THERMAL ANOMALYES IN THE ÎNTORSURA BUZĂULUI DEPRESSION GENERATED BY ABSOLUTE EXTREMES

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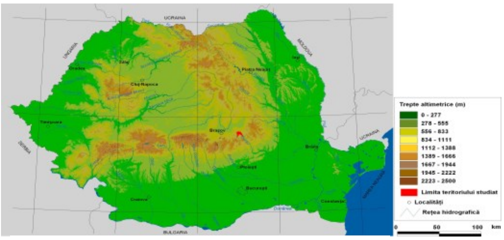
Abstract. Thermal anomalyes in the Întorsura Buzăului Depression generated by absolute extremes. This article analyzes the characteristics of climatic elements and risk phenomena in the Întorsura Buzăului Depression (707 m altitude), based on the data from the 1961-2010 period obtained from the instrumental and visual observations performed at the meteorological stations in the region, and not only.

Keywords: thermal hazard, Întorsura Buzăului Depression, absolute extremes

1. INTRODUCTION.

The Întorsura Buzăului Depression, with all the geographic features it presents, features that highlight both the geological and geomorphological elements, but especially the hydrographic ones, has been rather poorly studied from the climatic point of view compared to other intra-Carpathian depression areas.

Bearing in mind that in the last few years we have witnessed a broad global warming process - as is clear from the IPCC IV Report (2007) - a process that causes a number of extreme climatic phenomena, it was considered that one of the most important climatic parameters that mainly target the thermal hazards/risks, is the temperature.



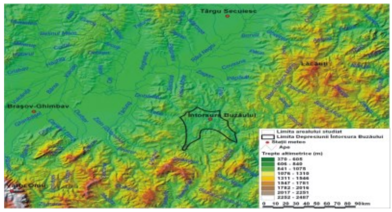


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Fig.1. The geographic position of the Întorsura Buzăului Depression within the country (A) and the mountain frame (B)

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"Ţara Buzaielor", as it is called, is distinguished from a climatic point of view due to its geographic position, but also the presence of the nearby surrounding mountain frame, giving it the appearance of a fortified citadel, as a transitional area from oceanic influences in the west and northwest, to continental influences from the east and southeast, to which are added the local climatic characteristics (Figure 2).

The shape and position of the Întorsura Buzăului Depression favors the appearence of strong temperature inversions during the winter and a very high frequency of minimum temperatures below -15 ... -20 ° C (Elena Mihai, 1984).

In addition to the geographic location, an equally important role lies in the active underlying surface by all its particularities (and especially its albedo), which is the second genetic factor of the climate.

2. DATA AND METHODS USED

The methods used were both classical and modern and consisted of selecting the closest meteorological stations that allowed comparisons and data processing using modern computing techniques following the intended purpose. Extreme temperatures are influenced by configuration of the relief, being dependent on altitude and air circulation. The most intense cooling and heating occur in the low depressions due to concave relief forms that cause discontinuity of relief and, implicitly, topo-climatic characteristics.

3. RESULTS AND DISCUTIONS

3.1. Thermal characteristics of the region

In the Intorsura Buzaului Depression, as in all intra-Carpathian depressions, the distribution of air temperature is closely related to the vertical thermal gradient.

As shown in Figure 2, the altitude variation of the average annual temperature highlights the following:

- The isothermal line has a concentric arrangement in the mountain area, as well as in the depression areas (Figure 2);
- Temperatures below 6°C are specific to the mountainous area (1,4°C at Lăcăuţi, respectively -2,4°C at Omu Peak), and the depression areas have higher values (6,3°C in the Întorsura Buzăului Depression; 7,1°C and 7,7°C in the Braşov Depression), from which it can be seen that they manifest themselves as areas of topoclimatic discontinuity (Bogdan, Niculescu, 1987) depending on geographic location and altitude (Figure 2);

- The value of vertical temperatures varies depending on the presence of valleys and depressions;
- Within the depression areas cold air leaks on the slopes facilitate the formation of thermal inversions.

