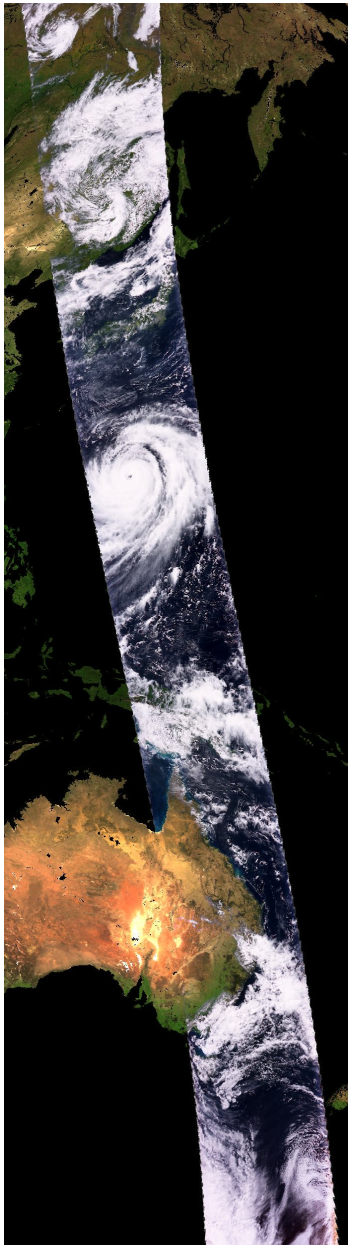


Aqua/MODIS and Parasol/POLDER3 Observations of Clouds and Aerosols Properties

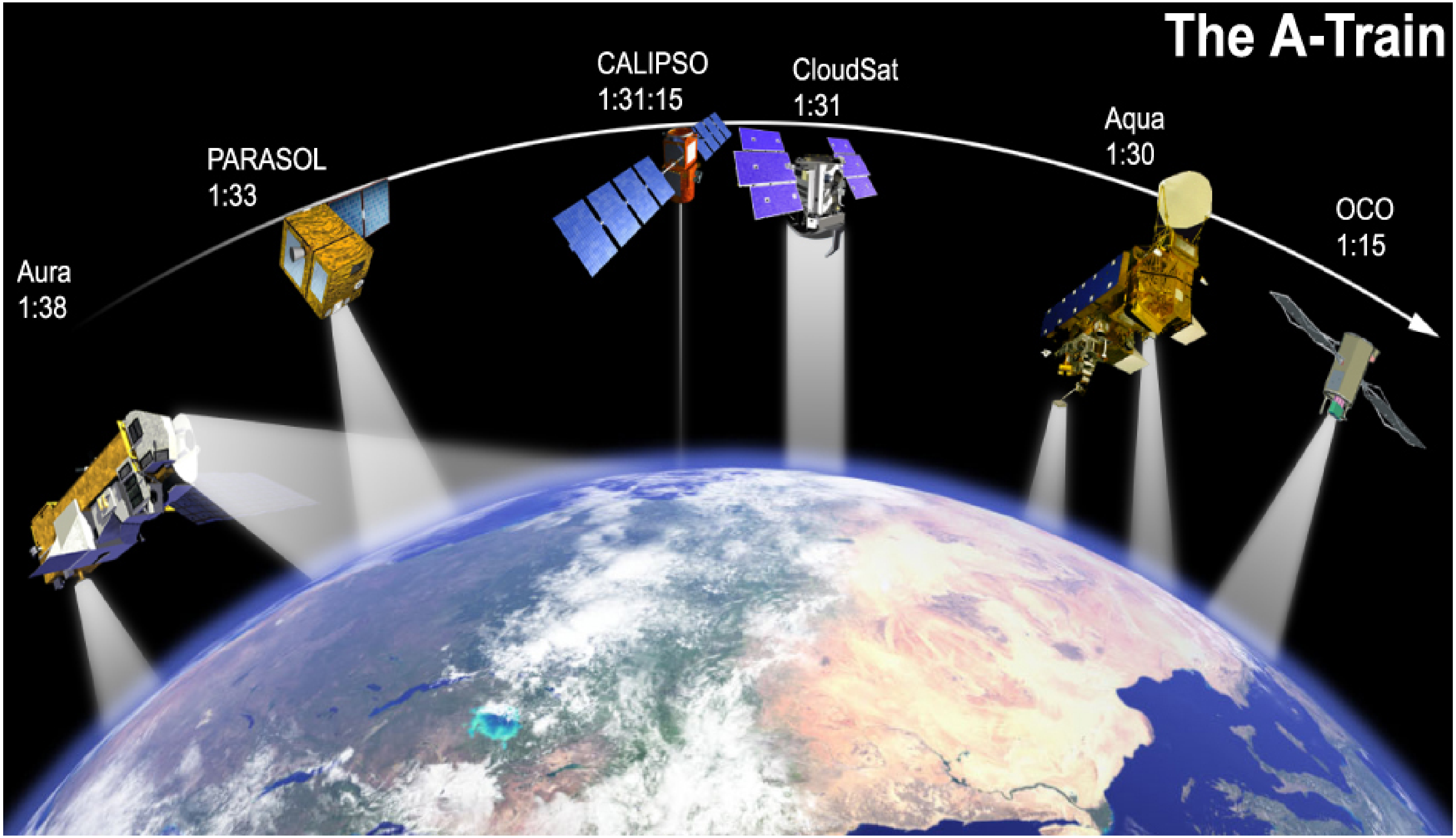
Jérôme Riédi, Didier Tanré, Frédéric Parol, Jean-Luc Deuzé
and the PARASOL science team.

Laboratoire d'Optique Atmosphérique, USTL, Lille, France

OUTLINE

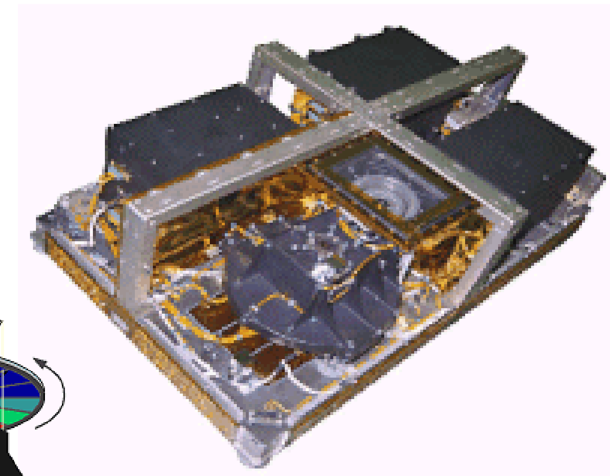
Context
Contribution from POLDER/Parasol
Instruments synergy
Data and products availability

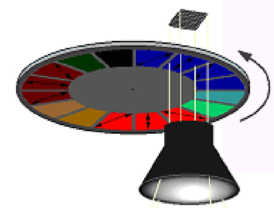
Context

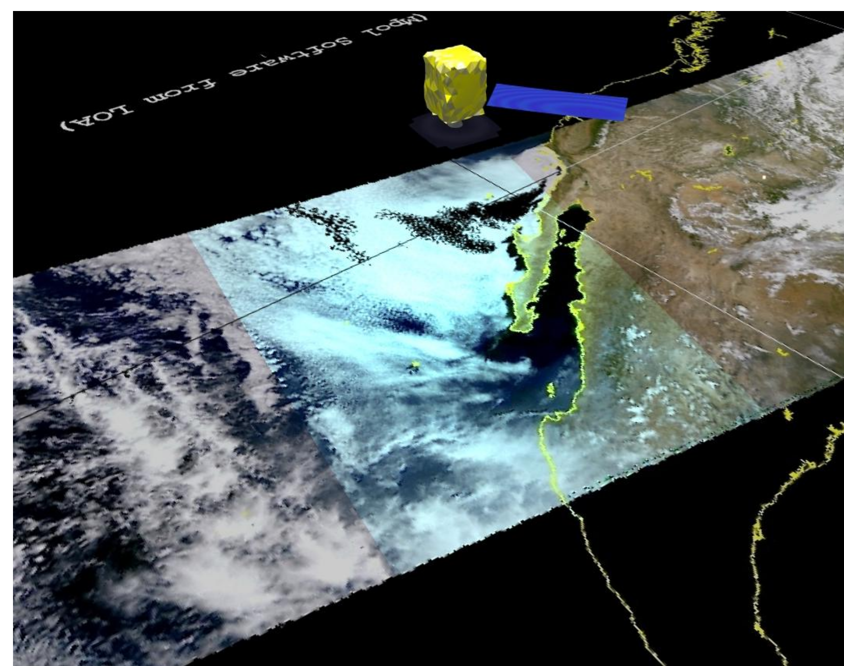

The A-Train
Aura
1:38
PARASOL
1:33
CALIPSO
1:31:15
CloudSat
1:31
Aqua
1:30
OCO
1:15

Instrumental Background : POLDER

- CNES/LOA instrument, Parasol launched Dec. 2004
  - ~ 705 km polar orbits, ascending (13:30 a.m.)
- Sensor Characteristics
  - 10 spectral bands ranging from 0.443 to 1.020 µm
  - 3 polarised channels
  - Wide FOV CCD Camera with 1800 km swath width
  - +/- 43 degrees cross track
  - +/- 51degrees along track
  - Multidirectionnal observations (up to 16 directions)
  - Spatial resolution : 6x7 km
  - No onboard calibration system - Inflight vicarious calibration :
    - 2-3% absolute calibration accuracy
    - 1% interband – 0.1% interpixel over clouds

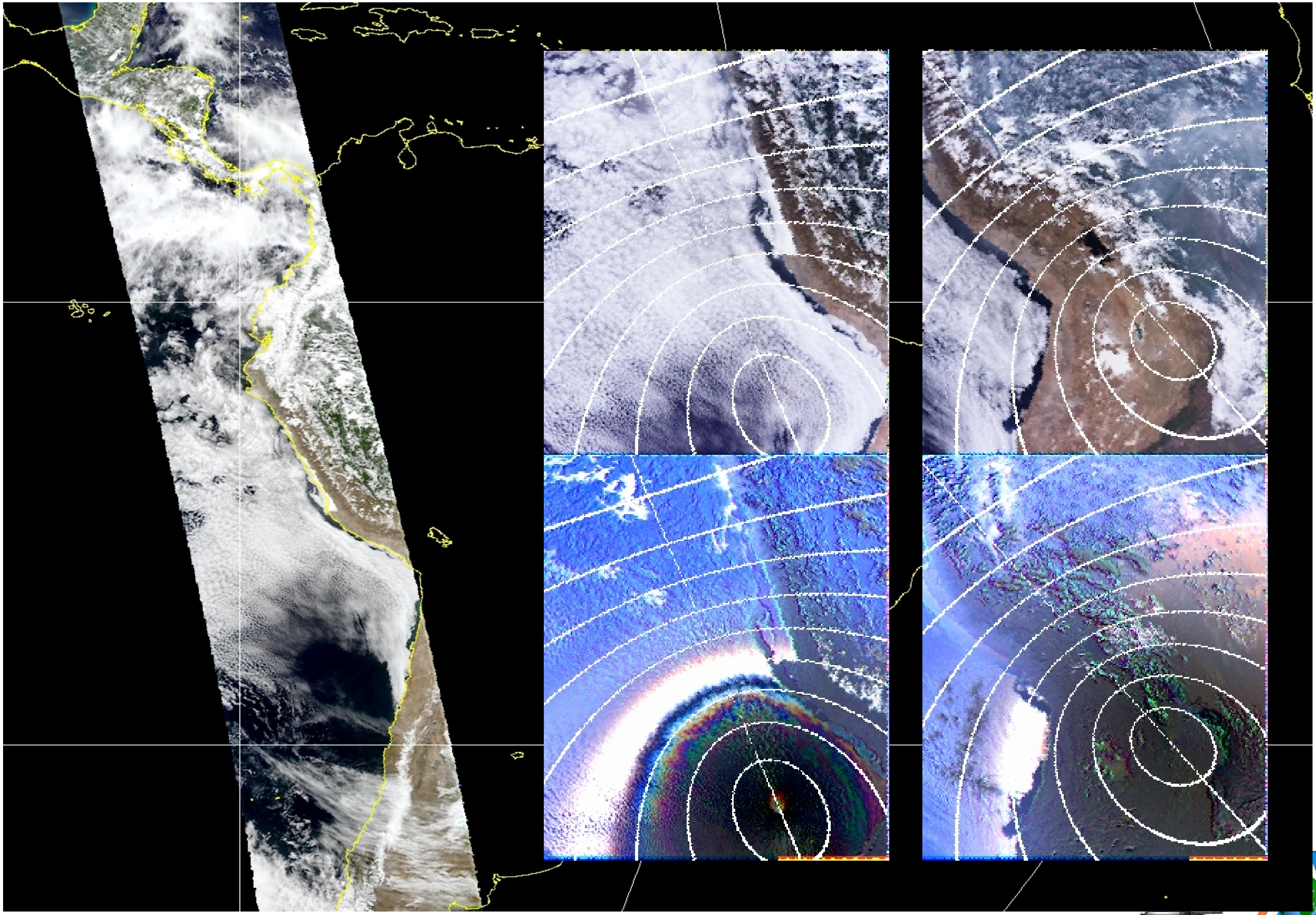






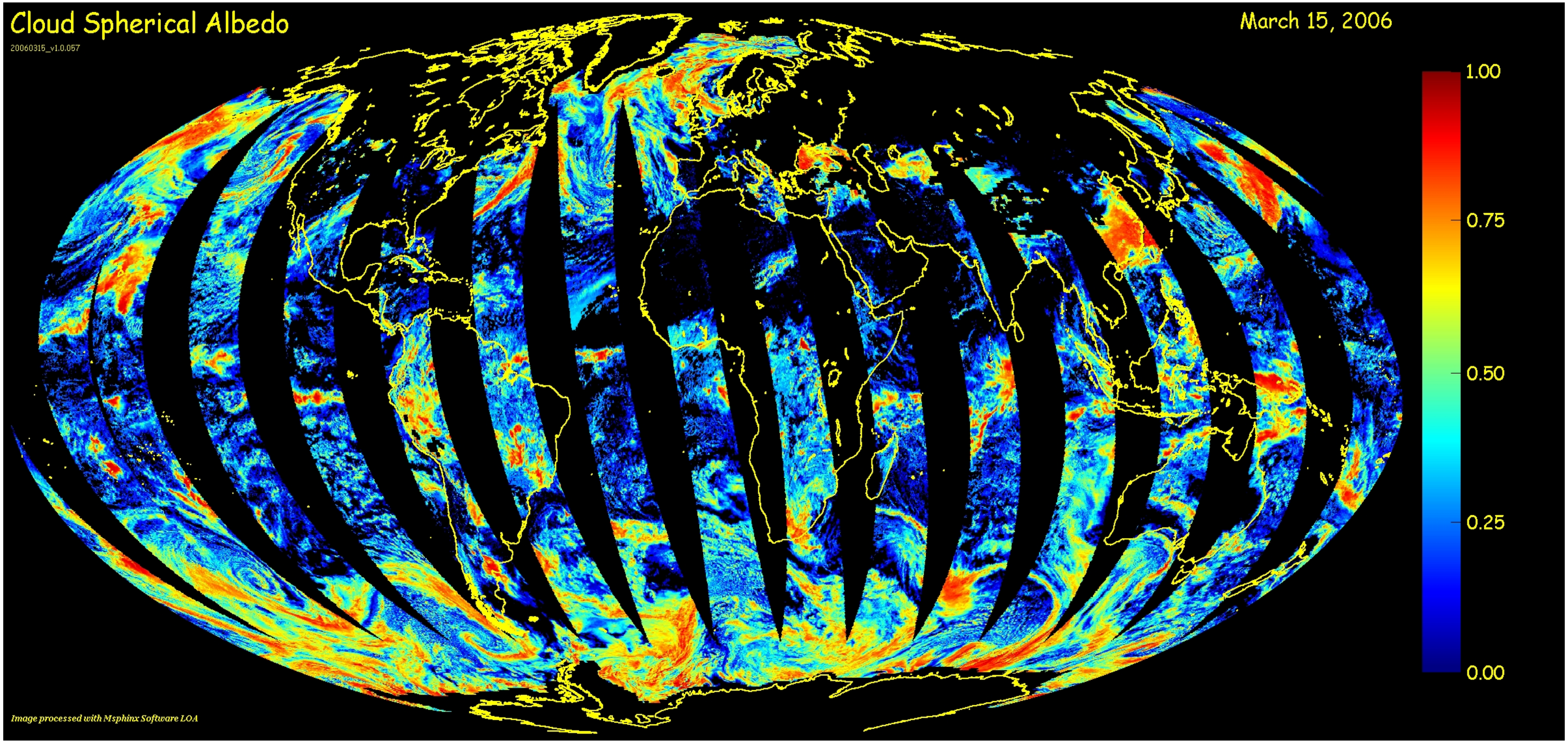
Contribution of POLDER/PARASOL to the A-Train

