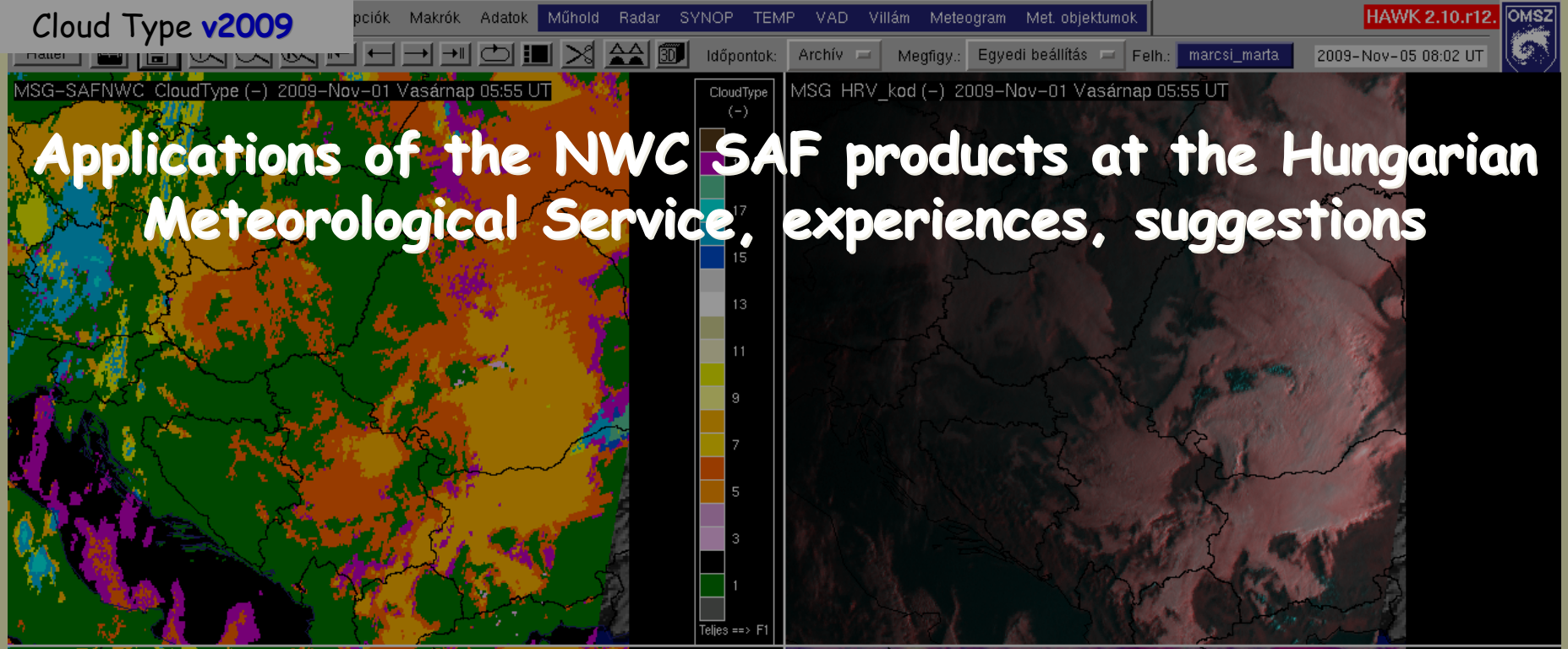
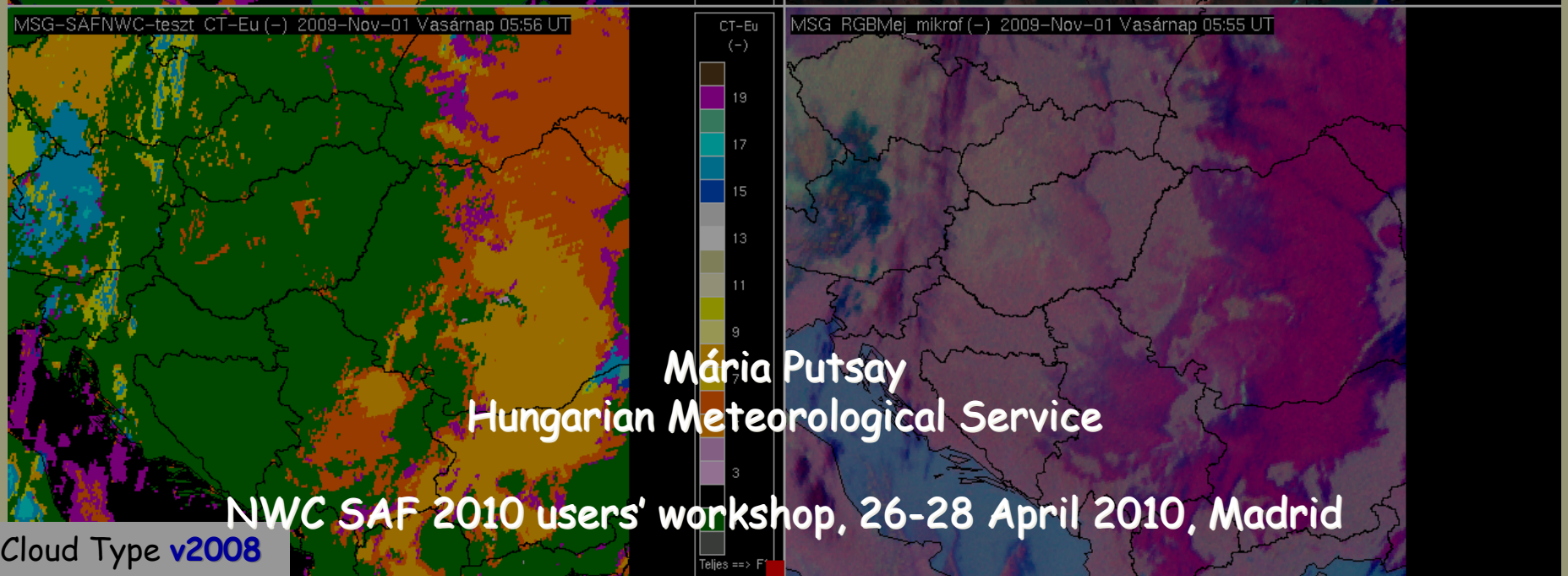
Cloud Type v2009



Applications of the NWC SAF products at the Hungarian Meteorological Service, experiences, suggestions



Mária Putsay
Hungarian Meteorological Service

NWC SAF 2010 users' workshop, 26-28 April 2010, Madrid

Cloud Type v2008

Cloud products:

Cloud mask (CMa), Cloud Type (CT), Cloud top temp. and height (CTTH)

We think these are the **most reliable** products of the NWC SAF

Automatic applications

- assimilation into ALADIN/HU
- Using in the Hungarian nowcasting system (MEANDER) + warning system
- Creating 'infra_cloud images' (instead of IR10.8) for partners, INTERNET/ intraweb
- Creating 'cloud amount' images

Interactive applications

Visualization for

- the forecasters
- verification of NWP forecasts, simulations
- evaluation of case studies

Automatic applications of the NWC SAF cloud products

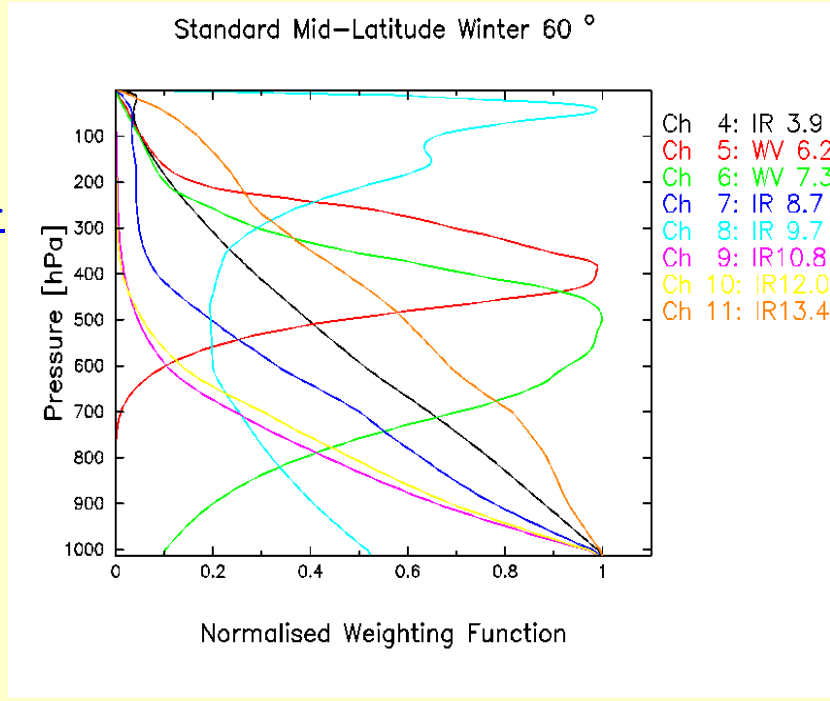
Using at assimilation into the ALADIN/HU Numerical Weather Prediction Model

Assimilated satellite data/product into the ALADIN/HU

- MPEF satellite retrieved wind product (AMV)
- NOAA ATOVS data
- **brightness temperature (TB) data of some MSG infrared channels**

Pre-processing:

The CT and CTTH products (and their quality flags) are used to select the pixels to be assimilated. The pixels are kept over cloud-free areas and above those clouds, for which the cloud-top pressure levels are below the tail of the weighting functions.



Test:

The WV6.2, WV7.3, IR8.7, IR10.8, IR12.0 brightness temperatures are assimilated into the ALADIN/HU model.

Operational since June 2009

Using only WV6.2 and WV7.3 channels together with SYNOP data (T2m and RH2m)

Automatic applications of the Cloud products

in the Hungarian nowcasting system (MEANDER) + warning system

MEANDER - Mesoscale Analysis, Nowcasting and Decision Routines

present applications - since 2005

CMa, CT for deriving cloud amount

CT for filtering radar noises on cloud-free areas (+ very thin cirrus + …)

CT for sending warning for potential foggy areas

(using CT + RH analyses, derived low visibility)

CTTH cloud top height (+ radar cloud top height + many other parameters)
estimate the **maximum wind speed in the thunderstorm outflow**

MEANDER software could use other SAFNWC products as well.

plans:

--- improve the **fog** module based on **CT** + using the 'Toulouse' algorithm (RH, wind, prec.)

--- using 6 hourly snow cover maps (**CT** + LandSAF Snow Cover product)

to assimilate it into the WRF model

--- using **RDT (with radar cell tracking)**

--- using LST (Land SAF)

Snow detection in NWC SAF CT

6 hourly snow cover maps were asked for using it in the MEANDER.

The Land SAF Snow Cover (SC) is a daily product. (available at ~2 UTC next day)

NWC SAF CT provide snow detection in every 15 minutes
>>> we create 6 hourly snow cover map from NWC SAF CT

NWC SAF CT provide snow detection only for **cloud-free** areas, only if the **sun elevation > 5 degree**.
(+ The snow detection is more reliable at high solar elevation)

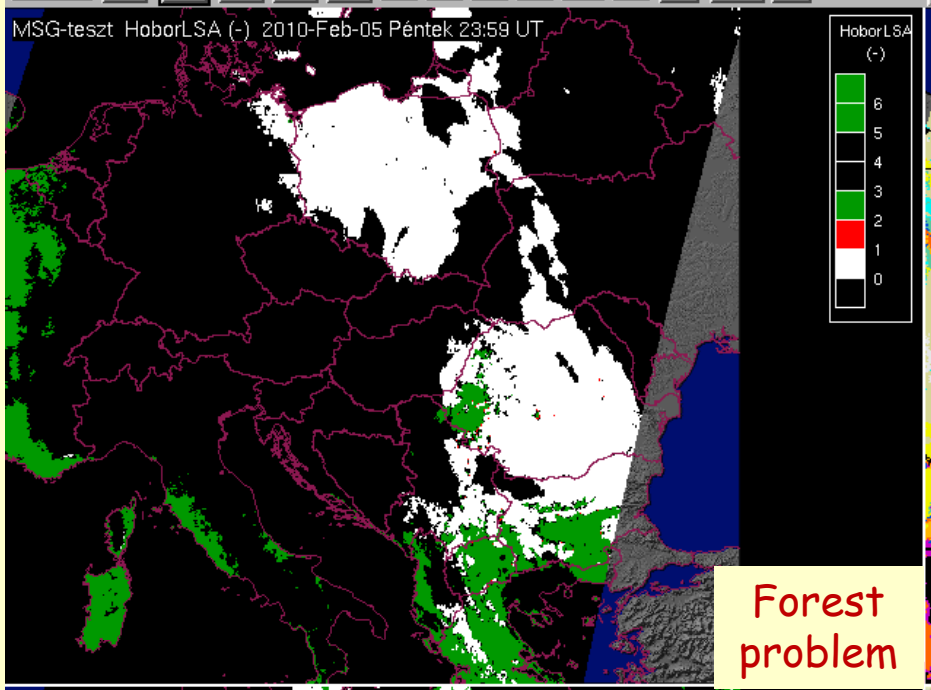
We compared Land SAF SC with NWC SAF CT by creating 24 hourly maps from NWC SAF as well.

How?
Daily map pixel is set to snowy, if CT=snow at least in 3 slots (sun elevation > 5 degree)
Daily map pixel is set to snow-free, if it is not set to snowy and CT=snow-free at least in 3 slots (sun elevation > 10 degree)
Other pixels are set to unclassified.

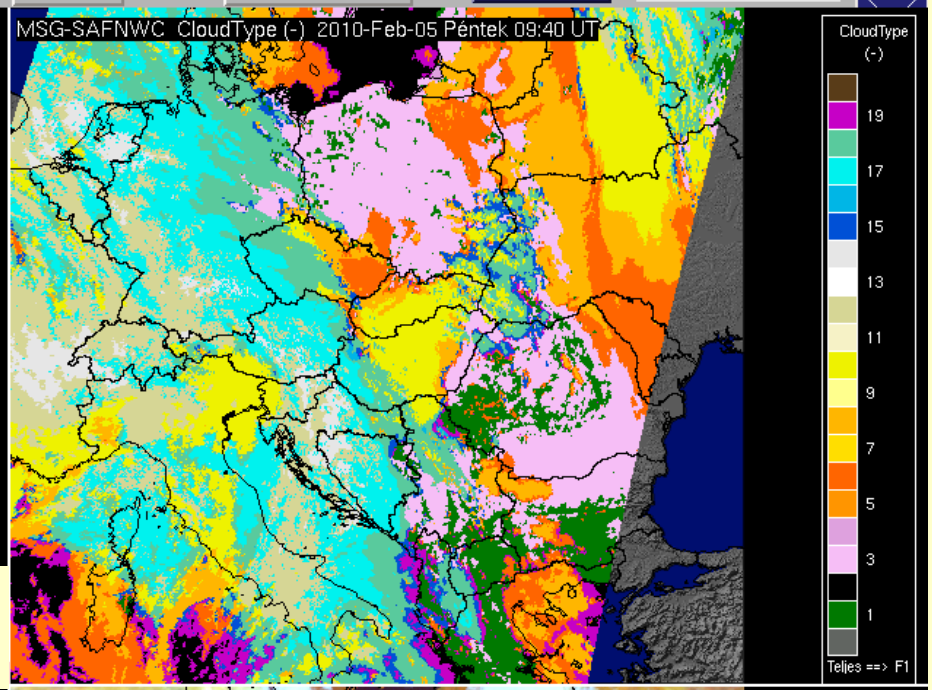
differences examples

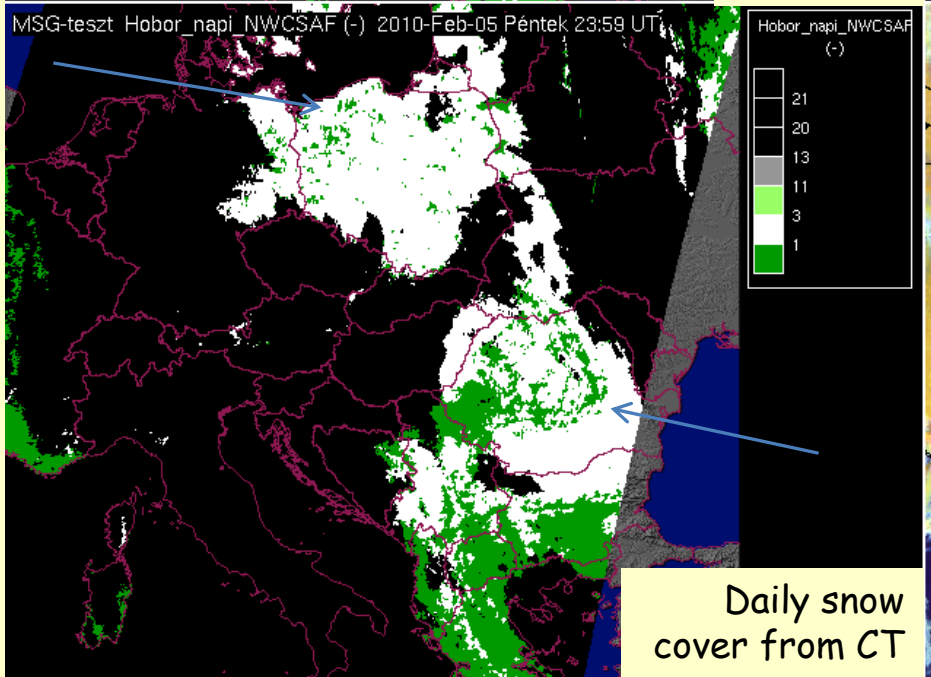
Land SAF snow cover 05.02.2010. whole day

