

**AIR'S TEMPERATURE AT SURFACE OF THE SOIL  
(LEVEL 0 M), IN THE AREA OF ORADEA CITY**

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**Abstract**

*The current study was achieved based on a rich fund of weather forecast data, registered at the weather station Oradea, on a long period of time, respectively for the period 1998 – 2008.*

*The use of methods and means specific to climate research pursued a processing as accurate as possible of all data available to us, by this researching the role played by the relief as climate factor in the evolution of air's temperature at the surface of the soil.*

*In the current work, we wish to analyze the monthly and yearly regime of air's temperature at the surface of the soil, the deviations of air's temperature at the soil from the multi-yearly average, the inter-monthly variation of thermal averages, the maximum and minimum average temperatures, extreme temperatures.*

*The absence of very low temperatures, under -30°C, emphasizes the moderate character of climate in the area of Oradea city.*

**Key words:** soil's temperature, deviations, monthly, multi-yearly average.

**INTRODUCTION**

Air's temperature at the surface of the soil is an extremely important element, taking into account that it depends of a series of physical and chemical processes necessary to the evolution and life of plants, as well as the evolution of air's temperature above it. The latter aspect is due to the fact that at the level of soil the radiant energy, received from the sun through the direct solar radiation and the diffuse one transforms in calorific energy, this being the main factor determining the heating of air blanket in the immediate vicinity of the soil, the air heating from the lowest part to the highest part, and in a smaller degree directly through solar radiation.

In the area of Oradea city, the relief has a certain influence on the spatial-temporal distribution of climate elements. Thus, the relief modifies the climate elements through altitude, exposure and inclination of slopes, fragmentation and orientation of valleys. The complexity and variety of relief, in the area of Oradea city, emphasized by the differences of altitude between the West Hills and Criş Valley, by the large fragmentation, by the presence of slopes exposed in all cardinal directions and by the crossing of city by the Crişul Repede from East to West, determines important variations of climate elements, generating a series of topoclimates.

The hydrographical network influences the thermal regime and the air's humidity due to evaporation phenomena. The presence of a rich hydrographical network determines the decrease of air's temperature with 2°- 4°C in comparison to the surrounding regions, due to the fact that the water heats harder than the soil, but also due to evaporation processes done with heat consumption.

The natural vegetation in the Oradea area belongs to sylvosteppe area, but it suffered modifications of anthropic nature, so that today a landscape of parches is imposed. The vegetation plays an active surface role at the superior part, where the transformations and transfers of energy and heat take place. It influences the climate's characteristics by floral composition, height of plants and surface occupied by various vegetal associations. The most important topoclimate modifications are caused by the wood vegetation from the woods neighboring the city, from parks and large orchards on Oradea's Hills. The forest vegetation, pretty rarefied determines the presence of lower temperatures inside the vegetal formation, in comparison to limitrophe areas.

The soils from the area of Crișul Repede represent a great variety of types, in relation to genetic factors, among which we mention morphology, hydro-climate conditions and vegetation. Thus, in the meadow of Crișul Repede and along its more important affluents appear alluvial soils in various evolution stages, which contain alluvions with a reduced content of carbonates. By its physical and chemical properties, the naked soil influences the the air's temperature from the layers immediately above it. Thus, the color, structure, porosity of soils, which determines, as well as the albedo, the difference between the calorific conductivity and the capacity of retention of water.

The presence of snow determines an increase of thermal differences. Here intervene the albedo and infrared emission coefficient, which are larger in the case of clean snow from the rural area (an accentuated decrease of temperature results) than in case of dirty snow, in a discontinuous layer, from the city.

By analyzing the subjacent active surface of the Oradea city, we may affirm that inside the urban centre, the main climate elements which suffer modifications are the solar radiation, air's temperature, air's humidity, nebulosity, speed and direction of wind and precipitations.

