THE COOLING BIOCLIMATIC INDEX IN OLTENIA AND THE THERMAL RISK AT LOW TEMPERATURES DURING THE COLD SEASON

MARINICĂ Ion, CHIMIŞLIU Cornelia, MARINICĂ Andreea Floriana

Abstract. The present paper analyses the significant cooling situations within Oltenia on the basis of the data registered in the winter 2009-2010 compared to the winters 2002-2003, 1941-1942, 1962-1963, and 1893-1894, in correlation with the situation at the level of Romania and worldwide. It was noticed that the frequency of the exceptional minimum values of temperature during winter was one at 50 years. The phenomena related to climate warming were strongly felt in Oltenia in the last half of the century, but, however, cold winters and the climatic risk generated by them are quite actual even in this part of the country.

Keywords: The CI bioclimatic index, thermal risk, absolute minimum temperatures, Oltenia.

Rezumat. Indicele bioclimatic de răcire în Oltenia şi riscul termic la temperaturi scăzute în sezonul rece. În lucrare sunt analizate situaţiile de răcire semnificative în Oltenia pe baza datelelor înregistrate în iarna 2009-2010, comparativ cu datele din iernile: 2002-2003, 1941-1942, 1962-1963 şi 1893-1894, în corelaţie cu situaţia la nivelul României şi pe plan global. S-a observat că frecvenţa valorilor minime excepţionale de temperatură în anotimpul de iarnă a fost de circa un la 50 ani. Fenomenele legate de încălzirea climatică s-au făcut resimţite puternic în Oltenia în ultima jumătate de secol, dar cu toate acestea iernile reci ca şi riscul climatic generat de acestea rămân actuale şi în această parte a ţării.

Cuvinte cheie: indicele bioclimatic de răcire, risc termic, temperaturi minime absolute, Oltenia.

INTRODUCTION

The climate of a region is an important ecological factor for social life, for providing those resources necessary for life, agricultural and industrial production.

The evaluation of the climatic conditions of a region is achieved through the study of the climatic parameters and their limits of variation, using certain climatic and bioclimatic indices, meant to support, as accurately as possible, the appreciation of the conditions necessary for certain types of human activities: tourism, balneary activities, agricultural production etc.

Out of the multitude of indices we shall analyse the **Cooling Index** (CI), which expresses the degree of thermal comfort through the combined action of air temperature and wind on the caloric balance of human organism.

Since this index is used by The National Meteorological Administration (NMA) in the cold season to draw the attention of the population on the risks of low temperatures on the territory of Romania, we considered necessary to offer more data about it.

In order to evaluate the thermal risk at low temperatures in Oltenia, we shall analyse the significant cooling situations in Oltenia, using data recorded in the winter of 2009-2010 compared with the data from the winters of years 2002-2003, 1941-1942, 1962-1963, and 1893-1894 analyzed in correlation with the situation at the level of Romania and worldwide.

MATERIAL AND METHODS

The **c**ooling index represents a measure of temperature experienced by the human body, which depends on air temperature and wind speed. The mathematical formula of this index was designed starting from the analysis of the mode in which, in situations of low temperatures and intense wind, the protective, thermal layer existing around the human body is destroyed. Thus, the body temperature decreases rapidly and the cold feeling is stronger. The methodology for calculating the CI implemented at the NMA and the regional centers is given in Table 1.

Table 1. Cooling Index calculation (CI) depending on wind speed.
Tabel 1. Calculul indicelului de răcire (IR) în funcţie de viteza vântului.

Wind speed (m/s)	Calculation formula for CI (°C)
0-1	CI=T[1]
2-3	CI=1,0335T - 2,1235
≥4	CI= 1,338931T-1,59197v + 2,29921

[1] T= Air temperature given by the thermometer installed in standard conditions at the meteorological station

RESULTS AND DISCUSSIONS

Values of the cooling index in Oltenia

Although the 2009-2010 winter was marked by large periods with snow cover, 54 days on average for the whole region and two moderate cold waves, in accordance with the general average for the whole region, it takes the second place (for the area under 600 m) after the 2002-2003 winter, which was the coldest winter in the past 11 years.

By the harshness with which it manifested itself in certain intervals of time, the big number of days with snow, blizzards, intensifications of wind and the duration of the snow cover, it was a severe winter confirming the old observation that became popular, in conformity with which "the winter that starts early is not easy".

As a result of these phenomena for severe winter, there were issued 17 meteorological warnings of yellow or orange code for blizzards, heavy snows, frost, wind intensifications and abundant rainfalls, which also included the counties of Oltenia, while for various areas across the whole country, their number reached 23. The National Institute of Hydrology and Water Management issued numerous warnings of yellow and orange code for dangerous hydrological phenomena on rivers and the Danube River as a result of the periods of rapid warming and heavy rains.

The numerous winter meteorological phenomena, as well as the large number of issued warnings, are due to some intense activity of numerous Mediterranean cyclones affecting the territory of Romania. Meteorological warnings of yellow, orange or red code were issued by almost all the countries of the continent this winter (2010) as a result of severe phenomena. The numerous meteorological phenomena of severe winter are due to the North Atlantic oscillation, which has been in negative phase this winter.

Due to the blizzard, numerous roads were closed, and in certain critical periods in some counties, the schools were closed, as well. As a result of frost, in the interval January 22-25, about 22 persons died in three days, half of them on the night of January 24/25, 2010, in the entire country (source: http://www.agentia.org/anchete/11-morti-de-la-ger-in-ultimele-24--583.html). After the winter 1995-1996, this winter registered the highest precipitation amounts.

The cold wave registered in the period of December 19-21, 2009

Since the beginning of winter, across the north and especially north-eastern part of Europe, a very cold air mass installed and circulated towards Europe by an intensive Eastern European anticyclone connected with the Russian-Siberian anticyclone north-eastward and with the Azoric one westward (Fig. 1). The presence of the cyclonic field over the Black Sea and the Mediterranean Sea in coupling with the vast anticyclonic field amplified the cold air advection towards Romania. In these conditions, on December 19, 2009 at 00 UTC, in the lower troposphere at 850 hPa, the -10°C isotherm covered more than ¾ of the country and that of -12°C extended over the entire north-western part (Fig. 2). The apogee of the cooling was reached in the morning of December 21, 2009 (Figs. 3 and 4), when at Apa Neagră, in the Subcarpathian Depression of Oltenia, there were recorded -24.2°C. Though in the altitude, the intense area of the cold wave retreated to the north of the country, in the area of the Subcarpathian Depressions, the intense nocturnal cooling air, on clear weather and in the presence of the snow cover continued, determining the occurrence of this temperature value. At the meteorological stations in the south of Oltenia, the maximum cooling intensity was recorded on December 19, when the thermal minimum recorded at Calafat was -19.8°C.

Due to the geographical position of Oltenia, benefiting from "shelters" on three sides – the Carpathian chain surrounding it to the north and west, and then the Balkans, in the south, in such situations, usually, the wind does not increase and so the values of the CI index were equal to those of air temperature (Table 1).

The cold wave registered in January 2010

In the interval between January 25 and 26, it was recorded a cold wave that covered the whole country with different intensities in different areas of Romania. In the morning of January 25, 2010 in Oltenia, there were recorded minimum monthly values at 12 meteorological stations out of 17 and on the date of 26 at 7 stations.

The initiation of the penetration of the cold wave from the north-east to our country produced on January 19 at 12 UTC, when at the level of 850 hPa a cold nucleus with temperature values below -10°C occurred over the north-eastern extreme. Then on January 22, 12 UTC, the isotherm of - 10°C covered the whole country and that of -12°C extended from the north-east of the country over the Carpathians to the east of Oltenia and west of Muntenia, and at 18 UTC in the south of the country, in the mentioned area, at this level, there were registered values of -14°C. The penetration of cold air accentuated on January 24, 2010 at 18 UTC. At this date, at the soil level, a strong anticyclone field was observed causing an anticyclonic belt formed of the Azoric, Scandinavian and East-European anticyclone united farther north-east to the Russo-Siberian Anticyclone (Fig. 5).

The monthly thermal minimum values in January oscillated between -16.7°C at Bâcleş and -23.7°C at Tg. Logreşti, and in the mountain zone between -26.0°C at the Lotru Observatory and -16.7°C at Parâng. Most monthly minimum values were recorded in the morning of January 25, 2010 and the others on the date of January 26.

There was observed a high intensity of the Greenland anticyclone with values of over 1040 mb, the center of which included almost the whole Eastern Europe and the south-east of Minor Asia and the extreme east of the Mediterranean Sea a weak depressionary vast zone with slightly values below 1010 hPa. This coupling, cyclone-anticyclone and its position (Fig. 5) is typical for situations of cooling during the cold season and it constitutes a strong 'gearing' that circulates the cold air masses from the north - east (and often east, depending on the orientation of the isohypses of the baric field and of the geopotential) to our regions and which often transports it to the south of the Balkan Peninsula and sometimes to Italy.

