



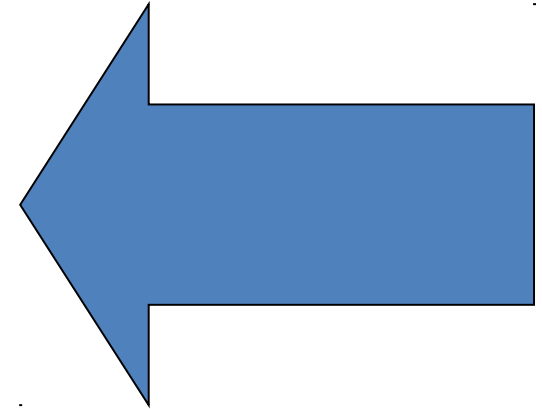
The EUMETSAT
Network of
Satellite Application
Facilities



NWCSAF Convection Products

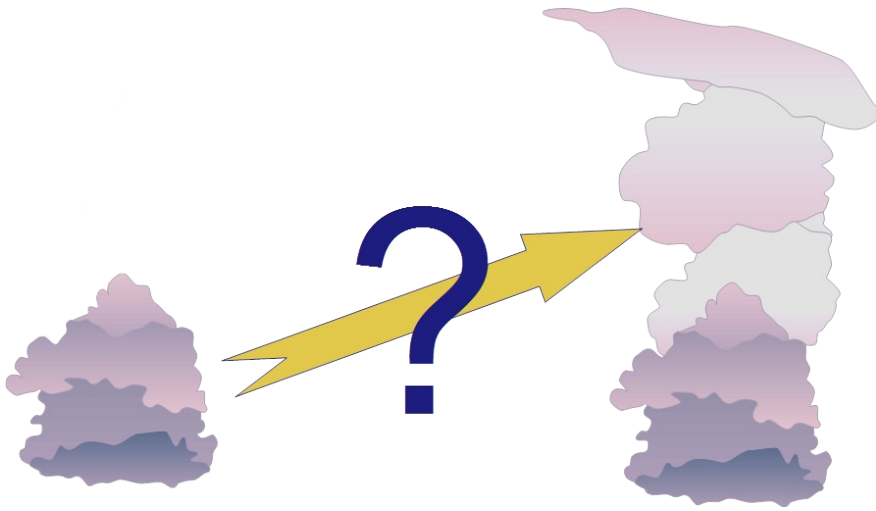
Jean-Marc Moisselin, Frédéric Autonès, Michael Claudon
CWG 21st April 2020

1. CI Convection Initiation



2. RDT Rapidly Developing Thunderstorm

CI at a glance



- Probability of a cloudy pixel to become convective for 3 steps 0-30', 0-60' and 0-90'
- v2018: new tuning of relevant BT, BTD and trends
- v2018: daily use of microphysics
- v2018: use of a 2D movement field
- Validation: quantitative (TROPOS) and case-studies
- v2018.1: GOES16 compliant

Status=Pre-Operational

CI Algorithm

- 1) Definition of **eligible-CI pixels** thanks to filters: NWP instability index, Cloud Type, CMIC (day-time only), BT IR10.8
- 2) cell-to-cell **tracking** or HRW or NWP U/V 850 hPa: trends calculation possible after this step
- 3) Définition of **pre-CI pixels** using 1 condition only among several BT, BTD and trends criteria
- 4) **Probability estimate** (0,]0, 25%],]25, 50%],]50, 75%],]75, 100%] using 3 categories of criteria: glaciation, height, height□trends following SATCAST methodology
- 5) **Spread** the diagnosis along the trajectory

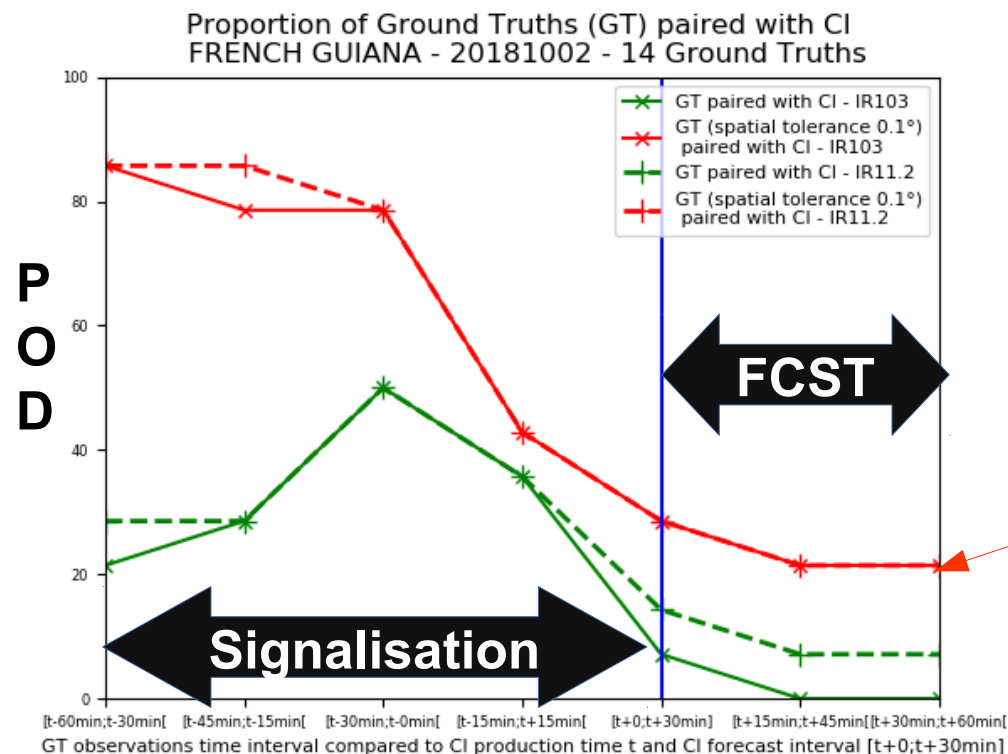
v2018 highly improved Some of improvement defined by VSA (A. Karagiannidis)

CI v2018 – GOES-16 qualitative validation

Use of radar-based convection objects

The main difficulty for CI validation or tuning is to compare CI pixels with **NEW** convective signal.