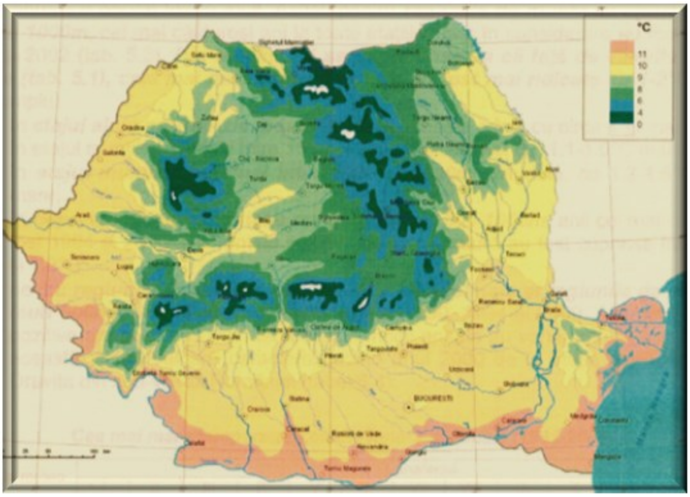

Fig.2. Territorial distribution of annual average temperature
(after Clima României, 2008, p.135)

An important role is played by the orographic barrier of the mountains, which through displacement and altitude allow the movement of air to and from the depression. Compared to other regions located at the same latitude (45°43'N), but at different altitudes with specific physical-geographic characteristics, the Întorsura Buzăului Depression, like all intracarpic depression areas, is covered by a "carpet" of air colder and wetter for most of the year, which leads to the formation of lower or near average annual temperatures in the country, highlighting the presence of temperature inversions.

3.2. The variation in monthly average temperatures during the year

In the Întorsura Buzăului Depression, as in all intra-Carpathian depressions, the temperature distribution is closely interdependent with the vertical thermal gradient, the general air circulation, the main components of the radiation balance, as well as the characteristics of the underlying active surface.

Air temperature may vary over a year from one month to another, reaching *a maximum in July or August* and *a minimum in January or February*. Therefore, depending on the vertical thermal gradient at altitudes above 2500 m, the maximum annual value is recorded *in August* in the mountainous area and at heights less than 1000-1800 m *in July*, as in the intramontane depressions.

The annual thermal minimum is recorded *in January*, except for the mountain areas where it can be recored *in February* (Figure 3).

Figure 3 shows that during the year, the temperature has an ascending trend until July, after which a descending trend appears from August to January.

The time interval with positive monthly temperatures increases with the altitude reduction, from 7 months in mountain regions to 9 months in inclosed depressionary spaces (Figure 3). In case of negative monthly temperatures, appears an increasing trend with the altitude from 3 months in the depressions to 5 months on the neighboring massifs.

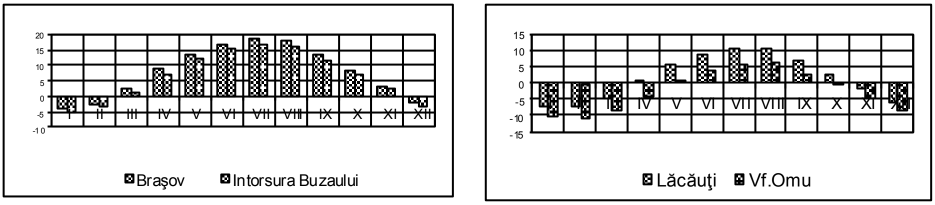

Fig.3. The variation in annual average temperatures

It is worth mentioning that there are numerous variations in the air temperature in the cold range of the year. It is noted that the alternation of negative and positive temperatures even on the mountain slopes at different altitudes, especially in the subalpine and alpine areas, which generates an alternation of the frost - freezing process causes phenomena of gelling and gelling. These weaken the cohesion of the soil and determine its fragility and destabilization (*M. Cosconea*, 2011).

3.3. The smallest and largest monthly averages and their deviations.

3.3.1. The lowest monthly air temperature averages

The negative values recorded during November - March in the depression areas and from October to April in the mountainous area near Lăcăuţi (below 1800 m altitude), as well as from September to May at the Omu Peak at over 2500 m altitude, were extracted of the series of observations made during the 50 year interval (1961-2010).

