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# USING OF SATELLITE IMAGERY FOR THE IDENTIFYING AND FORECASTING OF CONVECTIVE PHENOMENA ON THE EXAMPLE OF UKRAINE

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**Abstract**

Recently, the convection phenomena are attracting increasing attention of weather forecasters and researchers in the field of meteorology, since such seemingly local phenomena can reach significant development and cause enormous damage to the economy and infrastructure.

Satellite imagery are very useful tool for forecasting, especially in cases with convective phenomena. The rapid growth of convective clouds and their subsequent evolution are well observed in satellite images, especially if these are specific types of images, such as Convective RGB or Airmass RGB. Using and analysis of satellite images in a daily forecast allows you to detect convective clouds in the early stages of development and warn about this phenomenon in advance. Combined with the analysis of surface weather maps, vertical cross sections of the atmosphere radar and model data, satellite imagery is an indispensable tool for successful prediction and of course it can help decrease damages and even preserve human life. And this, in our opinion, is the main task of weather forecasting.

On the example of the real situation with severe convection, that took place in Ukraine on May 10, 2016, we have the opportunity to assess the importance of using satellite data in prediction.

## Introduction

Events with severe convection are observed in Ukraine relatively often. They usually occur during the warm season, between April and October. As we know convective events belong to the short-living weather phenomena. Due to their associated risks caused by heavy rainfall, hail, lightening or squalls they are of great interest for the customers. An accurate forecast of summer convection is one of the most important tasks for forecasters. Satellite and radar data combined with synoptic information give the opportunity to monitor the relevant developments especially for nowcasting.

## The case study

A severe convective outbreak occurred over extensive part of Ukraine, including Northwestern, Central, Southern and Eastern regions. It took place on May 10th 2016 between 12 and 18 UTC. During this day thunderstorms with squalls, heavy rain and large hail were observed. The strongest wind gusts reached 25 m/s. Also the amount of rain on different stations was 25-37 mm from 12 to 18 UTC. Moreover, there were thunderstorms with hail of diameter 11 cm. This led to large damages, especially in the farming sector and the infrastructure. After this convective event in Ukraine thousands of households have been left without electricity, damaged people's property and nature. (Fig. 1 and Fig. 2)

*Figure 1:* **Damages after convective event 10-05-2016**

*Figure 2:* **Damages after convective event 10-05-2016**

## Synoptic analysis

There is known that thunderstorms to form usually need: warm and moist air at low levels; cool dry air at upper levels; synoptic scale disturbance; upper level divergence. On this day the synoptic maps showed conditions favourable for severe thunderstorms over an extensive area. As can be seen from Fig. 4 almost whole territory of Ukraine was under the influence of low pressure. There was not front over Ukraine. The arctic atmospheric fronts were located over north of Europe and the polar fronts were situated over central part of Europe.

