AOT

aerosol optical thickness

(… or aerosol optical depth)

Overview

- available data
  - is there a superior aot data-set ?
  - AERONET for global modeling ? (scale issues)
- simulations
  - what is takes to simulate aot in global modeling
- comparisons
  - global and regional differences

available satellite data-sets

Satellite	***Advantage***	**Disadvantage**
AVHRR	***historic record***	**calibration, not over land**
TOMS	***historic record***	**large (50km) pixel**
		height or abs. assumed
MODIS	***small pixel***	**failure over deserts**
MISR	***altitude info***	**temporally sparse**
POLDER		**short record, over land:**
		less sens. to large sizes
SEAWIFS		**not over land, no IR ch.**
GOES/MSG	***high temporal***	**less detail with b-bands**

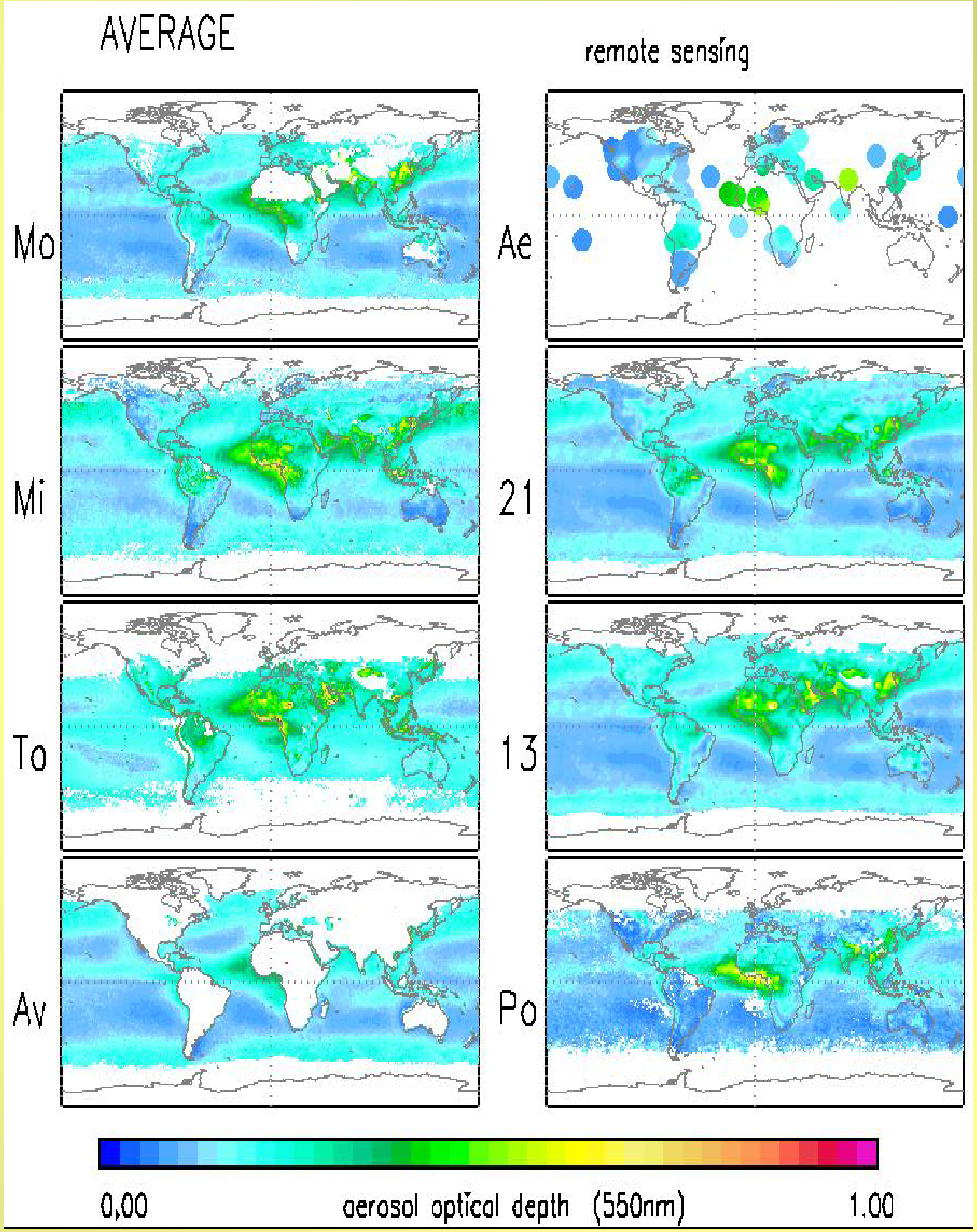
- **what data should be used?**
  - **can local quality data (e.g. AERONET) assist ?**

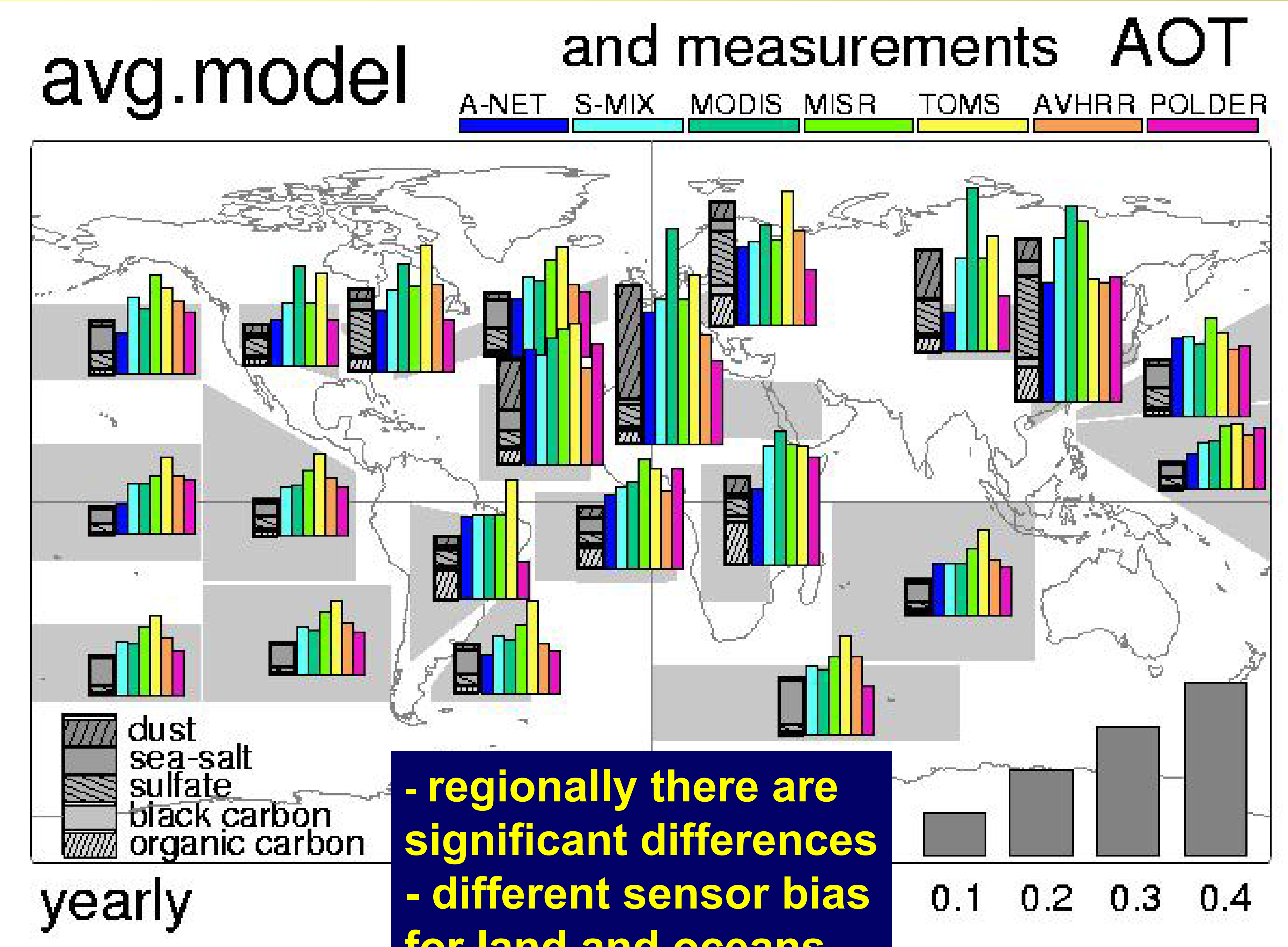
global fields

Mo: MODIS	**composites:**
Mi: MISR	**12:Mo,Mi**
To: TOMS	**13:Mo,To**
Av: AVHRR	
Po: POLDER	**Ae:Aeronet**

difficult to depict a best global retrieval ⇨composite needed

a MODIS *(ocean)* MISR *(land)* combination seems promising … …but differences to AERONET still exist