The coldest years were: 1963, 1964 and 1985, when cold polar waves occurred, which generated low average temperatures. Thus, during the mentioned periods, the lowest values of this parameter were achieved in January in the depression areas, being < -10°C (-10.3°C/1985 at the Brasov meteorological station and -11.2°C/1963, 1985 at Întorsura Buzăului) and in February in the mountainous area, being < -14°C (-14.8°C/1985 at Lăcăuţi and -18.2°C / 1985 at the Omu Peak).

The consequence of these vertical values is the gradual decrease of these values at the same time as the increase of the altitude.

In April - October, in the depressions, the lowest average monthly temperatures have positive values in seven consecutive months of the year and are increasing as the heating process increases during the day or year (Figure 4).

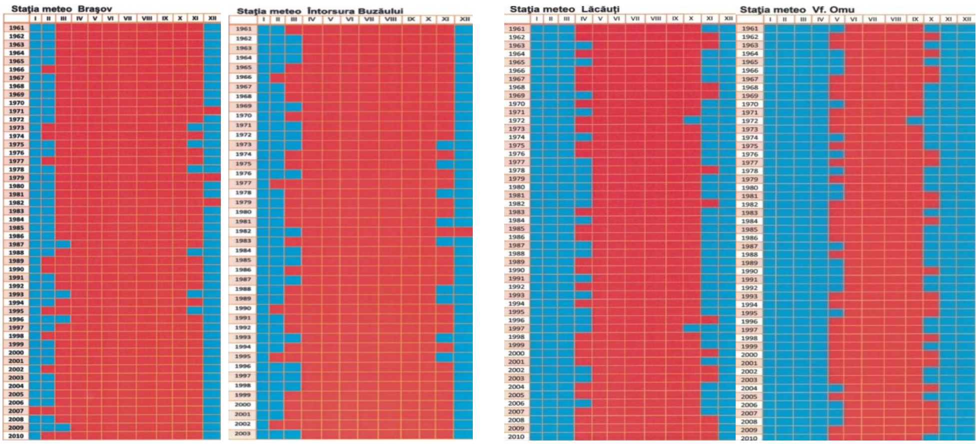

Fig.4. The duration of the hot / cold range at the weather stations in the depression and mountain range

The highest values of these parameters were achieved in July, decreasing vertically in parallel with the increase in altitude (7.5°C/1979 at Lăcăuţi and 3.3°C/1984 at Omu Peak).

3.3.2. The highest monthly air temperature averages

On the opposite side are the highest average monthly temperatures. These were positive during all months of the year, in the depression area, while in the mountainous area, only in eight months at altitudes below 1800 m and in 6 months at over 2500 m altitude (Figure 5, 6).

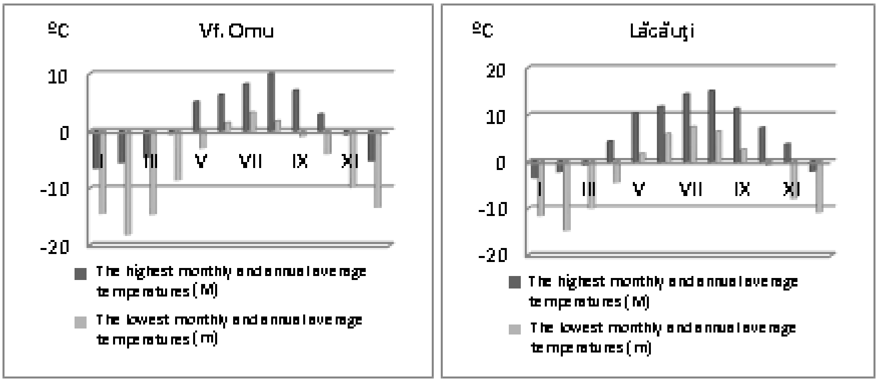

Fig.5. The highest (M) and the lowest (m) average monthly temperatures in the mountainous area (1500-2500 m)

The lowest values of this parameter extracted from the monthly statistical series during the 50 years (1961-2010) occurred during the winter months, being positive in the depression and negative in the neighbouring mountainous area.

