NWCSAF convection products: RDT (Rapidly Developing Thunderstorm) and CI (Convection Initiation)

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+ contribution from NWCSAF LE

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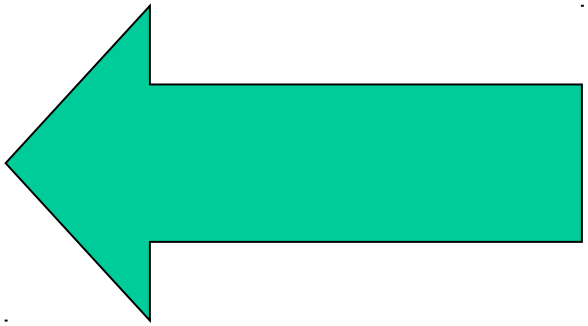
Eumetsat training Workshop 2019 Thessaloniki

Overview

1.Introduction



2. CI - Convection initiation

3. RDT

4. Future works

NWCSAF concept

- ✓ **To ensure the optimum use of meteorological satellite data in Nowcasting and Very Short Range Forecasting:**
- ✓ **The NWC SAF develops and maintains SW Packages (for GEO and POLAR Satellites) freely distributed to registered users to generate satellite products with a direct application in Nowcasting**
- ✓ **User support**
- ✓ **Training**

nwc-saf.eumetsat.int

NWC SAF Consortium

Leading Entity. Winds, Precipitation and stability GEO products

Cloud and Convection GEO products

Extrapolation and meteorological features detection GEO products

PPS SW package. Clouds and precipitation products for polar satellites

GEO/PPS product comparison. Prototyping future MTG lightning products

New NWC SAF Software Packages

Geostationary Satellites:

GEO v2018, available since February 2019

Applicable to MSG data, Himawari, GOES-N (limited to a few products)

Support to GOES-16 planned for end 2019

Continuous monitoring, space resolution and illumination conditions good for low and middle latitudes

Polar Satelites:

PPS v2018: available to users since January 2019

Process data from the joint polar system (EUMETSAT and NOAA polar satellites)

Relatively good coverage for high latitudes

NWC SAF services (nwc-saf.eumetsat.int)

- **Register** as a user (free and online)
- Access to the **NRT NWCSAF GEO and PPS product images:**

http://www.nwcsaf.org/web/guest/nwc/geo-geostationary-near-real-time-v2018

- Access to **GEO product images archive**
- Some general information and documentation
- After registration:
  - ✓ **Download** NWCSAF SW and other tools
  - ✓ User support via **ticketing** system
  - ✓ Broader information and documentation

Latest Training activities and Users' Guide, available online

EUMETrain events:

- **Event week on Aviation Meteorology 2018**
  http://www.eumetrain.org/events/aviation_week_2018.html
- **Event Week on convection 2019**
  http://www.eumetrain.org/events/convection_week_2019.html
- **NWCSAF training: online introduction lectures on scientific and technical aspects of the PPS v2018 software package**
  http://www.eumetrain.org/resources/nwcsaf_pps_v2018.html

Guide to Forecasters in NWCSAF website:
http://www.nwcsaf.org/web/guest/guide_to_forecasters

NWC SAF Users' Workshop 2020

Users will have the opportunity

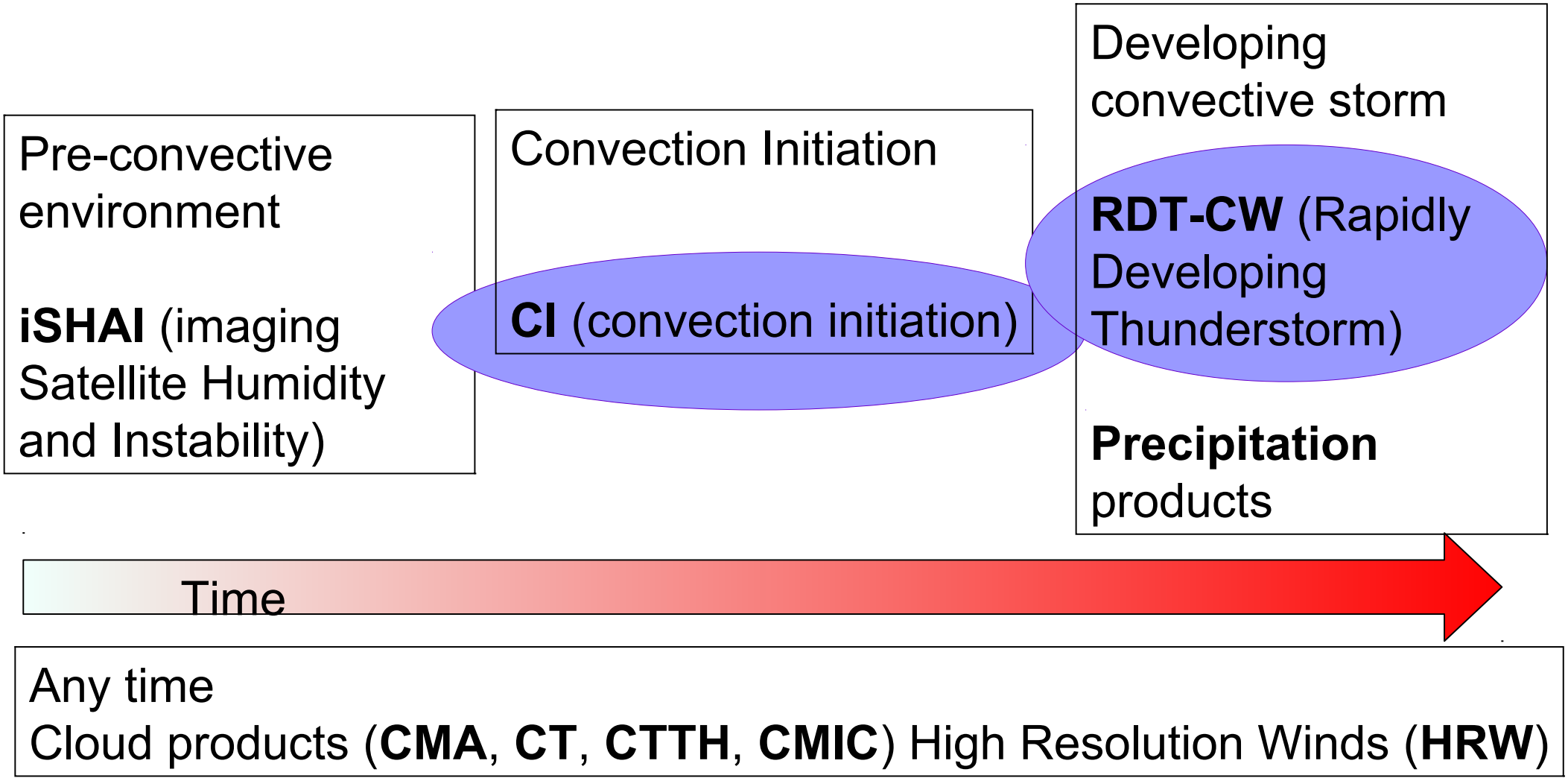
- **To present their work using NWC SAF products**
- **Tell the NWC SAF team about their needs in nowcasting with satellite data**
- **To know the plans of NWC SAF for the next years**

10-12 March 2020
AEMET HQ, Madrid, Spain.

Official announcement in September 2019 in nwc-saf.eumetsat.int

NWCSAF GEO Products: storms monitoring at different development stages - A portfolio for CONV

Courtesy NWCSAF LE



Overview

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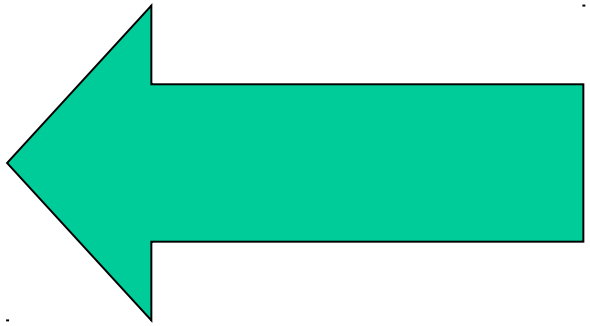
2.CI - Convection initiation



3. RDT

4. Future works

Convection Initiation (CI) - Definition

- CONVECTIVE INITIATION NOWCASTING: WHICH CLOUDS WILL BECOME THUNDERSTORMS IN THE NEAR FUTURE?

Convection Initiation: a (new) Nowcasting SAF product

Probability for a pixel to become a thunderstorm

First version : v2016.
Now : v2018 (**PRE-OPERATIONAL** status)

Based on :

- Satellite data (multiple channels)
- Numerical Weather Prediction data
- NWCSAF products: Cloud Products (CT, CTTH, CMIC), HRW

Output :

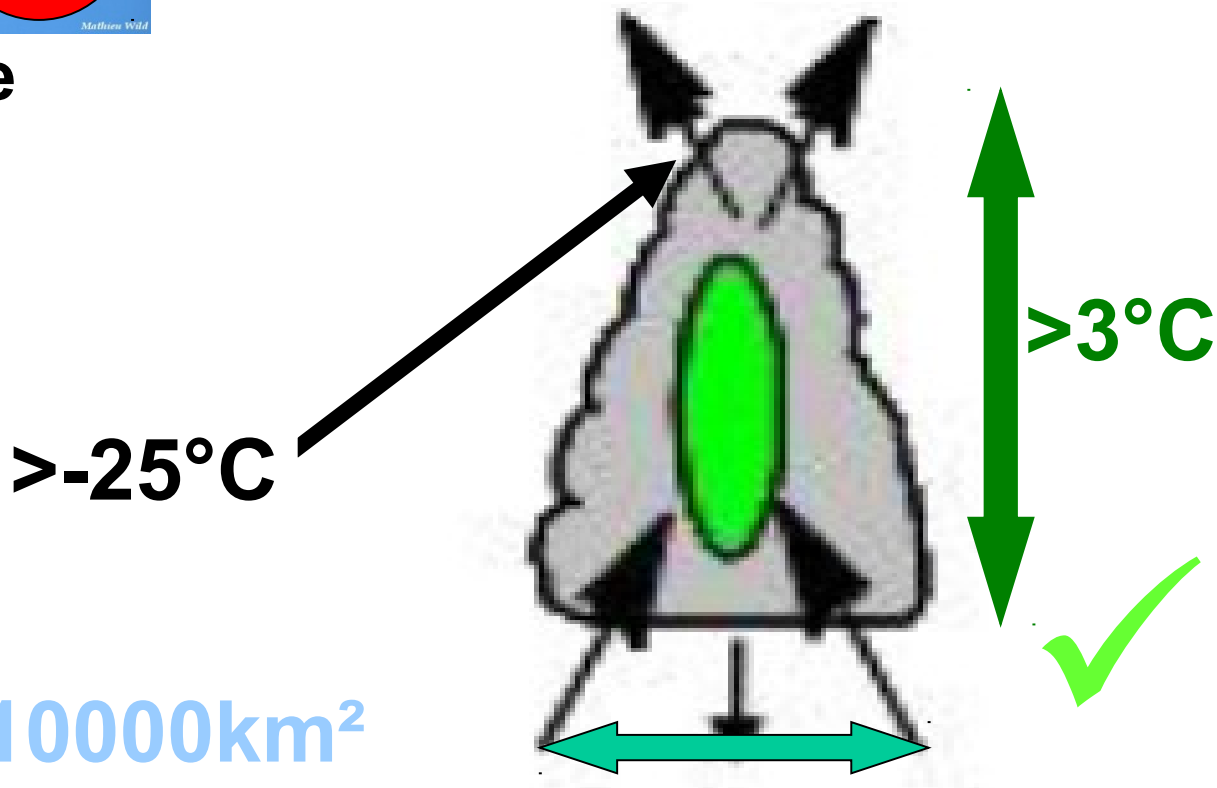
NetCDF Pixel-based product, with 4 classes of probability (very low, low, medium, high) and 3 forecast periods (**30**, 60 and 90 minutes)

CI: a product for warm clouds

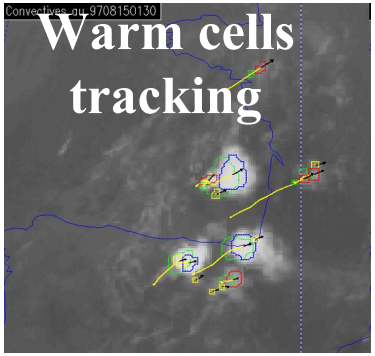
First step: “Warm” Cells Detection

Cloud-free pixels

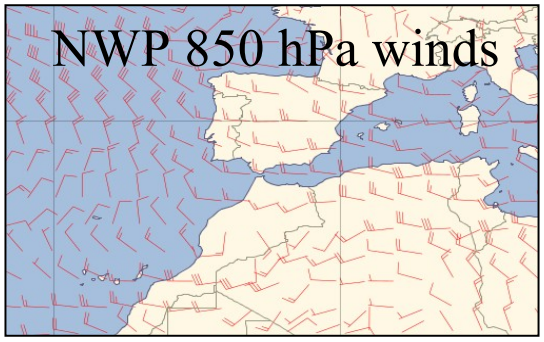
Too cold pixel

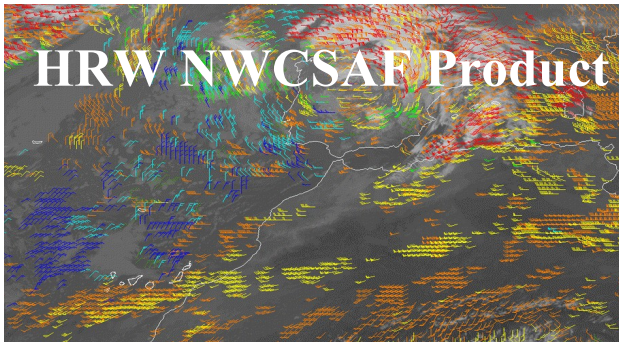


CI- Necessity to track the pixels



Priority





Second step: Displacement fields

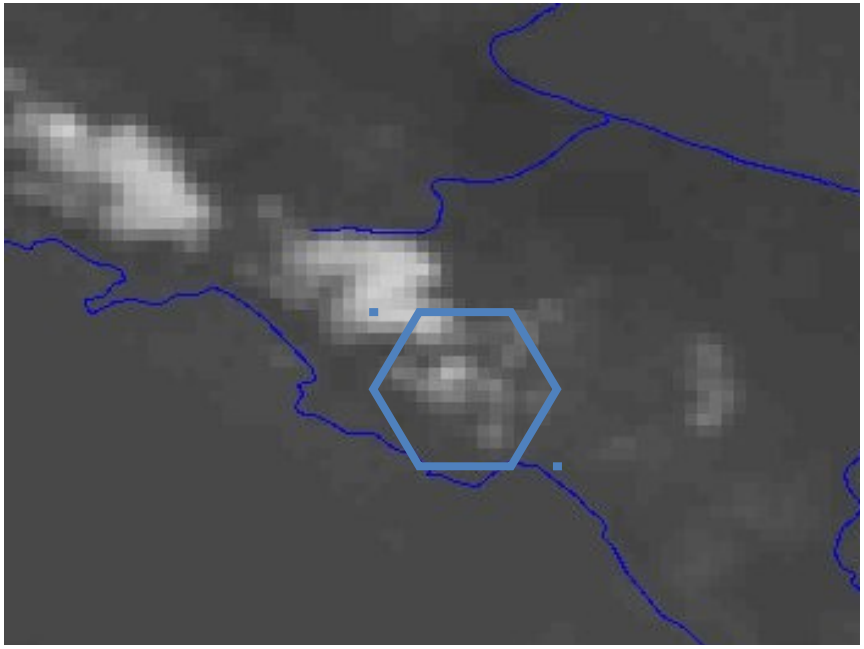
Objective: to determine previous pixels-position (and then to calculate dynamic trends)

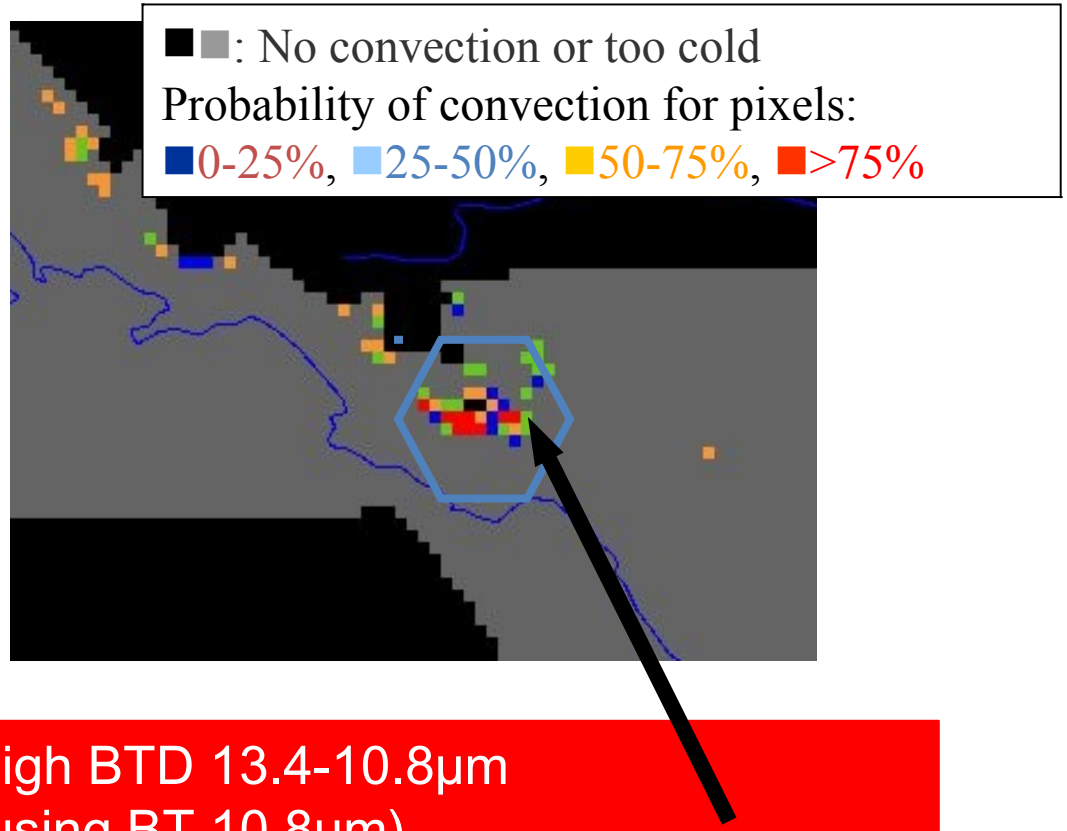
- ❑ Usual tracking (cell overlap criteria between two consecutive slots)
- ❑ NWP wind data and HRW are combined to determine a 2D displacement fields useful for:
  - ❑Orphan cells
  - ❑Cold start

The smaller the cell, the more difficult the tracking !

Area of interest, pixel of interest, probability assessment

A **succession of filters** helps to focus on area of interest. Warm-cell-displacement estimate helps to calculate the **trends**. If not, we use a HRW/NWP estimate

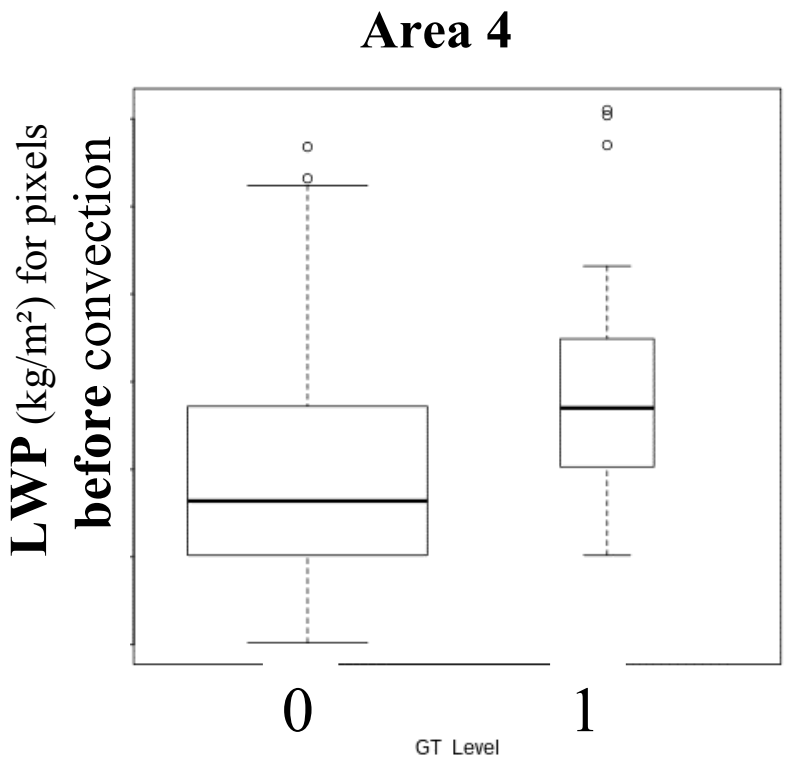




- **Vertical extension criteria**: BTD 6.2-10.8µm, high BTD 13.4-10.8µm
- **Glaciation**: cold BT10.8µm, time below 0°C (using BT 10.8µm)
- **Updrafts**: strong negative trends of BT10.8µm, strong trend of BTD6.2-10.8µm

Inspirated by SATCAST methodology, described in « Best Practice Document, 2013, for EUMETSAT Convection Working Group, Eds J.Mecikalski, K. Bedka and M. König »

CI discrimination process : tuning of thresholds for parameters of interest - Radar data as Ground Truth



CI verification - no (0) or yes (1)

Boxplots for various regions and test cases helped to define the relevant thresholds

Karagiannidis, A., **2016**, *Final Report on Visiting Scientist Activity for the validation and improvement of the Convection Initiation (CI) product of NWC SAF v2016 and v2018*, Visiting Scientist Activity followed in Nowcasting Department of Météo France, Toulouse, France Period June-December 2016

CI diagnosis
From parameters categories to decision tree

SATCAST Methodology

Height parameters	Growth parameters	Glaciation parameters
✗ (6.2 µm – 10.8 µm) BTD ✗ (6.2 µm – 7.3 µm) BTD ✗ (12 µm – 10.8 µm) BTD ✗ (13.4 µm – 10.8 µm) BTD	✗ BTRate(15') for 10.8 µm channel ✗ BTRate(30') for 10.8 µm channel ✗ BTDRate(15') for (6.2µm – 10.8 µm) BTD ✗ BTDRate(15') for (6.2µm – 10.8 µm) BTD	✗ 10.8 µm BT ✗ Time since freezing point (10.8 µm BT) ✗ (10.8 µm – 8.7 µm) BTD

