



RISK WEATHER PHENOMENA IN CLUJ COUNTY IN JUNE 2010

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ABSTRACT. – *Risk weather phenomena in Cluj county in June 2010.*

June, in the Cluj county area, has been a month of extremes, in both heat and precipitation. The beginning of the month debuted with daily maximum temperatures close to the normal heat period product and then gradually heating the air occurred, the maximum temperatures increasing from day to day, reaching very high values, up 34 °C, by the middle of the month, when the temperature-humidity index (ITU) reached and exceeded, in relatively large areas, the critical level of 80. In the second part of June, the target area was characterized by atmospheric instability that fostered the development of strong convective structures, which led to the recording of large amounts of rain from showers and heavy rain, that were associated with floods and strong winds, which turned into storms with hail and lightning. For the second half of the month, a particular case dated 06/21/2010 was analyzed, the day in which the most destructive effects of the floods, seen as phenomenon hazardous weather reported by the Inspectorate for Emergency Situations (ISU) in Cluj County: the death of a person in the Morlaca area, 250 homes flooded in the cities of Huedin, Morlaca, Sâncraiu, Săcuieu, Călata, Poeni. There have also been floods in the cities of Turda, Copaceni and Martinesti. Landslides were recorded in Domosu and Horlacea.

Keywords: ITU, thermal convection, precipitation, floods.

1. INTRODUCTION

The maximum temperatures recorded at the weather stations in the county of Cluj in the first days of June were close to the normal heat period, a warming of the air occurred gradually, increasing the maximum temperatures day by day, reaching values up to 34°C in the middle of the month, when the temperature-humidity index (ITU) reached and exceeded the critical threshold of 80.

Pronounced instability characterized both Romania and the Cluj county area in the second half of June, when the precipitation that fell over extended areas led to the recording of large amounts of rain water from showers and heavy rain, that were associated with floods and the intensification of the wind, which transformed into storms with hail and lightning.

Warnings are issued when the ITU index is above 80. The severe phenomena recorded in the second half of June, required radar monitoring,

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observational data provided by the Doppler radars in Bobohalma and Oradea, using OmniWeatherTrack applications and PUP and monitoring of the satellite images.

2. DATA AND METODEDES

Data from hourly, daily and monthly meteorological measurements were used, obtained from meteorological and precipitation stations. Precipitation and temperature values recorded at all stations in the area were extracted. For the synoptic analysis, ground level and altitude maps of the standard isobaric surfaces of 500 and 850 hPa and reanalysis maps were used. Radar data have been analyzed: Reflectivity, Composite Reflectivity, VIL's, OHP's, THP's, Echo Tops, Hail Index, Storm Traking Info, Storm Total Rainfall, Satellite imagery and upper air soundings survey data from Cluj-Napoca.

3. EXCESSIVE HEAT IN THE FIRST HALF OF JUNE

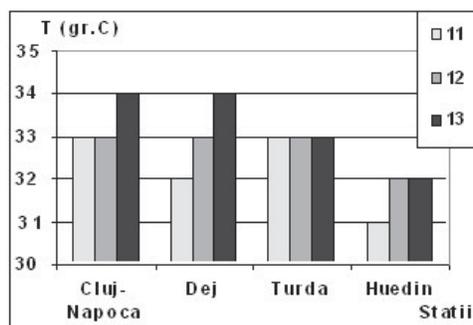


Figure 1. Stations at which the ITU index (with the threshold of 80) was overcome on the 11th, 12th and 13th of June 2010

In the beginning of June, during the first four days, the daily maximum temperatures recorded were lower by 2.5 - 6°C than the normal values (21-22°C) of the period. Then a heating of air gradually occurred, maximum temperatures increasing from day to day, reaching at the end of the first decade of June values of 29-31°C, higher than the average daily maximum (23-24°C). Continuing this increasing trend, at the beginning of the second decade, on 6/13/2010, the maximum temperatures reached the highest values of June and were within the range 32-34°C. The highest value of 34°C was recorded in Cluj-Napoca and Dej. Temperatures of 33°C were recorded in Turda and 32°C in Huedin. Thereafter, there is a gradual decrease in the maximum temperature, but it is still higher than normal values (22-24°C). In the third decade of the month, on June 23rd, the beginning of a cooling period is observed, which lasted until 27th June. Beginning with 27th June, the maximum temperatures and recorded an increase, getting close to the normal thermal period (24-25°C). The temperature-humidity index (ITU) has reached and exceeded the critical threshold of 80 in large areas, on 11th, 12th and



13th of June (Figure 1). The maximum air temperatures, at the stations which have recorded a value greater than the critical threshold of 80 for ITU, were 33-34°C in Cluj-Napoca, 31-32°C in Huedin, 32-34°C in Dej 33°C and in Turda.

