nd Cloud Products

ultiangle cloud remote sensing from POLDER 1 a

C. Buriez[1], F. Parol[1], C. Vanbauce[1], J. Riedi[1], L.C.-
bonnote[1],
Doutriaux-Boucher[1], M. Vesperini[1],
Sèze[2], P. Couvert[3], M. Viollier[4], and F.M. Bréon[3].

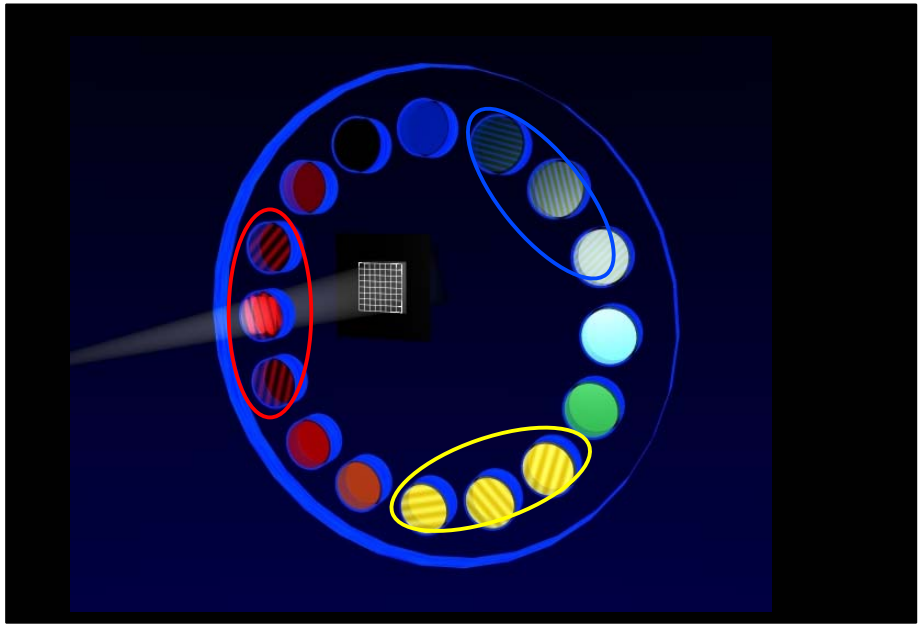
aboratoire d'Optique Atmosphérique, Université des Sciences et
chnologies de Lille
aboratoire de Météorologie Dynamique, CNRS, Université Pierre
rie Curie
aboratoire des Sciences du Climat et de l'Environnement,

OLDER Earth Radiation Budget, Water
apor
nd Cloud Products
ultiangle cloud remote sensing from POLDER 1 a

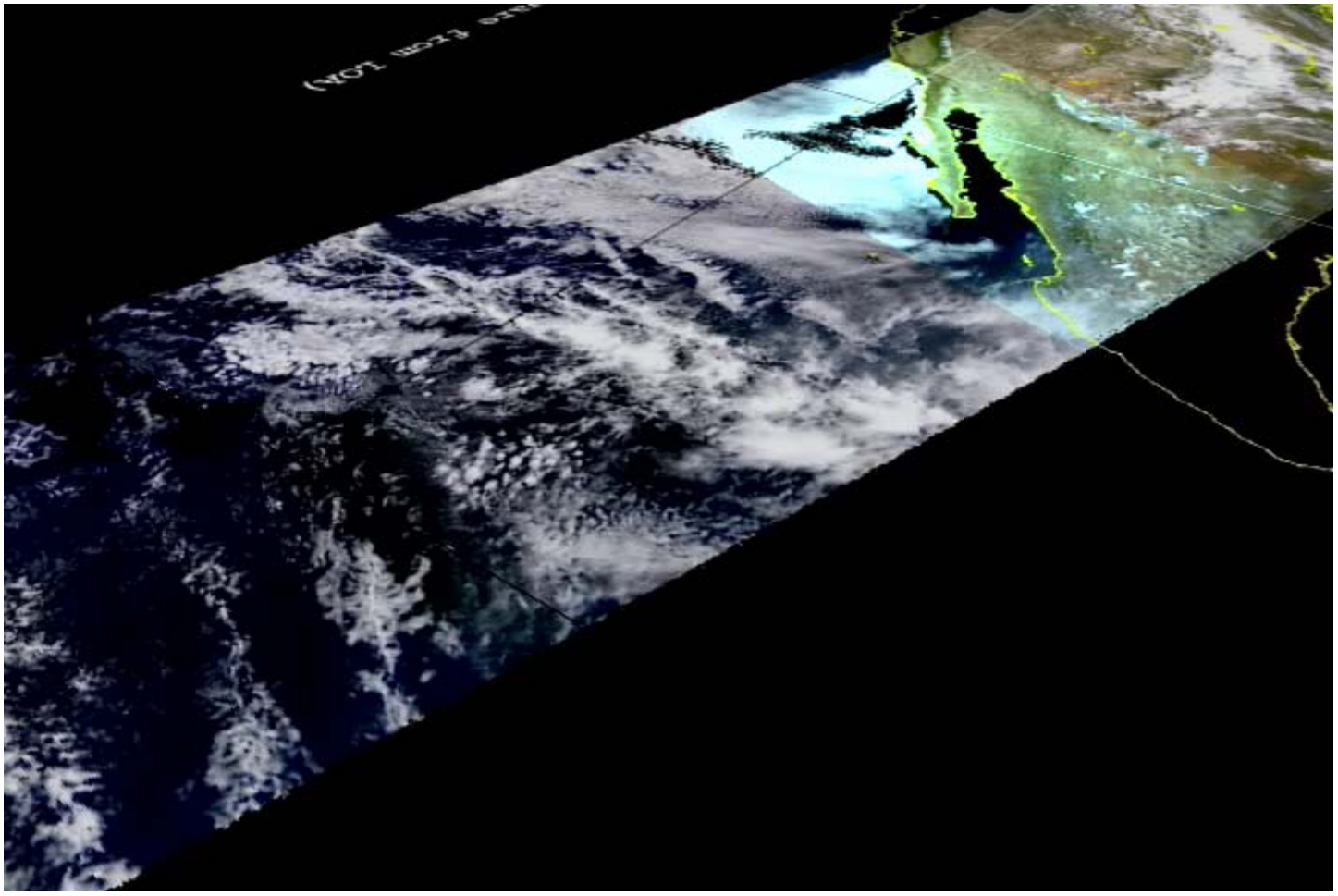
- Instrumental background
- POLDER ERB,WV and Clouds Products
  - Outline of Processing line and product
  - Level 2, Level 3 and Joint Atmosphere Product
- Products quality, potential biases and Guidelines
- Data availability and Tools

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



OLDER ERB,WV and Clouds Products
utline of processing path and selected
roducts

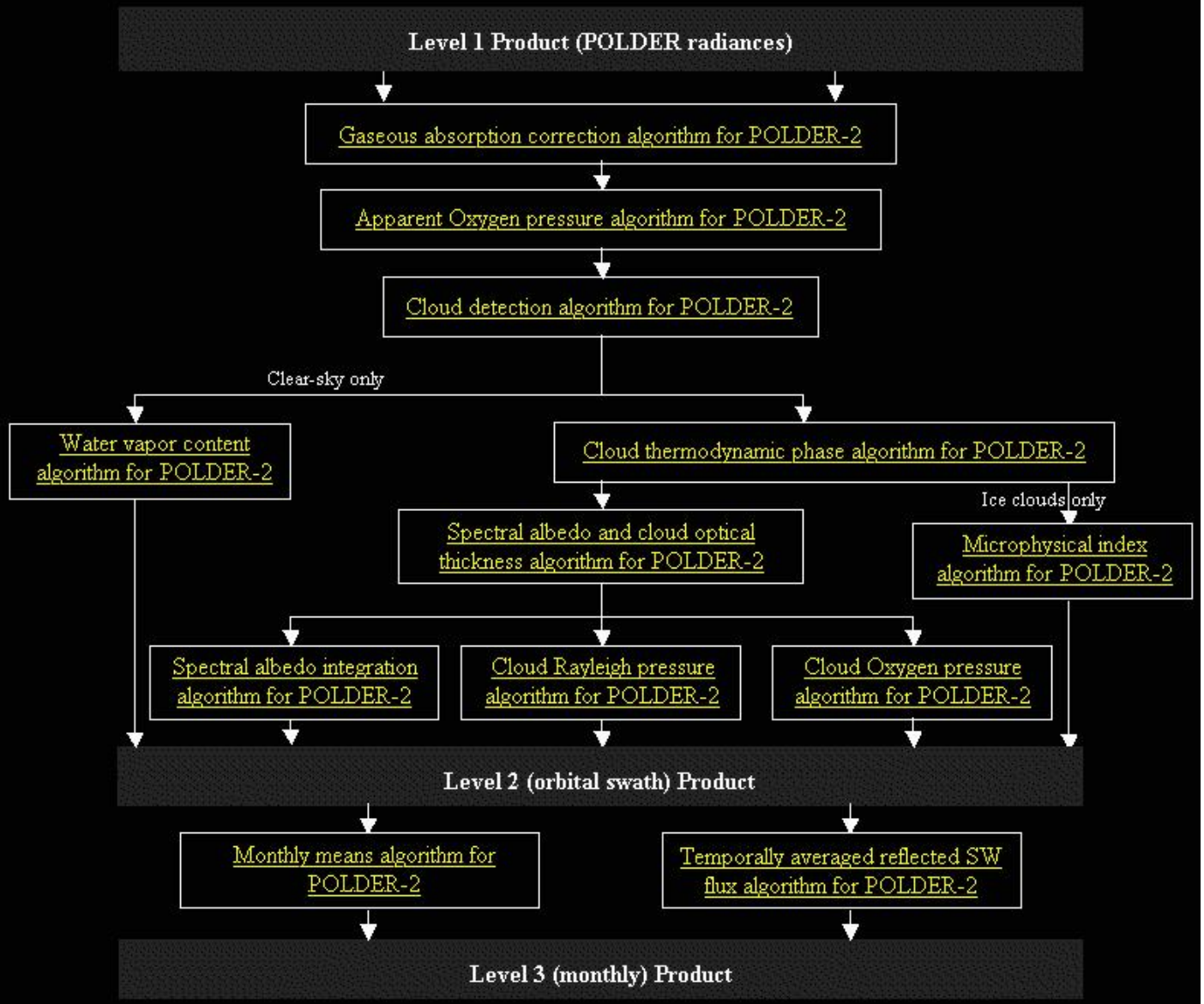
evel 2, Level 3 and Joint Atmosphere roduct

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

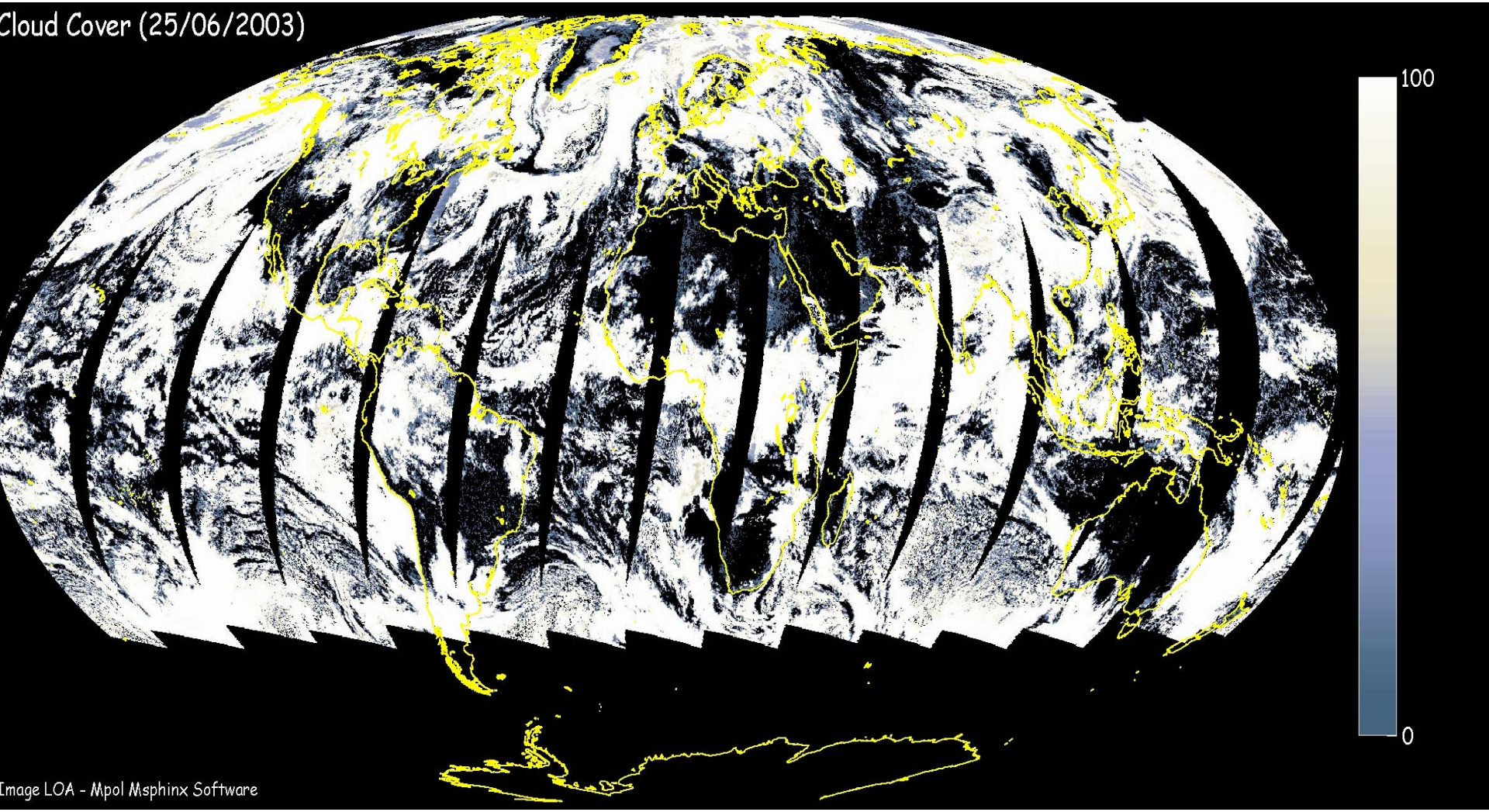
- a better spatial resolution of the ""ERB, WV & clouds"" products
- a better cloud detection, especially in presence of dust events and over ice/snow surfaces.
- a reduction of the bias in total water vapor content by determining the reflectance ratio to water vapor parameterization directly with respect 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

