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NUMERICAL STUDY OF DIURNAL TEMPERATURE VARIATIONS AT THE METEOROLOGICAL STATION OF HELLINIKON FROM 8 SYNOPTIC OBSERVATIONS

by

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Abstract: *A Newton's polynomial interpolation was effeeted for the period from 1956 to 1971; as interpolating points were taken the 24 temperature values from synoptic observations of three consecutive days (3 × 8), thus rendering minimum the boundary error of the middle day. From the interpolated polynomial, hourly values of temperature were also estimated. For every month, mean hourly temperatures —both real and interpolated— were calculated, as well as standard deviations and mean values of differences* ($\Delta T = T_{real} - T_{Newton}$), *indicating thus the aecuracy of the interpolation,*

It is shown that mean hourly temperatures of a eertain time interval, may be obtained by ealculating the mean Newton's coefficient for the same time interval. Moreover the monthly mean values of diurnal temperature variations, for every month, were obtained from the mean coefficient. From the equation of diurnal temperature variations (and on eondition that the extreme temperatures are known), was deduced the time at which the maximum and minimum oecured.

Finally it is shown that there is a tendency in Newton's interpolating formula, to underestimate the times at which minimum temperature oecurs during the warm months.

INTRODUCTION

It is desirable to estimate some meteorological variables, such as temperature at certain hours or levels, where the only available data are values from neighbouring points. These variables may be obtained by using an interpolation method.

Thus Brooks[2] proposed a method for calculating daily values, or date of occurence of any given value, from monthly means, on the assumption that 3 successive months can be represeuted by a sine curve with aunual period.

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Zmuda and McClay[8], because of the discreteness of the data obtained in magnetic surveys, did interpolation between measured points, before charts could be drawn. Rigorous relations connecting surface variations of different elements were introduced into the interpolation formulas, so that the resulting charts were mutually consistent.

Related elements are continued by a power series, in which the unknown coefficients are computed under the conditions of consistency.

Fletcher[4] showed that there are personal bias introduced during interpolation. Simple mathematical surfaces were used by Johnson[5] to interpolate numerically within two-dimensional networks of 500mb contour heights and winds.

McDonald[6] did a small series of tests of one objective estimation scheme, applied to missing seasonal totals rather than to missing storm totals.

Stumpff[7] discussed analysis of series of observations, to replace a smoothed curve by a few superposed sine curves.

In compiling monthly mean rainfall maps for Germany, various methods of correcting short series were tried by Schirmer and Hans (1952). They found the annual total and divided among the months, in proportions given by neighboring stations, with regard to topography.

In Chapter 2 is presented a discussion and application of Newton's interpolating formula for the meteorological station of Hellinikon (Athens airport).

In Chapter 3, are calculated the times of occurence of extreme temperature values.

In Chapter 4 are discussed comments and conclusions on the application of Newton's interpolating formula for the meteorological station of Hellinikon.

Finally, in Chapter 5 are illustrated some appendixes.

Chapter 2.

2.1. Twenty-three Degree Newton's Polynomial Interpolating Passing through 24 Points.

Consider three consecutive days. Let T_i, $i = 2\,(3)\,23$* be the 8

* The symbolism T_i, $i = 2\,(3)\,23$ means that the subscript i takes original value 2, final 23, and step 3.

values of temperature which were recorded at Xi, i = 2 (3) 23 synoptic hours* of the middle day. Hereafter the minus and plus sign stand for the days next to the middle day.

If the base points are Xi and the corresponding functional values are Ti, then the 24 interpolating points are:

8 points of the day before the middle day (T-i, X-i), i = 2 (3) 23.

8 points of the middle day (Ti, Xi), i = 2 (3) 23.

8 points of the day after the middle day (T+i, X+i), i = 2 (3) 23.

Let X—(24—i), i = 2 (3) 23 and X+(24+i), i = 2 (3) 23 be a representation for X—i and X+i respectively, then the interpolating points Xi lies in the closed interval (—22,47), and it is always $Xi \neq Xj \ \forall \ i \neq j$.

Now for the function Ti which is continuously differentiable 24 times, the above 24 points are known. Our problem is then to find the function value T (x) corresponding to a given value x. We consider the solution given by Newton (1), (3). Therefore the equation of the diurnal variation of temperature for the middle day is given by:

$$T(x) = A_1 + \sum_{j=2}^{24} Aj \prod_{i=1}^{j-1} (x - x_{3i-25}) \quad \forall \ x \in (1, 24) \qquad (1)$$

where the coefficients A_j, j 1 (1) 24 satisfy the linear system

$$A_1 = T_{-22}$$

$$A_1 + \sum_{j=2}^{k} Aj \prod_{i=1}^{j-1} (X_{3k-25} - X_{3i-25}) = T_{3k-25}, \quad k = 2\ (1)\ 24 \qquad (2)$$

Since the matrix of the unkown is down-triangular, its value is equal to the product of the diagonal elements, i.e.

$$\prod_{i=1}^{23} \left[\prod_{j=1}^{i} (X_{3i-22} - X_{3j-25}) \right] \qquad (3)$$

Since the product 3 is always different from zero (always $j \leq i$ and $X_{3i-22} > X_{3j-25}$), system (2) has always a solution.

Therefore, the temperature of equation (1) for a given value of x, cau be found if previously the coefficients Aj are determined by solving the system (2).

* Local time of Greece.

2.2. Application of Newton's Interpolation Formula in the Meteorological Station of Hellinikon.

2.2.1. Hourly Temperatures from the 8 Synoptic Observations.

For every month and for every three consecutive days of the period 1956-1971, a calculation of Newton's coefficient was carried out. Then, from equation (1) hourly temperatures of middle day ($T_{Newton}(i)$, $i = 1\ (1)\ 24$) were calculated. In order to get a measure of errors due to interpolation, since the real hourly temperatures were known, ($T_{Real}(i)$, $i = 1\ (1)\ 24$), the differences:

$$\Delta T_{(i)} = T_{Real(i)} - T_{Newton(i)},\ i = 1\ (1)\ 24$$

were found. Moreover, for every month of the period 1956-1971, were calculated the following:

— Newton's interpolated mean hourly temperatures ($\overline{T_{Newton}}(i)$, $i = 1\ (1)\ 24$).

— Real hourly mean temperature ($\overline{T_{Real}}(i)$, $i = 1\ (1)\ 24$).

— Mean values of the differences ($\overline{\Delta T}(i)$, $i = 1\ (1)\ 24$).

— Standard deviation of the differences denoted by: $\overline{S\overline{\Delta T}}(i)$, $i = 1\ (1)\ 24$.

The results are shown in Table A, of Appendix B, Chapter 5. Comments about results are presented in Chapter 4, in connection with conclusions.

2.2.2. Mean Monthly Coefficient of Newton — Mean Monthly Values of Diurnal Temperature Variations.

We have seen that the diurnal temperature variation for the middle day is well approximated by a twenty-three degree interpolating polynomial passing through the 24 points of three consecutive days.

Let M be the number of days of 1956-1971; if for every day of this period a computation of coefficients Ai, $i = 1\ (1)\ 24$ is made, then an introduction of the mean Newton coefficient may be defined as follows:

$$\overline{Aj} = \frac{\sum_{j=1}^{N} A_j}{N},\ j = 1\ (1)\ 24 \text{ where } N = M-2$$

and similarly: $\overline{T(x)} = \frac{\sum\limits_{x=1}^{N} T(x)}{N}$, x = 1 (1) 24.

Now consider an arbitrary day of the above period; the coefficients and temperatures of this day can be written as follows:

$Aj = \overline{Aj} + A'j$, j = 1 (1) 24 and $T(X) = \overline{T(x)} + T'(x)$, x = 1 (1) 24.

Where A'j and T'(x) are the deviations of coefficients and temperatures from the mean values. Therefore, equation (1) may be written as follows:

$$\overline{T}(x) + T'(x) = \overline{A}_1 + A'_1 + \sum_{j=2}^{24} (\overline{A}_j + A'_j) \prod_{i=1}^{j-1} (x - x_{3i-25}) \quad (4)$$

Integration of equation (4) for a definite x, i.e. x=12h from 0 to T gives:

$$\frac{1}{T}\int_0^T \overline{T}(x)\,dT + \frac{1}{T}\int_0^T T'(x)dT = \frac{1}{T}\int_0^T \overline{A}_1 dT + \frac{1}{T}\int_0^T A'_1 dT +$$

$$+ \sum_{j=2}^{24} \frac{1}{T}\int_0^T (\overline{A}j + A'j)\,dT \prod_{i=1}^{j-1} (X - X_{3i-25})$$

Now since: $\frac{1}{T}\int_0^T T'(x)dT = \frac{1}{T}\int_0^T A'_1 dT = \frac{1}{T}\int_0^T A'_j T = 0$

we obtain: $$\overline{T}(x) = \overline{A}_1 + \sum_{j=2}^{24} \overline{Aj} \prod_{i=1}^{j-1} (X - X_{3i-25}) \quad (5)$$

For every x which belongs to the interval [1, 24] an expression similar to (5) may be obtained: therefore, equation (5) is defined for all x∈[1, 24].

From equation (5) we can infer that: if mean temperatures are to be found in a certain time interval this can be done by evaluating the mean Newton coefficient in this interval.

The monthly mean coefficient and the equation of the diurnal variation of temperature, are shown in Appendix A of Chapter 5, in Tables A and B respectively.

Chapter 3.

3.1. Calculation of Occurence Time of Extreme Temperatures by Numerical Method.

The contribution of Newton's interpolating formula in calculating the mean diurnal temperature variation is very important. Because not only hourly temperatures, but the time by which the extreme temperatures occur can also be found.

Consider a time interval greater than a day and let $\overline{T_{max}}$ and $\overline{T_{min}}$ be the mean maximum and minimum temperatures respectively. The equation of mean diurnal variation of temperature in this period is given by equation (5). Obviously the time by which the maximum and minimum temperatures occur, are solutions, with respect to x (time) of the following equations:

$$\overline{A_1} + \sum_{i=2}^{24} \overline{A_i} \prod_{j=1}^{i-1} (x - x_{3j-25}) = \overline{T_{max}} \tag{10}$$

$$\overline{A_1} + \sum_{i=2}^{24} \overline{A_i} \prod_{j=1}^{i-1} (x - x_{3j-25}) = \overline{T_{min}} \tag{11}$$

The value of x which satisfies equation (10) [(11)] determines the time by which the maximum (or minimum) occurs.

Solutions of equations (10) and (11) were obtained by the following iterative procedure.

Consider the iterative procedure by which the variable x takes original value 1, final 24 and step h, i.e. h =0.5 hours. We look for values x = H such that the corresponding function value $\overline{T(H)}$ satisfies the relations:

$$|\overline{T(H)} - \overline{T_{max}}| \leq \varepsilon \tag{12}$$

$$|\overline{T(H)} - \overline{T_{min}}| \leq \varepsilon \tag{13}$$

where ε is the required approximation, i.e. $\varepsilon = 0.5°$ C.

