Detection and nowcasting of convective cloud systems using SEVIRI data.

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Presidency of the Council of Ministers

Department of Civil Protection

THE NATIONAL EARLY WARNING SYSTEM AND THE REAL TIME MANAGEMENT OF NATURAL AND ANTHROPOGENIC RISK

outline

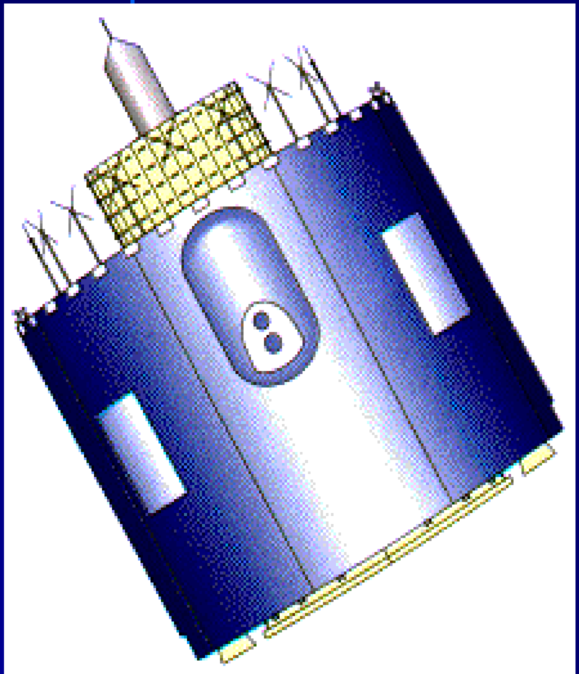
- Meteosat Second Generation satellite;
- Severe convective phenomena;
- RGB combination: day time, night time;
- NEFODINA: Convective cell automatic tool using 10.8 μm, 6.2 μm, 7.3 μm
  - detection phase;
  - forecasting phase;
  - validation phase.
- Rapid Detection thunderstorm (RDT) NWC-SAF;
- Ancillary data.

PART - 1

MSG-1: METEOSAT 8 LAUNCH ON 28-AUG-2002

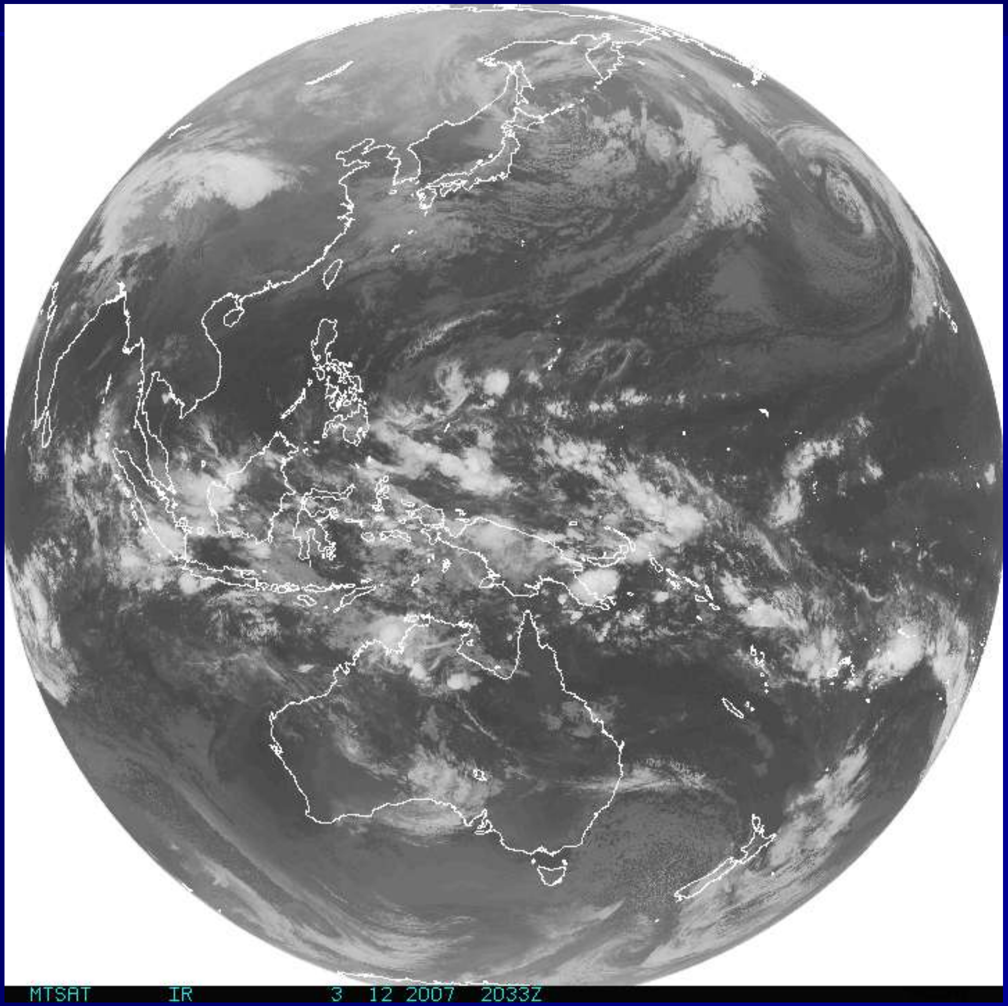
EUMETSAT

Meteosat Second Generation (MSG): SEVIRI



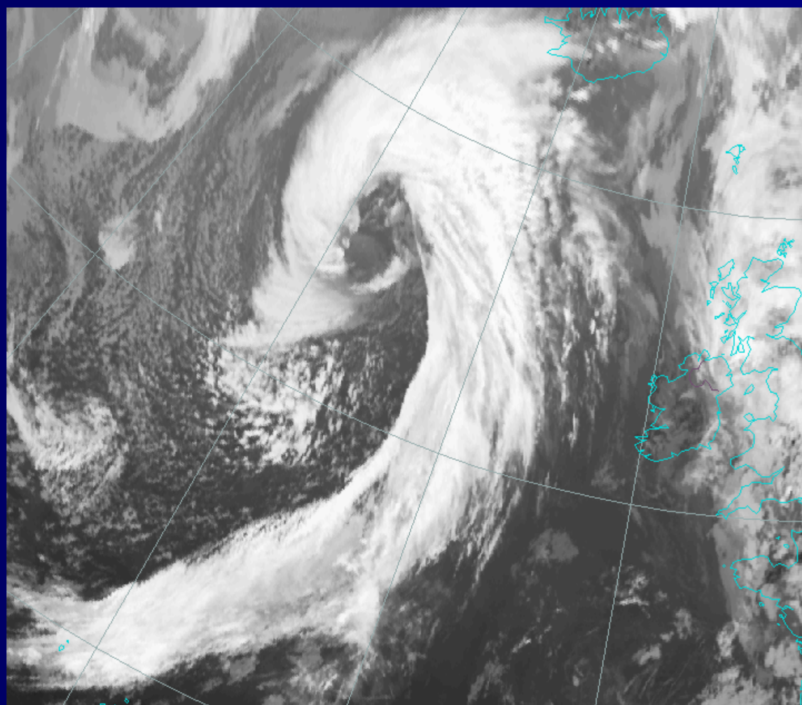
- Images every 15 Minutes
- 3 km horizontal ‘sampling distance’ at Sub-Satellite Point (SSP)
- Hi-Res VIS-Channel 1 km sampling distance (SSP)
- 12 Spectral Channels

AREA: fUll disk



SPATIAL RESOLUTION: 3 Km
HRV: 1Km

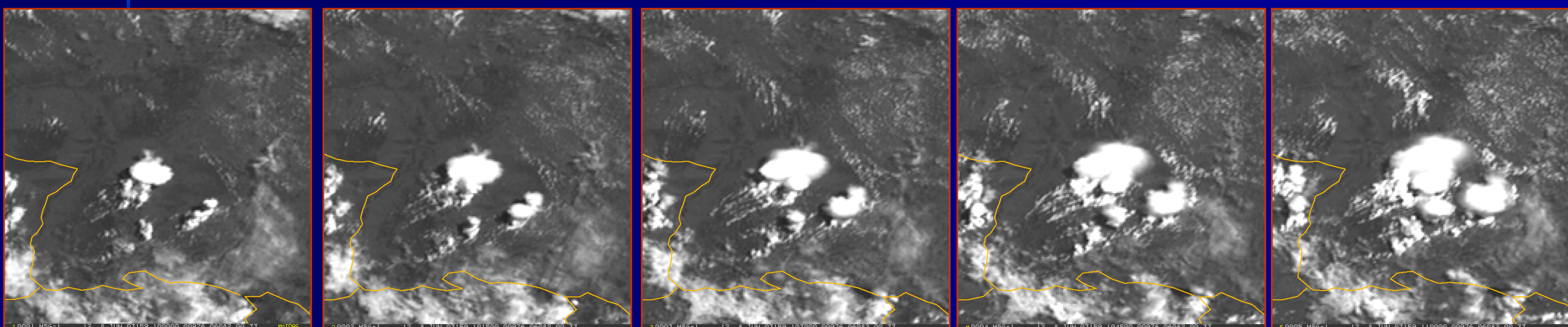
(Example: 13 October 2003, 12:15 UTC)



MSG IR 10.8 Channel 3 km
5 km in Europe Latitude

MSG HRV channel ~ 1 km

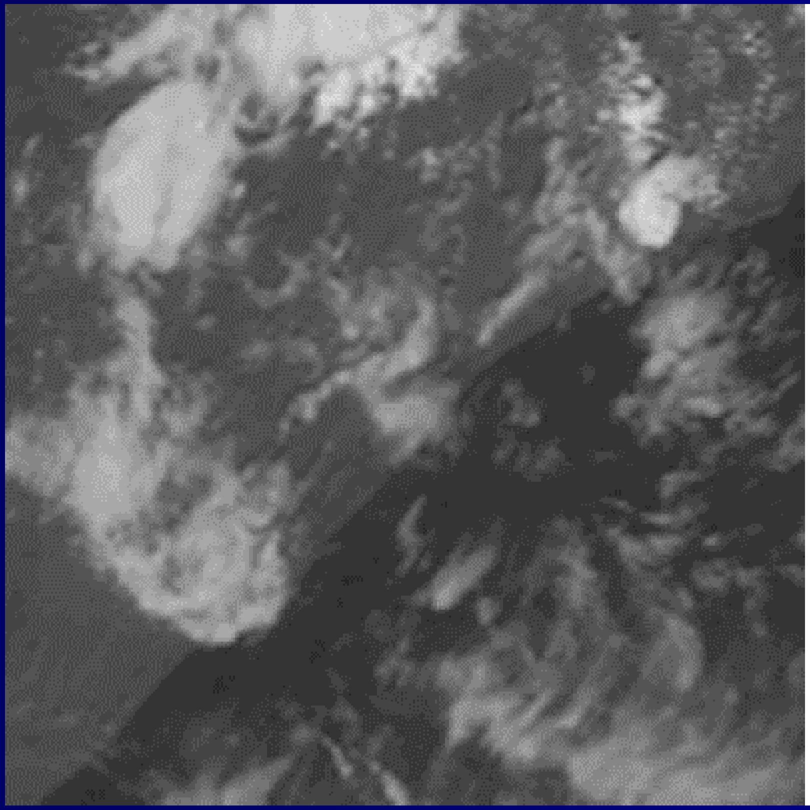
TIME RESOLUTION: 15 minutes for full disk



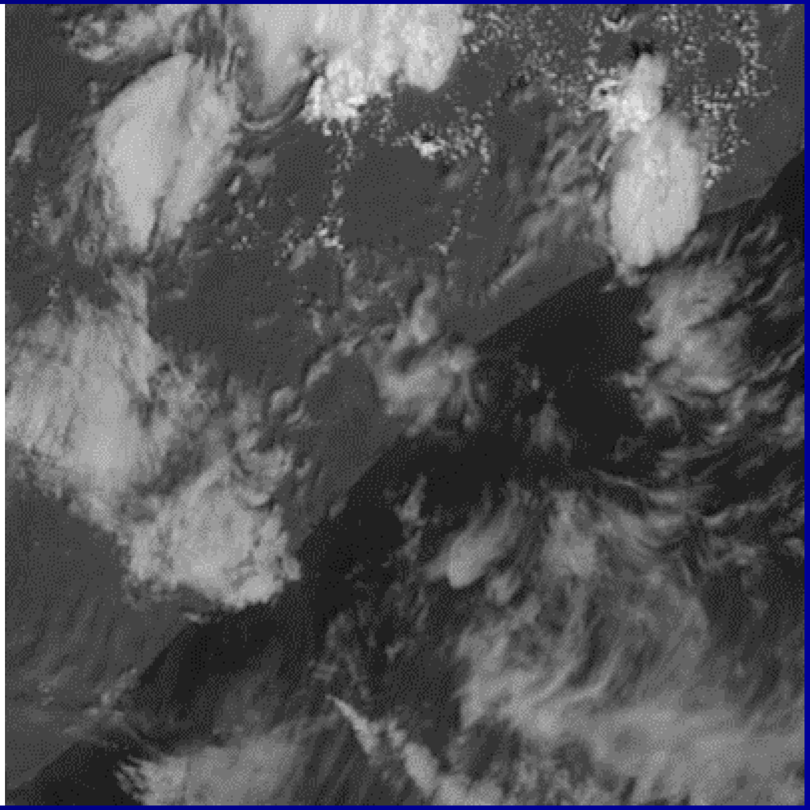
10:00 10:15 10:30 10:45 11:00

(Example: 8 June 2003) MSG HRVIS, 15 min

MSG Rapid Scans: 5 minutes for a subregion



MFG VIS 2.5 km/30 min



MSG HRVIS 1 km/5 min

SEVIRI channels

	SEVIRI Spectral Bands in μm			Applications
	λ_{cen}	λ_{min}	λ_{max}	
HRV	Broadband visible 0.4 – 1.1 um			Surface, clouds, high resolution wind fields
VIS 0.6	0.635	0.56	0.71	Surface, clouds, wind fields
VIS 0.8	0.81	0.74	0.88	Surface, clouds, wind fields
NIR 1.6	1.64	1.50	1.78	Cloud phase
IR 3.9	3.90	3.48	4.36	Surface, clouds
WV 6.2	6.25	5.35	7.15	Water vapour, clouds, atmospheric instability, wind fields
WV 7.3	7.35	6.85	7.85	Water vapour, atmospheric instability
IR 8.7	8.70	8.30	9.10	Clouds, atmospheric instability
IR 9.7	9.66	9.38	9.94	Ozone
IR 10.8	10.80	9.80	11.80	Surface, clouds, wind fields, atmospheric instability
IR 12.0	12.00	11.00	13.00	Surface, clouds, wind fields, atmospheric instability
IR 13.4	13.40	12.40	14.40	High level clouds, atmospheric instability

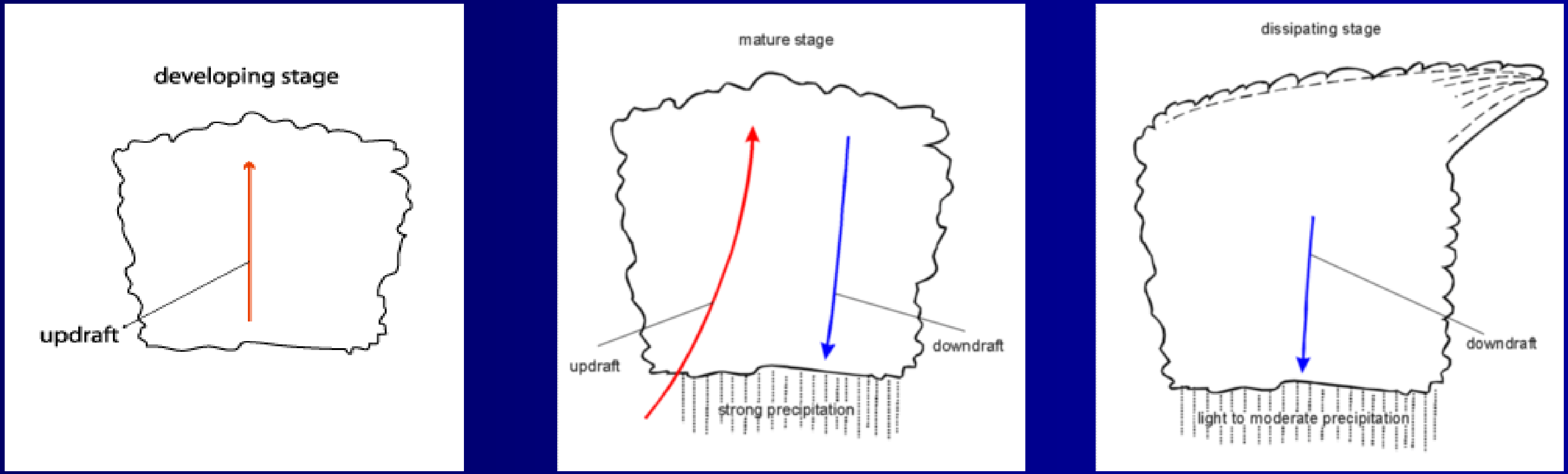
PART - 2

Severe convective phenomena

Classes	Duration	Linear dim. (m/**pixels)**	Areal dim. (Km/**pixels)**
Single cell thunderstorm	30-50 min.	5-10 / **1-2**	20-80 / **1-3**
Multiple cell thunderstorm	2-6 hours	20-30 / **3-5**	310-700 / **8-20**
Supercell thunderstorm	1-6 hours	20-30 / **3-5**	310-700 / **8-20**
Mesoscale convective system	6-12 hours	350-500 / **60-80**	100.000-200.000/ **2800 - 5500**

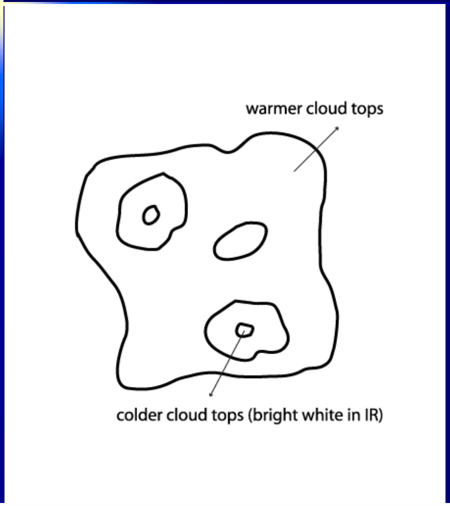
- Different for dimension and duration.
- Dangerous during the take-off and the landing of the aircraft.
- Often a correlation between these and the extreme events of precipitation has been observed.

