Aerosol absorption measurements from space by the Aura-OMI sensor

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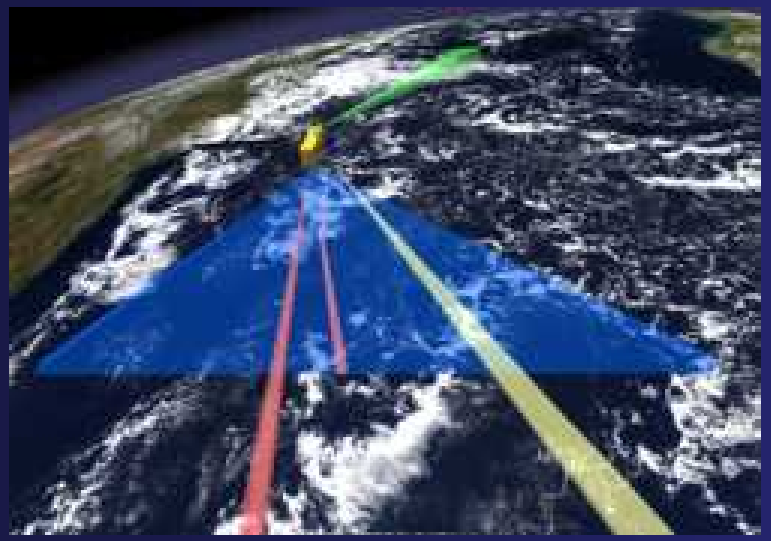
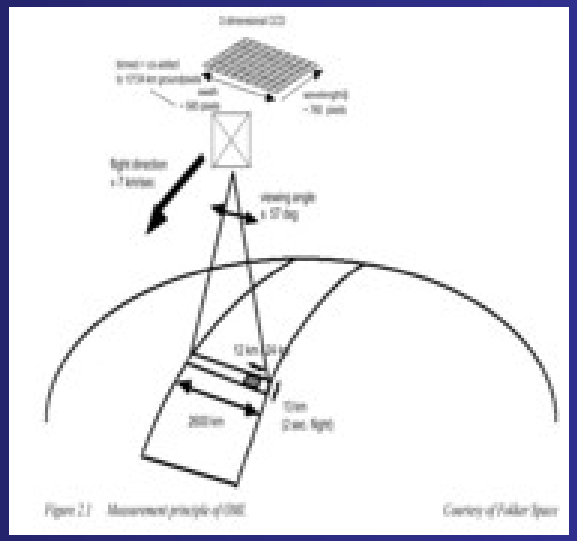
Outline of Presentation

-OMI Sensor
-Assessment of aerosol products
-2008 SH Biomass Burning Season
-OMI-Calipso Analysis

Ozone Monitoring Instrument (OMI)





Nadir solar backscatter spectrometer
-270-500 nm

-13X24 km footprint

-2600 km swath width

-Launched on 07-15-04

One of four sensors on the EOS-Aura platform

An international project: Holland, USA, Finland

Retrieval Products:
Radicals: Column O_3, NO_2, BrO, OClO
O_3 profile
Tracers: Column SO_2
Cloud top pressure
Aerosols

Aerosols:

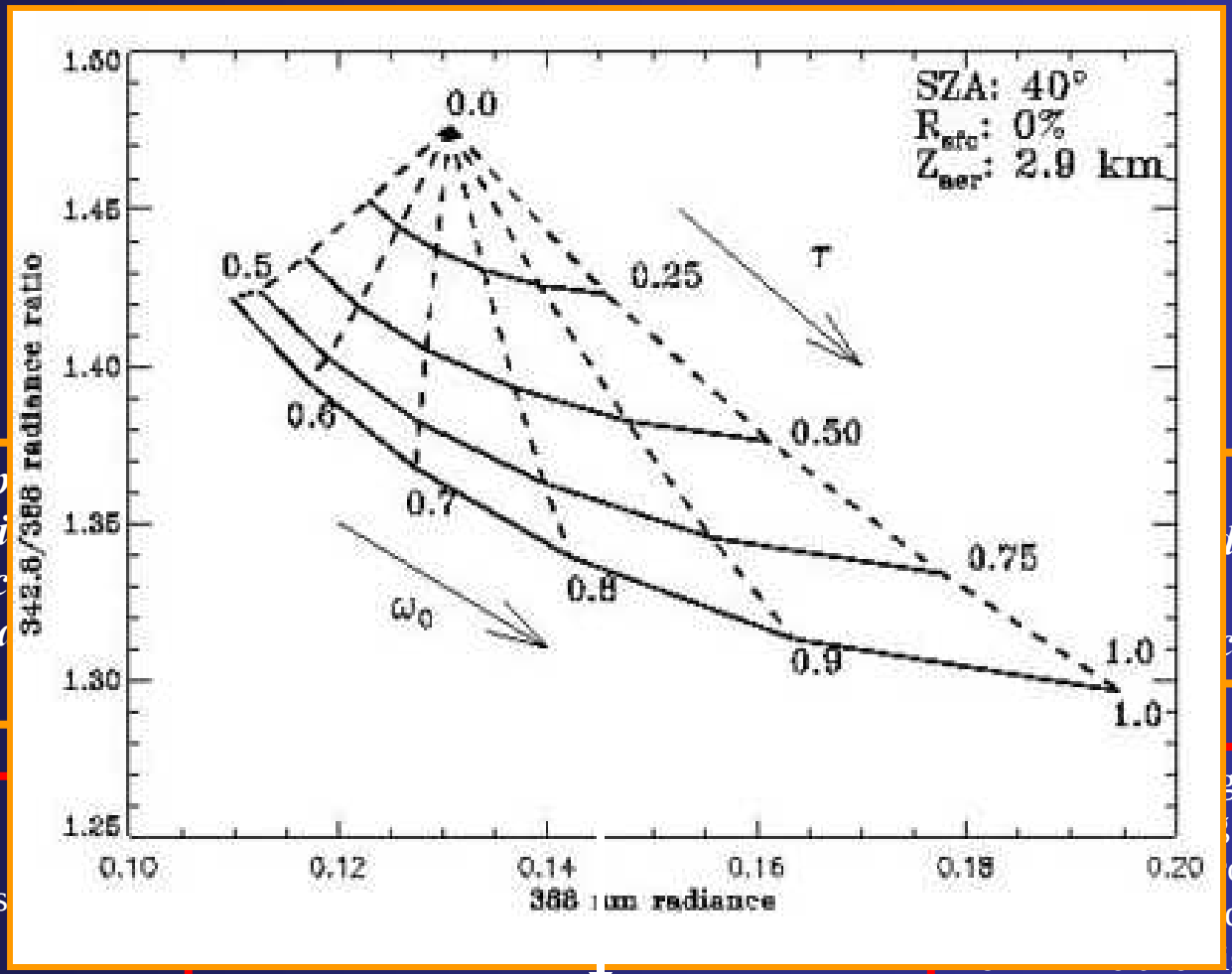
Near UV Algorithm
-Aerosol Index (AI)
-Extinction Optical Depth (AOD)
-Absorption Optical Depth (AAOD)

Multi-wavelength Algorithm
-Spectral Optical Depth, Aerosol type

Trans-oceanic Aerosol Transport as seen by OMI

LUT's:

Assumed aerosol p
-Particle size distri
-Real comp. refrac
-Relative spectral a
refractive index.



...lo (354, 388 nm)

...cal Distribution

Three aerosol types:
-Desert Dust
-Carbonaceous aeros
-Weakly absorbing
Seven aerosol models per type (varying ω_0)

Nodal points on:
Extinction Optical Depth
Single scattering Albedo
Aerosol Layer Height

...ght
... (surface)
...osols:
...quator
...gh latitudes
-Desert Dust
Global monthly Climatology from GOCART calculations.

Retrieved parameters:

Absorbing Aerosol Index

Extinction optical depth τ_{ext}

Absorption optical depth τ_{abs} (354, 388, 500 nm)

Standard OMI retrieval:

Retrieves aerosol optical depth (AOD) and aerosol single scattering albedo (ω_o) for 5 different assumptions of aerosol layer height:

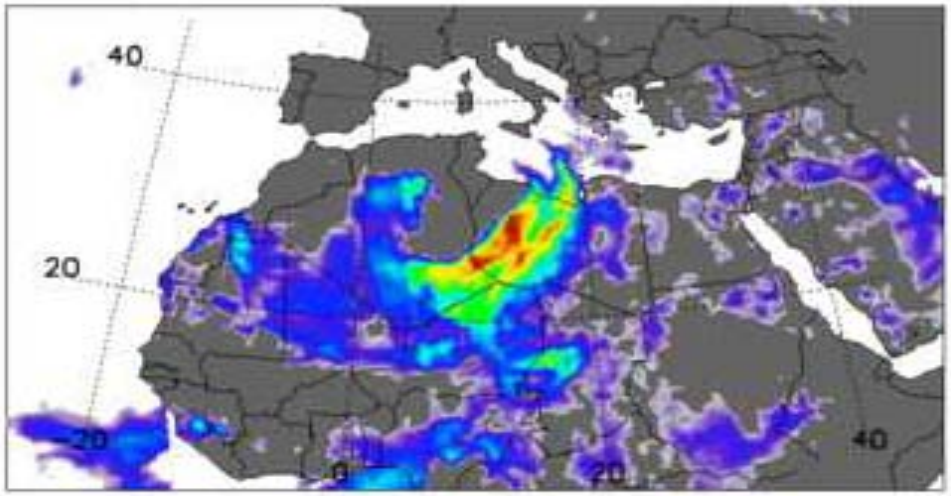
0 km	AOD1	$\omega_o 1$
1.5 km	AOD2	$\omega_o 2$
3.0 km	AOD3	$\omega_o 3$
6.0 km	AOD4	$\omega_o 4$
10 km	AOD5	$\omega_o 5$

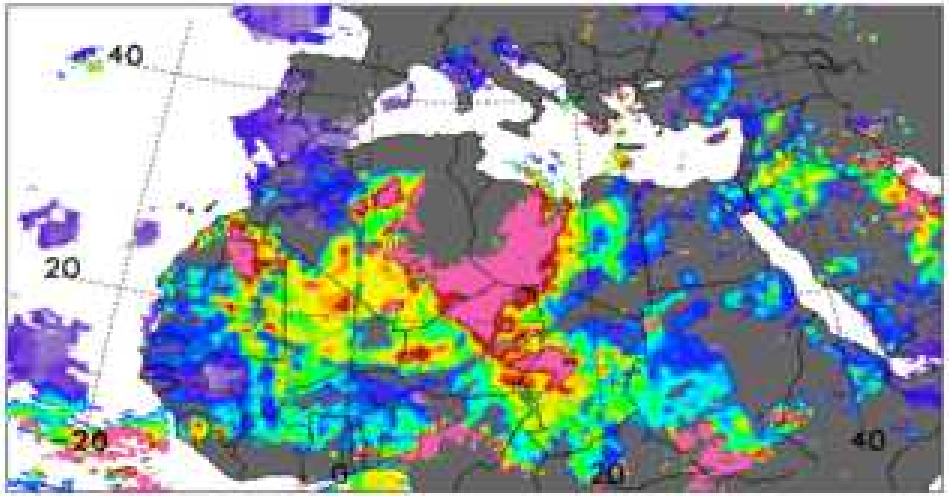
Then assumes an aerosol layer height from climatological considerations, and returns the most likely AOD and single scattering albedo .

Aerosol Absorption Optical Depth (AAOD) is calculated as AOD(1.-ω_o).

The height dependent set of retrievals as well as the recommended solution are reported in the Level-2 Product.