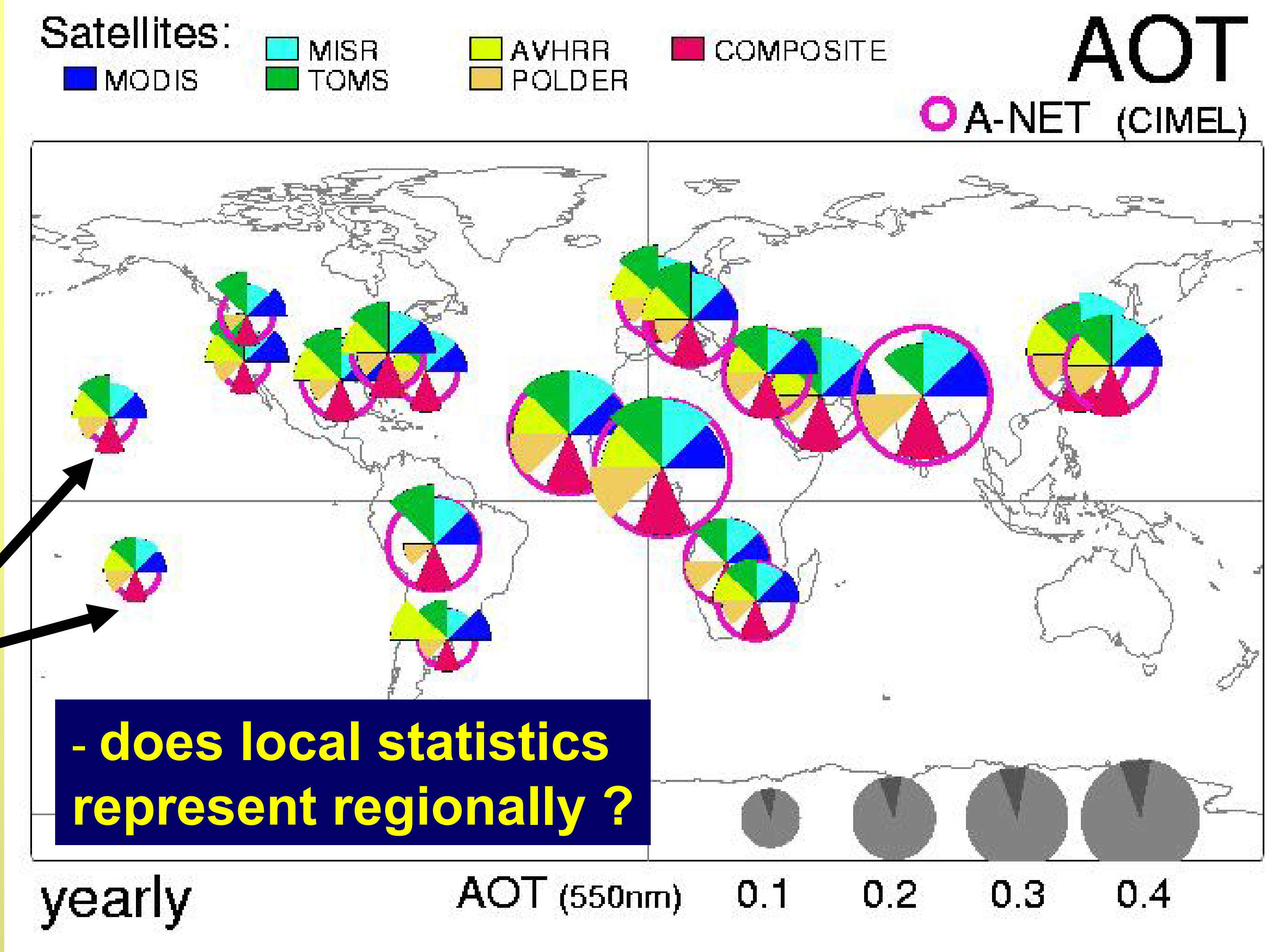




- regionally there are significant differences
- different sensor bias for land and oceans

interpolation of 1*1 degree satellite aot data-sets

… at AERONET sites

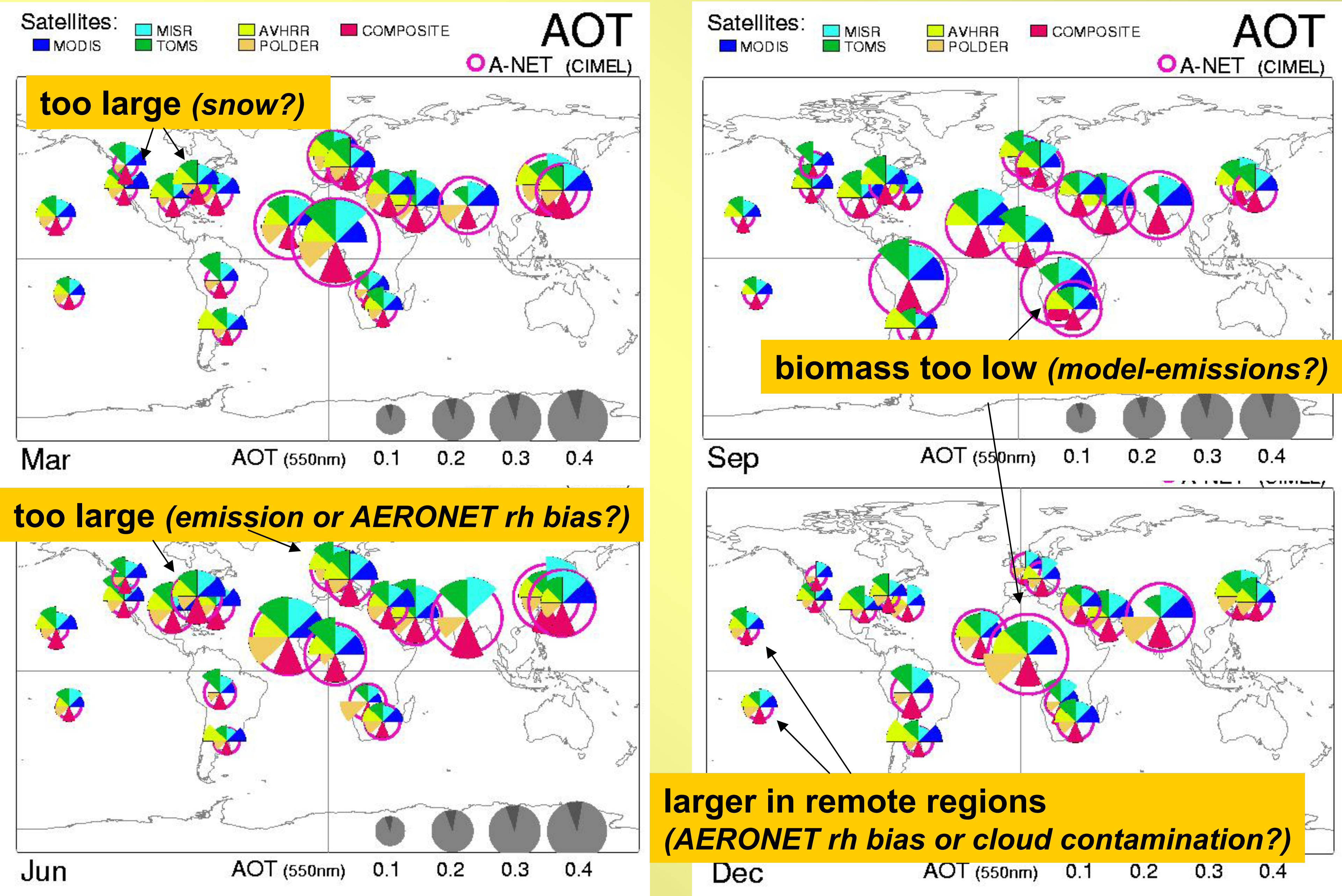


- does local statistics represent regionally ?

composite: MISR / MODIS

… still satellite data are generally larger than AERONET, particular in urban regions

seasonal comparisons at AERONET



first impressions

- **MODIS** best choice over the oceans … but too low in dust outflow regions *(high aot 'filtered as' clouds)*
- **MISR** most complete land cover … while biased high over oceans *(poor temporal sampling at ca 1/week)*
- **MODIS** *(ocean)* / **MISR** *(land)* **combination** the 'best' satellite product is generally larger than AERONET

