CONSIDERATIONS ON THE STANDARDIZED AIR TEMPERATURE ANOMALIES IN THE WESTERN PLAIN OF ROMANIA, NORTH OF THE MUREŞ RIVER

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Abstract

In the present work, we used the annual average values of air temperature recorded during the period 1961-2002 at 10 weather stations, located on the territory of the Western Plain of Romania, North of the Mureş River. The attribution of the thermic marks for the years of the period 1961-2002 was made using the method of the standardized anomalies. The standardized deviations were calculated for 5 weather stations, which had the complete data rows. The results showed that the years 2000, 2002 and 1994 were "excessively hot" and 1980, 1985 and 1978 "very cold". There were no "exceptionally hot" years, with deviations of over 2.5, and there were no "excessively cold" or "exceptionally cold" years. The hottest year was 2000 and the coldest years were 1980 and 1985. There was an upward linear tendency of the standardized temperature anomalies. The annual average air temperature varies very little on the plain's territory, between 9.5 and 10.7°C.

Key words: air temperature, standardized anomaly, deviation, tendency.

INTRODUCTION

On the territory of the Western Plain of Romania, North of the Mureş River, the air temperature varies very little, with a difference of 1.2°C between the southernmost station, Sânnicolau Mare and the northernmost, Satu Mare. The average annual temperature values rise at 9.5-10.7°C (in the period 1961-2002). On the narrow, homogenous territory of the plain, oriented southwest to northeast, the temperature gets lower along the same direction, once the latitude increases and gives the intensity of the solar radiation. The highest average annual temperature values are recorded at the southern stations of Sânnicolau Mare, Arad and Ineu (10.5-10.7°C), which benefit from higher values of radiation-heat balance, but also from frequent advections of warm, tropical air masses. The lowest values are recorded at the northern station Satu Mare (9.5°C), because of the weakening of the solar radiation intensity and also because of the frequent advections of moist, oceanic air masses that work as a thermic moderator.

Thus, over almost the entire studied territory, the temperature presents annual average values of 10-11°C and only in the lower Plain of Someş they are between 9 and 10°C.

MATERIAL AND METHODS

In the present work, we used the annual average values of air temperature. In order to see which years were the hottest and respectively the coolest in the plain at the west of the country and to be able to attribute these years thermic marks, the annual average temperature deviations were calculated compared to the multi-annual average. And for the deviations to be as relevant as possible, they were standardized.

The attribution of the thermic marks for the years of the studied period 1961-2002 was made using the method of *the standardized anomalies* (SA). The method was first used in Romania by Busuioc (1992) to determine *the standardized precipitation anomalies* (SPA). Subsequently it appeared that it could be applied to other climatic elements as well, such as air temperature, atmospheric pressure etc. (Busuioc, 1992; Wilks, 1995). The formula used for calculating the standardized anomalies is:

$$SA = (x - \bar{x}) / \sigma \qquad \sigma = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$$

where x represents the thermic average of a particular year, $\bar{x}$ stands for the multi-annual thermic average, σ is standard deviation and n the length of the data row.

The standardized deviations were calculated for 5 weather stations, exactly for the ones that had the complete data rows for the period 1961-2002: Satu Mare, Săcueni, Oradea, Arad and Sânnicolau Mare. Although it didn't belong to the analysed territory, the station Sânnicolau Mare was used for comparison.

The thermic marks were established starting with "excessively hot" to "excessively cold", with the following thresholds: 2.0-2.49; 1.5-1.99; 1.0-1.49; 0.5-0.99; -0.49…0.49; -0.5…-0.99; -1.0…-1.49; -1.5…-1.99; -2.0…-2.49. The thresholds were chosen – with few alterations – in accordance with the ones established by McKee et al. (1993) for the Standardized Precipitation Index.

Apart from the 5 weather stations, temperature data were used from other 5 weather stations placed within the analysed territory, but having shorter data rows (Chişineu-Criş, Holod, Salonta, Ineu and Şiria). All the meteorological data used in the present work came from the Archives of the National Meteorology Administration.

RESULTS AND DISCUSSIONS

On the territory of the Western Plain of Romania, North of the Mureş River, the air temperature varied a lot during the period 1961-2002 (fig.1-2). The figures show the similar curves progress, which means that on

the homogenous territory of the plain, both warm periods and cold periods occurred due to the concomitant advections of warm air masses, respectively cold masses.