OMI Retrieved Dust Properties (March 9-2007)



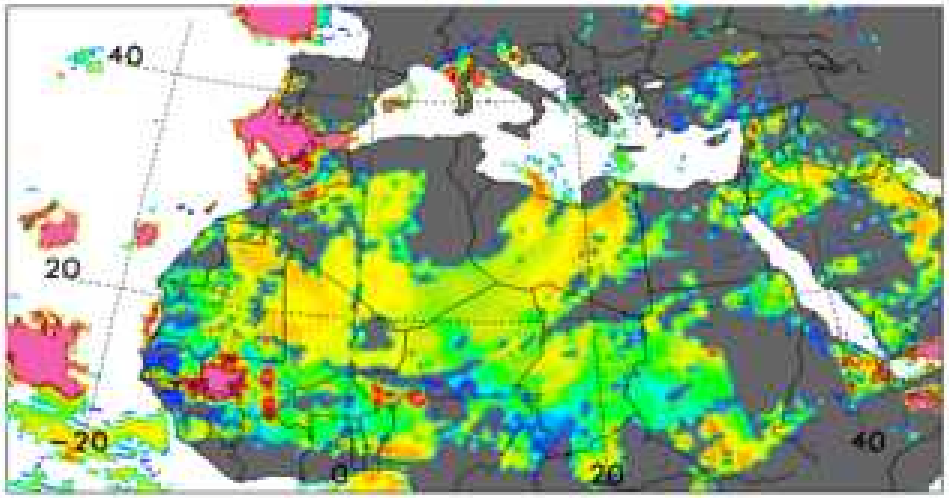


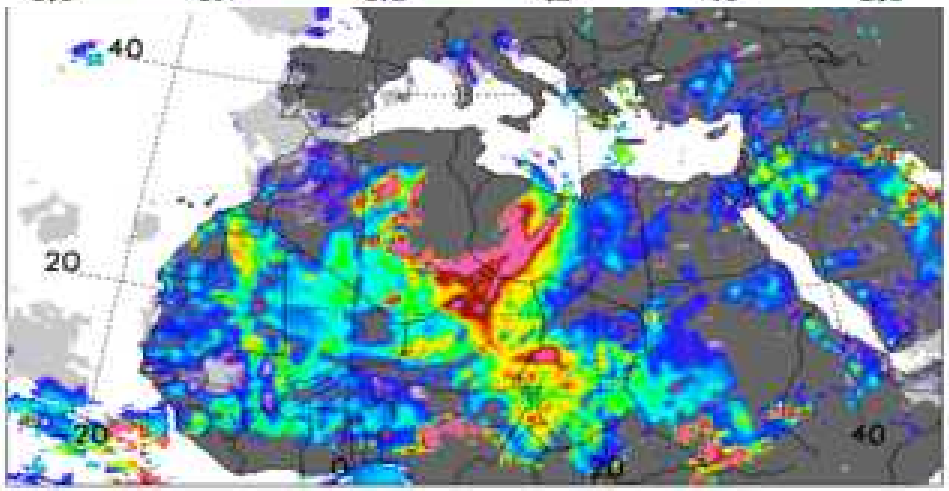
Aerosol Index

1.0 2.5 4.0 5.5

Aerosol Optical Depth

0.0 0.4 0.8 1.2 1.6 2.0





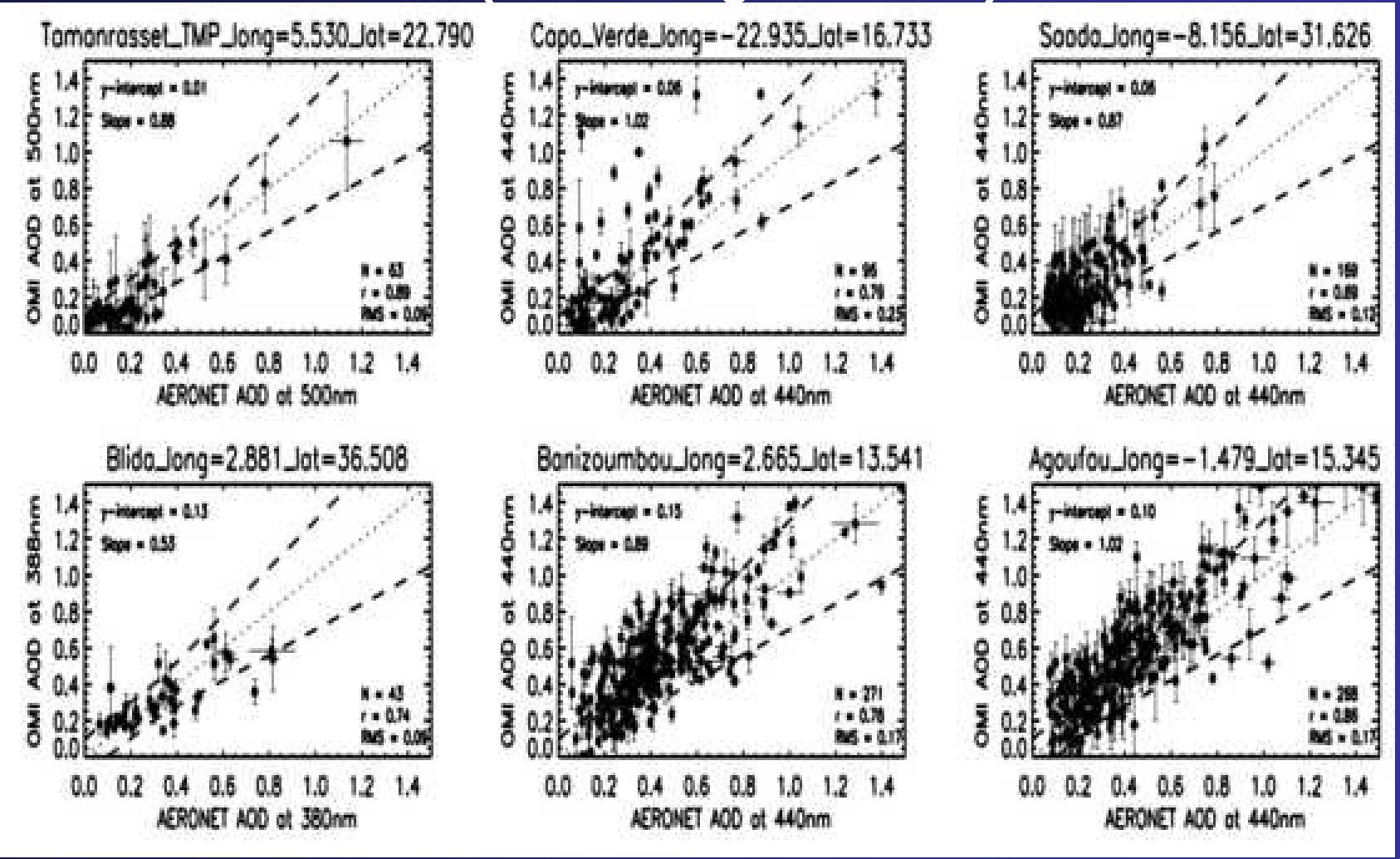
Single Scattering Albedo

0.75 0.80 0.85 0.90 0.95 1.00

Aerosol Abs. Optical Depth

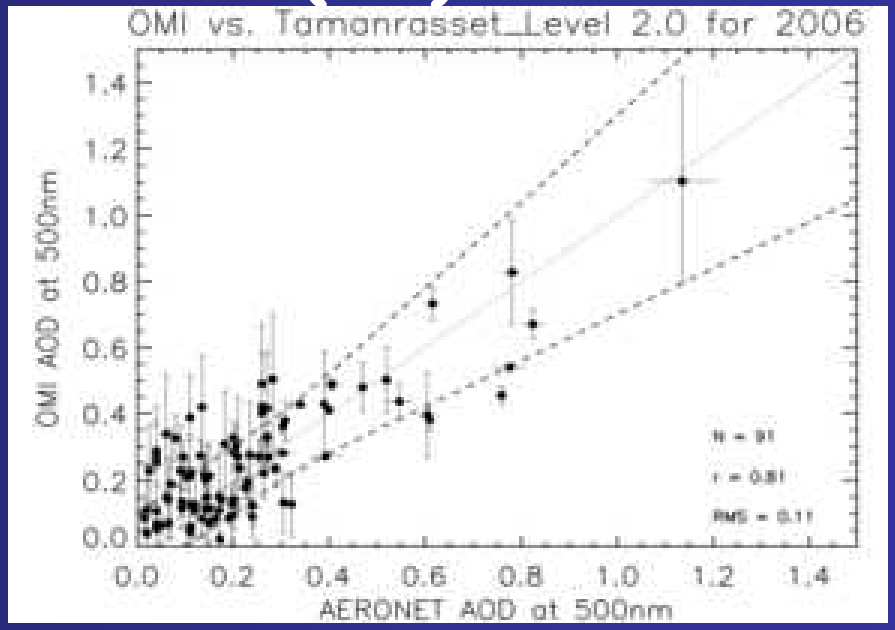
0.0 0.1 0.2 0.3

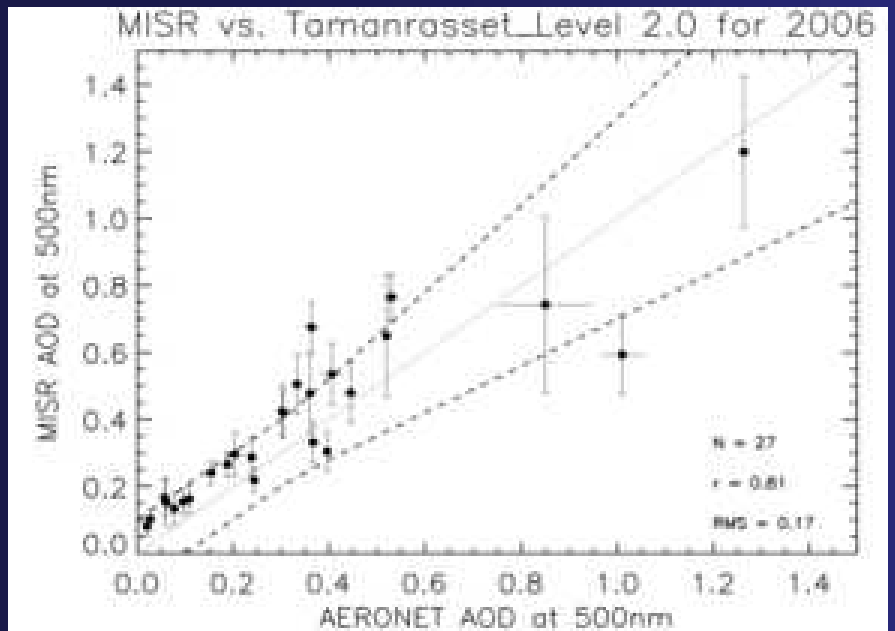
Evaluation of extinction AOT using AERONET observations (absorbing aerosols)

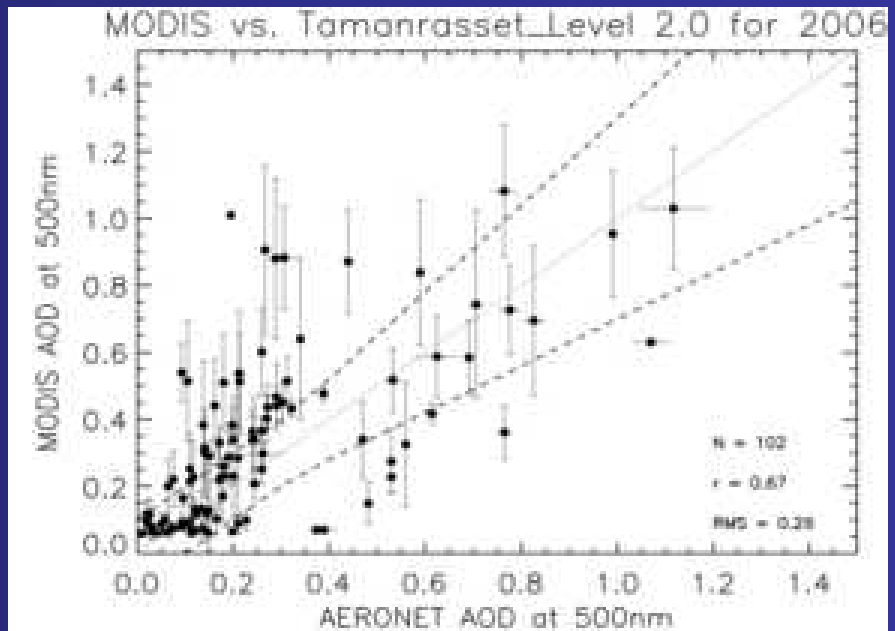


Under miminum sub-pixel cloud contamination conditions the OMI near-UV algorithm (OMAERUV) performs reasonably well.

