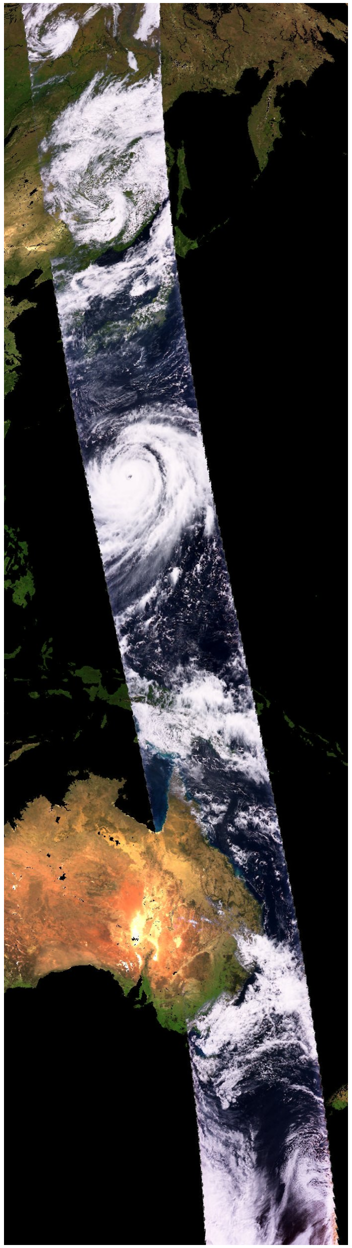

Cloud Properties Retrieval from synergy between POLDER3/Parasol and MODIS/Aqua Preliminary Results

Jérôme Riédi [1], Cécile Oudard [1], Jean-Marc Nicolas [1], Laurent Labonnote [1], Frédéric Parol [1], Steven Platnick et al [2]

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(2) Laboratory for Atmospheres, NASA Goddard Space Flight Center

OUTLINE

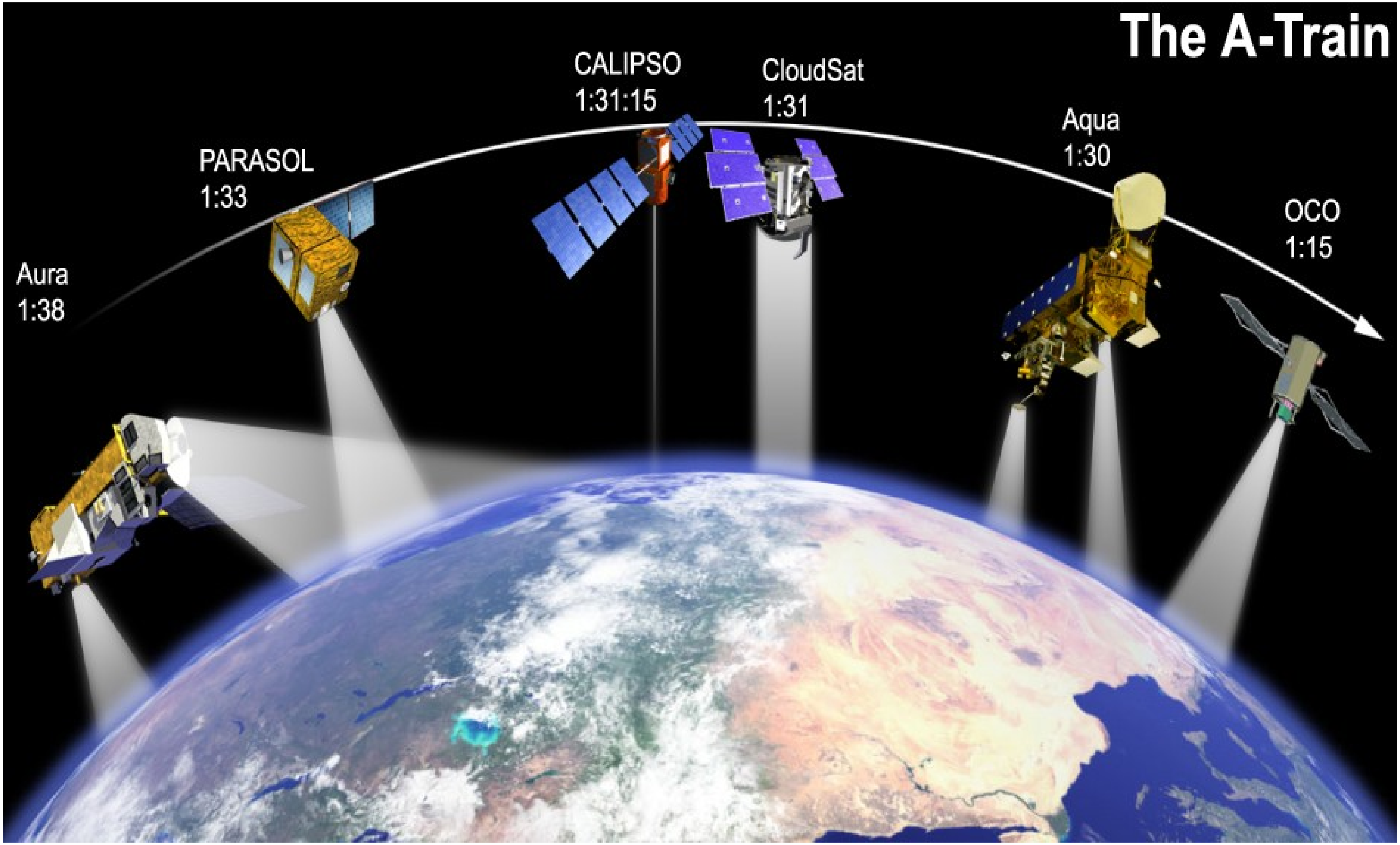
Context and Rationale

Methodology

Current developments

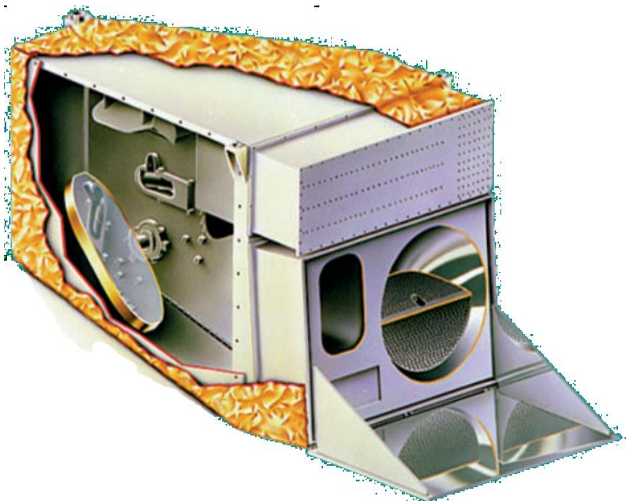
Perspectives

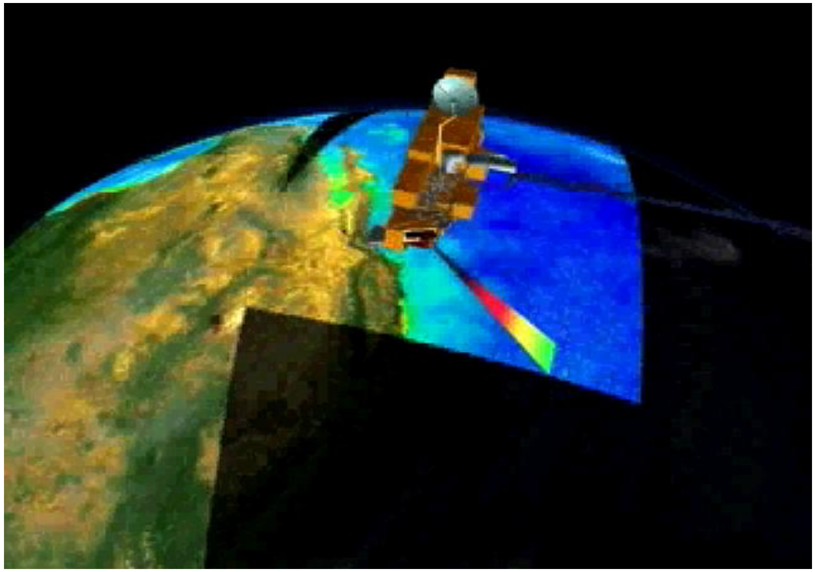
Context and Rationale



Instrumental Background : MODIS

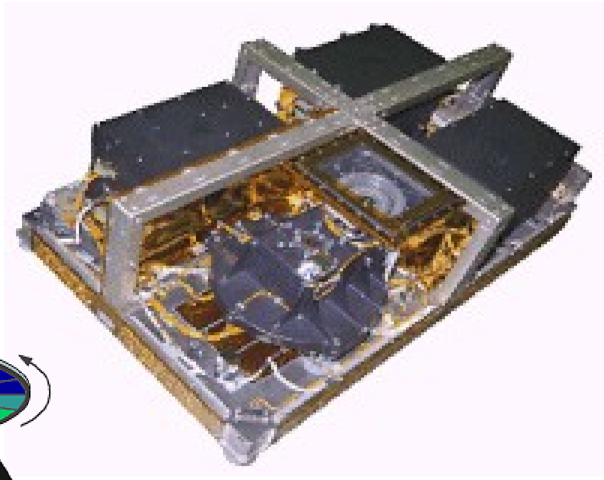
- NASA, Terra & Aqua
  - launched 1999, 2002
  - 705 km polar orbits, descending (10:30 a.m.) & ascending (1:30 p.m.)
- Sensor Characteristics
  - 36 spectral bands ranging from 0.41 to 14.385 µm
  - cross-track scan mirror with 2330 km swath width
  - Spatial resolutions:
    - 250 m (bands 1 - 2)
    - 500 m (bands 3 - 7)
    - 1000 m (bands 8 - 36)
  - 2% reflectance calibration accuracy
  - onboard solar diffuser & solar diffuser stability monitor

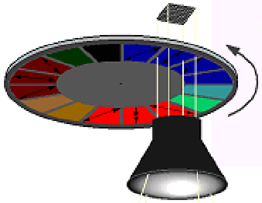


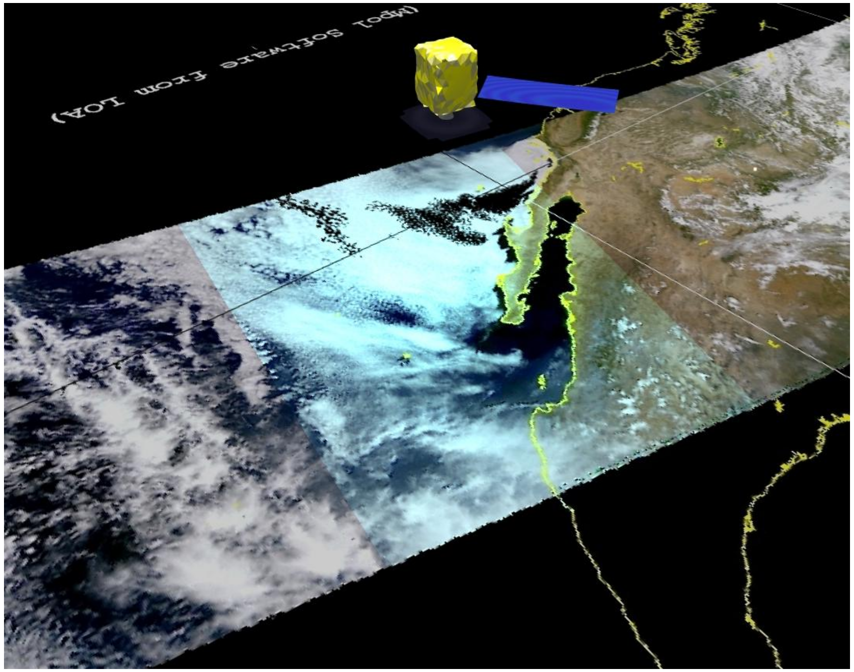


Instrumental Background : POLDER

- CNES/LOA instrument, Parasol launched 2005
  - ~ 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







Context and Rationale

MODIS/Aqua and POLDER/Parasol in flight since January 2005.

