DATA

available data-sets
for added model-evaluations

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Overview

- **Aerosol vertical distributions**

  (aerosol altitude influences aerosol transport and lifetime)

  – aircraft in-situ statistics

  – lidar statistics (sites of Lidar-networks or DOE-sites)

- **Cloud properties**

  (clouds are essential in aerosol processing)

  – ISCCP *[year 2000 daily data are available!]*

  – MODIS *[cloud data next to aerosol data!]*

- **Cloud-Aerosol correlations**

  (cloud – aerosol interactions in global modeling have deficits)

  – MODIS first ideas of correlations

vertical profiling / variability

Andreas Paetzold (DLR, Germany):

- **aerosol vertical distribution in the mid-latitude free troposphere was examined in several national and international experiments**:

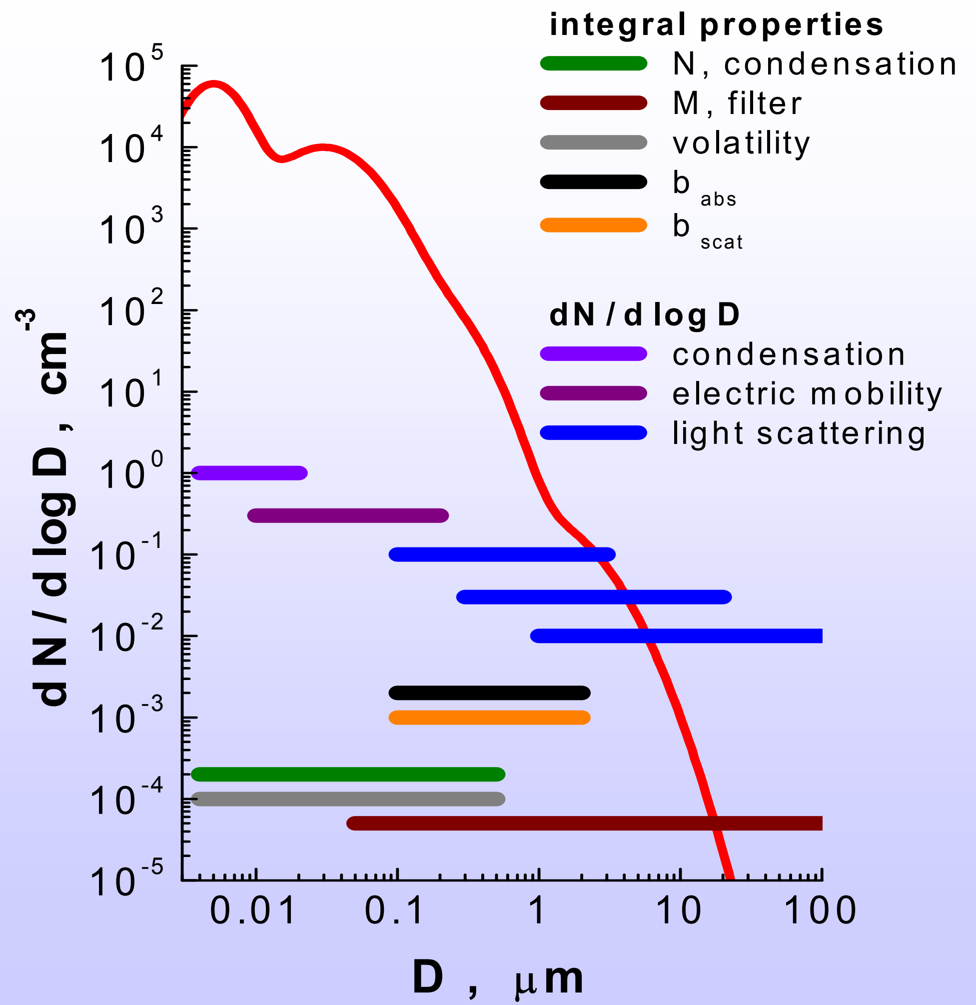
– **LACE**	anthropogenic sources	NH (Germany)	7-8/98
– **INCA**	background (maritime)	SH (south-Chile)	4-5/00
– **INCA**	pollution influenced	NH (Scotland)	9-10/00
– **UFA/export**	anthropogenic sources	NH (Europe)	7-8/00
– **SCAVEX**	anthropogenic sources	NH (Europe)	11/02

- the aerosol instrumentation was identical bei all experiments
  ⇨ **the different vertical profiles can be directly compared**

DLR FALCON aircraft data

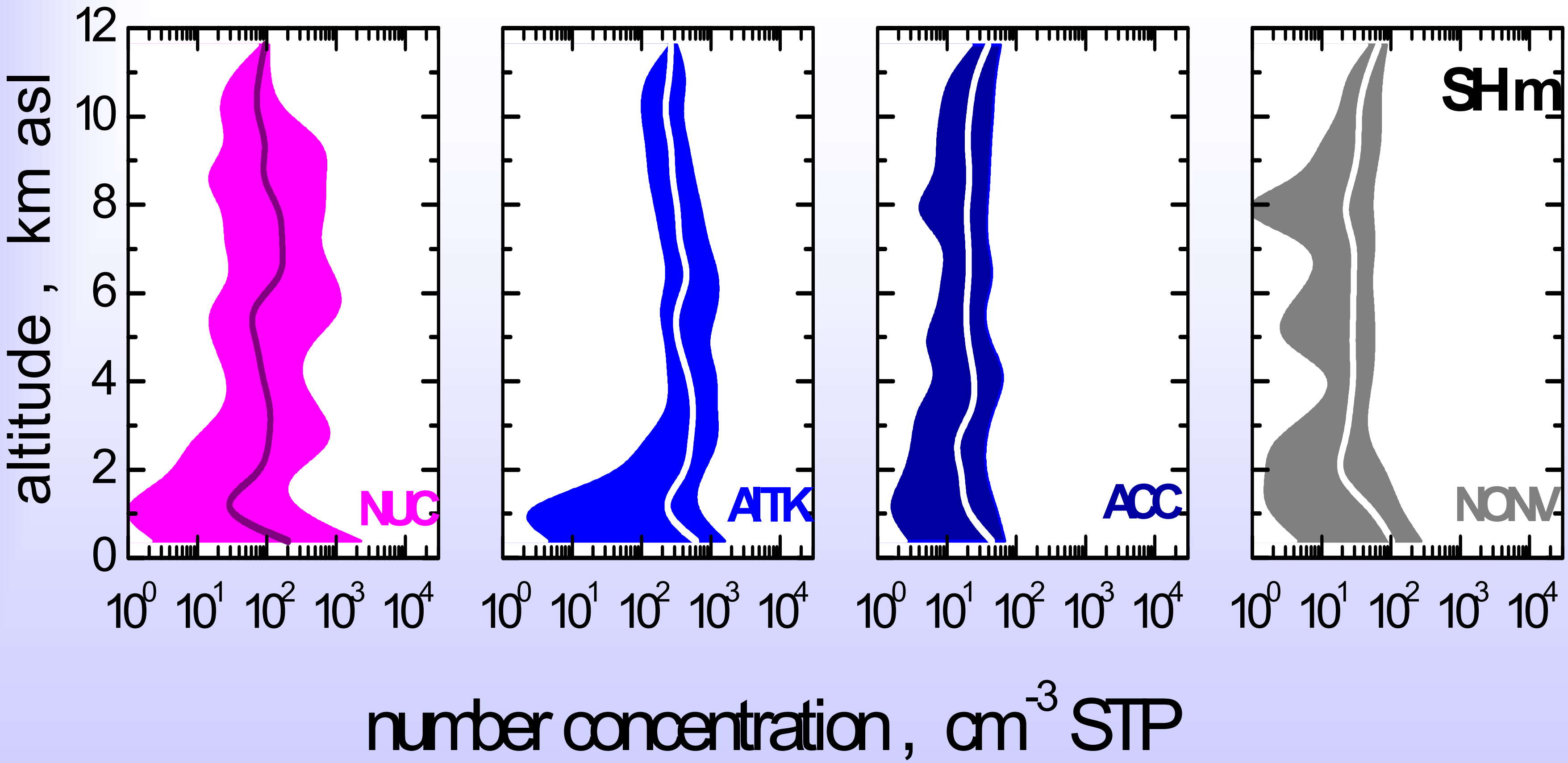
- scattering-light spectrometer
  - size range: 0.1-0.9 μm
- condensation nuclei counter
  - all sizes > 14nm
- condensation nuclei counter
  - all sizes > than 5nm

