

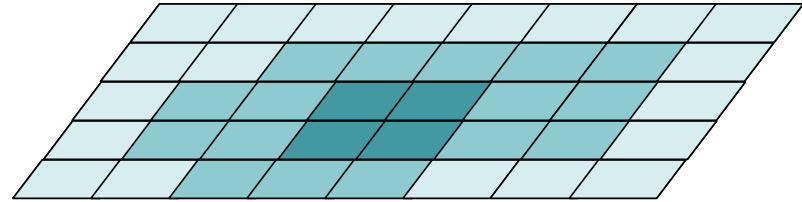
NWCSAF convection products: CI and RDT

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Météo-France, Nowcasting Department

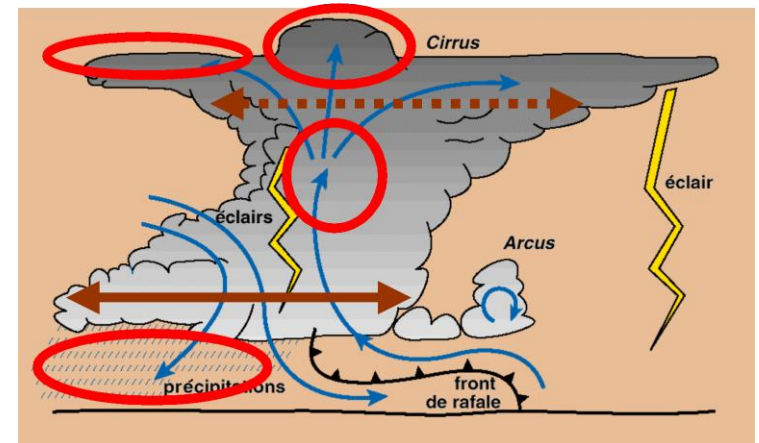
Convection Working Group 2016, Florence 4-8/4/2016

Introduction

- **CI**=Convection Initiation
 - Pixel-based product
 - First delivery NWCSAF v2016

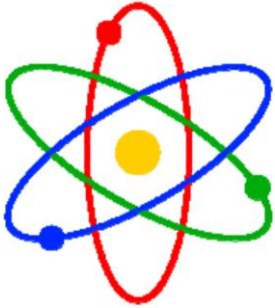


- **RDT**=Rapidly Developing Thunderstorm
 - Object-mode product
 - Actual delivery: v2013
 - Next delivery: v2016

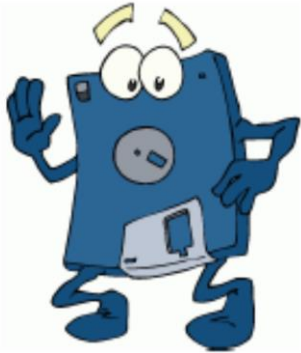


- PGEs in **NWCSAF** package (Convection Group)

Science / Software / Production



CI and RDT take advantage of scientific community progress and new satellites upcoming.



CI and RDT are softwares mainly developed in the context of NWCSAF. Integrated inside task manager



RDT is operated by many end-users, including Météo-France.

CI soon operated

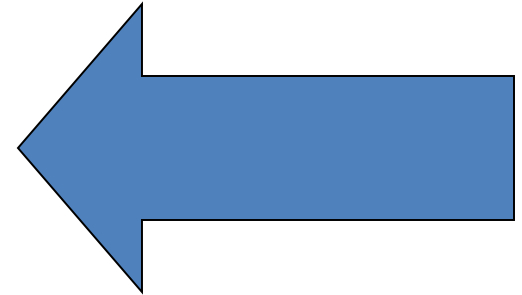
Science / Software / Production /Users



Research or Operation

Overview

1.CI - Convection initiation



1.RDT

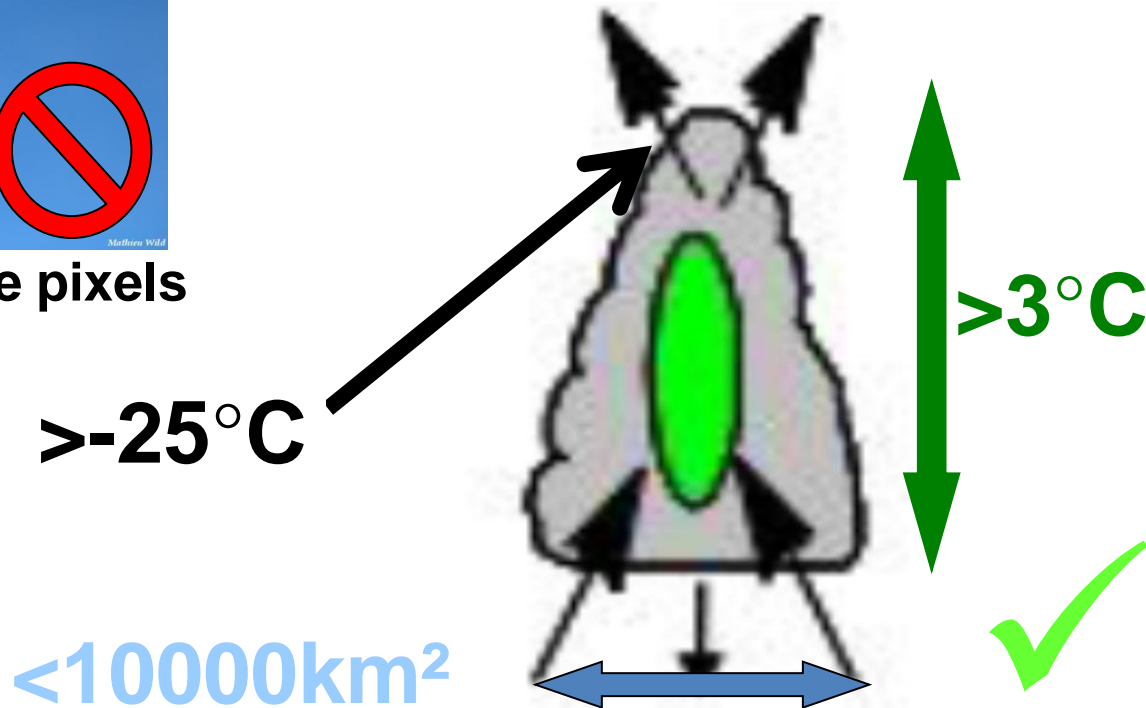
1.Future works

Convection Initiation (CI) - Definition

Convective initiation nowcasting: **which clouds will become thunderstorms in the near future?** Definition of CI: radar precipitation echo intensity criteria of 30–40 dBZ



