Experiences on the interpretation and some test results of the SAFNWC/MSG program package products at the Hungarian Meteorological Service

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Hungarian Meteorological Service

SAFNWC PAR Workshop Madrid

Hungarian Meteorological Service –

early user of the SAFNWC/MSG program package as a beta tester,

and since then we are running the actual version of the program package.

The SEVIRI data are received by Kongsberg system. (HRIT slots)

ECMWF fields are used as NWP data,

in every 3 hours with 0.5 x 0.5 degree spatial resolution up to 10hPa

Region Central European (640x480 pixel)

Now we run the 1.2 version and produce all products operationally.

Some of the products are operationally sent for the duty forecasters

Name of product	yes	no
Cloud detection CMa	x	
Dust, volcanic plume CMa		xx
Cloud types CT	x	
Cloud top temperature, pressure and hight CTTH	x	
Effective cloudiness CTTH		x
Precipitating clouds PC, (probability of precipitation)	x	
Convective rain rate CRR		x
Precipitable water TPW, LPW, SAI		xxx
High resolution wind HRW	x	
Automatic Satellite Image Interpretation ASII-SAT, ASII-NWP, AMW-IR AMV-WV	xxx	 x
Rapid Developing Thunderstorms RDT		x
Air Mass Analyses AMA Air mass classification Ridge Line,T gradient , WV dark stripe	 xxx	 x

From CMa and CT a cloud amount image is calculated x

HAWK Hungarian Advanced Weather worKstation software

Tool for visualization (developed in Hungary) for the duty forecasters

- NWP fields
- SYNOP and automatic weather station measurements
- Radar data
- Satellite data NOAA, METEOSAT, MSG

  MSG single channels, composite images, SAFNWC products
- Radisonde data
- Lightning data
- etc

MEANDER software

Mesoscale Analysis, Nowcasting and Decision Routines

An automatic nowcasting system for helping the work of the duty forecasters developed for nowcasting purposes.

- radiosonde,
- synop and automatic weather station measurements,
- mesoscale numerical model outputs,
- radar,
- satellite images,
- lightning data.

Satellite based input parameters

-cloudiness, cloud top height and cloud types,

-earlier calculated from METEOSAT data,

- already replaced with the new SAFNWC/MSG outputs (CMa, CT, CTTH).

- it could use other SAFNWC products as well.

An automatic warning dispatch system is part of the MEANDER service.

It is used by the forecasters to create and manage warning conditions:

- the presence of certain values, or
- if the value of a variable in the specified geographical area falls into a specified interval.

If warning conditions are met:

- e-mails are sent
- Warning events are archived.

The SAFNWC CT product (together with derived low visibility) is also used to send warning of potential night-time fog.

Applications of SAFNWC products

- Visualization for forecasters
- input in a Nowcasting program
- Investigation of case studies

But before

Testing of SAFNWC products

Both satellite meteorologists and forecasters test the SAFNWC products. Case studies are investigated and for some products statistics are calculated.

Rapid Developing Thunderstorms

We think this product would be useful for forecasters

We would use it visualizing for forecasters (and for satellite researchers)

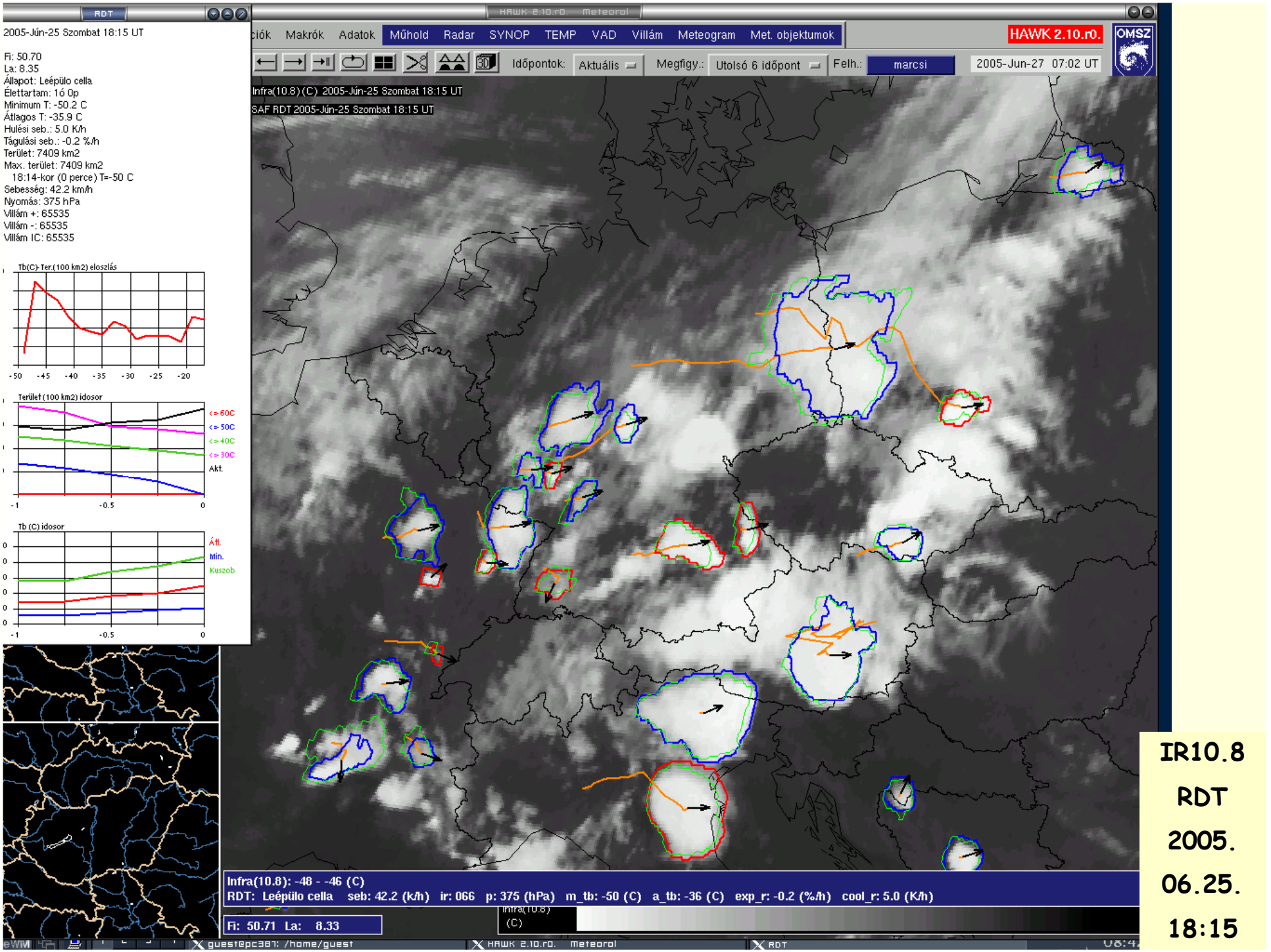
in programs as input data -- nowcasting program

other application

(I have already used it by both ways (looking and in program)

in verification of CRR.)

RDT could be an input data in an automatic software (MEANDER) developed for nowcasting purposes. There is a thunderstorm module in it, and the additional information from RDT could increase the quality of this module.



IR10.8
RDT
2005.
06.25.
18:15

Difficult to visualize it -- complicated

Difficult to check the visualization (output file)

Lightning data only for Hungary

Webpage of the developers - real time demo for Europe

http://www.meteo.fr/special/PI/OPIC/Europe/index.htm

It is difficult to compare with the webpage of the developers

•Lightning data as input (for some area one can not know whether it was used lightening data or not)

(I should not have 'additional' cells)

•They do not use the same software/same input SEVIRI data (not HRIT slot)

•One can not save the image, nor look the previous ones

RDT output on Help Desk

•Only for Spain, a part of France

•Lightning data is used, but not indicated where it was

•Retrieved parameters are not seen

First we run RDT without lightning data (optional input)

We were not satisfied with the results, but

we did not know the reason

- There is some mistake in the visualization
- Or because we do not use lightning data, maybe the algorithm needed more the lightning data than I supposed

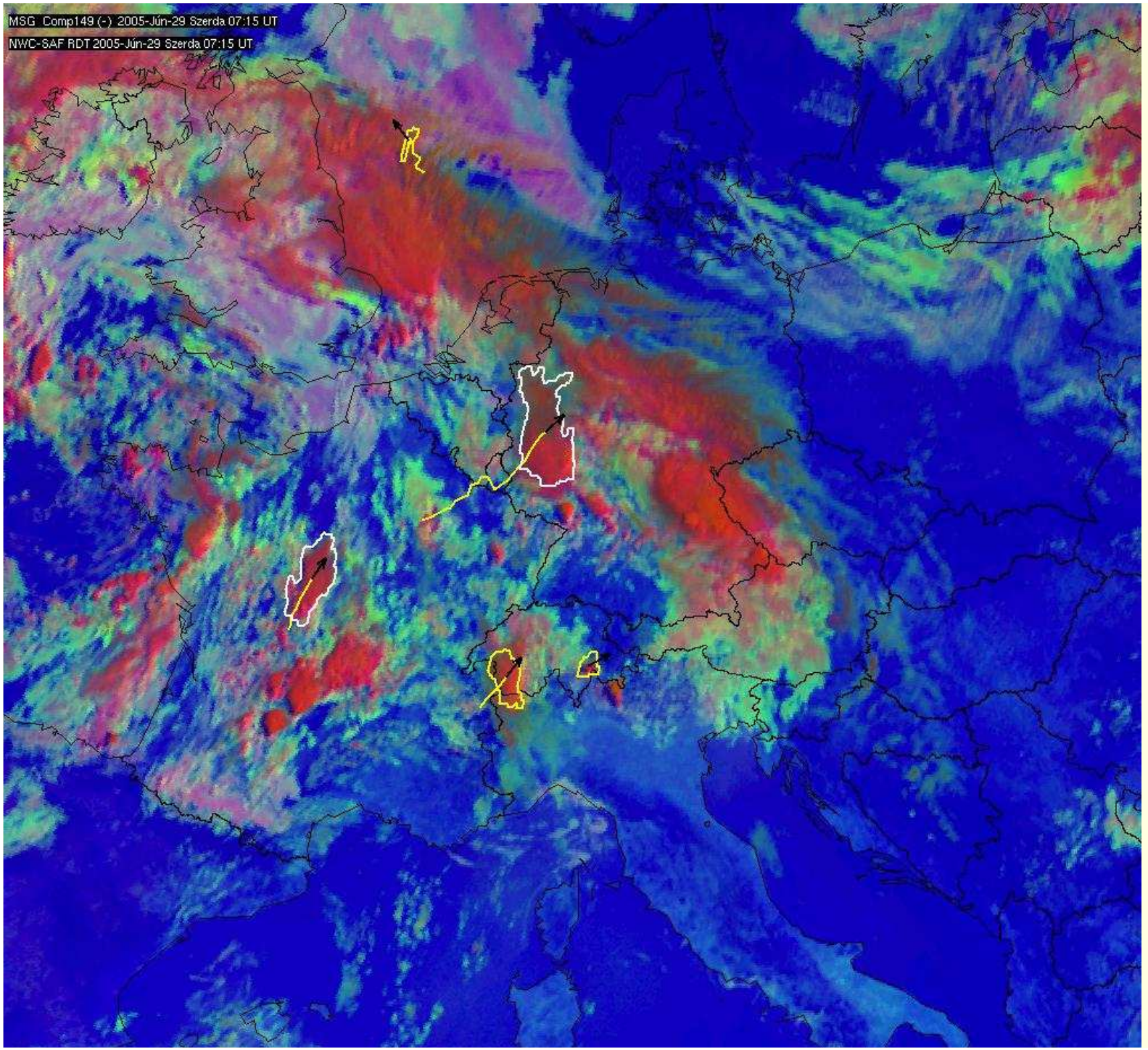
Later we added lightning data, but we have lightning data only for Hungary and a part of Slovenia

Why were we not satisfied?

Without lightning data

It does not detect all convective cells, thunderstorms, sometimes neither the very marked typical Cb, or only rather late in its life cycle.

(And sometimes it tracks a very uninterested cloud during 2-3 hours.)



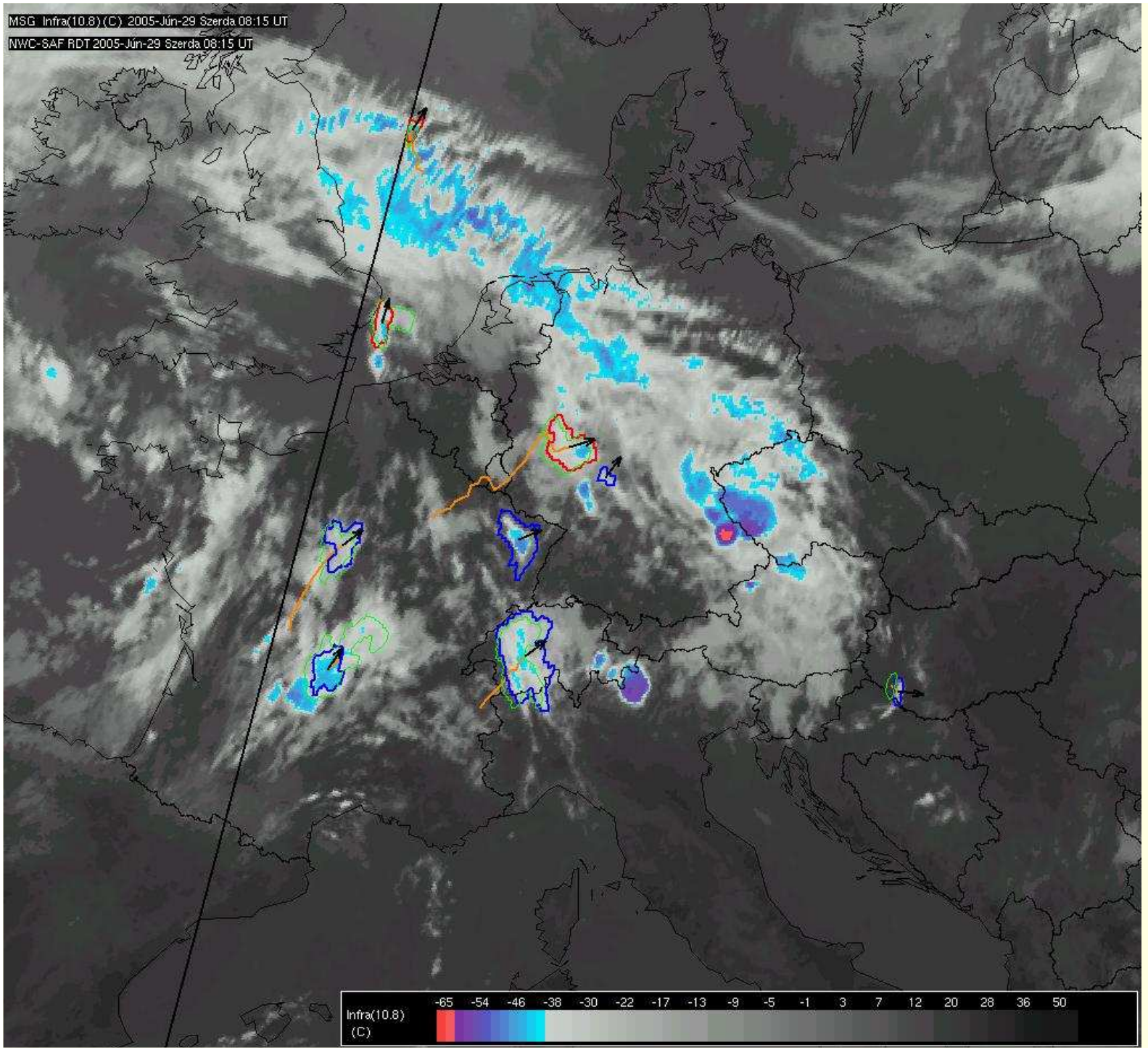
It does not detect every convective cell.

