SAFNWC/MSG Cloud products

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Météo-France / CMS lannion

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 and v2017

NWCSAF context

-NWCSAF delivers software to process data from MSG and polar platforms (METOP/NOAA) .

- more than **100** registered users, including about **29** National Meteorological Services and **3** SAFs (OSISAF, CMSAF, LSASAF)

-NWCSAF/MSG SW includes three cloud products (**CMa, CT, CTTH**) developed by Météo-France/Lannion

-Detailed description of cloud algorithms and validation results available from www.nwcsaf.org

-NWCSAF/MSG SW **v2013** is the latest version

The EUMETSAT Network of Satellite Application Facilities

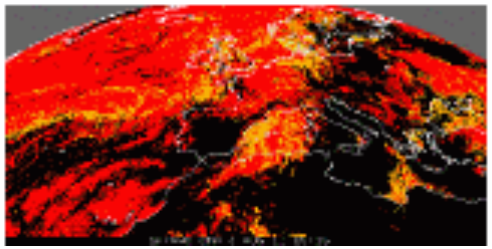
NWC SAF
Support to Nowcasting and Very Short Range Forecasting

METEO FRANCE
Toujours un temps d'avance

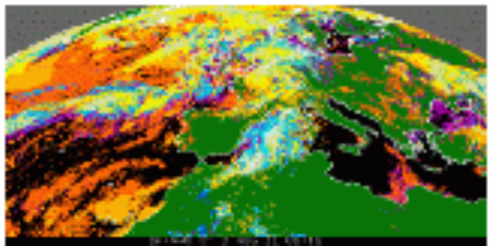
MSG

MSG Cloud Products

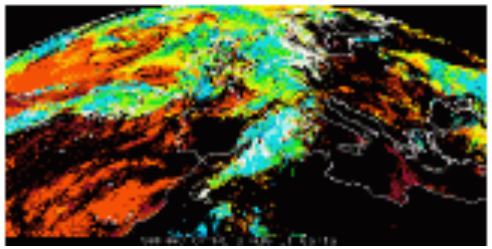
Cloud Mask
(Description)



Cloud Type
(Description)



Cloud Top Temperature and Height
(Description)

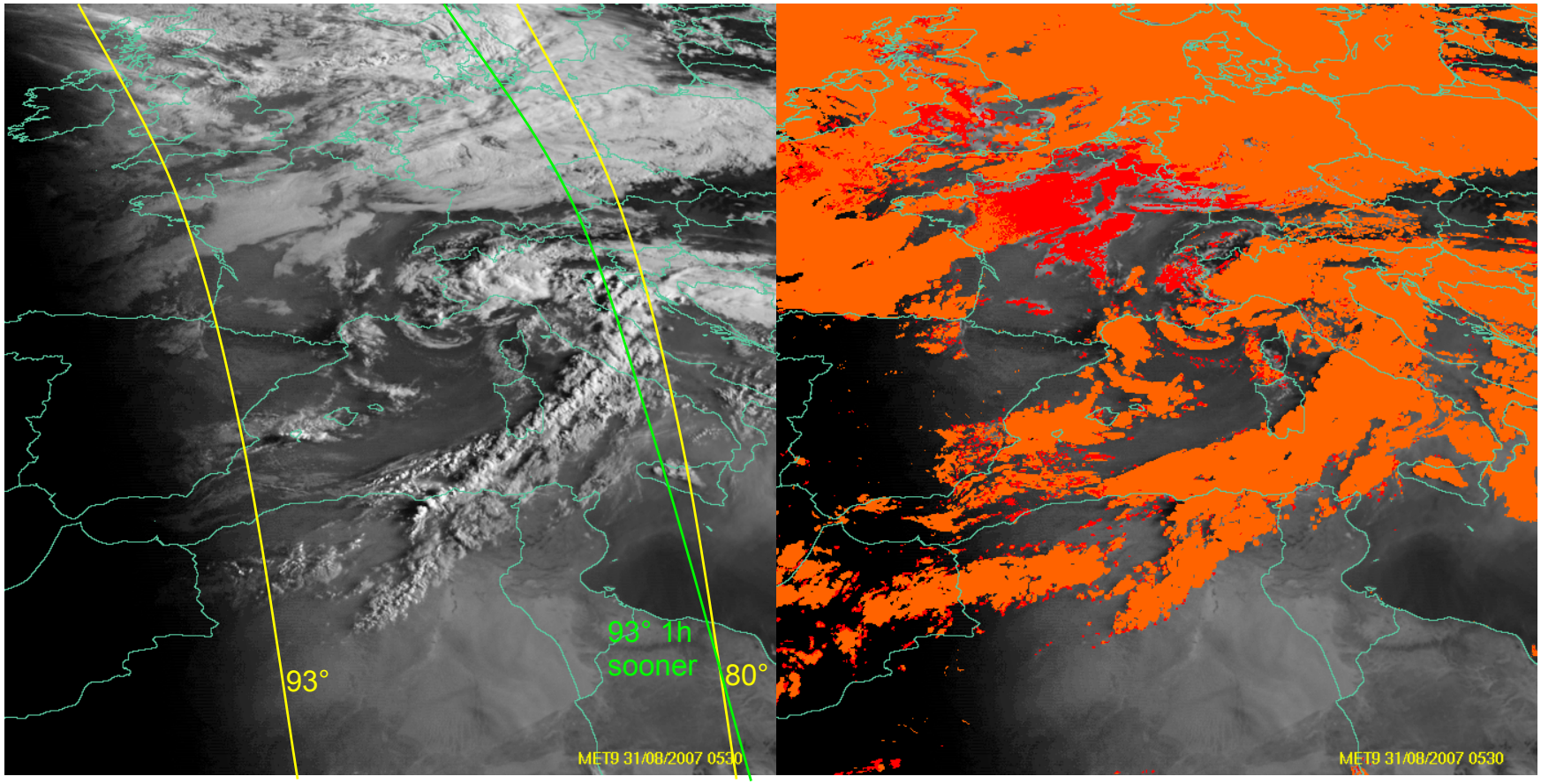


CMA algorithm: main steps

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 offline 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

