SAFNWC : GEO-I Cloud

Eumet train 2025 June 27th

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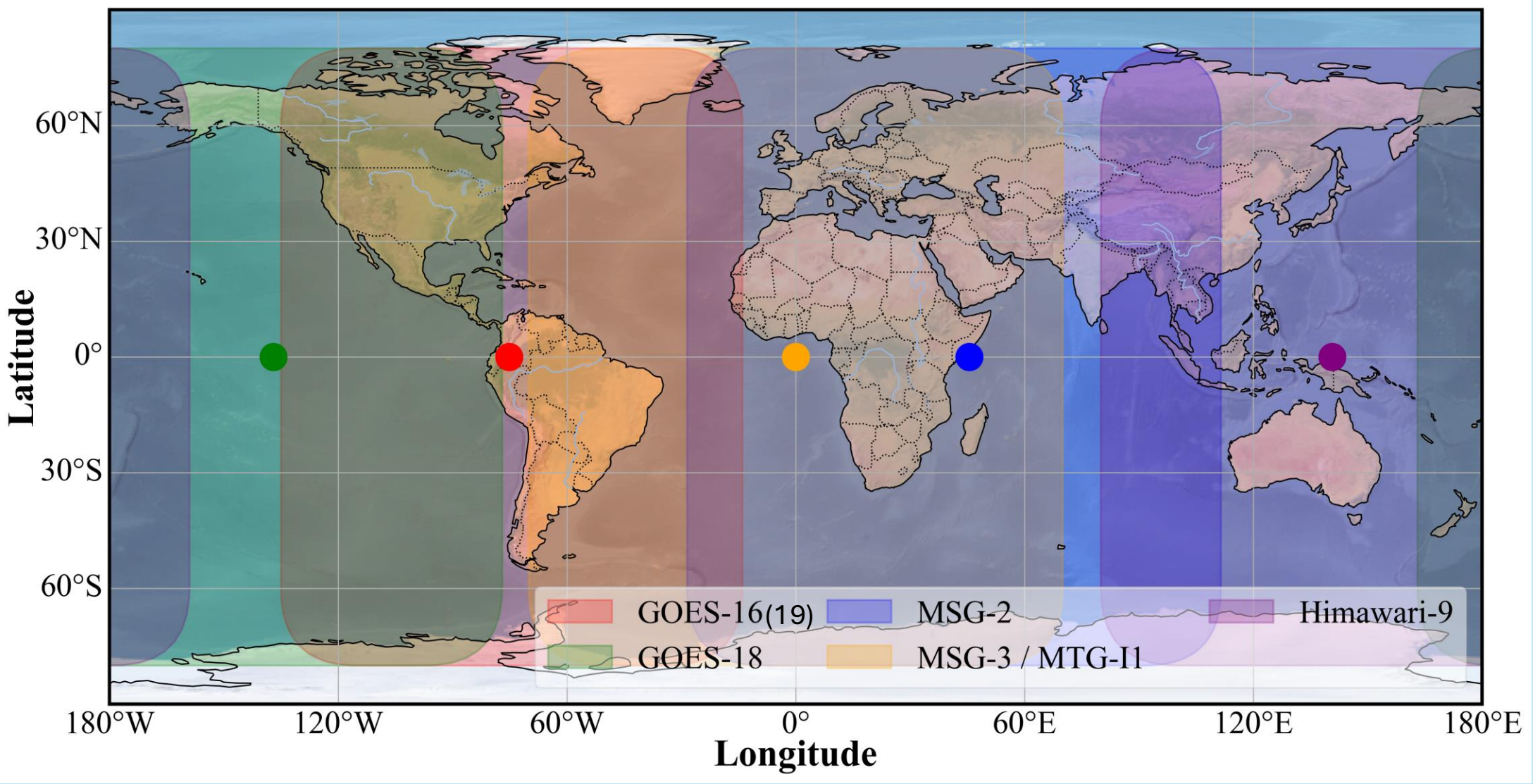
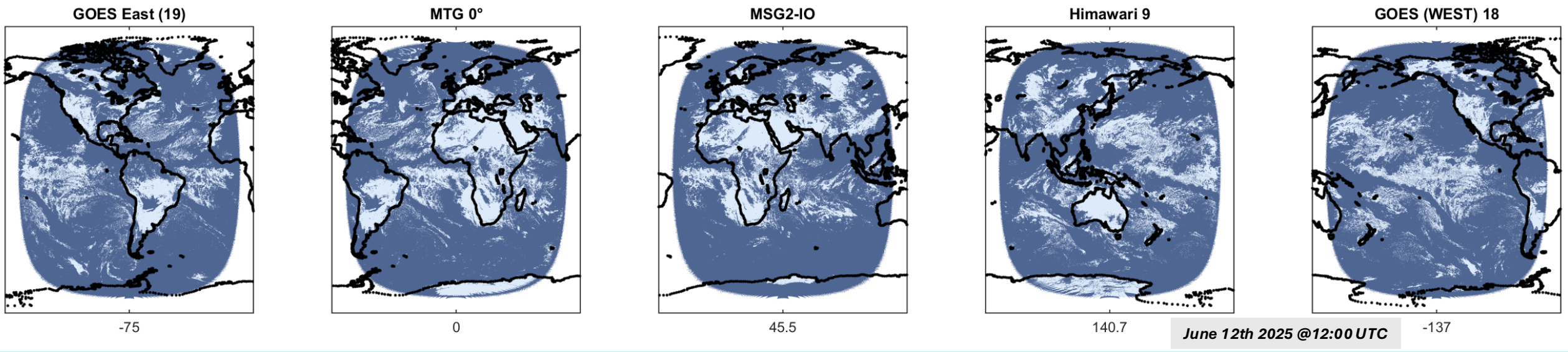
introduction

Today the SAFNWC-GEO v2025 Softwares can process geostationnary satellites around the Globe.



The cloud Product : CMA



CMA – Cloud Mask: cloud detection, and snow detection during daytime.

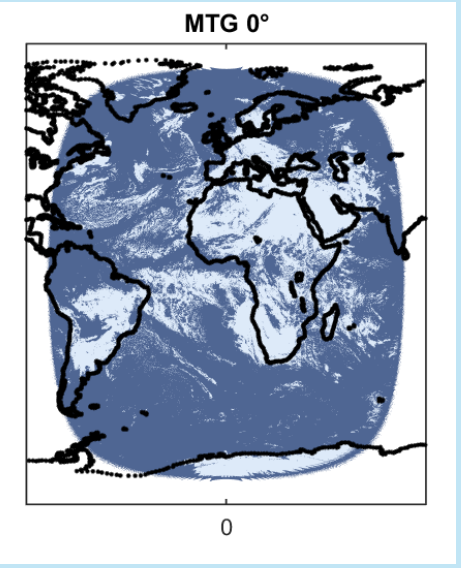
- Used as a complement to visible images during the day.
- More useful during the night, due to difficulties to identify some low cloud types in IR images.
- Input for other SAFs product (SAFNWC,SAFLAND,SAFOSI,…)

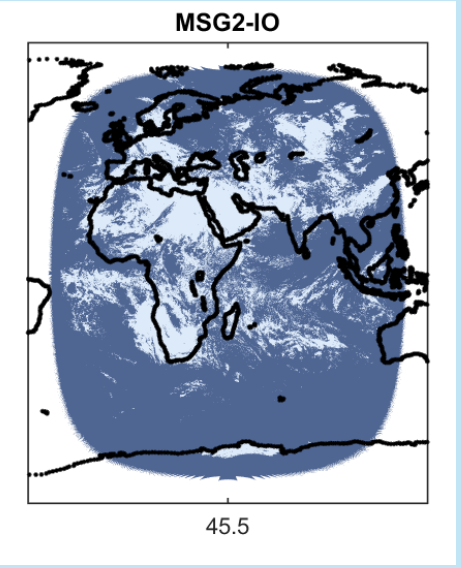
The cloud Product : CMA

Validation of Cloud MASK with SYNOP/SHIP observations : selection of days in october 2024 (More details in the validation report when available on the safnwc website www.nwcsaf.org in the documentation section)

