

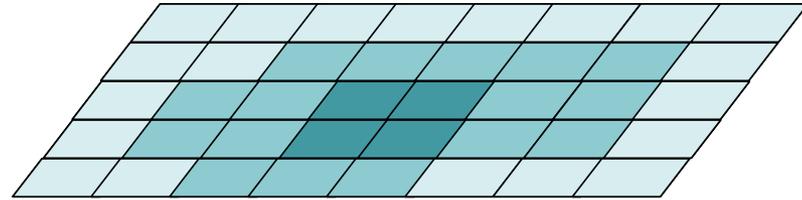
NWCSAF convection products: CI and RDT

Jean-Marc Moisselin, Frédéric Autonès
Météo-France, Nowcasting Department

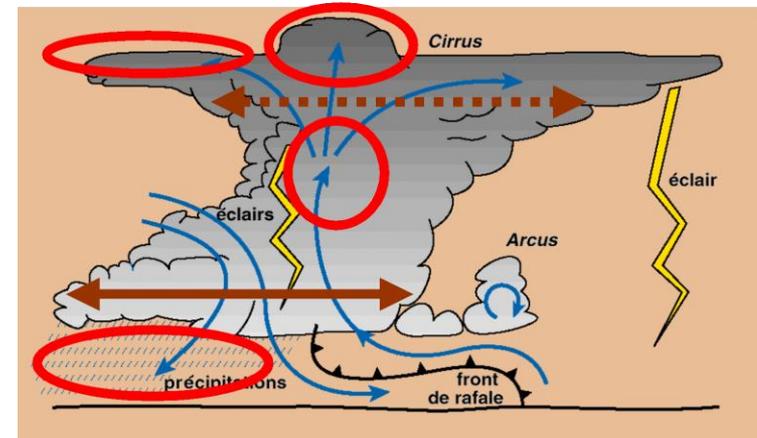
Convection Working Group 2016, Florence 4-8/4/2016

Introduction

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

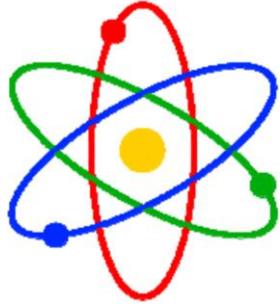


- **RDT**=Rapidly Developing Thunderstorm
 - Object-mode product
 - Actual delivery: v2013
 - Next delivery: v2016

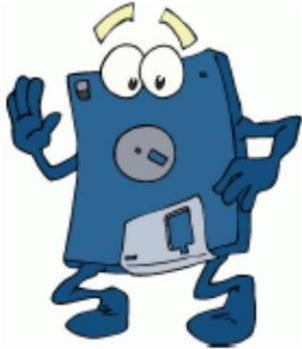


- PGEs in **NWCSAF** package (Convection Group)