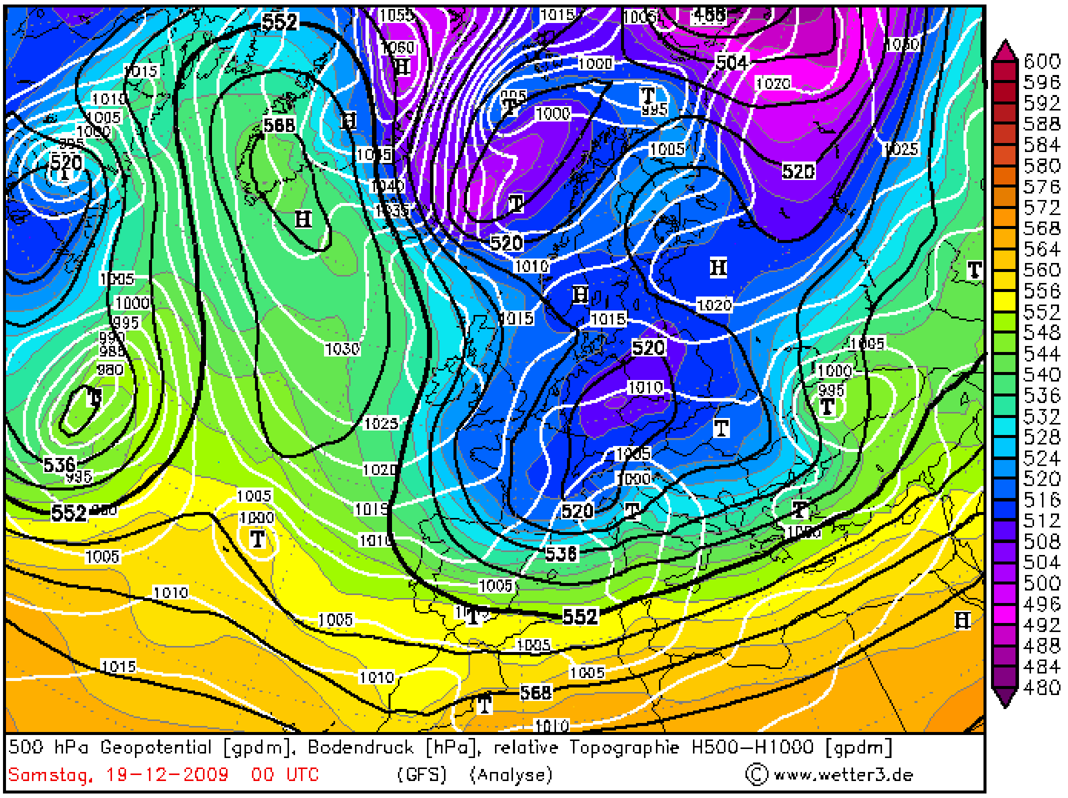

Figure 1. Synoptic situation at the soil level superposed with that in the altitude at the level of 500 hPa on December 19, 2009, at 00 UTC, at the moment of intensification and expansion of the cold wave over Romania (according to Wetterzentrale – Kartenarchiv)
Figura 1. Situaţia sinoptică la nivelul solului suprapusă cu cea din altitudine la nivelul de 500 hPa în data de 19 decembrie 2009, ora 00 UTC, la momentul intensificării şi extinderii valului de frig peste România (după Wetterzentrale - Kartenarchiv).

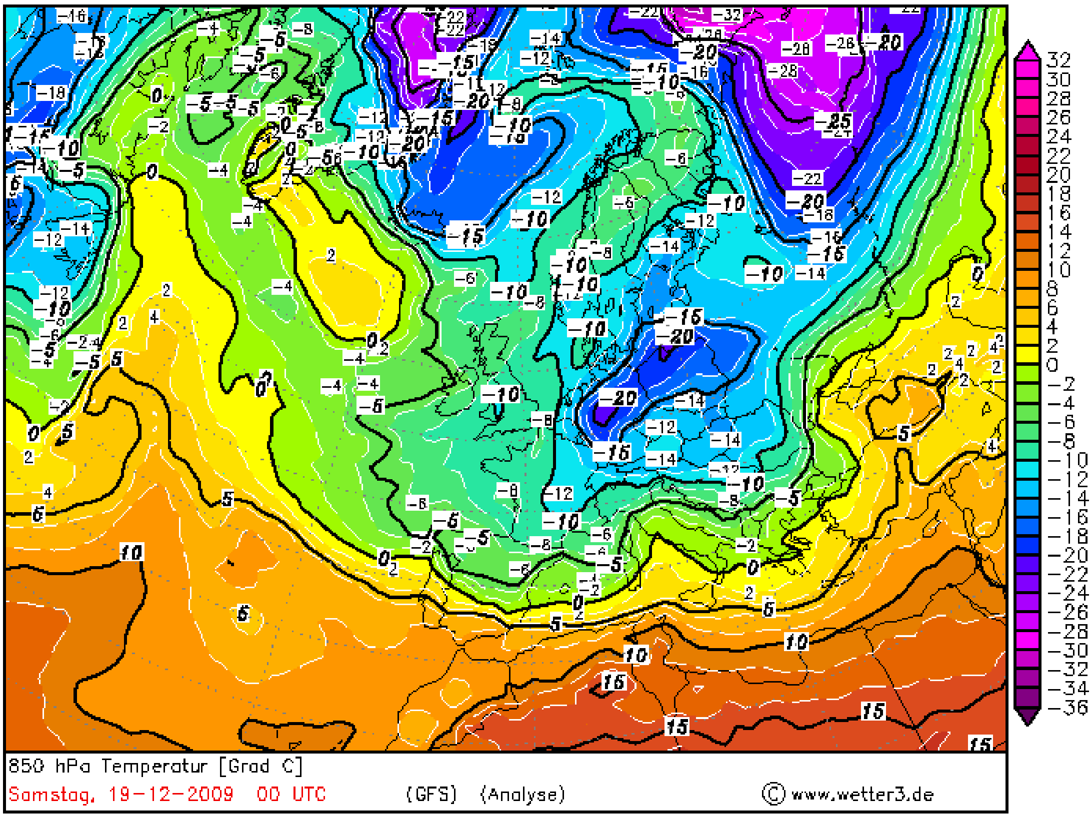

Figure 2. Thermal field at the altitude of 850 hPa on December 19, 2009, at 00 UTC, at the moment of intensification and expansion of the cold wave over Romania (according to Wetterzentrale – Kartenarchiv).
Figura 2. Câmpul termic din altitudine la nivelul de 850 hPa în data de 19 decembrie 2009, ora 00 UTC, la momentul intensificării şi extinderii valului de frig peste România (după Wetterzentrale - Kartenarchiv).

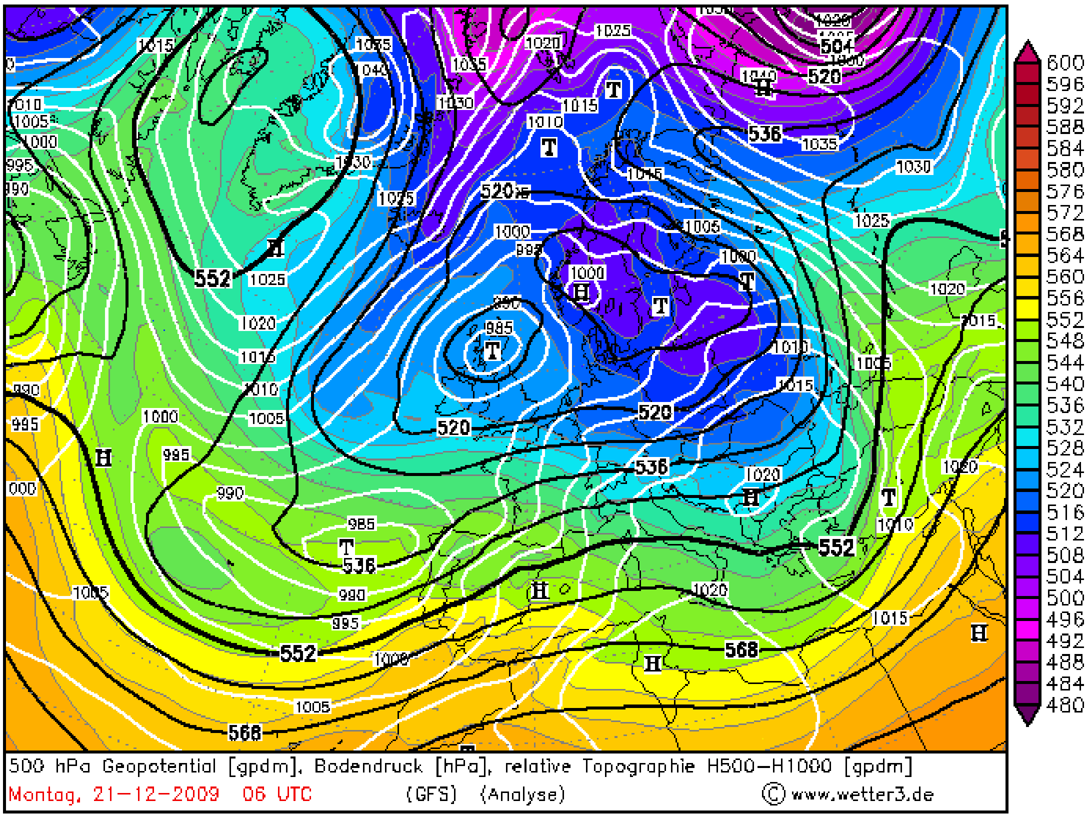

Figure 3. Synoptic situation at the soil level superposed with that in the altitude at the level of 500 hPa on December 21, 2009, at 00 UTC, at the moment of maximum intensity of the cold wave over Romania (according to Wetterzentrale – Kartenarchiv).
Figura 3. Situația sinoptică la nivelul solului suprapusă cu cea din altitudine la nivelul de 500 hPa în data de 21 decembrie 2009, ora 06 UTC, la momentul intensității maxime a valului de frig peste România (după Wetterzentrale - Kartenarchiv).

