THERMAL VARIATIONS IN OCTOBER 2013 IN NORTH-WESTERN ROMANIA

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ABSTRACT. Thermal variations in October 2013 in north-western Romania. The present analysis refers two weather situations in October 2013 in north-western Romania, represented by a period of cold weather in the first part of the month, and, respectively, a warm period in the last decade of the month. The cold wave produced minimum daily temperatures ranging between -6.4 and -1.9°C, in the lower areas, while in the mountainous region they were between -9.4 and -7.2°C. These values are by 0.2 to 5.6°C lower than the absolute daily minimum temperatures registered between 1961-2012 period. Positive deviations from the maximum daily absolute temperatures up to 4.0°C were recorded in the warm period at the end of the month. The data base used in the study was made up of minimum and maximum daily temperatures for the periods 3-8 and 22-30 October 2013, registered at 14 meteorological stations situated in north-western Romania. Other data used were the air temperature at standard isobaric levels of 850, 700 and 500 hPa, in the period 1973-2013. Synoptic reanalysis maps for the period 1961-2013 were also used.

Keywords: north-western Romania, October 2013, heat wave, cold wave.

1. INTRODUCTION

Cooling and warming periods are typical to the temperate climate, especially to the continental one, as a consequence of alternation of different air masses (Bogdan, Niculescu, 1999). The present analysis shows two situations produced in October 2013 in north-western Romania,: one of cold wave and, respectively, one of a warm air invasion. Between 3-8 October, the cold wave produced the lowest daily minimum temperatures for this period ever registered. In the last decade of the month, due to an excessive warming process, daily maximum temperatures were recorded, which several days were above the absolute daily maximum values.

2. DATA AND METHODS

For this study there were used minimum and maximum daily temperatures for the periods 3-8 and, respectively, 22-30 October 2013, registered at 14

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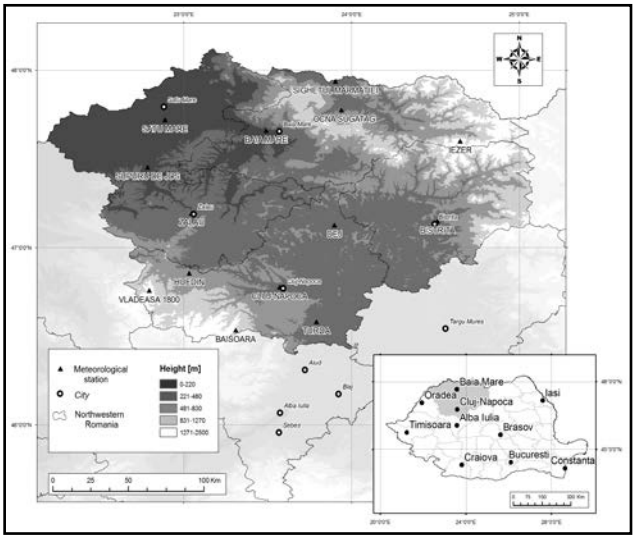
meteorological stations in north-western Romania (Fig. 1). The data have been provided by the NMA (National Meteorological Administration), for the following intervals: 1961-2013, for the stations Satu Mare, Baia Mare, Sighetu Marmaţiei, Ocna Şugatag, Zalău, Bistriţa, Huedin, Cluj-Napoca, Turda, Dej, Băişoara and Iezer; 1971-2013, for Supuru de Jos; 1987-2013 for Tg. Lăpuş.

In order to point out the intensity of the cooling and warming processes, we used air temperature values at the standard isobaric levels of 850, 700 and 500 hPa for the period 1973-2013, measured by the Cluj-Napoca atmospheric soundings at 00 UTC. There were also used ground level synoptic maps and geopotential field maps of standard isobaric levels (850, 700, 500 hPa), as well as temperature values at 850 hPa level, before 1973.

From the methodological point of view, the synoptic analysis consisted in identifying the synoptical structures and their evolution within each interval, and their correlation with the air temperature values registered at the meteorological stations.