When the variable x with the given step h runs through the interval (1, 24), a determination of values of x denoted by H, which satisfy equation (12) and (13) will be carried out. The average of the values of H which satisfy (12) [(13)] determine the time by which the maximum (minimum) occurs.

The results of the application of the above method for the meteorological station of Hellinikon are summarized in Table I.

The same Table I contains the real times (means) of occurence of extreme temperatures. These real times were deduced from the mean hourly real temperature with the help of the Graph in Appendix B of Chapter 5.

TABLE I

Mean times of occurence of extreme temperatures and errors of estimate of these occurence times.-

Month	MAXIMUM Mean Real Time	Error of estimate	Time deduced from interpolation		MINIMUM Mean Real Time	Error of Estimate	Time deduced from interpolation	
J	$14^h30'$	±15'	$14^h00'$	The error in all cases is smaller than +30' and greater than -30'.	$7^h00'$	±30'	$7^h00'$	The error in all cases is smaller than +30' and greater than -30'.
F	$14^h30'$	±15'	$14^h00'$		$6^h30'$	±30'	$6^h30'$	
M	$14^h30'$	±15'	14^h30		$6^h30'$	±15'	$6^h00'$	
A	$14^h30'$	±15'	$14^h30'$		$6^h00'$	±15'	$4^h30'$	
M	$14^h45'$	±30'	$14^h45'$		$5^h45'$	±15'	$4^h15'$	
J	$15^h00'$	±15'	$15^h00'$		$5^h30'$	±15'	$4^h15'$	
J	$15^h00'$	±15'	$15^h00'$		$5^h30'$	±15'	$4^h15'$	
A	$15^h00'$	±15'	$15^h00'$		$6^h00'$	±15'	$4^h30'$	
S	$14^h15'$	±15'	$14^h15'$		$6^h15'$	±15'	$4^h45'$	
O	$14^h00'$	±15'	$13^h45'$		$6^h45'$	±15'	$6^h15'$	
N	$14^h00'$	±15'	$13^h30'$		$7^h00'$	±30'	$7^h00'$	
D	$14^h00'$	±15'	$13^h30'$		$6^h45'$	±30'	$6^h30'$	

Chapter 4.

Comments and Conclusions.

4.1 Conclusions on Chapter 2.

1. Since the hours 2, 5, 8, 11, 17, 20, and 23 are the base points of interpolation, it is always $T_{Newton}(i) = T_{Real}(i)$, $i = 2\ (3)\ 23$.

Thus the mean value and standard deviation of the differences $\Delta T(i) = T_{Real}(i) - T_{Newton}(i)$ at these points are zero.

2. More than 8 points (synoptic observations of one day) are necessary to be taken if someone wishes to get accurate interpolated values. By this way the base points of the interest day become more central, and so there is a significant reduction of boundary error. In this work 8 base points of the previous and next day are taken, in order to make the base points of the middle day more central.

3. From Tables A, Appendix A, Chapter 5, we find that the hourly values of temperatures calculated by Newton's interpolating formula of 24 base points, are almost identical to the real hourly values of temperature.

The mean values of the differences $\Delta T(i) = T_{Real}(i) - T_{Newton}(i)$ $i = 1\ (1)\ 24$, are less than 0.5° C and only once in a month they are greater than 0.5° C. Besides the fact that the standard deviation of the differences is small (less than 1° C in all cases), all the results show that the real diurnal temperature variation is well fitted by Newton's interpolating formula.

4. We can generally conclude that hourly temperature can be calculated to a high point of accuracy by Newton's interpolating formula passing through 24 points of three consecutive days.

4.2. Conclusions and Comments on Chapter 3.

1. From Table 1 of Chapter 3 we conclude that the deduced times of occurence of maximum temperature provided by Newton's interpolating formula of 24 points, are identical to real ones. The small deviations found, are within the limits of the errors introduced when the times of occurence of the maximum temperature (Real - Newton's) were calculated.

2. The times of occurence of minimum temperature (according to Newton) for the cold months: January, February, November and December, are to a great degree of accuracy similar to real ones.

3. For the remaining months, there are great differences denoted by Δh, which are symmetrically distributed over the year, with respect to the middle months of June and July (See Fig. 1). The differences are most pronounced during the warm months of April, May, June, July, August, and September.

Since deviations due to transient effects can not produce such a symmetrical distribution, we are bound to conclude that part of these deviations are due to permanent effects. Such permanent effects is the mountain effect of Himittos. The maximum height of mount Himittos,

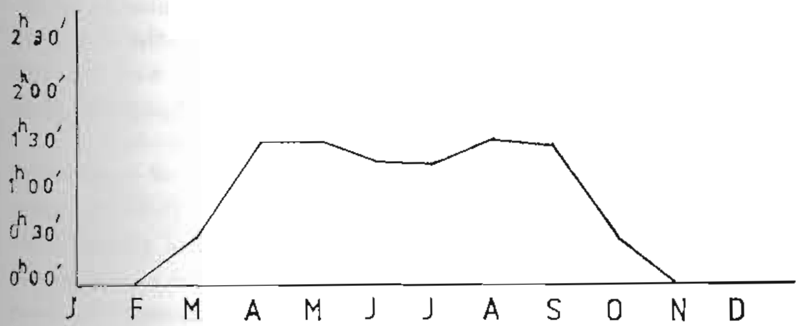

Fig. 1 Graph of differences Δh=Real time of occurence of minimum —Time due to Newton

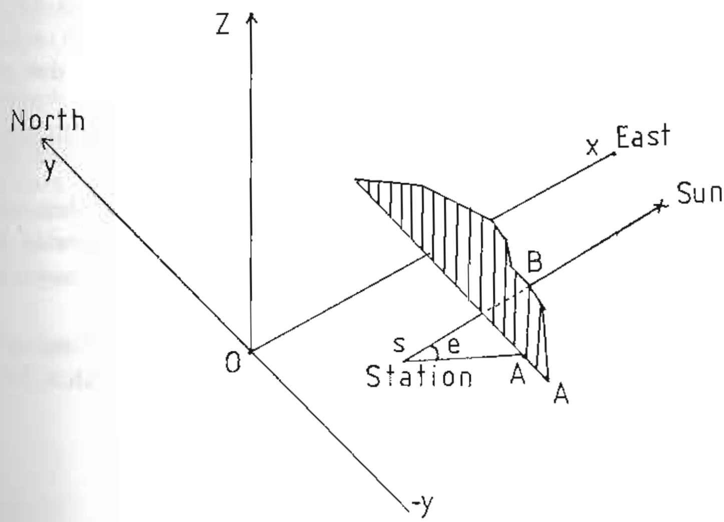

Fig. 2 Graph of vertical cross section of Imittos by plane parallel to yoz and position of Met. station of Hellinikon.

affecting the occurence time of minima is AB = 0.765 km and the disstance is SA = 7.5 km (Fig. 2). Thus the influence of Mt Himittos on the time of occurence of minimum is given by the angle e expressed in hours.

Maximum mountain effects: $\tan^{-1}\dfrac{AB}{AS}\,\dfrac{1}{15} \simeq 30'$

Since the maximum Δh is about 1h 30′, still $\Delta h = 1h$ remains to be explained. This difference ($\Delta h = 1h$) during the warm months is due to inability of Newton's interpolating formula to simulate well the real variation of temperature from 06 : 00 to 08 : 00 (See Appendix B of Chapter 5).

From these figures can be seen that the real rate of increase of temperature from 6 to 8 for the warm months, is greater than any other rate. We can say that this part of mean monthly values of diurnal temperature variation is something independent from the rest of the curve. Thus Newton's polynomial of 24 points which pass through the base points, can not follow the real variation during these hours.

Since the rate of increase of temperature due to interpolarion from 6 to 8 is smaller than the real one, we infer that there is a *tendency of Newton's interpolating formula to shift the time of occurence of minimum towards smaller honrs during the warm months.*

This is the reason why an underestimation of occurence time of minima took place.

4. During the months of January, February, November, and December, there is a southwards movement of the points of sunrise, and therefore the sunrise-time of the station is not affected by the mountain mass of Himittos.

5. During the months of March and October, the time of minimum is affected by Mt Himittos; thus there is a difference $\Delta h \simeq 30'$.

APPENDIXES

Appendix A consists of three tables for every month, that is

— Table A contains mean hourly temperatures (Real, obtained by interpolation of 24 points) for every month of the period 1956-1971 and also mean values and standard deviations of differences $T_{Real} - T_{Newton}$

— Table B: Mean monthly coefficients of interpolation of 24 points are presented.

— Table C: The equation of mean diurnal variation of tempetature for every month is presented.

Appendix B: Illustrations of mean diurnal variation of temperature for both real and due to interpolation, are presented for every month.

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APPENDIX A

Met. Station of Hellinikon

Month: January
Period: 1956-1971

TABLE A

Hours	Mean hourly temperatures		Differences ΔT_i		Hours	Mean hourly temperatures		Differences ΔT_i	
	Real	Inter-polated	Mean Value	Standard Deviation		Real	Inter-polated	Mean Value	Standard Deviation
1	9.05	8.83	0.22	0.74	13	12.30	12.43	-0.13	0.60
2	8.93	8.93	0.00	0.00	14	12.52	12.52	0.00	0.00
3	8.77	9.00	-0.23	0.70	15	12.52	12.36	0.16	0.65
4	8.60	8.85	-0.25	0.77	16	12.30	12.05	0.25	0.61
5	8.51	8.51	0.00	0.00	17	11.65	11.65	0.00	0.00
6	8.42	8.17	0.25	0.69	18	10.88	11.17	-0.29	0.55
7	8.38	8.08	0.30	0.79	19	10.40	10.65	-0.25	0.58
8	8.43	8.43	0.00	0.00	20	10.13	10.13	0.00	0.00
9	9.14	9.21	-0.07	0.68	21	9.84	9.70	0.14	0.63
10	10.36	10.23	0.13	0.68	22	9.55	9.43	0.12	0.72
11	11.24	11.24	0.00	0.00	23	9.31	9.31	0.00	0.00
12	11.89	12.01	-0.12	0.66	24	9.10	9.25	-0.15	0.69

TABLE B

Mean Monthly Coefficient of Newton Interpolation.

