RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

METEO FRANCE
À VOS CÔTÉS, DANS UN CLIMAT QUI CHANGE

EUMETSAT
NWC SAF
SUPPORT TO NOWCASTING AND VERY SHORT RANGE FORECASTING

Application of NWC SAF convection (RDT and CI) products in the tropics.

M. Claudon, J.-M. Moisselin, R. Houel
20261021, online, Event Week on Tropical Meteorology

NWC SAF portfolio for convection

Pre-convective environment

Clear Sky products iSHAI

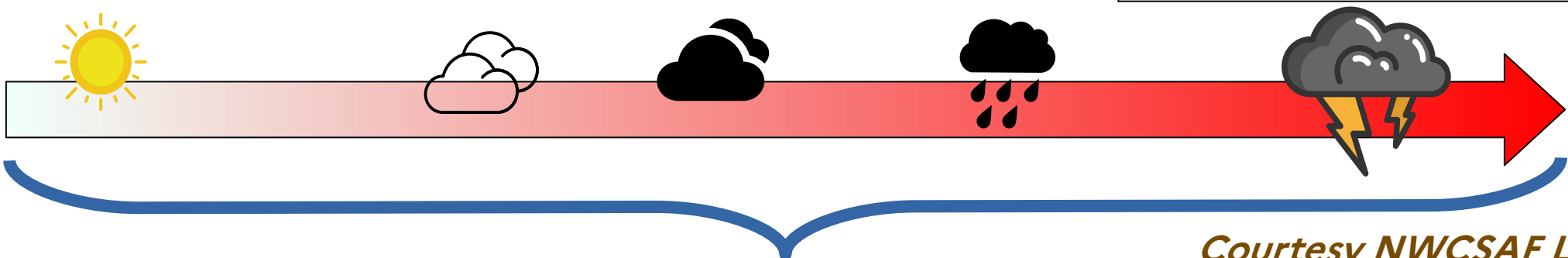
Convection Initiation

CI

Established convection

RDT-CW

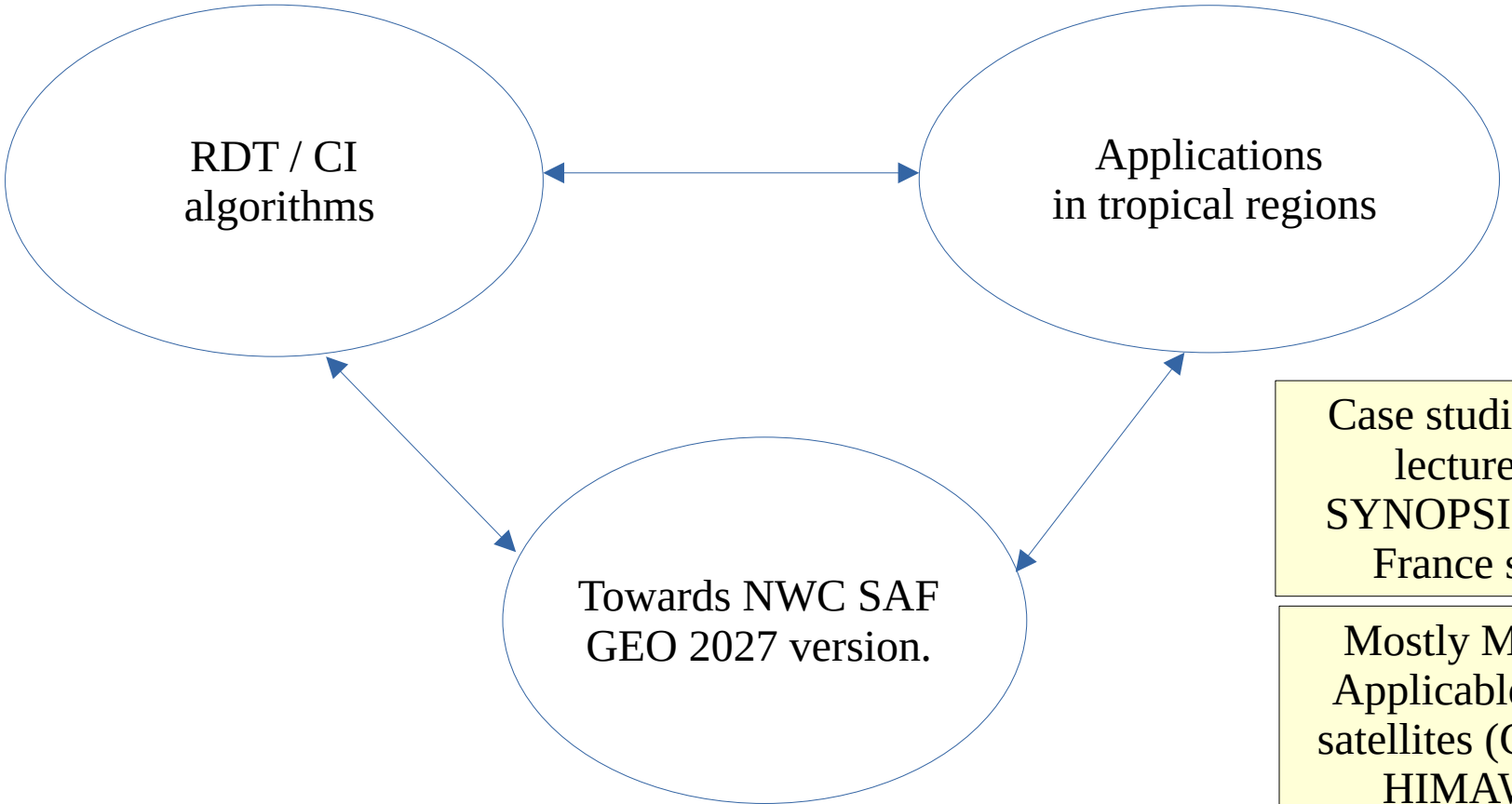
Precipitation Products



Courtesy NWCSAF LE

Other products, Cloud, AMV, etc.

Scope of the presentation



Case studies of this lecture with SYNOPSIS Météo-France system

Mostly MTG data
Applicable to other satellites (GOES and HIMAWARI)

1. Application of the NWC SAF RDT-CW product in the tropics

Overview of the RDT-CW algorithm

Input:

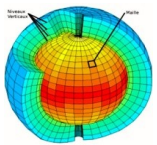
GEO Satellite data

(multi-channels IR, VIS ...)



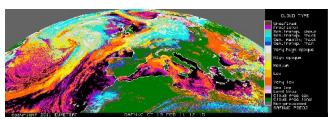
Numerical Weather Prediction models

(instability indices, tropopause, winds)



Other NWC SAF products

(Cloud type, cloud top, cloud microphysics, rainfall rate, winds)



Lightning data



1: Detection

IR adaptive thresholding

→ *identification of the bases and the tops of cloud towers*

2: Tracking

Cell recovery *between consecutive images*

→ *motion field, trajectory, tendency*

3: Discrimination

statistical models + empirical rules associated to trends

→ *identification of convective cells*

4: Nowcast

Linear advection of the base of the cloud towers, including a trend of the severity parameter

→ *forecast cells up to 1h*

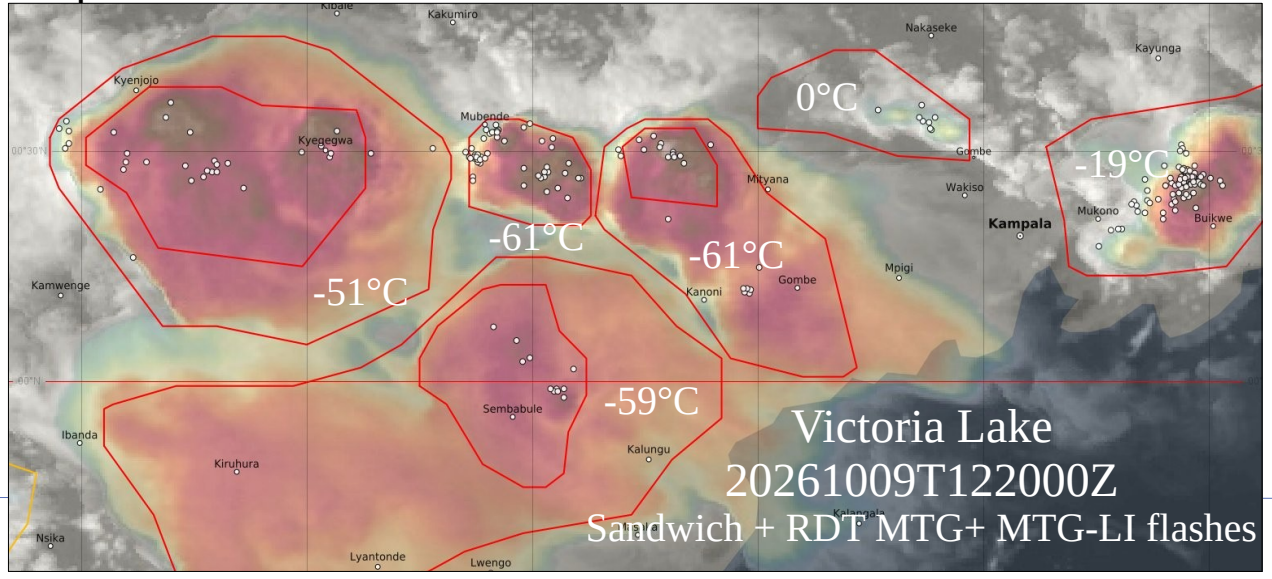
Output: description of observed and forecast convective objects:

- **Static attributes** (morphology, extreme values, overshooting top)
- **Dynamic** attributes (through the tracking and the trends)
- **Hazard** thanks to the data fusion (lightning, cloud top pressure, icing)
- **Synthesis attributes** severity, phase of life