  … but too low during the biomass burning season

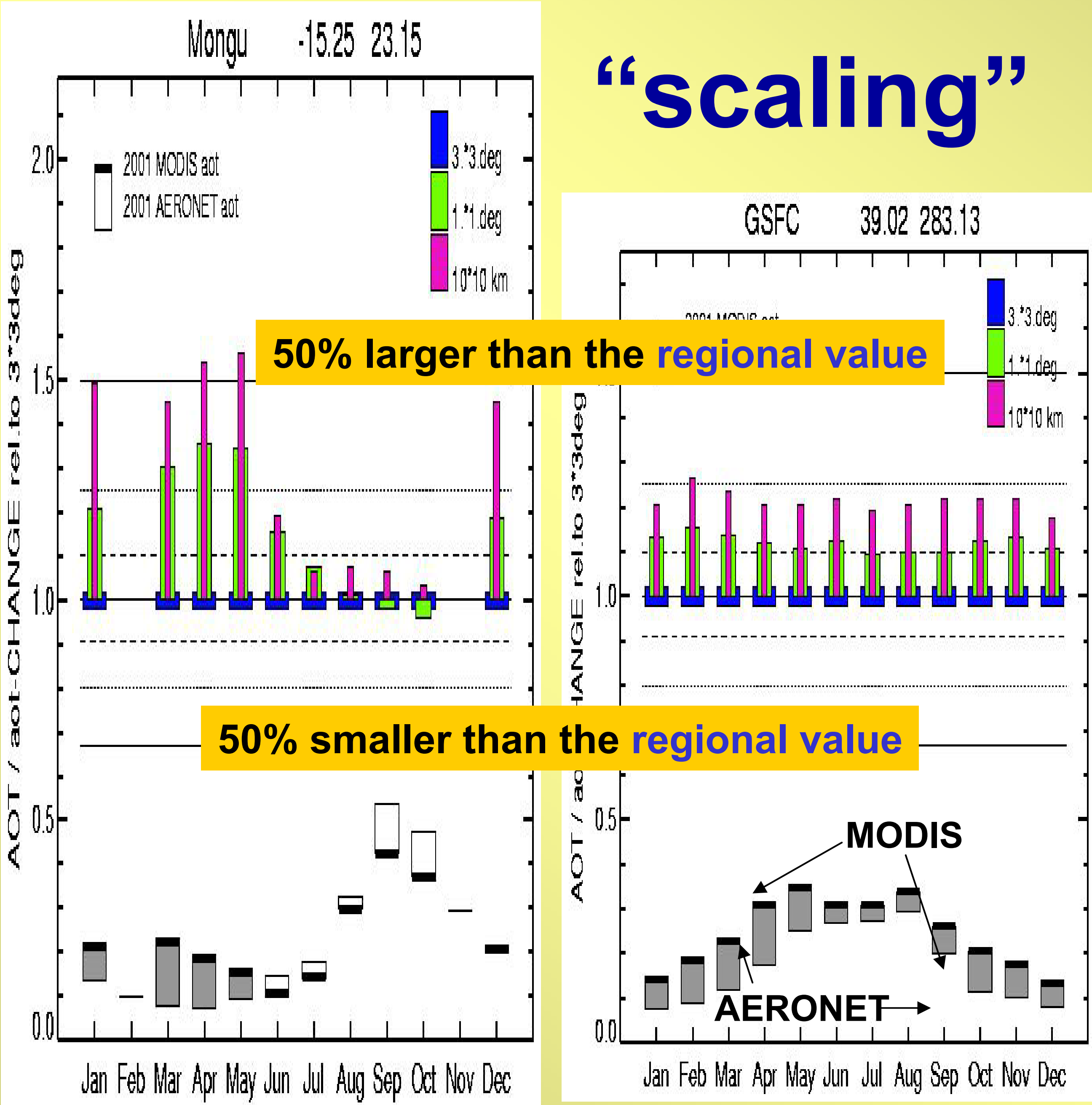
open issues:

- discrepancy to AERONET (A-NET clear-sky bias ?)
- quality of retrievals of low aots in remote regions
- is it 'fair' to compare point data with regional data?

test regional representation

- use spatial information of satellite data
  - to relate local measurement detail to
    - coarse gridded data-sets
    - coarse resolution data in global modeling
- how ?
  - compare averages for different scales
    - agreement … indicates a ‘useful’ site
    - bias: ‘useful’ site after a bias adjustment
    - highly variable (season/years) : leave off comparison … unless secondary data exist

"scaling"



- **Comparison of**
  - **300*300km data**
  - **100*100km data**
  - **10*10km data**
- ***GSFC (urban)***
  - **20% above the regional average**
- ***Mongu (biomass)***
  - **good match for the biomass season (Jul-Nov)**

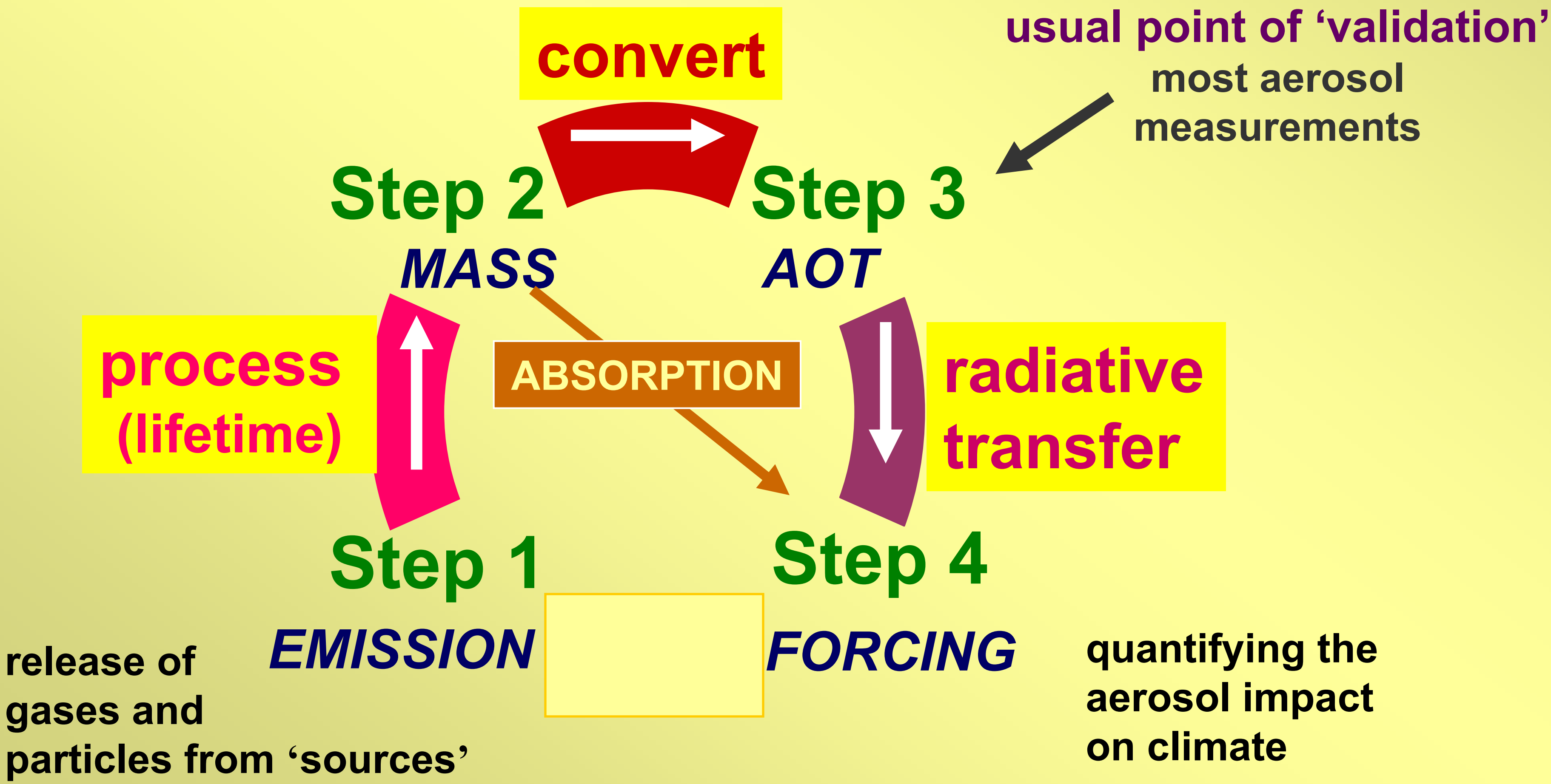
⇦ at the bottom are AERONET-MODIS comparisons (2001)
note: MODIS statis-tics are very poor!

needed scaling activities

- for different spatial domains a data-base of simultaneous satellite retrievals over AERONET sites is needed
- satellite requirements:
  - small (~1km) pixel retrievals at regional coverage
  - sufficient data (for seasonal /annual dependence)
  - coverage of all AERONET sites (incl. desert sites)

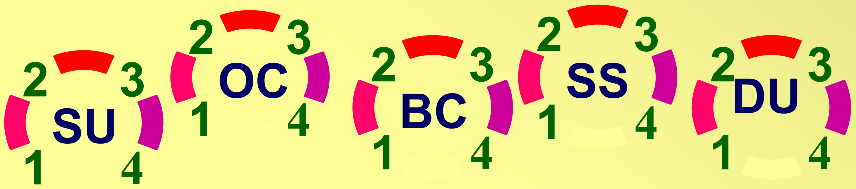
MODIS and MISR data are a start … although their smallest pixels size at 10.0 and 17.6 km is too large to represent 'truly' local characteristics

aerosol (in global) modeling
a 4 Step process



Tuning opportunities !