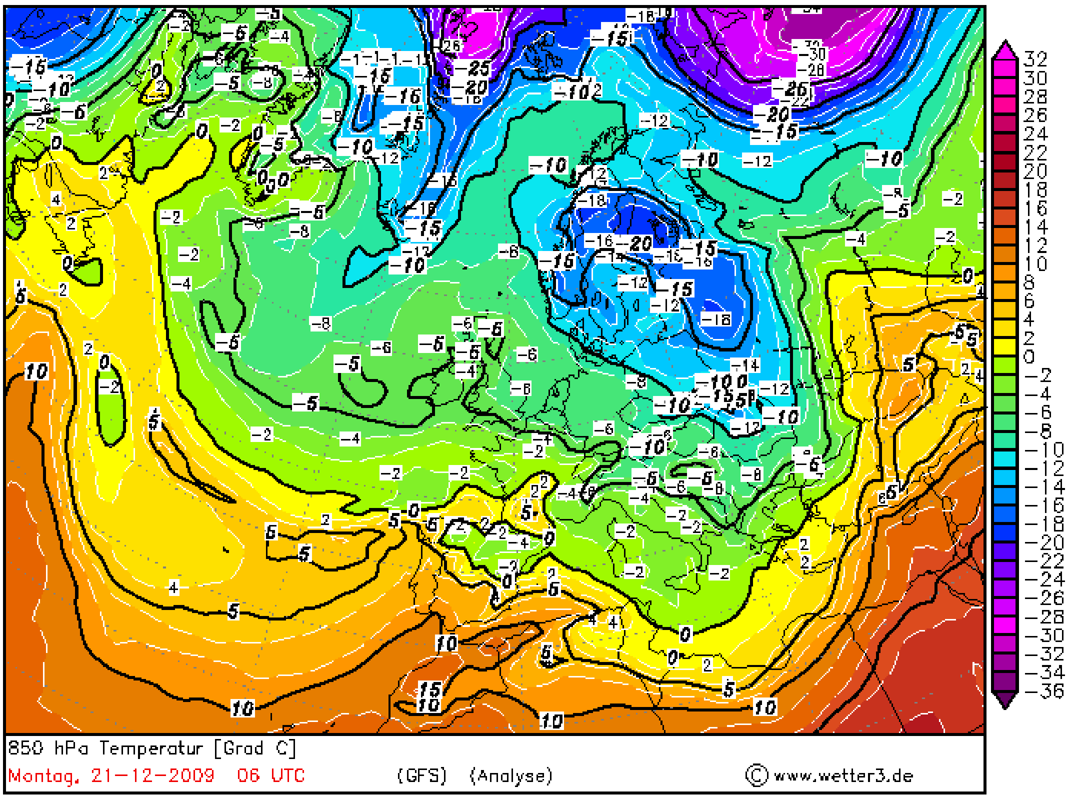

Figure 4. Thermal field at the level from the altitude at the level of 850 hPa on December 21, 2009, at 06 UTC, at the moment when at the level of 2m altitude, the intensity of the cold wave over Romania was maximum (according to Wetterzentrale - Kartenarchiv).
Figura 4. Câmpul termic din altitudine la nivelul de 850 hPa în data de 21 decembrie 2009, ora 06 UTC, la momentul când intensitatea valului de frig peste România a fost maximă (după Wetterzentrale - Kartenarchiv).

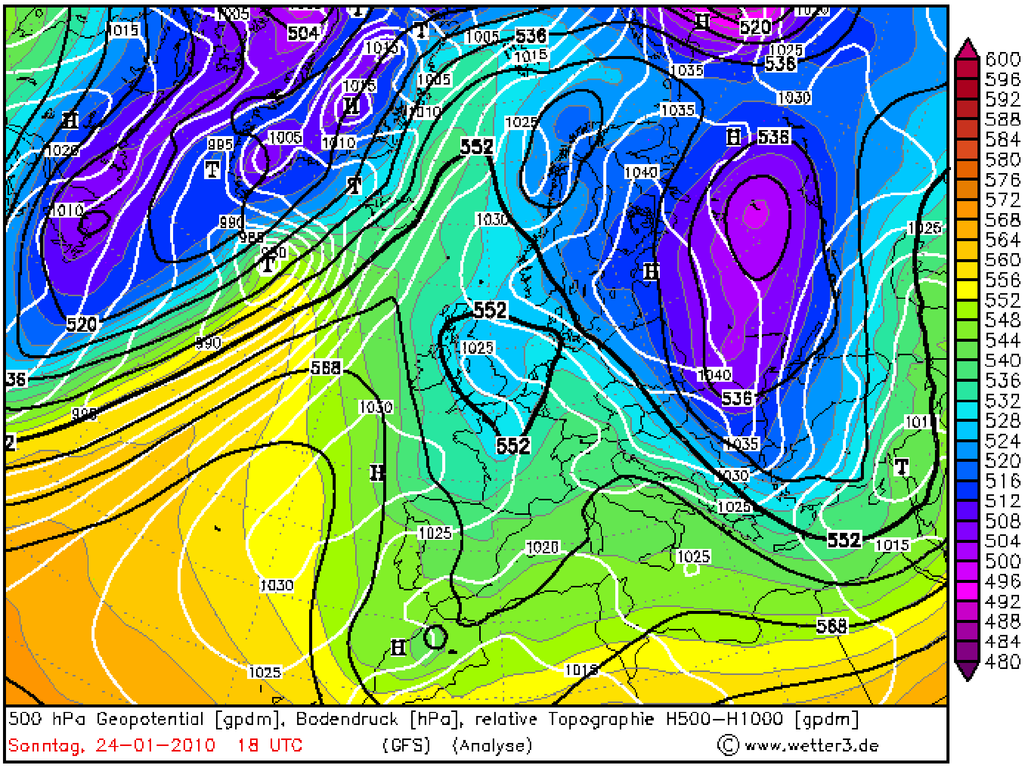

Figure 5. Synoptic situation at the soil level superposed with that from the altitude at the level of 500 hPa on January 24, 2010, at 18 UTC, at the moment of initiation of the maximum intensity of the cold wave over (according to Wetterzentrale - Kartenarchiv).
Figura 5. Situaţia sinoptică la nivelul solului suprapusă cu cea din altitudine la nivelul de 500 hPa în data de 24 ianuarie 2010, ora 18 UTC, la momentul iniţierii intensităţii maxime a valului de frig peste România (după Wetterzentrale - Kartenarchiv).