$\bar{A}_1 = 0.9084 \times 10^{1}$	$\bar{A}_7 = -0.239 \times 10^{-4}$	$\bar{A}_{13} = -0.4122 \times 10^{-12}$	$\bar{A}_{19} = -0.1382 \times 10^{-19}$
$\bar{A}_2 = -0.1412 \times 10^{0}$	$\bar{A}_8 = 0.1102 \times 10^{-5}$	$\bar{A}_{14} = 0.2834 \times 10^{-13}$	$\bar{A}_{20} = 0.5101 \times 10^{-21}$
$\bar{A}_3 = 0.201 \times 10^{-1}$	$\bar{A}_9 = -0.4186 \times 10^{-7}$	$\bar{A}_{15} = -0.1963 \times 10^{-14}$	$\bar{A}_{21} = -0.1687 \times 10^{-22}$
$\bar{A}_4 = 0.1532 \times 10^{-1}$	$\bar{A}_{10} = 0.1770 \times 10^{-8}$	$\bar{A}_{16} = 0.1246 \times 10^{-15}$	$\bar{A}_{22} = 0.5061 \times 10^{-24}$
$\bar{A}_5 = -0.3542 \times 10^{-2}$	$\bar{A}_{11} = -0.1004 \times 10^{-9}$	$\bar{A}_{17} = -0.6900 \times 10^{-17}$	$\bar{A}_{23} = -0.1396 \times 10^{-25}$
$\bar{A}_6 = 0.3682 \times 10^{-3}$	$\bar{A}_{12} = 0.6353 \times 10^{-11}$	$\bar{A}_{18} = 0.3307 \times 10^{-18}$	$\bar{A}_{24} = 0.3590 \times 10^{-27}$

TABLE C

Equation of Monthly Mean Value of Diurnal Temperature Variation.

$$\bar{T}(x) = \bar{A}_1 + \sum_{i=2}^{24} \bar{A}_i \prod_{j=1}^{i-1} (X - X_{3j-25}) \quad \forall\, x \in [1,24]$$

where $X_{3j-25} = 3j-25$, $j = 1(1)23$ and $\bar{A}_i$, $i = 1(1)24$ are given in Table B.

Met. Station of Hellinikon

Month: February
Period: 1956-1971

TABLE A

Hours	Mean hourly temperatures		Differences ΔT_i		Hours	Mean hourly temperatures		Differences ΔT_i	
	Real	Inter-polated	Mean Value	Standard Deviation		Real	Inter-polated	Mean Value	Standard Deviation
1	9.44	9.12	0.32	0.80	13	13.32	13.45	-0.13	0.74
2	9.24	9.24	0.00	0.00	14	13.53	13.53	0.00	0.00
3	9.04	9.33	-0.29	0.76	15	13.56	13.39	0.17	0.73
4	8.84	9.14	-0.30	0.72	16	13.30	13.12	0.18	0.57
5	8.70	8.70	0.00	0.00	17	12.75	12.75	0.00	0.00
6	8.58	8.27	0.31	0.67	18	11.99	12.24	-0.25	0.57
7	8.55	8.20	0.35	0.74	19	11.33	11.60	-0.27	0.54
8	8.69	8.69	0.00	0.00	20	10.92	10.92	0.00	0.00
9	10.00	9.71	0.29	0.80	21	10.53	10.36	0.17	0.57
10	11.31	10.98	0.33	0.72	22	10.24	10.05	0.19	0.63
11	12.17	12.17	0.00	0.00	23	9.97	9.97	0.00	0.00
12	12.84	13.02	-0.18	0.63	24	9.73	9.95	-0.22	0.71

TABLE B

Mean Monthly Coefficient of Newton Interpolation.

$\bar{A}_1 = 0.9183 \times 10^{1}$	$\bar{A}_7 = -0.3540 \times 10^{-4}$	$\bar{A}_{13} = -0.1151 \times 10^{-11}$	$\bar{A}_{19} = -0.1917 \times 10^{-19}$
$\bar{A}_2 = -0.1820 \times 10^{0}$	$\bar{A}_8 = 0.2060 \times 10^{-5}$	$\bar{A}_{14} = 0.6187 \times 10^{-13}$	$\bar{A}_{20} = 0.7170 \times 10^{-21}$
$\bar{A}_3 = 0.3020 \times 10^{-1}$	$\bar{A}_9 = -0.1130 \times 10^{-6}$	$\bar{A}_{15} = -0.3449 \times 10^{-14}$	$\bar{A}_{21} = -0.2428 \times 10^{-22}$
$\bar{A}_4 = 0.1821 \times 10^{-1}$	$\bar{A}_{10} = 0.6521 \times 10^{-8}$	$\bar{A}_{16} = 0.1908 \times 10^{-15}$	$\bar{A}_{22} = 0.7518 \times 10^{-24}$
$\bar{A}_5 = -0.4405 \times 10^{-2}$	$\bar{A}_{11} = -0.3847 \times 10^{-9}$	$\bar{A}_{17} = -0.9863 \times 10^{-17}$	$\bar{A}_{23} = -0.2153 \times 10^{-25}$
$\bar{A}_6 = 0.4849 \times 10^{-3}$	$\bar{A}_{12} = 0.2158 \times 10^{-10}$	$\bar{A}_{18} = 0.4599 \times 10^{-18}$	$\bar{A}_{24} = 0.5767 \times 10^{-27}$

TABLE C

Equation of Monthly Mean Value of Diurnal Temperature Variation.

$$\hat{T}(x) = \bar{A}_1 + \sum_{i=2}^{24} \bar{A}_i \prod_{j=1}^{i-1} (X - X_{3j-25}) \quad \forall\, x \in \{1,24\}$$

where $X_{3j-25} = 3j-25$, $j = 1(1)23$ and $\bar{A}_i$, $i = 1(1)24$ are given in Table B.

Meteorological Sation of Hellinikon.

Month: March
Period: 1956-1971

TABLE A

Hours	Mean hourly temperatures Real	Mean hourly temperatures Inter-polated	Differences ΔT_i Mean Value	Differences ΔT_i Standard Deviation	Hours	Mean hourly temperatures Real	Mean hourly temperatures Inter-polated	Differences ΔT_i Mean Value	Differences ΔT_i Standard Deviation
1	10.56	10.41	0.15	0.74	13	14.55	14.53	-0.02	0.60
2	10.36	10.36	0.00	0.00	14	14.66	14.66	0.00	0.00
3	10.13	10.27	-0.14	0.62	15	14.72	14.63	0.09	0.61
4	9.92	10.05	-0.13	0.68	16	14.54	14.47	0.07	0.55
5	9.77	9.77	0.00	0.00	17	14.16	14.16	0.00	0.00
6	9.63	9.64	-0.01	0.62	18	13.50	13.64	-0.14	0.52
7	9.63	9.86	-0.23	0.75	19	12.76	12.95	-0.19	0.48
8	10.51	10.51	0.00	0.00	20	12.22	12.22	0.00	0.00
9	11.89	11.48	0.41	0.71	21	11.84	11.62	0.22	0.54
10	12.78	12.56	0.12	0.61	22	11.50	11.29	0.21	0.55
11	13.51	13.51	0.00	0.00	23	11.19	11.19	0.00	0.00
12	14.05	14.17	-0.12	0.58	24	10.90	11.15	-0.25	0.65

TABLE B

Mean Monthly Coefficient of Newton Interpolation.

$\bar{A}_1 = 0.1028 \times 10^{2}$	$\bar{A}_7 = -0.2594 \times 10^{-4}$	$\bar{A}_{13} = -0.1399 \times 10^{-11}$	$\bar{A}_{19} = -0.1007 \times 10^{-19}$
$\bar{A}_2 = -0.1926 \times 10^{0}$	$\bar{A}_8 = 0.1794 \times 10^{-5}$	$\bar{A}_{14} = 0.5895 \times 10^{-13}$	$\bar{A}_{20} = 0.4032 \times 10^{-21}$
$\bar{A}_3 = 0.7034 \times 10^{-1}$	$\bar{A}_9 = -0.1246 \times 10^{-6}$	$\bar{A}_{15} = -0.2435 \times 10^{-14}$	$\bar{A}_{21} = -0.1470 \times 10^{-22}$
$\bar{A}_4 = 0.6424 \times 10^{-2}$	$\bar{A}_{10} = 0.8638 \times 10^{-8}$	$\bar{A}_{16} = 0.1068 \times 10^{-15}$	$\bar{A}_{22} = 0.4937 \times 10^{-24}$
$\bar{A}_5 = -0.2660 \times 10^{-2}$	$\bar{A}_{11} = -0.5469 \times 10^{-9}$	$\bar{A}_{17} = -0.4974 \times 10^{-17}$	$\bar{A}_{23} = -0.1526 \times 10^{-25}$
$\bar{A}_6 = 0.3239 \times 10^{-3}$	$\bar{A}_{12} = 0.2984 \times 10^{-10}$	$\bar{A}_{18} = 0.2308 \times 10^{-18}$	$\bar{A}_{24} = 0.4379 \times 10^{-27}$

TABLE C

Equation of Monthly Mean Value of Diurnal Temperature Variotion.

$$\bar{T}(x) = \bar{A}_1 + \sum_{i=2}^{24} \bar{A}_i \prod_{j=1}^{i-1} (X - X_{3j-25}) \quad \forall\ x \in \{1,24\}$$

where $X_{3j-25} = 3j-25$, $j = 1(1)23$ and $\bar{A}_i$, $i = 1(1)24$ are given in Table B.

Mete Station of Hellinikon

Month: April
Period: 1956-1971

TABLE A

Hours	Mean hourly temperatures		Differences ΔT_i		Hours	Mean hourly temperatures		Differences ΔT_i	
	Real	Inter-polated	Mean Value	Standard Deviation		Real	Inter-polated	Mean Value	Standard Deviation
1	13.79	13.93	-0.14	0.80	13	18.34	18.39	-0.05	0.80
2	13.44	13.44	0.00	0.00	14	18.64	18.64	0.00	0.00
3	13.14	12.95	0.19	0.67	15	18.66	18.67	-0.01	0.85
4	12.88	12.64	0.24	0.73	16	18.44	18.47	-0.03	0.68
5	12.66	12.66	0.00	0.00	17	18.03	18.03	0.00	0.00
6	12.53	13.06	-0.43	0.87	18	17.45	17.39	0.06	0.67
7	13.09	13.80	-0.71	0.83	19	16.59	16.64	-0.05	0.64
8	14.74	14.74	0.00	0.00	20	15.92	15.92	0.00	0.00
9	15.90	15.72	0.18	0.64	21	15.44	15.33	0.11	0.61
10	16.70	16.63	0.07	0.34	22	15.00	14.91	0.09	0.65
11	17.38	17.38	0.00	0.00	23	14.62	14.62	0.00	0.00
12	17.96	17.97	-0.01	0.69	24	14.23	14.36	-0.13	0.69

TABLE B

Mean Monthly Coefficient of Newton Interpolation.

