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SUNSHINE DURATION IN CRETE

by

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Abstract: *We examine sunshine duration of the 1968-1974 period in Crete, the southernmost island in the Aegean Sea, believing that this is the most suitable area for heliotechnical applications.*

This island, of oblong form, stands between coordinates of:

$\varphi = 34^0\ 50'$ *to* $35^0\ 35'$ *N and*

$\lambda = 23^0\ 30'$ *to* $26^0\ 15'$ *E*

Its area equals 8.331 km square.

Our data pertain to every station where Campbell-Stokes sunshine-recorders are operating.

For every station we give annual, monthly and hourly values of sunshine duratiou, and days are divided in groups according to their uumber of hours of bright sunshiue; sunless days receive special attention. Also diurnal variation as well as sequences of consecutive sunless days during the cold (October - March) and the warm (April-September) semester are examined.

Fiually, conclusions are drawn from a set of comparative Tables and Graphs, where the increase of sunshine duration as we advance from the west eastwards (with its maximum at the southeasteru end of the island) is characteristically illustrated; differences betweeu stations are also accounted for.

INTRODUCTION

During this last quarter of our technological century, energy is the password for world economy. This password denotes a huge problem, uniting certain people under common interests while it separates others into an unbridgeable breach.

The principal energy sources that we mainly exploit and carelessly waste, are nothing more than solar energy stocked in previous geological eras, i.e. coal and petroleum. But other kinds of energy too, i.e. aeolian, water - falls etc. are generated by the sun, who by its heat produces winds and the hydrological cycle.

However, the mineral fuel, giving 90% of the energy that we need, are not inexhaustible; that is why the aims of technology turnnow in finding other sources of energy.

We believe that «humanity is standing on the threshold of a new era which could be named the solar era» (Werner von Braun) when the Sun, the primordial source, with the amounts of radiant energy, will diminish the acuteness of the problem, or according to the optimists, will even solve it for ever.

Yet, for the exploitation of solar energy, our efforts should aim at the following two objectives: The first is a detailed study of sunshine duration, that is the duration of bright sunshine in a certain place; the second being the advancement of utilization techniques, in order to provide more energy at a lower cost, and this is the business of technical engineers.

At the Aristotelian University of Thessaloniki, every member on the staff of the Institute of Meteorology and Climatology takes part in the «Sunshine Duration in Greece» project which is one of its main projects since 1969; the present publication is the 10th in a series of publications within the above project.

It is our belief that the island of Crete, standing at the first line of tourist development in our country, should become before long the site for large-scale applications of heliotechnique, in order to solve, at the least cost, problems concerning agricultural enterprise, operation of large touristic concerns, and production of drinking water by desalinization.

This last is a problem that is becoming more and more accute as the touristic index rises in the Greek islands, which are poor in rainfalls and subterraneous waters.

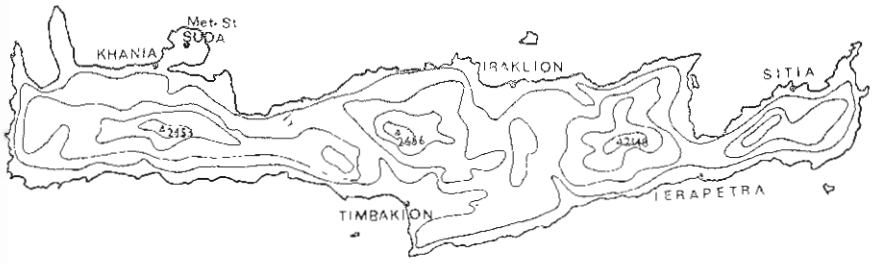
In the present work sunshine duration data by Campbell-Stokes sunshine recorders from six meteorological stations in the island of Crete, are studied in detail and compared with each other.

Observations from the stations of Suda, Iraklion, Sitia, Ierapetra cover the period between 1968-1974, those from the station of Khania the period 1968-1973, and those from the station of Timbakion the period 1971-1973.

All the above stations belong in the network of the Hellenic National Meteorological Service (E. M.Y.) and are the only stations whose sunshine-duration data have been processed for the E. M.Y. files. These same files have been used in the present study.

1. SUNSHINE DURATION AT THE METEOROLOGICAL STATION OF KHANIA

The meteorological station of Khania is housed in a city building, near the Aqueduct; its elevation is Hp=63 m, and the sunshine recorder is placed on top of its roof.



MAP. I

As it appears in the adjoined Map, the mountain mass of Western Crete rises as an obstacle at the East. In the station's horizontiogram, we observe that the ground relief obstructs sunrise by almost 5°, while the West is almost wholly unobstructed *(Livadas-Semertzidis[8])*.

Table I contains monthly mean and daily mean values of sunshine duration for the period 1968-1973; 1974 has not been included, because there have been many gaps in the observation of sunshine duration.

TABLE I

Monthly mean and daily mean values of sunshine duration at the met. station of Khania for the period 1968 - 1973.

Months	monthly mean values	daily mean values
J	108.1	3.5
F	128.2	4.5
M	180.4	5.8
A	223.2	7.4
M	321.2	10.3
J	350.1	11.7
J	380.5	12.2
A	357.1	11.4
S	270.8	9.0
O	177.9	5.7
N	173.5	5.8
D	112.6	3.6
Year	2783.6	7.6

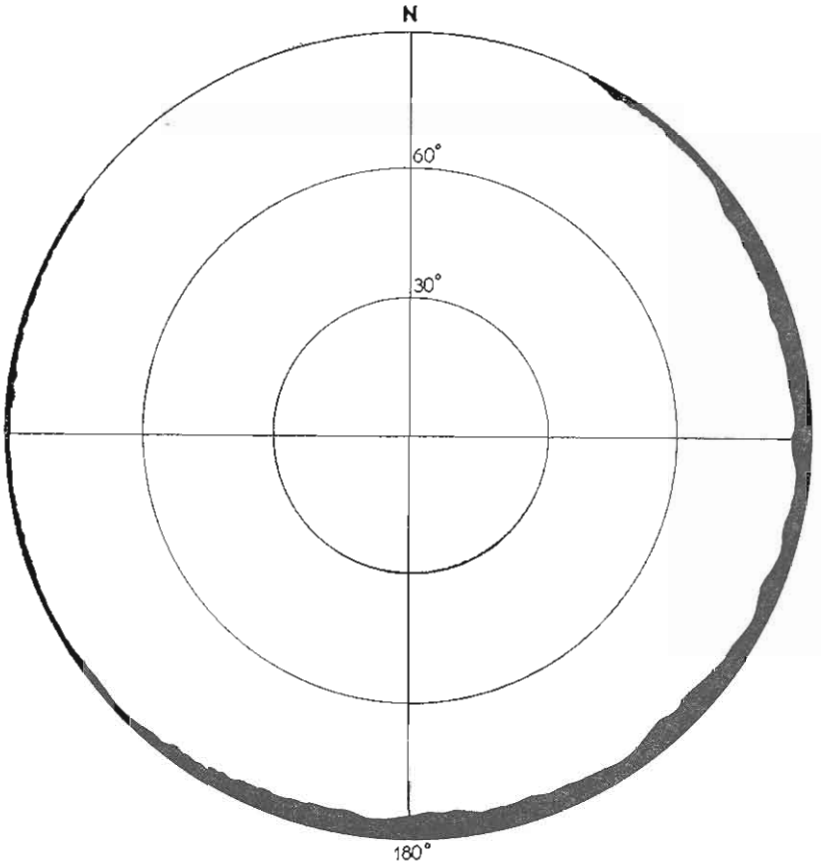


FIG. 1

We observe that: the mean maximum appears in July while the minimum mean is recorded in January with only a slight difference from December, which is the month when the minimum mean is usually recorded at Greek stations with long observational series *(Livadas*[4,5] *Livadas-Maldhoyannis-Flocas*[6], *Livadas G.C. and Flocas, A.A,*[7] *Mariolopoulos*[10], *Karapiperis-Katsoulis-Papachristopoulos*[3]. Graph I shows, besides meau values, absolute maxima and absolute minima for every month.

Daily mean sunshine duration.

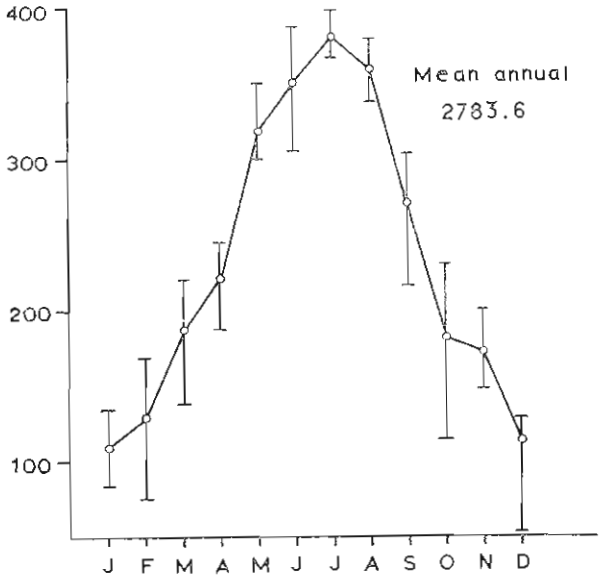
Besides monthly mean values, the study of daily mean ones is of particular interest, especially for the winter season, when days with

TABLE II

Distribution of daily sunshine duration values.
Met. Station: Khania, period: 1968 - 1973.

Duration in hours	J	F	M	A	M	J	J	A	S	O	N	D	Total	
13.50 - 14.49	—	—	—	—	—	13	12	—	—	—	—	—	25	0.0114
12.50 - 13.49	—	—	—	1	54	84	101	23	—	—	—	—	263	0.1200
11.50 - 12.49	—	—	—	29	49	38	51	108	19	—	—	—	294	0.1341
10.50 - 11.49	—	—	18	26	18	15	11	35	61	6	—	—	190	0.0867
9.50 - 10.49	—	9	16	28	11	8	6	10	39	26	3	—	156	0.0712
8.50 - 9.49	10	19	24	9	11	3	—	3	16	28	14	1	175	0.0798
7.50 - 8.49	19	11	15	11	11	5	1	—	11	15	31	17	147	0.0671
6.50 - 7.49	17	13	16	13	7	3	1	4	7	17	18	15	131	0.0598
5.50 - 6.49	16	16	15	5	8	3	4	2	4	17	15	16	118	0.0538
4.50 - 5.49	9	16	10	9	5	1	1	1	6	12	18	20	108	0.0493
3.50 - 4.49	17	21	16	10	4	3	1	—	3	10	12	12	109	0.0498
2.50 - 3.49	8	15	13	6	2	1	—	—	4	5	7	17	78	0.0356
1.50 - 2.49	16	8	15	8	3	—	—	—	3	11	6	11	81	0.0370
0.50 - 1.49	29	9	6	10	1	2	—	—	3	11	11	23	105	0.0478
0.01 - 0.49	10	12	4	7	2	—	—	—	1	9	6	18	69	0.0314
0	35	21	18	8	0	1	—	—	3	19	12	26	143	0.0652
	186	170	186	180	186	180	186	186	180	186	180	186	2192	1.0000

bright sunshine alternate with overcast ones; on the other hand,a «monotonous» weather prevails in summer, when one bright day is succeeded by another equally bright.



GRAPH I.

In Table II we have grouped 2192 observational days according to their daily sunshine duration, while in Table III these groups are given in percentages.

TABLE IV

Percentage of days with various sunshine durations during the cold semester.

Met. station Khania.

	J	F	M	O	N	D
> 5.50	33.3%	40.0%	55.9%	58.6%	60.0%	31.7%
< 1.50	39.8%	24.7%	15.1%	20.9%	16.1%	36.0%
< 0.49	24.2%	19.4%	11.8%	15.1%	10.0%	23.6%
= 0	18.8%	12.4%	9.7%	10.2%	6.6%	14.0%

If we consider as satisfactory the sunshine duration of 5.50 hours, especially for the cold season, for characterizing a day as «bright» and those with <1.50 hours as «very bad», we have Table IV for the cold season.

December has the smallest percentage of days with sunshine >5.50 hours, and November the highest. The largest percentage of «very bad» days belongs in January and the lowest in March.

A similar table for the warm season, gives percentages of days with sunshine duration >5.50 hours as follows: August 100%, July 99% to 67.8% for April.

TABLE V

Percentage of days with various sunshine duration during the warm semester. Met. station Khania.

	A	M	J	J	A	S
> 5.50	67.8%	90.8%	95.6%	99.0%	100%	87.2%
< 1.50	13.9%	1.6%	—	—	—	3 9%
< 0.49	8.3%	1.0%	0.6%	—	—	2.2%
= 0	4.4%	—	0.6%	—	—	1.7%

«Very bad» days are extremely rare for May and June while they practically do not exist in July and August.

TABLE VI

Mean per month occurence of sunless days at Khania.

J	5.8
F	3.5
M	3.0
A	1.3
M	0
J	0.2
J	0
A	0
S	0.5
O	3.2
N	2.0
D	4.3
Year	23.8

If we examine the distribution sunless days throughout the year, as per the above Table VI, we observe that:

— They almost do not exist during the warm season.

— January, with December coming next, have the highest number.

— October exceeds November; this fact however may posibly be due to the small number of observational years, since this is not to be found in stations with long observational series.

— April has 1.33 days, March 3.00, while May 0, thus bespeaking the view that this is a transitioual month between the cold and the warm season.

Consecutive Sunless Days.

We believe that sunless days should be examined as to whether they occur singly or in sequences, on one hand for reasons of touristic promotion of a place and on the other for technological applications of solar energy *(Livadas-Pennas[9])*.

In Table VII we have included groups of consequtive sunless days, with sunshine duration=0, and in Table VIII groups of consequtive «practically sunless» days, with sunshine duration <0.49 hours.

From Table VII we observe that:

a) Sunless days in a percentage of 58.7% (84:143) occur in sequences.

b) Sequences of sunless days occur only during the cold season.

c) Sunless days, in a percentage of 36% (9 cases out of 25) occured in sequences of two, while sequences of three have the same incidence percentage.

d) The longest sequences of consecutive sunless days have been observed in the months of February, March and October.

From Table VIII we observe that:

a) Days characterized as «practically sunless» occur in sequences in a percentage of 55.1%.

b) They are not observed during the warm season.

c) A percentage of 40.5% (15 cases out of 37) are in sequences of two.

d) The longest sequence of practically sunless days was observed in the month of January.

Diurnal Variation of Sunshine Duration - Hourly Values of Bright Sunshine.

Daylight period changes periodically and so does theoretic sunshine duration from day to day, month to month, throughout the year.

In Table IX we give mean values of bright sunshine for every hour

TABLE VII

Distribution of runs of consecutive sunless days.
Met. Station: Khania, period: 1968 - 1973.

