SAFNWC/MSG Cloud products

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Plan

- Main features + validation results for Cloud products retrieved from NWCSAF/MSG SW :

  CMA cloud mask (including dust and volcanic flags)

  CT cloud type (including cloud phase flag)

  CTTH cloud top temperature and height

- Outlook for v2015

The EUMETSAT Network of Satellite Application Facilities

NWC SAF

Support to Nowcasting and Very Short Range Forecasting

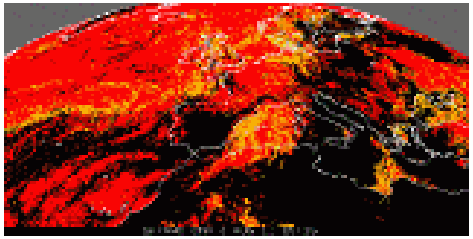
METEO FRANCE
Toujours un temps d'avance

MSG

MSG Cloud Products

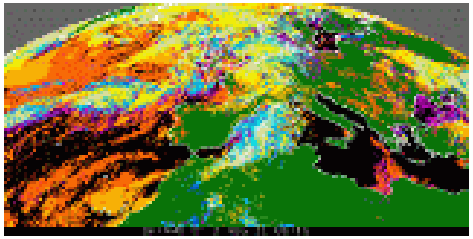
Cloud Mask

(Description)



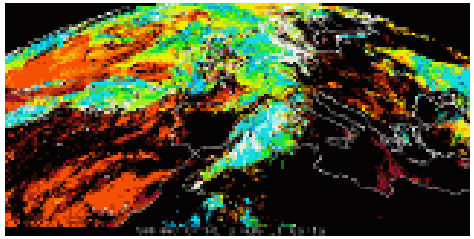
Cloud Type

(Description)



Cloud Top Temperature and Height

(Description)

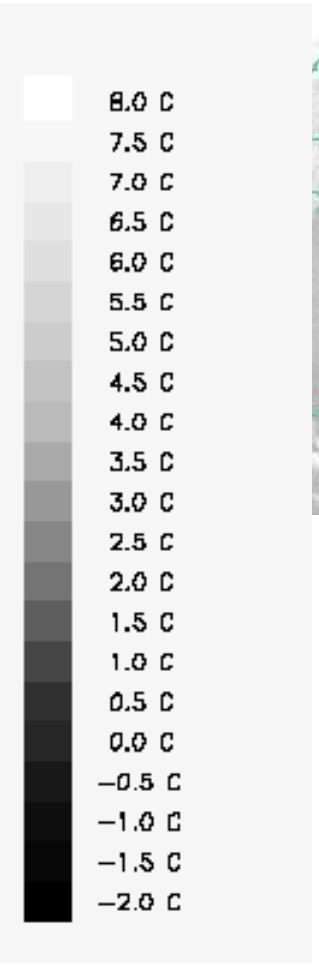


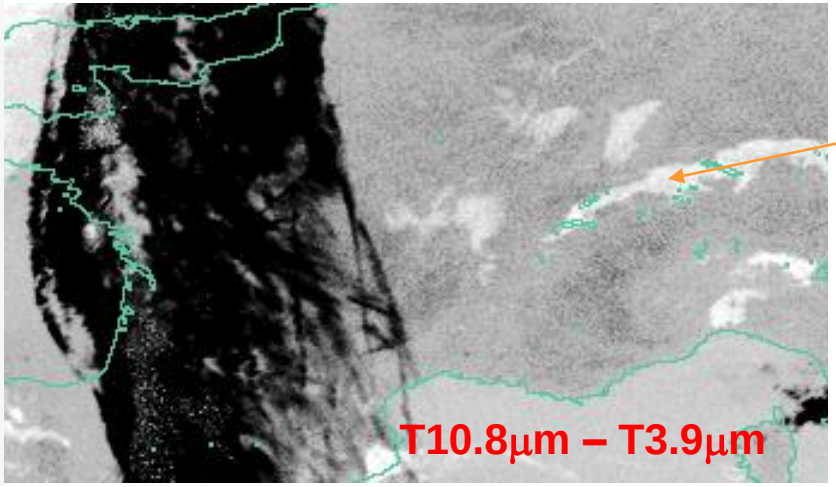
CMA algorithm: main steps

Clouds are detected in four steps:

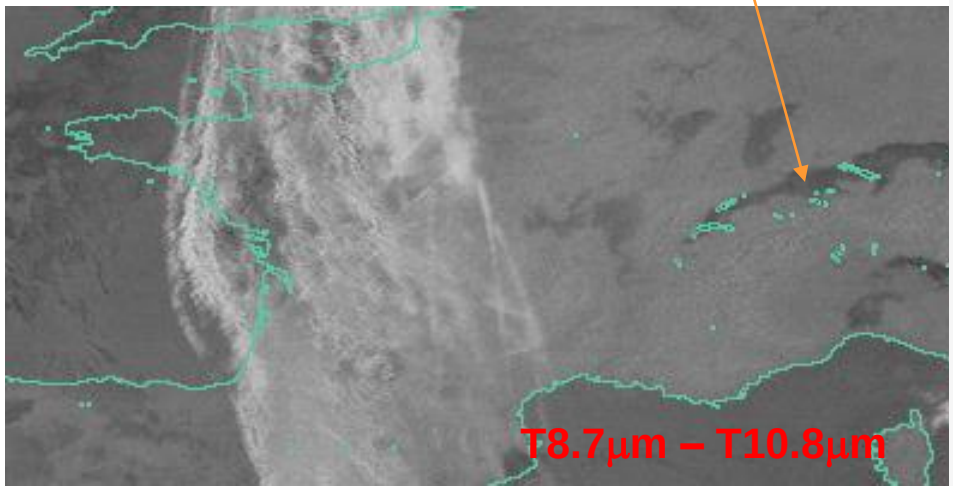
- ✓ Multispectral thresholds (applied to each slot):
  - ✓ Channel differences are compared to thresholds supposed to correspond to cloud free conditions
  - ✓ Thresholds are tabulated using radiative transfer model in cloud free conditions (RTTOV,6S)
  - ✓ Atlas and NWP fields allow to describe surface and atmosphere
- ✓ Temporal analysis : to detect thin rapidly moving clouds
- ✓ Twilight processing: to detect clouds at day-night transition and thin rapidly moving clouds
- ✓ High resolution analysis (HRV): to detect sub-pixel clouds such as cumulus

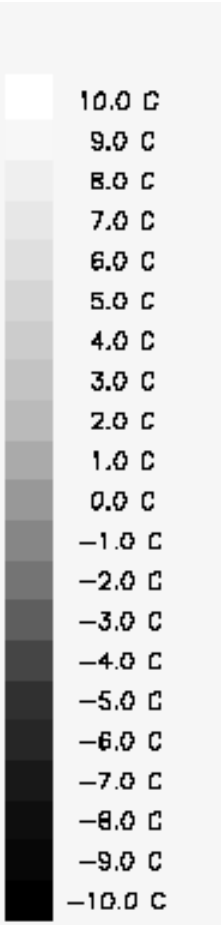
CMA algorithm: illustration of multispectral threshold

