RDT: Rapid Development Thunderstorm
MF productions, target visualization and Cases study

EUMETRAIN 2013

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The EUMETSAT Network of Satellite Application Facilities
NWC SAF
Support to Nowcasting and Very Short Range Forecasting

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Overview

1. Use and Visualisation
2. RDT Productions at Météo-France
3. Nowcasting
4. Cases studies

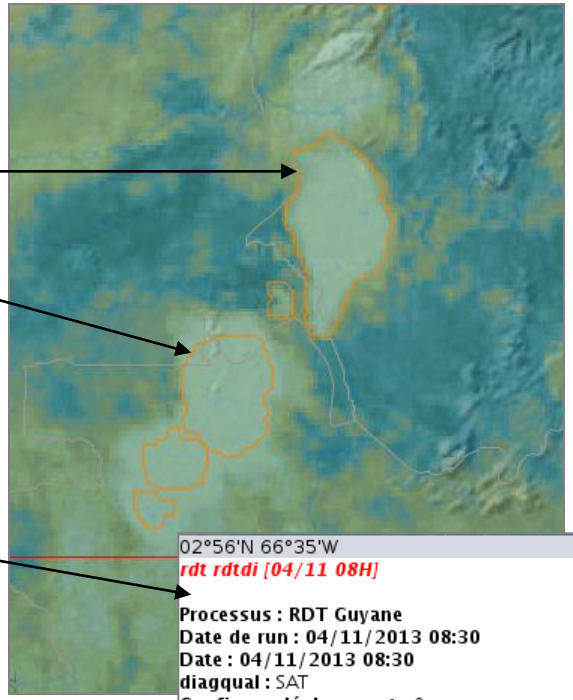
Use of RDT end-product

Which use of RDT for forecasters ?

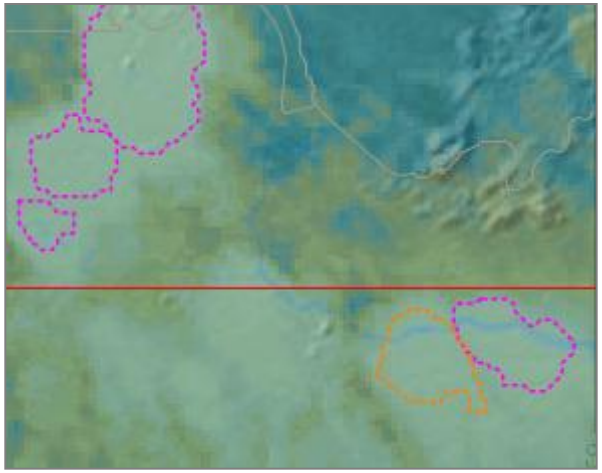
- Access (display) to a *synthetic* information for a given cloud system
  - Does not intend to replace forecaster's analysis
  - Gathers various kinds of information (trends, OTD ...)
  - Good candidate for data fusion (lightning, PGEs ...)
- Access (display) to *historical information* (tracks, evolutions, …)
  - more convenient for analyzing the evolution of the system
- *Nowcasting* possibilities (motion vector)
  - Up to now available on forecaster's tools
  - Will be integrated in v2015 release with production of observed AND extrapolated convective cells
- *Alert*
  - Radar-based products generally best fitted for that *when available*
  - Candidate for a backup alert system

Visualization of RDT end-product

- Basic display of end-product
  - *Filter* convective type only
  - Position of cells (*contours*)



- Enhanced display
  - attributes in an individual *Id-card*
    - ✓ static (*phase, morphology, temperatures…*)
    - ✓ from tracking (*speed , trends …*)
  - *contour aspect* driven by attributes



02°56'N 66°35'W
rdt rdtdi [04/11 08H]

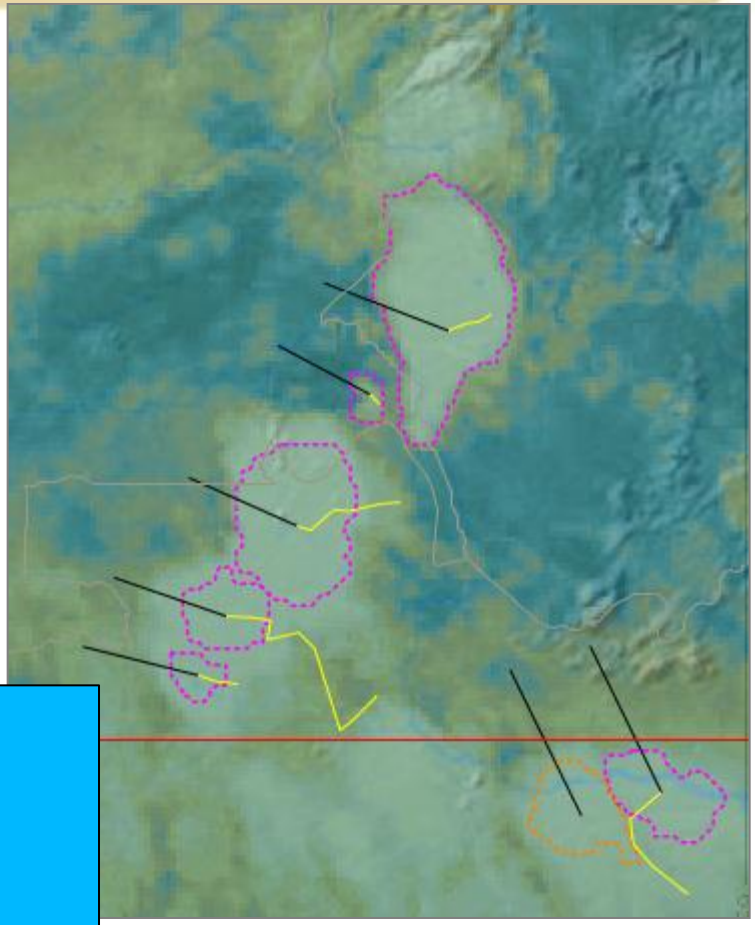
Processus : RDT Guyane
Date de run : 04/11/2013 08:30
Date : 04/11/2013 08:30
diagqual : SAT
Confiance déplacement : 0
Catégorie : Mature
Type de phénomène : CC
Décalage temporel : 0.0 min
diagqual : 100.0
Température moyenne : -61.5 °C
diagconv : 1.0
Vitesse : 9.0 km/h
Surface : 11955.0 km²
Définition du seuil : -32.0
Température minimale : -80.1999969482 °C
Direction : 291.0 °
Pression sommet : 0.0 hpa
Taux expansion surface : 6456.0 km²/h

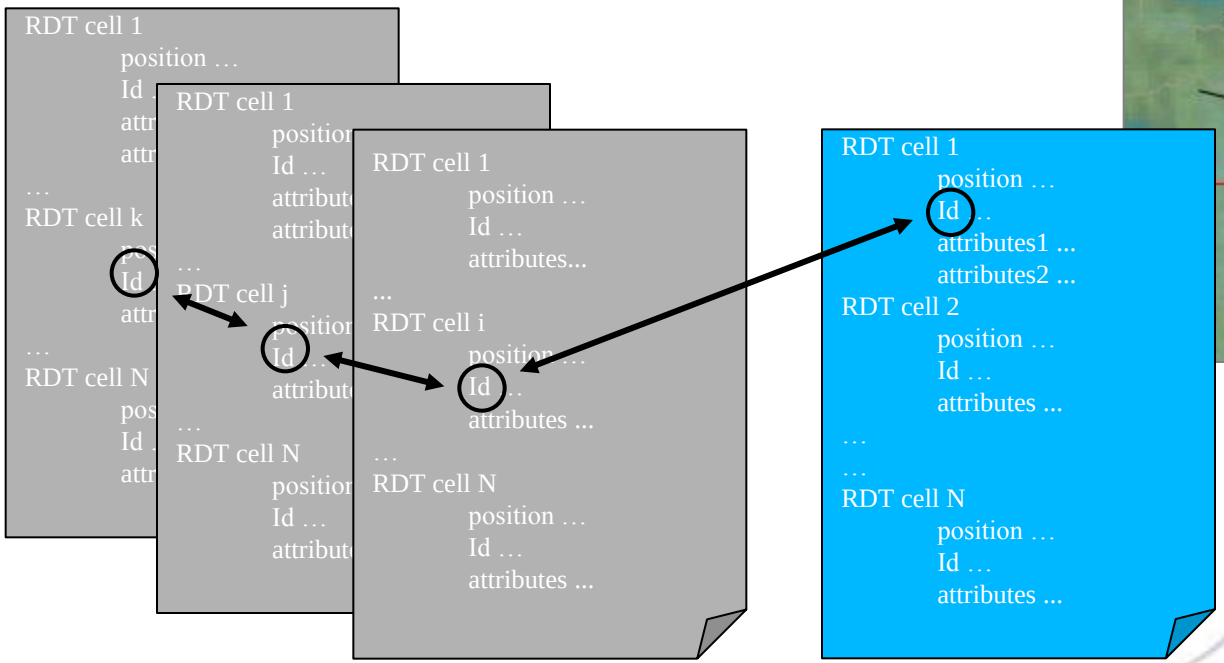
Visualization of RDT end-product

- Necessary Post-processing

  Objectives :
  reconstituting trajectories and historic by linking successive products together

  - Display past tracks of G.C. of each cell (temporal links)
  - Display past temporal evolution of attributes





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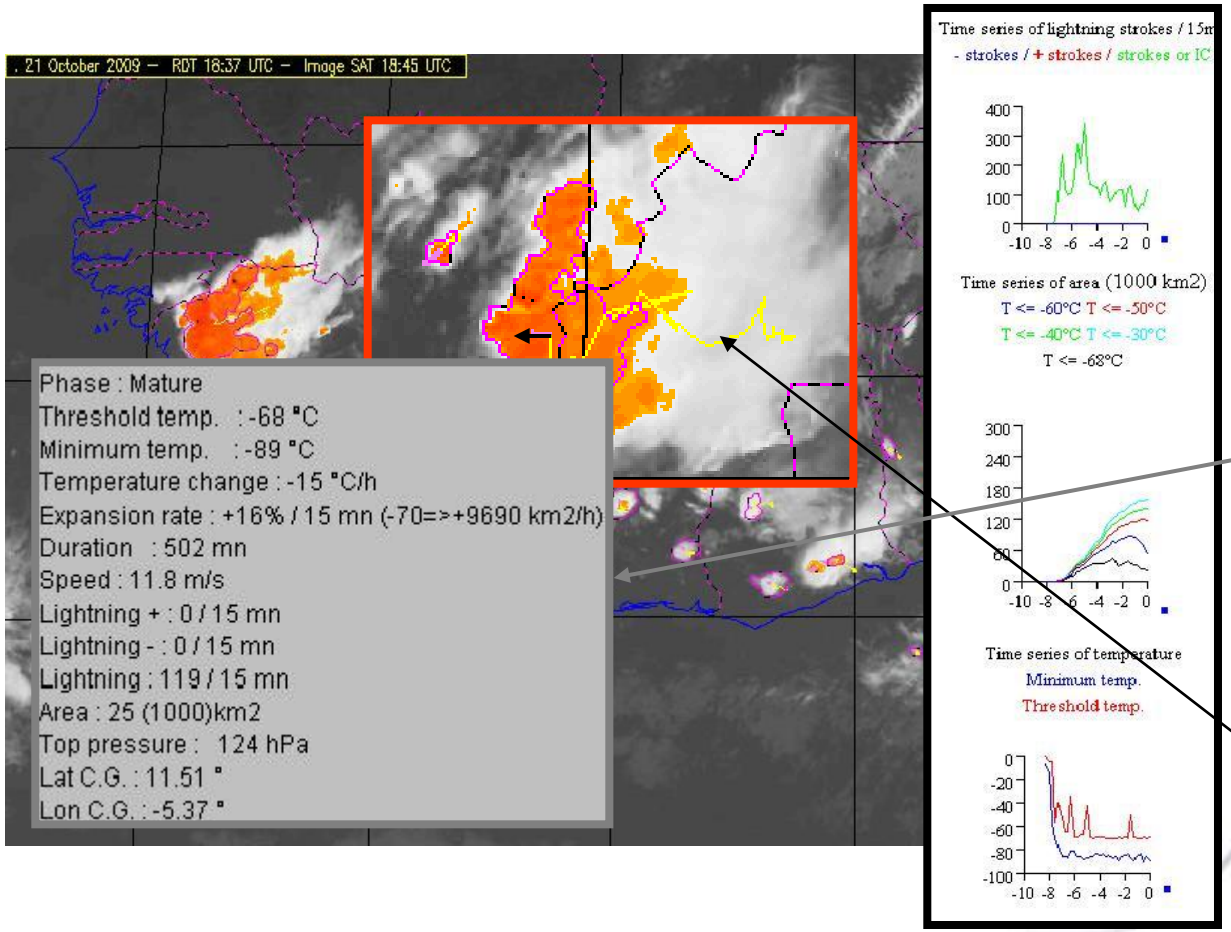
RDT - Target Visualization

↳ 3 aspects of visualization :

1. Localisation: *contours* of convective systems
2. Information (in a jauge) : *attributes* from Id card
3. History: *tracks* and past *evolution* of attributes (graphs)



Contour color from phases:
Yellow: Triggering
Red: Developing system
Purple: Mature system
Blue: Decaying system (filtered)
Orange : After a split of systems

Contour type from activity:
dash: no lightning
plain: lightning paired

Contour width from cooling:
thin: light or no cooling
thick: strong cooling

Attributes:
- Static parameters
- Dynamic parameters
- Data fusion parameters

History:
- Motion vector
- Trajectory of gravity centers
- Evolution of parameters

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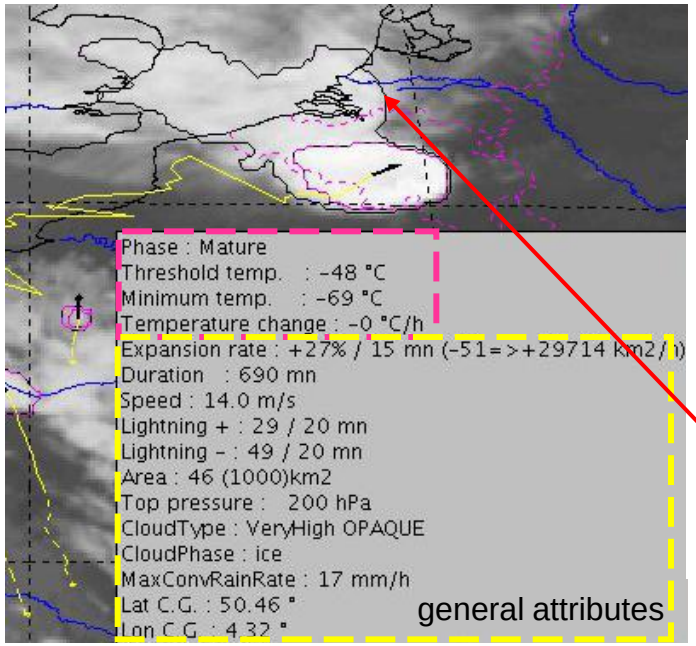
RDT – towards a multilevel description : 2nd level

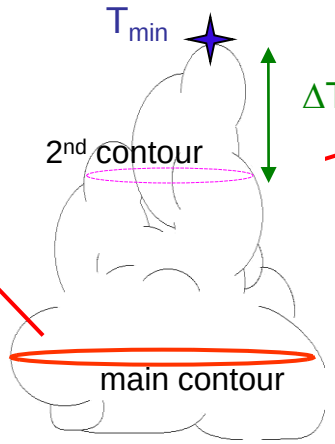
2nd level description *(a/c v2012)*

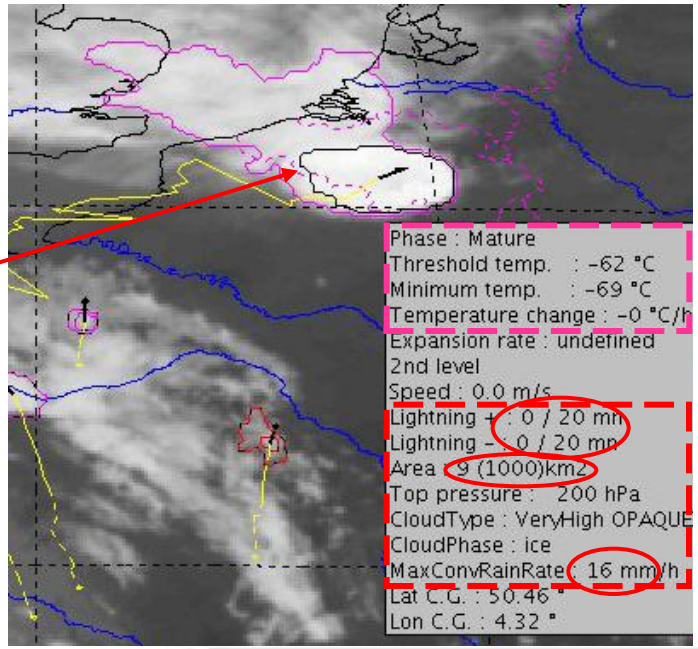
Depending on cell morphology (large cell-extension), it is sometimes interesting to have the depiction of another level additionally to « Base of Tower » level

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

Specific attributes
(some common with main contour)





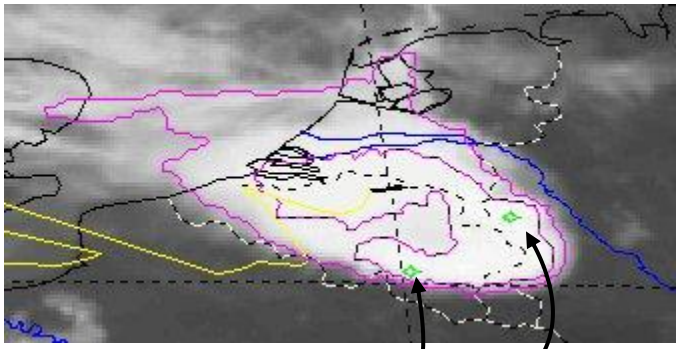


Note: the tracking remains based on main "Base of Tower" level

RDT – towards a multilevel description : OTD

OTD = Overshooting Top detection *(a/c v2013)*

- The knowledge of vertical IR10.8-morphology of cloud cell allows to seek and analyse overshooting tops
- Other channels (WV and VIS) and NWP data (for tropopause diagnosis) are used to confirm or not these features
- This provides additional description of convective features and activity



Phase : Mature
Threshold temp. : -45 °C
Minimum temp. : -69 °C
2 overshoots : -69°C BTD6 tropo+3 : -68°C BTD4 tropo+4
Temperature change : -8 °C/h
Expansion rate : +4% / 15 mn (-47=>+8943 km2/h)
Duration : 780 mn
Moving : 070 / 13m/s
Lightning + : 81 / 20 mn
Lightning - : 191 / 20 mn
Area : 57 (1000)km2
Top pressure : 175 hPa
CloudType : VeryHigh OPAQUE
CloudPhase : ice
MaxConvRainRate : 17 mm/h
Lat C.G. : 51.19 °
Lon C.G. : 4.79 °

Overshoot characteristics available in RDT :

- ⇨ min temperature
- ⇨ maximum BTD(WV6.2-IR10.8)
- ⇨ Negative delta temperature with tropopause