	2	3	4	5	6	7	8	9	10	Total of runs	Total of days	
J	2	1	4	—	—	—	—	—	—	23	35	65.7
F	1	—	1	—	1	—	—	—	—	12	21	57.1
M	—	—	1	—	1	—	—	—	—	10	18	55.6
A	3	—	—	—	—	—	—	—	—	6	8	75.0
M	—	—	—	—	—	—	—	—	—	—	—	—
J	—	—	—	—	—	—	—	—	—	—	—	—
J	—	—	—	—	—	—	—	—	—	—	—	—
A	—	—	—	—	—	—	—	—	—	—	—	—
S	—	—	—	—	—	—	—	—	—	—	3	—
O	2	—	—	—	1	—	—	—	—	10	19	52.6
N	—	2	—	—	—	—	—	—	—	6	12	50.0
D	1	1	3	—	—	—	—	—	—	17	26	65.4
Total of cases	9	4	9	—	3	—	—	—	—		143	
Total of days	18	12	36	—	18	—	—	—	—	84		

TABLE VIII

Distribution of runs of consecutive «practically sunless days». Met. Station: Khania.

	2	3	4	5	6	7	8	9	10	Total of runs	Total of days	
J	3	2	3	—	—	—	—	1	—	33	45	73.3
F	3	2	1	—	1	—	—	—	—	22	33	66.7
M	—	2	1	—	1	—	—	—	—	16	22	72.7
A	3	—	—	—	—	—	—	—	—	6	15	40.0
M	—	—	—	—	—	—	—	—	—	—	2	—
J	—	—	—	—	—	—	—	—	—	—	1	—
J	—	—	—	—	—	—	—	—	—	—	—	—
A	—	—	—	—	—	—	—	—	—	—	—	—
S	1	—	—	—	—	—	—	—	—	2	4	50.0
O	1	1	—	—	—	1	—	—	—	12	28	42.9
N	1	1	1	—	—	—	—	—	—	9	18	50.0
D	3	1	5	—	—	—	—	—	—	29	44	65.9
Total of cases	15	9	11	—	2	1	—	1			212	
Total of days	30	27	44	—	6	7	—	9	—	117		

TABLE IX

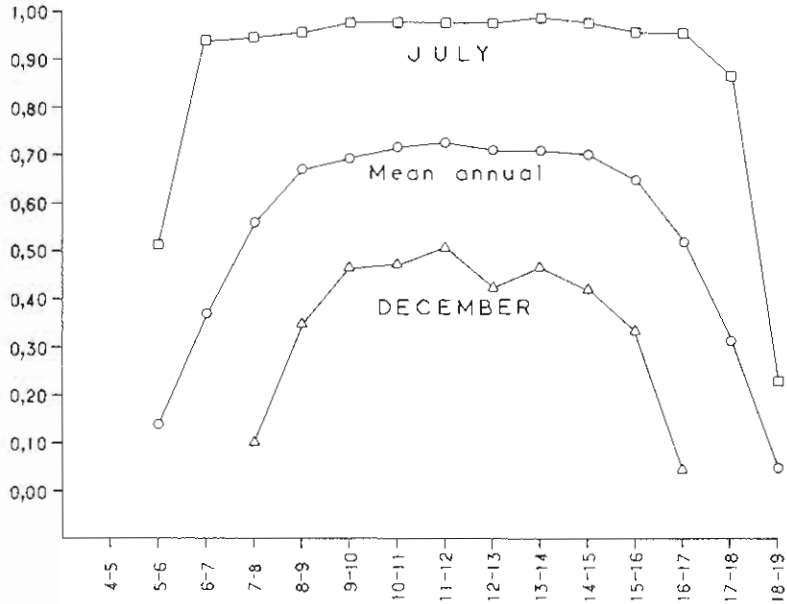
Mean hourly values of sunshine duration per hour and per month.
Met. Station: Khania

Month	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	Observed
J	—	—	0.12	0.37	0.43	0.45	0.48	0.41	0.44	0.38	0.32	0.39	—	—	3.49
F	—	0.01	0.26	0.45	0.51	0.55	0.55	0.54	0.54	0.48	0.42	0.22	—	—	4.53
M	—	0.14	0.45	0.57	0.60	0.63	0.63	0.62	0.60	0.58	0.54	0.39	0.07	—	5.82
A	0.04	0.39	0.60	0.65	0.68	0.70	0.72	0.70	0.68	0.68	0.65	0.61	0.32	0.01	7.44
M	0.35	0.76	0.82	0.86	0.85	0.88	0.88	0.88	0.87	0.86	0.80	0.78	0.64	0.2	10.36
J	0.57	0.86	0.91	0.92	0.93	0.94	0.91	0.92	0.94	0.94	0.90	0.91	0.78	0.25	11.67
J	0.51	0.94	0.95	0.96	0.98	0.98	0.98	0.98	0.99	0.98	0.96	0.96	0.87	0.23	12.28
A	0.18	0.86	0.95	0.97	0.97	0.95	0.97	0.97	0.97	0.96	0.97	0.97	0.73	0.04	11.46
S	—	0.42	0.79	0.83	0.85	0.87	0.88	0.86	0.86	0.85	0.82	0.74	0.24		9.03
O	—	0.06	0.46	0.58	0.60	0.61	0.64	0.64	0.63	0.62	0.52	0.35	0.02	—	5.74
N	—	—	0.21	0.49	0.58	0.59	0.60	0.60	0.61	0.59	0.53	0.25	0.03	—	5.10
D	—	—	0.10	0.35	0.47	0.48	0.51	0.43	0.47	0.43	0.34	0.05	—	—	3.63
Year	0.137	0.370	0.552	0.668	0.705	0.720	0.730	0.713	0.716	0.696	0.649	0.526	0.308	0.054	7.540

and each month of the year as this was recorded on sunshine-recorder charts.

We observe a minimum during the two winter-months of December and January; while the autumnal months of September, October and November, who come before and the vernal month of March likewise have actual sunshine duration of 12 hours (06:00-18:00). From April till August, sunshine duration becomes 14 hours.

Sunshine duration has quite high hourly mean values around midday, we can not however speak about diurnal variation in the intensity of sunshine, since the hourly mean value rises sharply a little after sunrise, and remains stable or with slight variations till sunset (Graph II).



GRAPH II

Thus between 09:00 and 15:00 hours, throughout the year, hourly variations are <0.20 h, the hourly mean seems to stay invariable and we have the so-called «sunshine duration plateau».

2. SUNSHINE DURATION AT THE MET. STATION OF SUDA

The station stands almost in the middle of the small peninsula. The surrounding area is smooth, and as shown in the station's horizontiogram, no obstacle obstructs direct solar radiation.

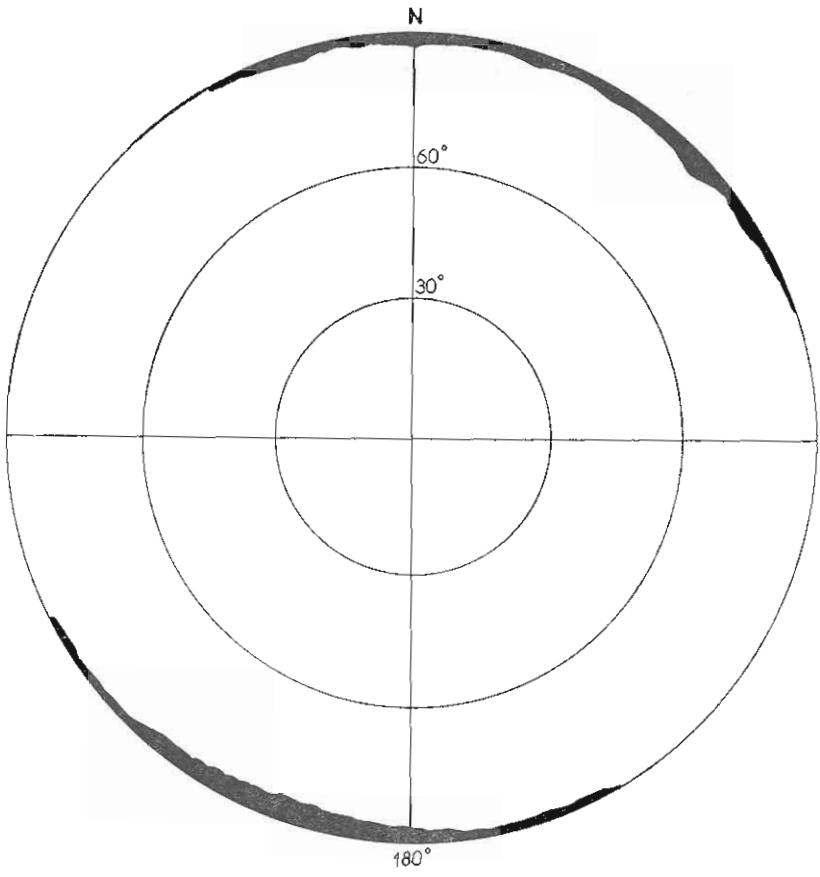


FIG. 2

Mountainous Western Crete stands to the South and the low hills of the peninsula to the North.

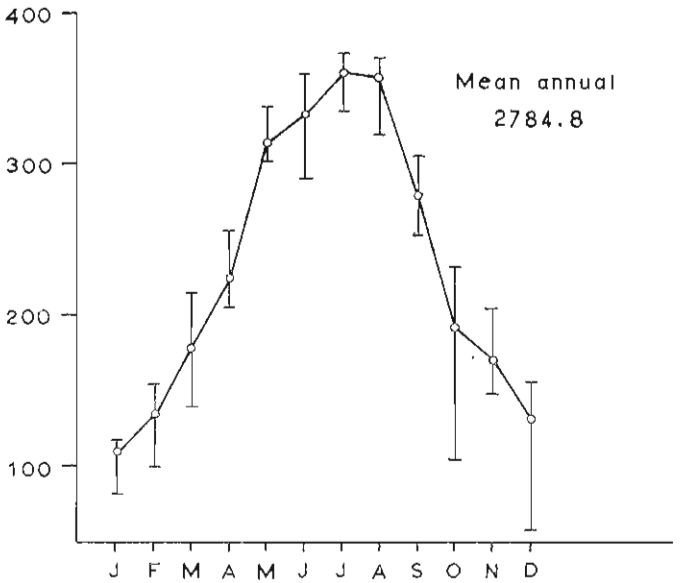
The mean maximum is observed in July and the mean minimum in January. The station stands at a distance of some kilometers from that of Khania, and the local ground relief being smooth the difference between their annual values is null.

Graph III shows besides mean values, the absolute maxima and minima of each month. For the seven-year period examined, the absolute maximum was recorded in August 1969, with 372.8 hours and the absolute minimum in December 1972, with 57.8 hours.

TABLE X

Monthly mean and daily mean sunshine duration values at the met. station of Suda for the period 1968 - 1974.

	Monthly mean values	Daily mean values
J	108.0	3.5
F	135.6	4.8
M	175.8	5.7
A	226.2	7.5
M	318.9	10.3
J	332.4	11.1
J	361.0	11.6
A	355.7	11.5
S	278.2	9.3
O	193.0	6.2
N	173.3	5.8
D	126.7	4.1
Year	2784.8	7.6



GRAPH III

Daily mean sunshine duration.

We have grouped the 2557 observational days of the Suda station, according to the number of hours of their daily sunshine duration as in Table XI. In Table XII we give the number of days in percentages.

TABLE XI

Distribution of daily sunshine duration values.
Met. Station: Suda, period: 1968 - 1974.

Duration in hours	J	F	M	A	M	J	J	A	S	O	N	D	Total	
13.50 - 14.49	—	—	—	—	—	2	—	—	—	—	—	—	2	0.0008
12.50 - 13.49	—	—	—	4	55	48	44	22	1	—	—	—	174	0.0680
11.50 - 12.49	—	—	—	39	59	56	101	132	16	—	—	—	403	0.1576
10.50 - 11.49	—	1	28	31	28	42	24	37	81	10	—	—	282	0.1103
9.50 - 10.49	1	11	22	21	14	9	34	12	39	45	9	—	217	0.8489
8.50 - 9.49	13	22	17	18	14	24	6	5	23	28	39	16	225	0.0880
7.50 - 8.49	20	17	21	10	8	10	4	2	10	14	39	17	172	0.0673
6.50 - 7.49	22	16	14	9	10	4	1	4	9	21	22	23	155	0.0606
5.50 - 6.49	15	22	18	13	7	2	2	3	6	19	17	20	144	0.0563
4.50 - 5.49	16	15	13	12	5	—	1	—	9	14	21	28	134	0.0524
3.50 - 4.49	15	23	11	6	7	5	—	—	5	13	16	23	124	0.0485
2.50 - 3.49	8	15	14	7	4	4	—	—	4	8	11	16	91	0.0356
1.50 - 2.49	21	14	18	13	3	1	—	—	1	8	7	16	102	0.0399
0.50 - 1.49	30	15	5	6	2	2	—	—	1	11	11	19	102	0.0399
0.01 - 0.49	17	5	3	8	—	—	—	—	—	7	6	13	59	0.0231
0	39	22	33	13	1	1	—	—	5	19	12	26	171	0.0668
	217	198	217	210	217	210	217	217	210	217	210	217	2557	1.0000

TABLE XII

Occurence percentage of various sunshine duration values.
Met. Station: Suda, period: 1968 - 1974.

Duration in hours	J	F	M	A	M	J	J	A	S	O	N	D
13.50 - 14.49	—	—	—	—	—	0.9	—	—	—	—	—	—
12.50 - 13.49	—	—	—	1.9	25.3	22.9	20.2	10.1	0.5	—	—	—
11.50 - 12.49	—	—	—	18.6	27.2	26.7	46.5	60.8	7.6	—	—	—
10.50 - 11.49	—	0.5	12.9	14.8	12.9	20.0	11.1	17.1	38.6	4.6	—	—
9.50 - 10.49	0.5	5.6	10.1	10.0	6.5	4.3	15.7	5.5	18.6	20.7	4.3	—
8.50 - 9.49	6.0	11.1	7.8	8.6	6.5	11.4	2.8	2.3	10.9	12.9	18.6	7.4
7.50 - 8.49	9.2	8.6	9.7	4.8	3.7	4.8	1.8	0.9	4.7	6.4	18.6	7.8
6.50 - 7.49	10.1	8.1	6.4	4.3	4.6	1.9	0.5	1.8	4.2	9.7	10.5	10.6
5.50 - 6.49	6.9	11.1	8.3	6.2	3.2	0.9	0.9	1.4	2.9	8.8	8.1	9.2
4.50 - 5.49	7.4	7.6	6.0	5.7	2.3	—	0.5	—	4.3	6.5	10.0	12.9
3.50 - 4.49	6.9	11.6	5.1	2.8	3.2	2.4	—	—	2.4	6.0	7.6	10.6
2.50 - 3.49	3.7	7.6	6.4	3.3	1.8	1.9	—	—	1.9	3.7	5.2	7.4
1.50 - 2.49	9.7	7.0	8.3	6.2	1.4	0.5	—	—	0.5	3.7	3.3	7.4
0.50 - 1.49	13.8	7.6	2.3	2.8	0.9	0.9	—	—	0.5	5.0	5.2	8.8
0.01 - 0.49	7.8	2.5	1.4	3.8	—	—	—	—	—	3.2	2.9	6.0
0	18.0	11.1	15.2	6.2	0.5	0.5	—	—	2.4	8.8	5.7	11.9
	100.0	100.0	99.9	100.0	100.0	100.0	100.0	99.9	100.0	100.0	100.0	100.0

TABLE XIII

Percentage of days with various sunshine durations in the cold semester.

