CLIMATIC RISK OF AUTUMN EARLY COOLING THE SITUATION IN THE INTERVAL 23-28 NOVEMBER 2013 – CASE STUDY

ANDREEA FLORIANA MARINICĂ[1], IULICA VĂDUVA[2], I. MARINICĂ[3]

ABSTRACT. Although 2013 has been classified as the sixth warmest year in the history (OMM Michel Jarraud), regionally, in the south-west of Romania, the climatic variability was exceptionally, marked by sudden changes from a warm and droughty weather to a cold (even cool) and rainy weather. Climatic alternations were registered in every month of the year. After the warmish and capricious summer, the autumn thermal regime came in the south-west of Romania. The autumn of 2013 was marked by three intense cooling, one in the end of September that continued in the beginning of October and culminated with low temperatures, negative minimum thermal values and intense hoarfrosts, which destroyed the vegetable crops. In November, the high daily air temperature means led to gradual enforcements, and in the end of the month autumn crops were in advanced development stages, and at rape the floral stems and bottoms appeared. Weather intense cooling and the snowfalls registered in the interval 26-28 November 2013 constituted an important climatic risk, because the crops were not prepared for the weather intense cooling. The snow layer reached 22 cm in Caracal in Romanați Plain. The paper is useful for specialists, PhD candidates, master graduates and all the people interested in climate evolution.

Keywords: excess of precipitation, weather intense cooling, early snowfalls.

1. Introduction

During the entire 2013 weather evolutions in Oltenia, Romania and in the whole European continent were atypical. In Oltenia, we note the following:

- Weather intense cooling in the interval 25-28 March 2013.
–Intense drought in the interval 10 April-21 May 2013.
–In the end of every summer month, intense weather cooling occurred.
– In the end of September two days with pouring rains were registered.

[1] Bachelor of Sciences, Klimacampus, Hamburg Germania, e-mail: andreea@gmail.com.
[2] Lecturer Dr., Faculty of Geography, Spiru Haret University, Bucharest, e-mail: iulicavaduva@yahoo.com.
[3] Ph.D., First Degree Weather Forecaster; SR II, Regional Meteorological Center Oltenia.

–Afterwards, there has been a long interval of gradual weather warming from 6 October to 25 November.

–Weather massive cooling which occurred in the rainy interval 23-27 November and especially in the night of 26/27 November led to the appearance of the thermal regime specific to December beginning with 27 November.

–The atypical weather continued in December and January.

The climatic risk analysis from the south-west of Romania in the autumn of 2013 is a continuation of some extended studies on the climatic variability (Marinică 2006, Sandu and collab. 2012).

2. Data and methods

We used Oltenia CMR data base and daily forecast. The data we used in the synoptic analysis were provided by Global Model of the European Center for Medium range Weather Forecasting – ECMWF and GFS model. We used METEOSAT9 (IR 10.8, WV6.2) satellite images, source: www.eumetrain.org, and satellite images used within METEOSAT8 National Administration of Meteorology (IR10.8, IR10.8 ENHANCED, and RGB 05-06, 08-09, 05i which is a combination of channels: R=difference WV6.2-WV7.3, G=difference IR9.7-IR10.8, B=channel WV6.2i, also called "RGB_00_ 18"). We also used products of Doppler radar in C band from Craiova, and the mediate values of the sea level pressure, geopotential and relative humidity were obtained by accessing the Earth System Research Laboratory – Physical Science Division (http://www.esrl.noaa.gov/psd/cgi-bin/data/composites/comp.day.pl).

3. Precipitation and massive wetaher cooling in the interval 23-28 november 2013.

In November 2013 the quantities of precipitation registered were comprised between 31.9 l/m^2 in Calafat and 93.1 l/m^2 in Apa Neagră.

Significant precipitation for crops was registered only in four days: 6, 23, 24, 26 and 27.November, of which it is noted that 24 November registered a mean for the entire region of 18.9 l/m^2.

The number of days with precipitation was comprised between 8 days in Calafat, Caracal and Slatina and 15 days in Bechet.

The number of days with precipitation ≥15 l/m^2 was comprised between 0 in Calafat, Bechet and Băileşti, 1 in most part of the region and 4 in Apa Neagră in Subcarpathians.

Daily precipitation ≥20 l/m^2 was registered in the hilly area in one single day (on 24 November), and in the mountainous area in two days (6 and 24 November).