05.02.2010. 09:40 UTC NWC SAF CT

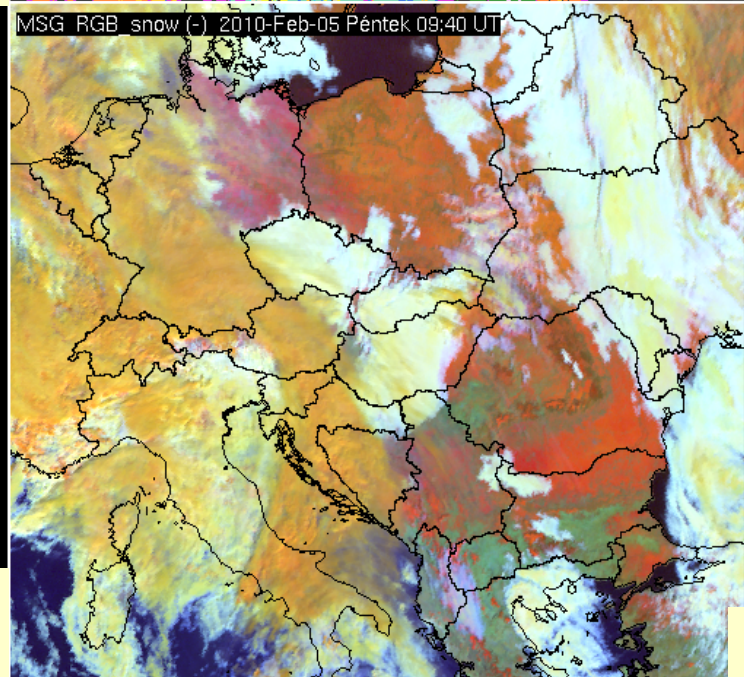


Forest problem

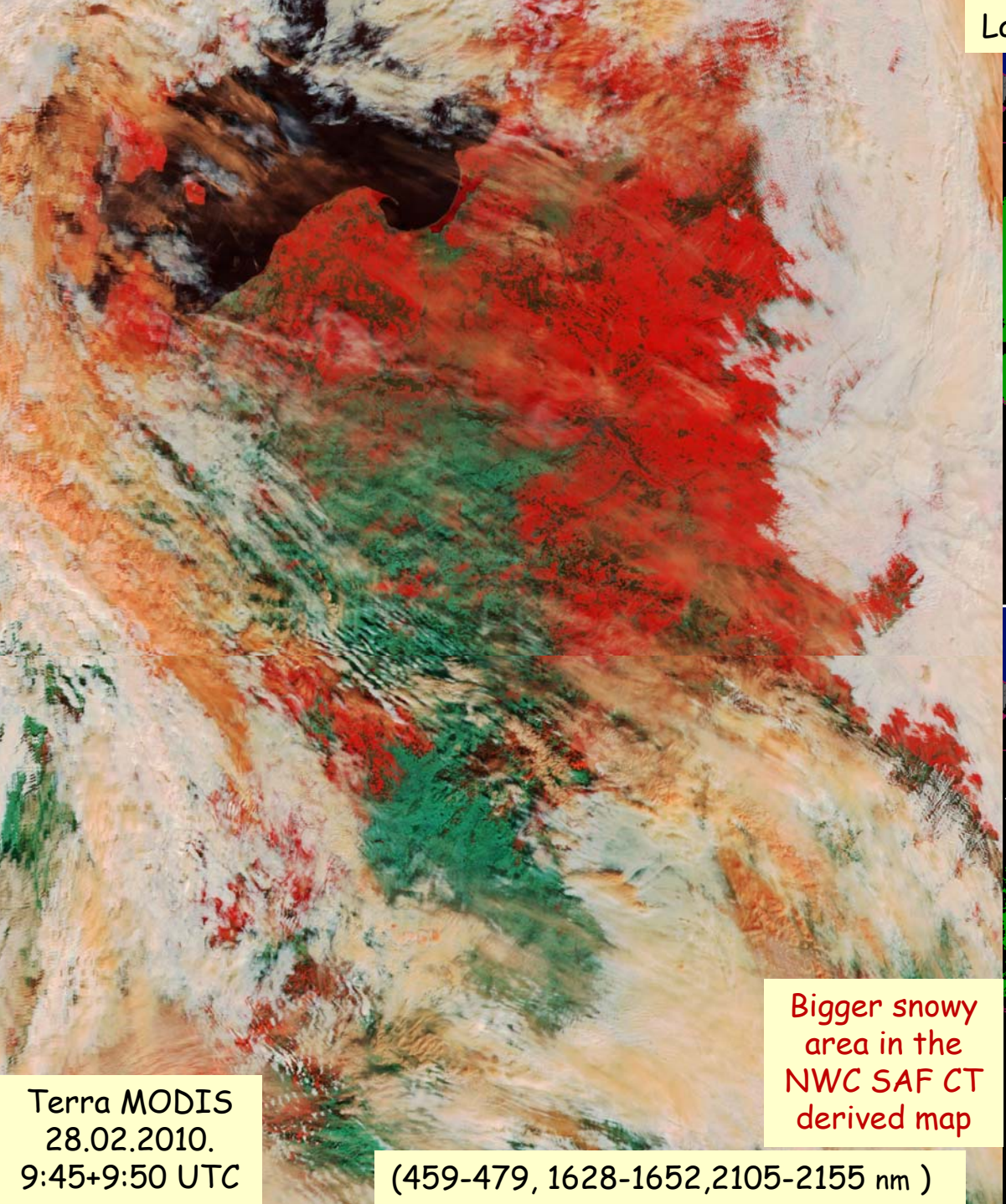




Daily snow cover from CT



Snow RGB

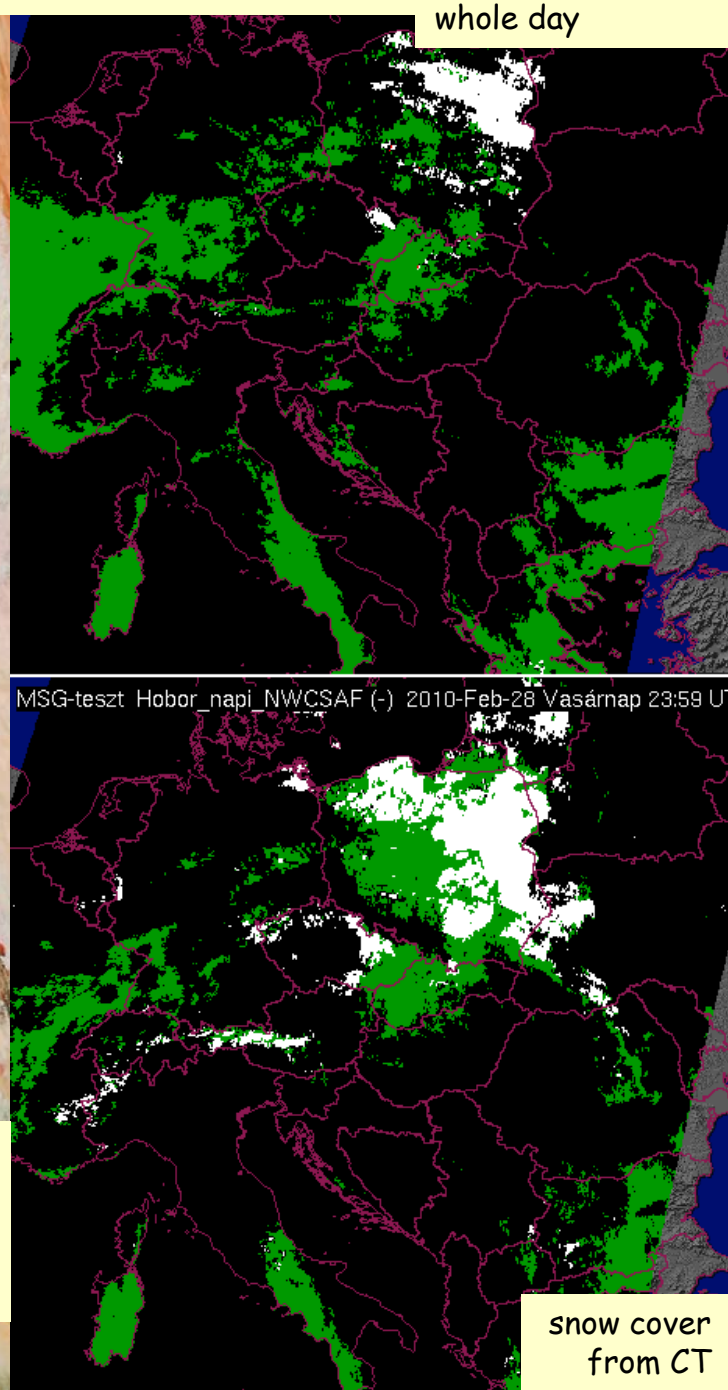


Terra MODIS
28.02.2010.
9:45+9:50 UTC

(459-479, 1628-1652,2105-2155 nm)

Land SAF snow cover

28.02.2010.
whole day



Bigger snowy area in the NWC SAF CT derived map

snow cover from CT

Verification of LSA SC and NWC SAF CT derived daily snow maps with the Hungarian surface snow depth observations

(stations with observer and 4 automatic stations)

Snow depth observations are performed once a day, at 6 UTC in the morning.

Cases with **observed snow depth>=2cm** in two consecutive mornings were selected. For these days >

'Snowy' and 'snow-free' pixels (with such observations) were counted

>> POD

		POD Snow depth >= 2cm	Number of cloud-free pixels	Pixels with info / all pixels (sd >=2cm)	NWC/LSA
December 2009	LSA	0,94	963	32%	
	NWC	0,78	1328	44%	1.38
January 2010	LSA	0,93	682	11%	
	NWC	0,71	1508	25%	2,21
February 2010	LSA	0,91	1390	18%	
	NWC	0,85	2241	29%	1,61
Dec-Febr 2009-2010	LSA	**0,93**	3035	**18%**	
	NWC	**0,79**	5077	**30%**	**1,67**

For the selected pixels - containing the meteorological station with snow depths observation >= 2cm both on the actual and next mornings - **the pixels with information (snow or snow free) were divided with all pixels. It was found that the NWC CT derived daily map gave information for 67% bigger area that SC.**

for a smaller, more reliable data set: **FAR=0** was found for both products (No of cases ~ 120-150)

Automatic application

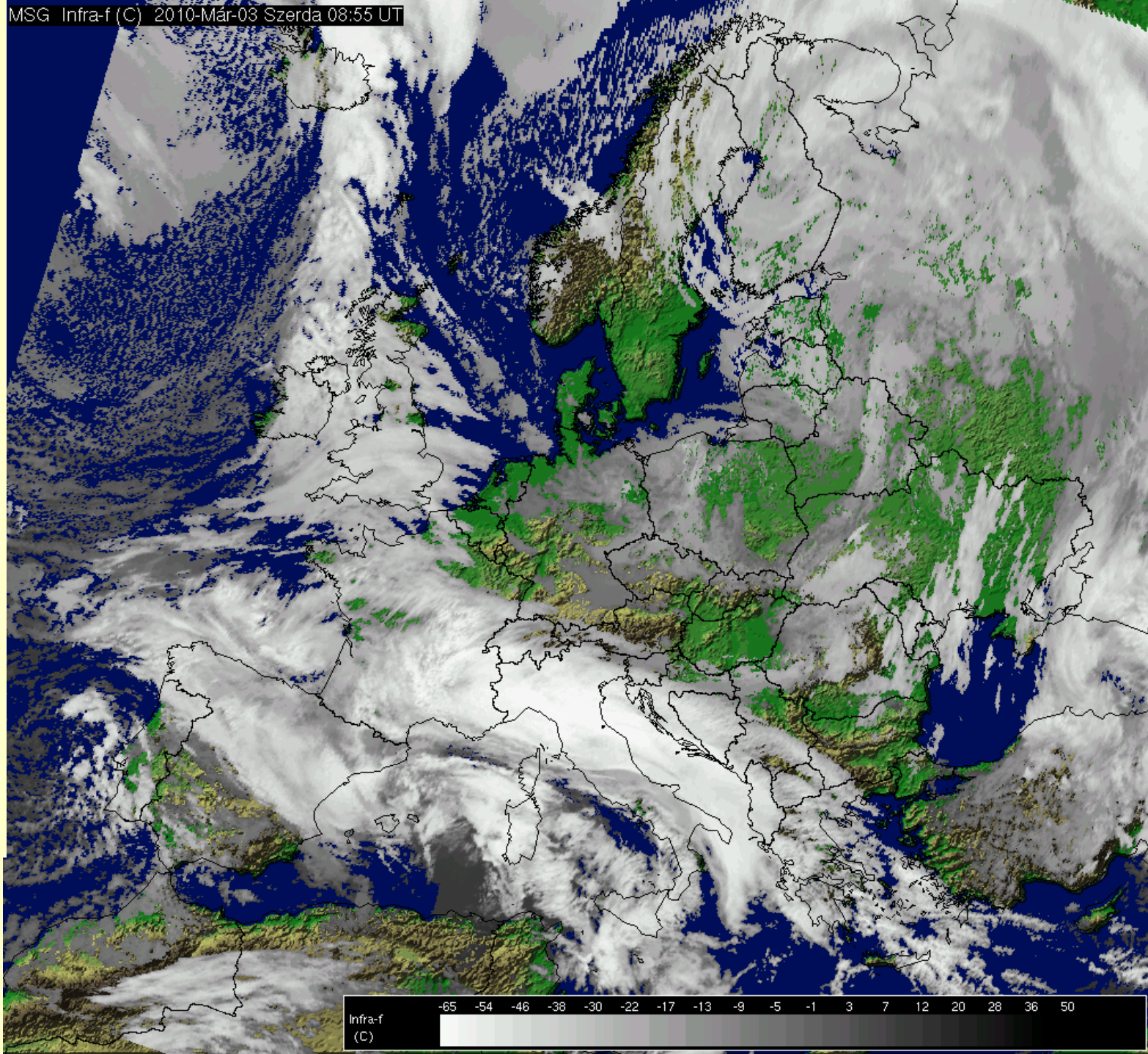
Creating

'Infra-clouds'

For partners
(e.g. Roads admin.)

CT as cloud mask
-- IR10.8
(black&white)
on cloudy areas
-- orographic map
(colors)
on cloud-free areas

03.03.2010.
08:55 UTC

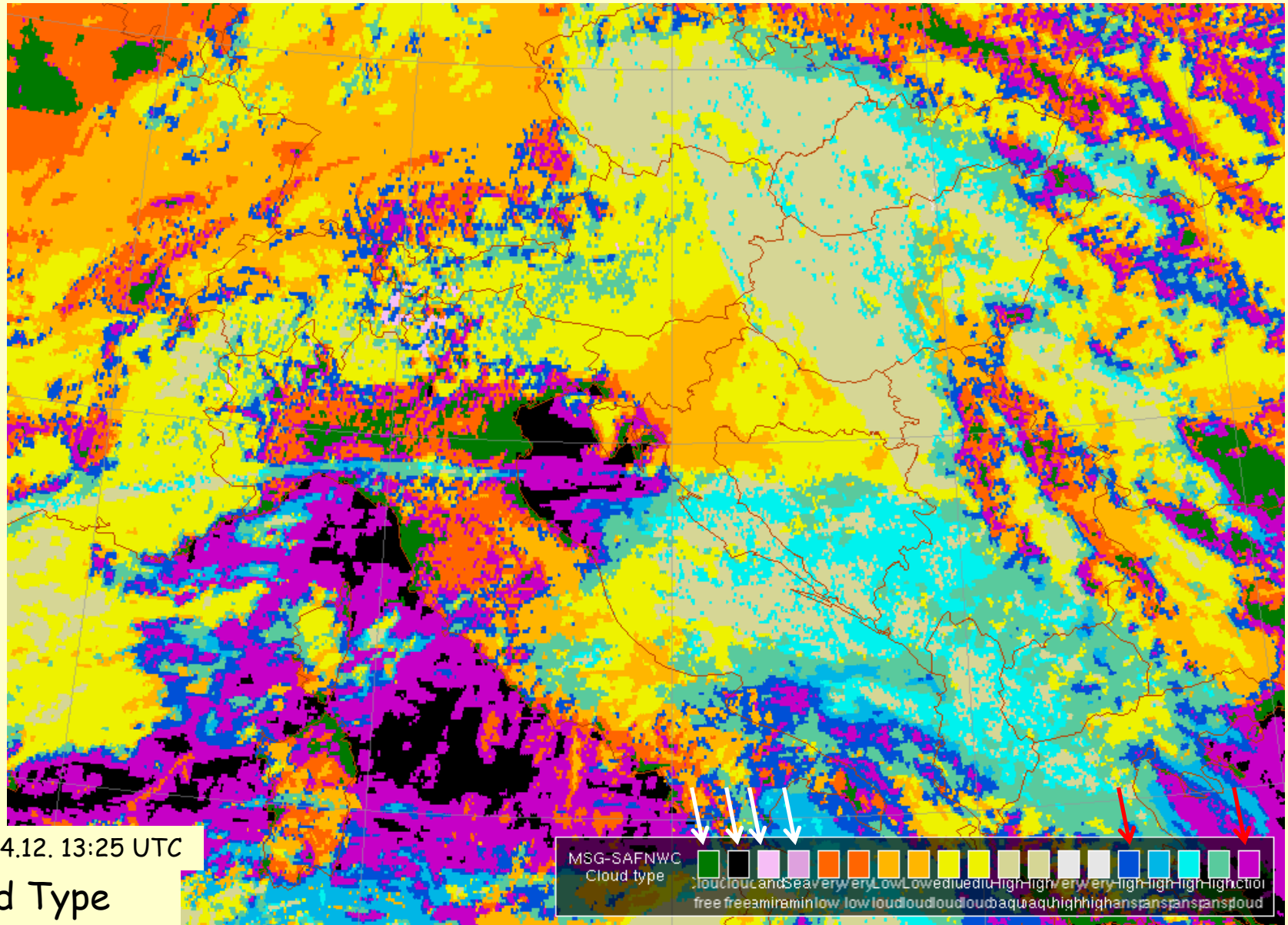


Automatic application - '**cloud amount**' map derived from the **CT** product

How? - Creating a 'cloud mask' from CT by setting

0 - cloud-free, 0.5 - broken clouds and very thin cirrus, 1 - other cloud types

Smoothing/averaging this image with a 5x5 window



2010.04.12. 13:25 UTC

Cloud Type

Automatic application - '**cloud amount**' map derived from the **CT** product

How? - Creating a 'cloud mask' from CT by setting

0 - cloud-free, 0.5 - broken clouds and very thin cirrus, 1 - other cloud types

Smoothing/averaging this image with a 5x5 window

Applications: **Verifying the forecasted cloud amount by the ALADIN/HU** (and other) NWP model

ALADIN forecasts the total cloud amount and the cloud amount in three different layers.

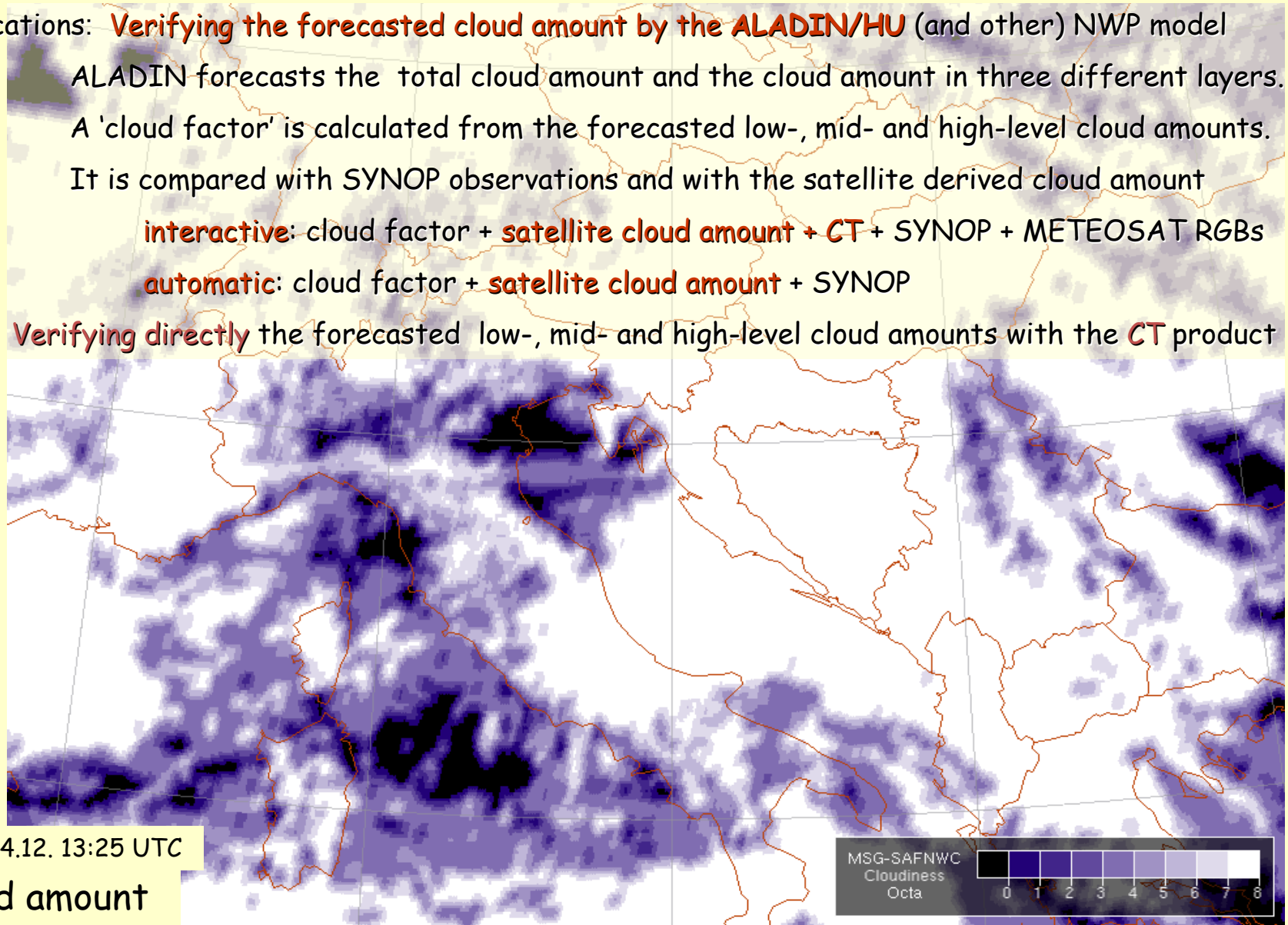
A 'cloud factor' is calculated from the forecasted low-, mid- and high-level cloud amounts.

It is compared with SYNOP observations and with the satellite derived cloud amount

interactive: cloud factor + **satellite cloud amount** + **CT** + SYNOP + METEOSAT RGBs

automatic: cloud factor + **satellite cloud amount** + SYNOP

Plan: **Verifying directly** the forecasted low-, mid- and high-level cloud amounts with the **CT** product



2010.04.12. 13:25 UTC

Cloud amount

Cloud products CMa CT CTTH

Interactive applications: Interactive applications

Visualization regularly in HAWK software for

- the forecasters
- verification of NWP forecasts, simulations
- evaluation of case studies

Duty forecasters

Winter period looking CT mainly to see the foggy areas (beside RGBs)

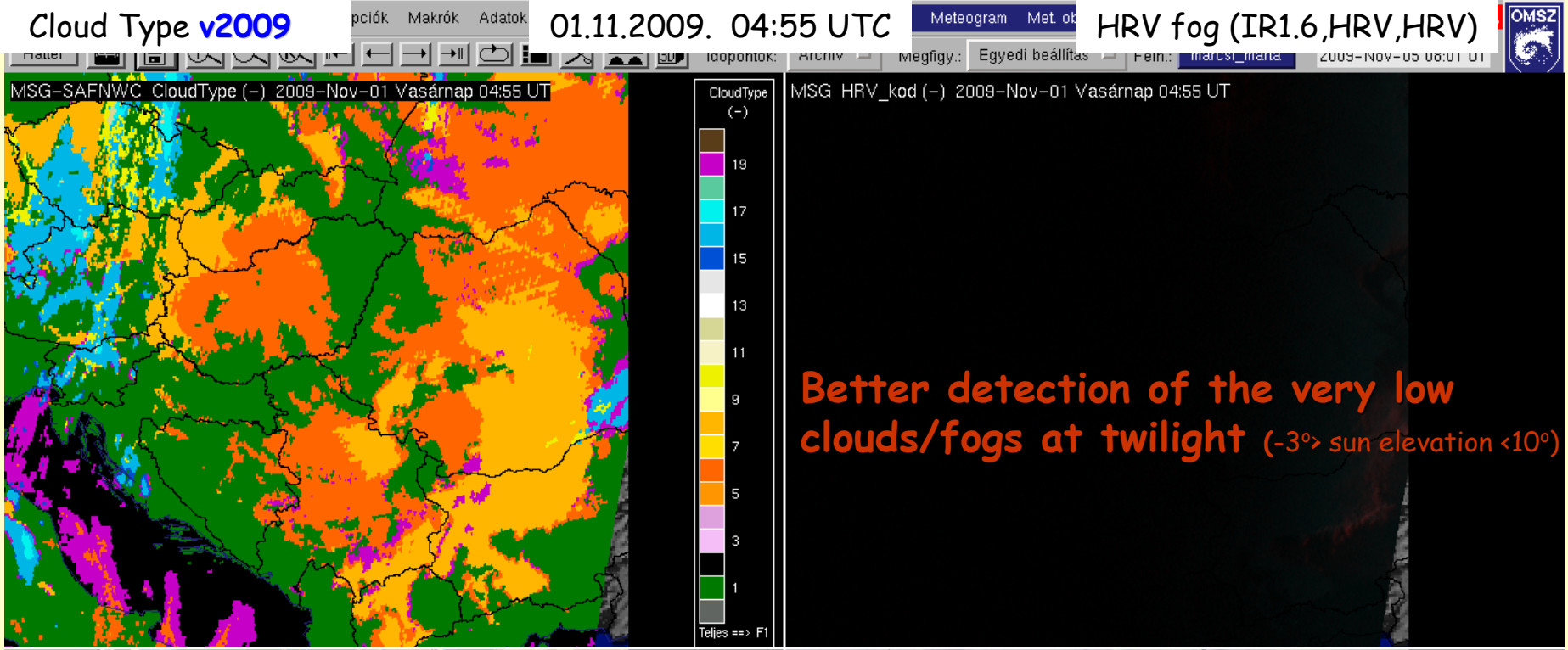
All year aviation meteorologists use CTTH to see the cloud top height (beside radar cloud top height) (eg. in-cloud icing)