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

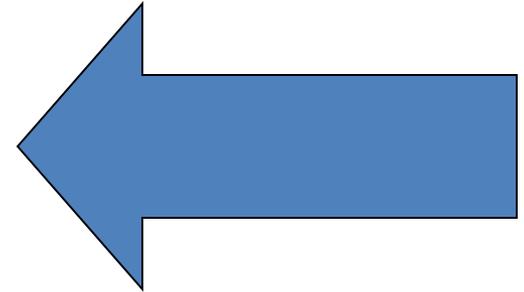
Science / Software / Production /Users



Research or Operation

Overview

1.CI - Convection initiation



1.RDT

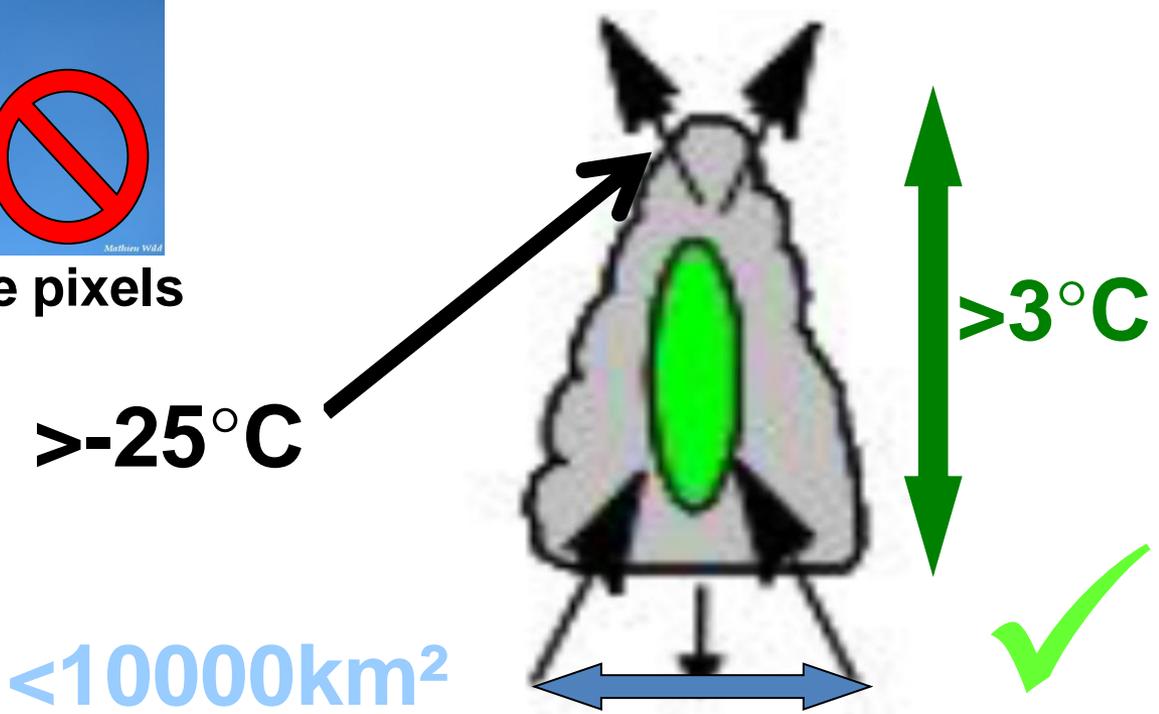
1.Future works

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



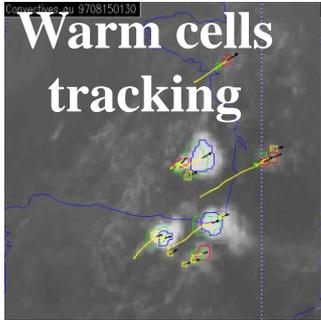
Cloud-free pixels



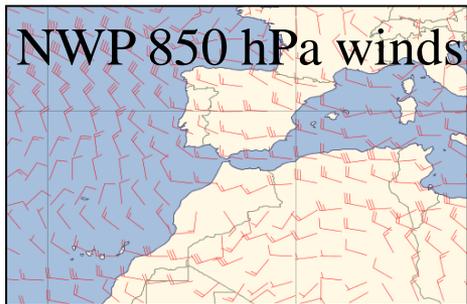
Too cold pixel

First step="Warm" Cells Detection

CI- Necessity to track the pixels



Priority



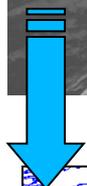
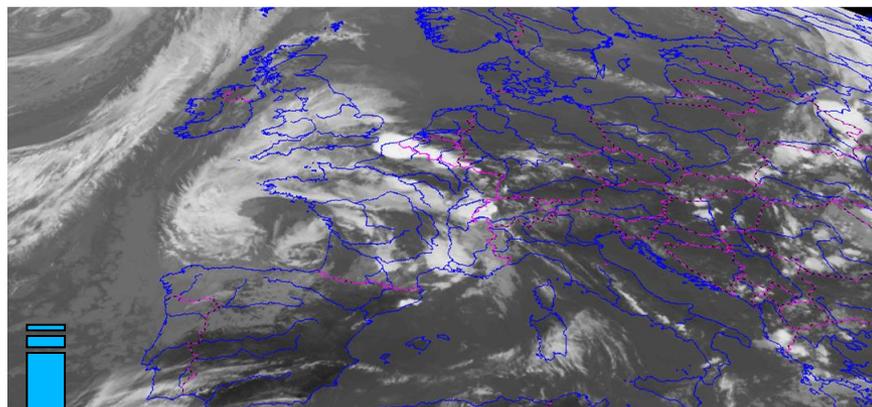
Second step: Displacement fields

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



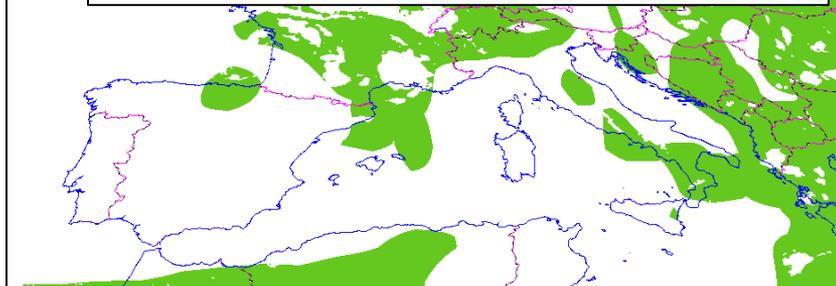
Area of interest, pixel of interest, probability assessment (1/2)



Areas of interest

Multimask Merging

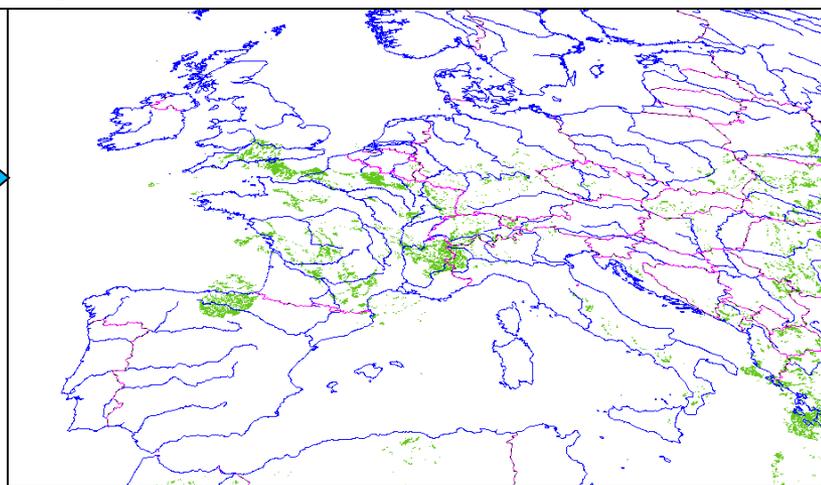
- Cloudy and non-stretched pixels
- Convective areas (NWP mask)
- Brightness temperature range