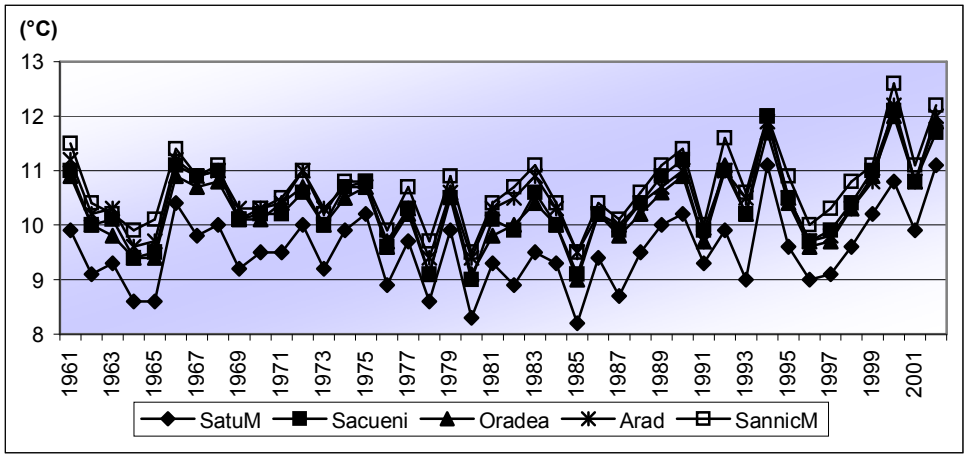

Fig. 1. Annual average air temperature in the Western Plain of Romania, North of the Mureş River (1961-2002).

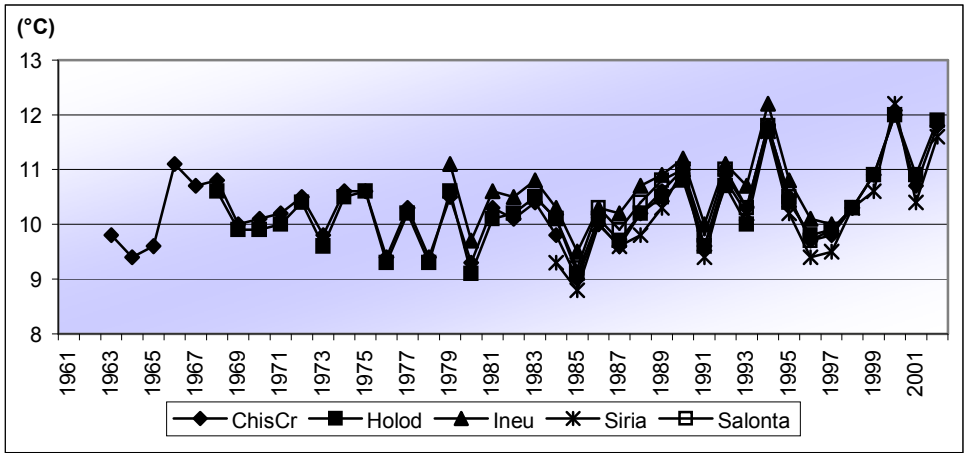

Fig. 2. Annual average air temperature at the stations Chişineu-Criş (1963-2002), Holod (1968-2002), Ineu (1979-1997), Şiria (1984-2002) and Salonta (1983-1998).

The highest average annual temperature values rose to 11.1-12.6°C and occurred especially in the last interval of the studied period. So, the highest values were recorded in the years *2000* (10.8-12.6°C) – which was *the hottest year of the analysed period* – 2002 and 1994. In 2000 the thermic maximum was recorded for almost the entire analysed territory, except for the North of the plain (Satu Mare) and the stations with short observation data rows (Ineu and Salonta), that had no records in this interval. At Satu

Mare the maximum annual value occurred in the years 1994 and 2002: 11.1°C.

The lowest average annual temperatures were 8.2-9.5°C and occurred especially in the middle of the analysed period (1978-1985). The annual thermic minimum was recorded in *1985* at most of the stations. Some stations reported the minimum in *1980* and one station in 1978 and 1980 (Arad). These were the coldest years of the analysed period.

As pointed out above, to give thermic marks to the years of the studied period 1961-2002, we have calculated the standardized temperature deviations. Their standardization made possible the mediation of the results at all 5 stations. Annual average values of deviations were obtained, in this way, for each year of the analysed period. These values are represented in figure no.3. The mediation can only be done given the conditions of a homogenous territory in terms of altitude, which is the case of the Western Plain of Romania, North of the Mureş River.

