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ANALYSIS OF AIR TEMPERATURE TENDENCY IN THE UPPER BASIN OF BARLAD RIVER

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Abstract. Study of air temperature in the upper basin of Barlad river (eastern Romania), during 1964 – 2007 period, indicates an increasing trend. Data from Negresti meteorological station, the only one in the studied area, and also from other two surrounding stations, Iassy and Vaslui, are analysed. To find the most appropriate expression of the annual mean temperature interannual evolution, different statistical procedures are used: regression models, Runs test and cumulative curve of the temperature standardized anomaly. The parametric analysis with regression models shows significant increasing trends, the quadratic trend model providing a better fit than the linear and exponential models. According to the quadratic model, the temperature increased with 0.9°C at Negresti and Vaslui and with 1°C at Iassy. In the non-parametric analysis the Runs test is used in order to verify if the temperature variation are caused by trend/oscillation and mixture/clustering in the data. At all the three meteorological stations, the results of Runs test, based on the number of runs above/below the median and on the number of runs up or down, did not clearly detect neither a cluster or mixture in the data nor a trend or an oscillation, because all the *p-values* obtained are below *α-level* (0.05). The shape of the cumulative curve suggests that the increasing tendency of the annual mean temperature and the observed fluctuations represent a microcycle. The results are emphasizing the idea that a micro-oscillation, connected with the natural variability of the climate, is more properly than a linear trend. Therefore, it is very probably that the temperature increasing is not an anthropic-induced linear process since 1964 until 2007, it is rather representing the ascensional part of a natural micro-oscillation, which is impelled in the last few years by the anthropical interventions on the environment.

Key words: annual mean temperature, quadratic trend, Runs test, temperature standardized anomaly, microcycle

1. INTRODUCTION

The upper basin of Barlad river is situated in the eastern part of Romania, between 46º06' – 46º45' North latitude and 27º03' – 27º32' East longitude, a geographical position that places it in the temperate climatic zone. Being a part of the Moldavian Plateau, the main climatic traits are modelated by the influence of the physico-geographical factors: the continental position, the western presence of Eastern

Carpathians orographic barrier and the wide openning to East. In detail, the spatial differentiation of the climatic traits is determined by the characteristics of the active surface: local specific of the relief, vegetation, soils and waters. As a result of these interferences, the upper basin of Barlad river has a temperate-continental climate with excessive influences.

The air temperature regime is analysed using data from the monthly meteorological tables of Negresti meteorological station, the only one in the studied area. The station has the geographico-mathematical coordinates about 46°51' North latitude and 27°27' East longitude, it is situated at 133 m altitude and it has a South-East position in the analysed teritory.

The studied area, with a surface of about 1045 km^2 and a mean altitude of 247.6 meters has an aspect of plateaus and hills ensemble of which surfaces are slowly descending to South-South-Est, forming a natural amphitheatre. This area belongs to the Central Moldavian Plateau physico-geographical subunit which is climatic differentiated comparing to the others subunits of the Moldavian Plateau because of the altitude and afforestation difference (it is higher and it has more forest areas). Therefore, it is difficult to interpolate climatic data from the meteorological stations situated in the areas neighbouring the upper basin of Barlad river. Considering this reason and the relative uniformity of the landscape, we think that at Negresti meteorological station the regime of climatic elements in generally, and that of the air temperature in particulary, are representative for the entire upper basin of Barlad river.

Because using statistical information from only one meteorological station might be considered irrelevant, we added into the analysis other two surroundings stations: Iassy (situated in the Jijia Plain, at 104 m altitude) and Vaslui (at the contact between Central Moldavian Plateau and Tutovei Hills, 116 m). Even if these two stations are not situated in the analysed area, the variation of the temperature at Negresti would be more credible if it is sustained by similar results at the neighbouring stations.