Size Range of Aerosol Instrumentation



Concentration

vertical profiles by size-mode



important detail for aerosol transport and aerosol processing!

ISCCP

- 18-year time-series of cloud data (globally)
- derived from operational satellite imaging data
- Products *(added info in the GEWEX 2002 newsletter)*
  - Radiance data (10km, 3hr resolution)
  - Cloud field characteristics
    - fractional cover (total, high-level, mid-level, low-level
    - optical depth
    - cloud top altitude
    - effective radius
  - Radiation budgets at ToA, surface and 3 atm. levels
    (,,, based on model simulations)

CALIBRATION

- satellites are normalized to "afternoon" polar orbiter
- polar orbiter normalized to reference-satellite NOAA-9
- NOAA-9 calibrated by ER-2 flights / vicarious methods
  - second calibration points with new imagers are planned
- estimated uncertainty

VISIBLE	3% relative	7% absolute
INFRARED	2% relative	2% absolute

- calibration "verification"

VISIBLE	2% relative	5%absolute
INDRARED	1% relative	2%absolute

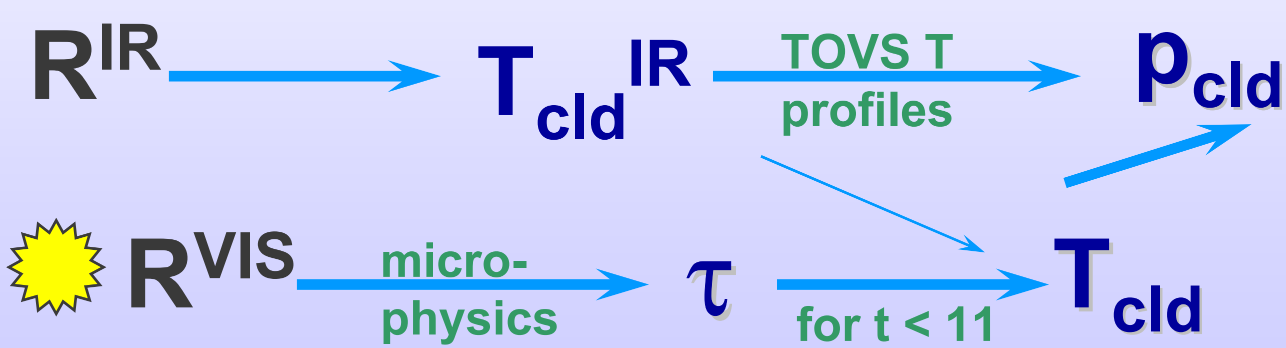
from comparing ISCCP Cloud Product fluxes to ERBE data

ANALYSIS

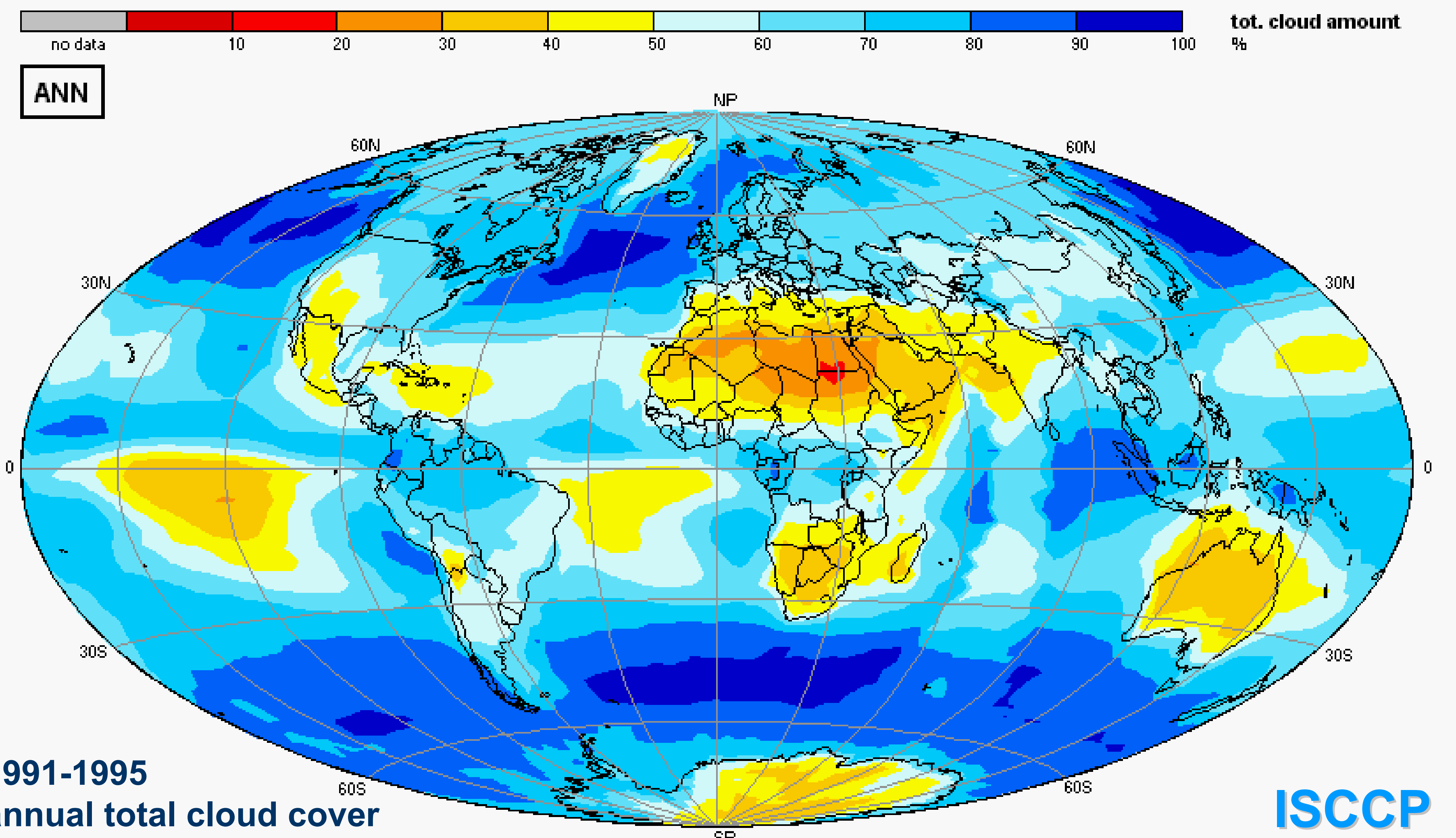
- **Cloud detection**
  - estimate clear-sky radiances by location and time
    - warm or dark extremes / low space-time variability
  - detect clouds by difference observed - clear radiances
    - difference must exceed uncertainty for clear-sky radiances
- **Cloud retrievals** (2.5°*2.5°) *daily (D1), monthly (D2)*
  - clear-sky conditions
    - surface temperature (all day) / visible reflectivity (daytime)
  - cloudy condition
    - cloud top temp.(all day) / visible opt. thickness (daytime)
    - distinction by cloud-type and altitude range (daytime)