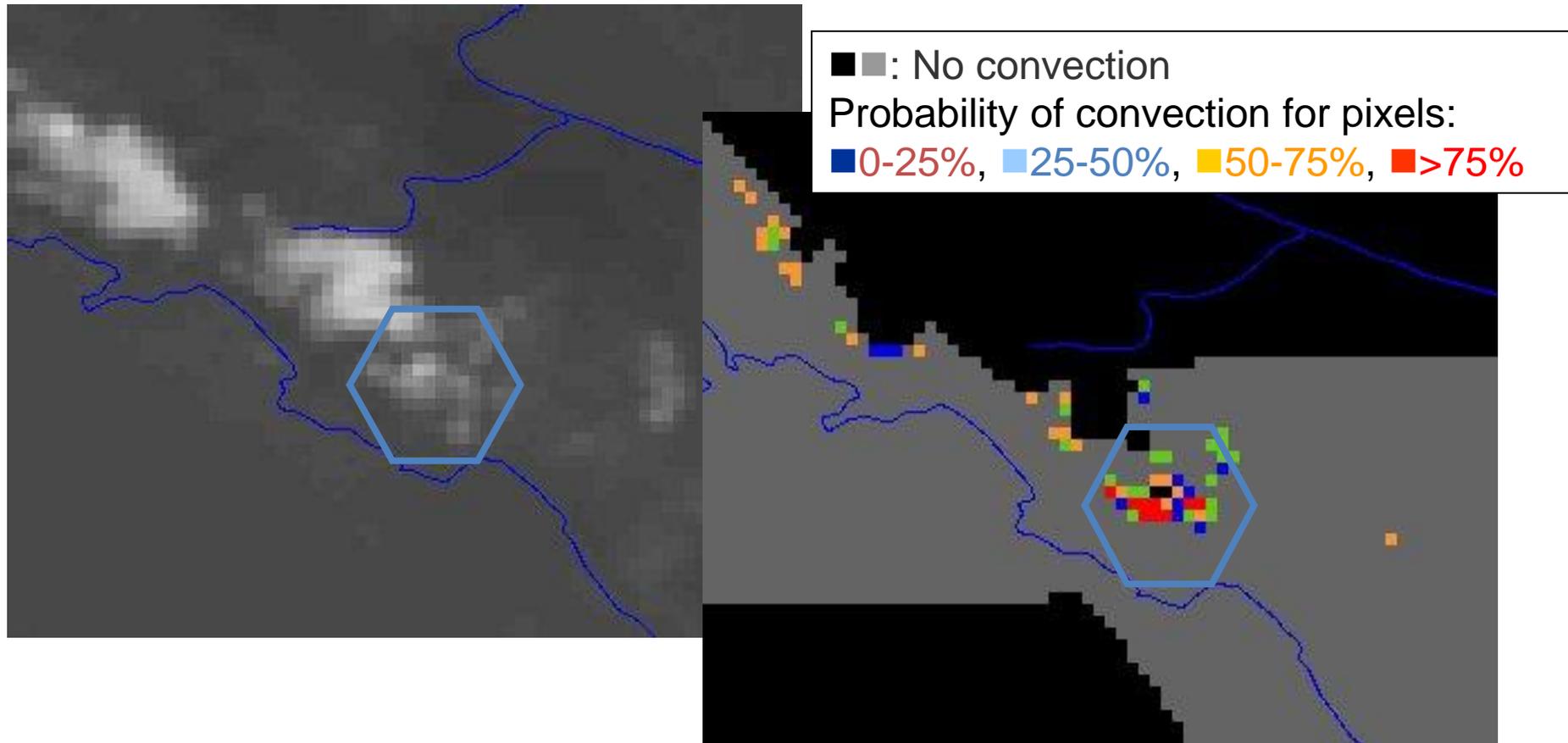
Succession of filters

Pixels of interest Multi-parameters analysis

- Vertical Extension
- Glaciation
- Updraft



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

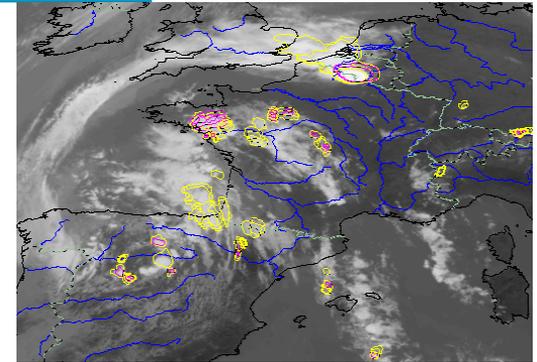


- ❑ Vertical extension criteria: BTD 6.2-10.8 μ m, high BTD 13.4-10.8 μ m
- ❑ Glaciation: cold BT10.8 μ m, time below 0°C (using BT 10.8 μ m)
- ❑ Updrafts: strong negative trends of BT10.8 μ m, strong trend of BTD6.2-10.8 μ m

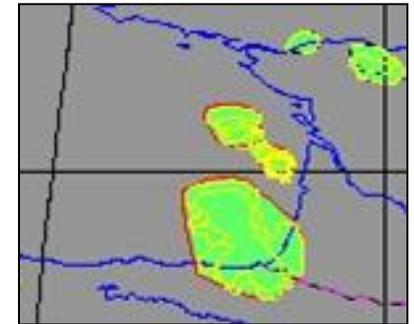
Inspired by SATCAST methodology, described in « Best Practice Document, 2013, for EUMETSAT Convection Working Group, Eds J.Mecikalski, K. Bedka and M. König »