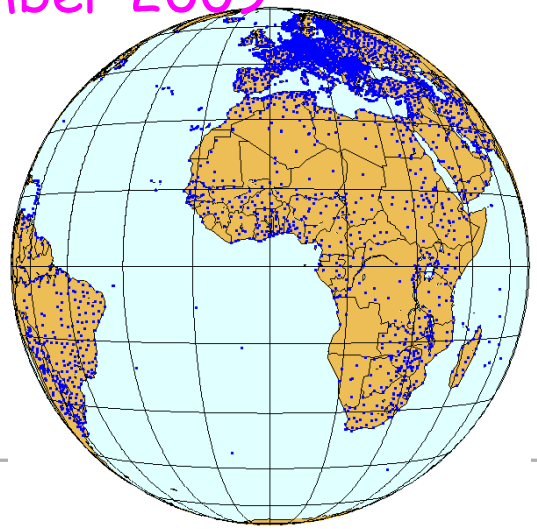
CMA algorithm: illustration of twilight processing

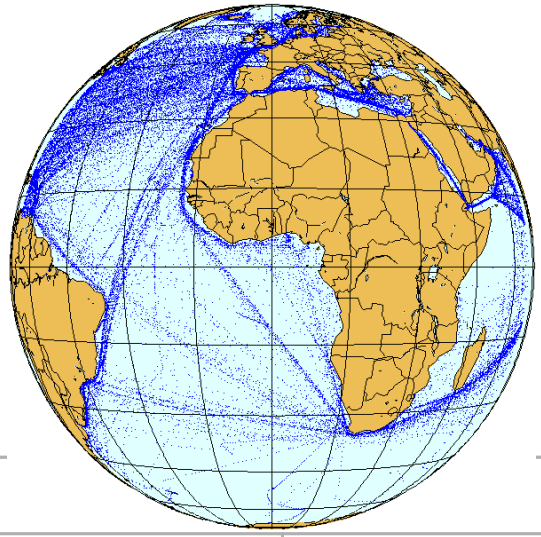


Cloud mask + **temporal scheme** superimposed on BRF 0.6 μm

CMA algorithm: validation

October 2009-December 2009





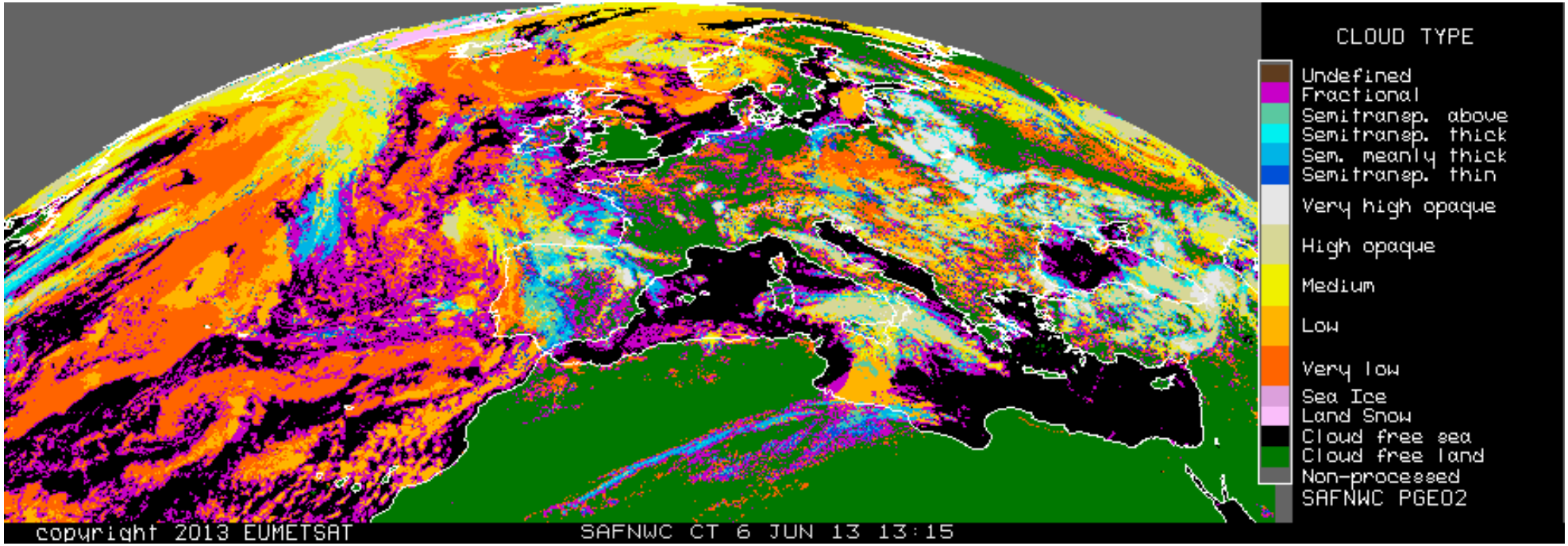
	POD (%)	**FAR (%)**	**POD (%)**	**FAR (%)**
All	94.3	6.5	96.3	14.9
Daytime	96.1	4.4	96.8	10.3
Night-time	93.4	8.4	95.6	20.3
Twilight	93.5	4.0	96.9	8.3

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].
- ✓**mid-level clouds** are reclassified as **low clouds**
  - ✓if a low level thermal inversion is detected in the NWP fields
  - ✓if T8.7μm-T10.8μm is lower than a threshold