This analysis tries to connect the temperature trend of this area with the so-called global climatic changes. Even if there are different theories infirming or non-infirming the climatic changes, it is generally accepted the fact that the global mean temperature has increased over the last 100 years, and in the last decades the warming rate has been accelerated (Solomon et al., 2007). Numerous studies have shown that the warming trend has appreciable spatial and temporal variabilities. In Romania, it is already formed an opinion that in 1901 – 2007 period the annual mean temperature increased by 0.5°C, with a higher rate in the extra-Carpathians regions.

2. ANNUAL MEAN TEMPERATURE

At Negresti meteorological station the multiannual mean air temperature during 1964 – 2007 period (44 years) is 9.2°C. If we compare the mean temperature of 8.9°C from 1964 – 1985 period with the mean of 9.5°C from 1986 – 2007 period, it can be observed an increasing with 0.6°C.

The annual mean temperature has fluctuations with an amplitude of 3.8°C from the multiannual mean. The fluctuations of the annual mean temperature are positive in 45% of the years (varying between 0.1 and 2.0°C), negative in 48%

(varying between 0.1 and 1.8°C) and in 7% of the years the annual mean equals the multianual mean. These fluctuations are generated by the general atmospheric circulation. The negative fluctuations are produced by a longer presence of some maritime and polar atmospheric masses, and the positive ones – by the continental-tropical or maritime advections, which arrive to the Central Moldavian Plateau already continentalized considering the thermic component. In the first part of the time series, between 1964 – 1988 (25 years), the negative fluctuations prevailed, with a mean of about 0.34°C. In the 1989 – 2007 period (19 years) the positive fluctuations prevailed, with a mean of about 0.46°C. These characteristics of the fluctuations show that in the analized period the annual mean temperature increased.

At Iassy meteorological station, during 1961 – 2007 period (47 years), the annual mean temperature is 9.6°C. The mean temperature in 1961 – 1985 period is 9.3°C and in 1986 – 2007 is 10°C, so it can be seen an increasing with 0.7°C.

The mean annual temperature at Vaslui during 1961 – 2007 period (47 years) is 9.5°C. By comparing the means of 1961 – 1985 (9.3°C) and 1986 – 2007 periods (9.9°C), the annual temperature also increased (with 0.6°C).

3. TREND ANALYSIS

The temperature trend is usually emphasized through the linear model, which is the most used and the simplest model for an unknown trend in this type of analysis. It is known that the linear model assumes that the rate of increase or decrease is constant and the linear model is very sensitive to outliers, abnormally high or low values at the start or end of a series having a disproportionate influence upon the estimated slope. But it is not compulsory that the trend should be linear, it could have unlinear models. In order to find out which is the most suitable trend model, we chosen among the linear, quadratic and exponential models calculated through the least squared method.

The trend analysis was made with the statistics package Minitab. Along with the coefficient of determination (R^2) and the graph containing the observations and predicted values versus time, in order to determinate the precision of the fitted values the program calculates three measures of accuracy. R^2 has values between 0 and 1. The closer is R^2 to 1, the stronger is the intensity of the connection between the two variables which here are temperature and time. When R^2 is 1.0, the relationship is perfect linear. The three indicators used are: the mean absolute percentage error (MAPE), the mean absolute deviation (MAD) and the mean squared deviation (MSD). These indicators are not very informative by themselves, but they are used to compare the values obtained by using different trend models. For all the three measures, smaller values generally indicate a better fitting model. By comparing the fits of the different methods we can decide which is the most adequate model.

MAPE expresses accuracy as a percentage:

$$\mathrm{MAPE} = \frac{\sum_{t=1}^{n} |(y_t - \hat{y}_t)/y_t|}{n} \times 100 \quad , \quad y_t \neq 0, \quad (1)$$

where: y_t represents the actual value, $\hat{y}_t$ represents the fitted value and *n* represents the number of observations.

