regional / seasonal) differences to data ?
  - how to explain (regional / seasonal) model diversity?
    - how to explain that diversity is larger at all sub-steps?
      - example: total aot vs component aot

aot – *uncertainty in modeling*



- (total) aot diversity < aot sub-component diversity WHY?

AeroCom *- an initiative of MPI and LSCE*

- validate against quality data!
  - surface concentrations (IMPROVE, EMEP, GAW, …)
  - surface remote sensing (AERONET, EARLINET, …)
  - remote sensing from space (MODIS, MISR, …)
- 15+ groups participate so far
  - A: 'best as you can' – simulation
  - B: year 2000 with prescribed emissions
  - C: year 2000 with pre-industrial emissions
    - B-C: addresses anthropogenic 'forcing'
  - *INDI:sensitivity studies for indirect effect simulations*

http://nansen.ipsl.jussieu.fr/AEROCOM