1.5 year of POLDER3/Parasol data already available



Contribution of POLDER/Parasol to the A-Train

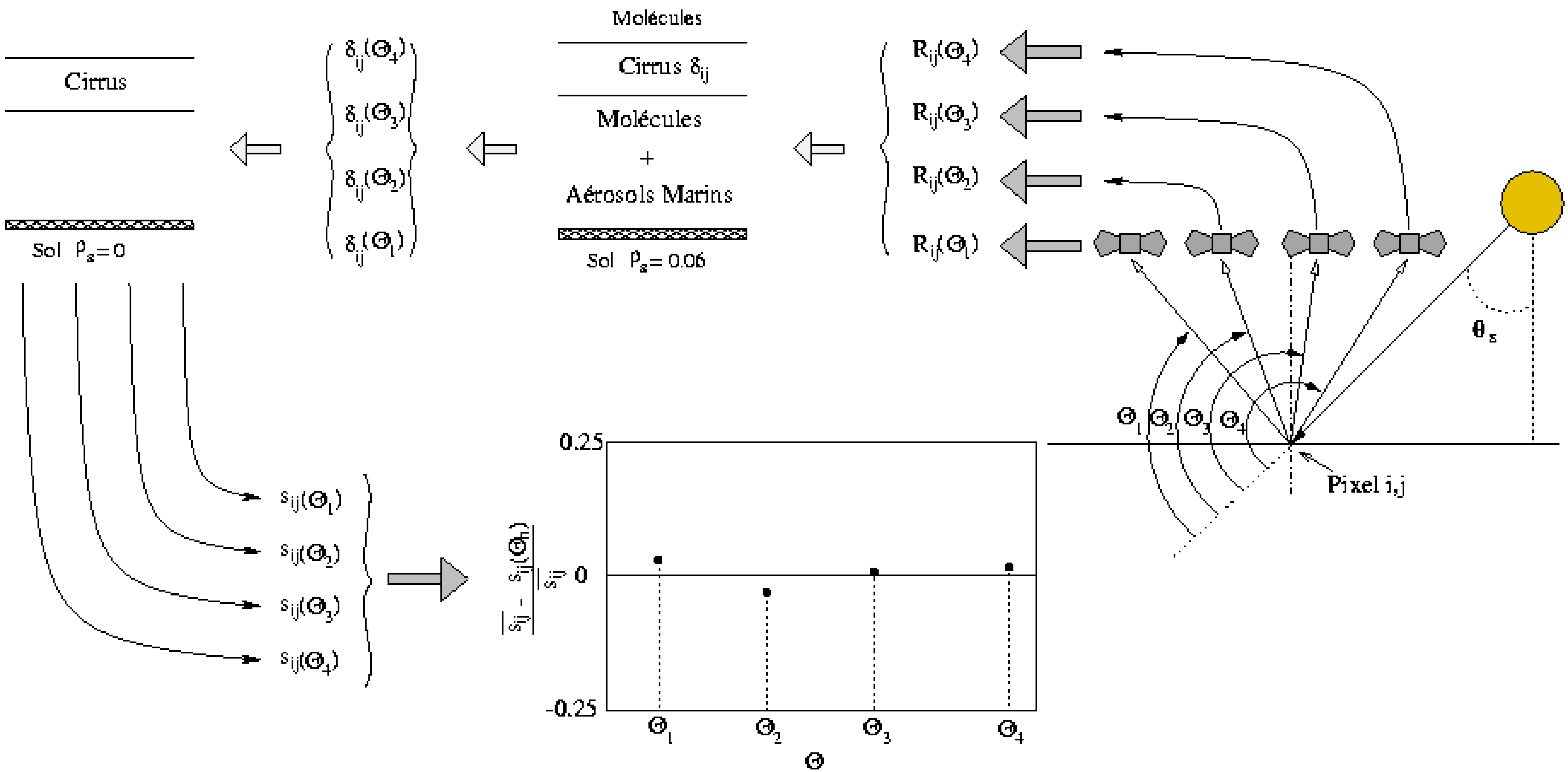
Benefits from multiangle observations : Application for clouds



Cloud spherical albedo is retrieved under up to 16 directions

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

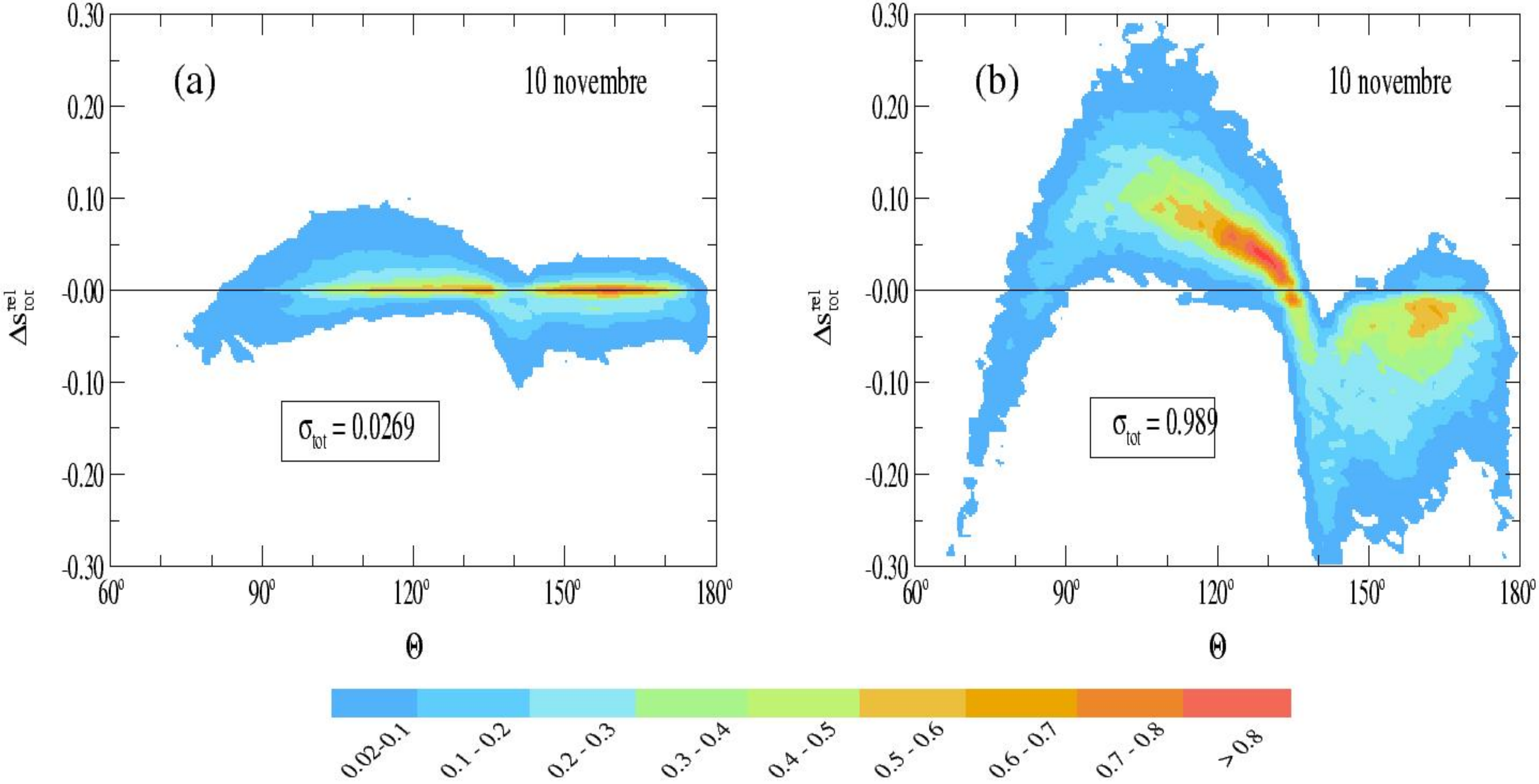
Testing cloud models from multiangle observation



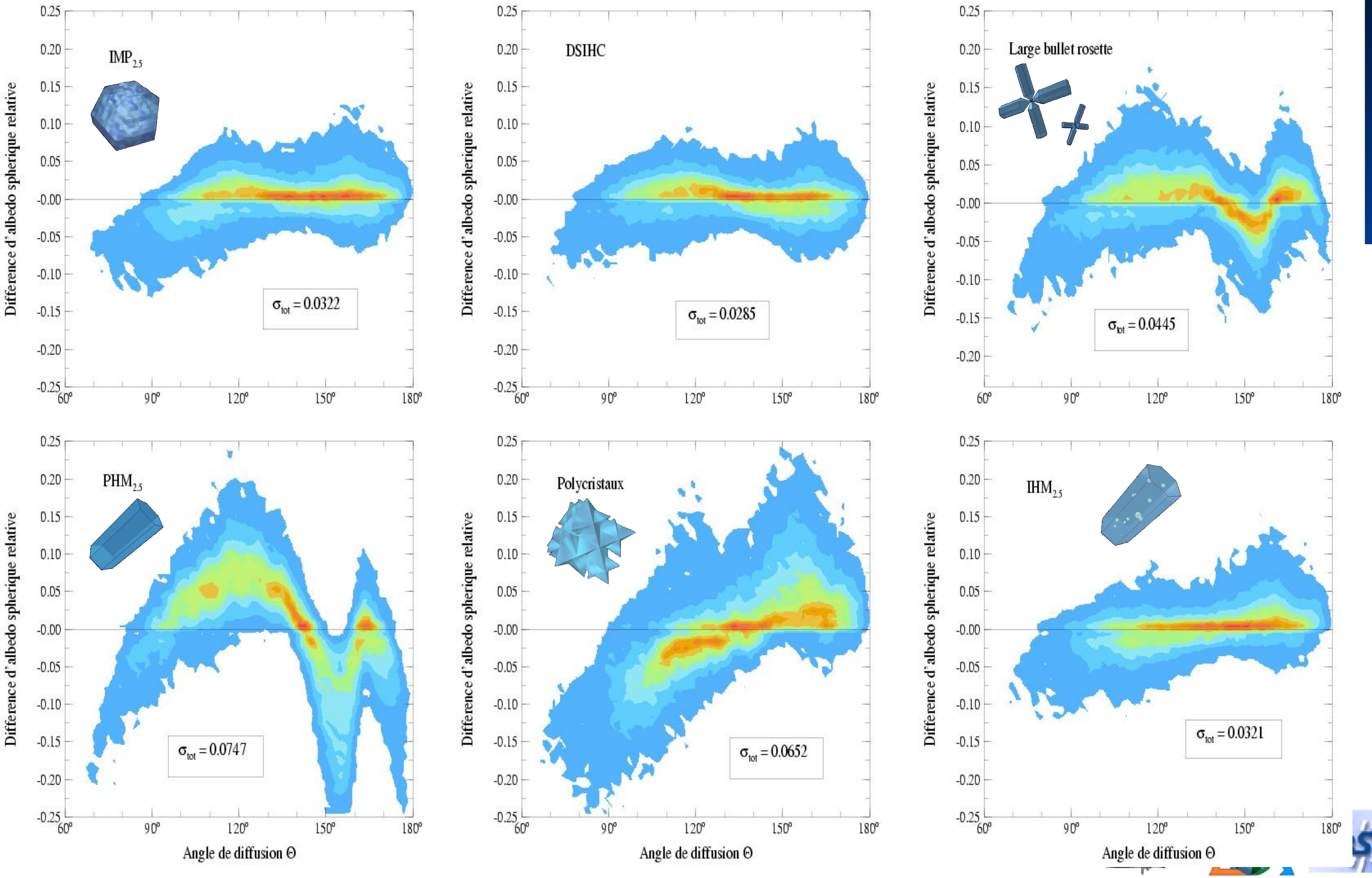
Testing cloud models from multiangle observation

Sphere used for liquid clouds

Sphere used for ice clouds



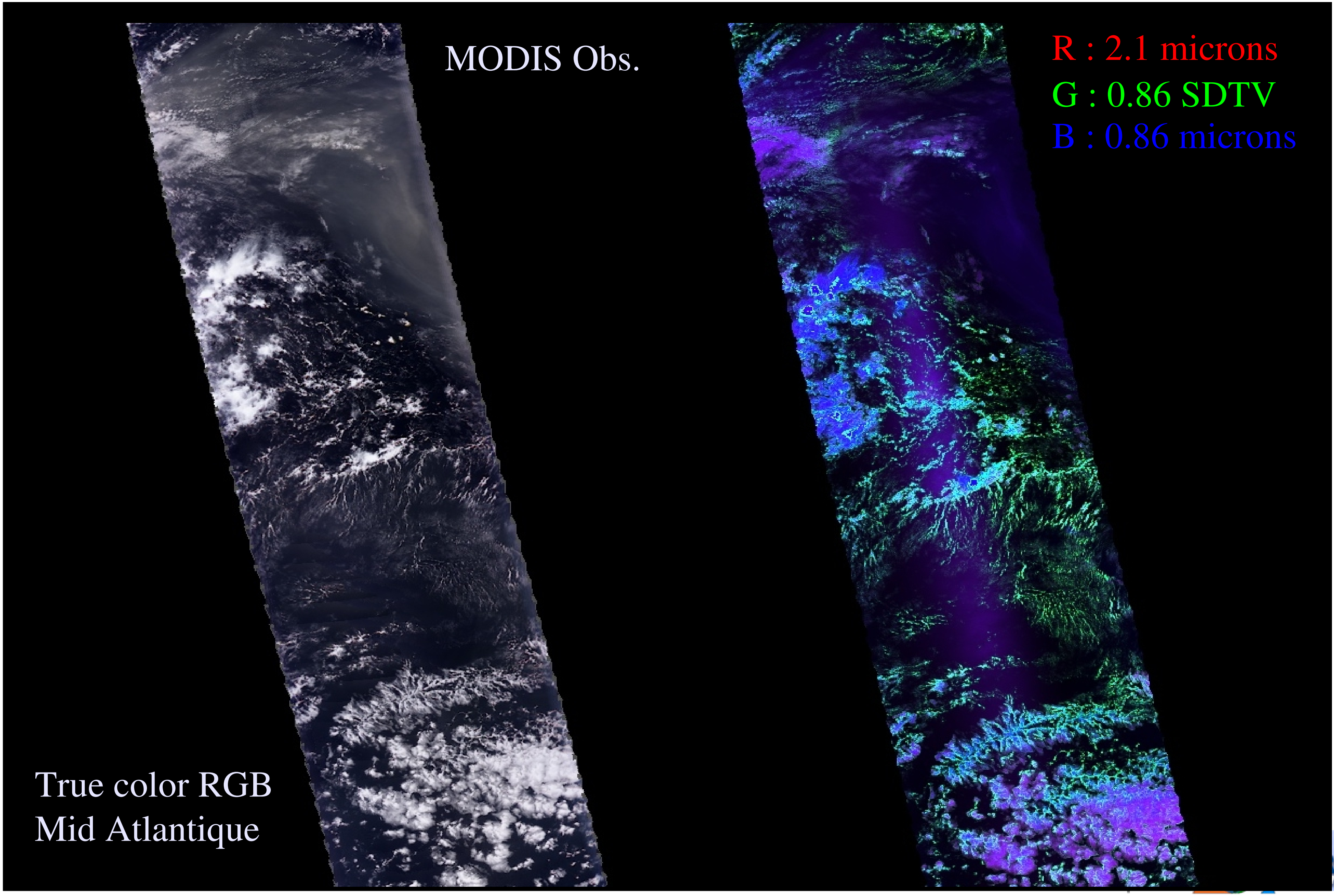
Testing cloud models from multiangle observation



But ... We have many other potential culprit for deviation from Plane Parallel Model

MODIS can help in removing or detecting effects from particle size, subpixel variability, etc...

