

# and Cloud Products

Multiangle cloud remote sensing from POLDER 1 and

*C. Buriez<sup>1</sup>, F. Parol<sup>1</sup>, C. Vanbauce<sup>1</sup>, J. Riedi<sup>1</sup>, L.C.-  
bonnote<sup>1</sup>,*

*Doutriaux-Boucher<sup>1</sup>, M. Vesperini<sup>1</sup>,*

*Sèze<sup>2</sup>, P. Couvert<sup>3</sup>, M. Viollier<sup>4</sup>, and F.M. Bréon<sup>3</sup>.*

*Laboratoire d'Optique Atmosphérique, Université des Sciences et  
Technologies de Lille*

*Laboratoire de Météorologie Dynamique, CNRS, Université Pierre  
Curie*

*Laboratoire des Sciences du Climat et de l'Environnement,*

*Commissariat à l'Énergie Atomique*



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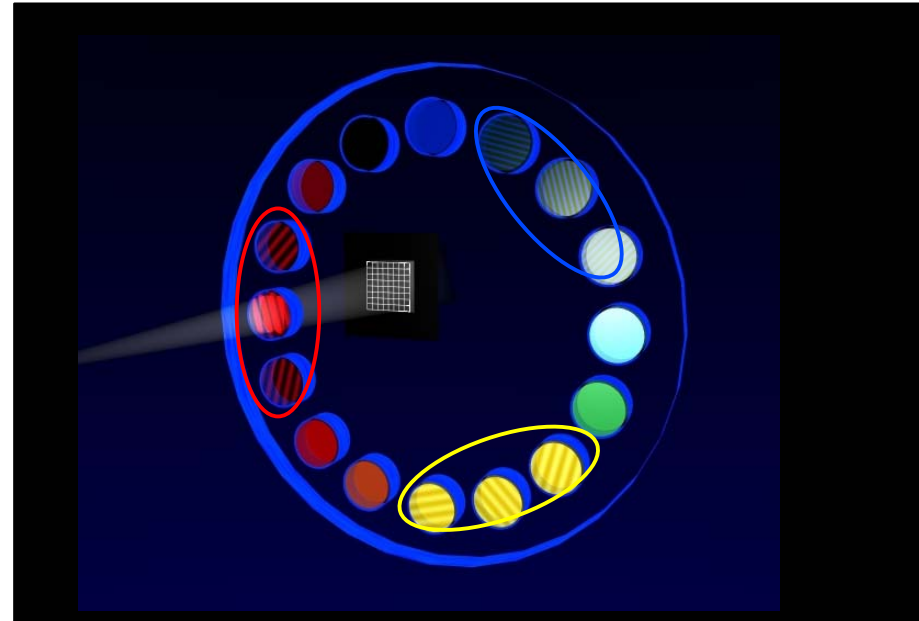
## and Cloud Products

Multiangle cloud remote sensing from POLDER 1 and

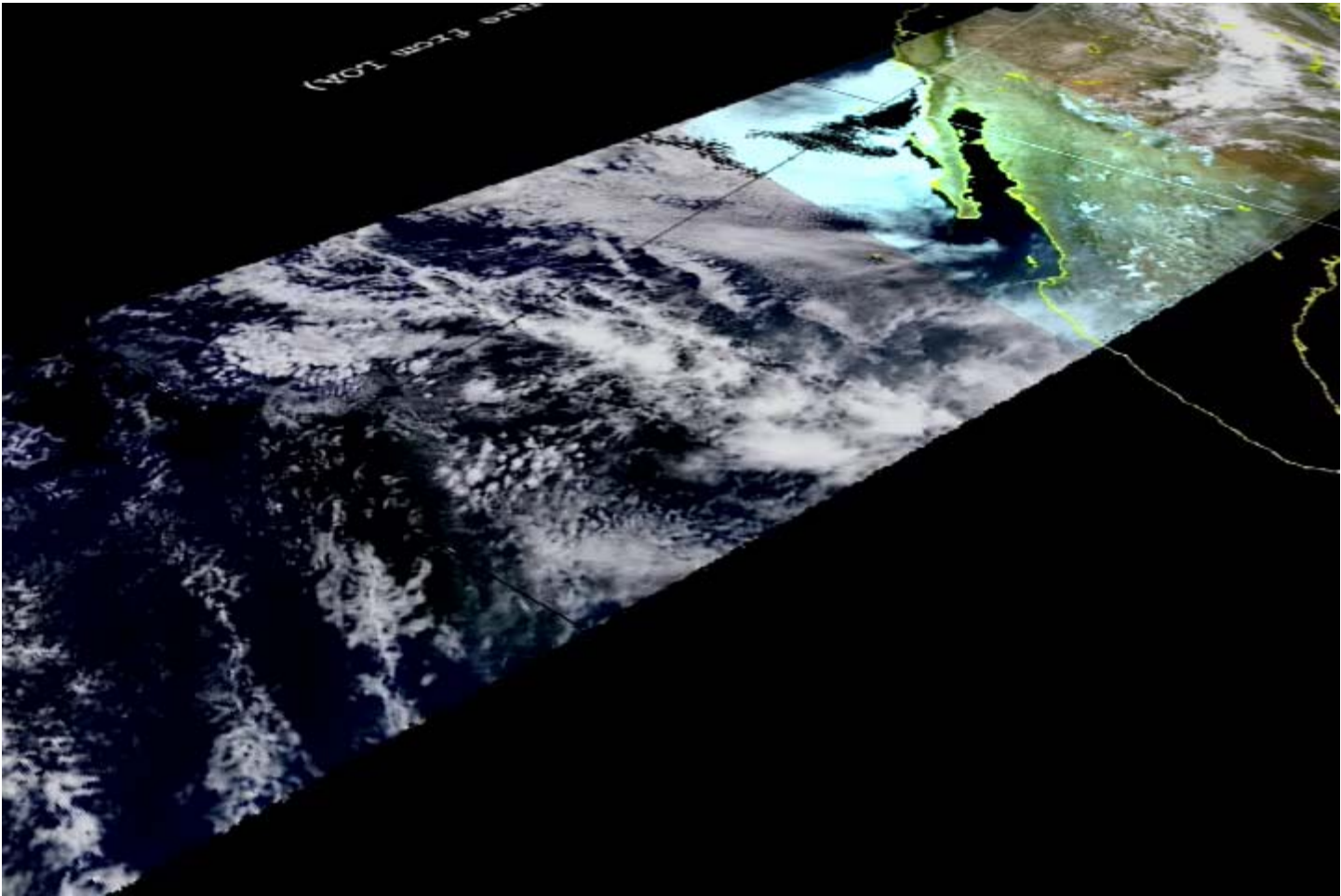
- › Instrumental background
- › POLDER ERB, WV and Clouds Products
  - › Outline of Processing line and product
  - › Level 2, Level 3 and Joint Atmosphere Product
- › Products quality, potential biases and Guidelines
- › Data availability and Tools

# POLDER concept and capabilities

- POLDER instrument LOA/CNES
- Platform Adeos 1 – Adeos 2
- Mission
  - POLDER 1 : Nov 1997 – June 1997
  - POLDER 2 : Jan 2003 – Oct 2003
- Main characteristics :
  - Wide field of view + CCD array
  - Multispectral : 443 nm - 910 nm
  - Multidirectionality
  - Polarisation in 3 bands : 443, 670, 865 nm



# POLDER concept and capabilities



# OLDER ERB, WV and Clouds Products

Outline of processing path and selected products

# Level 2, Level 3 and Joint Atmosphere Product

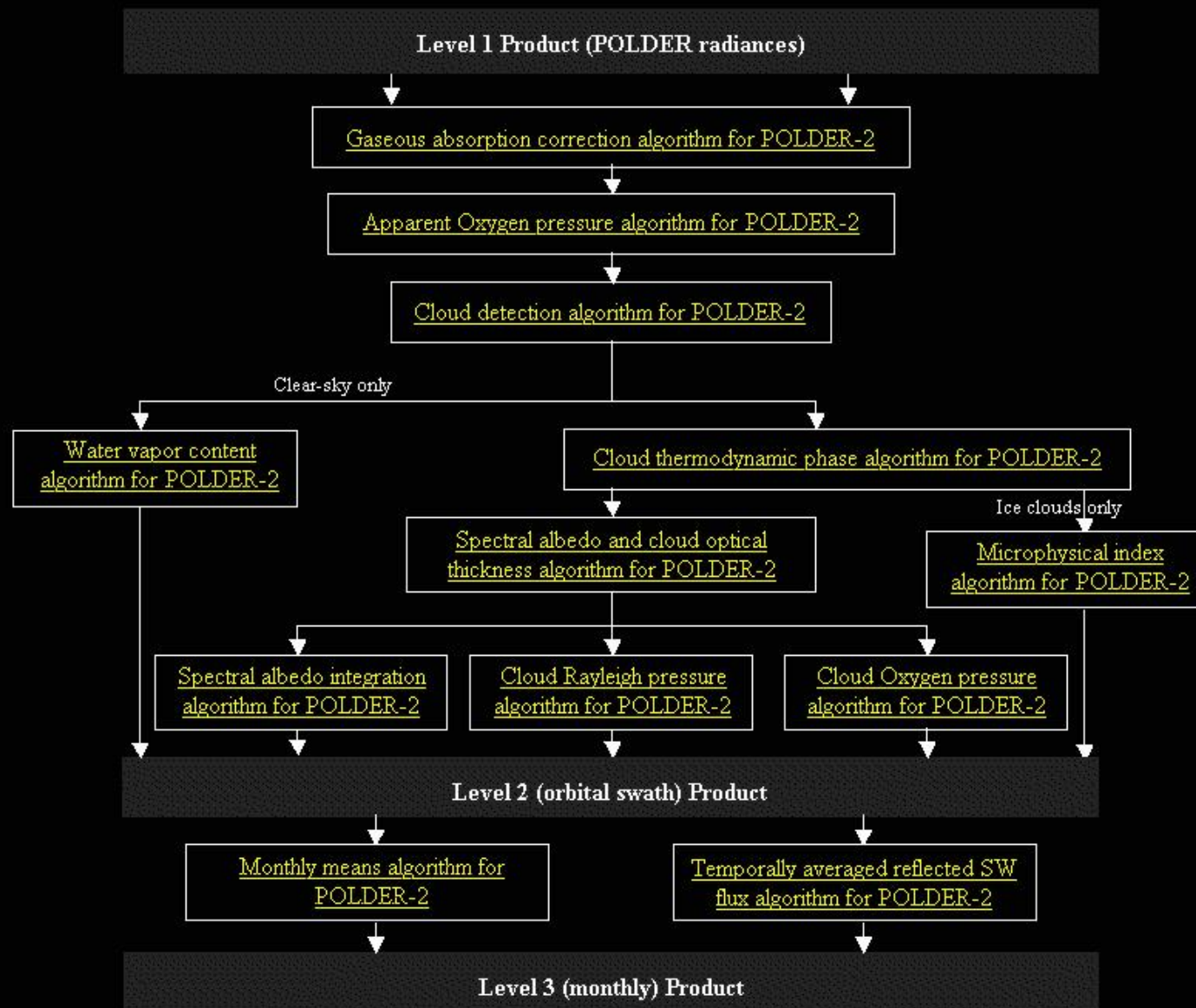
**An improved version of the algorithms have been applied to ADEOS 2 - POLDER data. The major improvements of collection 2 algorithms are :**

- a better spatial resolution of the ""ERB, WV & clouds"" products
- a better cloud detection, especially in presence of dust events and over ice/snow surfaces.
- a reduction of the bias in total water vapor content by determining the reflectance ratio to water vapor parameterization directly with respect to SSMI water vapor observations and by taking into account the effect of surface spectral variability.
- a more complete determination of the cloud thermodynamic phase
- a better retrieval of the ice cloud optical thickness
- a drastic reduction of the number of abnormally high values of retrieved cloud top pressure.
- a more accurate derivation of the spectral albedoes and the calculation of a monthly averaged reflected shortwave flux.



# "ERB, WV & Clouds" algorithm documents for POLDER 2

All files available for download on this page are stored in the PDF format.



# OLDER ERB, WV and Clouds Products

Cloud Cover (25/06/2003)

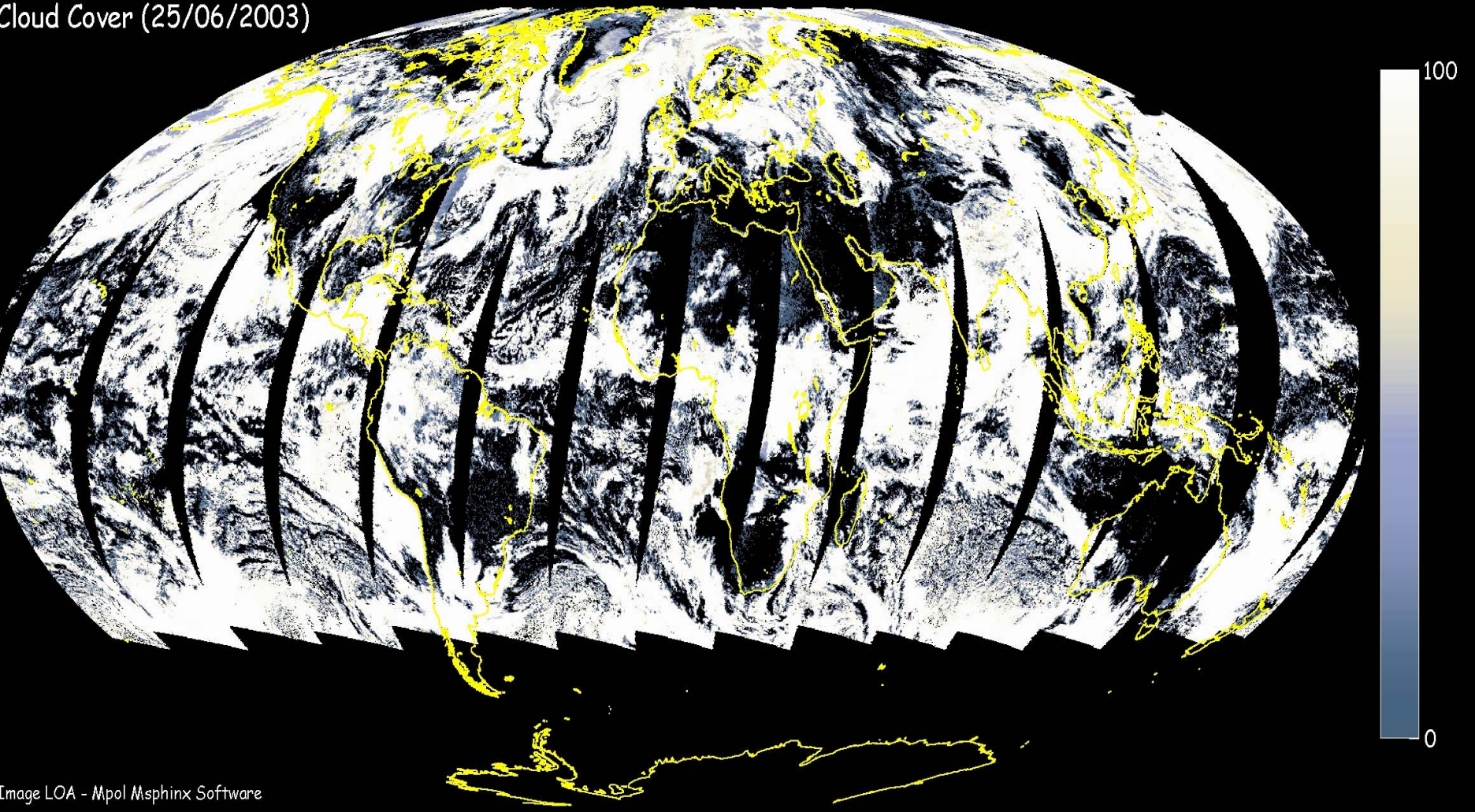


Image LOA - Mpol Mspinx Software



# OLDER ERB, WV and Clouds Products

Cloud Phase (25/06/2003)