RGB14r9

RDT

2005.06.29.

07:15



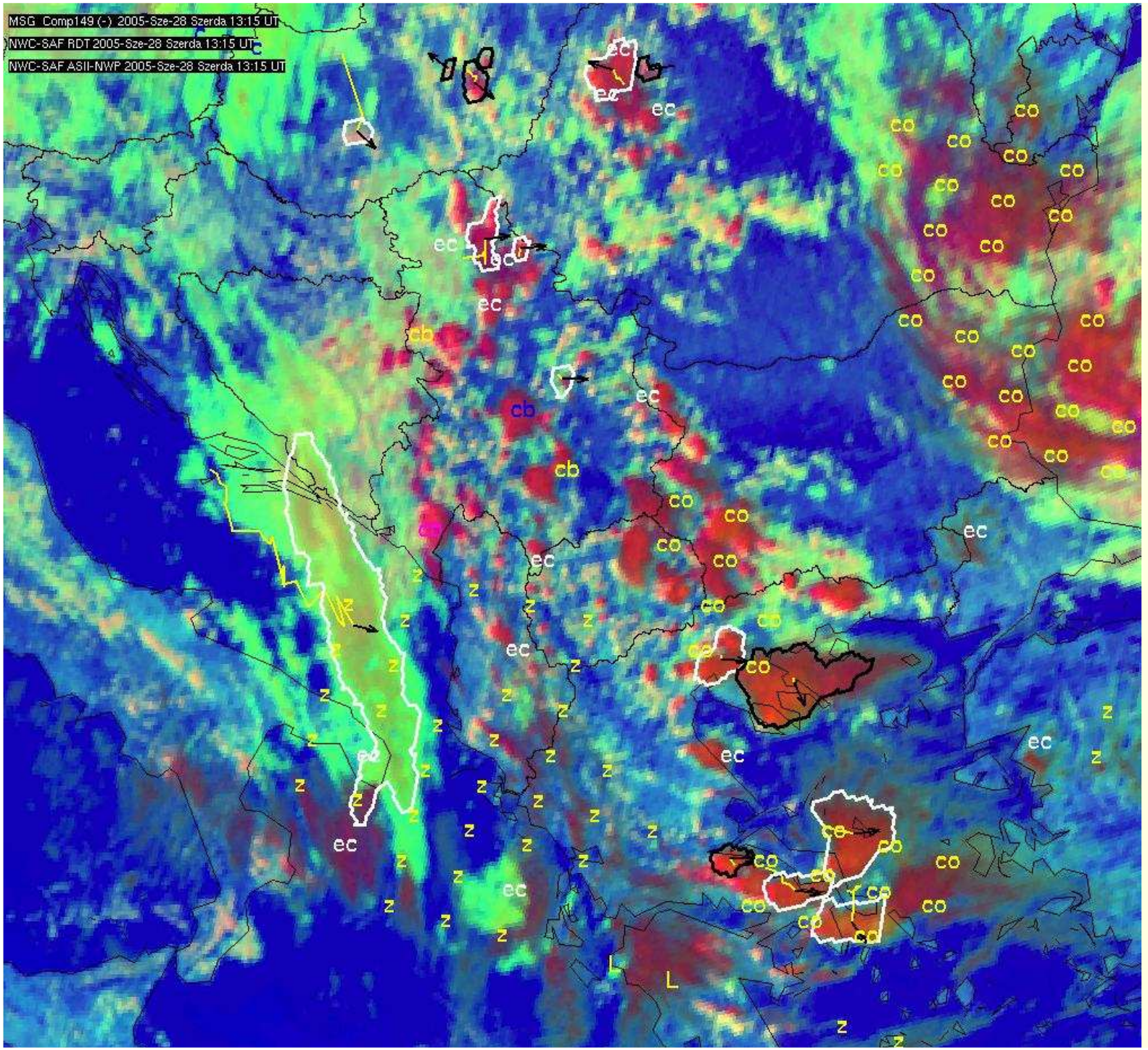
It does not detect every convective cell.

RGB14r9

RDT

2005.06.29.

08:15



It does not detect every convective cell.

RDT with ASII-NWP

RGB14r9

RDT

2005.09.28.

13:15

Misdetections

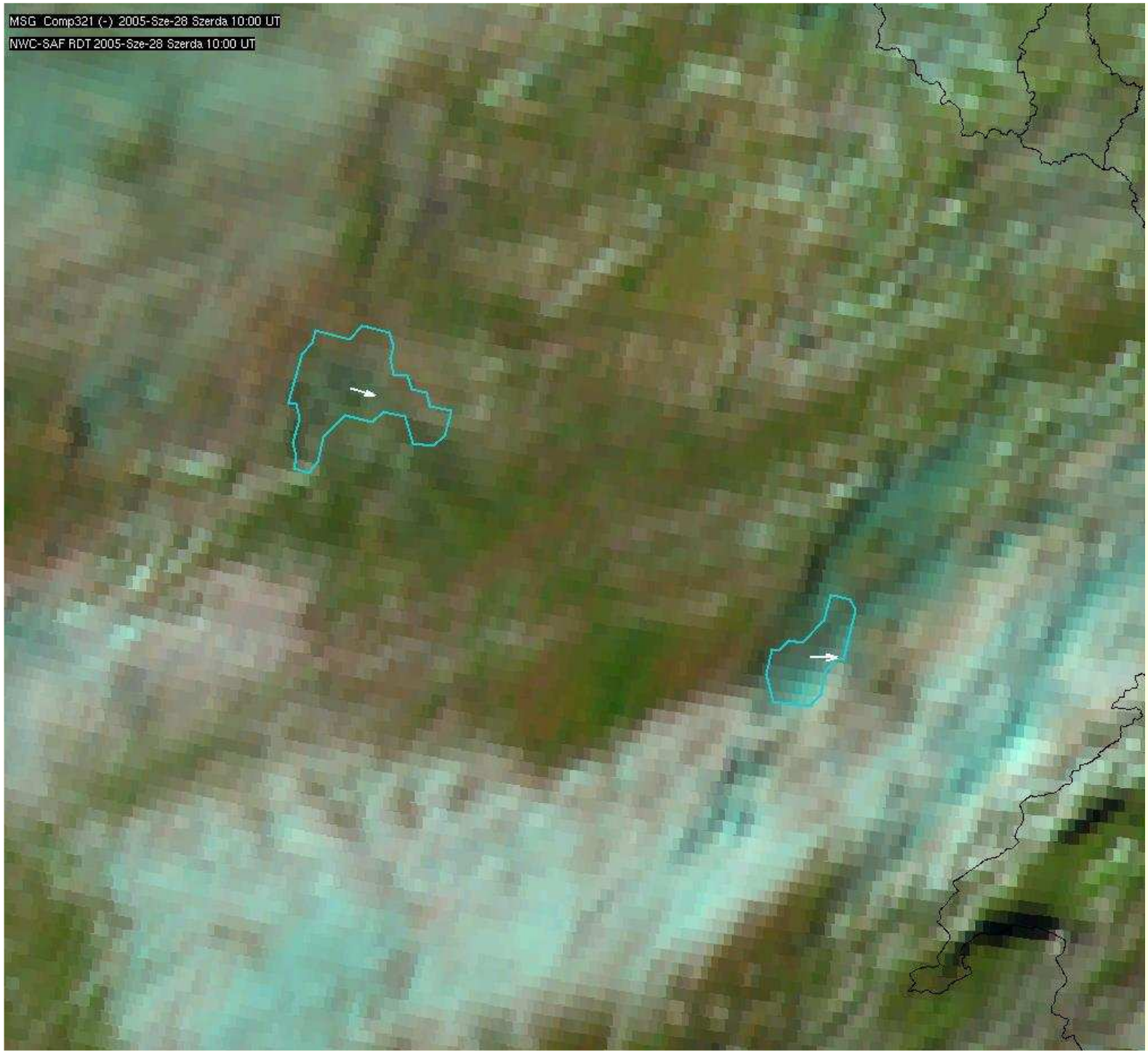
RDT often detects Ci as convective cloud

Only 1 channel data is used

We think the result would be better if they used more channel data

(Tb10.8 -TB12.0), (Tb10.8 - TB8.7)

and/or CT product for example to separate semitransparent clouds…



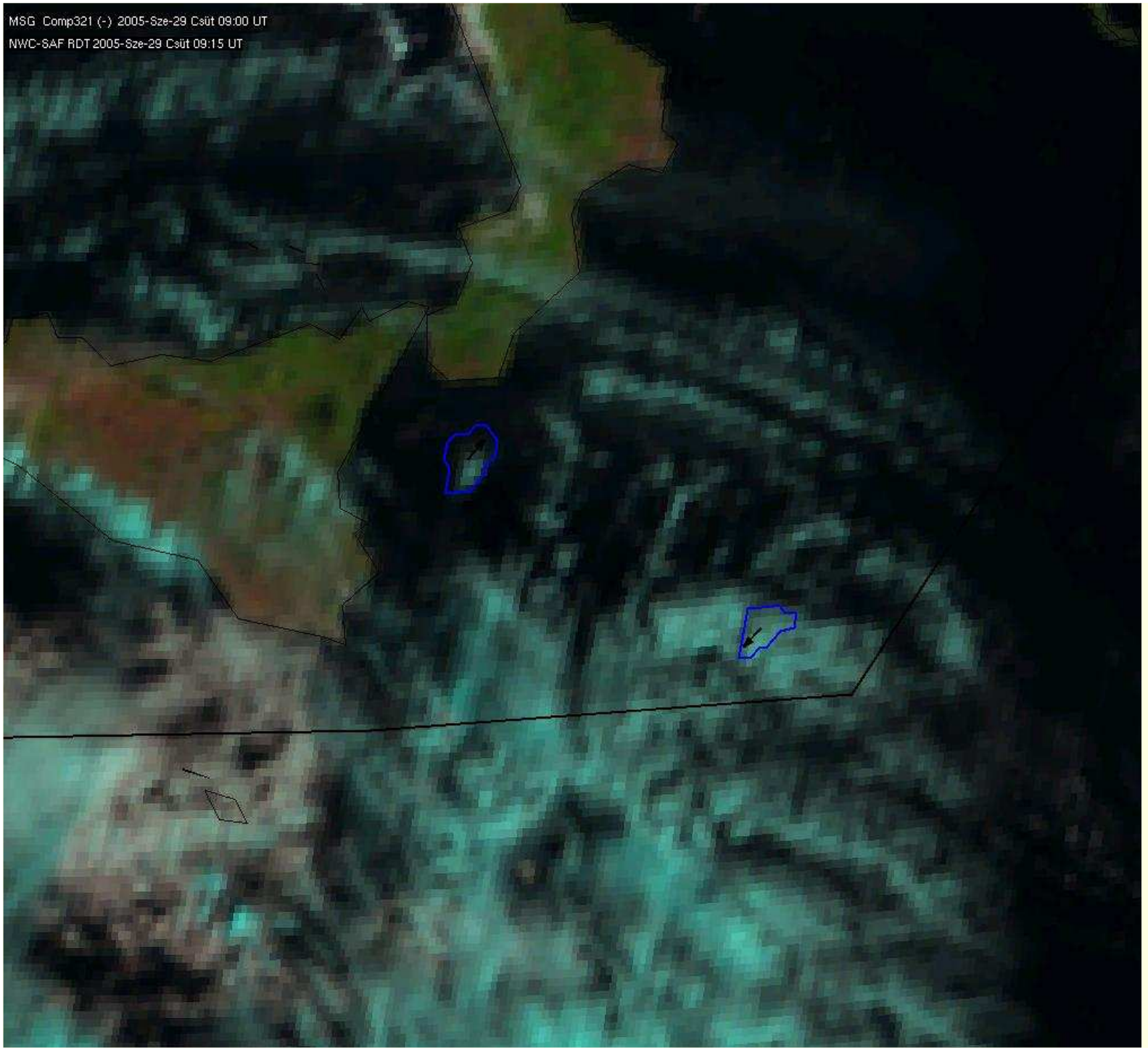
Ci clouds

RGB321

RDT

2005.09.28.