Inter-satellite Comparison
OMI - MISR- MODIS (DB)

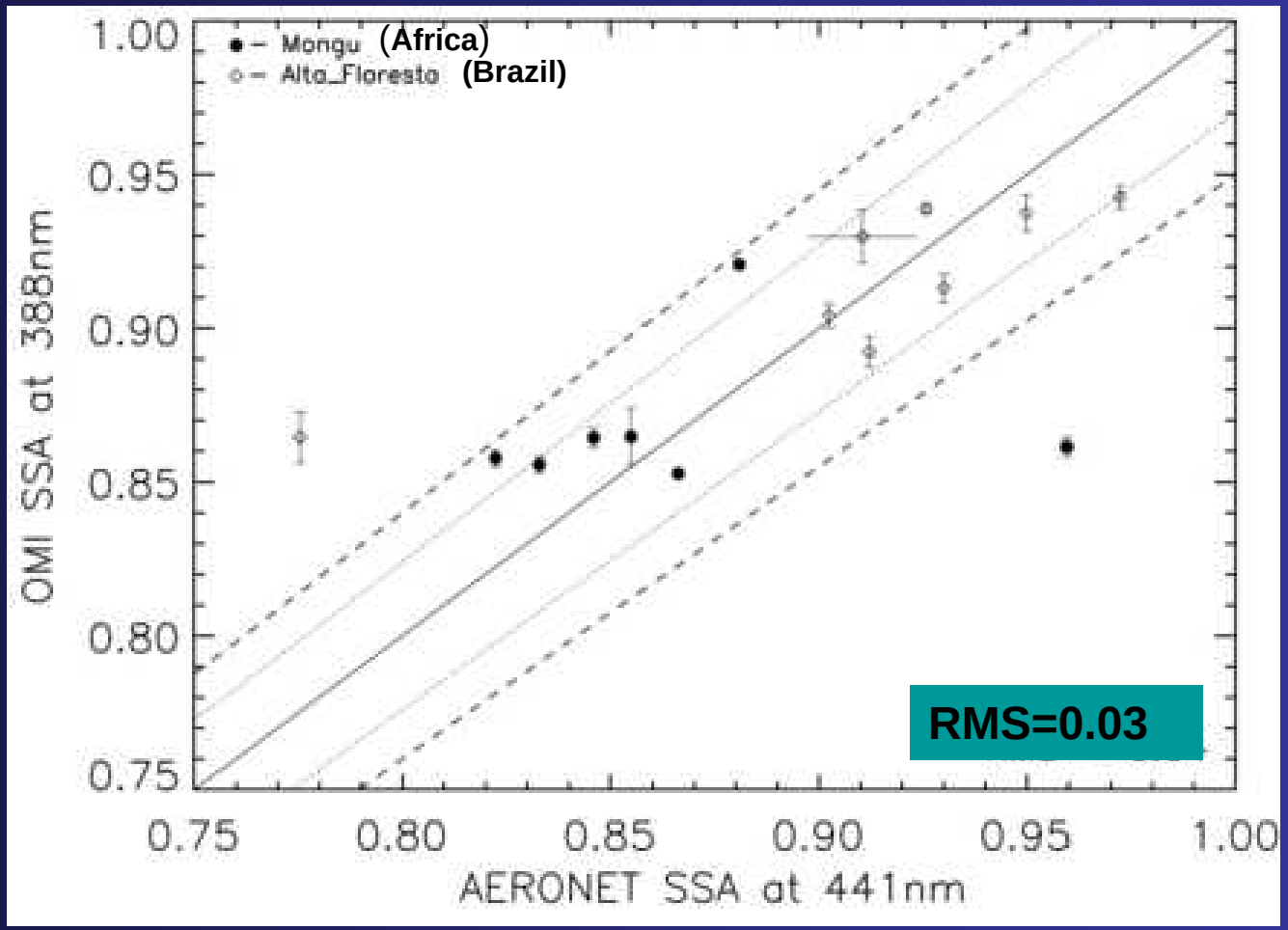




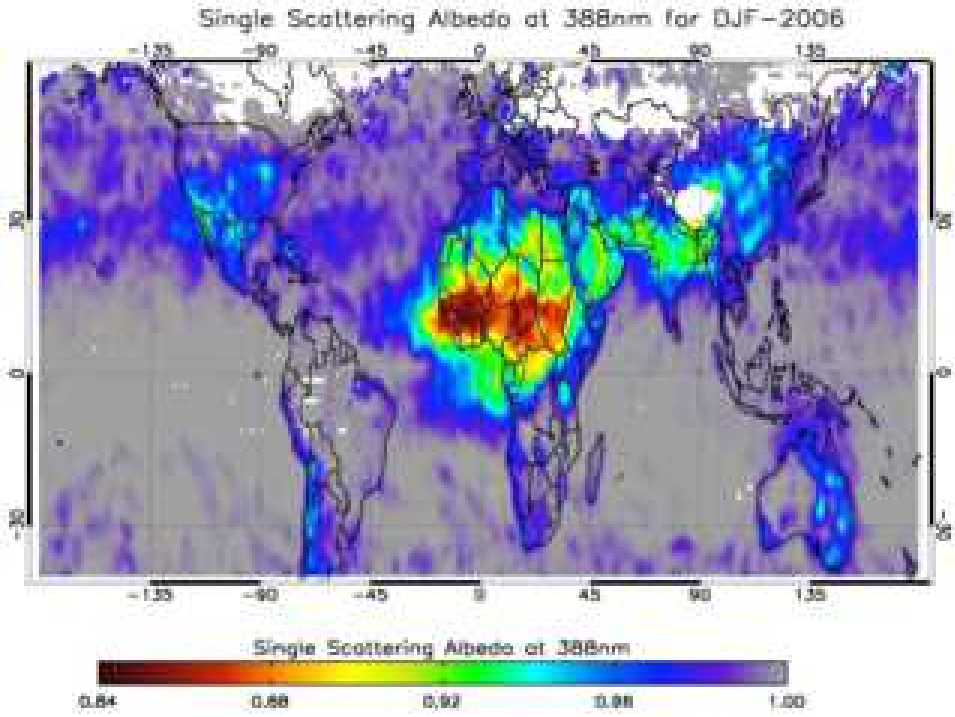


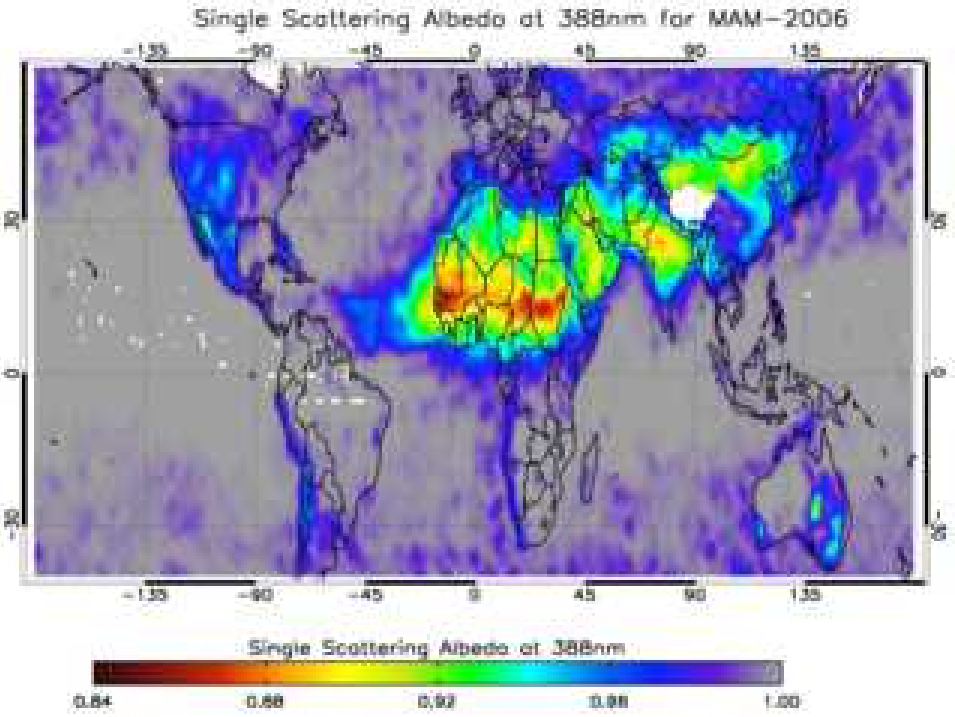
Assessment of OMI Aerosol Absorption Product