Tuning and validation: the ground truth

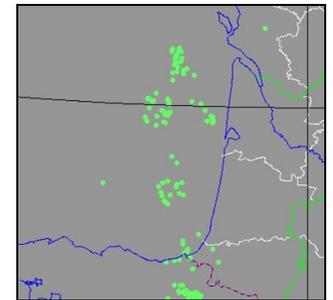
❑ Smoothed Path tracks from successive RDT **convective** cells



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



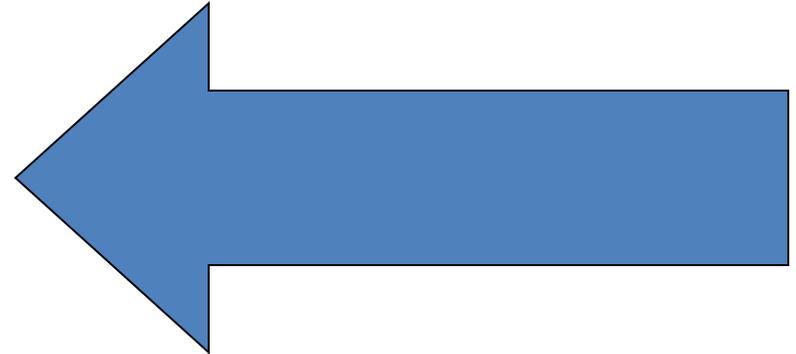
❑ Enlarged (~10km) plots from cumulated **strokes** for a given period



Overview

1.CI

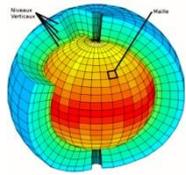
**1.RDT – Rapidly
Developing
Thunderstorm**



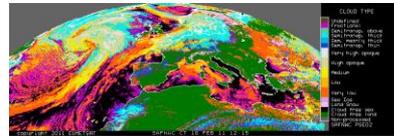
1.Future works

RDT: data fusion for description of convection

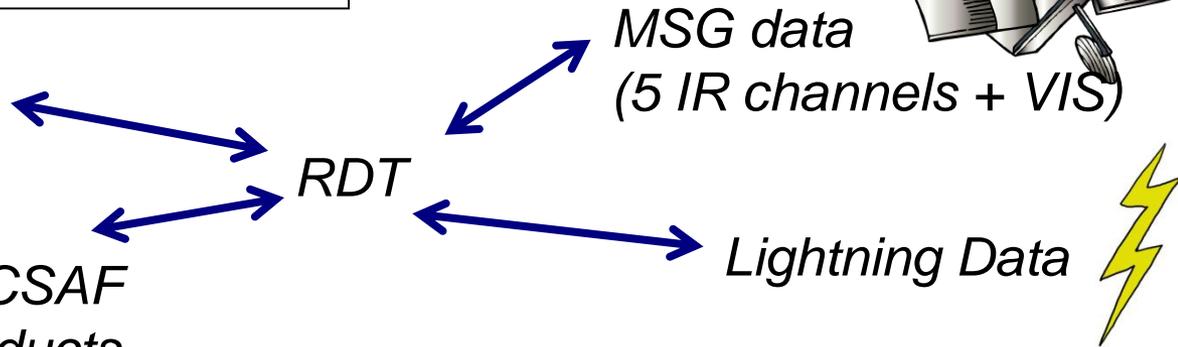
Input Data: Multisource



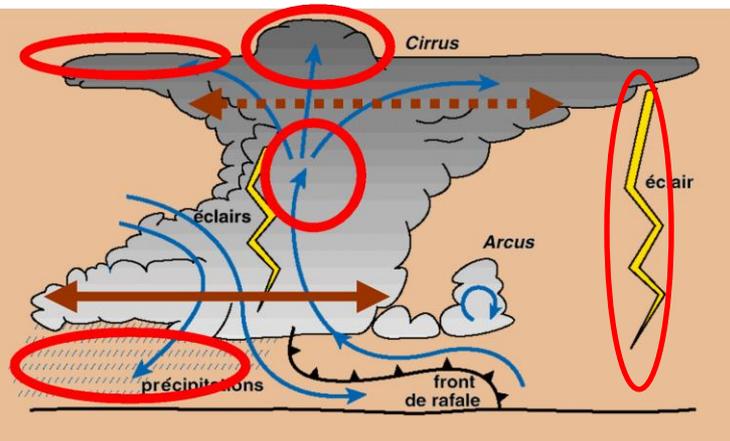
NWP
data



Other NWCSAF
products



Output: Multilevel Description Of Convection

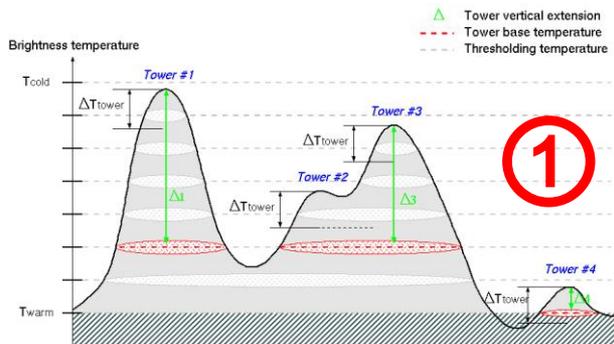


- *Main description of cell: Yes/No convection diagnosis, cell-development phase, position, surface, T, gap to tropopause, cloud type and phase, cloud top pressure. Severity Index high IWC hazard. Displacement Relevant trends are calculated*
- *Overshooting Tops, Lightning Activity, Convective Index,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

