POLDER Earth Radiation Bugdet, Water Vapor and Cloud Products

Multiangle cloud remote sensing from POLDER 1 and 2

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POLDER Earth Radiation Bugdet, Water Vapor and Cloud Products

## Multiangle cloud remote sensing from POLDER 1 and 2

➢ 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 caracteristics :
    - Wide field of view + CCD array
    - Multispectral : 443 nm - 910 nm
    - Multidirectionality
    - Polarisation in 3 bands : 443, 670, 865 nm
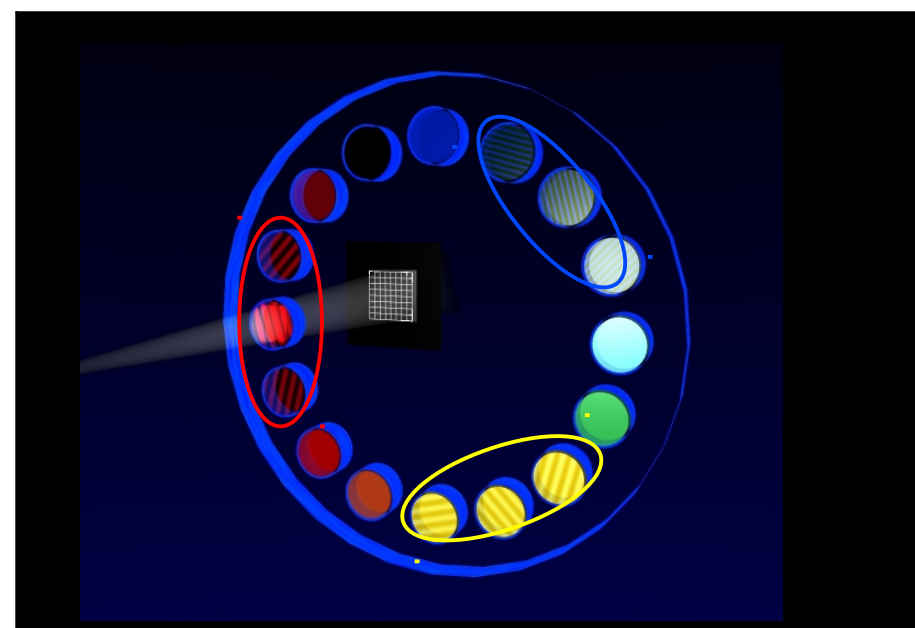
POLDER concept and capabilities
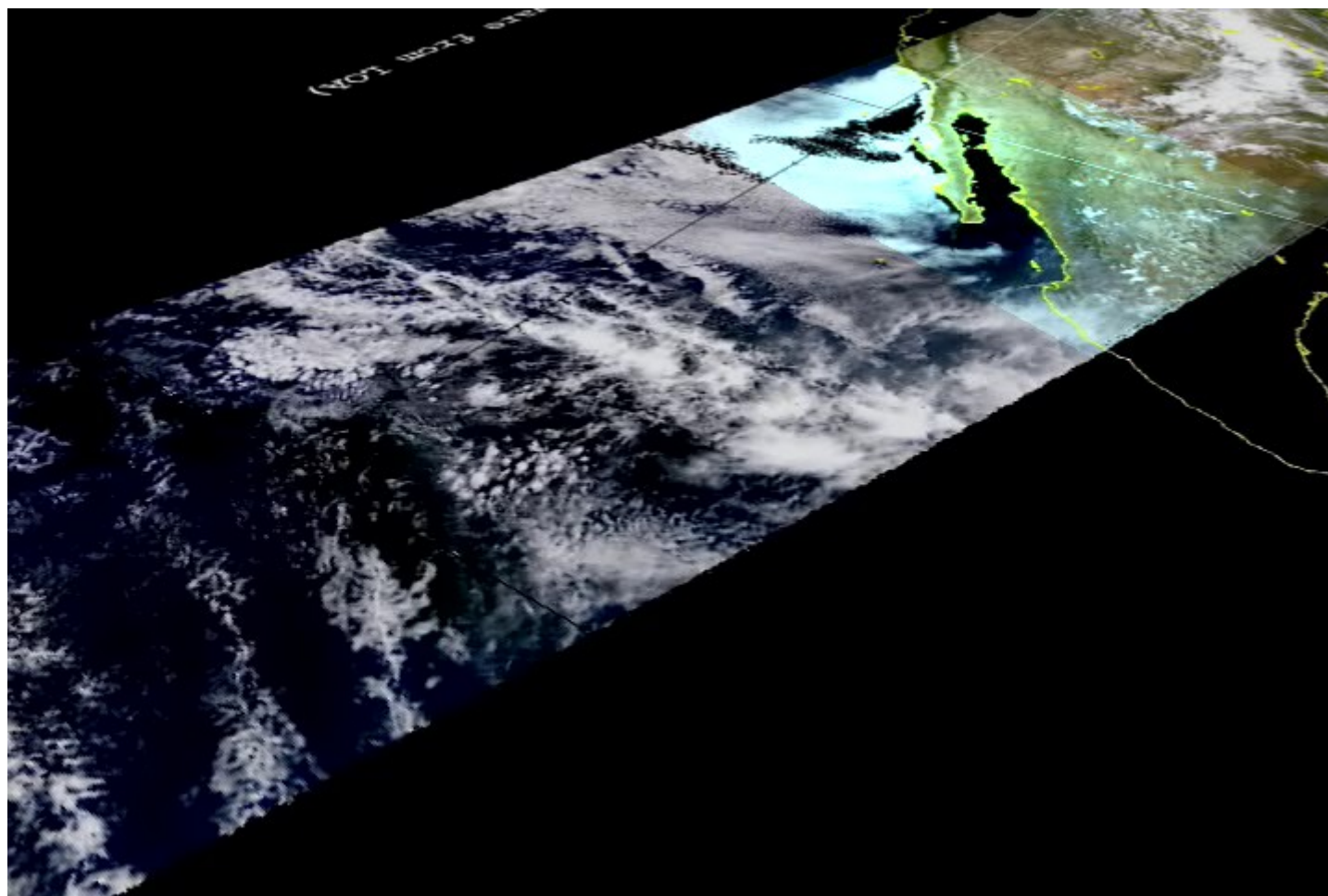
POLDER ERB,WV and Clouds Products
Outline of processing path and selected products

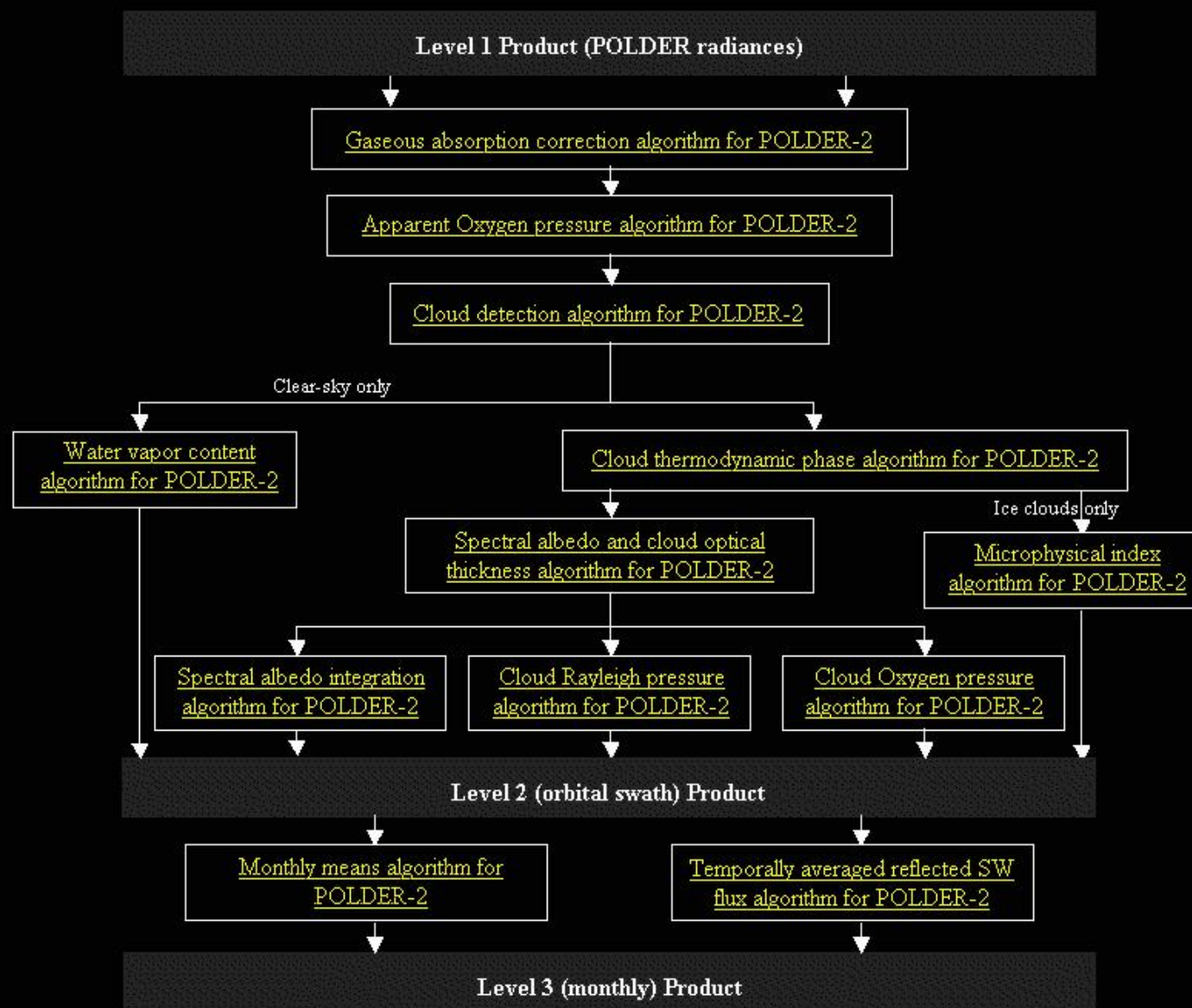# Level 2, Level 3 and Joint Atmosphere Product

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.

Level 1 Product (POLDER radiances)

Gaseous absorption correction algorithm for POLDER-2

Apparent Oxygen pressure algorithm for POLDER-2

Cloud detection algorithm for POLDER-2

Clear-sky only

Water vapor content algorithm for POLDER-2

Cloud thermodynamic phase algorithm for POLDER-2

Ice clouds only

Spectral albedo and cloud optical thickness algorithm for POLDER-2

Microphysical index algorithm for POLDER-2

Spectral albedo integration algorithm for POLDER-2

Cloud Rayleigh pressure algorithm for POLDER-2

Cloud Oxygen pressure algorithm for POLDER-2

Level 2 (orbital swath) Product

Monthly means algorithm for POLDER-2

Temporally averaged reflected SW flux algorithm for POLDER-2

Level 3 (monthly) Product

POLDER ERB,WV and Clouds Products

Cloud Cover (25/06/2003)

100

0
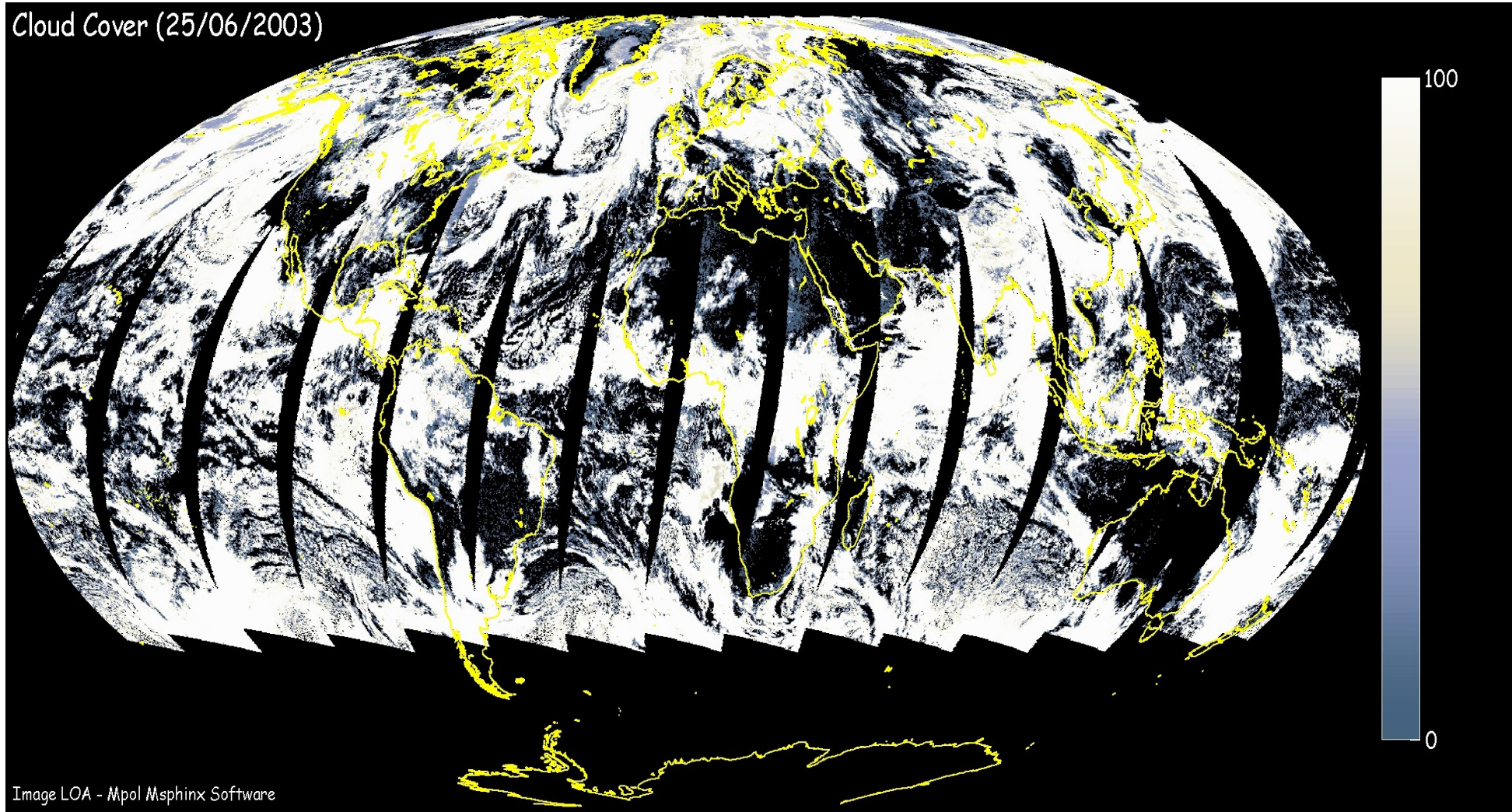
Image LOA - Mpol Msphinx Software

POLDER ERB,WV and Clouds Products

Cloud Phase (25/06/2003)