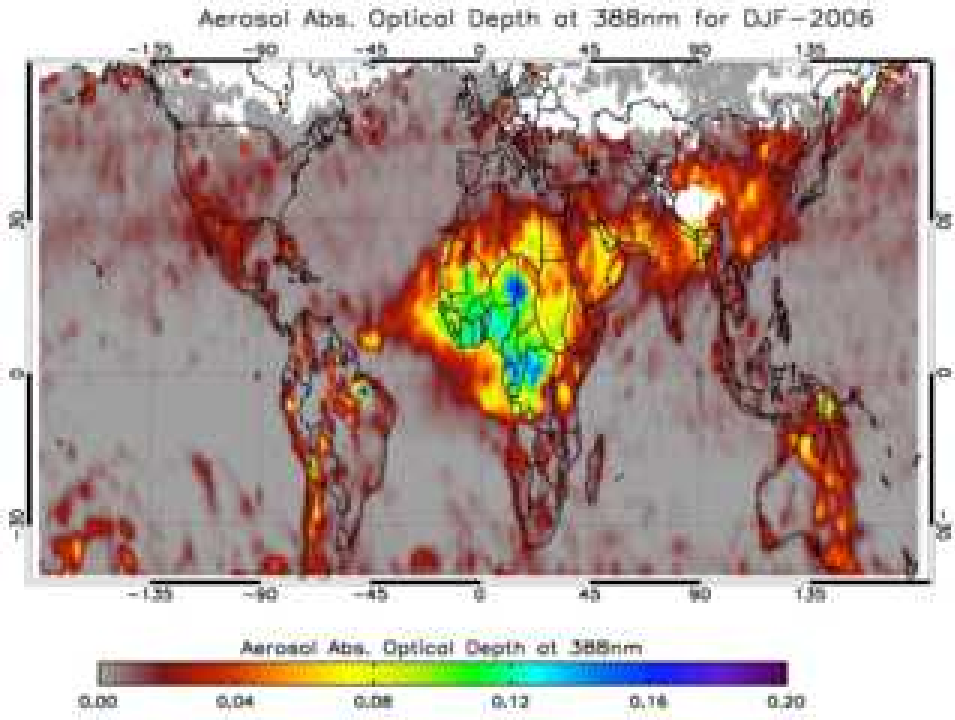
Comparison to AERONET Retrievals

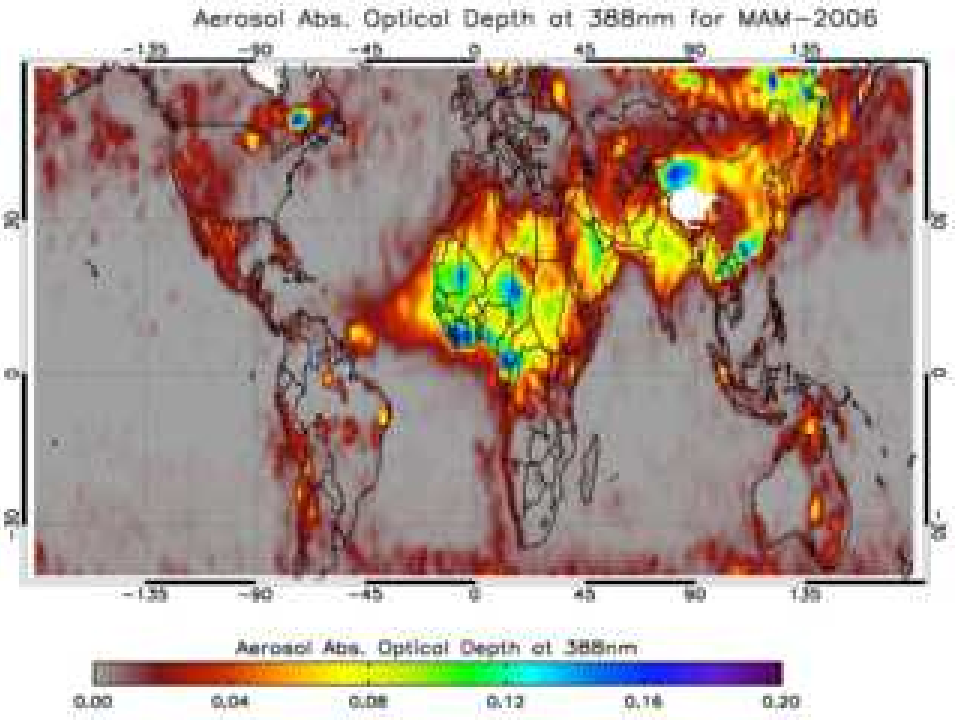


Absorption by Brazilian and African Savanna smoke

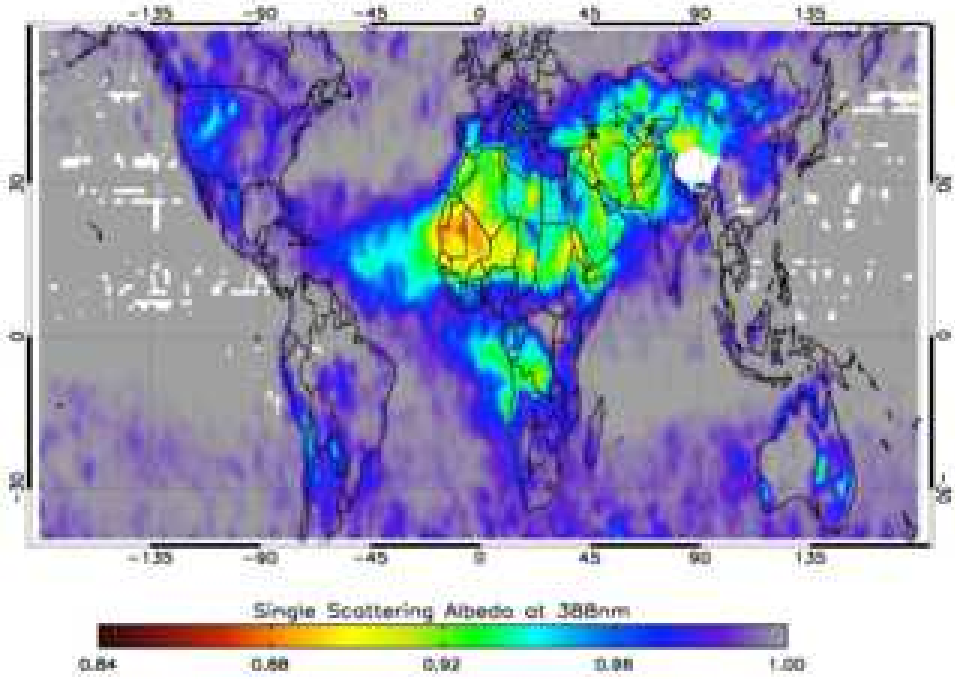

Single Scattering Albedo at 388nm for DJF-2006
-135
-90
-45
0
45
90
135
90
0
-90
Single Scattering Albedo at 388nm
0.84
0.88
0.92
0.96
1.00


Single Scattering Albedo at 388nm for MAM-2006
-135
-90
-45
0
45
90
135
90
0
-90
Single Scattering Albedo at 388nm
0.84
0.88
0.92
0.96
1.00

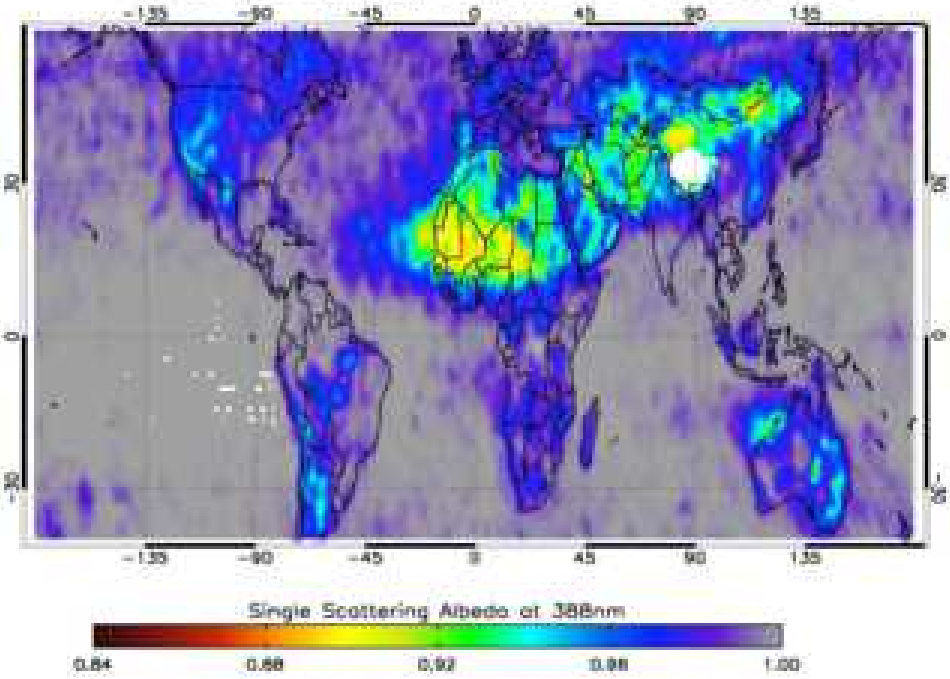

Aerosol Abs. Optical Depth at 388nm for DJF-2006
-135
-90
-45
0
45
90
135
90
0
-90
Aerosol Abs. Optical Depth at 388nm
0.00
0.04
0.08
0.12
0.16
0.20


Aerosol Abs. Optical Depth at 388nm for MAM-2006
-135
-90
-45
0
45
90
135
90
0
-90
Aerosol Abs. Optical Depth at 388nm
0.00
0.04
0.08
0.12
0.16
0.20

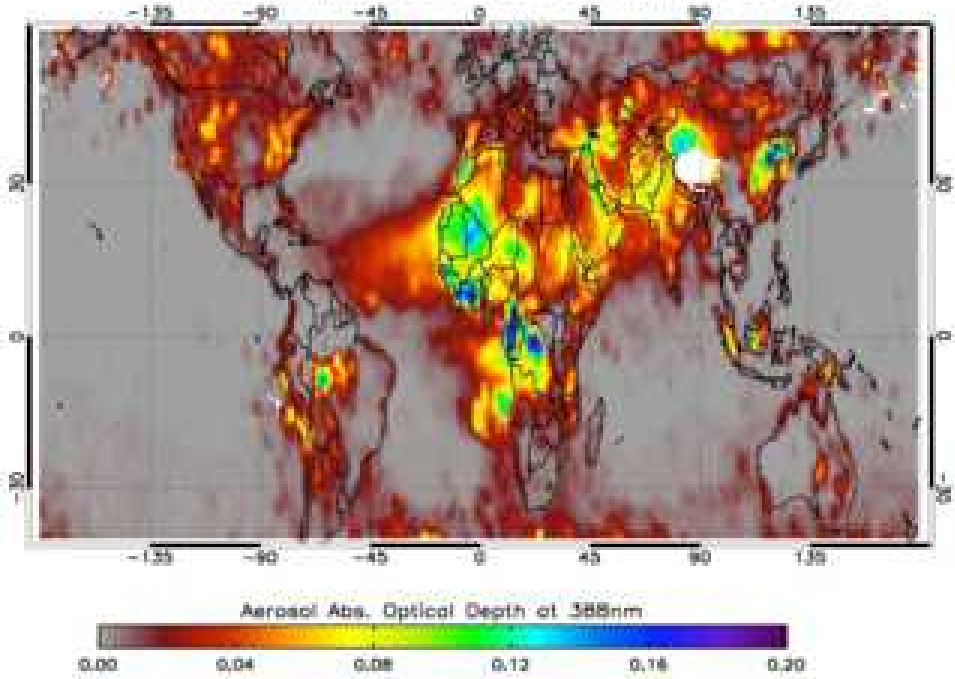
Single Scattering Albedo at 388nm for JJA-2006



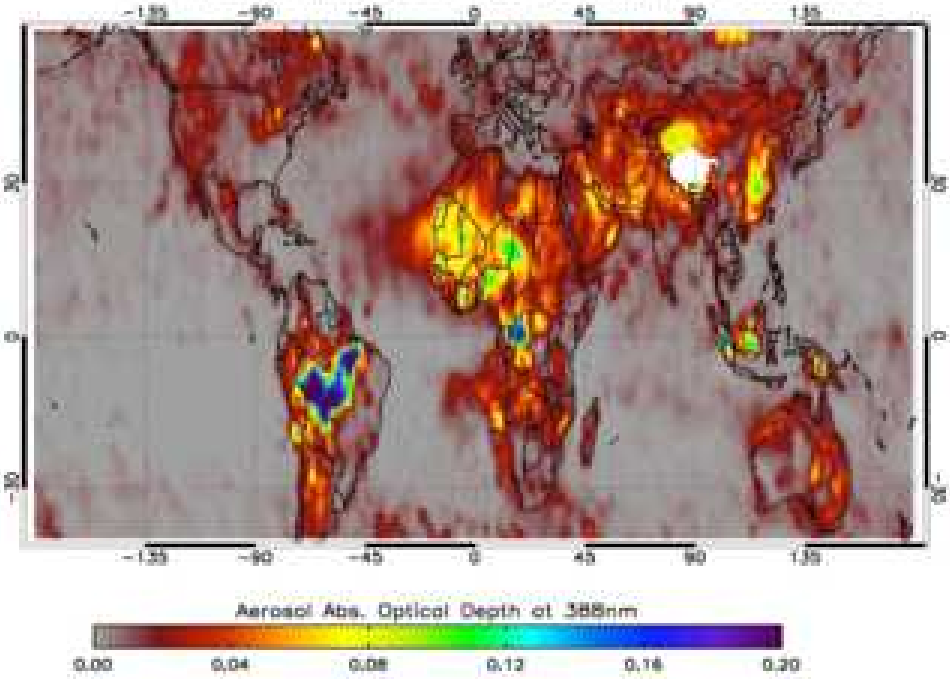
Single Scattering Albedo at 388nm for SON-2006