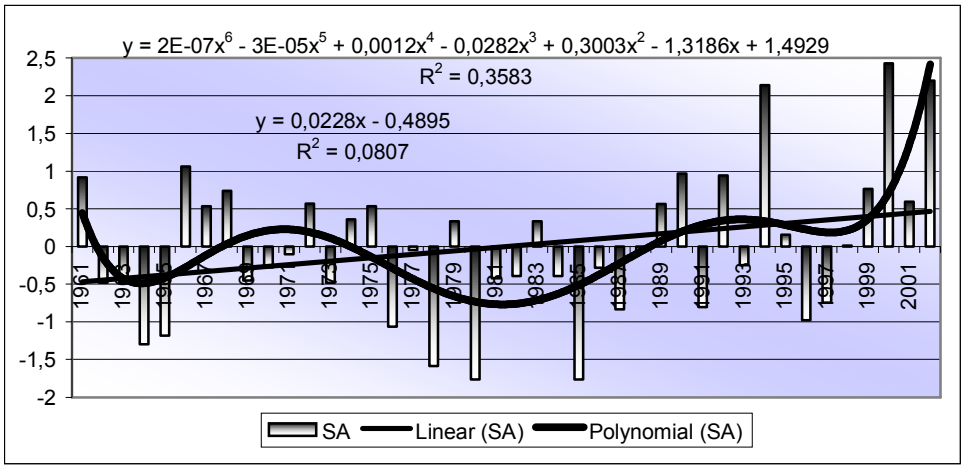

Fig. 3. Annual average values of the standardized air temperature anomalies and their linear and polynomial tendency, in the Western Plain of Romania, North of the Mureş River (1961-2002).

Table 1 shows the years corresponding to different thermic marks. One can note that on the plain's territory, the years 2000, 2002 and 1994 were "excessively hot" compared to the other years. There were no "exceptionally hot" years, with deviations of over 2.5 as there were no "very hot" years – only one "hot" year was recorded. Compared to hot years, the coldest years were just "very cold". There were no records of "excessively cold" or "exceptionally cold" years, in the interval 1961-2002. In the line of "hot" there were more years than in the line of "cold" (14 to 10).

As excessively hot years occurred in the last decade, the linear tendency of the standardized temperature anomalies (STA) has an *upward*

trend. The polynomial tendency shows the presence of periods of temperature growth and drop, in the interval 1961-2002. So, the periods 1962-1965, 1976-1988 and 1996-1997 were cold and 1966-1975, 1989-1995, 1999-2002 and the year 1961 were hot. One can also note the existence of periods of consecutive years with positive, respectively negative anomalies. *Most frequent are the periods of 2 consecutive hot years and 3 consecutive cold years*, but we can also see, in both cases, up to 5 consecutive years.

Table 1

Normal, hot and cold years registered in the Western Plain of Romania, North of the Mureş River (1961-2002).

Ther-mic mark	Exce-ssively hot	Very hot	Hot	Warm	Normal	Cool	Cold	Very cold	Exce-ssively cold
Years	**2000**	-	1966	1990	1974,1983	1996	1964	**1980**	-
	2002			1992	1979,1995	1987	1965	1985	
	1994			1961	1998,1977	1991	1976	1978	
				1999	1988,1971	1997			
				1968	1993,1970				
				2001	1986,1982				
				1972	1984,1981				
				1989	1969,1963				
				1975	1973,1962				
				1967					

Table 2 shows the hottest and the coldest years that have produced in the West of the country. According to the STA method, *the hottest year of the period 1961-2002 was 2000, and the coldest years 1980 and 1985*. The values of the anomalies of the years 1980 and 1985 are very close, as 1980 slightly overtakes the year 1985.

Table 2

The hottest/coldest years registered in the Western Plain of Romania, North of the Mureş River (1961-2002). The values of those years' anomalies, of the annual average temperature and their deviation from the multi-annual average.

	Year	STA value	Annual temp. (°C)	Deviation (°C)
Excessively hot	**2000**	**+2.43**	**10.8-12.6**	**+1.3…+1.9**
	2002	+2.20	11.1-12.2	+1.3…+1.6
	1994	+2.14	11.1-12.0	+1.3…+1.6
Very cold	**1980**	**-1.76**	**8.3-9.5**	**-1.1…-1.4**
	1985	-1.76	8.2-9.5	-1.0…-1.3
	1978	-1.59	8.6-9.7	-0.9…-1.3

CONCLUSIONS

On the territory of the Western Plain of Romania, North of the Mureş River, the annual average air temperature varies between 9.5 and 10.7°C. It drops from the southwest to the northeast, as the latitude grows.

The attribution of the thermic marks for the years of the period 1961-2002 was made using the method of the standardized anomalies. The results showed that the years 2000, 2002 and 1994 were "excessively hot" and 1980, 1985 and 1978 "very cold". There were no "exceptionally hot" years, with deviations of over 2.5, and there were no "excessively cold" or "exceptionally cold" years. The hottest year was 2000 and the coldest years were 1980 and 1985. There was an upward linear tendency of the standardized temperature anomalies. Periods of consecutive years with positive, respectively negative anomalies were found. Most frequent were the periods of 2 consecutive hot years and 3 consecutive cold years.

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