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THE MESOSCALE *CONVECTIVE* SYSTEM FROM 24.07.2010

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ABSTRACT. The Mesoscale *Convective* **System from 24.07.2010.** A severe weather event caused by a Mesoscale Convective System (MCS) resulted in torrential rains, storms, hail, lightning. All these phenomena have caused damage. Rainfall had a great magnitude, totaling 140 l/m^2 in 60 minutes, with a rate of 2.33 l / min.

Key word: Mesocale Convective System, phenomen, model ALADIN

1. Introduction

M***esoscale Convective*** System – (MCS) are associated with extreme weather events. This organization of cloud systems is a link between atmospheric convection and large-scale atmospheric circulation. Clouds are formed when, in response to atmospheric convection, are organized at a higher level (Houze, 2004).

2. Data and method of analysis

This paper is based on analysis of baric topography maps at ground level and geopotential height at 500 mb level, from 24.07.2010, to capture the main baric centers at European level, associated with mesoscale convective system initiation.

Atmospheric vertical structure was depicted by plotting the atmospheric soundings in Belgrade. It was used mainly for determining the degree of atmospheric instability and wind shear.

Numerical forecast model ALADIN (CAPE and MOCON runs indicators) was used for analysis of potential instability. Running both ALADIN and air soundings are for 24.07.2010.

Satellite image in different channels of visible spectrum comes to complete the radar dates.

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3. Results

The synoptic situation revealed, at 500 mb level, a dorsal between two troughs, descended from Island Cyclon. The weakening of ridge and its withdrawal eastward allowed penetration in Romania territory of a cold atmospheric front, connected with the cut-off area from 500 mb level, with values of 568 gpdm. At ground level, is of interest the depression to the north of Romania, with the core closed by 1000 mb isobar and the Azores Anticyclone, the marginal zone of which will find the atmospheric front.

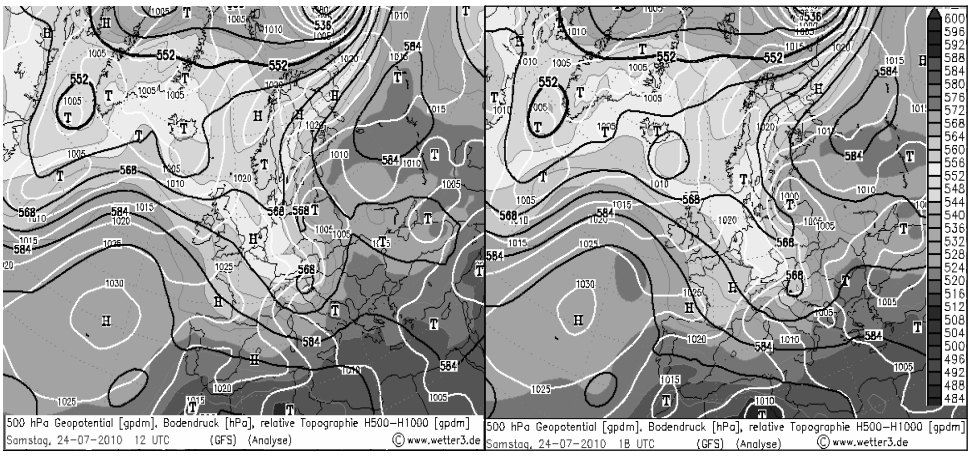

Figure 1. Distribution of the sea level pressure centers and of the 500 hPa level geopotential on 24.07.2010 h. 12 and 18.00 UTC (wetter3.de).

Several aspects are concerned about potential instability. For this reason we used runs of the ANM model ALADIN and atmospheric data of the soundings in Belgrade. High values of CAPE (Convective Available Potential Energy, or the amount of energy that can be used for convection) in the south of the Banat, of 5500-6000 j/kg, are specific for severe convection. The shape of high values respects somewhat cloudy structures form reality.

Stands out also CAPE persistence in the same areas between the two runs (fig. 2).

Over the CAPE maps we superimposed those of the low-level moisture convergence or MOCON. In the case of this indicator the values are less important than shape.

