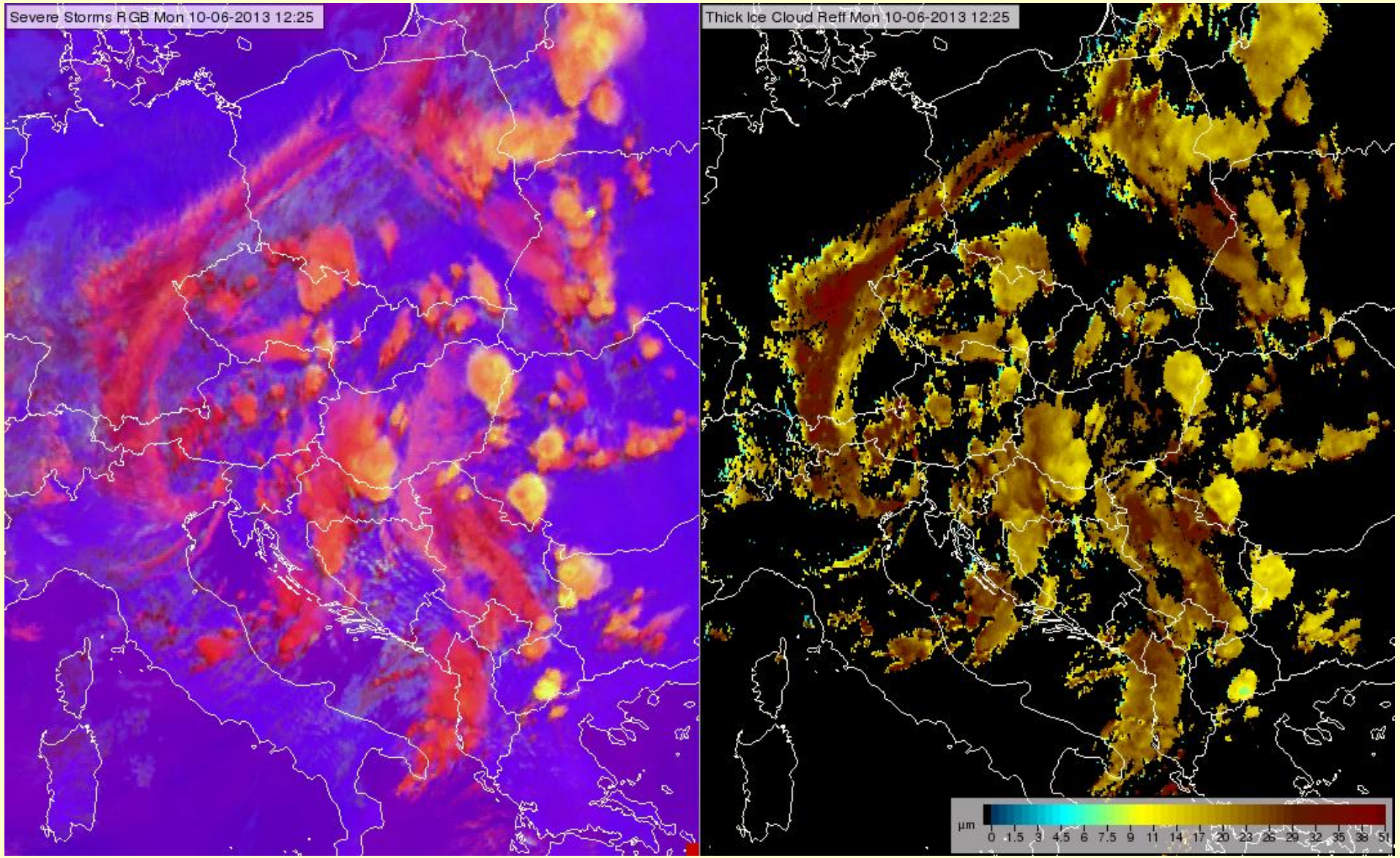
Applications of the NWC SAF products at the Hungarian Meteorological Service



Mária Putsay
Hungarian Meteorological Service
NWCSAF CDOP3 Users' Workshop 2020, 10-12 March 2020, Madrid

Outline

Introduction

Fields of applications at OMSZ

Routinely performed applications:

Automatic applications:

- Data assimilation into locally run LAMs
- Use of satellite data in the nowcasting (warning) system
- Cloud cover information for OMSZ (internal and external) homepage

Interactive applications:

- Visualisation for the forecasters and colleagues at OMSZ

Research, Projects, Training, Case studies, …

Suggestions, requests, comments

Conclusions

At the Hungarian Meteorological Service ONLY the **SAFNWC/MSG** program package is used

Presently we use SAFNWC/MSGv2018 program package. It is installed on an

- 'operational' PC

  We process 15 minute data for 3 regions.
  Most of the products are performed on a Central-European region (640x480 pixel).
  We use 3 hourly ECMWF data (up to 10 hPa) in half degree spatial resolution.

- backup PC

- developer PC

  A SAFNWC/MSG is installed for testing the new versions and for re-process old data.
  RSS (5-minute) products were produced only off-line for some studies.

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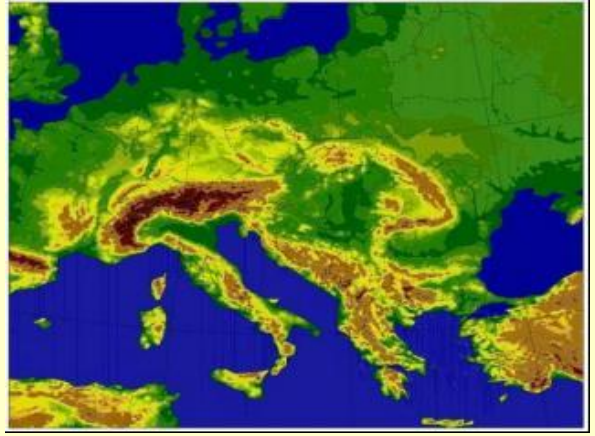
Assimilation in Hungary



Assimilation into the **ALADIN/HU** limited area model (runs at OMSZ)

The following satellite data are assimilated:

Operationally

MPEF AMV product

NOAA-18 ATOVS data

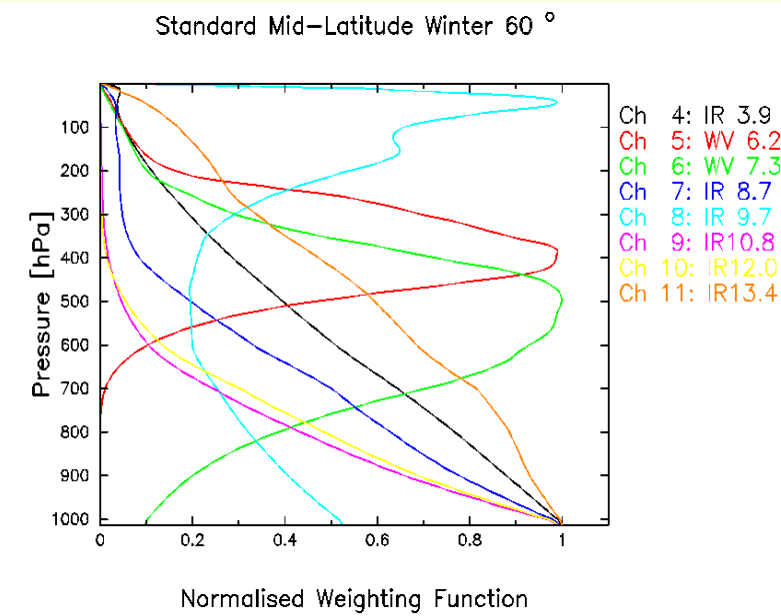
SEVIRI IR channel data –

NWCSAF cloud products are used at the **pre-processing** to select the area where the SEVIRI data will be assimilated.

How are the NWCSAF cloud products used at the assimilation of the SEVIRI IR data?

In pre-processing:

The CT and CTTH products (and their quality flags) are used to select the pixels where SEVIRI **WV6.2 and WV7.3** data should 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.



Assimilation in Hungary

Assimilation into the **AROME/HU** limited area **non-hydrostatic** model (runs at OMSZ)

The following satellite data are assimilated:

Operationally

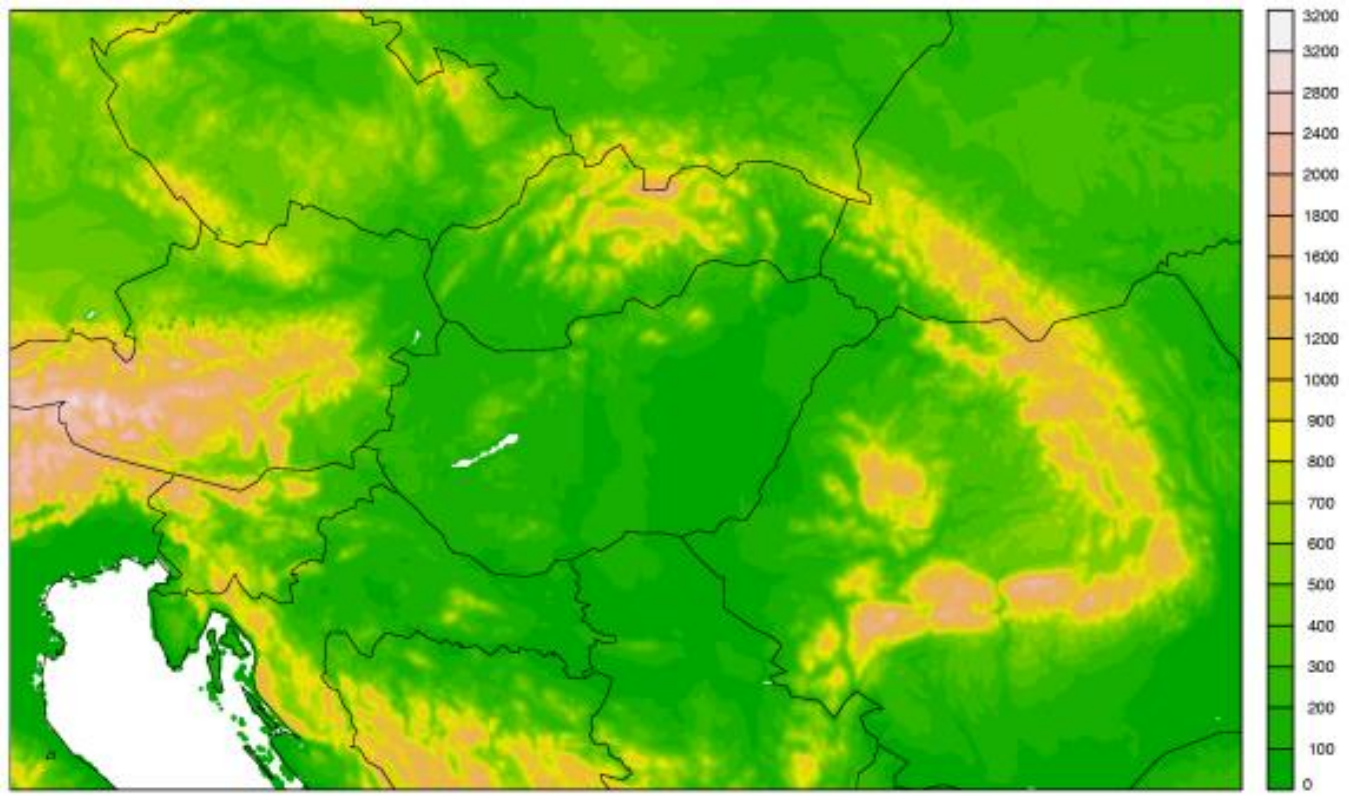
Non (only conventional data: Synop, amdar, radiosonde)

GNSS zenith total delay

In test mode

NWCSAF HRW MPEF AMV

Radar reflectivities



Data assimilation (into numerical models) is an important application field at the Hungarian Meteorological Service

RC LACE (Regional Cooperation for Limited Area modeling in Central Europe) project is a cooperation of some Central-European countries for developing locally run Limited Area Models.

Hungary is the leader of the assimilation related developments.

OPLACE: common observation pre-processing for LACE --- central databank for common data to be used for assimilation

The Hungarian satellite group of OMSZ is providing all satellite data for OPLACE.

SEVIRI IR channel data + **NWCSAF cloud products**
NWCSAF HRW
…….

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Automatic applications of the NWCSAF 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, or areas covered only by thin cirrus clouds
- **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) to estimate the **maximum wind speed in the thunderstorm outflow**
- Assimilate Land SAF vegetation fraction and albedo into the WRF model

Plans:

- improve the **fog** module based on **CT** + using the 'Toulouse' like algorithm (RH, wind, prec.)
- using **RDT** (together with radar cell tracking)
- assimilate Land SAF LST into the WRF model
- Assimilate 6 hourly snow cover maps (based on **CT** and/or LandSAF Snow Cover product) into the WRF model

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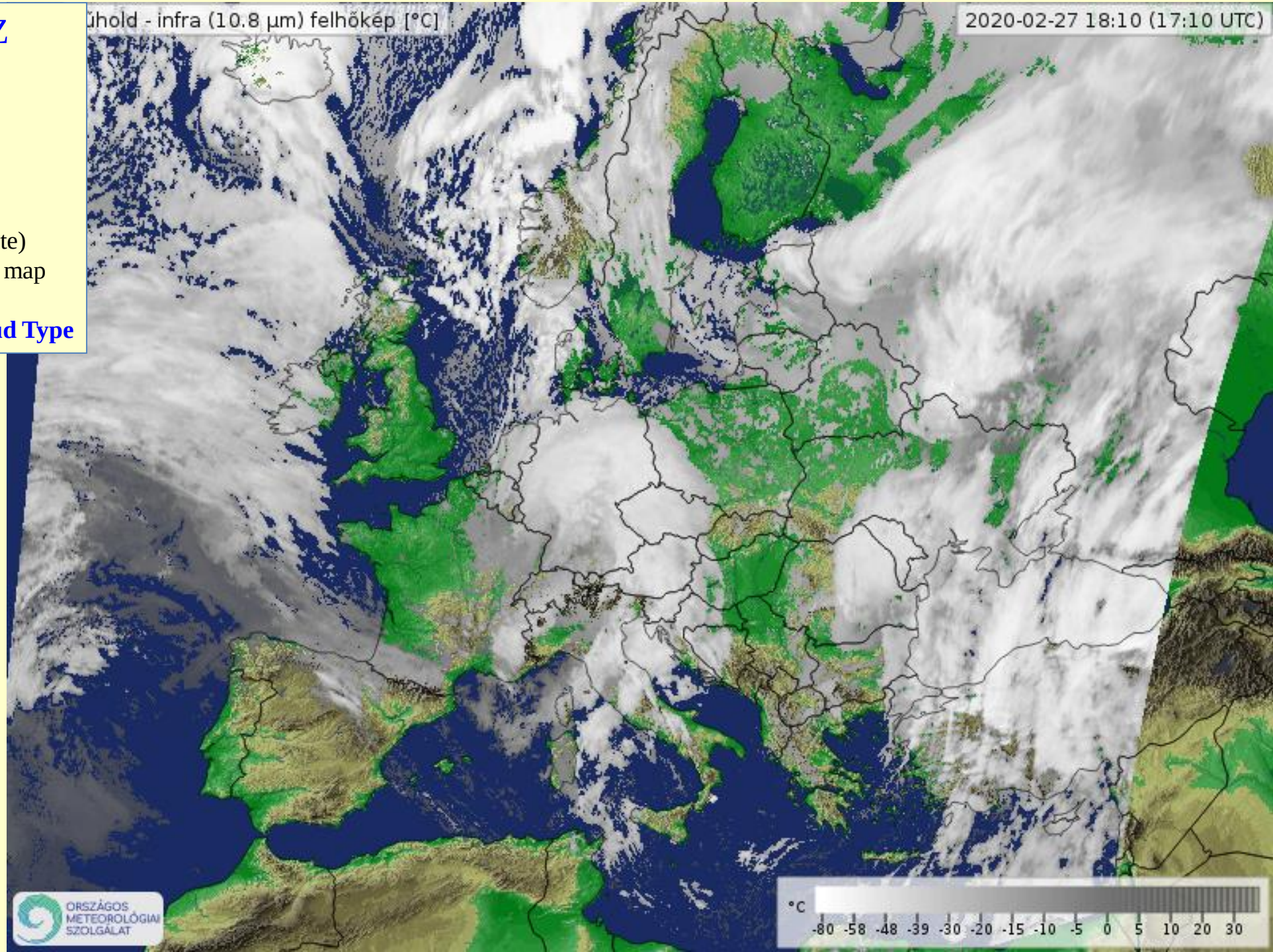
External, internal OMSZ homepage

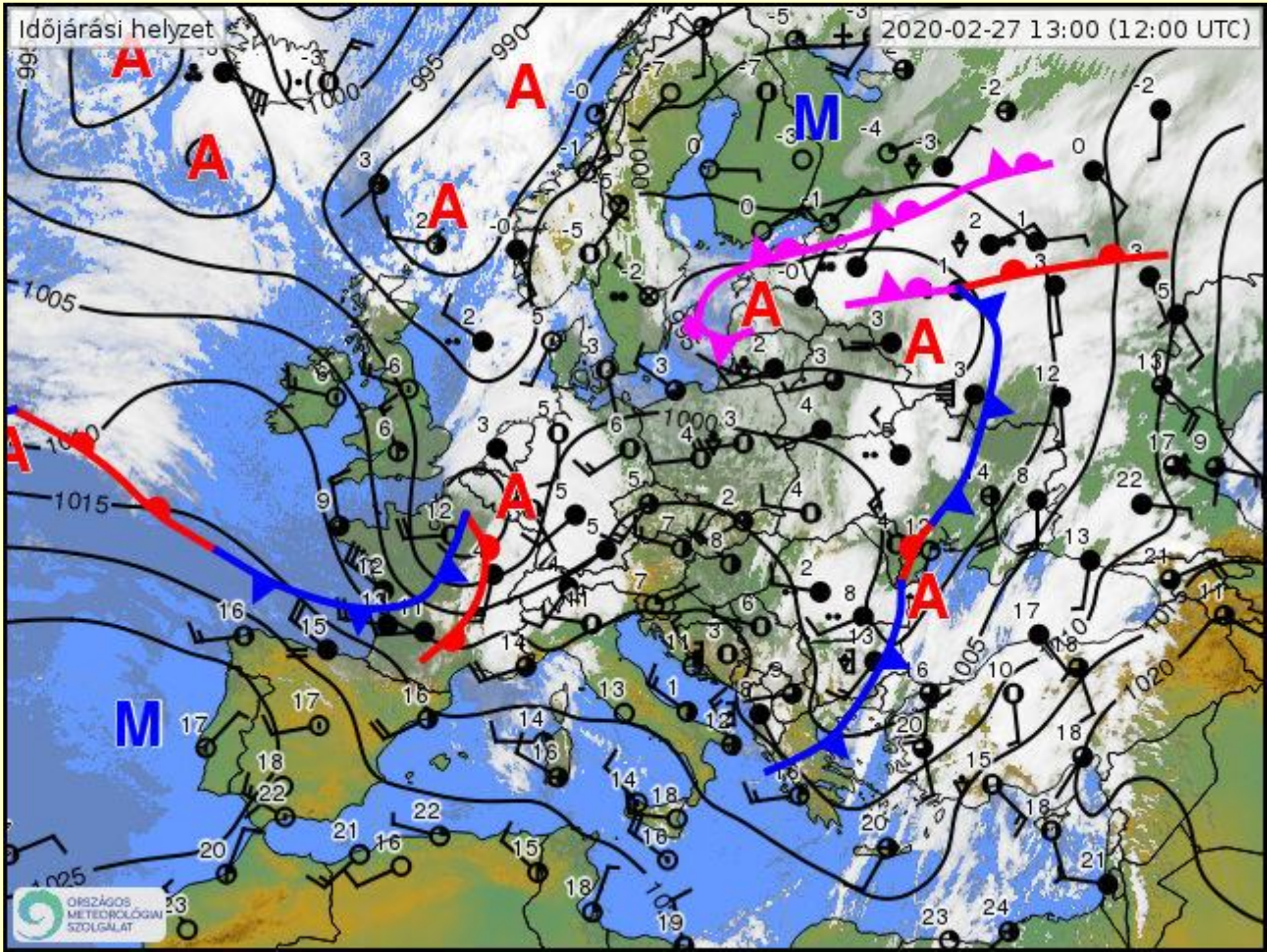
‘Infra-clouds’ image
27.02.2020 17:10 UTC

on cloudy areas: IR10.8 (black&white)
cloud-free areas: coloured orographic map

Using **NWCSAF Cloud Mask and Cloud Type**



Background image of the ‘surface chart’



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The following NWCSAF products are sent operationally into the HAWK visualization system for duty forecasters:

Name of product	yes	no
Cloud products		
• **Cloud Mask CMA** (Dust, volcanic ash)		**x**
• **Cloud Types CT**	**x**	
• **Cloud top temperature, pressure and height CTTH** (except effective cloudiness)	**x**	
• **Cloud Microphysics CMIC**		**x**
Precipitation products		
• **Precipitating clouds PC**		**x**
• **Convective rainfall rate CRR**		**x**
• **Precipitating clouds based on cloud physical properties PC-Ph**		**x**
• **Convective rainfall rate based on cloud physical properties CRR-Ph**	**x**	
Convective products		
• **Rapid Developing Thunderstorms RDT** (except Convection Initiation CI)	**x**	
Satellite Humidity and Instability products		**x**
Wind products		
• **High Resolution Wind HRW** (except trajectories)	**x**	
Conceptual Model products		
• **Automatic Satellite Image Interpretation ASII, AMV-IR/WV** (except ASII-TF, ASII-GW)	**x**	
Extrapolated Imagery products EXIM		x

All products are generated in 15-min time step.

Some products are visualised for forecasters (for everybody at OMSZ).

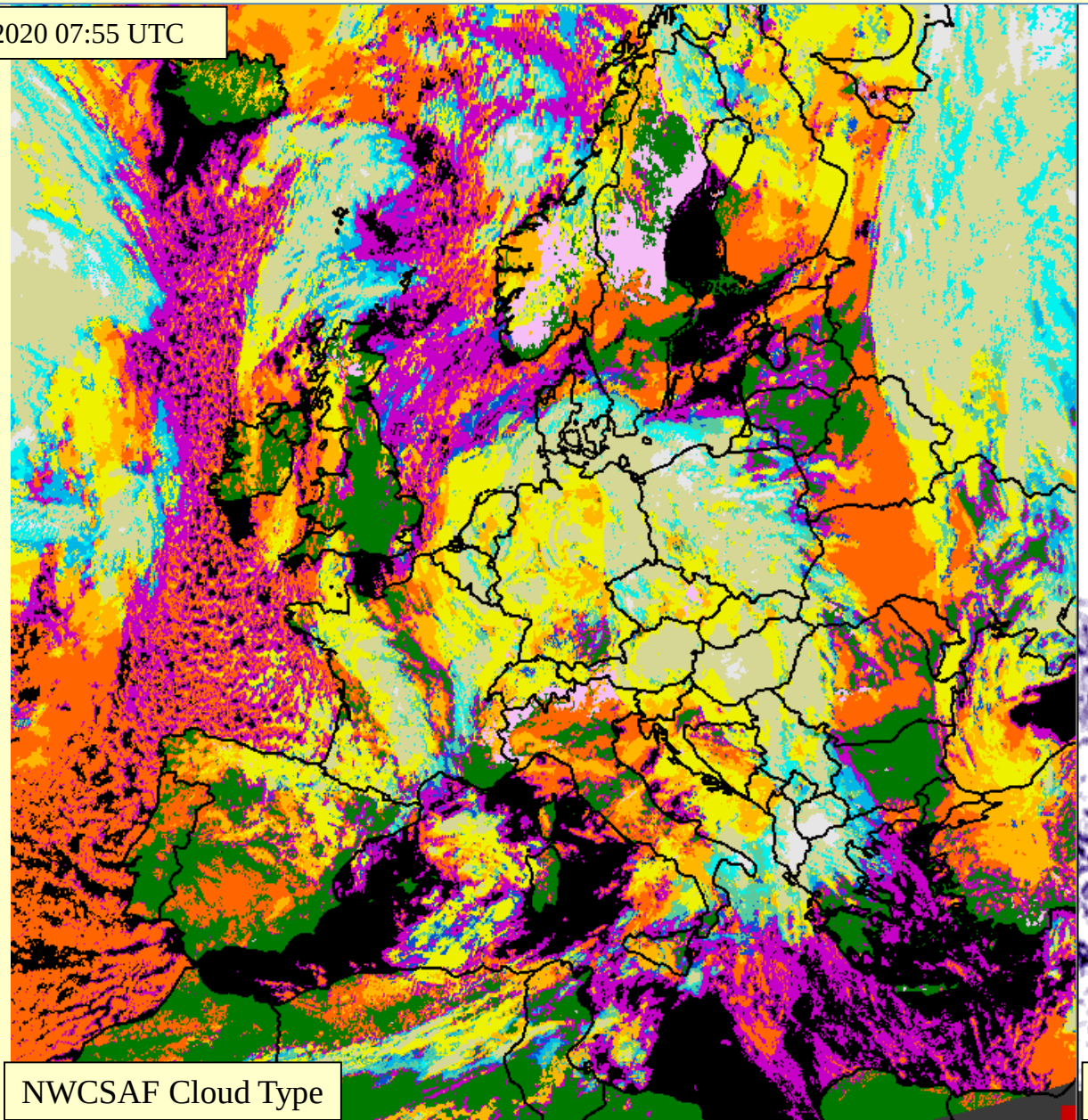
Other products are visualised only for the satellite group for testing.