For this point, radar-based objects have been used. These objects contain the **key information** about their **birth time**



0.1° tolerance
Better for
POD

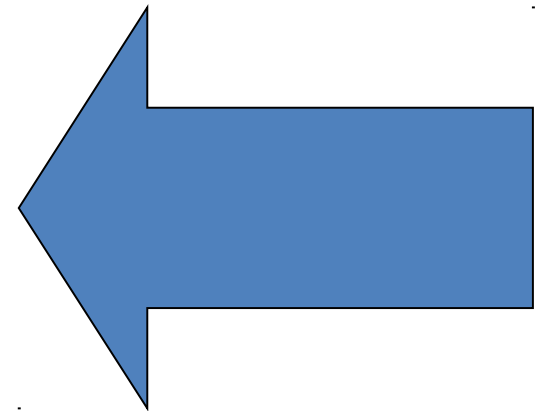
Validation

- Some validation performed by TROPOS during a NWCSAF AS
- v2018 at the boundary of the requirements
- Still room to be improved (False Alarm reduction)
- We elaborate a radar-based database for tuning and validation over a wide variety of territories
- CI production in MF to be evaluated by forecasters

Outlook

1. CI Convection Initiation

2. RDT Rapidly Developing Thunderstorm



RDT at a glance



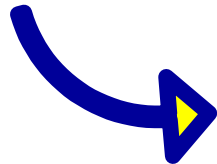
- Object-oriented approach, adding value to the satellite image
- v2018: end-users feedback taken into account (stability of outlines)
- v2018: new discrimination scheme CAL, adapted to the wide variety of satellite-scans
- v2018: lightning jump algorithm
- v2018.1: GOES16 compliant

Status=Operational

RDT - 4 steps algorithm

- 1) **Detection** of cloud systems
- 2) **Tracking** of cloud systems
- 3) **Discrimination** (*which clouds are convective ?*) logistic regression for several layers using BT, BTD and trends
- 4) **Forecast** of cloud systems

+ **Attribute** calculation : Lightning Jump, IWC hazard, Overshooting top, etc.



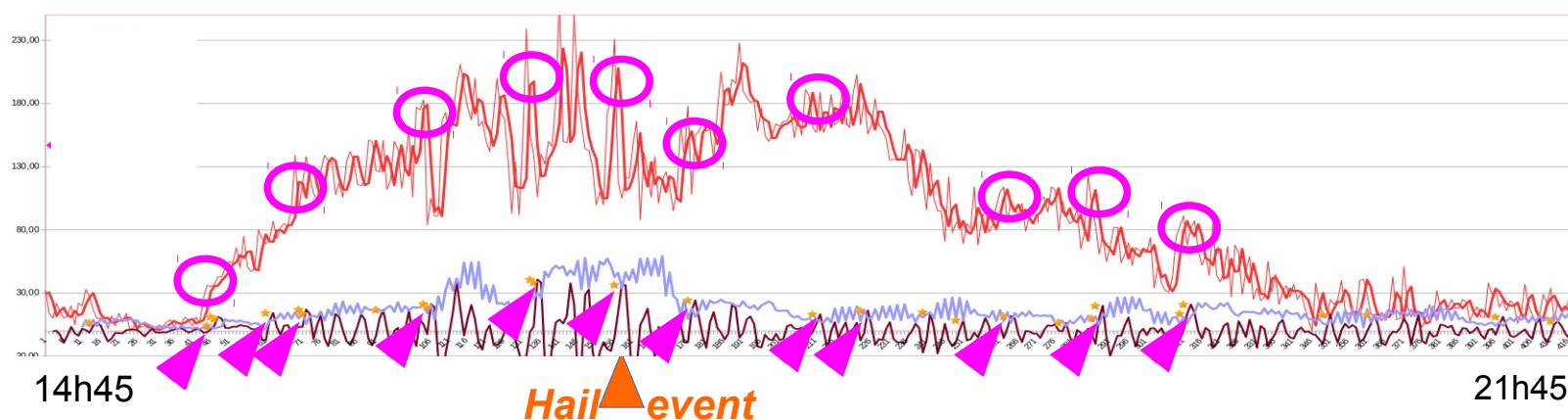
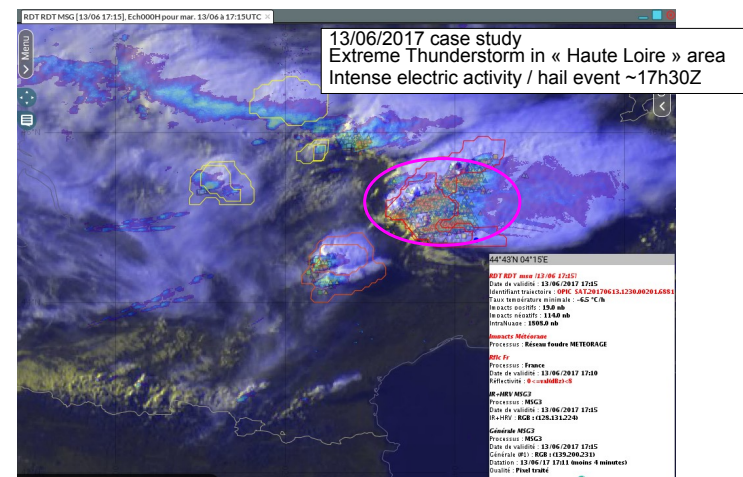
**Toward a 3D description of convection
(OT, 2nd Level, high altitude icing hazard)**

Lightning Jump diagnosis RDT-CW (impl. v2018)