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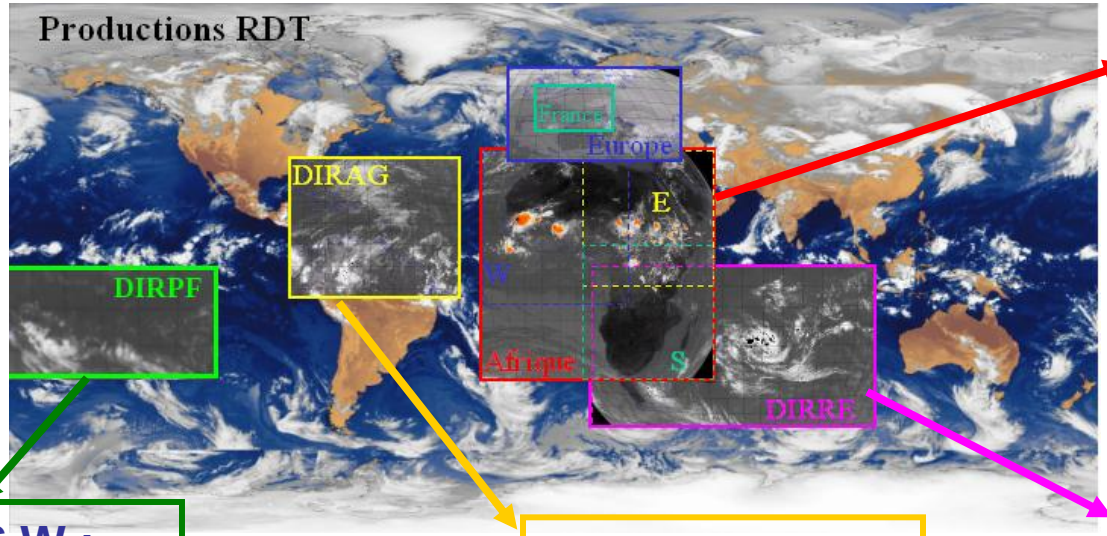
Météo-France RDT production

RDT productions for French overseas territories with input data coming from various geostationnary satellites

SAFNWC processing chains have been adapted

- input satellite data to be transcoded
- a slot every 30 minutes at least is necessary for correct RDT Tracking



MSG
Africa/Europe

GOES W :
Tahiti + Wallis et Futuna

GOES E : ***French Antillas and Guyana***

METEOSAT7 :
Idian Ocean / Reunion island

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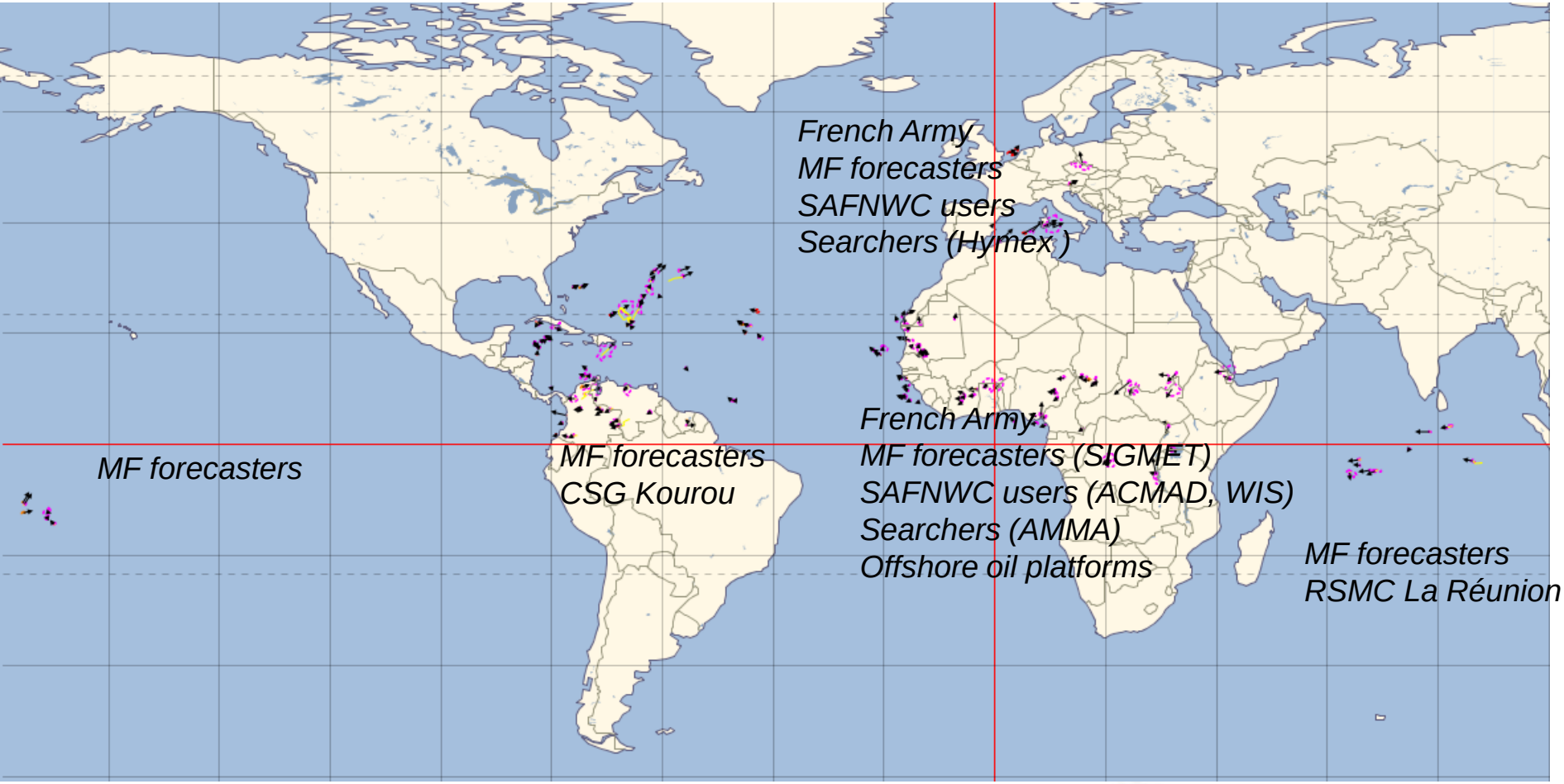
Météo-France RDT production

Panoramic view of RDTs through future forecaster's workstation SYNOPSIS



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Using RDT for Nowcasting

RDT product = analysis

- *static analysis* from current satellite image
- *past evolution* (moving and trends) from previous analysis

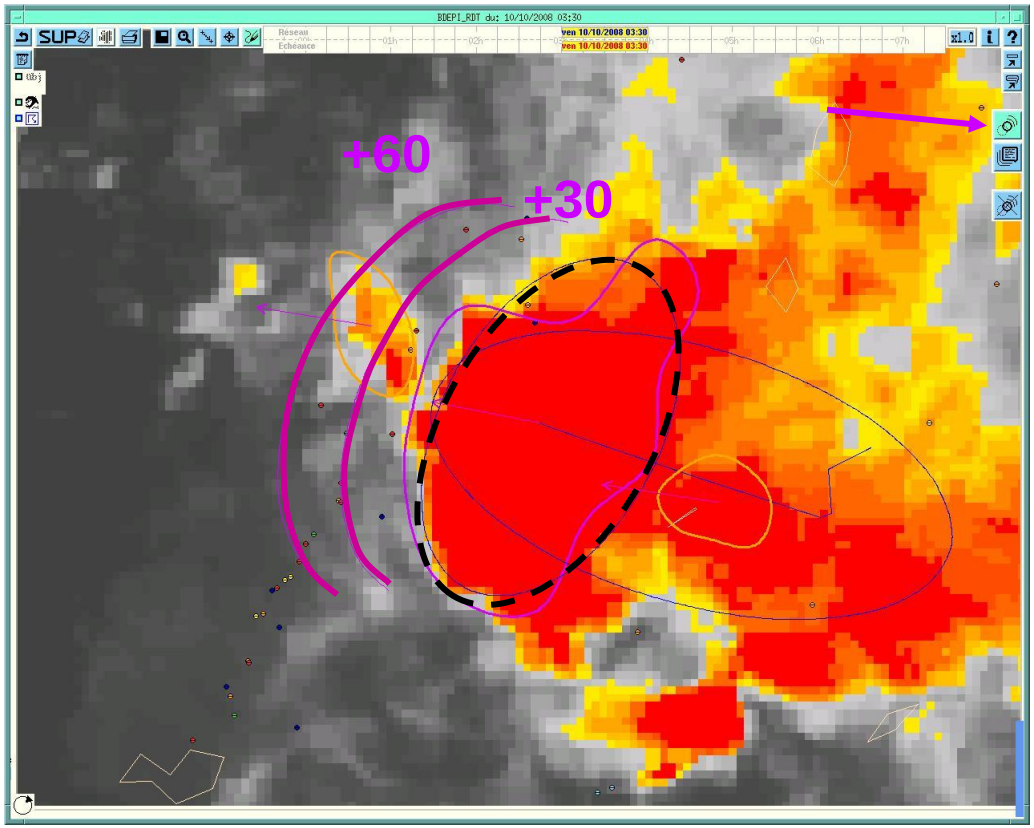
Nowcasting capabilities

- Up to now, not in SAFNWC perimeter
  - ➢ to be undertaken as a *post-processing*
    - from moving speed estimate
    - applicable to G.C. and/or contours and/or approaching ellipses
  - ➢ on *Forecasters' workstation*
    - local and/or global advection of RDT cell

- *Next release (v2015) will include analyzed AND nowcasted RDT cells*
  - Moving speed estimate will be improved
  - Other sources of data will be taken into account (AMVs …)

Visualization through SYNERGIE (Météo-France forecasters' workstation)

❑ Target Visualization and advection scheme



Advection scheme:

➢ Individual cell

▪ forecasted position front edge of approaching ellipse for a given cloud system

➢ Global

▪ linear advection of all systems vs time

▪ contours expanded

▪ caution : not coordinated

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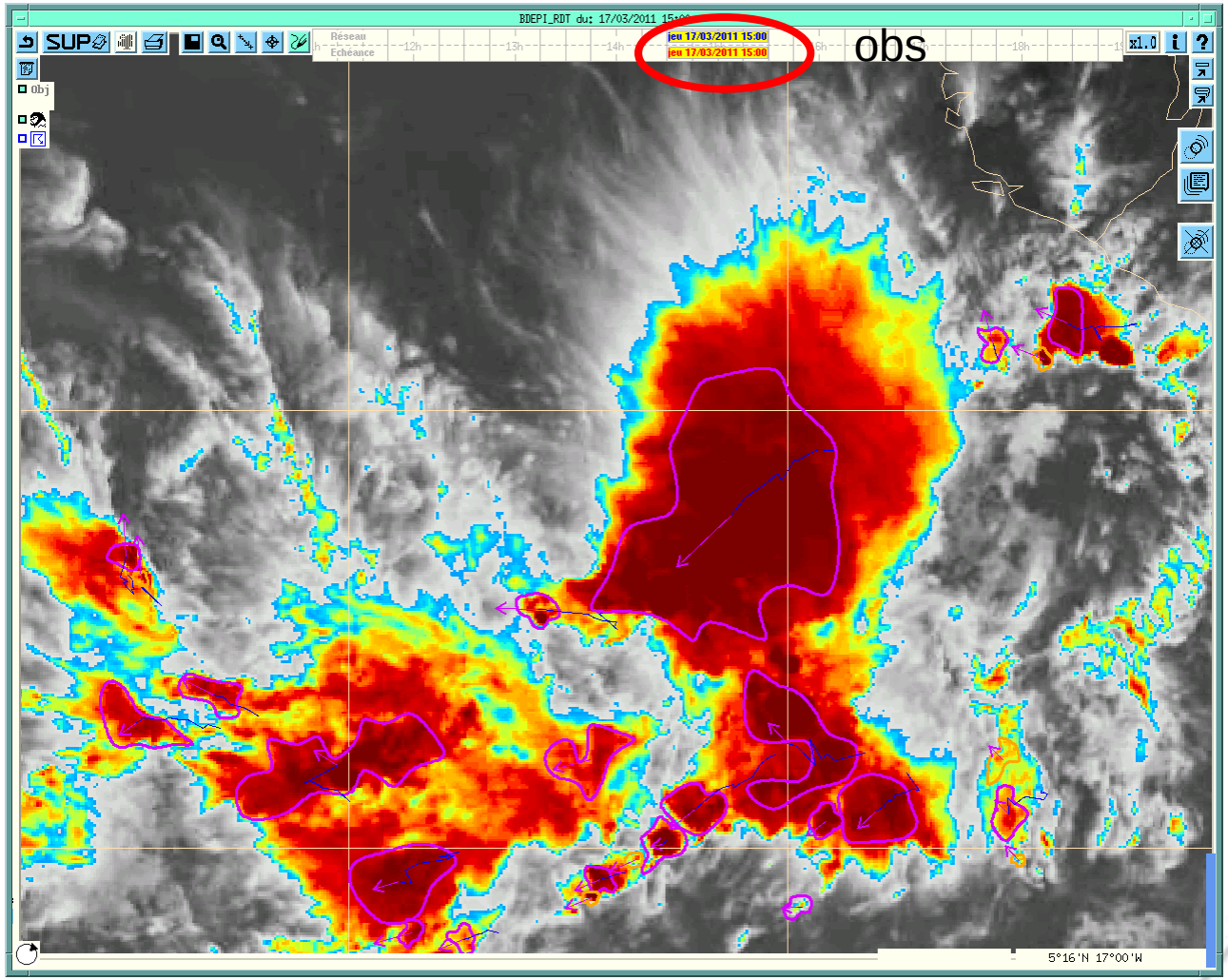

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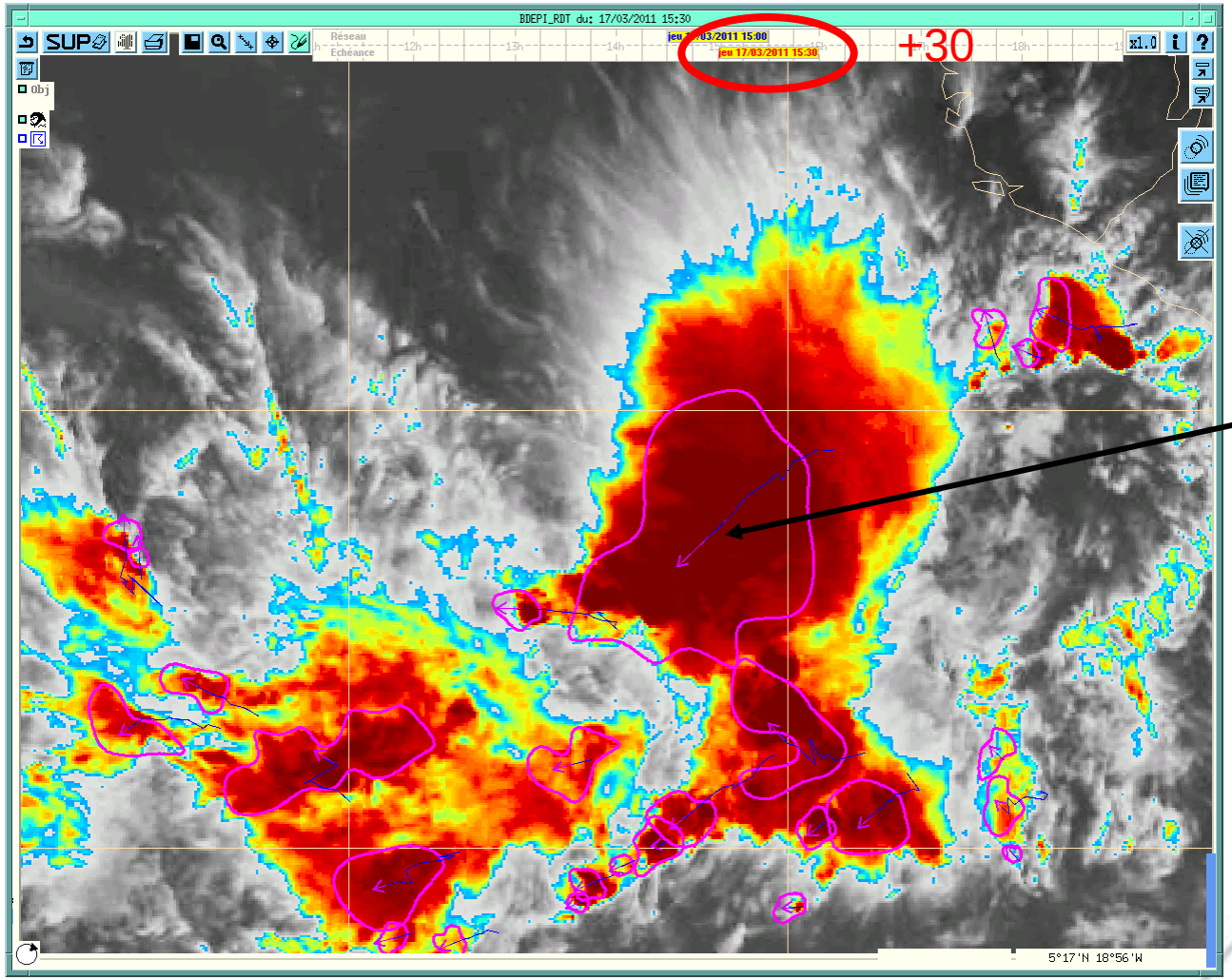

