SOME AIR TEMPERATURE CHARACTERISTICS IN THE IAŞI METROPOLITAN AREA

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Abstract. The metropolitan area of Iasi was set up in the year 2004, as a result of an agreement between Iaşi county council, Iaşi municipality and 13 surrounding communes. Its surface is of 800 km^2 and population of 400.000 inhabitans. The area is situated in the East of Romania, at the contact between the Central Moldavian Plateau and the Moldavian Hilly Plain, between 40 m and 416 m altitude. Have been established the thermal characteristics through a comparative analysis between plane plain and hilly areas with different slope inclination and exposition, between the forested areas, field, rural settlements and intraurban area.

Key words: air temperature, Iaşi Metropolitan Area.

UNELE CARACTERISTICI ALE TEMPERATURII AERULUI ÎN ARIA METROPOLITANĂ IAŞI

Rezumat. Aria metropolitană Iaşi a fost înfiinţată în anul 2004, ca rezultat a unui acord dintre Consiliul Judeţean Iaşi, municipalitatea Iaşi şi 13 comune înconjurătoare. Suprafaţa ei este de 800 km^2 şi populaţia de 400.000 locuitori. Aria este situată în estul României, la contactul dintre Podişul Central Moldovenesc şi Câmpia Colinară a Moldovei, între altitudinile de 40 m şi 416 m. Au fost stabilite caracteristicile termice printr-o analiză comparativă dintre ariile de câmpie plană şi ariile deluroase cu diferite înclinaţii şi expoziţii ale versanţilor, dintre ariile împădurite, câmp, aşezări rurale şi aria intraurbană

Cuvinte cheie: temperatura aerului, Aria Metropolitană Iaşi.

Introduction

There were utilised data from 4 meteorological station: Bârnova, in the forest, at 396 m altitude; Ciurea, in a valley, field, at 110 m altitude; Podu Iloaei, in te plain, near a rural settlement, at 100 m altitude; Iaşi, on a low hill, at the border of the Iaşi town, at 102 m altitude. In the climatic study of the city of Iaşi, we mention famous precursors, professors from the Iasi University, such as I. Gugiuman [c 1, c 2], the founder of modern Romanian urban climatology and Elena Erhan, author of the Iaşi climate monograph [a1]. Contributions were also made by researchers from the Meteorological Service-Iaşi [c3]. The climate of the city of Iaşi has been presented lately by I. Mihăilă in the monograph "Climate of the Moldavian Plain" [a 2]. Complex surveys of urban topo-climatology in urban areas with varied relief, based on an extended meteorological network that operated for a representative period, have been carried out 34 years ago in Piatra Neamt and Onești by the researchers from the Research Station "Stejaru" from Piatra Neamt [a 3, c 4].

Methods and materials used

Also were utilised data from another supplementary meteorological station from the urban area: ”Al. I. Cuza” University and Breazu. The data was statistically prolonged at the standard period, 1896-2009. Here and there references were also made to other data from the north-east of Moldavia. The spatial distribution of the thermal parameters was reported to the values of the extended area of Romania and the Plateau of Moldova [b 1].

Obtained results and discussions

Annual average temperature. Spatial distribution of the annual average of the air temperature is presented in fig. 1.