10:00



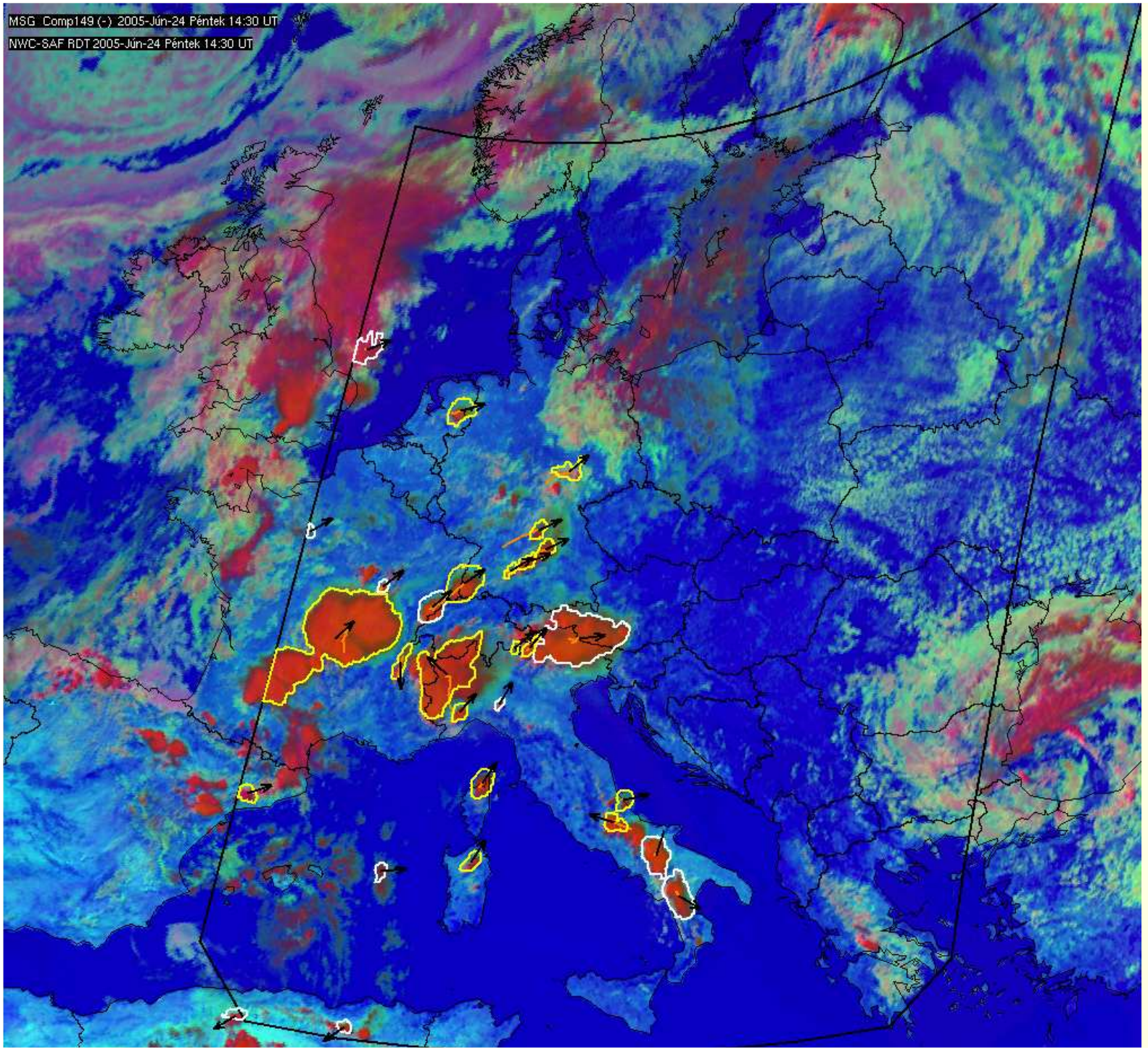
Ci clouds

RGB321

RDT

2005.09.29.

09:15



RGB14r9

RDT

2005.06.24.

14:30

Ci anvil

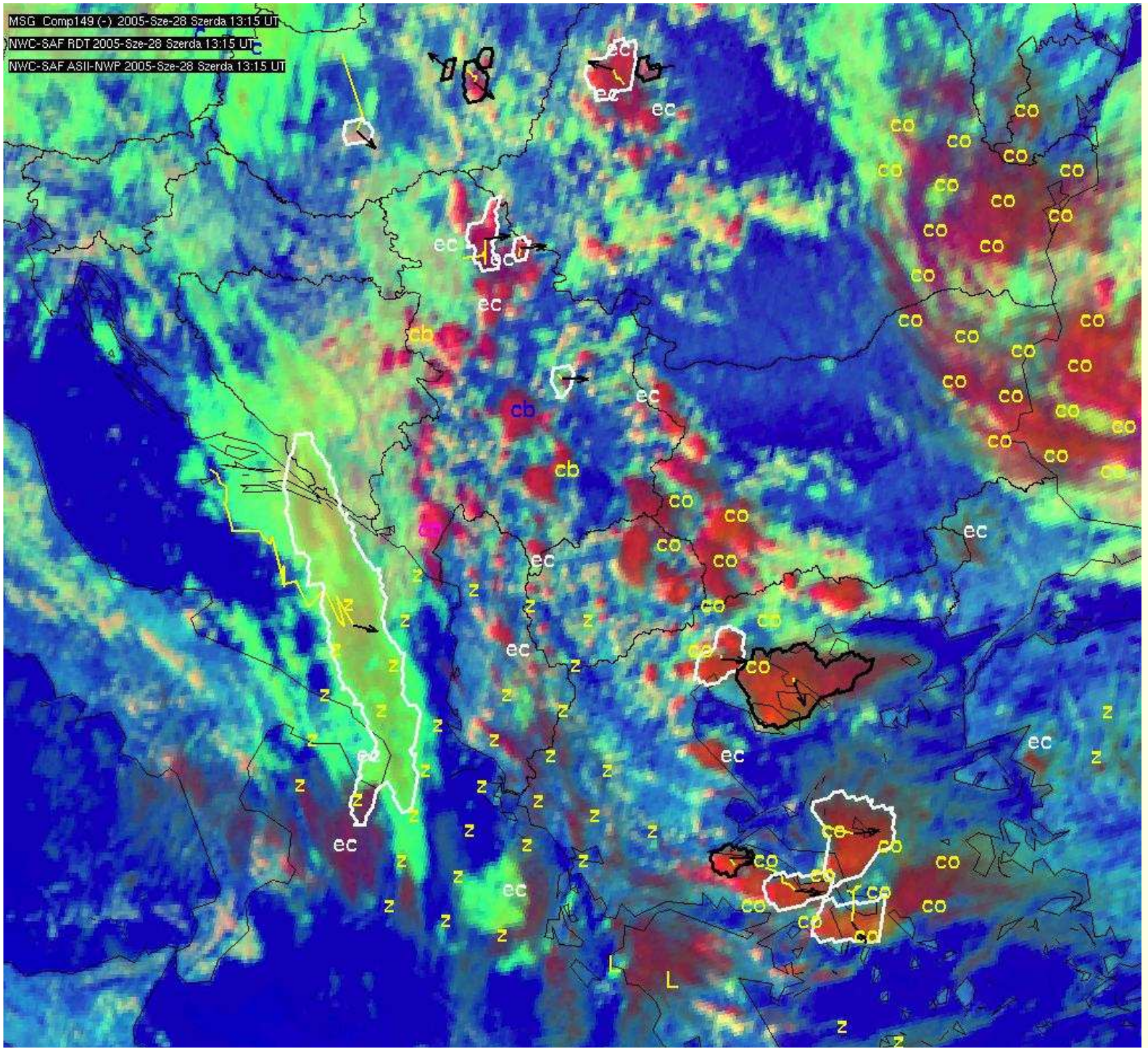
Misdetections

Part of a front

Low water clouds

Fog

Huge area which are not on the real time demo



It does not detect every convective cell.

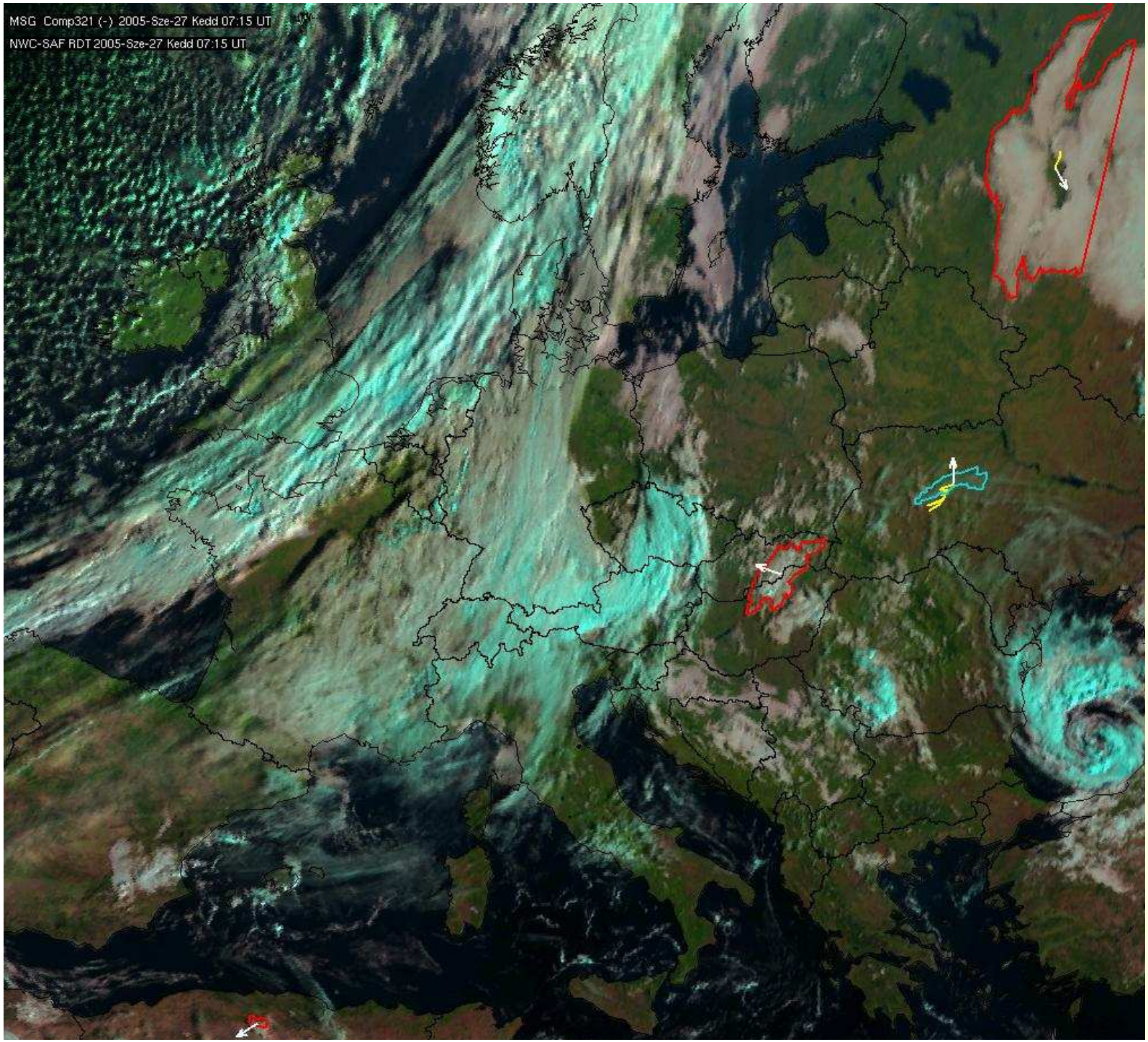
RDT with ASII-NWP

RGB14r9

RDT

2005.09.28.

13:15



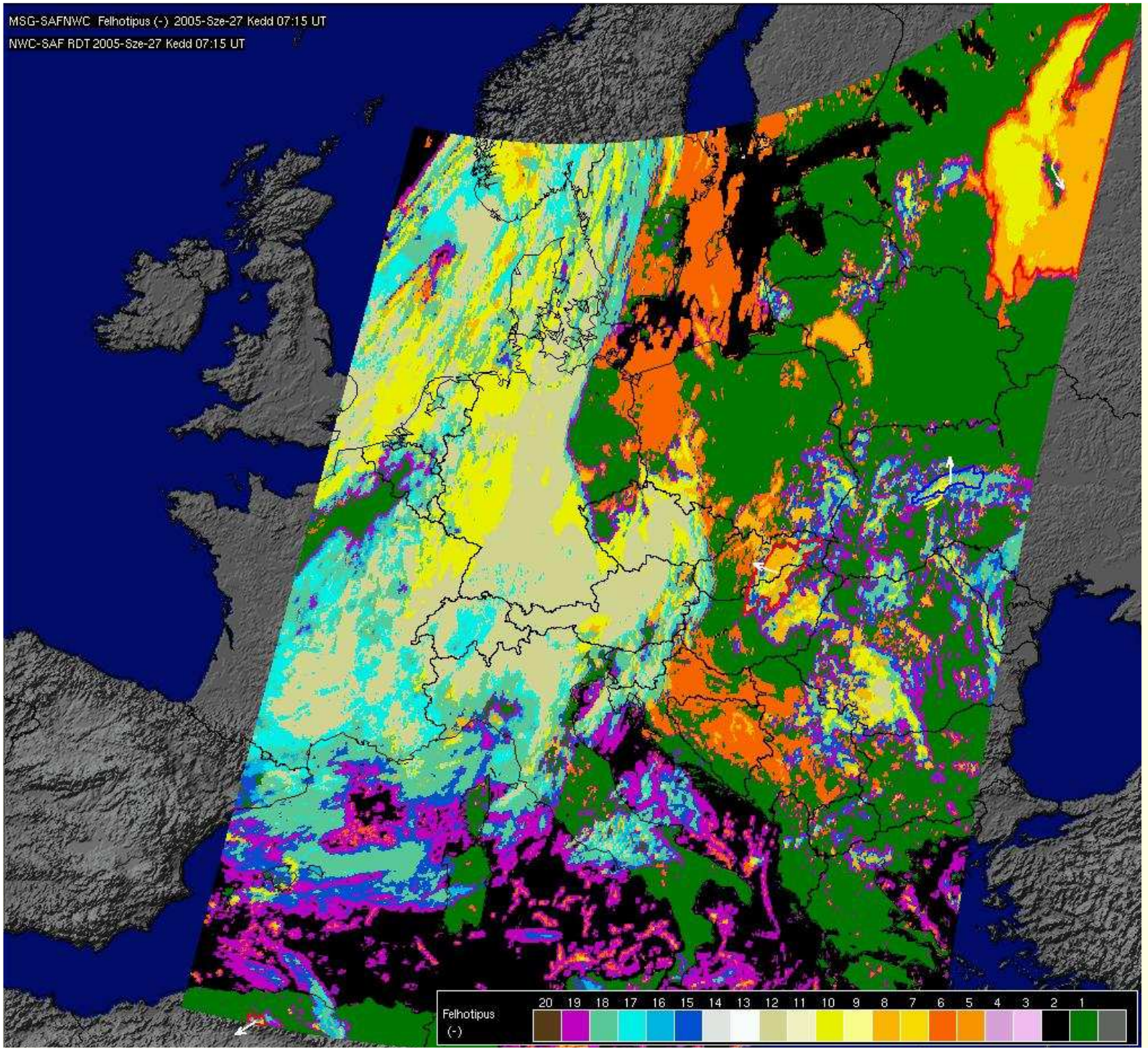
fog

RGB321

RDT

2005.09.27.