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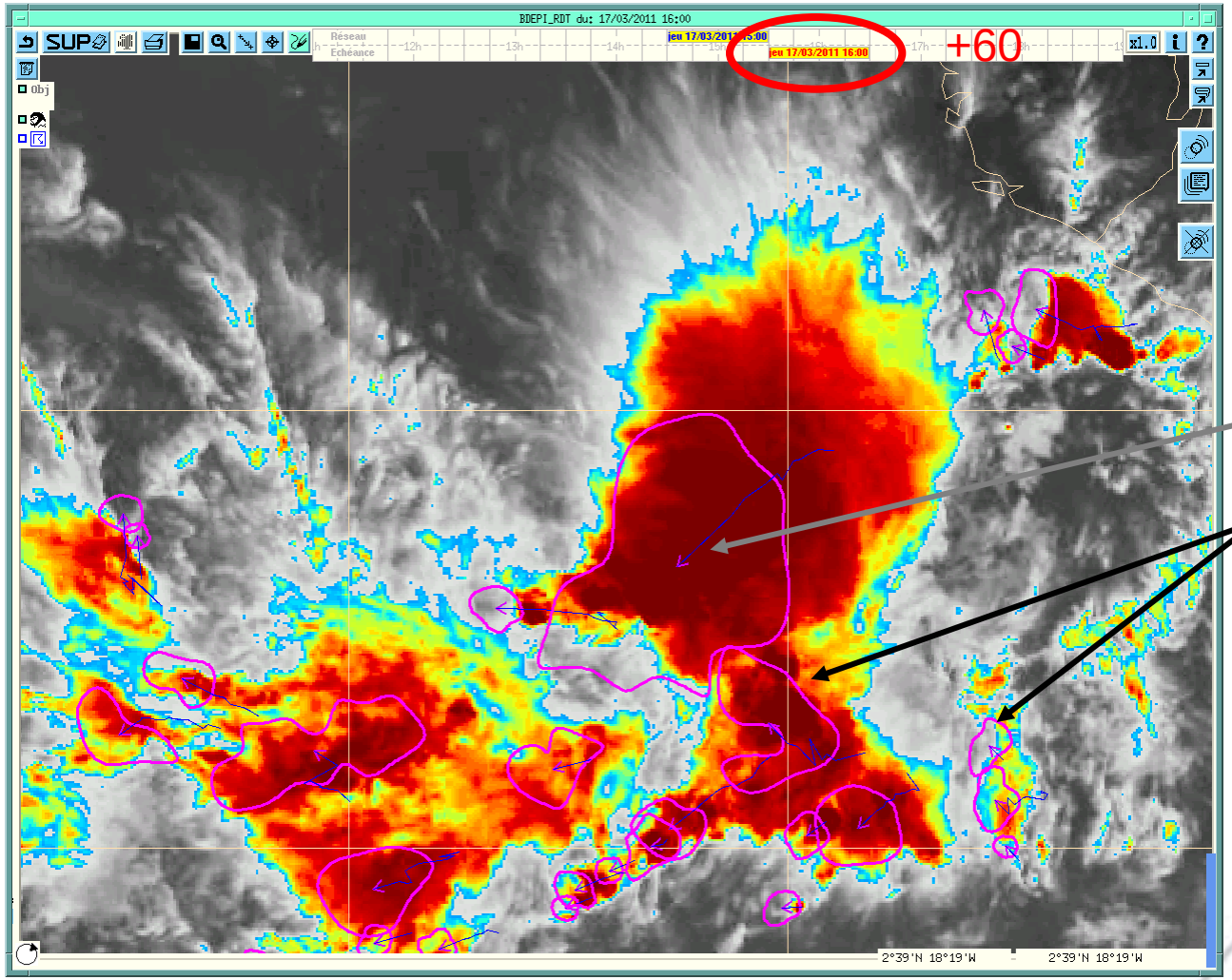

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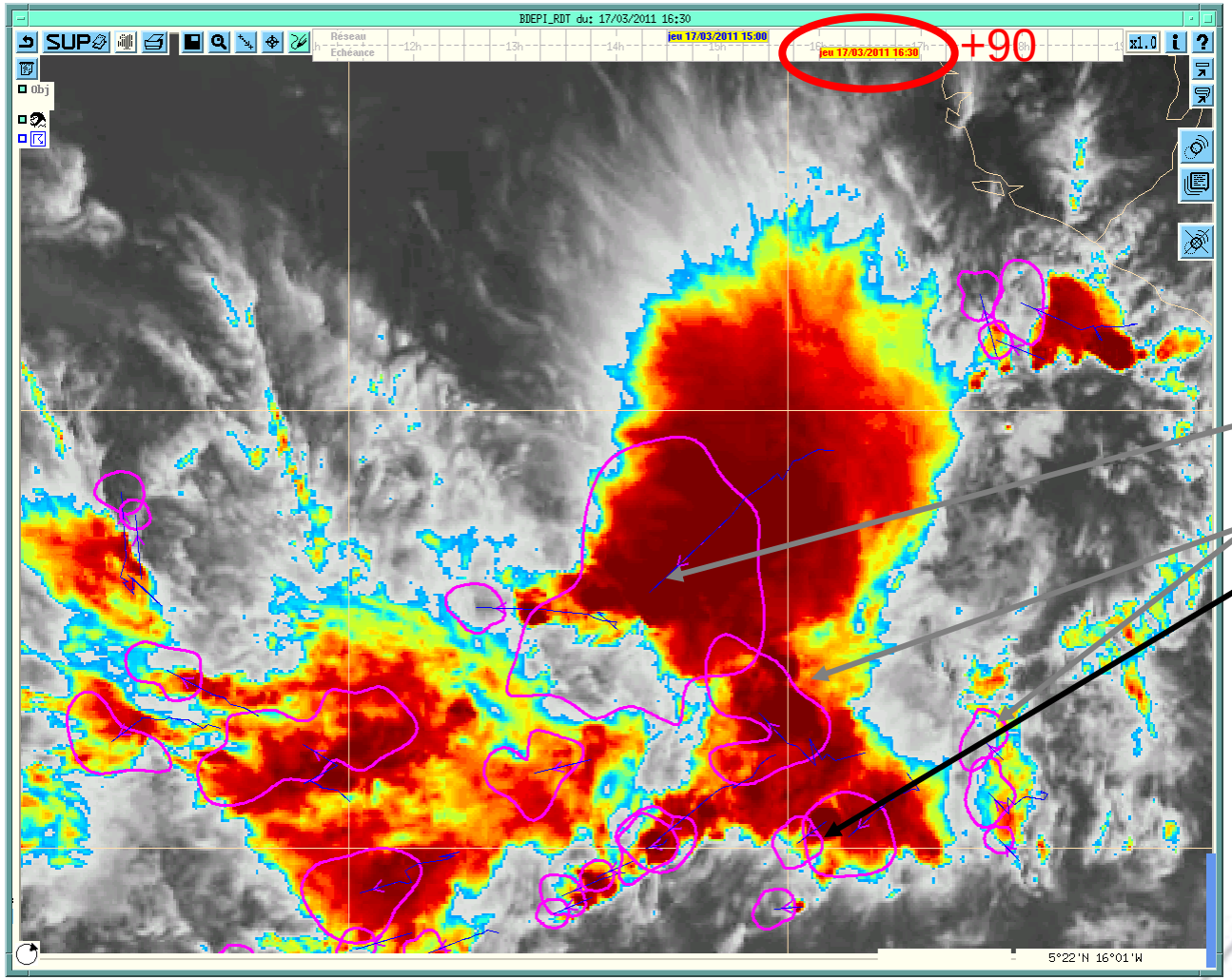

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▪ caution : not coordinated (merge not managed)

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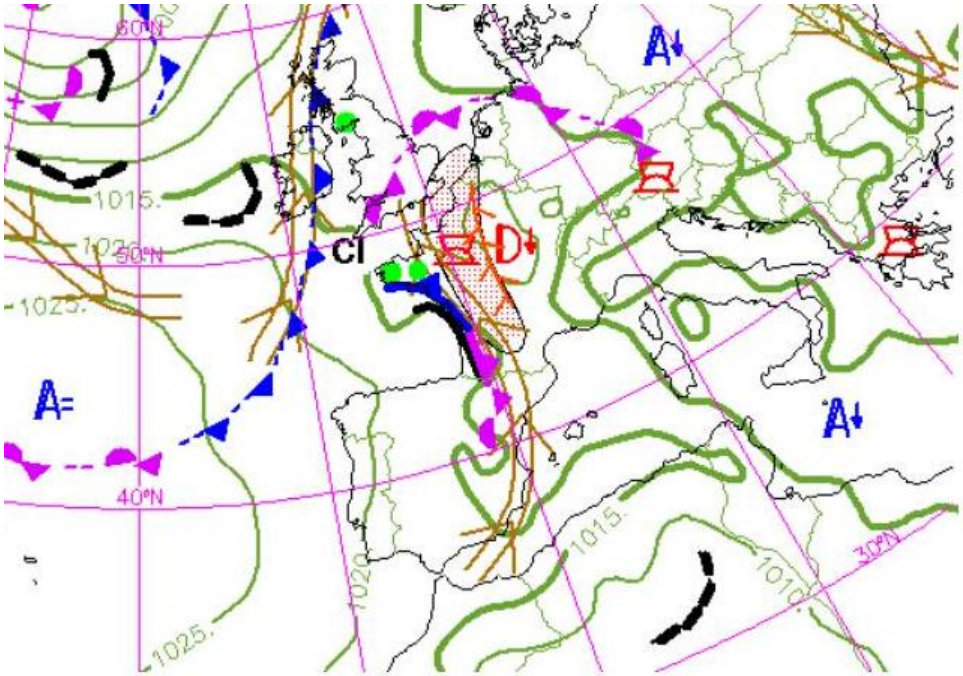
Case study 1 : Topical case – 25/05/2009

Severe Thunderstorm event over France, with strong gusts and heavy hail (*especially in Toulouse - 10cm thickness*).

- *Low pressure* over western Europe
- Upper Jet stream associated with *convergence line*

Strong *diurnal convection* over Adriatic edges



- Case study tested with successive RDT releases
- RDT v2013 run with full version output :
  - data fusion with SAFNWC PGEs (*Cloud type/phase, Rain Rate*)
  - Multilevel : 2nd level and OTD

https://www.nwcsaf.org/topicalimages/TOPICAL_IMAGES/RDT_20090525_Europe/index.html

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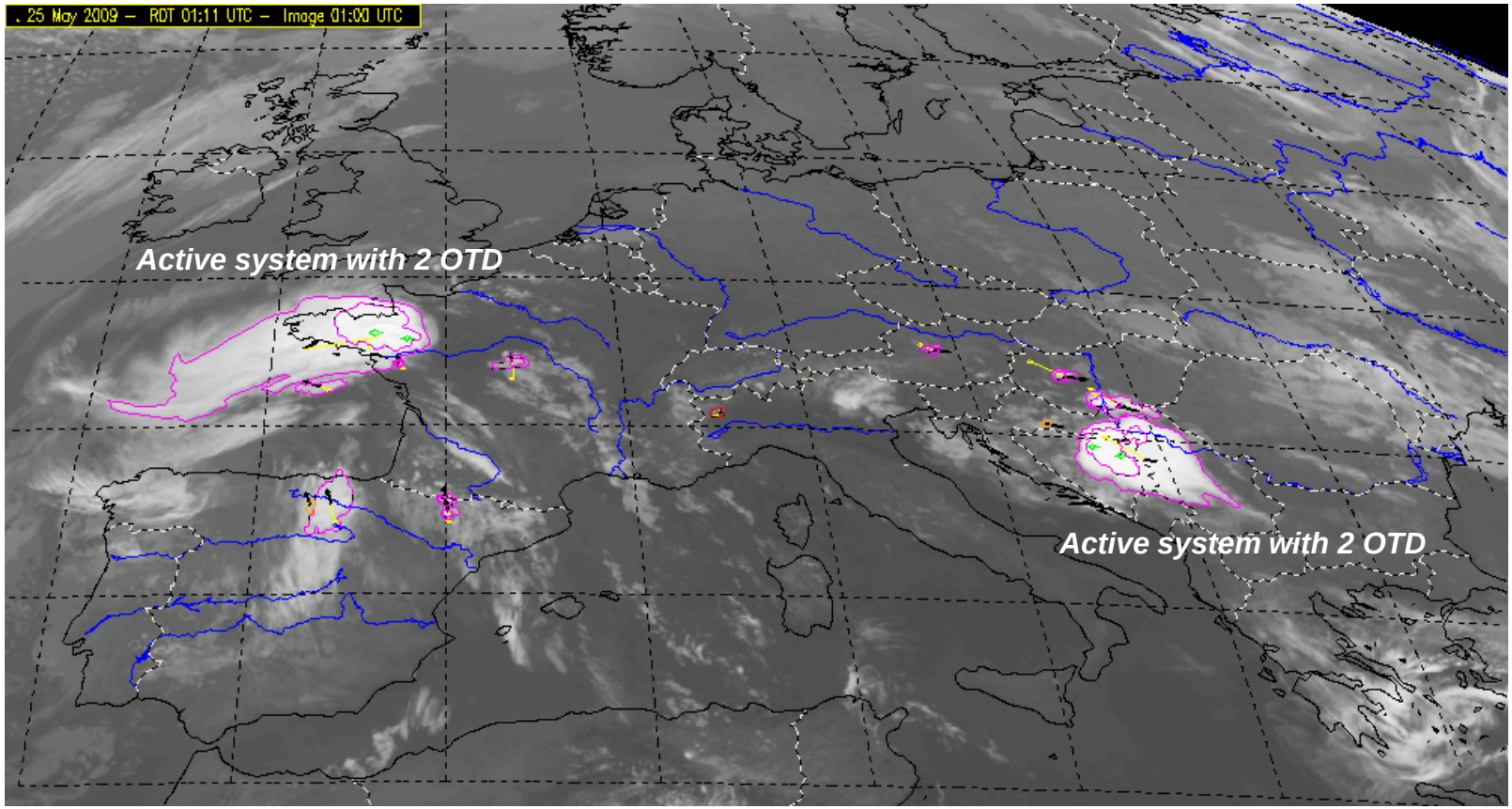

Satisfying behaviour of RDT

- very few misses - some false alarms, especially in warmest categories
- Most systems detected and visualized by RDT correspond to active MCCs or CBs, and if not, they reveal significant cooling. They are obviously convective, even if they don't always develop into large thunderstorms

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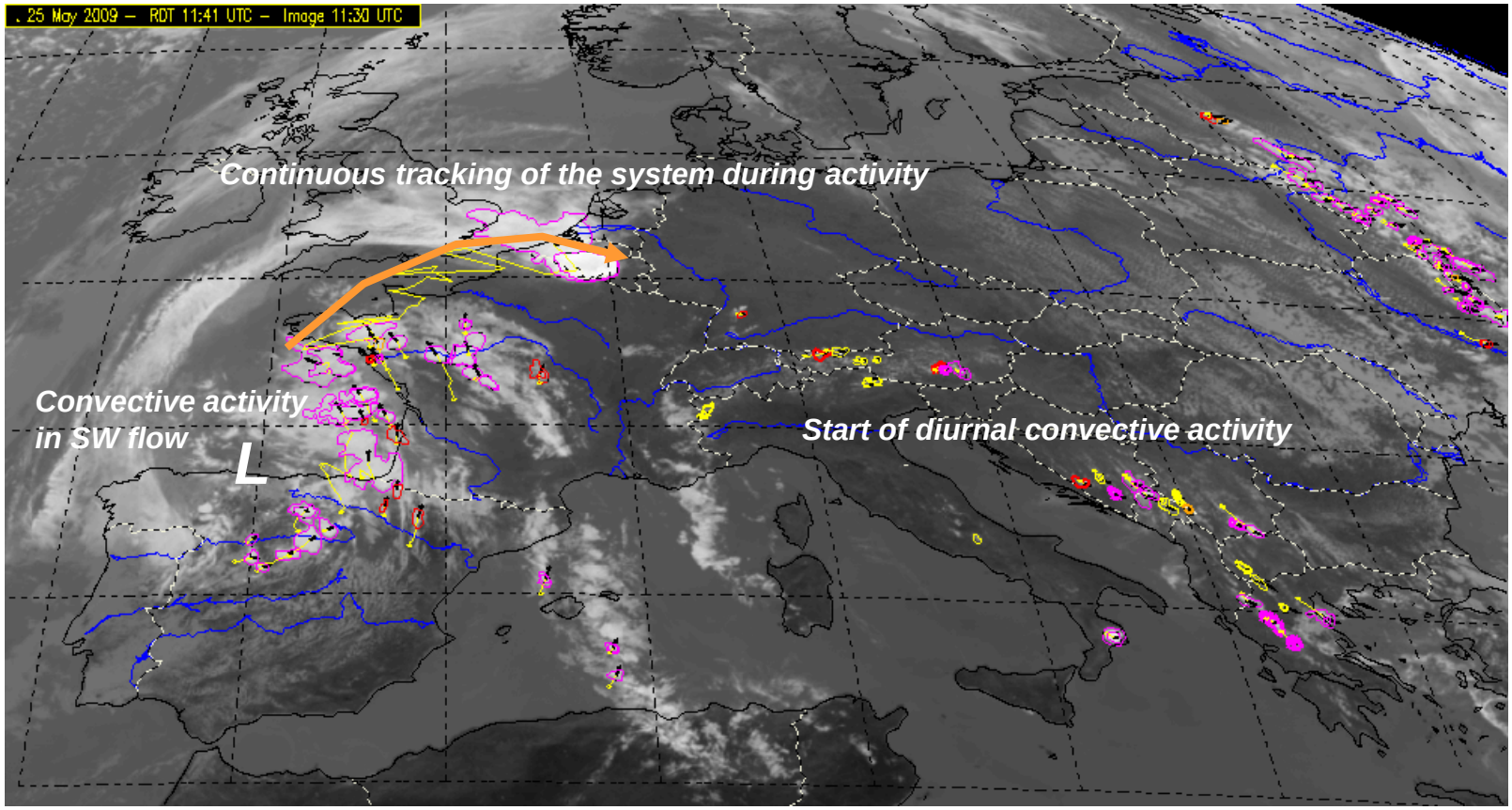

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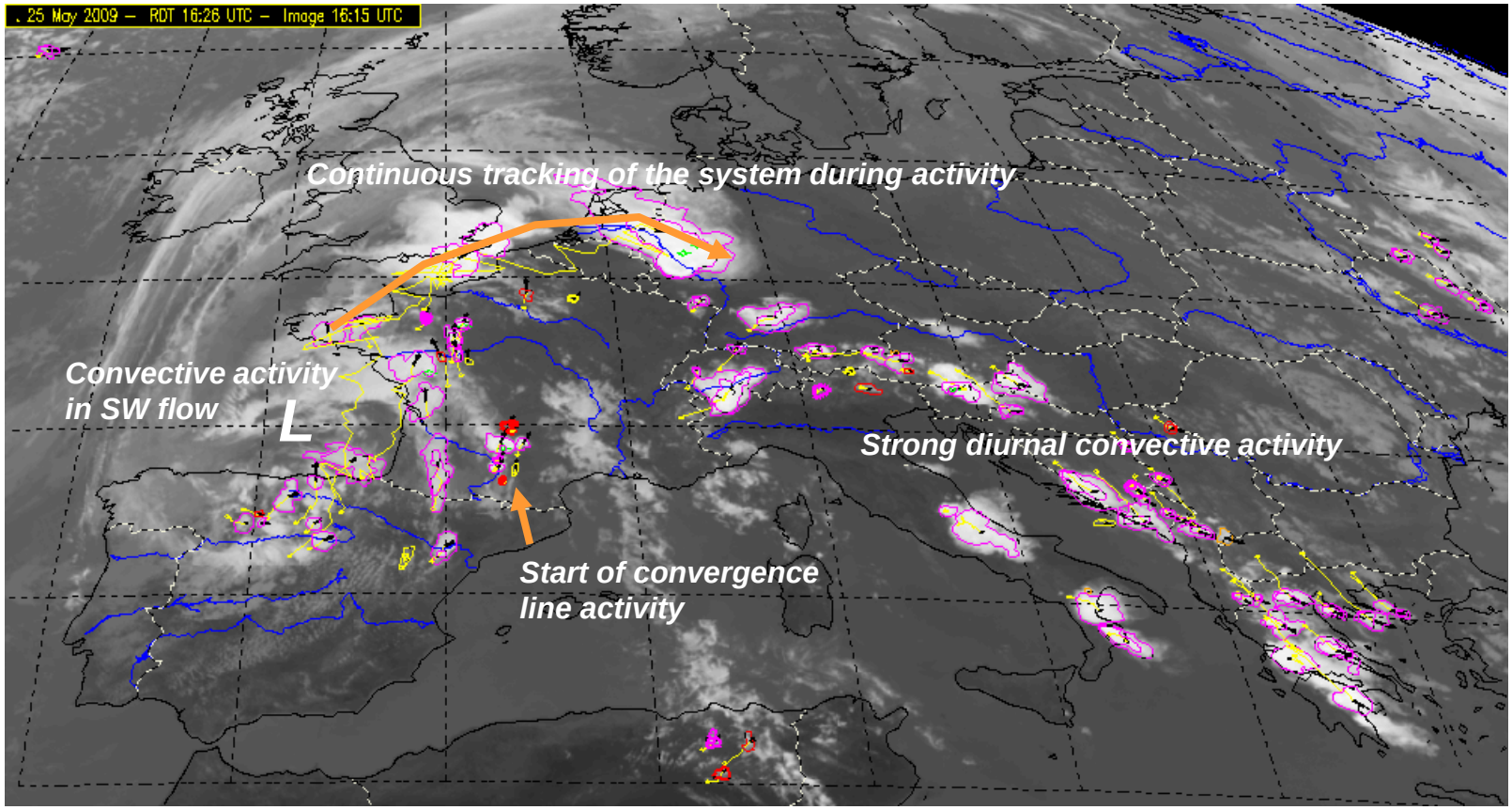