✓ Total Lightning rate analysis

- Need input data at **fine time-scale** (*seconde*).
- 1st step: pairing lightning data with RDT cell
- **Jump** if
 - × *Condition 1: Lightning rate* $> 10 \text{ min}^{-1}$
 - × *Condition 2: Lightning rate trend* $> 2 \times \text{rms}$

✓ Implementation **RDT v2018**



References

- Pedebay, S., P.Barnéoud, C.Berthet, *First results on severe storms prediction based on the French Lightning Locating System*, 24th International Lightning Detection Conference, 18-20 April 2016, San Diego, USA
- Schultz, C.J., W.A. Petersen, and L.D. Carey, 2009, *Pre-liminary developmeent and evaluation of lightning jump algorithms for te realtime detection of severe weather*. J.Appl. Meteor. Climatol., 48, 2543-2563
- Schultz and al, *Enhanced verification of the lightning jump algorithm* . XV International Conference on Atmospheric electricity, 15-20 June 2014, Oklahoma, USA

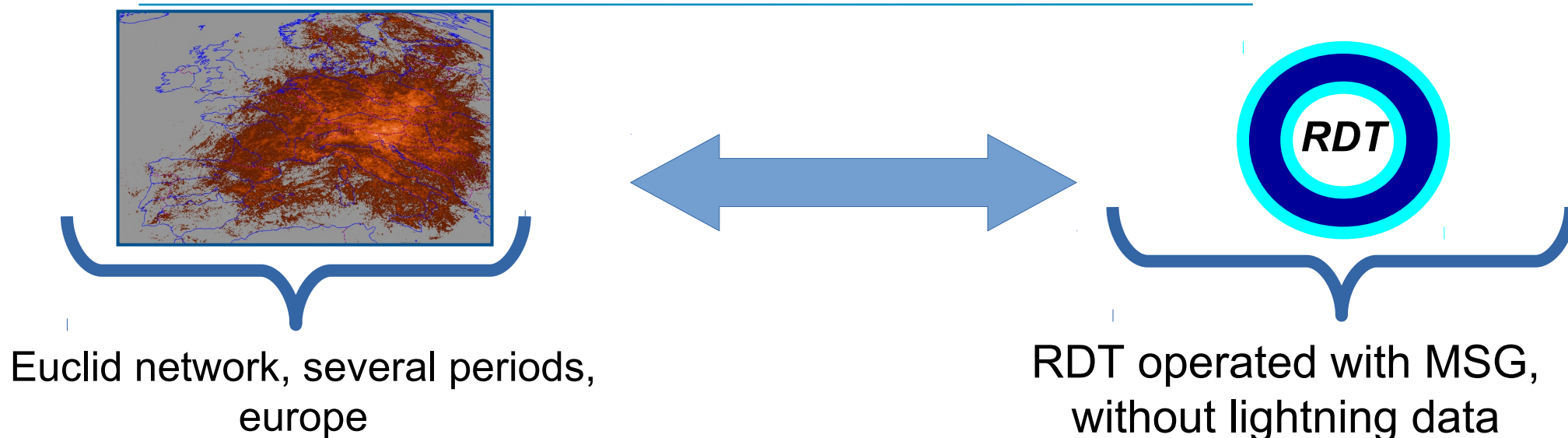
RDT - Validation

Several ways to validate RDT

- RDT detection and YES/NO convection diagnosis : against lightning data
- RDT forecast: against observed RDT
- RDT attributes:
 - Lightning Jump against hail data (or estimate)
 - Overshooting Top against super-rapid-scan CHMI database

Difficult to validate IWC hazard but KNMI algorithm we use has been validated with HAIC project measurement campaigns data

RDT – validation with ground-based lightning data network



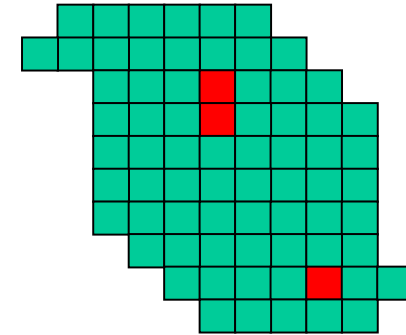
Identification of convective phenomenas

✓ $POD > 70\%$ spring/summer

Early diagnosis:

✓ 25% 15 min before 1st stroke

Validation of Overshooting Tops (OT) Detection within RDT (1/2)



Expertised **CHMI OT database**

- 2.5' experimental MSG1 scan 20130620 [09h-19h30] and 20130729 [13h-18h30]
- 1800 OT identified over Central Europe