The maximum quantity of precipitation registered in 24 hours was of 47.0 l/mp in Călimăneşti (Vâlcea County on 24 November).

The quantities of precipitation registered in the interval 23-27 November 2013 were comprised between 23.7 l/m^2 in Calafat and 62.1 l/m^2 in Apa Neagră, which compared to the normal monthly average values represent between 43.7% of the normal in Calafat and 107.4% in Drăgăşani (table no. 1).

Table 1. Quantities of precipitation (l/m^2) registered at the meteorological station in Oltenia, in the interval 23-27 November 2013 and their percentage from the normal quantities (calculated for the interval 1901-1990) (Source: processed data)

Metor. station	23.XI	24.XI	25.XI	26.XI	27.XI	**S**uma	N (1901-1990)	%N
Dr. Tr. Severin	16.0	***9.8***	-	19.2	6.0	51.0	71.5	71.3
Calafat	1.8	11.6	-	***5.9***	4.4	***23.7***	54.2	***43.7***
Bechet	5.8	12.0	-	10.2	10.0	38.0	49.3	77.1
Băileşti	2.3	8.3	-	10.7	10.4	31.7	57.2	55.4
Caracal	2.8	12.2	-	13.2	**17.5**	45.7	48.5	94.2
Craiova	5.6	17.6	1.0	9.7	11.0	44.9	44.7	100.4
Slatina	1.6	14.8	0.2	11.6	17.0	45.2	47.5	95.2
Bâcleş	13.7	11.4	-	18.7	6.0	49.8	47.9	104.0
Tg. Logreşti	7.8	27.0	0.7	9.0	2.1	46.6	49.8	93.6
Drăgăşani	3.6	24.2	**1.6**	14.9	12.2	56.5	52.6	**107.4**
Apa Neagră	**17.8**	19.4	-	**19.6**	6.1	**62.9**	87.1	72.2
Tg. Jiu	8.6	20.6	0.2	17.1	3.5	50.0	62.3	80.3
Polovragi	8.0	30.0	0.4	7.8	***1.4***	47.6	78.7	60.5
Rm. Vâlcea	***2.0***	**34.6**	0.9	7.9	2.4	47.8	55.0	86.9
Voineasa	5.8	25.0	-	-	-	30.8	53.3	57.8
Parâng	8.2	23.2	2.7	*2.2*	-	*36.3*	55.7	65.2
Media Oltenia	7.0	**18.9**	1.0	**11.8**	**7.9**	46.5	57.2	81.3

On 27 November weather cooling was severe and it snowed all over the region. The snow layer measured up to 22 cm in Craiova and Caracal, and in the mountainous area 30 cm in Parâng, registering the climatic phenomena of early winter with 27 days earlier than the normal average date of snowfalls in Oltenia[4].

According to NOAA (NOAA/ESRL Physical Sciences Division) analysis on 24 November ***the average quantity of precitable water of troposphere column*** above Oltenia was comprised between 15 and 20 kg/m^2, and on 26 November between 9 and 14, 20 kg/m^2, which corresponds well with the values of

[4] In Oltenia the average date of winter arrival (with stable and persistent snow layer) is 24 December

precipitation registered in Oltenia in the two days if we take into account that the continuous advection of moist and warm air mass above the Mediterranean Sea has continued during all this time being a continuous process, as well same as the precipitation process (fig.1).

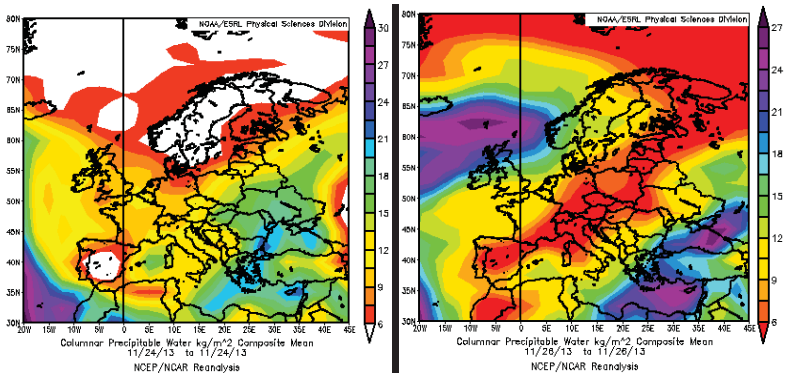

Figure1. The quantity of precipitable water from the troposphere Column on 24 and 26 November 2013.
(according to NOAA/ESRL Physical Sciences Division).