	J	F	M	O	N	D
>5.50	32.7%	44.9%	55.3%	63.1%	60.0%	35.0%
<1.50	39.6%	21.2%	18.9%	17.1%	13.8%	26.7%
<0.49	25.8%	13.6%	16.6%	12.0%	8.6%	6.0%
=0	18.0%	11.1%	15.2%	8.8%	5.7%	12.0%

January has the smallest percentage (32.7%) of days with sunshine duration >5.50 hours, with December coming next (35.0%); October has the highest percentage of such days (63.1%).

«Very bad» days, have percentages varying from 39.6% in January to 13.8% in November.

TABLE XIV

Percentage of days with various sunshine durations in the warm semester.

	A	M	J	J	A	S
>5.50	69.0%	89.9%	93.8%	100%	100%	88.1%
<1.50	12.8%	1.4%	1.4%	—	—	2.8%
<0.49	10.0%	0.5%	0.5%	—	—	2.4%
=0	6.2%	0.5%	0.5%	—	—	2.4%

TABLE XV

Mean per month distribution of suuless days

J	5.6
F	3.1
M	4.7
A	1.9
M	0.1
J	0.1
J	0
A	0
S	0.7
O	2.7
N	1.7
D	3.7
Year	24.5

July and August have percentages of 100% with days whose sunshine duration was >5.50 hours; April has the smallest such percentage.

Very bad days are encountered only in April (12.8%). Table XV gives the distribution of overcast or sunless days at the met. station of Suda for each month of the year.

The highest number of sunless days is observed in January.

During the warm season, such days are almost non-existent.

We believe that the small number of November is due to the same reasons we mentioned for the met. station of Khania.

Consecutive Sunless Days

Groups of consequtive sunless days with sunshine duration=0, and «practically sunless» days with sunshine duration <0.49 are given in Tables XVI and XVII respectively.

Sunless days occur in sequences in a percentage of 50.8% (87 days out of 171).

Sunless days occur in runs of concecutive days only during the cold season.

A percentage of 63.6% (21 cases out of 33) of these sunless days occur in sequences of two.

The longest sequence of consecutive sunless days has been observed in the months of March and October.

In Table XVII we observe that:

— Days characterized as «practically sunless» occur in sequences in a precentage of 59.2%.

— They are not observed during the warm season.

— A percentage of 59.6% (28 cases out of 147) are in sequences of two.

— The longest sequence of «practically sunless» days was observed in the month of March.

Diurnal Variation of Sunshine Duration - Hourly Values of Bright Sunshine.

Table XVIII gives mean sunshine duration values for every hour and each month of the year, and annual mean values for each hour.

The minimum is observed during the warm months of December and January, while autumnal months together with the vernal months of February and March have 12 hours of sunshine duration.

TABLE XVI

Distribution of runs of consecutive sunless days at the Met. Station of Suda.

	2	3	4	5	6	7	8	9	10	Total of rnns	Total of days	
J	4	3	1	—	—	—	—	—	—	21	39	53.8
F	3	—	1	—	—	—	—	—	—	10	22	45.5
M	4	1	2	1	—	—	—	—	—	24	33	72.7
A	3	—	—	—	—	—	—	—	—	6	13	46.2
M	—	—	—	—	—	—	—	—	—	—	1	—
J	—	—	—	—	—	—	—	—	—	—	1	—
J	—	—	—	—	—	—	—	—	—	—	—	—
A	—	—	—	—	—	—	—	—	—	—	—	—
S	—	—	—	—	—	—	—	—	—	—	5	—
O	1	—	1	1	—	—	—	—	—	11	19	57.9
N	1	1	—	—	—	—	—	—	—	5	12	41.7
D	5	—	—	—	—	—	—	—	—	10	26	38.5
Total of cases	21	5	5	2	—	—	—	—	—		171	
Total of days	42	15	20	10	—	—	—	—	—	87		

TABLE XVII

Distribution of runs of consecutive «practically sunless» days.
Met. Station: Suda, period: 1968 - 1974.

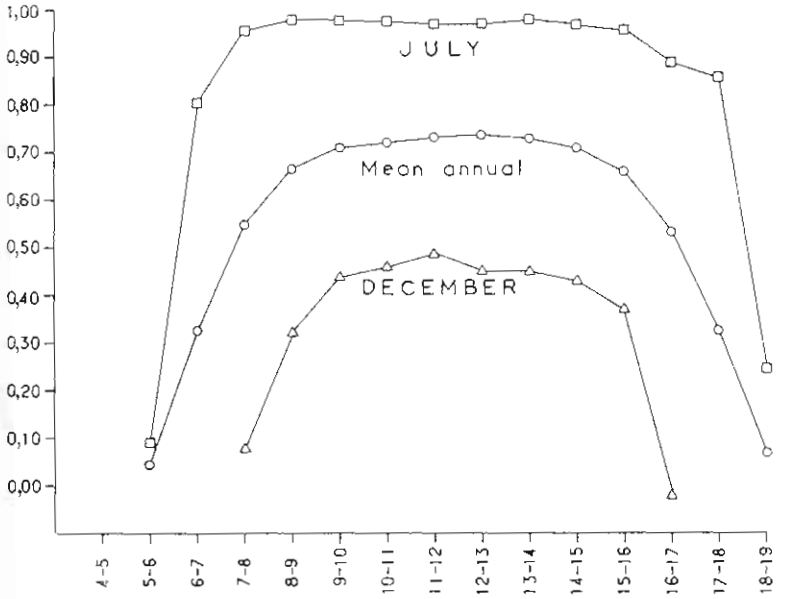
	2	3	4	4	6	7	8	9	10	Total of runs	Total of days	
J	7	1	3	1	—	—	—	—	—	34	56	60.7
F	2	1	2	—	—	—	—	—	—	15	27	55.6
M	3	1	2	1	—	—	1	—	—	30	36	83.3
A	3	—	—	—	—	—	—	—	—	6	21	28.6
M	—	—	—	—	—	—	—	—	—	—	1	—
J	—	—	—	—	—	—	—	—	—	—	1	—
J	—	—	—	—	—	—	—	—	—	—	—	—
A	—	—	—	—	—	—	—	—	—	—	—	—
S	—	—	—	—	—	—	—	—	—	—	5	—
O	3	—	1	1	1	—	—	—	—	21	26	80.8
N	3	1	—	—	—	—	—	—	—	9	18	50.0
D	7	1	1	—	—	—	—	—	—	21	39	53.8
Total of cases	28	5	9	3	1	—	1	—	—		230	
Total of days	56	15	36	16	5	—	8	—	—	136		

TABLE XVIII

Mean hourly values of sunshine duration per hour and per month.
Met. Station: Suda, period: 1968 - 1974.

Month	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	Observed
J	—	—	0.10	0.34	0.45	0.43	0.43	0.44	0.53	0.40	0.32	0.10	—	—	3.48
F	—	0.01	0.26	0.50	0.55	0.57	0.59	0.58	0λ54	0.50	0.44	0.24	0.01	—	4.79
M	—	0.13	0.44	0.51	0.58	0.60	0.59	0.59	0.61	0.58	0.52	0.41	0.11	—	5.67
A	0.05	0.38	0.59	0.66	0.69	0.71	0.72	0.72	0.70	0.68	0.64	0.57	0.37	0.08	7.54
M	0.15	0.70	0.83	0.85	0.86	0.88	0.87	0.88	0.89	0.88	0.83	0.77	0.68	0.21	10.29
J	0.25	0.79	0.91	0.91	0.92	0.94	0.92	0.93	0.93	0.92	0.87	0.84	0.73	0.22	11.08
J	0.09	0.81	0.96	0.98	0.98	0.98	0.97	0.98	0.98	0.97	0.96	0.89	0.86	0.25	11.65
A	0.06	0.77	0.95	0.96	0.97	0.97	0.97	0.97	0.96	0.96	0.97	0.97	0.84	0.15	11.48
S	—	0.39	0.80	0.85	0.86	0.87	0.90	0.88	0.87	0.87	0.85	0.76	0.36	—	9.27
O	—	0.06	0.47	0.62	0.62	0.64	0.66	0.71	0.66	0.65	0.61	0.48	0.05	—	6.23
N	—	—	0.24	0.56	0.64	0—65	0.57	0.72	0.70	0.68	0.58	0.32	0.01	—	5.78
D	—	—	0.08	0.32	0.44	0.46	0.49	0.45	0.45	0.43	0.37	0.08	—	—	3.58
Year	0.051	0.336	0.553	0.672	0.714	0.726	0.734	0.738	0.727	0.710	0.663	0.536	0.335	0.075	7.569

From April till August, inclusive, sunshine duration becomes 14 hours daily.



GRAPH IV

Graph IV illustrates the hourly mean bright sunshine for a summer month, for a winter month and the annual mean of hourly values.

3. SUNSHINE DURATION AT THE MET. STATION OF IRAKLION.

This is the most important meteorological station in Crete and one of the most important in the network of the Hellenic National Meteorological Service.

It is placed at Iraklion's airport; the horizon is almost completely free from any obstacles, and thus the intesity of sunshine duration is freely recorded on the charts of the Campbell - Stokes sunshine recorder.

As can be seen on the horizontiogram of this stations, existing obstacles are less than 3° on the East and 2° on the West.

In Table XIX are included monthly and daily mean values.

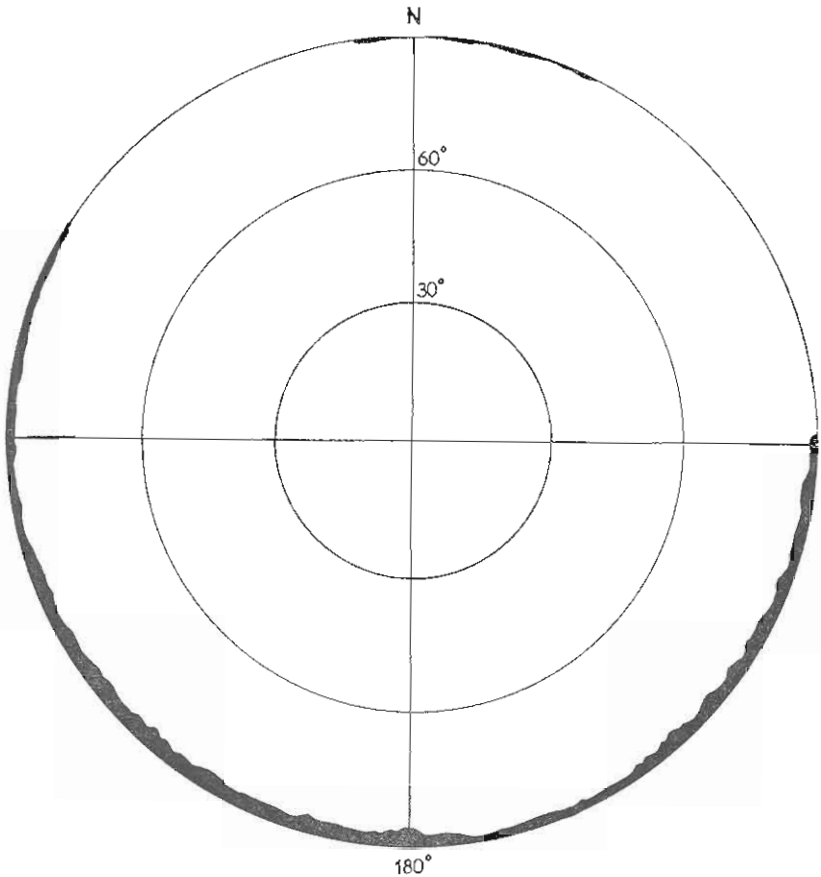


FIG. 3

TABLE XIX

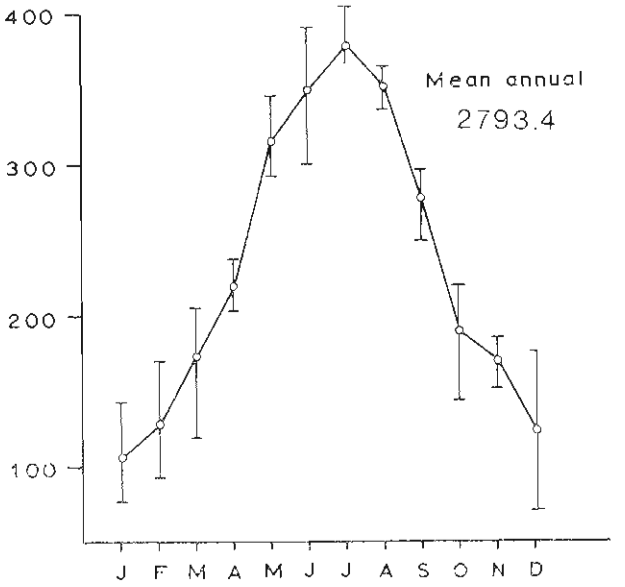
Monthly mean and daily mean values of sunshine duration at the met. station of Iraklion for the period 1968 - 1974.

	Monthly mean values	Daily mean values
J	104.4	3.4
F	128.0	4.5
M	172.6	5.6
A	220.1	7.3
M	316.1	10.2
J	349.3	11.6
J	381.1	12.3
A	351.6	11.3
S	280.9	9.4
O	193.2	6.2
N	170.6	5.7
D	125.5	4.0
Year	2793.4	7.6

The mean maximum is observed in July and the mean minimum in January.

During the 1968 - 1974 period examined herein the absolute maximum sunshine duration was recorded in July 1968, with 402.7 hours.

Graph V shows mean and extreme values for each month.



GRAPH V

Daily mean Sunshine Duration

In Table XX we have grouped the 2557 days of the seven years examined for Iraklion's station, according to the number of hours of their daily sunshine duration.

We observe that during the two summer months of July and August, this station has the highest number of days with sunshine duration >12.50 than any other station in Northern Crete (June 121 days and July 128 days).

In Table XXI these numbers of days have been converted to percentages.

For the cold season we have grouped days with sunshine duration >5.50, days with sunshine duration <1.50, «very bad» days, and days with sunshine duration <0.49 «practically sunless».

TABLE XX

Distribution of daily sunshine duration values.
Met. Station: Iraklion, period: 1968 - 1974.

