# ESA EarthCARE MSI cloud products

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*TROPOS / FU-Berlin*

2nd ESA-JAXA EarthCARE In-Orbit Validation Workshop

17-20 March 2025 | VIRTUAL EVENT

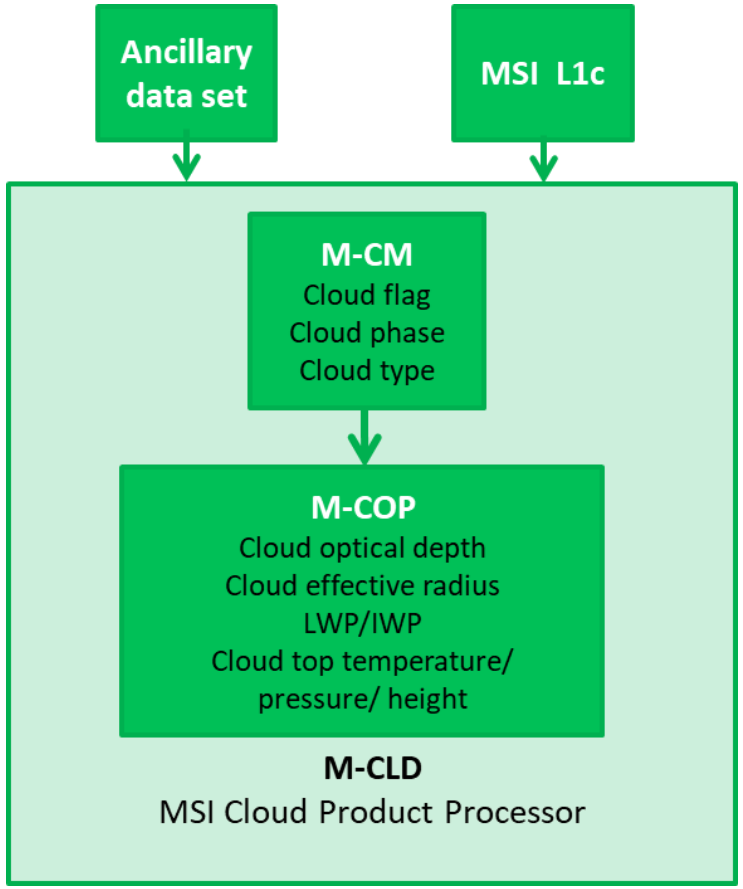
# MSI level 2 products M-CM and M-COP

## MSI L2 products since July until now

**M-CM**
the cloud mask product

**cloud_mask**
**cloud_type**
**cloud_phase**
**surface_classification**

**quality status**
**cloud_mask_quality_status**
**cloud_type_quality_status**
**cloud_phase_quality_status**




**M-COP**
the cloud optical and physical properties product

**cloud_optical_thickness**
**cloud_effective_radius**
**cloud_top_temperature**
**cloud_top_pressure**
**cloud_top_height**
**cloud_water_path**

**cloud_optical_thickness_error**
**cloud_effective_radius_error**
**cloud_top_temperature_error**
**cloud_water_path_error**
**Quality status**

Hünerbein, A. et al., 2023
*https://doi.org/10.5194/amt-16-2821-2023*

Hünerbein, A. et al., 2024
https://doi.org/10.5194/amt-17-261-2024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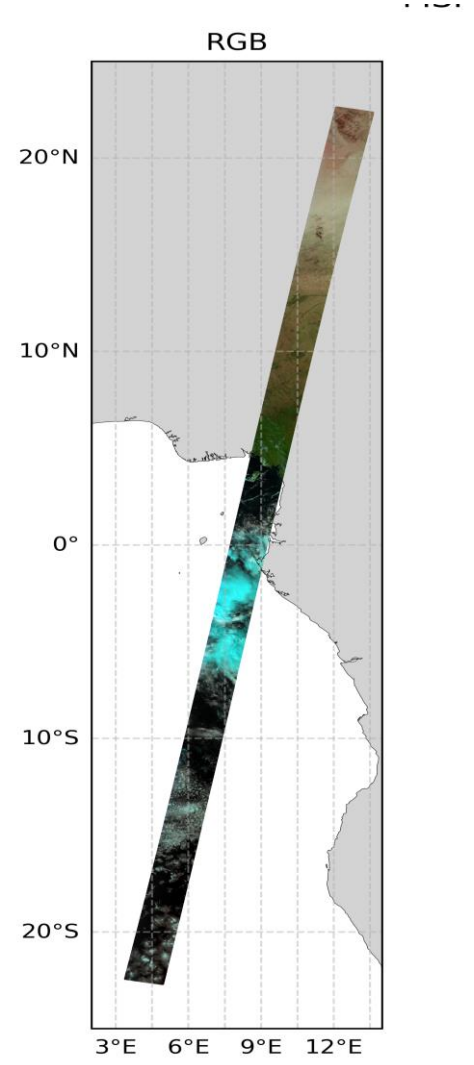
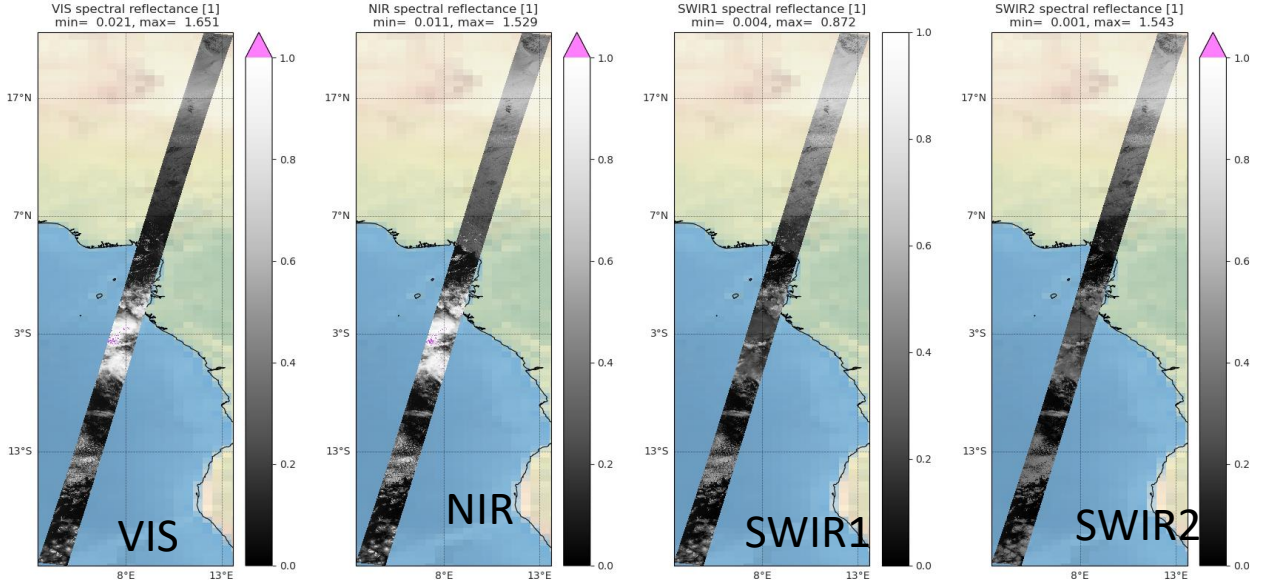
# MSI-Multi-Spectral Imager




The instrument operates in a pushbroom mode with two bands in the VNIR (Visible and Near Infrared), and two bands in the SWIR (Short Wave Infrared).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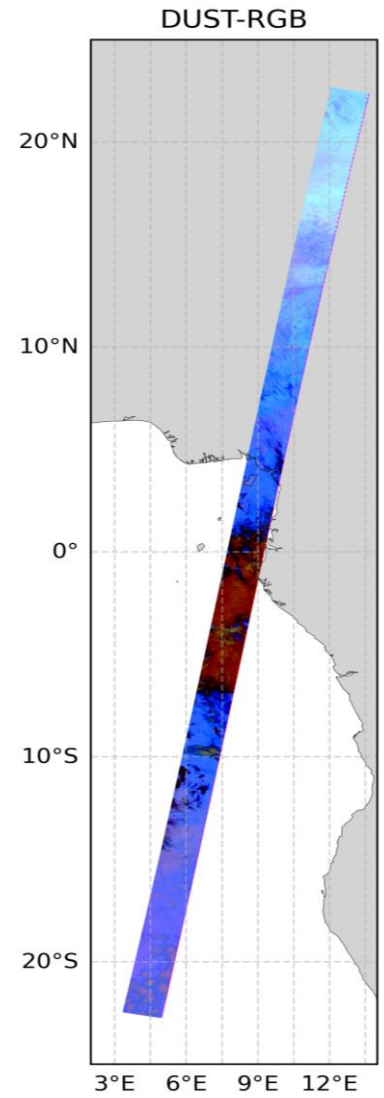
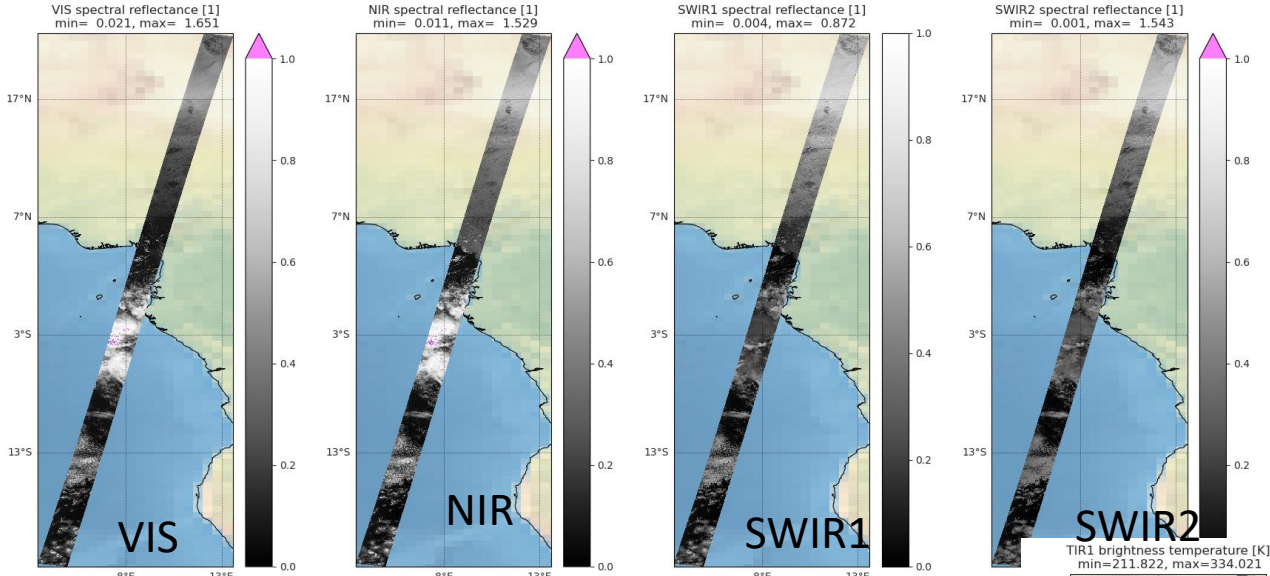
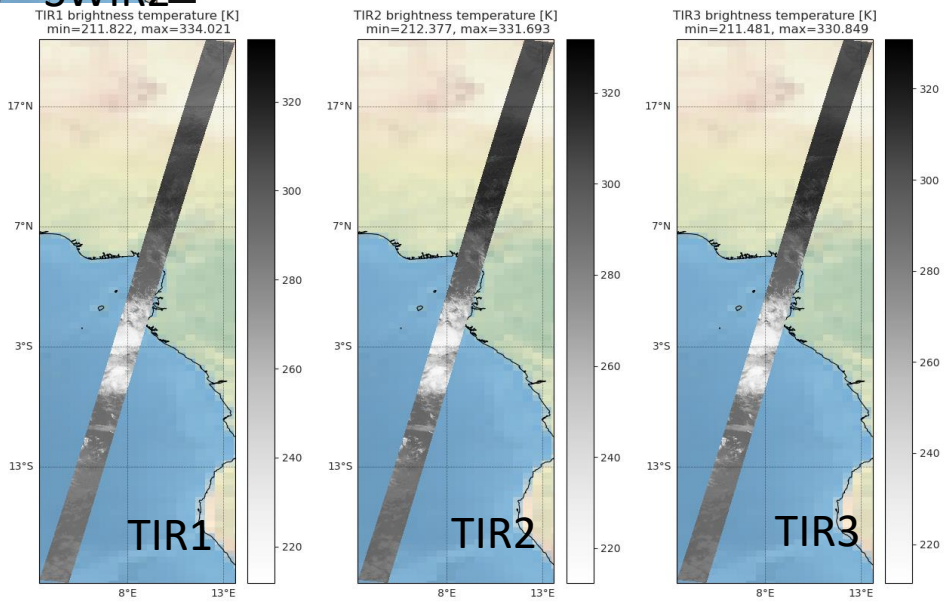



The instrument operates in a pushbroom mode with two bands in the VNIR (Visible and Near Infrared), and two bands in the SWIR (Short Wave Infrared).

Three bands are in the TIR (Thermal Infrared) part of the spectrum. The instrument is nadir-pointing with a spatial resolution of 500 m and a swath width of 150 km.