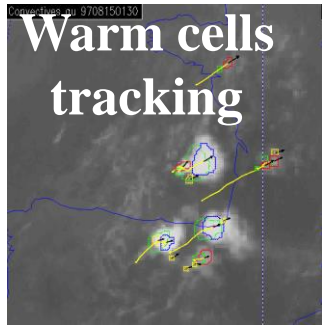
Cloud-free pixels



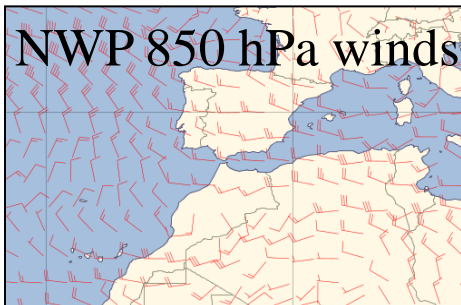
Too cold pixel

First step="Warm" Cells Detection

CI- Necessity to track the pixels



Priority



Second step: Displacement fields

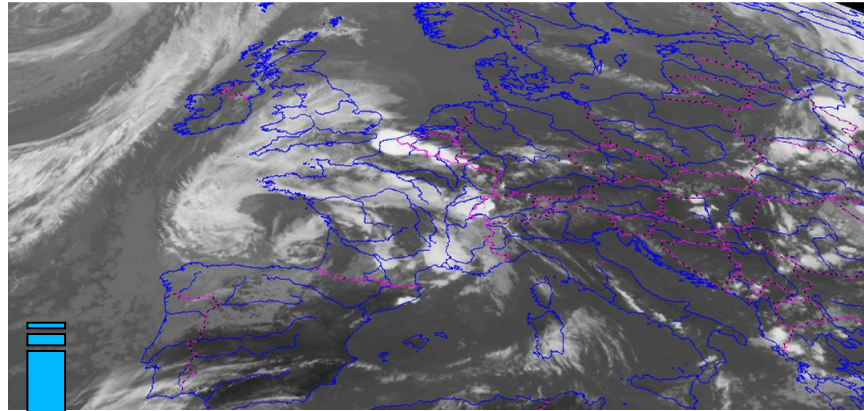
Objective: to determine previous pixels-position (and then to **calculate dynamic trends**)

- ☐ Classical 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

A satellite image showing a complex cloud pattern with yellow and green outlines. The text 'HRW NWCSAF Product' is overlaid in the top left.

NWCSAF convection products: CI and RDT

Area of interest, pixel of interest, probability assessment (1/2)



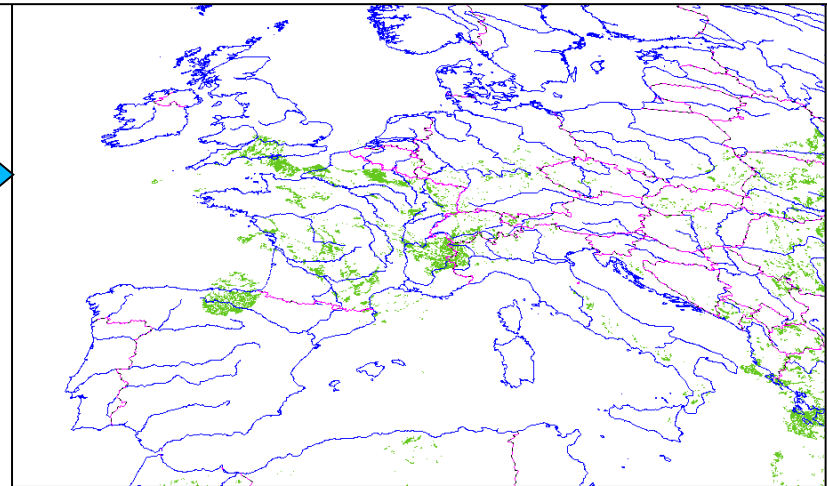
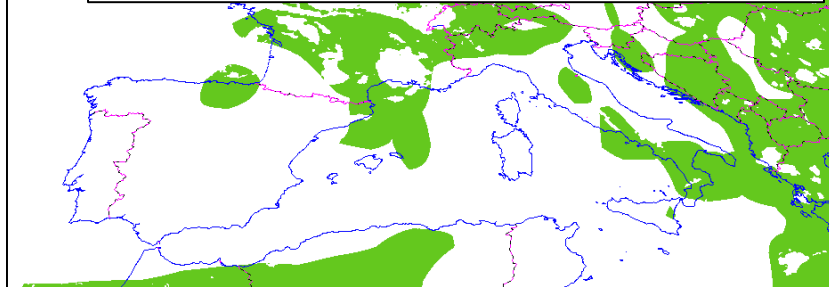
Succession of filters

