INTERPRETATION OF MSG IMAGES, PRODUCTS AND SAFNWC OUTPUTS FOR DUTY FORECASTERS

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ABSTRACT

At the Hungarian Meteorological Service an MSG receiving station was installed in September 2003. It has opened new possibilities for the use of satellite images in Nowcasting because of the better spectral temporal and spatial resolution of MSG compared to the first generation of METEOSAT. Duty forecasters wanted to have new images at their disposal as soon as possible. A transformation tool was worked out for the raw MSG images in order to send them to the Hungarian Advanced Weather worKstation (HAWK), where forecasters can visualise and handle them together with all available meteorological information. So when MSG had become operational the duty forecasters could see calibrated data, in 8 channels. We also had to improve the HAWK software to be able to visualise 24bit colour composite images. We are looking for the most useful channel combinations in co-operation with the forecasters. Our service is one of the beta testers of the SAFNWC/MSG software package, therefore we have experiences and prototypes of the products. We are already on the way to develop the transformation tool for the HAWK software to send and visualise these products of the SAFNWC/MSG. We have developed a program for calculating cloud amount from the cloud detection, which can be used directly for automatic forecast product generation, and comparable to surface based cloud observations.

1. INTRODUCTION

At the Hungarian Meteorological Service (HMS) digital images and derived products of METEOSAT and NOAA satellites are used operationally by the forecasters since 1991. Duty forecasters wanted to have new MSG images at their disposal as soon as possible. Our MSG receiving station was installed in September 2003. A transformation tool was worked out for the raw MSG images in order to send them to the Hungarian Advanced Weather worKstation (HAWK), where forecasters can visualise and handle them together with all available meteorological information (Kertész, 2000). Since MSG had become operational the duty forecasters can see calibrated data, in 8 channels, as well as 24bit colour composite images.
Our service is one of the beta testers of the SAFNWC/MSG software package; therefore we have experiences and prototypes of the products. Although we are already on the way to develop the transformation tool for the HAWK software to send and visualise these products of the SAFNWC/MSG, the products will be available for the forecasters only after the installation of the operative program version, SAFNWC/MSGv1.0 this summer.

2. VISUALISATION OF MSG SINGLE CHANNELS FOR FORECASTERS AT HMS

The better spatial and temporal resolution of MSG fits much better to forecasting and especially nowcasting tasks than the previous Meteosat images. In addition the wide range of spectral channels gives new opportunities compared to the 3 channels of Meteosat. The 12 channels of MSG make it possible to derive physical parameters like phase of cloud droplets, which were not possible with Meteosat.

The forecasters used all three channels of the previous Meteosat, generally one by one, but that time it was easier to obtain a comprehensive view. Now it is unrealistic to study all 12 channels of MSG one by one in every 15 minutes. Therefore the importance of composite images increased, when 3 different channels, or combination (e.g. difference) of channels can be visualized together in shades of three colours (red, green and blue) in order to summarize the information content of the channels on one image (Kerkman et al., 2004; Hyvärinen, 2003). Thus the analysis of the information is less time consuming for the duty forecaster.

Presently forecasters of HMS have access of 8 individual channels operationally in every 15 minutes. 8 is still too many to check all the time, but this is a learning period when forecasters can get used to the new data and can have influence to choose the most useful ones and also they have a possibility to understand better the composite images by looking the individual channels as well.

The subimages available for the forecasters cover Europe and part of the Atlantic Ocean. These images are calibrated to reflectivity or brightness temperature. The calibration is done by the SAFNWC/MSG software package, which runs routinely. The colour map used for the visualisation is usually greyscale, but the users can modify this individually in the HAWK.

At the beginning of the operational service, images of 4 channels were sent to the forecasters transformed for the HAWK:

- HRV (High Resolution Visible),
- VIS0.8 (visible),
- WV0.62 (water vapour absorption band),
- IR10.8 (infrared).

These spectral bands are close to those of the Meteosat, therefore only the spatial and temporal resolution were new for the forecasters, especially the resolution of HRV made them really interested in the new generation images.

Later 4 other channels were selected for operational service so that the forecastes can get used to the channels and understand better the composite images made from these channels:

- VIS0.6 (visible),
- NIR1.6 (near infrared),
- MIR3.9 (middle infrared)
- WV7.3 (water vapour absorption band).