The cloud cell detection in RDT

The goal of the detection algorithm is to define « cells » which represent the cloud systems as seen in the infrared 10.8 µm channel

- Method based upon an adaptive temperature thresholding
  - Each cloud system is represented by one or two cells defined by its own, cell-specific, temperature threshold

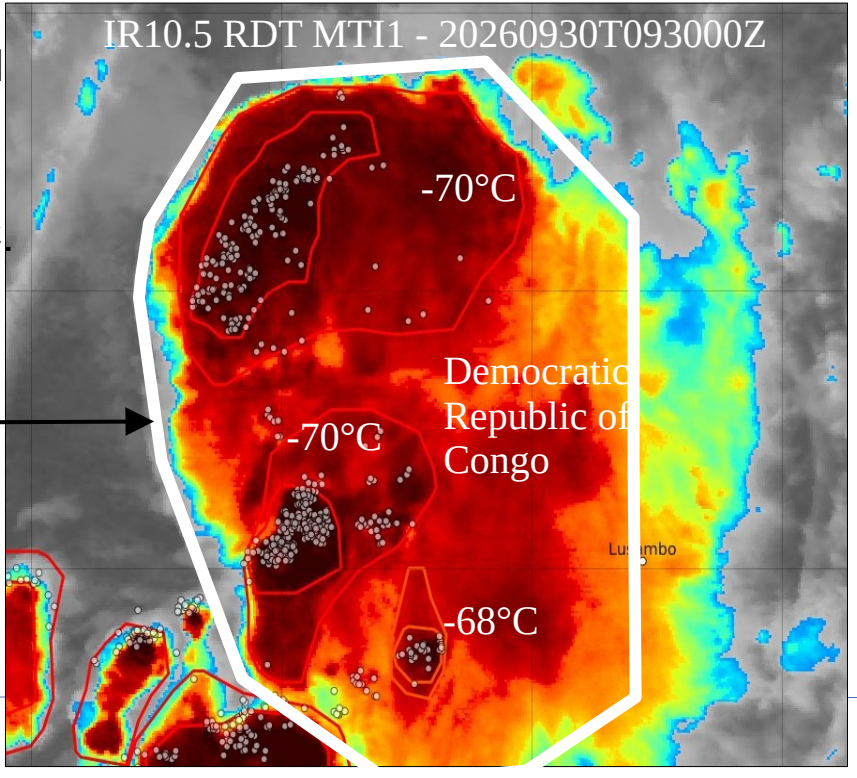


The cloud cell detection in RDT – application in the tropics (1)

A cold temperature threshold for the definition of the base of the cloud tower: **configurable BTLIMIT** argument.

- Purpose: mature convective systems in tropical regions or in warm air masses with high tropopause levels.
- Shift from -60°C (before 2021 version) to -70°C.

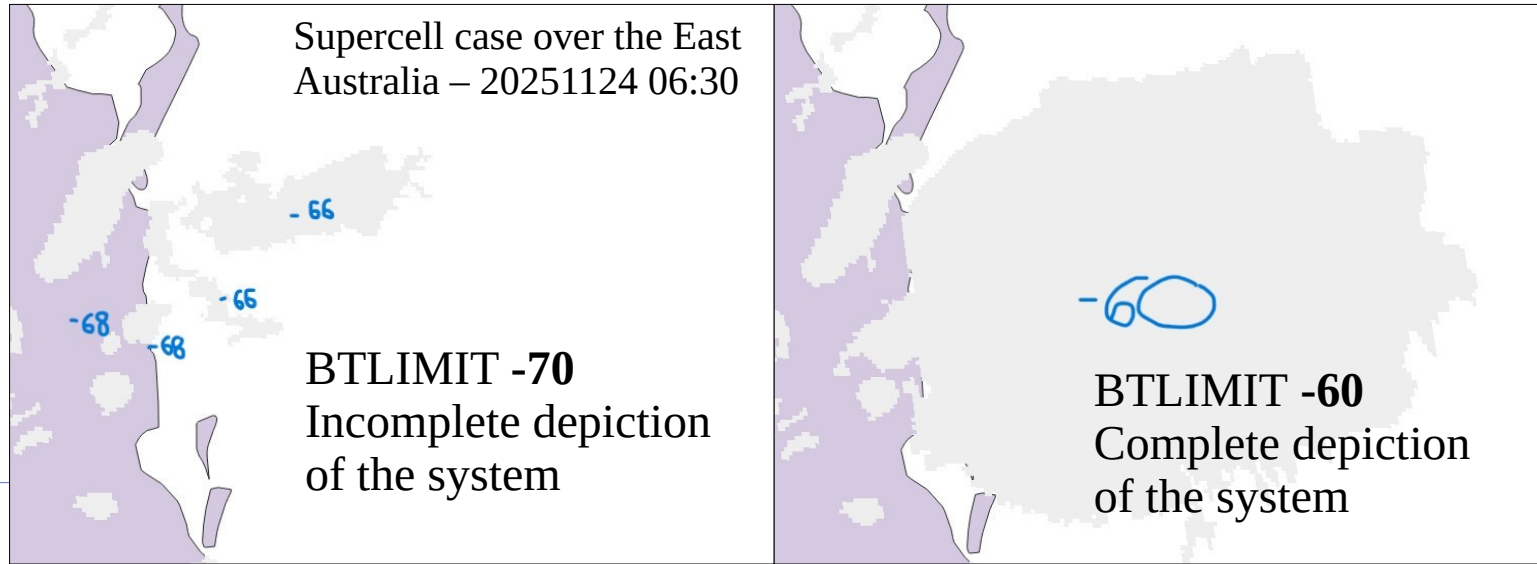
White line depicts the outline of the RDT cell if BTLIMIT was set to -60°C.



The cloud cell detection in RDT – application in the tropics (2)

A temperature threshold for the definition of the base of the cloud tower: **configurable BTLIMIT** argument.

- Purpose: mature convective systems in tropical regions or in warm air masses with high tropopause levels.
- Shift from -60°C (before 2021 version) to -70°C. As a counter-example, a recent ticket from a NWC SAF user

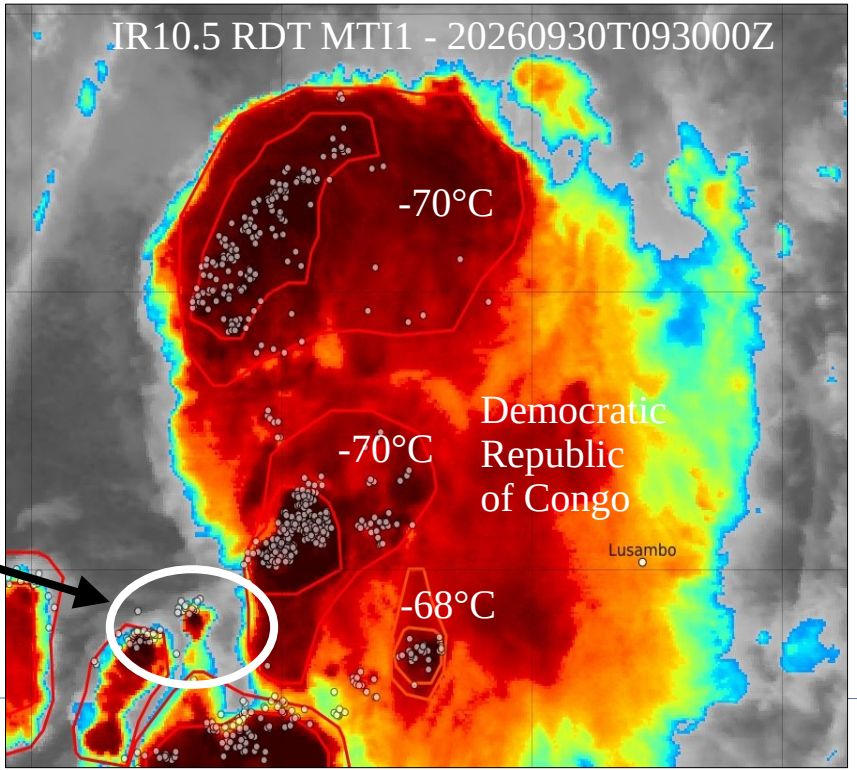


The cloud cell detection in RDT – application in the tropics (3)

A configurable threshold which represents the minimum surface for the definition of the base of the cloud tower: **configurable SMIN** argument.

- From 60 km² for 2nd generation to 200 km² for 3rd generation satellites
- V2027: back to 60 km² for all satellites
  - Earlier detection of growing towers
  - Improving early convective diagnosis

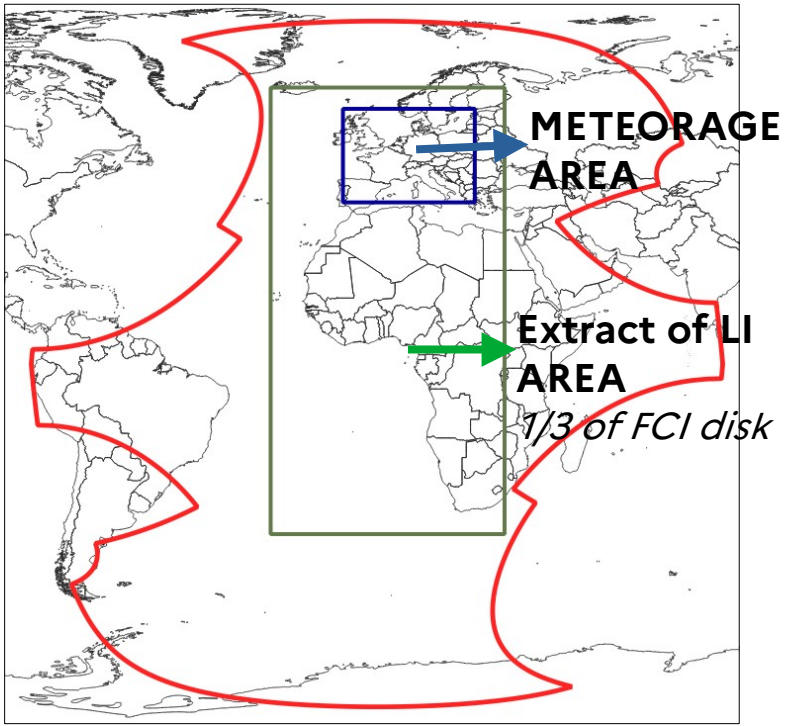
The RDT-CW product which is depicted on the illustration is run with ***SMIN=200km²*** *and misses the rapidly cooling and already electrical cell.*



The convective discrimination scheme in RDT

Discriminating convective from non-convective cloud cells.