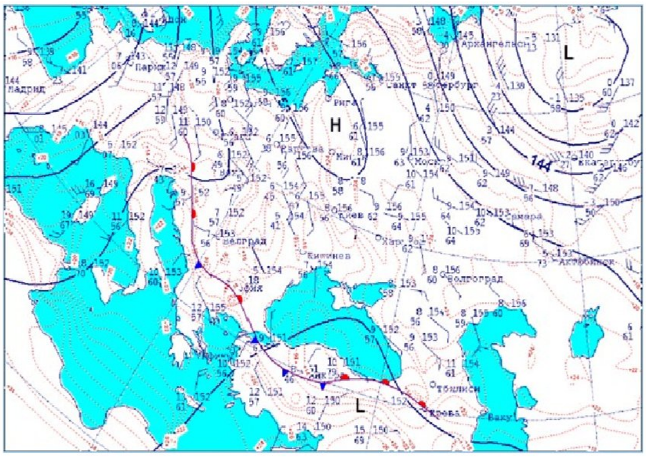

*Figure 3:* **850 hPa T and Geopotential Height, 12 UTC 10-05-2016**

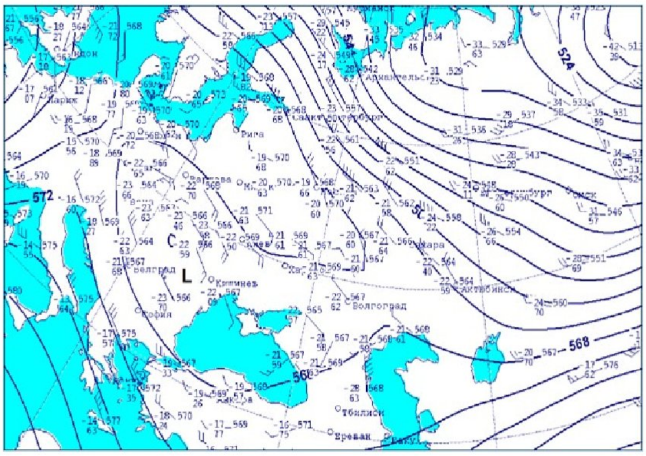

***Figure 4:*** **500 hPa Geopotential Height, 12 UTC 10-05-2016**

If be more specific, we can see, that near the surface part of polar front was located over Black Sea and wave over Crimean peninsula (Fig.5). The temperature was 13-20 °C, in some areas 21-25 °C. During the day, fields configuration particularly wasn't changed. In the afternoon and later the consequences of the front influence were unstable atmosphere, stormy weather over the Ukraine.

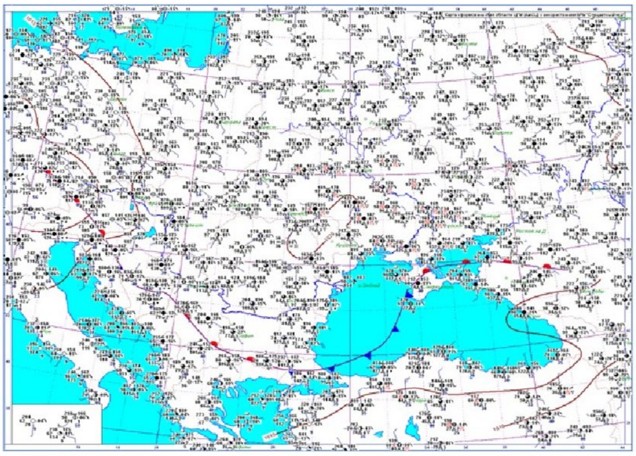

***Figure 5:*** **Surface pressure field, 12 UTC 10-05-2016**

It was obvious that atmosphere has a large moisture content, especially in the central part of the country (Fig.6).

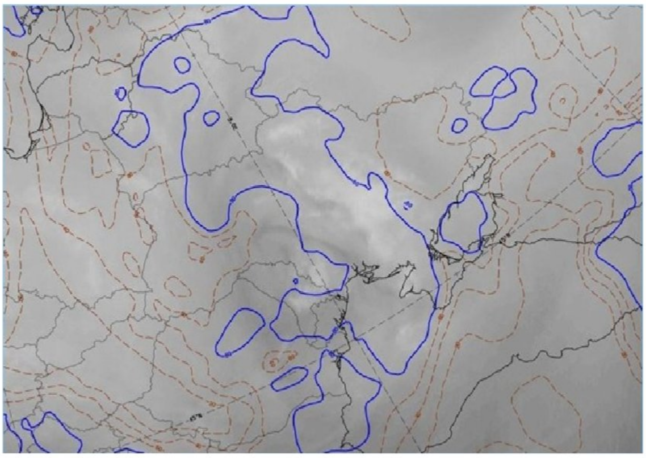

***Figure 6:*** **WV 6.2 + Relative Humidity (700 hPa) 00 UTC**

According to the aerological diagram in Kyiv (Fig.7), there is layer of convective unstable air - from 1.8 km to 10 km.

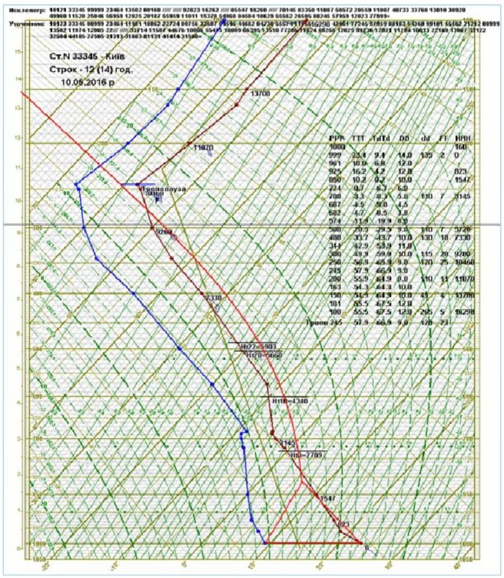


***Figure 7:*** **Aerological diagram, Kyiv, 12 UTC**

## Satellite analysis

Since the convective event developed during day time we used appropriate products such as Daytime Convection RGB (Fig.8). In this RGB product the yellow areas indicate the fast growing updraft carrying small ice crystals. We can see these areas with strong convection which have bright yellow color.