Convective Cell life phase

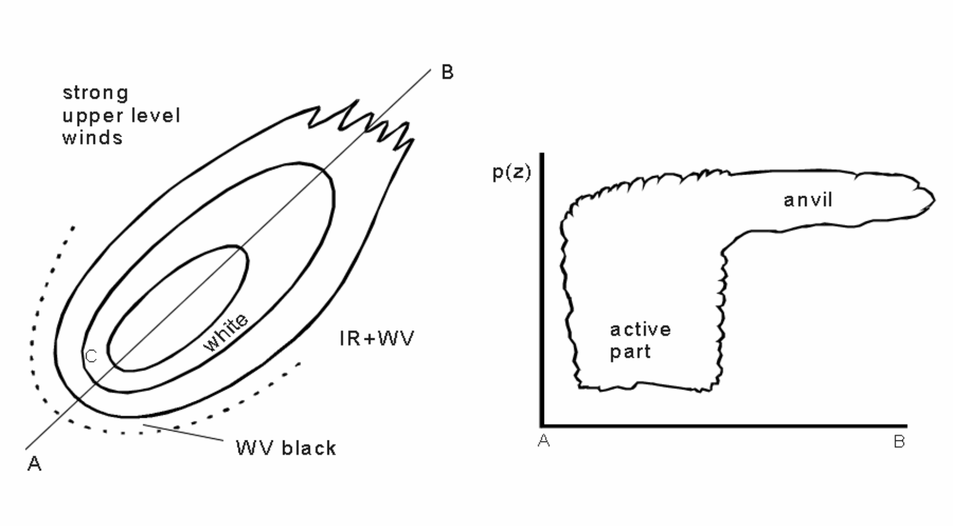


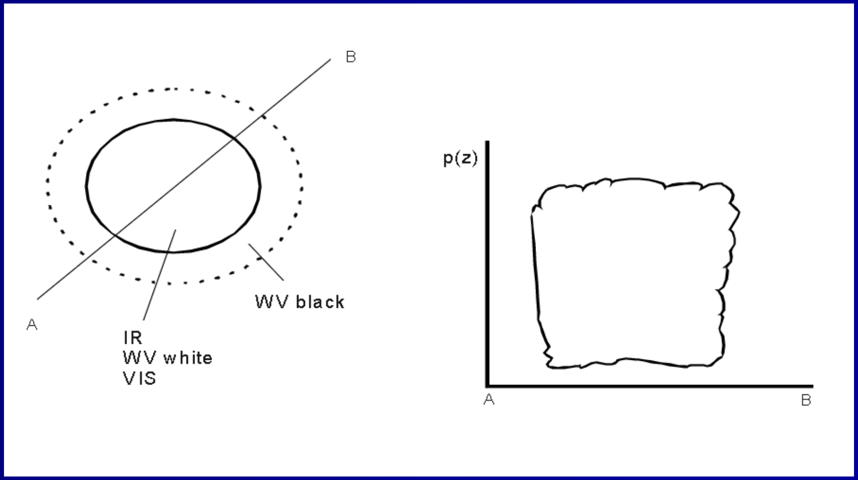
- **Developing stage of the CC** characterised by a distinct single updraft. The process of entrainment at the cloud edges is essential for the further development of the Cb and a supply of sufficient humidity from surface levels will support further growth of the developing cell.
- **Mature stage of the CC**. During this stage downdrafts develop associated with the falling of ice (hail stones) which are no longer kept aloft by the updraft of the cell. Simultaneously the updraft weakens because rising warm humid air is then removed by cool air spreading horizontally at the base of the cell.
- **The dissipating stage**, of a Cb is reached when the updraft weakens and increasing downdrafts of dry cold air spread at lower levels. The supply of warm moist air from the lower levels is then interrupted and the Cb dissipates.

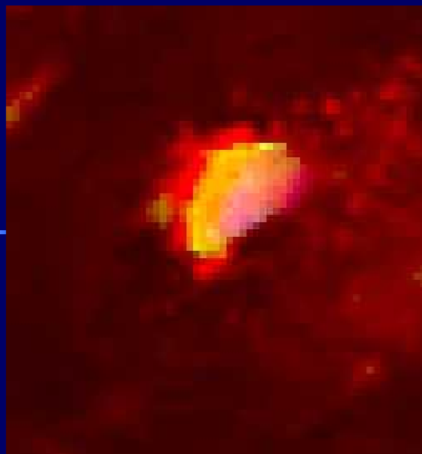
Convective systems



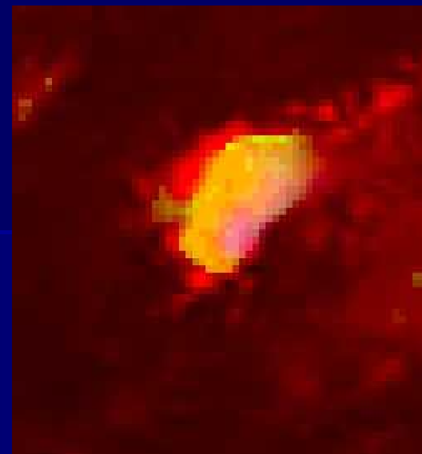
- Convection is defined as the transfer of heat by the movement of matter. the air is heated by the warm ground, becomes less dense than the surrounding air and rises.   If the atmospheric conditions are right, the air will rise until it cools to the dew point and clouds will form. If the rising motion continues, precipitation will form and if the rising motion is strong enough heavy thunderstorms will occur.



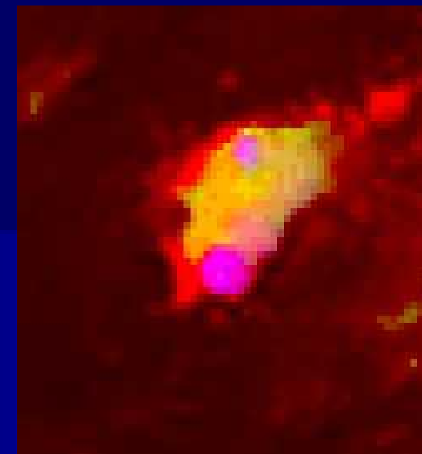




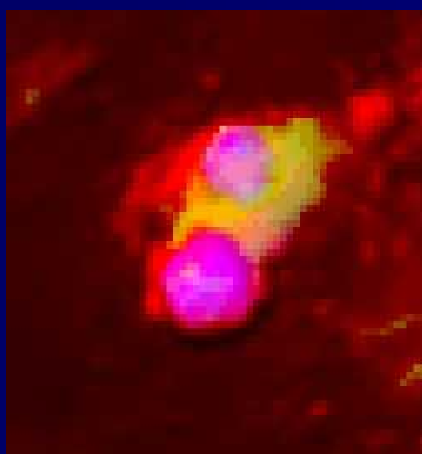
12:30 UTC



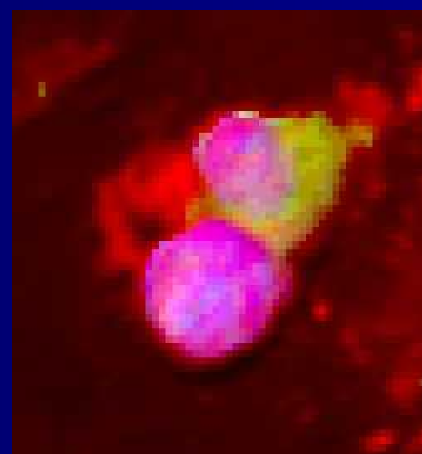
12:45 UTC



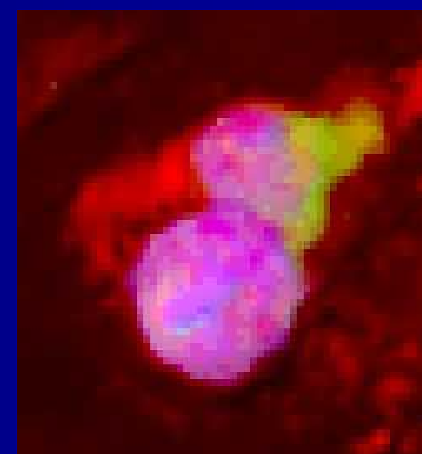
13:00 UTC



13:15 UTC



13:30 UTC



13:45 UTC

20 May 2003, RGB VIS0.6-IR3.9-IR12.0

Main Convective Object characteristics

- OVAL SHAPE;
- LIMITEDED AREA;
- SIZE 20-80 KM^2;
- COLD CLOUD TOP (BT < 236 K);

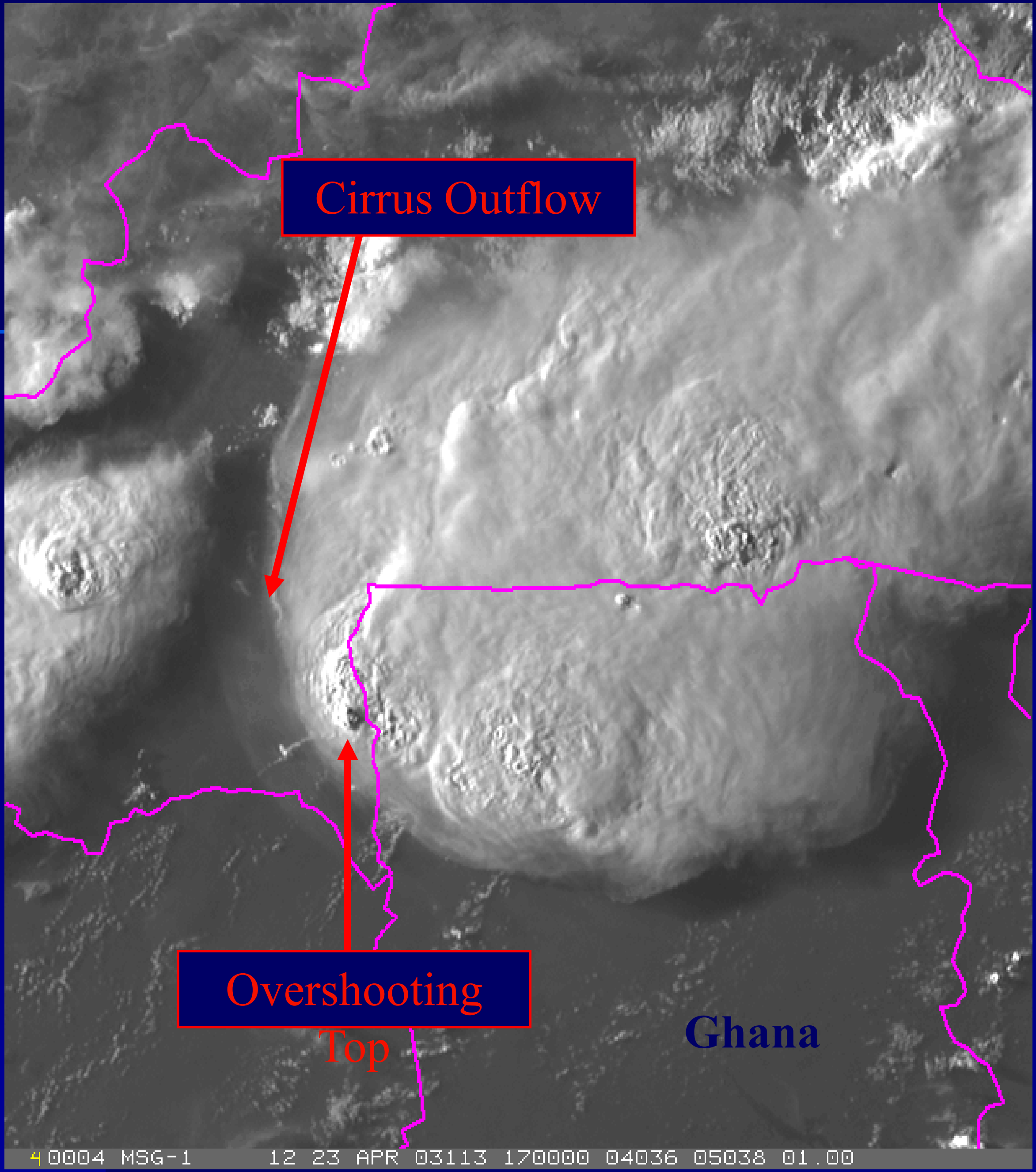
PART -3

SEVIRI recommended channels for Convective object detection

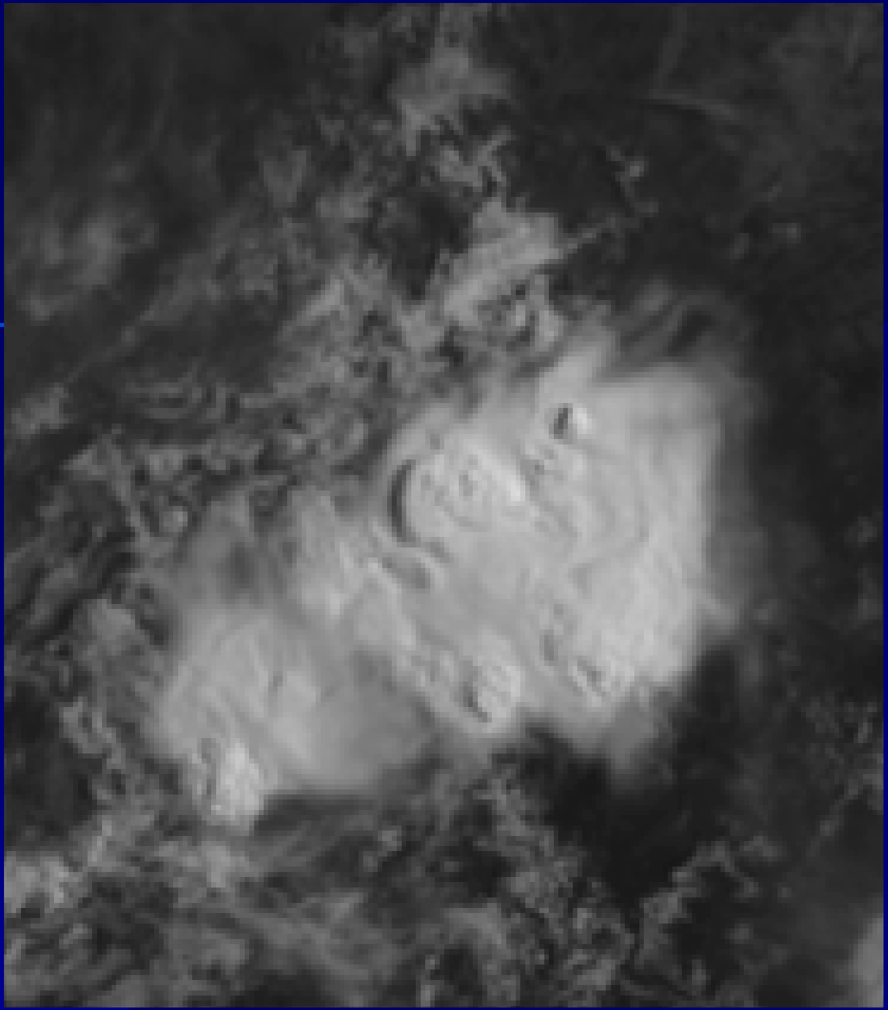
- **VISIBLE:**
  - HRV fine-scale structures
  - 0.6 optical thickness of clouds

- **INFRARED:**
  - WV6.2 upper-level moisture
  - WV7.3 mid-level moisture, early convection
  - IR10.8 top temperature

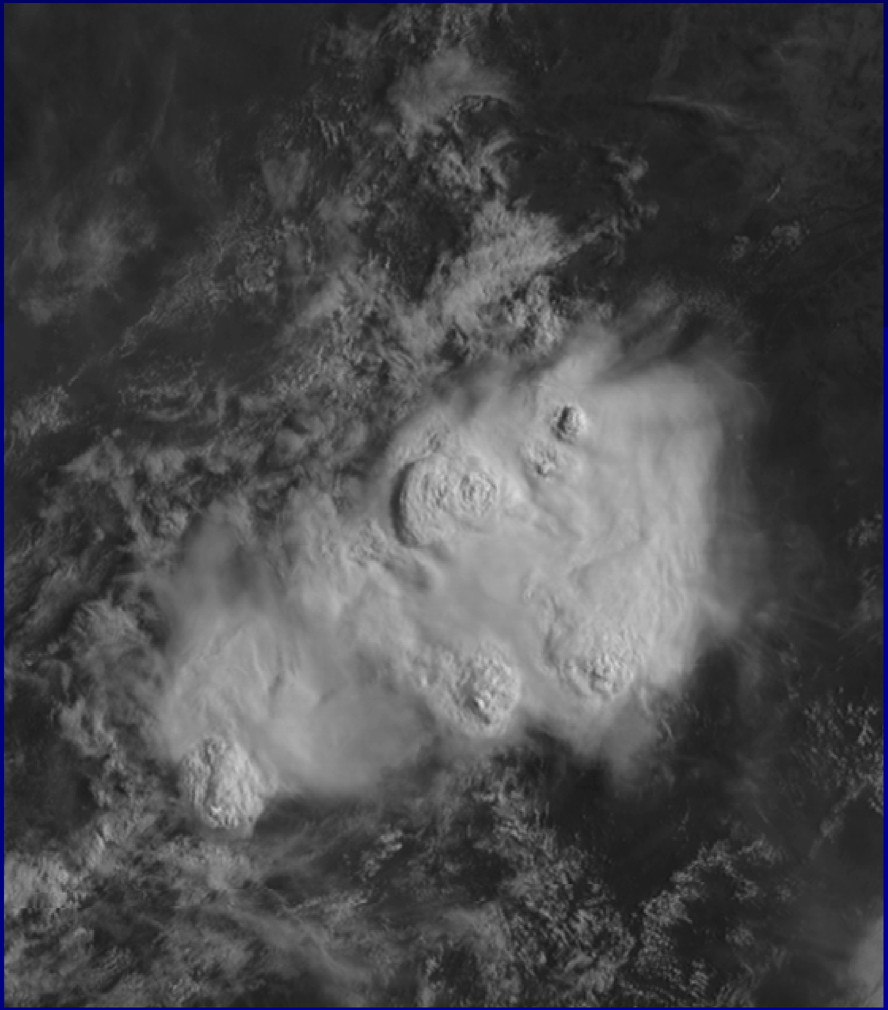
HRVIS Fine Scale Structures



MSG-1
23 April 2003
17:00 UTC
Channel 12 (HRVIS)



