ON THE ANNUAL VARIATION OF AIR TEMPERATURE IN THESSALONIKI

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(Introduced by Prof. G. C. Livadas)

Abstract: *Annual variation of air temperature in Thessaloniki is examined, after reduction to homogeneous and uniform series of monthly mean values from observations of a number of stations that operated here between the year 1892 - 1973, that is 82 full consecutive years.*

A slight decreasing trend of the annual mean and of the minima of monthly mean values is observed, while maxima remain almost steady.

INTRODUCTION

The annual variation of air temperature in Thessaloniki is studied in this paper from monthly mean values of the 1892 - 1973 period, that is 82 full years.

The subject has been examined at times by a number of scientists studying either the climate of Thessaloniki or that of the whole area of Greece including Thessaloniki, i. e. EREDIA [6], KUHLBRODT [10,11], MARIOLOPOULOS [16], ALEXANDROU [1], KYRIAZOPOULOS [12] and others.

In all the above works, the authors based their study of air temperature in Thessaloniki on data resulting from observational series effected at various sites within or outside the city, and for different observational periods.

The meteorological observations of the 1892 - 1973 period examined in the present paper were made at different hours for each station; as a consequence the resulting monthly mean values of air temperature could not be compared with each other without further elaboration.

This difficulty however may be outdone by establishing an homogeneous series of monthly mean air temperature values. Such homogeneity is attained by reducing all the monthly mean values of the obser-

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vational series of every station that ever operated in various sites, to one and the same site in the city of Thessaloniki: as such has been chosen the site of the met. station of the Aristotelian University of Thessaloniki, which has been operating at the same place ever since 1930.

Similar processes for the homogenization of observational series of air temperature were used lately by PAESLER [17], for an observational period from 1781 to 1968 in the city of Munich (Germany) and by ARSENI - PAPADIMITRIOU [3] for the 1858 - 1972 period in the city of Athens (Greece).

By this homogeneous series of monthly mean air temperature values of the 1892 - 1973 period, we obtain now a more complete picture of the annual variation of air temperature in Thessaloniki.

MATERIAL - SOURCES - HOMOGENIZING PROCESSES

The material for the present paper has been collected from the following sources:

1. Observations of the Austrian meteorological station from 1.1.1892 till 31.8.1915, published in the monthly meteorological bulletins of the Zentralanstalt für Meteorologie und Geodynamik in Wien [19].

These observations were effected from 1.1.1892 till 31.1.1894 at 08 : 00, 14 : 00, 21 : 00, (l.t.) during the cold season, and at 07 : 00, 14 : 00, and 21 : 00 in the warm season; while from 1.1.1895 till 30.11.1900 the observational hours remained unchanged at 08 : 00, 14 : 00, 21 : 00. From 1.12.1900 till 31.1.1901 the hour of the evening observation was moved to 18 : 00 and then from 1.2.1901 - 31.3.1901 it was changed to 17 : 00 .

During the interval 1.3.1901 - 30.11.1912 the observational hours remained at 07 : 00, 14 : 00, 18 : 00, while from 1.12.1912 - 31.8.1915 they underwent small changes, especially the morning and evening observations.

The thermometer stood at a height of 6-7 m from the ground during the whole observational period from 1.1.1892 to 31.8.1915.

2. Observations of the «Cyril and Methodius» Bulgarian Gymnasium: these were effected during the interval from 1.1.1900 to 30.6.1912 and published in the «Annuaire de l'Institut Météorologique de Bulgarie» [20]. These observations were held at 07 : 00, 14 : 00 and 21 : 00 hours during the whole observational period, without any change.

3. The observational series of the Greek Gymnasium of Thessaloniki, covering the period between 1.5.1909 - 30.11.1922, but with many interruptions and blanks in the observations. These observations

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have been published in the Annales de l'Observatoire National d'Athènes[21].

For the study of this series we have also used photocopies from the monthly sheets of observations. The hours of observation were the standard times of every station in the Greek network (08:00, 14:00, 21:00) without any change for the whole period that this station was in operation.

More detailed informations, concerning the site and the operating conditions of the stations of the above observational series are given by ALEXANDROU [1] and KYRIAZOPOULOS [12].

4. The observations of the met. station of the Flying School at Sedhes, covering the period between 1.5.1923 - 31.10.1923, and published in Vol. X of the Annales de l'Observatoire National d'Athènes [22]. In this case also we have made use of photocopies from the monthly sheets of observations of this station.

This same station, functioned under the name of Sedhes Air Base from 1.1.1936 till 30.6.1940 and again from 1.1.1950 till 31.5.1959. Observations of the first period have been published in the Annual Meteorological Bulletin, Vol. II - IV, of the Met. Service of the Ministry of Aviation [24] (1.1.1937 - 30.6.1940) and in the Annales of the National Met. Service, Vol. V - VIII [23] (1.1.1936 - 31.12.1939), and those of the second period in the Monthly Climatological Bulletin of the Hellenic National Meteorological Service [29].

5. Series of Meteorological Observations from the met. station of the American Farm School, covering the period between 1.7.1924 - 31.5. 1959.

These observations have been published as follows: those of the 1.7. 1924 - 31.12.1931 period in the «Annales de l'ObservatoireNational d' Athènes» [2], and those of the 1932 - 1939 period in the Annales of the Hellenic National Meteorological Service, Vol. I - VIII [23], while photocopies of the observations of the 1.1.1940 - 31.5.1959 period have been taken from the files of the National Meteorological Service [30].

Observations at the American Farm School were effected till 21.12. 1929 at 08:00, 14:00, 21:00, while from 1.1.1930 the time of the evening observation has been changed to 20:00.

6. Observations of the Meteorological Institute of the Aristotelian University of Thessaloniki (A.U.T.): these cover two complete observational series: from 1.1.1930 to 31.10.1940 and from 1.7.1945 to 31.12. 1973. The series between 1.11.1940 - 30.6.1945 is incomplete. These observations have been published in the series «Observations Météorologiques de Thessaloniki - Annuaire de l'Institut Météorologique»

On January 1, 1959 this station was moved from the site where it stood since 1.1.1930 to a new position at some 230 m to the east of its former site.

7. Observations of the German weather station in Thessaloniki, covering the period between 1.11.1941 to 31.7.1944 and published in the series «Climatologika» No 1. of the Meteorological Institute of the Aristotelian University of Thessaloniki (LIVADAS - ARSENI [28]).