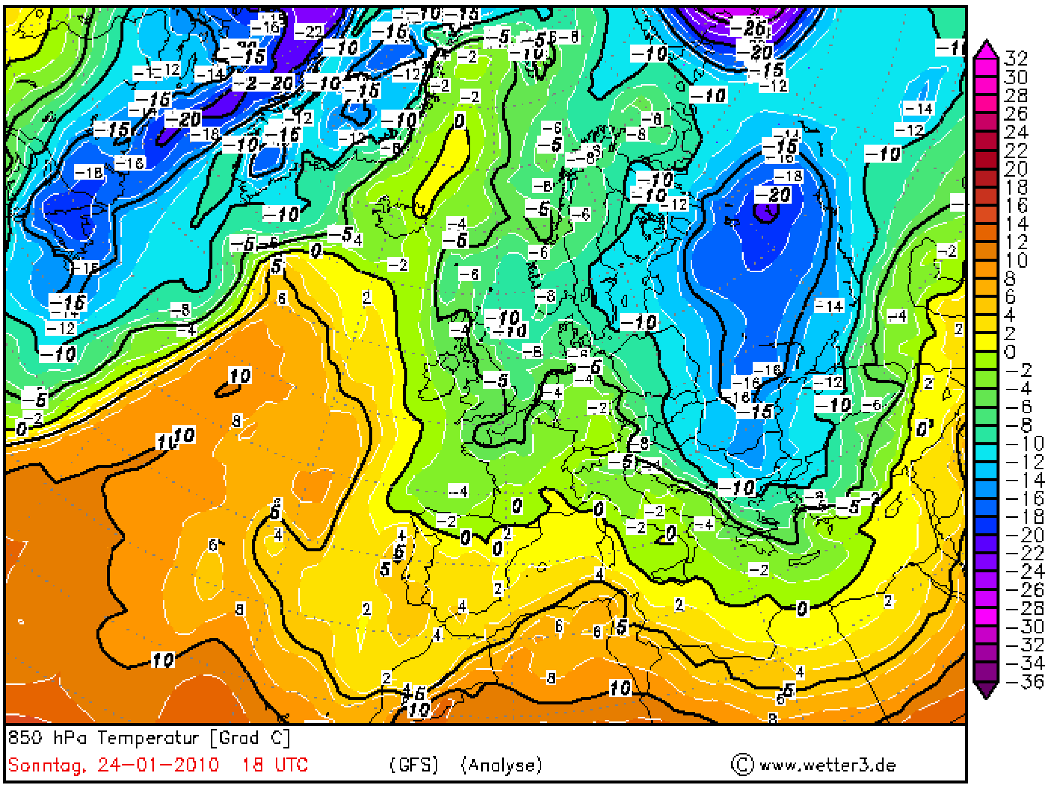

Figure 6. Thermal field at the altitude at the level of 850 hPa on January 24, 2010, 18 UTC, at the level of 2 m altitude in the moment of initiation of the maximum intensity of the cold wave over Romania (according to Wetterzentrale – Kartenarchiv).
Figura 6. Câmpul termic din altitudine la nivelul de 850 hPa în data de 24 ianuarie 2010, ora 18 UTC, în momentul iniţierii intensităţii maxime a valului de frig peste România (după Wetterzentrale - Kartenarchiv).

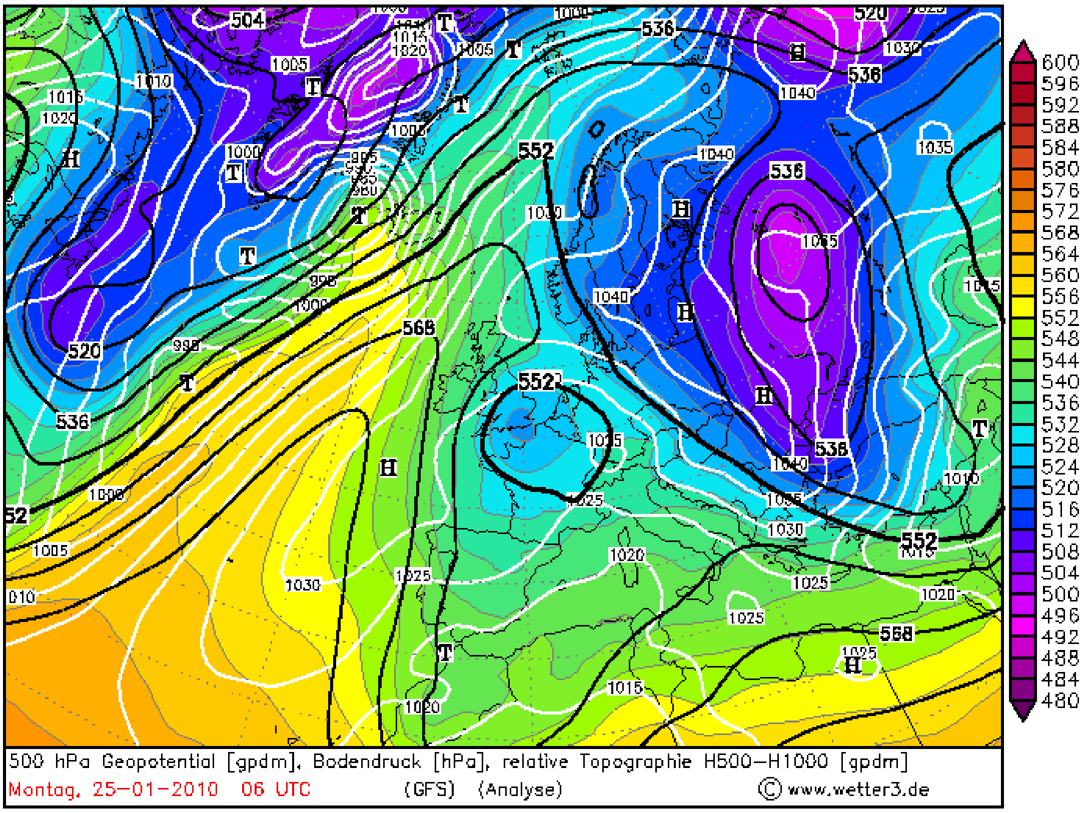

Figure 7. Synoptic situation at the soil level superposed with that from the altitude at the level of 500 hPa on January 25, 2010, at 06 UTC, in the moment of initiation of the maximum intensity of the cold wave over Romania (according to Wetterzentrale-Kartenarchiv).

Figura 7. Situația sinoptică la nivelul solului suprapusă cu cea din altitudine la nivelul de 500 hPa în data de 25 ianuarie 2010, ora 06 UTC, în momentul intensității maxime a valului de frig peste România (după Wetterzentrale - Kartenarchiv).

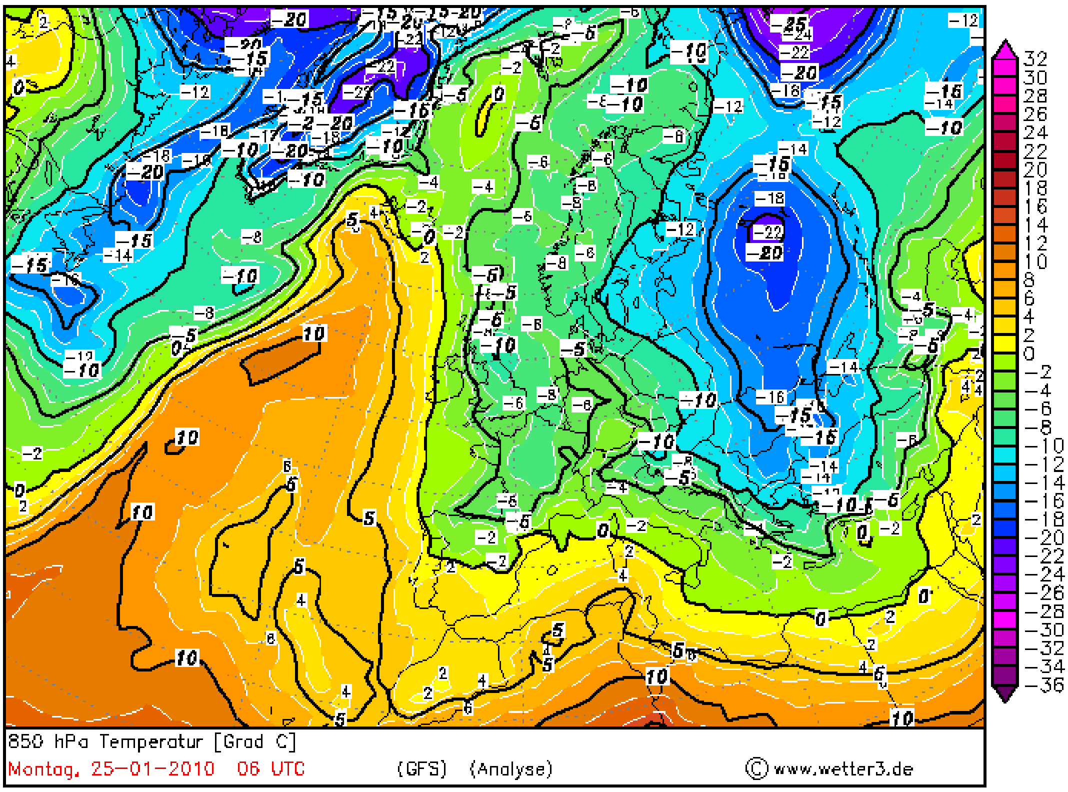

Figure 8. Thermal field at altitude at the level of 850 hPa on January 25, at 06 UTC, at the moment when at the level of 2m altitude at the moment of the maximum intensity of the cold wave over Romania (according to Wetterzentrale-Kartenarchiv).

Figura 8. Câmpul termic din altitudine la nivelul de 850 hPa în data de 25.I.2010, ora 06 UTC, la momentul intensității maxime a valului de frig peste România (după Wetterzentrale - Kartenarchiv).