- **better aerosol modules in all major climate models distinguish SU, SS, DU, OC, BC**
  - **many processes and assumptions (⇨ new errors ?)**

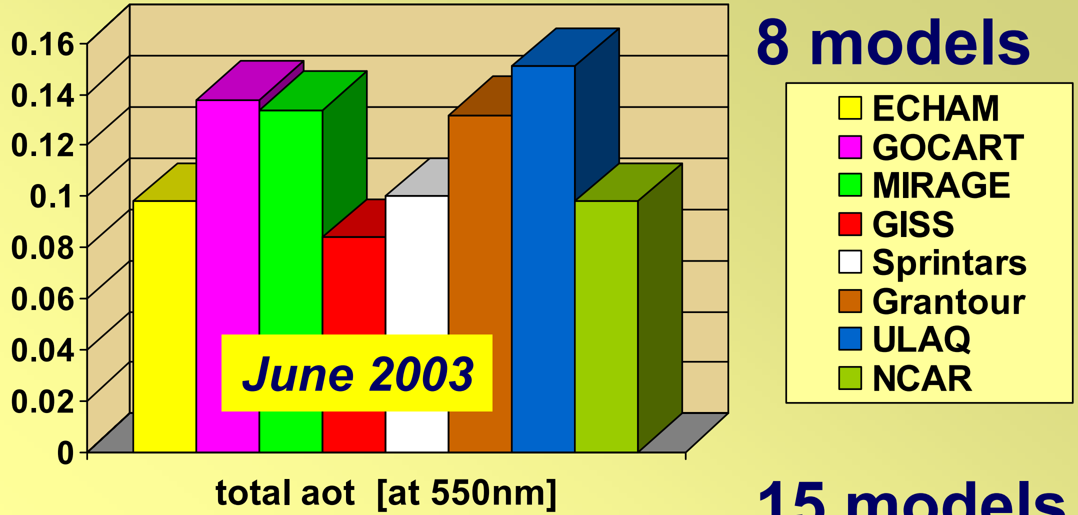


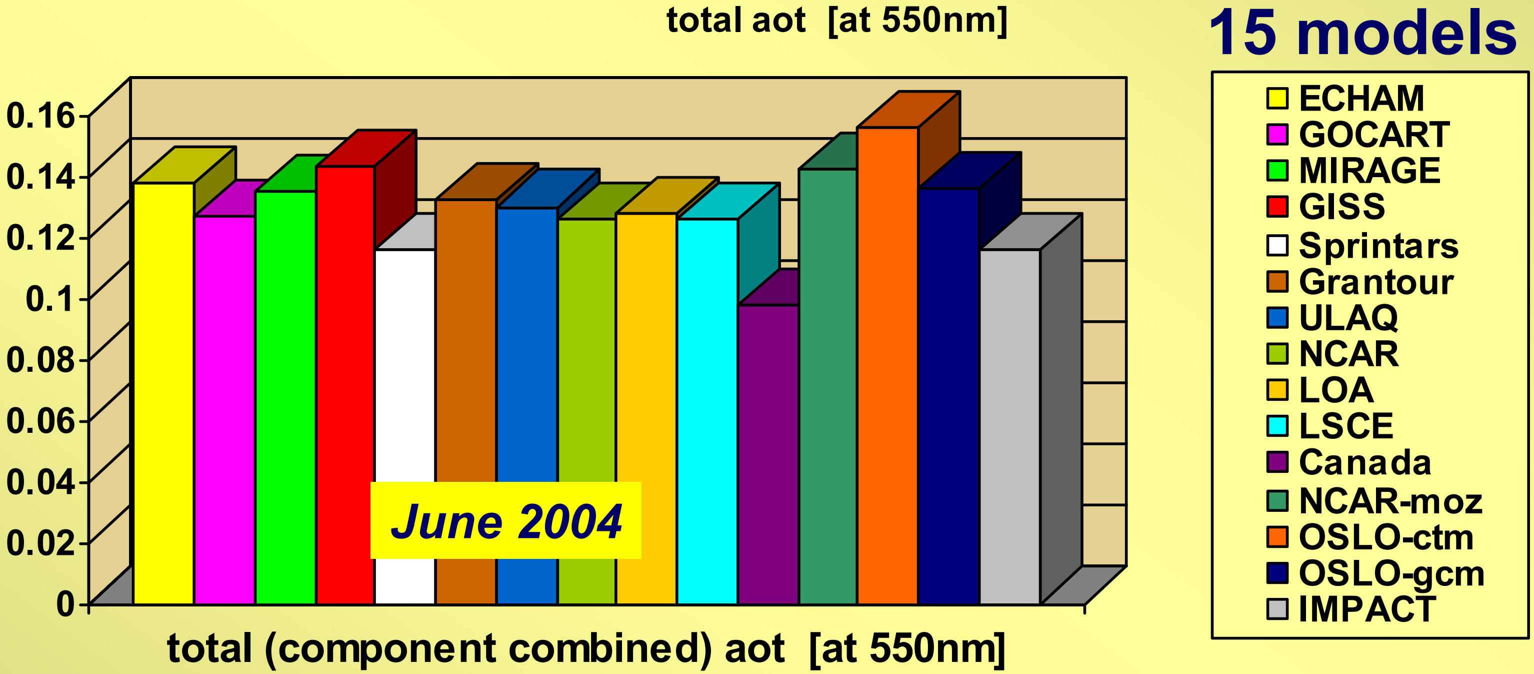
su-sulfate, ss-seasalt, du-dust, oc-org.carb, bc-soot

  - **one bad error is sufficent to destroy a good effort**

- **there are always way to ‘adjust’ to the globally (annual) averaged aot of satellites**

AOT
annual global average

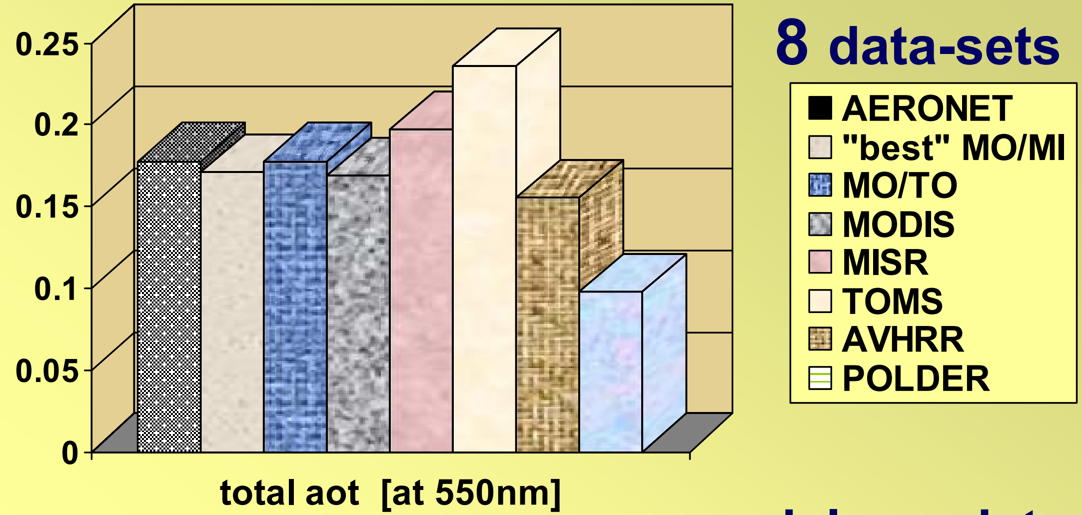


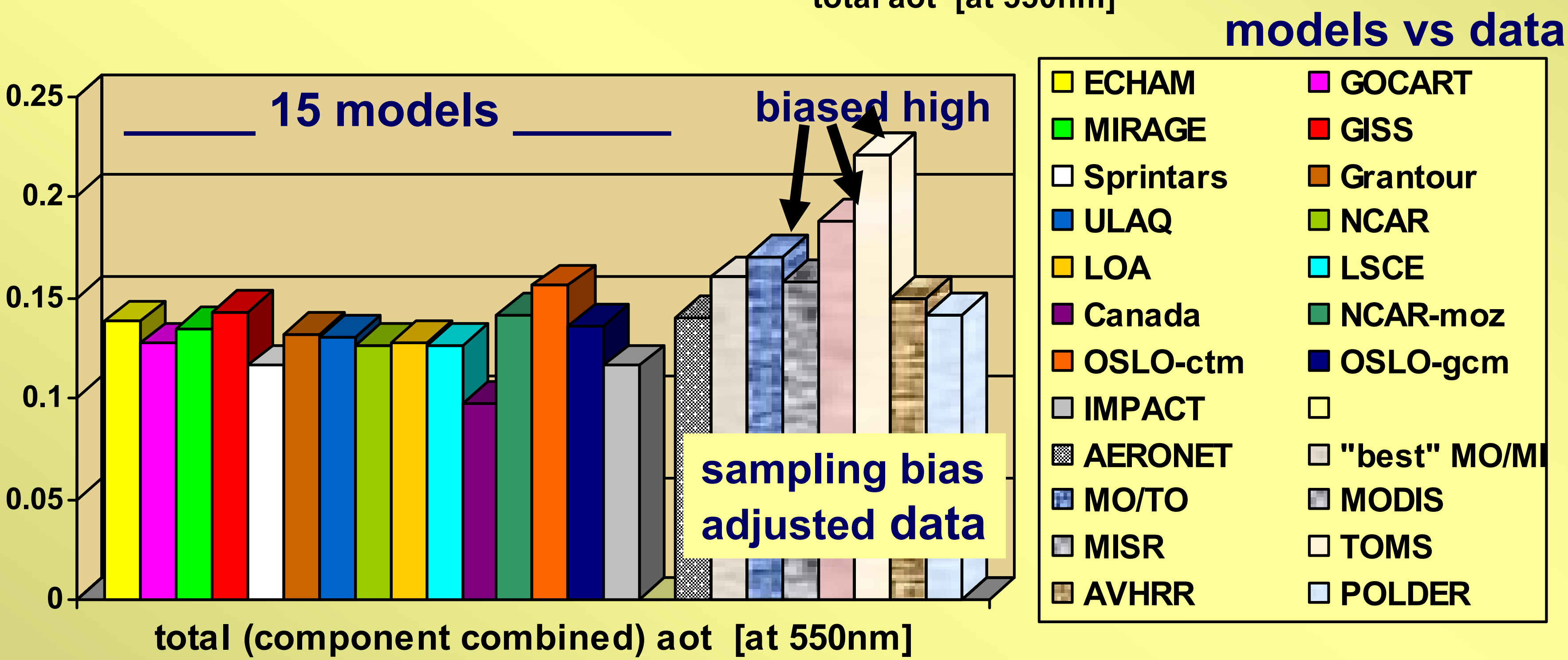


since the last year: more component models have appeared
models seem to converge towards one annual global average

AOT

annual global average





this agreement is encouraging – are we making progress?

quantify global uncertainty

- max/min factors of 15 *(* 13 'no extremes')* models with aerosol component modules
- different min/max factors for aot and mass demonstrate MEE-differences
- these are still global annual averages!