Examination of the material in hand indicated inhomogeneity in the monthly mean values of air temperature in Thessaloniki, mainly due to the difference in the observational hours of the various stations that have functioned in Thessaloniki during the period examined. This inhomogeneity has been overcome by reducing all the monthly mean values to the 24-hours mean, taken from thermograph recordings of the A.U.T. station of the 1930 - 1973 period.

There are several criteria for determining any existing homogeneity between the monthly mean air temperature values of two met. stations, the principal criteria being those of A. Schmidt [18] and Abbe, as it was completed later by V. Conrad [3,5].

According to Abbe's criterion, in order to consider a series of air temperature values $X_1, X_2, \ldots X_n$ as homogeneous to the corresponding series $Y_1, Y_2, \ldots Y_n$ of another station, the following relation has to be fulfilled:

$$1 - \frac{1}{\sqrt{n-1}} \leqslant \frac{2A}{B} \leq 1 + \frac{1}{\sqrt{n-1}}$$

where $A = \sum_{i=1}^{n} d_i^2 - \frac{d_1^2 + d_n^2}{2}$, $B = \sum_{i=1}^{n} (d_{i-1} - d_i)^2$, $d_i = \Delta_i - \overline{\Delta}$,

$$\overline{\Delta} = \frac{\sum_{i=1}^{n} \Delta_i}{n} \quad \text{and} \quad \Delta_i = X_i - Y_i$$

This criterion has been applied lately by PAESLER [17] in homogenizing various observational series between the years 1781 - 1968 in the city of Munich (Germany).

Application of Abbe's criterion to the series of air temperature values from the various stations that operated in Thessaloniki during the period examined, establishes their homogeneity.

The resulting figures of correlation coefficients (r) of these series (separately for each month), indicate the existence of a strong correla-

tion: Consequently, by using the regression line equation, it is possible to reduce them in a unique series of values or even to fill out missing values of one series from corresponding values of another.

According to the above process, we have reduced the various series of monthly mean air temperature values of Thessaloniki to a unique series.

Thus from the complete series (with the exception of January 1901) of the Austrian met. station and by using the regression line equation we have completed and extended till the year 1892 the series of air temperature values from the Greek Gymnasium, since a strong correlation exists between the above two series ($r = 0.99$). The missing figure for the month of January 1901 of the Austrian station has been replaced from the corresponding value of the Bulgarian met. station, again by the regression line equation, since we have $r = 0.97$. Thus a uniform series of monthly mean values of air temperature has been established for the Greek Gymnasium from 1.1.1892 to 1.1.1922, with a few missing figures (within certain intervals); we shall see below how these gaps were filled in.

The series of the American Farm School has been extended backwords till 1.5.1923, by application of the regression line equation, from the corresponding series of the Sedhes Flying School station, since the correlation coefficient between the two series for their common period between 1.1.1936 - 30.6.1940 and 1.1.1950 - 31.5.1959, is quite high, varying between 0.91 - 0.98.

Missing monthly mean values of air temperature in the series of the A.U.T. station for the interval 1.11.1940 - 30.6.1945 and extension backwords of the same series till 1.5.1923 has been effected again, by application of the regression line equation, from the corresponding values of the American Farm School and the German Weather Station, since the correlation between them is quite strong ($0.95 \leq r \leq 0.99$). By this process a uniform series of monthly mean values has been established for the A.U.T. station, covering the period between 1.5.1923 - 31.12.1973.

Since the site on which the station of the Greek Gymnasium had been operating is very near to the actual site of the A.U.T. station and these two stations have never been operating simultaneously, we consider the series of monthly values of the second station as sequence of the first.

Having thus established a uniform series of monthly mean air temperature values for the 1892 - 1973, with a few values missing during

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the 1916 - 1924 period, whose completion from the existing stations has been impossible, we had to recur to the data of the met. station of Volos: This station ($\varphi = 39^0$ 22', $\lambda = 22^0$ 57') had been functioning from 1894 till 1939, and had an almost complete series of monthly mean air temperature values. Application of Abbe's criterion on annual mean values, proved the existence of homogeneity between the series of A.U.T. and Volos ($0.78 < \frac{2A}{B} = 0.93 < 1.22$).

The resulting correlation coefficient values r, varying between 0.86-0.96 (separately for each month) indicate the existence of a satisfactory correlation between temperature values of these two stations. Thus, the missing values of the A.U.T. station have been calculated from the corresponding data of Volos station using again the regression line equation.

Through the processes described above, a complete and uniform series of monthly mean air temperature values has been established for the station of the Aristotelian University of Thessaloniki (A.U.T.), covering the period between 1892 - 1973. These values are given (in ⁰C) in the adjoined Appendix, separately for each year and month.

CONCLUSIONS

1. The annual mean value of air temperature (in ⁰C) in Thessaloniki for 82 full years (1892 - 1973), and also the annual maximum and minimum, have as follows:

Maximum	17.32	(1916)
Mean	16.18 ± 0.52	
Minimum	15.02	(1940)

The maximum annual value of air temperature in Thessaloniki (17.32 ⁰C) was recorded in 1916, a year that has been extremely warm for the whole area of Greece (Mariolopoulos [16]).

Graph I gives a picture of the variation of annual values of air temperature during the period examined (1892 - 1973).

Table I shows that 45 annual mean values (55 %) of air temperature are between 16.0 - 17.0 ⁰C, meaning that the absolute annual mean of the period 16.18 ⁰C stands between the limits that include the highest percentage of annual values.

2. The annual variation of air temperature has a single fluctuation, with a maximum in July and a minimum in January (Table II, Graph II).

The minimum monthly mean air temperatures are recorded in Thes-

Distribution of annual mean air temperature values.

Grades (°C)	15.0°	15.5°	16.0°	16.5°	17.0°	17.5°
Cases		10	22	25	20	5
Percentage (%)		12	27	31	24	6

saloniki in the months December, January. and February. Thus out of 82 cases of monthly minima, 21 %, 60 % and 17 % have been recorded in December, January and February respectively, and only 2 % in January and December of the same year.