07:15



fog

CT

RDT

2005.09.27.

07:15

We tried to compare with the webpage of the developers and big differences were found, not only because of using the lightning data.

We made RDT comparison for some cases with Paul de Valk, Netherlands.

Similar platform: Sun Solaris

Same input:

- HRIT slots
- same NWP data (needed for CTTH)

  ECMWF 3 hours 0.5 x 0.5 degree spatial resolution up to 10hPa
- same model config file

The regions are different but we have quite big common region.

He uses lightning data for Netherlands and I use for Hungary,

but I compared only the clouds detected without lightning data.

He sent me the bufr file.

•I converted his and my buf files to hdf5 file,

•I visualized theme with our software.

•I wrote the characteristics for the clouds with nature=0 in a text file.

We should have the same results (except the lightning clouds.)

Experiences of the comparisons:

There are differences between our outputs.

I compared:

20051003 09:00

20050929 09:00

20050928 10:00

20050927 07:15

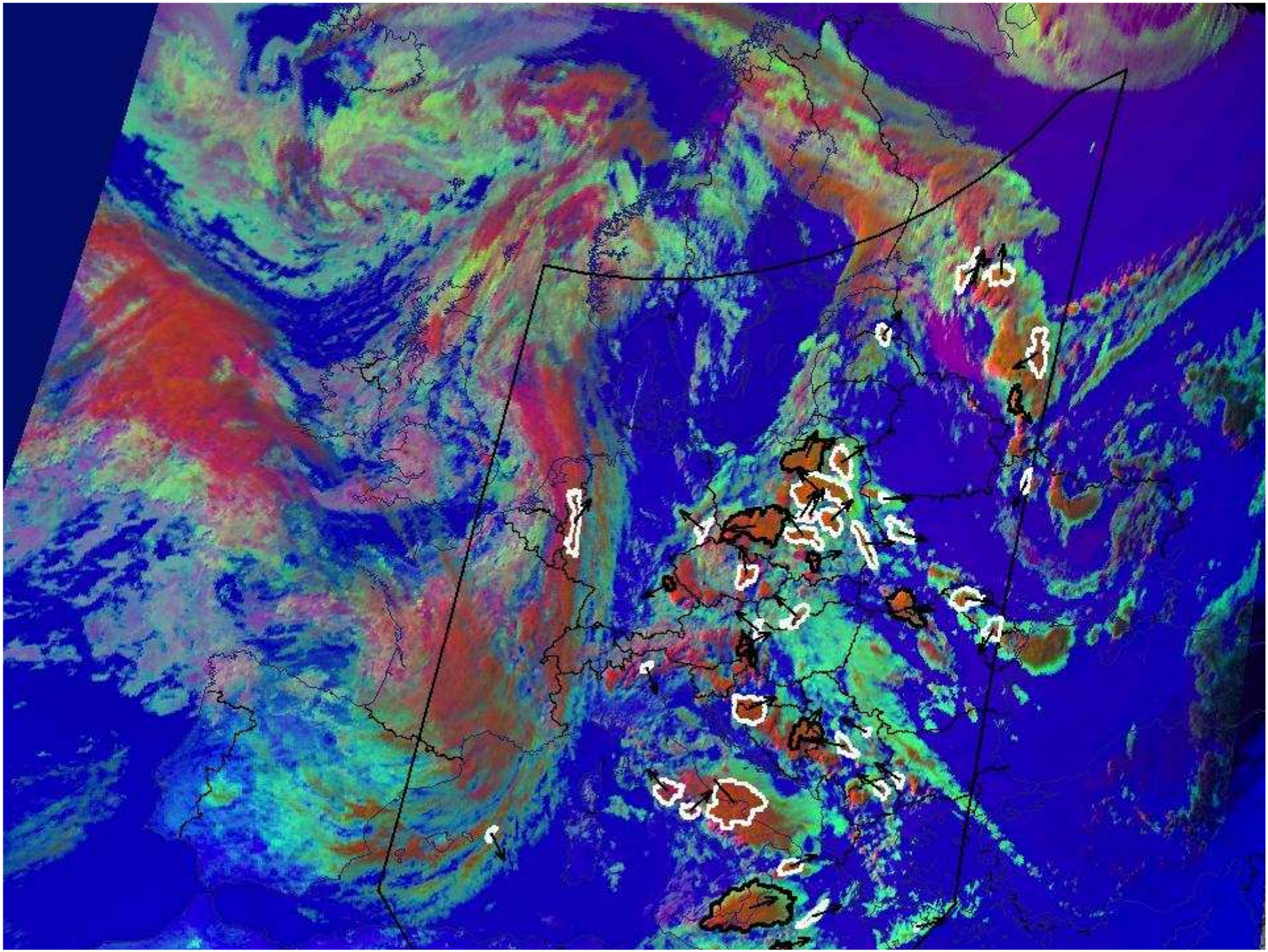
20050615 16:45

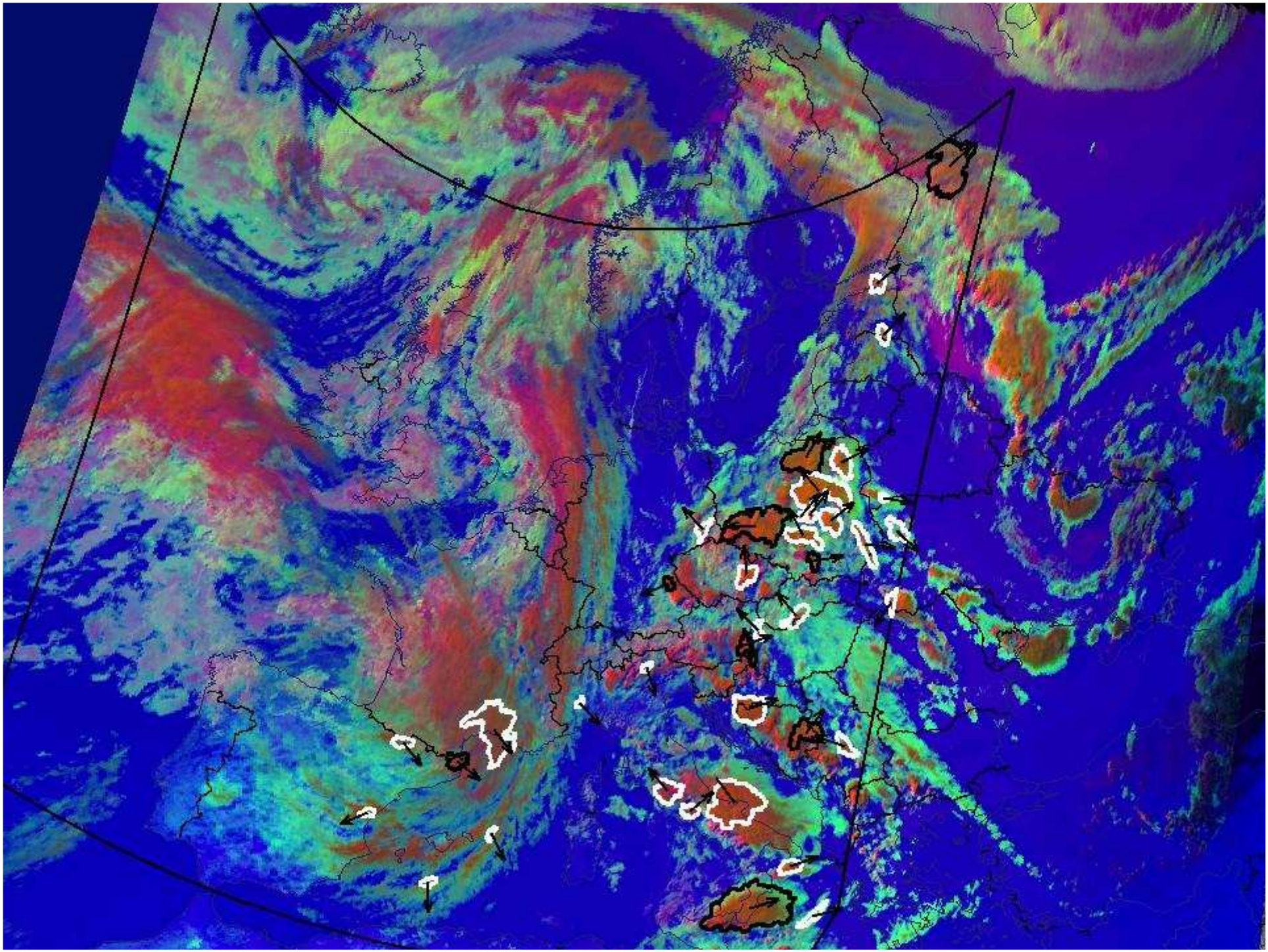
20050615 16:45

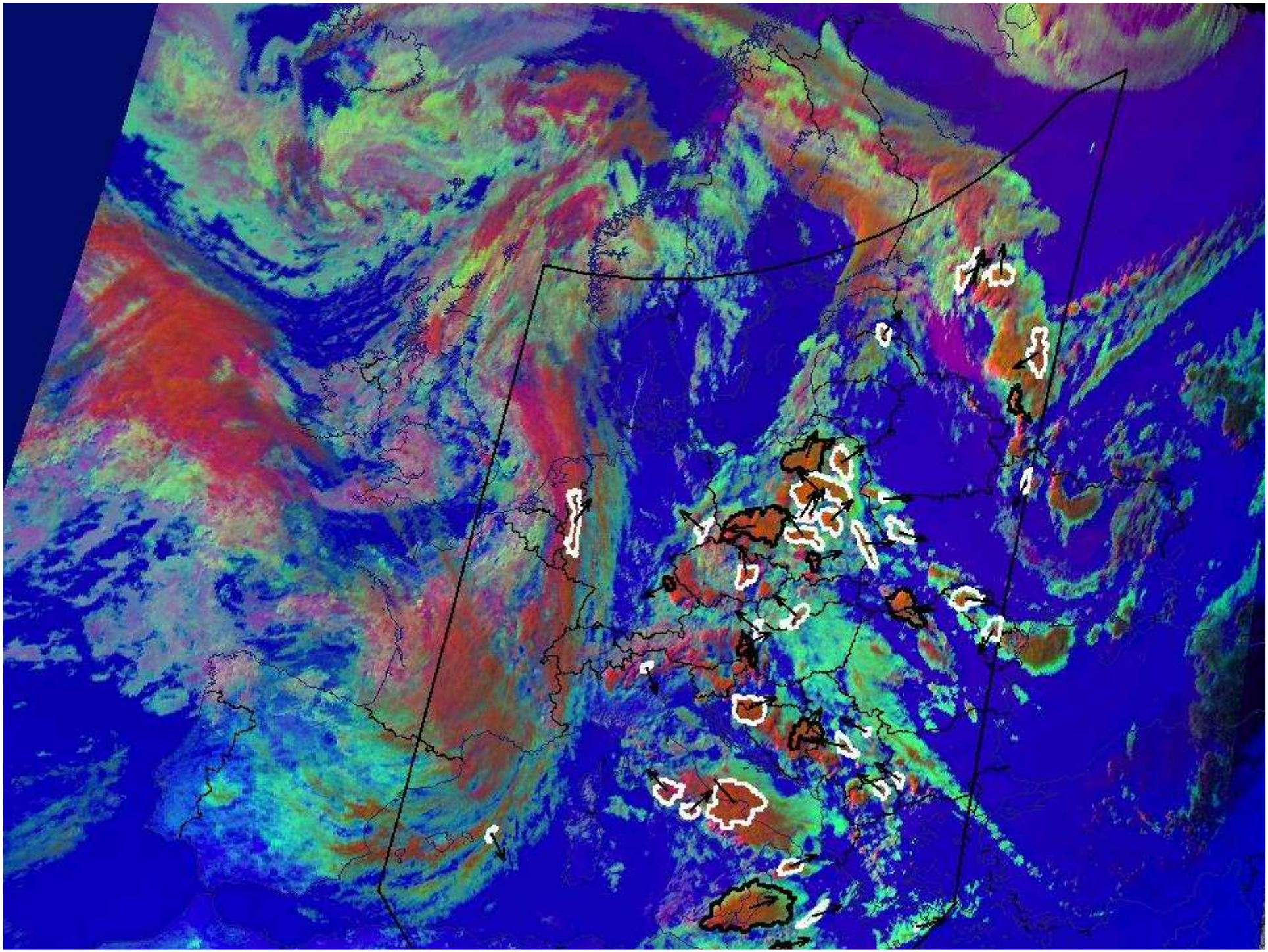
On the region of interest many clouds were detected by both of us