The IR8.7, IR9.7, IR12.0 and IR13.4 images are not sent to the duty forecasters, because no typical new features are recognisable visually on these images compared to IR10.8.

3. VISUALISATION OF MSG COMPOSITE IMAGES FOR FORECASTERS IN HAWK SOFTWARE AT HMS

Earlier the HAWK software could visualize 1 byte imagery only, while the composite images consist of at least 3 bytes (one per channel) for all pixels. Therefore the HAWK had to be developed in prior to this application.

The selection of channels depends on the kind of the physical parameter we want to focus on. The MSG Interpretation Guide (Kerkman et al, 2004) gives useful help to find the optimal combinations. However a practical problem arises for an automatic method, namely that the algorithm has to produce stable colours and brightness values for the same phenomenon (surface, cloud type) under various illumination conditions.

Presently one composite combination is used operationally by the forecasters. The visualisation of RGB321 composite is already included in HAWK. This is made from NIR1.6 (near infrared, channel 3), VIS0.8 (visible, channel 2) and VIS0.6 (visible, channel 1) images. On this image the ice-clouds and clear, snow covered areas appear in turquoise blue, the water-clouds are white, clear areas with dense vegetation are green, while bare soil is brown.

Stable colours were achieved by using sun angle corrected calibrated images. If the reflectance were more then 100% we set it to 100%. (Then we enhanced the range of 0-100% to values 0-255.) For twilight condition when solar zenith angle $\Theta > 80°$, Θ is set to 80° to avoid problems. Possibly we shoul d reduce this angle for early morning, as for the forward scattering conditions the reflectivity of clouds often exceeds 100% in all 3 channels producing white ice-clouds instead of turquoise blue.