## **MATERIAL AND METHODS**

This work's purpose it to analyze the variations in time of air's temperature at the surface of the soil, in the area of Oradea city, in the current work we attempted an analysis of its evolution, as well as of the factors imposing or generating them.

The main methods used for achieving this study are: the analysis method, the deductive method, the comparative method, statistical – mathematic and graphic methods.

The current study was achieved on the basis of a rich fund of thermal data, registered at the Oradea weather forecast station, on a long period of time, respectively on the period 1998 – 2008.

## **RESULTS AND DISCUSSION**

### **Yearly and monthly average temperatures**

For the calculation of multi-yearly average temperature of soil's ruface, data taken from the Oradea weather forecast station was used, on a period of 11 years, in the period 1998-2008. For the air's temperature at the soils's surface we used thermal values from level 0 m. For the period of time studied, the multi-yearly thermal averageat the soil was of 12°C.

The large variable of this climate element is also emphasized by the highest and lowest average. Thus, the air's temperature at the level of soil ranged between 10.5°C registered in the year 2005 and 13.6°C registered in the year 2000 (see figure 1). From the analysis of thermal values at the soil correlated with those of the air, the role of soil's temperature in influencing the air's temperature above is emphasized, in the years 2000 and 2005 representing the years with extreme values and for air's temperatures at 2 m.

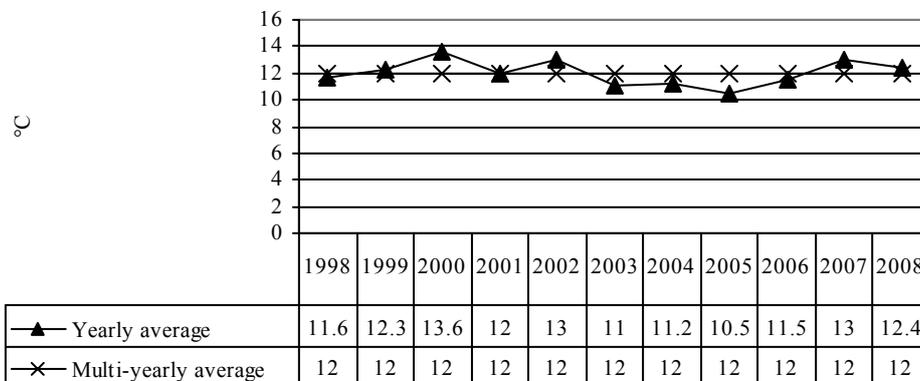


Figure 1 The deviations of air's temperatures at the soil from the multi-yearly average, in Oradea, in 1998-2008

By analyzing the yearly thermal averages, we notice that 45.5% from the total of years studied have positive thermal deviations, with averages above the multi-yearly average, 45.5% had negative deviations, the yearly value of thermal averages being situated beneath the value of 12°C, and in 9% of the cases, the values were equal to the multi-yearly average.

The evolution of values of air's temperature at soil, during a year results from the analysis of multi-yearly monthly averages. Their variation during a year depends on a series of factors, among which solar radiation, albedo, soil's status (color, humidity, loose degree), inclination of slopes and their exposure, the presence or absence of the layer snow, degree of coverage with snow etc., have an important role.

Through its peculiarities, the soil imprints personal characteristics to the air layer above, taking over the subjacent active surface role, the variation of air's temperature depending on the structure and composition of air during a year. Thus, analyzing the multi-yearly monthly averages for the period of time studied (1998-2008), we notice an increasing trend of the air's temperature at soil starting with the month of February until the month of July, when the monthly average value reaches the maximum value (25°C). At the same time with the decrease of duration of days, and implicitly of the quantity of solar radiation, the air's temperature at soil starts to decrease from the month of August, so that the month of January registers the lowest values (-0.4°C).

The soil's temperature registers a significant increase of the monthly value during the month of April, when the thermal leap is of 7.0°C, in comparison to the previous month, reaching the value of 12.7°C, compared to 5.5°C registered in March. This significant thermal increase from one month to another is caused by the increased of value of solar radiation, at which it is also added the lack of a rich vegetation absorbing a part of calorific energy, thus using, totally, in the process the heating the soil. The most reduced positive thermal leap is registered between the months of June and July, of only 1.5°C (table 1).

