Aerosol Remote Sensing from PARASOL and the A-Train

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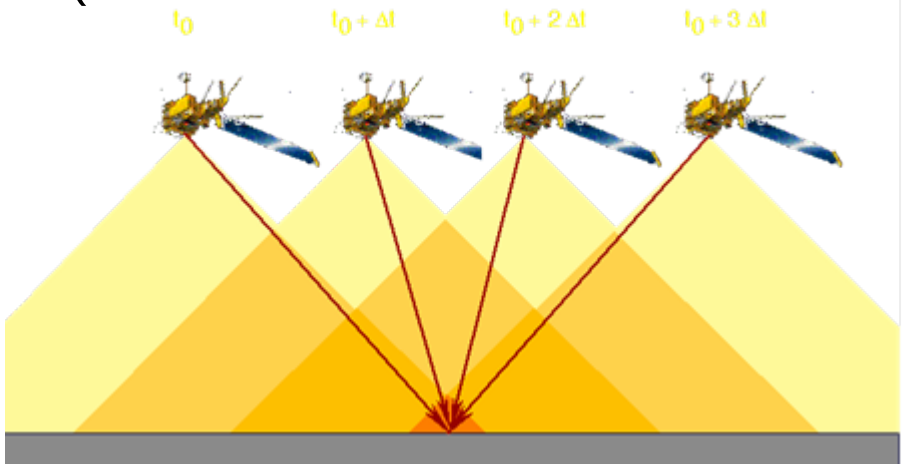
PARASOL

- Project managed by CNES
  - **http://parasol-mission.cnes.fr**
  - Principal Investigator Didier Tanré (CNRS-LOA)
  - Project scientist Anne Lifermann (CNES)
- Heritage from the POLDER series
    - POLDER-1/ADEOS-1: nov. 96-june 97
    - POLDER-2/ADEOS-2: apr.-oct. 03
- PARASOL (*POLDER-3*) launched in Dec. 2004 on a micro-satellite of the Myriad series
  - Start of scientific operation in March 2005
  - 1 year and 8 month of data, Availability is 87.8%

Principle of observation

- The directionality and the polarization degree of the reflectances are measured at the TOA.
  - Use of a rotating filter wheel carrying 15 filters and polarizers
  - Spectral range from 0.440µm and 1.04µm
  - Imaging of the Earth with a two-dimensional CCD detector array (pixel size 5.3 x 6.2 km) and a wide field-of-view optics (swath 1600 km cross-track and 2100 km along track)

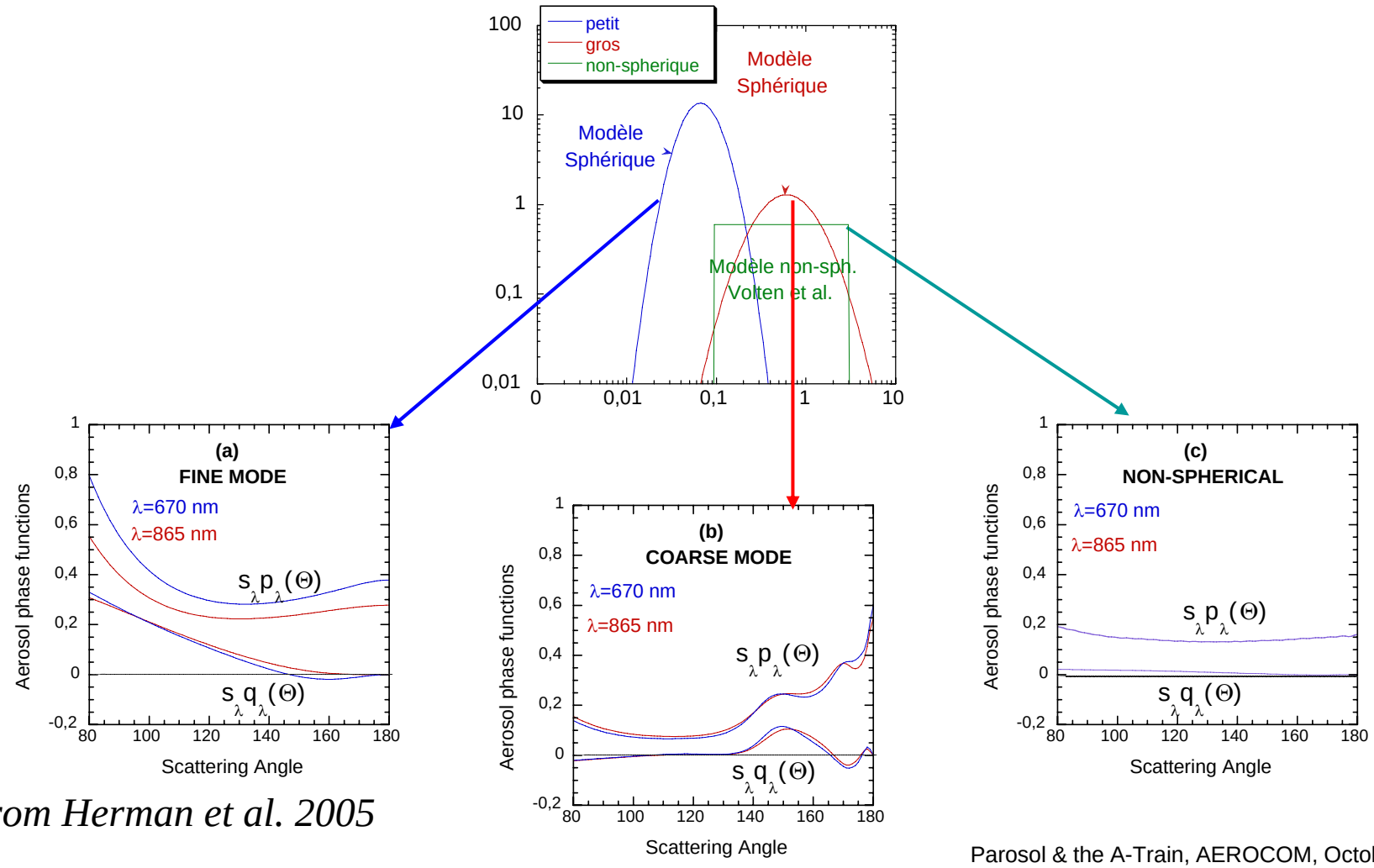


Up to 16 different viewing angles for a satellite overpass

Principle of inversion

- A look-up table approach
  - Over land: polarized radiances @670 and 865 nm
    - Modeled BPDF
    - Fine mode AOT
  - Over ocean: total and polarized radiances @670 and 865 nm
    - Total aot, f-aot, size, nonsphericity, refractive index
    - Information content depends on the range of scattering angle available

