Aerosol

a new climatology

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climatology – *why ?*

- if anyone asks: “ What are the typical properties for aerosol (amount, size and composition) at any specific geographic location and time ? ”

  do we have an answer ?

- if near real-time simulations rely on regular input on aerosol data, but expected sensor sources fail

  what aerosol data should we substitute ?

- we have **GADS** *(Koepke and Hess)* [5^{o}*5^{o} Jan,Jul]

  … but we should do better

data-source – *what to use ?*

- satellite retrievals ? **NO** or **not yet**
  - cannot determine all aerosol properties
  - those properties that are retrieved are of uncertain quality
  - sampling usually temporally too sparse for good statistics
  - regions of no data
- ground data / field exp.-statistics ? **NO** or **not yet**
  - lack in global coverage (a local sample)
  - even existing networks are spatially too sparse
- model data ? **Maybe**
  - model always provide a ‘complete’ answer
  - answer is only as good as model **(DANGER !)**

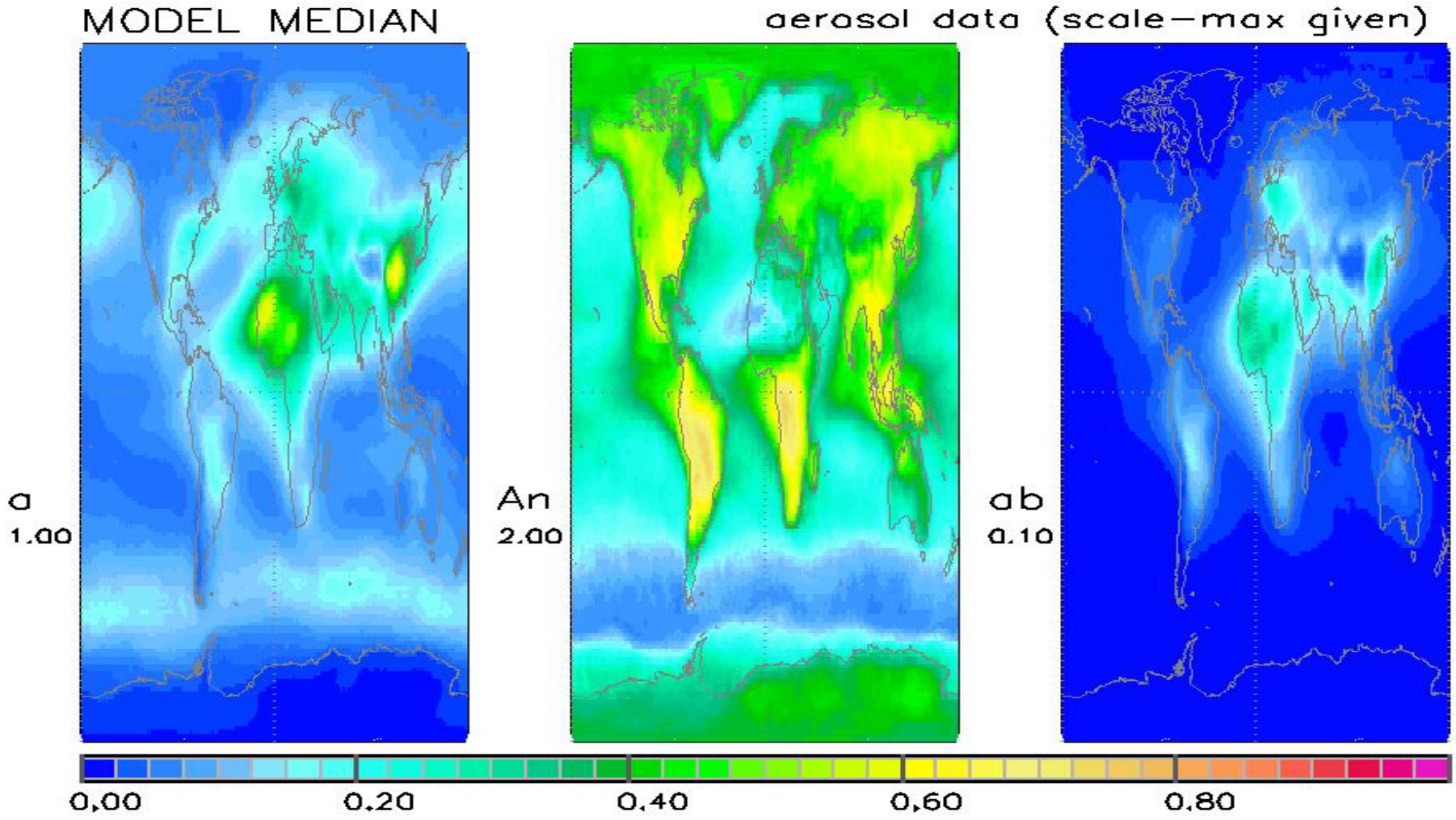
⇨ ***enhance modeling with quality ground data !***