GRAPH I

VARIATION OF THE MEAN ANNUAL AIR TEMPERATURE
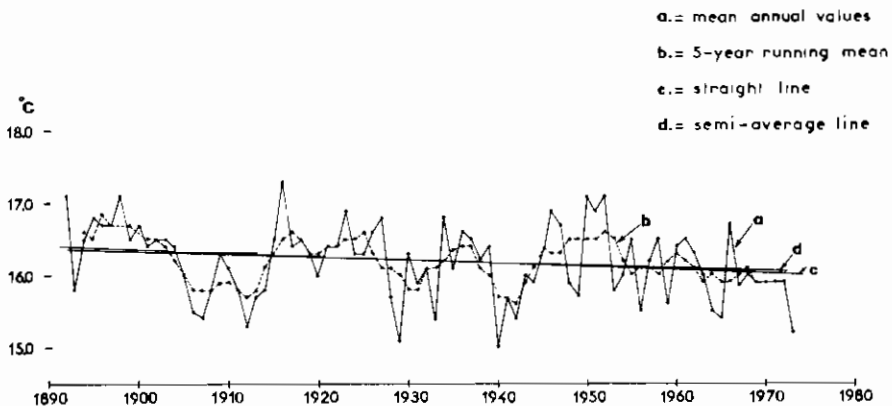
Although the coldest months are the main winter months (December, January, February), yet there are quite a few cases in November, March, or even April when the minimum thermometer falls to zero or even below, due to cold invasions occuring in that season (LIVADAS [14]).

On the other hand maximum monthly mean values within a year are recorded in the months of July and August, since in 68 % out of 82 cases maxima have been recorded in July and in 32 % in August.

July and August, the two warmest months of the year, slightly differ in their mean temperature values, while the mean of September (22.38 °C) is smaller than that of June by 1.4 °C only.

Data of Air Temperature in Thessaloniki (A.U.T. 1892 - 1973).

Month	Tmax	Year	T_M	±σ	C.V.%	T_R	Tmin	Year
J	10.49	1936	5.91	2.05	34.68	9.60	0.89	1942
F	11.33	1955	7.33	1.97	26.87	9.44	1.89	1929
M	13.72	1947	10.39	1.67	16.07	7.46	6.26	1956
A	17.36	1947	14.89	1.17	7.85	5.15	12.21	1955
M	23.15	1945	19.67	1.31	6.66	8.15	15.00	1919
J	26.58	1916	23.78	0.94	3.95	5.36	21.22	1921
J	28.25	1950	26.47	0.78	2.95	3.80	24.45	1969
A	28.39	1952	26.04	0.91	3.49	4.30	24.09	1949
S	25.42	1946	22.38	1.42	6.34	6.52	18.90	1941
O	21.47	1932	17.35	1.50	8.64	8.27	13.20	1972
N	15.53	1926	12.14	1.70	14.00	8.49	7.04	1920
D	11.72	1916	7.80	1.70	21.79	8.77	2.95	1948
Y	17.32	1916	16.18	0.52	3.21	2.30	15.02	1940

T_M = Monthly mean air temperature.
σ = Standard deviation.
C.V. = Coefficient of variation.
Tmax = Monthly mean maximum air temperature.
Tmin = Monthly mean minimum air temperature.
T_R = Monthly temperature range.

It should be mentioned that in 1916, which has been the warmest year of the period, have also been recorded the monthly maxima of June and December. The absolute minimum monthly values for January (0.89°C) and for February (1.89 °C) have been recorded in 1942 the first and in 1929 the second, that is during the coldest winters of the period examined (KARAPIPERIS[9], LIVADAS[13]).

3. From standard deviation values and the correlation coefficient for each month, we conclude that the mean variability of the different months is higher during the winter quarter of December - February and smaller during the summer quarter of June - August.

This is due to weather conditions prevailing during the winter months, characterized by intense variability, while during the main two summer months, July and August weather conditions tend to become smoother from day to day (FLOCAS[7,8]).

4. The monthly temperature range (Table II) acquires its highest values during the five months from November to March and again in May (7.46 - 9.60 °C), and its smallest values during the main summer months of July (3.80 °C) and August (4.30 °C).

The mean annual temperature range in the city of Thessaloniki

is 20.56ºC, that is higher than the corresponding range of Athens (19.3ºC, Arseni ') by almost 1.3 ºC. However the annual temperature range undergoes many variations: during the period from 1892 to 1973 its highest value is 25,20 ºC (1942), and its smallest 18.01 ºC (1955), meaning that its absolute range is 7.12 ºC.

G R A P H   II

ANNUAL VARIATION OF AIR TEMPERATURE
IN THESSALONIKI (1892-1973)
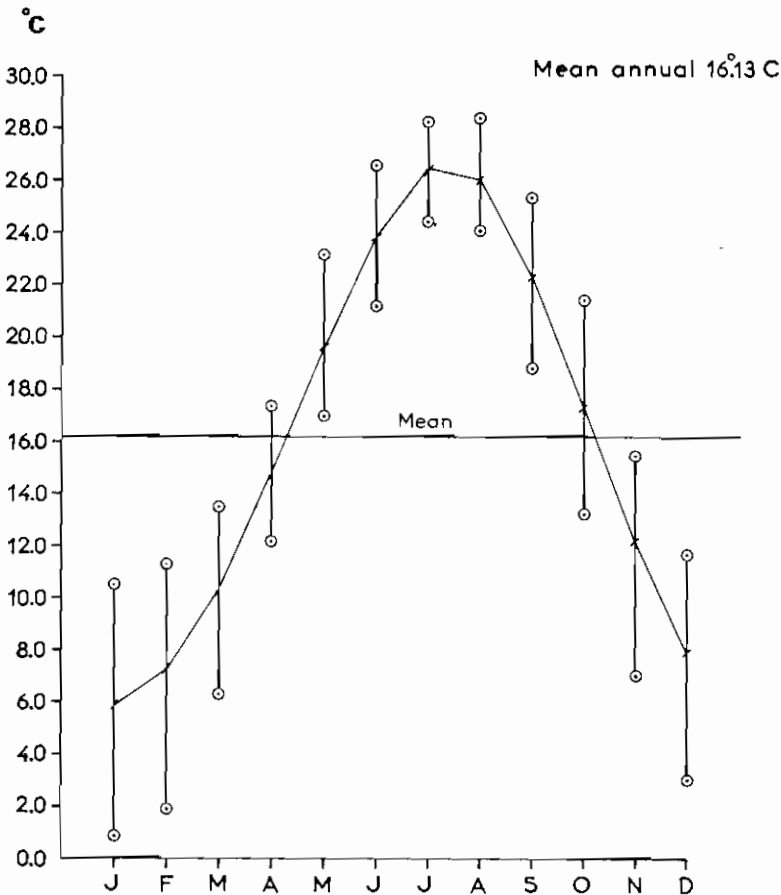
Thus the climate of Thessaloniki, according to its mean annual temperature range, should be classified in Gorczynski's classification as maritime temperate.