Duration in hours	J	F	M	A	M	J	J	A	S	O	N	D	Total	
13.50 - 14.49	—	—	—	—	—	8	1	1	—	—	—	—	10	0.0039
12.50 - 13.49	—	—	—	1	65	113	127	14	—	—	—	—	310	0.1252
11.50 - 12.49	—	—	—	36	51	34	64	122	5	—	—	—	312	0.1220
10.50 - 11.49	—	—	22	29	23	23	10	54	74	3	—	—	238	0.0930
9.50 - 10.49	1	8	20	17	11	7	5	14	68	40	2	—	193	0.0755
8.50 - 9.45	14	28	26	16	15	4	6	4	1	36	37	14	221	0.0865
7.50 - 8.49	10	14	9	16	8	4	1	1	11	26	37	21	158	0.0618
6.50 - 7.49	16	8	19	14	8	2	—	1	10	19	26	25	148	0.0579
5.50 - 6.49	22	26	20	15	15	4	—	4	4	9	25	14	158	0.0618
4.50 - 5.49	17	17	18	13	5	2	2	—	5	14	15	25	133	0.0520
3.50 - 4.49	16	17	14	9	7	1	—	—	5	20	16	23	128	0.0500
2.50 - 3.49	21	16	11	7	3	3	—	—	2	10	16	18	107	0.0419
1.50 - 2.49	20	15	9	13	2	2	—	—	—	9	10	23	103	0.0403
0.50 - 1.49	26	16	18	7	4	2	—	—	1	11	17	13	115	0.0449
0.01 - 0.49	16	13	12	8	—	—	—	—	2	2	3	4	780	0.0305
0	38	20	19	9	—	1	1	2	2	17	5	21	135	0.0528
	217	198	217	210	217	210	217	217	210	217	210	217	2557	1.0000

TABLE XXI

Occurence percentage of various sunshine duration values.
Met. Station: Iraklion, period: 1968 - 1974.

Duration in hours	J	F	M	A	M	J	J	A	S	O	N	D
13.50 - 14.49	—	—	—	—	—	3.8	0.5	0.5	—	—	—	—
12.50 - 13.49	—	—	—	0.5	29.9	53.8	58.5	6.5	—	—	—	—
11.50 - 12.49	—	—	—	17.1	23.5	16.2	29.5	56.2	2.4	—	—	—
10.50 - 11.49	—	—	10.1	13.8	10.6	10.9	4.6	24.9	35.3	—	—	—
9.50 - 10.49	0.4	4.0	9.2	8.1	5.1	3.3	2.3	6.5	32.4	1.0	1.0	—
8.50 - 9.45	6.5	14.1	12.0	7.6	6.9	1.9	2.8	1.8	10.0	17.6	17.6	6.5
7.50 - 8.49	4.6	7.1	4.1	7.6	3.7	1.9	0.4	0.4	5.2	17.6	17.6	9.7
6.50 - 7.49	7.4	4.0	8.8	6.7	3.7	1.0	—	0.4	4.7	12.4	12.4	11.5
5.50 - 6.49	10.1	13.1	9.2	7.1	6.9	1.9	—	1.8	1.9	11.9	11.9	6.5
4.50 - 4.49	7.8	8.6	8.3	6.2	2.3	1.0	0.9	—	2.3	7.1	7.1	11.5
3.50 - 4.49	7.4	8.6	6.5	4.3	3.2	0.4	—	—	2.3	7.6	7.6	10.6
2.50 - 3.49	9.7	8.1	5.1	3.3	1.4	1.4	—	—	1.0	7.6	7.6	8.3
1.50 - 2.49	9.2	7.6	4.1	6.2	0.9	1.0	—	—	—	4.8	4.8	10.6
0.50 - 1.49	12.0	8.1	8.3	3.3	1.8	1.0	—	—	0.5	8.1	8.1	6.0
0.01 - 0.49	7.4	6.6	5.5	3.8	—	—	—	—	1.0	1.9	1.9	9.2
0	17.5	10.1	8.8	4.3	—	0.4	0.5	0.9	1.0	2.4	2.4	9.6
	100.0	100.0	100.0	99.9	99.9	99.9	100.0	99.9	100.0	100.0	100.0	100.0

TABLE XXII

Percentage of days with various sunshine durations in the cold semester.

	J	F	M	O	N	D
> 5.50	29.0%	42.4%	53.5%	61.3%	60.5%	34.1%
< 1.50	36.9%	24.7%	22.6%	14.3%	12.4%	24.9%
< 0.49	24.9%	16.7%	14.3%	9.2%	19.0%	18.9%
=0	17.5%	10.1%	8.8%	7.8%	2.4%	9.7%

January has the smallest percentage (29%) of days with sunshine duration>5.50 hours (63 days) with December coming next.

The highest number of such days belongs in March 62,6 with October coming next with only a slight difference.

For the warm season, according to the same rules, we have grouped days as per Table XXIII.

TABLE XXIII

Percentage of days with various sunshine durations in the warm semester.

	A	M	J	J	A	S
> 5.50	68.6%	53.5%	94.8%	98.6%	99.1%	91.9%
< 1.50	11.4%	22.6%	1.4%	0.5%	0.9%	2.4%
< 0.49	8.1%	14.3	0.5%	0.5%	0.9%	1.9%
=0	4.3%	8.8%	0.5%	0.5%	0.9%	1.0%

July and August have 100% of days with sunshine duration>5.50 hours.

April has the smallest percentage (54.3%) of such days; the same month shows a percentage of 11.4% of «very bad» days, of which 4% are sunless days.

Table XXIV gives the distribution of sunless (sunshine duration =0) for every month of the year.

We observe that during the warm season, except for a small number in April, such days practically do not exist. This last month, standing between March with 2.71 days, and May with 0, bespeaks its characterization as «intermedite» between the cold and the warm season.

TABLE XXIV

Mean per month distribution of sunless days.

J	5.4
F	2.9
M	2.7
A	1.3
M	—
J	0.1
J	0.1
A	0.3
S	0.3
O	2.4
N	0.7
D	3.0
Year	19.3

January has the highest number, with a considerable difference from December who is next in order.

November, the last autumnal month, has a smaller number than every vernal month. We however, attribute this to the small number of observational years examined herein.

Consecutive sunless Days.

In Table XXV we have grouped sunless days that occured in sequences.

From this table XXV we observe that:

a) Sunless days occur in sequences in a percentage of 47.4% (64 days out of 135).

b) Runs of consecutive sunless days occur only during the cold season.

c) Sunless days in a percentageof 48 % (14 cases out of 29) occured in sequences of two.

d) The longest sequence of consecutive sunless days was observed in October.

In Table XXVI we have grouped runs of «practically sunless» days with sunshine duration <0.49.

TABLE XXV

Distribution of runs of consecutive «practically sunless days. Met. station. Iraklion.

	2	3	4	5	6	Total runs	Total of days	
J	2	2	2	—	—	18	38	47.4
F	4	—	—	—	—	8	20	40.0
M	2	1	—	—	—	7	19	36.8
A	1	1	—	—	—	5	9	55.6
M	—	—	—	—	—	—	—	—
J	—	—	—	—	—	—	1	—
J	—	—	—	—	—	—	1	—
A	—	—	—	—	—	—	1	—
S	—	—	—	—	—	—	—	—
O	2	1	—	—	1	13	17	76.5
N	—	—	—	—	—	—	5	—
D	3	1	1	—	—	13	21	61.9
Total of cases	14	6	3		6		135	
Total of days	28	18	12		6	64		

TABLE XXVI

Distribution of runs of consecutive «practically sunless» days. Met. Station: Iraklion.

	2	3	4	5	6	Total of runs	Total of days	
J	5	1	2	1	1	32	54	59.3
F	3	1	2	—	—	17	23	51.5
M	4	2	1	—	—	18	31	58.1
A	1	1	—	—	—	5	17	29.4
M	—	—	—	—	—	—	—	—
J	—	—	—	—	—	—	1	—
J	—	—	—	—	—	—	1	—
A	—	—	—	—	—	—	2	—
S	1	—	—	—	—	2	3	50.0
O	1	1	1	—	1	15	4	50.0
N	1	—	—	—	—	2	9	22.2
D	5	3	—	—	1	25	41	60.9
Total of cases	21	9	6	1	3		213	
Total of days	42	27	24	5	18	116		

TABLE XXV

Distribution of runs of consecutive «practically sunless days. Met. station. Iraklion.

	2	3	4	5	6	Total runs	Total of days	
J	2	2	2	—	—	18	38	47.4
F	4	—	—	—	—	8	20	40.0
M	2	1	—	—	—	7	19	36.8
A	1	1	—	—	—	5	9	55.6
M	—	—	—	—	—	—	—	—
J	—	—	—	—	—	—	1	—
J	—	—	—	—	—	—	1	—
A	—	—	—	—	—	—	1	—
S	—	—	—	—	—	—	—	—
O	2	1	—	—	1	13	17	76.5
N	—	—	—	—	—	—	5	—
D	3	1	1	—	—	13	21	61.9
Total of cases	14	6	3		6		135	
Total of days	28	18	12		6	64		

TABLE XXVI

Distribution of runs of consecutive «practically sunless» days. Met. Station: Iraklion.

	2	3	4	5	6	Total of runs	Total of days	
J	5	1	2	1	1	32	54	59.3
F	3	1	2	—	—	17	23	51.5
M	4	2	1	—	—	18	31	58.1
A	1	1	—	—	—	5	17	29.4
M	—	—	—	—	—	—	—	—
J	—	—	—	—	—	—	1	—
J	—	—	—	—	—	—	1	—
A	—	—	—	—	—	—	2	—
S	1	—	—	—	—	2	3	50.0
O	1	1	1	—	1	15	4	50.0
N	1	—	—	—	—	2	9	22.2
D	5	3	—	—	1	25	41	60.9
Total of cases	21	9	6	1	3		213	
Total of days	42	27	24	5	18	116		

TABLE XXVII

Mean hourly values of sunshine duration per hour and per month
Met. Station: Iraklion, period 1968 - 1974

Month	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	Observ.
J	—	—	0.12	0.34	0.41	0.45	0.44	0.44	0.42	0.36	0.29	0.10	—	—	3.37
F	—	0.01	0.28	0.47	0.53	0.52	0.55	0.53	0.53	0.49	0.41	0.21	—	—	4.53
M	—	0.07	0.43	0.57	0.60	0.61	0.62	0.60	0.60	0.55	0.49	0.37	0.07	—	5.57
A	0.02	0.36	0.58	0.66	0.70	0.71	0.71	0.69	0.69	0.67	0.64	0.56	0.33	0.02	7.34
M	0.23	0.73	0.81	0.86	0.87	0.87	0.84	0.87	0.85	0.83	0.82	0.77	0.67	0.17	10.20
J	0.39	0.84	0.90	0.91	0.93	0.94	0.93	0.93	0.93	0.92	0.92	0.90	0.85	0.35	11.64
J	0.37	0.92	0.97	0.98	0.99	0.99	0.99	0.99	0.98	0.97	0.97	0.95	0.93	0.30	12.29
A	0.08	0.78	0.94	0.97	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.75	0.05	11.34
S	—	0.26	0.83	0.87	0.92	0.92	0.90	0.92	0.91	0.89	0.89	0.81	0.24	—	9.36
O	—	0.03	0.41	0.64	0.66	0.70	0.70	0.71	0.71	0.66	0.60	0.39	0.02	—	6.23
N	—	—	0.22	0.58	0.67	0.71	0.71	0.70	0.60	0.66	0.55	0.19	—	—	5.69
D	—	—	0.09	0.37	0.49	0.54	0.55	0.56	0.52	0.49	0.36	0.07	—	—	4.05
Year	0.090	0.332	0.548	0.686	0.729	0.747	0.743	0.742	0.732	0.705	0.660	0.523	0.322	0.075	7.634

We observe again that:

a) Days characterized as «practically sunless» occur in sequences in a percentage of 54.5%.

b) Such days are not observed during the warm season.

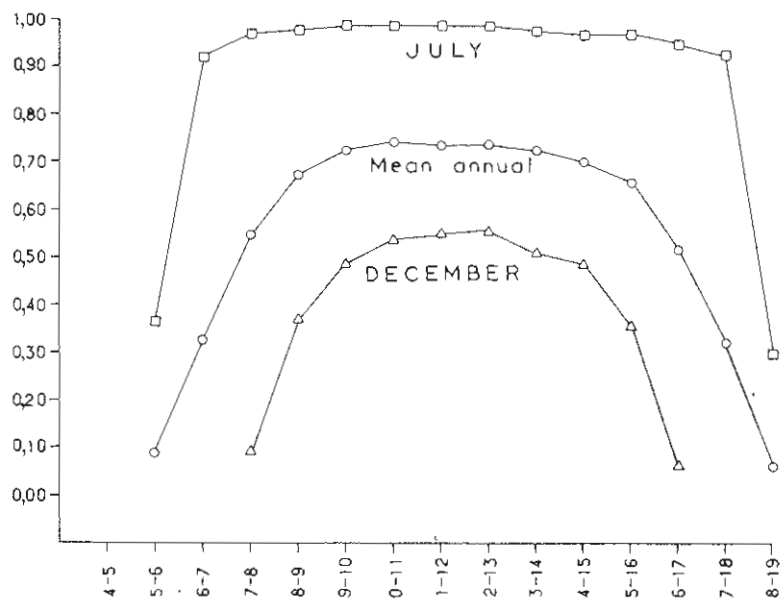
c) A percentage of 52.5% (21 cases out of 40) occured in sequences of two days.

d) The longest sequences of consecutive days were observed in the months of January, October and December.

Diurnal Variation of Sunshine Duration

In Table XXVII we give mean hourly values of bright sunshine per hour and per month, and also the annual mean for every hour of the day.

The minimum is observed during the winter months of December and January.



GRAPH VI

The two vernal monts of February and March and the two autumnal ones of September and October have actual sunshine duration 12 hours daily, while the five months from April August have 14 hours.

Graph VI illustrates: The hourly mean variation of sunshine duration for July, the hourly mean variation for December, and the annual variation for every hour from sunrise till sunset.

4. SUNSHINE DURATION AT THE MET. STATION OF SITIA

The station is housed in a town building. The sunshine recorder, standing on its roof, is ideally placed for the station's, site; however as the town is built upon a hill, houses standing to the west of the station, because of their higher elevation rise as obstacles of some 11° at sunset. Another obstruction of 4° at sunrise is due to the low hills rising at this last extremity of Eastern Crete.