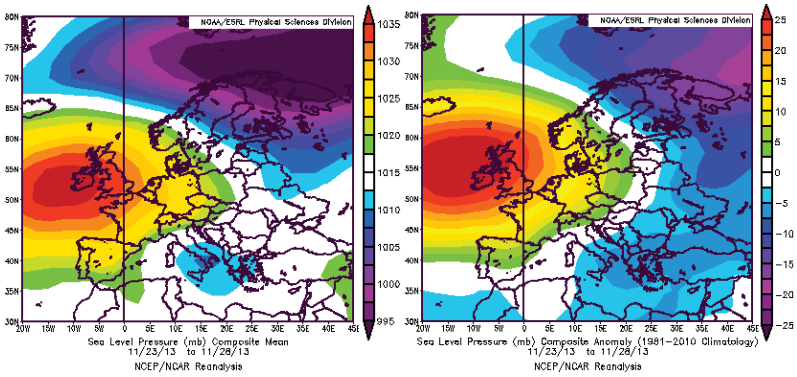

Figure 2. The average values of atmospheric pressure at the sea level in the interval 23-28 November 2013 and pressure anomaly compared to the means calculated for the interval 1981-2010
(according to NOAA/ESRL Physical Sciences Division).

Also the interaction of the cloudy system with the relief forms of Oltenia, and the ascension forced by them caused the intensification of condensation processes in some areas. This explains also the differential values of precipitation registered in different areas in Oltenia.

In the interval 23-28 November 2013 ***the average values of atmospheric pressure*** reduced at the sea level, above Oltenia (as well as Romania) were

comprised between 1012.5 and 1017.5 mb with ***negative deviations compared to the multiannual means*** registered in the interval 1981-2010, comprised between -7.5 mb and -2.5 mb (fig. 2).

3.1. The synoptic analysis on 22 November 2013 at 12 o'clock UTC (before rainfalls arrival)

On ***22 November 2013 at 12 o'clock UTC, at the level of earth surface***, in the Mediterranean Sea, above Sardinia and Corsica Islands there was a Mediterranean Cyclone with values of the atmospheric pressure in the centre below 1000 hPa (fig. 3). This cyclone was an Iceland Cyclone in origins, and moved then on the ***Va classical trajectory*** above the territory of France, penetrating in the Mediterranean Sea, and afterwards its movement continued on the ***Vc classical trajectory*** over the Balkan Peninsula and Romania, crossing directly Oltenia territory.

At that time in the inferior troposphere, for Oltenia, air circulation was southern-western, and the advected air mass over the Mediterranean Sea was warm and moist, maritime tropical (mT) (fig. 3).

At the level of 500 hPa, the nucleus of low geopotential with values below 536 damgp was located over Genoa Gulf, and air circulation at this level was southern-western too. In this interval the cyclone was reactivated, and the *cloudy systems* were re-fed with water vapors over the Mediterranean Sea. The process of cyclone regeneration and reactivation is signaled by the appearance of the additional cloudy system located on the western coast of Italy.

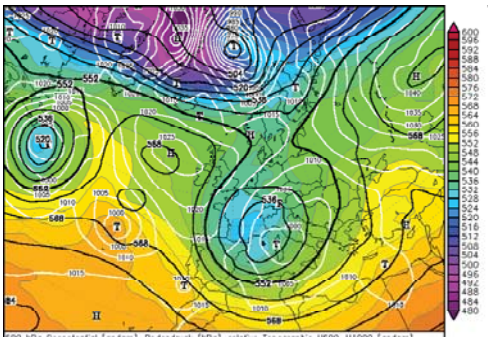

Figure 3. Synoptic situation at the ground level superposed over the altitudinal synoptic situation at the level of 500 hPa and the relative baric topography 500/1000 on 22 November 2013 at 12 o'clock UTC (acoording to www.wetter3.de).

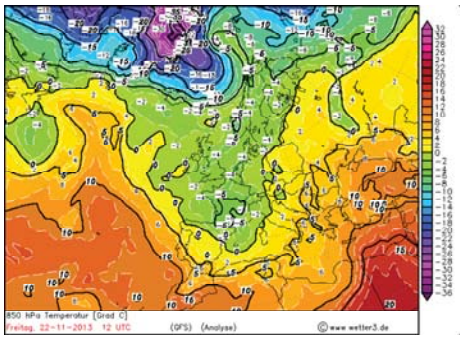

Figure 4. Thermal field at the level of 850 hPa over Europe on 22 November 2013 at 12 o'clock UTC (according to www.wetter3.de).