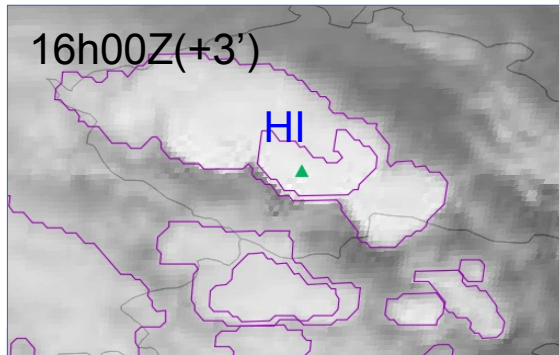
Reprocessed **RDT** : 4 configurations

- *FDSS-15' and RSS-5'*
- *v2018 and dev^t version with use of HRV*

Pairing method between **CHMI-OT** and **RDT-OT**

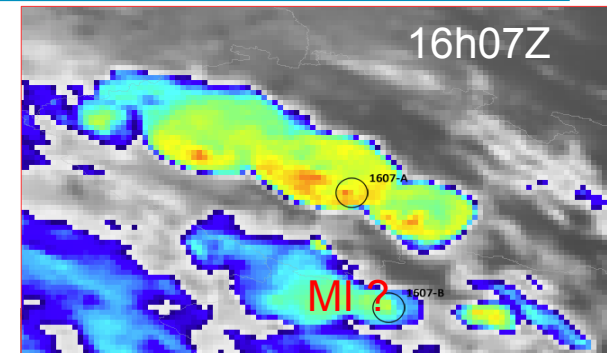
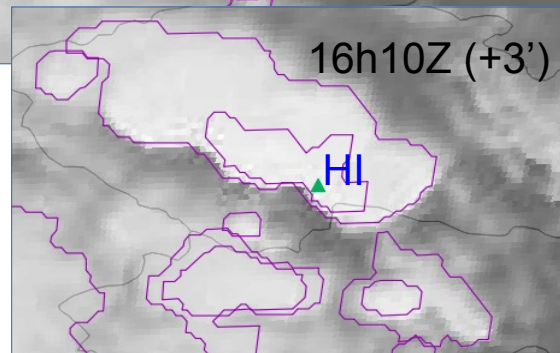
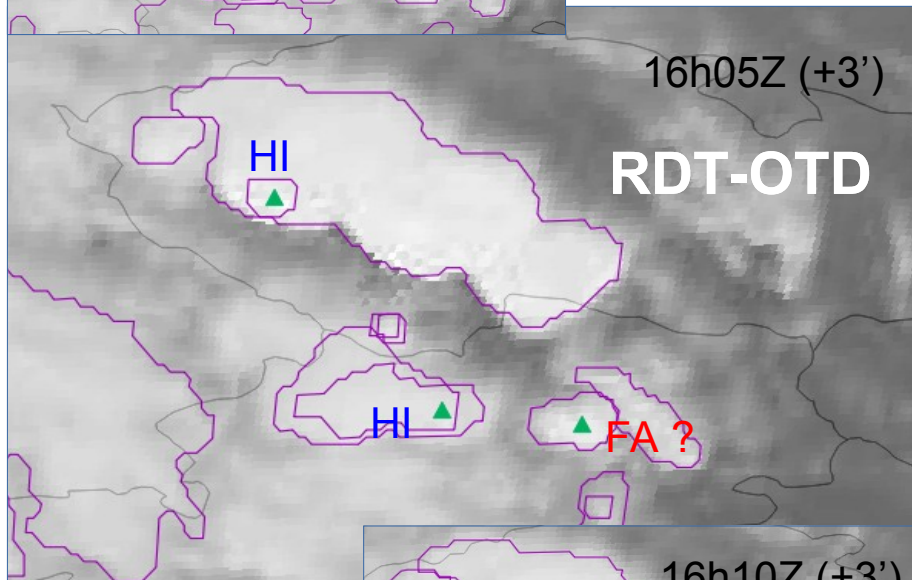
- *Time tolerance: maximum 5' (RSS) or 15' (FDSS) between RDT-OT and CHMI-OT*
- *Spatial tolerance: 20 km maximum distance (~ mean OT size)*
- *Score calculation:*
 - ✓ *HIT: at least one RDT-OT associated to a CHMI-OT*
 - ✓ *MISS : CHMI-OT without associated RDT-OT*
 - ✓ *FA : RDT-OT without associated CHMI-OT*

Overshooting Tops (OT) Detection: 20130729 RDT-RSS case study

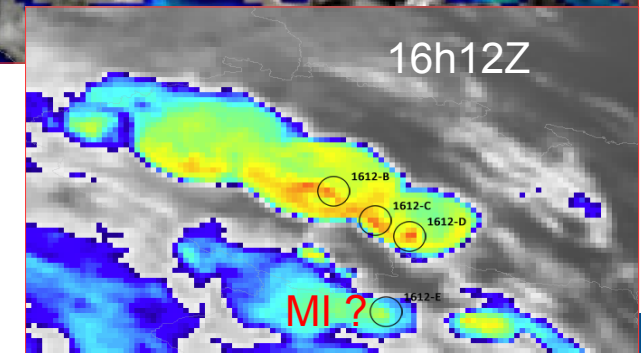
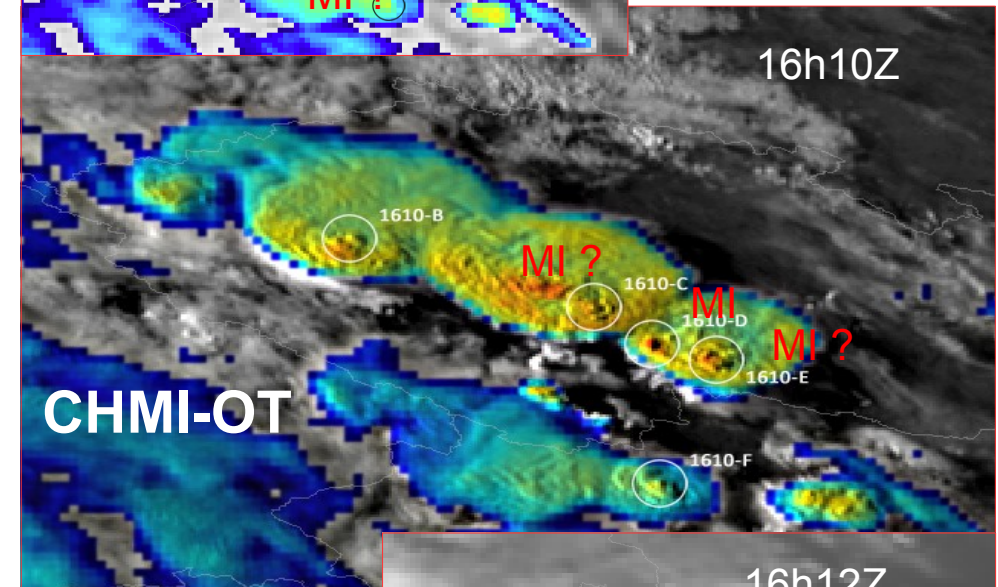


RDT-OTD:

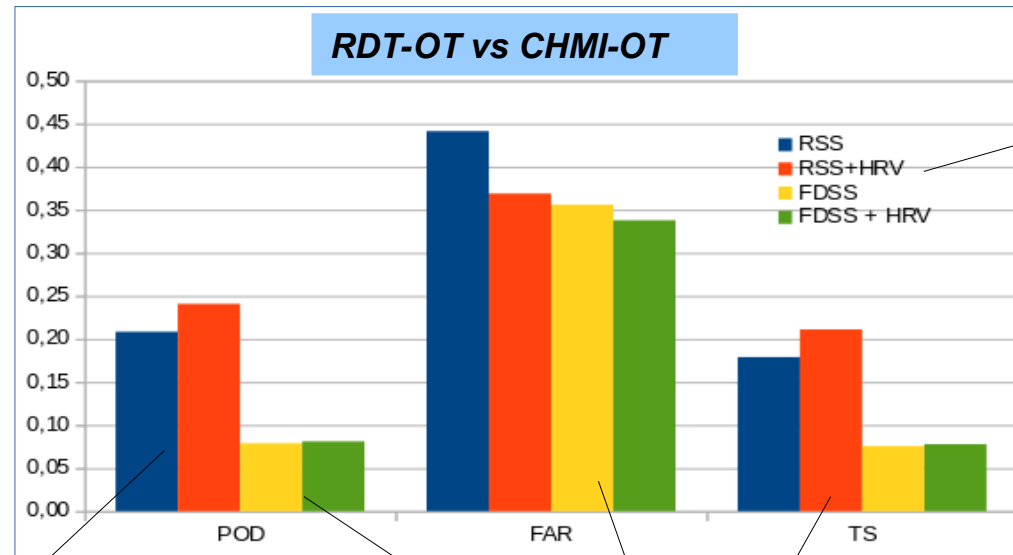
- Better performance with RSS
- Still some misses, less FA



Expert CHMI-OTs:
less space & time
variability of OTs
for this example



RDT-OT vs CHMI-OT (2/2) – Quantitative Results

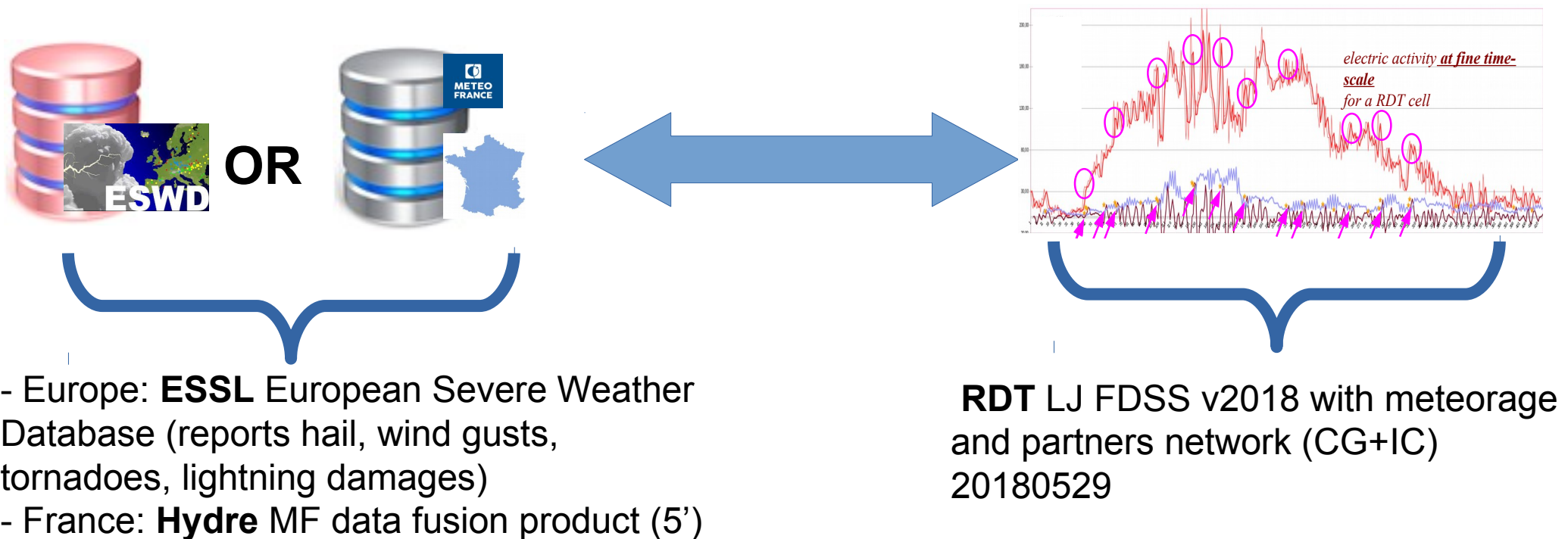


The four RDT configurations

Low POD due to unbalanced populations (more OT in CHMI database than seen by RDT)

RDT-OTD: RSS 5' better than FDSS 15' and RDT-OTD-HRV slightly better than RDT-OTD-VIS0.6

Validation of Lightning Jump (LJ) Detection within RDT (1/3)

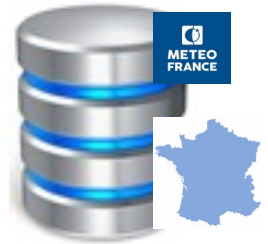


Pairing method between severe events and RDT-LJ

- Case study
- Visualisation of RDT cells with LJ diagnosis prior to hail events from both ESWD and Hydre databases

Lightning Jump Validation (2/3)