$\bar{A}_1 = 0.1336 \times 10^{2}$	$\bar{A}_7 = -0.4088 \times 10^{-5}$	$\bar{A}_{13} = -0.8210 \times 10^{-12}$	$\bar{A}_{19} = 0.7222 \times 10^{-20}$
$\bar{A}_2 = -0.2591 \times 10^{0}$	$\bar{A}_8 = 0.3439 \times 10^{-6}$	$\bar{A}_{14} = 0.1722 \times 10^{-13}$	$\bar{A}_{20} = -0.2225 \times 10^{-21}$
$\bar{A}_3 = 0.1555 \times 10^{0}$	$\bar{A}_9 = -0.4175 \times 10^{-7}$	$\bar{A}_{15} = 0.4687 \times 10^{-15}$	$\bar{A}_{21} = 0.5742 \times 10^{-23}$
$\bar{A}_4 = -0.1330 \times 10^{-1}$	$\bar{A}_{10} = 0.4475 \times 10^{-8}$	$\bar{A}_{16} = -00.7034 \times 10^{-16}$	$\bar{A}_{22} = -0.1195 \times 10^{-24}$
$\bar{A}_5 = 0.6117 \times 10^{-4}$	$\bar{A}_{11} = -0.3548 \times 10^{-9}$	$\bar{A}_{17} = 0.4350 \times 10^{-17}$	$\bar{A}_{23} = 0.1733 \times 10^{-26}$
$\bar{A}_6 = 0.4994 \times 10^{-4}$	$\bar{A}_{12} = 0.2046 \times 10^{-10}$	$\bar{A}_{18} = -0.1966 \times 10^{-18}$	$\bar{A}_{24} = -0.3668 \times 10^{-29}$

TABLE C

Equation of Monthly Mean Value of Diurnal Temperature Variation.

$$\bar{T}(x) = \bar{A}_1 + \sum_{i=2}^{24} \bar{A}_i \prod_{j=1}^{i-1} (X - X_{3j-25}) \quad \forall\, x\, \varepsilon \{1,24\}$$

where $X_{3j-25} = 3j-25$, $j = 1(1)23$ and $\bar{A}_i$, $i = 1(1)24$ are given in Table B.

Met. Station of Hellinikon

Month: May
Period: 1956-1971

TABLE A

Hours	Mean hourly temperatures		Differences ΔT_i		Hours	Mean hourly temperatures		Differences ΔT_i	
	Real	Inter-polated	Mean Value	Standard Deviation		Real	Inter-polated	Mean Value	Standard Deviation
1	18.14	18.47	-0.33	0.72	13	22.85	22.72	0.13	0.89
2	17.77	17.77	0.00	0.00	14	22.94	22.94	0.00	0.00
3	17.39	17.06	0.33	0.68	15	22.97	23.02	-0.05	0.87
4	17.11	16.68	0.43	0.72	16	22.80	22.90	-0.10	0.89
5	16.86	16.86	0.00	0.00	17	22.53	22.53	0.00	0.00
6	16.80	17.57	-0.77	0.68	18	22.06	21.97	0.09	0.91
7	18.42	18.62	-0.20	0.72	19	21.38	21.29	0.09	0.69
8	19.75	19.75	0.00	0.00	20	20.62	20.62	0.00	0.00
9	20.76	20.74	0.02	0.64	21	20.05	20.03	0.02	0.63
10	21.51	21.49	0.02	0.69	22	19.60	19.55	0.05	0.63
11	22.02	22.02	0.00	0.00	23	19.15	19.15	0.00	0.00
12	22.53	22.42	0.11	0.75	24	18.73	18.78	-0.05	0.71

TABLE B

Mean Monthly Coefficient of Newton Interpolation.

$\bar{A}_1 = 0.1758 \times 10^{2}$	$\bar{A}_7 = 0.3374 \times 10^{-5}$	$\bar{A}_{13} = -0.5536 \times 10^{-12}$	$\bar{A}_{19} = 0.1707 \times 10^{-19}$
$\bar{A}_2 = -0.2978 \times 10^{0}$	$\bar{A}_8 = 0.1645 \times 10^{-6}$	$\bar{A}_{14} = -0.9599 \times 10^{-14}$	$\bar{A}_{20} = -0.5575 \times 10^{-21}$
$\bar{A}_3 = 0.2107 \times 10^{0}$	$\bar{A}_9 = -0.4658 \times 10^{-7}$	$\bar{A}_{15} = 0.2444 \times 10^{-14}$	$\bar{A}_{21} = 0.1603 \times 10^{-22}$
$\bar{A}_4 = -0.2725 \times 10^{-1}$	$\bar{A}_{10} = 0.5134 \times 10^{-8}$	$\bar{A}_{16} = -0.1883 \times 10^{-15}$	$\bar{A}_{22} = -0.4086 \times 10^{-24}$
$\bar{A}_5 = 0.1887 \times 10^{-2}$	$\bar{A}_{11} = -0.3783 \times 10^{-9}$	$\bar{A}_{17} = 0.1029 \times 10^{-16}$	$\bar{A}_{23} = 0.9284 \times 10^{-26}$
$\bar{A}_6 = -0.9807 \times 10^{-4}$	$\bar{A}_{12} = 0.1929 \times 10^{-10}$	$\bar{A}_{18} = -0.4547 \times 10^{-18}$	$\bar{A}_{24} = -0.1909 \times 10^{-27}$

TABLE C

Equation of Monthly Mean Value of Diurnal Temperature Variation.

$$\bar{T}(x) = \bar{A}_1 + \sum_{i=2}^{24} \bar{A}_i \prod_{j=1}^{i-1} (X - X_{3j-25}) \quad \forall\, x \in \{1,24\}$$

where $X_{3j-25} = 3j-25$, $j = 1(1)23$ and $\bar{A}_i$, $i = 1(1)24$ are given in Table B.

Met. Station of Hellinikon

Month: June
Period: 1956-1971

TABLE A

Hours	Mean hourly temperatures		Differences ΔT_i		Hours	Mean hourly temperatures		Differences ΔT_i	
	Real	Inter-polated	Mean Value	Standard Deviation		Real	Inter-polated	Mean Value	Standard Deviation
1	22.40	22.76	-0.36	0.71	13	27.13	27.06	0.07	0.84
2	21.99	21.99	0.00	0.00	14	27.36	27.36	0.00	0.00
3	21.62	21.22	0.40	0.65	15	27.37	27.51	0.14	0.91
4	21.31	20.83	0.48	0.69	16	27.32	27.43	0.11	0.83
5	21.04	21.04	0.00	0.00	17	27.08	27.08	0.00	0.00
6	21.10	21.82	-0.72	0.70	18	26.57	26.48	0.09	0.79
7	22.93	22.95	-0.02	0.69	19	25.82	25.75	0.07	0.72
8	24.11	24.11	0.00	0.00	20	25.01	25.01	0.00	0.00
9	25.01	25.09	-0.08	0.68	21	24.32	24.36	-0.04	0.64
10	25.75	25.81	-0.06	0.79	22	23.85	23.82	0.03	0.67
11	26.32	26.32	0.00	0.00	23	23.38	23.38	0.00	0.00
12	26.82	26.71	0.11	0.76	24	22.94	22.97	-0.03	0.70

TABLE B

Mean Monthly Coefficient of Newton Interpolation.

$\bar{A}_1 = 0.2187 \times 10^{2}$	$\bar{A}_7 = 0.7842 \times 10^{-5}$	$\bar{A}_{13} = -0.5175 \times 10^{-12}$	$\bar{A}_{19} = 0.1996 \times 10^{-19}$
$\bar{A}_2 = -0.3166 \times 10^{0}$	$\bar{A}_8 = -0.7978 \times 10^{-7}$	$\bar{A}_{14} = -0.1523 \times 10^{-13}$	$\bar{A}_{20} = -0.6575 \times 10^{-21}$
$\bar{A}_3 = 0.2223 \times 10^{0}$	$\bar{A}_9 = -0.3822 \times 10^{-7}$	$\bar{A}_{15} = 0.2924 \times 10^{-14}$	$\bar{A}_{21} = 0.1912 \times 10^{-22}$
$\bar{A}_4 = -0.3000 \times 10^{-1}$	$\bar{A}_{10} = 0.5042 \times 10^{-8}$	$\bar{A}_{16} = -0.2191 \times 10^{-15}$	$\bar{A}_{22} = -0.4939 \times 10^{-24}$
$\bar{A}_5 = 0.2353 \times 10^{-2}$	$\bar{A}_{11} = -0.3854 \times 10^{-9}$	$\bar{A}_{17} = 0.1192 \times 10^{-16}$	$\bar{A}_{23} = 0.1142 \times 10^{-25}$
$\bar{A}_6 = -0.1534 \times 10^{-3}$	$\bar{A}_{12} = 0.1953 \times 10^{-10}$	$\bar{A}_{18} = -0.5281 \times 10^{-18}$	$\bar{A}_{24} = -0.2394 \times 10^{-27}$

TABLE C

Equation of Monthly Mean Value of Diurnal Temperature Variation.

$$\bar{T}(x) = \bar{A}_1 + \sum_{i=2}^{24} \bar{A}_i \prod_{j=1}^{i-1} (X - X_{3j-25}) \quad \forall\ x \in [1,24]$$

where $X_{3j-25} = 3j-25$, $j = 1(1)23$ and $\bar{A}_i$, $i = 1(1)24$ are given in Table B.

Met. Station of Hellinikon

Month: July
Period: 1956-1971

TABLE A

Hours	Mean hourly temperatures		Differences ΔT_i		Hours	Mean hourly temperatures		Differences ΔT_i	
	Real	Inter-polated	Mean Value	Standard Deviation		Real	Inter-polated	Mean Value	Standard Deviation
1	25.02	25.26	-0.24	0.79	13	30.28	30.17	0.11	0.79
2	24.63	24.63	0.00	0.00	14	30.44	30.44	0.00	0.00
3	24.23	23.98	0.25	0.66	15	30.49	30.56	0.07	0.98
4	23.90	23.61	0.29	0.75	16	30.47	30.48	-0.01	0.93
5	23.74	23.74	0.00	0.00	17	30.10	30.10	0.00	0.00
6	23.75	24.40	-0.65	0.76	18	29.51	29.46	0.05	0.89
7	25.38	25.45	-0.07	0.65	19	28.68	28.62	0.05	0.76
8	26.65	26.65	0.00	0.00	20	27.74	27.74	0.00	0.00
9	27.71	27.76	-0.05	0.68	21	26.96	26.97	-0.01	0.72
10	28.60	28.67	-0.07	0.68	22	26.41	26.37	0.04	0.67
11	29.33	29.33	0.00	0.00	23	25.94	25.94	0.00	0.00
12	29.91	29.81	0.10	0.66	24	25.48	25.58	-0.10	0.71

TABLE B

Mean Monthly Coefficient of Newton Interpolation.