A '**cloud amount**' map derived from the **CT** product by

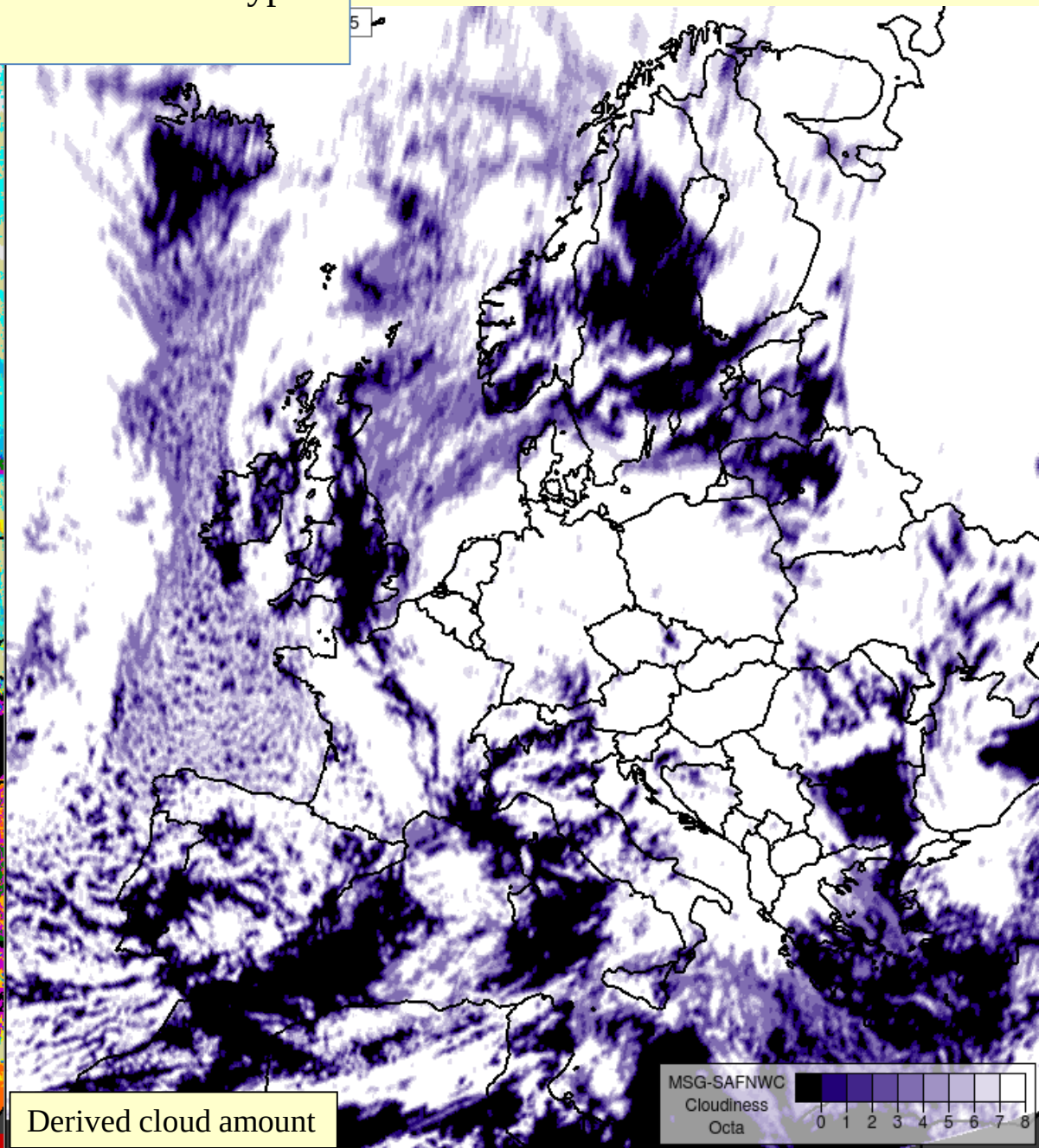
- Setting 0 - cloud-free, 0.5 - broken clouds and very thin cirrus, 1 - other cloud types
- Smoothing/averaging with a 5x5 window

Application: Verifying the forecasted cloud amount of NWP model(s)

03 March 2020 07:55 UTC



NWCSAF Cloud Type



Derived cloud amount

What and how do the forecasters use the NWCSAF products?

They have several NWCSAF products in their visualisation system.

They have the possibility to look at them.

They are usually short in time

Duty forecasters

Winter period - They look at CT, main interest to see the foggy / stratus covered areas

All year - aviation meteorologists use CTTH to see the cloud top height

They use it together with the radar cloud top height

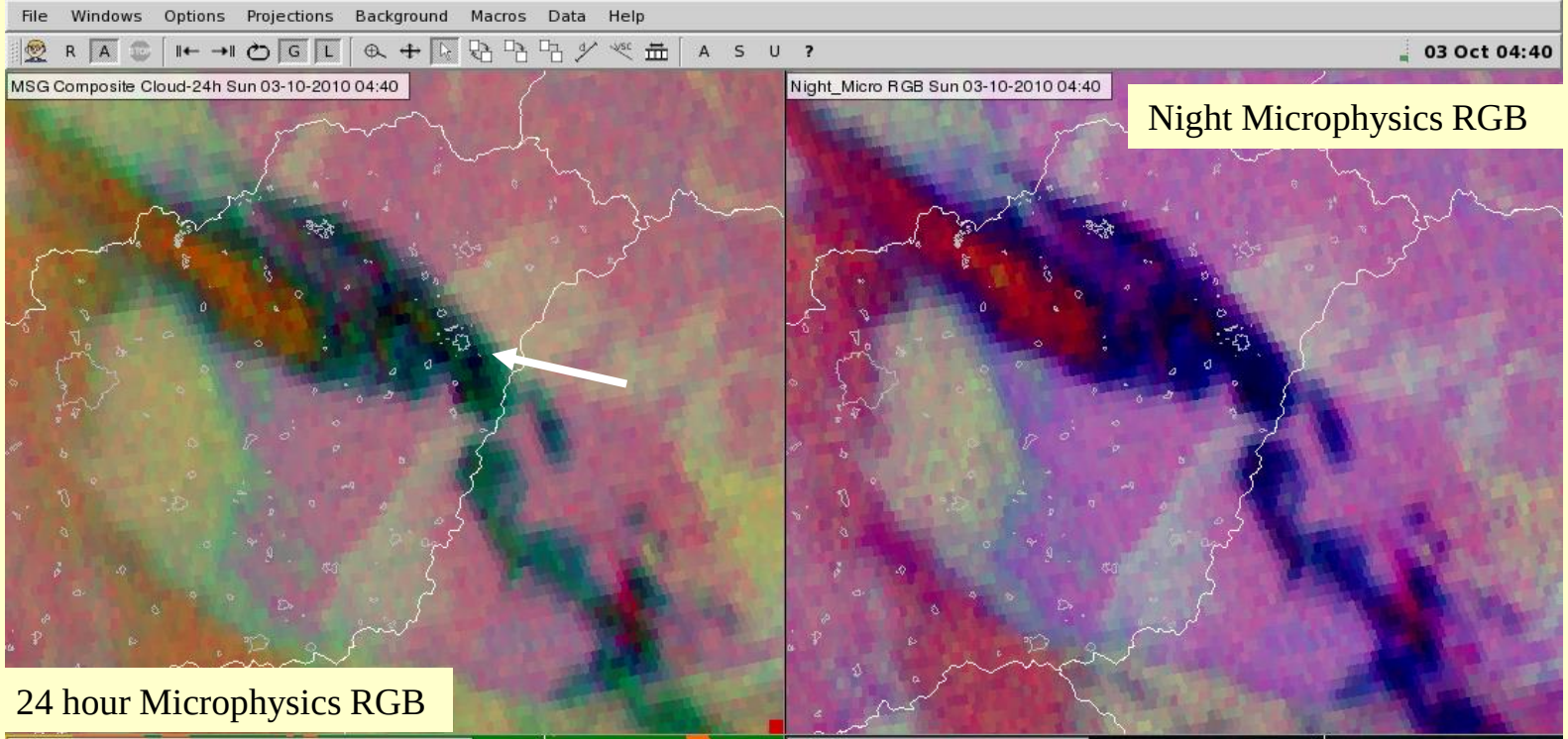
(interesting for example because of the in-cloud icing)

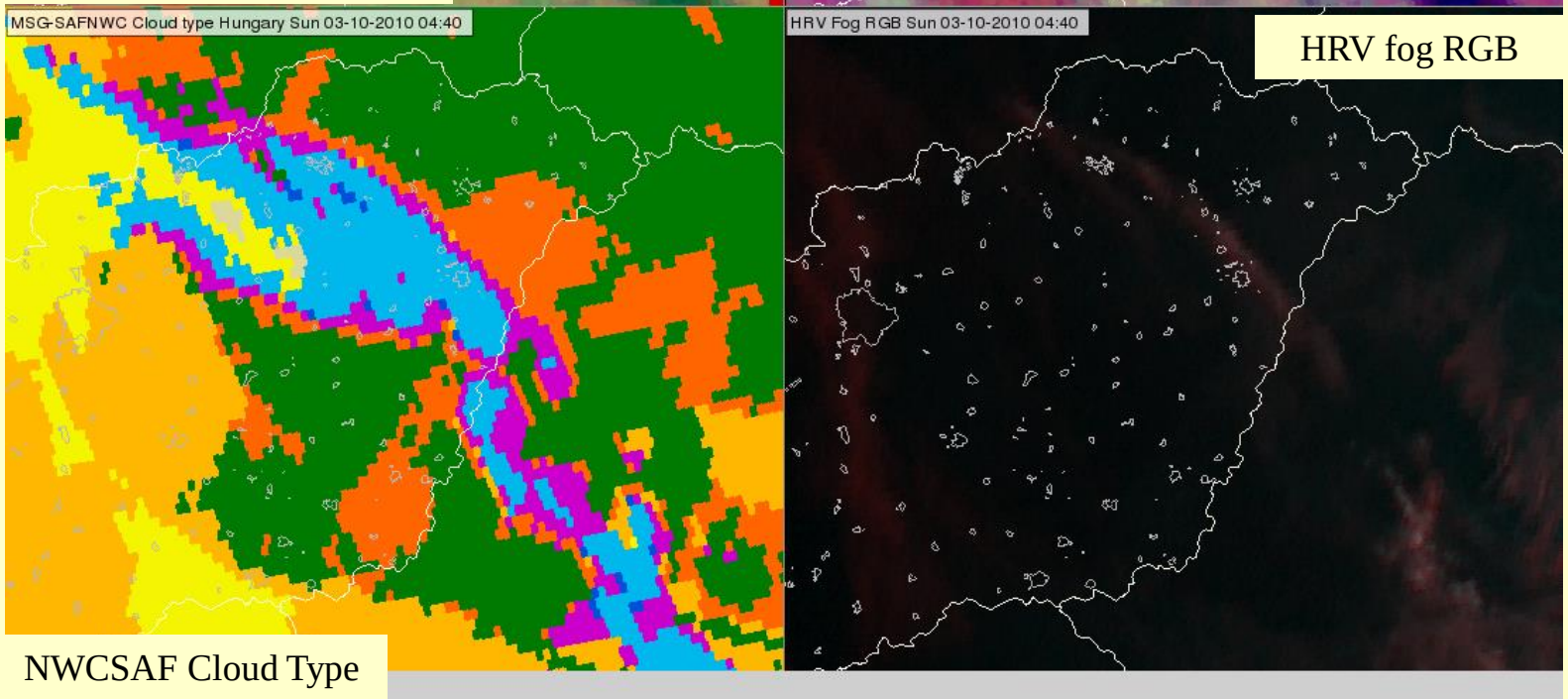
ASII is used by some forecasters to help in the analyses of the synoptic situation

RDT is used by some forecasters – mainly in **case studies** – cell characteristics, like cooling rate

World Hot Air Balloon Championships near the city Debrecen

4-panel visualisation
Cloud Type + RGBs
3 March 2010 04:40 UTC
(nighttime)

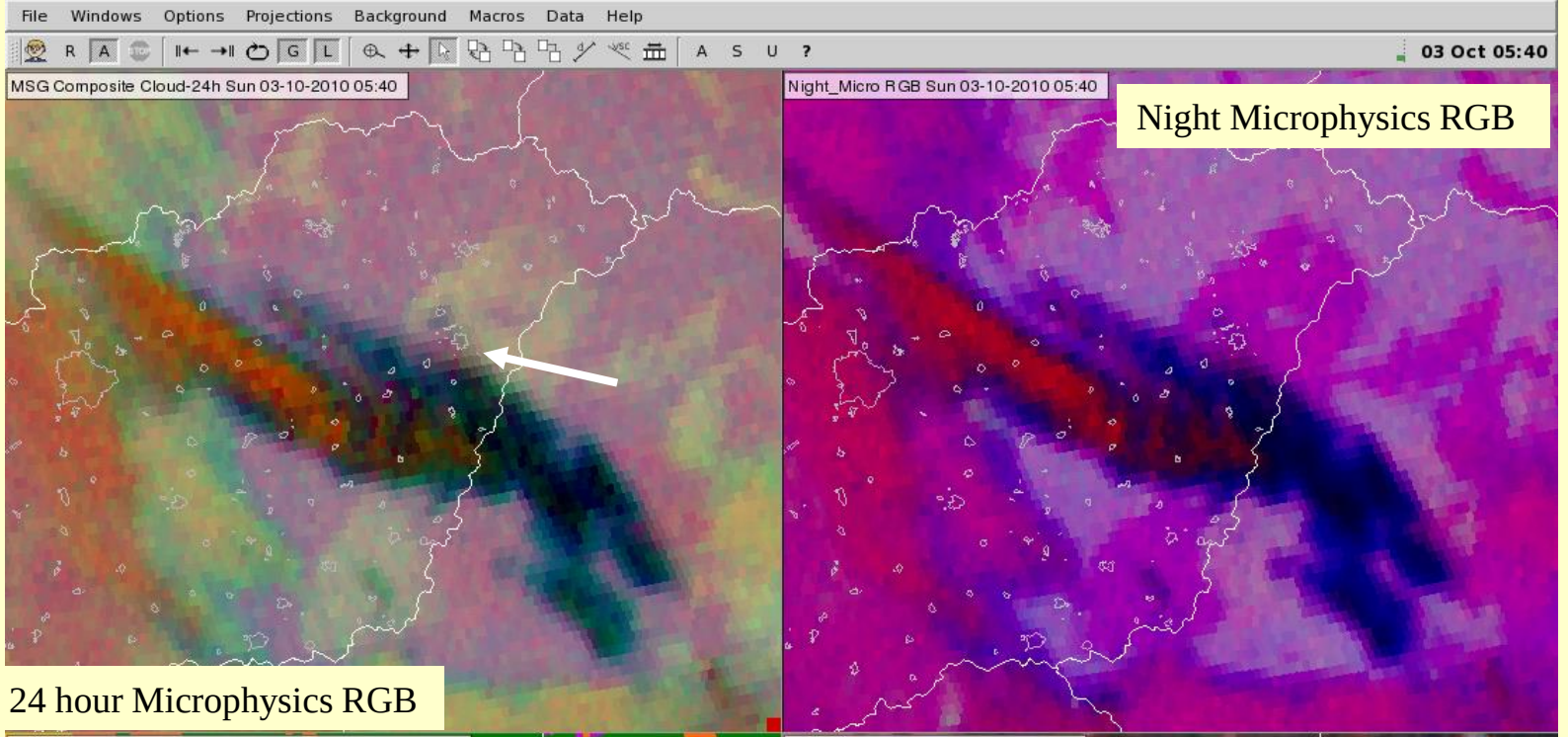


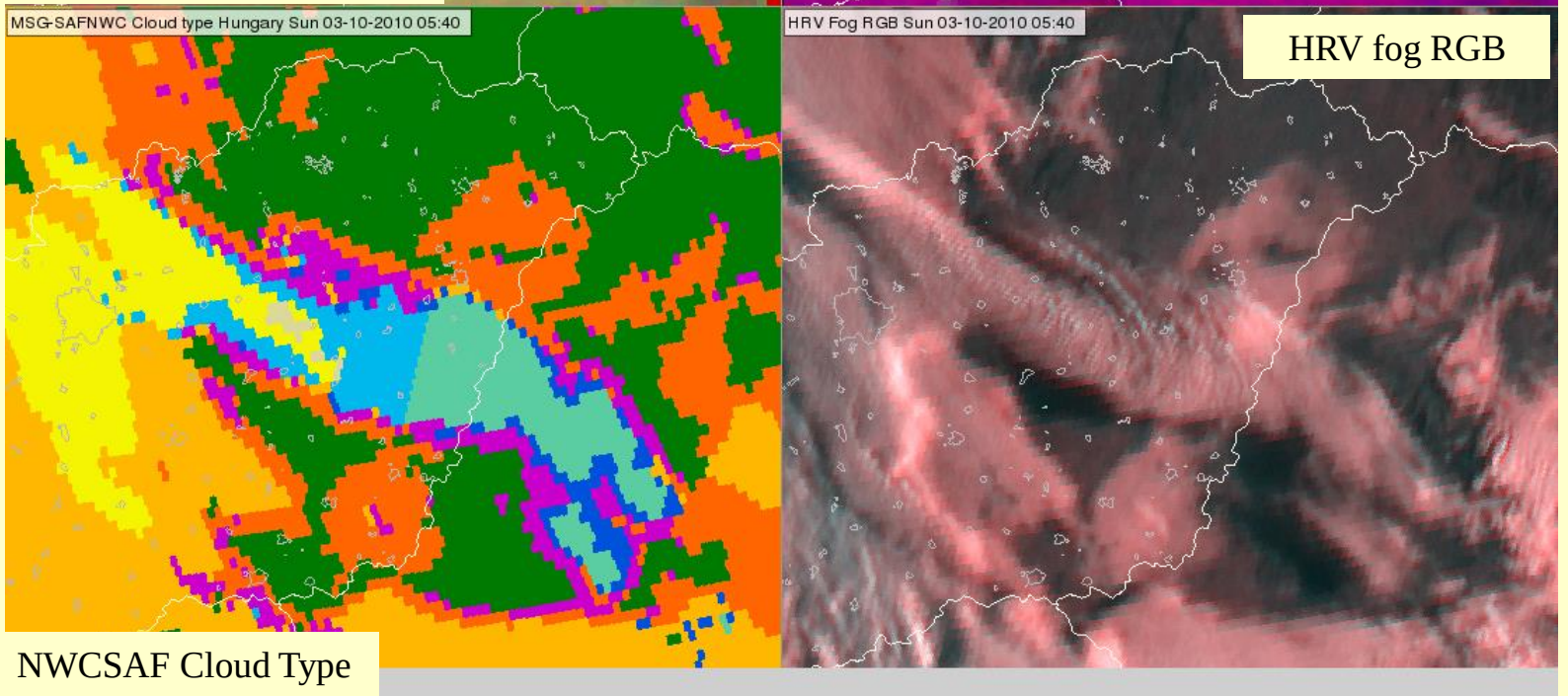


Fog advection in the morning
High-level cloud overruns the fog

World Hot Air Balloon Championships near the city Debrecen

4-panel visualisation
Cloud Type + RGBs
3 March 2010 05:40 UTC (daytime)





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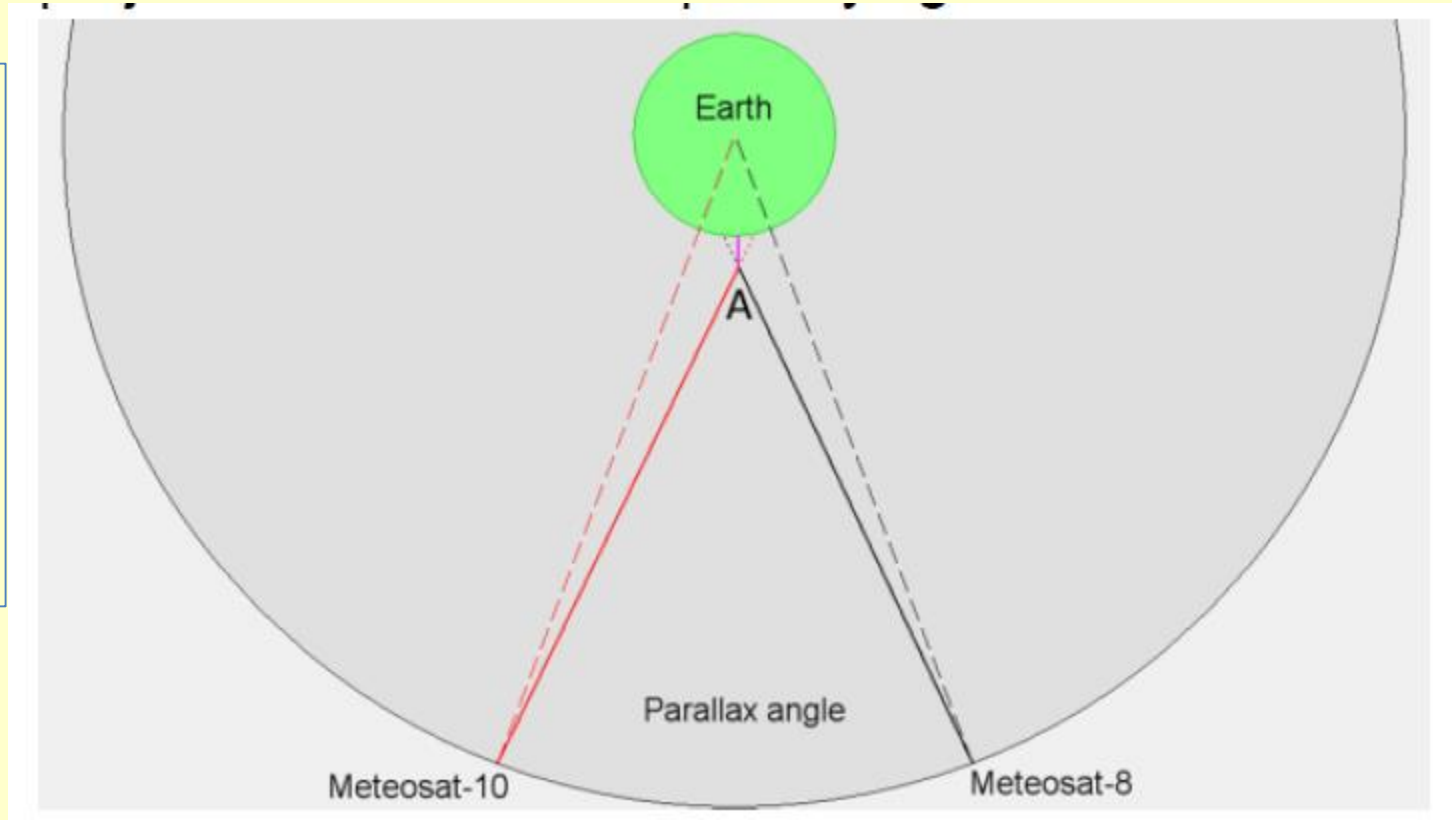
Research

Cloud top height were calculated by the

- 3D parallax method by parallel using of Meteosat-8 (over 0 °E longitude) and Meteosat-10 (over 41.5 °E longitude) imagery, and
- SAFNWCv2016 program package.