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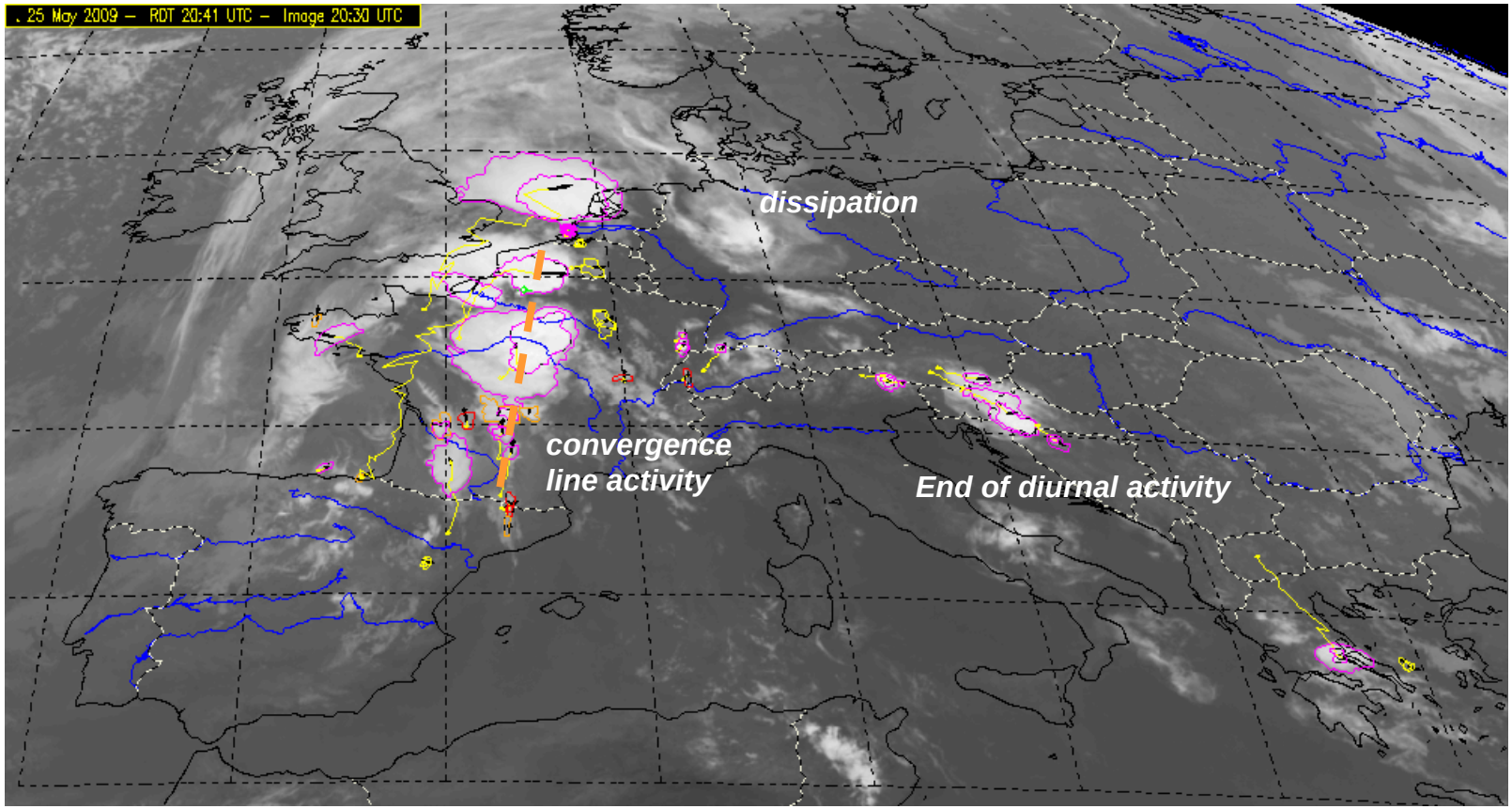

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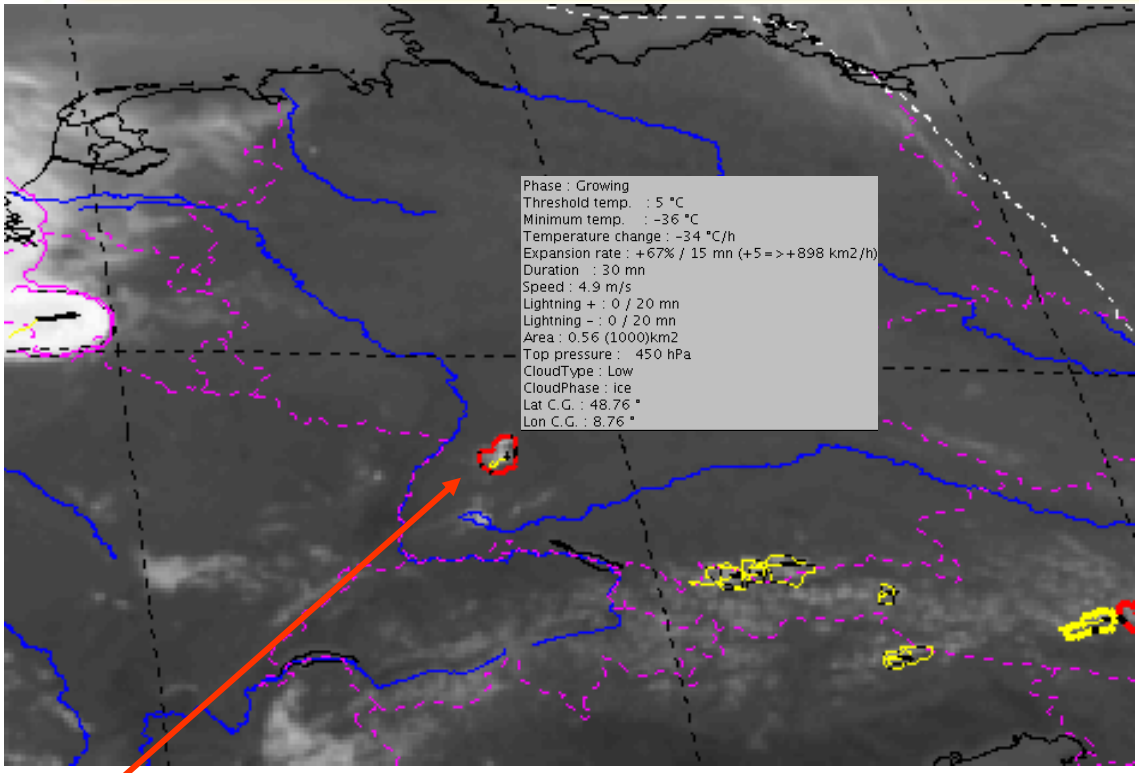
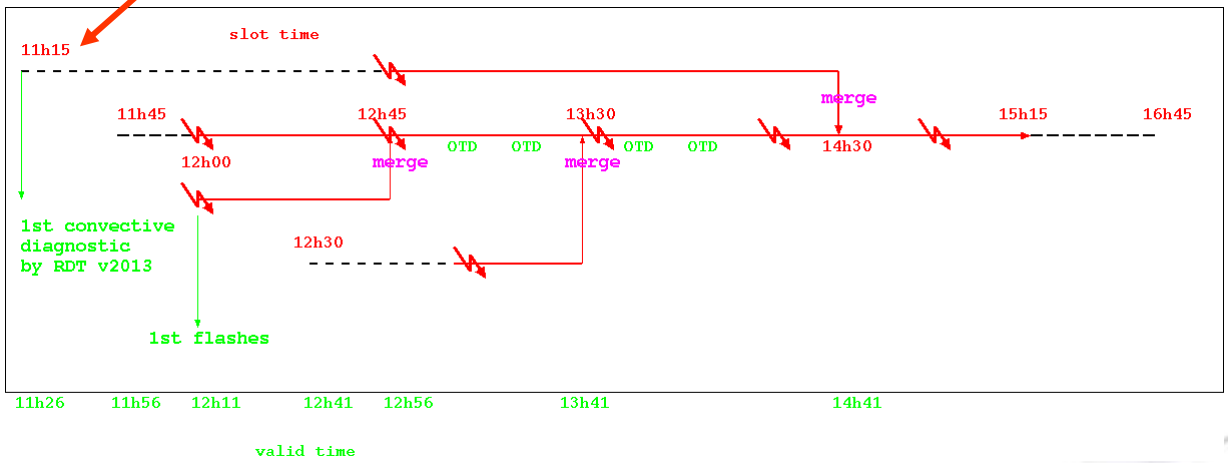
Case study 1 : early convective diagnosis





From noon, a group of convective cells rises in the south-west of Germany, merging to give a large convective system

- Slot 11h15 => A first cell is diagnosed, with minimum temperature of -36° , after 30 min tracking and a weak cooling.

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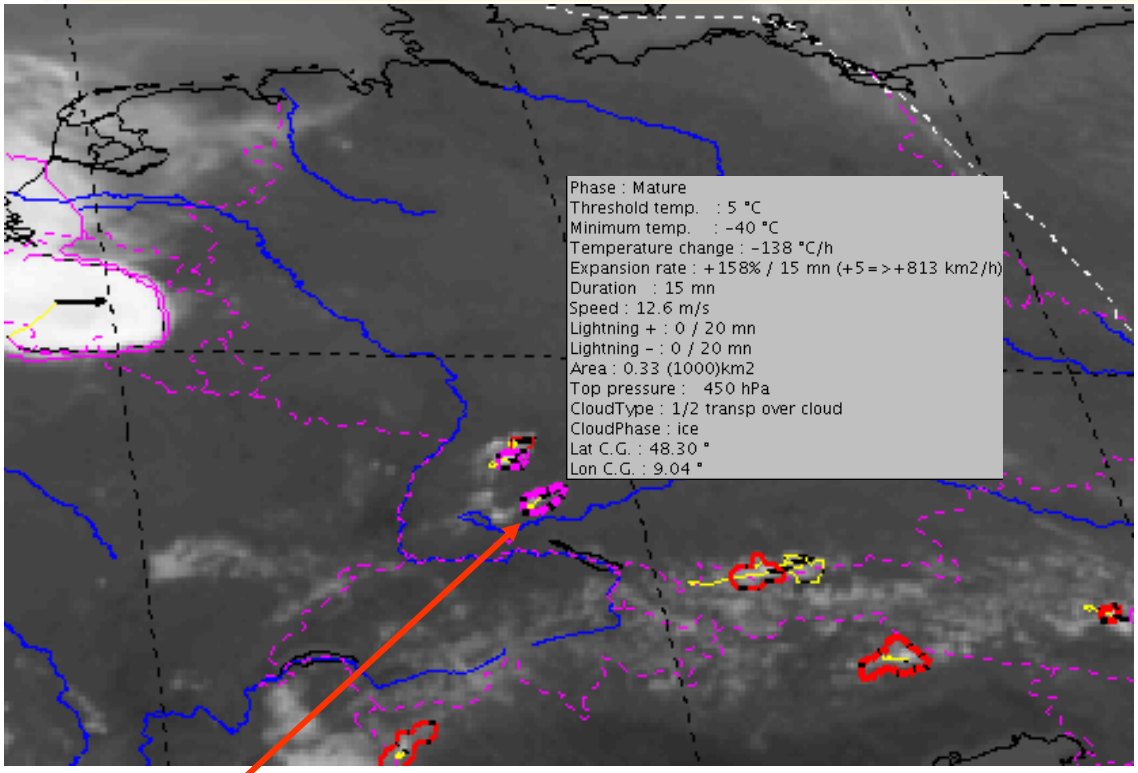

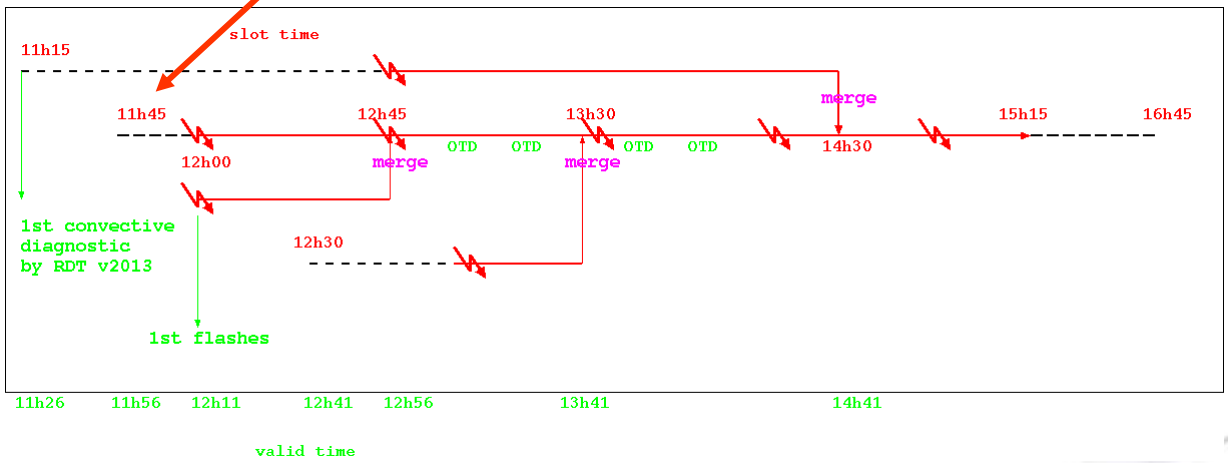

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- Slot 11h15 => A first cell is diagnosed, with minimum temperature of -36° , after 30 min tracking and a weak cooling.
- Slot 11h45 => A second cell is diagnosed few kilometers southeastwards, which will become the main one. It has risen 15min earlier some km southward.

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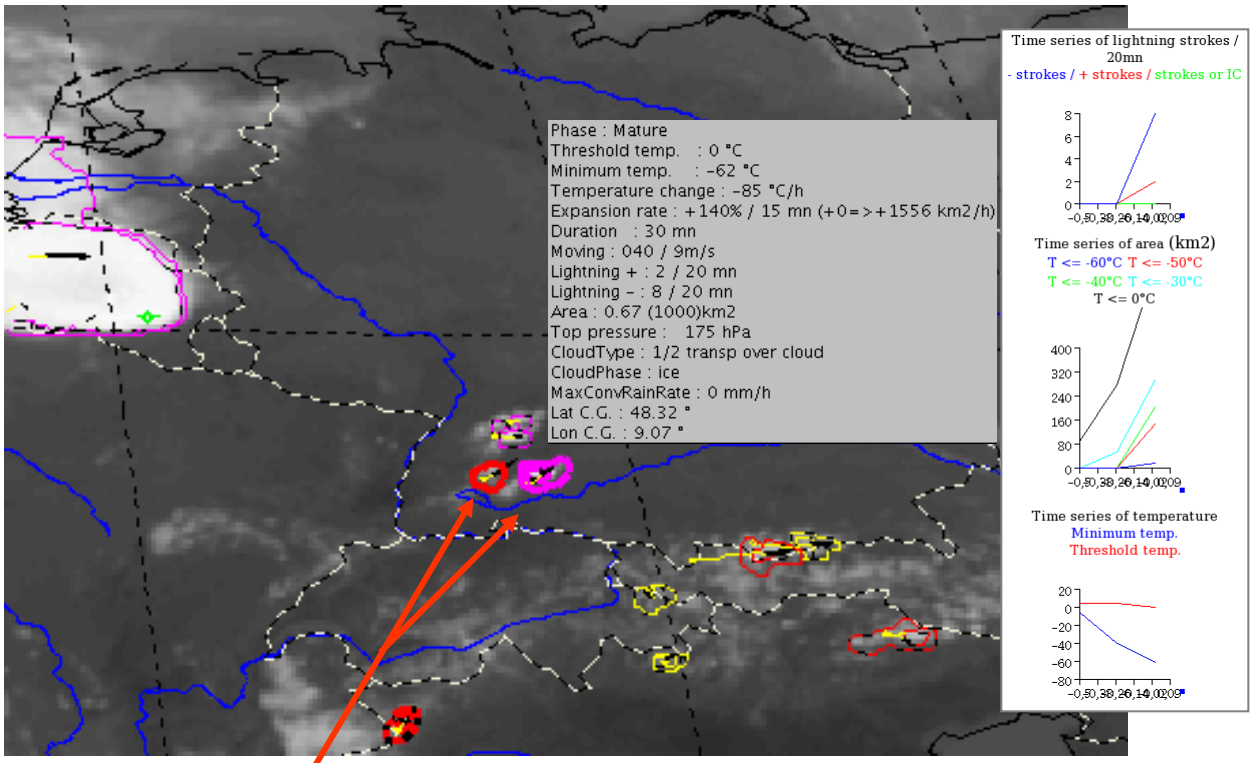

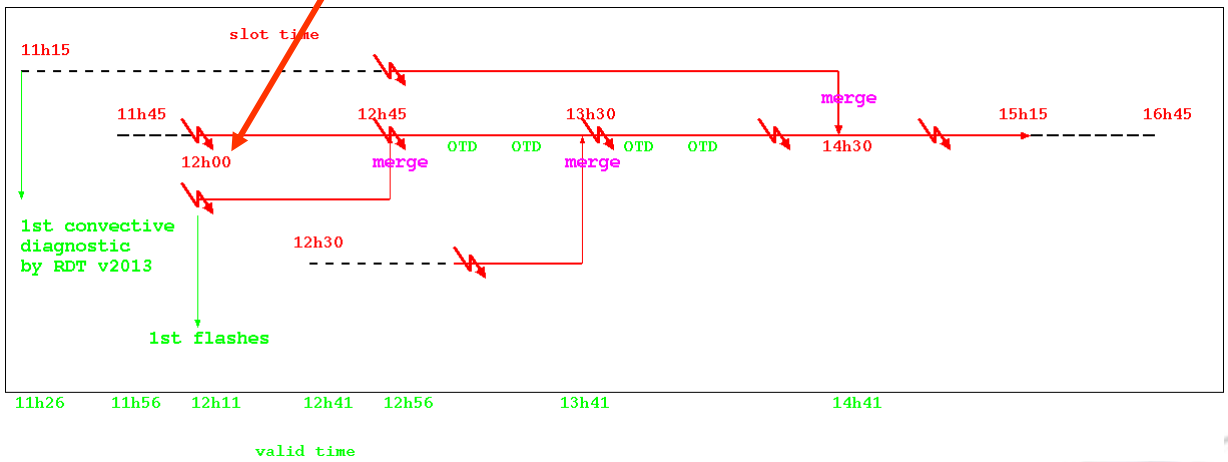

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- Slot 12h => Lightning activity begins in the main cell, like in a third new diagnosed small cell, which will merge into the main one 30 min later