Convergent flow of moisture from lower layers is a key element in convective processes. Concentric structures are those that are characteristic of severe cases, especially when they overlap areas with high CAPE. These are obvious on ALADIN runs images, in the south of Banat and mountainous areas (fig. 3).

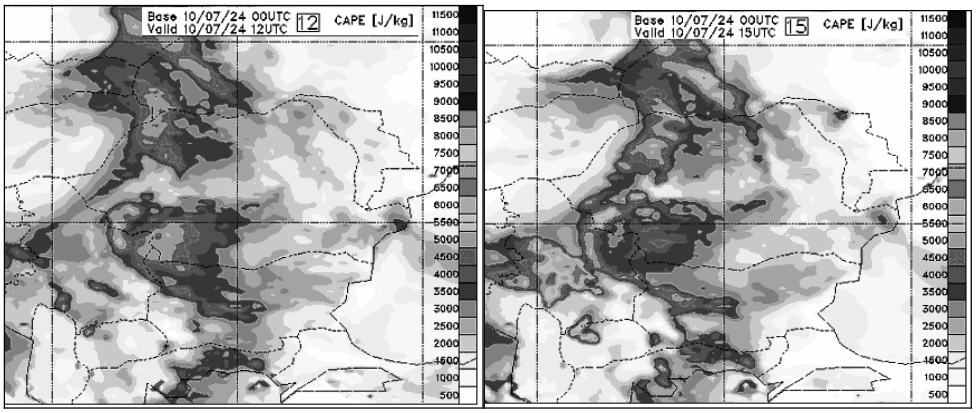

Figure 2. ALADIN model forecast for MOCON in 24.07.2010 h. 12 and 18 UTC.

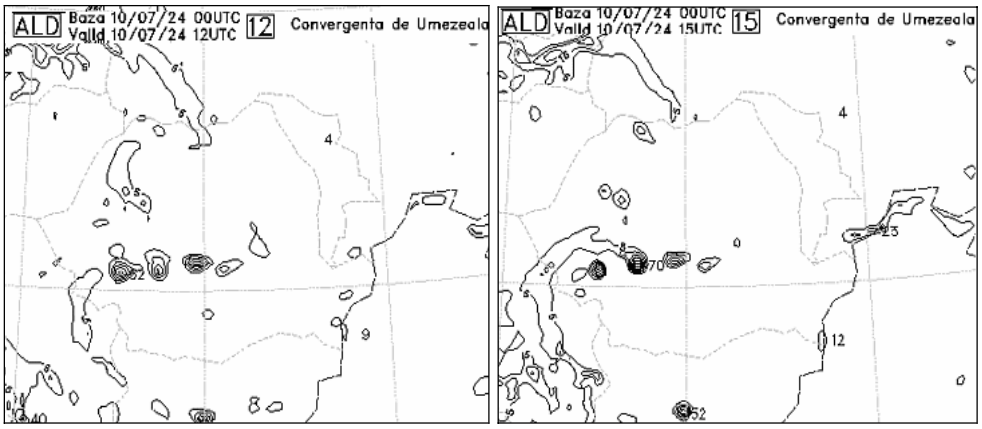

Figure 3. ALADIN model forecast for MOCON in 24.07.2010 h. 12 and 18 UTC.

For a more thorough analysis of atmospheric instability, given the serious events reported, we also used atmospheric soundings in Belgrade, from the afternoon of 24 July. A further argument for this approach was the fact that weather phenomena, respectively the mesoscale convective system arose and initially evolved on Serbian territory, on the north-east of it.

As shown in figure 4, in the lower layers of the atmosphere there was a wind direction shear. Thus, near the ground, the wind had a north-north-west component then it will become south-west.

Convective available potential energy (CAPE), calculated as an average value, had values of 414 J/kg, specific for moderately to severe convection. Particle acceleration, calculated taking into account the level of free convection (LFC), the

equilibrium level (EL) and CAPE, is relatively low, with a value of 0.06 J kg^{-1}.

This is due to the shape of CAPE on the diagram and higher equilibrium level, at less than 250 mb or above 10 500 m (these have resulted in considerable vertical development of convective clouds). Inhibition energy (CIN Convection Inhibition) could be overcome by daytime heating processes.