Interestingly, ***in the depression*** areas the highest monthly average values had the lowest values ***in December*** and not in the coldest month of January, as expected: +1.2°C/1982 at Braşov and +0.2°C/1982 at Întorsura Buzăului, this being the smallest of the three intra-mountain depressions (Figure 7).

In ascending order, ***Januar***y: +1.6ºC/2007 at Brasov and +0.8ºC/2007 at Întorsura Buzăului, which is also the lowest.

The highest January monthly averages occurred both in the Întorsura Buzăului Depression and in the other two depressions that were compared in the winter of 2007, considered at that time to be the warmest in the history of meteorological measurements.

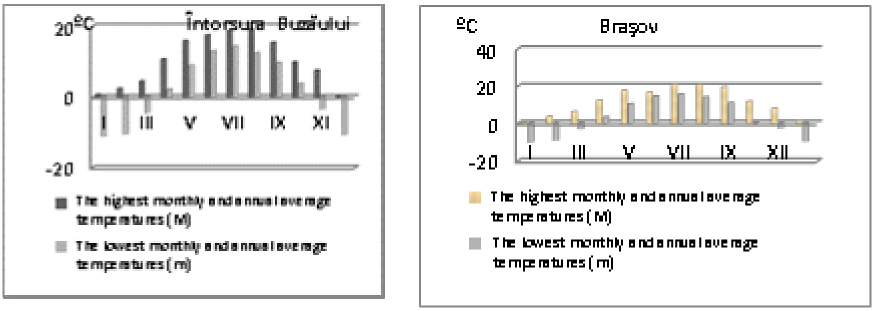

Fig.6. The highest (M) and the lowest (m) average monthly temperatures in the depression area (500-1000 m)

In the high mountain regions, the highest monthly average temperatures recorded the lowest values in January, opposite to the depression areas, as follows: -3.5°C/1971 at Lăcăuţi in January, compared to -2.1°C/2000 in December, respectively -6.6ºC/1997 at Omu Peak in January compared to -5.3ºC/2000 in December.

During the year, the highest monthly averages show the highest values in July only in the Brașov Depression (21.0ºC/2007) and *in August* at all the other stations (+ 19.4°C at Întorsura Buzăului; + 15.1ºC at Lăcăuți, + 10.0°C at Omu Peak). All values belong to 2010.

It is also noteworthy that the highest monthly averages in the first two depression areas appeared in the summer of 2007, the hottest in the history of meteorological observations in Romania when there were heat waves that generated heat in most regions of the country, and Calafat reached the highest temperature, the record of July, 44.3ºC/5.07.2007, only 0.2ºC lower than the absolute thermal record of the country registered at Ion Sion Farm Braila County, 44.5ºC/10.08.1951.It is also noted that in the neighboring mountainous area, as well as in the Întorsura Buzăului Depression, the highest average monthly temperatures were reached in August 2010, one of the 14 warmest years at that time in the history of meteorological observations at the level global, not only regional.The highest monthly average temperatures occurred in the years 2000, 2002, 2003, 2007, 2009 2010, in the 14 years of the warmest globally, in the history of meteorological observations

. **3.4.1 Absolute minimum monthly temperatures**

The lowest minimum temperature recorded in the Întorsura Buzăului Depression was -35.8 ºC / 08.02.2005, representing the record for the whole area analyzed. A near value was recorded at the Omu Peak, at -35.5ºC/20.02.1985. Lower values of -30.0°C were also recorded in Brasov, -32.3ºC/14.02.1985. Only in Lăcăuţi, the absolute minimum for the period considered was of ...-28.7°C/17.01.1963.

At most stations, absolute minimum values were recorded during two massive cooling phases, namely, 18-25 January 1963 and 14-15 January 1985 respectively.In the Întorsura Buzăului Depression, the absolute minimum varied between ... -35.5°C in the air, and... -41°C on the ground. Very close to this was in 2010 when it dropped to -34.0°C. The lowest temperature was recorded in the depression on February 8, 2005, and reached the value of -35.8°C.