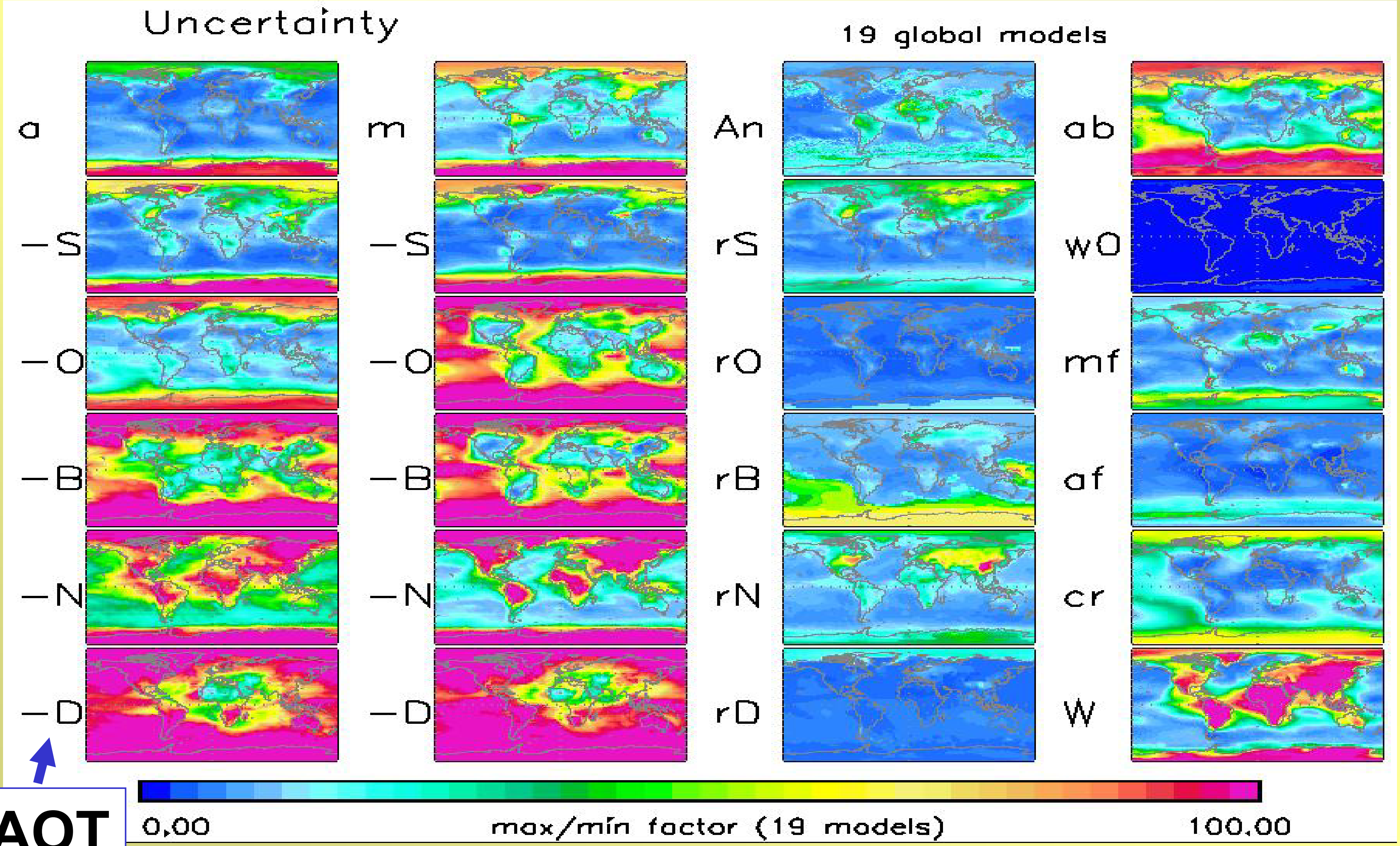
	mass max/min	mass* max/min	aot max/min	aot * max/min
SU	2.4	1.9	3.8	2.1
BC	3.3	2.1	11	3.2
OC	3.5	1.5	4.0	2.1
DU	14	5.5	8.8	4.1
SS	6.0	2.6	7.4	3.6
TO	2.6	1.9	2.6	1.9
ffrac*	3.0	2.1	2.3	1.5

** ffrac: fine mode (sizes >1μm) fraction*

dust and sea-salt are associated with largest disagreements
good agreement for OC surprises ("if uncertain, look what others do")

max/min
ratios
(19 models)

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	*aero water mass*	*-D*	*dust*		