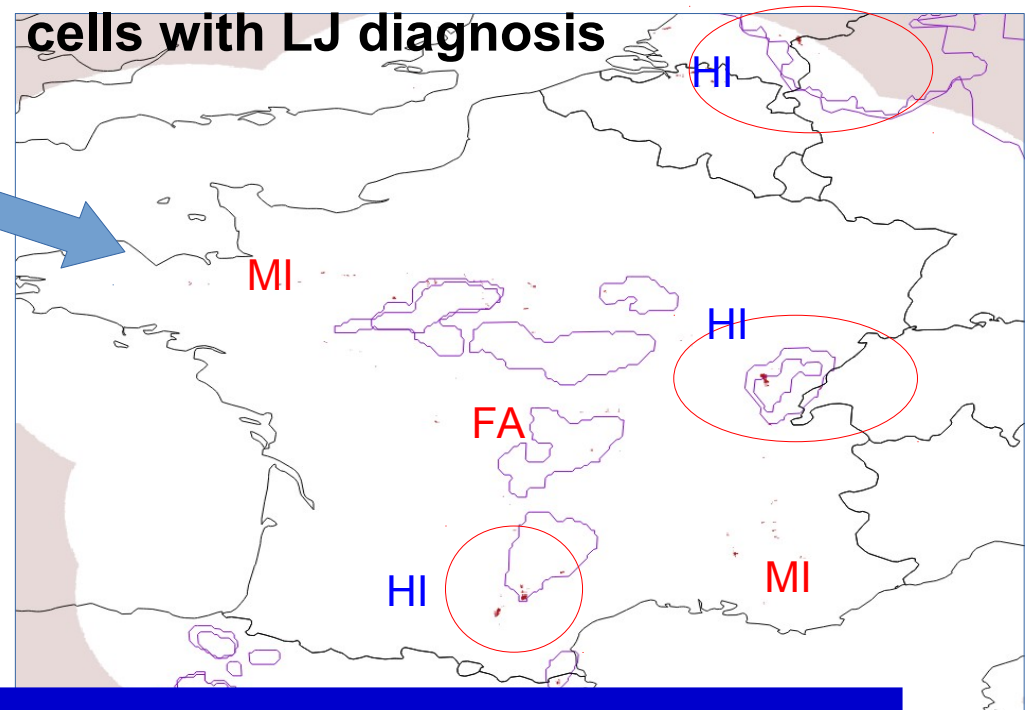
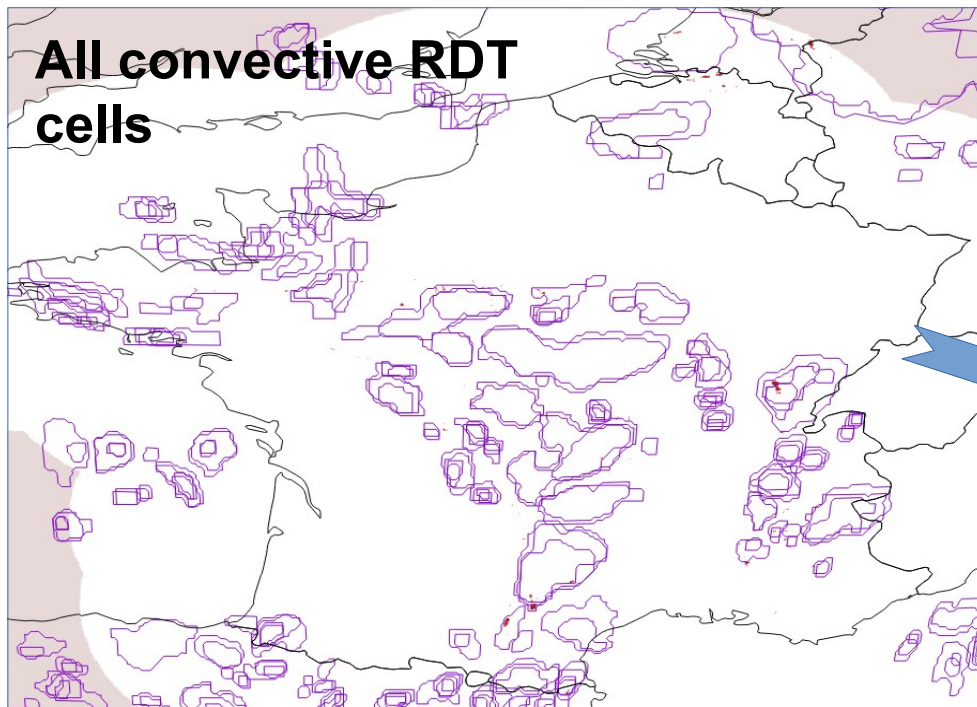
RDT-LJ vs HYDRE Hail detection



20180529 case study:

[15h30-16h00] RDT (contours)

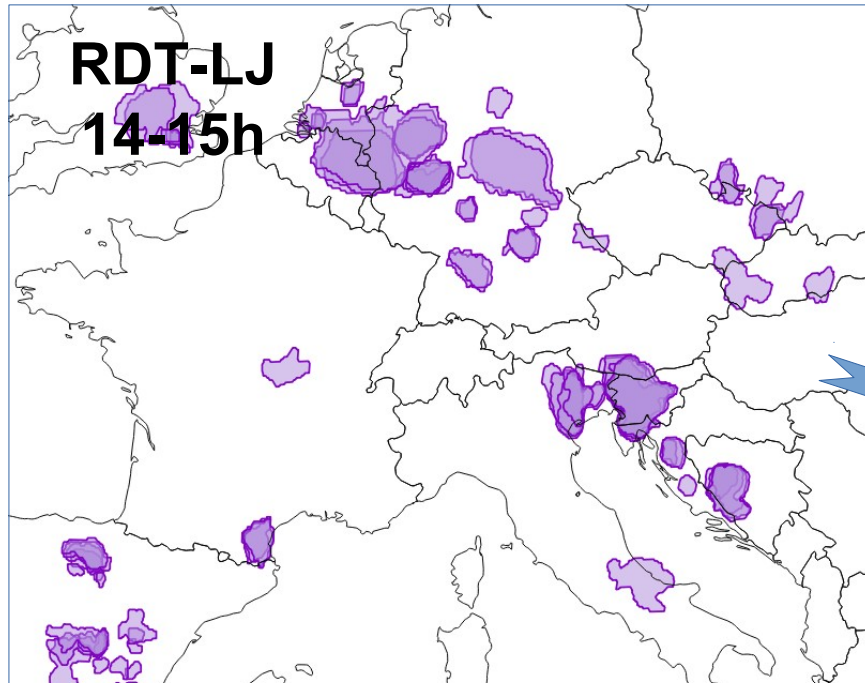
[16h-16h15] HYDRE medium and large hail detection (accumulated pixels)



Subjectively good co-location Hail/RDT-LJ. RDT-LJ sometimes precursor of Hail event. Isolated Hail pixels to be considered ?