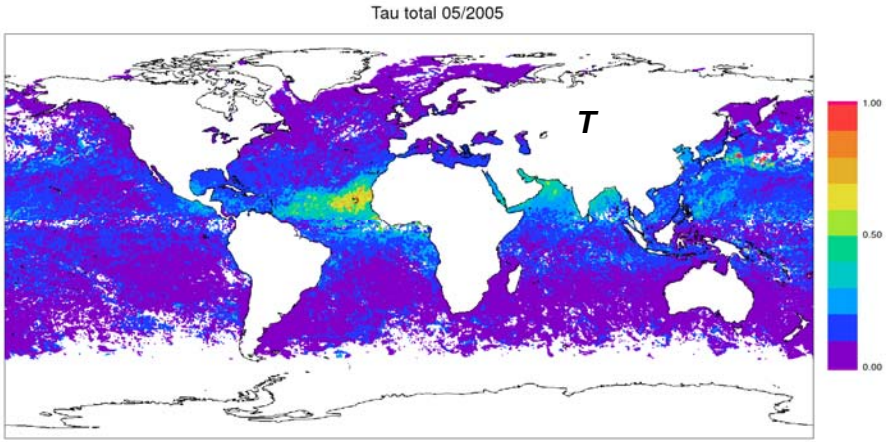
Information content. Ocean

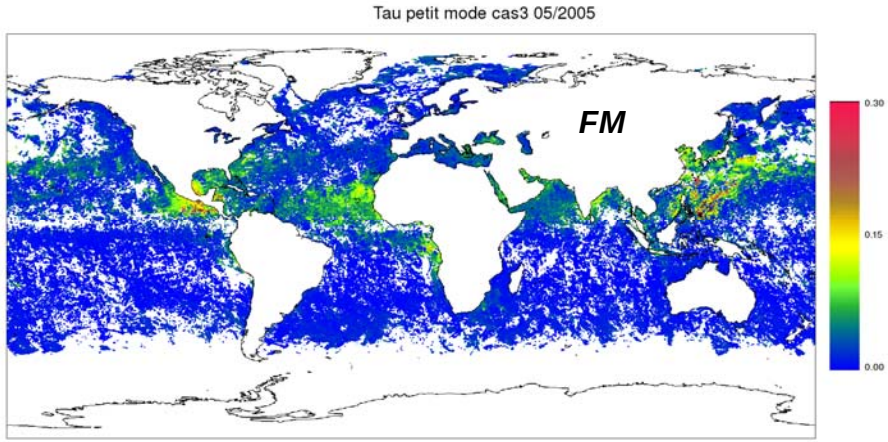


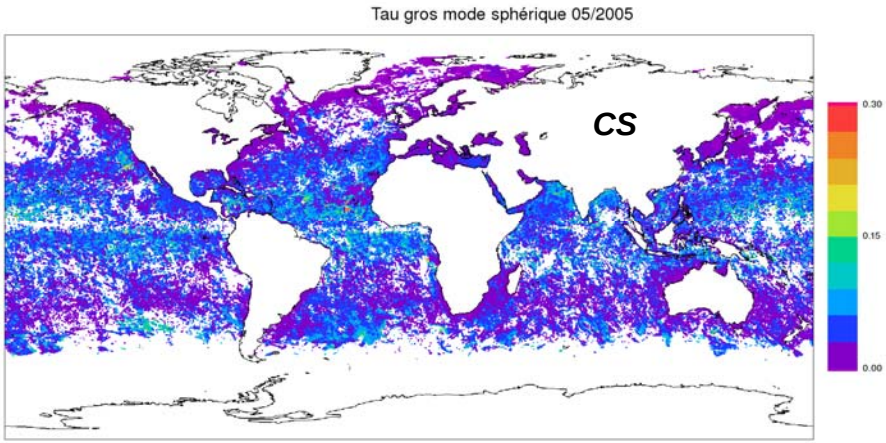
From Herman et al. 2005

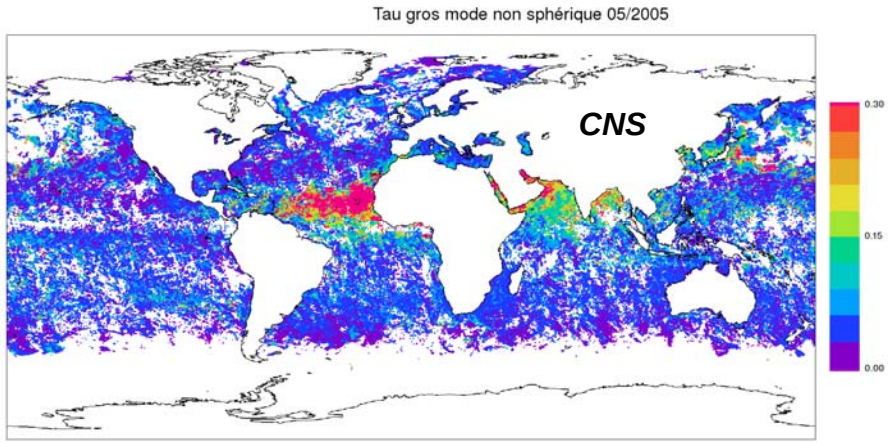
Global Aerosol Optical thickness - ocean

(@ 865 nm, monthly mean May 2005)