Fia. 1. Location of meteoroloaical stations

For the purpose of graphical representation of the daily minimum and maximum temperatures recorded before 2013, we opted for the boxplot representation, which renders several statistical characteristics of the data series, such as the median, the first and third quartile, and the absolute extreme values (http://www.physics.csbsju.edu/stats/box2.html).

3. RESULTS

From the synoptic point of view, the 3-8 October 2013 period was characterised by a high pressure field over Romania's territory (above 1020 hPa), as a result of the ridge extension and, later on, of the passage of a mobile Scandinavian Anticyclone. In Europe, the Scandinavian Anticyclone was present even from late September as a ridge gradually extending from the polar seas to the Scandinavian Peninsula. Within this context, on 1 October, an anticyclonic nucleus (over 1025 hPa) appears over The Scandinavian Peninsula and The Baltic Sea, formed below the altitude ridge of The Tropical Anticyclone. The development and

extension to the south of The Scandinavian Anticyclone blocks the movement of the Atlantic depressions coming from the west towards Eastern Europe (Topor, Stoica, 1965). The high pressure field extension and maximum development were observed on 4 October, when it influenced almost all the eastern half of Europe (Fig. 2.). This high pressure field presented a tendency to unite with the Azorean Anticyclone ridge, extended over the south-western part of the continent. This process formed an anticyclonic arch above the southern half of Europe, with the maximum spatial extension on 7 October.

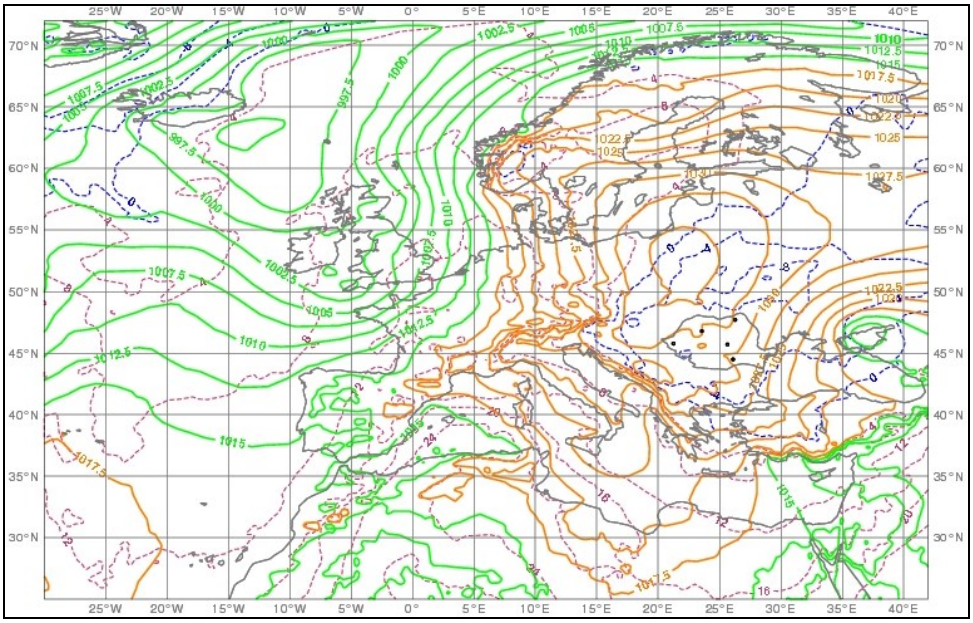


Fig. 2. The field of atmospheric pressure at ground level (solid lines, hPa), and of air temperature at 850 hPa level (dashed line, ºC), on 04.10.2013, 00 UTC
(source NMA Archives)

In accordance with the standard isobaric levels of 850, 700, 500 and 300 hPa, an altitude ridge is formed over Central Europe, associated in its anterior part with a trough which favoured a cold advection over the Eastern Europe.