4-steps algorithm of RDT

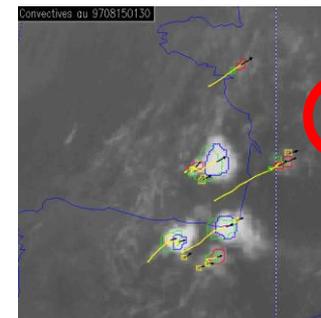
STEP1: 10.8 μm detection

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



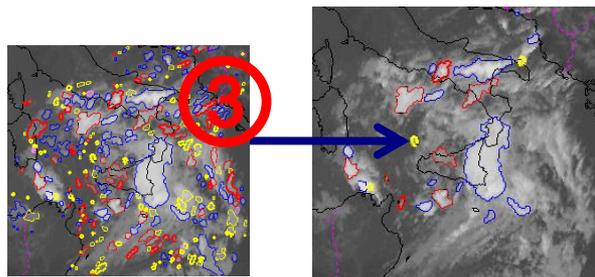
STEP2: Tracking

- 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)

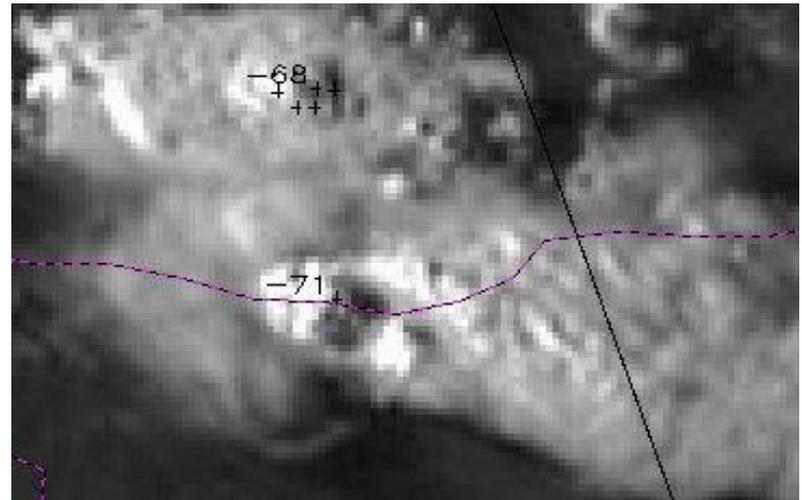
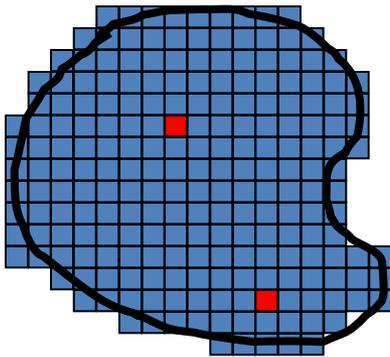


Overshooting Tops Detection - v2013

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



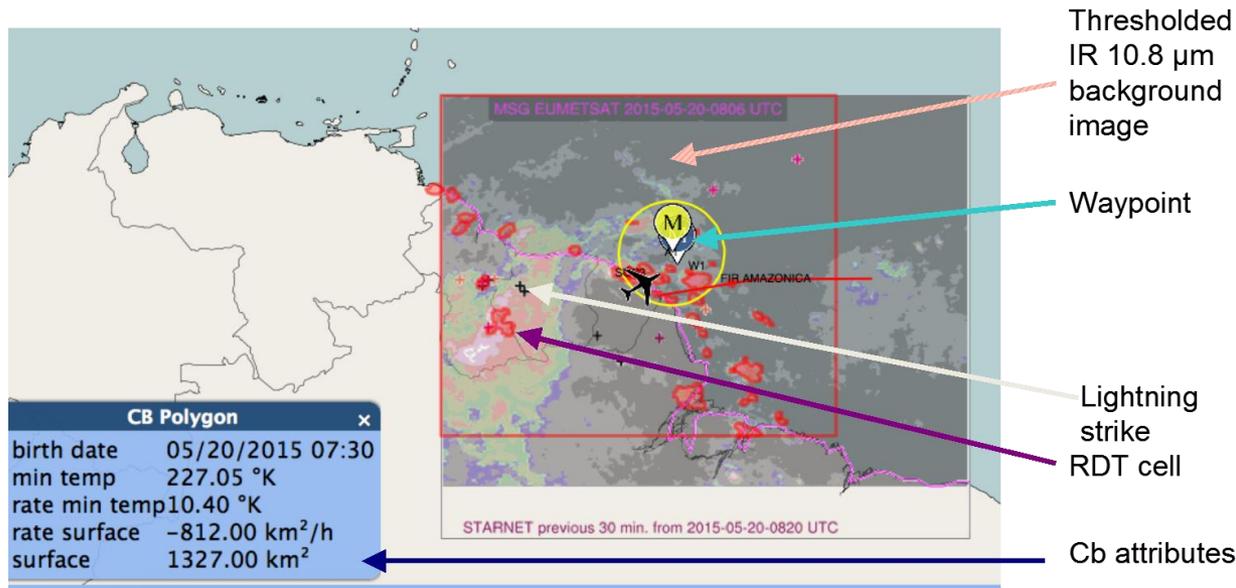
RDT and high IWC (Ice Water Content)

