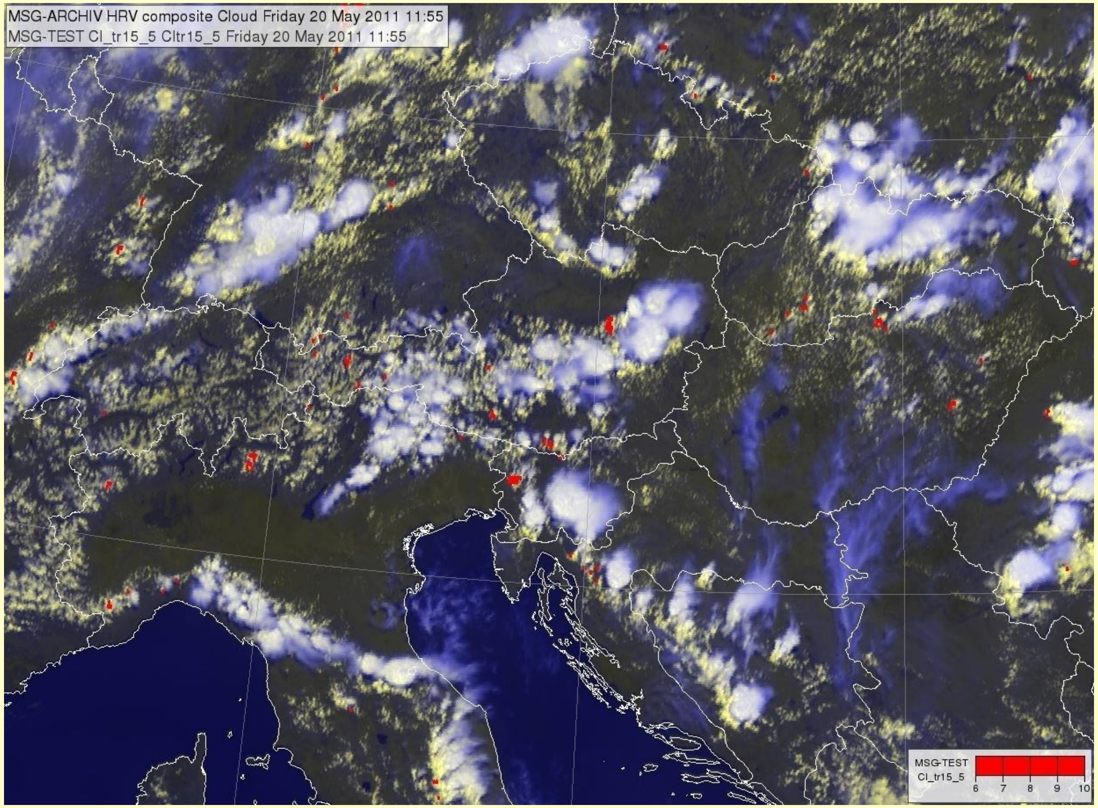
Benefits of RSS data in the Convective Initiation calculation



Mária Putsay and **Zsófia Kocsis**
Hungarian Meteorological Service

EUMETSAT - CHMI course on
use of rapid scan data for monitoring and nowcasting of high impact weather
2 - 6 November 2015, Prague, Czech Republic

Outlines

Definition of Convective Initiation (CI)

How does a CI algorithm work?

The two algorithms we worked with

- ‘Box-averaging method’ without cloud tracking
- Cloud tracking CI algorithm with NWCSAF HRW vectors

Comparison of the 5-min ‘box averaging’ and 15-min ‘cloud tracking’ CI algorithms

Problems with the cloud mask, undetected thin cirrus

Summary

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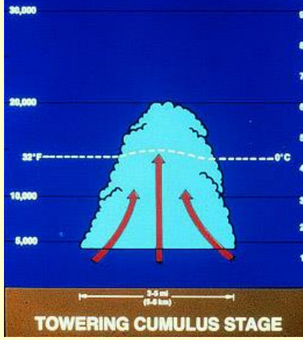
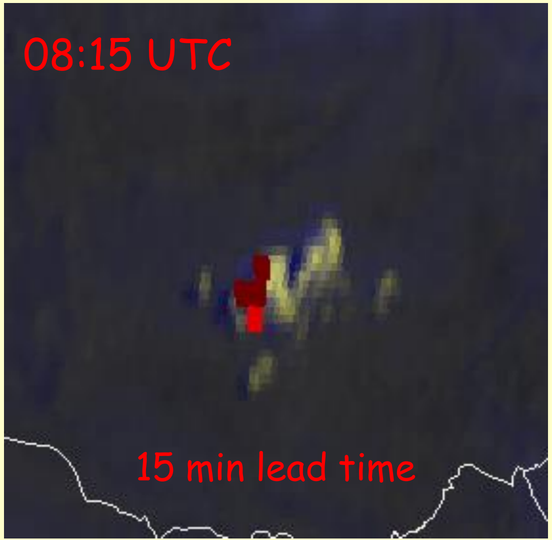
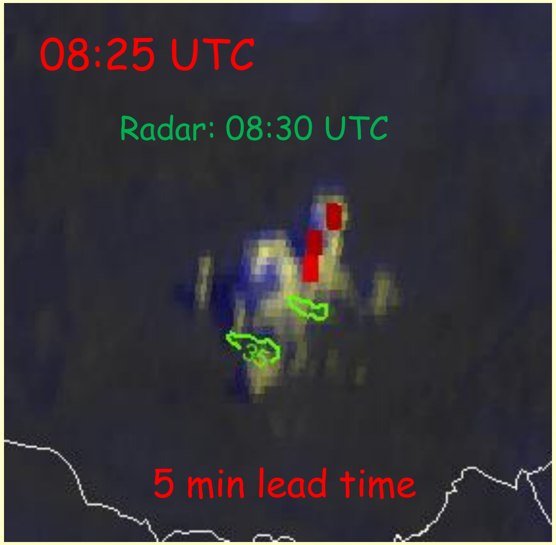
DEFINITION Convective Initiation (CI)



Aim: to find those already existing cumulus clouds, which are very likely to develop into mature Cumulonimbus clouds.

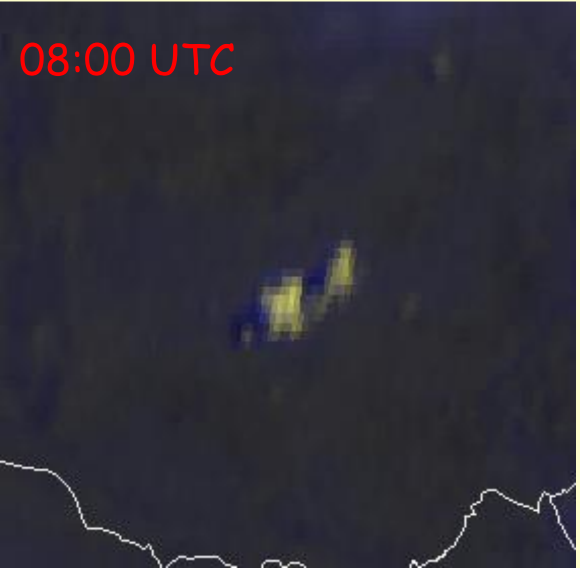
Quantitative definition: CI indicates the clouds for which a new 35 dBZ (~5.6 mm/h) radar signal is likely to appear in the next hour



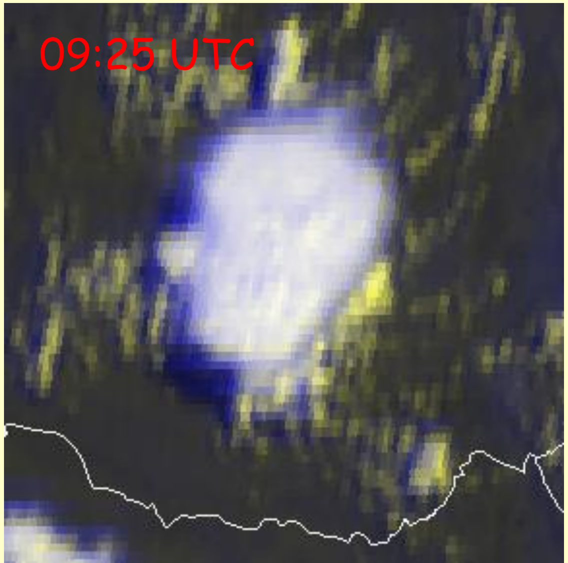


red pixels: CI

Green contour: 35dBZ radar signal



illustration



21.05.2011.

Box averaging m.

An algorithm which finds automatically those cumulus clouds which are likely to became mature Cb would be very useful for forecasters.

On satellite images such cells could be seen earlier then in the radar data.

The aim is to detect them by a program. To have **lead-time**.

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How does it work?