Visible 0.6 μm



High-res. Visible

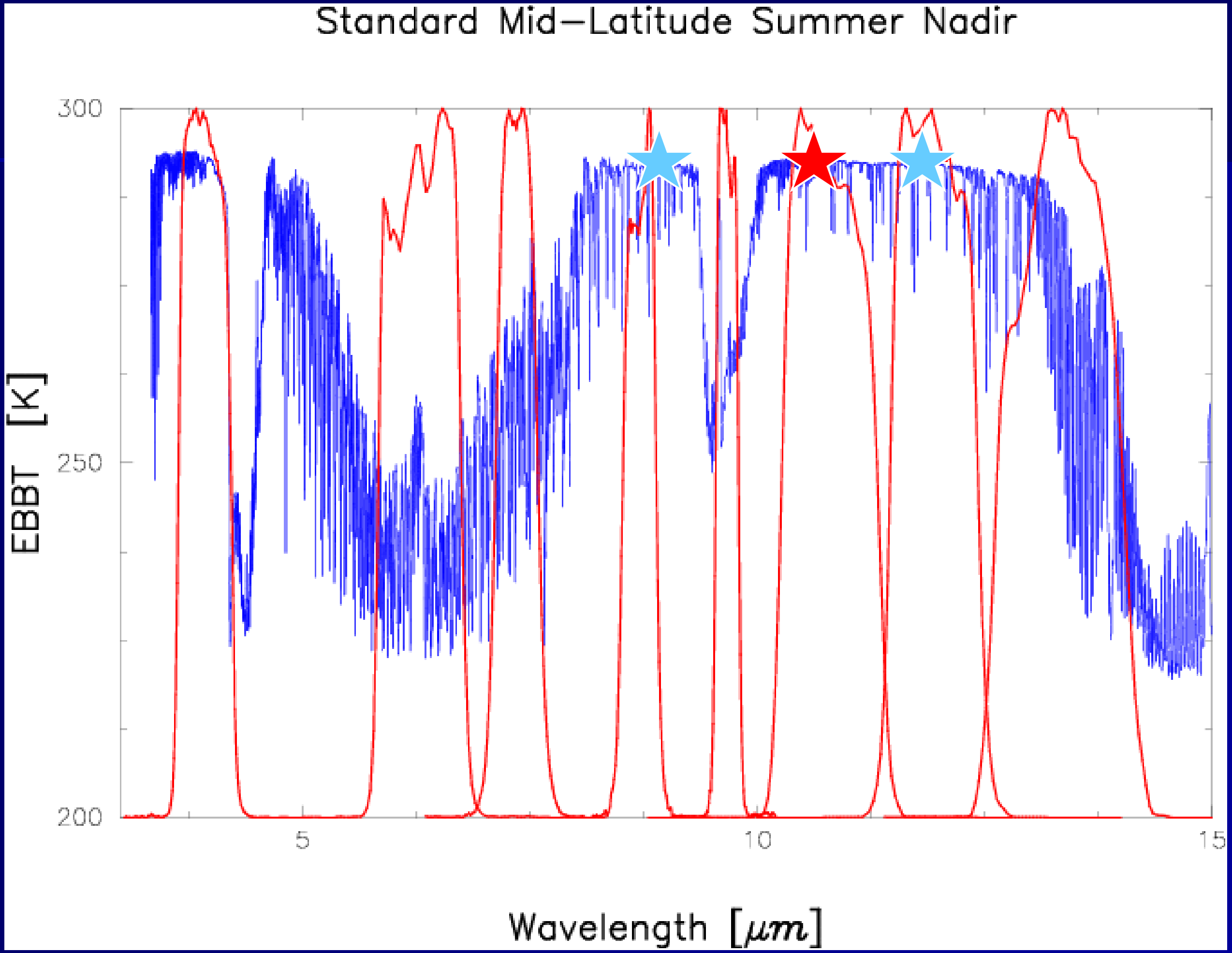
Cb clouds over Nigeria as seen in the high-res. visible channel
MSG-1, 24 April 2003, 08:00 UTC

0.6 channel characterization

- Ice cloud- water cloud
- Particle size

infrared window channels: 8.7, 10.8, 12 μm

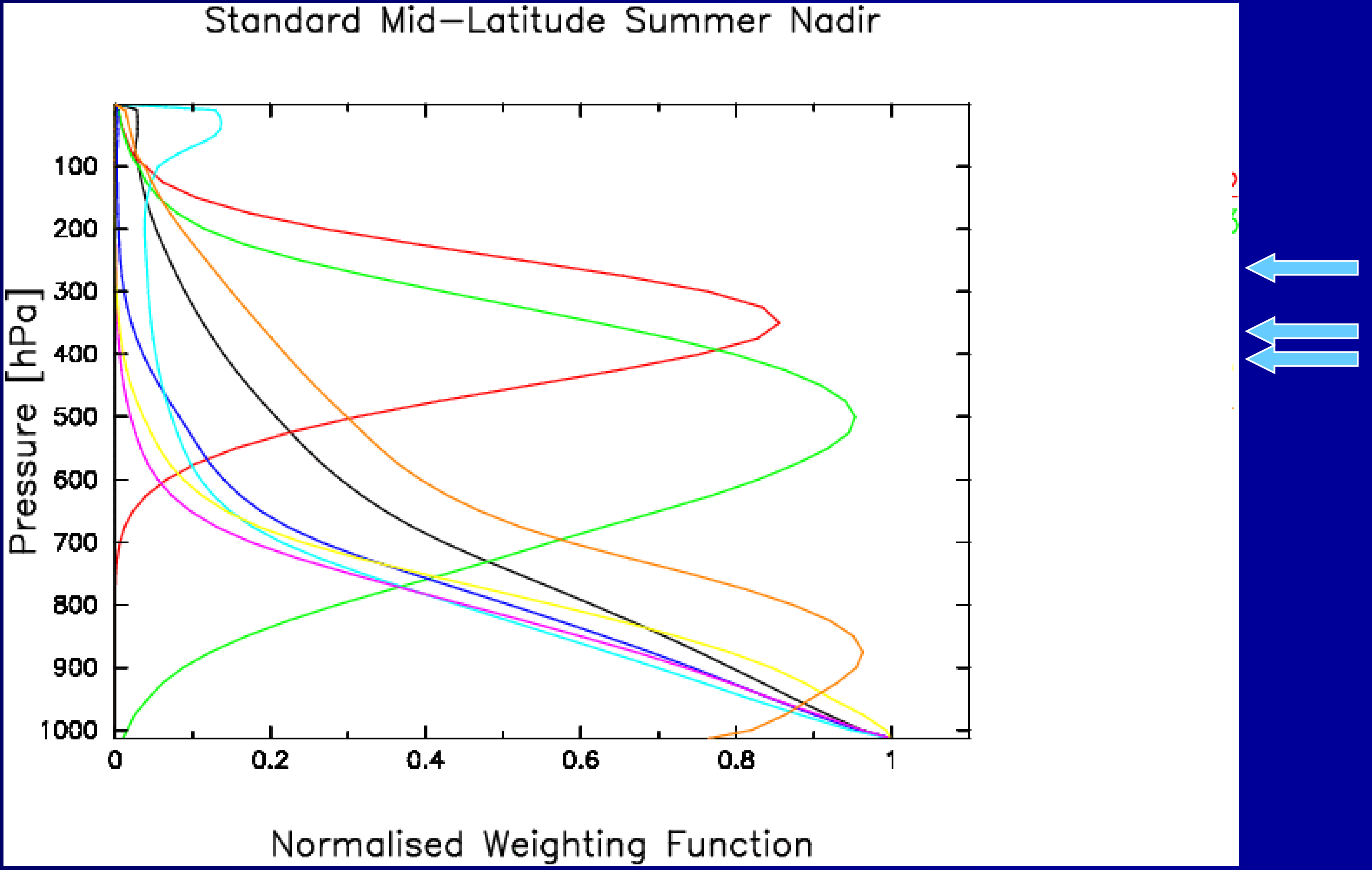
Energy spectrum
Source: EUMETSAT

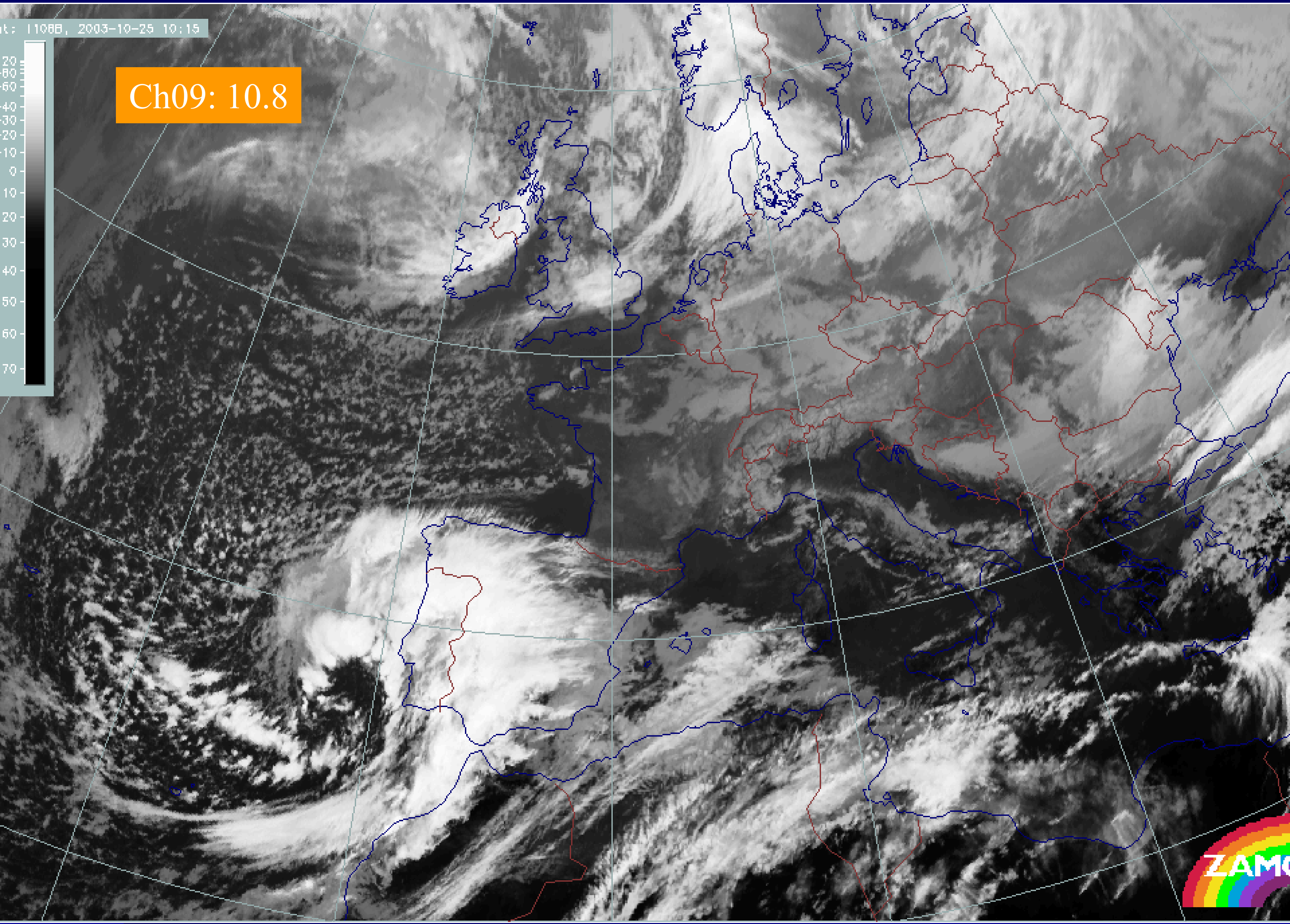


- Ch07, 09, 10 in window region
- Recognition of cloud systems because of the thermal radiation of cloud and earth surface

Max. signal in the window channels from the surface and lower part of troposphere

Weighting functions Source:





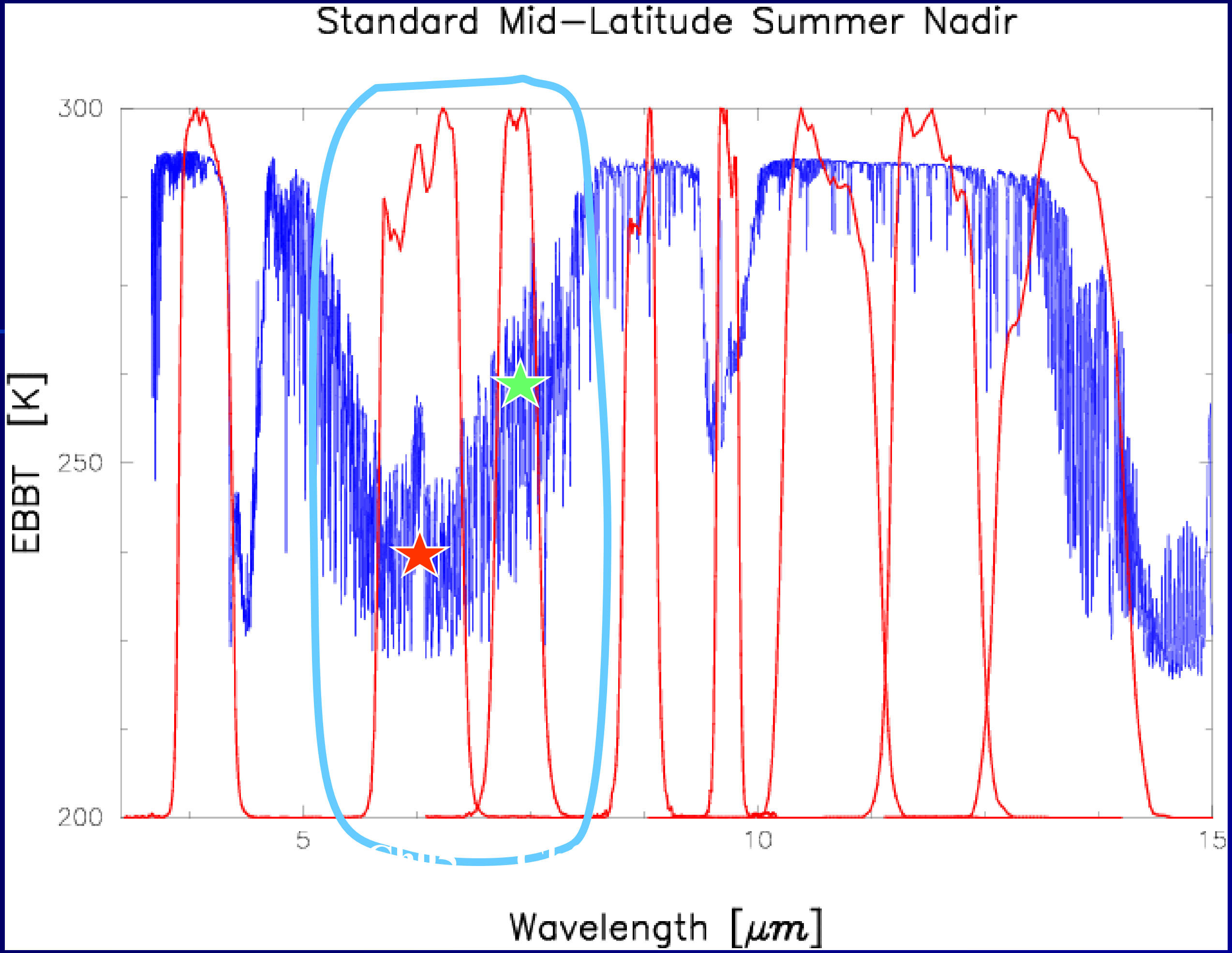
Ch09: 10.8
t: 1108B, 2003-10-25 10:15
20
80
60
40
30
20
10
0
10
20
30
40
50
60
70

Watervapor channels
Ch05, Ch06

- WV has an absorption band around 6 μm
  – absorbs radiation from below

- Greyshades in the WV are indicative of the WV content in the upper and middle part of the troposphere