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# MSI cloud mask (M-CM)

- Cloud flag (Threshold Technique based on MODIS (binary cloud flag )
- Cloud type (Maximum-Likelihood Classifier, ISCCP)
- Cloud phase (Pavolonis et al. 2005)

| Channel | Center Wavelength µm | Bandwidth (50%) |
|---|---|---|
| VIS | 0.67 | 20 nm |
| NIR | 0.865 | 20 nm |
| SWIR-1 | 1.65 | 50 nm |
| SWIR-2 | 2.21 | 0.1 µm |
| TIR 1 | 8.80 | 0.9 µm |
| TIR 2 | 10.80 | 0.9 µm |
| TIR 3 | 12.00 | 0.9 µm |

Hünerbein, A. et al., 2023
*https://doi.org/10.5194/amt-16-2821-2023*


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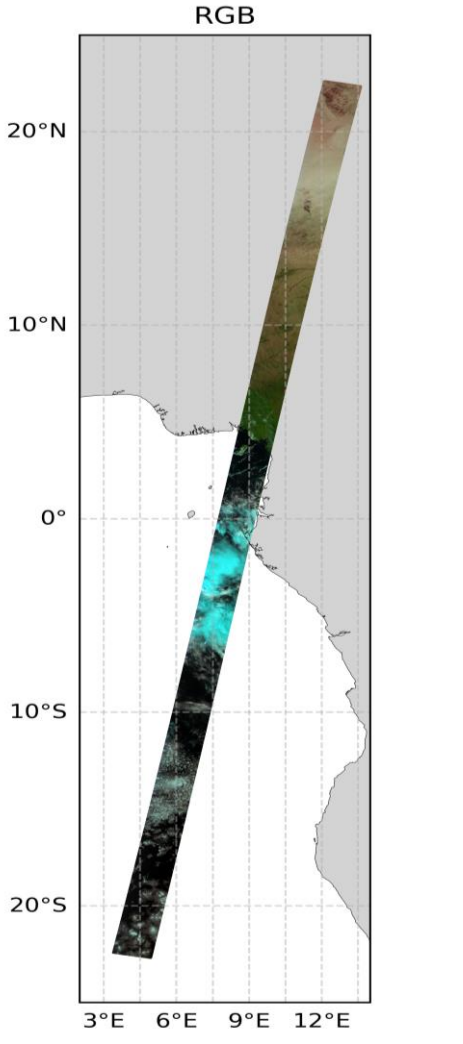
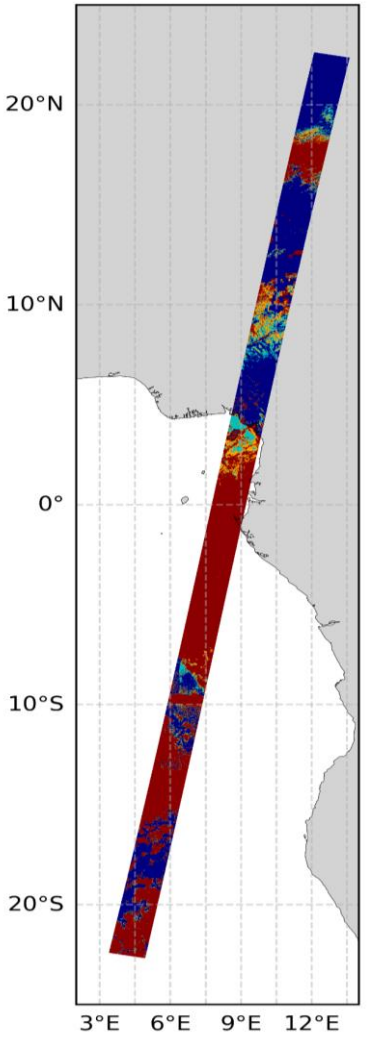
# MSI level 2 products M-CM

RGB

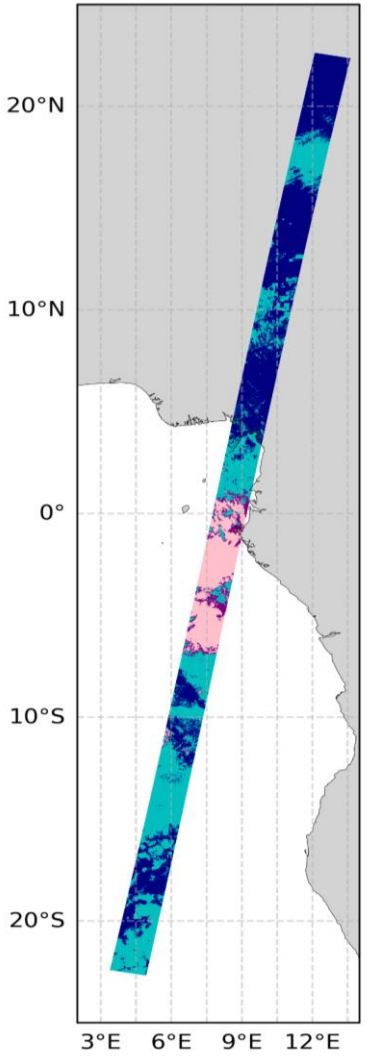


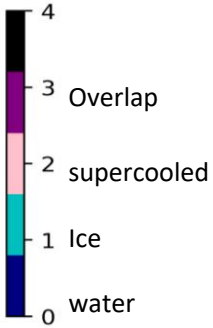

Cloud Mask



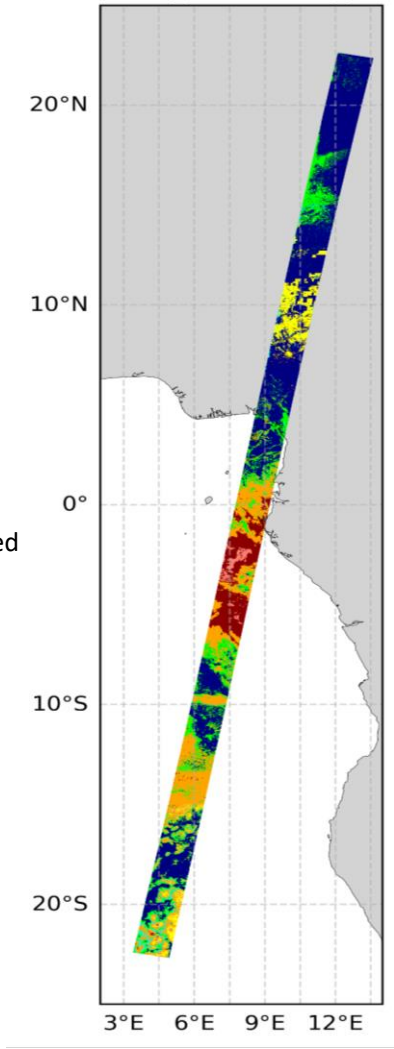


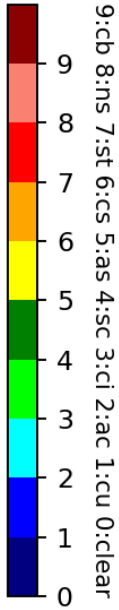
Cloud Phase




Cloud type



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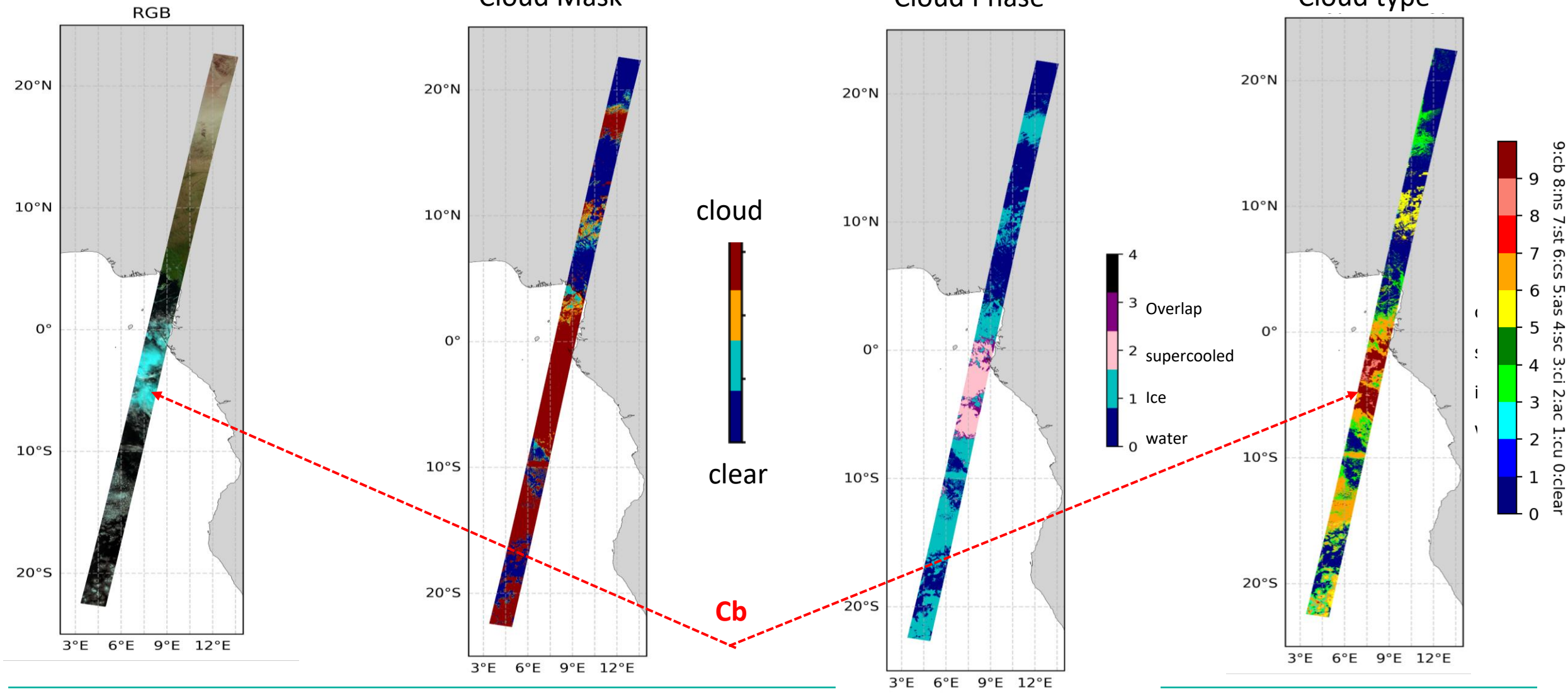
# MSI level 2 products M-CM



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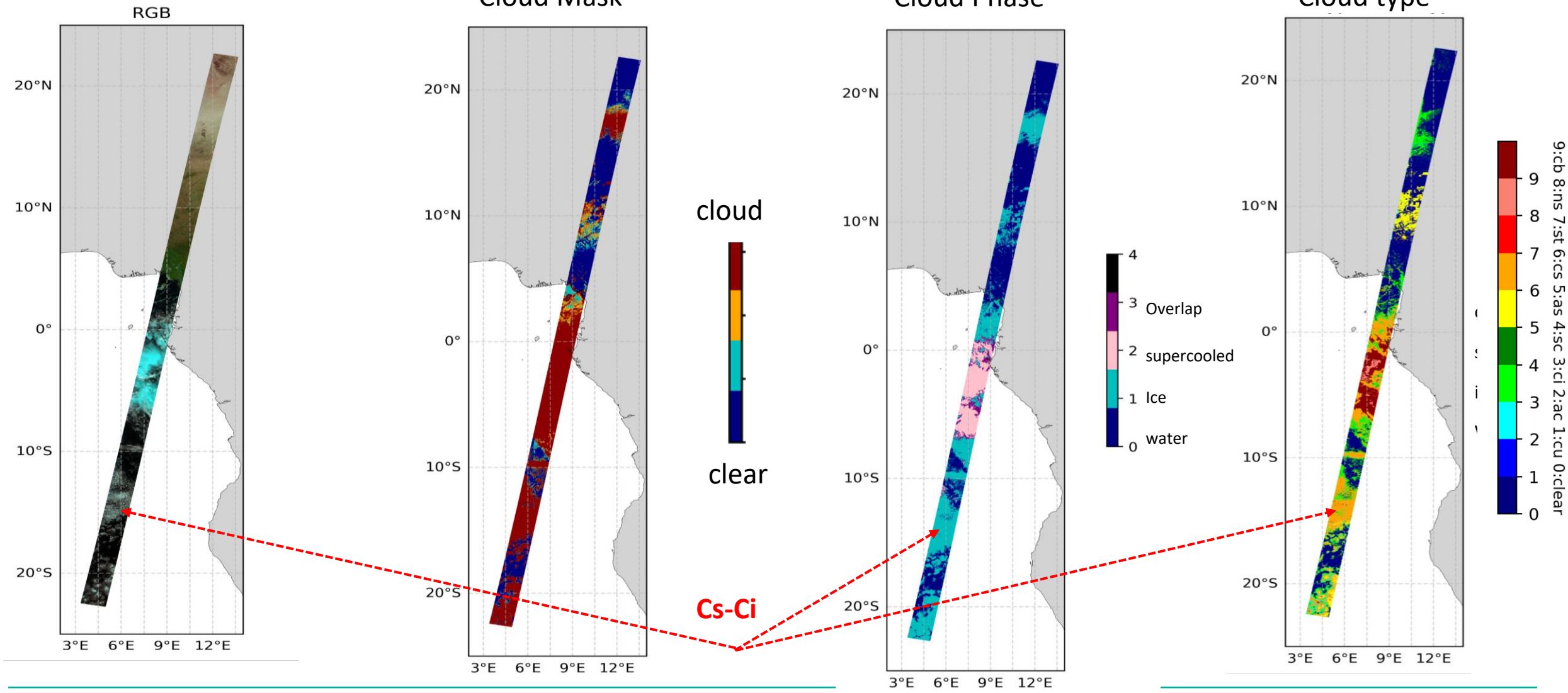
# MSI level 2 products M-CM