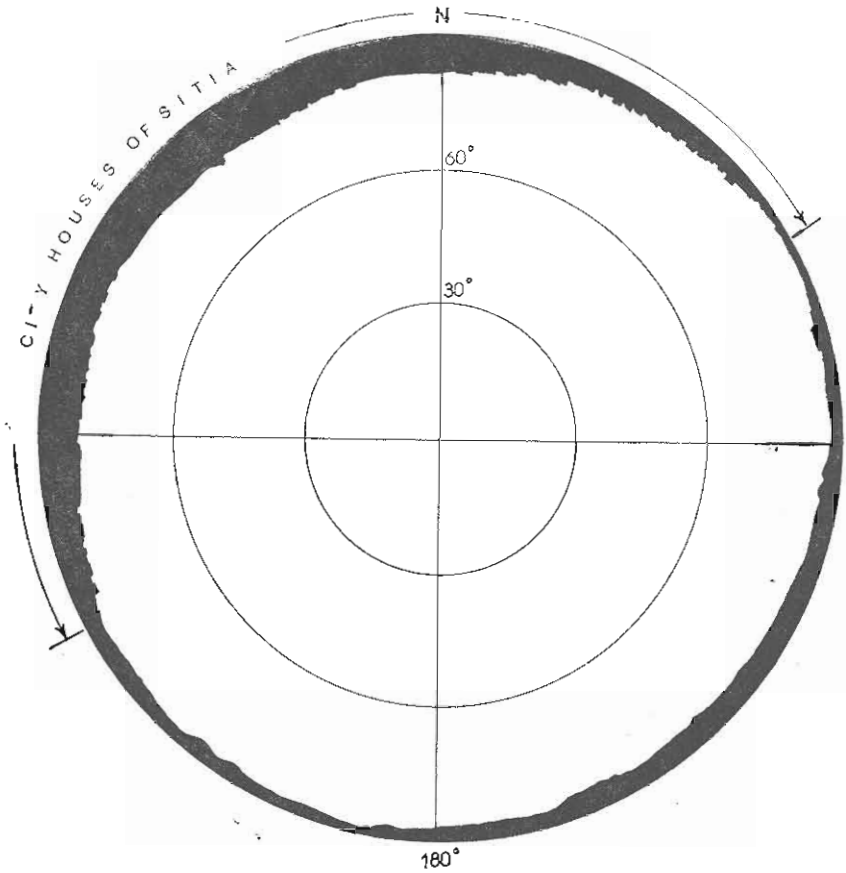


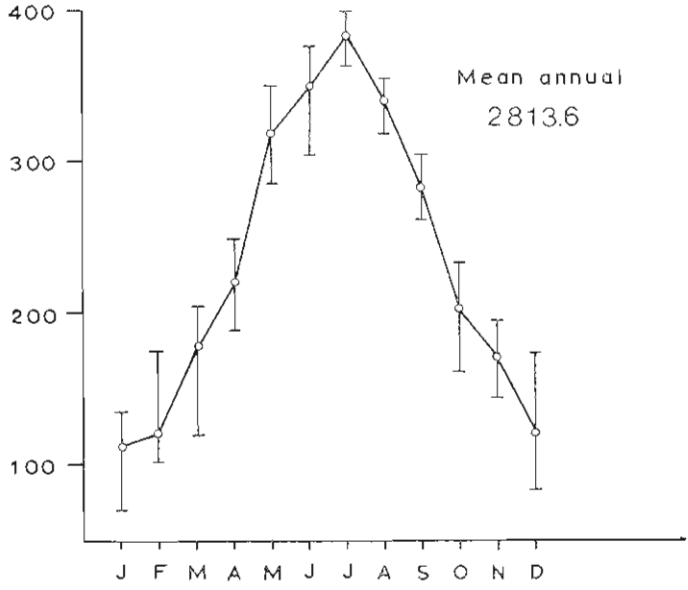
FIG. 4

Table XXVIII includes monthly and daily mean sunshine duration values.

The mean maximum is observed in July with June coming next.

The mean minimum is observed in January.

Graph VII illustrates mean and extreme values for each month.



GRAPH VII

TABLE XXVIII

Monthly mean and daily mean values of sunshine duration at the met. station of Sitia for the period 1968 - 1974.

Months	Monthly mean values	Daily mean values
J	111.8	3.8
F	138.4	4.9
M	174.3	5.6
A	221.7	7.4
M	319.2	10.3
J	348.3	11.6
J	382.0	12.3
A	341.0	11.0
S	281.4	9.4
O	199.7	6.4
N	127.2	5.8
D	123.1	3.9
Year	2813.6	7.7

Daily mean sunshine duration

In Table XXIX we have grouped 2557 observational days according to their daily sunshine duration.

We observe that August has no day with sunshine duration >12.50 hours. This is due to obstacles, especially those rising on the west, which affect the met. station of Sitia in August more than any other month.

In Table XXX these groups of days are converted in percentages(%).

For the cold semester we have grouped observational days in: days with sunshine duration>5.50 hours; days with sunshine duration<1.50 hours «very bad», and days with sunshine duratiou <0.49 «practically sunless» as in Table XXXI.

TABLE XXXI

Percentage od days with various sunshine durations in the cold semester.

	J	F	M	O	N	D
>5.50	32.3%	46.5%	53.5%	65.9%	60.0%	32.7%
<1.50	32.3%	19.7%	15.7%	9.2%	11.4%	24.9%
<0.49	19.8%	13.1%	9.2%	6.0%	5.7%	17.1%
=0	11.5%	8.6%	6.0%	4.6	2.4%	9.7%

January and December have the smallest number of days with sunshine duration>5.50 hours, while October has the most.

According to the same criteria, we have grouped days of the warm semester as per Table XXXII.

TABLE XXXII

Percentage of days with various sunshine durations in the warm semester.

	A	M	J	J	A	S
>5.50	68.6%	89.4%	100%	100%	99.1%	92.9%
<1.50	14.3%	2.3%	1.0%	—	0.5%	1.0%
<0.49	8.6%	1.4%	0.5%	—	0.5%	—
=0	3.8%	0.5%	—	—	0.5%	—

For the months of July and August the percentage of days with sunshine duration>5.50 hours is 100%.

TABLE XXIX

Distribution of daily sunshine duration values.
Met. Station: Sitia, period: 1968 - 1974.

Duration in hours	J	F	M	A	M	J	J	A	S	O	N	D	Total	
13.50 - 14.49	—	—	—	—	—	6	7	—	—	—	—	—	13	0.0050
12.50 - 13.49	—	—	—	3	63	104	100	0	—	—	—	—	270	0.1056
11.50 - 12.49	—	—	—	30	63	55	92	87	5	—	—	—	332	0.1293
10.50 - 11.49	—	—	21	32	17	10	8	74	61	4	—	—	227	0.0888
9.50 - 10.49	—	11	13	23	16	7	4	38	72	34	5	—	223	0.0872
8.50 - 9.49	10	20	27	13	6	4	4	8	33	33	40	9	207	0.0809
7.50 - 8.49	20	18	20	21	11	7	2	5	14	36	29	22	205	0.0802
6.50 - 7.49	17	28	20	13	12	3	0	3	4	20	28	22	170	0.0664
5.50 - 6.49	23	15	15	9	6	3	0	0	6	16	24	18	135	0.0528
4.50 - 5.49	22	17	19	9	5	3	0	1	5	14	18	28	141	0.0562
3.50 - 4.49	12	22	16	14	5	1	0	0	5	17	17	22	131	0.0513
2.50 - 3.49	19	15	15	7	3	4	0	0	1	14	15	18	111	0.0435
1.50 - 2.49	24	13	17	6	5	1	0	0	2	9	10	24	111	0.0435
0.50 - 1.49	27	13	14	12	2	1	0	0	2	7	12	17	107	0.0418
0.01 - 0.49	18	9	7	10	2	1	0	0	0	3	7	16	73	0.0285
0	25	17	13	8	1	0	0	1	0	10	5	21	101	0.0394
	217	198	217	210	217	210	217	217	210	217	210	217	2557	1.0000

TABLE XXX

Occurence percentage of various sunshine duration values.
Met. Station: Sitia, period: 1968 - 1974.

Duration in hours	J	F	M	A	M	J	J	A	S	O	N	D
13.50 - 14.49	—	—	—	—	—	2.9	3.2	—	—	—	—	—
12.50 - 13.49	—	—	—	1.4	29.0	49.5	46.1	—	—	—	—	—
11.50 - 12.49	—	—	—	14.3	29.0	26.2	42.4	40.1	2.4	—	—	—
10.50 - 11.49	—	—	9.7	15.2	7.8	4.8	3.7	34.1	29.0	1.8	—	—
9.50 - 10.49	—	5.6	6.0	10.9	7.4	3.3	1.8	17.5	34.2	15.7	2.4	—
8.50 - 9.49	4.6	10.1	12.4	6.2	2.8	1.9	1.8	3.7	15.7	15.2	19.0	4.1
7.50 - 8.49	9.2	9.0	9.2	10.0	5.1	3.3	0.9	2.3	6.7	16.6	13.8	10.1
6.50 - 7.49	7.8	14.1	9.2	6.2	5.5	1.4	—	1.4	1.9	9.2	13.3	10.1
5.50 - 6.49	10.6	7.6	6.9	4.3	2.8	1.4	—	—	2.8	7.4	11.4	8.3
4.50 - 5.49	10.1	8.6	8.8	4.3	2.3	1.4	—	0.9	2.4	6.5	8.6	12.9
3.50 - 4.49	5.5	11.1	7.4	6.7	2.3	0.5	—	—	2.4	7.8	8.1	10.1
2.50 - 3.49	8.8	7.6	6.9	3.3	1.4	1.9	—	—	0.5	6.5	7.1	8.3
1.50 - 2.49	11,0	6.6	7.8	2.9	2.3	0.5	—	—	1.0	4.1	4.8	11.1
0.50 - 1.49	12.4	6.6	6.5	5.7	0.9	0.5	—	—	1.0	3.2	5.7	7.8
0.01 - 0.49	8.3	4.5	3.2	4.8	0.9	0.5	—	—	—	1.4	3.3	7.4
0	11.6	8.6	6.0	3.8	0.5	—		0.9	—	4.6	2.4	9.7
	99.9	100.0	100.0	100.0	100.0	99.9	99.9	99.9	100.0	100.0	99.9	99.9

April has the least number with 68.6%; the same month has a percentage 14.3% of «very bad» days, including 4% of sunless ones.

Table XXXIII gives the distribution of sunless days per every month of the year.

TABLE XXXIII

Mean per month distribution of sunless days.

J	3.5
F	2.4
M	1.9
A	1.1
M	0.1
J	—
J	—
A	0.1
S	—
O	1.1
N	0.7
D	3.0
Year	13.9

Here we observe that: except for a very small percentage, sunless days do not exist during the warm season from April to September.

In the cold season, November has the least number of such days. We however attribute this fact to the small number of observational years.

Consecutive Sunless Days

In Table XXXIV we have grouped sunless days that occured in sequences, and we observe that:

a) Sunless days occur in sequences in a percentage of 26.7% (27 cases out of 101).

b) 30% of such cases (9 out of 27) occur in sequences of two.

c) Such days are not observed during the warm season.

In Table XXXV we have grouped «practically sunless days» occuring in sequences and we observe again that:

TABLE XXXIV

Distribution of runs of consective sunless days at the met. station of Sitia.

	2	3	Total of runs	Total of days	
J	2	1	7	25	28.0
F	3	—	6	17	35.3
M	1	—	2	13	15.4
A	—	—	—	8	—
M	—	—	—	1	—
J	—	—	—	—	—
J	—	—	—	—	—
A	—	—	—	1	—
S	—	—	—	—	—
O	1	1	5	10	50.0
N	1	—	2	5	40.0
D	1	1	5	21	23.8
Total of cases	9	3		101	
Total of days	18	9	27		

TABLE XXXV

Distribution of runs of consecutive «practically sunless» days at the met. station of Sitia

	2	3	4	Total of runs	Total of days	
J	3	2	1	16	43	37.2
F	5	1	—	13	26	50.0
M	1	—	—	2	20	10.0
A	1	—	—	2	18	11.1
M	—	—	—	—	3	—
J	—	—	—	—	1	—
J	—	—	—	—	1	—
A	—	—	—	—	—	—
S	—	—	—	—	—	—
O	2	1	—	7	13	53.8
N	2	—	—	4	12	33.3
D	4	1	1	15	37	40.5
Total of cases	18	5	2		174	
Total of days	36	15	8	59		

TABLE XXXVI

Mean hourly values of sunshine duration per hour and per month.
Met. Station: Sitia, period: 1968 - 1974.

Month	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	Observed
J	—	—	0.13	0.37	0.44	0.47	0.48	0.47	0.48	0.40	0.29	0.07	—	—	3.61
F	—	0.01	0.30	0.51	0.58	0.58	0.55	0.57	0.56	0.54	0.47	0.23	—	—	4.89
M	—	0.13	0.41	0.54	0.62	0.64	0.64	0.59	0.60	0.55	0.52	0.34	0.06	—	5.62
A	—	0.05	0.40	0.58	0.67	0.68	0.71	0.69	0.70	0.69	0.68	0.67	0.59	0.29	7.39
M	0.33	0.76	0.83	0.87	0.86	0.87	0.86	0.85	0.85	0.87	0.82	0.77	0.64	0.12	10.30
J	0.46	0.86	0.92	0.93	0.92	0.93	0.93	0.93	0.94	0.94	0.92	0.90	0.82	0.20	11.61
J	0.50	0.95	0.98	0.99	1.00	0.99	0.99	0.99	0.99	1.00	0.98	0.97	0.85	0.12	12.32
A	0.10	0.74	0.97	0.98	0.99	0.99	0.99	0.98	0.98	0.97	0.96	0.91	0.44	—	11.00
S	—	0.29	0.82	0.92	0.94	0.95	0.94	0.94	0.92	0.91	0.89	0.73	0.13	—	9.38
O	—	0.04	0.40	0.61	0.70	0.72	0.75	0.75	0.73	0.71	0.64	0.38	0.01	—	6.44
N	—	—	0.25	0.58	0.58	0.71	0.70	0.71	0.70	0.66	0.56	0.21	—	—	5.76
D	—	—	0.10	0.36	0.47	0.51	0.53	0.54	0.56	0.49	0.36	0.06	—	—	3.97
Year	0.120	0.348	0.559	0.695	0.739	0.757	0.753	0.751	0.750	0.725	0.674	0.513	0.270	0.037	7.691

a) Days characterized as «pracrically sunless» occur in sequences in a percentage of 33.9%.

b) A percentage of 30.5% (18 cases out of 59) consists of sequences of two.

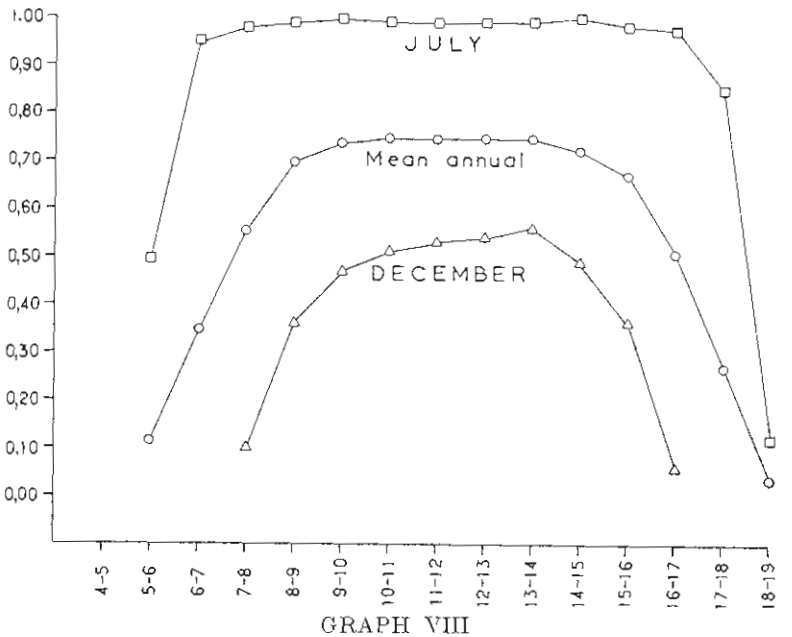
c) The longest sequences of consecutive «practically sunless» days were observed in January and December.