5. Absolute temperature maxima and minima recorded in Thessaloniki during the 1892 - 1973 period and presenting climatological interest, are given in *Table III*.

Data of Air Temperature in Thessaloniki (A.U.T. 1892 - 1973).

Month	Abs. Max.	Date	Year	Abs. Min.	Date	Year	Absolute range of temperature
J	19.5	13	1952	—12.6	14	1968	32.1
F	24.2	17	1957	—9.5	10	1911	33.7
M	30.1	31	1952	—4.7	3	1940	34.8
A	32.2	29	1968	—0.4	1	1935	32.6
M	37.8	24	1945	5.2	13	1944	32.6
J	38.3	10	1908	9.7	18	1952	28.6
J	41.8	24	1934	7.1	10	1909	34.7
		19	1973				
A	40.6	24	1911	10.3	21	1949	30.3
S	37.2	1	1902	5.6	27	1906	31.6
O	36.2	1	1928	2.1	31	1920	34.1
N	27.5	3	1916	—6.0	28	1941	33.5
D	21.8	23	1925	—9.6	4	1941	31.4
Period 1892 - 1973	41.8 (24.7.1934) (19.7.1973)			—12.6 (14.1.1968)			54.4

From the above Table III we find that the absolute maximum of air temperature (41.8 °C) has been recorded twice, once on 24.7.1934, and again on 19.7.1973; thus the absolute thermometric range is 54.4° C.

We also mention the following characteristic temperatures, only slightly differing from the corresponding absolute monthly maximum and minimum values: 38.2 °C (30.6.1963), 21.2 °C (18.12.1955) and 2.2 °C (31.10.1971).

6. The following Table IV contains distribution of deviations from the mean of 984 monthly mean values and 82 annual mean values.

From this Table IV we find only one case out of 984 (0,1 %) with a value < mean -3σ, and this is the monthly mean temperature of May 1919: 15.00 °C. (Mean $- 3\sigma = 19.67$ °C $- 3\sigma = 15.74$ °C > 15.00 °C).

However, examination of weather conditions that prevailed during the first ten-days of May 1919, indicates that the area of Greece had been under the effect of extended lows, which resulted in a considerable

TABLE IV

Distribution of deviations from mean annual and monthly values.

	−3σ	−2σ	−σ	M	+σ	+2σ	+3σ Total	Percentages ±σ	±2σ	±3σ	T+	T−
A. (Annual)	1	12	26	30	12	1						
%	1	15	32	36	15	1	100	68	98	100	52	48
B. Monthly	1 *	27	127	350	330	127	22 984					
%	0.1	2.7	12.9	35.6	33.5	12.9	2.2 99.9	69.1	94.9	99.9	50.7	49.3

* Significant deviation: May 1919 (15.74); 15.00.

for the season number of rainy days, and fall of temperature.

Distribution of monthly mean values of air temperature (1892 - 1973).

Grades (°C)	J	F	M	A	M	J	J	A	S	O	N	D	Total	%
28.0-28.9						2	2						4	0.4
27.0-27.9						23	9						32	3.2
26.0-26.9					2	31	36						69	7.0
25.0-25.9					4	24	26	4					58	5.9
24.0-24.9					30	2	9	7					48	4.9
23.0-23.9					1	31		16					48	4.9
22.0-22.9					3	14		27					44	4.5
21.0-21.9					7	1		12	1				21	2.1
20.0-20.9					20			13	3				36	3.7
19.0-19.9					28			1	5				34	3.4
18.0-18.9					18			2	17				37	3.8
17.0-17.9				2	4				25				31	3.1
16.0-16.9				15					18				33	3.3
15.0-15.9				21	1				6	2			30	3.0
14.0-14.9				24					6	10			40	4.1
13.0-13.9			6	15					1	16			38	3.9
12.0-12.9			9	5						17			31	3.2
11.0-11.9		2	13								21	4	40	4.1
10.0-10.9	3	6	23								7	3	42	4.3
9.0- 9.9	4	6	14								5	8	37	3.8
8.0- 8.9	5	16	11								3	21	56	5.7
7.0- 7.9	15	19	4								1	27	66	6.7
6.0- 6.9	15	15	2									7	39	4.0
5.0- 5.9	9	10										7	26	2.6
4.0- 4.9	15	2										3	20	2.0
3.0- 3.9	12	4										1	17	1.7
2.0- 2.9	3	1										1	5	0.5
1.0- 1.9		1											1	0.1
0.0- 0.9	1												1	0.1
	82	82	82	82	82	82	82	82	82	82	82	82	984	100.0

7. Most of the monthly mean values of each season are included within certain limits (see Table V).

The five months from November to March, with monthly mean air temperatures < 16 °C, consist the main cold season, while the 5-months from May to September with monthly mean air temperatures varying

between 17.0 to 28.9 °C (with the afore mentioned exception of May 1919 : 15.0 °C), consist the warm season.