$\bar{A}_1 = 0.2455 \times 10^{2}$
$\bar{A}_2 = -0.2902 \times 10^{0}$
$\bar{A}_3 = 0.2106 \times 10^{0}$
$\bar{A}_4 = -0.2512 \times 10^{-1}$
$\bar{A}_5 = 0.1441 \times 10^{-2}$
$\bar{A}_6 = -0.4980 \times 10^{-4}$

$\bar{A}_7 = -0.8914 \times 10^{-6}$
$\bar{A}_8 = 0.5389 \times 10^{-6}$
$\bar{A}_9 = -0.7719 \times 10^{-7}$
$\bar{A}_{10} = 0.7227 \times 10^{-8}$
$\bar{A}_{11} = -0.4930 \times 10^{-9}$
$\bar{A}_{12} = 0.2433 \times 10^{-10}$

$\bar{A}_{13} = -0.7373 \times 10^{-12}$
$\bar{A}_{14} = -0.3226 \times 10^{-14}$
$\bar{A}_{15} = 0.2169 \times 10^{-14}$
$\bar{A}_{16} = -0.1725 \times 10^{-15}$
$\bar{A}_{17} = 0.9341 \times 10^{-17}$
$\bar{A}_{18} = -0.4032 \times 10^{-18}$

$\bar{A}_{19} = 0.1462 \times 10^{-19}$
$\bar{A}_{20} = -0.4539 \times 10^{-21}$
$\bar{A}_{21} = 0.1212 \times 10^{-22}$
$\bar{A}_{22} = -0.2750 \times 10^{-24}$
$\bar{A}_{23} = 0.5110 \times 10^{-26}$
$\bar{A}_{24} = -0.7065 \times 10^{-28}$

TABLE C

Equation of Monthly Mean Value of Diurnal Temperature Variation.

$$\bar{T}(x) = \bar{A}_1 + \sum_{i=2}^{24} \bar{A}_i \prod_{j=1}^{i-1} (X - X_{3j-25}) \quad \forall\, x \in \{1,24\}$$

where $X_{3j-25} = 3j-25$, $j = 1(1)23$ and $\bar{A}_i$, $i = 1(1)24$ are given in Table B.

Met. Station of Hellinikon.

Month: August
Period: 1956-1971

TABLE A

Hours	Mean hourly temperatures		Differences ΔT_i		Hours	Mean hourly temperatures		Differences ΔT_i	
	Real	Inter-polated	Mean Value	Standard Deviation		Real	Inter-polated	Mean Value	Standard Deviation
1	25.47	25.57	-0.10	0.67	13	30.72	30.73	-0.01	0.91
2	25.03	25.03	0.00	0.0	14	31.06	31.06	0.00	0.00
3	24.68	24.48	0.20	0.60	15	31.14	31.20	-0.06	0.82
4	24.40	24.13	0.27	0.62	16	30.97	31.08	-0.11	0.79
5	24.14	24.14	0.00	0.00	17	30.65	30.65	0.00	0.00
6	23.96	24.59	-0.63	0.70	18	29.91	29.91	0.00	0.77
7	24.90	25.45	-0.55	0.71	19	28.88	28.97	-0.09	0.69
8	26.55	26.55	0.00	0.00	20	28.00	28.00	0.00	0.00
9	27.80	27.70	0.10	0.79	21	27.35	27.19	0.16	0.59
10	28.79	28.74	0.05	0.65	22	26.74	26.61	0.13	0.58
11	29.60	29.60	0.00	0.00	23	26.25	26.25	0.00	0.00
12	30.24	30.25	-0.01	0.80	24	25.78	25.94	-0.16	0.66

TABLE B

Mean Monthly Coefficient of Newton Interpolation.

$\bar{A}_1 = 0.2512 \times 10^{2}$	$\bar{A}_7 = -0.5843 \times 10^{-5}$	$\bar{A}_{13} = -0.1380 \times 10^{-11}$	$\bar{A}_{19} = 0.7260 \times 10^{-20}$
$\bar{A}_2 = -0.3050 \times 10^{0}$	$\bar{A}_8 = 0.7650 \times 10^{-6}$	$\bar{A}_{14} = 0.3580 \times 10^{-13}$	$\bar{A}_{20} = -0.2080 \times 10^{-21}$
$\bar{A}_3 = 0.1863 \times 10^{0}$	$\bar{A}_9 = -0.9200 \times 10^{-7}$	$\bar{A}_{15} = 0.9452 \times 10^{-17}$	$\bar{A}_{21} = 0.4545 \times 10^{-23}$
$\bar{A}_4 = -0.1702 \times 10^{-1}$	$\bar{A}_{10} = 0.8640 \times 10^{-8}$	$\bar{A}_{16} = -0.6410 \times 10^{-16}$	$\bar{A}_{22} = -0.5715 \times 10^{-25}$
$\bar{A}_5 = 0.3122 \times 10^{-3}$	$\bar{A}_{11} = -0.6200 \times 10^{-9}$	$\bar{A}_{17} = 0.4437 \times 10^{-17}$	$\bar{A}_{23} = -0.8302 \times 10^{-27}$
$\bar{A}_6 = 0.4166 \times 10^{-4}$	$\bar{A}_{12} = 0.3403 \times 10^{-10}$	$\bar{A}_{18} = -0.2035 \times 10^{-18}$	$\bar{A}_{24} = 0.8594 \times 10^{-28}$

TABLE C

Equation of Monthly Mean Value of Diurnal Temperature Variation.

$$\bar{T}(x) = \bar{A}_1 + \sum_{i=2}^{24} \bar{A}_i \prod_{j=1}^{i-1} (X - X_{3j-25}) \quad \forall\, x \in \{1,24\}$$

where $X_{3j-25} = 3j-25$, $j = 1(1)23$ and $\bar{A}_i$, $i = 1(1)24$ are given in Table B.

Met. Station of Hellinikon

Month: September
Period: 1956-1971

TABLE A

Hours	Mean hourly temperatures Real	Interpolated	Differences ΔT_i Mean Value	Standard Deviation	Hours	Mean hourly temperatures Real	Interpolated	Differences ΔT_i Mean Value	Standard Deviation
1	21.64	21.63	0.01	0.73	13	26.85	26.94	-0.09	0.67
2	21.31	21.31	0.00	0.00	14	27.12	27.12	0.00	0.00
3	20.96	20.96	0.00	0.62	15	27.04	27.06	-0.02	0.78
4	20.74	20.65	0.09	0.70	16	26.77	26.76	0.01	0.76
5	20.51	20.51	0.00	0.00	17	26.23	26.23	0.00	0.00
6	20.31	20.70	-0.39	0.65	18	25.34	25.50	-0.16	0.73
7	20.51	21.29	-0.78	0.95	19	24.34	24.63	-0.29	0.55
8	22.26	22.26	0.00	0.00	20	23.75	23.75	0.00	0.00
9	23.77	23.46	0.31	0.56	21	23.24	23.02	0.22	0.54
10	24.84	24.67	0.17	0.55	22	22.72	22.52	0.20	0.53
11	25.72	25.72	0.00	0.00	23	22.22	22.22	0.00	0.00
12	26.38	26.48	-0.10	0.58	24	21.84	21.99	-0.15	0.67

TABLE B

Mean Monthly Coefficient of Newton Interpolation.

$\bar{A}_1 = 0.2144 \times 10^{2}$	$\bar{A}_7 = -0.1672 \times 10^{-4}$	$\bar{A}_{13} = -0.9213 \times 10^{-12}$	$\bar{A}_{19} = -0.7217 \times 10^{-21}$
$\bar{A}_2 = -0.2653 \times 10^{0}$	$\bar{A}_8 = 0.1087 \times 10^{-5}$	$\bar{A}_{14} = 0.2700 \times 10^{-13}$	$\bar{A}_{20} = 0.7442 \times 10^{-22}$
$\bar{A}_3 = 0.1425 \times 10^{0}$	$\bar{A}_9 = -0.7808 \times 10^{-7}$	$\bar{A}_{15} = -0.4218 \times 10^{-15}$	$\bar{A}_{21} = -0.4170 \times 10^{-23}$
$\bar{A}_4 = -0.5467 \times 10^{-2}$	$\bar{A}_{10} = 0.5993 \times 10^{-8}$	$\bar{A}_{16} = -0.5841 \times 10^{-17}$	$\bar{A}_{22} = 0.1801 \times 10^{-24}$
$\bar{A}_5 = -0.1462 \times 10^{-2}$	$\bar{A}_{11} = -0.4085 \times 10^{-9}$	$\bar{A}_{17} = 0.5595 \times 10^{-18}$	$\bar{A}_{23} = -0.6562 \times 10^{-26}$
$\bar{A}_6 = 0.2165 \times 10^{-3}$	$\bar{A}_{12} = 0.2225 \times 10^{-10}$	$\bar{A}_{18} = -0.9735 \times 10^{-20}$	$\bar{A}_{24} = 0.2098 \times 10^{-27}$

TABLE C

Equation of Monthly Mean Value of Diurnal Temperature Variation.

$$\bar{T}(x) = \bar{A}_1 + \sum_{i=2}^{24} \bar{A}_i \prod_{j=1}^{i-1} (X - X_{3j-25}) \quad \forall\, x \in \{1,24\}$$

where $X_{3j-25} = 3j-25$, $j = 1(1)23$ and $\bar{A}_i$, $i = 1(1)24$ are given in Table B.

Met. Station of Hellinikon

Month: October
Period: 1956-1971

TABLE A

Hours	Mean hourly temperatures		Differencies ΔT_i		Hours	Mean hourly temperatures		Differences ΔT_i	
	Real	Inter-polated	Mean Value	Standard Deviation		Real	Inter-polated	Mean Value	Standard Deviation
1	17.41	17.27	0.14	0.76	13	22.32	22.41	-0.09	0.66
2	17.15	17.15	0.00	0.00	14	22.44	22.44	0.00	0.00
3	16.94	17.02	-0.08	0.66	15	22.34	22.17	0.17	0.60
4	16.72	16.78	-0.06	0.65	16	21.90	21.70	0.20	0.53
5	16.53	16.53	0.00	0.00	17	21.10	21.10	0.00	0.00
6	16.39	16.45	-0.06	0.62	18	20.13	20.42	-0.29	0.53
7	16.35	16.74	-0.39	0.83	19	19.46	19.71	-0.25	0.48
8	17.50	17.50	0.00	0.00	20	19.03	19.03	0.00	0.00
9	19.12	18.64	0.48	0.70	21	18.59	18.47	0.12	0.58
10	20.28	19.94	0.34	0.77	22	18.21	18.10	0.11	0.59
11	21.12	21.12	0.00	0.00	23	17.88	17.88	0.00	0.00
12	21.85	21.98	-0.13	0.72	24	17.55	17.77	-0.22	0.67

TABLE B

Mean Monthly Coefficient of Newton Interpolation.