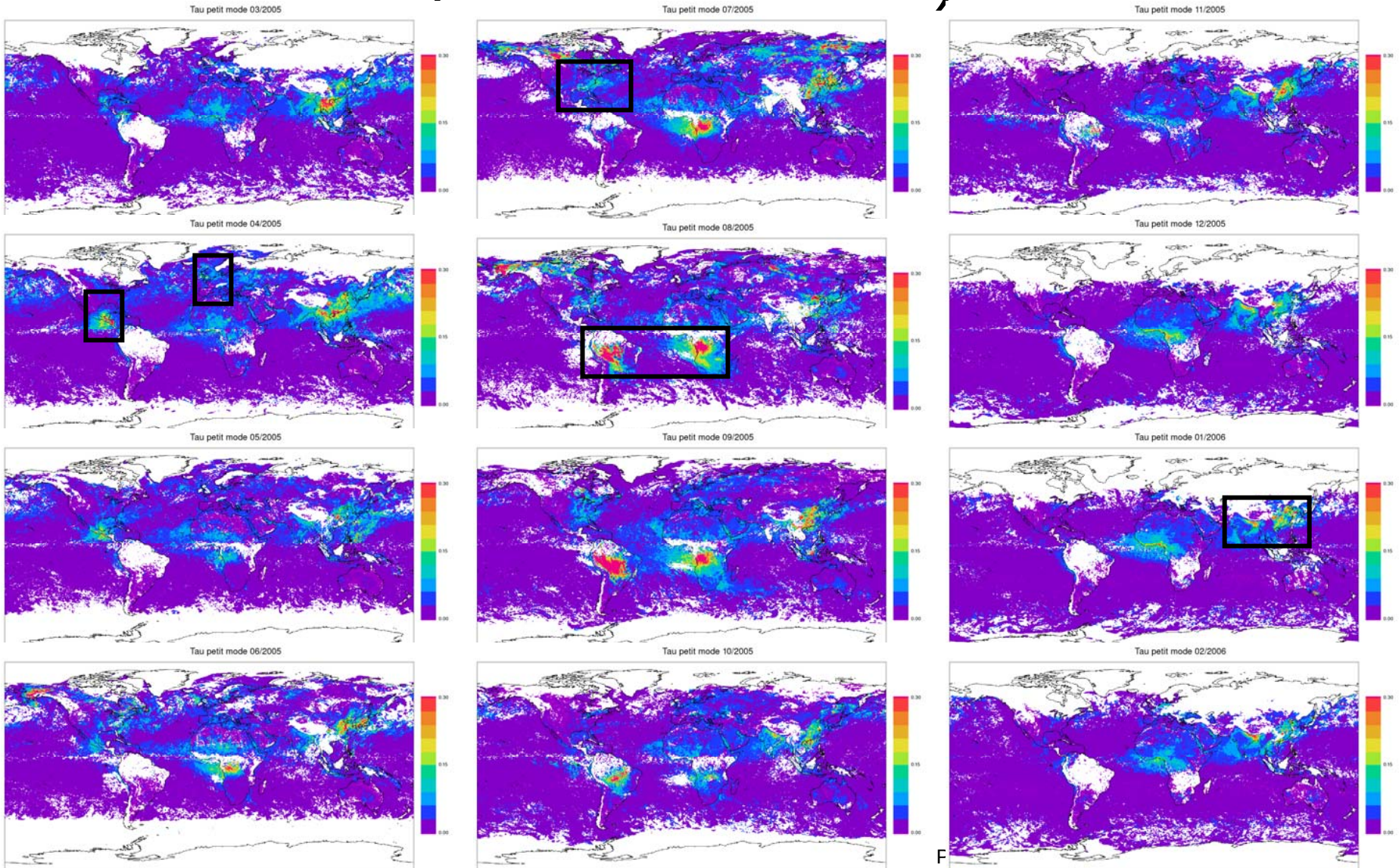






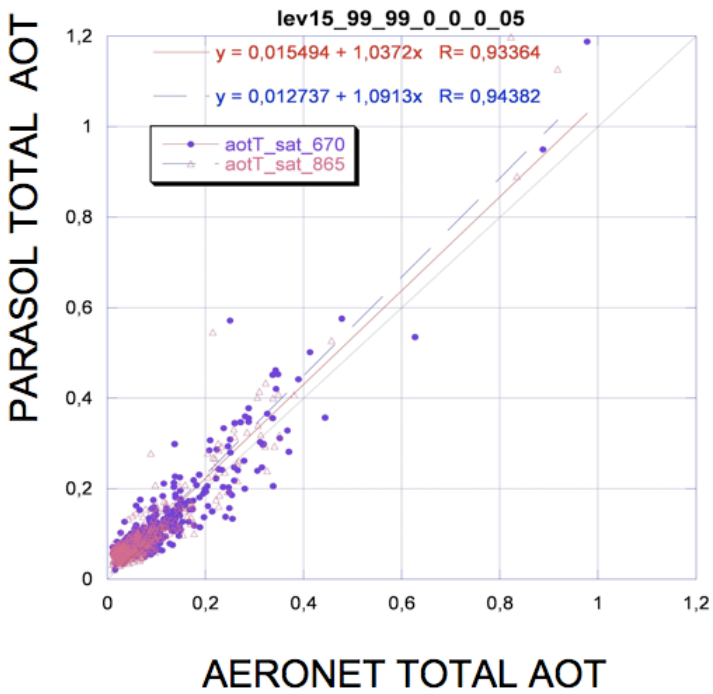
Parosol & the A-Train, AEROCOM, October 2006