CT algorithm: exemple



CT algorithm: cloud phase

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

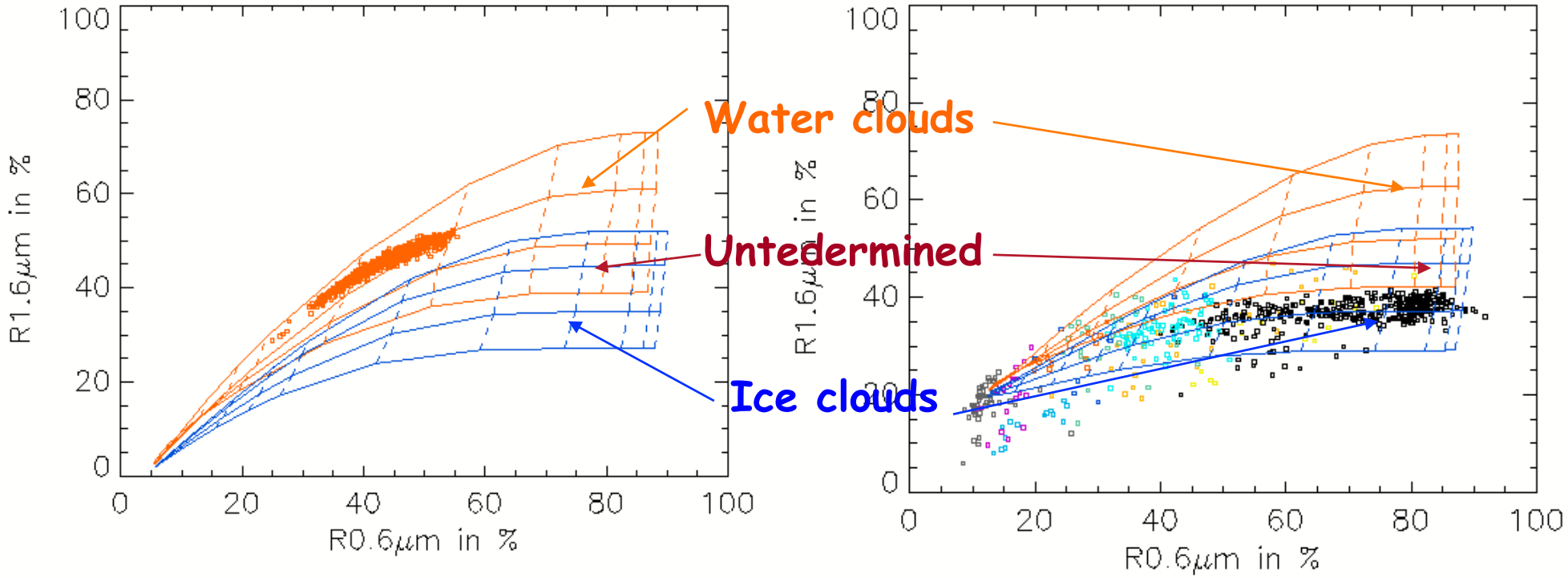
Water clouds	Ice clouds
	Classified as high-semitransparent or
opaque & T10.8 > 273.15K or	opaque & T10.8 < 233.15K or
opaque & T8.7-T10.8 < thres_wat(satzen)	opaque & T8.7-T10.8 > thres_ice(satzen)

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
(for ice cloud: Baum severely roughened ice particles)

Dots: SEVIRI R0.6μm and R1.6μm measurements



Oceanic Stratocumulus

Convective system (France)

CTTH algorithm: methods

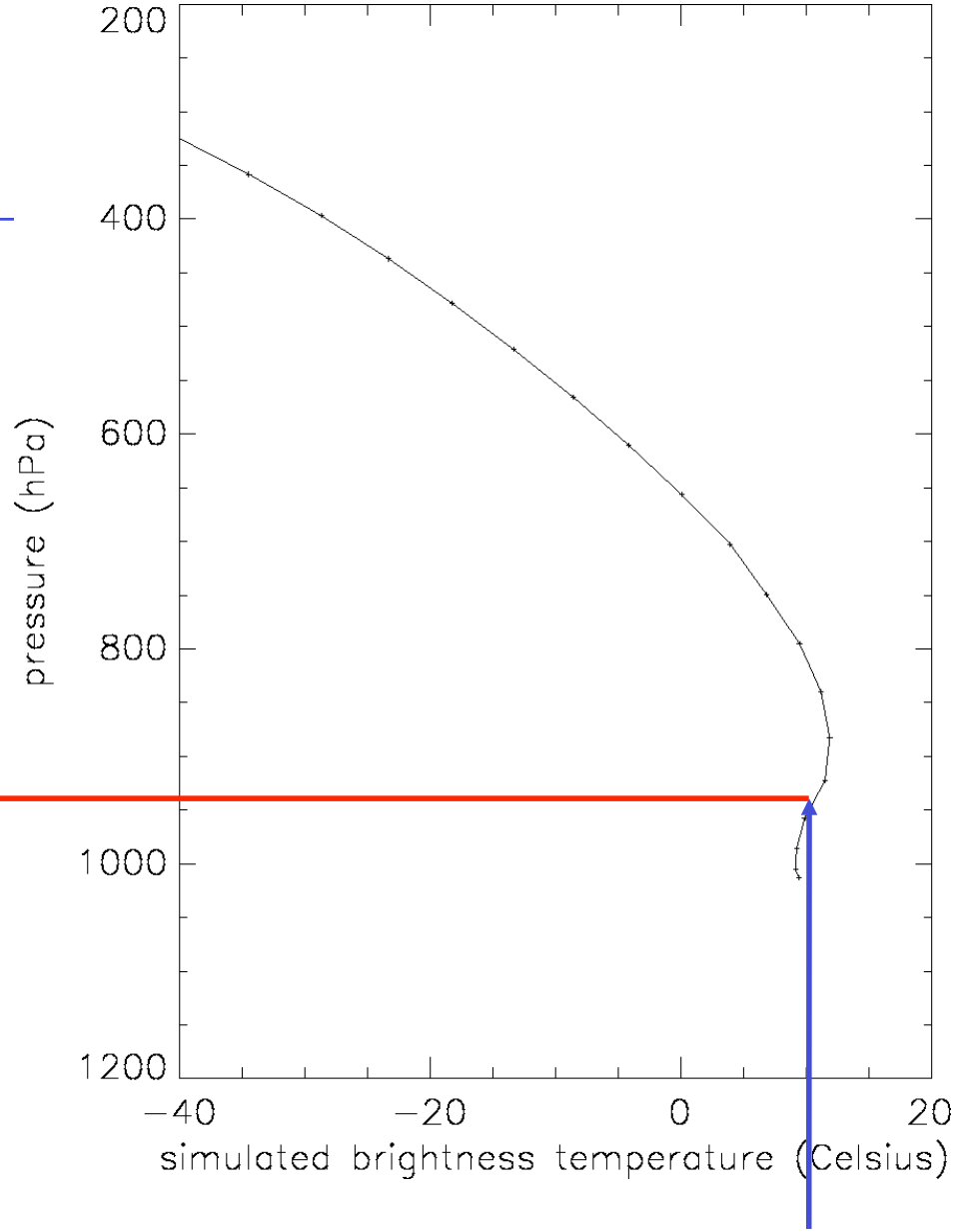
Retrieve height from MSG/SEVIRI temperatures requires:
-> vertical temperature & humidity profile forecast by NWP
-> simulated TOA radiances from overcast opaque clouds set at various pressure levels with RTTOV