The two kinds of cloud top height retrievals were compared statistically in NWCSAF Cloud Type classes.

Simplified scheme of dual parallax observations

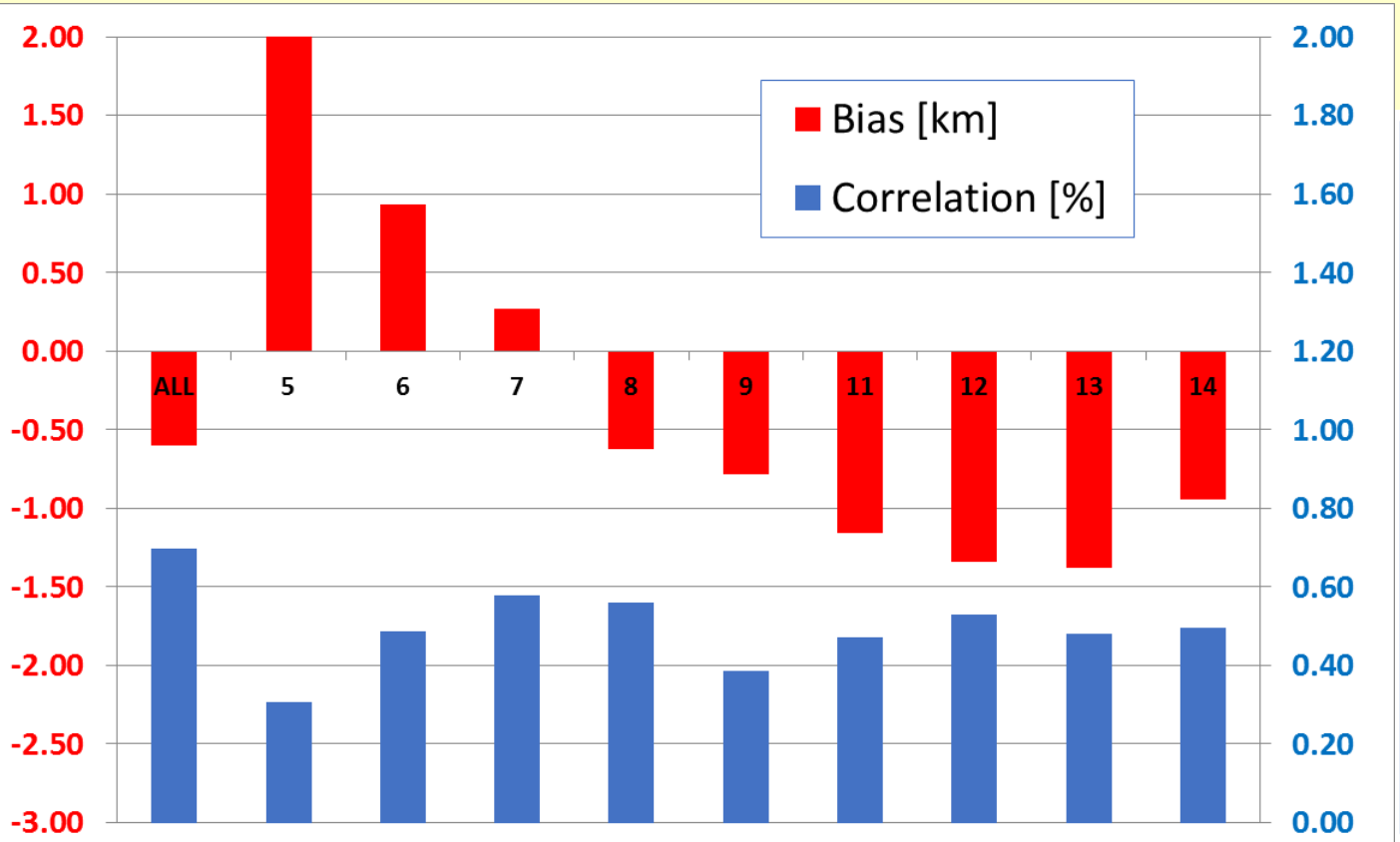


Kaňák, J., Okon, Ľ., Setvák, **M., Diószeghy**. M., Nietosvaara, V., 2017:
Scientific and application potential of **stereoscopic imagery** based on METEOSAT satellites.
Proceedings for the 2017 EUMETSAT Meteorological Satellite Conference, 2-6 October 2017, Rome, Italy.

SAFNWC CT and CTTH data were provided by OMSZ to this study.

How correspond to each other the two kinds of cloud top height retrievals?

Mid- and high-level opaque clouds – the best
Very low clouds, semitransparent thick clouds - most problematic



Cloud type	Cloud index
All clouds	ALL
Very low clouds	5
Low clouds	6
Mid level clouds	7
High opaque clouds	8
Very high opaque clouds	9
High semitransparent thin clouds	11
High semitransparent meanly thick clouds	12
High semitransparent thick clouds	13
High semitransparent above low or medium clouds	14

Projects NWCSAF products were used for - in the last 5 years

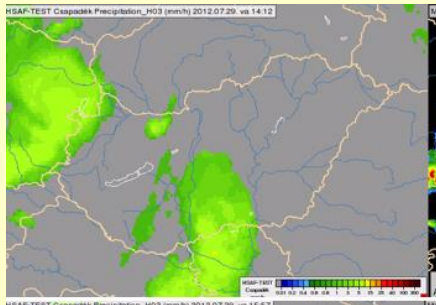
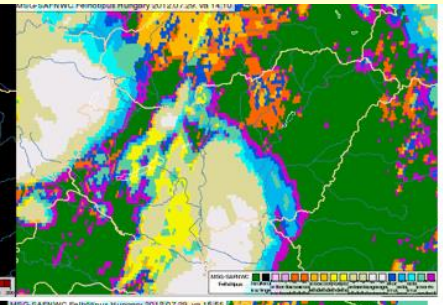
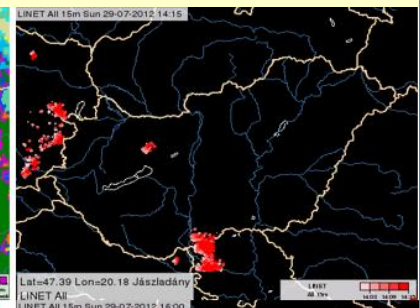
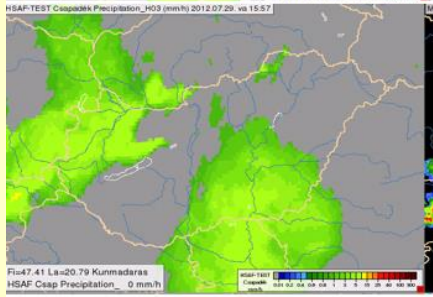
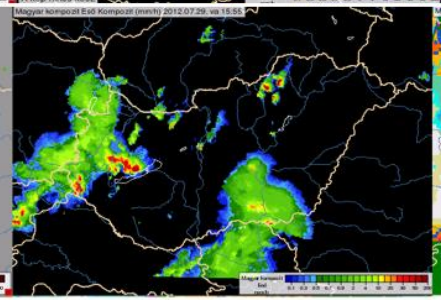
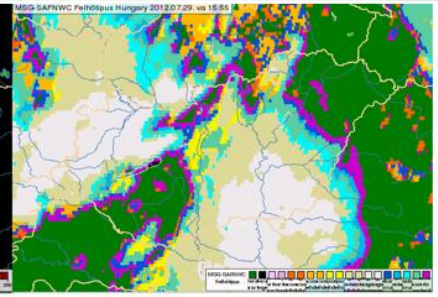
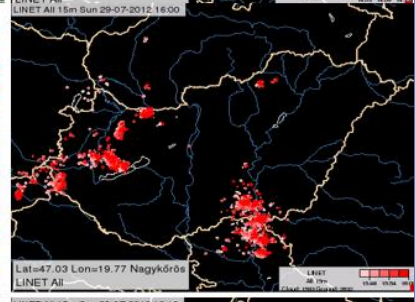
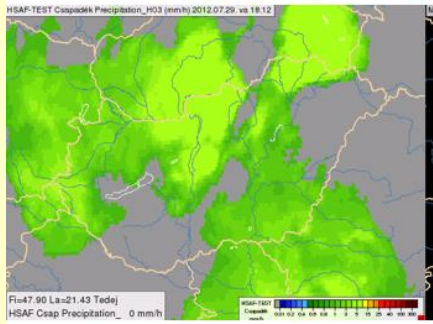
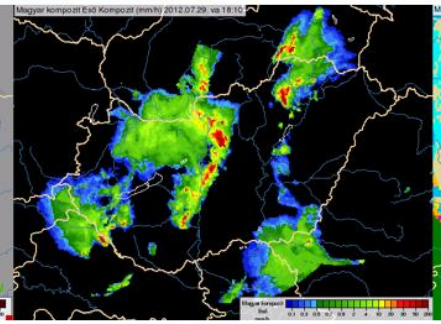
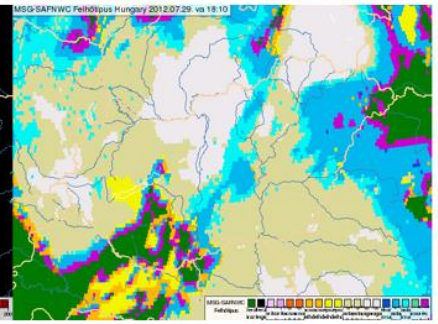
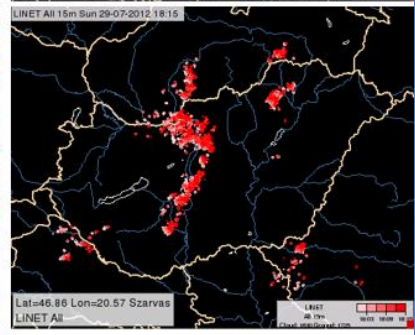
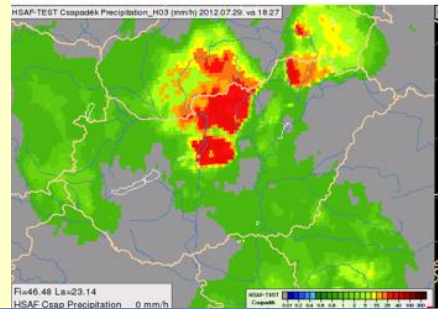
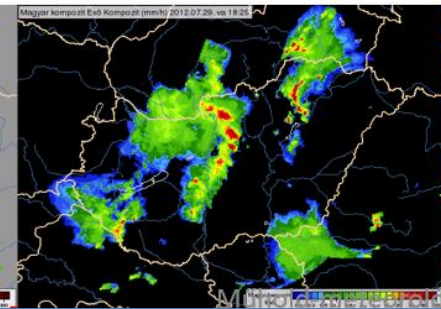
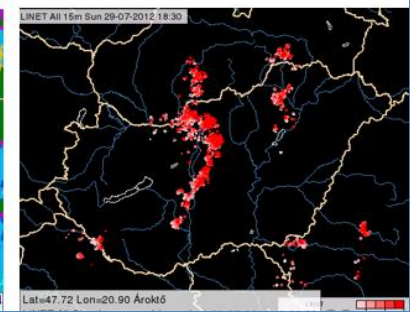
HSAF project

OMSZ - Verification of precipitation products

NWCSAF CT is often used in interactive case studies

H03: retrieved from SEVIRI + MW data (when polar MW is available)

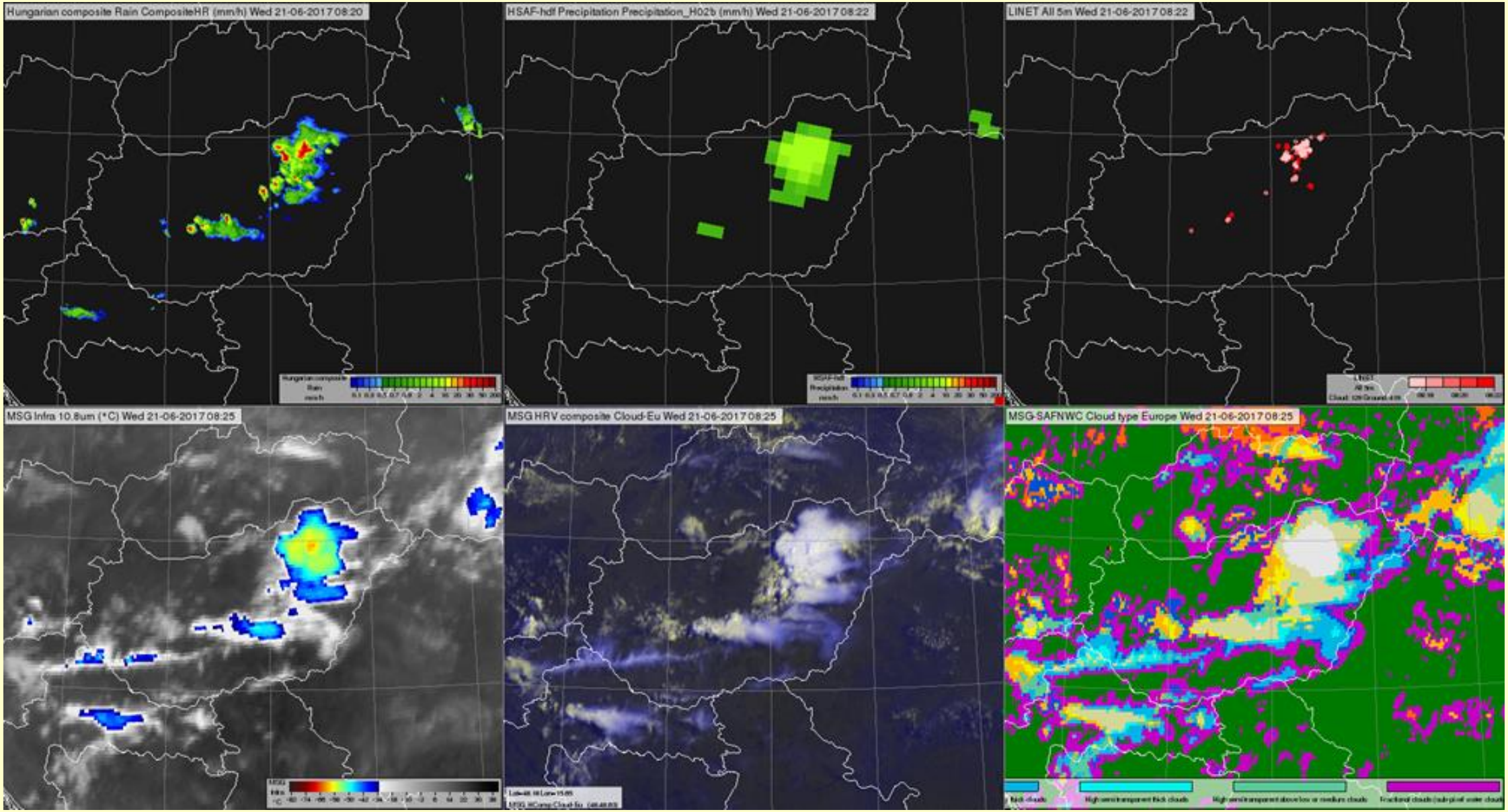
2012.07.29.

	HSAF rain rate (H03)	Radar	SAFNWC Cloud Type	Lightning
14:10				
14:55				
18:10				
18:25				

Hungarian radar Cmax

H02B precipitation product

Lightning data (LINET network)



SEVIRI IR10.8 μm

SEVIRI HRV Cloud RGB

NWCSAF Cloud Type

21 June 2017, 08:22 UTC

H02B: retrieved from MW measurements (NOAA, METOP AMSU and HMS)

Projects NWCSAF products were used for - in the last 5 years

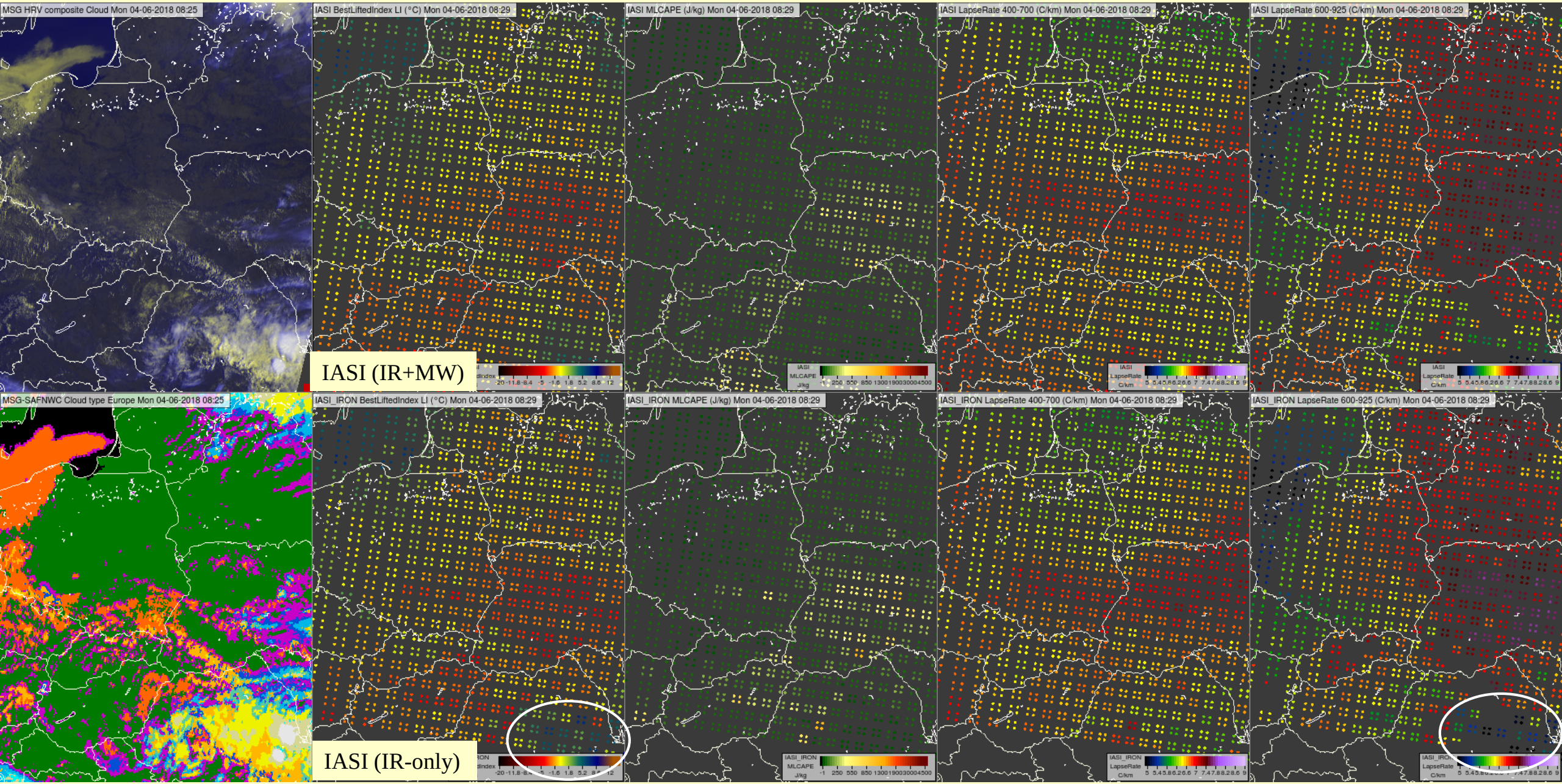
EUMETSAT studies

2017: Common use of satellite lightning and radar data in convective case studies and
Investigating potential usefulness of IASI L2 product (**based on IR+MW measurements**) for nowcasting purposes

2019: Investigating potential usefulness of IASI L2 product (**based on IR-only measurements**) for nowcasting purposes

In both products NWCSAF Cloud Type was used at case studies

SEVIRI | Best Lifted index | MLCAPE | 400/700 hPa lapse rate | 600/925 hPa lapse rate



04 June 2018

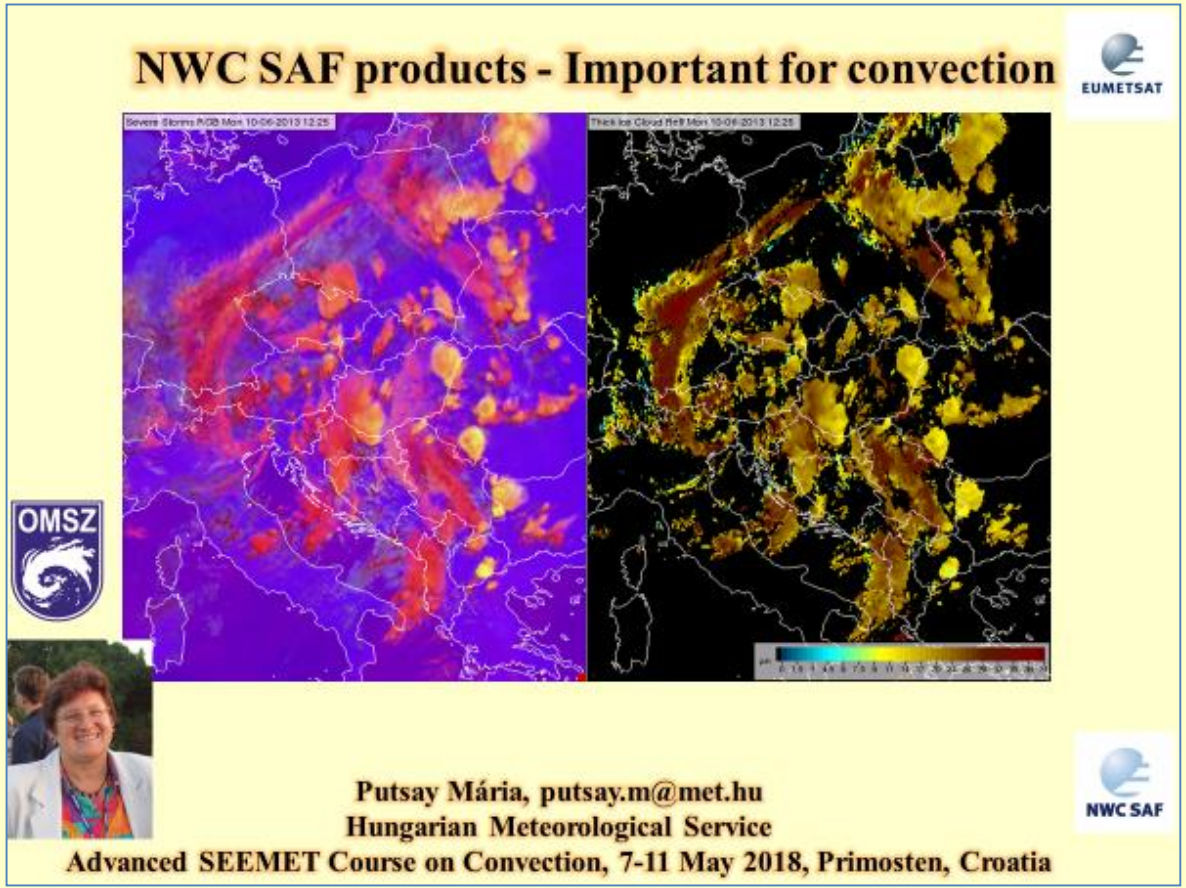
(IR+MW) and IR-only derived parameters have similar structures, larger differences on areas covered by mid/high-level opaque clouds

Projects NWCSAF products were used for - in the last 5 years

Training projects

Presentation on NWCSAF on satellite courses

- 2016 – M. Putsay: NWC SAF products. EUMETSAT – AUTH Training Workshop on the "Use of satellite data on nowcasting high impact weather", 12 – 16 September 2016, **Thessaloniki, Greece**
- 2016 – M. Putsay: NWC SAF products. Training Workshop on Monitoring and Forecasting Severe Weather with Remote Sensing Technology. **Taipei, Taiwan**, 28 November – 1 December, 2016
- 2017 – M. Putsay: RGBs combined with derived products. Basic SEEMET Satellite Course, 8-12 May 2017, **Bar, Montenegro**
- 2018 – M. Putsay: NWCSAF products – Important for convection, Advanced SEEMET course on Convection,2018, **Primosten, Croatia**



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Suggestions, requests, comments

Conclusions

Suggestions, requirements

Cloud products

- Improve the detection of very thin cirrus clouds (with the MTG new **NIR1.3** channel and better spatial resolution).
- Improve the reliability of the 'cirrus over lower clouds' class - if possible
- Separation of cumuliform and stratiform clouds in the opaque cloud classes. It might be easier with the *higher spatial resolution* of MTG.
- Improve the separation between the very thin semitransparent clouds and fractional clouds (with MTG NIR1.3).
- Use the new NIR2.25 channel of MTG to improve the snow detection.
- Improve the dust and volcanic ash flags by using the new visible and NIR channels on MTG.
- Consider creating flag for smoke plume caused by fire as well, if it is possible and reasonable.