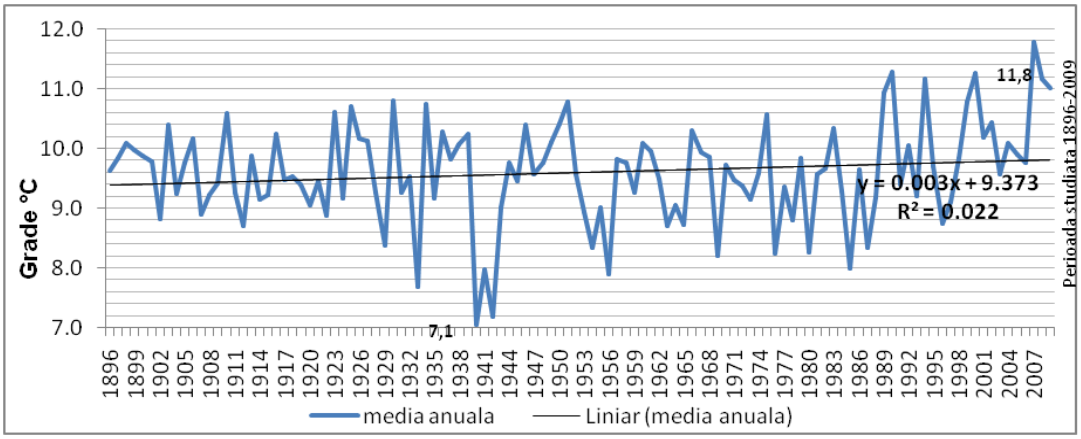


Figure 1. The annual averages of the air temperature and its trends at Iaşi meteorological station.

This small increasing of the mean temperature at Iaşi, in an interval of 60 years (fig. 2), was due by the changing the emplacement of the meteorological station, from town at te border of town, at the same altitude same altitude, because, evident in the old emplacement, in the town, the mean of temperature increased with 0,7°C, due by the global warming and by increasing of the urbanization degree and of the auto traffic. For the 1896-2009 period, the highest annual average value of air temperature was recorded in 2007 at Iaşi (11.8°C) exceeding with 2.1°C the multiannual average, and the coldest year was 1942, with 7.2°C, at Iaşi. Compared with the multiannual average values, the air temperature displayed fairly high non-periodic variations, dependent on the frequency and intensity of advections of the different masses of air. In few cases the multiannual average temperature is found in the annual averages and a great increasing, begin with 1990.

For the 1896-1965 periods, the annual average temperature at Iaşi was 9.5°C, (Gugiuman, 1968). For the Iaşi metropolitan area, the multiannual average temperature for the 1966-2009 intervals was 9.8°C at Iaşi, at Podu Iloaiei 9.7°C, at Ciurea de 9.5°C, while at Bârnova the average temperature was 8.4°C (fig. 2).