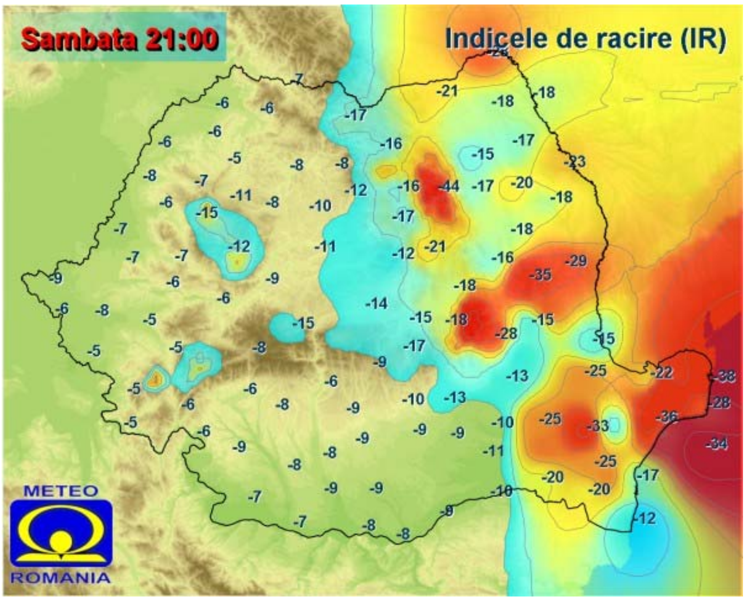

Figure 9. The map of the cooling index on January 23, 2010 at the moment of initiation of the cooling wave over Romania, at 9 p.m. winter hour of Romania. It is observed the effect of shelter for Romania (according to ANM Bucharest).
Figura 9. Harta indicelui de răcire în data de 23.I.2010 la momentul iniţierii valului de frig peste România, ora 21 OIR[2]. Se observă efectul de adăpostire pentru Oltenia (după ANM Bucureşti).

The record of low temperatures in the city of Craiova

In the month of January (2010) there were recorded the lowest temperature values not only in Romania but also at the level of the whole continent. The absolute thermal minimum of Romania is -38.5°C recorded on the night of January 24/25, 1942 at Bod in Braşov. In the same night, there were also recorded the absolute thermal minimum of -34.8°C on the dates of January 24/25, 1942, in Alexandria, the value equal to that from Roşiorii de Vede, recorded on the same date of January 25, 1942, at Târgul Mureş of -32.8°C and of -32.2°C in Bucharest. Cold nights were also recorded in January 1963, when on January 25, there was registered the absolute thermal minimum value in Craiova -35.5°C, in Timişoara -35.3°C on January 29 and in Cluj Napoca -34.2°C on January 23. We mention that the value of -35.5°C from Craiova is the lowest temperature ever recorded in the Romanian Plain and the Getic Piedmont; the absolute minimum value is only a tenth of a degree lower, namely -35.6°C at Slatina on January 15, 1894. Also in January 1963, on the date of 18, at Joseni, there was recorded -38.0 °C**.**

Due to these massive coolings from this month, in the popular calendar the month of January is also called "gerar" and the coldest period of winter, also named the peak of winter, is regularly the interval between January 15 and February 15. We still observe that although the winter solstice occurs on December 21, when the shortest day of the year is recorded and then the day begins to grow, temperature continues to drop for about a month and a half and then it begin to slowly rise.

In January 1963, in Romania, the initiation of the cold wave, considered the second wave of intense cold of the last century after that from January 1942, was registered on January 21, when the configuration of the baric field at the soil level determined a north-east type at the coupling of the Scandinavian anticyclone with a field of low pressure located on the Great Russian Plain. Although the penetration of the cold air of maximum intensity in the altitude was on January 22, 1963 when at the level of 850 hPa over the north of Romania was positioned the isotherm of -22.5°C, and at the south of the Danube that of -15°C, the maximum air cooling in Oltenia produced in the morning of January 25, 1963, when the combined effect of the advection of the cold air from the Big Russian Plain and the thermal inversions from Oltenia (which appears frequently in winter) was maximum. In Fig. 9:10 we present the structure of the baric field at soil level and the thermal field at the level of 850 hPa.

On January 25, 1963 at the level of soil a strong anticyclonic belt covered most of Europe from the Atlantic Ocean to the Great Russian Plain and it was joined on with the powerful Russian-Siberian anticyclone (Fig. 9). A weak depressionary field centered in the south-west of Asia Minor, coupled with this anticyclonic field, constituted thus a genuine mechanism for the circulation of particularly cold air to Romania. At altitude, at the level of 500 hPa (about 5,000 m altitude), a particularly cold air came from Scandinavia over Romania. Below, at the level of 850 hPa (about 1,500 m altitude), a particularly cold air nucleus with values of -15°C was positioned over most of the south of Romania. And in this case, too, Oltenia is situated in the full anticyclone field far away from the zone of coupling with the depressionary field; the speed of wind was low 0-1 m/s (little wind) and at Craiova the minimum value of CI = -35.5°C, which constituted *the absolute minimum record of this bioclimatic index for Craiova and The Romanian Plain.* In Fig. 12, we render the area occupied by a very cold air mass at Craiova on January 25, 1963 (MARINICĂ, 2006).

[2] WHR = winter hour of Romania / OIR=ora de iarnă a României.

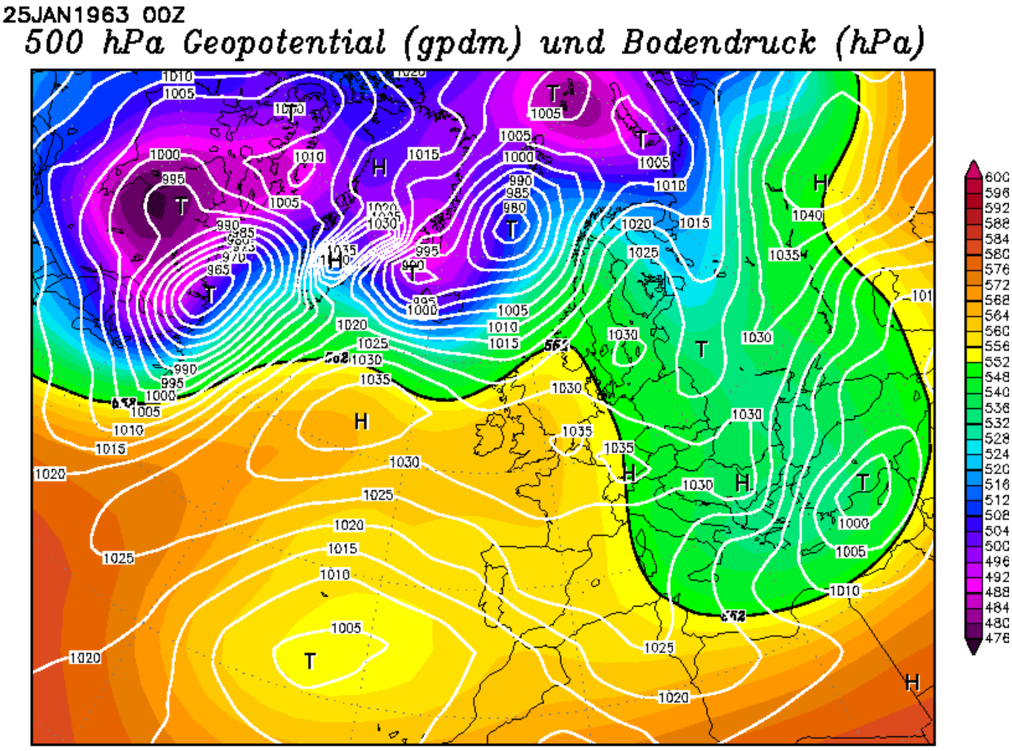

Figure 10. Synoptic situation at the level of soil superposed with that from the altitude at the level of 500 hPa on January 25, 1963, at 00 UTC, at the moment of maximum intensity of the second big cold wave over Romania from the past century (according to Wetterzentrale - Kartenarchiv).

Figura 10. Situația sinoptică la nivelul solului suprapusă cu cea din altitudine la nivelul de 500 hPa în data de 25 ianuarie 1963, ora 00 UTC, la momentul intensității maxime a celui de al doilea mare val de frig peste România din secolul trecut (după Wetterzentrale - Kartenarchiv).