- Modify the cloud top height/pressure retrieval within the warm spot of a cold-ring/cold-U shaped thunderstorm. Do not retrieve lower cloud top height (higher cloud top pressure) within the warm spot.

- **Try to minimise the inconsistency between CT and CTTH products**
- Take into account the dew point deficit at the CTTH retrieval algorithm

Cloud products **Reliable** ☺☺

Inconsistency between CT and CTTH

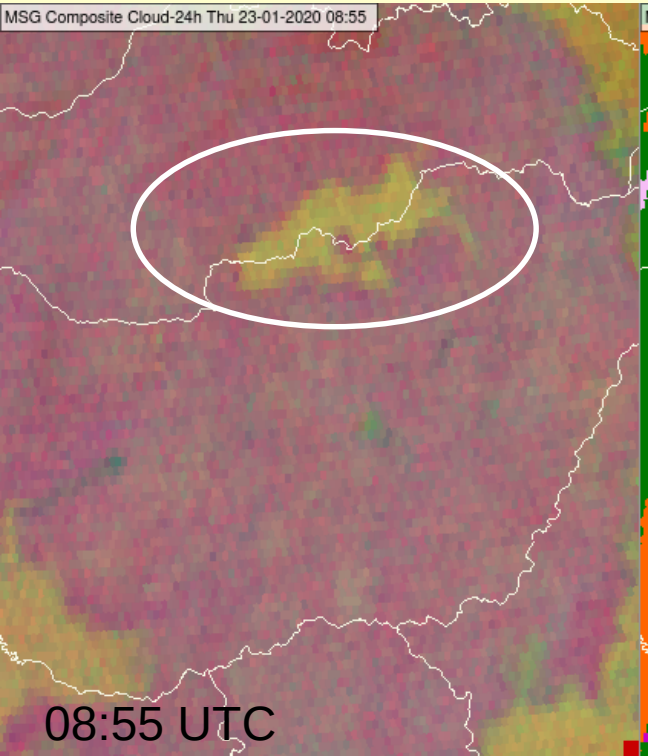
23 January 2020 - winter cold pool situation - fog/stratus in the encircled area
NWCSAF CT retrieved very low cloud
NWCSAF CTTH retrieved cloud top pressure ~700 hPa in several pixels, a mid-level cloud top
No consistency between CT and CTTH!

~850 hPa

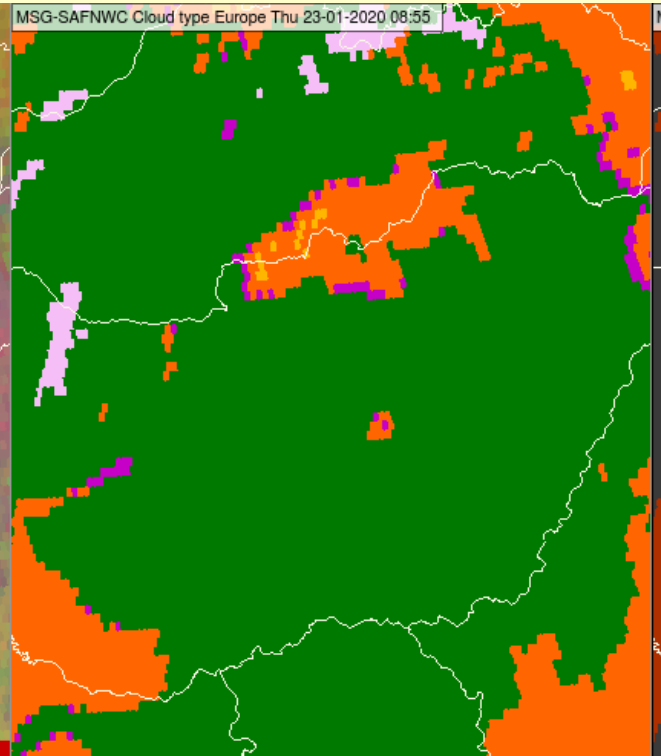
~700 hPa

In ECMWF model
this area is cloud-free

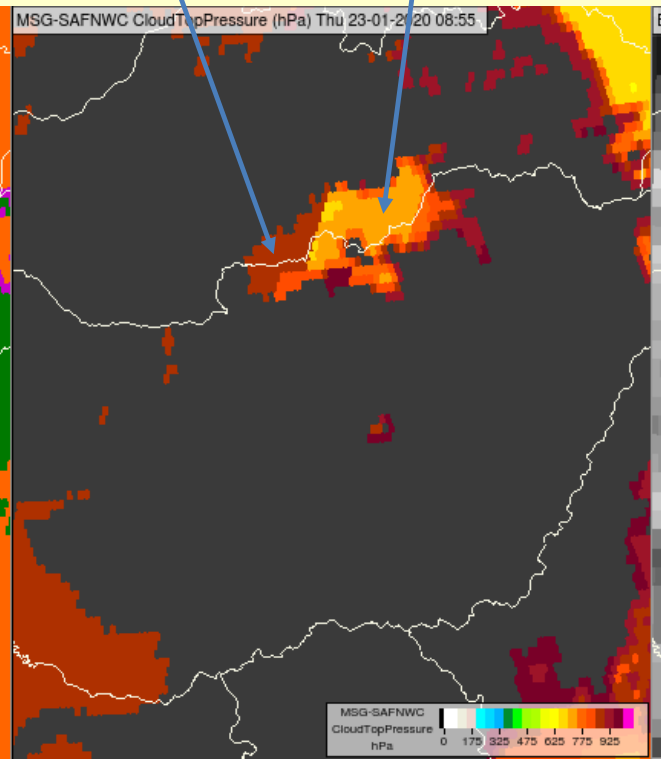
24h Microphysics RGB



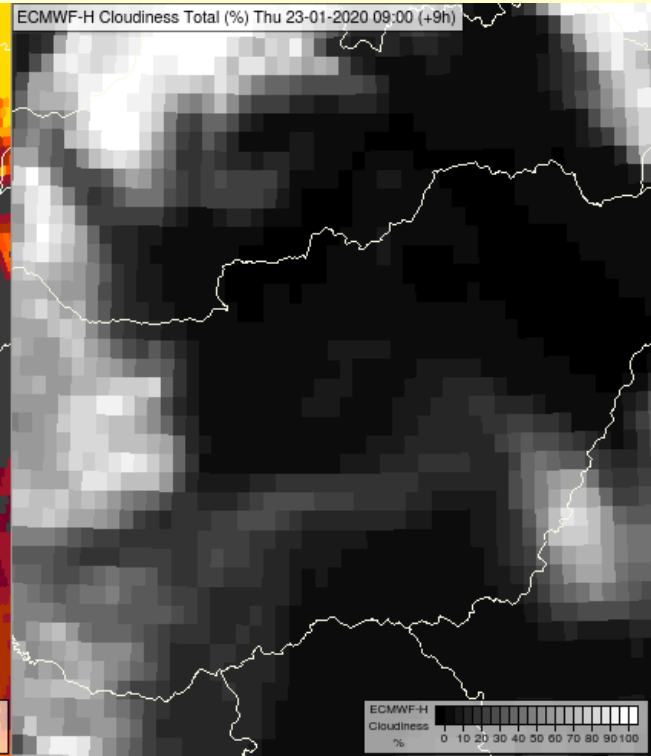
NWCSAF Cloud Type

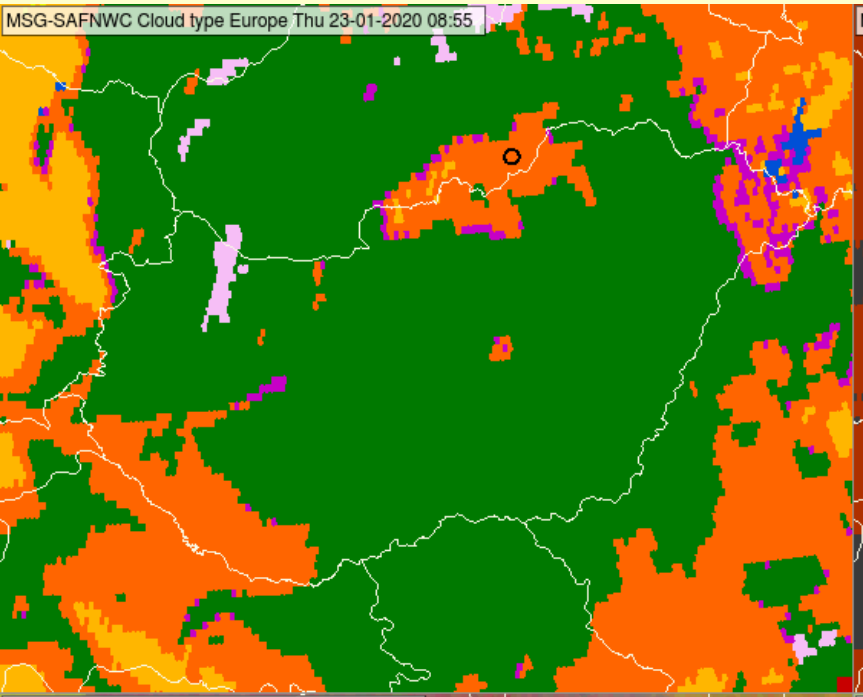


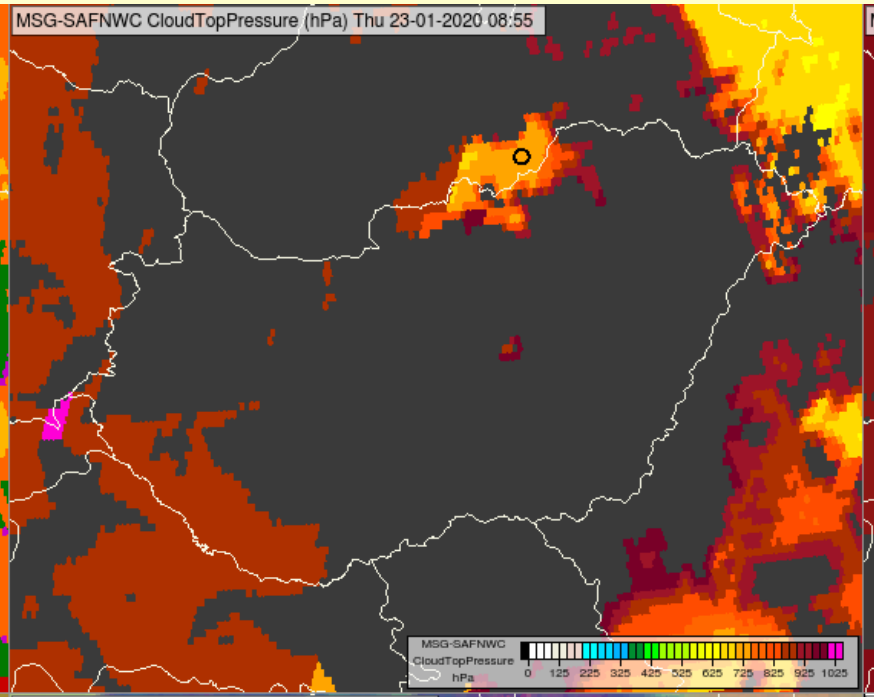
NWCSAF Cloud top Presssure

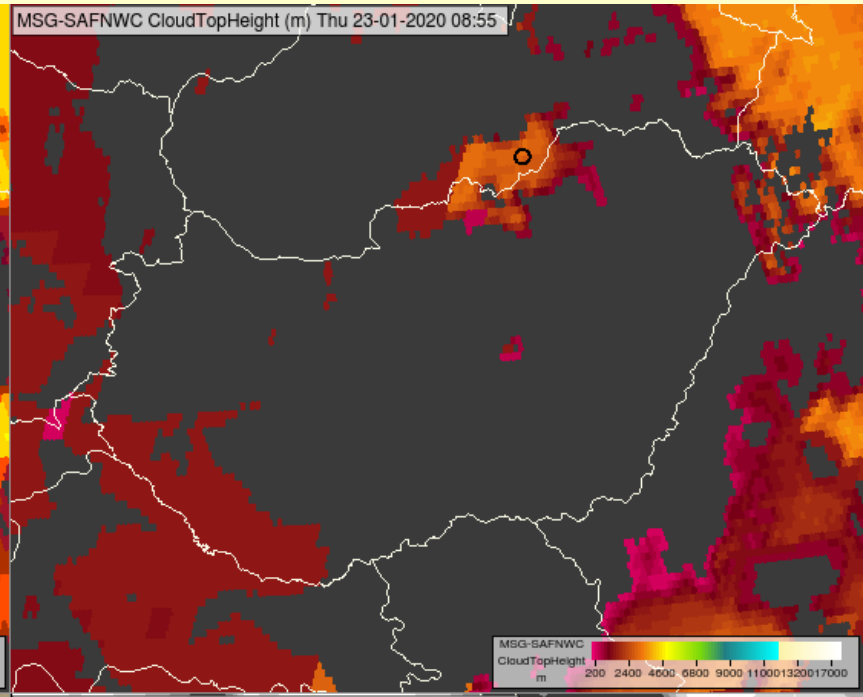


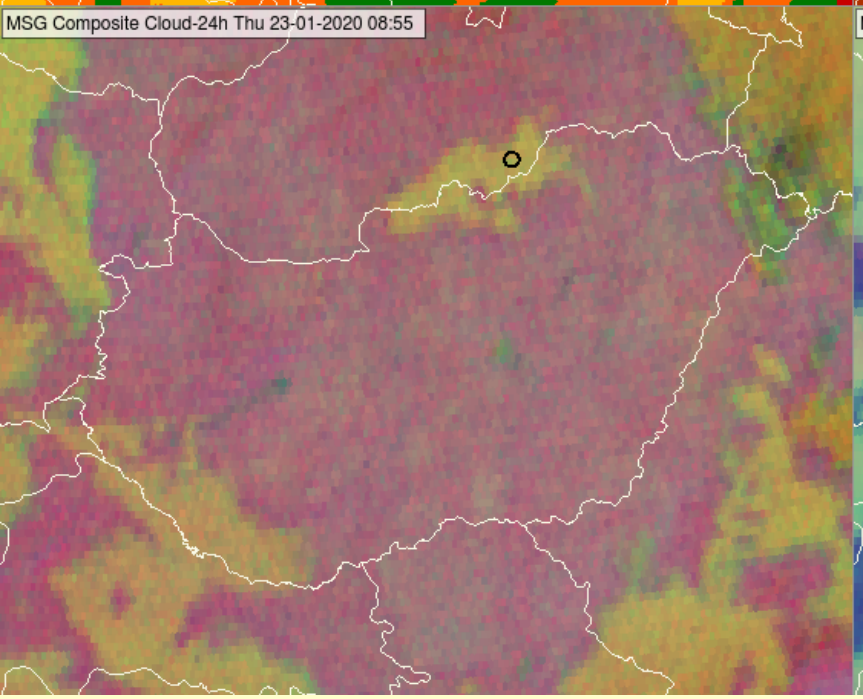
ECMWF Total cloudiness

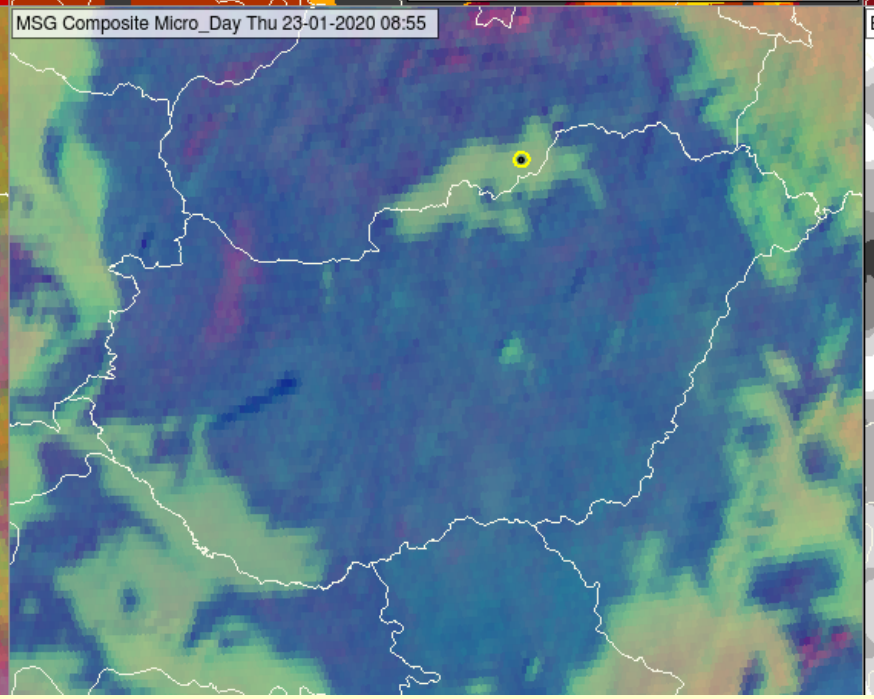


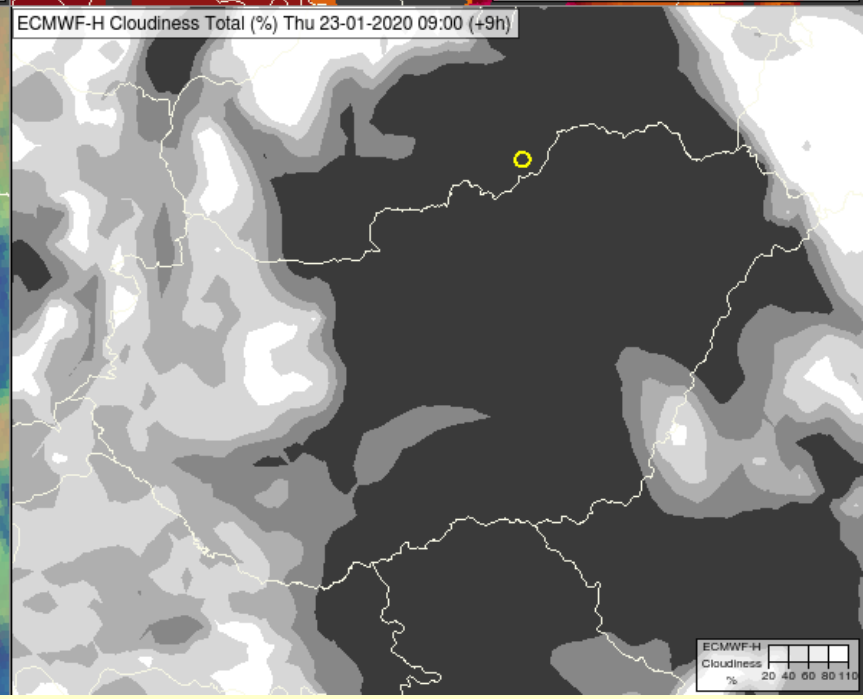

MSG-SAFNWC Cloud type Europe Thu 23-01-2020 08:55


MSG-SAFNWC CloudTopPressure (hPa) Thu 23-01-2020 08:55
MSG-SAFNWC
CloudTopPressure
hPa
0 125 225 325 425 525 625 725 825 925 1025

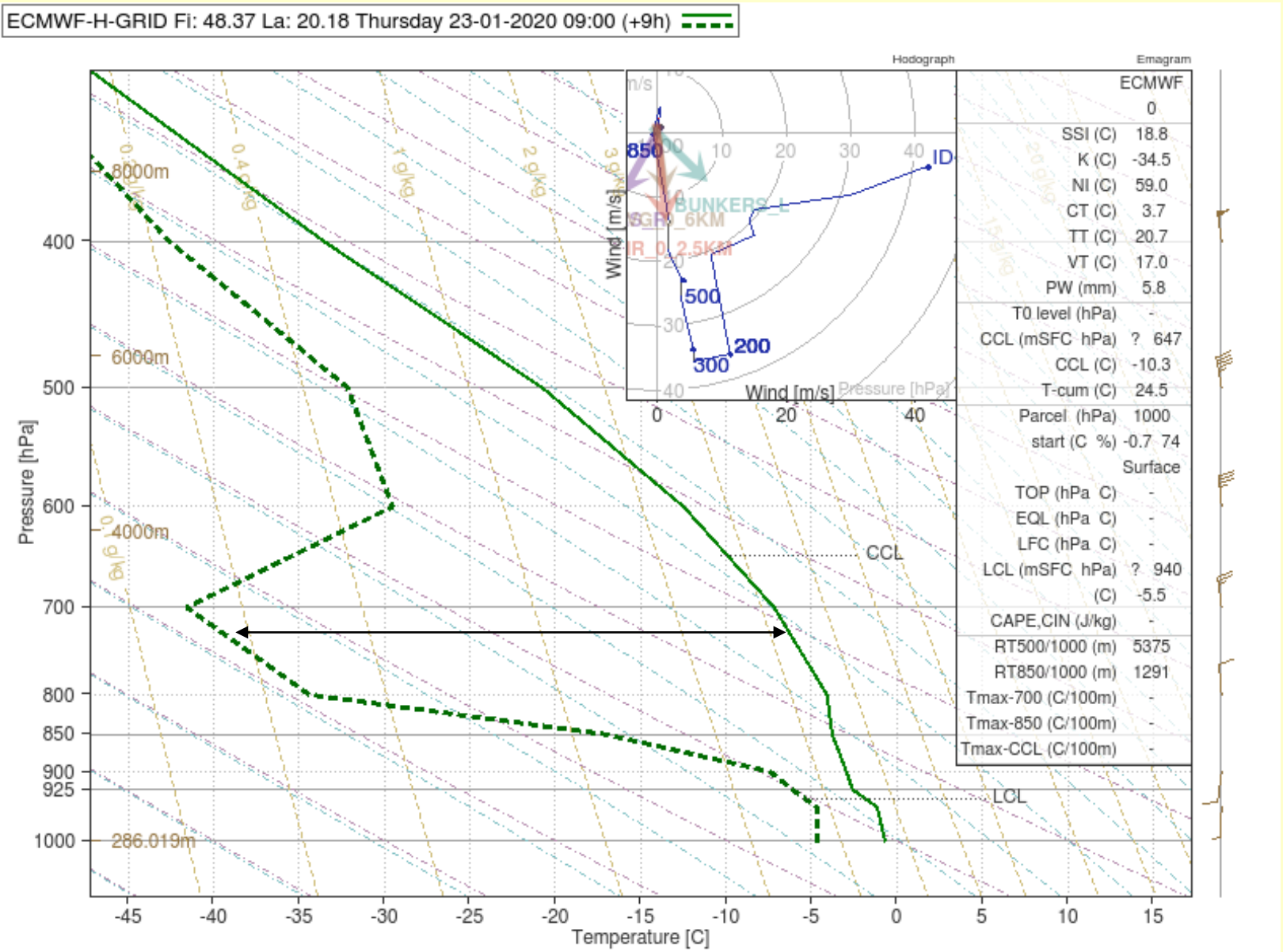

MSG-SAFNWC CloudTopHeight (m) Thu 23-01-2020 08:55
MSG-SAFNWC
CloudTopHeight
m
200 2400 4600 6800 9000 11000 13200 17000


