NWCSAF Convection Products

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NWCSAF 2020 Users' Workshop

Objectives of the lecture

a) To remind the description of the products and their status

b) To sum-up the validation results

c) To have a look on the production and to encourage feedback

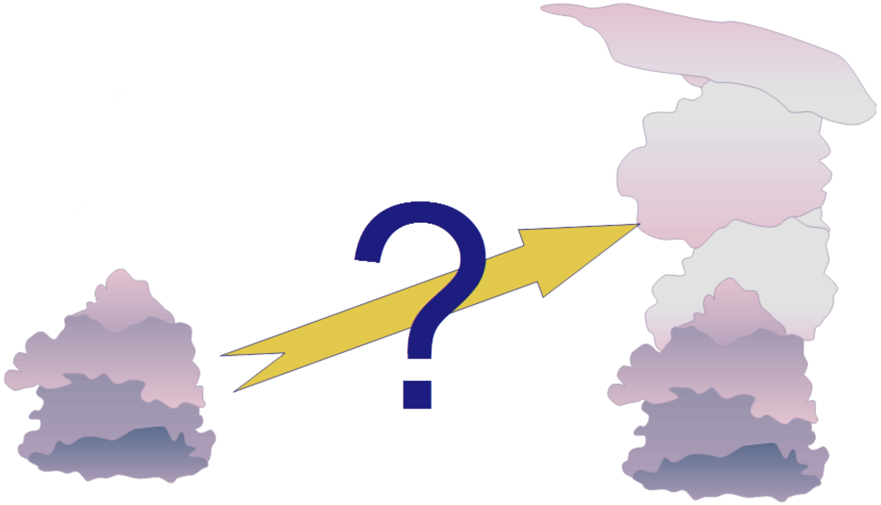
d) To describe the future: end of CDOP3, CDOP4, MTG

Outlook

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)

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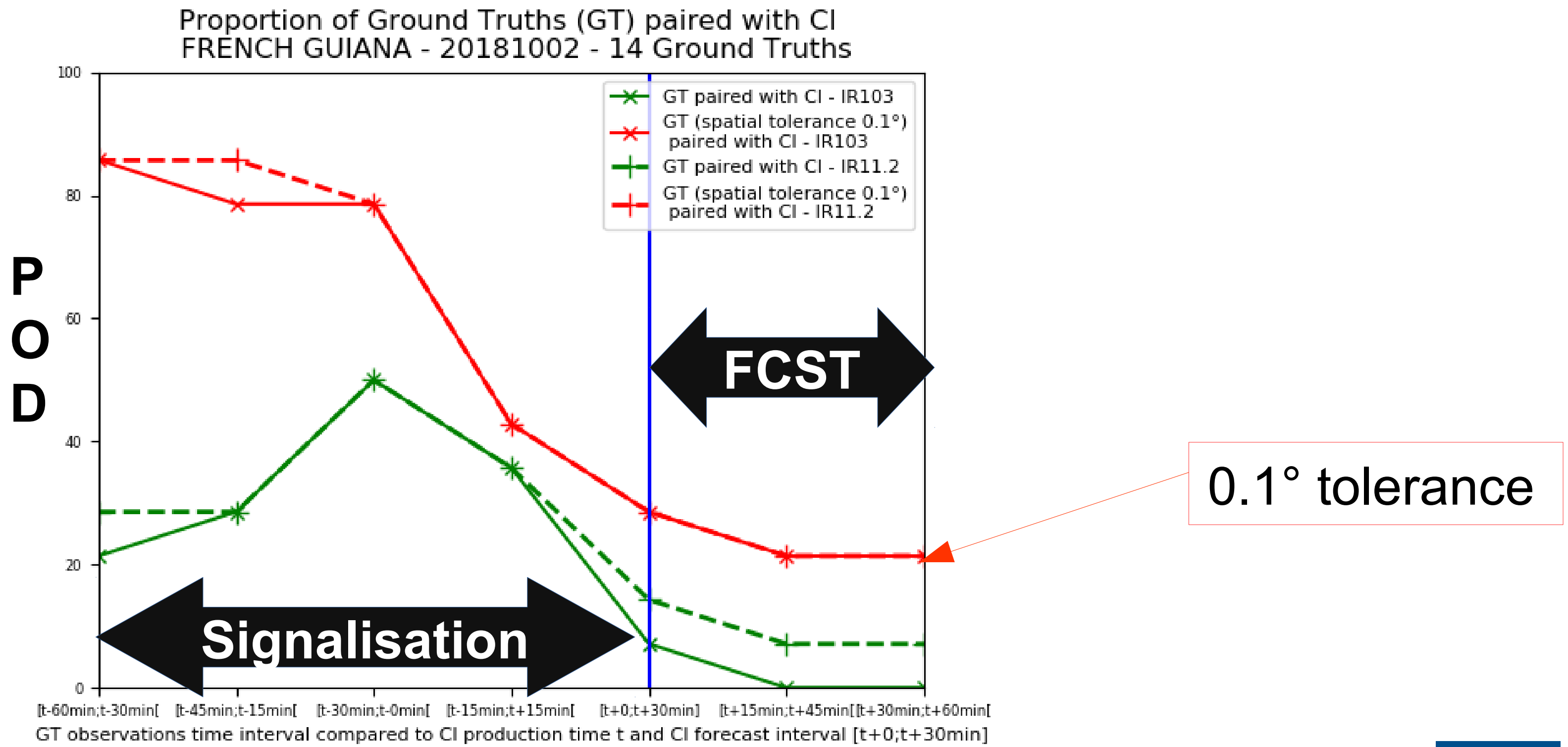
CI v2018 – GOES-16 qualitative validation
Use of radar-based convection objects