The thermal field over Europe at the level of 850 hPa presents a massive cold entering from the polar region towards South, above all the Western Europe, up to the Western basin of the Mediterranean Sea. It was favored by the altitudinal atmospheric circulation, which was of the same type (Northern type) at all the atmospheric levels and for all the Western Europe (fig. 4).

The feeding with cold air contributed to the cyclone regeneration and alimentation during all this interval.

3.2 The synoptic analysis on 24 November 2013 at 12 o'clock UTC (the first day with abundant precipitation)

Cyclone evolution on its trajectory was extremely slow, which led to a time of influence and action over Oltenia of 6 days (22-27 November), and if we take into consideration the poor precipitation in the interval 19-21 November, the interval was even of 9 days[2] ([2] Usually, the action of a Mediterranean Cyclone above our country lasts about 3-4 days or even less.). *Precipitation in Oltenia* was registered on extended areas and was abundant in the night of 24/25 November 2014, and in what the extension on the continent is concerned they covered most part of the Southern and Eastern Europe. The area with the most intense precipitation was above Romania mainly due to the location of the cloudy system of the occluded front and its interaction with the relief of our country.

At the level of earth surface on 24 November 2013 at 00 o'clock UTC the Mediterranean Cyclone was much more extended in the basin of the Mediterranean Sea, presented the isobar of 1005 damgp closed, which meant that the occlusion process had been already initiated. In the inferior troposphere, the circulation of air masses was from the southern sector, with warm air masses rich in moisture (mT) (fig. 5).

At the level of 500 hPa the nucleus of low geopotential had the isohypse of 548 dagp closed, located over the nucleus of low pressure, which denotes that the position of the vertical axis was perpendicular on the earth surface, an aspect which indicates the maximum development phase and also the starting of the occlusion process. In Oltenia on the entire troposphere column at that moment air circulation was southern (fig. 5).

The thermal field at 850 hPa is presenting in this moment a slight withdrawal towards north of the mass of cold air from the basin of the Mediterranean Sea, due to the strong advection of cold air from South, especially in the Eastern side. This withdrawal, due to the movement of the mass of warm air caused the interruption of the feeding with cold air of the cyclone and the beginning of the occlusion process (fig. 6).

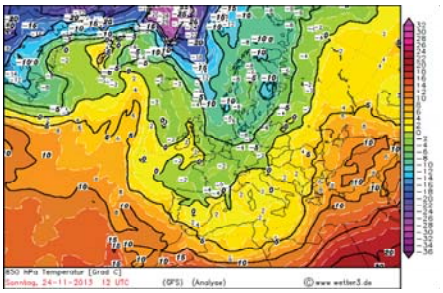

Figure 5. Synoptic situation at the ground level superposed over the altitudinal synoptic situation at the level of 500 hPa and the relative baric topography 500/1000 on 24 November 2013 at 12 o'clock UTC (acoording to www.wetter3.de).

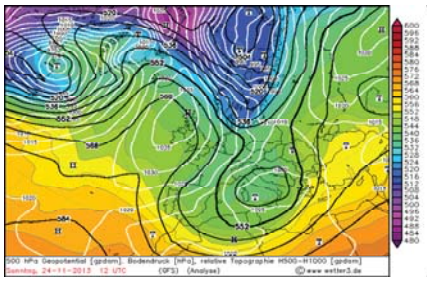

Figure 6. Thermal field at the level of 850 hPa over Europe on 24 November 2013 at 12 o'clock UTC (according to www.wetter3.de).

The cloudy systems in this moment are well developed and affects extended areas on the continent, and the occluded front of the cyclone is located above the Southern-Western half of Romania. It is known that in certain situations the occluded fronts cause intense precipitation, which are sometimes pouring and can lead to floods in some areas where there is a fast accumulation of waters drained from slopes or from surrounding areas. This fact explains the significant intensity of precipitation registered during the night of 24/25 November 2013.