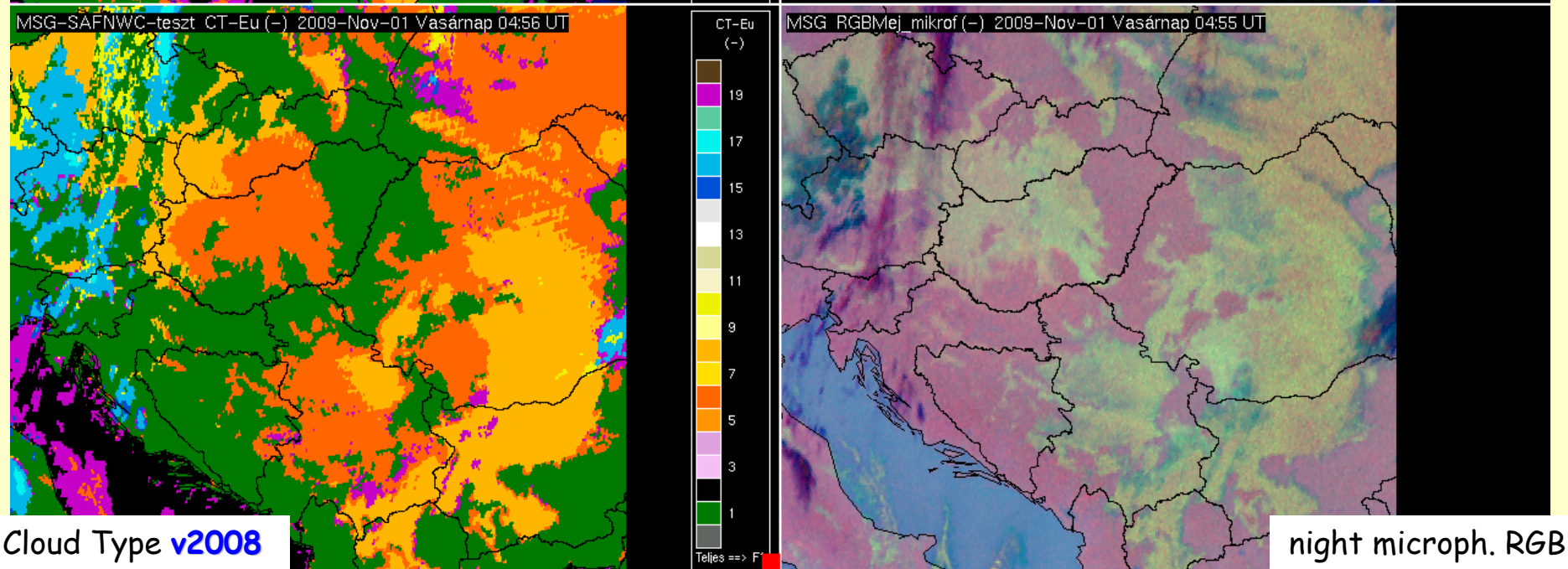
We show examples of **recent improvement** in CT, which are important **both in automatic and interactive** applications.

Cloud Type **v2009**

01.11.2009. 04:55 UTC

HRV fog (IR1.6,HRV,HRV)





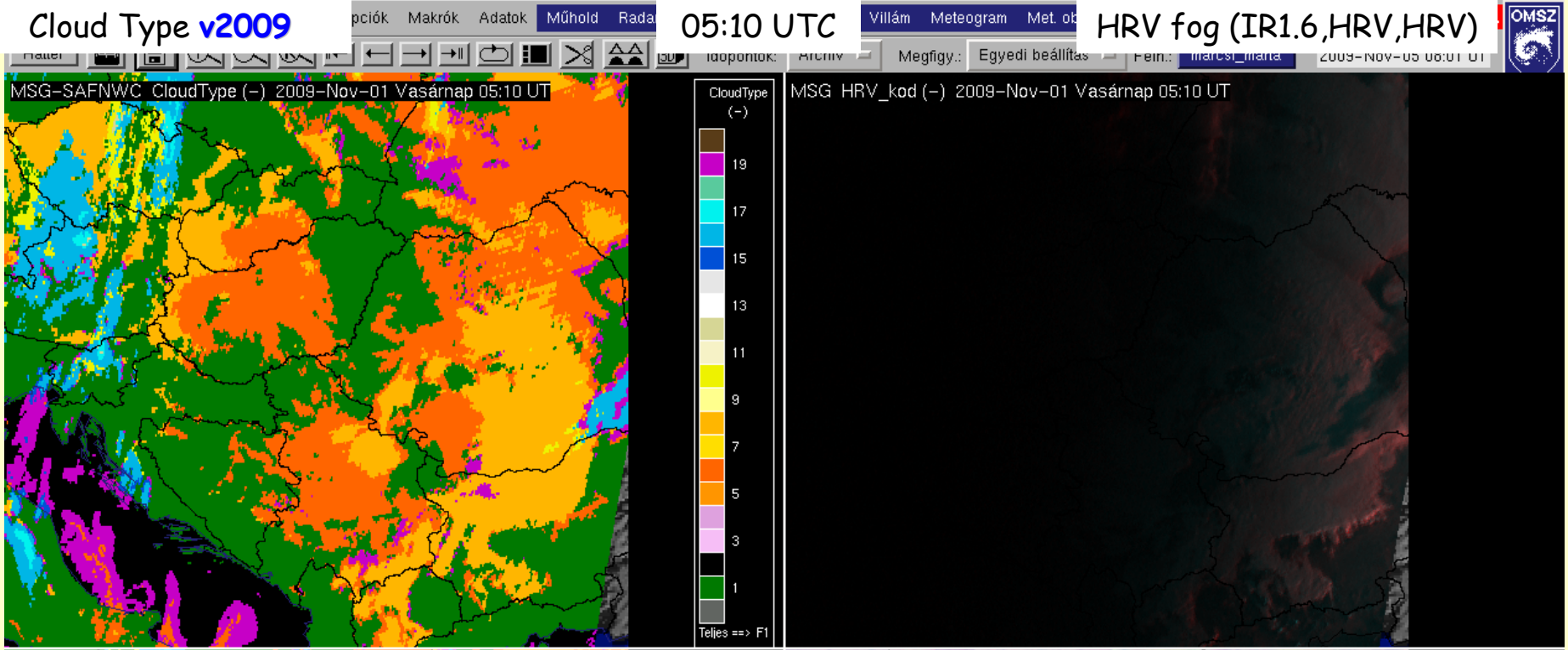
Cloud Type **v2008**

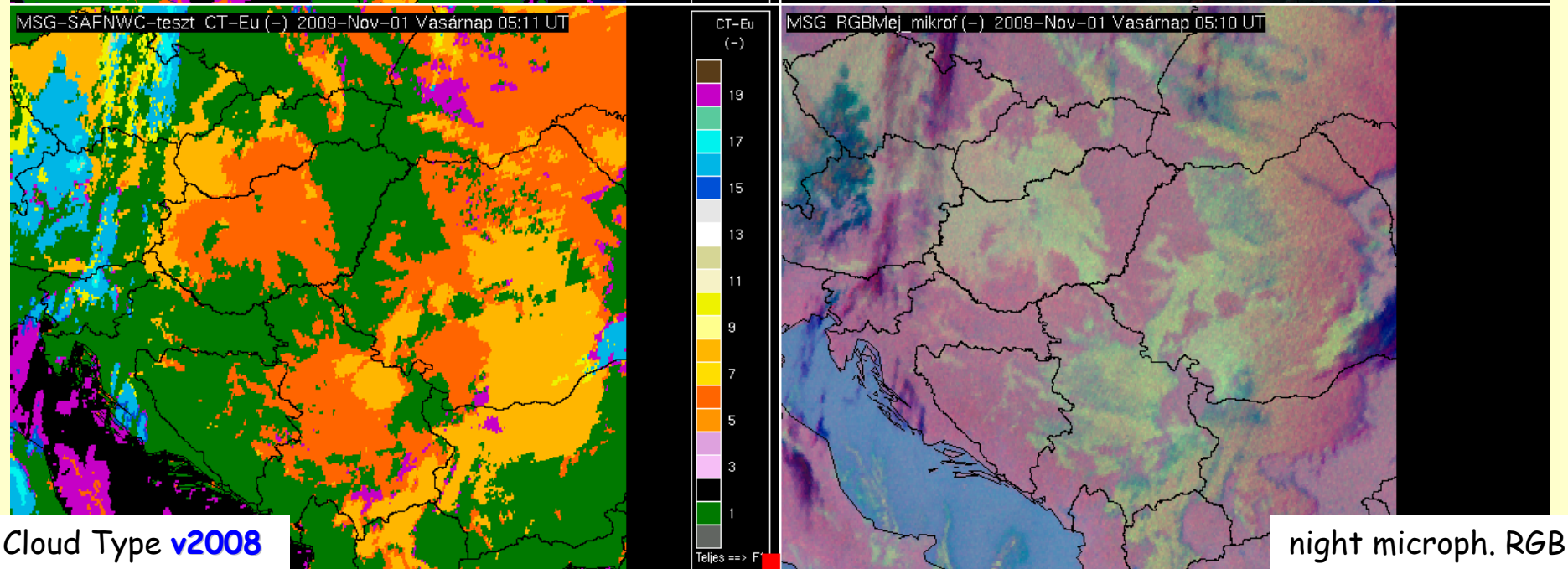
night microph. RGB

Cloud Type **v2009**

05:10 UTC

HRV fog (IR1.6,HRV,HRV)





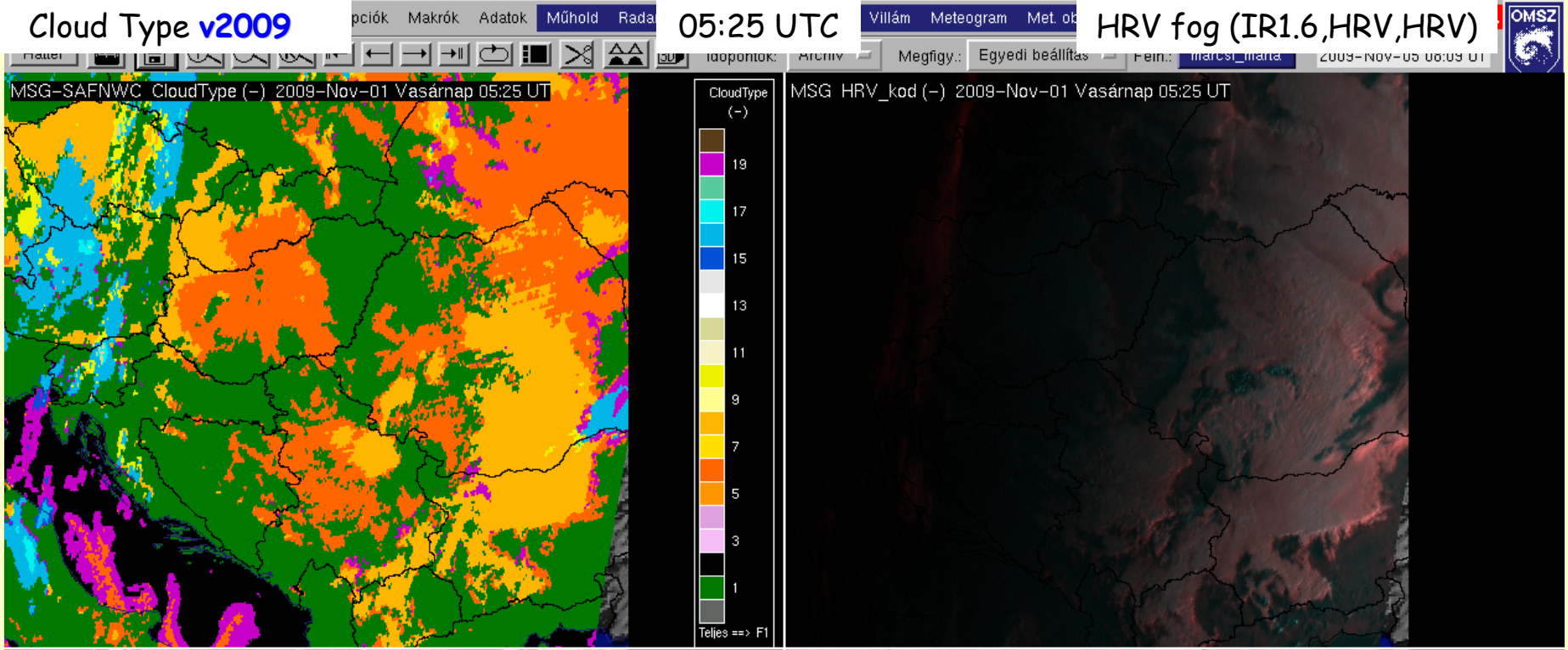
Cloud Type **v2008**

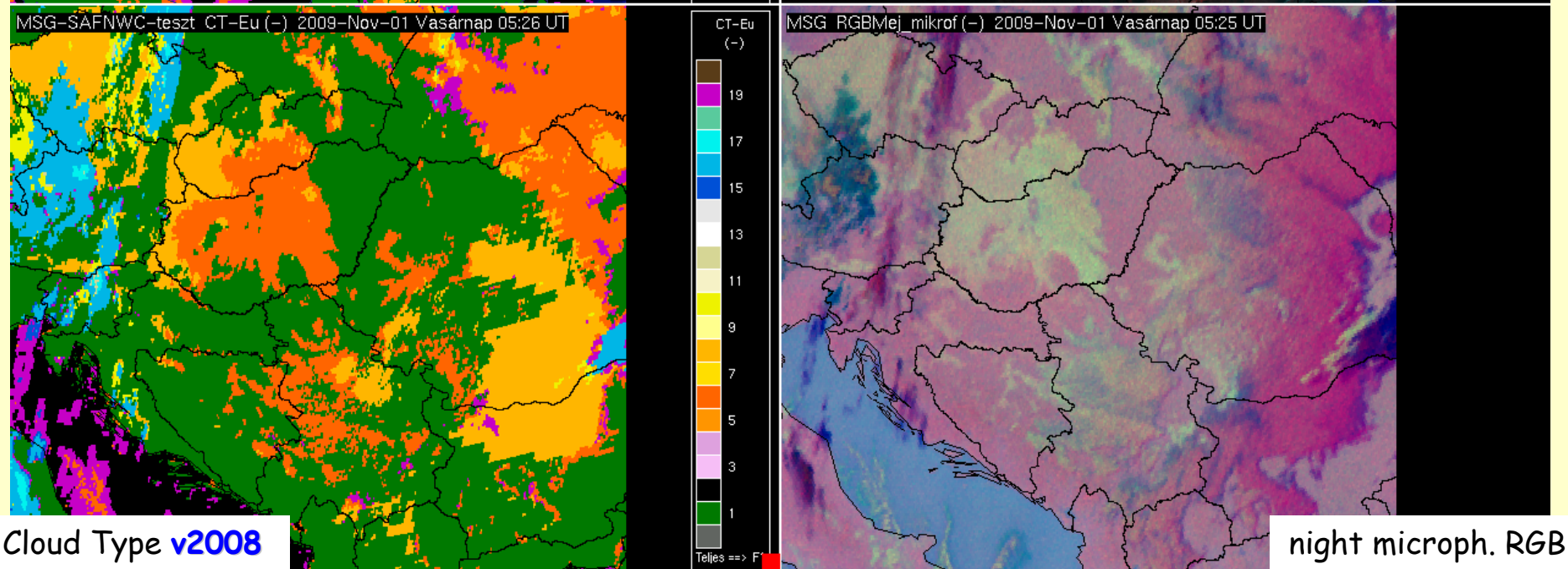
night microph. RGB

Cloud Type **v2009**

05:25 UTC

HRV fog (IR1.6,HRV,HRV)





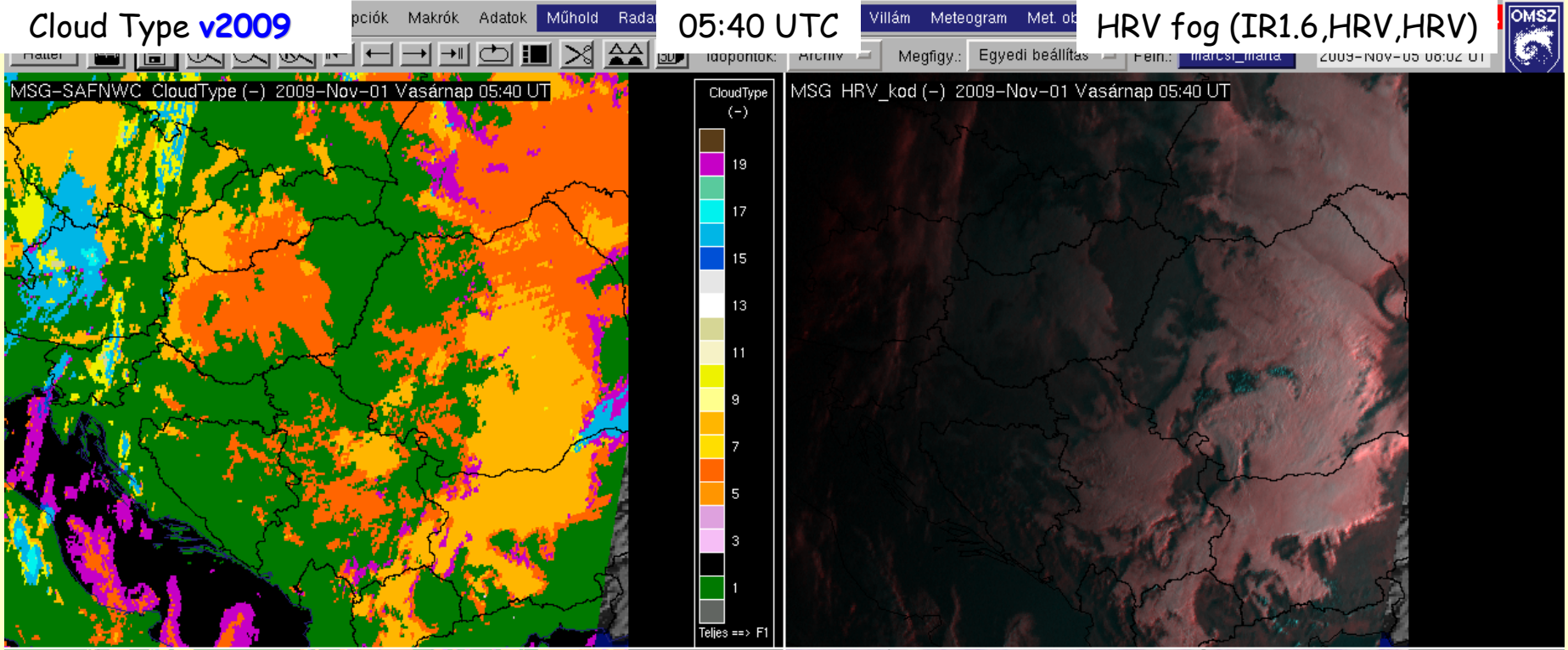
Cloud Type **v2008**

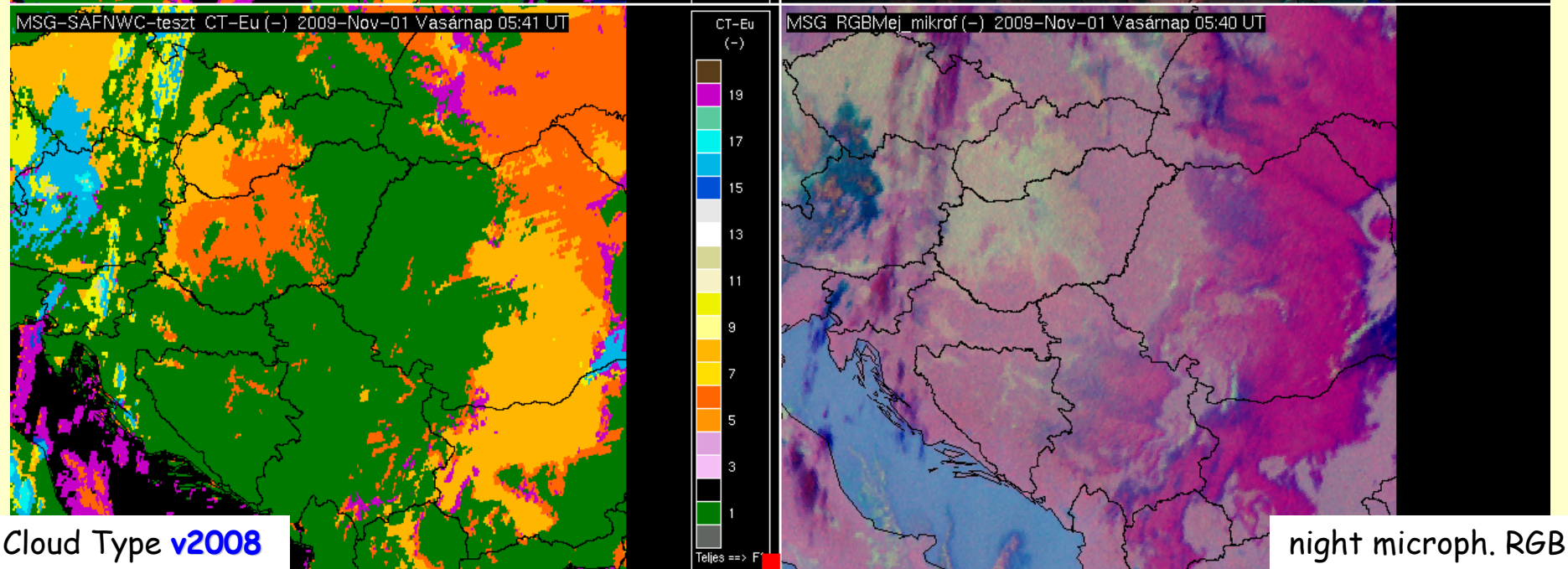
night microph. RGB

Cloud Type **v2009**

05:40 UTC

HRV fog (IR1.6,HRV,HRV)