MAD expresses accuracy in the same units as the data, helping to conceptualize the amount of error:

$$\mathrm{MAD} = \frac{\sum_{t=1}^{n} |y_t - \hat{y}_t|}{n} \quad (2)$$

MSD is regardless of the model, so it can be compared across models. MSD is a more sensitive measure of an unusually large forecast error than MAD. The formula is:

$$\mathrm{MSD} = \frac{\sum_{t=1}^{n} |y_t - \hat{y}_t|^2}{n} \quad (3)$$

For Negresti meteorological station, the performance of each model is presented in table 1. The value of R^2 for the quadratic model (0.2095) even it is rather far from the ideal value of linearity, is higher comparing to the linear and exponential model, and it indicates that this model is the most appropriate. Also, all the three accuracy indicators have lower values for the quadratic model compared to the linear and exponential models; therefore, the quadratic trend model seems to provide the better fit. According to the quadratic model, for 1964 – 2007 period, it can be observed an increasing trend of the air temperature (Fig. 1). The regression equation of the temperature shows that in the whole period of 44 years, the mean temperature raised with 0.9°C, overtaking the significance level of 5% from the multiannual mean (5% represent 0.5°C).

Table 1, Annual mean temperature at Negresti – characteristics of the trend models

Trend model	MAPE (%)	MAD (°C)	MSD (°C^2)	Estimating equation	R^2
Linear	6.9620	0.6325	0.6171	$Y_t = 0.022t + 8.7134$	0.1125
Quadratic	6.5857	0.6008	0.5497	$Y_t = 0.001802t^2 - 0.059t + 9.335$	0.2095
Exponential	6.9152	0.6305	0.6165	$Y_t = 8.7031e^{0.0023t}$	0.1059

In the case of Iassy and Vaslui stations (Tab. 2), R^2 has the higher value for the same quadratic estimating equations. At Iassy, the measures of accuracy have lower values also for the quadratic model. At Vaslui, the quadratic model is sustained only by MAPE and MSD, MAD having the lower value for the linear model. But, because only one value does not indicate the quadratic model, we can consider this model is the most appropriate for the annual mean temperature at Vaslui meteorological station. The quadratic equation indicates that in 1961 – 2007 period the annual mean temperature increased at Iassy with about 1°C and at Vaslui with about 0.9°C (Fig. 2). At both meteorological stations, the increasing trend is significant, overtaking the level of 5%.

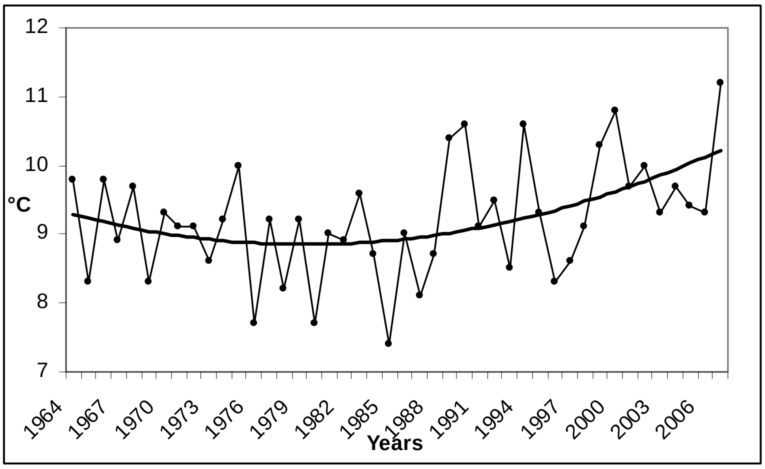

Figure 1, The annual mean temperatures (thin line) and the quadratic trend (thick line) at Negresti, 1964 – 2007

Table 2, Annual mean temperature at Iassy and Vaslui – characteristics of the trend models