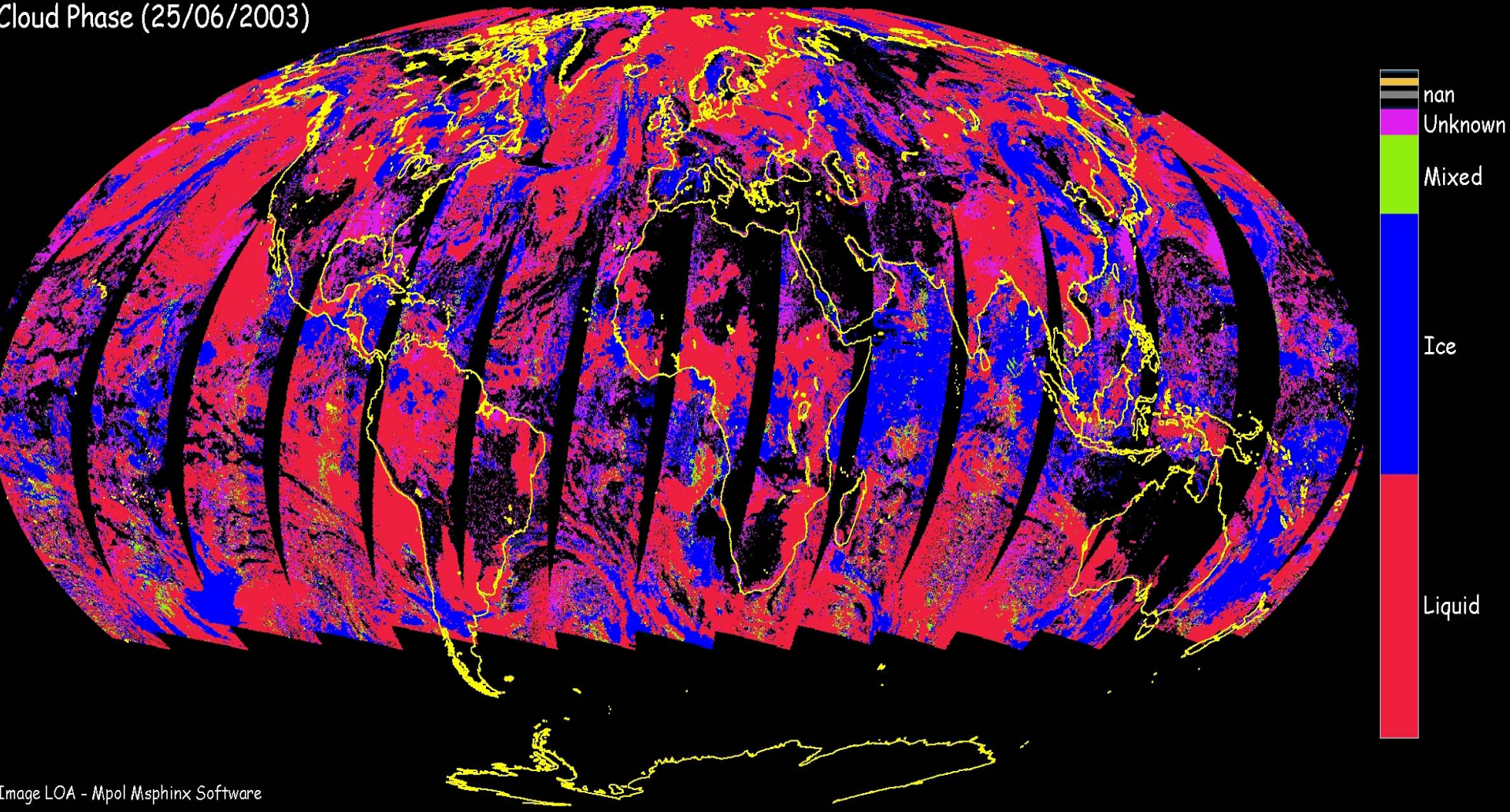


Image LOA - Mpol Mispinx Software

# OLDER ERB, WV and Clouds Products

Optical Thickness (25/06/2003)

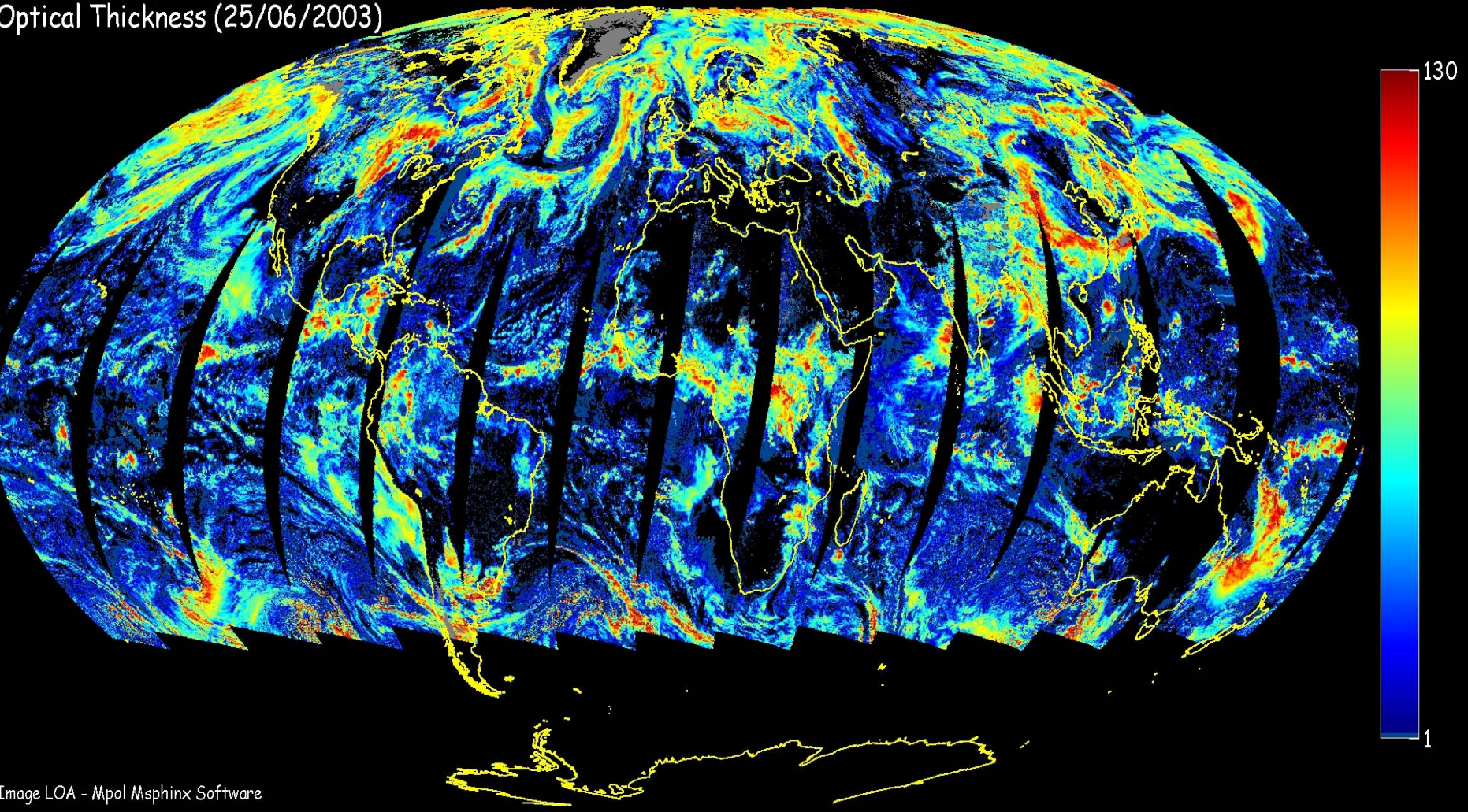


Image LOA - Mpol Mispinx Software

# OLDER ERB, WV and Clouds Products

Oxygen Pressure (25/06/2003)

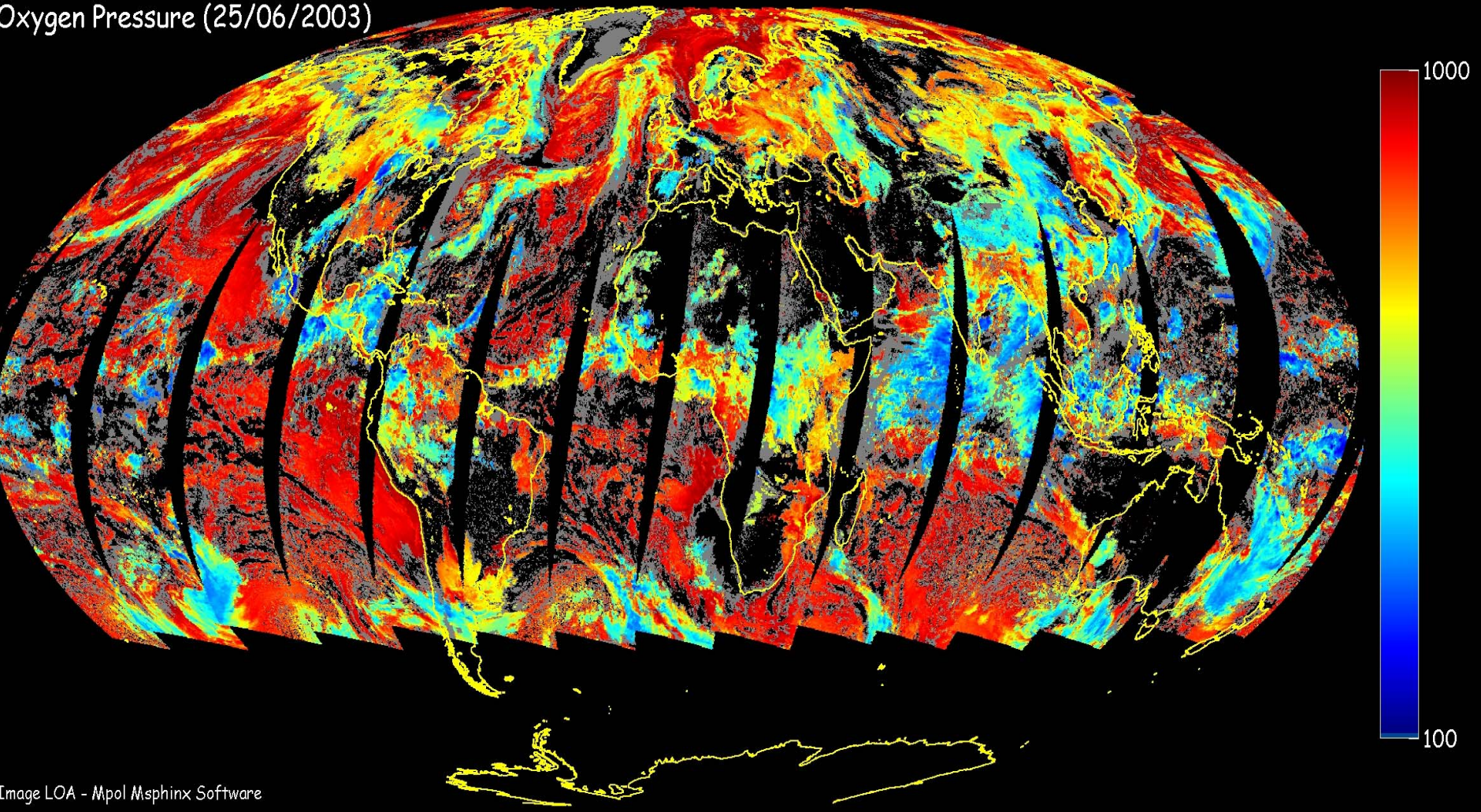


Image LOA - Mpol Mispinx Software

# OLDER ERB, WV and Clouds Products

Mean Spectral Albedo (25/06/2003)

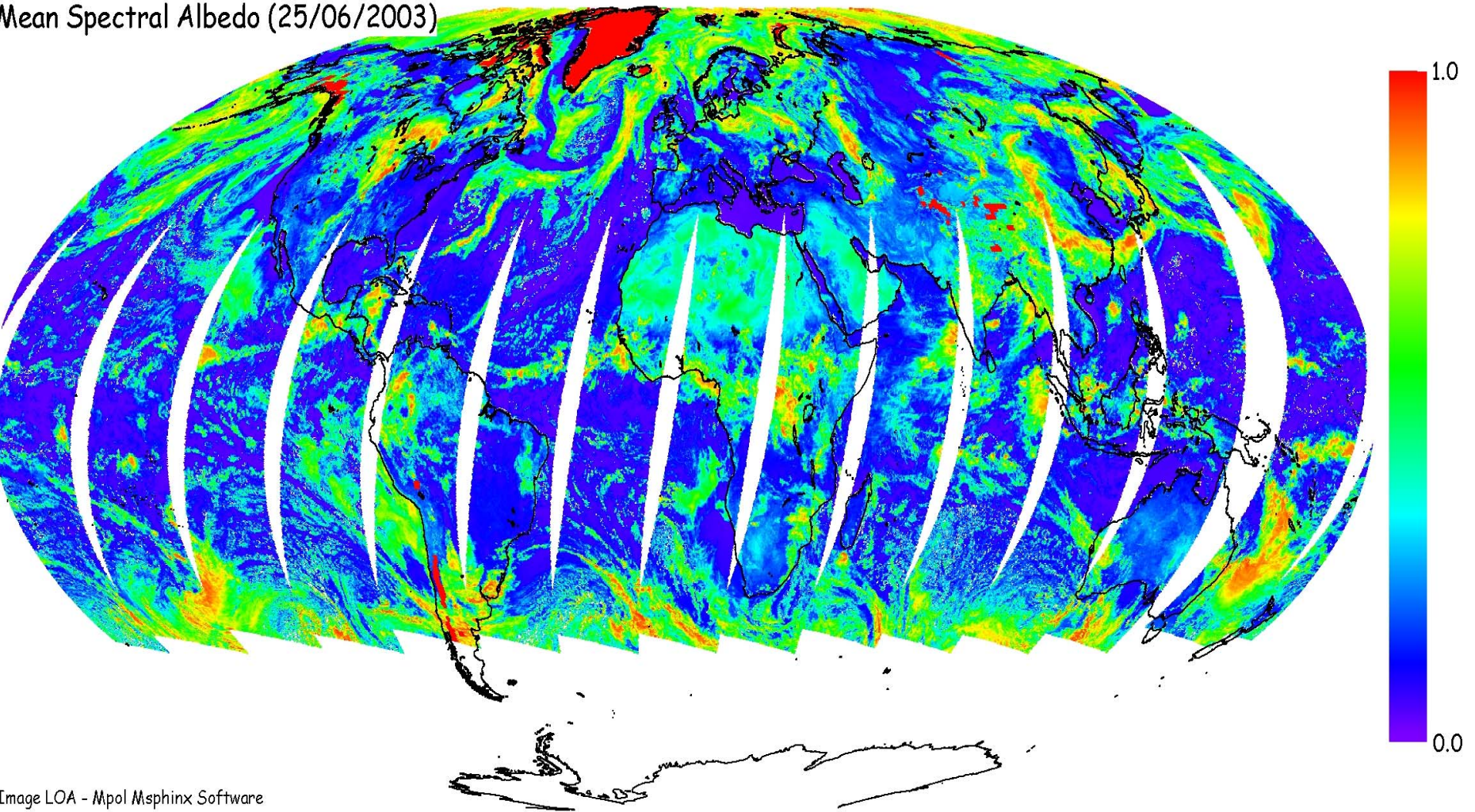


Image LOA - Mpol Mispinx Software

# OLDER ERB, WV and Clouds Products

Relative Angular Deviation of Spectral Albedo (25/06/2003)