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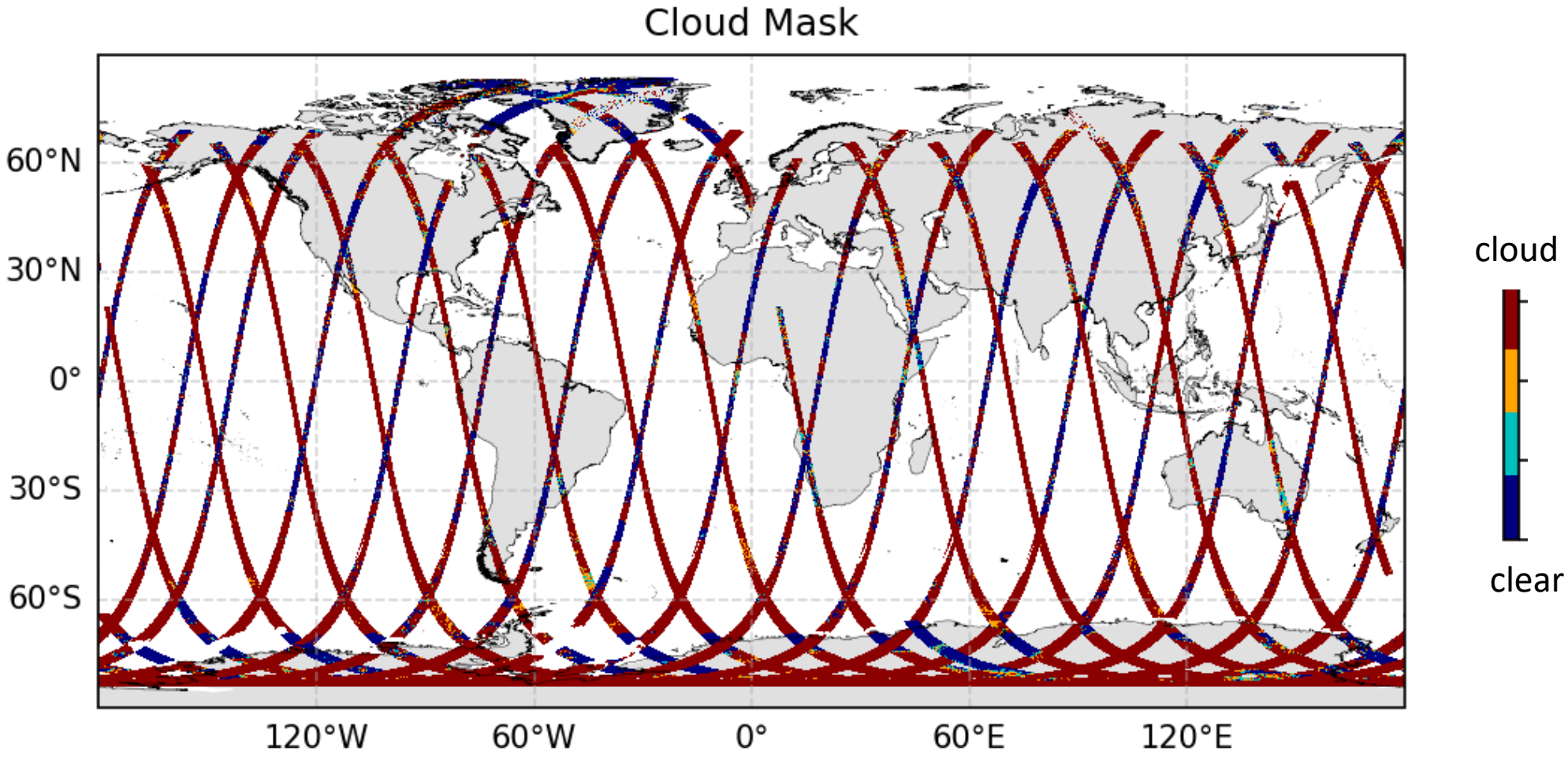
# MSI level 2 products M-CM

## M-CM

Daily coverage of the cloud mask





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# MSI cloud optical and physical properties (M-COP)

Optimal estimation approach are used:

- Cloud optical thickness
- Cloud effective radius
- Cloud top temperature (height, pressure)

| Channel | Center Wavelength µm | Bandwidth (50%) |
|---|---|---|
| VIS | 0.67 | 20 nm |
| NIR | 0.865 | 20 nm |
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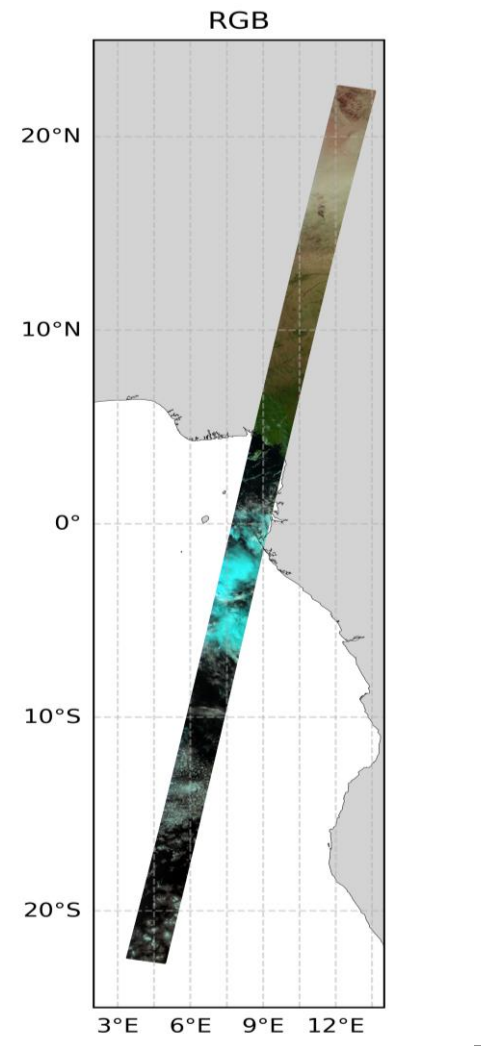