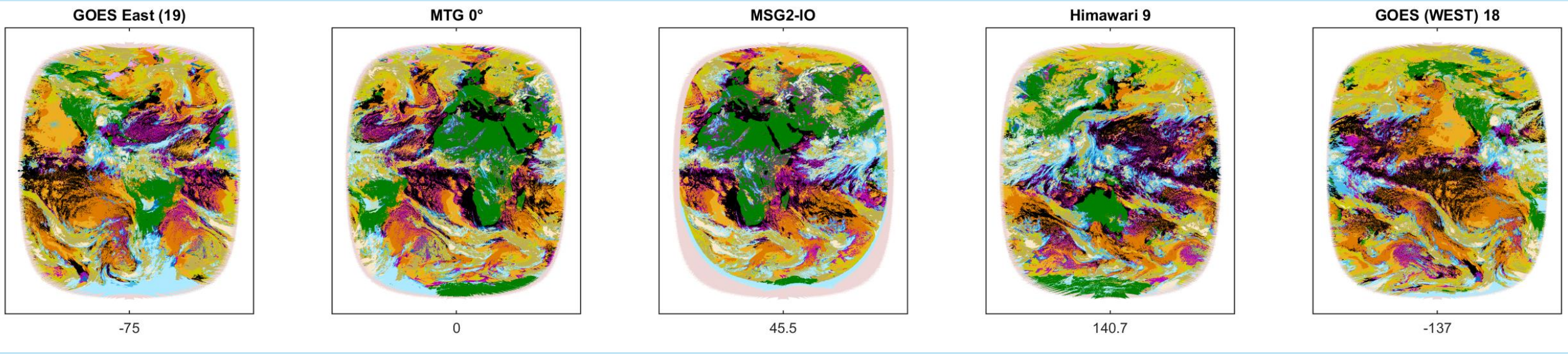
MTG-I1 v2025	POD	FAR
DAY	83.6%	4.6%
NIGHT	86.7%	8.6%
TWILIGHT	90.0%	4.5%
ALL Illuminations	85.9%	6.4%

POD : Probability of Detection
FAR : False Alarm rate
The reference are SYNOP/SHIP observations (octas >5 is cloud / octas <3 is no cloud / between not considered)





The cloud Product : CT



Land	Sea	snow	Sea ice	Very low to very high Opaque		Thin To Thick Ice clouds	Thin over Opac	Thin over Snow

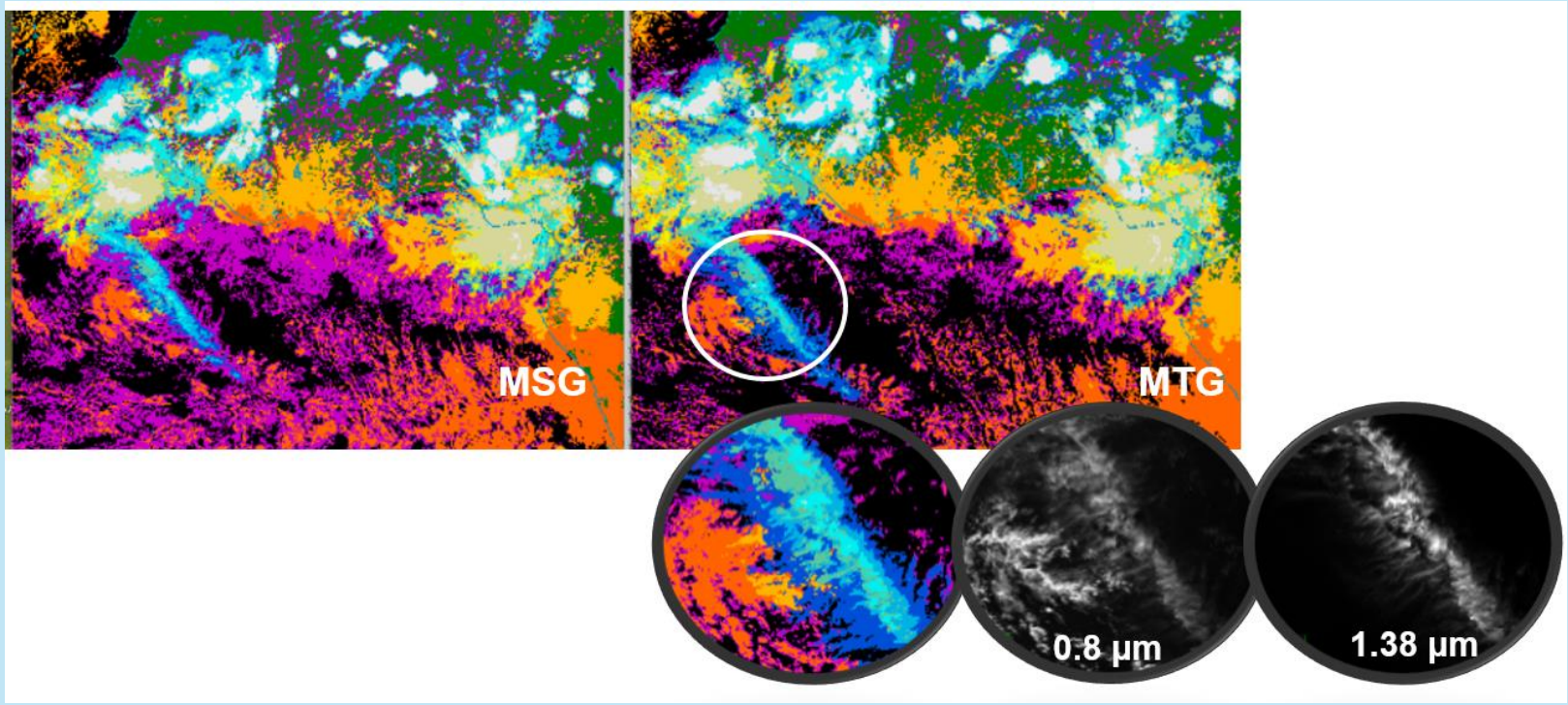
CT – Cloud type

- **Cloud classification** based on the “opacity/transparency” and “level of the cloud top”.
  (Ex: “Cb” classified as “high opaque cloud”).

The cloud Product : CT

❖ **Improvement of cirrus cloud detection (high semi-transparent types ; start v2025)**

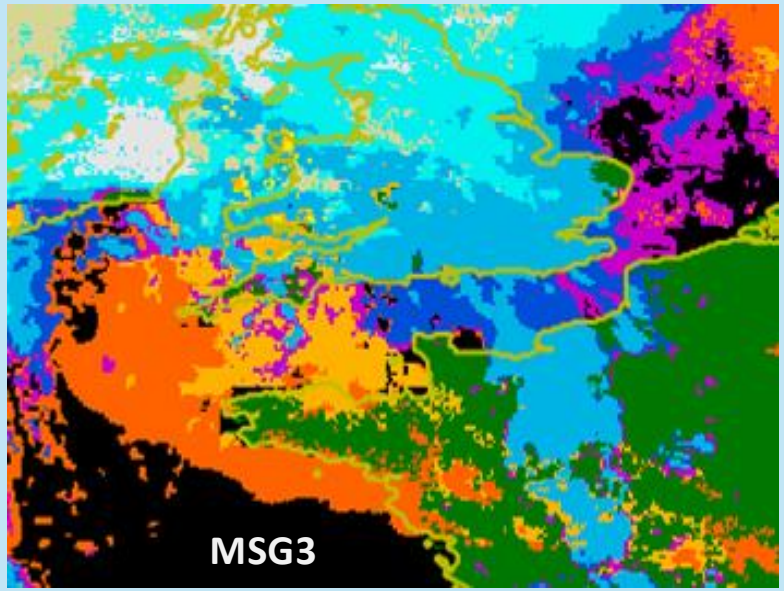
Use of Near infra red channels 1.3µm (available for GOES NG and MTGs) to Improve thin cirrus detection

