

Rapid Development Thunderstorm (RDT)

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

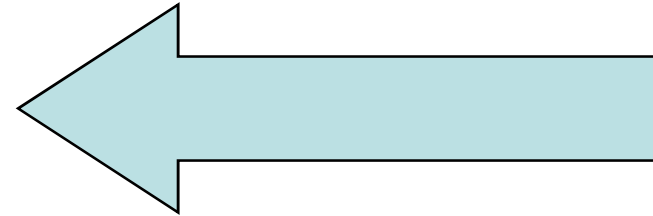
 **EUMETSAT**



METEO FRANCE
Toujours un temps d'avance

Outline

1. Description

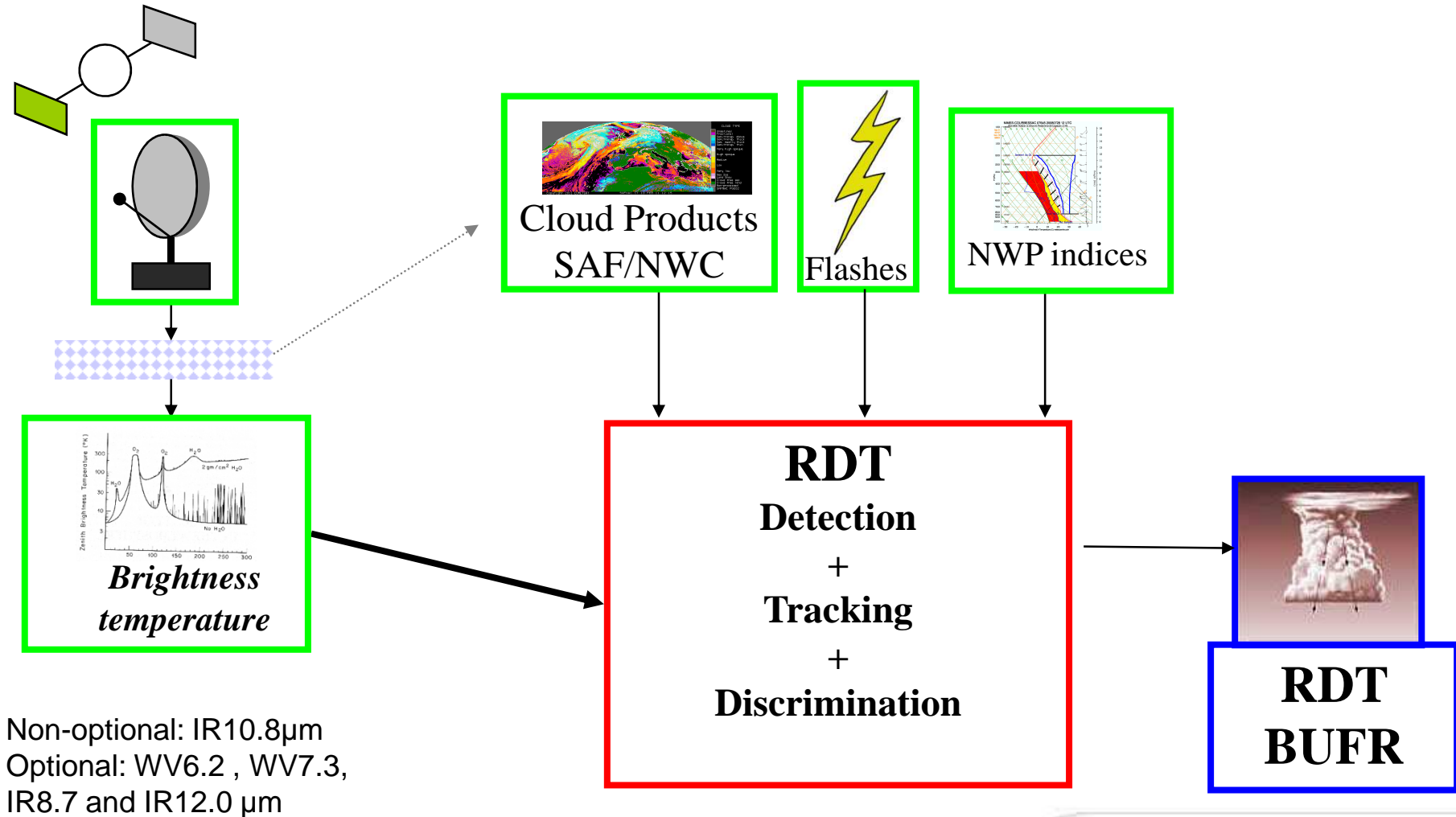


2. Validation

3. RDT and CDOP2

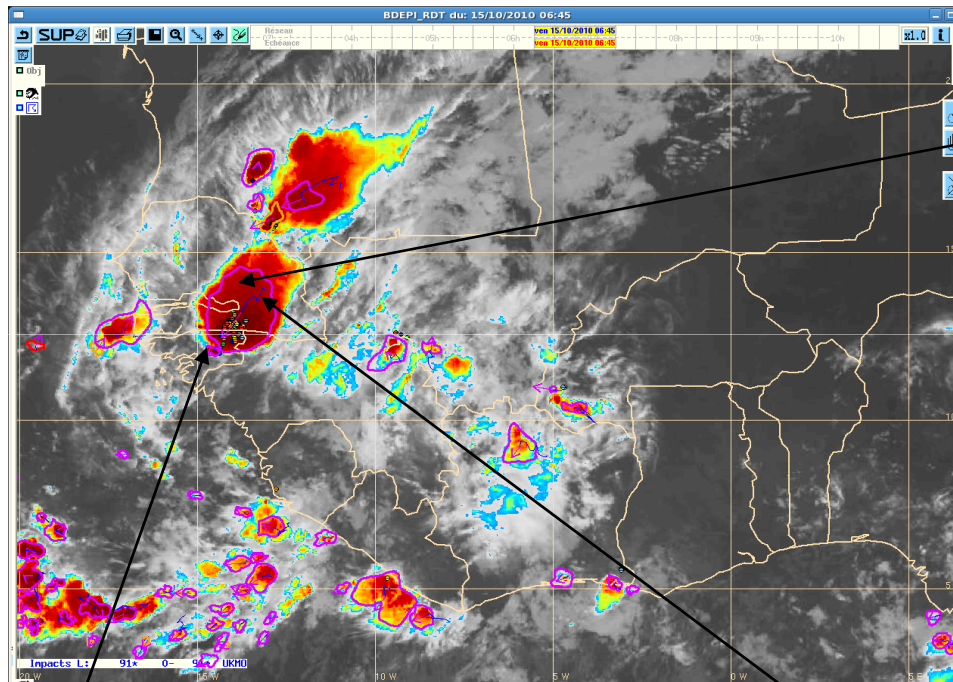
4. RDT and MTG

RDT main principles



RDT product

❑ Object-oriented satellite analysis



Attributes:

Phase	Mature
Lat CG	13.24 °
Lon CG	-13.76 °
Seuil temp (°C)	-66
Minimum temp (°C)	-85
Variation temp (°C/h)	5
Expansion (%/30mn)	-9
Début/Fin Phénomène	03h15 / Hffhh
Direction (°)	220
Vitesse (Km/h)	105
Impacts + (/15mn)	0
Impacts - (/15mn)	0
Eclairs (/15mn)	0
Surface (km2)	41656
Annuler	

Phases:

Yellow: First detection of convective system
Red: Developing system
Purple: Mature system