Energy spectrum
Source: EUMETSAT

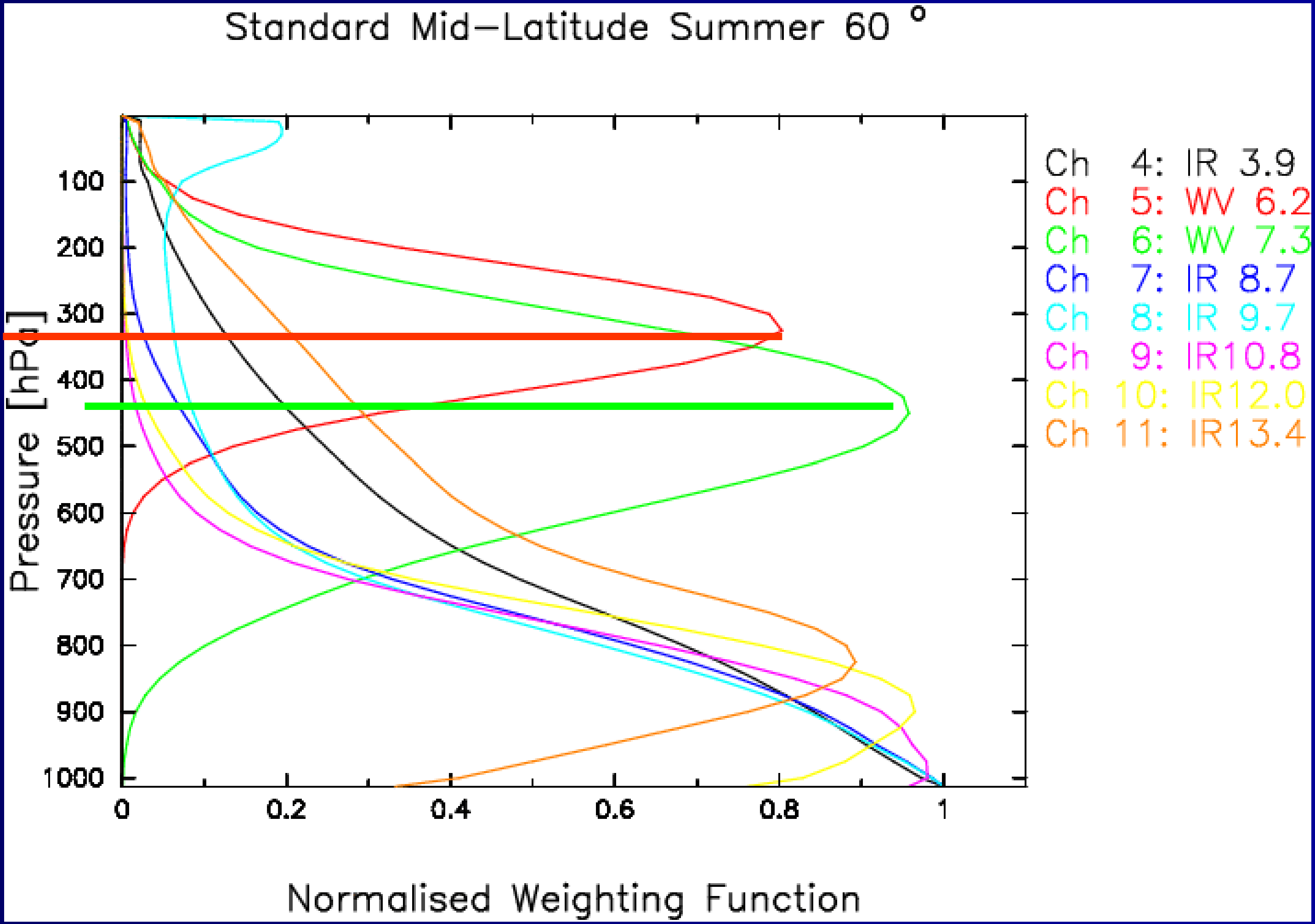


- Ch05 is more in the centre of the absorption band with strong absorption;
  - ★ – consequently radiation only from higher levels comes to the satellite;
- Ch06 is more to the wings of the absorption band with less strong absorption;
  - ★ – consequently radiation also from lower layers comes to the satellite

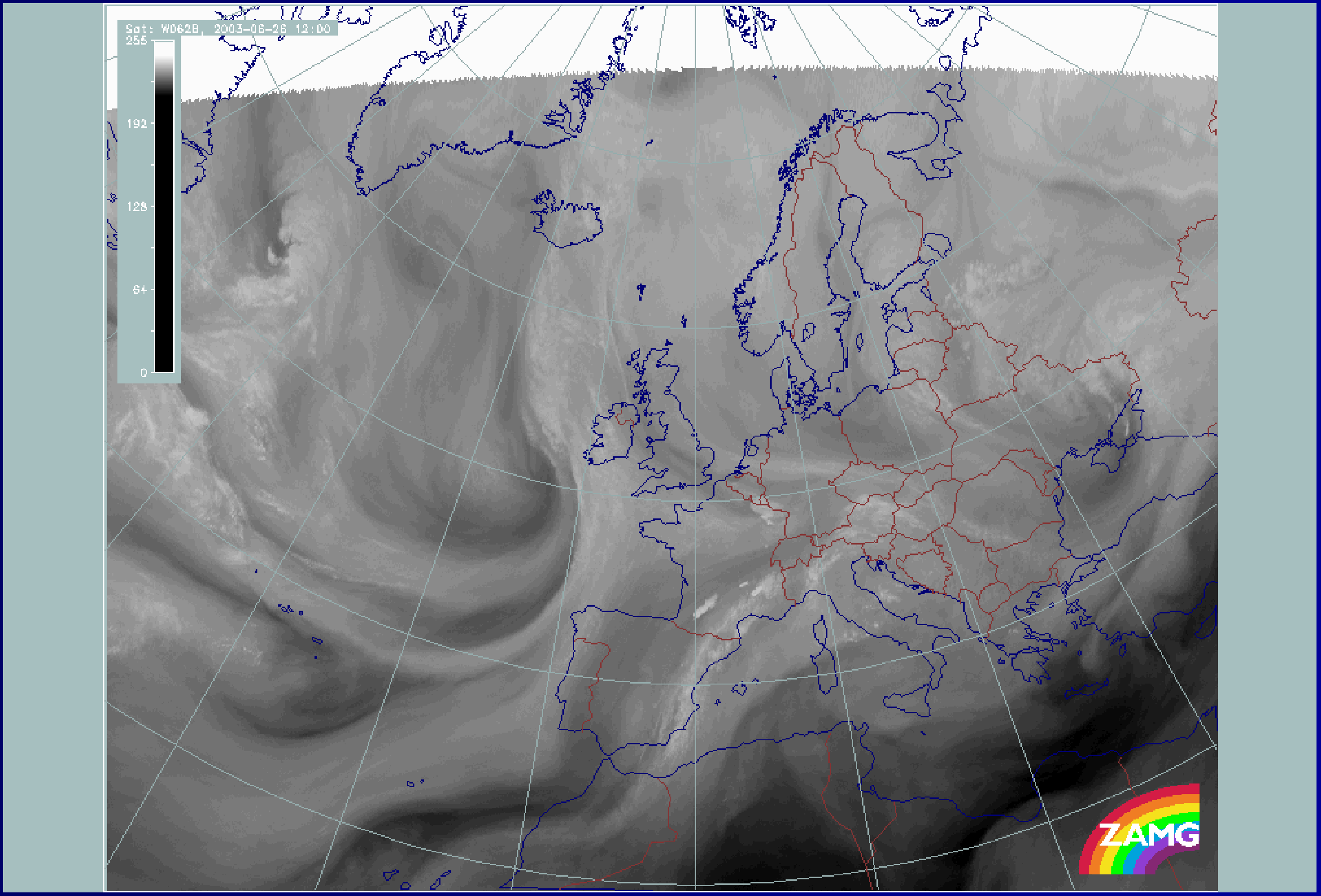
Weighting functions
Source: EUMETSAT

Max. signal in Ch05 from approx. 320 hPa
Max signal in Ch 06 from approx. 450 hPa

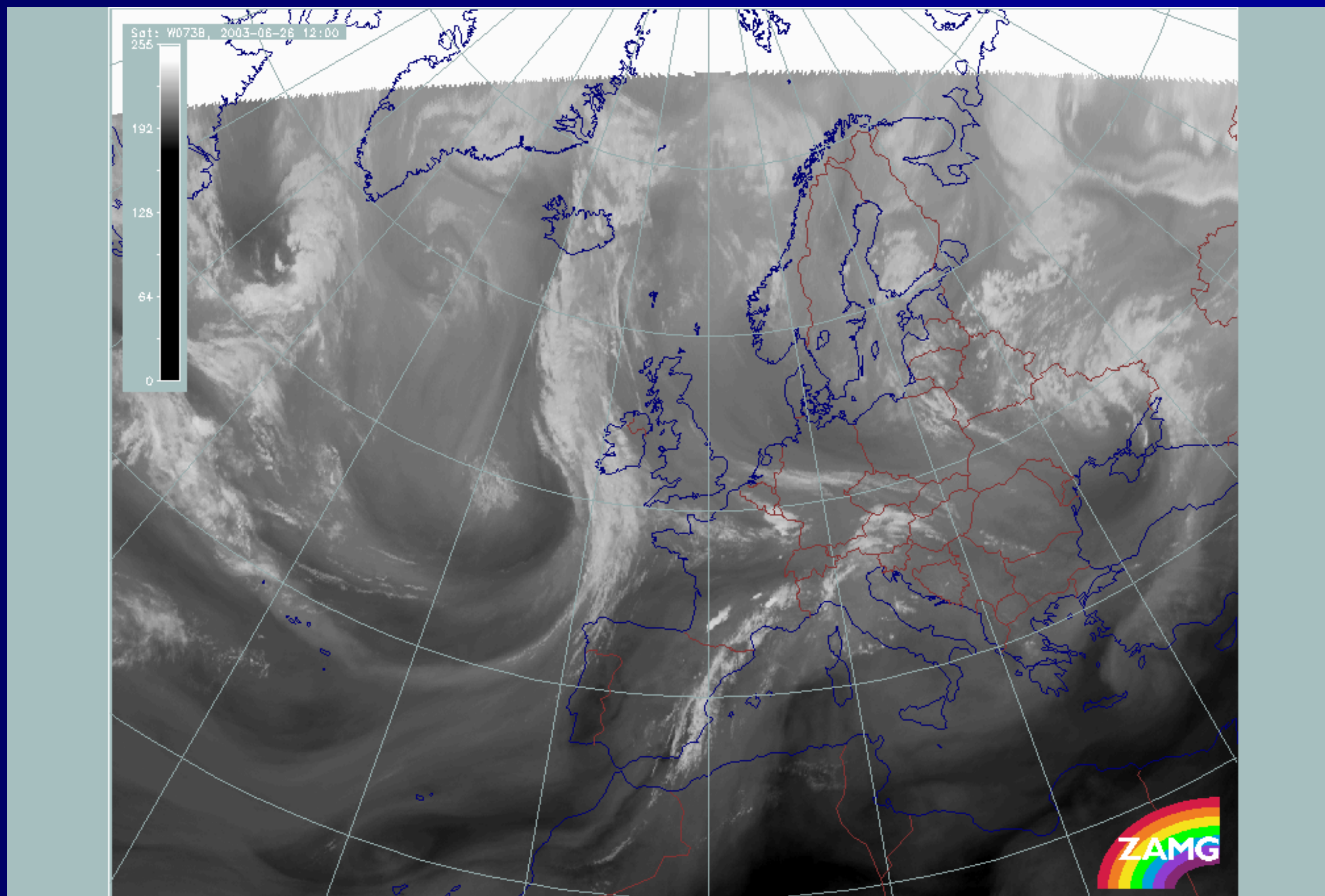
But: If there is no WV radiation from far below reaches the satellite



WV 6.2 μm



WV 7.3 μm



PART 4:

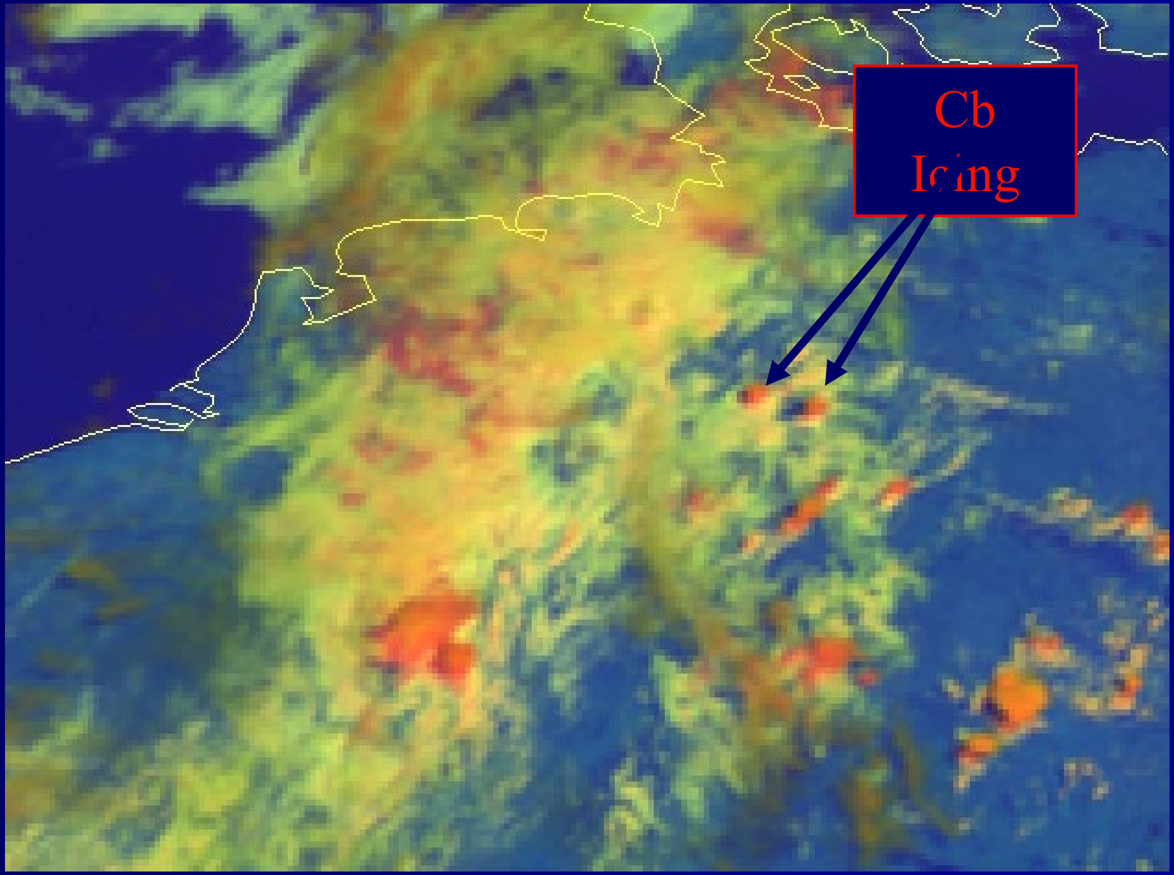
RECOMMENDED RED-GREEN-BLUE (RGB) COLOUR COMPOSITES FOR MONITORING CONVECTION

DAY-TIME

RGB 0.6-1.6-10.8 μm

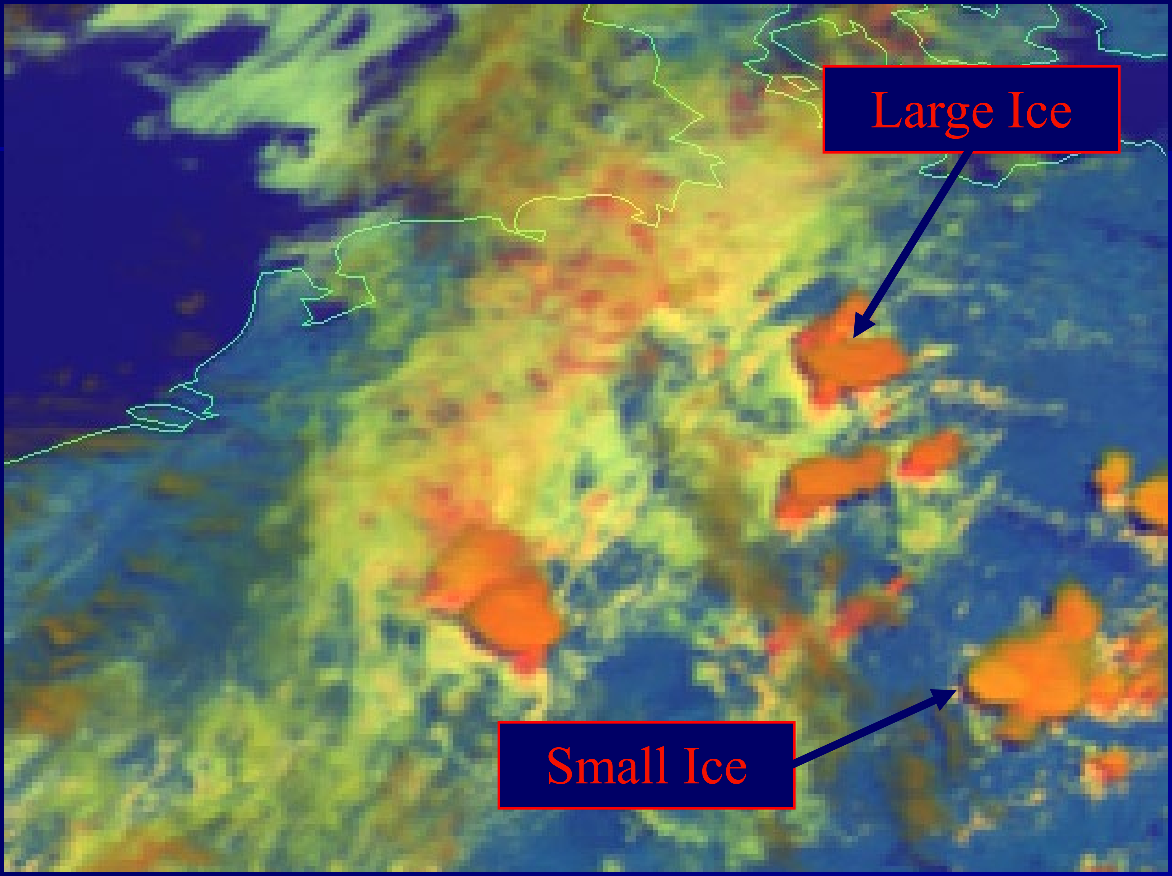
	Red VIS0.6	Green NIR1.6	Blue IR10.8	RGB
I. Very early stage yellow	255	255	200	white-light
II. First convection	255	255	100	yellow
III. First icing	255	200	0	orange
IV. Large icing	255	100	0	red-orange