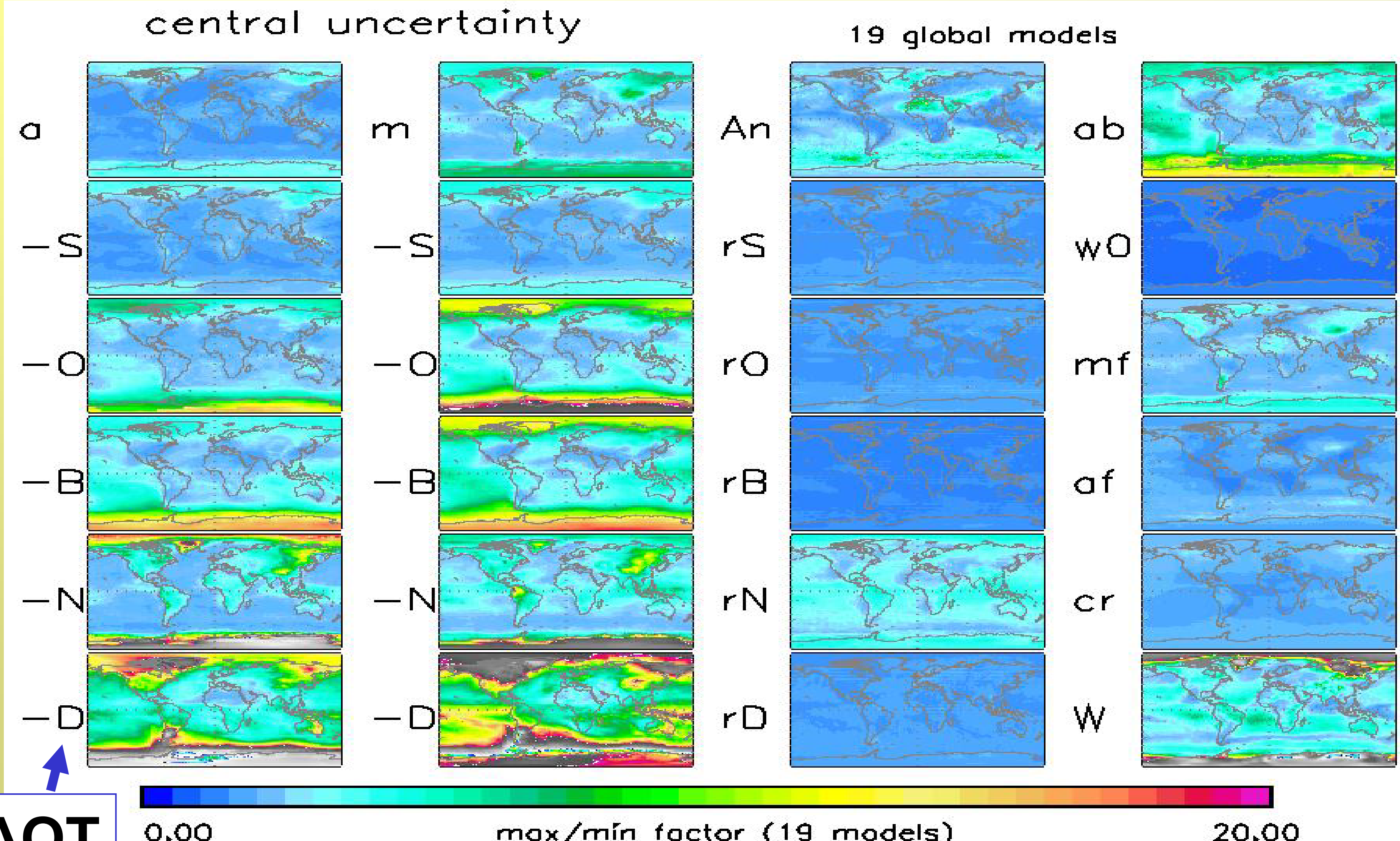
AOT

max/min

ratios

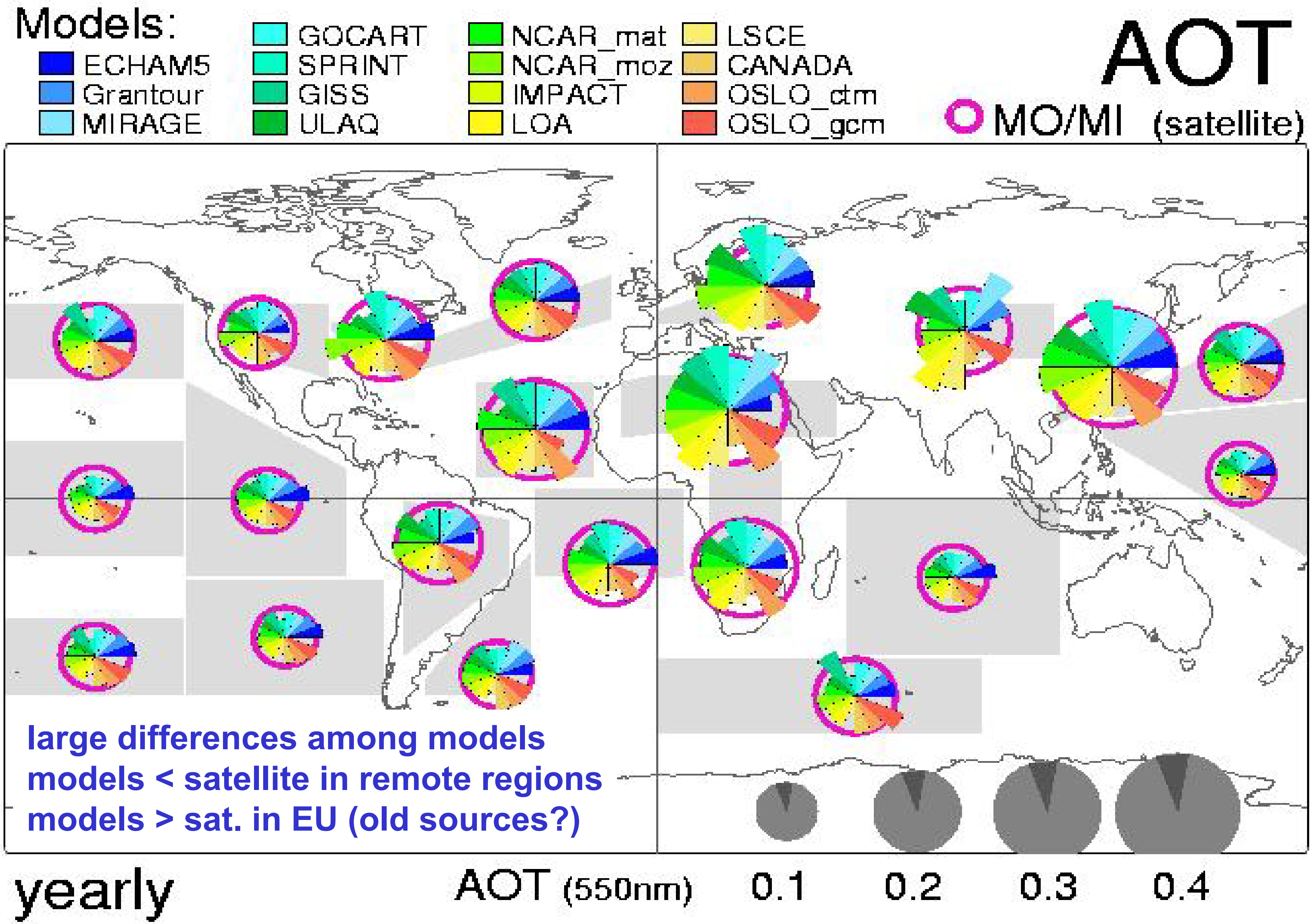
(10 central models)

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	*aero water mass*	*-D*	*dust*		