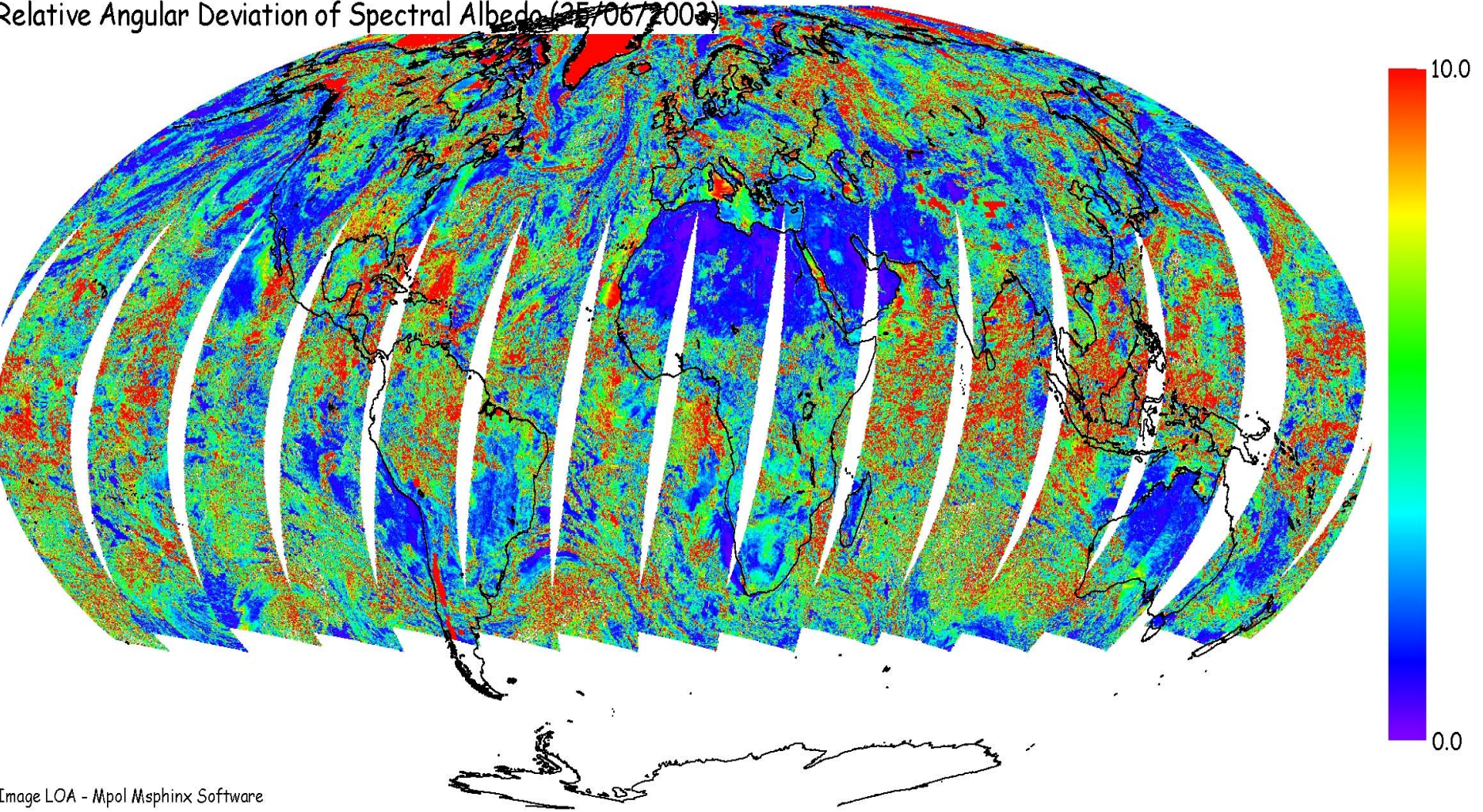
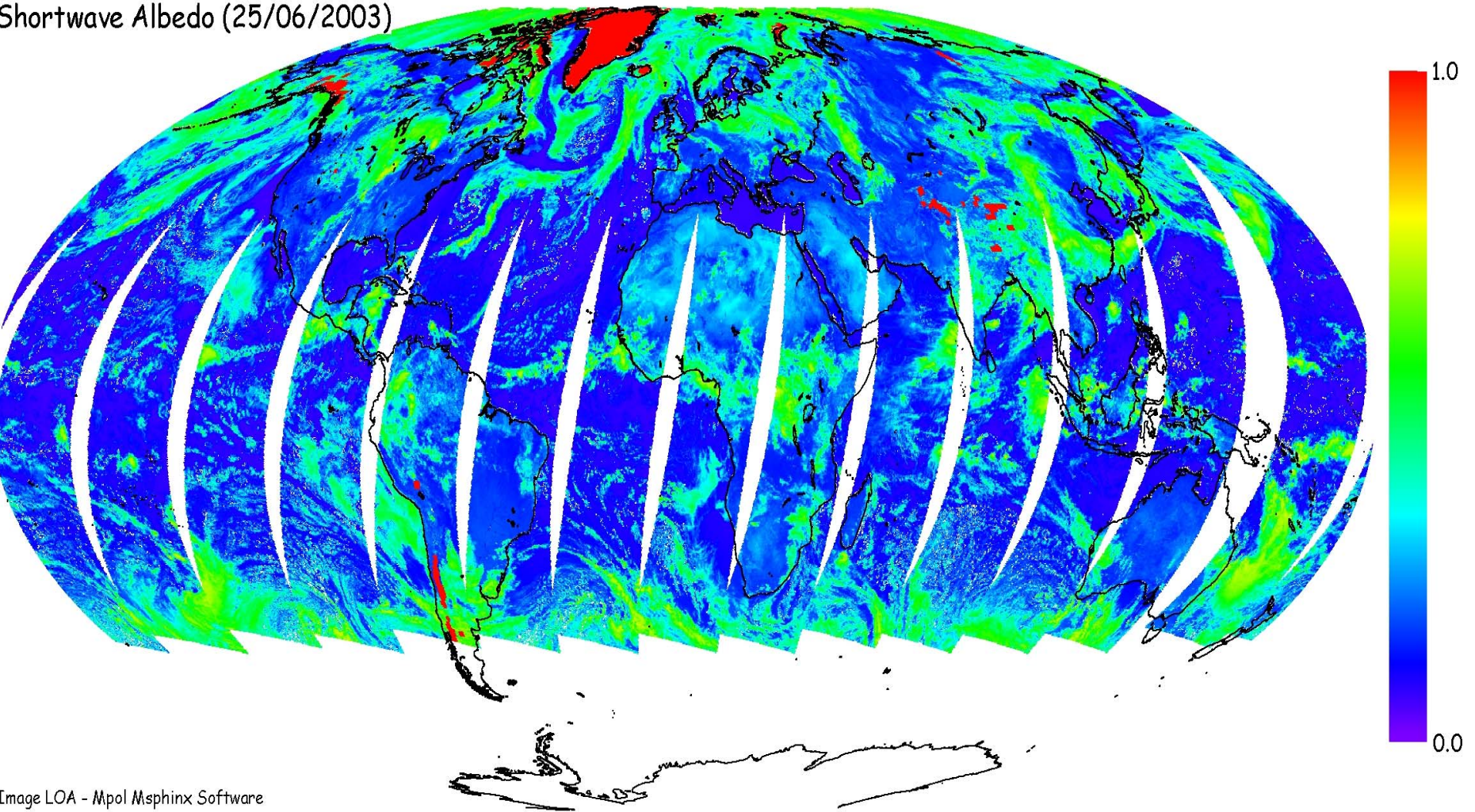


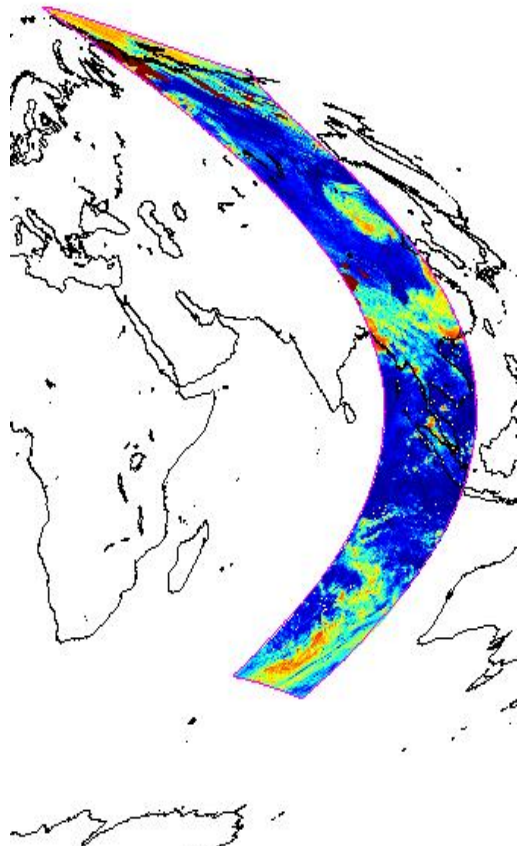
Image LOA - Mpol Msphinx Software

# OLDER ERB, WV and Clouds Products

Shortwave Albedo (25/06/2003)



# Level 2, Level 3 and Joint Atmosphere product



The level 2 (orbital swath) products contain about thirty non-directional parameters and ten directional parameters (for each of the 14 viewing directions).

Non Directional Parameters:  Select all

- 9[CHU]: Observation UT time hours
- 10[CHU]: Observation UT time minutes
- 11[CHU]: Number of available viewing directions
- 12[CHU]: Number of directions used for Rayleigh pressure
- 13[CHU]: Indices of the first / last direction containing
- 14[CHU]: Cosine of solar zenith angle for the central pixel
- 15[SHU]: Mean spectral albedo at 670 nm [land] and 865 nm
- 16[CHU]: Relative Spatial dispersion of the albedo (base)
- 17[CHU]: Relative Angular dispersion of the albedo (base)
- 18[CHU]: Albedo quality index (0;bad 1;excellent)
- 19[SHU]: Scene albedo
- 20[CHU]: Relative Angular dispersion of the scene albedo
- 21[CHU]: Clear albedo (modeled, independent of POLDER measurement)
- 22[SHU]: Shortwave albedo
- 23[CHU]: Clear shortwave albedo (modeled, independent of POLDER measurement)
- 24[CHU]: Cloud Cover
- 25[CHU]: Fraction of obs classification from uncertain.
- 26[CHU]: Cloud cover quality index (0;bad 1;excellent)
- 27[CHU]: Water vapor column (g,cm-2)
- 28[CHU]: Standard deviation of water vapor estimates (g,cm-2)
- 29[CHU]: Cloud pressure derived from Oxygen channels. (hPa)

Directional Parameters:  Select all

- 65[CHU]: Relative azimuth angle (for the central pixel)
- 66[SHU]: Reflectance corrected for gas absorption at 670 nm
- 67[SHU]: Spectral albedo estimated from the above reference
- 68[SHU]: Reflectance corrected for gas absorption at 865 nm
- 69[SHU]: Shortwave albedo
- 70[CHU]: Polarized normalized radiance at 865 nm, corrected for polarization
- 71[CHU]: Number of cloudy / clear pixels
- 72[CHU]: Directional apparent cloud cover
- 73[CHU]: Spectral cloud albedo (mean on cloudy pixels)

# Level 2, Level 3 and Joint Atmosphere

The level 3 (monthly) products contain about forty parameters.

Record Number in the file : $2 \leq \text{RecNum} \leq \text{Nrec} + 1$	Standard Deviation of the Clear Sky SW Albedo
Length of this record (bytes): 84	Monthly mean of the Clear SW albedo, based on radiative transfer simulations only
Line Num. of the pix. in POLDER medium res. grid	TOA monthly-mean incoming solar Flux [ $\text{W.m}^{-2}$ ]
Col. Num. of the pix. in POLDER medium res. grid	TOA monthly-mean reflected Flux [ $\text{W.m}^{-2}$ ]
Mean pixel altitude from the DEM in the 3x3 super pixel (meters)	Monthly-mean SW cloud forcing [ $\text{W.m}^{-2}$ ]
Land, Water, Mixed indicator <sup>11</sup>	Monthly mean cloud cover
Number of days with POLDER measurements	Standard Deviation of cloud cover estimates
Number of observations (there may be several observation within a single day at high latitudes)	CN <sub>+</sub> : Fraction of observations classified from "uncertain" to "cloudy"
Number of observations with snow/ice indicator	CN <sub>-</sub> : Fraction of observations classified from "uncertain" to "clear"
Number of observations with clear sky	Four bit each: One byte contains 16 CN <sub>+</sub> + CN <sub>-</sub> .
Number of observations with cloud presence.	Monthly mean water vapor column [ $\text{g cm}^{-2}$ ]
Number of cloud optical thickness estimates	Std. deviation water vapor column [ $\text{g cm}^{-2}$ ]
Number of oxygen pressure estimates	Cloud pressure based on oxygen channels (monthly mean weighted by cloud cover) [hPa]
Number of Rayleigh pressure estimates.	Standard Deviation of Oxygen Cloud pressure [hPa]
Number of cloud phase estimates	Cloud pressure based on Rayleigh method (monthly mean weighted by cloud cover) [hPa]
Number of water vapor column estimates	Std. deviation of Rayleigh cloud pressure [hPa]
Monthly mean of the cosine of the solar zenith angle	Mean cloud optical thickness
Monthly mean of the spectral <sup>12</sup> Albedo	Relative dispersion of cloud optical thickness [%]
Standard Deviation of the spectral Albedo	Mean cloud optical thick., liquid phase occurrences
Monthly Mean Clear Sky spectral Albedo	Mean cloud optical thick., ice phase occurrences
Standard Dev. of the Clear Sky spectral Albedo	Mean cloud optical thick., mixed phase occurrences
Monthly mean of the Clear spectral albedo, based on radiative transfer simulations only	Mean Spherical Albedo
Monthly mean of the SW Albedo	Standard deviation on spherical albedo
	Relative frequency of phase [%]. Bins are "Unknown", "Liquid", "Ice" and "Mixed" <sup>13</sup> .
	Relative frequency of ice cristal shapes. [%]



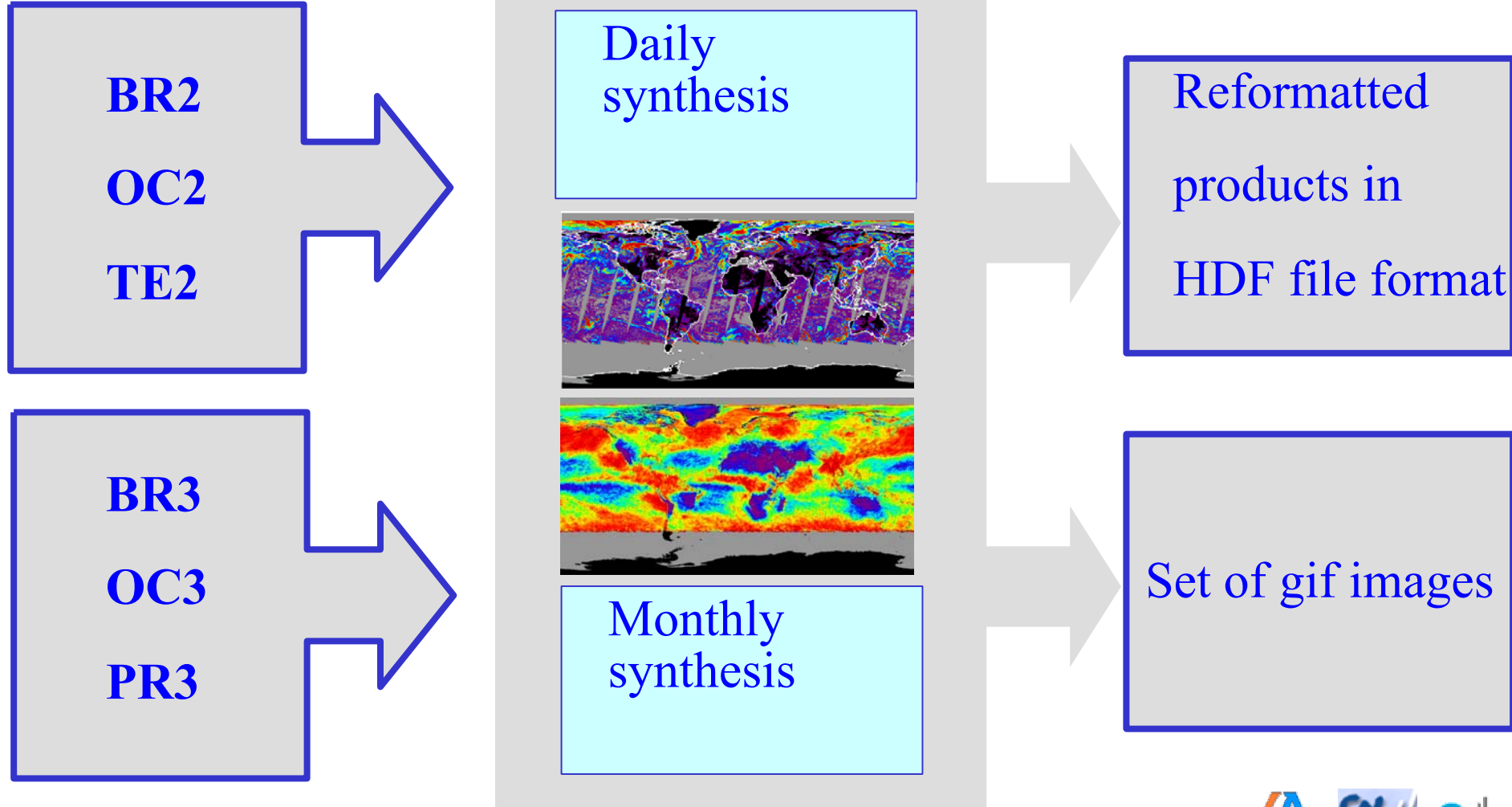


# Level 2, Level 3 and Joint Atmosphere

## Product

projection Lat-Lon 1080\*2160 ( 1/6° )