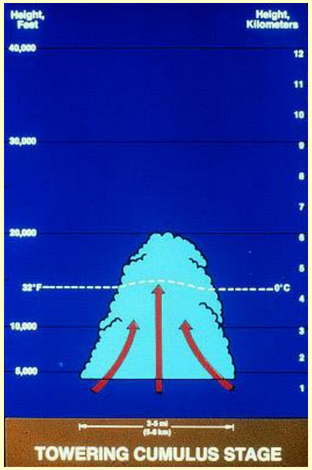
The algorithms are based on (Mecikalski and Bedka, 2006) **method**

Each pixel is analyzed whether it belongs to a rapidly growing cumulus cloud, or not.

Several tests are used **to compare** certain IR channel

- brightness temperatures (BT),
- their differences (BTD) /combinations and
- time trends (the so called **interest fields**)

to prescribed thresholds (**critical values**).



For **MSG data 10-17 different interest fields are tested**.

6 IR channel data (WV6.2, WV7.3, IR8.7, IR10.8, IR12.0, IR13.4)

in **3 consecutive slots** are analysed

15/5-min SEVIRI data → **30 or 10 min interval** is analysed

Example of Interest Fields and critical values for 15-minute MSG data, box-averaging method

	CI interest field	Critical values
15-minute cooling	IR10.8	(-50) – (-4) °C
30-minute cooling	IR10.8	< 15-min cooling
actual value	IR10.8	0 - (-20) °C
Cross the 0°C	IR10.8(t)<0C IR10.8(t-30)>0°C	goes below 0°C
actual value	WV6.2 - WV7.3	(-3) - (-25) °C
actual value	WV6.2 - WV10.8	(-10) - (-35) °C
15-min trend	WV6.2 – IR10.8	3-30 °C
actual value	IR8.7 – IR10.8	0 - (-10) °C
30-minute trend	IR8.7 – IR10.8	0 - 10 °C
actual value	IR12.0 – IR10.8	0 - (-3) °C
15-min trend	IR12.0 – IR10.8	0 - 10 °C
30-minute trend	IR12.0 – IR10.8	0 - 10 °C
actual value	IR13.4 – IR10.8	(-5) – (-25) °C
15-minute trend	IR13.4 – IR10.8	3 - 30 °C
actual value	(IR8.7 - IR10.8) – (IR10.8 - IR12.0)	0 – (-10) °C
15-minute trend	(IR8.7 - IR10.8) – (IR10.8 - IR12.0)	0 - 10 °C
30-minute trend	(IR8.7 - IR10.8) – (IR10.8 - IR12.0)	0 - 15 °C

Interest fields provide
information on:

Cloud-top temperature,
height relative to tropopause,
cooling rates,
updraft strength,
cloud-top height changes,
cloud-top glaciation

The interest fields are actual values or trends

If **the majority of the** interest field tests are fulfilled, the studied pixel is marked as a CI hit.

>> The pixel shows signs of an **immature towering cumulus** cloud.

The definition and the number of the interest fields, the critical values may be different, depending on the time step, region, tuning …

In order to properly calculate the **time trends, clouds must/should be tracked.**

Cloud tracking can be done in different ways
- No tracking - ‘box-averaging’ method.
- Tracking with AMVs
- Tracking with ‘object tracking’ method

We worked with two methods in the frame of EUMETSAT scientific studies and graduate trainee program

Box-averaging method

The clouds are not tracked.

For each pixels a box is defined and the averaged BTs are calculated in this box. (The **averaging** is made only over certain types of **cloudy pixels**.) Using the average BTs > BTD differences and trends are calculated and tested.

It works well if the cells do not (or only slowly) move

Cloud tracking method with AMVs (Zsofia Kocsis, Marianne König, John Mecikalski)

NWCSAF HRW product was used. Trends were calculated accurately

It works well if AMV is available and reliable, …

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First experiences with the box averaging method

We got a (first version) program from EUMETSAT which worked with 15-minute MSG data

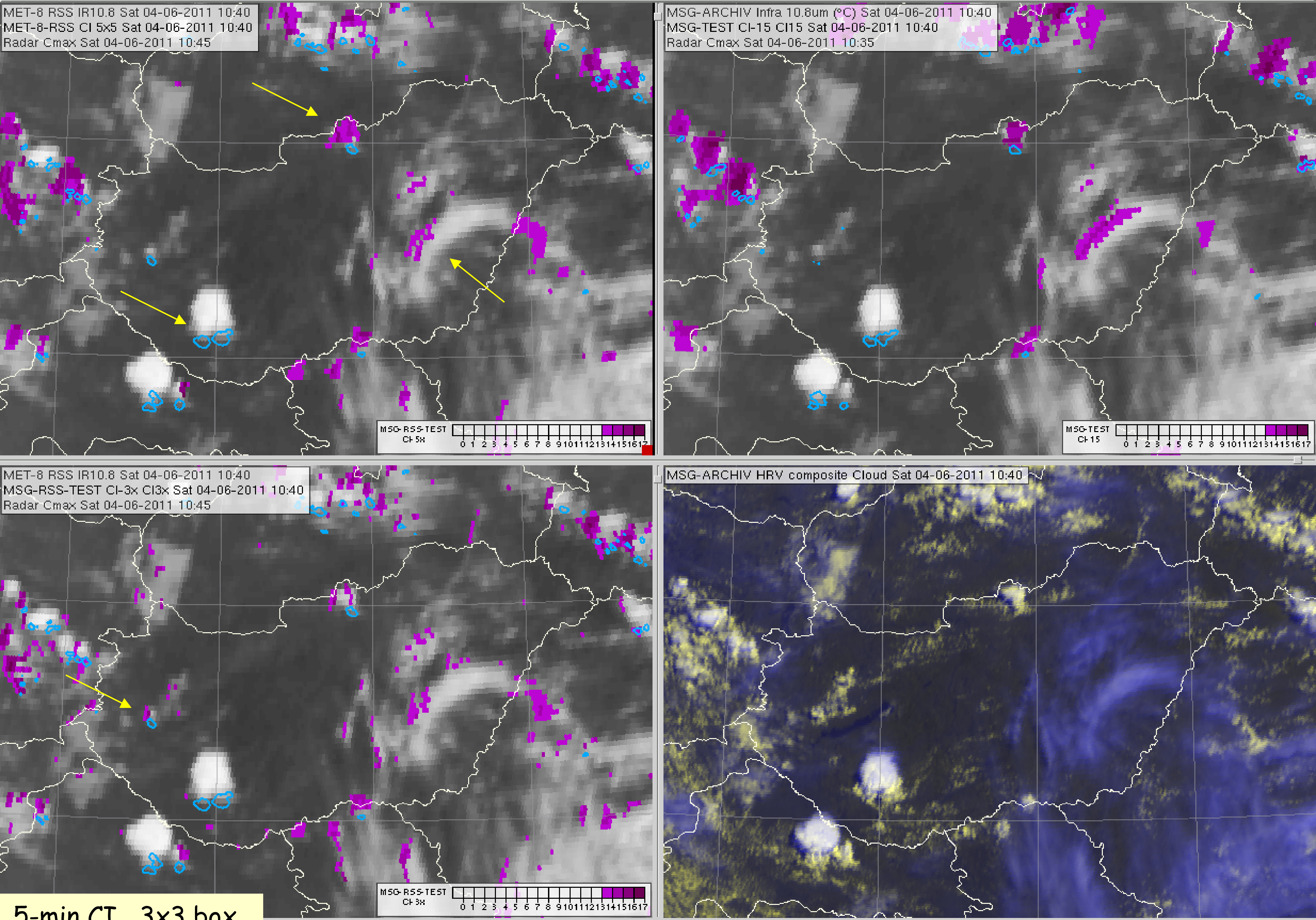
- We adapted it to 5-min data
- We compared CI results using 5-min and 15-min SEVIRI data

Example 04.06.2011.

04.06.2011.

5-min CI 5x5 box

15-min CI catches later the convection



5-min CI 3x3 box

Still on box-averaging method:

with 5-min CI algorithm we found (by analysing case studies)

- **more CI hits**
- **longer lead time**

Too many false alarms both with 5- and 15-min input data

Due to

- the cloud movement
- the lack of a **cumulus cloud mask** (for example thickening cirrus clouds gave CI hits)

→

We included several improvements to reduce the number of the false alarms by

- applying filters
- modifying the cloud mask

  the original EUMETSAT algorithm used a full cloud mask

  We reduced it by using the NWCSAF Cloud Type product

  using only some cloud types: very low, low and medium opaque clouds and high semitransparent above low or medium clouds

We managed to reduce the number of the false alarms considerably. It worked much better

Example later (still problems – due the cloud motion and ….)

(However, we improved only the 5-min version.)