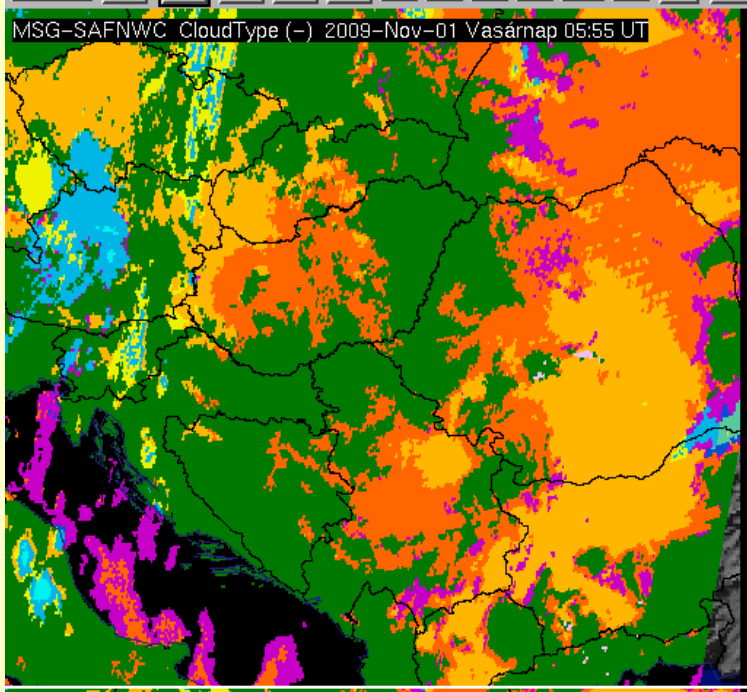
Cloud Type **v2008**

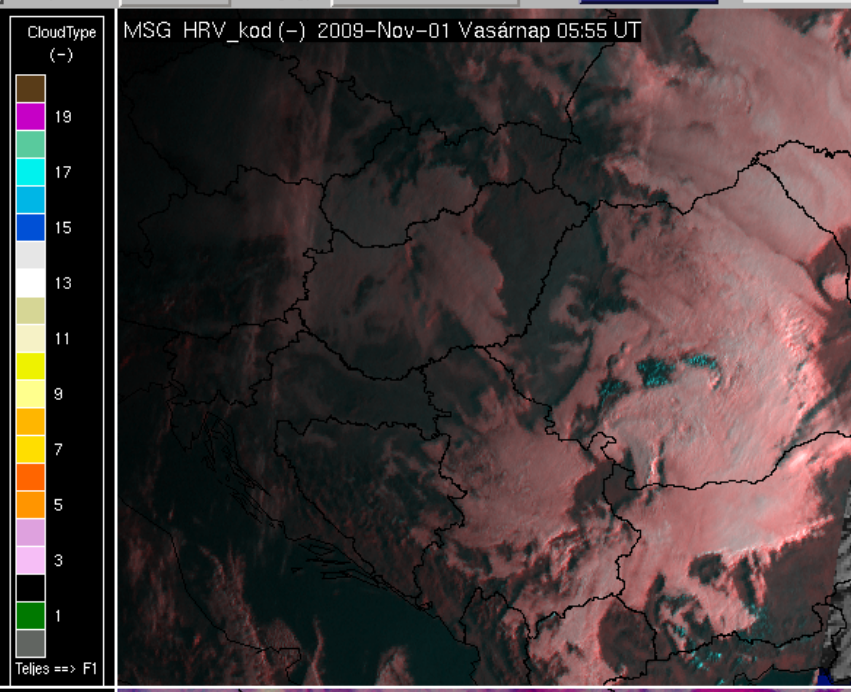
night microph. RGB

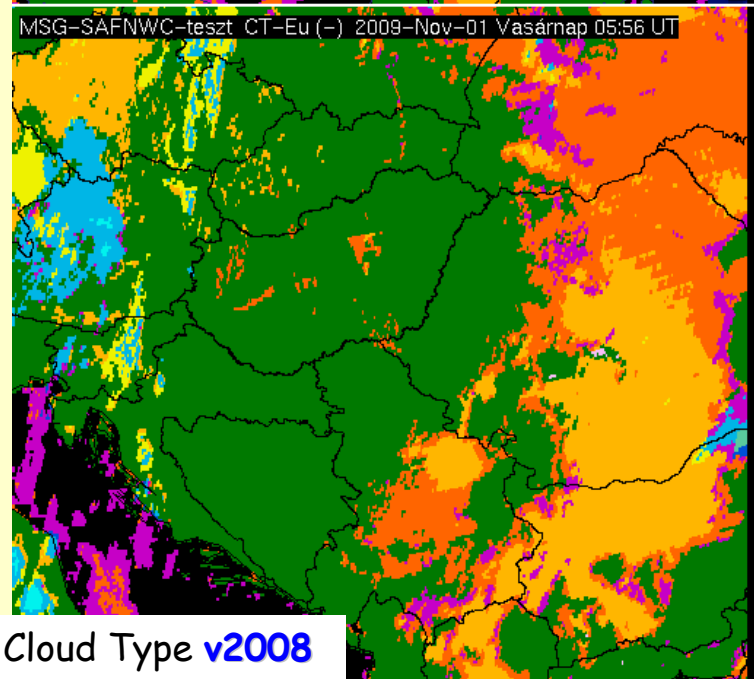
Cloud Type **v2009**

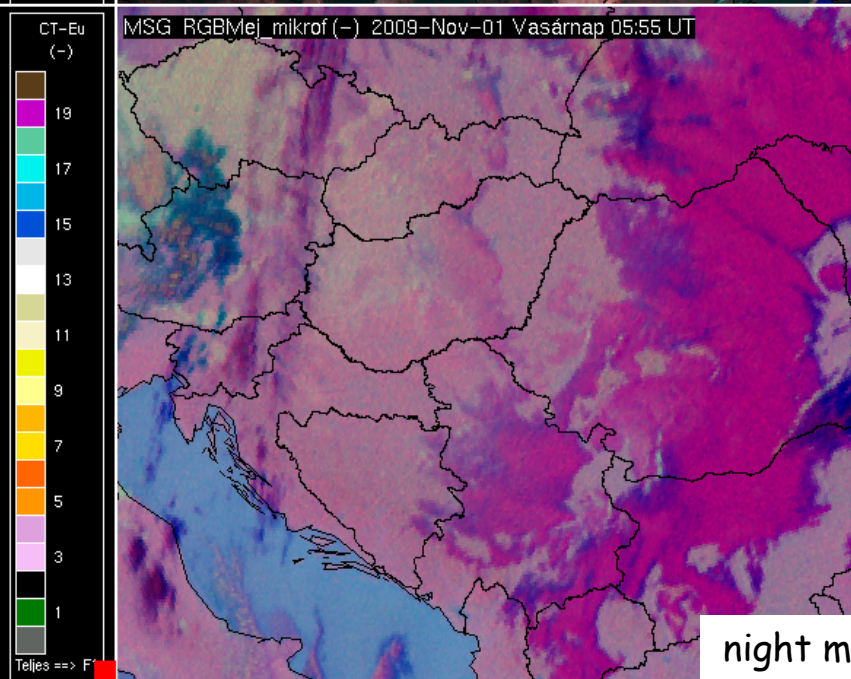
05:55 UTC

HRV fog (IR1.6,HRV,HRV)









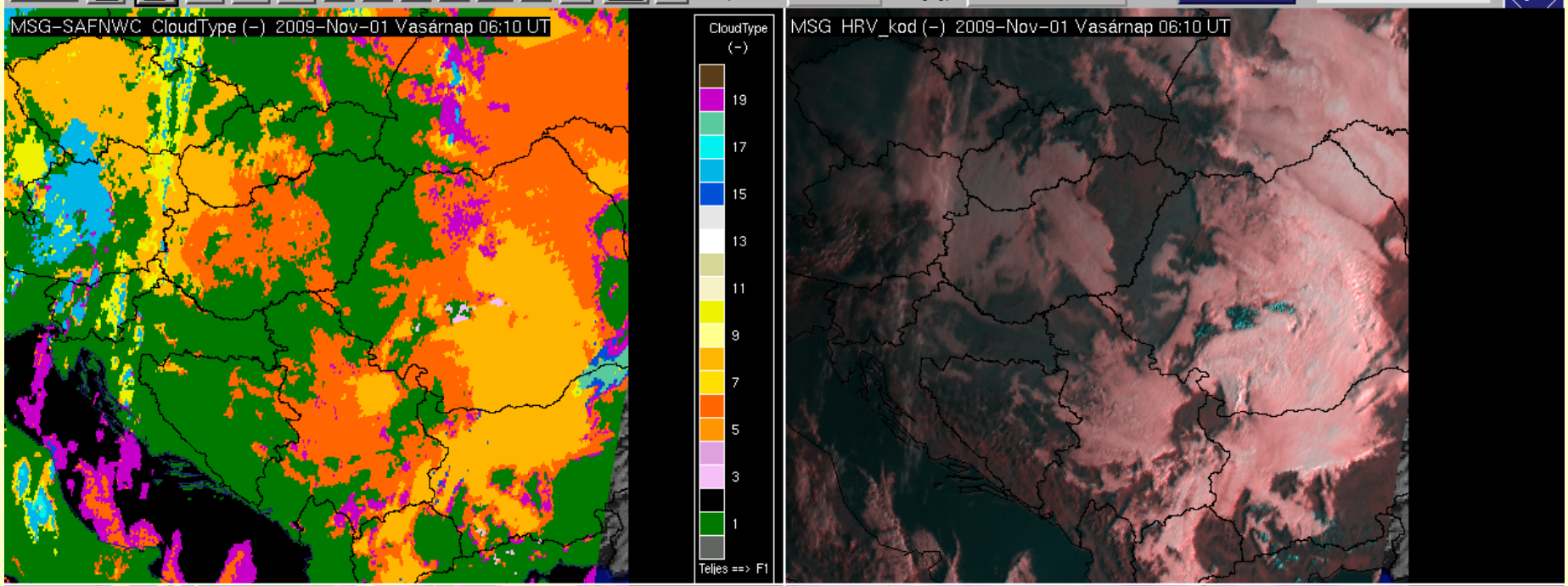
Cloud Type **v2008**

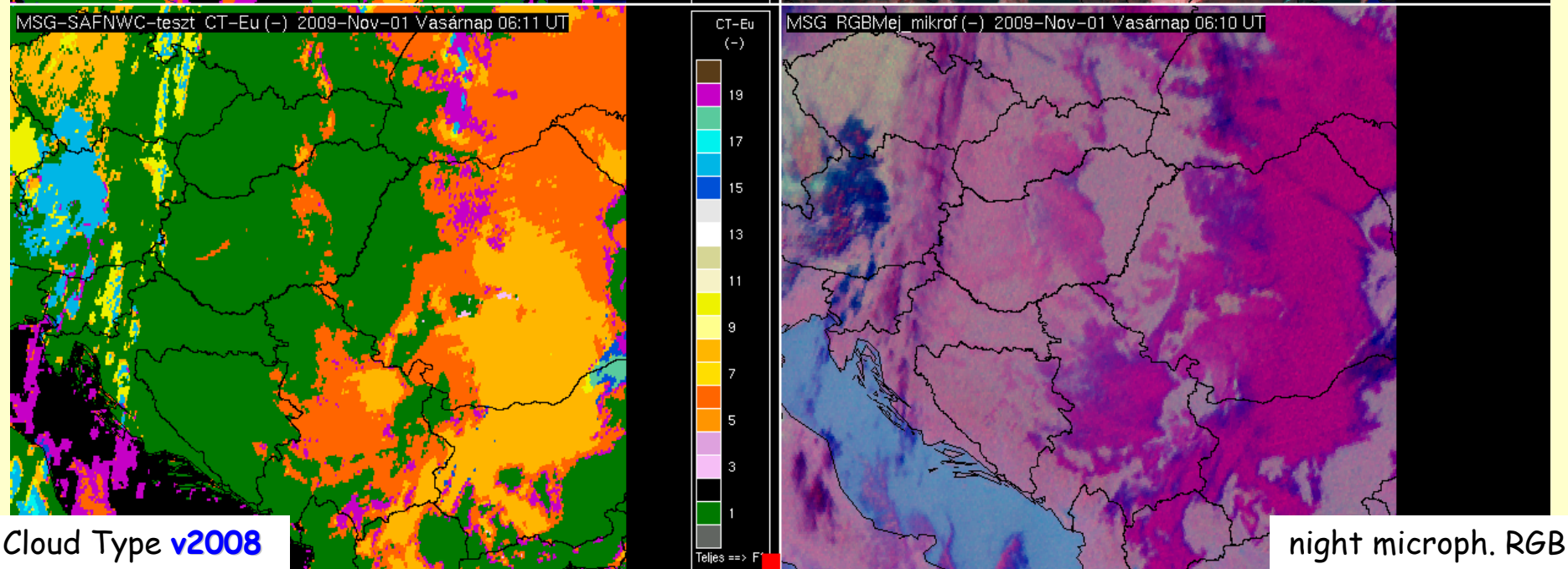
night microph. RGB

Cloud Type **v2009**

06:10 UTC

HRV fog (IR1.6,HRV,HRV)





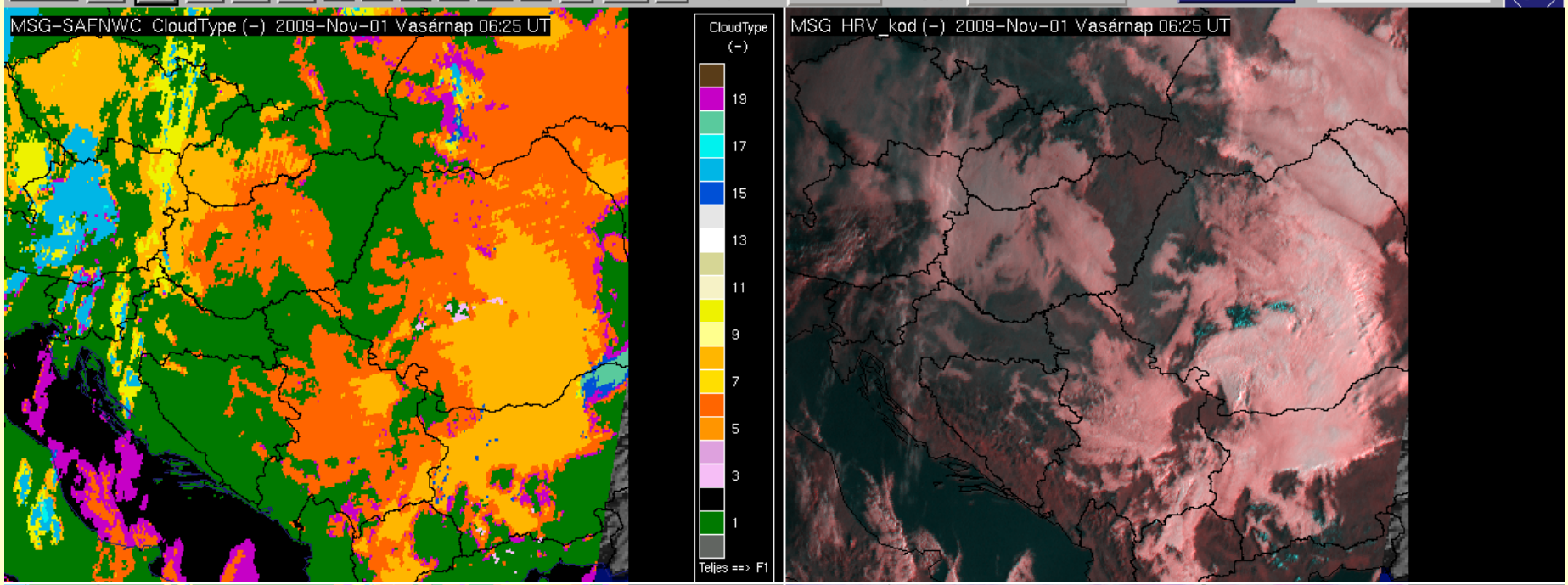
Cloud Type **v2008**

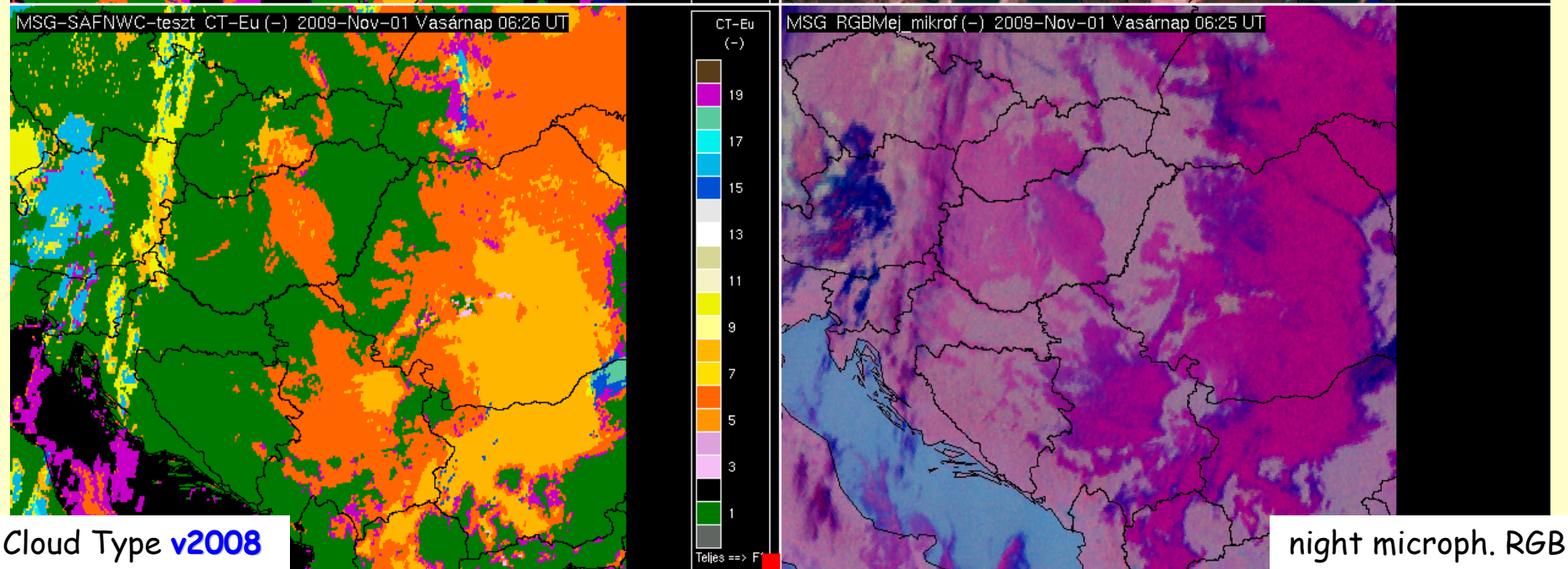
night microph. RGB

Cloud Type **v2009**

06:25 UTC

HRV fog (IR1.6,HRV,HRV)