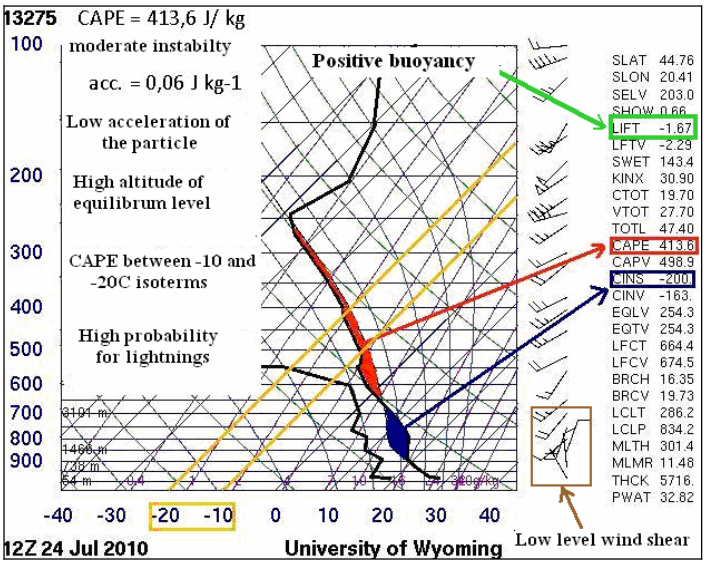

Figure 4. The analyze of the atmospheric sounding from Beograd on 24.07.2010 h.12 (weather.uwyo.edu).

Buoyancy, expressed as the difference between the environment temperature and particle temperature at 500 mb level, and played through the Lifted Index parameter, has a value of -1.87. This means that the volume of air at that level is warmer than the environment and will be moving upward.

CAPE location, between -10 and -20^{0}C isotherms, led to the anticipation of lightning. The first signs of convection in southern Banat were materialized as cumulonimbus clouds at around 11.30 UTC, as shown in the figure 5.

Subsequent developments have been considerable, cloud height exceeds 13-14 km. As reported phenomena we mentioned: hail (Caransebeş and Oravita), lightning (which struck and burned Catholic churches in Oravita) strong wind gusts, that left 22 villages without electricity in Caraş-Severin and broken trees that blocked roads in Sebiş, Gurahonţ and Birchiş areas, in Arad county.

Rains have accumulated 140 l/m^2 at Goleţ, 55 l/m^2 at Caransebeş, 51 l/m^2 at Semenic, 38 l/m^2 at Oraviţa. All these phenomena have been monitored both by weather radar and satellites.

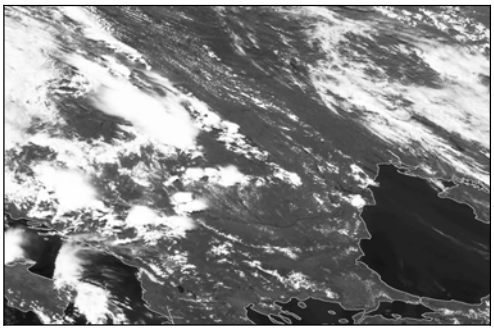

Figure 5. Satellite images the first lusters of thunderstorm occurrence

Related area Goleț-Bucoșnița-Slatina Timiș, where heavy rains have caused extensive damage, radar images capture vertical structures exceeding 11 000 m, maximum potential for hail, and a quantity of liquid at least substantially on a vertical column-VIL 76 kg/m^2 (fig. 6). All estimated hail was concertisated actually to liquid water.