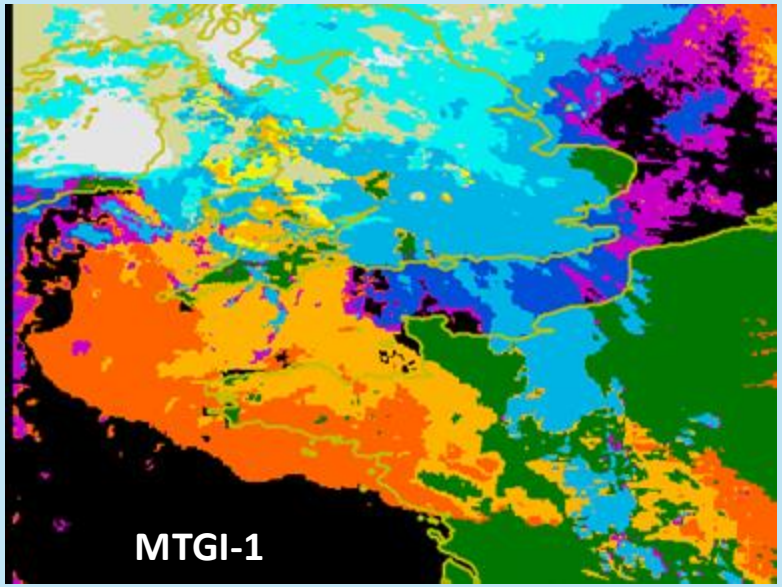


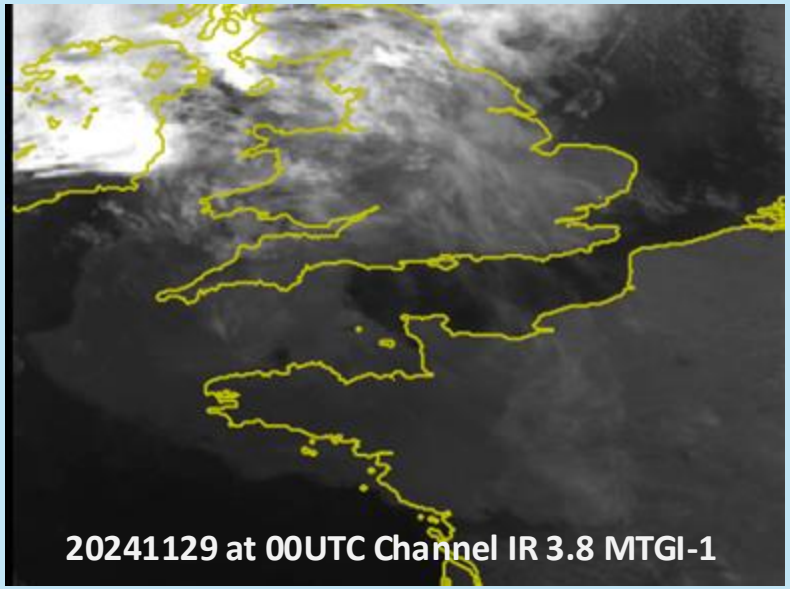
=> fractional clouds are now detected as cirrus and their CTTH can be retrieved

The cloud Product : CT

❖ **Better detection of Very Low & Low Opac clouds over land during Night (start with v2025)**







Observations : Brest cloudy 8/8, Rennes cloudy 8/8, Lorient cloudy 8/8

The cloud Product : CT

❖ **CT : distinction of stratiform like cloud from cumulus like cloud (will start with v2027)**

- **Summary of Cumulus properties vs Stratiform properties**

  The method is based on texture and pattern recognition with grey level difference vectors.

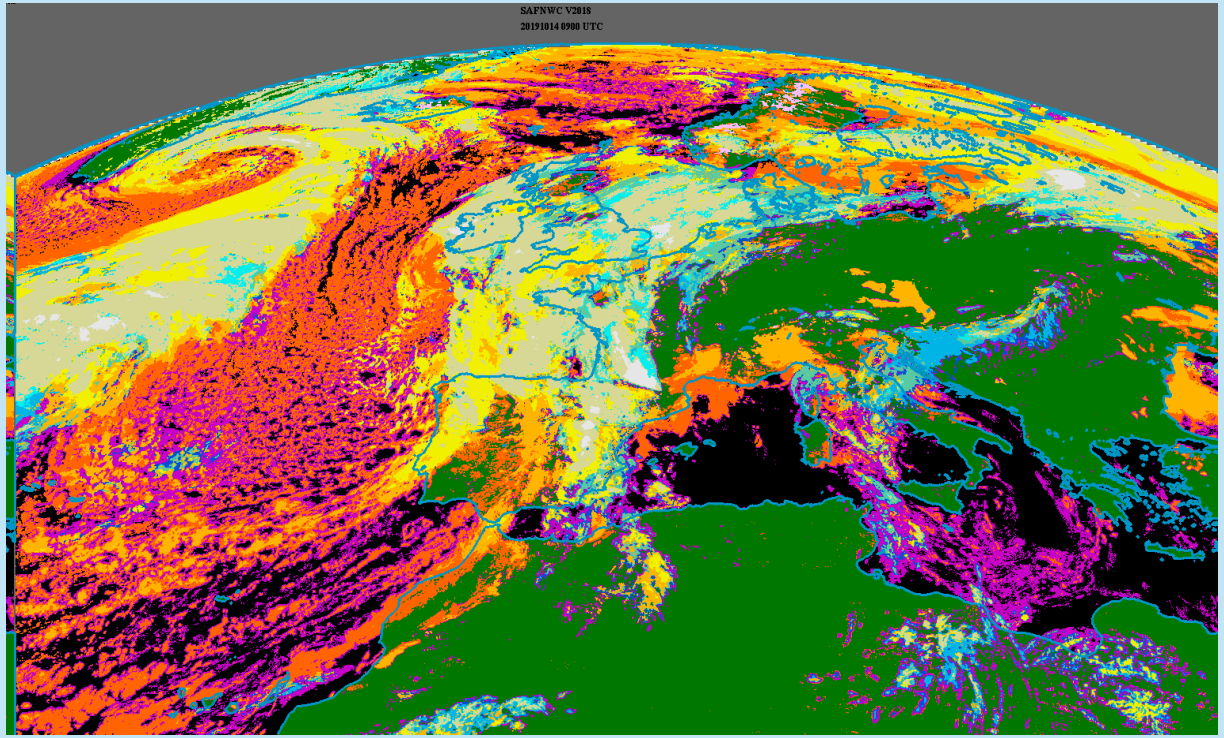
  Use of "entropy" in visible at high resolution and 10.8µm :
  higher entropy for Cumuliform than Stratiform (mixed class is between!)
  Better results with the use of visible at high resolution

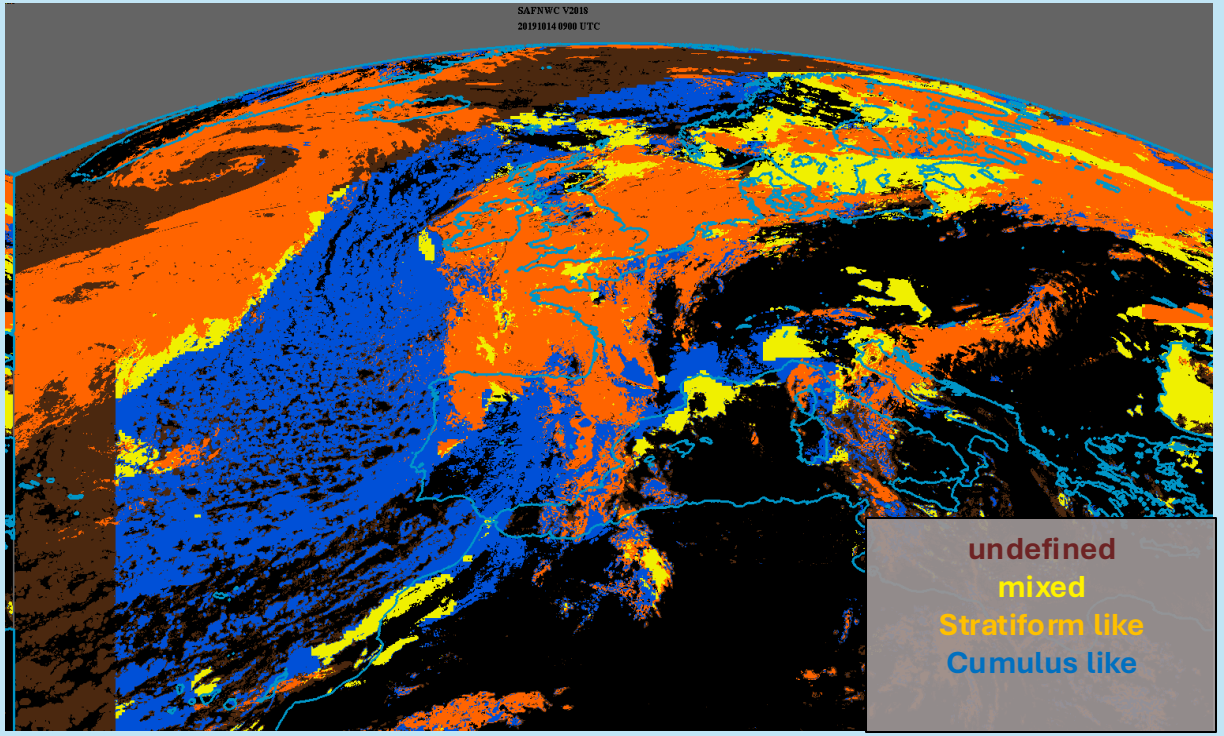
  Icy thin to thick semitransparent clouds are assumed as stratiform clouds
  The method is applied only on opaque clouds and fractionnal clouds types