nan
Unknown
Mixed
Ice
Liquid

Image LOA - Mpol Msphinx Software
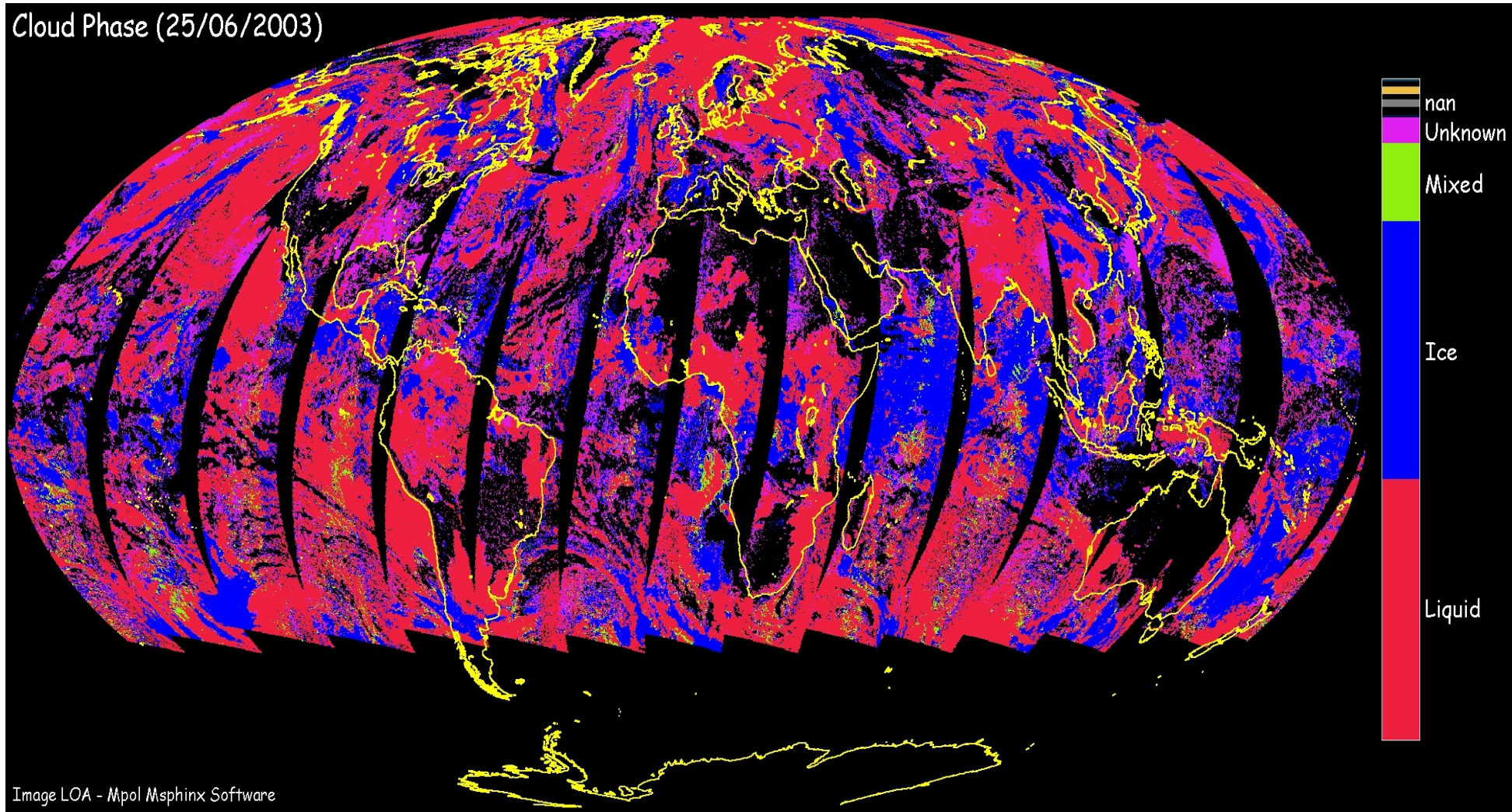
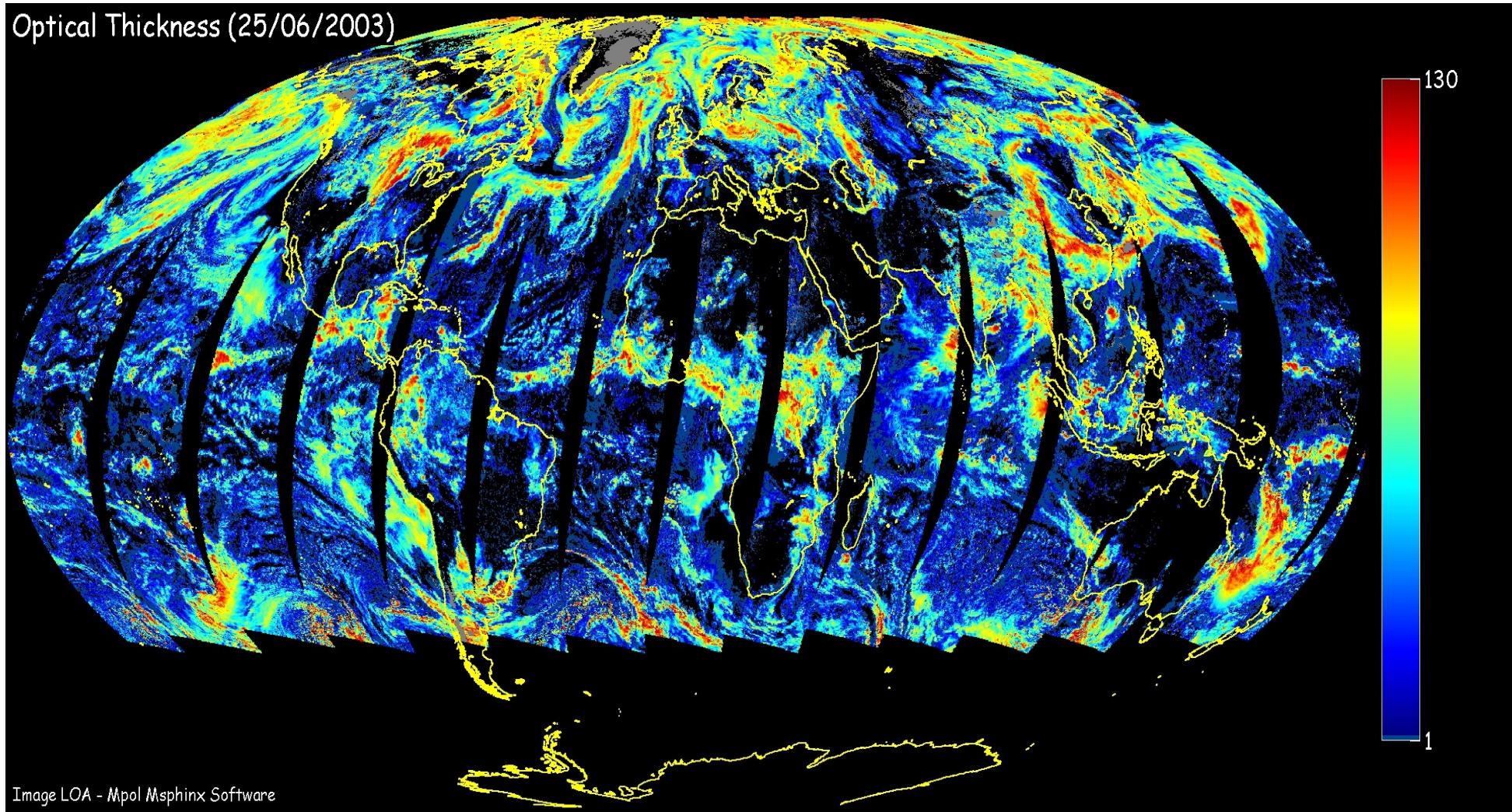# POLDER ERB,WV and Clouds Products

Optical Thickness (25/06/2003)

Image LOA - Mpol Msphinx Software

130

1

POLDER ERB,WV and Clouds Products
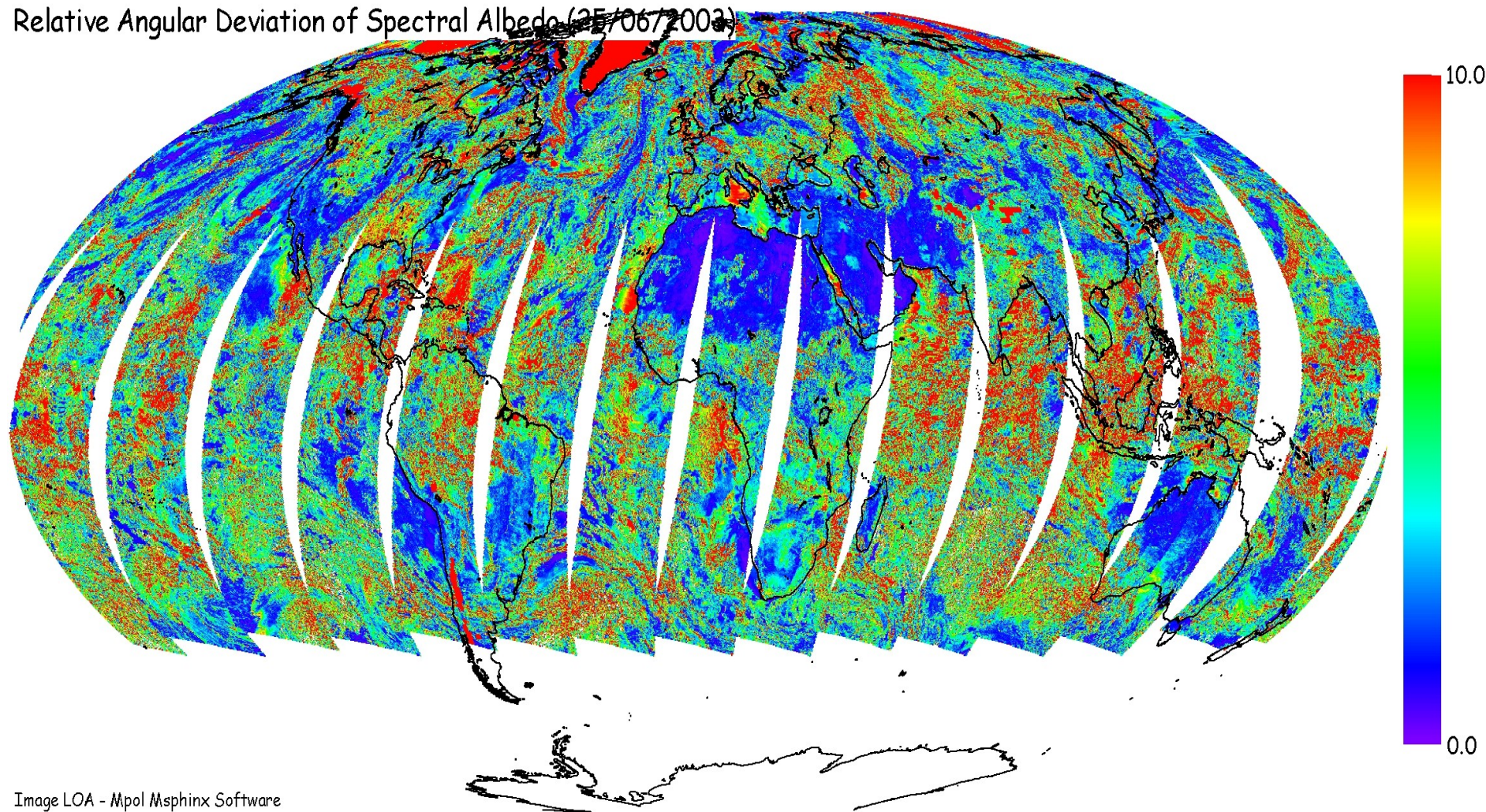
Oxygen Pressure (25/06/2003)

Image LOA - Mpol Msphinx Software

1000

100
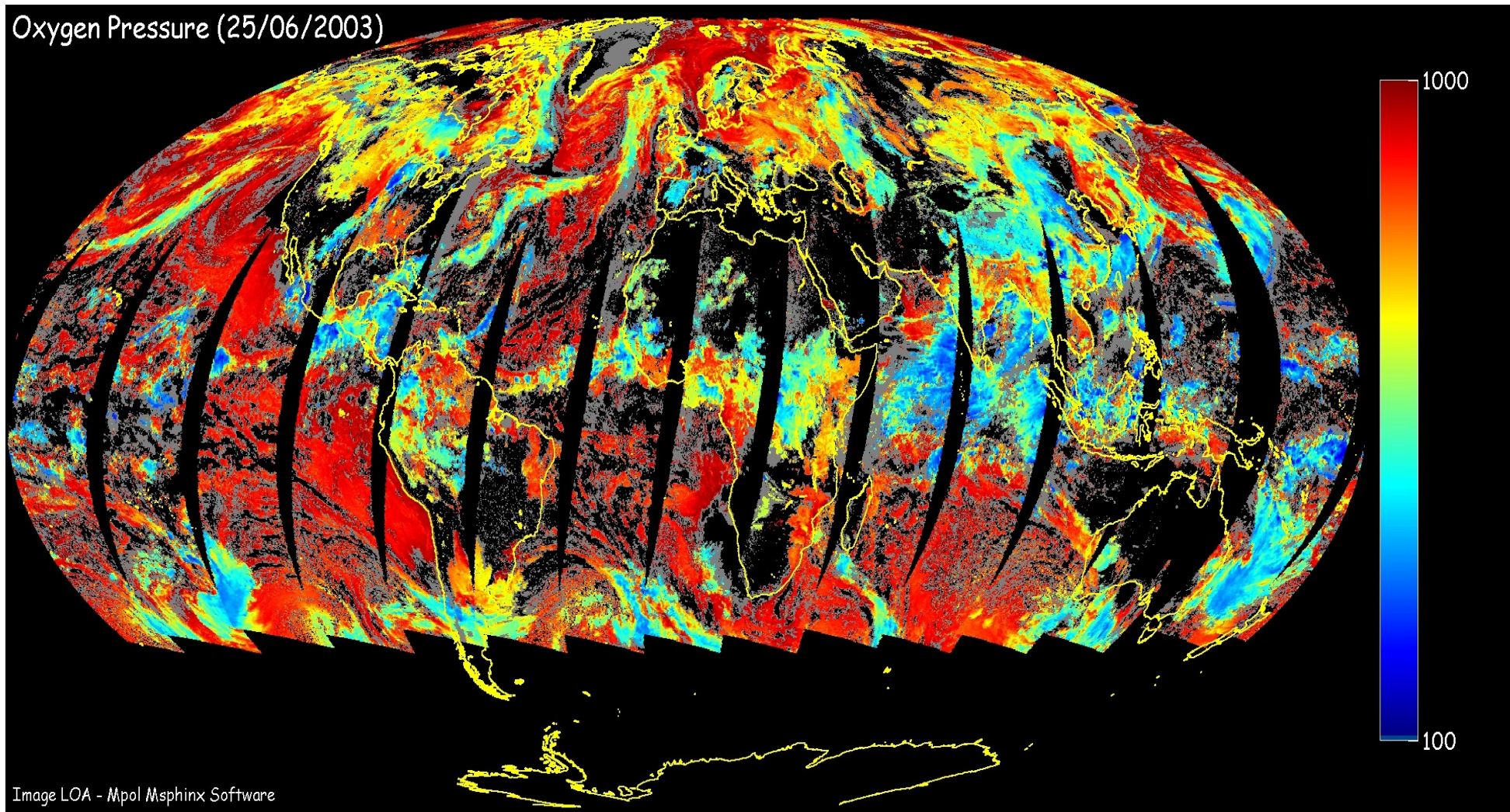
POLDER ERB,WV and Clouds Products

Mean Spectral Albedo (25/06/2003)