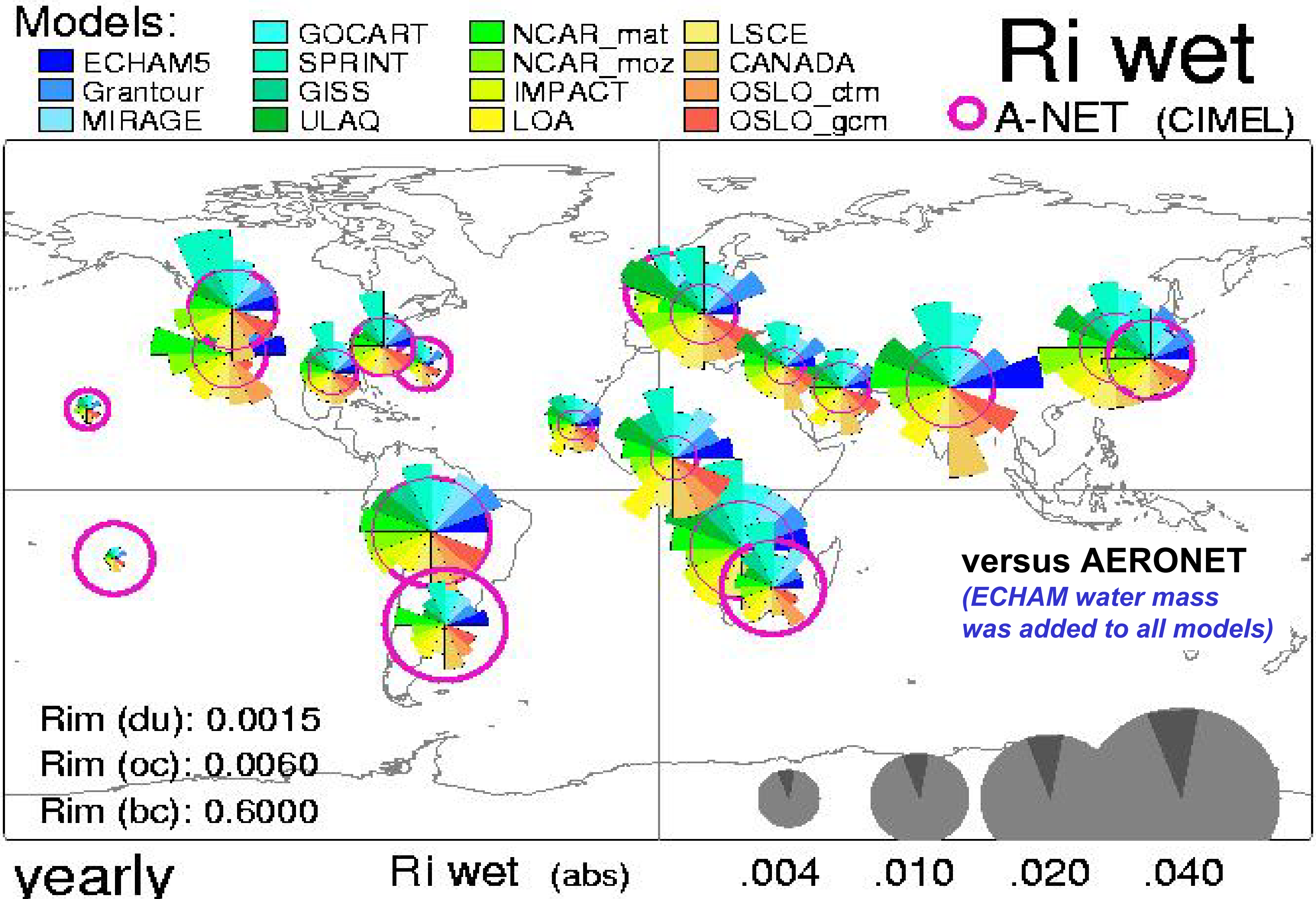


AOT

differences among models vary by region



compositional differences (absorption) are even larger



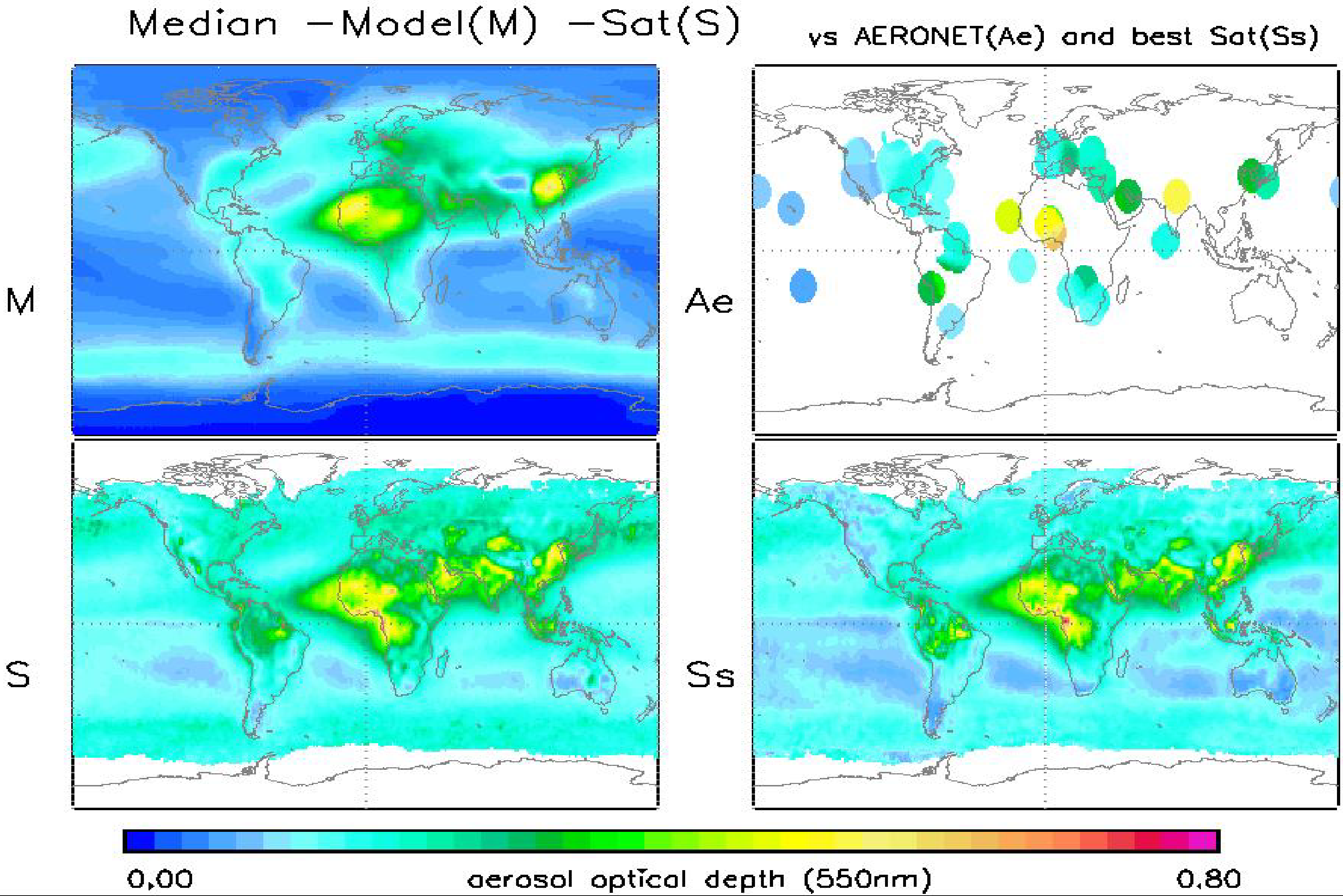
we have a modeling problem !

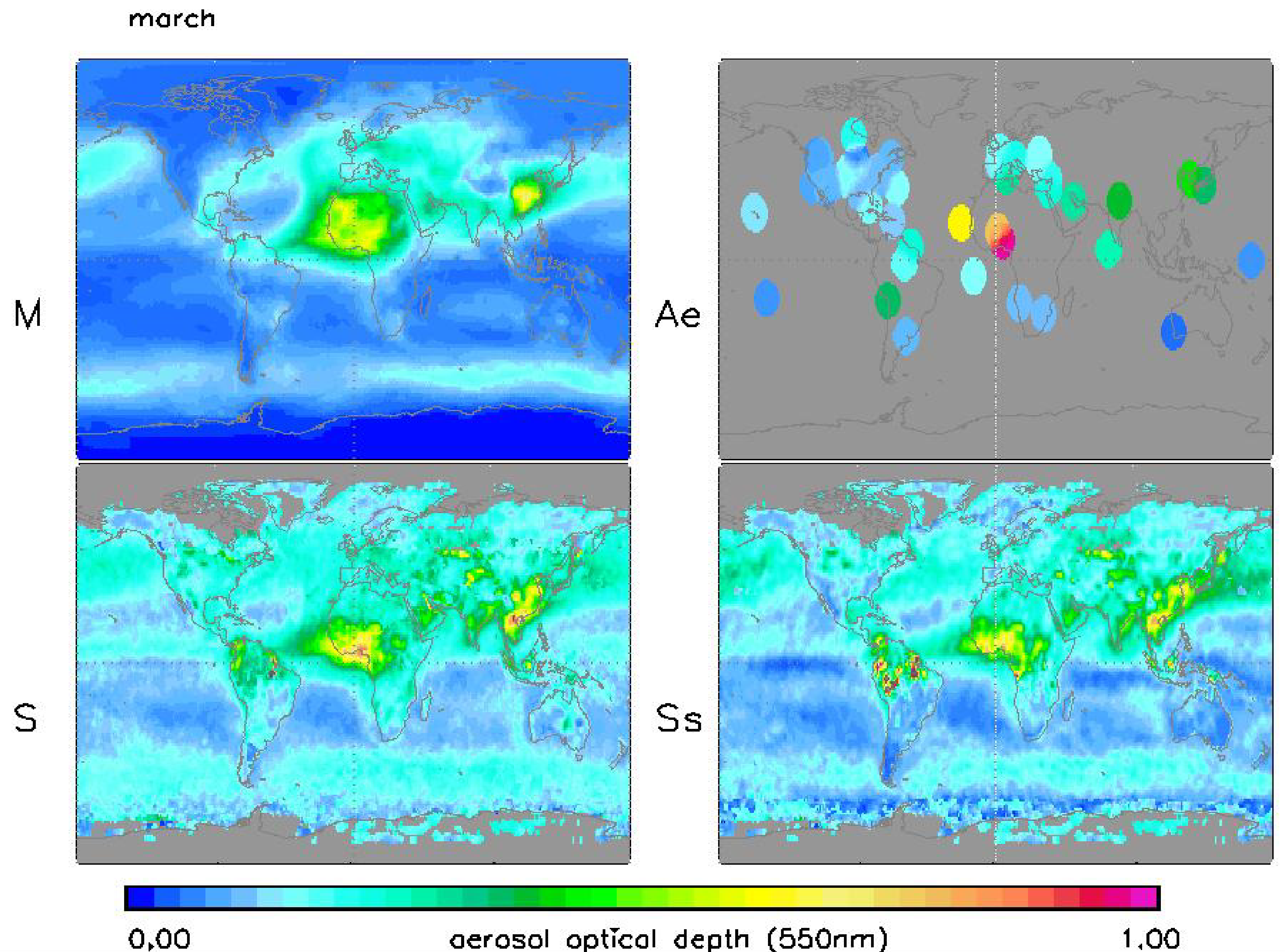
- **why these differences ?**
  - **input *(emission data, meteorology)***
  - **aerosol processing! *(clouds, chemistry, transport*)**
  - **assumptions *(size, water uptake)* … lack of data**

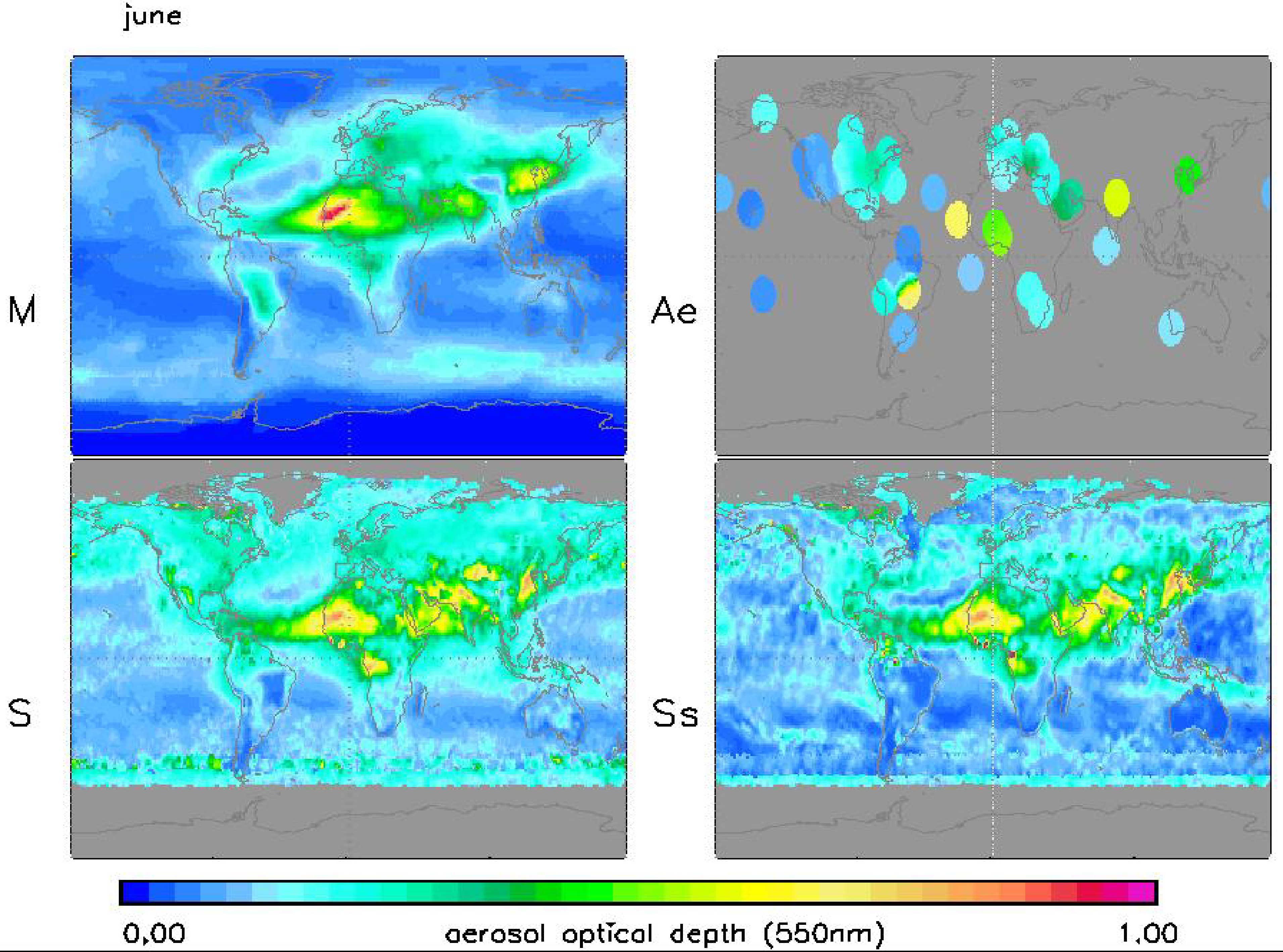
- **what to do?**
  - **acquire quality data *(determine data accuracy)***
  - **diagnose models *(comparisons to data)***
  - **assure comparability *(same input)***

