cloud-aerosol correlations

clues to interactions between aerosol and clouds ?

interpretations? be aware !

- **how accurate are the data (a bias?)**

  (although only trends are investigated … accuracy matters)

  – ***examples for MODIS retrievals***

  - **aerosol - aot: too large over land, too low for dust**
  - **clouds - eff. radius: too large for broken clouds**

- **cause or response ?**

  while exploring the effect of aerosol on clouds there are also effects of clouds on aerosol:

  - **aerosol removal** — **weaker aerosol signal**
  - **aerosol swelling** — **stronger aerosol signal**
  - **aerosol redistribution** — **stronger? aerosol signal**

2 way- correlations

A. pick a pair of co-located data-sets

B. rank data of the reference property

C. determine data averages of the reference property falling into the 5-30% and 70-95% PDF ranges

C. determine range associated data averages of the second property

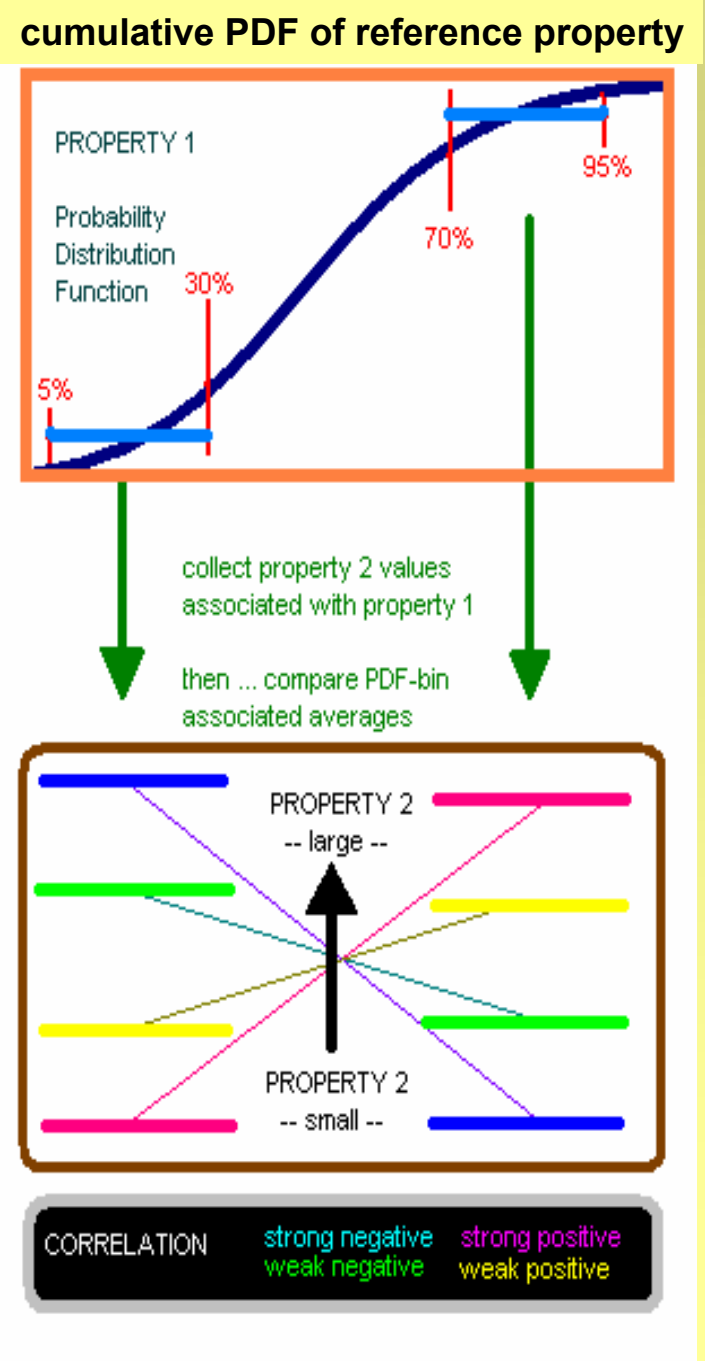
D. determine correlation:

+ slopes agree, - slopes disagree

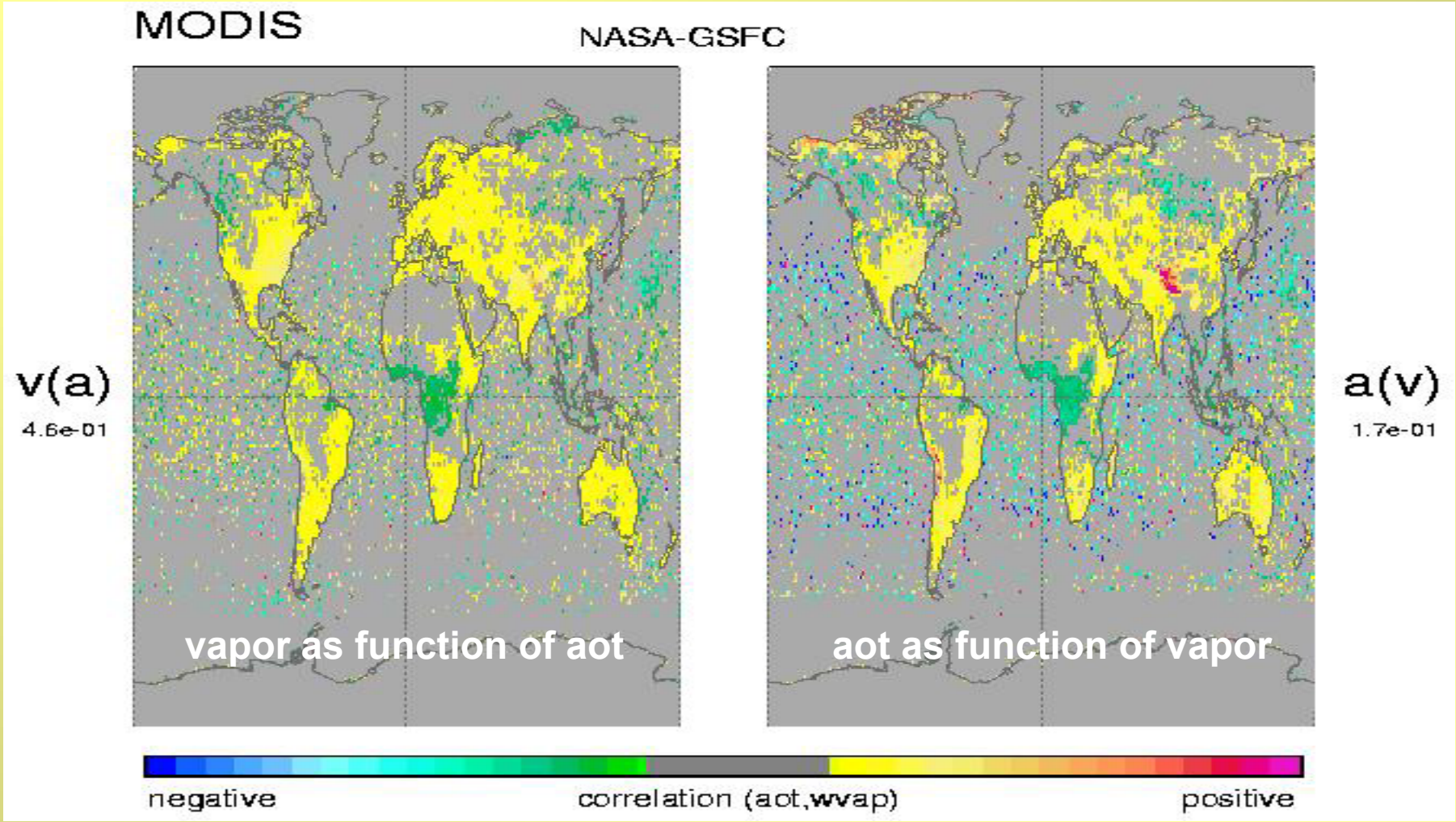
E. determine correlation strength:

use normalized slope steepness

F. repeat - by exchanging properties



aerosol



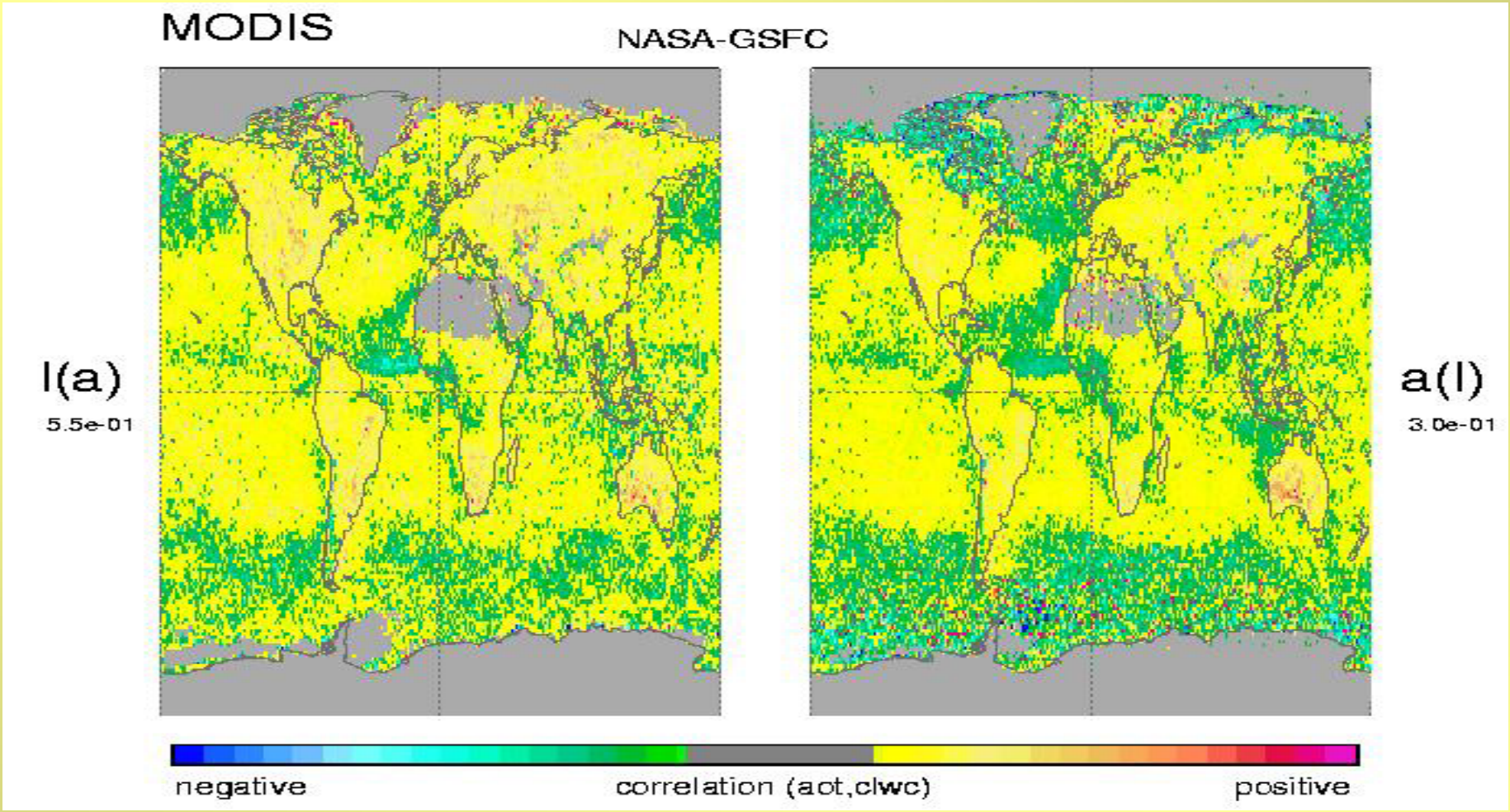
- **aerosol opt. depth (a) – water vapor column (v)**

high aerosol load at dry conditions? (biomass fires, wind blown dust)

explanations ?