*Table 1*

Inter-monthly variation of thermal averages at the surface of soil in Oradea, during  
1998-2008

I-II	II-III	III-IV	IV-V	V-VI	VI-VII	VII-VIII	VIII-IX	IX-X	X-XI	XI-XII
0.8	5.1	7.2	7.0	3.8	1.5	-1.3	-6.9	-5.4	-6.4	-4.8

Source: ANM's archives

The decrease of intensity of solar radiation starting with the month of August determines, starting with this month, negative thermal leaps, the values of soil's temperature decreasing from one month to another. The most significant inter-monthly decrease of soil's temperature is registered in the month of September, the negative thermal leap in comparison to the month of August reaching the value of 6.9°C. A close value is also registered during the month of November, when the value of air's temperature at soil decreases compared to the month of October, with 6.4°C. The most reduced negative thermal leap is registered during the months of July and August, when the air's temperature decreases with 1.3°C (table 1).

The high temporary variability of this climate element determines different values from one year to another and from one month to another. Thus, the highest monthly thermal average was registered in the month of July 2006 (28.3°C). The summer months with the lowest thermal values were June 2001, with the thermal average's value of 20.3°C, July 2000 and 2008 with 23.0°C and August 2006 when 20.9°C were registered (table 2).

*Table 2*

Maximum and minimum average temperatures, at the soil's surface, in Oradea, 1998-2008

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Highest monthly average	3.6	4.5	8.9	13.9	22.6	27.5	28.3	27.3	19.9	14.3	8.3	2.9
Year	2007	2002 2007	2007	2007	2000	2000	2006	2000	1999	2000	2000	2008
Lowest monthly average	-2.6	-6.2	2.5	9.5	16.4	20.3	23	20.9	14.7	8.3	2.6	-3.7
Year	2003	2003	2005	2003	2004	2001	2000 2008	2006	2007	2003	2001	1998 2001

Source: ANM's archives

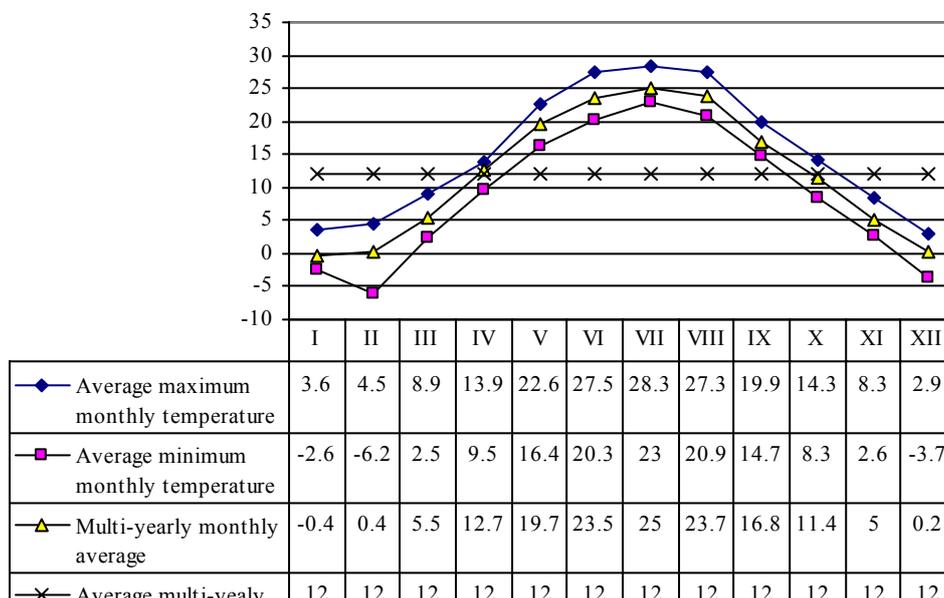


Figure 2 The regime of air's temperature at the surface of soil in Oradea, 1998-2008