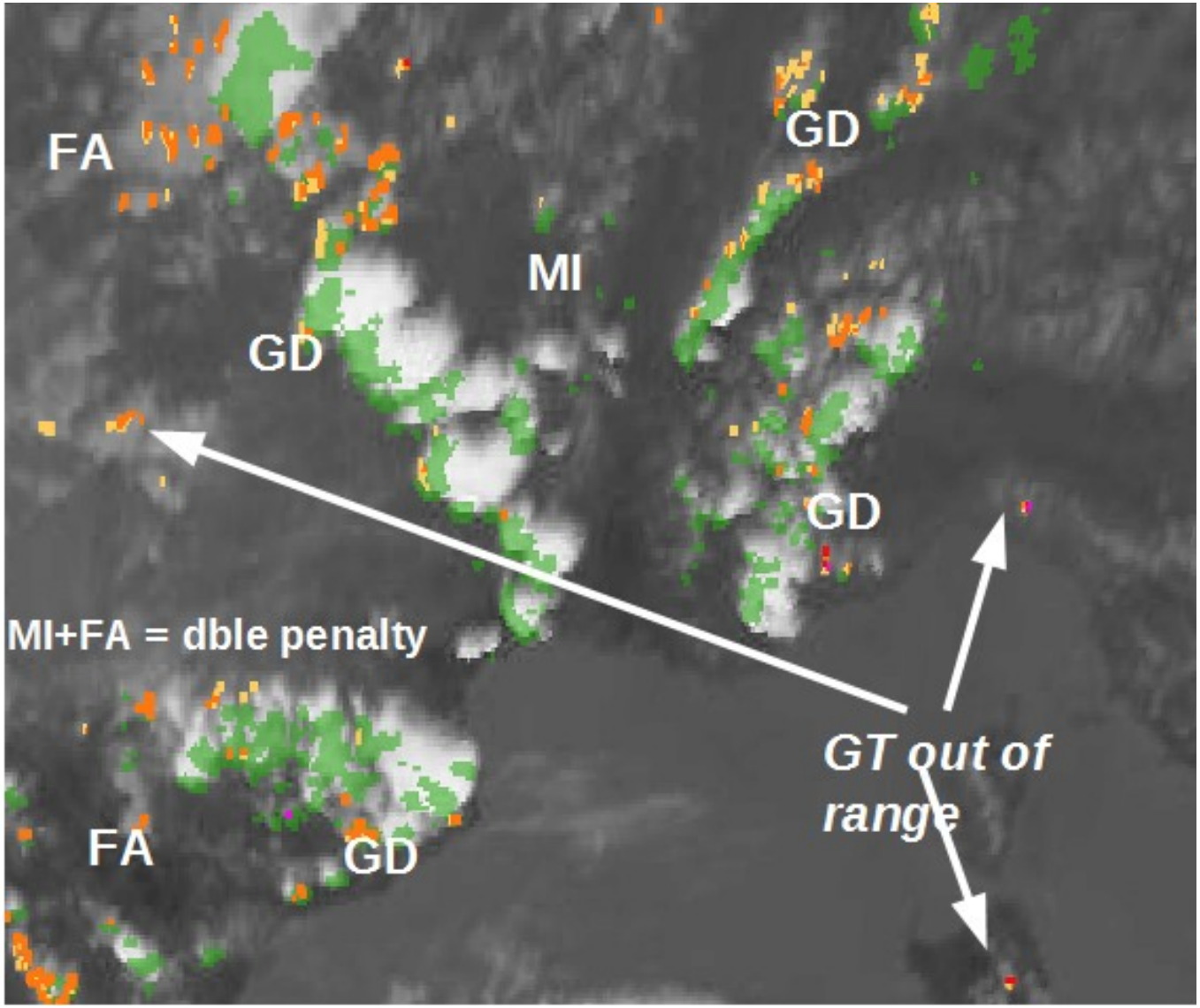
Nb of Height relevant parameters (over 4)	*Number of Growth relevant parameters (over 4)*	*Nb of Glaciation relevant parameters (over 3)*	*CI diagnosis*
≥ 4	≥ 3	≥ 3	HIGHPROB (4)
≥ 3	≥ 3	≥ 3	MODPROB (3)
≥ 4	≥ 3	≥ 2	LOWPROB (2)
≥ 4	≥ 2	≥ 3	MODPROB (3)
≥ 3	≥ 2	≥ 3	LOWPROB (2)
≥ 4	≥ 2	≥ 2	VLOWPROB (1)
≥ 4	>=1	≥ 3	VLOWPROB (1)
Other cases			0

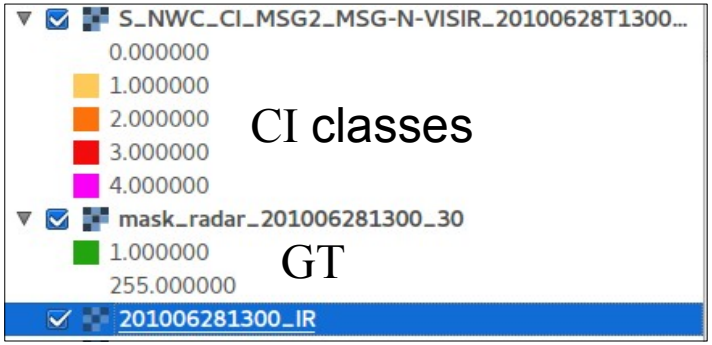
BT = Brightness Temperature

BTD = Brightness Temperature Difference

BTRate(15') = (BT(t) – BT(t-15min))/15

v2018 CI - Validation on MSG case studies
Radar Ground Truth





Generally relevant, even if all cases encountered :
Good Detection (GD)
False Alarms (FA)
Misses (MI)
Double penalties

The relevancy is clearly to analyse regarding the situation *(isolated, embedded, edge of cloud systems, etc.)*

MSG-IR10.8 + CI probability [0'-30'] product 13h00Z
+ Ground Truth = radar > 30dBZ [13Z-13h30Z]

v2018 CI - Validation on case studies - Summary

FAR problem seems the main one

- Sometimes explained by spatial double penalty as CI not so far away from new convective clouds
- Sometimes explained by delayed convection (CI [0-30'] should have been CI [0-60'])

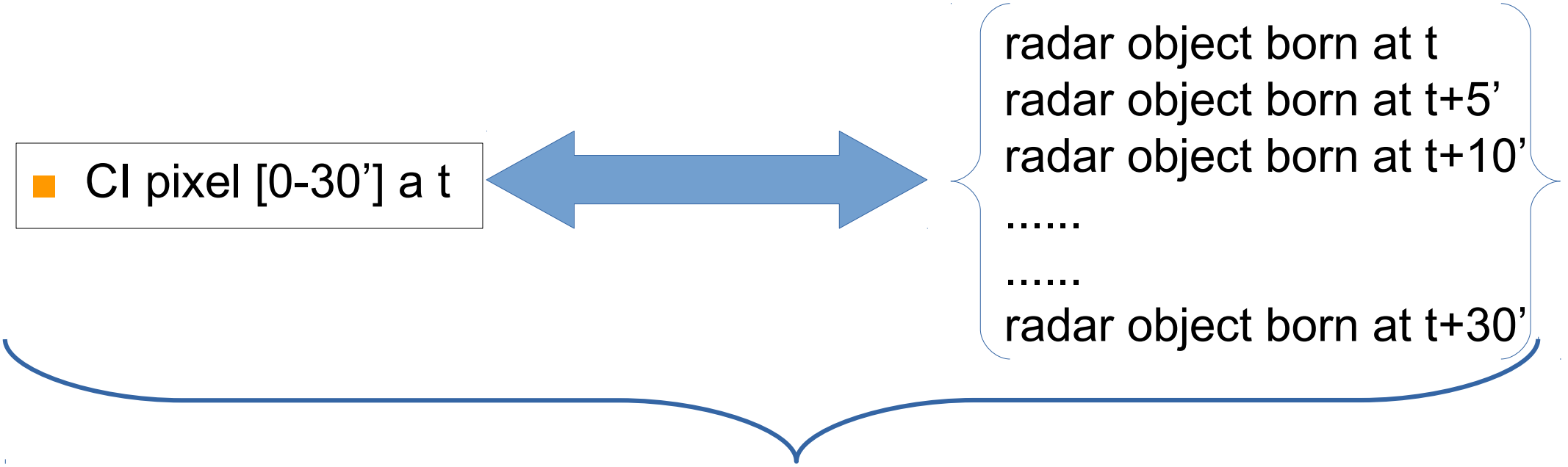
Less relevant in cold-air mass. Explanations :

- Threshold to be tuned
- Fractioned cloud type excluded of CI calculation
- Movement field more difficult to assess in that case

Useful signal for forecasters or other experienced users. As additional information (rather than replacing other ones)

CI verification with radar objects

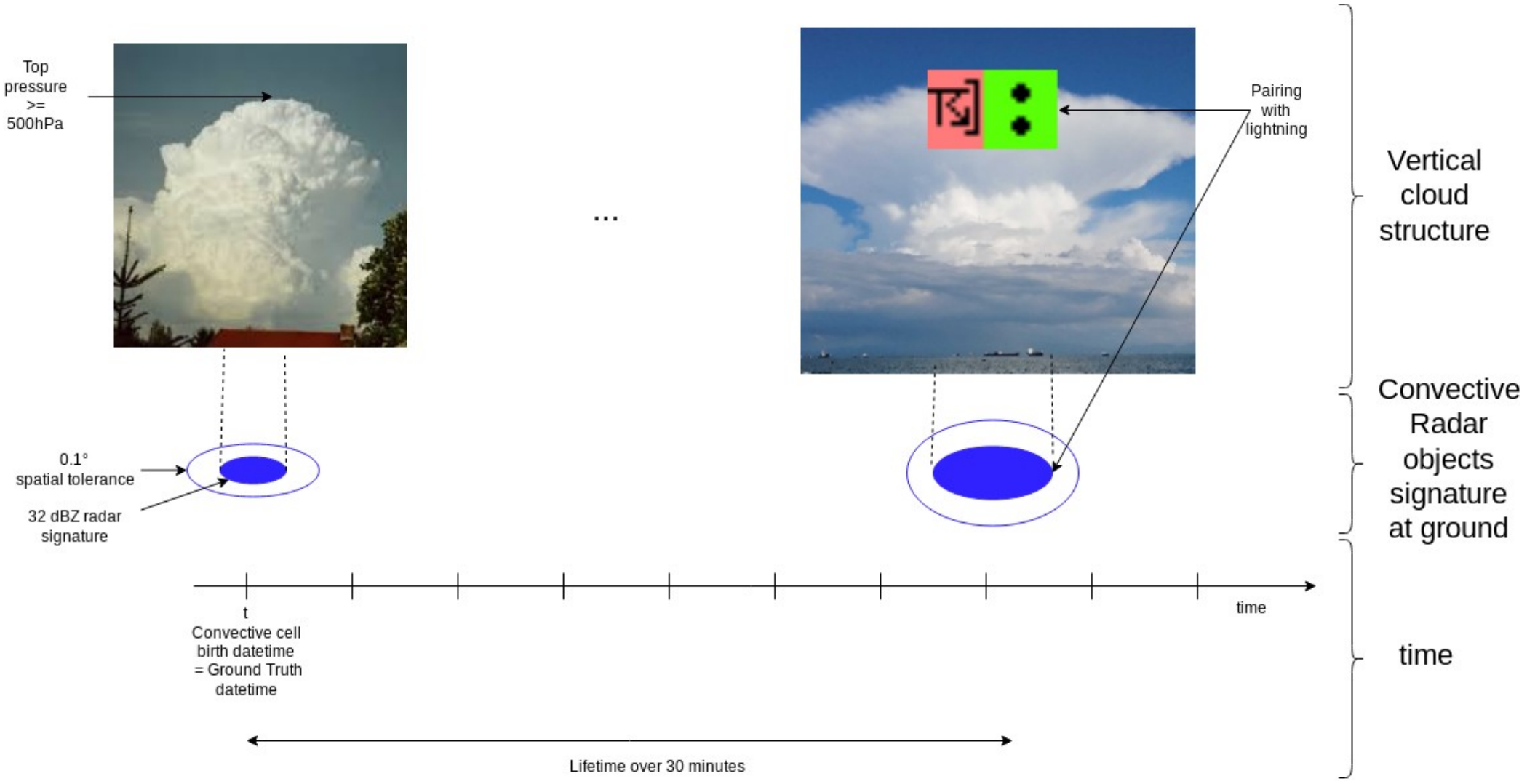
To verify CI, we use **radar** data. If we just apply a 30-35 dBZ threshold, we can not distinguish pre-existing convective cells from other ones'
To mitigate this problem, we use radar object. Radar object have an attribute that defines **date of birth** of the cell



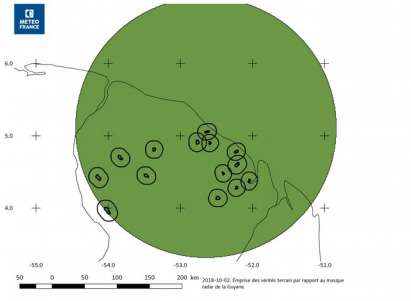
GD if at least one overlap, FA if no overlap at all

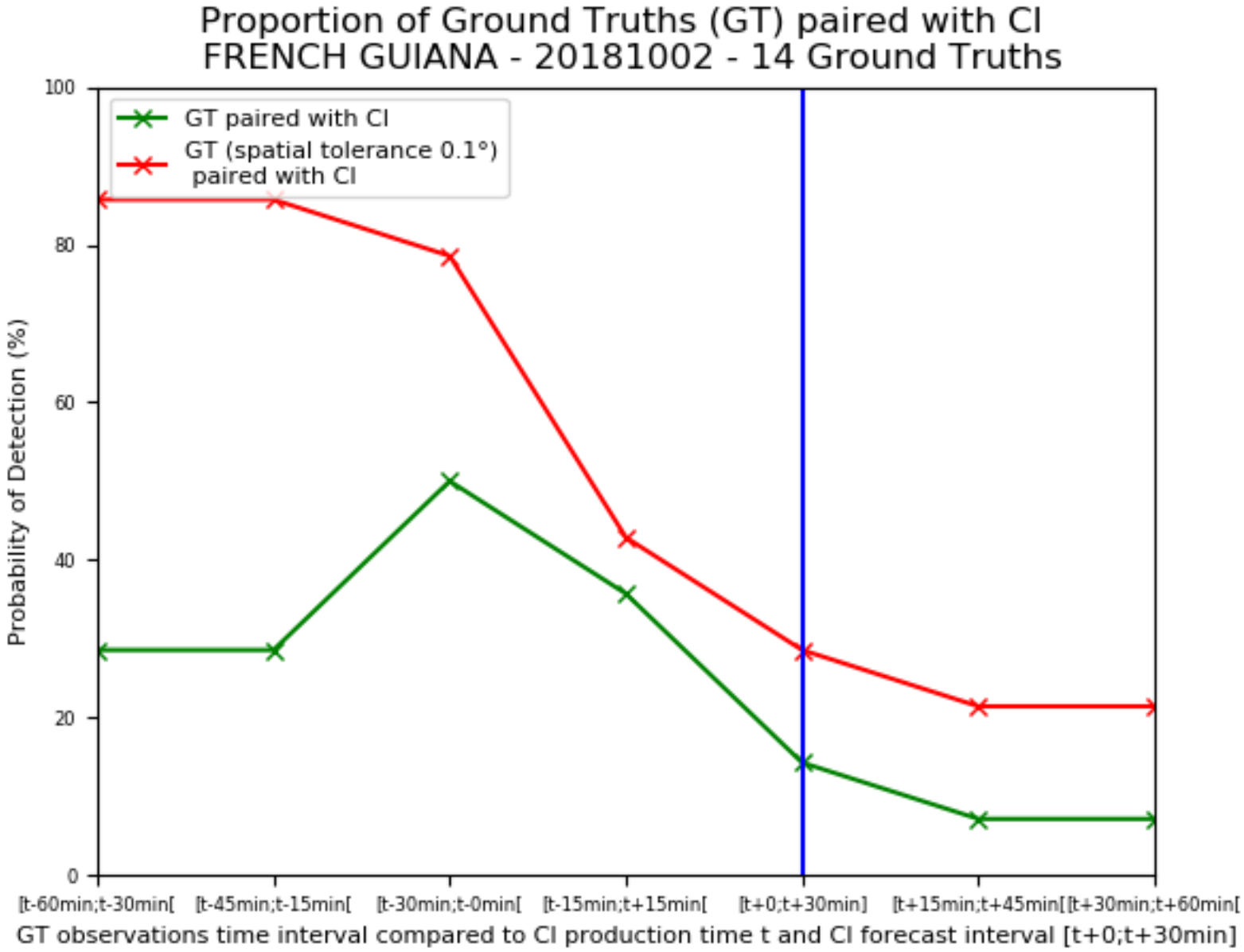
Note : radar objects have also to be paired with lightning data and the birth has to be in warm environment and the lifetime at least 30'

CI verification with radar objects

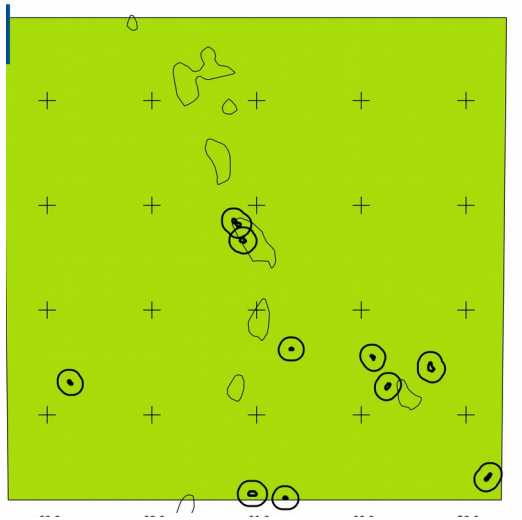


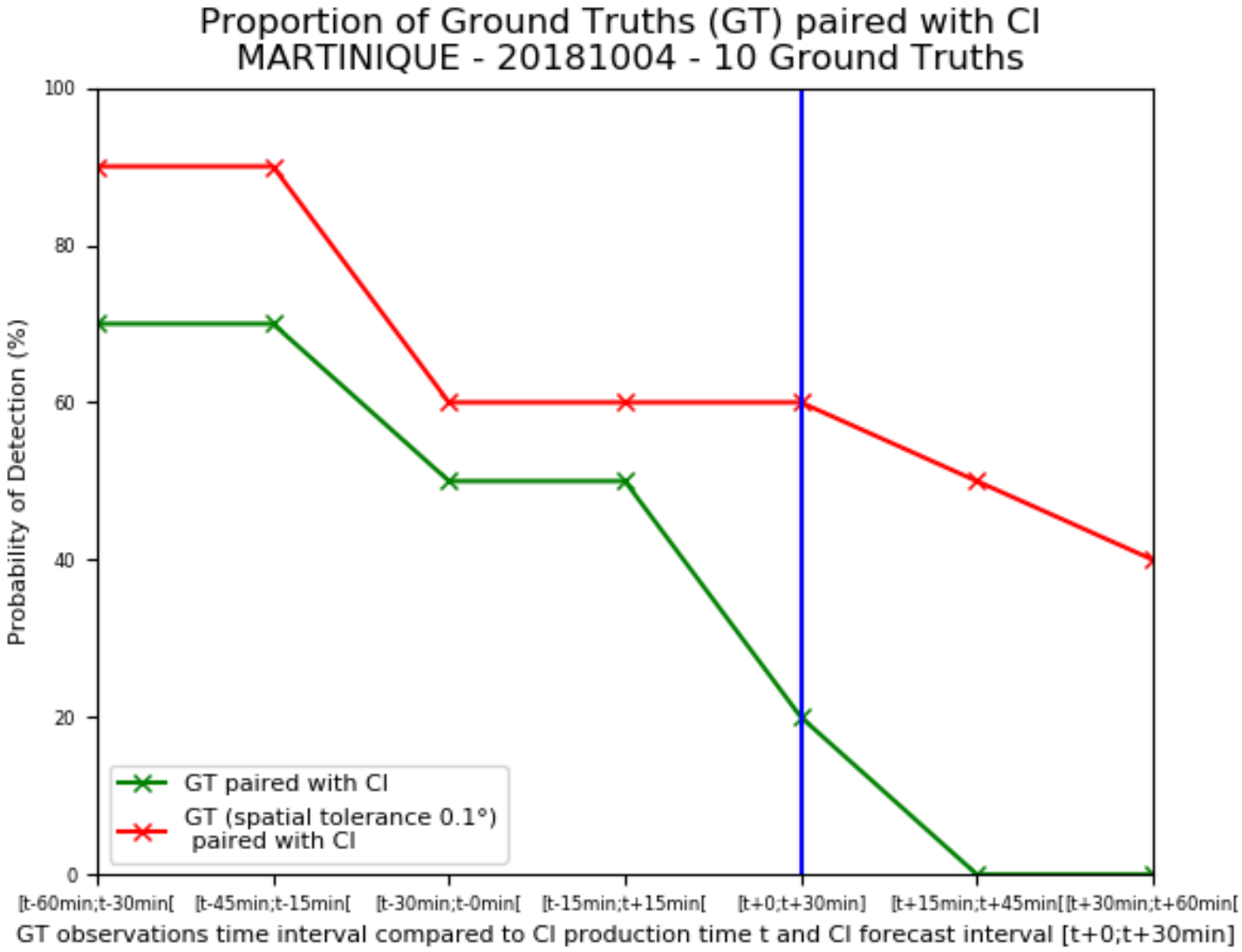
CI v2018 – verification over Guyane





CI v2018 – verification over Martinique/Guadeloupe



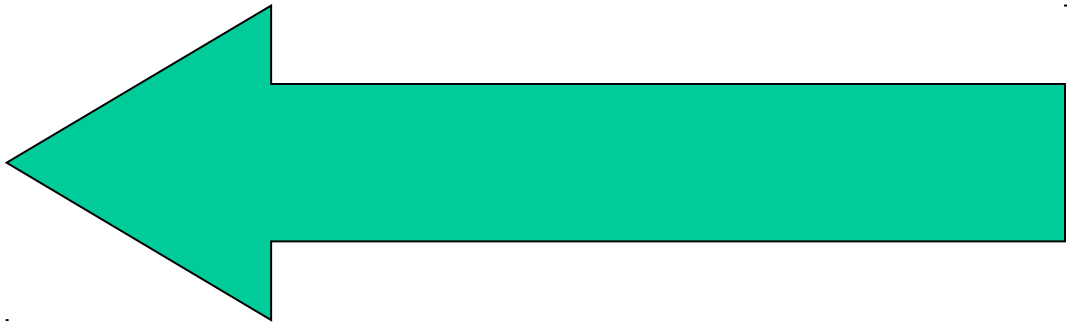


Overview

1. Introduction

2. CI - Convection initiation

3.RDT



4. Future works

RDT product

- Object-oriented analysis of satellite images
  - **Detection**, **tracking** and **forecast** of cloud systems as **objects**:
    - Localization (G.C., contours ...)
    - Attributes (*trend, morphology, motion vector, etc.*)
  - **Identification** of convective ones (*additional characteristics*)
  - From meso-alpha scale (200-2000 km) down to smaller scales (few pixels)