Aerosol Abs. Optical Depth at 388nm for JJA-2006

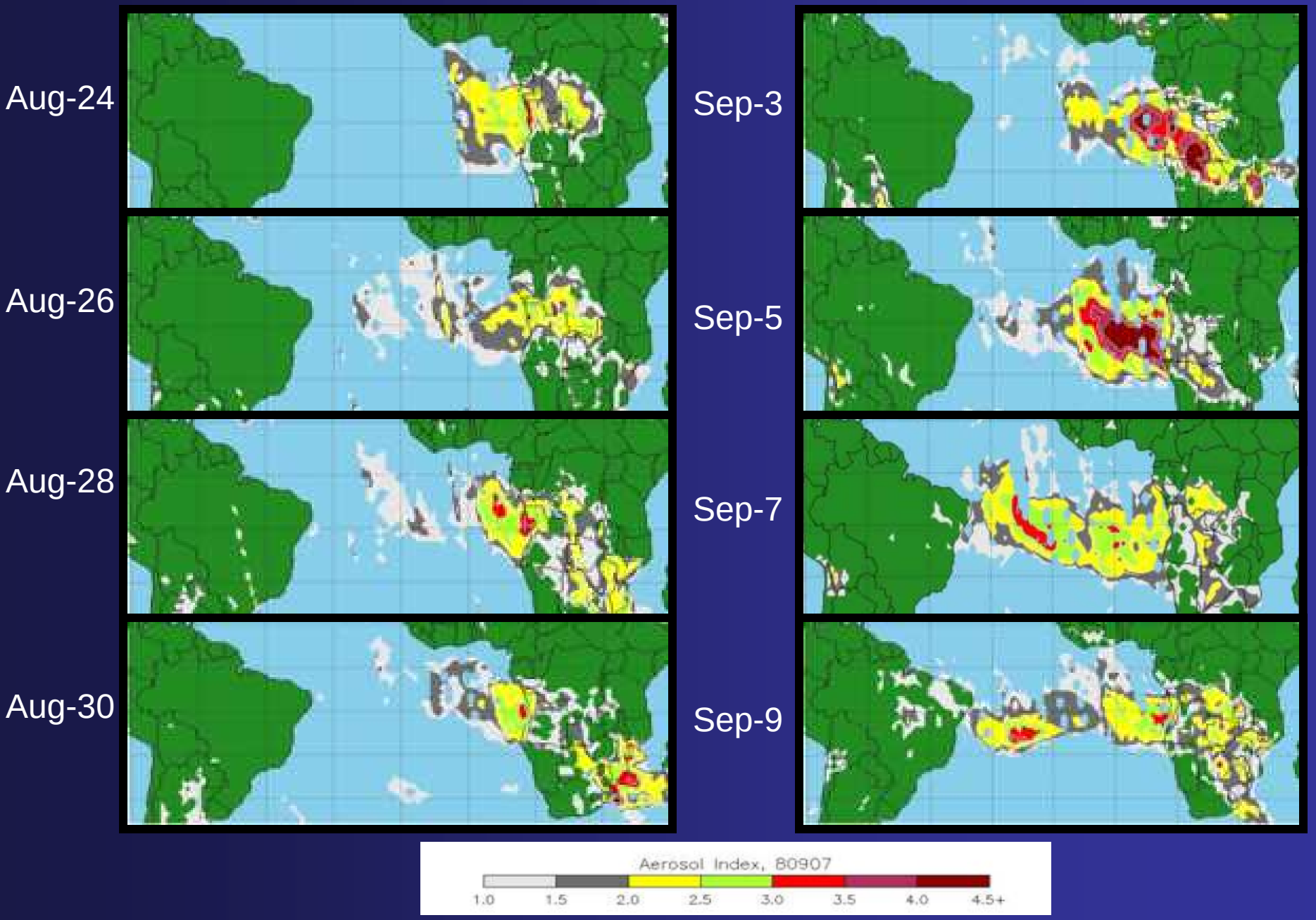


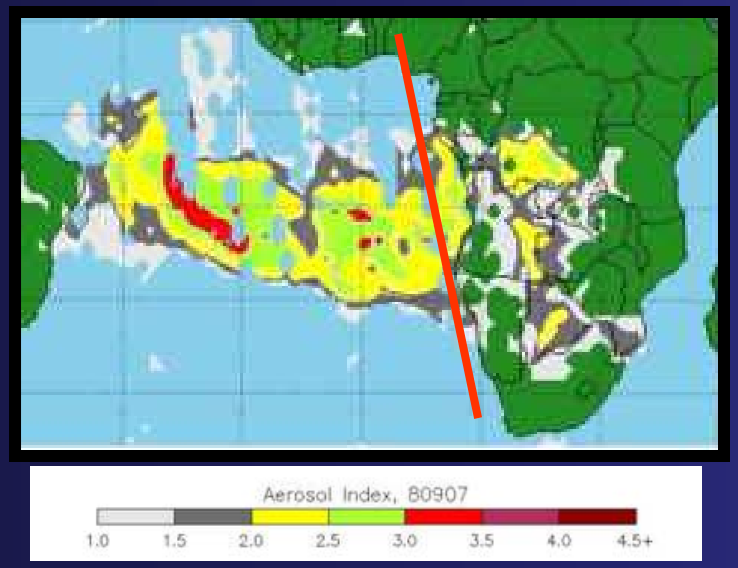
Aerosol Abs. Optical Depth at 388nm for SON-2006

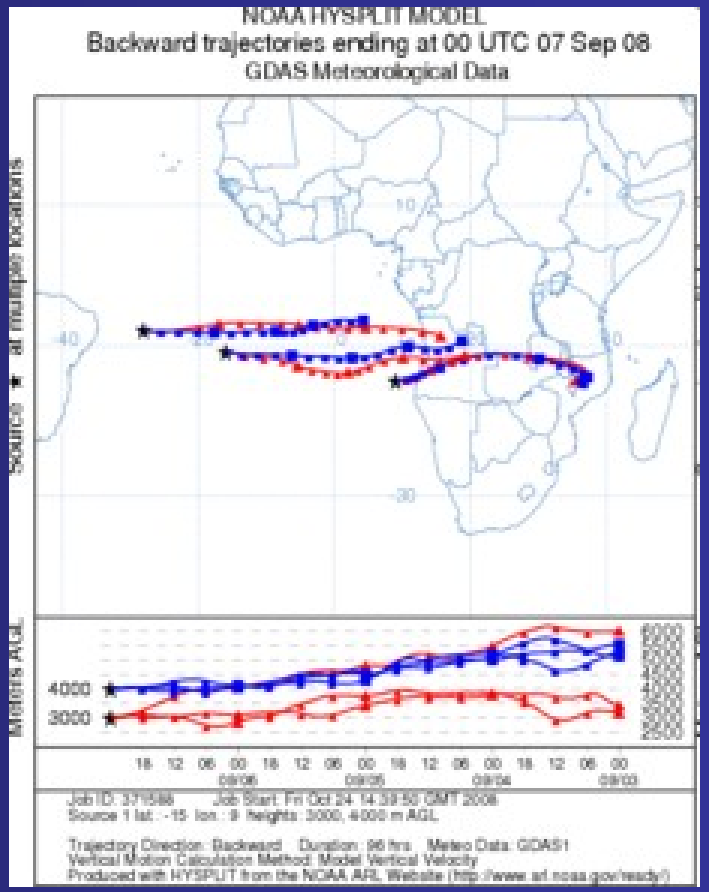


The anomalous 2008 Southern Hemisphere Biomass Burning Season Satellite Observations

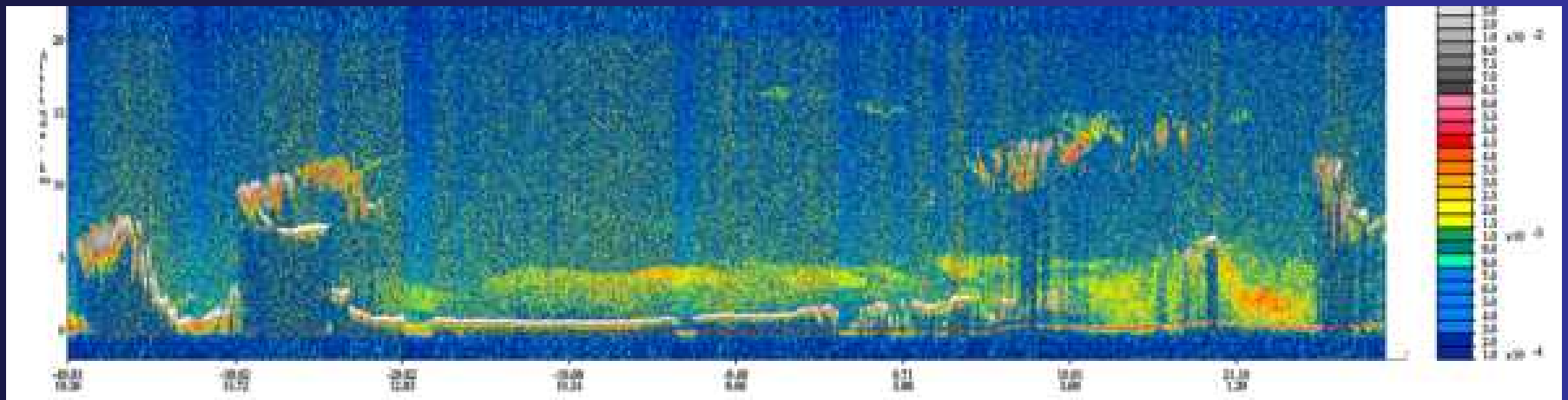
2008 Trans-Atlantic aerosol transport in the Southern Hemisphere