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CI algorithm with cloud tracking

It worked with 15-min data (that time the calibration of the RSS data was not reliable)

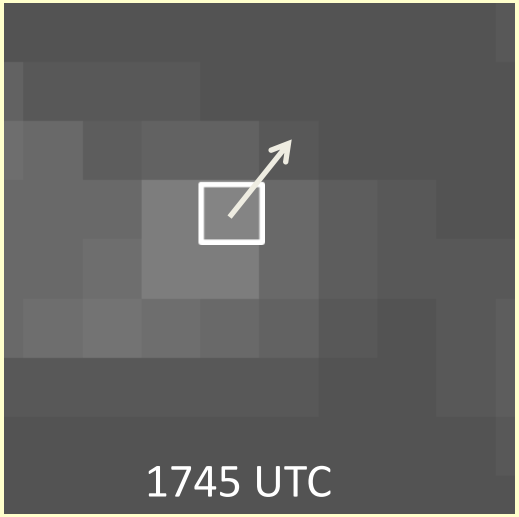
- NWCSAF Cloud Type product was used to perform a cloud mask of interest,
  (including very low, low and medium opaque clouds)
  Optimally a cumulus cloud mask would be needed

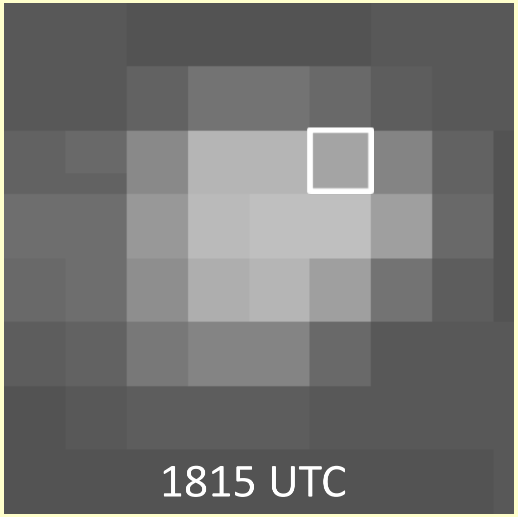
- The number of the interested fields were reduced,
- The critical values were retunes

Rank	CI interest fields	Range
Cloud depth		
1	6.2-10.8 µm	-20-0
2	10.8 µm TB	253-273
3	6.2-7.3 µm	-15--6
Glaciation indicators		
1	8.7-10.8 µm	-10--3
2	15 min 8.7-10.8 µm	0.4-10
3	15 min [(8.7-10.8)-(10.8-12.0)] µm	0.5-10
Updraft strength		
1	30 min 6.2-7.3 µm	0.6-10
2	30 min 10.8 µm TB	< 15 min 10.8 µm TB
3	15 min 6.2-7.3 µm	0.2-10
4	15 min 10.8 µm TB	-50--7.5

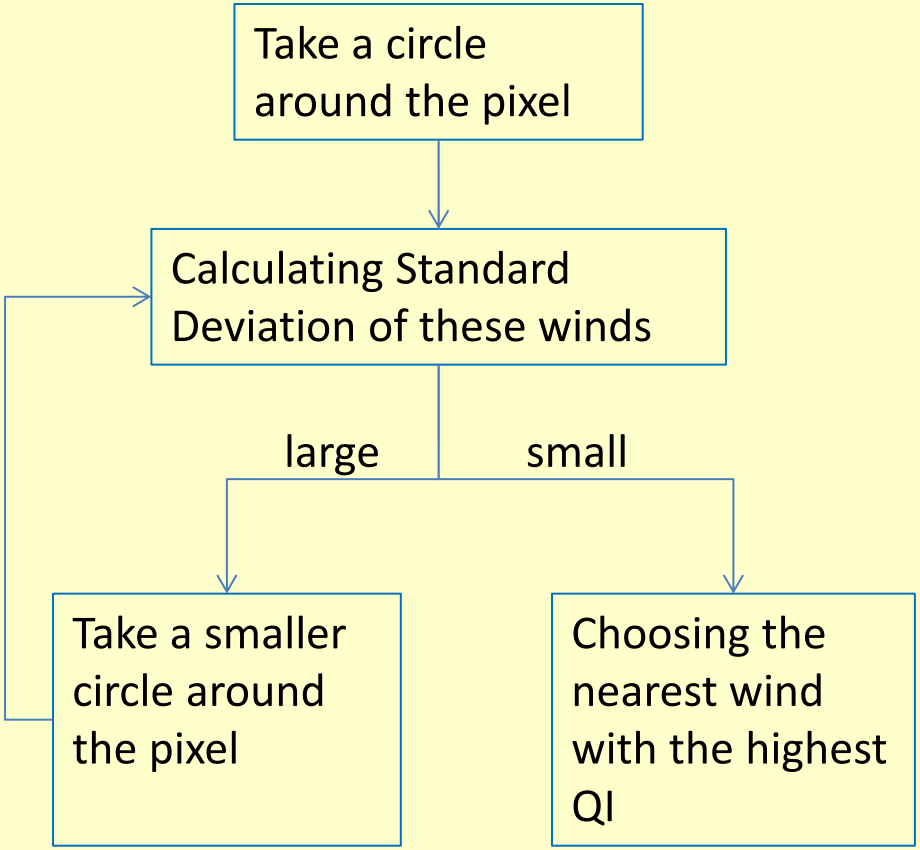
- Trends were calculated more precisely

  NWCSAF HRW AMV was used to track the clouds, to determine where the given pixel was in the previous time steps.





How is the wind vector chosen for the given pixel?

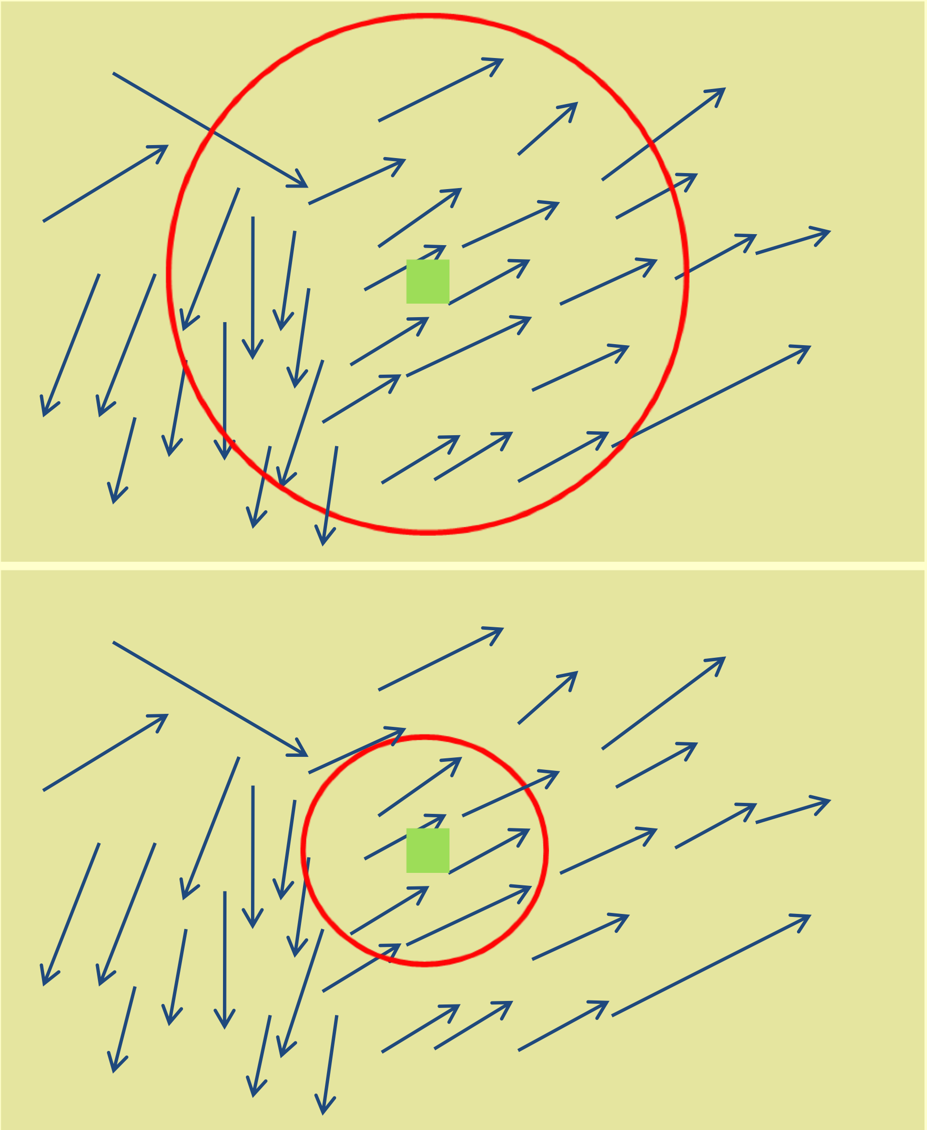


Take a circle around the pixel

Calculating Standard Deviation of these winds

Take a smaller circle around the pixel

Choosing the nearest wind with the highest QI



‘Near’ AMV, not sure that it was retrieved by tracking the studied cloud.