Local Daily Synthesis (observation ~ 10h30 H solar local time)



# Level 2, Level 3 and Joint Atmosphere

UT	Universal Time	D	
MASK	Coastline		
CC	Cloud Cover	D	M
QCC	Cloud Cover Quality Index	D	
WV	Total precipitable Water Vapor	D	M
SDWV	Standard Deviation of Water Vapor	D	
PHASE	Cloud thermodynamic Phase	D	
TAU	Cloud Optical Thickness	D	
PRAY	Cloud Rayleigh Pressure	D	M
POXY	Cloud Oxygen Pressure	D	M
AVIS	Albedo at 670/865 nm	D	M
QAVIS	Albedo Quality index	D	
AVISCL	Clear-sky Albedo at 670/865 nm		M
ASW	Shortwave Albedo	D	M
ASWCL	Clear-sky Shortwave Albedo		M

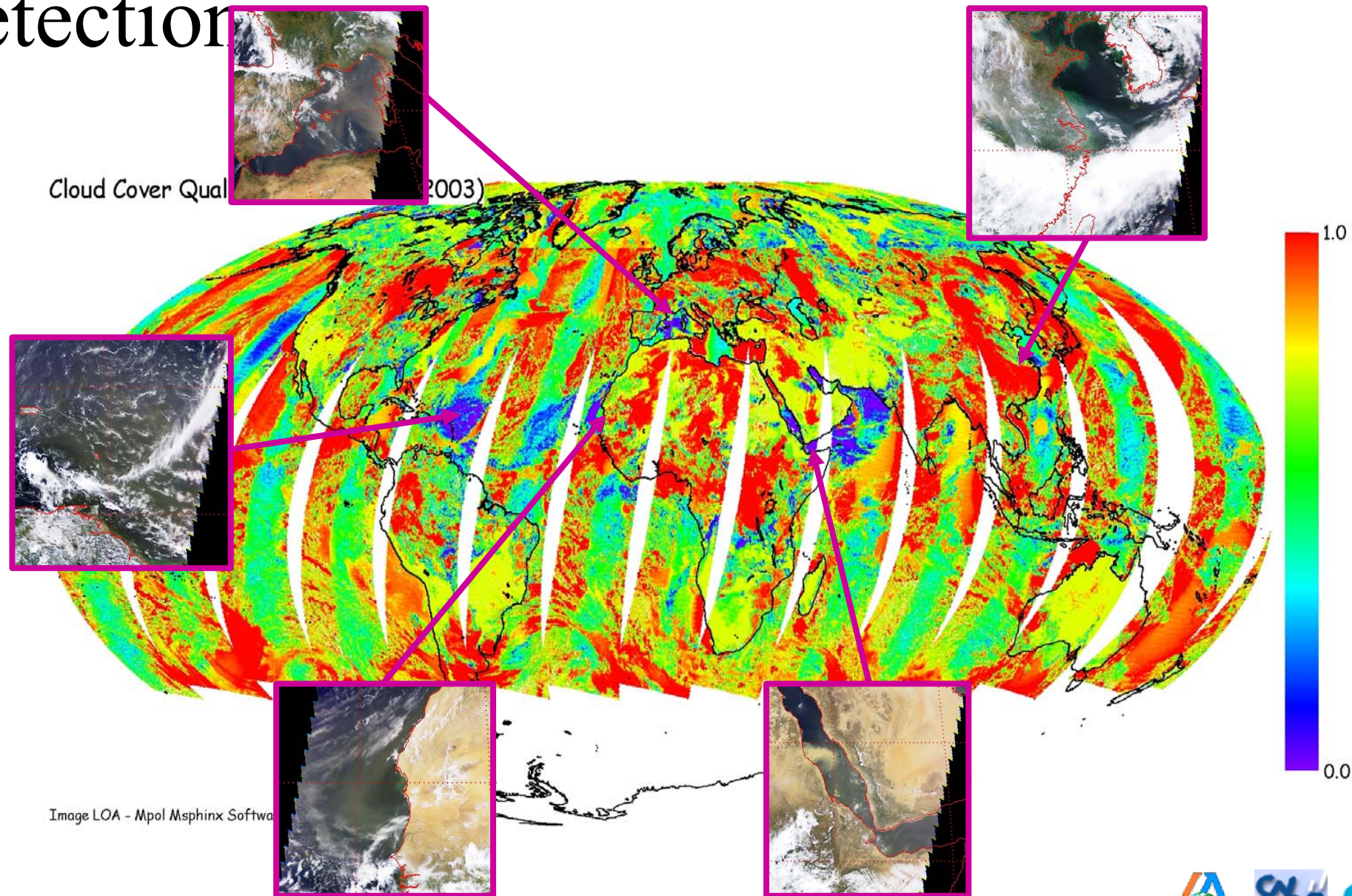
TOTFRE	Percent. of successful Phase retrievals		M
LIQFRE	Liquid Phase Frequency		M
ICEFRE	Ice Phase Frequency		M
MIXFRE	Mixed Phase Frequency		M
LIQTAU	Liquid Water Cloud Optical Thickness		M
ICETAU	Ice Cloud Optical Thickness		M
MIXTAU	Mixed-phase Cloud Optical Thickness		M
FINC	Shortwave Incident flux		M
FREFL	Shortwave Reflected flux		M
FCLEAR	Clear-sky Shortwave Reflected Flux		M
TAUA	Aerosol Optical Thickness at 865 nm	D	M
ANG	Angstrom Coefficient	D	M
TAUAFM	Aerosol Opt. Thick. (865nm Fine Mode)	D	M
ANGFM	Angstrom Coefficient for Fine Mode	D	M
INDA	Aerosol Index	D	M
IQAI	Aerosol Inversion Quality Index	D	

# OLDER ERB, WV and Clouds Products Products Accuracy Potential and Known Biases - Guidelines

# Multiangle measurements and Cloud Detection

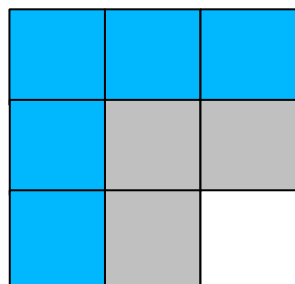
Cloud Cover Qual

(2003)



# Clouds / Aerosols : Products consistency

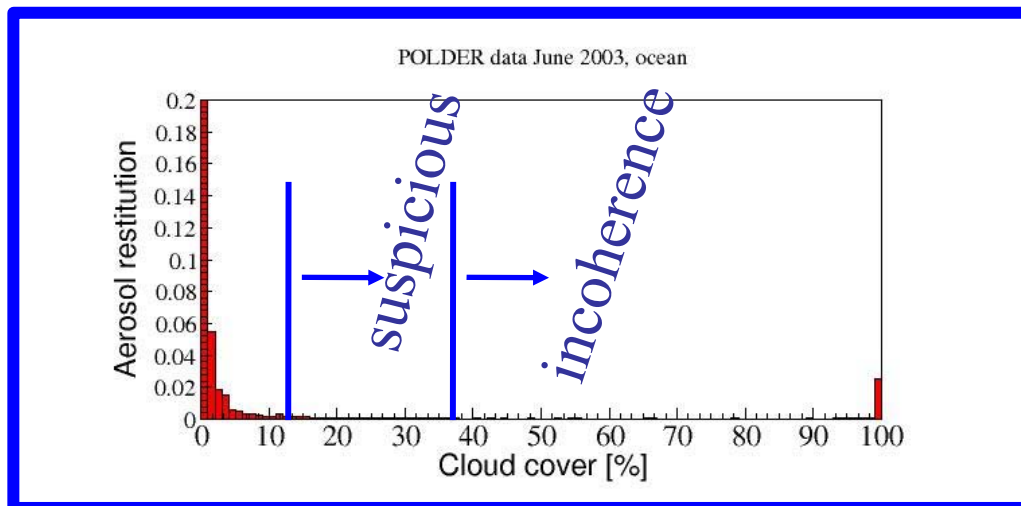
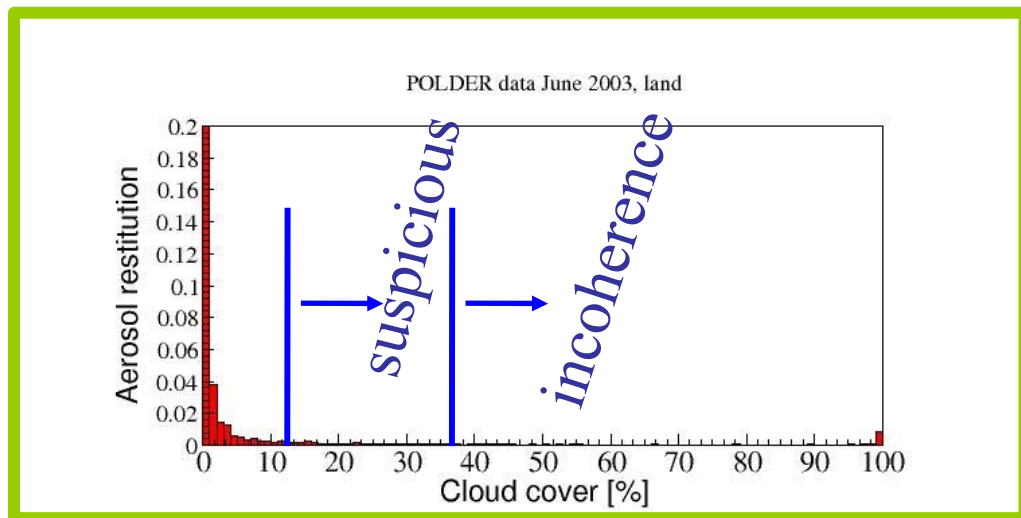
*Polder clouds and aerosols products are provided at the same resolution (3x3 L1) but use different cloud mask.*



*Aerosol retrievals performed when at least 5 over 9 pixels are clear*

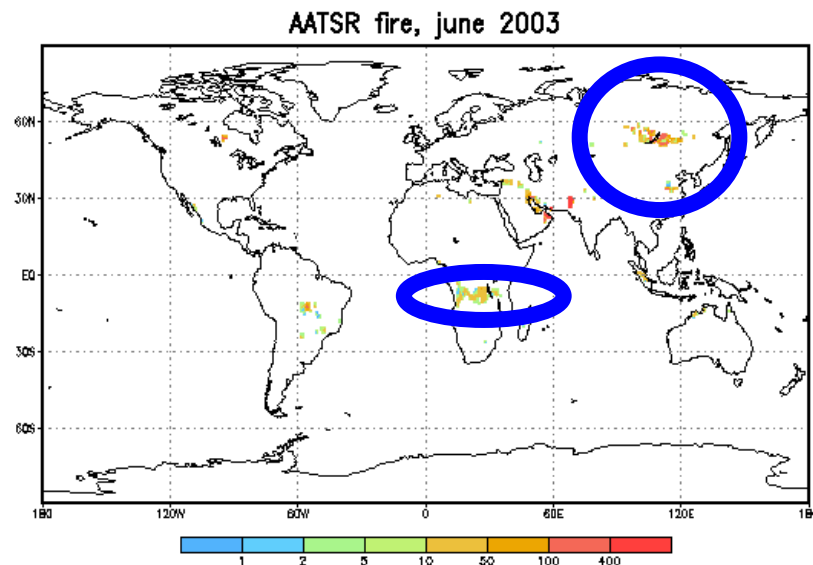
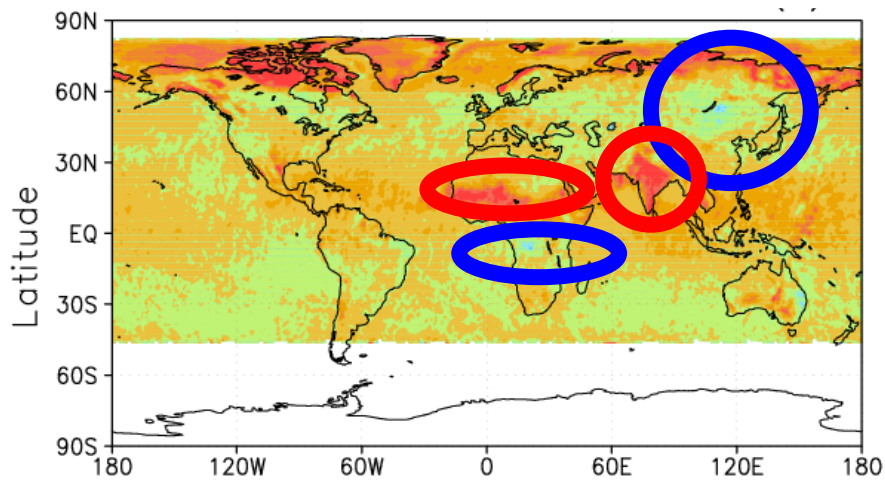
*Whenever 1 pixel is cloudy neighbors are rejected from the “clear” list*