Evolution of RDT product

- Since IOP (2002-2007)
- Pursued in CDOP, CDOP2, *proposal for CDOP3*

- Evolutions
  - v2011: use of NWP data
  - v2012: main cloud phase of the cell, highest convective rain rate inside the cell, second vertical level description
  - v2013: overshooting tops
  - *v2016: advection scheme + change in NWCSAF Library + new output format + CTRAJ*
  - *v2018: new tuning, lightning jump*

Overview

1. Introduction

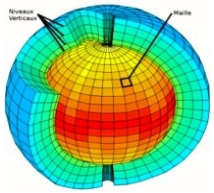
2. CI - Convection initiation

3. **RDT**
   - **i Algorithm and input data** 
   - ii Attributes
   - iii Validation
   - iv RDT and aviation

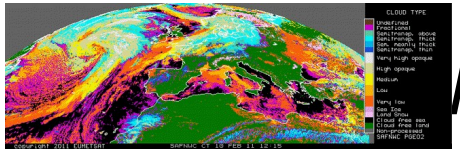
4. Future works

RDT: data fusion for description of convection

INPUT DATA: MULTISOURCE



NWP data



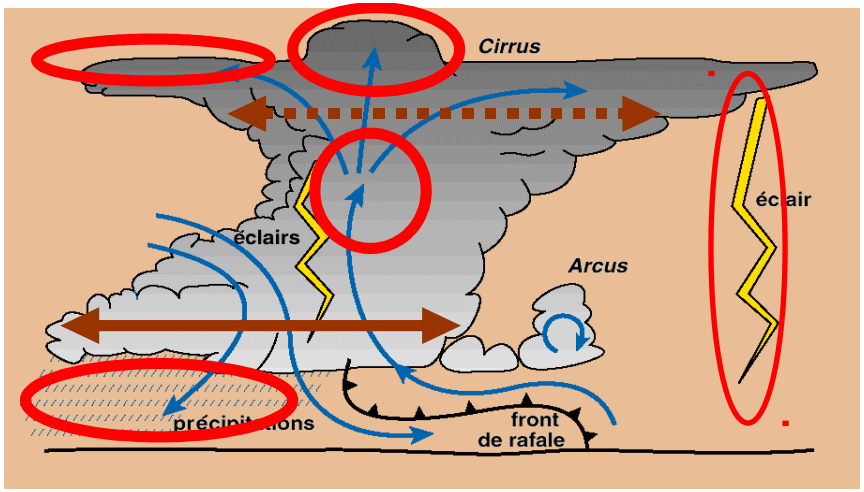
Other NWCSAF products

RDT

GEO data (5 IR channels + VIS)

Lightning Data

OUTPUT: MULTILEVEL DESCRIPTION OF CONVECTION

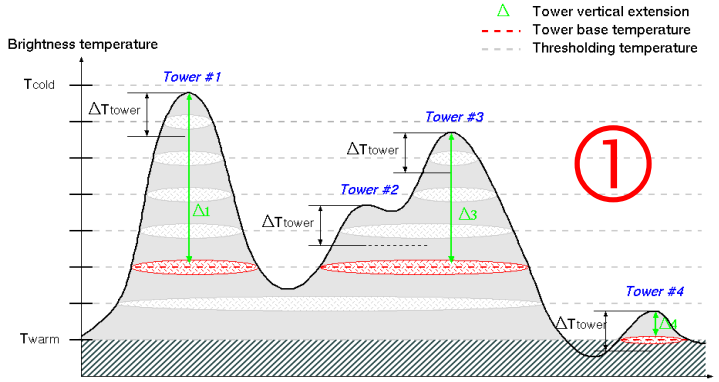


- *Main description of cell: <u>Yes/No convection diagnosis</u>, cell-development phase, position, surface, T, gap to tropopause, cloud type and phase, cloud top pressure. Displacement Relevant trends are calculated*
- *Overshooting Tops, Lightning Activity, Convective Index, Rainfall Activity*

4-steps algorithm of RDT

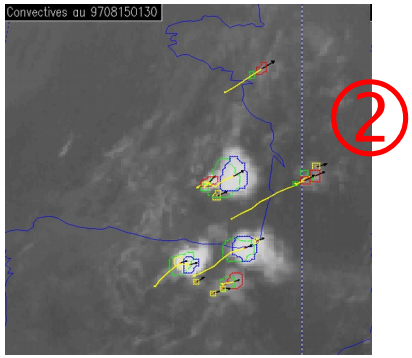
STEP1: 10.8 µm detection

- *In order to detect cells*
- *Vertical extension: at least 6°C*



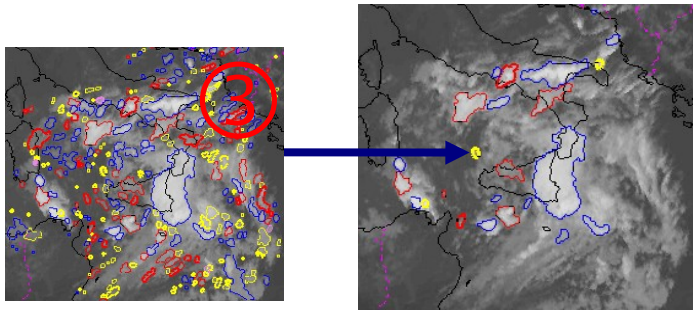
STEP2: Tracking

- *In order to recognize each cell in the previous slot)*
- *Trends calculation is then allowed*



STEP3: Discrimination

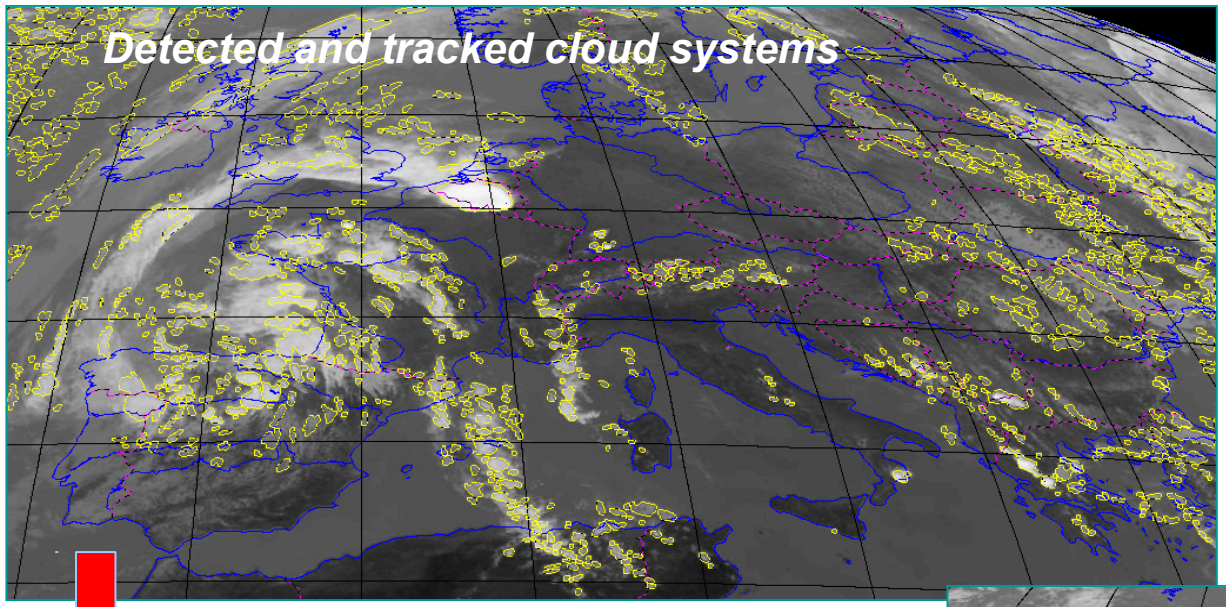
- *In order to identify convective cells*
- *Statistical process*



STEP4: Forecast *(v2016)*

- *No creation, no dissipation of cells*
- *Improvement of tracking (NWP, HRW)*

Step 3 - Convective Discrimination of cloud systems

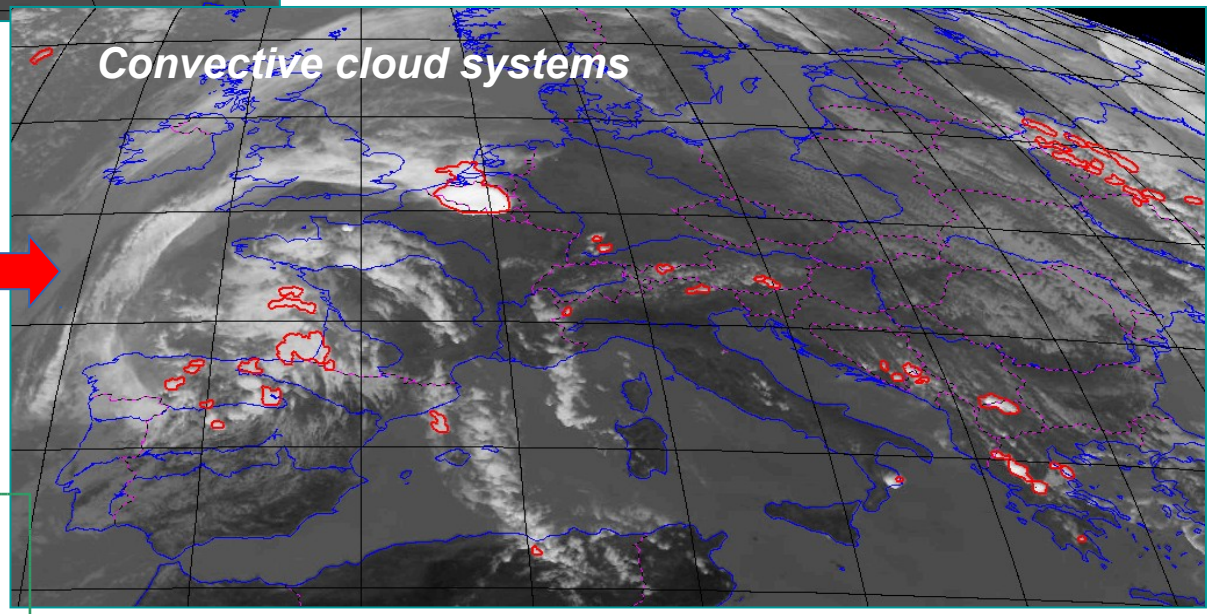


Difficulties:

- ❑ Unbalanced populations,
- ❑ Various sizes (isolated, embedded, MCS),
- ❑ Various stages (early warm to mature)

Method: statistical models

- Numerous predictors from 5 IR channels (extrema, trends, gradients, morphology, etc.)
- Additional input from NWP data



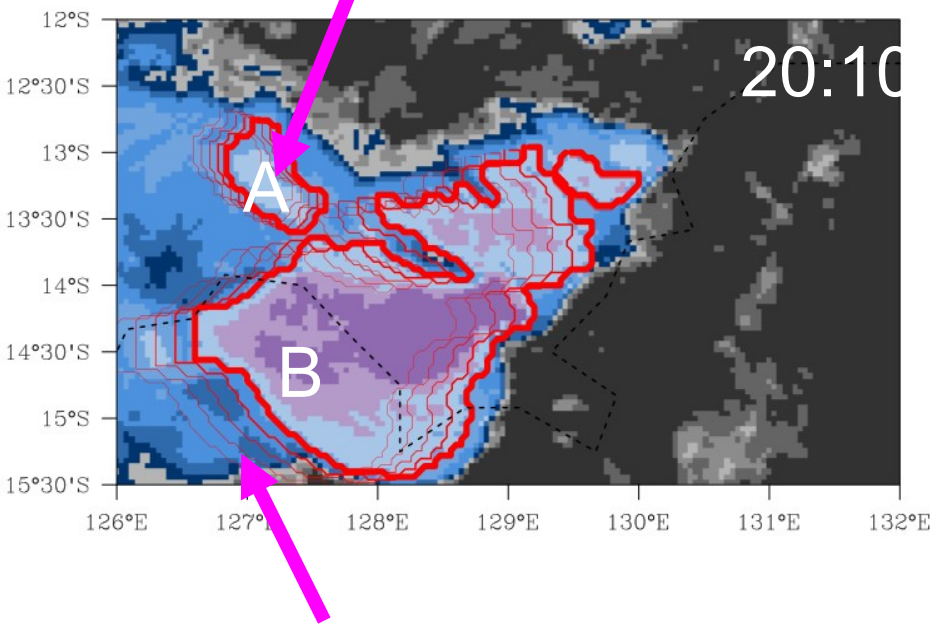
« No » Convection diagnosis may be changed with extra data

- *Lightning. If **real-time** network available with correct **strokes-localisation***
- *Convective Rain Rate > threshold*

RDT: +1h forecast (v2016)

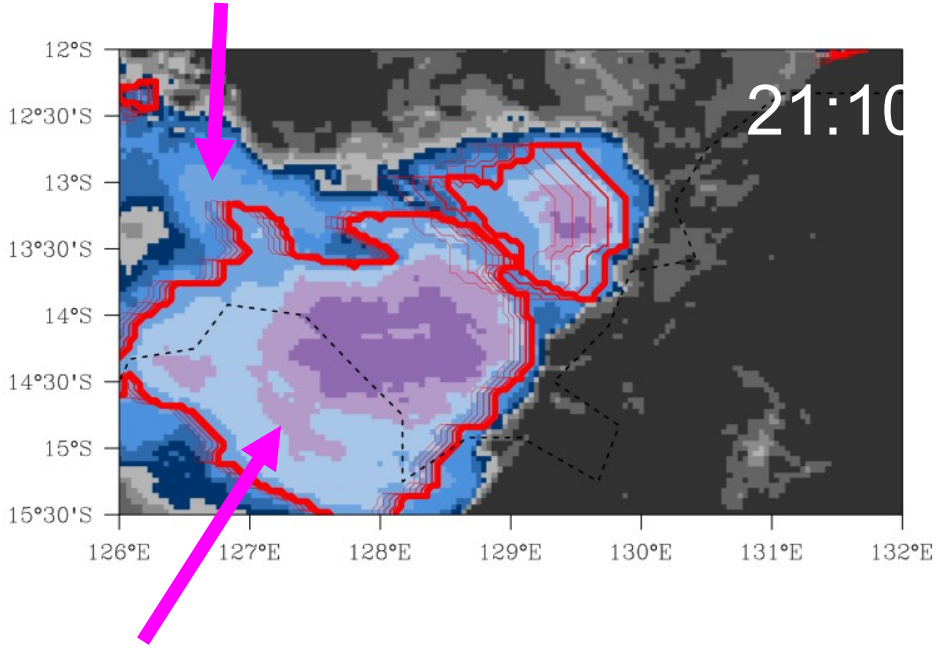
Advection scheme: RDT motion vector + HRW

WNW displacement of “A”



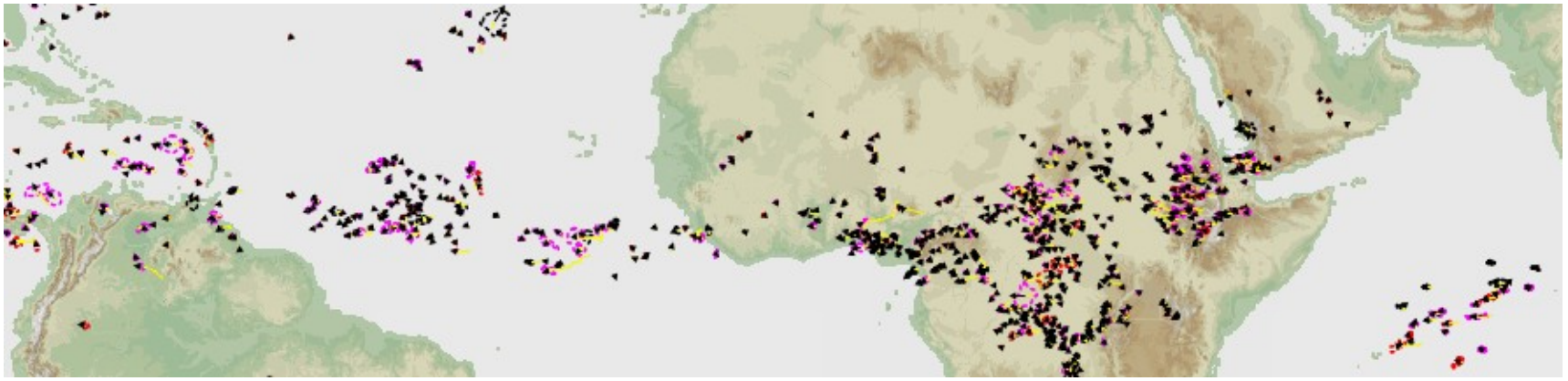
WSW displacement of cell “B”

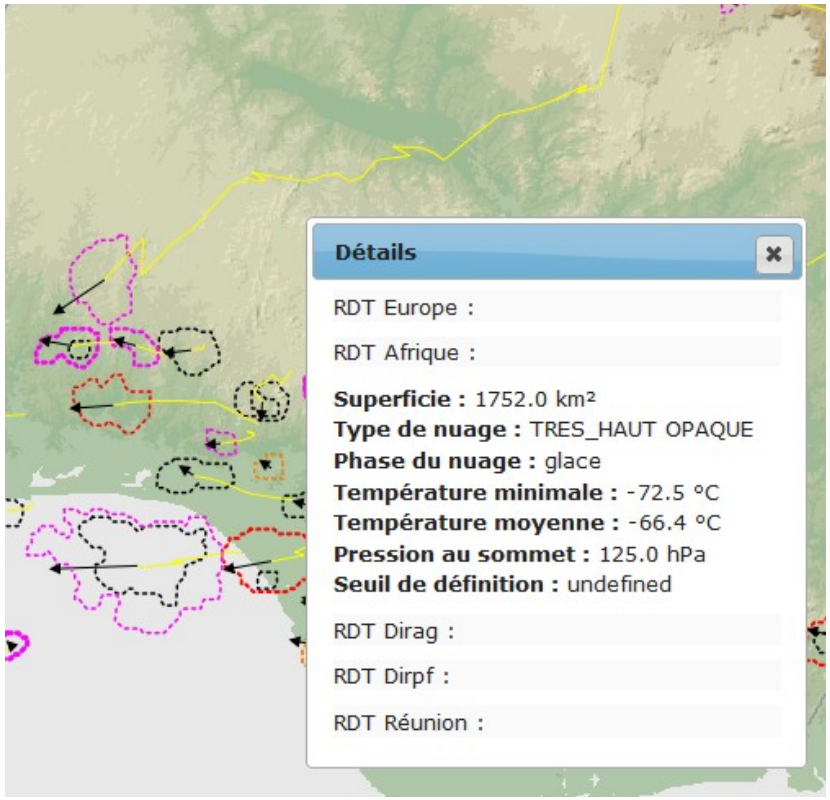
“A” cell has disappeared. Bad forecast (False Alarm of forecast scheme)



“B” at the expected location

RDT example of visualization





Base de la tour *(T° variable selon morphologie)*

Phase de développement	*Couleur*
Naissance ou développement	
Croissance	
Issu d'une Fission	
Maturité	
Décroissance	

Activité électrique	*Style de trait*
Impacts ou intra-nuage appariés à la cellule	
Sans activité électrique connue	

Refroidissement	*Épaisseur de trait*
Fort refroidissement < -30°/h	
Refroidissement modéré < -20°/h	
Refroidissement limité < -10°/h	
Refroidissement faible ou pas de refroidissement > -10°/h	

Sommet de la Tour *(Tmin+6°)*
couleur, épaisseur, style uniques

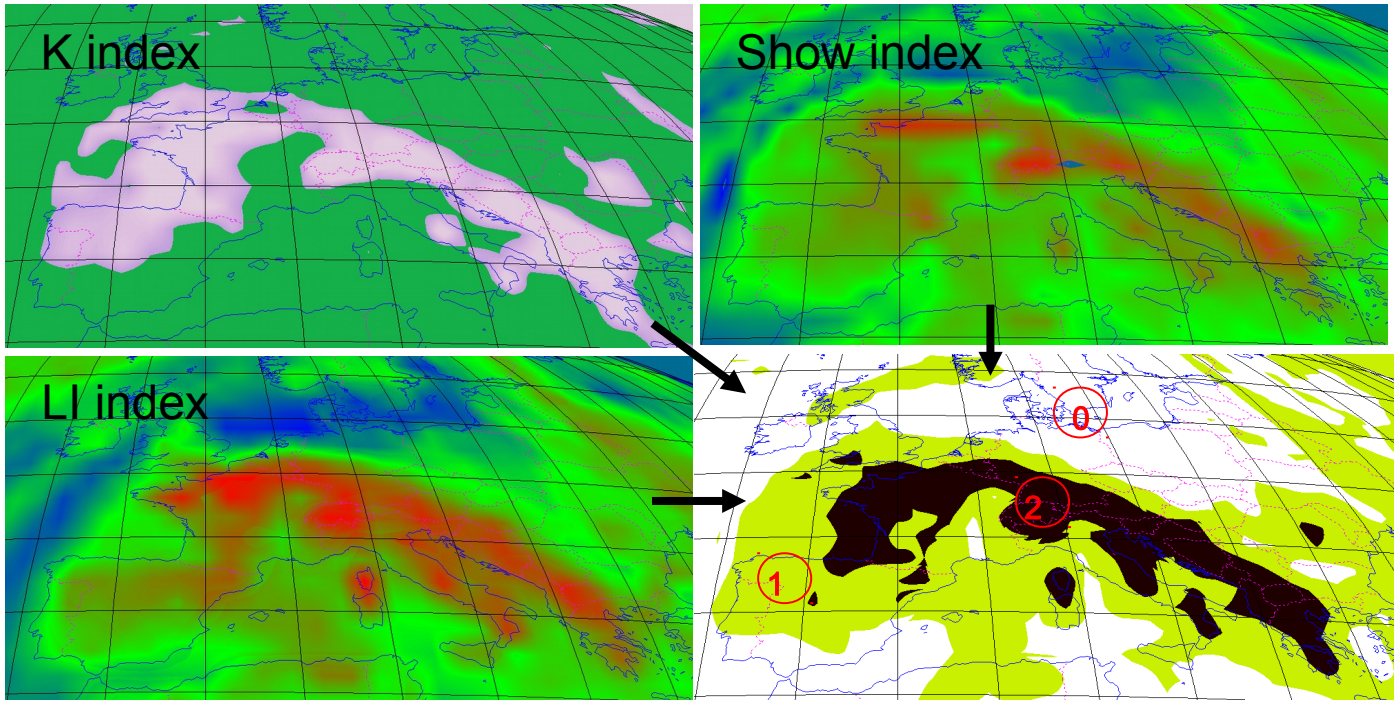
Trajectoire des centres de gravité des cellules
couleur, épaisseur, style uniques