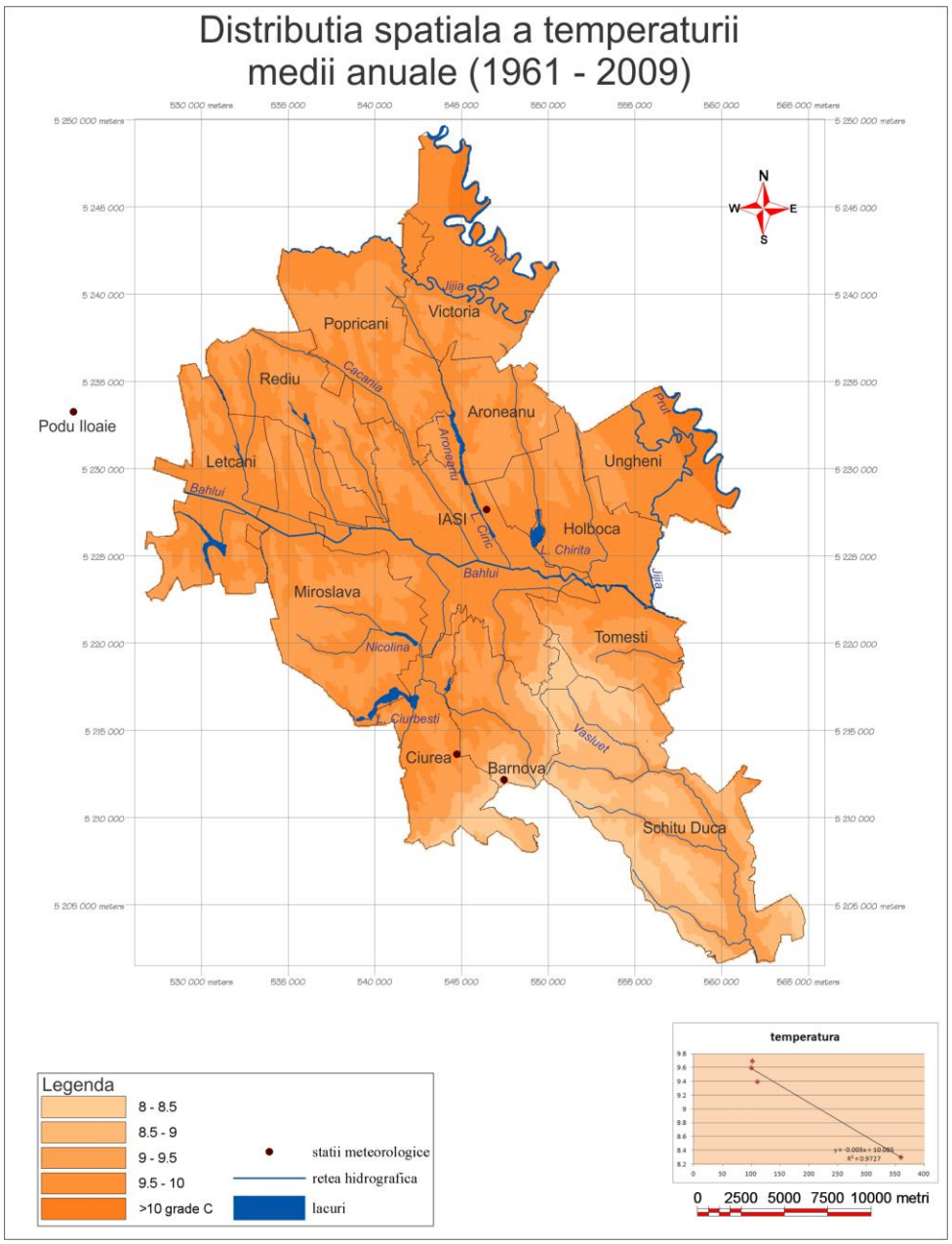
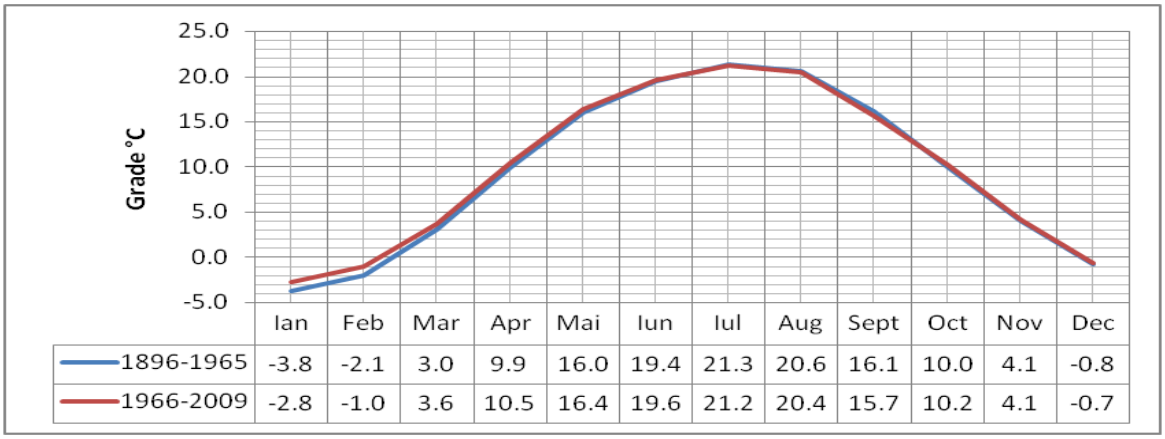


Figure 2. The spatial distribution of the average air temperature in Iaşi Metropolitan Area (1961-2009)

Annual average amplitude. In the metropolitan area the value of the annual average amplitude for the 1896-2009 period, is 24.7°C at Iaşi, 24.4°C at Ciurea, 24.8°C at Podu Iloaiei and 24.3 ° C at Bârnova, at the limit of the one of temperate continental climate indicators, 25,0ºC. The annual amplitude can exceeded 35,0°C (in 1963, 35.2°C at Iaşi and 35.5°C at Podu Iloaiei). The lowest annual average amplitude reached the value of 20.1°C in 1989, but it dropped even under 20°C at Ciurea and Podu Iloaiei, reaching the value of 19.3°C in the same year, 1989. The positive deviations of the annual average amplitude from the multiannual average represented the majority of cases with a frequency of 55.1%, while the negative deviations represented only 44.9% of cases, that show an aridization tendencies in the condition of increased quantities of precipitations but increased of torrentiality. The highest positive deviation from the

average recorded at Iaşi was in the year 1989, when the value of 5.8°C was reached, while the highest negative deviation was recorded in the year 1963 and reached the value of -9.3°C.