Diurnal Variation of Sunshine Duration - Hourly Values of Bright sunshine.

In Table XXXVI we give mean values of relative duration of bright sunshine per hour and per month and also the annual mean for every hour of the day.

The minimum is observed in the winter months of December and January.

The two autumnal months of September and October and March as well have actual sunshine duration of 12 hours, from 06 : 00 to 18:00.



GRAPH VIII

While every other station in Crete has 14 hours of actual sunshine duration during the five-months from April to August, at the met. station of Sitia this period is limited to the three-months, May, June and July; because of the afore mentioned obstacles, April and August have only 13 hours of actual sunshine duration.

In Graph VIII are illustrated:

The hourly mean variation of bright sunshine for July, the hourly mean for December, and the annual variation of relative duration of bright sunshine from sunrise till sunset.

This gives the chacteristic picture that we termed «Sunshine duration plateau».

5. SUNSHINE DURATION AT THE MET. STATION OF IERAPETRA

The station stands on the town's limits. The sunshine recorder is placed on the roof of the building. The open horizon allows direct solar radiation to be freely recorded on the recorder's strips. There is only one small obstacle of some 2°-5° to ENE-E-ESE, where the mountains

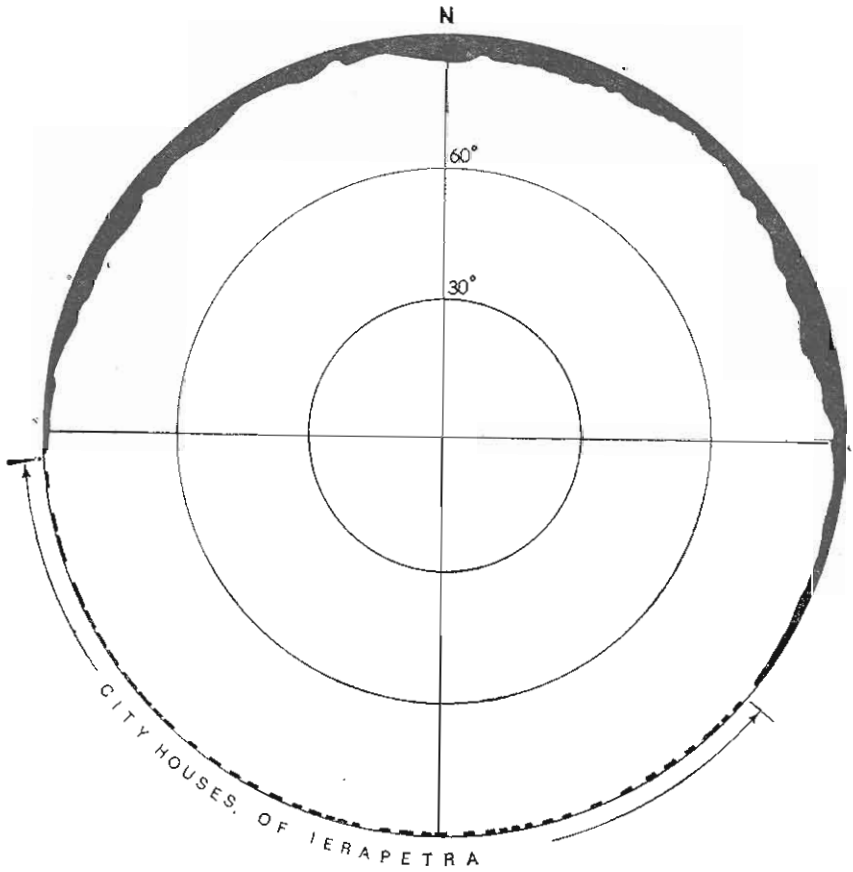


FIG. 5

of Lasithi rise; that is why during the five months from April to August we have small hourly values of bright sunshine at sunrise.

In Table XXXVII we have included monthly and daily mean values of sunshine duration.

The maximum mean is observed in July, and the minimum, which is more than 150 hours, in January.

TABLE XXXVII

Monthly mean and daily mean values of sunshine duration at the met. station of Ierapetra for the period 1968 - 1974.

Months	Monthly mean values	Daily mean values
J	152.4	4.9
F	157.6	5.6
M	205.8	6.6
A	239.3	7.9
M	324.1	10.5
J	352.3	11.7
J	386.0	12.5
A	366.1	11.8
S	300.0	10.0
O	234.6	7.6
N	203.0	6.8
D	166.2	5.4
Year	3087.4	8.4

Graph IX illustrates mean and extreme values for every month of the year.

During the seven years examined herein the absolute maximum exceeded 390 hours thrice: July 1968/391.3^h, July 1973/392.5^h, July 1974/392.0^h.

TABLE XXXVIII

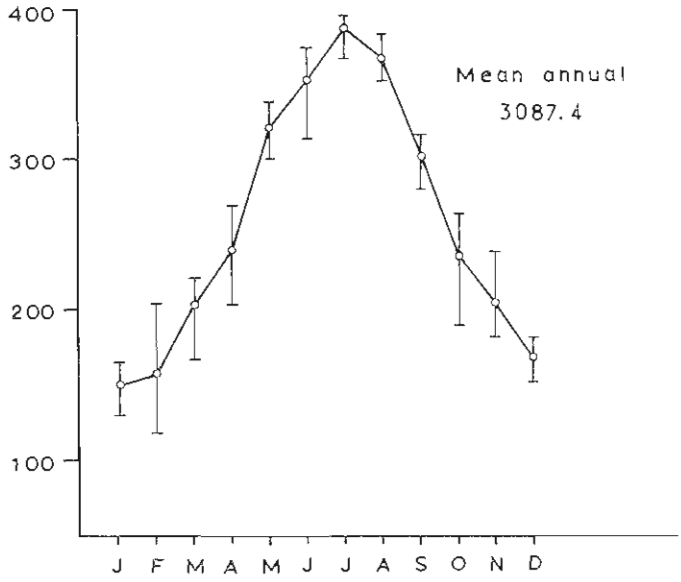
Distribution of daily sunshine duration values.
Met. Station: Ierapetra, period: 1968 - 1974.

Duration in hours	J	F	M	A	M	J	J	A	S	O	N	D	Total	
13.50 - 14.49	—	—	—	—	3	—	—	—	—	—	—	—	3	0.0011
12.50 - 13.49	—	—	—	—	59	112	154	22	—	—	—	—	347	0.1358
11.50 - 12.49	—	—	—	31	45	44	40	153	13	—	—	—	326	0.1274
10.50 - 11.49	—	—	21	42	38	17	14	29	97	6	—	—	264	0.1032
9.50 - 10.49	—	14	25	19	21	10	6	6	54	61	14	—	230	0.0899
8.50 - 9.45	20	31	20	23	13	7	2	3	19	39	53	27	257	0.1006
7.50 - 8.49	29	24	27	15	14	5	1	1	6	30	37	33	222	0.0868
6.50 - 7.49	31	17	31	16	7	5	—	2	10	22	31	36	208	0.0815
5.50 - 6.49	17	23	26	13	4	—	—	1	3	13	24	23	147	0.0574
4.50 - 5.49	32	14	14	10	5	1	—	—	1	16	16	20	129	0.0504
3.50 - 4.49	19	26	18	13	1	1	—	—	3	7	6	21	115	0.0449
2.50 - 3.49	19	9	9	7	4	2	—	—	1	7	10	19	87	0.0340
1.50 - 2.49	21	13	10	7	4	1	—	—	2	4	9	14	85	0.0334
0.50 - 1.49	10	13	7	6	1	2	—	—	—	6	5	10	60	0.0234
0.01 - 0.49	7	6	7	5	—	—	—	—	—	3	3	8	39	0.0154
0	12	8	2	3	1	—	—	—	1	3	2	6	38	0.0148
	217	198	217	210	217	210	217	217	210	217	210	217	2557	1.0000

TABLE XXXIL

Occurence pereentage of various sunshine dnration values.
Met. Station: Ierapetra, period: 1968 - 1974.

Duration in hours	J	F	M	A	M	J	J	A	S	O	N	D
13.50 - 14.49	—	—	—	—	—	1.4	—	—	—	—	—	—
12.50 - 13.49	—	—	—	—	27.2	53.3	70.9	10.1	—	—	—	—
11.50 - 12.49	—	—	—	14.8	20.7	20.9	18.4	70.5	6.2	—	—	—
10.50 - 11.49	—	—	9.7	20.0	17.5	8.1	6.5	13.4	46.2	2.8	—	—
9.50 - 10.49	—	7.1	11.5	9.0	9.7	4.7	2.8	2.8	25.7	28.1	6.7	—
8.50 - 9.49	9.2	15.7	9.2	10.9	6.0	3.3	0.9	1.3	9.0	17.9	25.2	12.4
7.50 - 8.49	13.4	12.1	12.4	7.1	6.5	2.4	0.5	0.5	2.8	13.8	17.6	15.2
6.50 - 7.49	14.3	8.6	14.3	7.6	3.2	2.4	—	0.9	4.7	10.1	14.8	16.6
5.50 - 6.49	7.8	11.6	12.0	6.2	1.8	—	—	0.5	1.4	6.0	11.4	10.6
4.50 - 5.49	14.7	7.1	6.5	4.8	2.3	0.5	—	—	0.4	7.4	7.6	9.2
3.50 - 4.49	8.8	13.1	8.3	6.2	0.5	0.5	—	—	1.4	3.2	2.9	9.6
2.50 - 3.49	8.8	4.5	4.1	3.3	1.8	1.0	—	—	0.4	3.2	4.8	8.8
1.50 - 2.49	9.7	6.6	4.6	3.3	1.8	0.5	—	—	0.9	1.8	4.3	6.5
0.50 - 1.49	4.6	6.6	3.2	2.9	0.5	1.0	—	—	—	2.8	2.3	4.6
0.01 - 0.49	3.2	3.0	3.2	2.4	—	—	—	—	—	1.4	1.4	3.7
0	5.5	4.0	0.9	1.4	0.5	—	—	—	0.9	1.4	1.0	2.8
	100.0	00.0	99.9	99.9	100.0	100.0	100.0	100.0	100.0	99.9	100.0	100.0



GRAPH IX

Daily Mean Sunshine Duration.

In Table XXXVIII we have classified the 2557 observational days of the seven years, in groups according to their daily sunshine duration.

In Table XXXIX these groups have been converted to percentages (%).

For the cold semester we have divided in groups days with sunshine duration$>$5.50 hours, days with sunshine duration$<$1.50 «very bad», and also «practically sunless» days with sunshine duration$<$0.49, as per the following Table XL.

TABLE XL

Percentage of days with various sunshine durations during the cold semester.

	J	F	M	O	N	D
$>$5.50	44.7%	55.1%	49.1%	78.7%	75.7%	54.8%
$<$1.50	13.3%	13.6%	7.3%	5.6%	4.7%	11.1%
$<$0.49	8.7%	7.0%	4.1%	2.8%	2.4%	6.5%
=0	5.5%	4.0%	0.9%	1.4%	1.0%	2.8%

January has least number of days with sunshine duration$>$5.50, yet their percentage approaches 45.0%.

October has the most with 79%.

For the warm semester, with the same restriction is grouping, we have the following Table XLI.

TABLE XLI

Percentage of days with various sunshine durations during the warm semester

	A	M	J	J	A	S
>5.50	75.6%	92.6%	96.5%	100.0%	100%	96.0%
<1.50	6.7%	1.0%	1.0%	—	—	0.9%
<0.49	3.8%	0.5%	—	—	—	0.9%
=0	1.4%	0.5%	—	—	—	0.9%

July and August have for almost all their days sunshine duration longer than 8.50 hours.

April has the least with a percentage of 75.6%; the same month has a small percentage of 6.7% of very bad days.

TABLE XLII

Mean per month distribution of suuless days

J	1.7
F	1.1
M	0.3
A	0.4
M	0.1
J	—
A	—
S	0.1
O	0.4
N	0.4
N	0.3
D	0.9
Year	5.3

Table XLII gives the mean per month number of sunles days throughout the year.

We observe that$_8$ with the exception of January and February that have more than one day, every other month has less than one, while the summer months have nil.

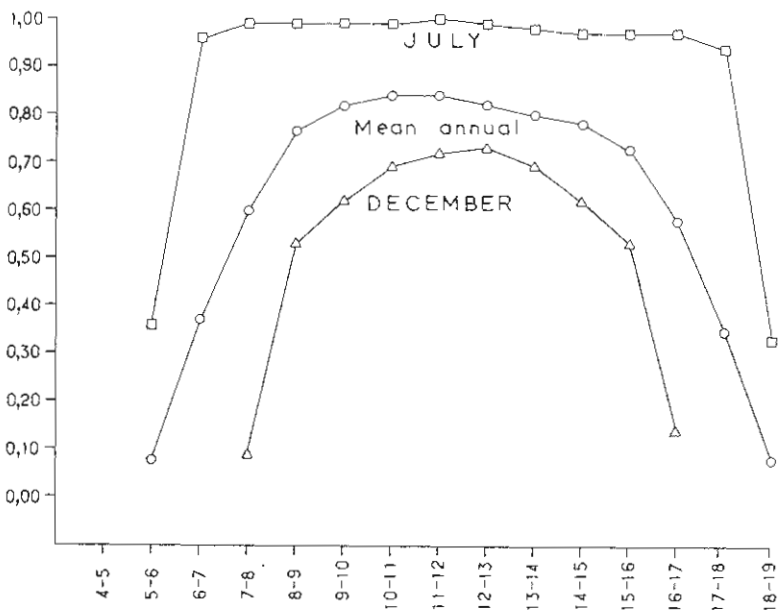
Consecutive Sunless Days

At the meteorological station of Ierápetra sunless days do not occur in runs, while «practically sunless» we find only 12 out of 2557 observational days, all in sequences of two, distributed as follows: February has three sequences, October one and December two.

Diurnal Variation of Sunshine Duration - Hourly values of bright sunshine.

Table XLIII gives hourly values of bright sunshine per hour and month, and also the annual mean for every hour of the day.

The minimum is observed in the three winter months, being followed by November. March with September and October have 12 hours of actual sunshine duration, while the five months from April to August have 14.



GRAPH X

Graph X illustrates: the mean per hour course of bright sunshine for July and December and its annual variation from sunrise till sunset.

TABLE XLIII

Mean hourly values of sunshine duration per hour and per month.
Met. Station: Ierapetra, period: 1968 - 1974.