Déplacement
flèche noire
longueur modulée selon vitesse

Use of NWP data (1/2)

NWP data for « possible convection » detection mask

Union of 3 indexes to exclude stable areas from RDT process

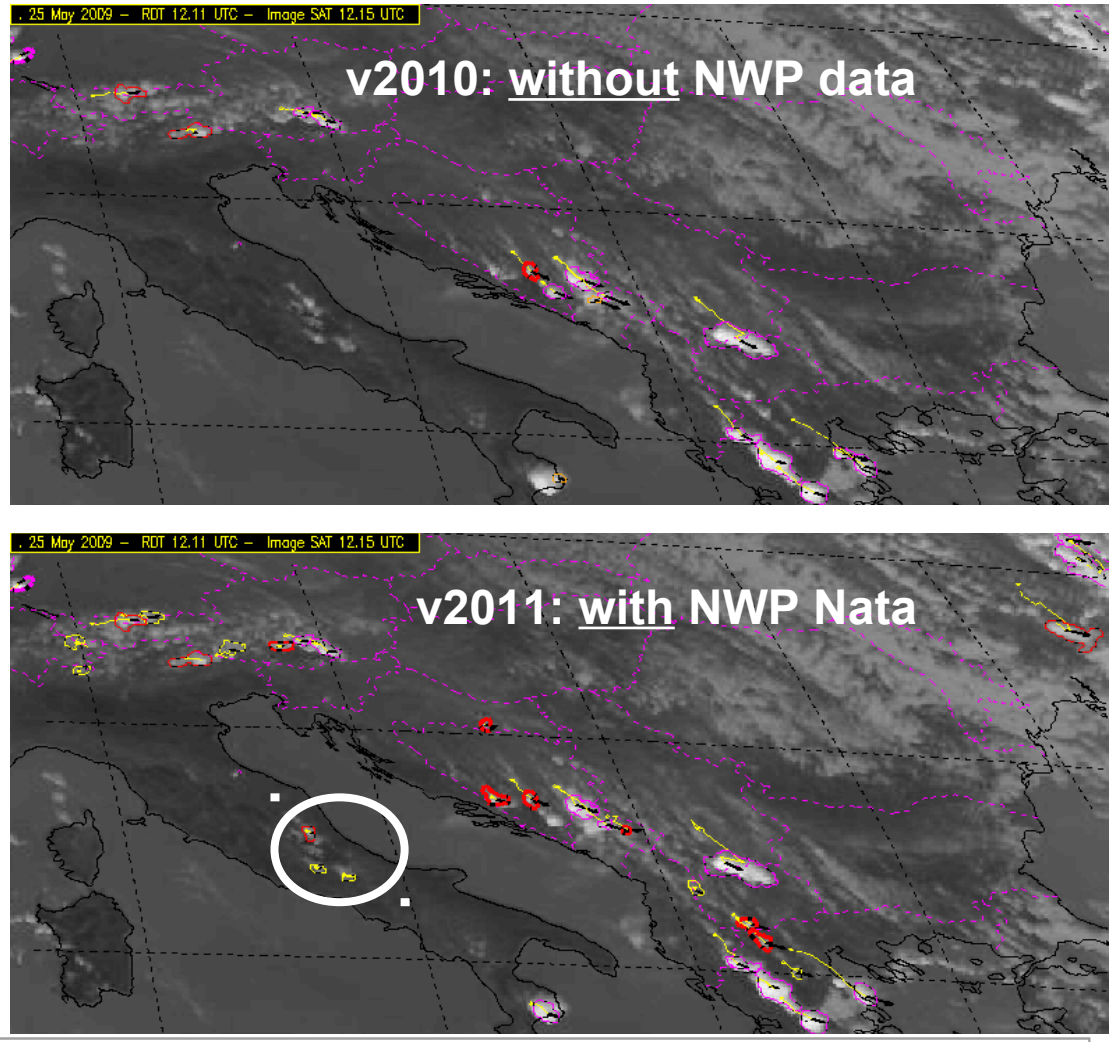


Allow to focus RDT on areas of interest, strong reduction of false alarms during intermediate and winter seasons

Use of NWP data (2/2)

NWP data allow better tuning

- *tune on areas of interest*
- *strongly reduce the unbalance between convective and non convective systems*
- *provide an additional predictor (Lifted Index)*
- *strongly improve statistical models in low levels*
- *improve early diagnosis for the convective cells*



*25 May 2009, 12h15 UTC. v2011 benefits from a better tuning in warmer categories, with higher precocity (cells over Italy diagnosed **30 min** previously to v2010)*

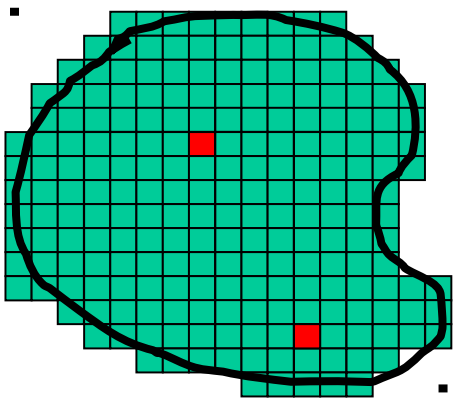
RECOMMENDATION: USE NWP DATA!

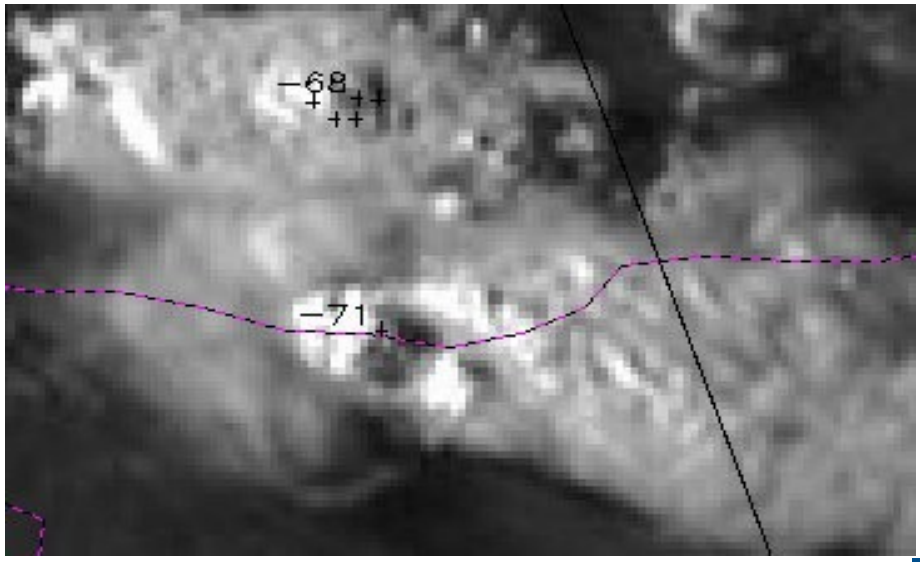
Overshooting Tops Detection

OT: the challenge of automatic detection

OTD Inside each RDT cell

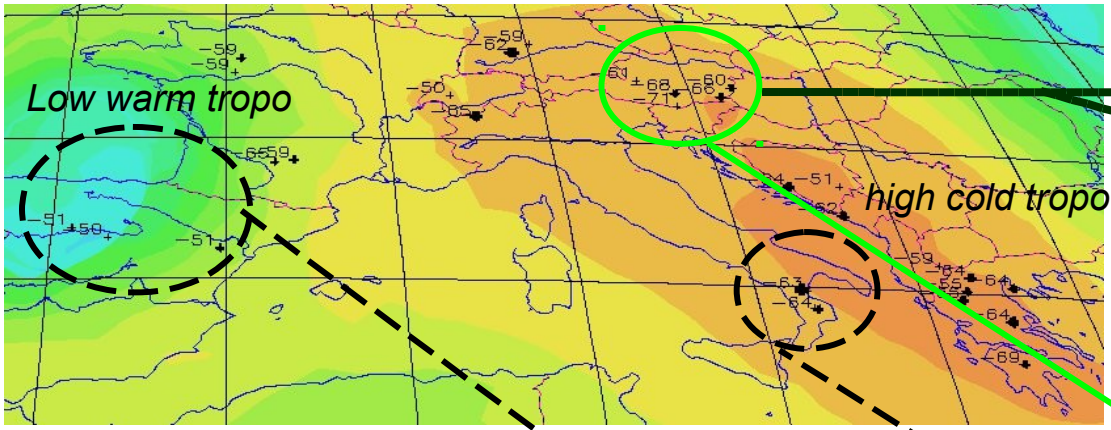
- ❑ Criteria: temperature of coldest pixel, BTD WV6.2-IR10.8, WBTD WV6.2-WV7.3, reflectance VIS0.6, gap to NWP tropopause.
- ❑ Morphologic criteria to confirm a spot of cold temperatures and to determine the pixels that belong to an OT
- ❑ HRV for tuning/validation

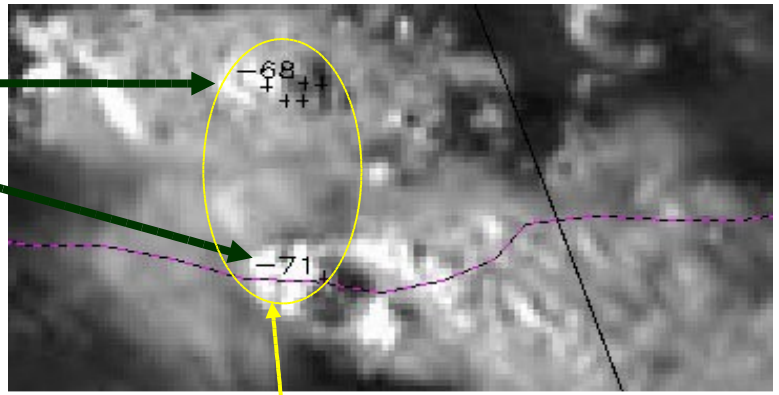




Overshooting Tops Detection

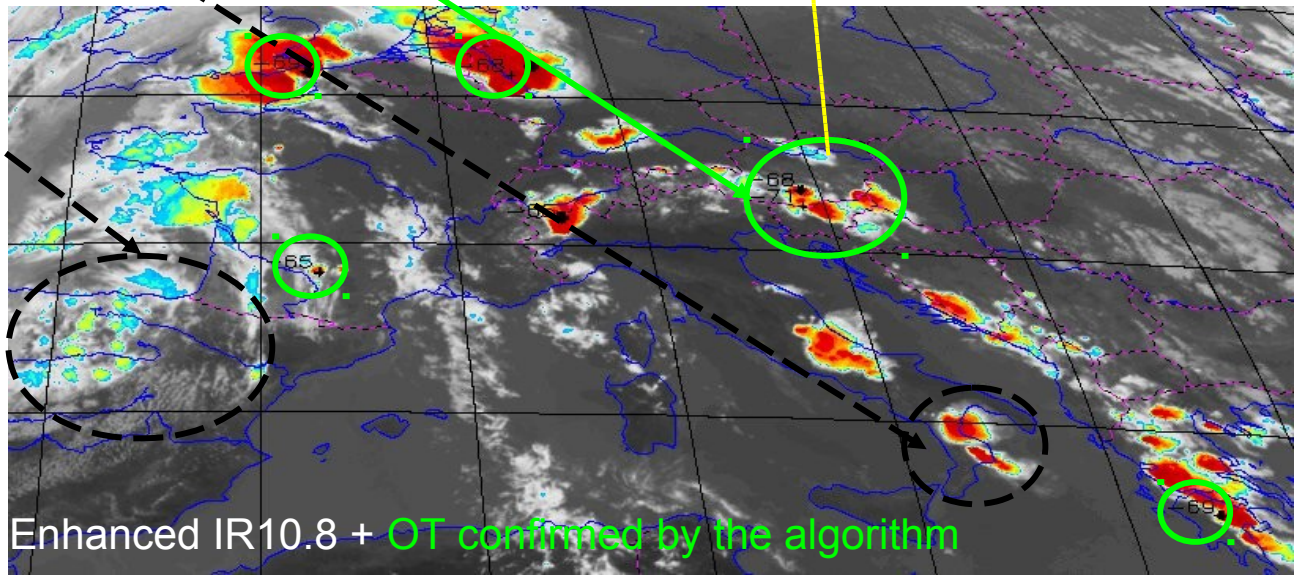
NWP tropopause T° field + pre-selected OT





HRV-use for tuning and validation

COLDER



Tropopause T° diagnosis helps to filter less significant pre-selected OT

Topical Case study (25th May 2009)

v2018 RDT - A well-known product

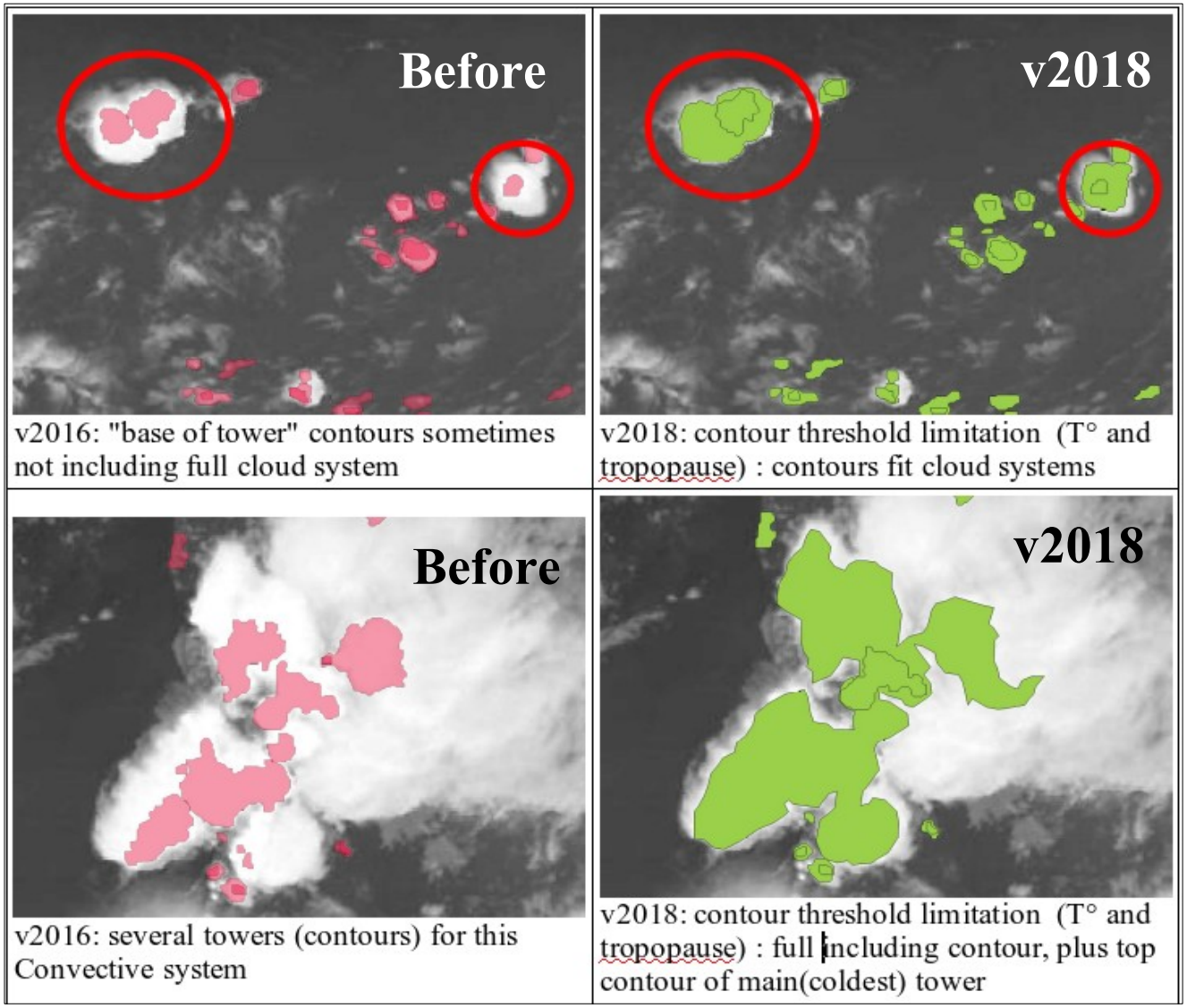
Operational (Eumetsat sense)

Many improvement in v2018: improved and configurable detection, lightning jump, discrimination scheme adapted to handle wide variety of satellite configurations (CAL), new Ice Crystal calculation, technically and scientifically adapted to Himawari-8 (additionally to MSG), new lightning pairing rules

A widely used product

Global RDT operated by MF used by thousands pilots (EFB eWas solution developed by GTD company)

RDT v2018 -
Detection with less broke up systems



v2016: "base of tower" contours sometimes not including full cloud system

v2018: contour threshold limitation (T° and tropopause) : contours fit cloud systems

v2016: several towers (contours) for this Convective system

v2018: contour threshold limitation (T° and tropopause) : full including contour, plus top contour of main(coldest) tower

RDT contours:

With BTLIMIT and tropopause LIMIT, we avoid too cold/small outlines of base of towers

The 2nd level of RDT helps to describe the coldest part, OT the most active part

A better match of cloud systems

An improvements thanks to feedback of aeronautical end-users

Overview

1. Introduction

2. CI - Convection initiation

3. **RDT**
   - i Algorithm and input data
   - **ii Attributes** 
   - iii Validation
   - iv RDT and aviation

4. Future works

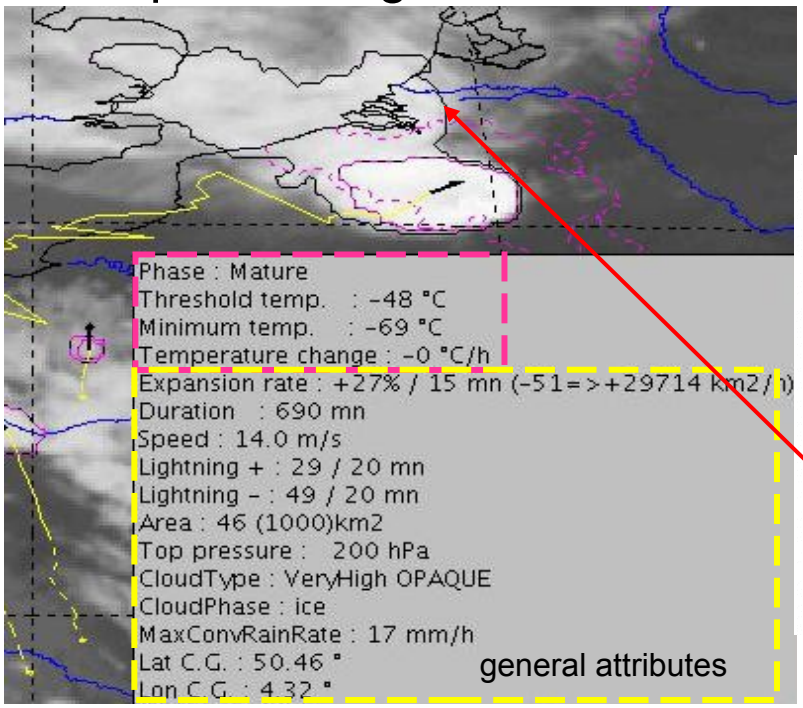
Multilevel description: second level for some cells

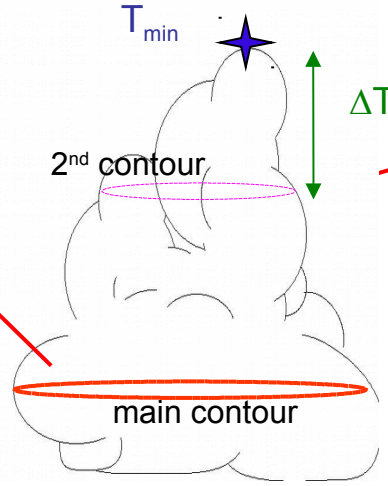
2nd level description (v2012)

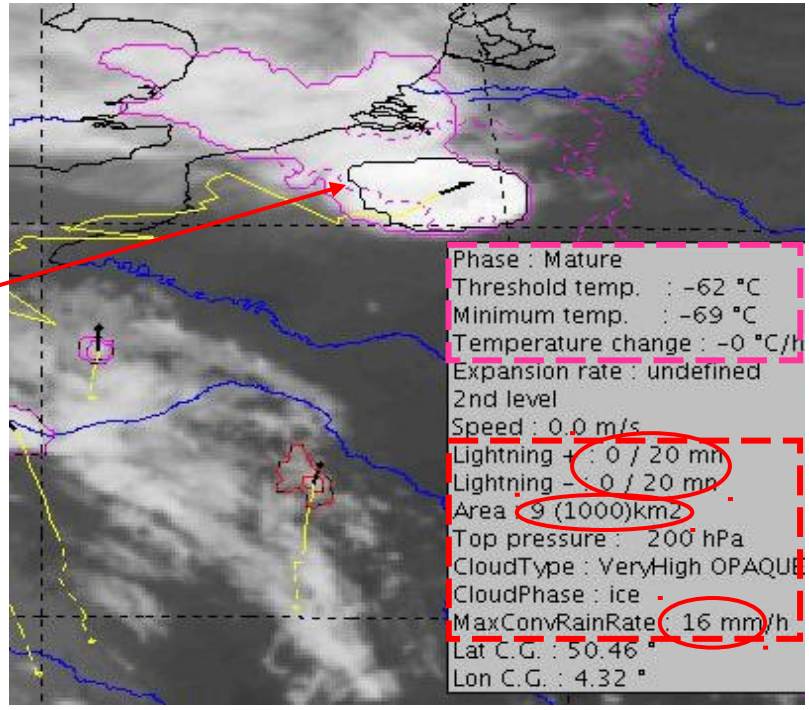
Depending on cell morphology (large cell-extension), it is sometimes interesting to have the depiction of another level additionally to « Base of Tower » level

- ❑ outline related to « top of Tower » has been added
- ❑ processing of attributes related to this contour

Specific attributes
(some common with main contour)







Note: the tracking remains systematicaly based on "Base of Tower" level

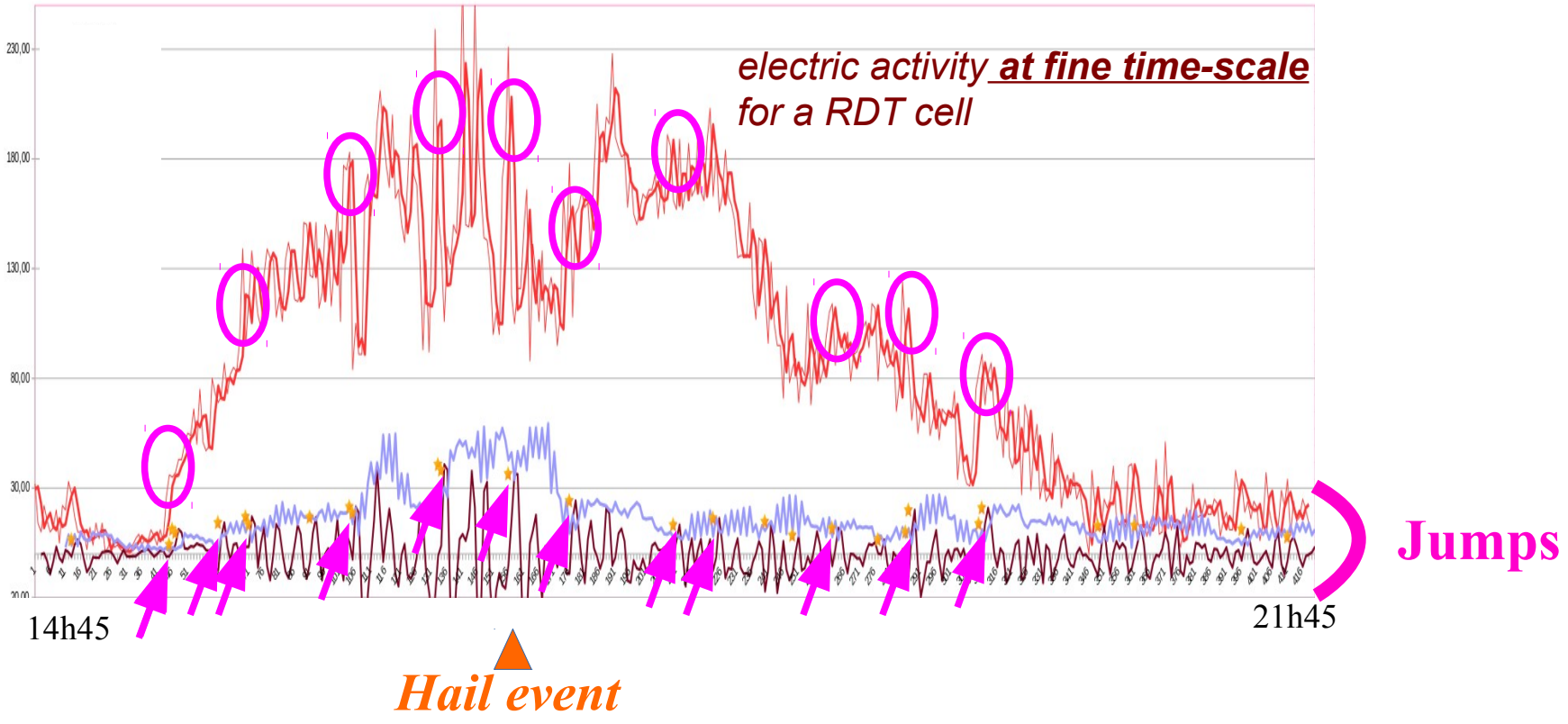
RDT v2018 - A lightning Jump diagnosis: how ?