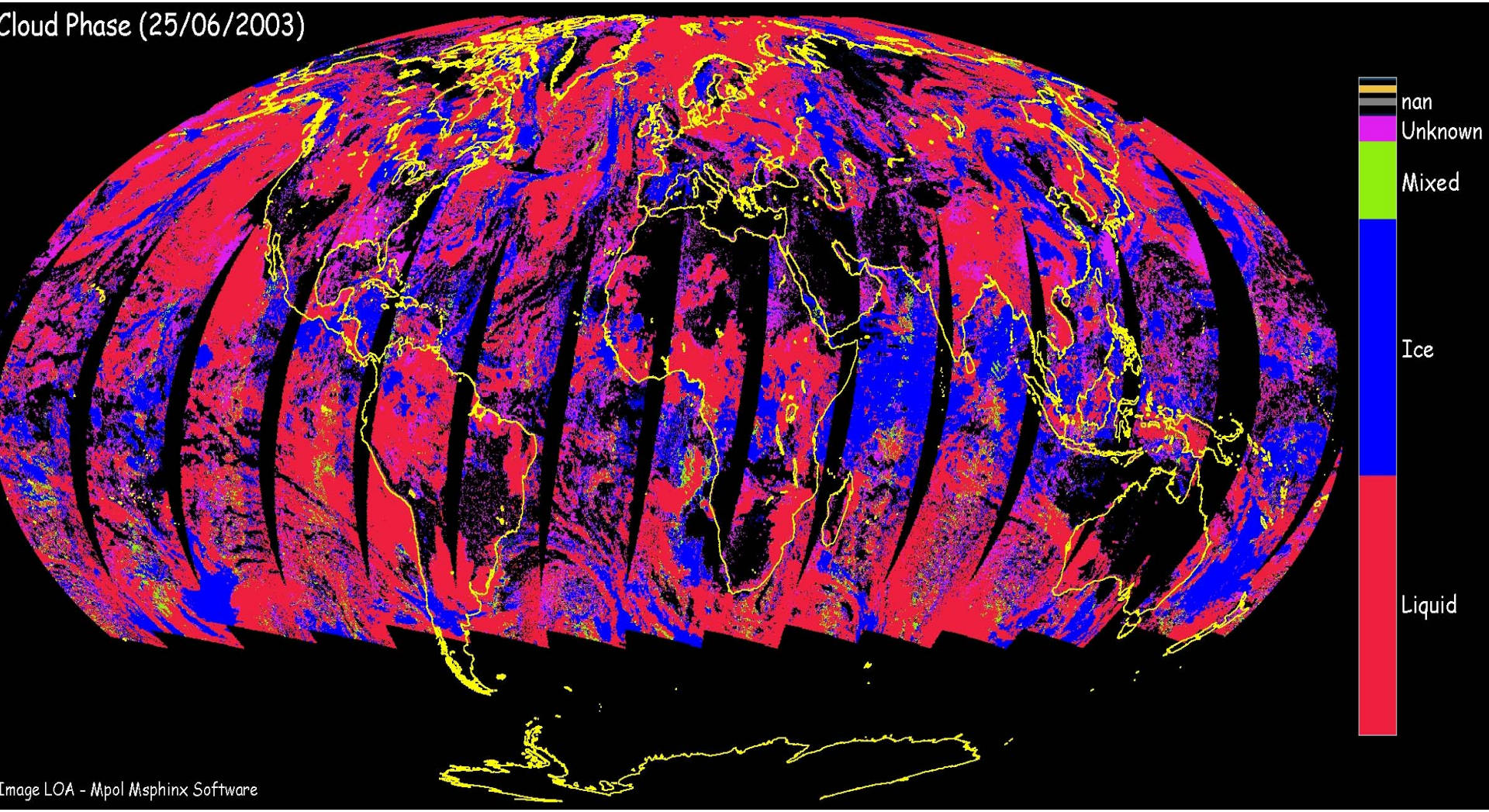
All files available for download on this page are stored in the PDF format.