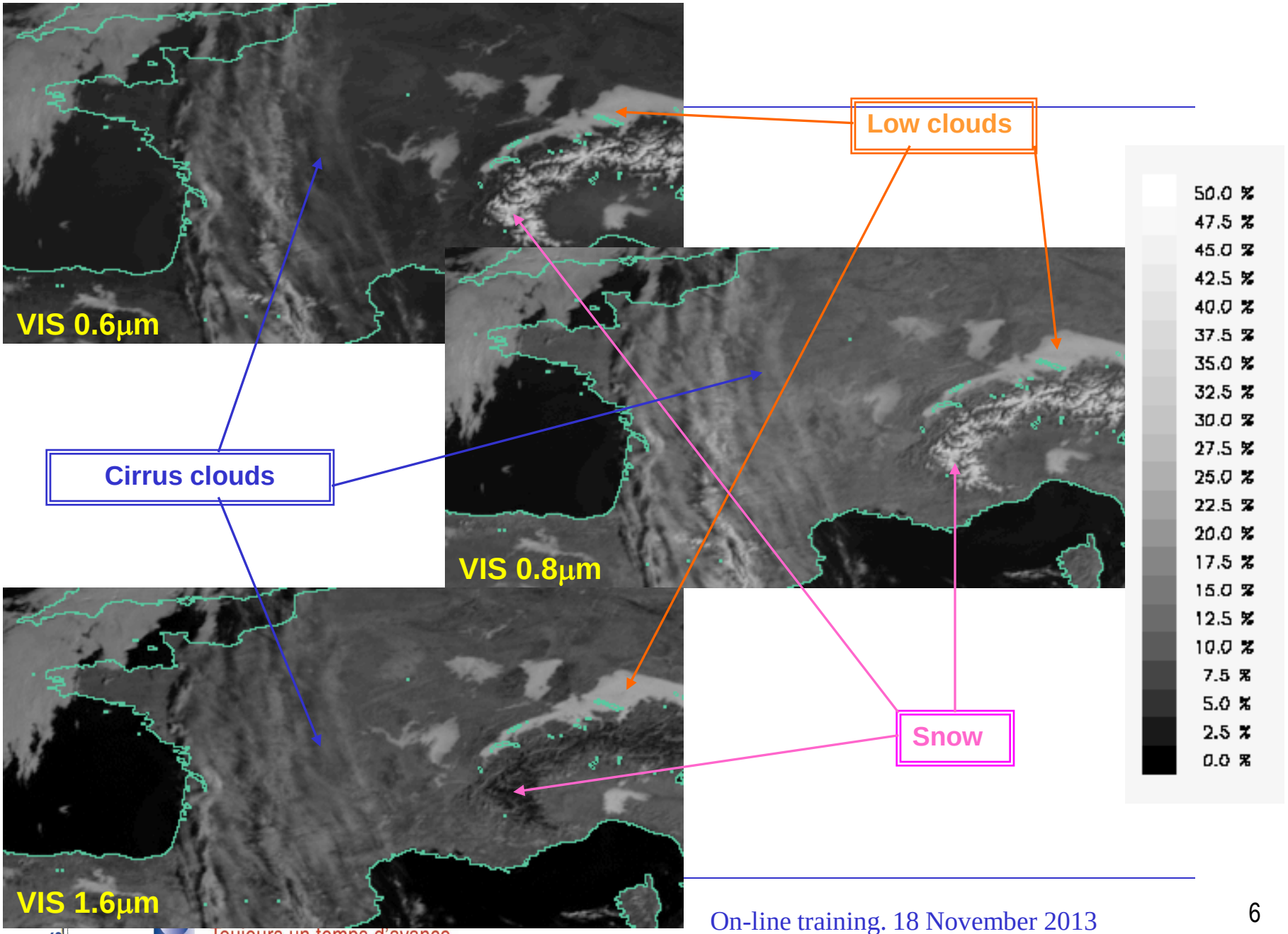




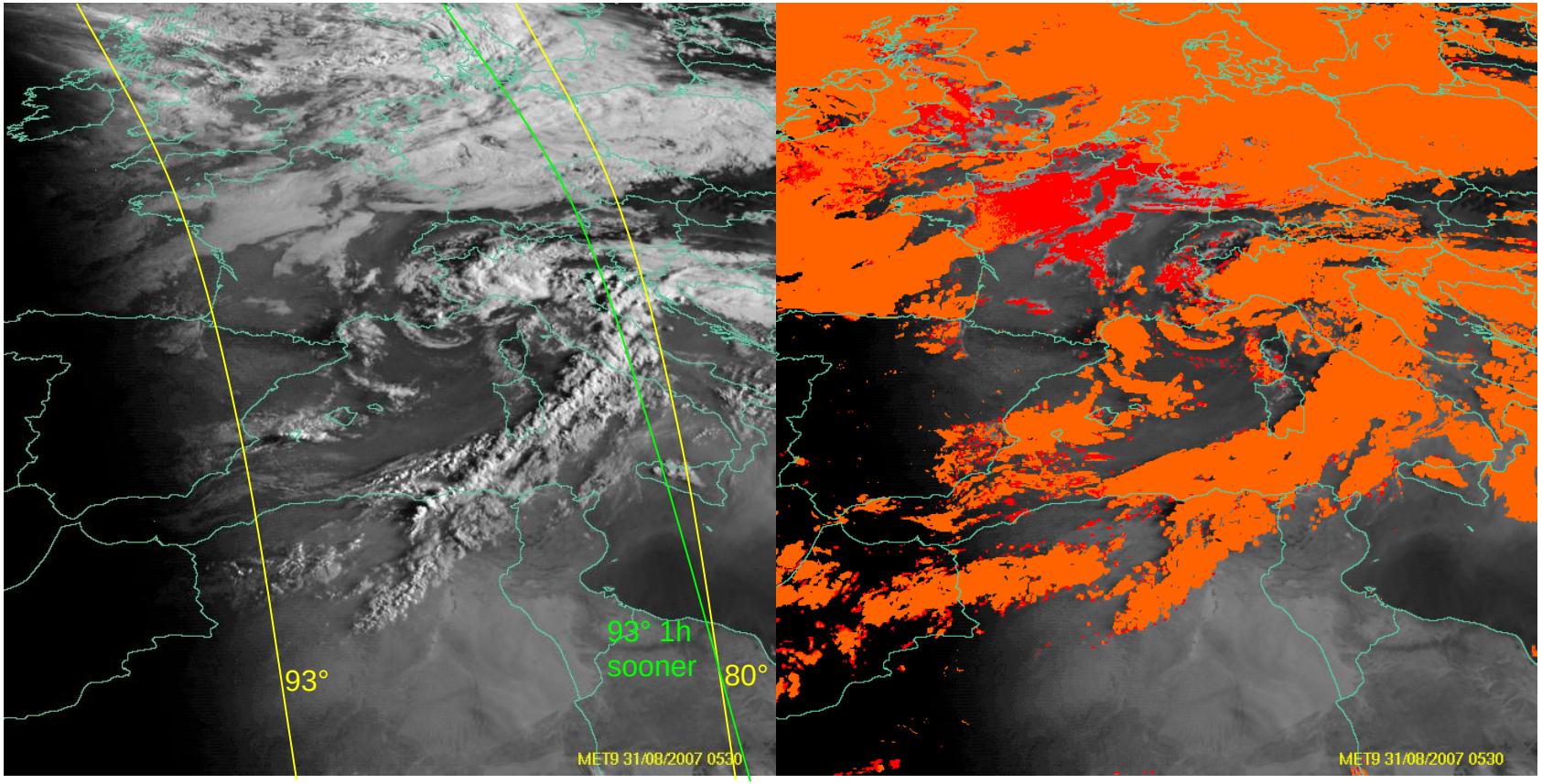
Low clouds





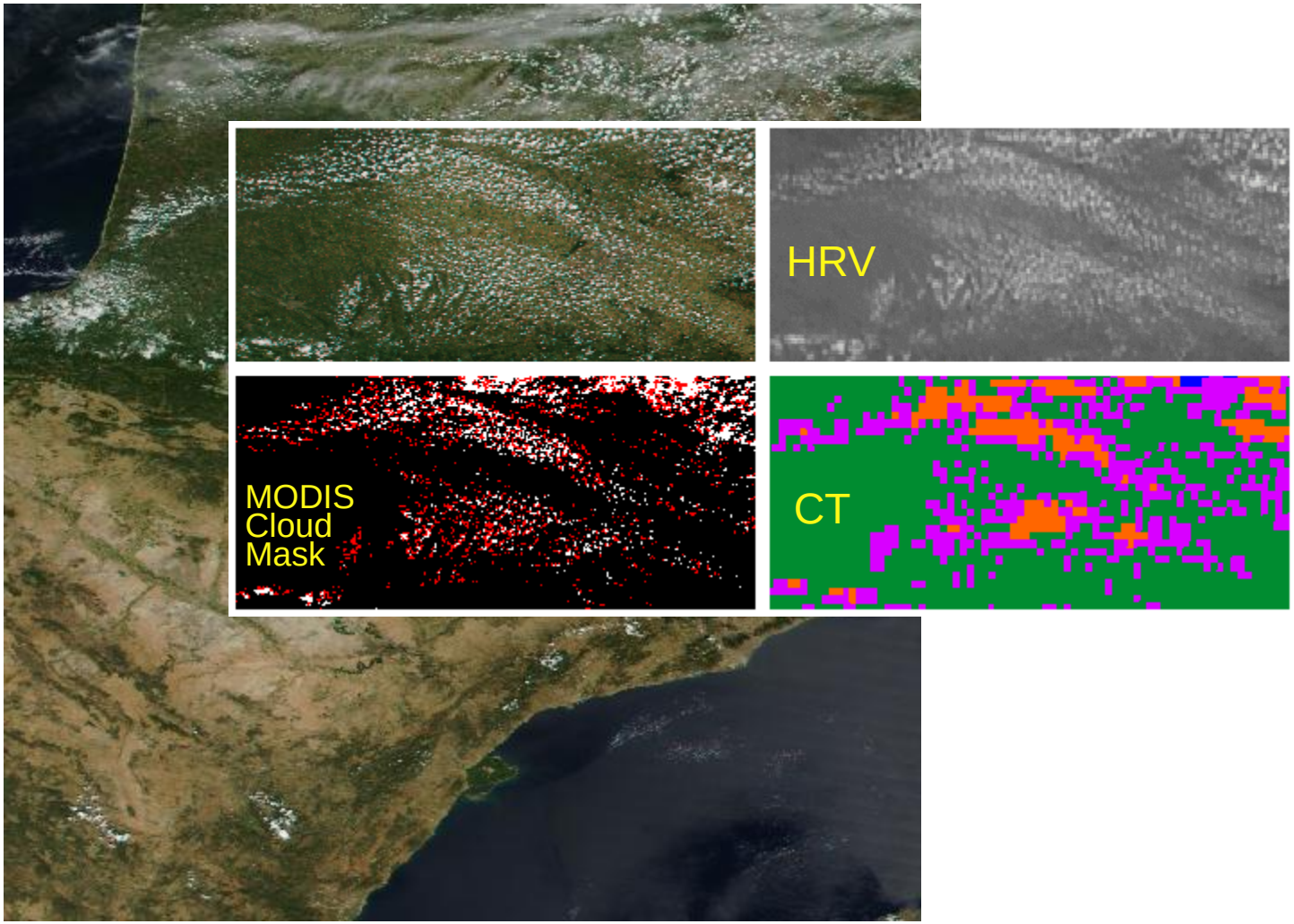

VIS 0.6µm
VIS 0.8µm
VIS 1.6µm
Low clouds
Cirrus clouds
Snow
50.0 %
47.5 %
45.0 %
42.5 %
40.0 %
37.5 %
35.0 %
32.5 %
30.0 %
27.5 %
25.0 %
22.5 %
20.0 %