Areas of interest
Multimask Merging

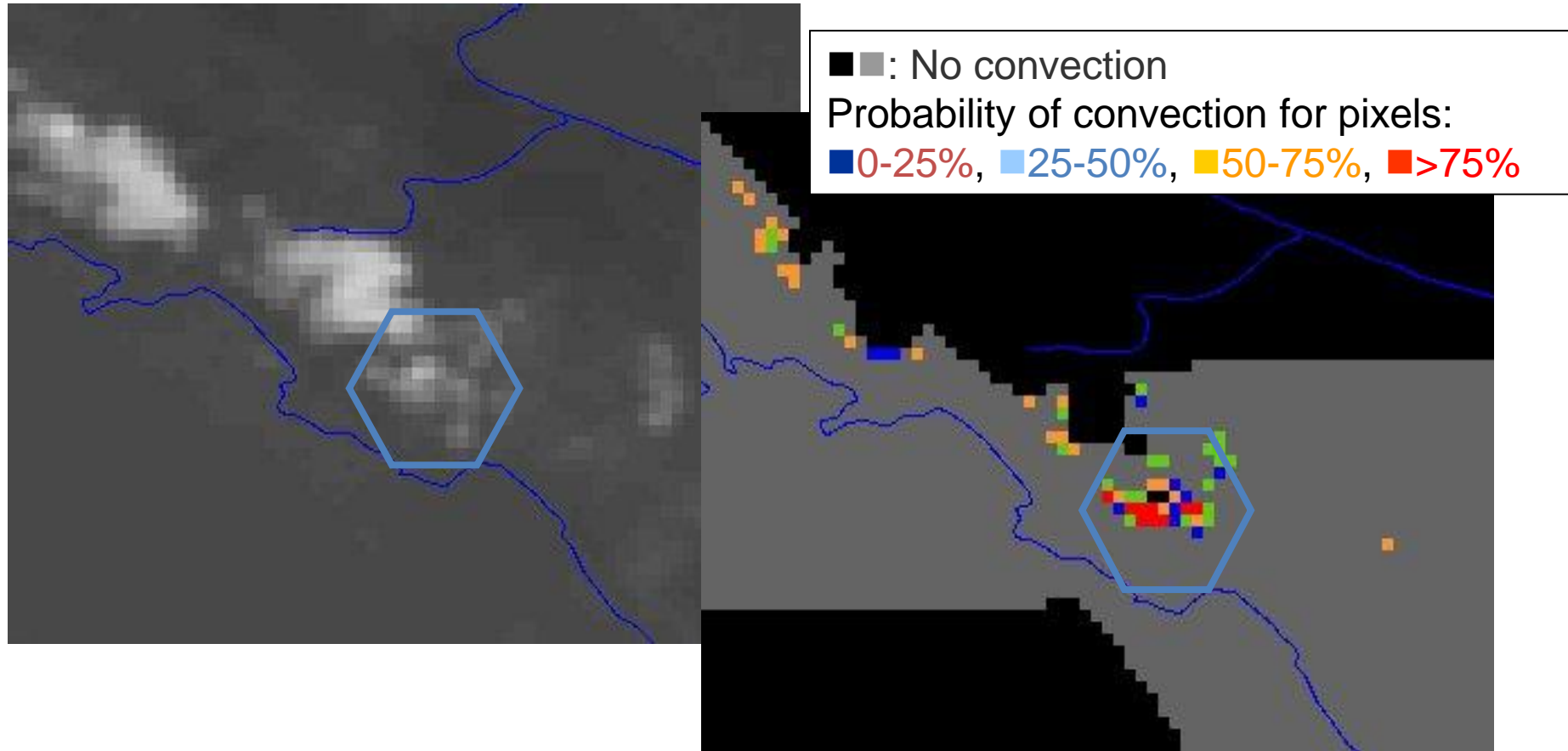
- Cloudy and non-stretched pixels
- Convective areas (NWP mask)
- Brightness temperature range

Pixels of interest Multi-parameters analysis

- Vertical Extension
- Glaciation
- Updraft



Area of interest, pixel of interest, probability assessment (2/2)

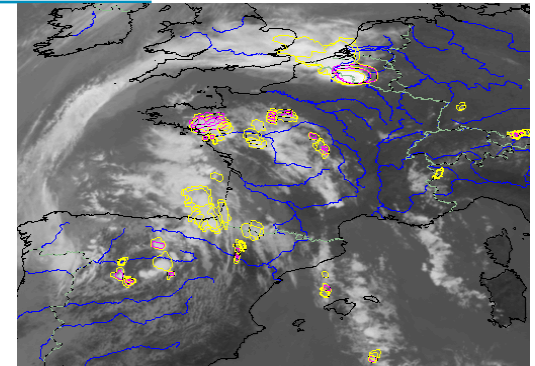


- ❑ Vertical extension criteria: BTD 6.2-10.8 μ m, high BTD 13.4-10.8 μ m
- ❑ Glaciation: cold BT10.8 μ m, time below 0°C (using BT 10.8 μ m)
- ❑ Updrafts: strong negative trends of BT10.8 μ m, strong trend of BTD6.2-10.8 μ m

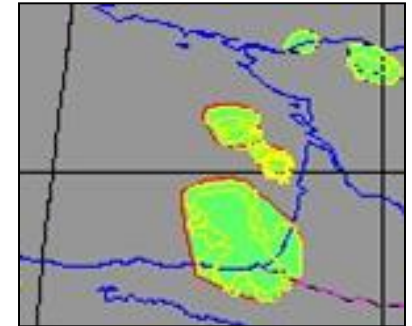
Inspired by SATCAST methodology, described in « Best Practice Document, 2013, for EUMETSAT Convection Working Group, Eds J.Mecikalski, K. Bedka and M. König »

Tuning and validation: the ground truth

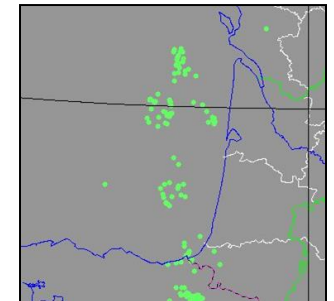
❑ Smoothed Path tracks from successive RDT **convective** cells



❑ Smoothed Path tracks from successive radar-based cells (30 dBZ)



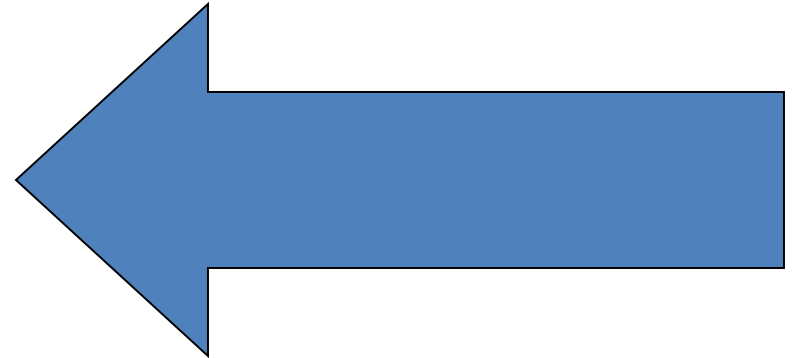
❑ Enlarged (~10km) plots from cumulated **strokes** for a given period



Overview

1.CI

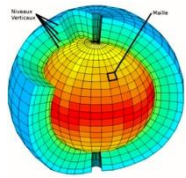
**1.RDT – Rapidly
Developing
Thunderstorm**



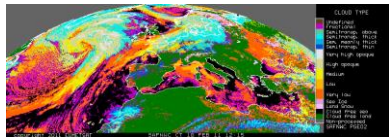
1.Future works

RDT: data fusion for description of convection

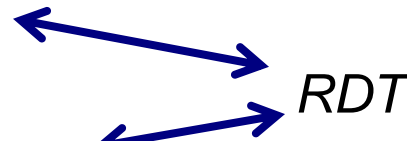
Input Data: Multisource



NWP
data



Other NWCSAF
products



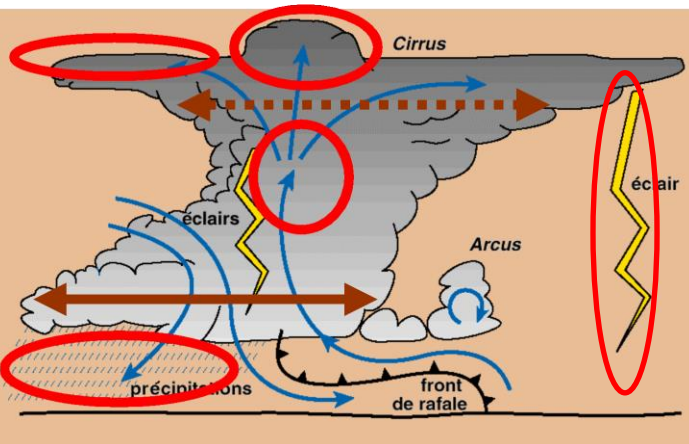
MSG data
(5 IR channels + VIS)