Experiences

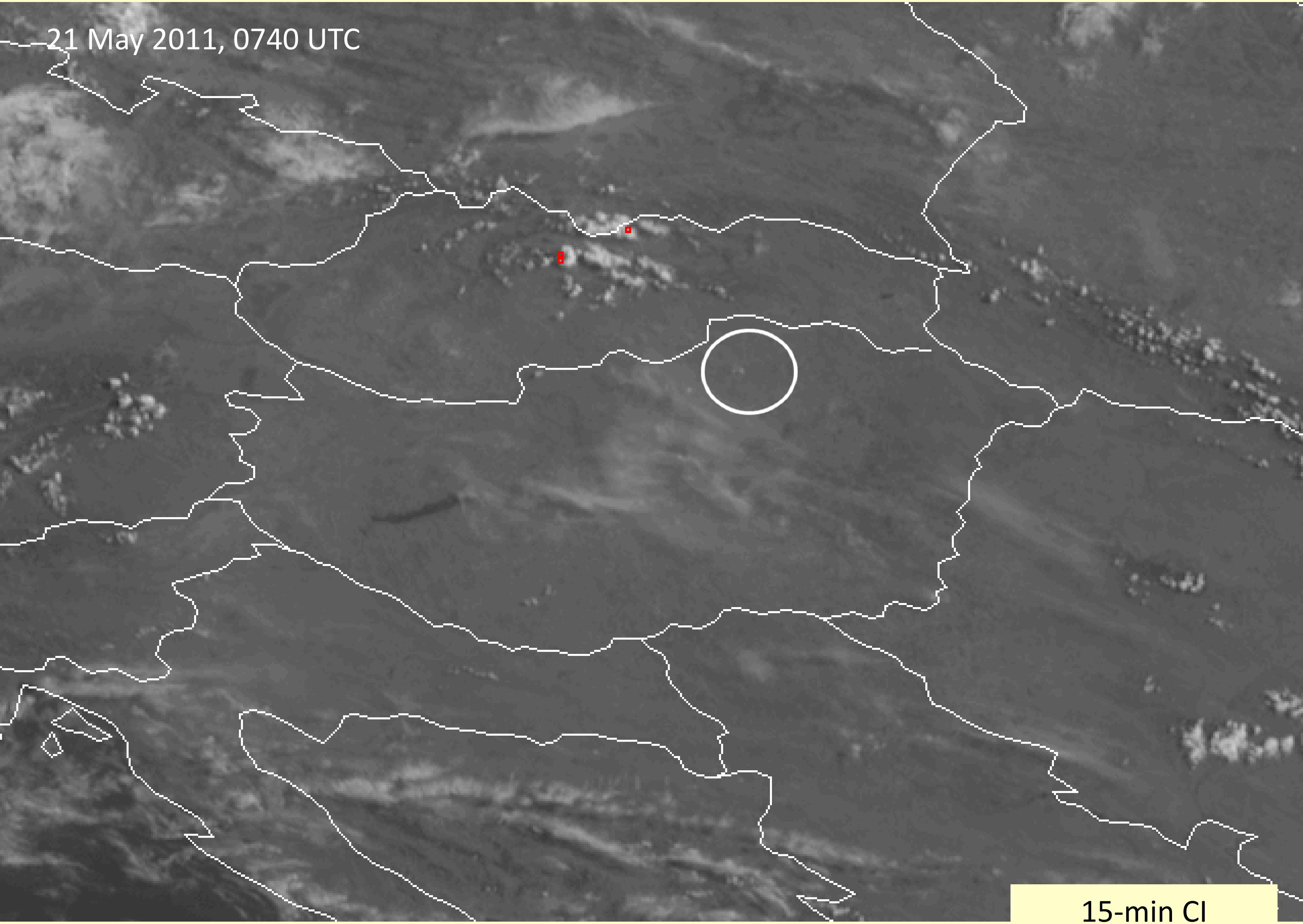
The algorithm worked much better for moving cells

There are still misses and false alarms due to several reasons

One of them:

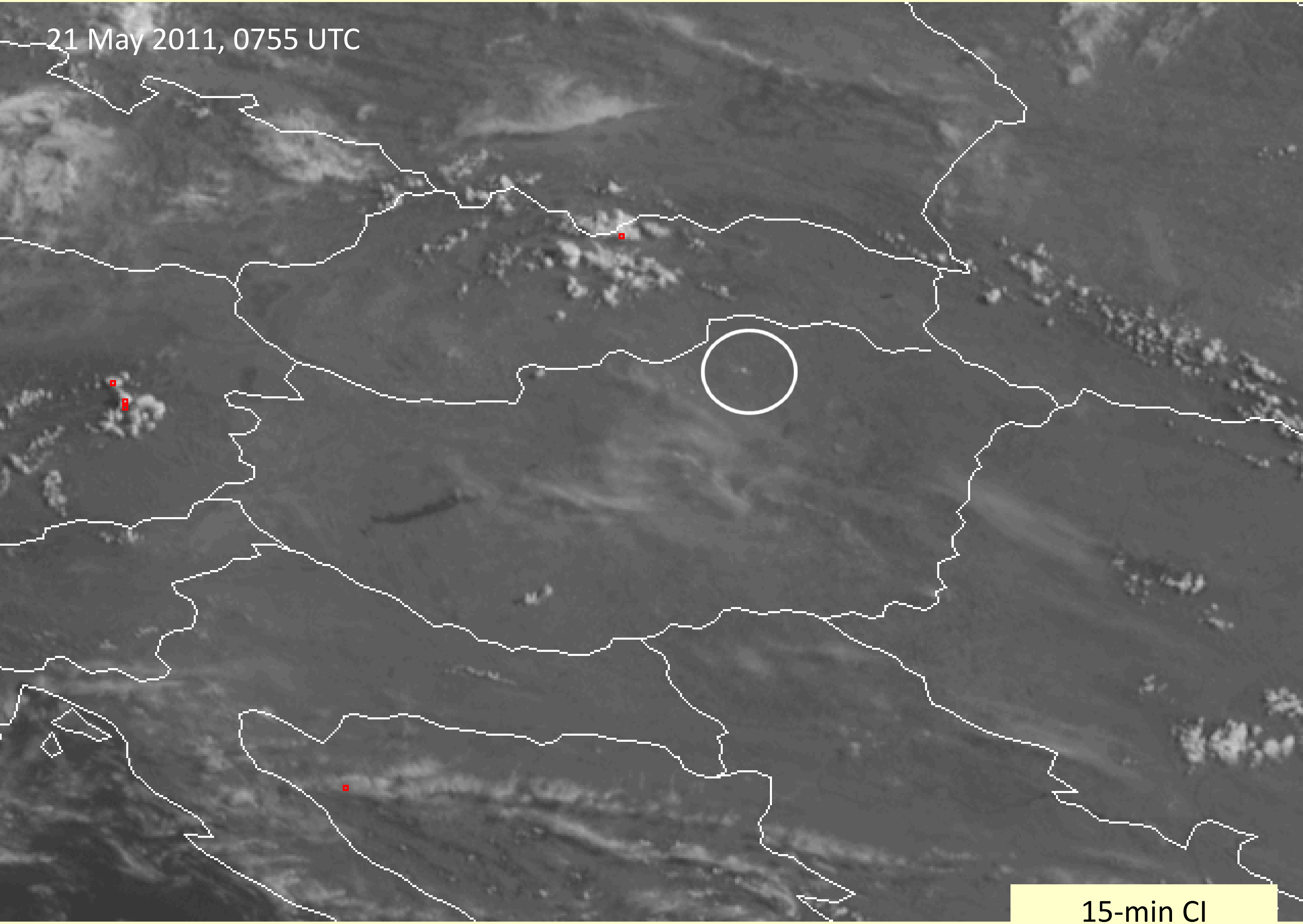
The **lack of the AMV vectors** causes miss
This happened mostly when the cloud was **growing very rapidly on an otherwise cloud-free area.**