Another very useful tools for identifying of convective storms are Airmass RGB (Fig.9) and Dust RGB (Fig.10). In Airmass RGB convective clouds appear bright white and in Dust RGB they are bright red. But in this case it’s not so easy to detect areas with the strongest convective activity, therefore we can compare these images with Daytime Convection RGB or Enhanced IR RGB (Fig.12) and it gives the best result. Also additional information we can get with Multi-Sensor Precipitation Estimate product (Fig.11), that is very suitable for convective precipitation and is intended mainly for areas with poor radar coverage. This is very actual for Ukraine, because its territory is not fully covered by radars.

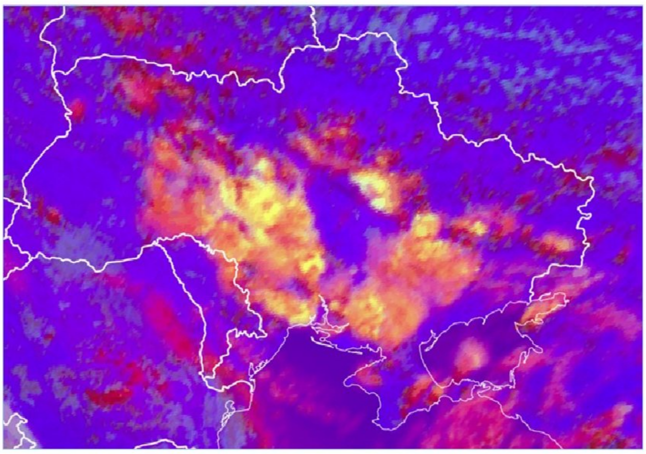

***Figure 8:*** **Convection RGB, 10-05-2016, 12 UTC**

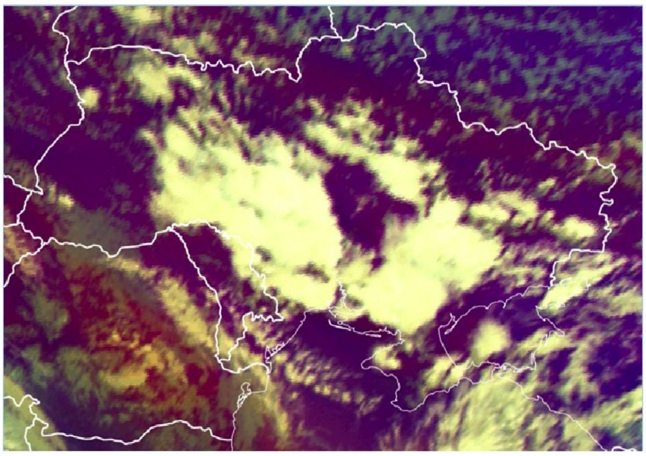

***Figure 9:*** **Airmass RGB, 10-05-2016, 12 UTC**

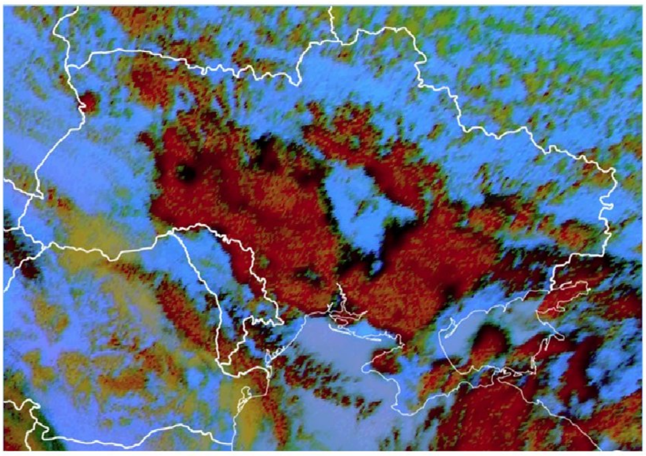

***Figure 10:*** **Dust RGB, 10-05-2016, 12 UTC**

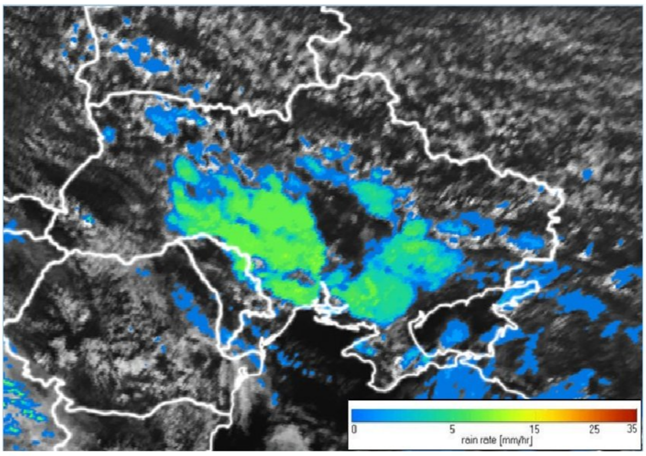


***Figure 11:*** **VIS01+Multi-Sensor Precipitation Estimate, 10-05-2016 12 UTC**

Enhanced IR images are especially useful for convective cloud systems. Beyond simply coloring the coldest clouds, enhanced IR images reveal structures typical for convective cells and systems like cold rings, warm cores, U/V structures and overshooting tops much more easily than basic channels alone would. According to this case bright yellow and orange areas indicate the presence of overshooting cloud tops with temperatures 220-215 K what is equal to -53-58 °C. Such low temperatures are the indicators of storm severity.