Blue: Decaying system
Orange : After a split of systems

Tracking:

Purple arrow : motion vector
 Blue line: trajectory

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Validation of RDT

 METEO FRANCE <small>Toujours un temps d'avance</small>	Validation Report for "Rapid Development Thunderstorms" (RDT-PGE11 v2.3)	Code: SAF/NWC/CDOP/MFT/SCI/VR/11 Issue: 2.3 Date: 15 February 2012 File: SAF-NWC-CDOP-MFT-SCI-VR-11_v2.3 Page: 1/36
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Validation Report for "Rapid Development Thunderstorms" (RDT-PGE11 v2.3)

SAF/NWC/CDOP/MFT/SCI/VR/11, Issue 2, Rev. 3
15 February 2012

Applicable to SAF/NWC/MSG version 2012

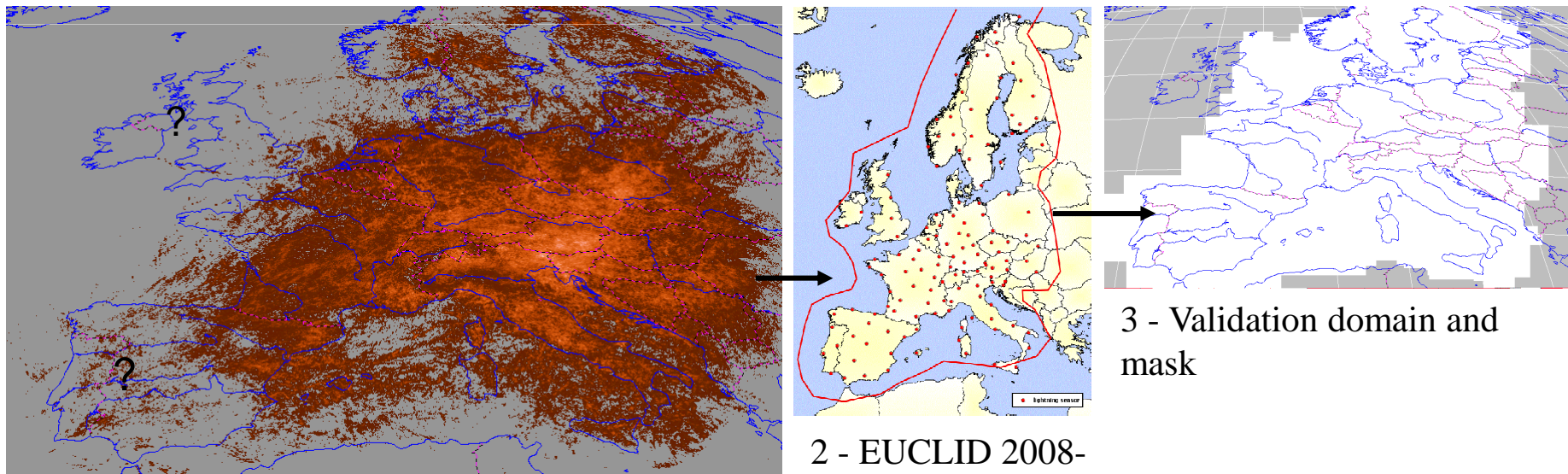
A new validation of RDT : with intermediate seasons, over EUROPE and concerning the last version CDOP (V2012).