The quantities of precipitation registered in this interval at the meteorological stations in Oltenia were comprised between 9.8 l/m^2 in Dr. Tr. Severin and 34.6 l/m^2 in Rm. Vâlcea, *the precipitation mean for the entire region* was 18.9 l/m^2, and the maximum quantity of precipitation was 47.0 l/m^2 in Călimăneşti (Vâlcea County) (table 1). After the passing of the frontal system, there were local wind gusts from the Western sector in the Southern half of the region, the maximum wind gust being of 72 km/h in Drăgăşani.

As a consequence of the movement from East to East and North-East of the cyclone, the atmospheric circulation restructured and a process of weather cooling began in Romania and in the countries situated in the West of our country. On 25 November precipitation stopped and only in the first part of the day it rained poorly, and in the night of 25/26 November it started to rain again.

3.3. The synoptic analysis on 26 November 2013 at 12 o'clock UTC (the second day with abundant precipitation)

Weather cooling process continued and became more severe in the night of 25/26 November and in the interval 26 November 2013 at 08 o'clock– 27

November 2013 at 08 o'clock. Snowfalls appeared and extended gradually in the night of 25/26 November 2013, during 26 November and in the night of 26/27 November.

Therefore, in the interval 26 November 2013 at 08 o'clock– 27 November 2013 at 08 o'clock, *weather was cloudy and cold. On extended areas there were rainfalls, sleet and snowfall. In the mountains, it snowed. The maximum quantity of precipitation registered was of 20 l/m^2 in Apa Neagră. The wind blew mildly with local wind gusts from the Eastern sector in the South of the region, the maximum wind gust being of 47 km/h in Calafat and Bechet. The maximum temperatures were comprised between 1°C in Voineasa and 5°C in Dr. Tr. Severin, Calafat and Halânga, and the minimum temperatures between -2°C in Bâcleş and 0°C in Voineasa, Rm. Vâlcea, Halânga, Dr. Tr. Severin, Apa Neagră, Tg. Jiu, Calafat, Băileşti and Bechet. A snow layer covered the entire region, and at 8 o'clock it measured up to 14 cm in Bâcleş* (according to C.M.R. Oltenia).

In the interval 24-26 November 2013 at 12 o'clock UTC, the Mediterranean Cyclone moved fast over the Romanian territory, near the frame of Eastern Carpathians, and on 26 November at 12 o'clock UTC its core was located in the Plain of Eastern Europe over the Republic of Belarus and Poland. During all this time *the Azores High* extended towards North comprising the Southern half of the Scandinavian Peninsula.

The altitudinal talweg of the Iceland Cyclone moved slightly towards East, thus in altitude at the level of 500 hPa above Romania air circulation maintained the Southern position, bringing in altitude warm and moist air. A nucleus of low geopotential with core values below 536 damgp is located in this thalweg above Italy. In the inferior troposphere above the Southern Balkan Peninsula, Eastern Mediterranean Sea and Asia Minor there is a thalweg of the Cyclone from the Arabian Peninsula, quasi-stationary, in most part of the year. This type of situation leads in Oltenia to the advection of cold air (cPk) in the inferior troposphere from North-East, near the frame of Eastern Carpathians (fig. 7), which is a process specific to the situation of snowstorm.

The situation specific to the snowstorm occurred especially in the night of 26/27 November, and the aerological survey, from 00 o'clock UTC, confirms this fact (fig. 8). On that survey we found the following situations: -the advection of cold air from the Eastern sector up to the level of 840 hPa,

- the existence of the thermal inversion (between 900 hPa and 840 hPa) and of a layer between 850 and 3007 m in which the moist air is saturated.

- two layers having different characteristics of the flow: - the layer on the ground, in which the circulation is Northern-Eastern following the frame of (Eastern and Southern) Carpathians Mountains, due to which the mass of cold air is directed in the space between Carpathians and Black Sea;

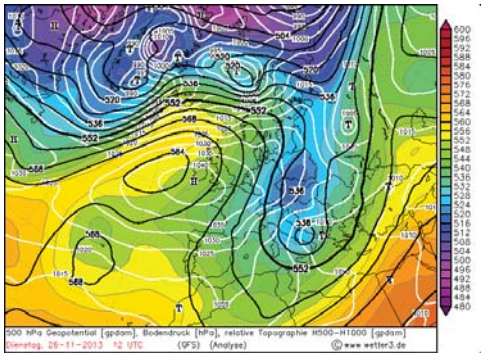

Figure 7. The synoptic situation at the ground level superposed over the altitudinal synoptic situation at the level of 500 hPa and the relative baric topography 500/1000 on 26 November 2013 at 12 o'clock UTC (according to www.wetter3.de).