III. First Icing



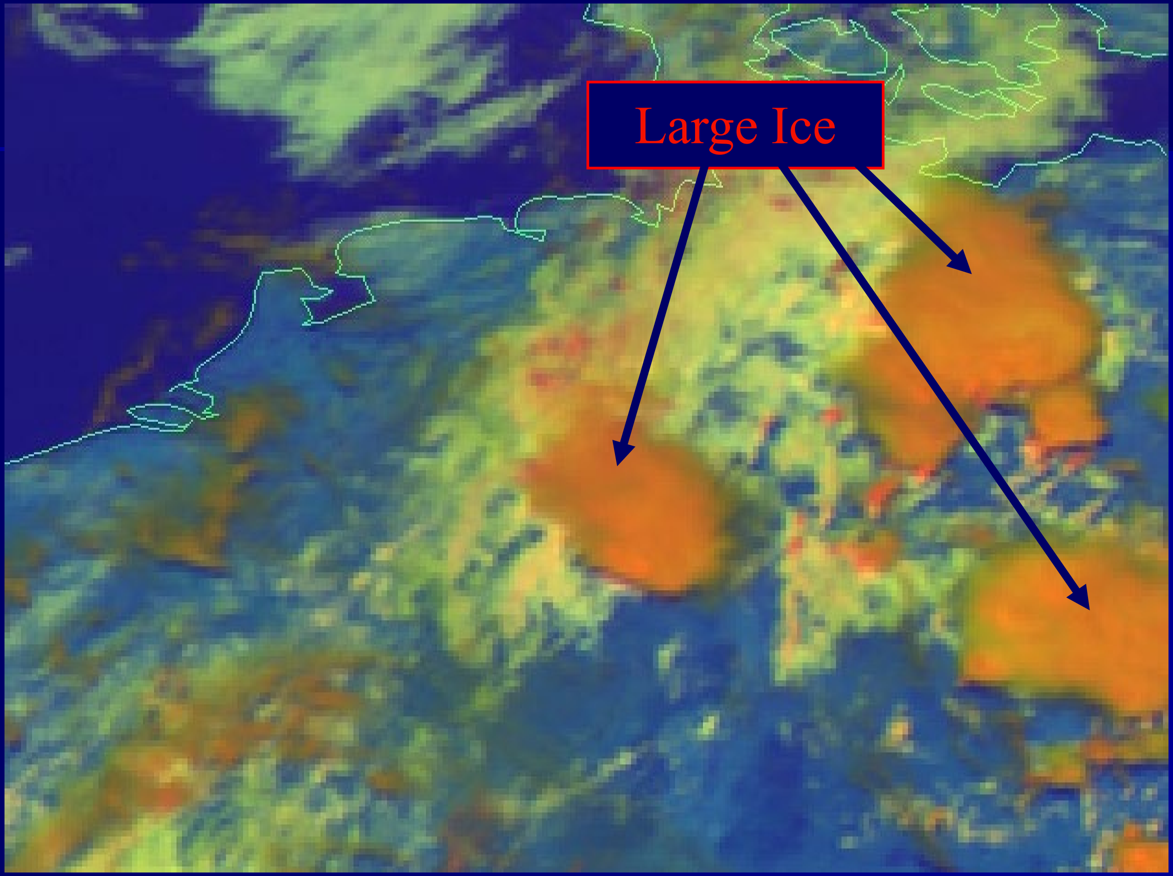
MSG-1, 5 June 2003, 10:30 UTC, RGB 01-03-09

IV. Large Icing



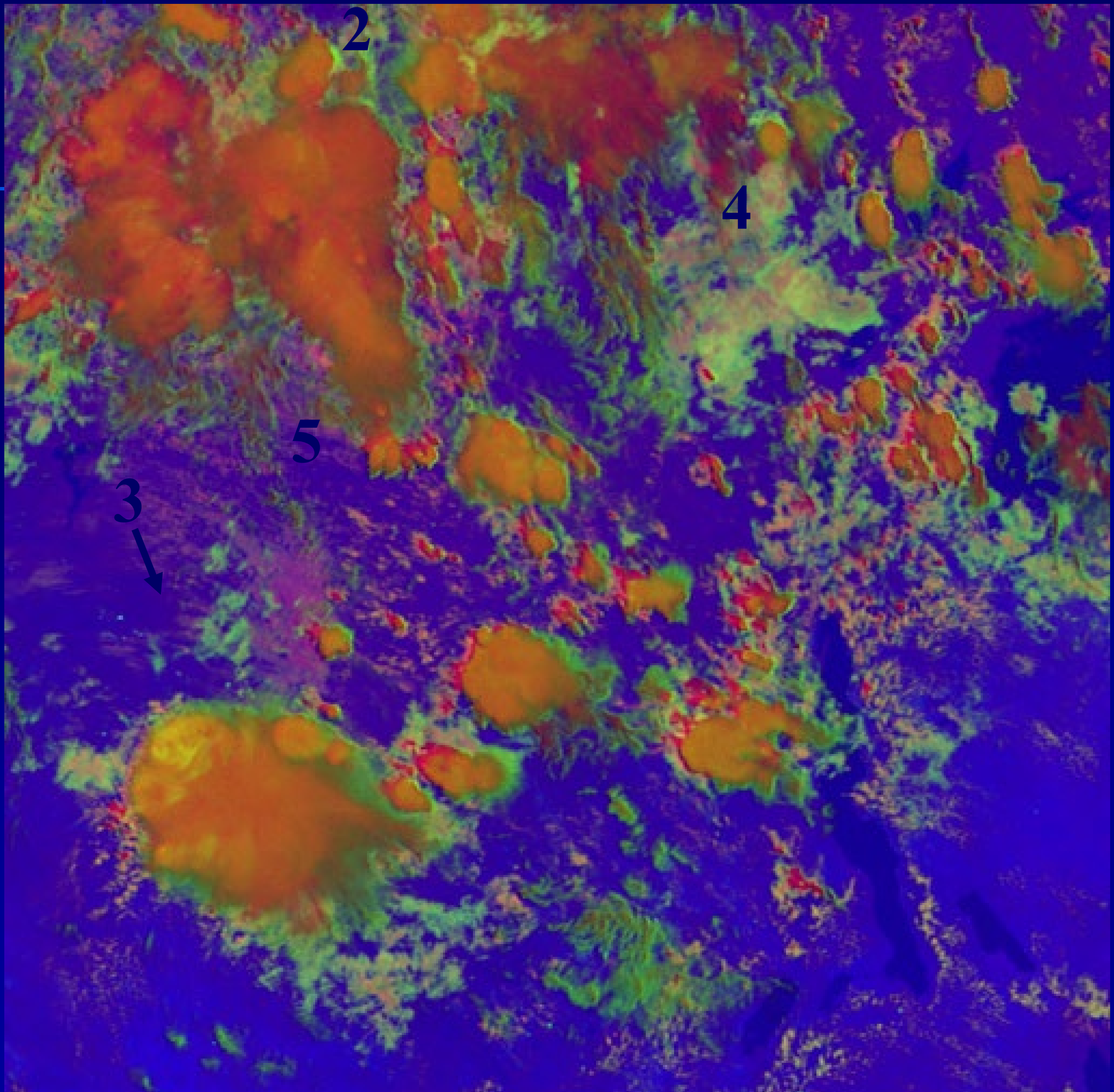
MSG-1, 5 June 2003, 11:30 UTC, RGB 01-03-09

V. Very Large Icing



MSG-1, 5 June 2003, 13:30 UTC, RGB 01-03-09

RGB 0.8-3.9-10.8 μm



1. Large warm ice
2. Large cold ice
3. Small cold ice
4. Small cold water
5. Large warm water

MSG-1
7 September 2003
11:45 UTC
RGB Composite
VIS0.8 - IR3.9 - IR10.8

RECOMMENDED
RED-GREEN-BLUE (RGB) COLOUR COMPOSITES FOR MONITORING CONVECTION

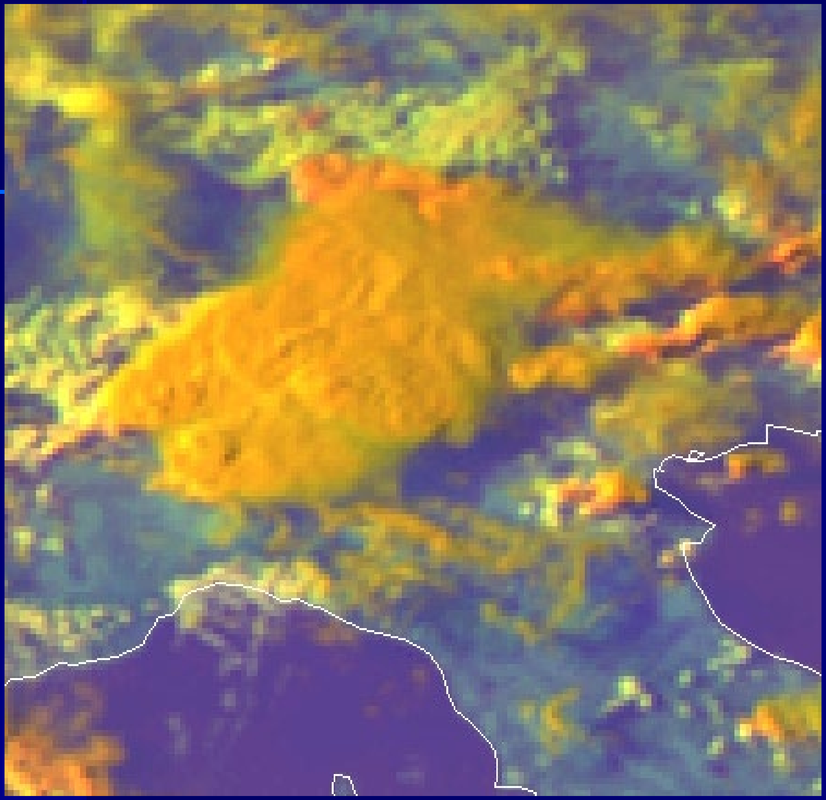
NIGHT-TIME

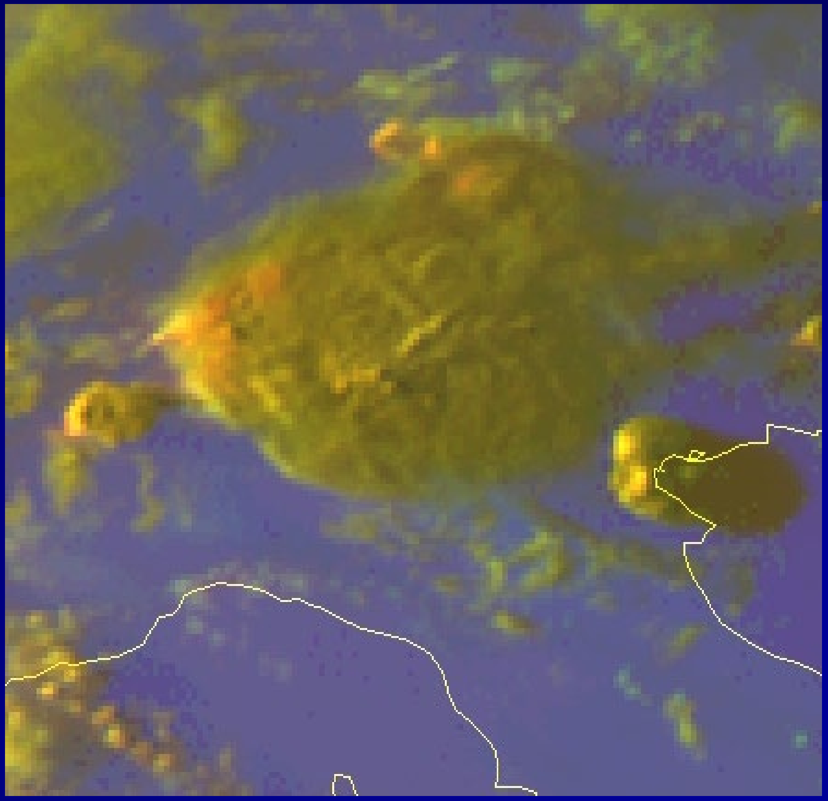
Recommended RGBs Night-time

Red: Cloud optical depth, approximated by the 12.0 - 10.8 μm or 10.8 - 8.7 brightness temperature.

Green: Cloud particle size and phase, approximated by the 10.8 - 3.9 μm brightness temperature.

Blue: Temperature, provided by 10.8 μm brightness temperature.





16:30 UTC **17:30 UTC**

MSG-1, 28 August 2003, RGB Composite

R=IR12.0-IR10.8, G=IR10.8-IR3.9, B=IR10.8

CONVECTIVE DETECTION

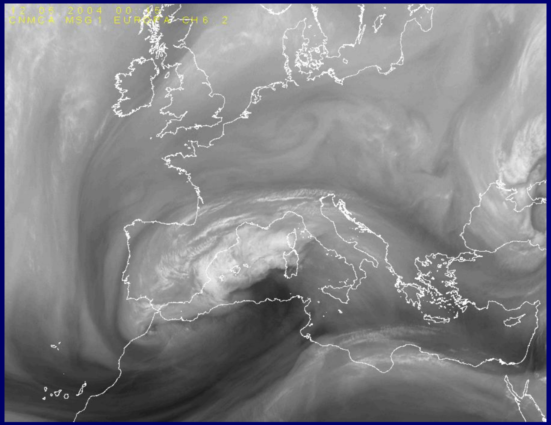
- RGB: VISUALIZATION TOOL
- AUTOMATIC TOOL

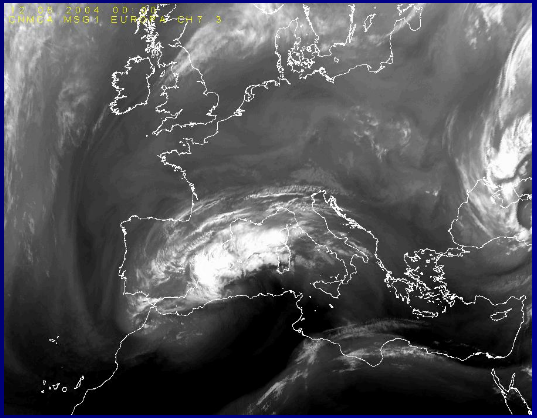
PART-4

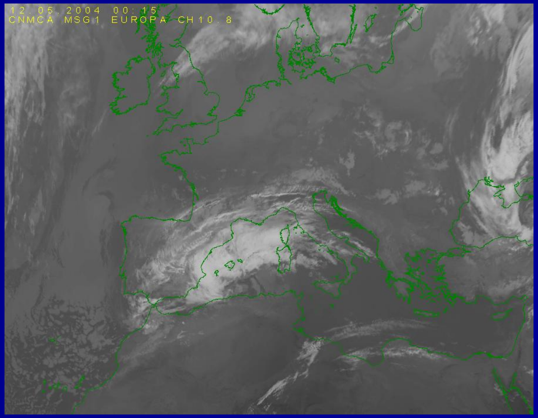
NEFODINA: an automatic tool for the Convective cluster detection and forecasting

At the Italian Meteorological Service of the Air Force an automatic model, called NEFODINA, has been developed to check the main convective nucleus.

MODEL INPUT: the last infrared images of the window channel 10.8 μm and absorption channels 6.2 μm and 7.3 μm.



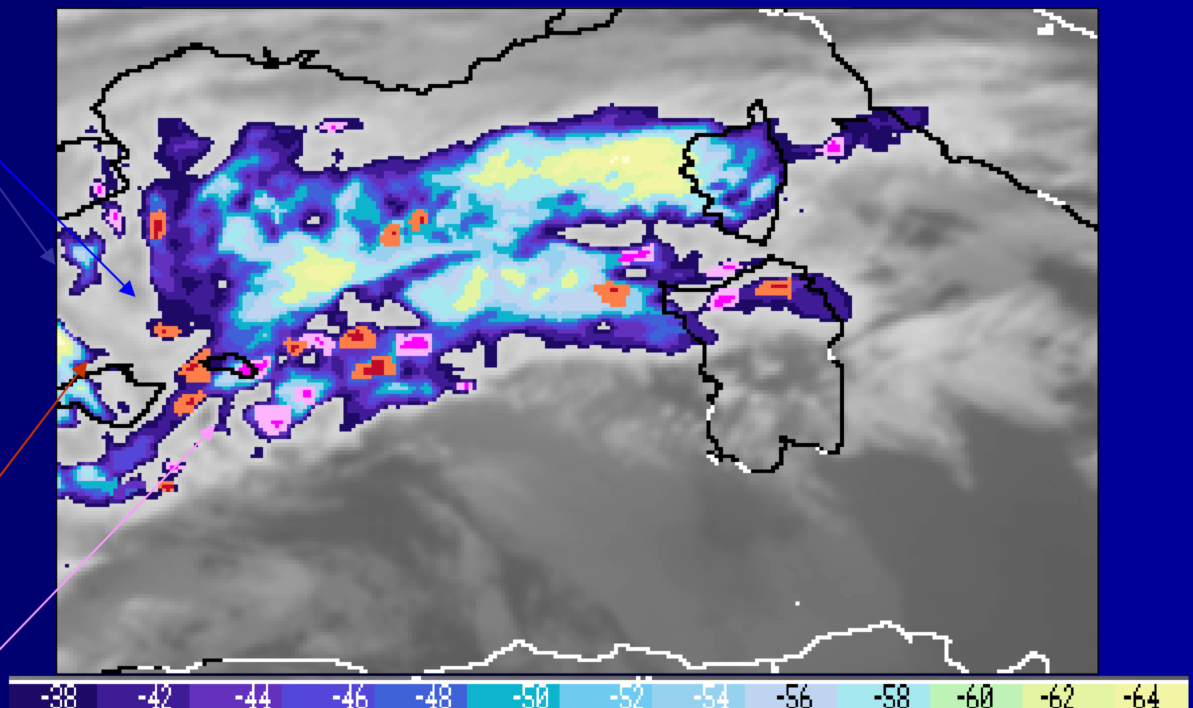




MODEL OUTPUT: the last 10.8 μm IR image over the Mediterranean area where the convective cells and their forecasts are represented.

MODEL OUTPUT: the last infrared image (ch10.8) over the italian area where the convective cells and their forecasted evolution are represented.