More than one year of coincident data is now available

Objectives :

Define and implement new scientific algorithms based on combination of MODIS and POLDER level 1 data in order to

- improve retrieval of existing parameters
- allow for retrieval of new parameters
- extend the vertical description of the active instrument to the full swath

Strategy :

- Direct analysis of combined level 1 data (i.e., look at real world data)

Challenging issues :

- merging data from instruments with very different characteristics
- getting ' compatible ' reflectances for joint algorithm
- understand when the combination of two is constructive

Potential Synergy

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 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, ...

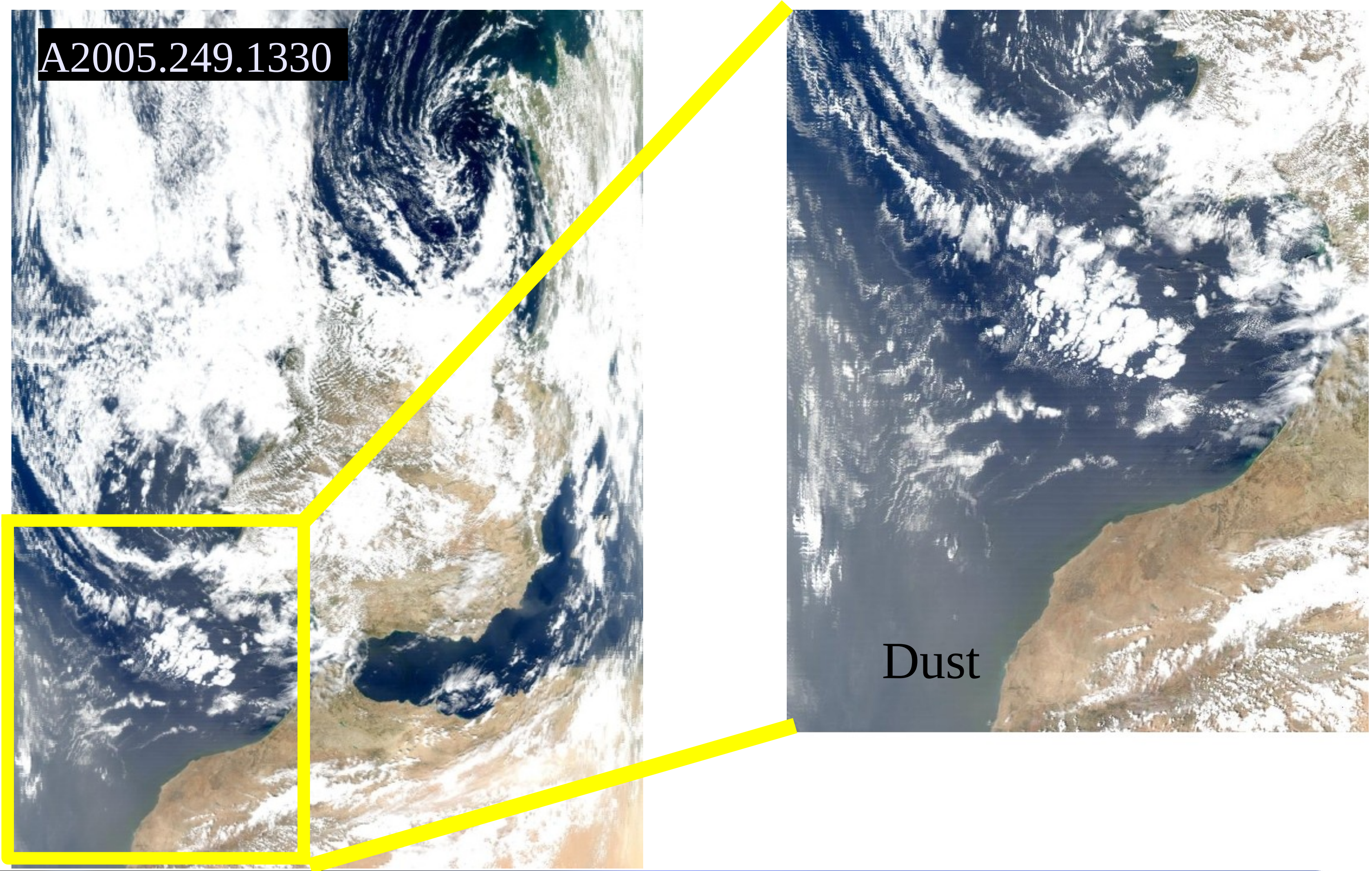
POLDER can also get into troubles due to lower resolution and limited spectral range
- hard time with thin cirrus, low broken clouds, snow/ice surface, ...

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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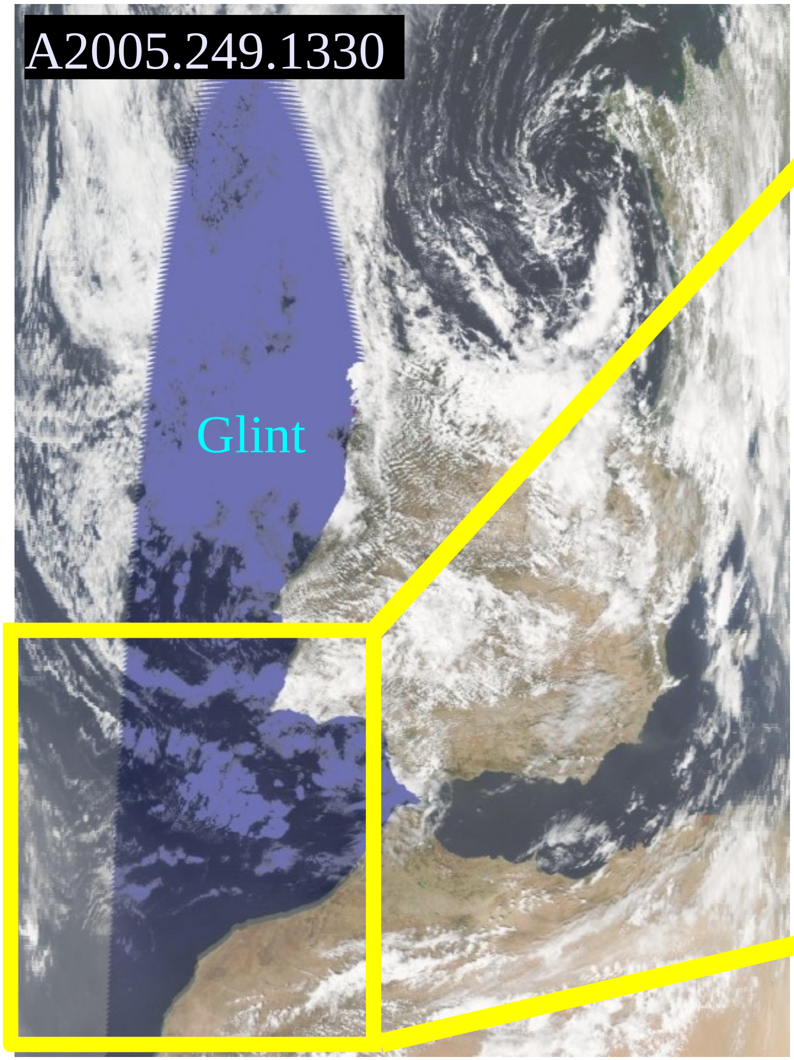
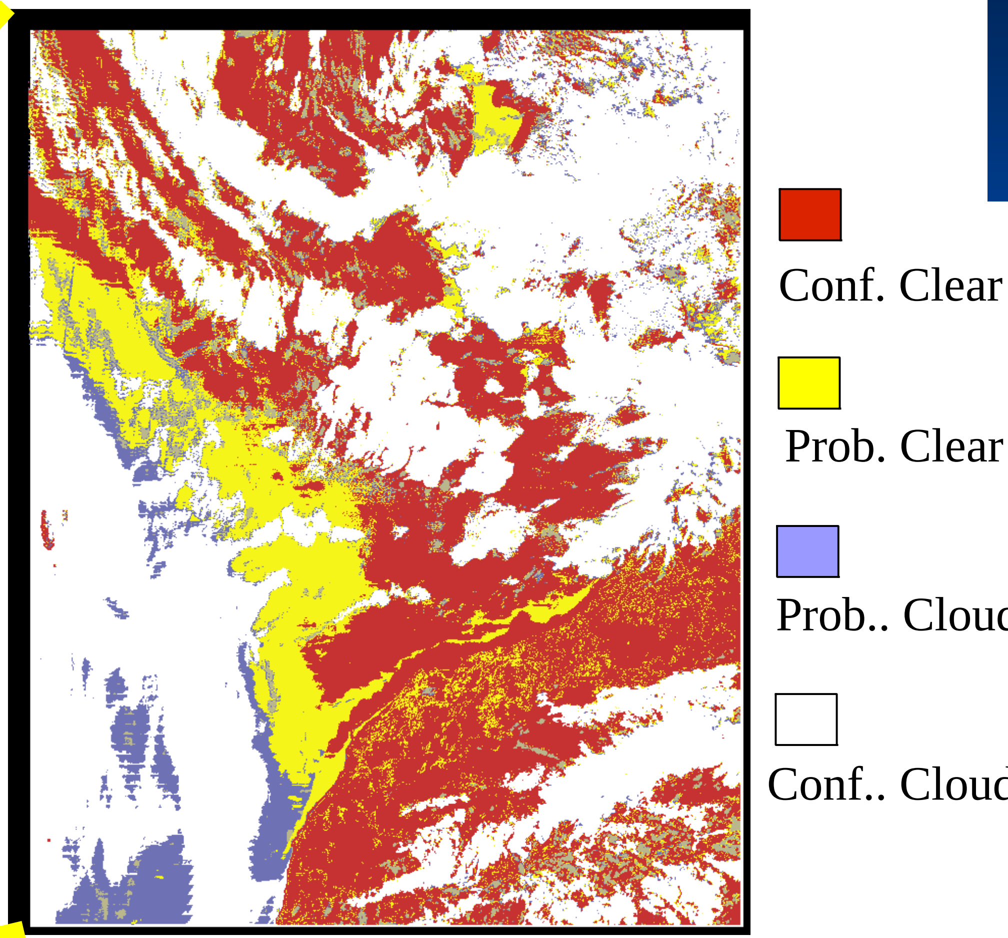
Example : Glint/Dust