- RDT tuning: a set of predictors of RDT cell trajectories are evaluated against a ground truth = a reference = the lightning activity
  - Requirement: a lightning detection network with good detection efficiency and a proper location accuracy
- NEW v2027:
  - Fine-tuning of RDT MTI1-FCI with MTI1-LI over Europe and Western part of Africa. **For the first time RDT is fine-tuned over Africa**
  - Fine-tuning of RDT GOES19-ABI with GOES19-GLM over America



The convective discrimination scheme in RDT (2)

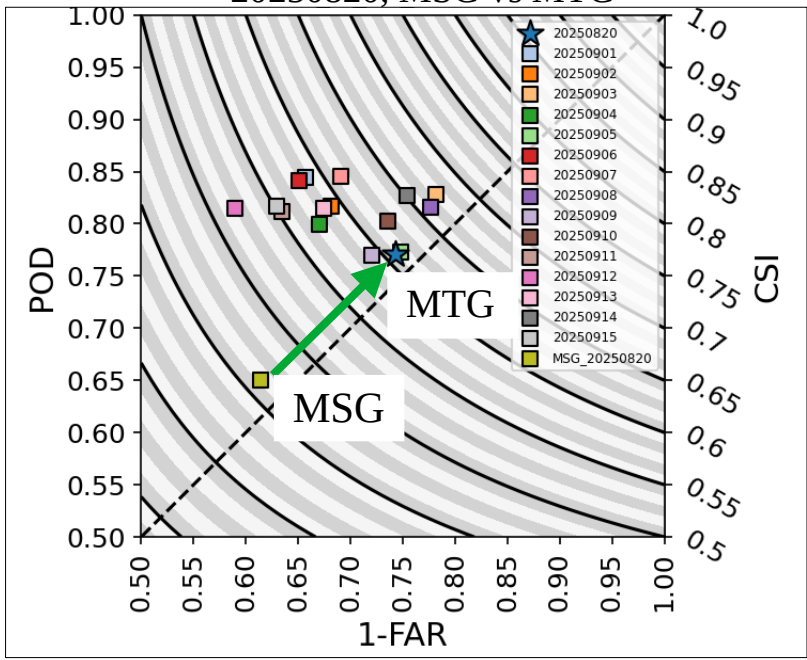
Improved discrimination skills (RDT MTG):

- POD 77 - 85%
- FAR 20 – 40%
- CSI 52 – 67 %
- FCI vs. SEVIRI comparison: significant improvement for FCI-operated RDT, as illustrated by the green arrow in the Performance Diagram

Early diagnosis

- 10 to 18 % of RDT cell trajectories are classified as convective 10 minutes before the first lightning flash,
- Rises to 85 to 90 % just 10 minutes after the first flash

Performance diagram
20250820, MSG vs MTG



The convective discrimination scheme in RDT – application in the tropics

A **configurable TROPICALDISCRI** option (deactivated by default)

- Changing the convective diagnosis of a cloud system from no to yes under some circumstances in the tropical regions, i.e. in case of very cold and very opaque clouds:
  - Minimum temperature below -70°C
  - BTD (WV6.2 – IR10.8 µm) > 0°C
  - NWC SAF Cloud type = VERY HIGH OPAQUE (predominantly)

Detection of overshooting tops in the RDT-CW product

Underdetection of overshooting tops with MTG-FCI in 2025 version (first version adapted to FCI)

- Issue described in NWCSAF document like Users' Manual and Verification report

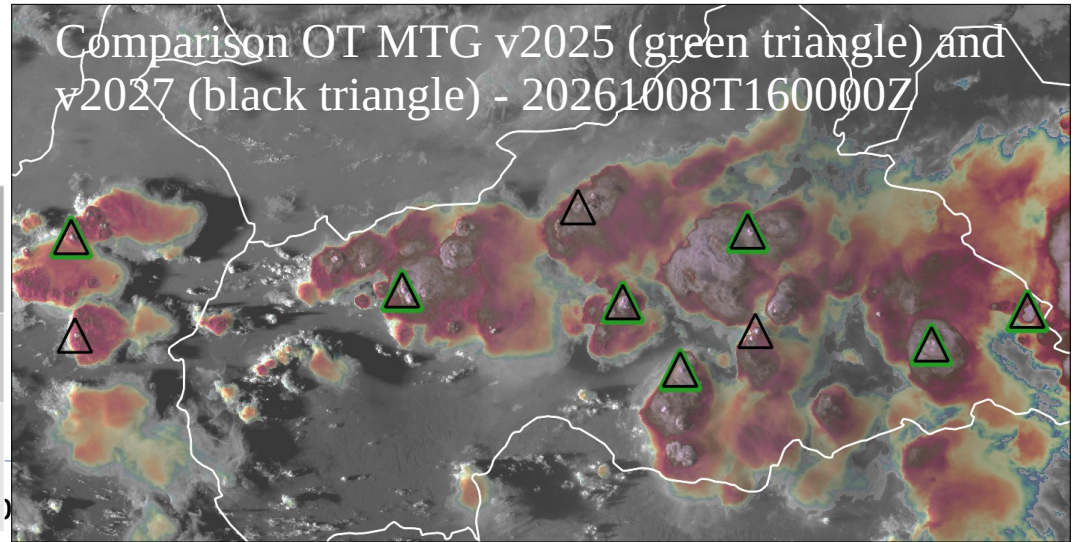
Since, a new algorithm has been implemented for v2027 **C. Cardinali, 2025**

- MTG: uses a 3x3 pixels box (instead of 1 pixel) + new set of BTD
- Other satellites: new thresholds

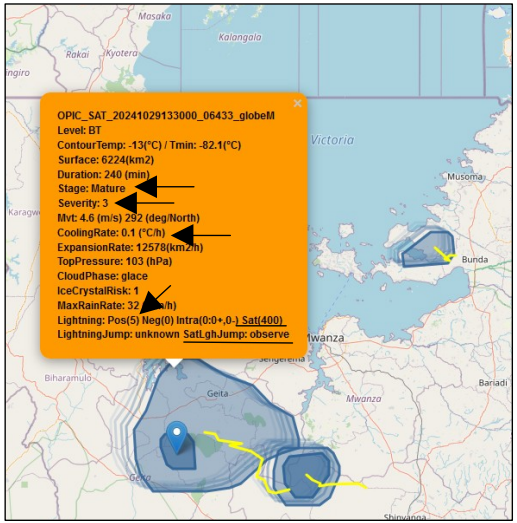
Note: thresholds are configurable

20261008 - #OT detected in RDT - full disc processing

MSG v2025	MTG v2025	MTG v2027
967	872	1418
10 OT / slot	6 OT / slot	10 OT / slot



Use of MTI1 - Lightning Imager (LI) in the RDT-CW cells (1)



Pairing of LI flashes with RDT cells

- Significant improvement over Africa
  - (right) 400 LI flashes compared to 5 lightning flashes from WWLLN network

Default RDT configuration: lightning activity to change the convective diagnosis from no to yes

- Complementary role to RDT discrimination scheme
- No late detection of RDT convective cells compared to the lightning activity

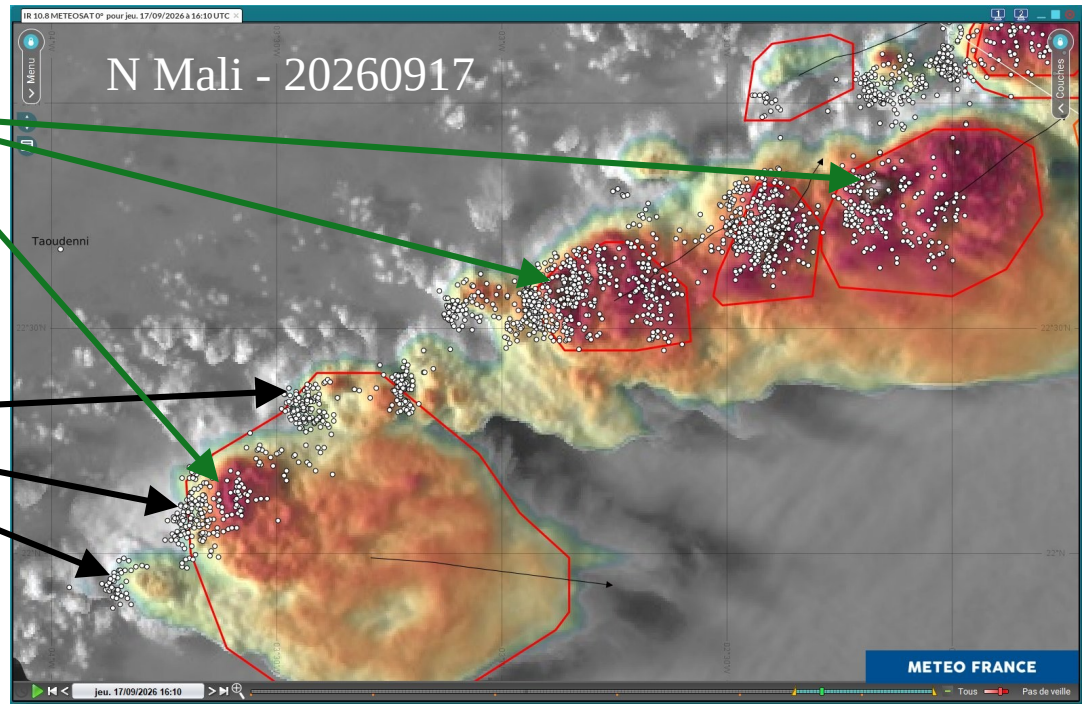
Since 2025 version, possibility to include EUMETSAT LI Level 2 AFA (Accumulated Flash Area)

- The maximum value over the cell.