RH effect on aerosol size vapor ~ sizes (and aot)

aerosol - cloud

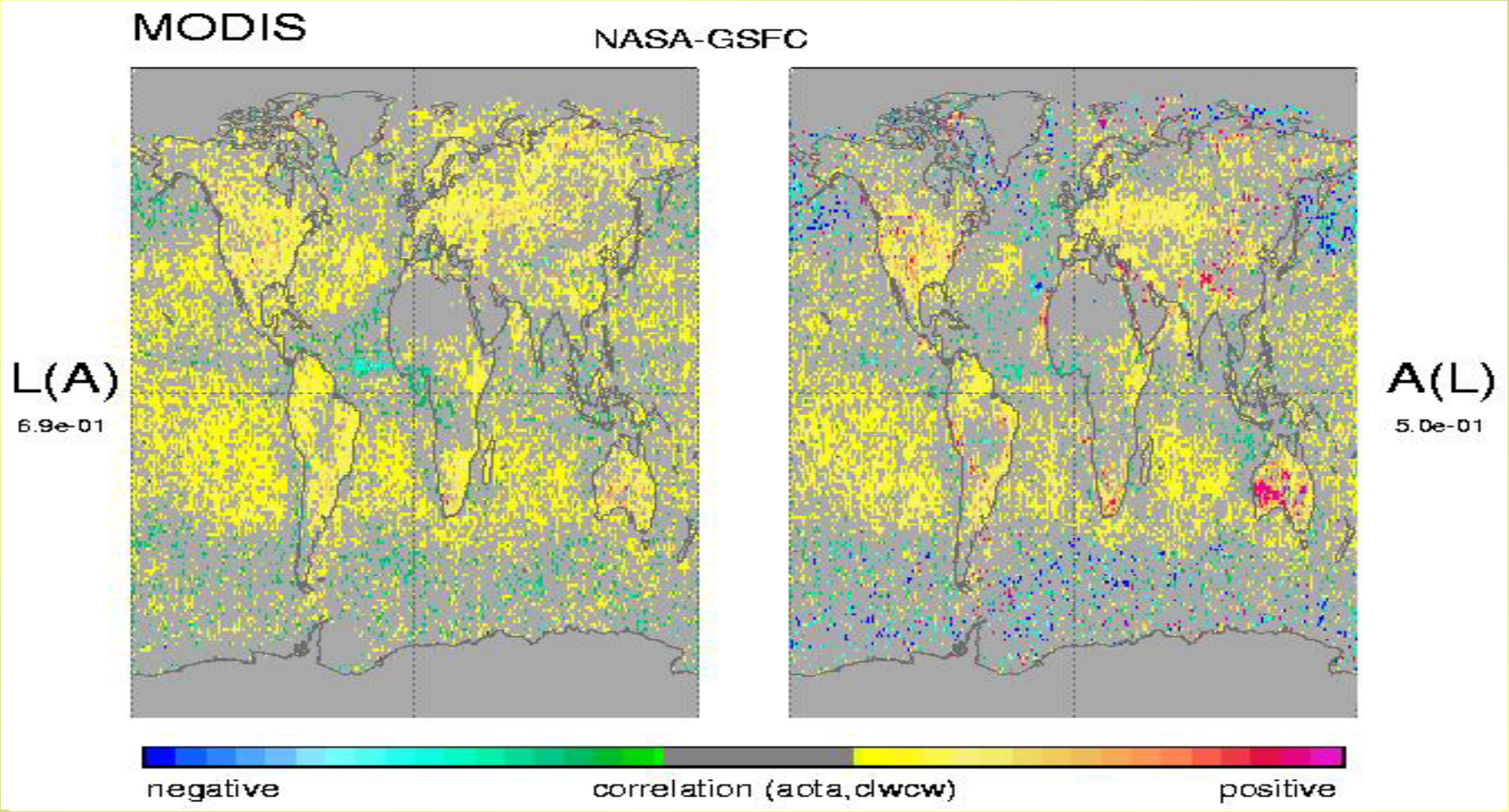


- **aerosol optical depth (a) – cloud liquid water (l)**

cloud removal dominant over aerosol swelling: no clouds ~ high aerosol load