Method

Results

GROUND TRUTH = LIGHTNING DATA

- ❑ The ground truth is based on the lightning data of EUCLID, a collaboration among **national lightning detection networks**
- ❑ Those data concern stroke returns of **Cloud-to-Ground flashes**, collected over Europe.
- ❑ Available parameters are: time of the event, impact point coordinates (Latitude and longitude), current intensity and polarity.
- ❑ Database has been explored to assess the geographical and temporal coverage of the data.



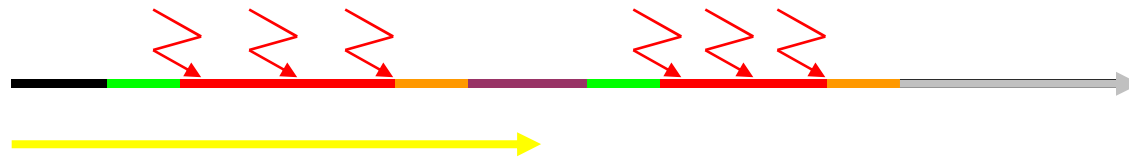
1 – [200806-08,200904-10] EUCLID lightning data density

2 - EUCLID 2008-2009 sensor coverage
(courtesy of S. Vaz Meteorage)

3 - Validation domain and mask

Various methods of validation

- We consider three approaches : full-trajectory, sections of trajectory or each time step



- The trajectories are classified into four categories : non-electric trajectories, low electrical activity, moderate electrical activity and severe electrical activity

- In order to ignore less reliable cases, some trajectories are ignored in certain validation sets: trajectories with low electrical activity, non-electric trajectories close to flashes.



- Contingency tables and scores are calculated for RDT validation

- Probability of detection (hit rate)
 $POD = A / (A+C)$

- False alarm ratio
 $FAR = B / (A+B)$

- Probability of false detection (false alarm rate)
 $POFD = B / (D+B)$

- Threat score (critical success index)
 $TS = A / (A+C+B)$

		
RDT Convection Diagnosis YES	A	B
RDT Convection Diagnosis NO	C	D

Main Results

POD / POFD / FAR / TS for different validation methods and periods
(separation of non-electric and electric trajectories based on a moderate activity)

	POD	POFD	FAR	TS
① Trajectory Approach, France, Summer 2005, Meteorage data, RDT v2009	66	2	44	43
② Trajectory Approach Europe, Summer 2008 + summer 2009, EUCLID data, RDT v2011	75	3.5	31	56
③ Trajectory Approach Europe, Full period, EUCLID data, RDT v2011	74	3.5	34	53
<i>Idem with flashes proximity tolerance of 35km</i>	74	2	22	61
④ Section approach Europe, Full period, EUCLID data, RDT v2011	77	4	28	59
<i>Idem with flashes proximity tolerance of 35km</i>	77	3	21	64
⑤ Time steps approach Europe, Full period, EUCLID data, RDT v2011	65	1.5	20	56
<i>Idem with flashes proximity tolerance of 35km</i>	65	1	14	59

①: Better results for this validation compared to the previous one's (mainly due to [version change](#))