Use of MTI1 - Lightning Imager (LI) in the RDT-CW cells (2)

LI *specificities*:

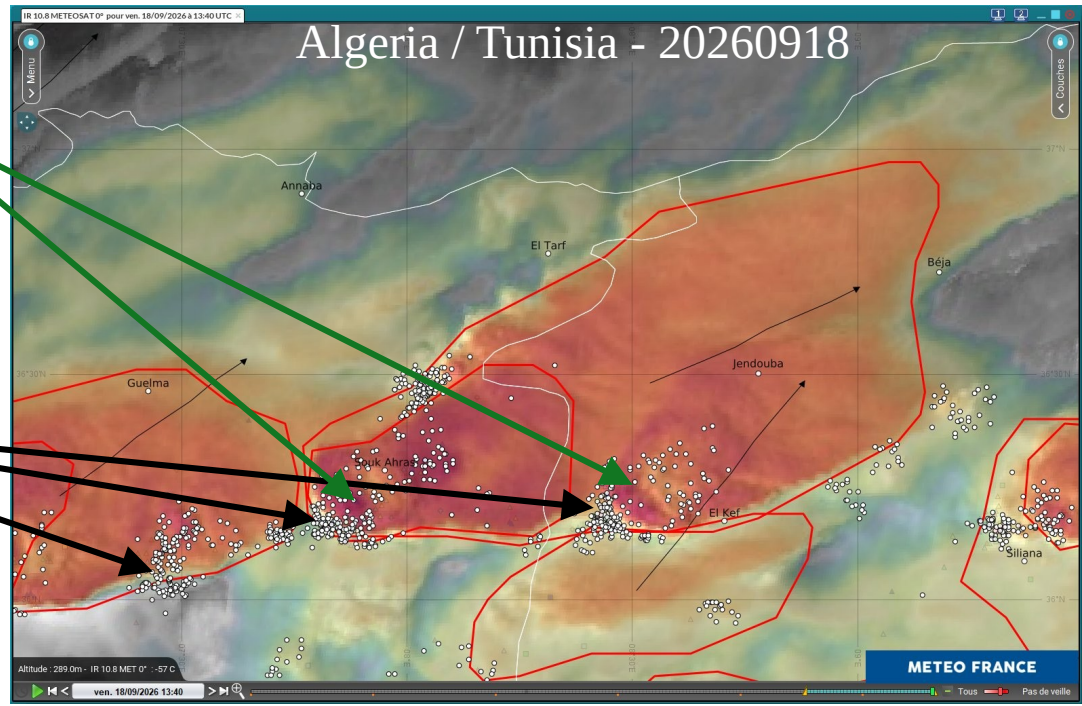
- Detection of holes at the position of a strong updraft (optical depth)
- LI flashes positioning on the edge of the anvil (light reflection on low clouds)



Use of MTI1 - Lightning Imager (LI) in the RDT-CW cells (3)

LI *specificities*:

- Detection of holes at the position of a strong updraft (optical depth)
- LI flashes positioning on the edge of the anvil (light reflection on low clouds)



Detection of lightning jumps (LJ) in the RDT

Two separate LJs diagnosed within an RDT cell using the 2-σ algorithm

- One from ground-based networks
- One from GEO ligthning sensors

For the first time RDT has the possibility to include LJ over whole African domain thanks to LI

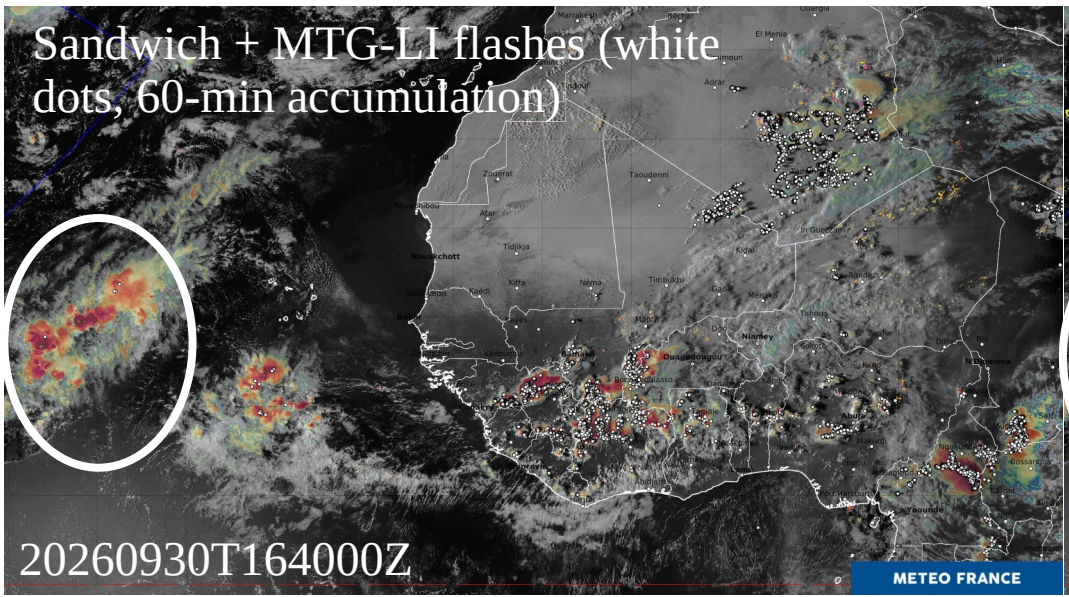
Improvement in v2027: precise LJ positioning is provided

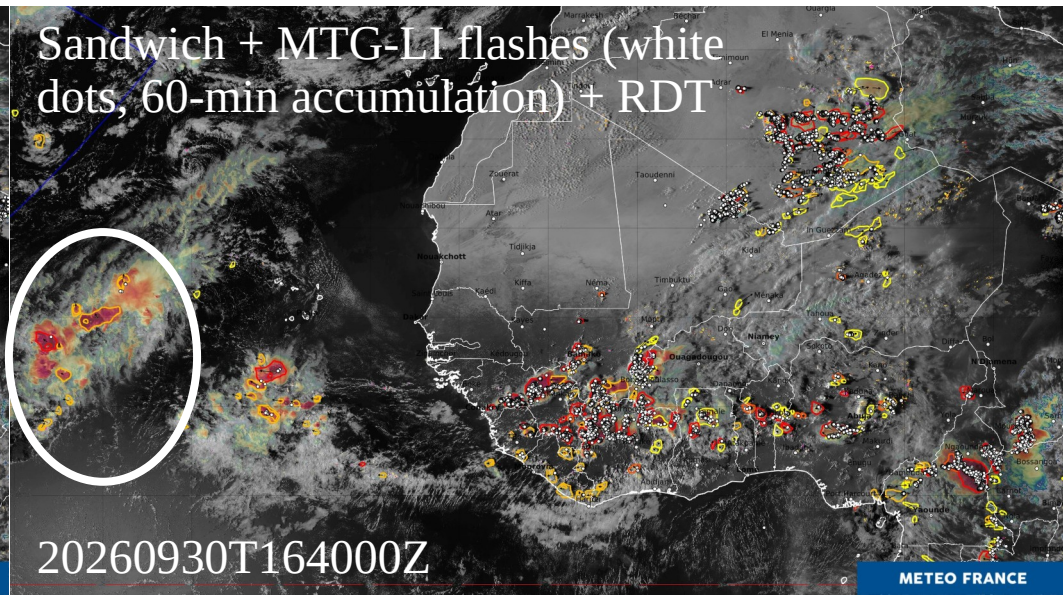
- Position at the pixel with the highest flash density