The 22-30 October period was characterised by warm weather, as a consequence of an anticyclonic field at the ground level, and respectively, of a warm ridge in the higher levels of the atmosphere. In this period, the eastern and south-eastern Europe were under the influence of an anticyclonic field formed by the extension towards the south-east of The Scandinavian Anticyclone. The south-western and southern part of Europe were influenced by The Azorean Anticyclone ridge and its mobile nucleus, which determined a warm advection from the south of the continent, favouring an important warming of the weather (Fig. 3). The upper levels of the atmosphere presented a ridge structure, favouring a warm advection

over the southern half of Europe. The intensification of the altitude warm ridge at all levels (850, 700, 500, 300 hPa) was observed in three 18-36 hrs periods of the following intervals: 23-24, 26-27 and 29 October.

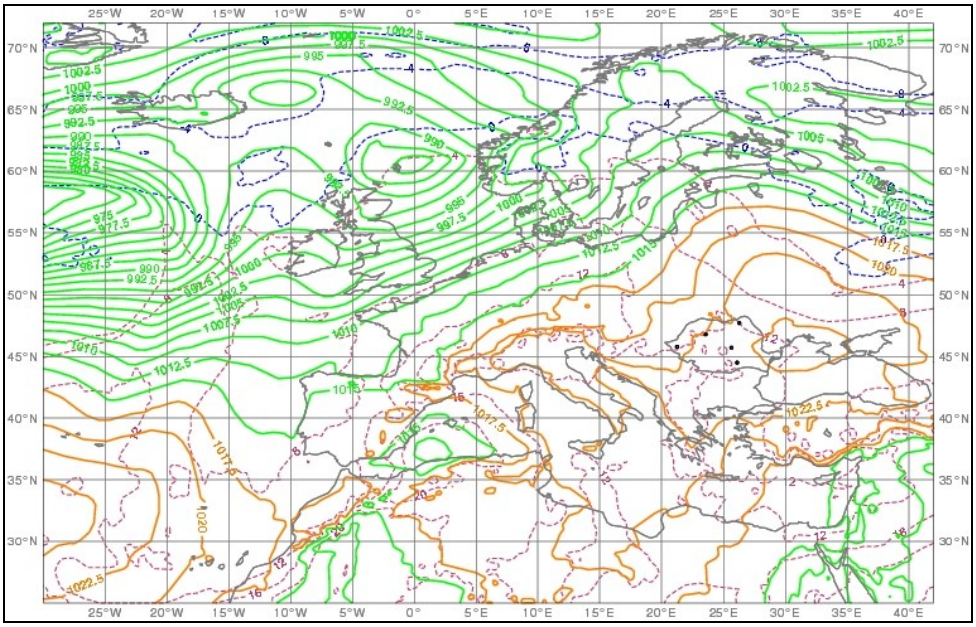


Fig. 3. The field of atmospheric pressure at ground level (solid lines, hPa), and of air temperature at 850 hPa level (dashed line, ºC), on 26.10.2013, 00 UTC
(source NMA Archives)

The cold and heat waves recorded in October 2013 are well illustrated by the thermal structure of atmospheric levels in the two periods. During the cold period at the beginning of the month, the temperatures at 850, 700, 500 and 300 hPa levels were the lowest on 3 October (-6.4ºC, -11.7ºC, -25.1ºC and, respectively, -48ºC), followed by a warming process. At 850 hPa level the temperatures on 3 and 4 October went below the absolute value of the period 1973-2012 (-2.5ºC), while at the 500 hPa level the absolute minimum temperature of this period (-25.1ºC) was reached on 3 October.

At the meteorological stations the daily minimum temperatures were very low, most frequently below freezing point, such as -6.4ºC at Tg. Lăpuş. The cooling process was intensified by the terrestrial radiation, favoured by a predominat clear sky during the night, at least in the first part of the period. On the plain and hilly parts of the area, the lowest temperatures were registered on 4 and 5 October: below -4ºC at Satu Mare, Supuru de Jos and Baia Mare (Fig. 4, up). In the depressions and valley corridors (Tg. Lăpuş, Huedin, Cluj-Napoca and Dej meteorological stations), with frequent thermal inversions, the lowest values were recorded in the 4-7 October period (fig. 4, down).