  Challenge remain for the distinction for congestus vs altocumulus (middle clouds)

The cloud Product : CT

- **CT : distinction of stratiform like cloud from cumulus like cloud**
  (PROCESSING TIME CAN BE TOO LONG TO USE it NowCASTING mode)
  - **example** 14th October 2019





Visible in high resolution is essential for the good detection of cumulus type clouds

The cloud Product : CT

Comparison of Cloud Types from MSG3 with the ones from MTG-I1 (validation report)

For Opac clouds :
Very Good Aggreement between the two satellites

For Semi-transparent Clouds :
Good aggreement, about 80% bewteen the two satellites

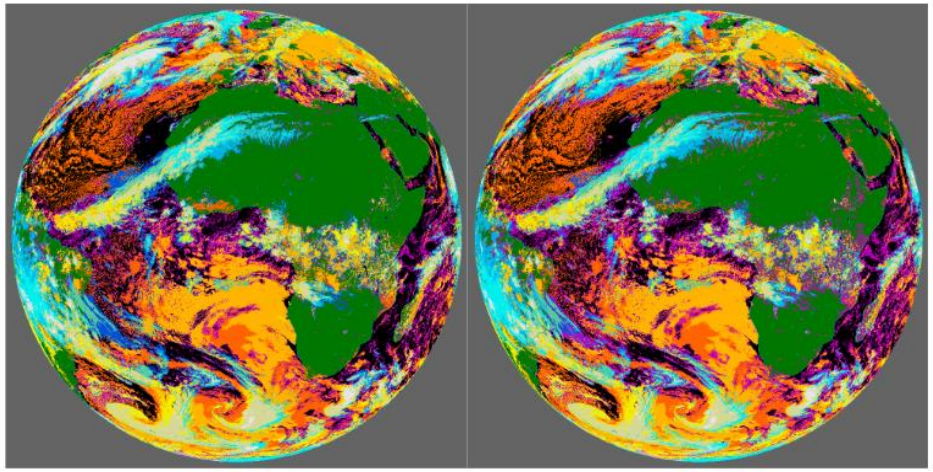
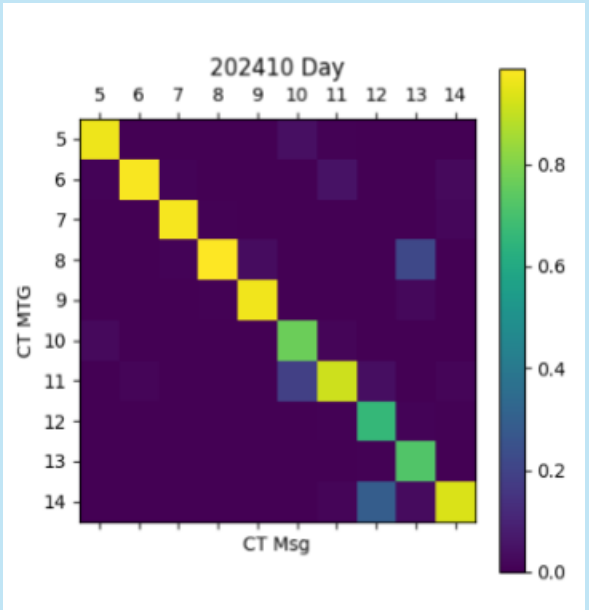
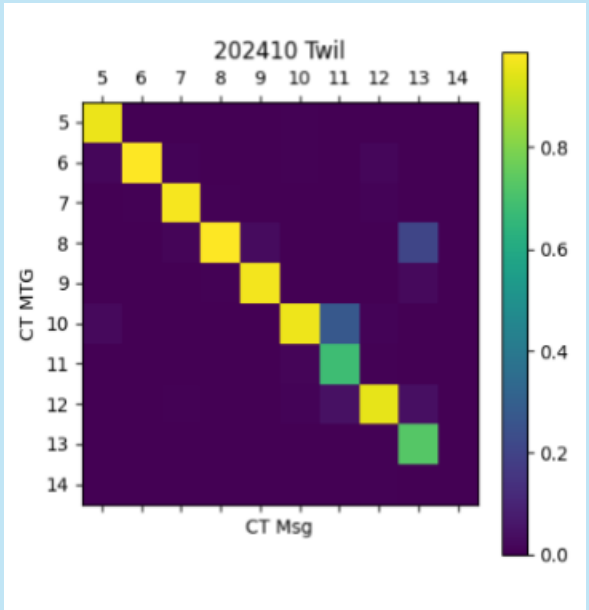
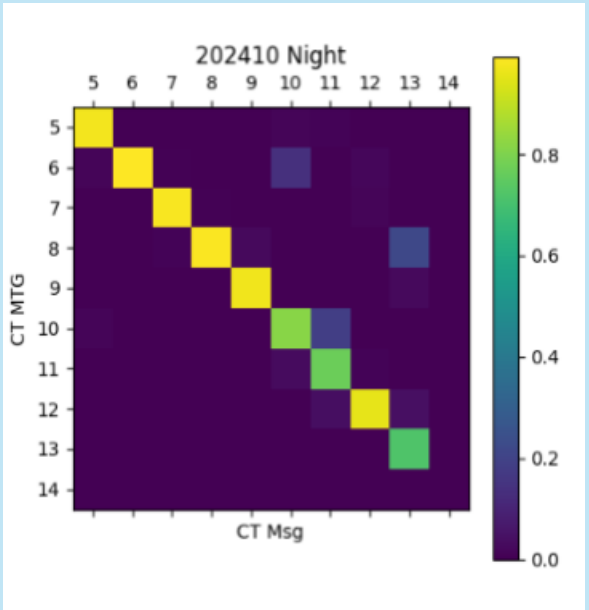


Figure 1: on the left CT for MTG-I1 valid for 20241203 09UTC and on the right CT for MSG3 valid for 20241203 09UTC.

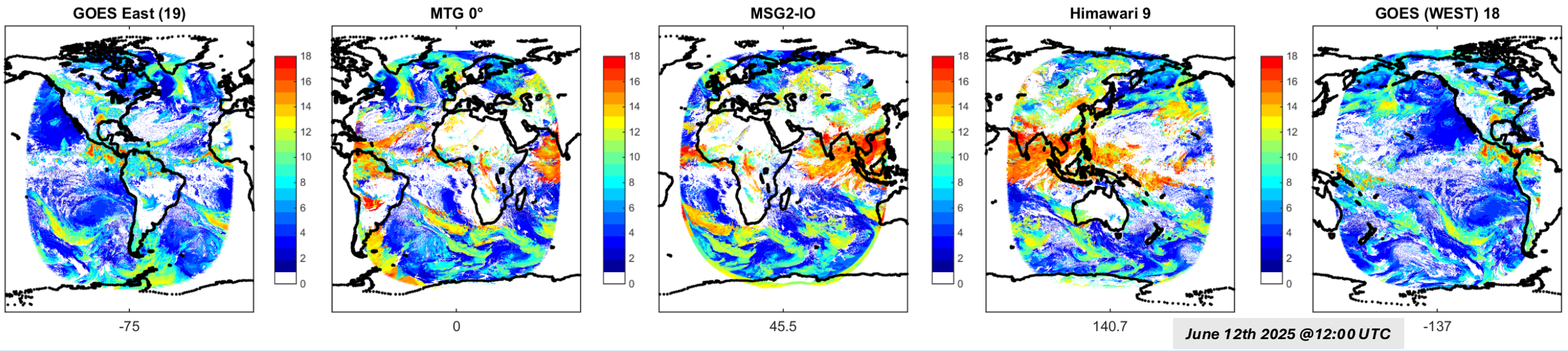
For Fractionnal clouds :
~ 80% of from MSG3 are **also** seen as fractionnal with MTG
~15% from MSG are seen as very Low or Low by MTG
~ 5% from MSG are seen as very thin semi-transparent with MTG