aerosol – *what optical properties ?*

- aerosol is defined by — **rad.transfer needs**
  - **amount** — "number concentration" ⇨ extinction
  - **size** — "size-distribution" ⇨ asymmetry-factor
  - **absorption** — "refractive index" ⇨ single-scatter albedo
    - **spectral variation** … as function of wavelength
  - (shape) … we prefer them to be spherical

- measurement substitutes are
  - **(vis) aerosol optical thickness (aot)** — *for **amount***
  - **aot-spectral dep [Angstrom param]** — *for **size***
  - **Single Scattering albedo (ω_0)** — *for **absorption***

the start – *the AeroCom model median*



of simulated annual averages (for **a**ot, **An**gstrom, **ab**sorption) from 16 global models

how we do better – *AERONET !*

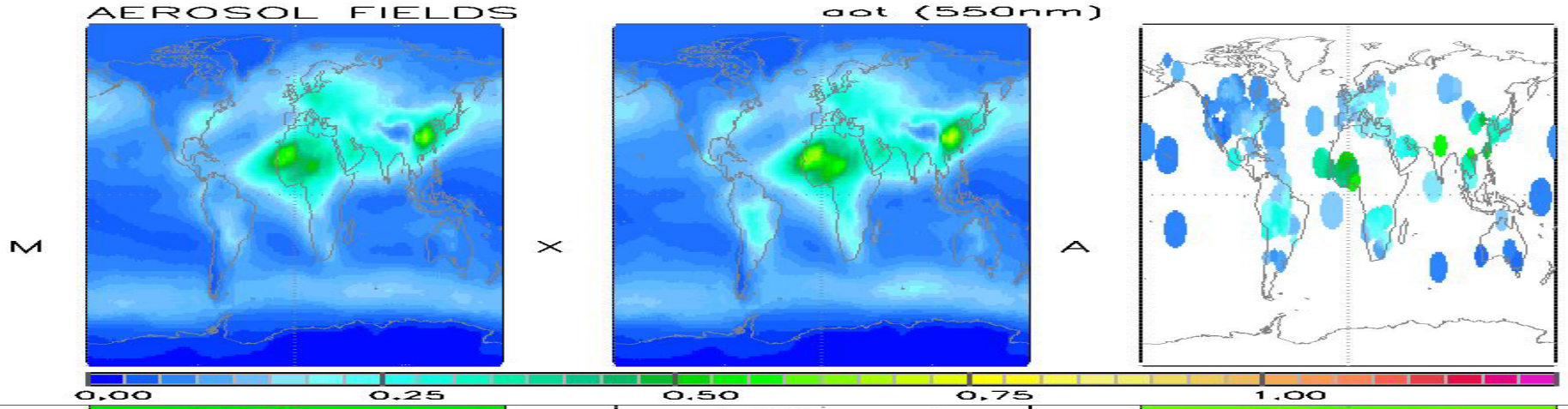
- tie ‘model freedom’ to quality data of AERONET
- AERONET sun/sky photometers **(300 + sites)** provide
  - **quality aot** (at different wavelengths)
  - **quality** (bi-modal) **size-distibutions**
  - **quality ss-albedo** (at high aot values)