17.5 %
15.0 %
12.5 %
10.0 %
7.5 %
5.0 %
2.5 %
0.0 %

CMA algorithm: illustration of twilight processing



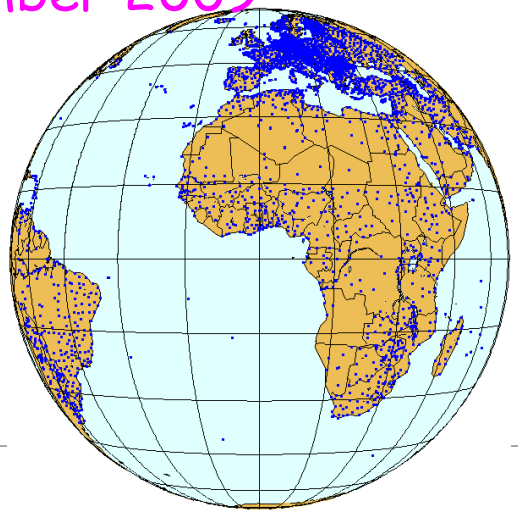
Cloud mask + **temporal scheme** superimposed on BRF 0.6 μm

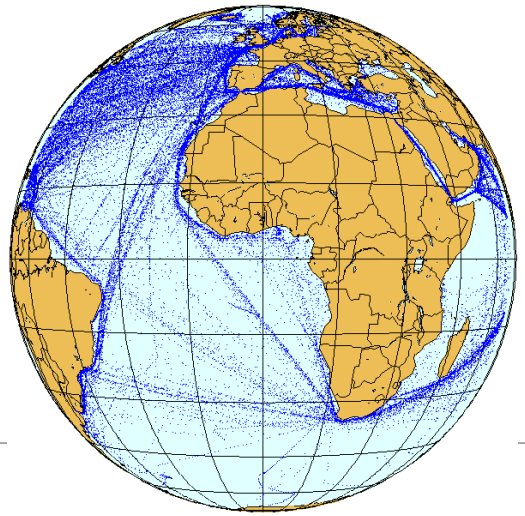
CMA algorithm: illustration of HRV processing