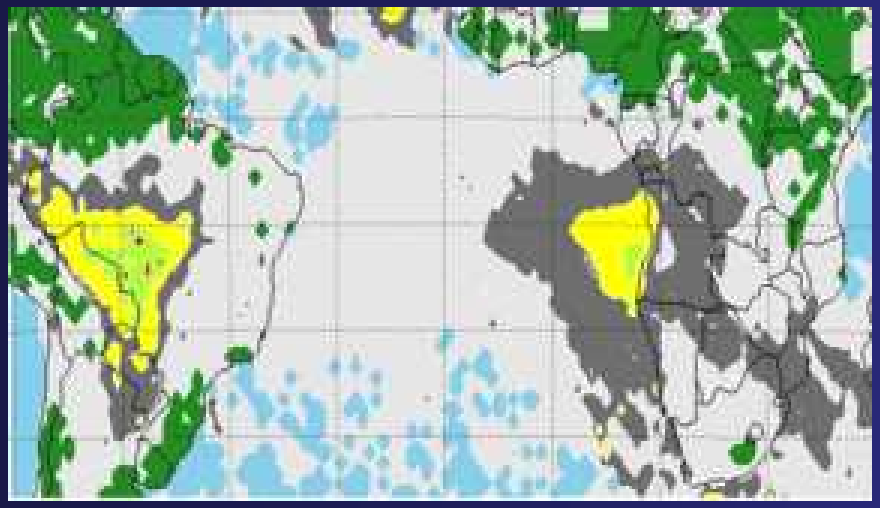


Smoke layer above clouds

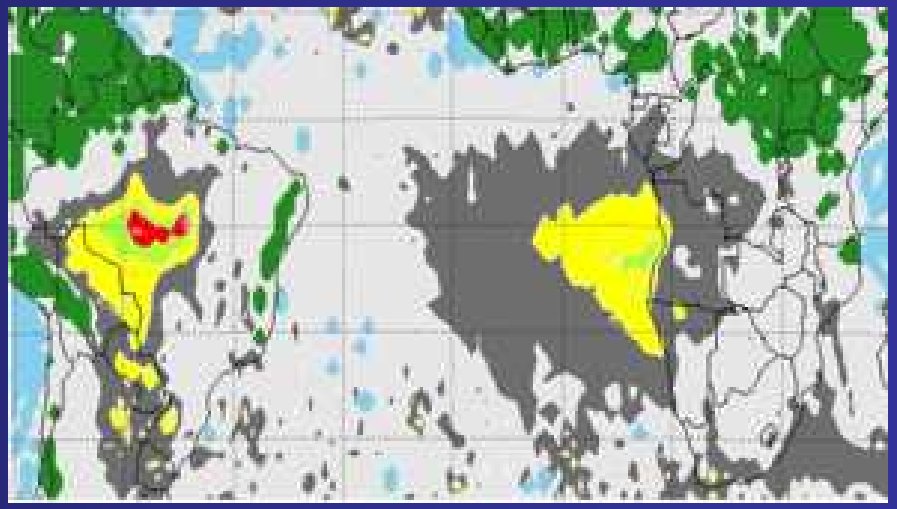


OMI Aerosol Index: Monthly Averages

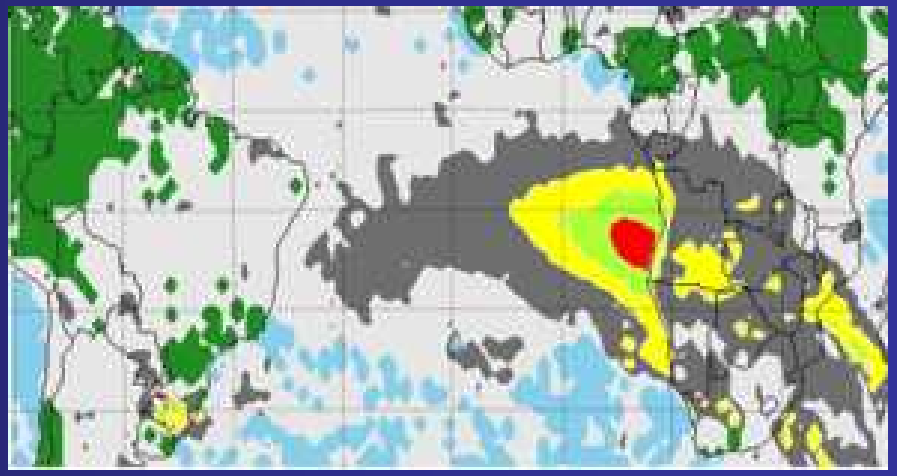
September 2005



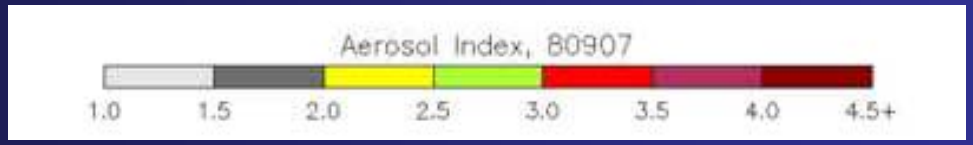
September 2007



September 2006

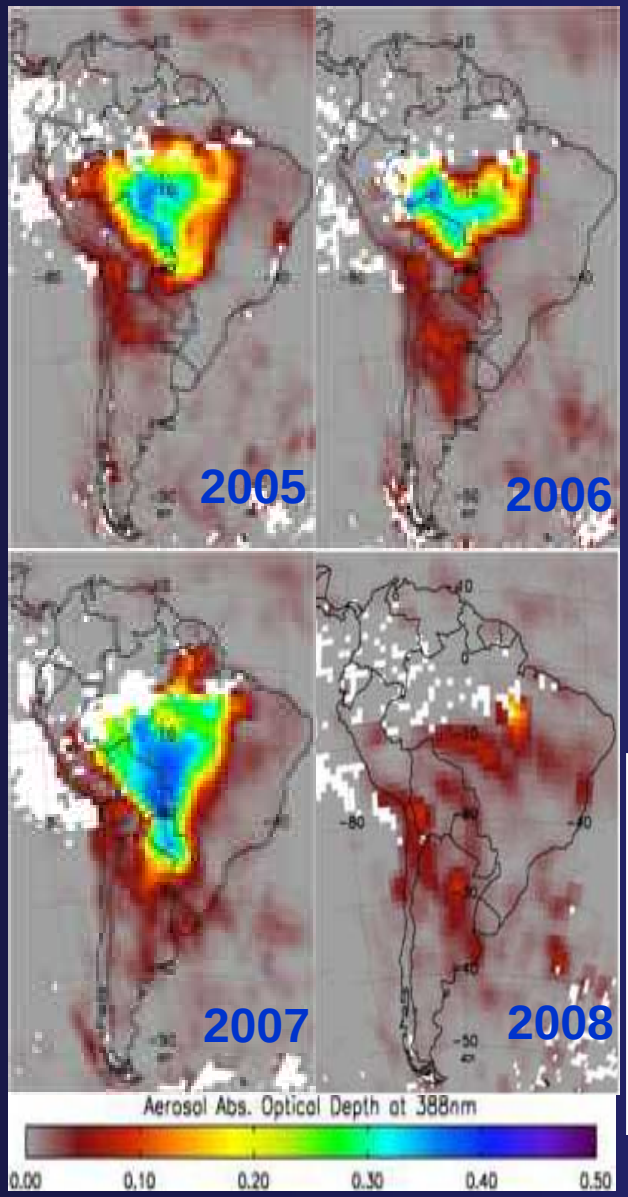


September 2008

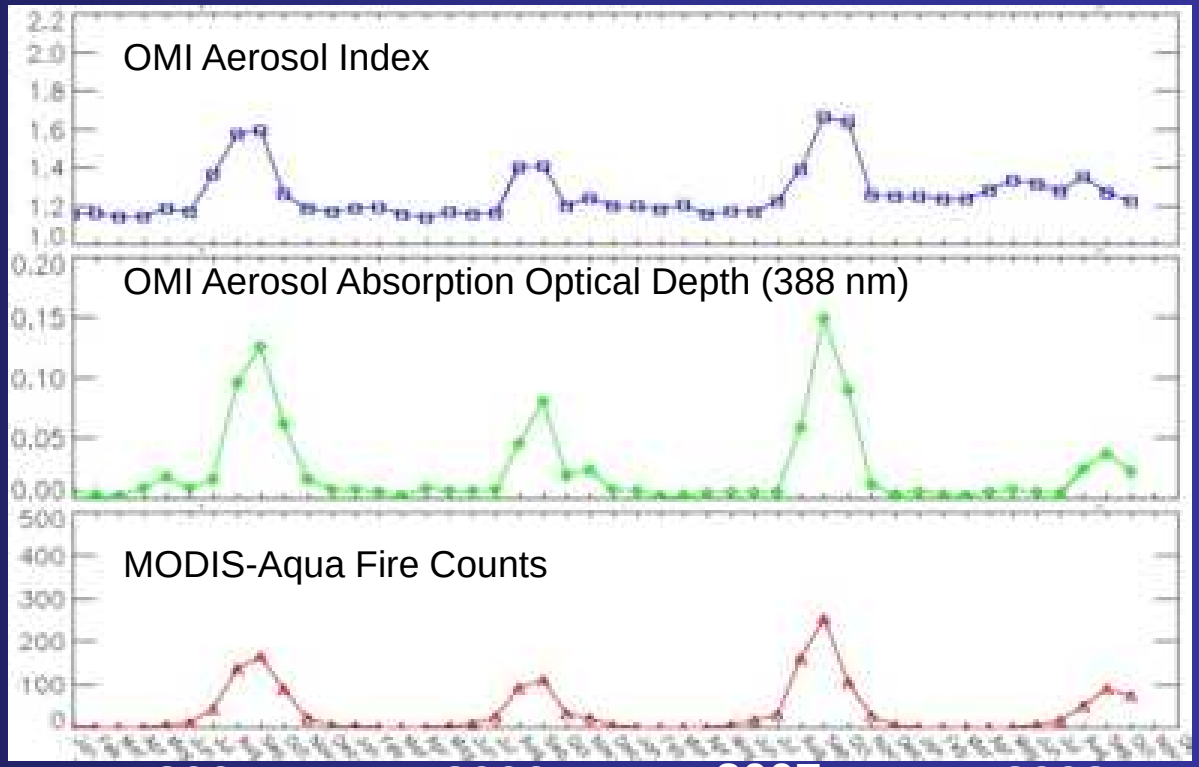


OMI Observations of Large Decrease of South American Biomass Burning in 2008

September Average Aerosol Absorption Optical Depth (388 nm) for 2005-2008



Time series of smoke-related parameters

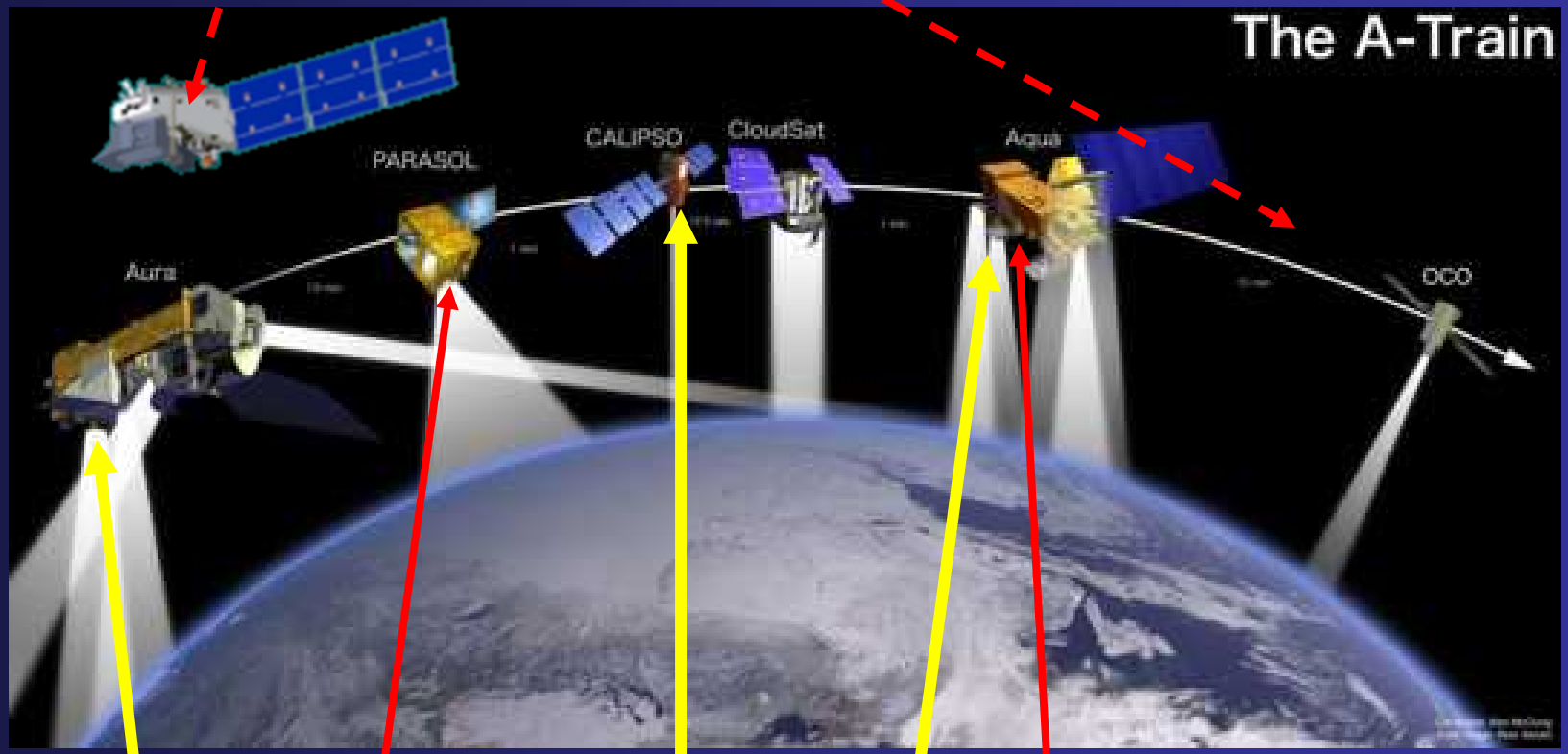


-The September 2008 number of fires in South America went down by 50% with respect to 2007.
-In Brazil alone the reduction was 62%. A 4% decrease was observed in rest of the sub-continent.
-The atmospheric aerosol load over the area of the analysis went down by 65%.
- The dramatic decrease in biomass burning activity cannot be explained by meteorological variability.