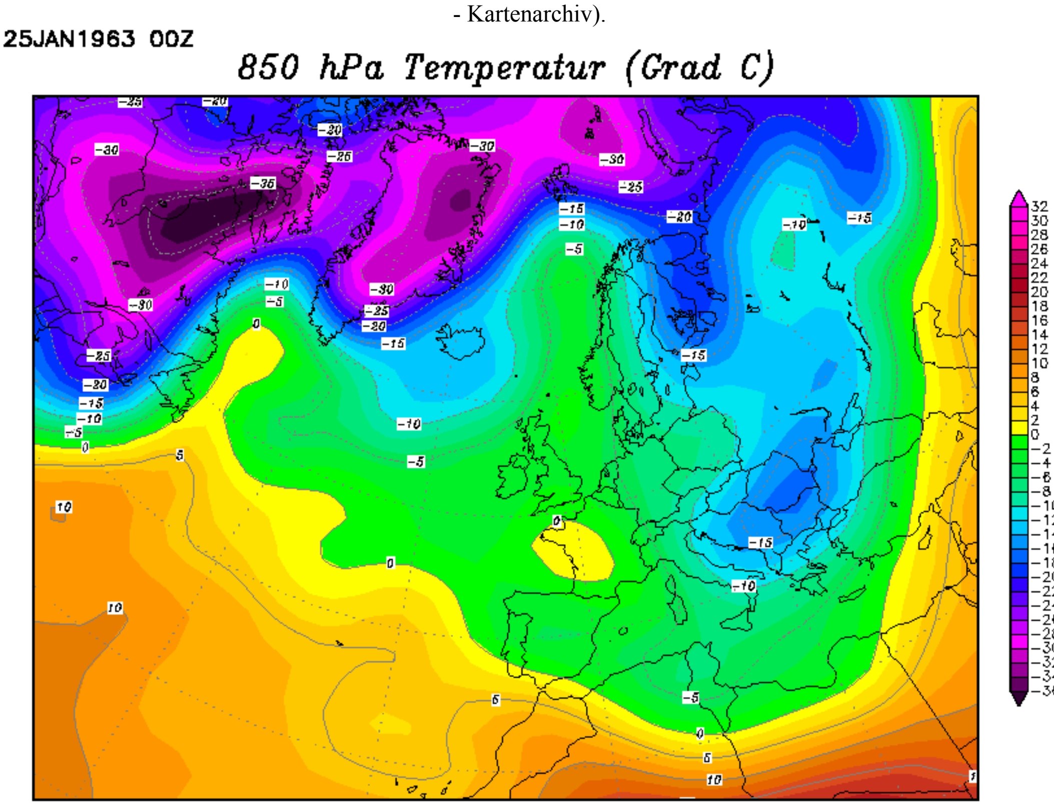

Figure 11. Thermal field at the level from the altitude of 850 hPa on January 25, 1963, at 00 UTC, at the level of 2m altitude at the moment of the maximum intensity of the second big cold wave over Romania (according to Wetterzentrale - Kartenarchiv)

Figura 11. Câmpul termic din altitudine la nivelul de 850 hPa în data de 25.I.1963, ora 00 UTC, la momentul intensității maxime al celui de-al doilea val mare de frig din secolul trecut, peste România (după Wetterzentrale - Kartenarchiv).

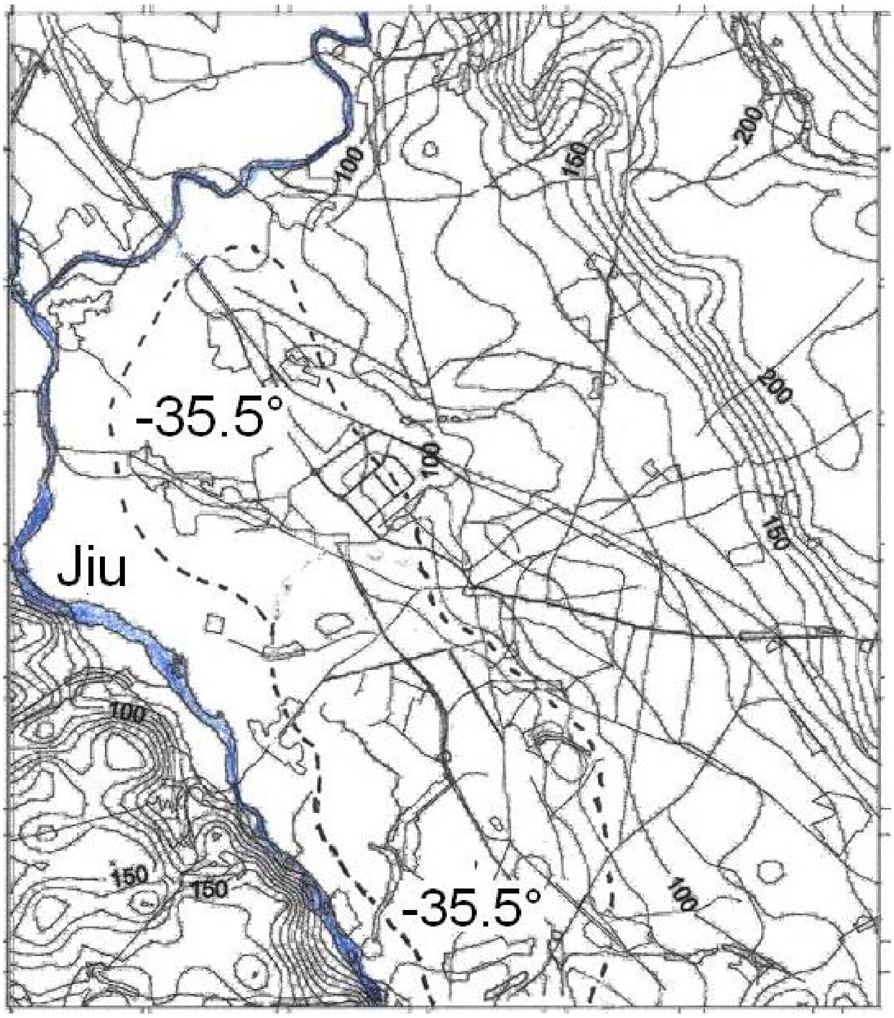

Figure 12. Contour lines for the city of Craiova (determined with the GPS system); In the central part of the map it is the central area of the city and the dotted curve represents the area in which the absolute thermal minimum was reached -35.5°C (according to MARINICĂ, 2006).
Figura 12. Curbele de nivel pentru oraşul Craiova (determinate cu sistemul GPS); În partea centrală a hărţii este arealul central al oraşului, iar curba punctată reprezintă arealul în care s-a atins minima termică absolută de -35.5°C (după Marinică, 2006).

On January 24, 25, 1963, the absolute minimum values were recorded at 9 meteorological stations functioning in Oltenia at that time, values that have not been exceeded till today, which show the intensity and extent of this massive cooling;

The record of low temperatures in Oltenia

In January 1894, the weather was particularly cold and the cooling of the weather has already started on January 1, 1894. On January 3, 1894, the south of the country was affected by an intense snow storm.

Though at that time, meteorology was at the beginning and there were no maps of the fields of altitude, we have an archive of maps from the soil level (Wetterzentrale Archiv der Bodendruckkarten (December 1, 1880 – December 31, 1949) that allow us to accurately evaluate the meteorological conditions registered 116 years ago.

According to the configuration of the baric field from the soil level (Fig. 13) a strong resemblance is observed to that of Fig. 10, and the cooling was caused by the advection of the particularly cold air from the Great Russian Plain. As in 1963, the depressionary area from Asia Minor has essentially contributed to the circulation of cold air towards Oltenia. In this case too, one can estimate that the wind speed was low, 0-1m/s and so the minimum value of CI was -35.6 °C, that is, it was equal to the absolute thermal minimum for Oltenia, recorded on January 15, 1894 at Slatina in the Getic Piedmont on the Strihareţ Hill (where it was placed at that time the meteorological station). Though officially it was considered that the meteorological station of Slatina was set up in 1977, at the end of the nineteenth century, systematic meteorological observations had been made since 1893 at the Agricultural High School.

Therefore, we conclude that *the minimum absolute bioclimatic index CI in Oltenia is* **- 35.6°C**, value remained unequaled so far. This is only 2.9°C higher than the absolute thermal minimum recorded in Romania. In this case too, the thermal inversion had an important role in producing this low value.

Since the values of the cooling index CI in C degrees are not calculated in any paper, we presented in Table 2 the values of the CI calculated for air temperature between -1°C and -15°C and the wind speed between 2-25 m/s. There were chosen the most frequent wind speed and temperature values that are recorded during winter snow storms.

These values can be used for practical purposes. Based on wind speed and temperature values communicated by the mass-media and the consulting the table above, one can learn the temperature felt by human body. The area marked with red represents the CI values lower of -32°C, which fall under the incidence of the Government Order 99/2000 concerning the work in extreme conditions.