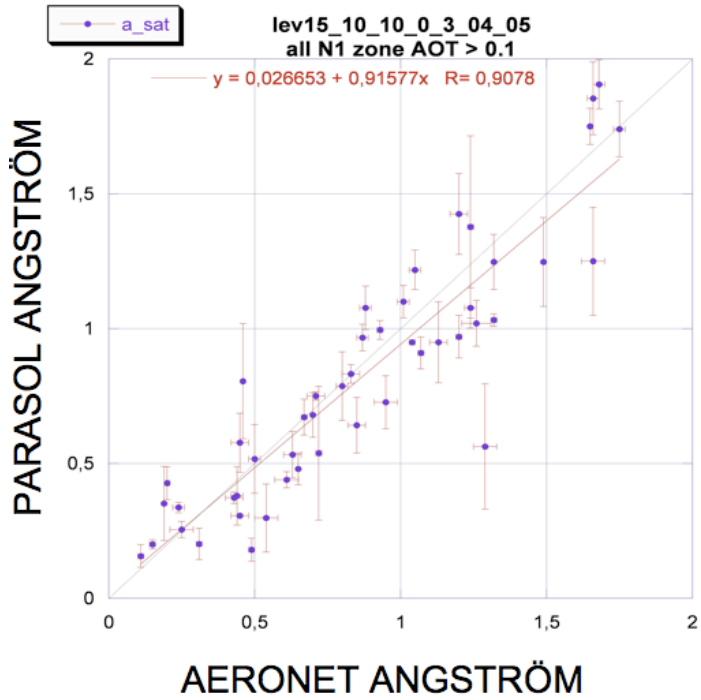
Fine Mode AOT Land & Ocean (03/2005-02/2006)



F

Validation versus Sun photometer observations. Ocean

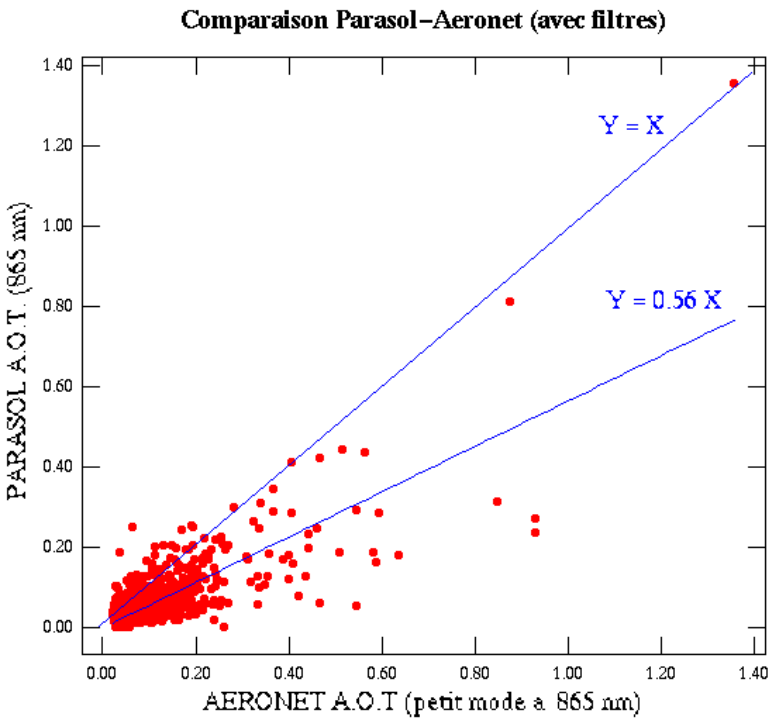




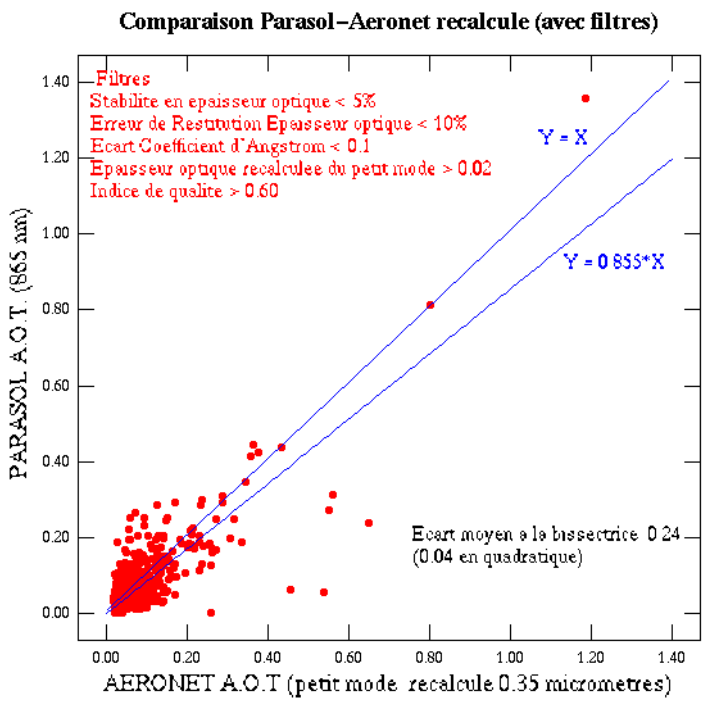
Agreement within 0.04 @865nm

(Goloub et al., 2006)