*June 2003*

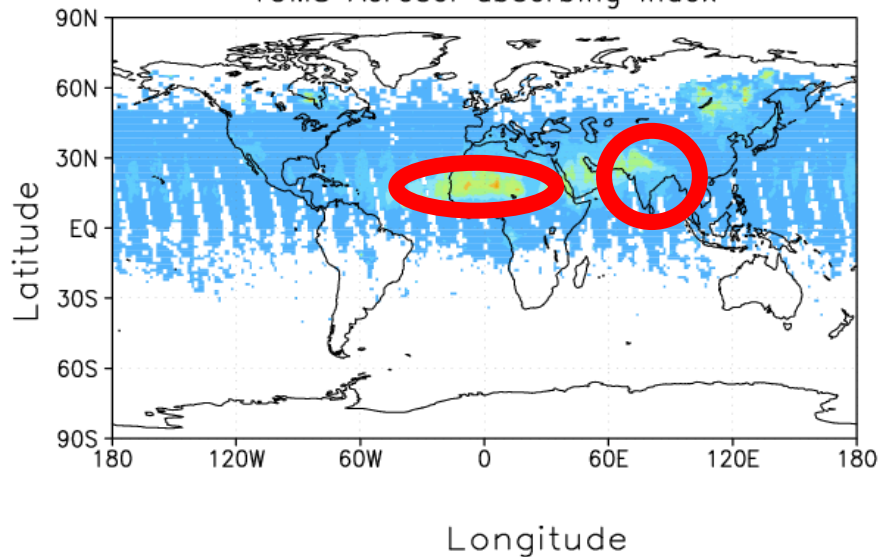


# Cloud products contamination by aerosols

MODIS (infrared day cloud fraction) - POLDER



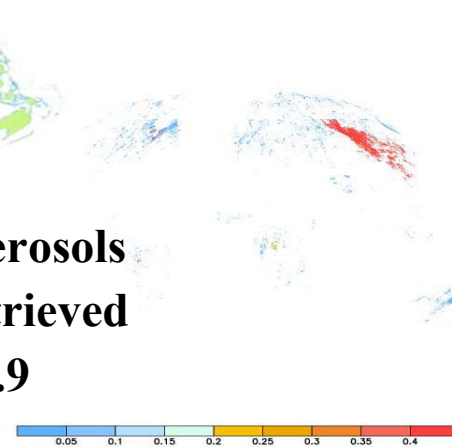
TOMS Aerosol absorbing index



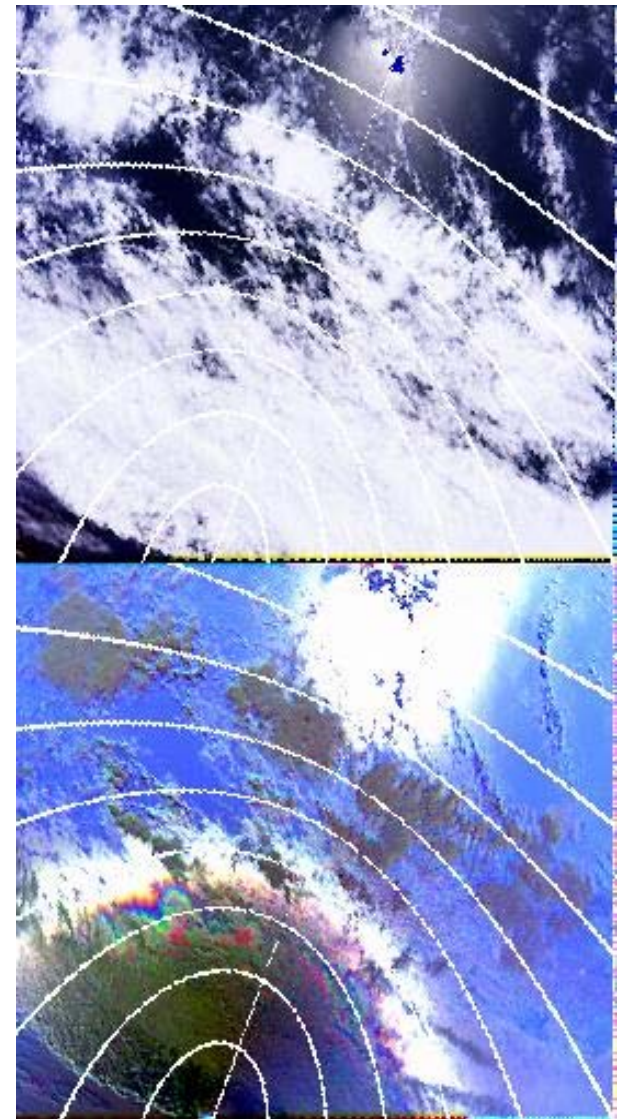
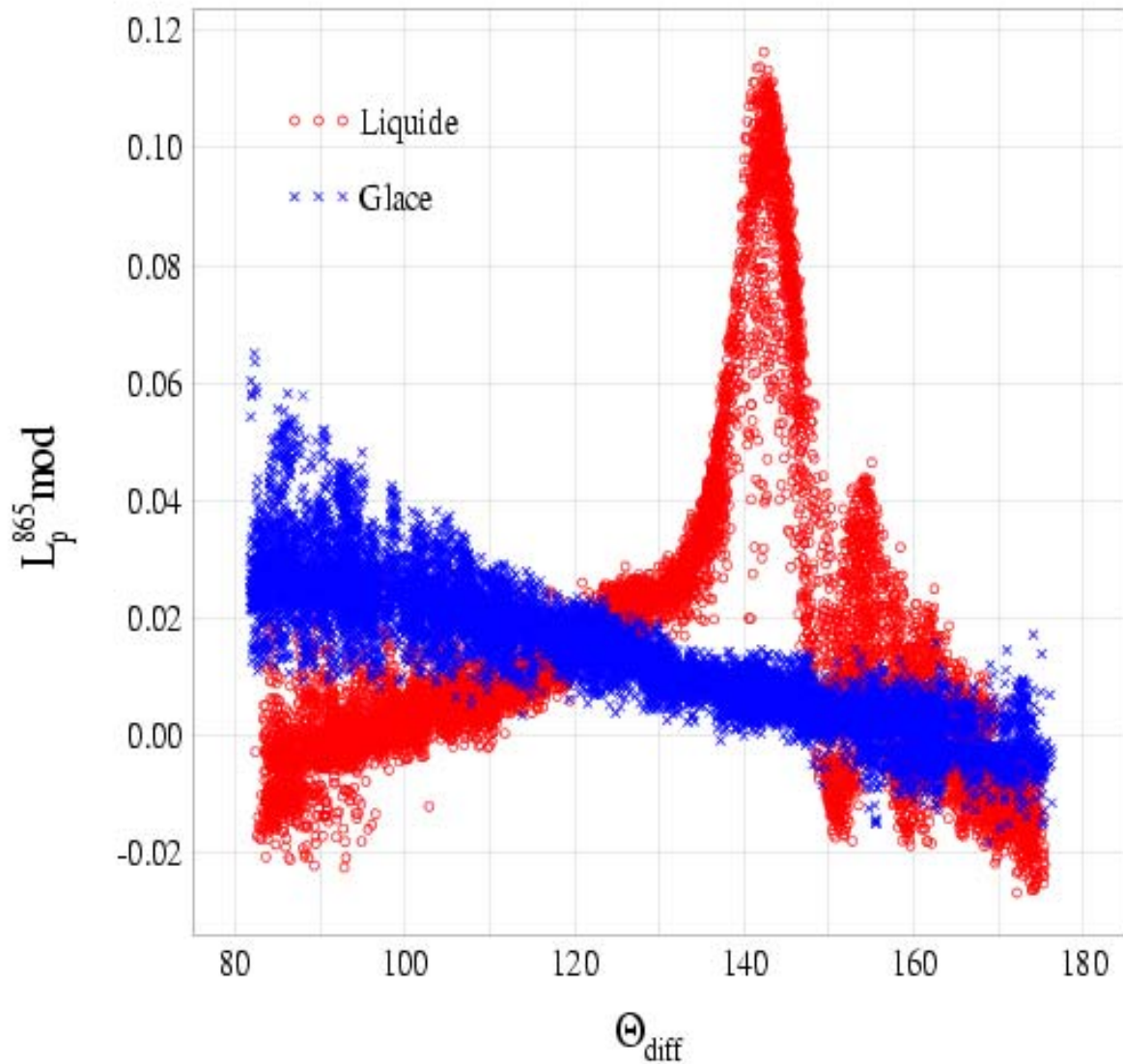
GADE: COLA/IBES

2004-10-17-21:3

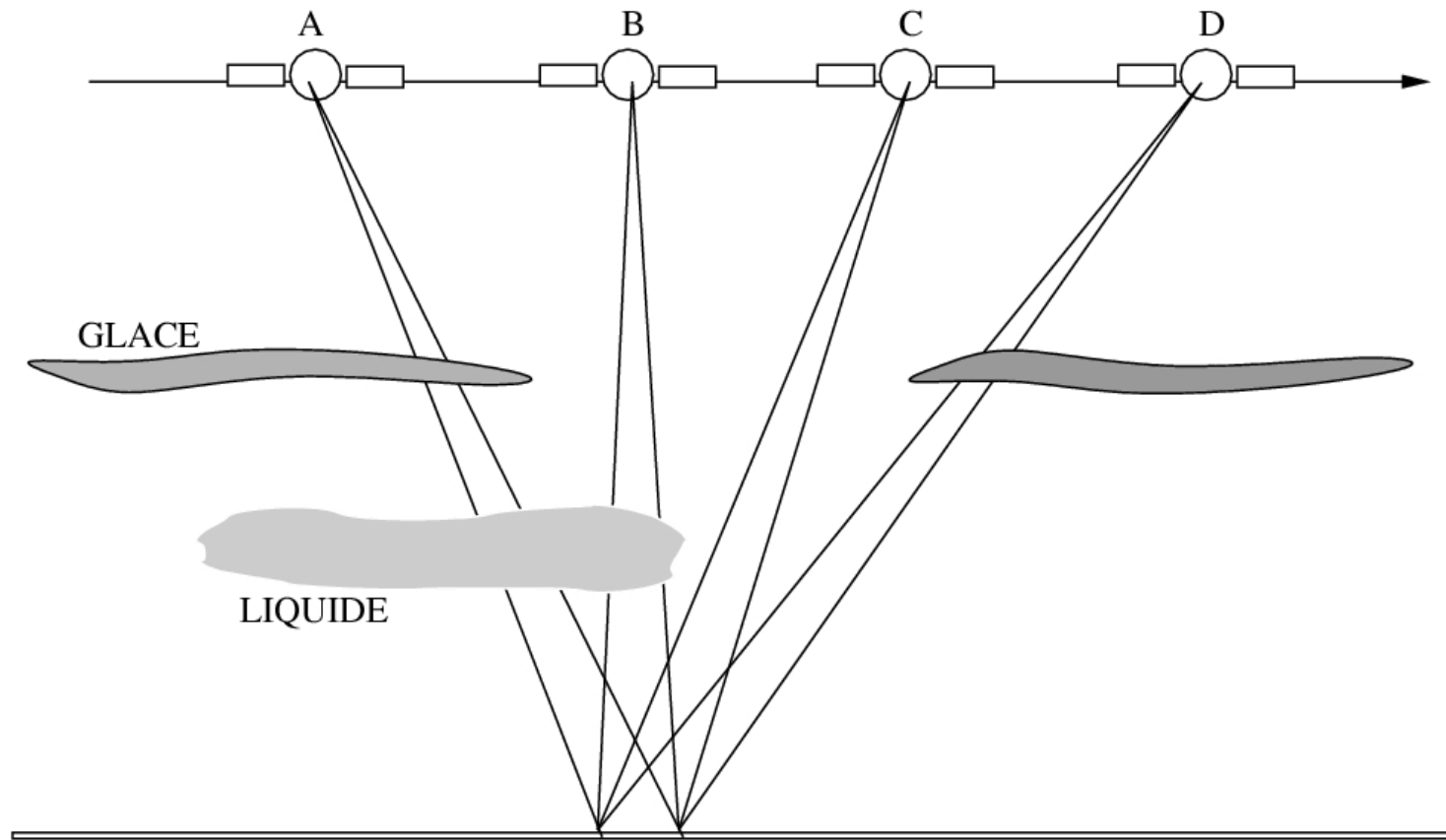
**POLDER aerosols  
products retrieved  
when  $cn > 99.9$**



# Multiangle polarisation measurements and Cloud Phase



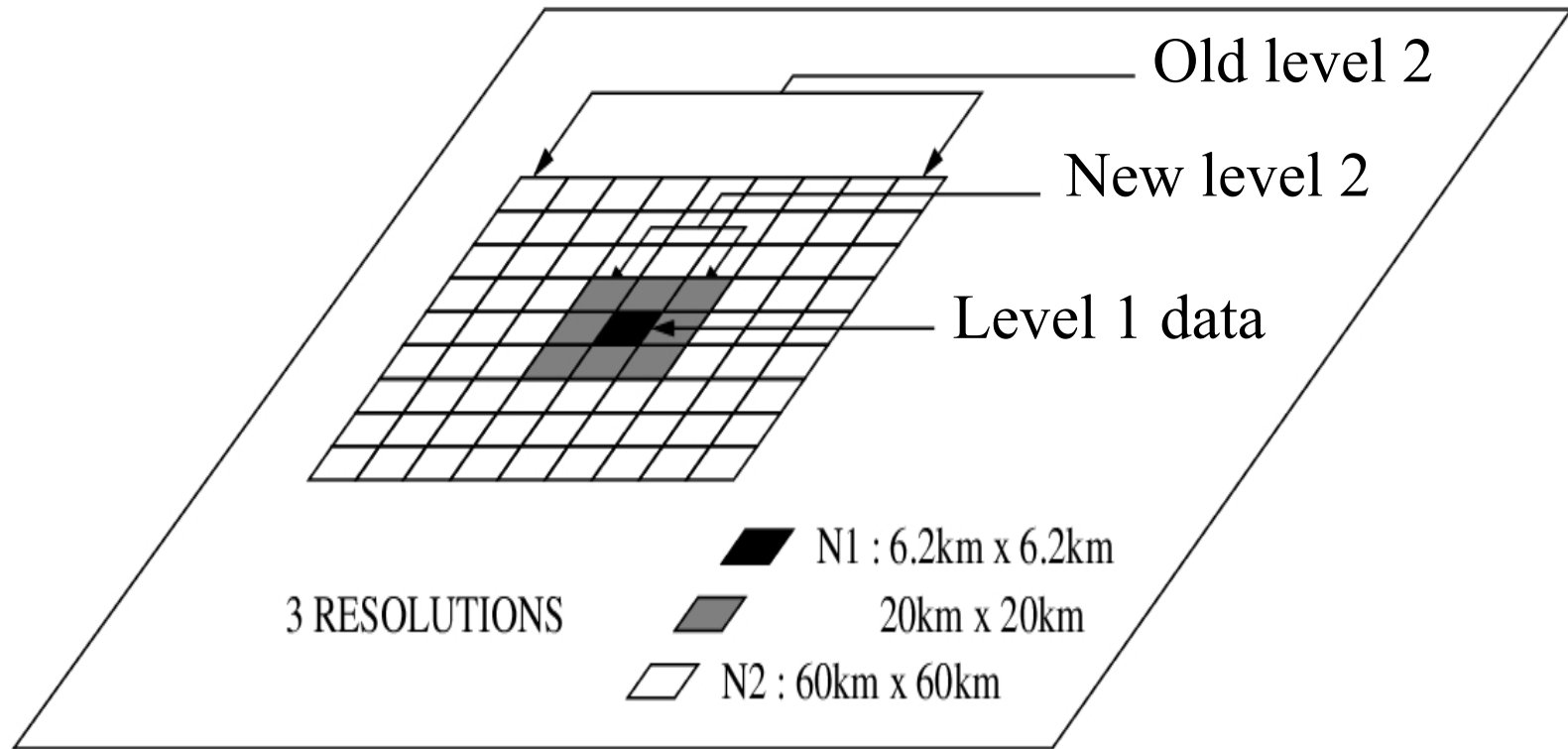
# OLDER Multiangle observation for summers