MODIS MYD35 Col. 5

Cloud detection

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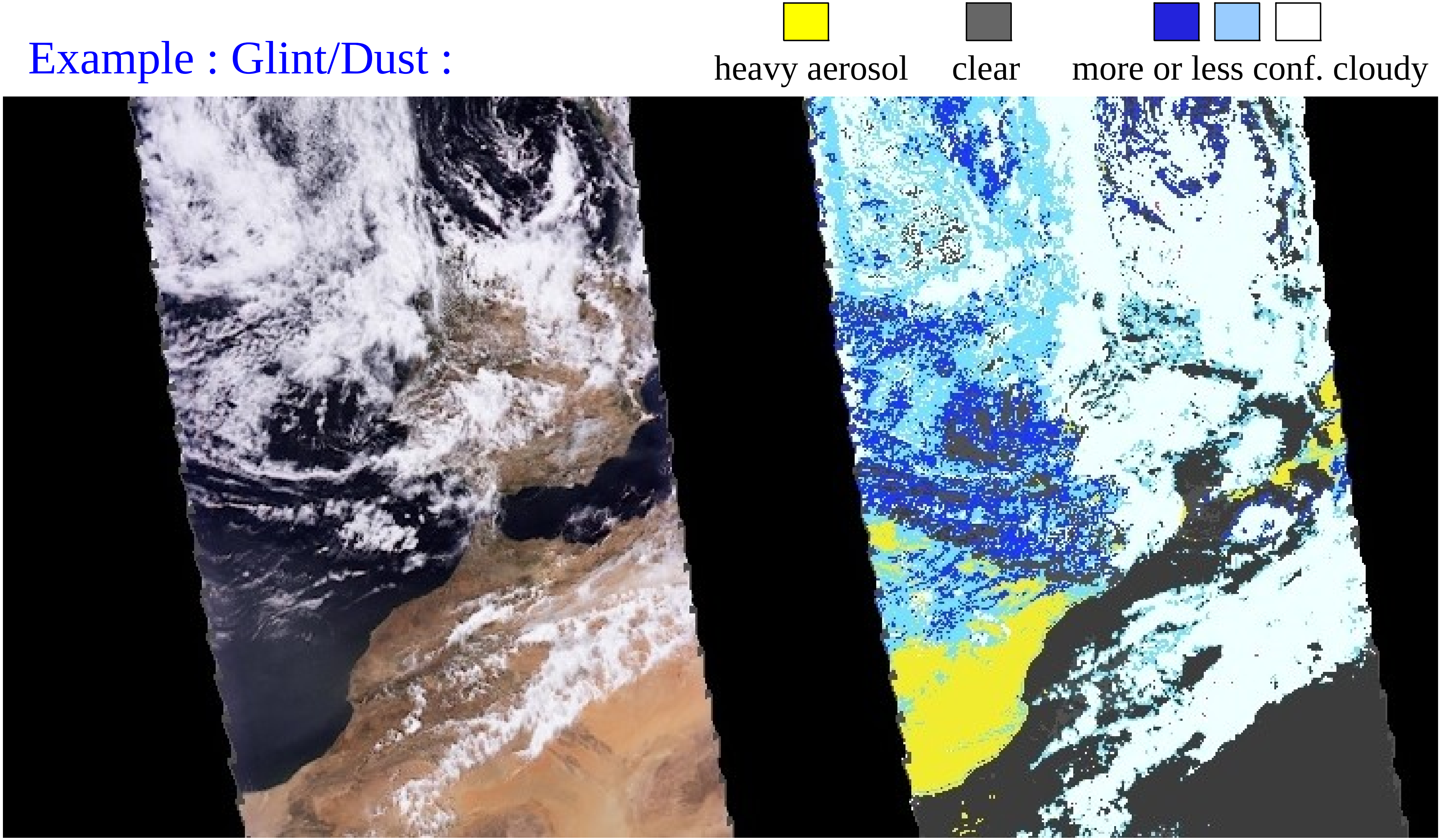
Example : Glint/Dust :

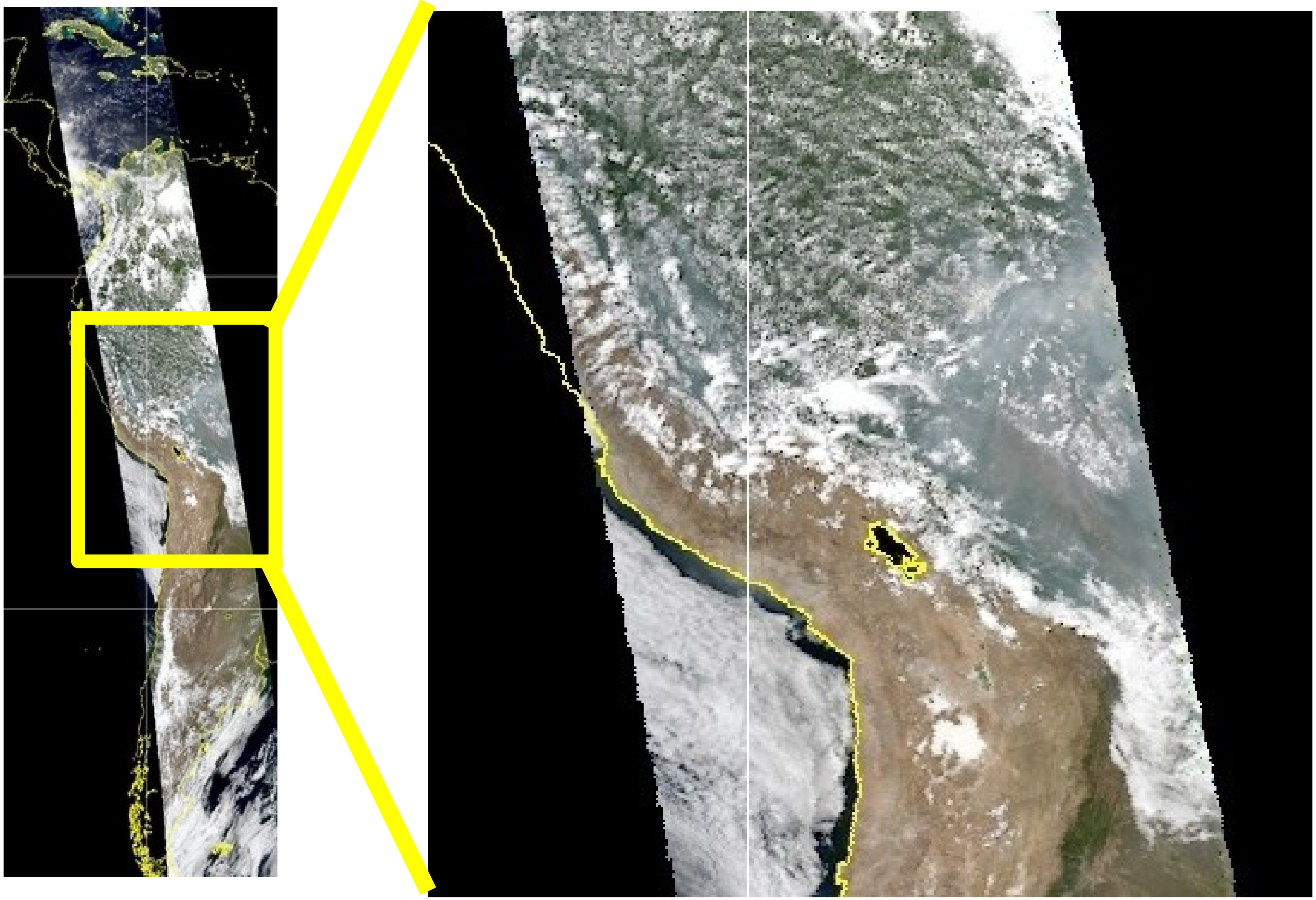


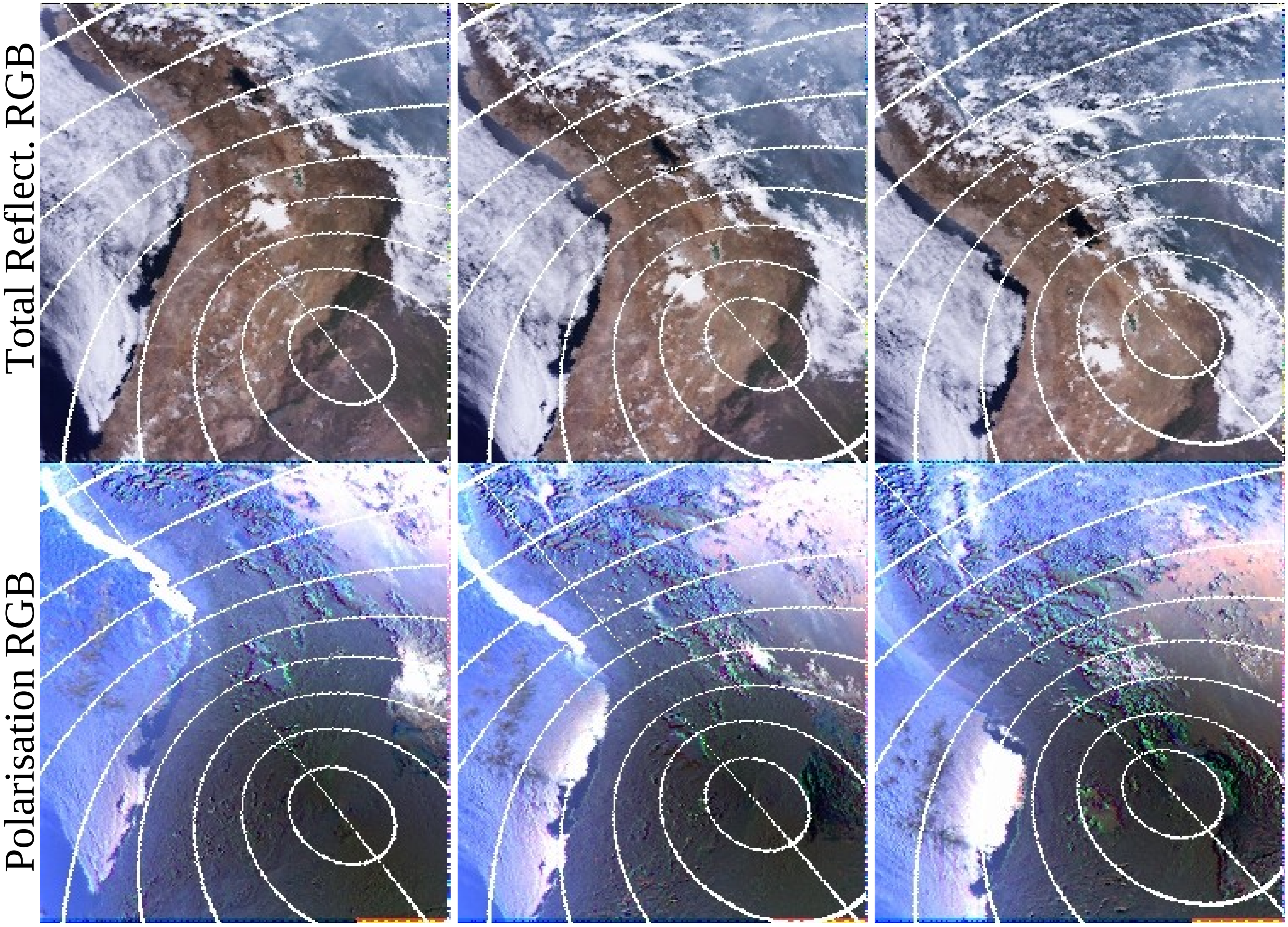
Aerosol detection is easier when looking off glint which is always possible with POLDER

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



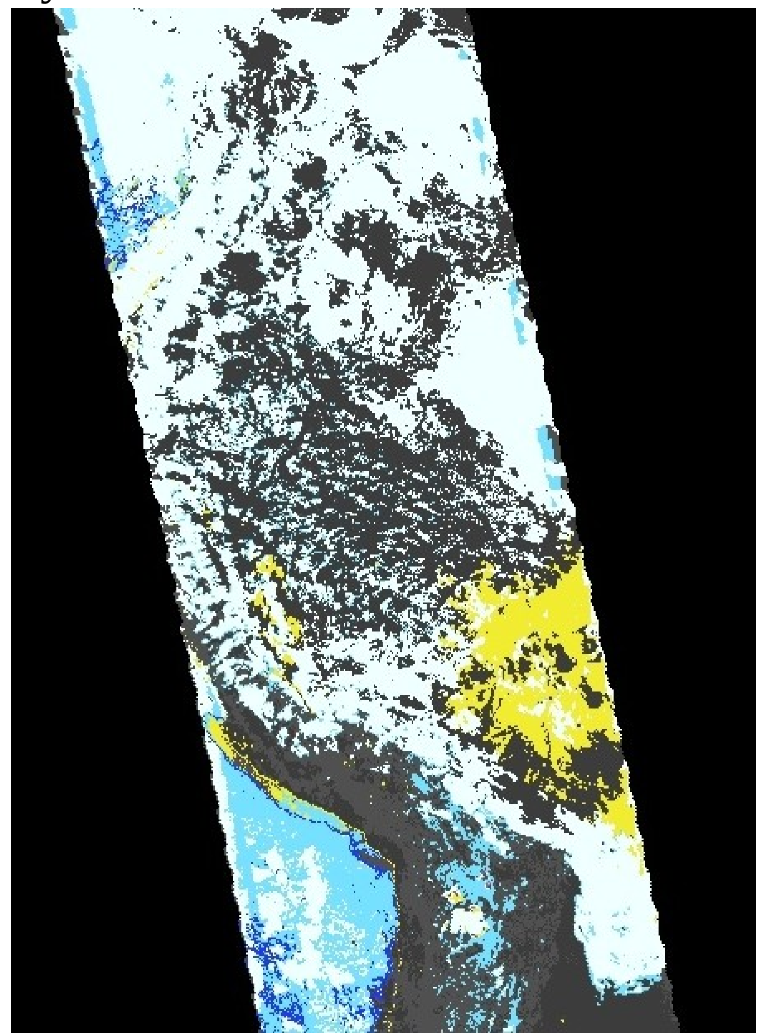

Total Reflect. RGB
Polarisation RGB

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 ...