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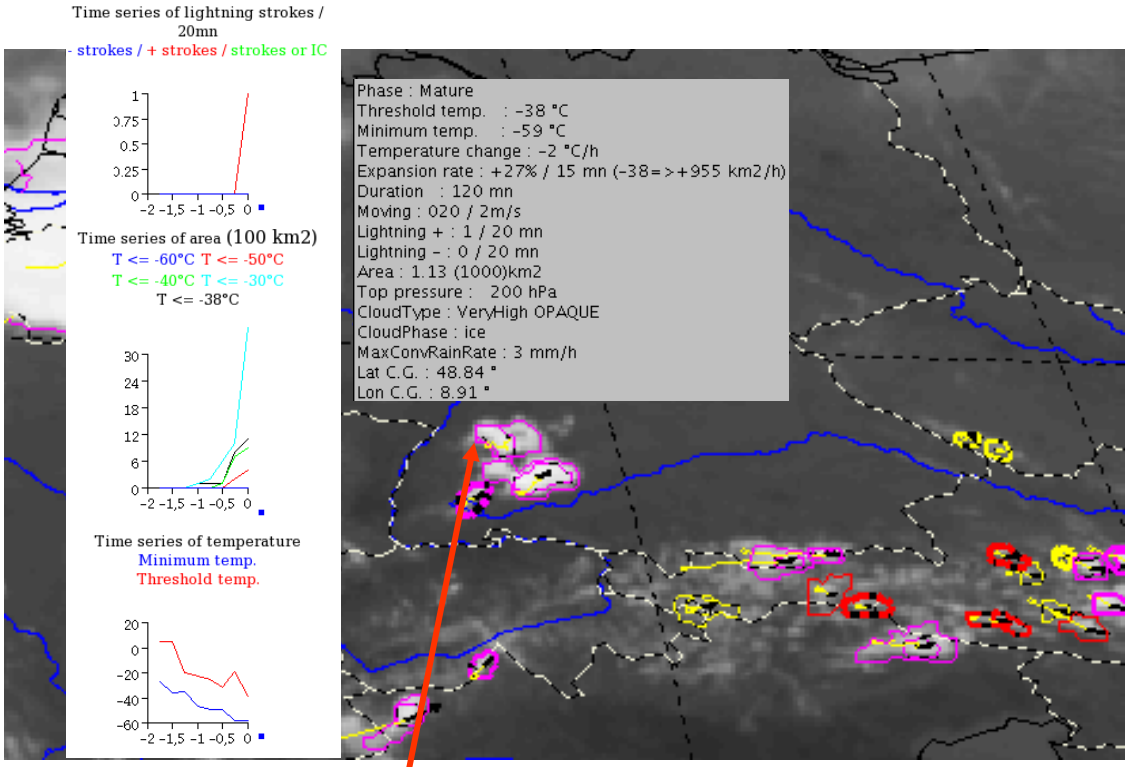

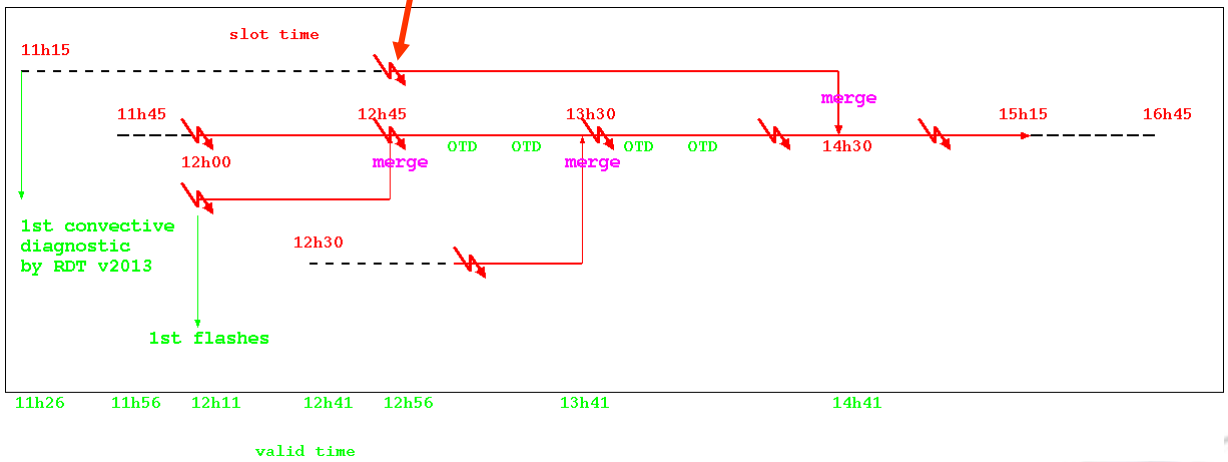

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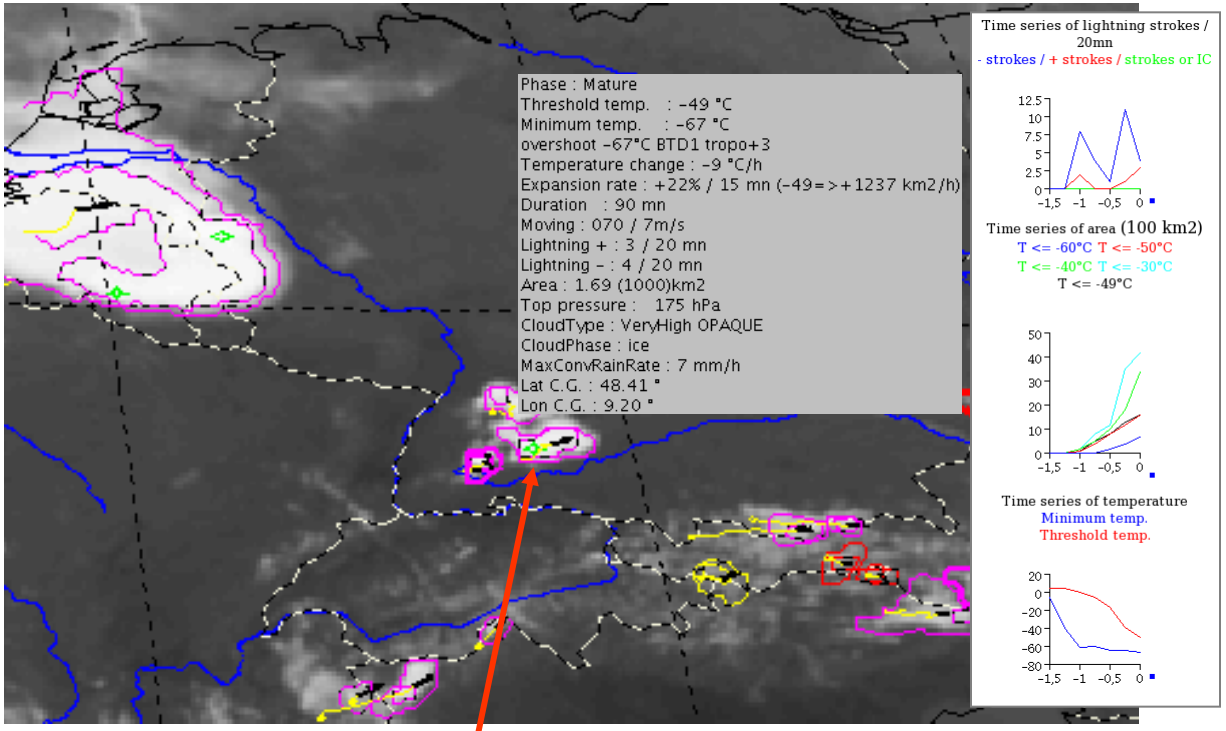

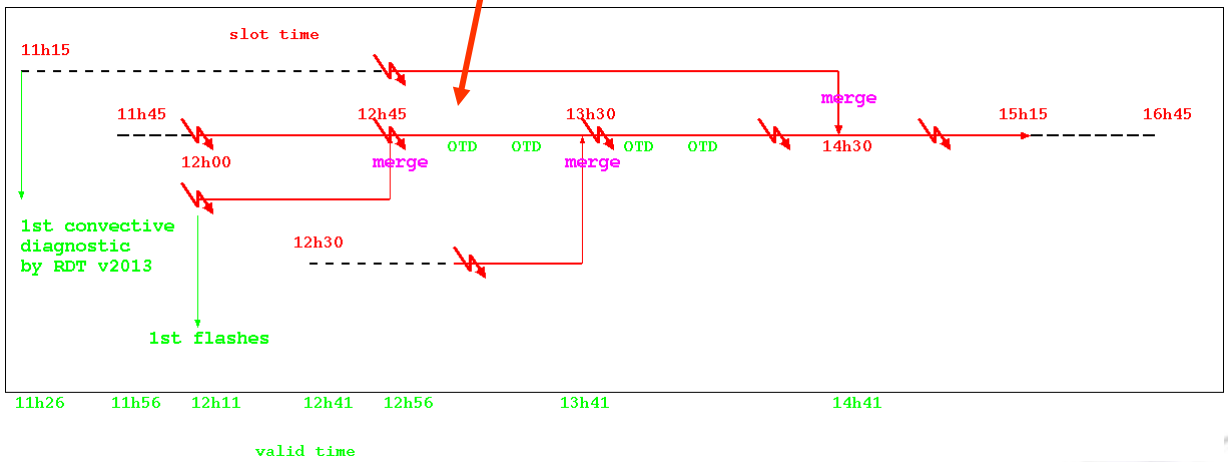

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- Slot 13h => first OTD

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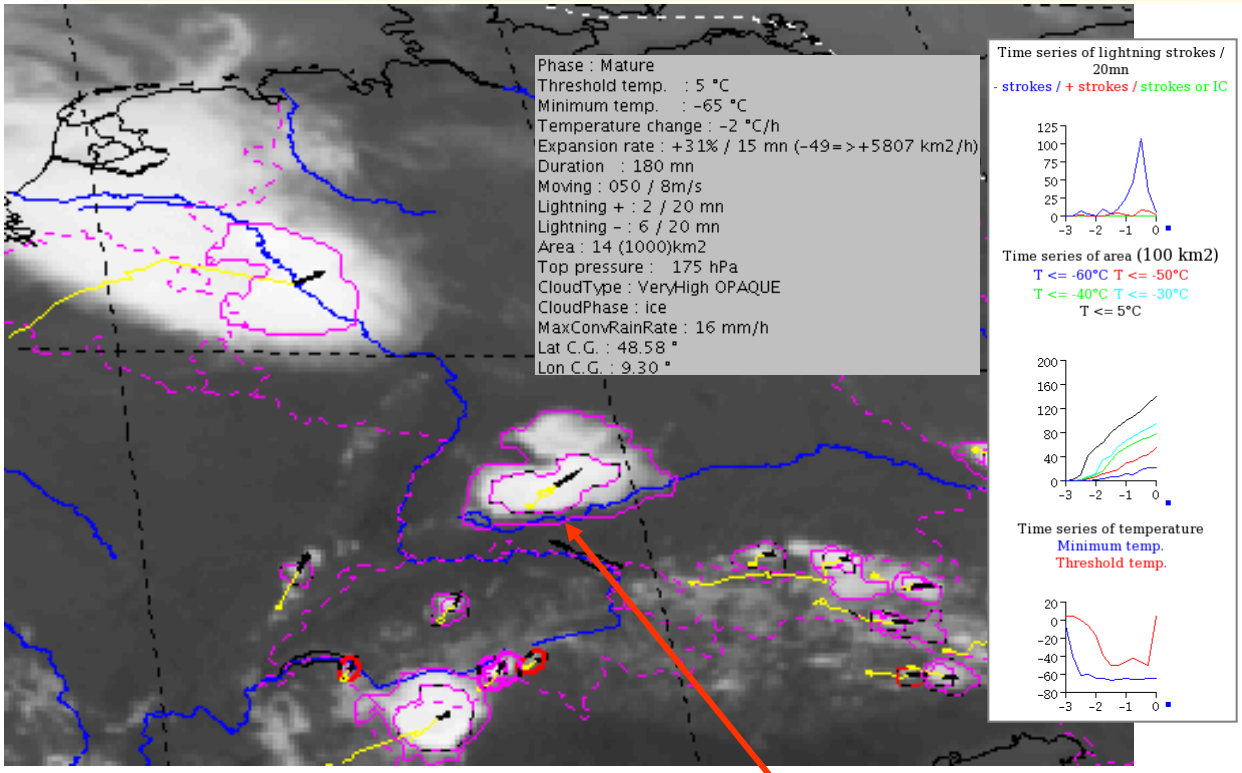

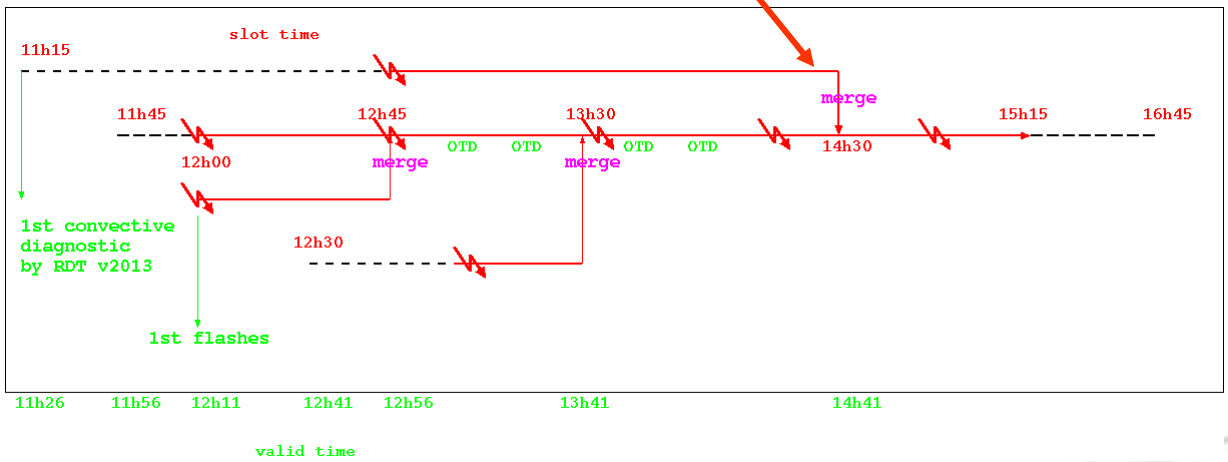

From noon, a group of convective cells rises in the south-west of Germany, merging to give a large convective system

- Slot 11h15 => A first cell is diagnosed, with minimum temperature of -36° , after 30 min tracking and a weak cooling.
- Slot 11h45 => A second cell is diagnosed, which will become the main one. It has risen 15min earlier some km southward.
- Slot 12h => Lightning activity begins in the main cell, like in a third new diagnosed small cell, which will merge into the main one 30 min later
- Slot 12h45 => Lightning activity appears in the first cell, 1h30 after the convective diagnosis by RDT
- Slot 13h => first OTD
- Slot 14h30 => the first cell merges finally into the main surrounding one

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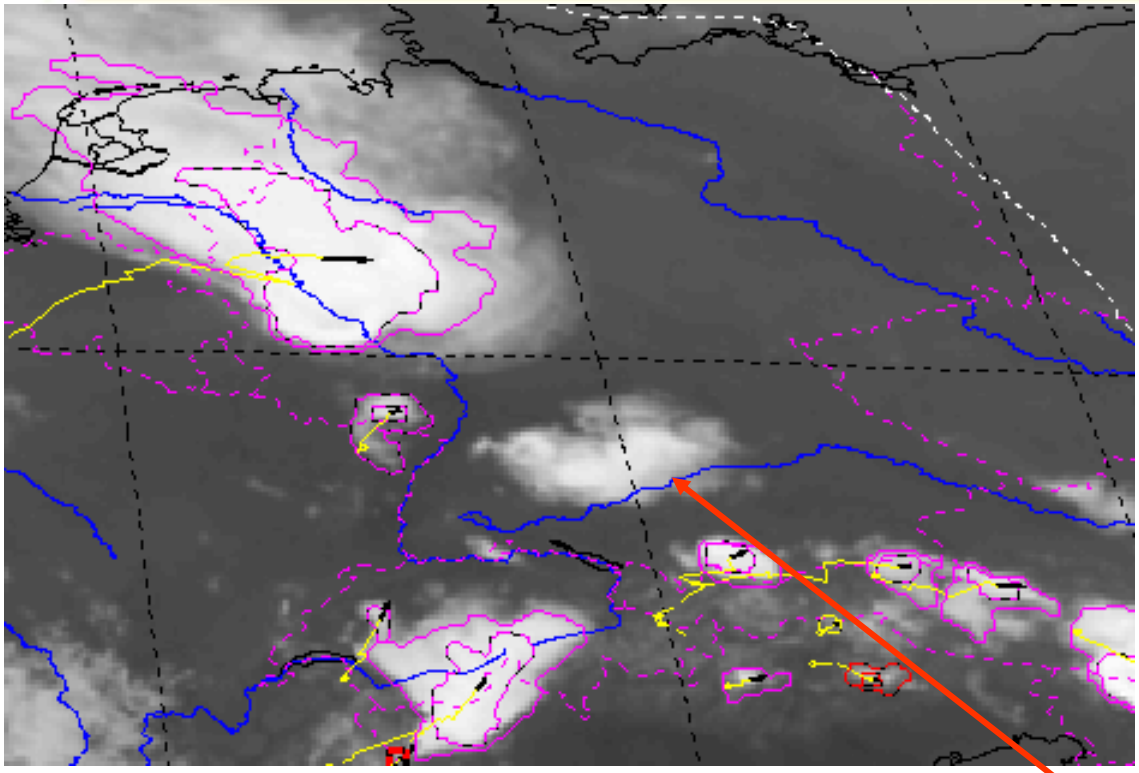

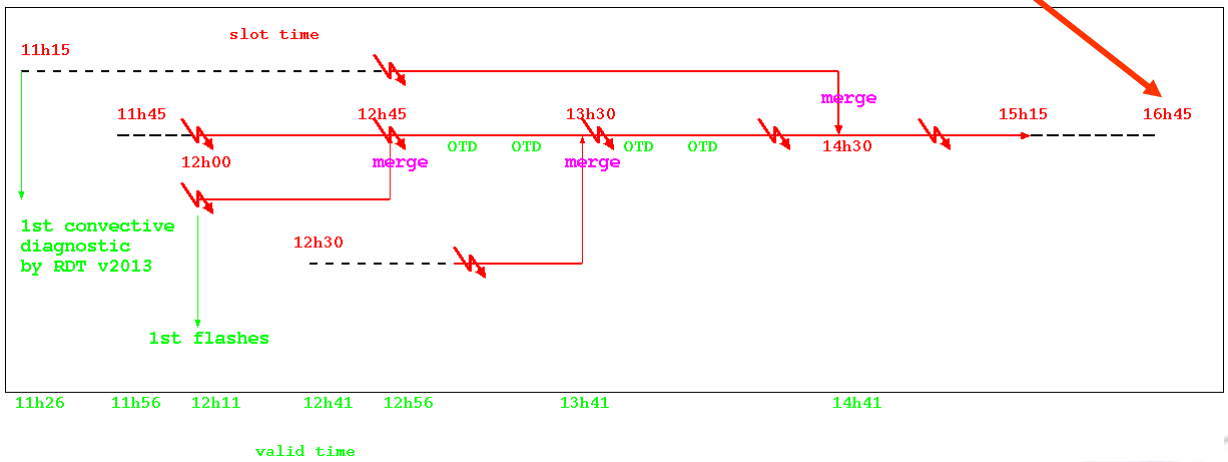

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- Slot 16h30 => the big cell is de-classified , and continue to dissipate until 19h00

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Case study 1 : early convective diagnosis

- Globaly speaking, one can consider that this part of the case study corresponds to a quite *good anticipation by RDT convective discrimination scheme*, for a 4 hours duration system, associated with a significant electrical activity.