On the geopotential map (Figure 7-a) it is noted that this excessive frost was generated by the advent of cold air masses in the north and northeast of the continent. Cold air has covered the northern, eastern and southeast parts of Europe.

In the Întorsura Buzăului Depression, the great amount of snow that caused the cooling of the active surface contributed to this cooling. In addition to these factors, the action of a high atmospheric pressure field has also played an important role, which has led to strong refinements, which favored and amplified the processes of night radiation and the production of ice deposits. All these have contributed to lower temperatures below -30.0°C (Figure 7-b).

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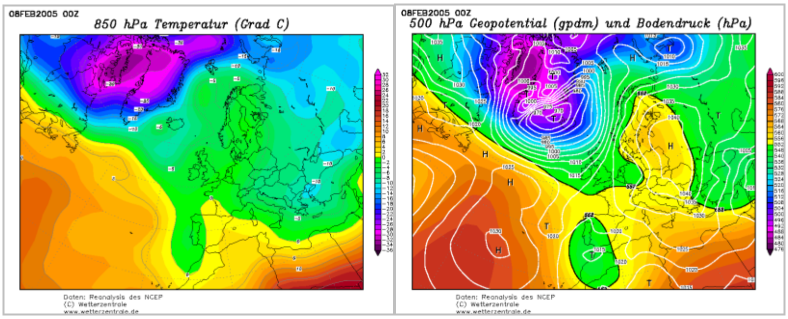

Fig.7. Geopotential map at Europe level (08.02.2005) (a) and aground temperature (b)

Flat plateau of the Întorsura Buzăului Depression, where cold air encounters favorable conditions of stagnation and continuous cooling installation, can rightfully be defined as the "Little Siberia" of the country.

By calculating the absolute minimum temperature in the Întorsura Buzăului Depression, it is noted that the highest frequency is between -30,1°C ... -35,0°C in the 1980-2010 period, followed by the values between. 20.0°C and 30.0°C. Throughout 2005, the absolute minimum temperature was January (42%), followed by February (32%) and December (26%) respectively.

In such cases of frost, many road accidents as well as the population (fractures of the lower and upper limbs, airway cooling, bronchial asthma, frostbite, etc., which the population suffers) occur.

3.5. Absolute maximum monthly temperatures

As with absolute minimum temperatures over periods and absolute maximum temperatures, they are unique values for each station and for the observation period taken into account.

The general trend of variation with the altitude of these temperatures is still a reduction. An exception is the Intorsura Buzaului station (35.8ºC / 24.07.2007) which is higher than that from Brasov 30.0ºC (8.07.1988) due to the topoclimatic shelter in the first case.

The maximum absolute temperature during the period was achieved in the Întorsura Buzăului Depression, at 707 m altitude at 35,8ºC/24.07.2007, and the lowest at the Omu Peak, at the highest heights, over 2500 m, of 22, 1ºC/14.07.1984. These absolute values for the period were made after 1980 when the heating process began to feel better.

Two of these values occurred in July 1987, namely: 30.0ºC/6.07.1988 in Brasov and 27.2ºC on 6.07.1988 at Lãcauti; one in 2007 at the Intorsura Buzaului, 35.6ºC/24.07.1998 and one in 2007 at Omu Peak 22.1ºC/14.08.1984. These values have been generated by tropical warm air waves that have led to similar values in southern and eastern extra-Carpathian areas, accompanied by heat, dryness and drought phenomena.

It is worth noting that the highest maximum absolute temperature per period was made at the Intorsura Buzaului, at 35.6°C/24.07.2007. In the study area, this year was the warmest of the history of meteorological observations in Romania for this station.

The synoptic situation that triggered this warming was due to the advection of a tropical-continental air mass from North Africa across the southeastern part of Europe (Figure 8-a). Across the southern part of Oltenia, at 850 hPa at about 1500 m altitude, the isotherm of 24°C was placed, and to the south of the Danube, the 25°C.