Lightning Jump Validation (3/3)

RDT-LJ vs ESWD data



Step by step analysis of **RDT-LJ sequences** vs following Severe Weather allow subjective good pairing

Most severe weather events find a correspondence with previous RDT with LJ

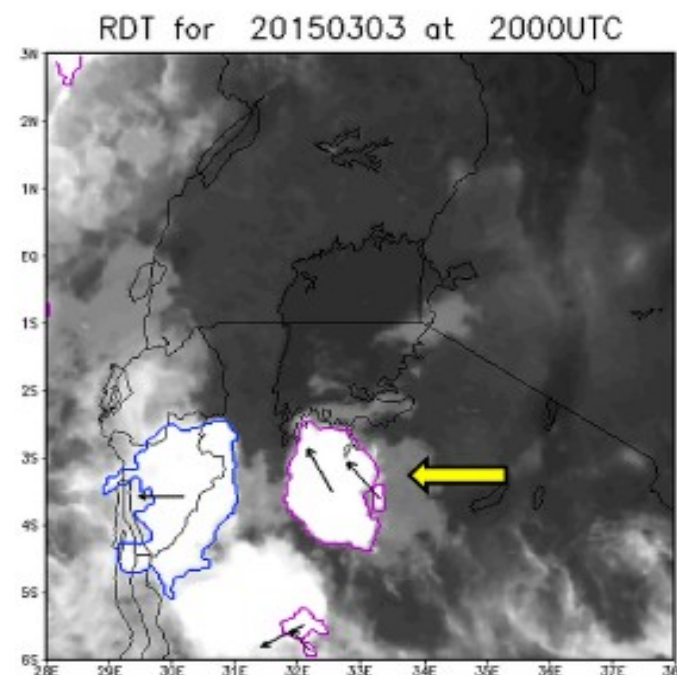
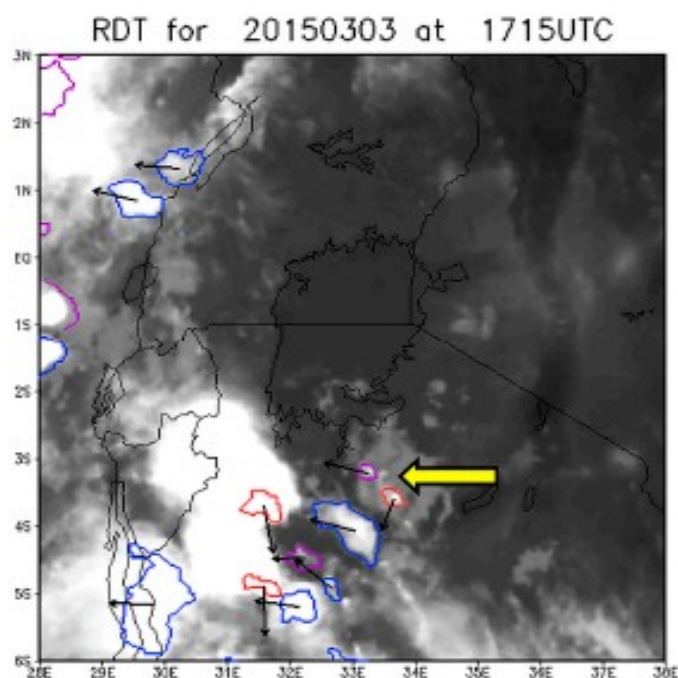
Numerous un-paired RDT-LJ : false alarms or lack of observation ?

Objective quantification needed for “paired” and “missed” Severe Weather events

The 3 March 2015 Case over Lake Victoria

World Meteorological Organization (WMO) initiative of an eastern Africa Severe Weather Forecast Demonstration Project (SWFDP)

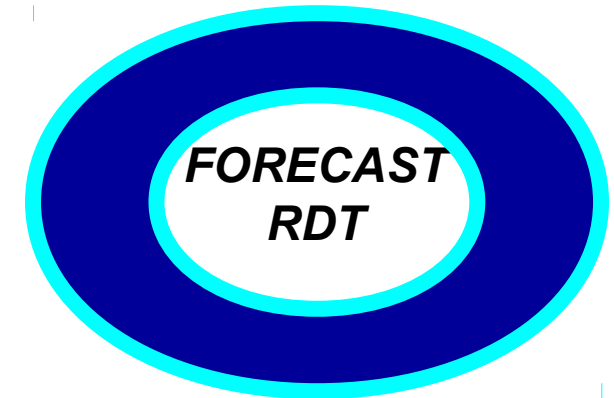
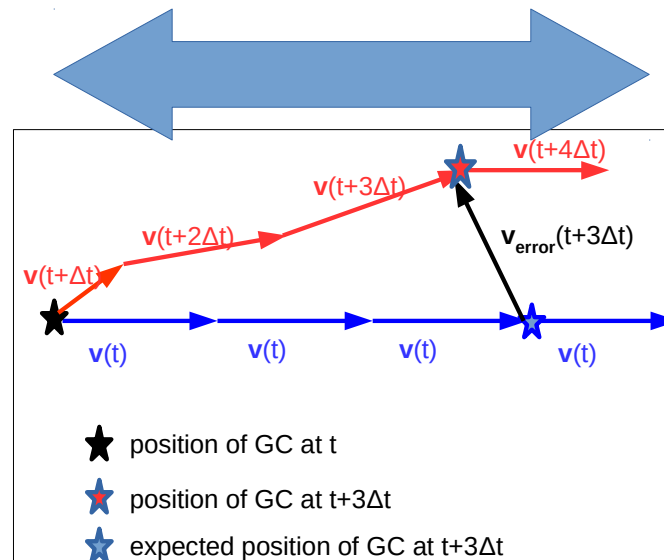
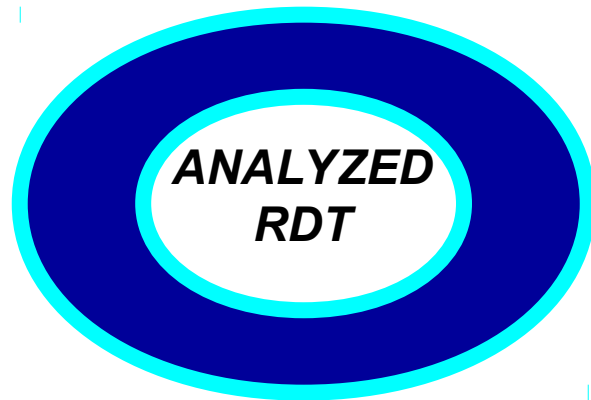
“The storm resulted in the deaths of 47 people, 5000 people were affected, and 634 houses were damaged. [...] This example highlights the importance of such a product over data sparse regions for the nowcasting of thunderstorms where little observational networks exist.”