All directional observations are relocated on the surface



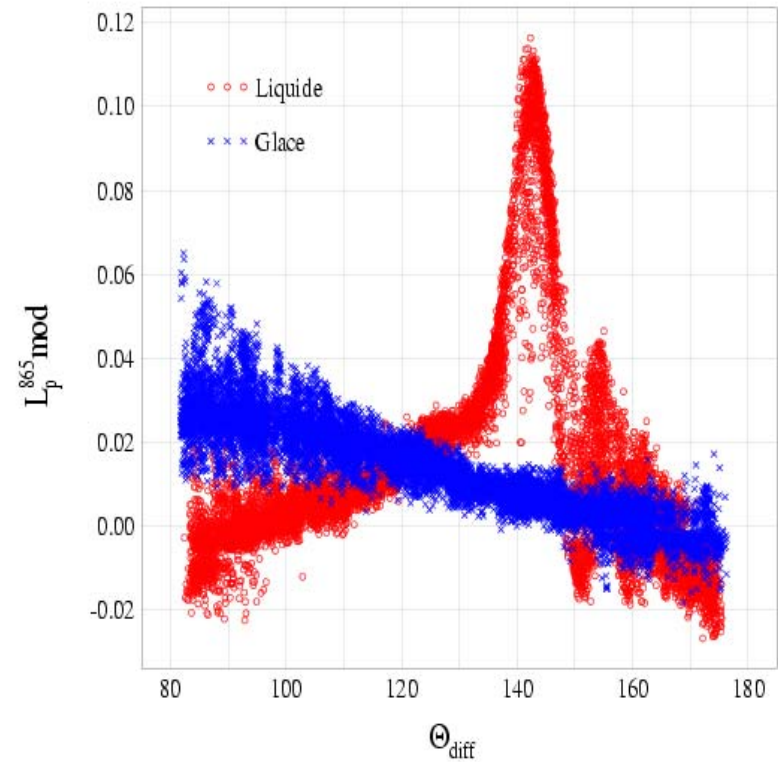
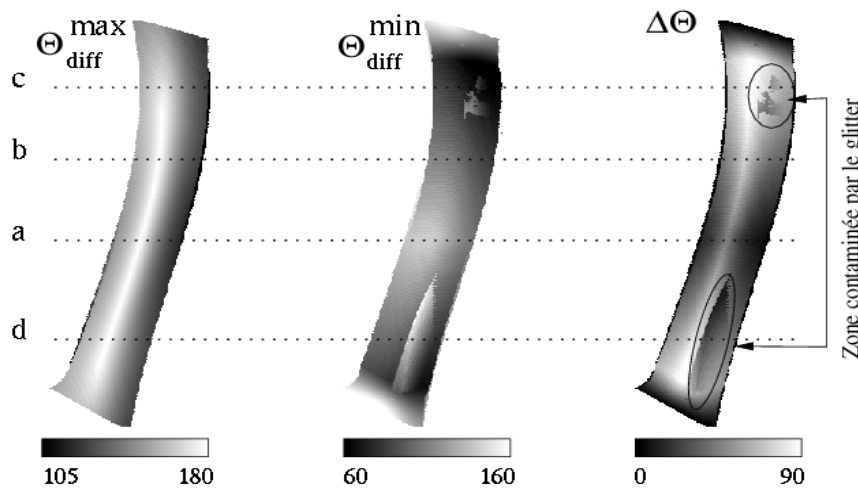
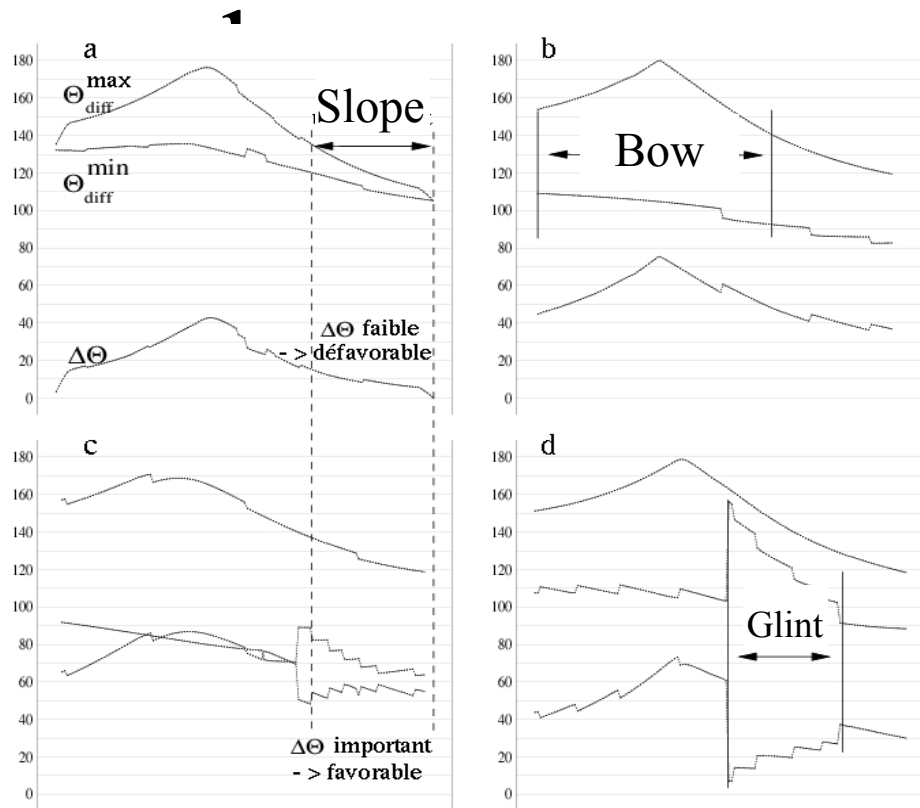
# OLDER Multiangle observation for summaries



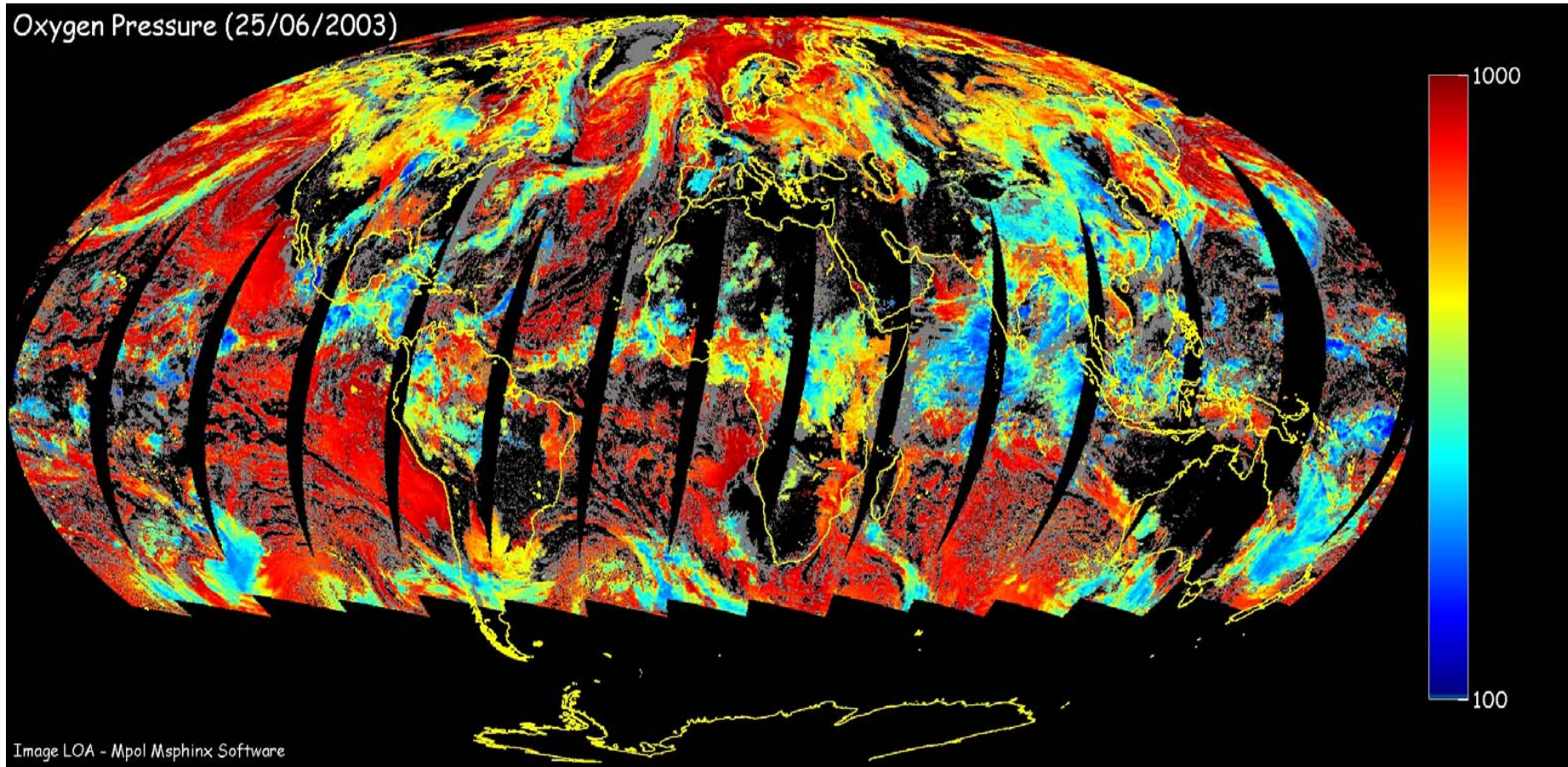
Products are retrieved and delivered at lower resolution to reduce relocation noise and biases

# OLDER Multiangle observation for

Diffusion angle range



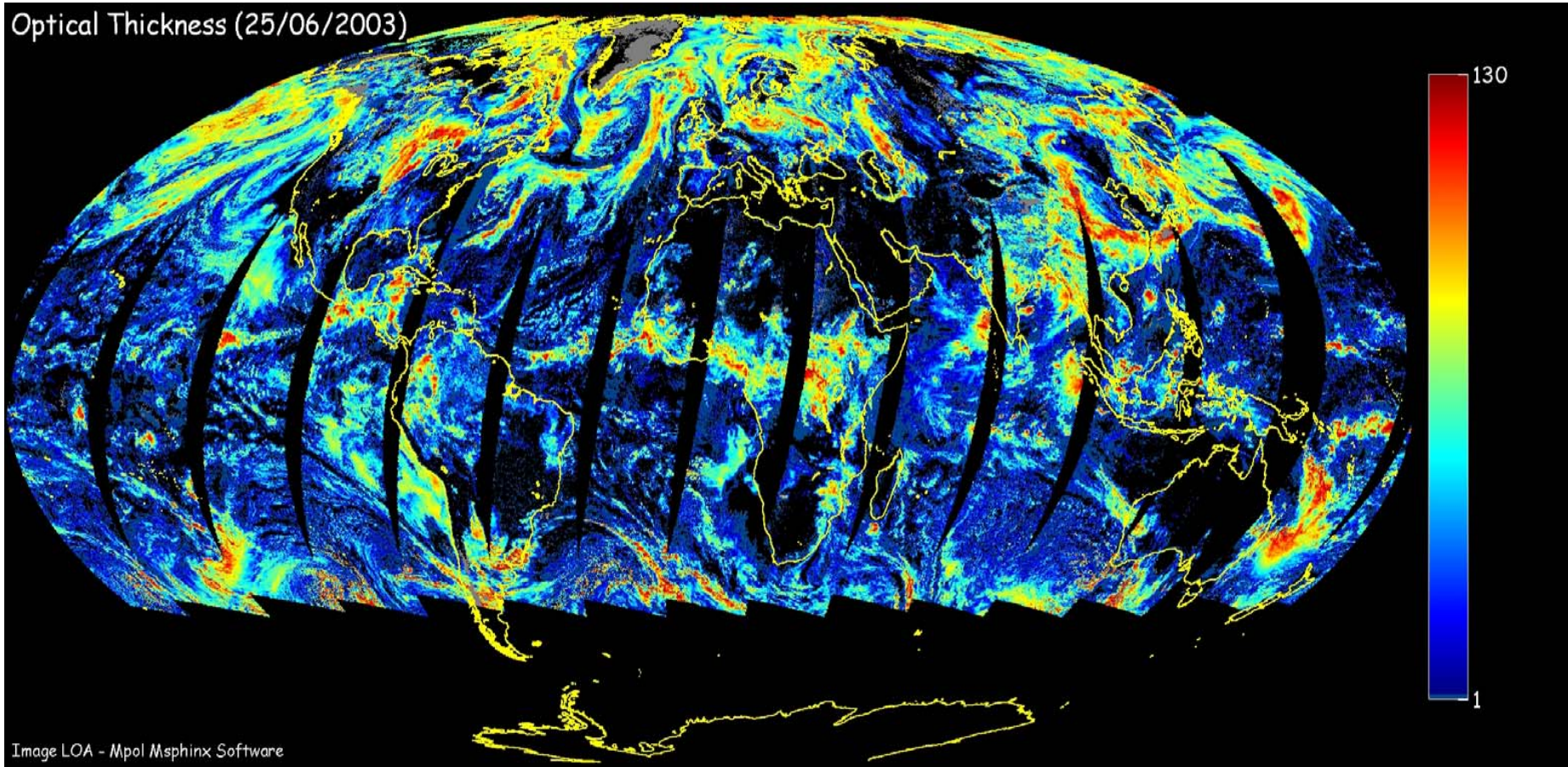
# Multispectral measurements



Differential absorption is used to infer cloud top (middle) pressure - 763nm and 765 nm

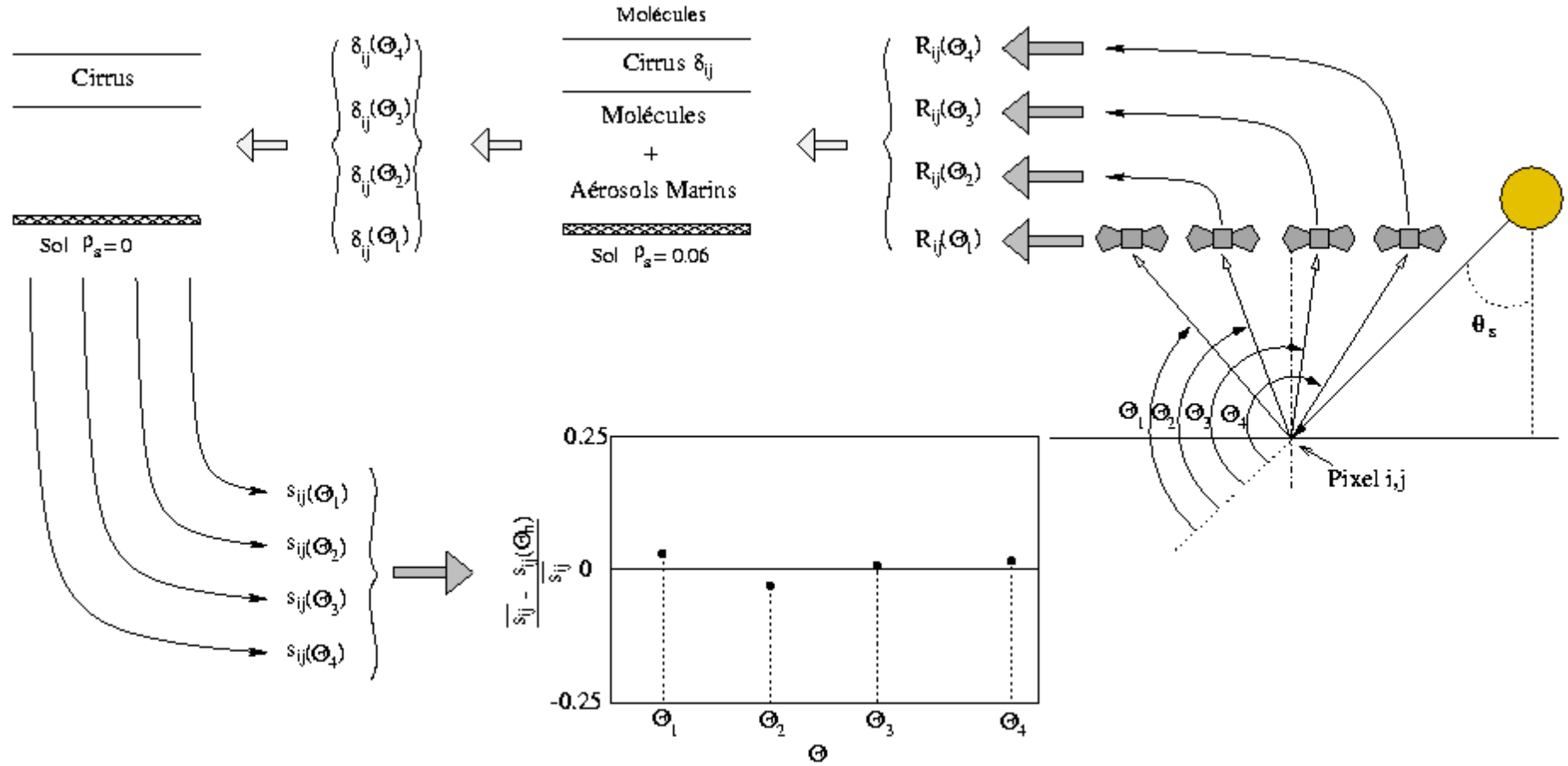
Directional product – Retrieval is performed in up to 14 directions