Detection of small broken clouds / pixel heterogeneity within Parasol FOV



Contribution of POLDER/Parasol to the A-Train

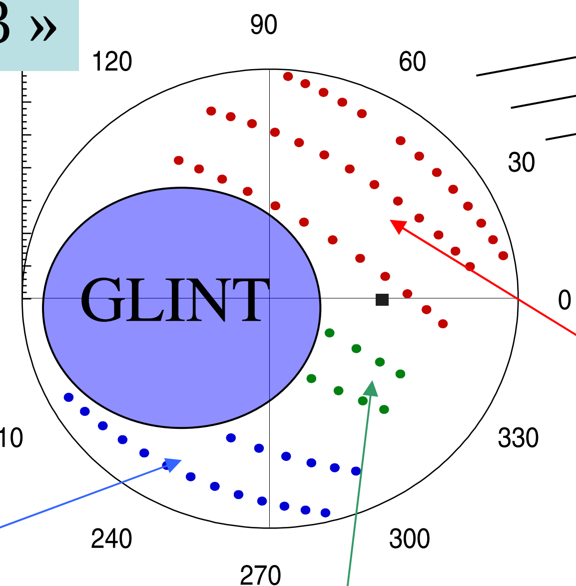
Benefits from multiangle observations : Application for aerosols

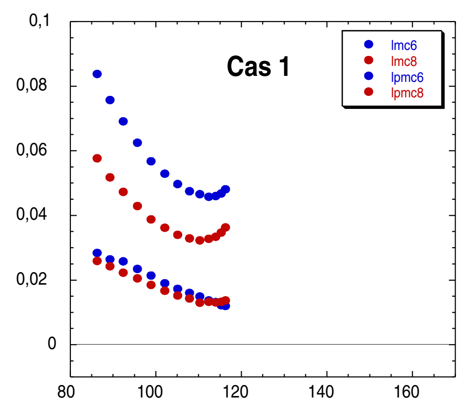
Over Ocean « Cases 1-2-3 »

13 views of the same target

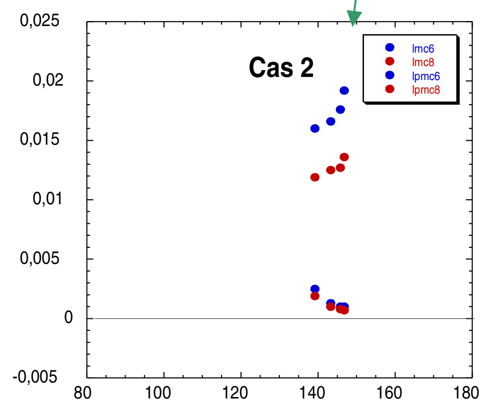
West

East

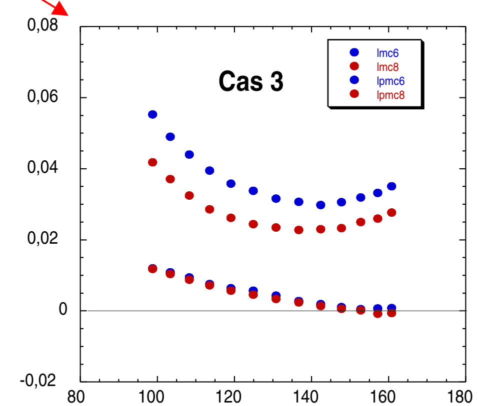




$\delta, \delta_{Acc}, r_{Acc}, m_{Acc}, \alpha$



$\delta, \delta_{Acc}, \alpha$



$\delta, \delta_{Acc}, r_{Acc}, m_{Acc}, m_{coarse}, \alpha$

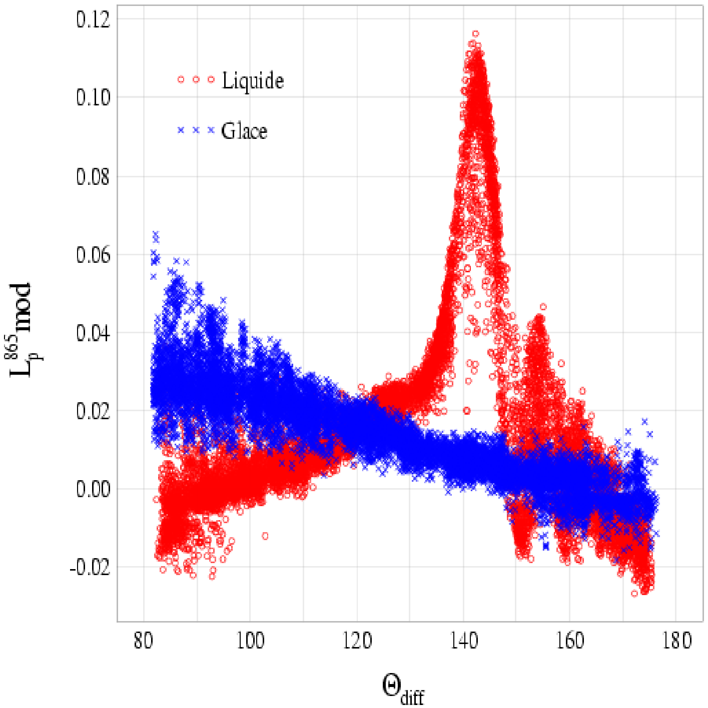
$NSI = \delta_{ns}/(\delta_{cs}+\delta_{cns})$

(Herman et al., J.G.R. 2005)

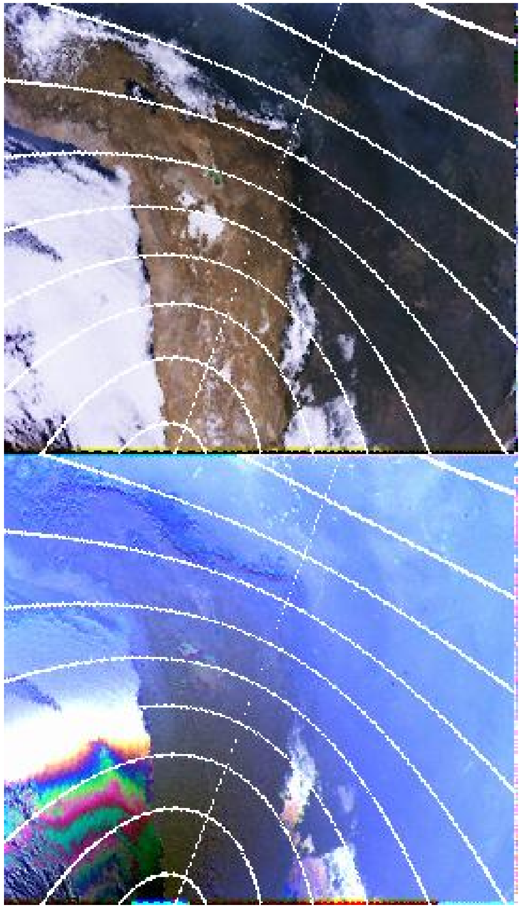
Contribution of POLDER/Parasol to the A-Train

Benefits from polarization observations : Application for clouds

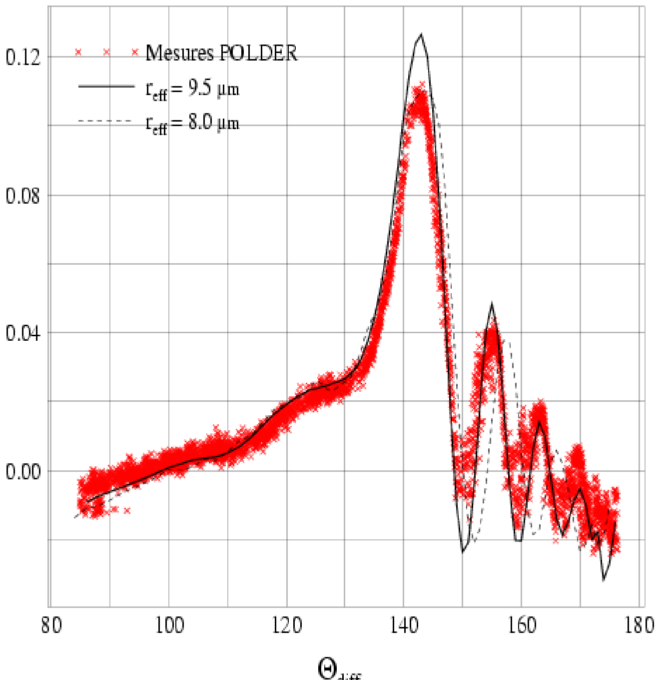
Cloud Phase



Riedi et al



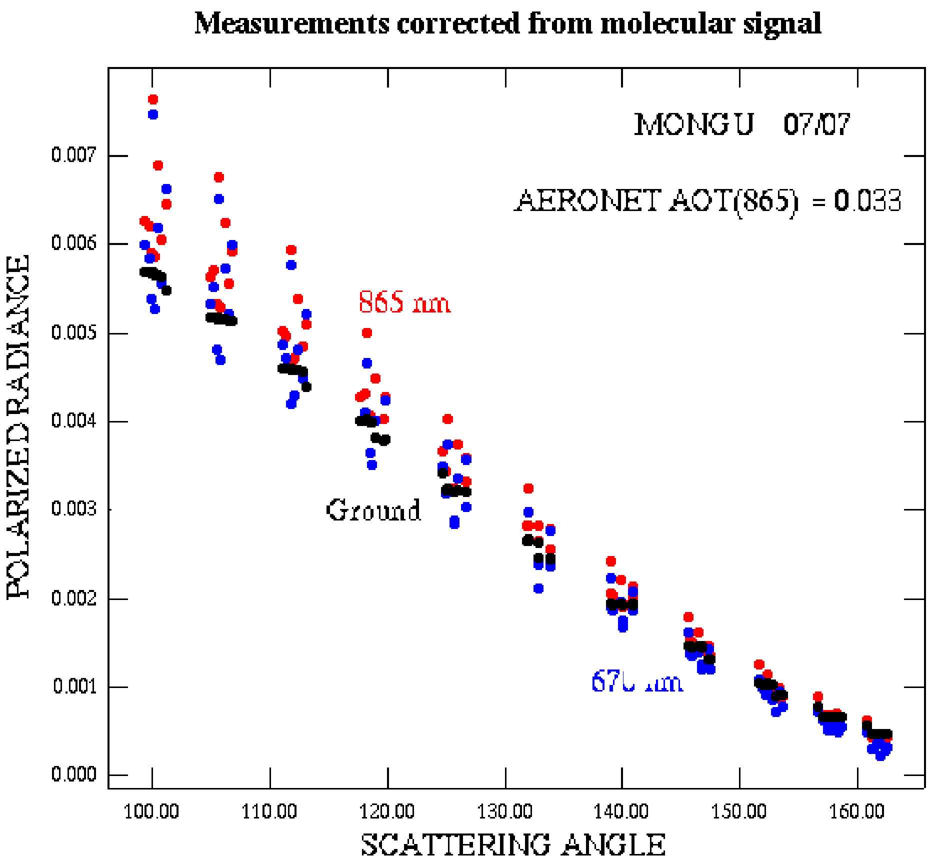
Cloud microphysics

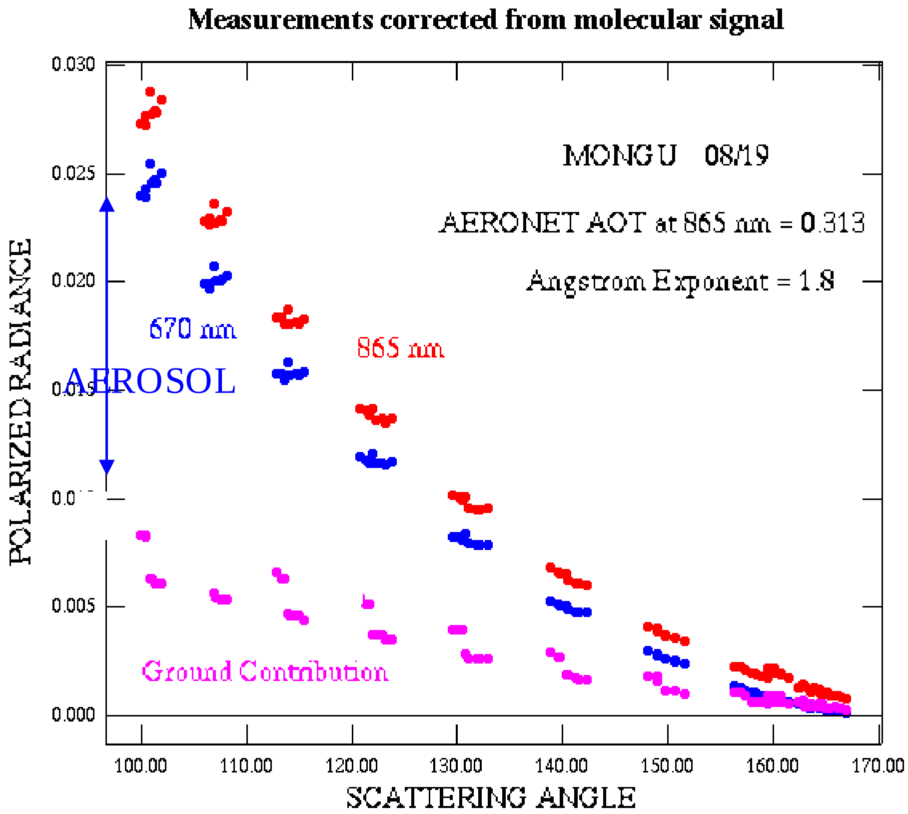


Bréon, Chepfer et al

Contribution of POLDER/Parasol to the A-Train

Benefits from polarization observations : Application for aerosols





Clear atmosphere (AOT=0.03) : the reflectance at TAO is close to the surface values

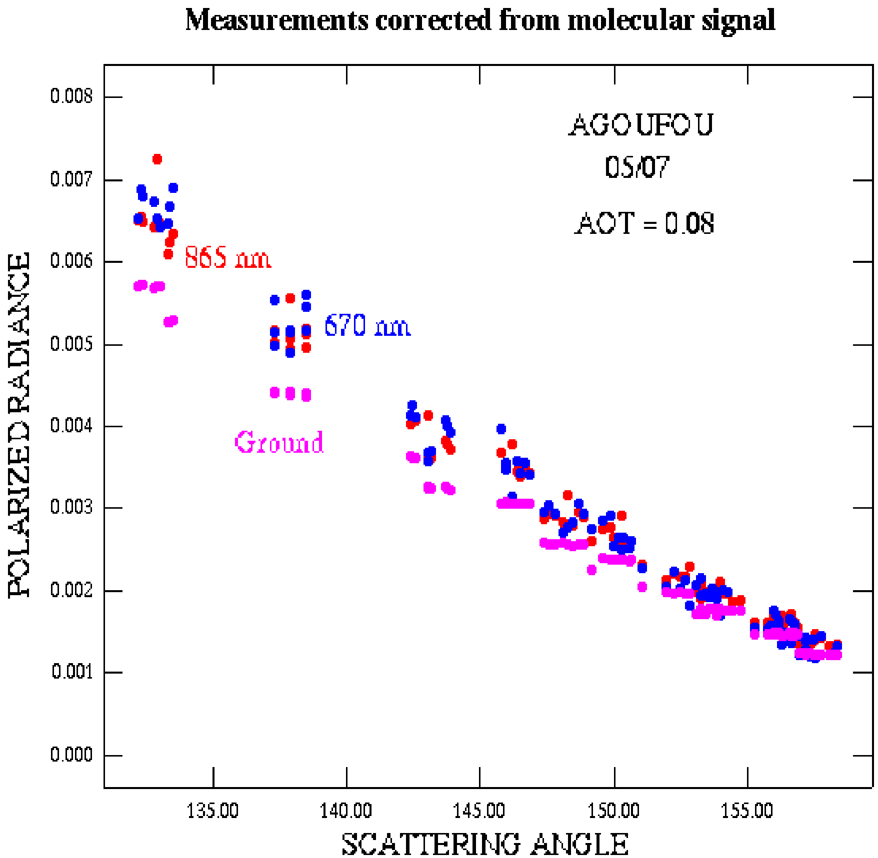
Hazy atmosphere (AOT=0.31) : large aerosol contribution

Illustration for Biomass Burning Aerosols (from POLDER2)

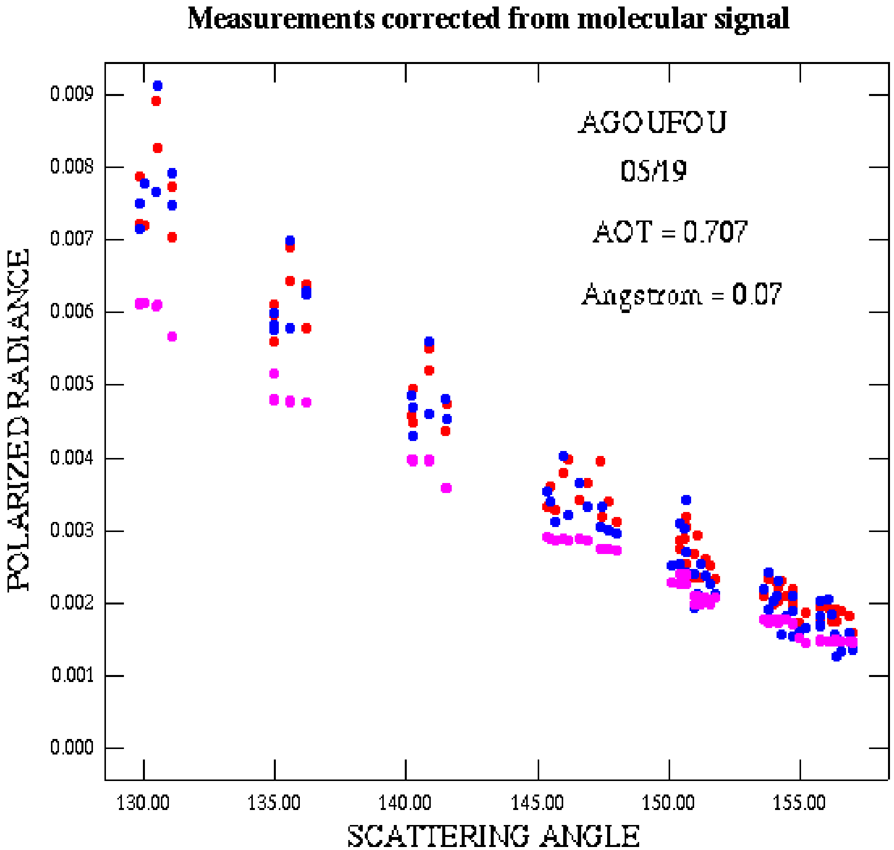
USTL

Contribution of POLDER/Parasol to the A-Train

Benefits from polarization observations : Application for aerosols



Clear atmosphere (AOT=0.08) : the reflectance at TAO is again close to the surface values