Trend model	MAPE (%)	MAD (°C)	MSD (°C^2)	Estimating equation	R^2
Iassy					
Linear	6.6217	0.6334	0.6282	$Y_t = 0.0244t + 9.0673$	0.1486
Quadratic	6.5443	0.6279	0.5932	$Y_t = 0.0011t^2 – 0.0301t + 9.5129$	0.196
Exponential	6.5645	0.6299	0.6275	$Y_t = 9.0627e^{0.0025t}$	0.1423
Vaslui					
Linear	6.2049	0.5870	0.5256	$Y_t = 0.0203t + 9.0582$	0.1258
Quadratic	6.2045	0.5880	0.5032	$Y_t = 0.0009t^2 – 0.0234t + 9.4147$	0.163
Exponential	6.2062	0.5888	0.5254	$Y_t = 9.0511e^{0.0021t}$	0.1204

Considering that the quadratic model found at Negresti is sustained by the same trend at Iassy and Vaslui, it can be admitted that this trend is the most suitable to decribe the annual mean temperature evolution in the upper basin of Barlad river.

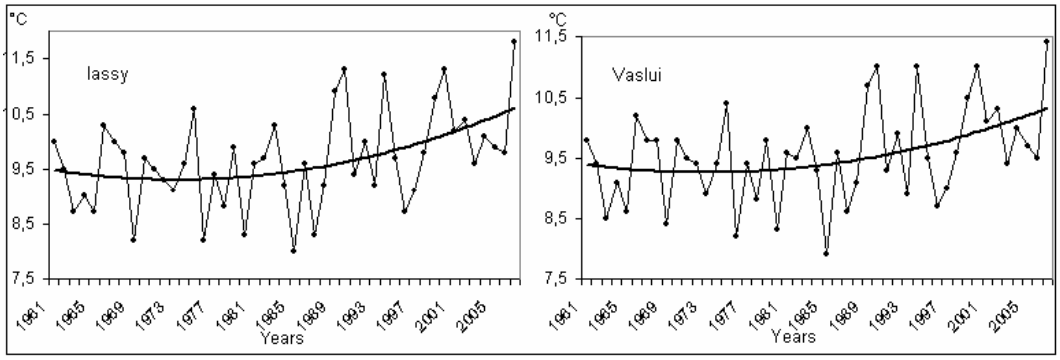

Figure 2, The annual mean temperatures (thin line) and the quadratic trend (thick line) at Iassy and Vaslui, 1961 – 2007

The increasing tendency of the annual mean temperature might be generated by various sources. One of them could be the anthropical pressure on the local environment. Since in the upper basin of Barlad river the anthropical interventions in the environment don't have a big development, the increasing temperature can not be caused entirely by these. The increasing trend of the air temperature at Negresti can't be very clearly connected neither with the global warming, mostly because it does not exist a recognizable and identical pattern in the response to global warming, sometimes in different regions the effects are conversely (Brunetti et al., 2004).

The increase of the temperature can be explained only by an unperiodical variation of the climate at a microregional scale. Because the climatic changes are produced at a very large time scale, this tendency of the temperature is more probably not an expression of the global climatic changes but a meteorological variation (Rusu, 2007). A climatic change is produced at a scale of hundred or even thousands of years. Even the classically described fluctuations for the last millennium are considered to be widespread but limited climatic changes: the so-called Medieval Warm Period (900-1400 A.D.) followed by the Little Ice Age (1500-1800 A.D.). It is considered that their succession would represent the last cycle (Bond et al., 2001) and the present climate "is in an ascending phase on its way to attaining a new warm optimum in a few centuries" (Bard & Frank, 2006).

Because the best fitted trend model is the quadratic one, it can be supposed that the increasing tendency of temperature in the last 20 years is the ascensional part of a microcycle. This is in accordance with the results of other researches (Le Mouël et al., 2005; Miyahara et al., 2008), who revealed a positive correlation of the air temperature with the solar and geomagnetic activity, in terms of 11- and 22-year, supporting the cyclical evolution of the climatic parameters.