- ✔ Lightning (total) rate analysis (min^{-1})
  - Input data at **fine time-scale** paired with RDT cell
  - For each RDT cell, **minute-analysis** of previous **12 minutes**
    - ✗ *Condition 1:* ***Lightning rate > 10 min^{-1}***
    - ✗ *Condition 2 :* ***Lightning rate trend > 2 x rms***
- ✔ Identification of «jumps», **precursor** for hazardous phenomena
  - Diagnosis during cloud cell pairing period
  - Input for **severity** index
- ✔ Implementation in **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

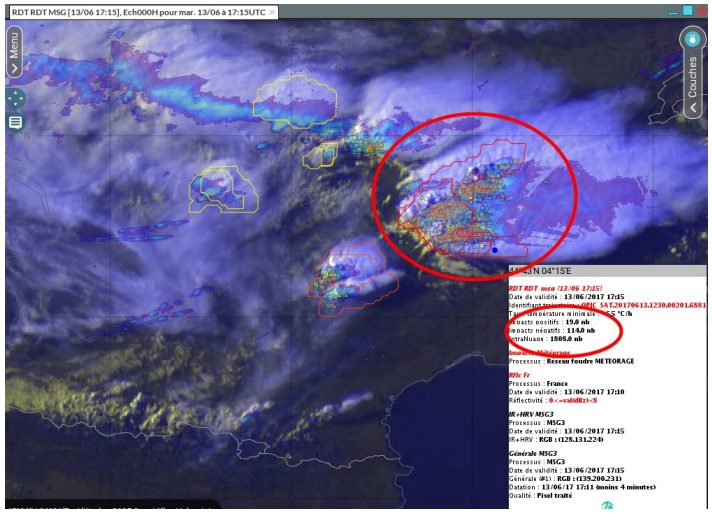
RDT v2018 - A lightning Jump diagnosis: why ?

13/6/2017 case study - Extreme Thunderstorm in « Haute Loire » area Intense electric activity / hail event ~ 17h30Z



Lightning Jumps criteria on **amount and acceleration** of electric activity

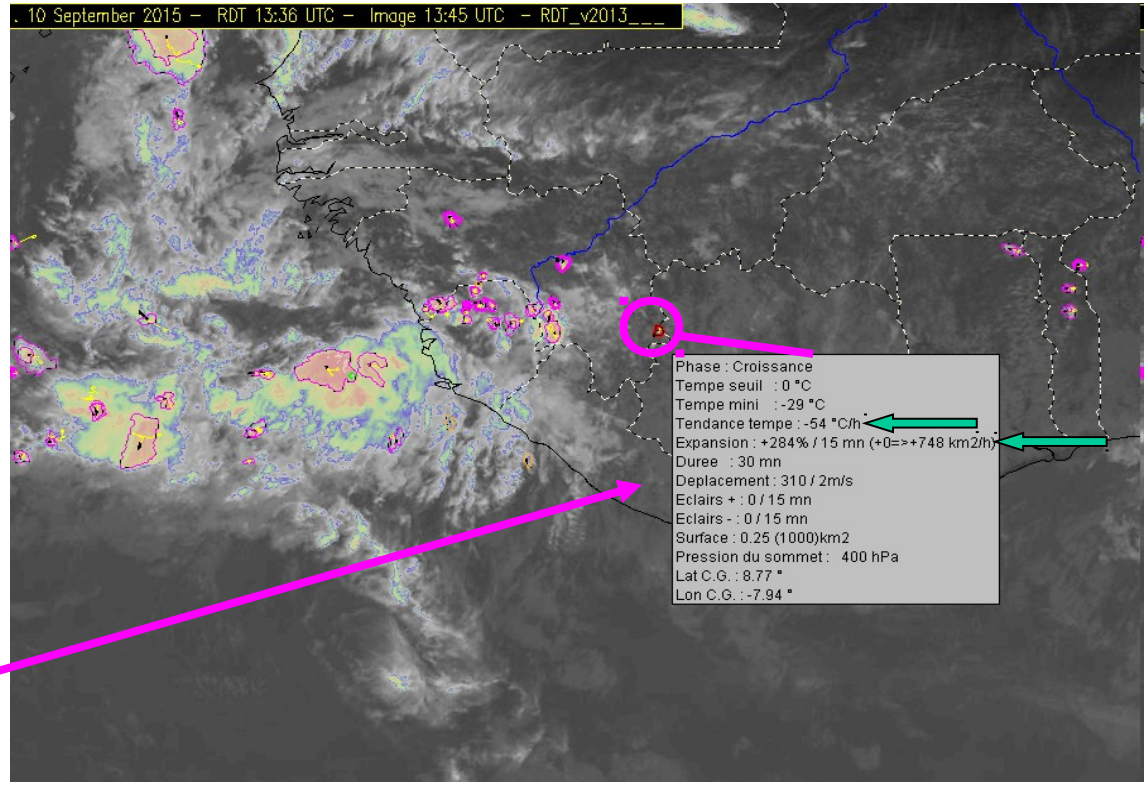
LJ=Precursor + Proxy FOR HAIL



RDT – Severity Attribute

- Each feature of convection is intesting and kept
- But it is also interesting to summarize severity in a single attribute.
  Based on following elements
  - Cooling rate
  - Overshooting Top presence
  - BTD 6.2-10.8 trend
  - Horizontal expansion rate
  - Convective rain rate
  - Lightning activity
- Implemented in v2016

This small system rapidly develops on horizontal and vertical scales.
Diagnosed as « severe » in severity algorithm (even if no lightning network available)



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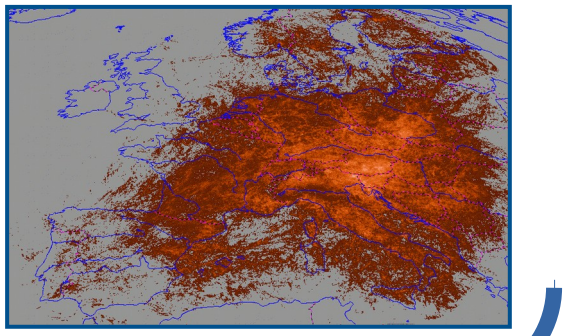
RDT – validation with ground-based lightning data network



Euclid network, several periods, europe

RDT

RDT operated with MSG, without lightning data

Identification of convective phenomenas

- ✓ **POD > 70% spring/summer**

Early diagnosis:

- ✓ **25% 15 min before 1st stroke**

RDT Validation by SAWS (1/2)

South African Weather Service

RDT

MSG +/-

Radar network
35dBZ threshold

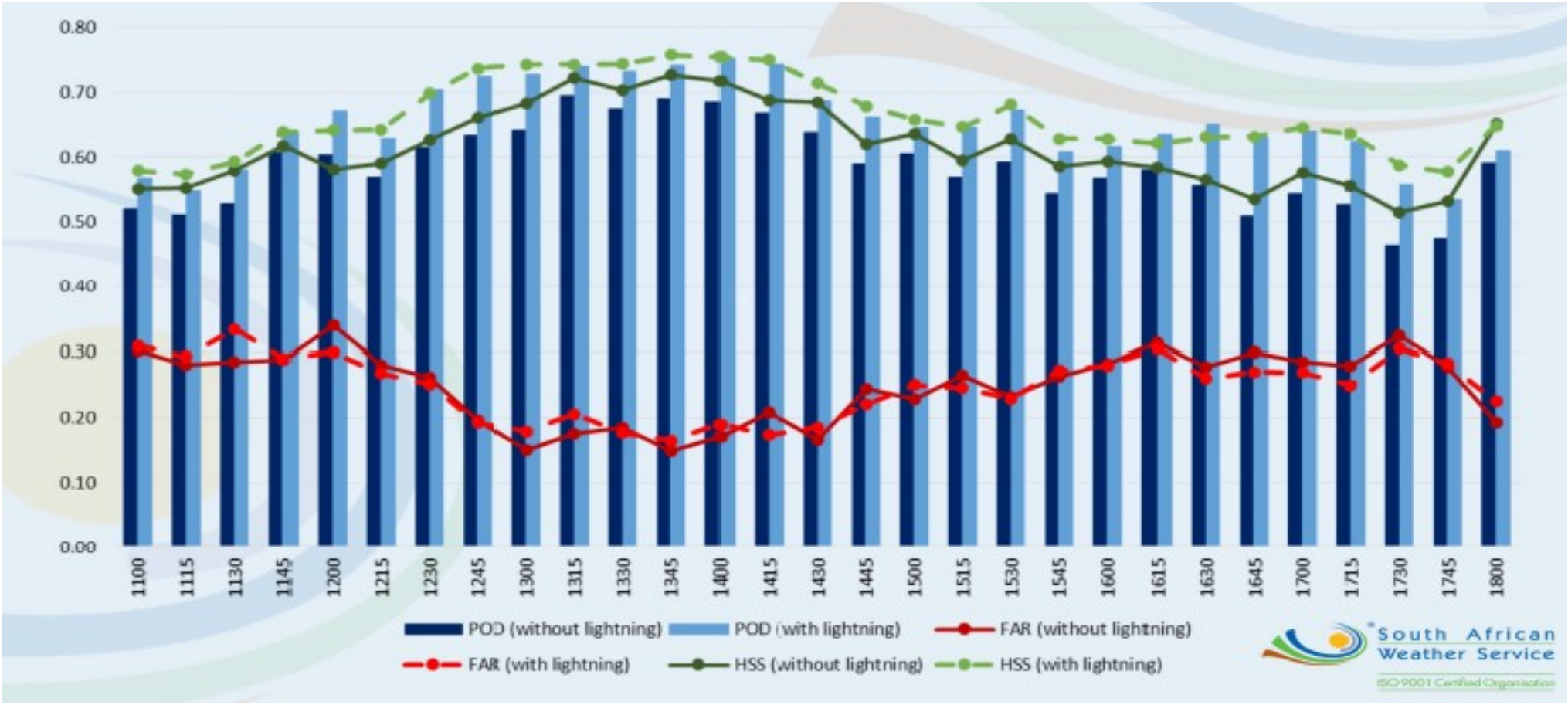
RDT operated with MSG, with or without lightning data (local network)

Object-based methodology

Courtesy SAWS

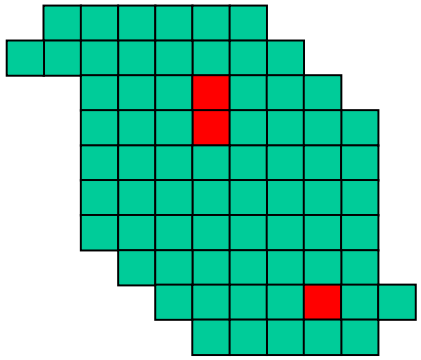
RDT Validation by SAWS (2/2)

Against 35 dBZ radar reflectivity
Object-bassed methodology
RDT operated with and without lightning data (25 cases)



Courtesy SAWS

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

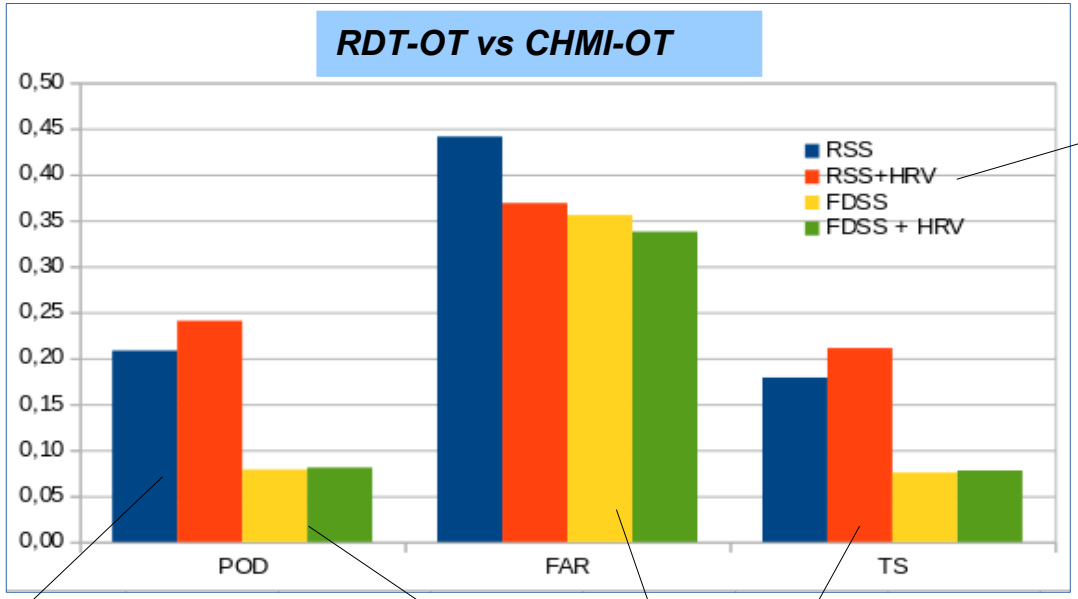


Expertised **CHMI OT database**
- 2.5' experimental MSG1 scan *20130620 [09h-19h30] and 20130729 [13h-18h30]*
- *1800 OT identified over Central Europe*

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*

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

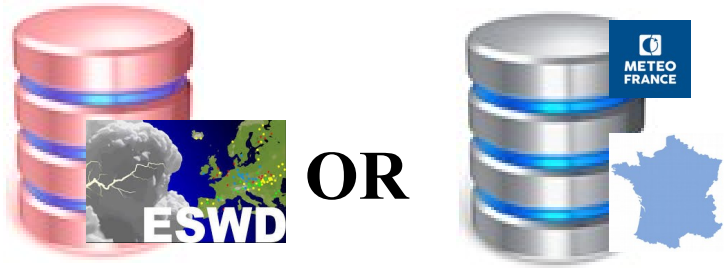


The four RDT configurations

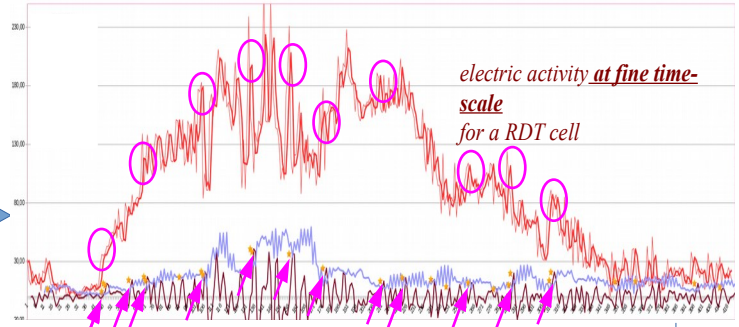
Low POD due to unbalanced populations (more OT in CHMI database than seen by RDT)

RDT-OTD: RSS 5' better than FDSS 15'
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

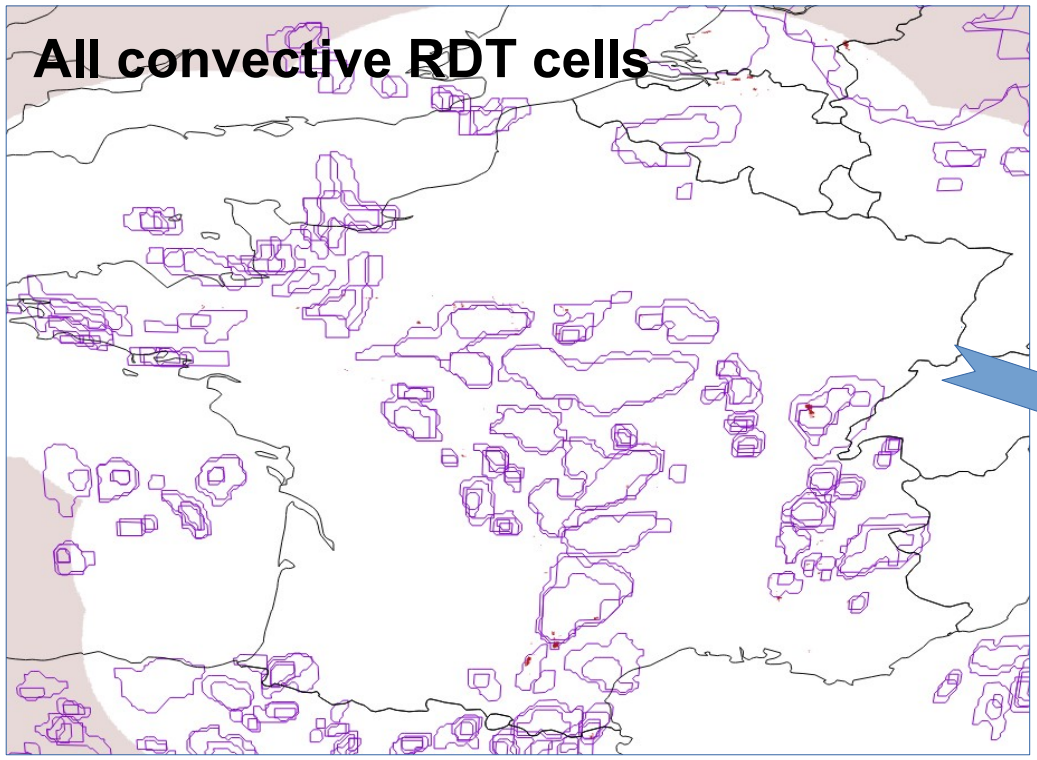
Pairing method between severe events and RDT-LJ

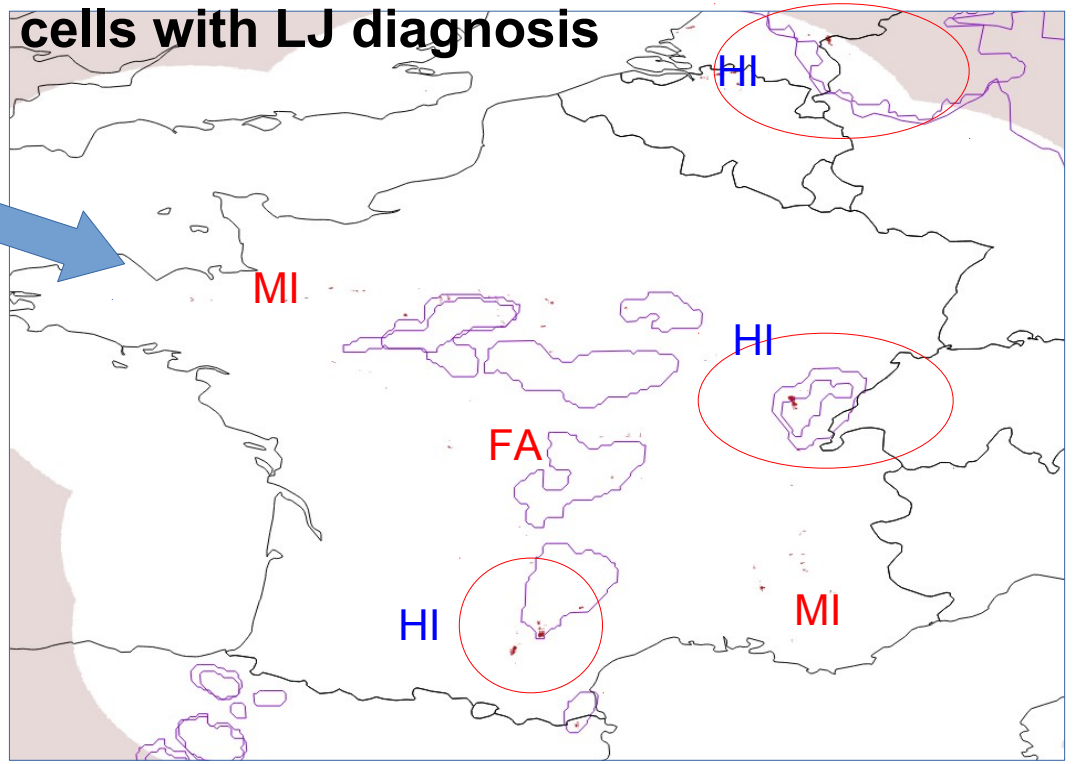
- Case study

- 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

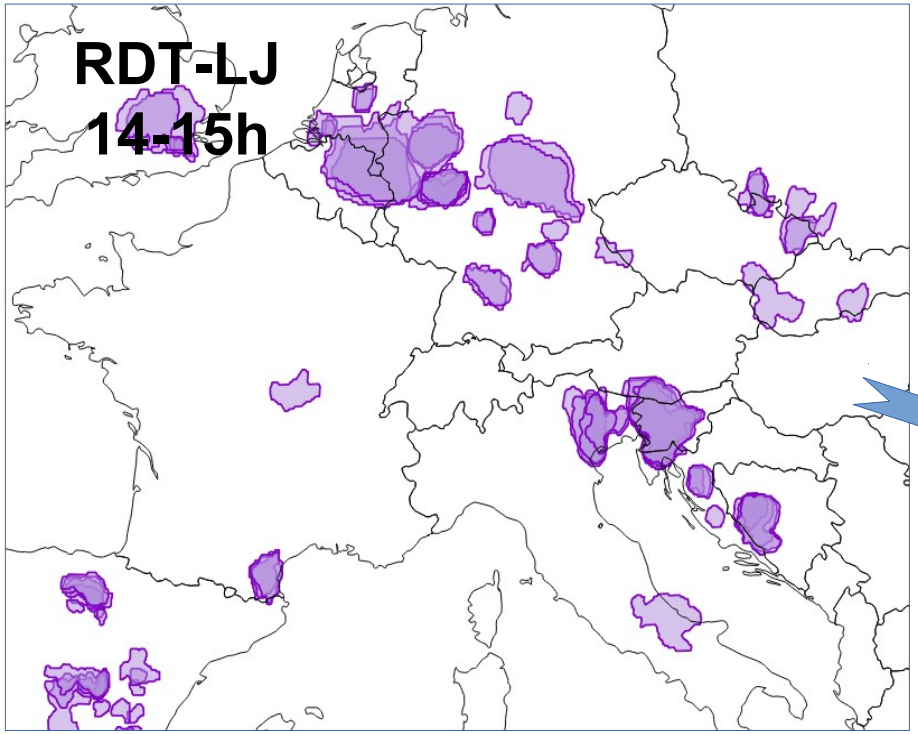
20180529 case study:
[15h30-16h00] RDT (contours)
[16h-16h15] HYDRE medium and large hail detection (accumulated pixels)