MSG Composite Cloud-24h Thu 23-01-2020 08:55


MSG Composite Micro_Day Thu 23-01-2020 08:55


ECMWF-H Cloudiness Total (%) Thu 23-01-2020 09:00 (+9h)
ECMWF-H
Cloudiness
%
20 40 60 80 110

ECMWF profile at the location indicated in the previous slide



At this location:
Retrieved cloud top pressure = 724 hPa,
ECMWF dew point deficit at 724 hPa **~ 33 K**

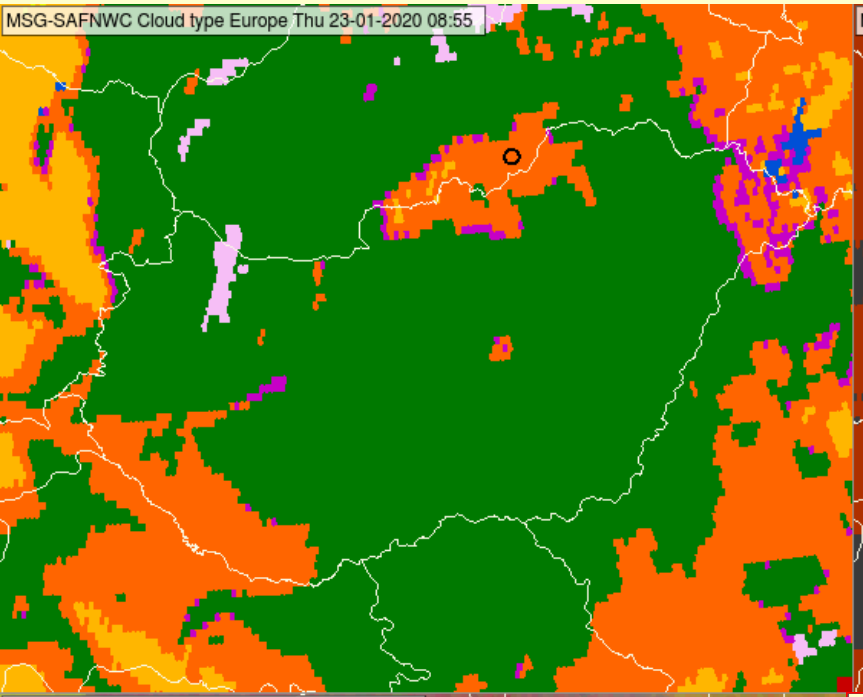
The retrieval cannot be good as the dew point deficit is too high at that level!

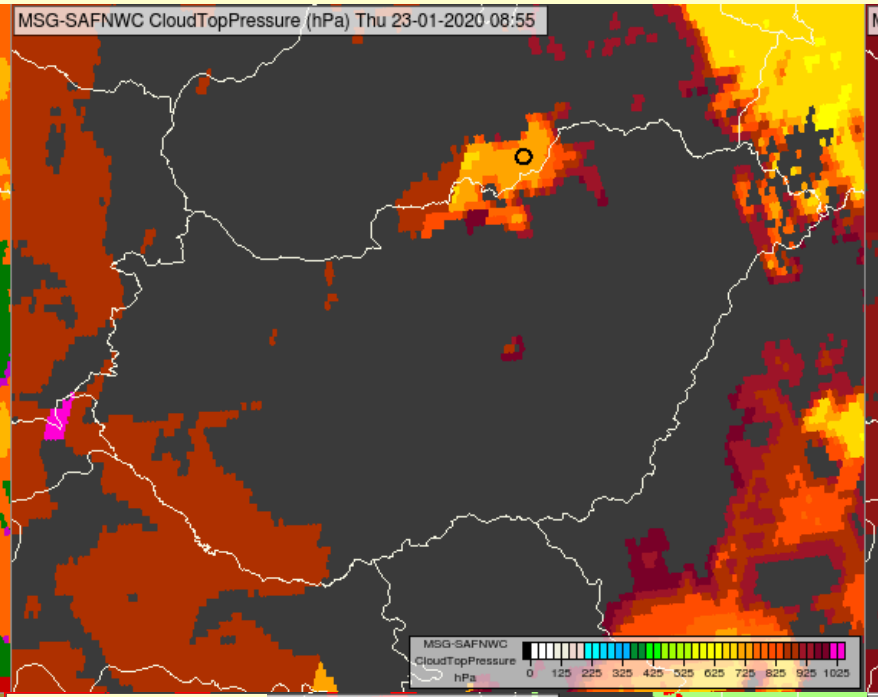
Taking into account the dew point deficit a cloud can be present only below the ~900 hPa level.

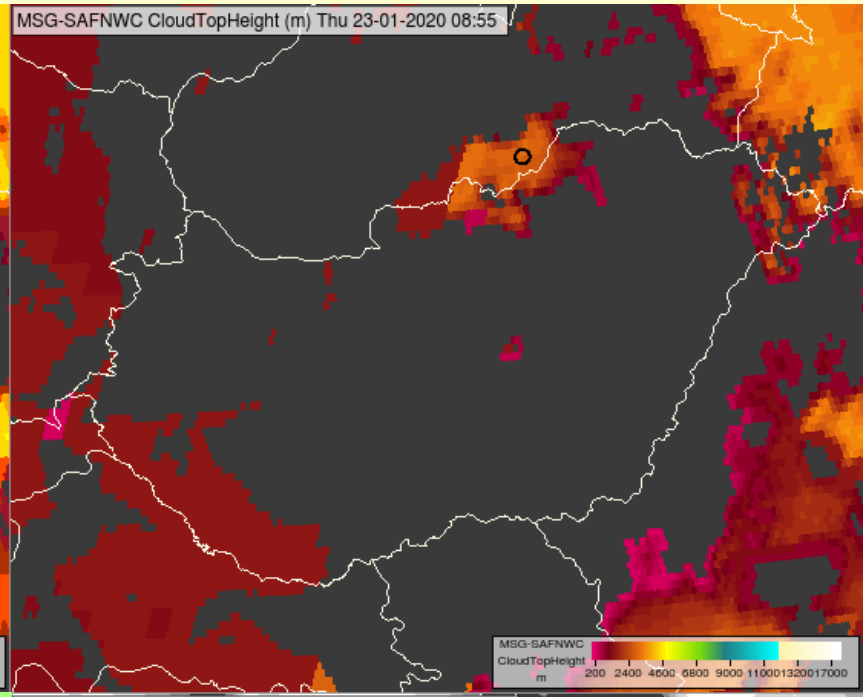
We suggest for the algorithm to check how far the retrieved cloud top level is from saturation, and refuse the retrieval if the cloud top level is too dry.

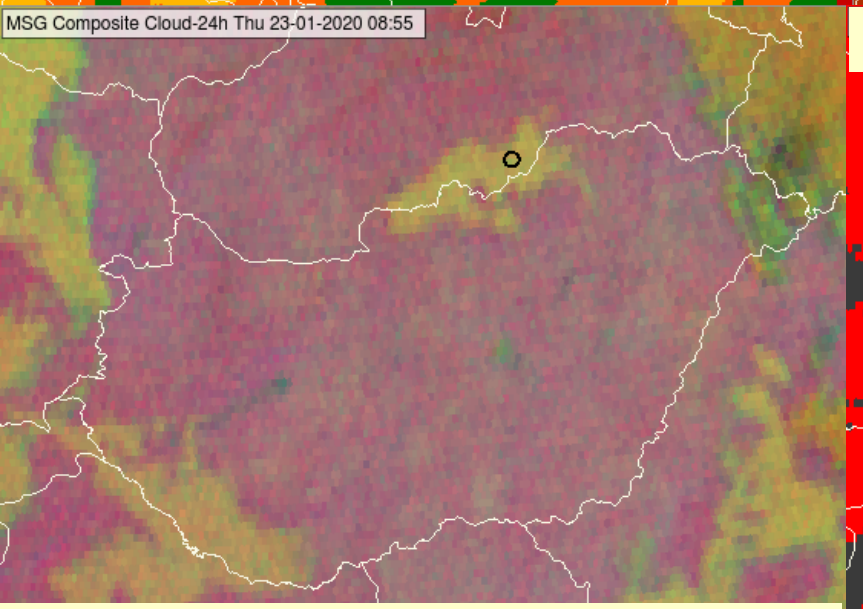
//

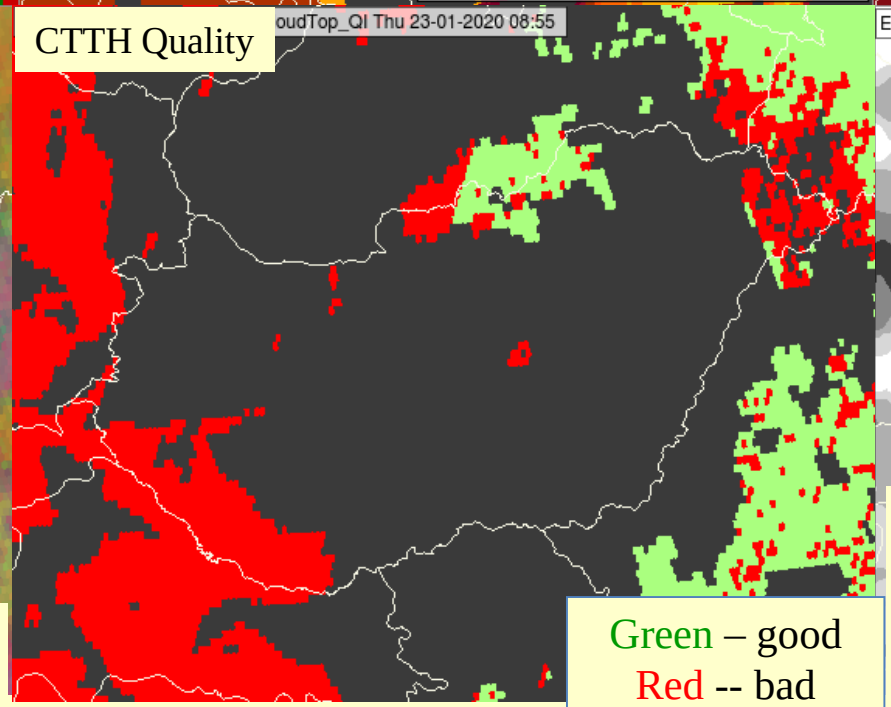
The CTTH algorithm used ECMWF profile, what differed from the real profile in the low layer, as the stratus/fog was not present in the model.

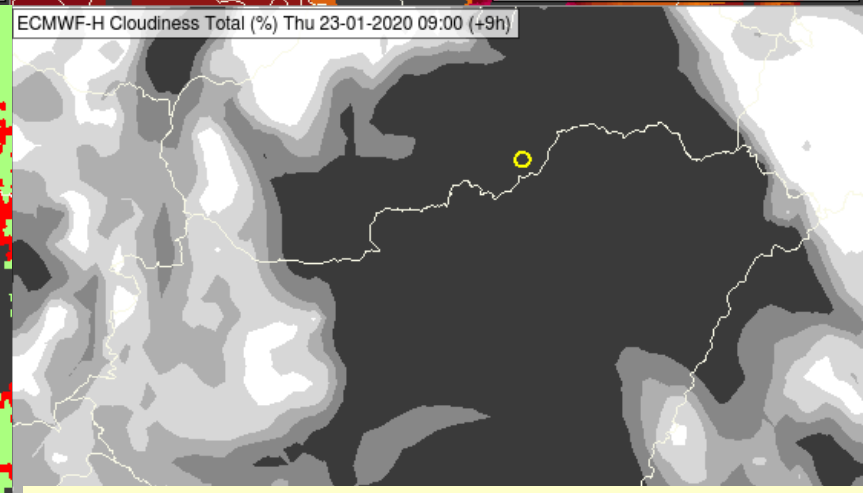








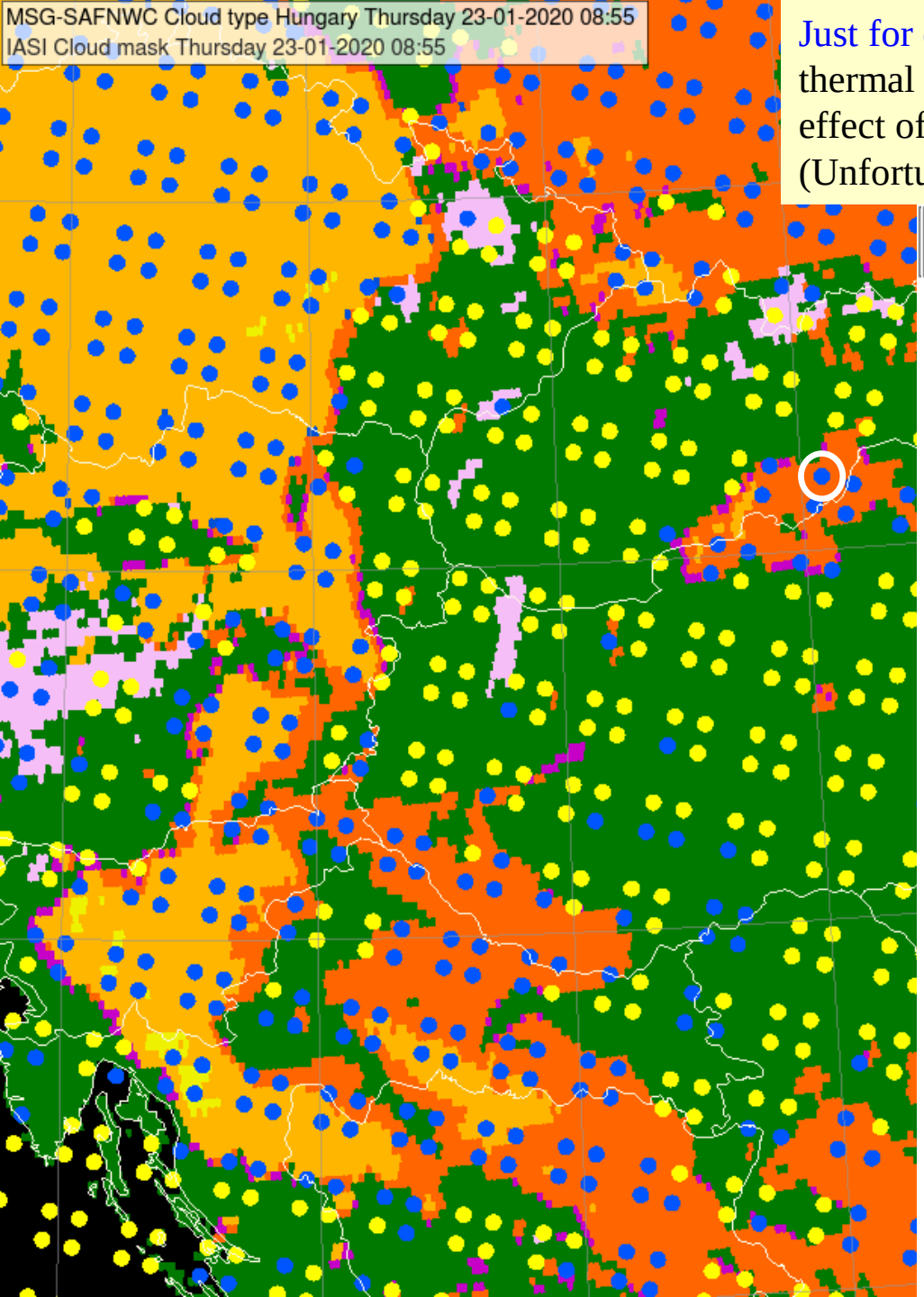




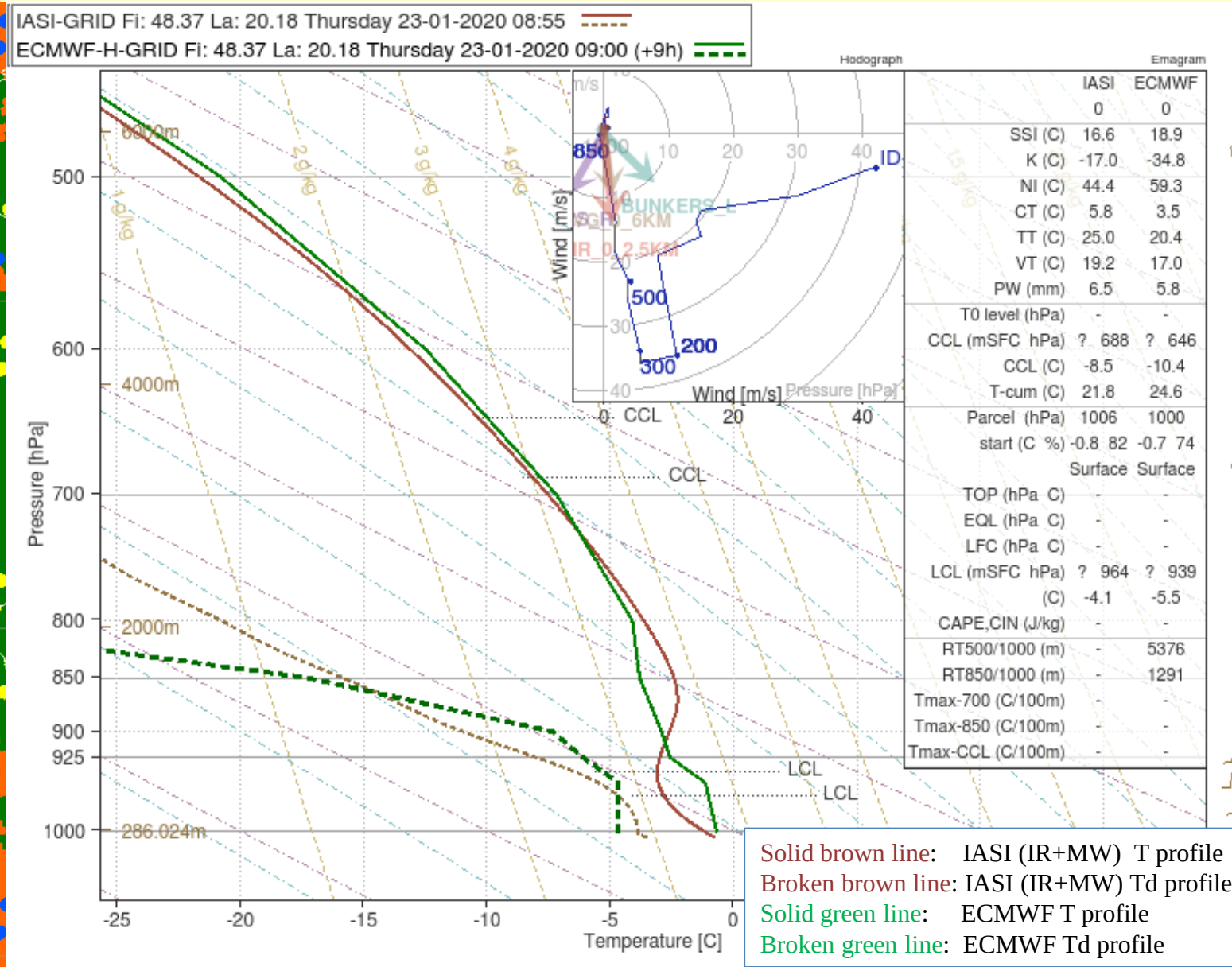
The same problem for other time steps and areas as well.

Green – good
Red -- bad

We checked the CTTH quality flag.
It showed the **opposite** compared to what we expected. Good for mid-level cloud top retrieval and bad for low level retrieval.

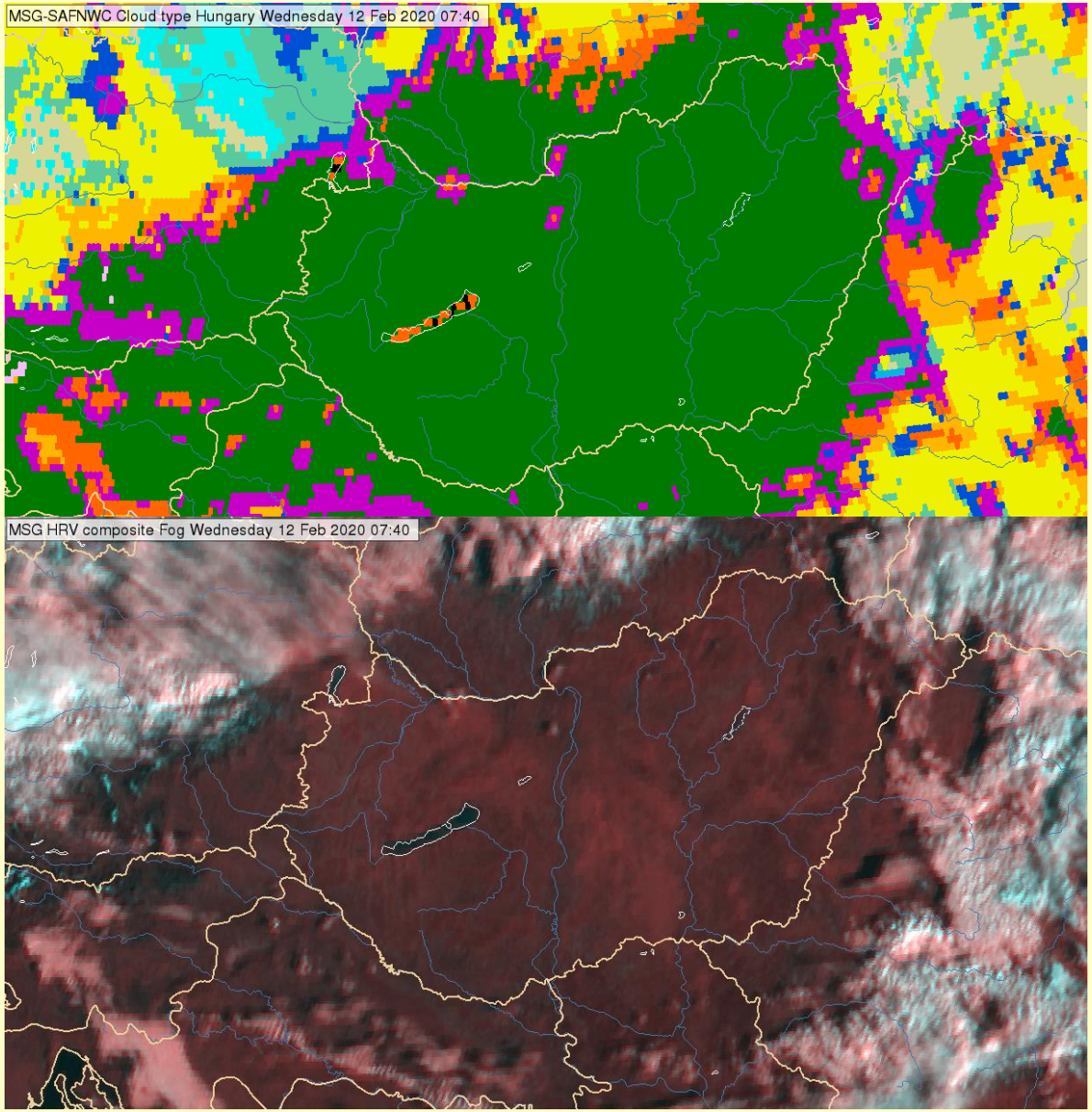


Just for curiosity we note that the IASI L2 profile (based on IR and MW measurements) shows thermal inversion (see the typical T profile shape for stratus cloud). IASI L2 profile reflects the effect of the real cloudiness. With IASI profile the retrieved cloud top height might be lower. (Unfortunately IRS profiles will be based only on IR data, without MW measurements.)