Month	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	Observed
J	—	—	0.12	0.48	0.50	0.67	0.67	0.62	0.59	0.56	0.46	0.14	—	—	4.92
F	—	—	0.30	0.59	0.64	0.68	0.67	0.65	0.62	0.59	0.51	0.31	—	—	5.57
M	—	0.09	0.49	0.66	0.74	0.75	0.76	0.74	0.69	0.65	0.56	0λ43	0.08	—	6.64
A	0.02	0.38	0.63	0.74	0.77	0.77	0.77	0.75	0.74	0.72	0.69	0.62	0.36	0.01	7.98
M	0.20	0.74	0.83	0.88	0.89	0.90	0.90	0.88	0.87	0.86	0.82	0.80	0.68	0.18	10.45
J	0.31	0.89	0.94	0.94	0.95	0.95	0.94	0.94	0.94	0.92	0.91	0.90	0.87	0.33	11.74
J	0.36	0.96	0.99	0.99	0.99	0.99	1.00	0.99	0.98	0.97	0.97	0.97	0.94	0.33	12.45
A	0.09	0.92	0.99	1.00	1.00	0.99	0.99	0.99	0.98	0.98	0.97	0.96	0.87	0.08	11.81
S	—	0.38	0.91	0.95	0.95	0.96	0.94	0.95	0.94	0.93	0.92	0.86	0.31	—	10.00
O	—	0.03	0.58	0.77	0.84	0.84	0.82	0.82	0.80	0.80	0.71	0.53	0.02	—	7.57
N	—	0.01	0.30	0.73	0.79	0.84	0.81	0.80	0.79	0.74	0.65	0.30	—	—	6.77
D	—	—	0.09	0.53	0.62	0.69	0.72	0.73	0.69	0.62	0.53	0.14	—	—	5.36
Year	0.082	0.368	0.599	0.771	0.815	0.837	0.833	0.823	0.805	0.778	0.728	0.580	0.345	0.077	8.438

We observe that the hourly course of bright sunshine is in July, from 08:00 till 17:00 hours, an almost straight line, defined by ten identical hourly values.

6. SUNSHINE DURATION AT THE MET. STATION OF TIMBAKION

The station is situated within the aerodrome of Timbakion, at a small distance from the town.

The sunshine recorder, placed on a building roof, unobstructedly records bright sunshine.

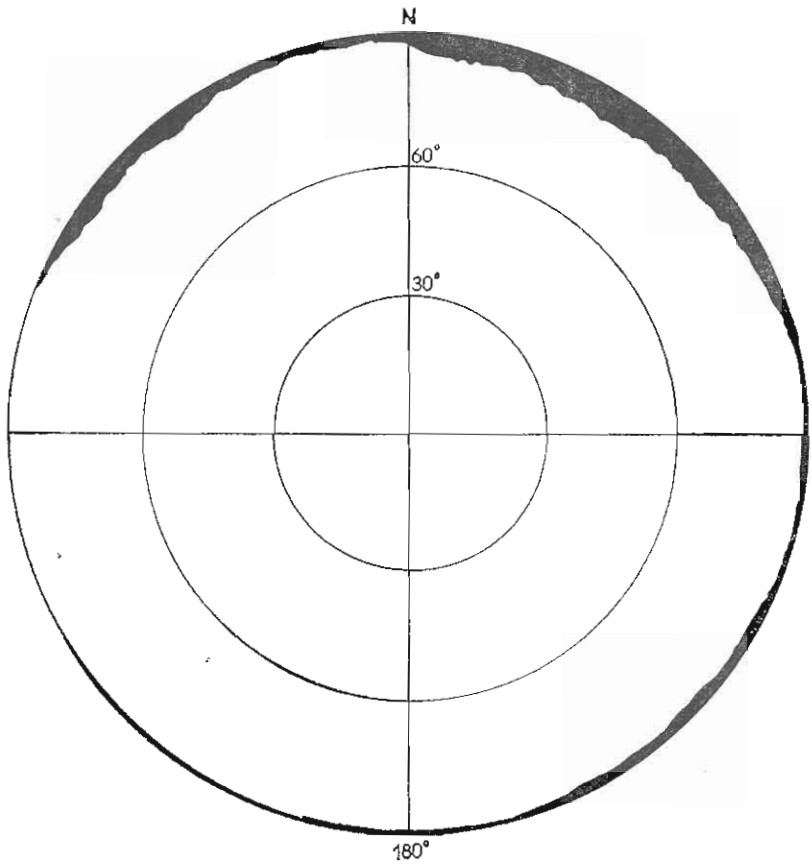
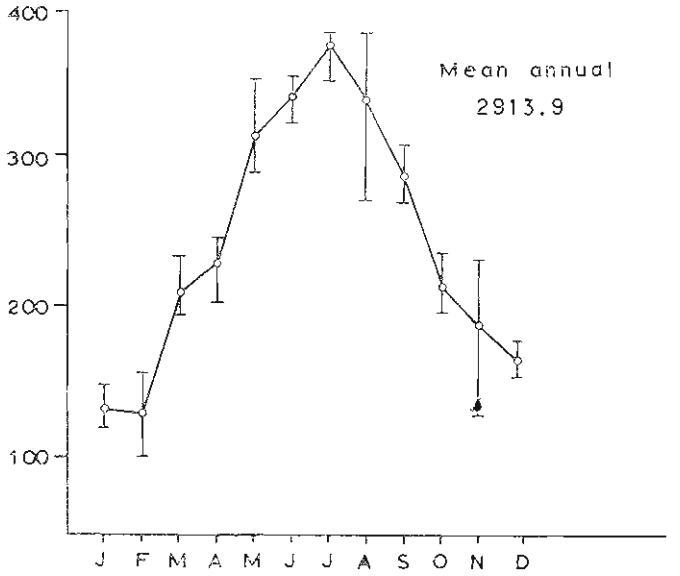


FIG. 6

The mountain masses of Central Crete stand to NE, outside of the arc traced by the sun in its course from sunrise to sunset.

Of course the observational years available for study are quite few; not enougt even for an initial study of sunshine duration, while in some months there is a notice that «the sunshine recorder does not operate well». We, however, have taken this station into account because in Southern Crete only this and the station of Ierapetra have data on sunshine duration.



GRAPH XI

TABLE XLIV

Monthly mean and daily mean values of sunshine duration at the met. station of Timbakion for the period 1971 - 1973.

	Monthly mean values	Daily mean values
J	133.0	4.3
F	129.7	4.6
M	211.7	6.8
A	228.3	7.6
M	316.5	10.2
J	337.0	11.2
J	368.8	11.9
A	334.0	10.8
S	228.7	9.6
O	214.5	6.9
N	184.9	6.2
D	166.5	5.4
Year	2913.9	7.9

TABLE XLV

Distribution of daily sunshine duration values.
Met. Station: Timbakion. period: 1971 - 1973.

Duration in hours	J	F	M	A	M	J	J	A	S	O	N	D	Total	
13.50 - 14.49	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12.50 - 13.49	—	—	—	—	22	20	22	9	—	—	—	—	73	0.0666
11.50 - 12.49	—	—	—	10	25	30	46	46	2	—	—	—	159	0.1450
10.50 - 11.49	—	—	9	17	11	22	22	20	37	2	—	—	140	0.1277
9.50 - 10.49	—	6	13	13	6	8	3	1	29	25	11	0	115	0.1049
8.50 - 9.49	6	8	10	6	9	5	0	2	11	18	18	5	98	0.0894
7.50 - 8.49	11	6	10	4	5	2	0	5	1	8	13	21	86	0.0784
6.50 - 7.49	13	7	12	10	3	—	—	1	—	5	6	14	71	0.0648
5.50 - 6.49	7	6	8	5	4	2	—	3	2	5	8	11	61	0.0556
4.50 - 5.49	7	8	8	4	3	—	—	1	2	7	5	15	60	0.0548
3.50 - 4.49	10	9	10	3	2	—	—	4	1	8	5	5	57	0.0520
2.50 - 3.49	8	8	4	3	—	—	—	—	3	4	8	6	44	0.0402
1.50 - 2.49	9	7	4	5	3	—	—	1	1	2	6	6	44	0.0402
0.50 - 1.49	14	14	1	6	—	1	—	—	1	3	3	1	44	0.0402
0.01 - 0.49	3	1	—	2	—	—	—	—	—	1	6	3	16	0.0146
0	5	5	4	2	—	—	—	—	—	5	1	6	28	0.0256
	93	85	93	90	93	90	93	93	90	93	90	93	1096	1.0000

TABLE XLVI

Occurence percentage of various sunshine duration values.
Met. Station: Timbakion, period: 1971 - 1973.

Dnration in hours	J	F	M	A	M	J	J	A	S	O	N	D
13.50 - 14.49	—	—	—	—	—	—	—	—	—	—	—	—
12.50 - 13.49	—	—	—	—	23.7	22.2	23.7	9.7	—	—	—	—
11.50 - 12.49	—	—	—	11.1	26.9	33.3	49.4	49.4	2.2	—	—	—
10.50 - 11.49	—	—	9.7	18.9	11.8	24.4	23.7	21.5	41.1	—	—	—
9.50 - 10.49	—	7.1	14.0	14.5	6.4	8.9	3.2	1.1	32.2	26.9	12.2	—
8.50 - 9.49	6.5	9.4	10.7	6.7	9.7	5.6	—	2.2	12.2	19.4	20.0	5.4
7.50 - 8.49	11.8	7.1	10.7	4.4	5.4	2.2	—	5.3	1.1	8.6	14.4	22.6
6.50 - 7.49	14.0	8.2	12.9	11.1	3.2	—	—	1.1	—	5.4	6.7	15.0
5.50 - 6.49	7.5	7.0	8.6	5.6	4.3	2.2	—	3.2	2.2	5.4	8.9	11.8
4.50 - 5.49	7.5	9.4	8.6	4.4	3.2	—	—	1.1	2.2	7.5	5.6	16.1
3.50 - 4.49	10.8	10.6	10.7	3.3	2.2	—	—	4.3	1.1	8.6	5.6	5.3
2.50 - 3.49	8.6	9.4	4.3	3.3	—	—	—	—	3.3	4.3	8.9	6.5
1.50 - 2.49	9.7	8.2	4.3	5.6	3.2	—	—	1.1	1.1	2.1	6.6	6.5
0.50 - 1.49	15.0	16.5	1.1	6.6	—	1.1	—	—	1.1	3.2	3.3	1.1
0.01 - 0.49	3.2	1.2	—	2.2	—	—	—	—	—	1.1	6.7	3.2
0	5.4	5.9	4.3	2.2	—	—	—	—	—	5.4	1.1	6.5
	100.0	100.0	99.9	99.9	100.0	99.9	100.0	100.0	99.9	99.9	100.0	100.0

Graph XI shows mean and extreme values (absolute maxima and minima) for every month of the year.

Daily Mean Sunshine Duration.

In Table XLV we have divided in groups the 1096 days of the three observational years according to their daily sunshine duration, while in Table XLVI these groups have been converted to percentages.

TABLE XLVII

Mean per month distribution of sunless days.

J	1.7
F	1.7
M	1.3
A	0.7
M	—
J	—
J	—
A	—
S	—
O	1.7
N	0.3
D	2.0
Year	9.3

In Table XLVII we give the distribution of sunless days per each month of the year

Diurnal Variation of Sunshine Duration-Hourly volues of bright sunshine.

In Table XLVIII are given mean per hour and per month hourly values of bright sunshine as well as the annual mean for every hour of daytime.

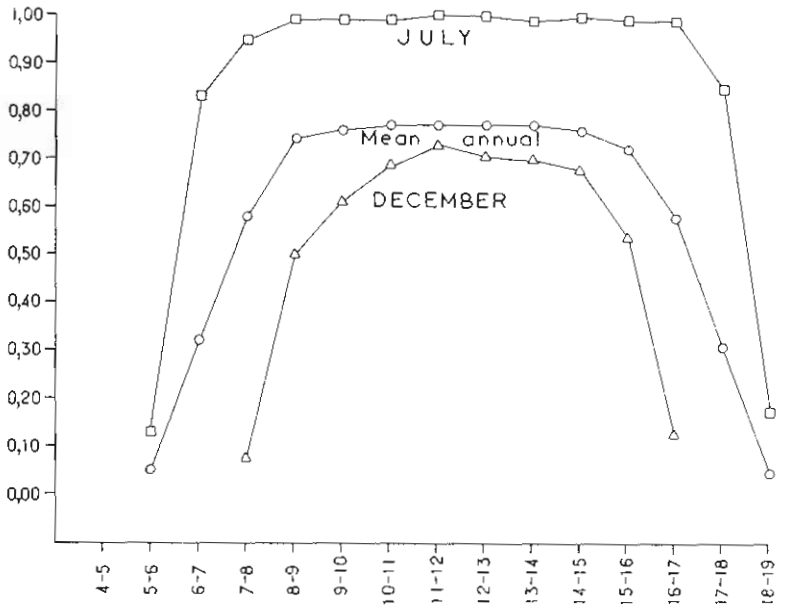
The minimum is observed in December and January and the maximum during the five-months form April to August, with 14 hours of daily sunshine duration.

Graph XII illustrates the mean per hour course of bright sunshine for July, December, and for the year.

TABLE XLVIII

Mean values of sunshine duration per and hour per month.
Met. Station: Timbakion, period: 1971 - 1973.

Month	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	Obderved
J	—	—	0.11	0.47	0.47	0.56	0.57	0.58	0.52	0.50	0.39	0.13	—	—	4.30
F	—	0.01	0.25	0.43	0.51	0.54	0.50	0.54	0.52	0.50	0.48	0.29	0.01	—	4.58
M	—	0.06	0.52	0.71	0.70	0.70	0.76	0.75	0.73	0.58	0.64	0.50	0.08	—	6.83
A	0.01	0.32	0.60	0.70	0.71	0.72	0.73	0.75	0.77	0.70	0.66	0.57	0.35	0.02	7.61
M	0.17	0.70	0.80	0.85	0.88	0.93	0.88	0.87	0.87	0.84	0.83	0.75	0.67	0.19	10.21
J	0.18	0.78	0.89	0.95	0.97	0.97	0.96	0.97	0.96	0.96	0.94	0.91	0.66	0.14	11.23
J	0.13	0.83	0.95	0.99	0.99	0.99	1.00	1.00	0.99	1.00	0.99	0.99	0.85	0.18	11.90
A	0.09	0.84	0.98	0.98	0.92	0.87	0.84	0.83	0.82	0.86	0.91	0.96	0.80	0.09	10.77
S	—	0.27	0.86	0.92	0.92	0.93	0.92	0.93	0.93	0.94	0.93	0.85	0.26	—	9.62
O	—	0.03	0.61	0.74	0.71	0.71	0.69	0.70	0.72	0.72	0.70	0.56	0.04	—	6.92
N	—	—	0.33	0.65	0.58	0.69	0.57	0.56	0.59	0.72	0.71	0.36	0.01	—	6.16
D	—	—	0.08	0.50	0.61	0.69	0.73	0.71	0.70	0.68	0.54	0.13	—	—	5.37
Year		0.048	0 321	0.581	0.740	0.756	0.771	0.771	0.774	0.769	0.758	0.725	0.584	0.309	7.959



GRAPH XII

COMPARATIVE TABLES OF SUNSHINE DURATION AT THE MET. STATIONS OF CRETE

A. In Table XLIX we compare monthly mean values of sunshine duration from the four stations having the same observational years.

We observe that among stations of Northern Crete, Iraklion has a shorter sunshine duration than Sitia and longer than Suda.

Ierápetra, at the SE end of Crete, definitely exceeds every other station by 270 to 300 hours of sunshine duration per year.