CMA algorithm: validation

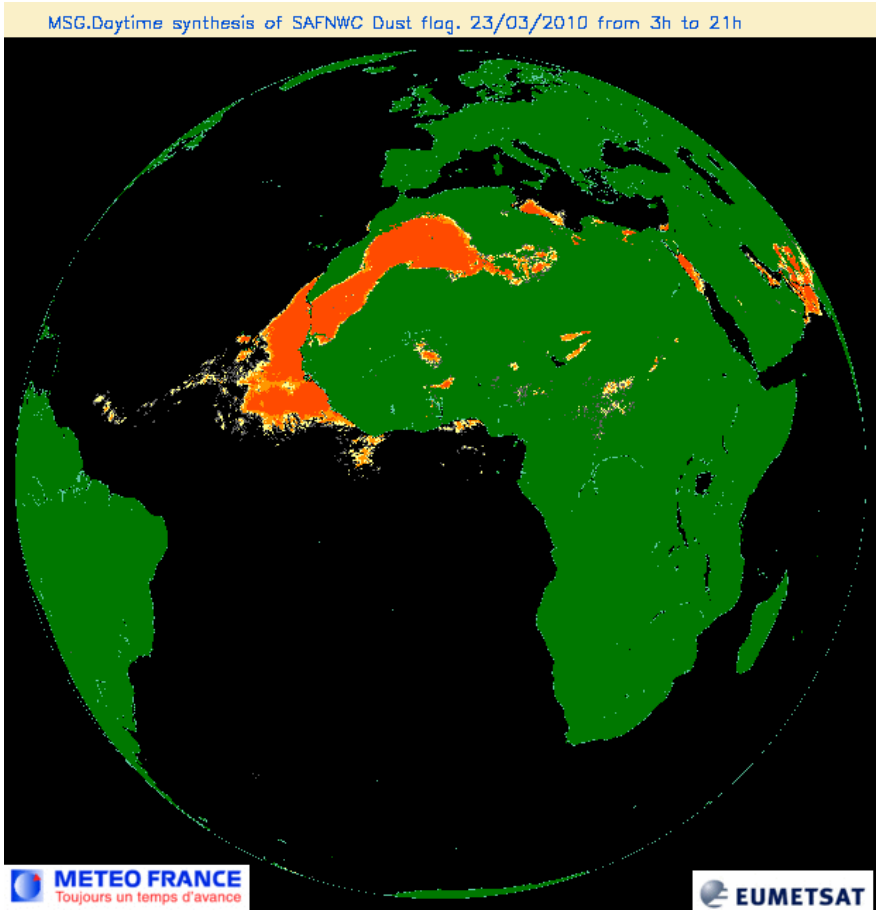
October 2009-December 2009



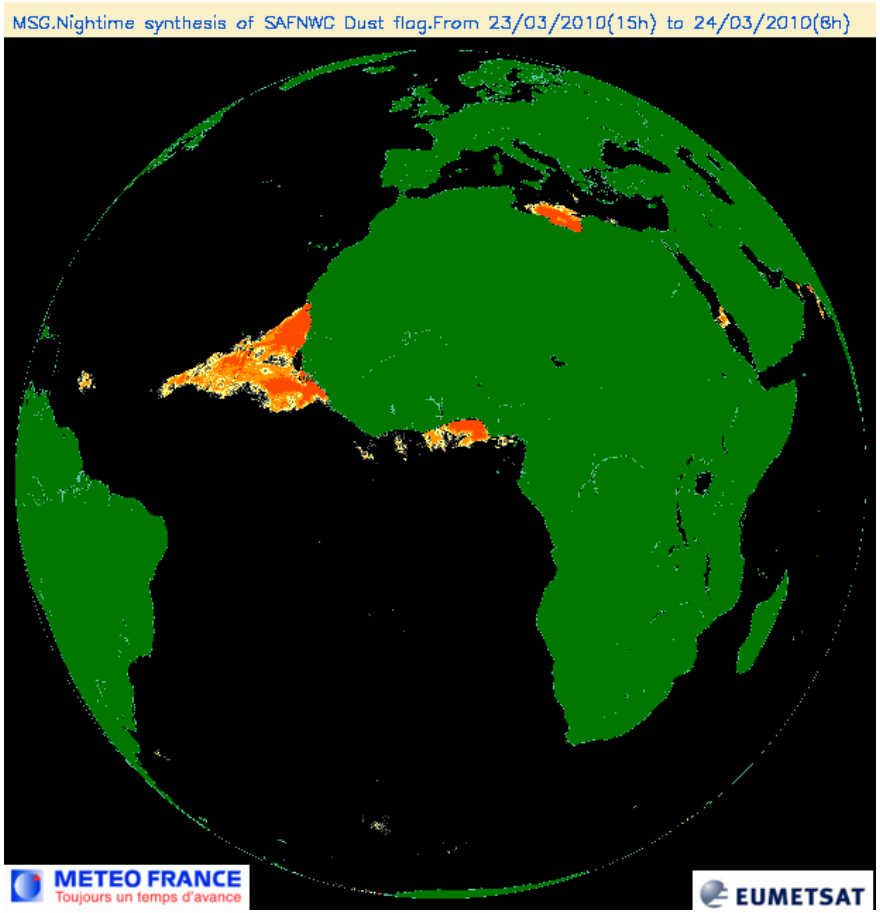


	POD (%)	**FAR (%)**	**POD (%)**	**FAR (%)**
All	94.3	6.5	96.3	14.9
Daytime	96.1	4.4	96.8	10.3
Night-time	93.4	8.4	95.6	20.3
Twilight	93.5	4.0	96.9	8.3

CMA algorithm: dust flag



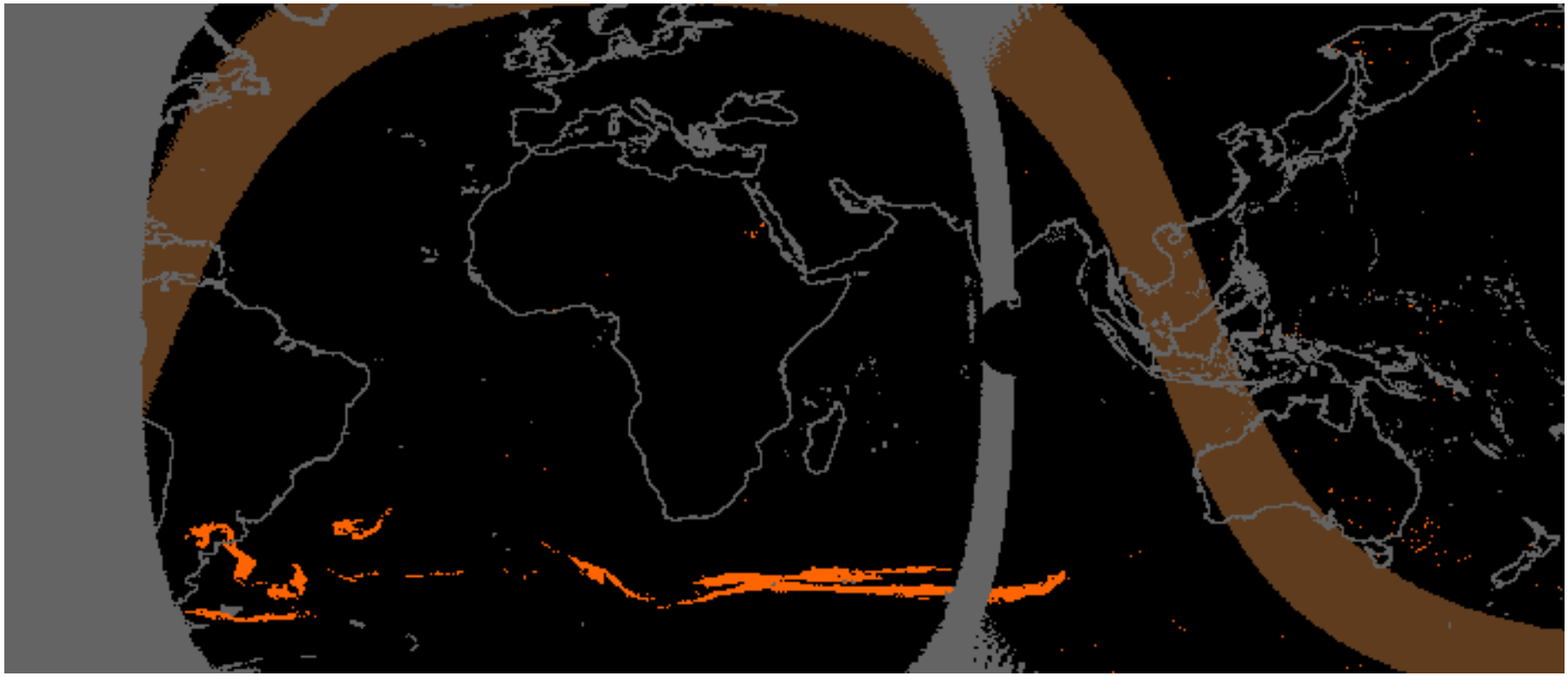
Daytime dust flag



Night-time dust flag

CMA algorithm: volcanic ash (Puyehue, Chile)

June 2011



CT algorithm: main steps

Cloudy pixels are classified according their radiative characteristics:

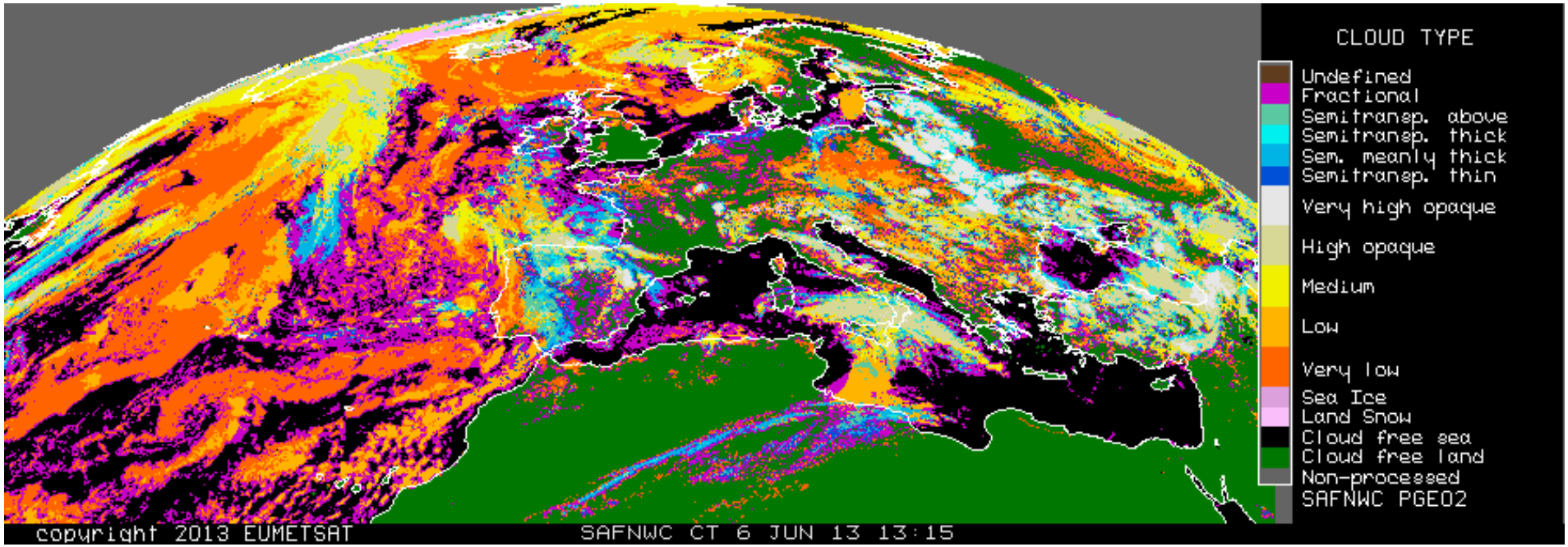
- ✓**Semi-transparent and fractional clouds** are distinguished from low/medium/high clouds using spectral features:
  low T10.8μm-T12.0μm, low T8.7μm-T10.8μm
  high T10.8μm-T3.9μm (night), high R0.6μm (day)
- ✓**Low, mid-level and high** clouds are then separated by comparing their T10.8μm to combination of NWP forecast temperature at various pressure levels [850, 700, 500 hPa and at tropopause levels].