②: Scores remain good when non-summer months are added

③: Flash proximity tolerance lowers the FAR

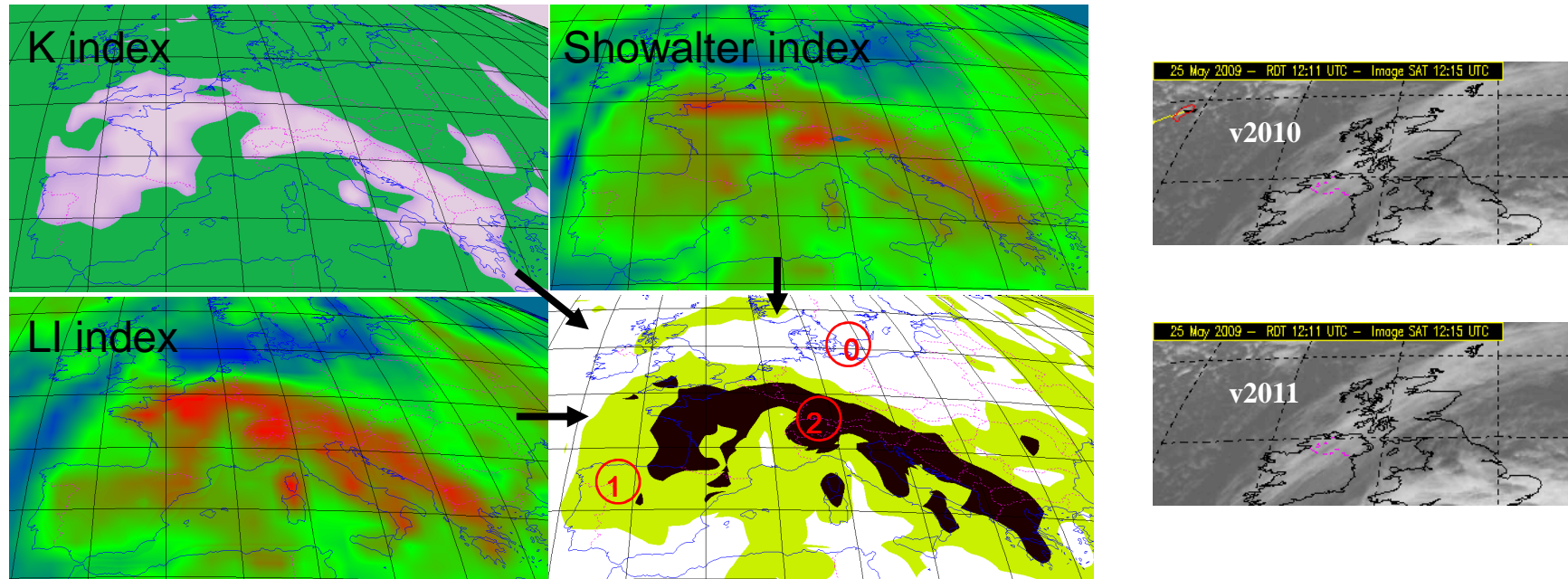
④: Best results concern the Section Approach due to time-tolerance given to sections before and after lightning activity

⑤: Time step approach is much less advantageous but scores remain correct

RDT v2011: NWP convective mask

□ NWP data for convective mask

Union of 3 indexes to exclude stable areas from convective diagnosis



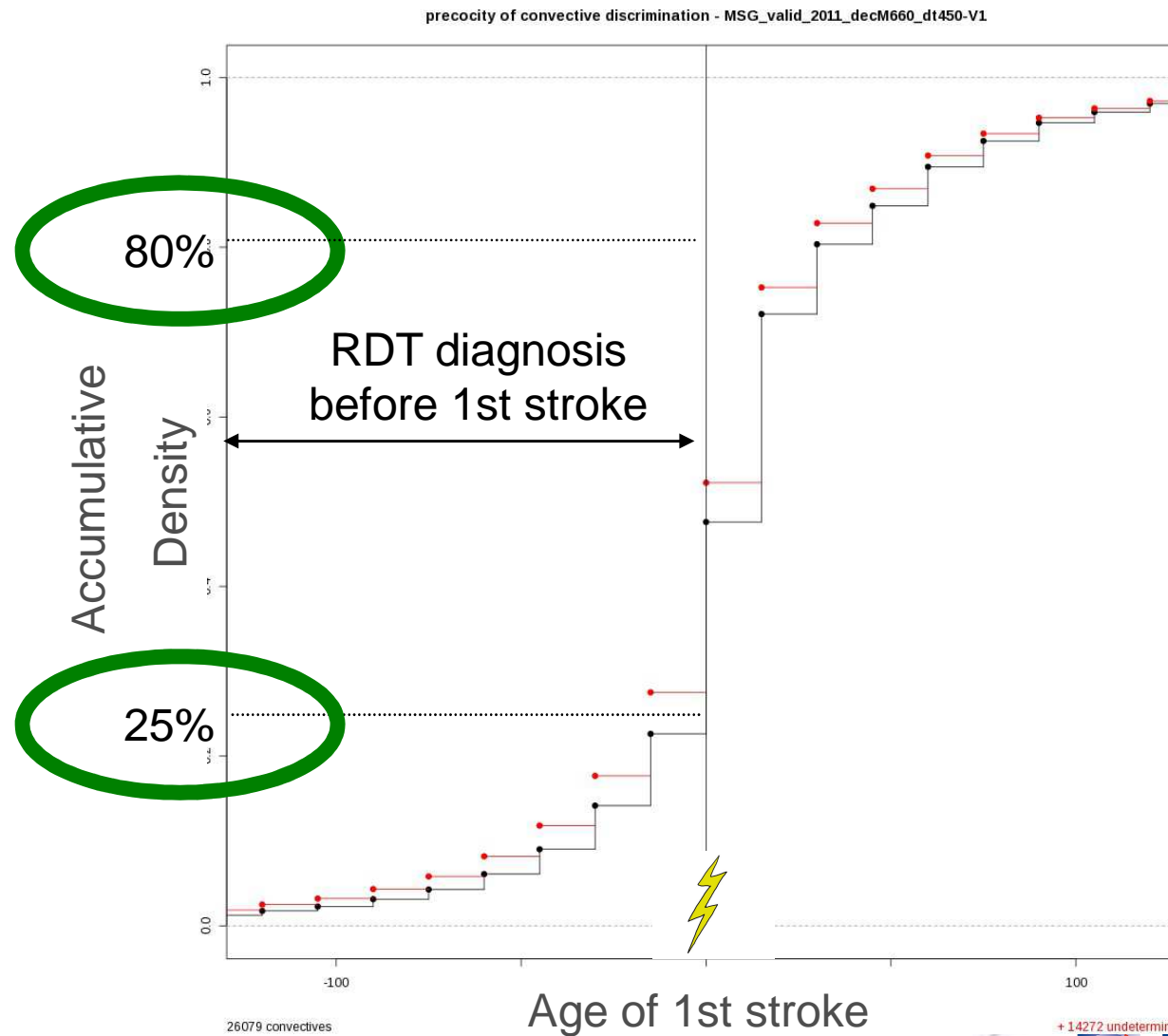
Allows:

- To focus RDT on areas of interest,
- To strongly reduce the false alarms during intermediate and winter seasons
- To improve precocity for the convective cells



Precocity of RDT convective diagnosis

RDT v2011 discrimination for moderate (black) and low (red marks) ground truths.



Conclusions on objective validation V2012

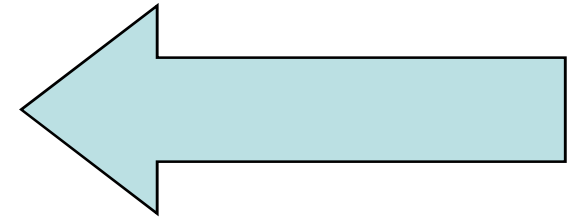
- Even if RDT is slightly better during the summer, RDT remains reliable when evaluated in intermediate seasons.
- Moreover, the skills obtained with EUCLID data, over Europe and for v2011 are better in all configurations and for all approaches than for the previous validation.
- **Those results fulfil the target accuracy requirements over a large domain and for an extended period:**
 - detection is superior to 70% and
 - 25% of convective systems are diagnosed before lightning activity.
- **On the other hand, RDT is a very satisfying product widely used for Research and Operations by Météo-France and its partners**
 - AMMA, Hymex , Flysafe, NOAA, ACMAD...

**On the basis of the arguments given above,
SAF/NWC Steering Group agreed to upgrade RDT status
to “operational”**

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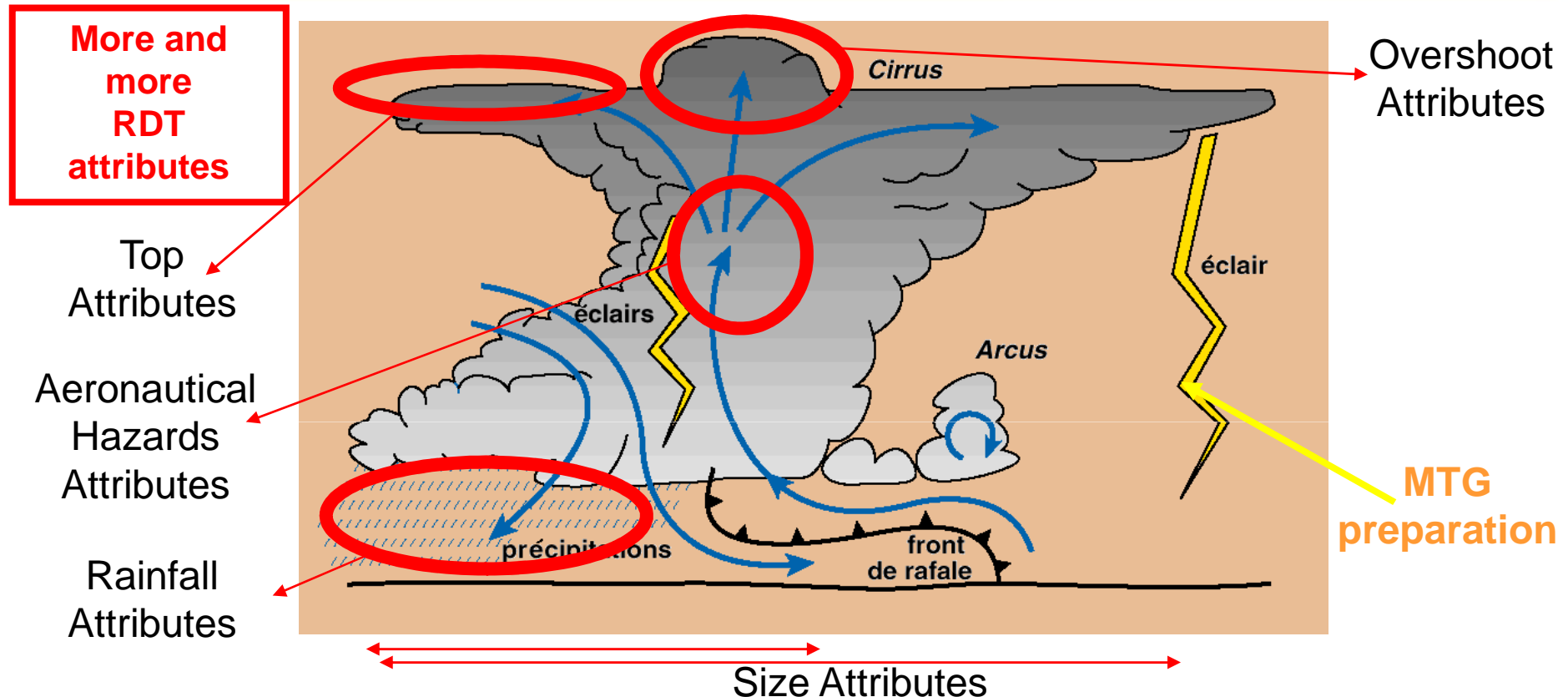
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CDOP2 (2012-2016)