aerosol swelling near clouds extended cloud-lifetime over land

aerosol - cloud

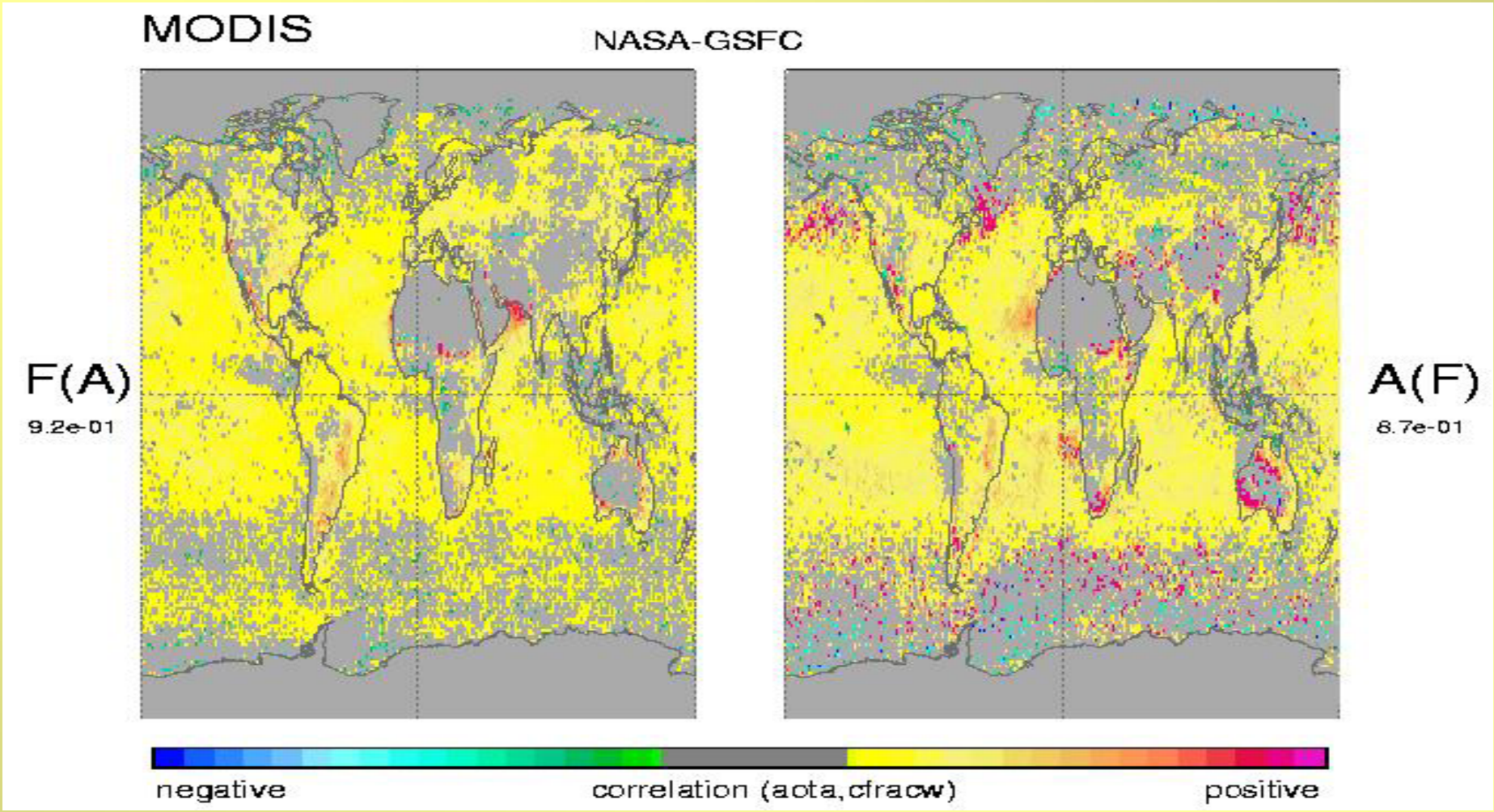


- **aerosol optical depth (A) – cloud liquid water (L)**
  (accumulation mode) *(water cloud [T >260K])*

higher altitude dust signal disappears

land signal increases (+ lifetime?)