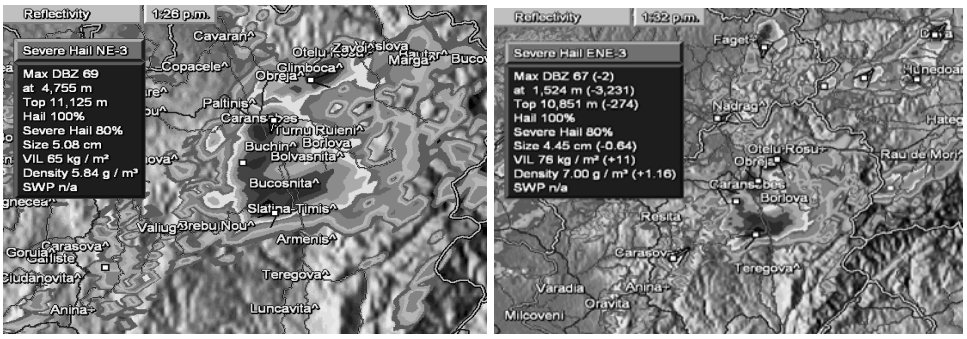

Figure 6. Images from reflectivity field of the convective structure in Goleț-Bucoșnița-Slatina Timiș aria, away to Caransebeș.

Convective system has expanded and, in the radial velocities field, appeared elements of shear elements, specifics only to supercells. There have been reported torrential rain and hail in Caransebeș (fig. 7).

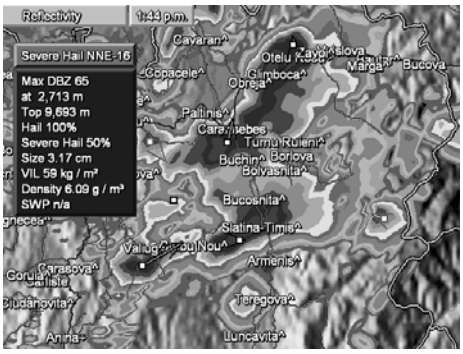

Figure 7. Widening to north of the convective system.

The structure which caused the meteorological phenomena from Caransebeş had, according Cell Trends algorithm (fig. 8) vertical extend of over 10 km, VIL above 70 kg/m² and a maximum reflectivity of ≈ 63 dBZ.