1.0

0.0

Image LOA - Mpol Msphinx Software
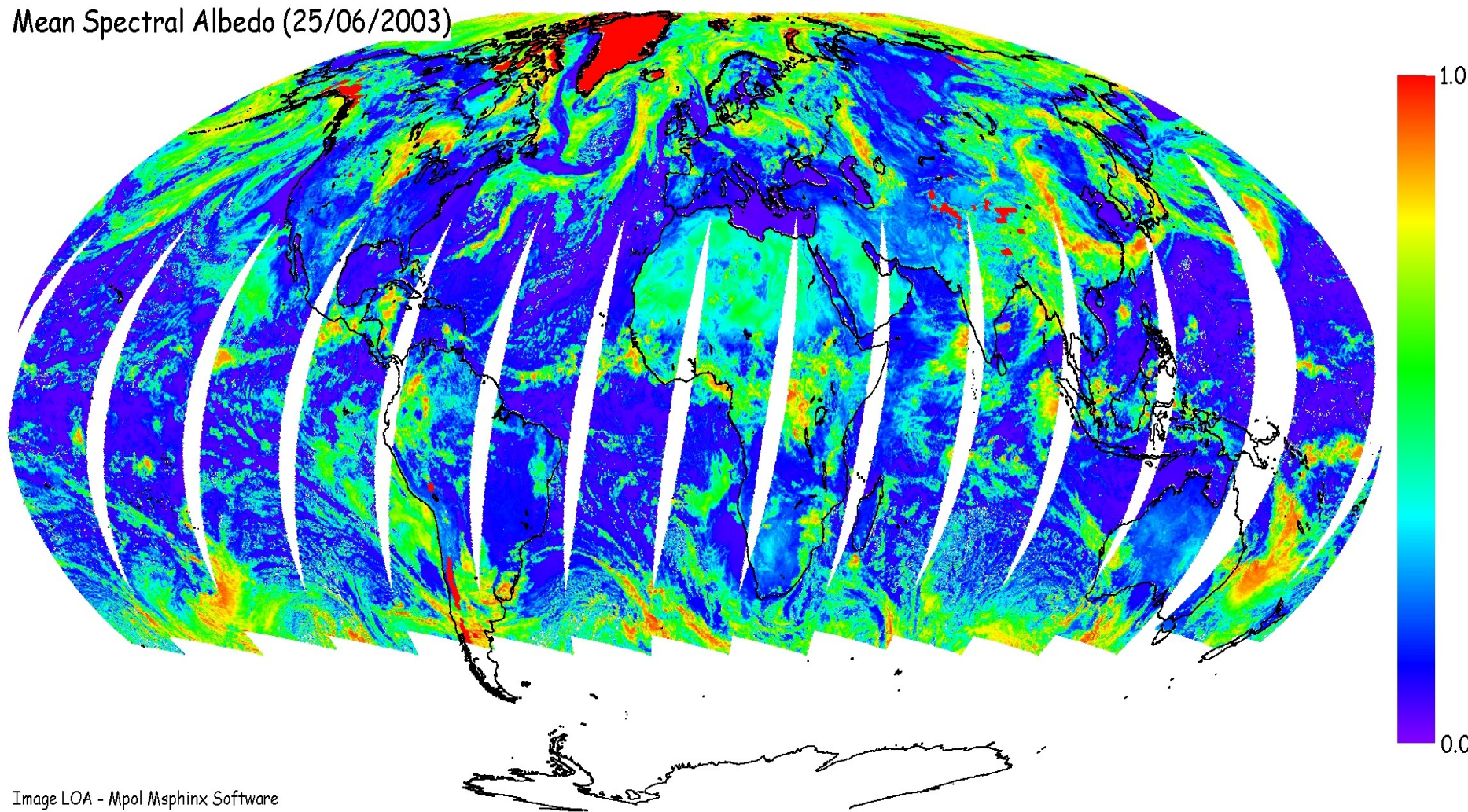
POLDER ERB,WV and Clouds Products

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

10.0

0.0

Image LOA - Mpol Msphinx Software

POLDER ERB,WV and Clouds Products

Shortwave Albedo (25/06/2003)

1.0

0.0

Image LOA - Mpol Msphinx Software
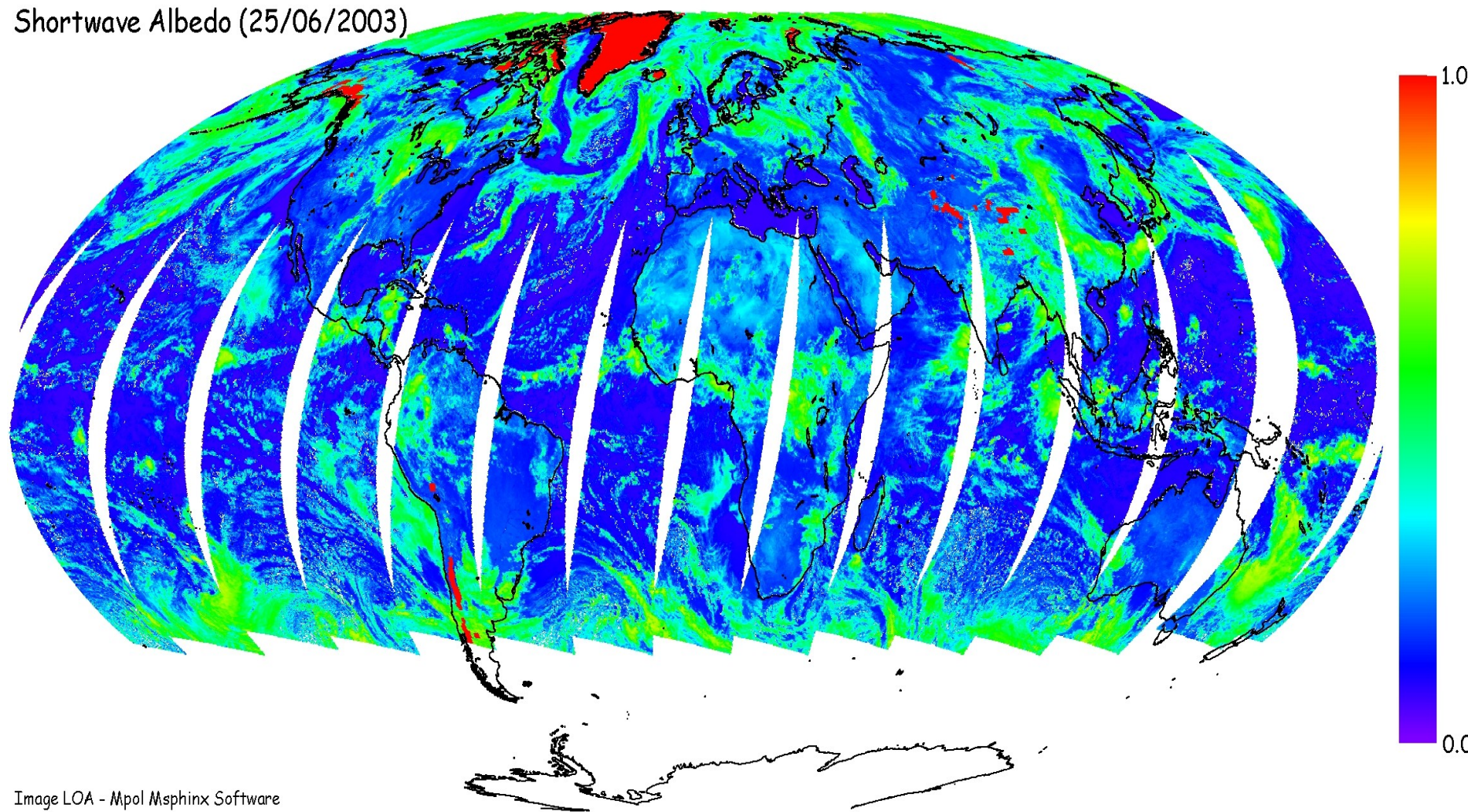
Level 2, **Level 3** and Joint Atmosphere Product
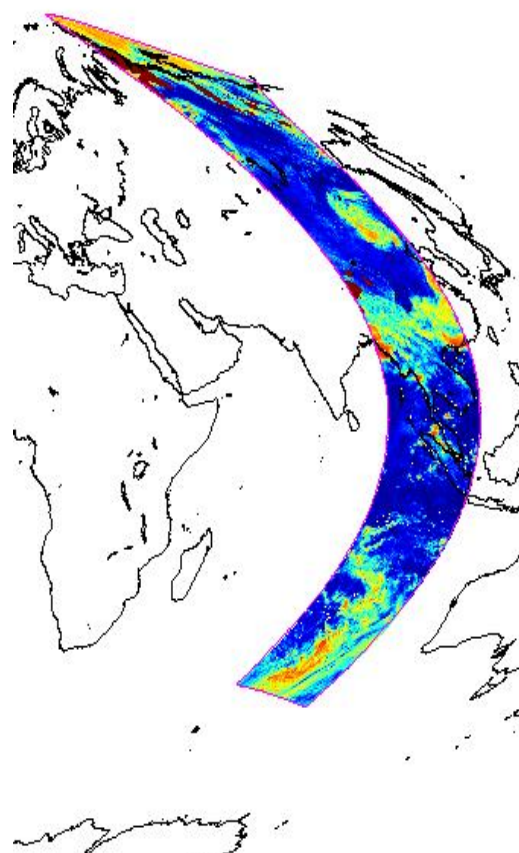
The level 2 (orbital swath) products contain about thirty non-directional parameters and ten directional parameters (for each of the 14 viewing directions).

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 contamina
14[ChU]: Cosine of solar zenith angle for the central pi
15[ShU]: Mean spectral albedo at 670 nm [land] and 865 n
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 me
22[ShU]: Shortwave albedo
23[ChU]: Clear shortwave albedo (modeled, independent of
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.
29[ChU]: Cloud pressure derived from Oxygen channels. (h
```

Directional Parameters: ☐ Select all

```
65[ChU]: Relative azimuth angle (for the central pixe
66[ShU]: Reflectance corrected for gas absorption at !
67[ShU]: Spectral albedo estimated from the above ref
68[ShU]: Reflectance corrected for gas absorption int:
69[ShU]: Shortwave albedo
70[ChU]: Polarized normalized radiance at 865 nm, cor:
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 Product

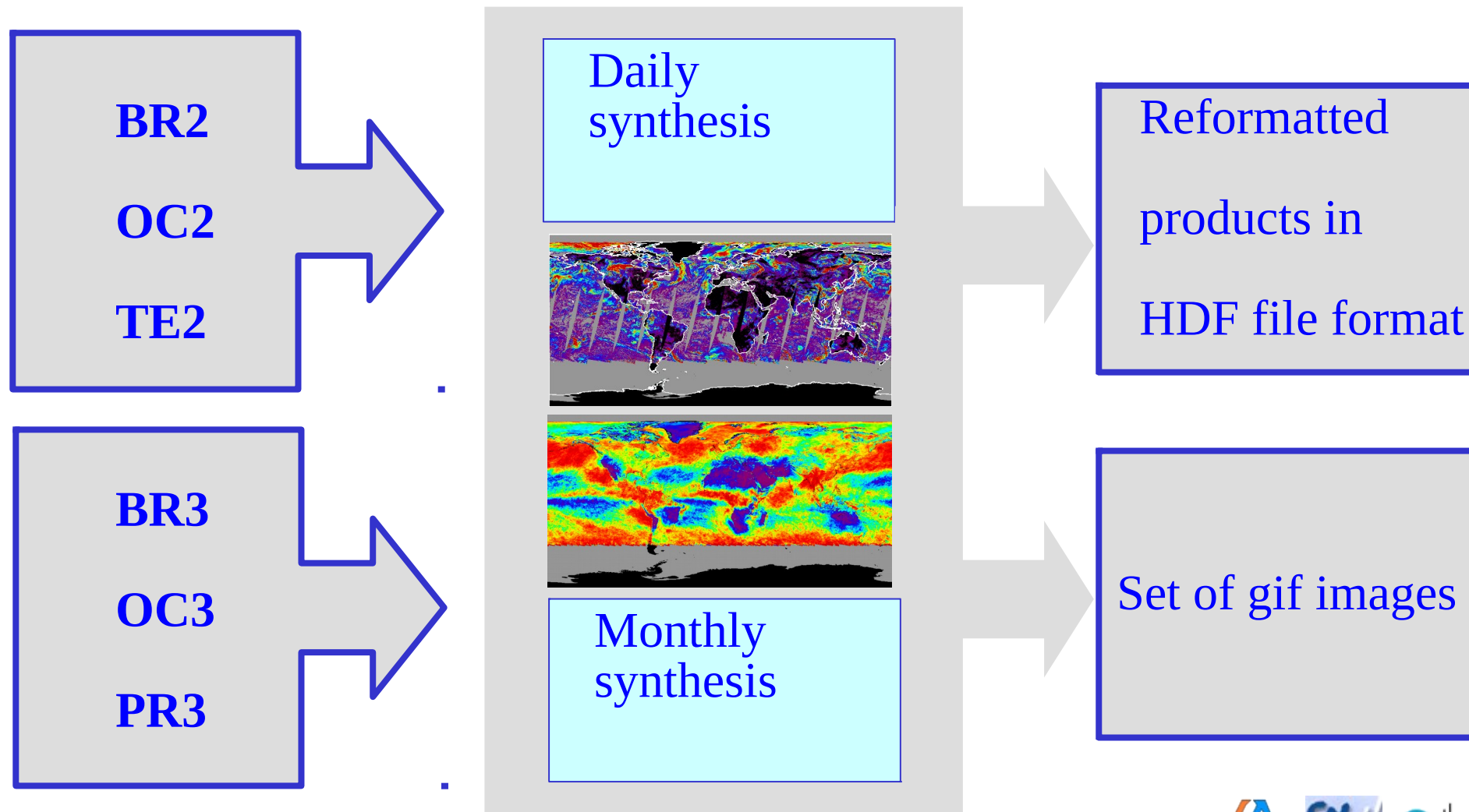## The level 3 (monthly) products contain about forty parameters.