ISCCP

- **ISCCP 1983-2001** *(Rossow et al., BAMS Nov 1999)*
  - LEO: 2 radiances during daylight (1 IR + 1 VIS)
  - GEO: every 3 hours, 5 km res. sampled to 30 km ⇨2.5°
  - products cloud-cover *(total, by type)* , τ, T_{TOP}, p_{TOP}
  - web-access *http://www.giss.nasa.gov/isccp*



ISCCP – Cloud Cover



1991-1995
annual total cloud cover
[Börnstein, Obs.Climate 2004]

ISCCP
International Satellite Cloud Climatology Project

other long-term climatologies

- **TOVS vertical sounders on LEO (polar orbitors)**
  - since 1979
  - products: cloud-cover *(total, by type)* , τ, T_{TOP}, p_{TOP}
- **TOVS *Path B* 1987-1995** *(Scott et al., BAMS Dec 1999)*
  - LEO: 6 hours, 20km resolution ⇨ 1°
  - good spectral resolution (HIRS: 19ir, 1vis, MSU: 4μw)
- **HIRS 1979-2002** *(Wylie and Menzel, J. Clim. Jan 1999)*
  - LEO: near-nadir, sampled HIRS observations

Statistics ISCCP vs TOVS

- **total cloud cover: ~ 70 %** *more over ocean than over land*
- **high cloud cover: ~ 30%** *only 3% deep convection*
  - vertical sounders (TOVS) more sensitive to cirrus (10% more!)
- **low cloud cover: ~ 30%** *more over ocean than over land*

5 years (1991-1995) **ISCCP** / ***TOVS Path-B***

Cloud type amounts (%)	global		ocean		land	
total cloud cover	67.0	*73.0*	71.0	*75.0*	57.0	*69.0*
deep convection	2.8	*2.4*	2.8	*1.9*	2.7	*3.5*
high-level (cirrus)	18.7	*27.1*	17.6	*26.9*	21.5	*27.5*
mid-level cover	18.4	*12.0*	18.3	*10.2*	18.5	*16.6*
low-level cover	26.7	*31.7*	30.7	*35.9*	17.4	*20.8*

MODIS

- **LEO**
  - am (10.30am local time) daily on NASA's *Terra* (Mar 2000 -)
  - pm (1.30pm local time) daily on NASA's *Aqua* (2003 -)

– multi-spectral sensors (UV, VIS, n-IR, IR)

– retrieved properties

- *Aerosol* (optical depth, Angstrom parameter, eff. radius, opt. depth for sizes smaller than 1μm)
- *Clouds* (optical depth, cloud top temperature, liquid water content, eff. radius, cloud-fraction, …)
- *Gases* (water vapor, ozone)