4. ATMOSPHERIC INSTABILITY IN THE 21ST OF JUNE

The events in the second half of June 2010 occurred in the context of synoptic- scale blocking movement. In the second part of June, the continuance of an accentuated air instability in our country's region, the high temperatures, high humidity and the physical and geographical conditions (extension, shape and altitude of the relief) favored the development of convective structures and prompted large amounts of rainfall, exceeding the monthly averages. Thus, the meteorological and precipitation stations in the county of Cluj, during the month of June 2010, recorded that the value of the precipitation totaled an amount of water between 236.6 mm at Belis and 83.5 mm at Salatiu. In relatively large areas the quantity of water exceeded 100 l / m².

In the operational forecast of convective phenomena, more traditional methods are still used to determine the characteristics of air masses, easily used for establishing the estimative parameters of the degree of instability and the possibility of producing thunderstorms, strong wind gusts, showers and hail: Showalter Index, Lifted Index, K Index, Vertical Totals, Cross Totals, CAPE, CIN, and other similar ones.

The instability index values determined from the soundings survey reflect the degree of instability in Cluj-Napoca on the 21st of June 2010. The SSI Index (*Showalter Stability Index*) is an index used to forecast severe weather. It has a value of -0.36, indicating a moderate instability. The LI (*Lifted Index*) has a value of 1.57 associated with weak instability, with showers. The KI (*K Index*), which is used to identify convective environments that produce heavy rain, has a value of 34.10, indicating a probability of occurrence of thunderstorms and non-frontal storms of 60-79%. The VTI (*Vertical Total Index*), which is directly related to the vertical thermal gradient between the 850 and 500 hPa levels, representing the intensity of vertical transport, turbulent air has values of 26°C, indicating the production of strong convective storms. The CTI (*Cross Total Index*), which determines the contribution of the lower levels to moisture, in an unstable air mass has values of 23°C. The TTI (*Total Total Index*), another severe weather index, is obtained by adding CTI and VTI, has values of 49.30, indicating the production of severe storms. The CAPE Index (*Potential Energy Available for Convection*) has small values, compared with an empirical threshold of 1000 J/kg, required by moderate instability. The CIN Index (*Convective Inhibition*) has values of -116.48 (Figure 2).

Numerical models, even those with fine resolution do not always manage to capture the local characteristics specific to the region. In the area of interest several convective cells have developed, starting in the morning. The presence on their direction of travel of the lakes Beliș, Fântânele and Tarnița, formed an additional moisture factor that contributed to the increase of the convection.

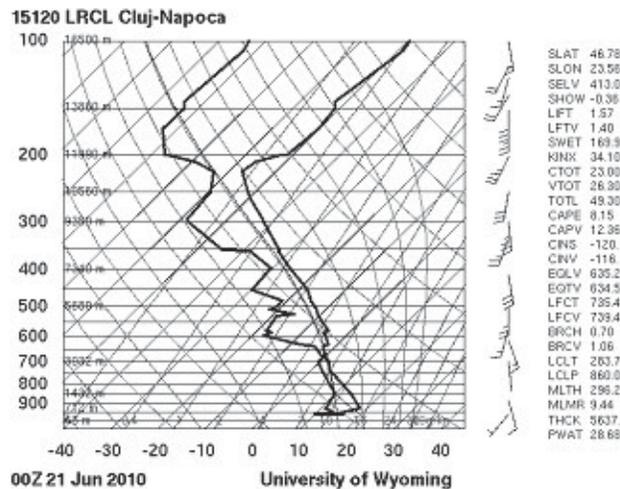


Figure 2. Upper Air Sounding on 21st of June 2010, (00 UTC) at Cluj-Napoca

5. RADAR ANALYSES

All nowcasting warnings were issued for Cluj county were based on data and radar images, received from the WSR98D radar from Oradea and Bobohalma, using OmniWeatherTrack and PUP applications, which allow the display on the screen the radar products. On the 21st of June 2010, several convective cells were developed, initially in the western part of the county, then in the eastern part. Base reflectivity shows the intensity of reflectivity for each of the four angles of elevation (height) of the volume, while the composite reflectivity shows the highest intensity on a vertical column, regardless of the height of storms. The first warning was issued for the county of Cluj at 8:45 UTC, for Huedin area. For the 40 dBZ reflectivity threshold, it was used as a marker to identify areas where the deep convection can be triggered, and the 50 dBZ threshold was used to locate areas with mature thunderstorms, which could produce severe weather phenomena.