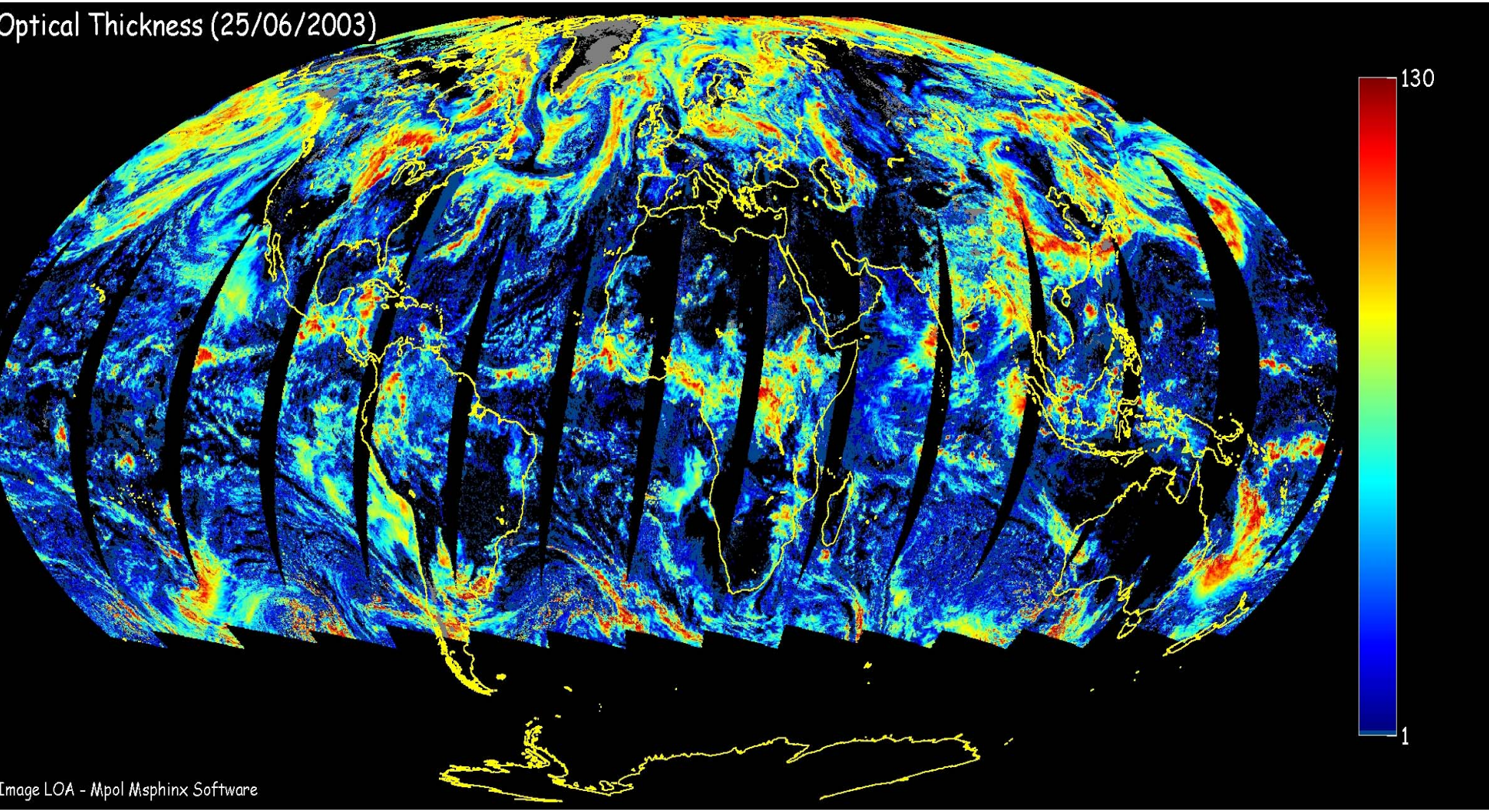
OLDER ERB,WV and Clouds Products



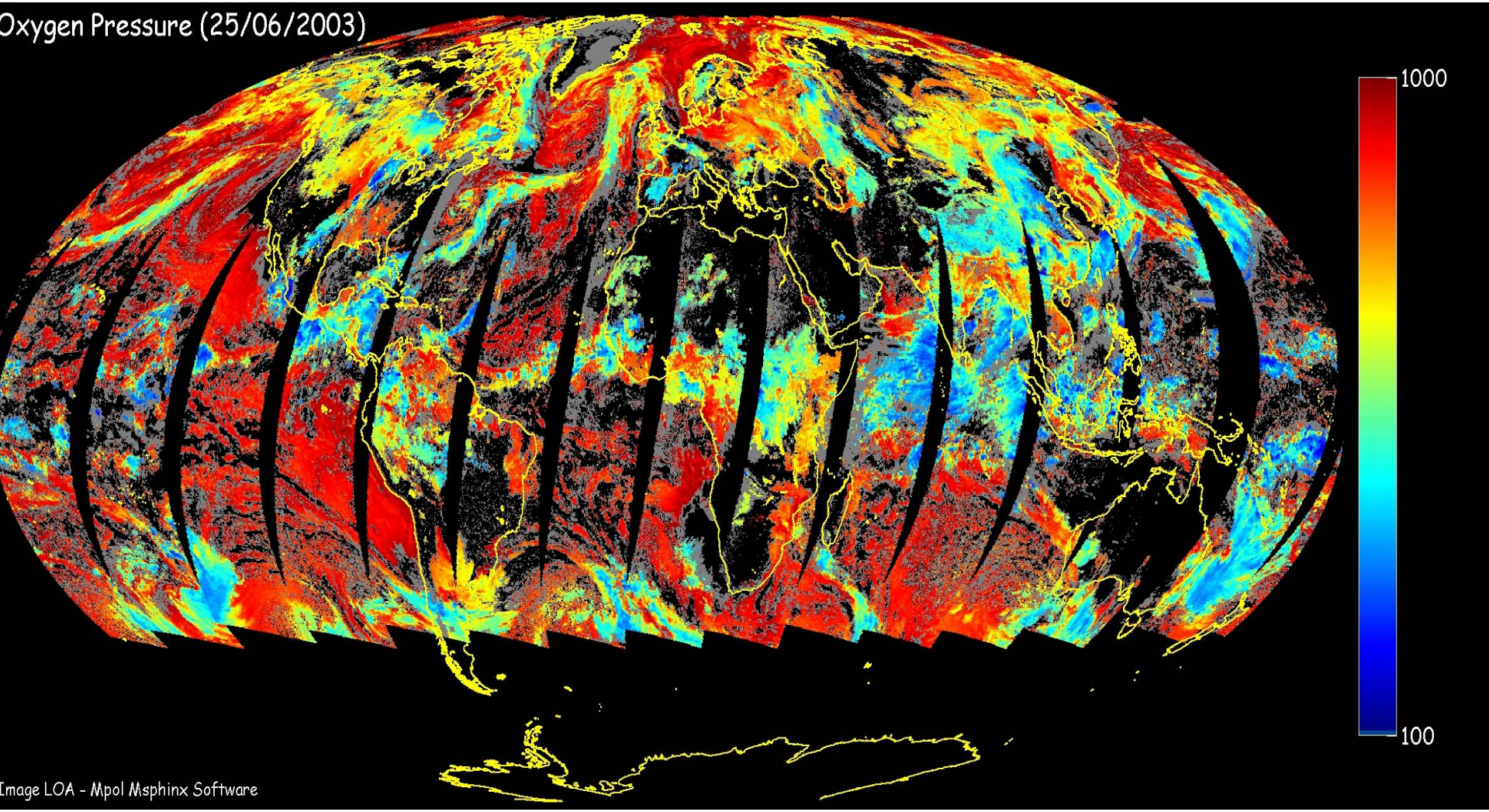
OLDER ERB,WV and Clouds Products



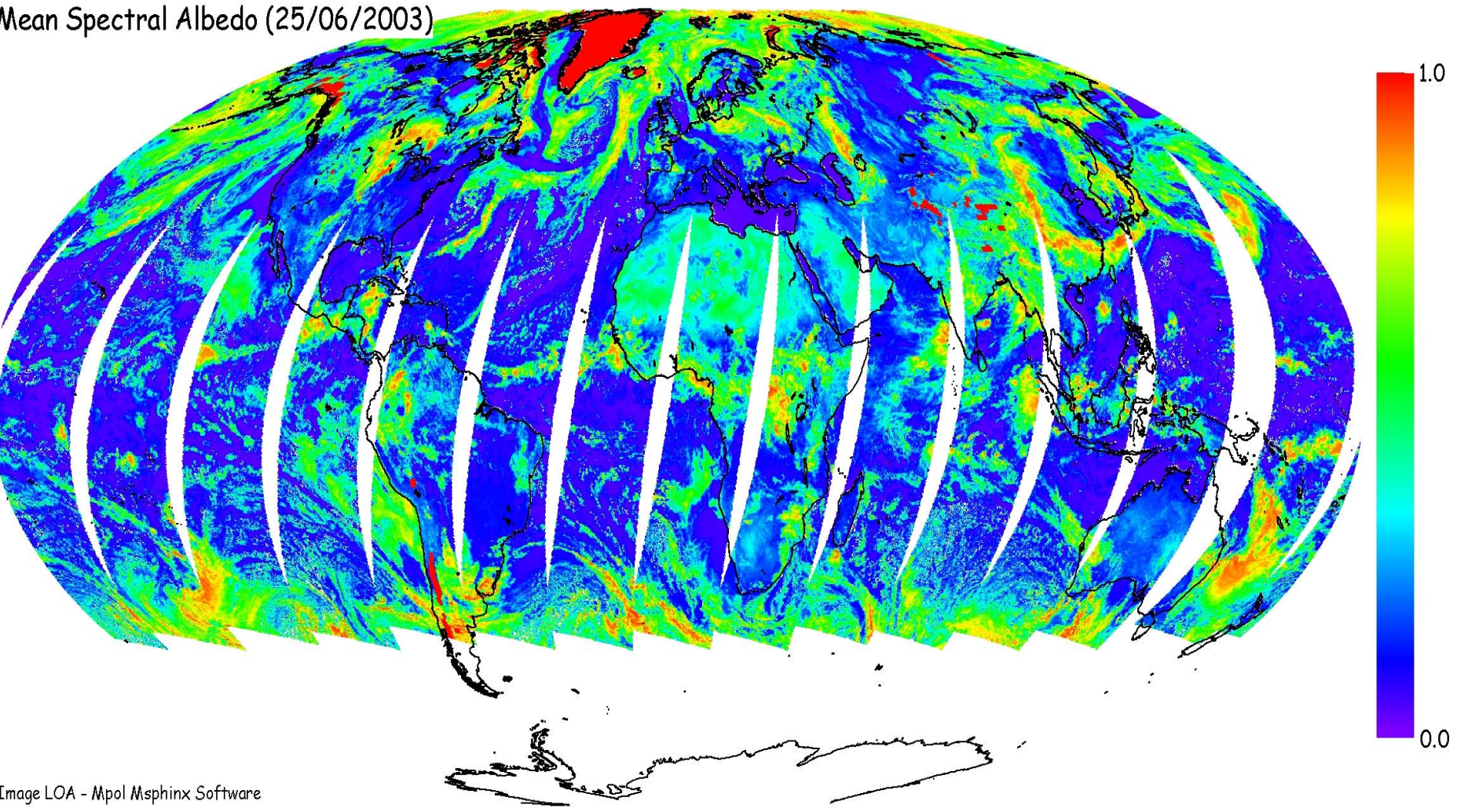
OLDER ERB,WV and Clouds Products



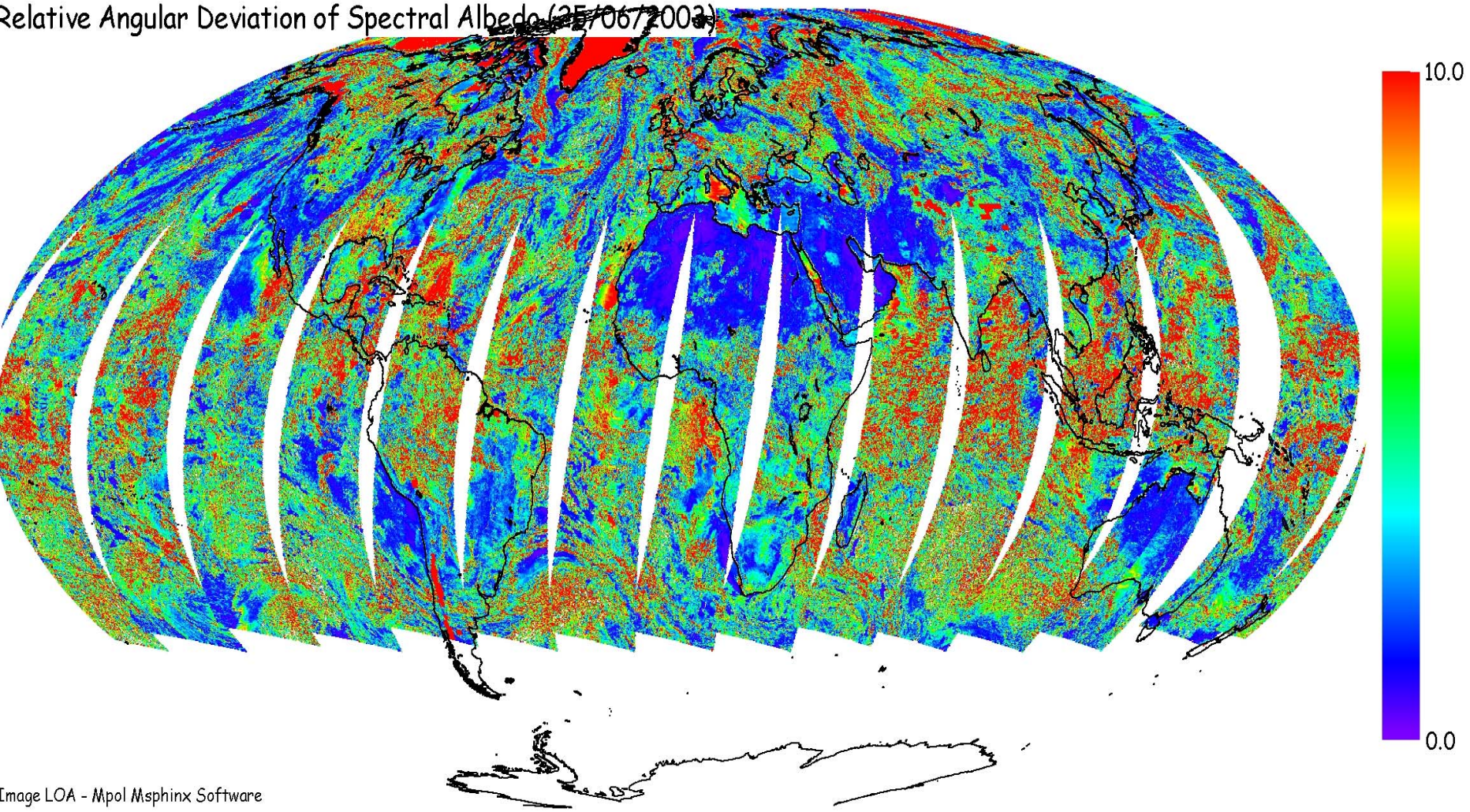
OLDER ERB,WV and Clouds Products



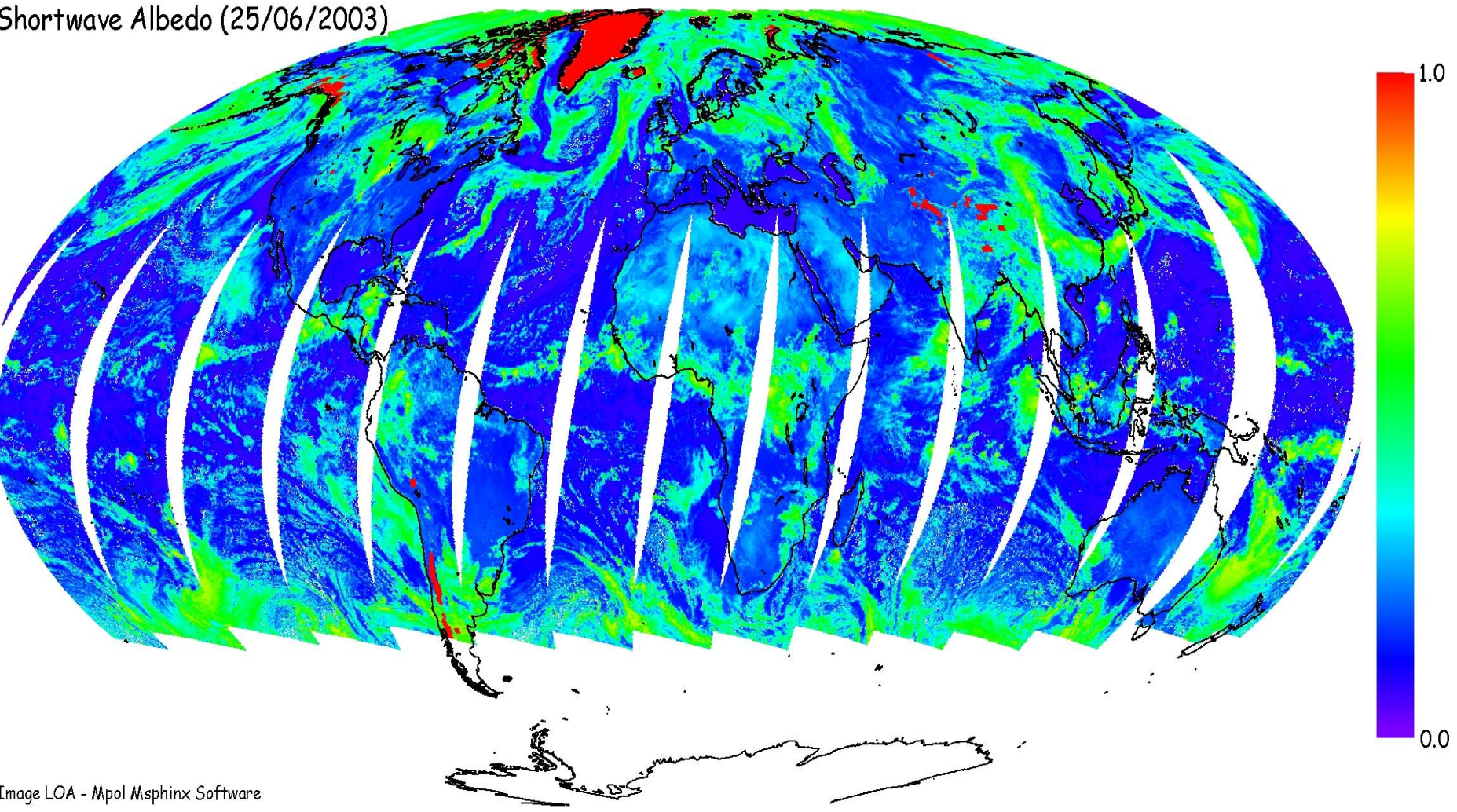
OLDER ERB,WV and Clouds Products



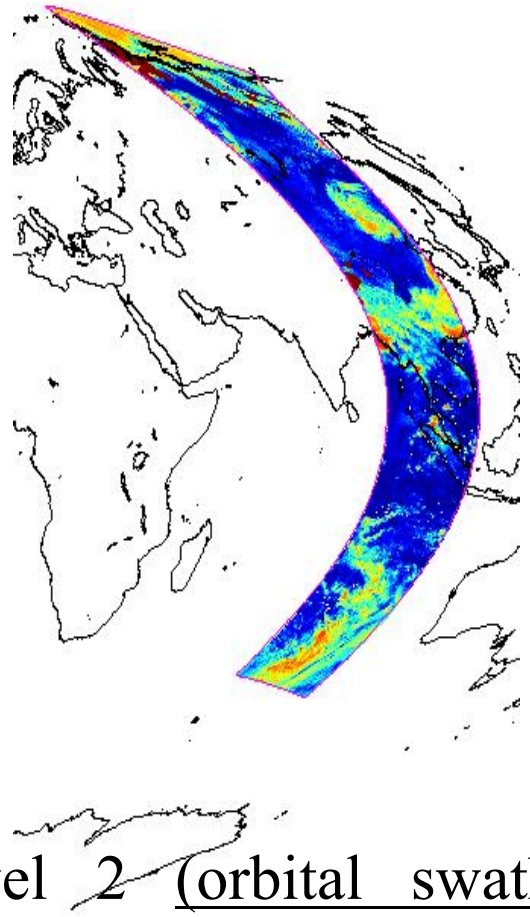
OLDER ERB,WV and Clouds Products



OLDER ERB,WV and Clouds Products



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
```

evel 2, **Level 3** and Joint Atmosphere

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

Record Number in the file : 2≤RecNum≤Nrec+1
Length of this record (bytes): 84
Line Num. of the pix. in POLDER medium res. grid
Col. Num. of the pix. in POLDER medium res. grid
Mean pixel altitude from the DEM in the 3x3 super pixel (meters)
Land, Water, Mixed indicator[11]
Number of days with POLDER measurements
Number of observations (there may be several observation within a single day at high latitudes)
Number of observations with snow/ice indicator
Number of observations with clear sky
Number of observations with cloud presence.
Number of cloud optical thickness estimates
Number of oxygen pressure estimates
Number of Rayleigh pressure estimates.
Number of cloud phase estimates
Number of water vapor column estimates