smallest pixel size (VIS) 250m ⇨ good cloud detection

1^0*1^0 lat/lon daily data available through data-centers

Aerosol Property Sample

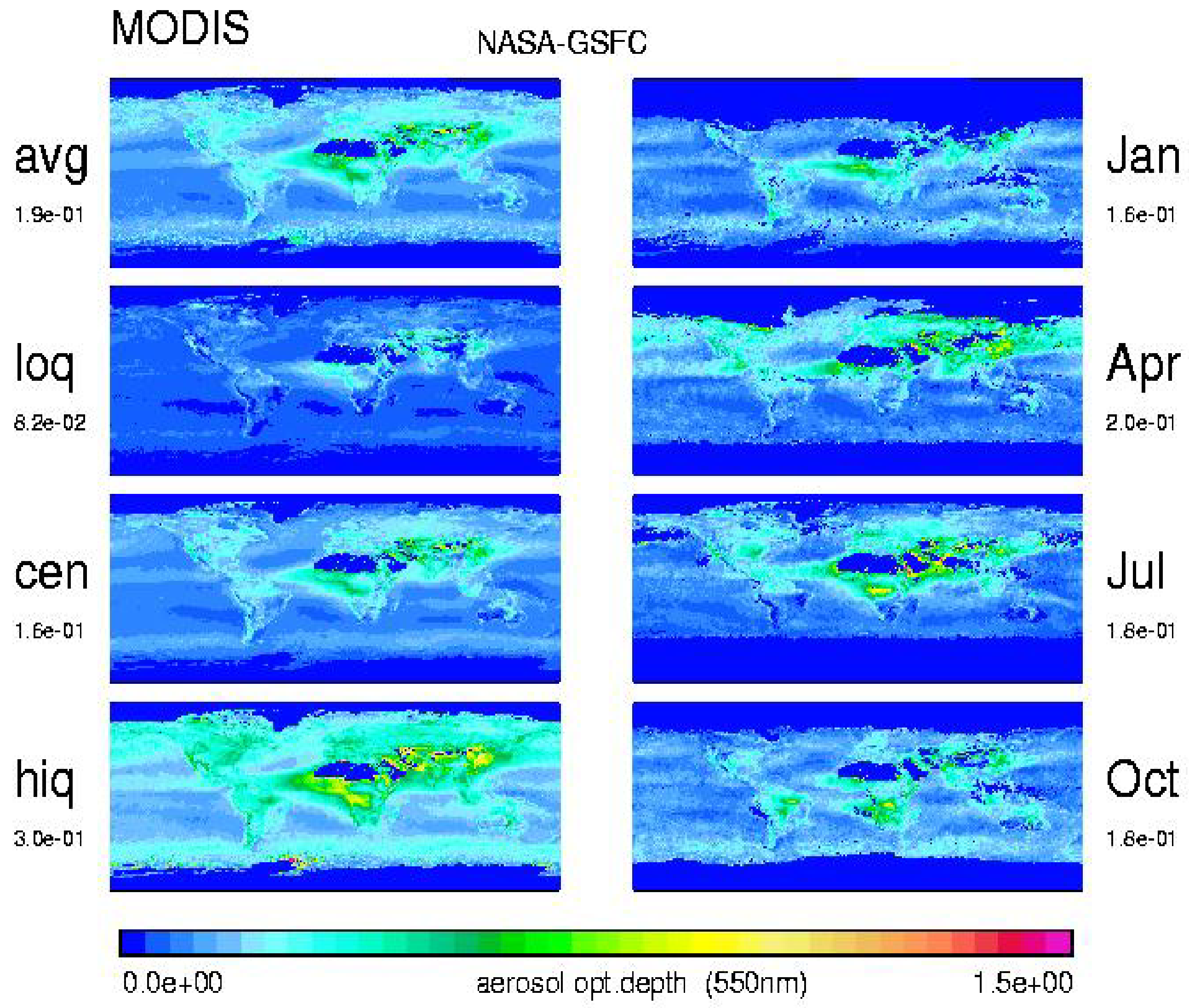
- aerosol optical depth

yearly average

- all data
- 5-30% PDF
- 30-70% PDF
- 70-95% PDF

monthly mean

- Jan
- Apr
- Jul
- Oct



Cloud Property Sample

- cloud drop eff. radius

yearly average
- all data
- 5-30% PDF
- 30-70% PDF
- 70-95% PDF

monthly mean
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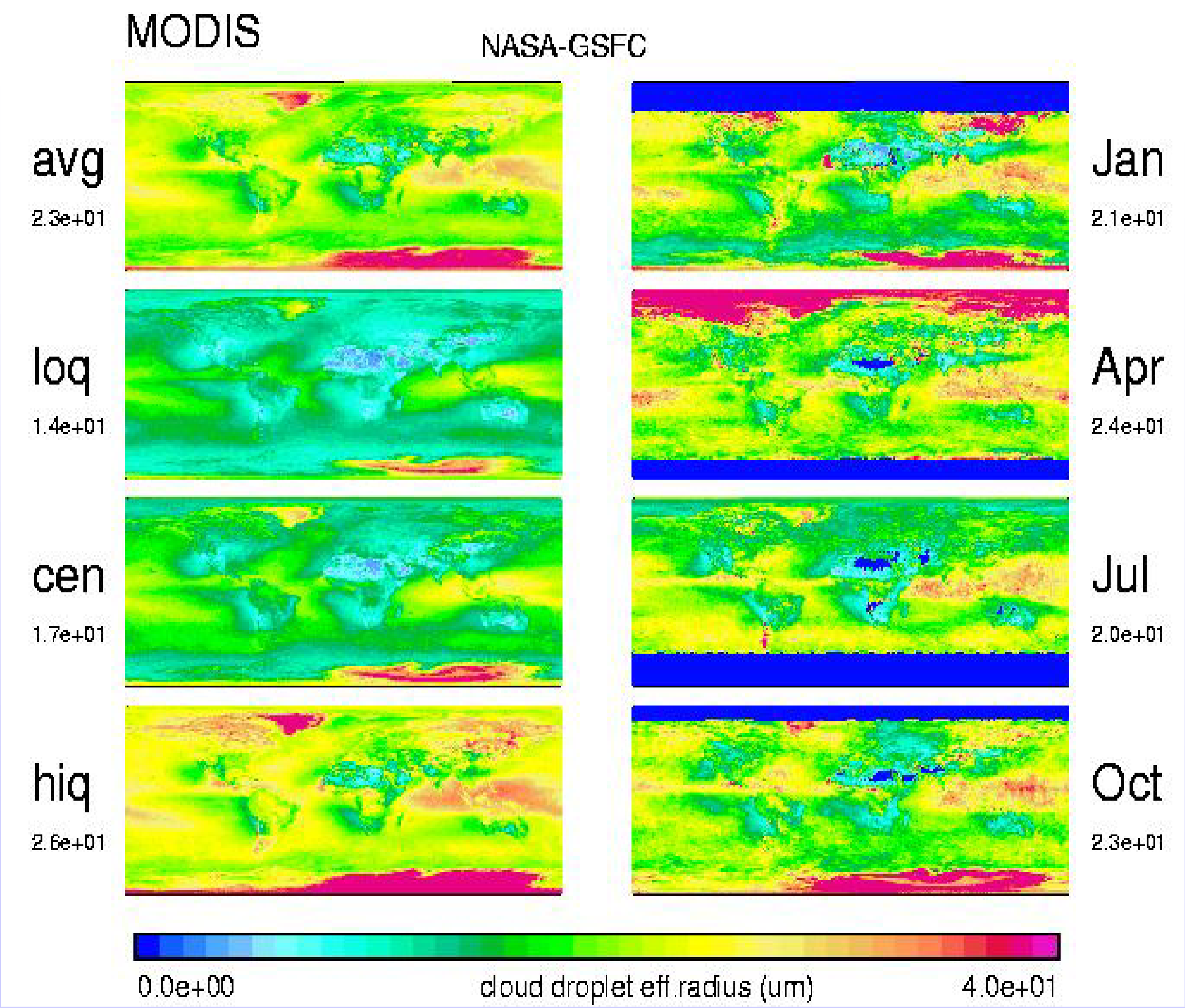


Correlations !