# Multispectral measurements

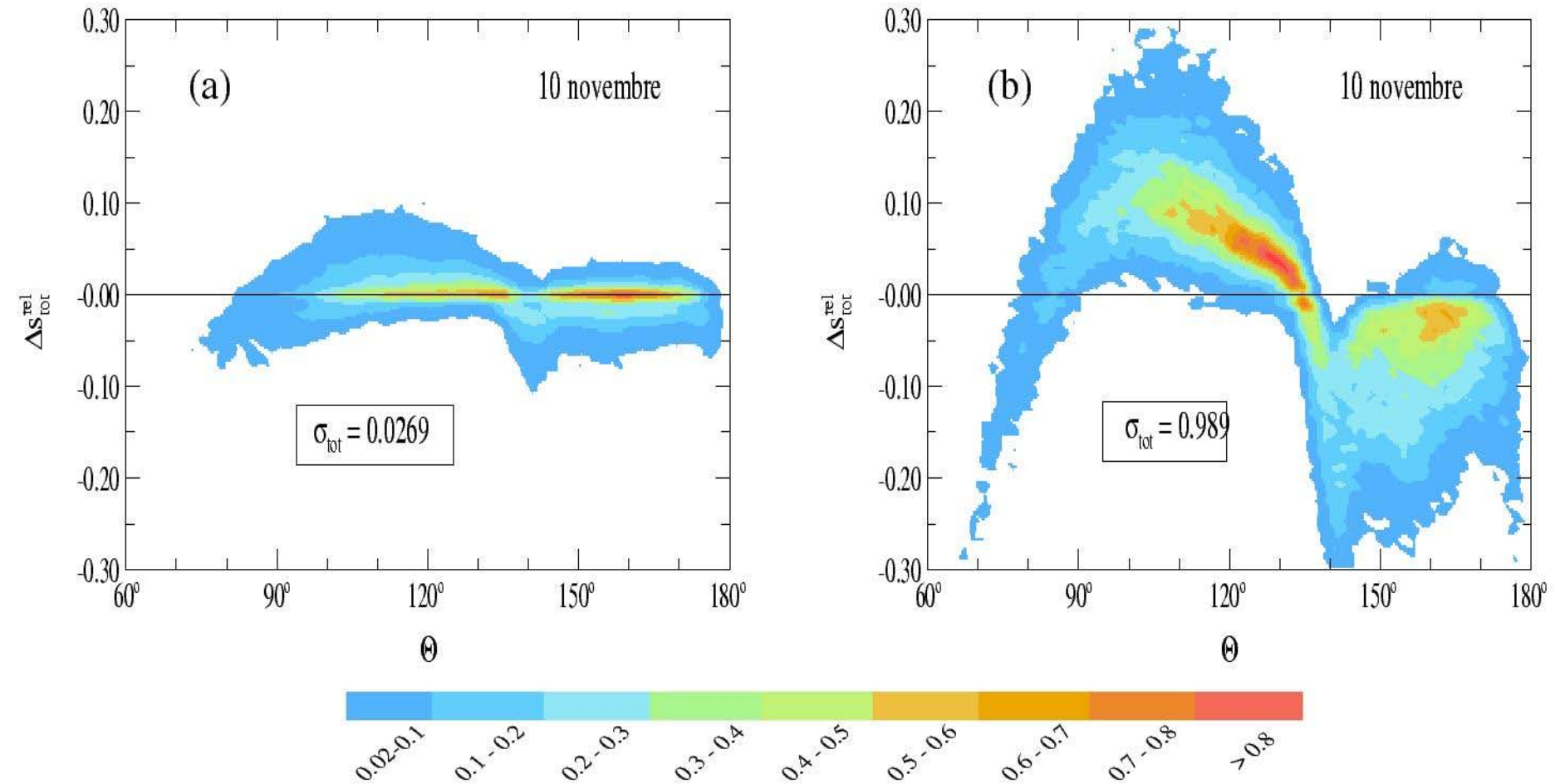


Cloud optical thickness is retrieved under up to 14 directions  
Directional product provided at 670nm (land) and 865 nm (ocean)

# Testing cloud models from multiangle observation

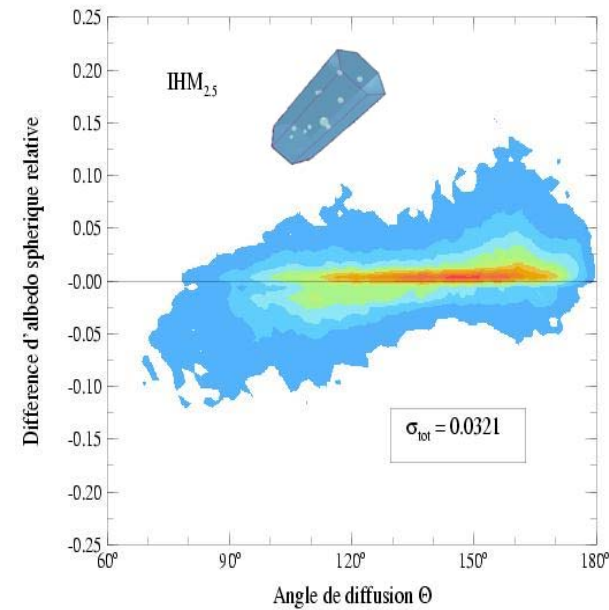
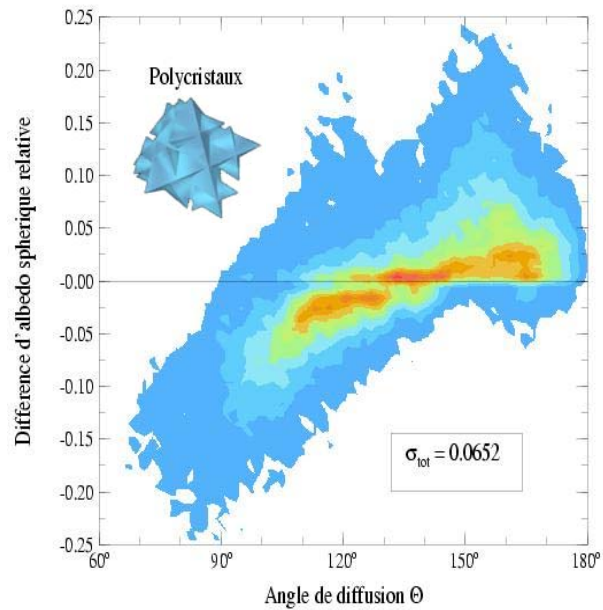
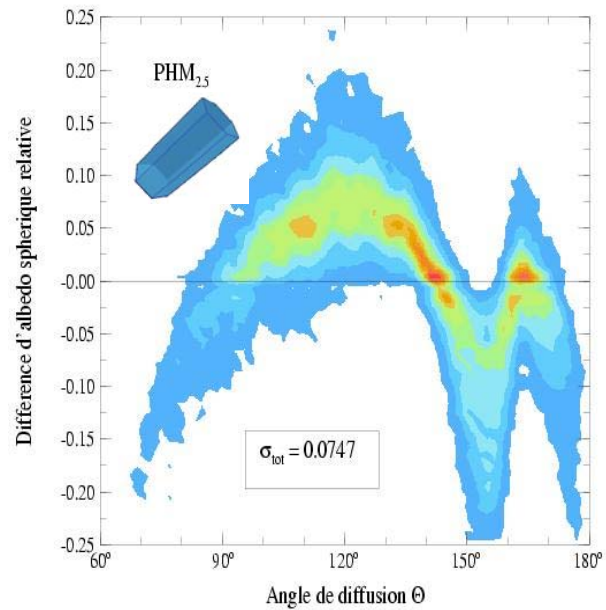
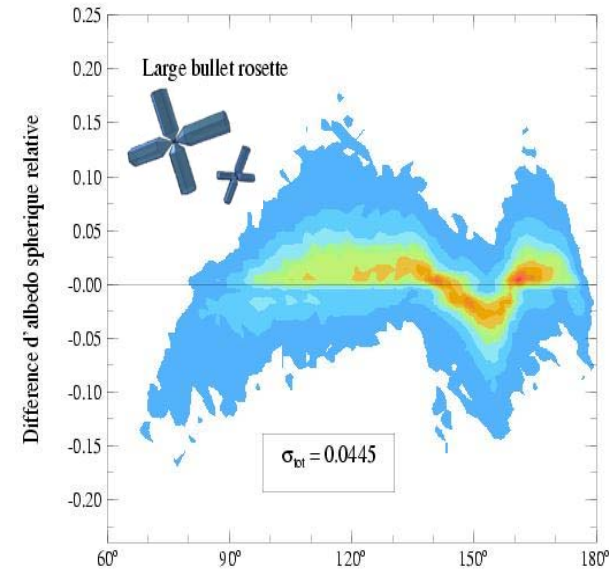
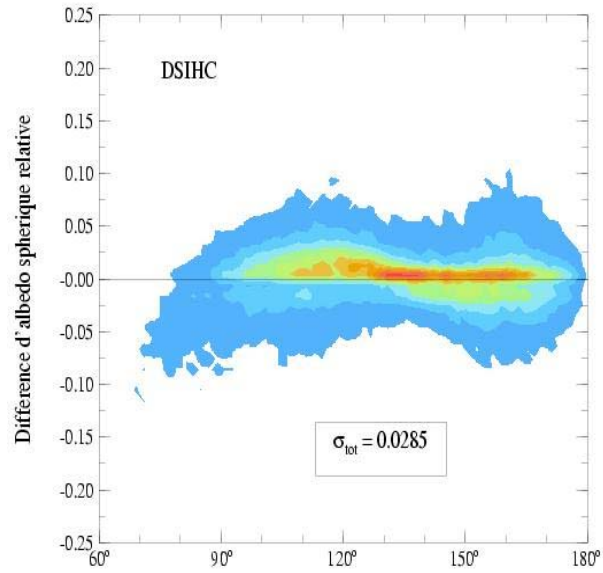
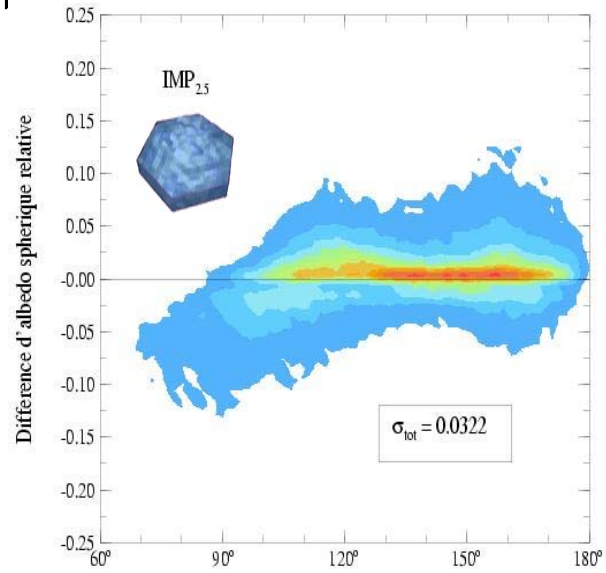


# Testing cloud models from multiangle observation

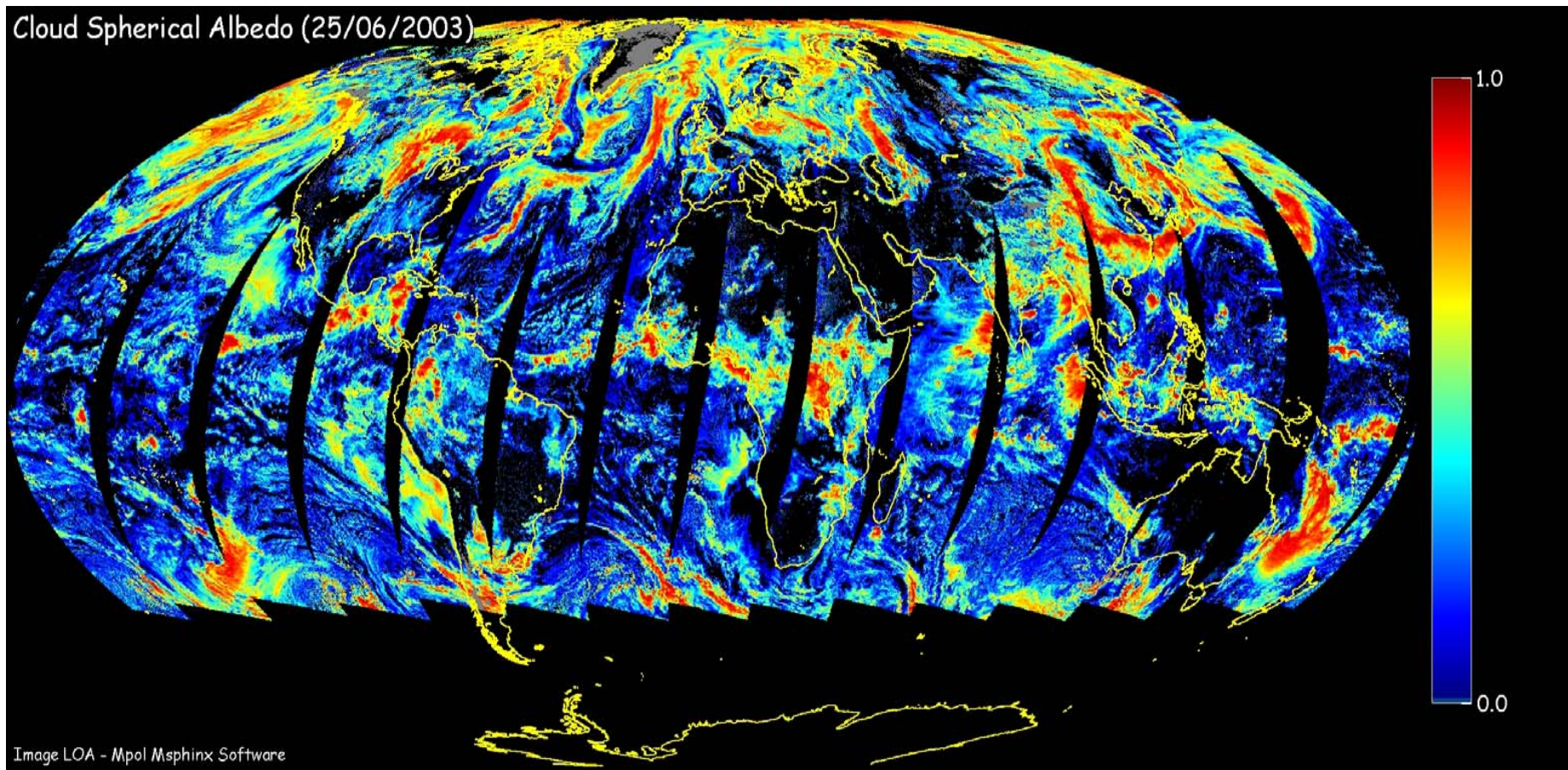


# Testing cloud models from multiangle

## Observation



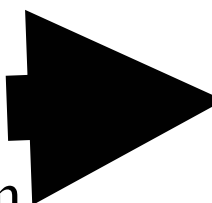
# Multiangle multispectral measurements



3 Spectral  $\lambda = 443 \text{ nm} \Rightarrow 200 - 550 \text{ nm}$

Cloud Albedo  $\lambda = 670 \text{ nm} \Rightarrow 550 - 700 \text{ nm}$

$\lambda = 865 \text{ nm} \Rightarrow 700 - 4000 \text{ nm}$



SW CLOUD ALBEDO

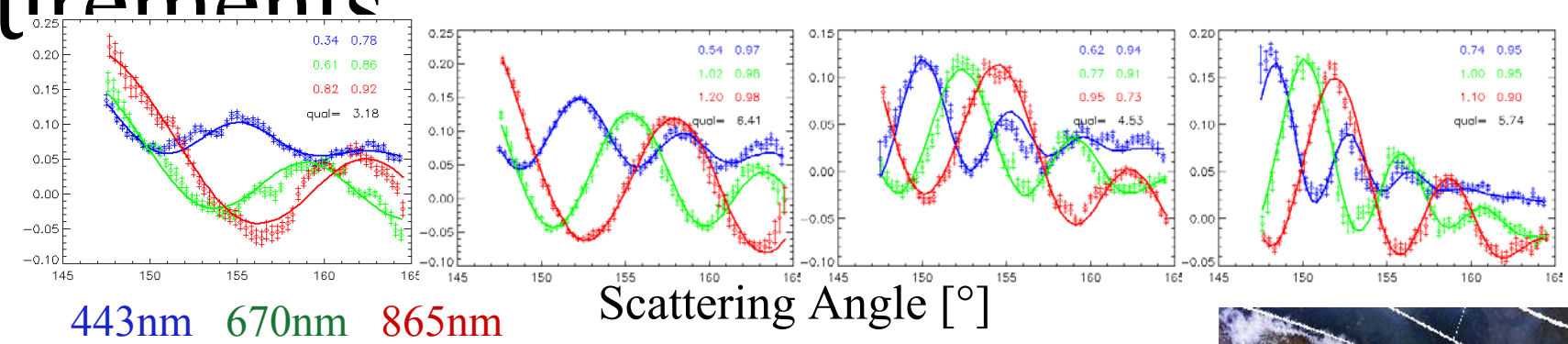




# Cloud Radiative Properties Retrievals from multiangle, multispectral polarisation measurements

## Polarized Reflectance Measurements

Polarized Reflectance

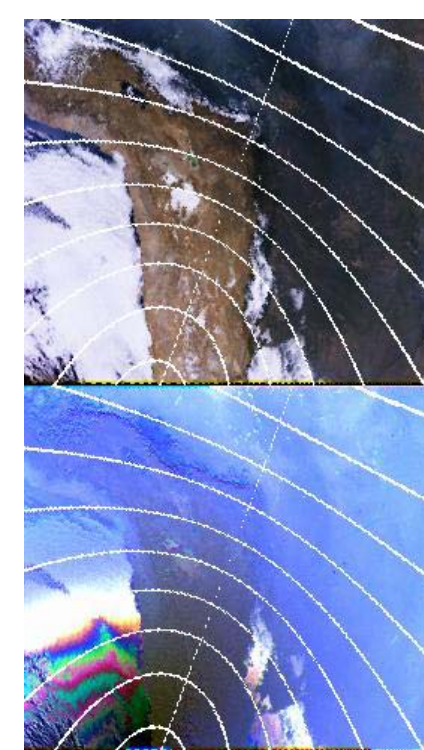


Based on the directional signature of the polarized reflectance  
Believed to be very accurate (multiple internal consistency check)  
Requires very specific conditions