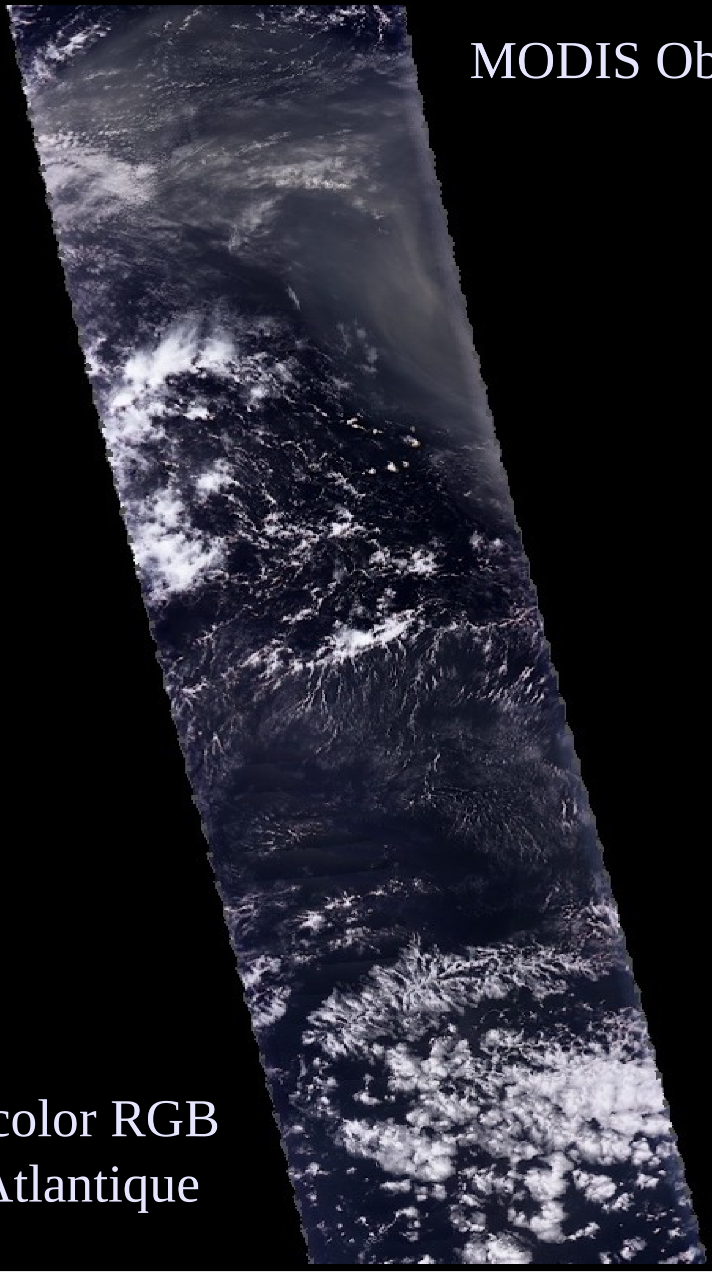
Example : Smoke over land mixed with clouds

heavy aerosol clear more or less conf. cloudy

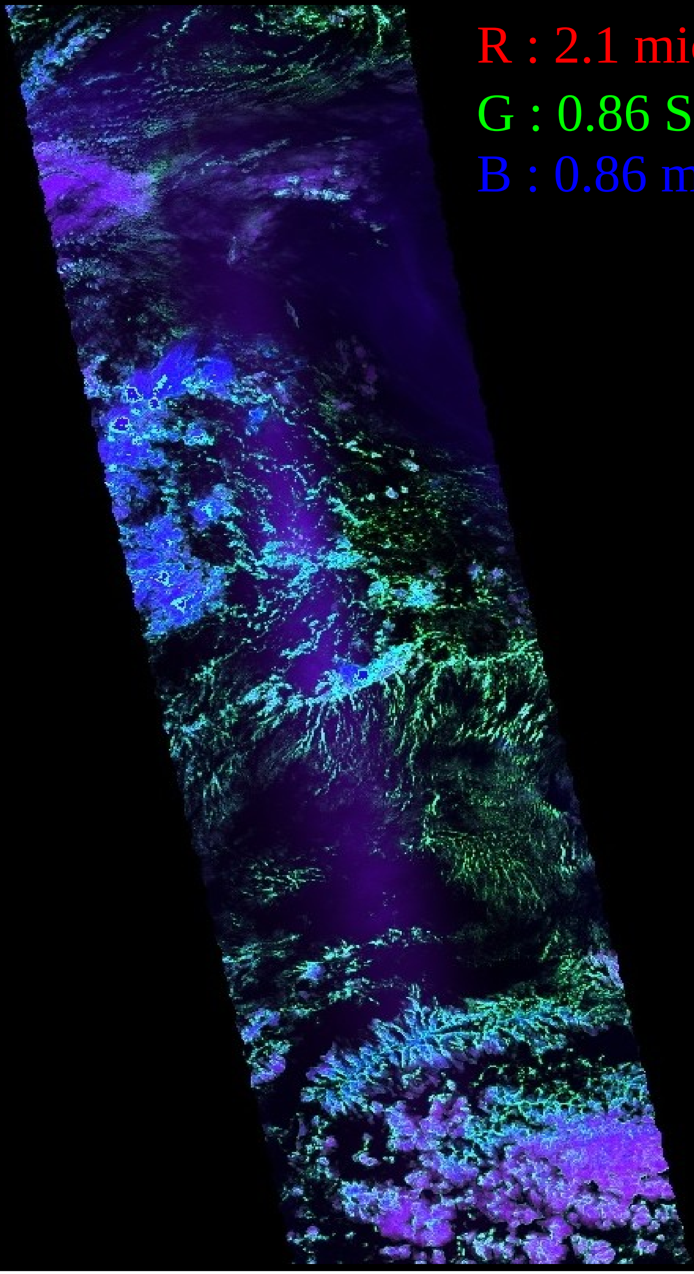


Detection of small broken clouds / pixel heterogeneity within Parasol FOV

MODIS Obs.



True color RGB
Mid Atlantique



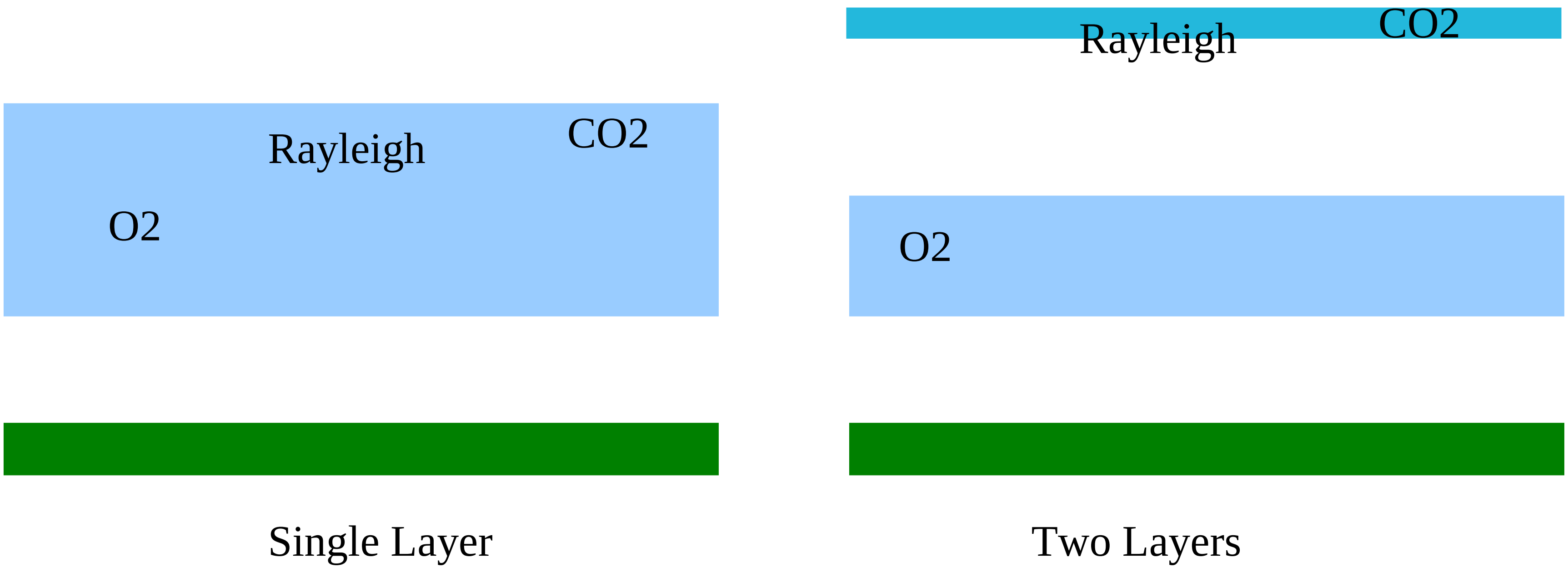
R : 2.1 microns
G : 0.86 SDTV
B : 0.86 microns

Cloud layers height

Deriving multiple cloud top pressure (O_2, Rayleigh, CO_2 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

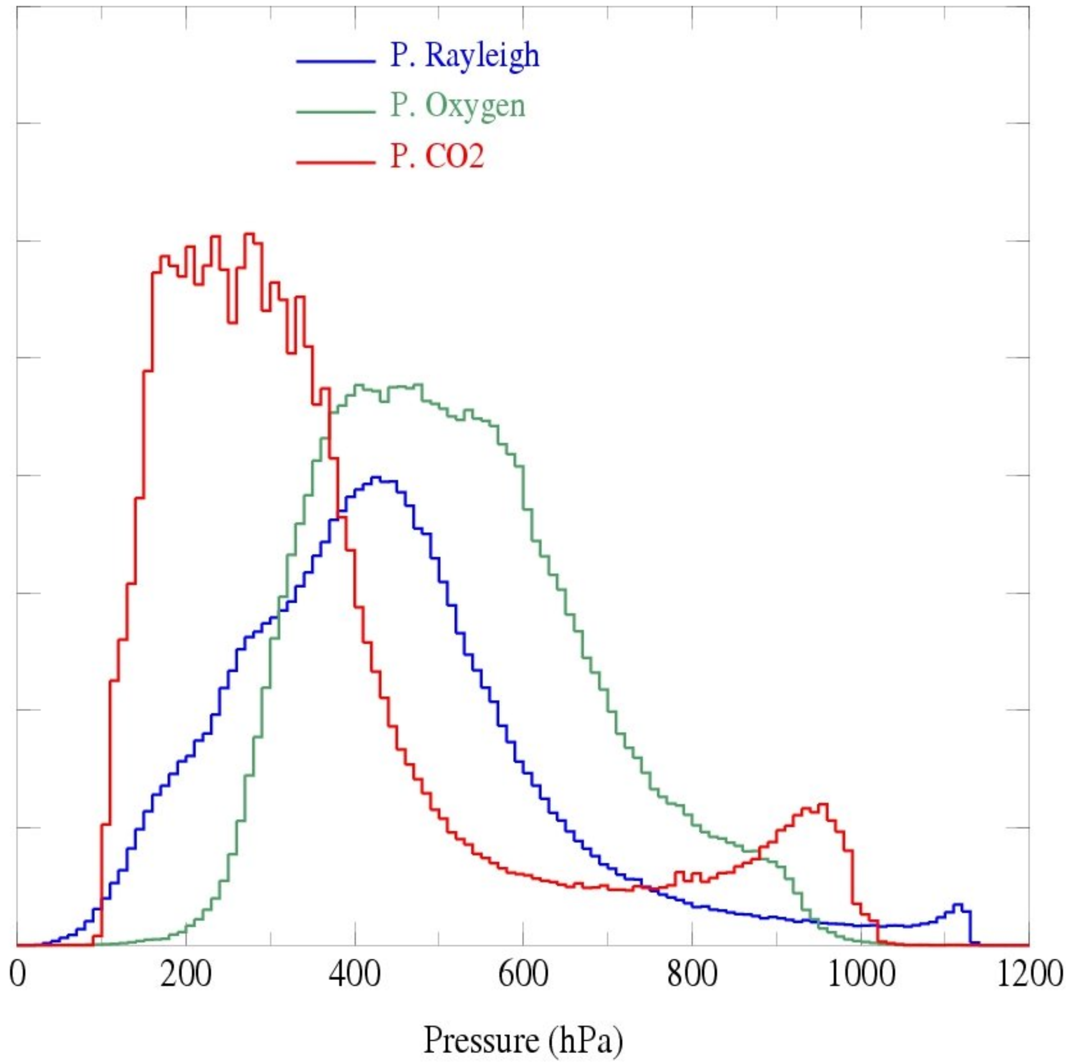
Rayleigh : Polarization Rayleigh Scattering absorption