$\bar{A}_1 = 0.1728 \times 10^{2}$	$\bar{A}_7 = -0.2460 \times 10^{-4}$	$\bar{A}_{13} = -0.4821 \times 10^{-12}$	$\bar{A}_{19} = -0.9114 \times 10^{-20}$
$\bar{A}_2 = -0.2137 \times 10^{0}$	$\bar{A}_8 = 0.1189 \times 10^{-5}$	$\bar{A}_{14} = 0.2304 \times 10^{-13}$	$\bar{A}_{20} = 0.3566 \times 10^{-21}$
$\bar{A}_3 = 0.9198 \times 10^{-1}$	$\bar{A}_9 = -0.4937 \times 10^{-7}$	$\bar{A}_{15} = -0.1208 \times 10^{-14}$	$\bar{A}_{21} = -0.1241 \times 10^{-22}$
$\bar{A}_4 = 0.5807 \times 10^{-2}$	$\bar{A}_{10} = 0.2476 \times 10^{-8}$	$\bar{A}_{16} = 0.7037 \times 10^{-16}$	$\bar{A}_{22} = 0.3899 \times 10^{-24}$
$\bar{A}_5 = -0.3011 \times 10^{-2}$	$\bar{A}_{11} = -0.1572 \times 10^{-9}$	$\bar{A}_{17} = -0.4010 \times 10^{-17}$	$\bar{A}_{23} = -0.1120 \times 10^{-25}$
$\bar{A}_6 = 0.3591 \times 10^{-3}$	$\bar{A}_{12} = 0.9440 \times 10^{-11}$	$\bar{A}_{18} = 0.2045 \times 10^{-18}$	$\bar{A}_{24} = 0.2977 \times 10^{-27}$

TABLE C

Equation of Monthly Mean Value of Diurnal Temperature Variation.

$$\bar{T}(x) = \bar{A}_1 + \sum_{i=2}^{24} \bar{A}_i \prod_{j=1}^{i-1} (X - X_{3j-25}) \quad \forall\, x \in \{1,24\}$$

where $X_{3j-25} = 3j-25$, $j = 1(1)23$ and $\bar{A}_i$, $i = 1(1)24$ are given in Table B.

Meteorological Station of Hellinikon

Month: November
Period: 1956-1971

TABLE A

Hours	Mean hourly temperatures		Differences ΔT_i		Hours	Mean hourly temperatures		Differences ΔT_i	
	Real	Interpolated	Mean Value	Standard Deviation		Real	Interpolated	Mean Value	Standard Deviation
1	14.84	14.47	0.37	0.79	13	18.92	19.13	-0.21	0.62
2	14.64	14.64	0.00	0.00	14	19.06	19.06	0.00	0.00
3	14.44	14.79	-0.35	0.70	15	18.98	18.74	0.24	0.62
4	14.24	14.62	-0.38	0.72	16	18.56	18.30	0.26	0.59
5	14.17	14.17	0.00	0.00	17	17.82	17.82	0.00	0.00
6	14.05	13.73	0.32	0.69	18	16.94	17.28	-0.34	0.99
7	13.89	13.65	0.24	0.64	19	16.46	16.68	-0.22	0.58
8	14.18	14.18	0.00	0.00	20	16.06	16.06	0.00	0.00
9	15.70	15.27	0.43	0.70	21	15.72	15.55	0.17	0.66
10	16.96	16.64	0.32	0.65	22	15.45	15.26	0.19	0.65
11	17.90	17.905	0.00	0.00	23	15.17	15.17	0.00	0.00
12	18.54	18.77	-0.23	0.63	24	14.95	15.14	-0.19	0.69

TABLE B

Mean Monthly Coefficient of Newton Interpolation.

$\bar{A}_1 = 0.1470 \times 10^{2}$	$\bar{A}_7 = -0.3892 \times 10^{-4}$	$\bar{A}_{13} = -0.6249 \times 10^{-12}$	$\bar{A}_{19} = -0.2039 \times 10^{-19}$
$\bar{A}_2 = -0.1561 \times 10^{0}$	$\bar{A}_8 = 0.2064 \times 10^{-5}$	$\bar{A}_{14} = 0.4113 \times 10^{-13}$	$\bar{A}_{20} = 0.7640 \times 10^{-21}$
$\bar{A}_3 = 0.2695 \times 10^{-1}$	$\bar{A}_9 = -0.91165 \times 10^{-7}$	$\bar{A}_{15} = -0.2806 \times 10^{-14}$	$\bar{A}_{21} = -0.2566 \times 10^{-22}$
$\bar{A}_4 = 0.1985 \times 10^{-1}$	$\bar{A}_{10} = 0.4015 \times 10^{-8}$	$\bar{A}_{16} = 0.1781 \times 10^{-15}$	$\bar{A}_{22} = 0.7819 \times 10^{-24}$
$\bar{A}_5 = -0.4866 \times 10^{-2}$	$\bar{A}_{11} = -0.1963 \times 10^{-9}$	$\bar{A}_{17} = -0.9939 \times 10^{-17}$	$\bar{A}_{23} = -0.2189 \times 10^{-25}$
$\bar{A}_6 = 0.5428 \times 10^{-3}$	$\bar{A}_{12} = 0.1059 \times 10^{-10}$	$\bar{A}_{18} = 0.4815 \times 10^{-18}$	$\bar{A}_{24} = 0.5702 \times 10^{-27}$

TABLE C

Equation of Monthly Mean Value of Diurnal Temperature Variation.

$$\bar{T}(x) = \bar{A}_1 + \sum_{i=2}^{24} \bar{A}_i \prod_{j=1}^{i-1} (X - X_{3j-25}) \quad \forall\, x \in \{1, 24\}$$

where $X_{3j-25} = 3j-25$, $j = 1(1)23$ and $\bar{A}_i$, $i = 1(1)24$ are given in Table B.

Met. Station of Hellinikon

Month: December
Period: 1956-1971

TABLE A

Hours	Mean hourly temperatures		Differences ΔT_i		Hours	Mean hourly temperatures		Differences ΔT_i	
	Real	Interpolated	Mean Value	Standard Deviation		Real	Interpolated	Mean Value	Standard Deviation
1	11.27	11.00	0.27	0.95	13	14.67	14.89	-0.22	0.64
2	11.13	11.13	0.00	0.00	14	14.87	14.87	0.00	0.00
3	11.00	11.22	-0.22	0.84	15	14.74	14.59	0.15	0.64
4	10.90	11.07	-0.17	0.80	16	14.37	14.17	0.20	0.55
5	10.71	10.71	0.00	0.00	17	13.70	13.70	0.00	0.00
6	10.63	10.34	0.29	0.79	18	12.98	13.21	-0.23	0.66
7	10.57	10.26	0.31	0.80	19	12.54	12.70	-0.16	0.66
8	10.67	10.67	0.00	0.00	20	12.21	12.21	0.00	0.00
9	11.52	11.53	-0.01	0.70	21	11.93	11.81	0.12	0.83
10	12.80	12.65	0.15	0.61	22	11.69	11.56	0.13	1.01
11	13.73	13.73	0.00	0.00	23	11.46	11.46	0.00	0.00
12	14.31	14.52	-0.21	0.64	24	11.32	11.42	-0.10	1.19

TABLE 8

Mean Monthly Coefficient of Newton Interpolation.

$\bar{A}_1 = 0.1220 \times 10^{2}$	$\bar{A}_7 = -0.2840 \times 10^{-4}$	$\bar{A}_{13} = -0.1516 \times 10^{-12}$	$\bar{A}_{19} = -0.1505 \times 10^{-19}$
$\bar{A}_2 = -0.1397 \times 10^{0}$	$\bar{A}_8 = 0.1273 \times 10^{-5}$	$\bar{A}_{14} = 0.1798 \times 10^{-13}$	$\bar{A}_{20} = 0.5600 \times 10^{-21}$
$\bar{A}_3 = 0.2095 \times 10^{-1}$	$\bar{A}_9 = -0.3876 \times 10^{-7}$	$\bar{A}_{15} = -0.1656 \times 10^{-14}$	$\bar{A}_{21} = -0.1854 \times 10^{-22}$
$\bar{A}_4 = 0.1687 \times 10^{-1}$	$\bar{A}_{10} = 0.7842 \times 10^{-9}$	$\bar{A}_{16} = 0.1204 \times 10^{-15}$	$\bar{A}_{22} = 0.5534 \times 10^{-24}$
$\bar{A}_5 = -0.4013 \times 10^{-2}$	$\bar{A}_{11} = -0.1400 \times 10^{-10}$	$\bar{A}_{17} = -0.7132 \times 10^{-17}$	$\bar{A}_{23} = -0.1508 \times 10^{-25}$
$\bar{A}_6 = 0.4300 \times 10^{-3}$	$\bar{A}_{12} = 0.1045 \times 10^{-11}$	$\bar{A}_{18} = 0.3537 \times 10^{-18}$	$\bar{A}_{24} = 0.3809 \times 10^{-27}$

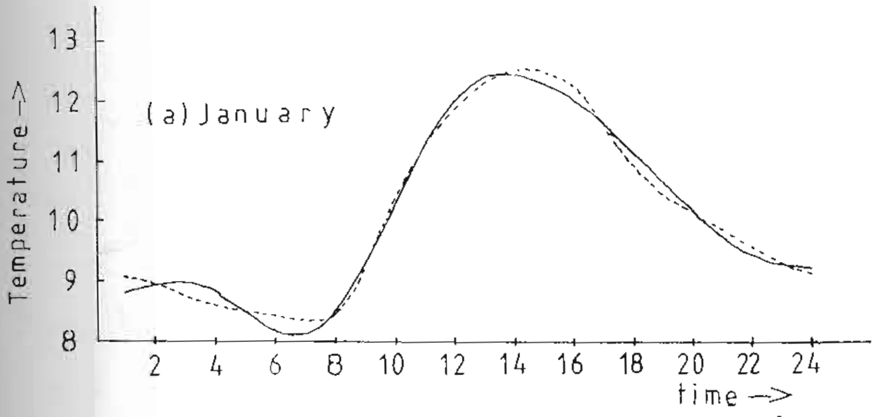
TABLE C

Equation of Monthly Mean Value of Diurnal Temperature Variation.

$$\bar{T}(x) = \bar{A}_1 + \sum_{i=2}^{24} \bar{A}_i \prod_{j=1}^{i-1} (X - X_{3j-25}) \quad \forall\ x \in [1,24]$$

where $X_{3j-25} = 3j-25$, $j = 1(1)23$ and $\bar{A}_i$, $i = 1(1)24$ are given in Table B.