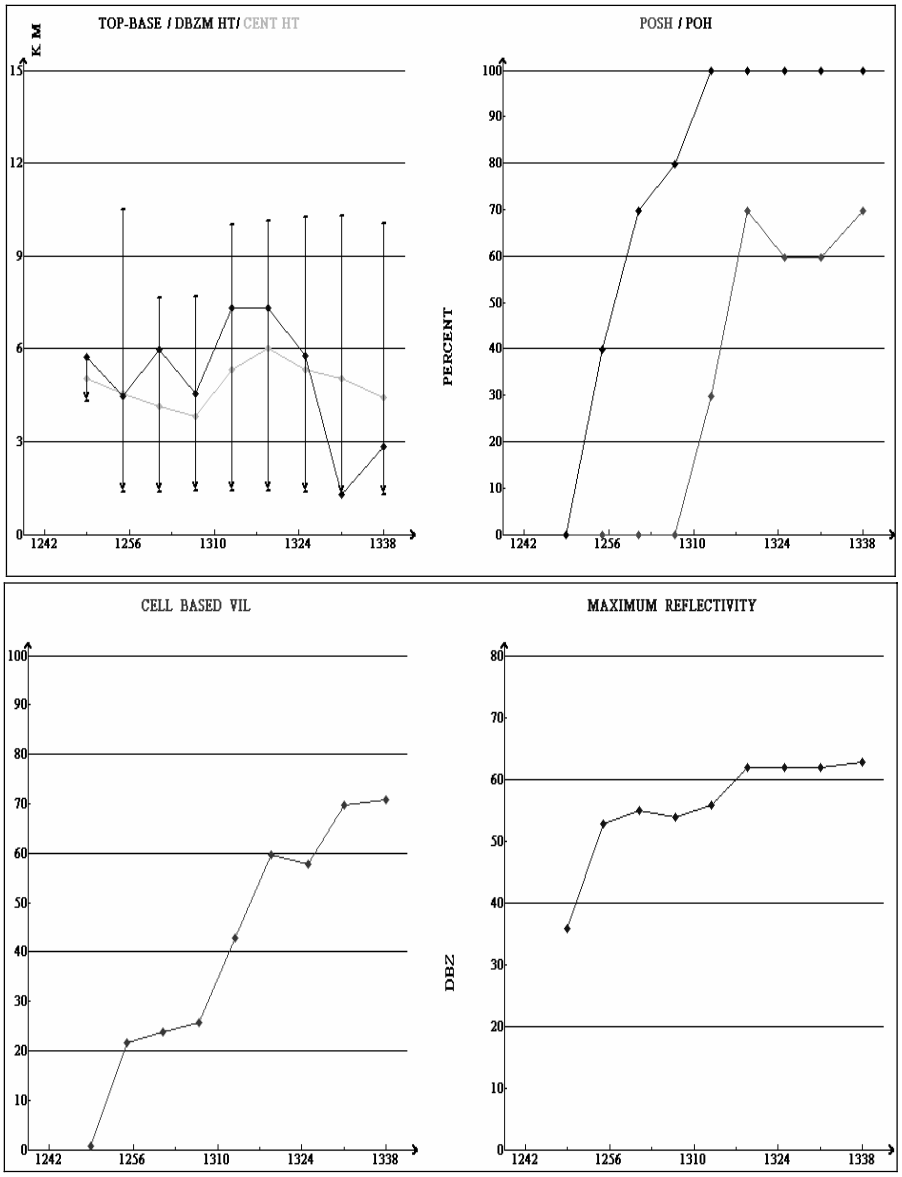

Figure 8. Cell Trends Algorithm for the structure which caused torrential rains and hail at Caransebeş.

The physical characteristics detected by radar were translated into large amounts of precipitation as estimated for one hour (127 l/m^2 - Fig. 9 and for 3 hours (up to 213 l/m^2 – fig. 10).

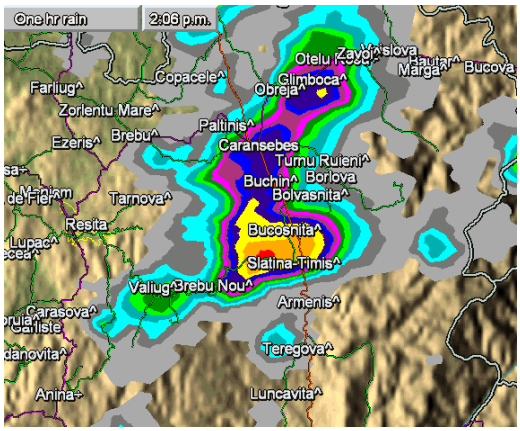

Figure 9. Radar rainfall estimation algorithm for one hour.

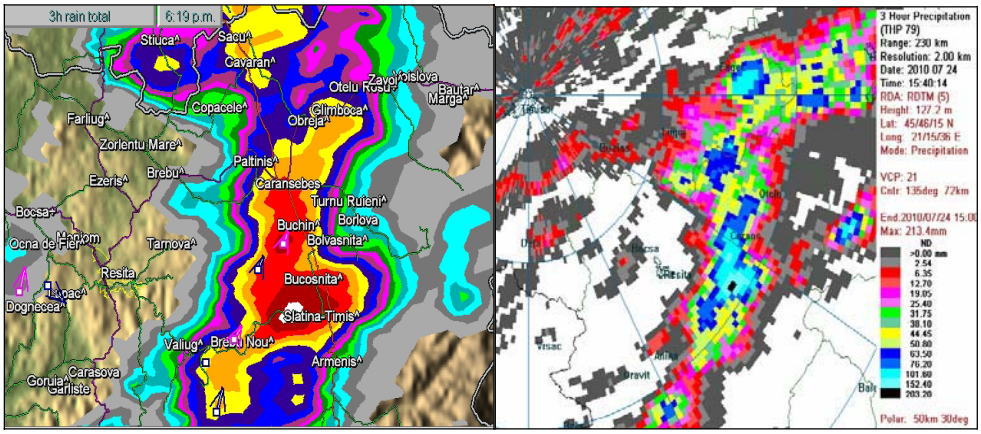

Figure 10. Radar rainfall estimation algorithm for three hour.

Mesoscale convective system has spread, affecting the north and east of Timiş county, east of Arad county and almost all Caraş-Severin county (fig. 11-12).

Satellite images, obtained by the goodwill of colleagues from ANM, capture the extension of convective system over Romania, with a larger area in its west part.