aerosol - cloud

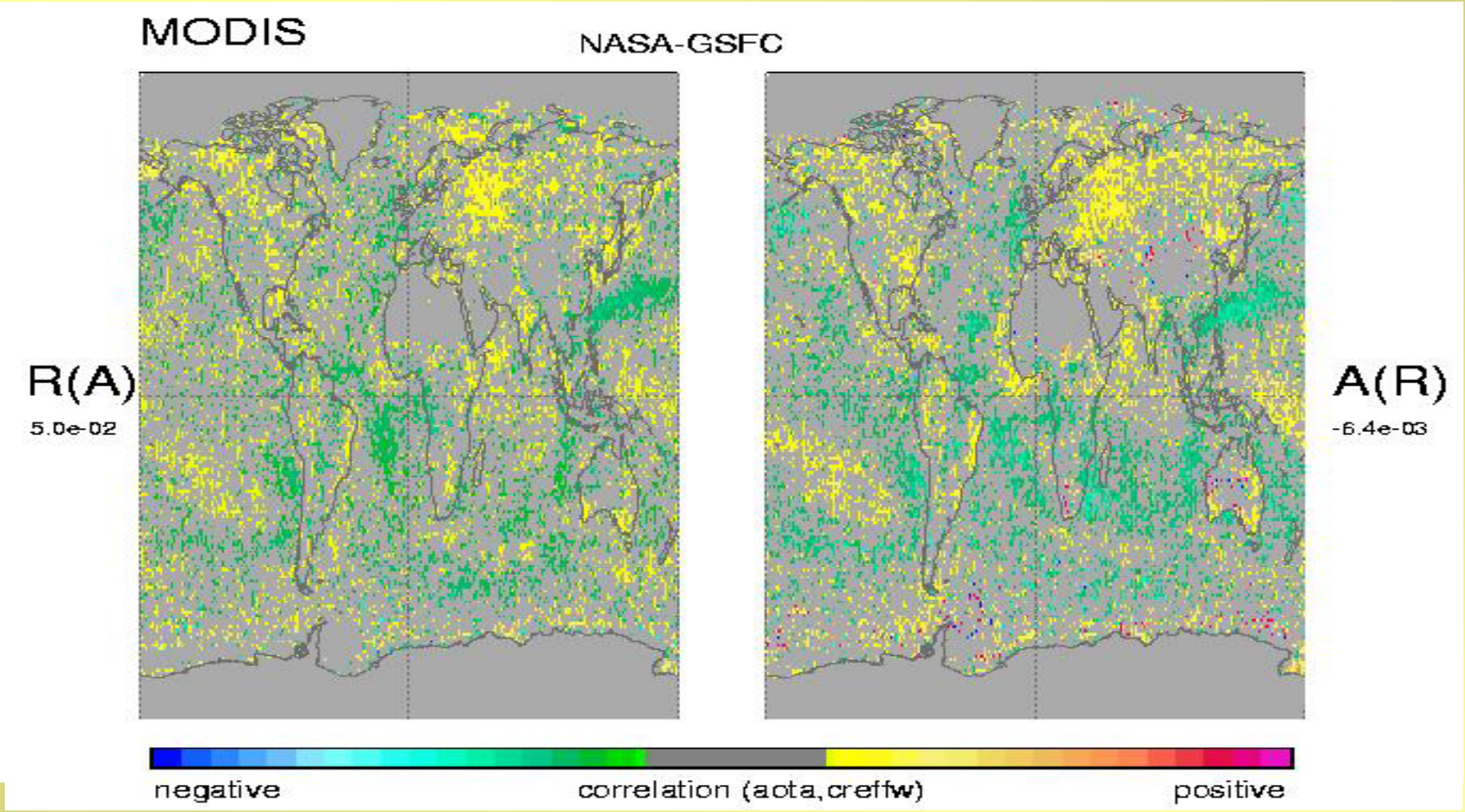


- **aerosol optical depth (A) – cloud fraction (F)**

  (accumulation mode) ***(water cloud [T >260K])***

cloud extra lifetime (aerosol ⇨ clouds) or aerosol swelling (clouds ⇨ aerosol) or ?