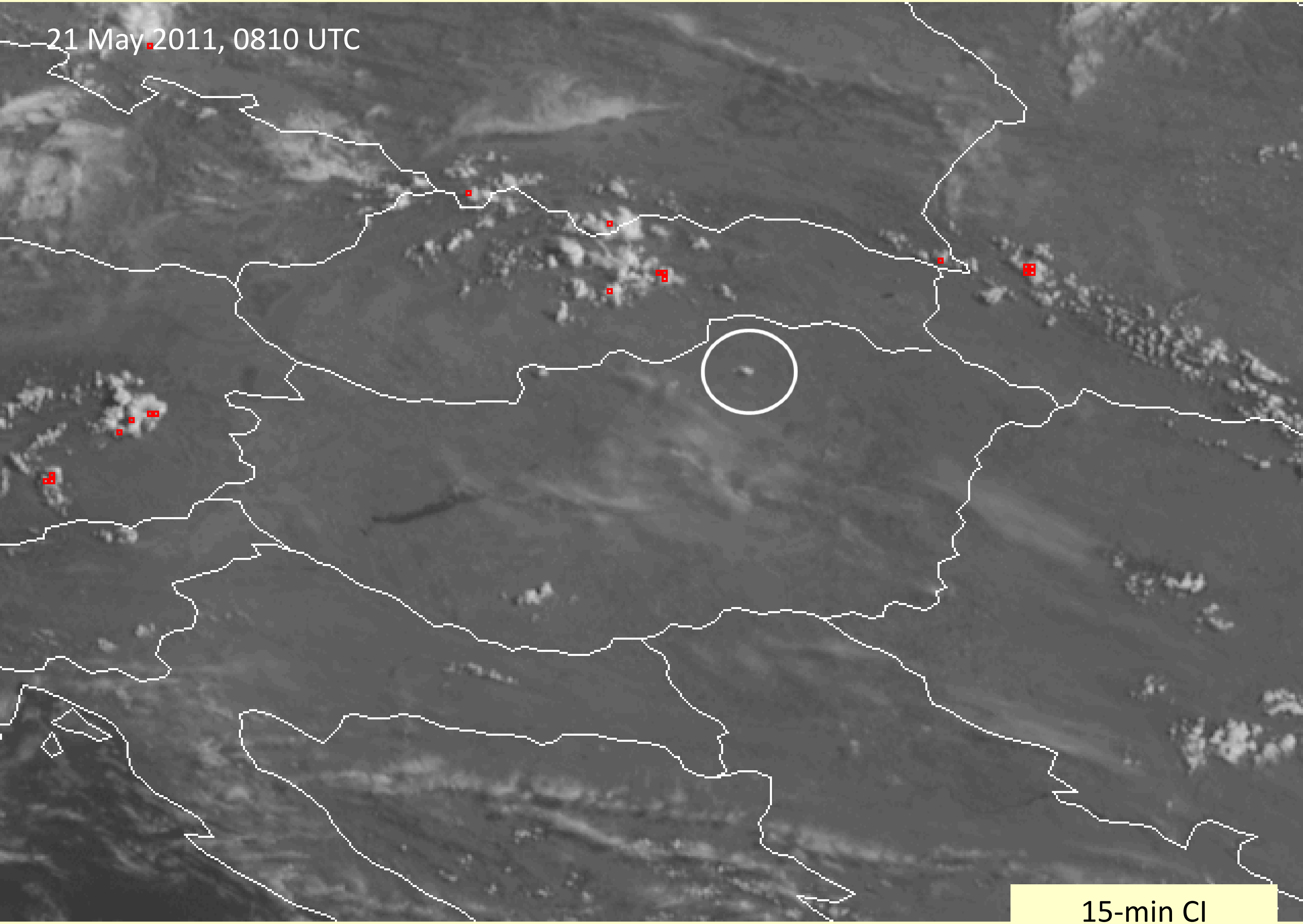
Example below



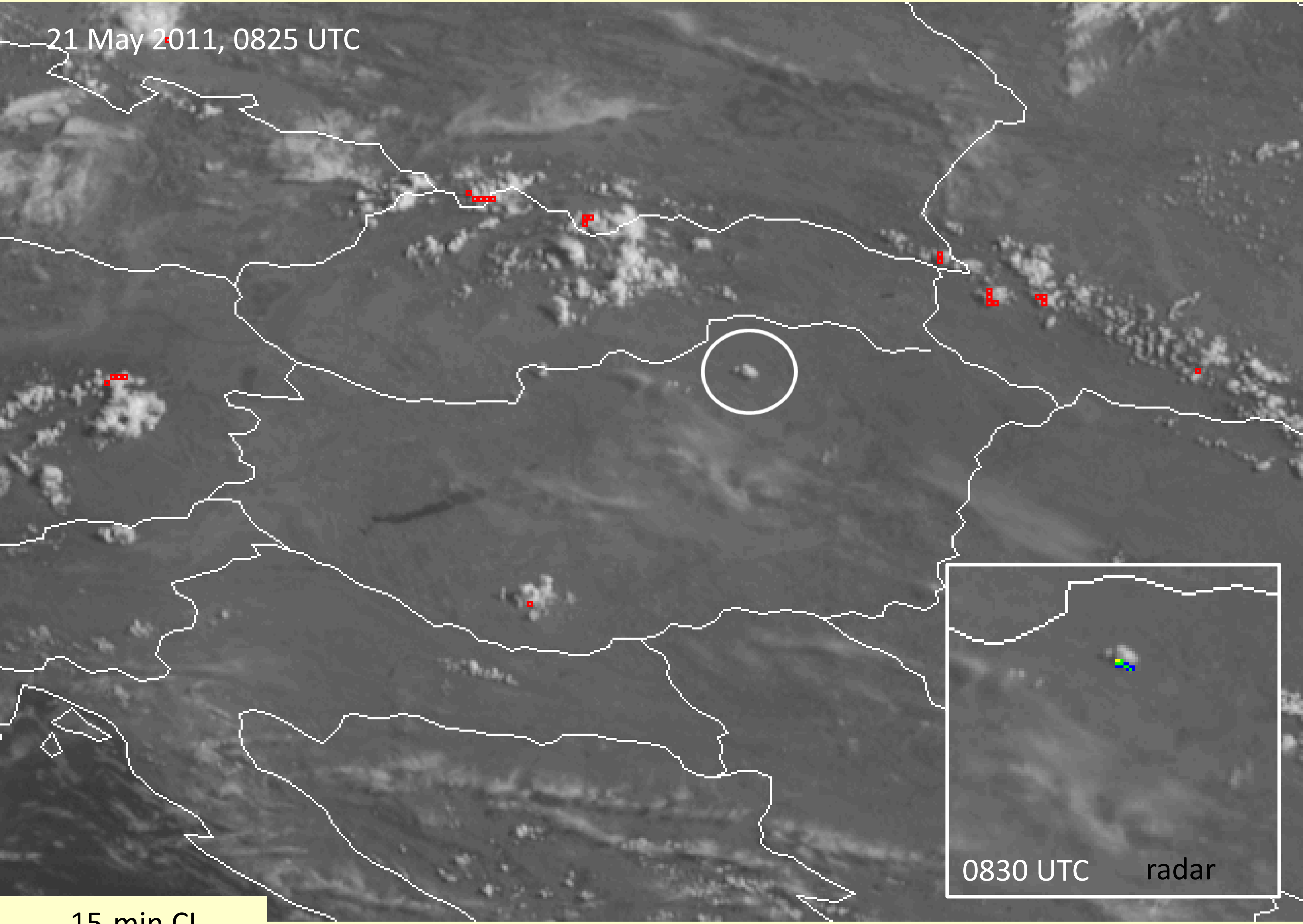
21 May 2011, 0740 UTC

15-min CI


21 May 2011, 0755 UTC
15-min CI


21 May 2011, 0810 UTC

15-min CI



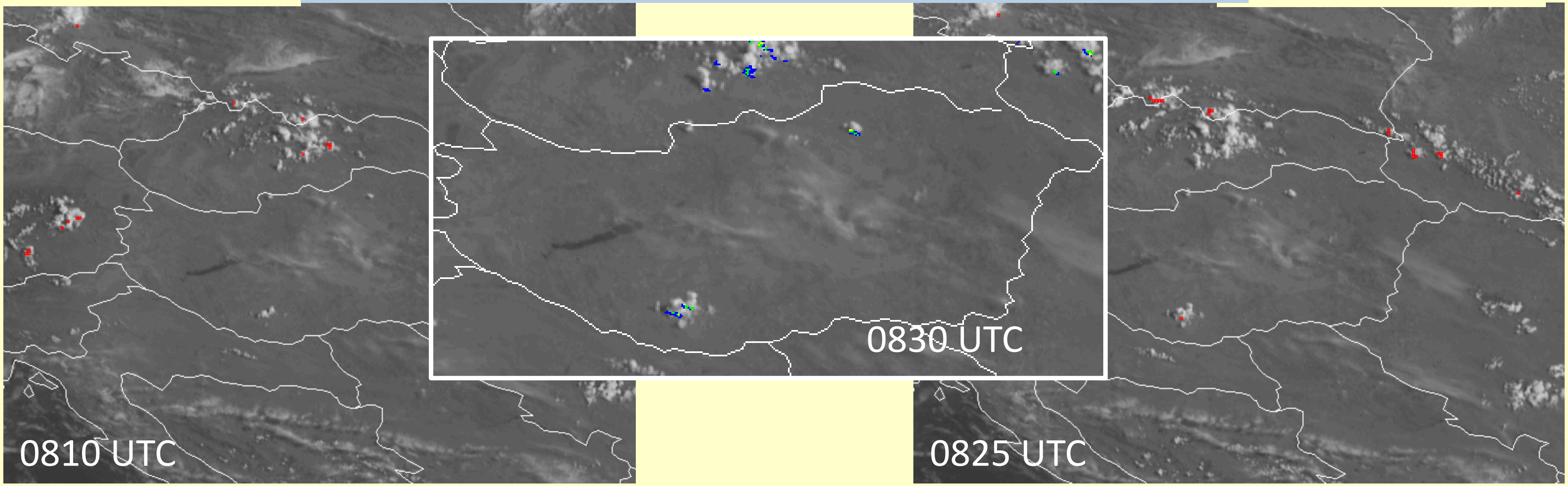
15-min CI

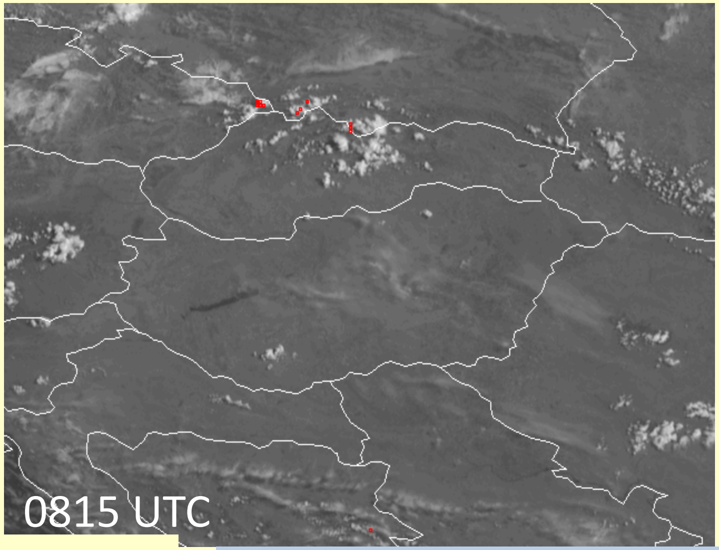
The same cumulus cloud was detected when the algorithm run with 5-min input data.

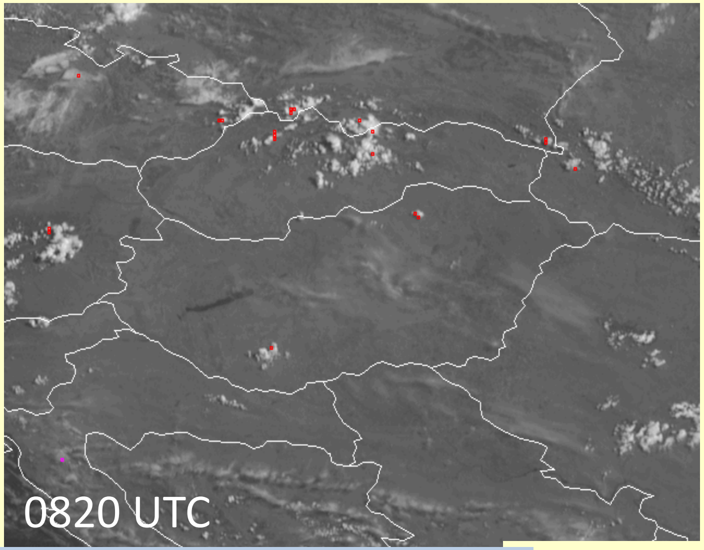
15-min CI

With 15-min cloud tracking CI algorithm

15-min CI







5-min CI

With 5-min cloud tracking CI algorithm

5-min CI

Why we had CI alert with 5-min algorithm and not with 15-min algorithm?

The cloud was growing on a cloud-free areas.

→ No AMV calculated from the ‘near’ clouds

To calculate the trends - AMVs are needed for the **present** and **previous** time steps.
However, to extract an AMV vector (with good quality index) cloudy pixels are needed in 3 consecutive time steps