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

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 cloud



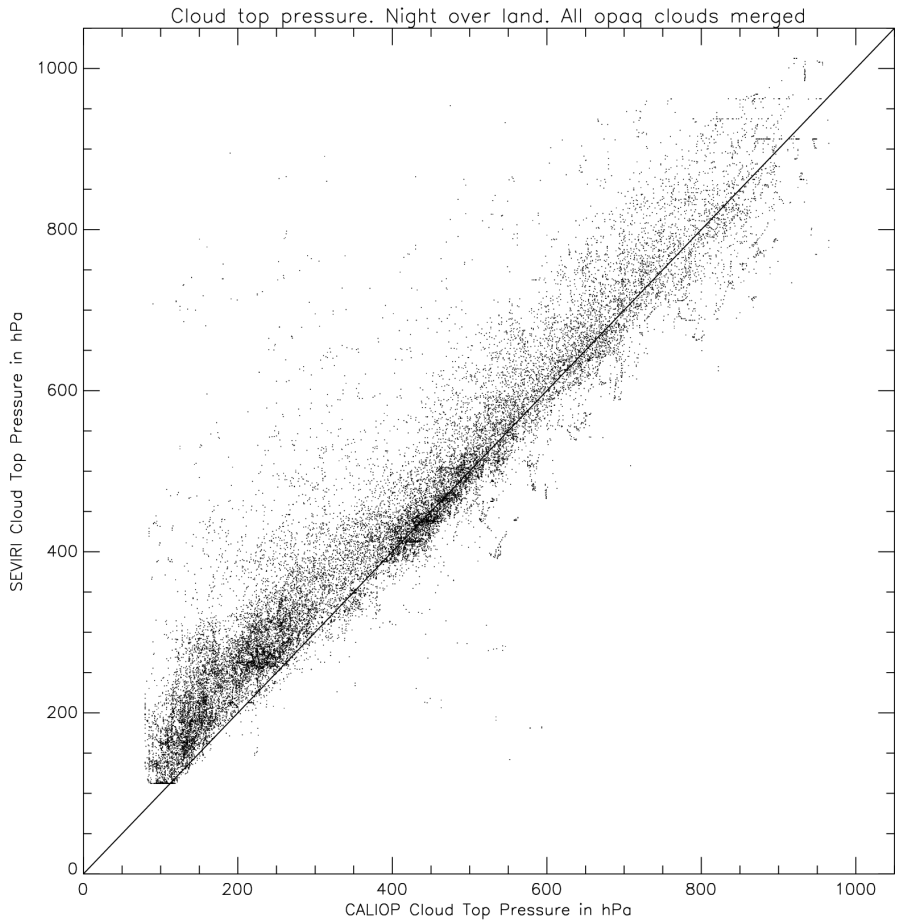
Retrieved cloud top pressure

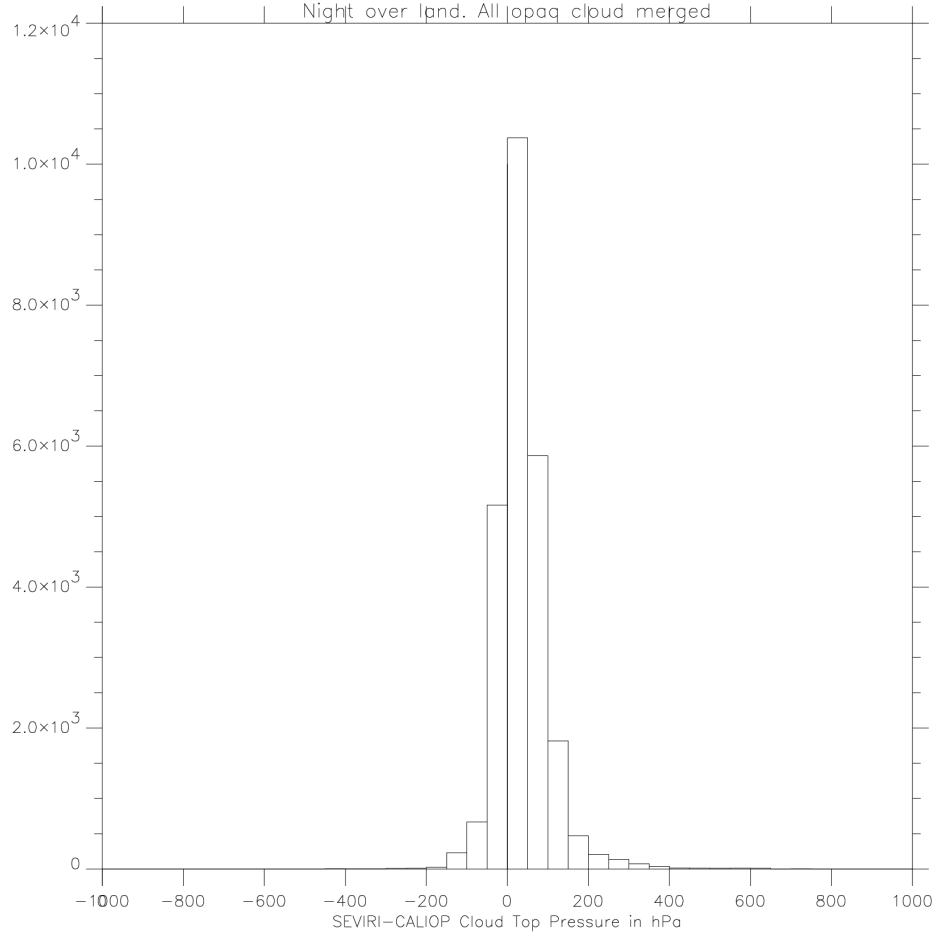
Measured brightness temperature

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

CTTH algorithm: validation with Caliop

Opaque clouds over land in night-time conditions





Outlook for v2015

NWCSAF/GEO new features:

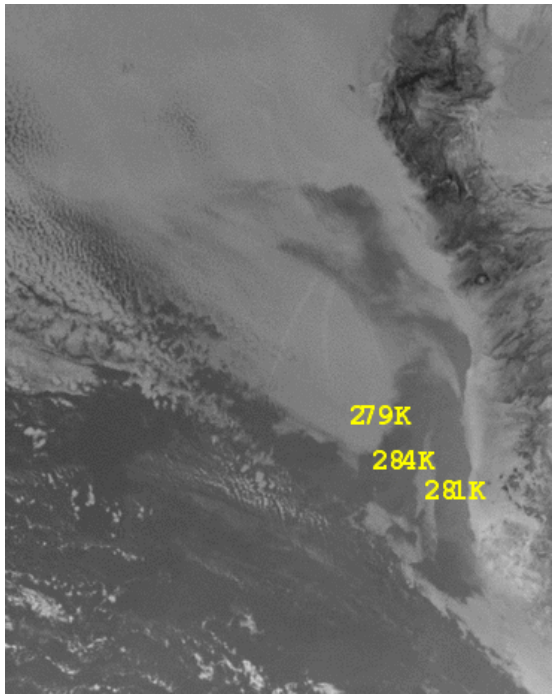
-New cloud product: cloud microphysics (Phase, Reff, cod, lwp/iwp)

-Online-use of RTM (RTTOV) to improve cloud detection

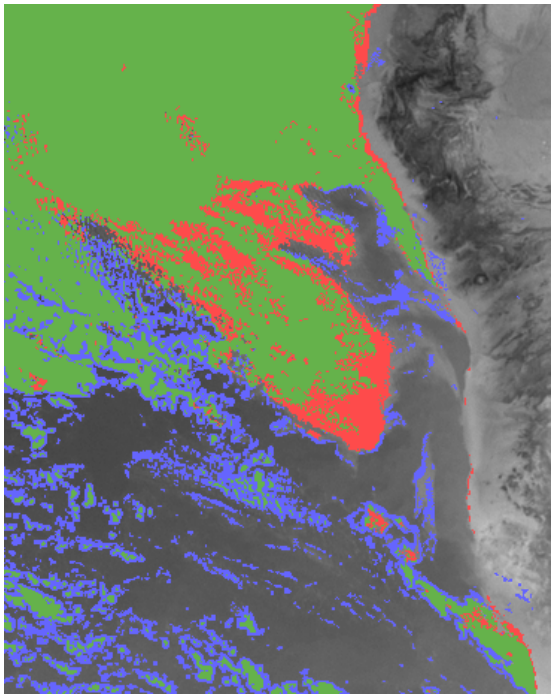
-Possibility to process other geostationary meteorological satellite (Himawari8/9, GOES-R/S, GEO-KOMPSAT-2A/2B, MTG)

RTTOV on line to improve cloud detection

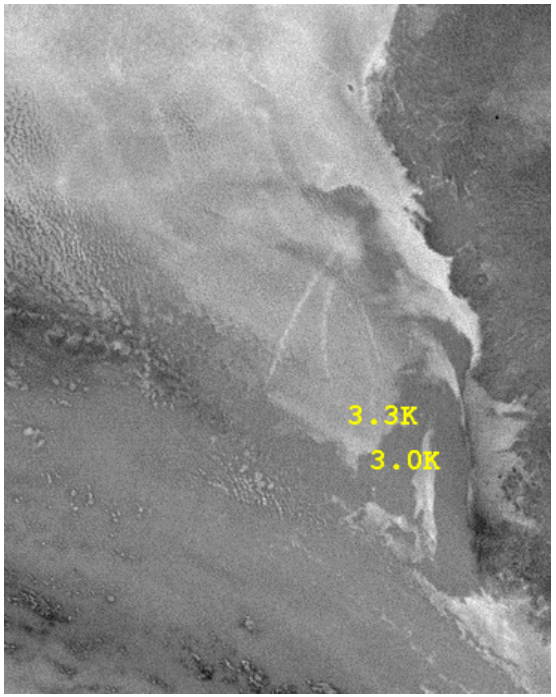
Example of Namibian/Angolan boundary layer marine stratocumulus detection