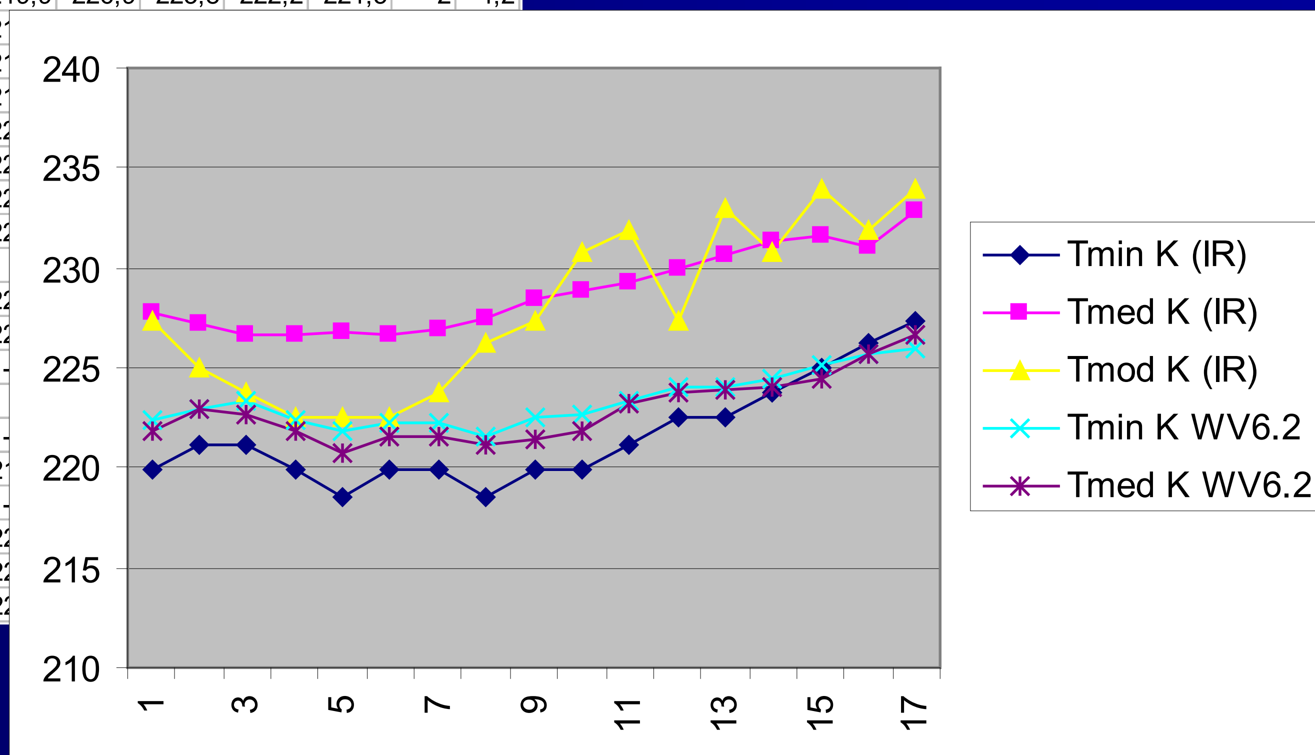
- **Blue shades are used to show the cloud which we are interested in (TB(10.8)< 236 K) . Dark blue is used for lowest cloud and light blue/yellow for highest clouds.**



- **With red shades the cloud top of the detected convective cell forecasted in growing phase is indicated**
- **With pink shades the cloud top of the detected convective cell forecasted in decreasing phase is indicated.**
- **The dark red and dark pink colors are used to indicate the most intensive convective regions.**

Nefodina history log file

numero identificativo de	AA MM GGG	ora	minuti	riga (stiamo sostituendo	colonna (stiamo sostitue	Tmin K (IR)	Tmed K (IR)	Tmod K (IR)	Tmin K WV6.2	Tmed K WV6.2	Area (IR) (ora fissa)	slope index (IR)
27	5 2 15	12	30	243	346	219,9	227,8	227,4	222,4	221,9	2	3,6
27	5 2 15	12	15	241	346	221,2	227,2	225	223	223	2	2,4
27	5 2 15	12	0	241	352	221,2	226,7	223,8	223,3	222,7	2	3
27	5 2 15	11	45	242	353	219,9	226,6	222,5	222,4	221,8	2	3,6
27	5 2 15	11	30	244	354	218,5	226,8	222,5	221,9	220,8	2	2,9
27	5 2 15	11	15	244	355	219,9	226,6	222,5	222,3	221,5	2	3,6
27	5 2 15	11	0	247	353	219,9	226,9	223,8	222,2	221,5	2	4,2
27	5 2 15	10	45	248	354	21						
27	5 2 15	10	30	248	354	21						
27	5 2 15	10	15	248	354	21						
27	5 2 15	10	0	247	354	22						
27	5 2 15	9	45	246	355	22						
27	5 2 15	9	30	245	355	22						
27	5 2 15	9	15	246	357	22						
27	5 2 15	9	0	247	358							
27	5 2 15	8	45	248	360	22						
27	5 2 15	8	30	251	362	22						
-999	##########	-999	-999	-999	-999	-						
28	5 2 15	12	30	240	149							
-999	##########	-999	-999	-999	-999	-						
30	5 2 15	12	30	277	139	21						
-999	##########	-999	-999	-999	-999	-						
32	5 2 15	12	30	265	512	22						
32	5 2 15	12	15	266	508	22						
32	5 2 15	12	0	266	502	22						



Main phases:

- CONVECTIVE NUCLEUS DETECTION
  IR 10.8 μm, WV 6.2 μm, WV 7.3 μm

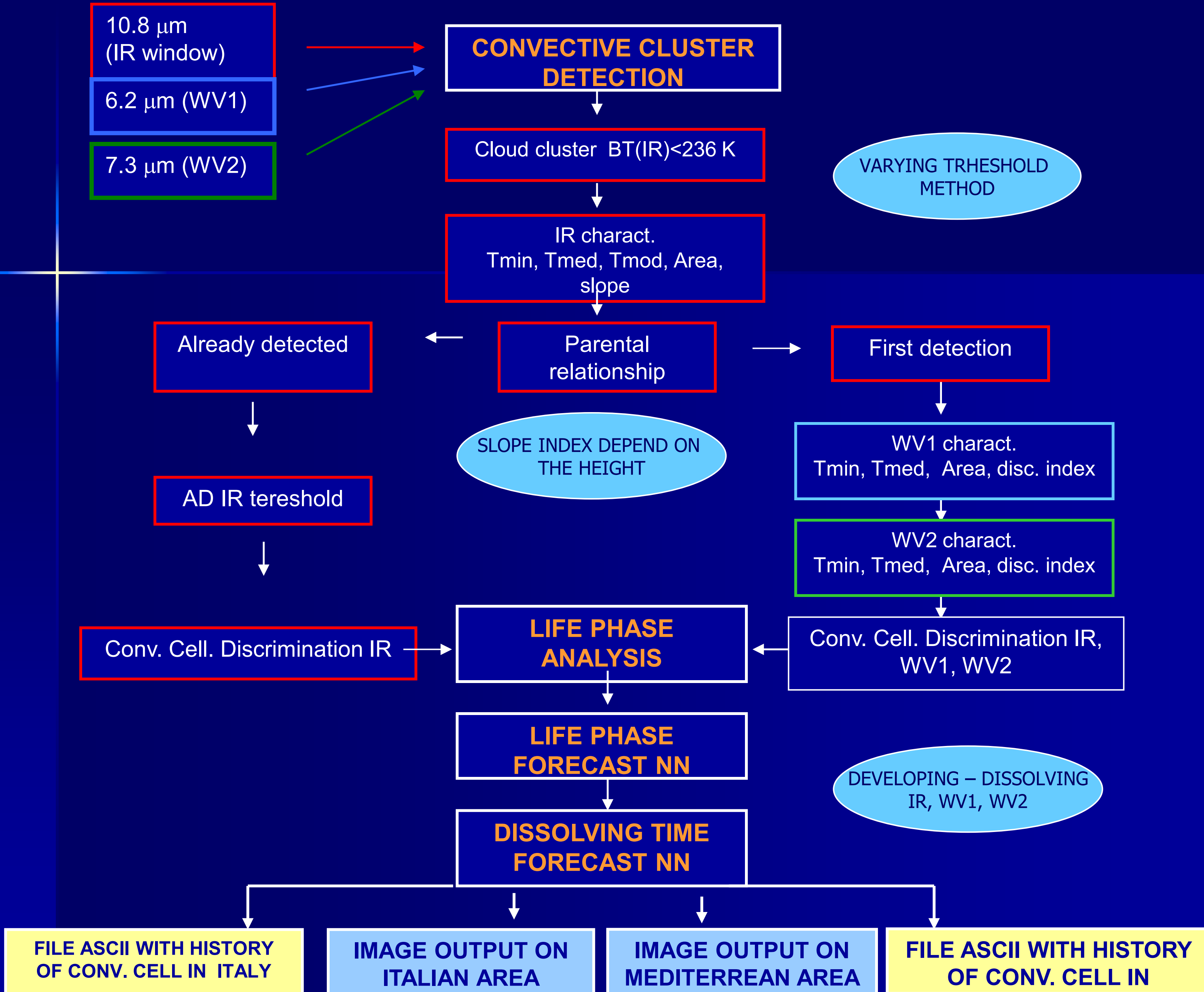
  - FIRST DETECTION
  - ALREADY DETECTED

- PARENTAL RELATIONSHIP
  between two slots

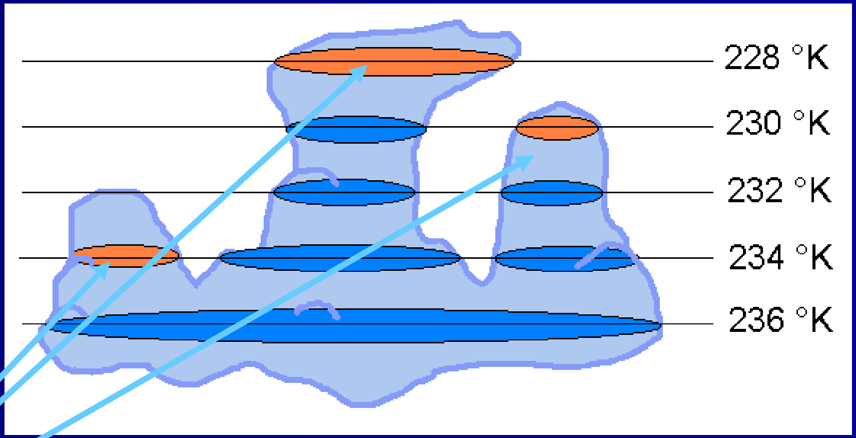
- CHARACTERISE THE CO's LIFE PHASE;

- LIFE PHASE FORECAST BY NEURAL NETWORK
  DEVELOPING or DISSOLVING

- DISSOLVING TIME FORECAST BY NEURAL NETWORK

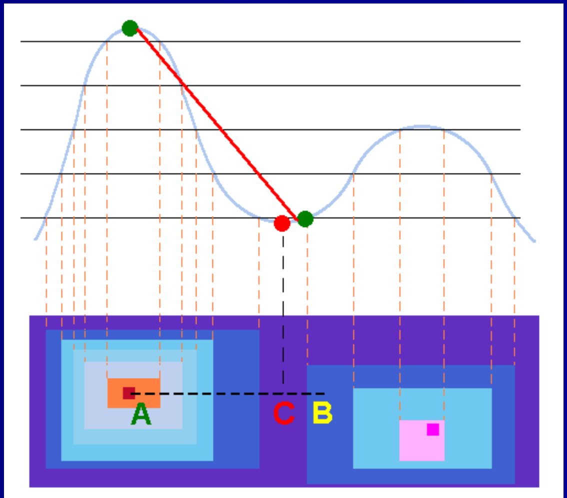

10.8 µm (IR window)
6.2 µm (WV1)
7.3 µm (WV2)
CONVECTIVE CLUSTER DETECTION
Cloud cluster BT(IR)<236 K
VARYING TRHESHOLD METHOD
IR charact. Tmin, Tmed, Tmod, Area, slope
Already detected
Parental relationship
First detection
SLOPE INDEX DEPEND ON THE HEIGHT
WV1 charact. Tmin, Tmed, Area, disc. index
AD IR tereshold
WV2 charact. Tmin, Tmed, Area, disc. index
Conv. Cell. Discrimination IR
LIFE PHASE ANALYSIS
Conv. Cell. Discrimination IR, WV1, WV2
LIFE PHASE FORECAST NN
DEVELOPING – DISSOLVING IR, WV1, WV2
DISSOLVING TIME FORECAST NN
FILE ASCII WITH HISTORY OF CONV. CELL IN ITALY
IMAGE OUTPUT ON ITALIAN AREA
IMAGE OUTPUT ON MEDITERREAN AREA
FILE ASCII WITH HISTORY OF CONV. CELL IN

- The cloud objects are identified using a varying threshold method on IR BT with a step of 1 K;



- First charact. IR only:

  Tmin, Tmed, Tmod, Area, slope index;



- PARENTAL RELATIONSHIP: The cross correlation between the cloud cells detected at time *t* and the CCs detected at time *(t-1)*, is so evaluated minimizing the distance function based on the position of the centre of gravity, minimum temperature and modal temperature.

$$\sqrt{d_1^{\,2} + d_2^{\,2} + d_3^{\,2} + d_4^{\,2} + d_5^{\,2}}$$

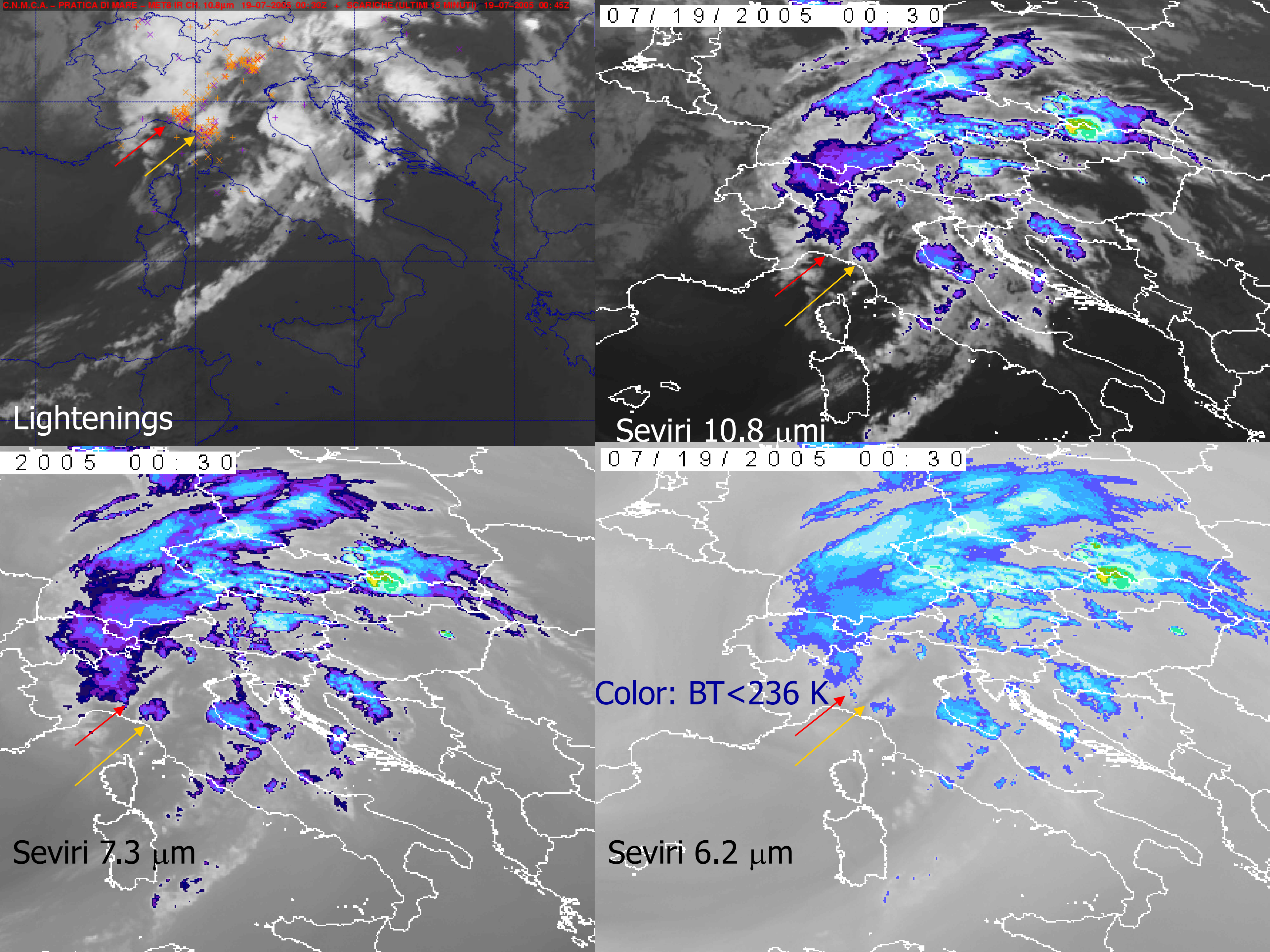
- It is so possible to classify the COs as *first detection* or *already detected* and then apply a threshold method to the static parameters of the cloud cell with a different tuning

- FIRST DETECTION or ALREADY DETECTED:
  - The investigation and the thresholds for the convective discrimination are different;
  - If it is a convective object already detected the probability to be still convective is high, we have only to investigate the IR area and slope:

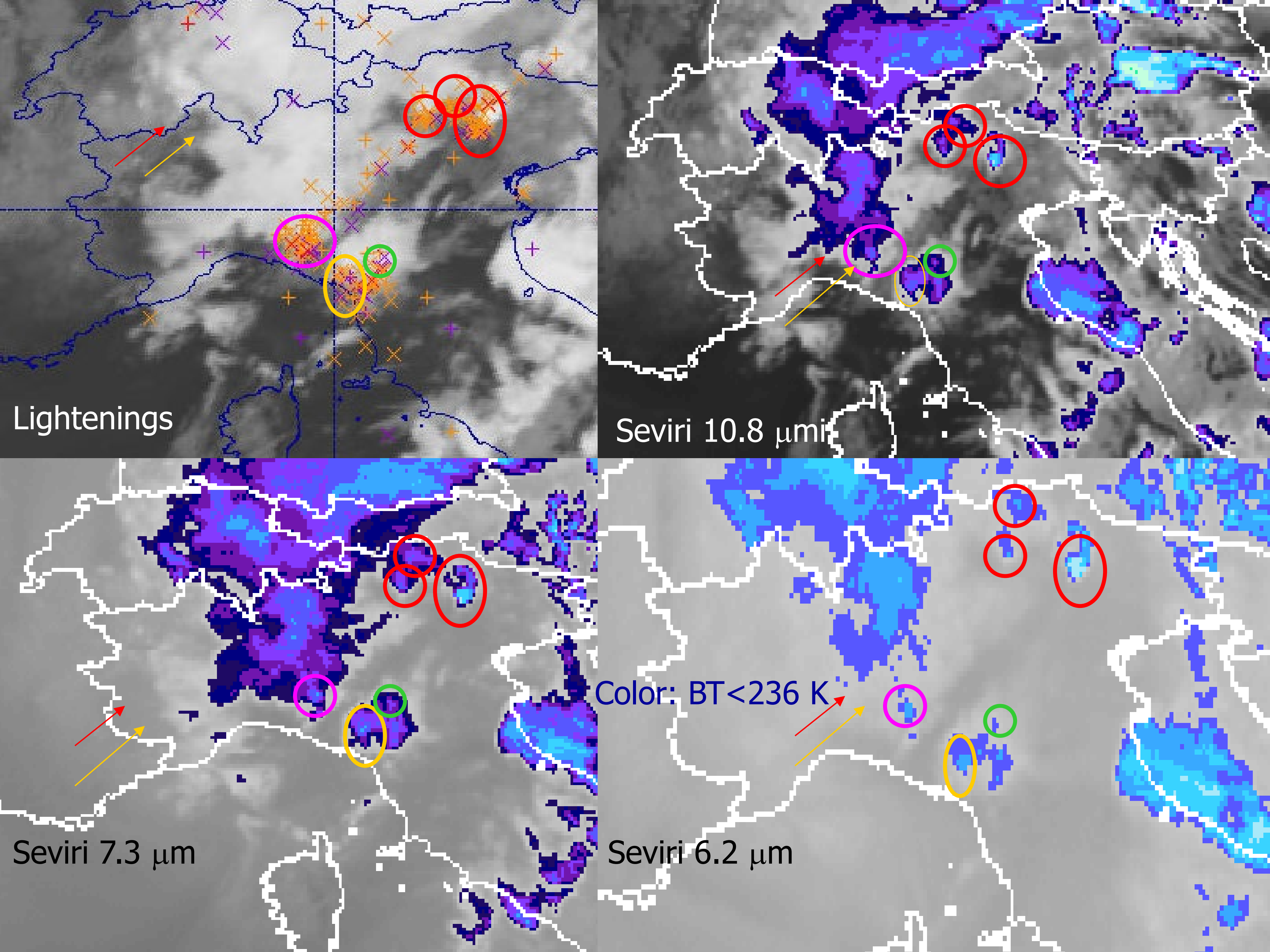
    → IR thresholds

  - If it is the first detection the IR information are not enough.

    There is then an analysis of the WV1 BT and the WV2 BT spatial distribution. The idea is that if the cloudy object is convective a defined structure has to be present also in the WV1 WV2 channels:



C.N.M.C.A. – PRATICA DI MARE – MET8 IR CH. 10.8µm 19–07–2005 00:30Z + SCARICHE (ULTIMI 15 MINUTI) 19–07–2005 00:45Z
Lightenings
07/19/2005 00:30
Seviri 10.8 µm
2005 00:30
Seviri 7.3 µm
07/19/2005 00:30
Color: BT<236 K
Seviri 6.2 µm


Lightenings
Seviri 10.8 µm
Seviri 7.3 µm
Color: BT<236 K
Seviri 6.2 µm

-to confirm the presence of these cells in the WV channels. Some characteristic parameters are so estimated for each object:

- minimum temperature (value and position) in IR, WV1, WV2 ;
- average temperature in IR, WV1, WV2;
- modal temperature in IR, WV1, WV2;
- total area in IR, WV1, WV2;
- modal temperature area in IR, WV1, WV2;
- position of the centre of gravity in IR, WV1, WV2;
- ellipticity (ratio of max. semi dispersion and min. semi dispersion) in IR only;
- slope index in IR only;
- discontinuity index in WV1, WV2.

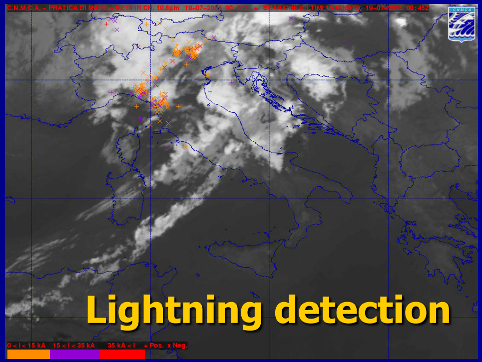
- The slope index depends on the cloud top height:

  Convective objects which were not selected becuase their top was near the tropopause and so the slope index was too low.

Validation phase: lightning detection
an automatic tool

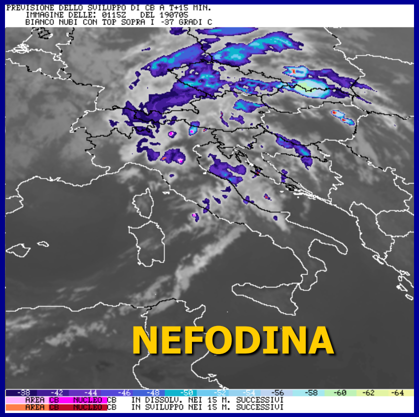
lightning → nefodina

Regions where the lightning network measures an electric activity and the top temperature of the cloud is below the temperature threshold (236 K), nefodina has to single out convective area. (previous and next 15 minutes).



nefodina → lightning

Regions where nefodina detects convective area and during the development of the cloudy cluster an electric activity is measured.



→ **POD=0.84 FAR=0.17**

LIFE PHASE ANALYSIS

- **Definition of developing and dissolving phase**: with IR data only

  – A convective cell is considered in a *developing phase* if its top is growing, or if the top is the same, if its area is enlarging:

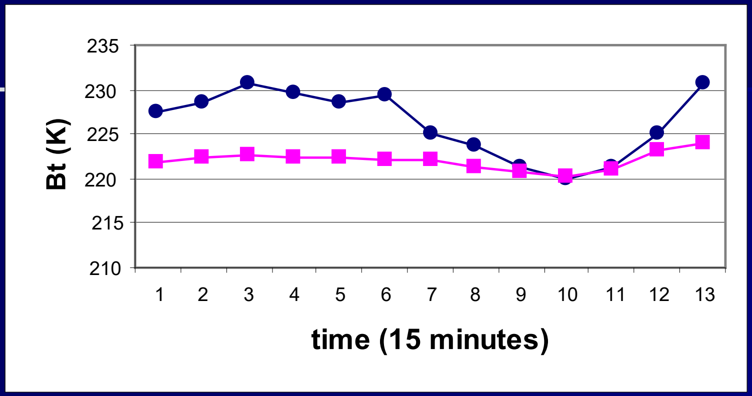
  T= minima temperature of the convective cell

  $[\Delta T^{IR} /dt < 0]$ or $[\Delta T^{IR} /dt = 0$ and $div\,(Area^{IR}) > 0]$

- The combination of IR and WV data showed to be important also during the forecasting phase.

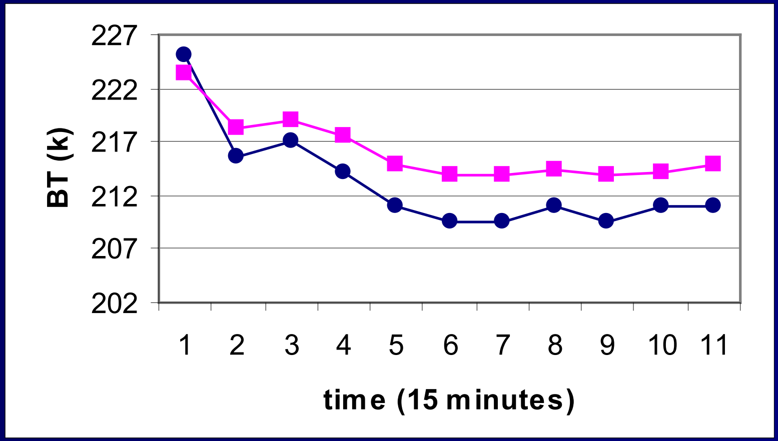
- The first results, obtained using rapid scan data, with a time sampling of 10 minutes, show the importance to introduce information on the domain of the COs using the WV data.

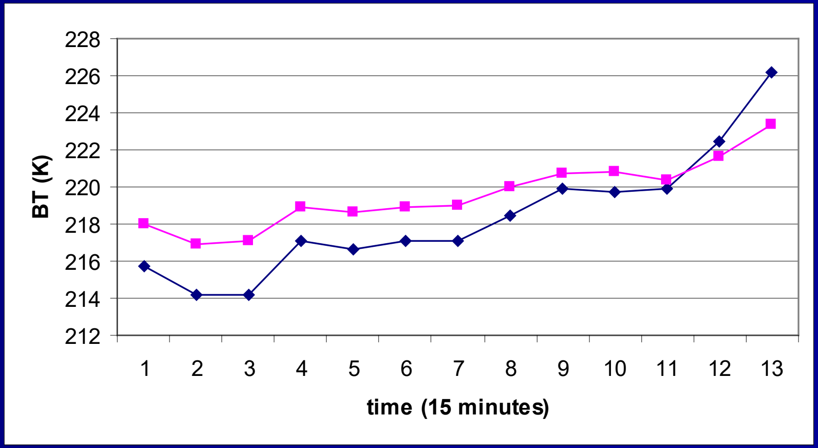
Water vapor and infra red minimum temperature of a convective cells Meteosat Second Generation data



The series 1 = minimum temperature of the convective cell in IR.

The series 2 = minimum temperature of the convective cell in WV.





- The defination with IR and WV data is more representative of the real life evolution of a CO.

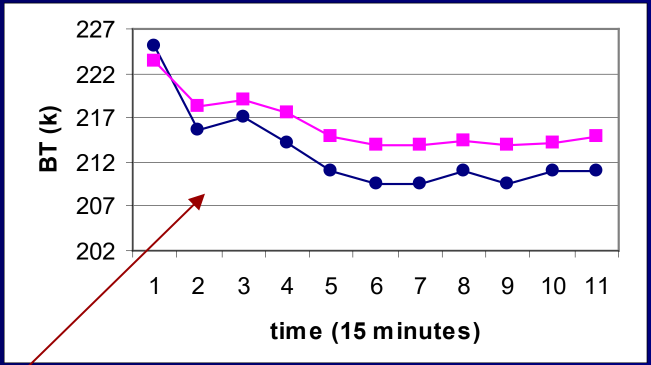
Definition of developing and dissolving phase: with IR and WV data:

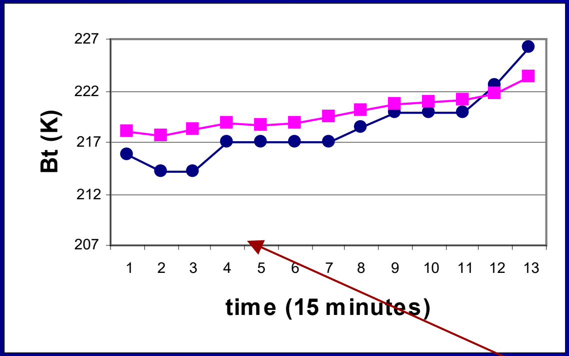
A convective cell is considered in a ***developing phase*** *if its top is growing or if the IR temperature has not a substantial change and the water vapor is increasing :*

$$[\Delta T^{IR}/dt < 0] \quad \text{or} \quad [(\Delta T^{IR}/dt < \alpha, \alpha \text{ small}) \ \text{and} \ \Delta T^{WV}/dt < 0].$$

where $T^{IR} = (T^{IR}(t) - T^{IR}(t-1))/2$ *and* $T^{WV} = (T^{WV}(t) - T^{WV}(t-1))/2$

In all the others cases the convective cell is ***dissolving****.*

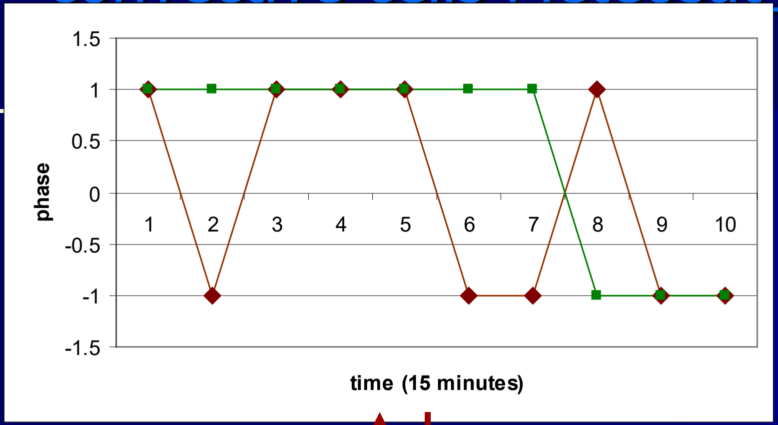




GROWING PHASE

DISSOLVING PHASE

Water vapor and infra red minimum temperature of a convective cells Meteosat Second Generation data



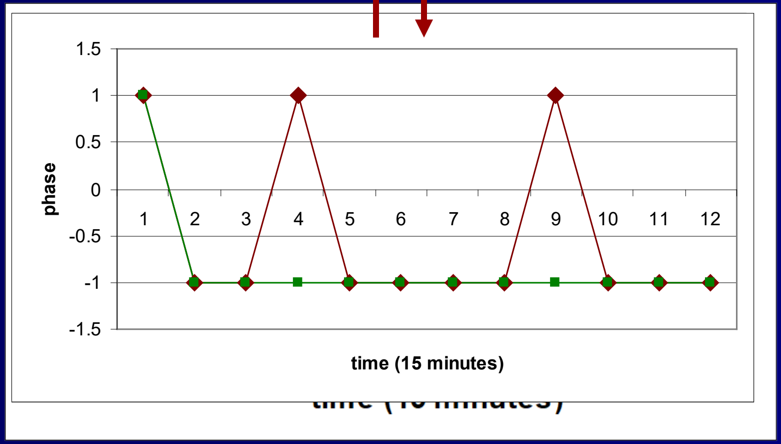
The series 1 = minimum temperature of the convective cell in IR.

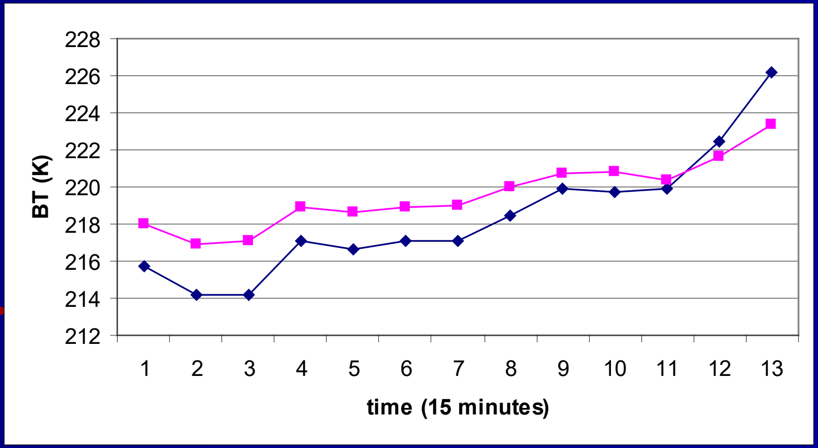
The series 2 = minimum temperature of the convective cell in WV.

The series 3= phase def1 (IR + WV data)

The series 4= phase def2 (IR data)

1= growing ph. , -1 =dissolving ph.





- IR channel: many oscillations. Dissolving time difficult to forecast.
- WV channel (smoother curve) is an important tracking of the convective cells development;

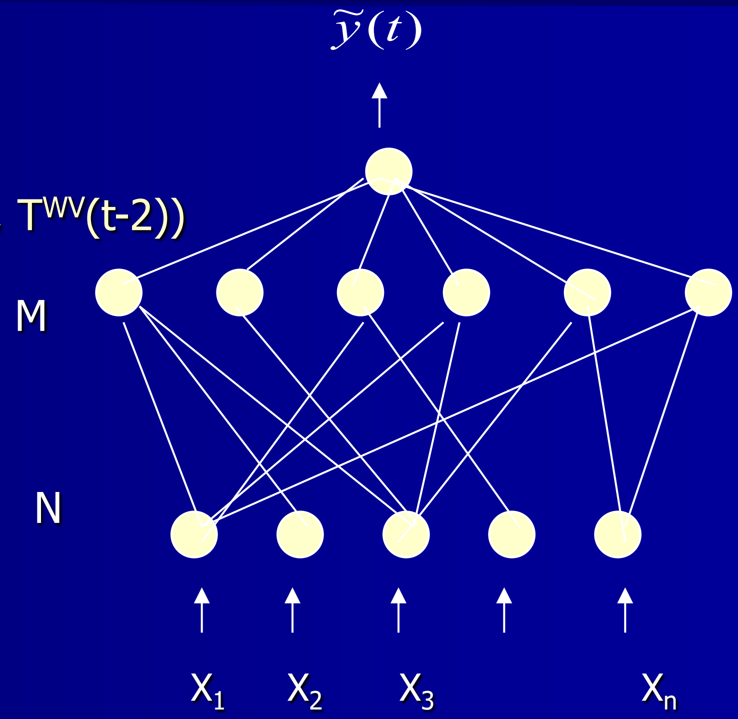
Nonlinear model: neural network

- Input vector:

X^t= (T^{IR}(t), T^{IR}(t-1), T^{IR}(t-2))

X^t= (T^{WV}(t), T^{WV}(t-1), T^{WV}(t-2))

X^t= (T^{IR}(t), T^{IR}(t-1), T^{IR}(t-2),T^{WV}(t), T^{WV}(t-1), T^{WV}(t-2))



- Synaptic weights:

  $h_{i,j}$ with i=1,..,M, j=1,..,N

  $w_{1,j}$ with j=1,..,M

- Output vector :

$$\tilde{y}(t) = \sigma_1\left(\sum_{j=1}^{M} w_{1,j}\sigma_0\left(\sum_{i=1}^{N} h_{j,i}x_i\right)\right)$$

where σ(x) is the sigmoidal function:

$$\sigma_i(x) = \frac{1}{1+e^{-\lambda_i x}}$$

- **Learning phase:**

$$E_L = \frac{1}{P}\sum_{t=1}^{P}\alpha^t \left|Y^t - \widetilde{Y}^t\right|$$

P is the number of learning patterns.