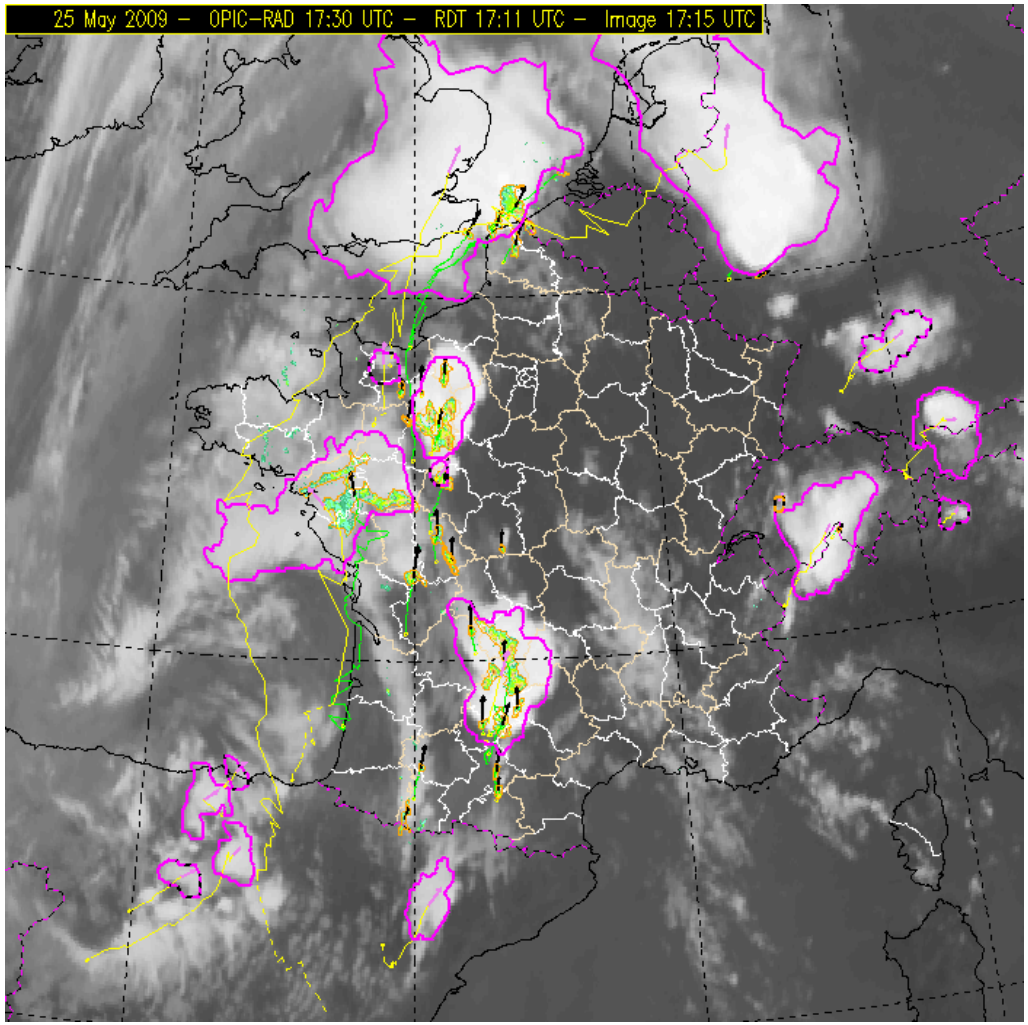
- Cell by cell, the evaluation is quite variable :
  - the first cell becomes electrical 1h30 after its first convective diagnosis, but electrical activity begins in the vicinity only 45min after
  - the main one is diagnosed 15 minutes before electrical activity
  - a third one is diagnosed at the same time than the start of electrical activity

- What about using a different ground truth ?

Case study 1 : Satellite and radar

- Alerts and early warning are rather based on radar data in Meteo-France
- RDT software initially applied to radar data for thunderstorm-core tracking
- Superimposition of
  - satellite-RDT convective cells (v2009) and
  - Radar-tracked cells (a/c 35 dBZ)

Case study 1 : Satellite and radar



Superimposition of

Satellite-RDT convective cells (v2009)

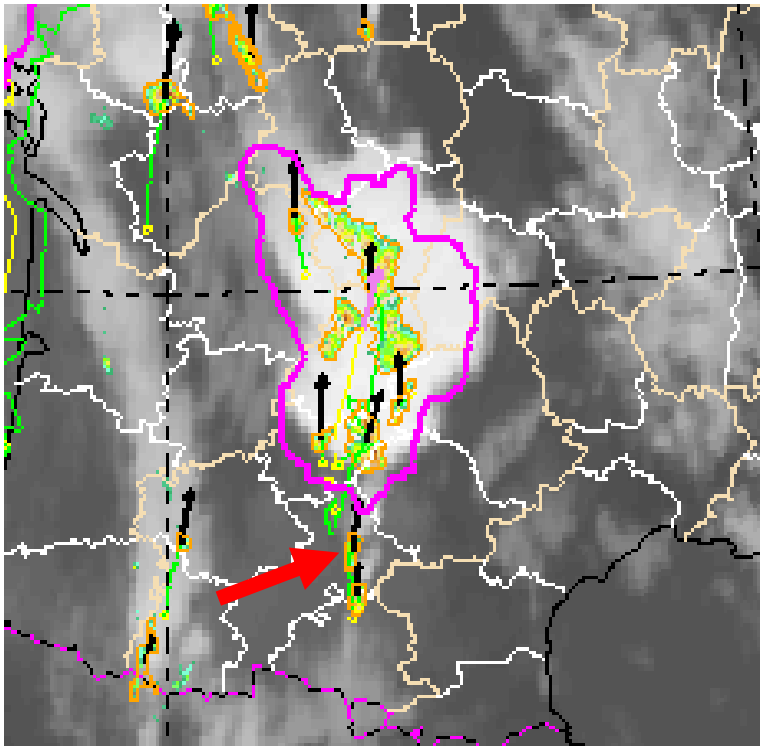
- tracks in yellow
- motion vectors in pink

+

Radar-tracked cells (a/c 35dBZ)

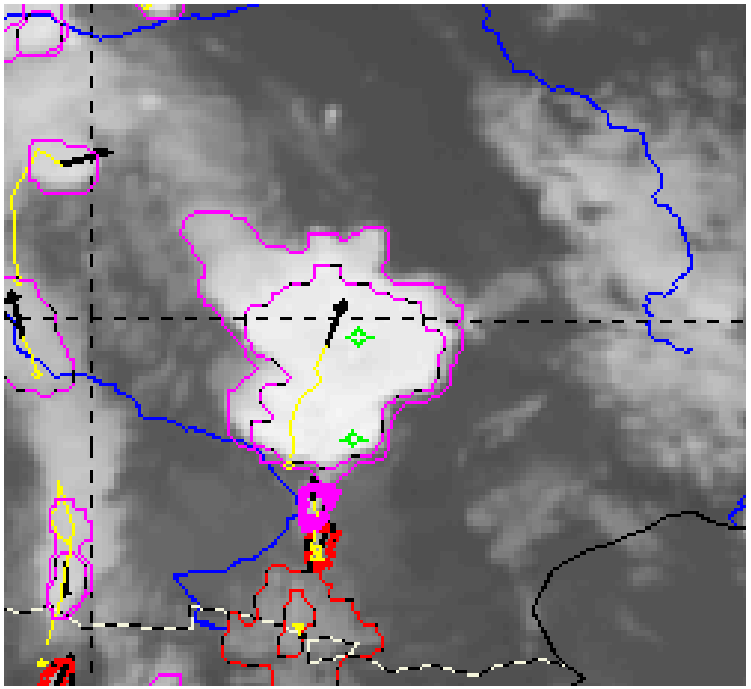
- green tracks in green
- motion vectors in black

Case study 1 : Satellite vs radar



Strong hail above Toulouse

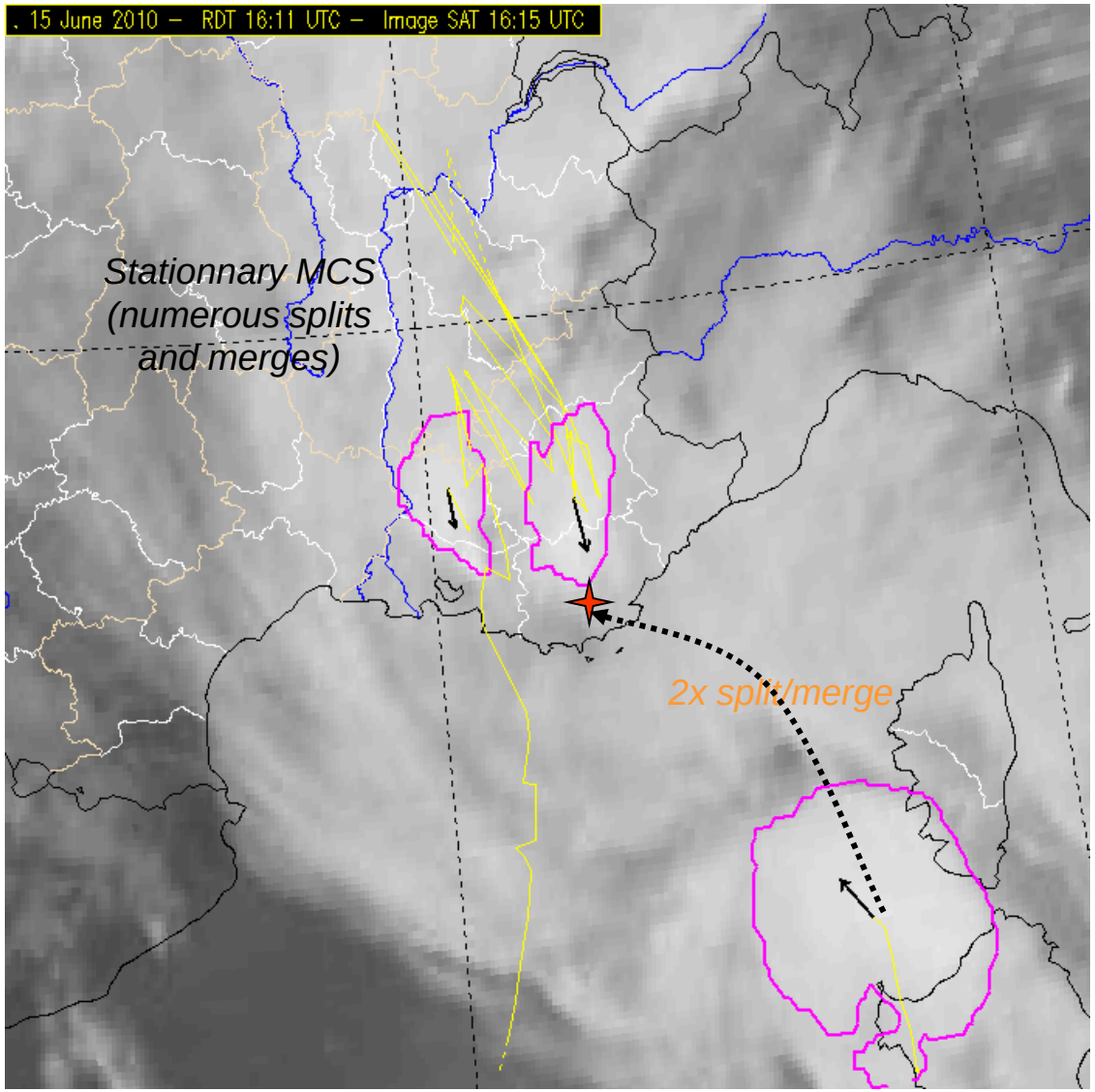
Earlier detection of radar vs RDTv2009



RDTv2013 benefits from

- Earlier convective diagnosis (NWP, other chanels, …)
- Additional information about cell activity (OTD, ...)

Case study 2: Flash floods 15/06/2010



- *Regenerative V system until begining of afternoon over SE of France (unusefull tracks and speeds)*
- *A new system reaching « Var » department during evening, causing deathly flash floods (people drawned in their houses!)*

☹ Contours variability due to morphological evolutions of convective system, with splits and merges

☺ But a *good tracking of convective system*, despite splits and moving direction change

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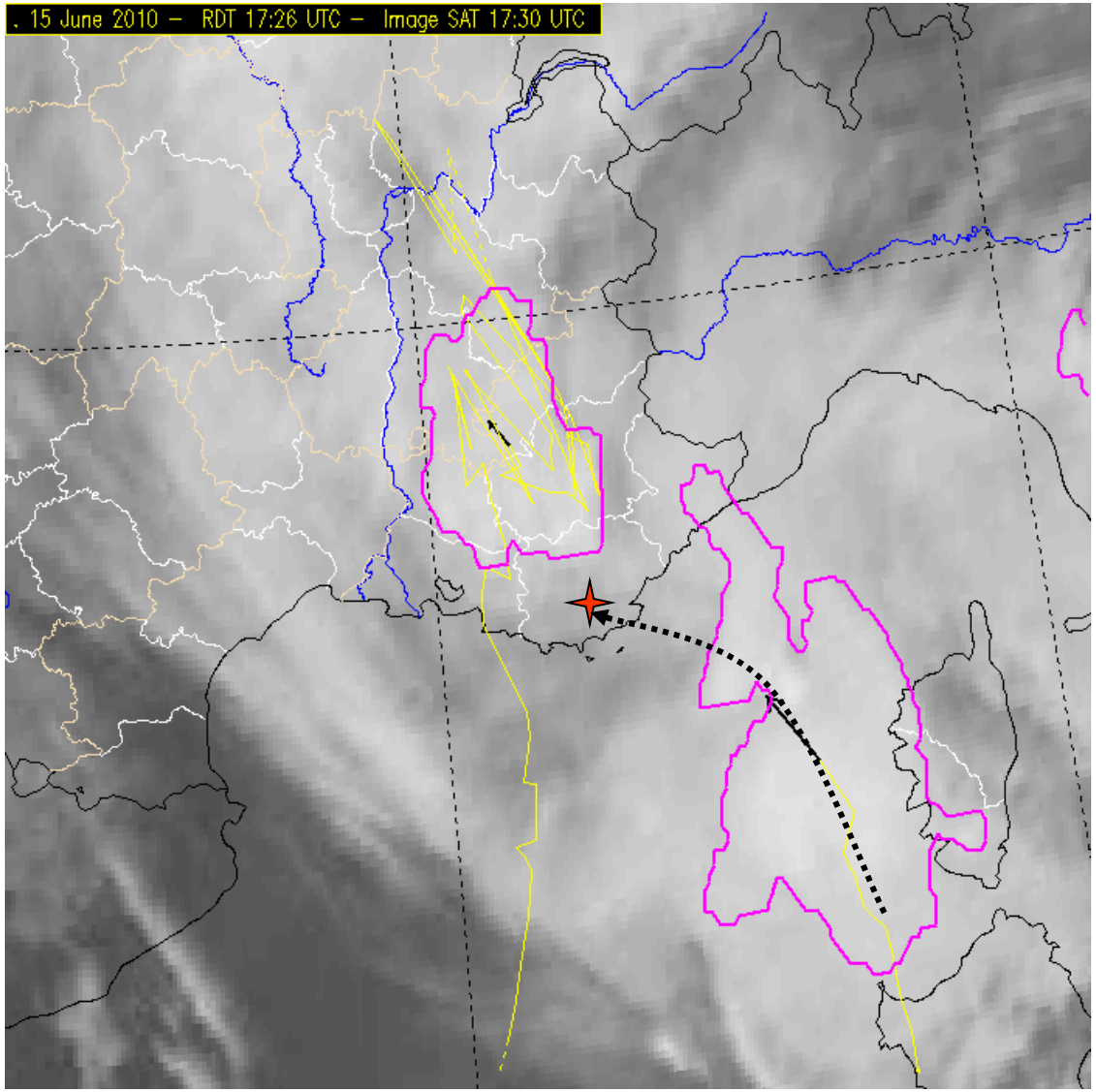

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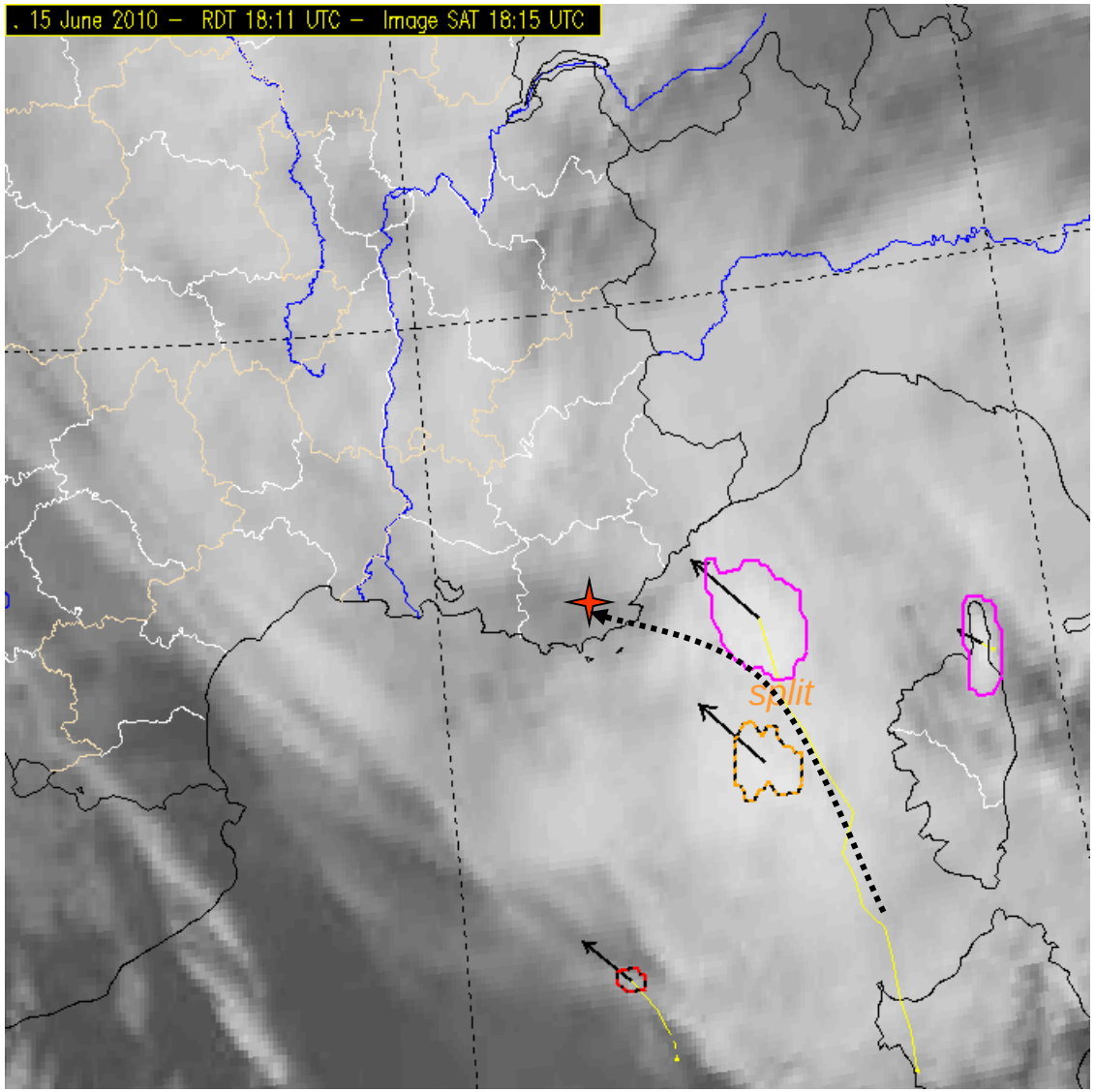