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**



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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

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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

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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

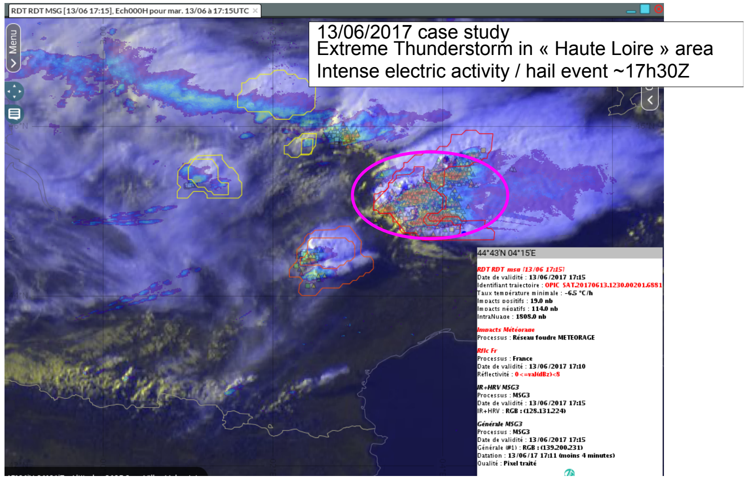
4) **Forecast** of cloud systems

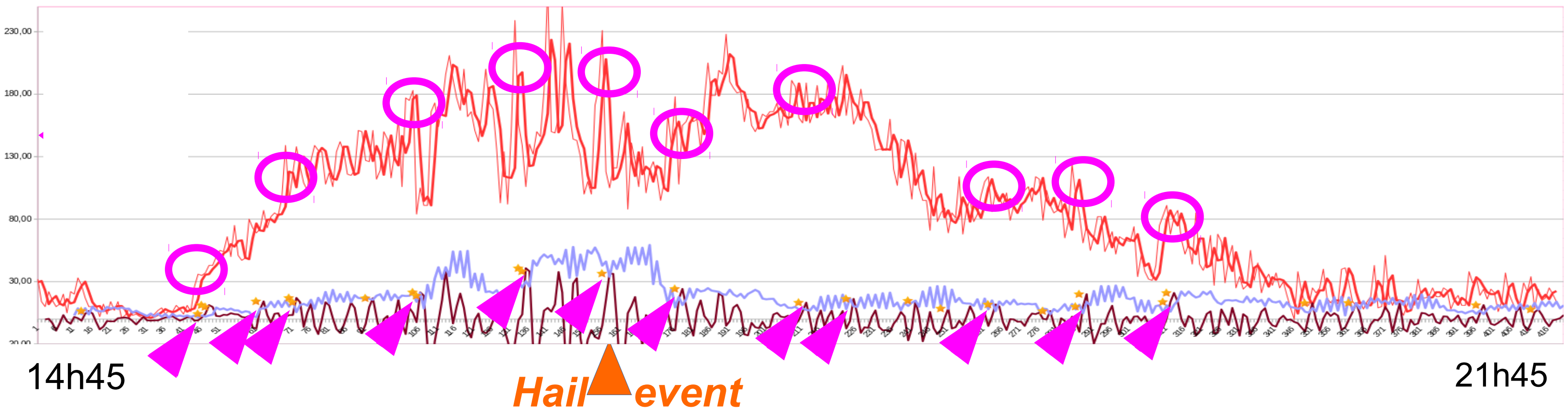
✚ **Attribute** calculation : Lightning Jump, IWC hazard, Overshooting top, etc.

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

Lightning Jump diagnosis RDT-CW 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 min^{-1}*
    - ✗ *Condition 2 : Lightning rate **trend** > 2 x rms*
- ✔ Implementation **RDT v2018**





References
- Pedeboy, 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

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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

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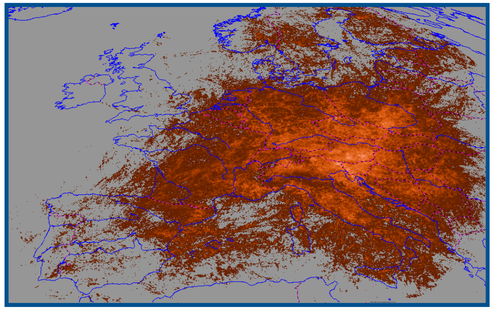
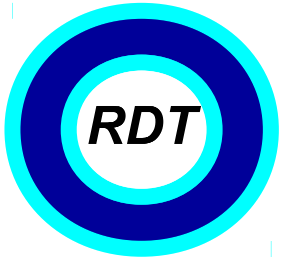
RDT – validation with ground-based lightning data network





Euclid network, several periods, europe

RDT operated with MSG, without lightning data

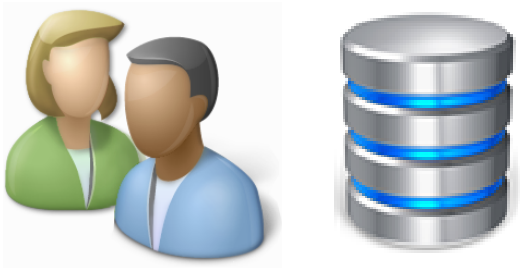
Identification of convective phenomenas

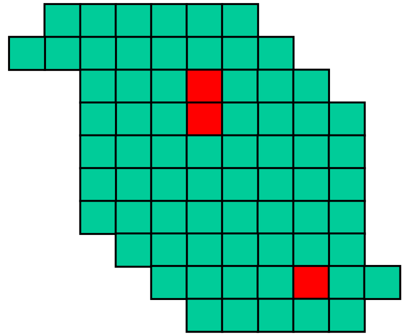
- ✓ **POD > 70% spring/summer**

Early diagnosis:

- ✓ **25% 15 min before 1st stroke**

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



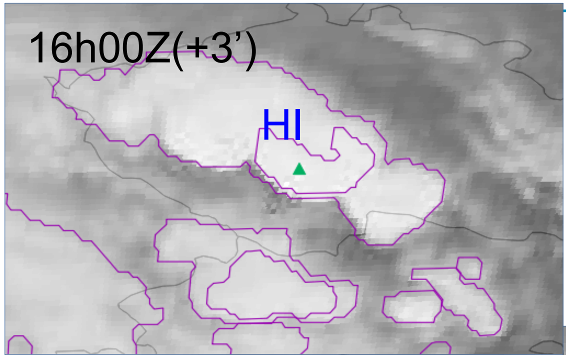


Expertised **CHMI OT database**
- 2.5’ experimental MSG1 scan *20130620 [09h-19h30] and 20130729 [13h-18h30]*
- *1800 OT identified over Central Europe*

Reprocessed **RDT** : 4 configurations
- *FDSS-15’ and RSS-5’*
- *v2018 and dev^t version with use of HRV*

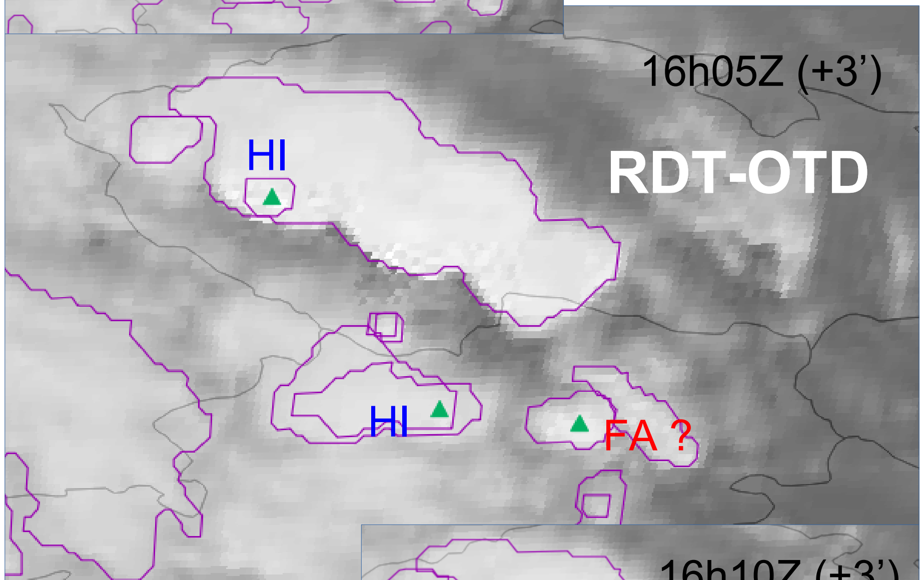
Pairing method between CHMI-OT and RDT-OT
- *Time tolerance: maximum 5’ (RSS) or 15’ (FDSS) between RDT-OT and CHMI-OT*
- *Spatial tolerance: 20 km maximum distance (~ mean OT size)*
- *Score calculation:*
  - ✔ *HIT: at least one RDT-OT associated to a CHMI-OT*
  - ✔ *MISS : CHMI-OT without associated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

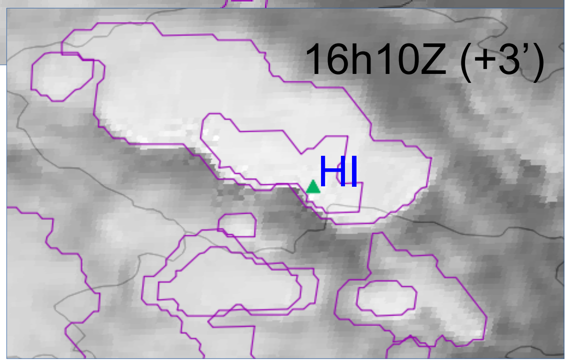
Overshooting Tops (OT) Detection: 20130729 RDT-RSS case study

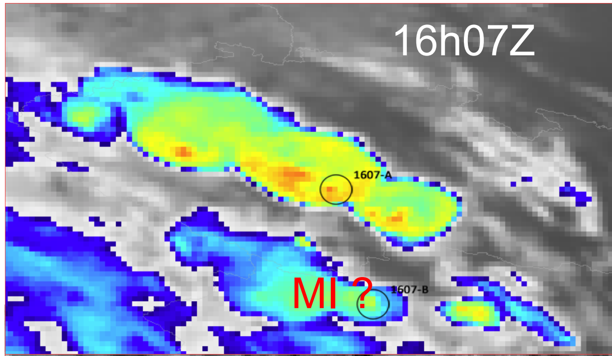


RDT-OTD:

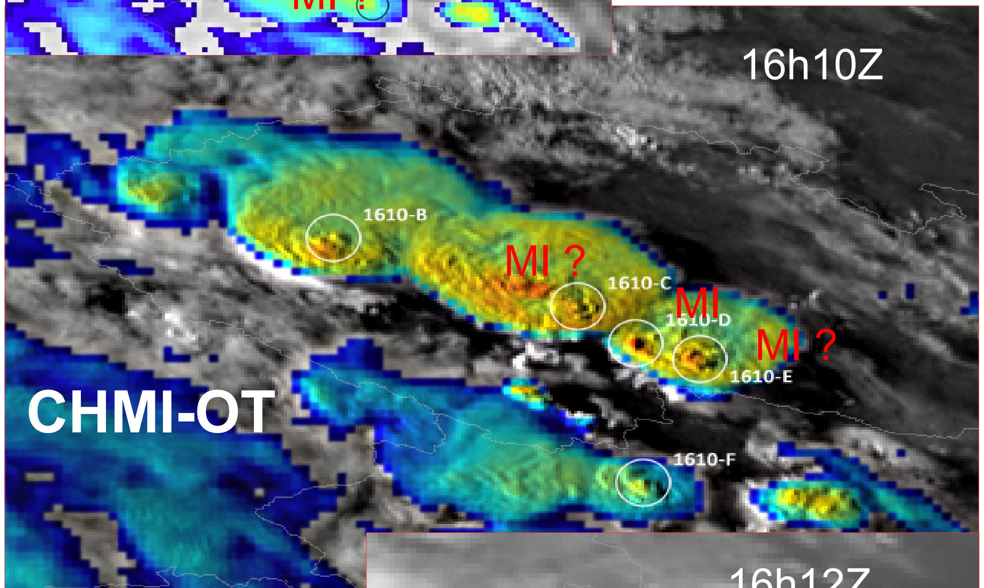
- Better performance with RSS
- Still some misses, less FA

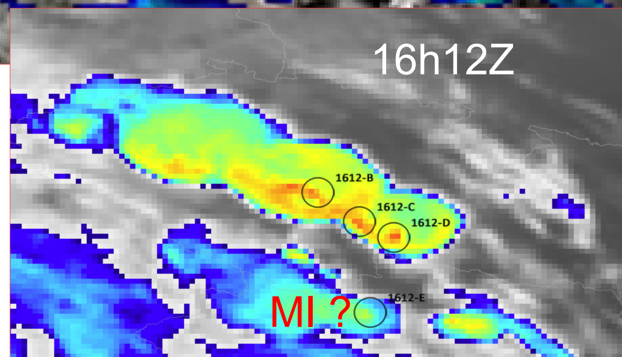






Expert CHMI-OTs: less space & time variability of OTs for this example





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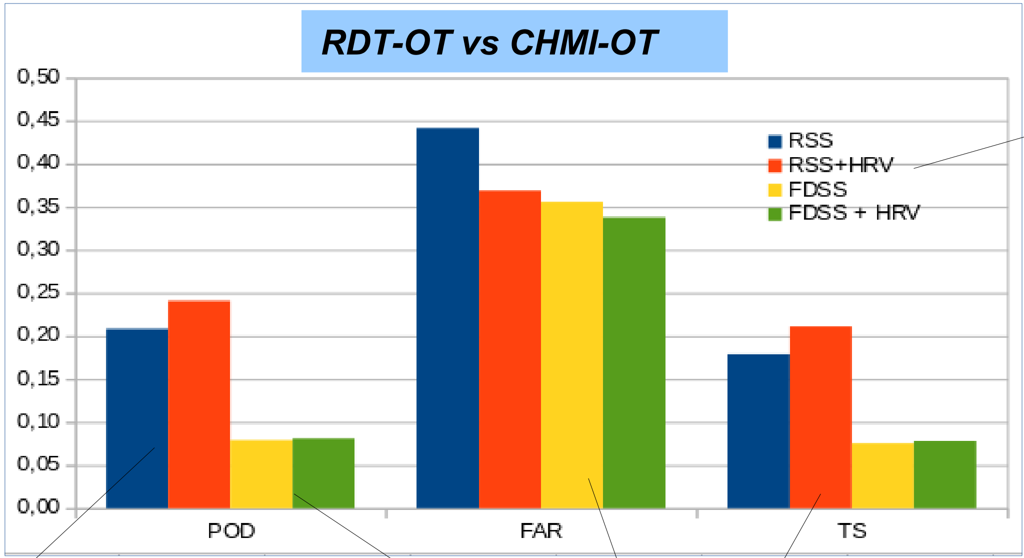
RDT-OT vs CHMI-OT (2/2) – Quantitative Results



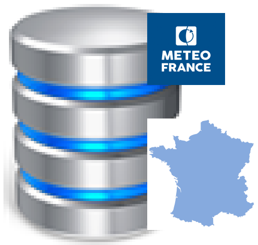
The four RDT configurations

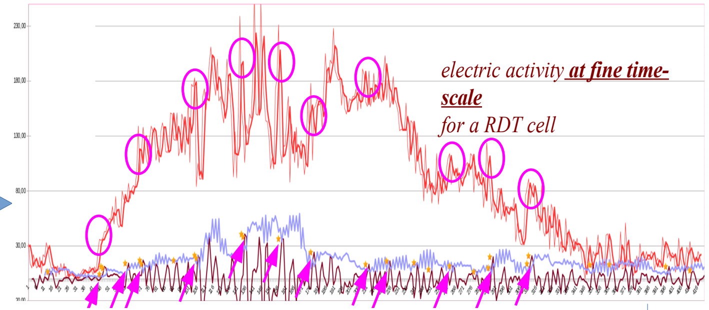
Low POD due to unbalanced populations (more OT in CHMI database than seen by RDT)

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

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

OR





- Europe: **ESSL** European Severe Weather Database (reports hail, wind gusts, tornadoes, lightning damages)
- France: **Hydre** MF data fusion product (5')