beyond cloud properties …

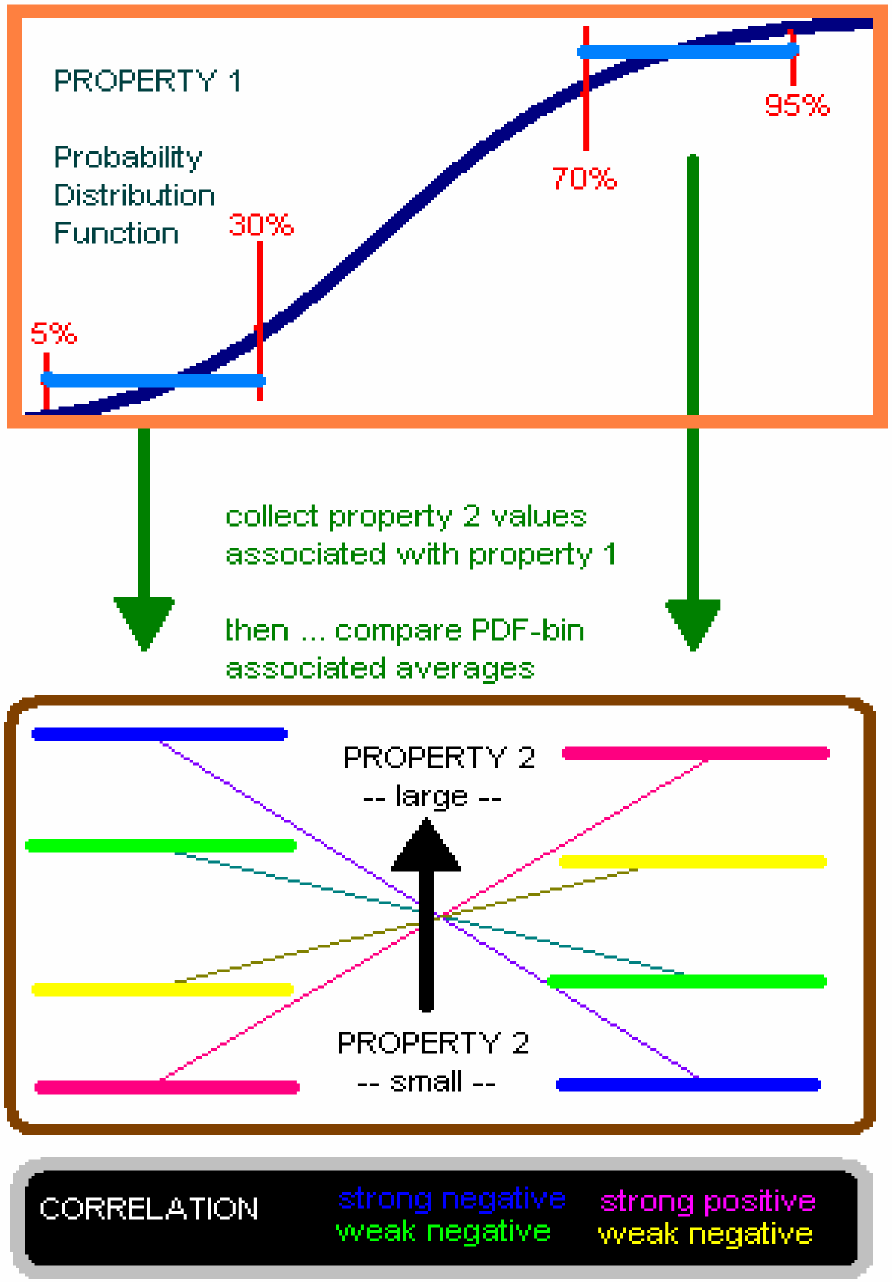
- MODIS provides data on trace-gases and aerosol
- look at correlations among properties
  - for added insights into aerosol-cloud interactions
  - for added insights into aerosol-trace gas interactions

  … also see correlations as another tool to evaluate models !

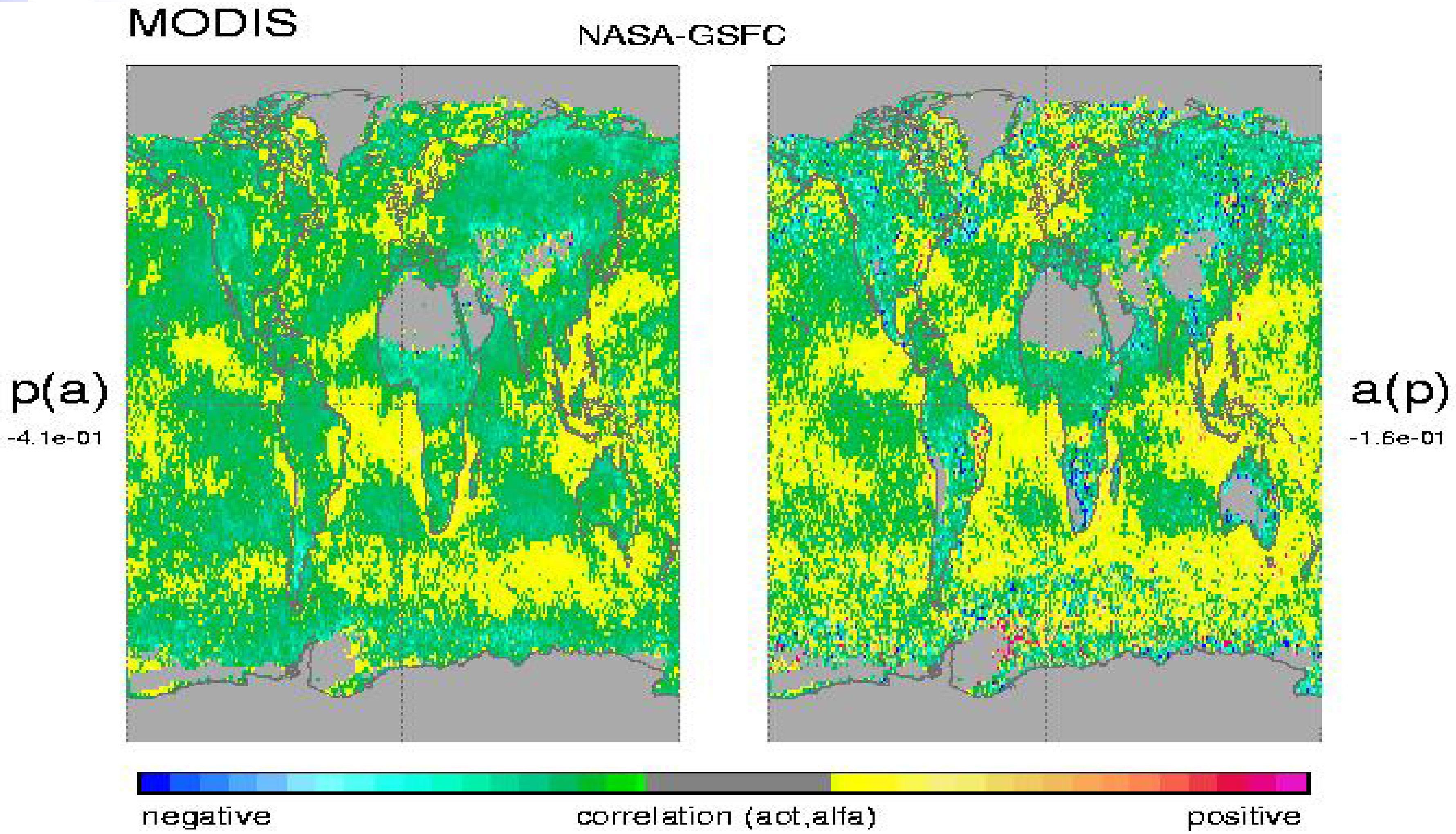
- next
  - the correlation concept
  - a few correlation samples (for more see the poster)