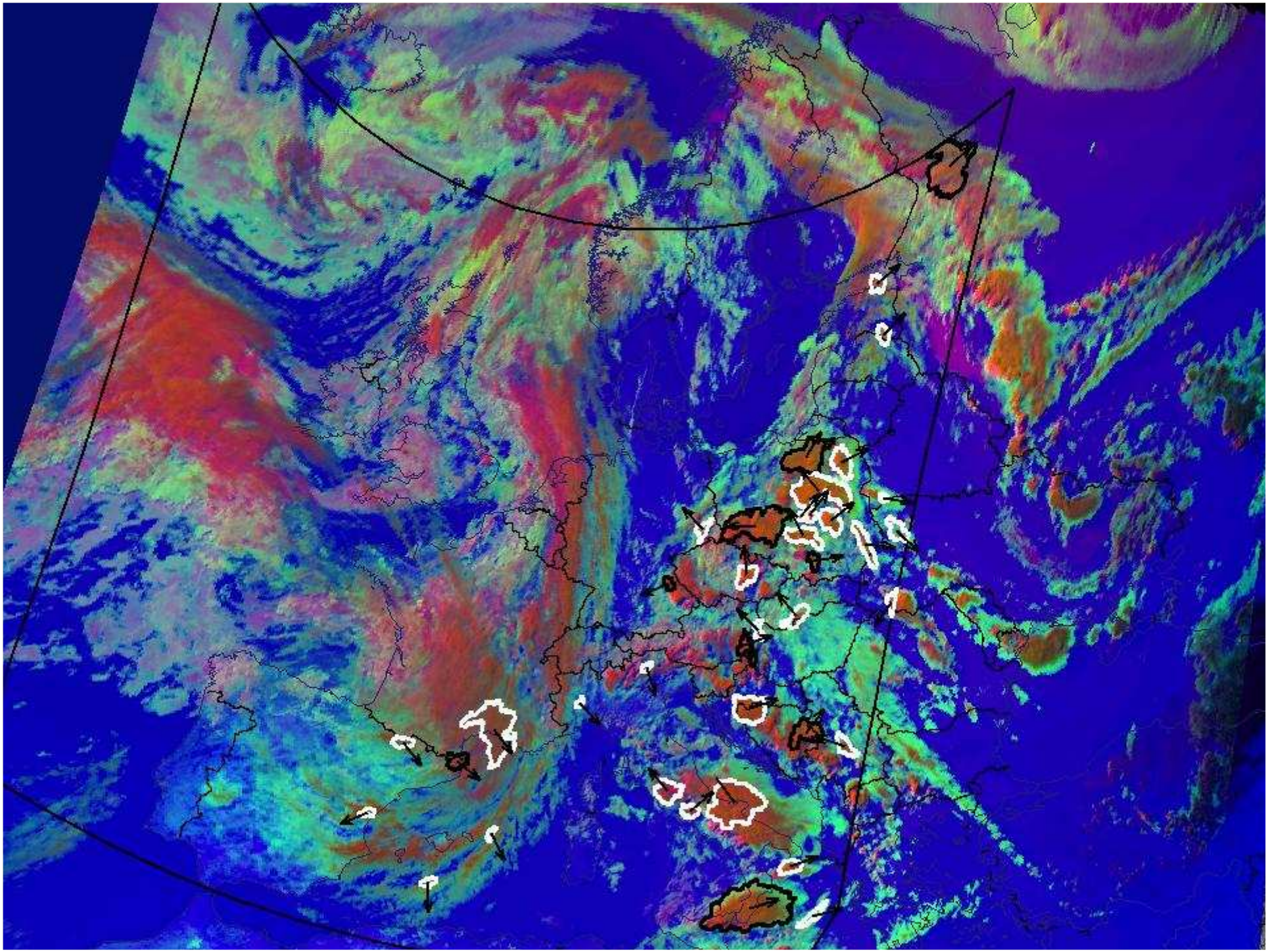
But there are some clouds detected only by him and some others detected only by me.

The system directions are different, but other characteristics are EXACTLY the same.









20050929 09:00

The results were similar. Paul de Valk had 2 clouds which I did not have.

For the common clouds the system direction were different.

for 20051003 09:00

On the region of interest all cells were detected by both of us.

The characteristics were the same, except the system direction.

20050927 07:15 On the common area I had 1 cell, Paul de Valk had no cell.

20050928 10:00

The results were totally different. **We had no common system detected**!

I had one cell, which was detected by me, but not by Paul de Valk.

Paul had 3 such cells.

((There were clouds over Netherlands detected by him with lightning,

But I had not these clouds using only IR data.))

Why sometimes KNMI detects a cloud not picked up by me and vice versa?

for 20050615 the KNMI results are always higher than the Hungarian ones.
for 20050929 the KNMI results are again higher but the absolute difference is less
Is there an explanation for this?

It is not due to a programic error

It is due to the different region.

Discrimination depends on the life age

If it is near to the boundary of my region and far from the boundary of his region then it may be 'young' for me and 'old' for him so other discrimination algorithm would be used.

Does it mean that we should use much bigger region and trust only the 'inner' part?

Maybe the reason that we found big differences with real time demo is not only that we do not have lightning data but also we use not enough big region, or same area should be masked.

RDT gives much better results with lightning data,

but many users have not lightning data for a 'big' area.

How big region to run RDT for?

- Only for a region, where we have lightning data? Just for the country?
- A huge region being far from the boundaries?

Does RDT gives better/other information then an image overlaid by lightning data?

It gives additional information

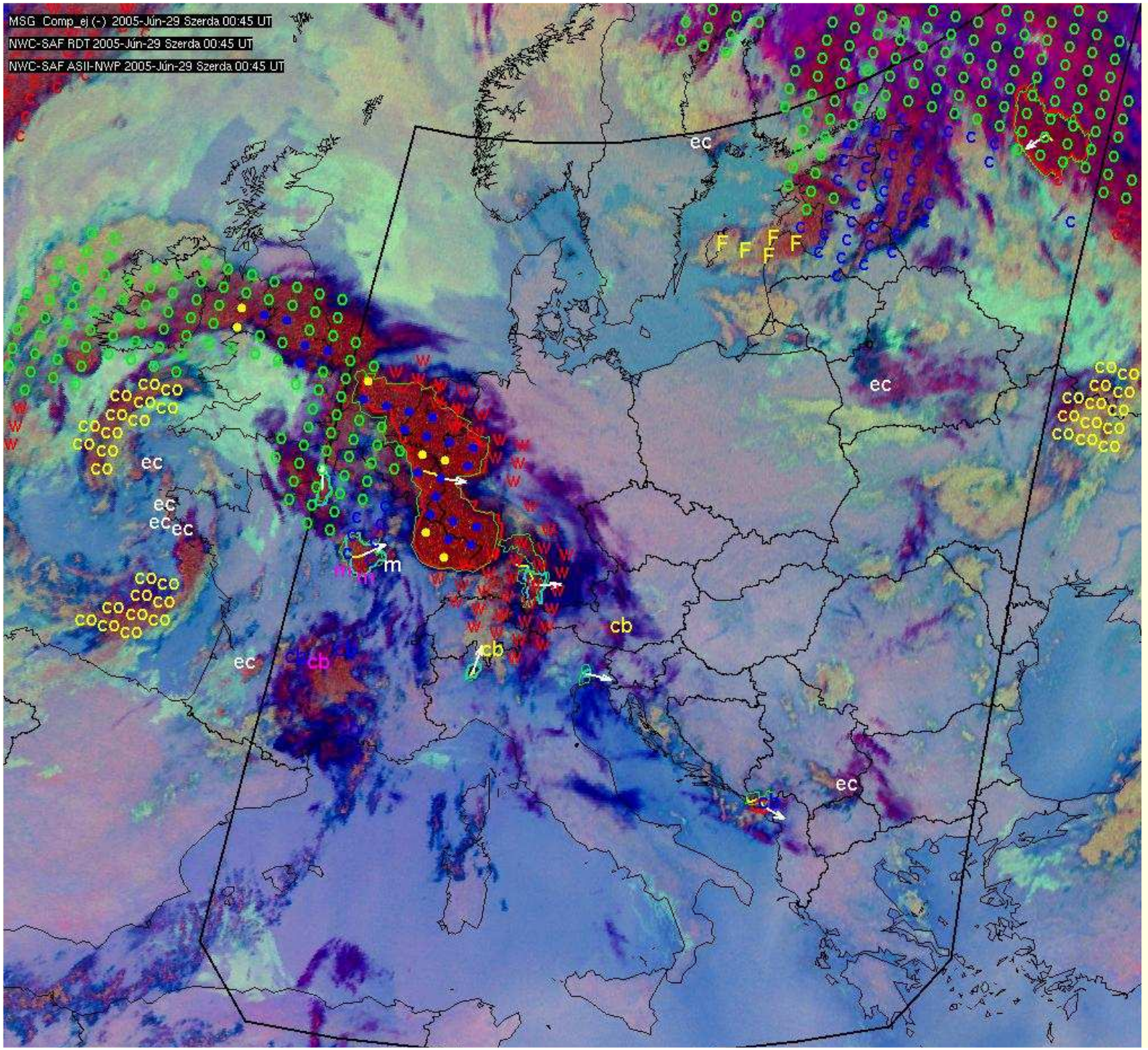
- cooling rate
- expanded rate
- speed of expectable movement.

But if the detection has many problems (misdetection and not detection) then the advantages can 'dissolve'.

Then maybe a good composite image overlaid by lightning data is more reliable.

Difficult to check the visualization (output file)

- A webpage is needed -- outputs for Europe
- Which uses the same SAFNWC/MSG program, same HRIT slot inputs
- Output without lightning data !!
    - Possibility of saving the image and looking the previous ones as well
- Output with lightning data



At night

Embedded cell

RGB_night

RDT

ASII-NWP

2005.06.23.

00:45UTC

Cloud Mask CMa,

Cloud type CT,

Cloud top temperature, pressure and height CTTH

We visualize CMa, CT and CTTH products for the duty forecasters since August 2004 (from May 2005 the v1.2)

(From CMa and CT a cloudiness image is calculated and visualized for forecasters)

CMa, CT and CTTH were integrated in MEANDER since November 2004.

input parameters in a program

The forecasters can use it also in the automatic warning system

(PC + derived low visibility) to detect potentially night time fog

Aviation meteorologist use CTTH to estimate the cloud top height

Radar and/or CTTH, surface observations

From CMa and CT we perform 'cloud amount image' and visualize it.

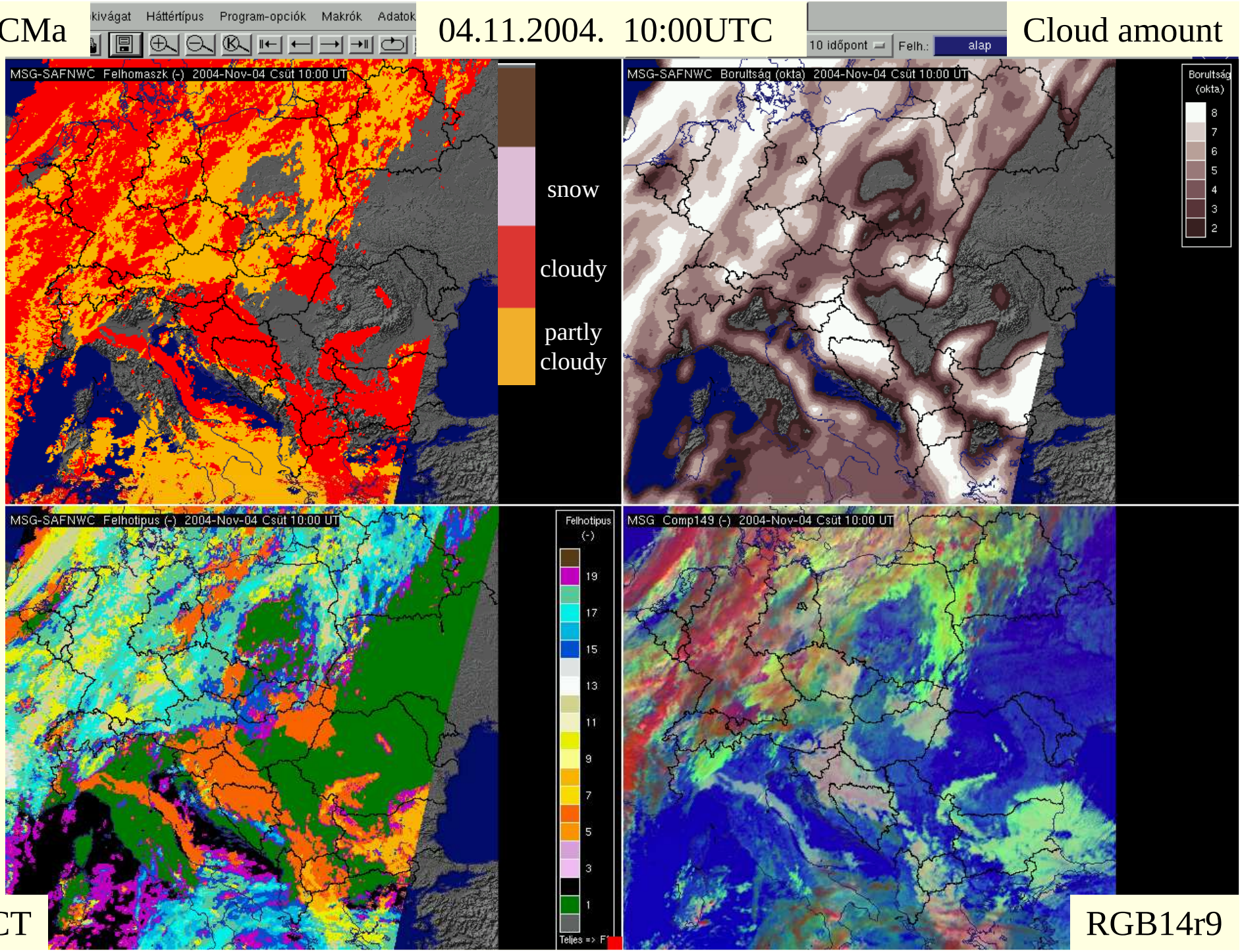
We use mainly CT (more elaborated algorithm)