❑ 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



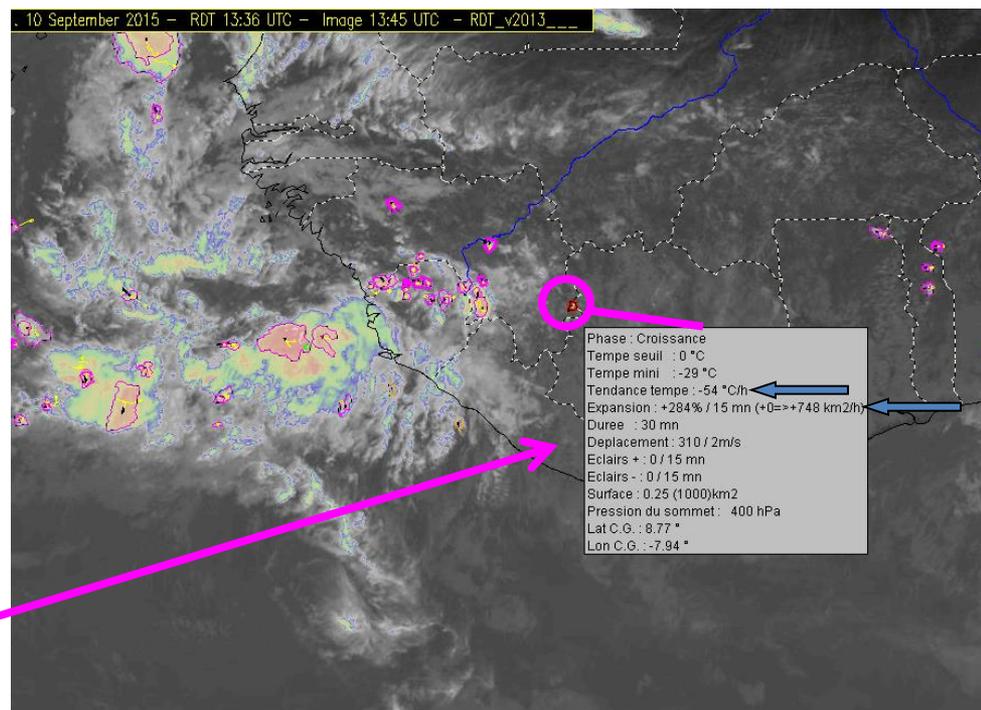
RDT – Severity Attribute

❑ 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)