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

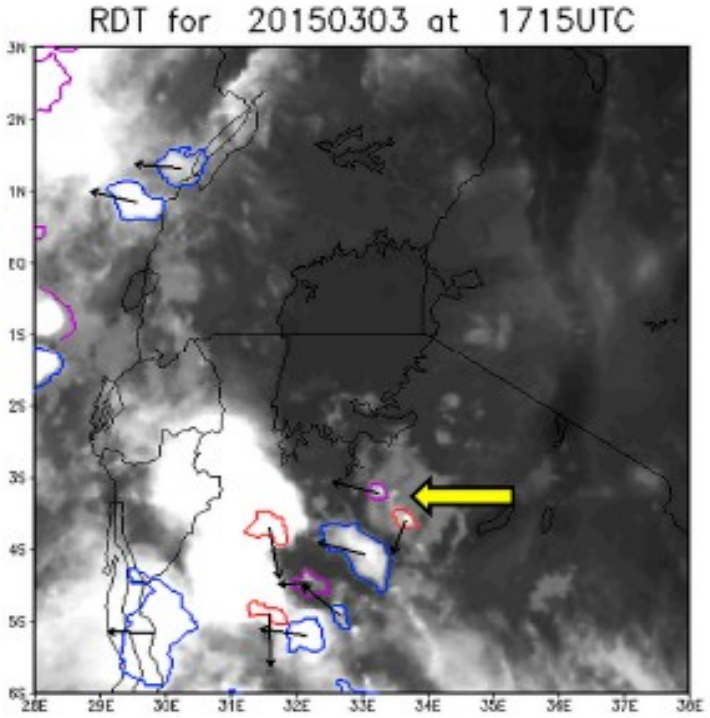


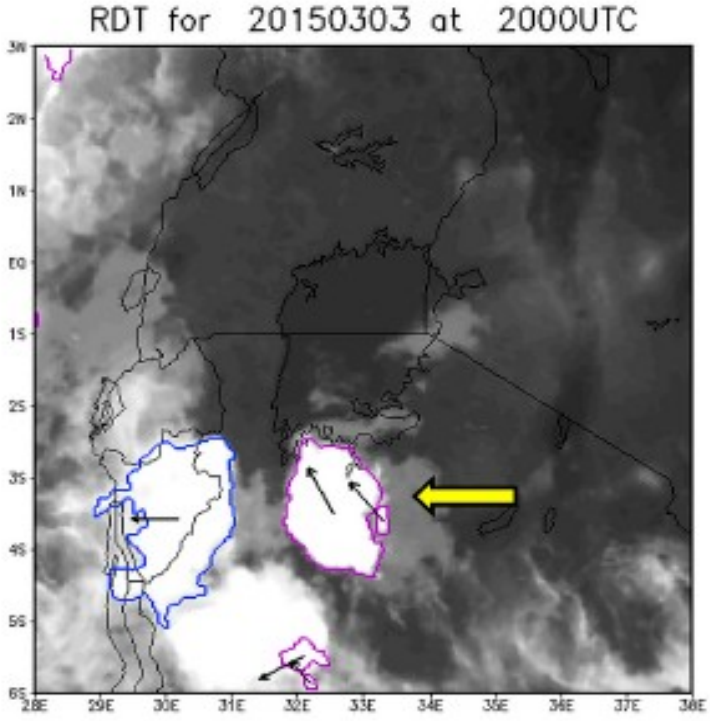
Step by step analysis of **RDT-LJ sequences** vs **following SW** allow subjective good pairing
Most severe weather events find a correspondence with previous RDT with LJ
Numerous non paired RDT-LJ : false alarms or lack of observation ?
Objective quantification needed for “paired” and “missed” SW events

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: validation

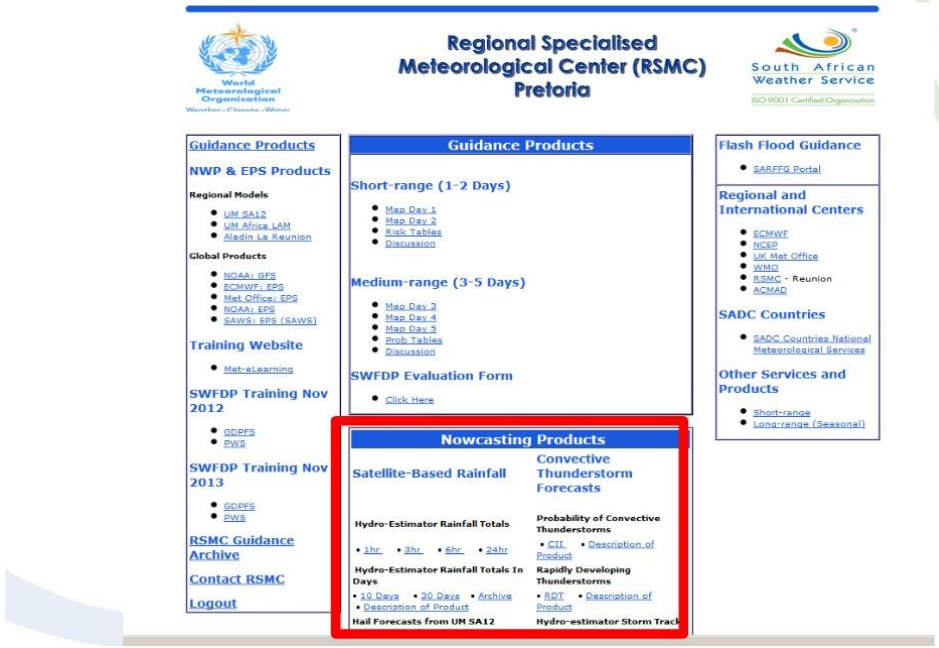
Any feedback is welcome !

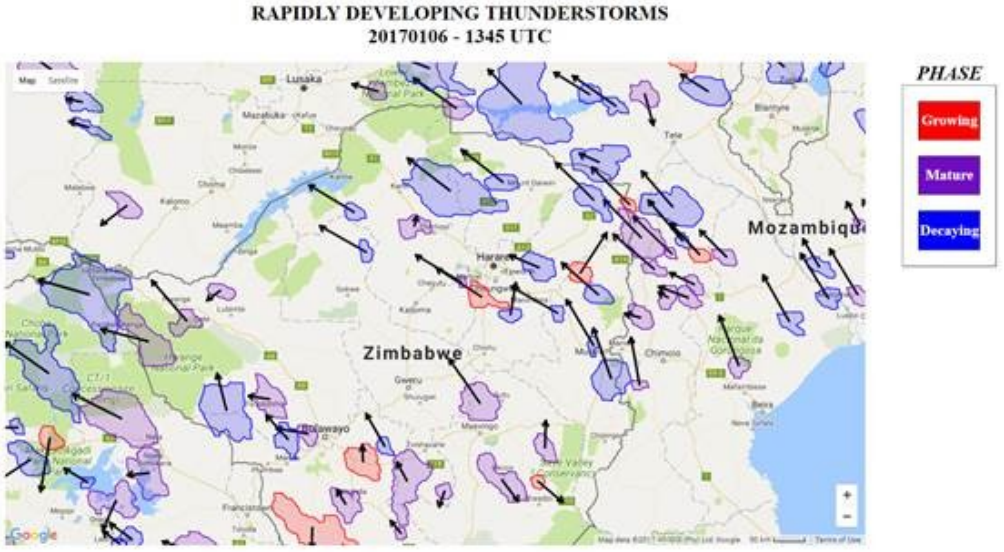
RDT in WMO RSMC Prétoria

Courtesy Morné Gijben, SAWS

RDT produced by SAWS is now available on WMO RSMC (Regional Specialised Meteorological Center) of Pretoria.
16 African countries of SWDFP (Severe Weather Forecasting Demonstration Project) from southern part of African continent can visualize real-time RDT!

Satellite based Nowcasting products on RSMC website



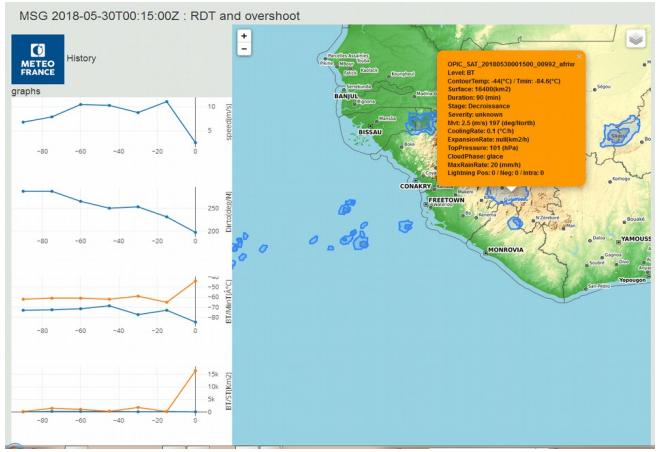


RDT outside MF

- By NWCSAF end-users
- By NWCSAF, visible on NWCSAF website

- Production MF for some users, e.g. ACMAD
www.acmad.net

*- RDT produced by SAWS is now available on WMO **RSMC** (Regional Specialised Meteorological Center) of Pretoria. 16 African countries of SWDFP (Severe Weather Forecasting Demonstration Project) from southern part of African continent can visualize real-time RDT!*
- Idem RSMC Dakar for West Africa



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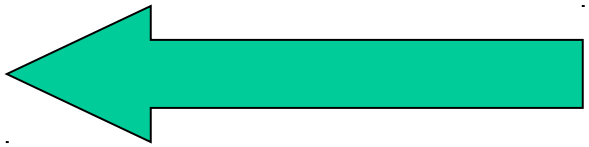
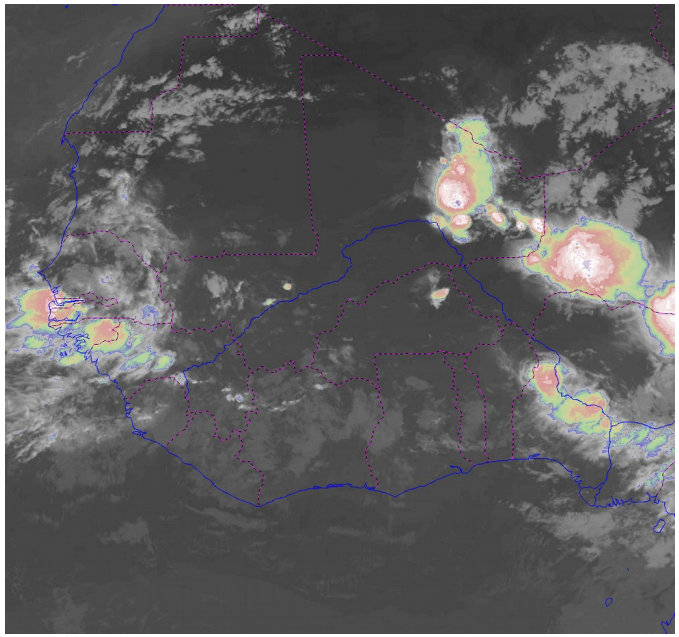
iv RDT and aviation 

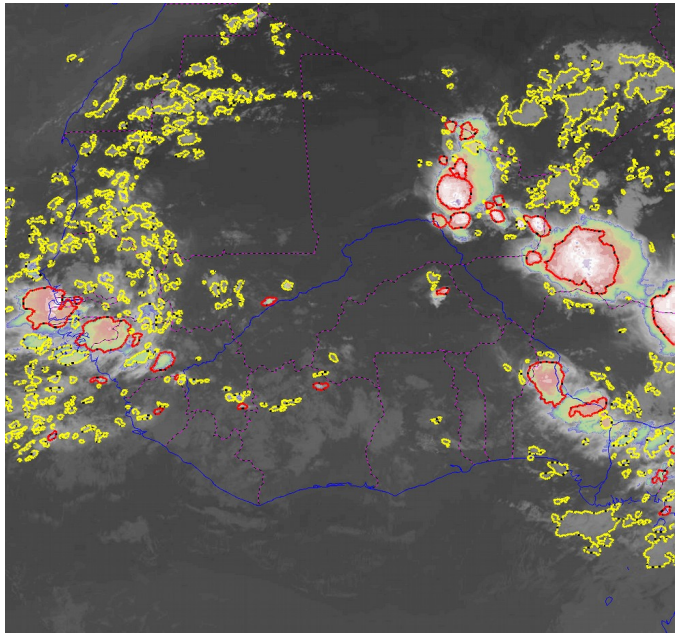
4. Future works

Ready for Uplink (1/2)



Enhanced satellite 10.8µm image

Convection is here. *Where precisely*?



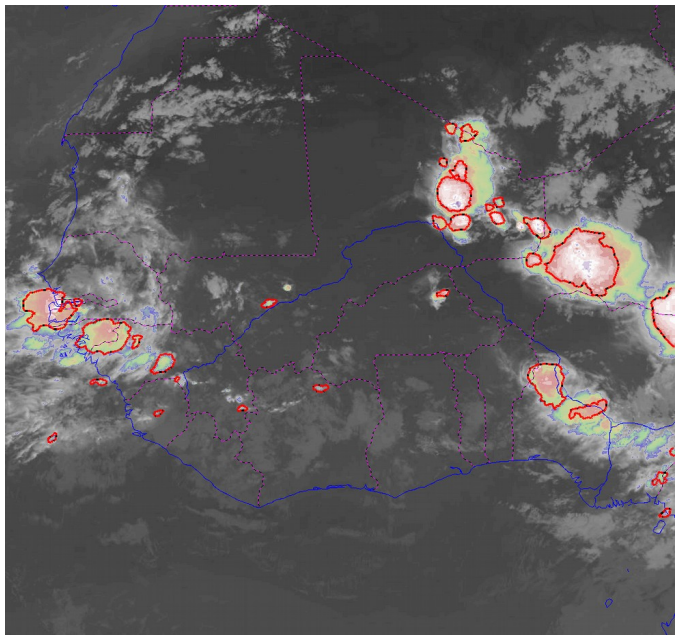
Enhanced satellite 10.8µm image + objects that have at least 6°C of vertical extension

Note:

- Even non-convective objects may be tracked and described
- Non convective-objects are watched because they may become convection in next image.

If we only focus on convection … (next slide)

Ready for uplink (2/2)

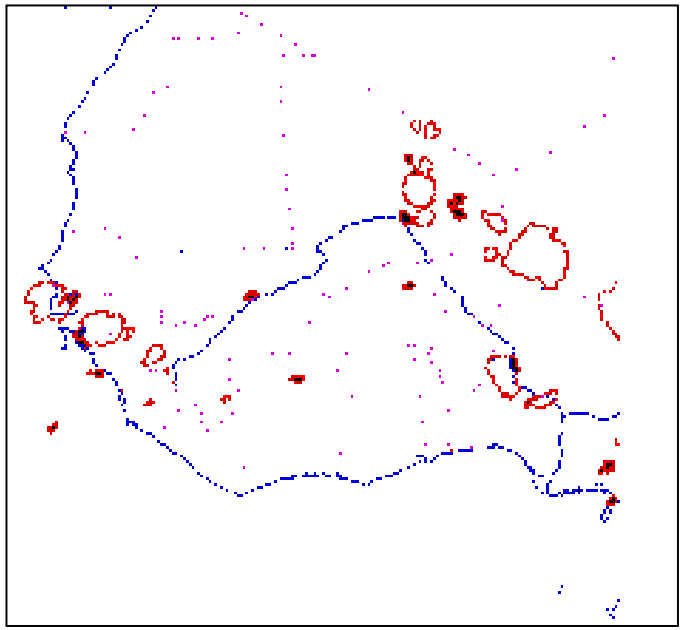


Enhanced satellite 10.8µm image + convective objects

After the "discrimination" phase of the RDT algorithm

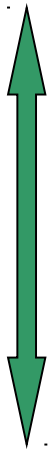
Each object is described with a complete set of attributes

If we want to reduce the information to its kernel



Convective objects outlines alone

+ Possibility to reduce the set of attributes

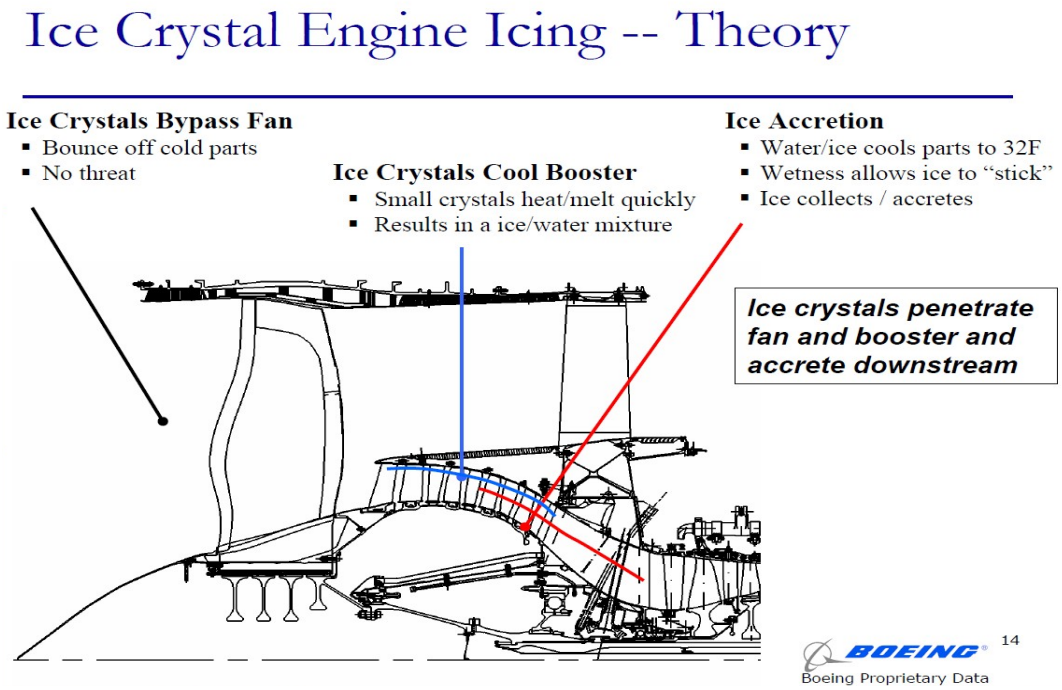


UPLINK

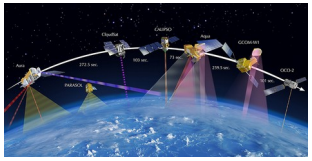
RDT and high IWC (Ice Water Content)

- Ice crystals: cold meteors of very small size. Often non visible though onboard radar.
- Different of classical icing.
- High altitude (>22000 ft), inside or close to convective clouds