Record Number in the file : 2≤RecNum≤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 [W.m^{-2}]
Col. Num. of the pix. in POLDER medium res. grid	TOA monthly-mean reflected Flux [W.m^{-2}]
Mean pixel altitude from the DEM in the 3x3 super pixel (meters)	Monthly-mean SW cloud forcing [W.m^{-2}]
Land, Water, Mixed indicator[11]	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$_+$: Fraction of observations classified from "uncertain" to "cloudy"
Number of observations with snow/ice indicator	CN$_-$: Fraction of observations classified from "uncertain" to "clear"
Number of observations with clear sky	Four bit each: One byte contains 16 CN$_+$ + CN$_-$
Number of observations with cloud presence.	Monthly mean water vapor column [g cm^{-2}]
Number of cloud optical thickness estimates	Std. deviation water vapor column [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	
Monthly mean of the cosine of the solar zenith angle	Std. deviation of Rayleigh cloud pressure [hPa]
	Mean cloud optical thickness
Monthly mean of the spectral[12] Albedo	Relative dispersion of cloud optical thickness [%]
Standard Deviation of the spectral Albedo	Mean cloud optical thick., liquid phase occurences
Monthly Mean Clear Sky spectral Albedo	Mean cloud optical thick., ice phase occurences
Standard Dev. of the Clear Sky spectral Albedo	Mean cloud optical thick., mixed phase occurences
Monthly mean of the Clear spectral albedo, based on radiative transfer simulations only	Mean Spherical Albedo
	Standard deviation on spherical albedo
Monthly mean of the SW Albedo	Relative frequency of phase [%]. Bins are "Unknown", "Liquid", "Ice" and "Mixed"[13].
	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)

BR2

OC2

TE2

BR3

OC3

PR3

Daily synthesis

Monthly synthesis

Reformatted products in HDF file format

Set of gif images

Level 2, Level 3 and <u>**Joint Atmosphere Product**</u>

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	

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

Multiangle measurements and Cloud detection

Cloud Cover Qual   2003)

Image LOA - Mpol Msphinx Softwa
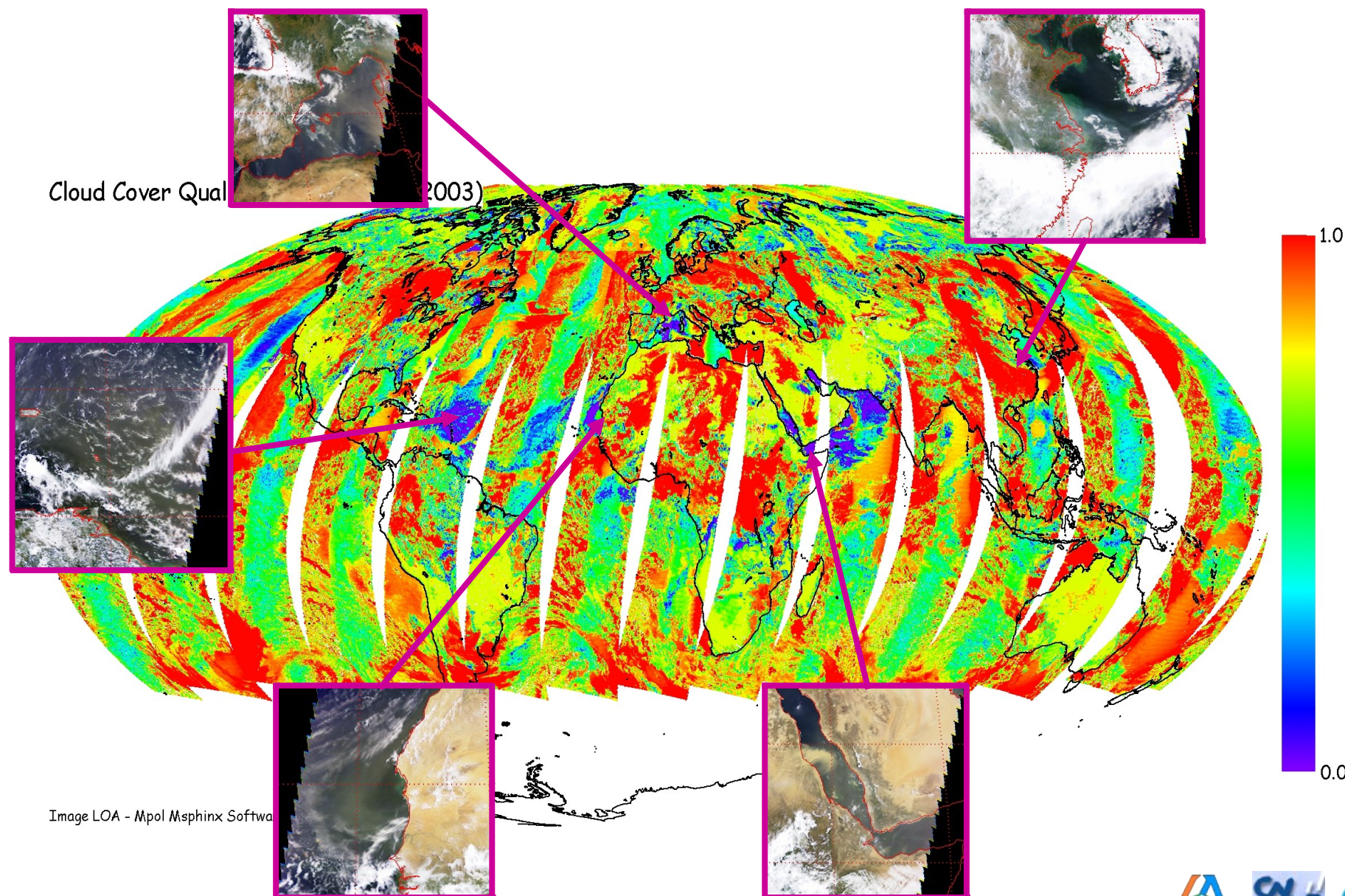
Clouds / Aerosols : Products consistency

Polder clouds and aerosols products are provided at the same resolution (3x3 L1) but use different cloud mask.
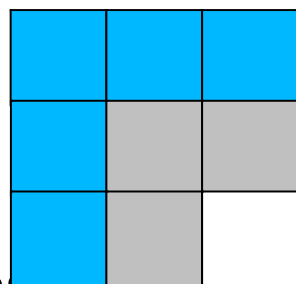
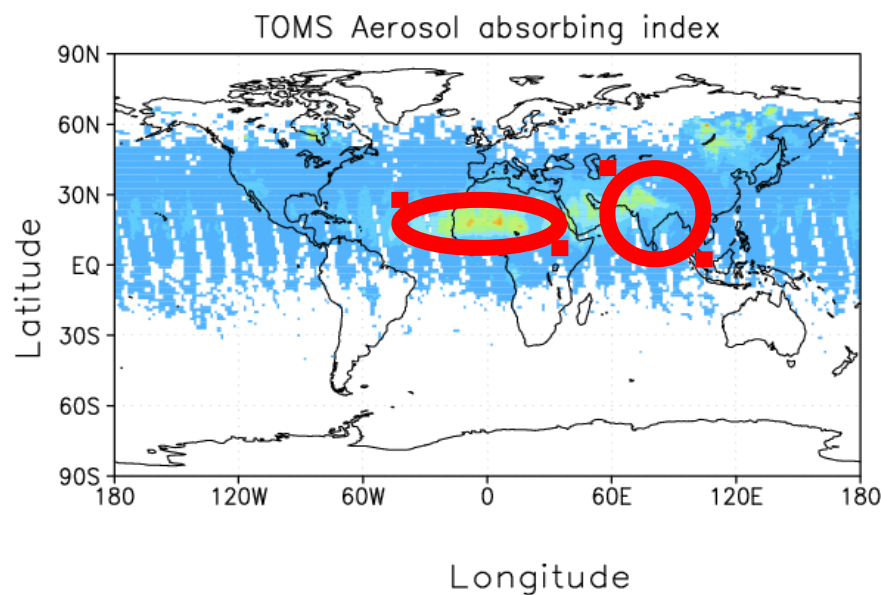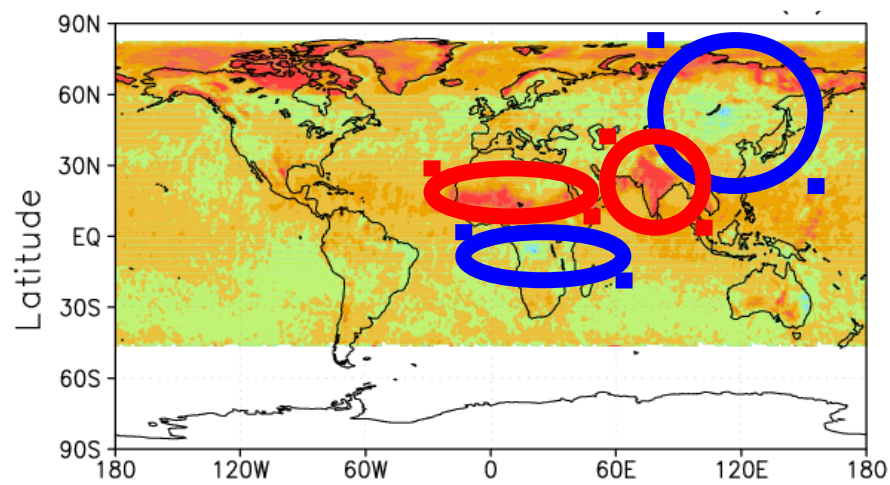*Aerosol retrievals performed when at least 5 over 9 pixels are clear*

Whenever 1 pixel is cloudy neighbors are rejected from the "clear" list

June 2003
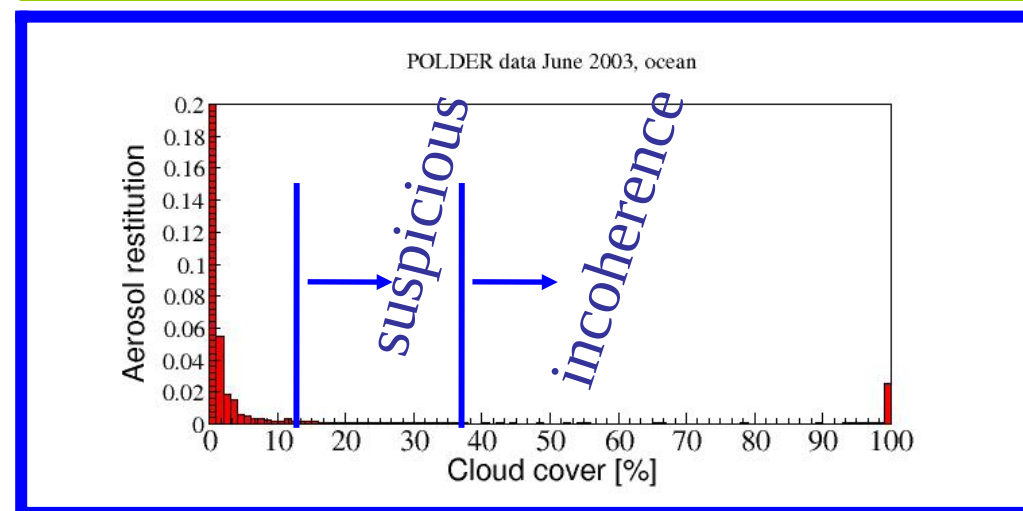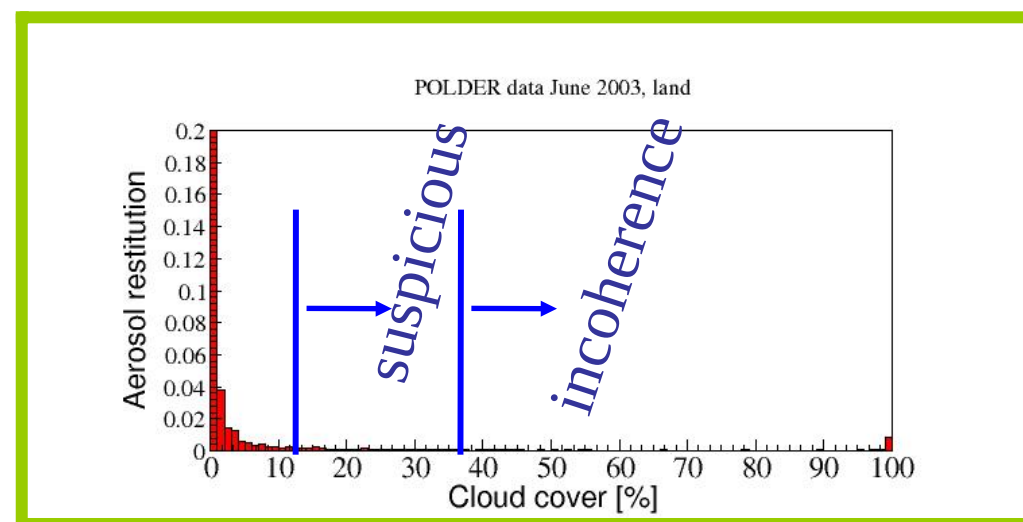
Cloud products contamination by aerosols

MODIS (infrared day cloud fraction) - POLDER
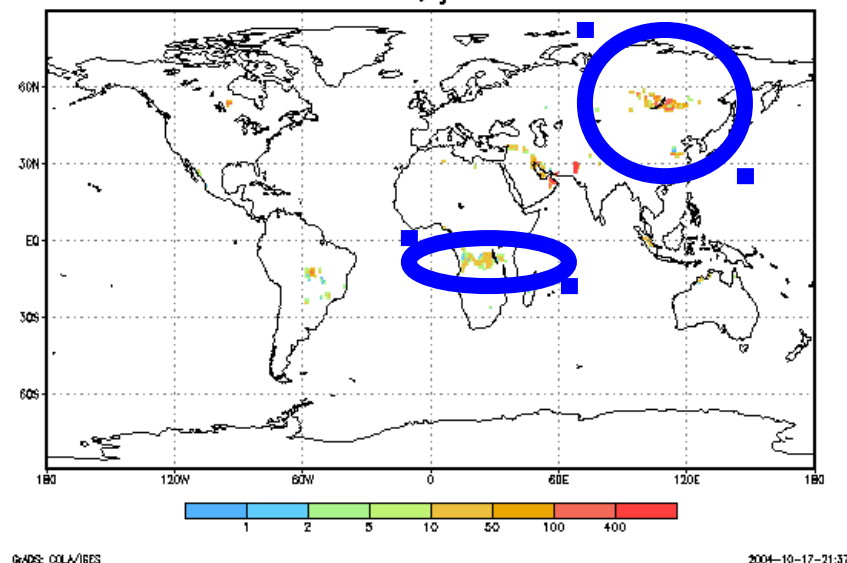
POLDER aerosols products retrieved when cn>99.9