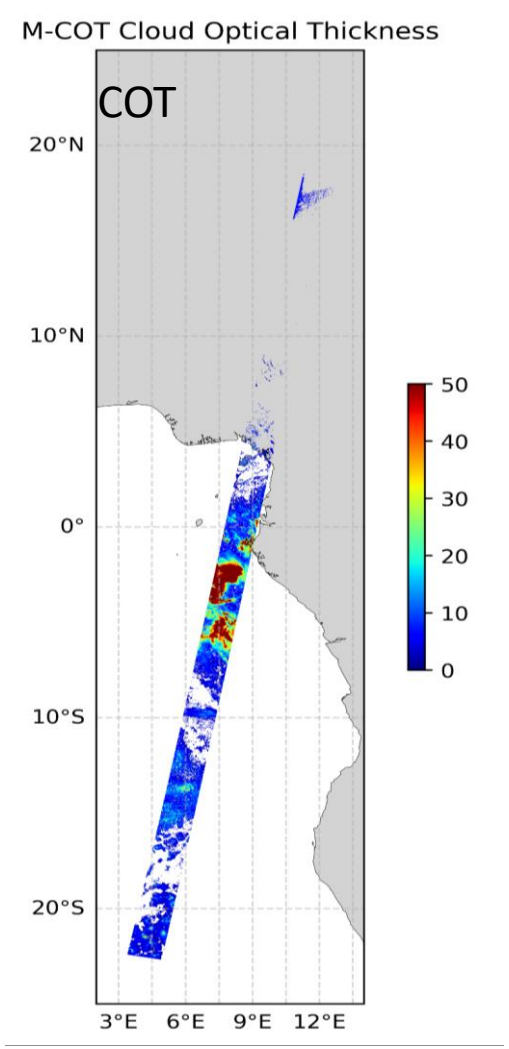


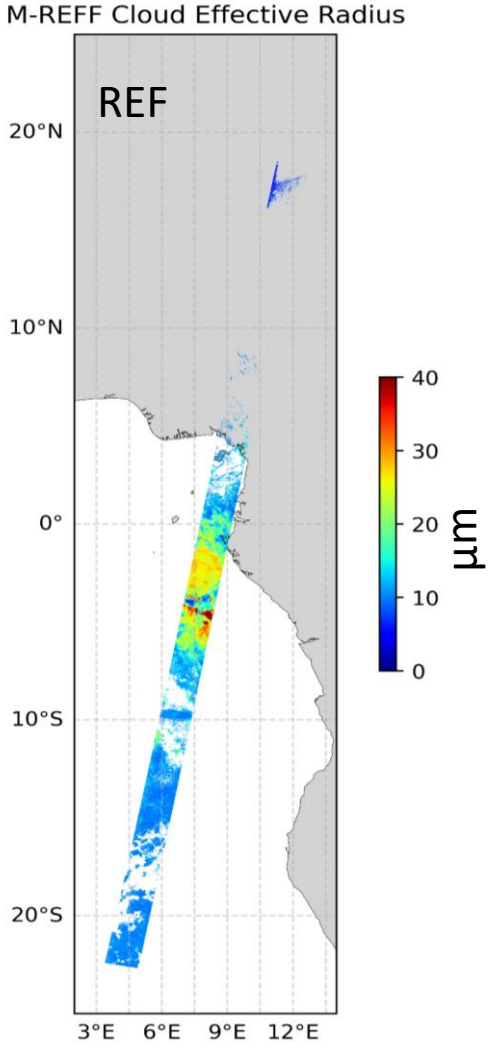


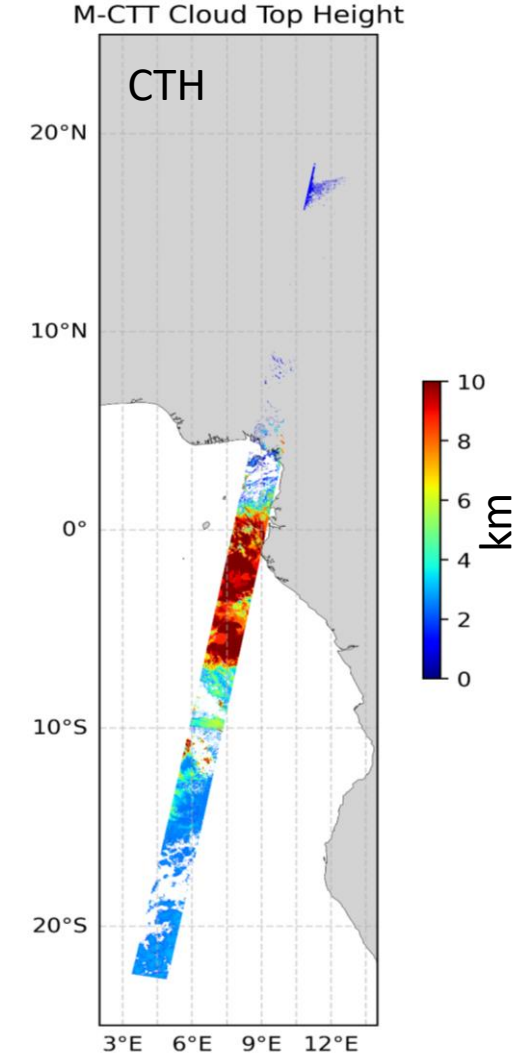


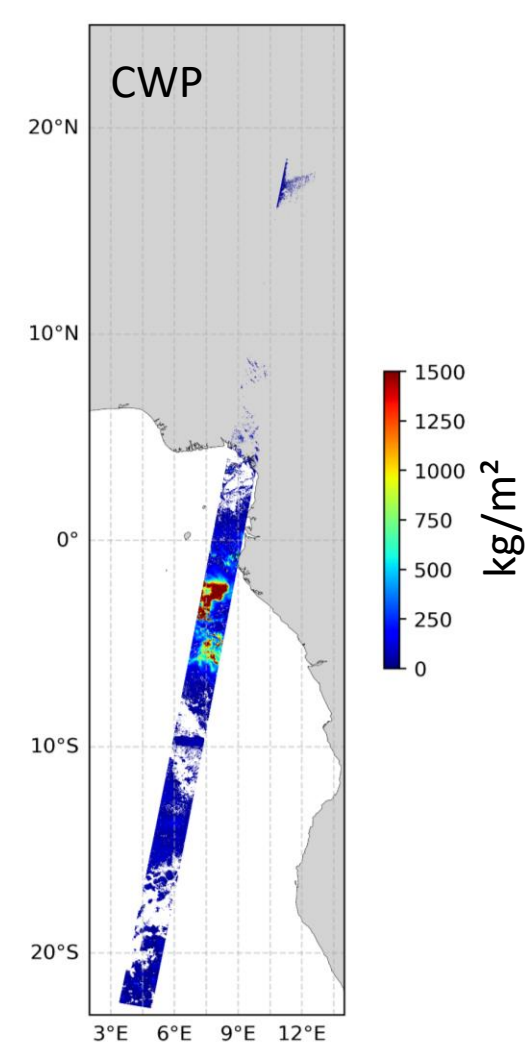




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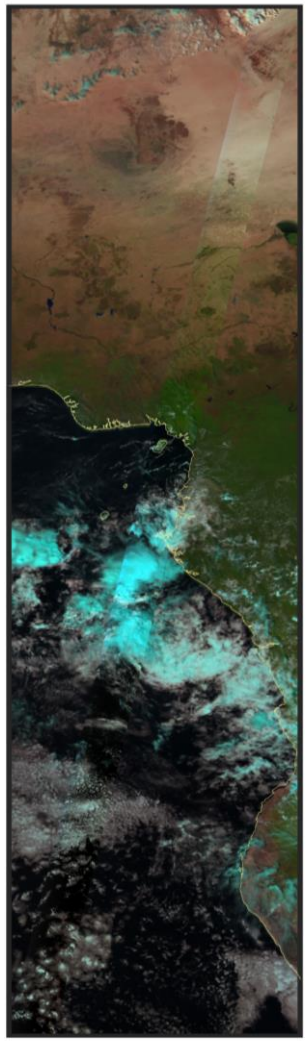
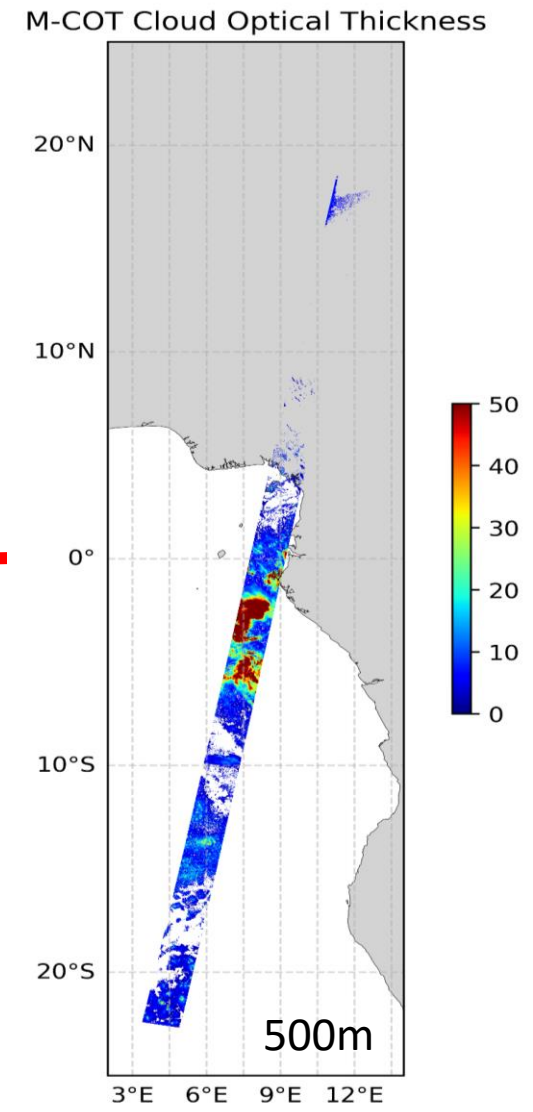
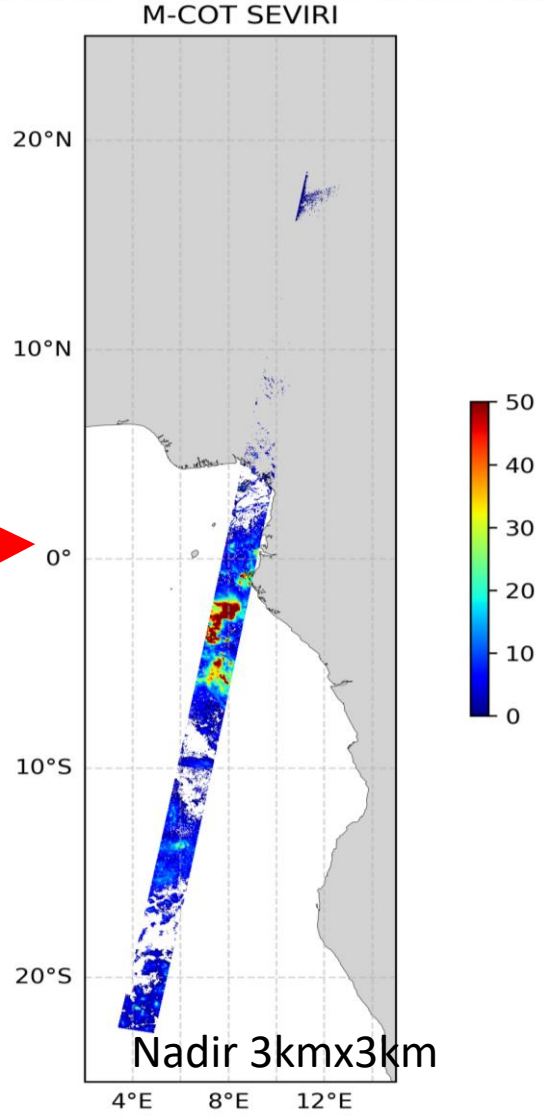
# MSI level 2 products M-COP: Comparison with SEVIRI

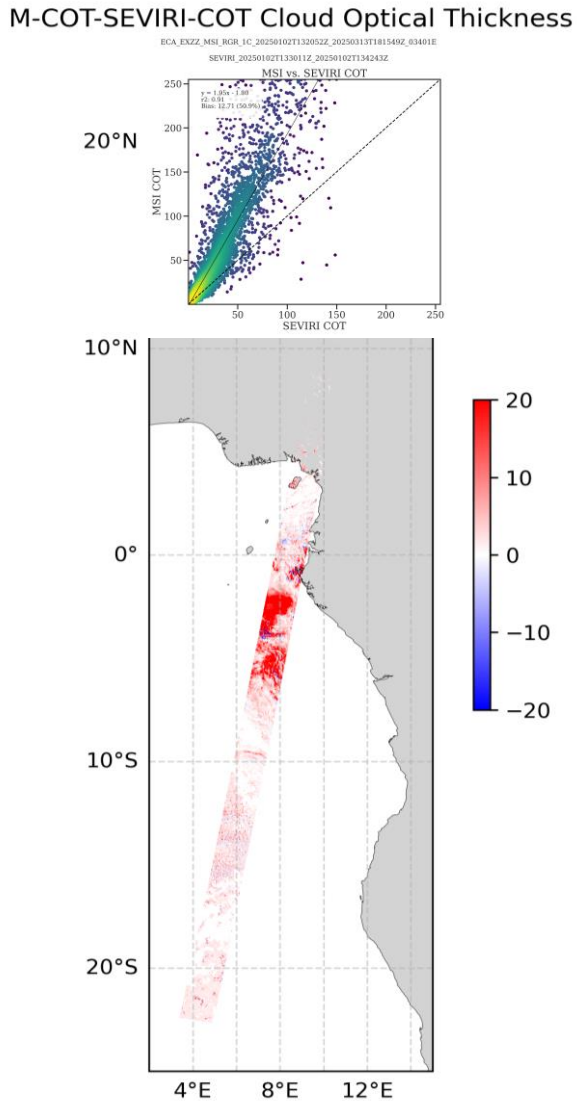





Nearest neighbour

no interpolation



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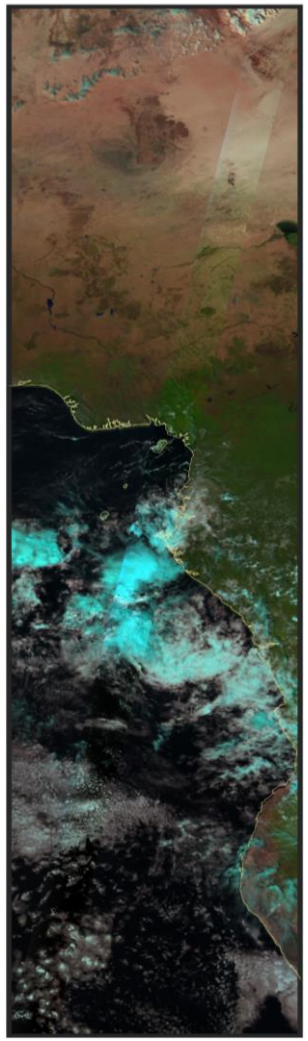

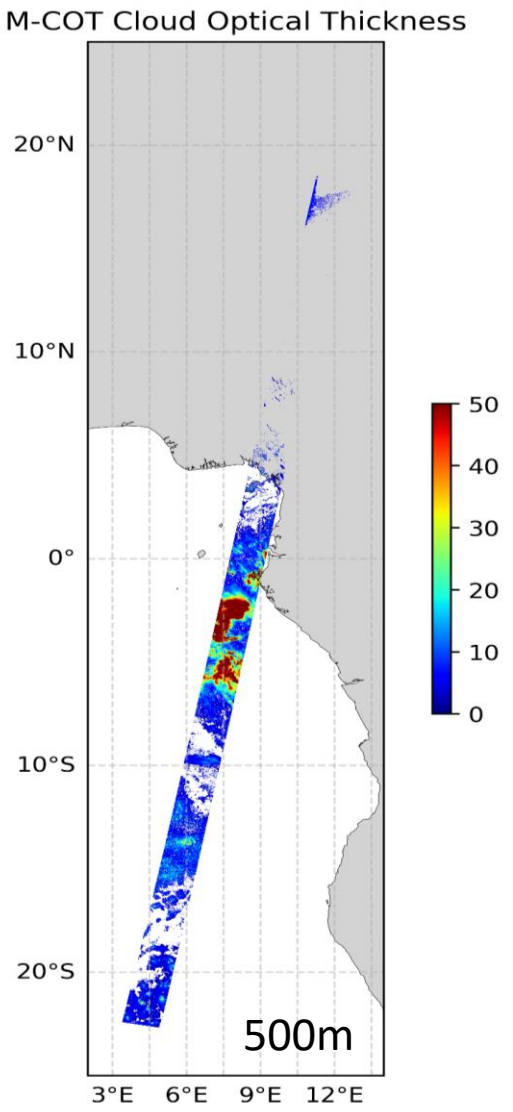


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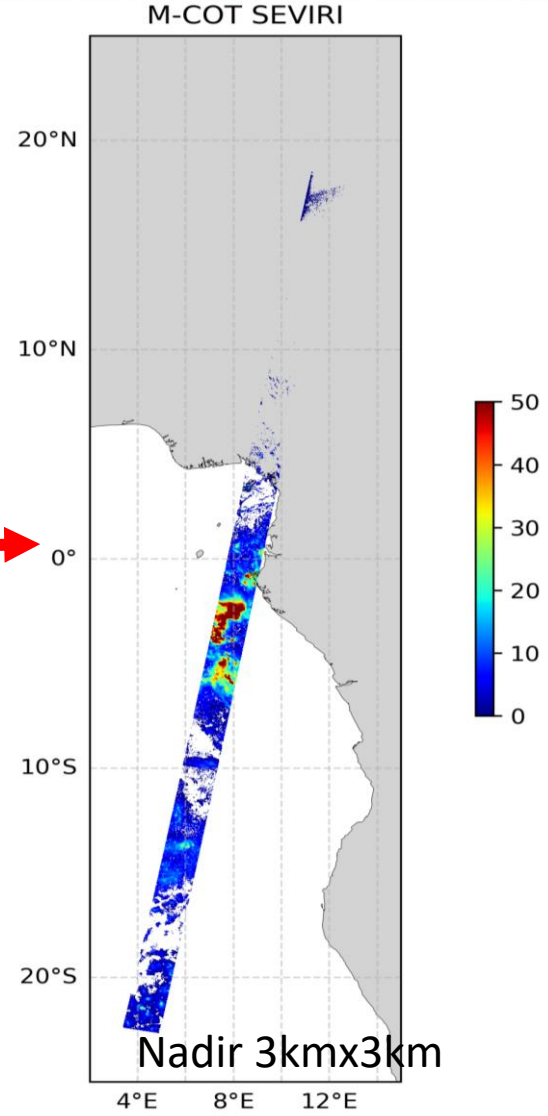