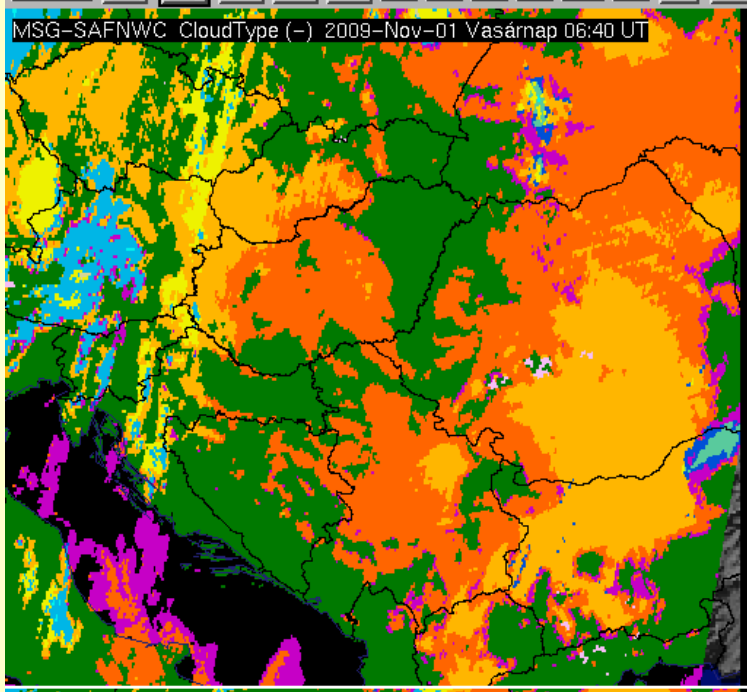
Cloud Type **v2008**

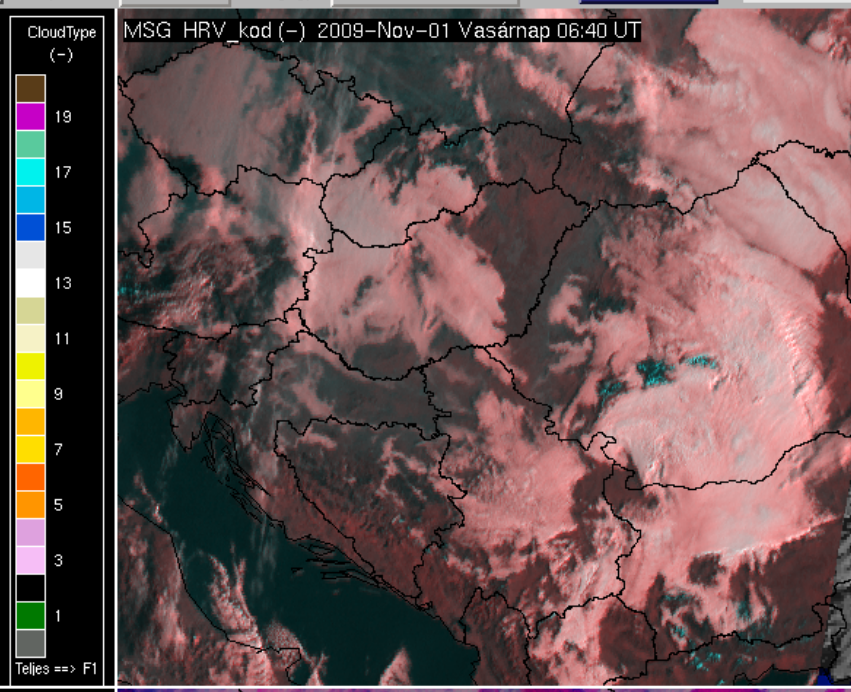
night microph. RGB

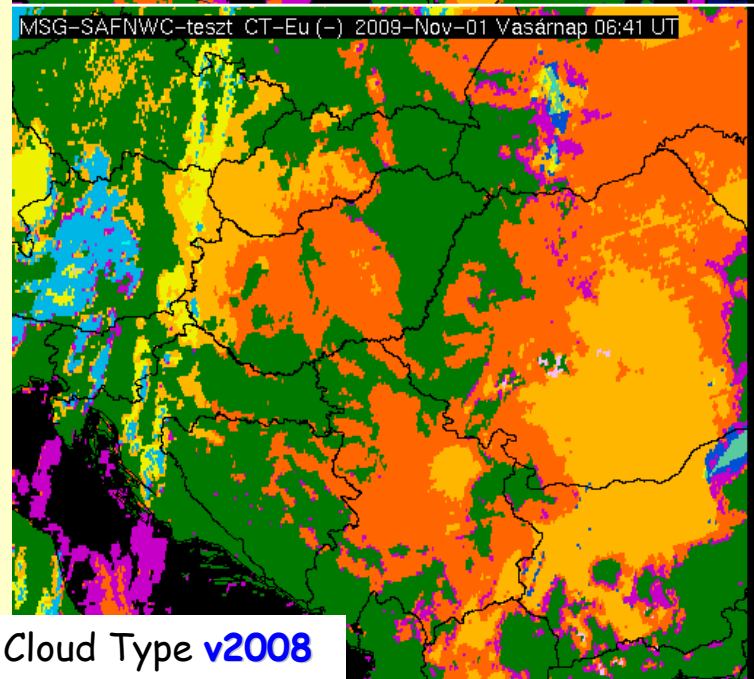
Cloud Type **v2009**

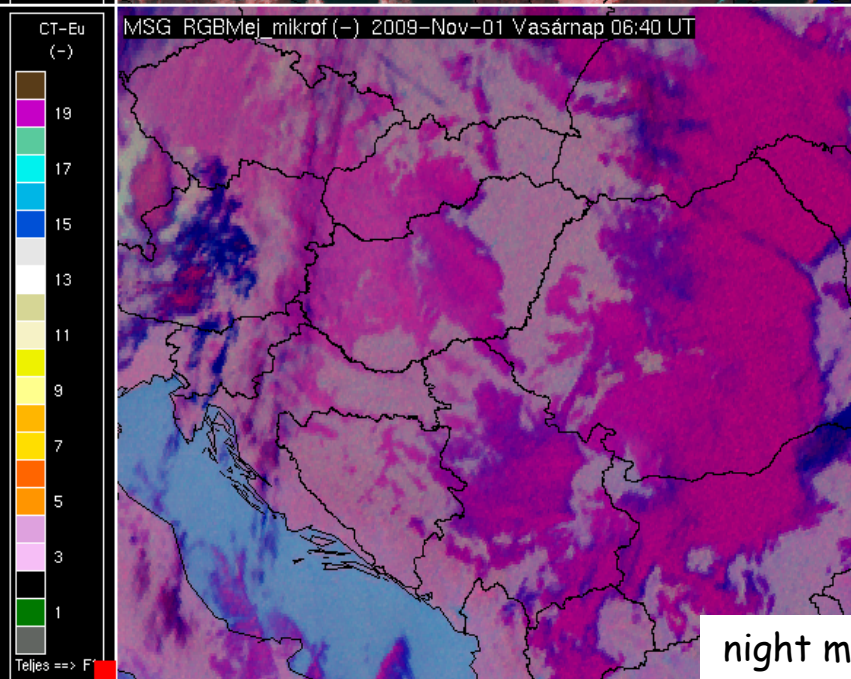
06:40 UTC

HRV fog (IR1.6,HRV,HRV)









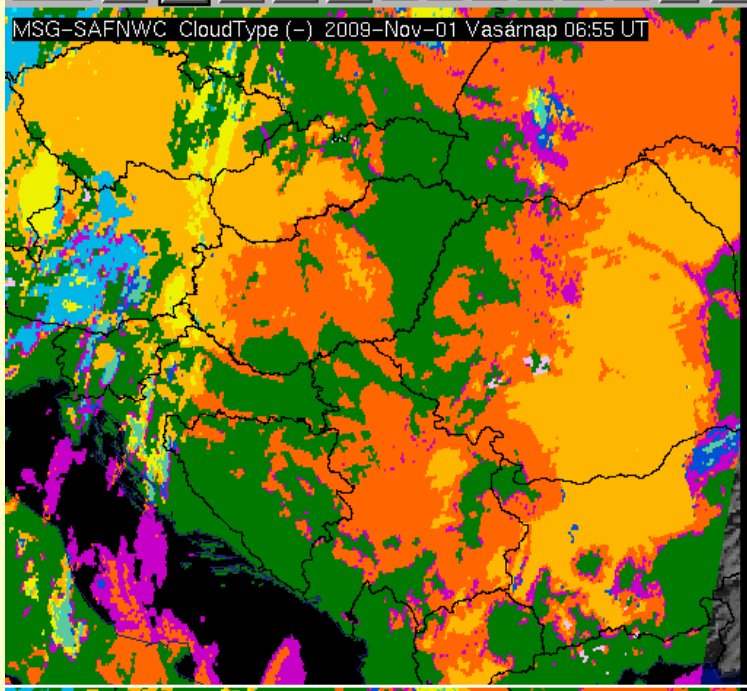
Cloud Type **v2008**

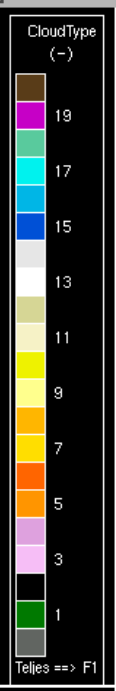
night microph. RGB

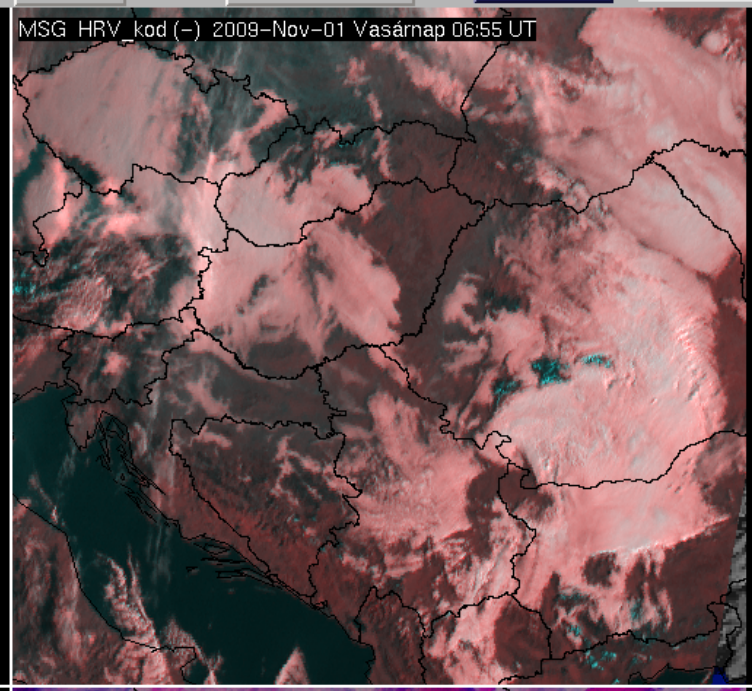
Cloud Type **v2009**

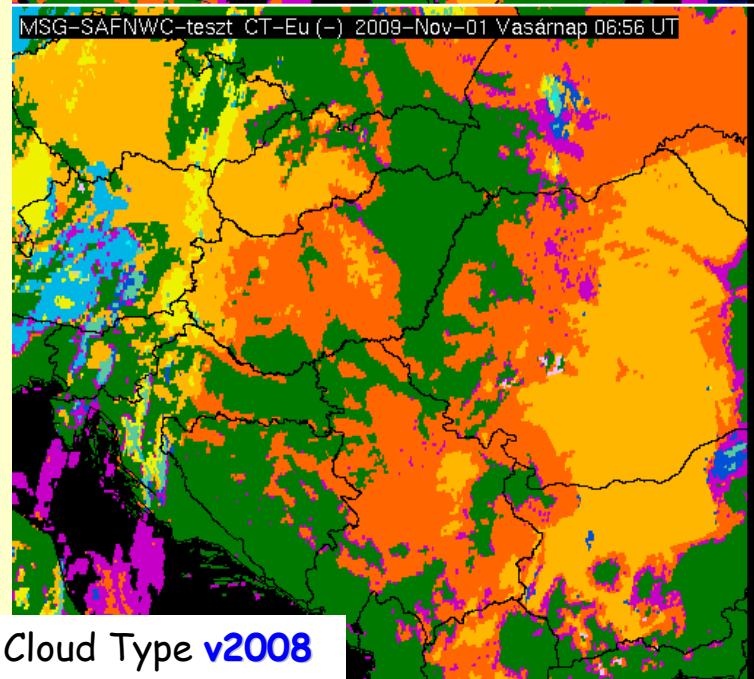
06:55 UTC

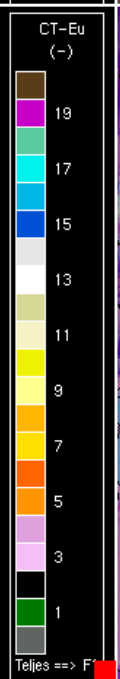
HRV fog (IR1.6,HRV,HRV)

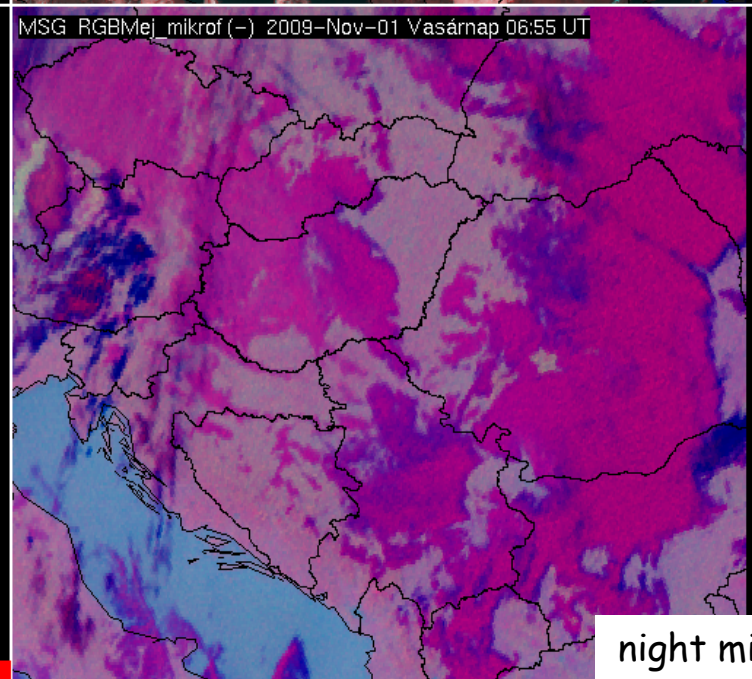






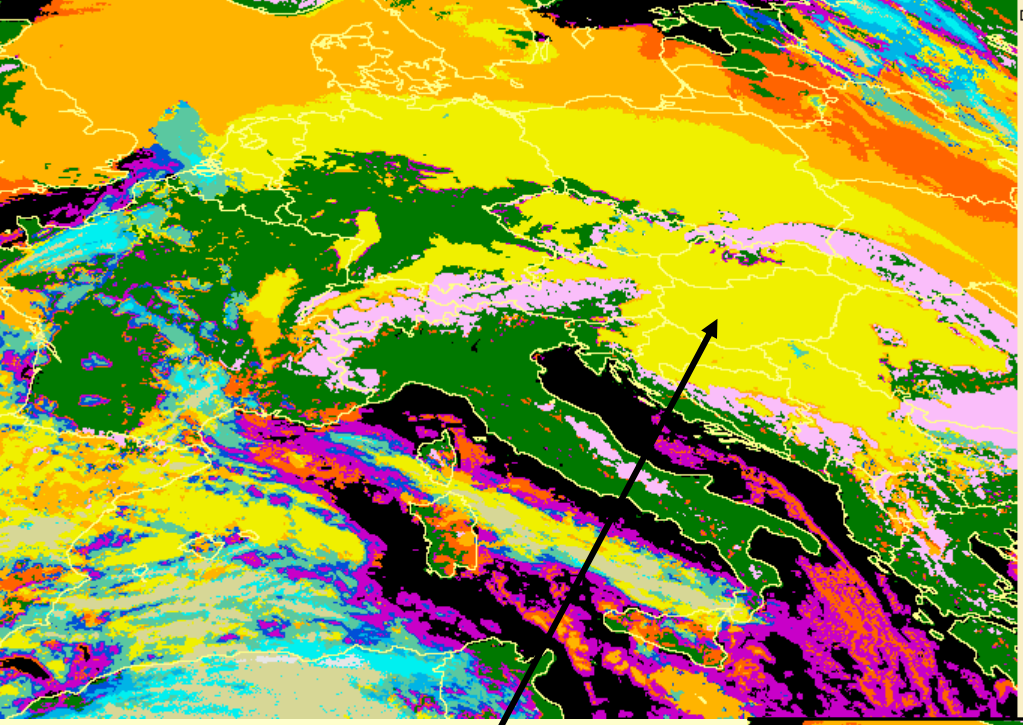






Cloud Type **v2008**

night microph. RGB



Cloud Type v2009

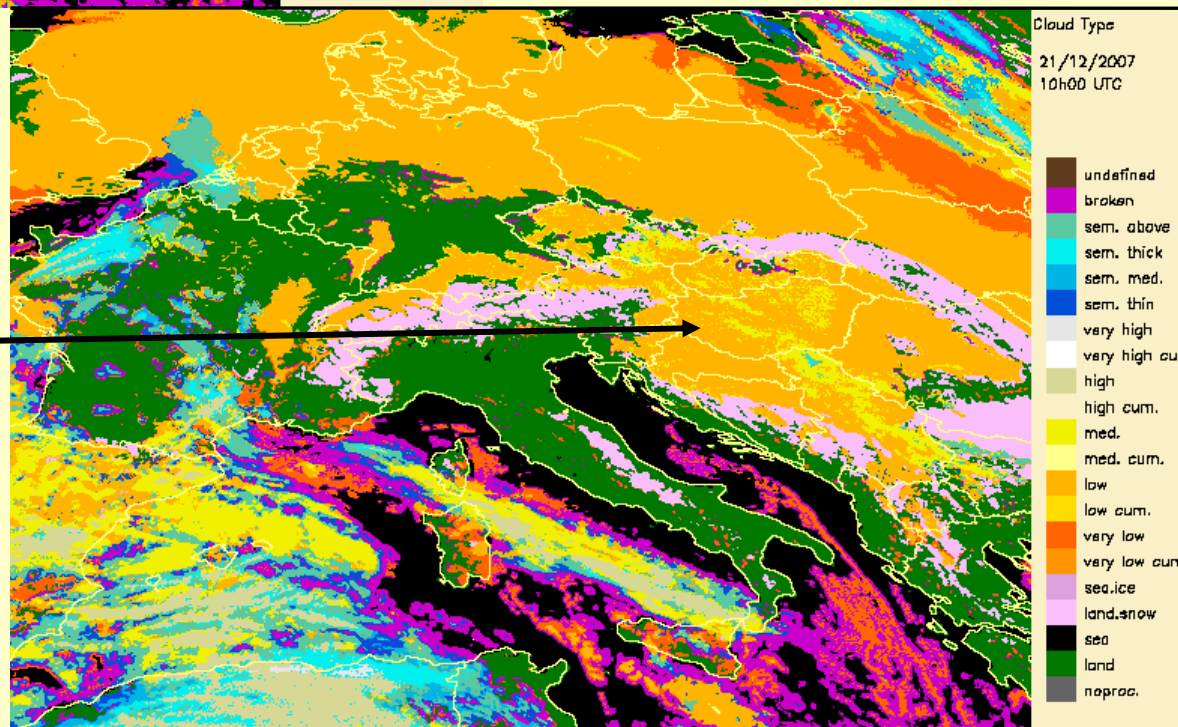
METEO FRANCE
Toujours un temps d'avance

We look forward to the version 2010 improvement of the CT in cold air pool situation (temperature inversion).

Cold air pool situation in the Carpathian basin 21 December 2007

Mid-level cloud

Low-level cloud



Cloud Type v2010

Suggestions how to improve the cloud product?

CMa

1. Improve the dust and vulcanic ash flags by using the new visible and NIR channels on MTG

CT

1. Improvement of nighttime separation of cloud-free and cloudy pixels over snowy areas
2. Improve the detection of very thin cirrus with the MTG new NIR1.3 channel and better spatial resolution
3. Improve the separation between the very thin semitransparent clouds and fractional clouds (with MTG NIR1.3)
4. With better very thin cirrus detection more pixels will be in the very thin Cirrus CT class. However, there is some possibility to see surface/lower level cloud features through very thin semitransparent clouds. It would be nice not to loose this information.
   - Add a class 'snow under very thin cirrus cloud'.
5. Maybe add a partial snowy land class, to detect the snowy forests
   using land use map + different thresholds for forested areas + looking the neighborhood?
6. Use the new NIR2.2 channel of MTG to improve the snow detection

Suggestions how to improve the NWC SAF cloud product – cont.

CT

•**Separation of cumuliform and stratiform** clouds in the opaque cloud classes. It might be easier with the *higher spatial resolution* of MTG. The separation could be useful for example in case of dry convergence lines (with no radar signal, only satellite). The cumuliform pattern, its temporal evolution could refer to strong wind

•**Cloud top microphysics** - beside the cloud top phase the **effective radius** of the cloud top particles also can hold useful information for (interested) forecasters, researchers (for example on storm severity, or for verification of the numerical simulation results).

Interesting field of research,

The new channel NIR2.2 will help to retrieve even more accurate effective cloud top particle size values

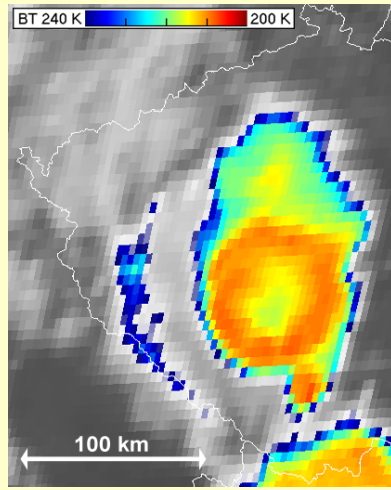
CTTH

•To recommend **officially** the users to use the **NWP model up to 100 hPa** – it would give more accurate results for CTTH

•Storms penetrating into the tropopause, lower stratosphere -- see **next slide**

Severe storm features

Cold ring, cold U/V features, overshooting tops, …



Why are these features interesting?
Why could be useful to detect them within the NWC SAF activity?

1.
These features may be indicators of the **storm severity** (not always) - **warning**
Intense fields of **research**

- relation of these features to storm severity
- relation between cloud top microphysics (phase, effective radius) and storm severity/precipitation

there are not yet ready methods for automatic applications – but in 7 years….
Later - Use in RDT as possible severity indicator???

Wrong concept !!!