- Impact on probes
- Impact on engines



HAIC – Analyse des performances



OR

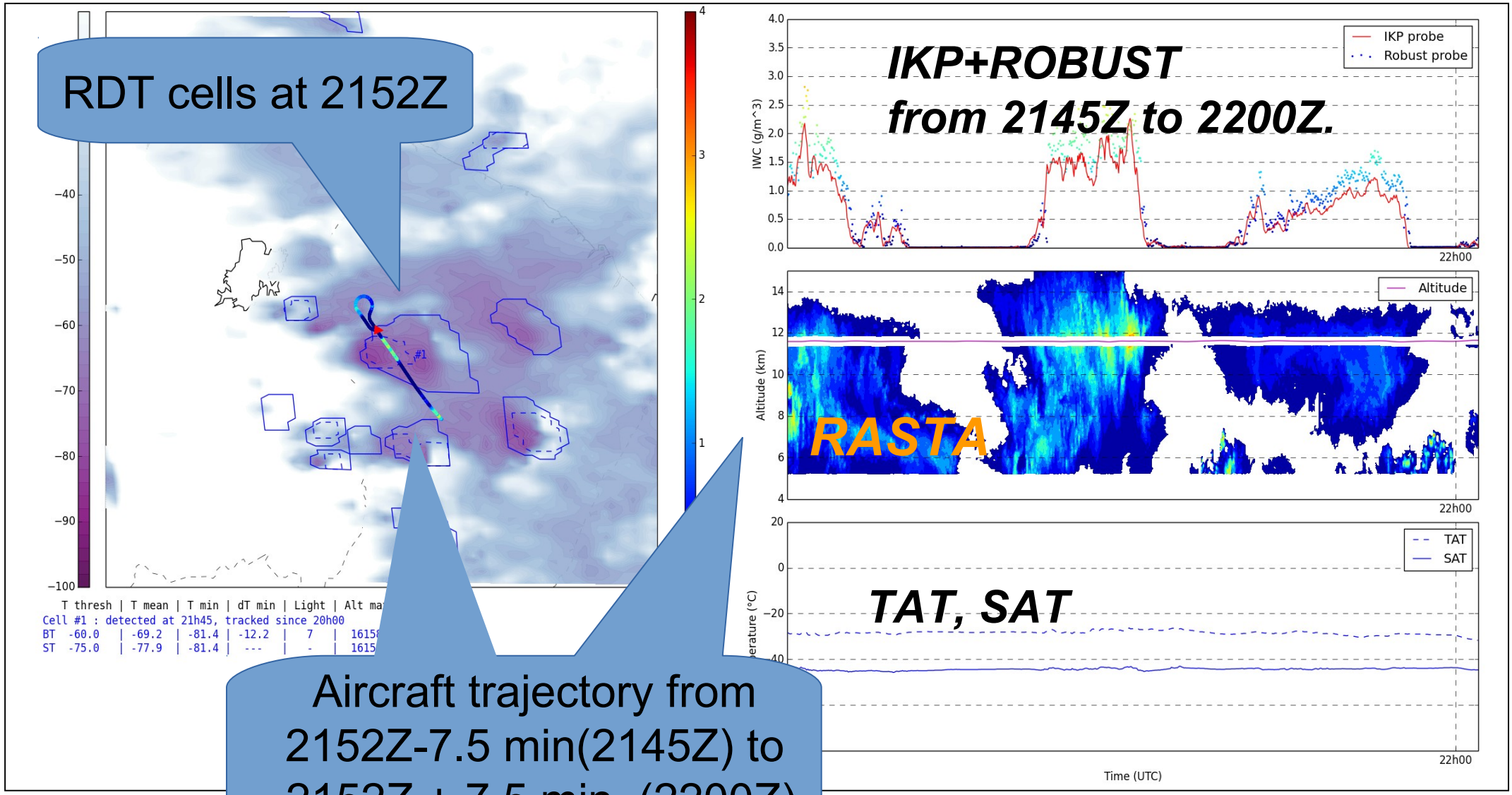
- Research aricraft measurements
- DARDAR IWC retrieval from CALIPSO and CLOUDSAT (A-Train)

RDT

RDT operated with satellite field campaign areas

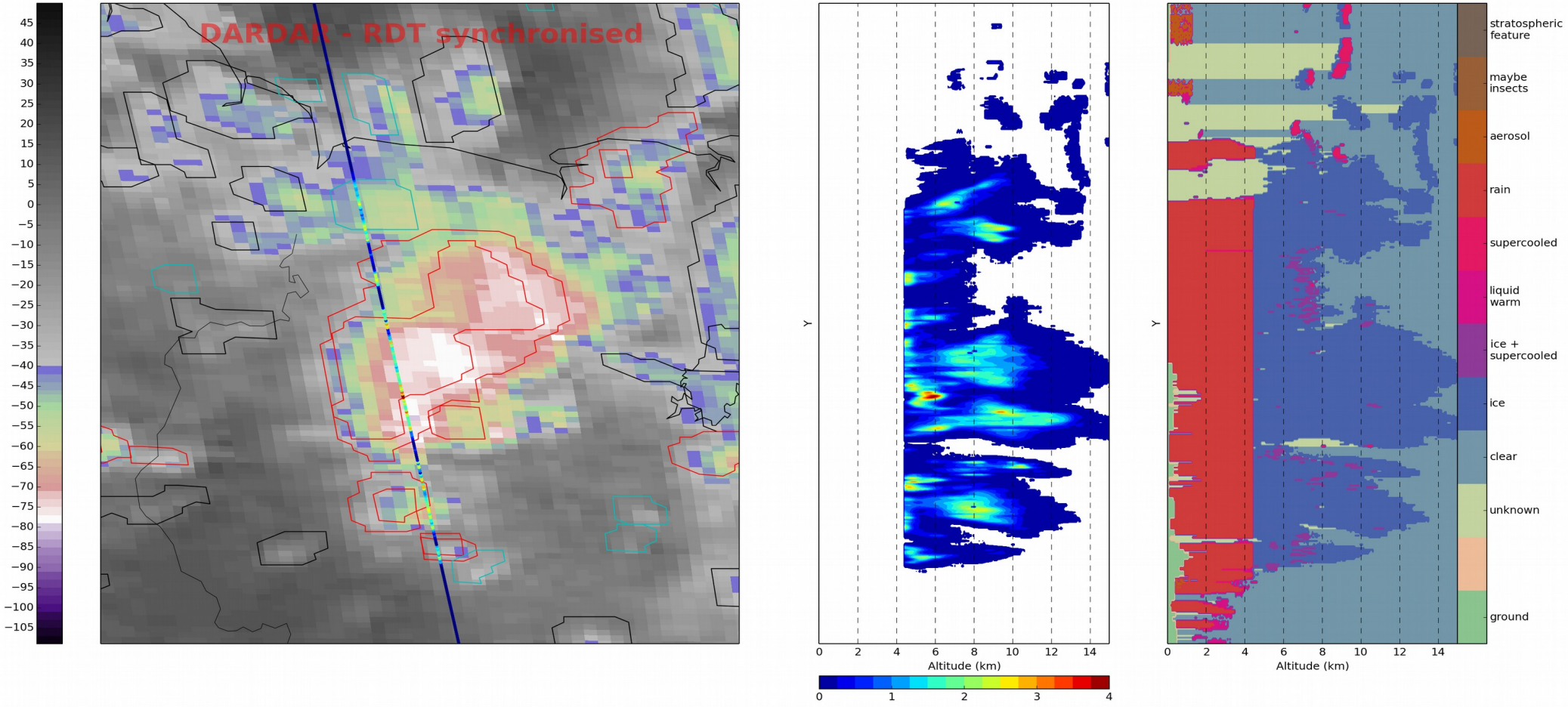
- Does RDT fits the high IWC (Ice Water Content) retrievals ?
- Object and subjective validation

Cayenne 2015 Campaign methodology example



Subjective verification with DARDAR

20150530



Sum-up of objective verification

	POD	*FAR*	nb of flights
Darwin2014	**0.84**	**0.69**	16
Cayenne 2015	**0.71**	**0.72**	16
Darwin 2016	**0.51**	**0.68**	2
La Réunion2016	**0.73**	**0.32**	3
DADAR2015 - First tests	**0.38**	**0.91**	21 paths

FAR relatively high but without the use of the high IWC attribute developped after the HAIC project

RDT in HAIC sum-up

- RDT successfully operated in all HAIC campaigns, with various generation of satellites: localisation of convective activity for Flight guidance + Uplink to Research Flights

- RDT as a tool for detection of large IWC areas. Reducing No detection cases. TRL5 level reached in HAIC (after TRL3 Level)

- Ways of improvement identified after the project: attribute IWC mature systems handling + to follow cells or ensemble of cell at a defined temperature level. Implemented (v2016, v2018)

Some RDT improvement connected to HAIC works

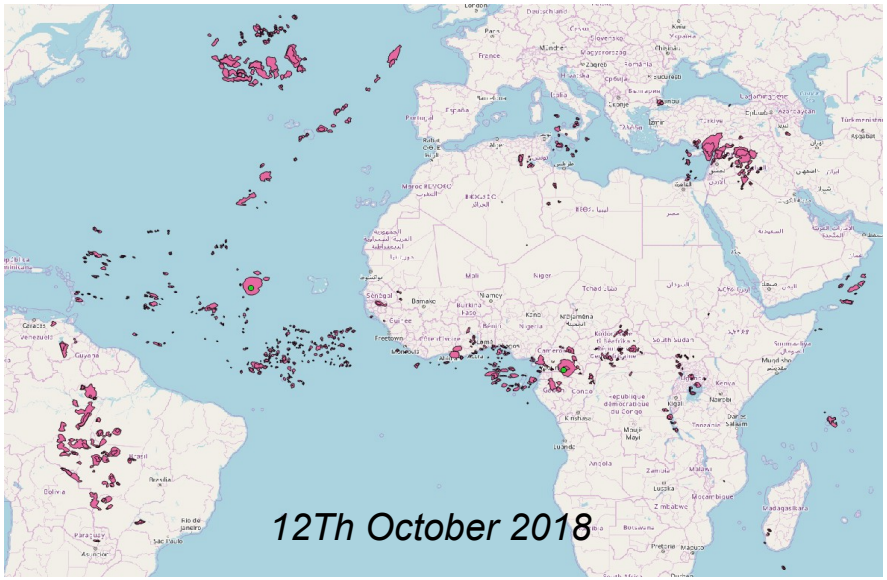
v2016 NWCSAF delivery: a new attribute concerning IWC hazard estimate (Day only): **KNMI algorithm developed in the framework of HAIC with Météo-France NWCSAF microphysics input**

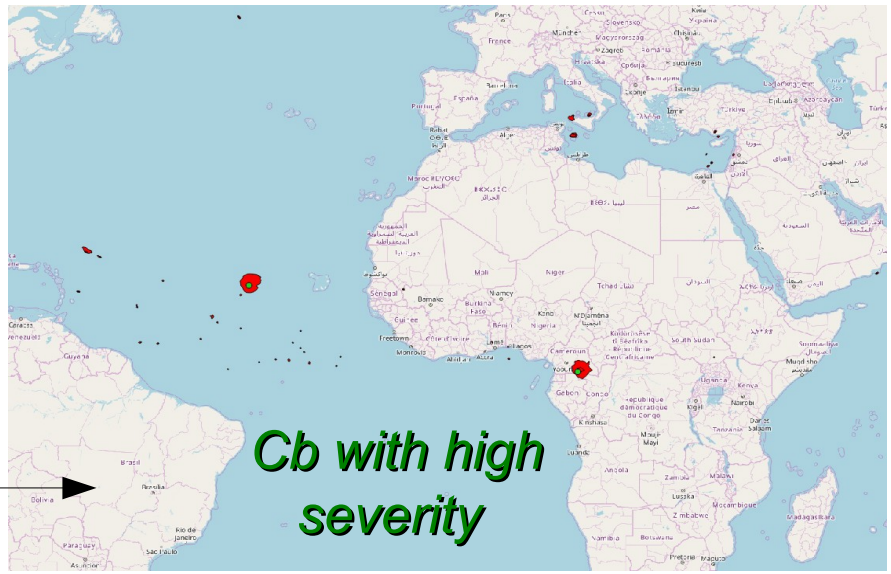
v2018 NWCSAF: high IWC attribute inside a RDT cell improved (still following **KNMI** algorithm)

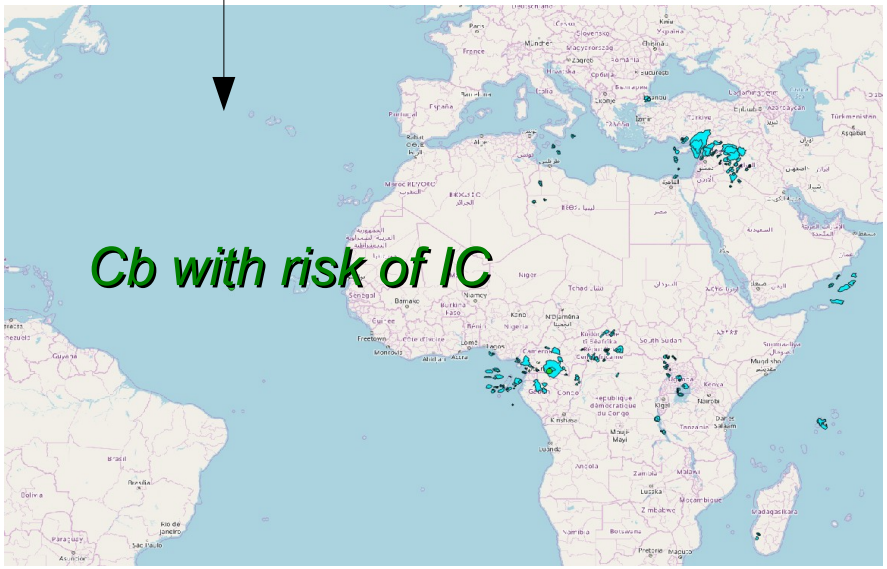
v2018: RDT blinking effect mitigated, new rules for declassification of mature systems

RDT operated with new satellites in HAIC and now RDT is GLOBAL!

RDT parameters – *Severity , Ice Crystals risk*



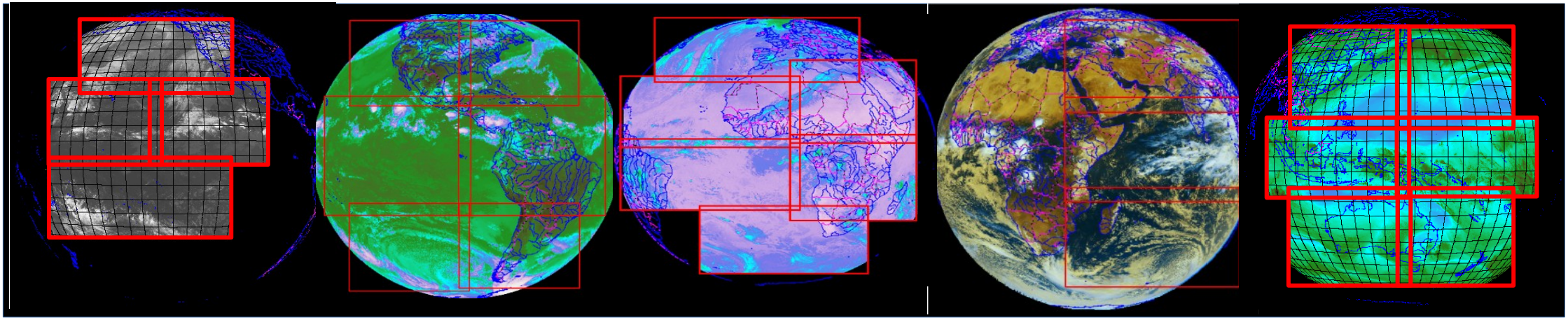




IWC attribute goal:
reduction of false alarms !

RDT – Météo-France productions

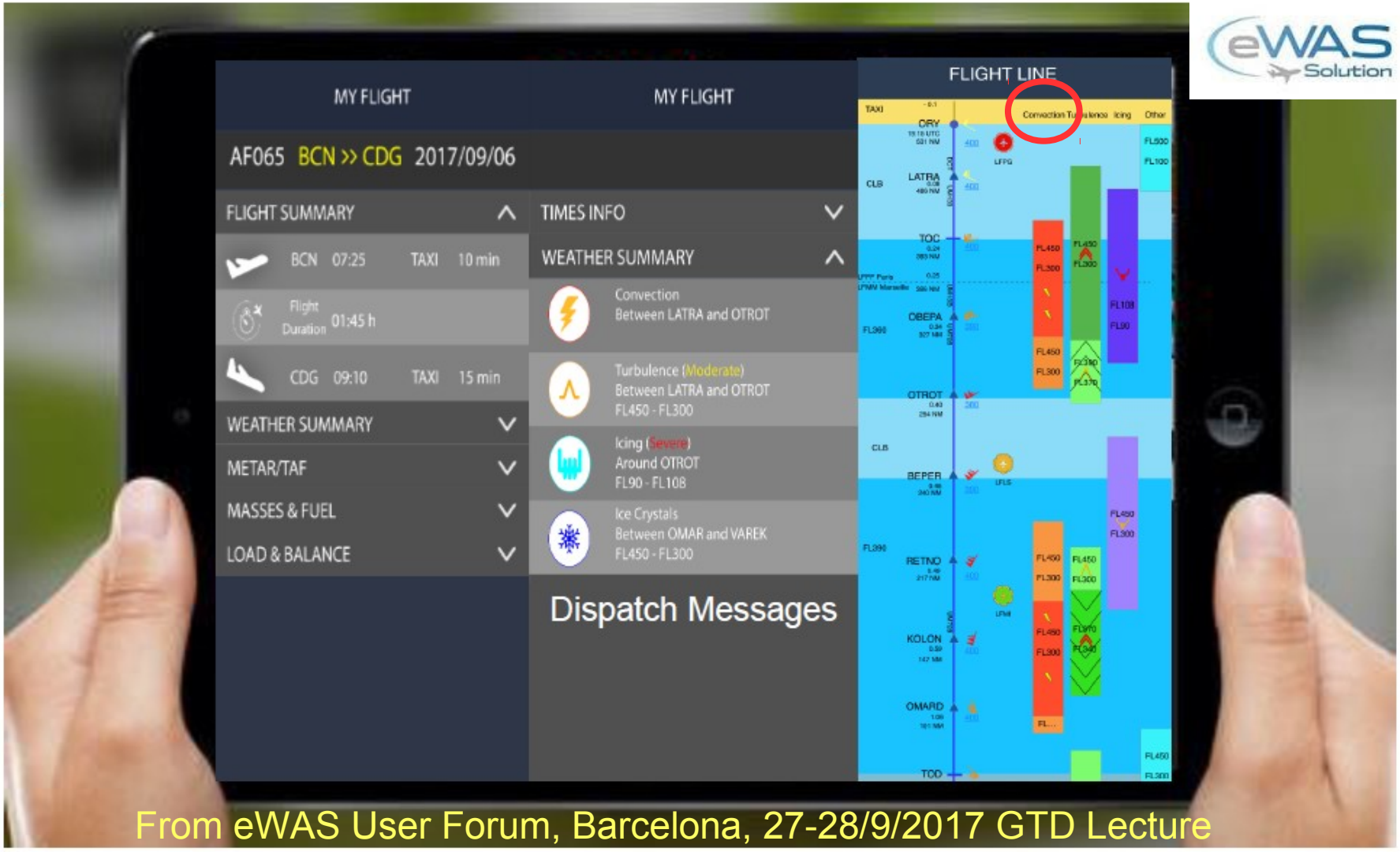
GOES-W 135°W	GOES-E 75°W	MSG 0°	MSG 41.5E	Himawari 140°E
15 min	10 min	15min	15min	20min



Mutliple and parallel productions before blending in a single product
A widely used product
Global RDT operated by MF used by thousands of pilots (EFB eWas solution developed by GTD company)

RDT on-board eWas Solution

- OFP Details
- Airports details
- Weather details
- Dispatch Messages
- Fuel information
- App Launchers (Doc, Load & Balance)



From eWAS User Forum, Barcelona, 27-28/9/2017 GTD Lecture

32000 Pilots / Positive Feedback / Global

RDT on-board eWas Solution

- **Tablets and EFB have created new opportunities for content in the cockpit**
- **Cockpit Connectivity** is finally coming.
- There's a need to **compliment the tactical weather** information provided by aircraft radar by a more strategic vision.
- Many airlines are or have been doing "weather proof of concepts".

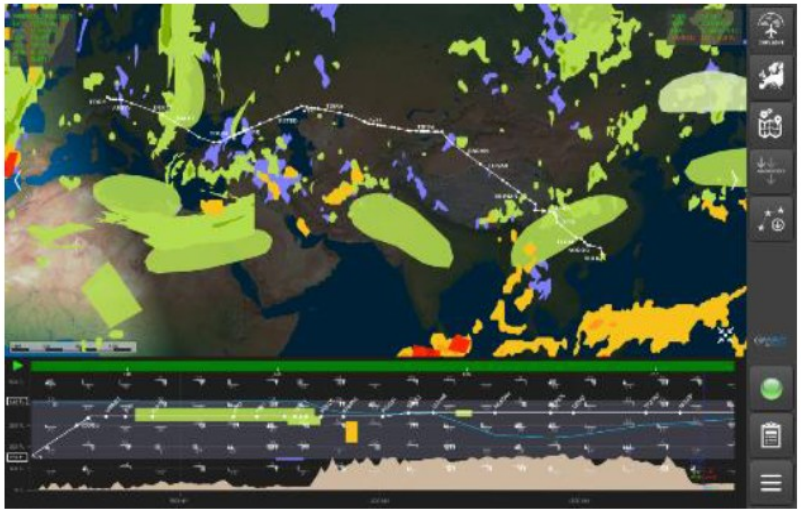
- **Airlines are looking for an operational solution**.

From eWAS User Forum, Barcelona, 17th November 2016
GTD Lecture

RDT on-board eWas Solution 1

Worldwide Weather Information

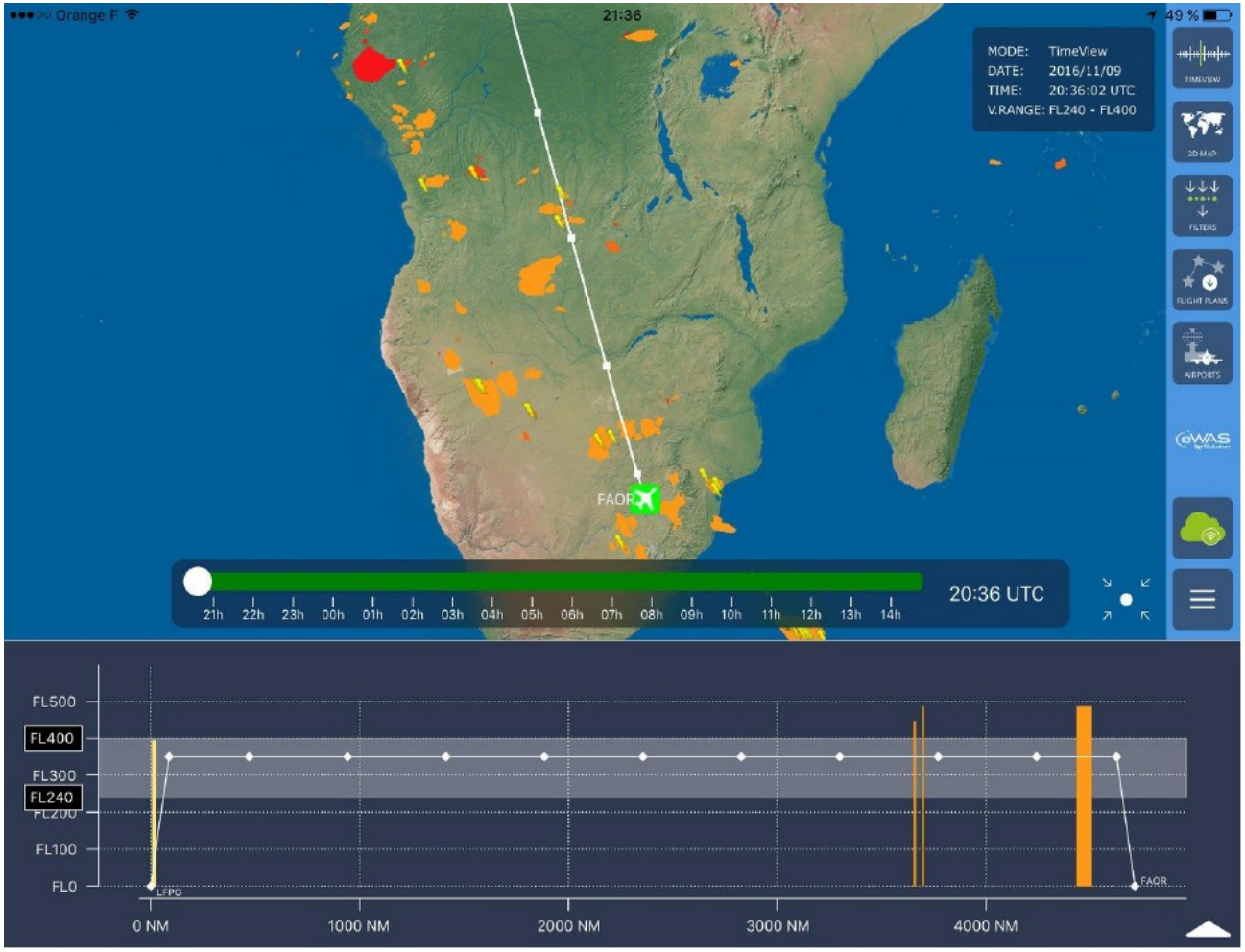
- Thunderstorm nowcasts (Cb) (15min)
- Thunderstorm forecasts (6h)
- Clear Air Turbulence (CAT) (6h)
- Icing (6h)
- Volcanic Ash (6h)
- PIREPs
- SIGMET
- Lightning (10 min)
- Wind & Temperature
- Tropopause
- Metar/Taf/Sigmet
- Ice Crystal
- **More under request...**



- Multi-Weather Providers:

METEO FRANCE · Météorage · Met Office · Schneider Electric · WSI

RDT in on-board eWas Solution



From eWAS User Forum, Barcelona, 17th November 2016
Regional flight Experience from Cpt. Giacomo FAGLIA Professional Pilot since 1995

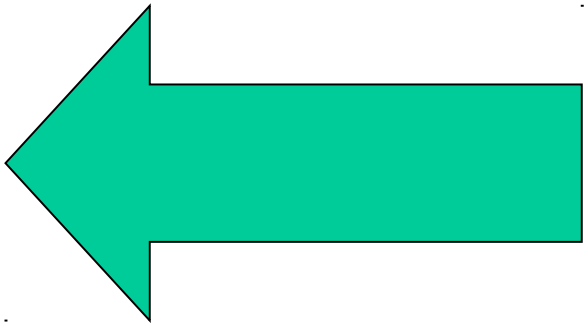
Overview

1. Introduction

2. CI - Convection initiation

3. RDT

4. Future works



MTG Context

IRS (sounder): direct use still uncertain for convection products.