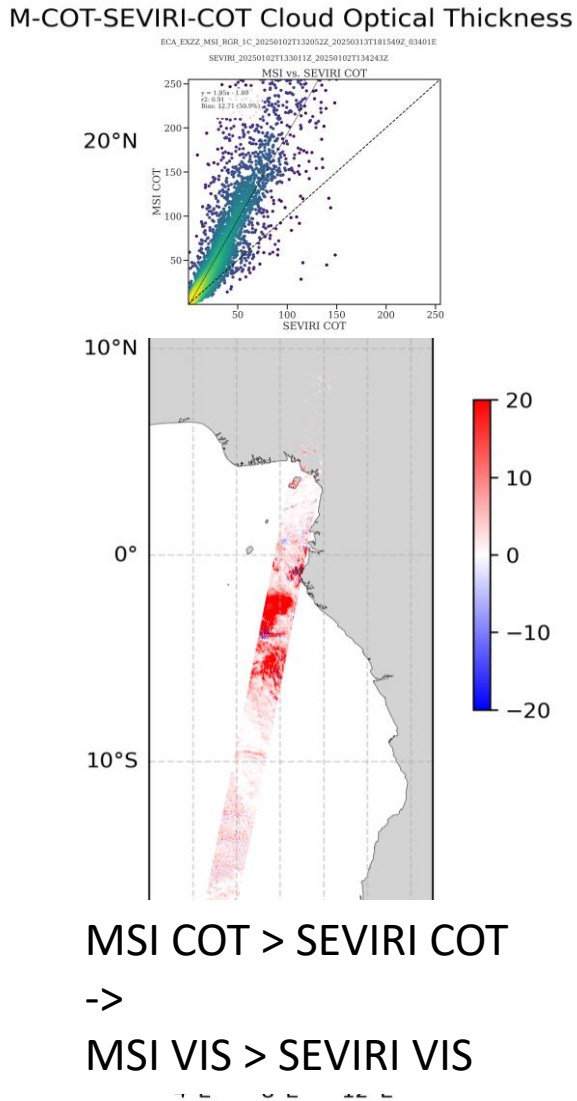


MSI COT > SEVIRI COT

->

MSI VIS > SEVIRI VIS



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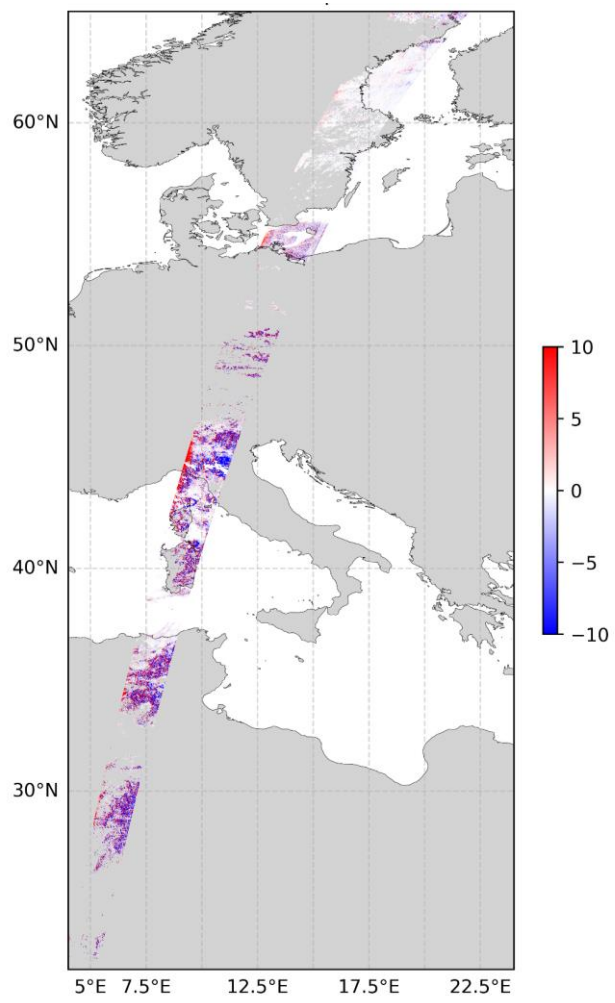
# Known issues

- Currently at version 11.30 – baseline AB (since 11.03.2025 implemented- frame 04458B)

| Input baseline | Output baseline | Period | Notes |
|---|---|---|---|
| M-RGR | M-CLD | | |
| AF | AB | 28 Jan 2025 (03807C) - | M-RGR baseline AF, CCDB v14 issues reported in [RD-3] |
| AF | AB | 27 Jan 2025 - 28 Jan 2025 | M-RGR baseline AF, CCDB v13 issues reported in [RD-3]) |
| AE | AB | 13 Jan 2025 – 27 Jan 2025 | M-CM and M-COP products quality is affected by known M-RGR issues, [RD-3]) |

M-COP AE-AF




➢ Example highlights influence of changed VIS spectral solar irradiance change specifically for M-COT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# Known issues - Disclaimer

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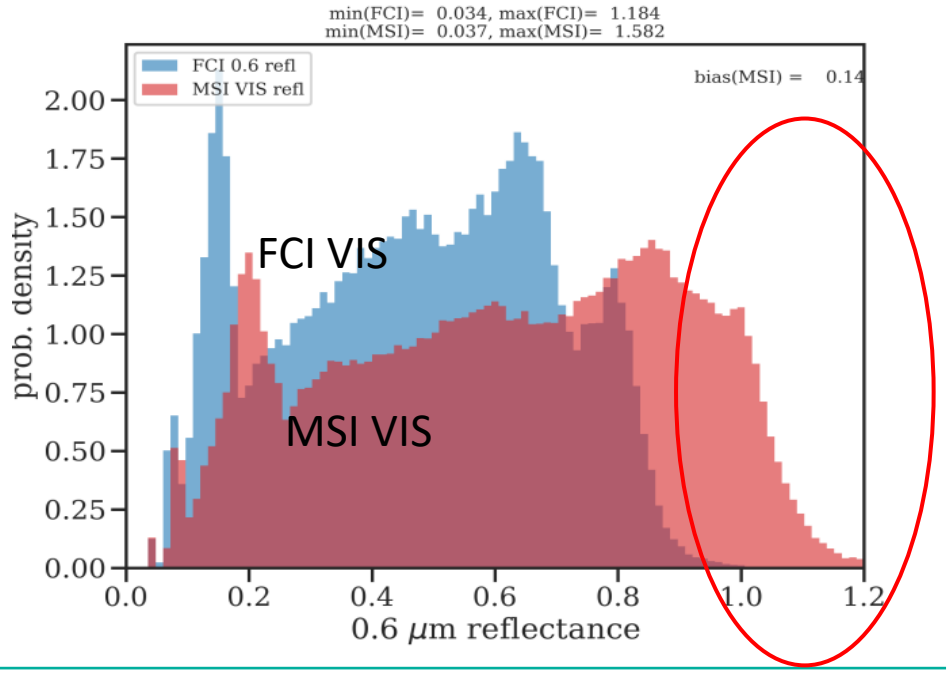
**VIS and NIR channel reflectance**

- Can be far over 1, which leads to misclassification in the M-Ctype as well as no results in the M-COP products





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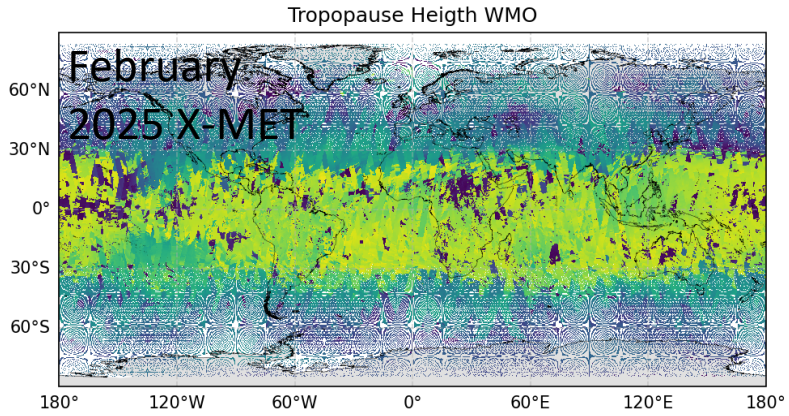
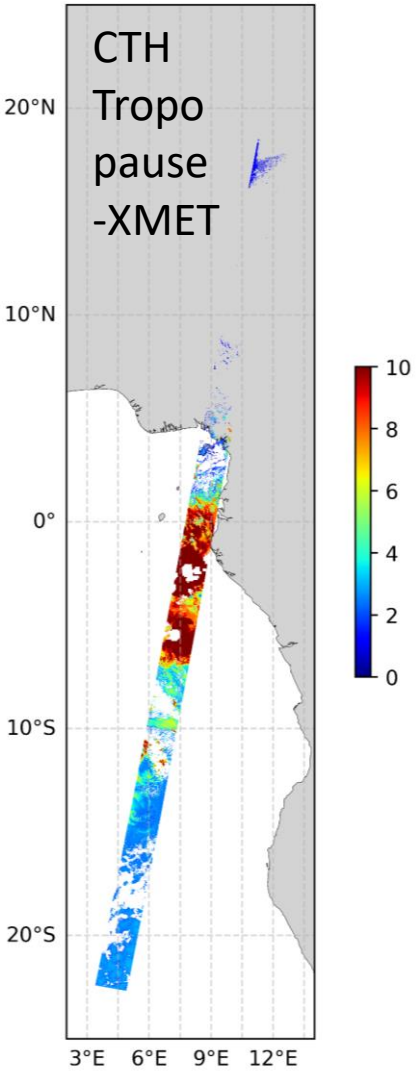
**Low tropopause height in X-MET**

- Affects the M-CTT/M-CTH/M-CTP products





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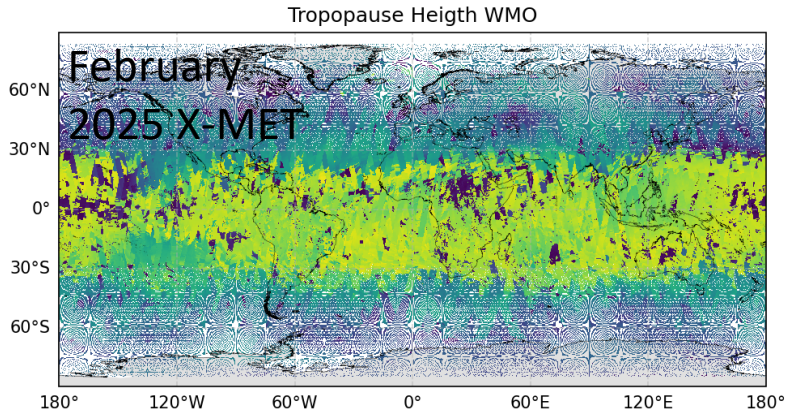


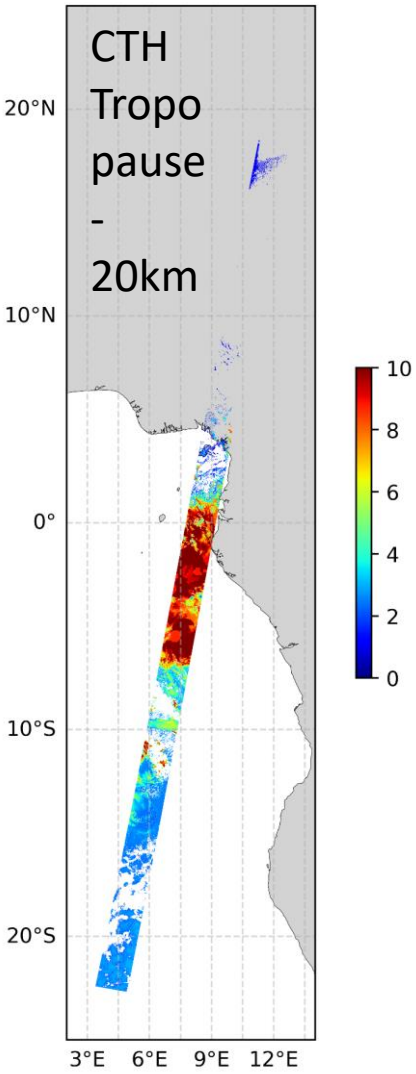



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# Thank you!