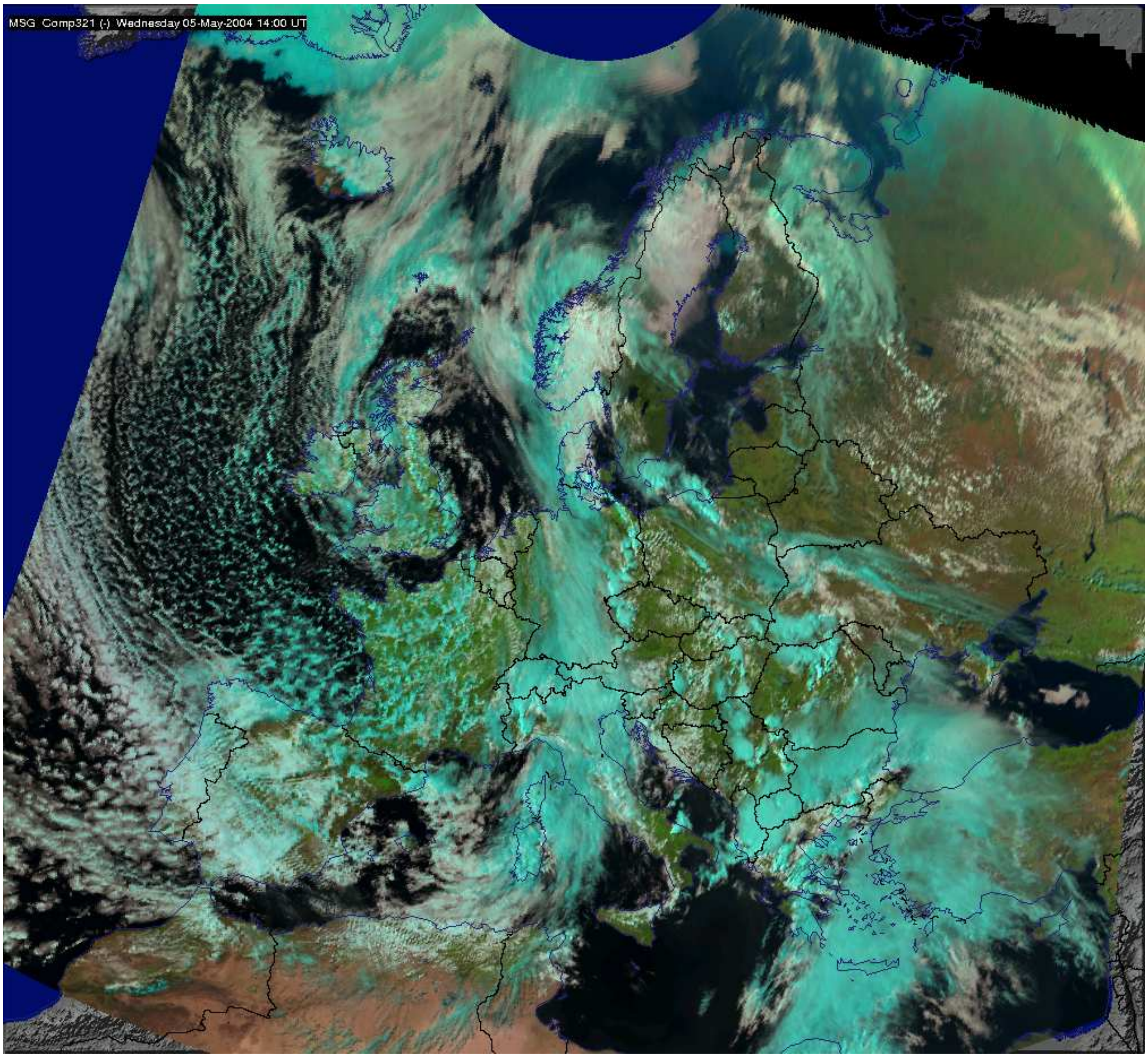

Fig 1. MSG composite image for 05.05.2004. 14:00UTC
RGB321 (R: NIR1.6, G:VIS0.8, B:VIS0.6)

An example of RGB321 composite image can be seen in figure 1 visualised by the HAWK system. All the illustrations in the paper correspond to the image taken 05.05.2004. 14:00UTC. Frontal cloudiness can be examined above Germany and Italy within the occluded cyclone centred around the British Isles. Convective cells are visible above the Atlantic, while continental convection caused Cumulonimbus clouds in Central Europe.

Another composite image, RGB139 is under development. For Red and Green we have ch1 and ch3 reflectance values (sun angle corrected). The range was enhanced from 0-100% to the colour value range of 0-255. The ch9 brightness temperature Tb10.8 is put in blue. We enhance the range -70to -20Celsius to the colour value range of 0-100.

On this RGB image the red, orange and lilac colours represent ice-clouds or snow-covered areas. The lilac (or violet) clouds usually have less cold cloud tops, while orange clouds have colder tops The yellow, green, white colours visualise water-clouds.