Multiangle polarisation measurements and Cloud Phase
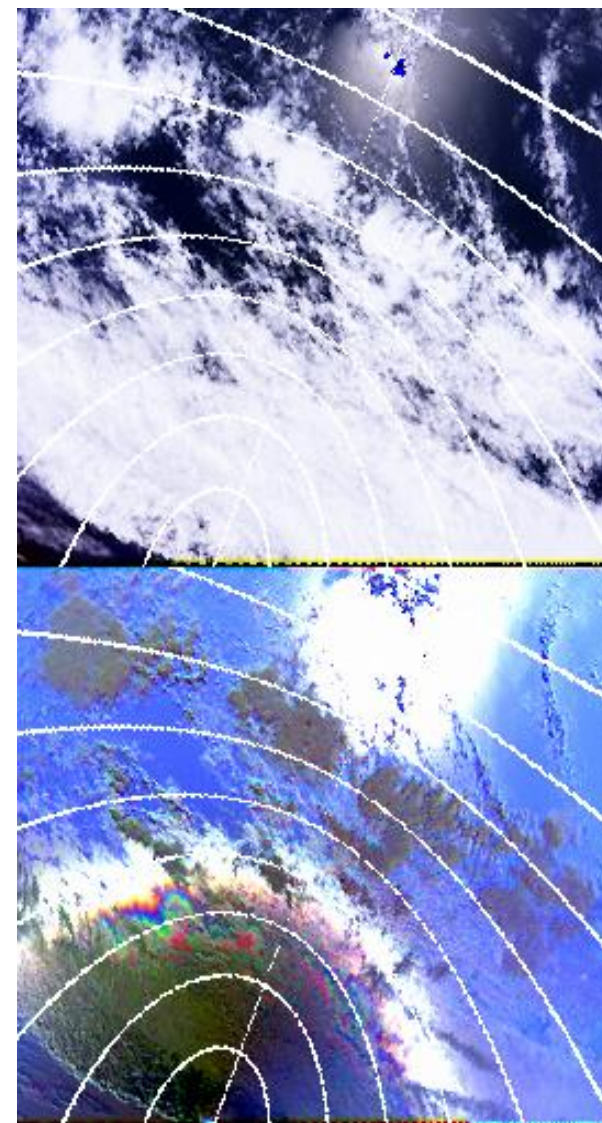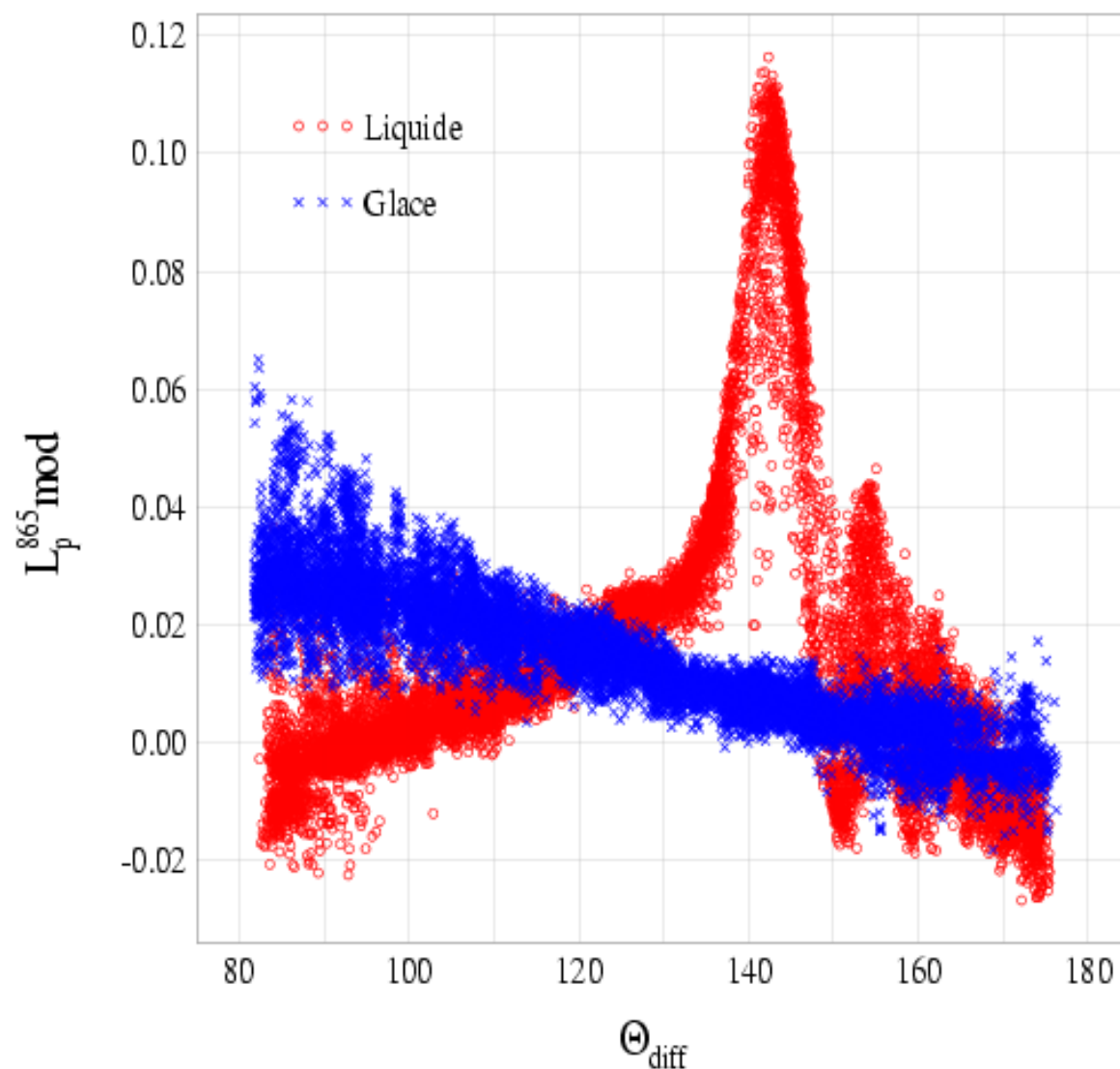
POLDER Multiangle observation for dummies
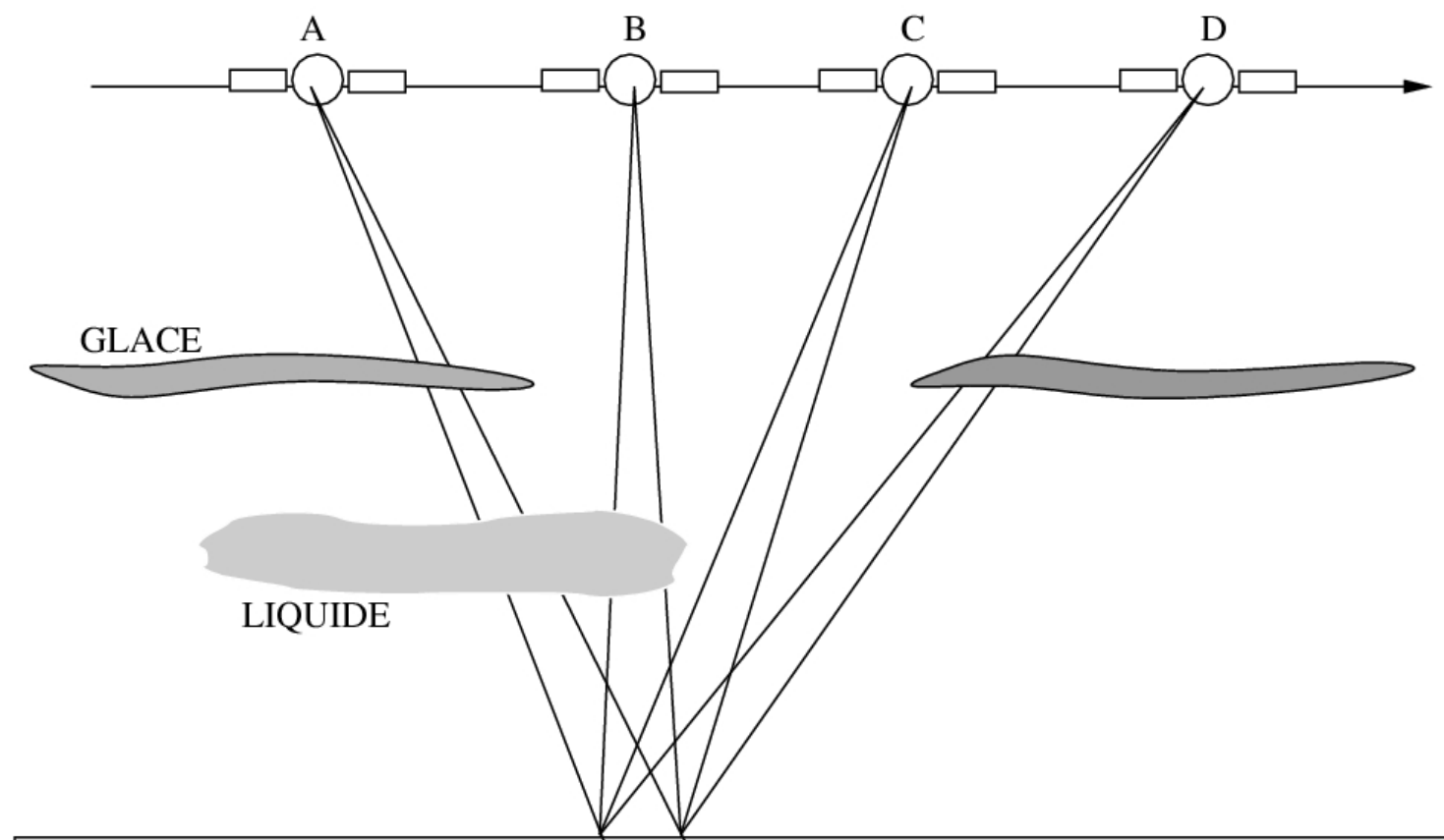
All directional observations are relocated on the surface

POLDER Multiangle observation for dummies

Old level 2

New level 2

Level 1 data

3 RESOLUTIONS

- N1 : 6.2km x 6.2km
- 20km x 20km
- N2 : 60km x 60km
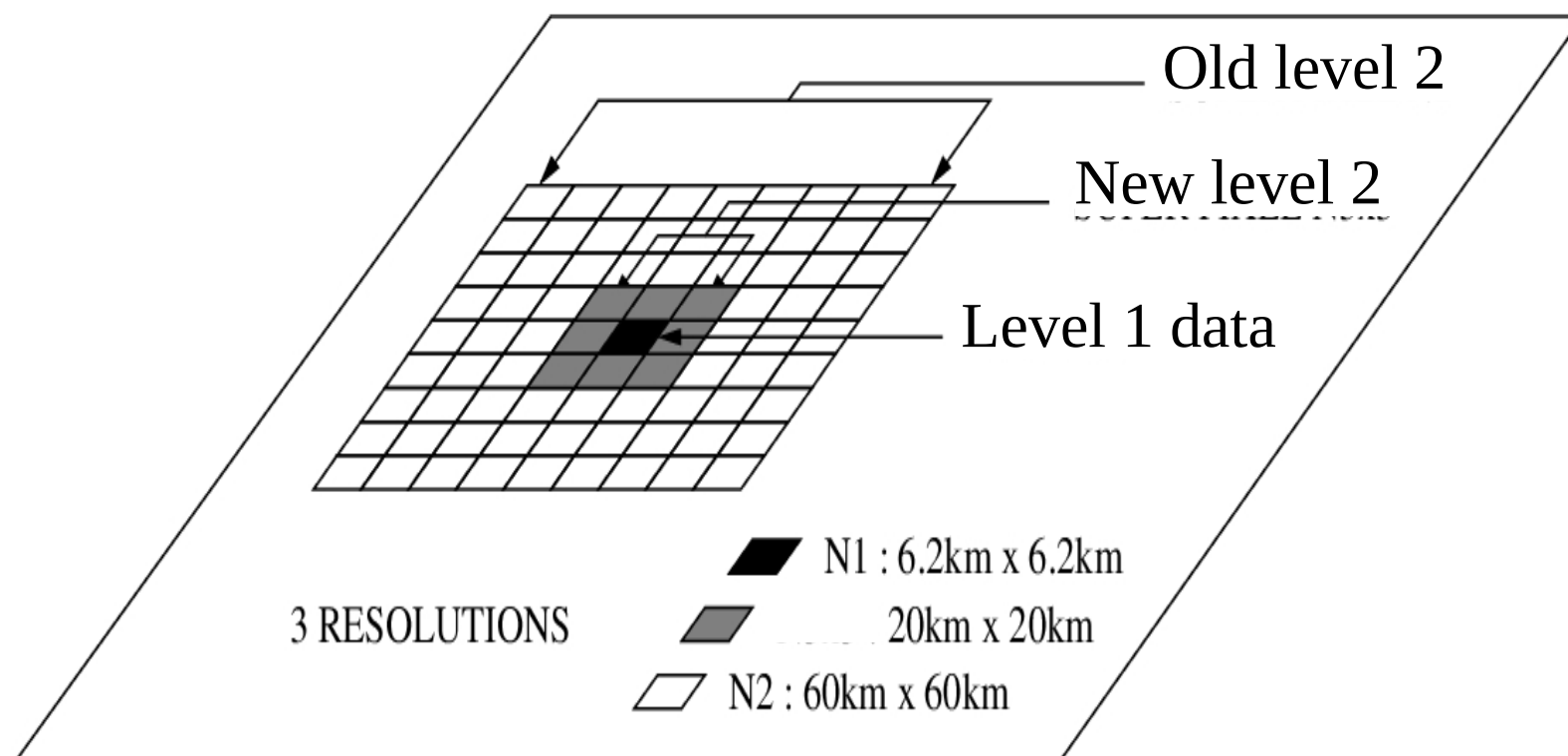
Products are retrieved and delivered at lower resolution
to reduce relocation noise and biases

POLDER Multiangle observation for advanced users

Multiangle multispectral measurements

Oxygen Pressure (25/06/2003)