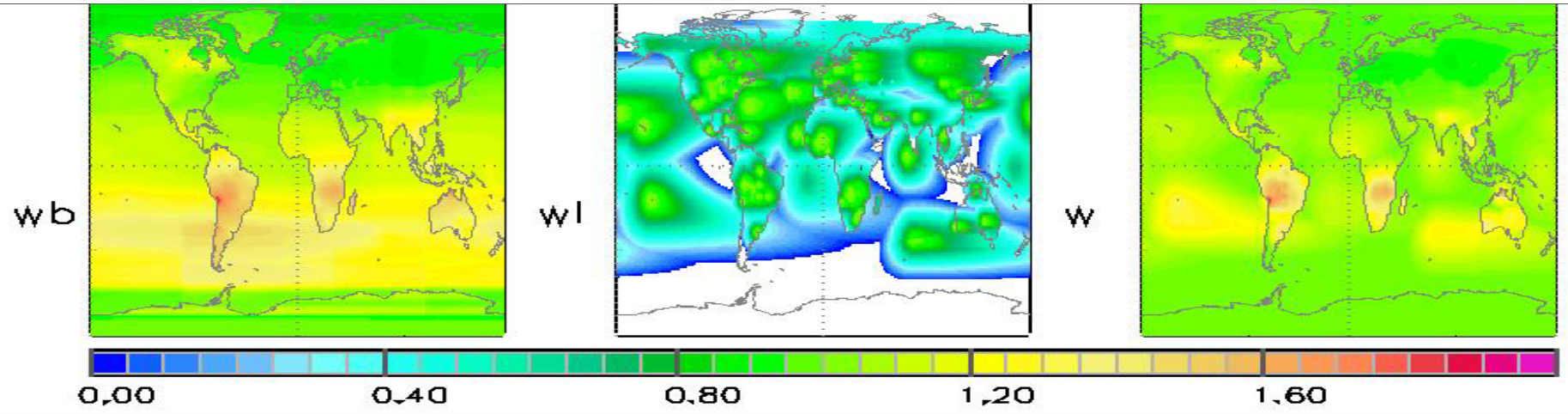
- merge monthly statistics into modeling
  - **1.** assign site ‘**quality**’ and ‘**range**’ score
  - **2.** use ‘**quality**’ to establish inverse distance global weight of site associated differences to model median ***(no weights from ocean sites are allowed to influence land data)***
  - **3.** use ‘**range**’, where linearly reduced weights away from site reaches zero ***(stretch range according to predominant wind, ocean ranges are extended but not allowed to make landfall***