The winter months benefit of reduced quantities of radiant energy, of the presence during long time of anti-cyclone regimes, generating frequent thermal inversions, and in the past years the presence of snow layer determines an increase of albedo, which, correlated with the radiative coolings, give extreme thermal values. Thus, the coolest months from the period studied were January 2003 with a thermal average of  $-2.6^{\circ}\text{C}$ , February 2003 with a value of  $-6.2^{\circ}\text{C}$  and December 1998 and 2001 when the thermal average was of  $-3.7^{\circ}\text{C}$  (see figure 2). The highest values for thermal averages of the winter months were registered during the months of January when the average temperature was of  $3.6^{\circ}\text{C}$ , during the year 2007, in February 2002 and 2007 with a thermal average of  $4.5^{\circ}\text{C}$  and December 2008 when the average temperature was of  $2.9^{\circ}\text{C}$ .

#### Air's extreme temperatures at the surface of soil

In the Western part of Romania, and, implicitly, in the area of Oradea city, enter various air masses with thermal and hydric character, of air masses of maritime tropical origin, oceanic air masses, up to air masses with polar-arctic origin. All these give to the weather and climate personal characteristics, also emphasized by the values of extreme temperatures.

Thus, on the period studied 1998-2008, the absolute maximum temperature of the air at soil was in Oradea of  $64.2^{\circ}\text{C}$ , value registered at 17th of August 2000 (table 3). The maximum absolute temperatures reached values of over  $55^{\circ}\text{C}$ , except the years 2002 ( $53^{\circ}\text{C}$ ), 2003 ( $48.4^{\circ}\text{C}$ ) and 2004 ( $43.9^{\circ}\text{C}$ ).

Table 3

Absolute maximum temperatures of air at the surface of soil in Oradea, (1998-2008)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Absolute maximum temperatures	17.2	22.0	34.1	48.9	55.0	60.0	60.4	64.2	46.3	39.2	28.0	17.3
Year	2002	1998	1999	2000	2000	2000	2007	2000	2000	2000	2000	2003
Date	30	28	27	28	28	22	20	17	13	3	1	1

Source: ANM's archives

The month with the largest frequency of maximum yearly absolute temperature is July, with 54.5% of the cases, meanwhile in the month of August, their frequency was of 27.3%. Also, in the month of May were registered cases with maximum absolute temperatures having a frequency of 18.2%. The presence of absolute maximum values is possible in the period 4th of May (the earliest value of yearly absolute maximum temperature, registered in the year 2002) and 17th of August (the lowest absolute maximum temperature registered in the year 2000).

The absolute minimum temperature for the interval studied had a value of -28.5°C, registered at the date of 13.01.2003 (table 4). The absolute minimum temperatures were, in most cases, values ranging between -15°C and -25°C with a frequency of 81.8% of the cases, meanwhile the absolute minimums with values higher than -15°C were registered in 18.2 % of the cases. The highest absolute minimum temperature for the winter months was registered at 16th and 17th of February 2002, having a value of -3.6°C. On the entire period studied, the highest value of absolute minimum temperature was registered in the month of August of the year 2007, having the value of 12.8°C.

Table 4

Air's absolute minimum temperatures at the soil's surface in Oradea (1998-2008)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Absolute minimum temperatures (°C)	-28.5	-23.5	-14.9	-8.1	-1.2	3.00	8.7	3.5	0.0	-6.1	-8.6	-24.0
Year	2003	2005	2005	2000	2007	2000	2000	2000	2003	2006	2005	2001
Date	13	6	11	7	2	18,19	10	27	4	31	23	25