The months of April and October, with monthly mean values at

H I S T O G R A M   I

FREQUENCIES DISTRIBUTION OF MONTHLY MEAN VALUES
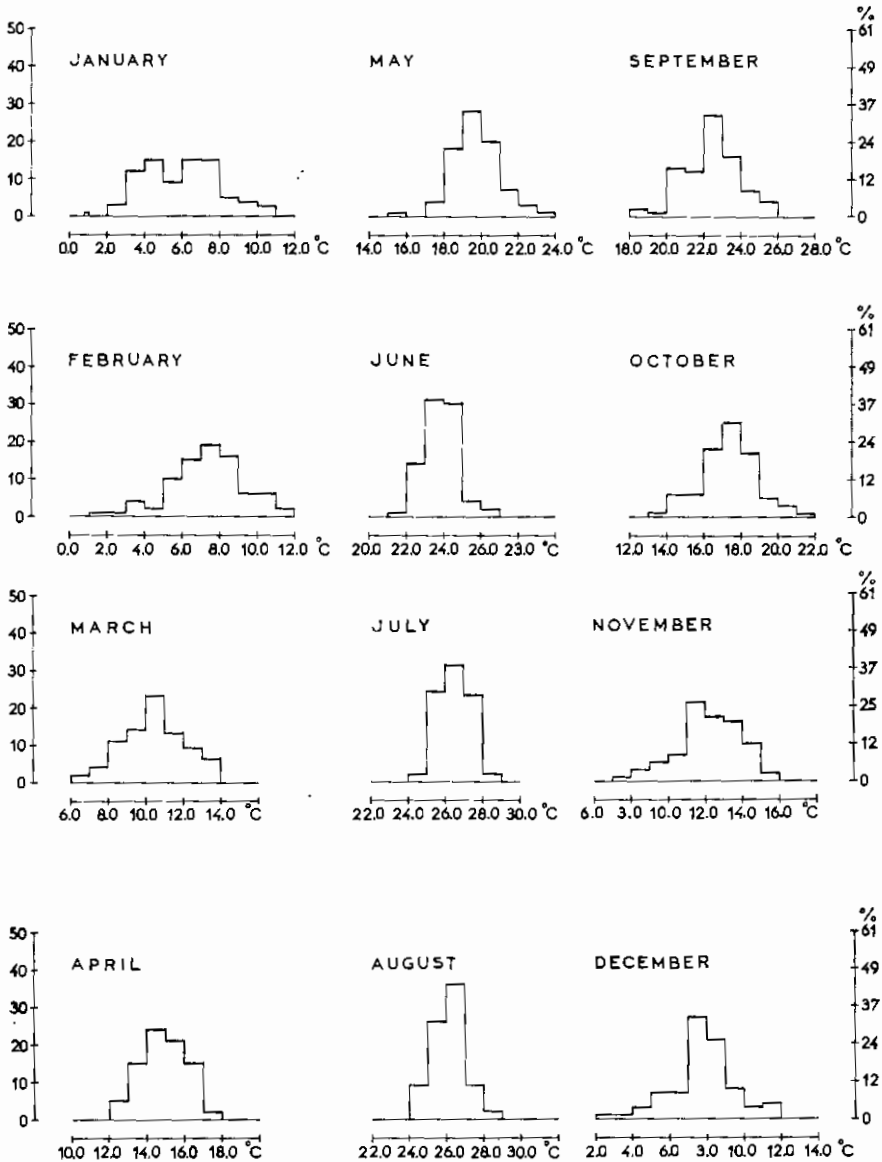
about the same levels as the annual mean (16.18 ºC) can be considered as transitory months between two seasons.

8. Winter (December, January and February) is of course the coldest season of the year, and summer (June, July and August) the warmest, while of the two transitory seasons, spring (March, April, May) and autumn (September, October, November), the second is the warmer. This applies not only to the seasonal mean values of the period examined 1892 - 1973, but also to those of each decade separately (see *Table VI*).

<div align="center">TABLE VI</div>

Mean Seasonal and Annual Air Temperature Values in Thessaloniki

Period	Spring	Summer	Autumn	Winter	Year	Mean Annual Temperature Range
1892-1903	15.52	25.36	17.84	7.60	16.61	20.08
1904-1913	15.13	25.33	16.52	6.51	15.84	21.87
1914-1923	15.47	25.38	17.22	7.53	16.45	18.94
1924-1933	14.56	25.38	17.80	6.65	16.06	20.39
1934-1943	14.65	25.48	17.45	6.59	16.06	21.35
1944-1953	15.36	26.03	17.30	7.10	16.39	20.31
1954-1963	14.58	25.75	17.26	6.97	16.16	20.73
1964-1973	14.51	24.76	16.84	6.90	15.79	19.94
1892-1973	14.99	25.43	17.29	7.00	16.18	20.56

This variation of seasonal values of air temperature during the period examined, is illustrated in Graph III.

From this graph III we see that, as a rule, air temperatures are higher in autumn than in spring, since out of 82 autumnal temperature values, only 6 (7 %) are smaller than the corresponding spring values.

It should be mentioned that during the last decade, from 1964 to 1973, have been recorded the smallest seasonal values for spring and summer, and also the smallest annual mean.

9. By applying the method of least squares on annual mean air temperature values of the 1892 - 1973 period, we have found the following straight line equation.

$$y = 16.413 - 0.005\ t \qquad (1)$$

where t the order of each value.

Also application of the method of semi - averages results in the equation:

$$y = 16.357 - 0.004 \, t \tag{2}$$

From equations (1) and (2) and also from Graph I we observe a slight descreasing trend of air temperature in the city of Thessaloniki.

10. Application of the least squares method on the maxima and minima of monthly mean values of air temperatures, resulted in the following straight line equations:

$$Y_{max} = 26.715 - 0.001 \, t \tag{3}$$
$$Y_{min} = 5.419 - 0.005 \, t \tag{4}$$

Also application of semi - averages yields the following equations:

$$Y_{max} = 26.588 + 0.002 \, t \tag{5}$$
$$Y_{min} = 5.458 - 0.006 \, t \tag{6}$$

From equations (3) and (5) and from Graph IV we find that the maxima of monthly mean values of air temperature are almost steady, while equations (4), (6), and Graph V indicate that minima have a slight decreasing trend, resulting in the increasing trend of the annual mean temperature range.
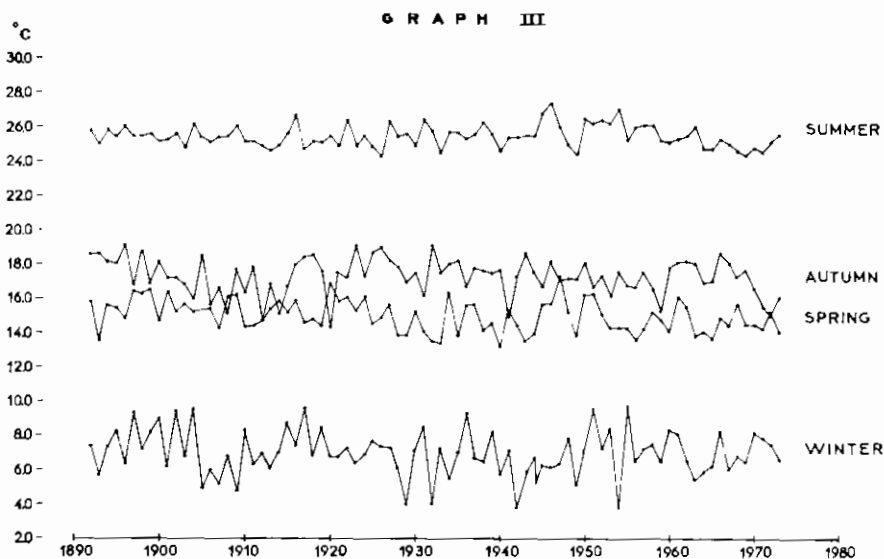
GRAPH III

Application of a similar process on temperature data from the city of Athens of the 1858 - 1972 period (ARSENI [2]), indicated an increasing trend of maxima as well as minima and annual mean values of air temperature.