In comparison with the minimum temperature values registered in the same period before 2013, it was observed that their median varied between 4 and 9°C in the lower areas and, respectively, between 1-6°C in the mountains. The highest temperatures of the lower areas were registered in the hilly regions and the sheltered depressions (Turda, Zalău, Baia Mare), followed by those in the plains and the Maramureş Depression (between 6 and 8°C), respectively in the depressions affected by thermal inversions and valley corridors (between 4 and 7°C) (Fig. 4). Besides, the daily minimum temperatures of the same period registered before 2013, included between the first and third quartile, were between 2 and 12°C, slightly higher in the hilly regions and, respectively, lower in the mountains (Fig. 4). The cold character of the period is shown by the fact that, at least on one of the days between 3-8 October, the minimum temperature was lower than the absolute daily minimum. The largest number of such days were registered at Baia Mare station (on 5 consecutive days).

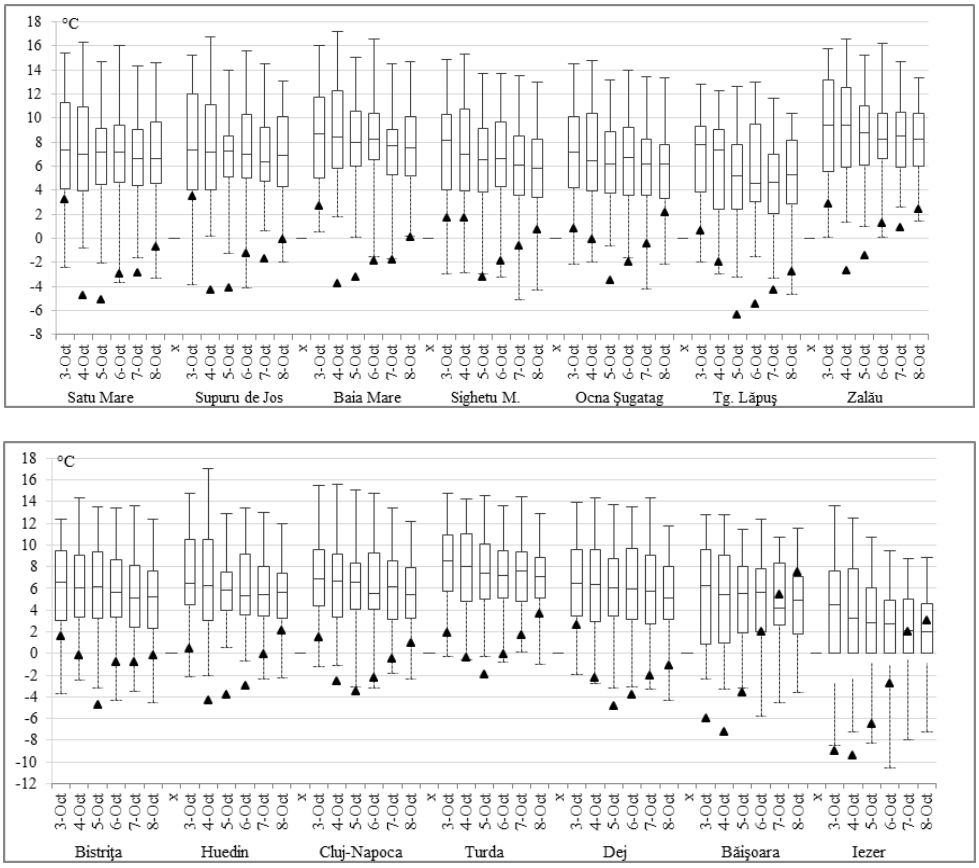


Fig. 4. Variation of daily minimum temperature in the period 3-8 October 2013(▲) as against the minimum thermal values of 3-8 October period recorded at the meteorological stations before 2013

The deviation of daily minimum temperatures in the analysed period, from the ones registered before 2013, was over 4°C in the plain and depression areas in the north-western part of the region (at Satu Mare, Supuru de Jos, Baia Mare, Zalău stations) and in the depression areas affected by thermal inversions (Tg. Lăpuş, Huedin), their intensity being higher at the beginning of the cooling process.