Validation versus Sun photometer observations. Land



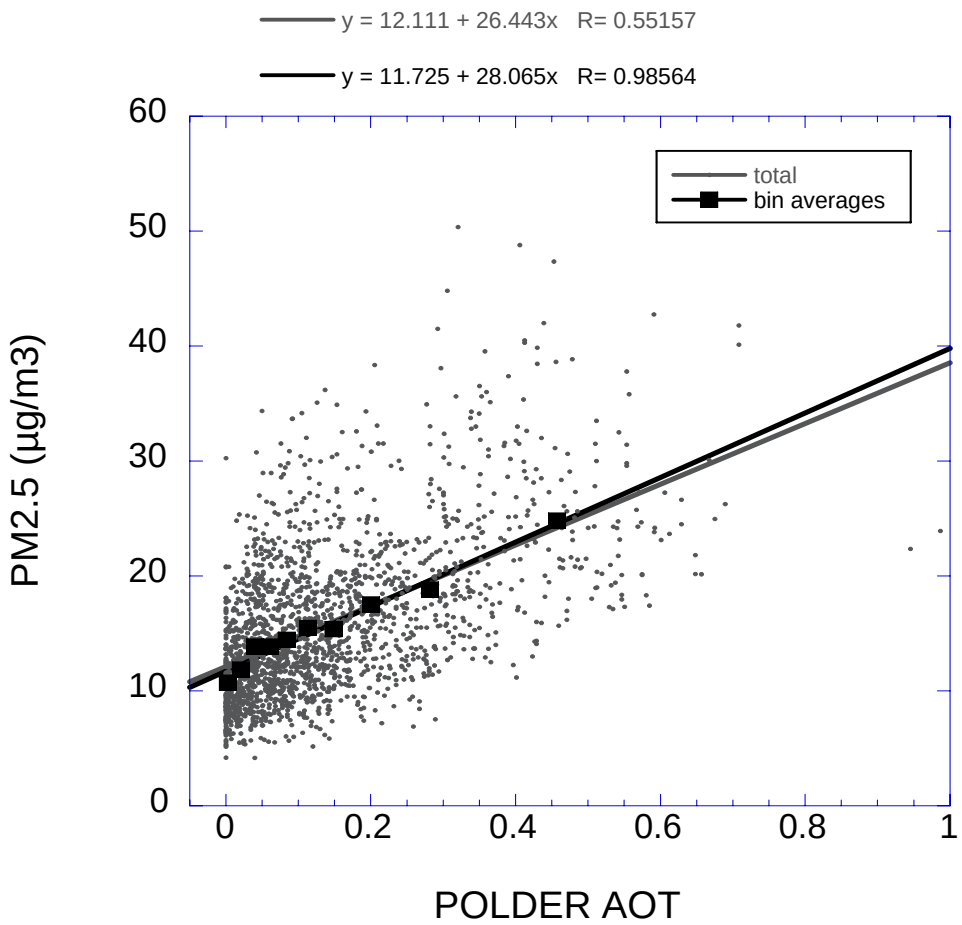
F-AOT (<0.6 µm)



F-AOT (<0.35 µm)

Courtesy of J.-L. Deuzé, LOA

Application to ground PM2.5 monitoring



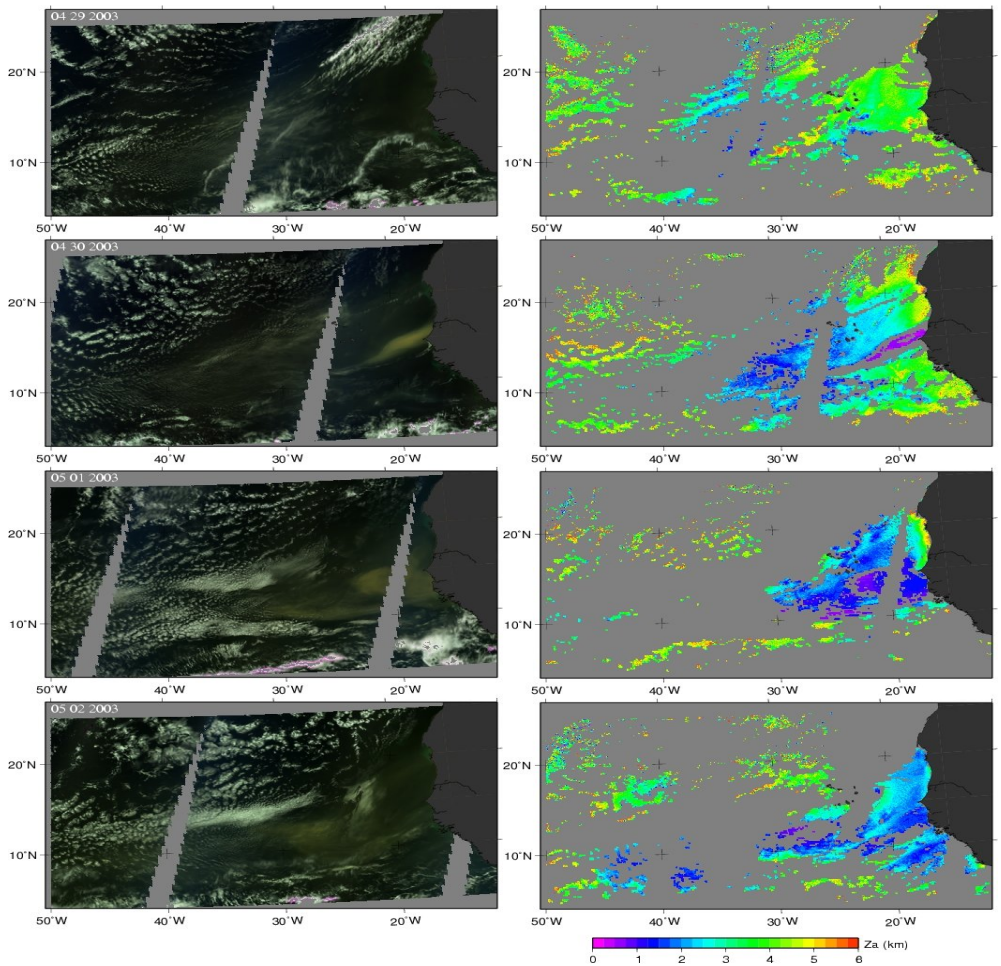
- Direct comparison of ground PM2.5 and F-AOT (POLDER-2 data) over France (28 stations,1974 points)
- Threshold of AOT=0.17 at 440 nm corresponds to EPA “moderate” AQC (daily concentration above 15.5 µg/m3)