Lightning Data



Output: Multilevel Description Of Convection

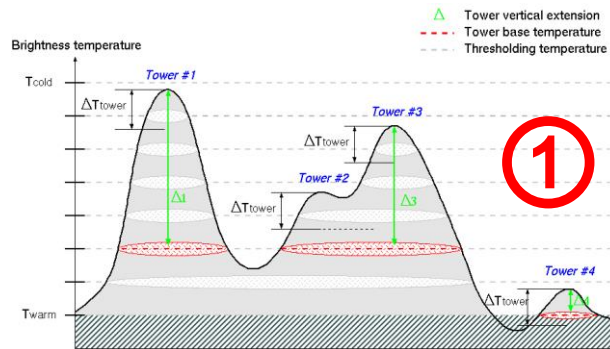


- Main description of cell: Yes/No convection diagnosis, cell-development phase, position, surface, T, gap to tropopause, cloud type and phase, cloud top pressure. Severity Index high IWC hazard. Displacement Relevant trends are calculated
- Overshooting Tops, Lightning Activity, Convective Index, Rainfall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

4-steps algorithm of RDT

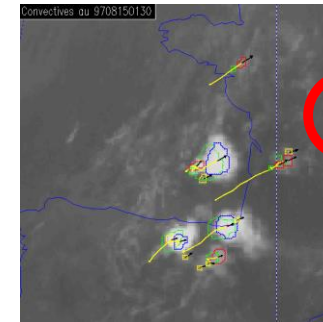
STEP1: 10.8 μm detection

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



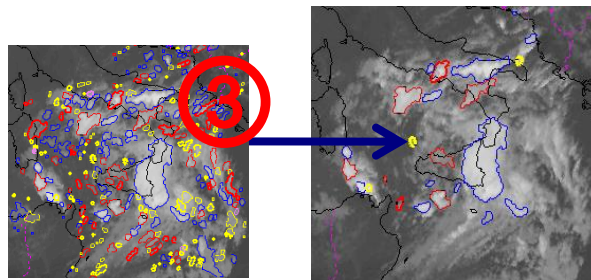
STEP2: Tracking

- 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)

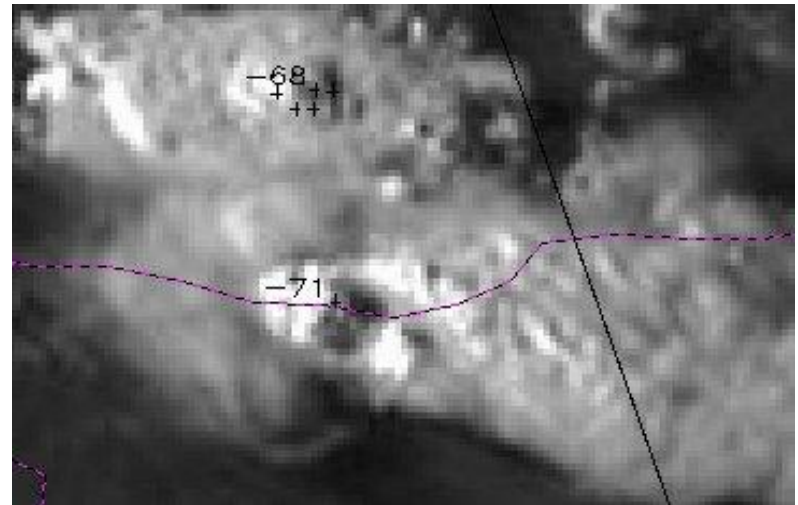
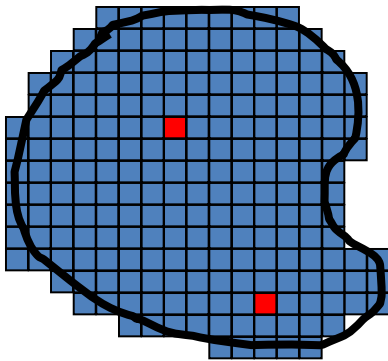


Overshooting Tops Detection - v2013

OT: the challenge of automatic detection

OTD Inside each RDT cell. Day&Night algorithm

- ❑ 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



RDT and high IWC (Ice Water Content)

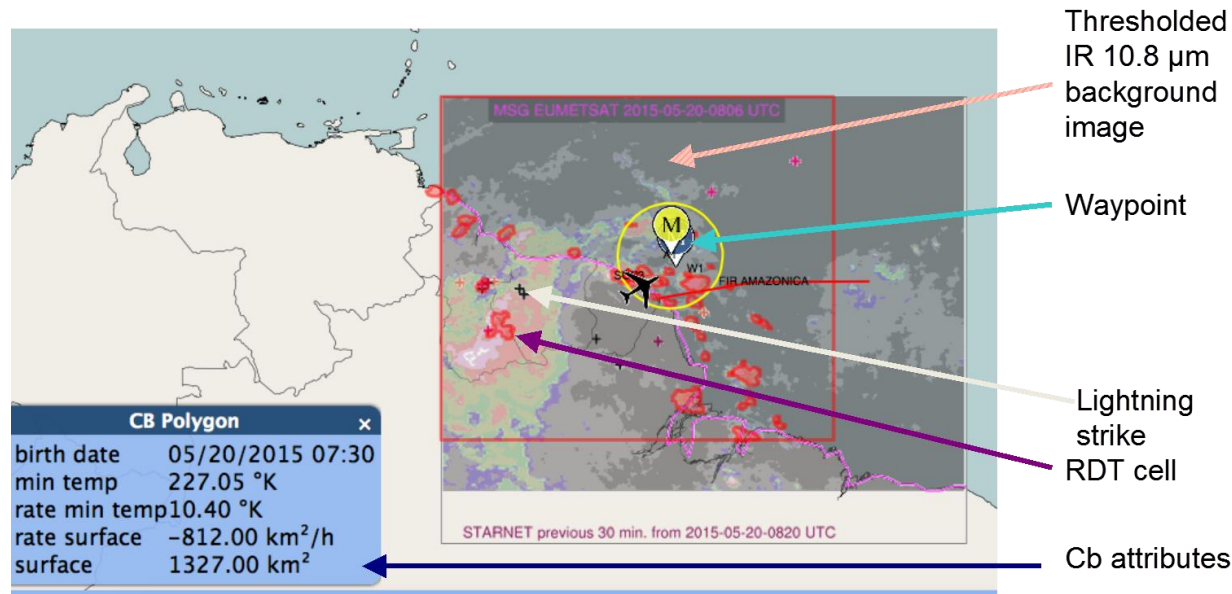
❑ HAIC project. Project co-funded by the European Commission within the Seventh Framework Programme (2012-2016). <http://www.haic.eu/>