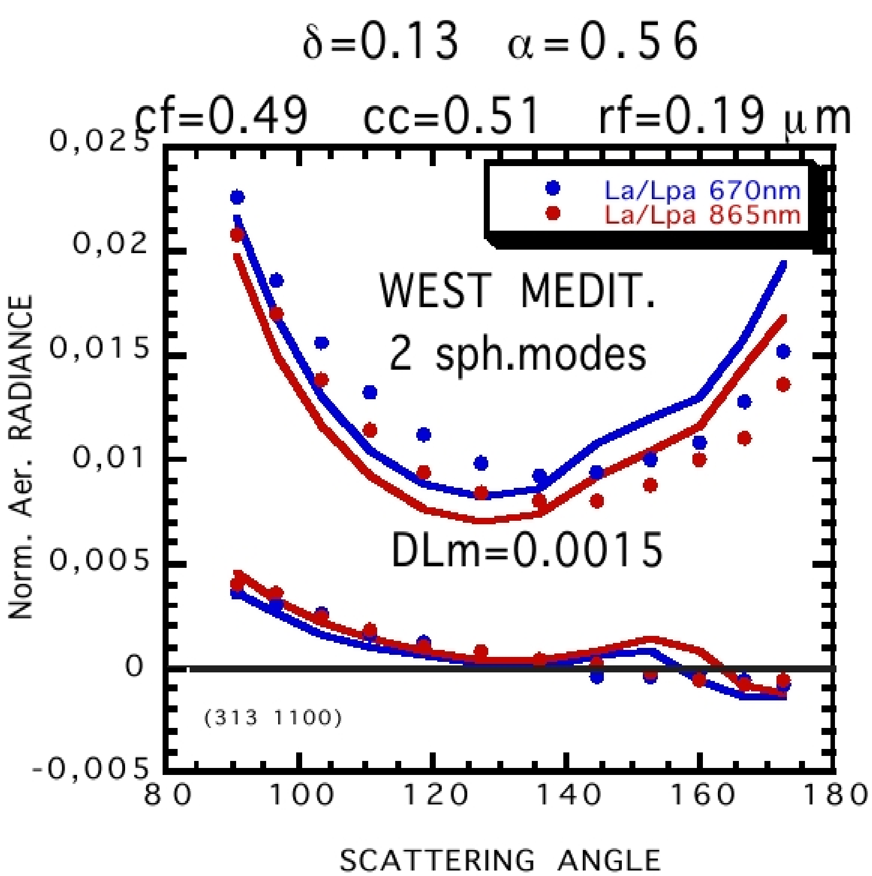
Hazy atmosphere (AOT=0.71) : no aerosol contribution

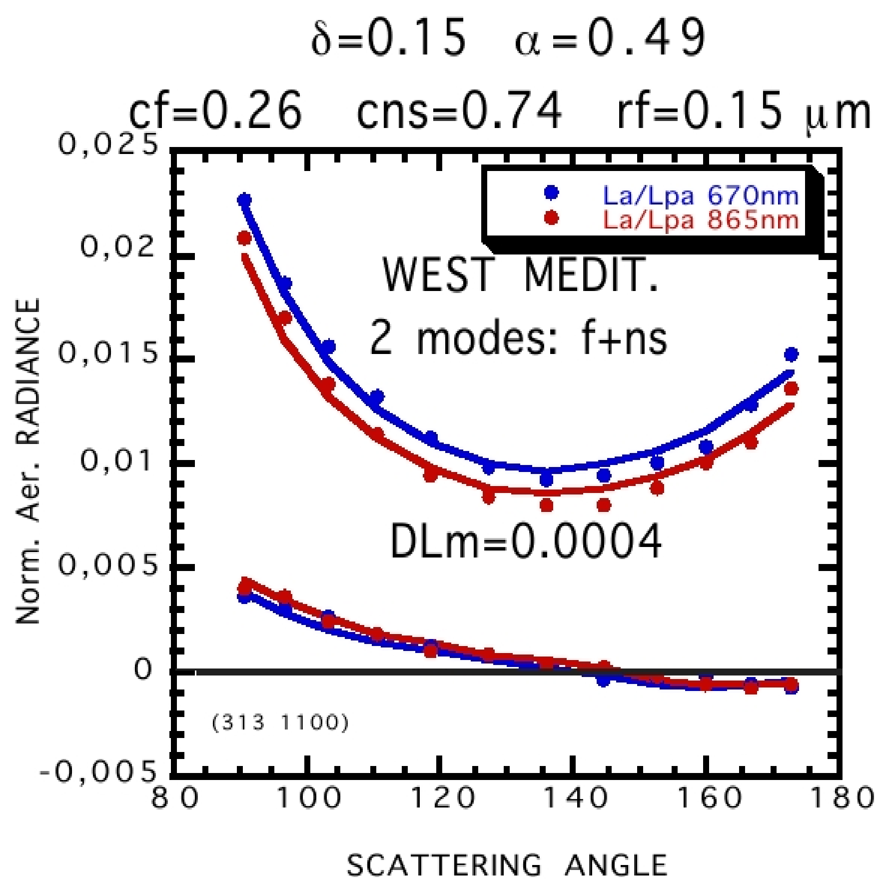
Illustration for Desert Aerosols (POLDER2)

Contribution of POLDER/Parasol to the A-Train

Benefits from polarization observations : Application for aerosols

Discrimination between spherical and non-spherical aerosols





Deuzé, Herman et al

Potential Synergy for Clouds

Cloud detection

Cloud detection can be tricky under many circumstances (heavy aerosol loading, glint, bright surfaces : desert, snow/ice)

Cloud layers height

Deriving multiple cloud top pressure (O2, Rayleigh, CO2 slicing, H20) to detect multilayer clouds and better describe vertical structure

Cloud thermodynamic phase

Combination of information on particle shape and absorption properties help

Improved cloud retrievals

ex : Using Size retrieval from MODIS to improve multidirectionnal OT retrievals from POLDER

Cloud Heterogeneities

Using MODIS 250m information to understand angular behavior in POLDER measurements and separate 3D effect from subpixel heterogeneities

Cloud thermodynamic phase

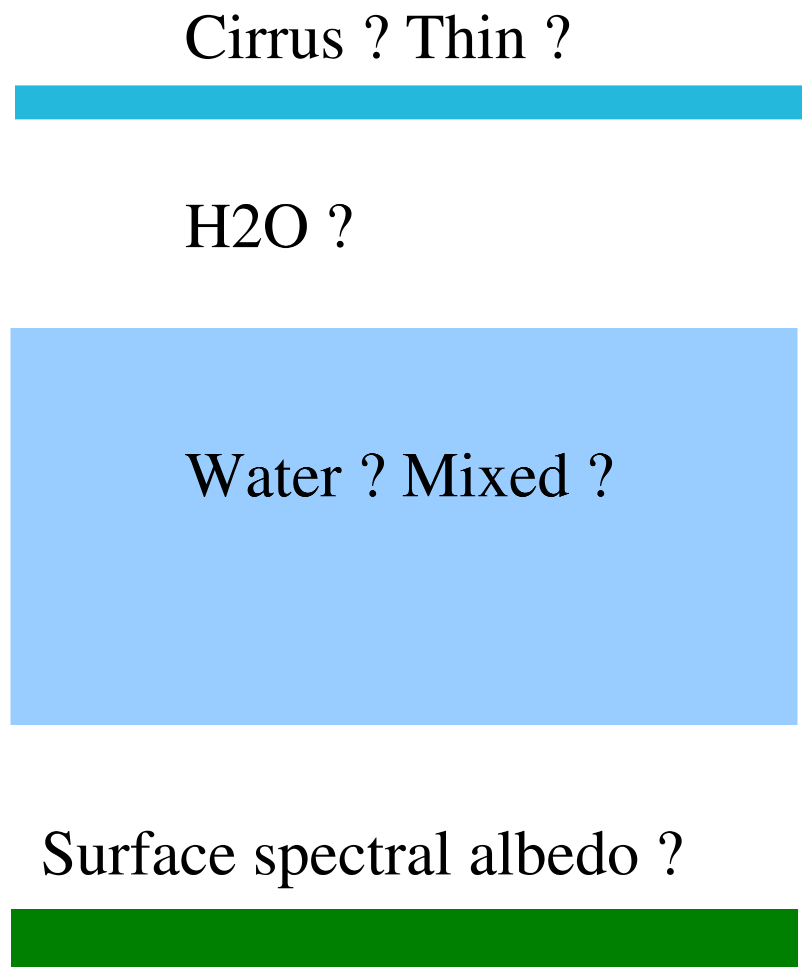
Combination of information on particle shape and absorption properties

Basis

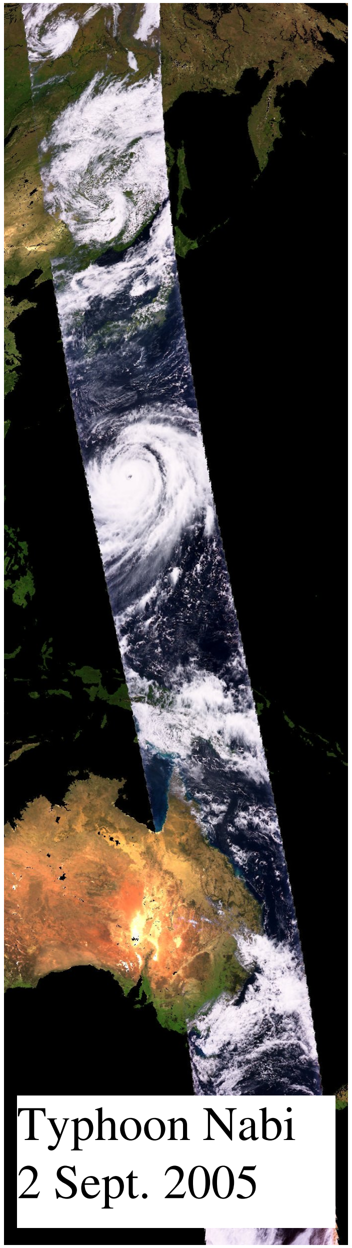
Polarization (Riedi et al)
mostly single scattering
sensitive to particle shape
Top of cloud but see through it if very thin

SWIR (Platnick et al)
Differential Water/Ice Absorption
sensitive to particle size
Some depth in the cloud

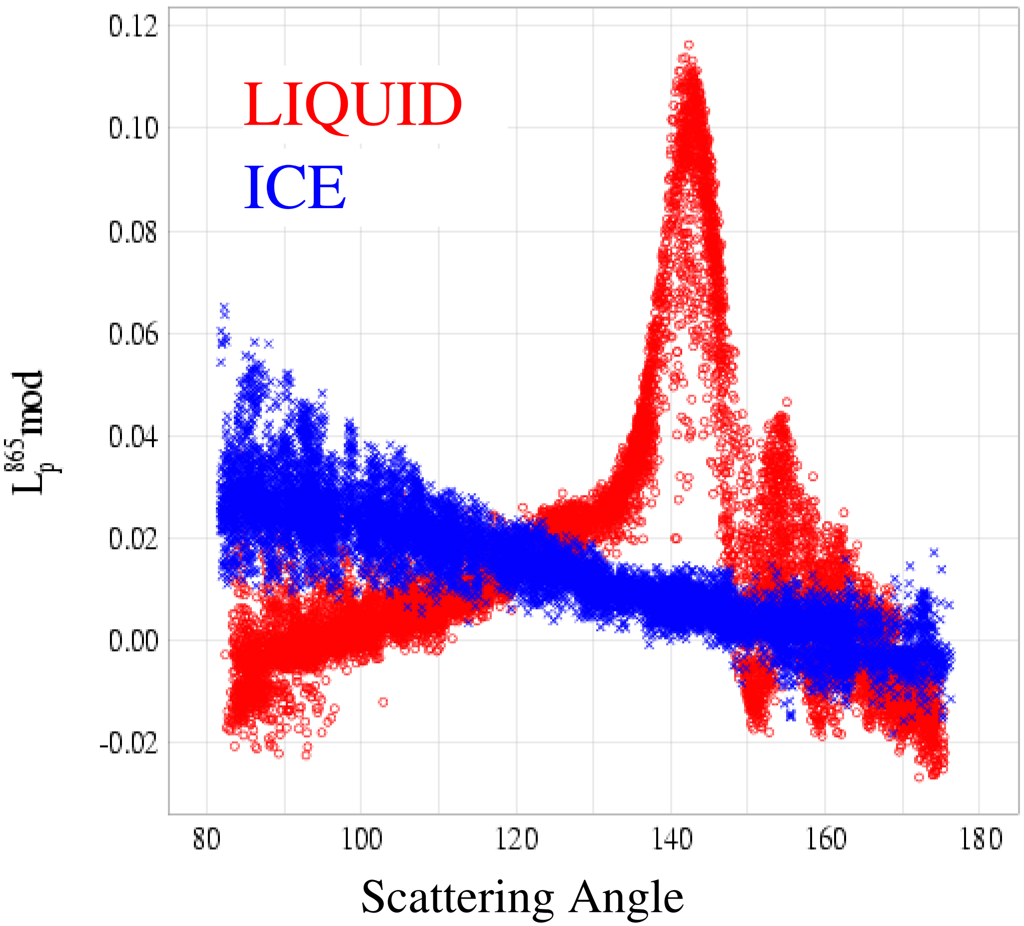
Thermal IR (Baum et al)
Diff. Water/Ice,
also sensitive to surf. emissivity, H_2O
Some depth in the cloud except thin cirrus