aot

model median + AERONET

- Model – Mixture – AERONET

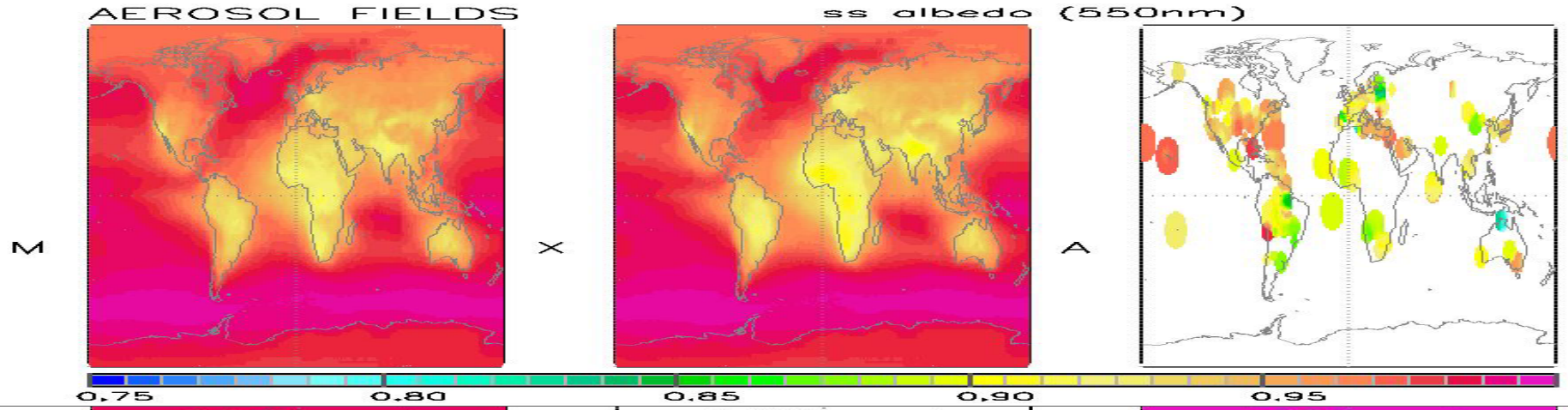


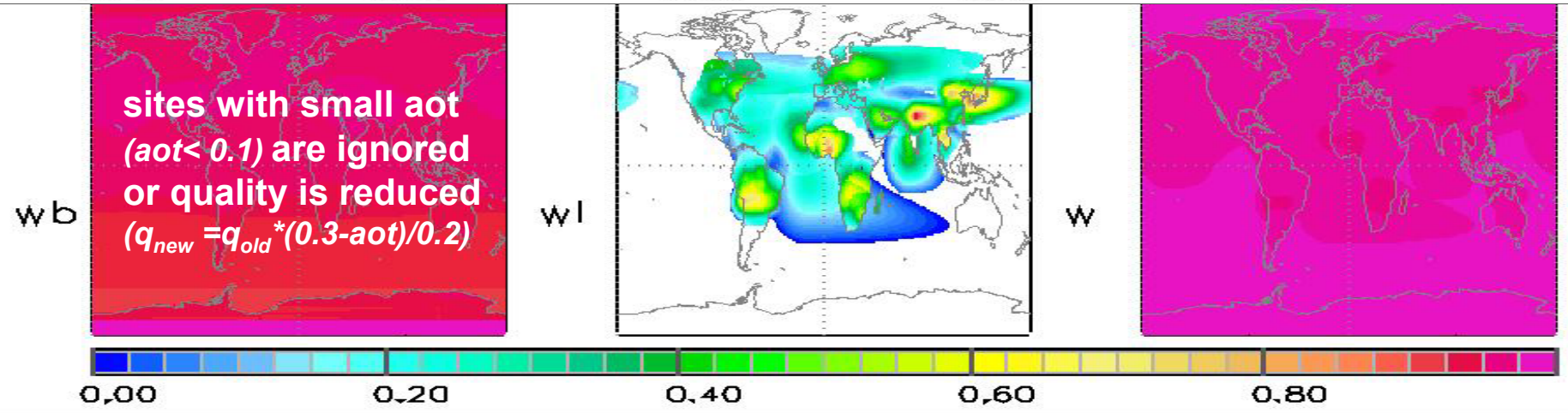