CT algorithm: low/mid-level separation

Low clouds may be wrongly classified as mid-level clouds in the presence of a thermal inversion. Two approaches are used to minimise the confusion:

- ✓ mid-level clouds are reclassified as low clouds if T10.8μm-WV73μm is « large »
- ✓ mid-level clouds are reclassified as low clouds if a low level thermal inversion is detected in the NWP fields input by the user and if T8.7μm-T10.8μm is lower than a threshold (decreasing with viewing angles)

CT algorithm: exemple



CT algorithm: limitations

Stability of CT classifier to illumination (except snow)

Very thin clouds may be classified as fractional

Low clouds surmounted by thin cirrus may be classified as mid-level.

CT algorithm: cloud phase

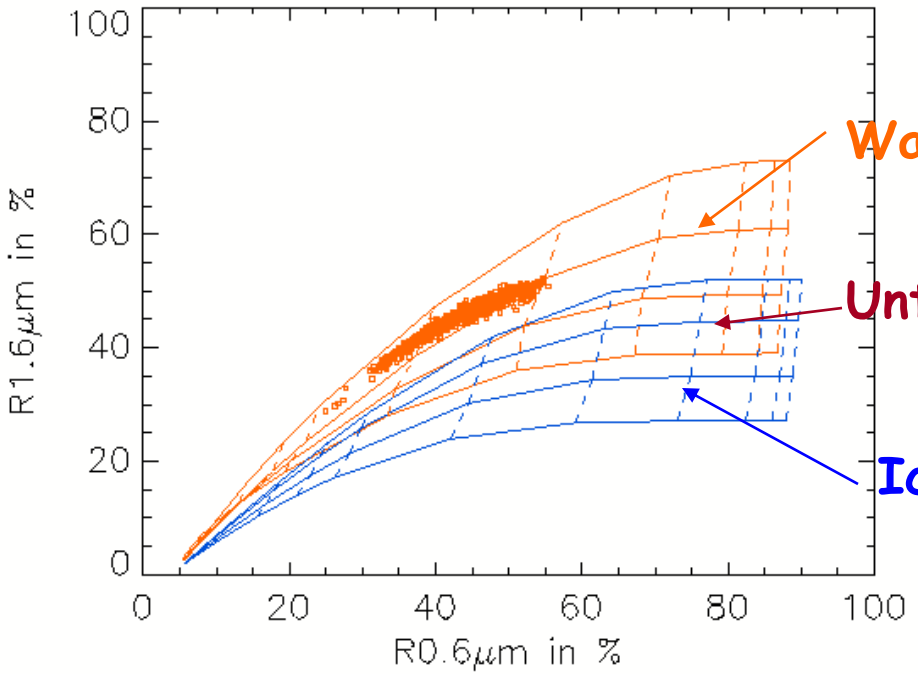
The cloud phase identification is based on two steps: the first one is summarized in the following table:

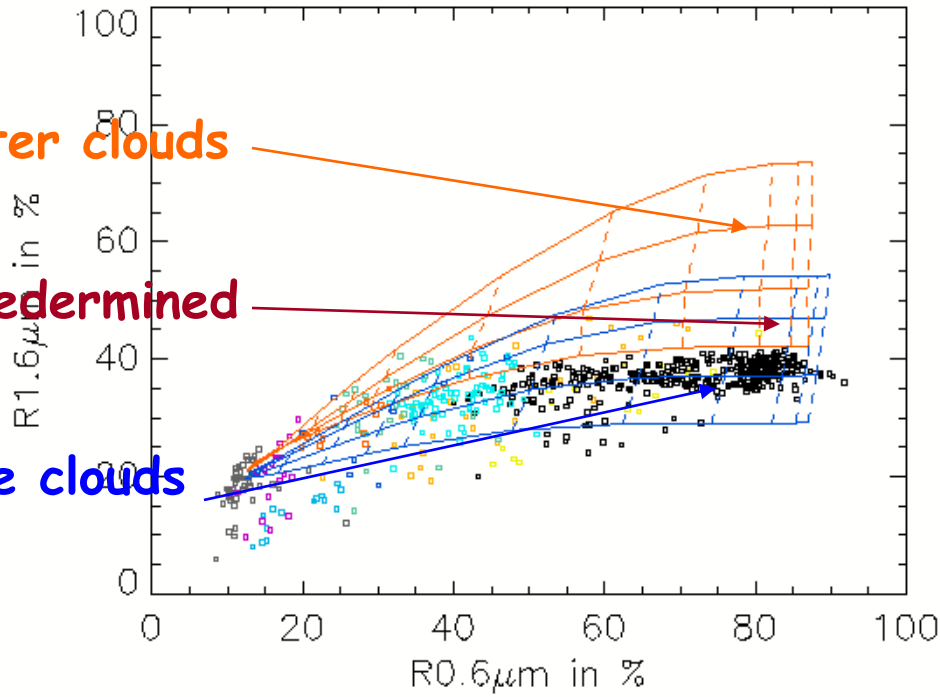
Water clouds	Ice clouds
	Classified as high-semitransparent or
opaque & T10.8 > 273.15K or	opaque & T10.8 < 233.15K or
opaque & T8.7-T10.8 < thres_wat(satzen)	opaque & T8.7-T10.8 > thres_ice(satzen)

If status is still « **undetermined** », a second step is applied daytime: it is based on simulated cloud reflectance (at 0.6μm and 1.6μm) and is illustrated next slide

CT algorithm: cloud phase

Curves: Simulated R0.6μm and R1.6μm for 4 water clouds and 4 ice clouds.
Dots: SEVIRI R0.6μm and R1.6μm measurements





Oceanic Stratocumulus

Convective system (France)

CTTH algorithm:

✓Objective: retrieve height from MSG/SEVIRI temperatures

-> Needed: Vertical temperature & humidity profile forecast by NWP

-> Computed: TOA radiances from the top of overcast opaque clouds put at various pressure levels are simulated with RTTOV

CTTH algorithm: methods

For opaque clouds (known from CT)
The cloud top pressure corresponds to the best fit between the simulated and measured 10.8μm radiances

For semi-transparent clouds :
10.8μm radiances contaminated by surface
-> Cloud top pressure computed from a window channel 10.8μm and a sounding channel (13.4μm, 7.3μm or 6.2μm)

For broken low clouds
No technique has been implemented.