1000

100

Image LOA - Mpol Msphinx Software
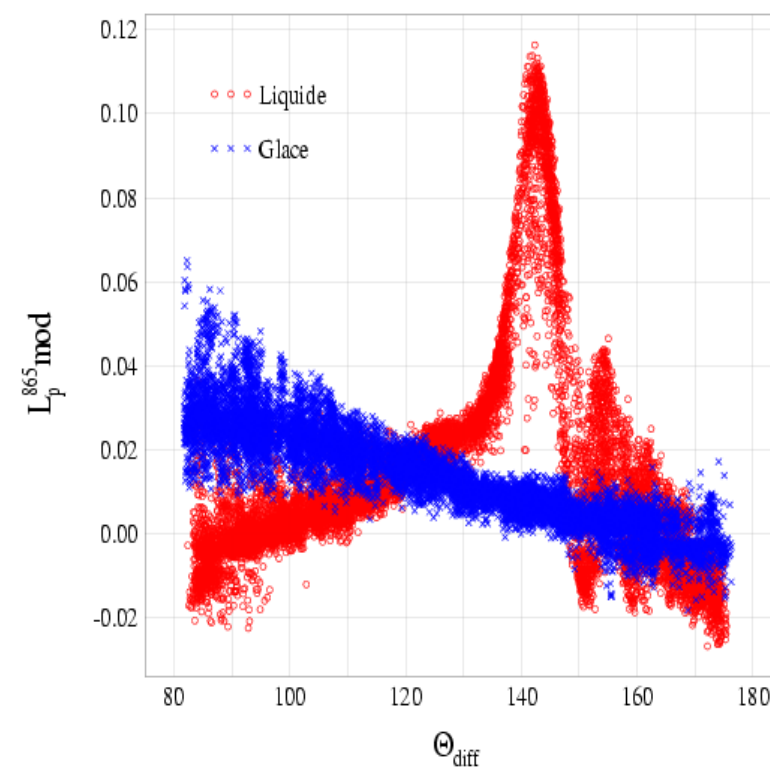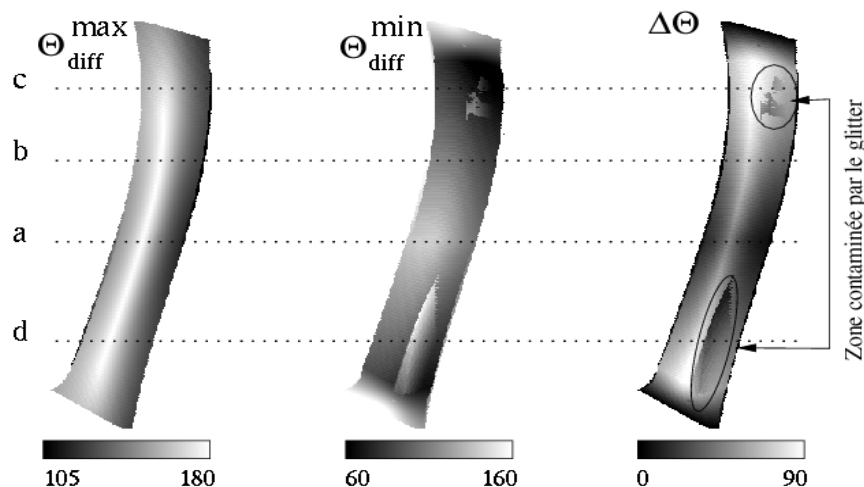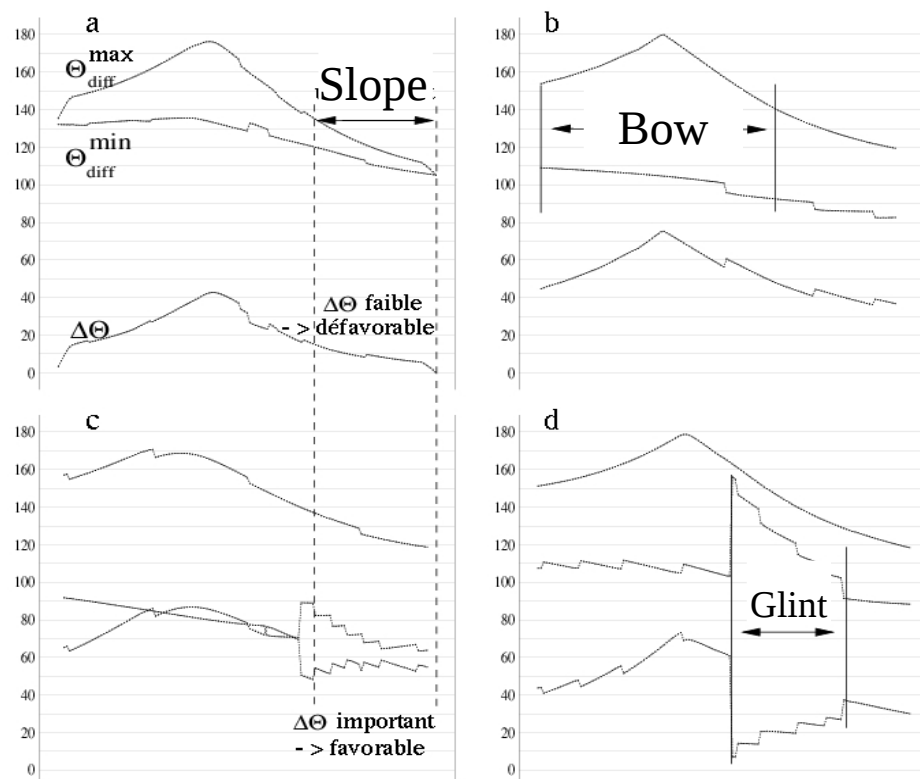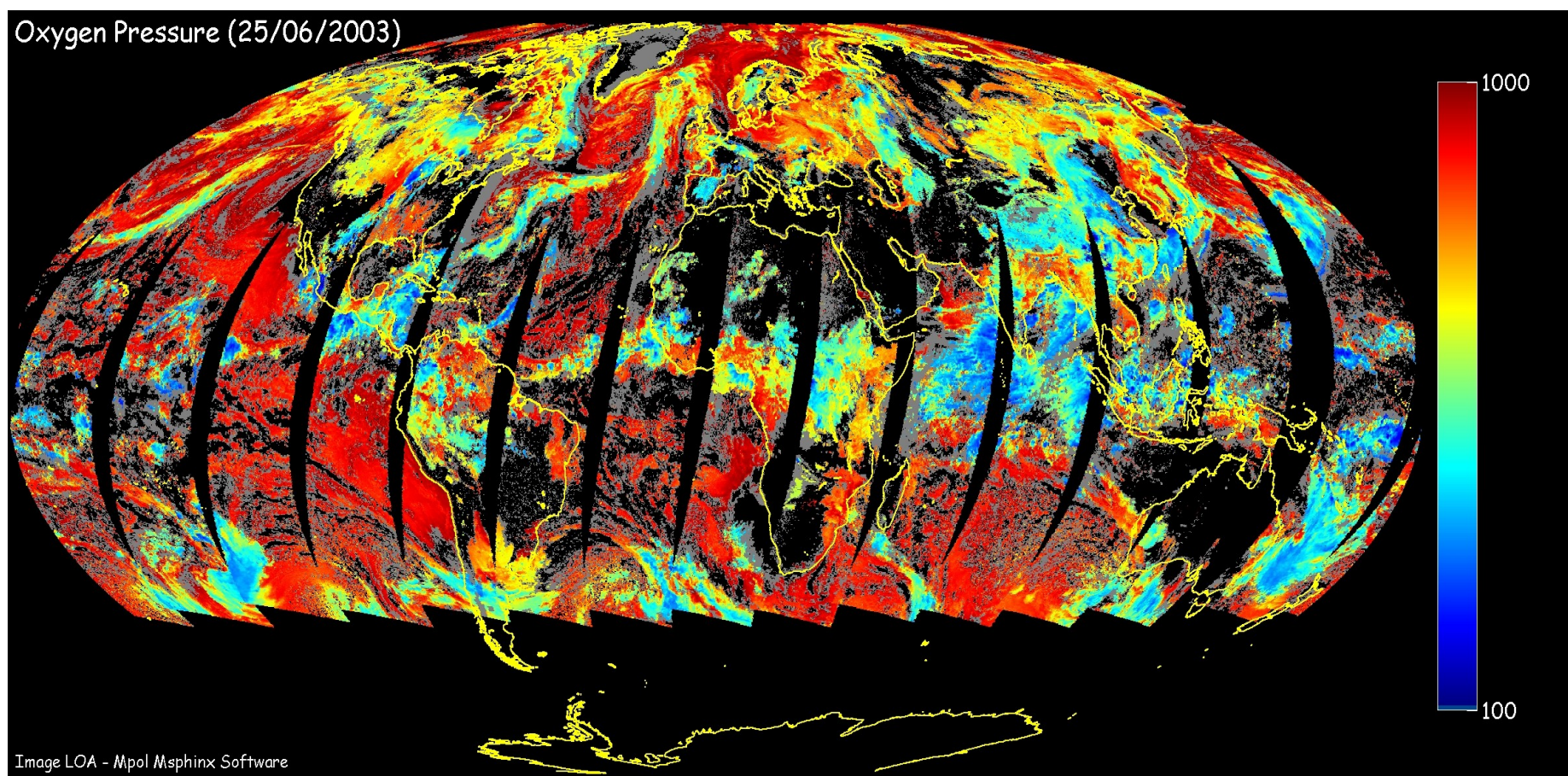
Differential absorption is used to infer cloud top (middle) pressure - 763nm and 765 nm

Directional product – Retrieval is performed in up to 14 directions

Multiangle multispectral measurements

Optical Thickness (25/06/2003)

130

1

Image LOA - Mpol Msphinx Software
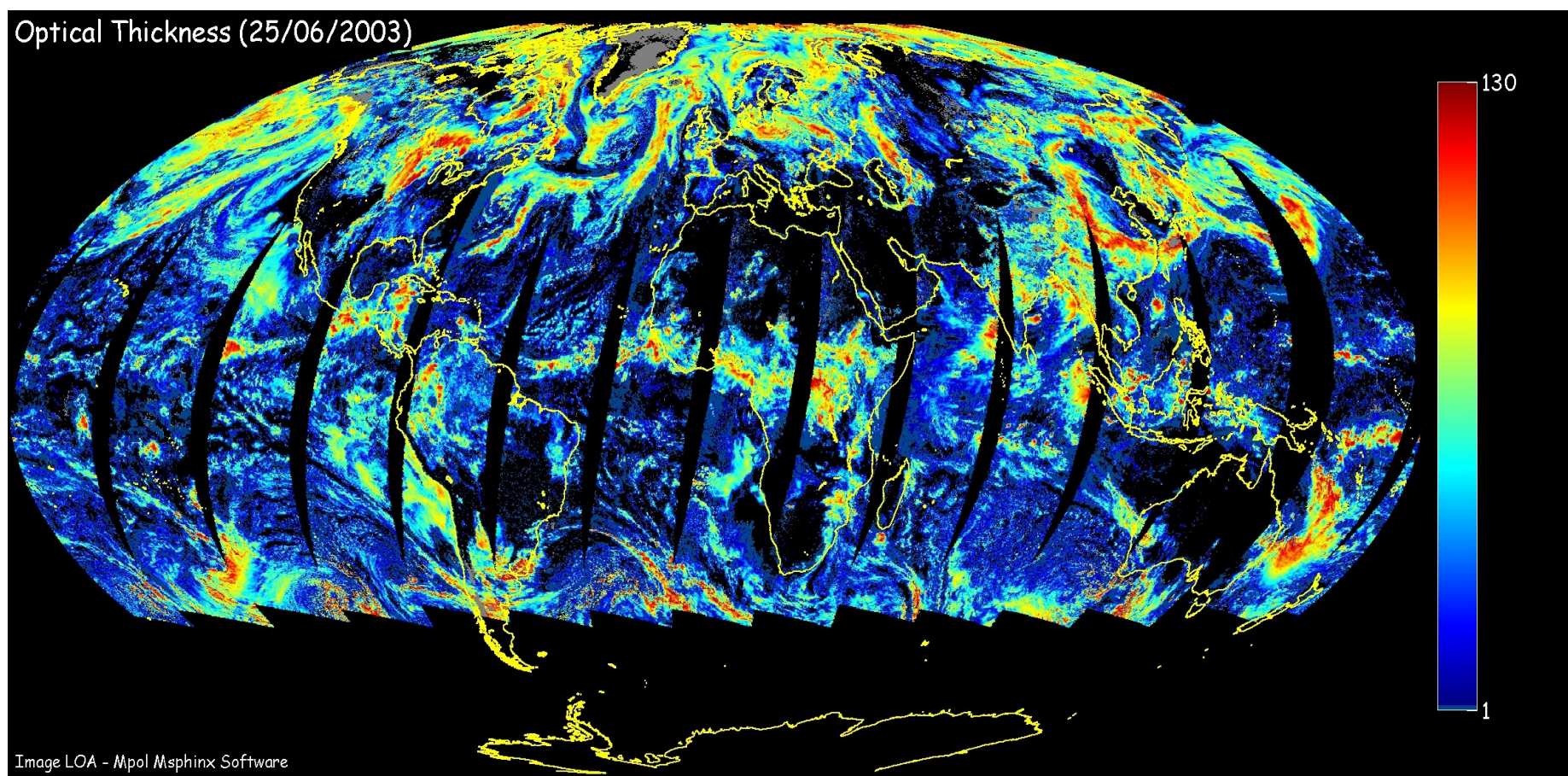
Cloud optical thickness is retrieved under up to 14 directions

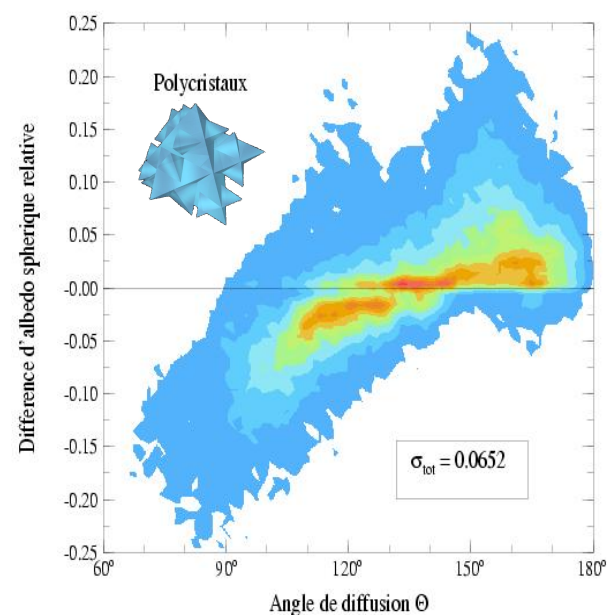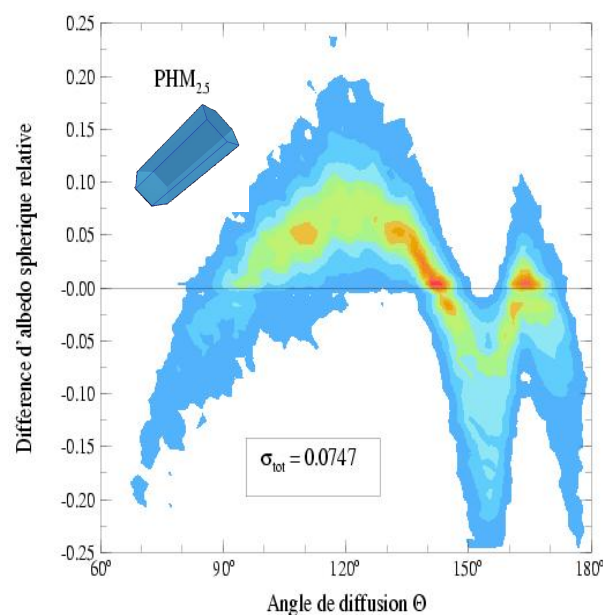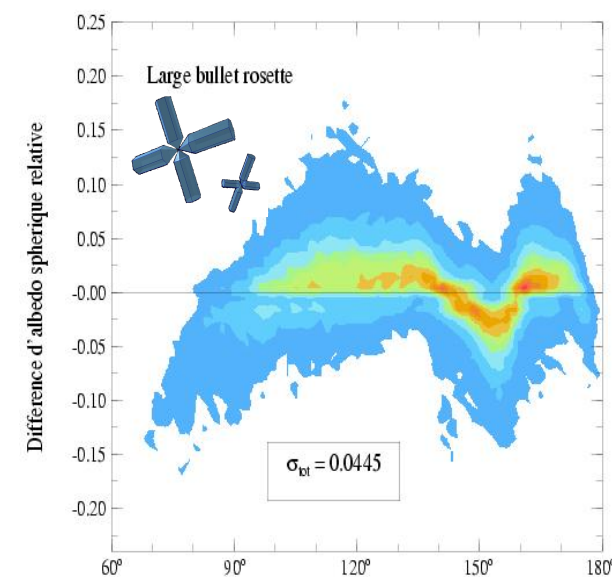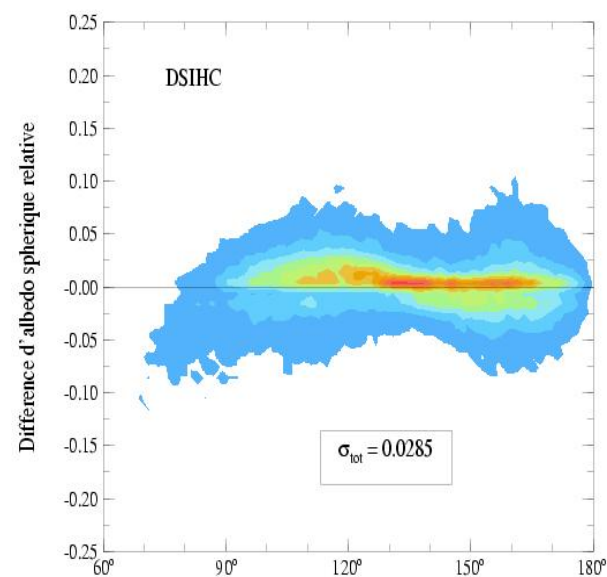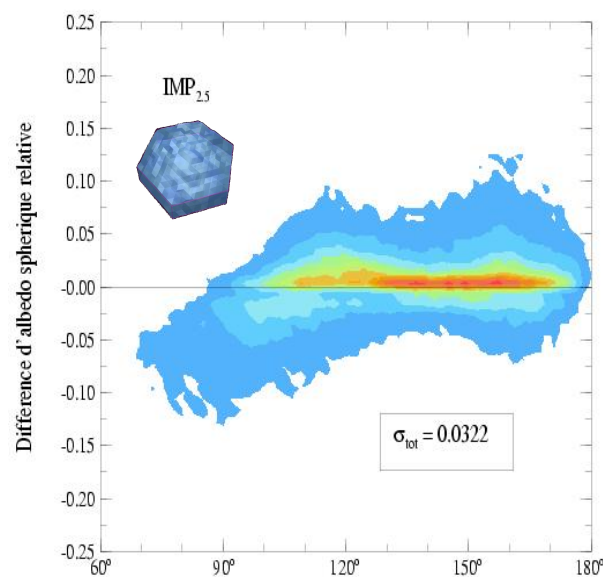Directional product provided at 670nm (land) and 865 nm (ocean)