T3.9µm



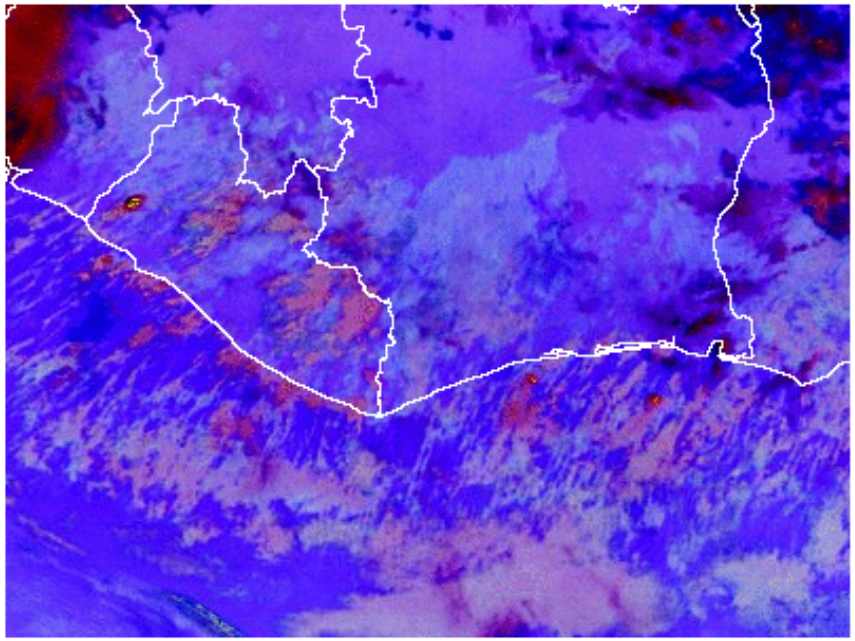
In red, improvement with RTTOV



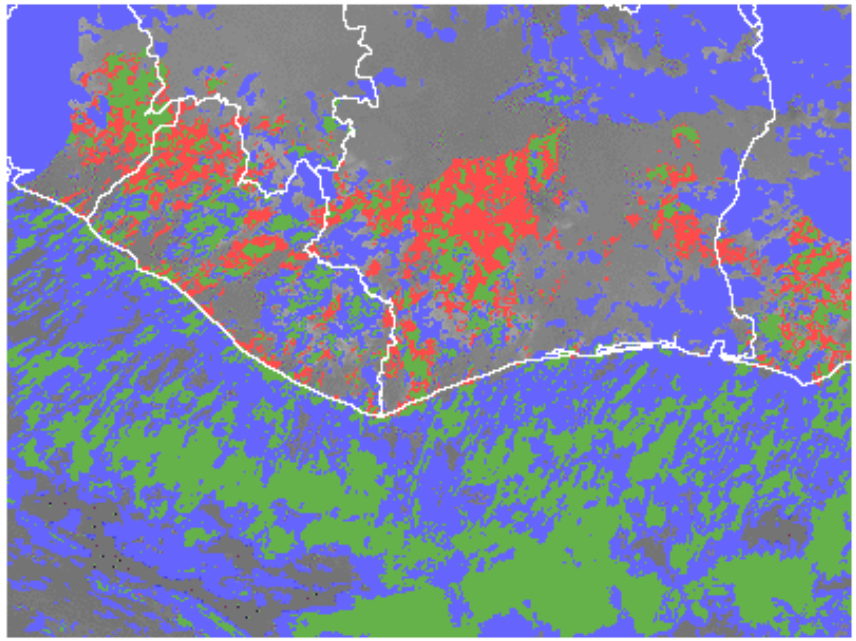
T10.8µm-T3.9µm

RTTOV on line to improve cloud detection

Detection of low clouds over land in night-time in tropical conditions

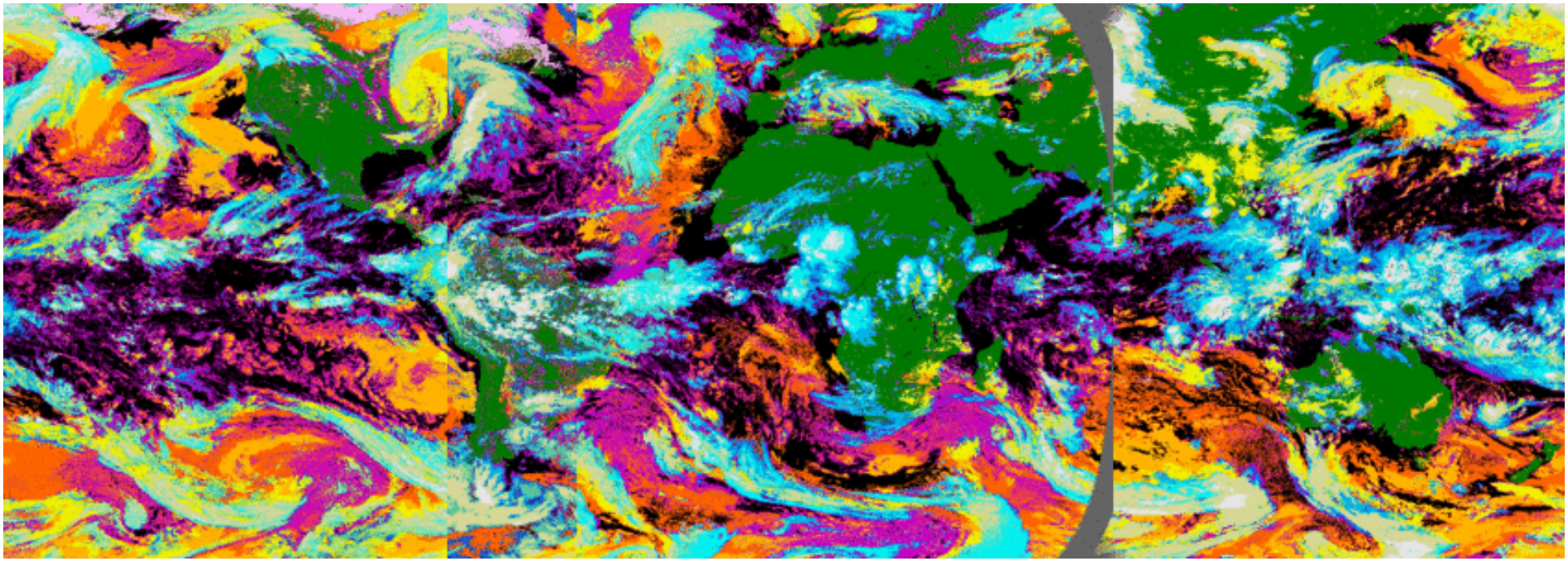


Eumetsat fog RGB



In red, improvement using RTTOV

Outlook for v2015



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.