Concept

1. rank Property 1 data by value
2. determine averages for values falling into the 5-30% and 70-95% range of the Probability Distribution Function
3. determine averages for values of Property 2, that are associated with each Property 1 range
4. determine correlations: if slopes among property averages agree (positive) or disagree (negative)
5. determine correlation strength from steepness in Property 2 slope
6. repeat procedure by exchanging properties

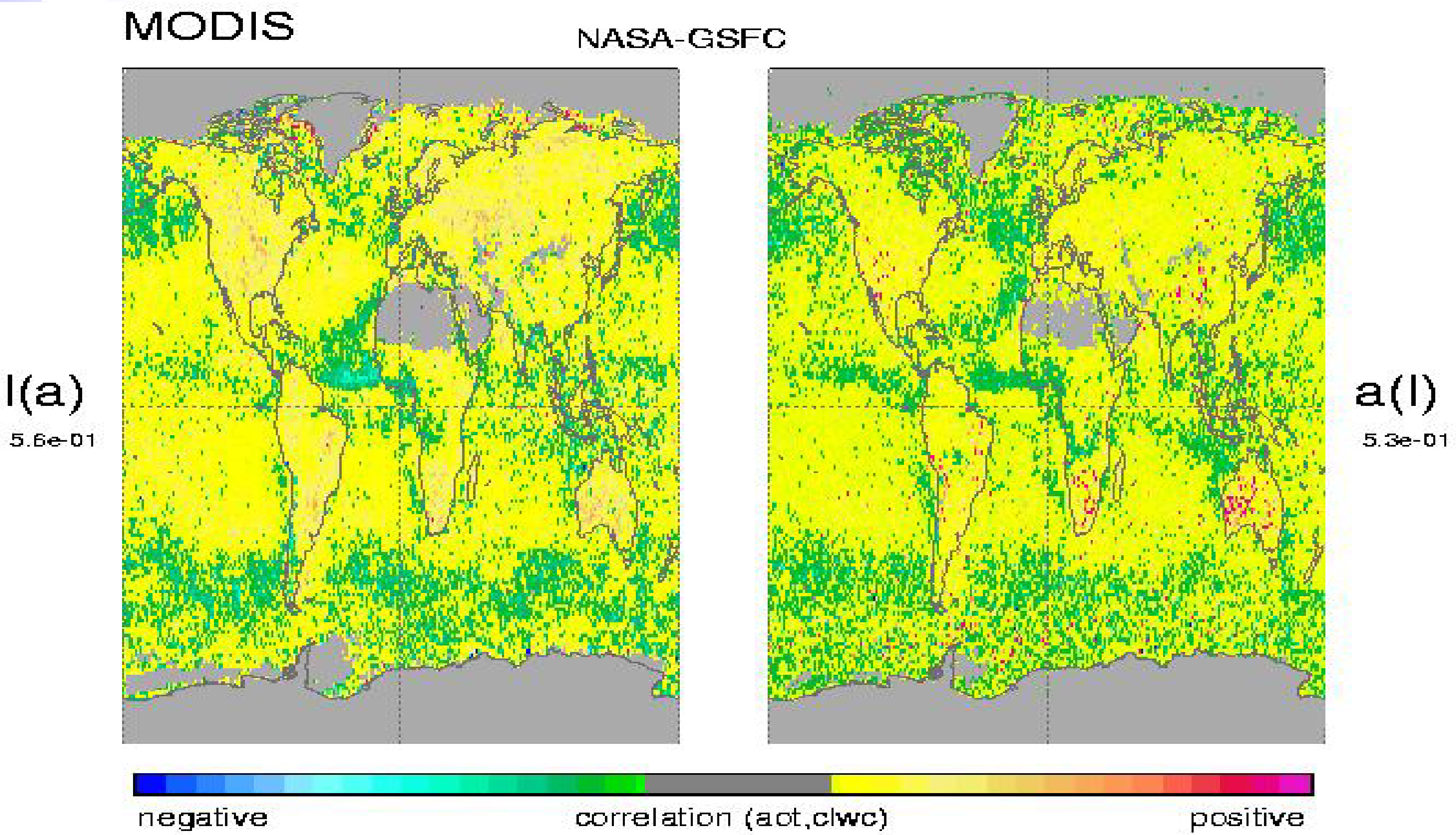


aerosol - aerosol



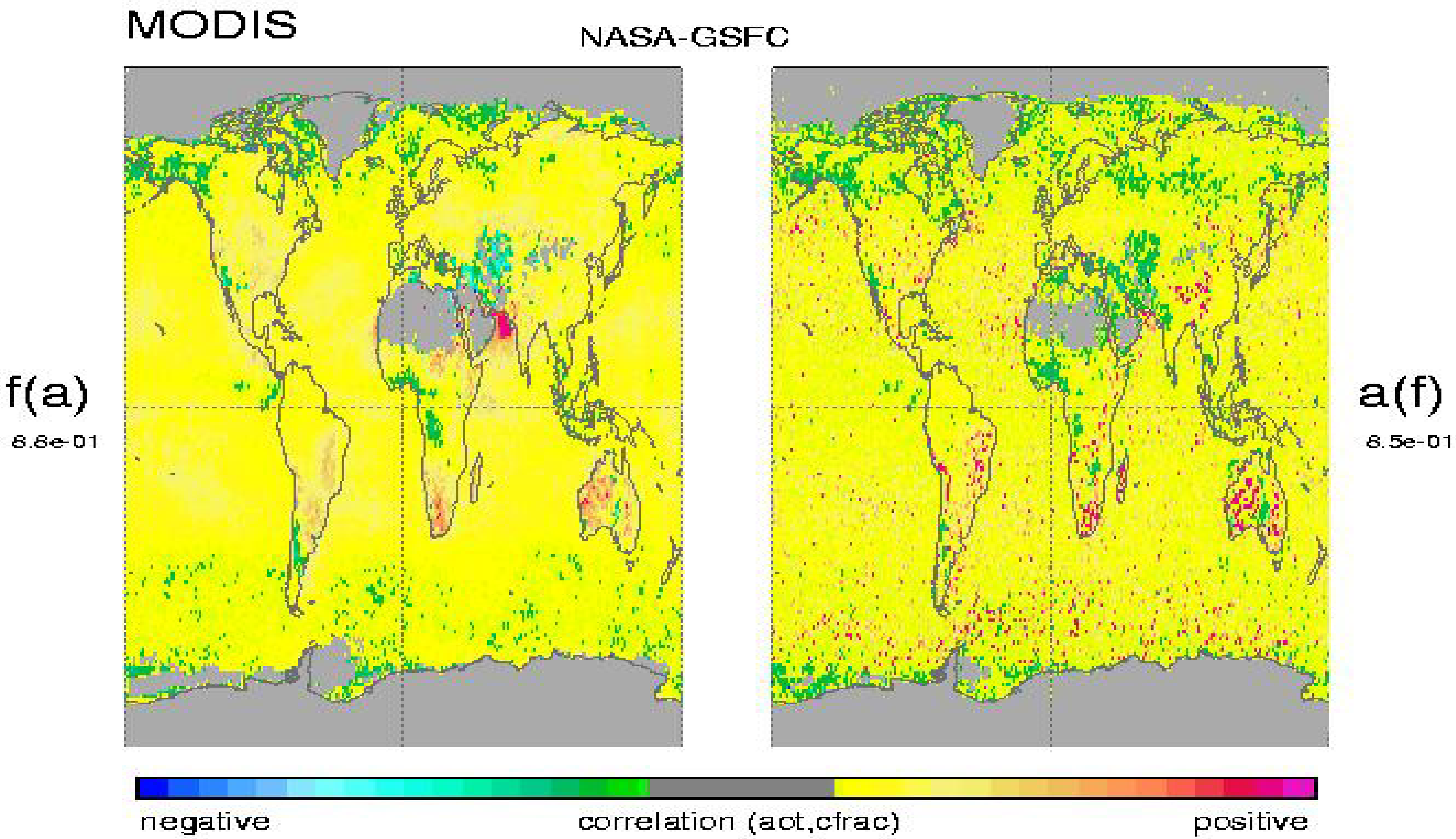
- aerosol optical depth (a) – Angstrom parameter (p)