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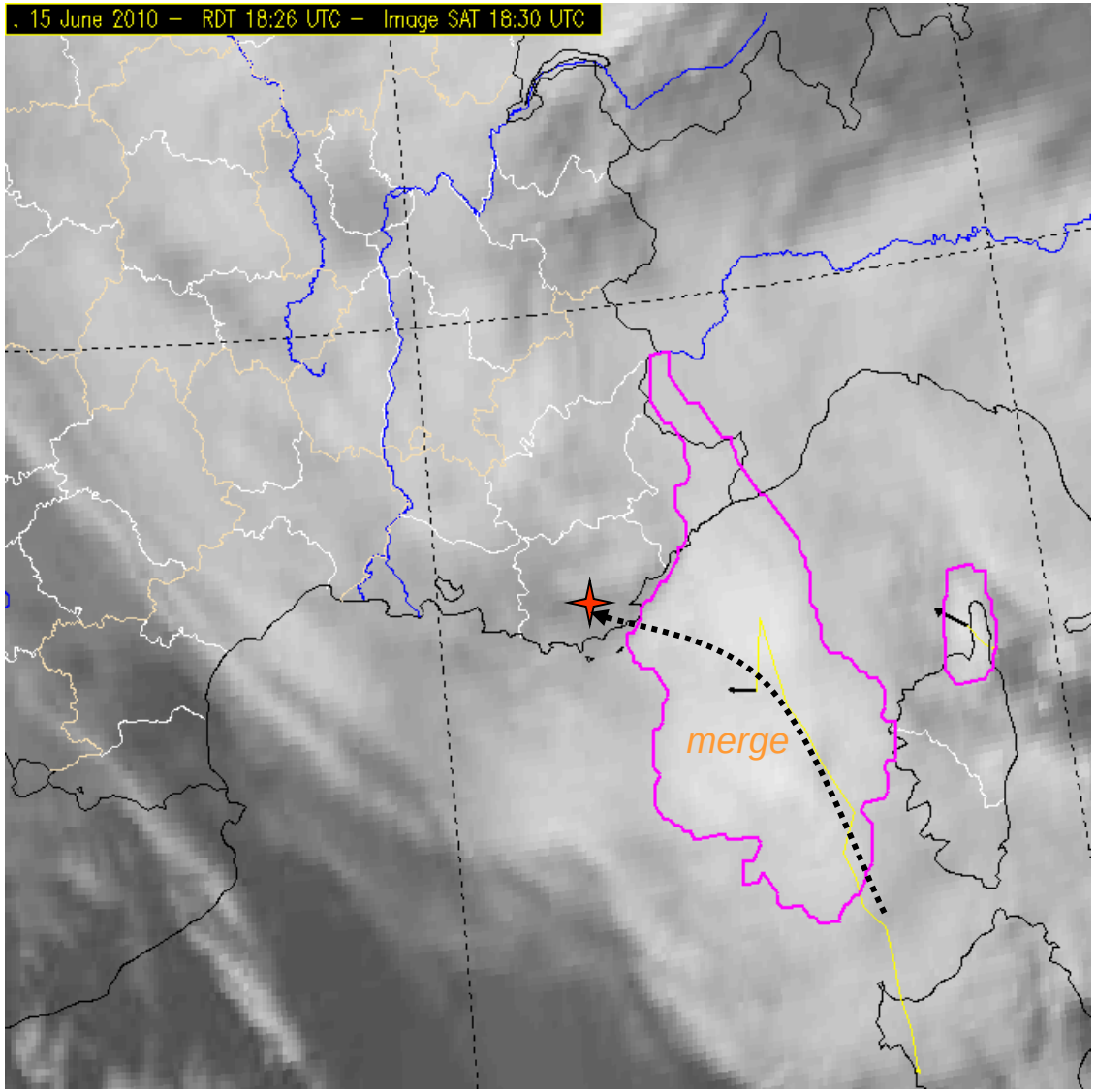

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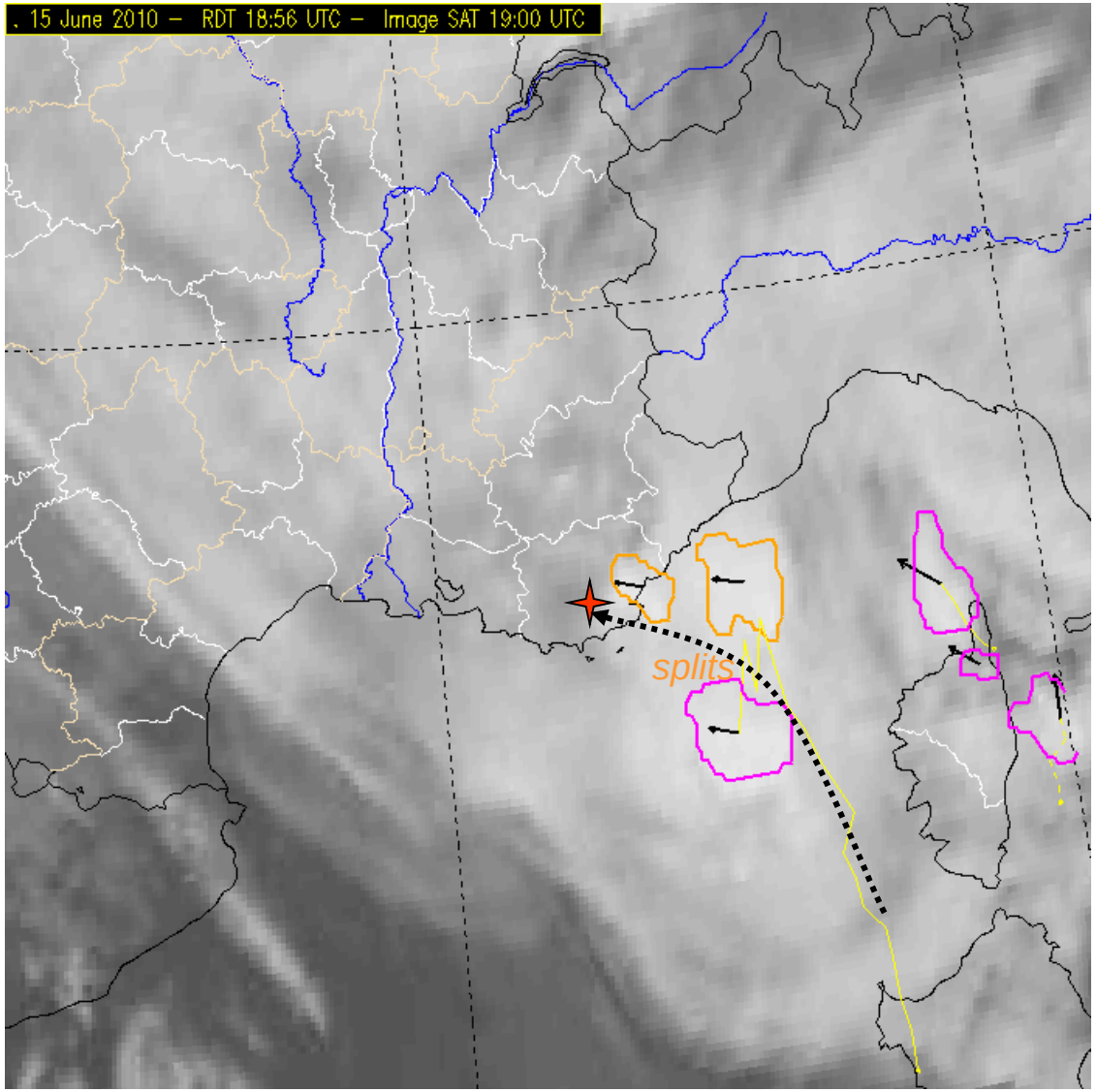

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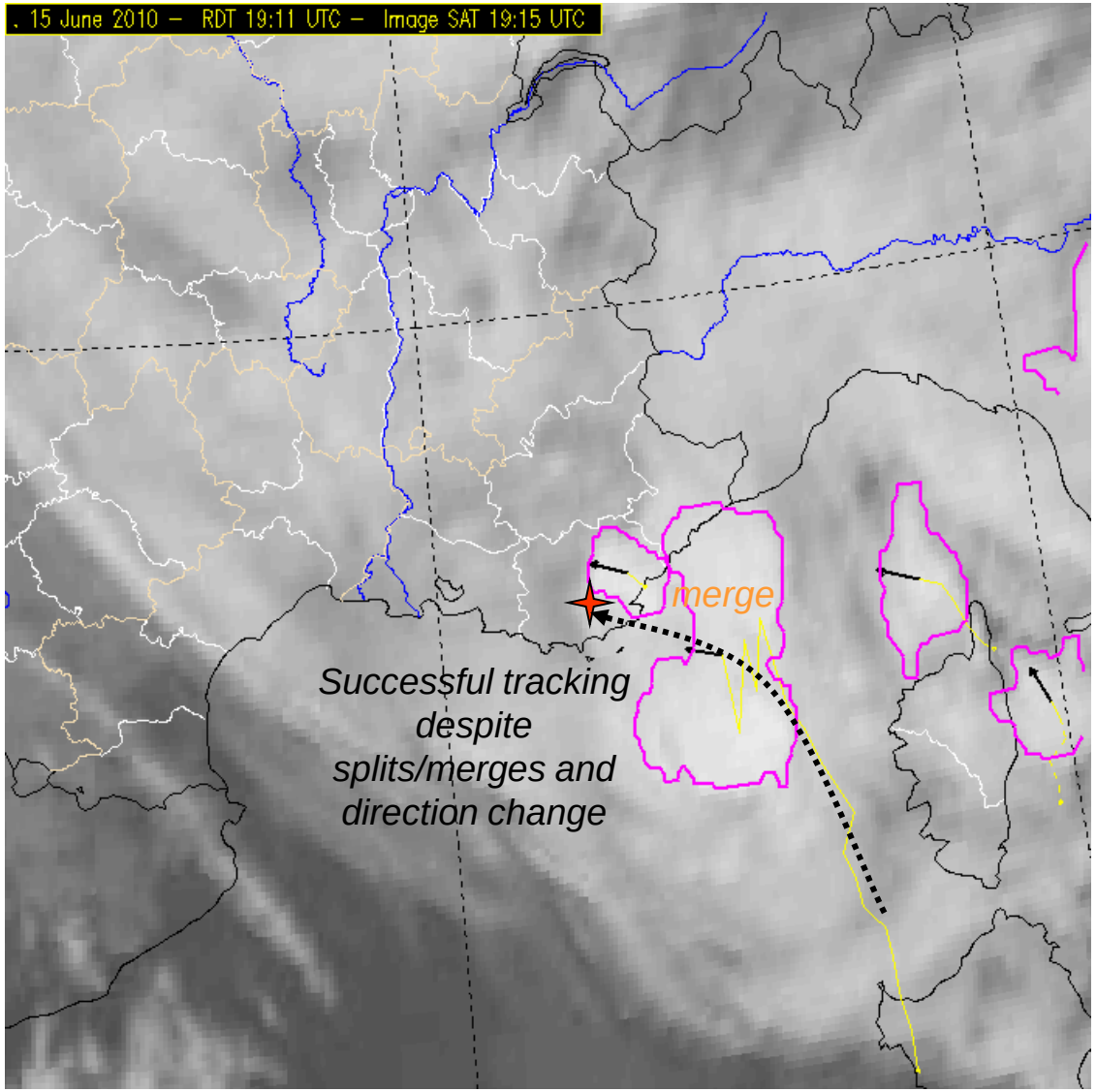

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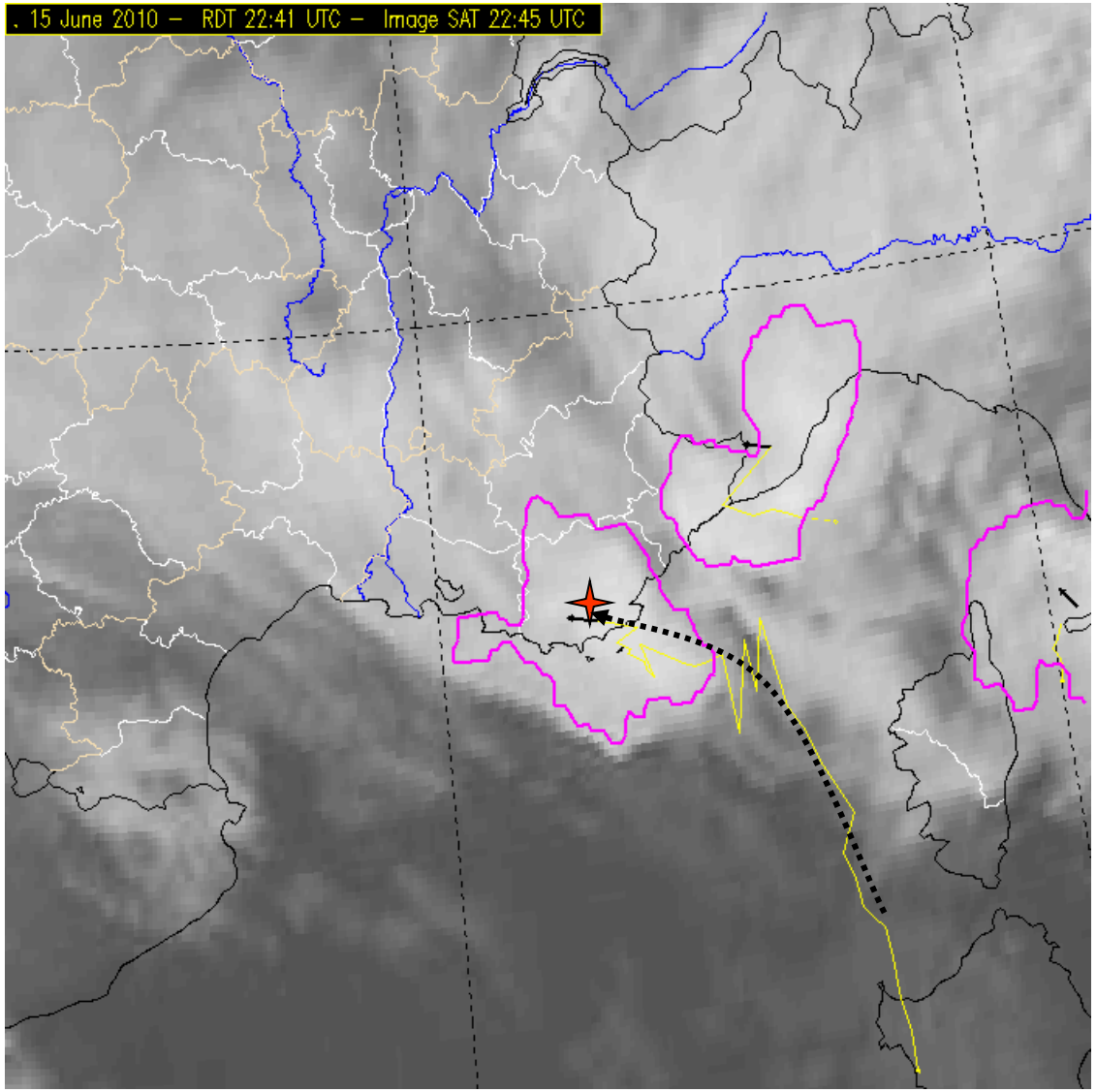

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Case study 2

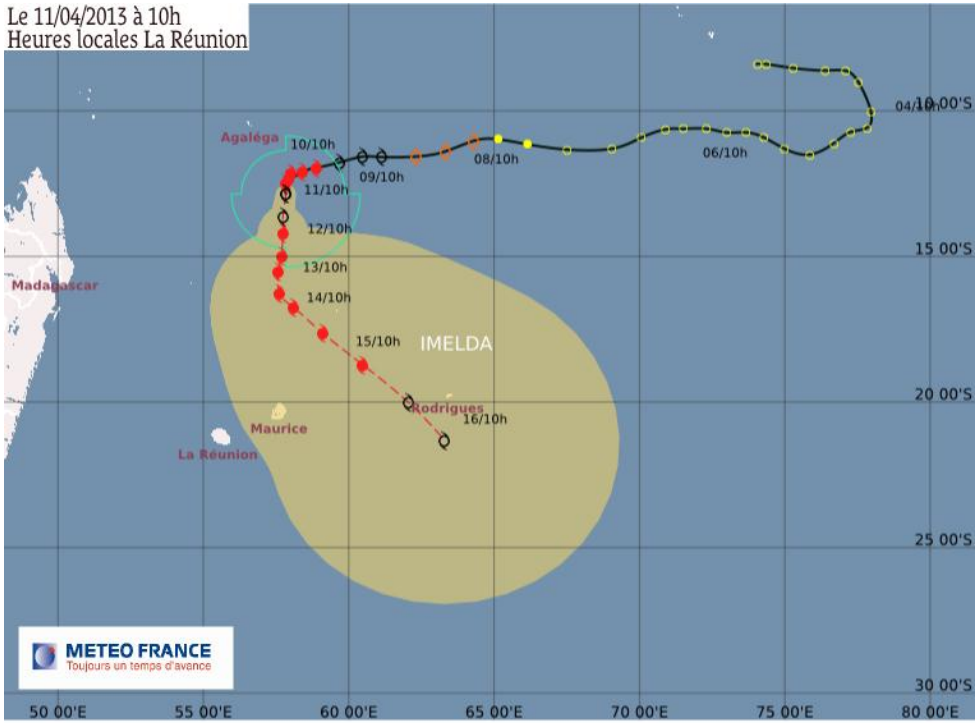
En quelques minutes, aux alentours de 18 h, le quartier Saint Hermentaire et les Florentins sont submergés par des eaux furieuses. Les sinistrés ne devront leur salut qu'aux hélitreuillages et à leur fuite par les toits de leurs maisons.