CO2 : CO2 Slicing (IR)

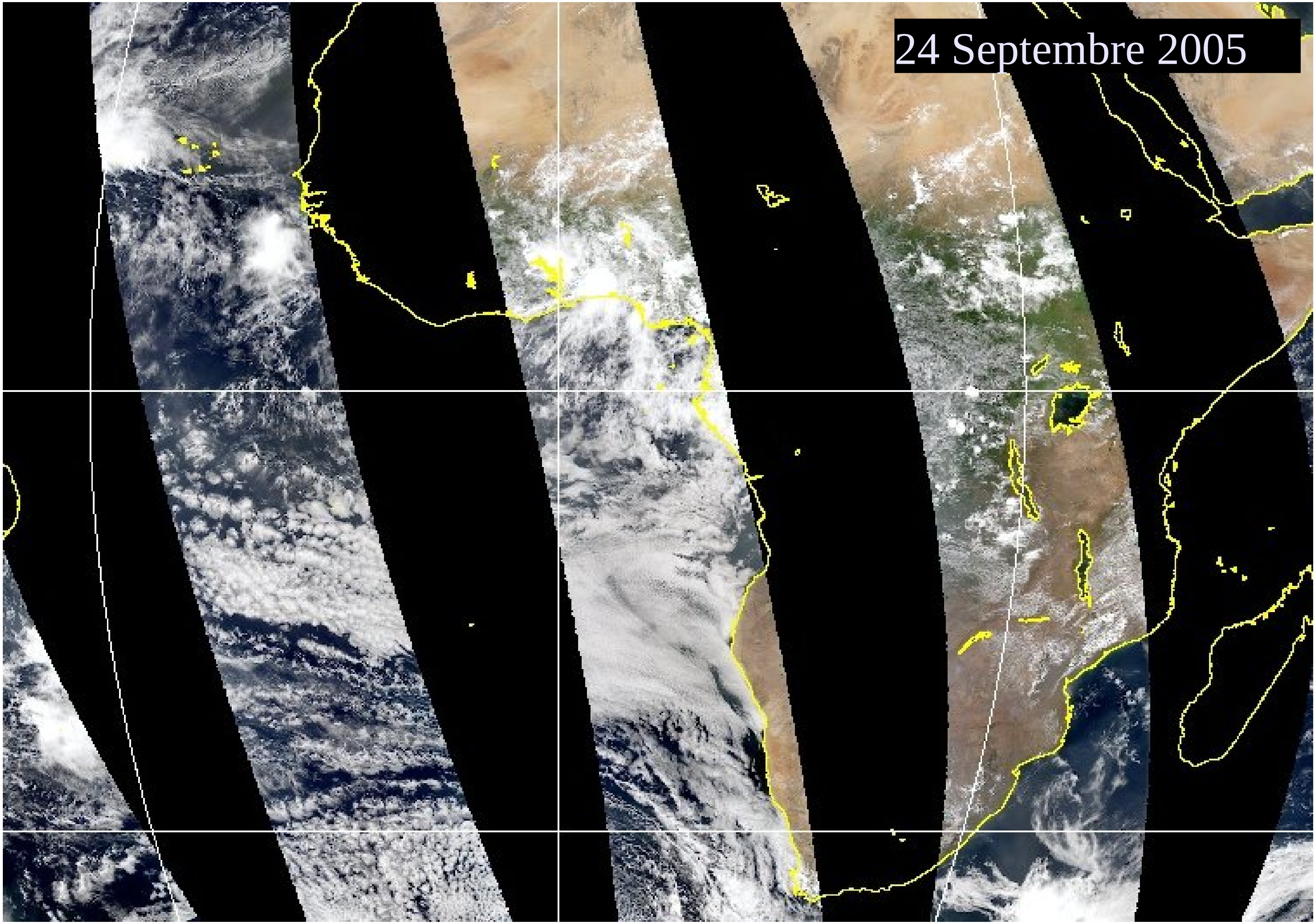
Cloud layers height

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

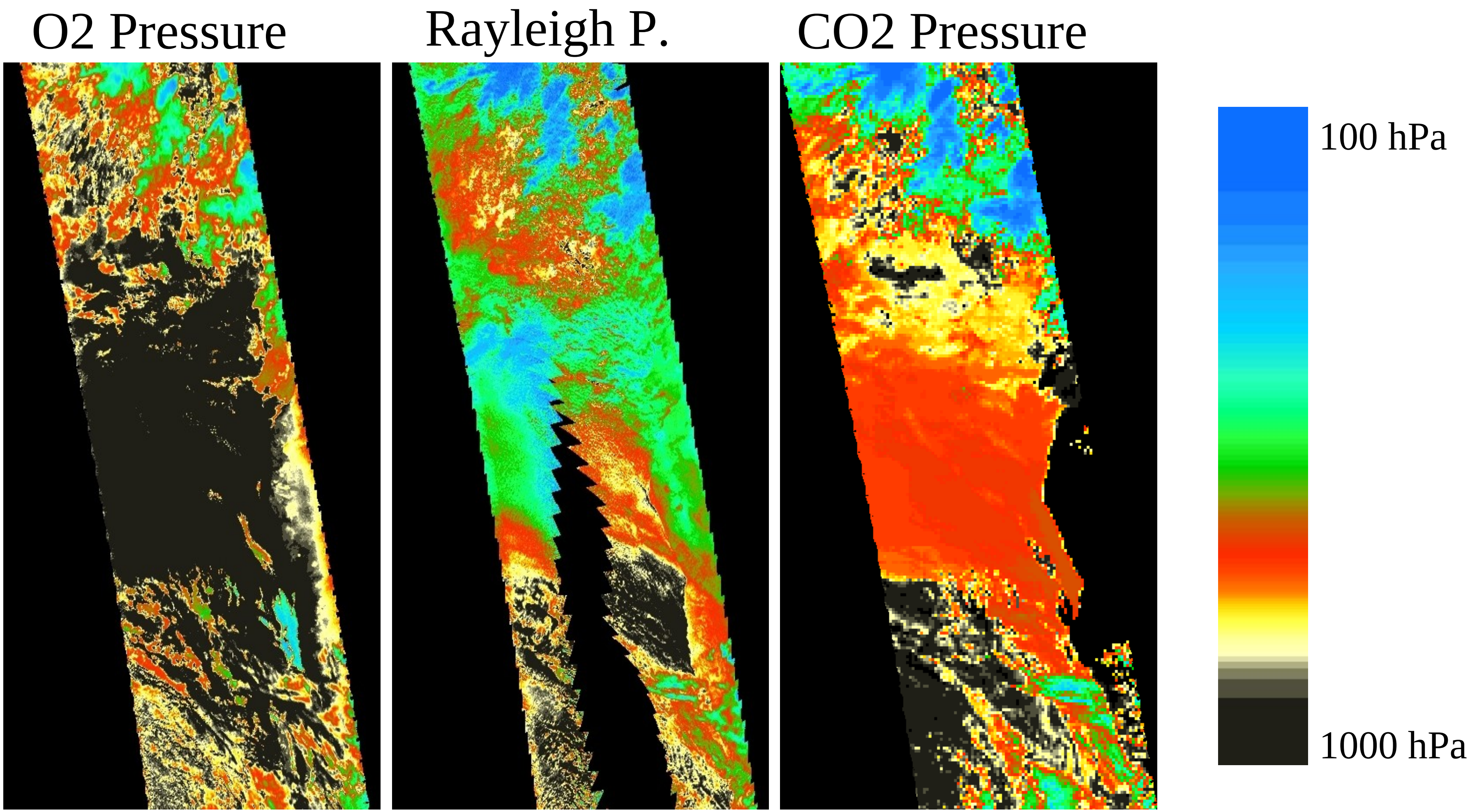
Example of retrieved Cloud Top Pressure Histograms for Ice clouds