Cloud amount in octa, 5x5pixel mean

CMa

04.11.2004. 10:00UTC

Cloud amount



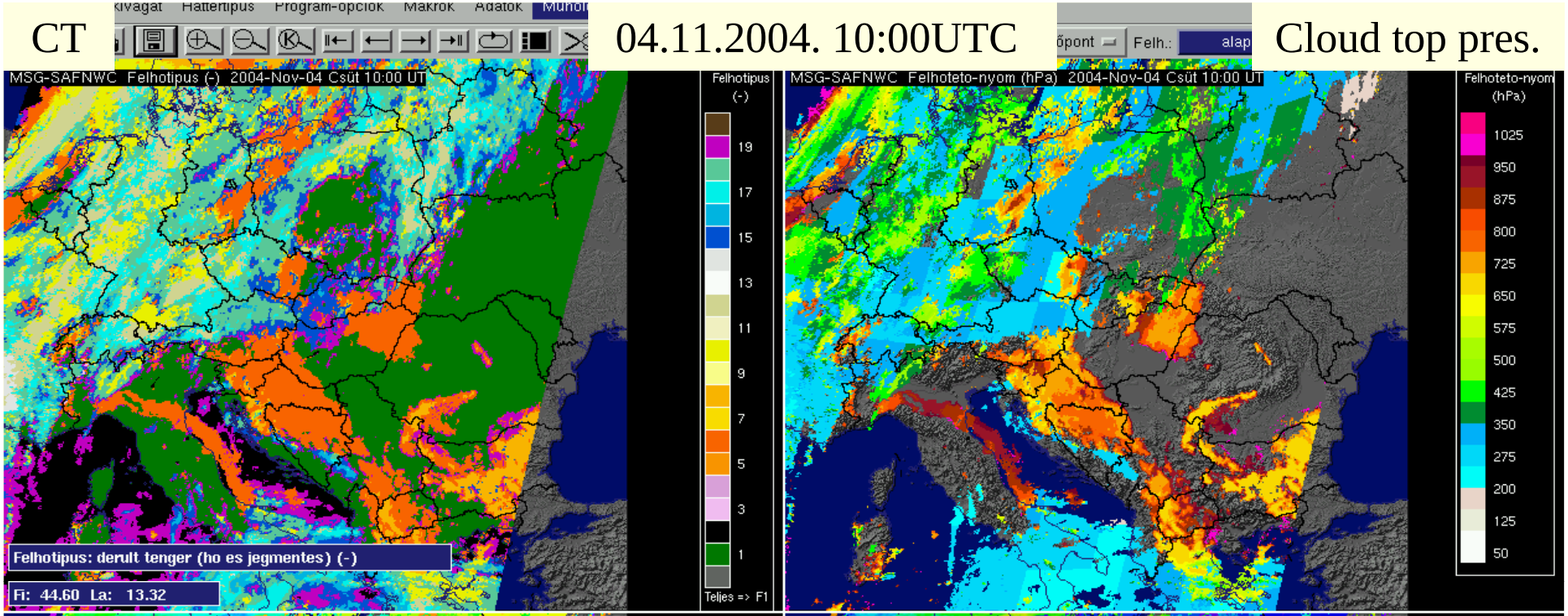
CT

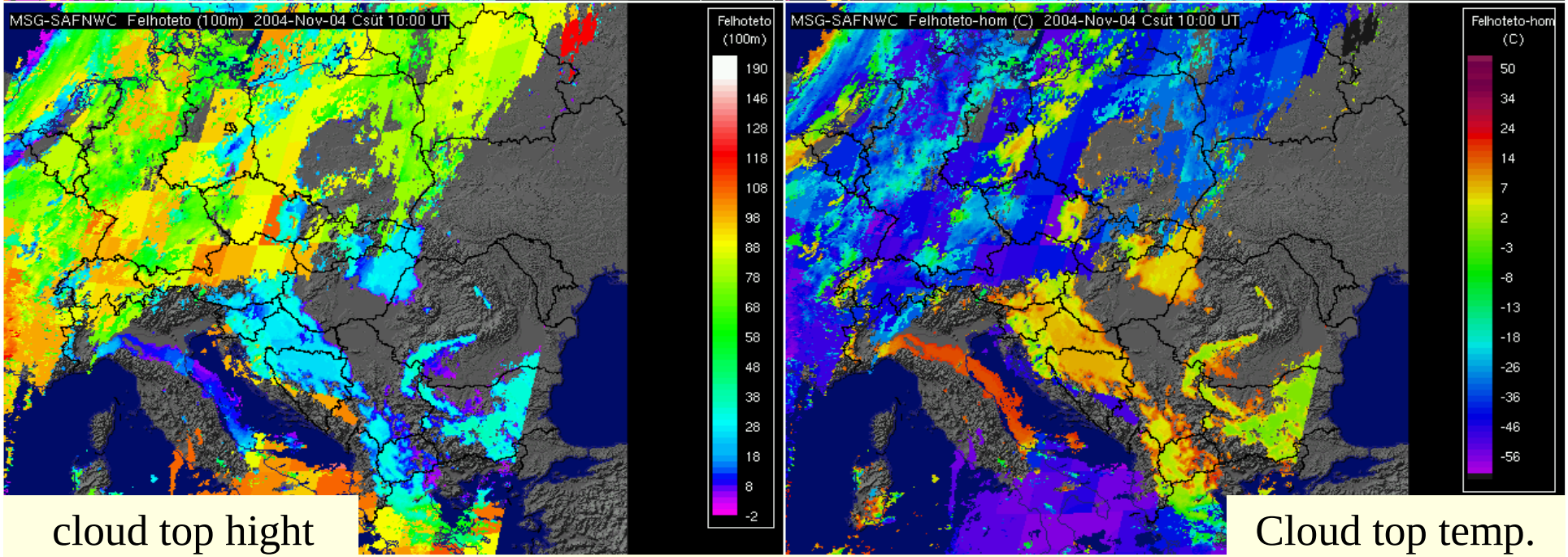
RGB14r9

CT

04.11.2004. 10:00UTC

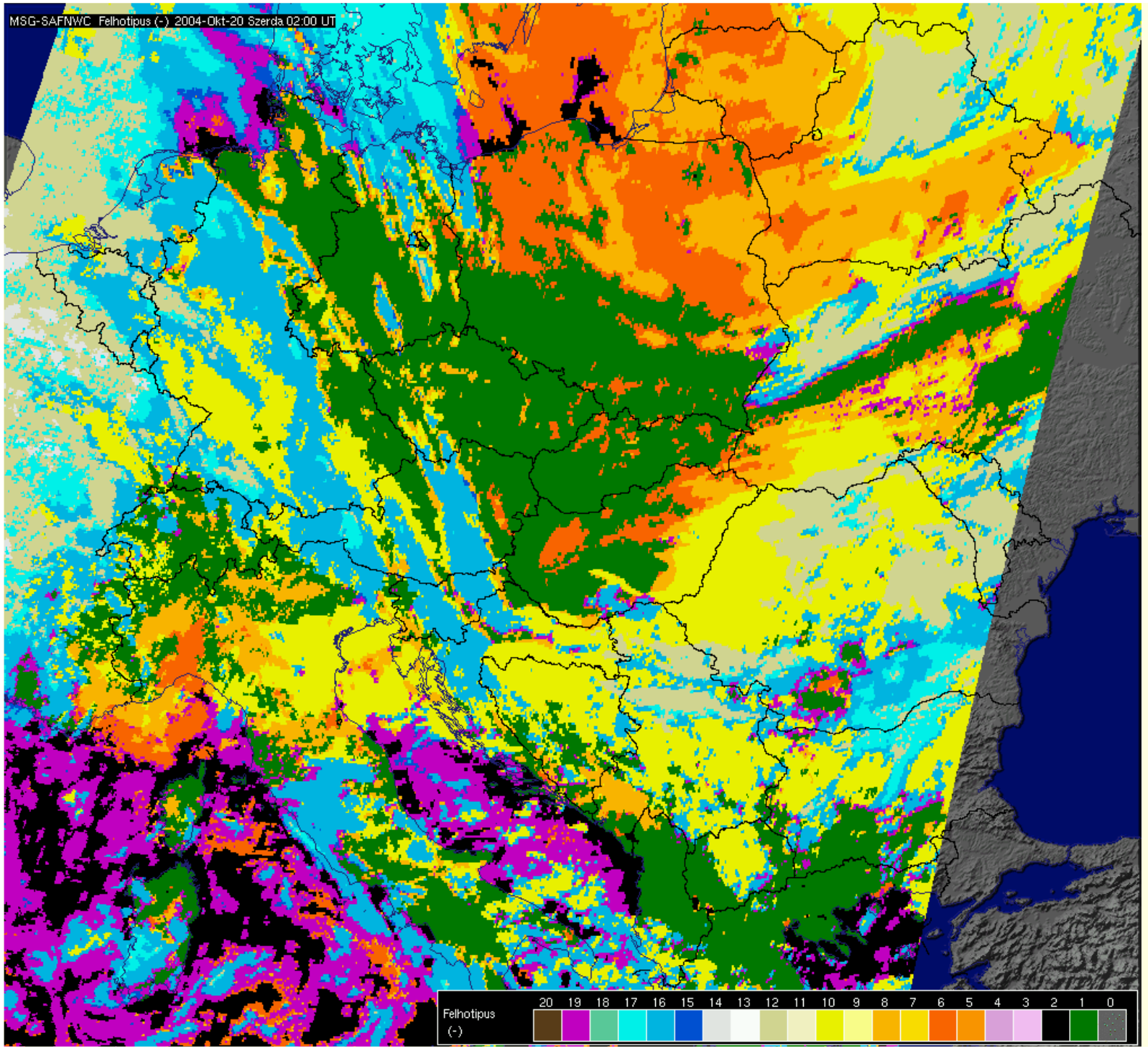
Cloud top pres.





cloud top hight

Cloud top temp.



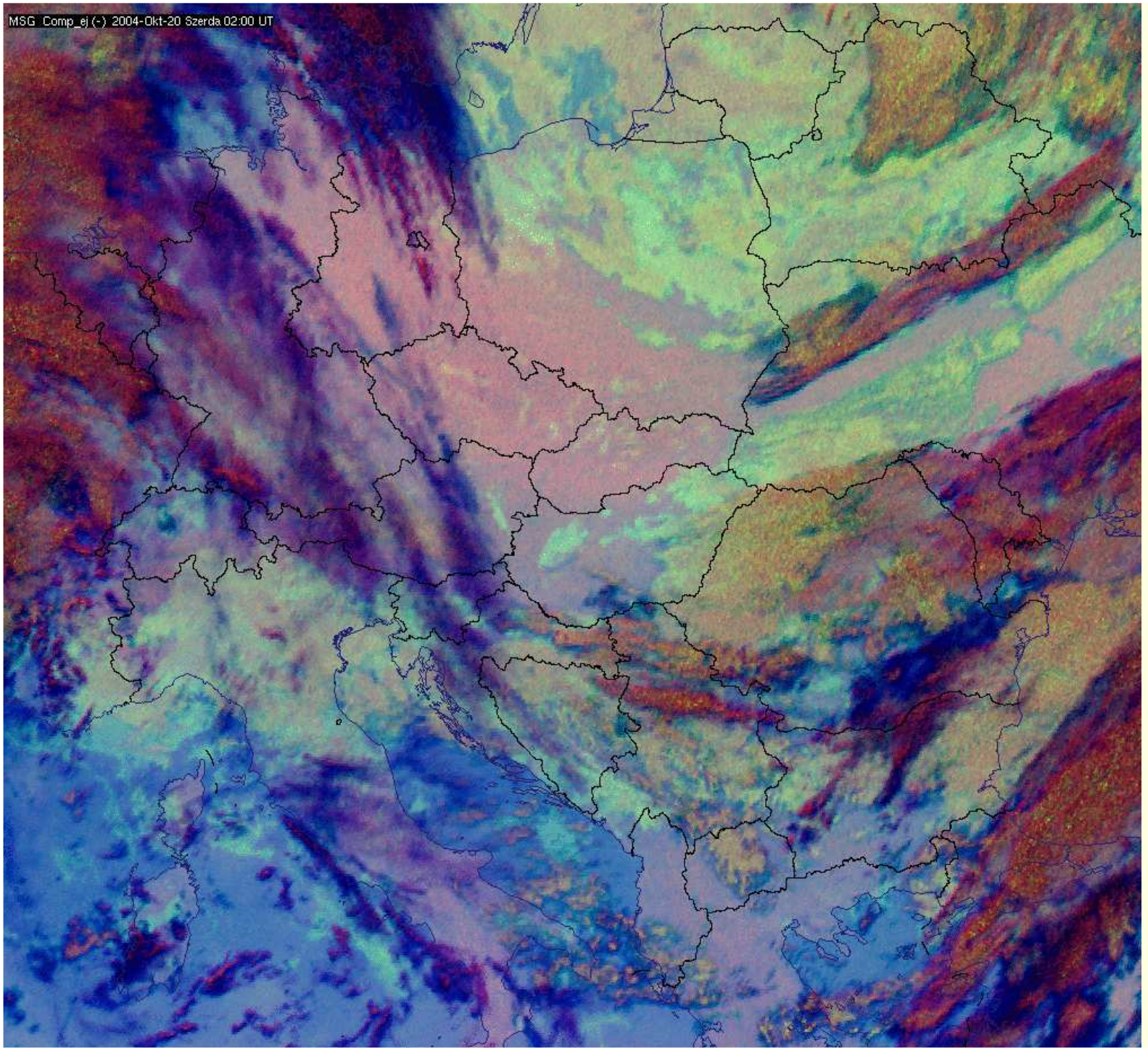
SAFNWC

CT

Cloud type

2004.10.20.

02:00



RGB_night

2004.10.20.

02:00

We compared the SAFNWC CMa product with the SYNOP observations.

2 months data from middle of September to middle of November 2004.

The following table shows the per cent values when the CMA product give cloudy/partly cloudy for the cases reported as fog by the SYNOP.