At Oravița were reported hail, torrential rains, increased wind and lightning that caused fires. Vertical developments at Oravița - Ciclova Română area exceeded 10 000 m and the potential of hail was considerably (fig. 13).

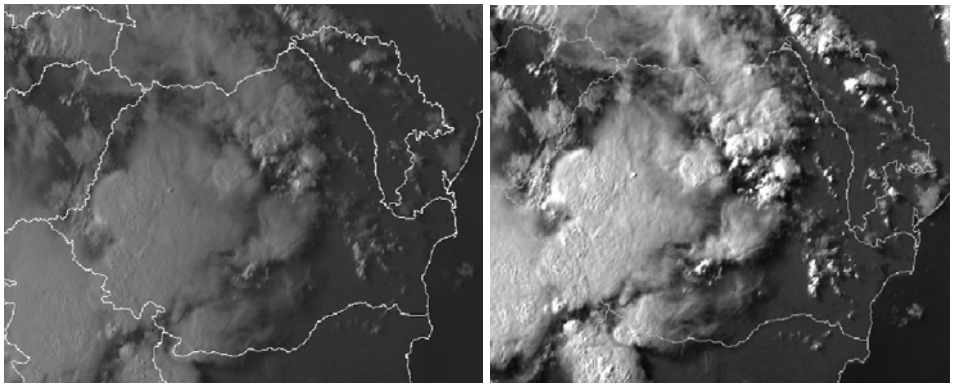

Figure 11. Satellite images (High Resolution Visible) of the mesoscale convective system.

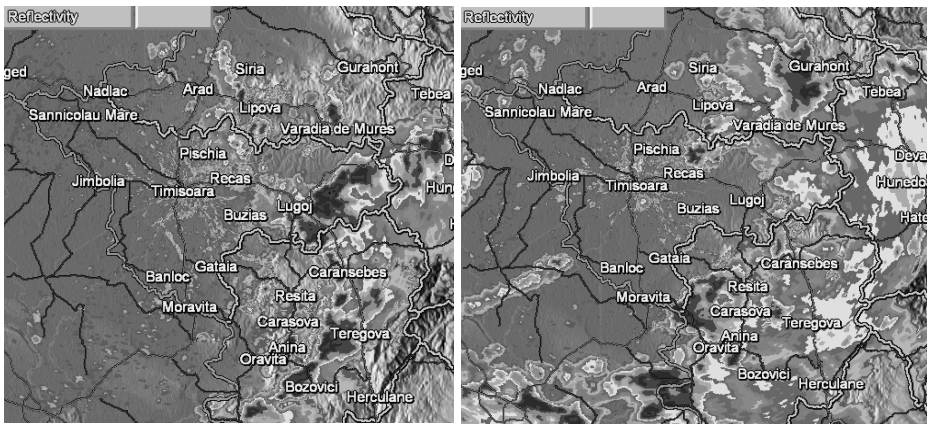

Figure 12. Radar overview images (reflectivity) of the mesoscale convective system.

Figure 13. Radar image of cloudy system over Oravița.

According to the Cell Trends algorithm, the amount of vertically integrated liquid (VIL) reached values of 70 kg/m^2 and the maximum reflectivity exceeded 66 dBZ (fig. 14).

The structure from Oravita had supercellular character, considering Meso information labeled by radar.