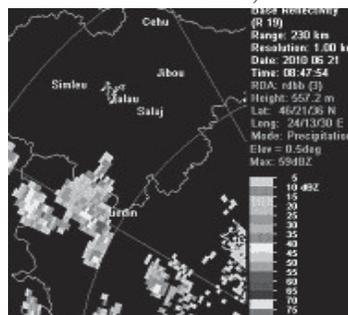


Fig. 3. Base reflectivity, at 8:47

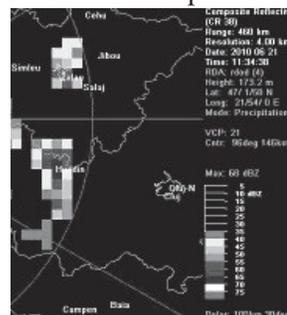


Fig. 4. Composite reflectivity, at 11:34



Intense convective activity is observed in the north-west part of the county, with up to 60dBZ reflectivity near the city of Huedin. At 8:47 UTC the reflectivity was approximately 55 dBZ at Huedin according to the Bobohalma radar estimates (Figure 3), then at 11:34 the reflectivity composite reached 65dBZ according to the Oradea radar estimates (Figure 4).

For the OHP products (1 hour precipitation) which shows the horizontal distribution of rainfall expected over a period of one hour and the THP (3 hour precipitation) which shows the horizontal distribution of rainfall for a period of three hours, the threshold of 25 mm and 45 mm were used as lower limits for the accumulation of amounts of precipitation that can cause damages. At 9:38, the OHP product, near the city of Huedin had maximum rainfall amounts of up to 76.20 mm (Figure 5). The THP product, at 12.54, estimates for three hours maximum values of rainfall of 101.60 mm (Figure 6).

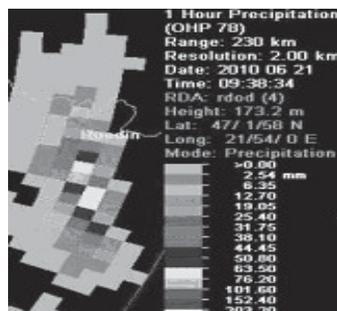


Figure 5. OHP, at 9:38 UTC

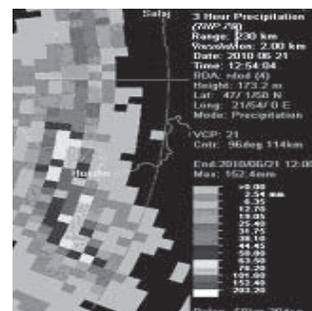


Figure 6. THP, at 12:54 UTC

For the VIL (Vertical Integrated Liquid), the estimation of liquid water contained in a storm, the value of 25 kg/m² was used as the threshold for potential production of large quantities of precipitation. VIL is also used for the probability of the creation of hail and detecting the presence hail. For values greater than 20 kg/m², it can be associated with severe hail. At 9:44 UTC, near the city of Huedin, the radar at Oradea estimated that the liquid water contained in the storm had values of 35-40 kg/m² and radar estimates of the presence and size of hail stone in the Hail Index radar product, show the presence of hail at 9:32, near Huedin, a fact confirmed by observations at the meteorological station, where the presence of small hail was reported.

The amounts of water recorded at the meteorological and precipitation stations for which warnings were issued (32 l/m² at Huedin between the hours of 12:35 p.m. to 1:35 p.m. OVR, 27.6 l/m² at Belis from 1:00 p.m. to 2:00 p.m. OVR, at Călata between 11:30 a.m. to 1:30 p.m. OVR - 33.6 l/m² and between 1:30 p.m. to 3:30 p.m. OVR - 39.1 l/m²), confirmed the predicted precipitation.

Due to the intense and sustained convective activity, the temperature at Huedin did not exceed the maximum 22°C.

During the afternoon and evening, the convective activity took place in the eastern part of the county of Cluj, on a NW-SE path. Intense convective activity is



observed in the extreme east of the county, with reflectivity up to 65dBZ near the town of Turda. The field of reflectivity remaining high at several successive radar scans.

Using the cumulative rainfall image (Storm Total Rainfall), the Bobohalma radar can estimate the evolution of rainfall in the city of Huedin. In the early hours of the 21st of June 2010, at 00:01 UTC, the precipitation amount was of 152.4 l/m² (Figure 7), resulting from the aggregation of rainfall beginning with the date of the 9th of June 2010, at 7:40 UTC until the 21st of June 2010, at 00:01 hours UTC. At the end of the day, at 11:46 p.m. UTC, the quantity of water fallen in the same place were 381.0 l/m² (Figure 8). For the same product (Storm Total Rainfall) of the Oradea radar, the beginning of the interval is the 2nd of June 2010, at 10:07 p.m., and by the end of the 21st of June 2010, at 11:55 p.m. UTC, the same amount of 381.0 l/m² is observed in area Huedin (Figure 9).

For the 21st of June, the radar estimates of the total quantities of water from rainfall fallen in Huedin is 228.6 liters per square meter.