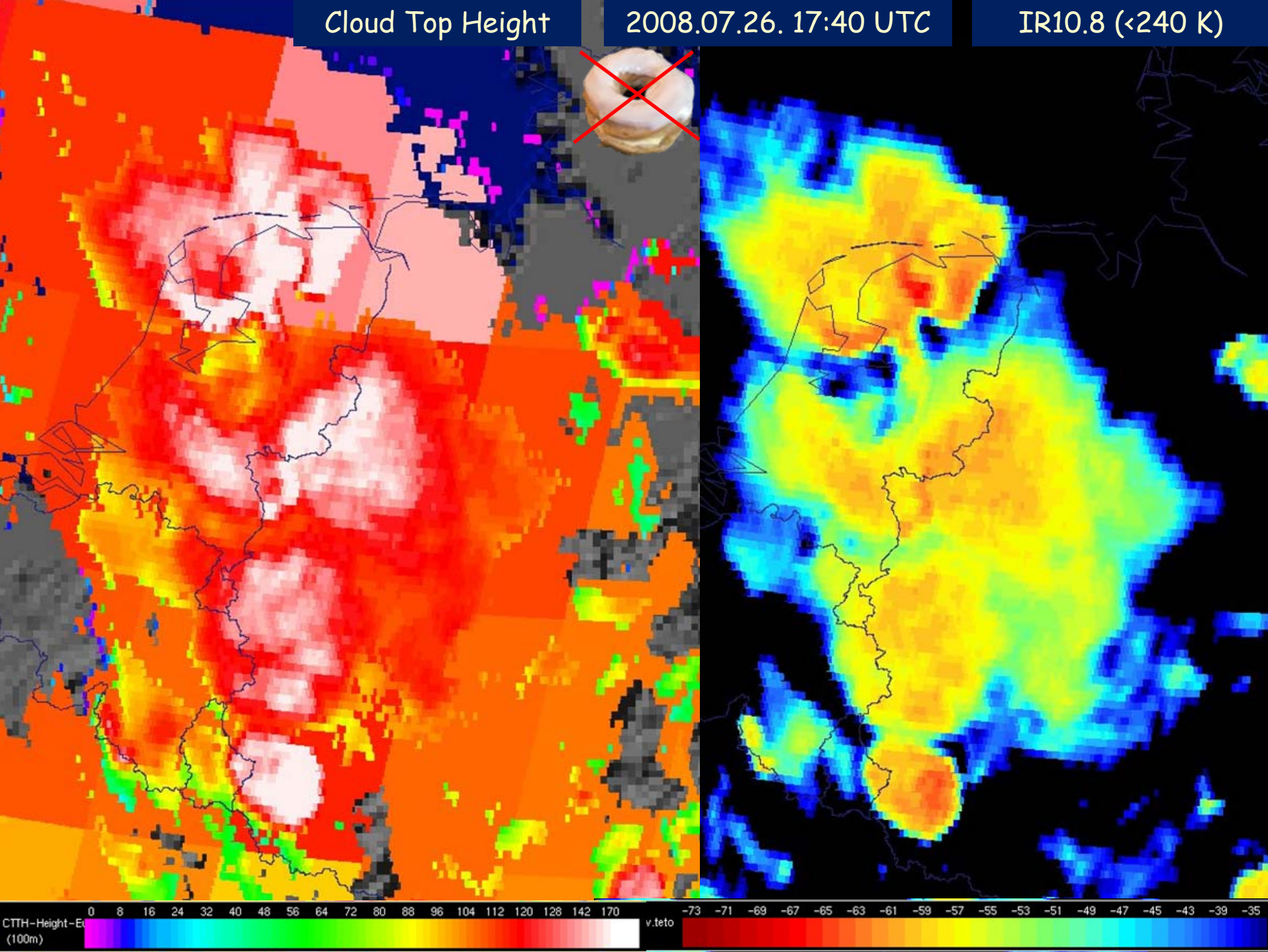
☺ ☺ ☺

2.
These features can 'spoil' some products **CTTH**, **CRR**, (PC)
Why?
Storm penetrated in the tropopause, lower stratosphere (temperature inversion)
Cloud top may be not in thermal equilibrium with the environment

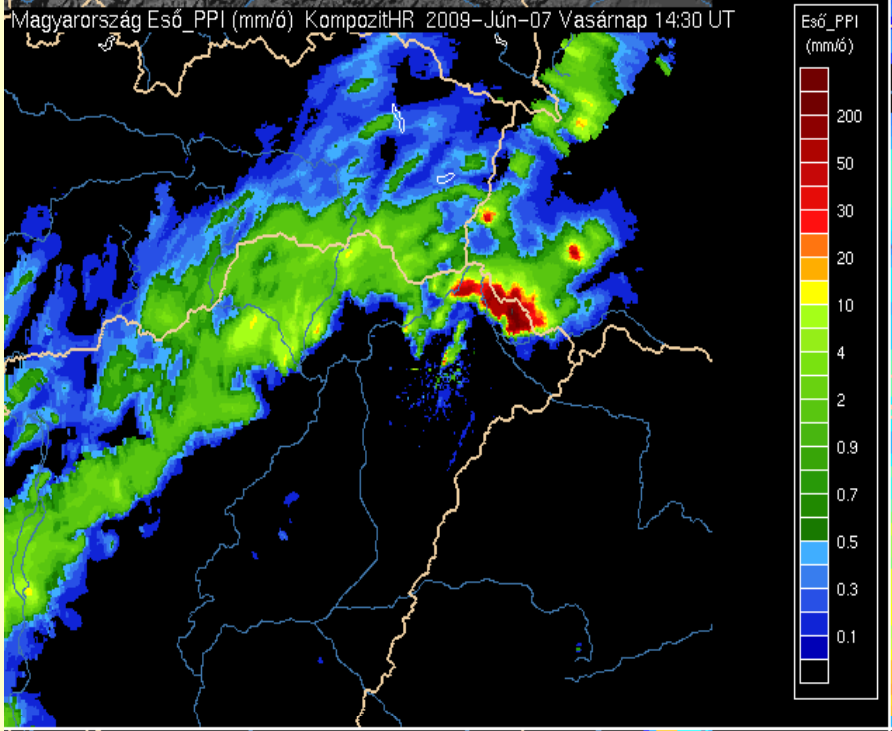
- Overshooting top – very cold due to adiabatic cooling (colder)
- Warm spots inside the cold ring, cold U/V features are warmer

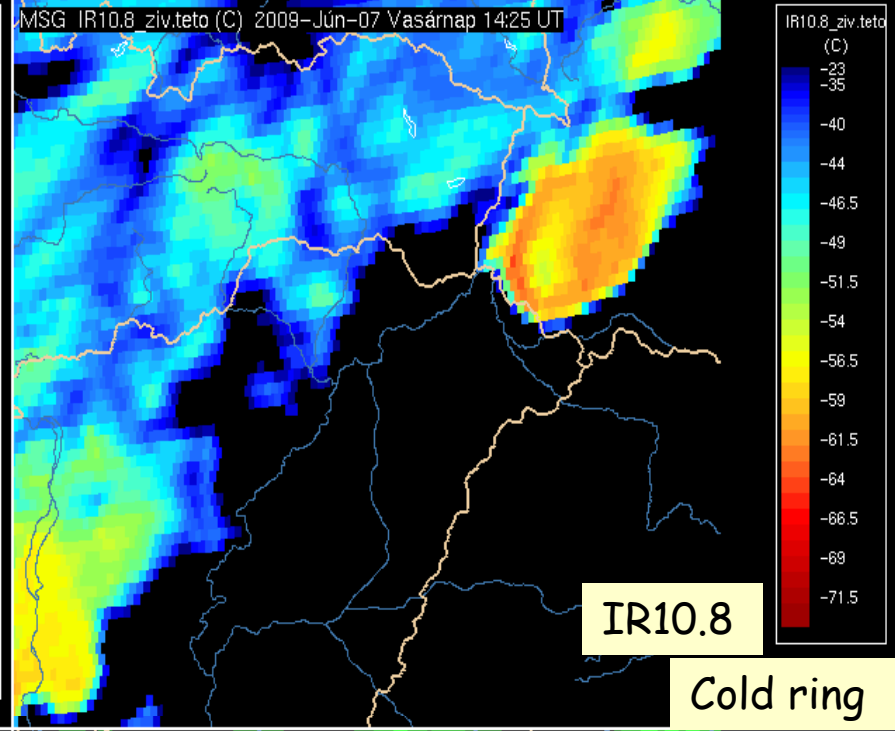
>>>
Difficult to estimate the **cloud top height/pressure**, one cannot retrieve them using only the profile (T,z/p) of the environment

Through the brightness temperature the feature could be seen also in **CRR**, **PC**
(More often seen in CRR then in PC, CRR seem to depend more strongly on IR10.8 TB then PC day)
What to do with the mistaken cloud top products??? For example detect the ring and fill in the cloud top height????

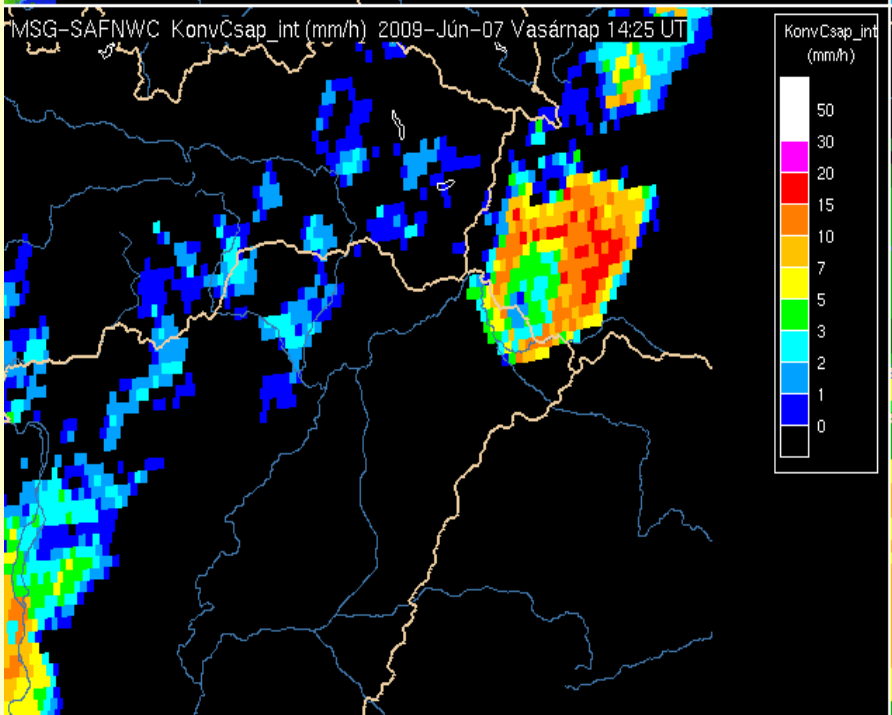

Cloud Top Height
2008.07.26. 17:40 UTC
IR10.8 (<240 K)
0 8 16 24 32 40 48 56 64 72 80 88 96 104 112 120 128 142 170
CTTH-Height-E
(100m)
-73 -71 -69 -67 -65 -63 -61 -59 -57 -55 -53 -51 -49 -47 -45 -43 -39 -35
v.teto

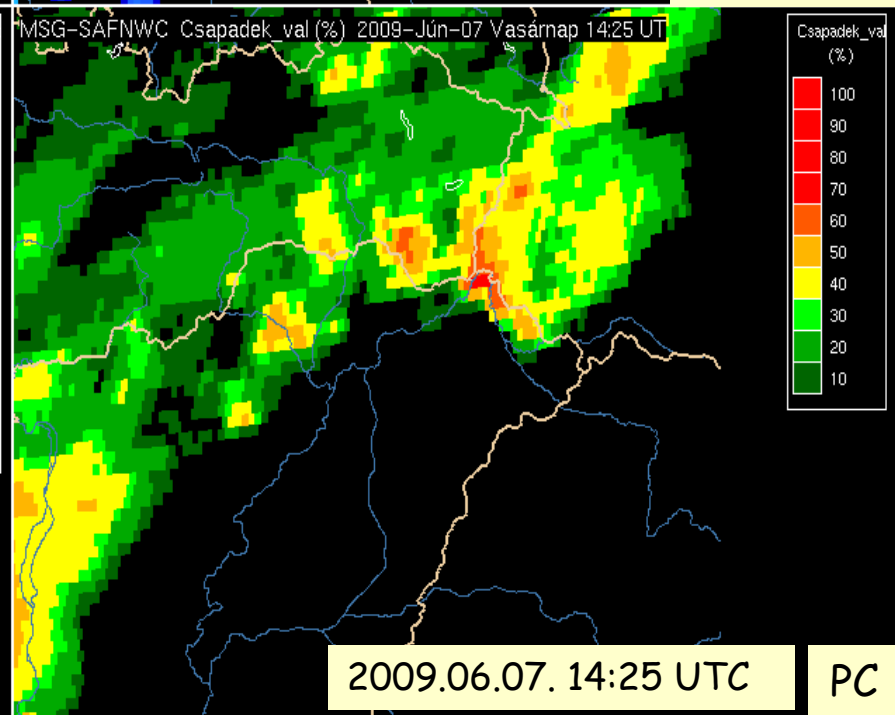
radar





Cold ring





CRR

2009.06.07. 14:25 UTC

PC

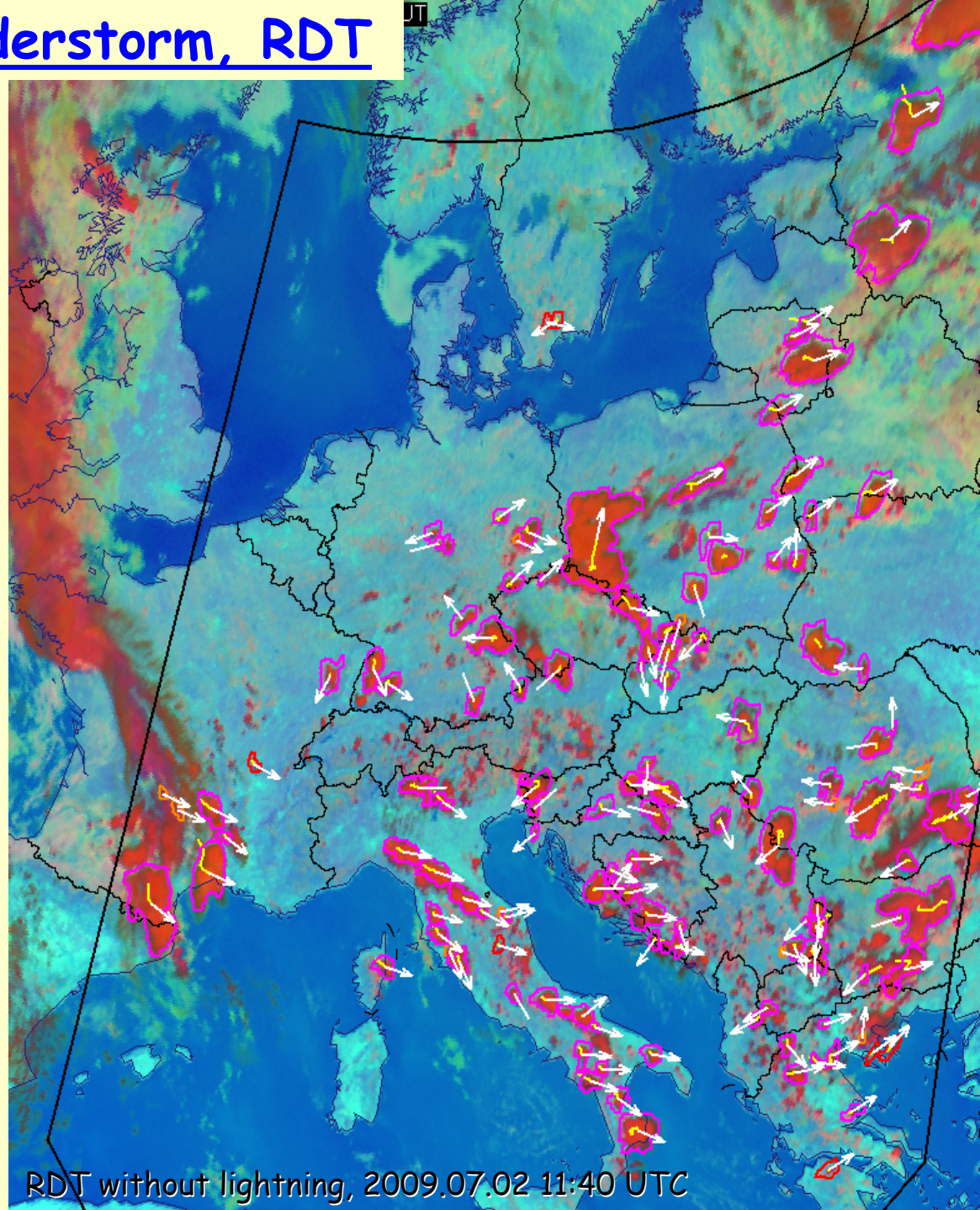
Rapid Developing Thunderstorm, RDT

Very important product – big **interest/need** for using it

- **interactively** by duty forecasters and researchers at case studies,
- **automatically** in the mesoscale nowcasting system.

RDT product is **much more reliable** now. It detects the **majority of the mature phase convective clouds**. The **time stability improved**.

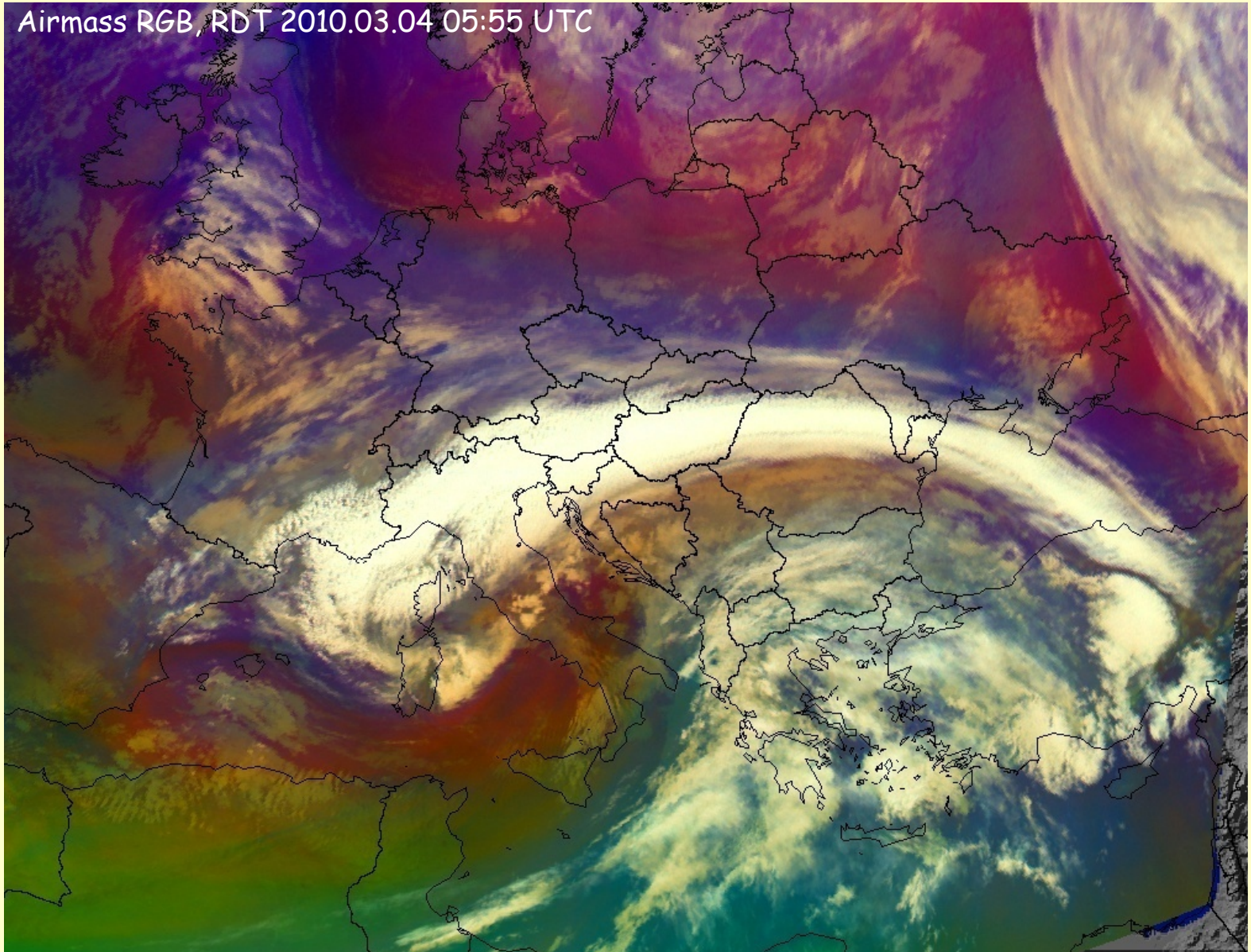
Not perfect yet, but due to the big interest we will past it routinely from this summer to the duty forecasters.



Requests, suggestions to the RDT developers:

Improve the reliability of **separation convective from non-convective cloud systems**.

Sometimes a huge part of a **front** is detected as convective. With this the automatic application could be problematic.