Monthly mean of the cosine of the solar zenith angle
Monthly mean of the spectral[12] Albedo
Standard Deviation of the spectral Albedo
Monthly Mean Clear Sky spectral Albedo
Standard Dev. of the Clear Sky spectral Albedo
Monthly mean of the Clear spectral albedo, based on radiative transfer simulations only
Monthly mean of the SW Albedo

Standard Deviation of the Clear Sky SW Albedo
Monthly mean of the Clear SW albedo, based on radiative transfer simulations only
TOA monthly-mean incoming solar Flux [W.m^{-2}]
TOA monthly-mean reflected Flux [W.m^{-2}]
Monthly-mean SW cloud forcing [W.m^{-2}]
Monthly mean cloud cover
Standard Deviation of cloud cover estimates
CN_+ : Fraction of observations classified from "uncertain" to "cloudy" CN_-: Fraction of observations classified from "uncertain" to "clear" Four bit each: One byte contains 16 $CN_+ + CN_-$
Monthly mean water vapor column [g cm^{-2}]
Std. deviation water vapor column [g cm^{-2}]
Cloud pressure based on oxygen channels (monthly mean weighted by cloud cover) [hPa]
Standard Deviation of Oxygen Cloud pressure [hPa]
Cloud pressure based on Rayleigh method (monthly mean weighted by cloud cover) [hPa]
Std. deviation of Rayleigh cloud pressure [hPa]
Mean cloud optical thickness
Relative dispersion of cloud optical thickness [%]
Mean cloud optical thick., liquid phase occurences