RDT LJ FDSS v2018 with meteorage and partners network (CG+IC) 20180529

Pairing method between severe events and RDT-LJ

- Case study

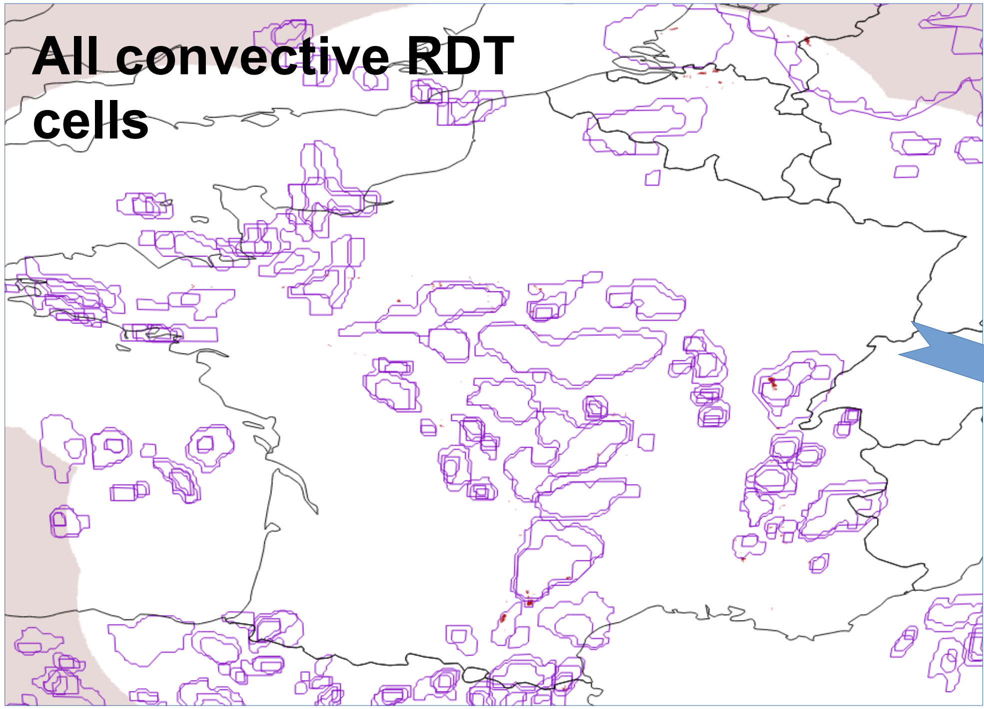
- Visualisation of RDT cells with LJ diagnosis prior to hail events from both ESWD and Hydre databases

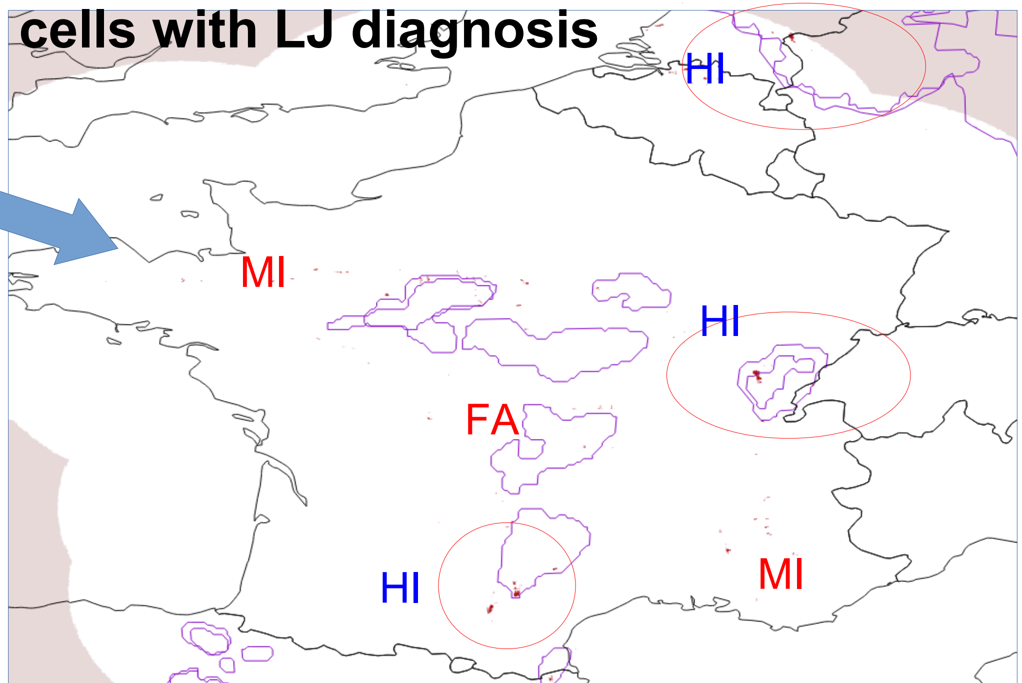
Lighning Jump Validation (2/3)
RDT-LJ vs HYDRE Hail detection

20180529 case study:

[15h30-16h00] RDT (contours)

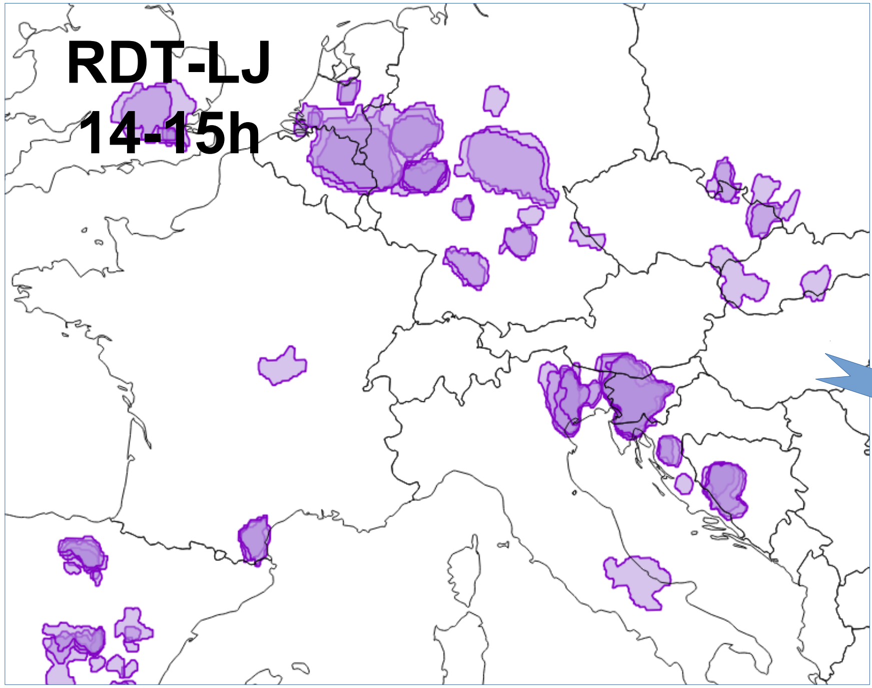
[16h-16h15] HYDRE medium and large hail detection (accumulated pixels)