From RDT to Convection Warning Object (RDT-CW)



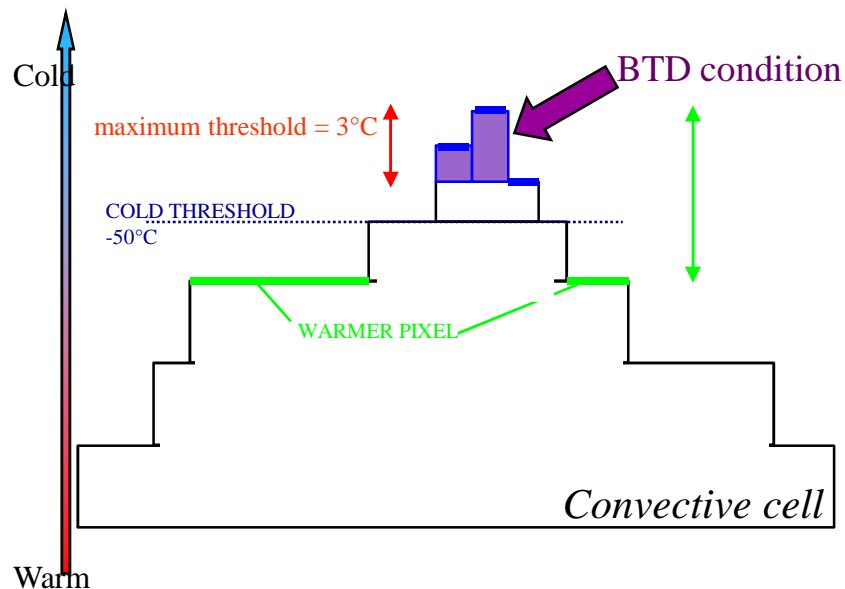
- Use of other channels (IR3.9 μ m, Vis, ...)
- Use of other data sources: Phase of cloud (SAF/NWC Cphase), Microphysical characteristics (SAF/NWC CMIC), other convective data (CI, GI, ...)
- Increase reliability of speed estimates for nowcasting: Multi-level speed estimations, use of a guess field (Atmospheric Motion Vector SAF/NWC product, NWP)
- Nowcasting of the phenomena (about 1h)
- MSG/GOES/MTSAT(cont): Tuning and validation

Main improvement of RDT v2013

Overshooting Tops Detection (OTD)

- I. Detection based on
 - ✓ morphological characteristics of convective cells
 - ✓ BTD WV6.2-IR10.8 criteria
 - ✓ VIS0.6 reflectance value (at daytime)
 - ✓ NWP tropopause temperature

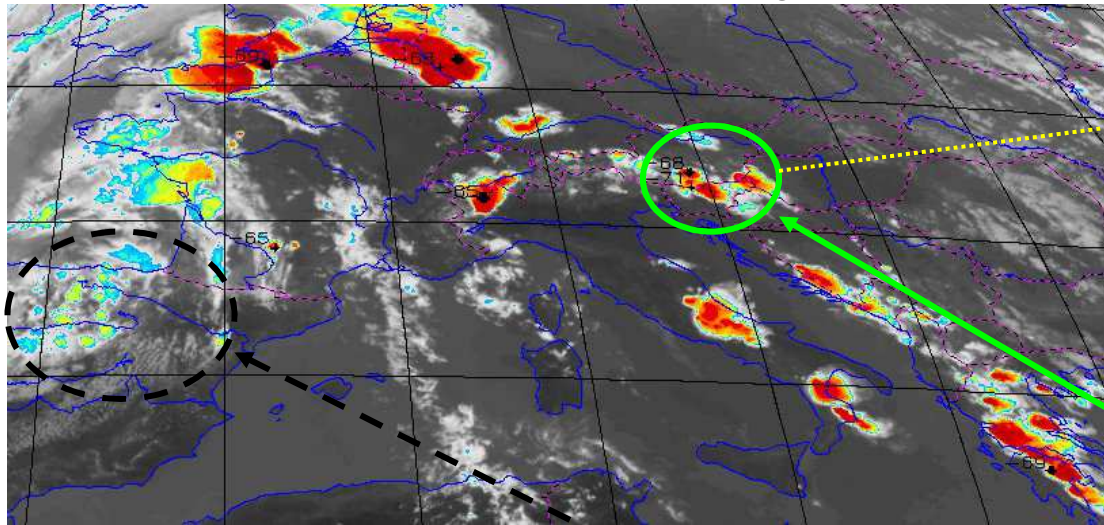
- II. Validation and empirical tuning on case studies (using HRV).