- Multi-Directional polarized reflectance measurements
- Homogeneous cloud field over 150x150 km<sup>2</sup>
- Narrow size distribution

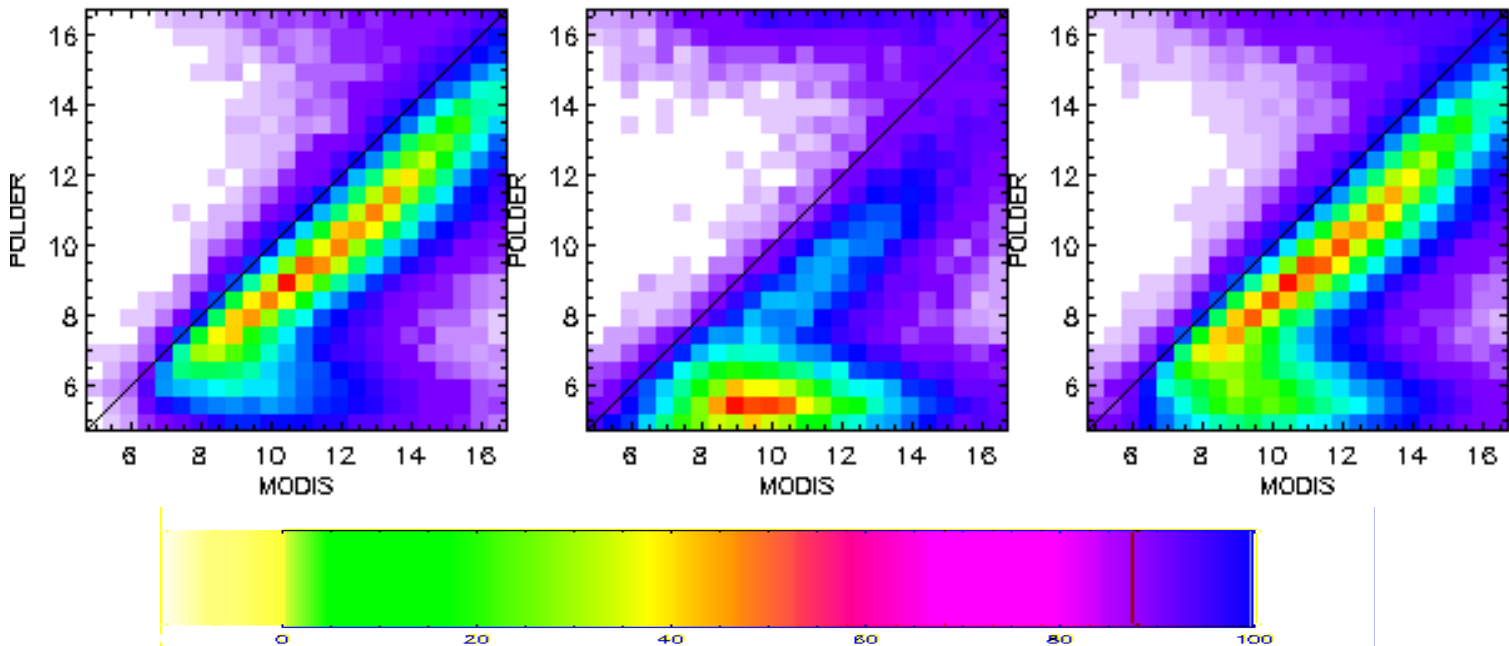
Sampling biased to specific cloud types

Some clouds, such as the broken cumulus of the tropics, are never sampled



# Liquid Particle Effective Radius Retrievals from multiangle, multispectral polarisation measurements

## POLDER vs MODIS comparison



Excellent correlation, except for small droplets

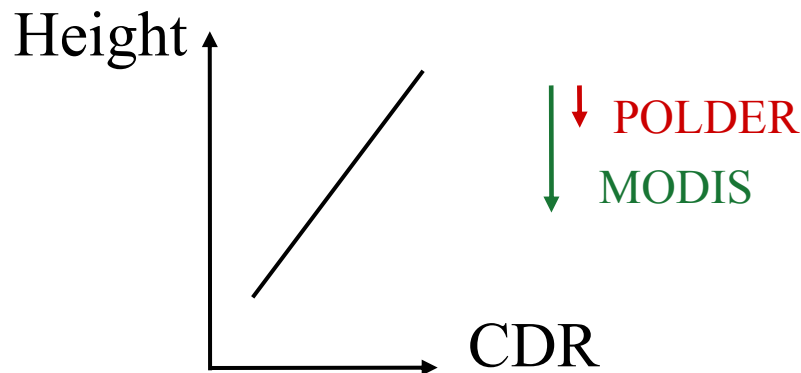
2  $\mu\text{m}$  bias (MODIS > POLDER)

Little correlation over land (small droplets according to POLDER)

# from multiangle, multispectral polarisation measurements

## Measurements Hypothesis for bias

### Vertical profile of CDR



POLDER samples the very cloud top (opt. th.  $\approx 1$ ) while MODIS probes the cloud deeper. But, a decrease of CDR with depth is expected. => Bias of opposite sign.

OR: Different process at the very cloud top (evaporation) ???

### Summary - Conclusions

POLDER polarization measurements provide an alternative to the MODIS spectral method for the estimate of CDR in clouds.

Requires specific cloud and viewing geometry conditions. Climatological means to be used with cautions as the sampling may be biased

Comparison with MODIS coincident retrievals. High correlation for range 9-15  $\mu\text{m}$  but bias 2  $\mu\text{m}$ . Poor correlation for smaller radii.

No satisfactory explanation for bias and poor correlation at small  $Re$ .

# OLDER ERB, WV and Clouds Products Products Availability

# Products availability

POLDER1 : November 1996 to June 1997

POLDER2 : April 2003 to October 2004

Level1 : calibrated georeferenced data

Level2 : daily products – one file per orbit swath

Level3 : monthly products

Joint Atmosphere product (selected daily and monthly products)

Data processed with collection 2 algorithms for POLDER 2 and under reprocessing for POLDER 1

Data ordering interface from the CNES POLDER web portal ...

# Web POLDER

## Multiple angle ... and multiple web portal

The screenshot shows the French version of the POLDER website. The header features the CNES logo and the POLDER mission name: "Atmosphere, Land and Ocean mission, Climate Research and Environment Monitoring". A navigation menu includes links for HOME, NEWS, OBJECTIVES, SATELLITE, INSTRUMENT, GROUND SEGMENT, ORGANIZATION, CONTACTS, GALLERY, and RELATED SITES. The main content area is titled "The project main steps" and includes a timeline for POLDER-1 (08/96 to 05/97) and POLDER-2 (12/02 to 10/03). A "CHARACTERISTICS" sidebar lists details for both instruments, such as their altitude and useful lifetimes. A "NEWS" section on the right lists key events from 2002 to 2004. The footer contains a "GALLERY" section with photos of the sensor integration phase.

The screenshot shows the English version of the POLDER website. The header includes the POLDER logo and navigation links for Home, Information, Fields, Products, User Desk, and Contact. A search bar and a language selector (French/English) are also present. The main content area is titled "POLarization and Directionality of the Earth's Reflectances" and features a "LATEST POLDER NEWS" section with links to data distribution, calibration reports, and satellite loss news. A central graphic displays a globe divided into four quadrants representing different data fields: "ERB, WV AND CLOUDS", "OCEAN COLOR", "AEROSOLS", and "LAND SURFACES". Below this is a "LEVEL 1 DATA" section with a "Gallery" of satellite images. The footer includes logos for CNES and JAXA, a "Site Security Policy" link, and the date "Latest update: July 19th, 2004".

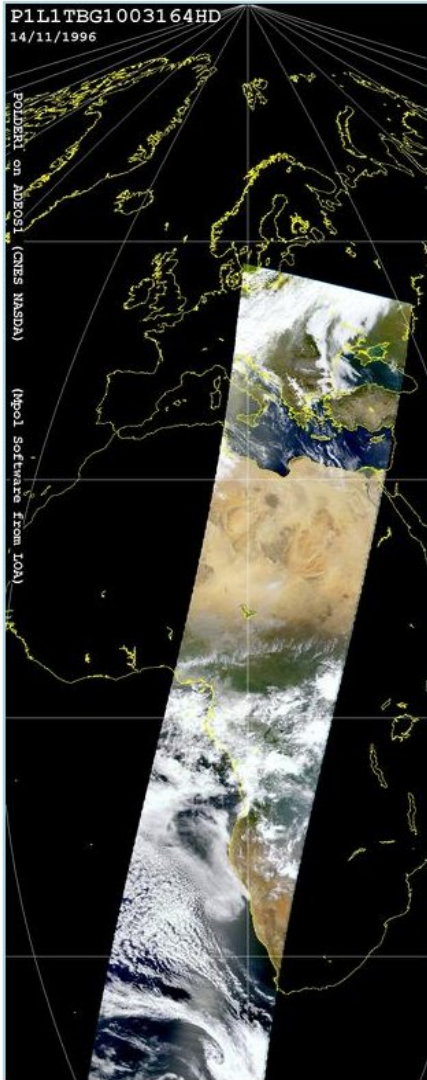
<http://smc.cnes.fr/POLDER/index.htm>

<http://polder.cnes.fr>

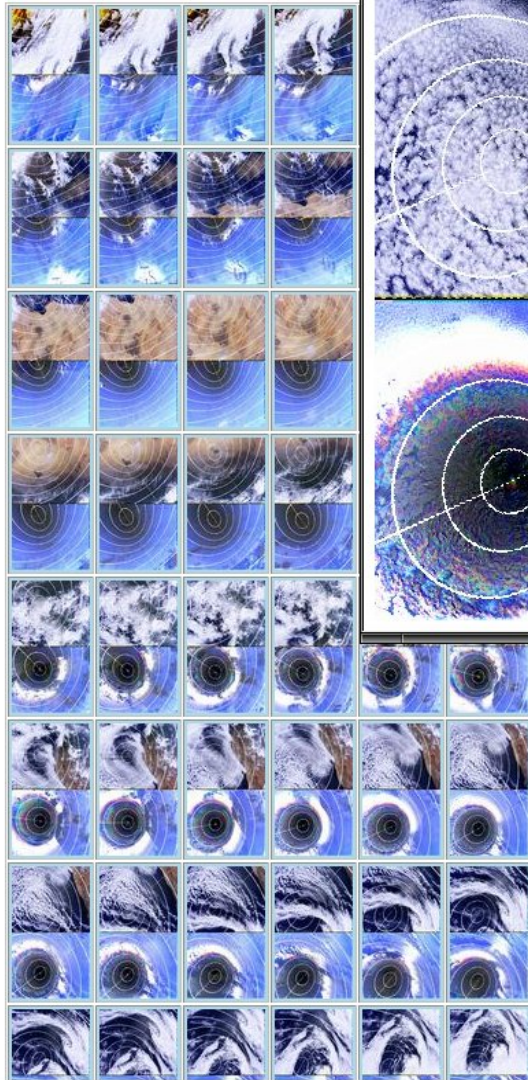


P1L1TBG1003164HD  
14/11/1996

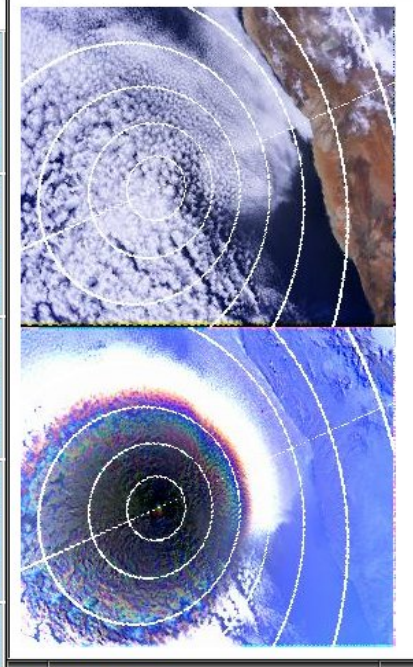
(POLDER on Airbus)  
(NASA SENS)  
(POLDER Software from LOA)



Quicklook for orbit 003164



M003164\_070.JPG (JPEG Image, 274x46)



# Data format and Tools

## Mpol

Visualize/Extract data from  
POLDER file (binary format)

Sequence creator/navigator

Dump data to bin/hdf file

Full support for every L1, L2  
and L3 products

Command line converter to  
HDF-EOS format for all  
products

Mpol (version 4.0Beta)  
Mpol: a multi functional analysis and interpretation tool

Download now

Generalities

- [Introduction](#)
- [Platforms](#)
- [Glossary](#)

Level 1 data

- [Visualisation](#)
- [Super pixel value](#)
- [Multiangular data analysis](#)
  - [features over clouds](#)
  - [Sun glint](#)

Direct link with the AERONET data base

- [Msky](#)

Level 2 and 3 data

- [Visualisation](#)

HDF EOS data extractions

- [HDFEOS](#)

Command line capabilities

- [Keywords](#)
- [Build a browse](#)
- [Build a browse \(Auto crop option\)](#)
- [POLDER to HDF-EOS Customized\(1\)](#)
- [POLDER to HDF-EOS Customized\(2\)](#)
- [Product parameters list](#)

Previous version...

- [POLDER data with Msphinx](#)

Sequence no: 57 over 116

RGB composite from Radiances and Polarization effects

**POLDER Main window and zoom capabilities (data main geometry is integerized sinusoidal)**

A true color composite quick look image can be displayed for the orbit to help in data interpretation and scene selection. Both orbit and sequences true color images are built from atmospheric corrected reflectances for an improved view of land, aerosols and cloud features.

P2L1TBG1038033AL,P2L1TBG1038033AD

File Selection Window Color Plot Projections Misc Help

4,9167 86,1803



# Conclusions / Perspectives

The bad news :  
No long time serie available

The good news :

One more chance to go in December  
to join A-Train

(Parasol, MODIS, Cloudsat, Calipso)

Very nice research instrument and still no equivalent