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

Lighning Jump Validation (3/3)
RDT-LJ vs ESWD data



Step by step analysis of **RDT-LJ sequences** vs **<u>following</u> SW** allow subjective good pairing

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

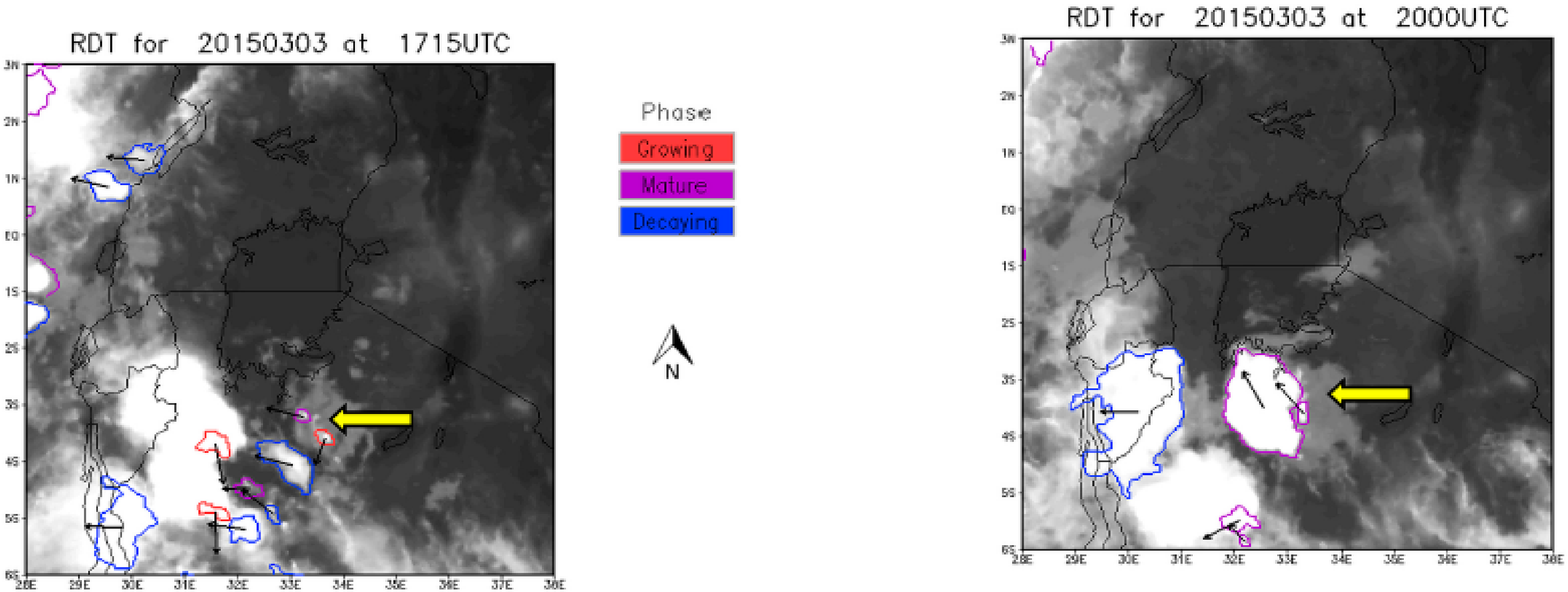
Numerous non paired RDT-LJ : false alarms or lack of observation ?