	No inversion			inversion		
	Night	Twilight	day	night	Twilight	day
%	83	71	95	66	58	91

Our forecasters use regularly the CT product and find it very useful!

feed back, questions when something is wrong.

at winter nighttime (high season for fogs and temperature inversion) v1.1

incoherency between CT and CTTH may happen

(one shows low, other shows medium cloud)

Limitations

- problems with fog/low cloud detection at twilight

  at visualization

    The forecasters know about this problem

    They look animation, composite images may help RGB_night

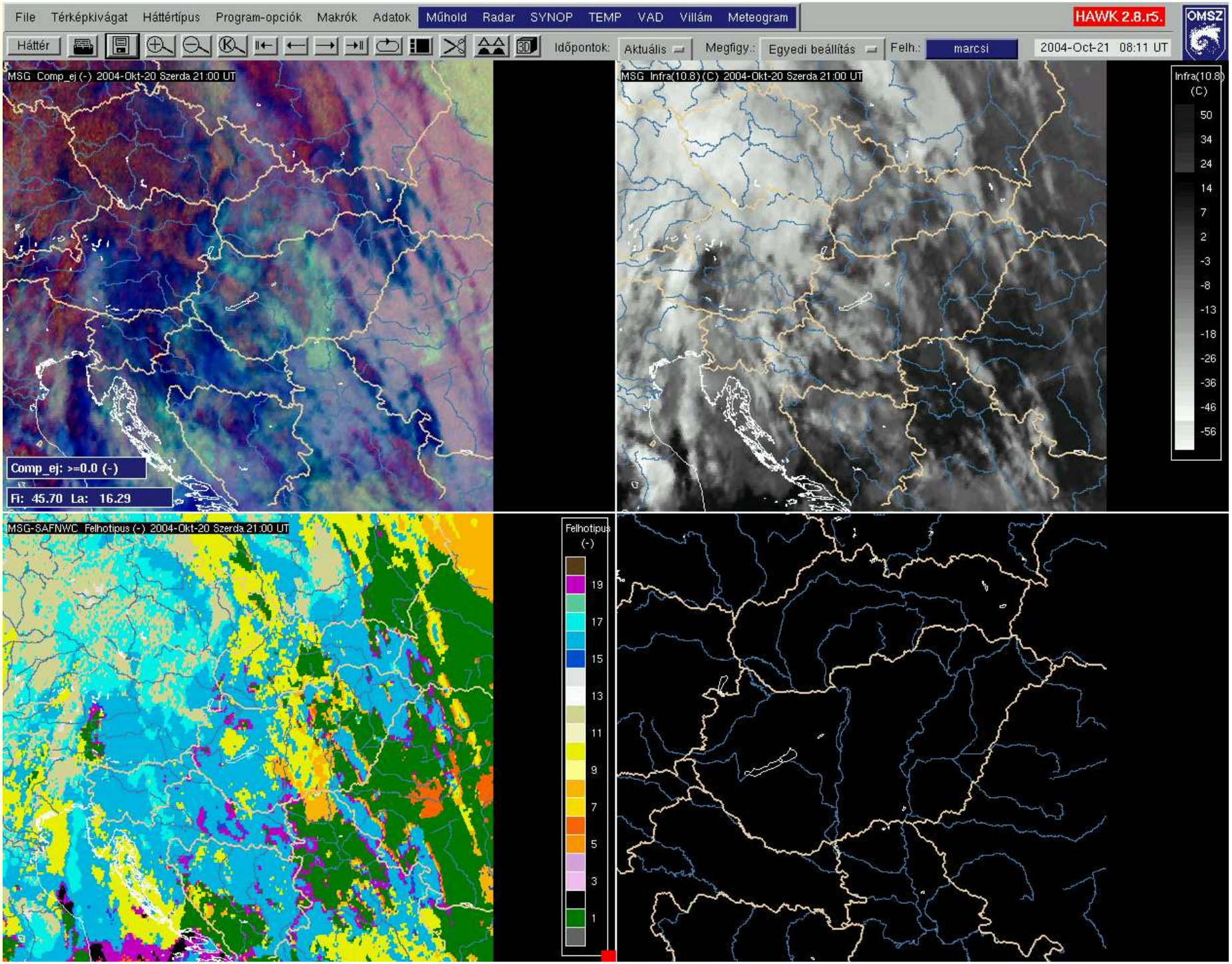
  for the input in a program

    It is more difficult to handle this problem.

- problems with fog/low cloud detection under thin Ci

  at visualization

    composite images may help


File Térképkivágat Háttértípus Program-opciók Makrók Adatok Műhold Radar SYNOP TEMP VAD Villám Meteogram
HAWK 2.8.r5.
OMSZ
Háttér
Időpontok: Aktuális
Megfigy.: Egyedi beállítás
Felh.: marcsi
2004-Oct-21 08:11 UT
MSG Comp_ej (-) 2004-Okt-20 Szerda 21:00 UT
Comp_ej: >=0.0 (-)
Fi: 45.70 La: 16.29
MSG Infra(10.8) (C) 2004-Okt-20 Szerda 21:00 UT
Infra(10.8) (C)
50
34
24
14
7
2
-3
-8
-13
-18
-26
-36
-46
-56
MSG-SAFNWC Felhotipus (-) 2004-Okt-20 Szerda 21:00 UT
Felhotipus (-)
19
17
15
13
11
9
7
5
3
1

Requirements of forecasters and of the developer of the MEANDER software

Dreams

- SEPARATE FOG FROM LOW CLOUDS.
- Separate fog/stratus from stratocumulus
- Separate Cb from opaque high-very high clouds

For aviation meteorologists, it is very important to separate the fog/low stratus from other clouds like stratocumulus.

-- to introduce a new threshold at about 925hPa to split the class 6.

-- the separation of cumuliform and layer clouds

Probability of precipitation PC

Convective rain rate CRR

Visiting Scientist Activity (Associated Scientist, 5 months)

Validation the SAFNWC/MSGv1.2 precipitation products: PC and CRR

2.5 months summer data (13.06.2005-04.09.2005).

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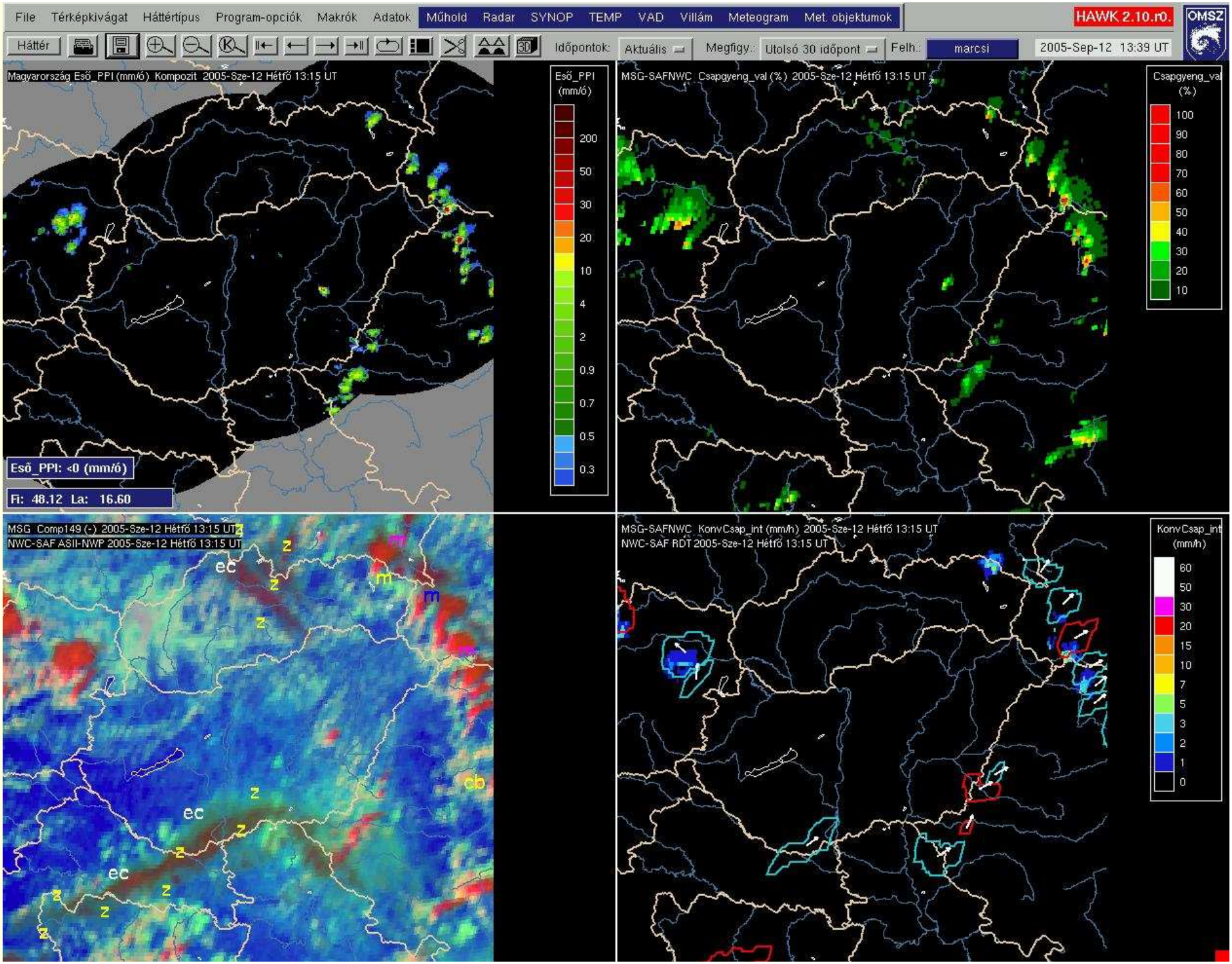
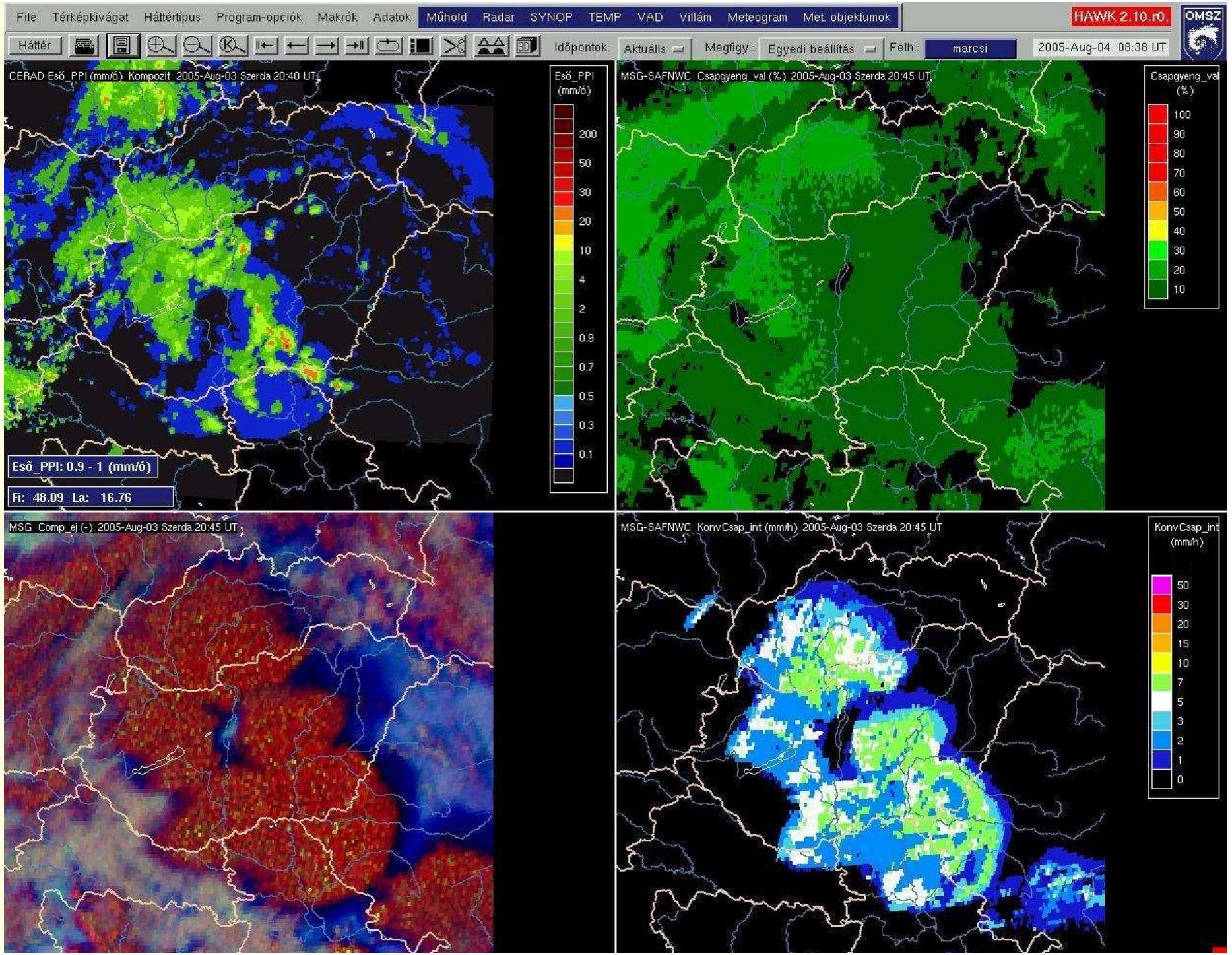
The TB data set and the results are delivered for the developers to help the tuning.

Case studies for comparing PC and CRR with radar data

Radar	PC
Composite	CRR
ASII	RDT

We overlaid ASII and RDT as well. These products may help us to see the synoptic situation and to identify the convective clouds.