4. NON-PARAMETRIC TESTS

Another way to test if there is a trend or an oscillation in the data is represented by the non-parametric tests. The non-parametric testing is an alternative to the linear and nonlinear trend models, because it does not assume that the data follow a specific distribution and it is less sensitive to extreme values. Because this analysis is based only on a single time series (from Negresti), the non-parametric test which is used here is one of the tests recommended by the World Meteorological Organization (WMO, 1983), namely Runs test. This test is considered to be one of the easiest to apply procedure for testing randomness (Koutras, Alexandrou, 1997). The procedure is based on the Wald-Wolfowitz test, developed in 1940 by the Romanian born US statistician Abraham Wald (1902 – 1950) and the Polish born US statistician Jacob Wolfowitz (1910 – 1981).

The Runs test shows if special causes are influencing the time series. The test is based on the idea that the variation which can occur in a process can be common or special. The common variation is a natural part of all processes in the environment. The special variation is due to additional factors which came from outside the system and can cause recognizable patterns, shifts or trends in the data. Of course, the signal of the special variation is hidden in the common variation and it can be difficult to detect.

Based on the number of runs, Minitab program performs two tests to determine if there are variations in the data due to clustering, mixtures, trends or oscillations. One of the tests is based on the number of runs above or below the median and the other is based on the number of runs up or down.

4.1. Test for number of runs about the median

The test for number of runs about the median is based on the total number of runs that occur both above and below the median value of the series. A run about the median represents one or more consecutive points on the same side of the median (when the points are connected by a line, a run ends when the line crosses the median; a new run begins with the next plotted point). The test is sensitive to two types of non-random behavior – mixtures and clusters. Mixtures are characterized by the absence of points near the median. Clusters are groups of points that have similar values.

The test compares the observed number of runs with the expected number of runs above and below the median. When the observed number of runs is statistically less than the expected number of runs, then clusters are suggested. Assuming a standard normal distribution, *p-value* for clustering, noted here p'$_1$-value, is:

$$p'_1\text{-value} = \text{cdf}(Z_1) \quad (4)$$

where *cdf* represents the cumulative probability to Z_1, while Z_1 is being calculated with the formula:

$$Z_1 = \frac{r_1 - E_1(\text{runs})}{\sqrt{\sigma_1^2}} \quad (5)$$

where: r_1 is the total number of runs, E_1(runs) is the expected number of runs and σ_1^2 is the variance of the expected number of runs distribution.

E_1(runs) is calculated with the formula:

$$E_1(\text{runs}) = 1 + \frac{2m_1n_1}{m} \quad (6)$$

where: m_1 is the number of points above median, n_1 is the number of points below and on the median and *m* is the total number of observations (sum of m_1 and n_1).

The variance σ_1^2 is given by the formula:

$$\sigma_1^2 = \frac{2m_1n_1(2m_1n_1 - m)}{m^2(m-1)} \quad (7)$$

When the observed number of runs is statistically greater than the expected number of runs, then mixtures are suggested. Assuming a standard normal distribution, the *p-value* for mixtures, noted here p''$_1$-value, is:

$$p''_1\text{-value} = 1 - \text{cdf}(Z_1) \quad (8)$$

where cdf(Z_1) has the same significances as above.

The test shows that at Negresti the number of observed runs about the median (19) is statistically less than the expected number of runs (22.4) so the clustering of date is suggested. But because the difference is not very large, we can say that the clustering is not very obvious, is more like a slight tendency. Also, the *p-values* for clustering (0.146) and mixtures (0.854) are greater than the α-*level* of 0.05. Therefore, we can conclude that the data does not really indicate mixtures or clusters, but because the *p-value* for clustering is closer to the α-*level* than the *p-value* for mixtures we can say that there are indications for a slight clustering. The observed clustering might be connected with the fact that there are some segments of the time series with clusters of observations but this is not a trait for the whole series.

The case of Iassy station is very similar with the one from Negresti station. That is the number of observed runs about the median (21) is statistically less than the expected number of runs (24.5) and *p-values* for clustering (0.152) and mixtures (0.848) are greater than the α-*level* of 0.05. These are also suggesting a clustering in the date.