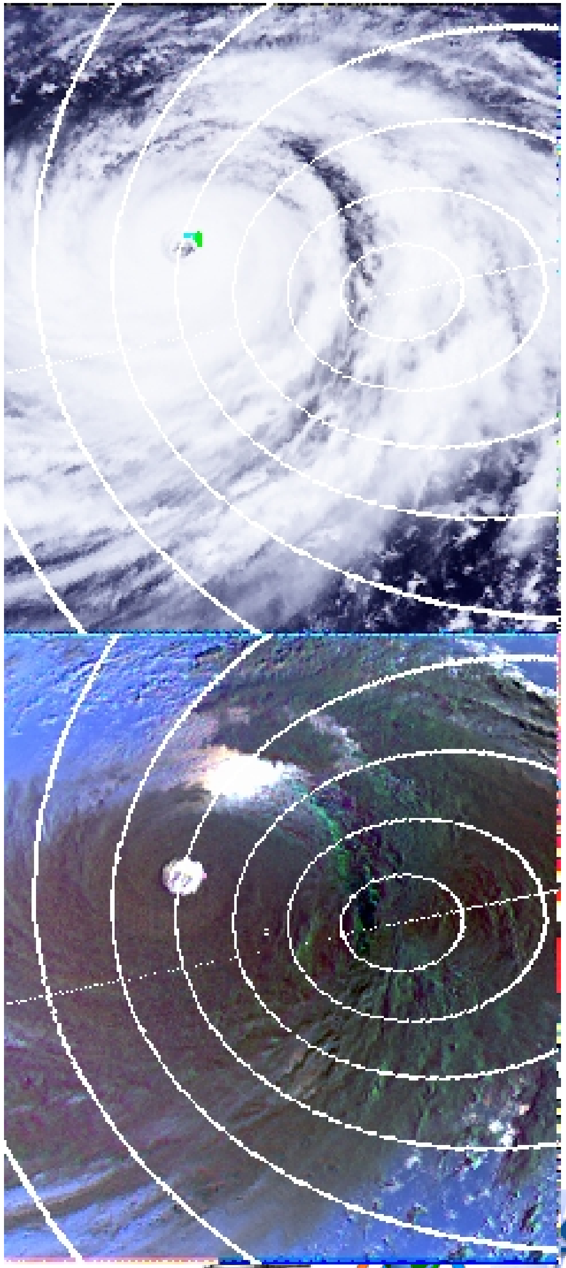


Cloud thermodynamic phase

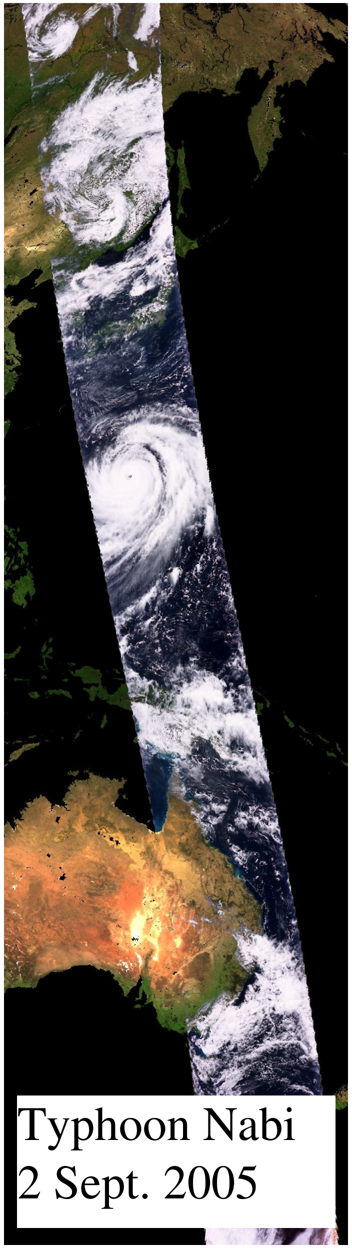


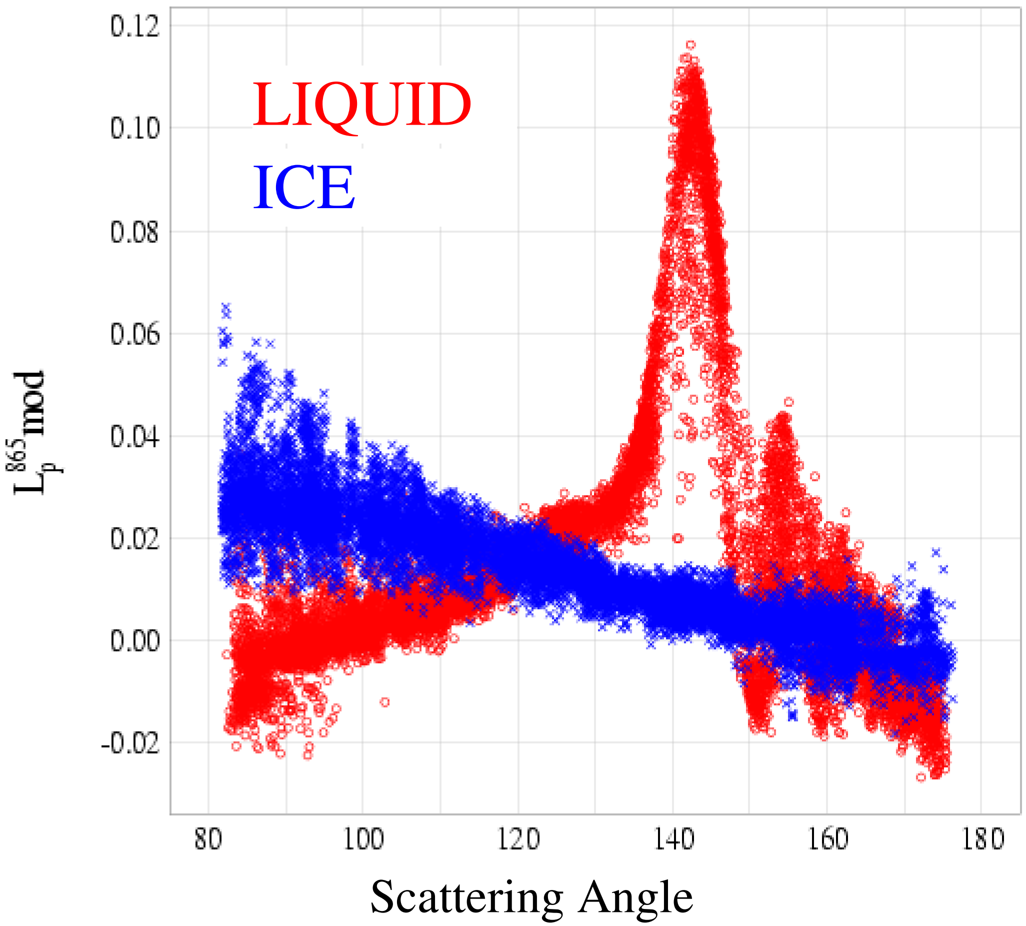
Typhoon Nabi
2 Sept. 2005

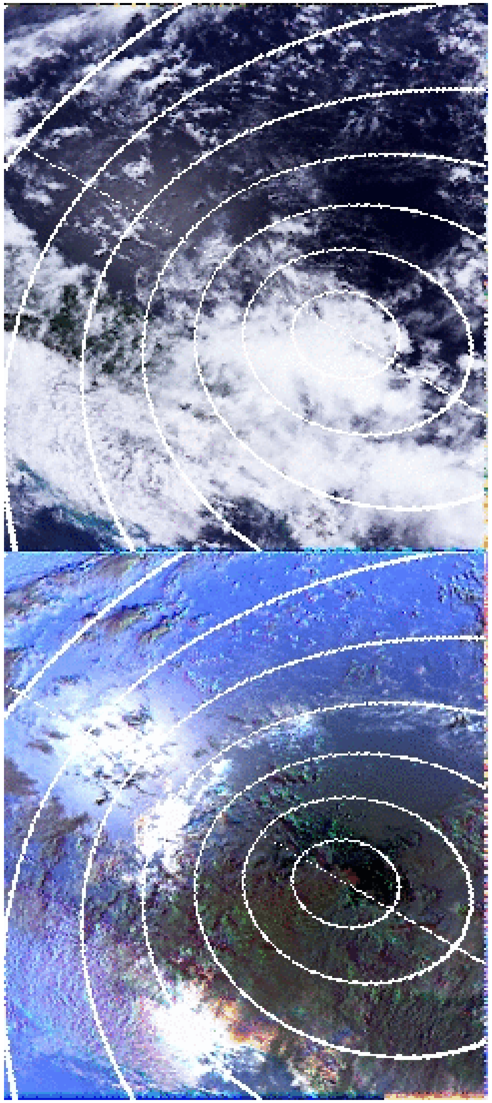




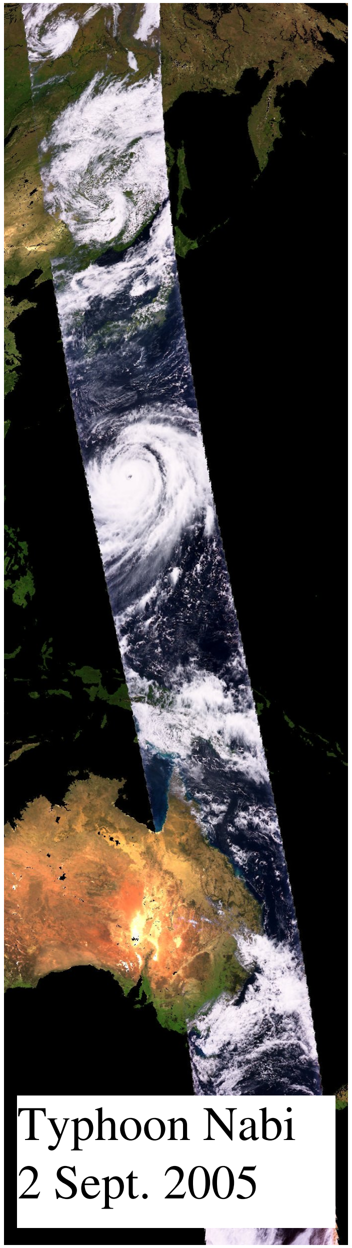
Cloud thermodynamic phase



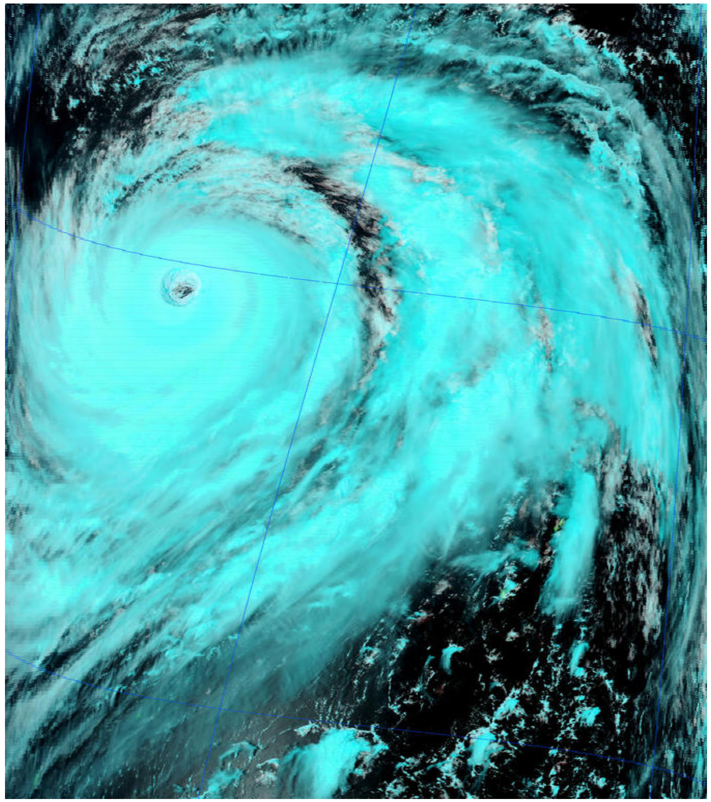




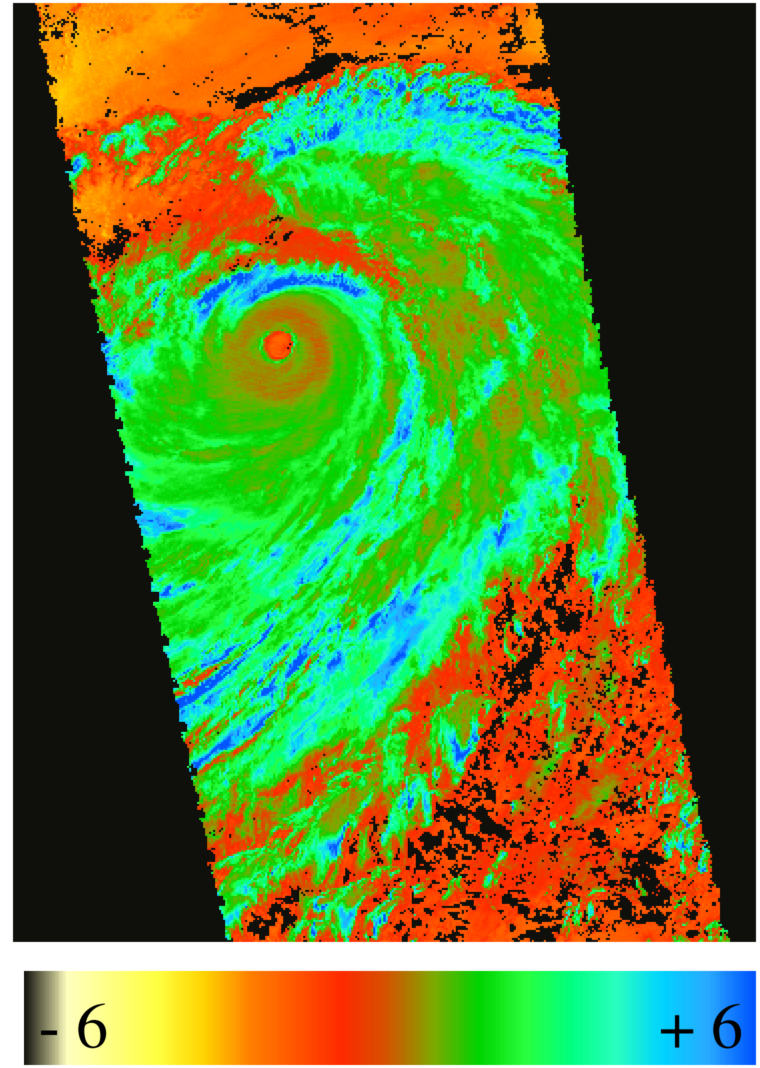
Cloud thermodynamic phase



Typhoon Nabi
2 Sept. 2005



SWIR + VIS
RGB Composite
(MODIS bands 1, 2 and 7)