Mean cloud optical thick., ice phase occurences
Mean cloud optical thick., mixed phase occurences
Mean Spherical Albedo
Standard deviation on spherical albedo
Relative frequency of phase [%]. Bins are "Unknown", "Liquid", "Ice" and "Mixed"[13].
Relative frequency of ice cristal shapes [%]

evel 2, Level 3 and **Joint Atmosphere roduct**

projection Lat-Lon 1080*2160 (1/6°)

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

BR2

OC2

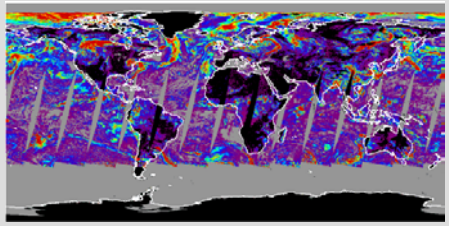
TE2

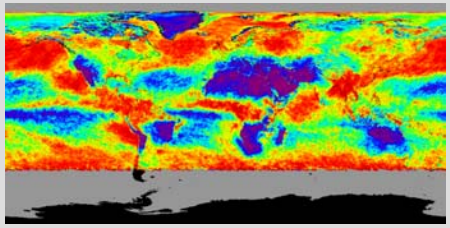
BR3

OC3

PR3

Daily synthesis





Monthly synthesis

Reformatted products in HDF file format

Set of gif images

evel 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

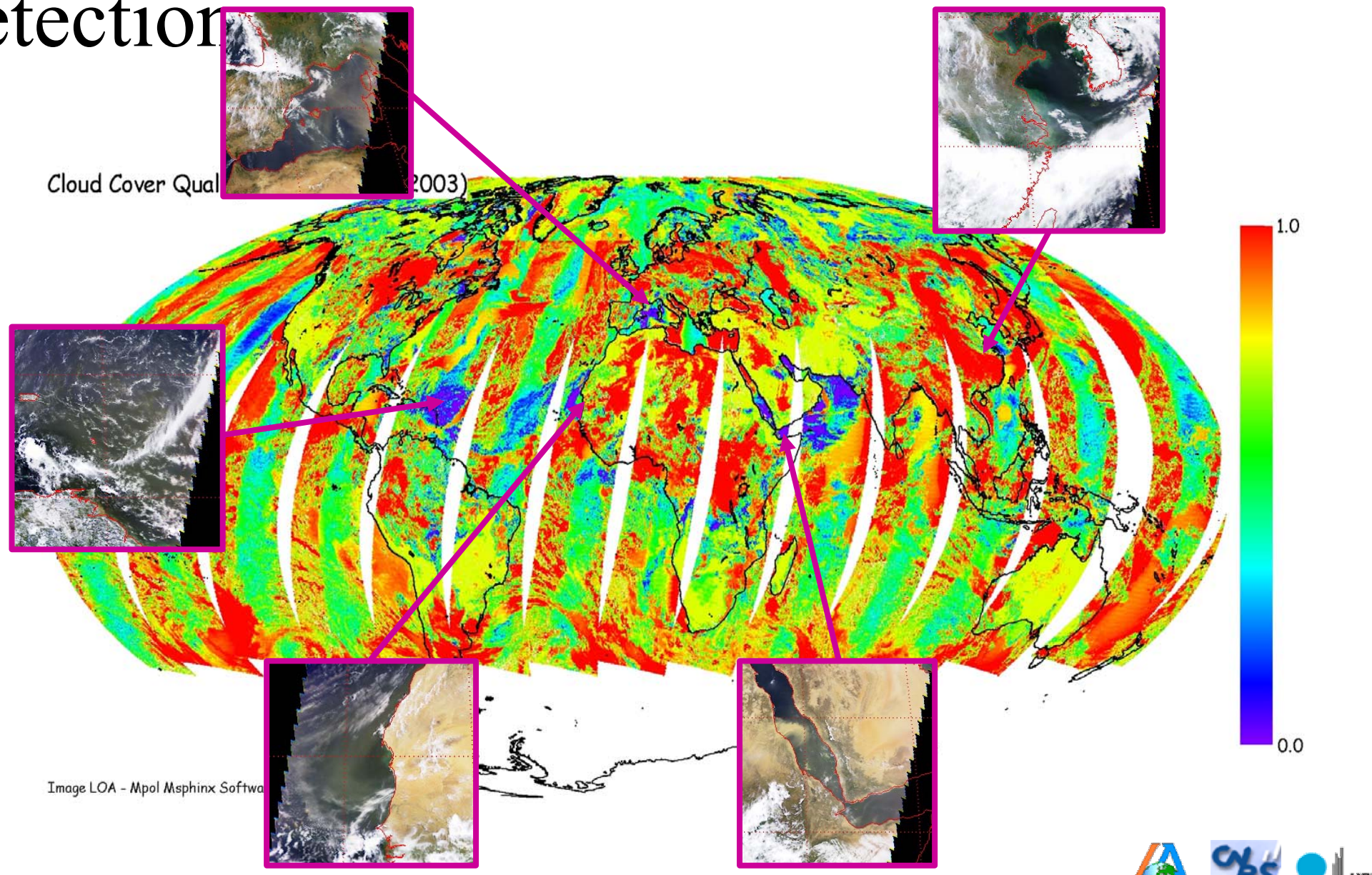
TOTFRE	Percent. of successful Phase retrievals		M
LIQFRE	Liquid Phase Frequency		M
ICEFRE	Ice Phase Frequency		M
MIXFRE	Mixed Phase Frequency		M
LIQTAU	Liquid Water Cloud Optical Thickness		M
ICETAU	Ice Cloud Optical Thickness		M
MIXTAU	Mixed-phase Cloud Optical Thickness		M
FINC	Shortwave Incident flux		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

roducts Accuracy

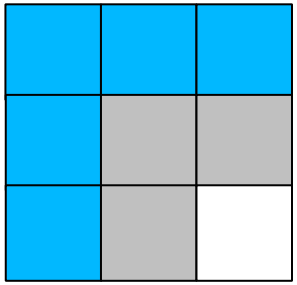
otential and Known Biases - Guidelines

ultiangle measurements and Cloud etection



louds / Aerosols : Products consistency

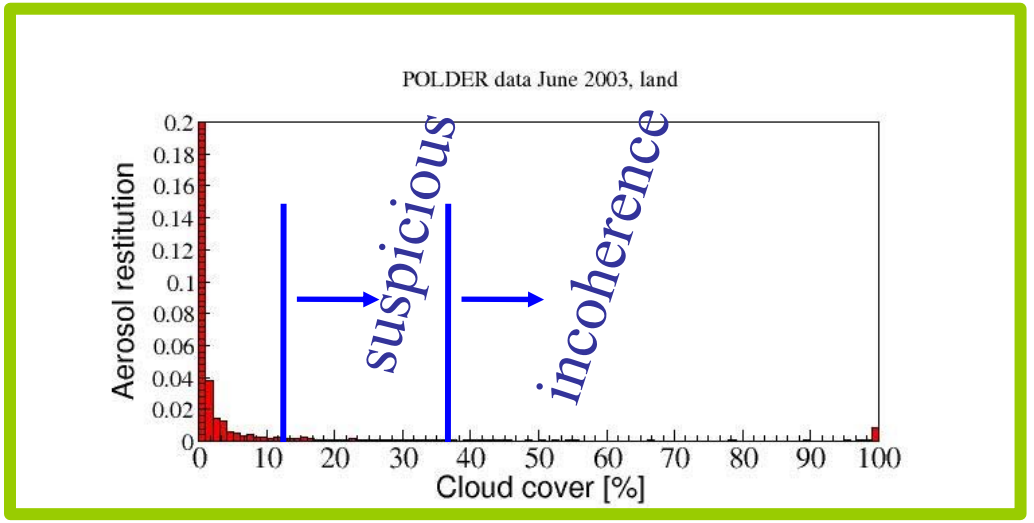