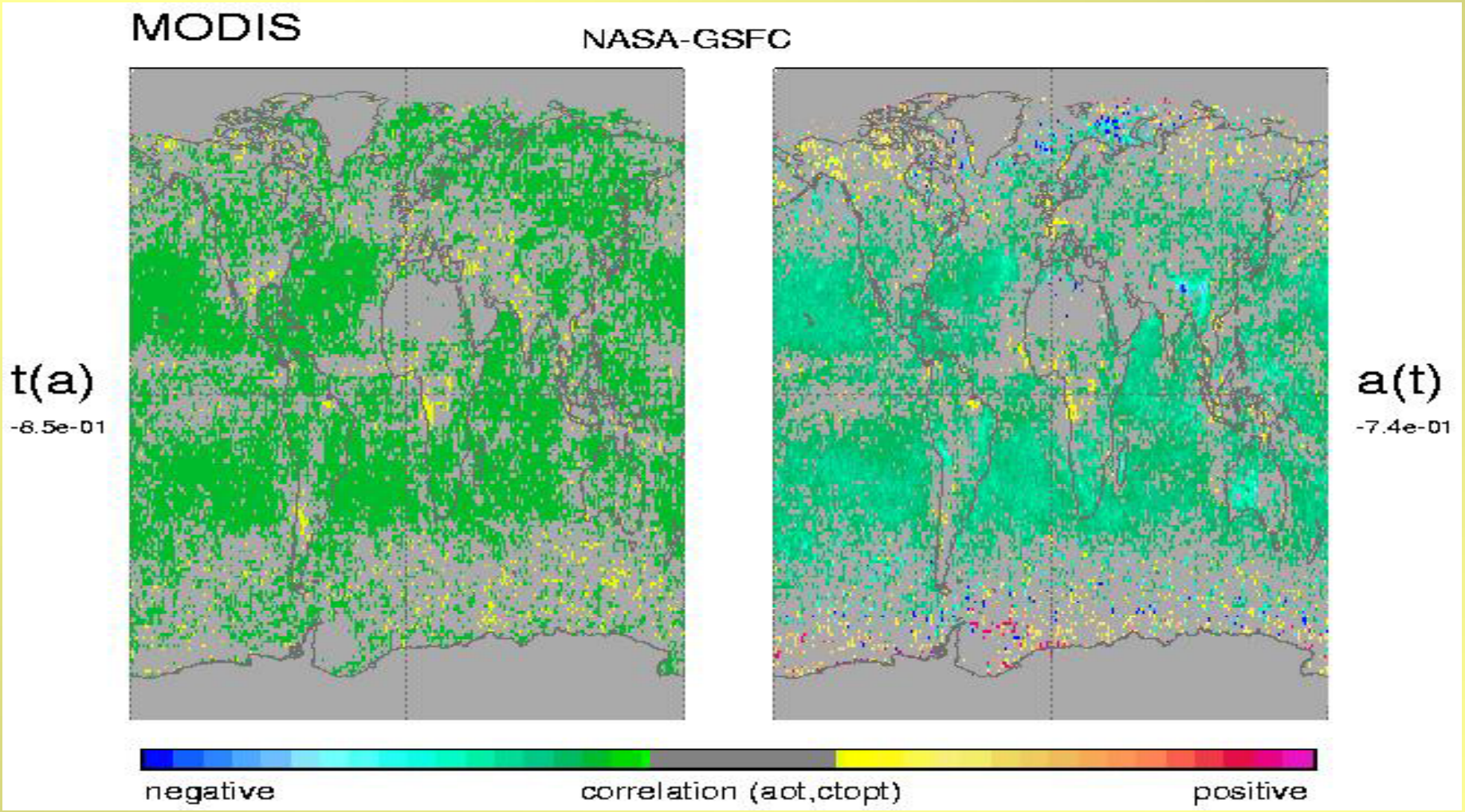
aerosol - cloud



- **aerosol opt. depth (A) – cloud eff. radius (R)**
  (accumulation mode) *(water cloud [T >260K])*

higher probability for the Twomey effect (especially over ocean shipping routes)

aerosol - cloud



- **aerosol optical depth (a) – cloud top temp. (t)**

higher cloud-top with larger aerosol optical depth - a real interaction?

smaller aot at warmer clouds: related to convection or low cloud removal?