α^τ is defined in order to have i.i.d. developping and dissolving cases

Minimizing phase

Monte Carlo method

Simulated annealing

- **Testing phase:**

$$E_T = \frac{1}{PT}\sum_{t=1}^{PT}\left|Y^t - \widetilde{Y}^t\right|$$

PT is the number of testing patterns.

Forecast with neural network the convective cell life phase at time *t+10* min with RS data

- The best results has been obtained with the input vector equal to:

  $\mathbf{X}^t = (T^{IR}(t), T^{IR}(t-1), T^{IR}(t-2), T^{WV}(t), T^{WV}(t-1), T^{WV}(t-2))$

  so we nave 6 neurones in the input layer and 20 neurones in the hidden.

*A convective cell is considered in a **developing phase** if its top is growing or if the IR temperature has not a substantial change and the water vapor is increasing :*

$[\Delta T^{IR}/dt < 0]$ *or* $[(\Delta T^{IR}/dt < \alpha, \alpha \text{ small})$ *and* $\Delta T^{WV}/dt < 0]$.

where ***T****IR= (TIR(t)- TIR(t-1))/2 and* ***T****WV= (TWV(t)- TWV(t-1))/2*

*In all the others cases the convective cell is **dissolving**.*

- The output neuron has a binary value: DEVELOPING or DISSOLVING phase.

$$\tilde{y}(t) = \{-1, +1\}$$

$$\tilde{y}(t) = f\left[\sigma_1\left(\sum_{j=1}^{M} w_{1,j}\sigma_0\left(\sum_{i=1}^{N} h_{j,i}x_i\right)\right)\right]$$

Ep= 11%	**VAR=8%**	**CORR=0.88**

Forecast with neural network of the phase of the convective cell at time *t+20* min with RS data

The structure of the neural network does not change:

$$\mathbf{X}^t = (T^{IR}(t), T^{IR}(t-1), T^{IR}(t-2), T^{WV}(t), T^{WV}(t-1), T^{WV}(t-2))$$

- N=6, M=20
- The output neuron has a binary value: DEVELOPPING or DISSOLVING phase.
- But the output of the neural network is the forecast at time *t+2*.

Ep= 12%	**VAR=9%**	**CORR=0.8**

Forecast with neural network of the phase of the convective cell at time *t+30* min with RS data

Ep= 15%	**VAR=9%**	**CORR=0.8**

Forecast with neural network of the phase of the convective cell at time *t+15* min with MSG data

- We have then defined a two layers back propagation network with 6 neurons in the input layers, 60 neurons in the hidden layer and a neuron in the output layer.
- The input vector is changed as follow:

$$\mathbf{X}^t = (T^{IR}(t), T^{IR}(t-1), T^{WV1}(t), T^{WV1}(t-1), T^{WV2}(t), T^{WV2}(t-1))$$

where with IR, WV1 and WV2 are indicated the 10.8μm, the 6.2μm and the 7.3μm channel respectively. The same transfer function has been used obtaining the following results:

Ep= 10.6%	**VAR=7%**	**CORR=0.8**

Forecast with neural network of the phase of the convective cell at time *t+30* min with MSG data

Ep= 13%	**VAR=8%**	**CORR=0.78**

- The two WV channels, that allow us to see the presence of water vapor in a wider layer of the troposphere seems to compensate the best time sampling of the Meteosat 6 RS.

Forecast by neural network of dissolving time of the convective cell

- The next step is to forecast the dissolving time

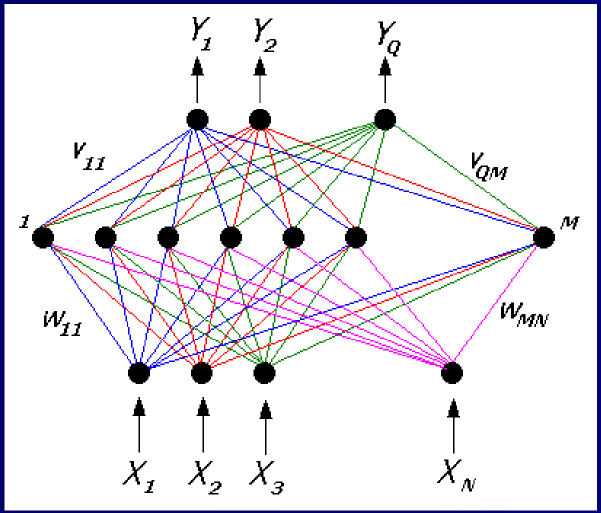
  'Dissolving time' : how long the convective activity will last?

  15 min, 30 min, ..1 hour?

- This is an important question for the ..
  - AIRFORCE: during the take-off and the landing of the aircraft.
  - CIVIL PROTECTION: a correlation between severe convective systems and the extreme events of precipitation has been often observed.

- To obtain good results a two layers neural network is not enought.

We need a three layers back propagation network



Sinaptic weights

$$\omega_{i,j} \quad i = 1,2,\ldots,M \quad , \quad j = 1,2,\ldots,N$$

$$v_{h,k} \quad h = 1,2,\ldots,Q \quad , \quad k = 1,2,\ldots,M$$

OUTPUT

$$y_h = \sigma_2\left(\sum_{k=1}^{M} v_{h,k}\,\sigma_1\left(\sum_{j=1}^{N} \omega_{k,j} x_j\right)\right)$$

$$E_{TOT} = \frac{1}{P}\sum_{\mu=1}^{P} e_\mu$$

with

$$e_\mu = \frac{1}{2}\sum_{h=1}^{Q}\left(\bar{y}_h^{\mu} - y_h^{\mu}\right)^2 = \frac{1}{2}\sum_{h=1}^{Q}\left(\bar{y}_h^{\mu} - \sigma_2\left(\sum_{k=1}^{M} v_{h,k}\,\sigma_1\left(\sum_{j=1}^{N} \omega_{k,j} x_j\right)\right)\right)^2$$

Forecast by neural network of dissolving time of the convective cell:

- We have then defined a three layers back propagation network with 12 neurons in the input layers, 12 neurons in the first hidden layer, 12 neurons in the second hidden layers and a neuron in the output layer.

- **The input vector is:**

$$X^t = (T^{IR}(t), T^{IR}(t-1), sl, ph, age, DT^{IR}(t), T^{WV1}(t), T^{WV1}(t-1), D\, T^{WV1}(t), T^{WV2}(t), T^{WV2}(t-1), D\, T^{WV2}(t))$$

Forecast by neural network of dissolving time of the convective cell

- The operational neural network for the dissolving time has been evaluated on a data set of 12000 data (January – September).

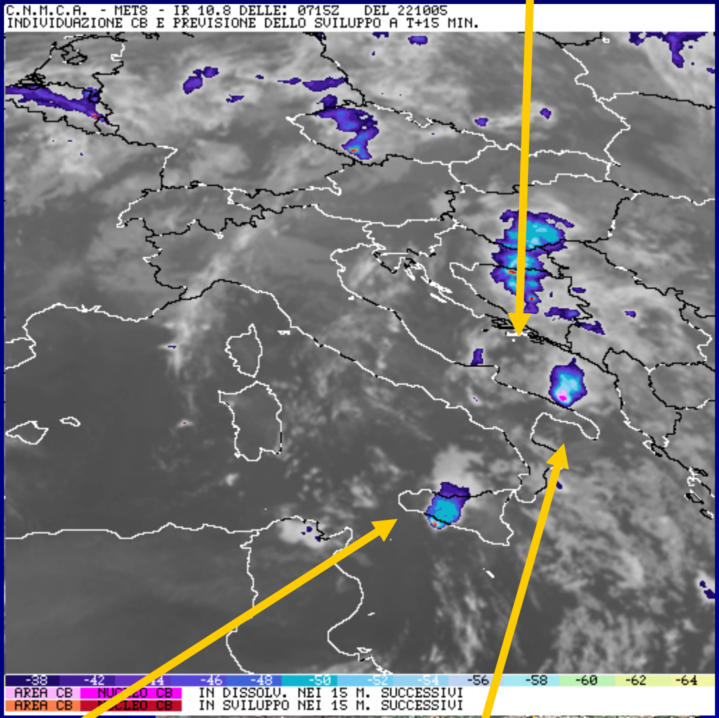
  - 8000 for learning set
  - 4000 for testing set

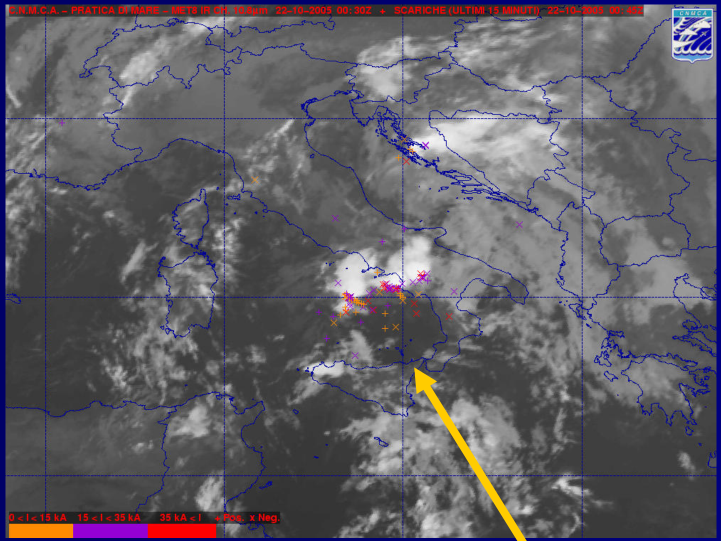
The best performances have been obtained with a three layers back propagation network with 12 input neurons, 24 hidden1 layer neurons, 24 hidden2 layer neurons, 1 output neuron.

→

MAD= 17 min	MD=1 min

--Nefodina is an air flight assistance support running every day at the Italian military airport
--It is used also for the monitoring and forecasting of flash floods at DPC





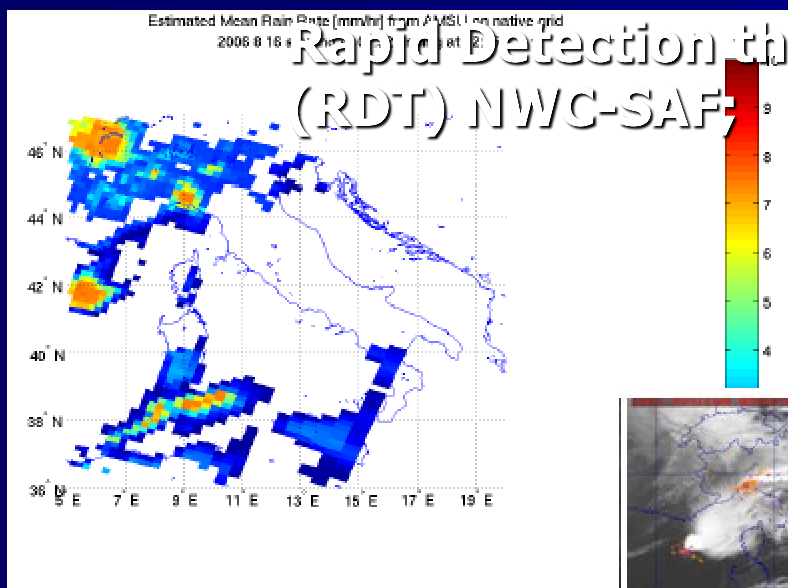
Refinement and operational implementation of a rain rate algorithm based AMSU/MHS, and SEVIRI data within the Hydrological-SAF

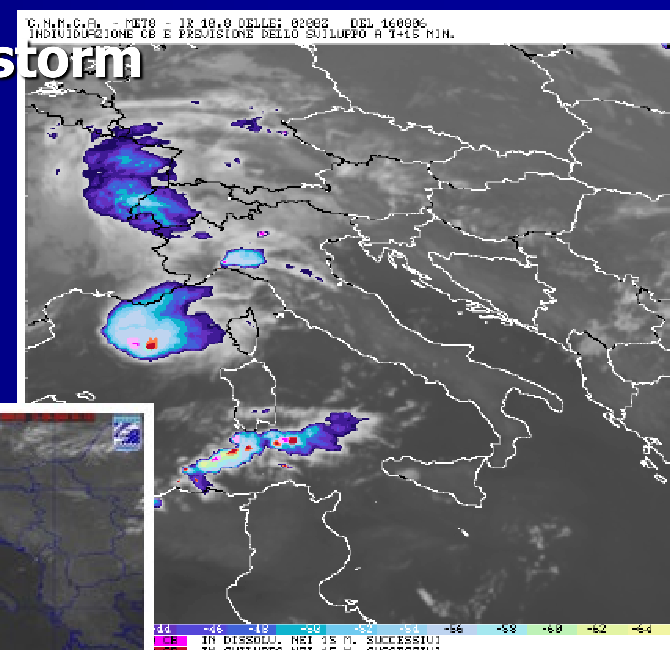
Met. Serv. Of the airforce

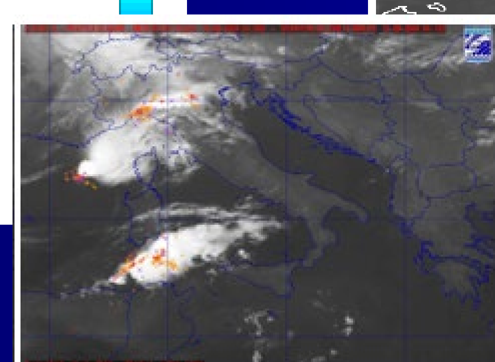
DPC

Paolo Antonelli

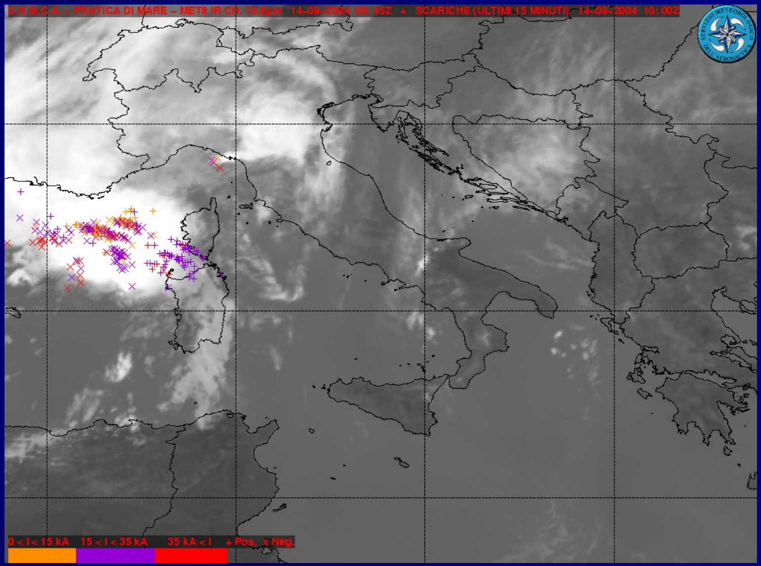
Rapid Detection thunderstorm (RDT) NWC-SAF;

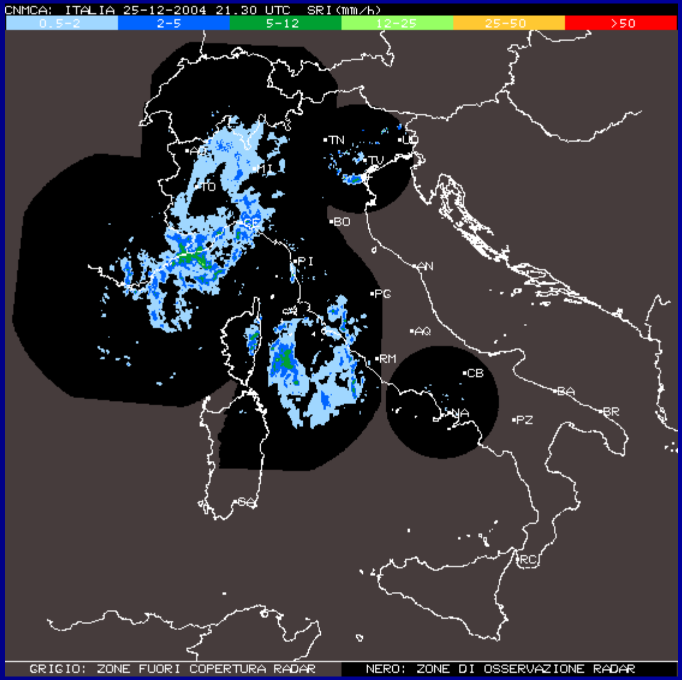






Ancillary data: radar, lightning





- **Rapid Detection thunderstorm (RDT) NWC-SAF;**

Uses seviri and lightning data

Summary

- **SEVIRI:**
  - Images every 15 Minutes
  - 3 km horizontal ‘sampling distance’ at Sub-Satellite Point (SSP)
  - Hi-Res VIS-Channel 1 km sampling distance (SSP)
  - 12 Spectral Channels

- **CONVECTION DETECTION with RGB (visual):**
  - DAY TIME: 0.6-1.6-10.8 μm or 0.8-3.9-10.8 μm;
  - NIGHT TIME: 12.0-10.8, 10.8-3.9, 10.8 μm;

- **NEFODINA: convective detection automatic tool.**
  - developed to detect and forecast the severe convective systems present on the scene and main convective object inside these systems using Meteosat Second Generation data;
  - Based on a multi channel approach allows for detection and investigation of convective cloud structure
  - Uses the IR window channel and the two wv infrared absorption channels.