APPENDIX B



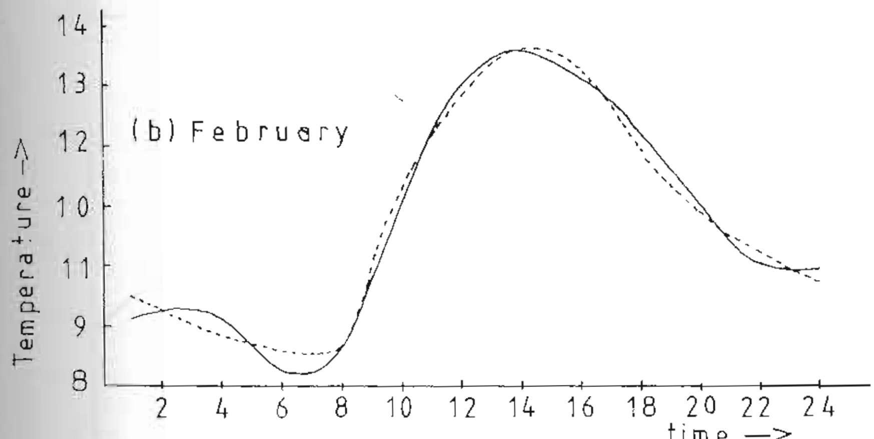
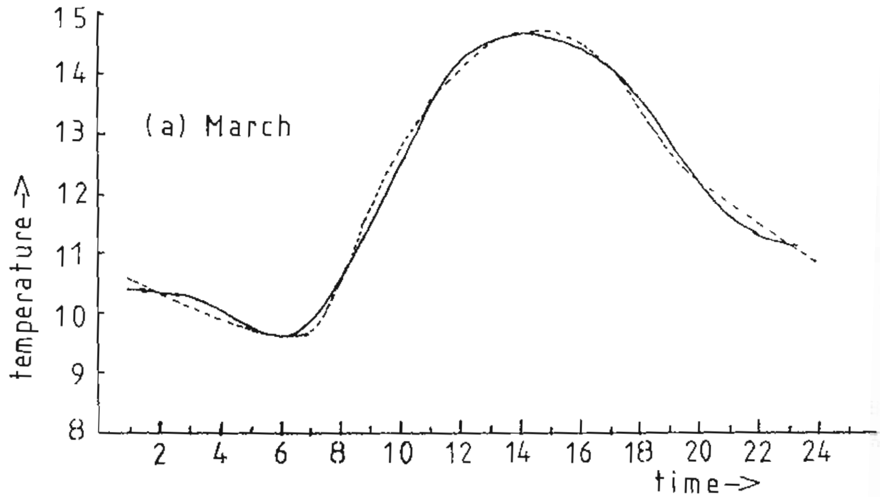


Fig 3a. Mean daily temperature variation real (dashed line) and due to interpolatin (solid line) in meteorological station of Helli-nikon for the period 1956-1971 and for January.
3b As in fig. 3a except for February.



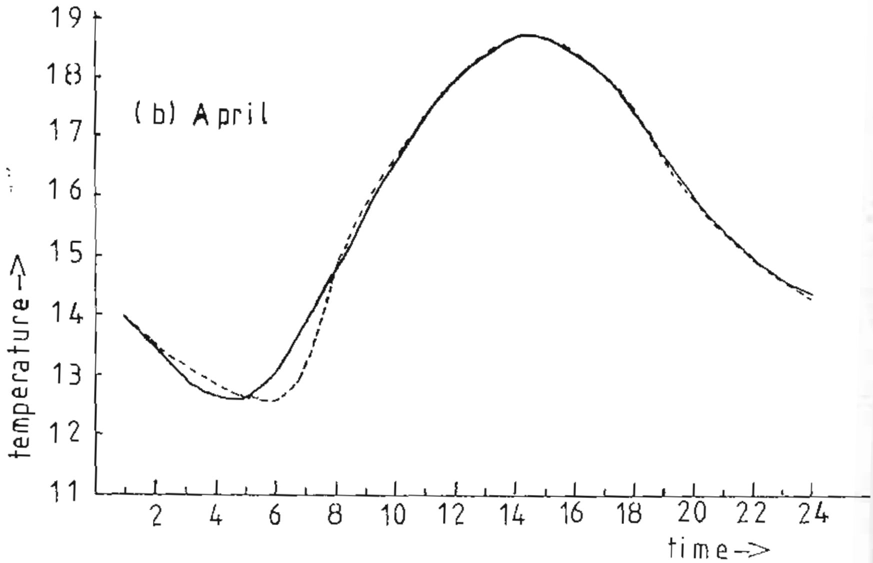


Fig. 4a. As in Fig. 3a except for March.
4b. As in Fig. 3a except for April.

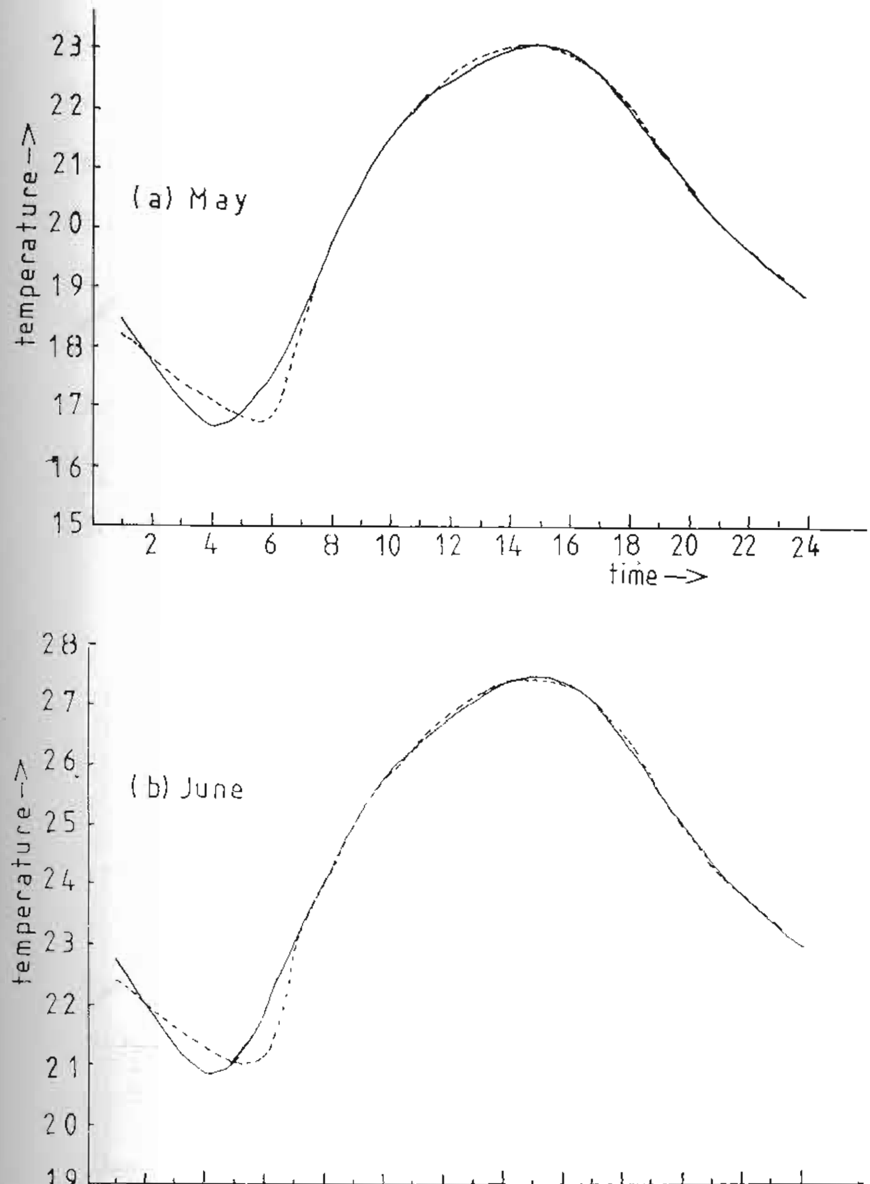


Fig. 5. As in Fig 3a except for (a) May and (b) June.

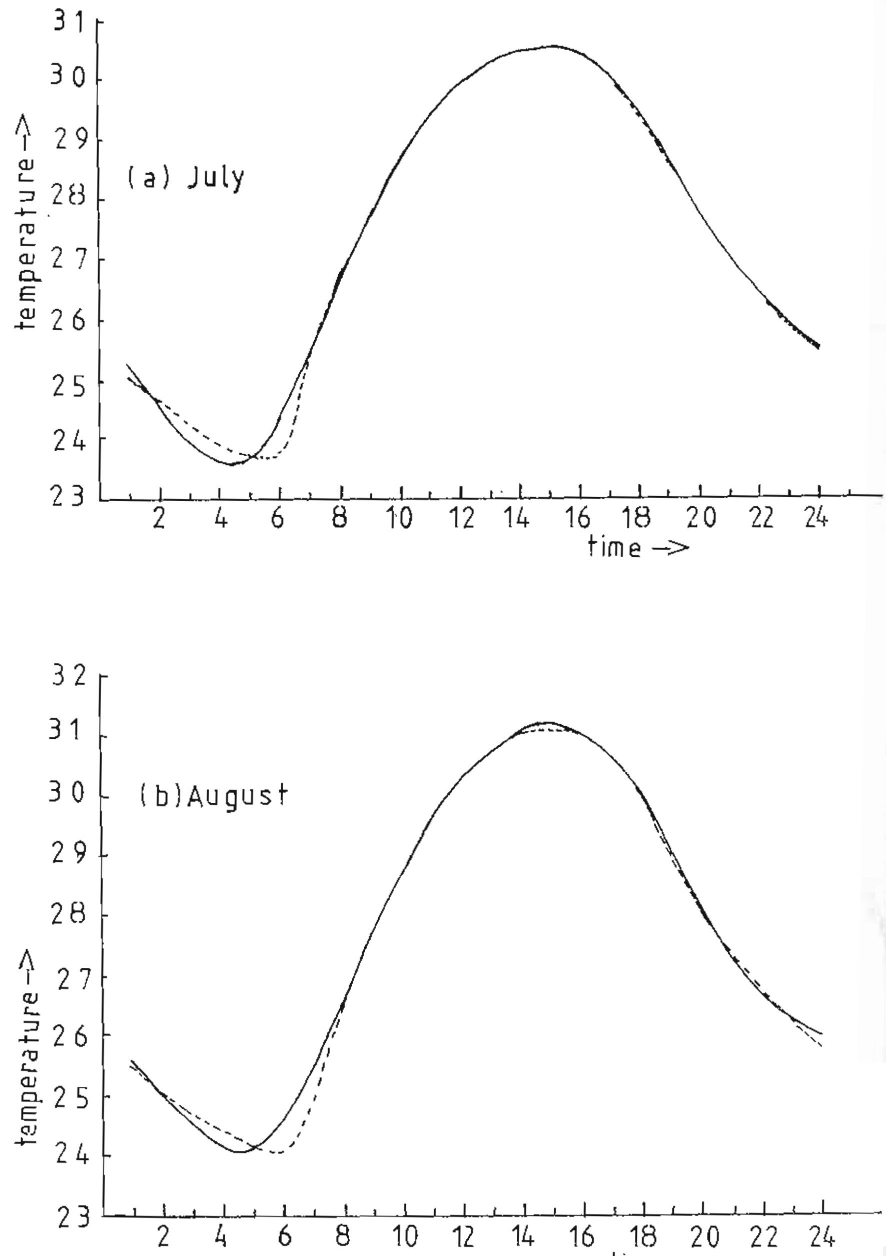


Fig. 6. As in Fig. 3a except for (a) July and (b) August.