GRAPH IV

VARIATION OF MEAN MAXIMUM VALUES OF AIR TEMPERATURE

a. = mean monthly values
b. = 5 year running mean
c. = straight line
d. = semi average line
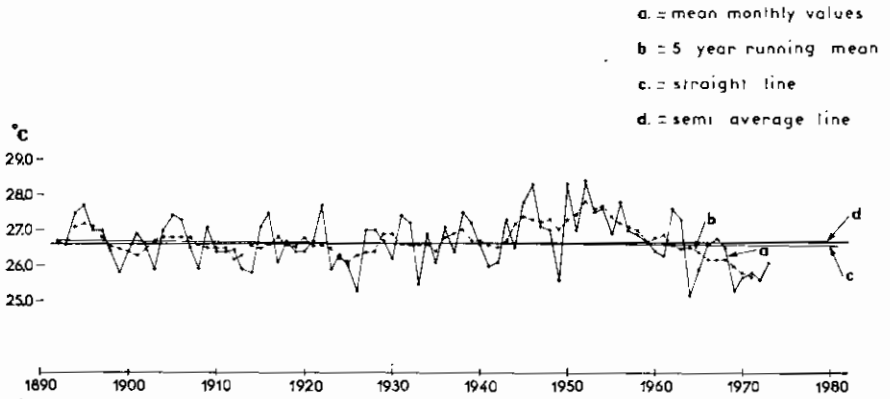
VARIATION OF MEAN MINIMUM VALUES OF AIR TEMPERATURE

GRAPH V

a. = mean monthly values
b. = 5 year running mean
c. = straight line
d. = semi average line
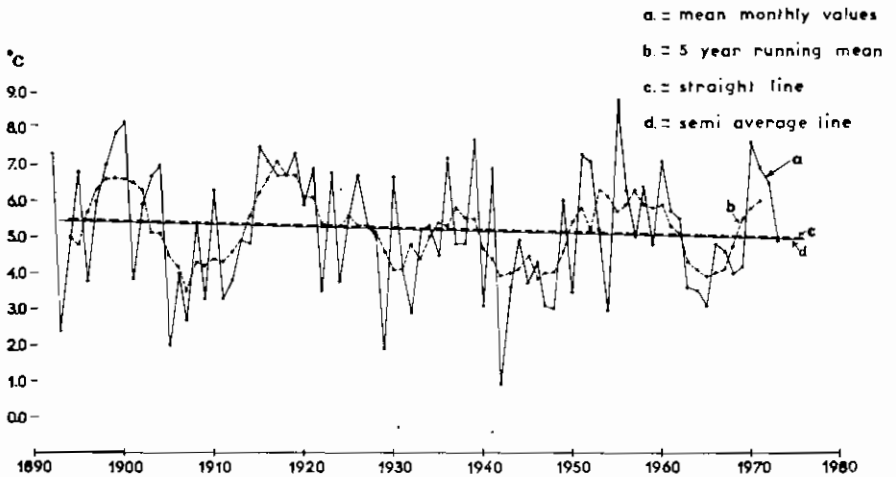
APPENDIX

Monthly mean air temperature (°C) in Thessaloniki (1892 - 1973).

Year	J	F	M	A	M	J	J	A	S	O	N	D	Y
1892	7.32	8.46	11.40	15.39	20.62	25.08	25.84	26.70	25.08	20.05	10.74	8.36	17.09
1893	2.38	6.75	9.40	12.45	18.53	22.99	26.60	25.46	22.42	18.72	14.63	9.69	15.84
1894	5.04	7.03	10.93	15.20	20.52	24.52	27.46	25.32	22.80	19.67	11.78	7.60	16.49
1895	10.17	6.75	10.93	15.58	19.75	23.18	27.74	25.32	22.42	18.62	13.11	8.46	16.84
1896	3.80	7.03	12.45	12.73	19.19	24.23	26.98	26.70	23.37	20.62	13.30	9.69	16.67
1897	8.27	9.79	13.30	16.53	19.75	22.90	26.98	26.60	24.80	16.63	8.74	5.99	16.69
1898	7.03	8.65	11.59	16.63	20.62	24.70	26.44	25.37	23.18	19.29	13.78	7.89	17.10
1899	7.89	8.74	11.69	16.15	21.38	23.37	25.75	24.61	22.80	16.25	11.59	7.89	16.51
1900	8.17	10.83	9.88	15.20	18.91	23.47	26.44	25.37	20.90	18.53	14.73	8.17	16.72
1901	3.80	7.03	13.30	15.96	19.95	23.94	26.89	25.08	22.52	17.96	10.96	9.79	16.43
1902	7.79	10.55	10.64	15.39	19.57	24.23	26.60	25.94	22.52	18.91	10.26	5.89	16.52
1903	6.65	7.89	11.59	15.20	20.33	22.99	25.65	25.75	21.66	17.29	11.50	11.12	16.47
1904	7.03	10.36	10.07	15.11	20.33	25.18	26.98	26.22	20.81	17.77	9.41	7.89	16.43
1905	2.00	5.04	10.55	15.01	20.33	23.37	27.36	25.32	22.99	18.48	14.06	7.32	15.99
1906	3.99	6.75	11.88	15.11	19.29	23.09	27.27	24.99	20.43	14.63	11.78	7.41	15.55
1907	2.66	5.61	6.56	13.49	22.71	24.32	26.51	25.46	20.62	17.96	11.21	7.89	15.41
1908	5.42	7.22	10.83	15.11	22.52	24.51	25.94	25.75	21.09	15.68	8.46	7.03	15.80
1909	3.99	3.33	12.07	16.53	10.07	24.39	27.05	26.66	24.34	17.74	11.14	8.42	16.31
1910	6.25	10.37	9.45	14.25	19.23	22.99	25.97	26.37	21.45	16.59	10.73	9.65	16.11
1911	6.00	3.32	9.65	14.38	19.19	23.13	25.67	26.38	22.13	16.89	14.22	8.42	15.78
1912	3.80	8.74	12.45	13.21	18.43	22.61	26.51	25.56	18.91	14.92	10.26	7.79	15.27
1913	5.61	4.85	11.31	16.15	18.72	23.94	25.87	24.42	22.52	17.10	11.14	6.84	15.71
1914	4.75	9.41	11.69	16.63	19.23	23.75	25.84	24.99	20.52	15.20	9.60	7.70	15.78
1915	9.79	8.74	11.04	14.92	19.23	23.46	27.11	26.32	20.52	17.61	11.85	7.54	16.51