Average monthly temperatures. From the analysis of the monthly average values of the air temperature, it is observed that they have a normal course, sketching an ascending curb in the first part of the year, as a result of the rise in intensity of solar radiation, with a maximum in the month of July, after which the variation curb turns downward, dropping to a minimum in January. For the period 1896-1965, the lowest monthly average being recorded in January (-3.8°C) and the highest in July (21.3°C), (Gugiuman, 1968). In the period 1966-2009, the minimum monthly value of air temperature at Iaşi (for is recorded in January, with a value of -3.0°C, and the maximum in July, when it reaches 21.2°C, leading to multiannual monthly amplitude of 24.2°C. Between these two periods was a rise of mean temperatures in the winter season and small decreasing of the mean temperatures in the summer (fig. 3).



	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sept	Oct	Nov	Dec
1896-1965	-3.8	-2.1	3.0	9.9	16.0	19.4	21.3	20.6	16.1	10.0	4.1	-0.8
1966-2009	-2.8	-1.0	3.6	10.5	16.4	19.6	21.2	20.4	15.7	10.2	4.1	-0.7

Figure 3. A comparison between monthly means of the air temperature at Iaşi

The lowest multi-monthly value of January was recorded at Bârnova (-3.7°C), and the lowest at Ciurea, with 0.2°C higher than at Iaşi, and with only 0,9°C higher than at Bârnova, although the altitudinal difference between the two stations is about 286 m. From the data analysis it is observed that the monthly thermic minimum did not occur only in the month of January. As such, in the hierarchy of cold months, the frequency of years in which the month of January had the lowest temperatures is a percentage between 59.0% at Iaşi and 61% at Podu Iloaiei and Bârnova. In a descending order follow afterwards the months of February and December with considerably smaller percentages, of 19-23% for February and values between 16% and 18% for December. For the entire metropolitan area the month of November 1993 distinguishes itself, when the lowest monthly averages were recorded, with values of -2.6°C at Iaşi and -3.5°C at Podu Iloaiei, this also being the only month in which there was recorded the monthly minimum average outside of the months of the winter season, for the analyzed period, both for air temperature and temperature at the surface of the ground.

The 2004-2009 period highlights to us the fact that, besides the rise in the multiannual average temperature, and the winter season temperatures, for the month of December the averages are positive for all the three analyzed stations, so that at Iaşi the average temperature in December for this period is 0.8°C, at Ciurea 0.9°C and at Bârnova 0.7°C. At the Iaşi weather station increases of average values were recorded for all the 12 months, with values that oscillated between 0.3°C in May and September and 1.6°C in December. Besides, the biggest increases, of over 1°C were recorded in the two winter months (1.3°C-January, 1.6°C-December) and one each in the spring season (1.4°C-March) and summer (1.3°C-July), fact which has led to the rise in the multiannual average temperature with 0.9°C, compared to the 1961-2009 period.

Daily and horary temperatures. For the studied period, the multiannual daily average temperature presented important variations, the lowest daily average being -4.3°C on January 9th, and the highest daily average value was 22.3°C on July 4th. The resulting amplitude has a value of 26.6°C, 0.7°C higher than the annual amplitude of the monthly thermic averages. Compared with the western part of the country, the extreme diurnal values occur earlier both in the winter and in the summer. So that at Iaşi, in the eastern part of the country, the average diurnal minimum is 1.2°C lower than at Oradea, and it occurs 10 days earlier, and the maximum has a value higher with approximately 0.4°C, measuring 22.3°C at Iaşi, and it occurs almost a month earlier than at Oradea (21.9°C - August 3rd). In conditions where in the winter there is recorded the most intense cyclonic circulation, there can be pointed out the highest inter-diurnal jumps in temperature, when in the month of January the diurnal maximum rose to 9.7°C on January 28th 1983 and 14.01.2007, and the diurnal minimum had the value of -23.4°C, on January 20th 1963, resulting in a monthly amplitude, in January, of 33.1°C.