In case of no ‘near’ AMVs cloudy pixels are needed in 4 consecutive time steps

In case of 15-min CI algorithm
An isolated cloud should exist already since 45 minutes and still be a developing cloud.
Some interest fields test the immaturity.

That is the reason why some rapidly developing ‘isolated’ cumulus clouds are not detected.

In case of 5-min CI algorithm
An ‘isolated’ cloud should exist only since 15 minutes (and still be a developing cloud).

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Summary

We have two different CI algorithms:

- a box averaging CI algorithm working with 5-min data
- A cloud tracking CI algorithm working with 15-min data

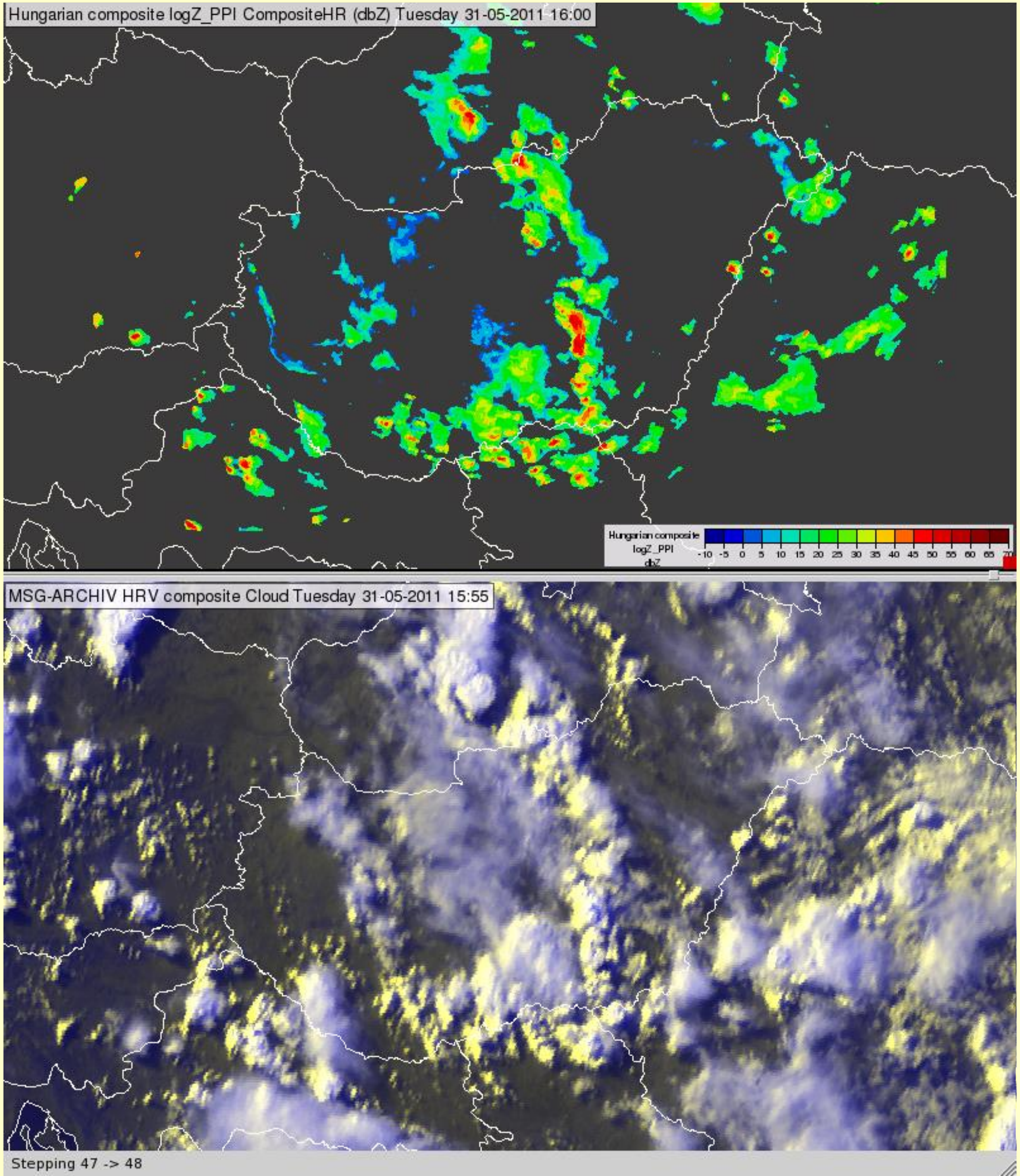
We made several comparisons.

Example: 31 March 2011

> Not only the temporal resolution of the input data are different, there are several other differences as well!