Example : aerosols over cloud

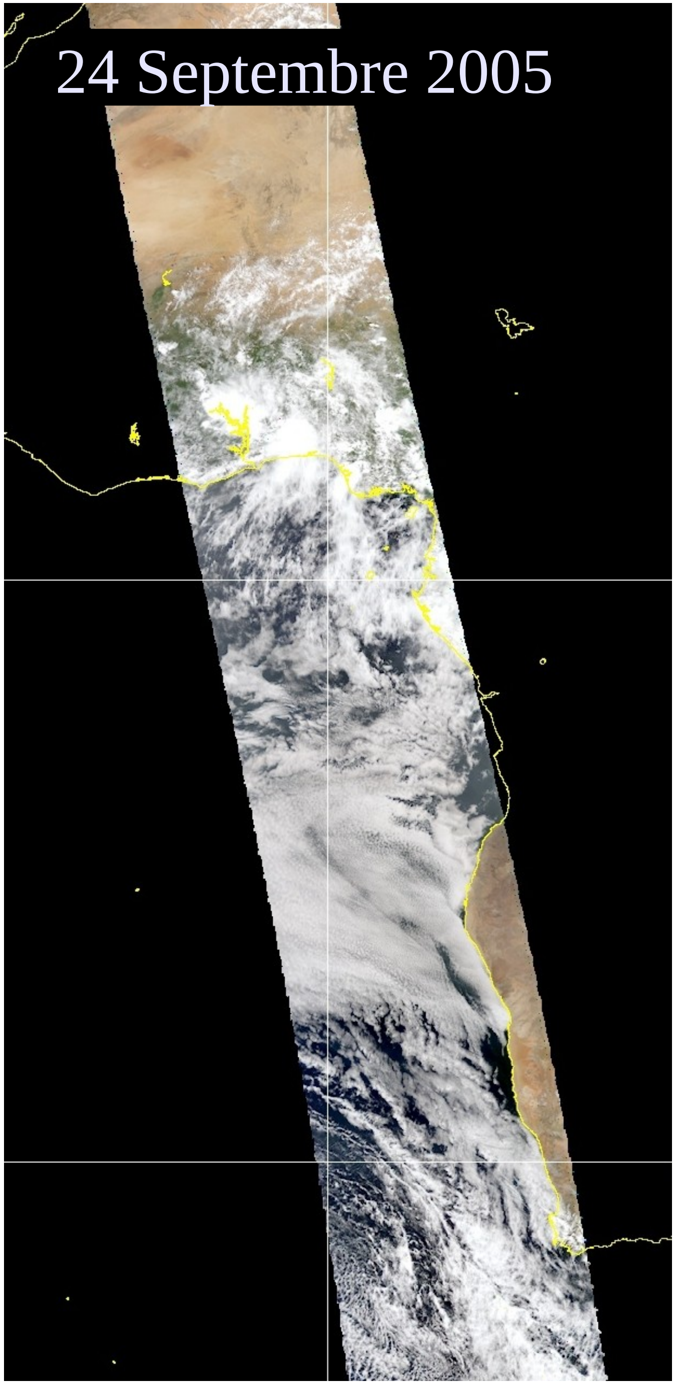


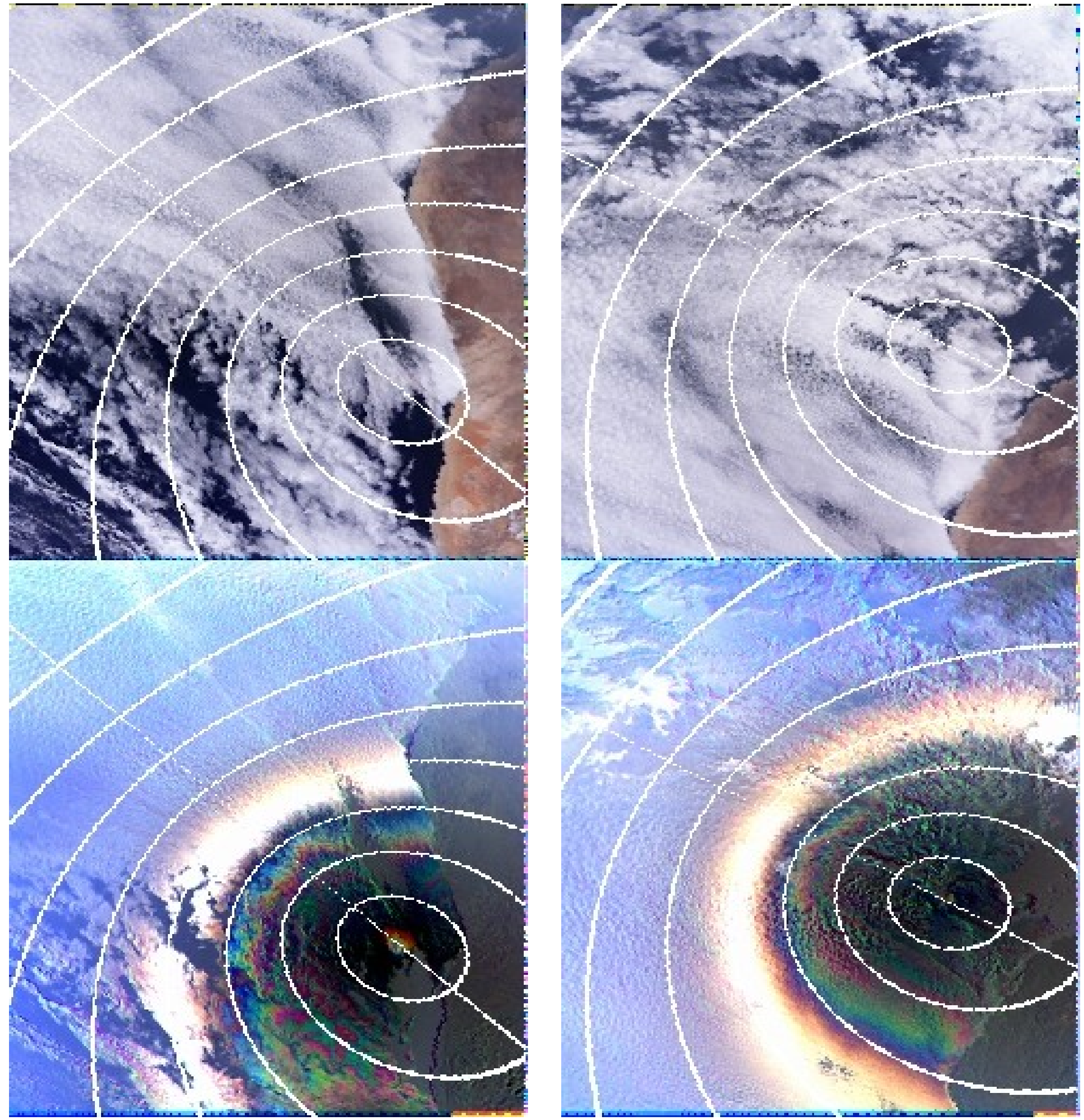
Example : aerosols over cloud



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


24 Septembre 2005



Cloud thermodynamic phase

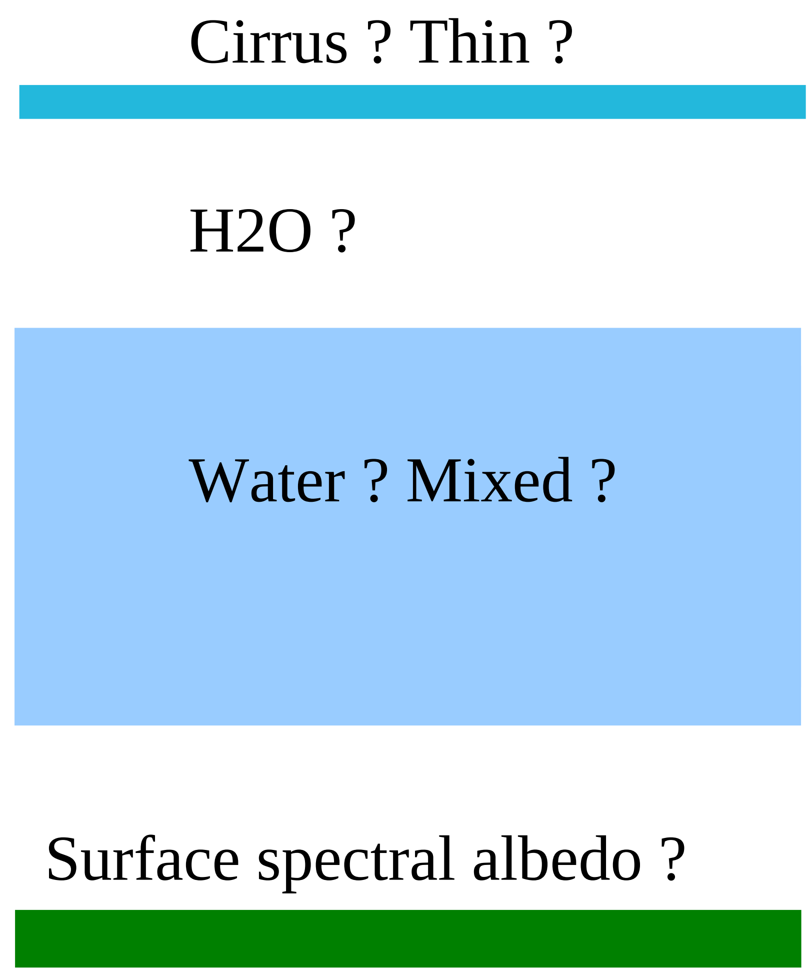
Combination of information on particle shape and absorption properties

Basis

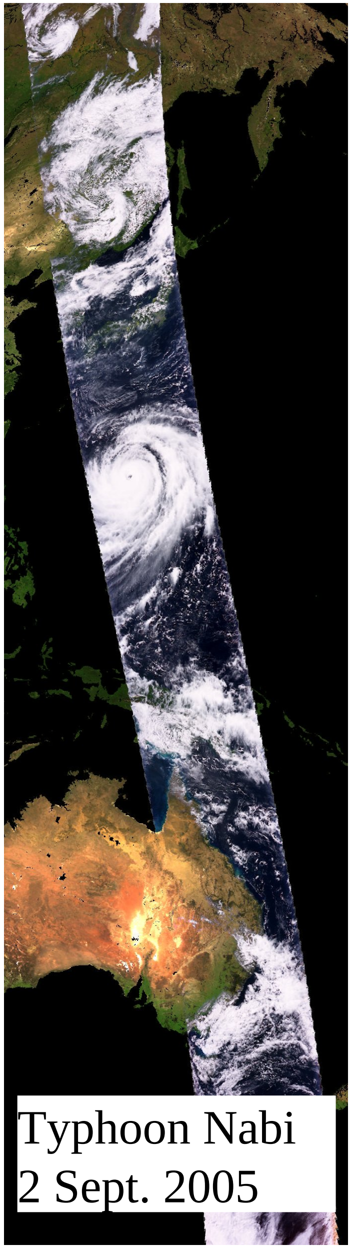
Polarization (Riedi et al)
mostly single scattering
sensitive to particle shape
Top of cloud but see through it if very thin

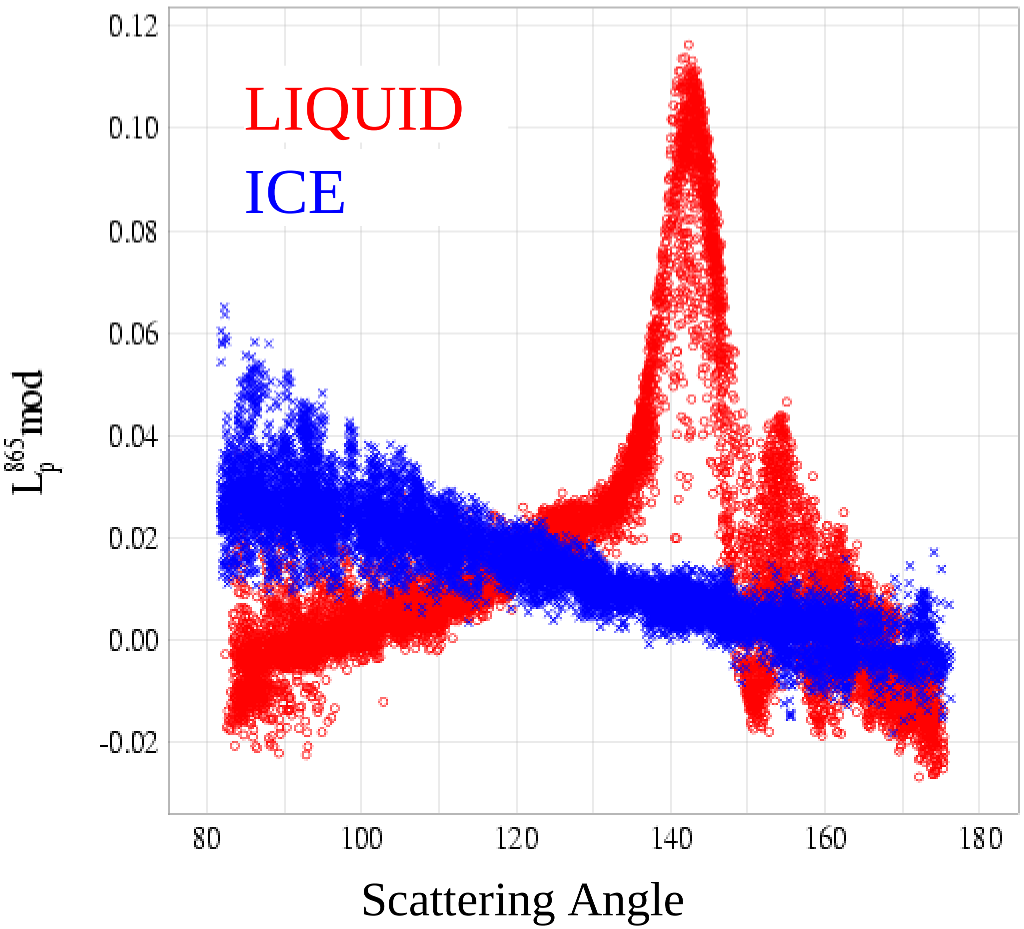
SWIR (Platnick et al)
Differential Water/Ice Absorption
sensitive to particle size
Some depth in the cloud