O. Torres, PI OMI-aerosols

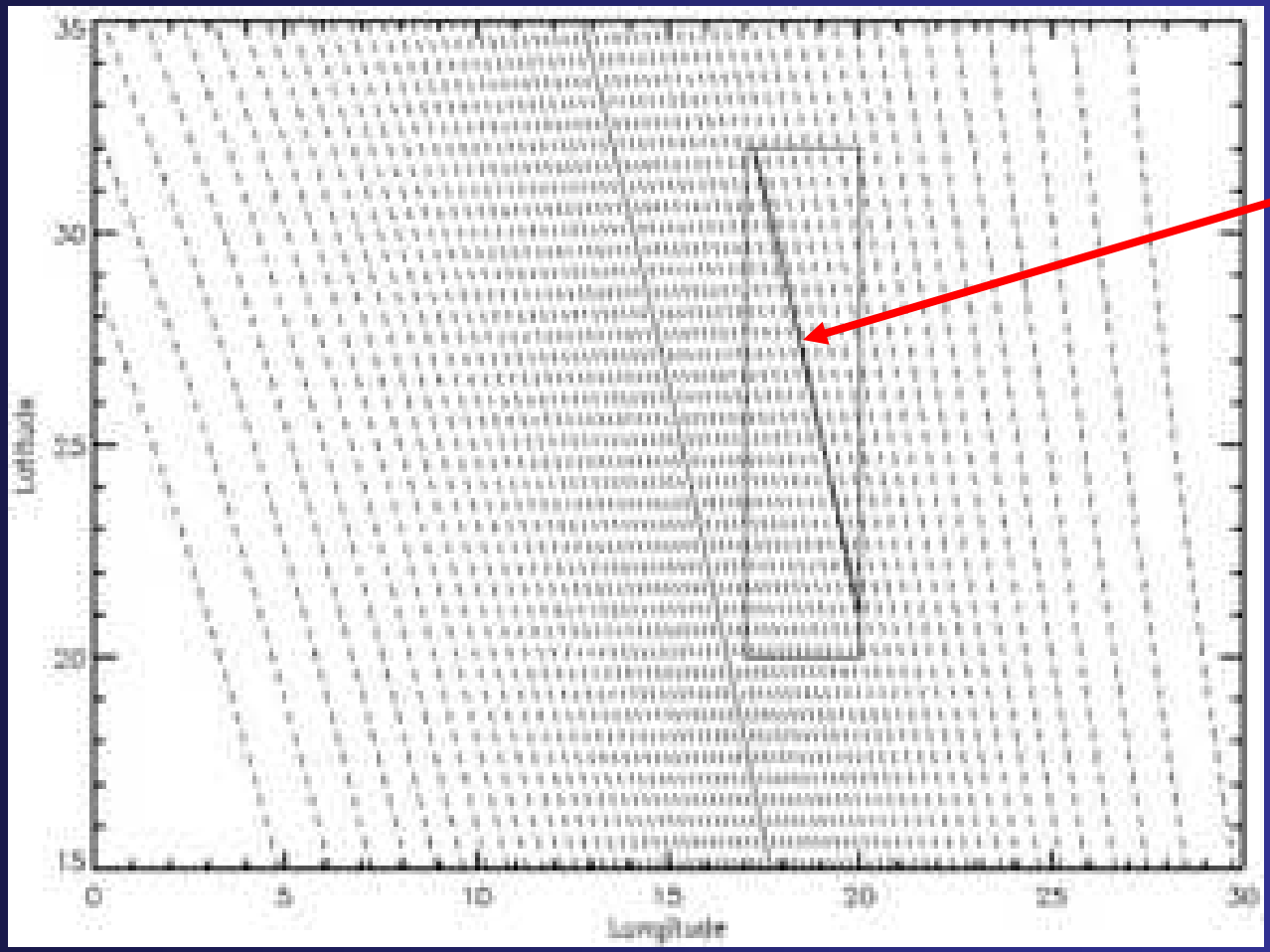
Aerosol-sensing instruments in the A-train

NPP-VIIRS and Glory-APS will join the A-train



OMI, PARASOL, Calipso, MODIS, AIRS are currently operational

Analysis of collocated CALIPSO - OMI data



Calipso orbital track

Properties of the Aerosol Index

-Positive values for UV-absorbing particles: desert dust, smoke, volcanic ash

-Negative values for small particles non-absorbing particles. Difficult to separate aerosol effects from other non-aerosol effects that also produce negative AI values (mainly over the oceans).

-Nearly zero for clouds

-Absorbing aerosols are detected even when mixed with clouds

-Absorbing aerosols are detected above all surface types including bright backgrounds (snow, ice, cloud decks)

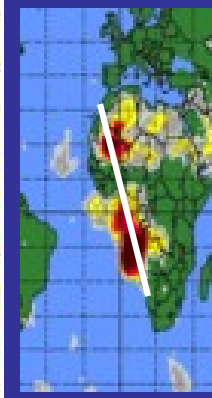
-Magnitude of Positive AI depends on aerosol absorption optical Depth and height of aerosol layer

-AI signal is amplified when the absorbing layer lies above clouds.

-AI signal meaningful above 0.5

AI

Height (km)



Height (km)

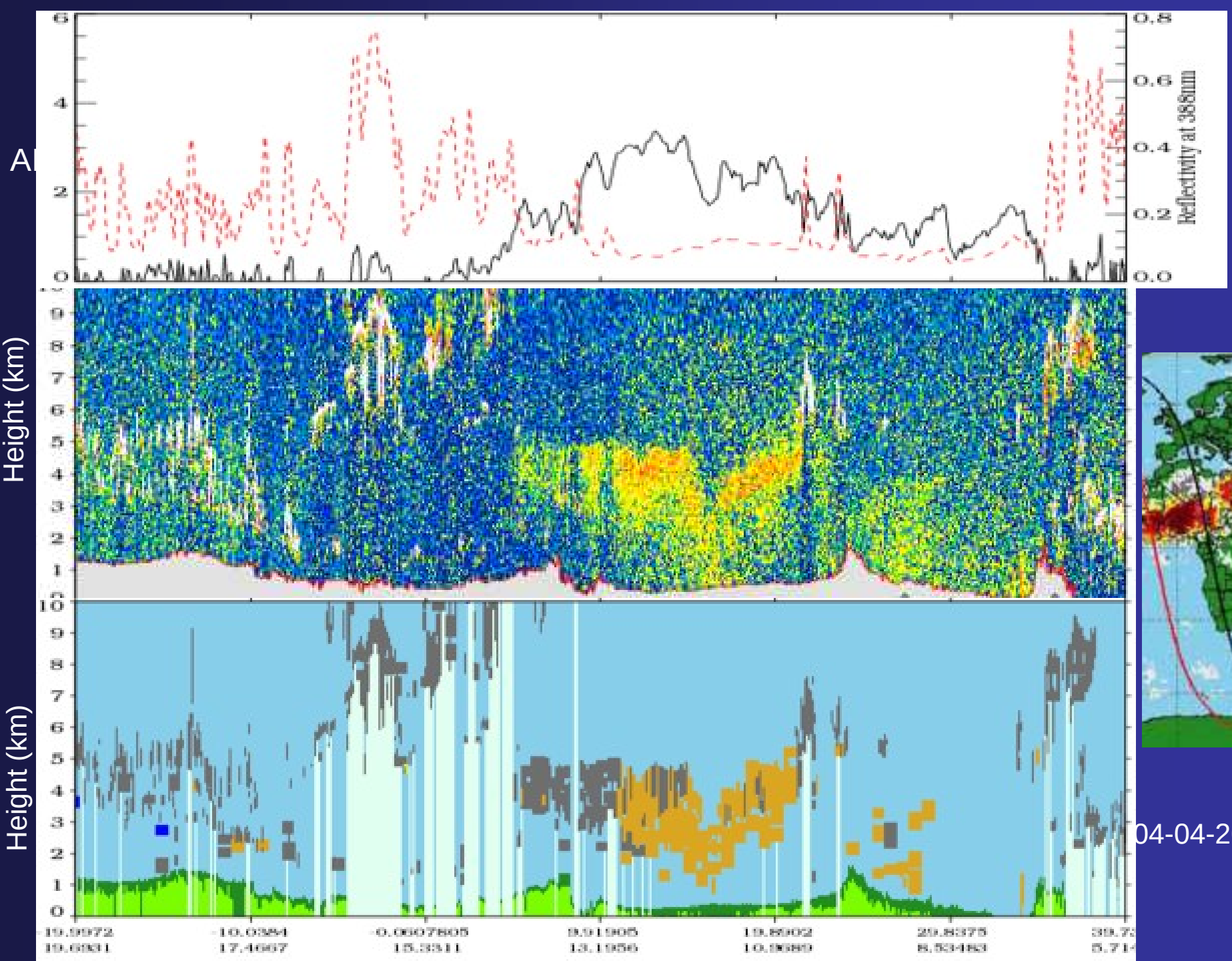
08-12-2006

AI

Height (km)

Height (km)

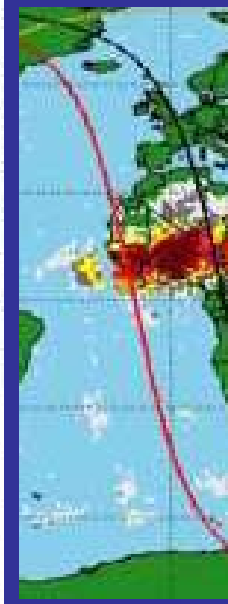
04-04-2007


Reflectivity at 386nm
Height (km)
Height (km)
04-04-2007

AI

Height (km)

Height (km)

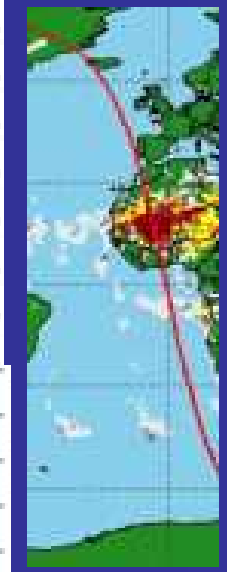


04-04-2007

AI

Height (km)

Height (km)



05-28-2007

AI

Height (km)

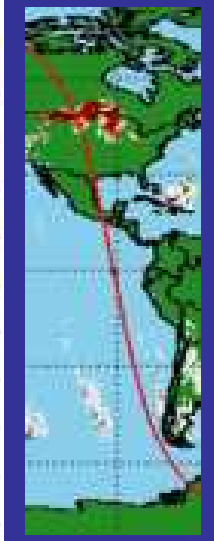
Height (km)

06-23-2007

AI

Height (km)

Height (km)



08-13-2007

AI

Height (km)

Height (km)

09-30-2007

AI

Height (km)

Height (km)