Outflow boundaries seen on radar and satellite images (31 March 2011, 11– 16 UTC)

In the morning:
The cells formed along a stationary convergence line.
They do not move
–
ideal for box-averaging CI method



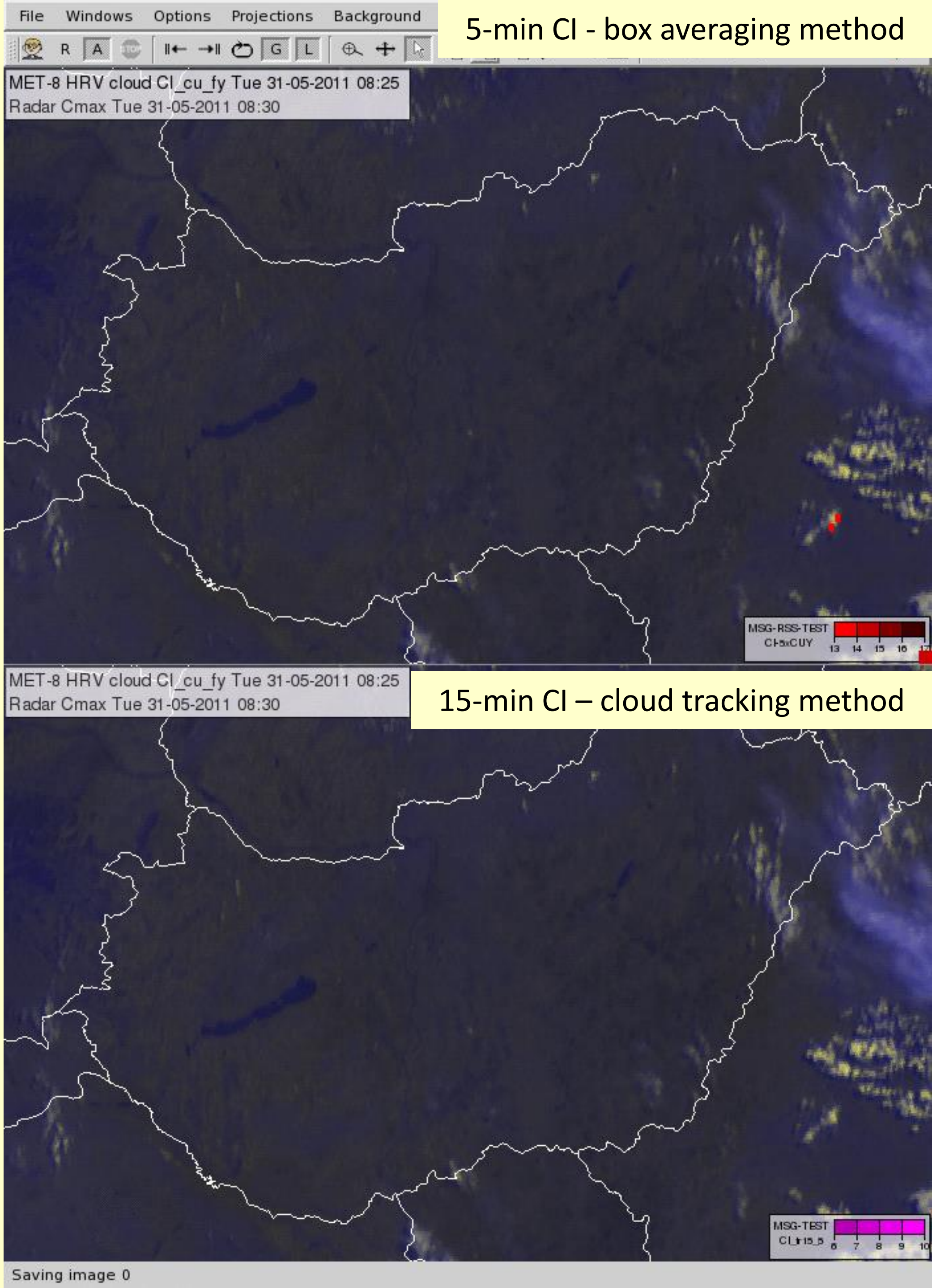
In the afternoon:
New cells formed along outflow boundaries.
They move.

Animated gif created from HRV cloud RGB images overlaid with 35 dBZ radar contours and CI hits (08:25 – 15:35 UTC)

Morning
5min box averaging algorithm -
More CI hits and higher lead-time.

due to 5-min time step

Afternoon
Better results with cloud track algorithm
due to cloud tracking


5-min CI - box averaging method

MET-8 HRV cloud CI_cu_fy Tue 31-05-2011 08:25
Radar Cmax Tue 31-05-2011 08:30

15-min CI – cloud tracking method

MET-8 HRV cloud CI_cu_fy Tue 31-05-2011 08:25
Radar Cmax Tue 31-05-2011 08:30

Saving image 0

‘Normally’ (in case we have nearby AMVs)

To have a CI alert cloudy pixels are needed in 3 consecutive time steps

→ This is 30 min interval in case of 15-min SEVIRI data

→ 10 min interval in case of 5-min SEVIRI data

The cloud should

- **exist already since 30/10 minutes – otherwise we cannot calculate the trends**
- **show signs of convective development– to fulfil several of the tests**
- **still be a developing cloud - Some interest fields test the immaturity.**

With 15-min input data the **rapidly developing cells** could be not (or only too late) detected

→ miss or short lead time

→15 min time step might be too long

A 30 min trend increases slower than a 10 min trend this can cause also shorter lead time

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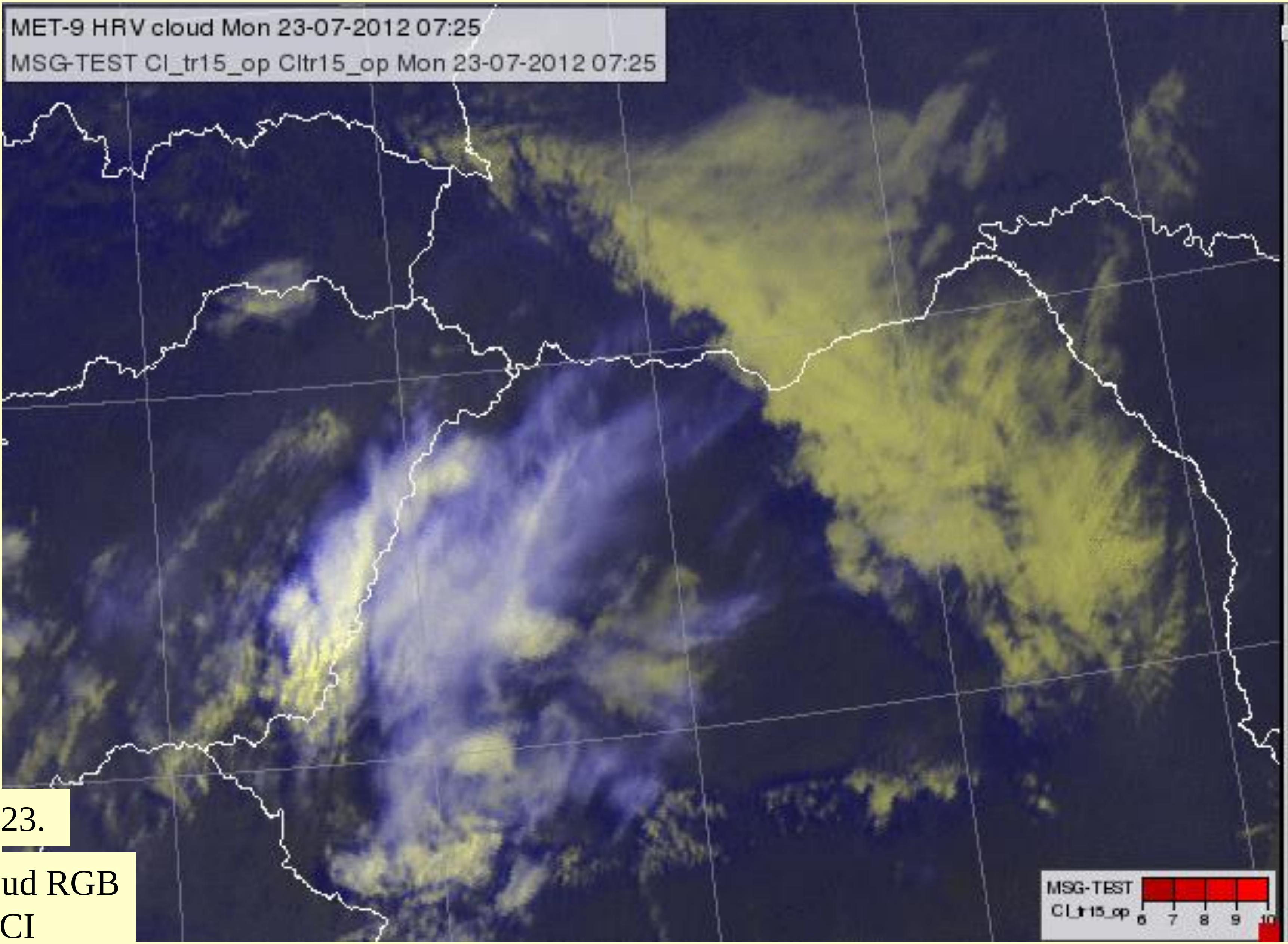
Problems with cloud mask

- A **cumulus cloud mask** would be needed
- **Undetected thickening thin cirrus clouds** (over low or medium opaque clouds) cause false alarms - see the example.