Illustration for low clouds

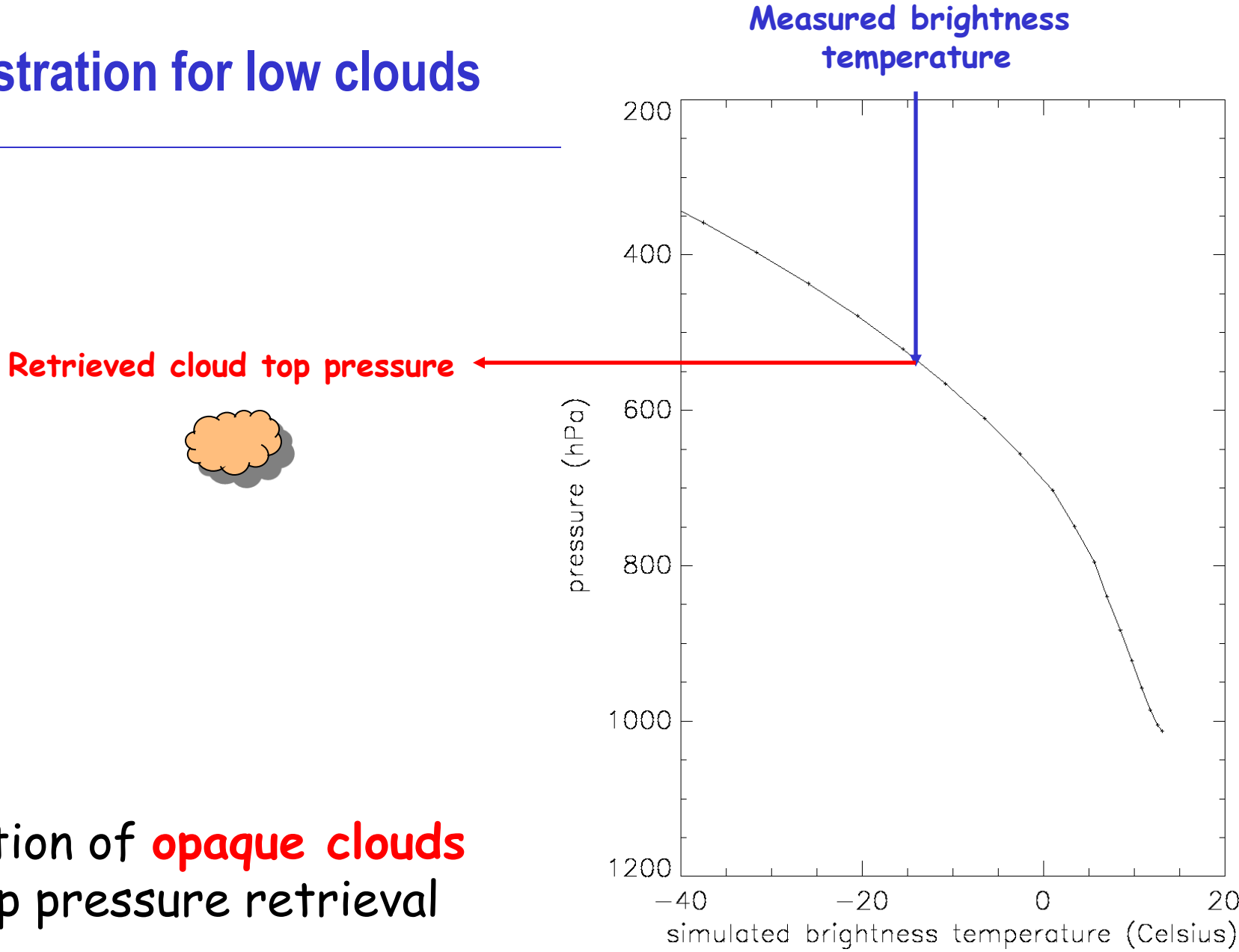


Illustration of **opaque clouds** cloud top pressure retrieval

Illustration for low cloud

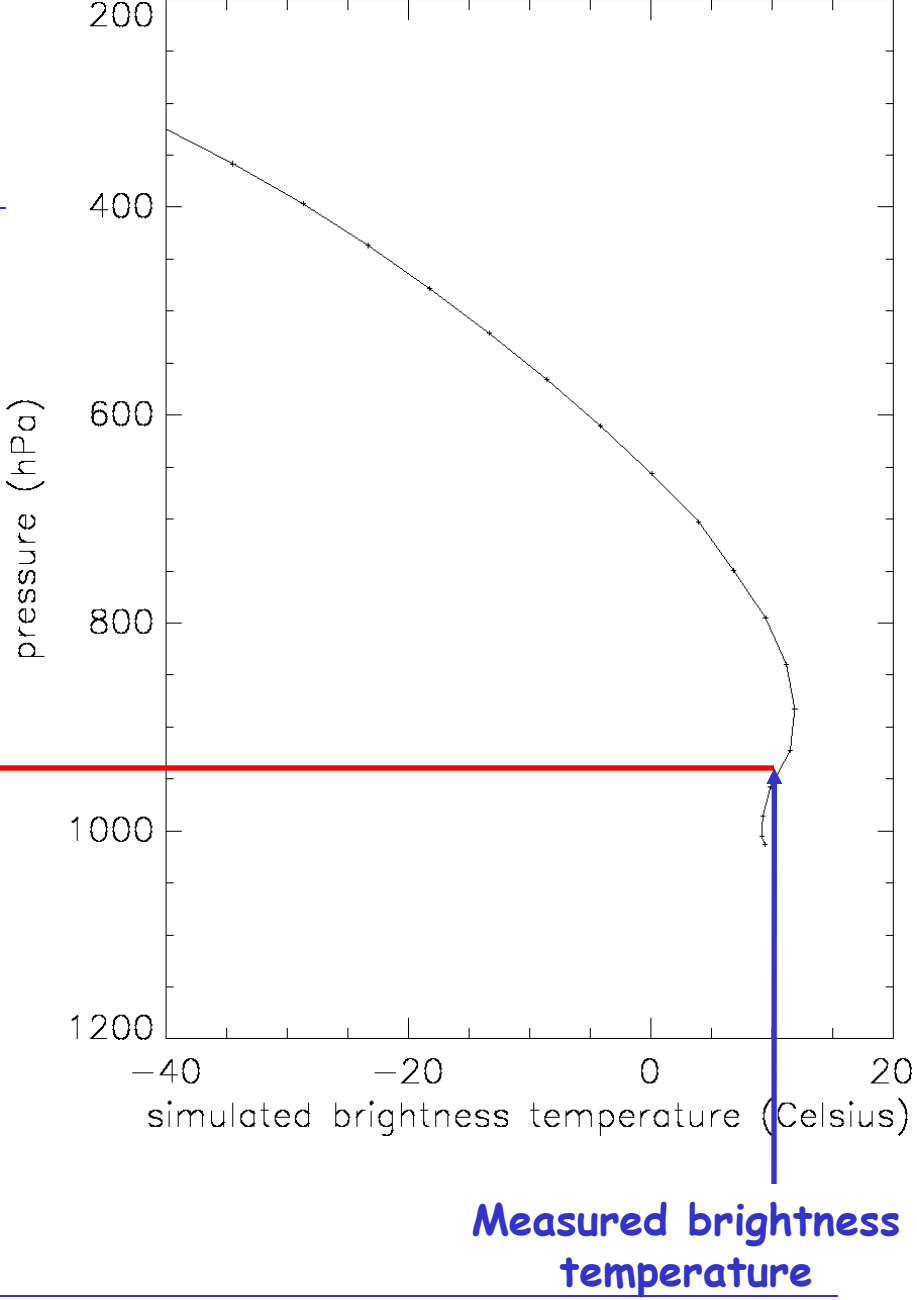
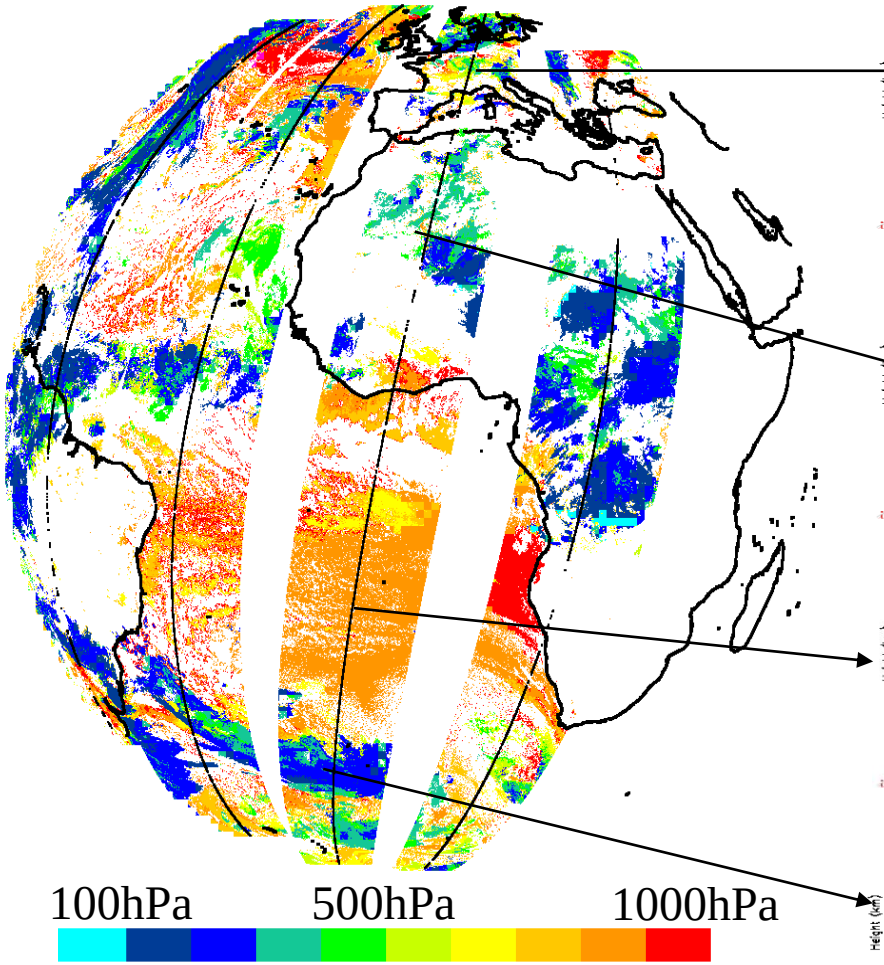