- backgr. weight - weight factor - total weight

ω_0 *model median + AERONET*

- Model – Mixture – AERONET

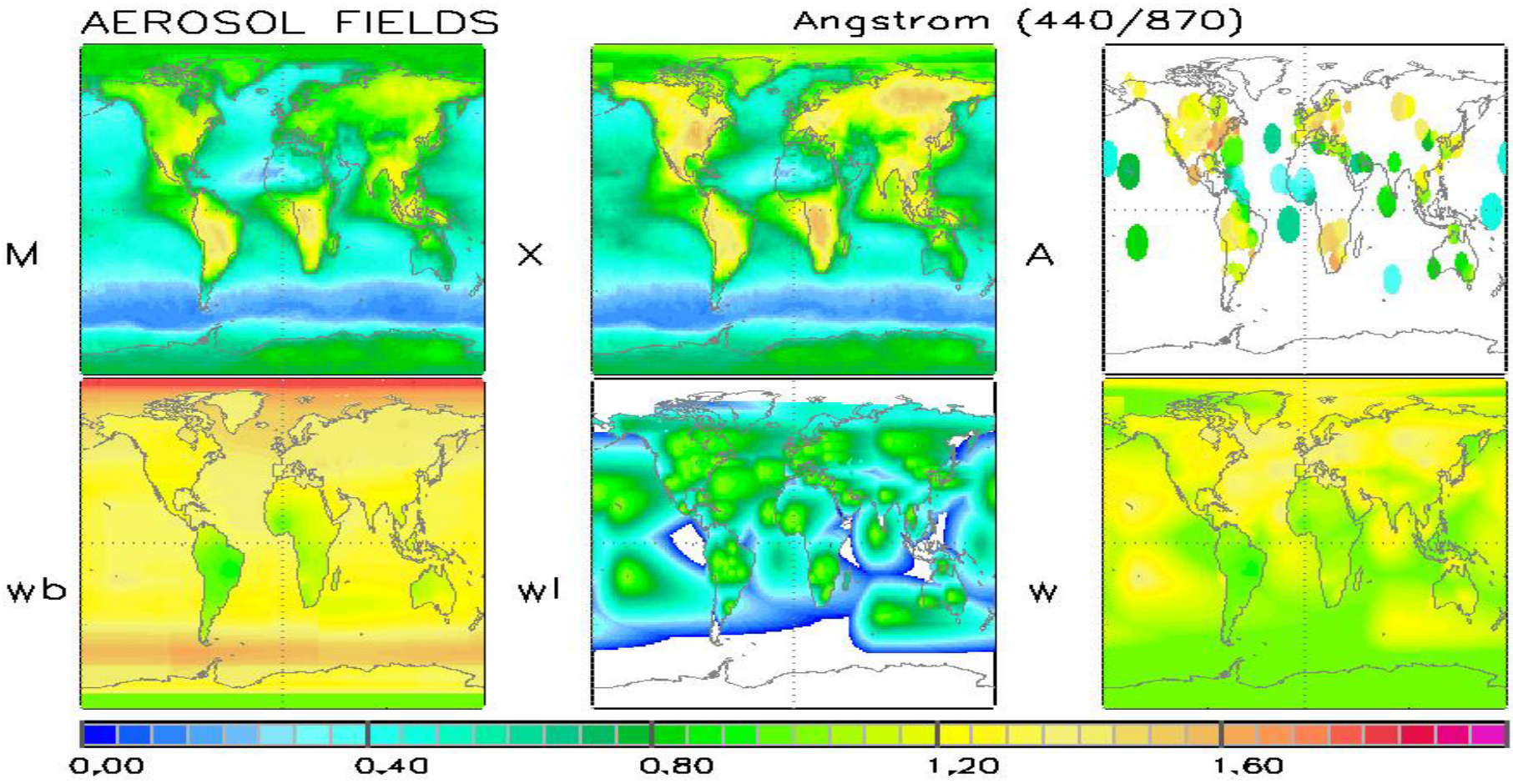




- backgr. weight - weight factor - total weight