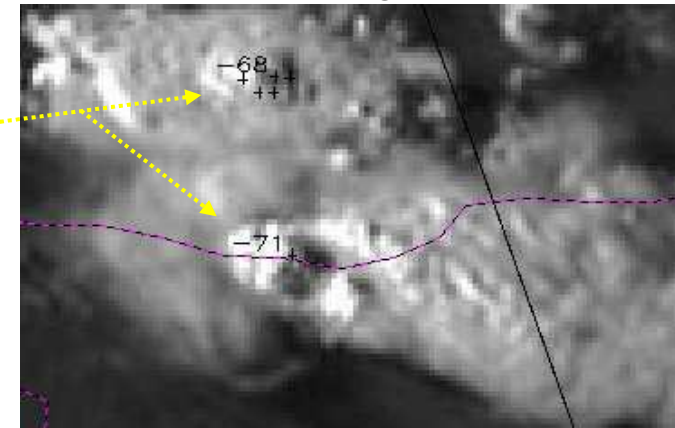
RDT v2013 - OTD

Validation on case study (May 25, 2009)

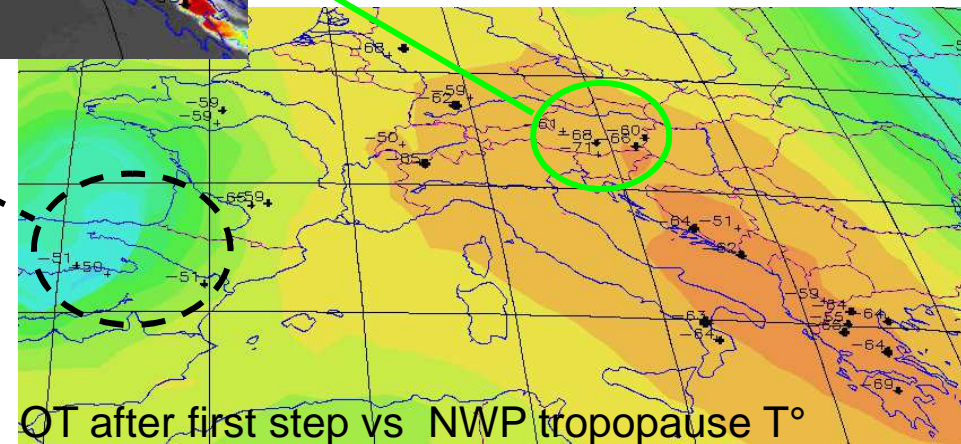
enhanced IR10.8 + OT detected by the algorithm