Outlook for v2017

NWCSAF/GEO v2017 new features:

-use of additional channels:

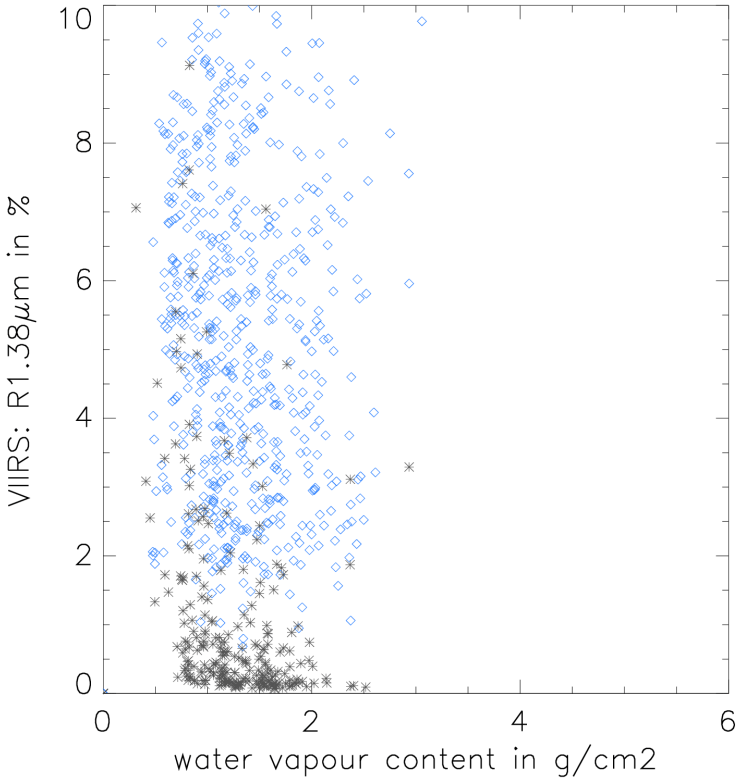
1.38μm for cirrus characterisation,

2.25μm for cloud microphysics

-products available at two spatial resolutions

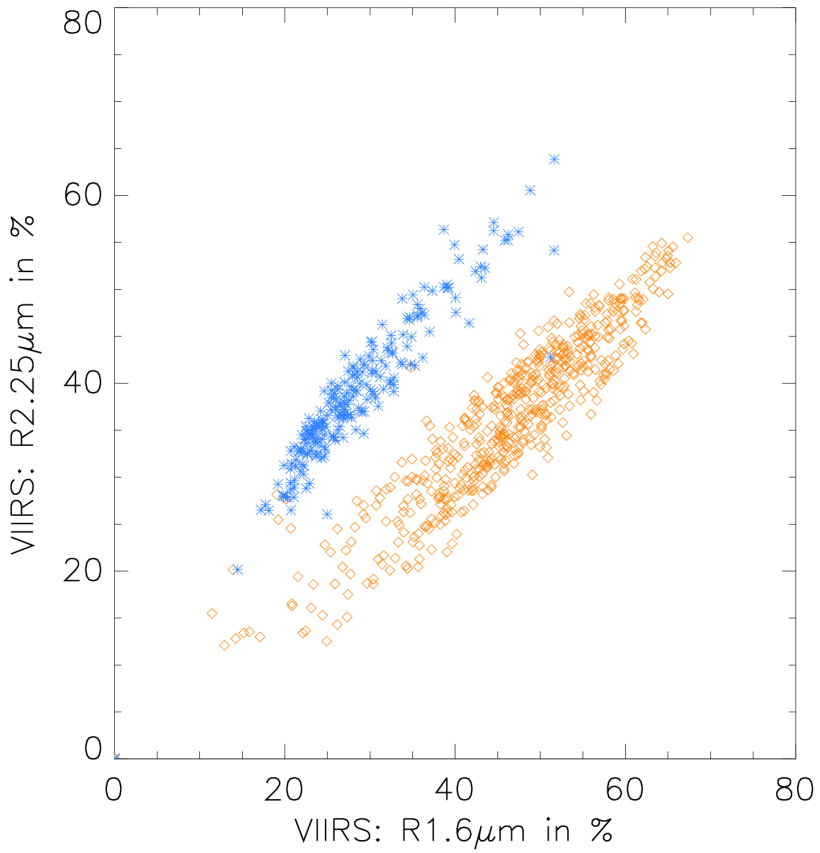
-configuration files for MTG/FCI, HIMAWARI/AHI, GOES/ABI…