Solid brown line: IASI (IR+MW) T profile
Broken brown line: IASI (IR+MW) Td profile
Solid green line: ECMWF T profile
Broken green line: ECMWF Td profile

Misclassification of Lake Balaton - CT



Balatongyörök, 07:40 UTC

Siófok, 07:40 UTC

Siófok, 07:45 UTC

Suggestions, requirements

Wind products

- Produce wind using the **better spatial resolution** of MTG
- Consider whether an automatic recognition of right (left)-mover thunderstorms is possible, reasonable or not (it would be useful for the severity estimation of RDT)

- Produce **3D wind from the IRS** of MTG
- Combine IRS wind for cloud-free areas and 'traditional' wind for cloudy areas.
- Consider to retrieve lift or **wind-shear** from the IRS 3D wind field – in case the wind field will be enough accurate for this purpose

Convection products

- Improve the reliability of CI product
- Improve the reliability of the separation between convective from non-convective cloud systems.
- Find a solutions for getting **smoother trajectories**
- It might be useful a lifting velocity parameter (vertical speed of the cloud top height lifting in **m/sec**). It is important mainly in the developing phase. Besides the cooling rate, the lifting velocity is also informative.

- Detect further indicators of the possibly storm severity
  - Detect ice-plume – if possible
  - Detect cold ring, cold/U shaped clouds, and indicate if its lifetime is longer than 45 minute.

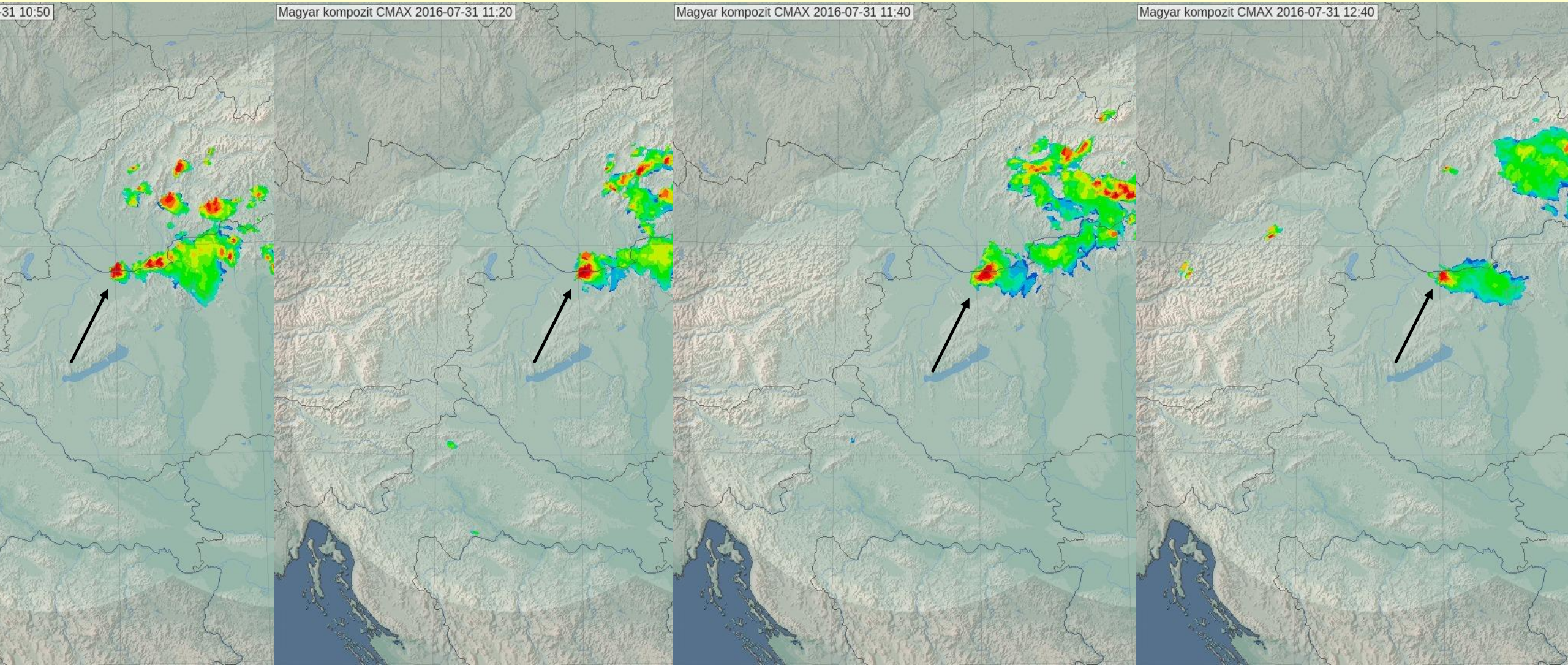
- Adapt RDT and CI products to MTG.
- Use **LI** data of MTG.

Case study of flash flood
31.07.2016

Convective multicell system

The most intense part (the area with the highest rain rate) is stationary. However, the anvil expands.

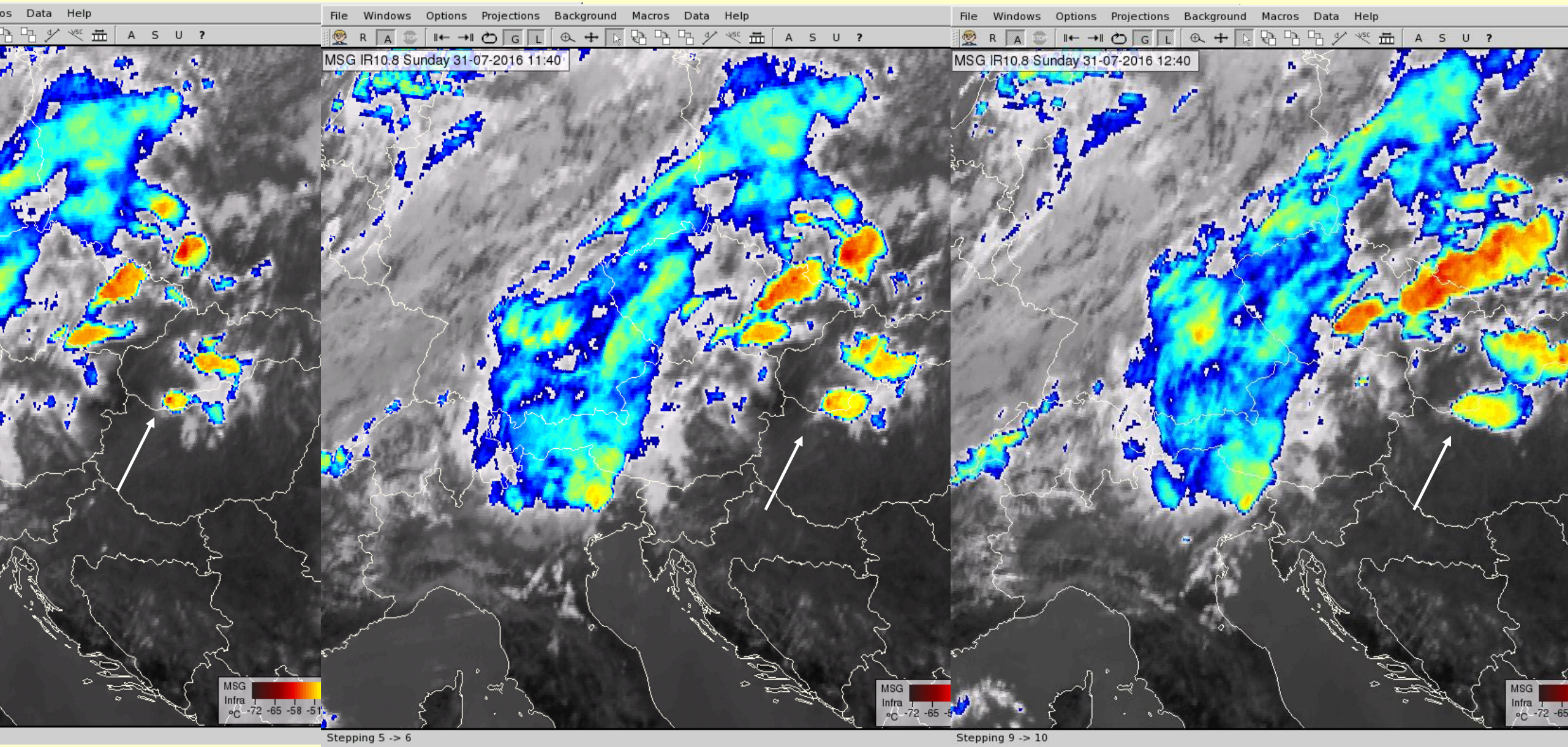
→→ HRW retrieves non zero AMV, and RDT retrieves expected movement.



Convective multicell system

The most intense part (the area with the highest rain rate) is stationary. However, the anvil expands.

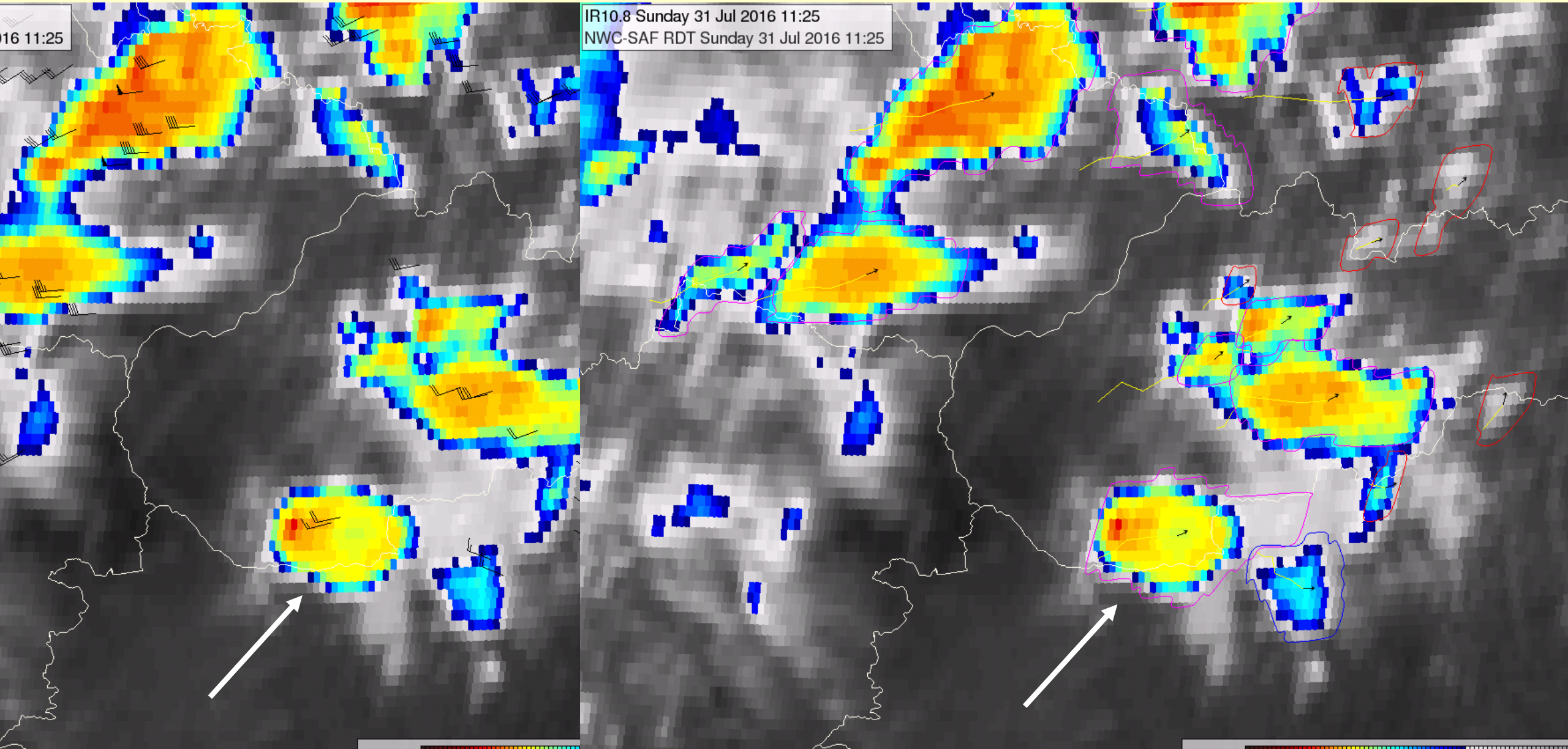
→→ HRW retrieves non zero AMV, and RDT retrieves expected movement.



Convective multicell system

The most intense part (the area with the highest rain rate) is stationary. However, the anvil expands.

→→ HRW retrieves non zero AMV, and RDT retrieves expected movement and trajectory.



Suggestions, requirements

Precipitation products

- Improve the separation of convective precipitation from non-convective
- Adapt the products for MTG.
- Use LI data of MTG

Satellite Humidity and instability products

- Improve the accuracy of the low-layer moisture content by using **NIR0.9** of MTG

- Use IASI L2 retrieval (developed by EUMETSAT) to get temperature and humidity profiles, instability and moisture content from IRS data
- Consider to derive (low-level) humidity advection from the 3D humidity and wind products retrieved from IRS data – in case the wind field will be enough accurate for this purpose

Automatic Image Interpretation

- Adopt the ASII-NG products to Meteosat Third Generation

Documentation and error messages
Suggestions for improvement to be more user friendly

These suggestions are about RDT documents.
However, the similar problems are experienced with other modules as well.
We ask for more (and informative) error/warning messages.

- If the lightning data file name is incorrect RDT product will not be created whithout any **error message**. The only message is that RDT has concluded with „**signal 11**” but we couldn’t find anywhere what that means.
  - It would be nice to have informative **error/warning message** that file name is incorrect.
  - Please, provide a list with the **meanings of the signals**.

- If the format of the lightning data within the lightning file is incorrect, the RDT module does not use it, without any massage. The user might not understand the reason.
  - It would be more user friendly if the program sent a message that it was not used and why.

Outline

Introduction

Fields of applications at OMSZ

Routinely performed applications:

Automatic applications:

- Data assimilation into locally run LAMs
- Use of satellite data in the nowcasting (warning) system
- Cloud cover information for OMSZ (internal and external) homepage

Interactive applications:

- Visualisation for the forecasters and colleagues at OMSZ

Research, Projects, Training, Case studies, …

Suggestions, requests, comments

Conclusions

Summary, conclusions

The program package (SAFNWC/MSG) is

- easy to install,
- easy to handle (with several years of experiences).

The help desk works well.

The documents are not always user friendly – sometimes it is difficult to find which document to read

The error messages are not always informative. Sometimes there are no error messages.

The configuration files are 'user friendly' – many configurable parameters

There are several useful products in the program package. There are improvements we are happy with.

In Hungary the **automatic applications** are the primary use of the NWCSAF products.

We look forward the new generation satellite data and products.

Thank you for your attention!

RGBs combined with derived products – SEEMET course in Monte Negro

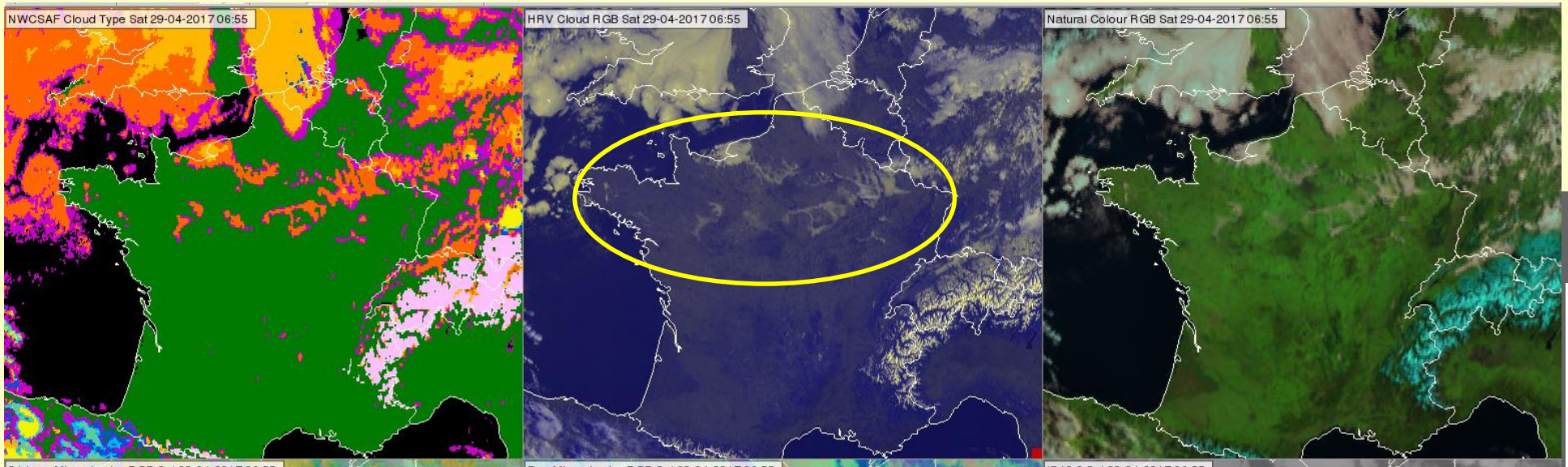
29 April 2017 10:25 UTC

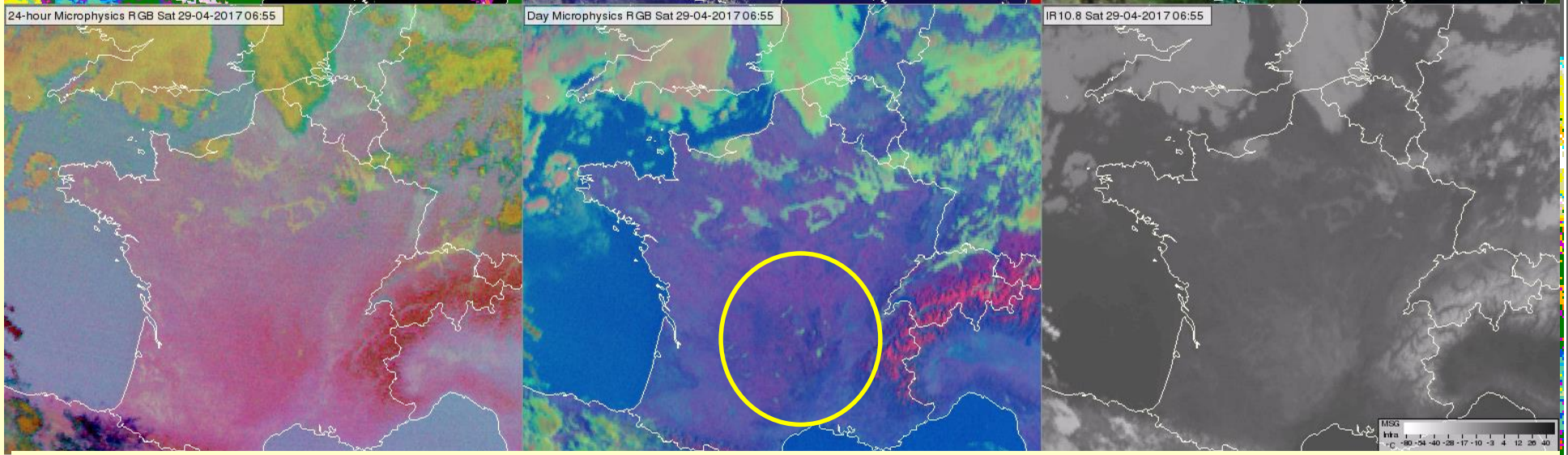
Valley fog

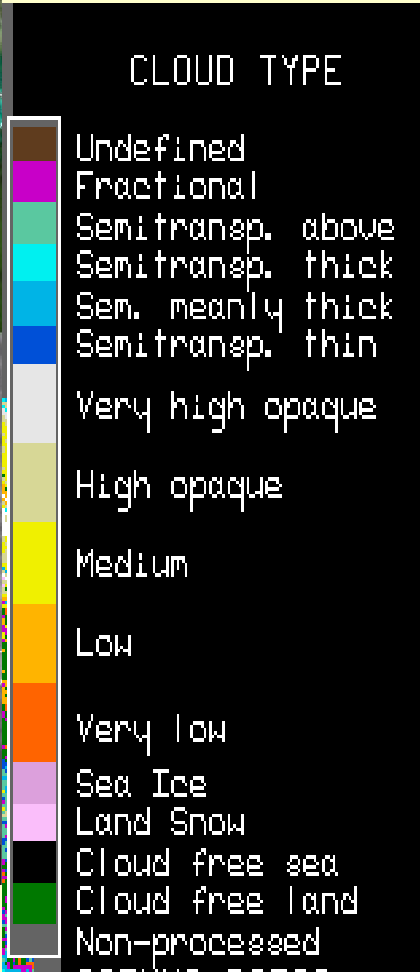
NWCSAF Cloud Type

HRV Cloud RGB

Natural Colour RGB







24h Microphysics RGB

Day Microphysics RGB

IR10.8

NWCSAF products – Important for convection, SEEMET course on Convection, **Croatia**

Training material on CMIC (based on version 2016)
Visual cross-verification of NWCSAF Cloud Microphysics products and Severe Storms RGB (Convection RGB)