HRV-use for tuning and validation

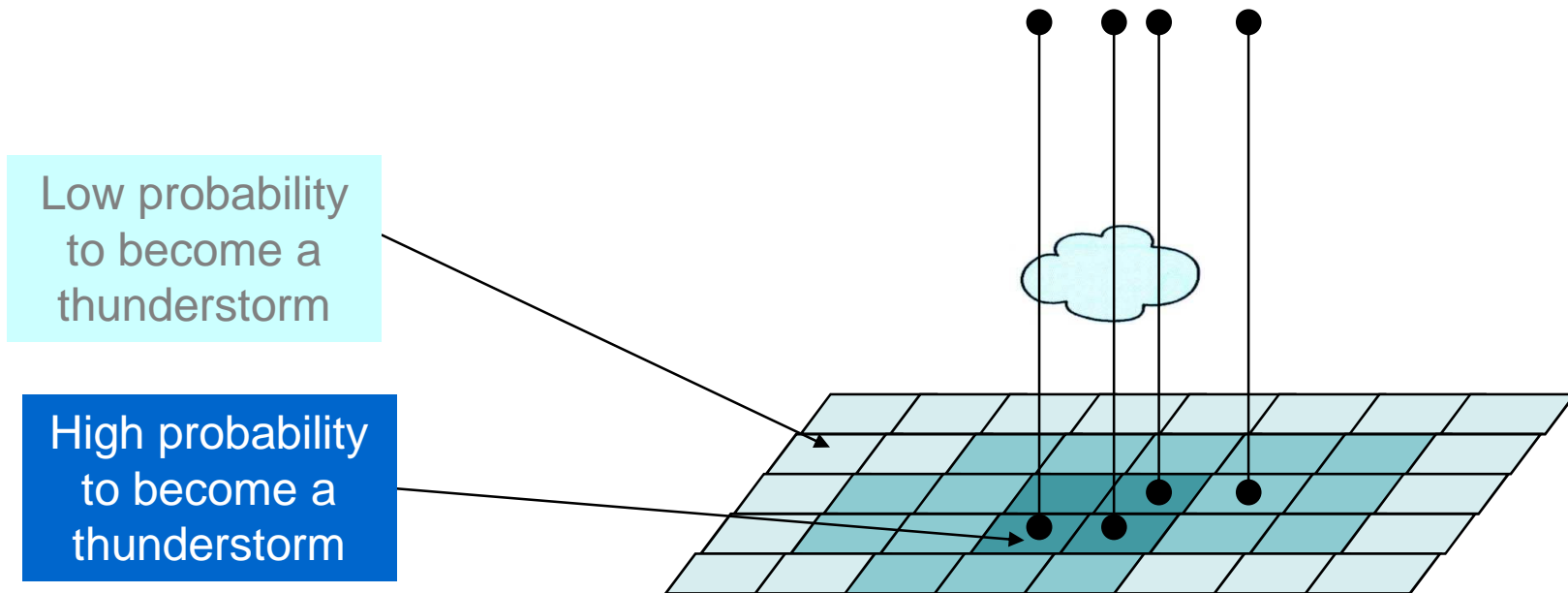


Tropopause T° diagnosis helps to eliminate wrong OT detected after first step



OT after first step vs NWP tropopause T°

Convection Initiation (CI)



The convection probability for each pixel is based on:

- SAF/NWC Clear Air Product, ie Precipitable Water parameters, Instability Index
- SAF/NWC Cloud Product, ie type of cloud, vertical extension, liquid water/ice phases
- SAF/NWC Wind Product, ie convergence, vorticity
- Model product, ie instability indexes
- Past positions and characteristics of the pixel

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Convection Products in MTG context

	 METEO FRANCE Toujours un temps d'avance	Scientific report on MTG impact on RDT	Code : SAE/NWC/CDOP/MFT/SCLR/P2 Date : 30 November 2011 File : SAE-NWC-CDOPMFT-SCI-RD-02.doc Page :
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Scientific report on MTG impact on RDT

How can MTG improve RDT product?
(WP 6300 MTG algorithm for RDT)

SAE/NWC/CDOP/MFT/SCLR/P2
30 November 2011

Météo-France/Direction de la Prévision/J.-M. Moisselin

What will be the benefits of following MTG instruments ?

- FCI (FDSS / RSS)
- LI
- IRS

FCI instrument is eagerly expected

- Case of new channels
 - RDT algorithm has always benefited from the increase of the number of channels
 - New channels :
 - 0.91 μm channel: total column precipitable water
 - 1.38 μm channel: detection of very thin cirrus clouds, ice at top clouds
 - 2.25 μm channel: cloud microphysics

- Case of pre-existing channels
 - Resolution increases
 - Improves estimate of surface, surface evolution, and shape,
 - Improves speed estimate => better lagrangian advection,
 - Is a key point for small-scale phenomena associated with RDT, for example Overshooting Top.
 - The better spectral accuracy will improve the convection diagnosis.
 - The shift of IR central value channel from 10.8 μm to 10.5 μm has to be analysed for many aspects of RDT (morphology, speed estimate).

- Case of scan modes
 - *Full Disk Scan Service* provides both a continuity between the generation of satellites and a clear improvement in all dimensions: horizontal resolution, number of channels, channel accuracy.
 - The next generation of *Rapid Scan Service* could create new challenges :
 - The way to benefit from the 2.5 min refresh of the satellite image is still uncertain.
 - The lack of channels in RSS means for RDT a lack of predictors.

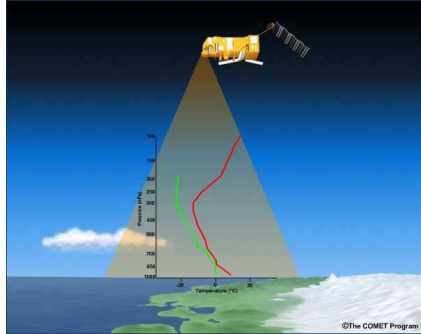
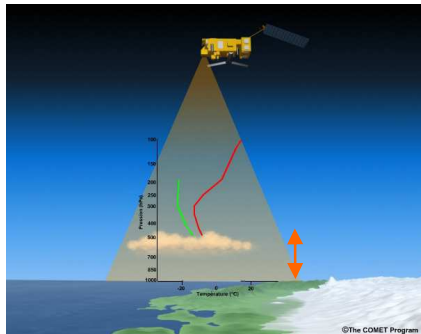
LI instrument is eagerly expected

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

- to tune the statistical discrimination scheme on new domains,
- to force the convective diagnosis in real time mode,
- to enhance characteristics for a more complete description of convection,
- to monitor the convective diagnosis.



IRS and NWP data : T/q profiles

	IRS	NWP data
Clear Sky (or sparsely cloudy sky)		<ul style="list-style-type: none"> ■ NWP to improve IRS profiles ■ NWP to fill the horizontal gap where IRS profiles are not available
Cloudy Sky		<ul style="list-style-type: none"> ■ NWP to fill the vertical gap below the clouds ■ NWP data to improve IRS profiles above the clouds ■ NWP to fill the horizontal gap where IRS profiles are not available

Thanks for your attention!