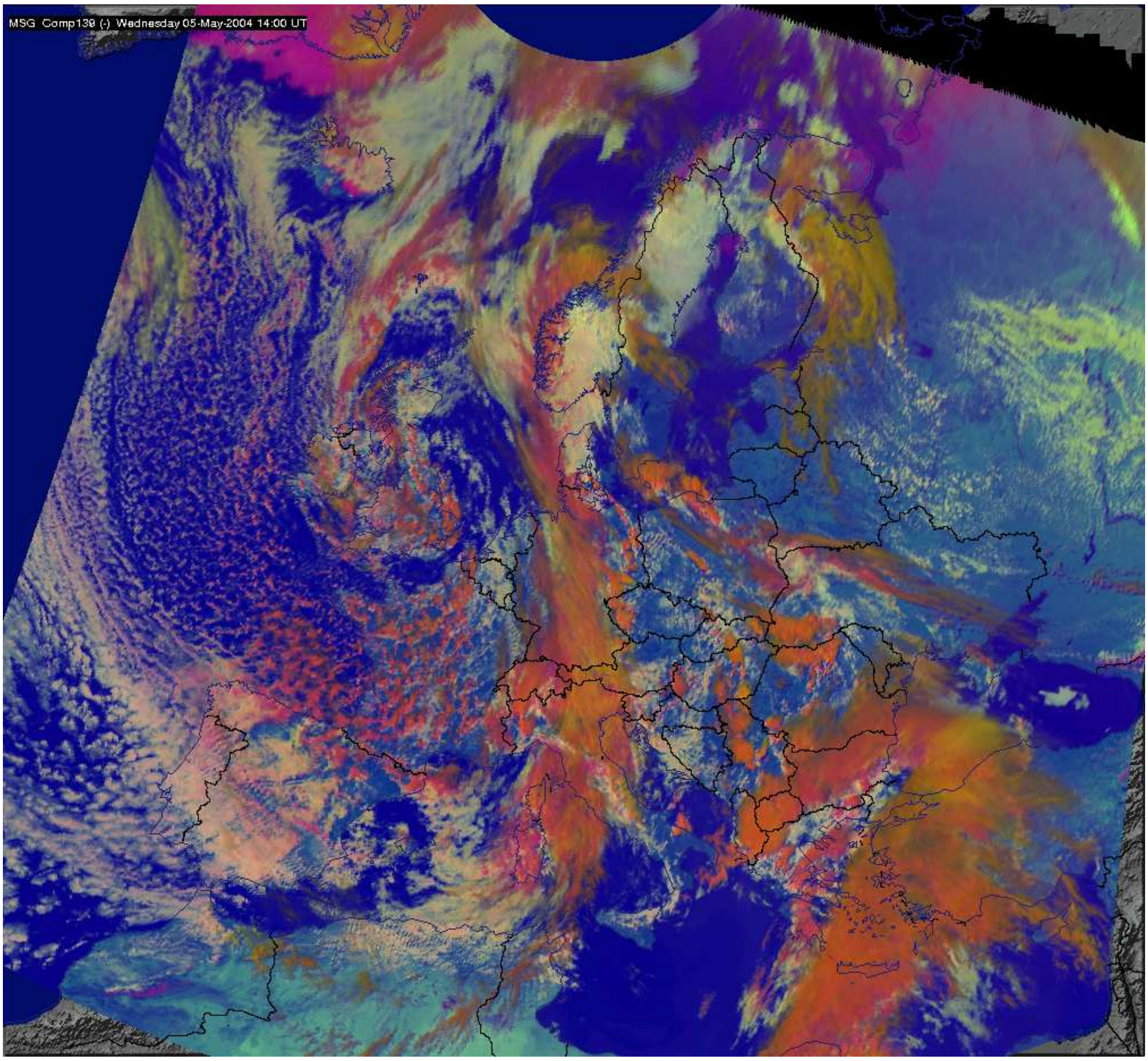

Fig 2. MSG composite image for 05.05.2004. 14:00UTC
RGB139 (R:VIS0.6, G:NIR1.6, B:IR10.8)

We are also producing and testing the RGB24r9 composite images; where 4r is the solar reflective component of MIR3.9 channel. Only one of RGB139 and RGB24r9 images will be sent operationally for the forecasters, as they are quite similar in appearance. We are presently testing which composite image of RGB139 and 24r9 are more informative for forecasters.

4. VISUALISATION OF SAFNWC/MSG PRODUCTS AT HMS

Our service is one of the beta testers of the SAFNWC/MSG software package, therefore we have experiences and prototypes of the products (Putsay et al., 2004). We are already on the way to develop the transformation tool for the HAWK software to send and visualise these products of the SAFNWC/MSG. The visualisation will be made for a smaller area selected for the SAFNWC software runs. The forecasters will only have access of the products after the operational version will be installed this summer.

Some examples of the outputs are presented in figures 3 and 4 by the HAWK visualisation system. In figure 2. the cloud mask, type and top pressure from SAFNWC/MSG outputs are shown together with the cloud amount which was calculated using the cloud mask. All 4 images correspond to the date 05.05.2004 14:00UTC.