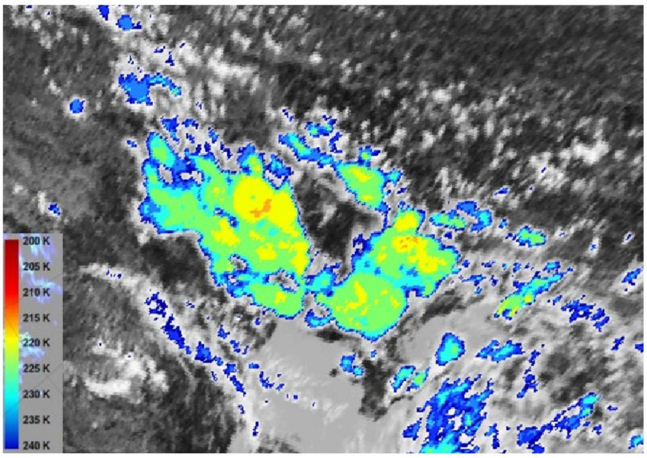


***Figure 12:*** **Enhanced IR RGB 10-05-2016 12 UTC**

## Radar analysis and lightning

Areas with thunderstorms (pink and red colors) and hail (yellow and brown colors) were clearly seen in the Doppler weather radar, which is situated in Kyiv. (Fig.13). As an additional resource of information for forecasters can be websites like blitzortung.org, that shows lightning in a real time over whole planet (Fig.14).

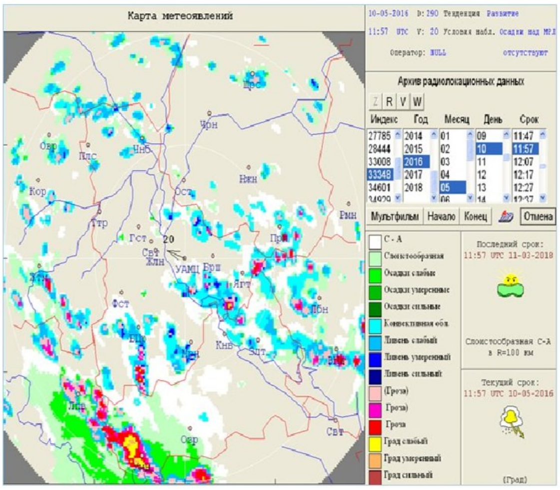


***Figure 13:*** **Doppler weather radar, 12:00 UTC, 10-05-2016 over north and central regions of Ukraine**

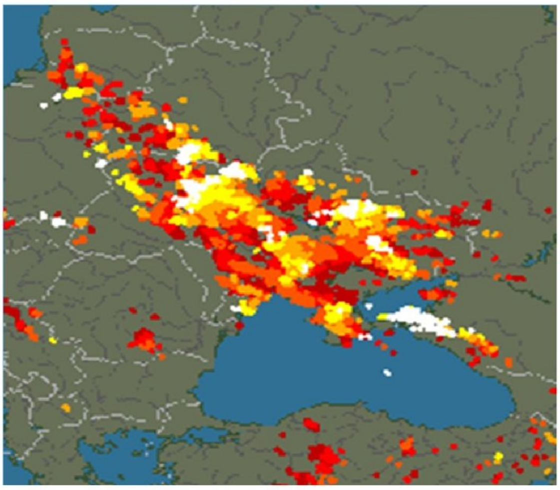

***Figure 14:*** **6-hour Accumulated Lightning Strikes 12UTC - 18UTC 10-05-2016 (blitzortung.org)**

## Conclusions

Forecasting for the first 12h requires extensive use of remote sensing tools including satellite, radar and lightning networks. Operational forecasters need easy, simple ways to integrate all relevant data to make very short-range forecasts and nowcasts of convective activity.

Satellite products provide a big variety of useful information and in combination with NWP models, radar and lightning data give very good result for the forecasts.

**References**

Blitzortung.org, DWD archive, ecmwf.int, eumetrain.org, Ukrainian HMC archive.