Case Study 3 : Indian Ocean - Imelda Hurricane – 06-11/04/2013

RDT not fitted for hurricane tracking (focusing on cloud « towers ») …

… but usual range of brightness temperature analysis (0°/-70° for tropics) by RDT often allow to catch sometimes whole system as an object …

… and strong convective activity enables an efficient convective diagnosis



Imelda hurricane *more or less correctly tracked* by RDT

Tracking *interrupted when* system is *weakening* (*no active towers*)

- 7/04
- 9/04
- 11-12/04

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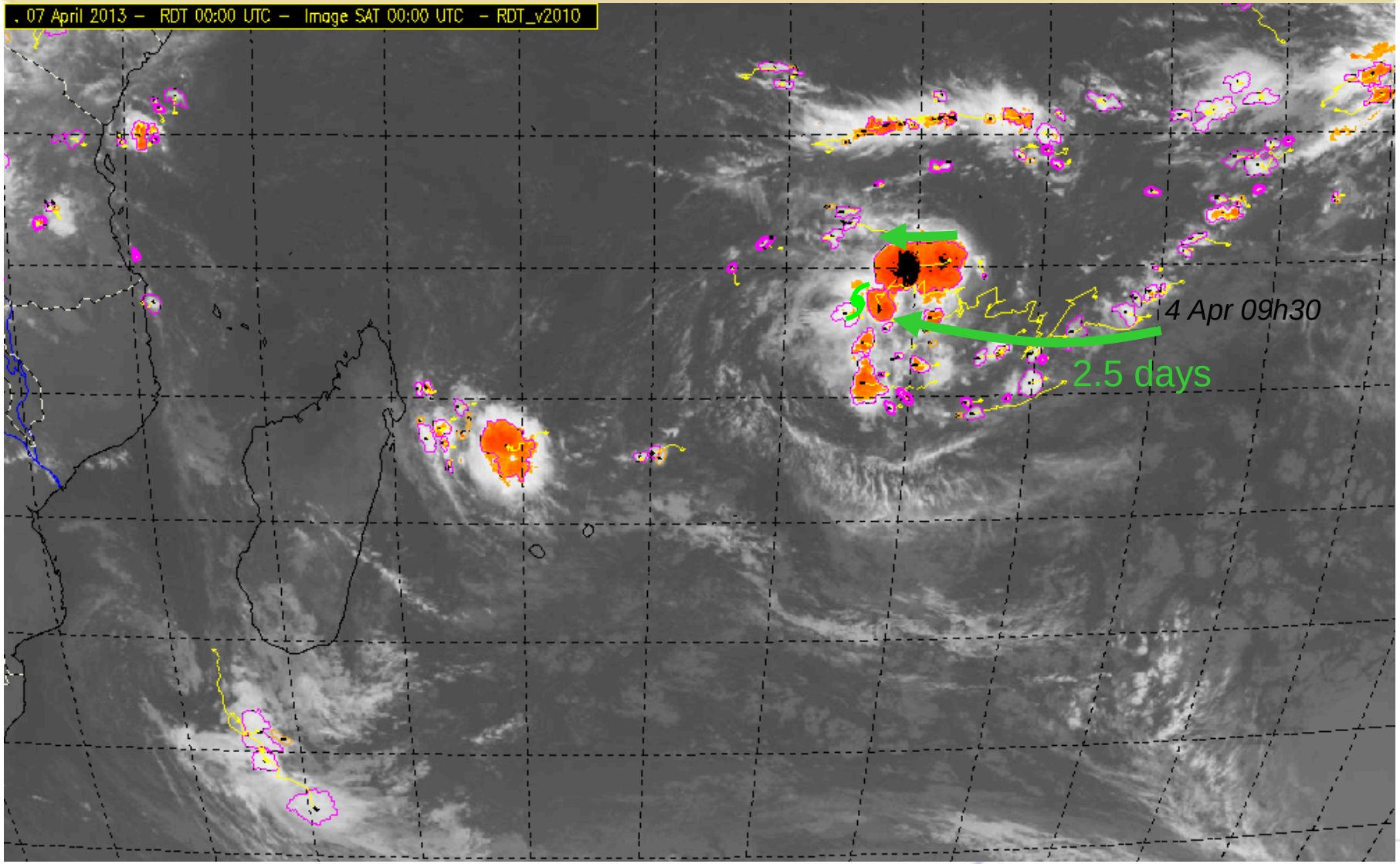

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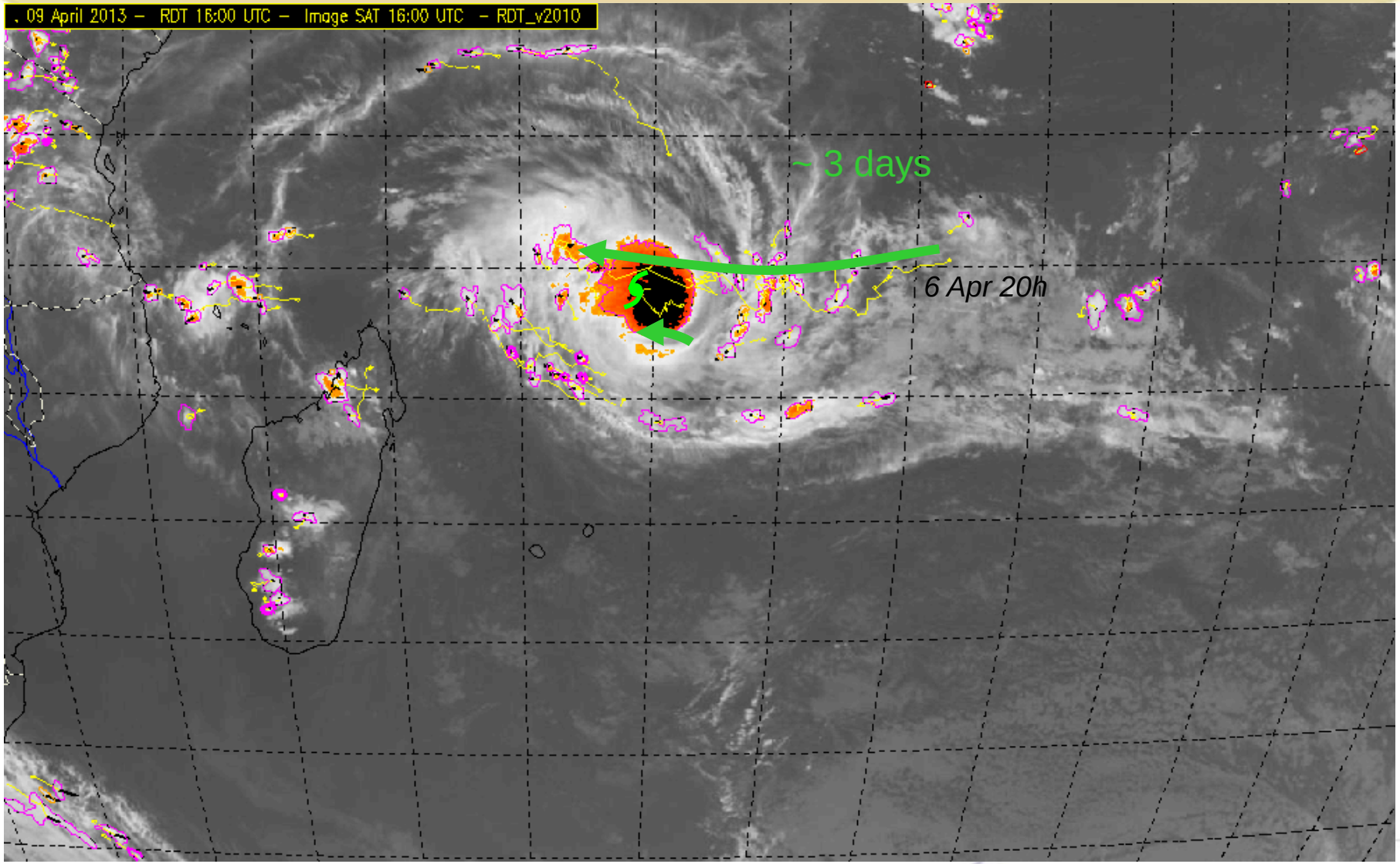

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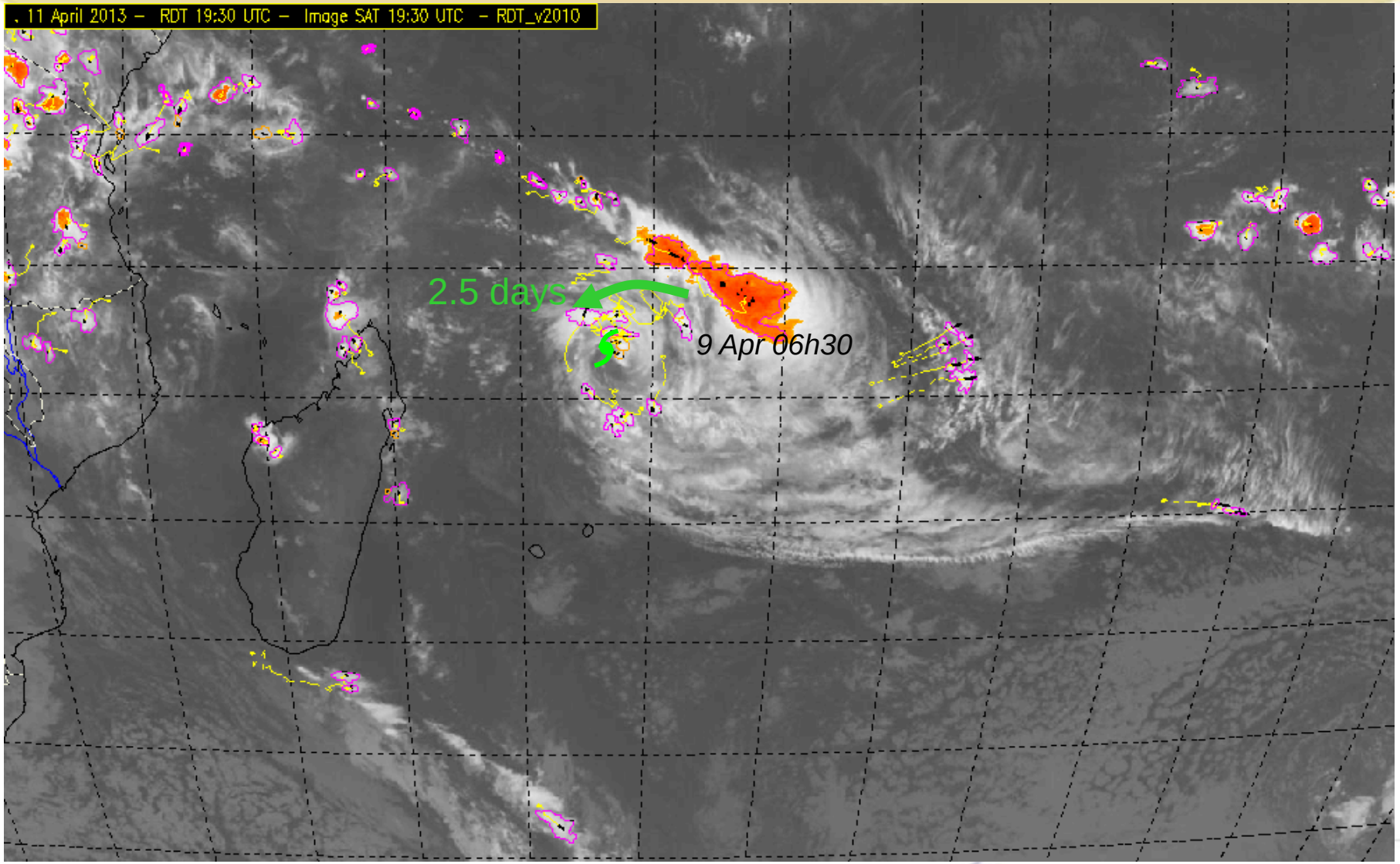

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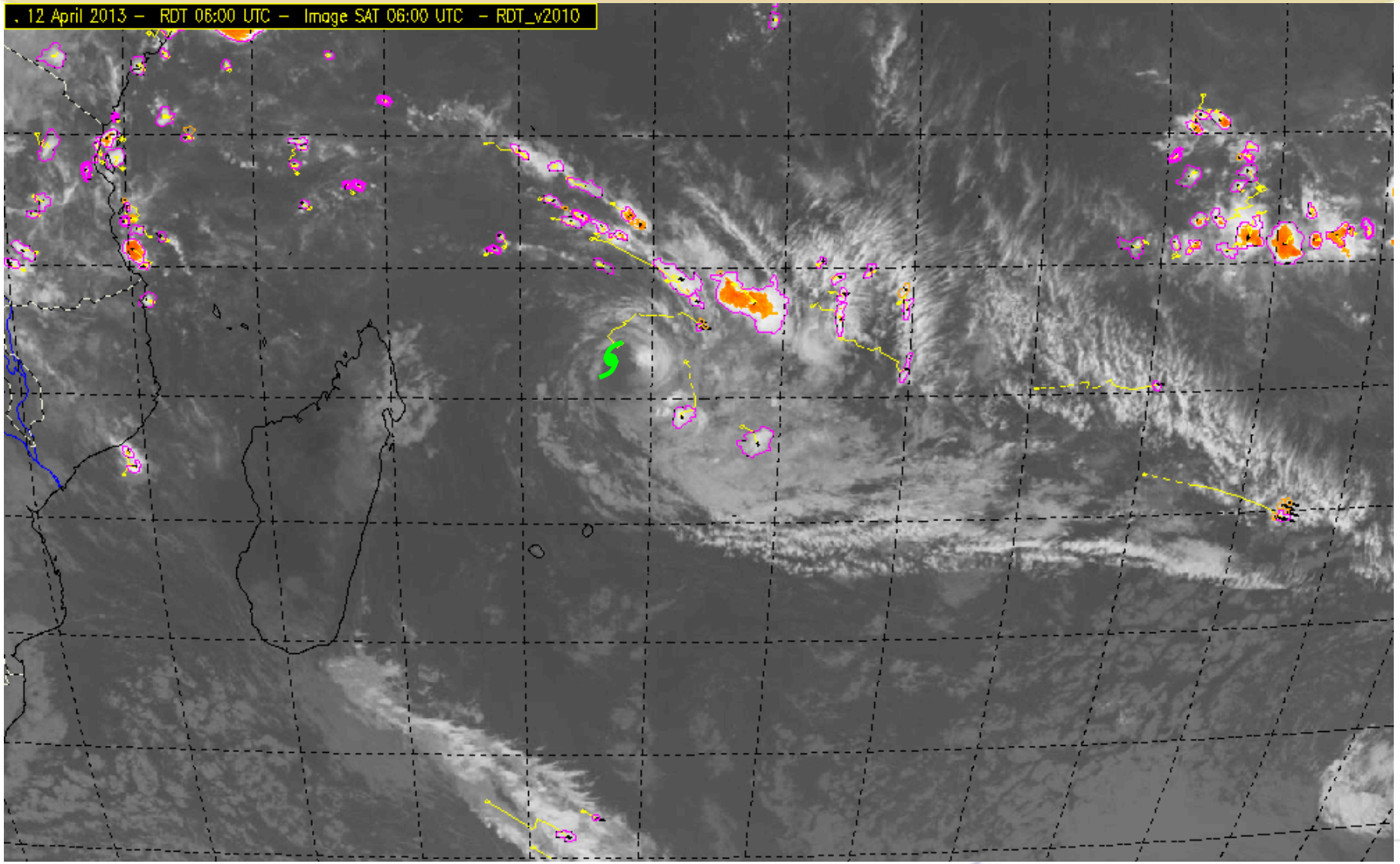

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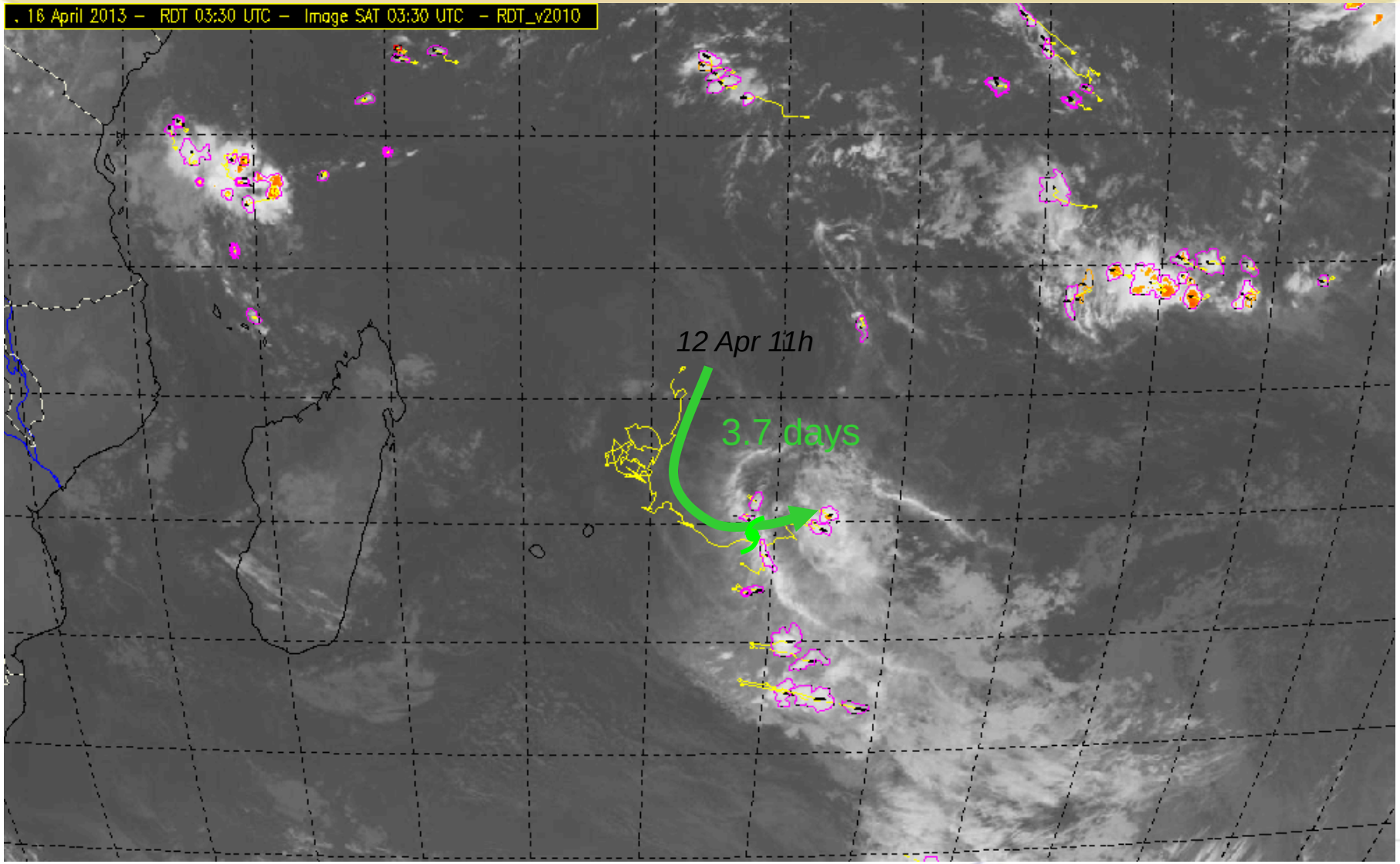

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