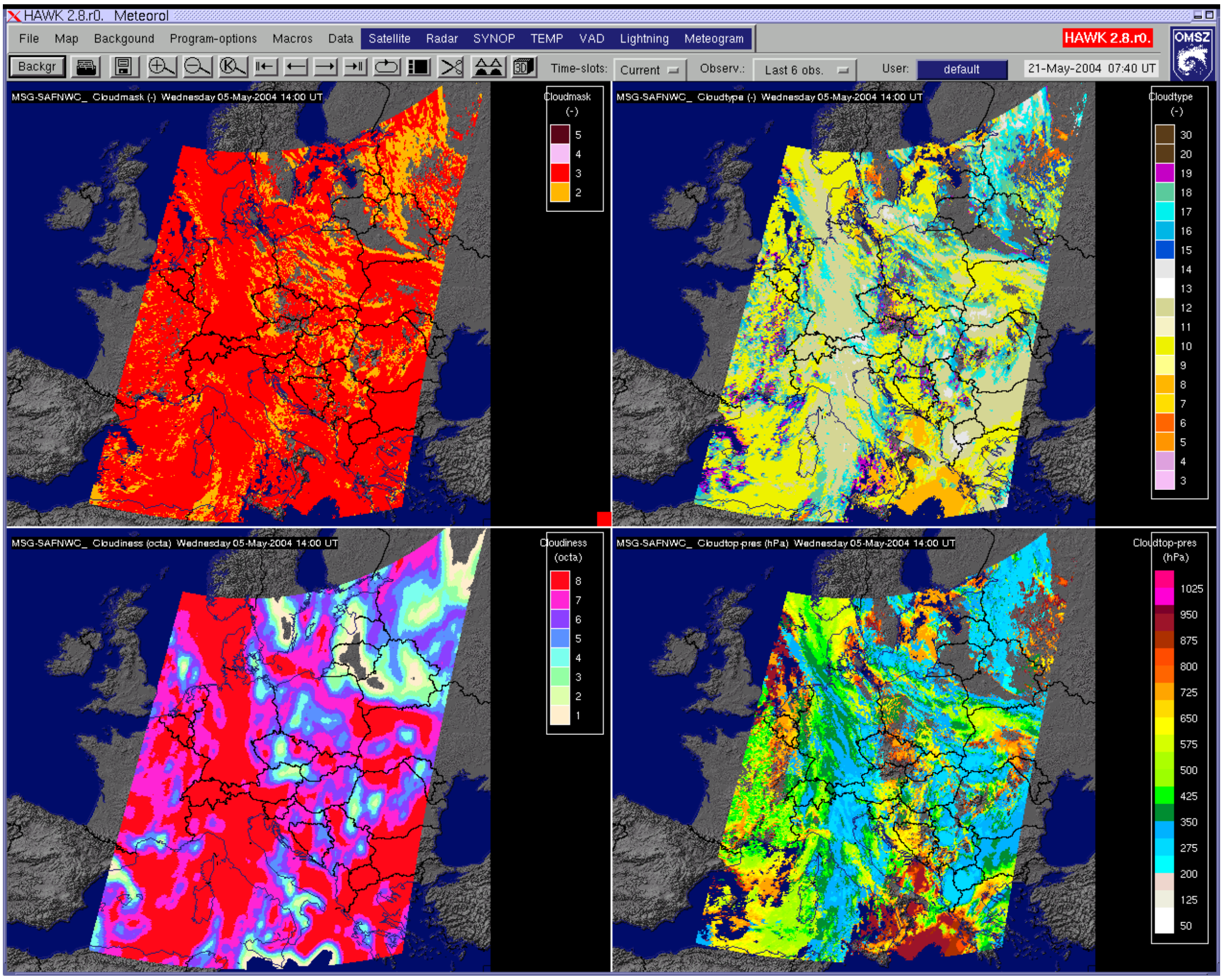

Fig 3. Upper left: cloud mask,
Upper right: Cloud type (including fog)
Lower left: cloud amount
Lower right: Cloud top pressure
The cloud mask type and cloud top pressure are the product of SAFNWC/MSGv0.1 program package.
The cloud amount is calculated from Cloud mask data.
All 4 images correspond to the date 05.05.2004 14:00UTC.

The duty forecasters require cloud amount product from satellite data besides the cloud mask, as less and less surface cloud observations are available. We estimated the cloud amount by averaging the cloud mask by 17x17pixel areas (approximately 40x40km in central Europe)- assuming that the partly covered pixels are half covered - and expressing the results in octas. This product can be used directly for automatic forecast product generation and comparable to surface based cloud observations.