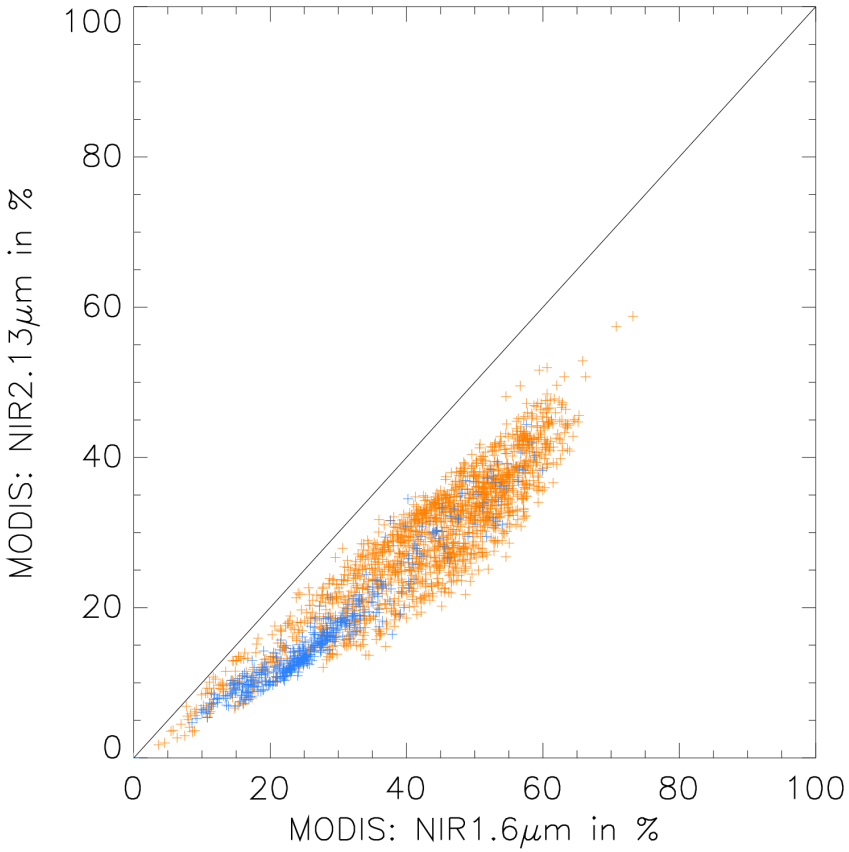
1.38µm for cirrus characterisation in day time



VIIRS measurements: In blue: cirrus ; in black small cumulus

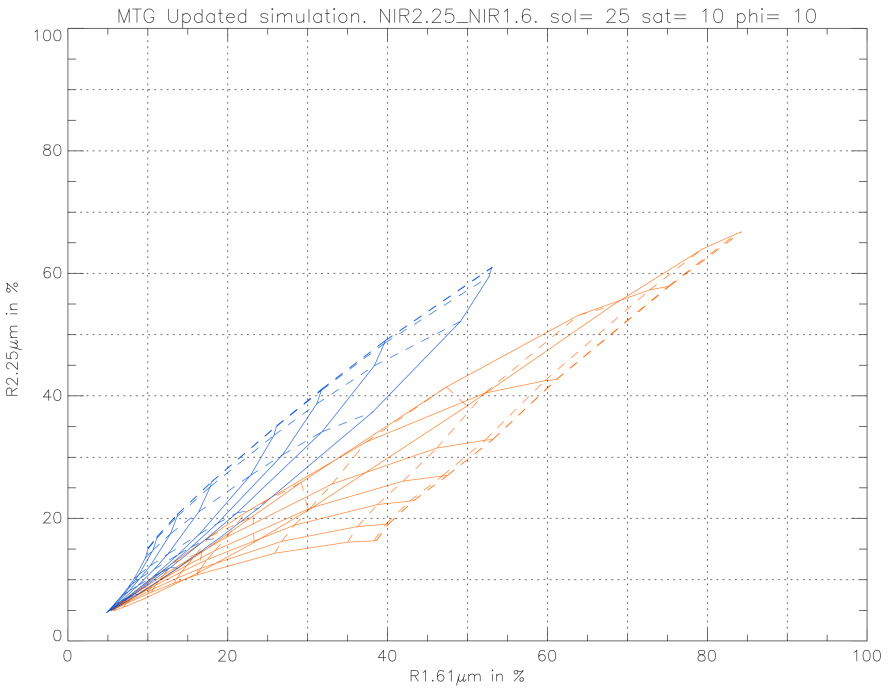
2.25µm for cloud phase retrieval

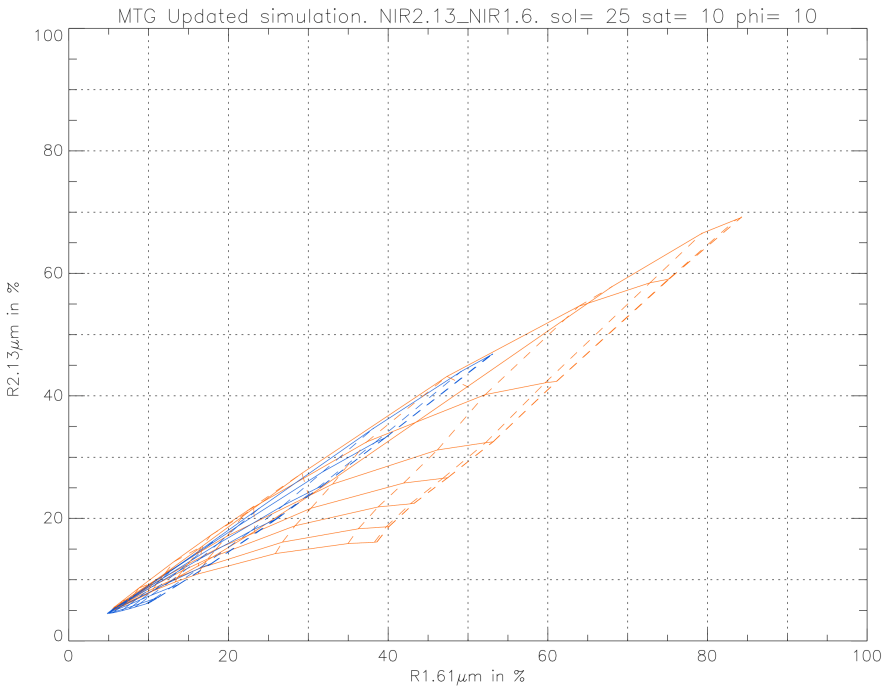




In orange water clouds (St/Sc) In blue: ice clouds (Cb/Cs)

2.25µm for cloud phase retrieval





In orange water clouds In blue: ice clouds

For more information

www.nwcsaf.org for more information