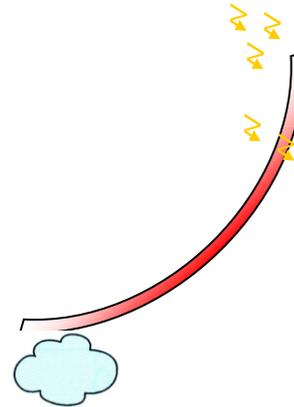


RDT: validation

- **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 !**   

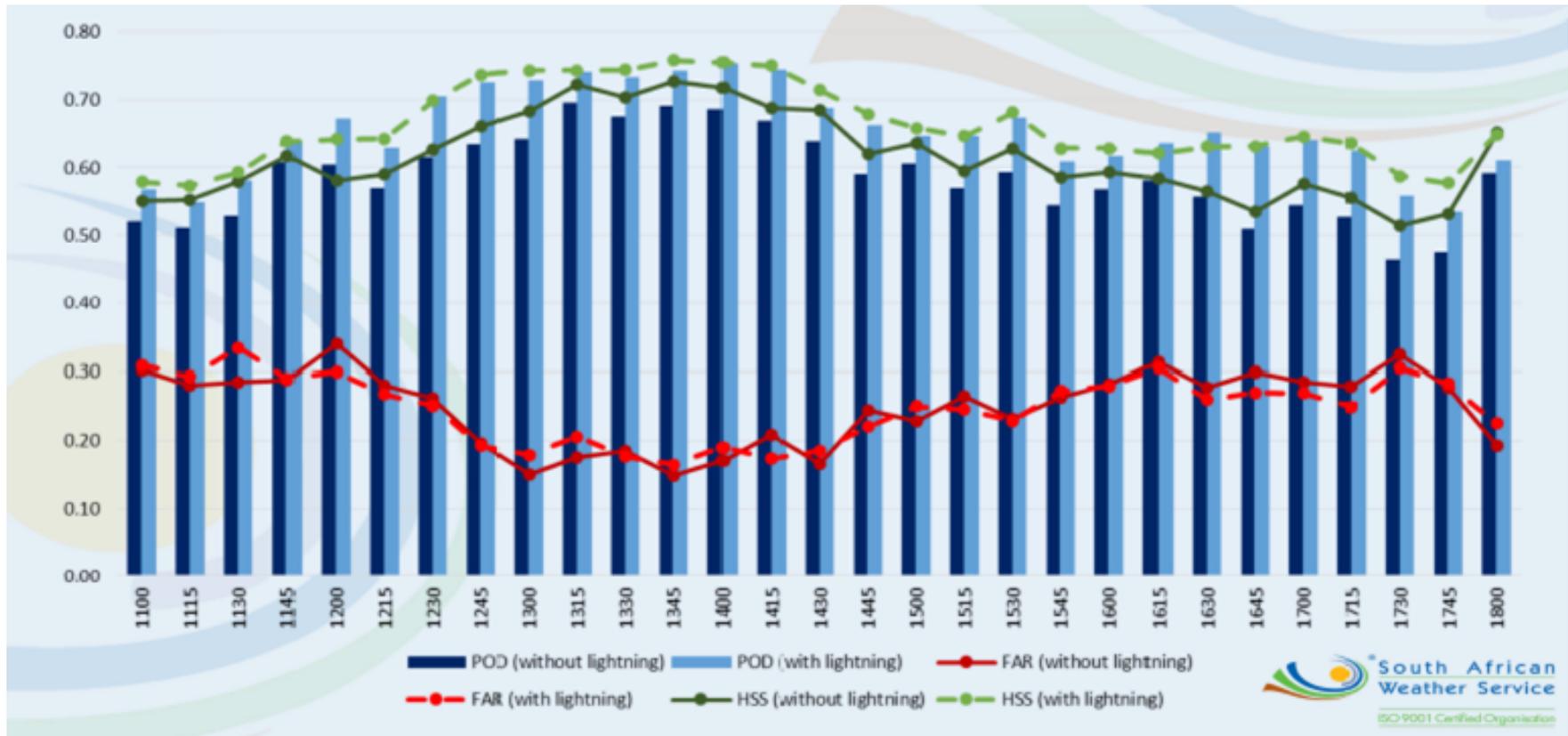


RDT Validation by SAWS

Against 35 dBZ radar reflectivity

Object-based methodology

RDT operated with and without lightning data (25 cases)



Courtesy E. De Coning (SAWS)

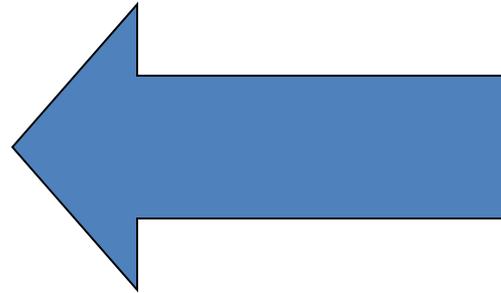
NWCSAF convection products: CI and RDT

Overview

1.CI - Convection initiation

1.RDT

1.Future works



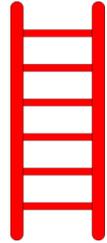
MTG Context for RDT

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

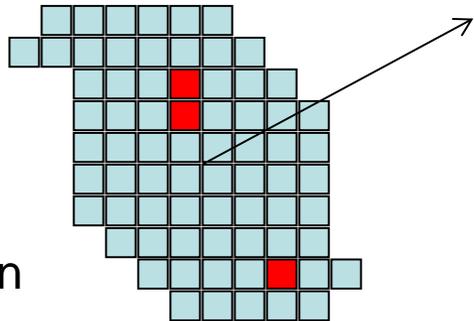


FCI Resolution:

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 town, likely in the Alps, is shown from a high angle. The town is surrounded by green hills and is partially obscured by a thick layer of white clouds. Overlaid on the bottom half of the image is a white weather map showing isobars (lines of equal atmospheric pressure) and wind vectors (arrows). The isobars are labeled with values such as 1010, 1015, 1020, 1025, 1030, 1035, 1040, and 1045. The wind vectors indicate a flow from the southwest towards the northeast. The background of the entire image is a deep blue gradient.

Thanks for your attention



METEO FRANCE
Toujours un temps d'avance

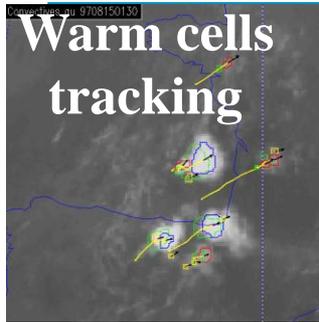
Parameter of interest / thresholds

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				

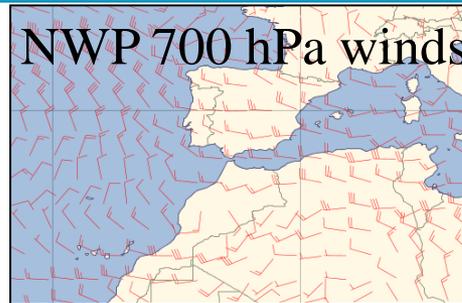
Empirical rules for CI-diagnosis

<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

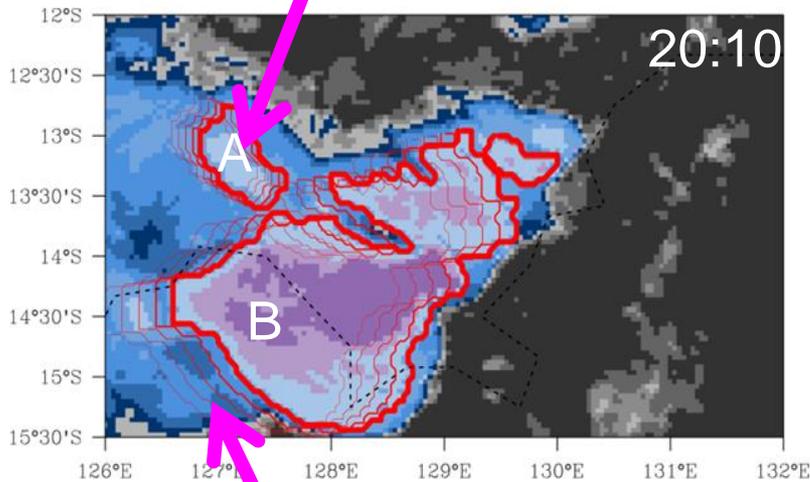
NWP data and other PGEs for speed cell estimate