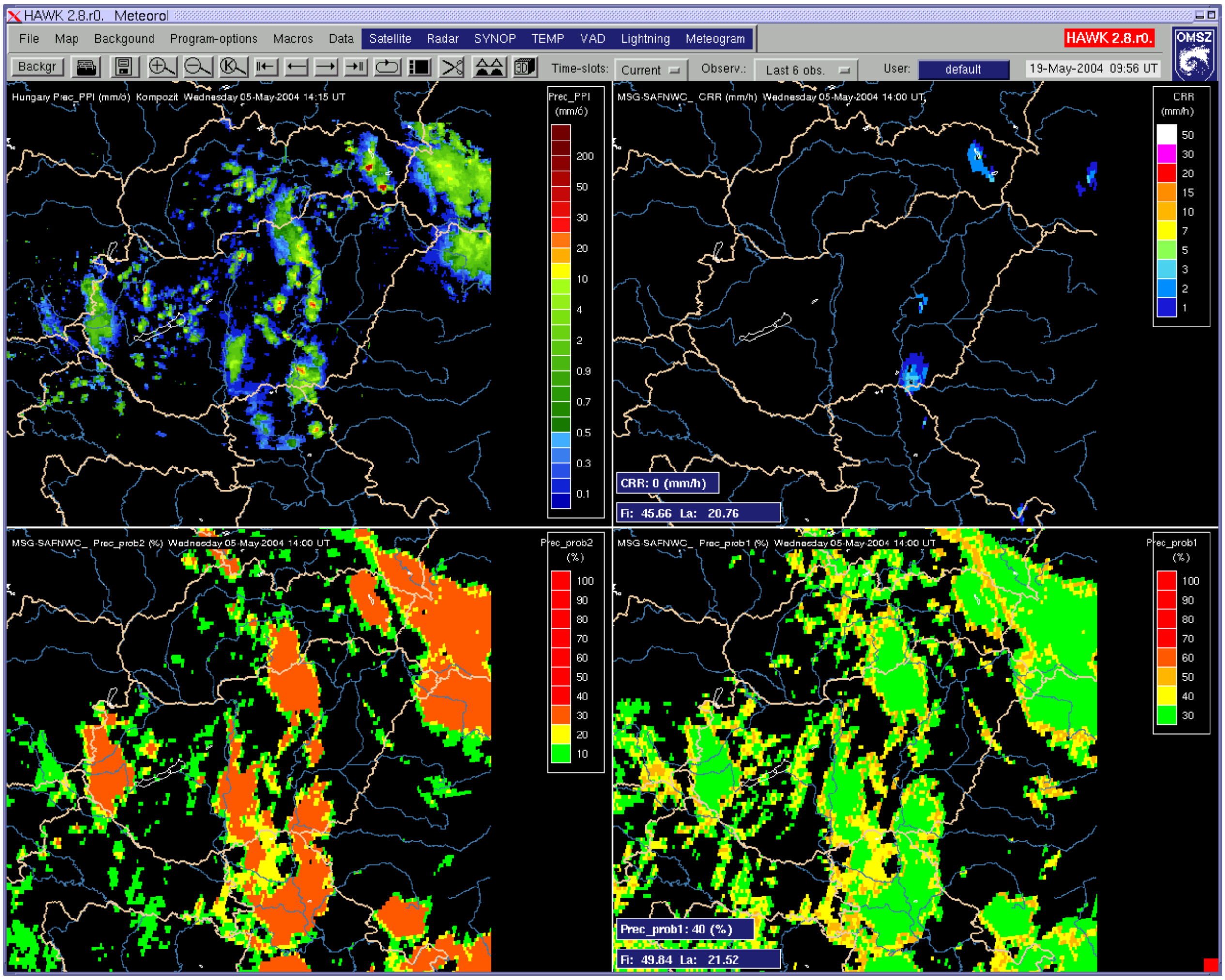

Fig 4. Upper left: radar rain rate,
upper right: convective rainfall rate,
lower left: precipitable cloud, probability of heavy precipitation (>5mm/hour),
lower left: precipitable cloud, probability of light to moderate precipitation (<5mm/hour),
The upper right and the lower images are the product of SAFNWC/MSGv0.1,
All images are for 05.05.2004 14:00UTC

In figure 4 three precipitation related SAFNWC/MSG products are shown together with radar rain rate data visualised by the HAWK system: the convective rainfall rate, the probability of heavy precipitation(<5mm/hour) and the probability of light to moderate precipitation (>5mm/hour). (In the probability image of the light to moderate precipitation the probability of 10 and 20% are not shown.) All images are for 05.05.2004 14:00UTC.

5. FUTURE PLANS

As soon as the operative version of SAFNWCv1.0 will be installed this summer the forecaster will have access to the products. We plan to develope composite images for nighttime as well. A difference image for nighttime fog and low cloud detection is also under developement

We have an automatic nowcasting system as well to help the work of the duty forecasters. The Mesoscale Analysis, Nowcasting and Decision Routines (MEANDER) makes use of most of the available data like radiosonde, synop and automatic weather station measurements, mesoscale numerical model outputs, radar, satellite images and lightning data. The satellite based input parameters - cloudiness, cloud top height and cloud types – are being replaced with the new SAFNWC/MSG outputs.

6. ACKNOWLEDGEMENT

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7. REFERNCES

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