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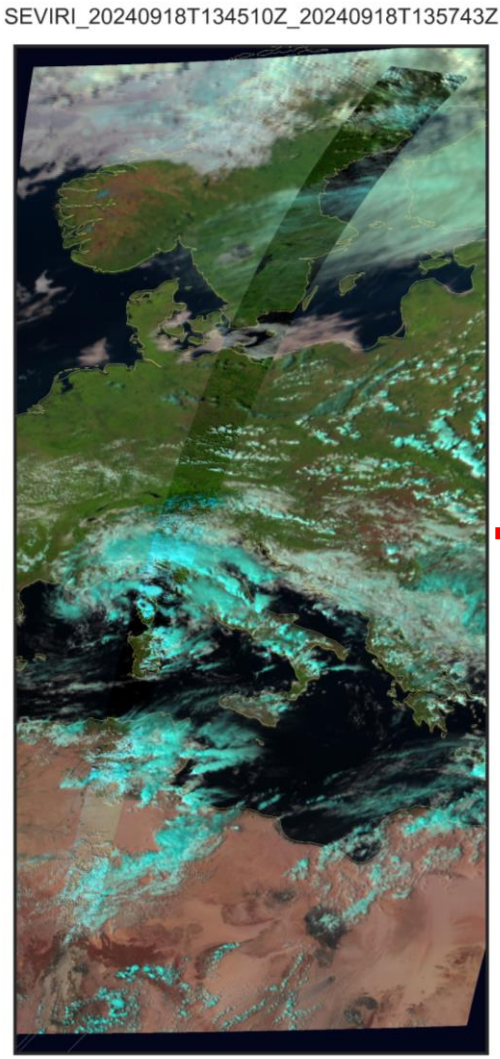
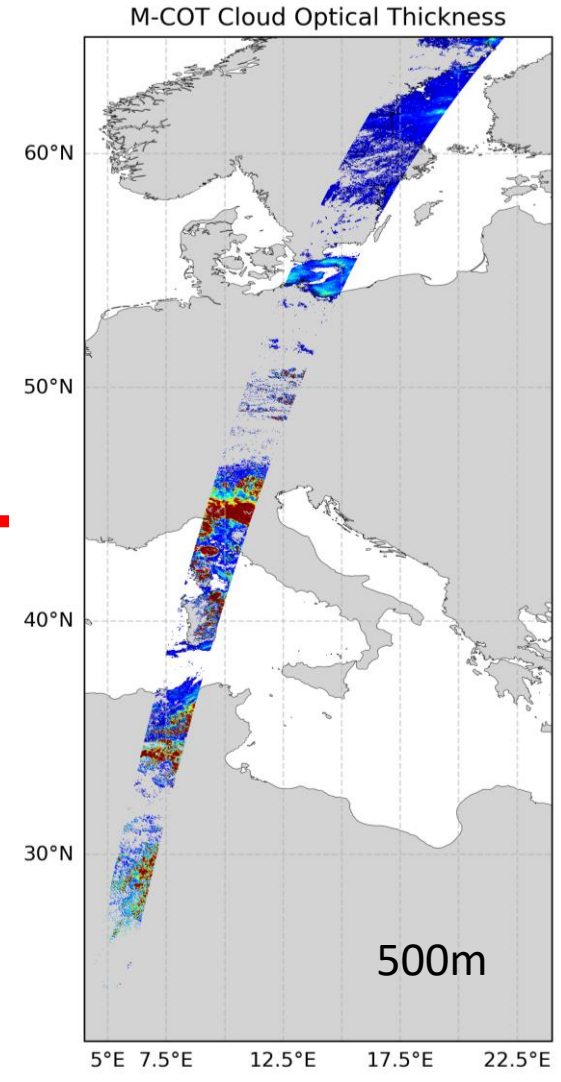
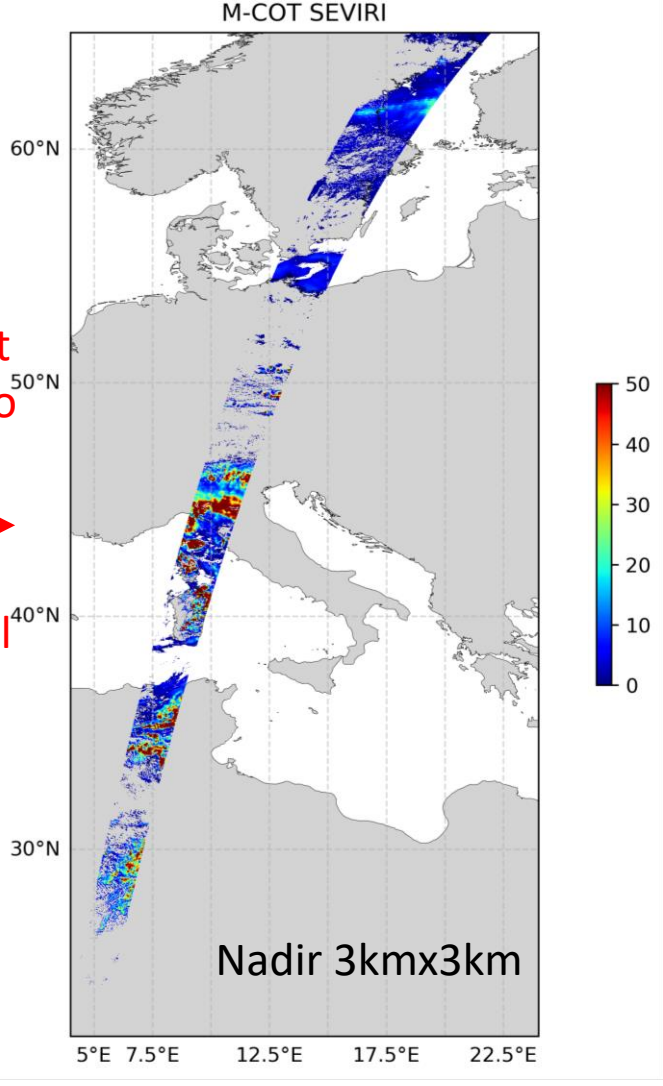
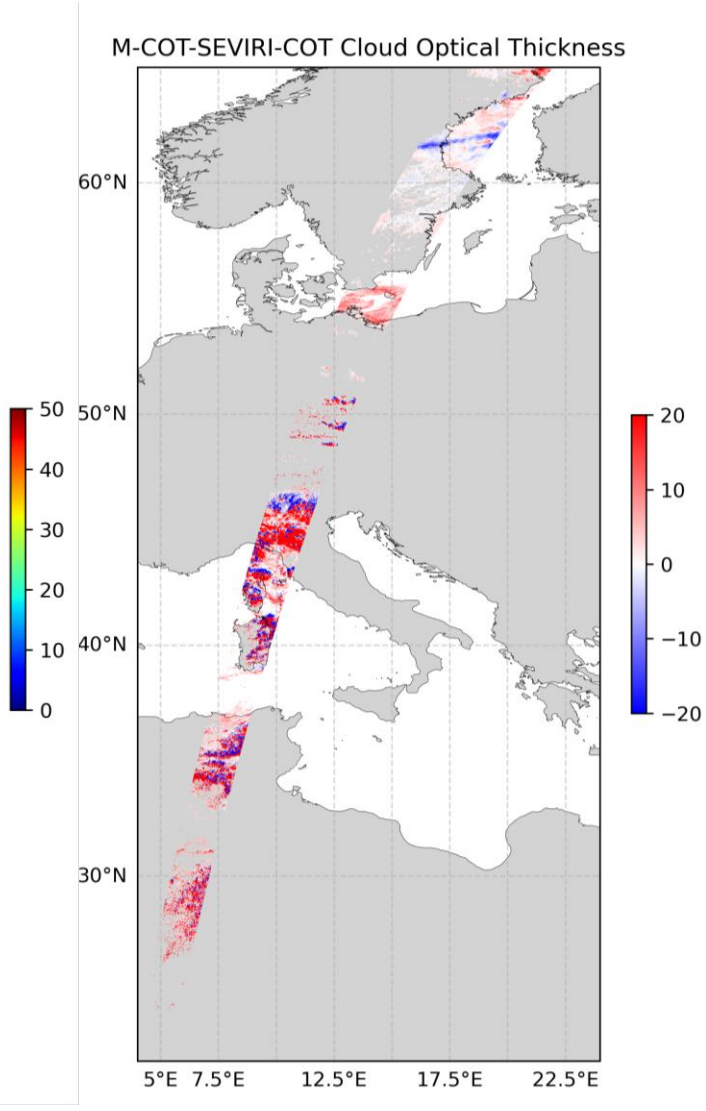
# MSI level 2 products M-COP




Nearest neighbour interpolation



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# MSI level 2 products M-CM

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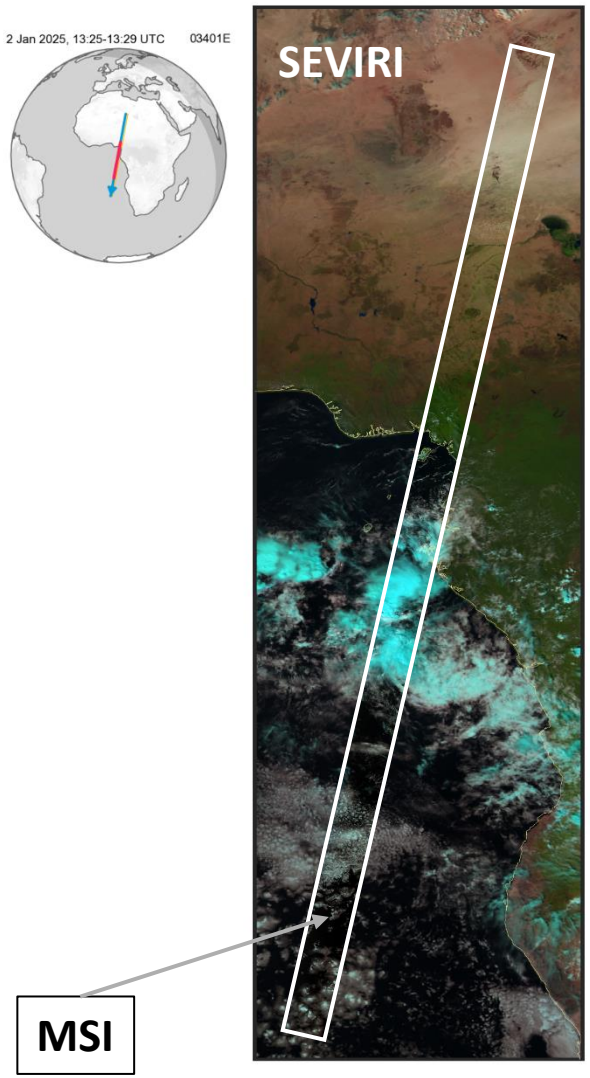
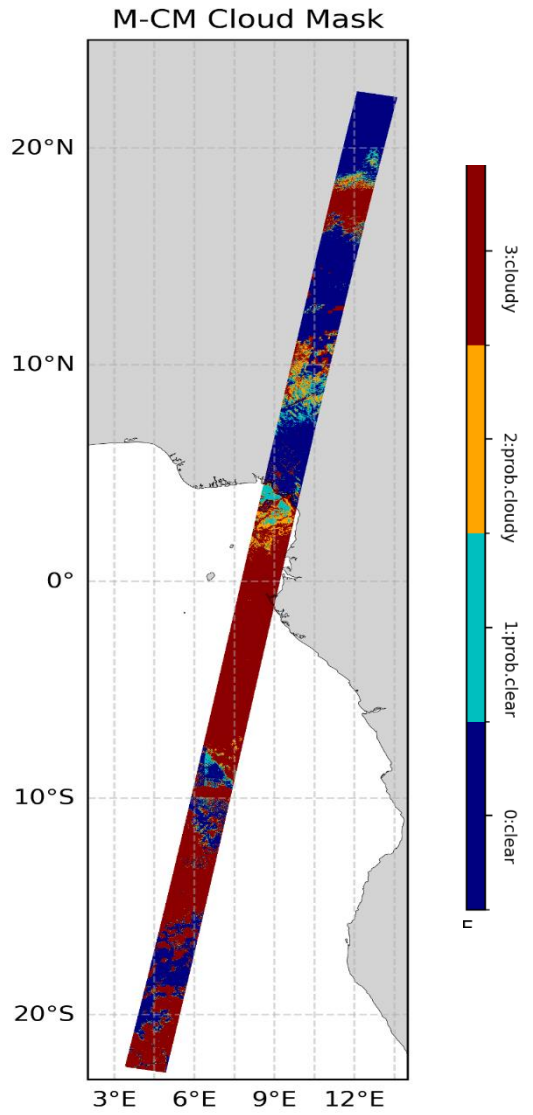
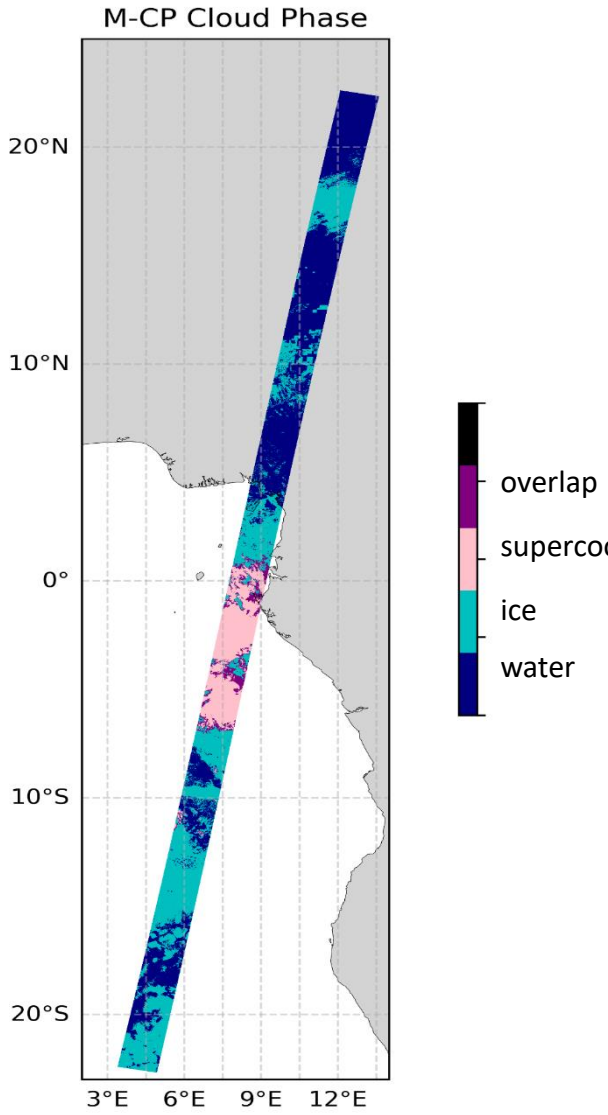
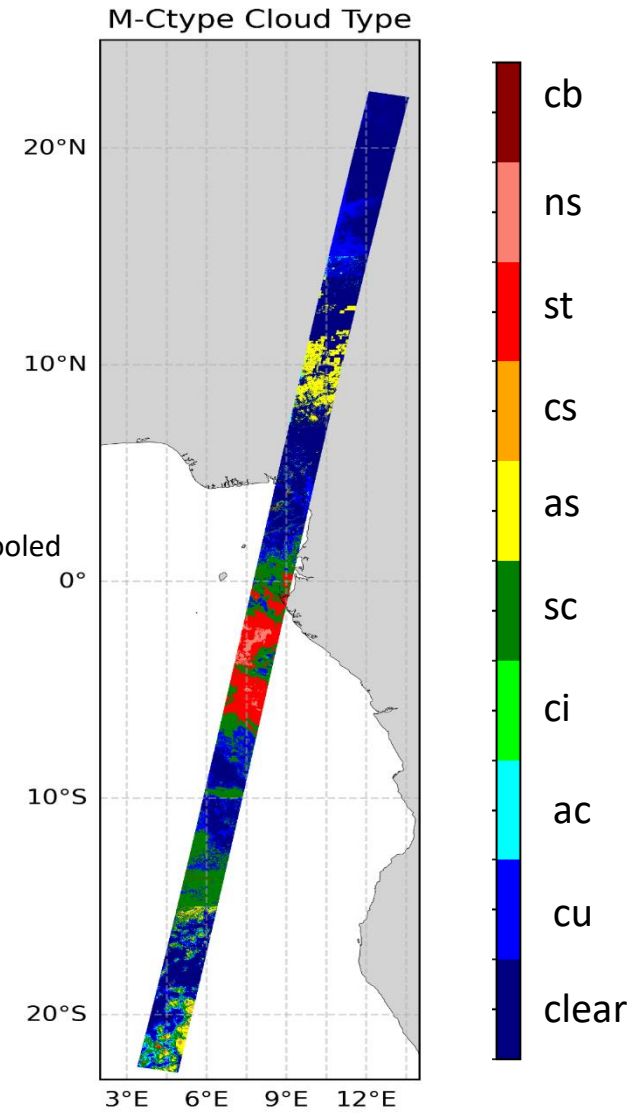
SEVIRI_20250102T133011Z_20250102T134243Z