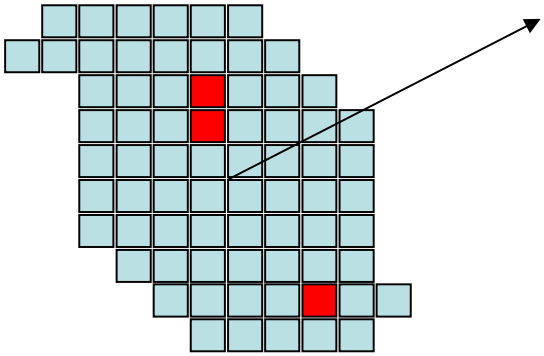
FCI (Flexible Combined Imager) and LI (Lightning Imager) are expected

MTG Context for RDT

FCI Number of channels:
Experienced.
Expected.
New physical properties (e.g. 0.91µm for total column precipitable water)

Spectral accuracy:
Experienced
Expected
Better estimate of BT

FCI Resolution:
Experienced
Expected
Small scale phenomena detection



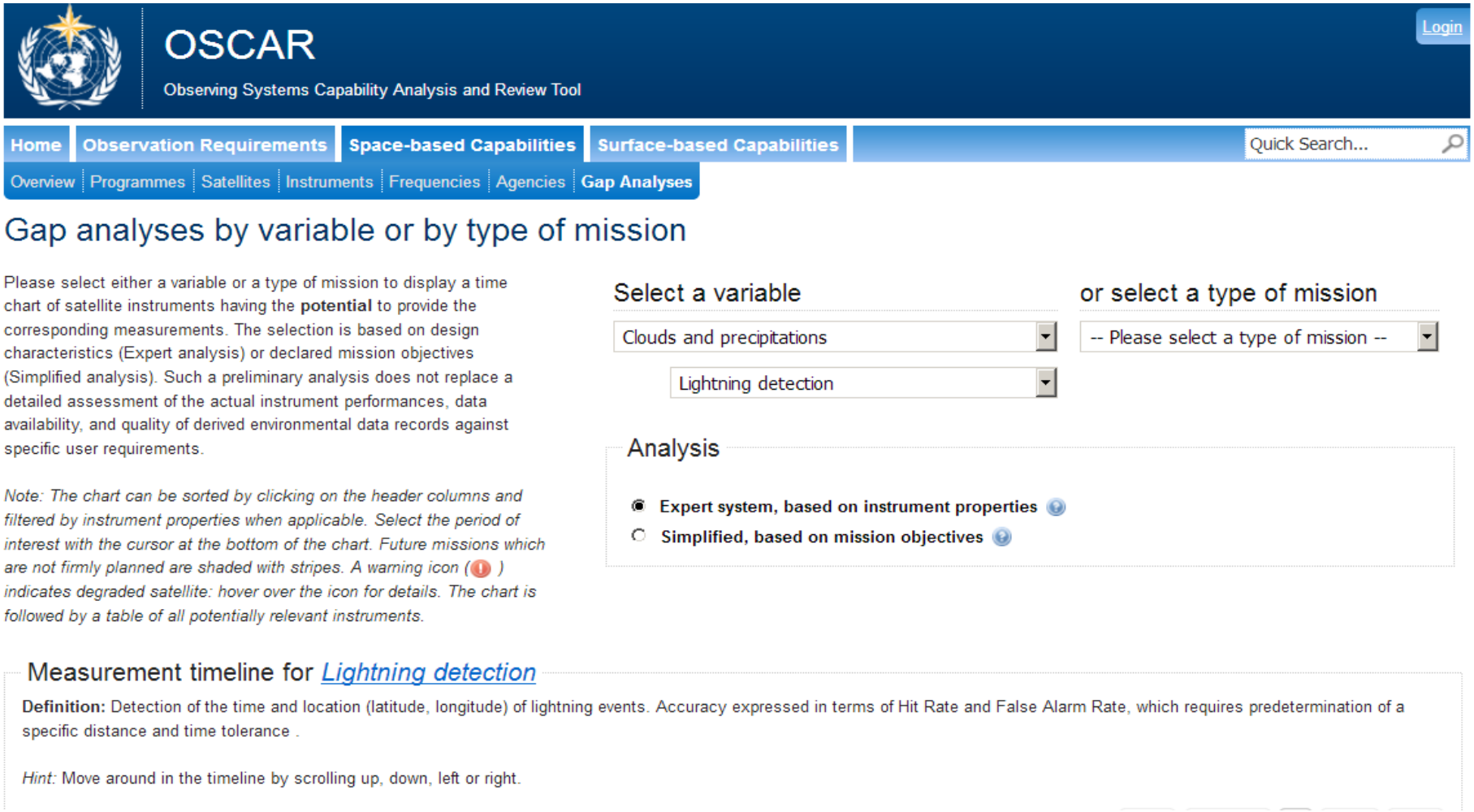
LI
un-experienced.
Highly expected.
Impact on RDT validation, tuning, description,
real-time mode, monitoring

MTG Context
LI is eagerly expected

LI instrument is eagerly expected to improve many components of RDT:

- ❑ Statistical scheme (no geographical limitation)
- ❑ Real time mode
- ❑ Enhancement of characteristics for a more complete description of convection
- ❑ Monitoring.

The WMO Oscar tool



Lightning satellite missions up to 2016

Instrument	NRT?	Relevance	Satellite	Orbit	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
GLM		1 - primary	GOES-T	137°W																				
GLM		1 - primary	GOES-16	89.5°W																				
GLM		1 - primary	GOES-S	75°W																				
GLM		1 - primary	GOES-U	75°W																				
LM		1 - primary	Electro-M N3	0°																				
LI		1 - primary	MTG-I1	9.5°E																				
LI		1 - primary	MTG-I2	9.5°E																				
LI		1 - primary	MTG-I3	9.5°E																				
LI		1 - primary	MTG-I4	9.5°E																				
LM		1 - primary	Electro-M N1	76°E																				
LM		1 - primary	Electro-M N2	77.8°E																				
LMI		1 - primary	FY-4C	86.5°E																				
LMI		1 - primary	FY-4E	86.5°E																				
LMI		1 - primary	FY-4G	86.5°E																				
LMI		1 - primary	FY-4A	99.5°E																				
LMI		1 - primary	FY-4B	105°E																				
LMI		1 - primary	FY-4D	105°E																				
LMI		1 - primary	FY-4F	105°E																				
LIS		4 - fair	TRMM	35 °		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
LIS (ISS)		4 - fair	ISS LIS	51.6 °																				
OTD		4 - fair	OrbView-1/MicroI	70 °	X	X	X	X																
ISUAL		5 - marginal	FORMOSAT-2	09:30 desc								X	X	X	X	X	X	X	X	X	X	X	X	X

All instruments for measuring *Lightning detection*

Instruments	Relevance	Operational limitations
GLM	1 - primary	No specific limitation..
LI	1 - primary	No specific limitation..
LM	1 - primary	No specific limitation..
LMI	1 - primary	No specific limitation..
LIS	4 - fair	Discontinuous availability..
LIS (ISS)	4 - fair	Discontinuous availability..
OTD	4 - fair	Discontinuous availability..
ISUAL	5 - marginal	Discontinuous availability.. Night time only..

Lightning satellite missions from 2017

Instrument	NRT?	Relevance	Satellite	Orbit	16	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	203
GLM		1 - primary	GOES-T	137°W				X	X	X	X	X	X	X	X	X	X	X	X						
GLM		1 - primary	GOES-16	89.5°W	X	X	X	X	X	X	X	X	X	X	X	X									
GLM		1 - primary	GOES-S	75°W			X	X	X	X	X	X	X	X	X	X	X	X							
GLM		1 - primary	GOES-U	75°W										X	X	X	X	X	X	X	X	X	X	X	
LM		1 - primary	Electro-M N3	0°														X	X	X	X	X	X	X	
LI		1 - primary	MTG-I1	9.5°E					X	X	X	X	X	X	X	X	X								
LI		1 - primary	MTG-I2	9.5°E								X	X	X	X	X	X	X	X	X					
LI		1 - primary	MTG-I3	9.5°E											X	X	X	X	X	X	X	X	X		
LI		1 - primary	MTG-I4	9.5°E																X	X	X	X	X	
LM		1 - primary	Electro-M N1	76°E										X	X	X	X	X	X	X	X	X	X	X	
LM		1 - primary	Electro-M N2	77.8°E											X	X	X	X	X	X	X	X	X	X	
LMI		1 - primary	FY-4C	86.5°E					X	X	X	X	X	X	X	X									
LMI		1 - primary	FY-4E	86.5°E												X	X	X	X	X	X	X	X		
LMI		1 - primary	FY-4G	86.5°E																		X	X	X	
LMI		1 - primary	FY-4A	99.5°E		X	X	X	X	X															
LMI		1 - primary	FY-4B	105°E			X	X	X	X	X	X	X	X											
LMI		1 - primary	FY-4D	105°E								X	X	X	X	X	X	X	X						
LMI		1 - primary	FY-4F	105°E															X	X	X	X	X	X	
LIS		4 - fair	TRMM	35 °																					
LIS (ISS)		4 - fair	ISS LIS	51.6 °		X	X	X	X	X	X														
OTD		4 - fair	OrbView-1/MicroI	70 °																					
ISUAL		5 - marginal	FORMOSAT-2	09:30 desc	X	X																			

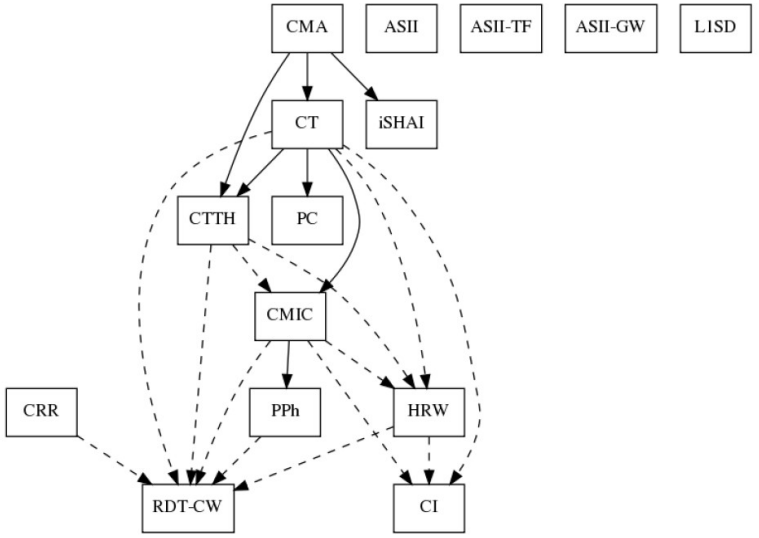
Let's be prepared !!

NWCSAF GEO Products

Wide use of nearly all future bands

LABEL	MTG FDHSI	CMA	CT	CTTH	CMIC	PC	CRR	PPh	iSHAI	HRW	EXIM	ASII	ASII-NG	CI	RDT-CW
VIS04	0,444 µm 1km										O				
VIS05	0,510 µm 1km										O				
VIS06	0,640 µm 1km	M	M		M	M	O			O	O				O
VIS08	0,865 µm 1km	O								O	O				
VIS09	0,914 µm 1km										O				
NIR13	1,380 µm 1km	O	O								O				
NIR16	1,610 µm 1km	O			M	M					O				
NIR22	2,250 µm 1km	O			O						O			O	O
IR38	3,800 µm 2km	M	M			M					O				
WV62	6,300 µm 2km			O		M	M		M	O	O		O	M	O
WV73	7,350 µm 2km	O	O	O		M			M	O	O		O	O	O
IR87	8,700 µm 2km	O	O		M				M		O			O	O
IR97	9,660 µm 2km								M		O		O		
IR108	10,50 µm 2km	M	M	M	M	M	M	O	M	O	O		O	M	M
IR120	12,30 µm 2km	M	M	O		M			M	O	O			O	O
IR134	13,30 µm 2km	O		O					M		O			M	

Strong dependencies (v2018)



- NWCSAF Products take benefit of all MSG SEVIRI bands. Example the cloud group uses all bands. Similar plans for MTG FCI
- Strong dependencies between products. Example the cloud product used by all other products

Conclusion

- CI

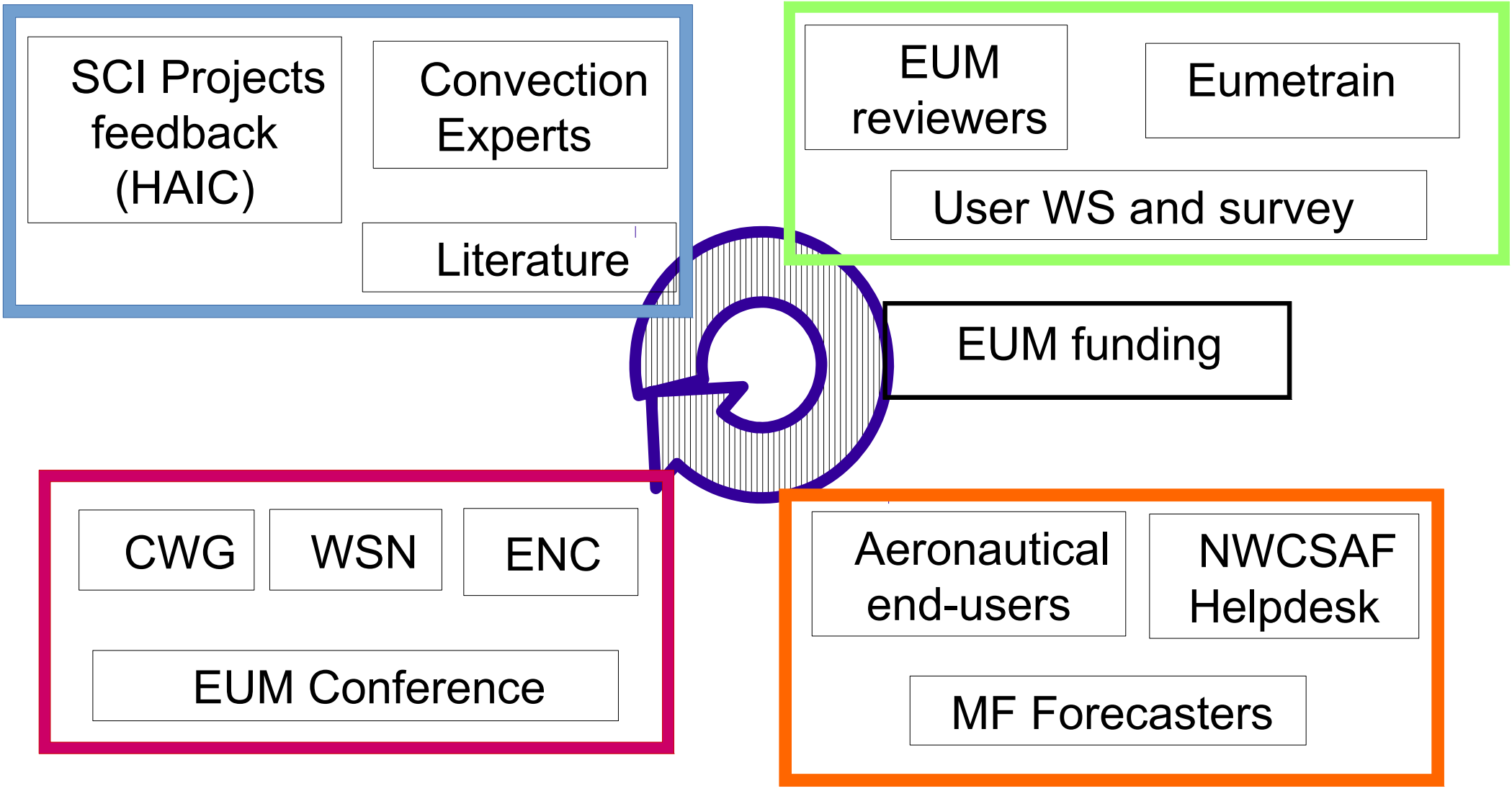
* Highly improved and now better known
* CI useful for forecasters and convection study
* A gap has been filed between v2016 and v2018
* We are a the boundary of the requirements
* TROPOS experts are relatively confident. “v2018 CI product constitutes a **clear improvemen**t over its predecessor v2016, in particular considering the fact that our validation using ground-based radar fields is rather strict”
* **v2018 reached the status pre-operational**
* Still room for development in future

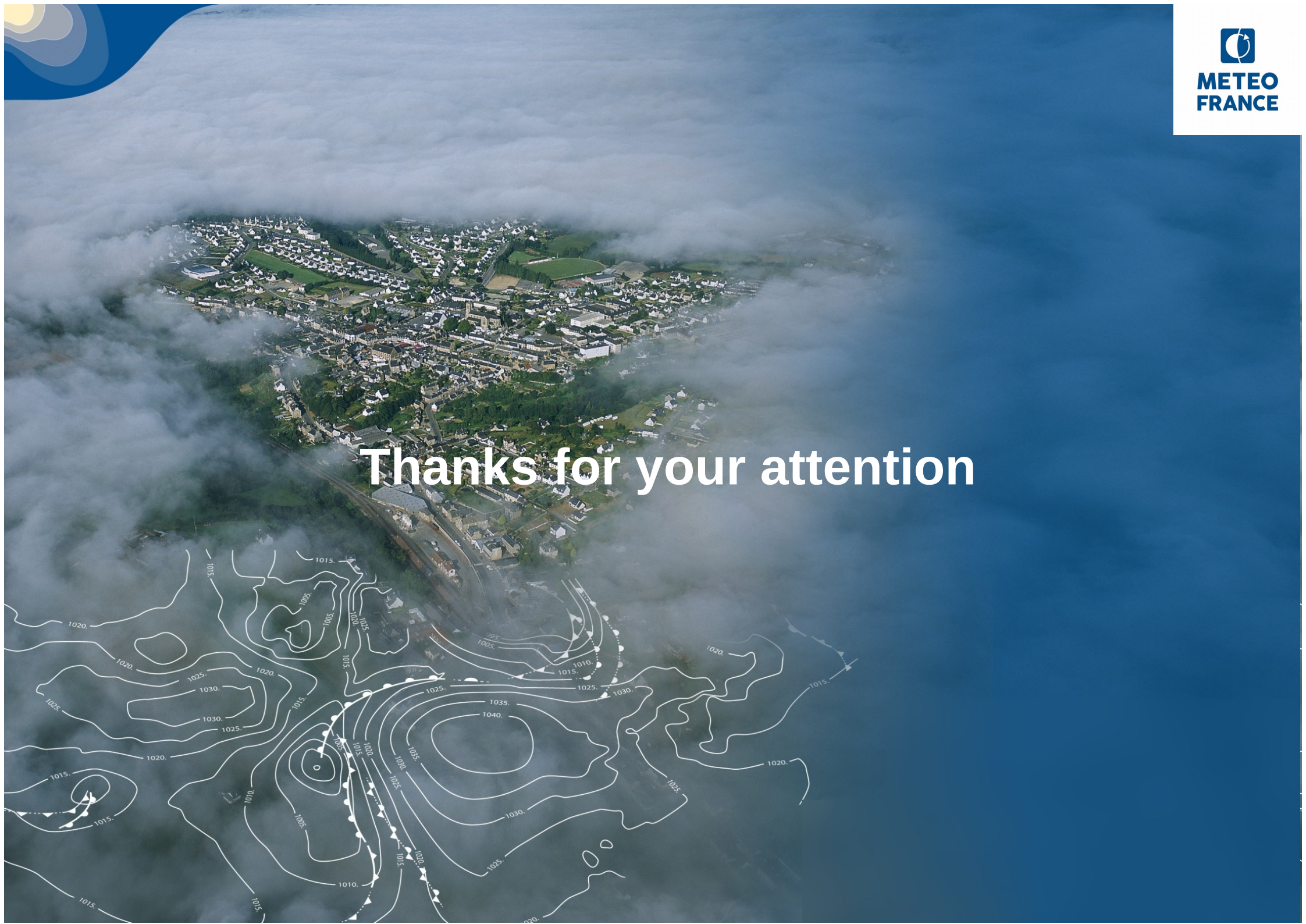
- RDT

* A broader and broader picture of convective systems !
* More configurable and adaptive than even before !
* Widely used for operation and research activities. Highly useful for aviation !

NEXT DELIVERIES : v2021 MTG Day1, v2023 MTG Day2

RDT and CI evolution Driving Forces




Thanks for your attention