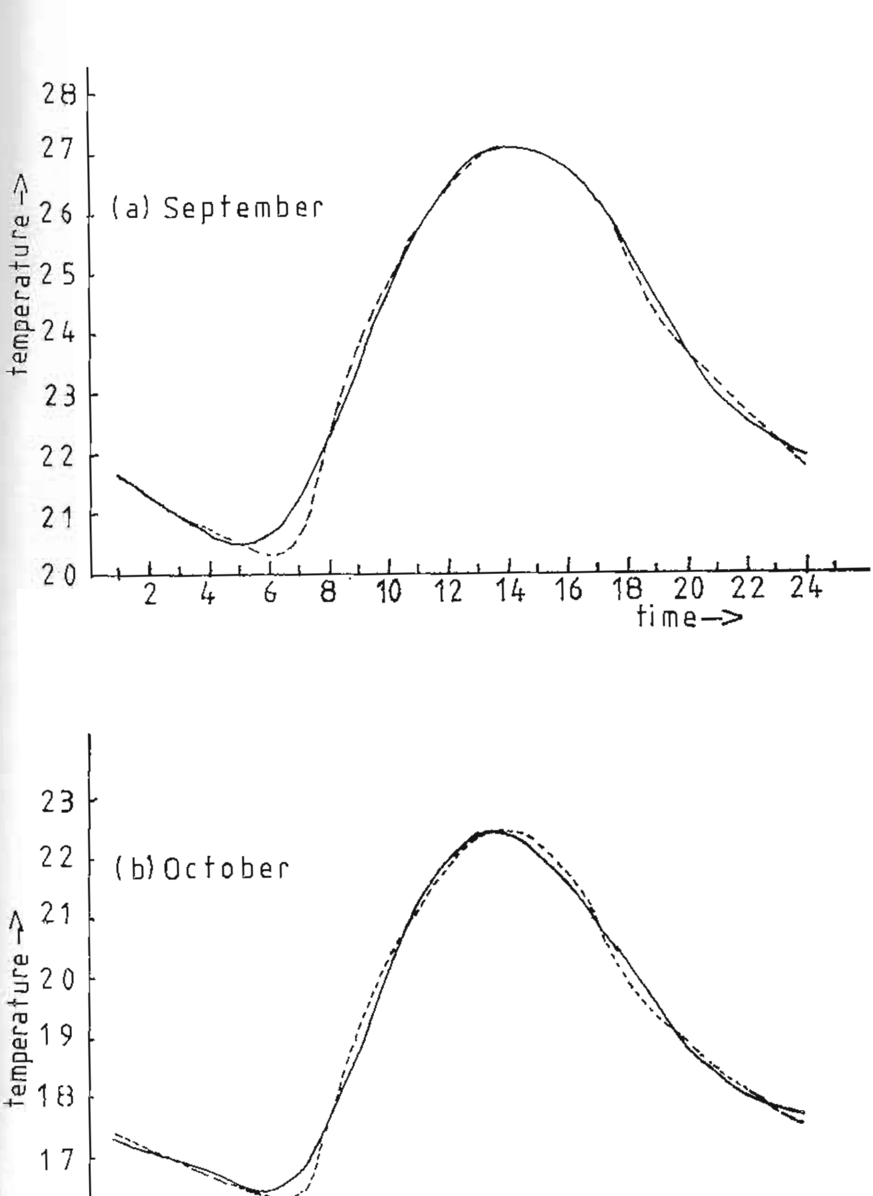


Fig.7. As in Fig. 3a except for (a) September and (b) October.

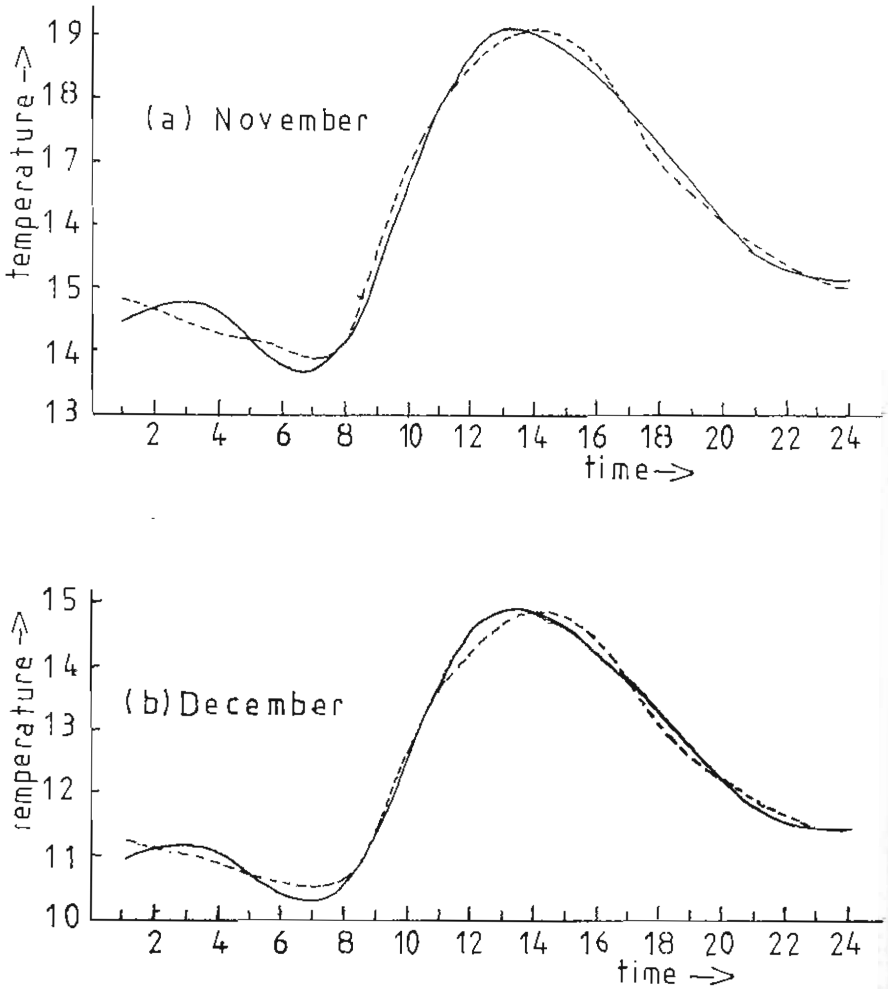


Fig. 8. As in Fig. 3a except for (a) November (b) December.

ΠΕΡΙΛΗΨΗ

ΑΡΙΘΜΗΤΙΚΗ ΜΕΛΕΤΗ ΤΩΝ ΗΜΕΡΗΣΙΩΝ ΜΕΤΑΒΟΛΩΝ ΤΗΣ ΘΕΡΜΟΚΡΑΣΙΑΣ ΑΠΟ 8 ΣΥΝΟΠΤΙΚΕΣ ΠΑΡΑΤΗΡΗΣΕΙΣ ΣΤΟ ΜΕΤΕΩΡΟΛΟΓΙΚΟ ΣΤΑΘΜΟ ΕΛΛΗΝΙΚΟΥ

Ὑπὸ

Β. Ε. ΑΓΓΟΥΡΙΔΑΚΗ* καὶ Γ. Σ. ΣΑΚΕΛΛΑΡΙΔΗ**

Μὲ τὴν ἐργασία αὐτὴ προσεγγίζεται ἡ συνάρτηση τῆς ἡμερήσιας μεταβολῆς τῆς θερμοκρασίας μὲ τὸ πολυώνυμο παρεμβολῆς Newton. Σὰν σημεῖα παρεμβολῆς πήραμε τὶς τιμὲς τῆς θερμοκρασίας ποὺ ἀντιστοιχοῦν στὶς συνοπτικὲς ὥρες παρατηρήσεων.

Στὴ συνέχεια ἐξετάζεται ὁ ἀριθμὸς τῶν σημείων παρεμβολῆς, ἔτσι ὥστε τὰ σφάλματα ὁρίου καὶ παρεμβολῆς νὰ εἶναι ἐλάχιστα, καὶ τὸ πολυώνυμο παρεμβολῆς νὰ προσεγγίζει ἄριστα τὴν πραγματικὴ συνάρτηση τῆς ἡμερήσιας μεταβολῆς τῆς θερμοκρασίας. Ἐξετάσθηκαν οἱ παρεμβολὲς τῶν 8, 14, καὶ 24 σημείων, καὶ ἀποδεικνύεται ὅτι, ἡ παρεμβολὴ τῶν 24 σημείων (8 σημεῖα παρεμβολῆς ἀπὸ τὴν προηγούμενη ἡμέρα, 8 ἀπὸ τὴν παρούσα, καὶ 8 ἀπὸ τὴν ἑπόμενη) προσεγγίζει καλύτερα τὴ συνάρτηση τῆς ἡμερήσιας μεταβολῆς τῆς θερμοκρασίας. Μὲ τὴ βοήθεια τῆς παρεμβολῆς τῶν 24 σημείων, ὑπολογίσθηκαν ὡριαῖες τιμὲς τῆς θερμοκρασίας γιὰ κάθε μήνα, γιὰ τὸ Μετεωρολογικὸ Σταθμὸ τοῦ Ἑλληνικοῦ καὶ γιὰ τὴν περίοδο 1956-1971. Στὴ συνέχεια, ὑπολογίσθηκαν οἱ μέσοι συντελεστὲς τοῦ πολυωνύμου παρεμβολῆς Newton, γιὰ κάθε μήνα τῆς παρούσης περιόδου. Μὲ τὴ βοήθεια τῶν συντελεστῶν, βρέθηκε ἡ μέση ἡμερήσια πορεία γιὰ κάθε μήνα. Τέλος, ἀπὸ τὴ μέση ἡμερήσια πορεία, ἐφ᾽ ὅσον ἦταν γνωστὲς οἱ μέσες ἄκρες θερμοκρασίες γιὰ κάθε μήνα, ὑπολογίσθηκαν οἱ ὧρες, κατὰ τὶς ὁποῖες σημειώνονται οἱ ἄκρες θερμοκρασίες.

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