In the case of Vaslui station, the situation is reverse: the number of observed runs about the median (27) is greater than the expected number of runs (23.8). Also, *p-values* for clustering (0.83) and mixtures (0.17) are greater than α-*level* of 0.05 but this time *p-value* for mixtures is closer to the α-*level*.

The results of this Runs test at Negresti are similar with those from Iassy, but contrary to those from Vaslui. Even so, because the differences between the number of observed and expected runs about the median are quite small, and because all the *p-values* for clustering/mixtures are greater than α-*level* we can admite that there is no special variation in the data due to cluster/mixture, only the common ones.

4.2. Test for number of runs up and down

The test for number of runs up and down is based on the number of increasing or decreasing runs and is sensitive to two types of non-random behavior, that are oscillations and trends. A run up or down represents one or more consecutive points in the same direction (a new run begins each time there is a change in direction, either ascending or descending; when the precedent value is smaller, a run up begins and continues until the precedent value is greater than the next point, and then it begins a run down). When the observed number of runs is statistically greater than the expected number of runs, then oscillation is suggested; when it is statistically less than the expected number of runs, then a trend is suggested.

In a standard normal distribution, the *p-value* for trends, noted here p'_2-value, is calculated with the formula:

$$p'_2\text{-value} = \mathrm{cdf}(Z_2) \qquad (9)$$

where *cdf* is the cumulative probability to Z_2 which is calculated with the formula:

$$Z_2 = \frac{r_2 - E_2(\text{runs})}{\sqrt{\frac{16N-29}{90}}} \qquad (10)$$

where: r_2 is the number of runs up or down, E_2(runs) is the expected number of runs up and down and N is the total number of medians or means (being the sum of m_2 and n_2).

E_2(runs) is calculated with the formula:

$$E_2(\text{runs}) = \frac{2(m_2+n_2)-1}{3} \qquad (11)$$

where m_2 is the number of points above center line and n_2 is the number of points below or equal to center line.

The *p-value* for oscillation, noted here p''$_2$-value, in a standard normal distribution is:

$$p''_2\text{-value} = 1 - \text{cdf}(Z_2) \qquad (12)$$

where cdf(Z_2) has the same significances as above.

In Negresti case, the number of runs up or down (32) is greater than the expected number of runs (28.3), so we can say that is suggested an oscillation but data do not vary up and down rapidly. The *p-values* for trends (0.912) and oscillation (0.088) are greater than the α-*level* of 0.05. Therefore, we can conclude that the data does not strongly indicate a trend or oscillation, but as the *p-value* for oscillation is smaller than the *p-value* for trend, then is more appropriate to say that an oscillation has a bigger probability than a trend.

At Iassy meteorological station the observed number of runs up or down (30) is less than the expected number of runs (31), but the difference between them is very small. Also, *p-values* for trends (0.362) and oscillation (0.638) are greater than the α-*level* of 0.05, but this time the value for trends is closer to the α-*level* than the value for oscillation.

In the case of Vaslui station the observed number of runs up or down (32) is greater than the expected number of runs (30.2), so this could indicate an oscillation. Also, *p-values* for trends (0.724) and oscillation (0.276) are greater than the α-*level* of 0.05, but the value for oscillation is closer to α-*level* than the values for trends.

As a consequence, the results of this test show that the situation at Negresti is similar with the one of Vaslui, where an oscillation is indicated and opposite to the one from Iassy, where *p-value* indicates a trend. Because no *p-value* obtained is below α-*level*, we can conclude that there is no strong proove that there is a special variation due to trend or oscillation. Even so, because from all the *p-value* obtained in both Runs tests, the closest to α-*level* (0.05) is *p-value* for oscillation (0.088) at Negresti, we can consider this as a sign for a possible oscillation.