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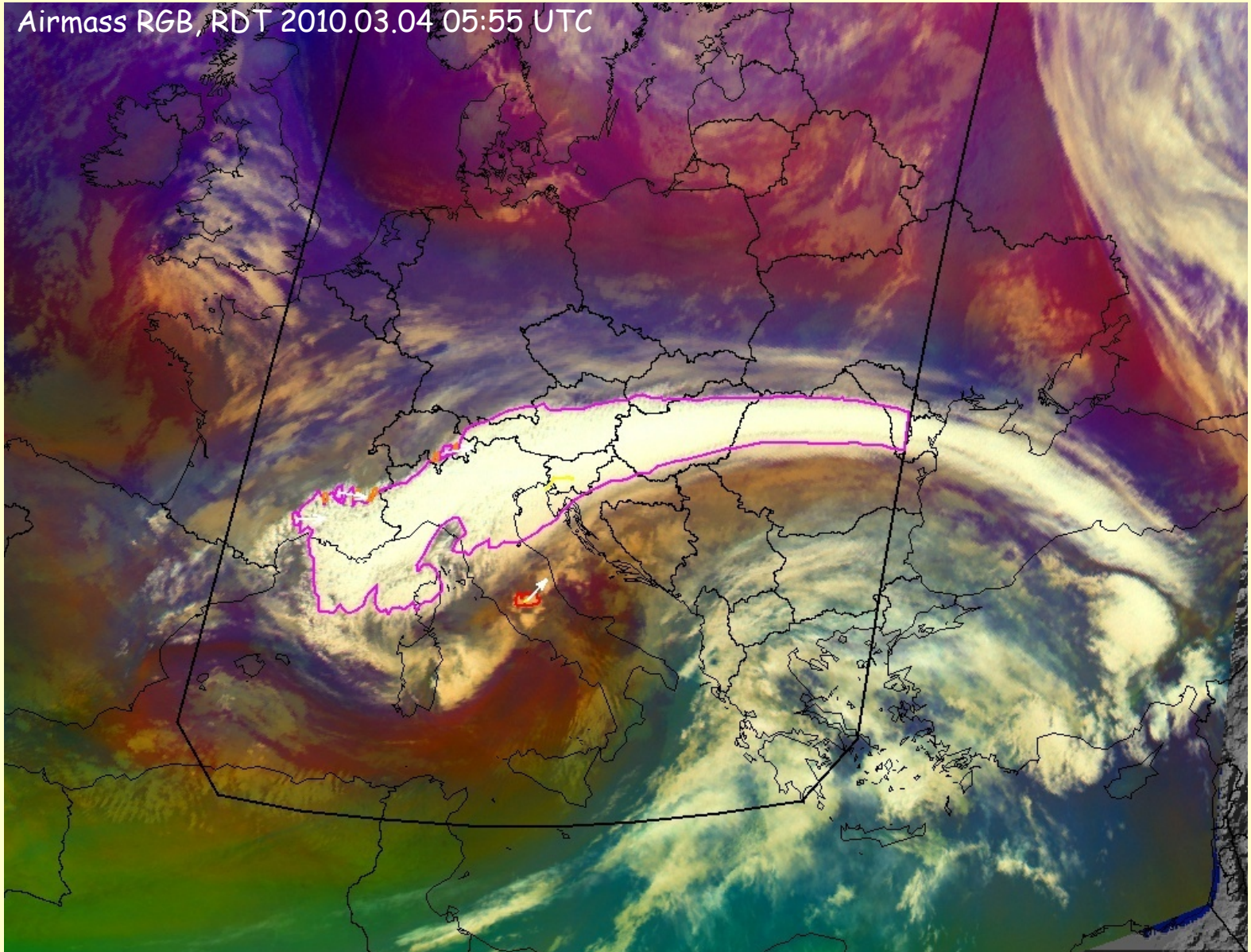


Requests, suggestions to the RDT developers:

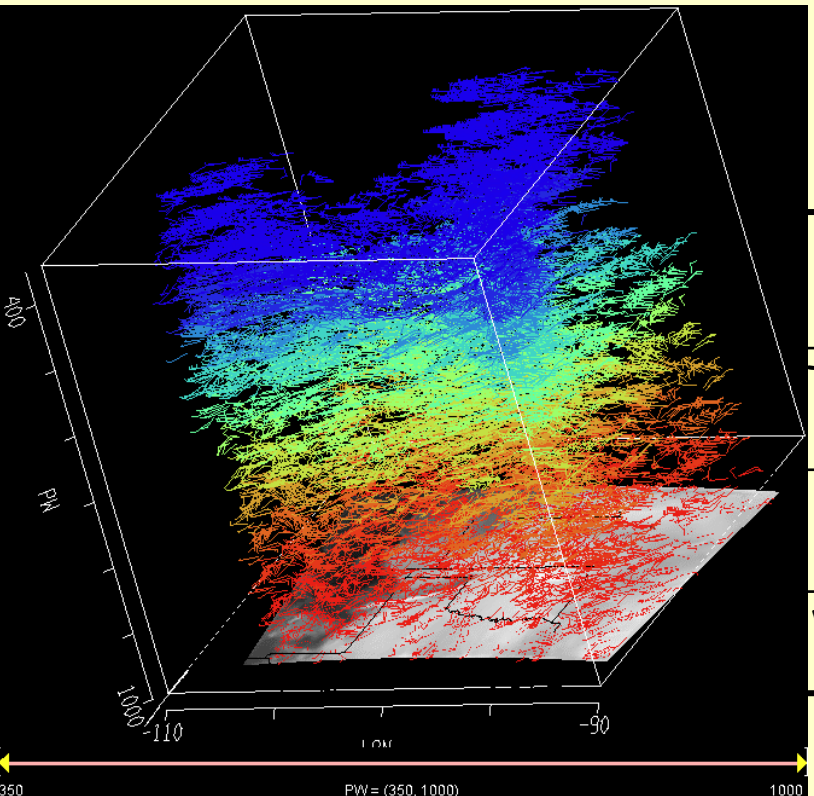
- Detect the convective cloud systems **as early as possible**. **(**Maybe with including HRV?)
  The **developing convective cells are often missed** without lightning input.
  The satellite information is the most useful in early stages of the convective cells, when no radar signal is available yet (no precipitation yet).
  Early detection would have the 'forecasting value'.
  However, in our case studies RDT without lightning input detected mostly only the mature phase objects (top T<=-40 °C).
  We recommend **running RDT with the optional lightning input** if possible.
- It might be useful a 'Lifting velocity' (vertical speed of the cloud top height lifting in m/sec).
  It is important mainly in the developing phase. RDT provides cooling rate. The lifting speed could be given additionally. Some forecasters feel it is more expressive.
- RDT would be even more useful in **5 minute time steps**.
- RDT is supposed to detect the towers of the cloud systems. However in some cases the **contour is too 'loose'**. We recommend improving the algorithm to get a contour not big for the cloud edge.
- Find a solutions for getting **smoother trajectories**

- Using **LI** data of MTG
- It would be the best to use a **synergetic method** of satellite + lightning + radar data for tracking and characterizing the convective cloud systems.

High Resolution Wind, HRW

Suggestions

- To produce wind **at night** as well
- To produce wind using the **better spatial resolution** of MTG
- To produce **3D wind from the IRS** of MTG
- To calculate **wind shear** from IRS profiles
- To **combine** IRS wind for cloud-free areas and 'traditional' wind for cloudy areas.

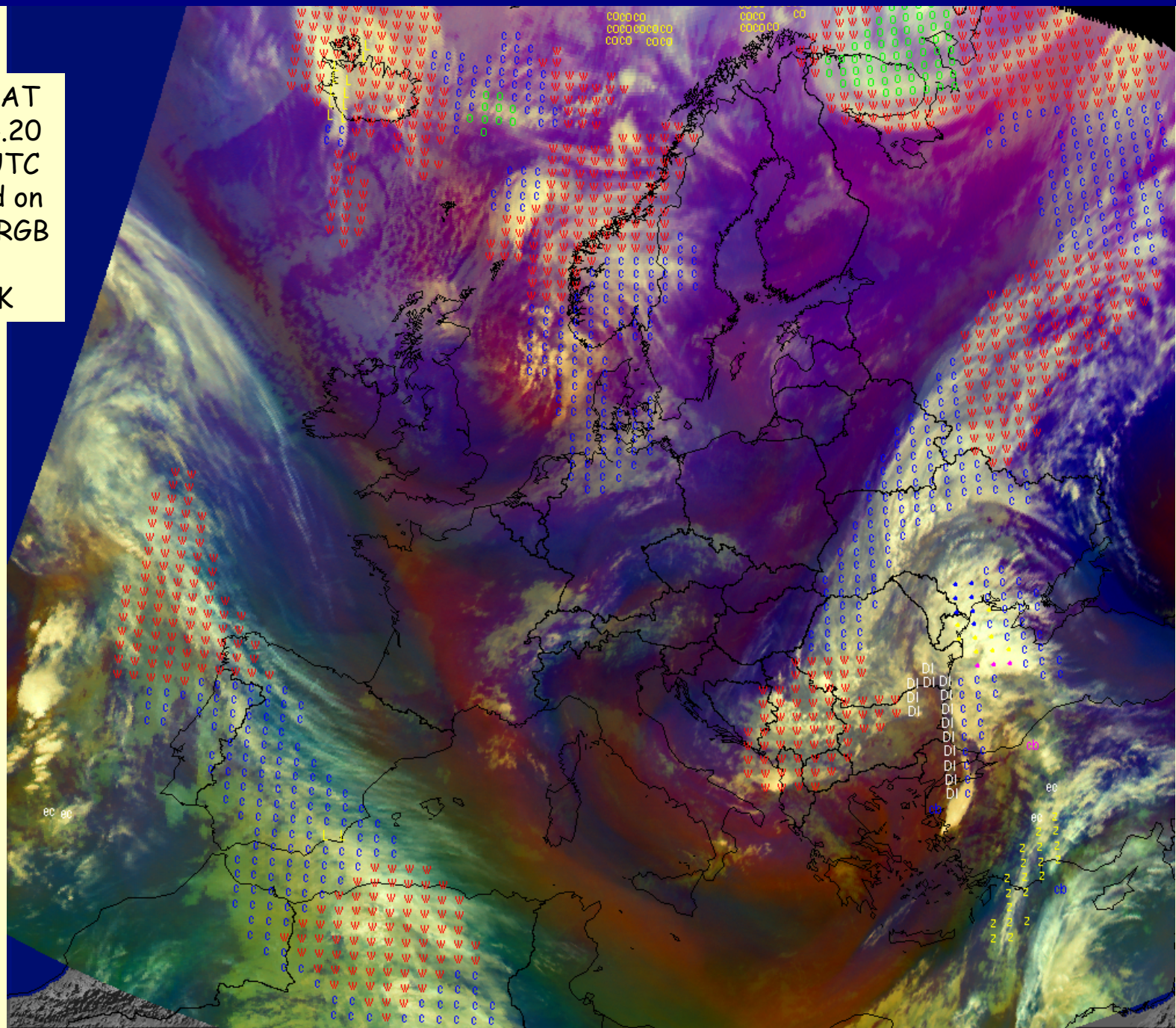


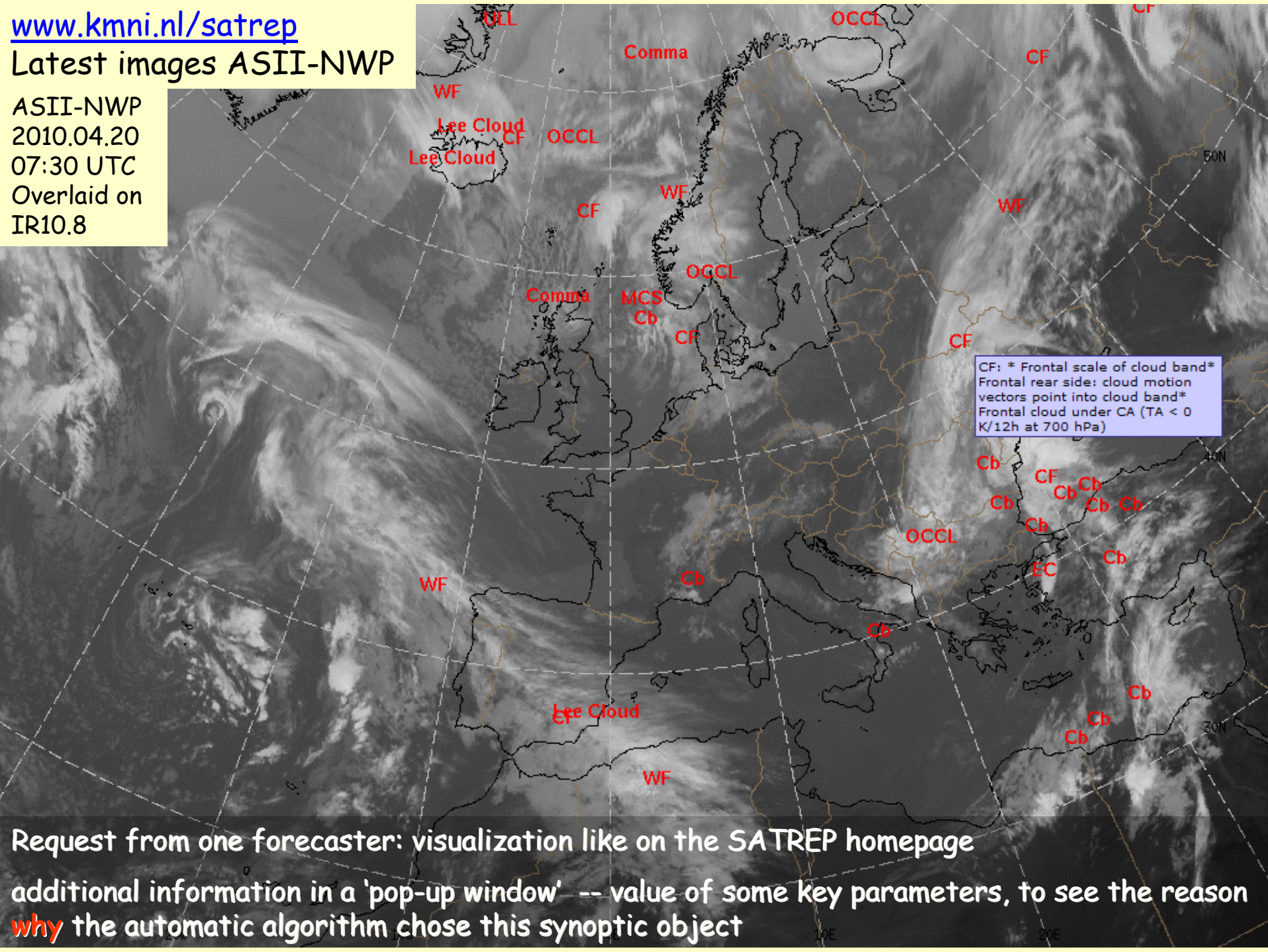
	Horizontal resolution	Vertikális resolution	accuracy
Temperature profile	4-6 km	1 km	1 K
Humidity profile	4 km	1-2 km	5-10%
Wind profile	30-60 km	1 km	~2m/sec

ASII is regularly visualized in HAWK -- Some forecaster use the manual SATREP instead

ASII-SAT
2010.04.20
07:40 UTC
Overlaid on
airmass RGB

HAWK





Request from one forecaster: visualization like on the SATREP homepage

additional information in a 'pop-up window' -- value of some key parameters, to see the reason why the automatic algorithm chose this synoptic object

PC, CRR, RDT

Separate presentation about cross-verification – poster on case studies

Suggestions for the developers of PC and CRR

PC

- Improving the **PC day** algorithm at **low solar elevation**.
- Try to include more directly the **cloud top microphysics** information. Maybe with a physical based algorithm instead/beside the statistical one?
- Including the **NIR2.2** channel data of MTG.
- Using **LI** for MTG?

CRR

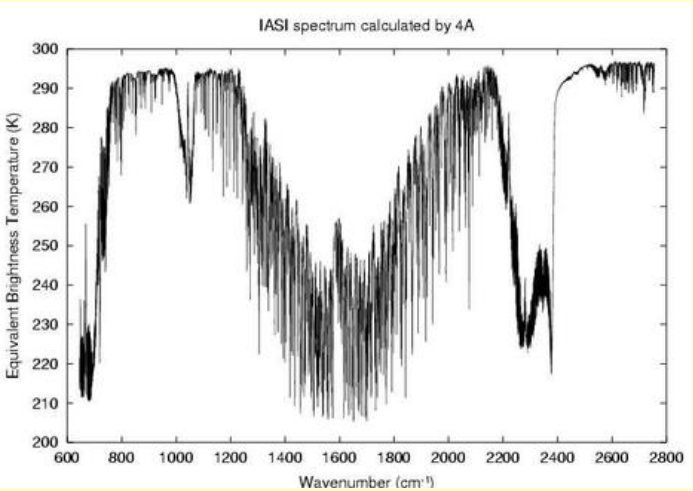
- Improve the **separation of convective precipitation from non-convective**
- including **more channel data**, using channels containing some indirect information on cloud top microphysics.
- including **microwave** information from a **polar satellite** as additional data.
- Including of **LI** of MTG.

TPW, LPW, SAI

In 2005 we made some TPW comparisons. We decided to wait. Later we did not follow the changes in the reliability of these products (lack of time). We use GII products instead. We look forward the PGE13 product.

Recommendations:

- Maybe to retrieve **more instability indices**, not only the lifted index, like in GII product
- Include the information of the **new VIS0.9 channel in MTG** to retrieve
  - Low level humidity
  - **Low level humidity advection**
- Use the data of **IRS** (infrared sounding mission) of MTG
  - it is supposed to provide 3D temperature and humidity profiles
  - To derive several instability indices from these profiles



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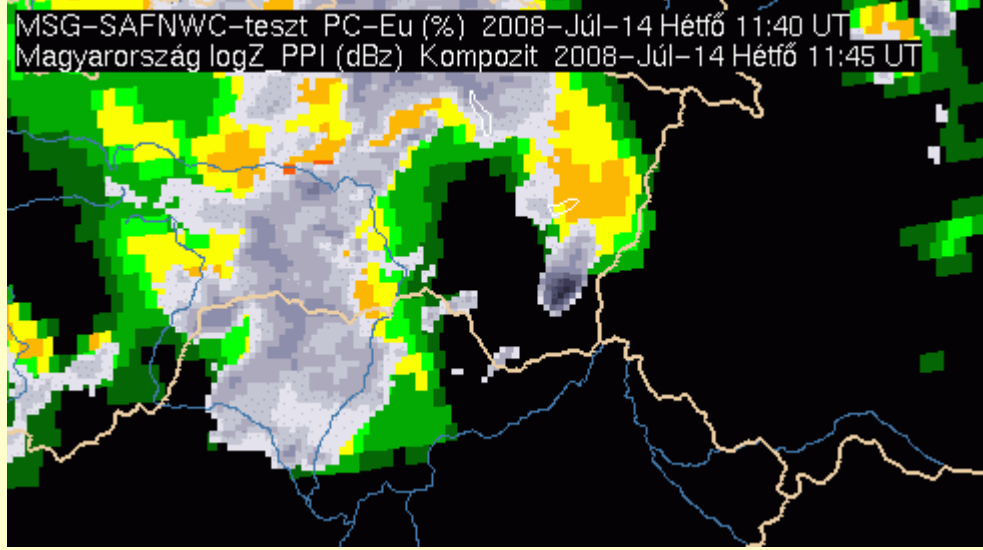
Temperature profile	4-6 km	1 km	1 K
Humidity profile	4 km	1-2 km	5-10%
Wind profile	30-60 km	1 km	~2m/sec

PC with radar



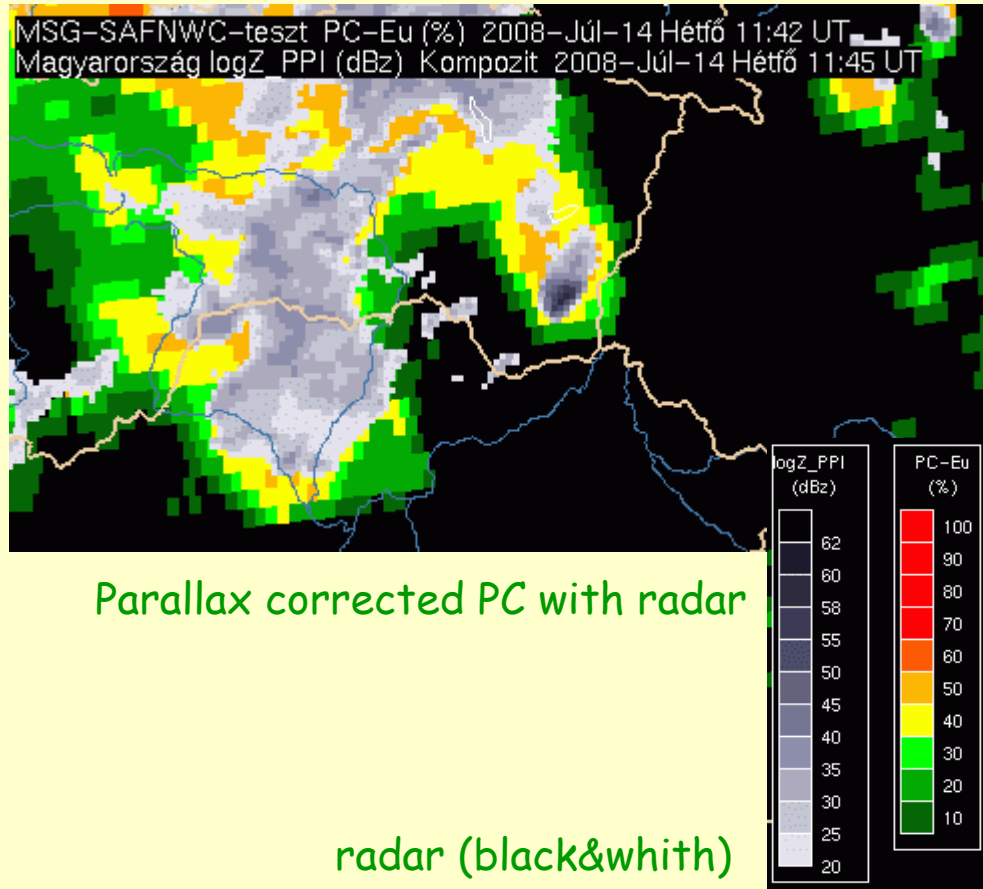
PARALLAX module – create module for parallax correcting the **HRV image**

NWP data – to make possible to use **different NWP** files for

- global – for ASII
- regional – for the other products

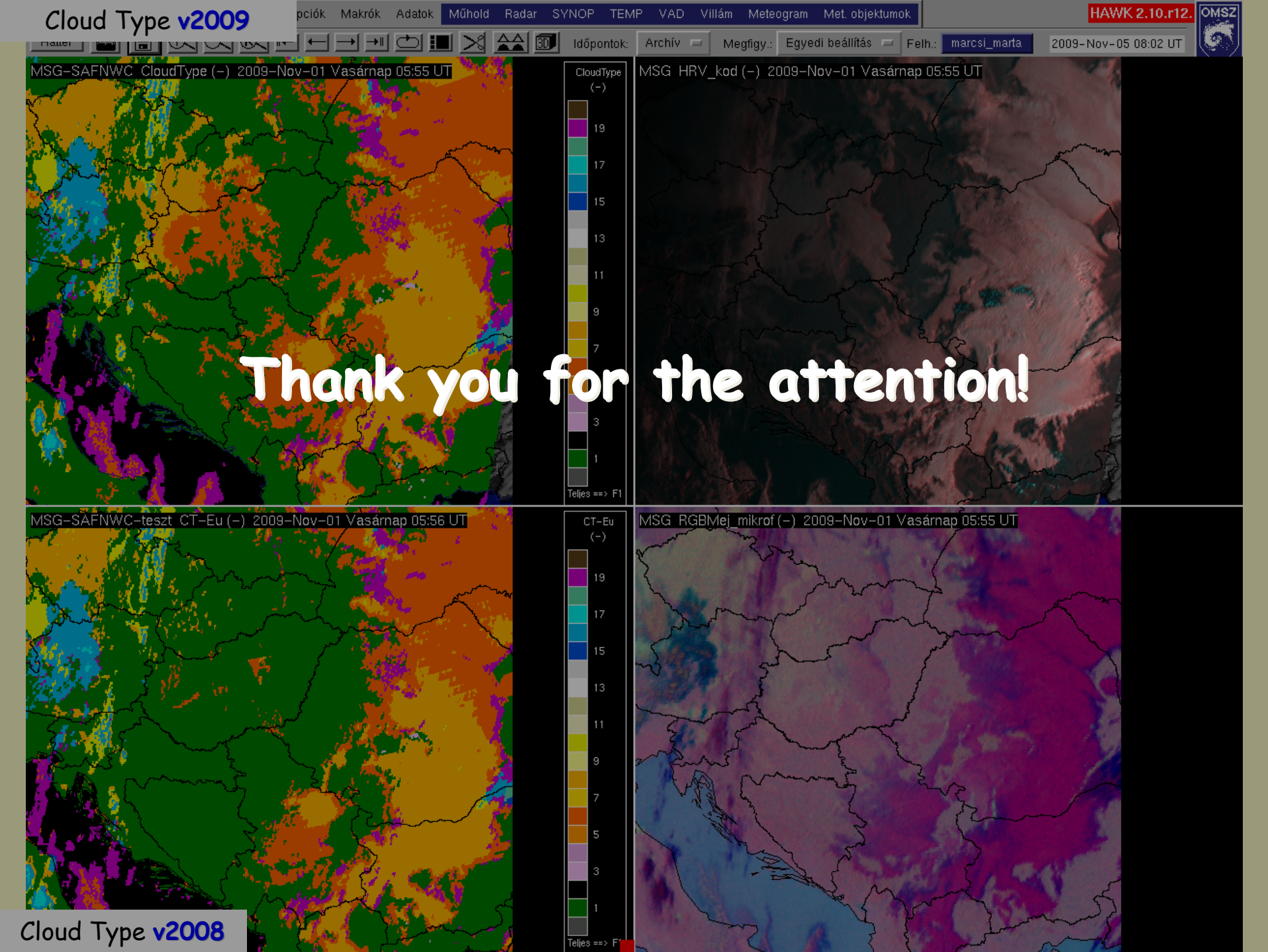
To recommend the users to use the **NWP model up to 100 hPa** – it would give more accurate results for CTTH

Performing parallax correction with IR10.8 method also might be better if the NWP profile would be used not only up to 200 hPa.