Testing cloud models from multiangle observation
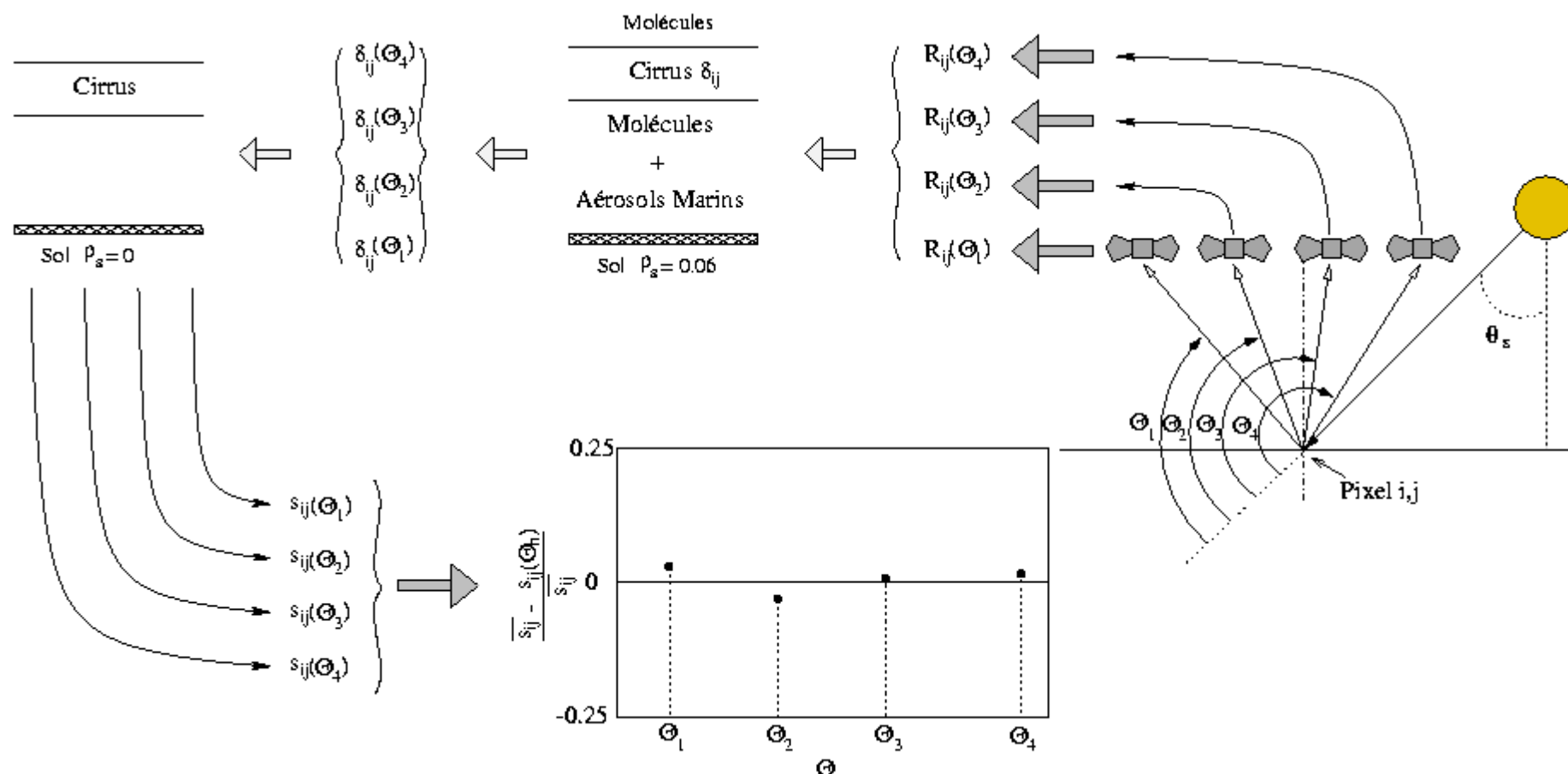
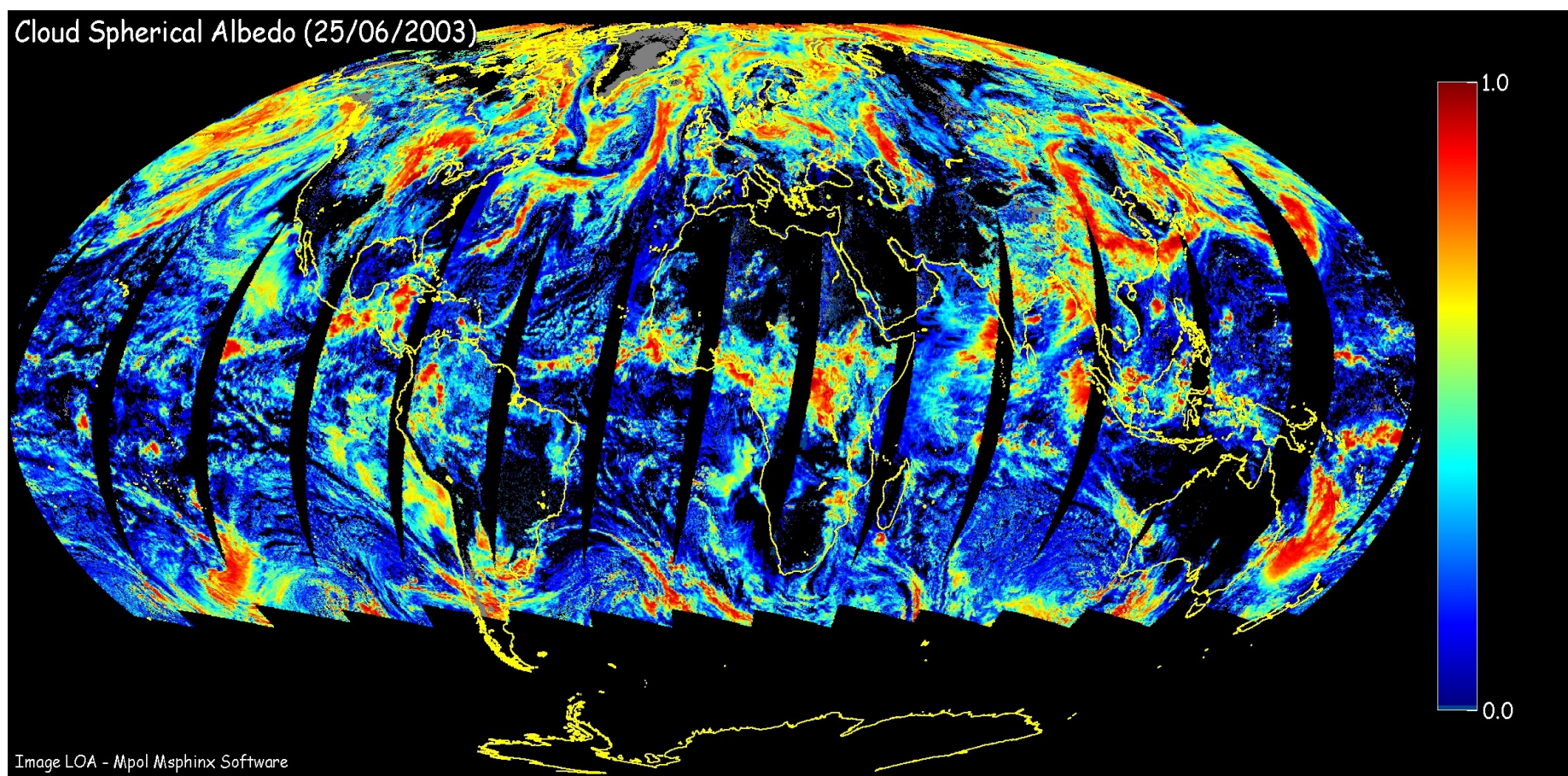# Testing cloud models from multiangle observation
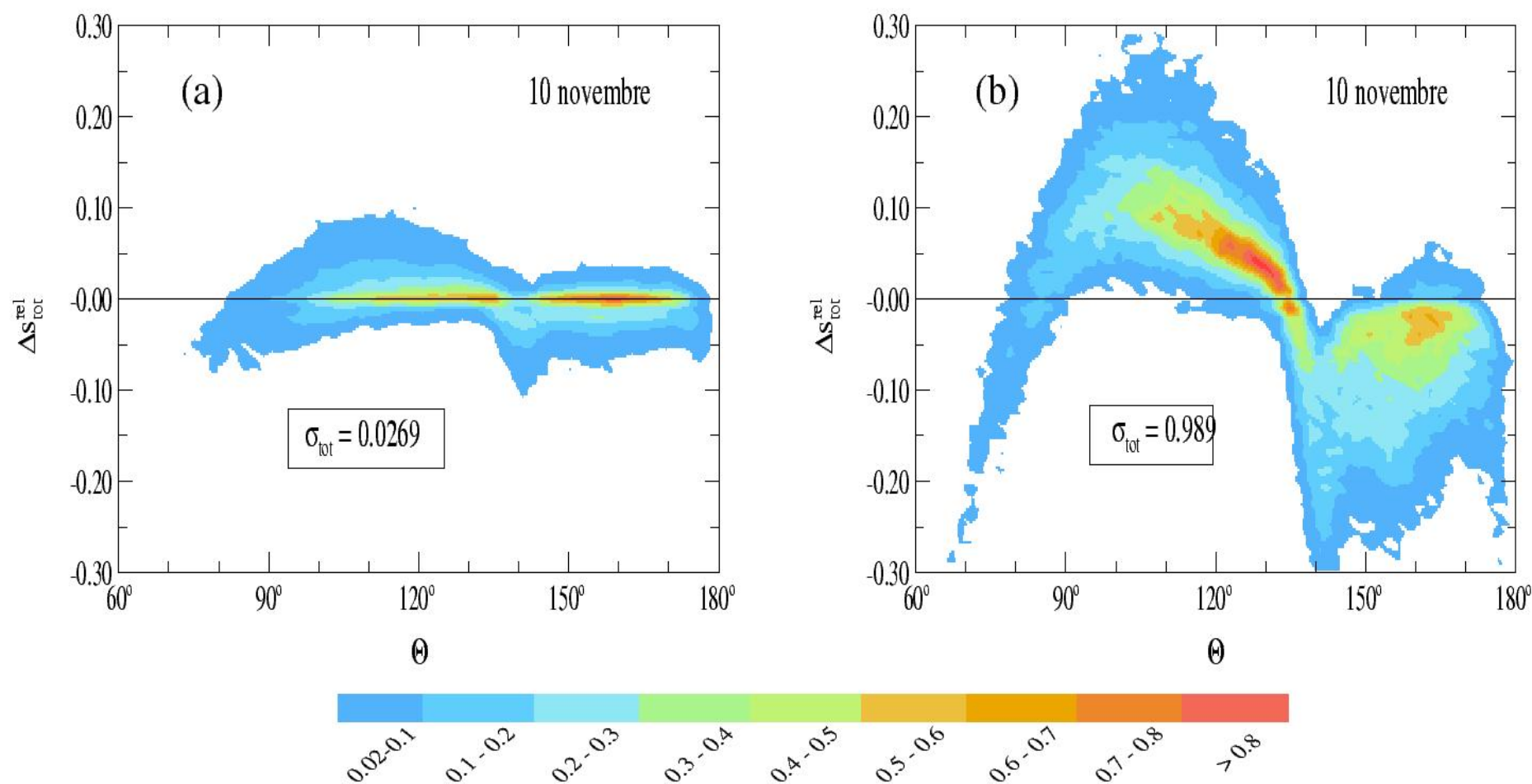
Testing cloud models from multiangle observation

Multiangle multispectral measurements

Cloud Spherical Albedo (25/06/2003)

1.0

0.0

Image LOA - Mpol Msphinx Software
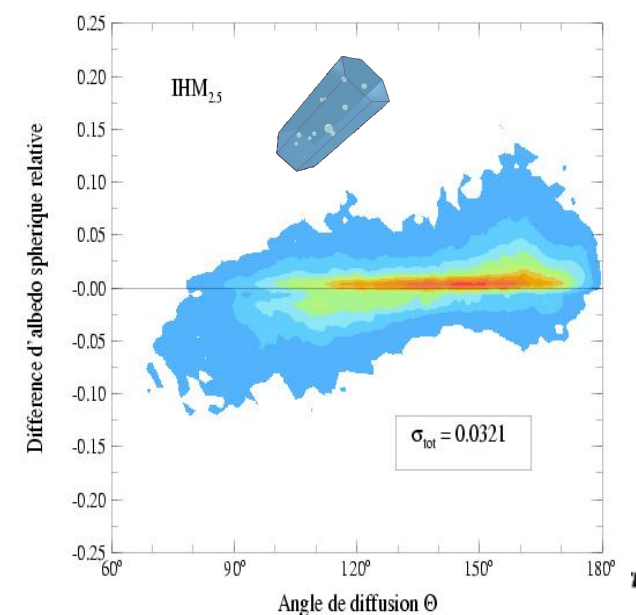
3 Spectral Cloud Albedo

$$\lambda = 443 \text{ nm} \quad 200 - 550 \text{ nm}$$

$$\lambda = 670 \text{ nm} \quad 550 - 700 \text{ nm}$$

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

SW CLOUD ALBEDO

Liquid Particles effective radius retrievals from multiangle, multispectral polarisation measurements