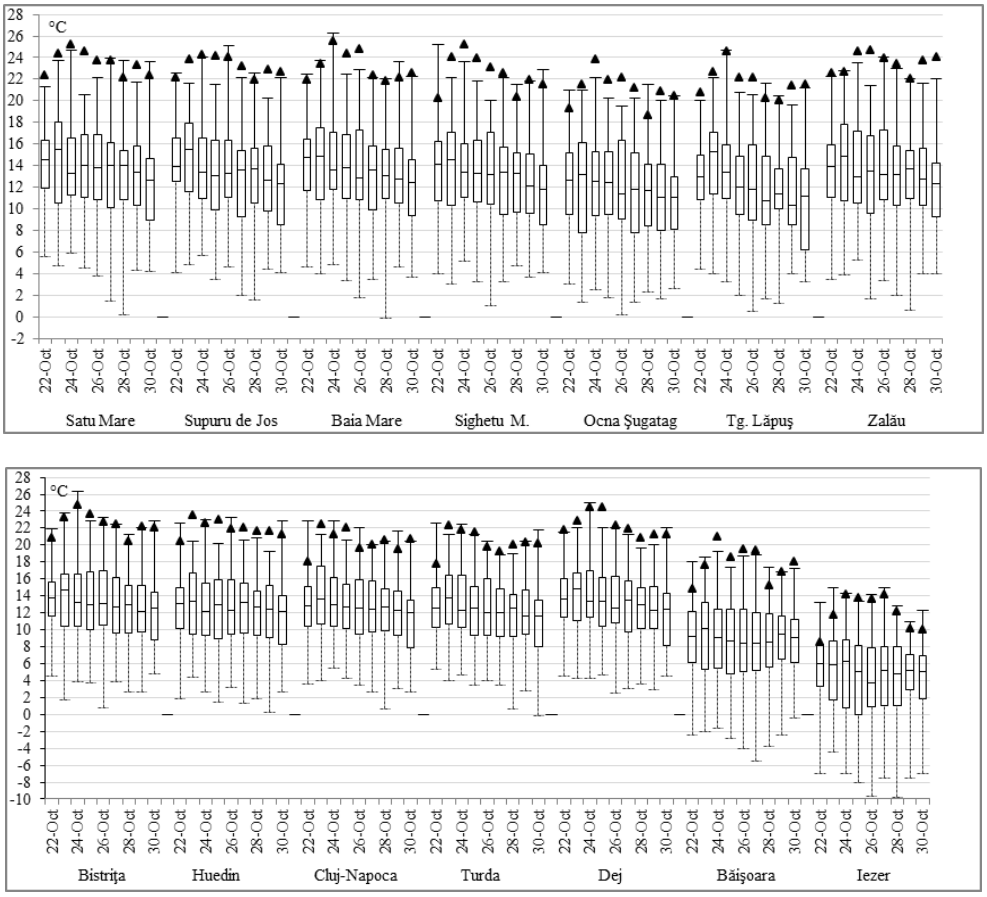


Fig. 5. Variation of daily maximum temperature in the period 22-30 October 2013(▲) as against the maximum thermal values of 22-30 October period recorded at the meteorological stations before 2013

The last decade in October 2013 was characterised by extremely warm weather, the highest daily maximum values being registered in the period 22-30 October. In the lower area of the unit they recorded values above 20°C almost every day, and the maximum reached was 25.2°C, at Sighetu Marmaţiei. The structure of the daily maximum thermal values in the period 22-30 October, as recorded before 2013 (Fig. 5), shows their median between 10 and 16°C, with the highest values registered in the plain areas (Satu Mare, Supuru de Jos), and the lowest in the depressions (Tg. Lăpuş) and mountain areas. In the lower areas, the

general limits of the first and third quartile were situated between 6 and 18°C, and the extreme values between -0.1 and 26.3°C. In the mountains the limits were between 0 and 14°C (in the case of quartiles) and between -9.8 and 19.2°C (in the case of extremes).