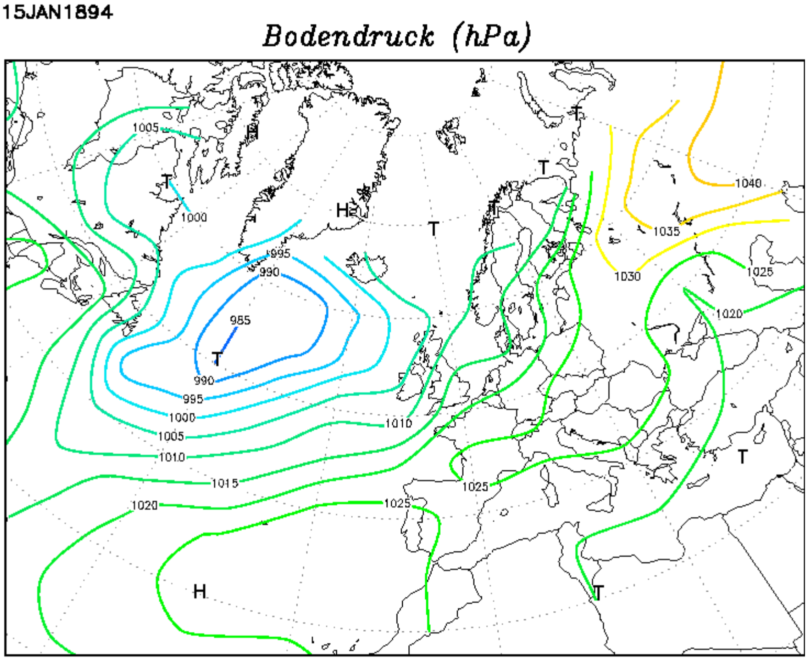

Figure 13. Synoptic situation at the soil level on January 15, 1894, at 00 UTC, at the moment of the maximum intensity of the most intense cold wave over Oltenia in the nineteenth century (according to Wetterzentrale - Kartenarchiv).
Figura 13. Situația sinoptică la nivelul solului în data de 15.I.1894, ora 00 UTC, la momentul intensității maxime a celui mai intens val de frig peste Oltenia din secolul XIX (după Wetterzentrale - Kartenarchiv).

Table 2. Cooling index values (°C) calculated for air temperature between -1°C and – 15 °C and the wind speed between 2 and 25 m/s.
Tabel 2. Valorile Indicelui de răcire (°C) calculat pentru temperatura aerului cuprinsă între -1°C - 15°C şi viteza vântului între 2-25 m/s.

Wind speed in m/s	Air temperature in °C														
	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15
2-3	-3.2	-4.2	-5.2	-6.3	-7.3	-8.3	-9.4	-10.4	-11.4	-12.5	-13.5	-14.5	-15.6	-16.6	-17.6
4	-5.4	-6.7	-8.1	-9.4	-10.8	-12.1	-13.4	-14.8	-16.1	-17.5	-18.8	-20.1	-21.5	-22.8	-24.2
5	-7.0	-8.3	-9.7	-11.0	-12.4	-13.7	-15.0	-16.4	-17.7	-19.1	-20.4	-21.7	-23.1	-24.4	-25.7
6	-8.6	-9.9	-11.3	-12.6	-13.9	-15.3	-16.6	-18.0	-19.3	-20.6	-22.0	-23.3	-24.7	-26.0	-27.3
7	-10.2	-11.5	-12.9	-14.2	-15.5	-16.9	-18.2	-19.6	-20.9	-22.2	-23.6	-24.9	-26.3	-27.6	-28.9
8	-11.8	-13.1	-14.5	-15.8	-17.1	-18.5	-19.8	-21.1	-22.5	-23.8	-25.2	-26.5	-27.8	-29.2	-30.5
9	-13.4	-14.7	-16.0	-17.4	-18.7	-20.1	-21.4	-22.7	-24.1	-25.4	-26.8	-28.1	-29.4	-30.8	**-32.1**
10	-15.0	-16.3	-17.6	-19.0	-20.3	-21.7	-23.0	-24.3	-25.7	-27.0	-28.3	-29.7	-31.0	**-32.4**	**-33.7**
11	-16.6	-17.9	-19.2	-20.6	-21.9	-23.2	-24.6	-25.9	-27.3	-28.6	-29.9	-31.3	**-32.6**	**-34.0**	**-35.3**
12	-18.1	-19.5	-20.8	-22.2	-23.5	-24.8	-26.2	-27.5	-28.9	-30.2	-31.5	**-32.9**	**-34.2**	**-35.5**	**-36.9**
13	-19.7	-21.1	-22.4	-23.8	-25.1	-26.4	-27.8	-29.1	-30.4	-31.8	**-33.1**	**-34.5**	**-35.8**	**-37.1**	**-38.5**
14	-21.3	-22.7	-24.0	-25.3	-26.7	-28.0	-29.4	-30.7	**-32.0**	**-33.4**	**-34.7**	**-36.1**	**-37.4**	**-38.7**	**-40.0**
15	-22.9	-24.3	-25.6	-26.9	-28.3	-29.6	-31.0	**-32.3**	**-33.6**	**-35.0**	**-36.3**	**-37.6**	**-39.0**	**-40.3**	**-41.7**
16	-24.5	-25.9	-27.2	-28.5	-29.9	-31.2	**-32.5**	**-33.9**	**-35.2**	**-36.6**	**-37.9**	**-39.2**	**-40.6**	**-41.9**	**-43.3**
17	-26.1	-27.4	-28.8	-30.1	-31.5	**-32.8**	**-34.1**	**-35.5**	**-36.8**	**-38.2**	**-39.5**	**-40.8**	**-42.2**	**-43.5**	**-44.8**
18	-27.7	-29.0	-30.4	-31.7	**-33.1**	**-34.4**	**-35.7**	**-37.1**	**-38.4**	**-39.7**	**-41.1**	**-42.4**	**-43.8**	**-45.1**	**-46.4**
19	-29.3	-30.6	**-32.0**	**-33.3**	**-34.6**	**-36.0**	**-37.3**	**-38.7**	**-40.0**	**-41.3**	**-42.7**	**-44.0**	**-45.4**	**-46.7**	**-48.0**
20	-30.9	**-32.2**	**-33.6**	**-34.9**	**-36.2**	**-37.6**	**-38.9**	**-40.3**	**-41.6**	**-42.9**	**-44.3**	**-45.6**	**-46.9**	**-48.3**	**-49.6**
21	**-32.5**	**-33.8**	**-35.1**	**-36.5**	**-37.8**	**-39.2**	**-40.5**	**-41.8**	**-43.2**	**-44.5**	**-45.9**	**-47.2**	**-48.5**	**-49.9**	**-51.2**
22	**-34.1**	**-35.4**	**-36.7**	**-38.1**	**-39.4**	**-40.8**	**-42.1**	**-43.4**	**-44.8**	**-46.1**	**-47.5**	**-48.8**	**-50.1**	**-51.5**	**-52.8**
23	**-35.7**	**-37.0**	**-38.3**	**-39.7**	**-41.0**	**-42.3**	**-43.7**	**-45.0**	**-46.4**	**-47.7**	**-49.0**	**-50.4**	**-51.7**	**-53.1**	**-54.4**
24	**-37.3**	**-38.6**	**-39.9**	**-41.3**	**-42.6**	**-43.9**	**-45.3**	**-46.6**	**-48.0**	**-49.3**	**-50.6**	**-52.0**	**-53.3**	**-54.7**	**-56.0**
25	**-38.8**	**-40.2**	**-41.5**	**-42.9**	**-44.2**	**-45.5**	**-46.9**	**-48.2**	**-49.6**	**-50.9**	**-52.2**	**-53.6**	**-54.9**	**-56.2**	**-57.6**

Thermal stress at low temperatures

Low temperatures generally act destructively on the biosphere. They affect spontaneous vegetation, wildlife, cultivated plants, domestic animals and humans. Damaging effects on the vegetal cover, trees and agricultural crops are manifested by the freezing of the sap that, by expansion, has the affect of "wedge" leading to the destruction of the vessels and some species are killed during frosty intervals. For the agricultural crops, vineyards and even fruit trees, surprised by big frosts, without a snow cover, the effects are in some years devastating. In frosty nights the trees often crack, due to the expansion of the frozen sap, which produces cracks in the trunks and branches.

In the intervals with frosty weather, the birds fly as little as possible or they do not fly to minimize the effect of low temperatures and some mammals hibernate early in winter.

In humans and animals, hypothermia and thermal shock at low temperatures determine a poor irrigation of the kidney, a vital organ, leading to the destruction of the filtration units because of the poor operation and the accumulation of toxins in the blood and then quite rapidly the death occurs as a result of the renal failure. The frost intensity is not felt by the human body proportionally to the decrease in air and body temperature, and due to the adaptation mechanisms described above, the massive chilblains and after that the frost of the whole body frequently occur, the person in question not being aware of the gravity of the situation.

In the situations when the ambient temperature falls below certain values, the human body feels the cold sensation and the physiological mechanism of thermogenesis starts, trembling appears, and in critical situations there occurs the decrease of the temperature of the peripheral organs (limbs, skin, etc.) through vasoconstriction and thus the conducting of heat to internal vital organs like heart, brain, liver, kidney etc. In situations when the ambient temperature is very low, below -40°C, water quickly freezes almost instantly and the human body can support only a very short time without adequate protection.

When the human body has heat loss beyond its capacity to regenerate it, hypothermia is installed. The danger of hypothermia occurs when the body temperature drops below 35°C (according to some medical textbooks below 36°C). Hypothermia is accompanied by major psychiatric disorders, trembles, pallor, cyanosis (necrosis the tissue is becoming blue-violet or black), weak pulse → coma → death;

Factors favoring the occurrence of hypothermia are wind, rains and the wet clothes that kept on the body and by evaporation increase the body cooling and thus they increase the feeling of cold. The water capacity to consume the internal body heat is much higher than that of the air and therefore the cooling power is particularly high increasing the risk of exposure to low temperatures. The older persons are more sensitive to this phenomenon because of health disorders and of diminished perception of cold state. As elders, children are equally vulnerable because of the underdeveloped organisms.