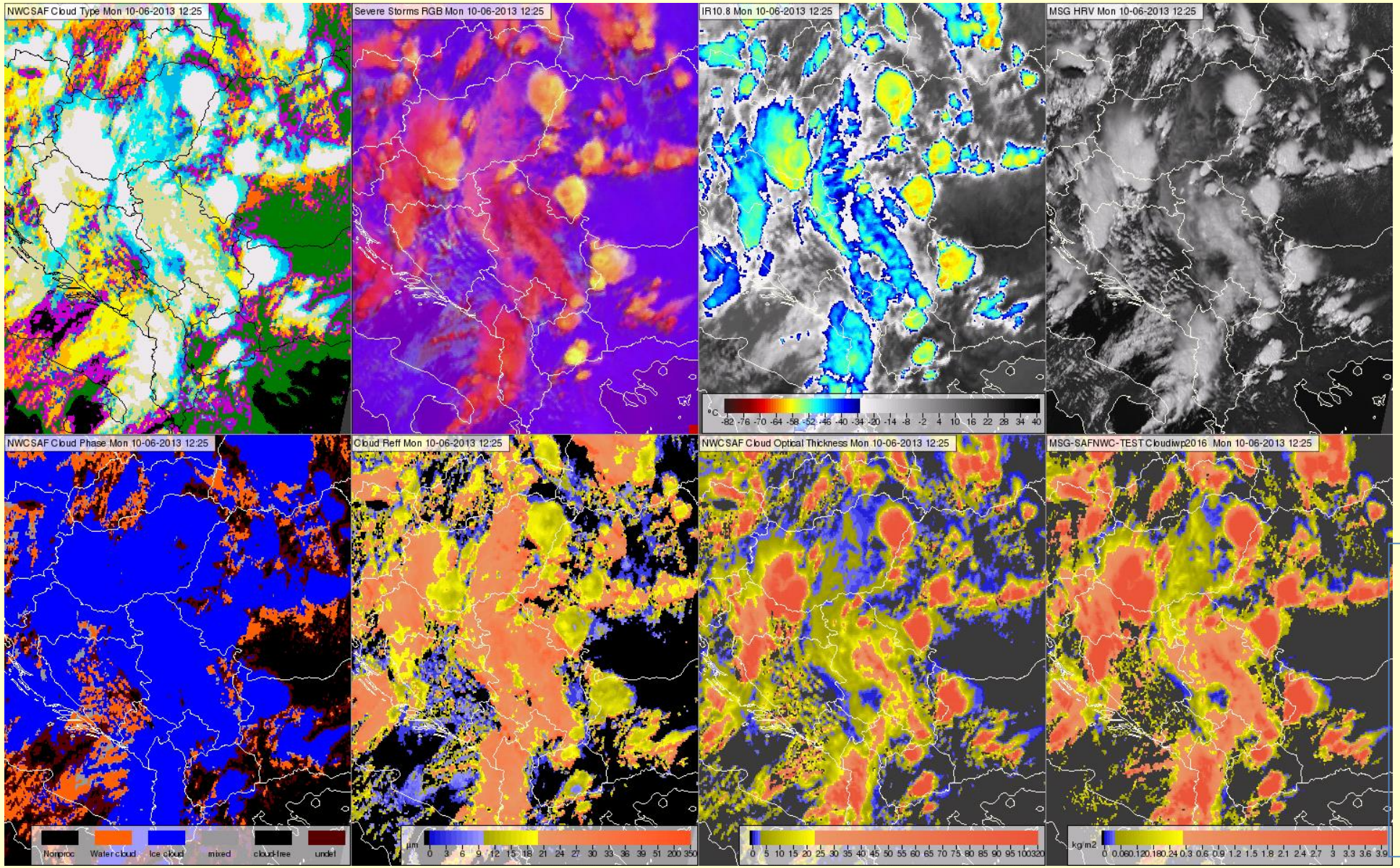
10 June 2013, 12:25 UTC

Cloud Type

Severe Storms RGB

IR10.8

HRV



Cloud Phase

Cloud top particle size

Cloud Optical Thickness

Ice Water Path

Colour scale with colour jump

Suggestion: Consider to use continuous colour scales

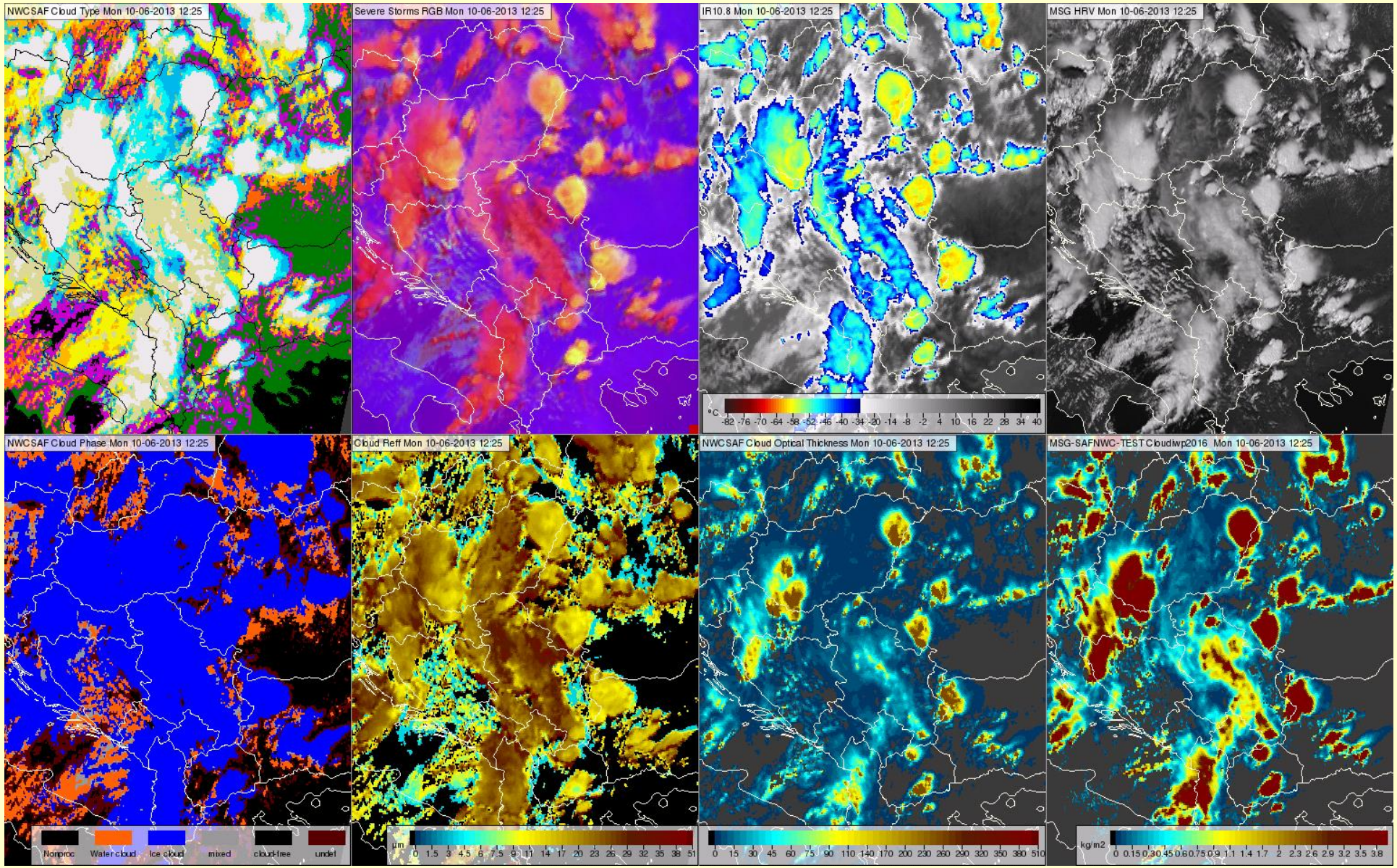
10 June 2013, 12:25 UTC

Cloud Type

Severe Storms RGB

IR10.8

HRV



Cloud Phase

Cloud top particle size

Cloud Optical Thickness

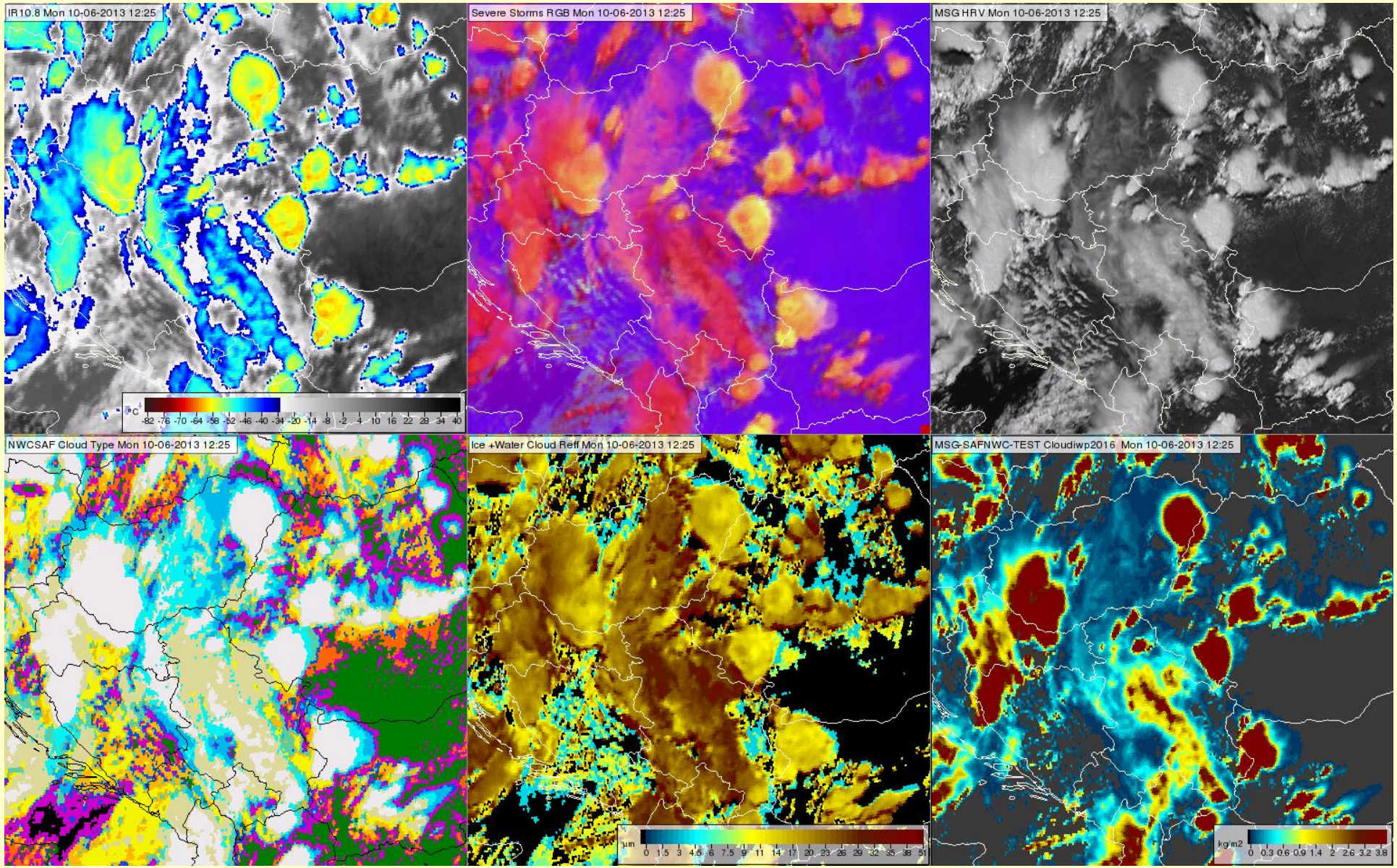
Ice Water Path

10 June 2013, 12:25 UTC

IR10.8

Severe Storms RGB

HRV



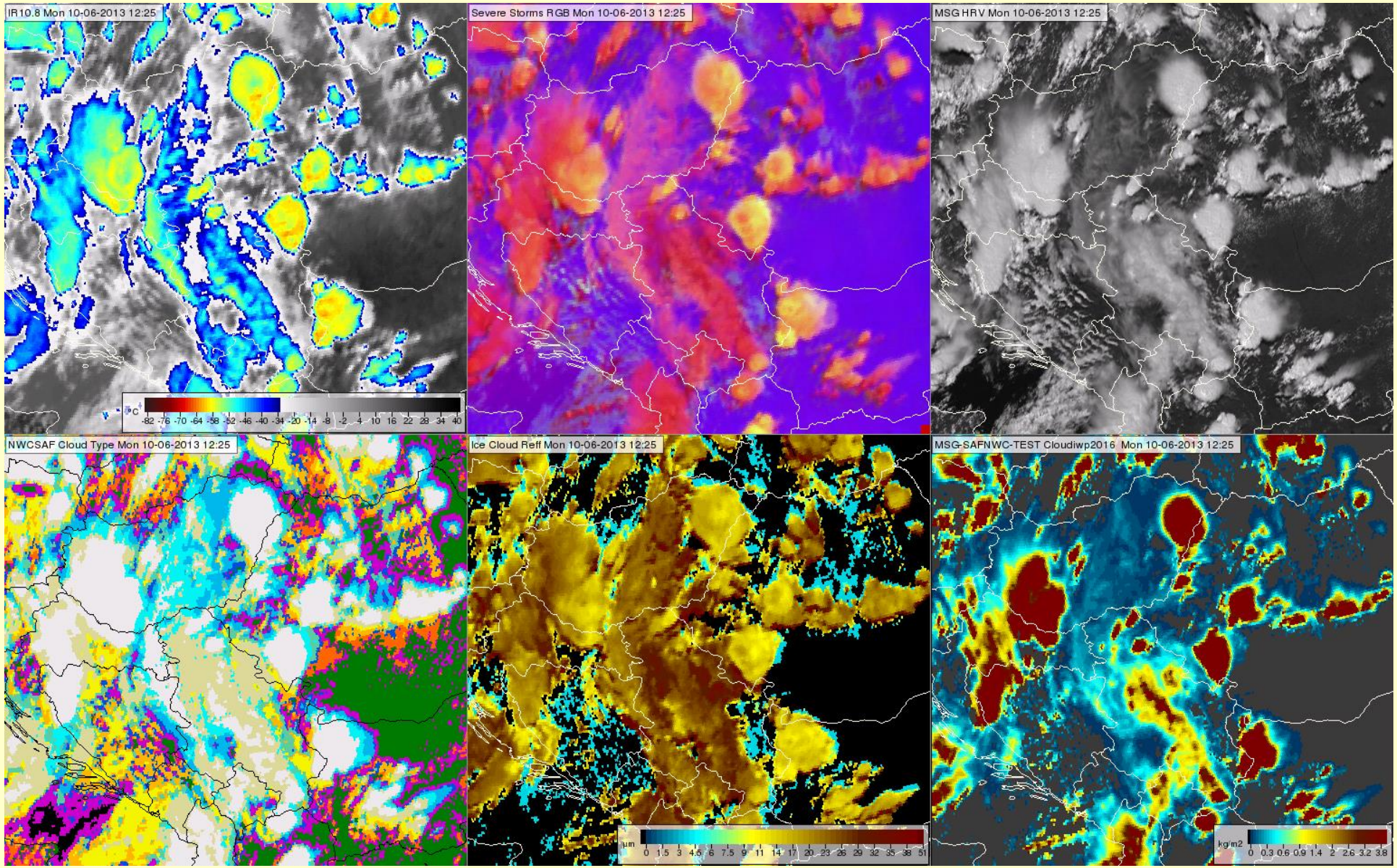
Cloud Type

Cloud top particle size

Ice Water Path

10 June 2013, 12:25 UTC

IR10.8 | Severe Storms RGB | HRV

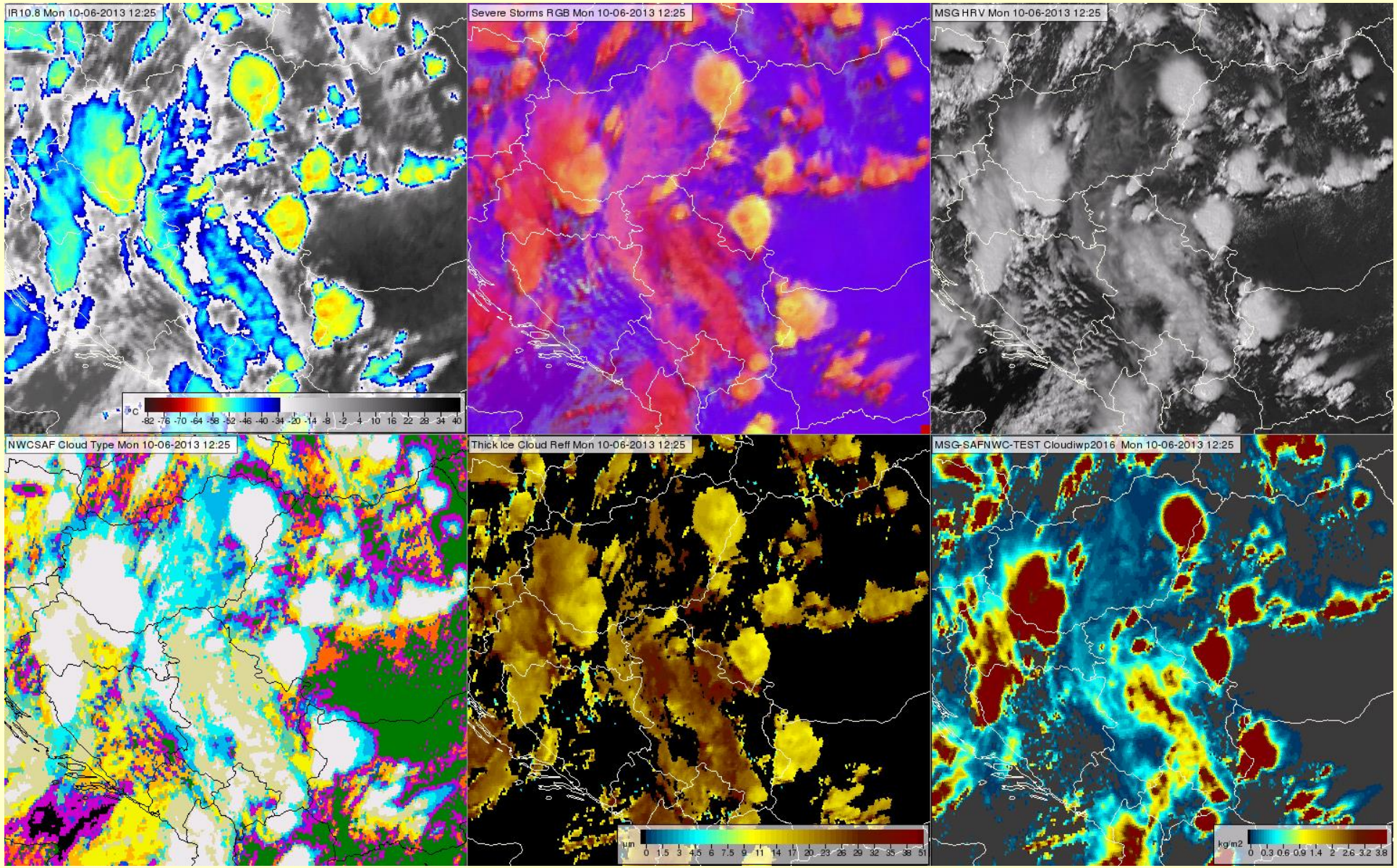


Cloud Type | Particle size of ice clouds | Ice Water Path

(Cloud phase is used for masking the water clouds.)

10 June 2013, 12:25 UTC

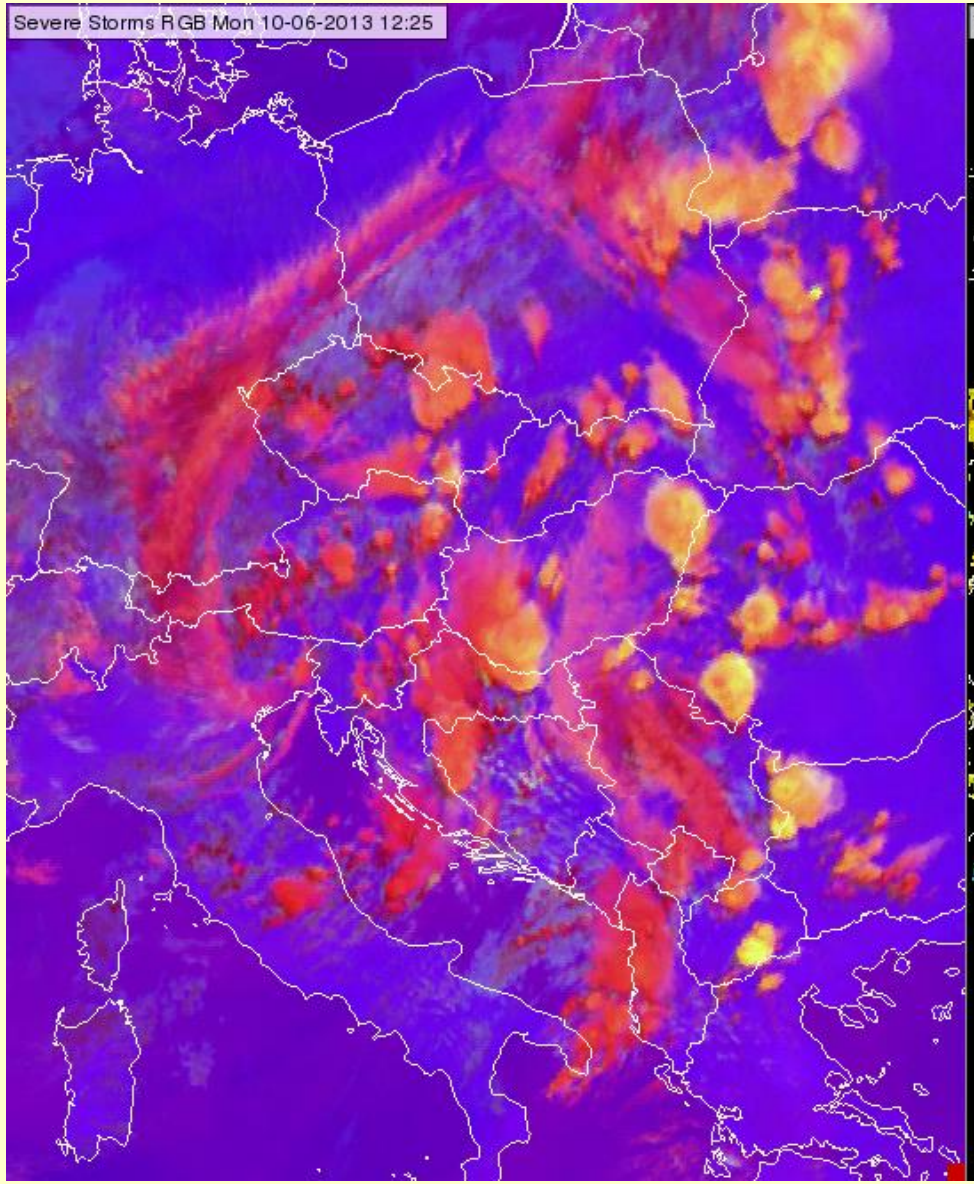
IR10.8 | Severe Storms RGB | HRV



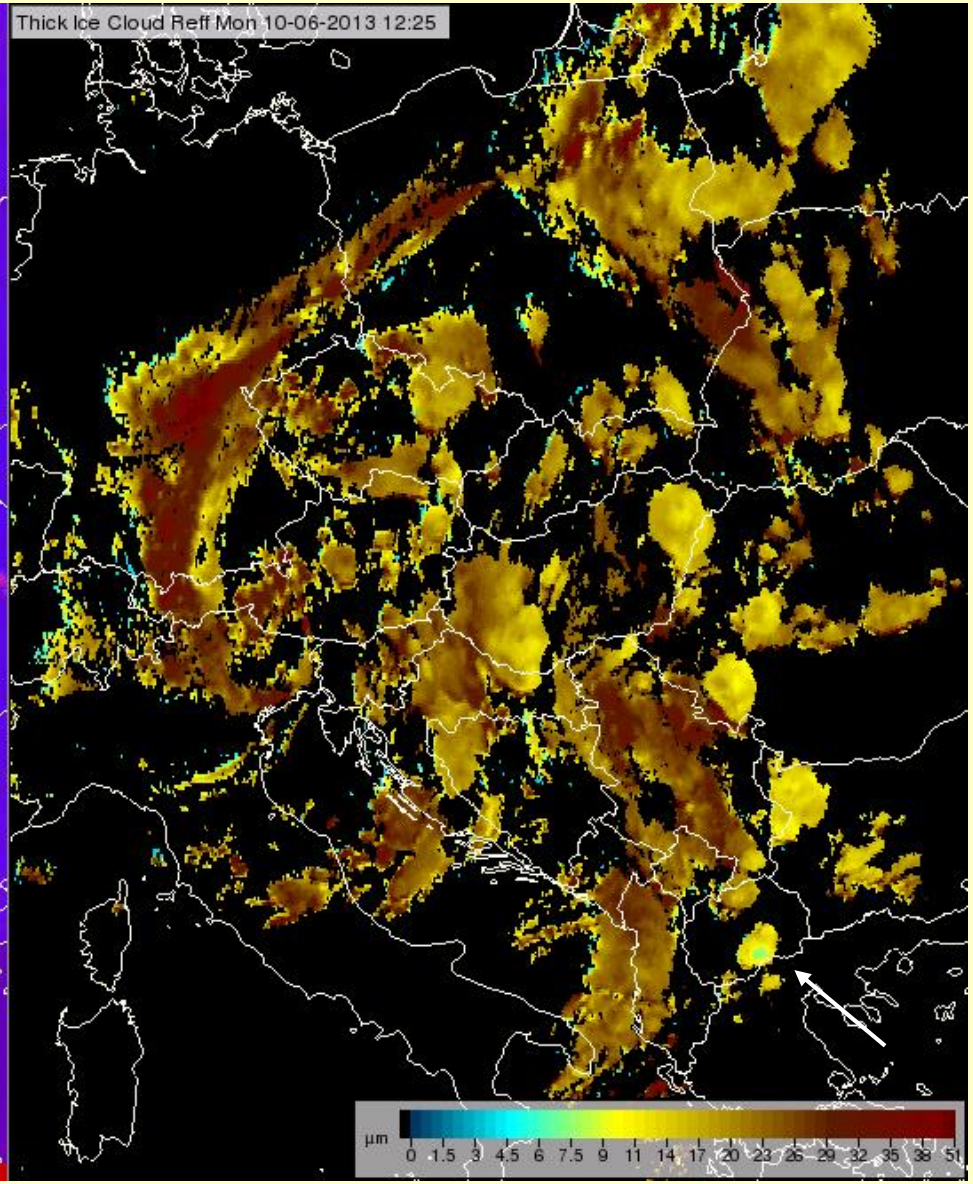
Cloud Type | Particle size of opaque ice clouds | Ice Water Path

(Cloud phase is used to mask water clouds, and optical thickness is used to mask thin clouds.)