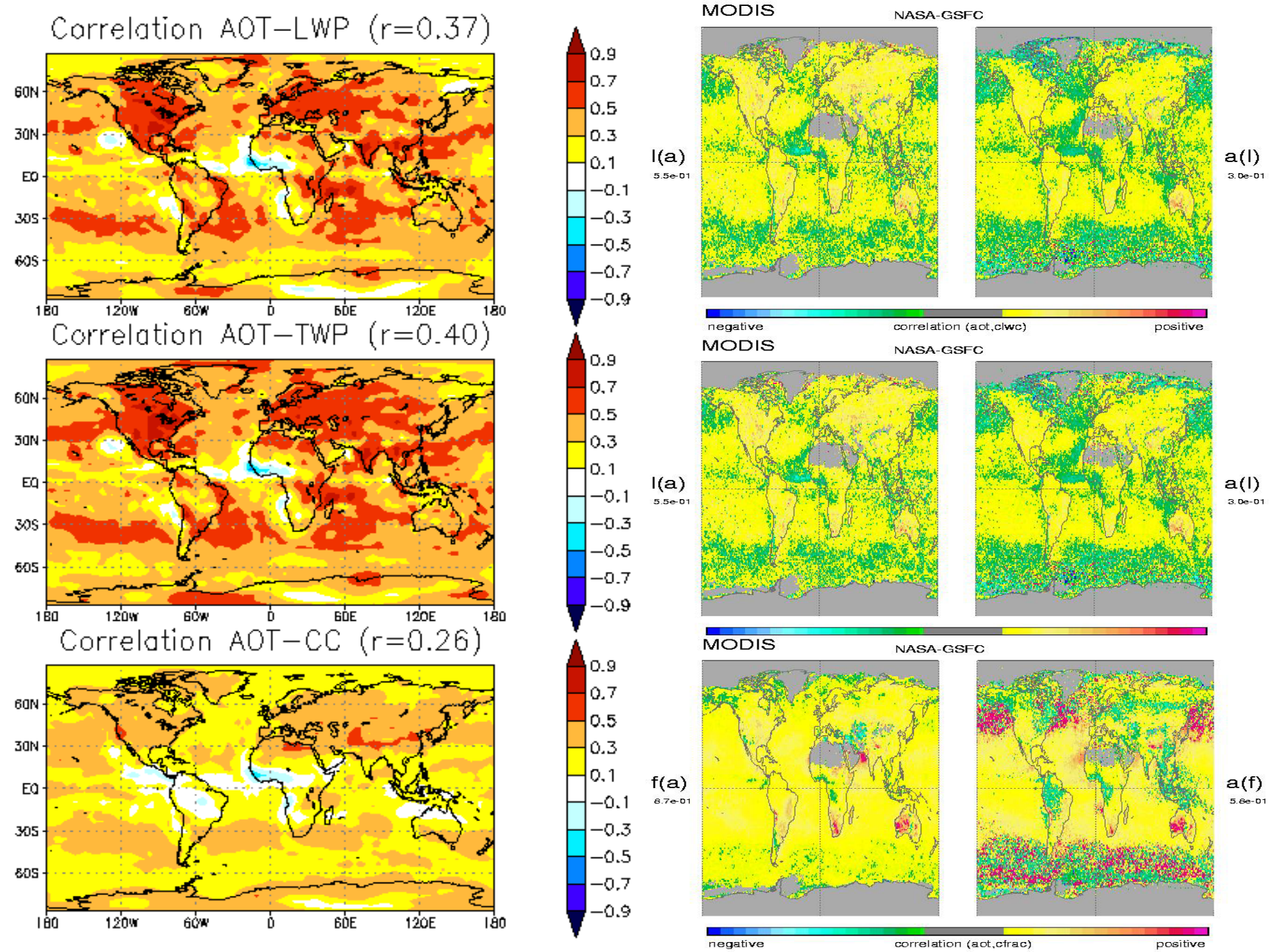
How do models compare ?

- **evaluate aerosol-cloud interactions in global modeling (within the AeroCom activity)**
  - **correlations of simulated data-fields have to match the correlation patterns of the data …do they ?**

a first example:

- **ECHAM4 correlation coefficients *(provided by U.Lohmann)***
  - **(similar but no distinction between individual strengths)**
- **for aot (a) vs total water content (l)**
- **for aot (a) vs liquid water(cloud) content (L)**
- **for aot (a) vs cloud fraction (f)**
  - **comparions are shown next (beware of diff. scales)**

  … and actually the major correlation patterns are reproduced!


Correlation AOT–LWP (r=0.37)
Correlation AOT–TWP (r=0.40)
Correlation AOT–CC (r=0.26)
60N
30N
EQ
30S
60S
180
120W
60W
0
60E
120E
180
0.9
0.7
0.5
0.3
0.1
−0.1
−0.3
−0.5
−0.7
−0.9
MODIS
NASA-GSFC
l(a)
5.5e-01
a(l)
3.0e-01
negative
correlation (aot,clwc)
positive
MODIS
NASA-GSFC
l(a)
5.5e-01
a(l)
3.0e-01
MODIS
NASA-GSFC
f(a)
8.7e-01
a(f)
5.8e-01
negative
correlation (aot,cfrac)
positive