The cloud Product : CTTH



CTTH:

- **"Fractional clouds" not having CTTH outputs, but les fractional clouds with MTG compared to MSG**
- **also available in Feets for aviation with NWCGEOv2025**

New option in the CTTH config file "*safnwc_CTTH.cfm*"

9 Enables CTTH output in Flight level
OUTPUT_FLIGHT_LEVEL **FALSE / TRUE**

The cloud Product : CTTH

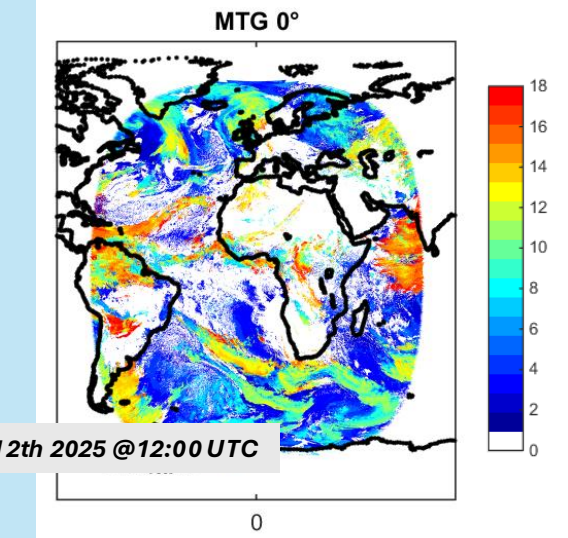
- Cloud Top Height is a data fusion product in which NWP data play a key role.
- Cloud Top Height Quality is strongly related to your nwp conf file configuration : See options

- NWP pressure levels

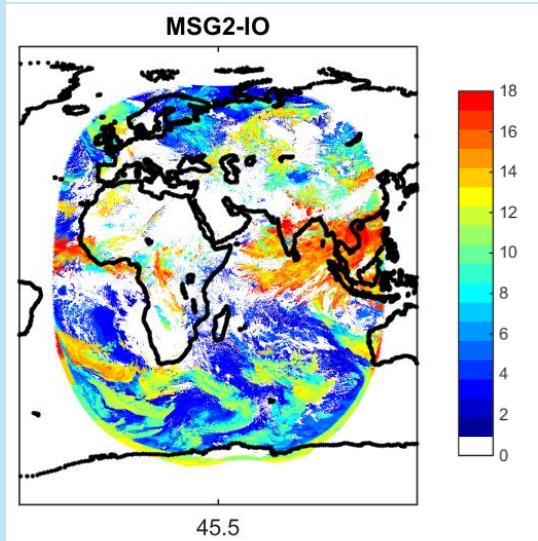
```
# List of available Pressure Levels in NWP model
# ----------------------------------------------
AV_PRESSURE_LEVELS 10 ,20 ,30 ,50 ,70 ,100 ,150 ,200 ,250, 300, 400, 500, 600, 700, 800, 850, 900, 925, 950, 1000
```

- Temporal frequency of NWP data

```
# Maximum allowed period between slot and NWP forecast validity time
# ----------------------  WARNING!!----------------------------
# The use of periods greater than 6 hours can produce quality-degraded products
NWP_MFVAL 6
```



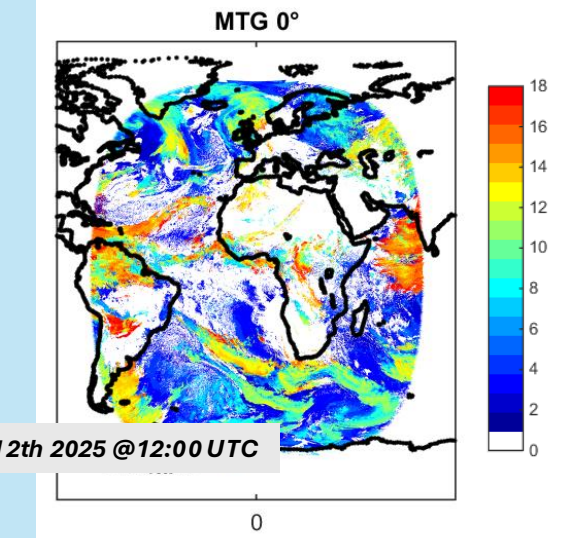
June 12th 2025 @12:00 UTC

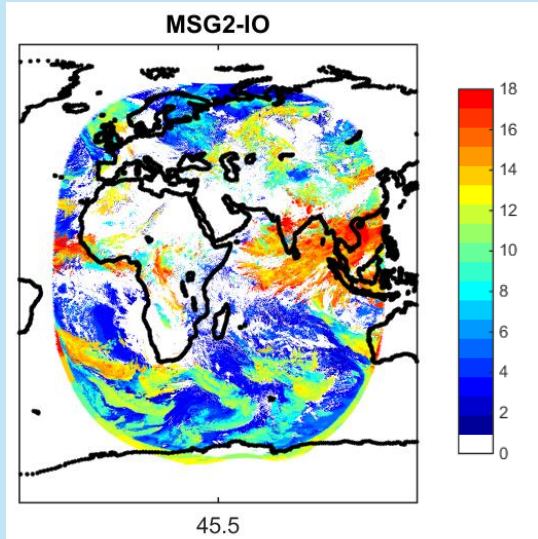


The cloud Product : CTTH

To **reduce the computation time** when running GEO software operationnally or over a large amount of data, the temptation is to reduce the spatio-temporal resolution of NWP data. But before doing that, **keep in mind that:**

- Removing higher NWP levels (even well beyond the tropopause!) has a significant impact on the cloud top altitude retrieved for semi-transparent clouds.
- A low vertical resolution of NWP data close to the surface (< 700 hPa) can largely modify the cloud top altitude estimation of low clouds in particular because of the poor representation of thermal inversions.
- Degrading temporal resolution of NWP data impacts all cloud top altitudes retrieved, especially in areas where the spatio-temporal variability of vertical profiles is significant (mid and high latitudes)
- CTTH is used as input for HRW, CMIC and RDT-CW products.