On 24.07.2007, between 16 and 18 o'clock (OVR), the maximum heating phase was reached, when many of the recorded temperatures became the absolute thermal maxims of July for Romania. The peak of the maximum phase occurred at 18 UTC, when the heat wave was characterized by temperatures ≥ 30°C, unprecedented until that time, at an altitude of 850 hPa, 1500 m altitude (Figure 8 b).The figure quoted shows the cold front from Western Europe to Romania, which led to the dislocation of hot air and its compression, accentuating the heating process. As a result, the Temperature - Moisture Index (ITU) reached values of over 80 units in the Depression of Buzău Intorsura, as well as in the other depressions and even in the mountain area (Bogdan et al., 2011).

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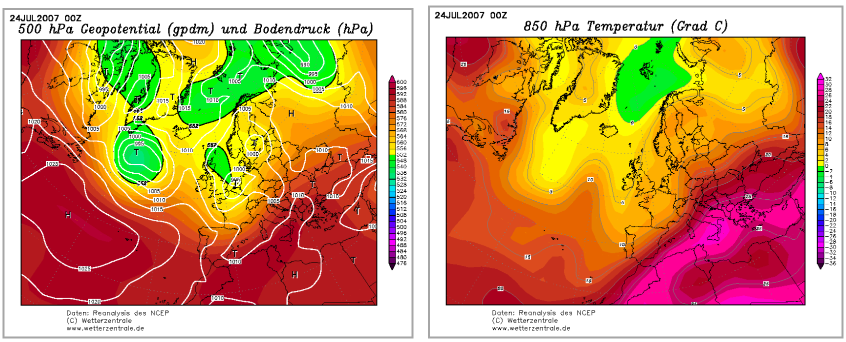

Fig. 8. The synoptic situation that characterized excessive heating on 24 July 2007

If we make a comparison between the absolute maximum temperature over a period recorded at the Omu Peak before 1980 which was 20.4ºC/15.08.1954, with that recorded after this year, respectively 22.1ºC/14.07.1984, it is notes that the latter was higher by +2.3°C.

The same conclusion results from the comparison of the respective values in Braşov: 37,1ºC/20.8.1946 compared to 37,3ºC/5.07.2000, which results in a positive difference of 0,2ºC, which also highlights the this way the warmest years of the second period after 1980, namely, 1984 and 2000, even though in those years the heat did not feel as good on the entire air column, from the lowest altitude, Braşov, to the largest, Omu. This does not mean that the respective years were not warm at the other stations, but these values have been exceeded over other years.

The two stations, Braşov and Omu, with long lines of observations that allowed this comparison, reflect the warming of the climate that has occurred, especially since 1980 and especially since 2000. It is still a definite proof of this phenomenon.

In support of this conclusion come the absolute minimum temperatures during the observation period we discussed in the previous paragraph, which were higher after 1980 compared to the previous year's when it was lower, but also the absolute minimum monthly temperatures that recorded the smallest values before this annual threshold (1980).

In these years, the highest heat temperatures experienced the heat of the entire geographic landscape through the high drought produced, as well as agglomeration and the entire national economy. There have also been numerous illnesses and deaths in the animal world and even on the population.

As a general conclusion, we note that the highest and lowest average monthly and annual average temperatures, and especially absolute (maximum and minimum) temperatures, are the most important thermal risks. Their highest intensity is the extreme extreme temperatures that can cause risk situations, both in heat and in severe frosts.

We also note that these two pairs of parameters represent the range of variations in thermal risks during the year, especially in the case of the latter, where a managerial plan of measures at the local level is needed to prevent and diminishing the negative effects produced.

At the same time, we note the fact that such thermal risks are dependent on climate warming, according to the IPSS V Report (2005), which emphasizes that such phenomena will become more frequent and intense in relation to global warming. In such situations management plans should also include conclusions on the adaptation of the population as well as of crops to these climatic conditions. It is supposed that these intramontane depressions themselves will perceive this heating as I pointed out throughout the paper.

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