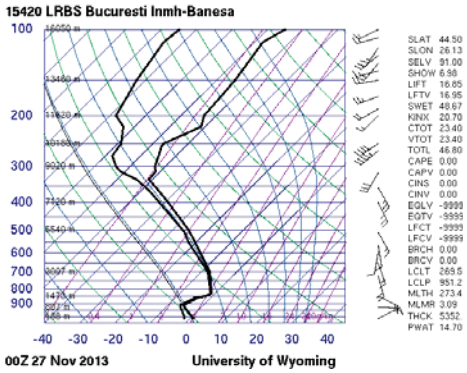

Figure 8. *Aerological survey on 27 November 2013 at 00 o'clock UTC* (according to the University of Wyoming).

- the layer above the thermal inversion (exceeding the level of 840 hPa), characterized through a Southern-Western circulation, through which the warm air is advected;

-warm and smooth tropical air slides above the cold polar continental air, which moves towards the ground surface; -the forced ascension of the warm air above the cold air caused a fast condensation of water vapors creating a thick nebulosity from which abundant precipitation fell under the form of snowfall;

The cloudy systems associated to this type of synoptic situation were vast, and the precipitation registered was on extended areas.

Thermal field at the level of 850 hPa on 26 November 2013 at 12 o'clock UTC indicates the entry of the cold air over most part of Europe up the South of Italy and on the Southern shore of the Mediterranean Sea (Tunis Cape). The isotherm of -5°C is located above the West of Romania, and above Oltenia there is the isotherm of -4°C, indicating a cooling at this level with 8.0°C compared to 24 November. The field of precipitation above Europe associated with this synoptic situation was vast, and over the South of Romania there was registered an area with intense precipitation.

The quantities of precipitation registered in the interval 26 November 2013 at 08 o'clock – 27 November 2013 at 08 o'clock were comprised between 7.8 l/m^2 in Polovragi and 19.6 l/m^2 in Apa Neagră, and the mean for the entire region was 11.8 l/m^2. During the night *a snow layer was formed in the entire region, and at 8 o'clock on 27 November it measured up to 14 cm in Bâcleş. Snowfalls* continued on

27 November, thus in the interval 27 November 2013 at 08 o'clock – 28 November 2013 at 08 o'clock, and in Oltenia *weather continued to be cloudy and cold. On extended areas especially during daytime it snowed. The maximum quantity of precipitation registered was of 20.8 l/mp in Albeşti (Dolj County). The wind blew mildly.*

The maximum temperatures were comprised between -1°C in Polovragi and 2°C in Calafat, Bechet and Apa Neagră, and the minimum temperatures between -3°C in Dr. Tr. Severin and 0°C in Băileşti, Bechet, Calafat, Rm. Vâlcea and Voineasa. At 08 o'clock the snow layer measured up to 24 cm in Pieleşti (Dolj County). There was a completely sparse fog (according to CMR Oltenia).

The snow layer measured 24 cm in Stolnici (Argeş County) and Alexandria (Teleorman County), and in the mountains 30 cm in Parâng (fig 9). For the entire region the mean of the quantities of precipitation registered in the interval 27 November at 08 o'clock – 28 November at 08 o'clock was 7.9 l/m^2.