Low lightning activity over the tropical oceans

RDT helps to detect convective systems not seen by lightning network

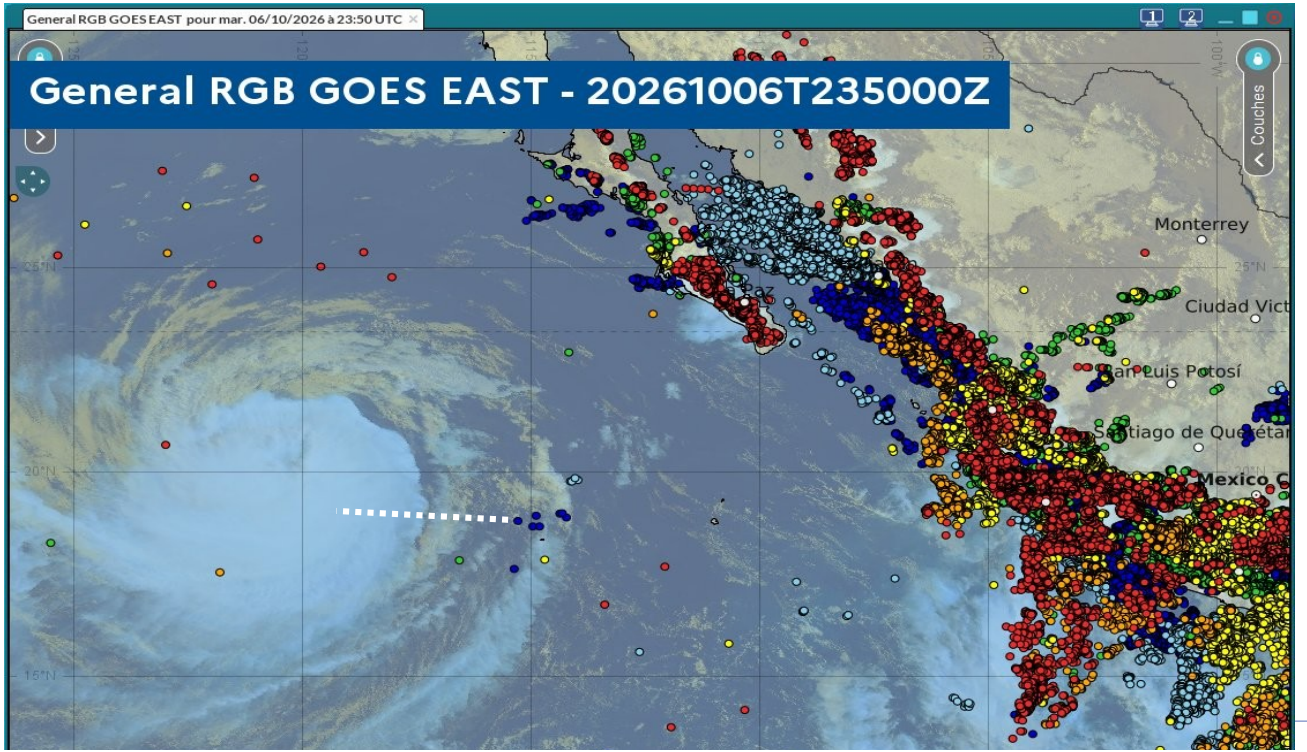
- As the lightning activity is used as a reference to score the RDT convective trajectories, there is an increase of FAR over the oceans





Low lightning activity over the tropical oceans (2)

Tropical cyclones are not systematically associated with lightning activity

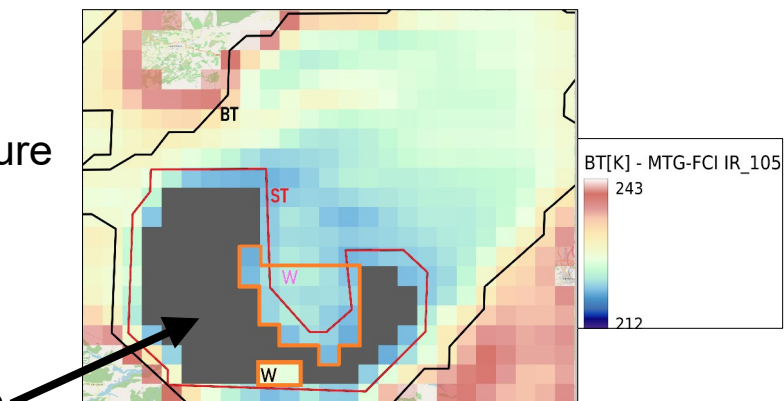


Rachel Tropical Cyclone,
48h past position (white dashed line)
48h-accumulated GOES19-GLM flashes (colored dots)

Detection of other cloud-top features in RDT

New algorithm in 2027 version: U/V shapes and cold rings

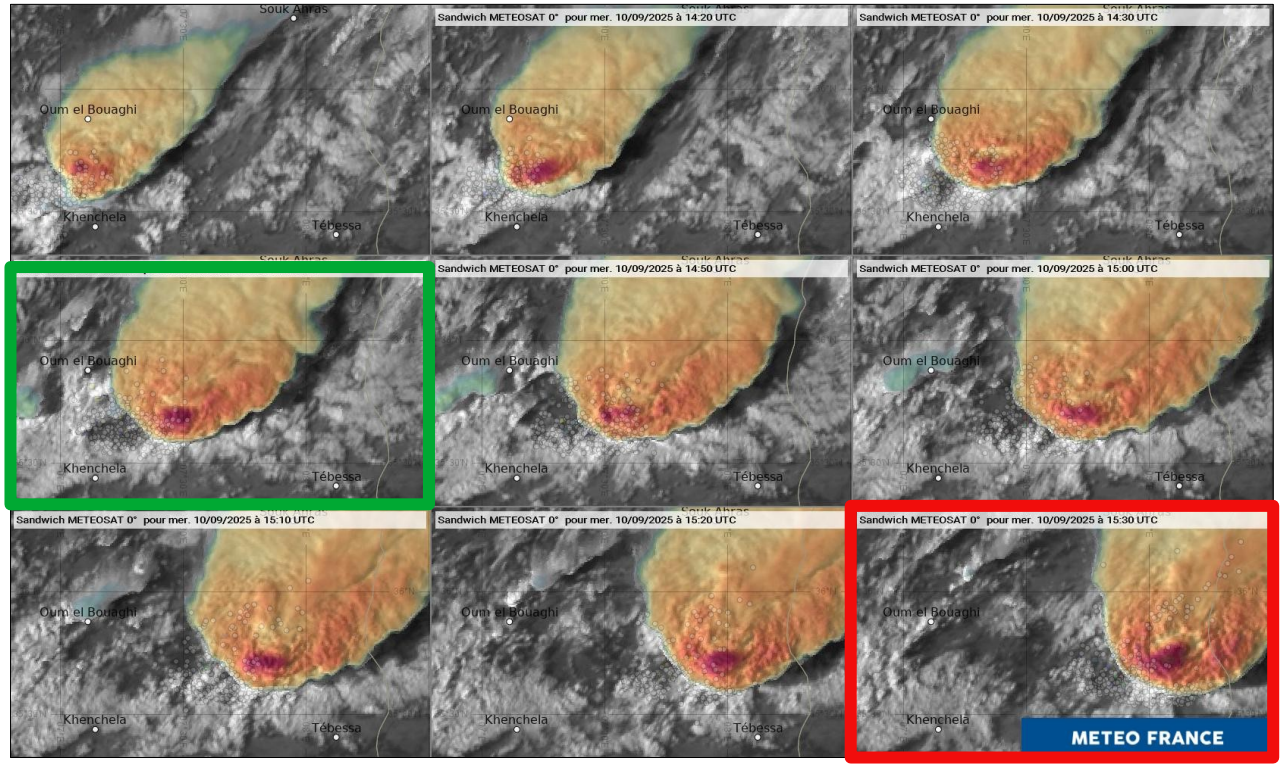
- Selection of candidates: search of an open (U/V shape) or closed (cold ring) geometry corresponding to a cold structure, embedding a warm area (EWA), in the main IR channel
- Validation of candidates:
  - Brightness temperature difference between the cold part and the EWA (thermal couplet),
  - Distance between the cold part and the EWA,
  - Maximum value of BTD
  - Cloud type
  - Gap with the NWP-estimated tropopause temperature
- Tuned over Europe, validated against ESWD
  - Deactivated by default in the tropics
  - Configurable in the tropics (*CTFLATMIN 30 → 0*)



U/V shape candidate

C. Cardinali, 2025

Detection of other cloud-top features in RDT – example in Algeria



First OT detected in RDT

First U shape detected in RDT

Good detection for this case of hailstorm over Algeria (10th September, 2025)

Limitation: detection may occur later than forecaster observation

2. Application of the NWC SAF CI product in the tropics

Overview of the CI algorithm

Convection initiation (CI) is defined in the NWC SAF as the probability that a pixel will develop into a thunderstorm within the next 30 (60 or 90) minutes

Input:

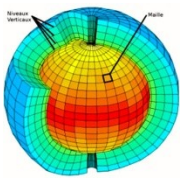
GEO Satellite Data

(multi-channels IR, VIS, WV...)



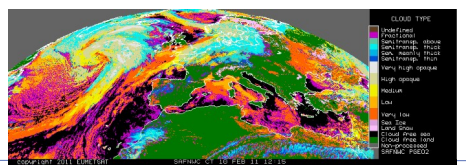
Numerical Weather Prediction model

(winds, instability indices)



Other NWC SAF products

(Cloud Mask, Cloud Type, Cloud microphysics...)