Kacelenenbogen et al., ACPD, 2006

Research Products
Dust height scale from PO_2

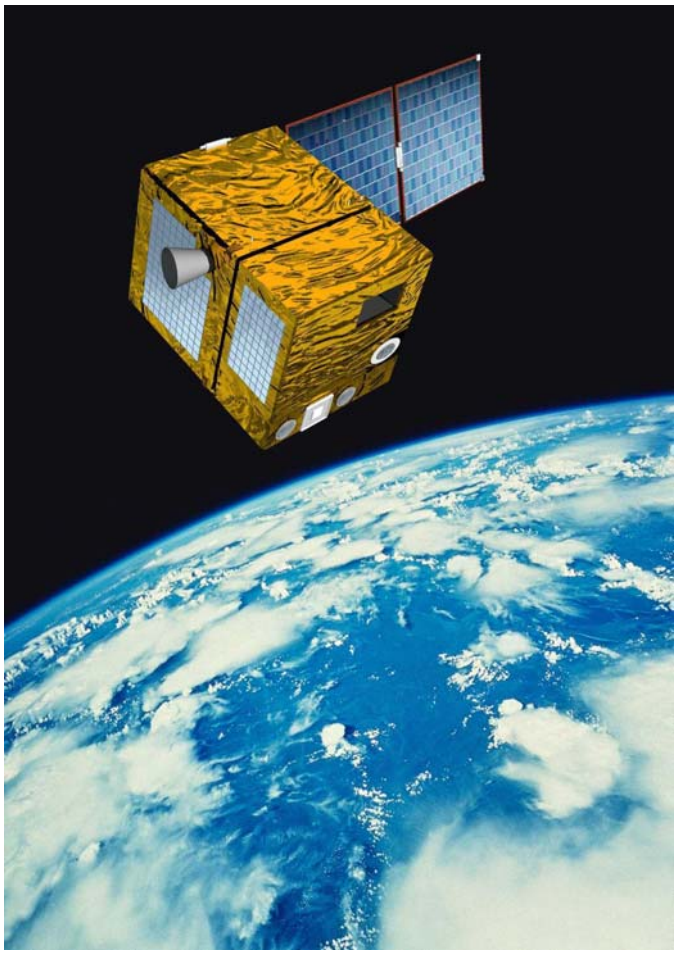
Theoritical accuracy of the retrieval as a function of the AOT