10-02-2007

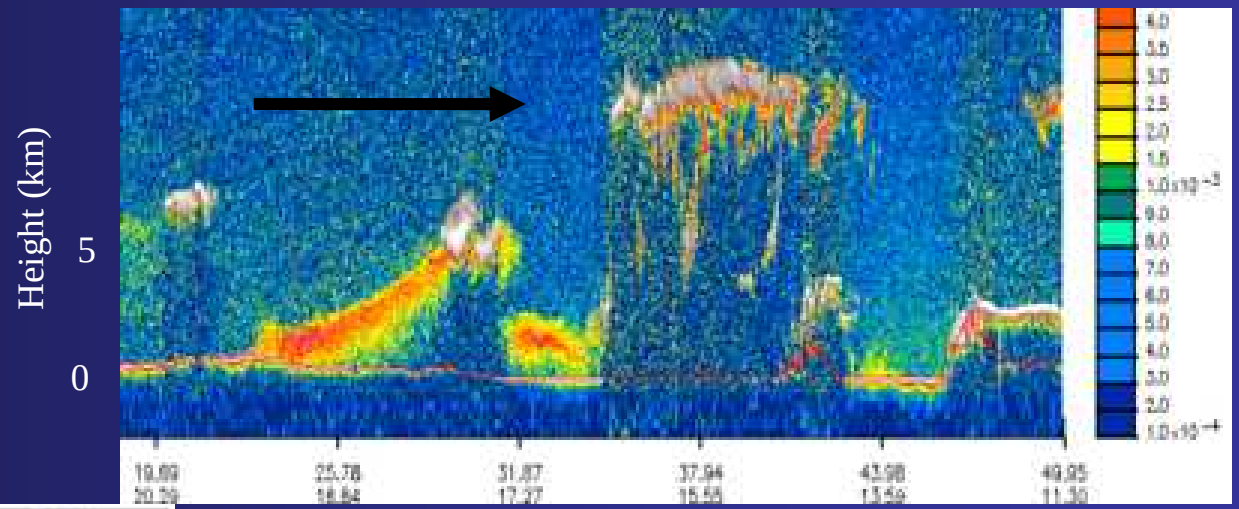
AI

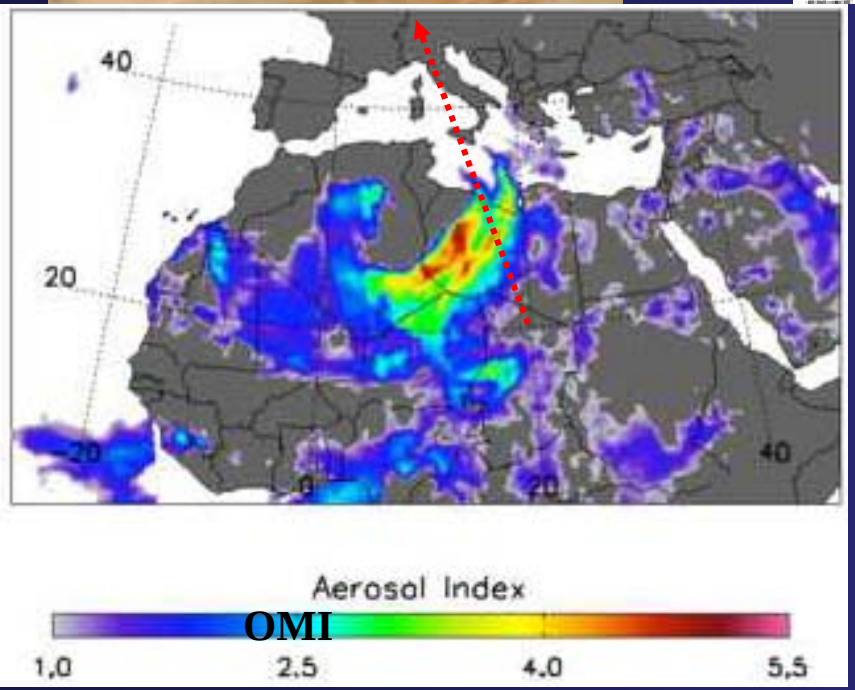
Height (km)

Height (km)

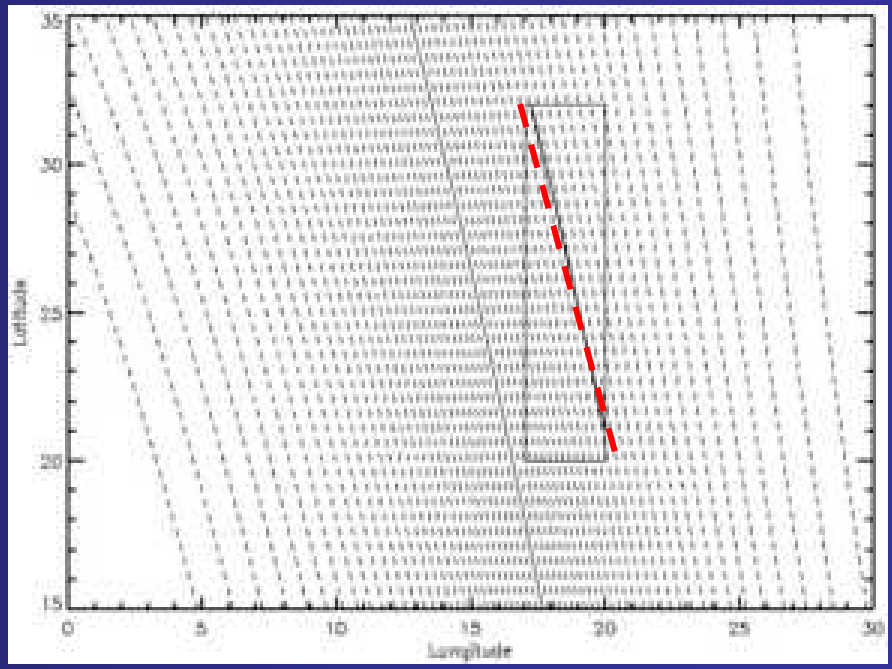
07-02-2008

OMI – Calipso Synergy, March 9, 2007

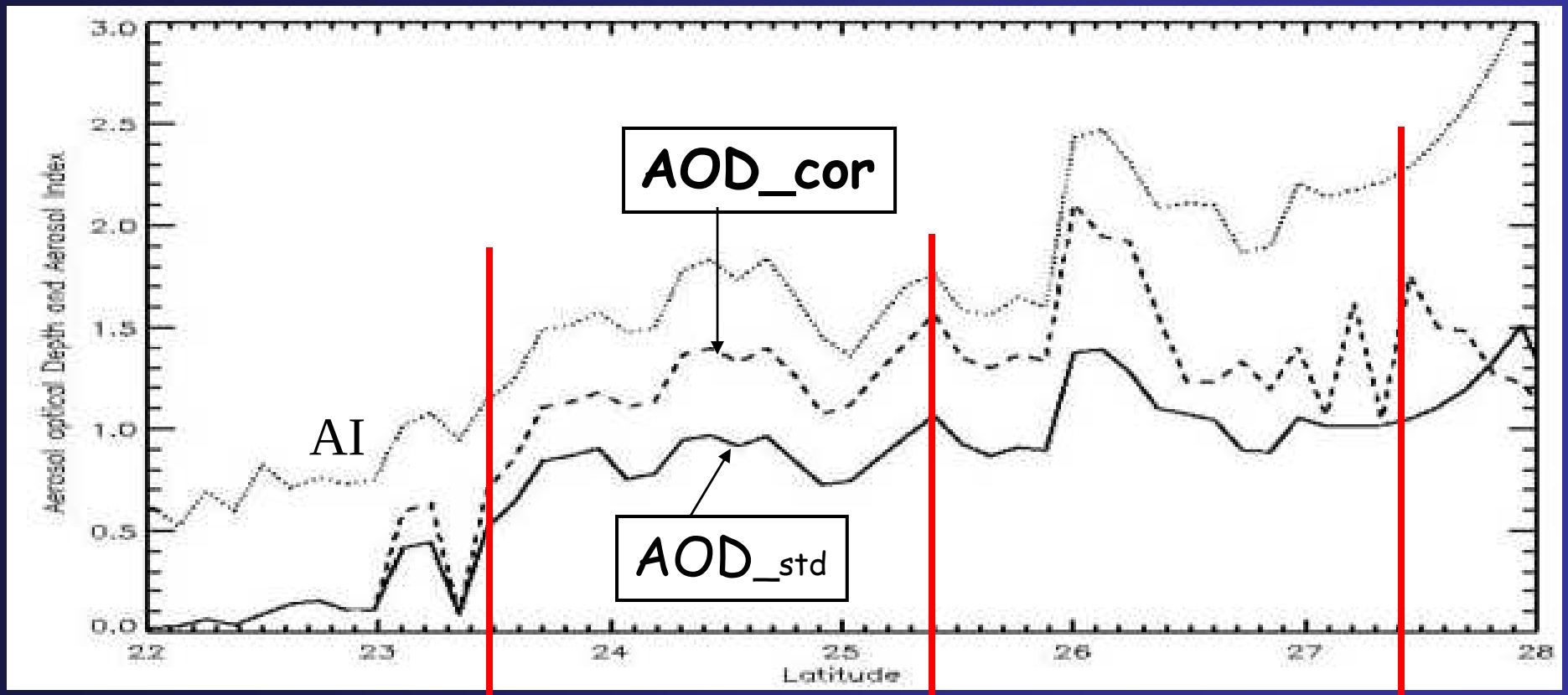


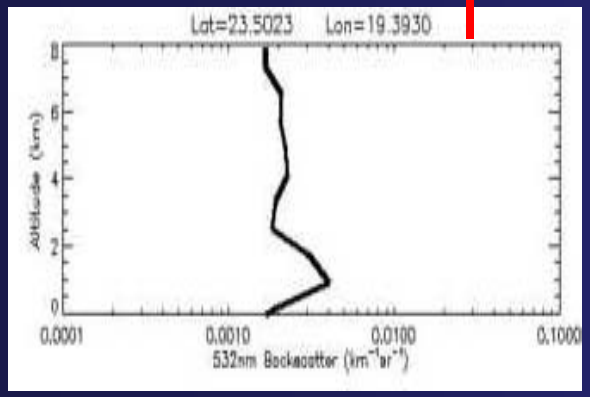


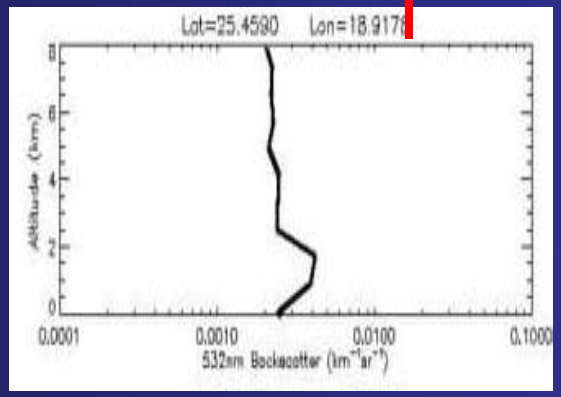
OMI, Calipso orbital coverage

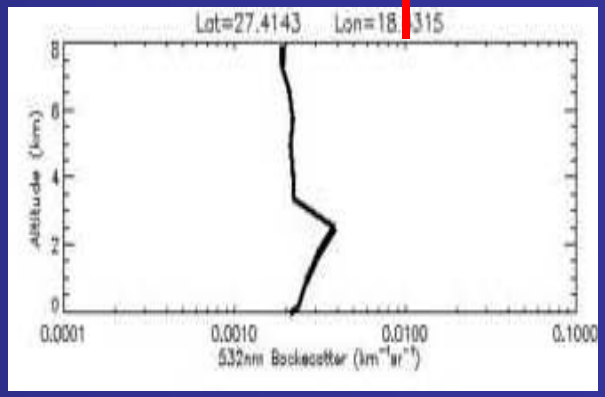


OMI –Calipso ,Synergy, March 9, 2007 (2)









Summary

-OMI near UV algorithm performing reasonably well in spite of instrumental limitations. Best results obtained over arid and semi-arid regions where sub-pixel cloud contamination is minimum.

-Combined use of observations by other A-train sensors (Calipso, Modis) improves the accuracy of absorption retrieval products.

Future Work

-New near-UV algorithm to retrieve aerosol absorption in the presence of clouds.

-Reprocessing of TOMS and OMI records (same algorithm).