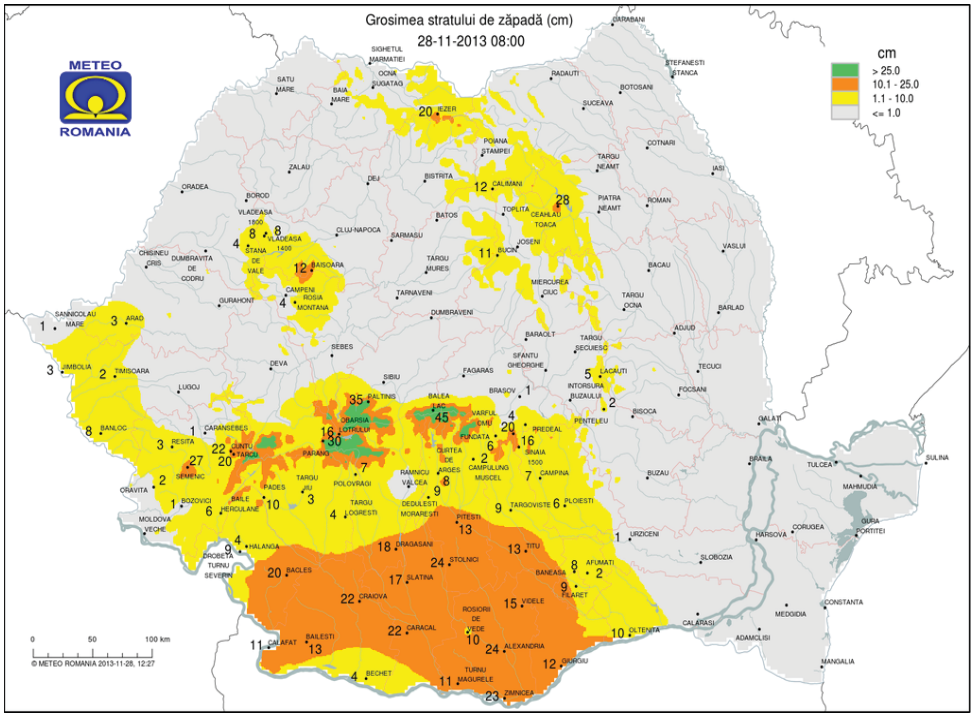

Figure 9. Thickness of the snow layer on 28 November 2013 at 08 o'clock (according to meteoromania.ro).

4. Conclusions

The analyzed situation is a case of *abundant precipitation* caused by a Mediterranean Cyclone, followed by a moderate short-term snowstorm (the night of 26/27 November), and weather cooling.

The precipitation cumulated in the 5 days (23-27 November 2013) was significant from a quantitative point of view and was comprised between 23.7 l/m^2 in Calafat and 62.1 l/m^2 in Apa Neagră representing between 43.7% (almost half) of the normal monthly quantity in Calafat and 107.4% in Drăgăşani.

The mean for the entire region was 46.5 l/m^2 representing 81.3% of the normal monthly mean. *The arrival of the snow layer,* the fall of the maximum air temperatures below 0°C, the ground frost led to the end of the autumn agricultural campaign (which had prolonged after the optimum period), and the arrival of winter in Oltenia with 27 days earlier.

Weather cooling continued, and on 30 November *the monthly minimum air and ground temperatures* were registered, thus the minimum thermal value in the air was -9.9°C in Caracal and Parâng (only 0.1°C under the climatic frost threshold) registered in the morning of 30 November, at the ground surface -9.8°C in Craiova. *The abundant precipitation* registered in this interval caused a water excess in the ground.

Weather intense cooling caused massive damages of vegetable crops and significant damages to farmers, but also the rise of the living cost by increasing the price of agricultural products and activating the heating systems of homes.

On the advection passage of cold and precipitation air, the snow layer extended from the Plain of Eastern Europe and Scandinavian Peninsula towards South-West up to Romania and Balkan Peninsula.

The presence of the mountainous Alps-Carpathians-Balkan chain represented a dam in the way of the masses of cold air advected from North-East and North, but also of the warm and moist air advected from South above the Mediterranean Sea, which led to snowfalls on extended areas in the Southern half of Europe .

The analyzed situation is a case of an exceptional early cooling followed by abundant rainfalls, which turned into sleet and then snowfall. The moderate short-term snowstorm in the night of 26/27 November was an early autumn snowstorm.

From maximum temperatures in the air comprised between 4°C and 12°C on 25 November the severe temperature drop led to maximum temperatures comprised between -1°C and 2°C on 27 November, that is a cooling with 10.0°C in two days. The analysis confirms that in Oltenia (as well as in the entire Romania) the climatic processes resonate well with those from the whole continent.

REFERENCES

1. Marinică I. (2006), *Fenomene climatice de risc în Oltenia,* Editura Autograf MJM, CRAIOVA, 386 p;
2. Sandu, I., Elena Mateescu şi colab. (2012), *Consideraţii privind clima Olteniei şi tendinţe actuale*, Publicaţiile Societăţii Naţionale Române pentru Ştiinţa Solului, Nr 38, A XX-a Conferinţă Naţională de Ştiinţa Solului.
3. * *http://www.wetterzentrale.de/topkarten/fssatms1.html
4. ***http://www.ecmwf.int/products/forecasts/d/charts/medium/deterministic/msl_uv850_z500/
5. ***http://www.eumetrain.org/eport/view.php?width=1366&height=768&date=2012051312&region=euro