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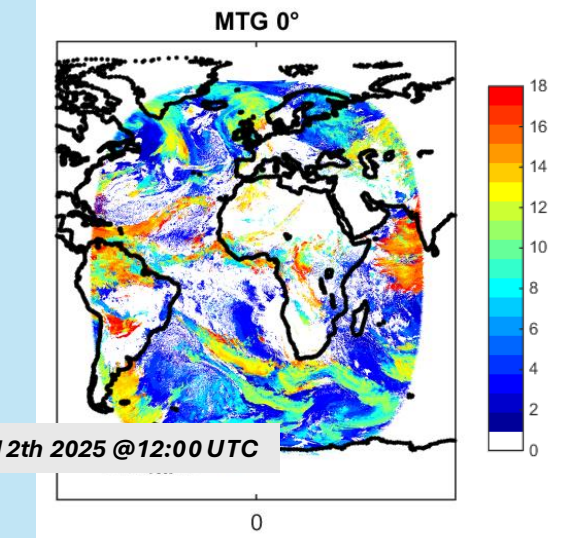
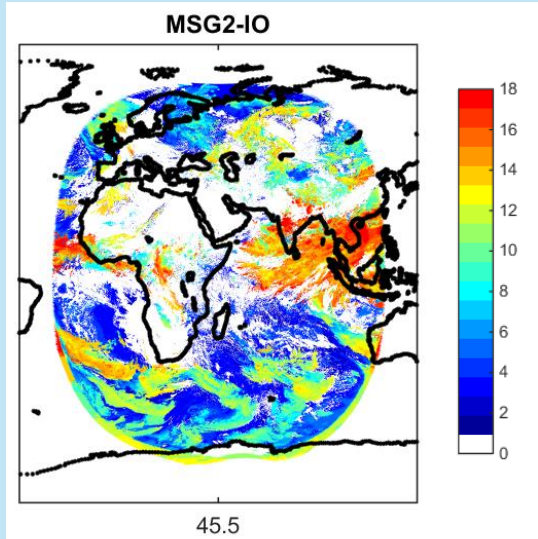
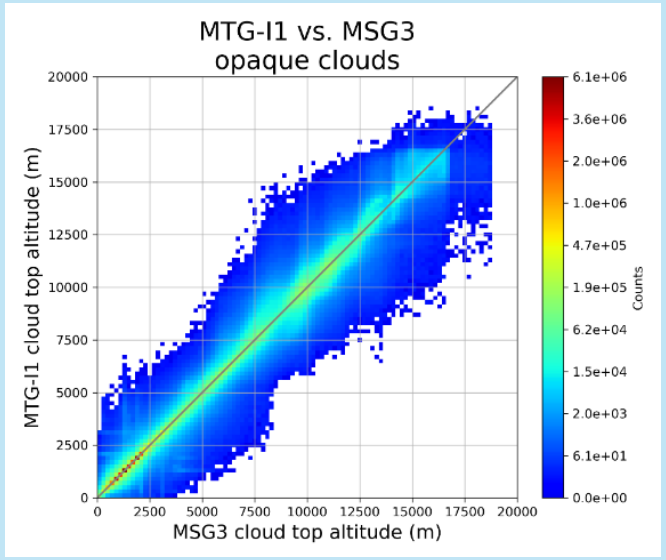
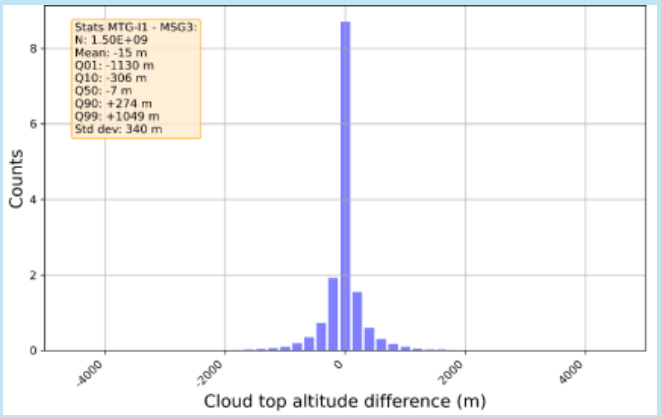




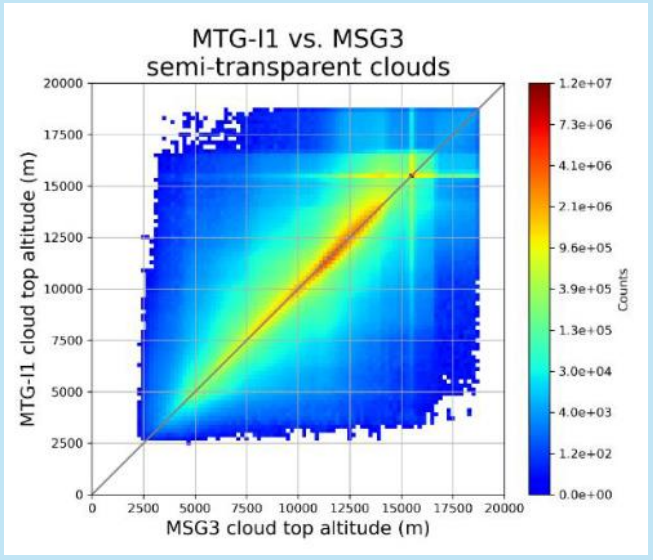
The cloud Product : CTTH

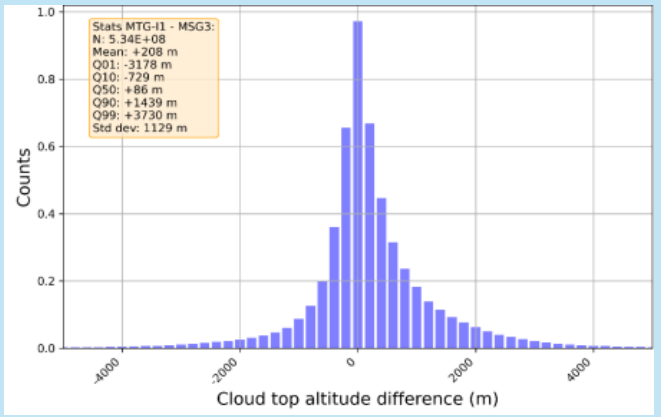
Comparison of Cloud Top Height from MSG3 with Cloud Top Height From MTG-I1 (see validation report)





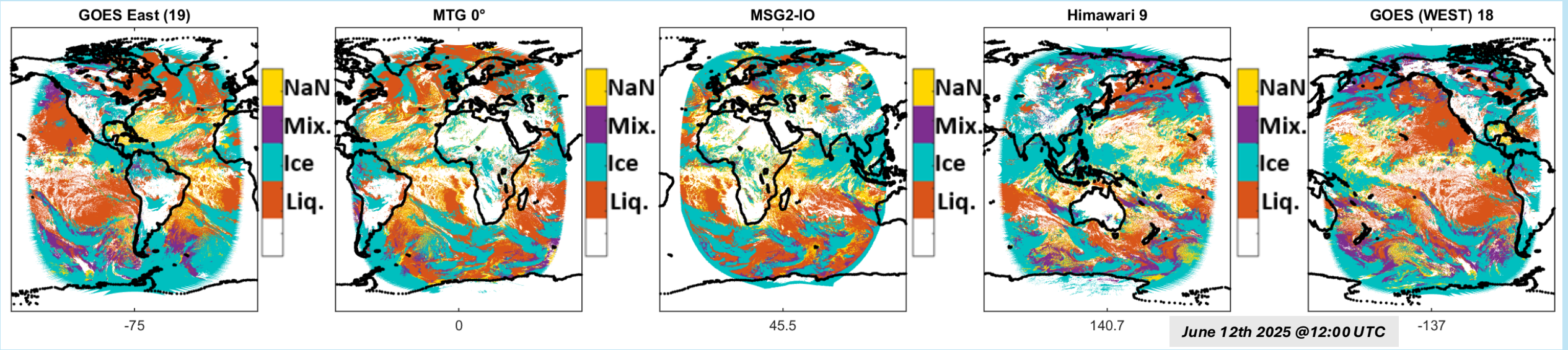
- Mean bias –15 meters
- Median Bias 7 meters
- Mean bias of MSG3 regarding CALIPSO is -460meters





- Mean bias+208 meters
- Median Bias 86 meters
- Mean Bias of MSG3 regarding CALIPSO is -1260meters