δ_{aero}	ΔZ_a (km)
0.1	2.1
0.2	1.2
0.3	0.9
0.6	0.6
0.9	0.5



Dubuisson et al., to be written, 2006

PARASOL



Polarization and

Anisotropy of

Reflectances for

Atmospheric

Sciences coupled with

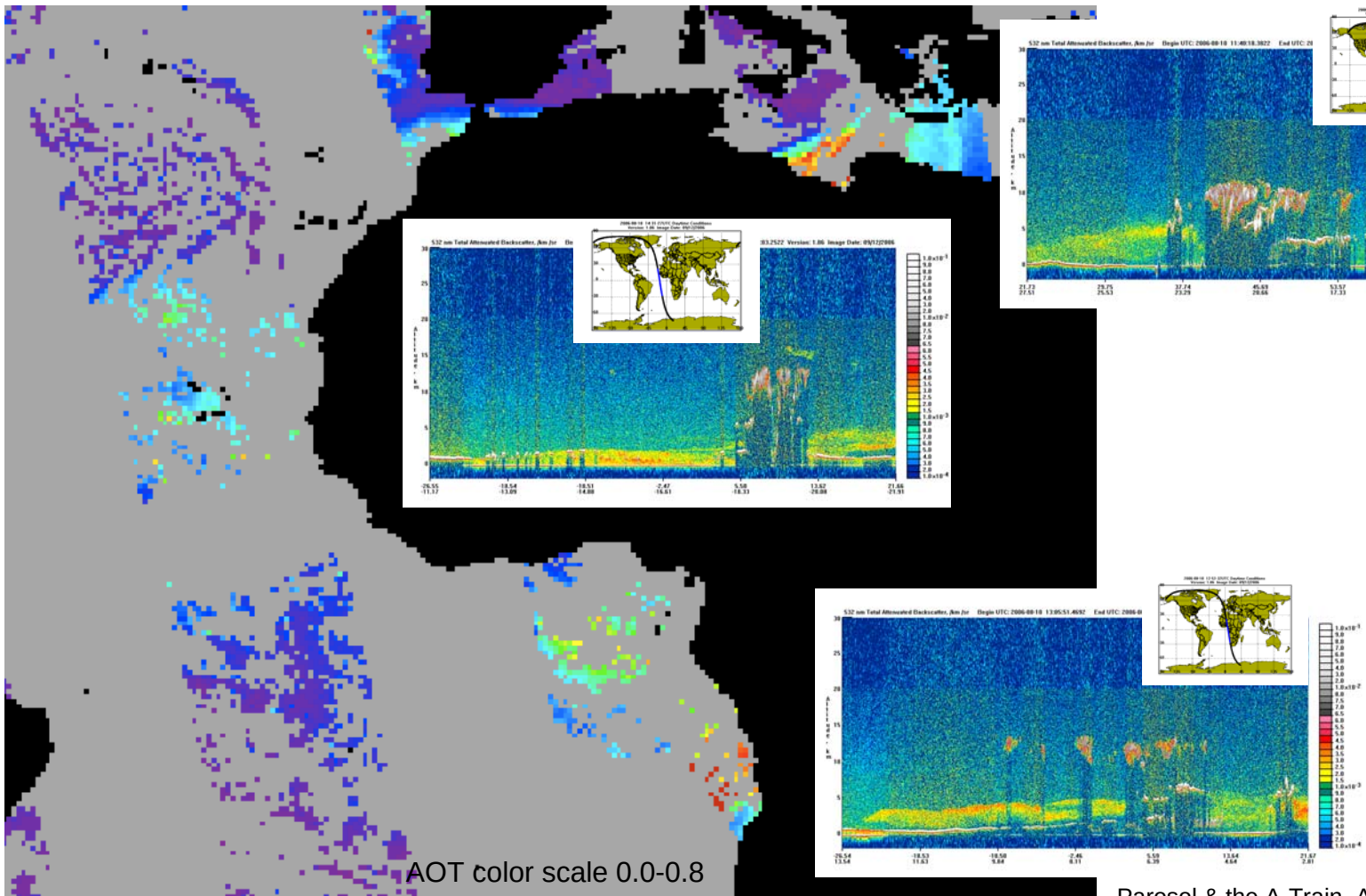
Observations from a

Lidar

The third dimension

August, 10th 2006

PARASOL AOT, CALIOP att. Backscatt. Coef. 532nm



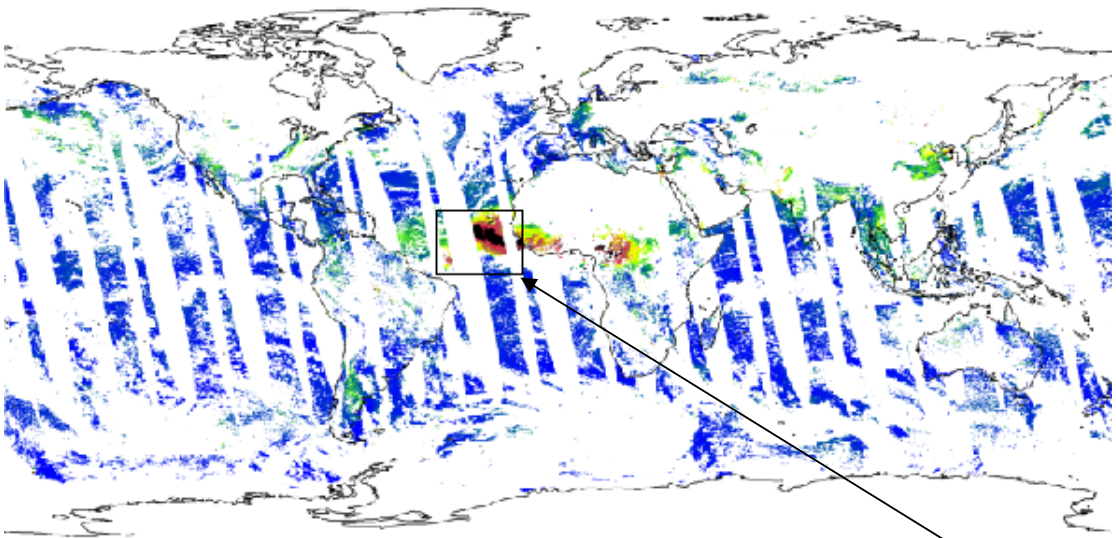
AOT color scale 0.0-0.8

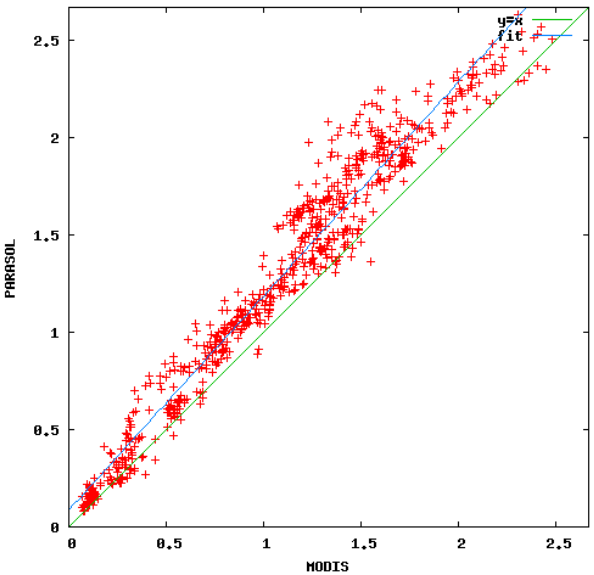
Parosol & the A-Train, AEROCOM, October 2006

A-Train synergy

- Different ways of combining data
  - Comparison/ validation of products or hypothesis
    - AOT, F-AOT (Parasol-Modis)
    - Cloud mask (Parasol-Modis-Caliop)
    - PO2, Rayleigh pressure (Parasol-Caliop-Omi)
    - Intercomparison of retrieval methods