File Térképkivágat Háttértípus Program-opciók Makrók Adatok Műhold Radar SYNOP TEMP VAD Villám Meteogram Met. objektumok
HAWK 2.10.r0.
OMSZ
Háttér
Időpontok: Aktuális
Megfigy.: Utolsó 30 időpont
Felh.: marcsi
2005-Sep-12 13:39 UT
Magyarország Eső_PPI (mm/ó) Kompozit 2005-Sze-12 Hétfő 13:15 UT
Eső_PPI (mm/ó)
200
50
30
20
10
4
2
0.9
0.7
0.5
0.3
Eső_PPI: <0 (mm/ó)
Fi: 48.12 La: 16.60
MSG-SAFNWC Csapgyeng_val (%) 2005-Sze-12 Hétfő 13:15 UT
Csapgyeng_val (%)
100
90
80
70
60
50
40
30
20
10
MSG Comp149 (-) 2005-Sze-12 Hétfő 13:15 UT
NWC-SAF ASII-NWP 2005-Sze-12 Hétfő 13:15 UT
MSG-SAFNWC KonvCsap_int (mm/h) 2005-Sze-12 Hétfő 13:15 UT
NWC-SAF RDT 2005-Sze-12 Hétfő 13:15 UT
KonvCsap_int (mm/h)
60
50
30
20
15
10
7
5
3
2
1
0

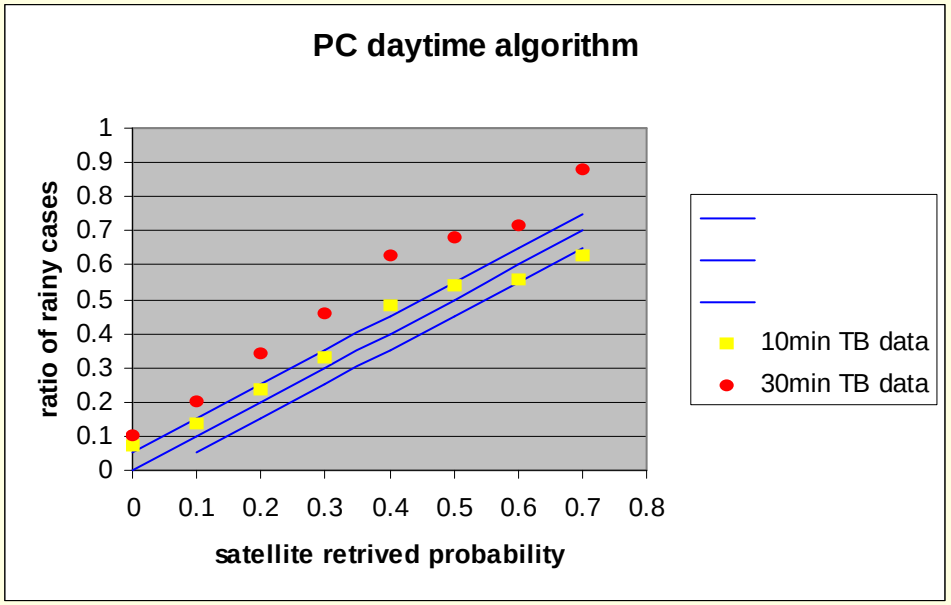

File Térképkivágat Háttértípus Program-opciók Makrók Adatok Műhold Radar SYNOP TEMP VAD Villám Meteogram Met. objektumok
HAWK 2.10.r0.
OMSZ
Háttér
Időpontok: Aktuális
Megfigy.: Egyedi beállítás
Felh.: marcsi
2005-Aug-04 08:38 UT
CERAD Eső_PPI (mm/ó) Kompozit 2005-Aug-03 Szerda 20:40 UT
Eső_PPI (mm/ó)
200
50
30
20
10
4
2
0.9
0.7
0.5
0.3
0.1
Eső_PPI: 0.9 - 1 (mm/ó)
Fi: 48.09 La: 16.76
MSG-SAFNWC Csapgyeng_val (%) 2005-Aug-03 Szerda 20:45 UT
Csapgyeng_val (%)
100
90
80
70
60
50
40
30
20
10
MSG Comp_ej (-) 2005-Aug-03 Szerda 20:45 UT
MSG-SAFNWC KonvCsap_int (mm/h) 2005-Aug-03 Szerda 20:45 UT
KonvCsap_int (mm/h)
50
30
20
15
10
7
5
3
2
1
0

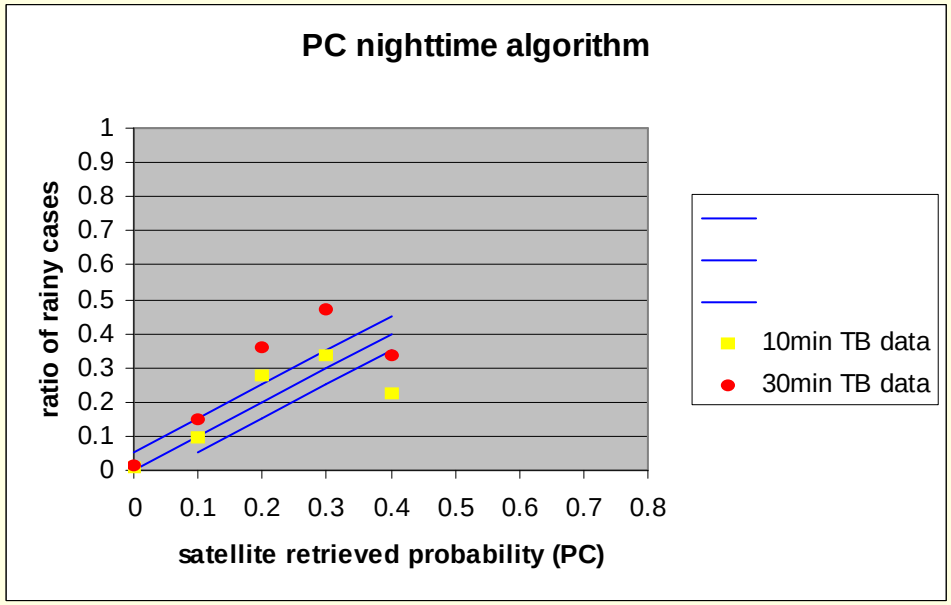
Conclusion of case studies on PC and CRR with radar data

•PC is most useful in convective and week front situation, and less useful in strong front situation.
•Particularly daytime for the smaller isolated convective clouds it often gives very nice results.
•The nighttime algorithm is less informative.
•There is a strong discontinuity between daytime and night-time algorithm.

At the CRR product we were interested first of all whether the product gives results really for the convective precipitation.
We used CT, RDT and ASII to identify the convective clouds.
•CRR and RDT contours matches well in a lot of cases.
•CRR detects well the developed thunderstorms even at night!
•In some cases RDT identify convective cloud, radar also shows moderate or heavy precipitation but CRR=0.
•Sometimes CRR gives rainy values where neither RDT nor ASII_NWP indicate any.

Verification of PC with 10- and 30-minute tipping bucket rain gauge (TB) data





The ratio of the rainy cases calculated from the surface measurements as a function of the satellite retrieved rain probability. The blue solid lines are guides to eye, ideal results would fit into this band.

Conclusion of verification of PC with TB data

- The satellite retrieved rain probability fits well to the observed ratios. (The highest probabilities fit less.)
- The verification gave better results using the 10-minute data set.
- The daytime algorithm gave better results than the nighttime algorithm.

Verification of CRR with 10- and 30-minute tipping bucket rain gauge (TB) data

CRR	0	1	2	3	4	5	6	7	8	9	10
Rain rate at daytime	0-1	1-2	2-3	3-5	5-7	7-10	10-15	15-20	20-30	30-50	50-
Rain rate at nighttime	0-1	1-2	2-3	3-5	5-7	7-10	10-				

We have to exclude the cases of CRR=0 from the statistics.

CRR>=1mm/hour, the TB data confirms this only in 30-36% of the cases. (We must note that in a higher percent (about 40-55%) there was some rain.)

CRR overestimate the rainy area.

Contingency tables were performed, (but we had to exclude the 0-1 mm/hour categories both from CRR and TB datasets).

Statistical characteristics were calculated from the contingency tables.

CRR	mm/hour	0	0-1		1-2	2-3	3-5	5-7	7-10	10-		
0	0	211094	3527		1934	1100	1011	466	354	381		5246
1	1-2	714	67		43	50	65	53	33	44		288
2	2-3	342	55		43	37	47	29	21	35		212
3	3-5	388	58		46	55	45	36	31	33		246
4	5-7	196	40		19	13	17	17	15	25		106
5	7-10	98	22		7	10	12	4	3	20		56
6	10-	1	1		0	0	0	0	0	5		5
sum		1739	243		158	165	186	139	103	162		913

Contingency table (n10) for comparing nighttime CRR with the surface measured 10-minute TB data.

		TB	0	0-1		1-2	2-3	3-5	5-7	7-10	10-15	15-20	20-30	30-50	50-		sum
CRR	mm/hour																
0	0		105806	4647		2691	1247	1046	379	258	172	67	61	41	12		5974
1	1-2		878	164		113	83	73	26	31	22	13	4	15	5		385
2	2-3		408	70		71	48	53	27	19	19	5	3	5	4		254
3	3-5		302	65		46	53	54	29	11	12	6	7	6	4		228
4	5-7		76	7		12	12	9	1	3	2	1	1	0	1		42
5	7-10		33	5		7	2	5	3	3	2	3	2	0	1		28
6	10-15		4	1		2	0	0	1	0	1	1	2	2	0		9
7	15-20		0	0		0	0	0	0	0	0	0	0	0	0		0
8	20-30		0	0		0	0	0	0	0	0	0	0	0	0		0
9	30-50		0	0		0	0	0	0	0	0	0	0	0	0		0
10	50-		0	0		0	0	0	0	0	0	0	0	0	0		0
sum			1701	312		251	198	194	87	67	58	29	19	28	15		946

Contingency table (d10) for comparing daytime CRR with the surface measured 10-minute TB data.

CONCLUSION OF VALIDATION OF CRR WITH TB

For CRR>0

The satellite algorithm overestimates the rainy area. The precipitation existence is between 32-55%.

The rain rate is underestimated on the average.

We have calculated the errors in rain rate units and also in categories (predefined rain rate intervals).

The mean error is between –0.5 and -1mm/hour, the mean category error is –1 category.

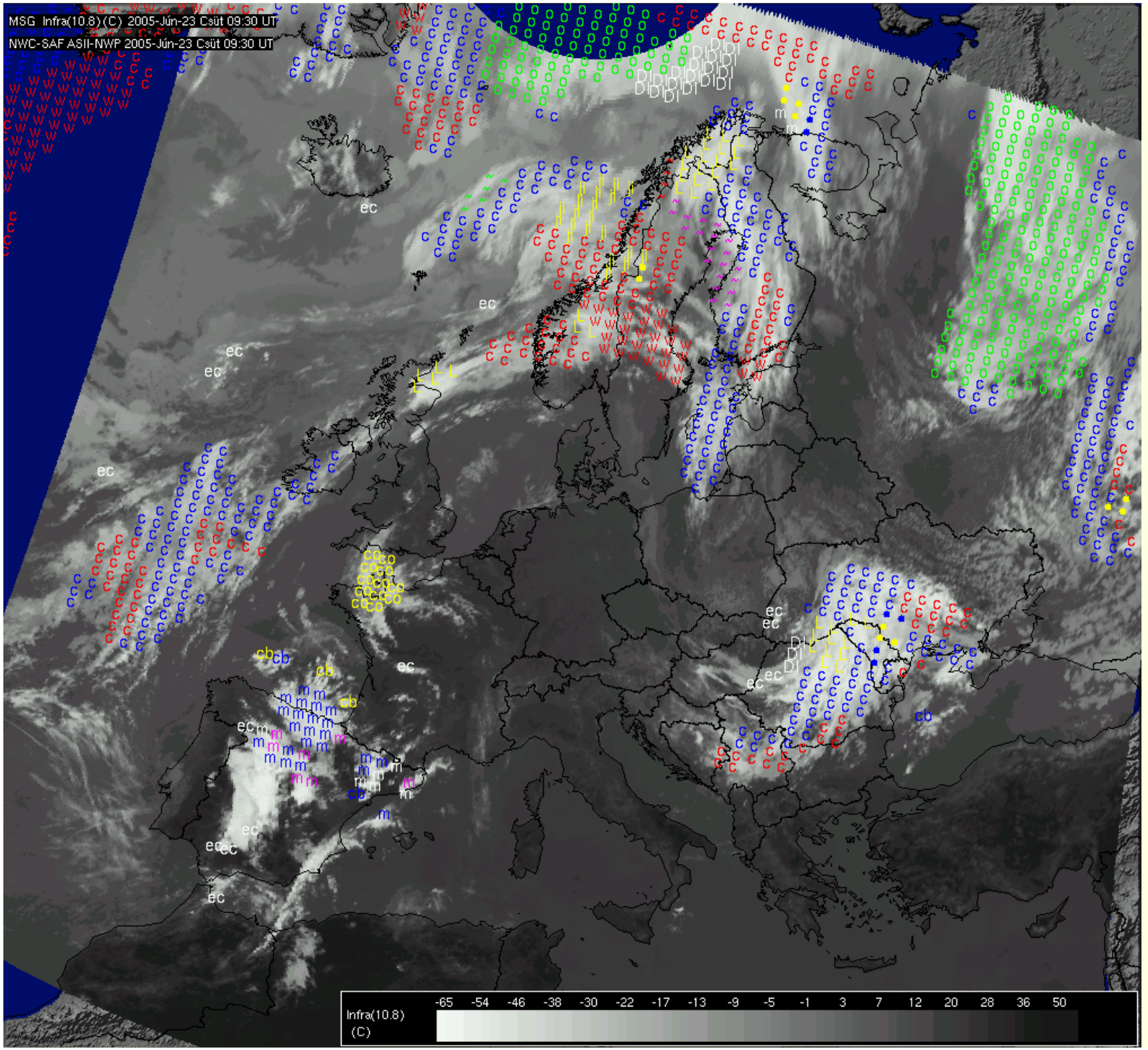
The mean absolute error is about 3mm/hour, while the mean category absolute error is a little less than 2 categories.

We have not found considerable differences between the results concerning 10- and 30-minute data sets.

AUTOMATIC SATELLITE IMAGE INTERPRETATION

ASII-SAT

ASII-NWP



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ASII_NWP

2005.07.23.

09:30

Remarks:

- In Hungary it often gives MCS for relatively small cells (discussed on Help Desk)
- ASII-SAT and ASII- NWP may give cold and warm front simultaneously

Suggestion:

- It may give even better results if it used 3 hourly NWP data.
- To create output for

  Motion corrected difference image

  (already implemented in SAFNWC program package)

Conclusions

Many useful products (I like to work with theme)

It is important to have webpages to compare the results

(exactly the same)

Help desk is good

Thank you!