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Year	J	F	M	A	M	J	J	A	S	O	N	D	Y
1916	7.11	7.48	12.98	14.84	19.94	26.58	27.48	25.91	22.29	17.34	14.21	11.72	17.32
1917	9.97	7.05	11.91	14.25	17.71	22.29	25.79	26.05	23.33	18.67	13.08	6.67	16.39
1918	6.68	7.31	9.54	14.86	19.92	22.63	26.72	26.33	25.10	18.98	11.36	8.44	16.49
1919	9.07	7.84	12.23	16.04	15.00	23.44	26.36	25.39	23.72	17.13	12.02	7.29	16.29
1920	7.08	5.88	13.49	17.06	20.26	23.96	26.39	26.07	21.38	14.61	7.04	8.40	15.97
1921	8.13	6.86	10.95	14.72	21.59	21.22	26.58	26.73	21.47	17.58	13.49	7.55	16.41
1922	7.12	7.26	12.71	16.25	19.28	24.53	27.72	26.95	23.96	19.35	8.49	3.52	16.40
1923	6.79	8.73	10.95	14.50	20.52	23.11	25.93	25.74	23.55	18.11	15.37	9.47	16.90
1924	3.82	7.52	10.80	16.85	20.78	24.27	26.29	25.90	24.85	17.22	9.77	7.54	16.30
1925	5.69	9.90	10.06	14.53	18.90	22.79	25.88	26.03	23.21	18.00	14.90	5.52	16.28
1926	6.73	9.87	9.70	15.56	19.32	23.30	25.28	24.39	22.55	18.76	15.53	8.65	16.64
1927	7.97	5.31	13.15	14.88	19.16	25.43	27.02	26.52	23.99	17.56	12.90	7.08	16.75
1928	6.24	4.99	7.94	15.65	18.22	23.27	26.96	26.32	23.49	16.84	13.40	5.53	15.74
1929	4.49	1.89	7.45	13.48	20.89	24.21	25.81	26.70	19.95	16.86	14.01	8.30	15.34
1930	6.70	6.70	11.30	15.70	19.00	22.60	26.20	26.00	22.80	17.50	12.10	8.90	16.26
1931	7.91	8.75	9.99	12.70	19.68	24.88	27.43	26.86	21.47	15.97	10.82	4.12	15.88
1932	4.99	2.89	7.40	14.11	19.42	24.12	27.18	26.14	24.07	21.47	11.68	9.24	16.06
1933	5.16	7.58	9.10	13.51	17.64	22.84	25.51	25.30	20.50	21.70	14.21	5.48	15.36
1934	5.28	5.68	12.61	15.86	20.45	23.93	26.88	26.31	23.09	17.62	13.36	10.04	16.76
1935	4.45	6.81	8.21	14.72	18.66	24.92	26.08	26.04	22.78	19.76	12.10	9.18	16.14
1936	10.49	8.30	12.23	16.03	18.43	23.04	27.08	25.89	21.60	16.34	12.25	7.21	16.57
1937	4.78	8.21	12.92	14.50	19.72	24.38	26.44	25.98	23.61	16.92	12.79	7.98	16.52
1938	4.79	6.57	10.97	12.89	18.44	24.07	27.50	27.07	22.17	17.92	12.82	8.84	16.17
1939	7.89	7.88	8.45	15.45	19.81	23.10	27.17	26.59	21.85	18.52	12.25	7.67	16.39
1940	3.09	6.76	8.11	13.94	17.51	22.88	26.57	24.30	21.44	18.48	12.95	4.24	15.02
1941	6.85	10.15	10.95	15.63	19.24	23.73	25.99	26.00	18.90	15.73	10.13	4.79	15.67
1942	0.89	5.61	8.55	13.89	20.67	24.61	25.40	26.09	23.77	17.48	10.70	7.30	15.41
1943	3.56	6.87	8.14	14.00	18.43	22.50	26.51	27.34	23.60	18.76	13.71	8.37	15.98
1944	4.96	6.67	8.71	14.93	18.28	24.72	26.51	25.18	23.10	18.16	11.28	7.64	15.85

APPENDIX (continued)