Polder clouds and aerosols products are provided at the same resolution (3x3 L1) but use different cloud mask.

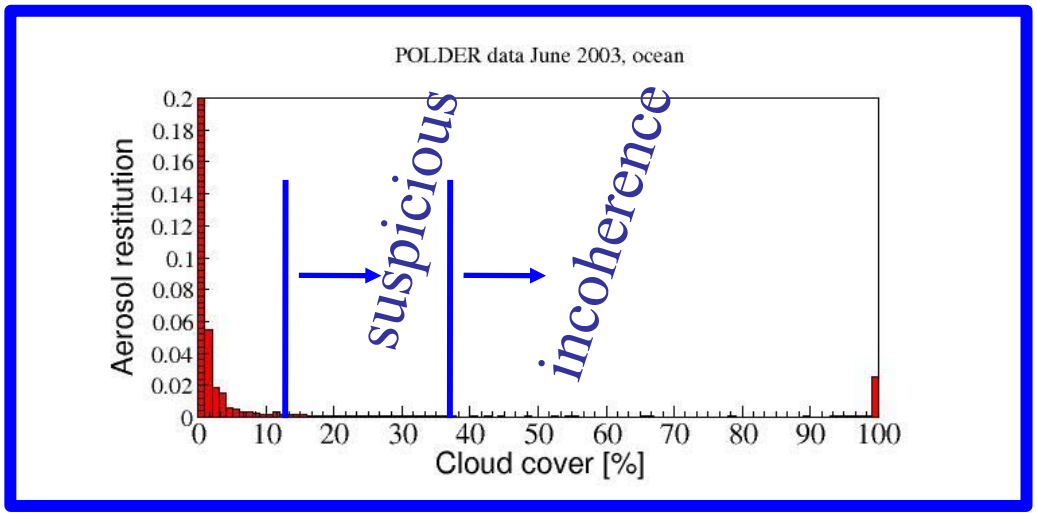


Aerosol retrievals performed when at least 5 over 9 pixels are clear

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

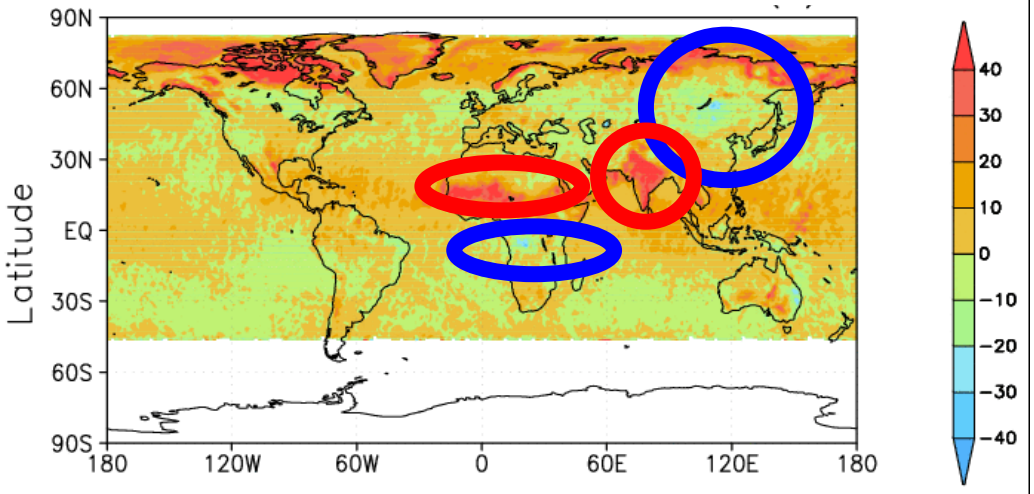
June 2003

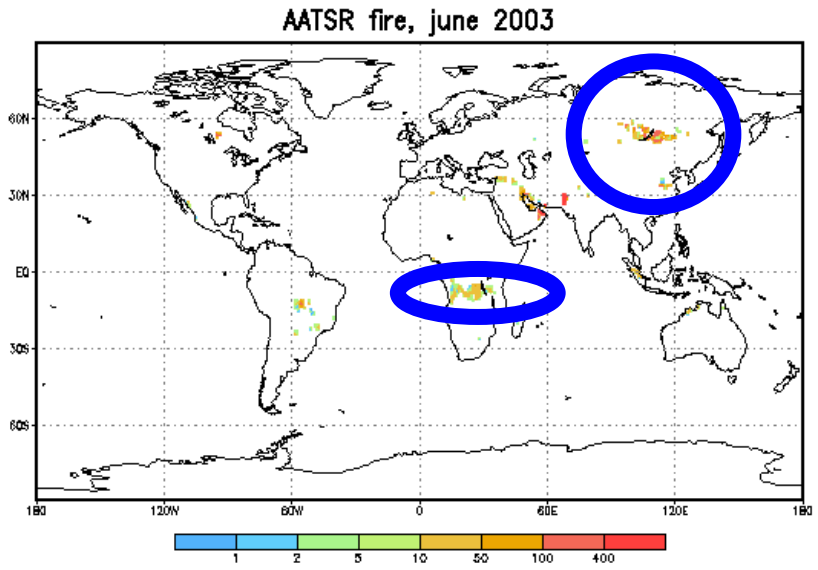


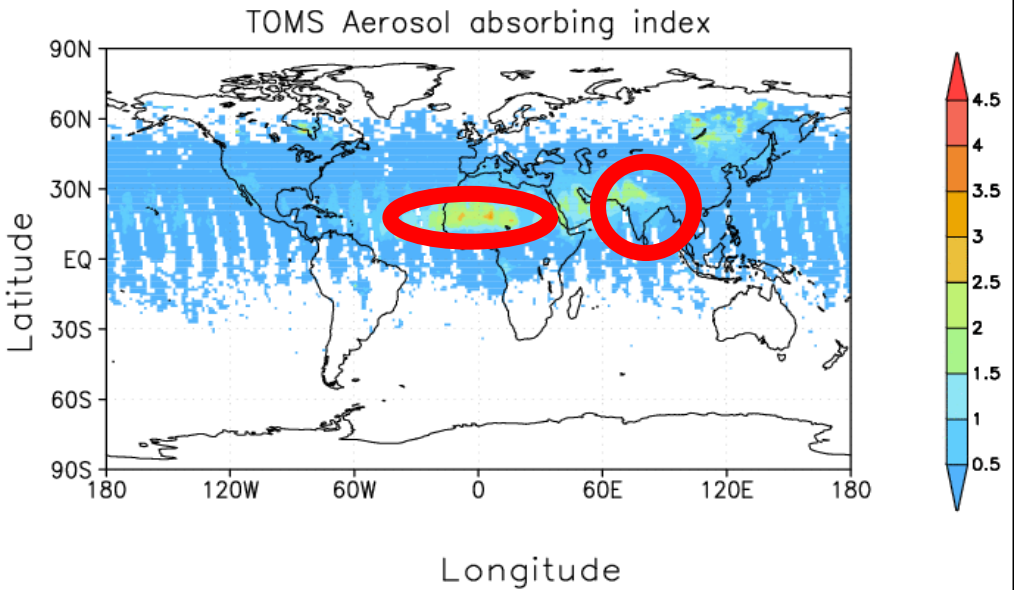


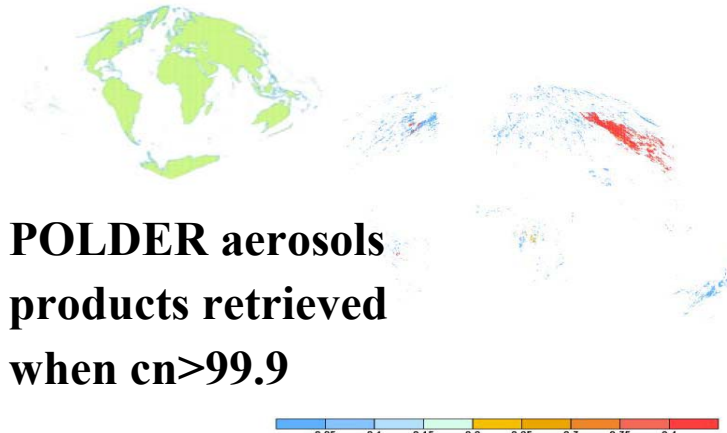
loud products contamination by aerosols

MODIS (infrared day cloud fraction) - POLDER



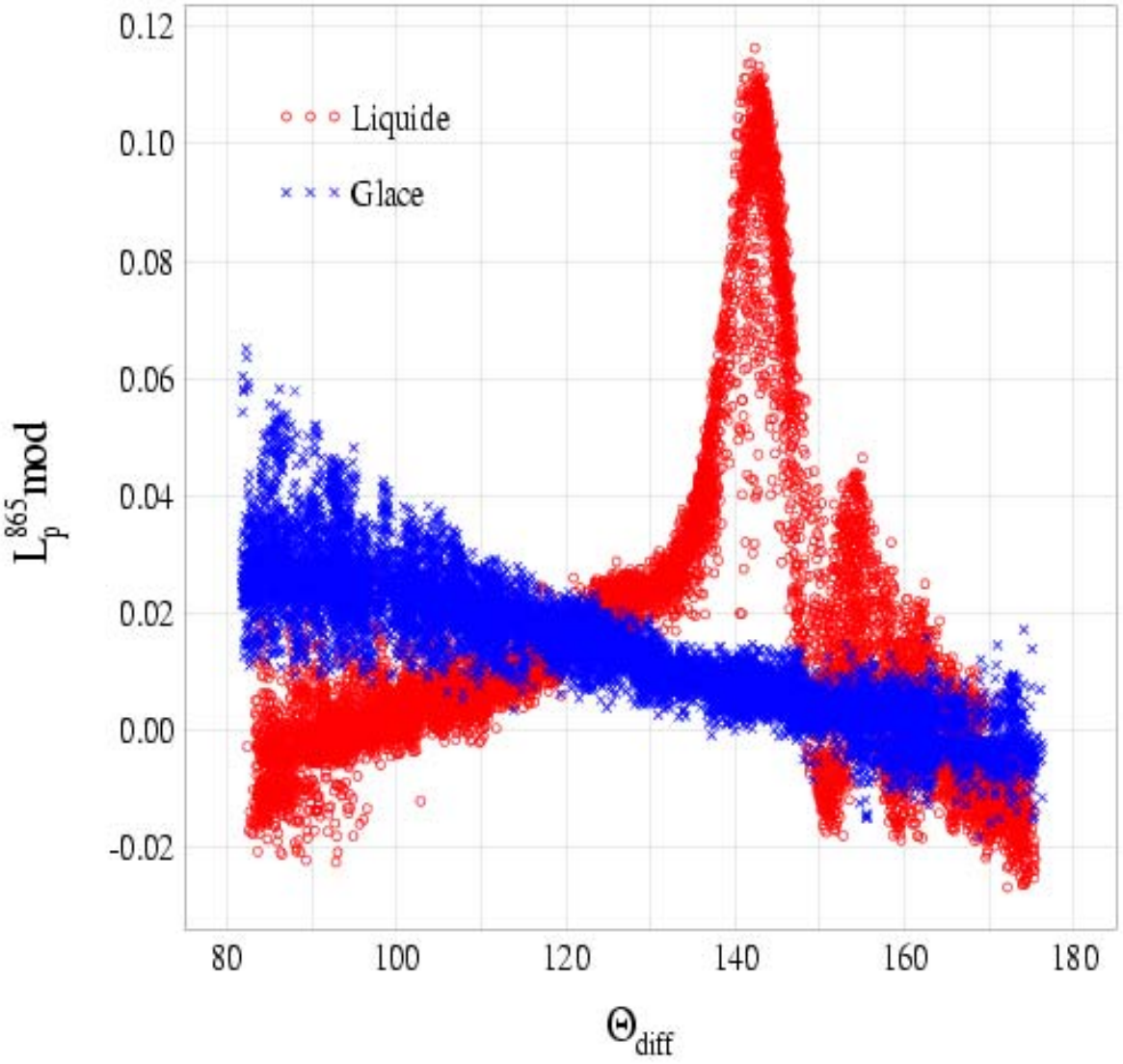


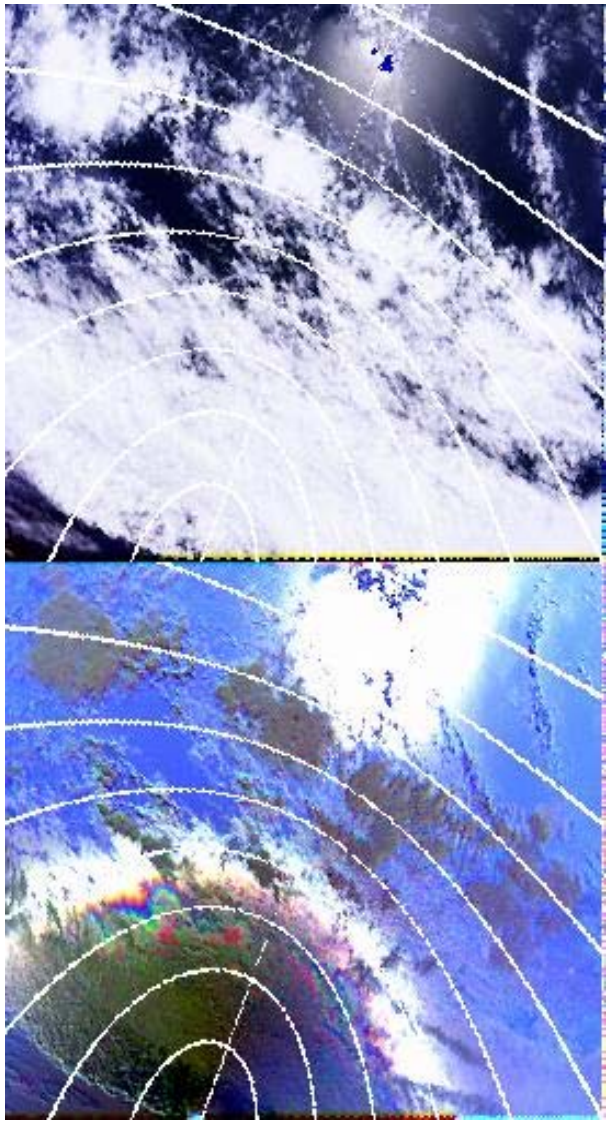




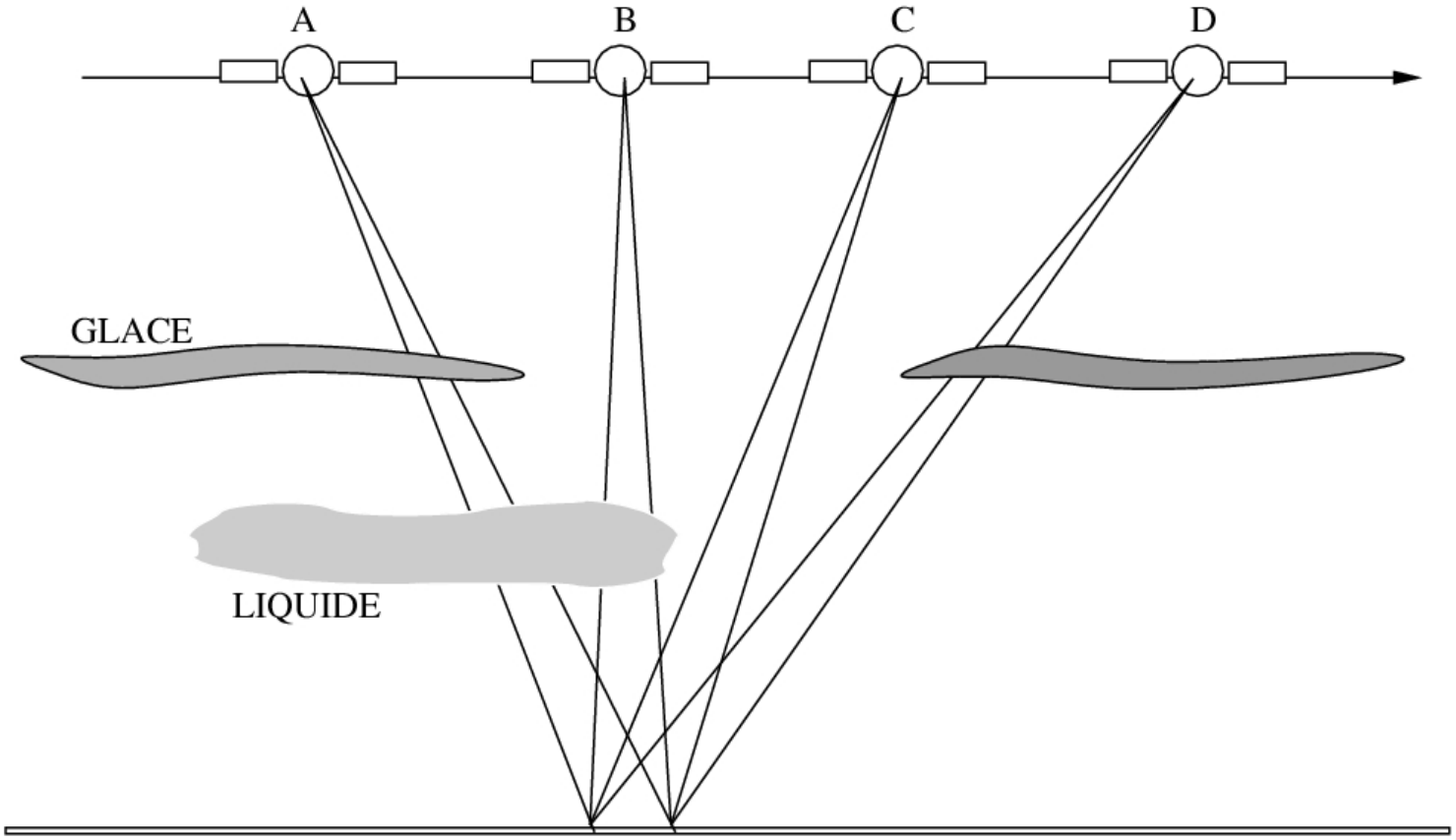
POLDER aerosols products retrieved when cn>99.9

ultiangle polarisation measurements and



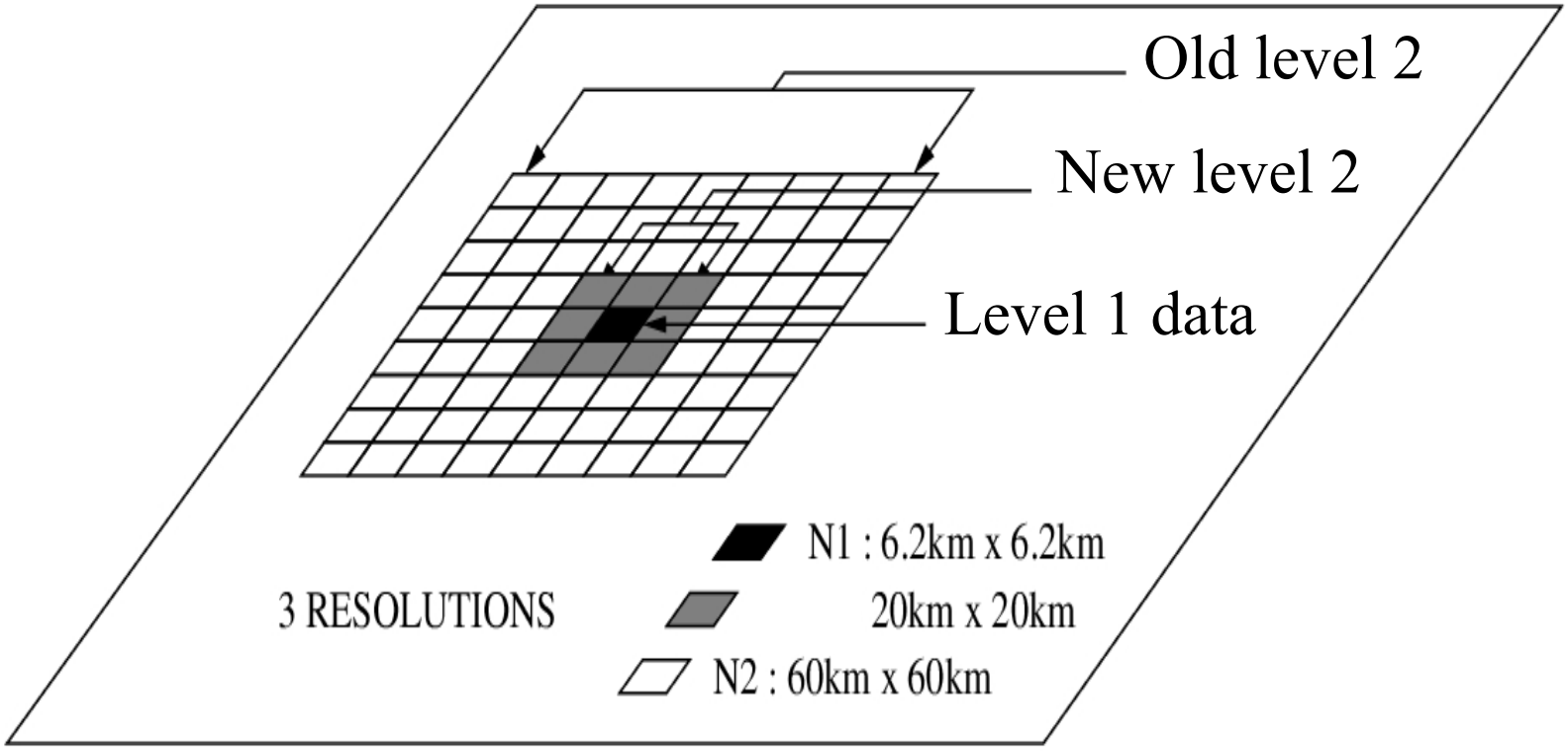


OLDER Multiangle observation for ummies



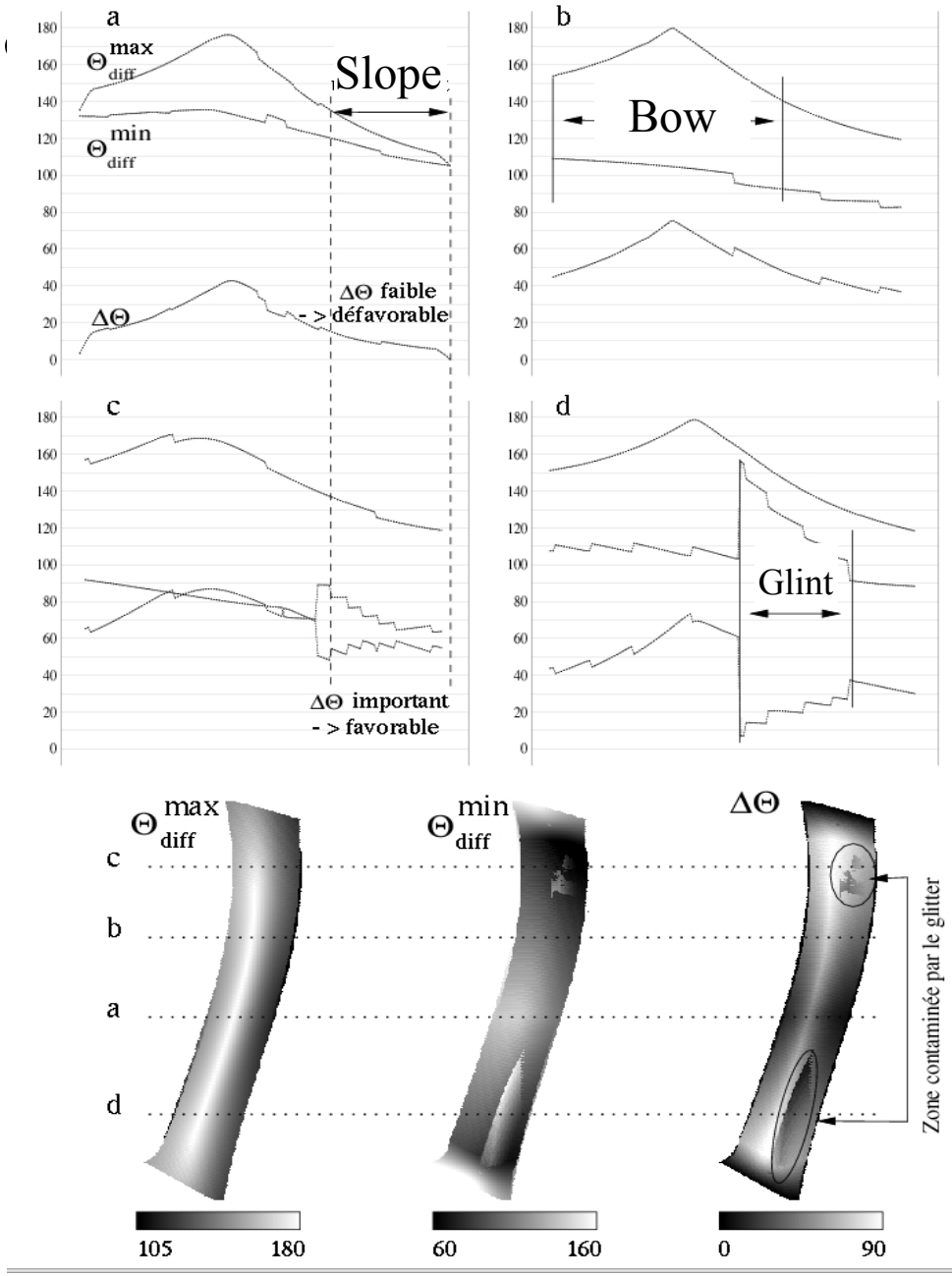
All directional observations are relocated on the surface

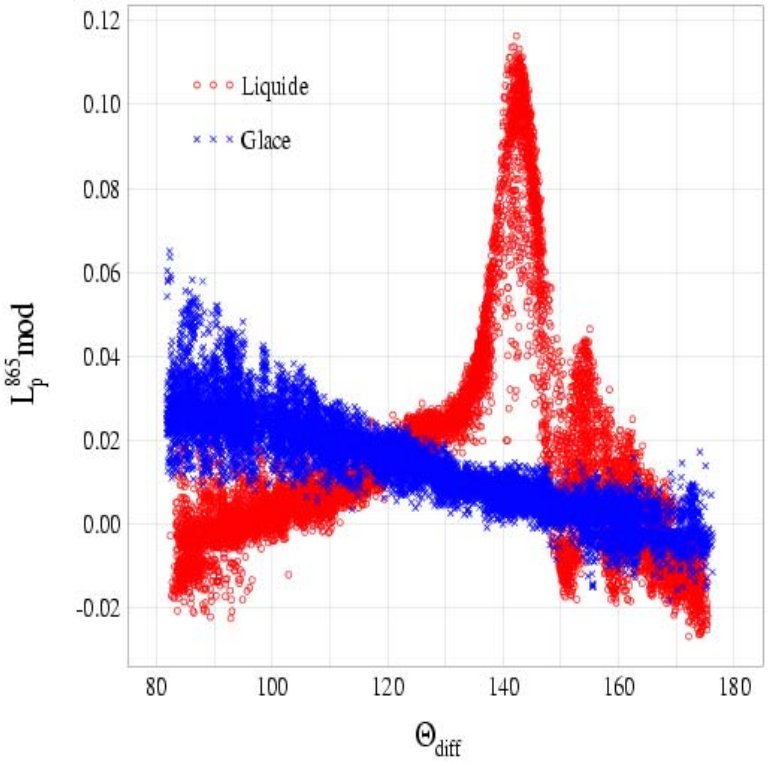
OLDER Multiangle observation for ummies



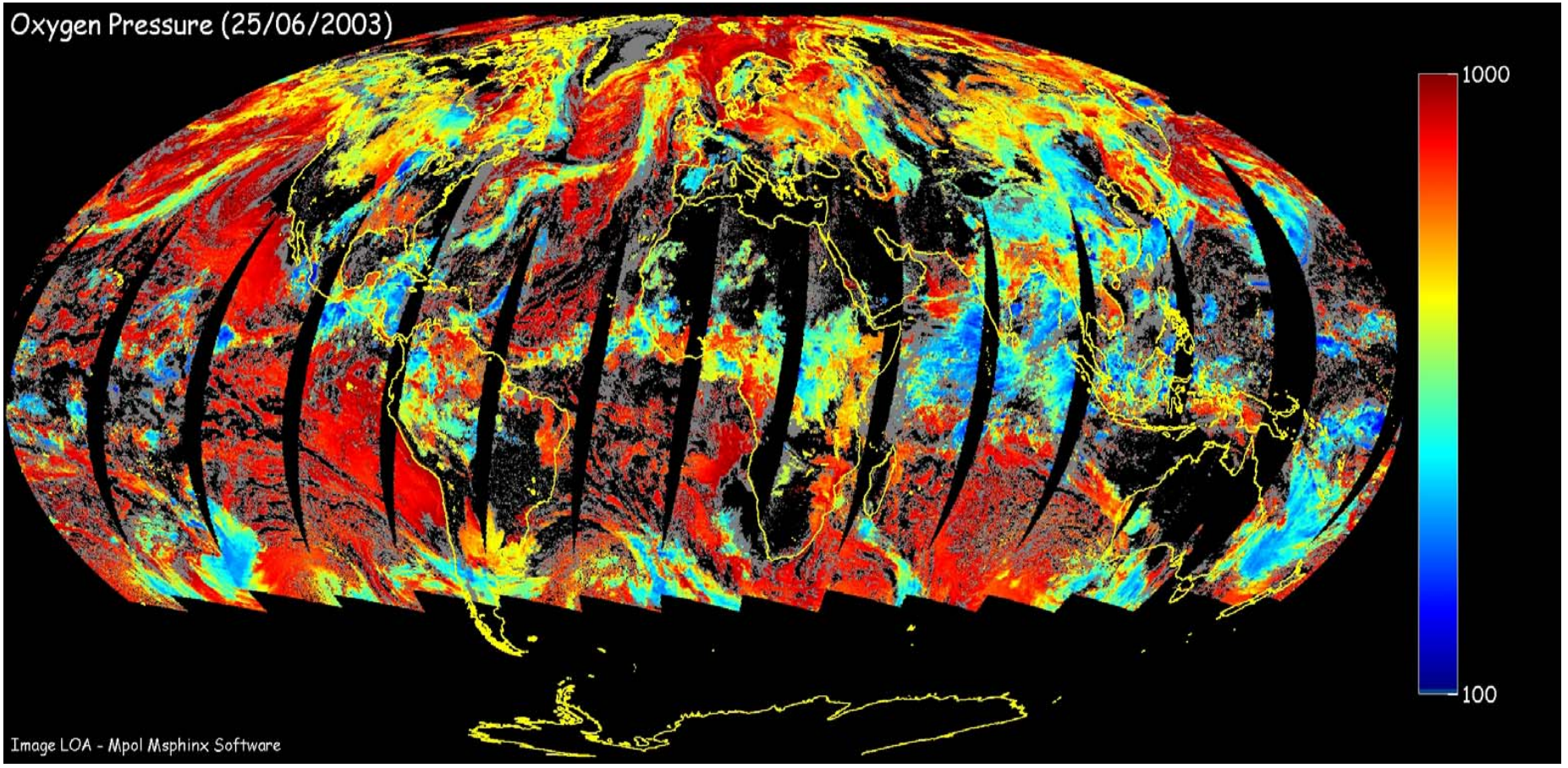
Products are retrieved and delivered at lower resolution to reduce relocation noise and biases

OLDER Multiangle observation for





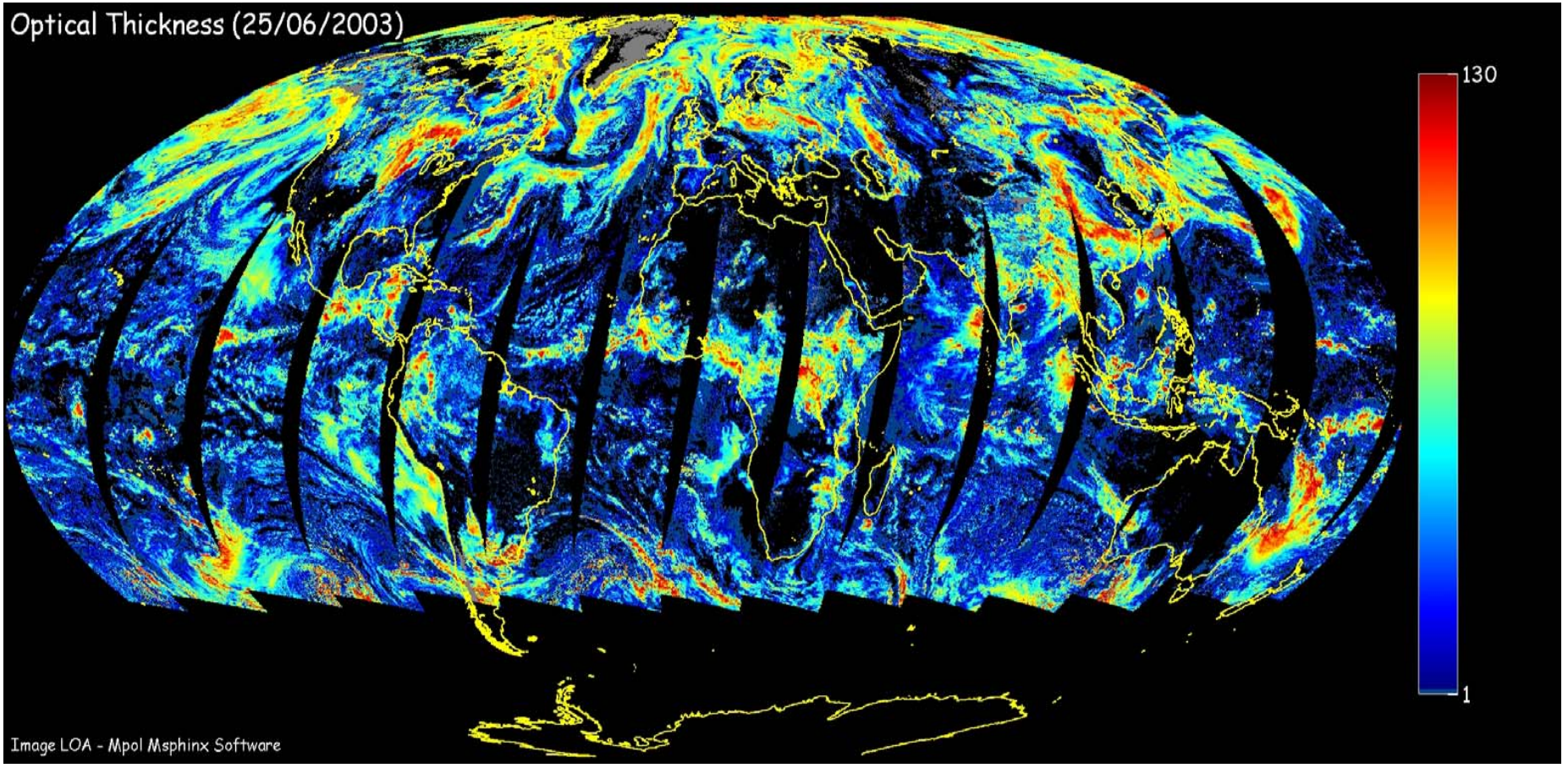
ultiangle multispectral measurements



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

Directional product – Retrieval is performed in up to 14 directions