aerosol - cloud



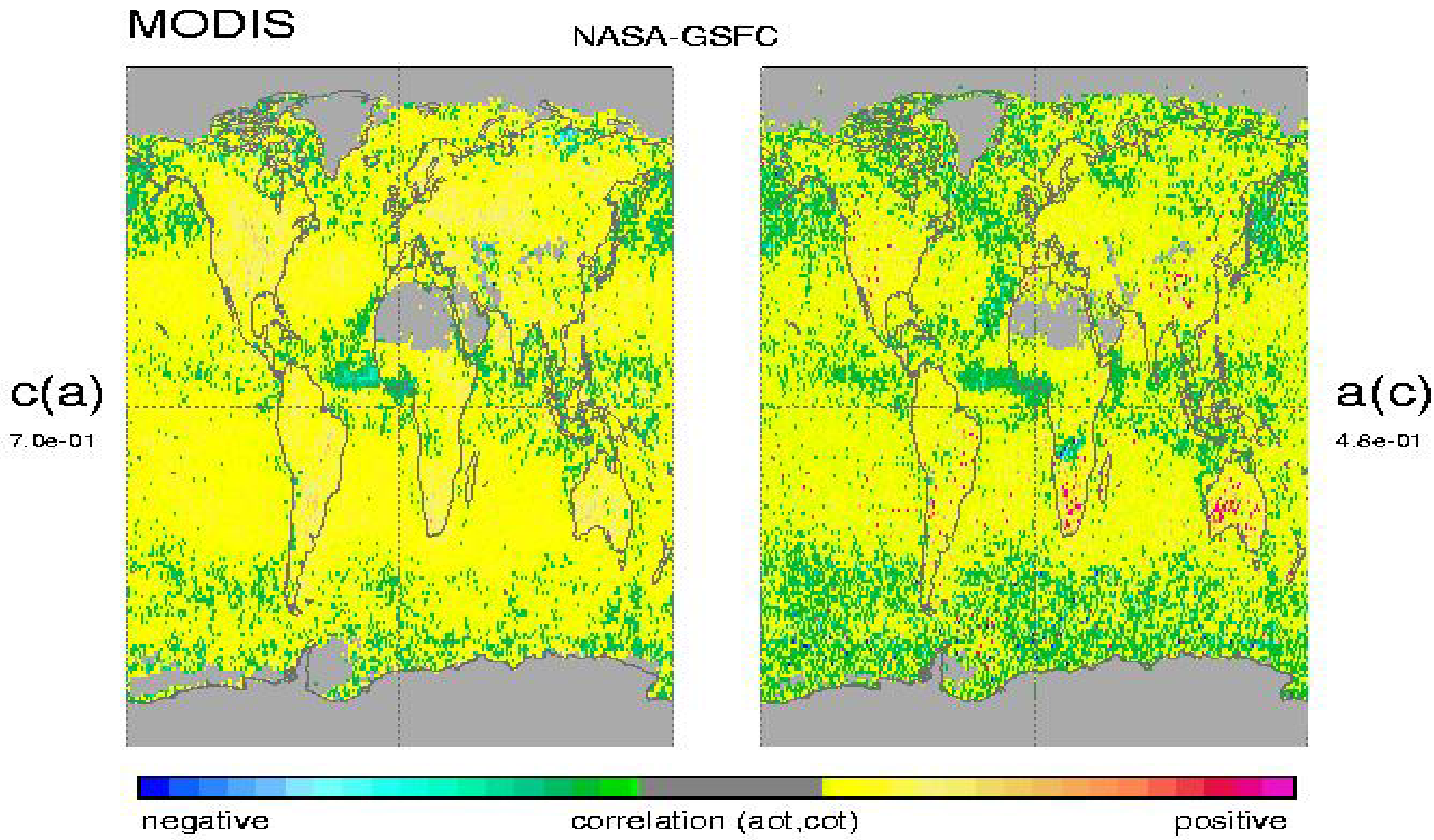
- aerosol optical depth (a) – cloud liquid water (l)