Priority

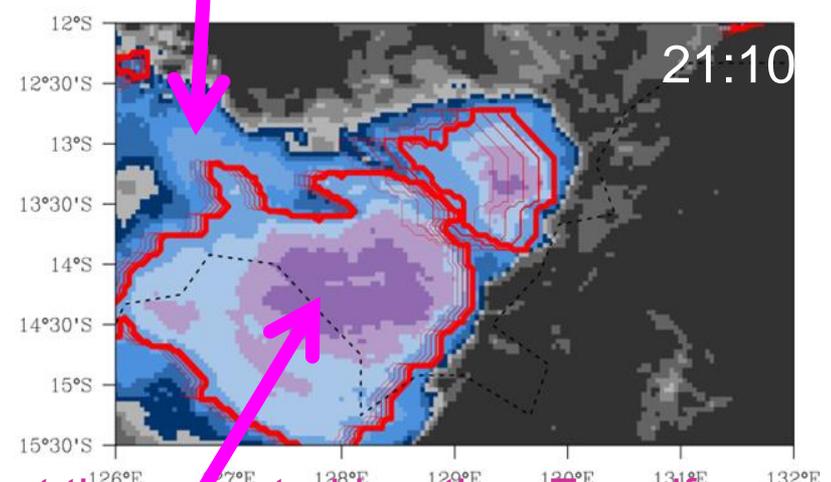


WNW displacement of "A"



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

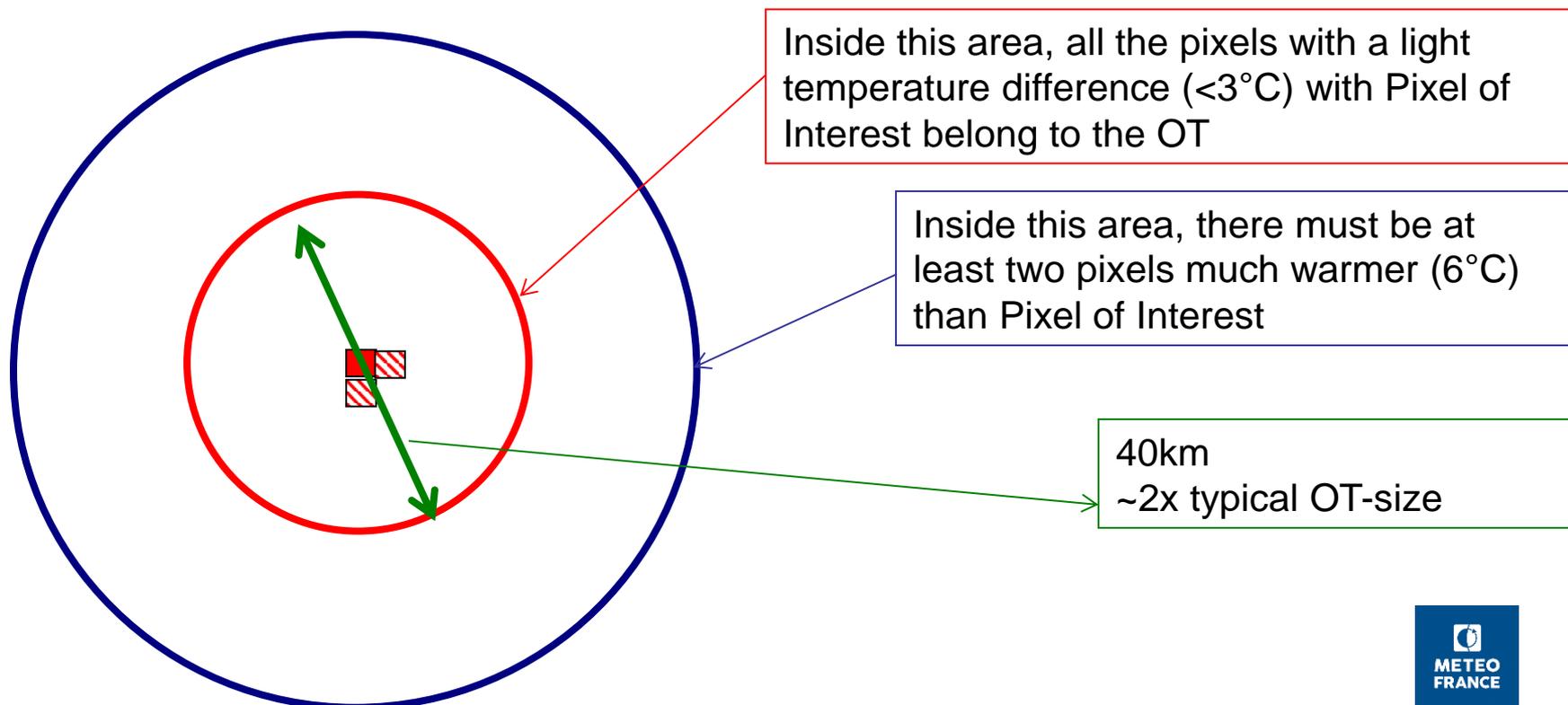


Overshooting Tops Detection (additional slide)

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°)