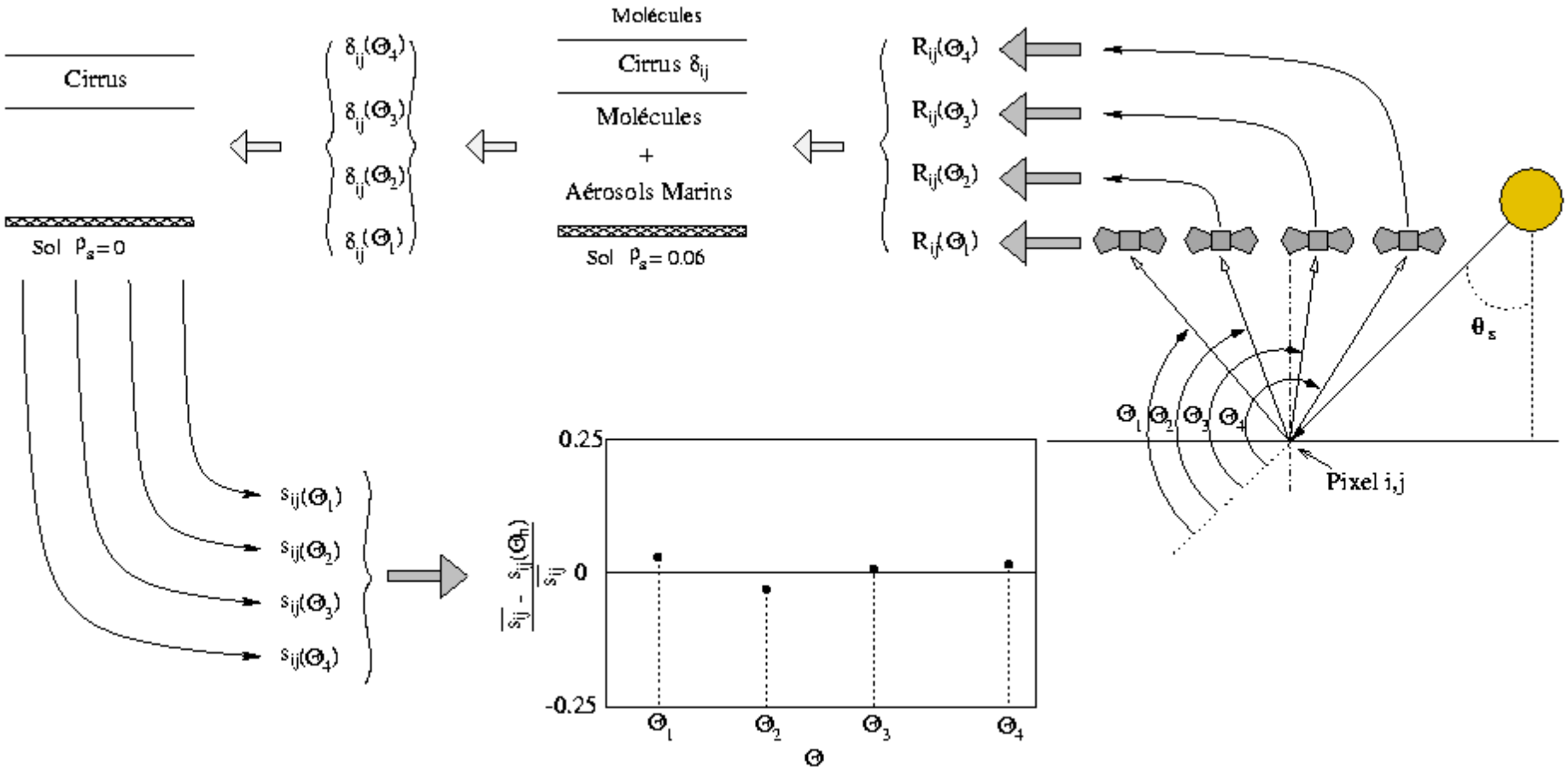
ultiangle multispectral measurements



Cloud optical thickness is retrieved under up to 14 directions

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

esting cloud models from multiangle
bservation



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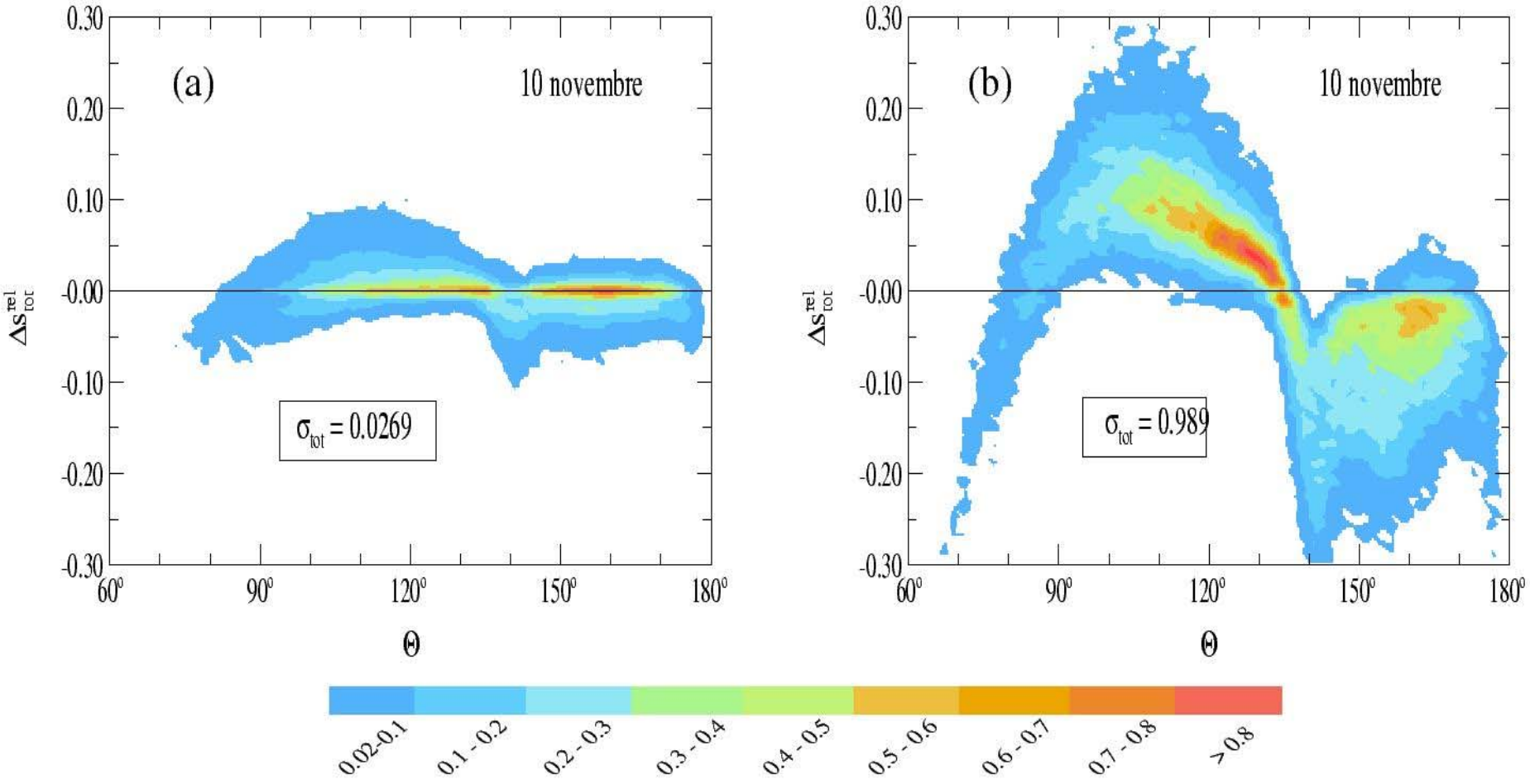

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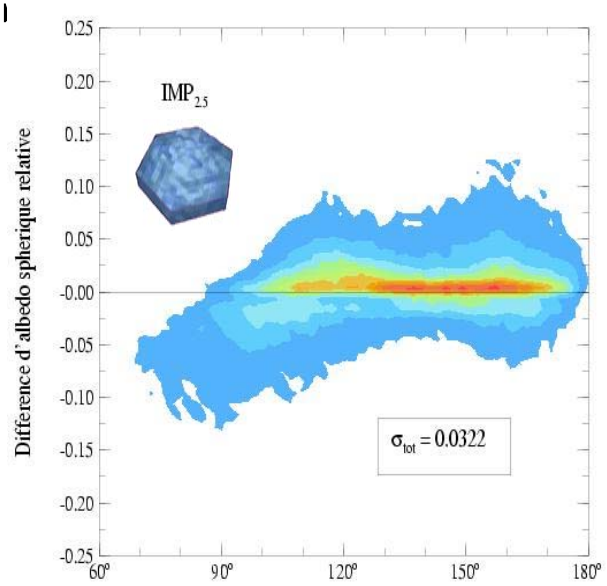
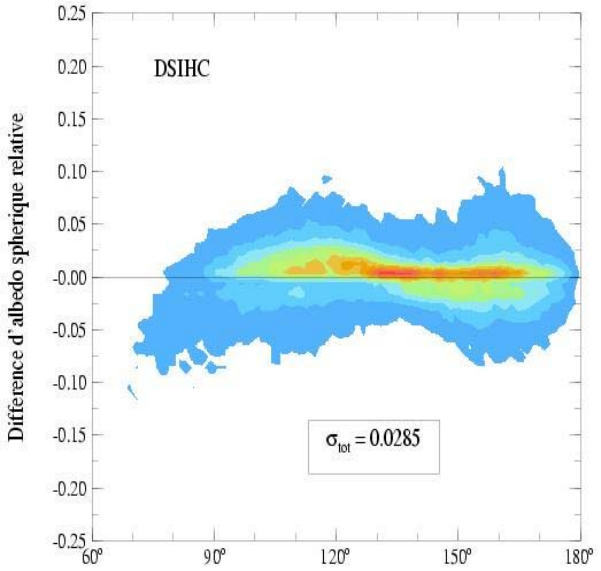
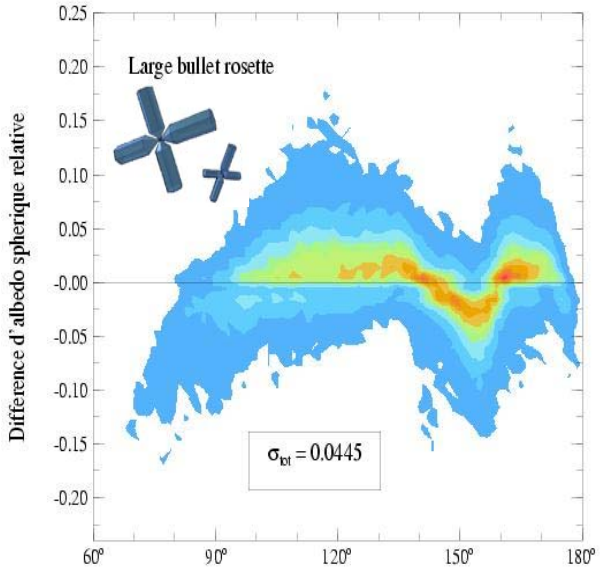
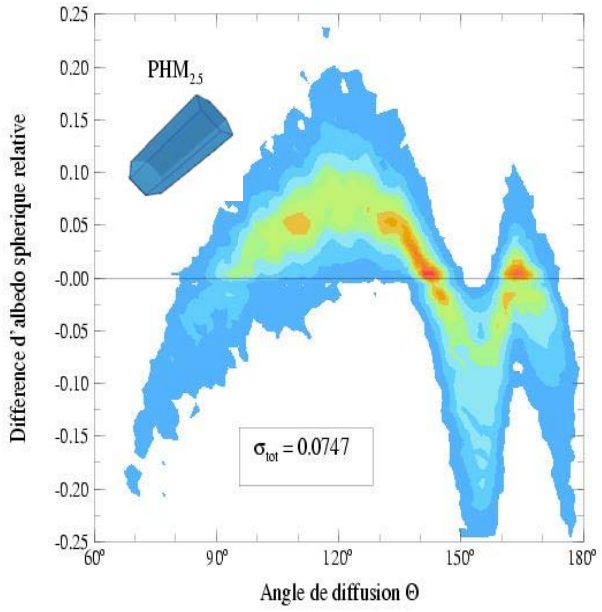
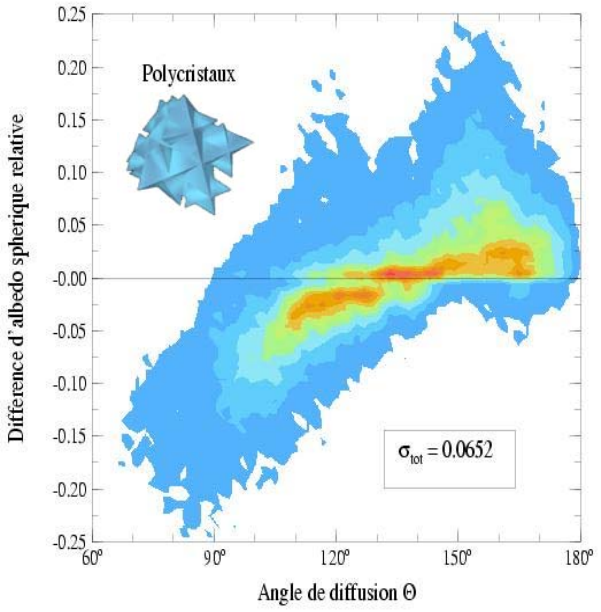
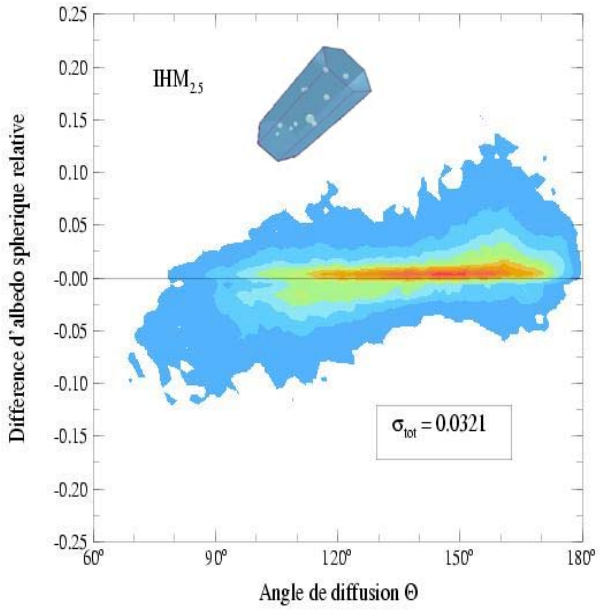




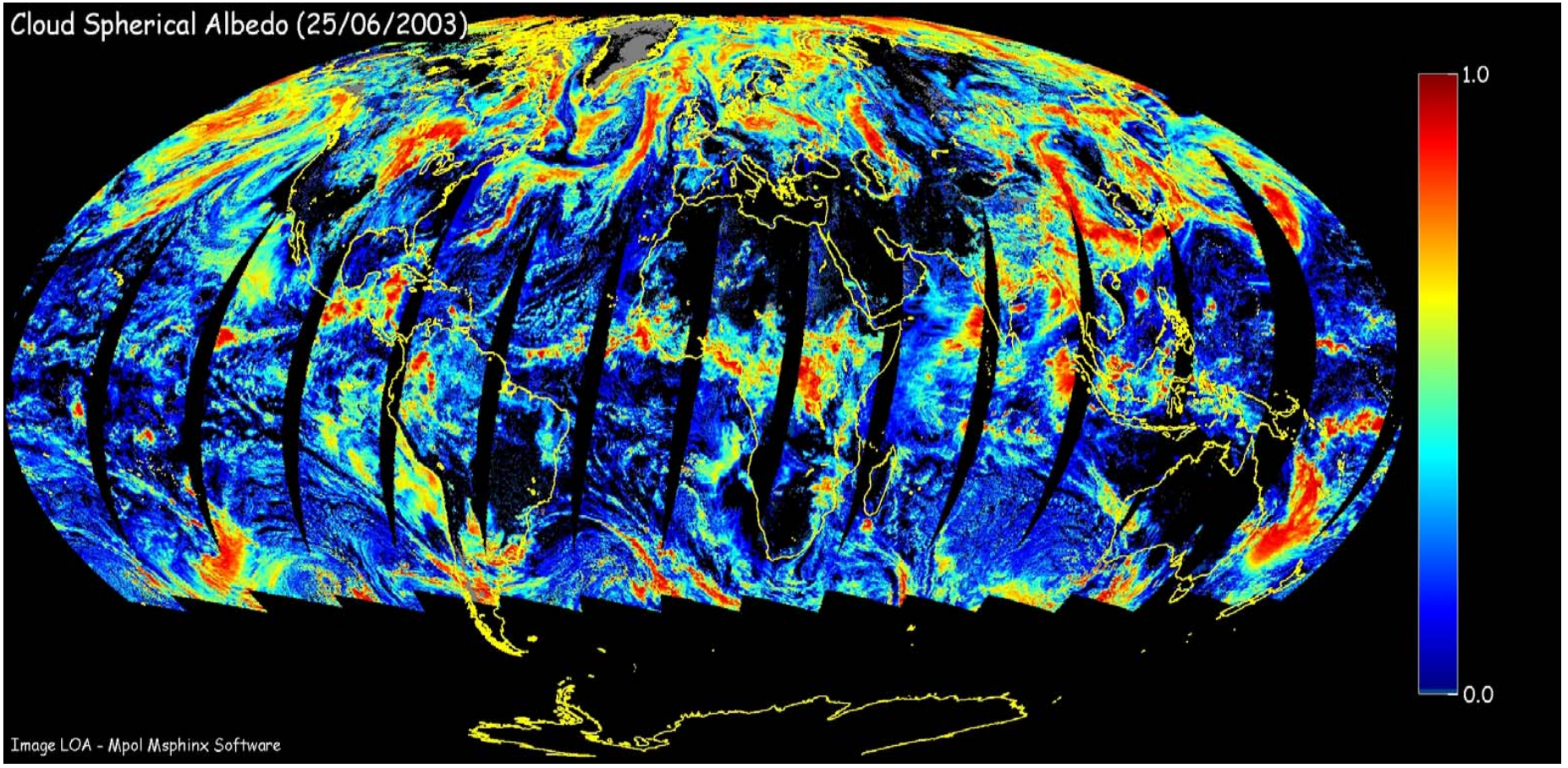








ultiangle multispectral measurements



3 Spectral Cloud Albedo

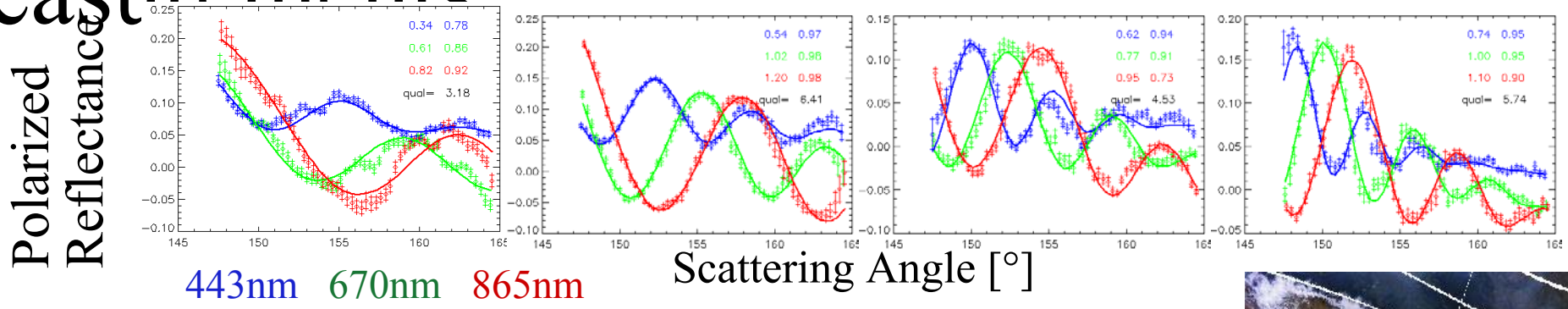
$\lambda = 443$ nm $\Rightarrow$ 200 – 550 nm

$\lambda = 670$ nm $\Rightarrow$ 550 – 700 nm

$\lambda = 865$ nm $\Rightarrow$ 700 – 4000 nm

$\Rightarrow$ SW CLOUD ALBEDO

Liquid Particles effective radius retrievals from multiangle, multispectral polarisation measurements



Based on the directional signature of the polarized reflectance

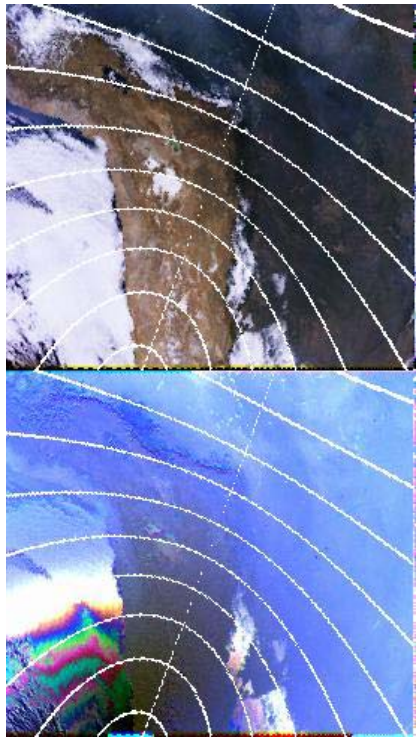
Believed to be very accurate (multiple internal consistency check)

Requires very specific conditions

- Multi-Directional polarized reflectance measurements
- Homogeneous cloud field over 150x150 km^2