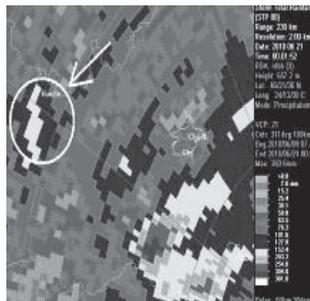


Figure 7. STR Bobohalma radar - 21.06.2010, at 00:01 UTC

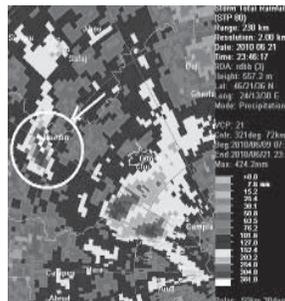


Figure 8. STR Bobohalma radar - 21.06.2010, at 11:46 p.m



Figure 9. STR Oradea radar - 21.06.2010, at 11:55 p.m UTC

In this context, on the 21st of June 2010 the weather was generally unstable. The sky was cloudy and on extended areas it rained, accompanied by lightning, short-term strong winds (47 km / h in Turda, and in the high mountain areas, the wind was up to 72 km / h at the Vlădeasa Peak, 1800). Isolated small-sized hail was reported at Huedin. In small areas were recorded torrential rains. The maximum amount of water that has fallen was 81.0 l/m² at Belis. Maximum temperatures ranged from 22°C at Huedin and 28°C at Dej and the minimum were between 14°C at Huedin and 18°C at Dej. There were 8 issued nowcasting warnings for immediate dangerous weather for Cluj county.

In many places, the storms caused damage and casualties among the population. There was a death of a 21 years old man in Morlaca (Cluj County), after the car he was in was taken by elevated waters of the Tibat and Domoș streams. From the ISU reports: in the towns of Huedin, Morlaca, Sancriau, Sacuieu, Călata, Poeni in the Cluj County, 250 households were flooded, and the E 60 highway was covered with water. There have been floods in Turda, Măartinești and Copăceni. All the events were reflected in the local press (Figure 10).



Figure 10. Pictures from the local press, on 21st iunie, in the town of Huedin (Cluj)

6. CONCLUSIONS

June 2010 was analyzed in a synoptic and mesoscale context, highlighting the differences between the first half of the month and the second half.

In early June, continuing its upward trend in the 13th of June 2010, maximum temperatures reached the highest values in of the month and ranging between 32-34°C. The highest, 34°C, was recorded in Cluj-Napoca and Dej.

From the 11th of June 2010 until the 13th of June, heat warnings for thermal discomfort were issued, when temperature-humidity index (ITU) has reached and exceeded the critical threshold value of 80, on extended areas.

In the second part of the month, the atmospheric instability was influenced by the development of convective structures related to the altitude nuclei of cut-off type and the presence of several frontal systems that have crossed our country. The presence of the low pressure altitude centers and warm, moisture air from the lower levels were the basic ingredients of the synoptic scale increase. Instability manifested itself during the day and evening hours, when showers fell, including lightning, strong wind, which also transformed into squall line. On small areas, rains had torrential character and hail fell. The important factor that contributed to the flooding of 21st June 2010 was the low movement over long periods of time of convective cores in the same place.

Comparing the amounts of precipitation that fell in June 2010 with maximum rainfall amounts over time, during this month it was found that at Huedin, where the effects of precipitation were the strongest, 218.8 mm/month were recorded, compared to 99.0 mm, standard Climatic norm of June. The sum of precipitation fallen in June 2010 is close to the absolute maximum of June: 246.3 mm / month in year 2009.

High values of the quantities of precipitation in June 2010 (compared to the climatic normal) were recorded at Turda 172.6 mm (77.9 mm), Cluj-Napoca 166.8 mm (85.9 mm) and Dej 134 mm (87.0 mm).

In the case presented in detail for the second half of June, the rain-affected areas where the degree of organization of convection was very strong, constituting an essential part of the registration of large amount of precipitation, were analyzed.

On the 21st of June, at the Huedin meteorological station 54.4 mm/24 hours were recorded, which is 24.5% of the total monthly rainfall, and at the Belis precipitation station 81.0 mm/24 hours were recorded, representing 34.23% of the monthly rainfall for June 2010.



On the 21st of June, the most intense effects of rainfall in June were recorded: one death, in Morlaca; 250 flooded households in Huedin, Morlaca, Sâncraiu, Săcuieu, Călata, Poeni; been floods in the city of Turda, Copăceni and Mărtinești; landslides were recorded in Domosu and Horlacea.

The ISU report on flood protection, recorded that for June 2010, rainfall exceeded the critical threshold, activating the run-off of slopes, torrent activation, formation of floodwater on the side and main courses, enabling the bank erosion and landslides, both in the city, and in the terrain. These phenomena have led to the recording of two victims in the county of Cluj (on 21st and 22nd June) and it produced significant damage

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