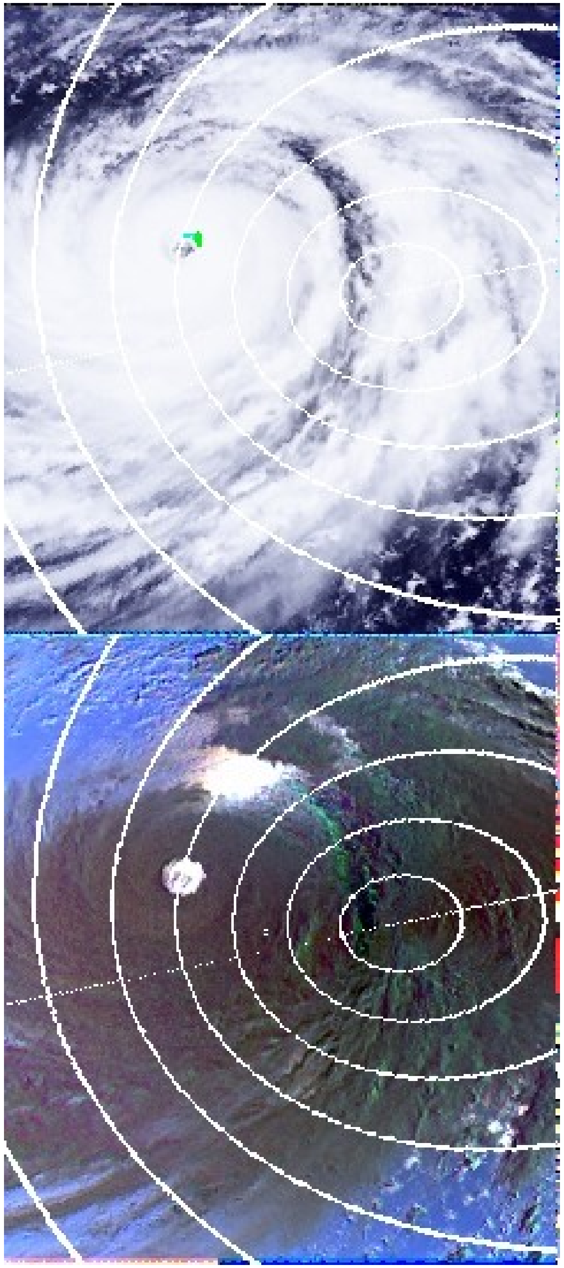
Thermal IR (Baum et al)
Diff. Water/Ice,
also sensitive to surf. emissivity, H_2O
Some depth in the cloud except thin cirrus