Objective quantification needed for “paired” and “missed” SW events

The 3 March 2015 Case over Lake Victoria

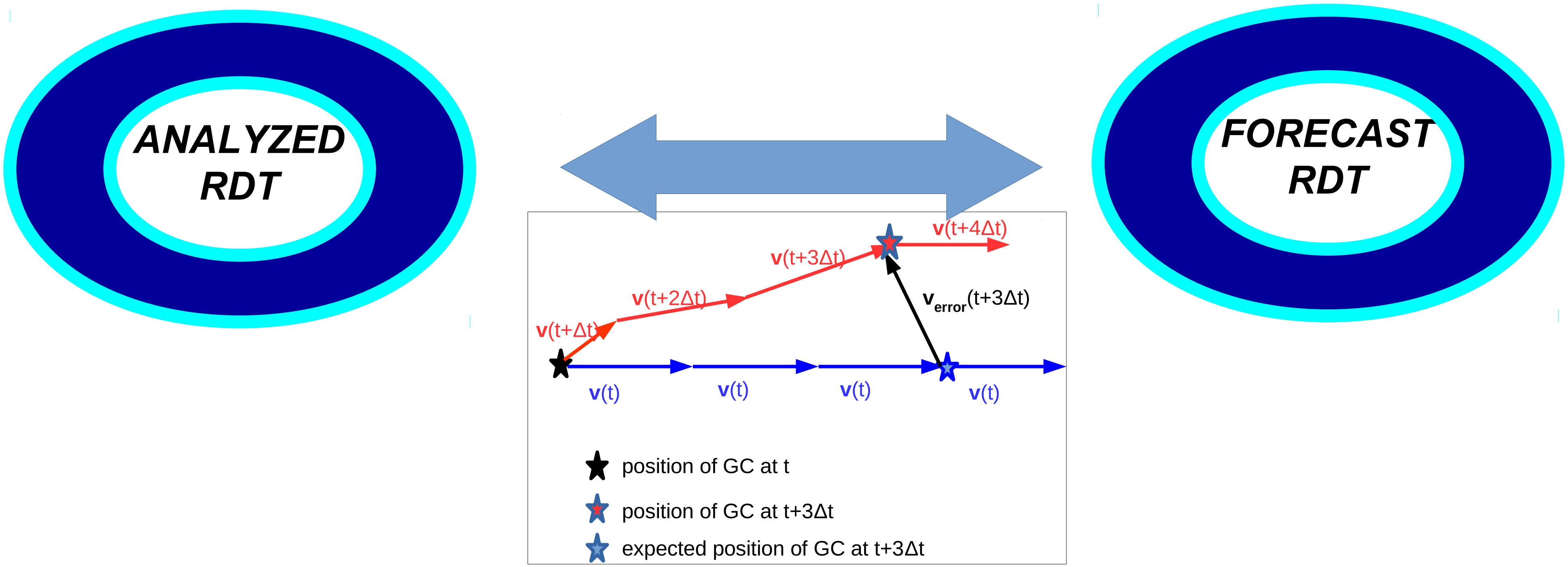
World Meteorological Organization (WMO) initiative of an eastern Africa Severe Weather Forecast Demonstration Project (SWFDP)

“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 »

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

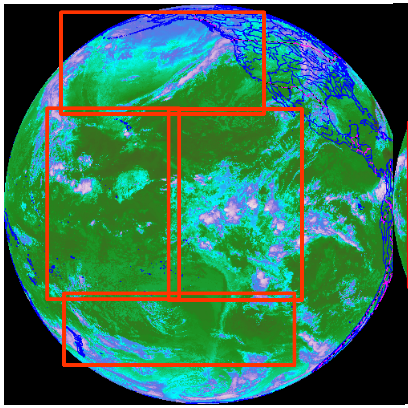
Moisselin, J.-M., Autonès, F., **2018**, *Scientific Report on verification of RDT forecast*, NWCSAF Scientific Report NWC/CDOP3/GEO/MFT/SCI/RP/01

RDT: validation

Any feedback is welcome !

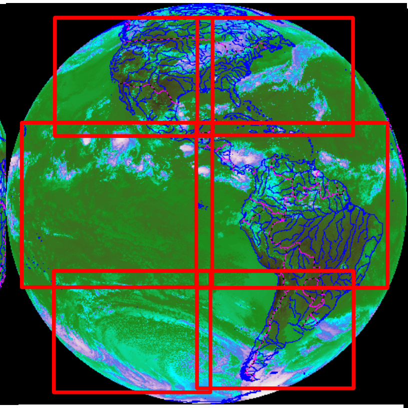
RDT – Global productions at Météo-France