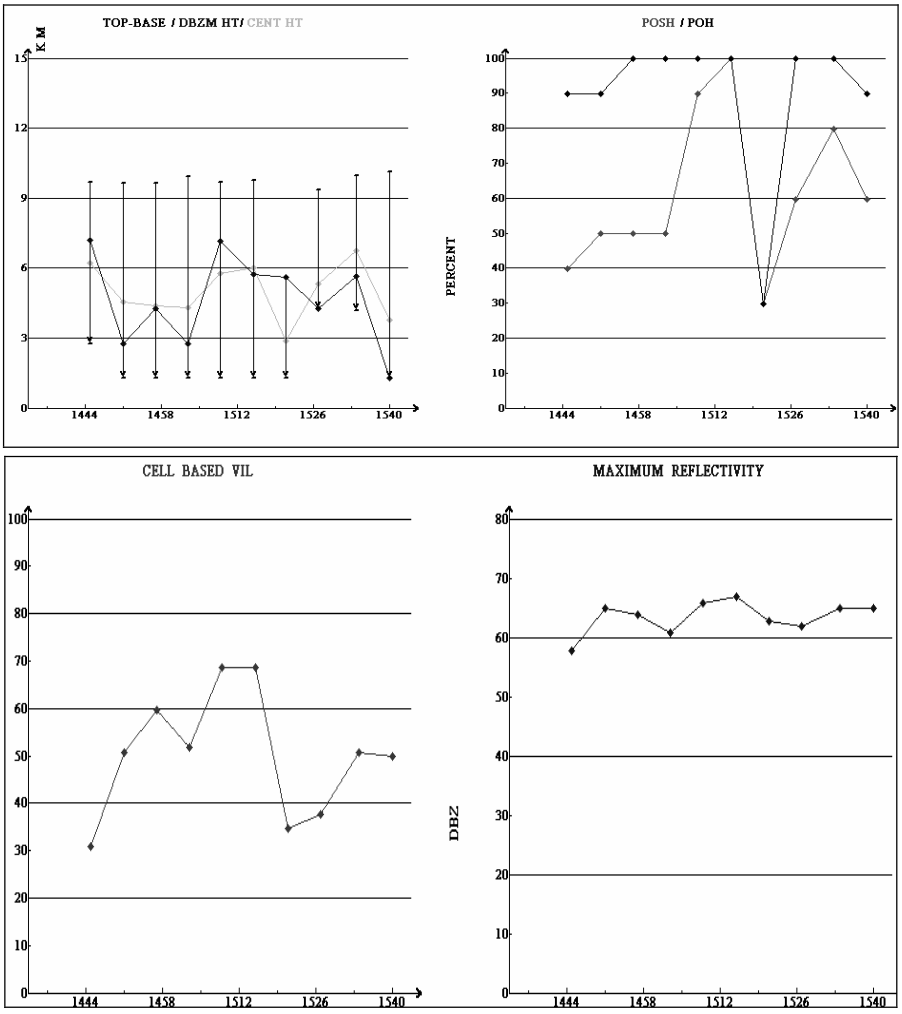

Figure 14. Cell Trends Algorithm for the structure which caused torrential rains and hail at Oravița.

Vertical development of clouds in Caras-Severin temporarily exceeds 14 km (fig. 15).

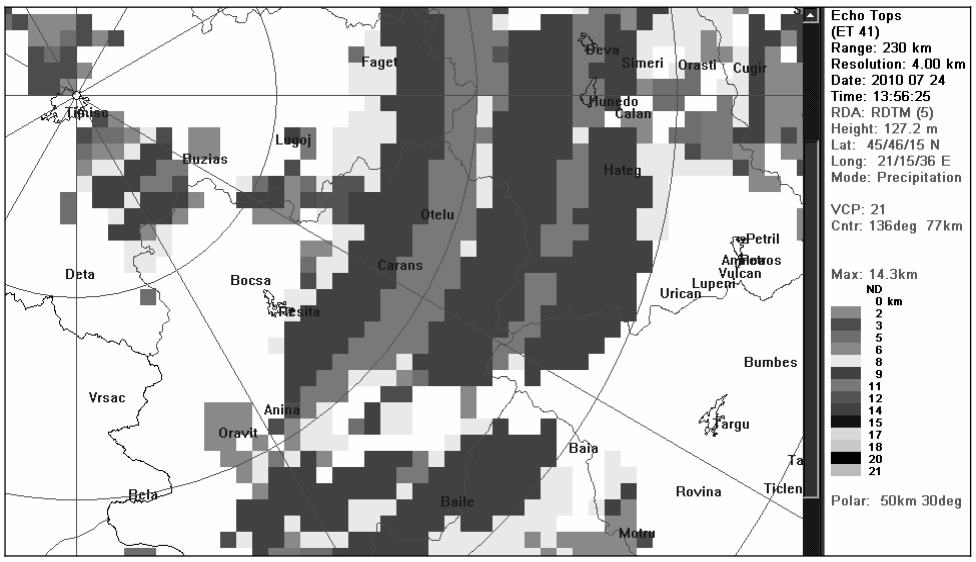

Figure 15. The Echo Tops Algorithm.