Angstrom *model median + AERONET*

- Model – Mixture – AERONET



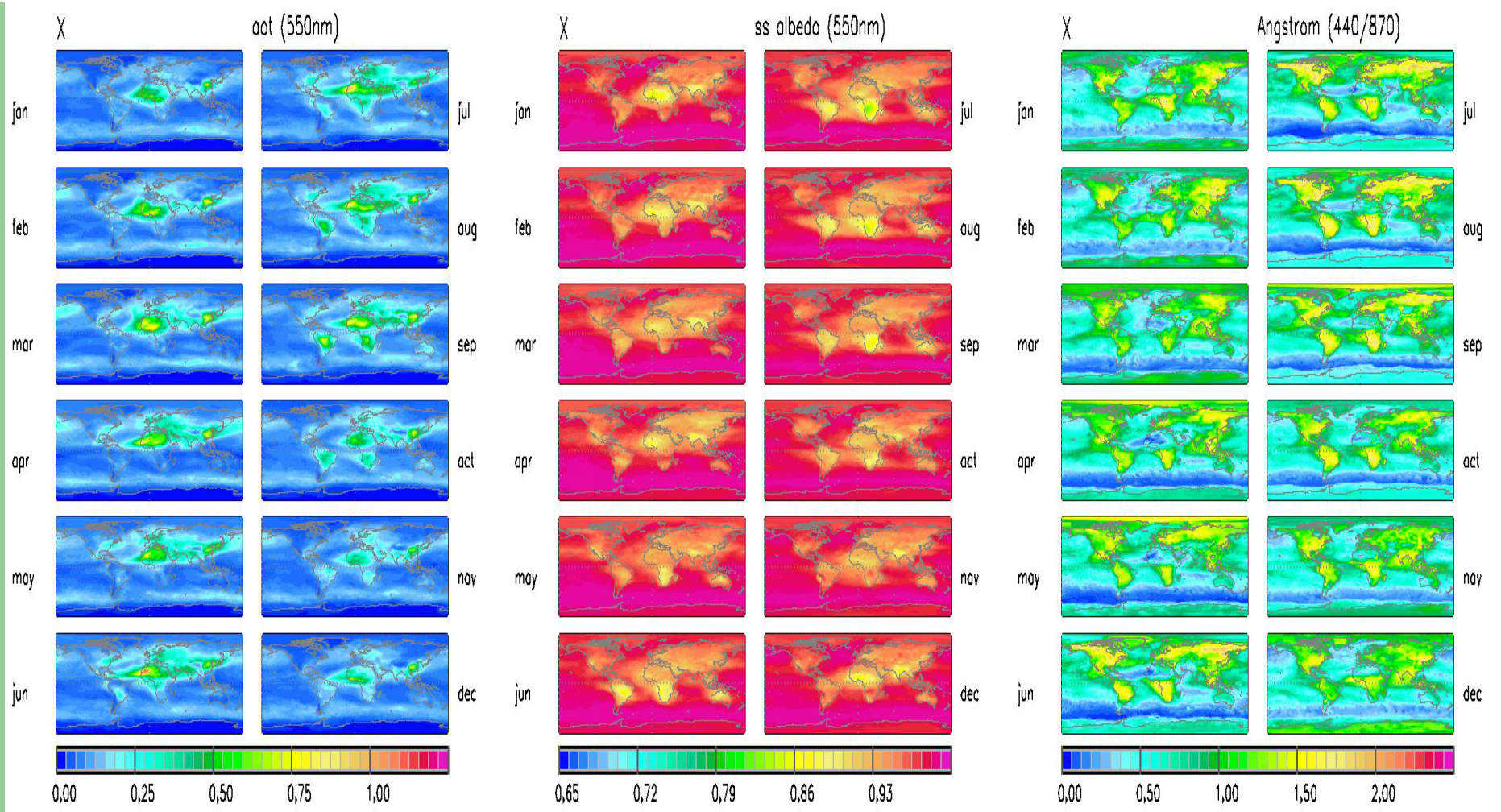
- backgr. weight - weight factor - total weight