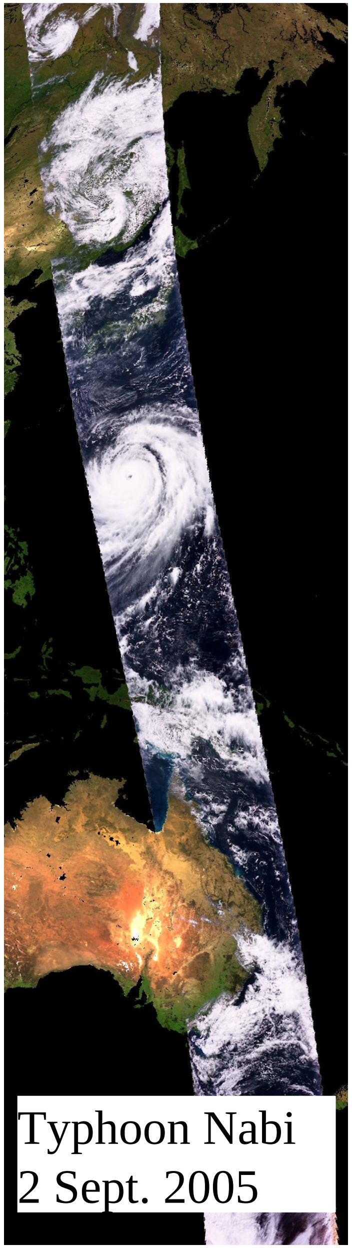
Cloud thermodynamic phase

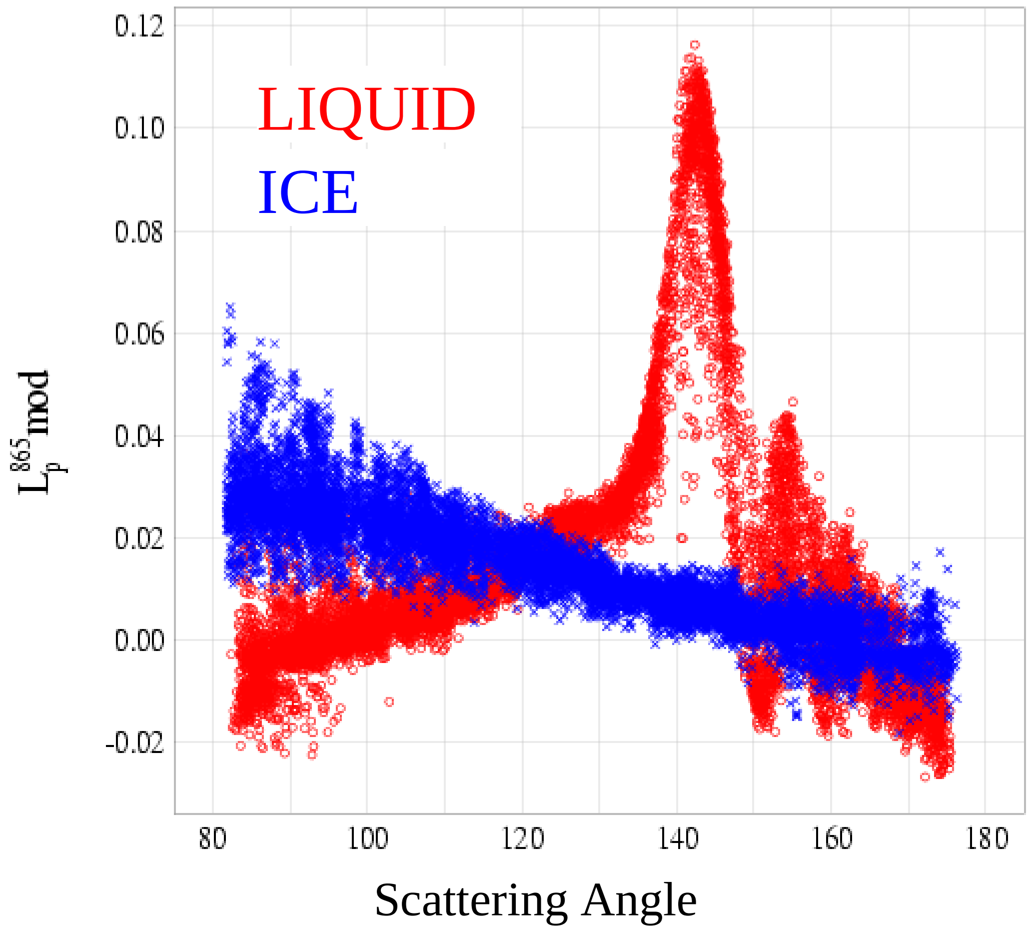


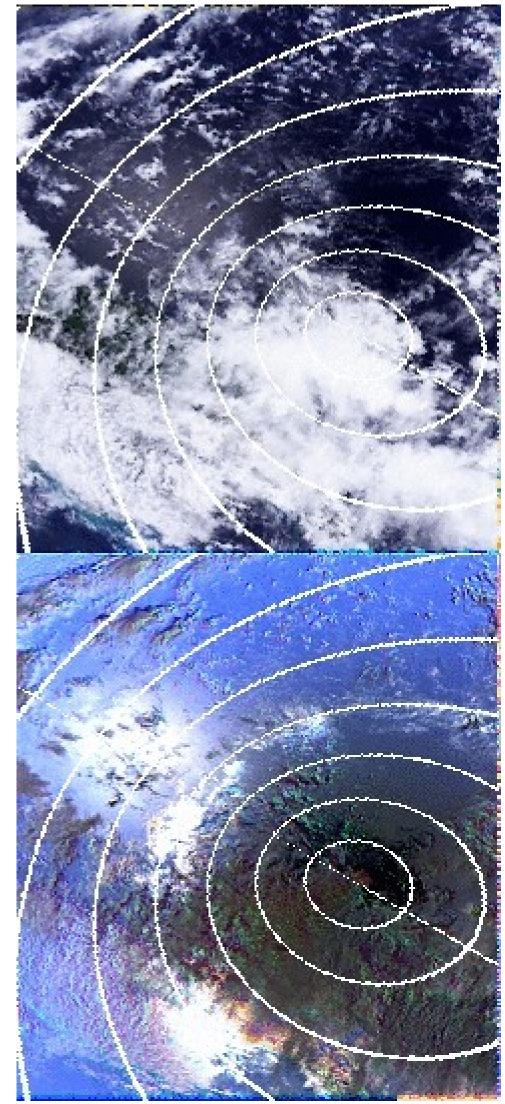




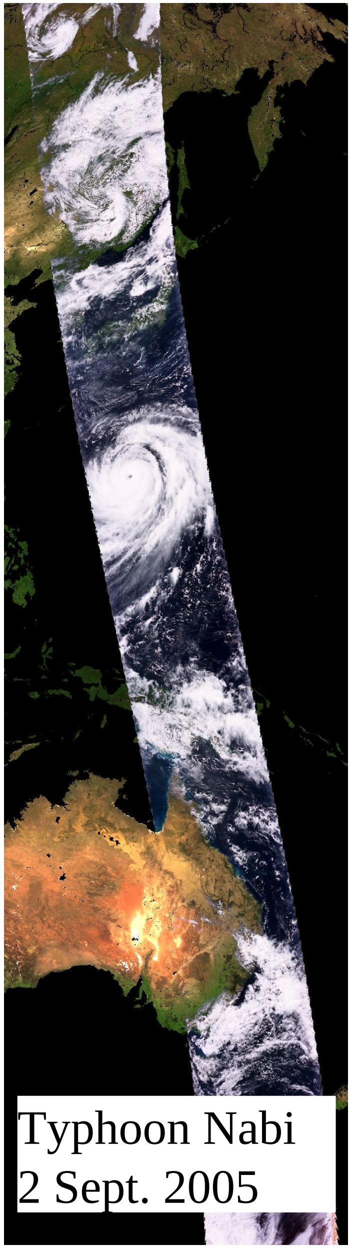
Cloud thermodynamic phase



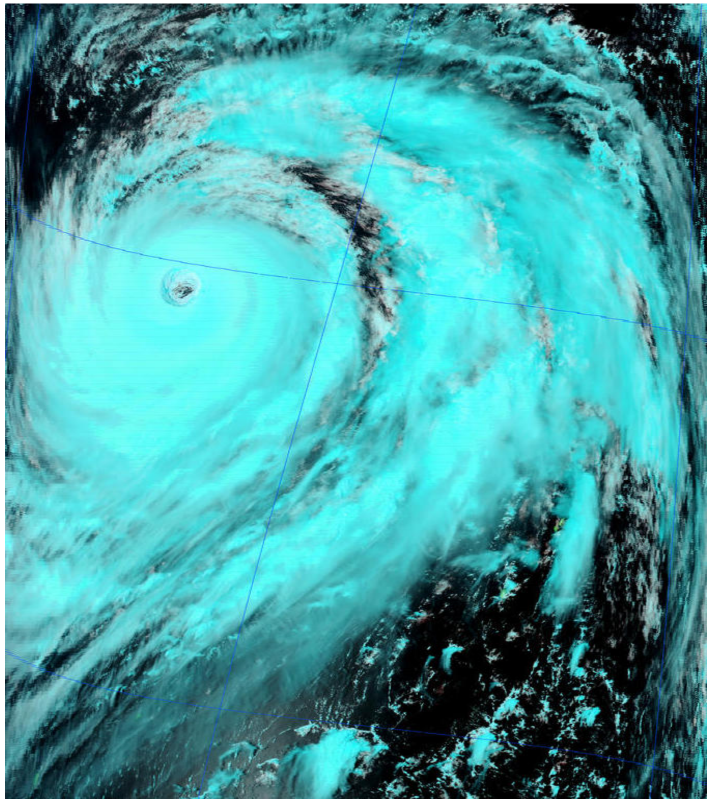




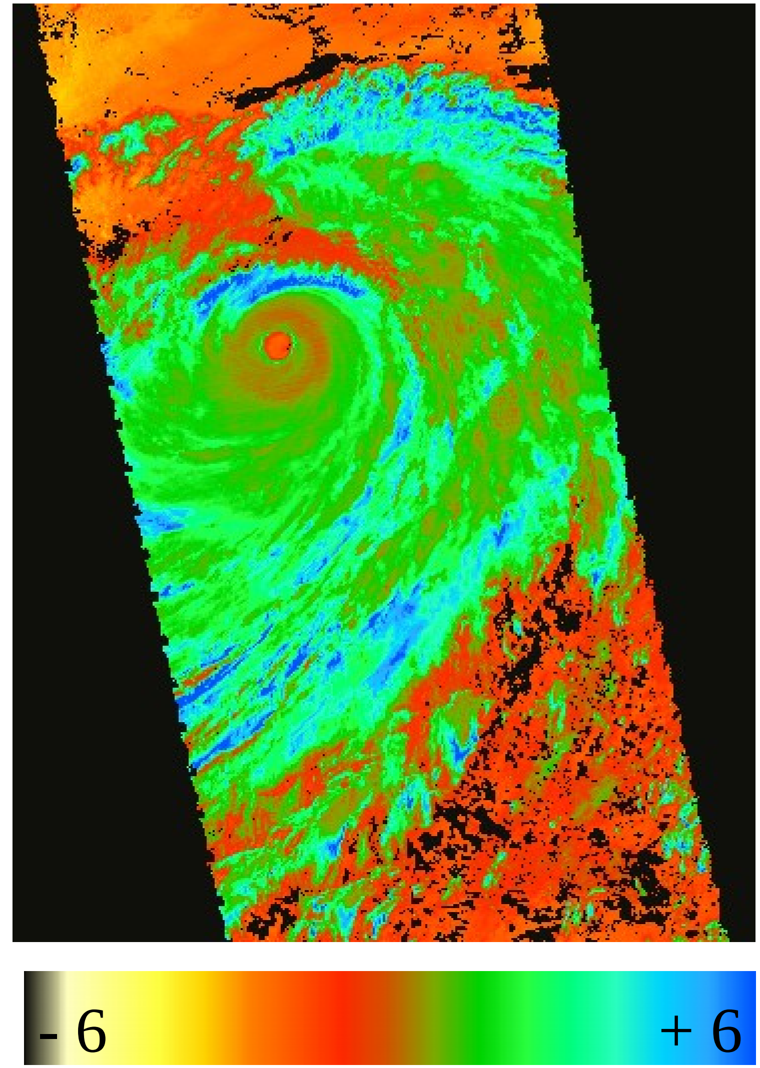
Cloud thermodynamic phase



Typhoon Nabi
2 Sept. 2005



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

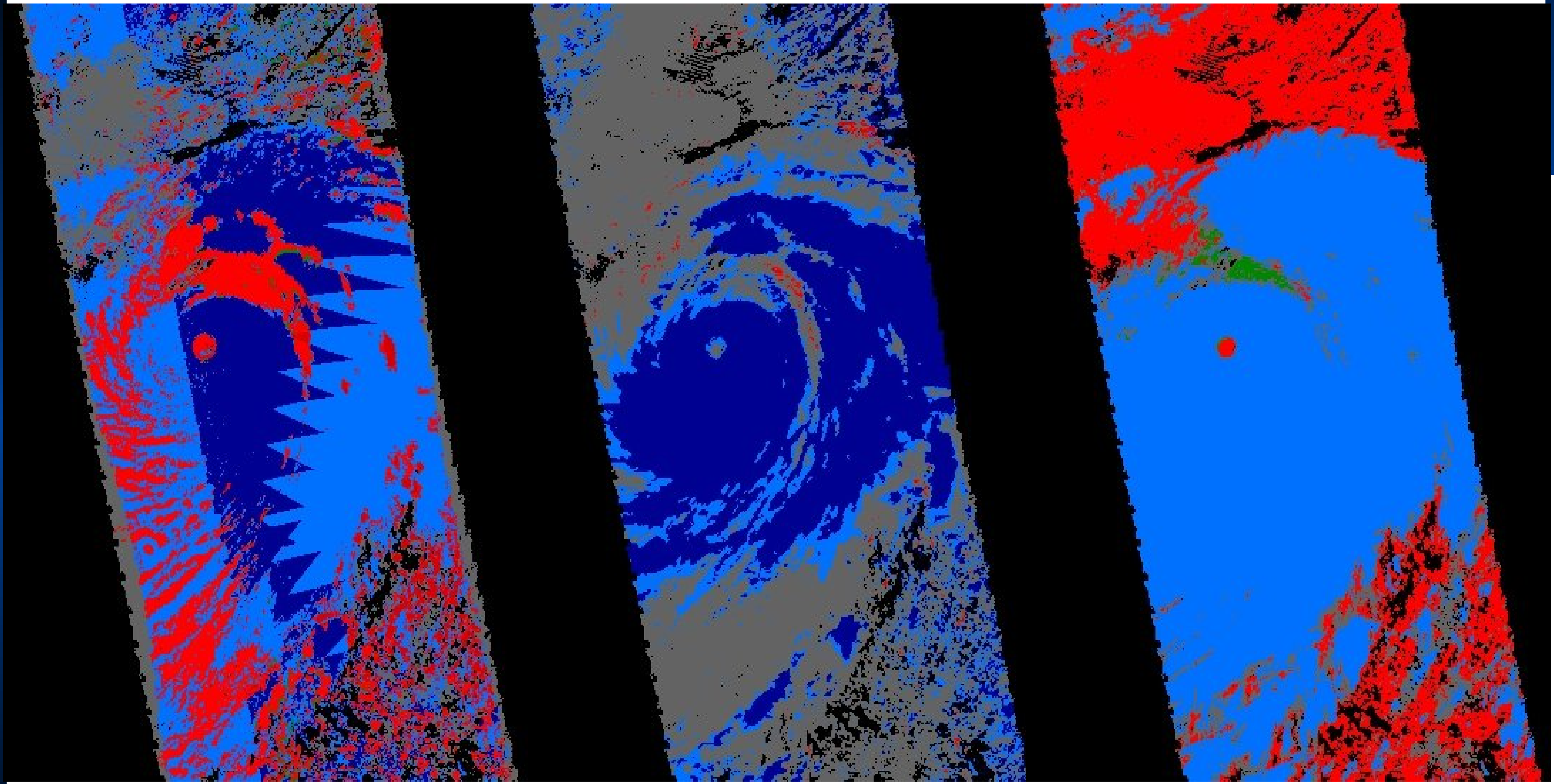


BTD 8 – 11 microns

Cloud thermodynamic phase

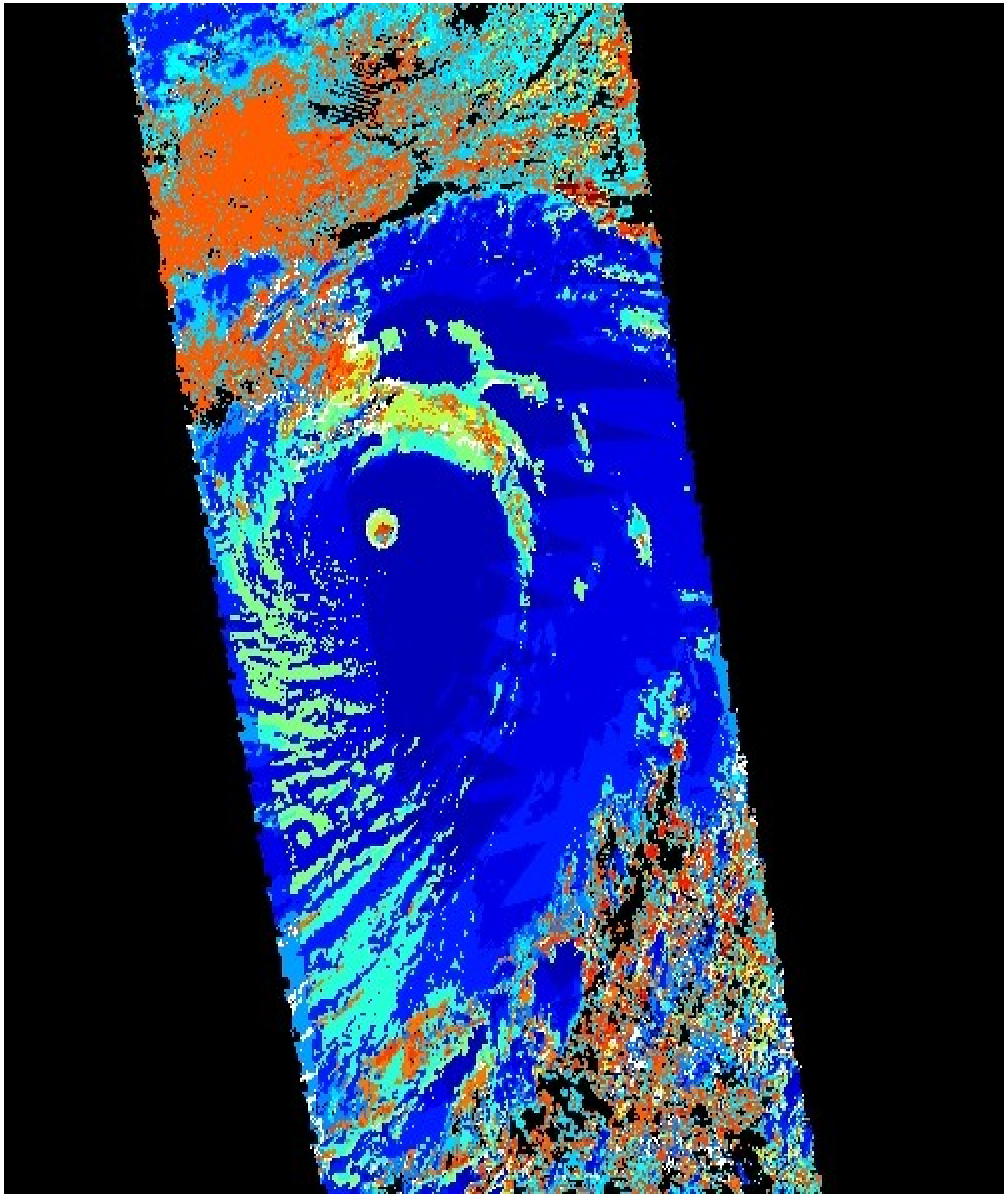
Combination of information on particle shape and absorption properties help

ICE UNKOWN LIQUID

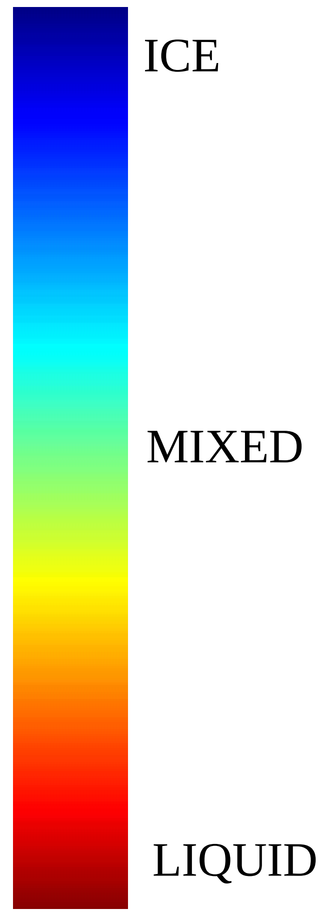


POLARIZATION SWIR/VIS Ratio IR Bispectral

Cloud thermodynamic phase



Results from the combined POLDER/MODIS phase algorithm



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

Work is undergoing to derive Tau/Re, and Cloud layers height using optimal estimate method (L. Labonnote)

Issues not addressed here : cross calibration, co-registration, ... (JM Nicolas)

Get involved : we provide users with POLDER/MODIS joint dataset and software to try out your ideas

Going operational : New products Parasol-Modis/Aqua soon available at

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

But wait ! there is more !!!

1 year of POLDER3/Parasol data finally available !!