10 June 2013, 12:25 UTC

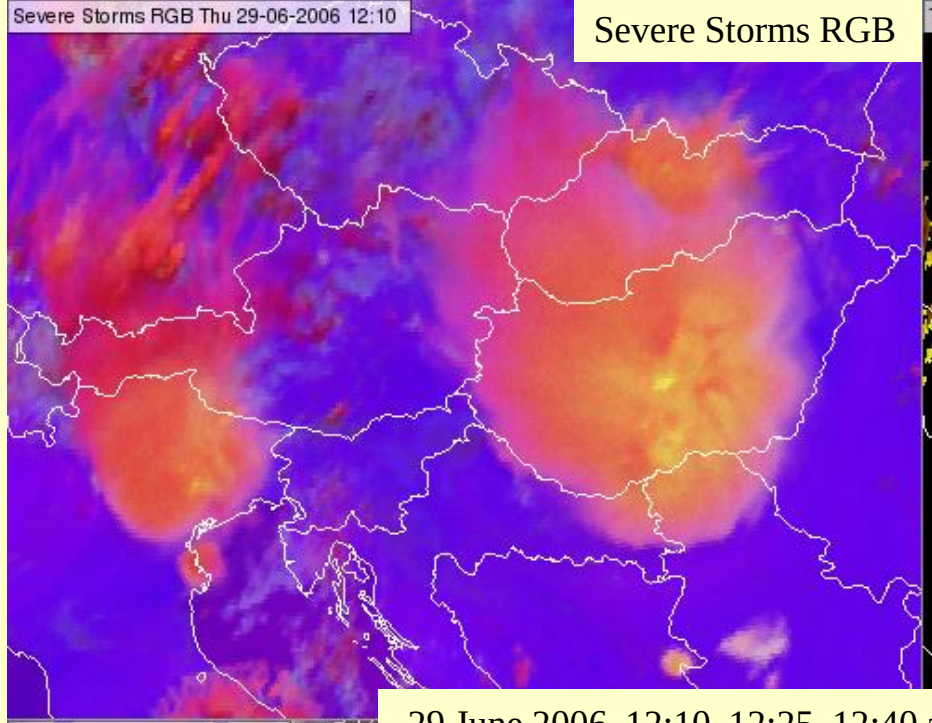


Severe Storms RGB

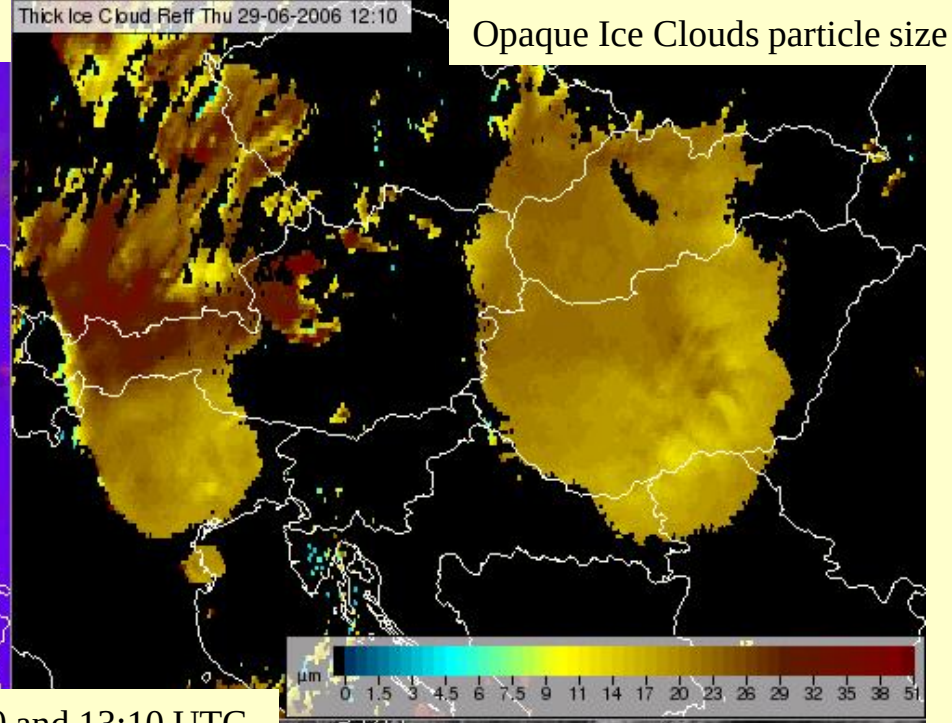


Particle size of opaque ice clouds

Other date!

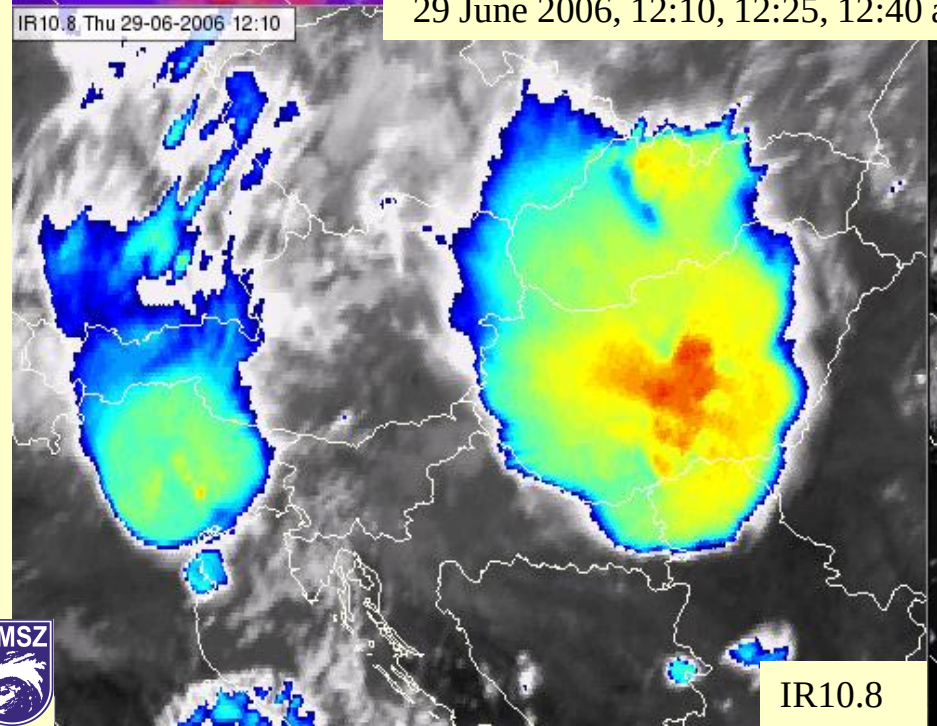


Severe Storms RGB

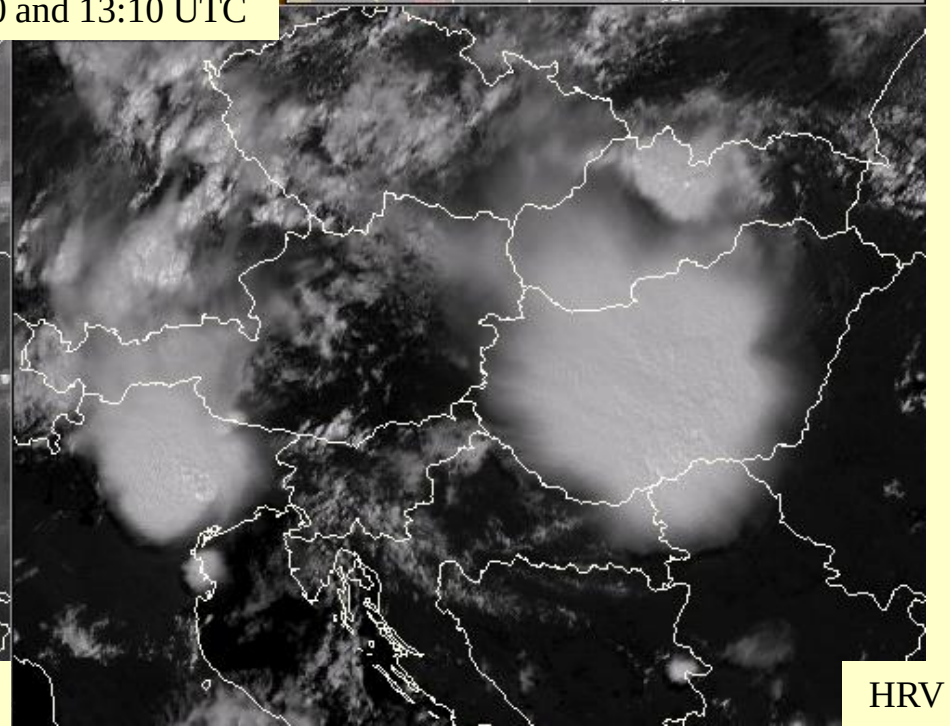


Opaque Ice Clouds particle size

29 June 2006, 12:10, 12:25, 12:40 and 13:10 UTC



IR10.8



HRV

NWCSAF products – Important for convection, SEEMET course on Convection, **Croatia**

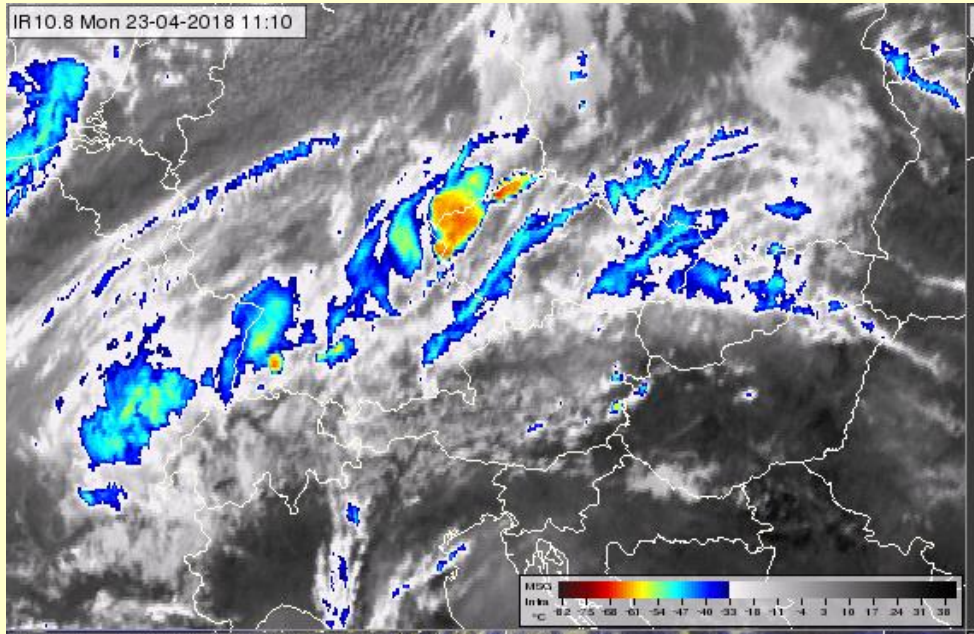
Precipitation Products

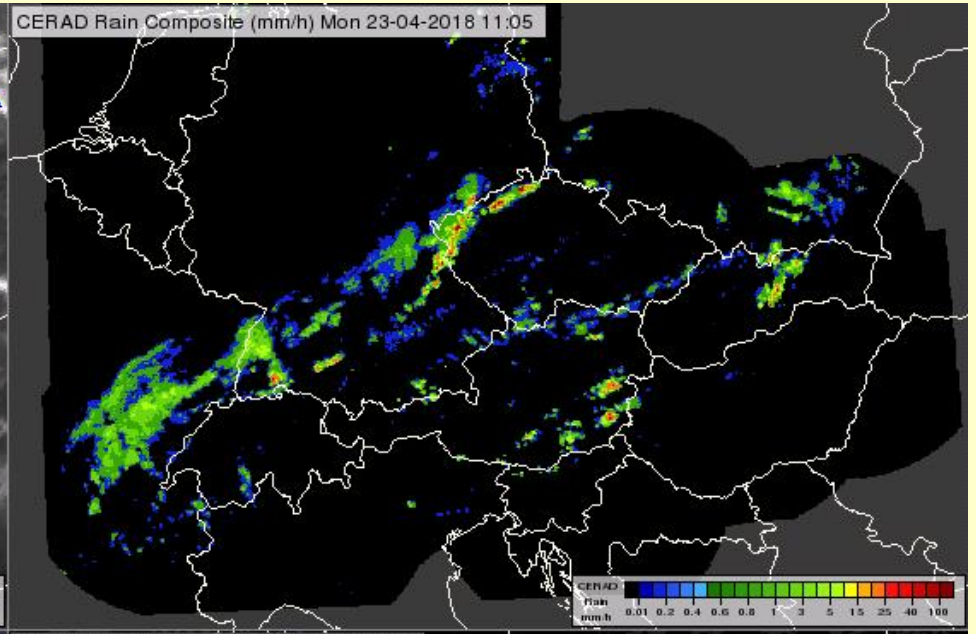
- Probability of precipitation (PC)
- Convective rainfall rate (CRR)
- Daytime probability of precipitation from **microphysical properties**
- Daytime convective rainfall rate **from microphysical properties**

23 April 2018, 11:10 UTC

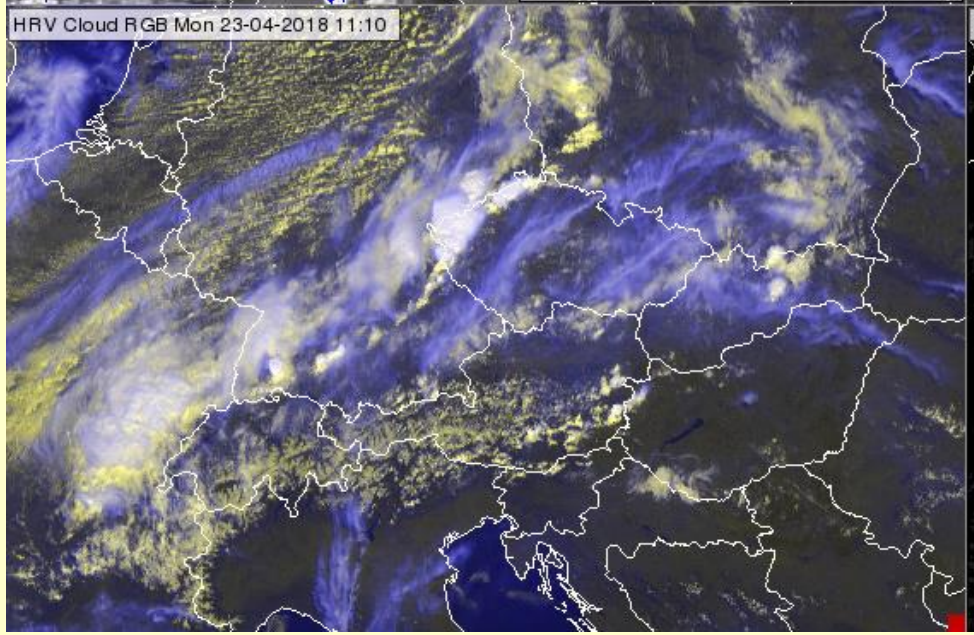
IR10.8

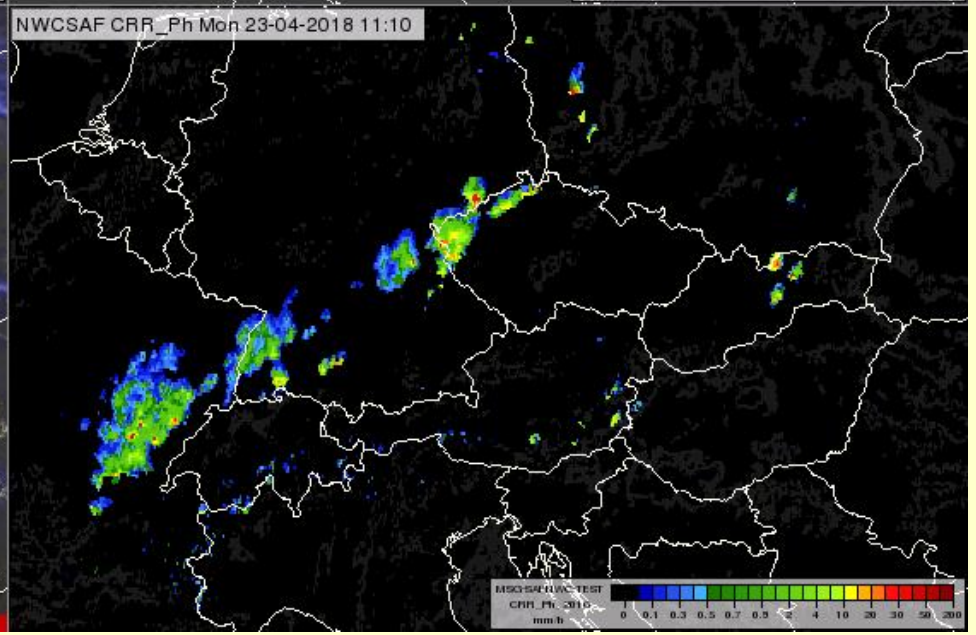
Central European radar network, rain rate





radar colour scale





radar colour scale

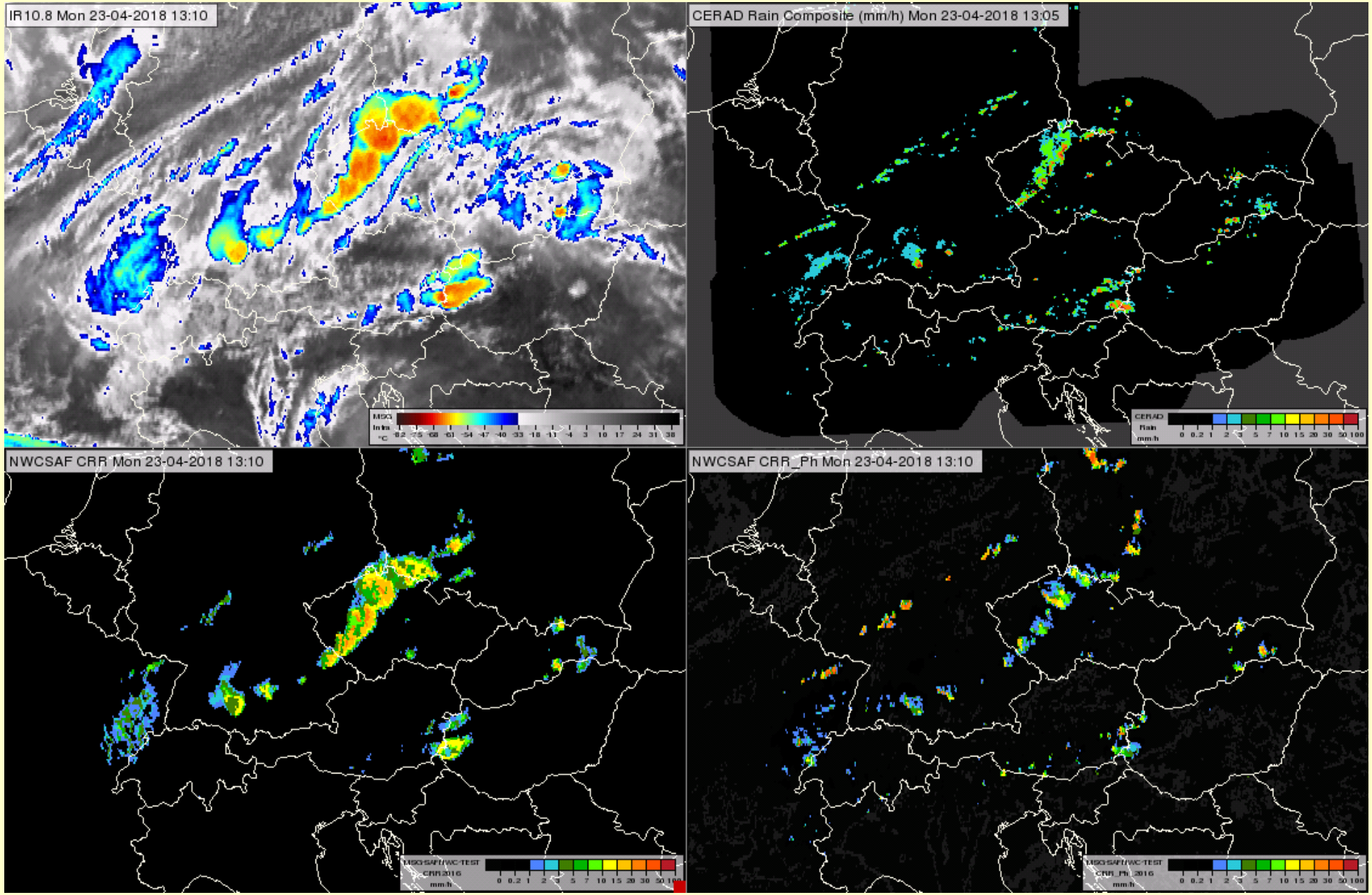
HRV Cloud RGB

CRR-Ph (using cloud top physical properties)

23 April 2018, 13:10 UTC, daytime

IR10.8

Central European radar network, rain rate



CRR colour scale

CRR colour scale

CRR colour scale

CRR

CRR-Ph (using cloud top physical properties)

Eumetrain project

Presentations on NWCSAF products on Event Weeks organized by OMSZ (Zsófia Kocsis)

Event Week on Aviation Meteorology 2018

- J. M. Moisselin (Météo-France): The high IWC (Ice Water Content) Hazard for aviation and satellite retrieval
- A. Wirth and A. Jann (ZAMG): Gravity wave pattern and tropopause fold detection as new products within the Nowcasting-SAF

Precipitation - Event Week 2015

- I. Pelajic (DHMZ): NWCSAF MSG precipitation products and their applications
- A. Thoss (SMHI): NWCSAF PPS precipitation product