5. CUMULATIVE CURVE OF THE TEMPERATURE STANDARDIZED ANOMALY

A modality to emphasize the periods with surplus or deficit of the annual mean temperature comparative with the multiannual mean is represented by the cumulative curve of the temperature standardized anomaly. The concept of the cumulative analysis is largely used in the climate research (Lozowski, 1989; Jin et al., 2005), based on the idea that the climate expresses not only its parameters at a given moment, but also their cumulative effects.

The temperature standardized anomaly (TSA) is calculated in the same way as the precipitation standardized anomaly (Maheras et al., 1999) with the formula:

$$TSA_i = \frac{X_i - X}{\sigma_i} \qquad (13)$$

where: *i* is the period for which TSA is calculated (year in this case), X_i is the mean temperature of the interval *i*, X is the multiannual mean temperature, σ_i represents the annual standard deviation of the monthly mean value of temperature.

The standard deviation is calculated with the formula:

$$\sigma_i = \sqrt{\frac{\sum_{i=1}^{n}(X_i - X)^2}{n-1}} \qquad (14)$$

where *n* represents the length of the time series, which here is 44.

The cumulative curve of TSA uses the TSA values calculated for consecutive years. The plotted points (fig. 4) have the values a_n calculated with the formula:

$$a_n = \sum_{i=1}^{n} TSA_i \qquad (15)$$

On the curve represented in fig. 3, the periods characterized by accumulations of the temperature surplus or deficit can be observed. The descending branch covers a period when the temperature deficit is accumulated and on the ascending branch the surplus is accumulated. When the curve crosses the zero-value of TSA then the deficit (if the values are lower than zero) or surplus (if the values are larger than zero) anterior accumulated is neutralized.

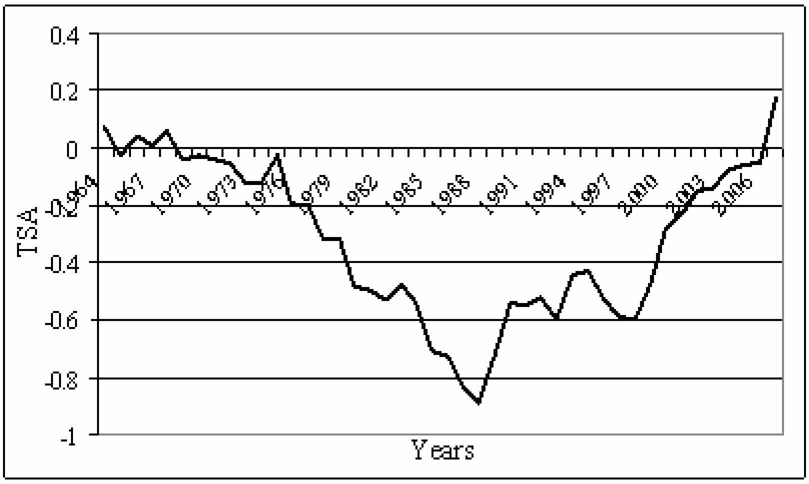

Figure 3, Cumulative curve of the temperature standardized anomaly at Negresti (1964-2007)

As it can be seen in the figure 3, at Negresti during 1964 – 1974 period, the TSA was firstly constant and then slightly decreasing and it was very close to the zero threshold-value. In 1975 – 2006 period the temperature deficit from the first part of the period is neutralized by the surplus from the second part. Because the grown value from 2007 year is explained by the fact that 2007 was an year of the climatic excesses, we can consider that the whole analysed period represents a cycle on a microclimatical scale.

The shape of the cumulative curve of the TSA at Negresti is generally similar with the one from Iassy and Vaslui (Fig. 4). The differences between them are very small, like the fact that the neutralization of the temperature deficit from the las few years began more rapidly at Iassy and Vaslui comparing with Negresti. This is a consequence of the fact that the annual mean temperature in the last few years was higher at Iassy and Vaslui comparing with Negresti. This might be connected with the fact that the anthropical interventions on the local environment is reduced in Negresti area comparative with the other two areas.