Polarized Reflectance (vertical axis label)

Scattering Angle [°]

443nm   670nm   865nm
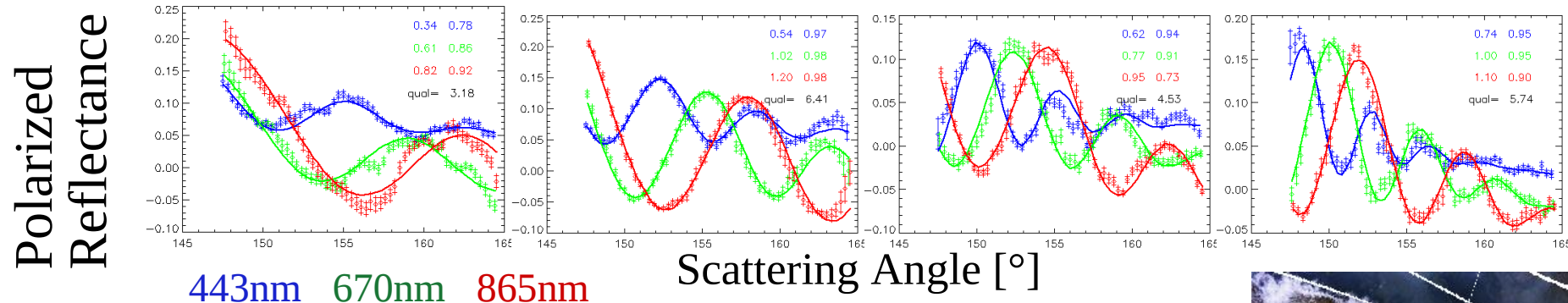
Based on the directional signature of the polarized reflectance

Believed to be very accurate (multiple internal consistency check)

Requires very specific conditions

  - Multi-Directional polarized reflectance measurements

  - Homogeneous cloud field over 150x150 km^2
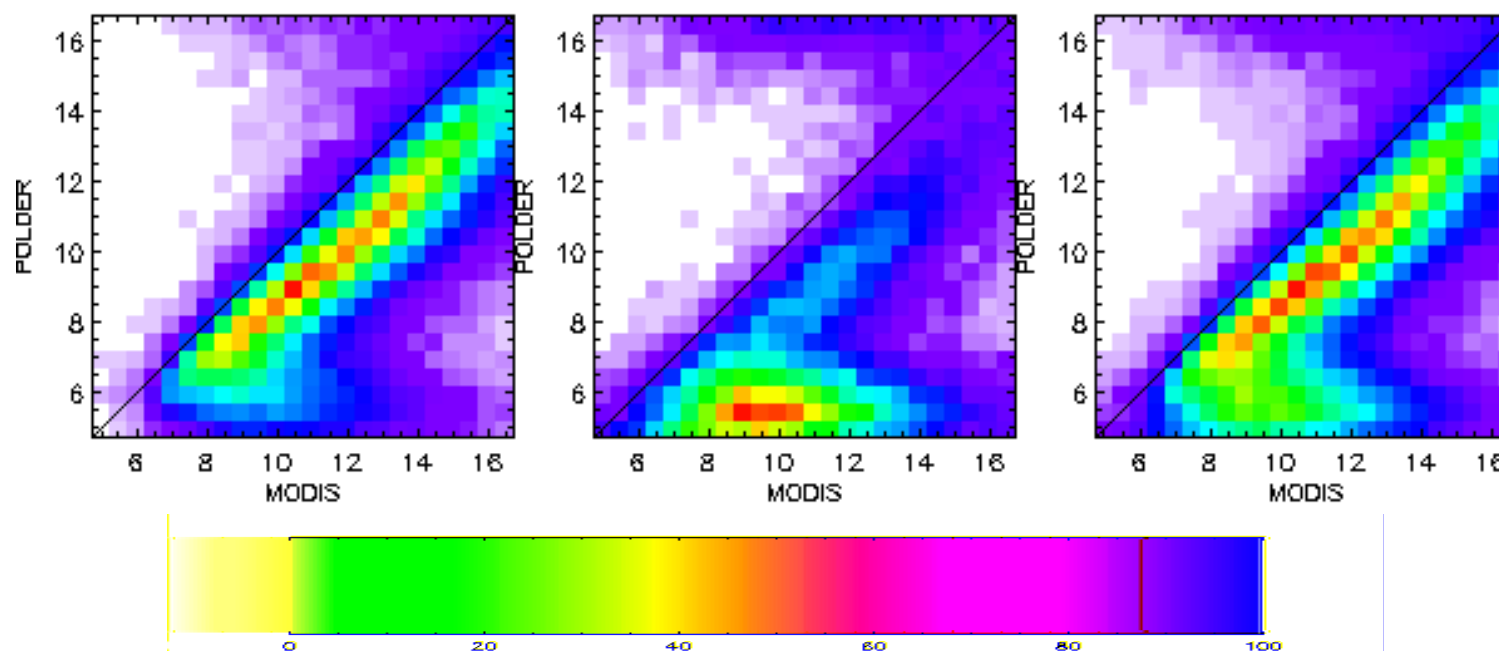
  - Narrow size distribution

Sampling biased to specific cloud types

Some clouds, such as the broken cumulus of the tropics, are never sampled
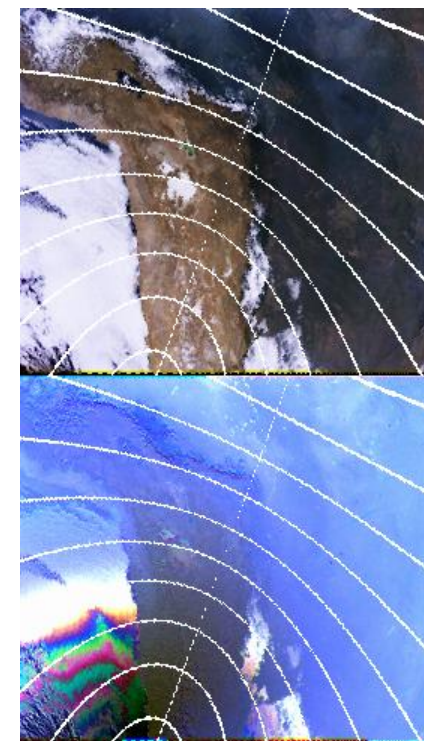
Liquid Particles effective radius retrievals from multiangle, multispectral polarisation measurements

POLDER vs MODIS comparison
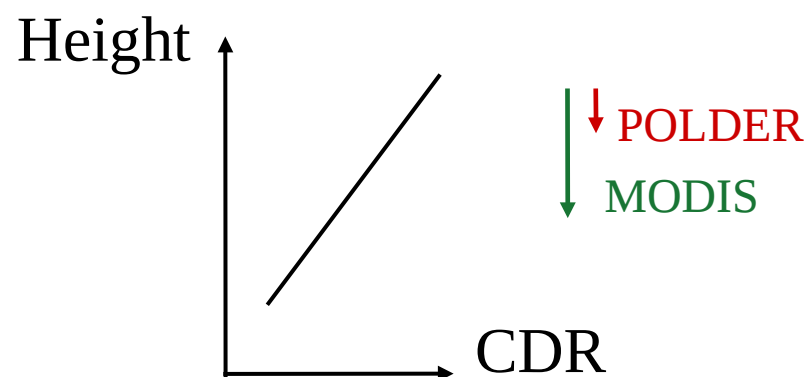

Excellent correlation, except for small droplets

2 µm bias (MODIS > POLDER)

Little correlation over land (small droplets according to POLDER)

Liquid Particles effective radius retrievals from multiangle, multispectral polarisation measurements

Hypothesis for bias

Vertical profile of CDR

Height

↓ POLDER

↓ MODIS

CDR

POLDER samples the very cloud top (opt. th.≈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 μm but bias 2 μm. Poor correlation for smaller radii.

No satisfactory explanation for bias and poor correlation at small Re

F.M. Breon : fmbreon@cea.fr

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POLDER 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
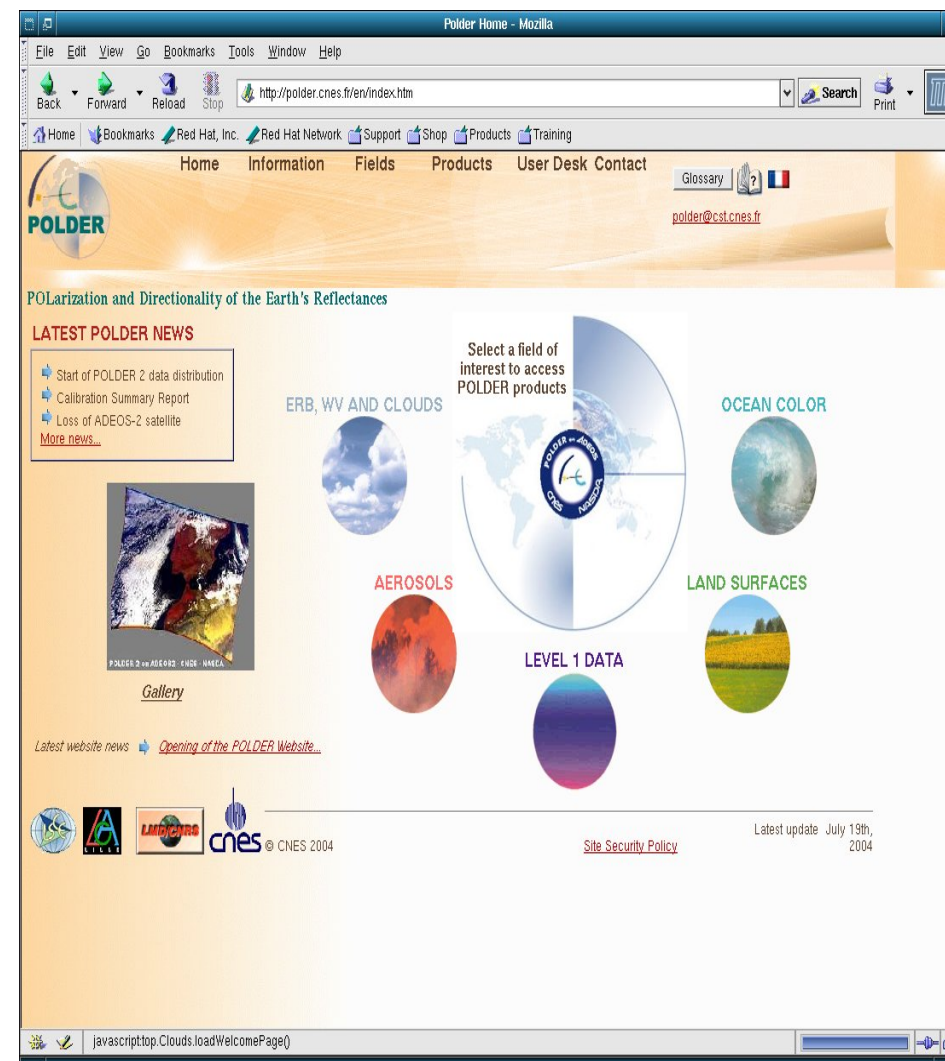Joint Atmosphere product (selected daily and monthly products)

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

http://smsc.cnes.fr/POLDER/index.htm   http://polder.cnes.fr

http://www-loa.univ-lille1.fr/recherche/polder
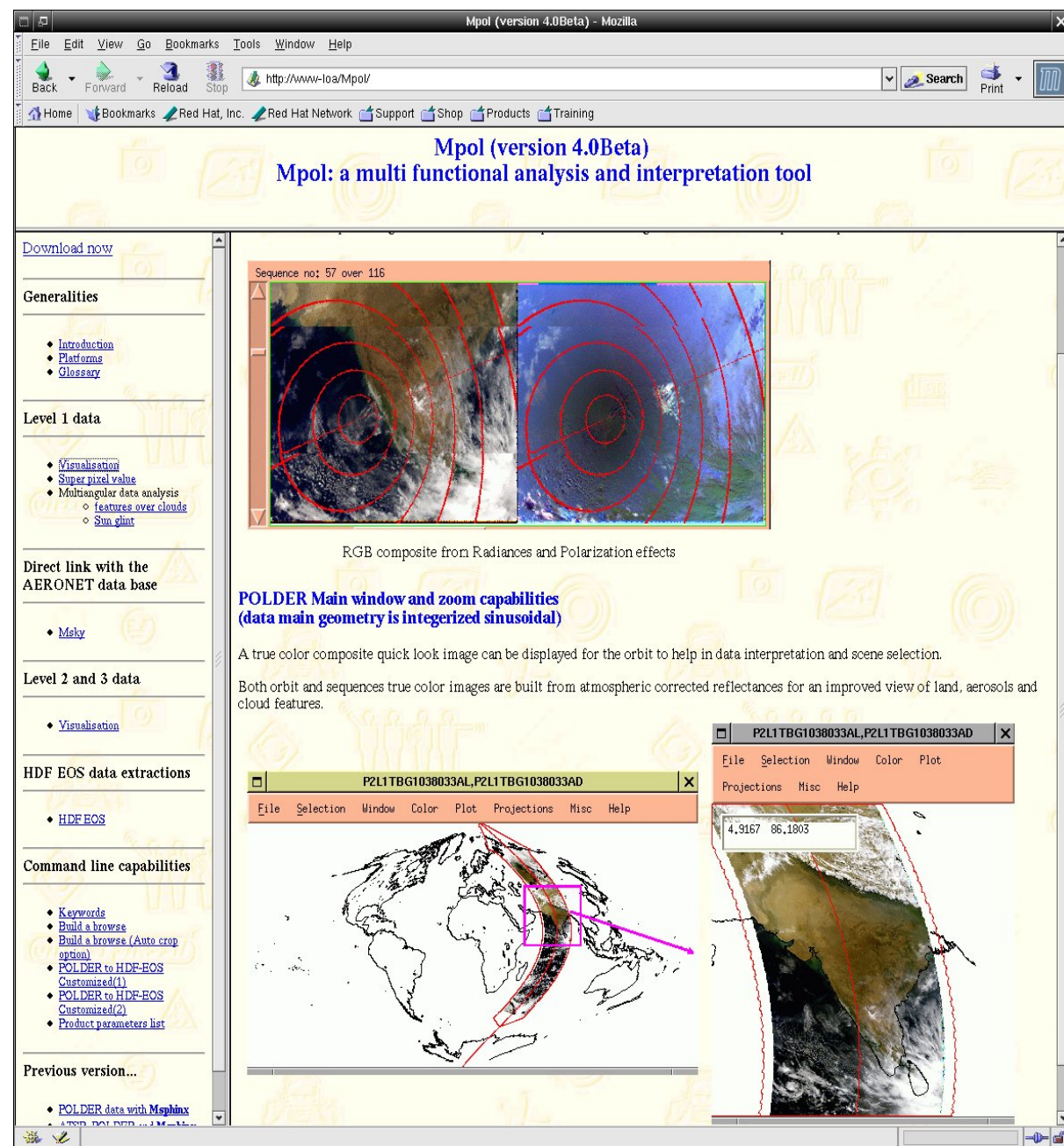
Data format and Tools

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

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