From : « Morné Gijben, Estelle de Coning, 2017, Using Satellite and Lightning Data to Track Rapidly Developing Thunderstorms in Data Sparse Regions, Atmosphere 2017, 8(4), 67;
doi:10.3390/atmos8040067 » CWG April 2020, Slide 19/26

RDT forecast scheme

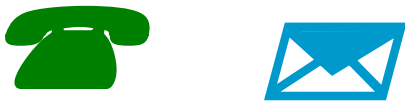
Error on Gravity Centre position



Order of magnitude of +1 h error : 50-100 km
22.5 % of trajectories are new after 15': provide an estimate of hit and misses of 15' forecast scheme

Moisselin, J.-M., Autonès, F., **2018**, *Scientific Report on verification of RDT forecast*, NWCSAF Scientific Report NWC/CDOP3/GEO/MFT/SCI/RP/01

Any feedback is welcome !



RDT – Global productions at Météo-France

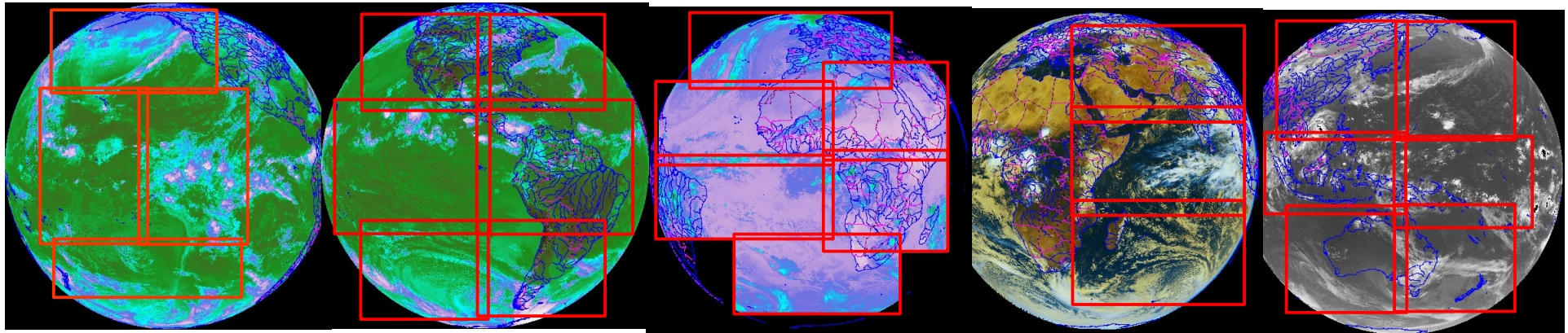
GOES-17
135°W

GOES-16
75°W

MSG
0°

MSG-IODC
41.5°E

Himawari-8
140°E



30min



10min

10min

15min

15min

20min



10min

Outlook

1. CI Convection Initiation
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 **CONCLUSION** 

CI and RDT products

- Algorithm: RDT algorithm has been developed before CI algorithm
- Meteorology / conceptual model: CI occurs before.
- Two products different in terms of presentation
 - × CI: image mode
 - × RDT: object mode
- Strong links between these two products: input data, exclusion mask, cross-validation
- Strong links with other NWCSAF products: cloud products, CRR, HRW
- Together and with other NWCSAF products (iSHAI, CRR) they offer a complete description of convection in various phases

Future Plans

End of CDOP3

MTG 2021+

CDOP4 2022-2027 (Users Workshop requirements)

CI

- **Objective: to move from pre-operational to operational status**
- Rooms of improvement: processing area filtering (e.g. use of previous clear sky NWCSAF instability indices), detection of cells, motion field estimate (that includes the use of NWCSAF HRW fields), parameter of interest (definition and tuning), high frequency scan benefit.

RDT-CW

- To provide a calibrated scheme for each satellite, depending on its channels, spatial resolution and scan frequency.
- To improve cloud top features (overshooting tops, cold rings and cold-U/V, upper-level divergence), contributing to a complete description of convection in terms of dimensions and in terms of attributes for a wide variety of end-users.
- GEO lightning detectors will be used to improve several parts of RDT-CW: validation, tuning, convection description, real-time operations and monitoring.

An aerial photograph of a town nestled in a valley, partially obscured by low-hanging clouds. The town features a mix of residential and commercial buildings, green spaces, and a railway line. Overlaid on the bottom left of the image is a weather map showing isobars and wind vectors. The background transitions from a light blue sky to a dark blue gradient on the right.

Thanks for your attention

**Thanks to CWG for quick and
creative organisation**

Take care !



METEO FRANCE
Toujours un temps d'avance