1: Object + motion analysis

Detection & tracking of small cloud cells

Initializing and updating a motion field (model and satellite winds)

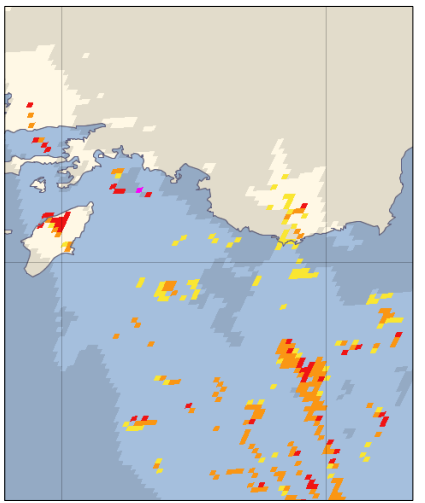
2: *Pixel analysis*

Filter eligible areas (unstable areas, low level clouds, etc.)
Calculation of parameters of interest and trends for each pixel

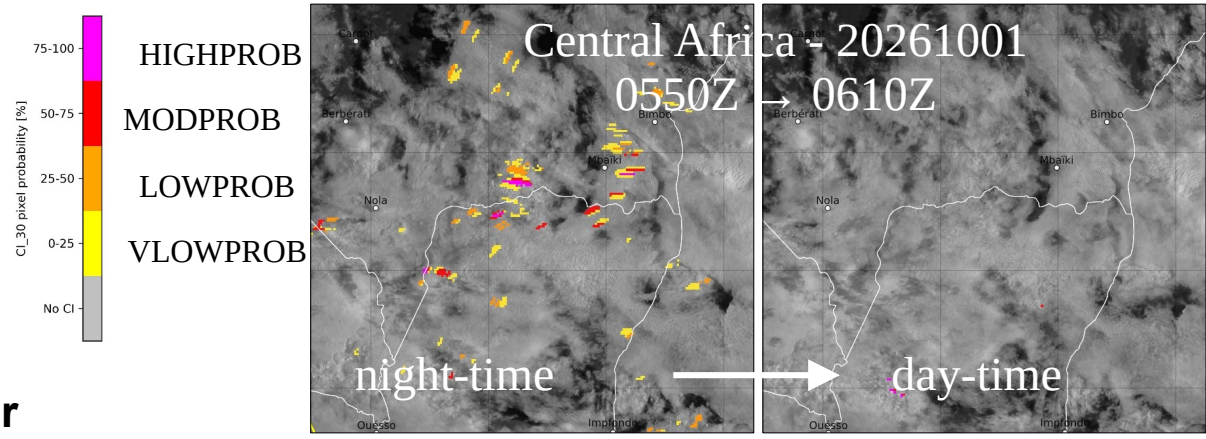
3: Pixels of interest and diagnostics

Selection of parameters of interest
Final diagnosis of convection initiation
Diagnosis extrapolation

Output:



CI Pixels



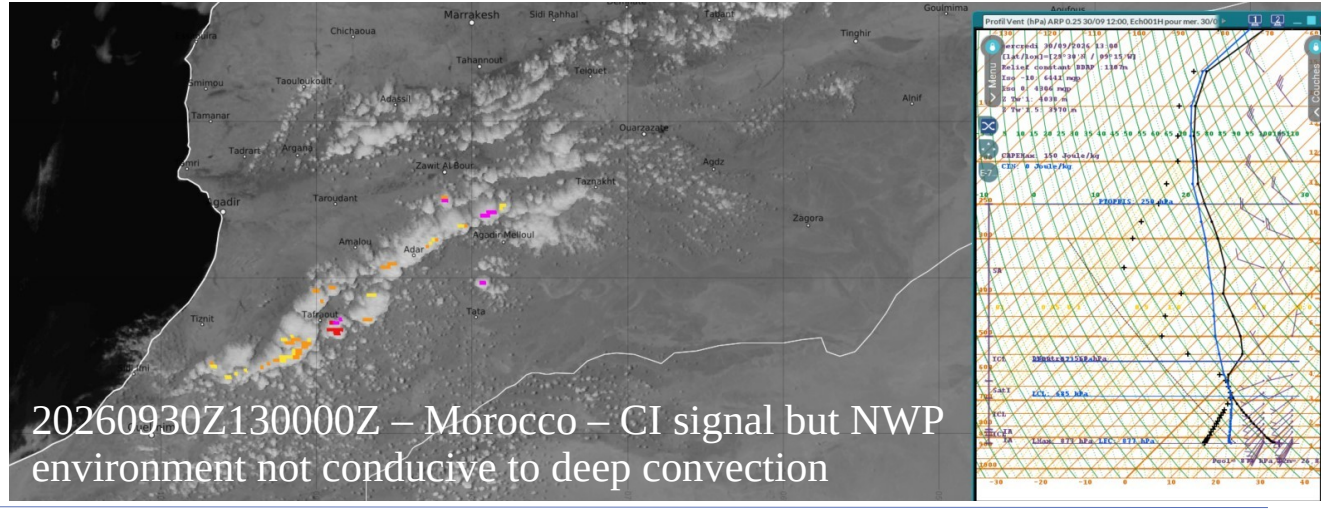
CI application in the tropics

Limitations

- No CI signal below a **Cirrus layer**
- The decision tree for the CI diagnosis was set up with mid-latitudes cases
- Night-time false alarms, in low-level clouds

Assets

- Diurnal land evolution from clear-sky scenes, with low motion field (= ideal cases)
- No strong NWP influence
- Helpful to highlight local coolings / CI where NWP models do not

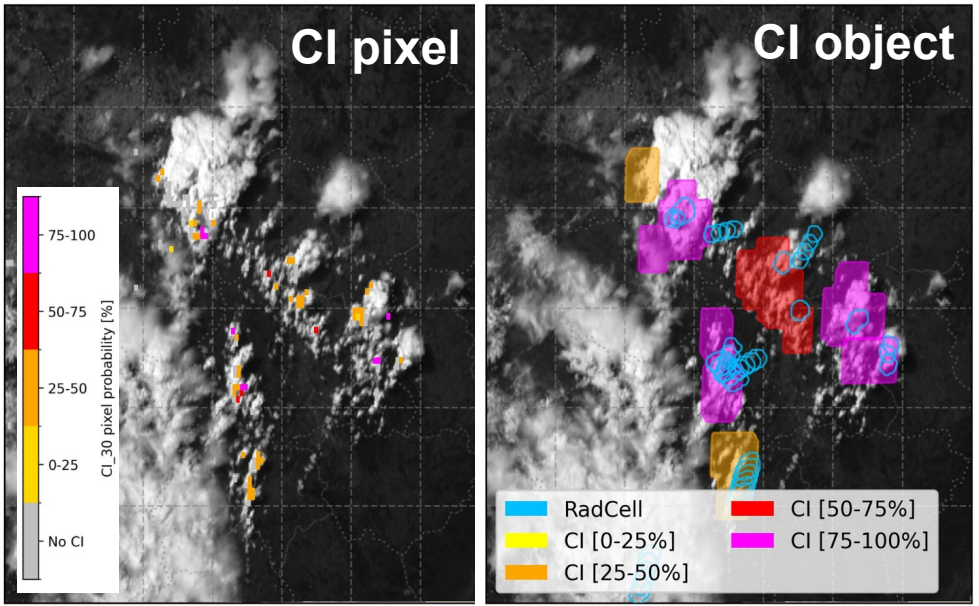


CI product: New object mode in 2027 version

CI objects → Define an area where convection is likely to develop by detecting cooling clouds within it

CI objects help reduce **spatial** and **temporal** localization uncertainties, improve product **visualization**, and simplify the **validation** methodology

CI object will be the **default output** in future v2027 version. Pixel output will be still available.

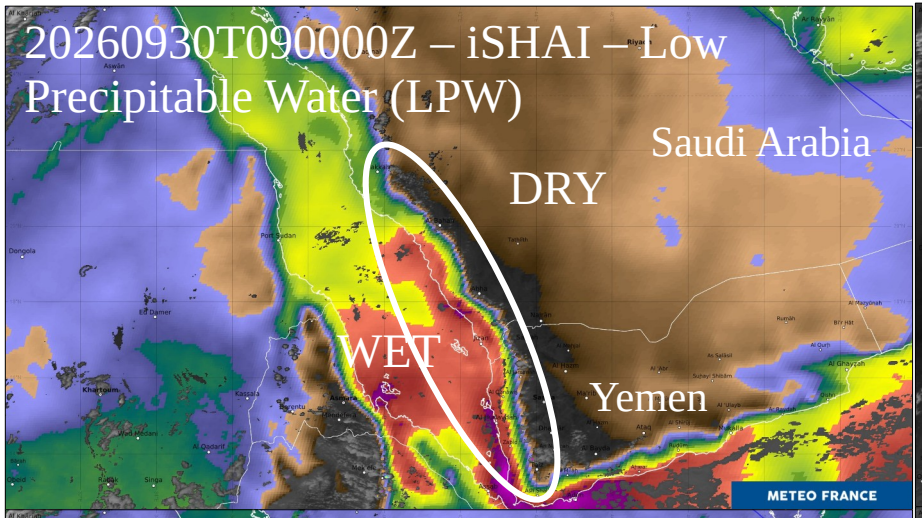


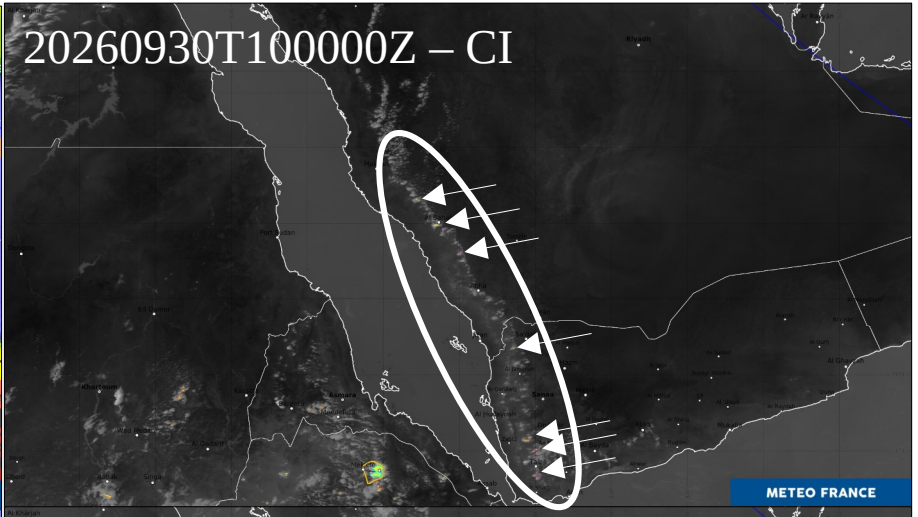
MTG - 1420 UTC - 20250625 - Central France. Radar cells, corresponding to the radar ground truth, over the next 30 minutes are also shown. The colors of the CI objects correspond to the maximum probability of the CI pixels that compose them