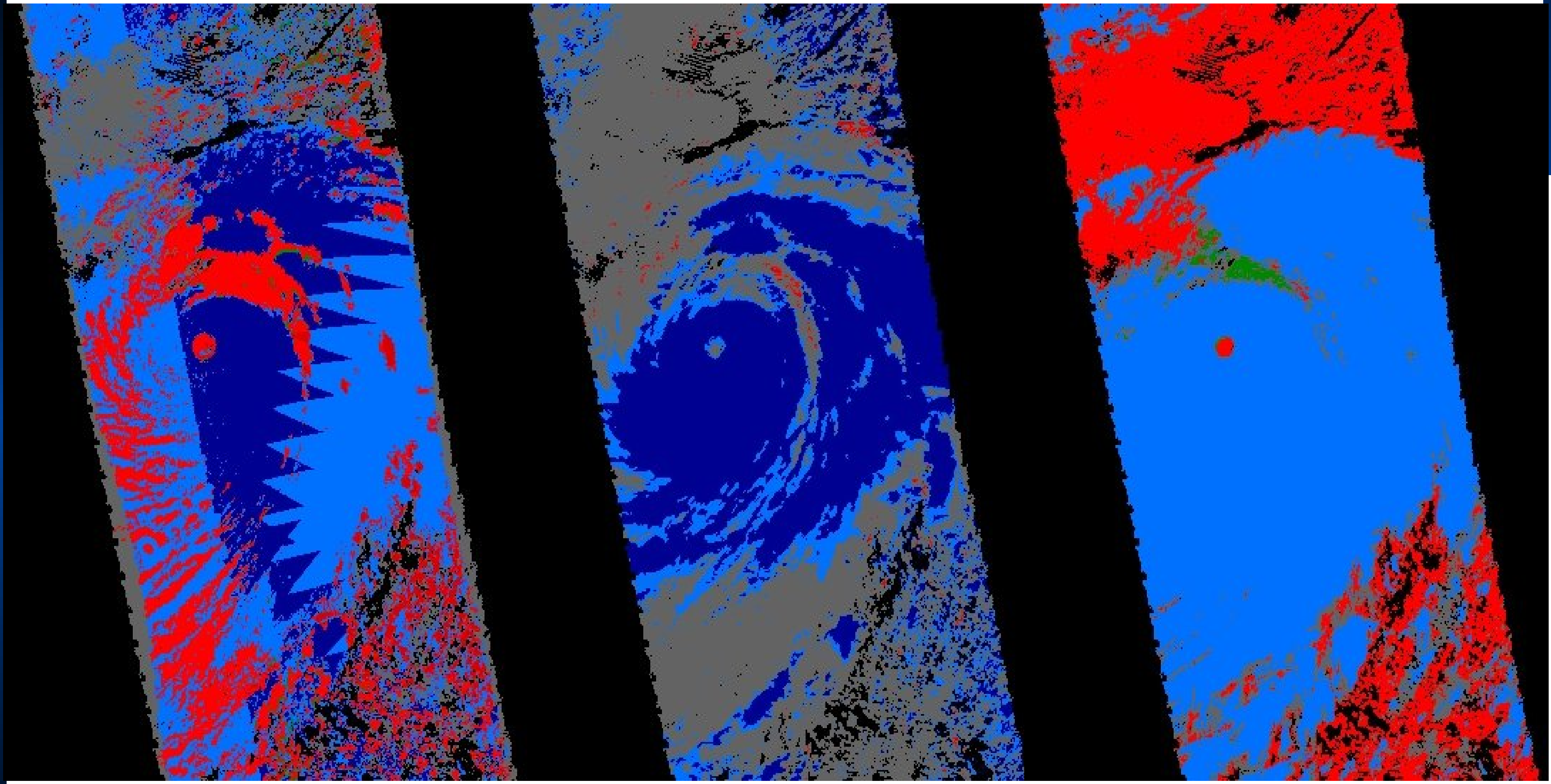


BTD 8 – 11 microns

Cloud thermodynamic phase

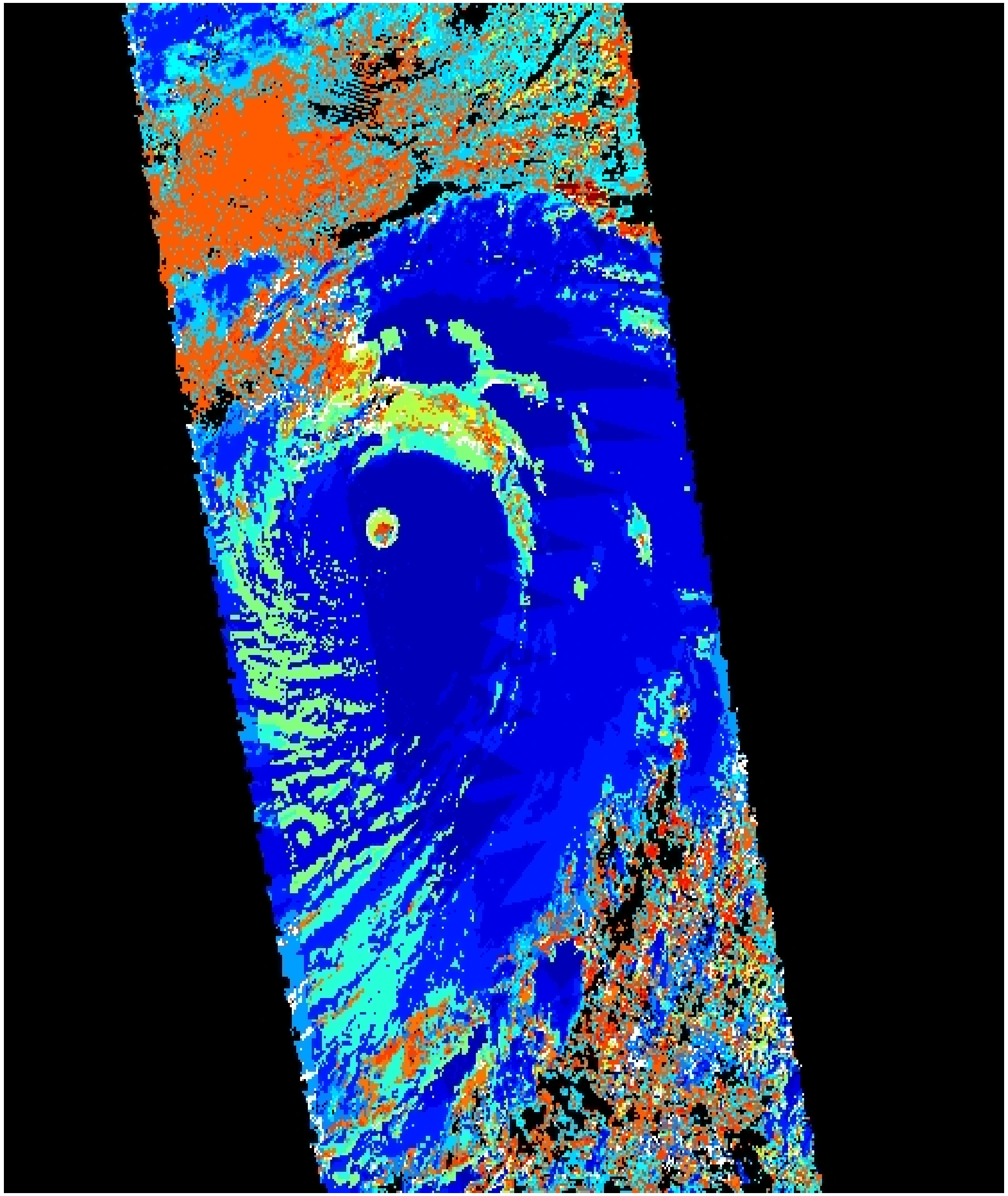
Combination of information on particle shape and absorption properties help

ICE UNKOWN LIQUID

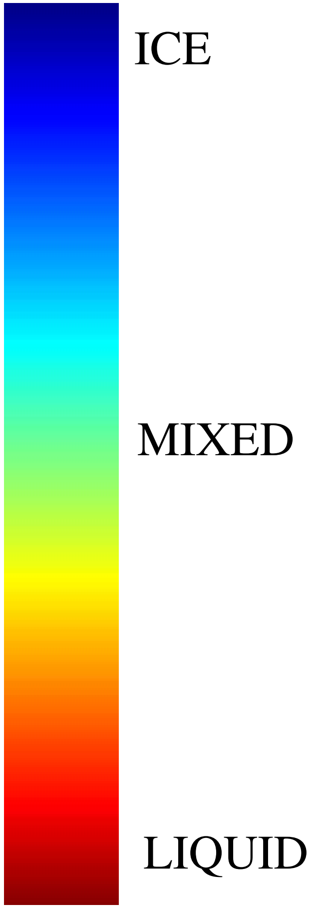


POLARIZATION SWIR/VIS Ratio IR Bispectral

Cloud thermodynamic phase



Results from the combined POLDER/MODIS phase algorithm

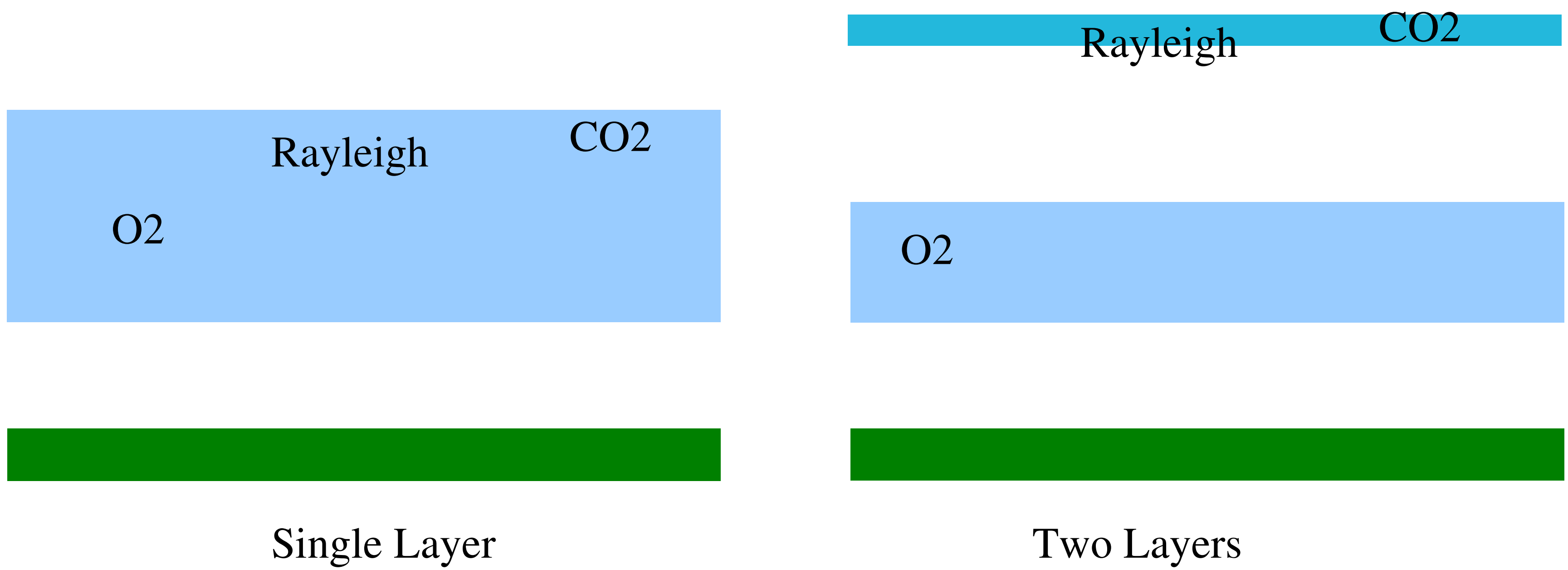


Cloud layers height

Deriving multiple cloud top pressure (O2, Rayleigh, CO2 slicing) to detect multilayer clouds and better describe vertical structure

Basis

We do expect differences in pressure due to resp. sensitivities and we also expect increasing differences in case of multilayer situations



O2 : Oxygen band differential absorption

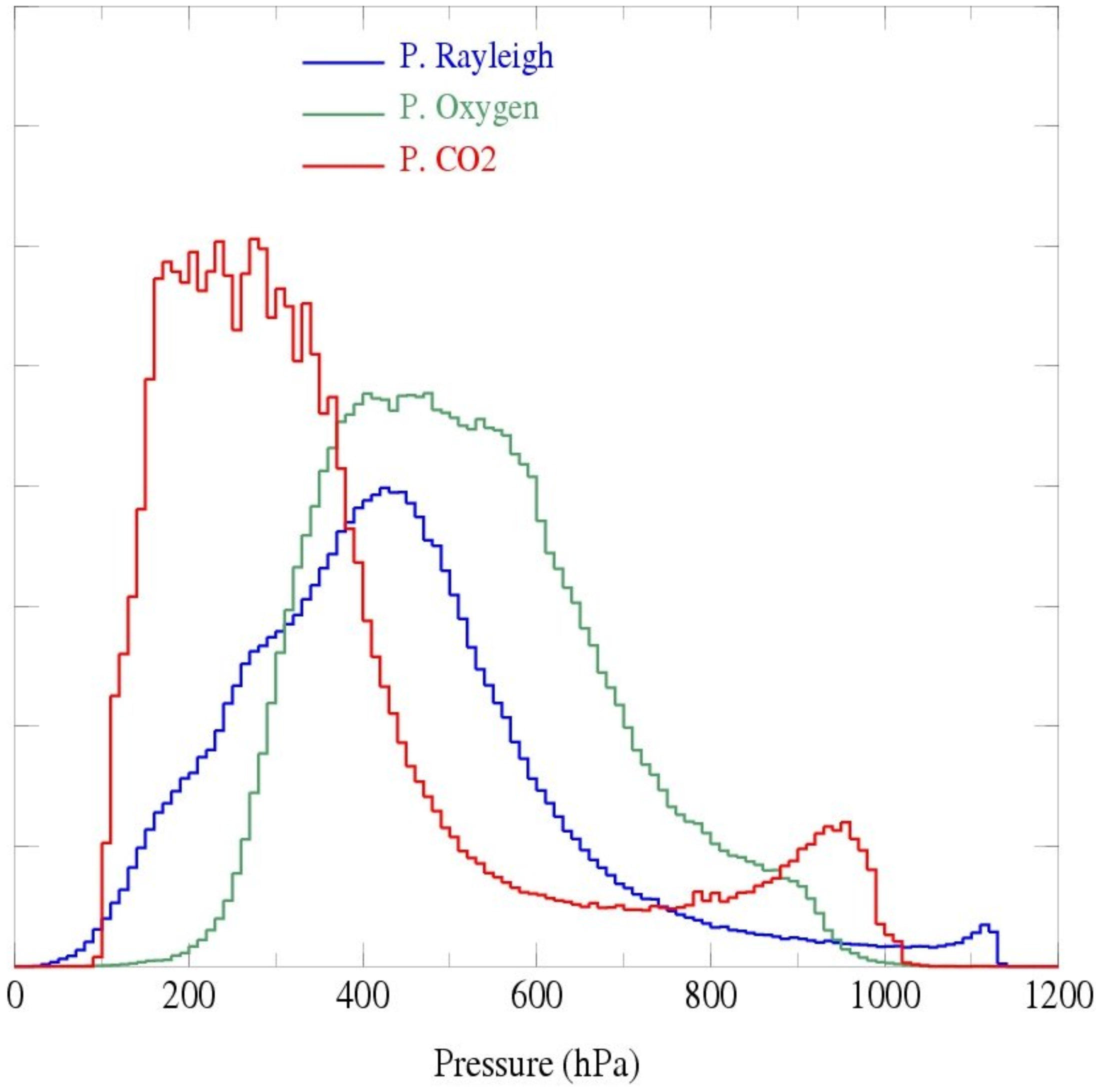
Rayleigh : Polarization Rayleigh Scattering absorption

CO2 : CO2 Slicing (IR)

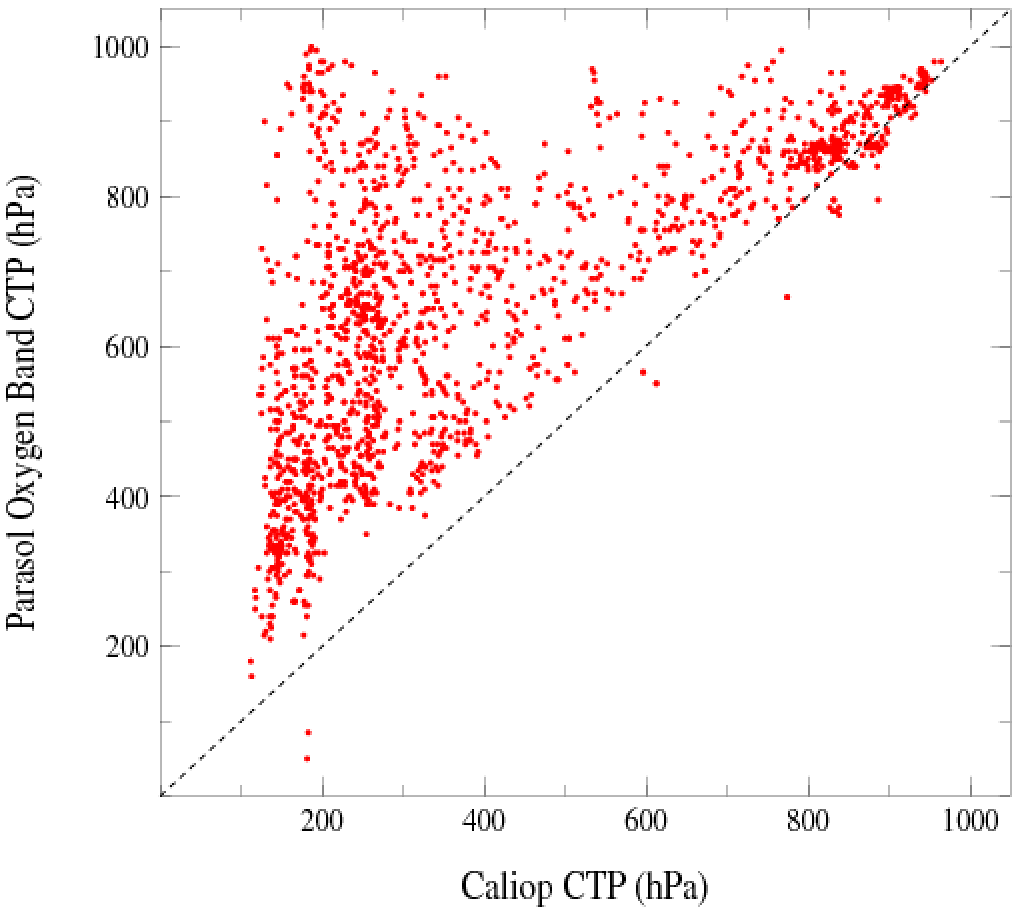
Cloud layers height

Deriving multiple cloud top pressure (O2, Rayleigh, CO2 slicing) to detect multilayer clouds and better describe vertical structure