Source: ANM's archives

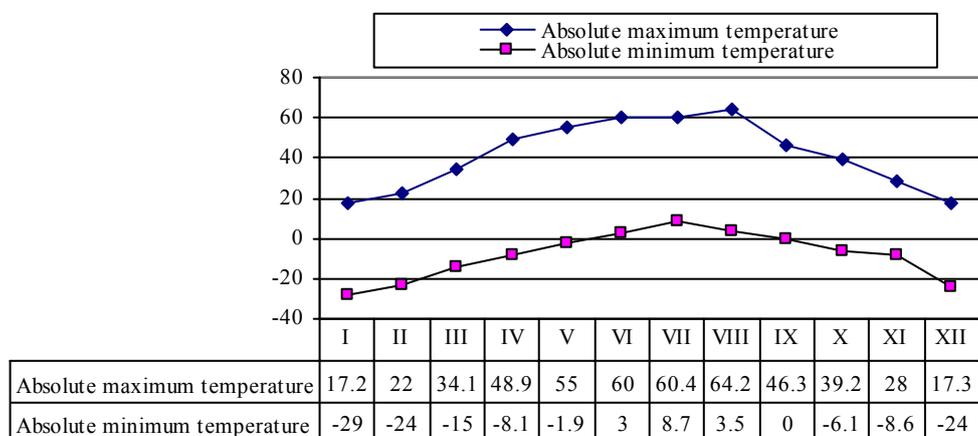


Figure 3 Absolute maximum and minimum temperatures, at the soil's surface, Oradea

The yearly absolute minimum temperatures are registered in the winter months, having in all cases negative values, meanwhile the monthly absolute minimums during summer reach positive values. Thus, the month with the highest frequency of absolute minimum temperatures is January with 45.5% of the cases. A large frequency of yearly absolute minimum temperatures also has the month of December, when the lowest temperature was registered in 36.3% of the cases, the month of February having a frequency of absolute minimum temperatures at soil of 18.2%. From the total of years studied, the air's absolute minimum temperature at soil in Oradea did not decrease in any case below -30°C, a single case being registered with the value under -25°C, the one thus

representing the multi-yearly absolute minimum, with  $-28.5^{\circ}\text{C}$ , from January 2003 (see figure 3).

The absence of very low temperatures, below  $-30^{\circ}\text{C}$ , emphasizes the moderate character of climate in the area of Oradea city.

## CONCLUSION

The average multi-yearly temperature of the air at the soil's surface has a value of  $12^{\circ}\text{C}$ .

By analyzing the yearly thermal averages, we notice that 45.5% of the total of years taken for study have positive thermal deviations, with averages above the multi-yearly average, 45.5% had negative deviations, and in 9% of the cases, the values were equal to the multi-yearly average.

The air's temperature at the level of soil registers an increasing trend starting with the month of February to the month of July, when the monthly average reaches the maximum value ( $25^{\circ}\text{C}$ ), meanwhile in the month of January the lowest values are registered ( $-0.4^{\circ}\text{C}$ ).

The soil's temperature registers a significant increase of the monthly value in the month of April, when the thermal leap is of  $7.0^{\circ}\text{C}$ , in comparison to the previous month, by reaching the value of  $12.7^{\circ}\text{C}$ , in comparison to  $5.5^{\circ}\text{C}$  registered in March. The most reduced positive thermal leap is registered between the months of June and July, of only  $1.5^{\circ}\text{C}$ . In the period studied 1998-2008, the air's absolute maximum temperature at the level of soil was in Oradea of  $64.2^{\circ}\text{C}$ , value registered at 17th of August 2000.

Of the total of years studied, the air's absolute minimum temperature in Oradea did not decrease under any circumstances under  $-30^{\circ}\text{C}$ , only one case being registered with the value under  $-25^{\circ}\text{C}$ , the one thus representing the multi-yearly absolute minimum value, with  $-28.5^{\circ}\text{C}$ , of 13th of January 2003. The absence of very low temperatures, under  $-30^{\circ}\text{C}$ , emphasizes the moderate character of climate in the area of Oradea city.

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