The cloud Product : CMIC



CMIC: example is Cloud Top Phase available during day and night

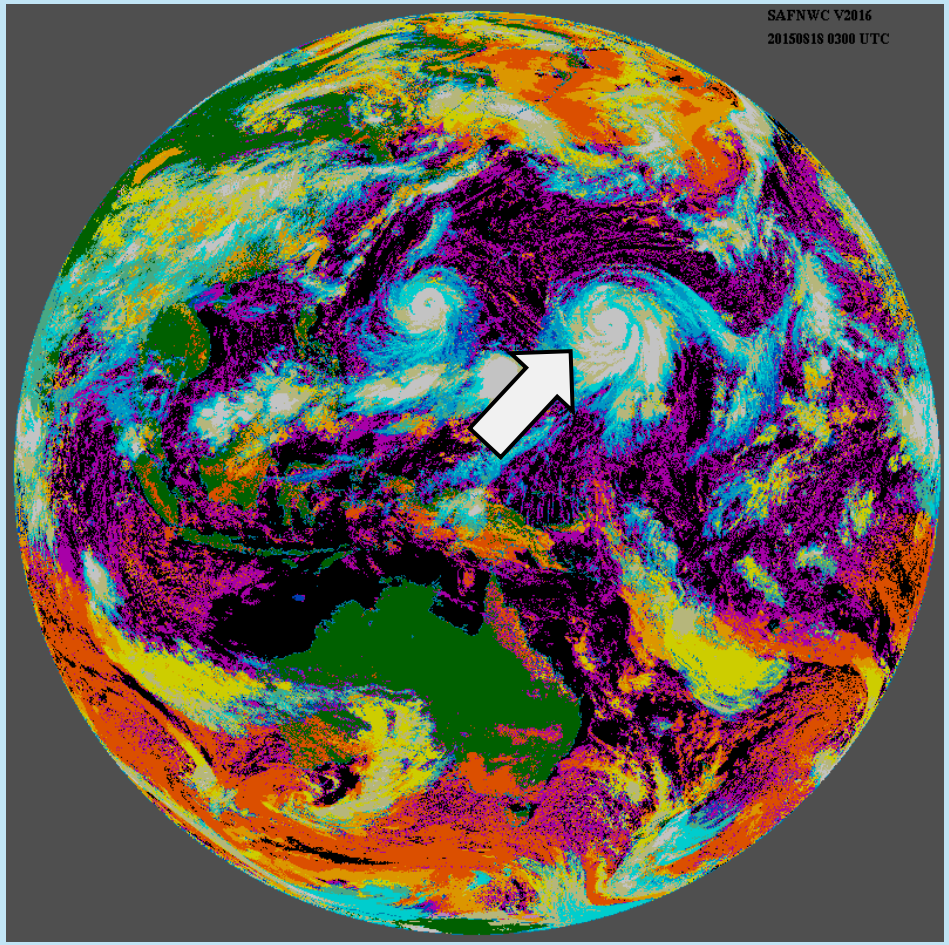
Other CMIC product only available during day (and will be available during night with v2027) :

- Cloud Top effective radius
- Cloud Optical Thickness (in the visible)
- Cloud Liquid and Ice water path

The cloud Product : CMIC

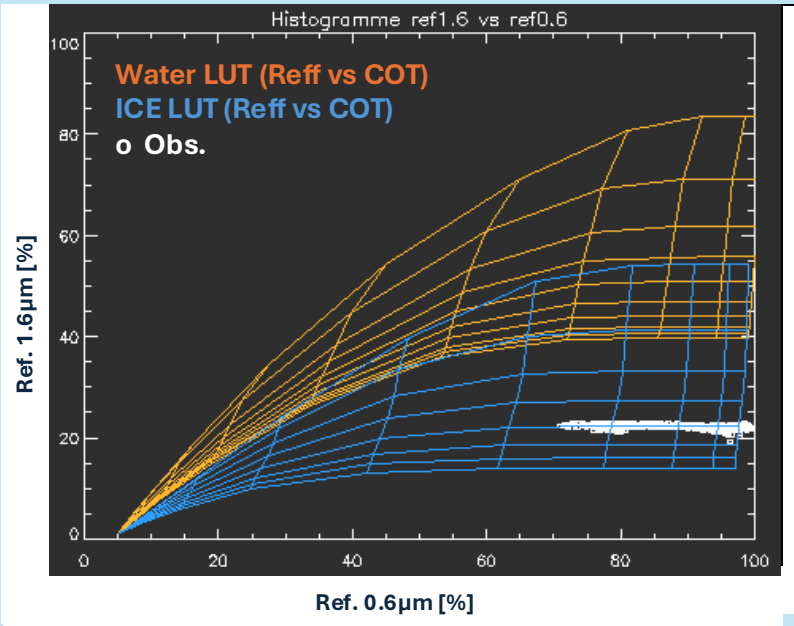
❖ Some improvement with v2025 : cloud top phase

Use of Near infra red channels 2.2µm to Improve water phase detection (available for GOES NG, Himawaris and MTGs)

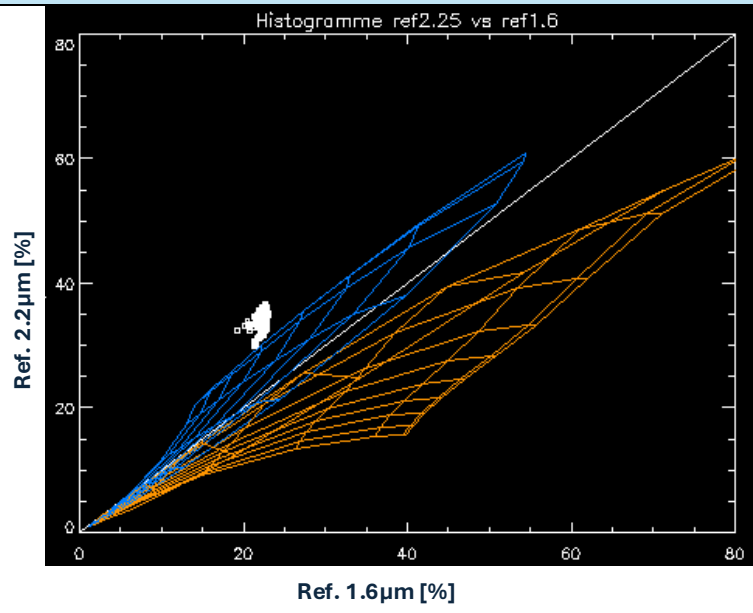


Himawari measurements superimposed to DISORT simulations

1.6µm vs 0.6 µm



1.6µm vs 2.2µm



The distinction of ice phase LUT and water phase LUT is more obvious doing 1.6µm vs 2.2µm than 1.6µm vs 0.6µm