❑ Use of RDT in order to detect and track convective systems that could generate conditions of high IWC (Ice Water Content). Uplink of RDT

Planet system

*Atmosphere
Company
courtesy T.
Dacla, S. Turner*



❑ Quantitative evaluation of RDT as a tool for detection of high IWC areas. New attribute in v2016. Elaborated thanks to new NWCSAF CMIC product

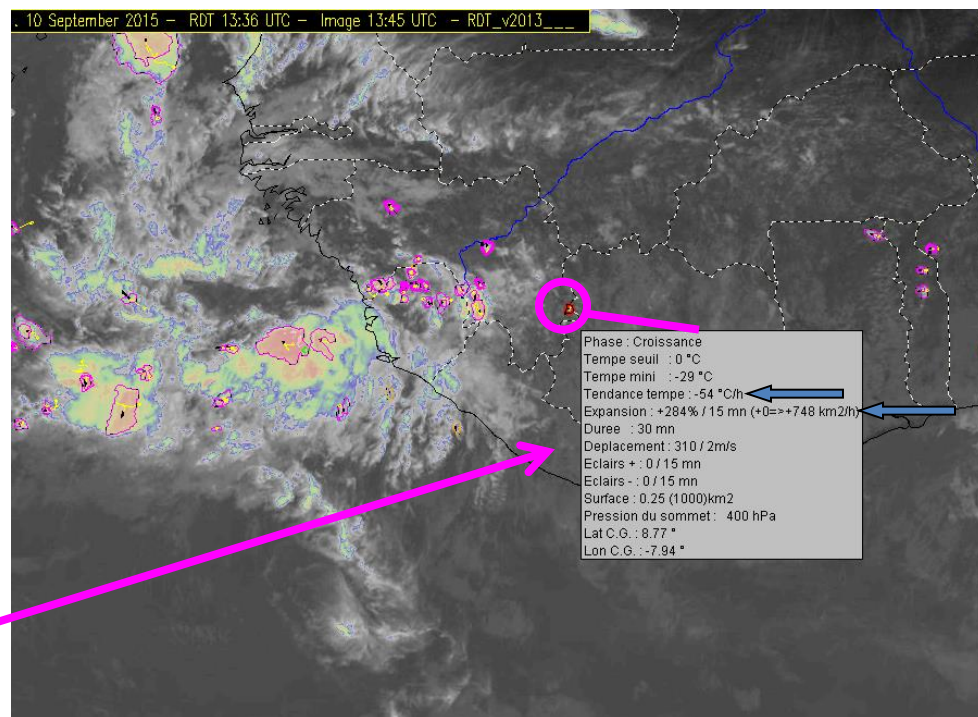
RDT – Severity Attribute

❑ Each feature of convection is interesting 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)

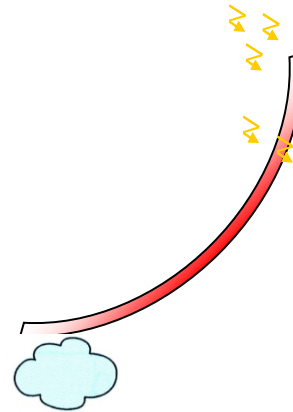


RDT: validation

- **Subjective** validation by Météo-France experts
- *various case studies, use of topical case for each release.*



- **Objective** validation by Météo-France (v2012)
 - Accuracy requirements fulfilled
 - Detection is superior to 70%
 - Early diagnosis for 25% of convective systems



- Validation by **users**
 - Research Projects, NMS, other NWCSAF users
 - User Survey 2014:
 - RDT is rated 6.7 (/10) in term of usefulness by users
 - Convection Initiation most expected product