MODIS-PARASOL



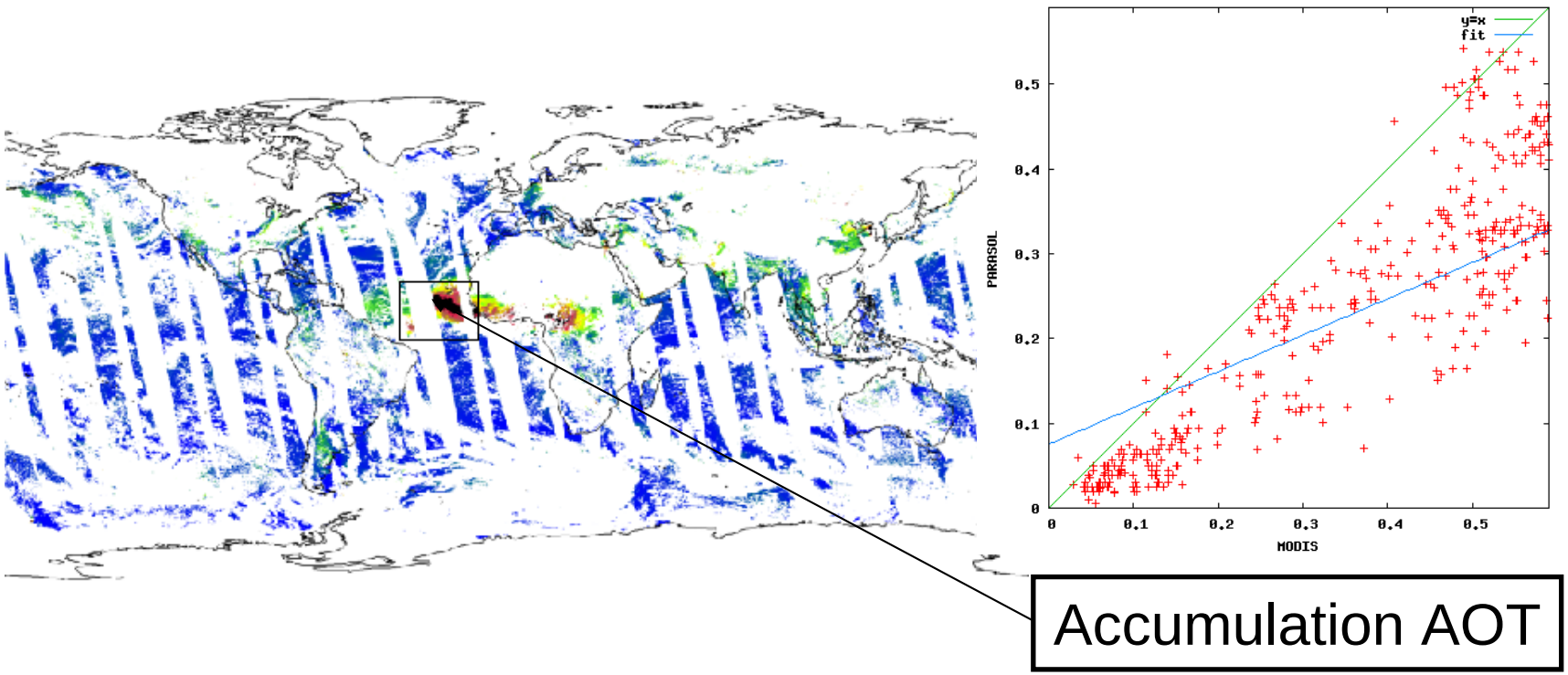


Total AOT

13 March 2006

Tanré et al., 2006

MODIS-PARASOL



Accumulation AOT

13 March 2006

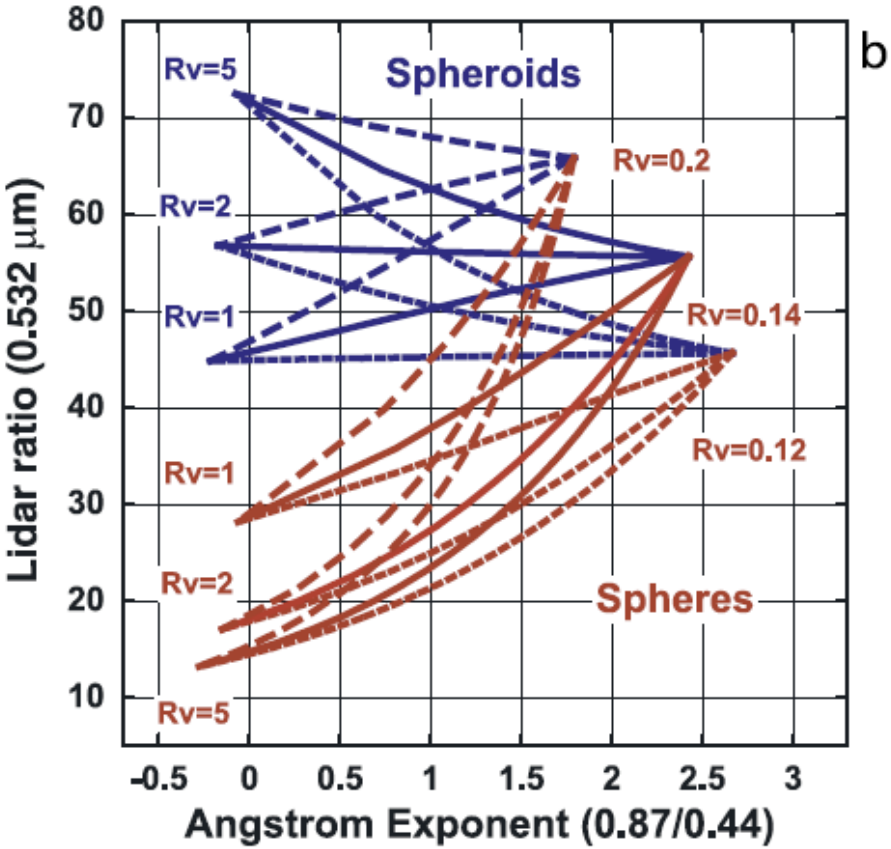
A-Train synergy

- Different ways of combining data
  - *Comparison/ validation of products or hypothesis*
    - *AOT, F-AOT (Parasol-Modis)*
    - *Cloud mask (Parasol-Modis-Caliop)*
    - *PO2, Rayleigh pressure (Parasol-Caliop-Omi)*
    - *Intercomparison of retrieval methods*
  - New joined algorithms
    - Parasol-MODIS SWIR information
    - Lidar aerosol retrieval constrained by radiometer observations

Benefices of combining PARASOL-Calipso Lidar

- Lidar extinction profiles retrievals depends on the choice of the lidar ratio
  - Lidar ratio depends on aerosol type,size, shape that can be assessed (column) by PARASOL

Non sphericity



- Simulation of lidar ratio and Angstrom exponent for a bimodal size distribution using sphere and spheroid (Dubovik et al., 2006)
- Coarse mode median radii 1, 2, 5 μm; fine mode median radii 0.12, 0.14, 0.2 μm

- Various value of the lidar ratio for a given Ang. Expon.
- Non-spherical coarse particle have higher lidar ratio than spherical ones

Benefices of combining PARASOL-Calipso Lidar

- *Lidar extinction profiles retrievals depends on the choice lidar ratio*
  - *Lidar ratio depends on aerosol type,size, shape that can be assessed (column) by PARASOL*
- Development of new products by adding more constrains in the retrieval
  - Vertical profiles of extinction of total and fine fraction and effective radius
  - Method developed and applied to MODIS-Airborne lidar observations (Kaufman et al., IEEE 2003; GRL, 2003; Léon et al., JGR, 2003, Waquet et al., JGR, 2005)
  - Application to PARASOL at work
    - Data processed at the Parasol L2 reference grid

PARASOL-CALIOP joined retrieval

- Basis (Daytime/cloud-free/ocean)
  - Use every possible combination of 1 fine and 1 coarse mode from the PARASOL set of models for a given fraction of non-spherical coarse particles
  - Use the ratio between 532 and 1064 nm lidar derived extinction coef. to adjust the respective contribution of the fine and coarse mode
  - Vertical integration of candidate profiles
  - Selected profiles matched best the Parasol inversion (within the accuracy of the Parasol retrieval)

Conclusions

- PARASOL fully operational within A-train
  - Products available at http://www-icare.univ-lille1.fr
- Unique polarization capabilities that provides information on particles type
  - Fine mode fraction, N-sphericity
- Various possibility of simple or advanced combination with A-Train observations
  - Passive-passive combination
  - Passive -active combination