Year	J	F	M	A	M	J	J	A	S	O	N	D	Y
1945	3.71	6.73	9.29	14.54	23.15	24.89	27.75	27.80	22.25	15.30	12.53	7.06	16.25
1946	4.33	7.08	10.85	15.18	21.10	25.40	28.11	28.30	25.42	15.38	13.92	7.87	16.91
1947	3.11	8.25	13.72	17.36	20.57	24.64	27.13	26.36	22.35	16.25	12.45	8.30	16.71
1948	9.41	6.05	10.16	14.79	20.61	22.29	25.82	26.98	22.58	17.82	11.25	2.95	15.89
1949	5.99	6.66	7.11	14.02	20.51	23.48	25.63	24.09	21.12	16.95	13.34	9.12	15.67
1950	3.45	8.61	11.24	16.92	20.50	24.66	28.25	26.70	24.22	17.87	11.90	11.23	17.13
1951	7.89	9.66	11.83	15.62	21.44	24.87	26.44	26.96	22.92	14.25	13.00	7.31	16.85
1952	7.49	7.05	9.70	16.81	18.87	24.28	26.52	28.39	25.28	17.20	12.53	10.57	17.06
1953	6.23	8.49	8.60	15.56	18.75	24.81	27.56	26.24	22.56	16.37	9.46	5.22	15.82
1954	3.02	3.44	10.74	13.08	19.15	26.42	27.62	27.05	23.94	17.09	11.87	8.64	16.01
1955	9.27	11.33	10.46	12.21	20.12	23.75	26.85	25.34	21.68	17.69	11.09	8.84	16.54
1956	6.53	3.99	6.26	14.75	19.68	23.36	26.73	27.76	22.44	16.72	11.06	6.56	15.49
1957	4.98	10.04	9.93	14.65	18.27	24.55	26.66	26.97	22.28	17.55	12.54	6.44	16.24
1958	6.41	9.53	9.28	13.95	22.34	24.47	26.93	26.82	20.64	16.42	12.65	8.83	16.52
1959	4.83	5.77	10.80	14.30	19.15	22.61	26.70	26.23	20.20	14.24	11.42	10.44	15.56
1960	7.05	7.82	9.31	13.93	19.04	23.39	25.40	26.37	20.43	18.46	14.51	11.50	16.43
1961	5.68	6.97	12.09	16.57	19.54	23.98	25.71	26.27	22.46	17.94	13.91	7.13	16.52
1962	7.09	5.57	9.98	14.91	21.63	23.08	25.92	27.60	22.75	17.46	14.39	5.49	16.32
1963	3.63	7.17	8.54	13.99	18.78	23.83	27.26	26.89	23.31	17.01	13.72	7.99	16.01
1964	3.45	6.28	9.98	14.35	18.03	23.99	25.18	24.89	20.38	17.56	12.78	8.75	15.47
1965	6.74	3.07	9.82	13.27	18.04	24.09	25.87	24.26	22.42	16.69	12.00	8.49	15.40
1966	4.81	11.23	10.16	15.67	18.87	22.68	26.43	26.64	22.21	20.39	13.15	7.77	16.66
1967	4.58	5.74	10.28	13.66	19.39	22.46	25.57	26.81	22.85	18.20	12.82	7.68	15.79
1968	4.04	8.65	9.50	15.64	21.82	23.31	26.45	24.33	22.16	16.30	13.09	7.05	16.03
1969	4.17	8.40	8.81	13.22	21.33	23.58	24.45	25.26	23.01	16.66	13.19	8.65	15.89
1970	7.62	8.43	10.21	15.98	17.36	23.43	25.18	25.68	21.82	15.95	11.84	7.63	15.93
1971	8.95	6.90	8.77	13.54	20.33	23.24	24.46	25.82	20.42	14.90	11.26	8.28	15.87
1972	6.67	7.52	10.36	15.42	19.51	24.42	25.59	25.32	20.23	13.20	11.53	6.48	15.52
1973	4.86	8.11	8.03	13.85	20.06	22.63	26.13	24.78	22.20	16.87	9.16	6.17	15.23

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Π Ε Ρ Ι Λ Η Ψ Ι Σ

ΠΕΡΙ ΤΗΣ ΕΤΗΣΙΑΣ ΠΟΡΕΙΑΣ ΤΗΣ ΘΕΡΜΟΚΡΑΣΙΑΣ ΤΟΥ ΑΕΡΟΣ ΕΝ ΘΕΣΣΑΛΟΝΙΚΗ

Ὑπὸ

Α. Α. ΦΛΟΚΑ καὶ Α. ΑΡΣΕΝΗ - ΠΑΠΑΔΗΜΗΤΡΙΟΥ

(Ἐργαστήριον Μετεωρολογίας καὶ Κλιματολογίας)

Μελετᾶται ἡ ἐτησία πορεία τῆς θερμοκρασίας τοῦ ἀέρος εἰς τὴν πόλιν τῆς Θεσσαλονίκης, διὰ τῆς ἀναγωγῆς εἰς μίαν ἑνιαίαν καὶ ὁμογενῆ σειρὰν τῶν μέσων μηνιαίων τιμῶν ὅλων τῶν λειτουργησάντων ἐνταῦθα μετεωρολογικῶν σταθμῶν, κατὰ τὴν περίοδον 1892 - 1973, ἤτοι ἐπὶ 82 πλήρη καὶ συνεχῆ ἔτη, τῇ βοηθείᾳ διαφόρων κριτηρίων ὁμογενείας καὶ τύπων ἀναγωγῆς.

Ἐκ τῆς μελέτης διαπιστοῦνται τὰ κάτωθι:

Ἀπλῆ κύμανσις τῆς ἐτησίας πορείας τῆς θερμοκρασίας τοῦ ἀέρος μὲ μέγιστον κατὰ Ἰούλιον καὶ ἐλάχιστον κατὰ Ἰανουάριον.

Ἡ μέση μεταβλητότης παρουσιάζεται μεγαλυτέρα κατὰ τὸ ψυχρὸν τρίμηνον Δεκεμβρίου - Ἰανουαρίου - Φεβρουαρίου, καὶ μικροτέρα κατὰ τὸ θερμὸν τοιοῦτον, Ἰουνίου - Ἰουλίου - Αὐγούστου.

Ἡ τιμὴ τοῦ μέσου ἐτησίου θερμομετρικοῦ εὔρους εἶναι 20.56 °C μὲ σημαντικὰς πάντως αὐξομειώσεις, κυμαινομένας ἀπὸ 18.01 °C (1955) μέχρι 25.20 °C (1942).

Τὸ κλῖμα τῆς Θεσσαλονίκης, ἀπὸ θερμομετρικῆς ἀπόψεως, κατατάσσεται κατὰ GORCZYNSKI εἰς τὸν τύπον τοῦ "θαλασσίου μεταβατικοῦ".

Ὁ μέγιστος θερμομετρικὸς δρόμος ἀνέρχεται εἰς 54.4 °C, μὲ ἄκρας τιμὰς 41.8 °C (24.7.1934 καὶ 19.7.1973) καὶ 12.6 °C (14.1.1968).

Ὑπεροχὴ κατὰ κανόνα, τῶν τιμῶν τῆς θερμοκρασίας τοῦ φθινοπώρου ἔναντι ἐκείνων τῆς ἀνοίξεως· ἐκ τῶν 82 τιμῶν θερμοκρασίας τοῦ φθινοπώρου, μόνον αἱ 6 (7%) εἶναι μικρότεραι τῶν ἀντιστοίχων τῆς ἀνοίξεως.

Ἐλαφρὰ τάσις ἐλαττώσεως τῆς μέσης ἐτησίας θερμοκρασίας τοῦ ἀέρος, ὡς καὶ τῶν ἐλαχίστων μέσων μηνιαίων τιμῶν, καὶ σχεδὸν σταθερὰ διαμόρφωσις τῶν μεγίστων τῶν μέσων μηνιαίων τιμῶν.