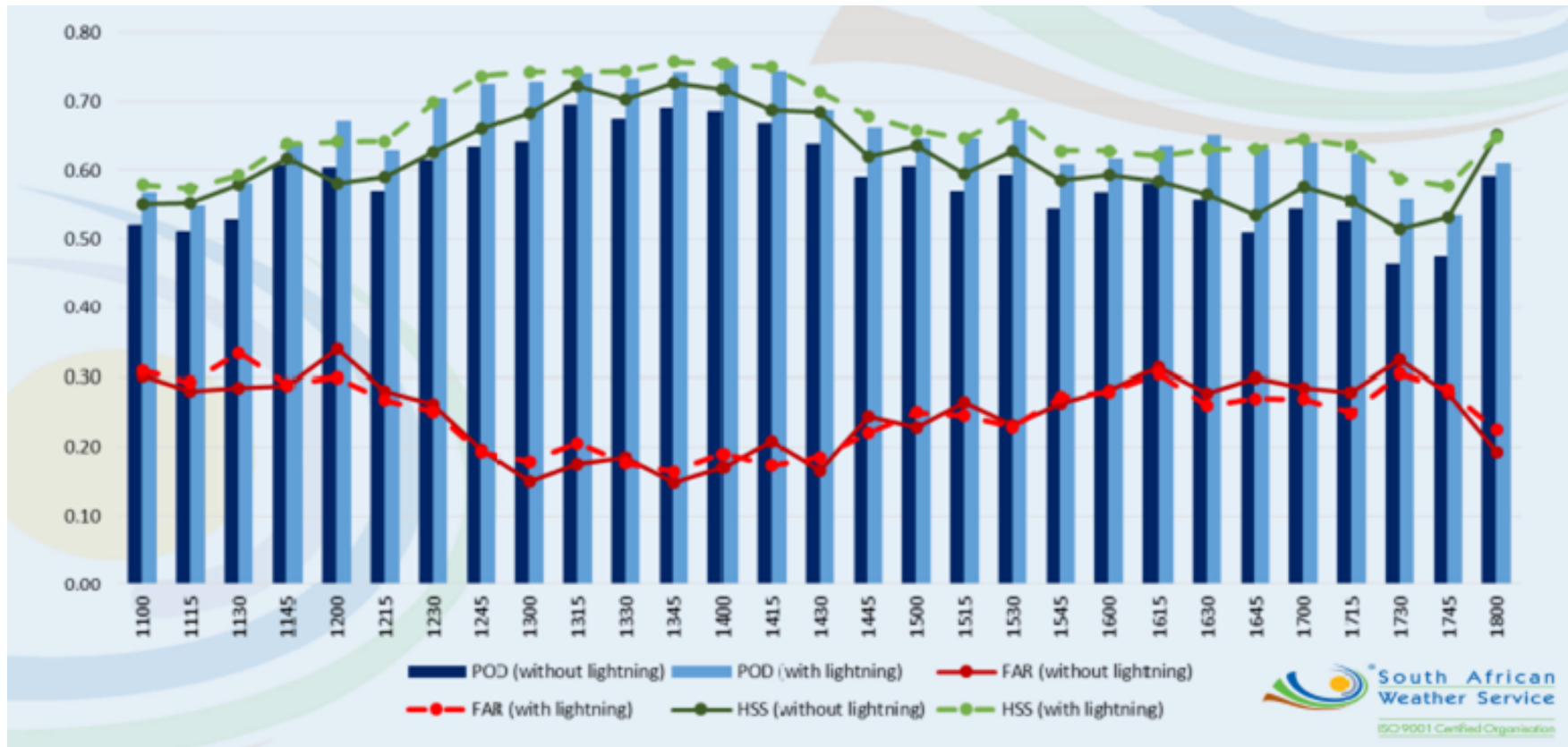
- **Any feedback is welcome !**   

RDT Validation by SAWS

Against 35 dBZ radar reflectivity

Object-based methodology

RDT operated with and without lightning data (25 cases)



Courtesy E. De Coning (SAWS)

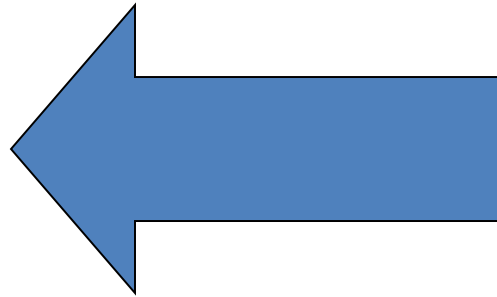
NWCSAF convection products: CI and RDT

Overview

1.CI - Convection initiation

1.RDT

1.Future works



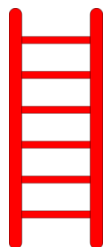
MTG Context for RDT

FCI Number of channels:

Experienced.

Expected.

New physical properties (e.g. $0.91\mu\text{m}$ for total column precipitable water)



Spectral accuracy:

Experienced

Expected

Better estimate of BT

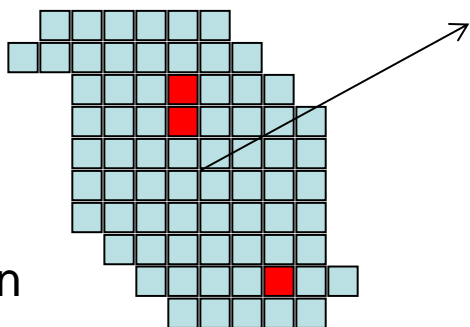


FCI Resolution:

Experienced

Expected

Small scale phenomena detection



LI

un-experienced.

Highly expected.

Impact on RDT validation, tuning, description, real-time mode, monitoring



RSS issue and NWCSAF needs (mirroring dissemination)... pending issue

CDOP3 proposal for CI and RDT

- ❑ Products will be developed during next phase
 - ❑ CI from Pre-operational (tbc) to Operational
 - ❑ CDOP2 v2016 1st release
 - ❑ CDOP3: V2019, v2022
-
- ❑ RDT. Still ways of improvement Road to MTG
 - ❑ CDOP2 v2013 last release (OTD)
 - ❑ CDOP2 v2016 next release (advection scheme, netcdf, etc.)
 - ❑ CDOP3: V2019, V2022
-
- ❑ New satellites : Himawari-8, MTG
-
- ❑ Taking advantage of NWCSAF: intergration of products, end-users interaction (from the requirements to the helpdesk), review process, 5-years plan, configurable SW

An aerial photograph of a mountain town, likely in the Swiss Alps, with a weather map overlay. The town is nestled in a valley, surrounded by steep, forested slopes. The weather map features white contour lines on a dark blue background, indicating pressure systems. A low-pressure system is visible to the left of the town, with a cold front (indicated by a line with triangles) extending towards the town. A high-pressure system is located to the right of the town. The text "Thanks for your attention" is overlaid in large white letters across the center of the image.

Thanks for your attention



METEO FRANCE
Toujours un temps d'avance

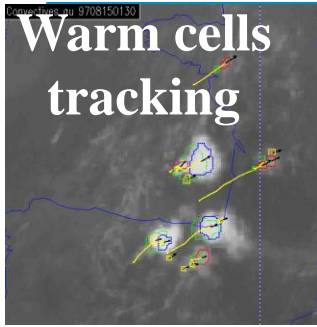
Parameter of interest / thresholds

Parameter name	Meaning			Mode			Relevant value	Use		
	Ice	Height	Growth	Inst.	Trend 15'	Trend 30'		Eligible CI	Pre-Ci	Ci-Diag.
BT 10.8	X			X			>-25°C	X		
BT 10.8	X			X			>-20°C		X	X
BT 10.8			X		X	X	]-4°15',-50°15'[		X	X
Time below 0°C	X						within 30'		X	x
BTD IR10.8-IR8.7	X			X			]-10°,0°[		X	X
BTD WV6.2-IR10.8		X		X			]-35°,-10°[		X	X
BTD IR13.4-IR10.8		X		X			]-25°,-10°[		X	X
BTD IR12.0-IR10.8		X					]-3°,0°[		X	X
WBTD WV6.2-WV7.3		X					]-25°,-3°[		X	X
BTD WV6.2- IR10.8			X		X		>3°C/15'		X	x
BTD WV6.2- IR10.8			X			X				
BTD IR10.8-IR8.7			X		X		]-0°15',10°15'[		X	
BTD IR10.8-IR8.7			X			X				
BTD IR12.0-IR10.8			X		X		]-0°15',10°15'[		X	
BTD IR12.0-IR10.8			X			X				
BTD IR 13.4- IR 10.8			X		X		>3°C/15'		X	
BTD IR 13.4- IR 10.8			X			X				