- Narrow size distribution

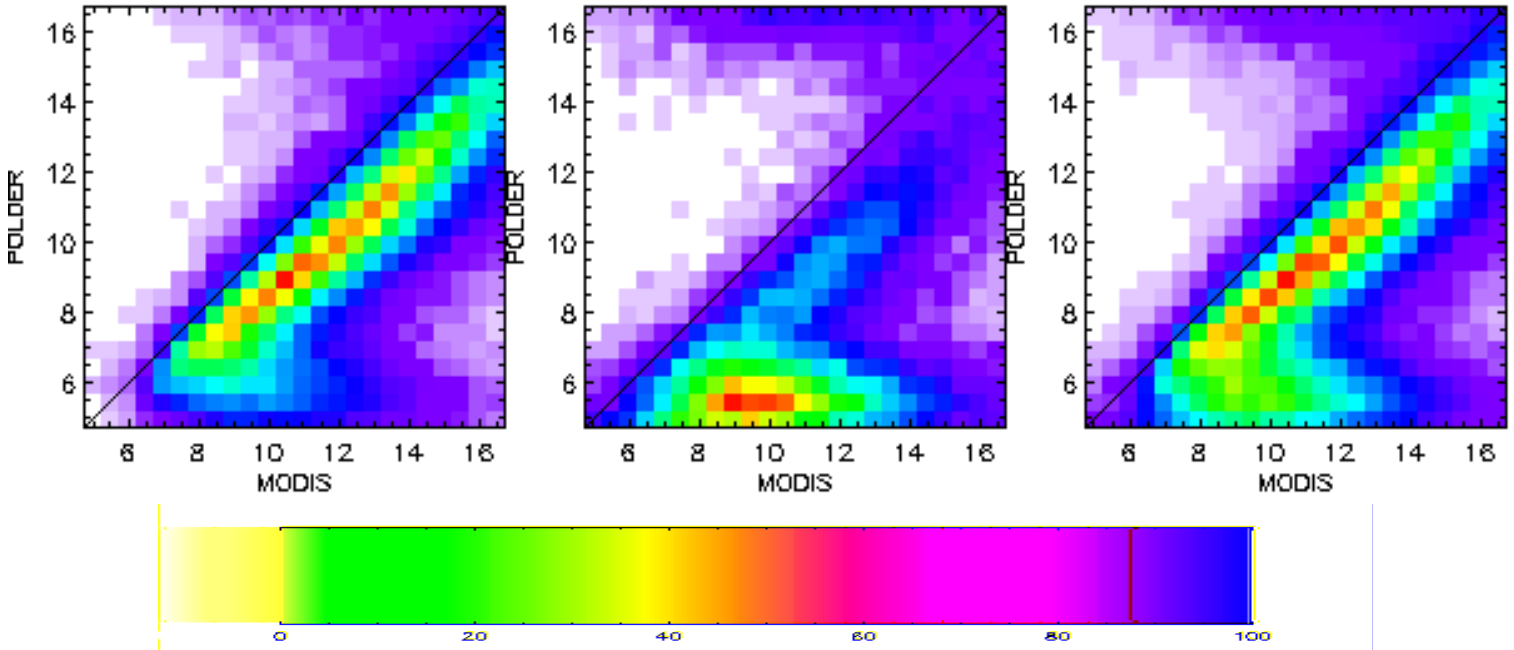
Sampling biased to specific cloud types

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



quid Particles effective radius retrievals om multiangle, multispectral polarisation easurements

POLDER vs MODIS comparison



Excellent correlation, except for small droplets

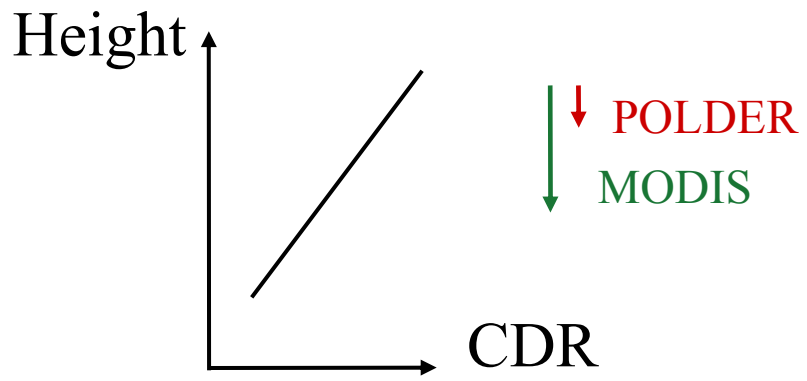
2 µm bias (MODIS > POLDER)

Little correlation over land (small droplets according to POLDER)

...quid Particles effective radius retrievals ...om multiangle, multispectral polarisation ...easurements

Hypothesis for bias

Vertical profile of 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

OLDER ERB,WV and Clouds Products
roducts Availability

roducts availability

POLDER1 : November 1996 to June 1997
POLDER2 : April 2003 to October 2004

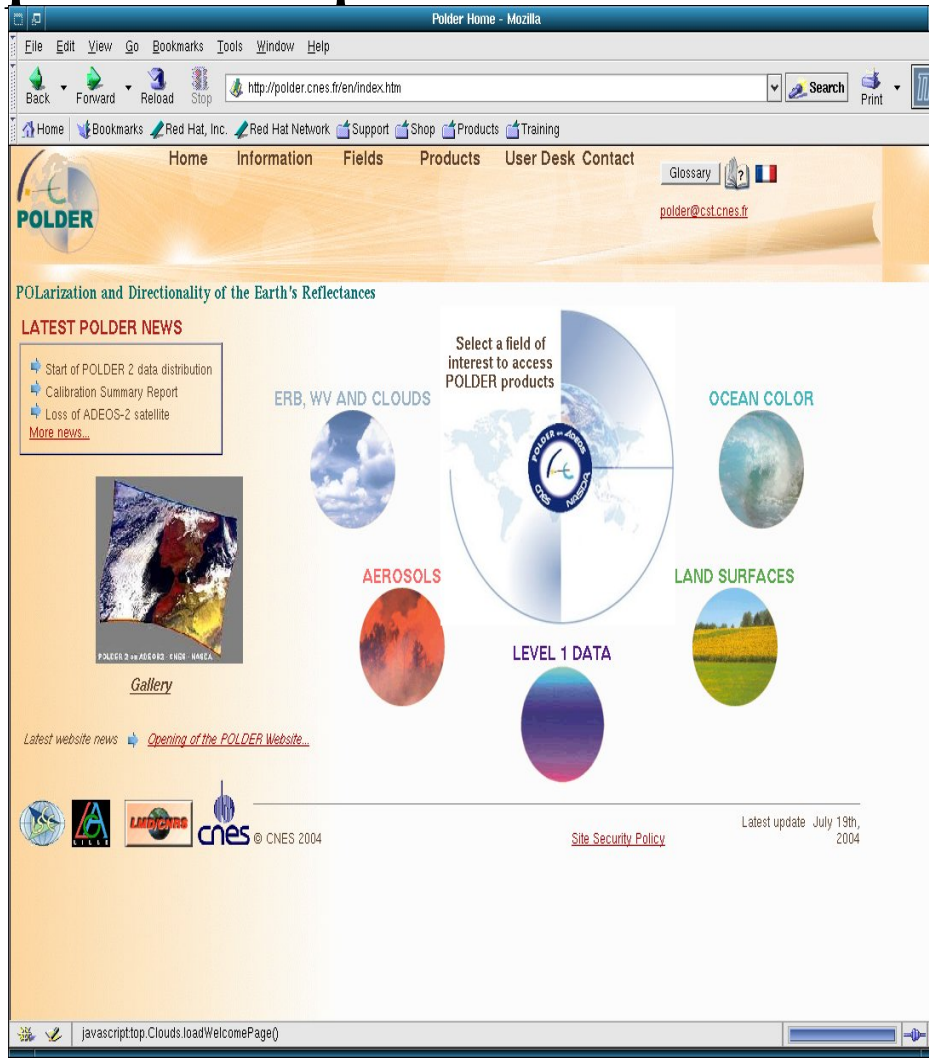
Level1 : calibrated georeferenced data
Level2 : daily products – one file per orbit swath
Level3 : monthly products
Joint Atmosphere product (selected daily and monthly products)

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

ata format and Tools

Mpol

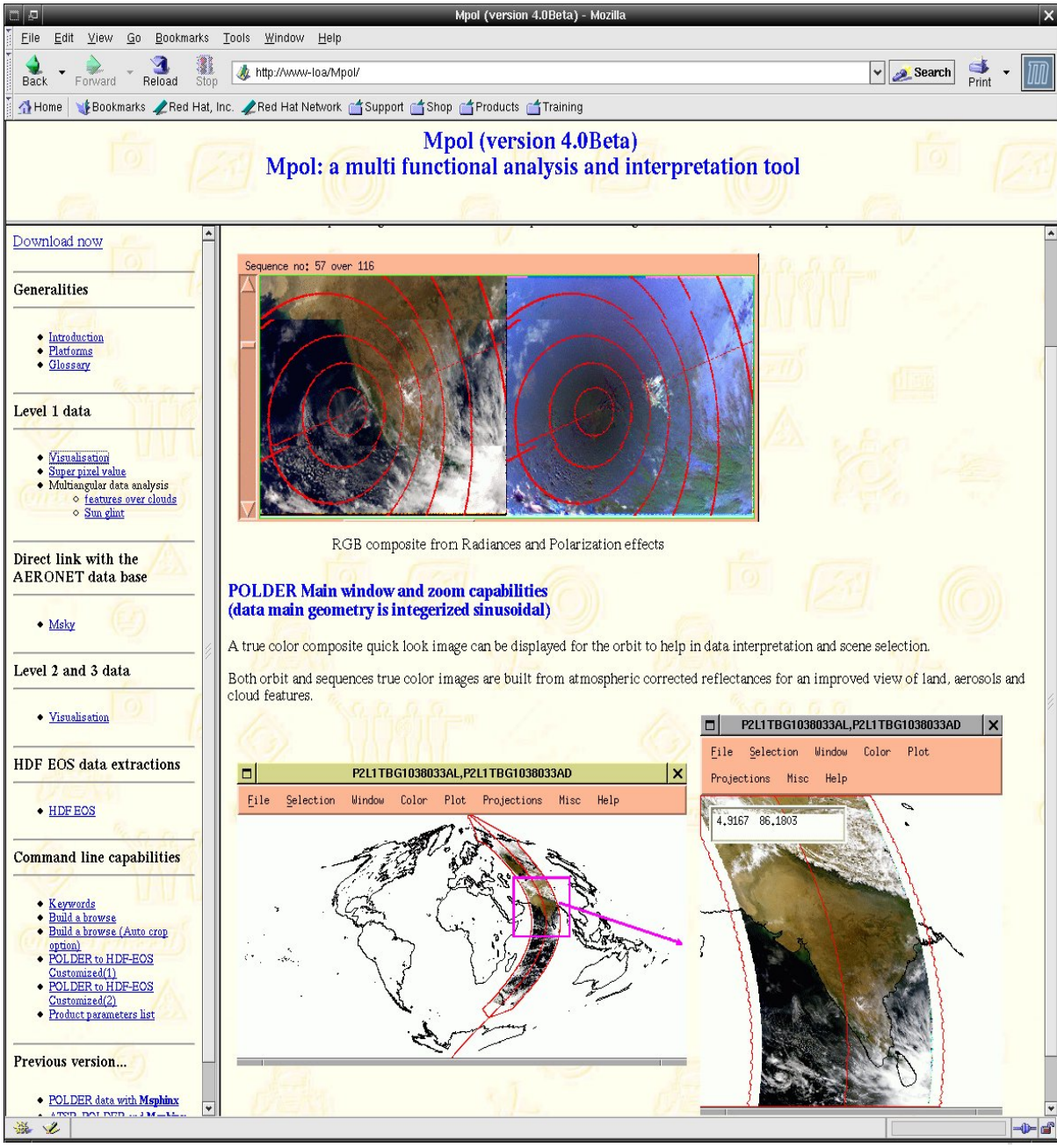
Visualize/Extract data from POLDER file (binary format)

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



onclusions / 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