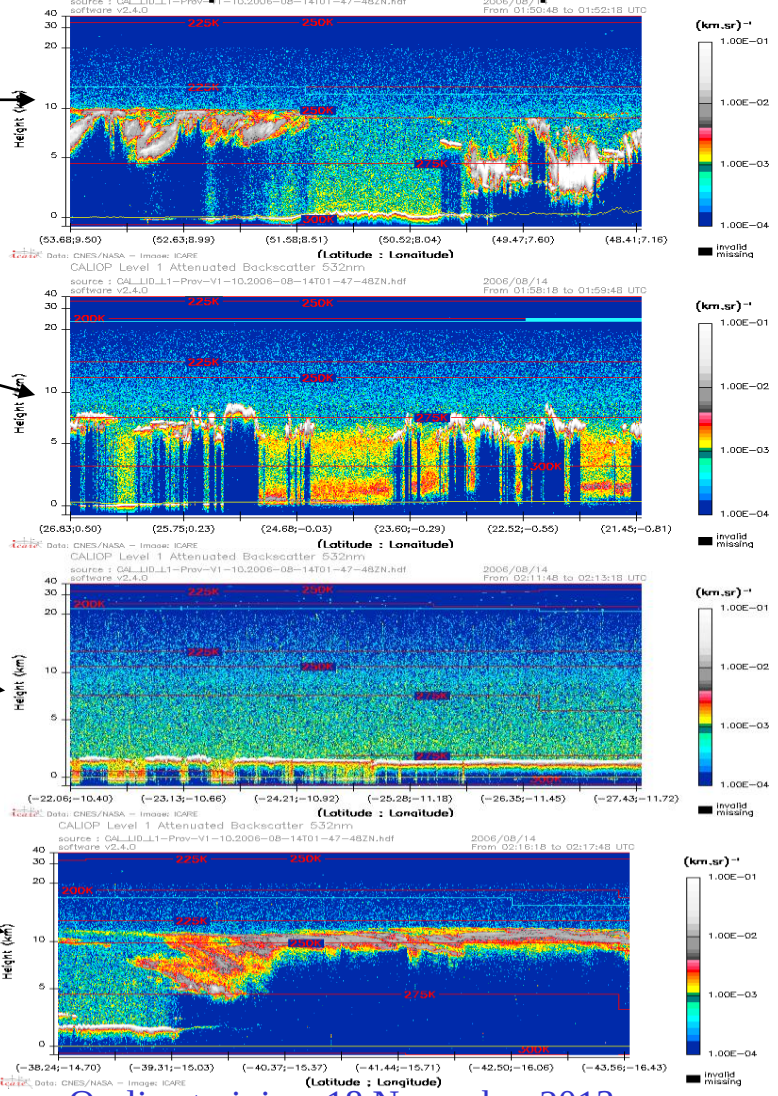
Illustration of **opaque clouds** cloud top pressure retrieval in case thermal inversion