aerosol - cloud



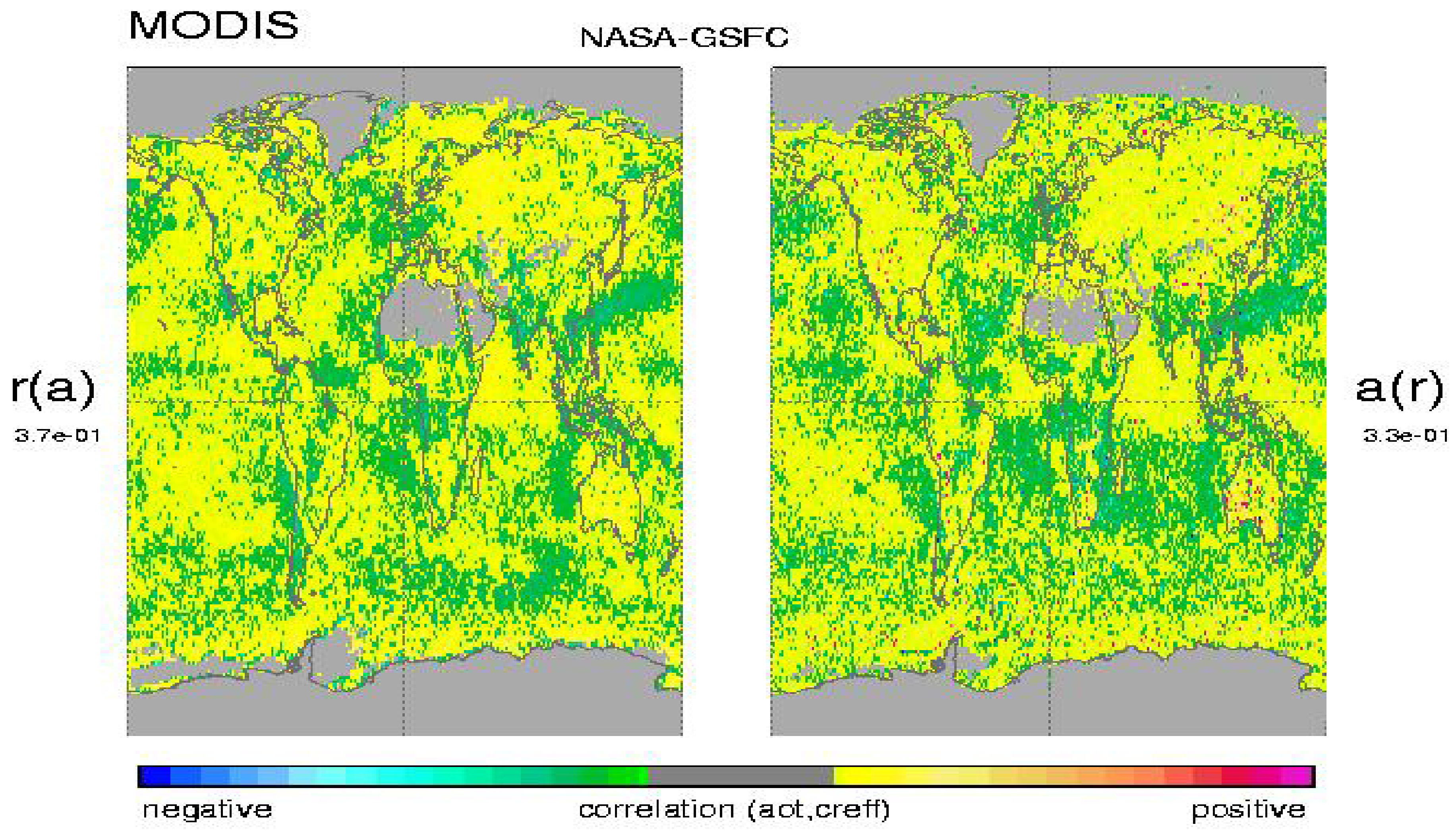
- aerosol optical depth (a) – cloud fraction (f)

aerosol - cloud



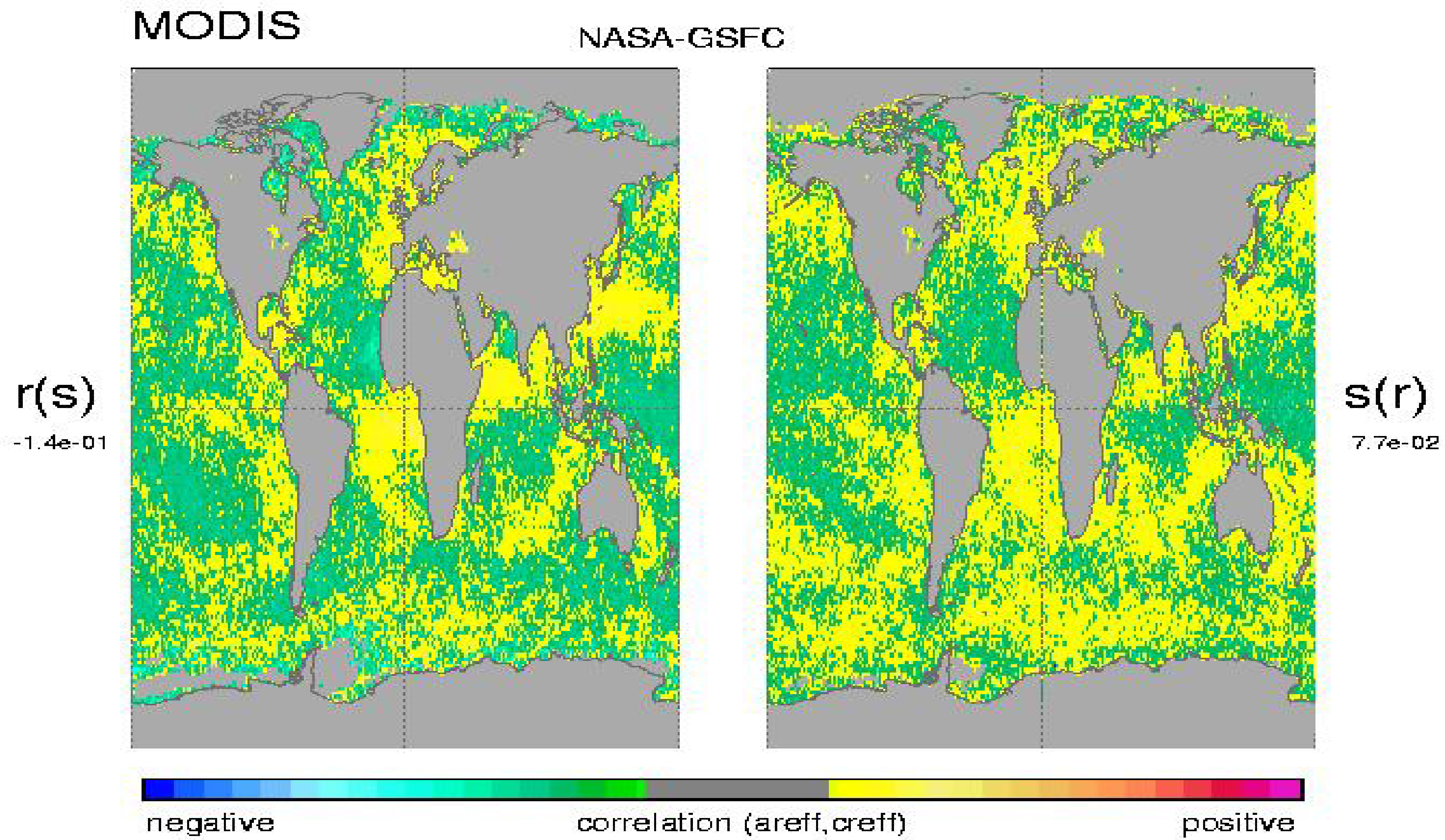
- aerosol optical depth (a) – cloud optical depth (c)

aerosol - cloud



- aerosol optical depth (a) – cloud eff. radius (r)

aerosol - cloud



- **aerosol eff. radius (s)** ***[ocean]*** **– cloud eff. radius (r)**

NEXT

- **investigate correlations in more detail**
  - **on spatially coarser resolution** ***(> 1*1 deg lat/lon)***
  - **for a temporal finer resolution** ***(season or month)***
  - **include adjacent data-points for better statistics**
  - **investigate correlations between data combinations** ***(e.g aerosol vs. cloud properties at low altitudes)***
- **expand to associations of many properties**
  - **simultaneous constraints by correlations involving associations among multiple properties**

⇨ **possible clues on the aerosol indirect effect?**