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# MSI level 2 products M-CM, M-COP and M-ACT

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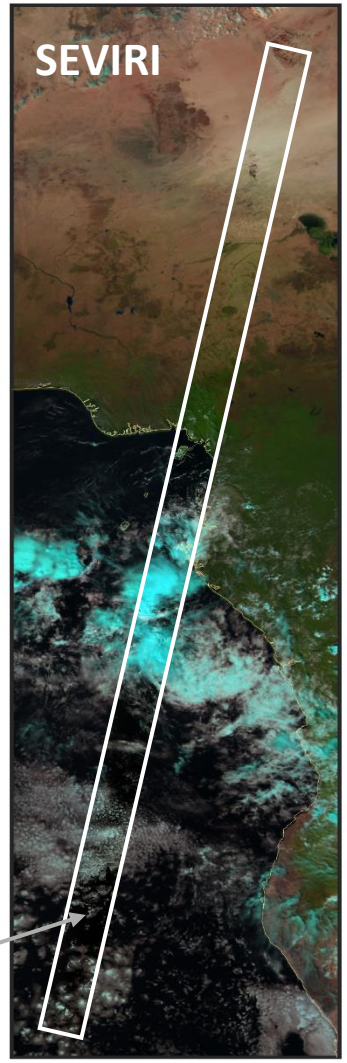
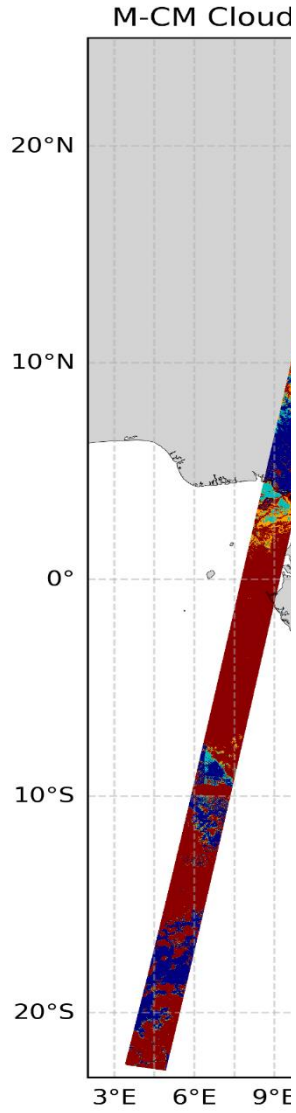
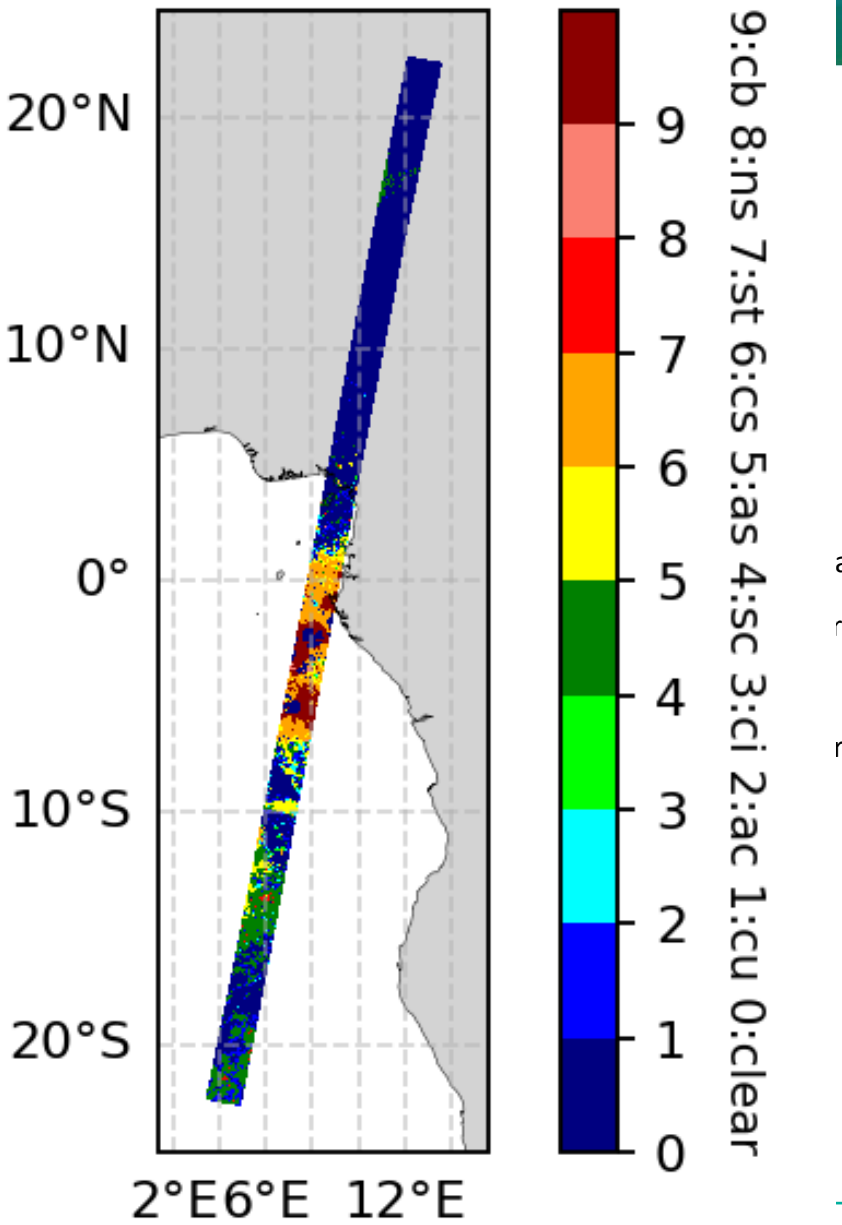
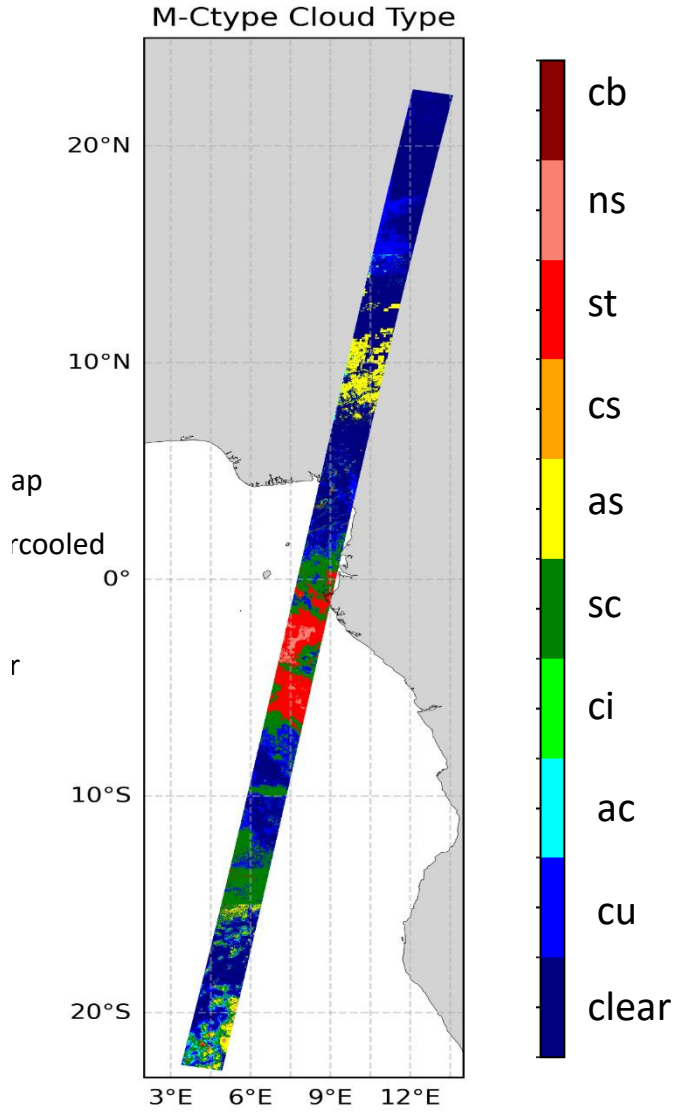
SEVIRI_20250102T133011Z_20250102T134243Z

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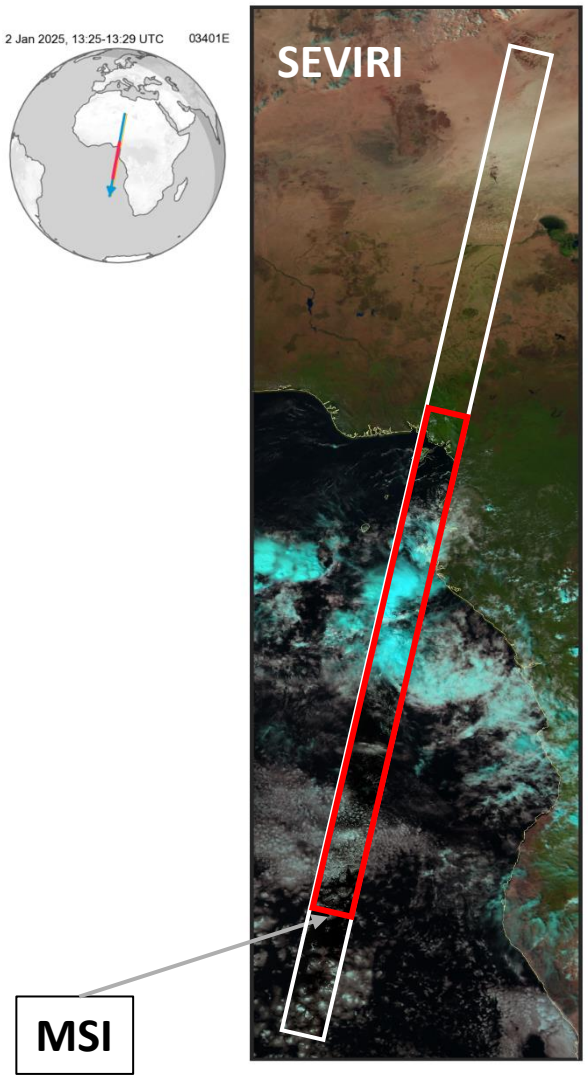
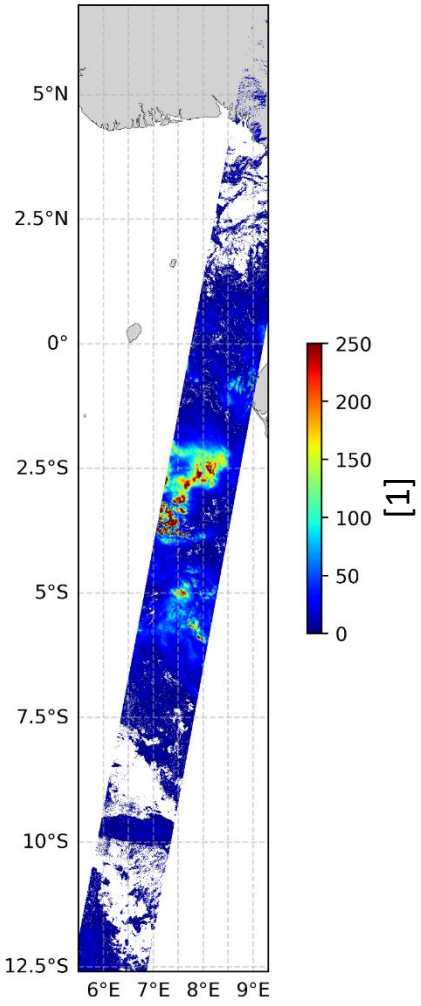
# MSI level 2 products M-COP

ECA_EXAD_MSI_RGR_1C_20250102T132052Z_20250102T145422Z_03401E

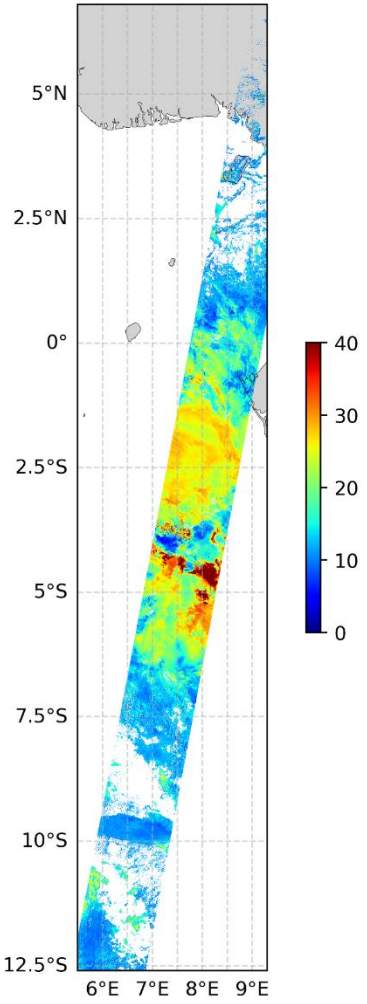
SEVIRI_20250102T133011Z_20250102T134243Z