Extreme absolute temperatures. For the Iaşi metropolitan area, in the 1960-2009 interval, the *maximum absolute temperature* was 40.1°C, recorded on July 22nd 2007, and the lowest was -30.6°C, recorded on January 20th 1963, resulting thus in a thermal absolute amplitude of 70.7°C. In the entire period of observations since the putting into operation of the Iaşi weather station the absolute minimum temperature was -35°C, recorded on February 1st 1937, so that the value of the absolute thermal amplitude is 75.1°C (75.0°C being a limit between transition and continental temperate climate). From the analysis of the annual averages of the if the absolute maximum temperatures it is observed that these varied, at Iaşi, between 20.3°C, value recorded in the year 1980, and 26.1°C in the year 2007, year characterized by the highest values of the absolute maximum temperatures. The multiannual average of the absolute maximum values for the analyzed time interval is 23.3°C. Although the absolute maximum temperature reached the value of 40.1°C, it is still lower than the national maximum, of 44°C, recorded on August 10 1951, at the Ion Sion weather station, Brăila County, highlighting once again the moderate character of the climate in the Iaşi metropolitan area.

For the considered time interval the *absolute minimum value of air temperature* was recorded in the year 1963, a value of -30.6°C, 4.4°C higher than the absolute minimum for the entire time interval in which meteorological observations were made at Iaşi (Erhan, 1979). For the analyzed periods the absolute minimums were -31.2°C at Podu Iloaiei (16.01.1985) and -26.2°C at Bârnova (23.01.2006). The highest absolute monthly amplitudes of temperature occur in winter, when they exceed 37.5°C, and the lowest in the summer. The annual amplitudes of absolute extreme temperatures in the Iaşi city area varied between 43.3°C (1963) and 70.5°C (1937), (Erhan, 1979).

Temperature inversions. In order to determine the temperature inversions in the metropolitan area there were calculated the average diurnal thermal differences between the daily average temperatures at the weather stations at Iaşi (102m), Ciurea (110m) and Bârnova (396m), in the 2004-2009 interval (tab. 1).

Table 1. The frequency of temperature inversions (%) in the metropolitan area (2004-2009)

Station/ Month	Alt. diff. m	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Iaşi-Ciurea	8	46	33	26	26	20	12	10	17	13	35	37	46	27
Iaşi-Bârnova	294	23	17	6	7	0	0	1	1	6	10	17	19	9

In the first case, Iaşi-Ciurea, the level difference is small, but is a difference of morphology of the relief. Iaşi meteorological station is situated in the plane ridge of a hill, with southern exposition and Ciurea station is situated in a valley, with northern exposition. In this case, the number of temperature inversions are maximum, its was present as average in 27% of the days of year. They are *relative temperature inversion*, with radioactive genesis, present especially in the second part of the nights and in the beginning of the mornings and are present in the whole year. They had a small thickness of the inversion layer and a small intensity and duration. In the cold semester, their number is doubled by the number of days with absolute temperature inversions.

At Bârnova, because the increased of altitude, the possibility that the temperature to be warmer in comparison with Iaşi, is reduced and the number with day with temperature inversions, too. The present temperature inversion is in majority absolute temperature inversions, with a great thickness of the inversion layer, a great duration and intensity. In the wintertime, these kinds of inversions are present especially in the periods of presence in Moldavia of the Euro-Siberian Anticyclone. The tracking of the average daily thermal differences between Iaşi and Bârnova highlights the presence of negative temperatures in the months of winter, spring and autumn, with values between -0.1°C and -7.1°C, the maximum value of the inversion being recorded on February 1st 2004.

At Iaşi and Ciurea, the minimum number of cases of thermal inversions was recorded in 2008, when the phenomenon was observed in 17 cases at Iaşi, and 43

respectively at Ciurea, with a maximum recorded in 2009 for Iaşi (90 cases) and in the years 2005 and 2006 for Ciurea (39 cases).

Conclusions

Significant changes in temperature regime in Iaşi metropolitan area was produced by global warming, urban structure development and its area expansion, and for the unprecedented increase in car traffic. Previous attempt to analyze urban topoclimate was unfortunately theoretical in the absence of representative weather observations periods from different areas of urban space [a 1, c 1, 5]. Only researches over the past 6-7 years has supported a extended meteorological network and climate sensors network [a 3], facilitating a topoclimatic analysis and climatic mapping of urban space and metropolitan area.

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