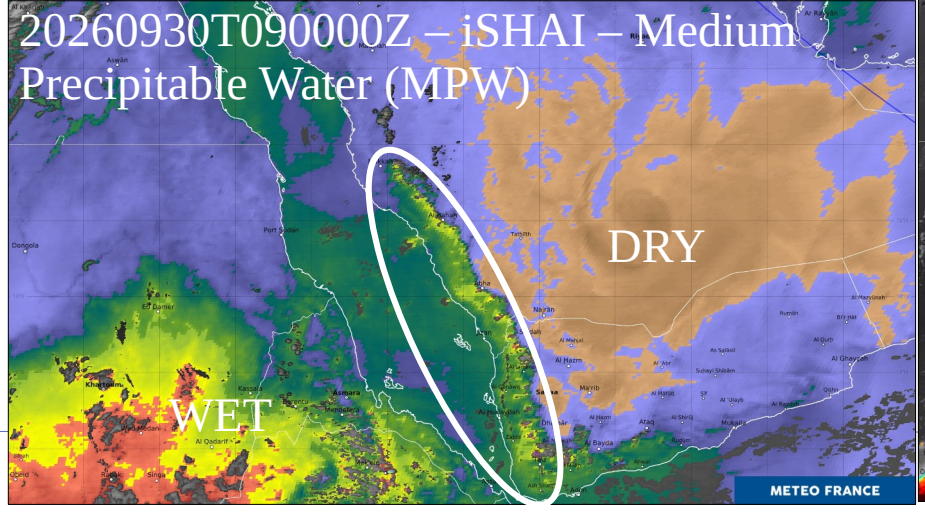
3. Complementarity between convection-related NWC SAF products

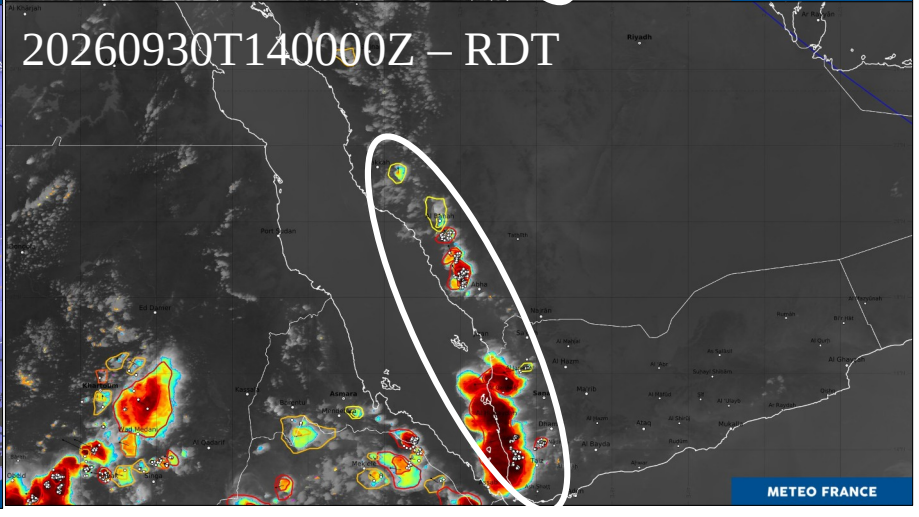
From clear scene to thunderstorms

iSHAI, CI and RDT are produced independently

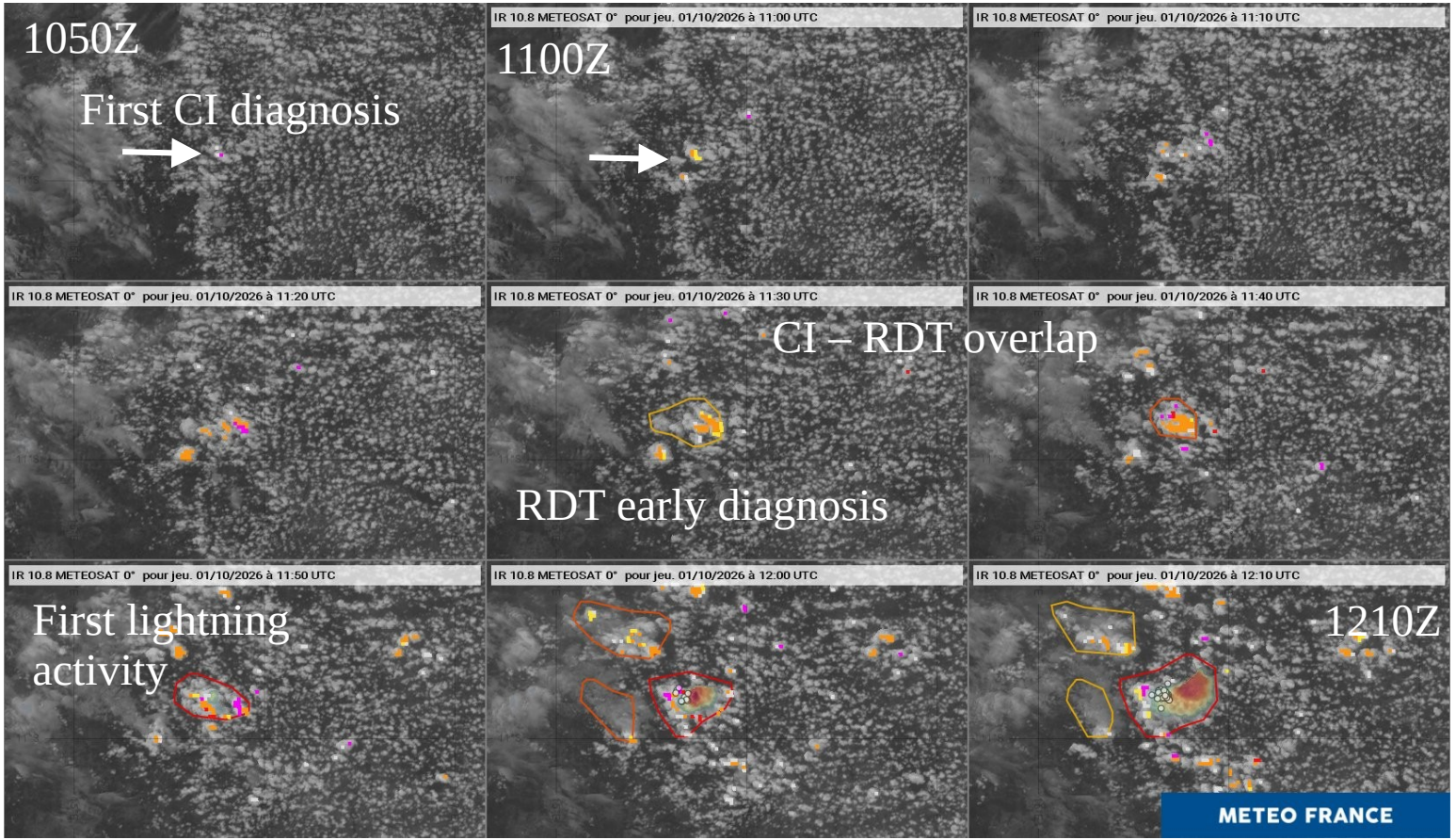








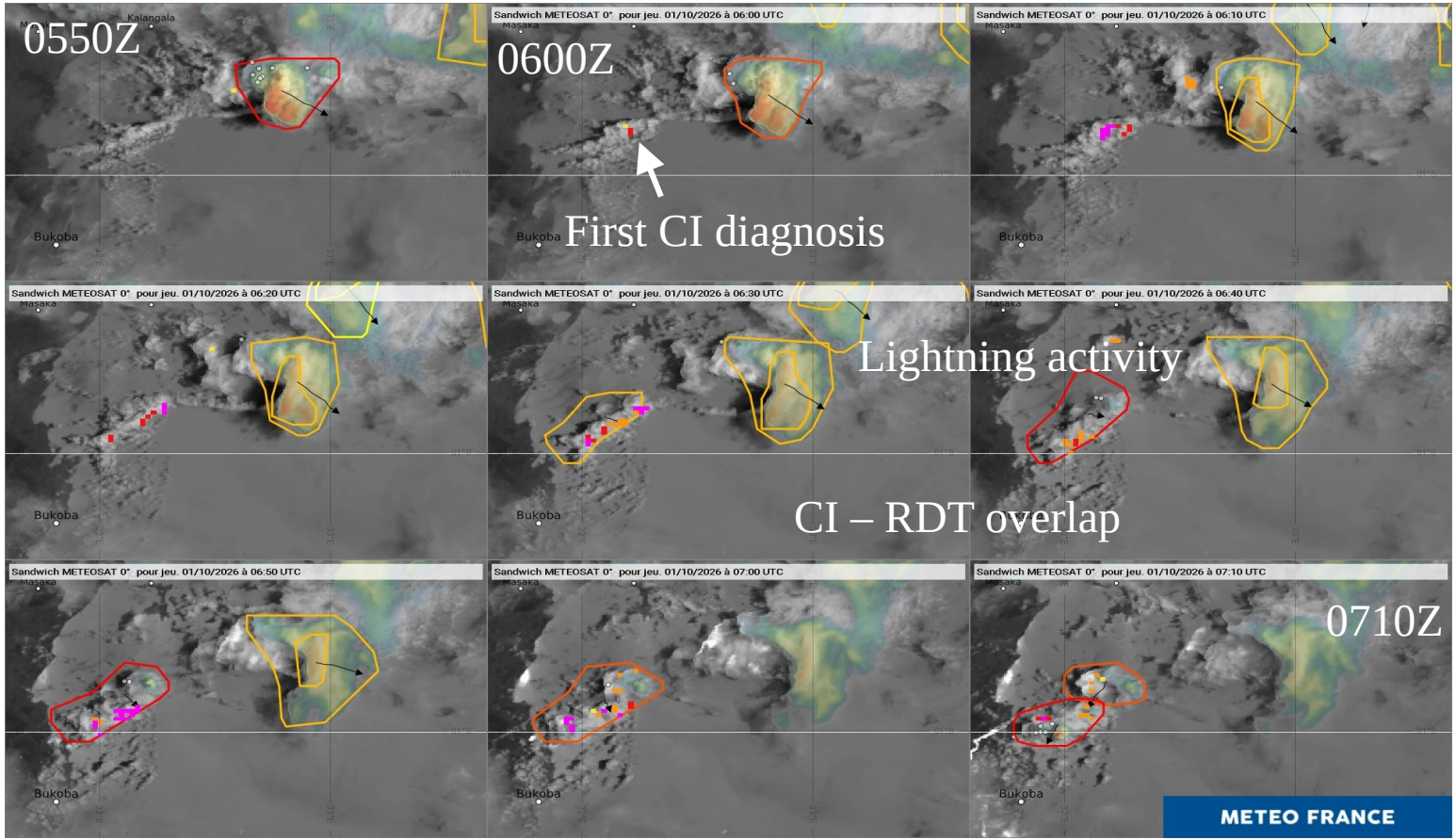
From cumulus fields to thunderstorms – Angola case