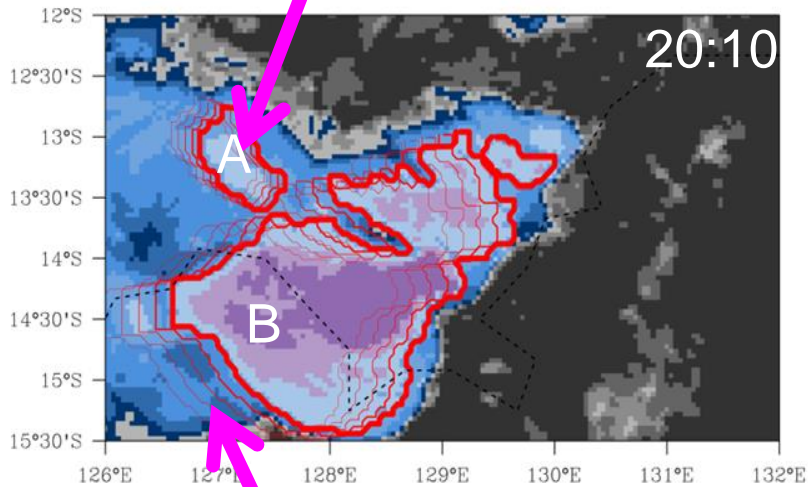
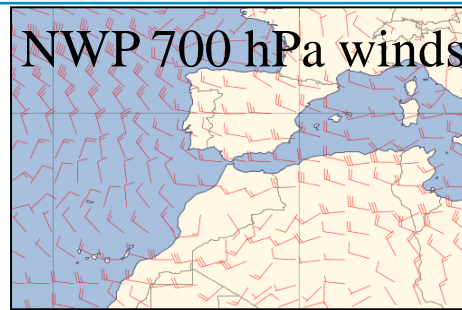
Empirical rules for CI-diagnosis

<i>Nb of Glaciation relevant parameters (over 3)</i>	<i>Nb of Height relevant parameters (over 4)</i>	<i>Nb of Growth relevant parameters (over 3)</i>	<i>Result</i>
≥ 3	≥ 4	≥ 2	HIGHPROB
	≥ 3		MODPROB
	< 3		LOWPROB
≥ 2	≥ 4		MODPROB
	≥ 3		LOWPROB
	< 3		VLOWPROB
≥ 3	≥ 4	≥ 1	MODPROB
	< 4		LOWPROB
≥ 2	≥ 4		LOWPROB
	≥ 3		VLOWPROB
≥ 3	≥ 3	0	LOWPROB
	< 3		VLOWPROB
Other cases			0

NWP data and other PGEs for speed cell estimate

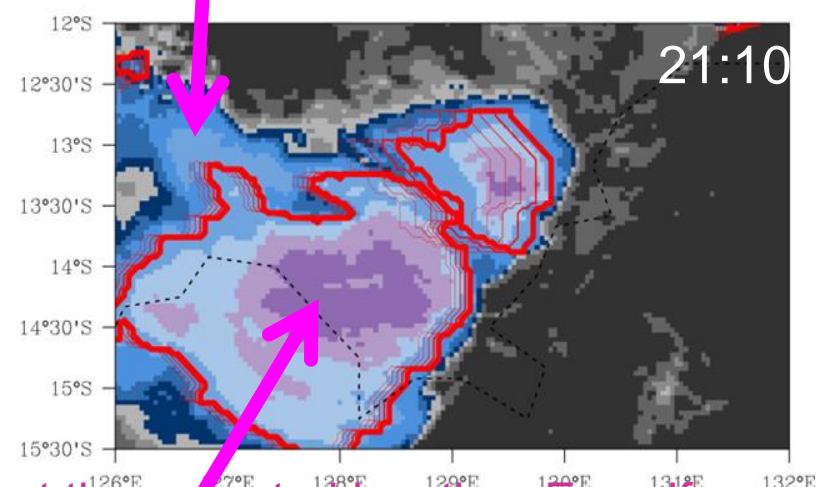


Priority



WSW displacement of cell “B”

“A” cell has disappeared. Bad forecast
(False Detection)