Parallax corrected PC with radar

radar (black&whith)


Cloud Type v2009
Műhold Radar SYNOP TEMP VAD Villám Meteogram Met. objektumok
HAWK 2.10.r12.
OMSZ
Időpontok: Archív
Megfigy.: Egyedi beállítás
Felh.: marcsi_marta
2009-Nov-05 08:02 UT
MSG-SAFNWC CloudType (-) 2009-Nov-01 Vasárnap 05:55 UT
CloudType (-)
19
17
15
13
11
9
7
3
1
Teljes ==> F1
MSG HRV_kod (-) 2009-Nov-01 Vasárnap 05:55 UT
Thank you for the attention!
MSG-SAFNWC-teszt CT-Eu (-) 2009-Nov-01 Vasárnap 05:56 UT
CT-Eu (-)
19
17
15
13
11
9
7
5
3
1
Teljes ==> F1
MSG RGBMej_mikrof (-) 2009-Nov-01 Vasárnap 05:55 UT
Cloud Type v2008

Snow detection in NWC SAF CT

6 hourly snow cover maps were asked for using it in the MEANDER.

The Land SAF Snow Cover (SC) is a daily product. (available at ~2 UTC next day)

NWC SAF CT provide snow detection in every 15 minutes
>>> we create 6 hourly snow cover map from NWC SAF CT

NWC SAF CT provide snow detection only for **cloud-free** areas, only if the **sun elevation > 5 degree**.
(+ The snow detection is more reliable at high solar elevation)

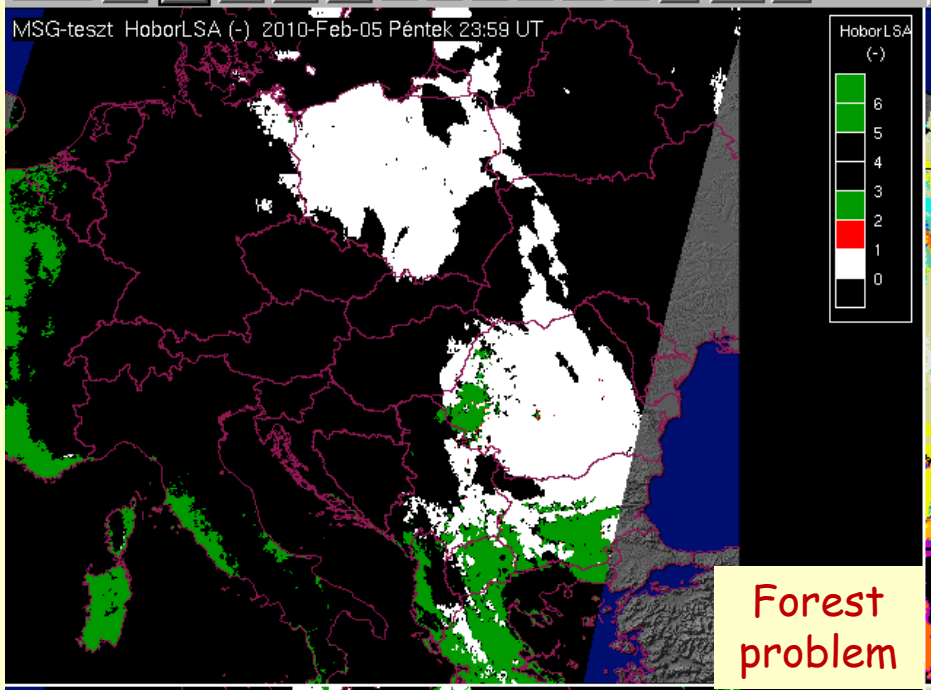
We compared Land SAF SC with NWC SAF CT by creating 24 hourly maps from NWC SAF as well.

How?
Daily map pixel is set to snowy, if CT=snow at least in 3 slots (sun elevation > 5 degree)
Daily map pixel is set to snow-free, if it is not set to snowy and CT=snow-free at least in 3 slots (sun elevation > 10 degree)
Other pixels are set to unclassified.

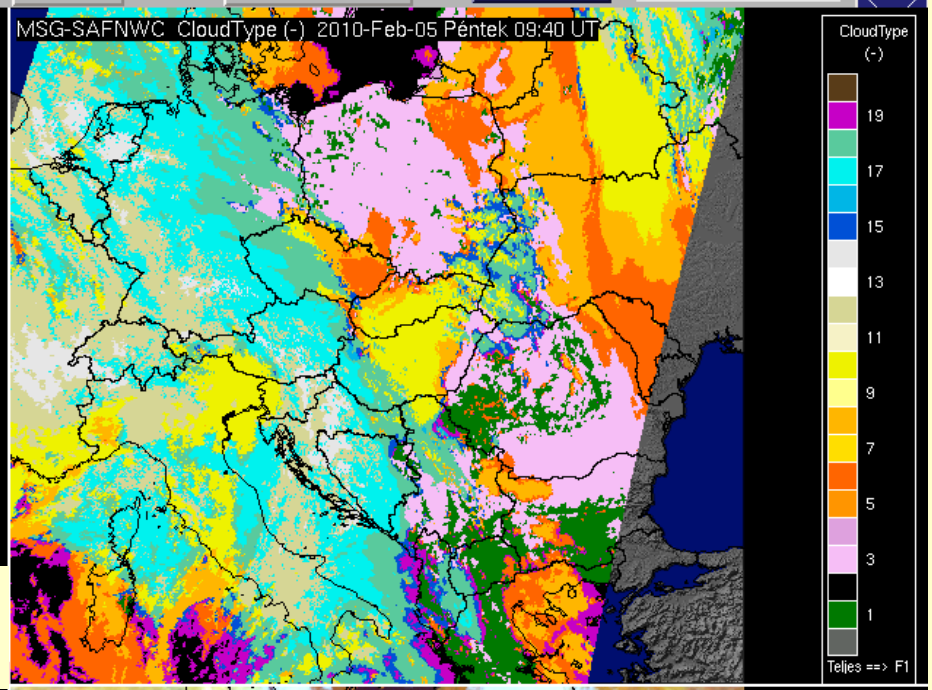
differences examples

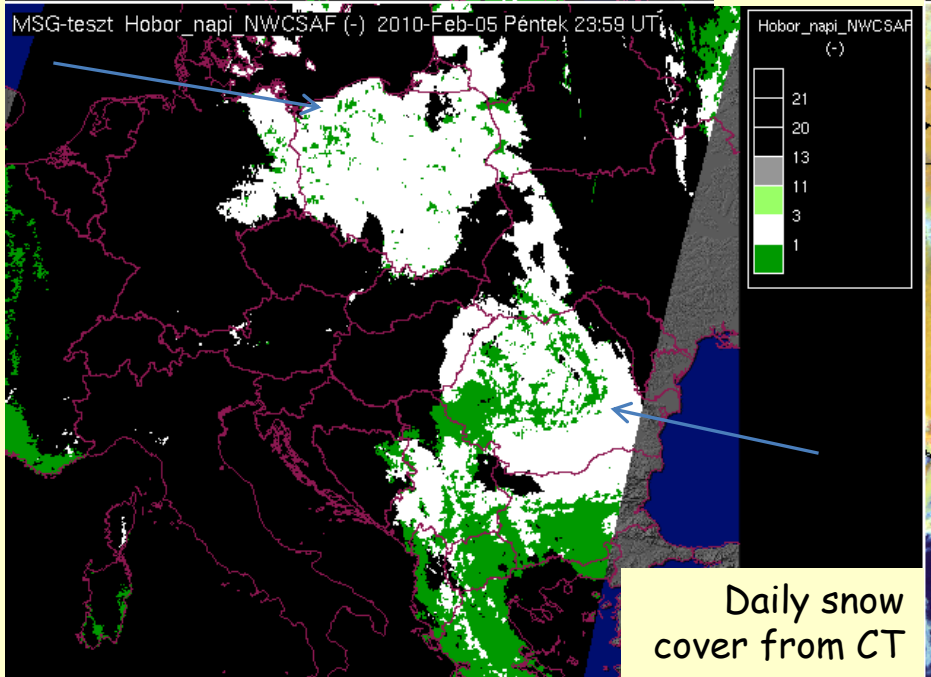
Land SAF snow cover 05.02.2010. whole day

05.02.2010. 09:40 UTC NWC SAF CT

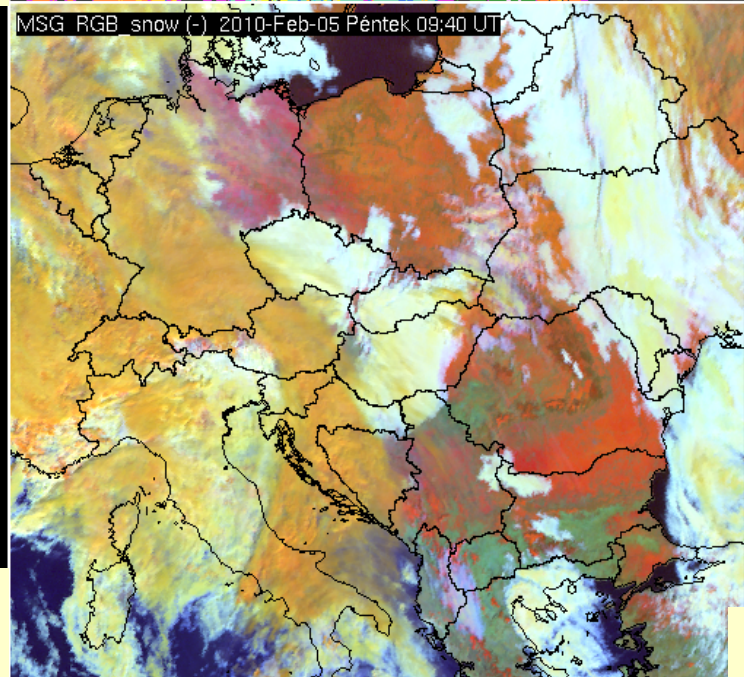


Forest problem

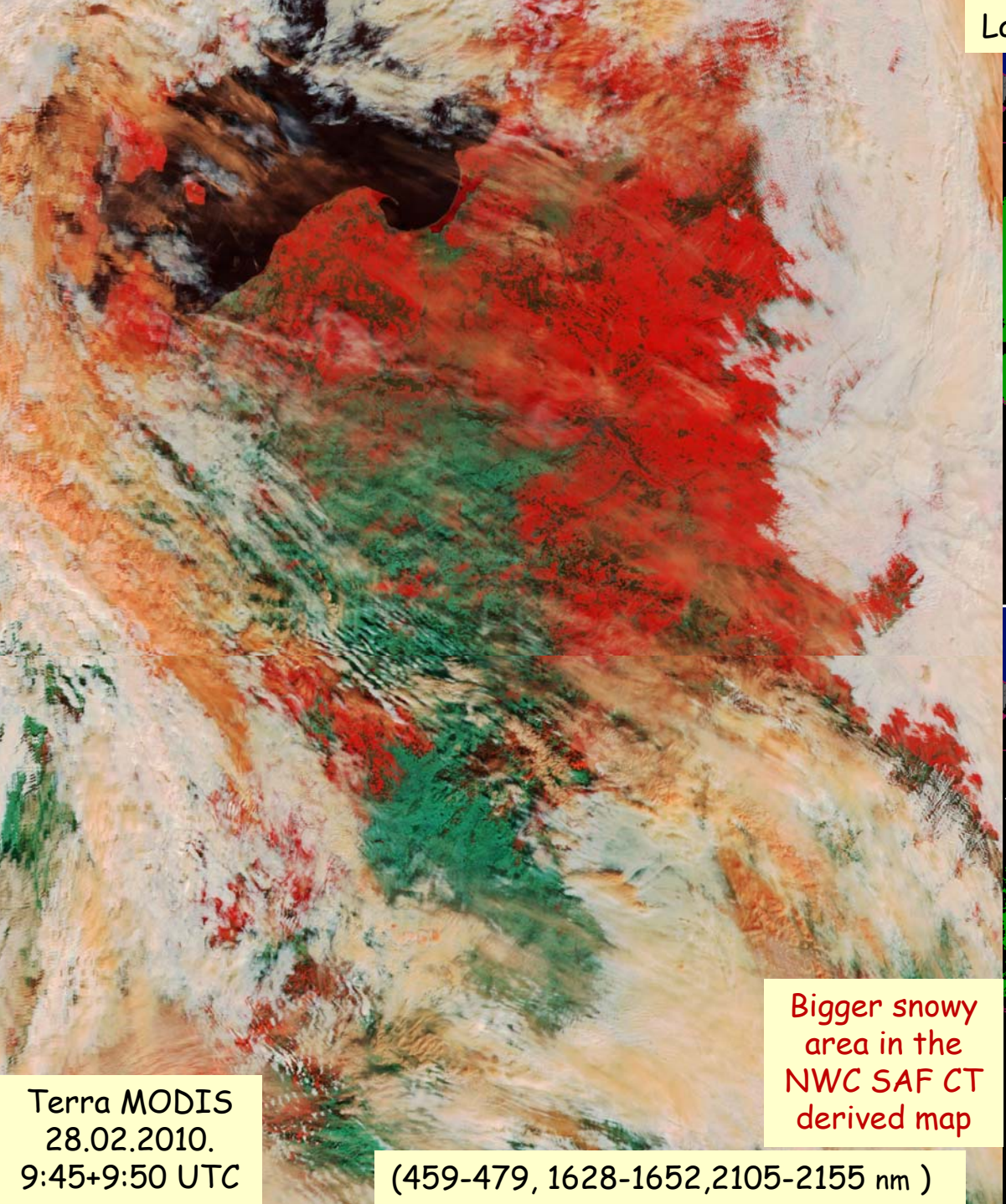




Daily snow cover from CT



Snow RGB

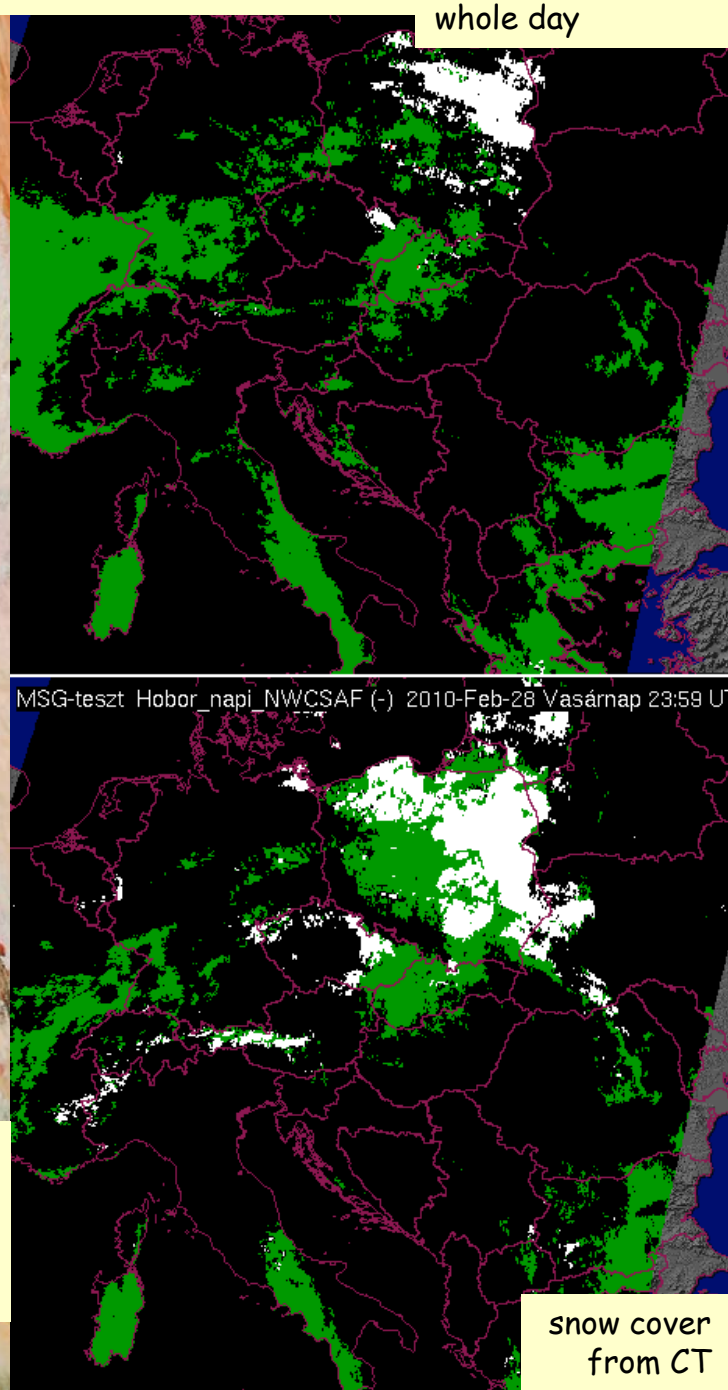


Terra MODIS
28.02.2010.
9:45+9:50 UTC

(459-479, 1628-1652,2105-2155 nm)

Land SAF snow cover

28.02.2010.
whole day



Bigger snowy area in the NWC SAF CT derived map

snow cover from CT

Some 'feeling' based on case studies in February 2010

Comparing CT derived daily snow map and Land SAF Snow Cover daily map

1. In CT derived map more '*snow covered by thin semitransparent clouds*' pixels are detected as snow than in LSA SC.
2. *LSA SC tends to detect more partly snowy area – forests.*

   CT detects partly snowy area as snow-free.

   snowy forest - the branches are not covered by snow and/or the sun is low – big shadows

3. Land SAF *SC provides information for smaller area*, than the CT derived daily snow map. LSA SC is much more cautious.

   Note: The 15-minute CT cannot give 'no info'. It has to decide between snowy or not snowy or cloudy classes. In the daily synthesis there are already some uncertain cloud-free pixels set to 'no info', but not so much as in SC.

Verification of LSA SC and NWC SAF CT derived daily snow maps with the Hungarian surface snow depth observations

(stations with observer and 4 automatic stations)

Snow depth observations are performed once a day, at 6 UTC in the morning.

Cases with **observed snow depth>=2cm** in two consecutive mornings were selected. For these days >

'Snowy' and 'snow-free' pixels (with such observations) were counted

>> POD

		POD Snow depth >= 2cm	Number of cloud-free pixels	Pixels with info / all pixels (sd >=2cm)	NWC/LSA
December 2009	LSA	0,94	963	32%	
	NWC	0,78	1328	44%	1.38
January 2010	LSA	0,93	682	11%	
	NWC	0,71	1508	25%	2,21
February 2010	LSA	0,91	1390	18%	
	NWC	0,85	2241	29%	1,61
Dec-Febr 2009-2010	LSA	**0,93**	3035	**18%**	
	NWC	**0,79**	5077	**30%**	**1,67**

For the selected pixels - containing the meteorological station with snow depths observation >= 2cm both on the actual and next mornings - **the pixels with information (snow or snow free) were divided with all pixels. It was found that the NWC CT derived daily map gave information for 67% bigger area that SC.**

for a smaller, more reliable data set: **FAR=0** was found for both products (No of cases ~ 120-150)