Example of retrieved Cloud Top Pressure Histograms for Ice clouds

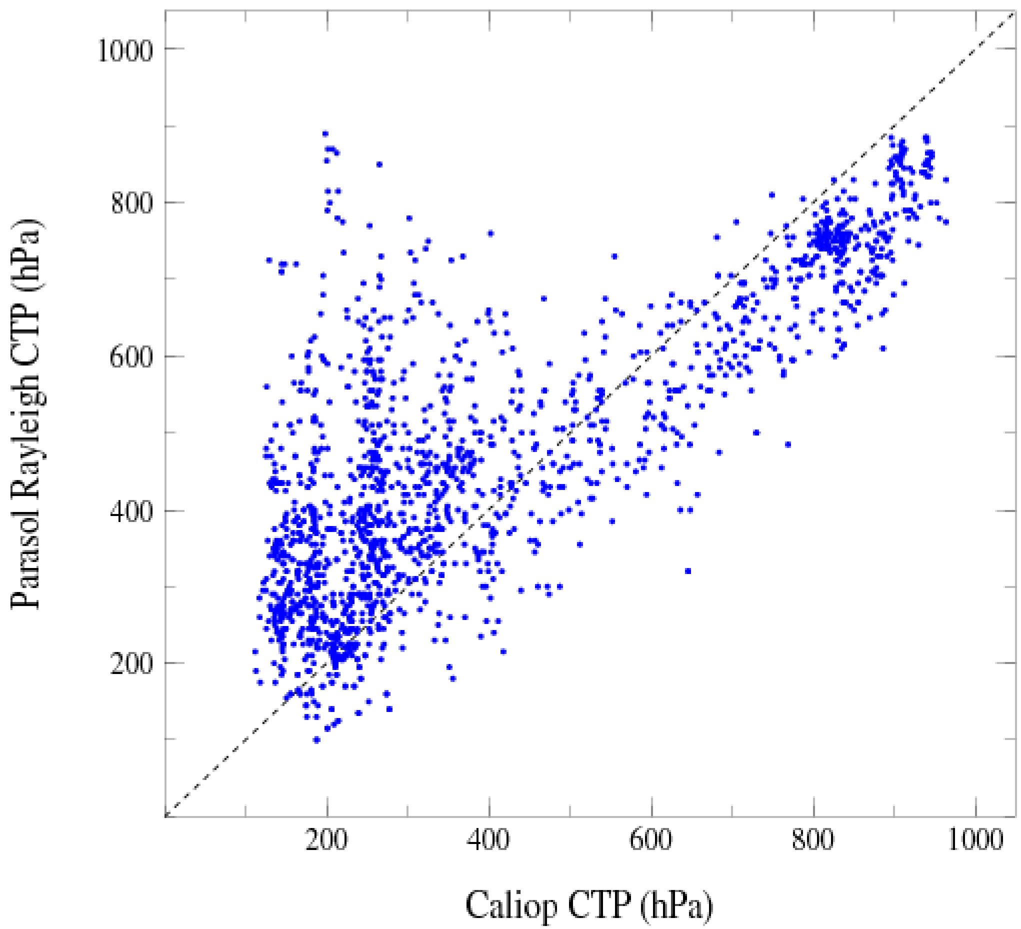


PARASOL and CALIOP Cloud Top Pressure Preliminary Comparison



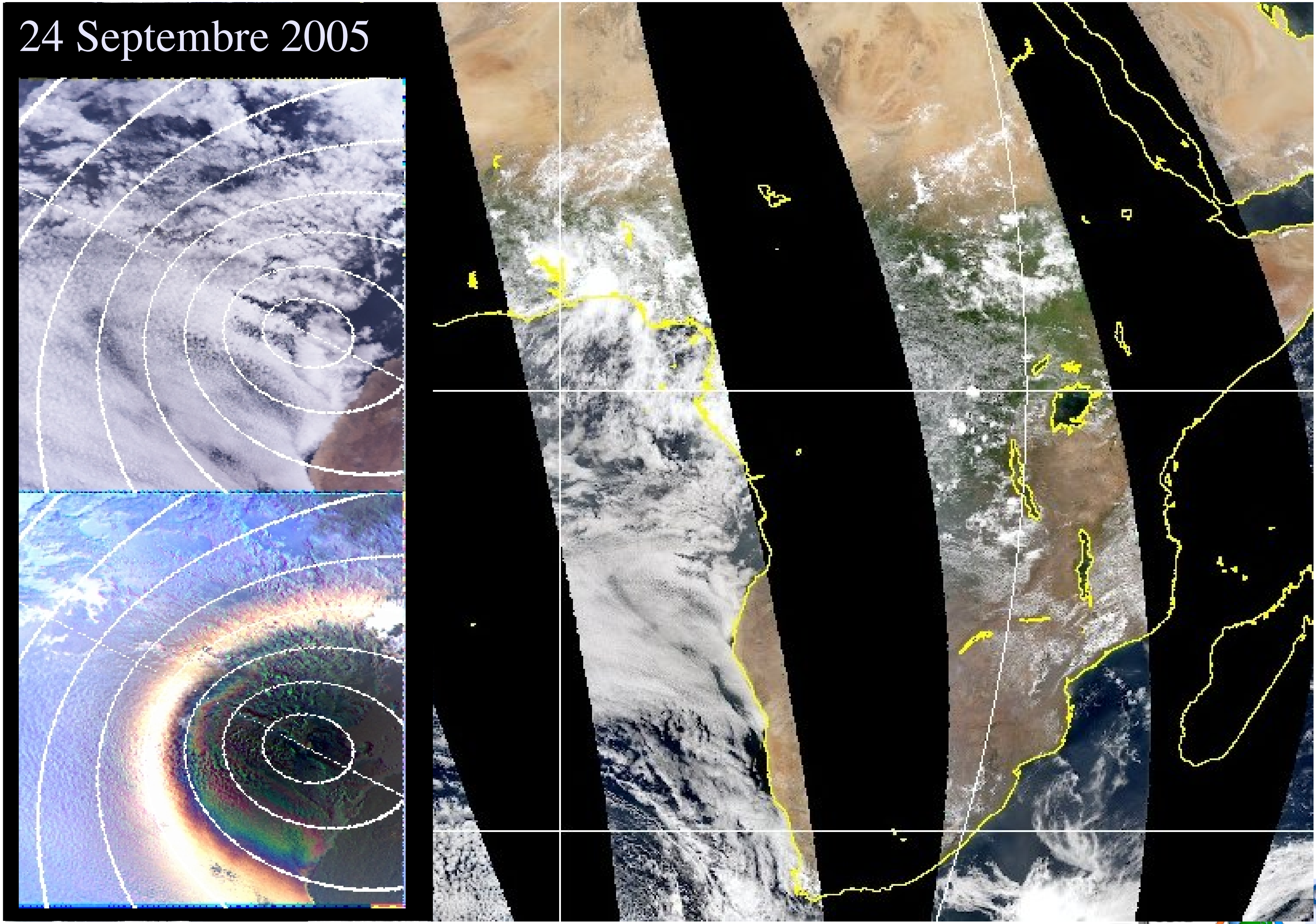
15 june 2006
POLDER Cloud Cover > 95%
CALIOP Alt. Stdev < 0.5 km

PARASOL and CALIOP Cloud Top Pressure Preliminary Comparison

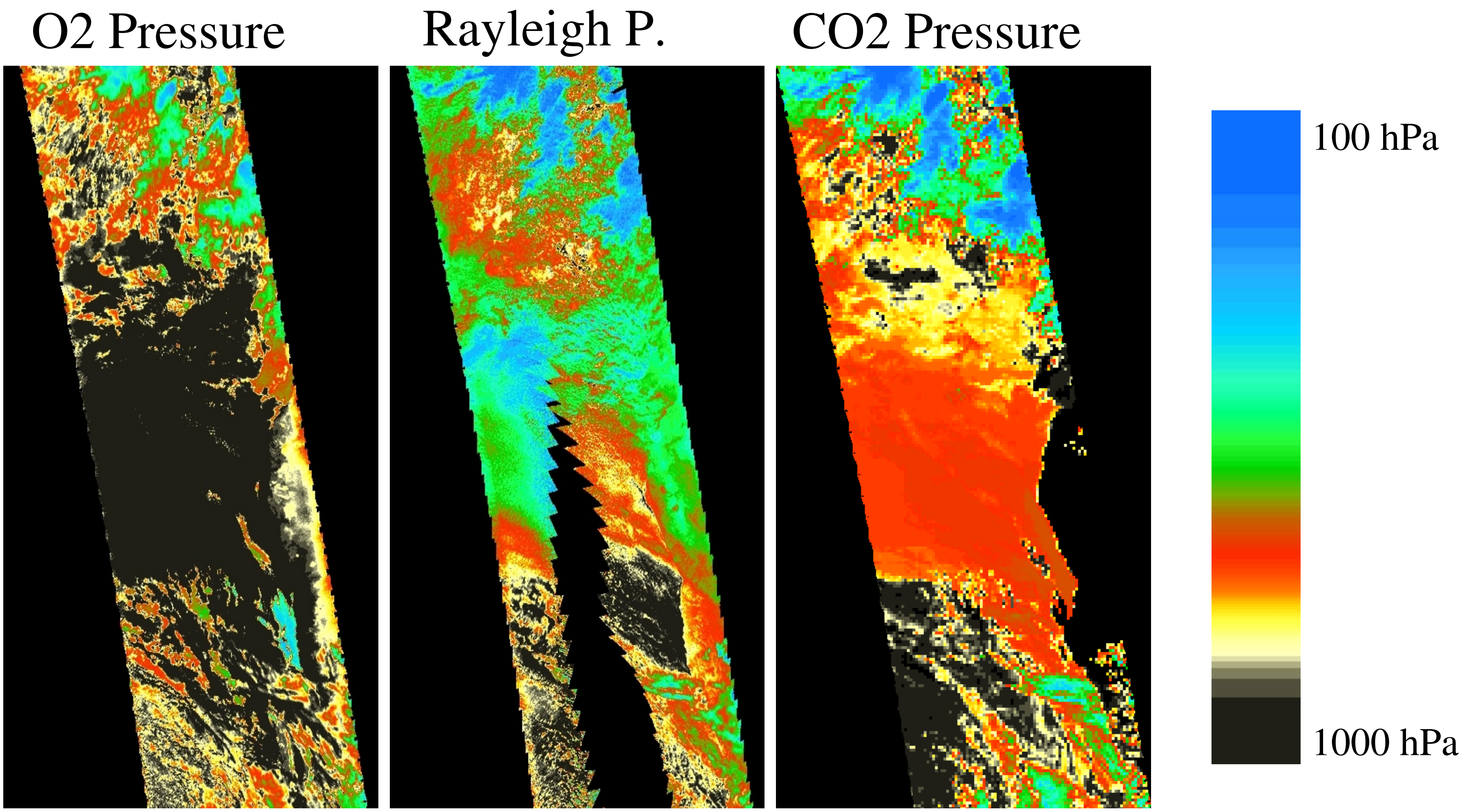


15 june 2006
POLDER Cloud Cover > 95%
CALIOP Alt. Stdev < 0.5 km

Example : aerosols over cloud



Example : aerosols over cloud



Usually with single layer : O_2 > Rayleigh > CO_2 with small differences

And here we have : O_2 > CO_2 >> Rayleigh due to presence of aerosol in the upper layer

POLDER3/Parasol Products availability

Data available since March 2005.

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 (heritage from POLDER1 and POLDER2 mission)

L1 data and products (also including MODIS/Aqua, Caliop, ...) available online from the ICARE data center

http://www.icare.univ-lille1.fr/

Summary

PARASOL/MODIS combination is a real opportunity to improve many existing parameters and can help design a next generation sensor

PARASOL/MODIS open perspectives to extend the active sensors observation to the full swath, increasing statistics

PARASOL/MODIS offer a test suite for definition of future cloud/aerosol missions

1.5 year of POLDER3/Parasol data are available through the ICARE data center : **http://www.icare.univ-lille1.fr/**

Get involved : we provide users with POLDER/MODIS joint dataset and software to merge data and try ideas.

Additional Material for Discussion

Cloud detection

Cloud detection

Cloud detection can be tricky under many circumstances (heavy aerosol loading, glint, bright surfaces : desert, snow/ice)

Basis

MODIS multispectral total reflectance measurements are not always sufficient to perform perfectly under all conditions
- hard time under glint condition, heavy smoke/dust, snow/ice surface, ...

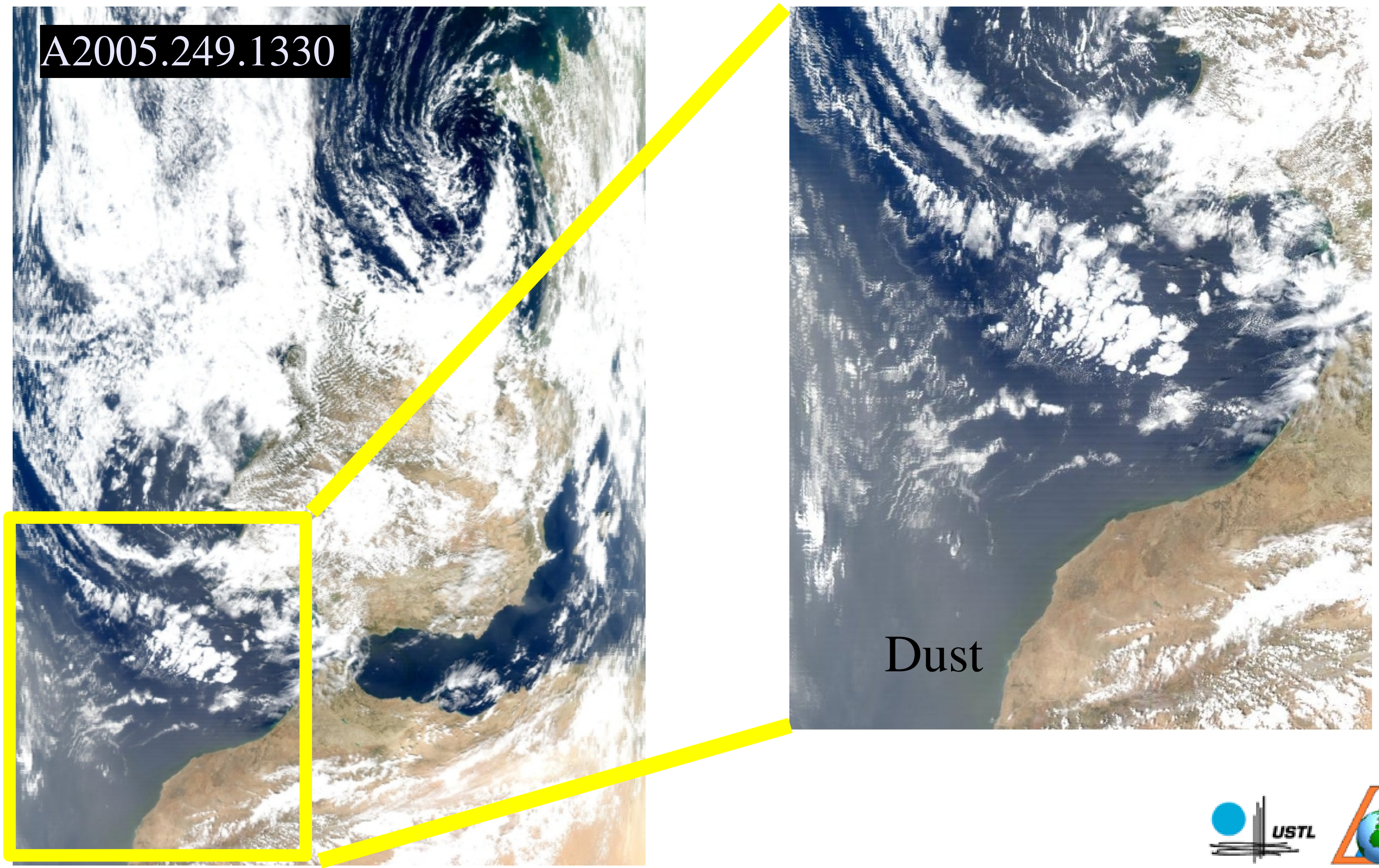
POLDER can also get into troubles due to lower resolution and limited spectral range
- hard time with thin cirrus, low broken clouds, snow/ice surface, ...

Taken advantages of the combined high resolution, multispectral, multiangle and polarisation measurement increases greatly the chance to get a correct cloud detection (though you're still stuck in the mud when you need to settle on the definition of a cloud)

Cloud detection

Cloud detection can be tricky under many circumstances (heavy aerosol loading, glint, bright surfaces : desert, snow/ice). Even worse when mixture of those ...

Example : Glint/Dust



Cloud detection

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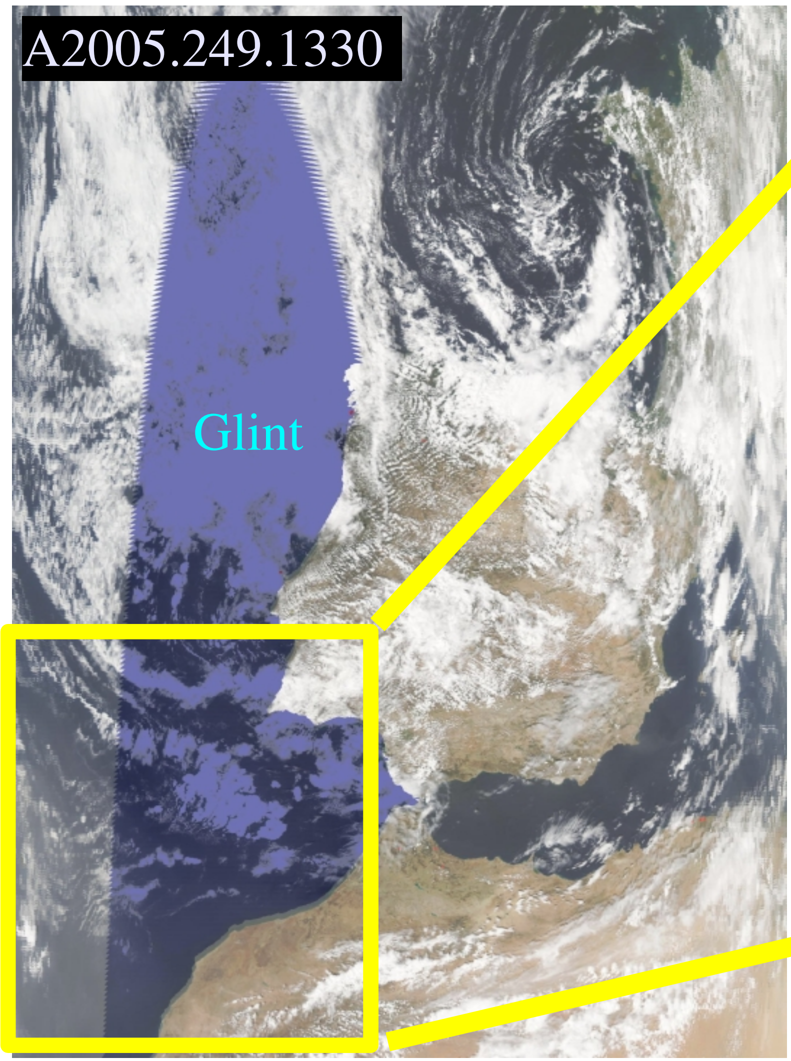
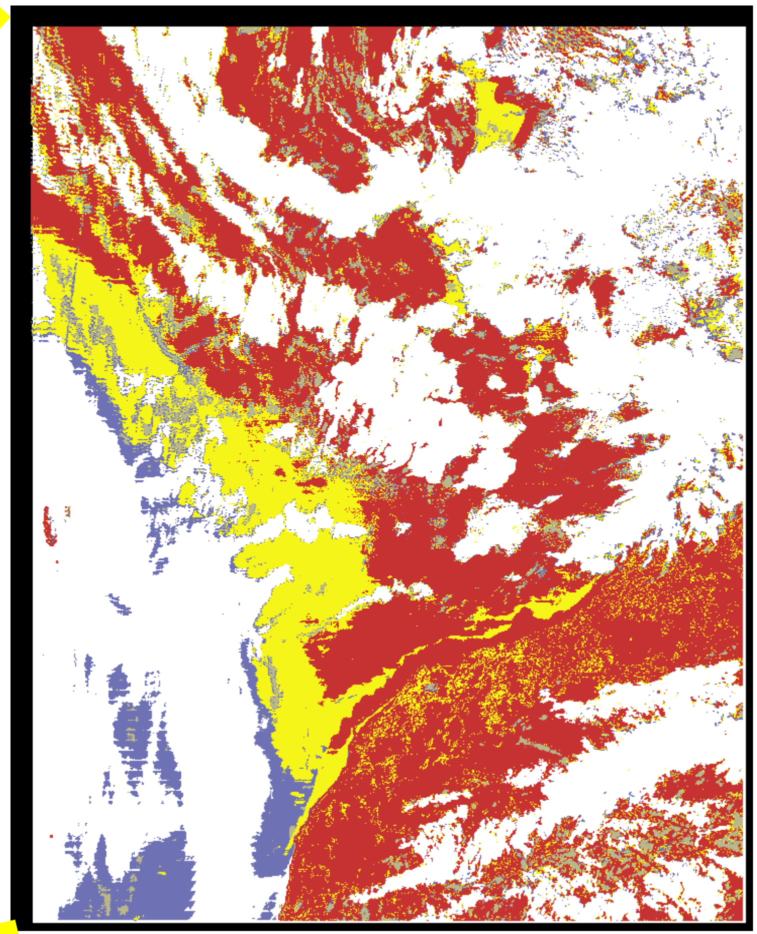
Example : Glint/Dust