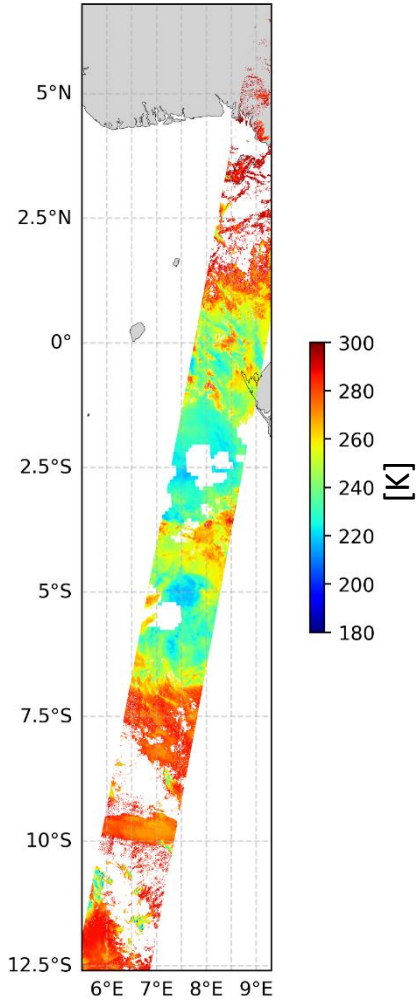

M-COT
Cloud optical thickness



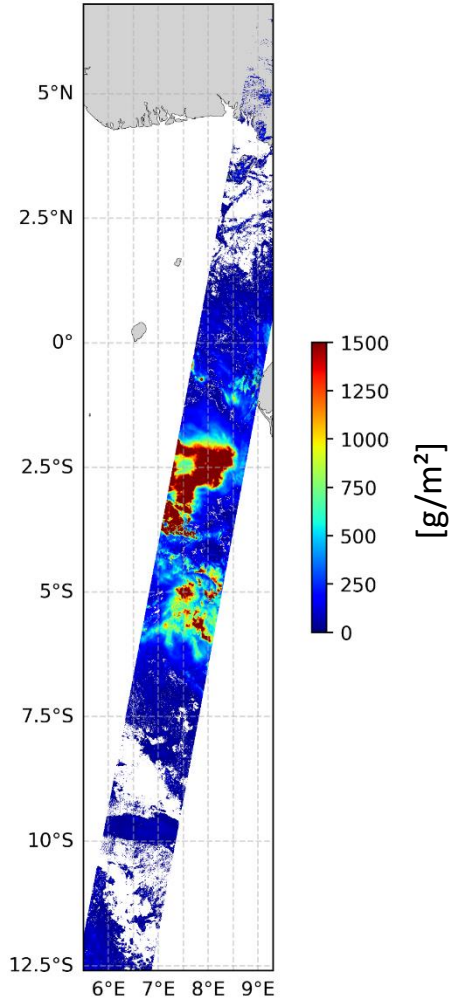

M-REFF
Cloud effective Radius




M-CTT
Cloud Top Temperature




M-CWP
Cloud Water Path



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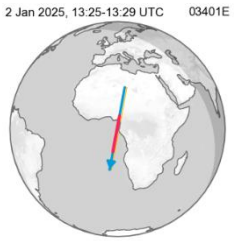
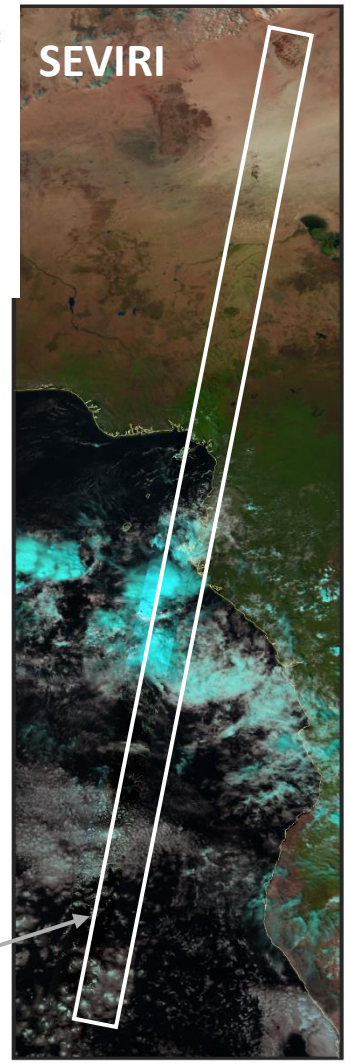
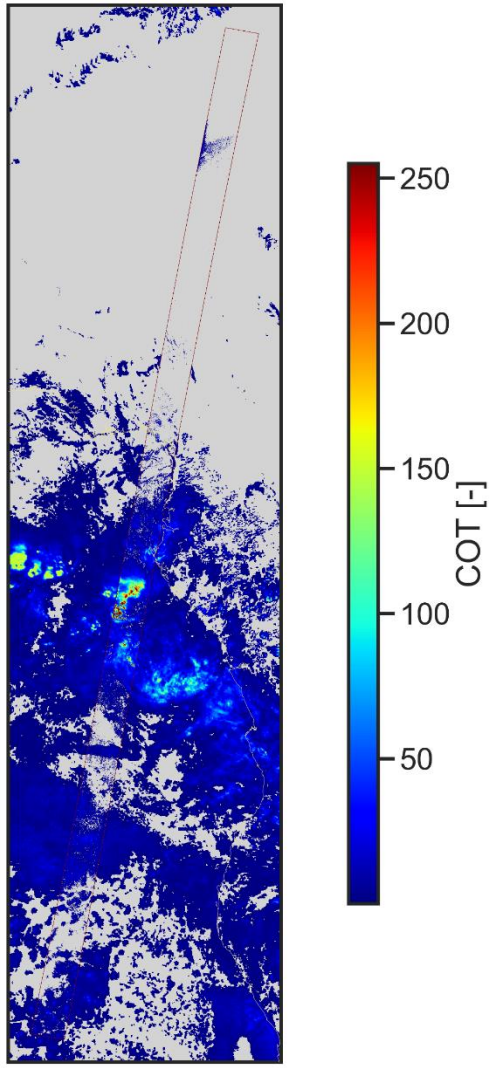
# M-COP vs SEVIRI

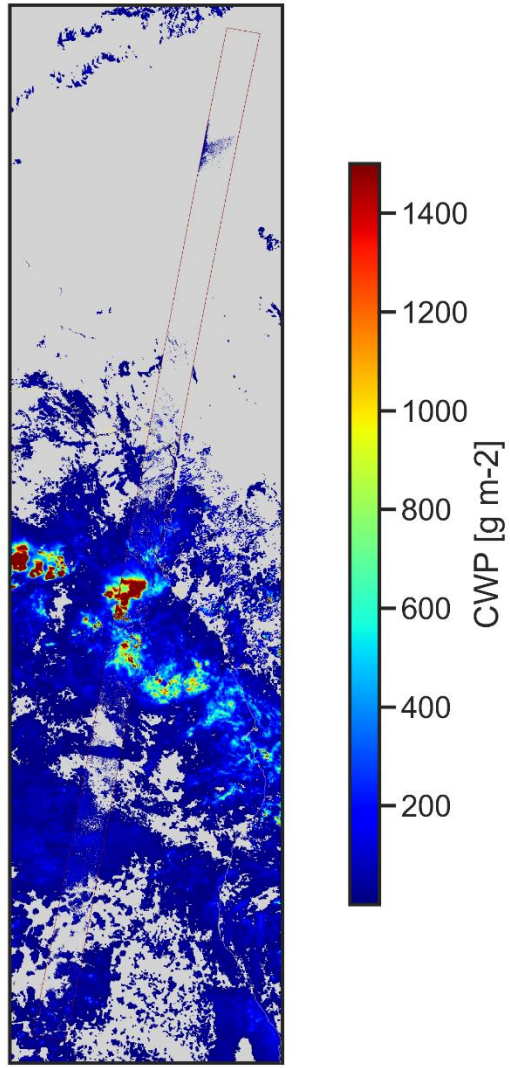
ECA_EXAD_MSI_RGR_1C_20250102T132052Z_20250102T145422Z_03401E

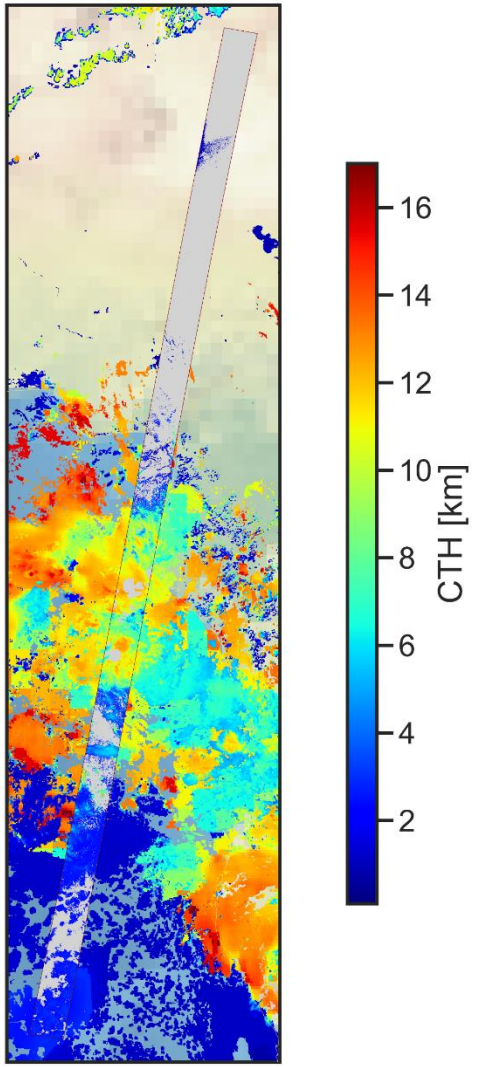
SEVIRI_20250102T133011Z_20250102T134243Z



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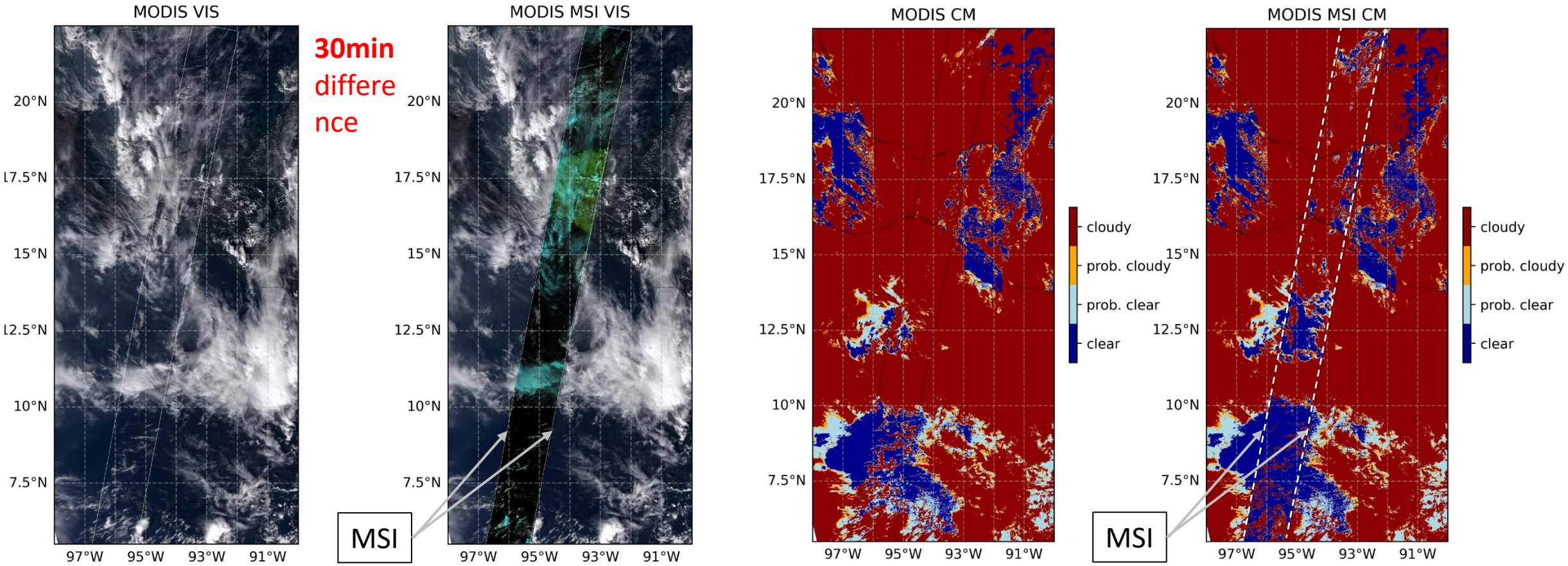
# M-CM vs MODIS

Geostationary SEVIRI/ polar orbiting MODIS (Aqua 30min differences)

**Cloud mask**




01/01/2025 frame 03390E



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