“B” at the expected location. Even if change in morphology is not forecast

NWCSAF convection products: CI and RDT

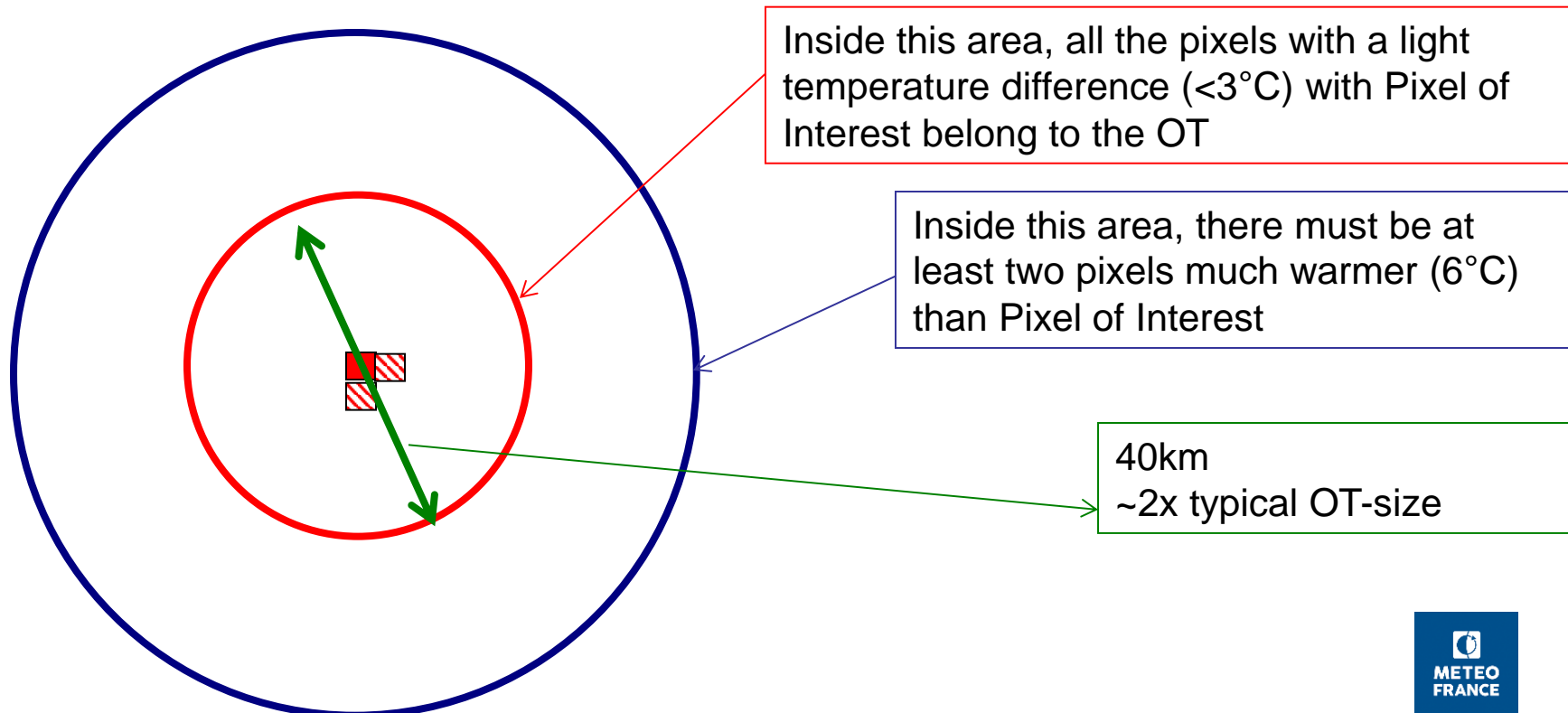


Overshooting Tops Detection (additional slide)

Analyse of the vicinity

We look around the Pixel of Interest, using typical values of OT-size values. For each pixel of interest, the aims of this step are

- ❑ **To define** the pixels that may belong to the OT
- ❑ **To confirm** that there are much warmer surrounding pixels



Overshooting Tops Detection (additional slide)

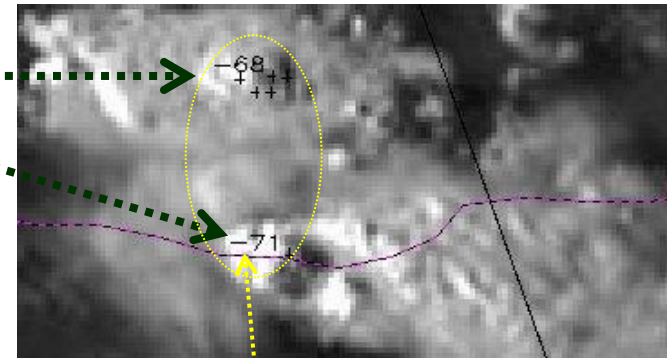
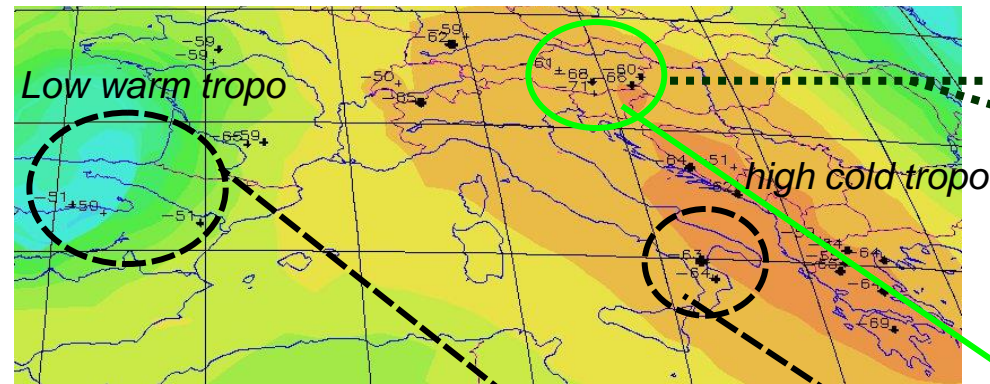
Despite the identification of cold significant pixels surrounded by warm pixels, detection of OT is not always confirmed by HRV images or tropopause height. A further confirmation step is necessary

Final tuned conditions to be satisfied

- ☐ OT candidate at least 5° C colder than **NWP** tropopause (*wet adiabatic relaxation of the air particle*)
- ☐ Or at least 2 conditions satisfied using following parameters of interest
 - ☐ Colder than NWP tropopause,
 - ☐ High BTD=WV6.2-IR10.8 >1.5
 - ☐ **VIS0.6** reflectance > 70%
 - ☐ Temperature difference between OT and average cloud-cell temperature (>6°)

Overshooting Tops Detection (additional slide)

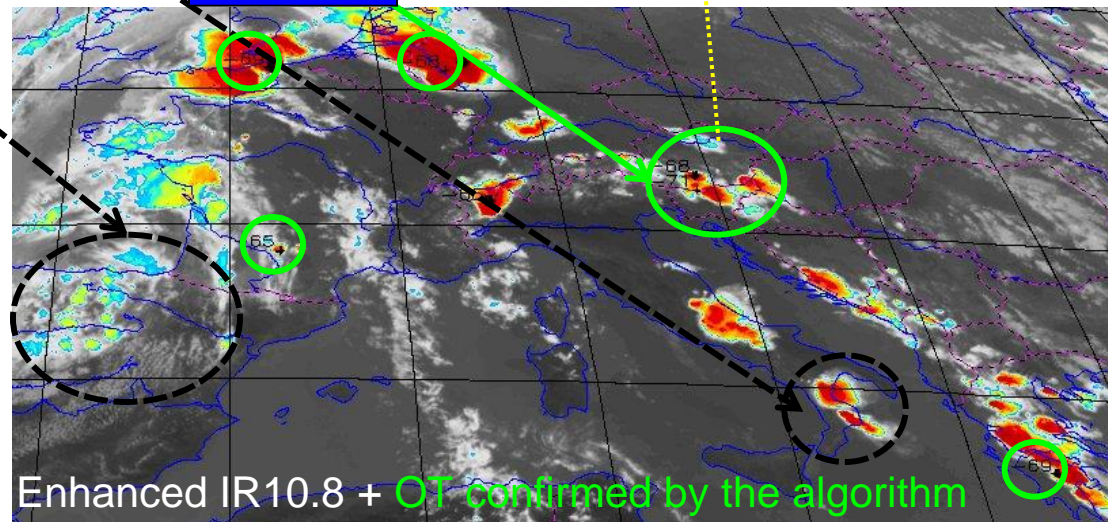
NWP tropopause T° field + pre-selected OT



HRV-use for tuning and validation

COLDER

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



Enhanced IR10.8 + OT confirmed by the algorithm

Topical Case study (25th May 2009)