weights – *a quick model diagnosis*

- **aot**
  - Sat-retrieval composite is too low over trop.biomass
  - Models are low over remote ocean and trop.biomass
  - Models have too much over Europe and central Asia
- ω_0
  - aerosol in Models lacks absorption
- **Angstrom**
  - modeled sizes are too large over Northern Hemisphere
  - modeled sizes are too small for trop. biomass

clues to rethink model assumptions → ***better products***

better – *but just at 550nm wavlength*



monthly climatology for **aot** ω_0 **Angstrom parameter**

broadband – *how it could be done*

needed : spectral dep. data for **aot**, ω_0 and **g**

- Angstrom establishes **aot** spectral dependence
- Angstrom / asymmetry-factor AERONET relation-ship establish solar spectral dependence for **g**
- ω_0 *(550nm)* is assumed for the entire solar region
- **g** and ω_0 for infrared assume dust composition

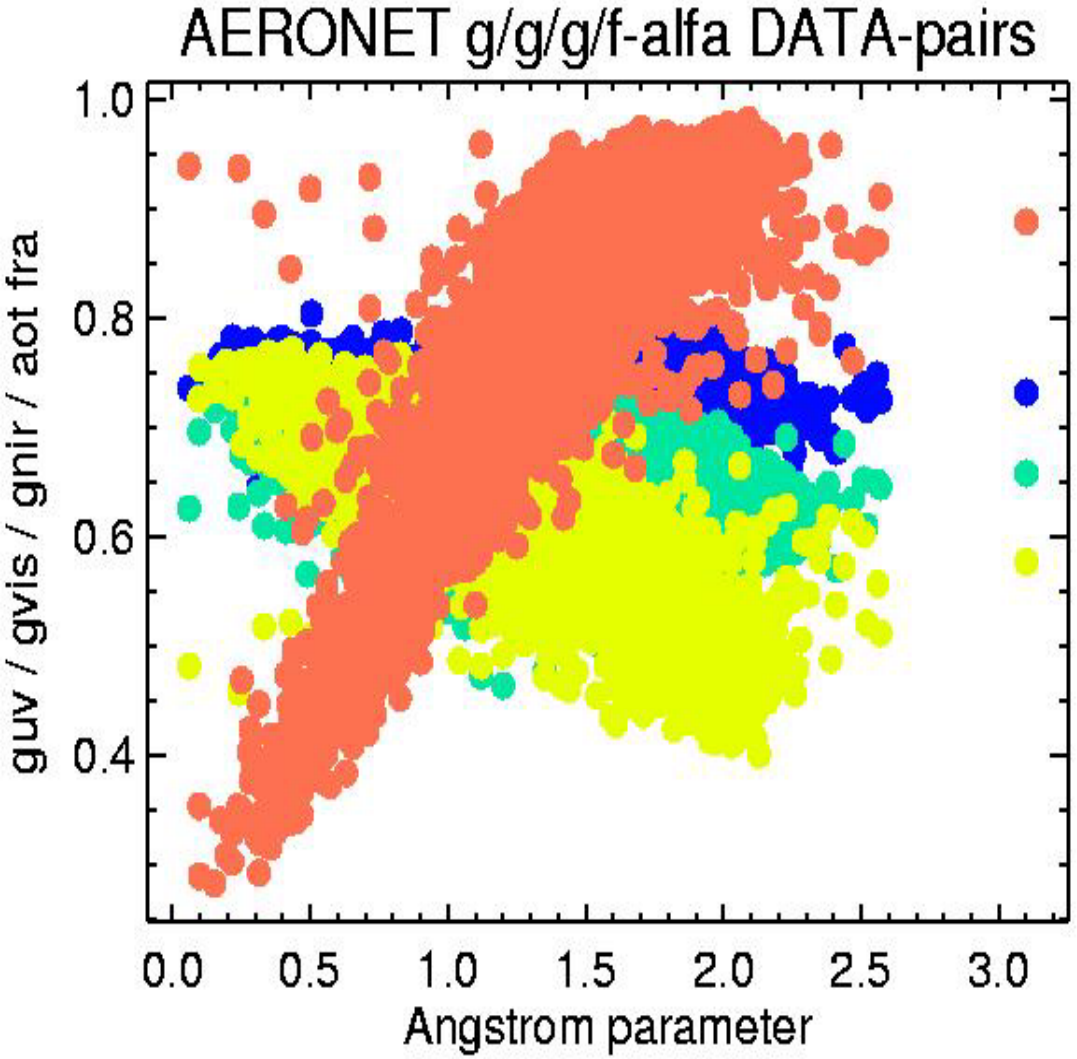
1. application: calculate aerosol direct radiative forcing

AERONET statistics – *5000 pairs*

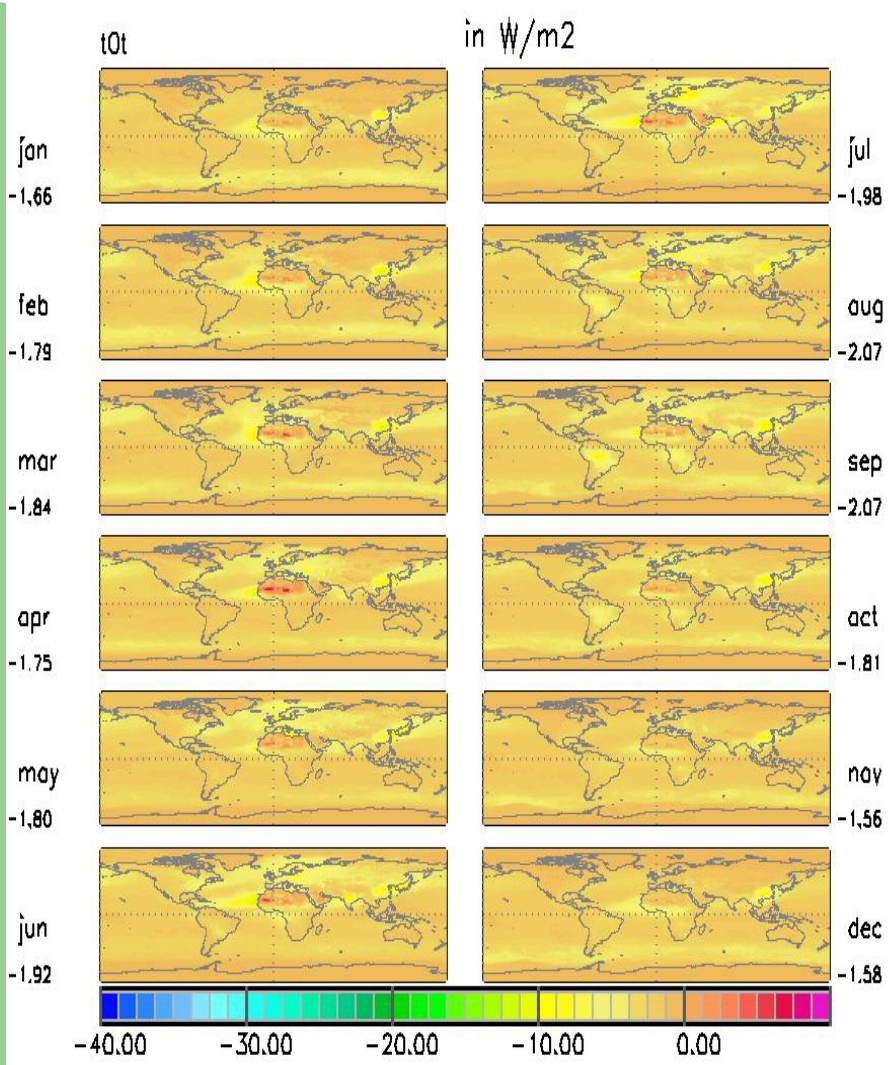
Angstrom relationships used:

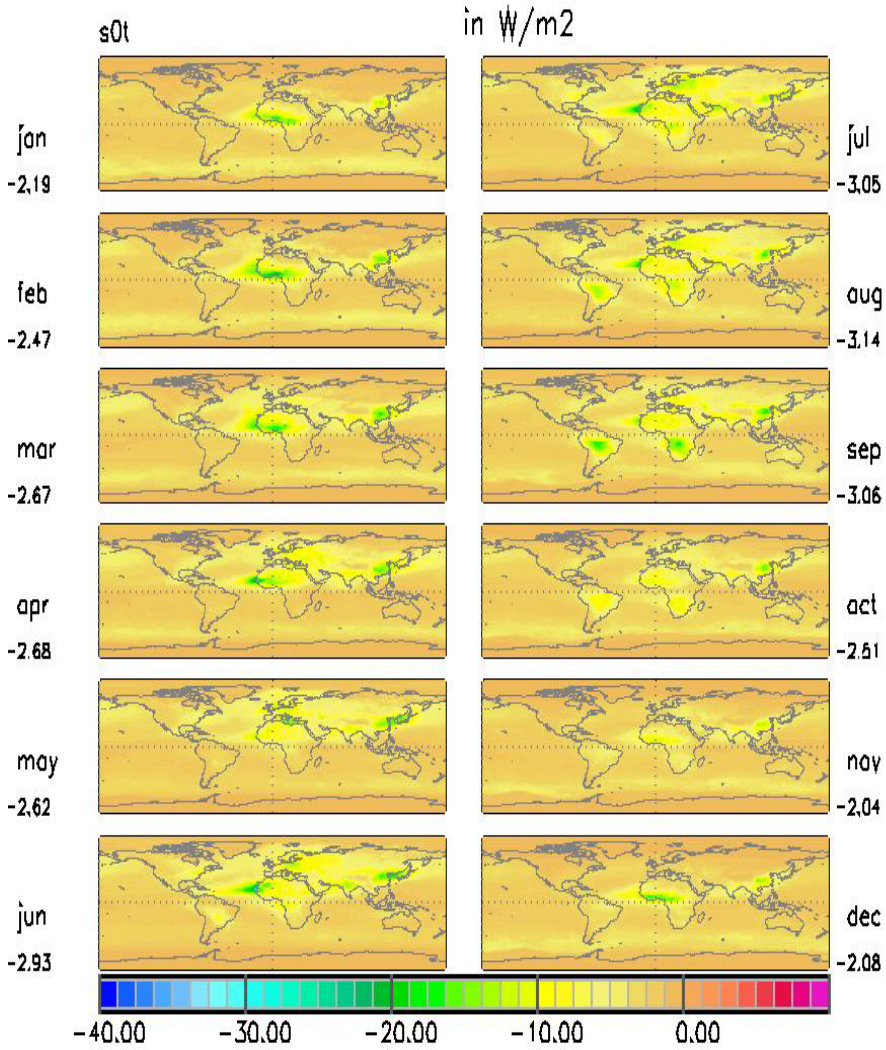
- vs asymmetry-factor in the **UV**, **VIS**, **n-IR**
- vs aot **fraction f** in accu. size-mode

  [f=.19+.687*ln(An+1)]



the first application - *forcing*





extras

climatology - aot / ω_0 / Angstrom