There were between 1-7 days in which the daily absolute maximum values of the period 22-30 October 2013 were exceeded. Their highest frequency was at the beginning and at the end of the interval, in the plains and The Maramureş Depression and, respectively, in the middle of the interval in northern Transylvania (Fig. 5). The daily deviations of the maximum temperatures from the absolute maximum values of the period were between 0.1 and 4°C, with the highest ones in the north-western part of the region (4°C at Satu Mare, 3.3°C at Zalău, 3.1°C at Sighetu Marmaţiei).

For a complete analysis of the temperatures in the two intervals of October 2013, they were studied from a synoptic point of view, in order to understand if in any of the years of the period 1961-2012 there existed cooling/warming intervals, and also to identify their synoptic characteristics. The conclusion was that, in the first decade of October, cold waves were also recorded in the years 1964, 1971, 1972, 1979, 1986, 1987 and 2010, when the daily minimum temperature registered negative values, and often even records. The analysis of the intensity and duration of the cooling process revealed the fact that, after 2013, the year 1979 registered the second lowest temperatures, followed by 1972.

From a synoptic perspective, in the above mentioned situations, there was identified an anticyclonic structure at gound level, generated by the ridge of The Scandinavian Anticyclone or a mobile nucleus of it, situated to the west, north-west or north of Romania. The altitude structure was characterised by the presence of a ridge above Central Europe, often extended to the north of the continent, associated in its anterior part with a trough structure situated over the eastern part of Europe.

Concerning the last decade of October 2013, the analysis of the similar periods in the interval 1961-2012 reveals the fact that high maximum thermal values were also registered in 1961, 1967, 1982, 1989, 2004 and 2006. Both from the duration and the intensity of the warming process, the year 2013 is followed by 1989 (esp. in the plain, hilly and mountainous areas of the unit), then by the years 1982 (esp. in depressions and valley corridors), 2004 and 2006.

From the synoptic point of view, in the analysed situations, the altitude structure of the atmosphere was characterised by the existence of a geopotential ridge above Central or South-Eastern Europe, facilitating a warm air transport from north Africa, while western Europe was under the influence of an altitude trough. At ground level, it was identified an anticyclonic field coming from the extension of the the Azorean Anticyclone ridge, or of one of its mobile nuclei. We observed that the intensification of the warming process was produced when the anticyclonic nucleus at ground level was positioned above eastern Europe, Romania being situated in its posterior part. Besides, the anticyclones present in the south-east of Europe determined the longest periods with high maximum temperatures.

4. CONCLUSIONS

The synoptic conditions which favoured the appearance of extreme daily temperatures in the first and last decades of October 2013 were, at ground level, the presence of an anticyclonic field, associated in altitude with a geopotential ridge or a trough structure, enabling the warm, respectively, cold air advections.

In the case of cold waves, at ground level an anticyclonic nucleus was present to the west, north-west or north of Romania, associated in altitude with a trough over the eastern part of the continent.

The heat waves are produces when, at ground level, an anticyclonic field is present to the east of Romania, associated in altitude with a thermal and geopotential ridge over Central Europe.

We also observed that the length of the warm waves was dependent on the duration of the anticyclonic field in south-eastern Europe. The intensity of these waves is influenced by the heating degree of the inferior atmospheric layers.

The intensity of the cold waves depended on the intensity of cold air advection and the characteristics of the active surface. Thus, the lowest minimum temperatures are registered in the depressions and valley corridors.

Statistically speaking, the cold wave frequency in the first decade of October, generating absolute minimum temperatures, was higher before 2000, while the warm waves, produced in the last decade of October, were more frequent after 1980.

The results of this study are important to the current forecasting of daily minimum and maximum temperatures.

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