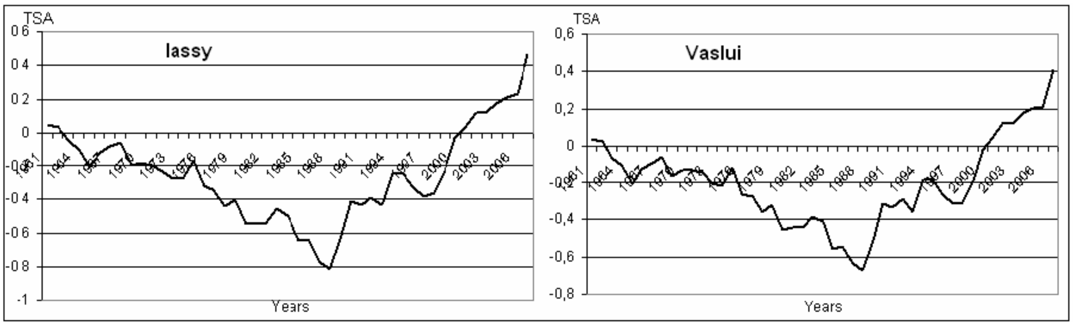

Figure 4, Cumulative curve of the temperature standardized anomaly at Iassy and Vaslui

The shape of the cumulative curve suggests that the increasing tendency of the annual mean temperature and the observed fluctuations represent a microcycle, expression of the normal variations of the climate, which in the last few years is reacting to the anthropical interventions.

6. CONCLUSIONS

The increasing tendency and variability of the air temperature in the upper basin of Barlad river have been investigated in this study. The analysis has been performed using the time series of the annual mean temperature recorded in a 44-year period (1964 – 2007) at the Negresti meteorological station. In order to sustain the results from Negresti, we also used data from two neigbouring stations, namely Iassy and Vaslui.

It was found that during this period, the mean annual temperature showed significant warming tendency. The values of R^2 and the three accuracy indicators (MAPE, MAD, MSD) are indicating that the quadratic model is the most suitable for the annual mean temperature evolution at all the meterorological stations considered. According to the quadratic model the temperature increased with 0.9°C at Negresti and

Vaslui and with 1°C at Iassy. Given the fact that the quadratic model provides a better fit than the linear and exponential models, we consider that the increasing of temperature is due not to a trend but to a micro-oscillation.

The multiannual mean temperature was also statistically examined by Runs test. The results of Runs test based on number of runs above/below the median is similar at Negresti with Iassy and opposite to Vaslui. The results of Runs test based on the number of runs up or down is similar at Negresti with Vaslui and opposite to Iassy. Even if the Runs test did not clearly detect neither a cluster or mixture in the data, nor a trend or an oscillation, the results of the test indicate that an oscillation is more probably than a trend, mixture or cluster in the data. Anyway, we can not expect that the results would clearly indicate a special variation because it is rather difficult to surprise the natural variability of a climatic element in a statistical analysis.

Because Runs tests showed no special variation, we think that the microcycle suggested in this paper is caused principally by the natural variability of the climate. It can not be established if this microcycle is periodical or unperiodical because the time series of 44-years record at Negresti and 47 at Iassy and Vaslui is too short to determine long-term periodicities accurately and to make generalization by extending for longer periods.

This micro-oscillation in the multiannual regime of mean temperature is also supported by the shape of the TSA cumulative curve at all the three stations involved.

It is hard to believe that the microscale oscillation showed in this paper is the result of a warming process generated exclusively by anthropogenic causes. The significant increasing of the temperature might be a part of the global warming phenomenon or can be related to the natural climate variability or can be a result of both. By definition, the climate of a specified location cannot be considered a constat environmental factor because of the systematic forcing changes (like the variarions of the Earth’s orbit) and because it has low frequency fluctuations. It is the most probably that the warming is not an anthropic-induced linear process since 1964 until 2007, it is rather the ascensional part of a natural micro-oscillation, which is impelled in the last few years by the human activities.

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