CTTH algorithm: validation with Caliop

CTTH computed from SEVIRI

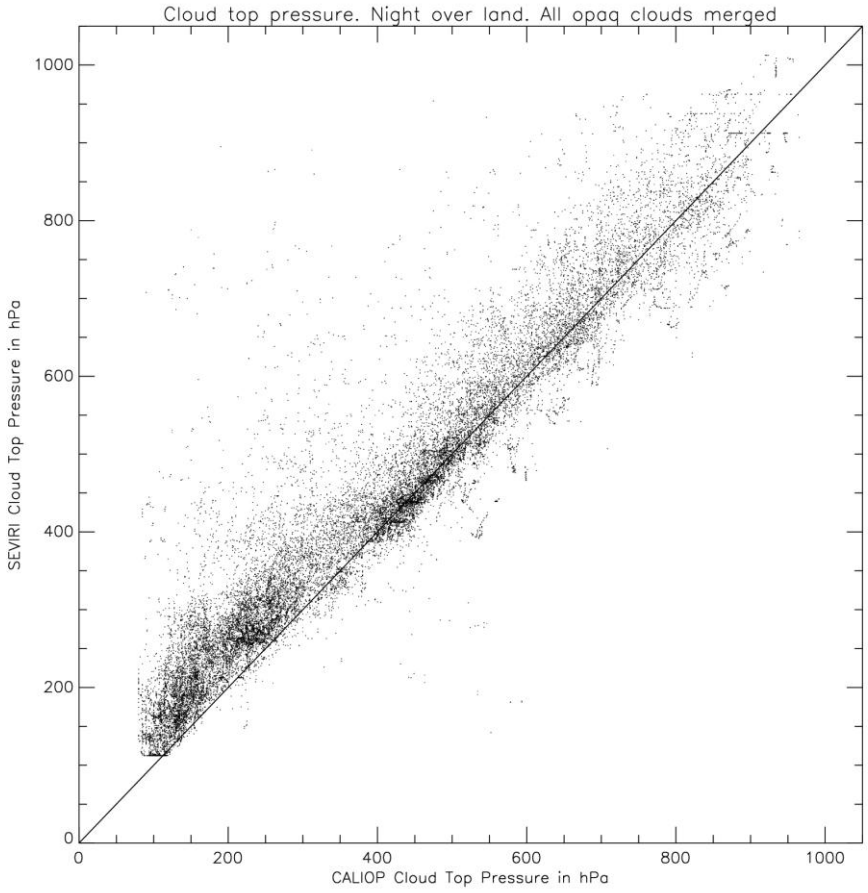


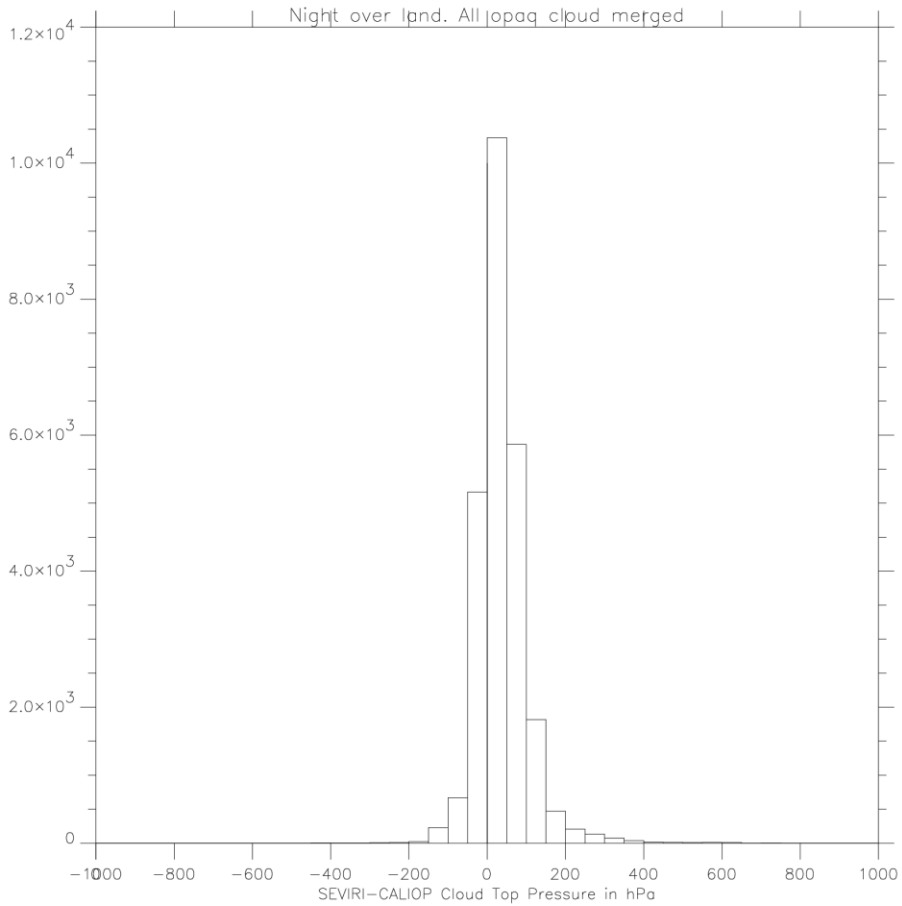
Caliop backscatter profile



CTTH algorithm: validation with Caliop

Opaque clouds over land in night-time conditions





Outlook for v2015

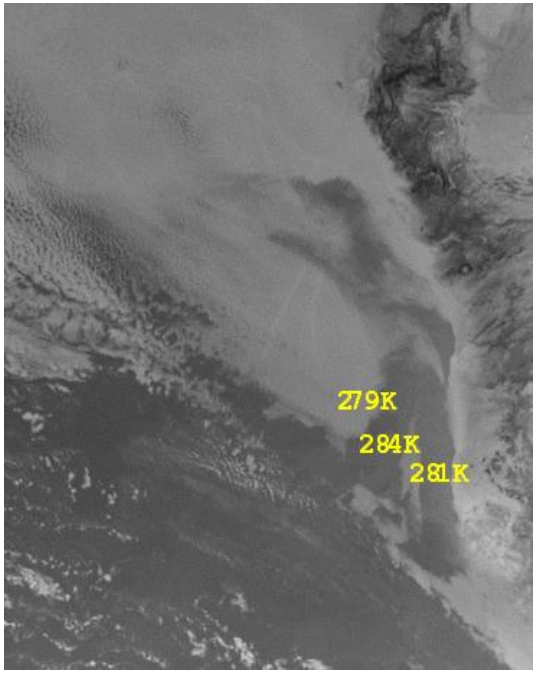
New cloud product: cloud microphysics

Use of RTTOV on-line to improve cloud detection

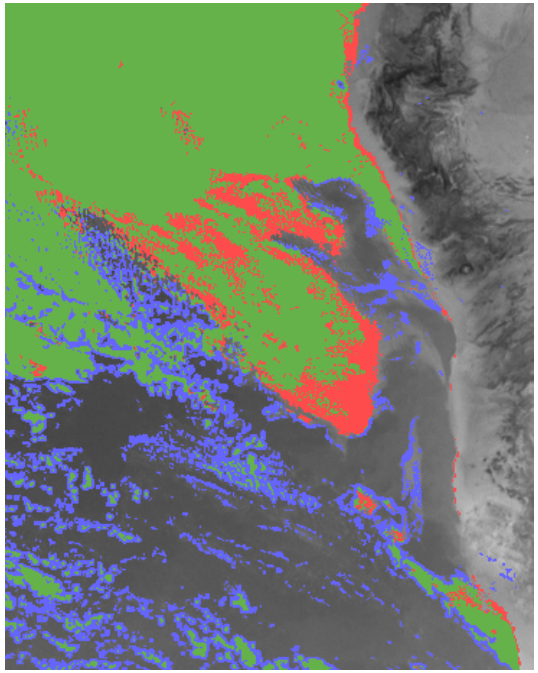
Possibility to process other geostationary meteorological satellite

v2015: RTTOV on line to improve cloud detection

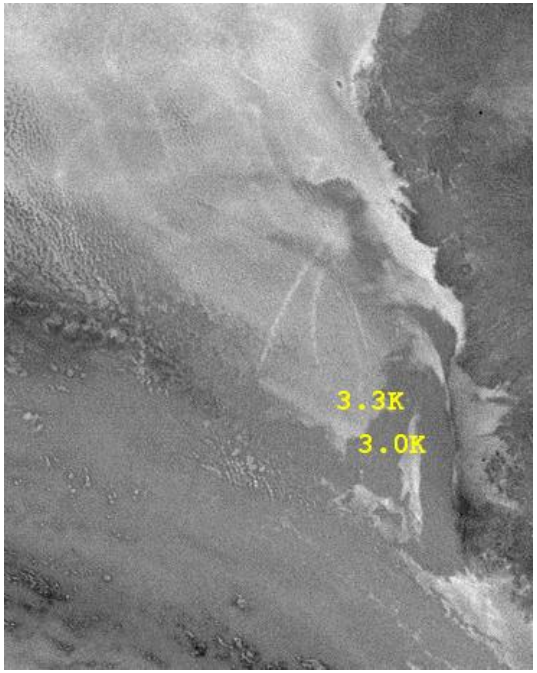
Example of Namibian/Angolan boundary layer marine stratocumulus detection



T3.9µm

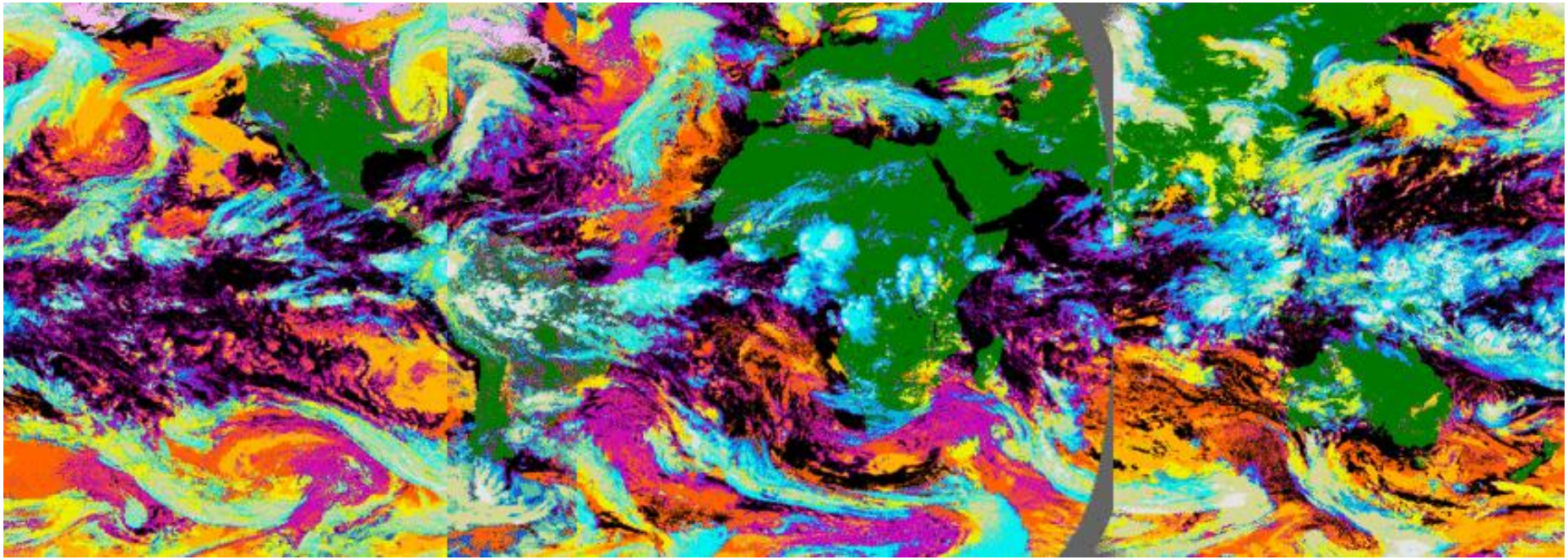


In red, improvement with RTTOV



T10.8µm-T3.9µm

V2015: process other geostationary satellites



GOES-W GOES-E MSG MTSAT GOES-W

Satellite data processed at ICARE Thematic Centre by Bruno SIX, in collaboration with Geneviève SEZE for MEGHA-TROPIQUES project, using SAFNWC package scientifically adapted by Meteo-France SAFNWC team.

v2015: New cloud microphysics products

Based on v2013 CT cloud phase algorithm

Output:

- -Cloud top phase
- -Cloud drop effective radius
- -Cloud optical thickness
- -Cloud liquid water path

Main change from v2013 algorithm in cloud simulation:

- ➢use of DISORT for radiative transfer model and Baum severely roughened ice particle model for ice clouds
- ➢use retrieved CTTH cloud top height to better account for atmosphere in cloud simulation

For more information

www.nwcsaf.org for more information