The main mechanism of defense against hypothermia is the tremble, which through the contractions of musculature generates heat. It becomes ineffective when the body temperature drops below 31°C. Studies have shown that the man first evolved in equatorial areas and then he migrated to high latitudes, thus being in his essence a "tropical" being (Mike Tipton, professor of Human Physiology at the University of Portsmouth, "Man is a Tropical Animal"). At temperatures ≤ 5°C body feels an accentuated thermal uncomfortable state (SCHARLAU, 1950).

In medical literature, in connection with the problems caused by low temperatures, specialized terms are used: algiditate-morbid state that is accompanied by decreasing of peripheral temperature, feeling of cold and collapse, even if the central temperature is mostly in normal limits.

Severe chilblain is a serious injury to tissues caused by cold, which affects mainly the extremities and is manifested by a feeling of pinch, then by a gradual benumbing. The skin is white and cold, then it gets purple and swollen; in the severe forms and untreated blisters appear filled with plasma and then gangrenes. Isothermognosis is the pathological sensitivity in which the pain and the cold are perceived as a heat sensation. The chilblains appear when the skin and flesh freeze, usually when the temperature drops below -10°C. Chilblains affect all the exposed parts of the body and most remote regions from the heart, which have the weakest circulation: hands and feet, the nose, ears and the face. Chilblains may be superficial or serious, depending on the degree of exposure. The first sign is a itching sensation as the skin freezes. Then on the skin spots appear with a waxy aspect, the tissues affected get benumbed, later they become hard and granular, with substantial pains, swell and blister before they die and then fall.

At the temperature of -25°C after a time of exposure something shorter, the chilblains of the skin appear (on the face, ears, nose, limb extremities) and at temperatures ≤ -55°C the chilblains appear in less than two minutes. Chilblains can have serious consequences such as the amputation of limbs leading to disability and often death of the person affected.

The history of research on the effects of low temperatures records the date of January 13, 1975, when in Canada at Kugaaruk (Nunavut), the thermometer showed -51°C and a cold wind was blowing with 56 km/h (15.5 m/s), thus, the temperature felt in the air was -78°C. In 1940, American explorers Paul Siple and Charles Passel measured in Antarctic area the speed with which the water was freezing depending on the wind speed. They set the equation 'Windchill', which measures the freezing level in watts/m^2, published in 1945 and which remained for half a century the measure of the wind freezing index used in North America.

In the situations in which the air temperature has extremely low values (below -20°C) or when the cooling index (CI) falls below the threshold value of -32°C, the Government Emergency Ordinance no. 99/2000 from June 29, 2000 is applied, referring to the measures that can be applied. The combined effect of wind and low temperature determines the rapid cooling of the body and the feeling of a temperature much lower than the real one. For example, at a wind with the speed of 27.8 km/h (8 m/s) and a temperature of -10°C the equivalent temperature felt by the body is -23°C.

CONCLUSIONS

Though in many situations Oltenia benefits from the effect of sheltering exerted by the mountain orographical dam, the wide opening eastwards and the relief configuration of Europe in the interaction with the general circulation of the atmosphere lead to situations of snow storms and massive coolings. These generate intervals of time in which the air temperature decreases, especially within low relief forms, where thermal inversions frequently and intensely develop. The snow storm affects more frequently the southern half of the region, an area where the risk of producing low values of the cooling index (CI) is higher.

Although in the last decade in the winter season, in Oltenia, the weather was warm (BOGDAN et al., 2010), the climate oscillations bring back in present time the cold winters and cold waves, the blizzards and the intensifications of wind that through the combined action of the wind and low temperatures subject the whole biosphere to a strong thermal stress, sometimes with destructive effects.

Taking into account that the exceptionally low thermal values registered in 1894 and 1963 did not repeat, we can conclude that such temperatures have a frequency of about once every 50 years, and climatic warming is confirmed in this way, too.

The bioclimatic index CI gives a good measure of temperature felt by the human body in cold weather situations and in the cases of snow storms; the combination of low temperatures and wind can be fatal especially for the persons blocked in vehicles on roads or surprised walking.

Although the phenomena associated with the climatic warming are more fully felt in many years, it should be consider that a cold or an extremely cold winter can come back any time and therefore the population is better to be prepared for winter.

REFERENCES

BOGDAN OCTAVIA & MARINICĂ I. 2007. *Hazarde meteo-climatice din zona temperată geneză şi vunerabilitate cu aplicaţii la România*. Edit. Universitaţii ,,Lucian Blaga". Sibiu: 422 pp.

BOGDAN OCTAVIA, MARINICĂ I., RUSAN N., RUSU SIMONA. 2007. *Riscul iernilor calde în România (cu aplicaţii la iarna 2006-2007)*. Riscuri şi Catastrofe. Editor Victor Sorocovschi An VI. 4. Edit. Casa Cărţii de Ştiinţă Cluj Napoca: 97-110.

BOGDAN OCTAVIA, MARINICĂ I., RUSAN N. 2007. *Unele consideraţii preliminare privind iarna caldă 2006-2007 din România*. Analele Univ. Spiru Haret. Seria Geografie. 10: 19-26.

BOGDAN OCTAVIA, MARINICĂ I., RUSAN N., SIMONA RUSU. 2008. *Warm winter risk in Romania*. Conference on water observation and information system for decision support BALWOIS 2008 abstacts 27-31 may. Ohrid. Republic of Macedonia: 84 pp.

BOGDAN OCTAVIA & MARINICĂ I. 2008. *Iarnă mediteraneană în Oltenia, 2006-2007*. Revista Geografică. **14-15.** Serie Nouă. ARS DOCENDI Universitatea din Bucureşti: 26-36.

BOGDAN OCTAVIA, MARINICĂ I., MIC LOREDANA-ELENA. 2008. *Consideraţii asupra ,,fenomenului de iarnă caldă" din România.* Universitatea din Bucureşti. Facultatea de Geografie. Comunicări de Geografie. Edit. Universităţii din Bucureşti. **12**: 139-144.

BOGDAN OCTAVIA & MARINICA I. 2009. *Caracteristici climatice ale iernii 2007-2008 în Oltenia*. Revista Geografică. Serie Nouă ARS DOCENDI Universitatea din Bucureşti. **15**: 73-81.

BOGDAN OCTAVIA MARINICĂ I., MARINICĂ ANDREEA FLORIANA. 2010. *Frequency of warm winters within Oltenia in 1999-2008 decade*. In: Aerul şi Apa Componente ale Mediului, dedicat Conferinţei Ştiinţifice cu acelaşi titlu 19-20.III.2010 Cluj Napoca, Universitatea Babeş-Bolyai Facultatea de Geografie. Catedra de Geografie Fizică şi tehnică în colaborare cu Direcţia Apelor Someş. Editori Gavril Pandi şi Florin Moldovan. Editura Presa Universitară Clujană: 45-54.

MARINICA I. 2006. *Fenomene climatice de risc în Oltenia.* Editura. Autograf MJM: 386 pp.

SCHARLAU K. 1950. *Einführung eines Schwülemasstabes und Abgrenzung von Schwülezonen durch Isohygrothermen,* Erdkunde. **4**: 188-201.

SOROCOVSCHI V. 2008. *Climatologie şi aplicaţii bioclimatice în turism*. Editura Casa Cărţii de Ştiinţă. Cluj-Napoca. 150 pp.

*** *Vremea şi apele Agenda 1985*. Consiliul Naţional al Apelor. Institutul de meteorologie şi Hidrologie. Editura Tehnică. Bucureşti.

*** *Terminologia meteorologică*. Standard de stat. ANM 2005.

*** *Ordonanţa de urgenţă a Guvernului nr. 99/2000 privind măsurile ce pot fi aplicate în perioadele cu temperaturi extreme pentru protecţia persoanelor încadrate în muncă*. Monitorul Oficial, Partea I, nr. 304 din 4 iulie 2000

*** *Hotarâre nr. 580 din 6/07/2000 pentru aprobarea Normelor metodologice de aplicare a prevederilor Ordonanţei de urgenţă a Guvernului nr. 99/2000 privind măsurile ce pot fi aplicate în perioadele cu temperaturi extreme pentru protecţia persoanelor încadrate în munca*. Monitorul Oficial, Partea I nr. 315 din 07/07/2000.

Ion Marinică
Regional Meteorological Center Oltenia
Str.Brestei No 3A et.IV.Craiova, Romania
E-mail: ionmarinica@yahoo.com.

Cornelia Chimişliu
The Oltenia Museum, Craiova, str. Popa Sapca, no. 8, Craiova, Romania
E-mail: chimisliu_cornelia@yahoo.com

Andreea Marinică
Earth and Space Science, Jacobs University, Bremen, Bremen, gGmbH.
E-mail: seryblack@yahoo.com

Received: April16, 2010
Accepted: July 07, 2010