GOES-17
135°W



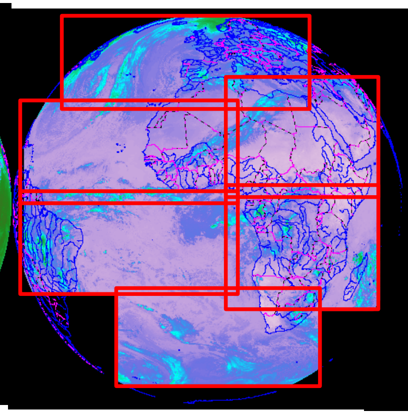
30min
10min

GOES-16
75°W



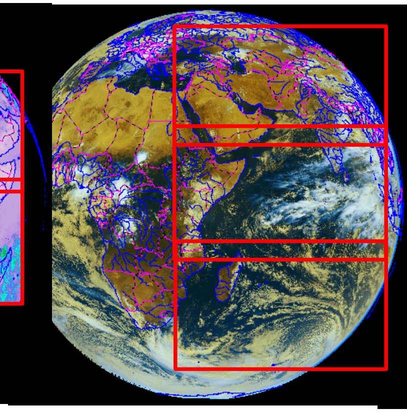
10min

MSG
0°



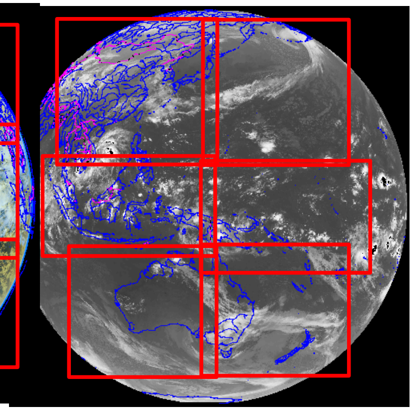
15min

MSG-IODC
41.5°E



15min

Himawari-8
140°E



20min
10min

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Outlook

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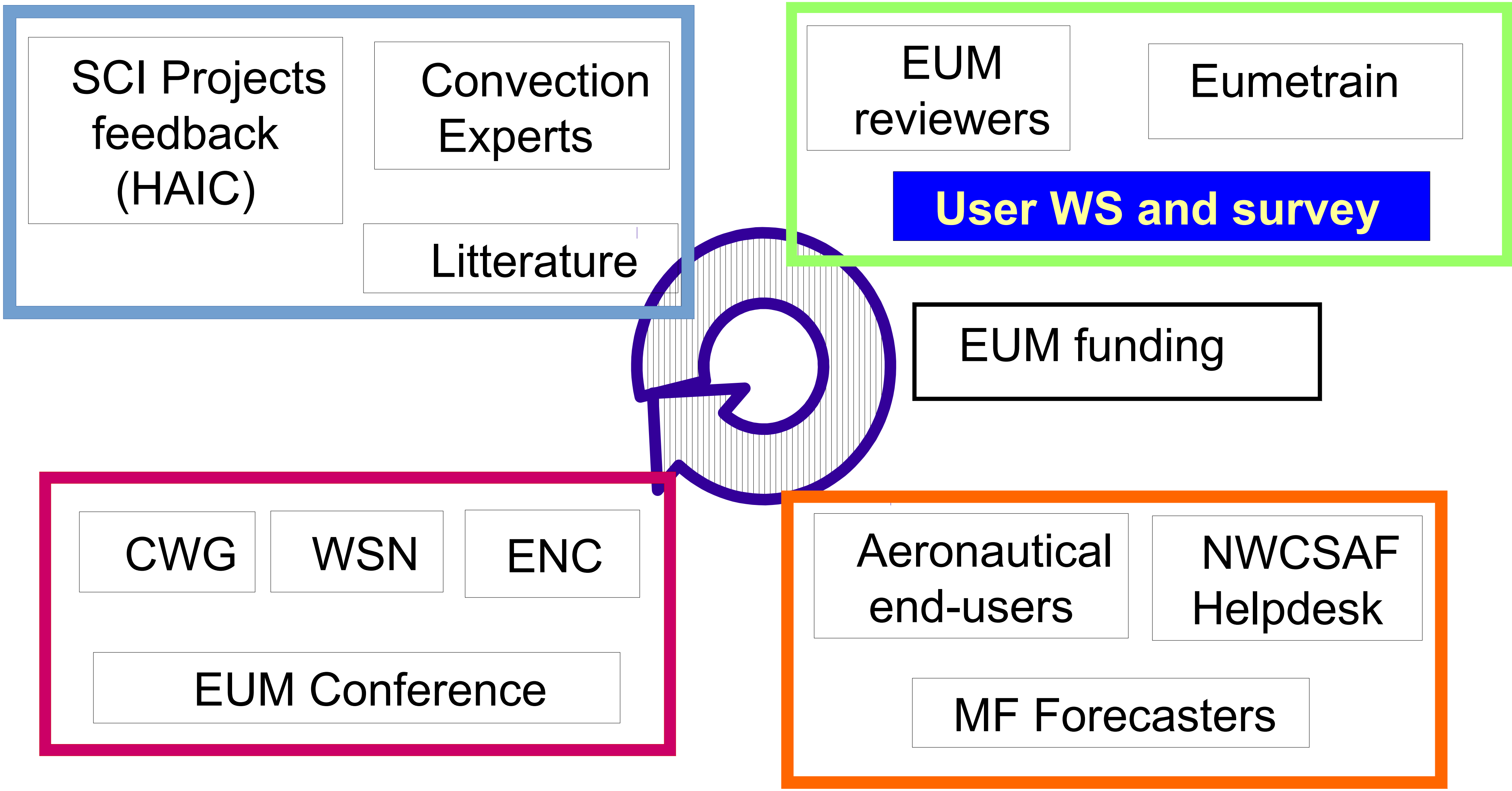
CONCLUSION

CI and RDT products

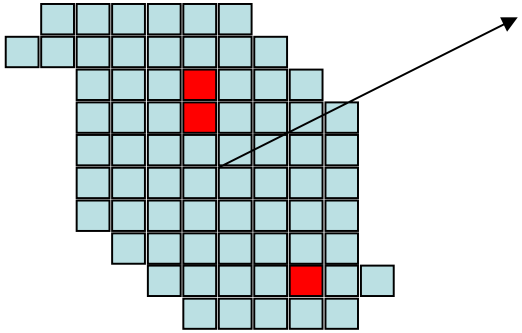
- Algorithm: RDT algorithm has been developed before CI algorithm
- Meteorology / conceptual model: CI occurs before.
- Two products different in terms of presentation
  - CI: image mode
  - RDT: object mode
- Strong links between these two products: input data, exclusion mask, cross-validation
- Strong 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

RDT and CI evolution Driving Forces



MTG and convection products

Characteristic **FCI**: better spatial or temporal resolution, lower bandwidth
Impact: better estimate of input data, better detection or short-lived or small-scale phenomena (overshooting tops)



Characteristic **FCI**: new channels
Impact access to new physical properties (e.g. 2.2 µm)

Upcoming **LI**
Tuning, validation, monitoring, real-time operation

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2020-2027 : End of CDOP3 and CDOP4

CI

- Objective: to move from pre-operational to operational status

- CDOP3 v2021 to prepare MTG

- CDOP4: Rooms of improvement for CI are numerous as CI is a relatively young product. That concern several parts of CI algorithm: 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).

- CDOP4: CI will take benefit of new generations of satellite and the scan frequency improvement will be a key point for CI. Cooperation with other institutes will be pursued. CI products may also be improved thanks to a wider use of NWP data.

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2020-2027 : End of CDOP3 and CDOP4

RDT-CW

- CDOP3 v2021 to prepare MTG
- One of CDOP4 objectives is to provide a calibrated scheme for each satellite, depending on its channels, spatial resolution and scan frequency.
- For MTG and other new-generation satellites RDT-CW will take full-benefit of high resolution e.g. to improve cloud top features (overshooting tops, cold rings and cold-U/V, upper-level divergence)

- Ambitions of previous development phases will be reinforced in CDOP4: to provide 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.

- Links between all convection products will be reinforced

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Thanks for your attention

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Toujours un temps d'avance