Severe weather manifestations were also reported in the eastern part of Timiş county and in the south and east of Arad county. The clouds exceeds 12 km high and potential for large hail was considerable (fig. 16).

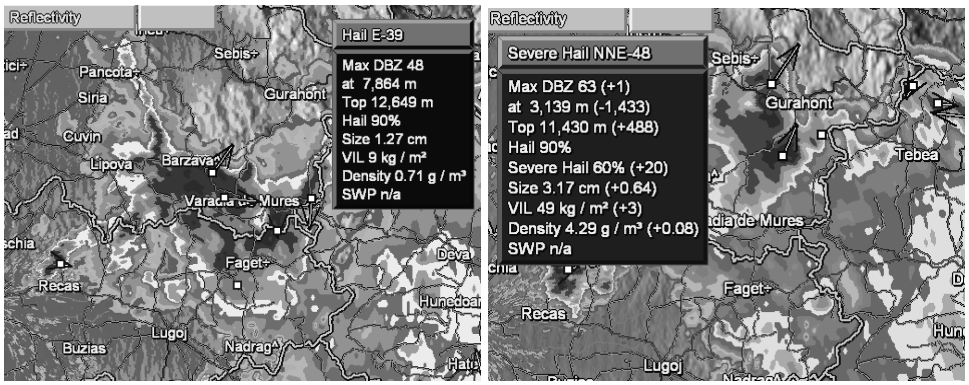

Figure 16. Radar images of convection in Timiş and Arad count.y

Damages had been reported caused by trees felled by wind and flooding caused by torrential rainfall.

Satellite images (fig. 17) shows convective cloud structures that have developed in conjunction with the structure of the geopotential field at 500 mb.

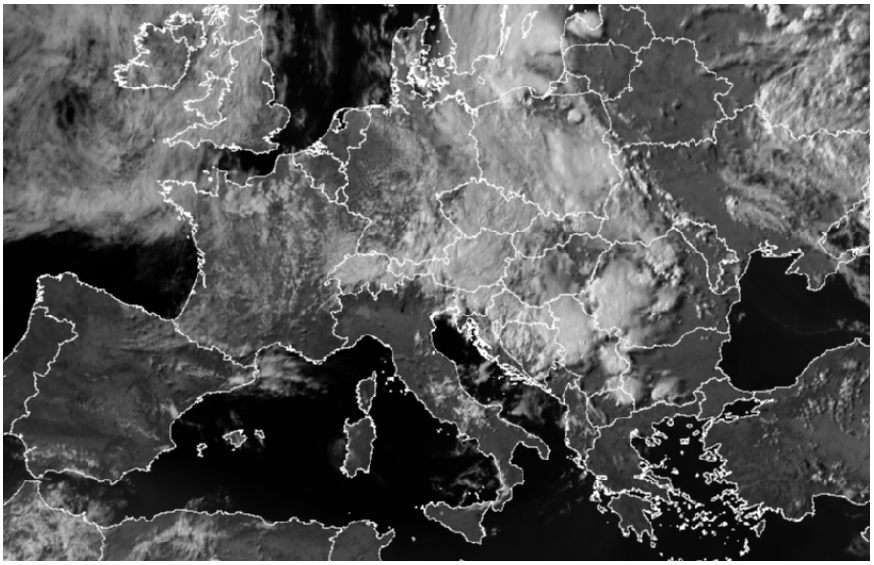

Figure 17. Satellite images of convective structura over Europe

4. Conclusions

A M***esoscale Convective*** System is a well-organized area of multiple thunderstorms or a large cluster of storms. In our case, the MCS had a group of multicell and some supercells. It was associated with extreme weather phenomena and caused a lot of damages. To forecast this weather events are used instruments like atmospheric soundings and ALADIN numeric runs for potential instability and radar and satellite images for real time monitoring.

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