CI and RDT are produced independently

CI and RDT overlap occurs when cloud systems are not too cold

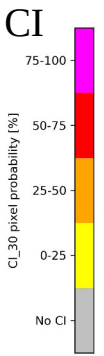
From cumulus fields to thunderstorms – Lake Victoria case (at dawn)



CI and RDT are produced independently

CI and RDT overlap occurs when cloud systems are not too cold

2027 version: CI object mode and RDT

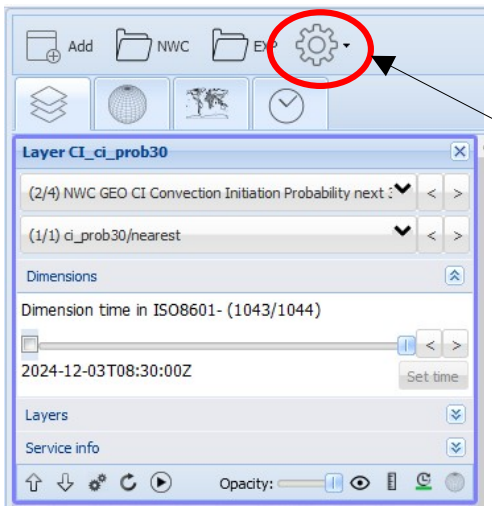


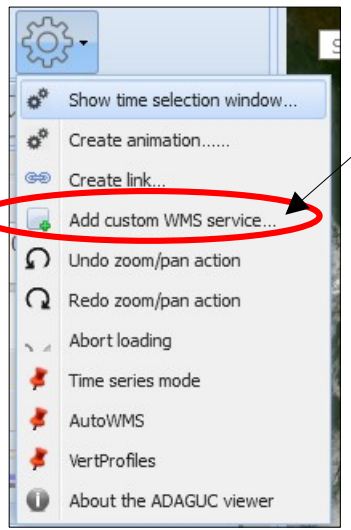
More information during *NWC SAF MTG-I Lightning Imager Prototype Products Workshop* 15th October 2026

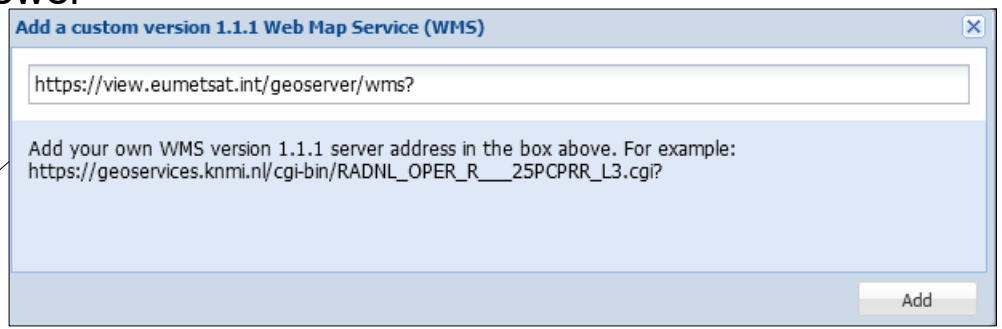
Where to find NWC SAF products for Africa

ADAGUC viewer: https://adaguc.nwcsaf.eumetsat.ewcloud.host/

- Available with MSG products, recently also with MTG ones
- Possibility to overlay data from Eumetsat viewer



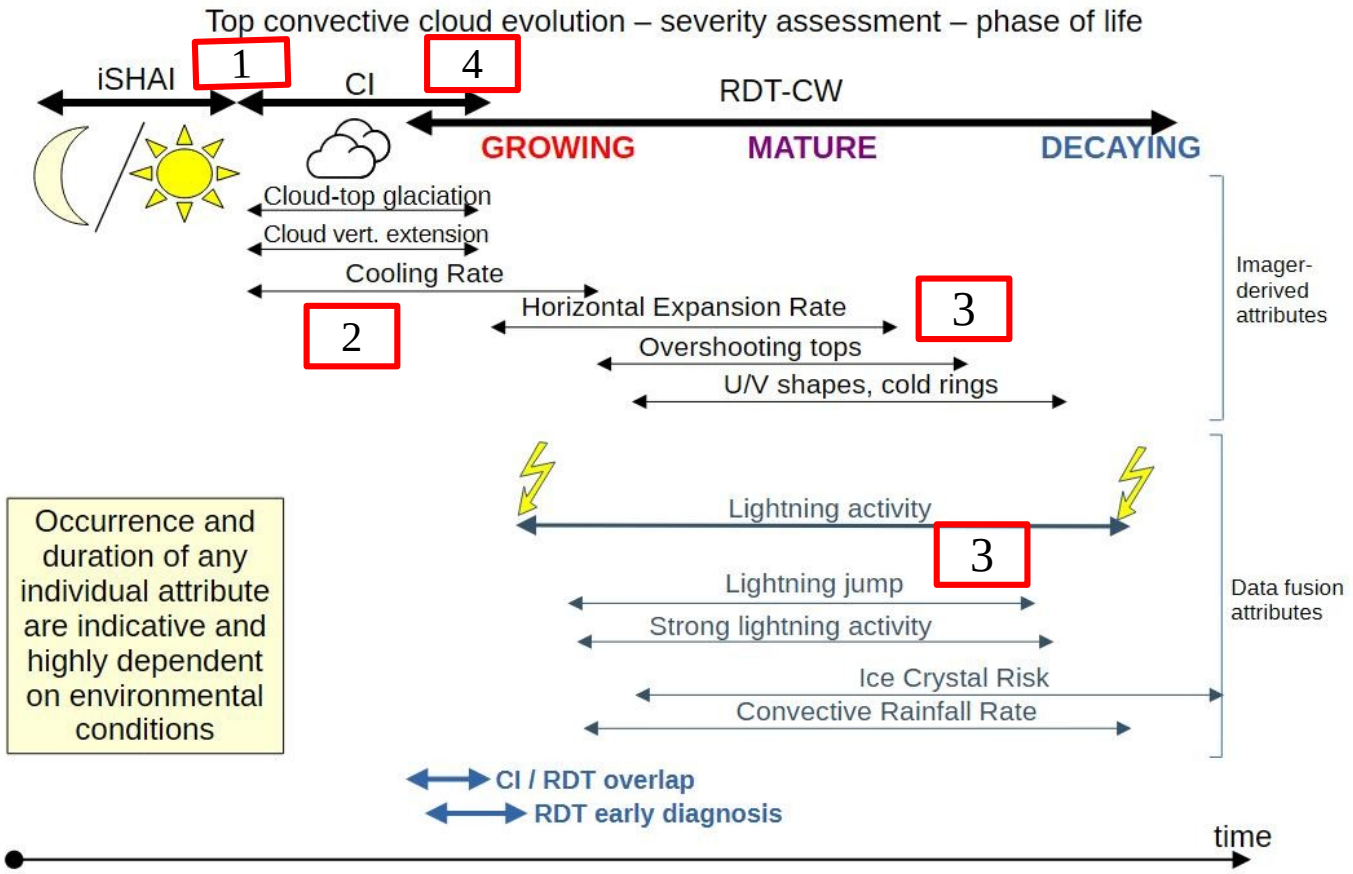




Adding the access to EUMETSAT geoserver – WMS services - to overlay MSG or MTG RGB
https://view.eumetsat.int/geoserver/wms?

Adding the access to ECMWF data
https://eccharts.ecmwf.int/wms/?token=public

Schematic view of NWCSAF Portfolio for convection - 2027 version
Perspective of development



1- Work on the link between clear-sky instability and humidity and convective clouds

2- Upgrading the CI decision tree

3- Detection, tracking and severity assessment of active cores in RDT

4- Improving complementarity between CI and RDT through CI objects and RDT active cores

Thanks for your attention.
Any feedback or suggestion on the products is appreciated

- **NWC SAF website → ticket**
- **emails for team responsible of NWC SAF convection products:**
  - **michael.claudon@meteo.fr**
  - **ronan.houel@meteo.fr**
  - **jean-marc.moisselin@meteo.fr**