The cloud Product : CMIC

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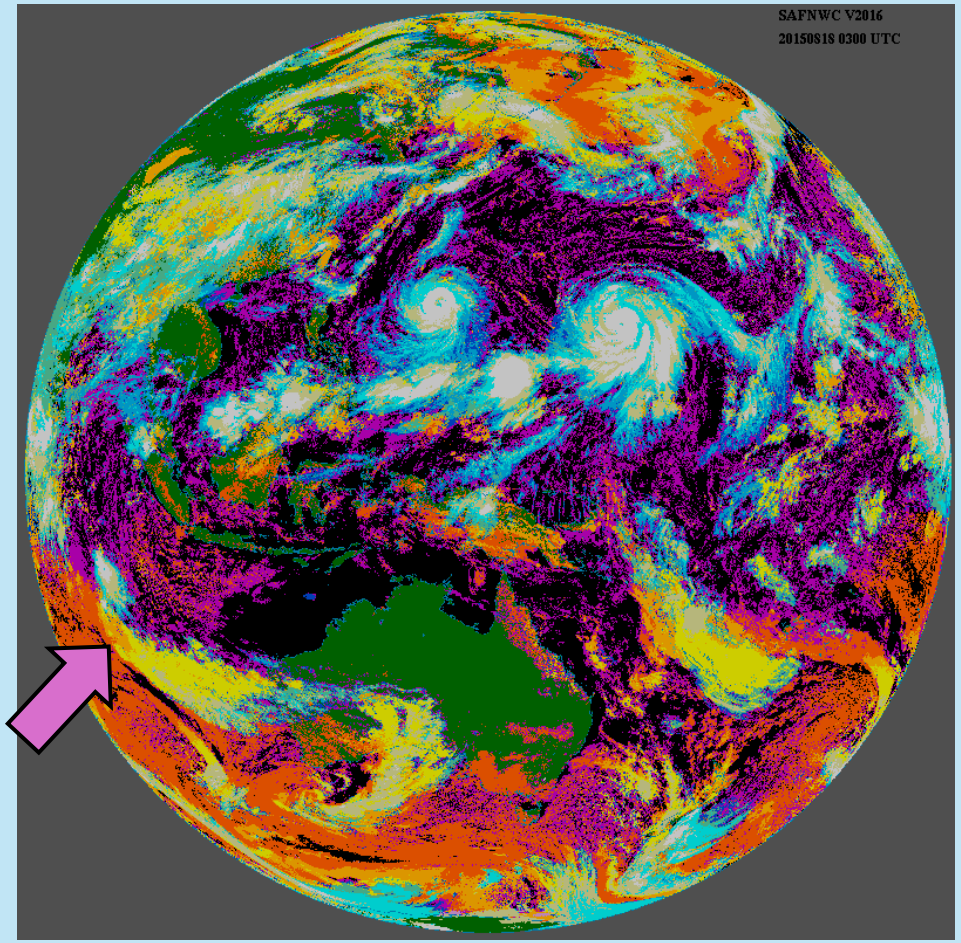
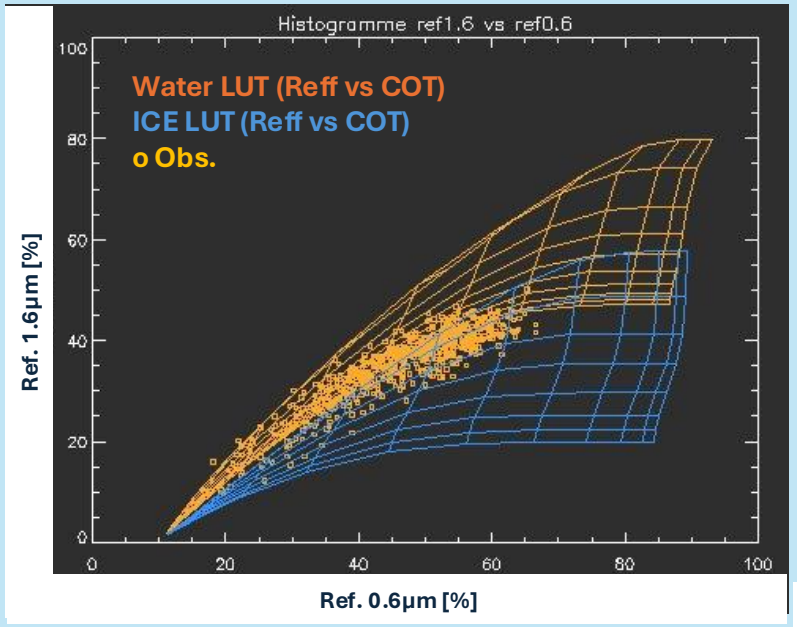
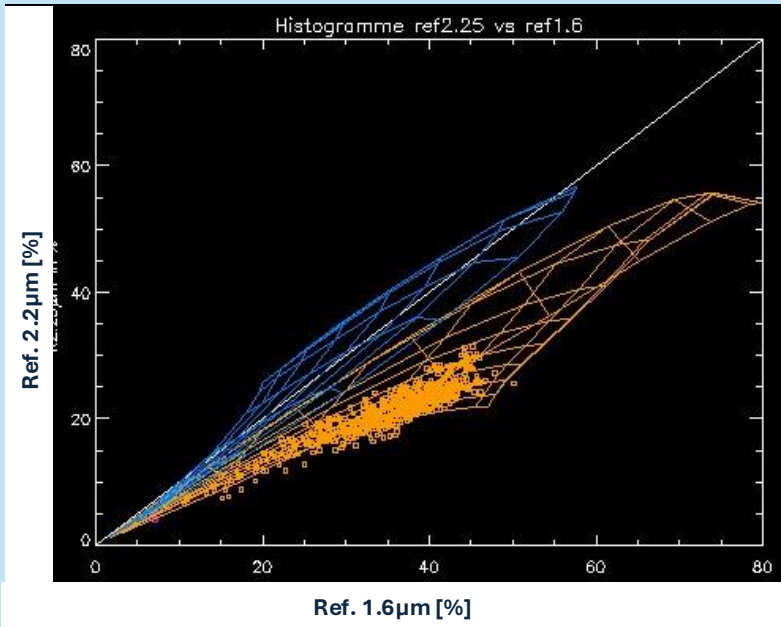


1.6µm vs 0.6 µm



1.6µm vs 2.2µm

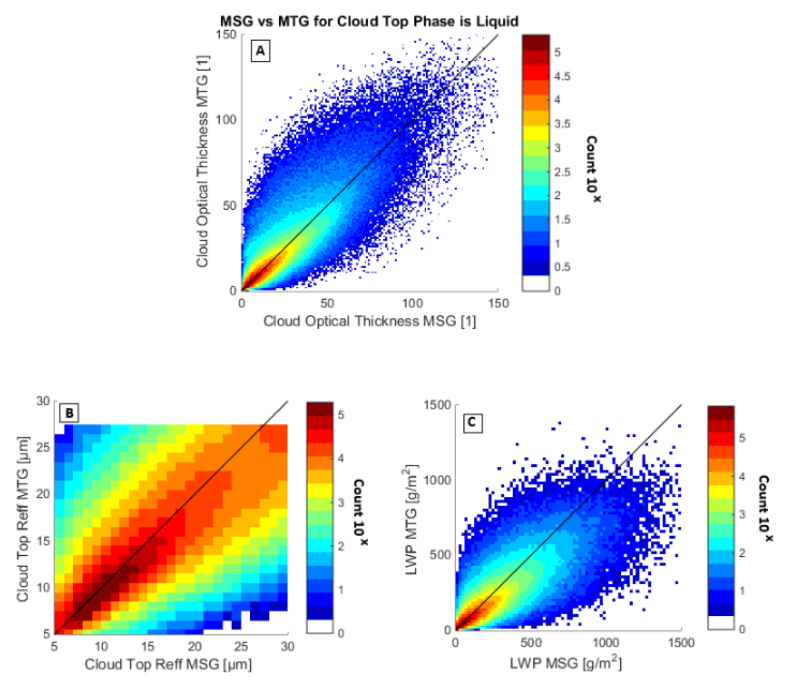


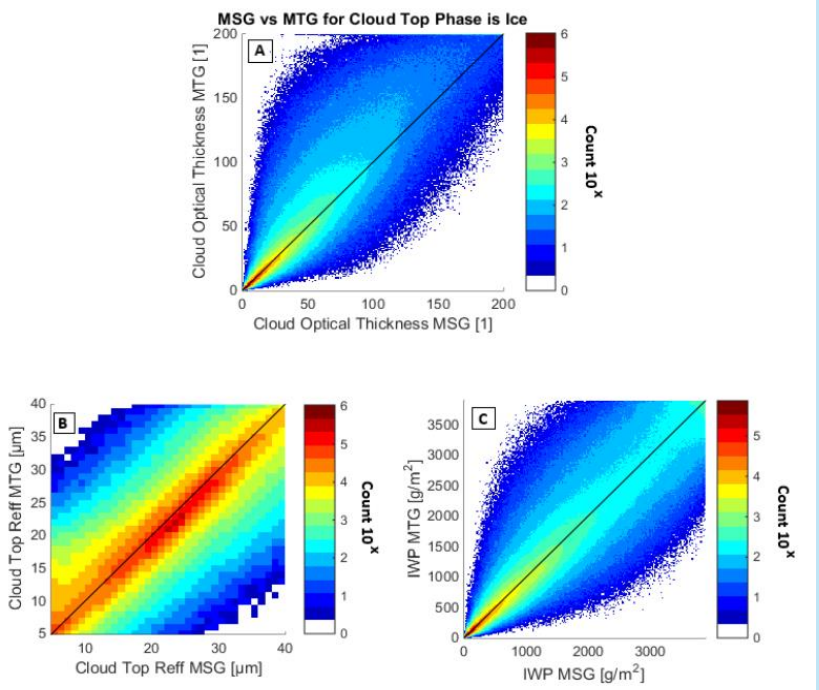
The distinction of ice phase LUT and water phase LUT is more obvious doing 1.6µm vs 2.2µm than 1.6µm vs 0.6µm

=> Improving the phase detection when there is ambiguity in1.6µm vs 0.6µm method

The cloud Product : CMIC

Comparison of Cloud microphysics from MSG3 with Cloud microphysics From MTG-I1 (see validation report)





Rel. Diff. Quantiles in %	10th	25th	median	50th	75th
Reff	-25	- 10	-4	3	16
COT	-21	-11	-1	12	33
LWP	-24	-13	-1	12	32

Rel. Diff. Quantiles in %	10th	25th	median	50th	75th
Reff	-21	- 13	-4	8	25
COT	-28	-15	-1	20	51
IWP	-38	-23	-5	23	66

Correction of microphysic for MTG in v2025 is introduced in order that microphysic in MSG3 and MSTG-I1 are similar (waiting with validation with EarthCARE)

With MTG:

- Version MTG Day 1 (use of new channels), v2025:
  - Use of NIR 1.38µm to improve the detection of cirrus
  - Retrieval of cloud top height in hecto feet (for flight level)

- Version MTG Day 2, v2027 :
  - A new flag for distinction of Stratiform like clouds against cumulus like clouds
  - Retrieval of Cloud Top Height using Neural Network
  - CMIC during Day using Neural Network