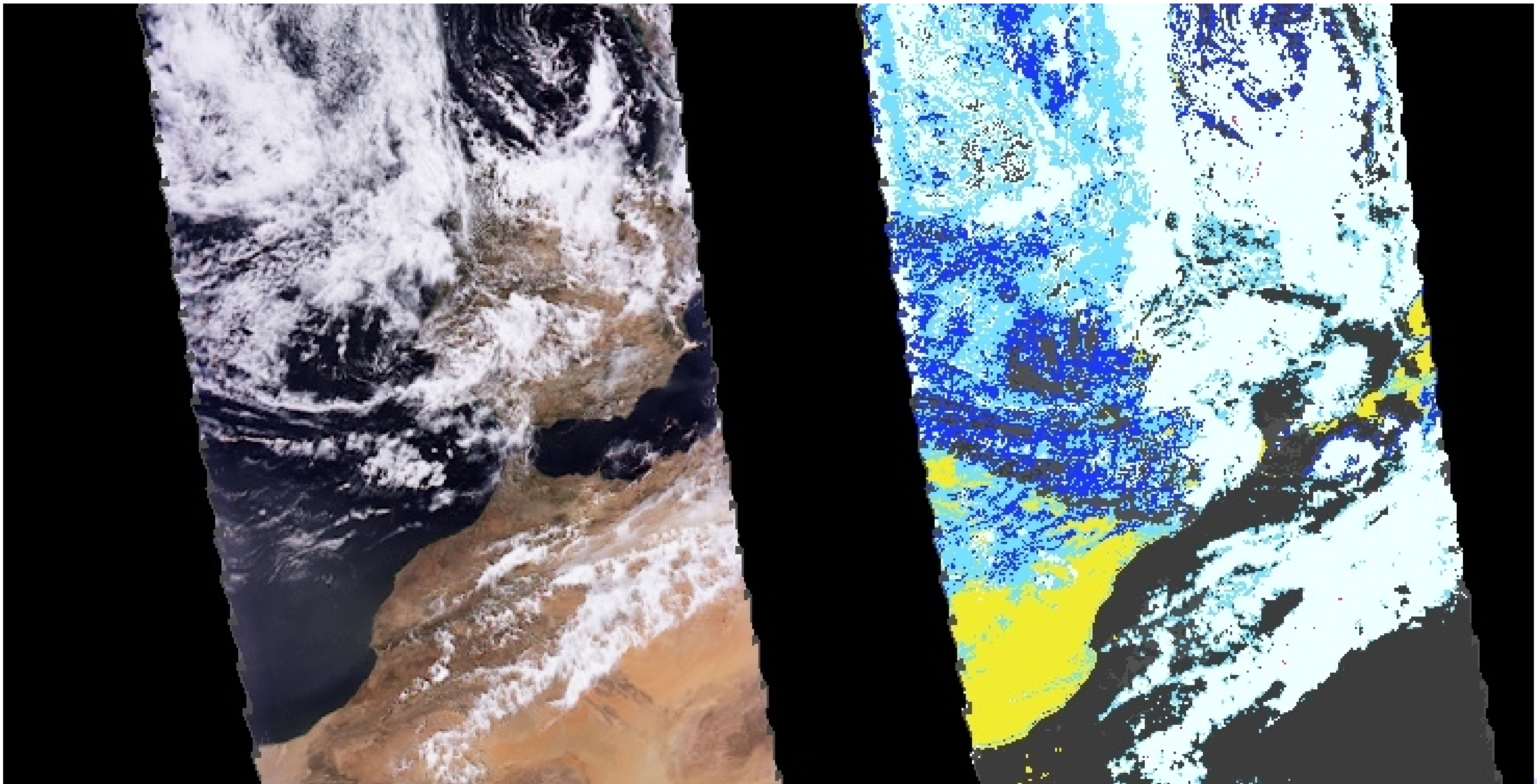
MODIS MYD35 Col. 5

Cloud detection

Cloud detection can be tricky under many circumstances (heavy aerosol loading, glint, bright surfaces : desert, snow/ice). Even worse when mixture of those ...

Example : Glint/Dust :

heavy aerosol clear more or less conf. cloudy

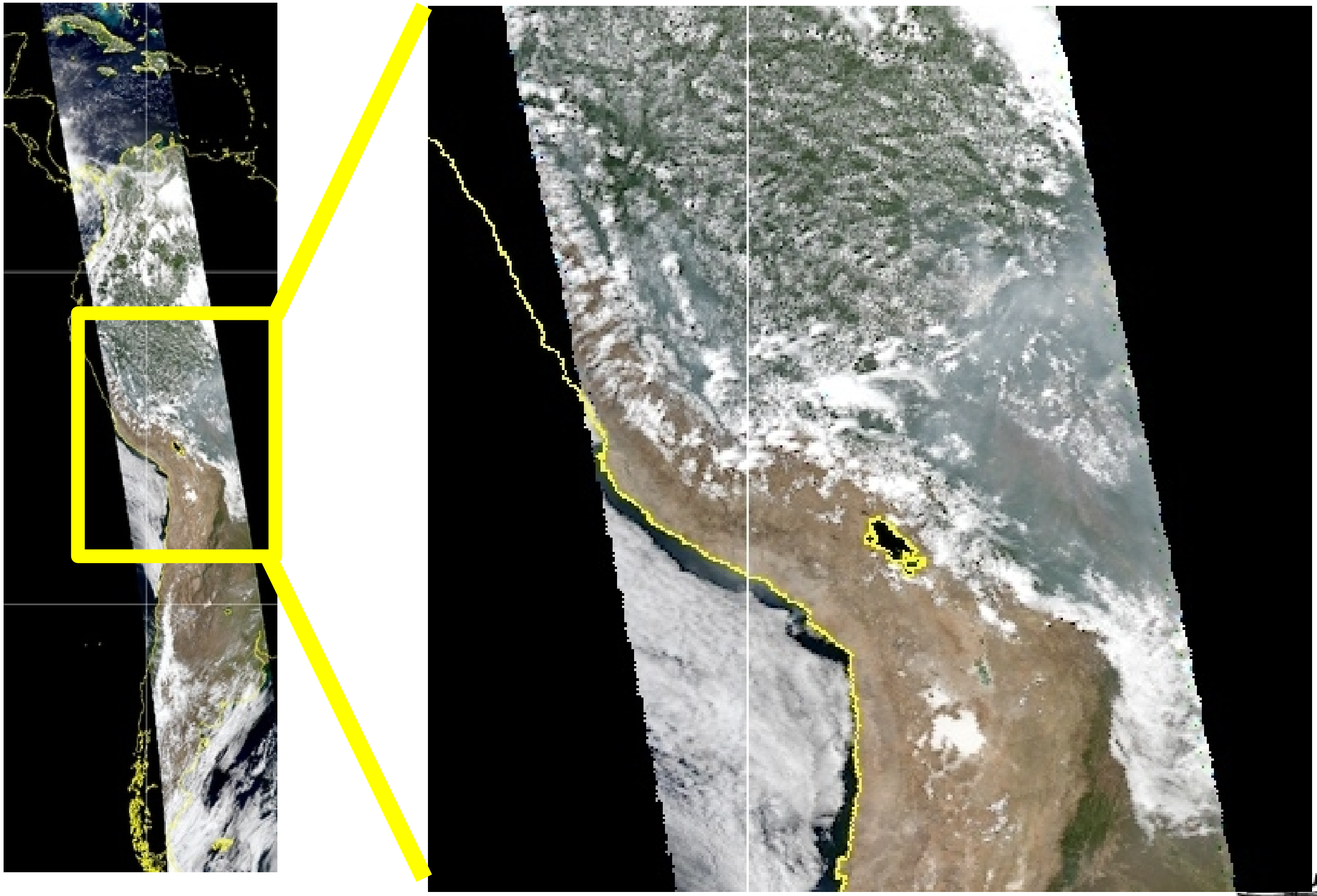


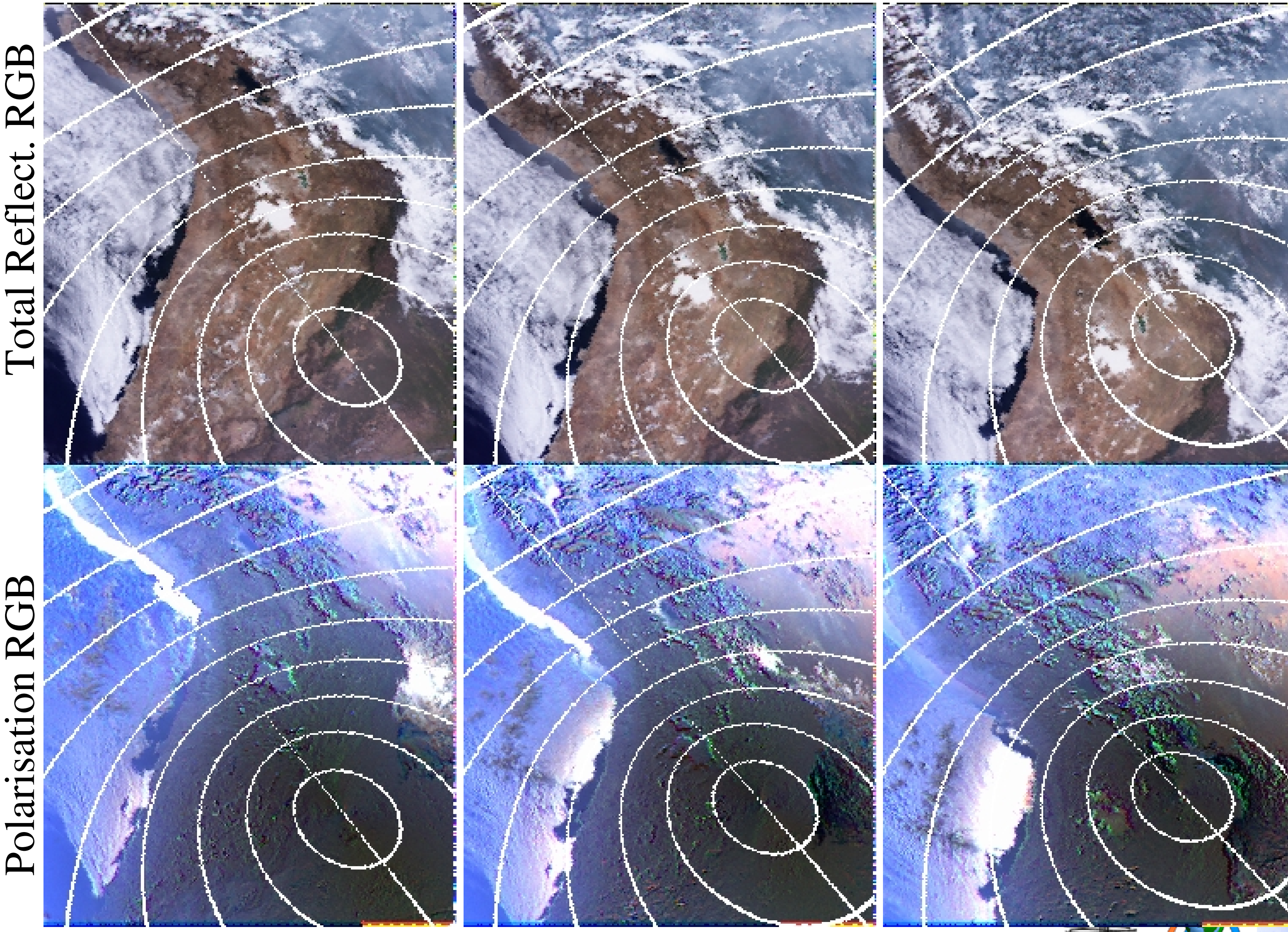
Aerosol detection is easier when looking off glint which is always possible with POLDER

Cloud detection

Cloud detection can be tricky under many circumstances (heavy aerosol loading, glint, bright surfaces : desert, snow/ice). Even worse when mixture of those ...

Example : Smoke over land mixed with clouds

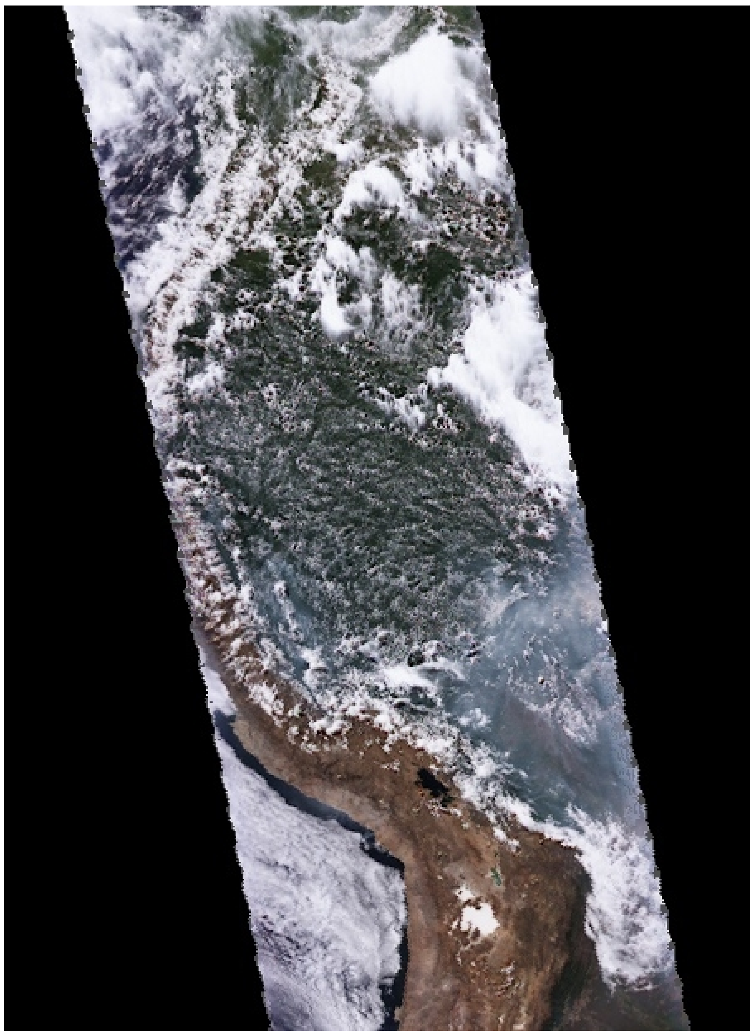



Total Reflect. RGB
Polarisation RGB

Cloud detection

Cloud detection can be tricky under many circumstances (heavy aerosol loading, glint, bright surfaces : desert, snow/ice). Even worse when mixture of those ...

Example : Smoke over land mixed with clouds



heavy aerosol clear more or less conf. cloudy