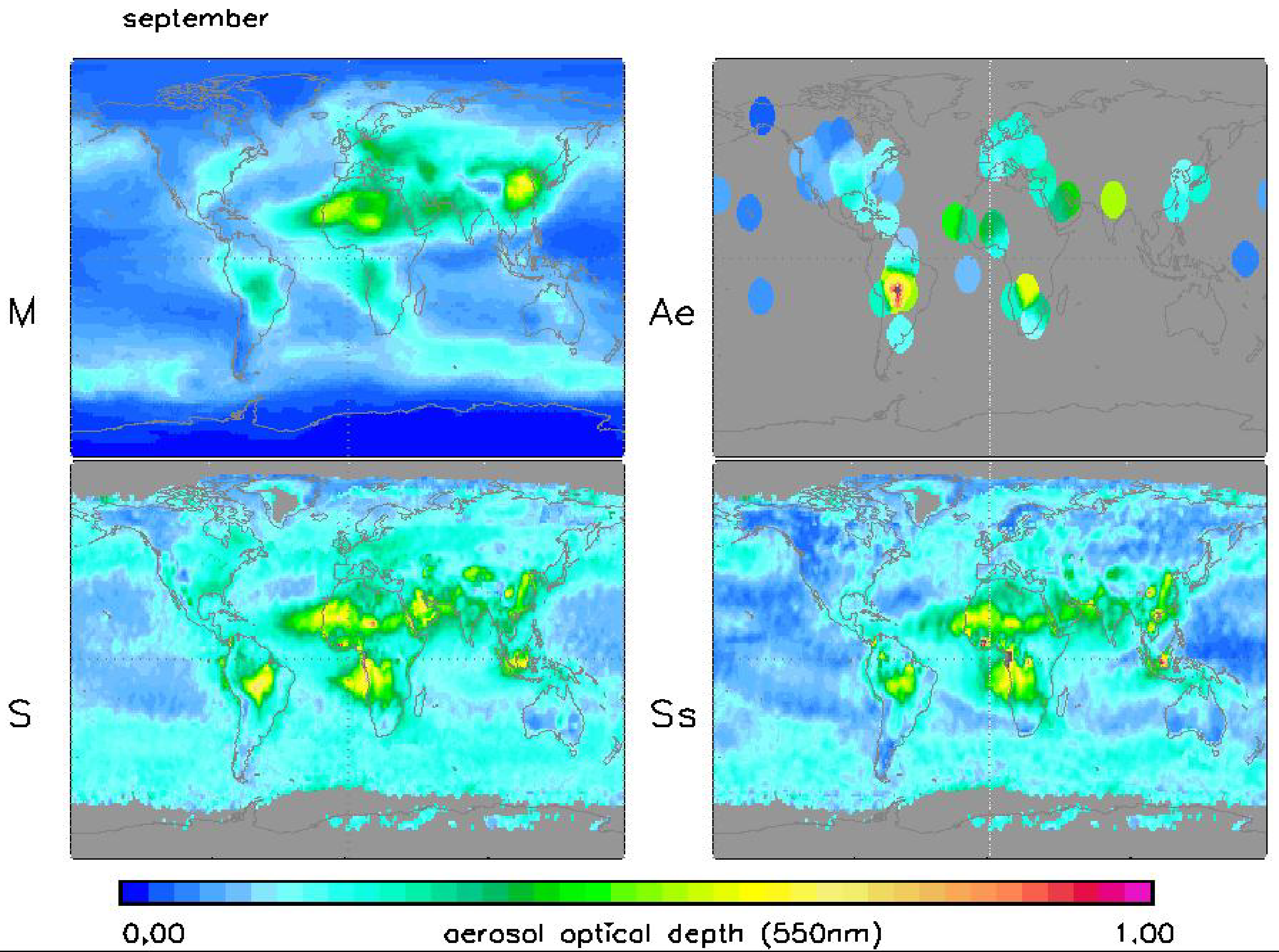
… finally **the "median" model**

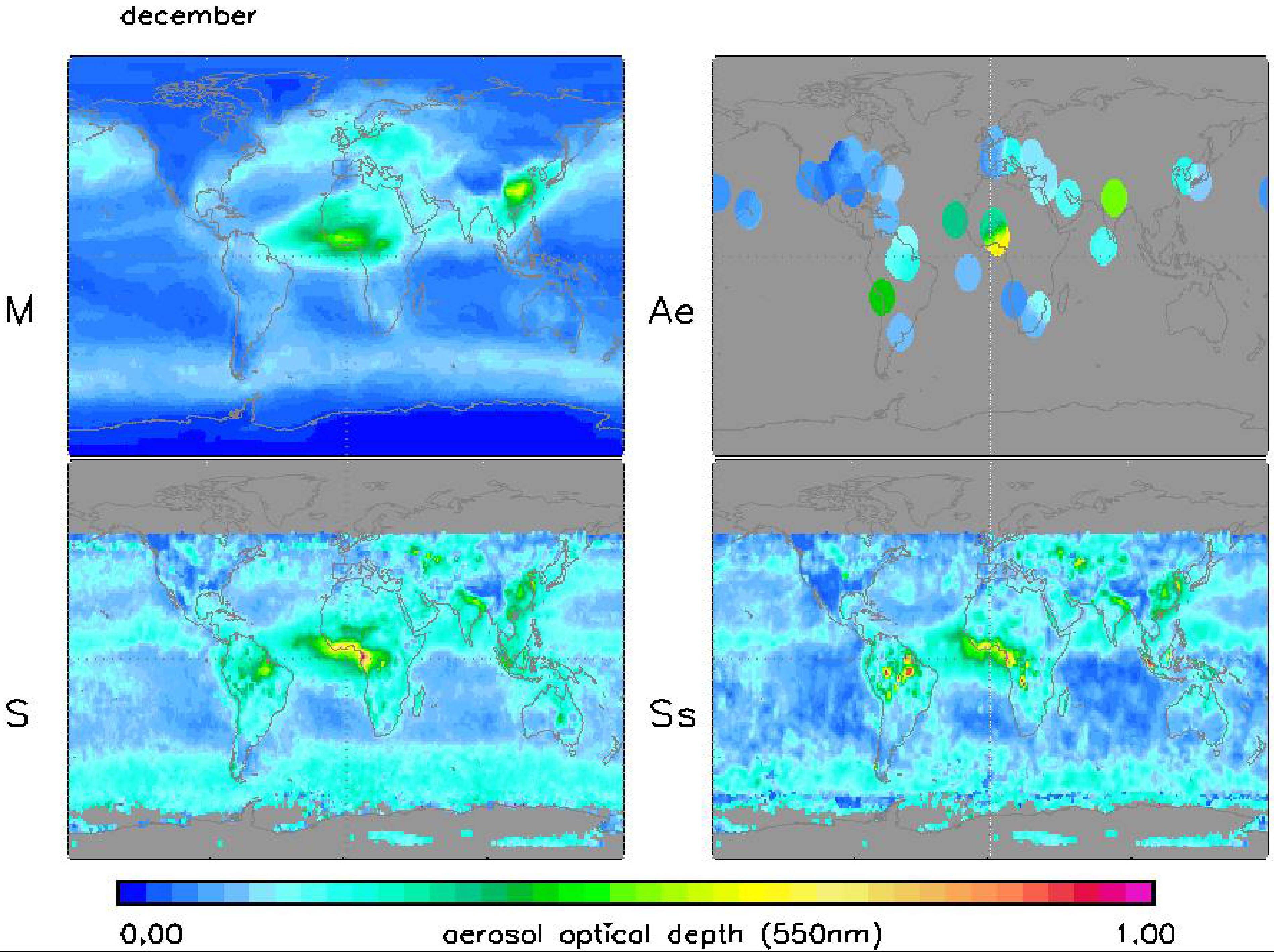
M – median model **Ss – best satellite data**
S – median satellite **Ae - AERONET**




march
M
Ae
S
Ss
0.00
aerosol optical depth (550nm)
1.00


june
M
Ae
S
Ss
0.00
aerosol optical depth (550nm)
1.00


september
M
Ae
S
Ss
0.00
aerosol optical depth (550nm)
1.00


december
M
Ae
S
Ss
0.00
aerosol optical depth (550nm)
1.00