Convective Initiation (CI) false alarms could be caused by:

non-detected thickening thin cirrus clouds (main problem)



2012.07.23.

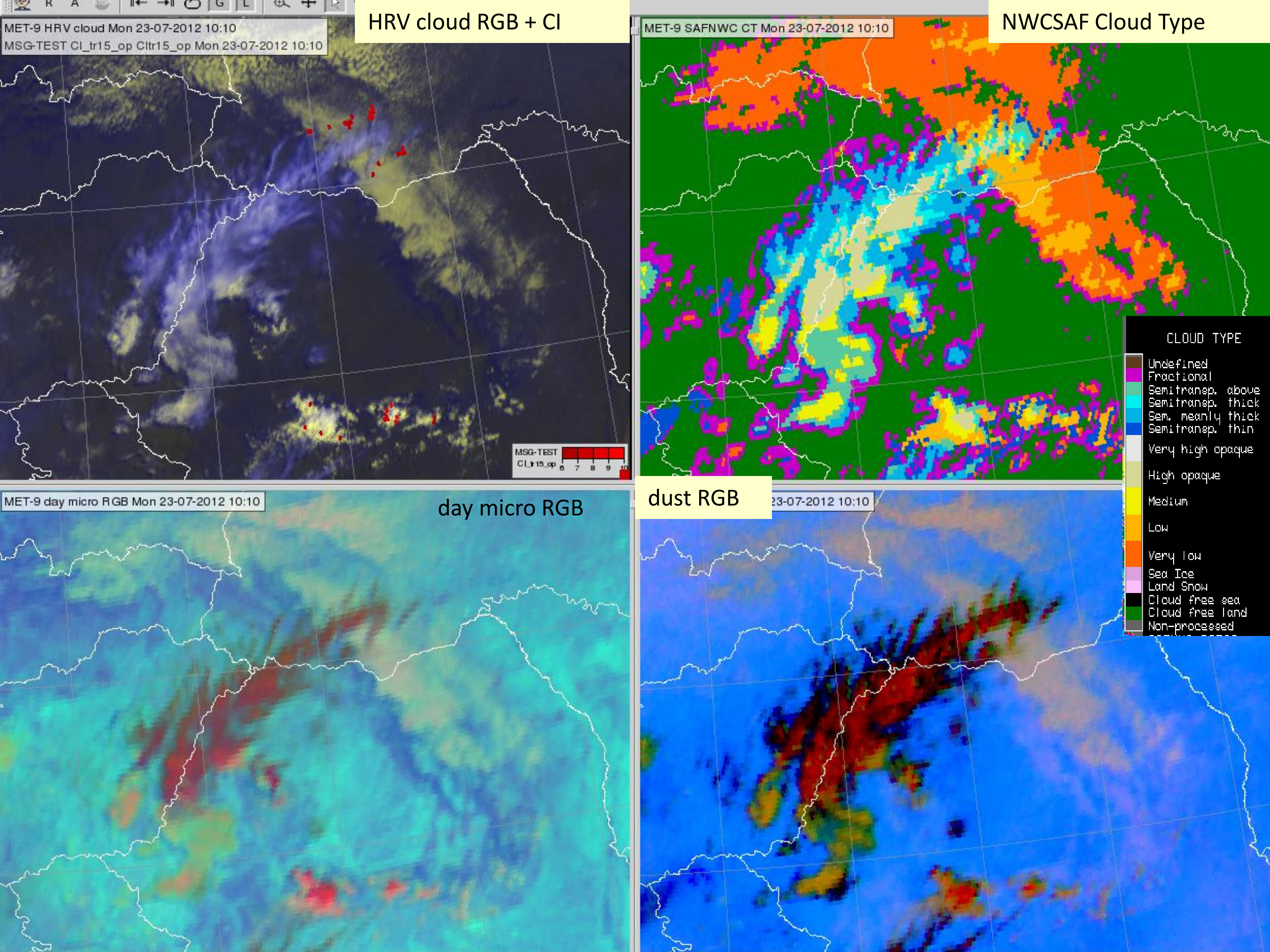
HRV cloud RGB
+ CI

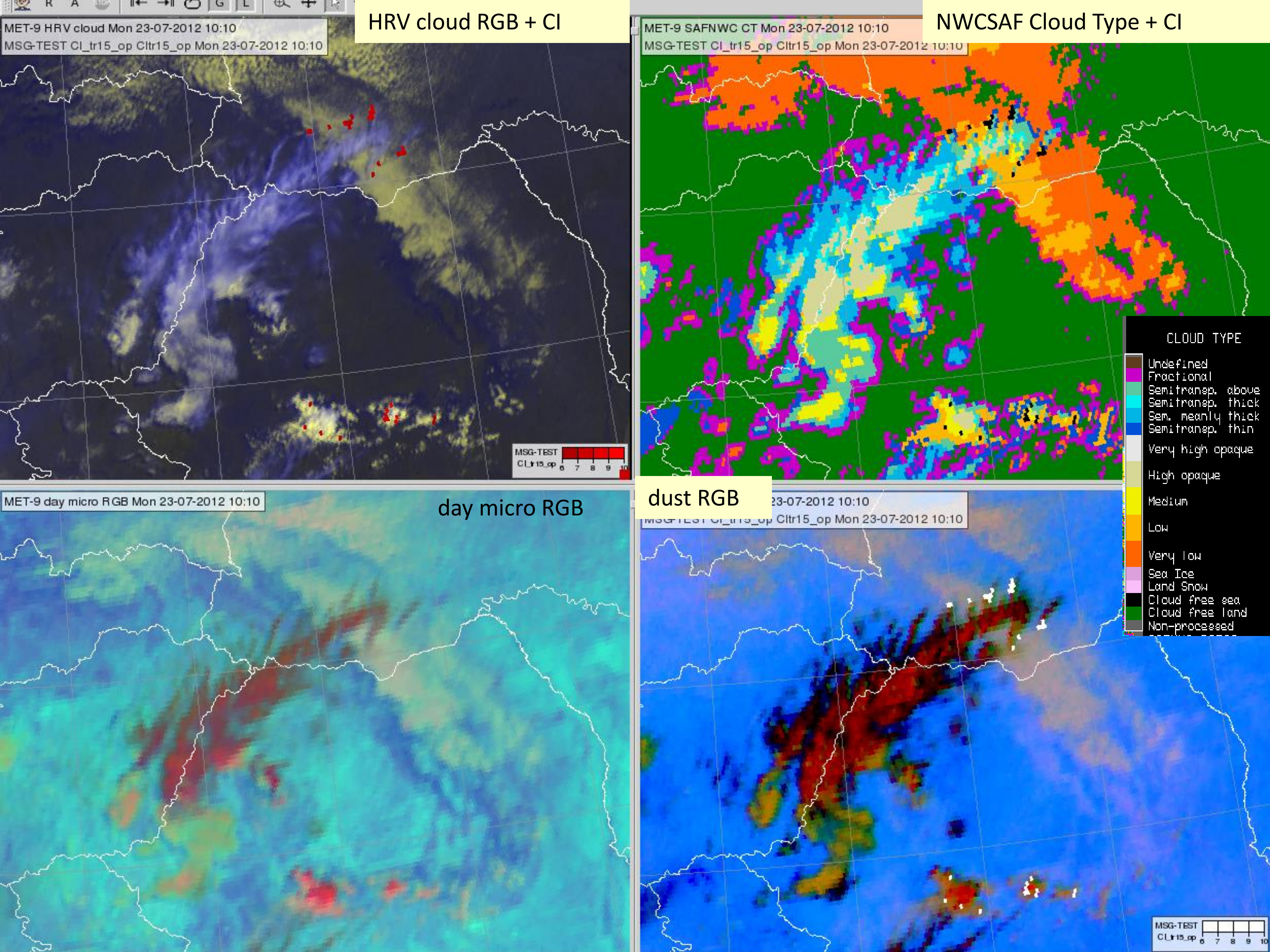
HRV cloud RGB + CI

NWCSAF Cloud Type

day micro RGB

dust RGB





HRV cloud RGB + CI

NWCSAF Cloud Type + CI

day micro RGB

dust RGB

Still many false alarm. We do not use it operationally.

We are waiting for the NWCSAF RDT CI product.

It works with object tracking method.

Maybe it will produce less false alarms

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A well working CI algorithm would be very useful

- NWCSAF RDT CI product – we are interested in its performance

Cloud tracking is needed

Further developments are needed (to reduce the number of false alarms)

- Cumulus cloud mask
- Thin cirrus detection should be improved
  (MTG FCI NIR0.9 new channel might help)

Shorter than 15 minute time step is better

- 10 min FCI data on MTG-I satellite might help
- To test/run the algorithm with 2.5 min time step one need cloud mask, AMV … more then 5 FCI channels would be needed operationally

Thank you for your attention!