The station of Sitia, although situated nearer to Ierapetra than to Iraklion, yet it has sunshine duration similar to that of Iraklion not only as to the number of hours per year, but also as to its monthly distribution. Of course the hastening of sunset produced by obstructions in the horizon plays a certain role in this decrease; yet for the difference of 273.8 hours, of which 199.6 are during the cold semester, dynamic factors should also play their role.

B. From Table L we observe that:

a. At the four stations examined, 115 months in seven years have

TABLE XLIX

Sunshine duration at four meteorological stations of Crete for the period 1968 - 1974.

	1	2	3	4					
	Ierapetra	Sitia	Iraklion	Suda	Δ1-2	Δ1-3	Δ1-4	Δ2-3	Δ3-4
J	152.4	111.8	104.4	108.0	40.6	48.0	44.4	7.4	-3.6
F	157.6	138.4	128.0	135.6	19.2	29.6	22.0	10.4	-7.6
M	205.8	174.3	172.6	175.8	31.5	33.2	30.0	1.7	-3.2
A	239.3	221.7	220.1	226.2	17.6	19.2	13.1	1.6	-6.2
M	324.1	319.2	316.1	318.9	4.9	8.0	5.2	3.1	-2.8
J	352.3	348.3	349.3	332.4	4.0	3.0	19.9	-1.0	16.9
J	386.0	382.0	381.1	361.0	4.0	4.9	25.0	0.9	20.1
A	366.1	341.0	351.6	355.7	25.1	14.5	10.4	-10.6	-4.1
S	300.0	281.4	280.9	278.2	18.6	19.1	21.8	0.5	2.7
O	234.6	199.7	193.2	193.0	34.9	41.4	41.6	6.5	0.2
N	203.0	172.7	170.6	173.3	30.3	32.4	29.7	2.1	-2.7
D	166.2	123.1	125.5	126.7	43.1	40.7	39.5	-2.4	-1.2
Year	3087.4	2813.6	2793.4	2784.8	273.8	294.0	302.6	20.2	8.6

sunshine duration >300 hours. This group consists of the three summer months, June July, and August and the month of May.

b. Sunshine duration between 200 and 300 hours have only the vernal and autumnal months.

c. Sunshine duration between 200 and 100 hours have mainly the winter months with March.

d. Finally a small number of months, representing a percentage of 4%, have sunshine duration between 40 and 100 hours; cases of this last group occured in December and January.

C. From Table LI we observe that:

a. At the meteorological station of Sitia in the month of August, there are only 87 days with sunshine duration>11.50 hours. This is due to the obstacles rising at the West, which are most effective in this month. This can be proved by the following calculation.

If we consider not only days with sunshine duration>11.50 hours, but also those with sunshine duration>9.50 hours, then we have for Ierapetra 210, for Iraklion 205, for Suda 203, and for Sitia 199, that is very small differences.

b. From 868 days of July at the four stations, 730 days, that is almost 84%, are «extremely good» and consequently rather unpleasant for human activities during this summer month.

c. «Very bad» days have a rather increased percentage of 8% at the met. station of Suda; the met. station of Iraklion follows with another 8%.

This similarity reappears in the month with the highest occurence of «very bad» days and in their number (January for both).

In Ierapetra, at SE Crete, their percentage is only 3%.

d. September may be added to the four-months from May to August, whose percentages are negligible.

D. From Table LII, we observe that:

a. From 08:00 till 18:00 relative duration of bright sunshine is highest at Ierapetra, in SE Crete, than in any other station.

b. The met. station of Suda has the smallest annual values for every hour of daytime.

c. At the met. station of Sitia, where the sunset is obstructed at

TABLE L

Groups of months with various sunshine dvration

Duration in hours	J	F	M	A	M	J	J	A	S	O	N	D	Total
400 - 301	—	—	—	—	25	28	28	28	6	—	—	—	115
300 - 201	—	1	8	27	3	—	—	—	22	16	4	—	81
200 - 101	21	26	20	1	—	—	—	—	—	12	24	23	127
100 - 40	7	1	—	—	—	—	—	—	—	—	—	5	13
	28	28	28	28	28	28	28	28	28	28	28	28	336

TABLE LI

Sunshine duration > 11.50

	J	F	M	A	M	J	J	A	S	O	N	D	Total
Suda	—	—	—	43	114	106	145	154	17	—	—	—	579
Iraklion	—	—	—	37	116	155	192	137	5	—	—	—	642
Sitia	—	—	—	33	126	165	199	87	5	—	—	—	615
Ierapetra	—	—	—	31	104	159	194	175	13	—	—	—	676
	—	—	—	144	460	585	730	553	40	—	—	—	2512

Sunshine duration < 0.49

Suda	56	27	36	21	1	1	—	—	5	26	18	39	230
Iraklion	54	23	31	17	—	1	1	2	4	20	9	41	213
Sitia	43	26	20	18	3	1	—	1	—	13	12	37	174
Ierapetra	19	14	9	8	1	—	—	—	1	6	5	14	77
	172	100	96	64	5	3	1	3	10	65	44	131	694

TABLE LII

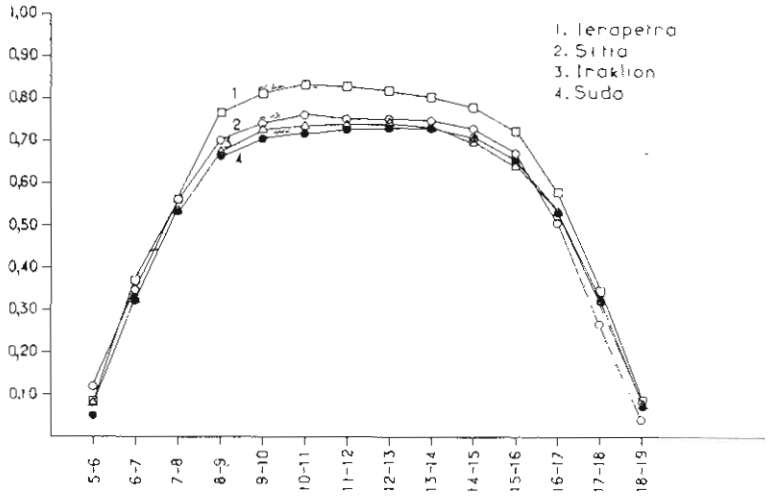
Mean annual sunshine duration values for every hour.

	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	Observed
Suda	0.051	0.336	0.553	0.672	0.714	0.726	0.734	0.738	0.727	0.710	0.663	0.536	0.335	0.075	7.569
Iraklion	0.090	0.332	0.548	0.686	0.729	0.747	0.743	0.742	0.732	0.705	0.660	0.532	0.322	0.075	7.634
Sitia	0.120	0.348	0.559	0.695	0.739	0.757	0.753	0.751	0.750	0.725	0.674	0.513	0.270	0.037	7.691
Ierapetra	0.082	0.368	0.599	0.771	0.815	0.837	0.833	0.822	0.805	0.778	0.728	0.580	0.345	0.077	8.440

almost 11°, by houses of the town that is built on a hillside, we observe very reduced values after 16:00 hours. The highest decrease is observed in the month of August because in this month the point where the sun sets coincides with the position of the higher buidings.

	August	
	17 - 18h	18 - 19h
Suda	0.84	0.15
Iraklion	0.75	0.05
Sitia	0.44	0.00
Ierapetra	0.87	0.08

Graph I shows the course of annual mean values of bright sunshine, for every hour of daytime, at the four stations examined herein.



E. Finally, in *Table LIII* we compare sunshine duration at Thessaloniki the northernmost station in Greece, where sunshine duration has been studied in detail, with that of Ierapetra, which is the southernmost station of the country.

TABLE LIII

Susnhine duration at Ierapetra and Thessaloniki for the period 1968 - 1974.

Months	Ierapetra	Theoretical	Thessaloniki	Theoretical*	Δ
J	152.40	315.0	86.89	298.50	65.56
F	157.60	306.0	108.70	297.85	48.90
M	205.80	371.0	149.20	369.73	56.60
A	239.30	392.0	217.42	398.77	21.88
M	324.10	435.0	299.65	447.95	24.45
J	352.30	435 0	305.00	451.33	47.30
J	386.00	442.0	343 14	457 83	42 85
A	366.10	415.0	321.15	427.16	44.95
S	300.00	370.0	242.47	374.17	57.53
O	234.60	349.0	198.69	345.15	35.91
N	203.00	311.0	152.19	298.25	50.81
D	166.20	305.0	113.87	289.87	52.33
Year	3.087.40	4.446.0	2.538.38	4.455.68	549.02

*Theoretical sunshine duration has been calculated for Thessaloniki by Alexandrou[1,2].

a. The precedence of Ierapetra begins from 21.88 hours in April, to reach 65.51 hours in June.

b. During the cold semester, this difference is almost 2 hours daily.

1. Comparing the annuaI variation of bright sunshine at the met. stations of Crete, we observe an increase from West to East. At the end of the island this increase reaches 300 hours, 200 of which during the cold semester, and it is due to cyclonic activity. During the cold season, associated lows moving along the main axis of the Mediterranean Sea, from West to East, affect more the western side of the island.

2. A percentage of 60% of the months examined, has more than 200 hours of sunshine duration. This includes every month of the warm semester from April to September, and .60% of Octobers.

Sunshine duration shorter than 100 hours, is observed only in a small percentage of 4% (13 months out of total of 336).

3. Percentages of extremely good days, with sunshine duration$>$11.50 hours, are quite high, varying (with small differences) from 26.4% at Ierapetra, with 676 days out of 2557, to 22.6% at Suda.

4. Examining the annual mean values for every hour of the day, we observe that the precedence of SE Crete, that is Ierapetra, is almost 1 hour daily.

5. April has more «very bad» days than any other month of the warm semester.

Out of a total of 694 days for all four stations, April has 64 «very bad» days, March 96, May 5-thus supporting our view that this is a transitive month between the cold and the warm semester. September with a very small number-10 days-has similarities with the summer months.

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REFERENCES

1. Alexandrou, L. 1933: Τὸ Κλῖμα τῆς Θεσσαλονίκης. Ἐπιστ. Ἐπετηρὶς τῆς Φ.Μ. Σχολῆς, Παν. Θεσσαλονίκης, τόμ. 1., The Climate of Thessaloniki. Sci. Annals, Fac. Phys. and Mathem., Univ. Thessaloniki, Vol. I.
2. Alexandrou, L. (1940: Διάρκεια ἡλιοφανείας ἐν Θεσσαλονίκῃ. Ἐπιστ. Ἐπετ. Φ. Μ. Σχολῆς, Παν. Θεσσαλονίκης, τόμος ΣΤ'. Sunshine duration in Thessaloniki. Sci. Annals, Fac. Phy. and Mathem., Univ. Thessaloniki, Vol. VI.
3. Karapiperis, L.-Katsoulis, B.-Papachristopoulos, K. 1974: «Συμβολὴ εἰς τὴν μελέτην τῆς ἡλιοφανείας ἐν Ἑλλάδι». «Contribution to the study of sunshine duration in Greece».
4. Livadas, G. C. 1969: Ἡ ἡλιοφάνεια ἐν Θεσσαλονίκῃ(1). Δημοσιεύματα Ἐργαστ. Μετεωρολογίας, ἀρ. 1, Μαθηματικὸν τμῆμα Ἰωαννίνων (Α.Π.Θ.). Sunshine duration in Thessaloniki (I). Publ. of the Meteorological Institute, No 1, Mathematics Section of Ioannina Campus (AUT).
5. Livadas, G. C. 1975: «Μαθήματα Γενικῆς Μετεωρολογίας». Ἔκδοσις ΙΙ, σελ. 73, Θεσσαλονίκη. «Lessons of General Meteorology», Sect II, Thessaloniki., p. 73.
6. Livadas, G. C. - Maldoyiannis, Th. and Flocas, A. A. 1970: Ἡ ἡλιοφάνεια ἐν Θεσσαλονίκῃ (ΙΙ), Δημοσ. Ἐργαστ. Μετεωρολογίας, ἀρ. 3, Μαθηματικὸ τμῆμα Παν. Ἰωαννίνων (Α.Π.Θ.) Sunshine duration in Thessaloniki (II). Publ. of the Met. Institute No 3, Mathem. section of Ioannina Campus (AUT).
7. Livadas, G. C. and Flocas, A. A 1972: Sunshine dnration in Thessaloniki-Greece II. «Meteorologika» No 15 (reprint from Sci. Annals, Fac. Phys. and Mathem., Univ. Thessaloniki, Vol. 12).
8. Livadas, G. C. and Semertzidis, Vl. A. 1973: Sunshine duratiou on Mt. Olympus-Greece. Sci. Annals Fac. of Physics and Mathem. of the A.U.T., Vol. 13, pp. 251-268 and «Meteorologika» No 28.
9. Livadas, G. C. and Pennas, P. 1973: Sunshine duration in Neos Marmaras-Chalkidiki. «Meteorologika» No 29 and Sci. Annals Fac. of Phys. and Mathem. of the A.U.T. Vol. 13, pp. 279-300.
10. Mariolopoulos, E. G. 1938: Τὸ Κλῖμα τῆς Ἑλλάδος. Ἀθῆναι. «The Climate of Greece». Athens.
11. Meteorological Office 1962: «Weather in the Mediterranean, Vol. 1 (second edition). London H.M.S.O.

ΠΕΡΙΛΗΨΗ

Η ΗΛΙΟΦΑΝΕΙΑ ΣΤΗΝ ΚΡΗΤΗ

Ὑπὸ

Π. ΠΕΝΝΑ

Μελετᾶται ἡ διάρκεια τῆς ἡλιοφάνειας στὴν Κρήτη, τὸ νοτιότερο νησὶ τοῦ Αἰγαίου Πελάγους, γιὰ τὸ χρονικὸ διάστημα 1968 - 1974, ἐπειδὴ πιστεύουμε ὅτι ἀποτελεῖ τὴν πιὸ κατάλληλη περιοχὴ γιὰ τὴν ἐφαρμογὴ τῶν μεθόδων τῆς ἡλιοτεχνικῆς.

Τὸ ἐπίμηκες σχῆμα της περιλαμβάνεται μεταξὺ τῶν συντεταγμένων.

$\varphi = 34^{\circ}\ 50'$ ὡς $35^{\circ}\ 35'$ N καὶ

$\lambda = 23^{\circ}\ 30'$ ὡς $26^{\circ}\ 15'$ E

ἡ δὲ ἐπιφάνειά της καλύπτει ἔκταση 8.331 τετρ. χιλ.

Τὰ δεδομένα ἀναφέρονται σὲ ὅλους τοὺς Μετεωρολογικοὺς Σταθμοὺς ποὺ λειτουργοῦν ἡλιογράφοι Campbell-Stokes.

Γιὰ κάθε Σταθμὸ δίνονται ἐτήσιες, μηνιαῖες καὶ ὡριαῖες τιμὲς καὶ ὁμαδοποιοῦνται οἱ μέρες τους ἀνάλογα μὲ τὶς ὧρες ἡλιοφάνειας, ἐνῶ γιὰ τὶς ἀνήλιες γίνεται μιὰ πιὸ λεπτομερὴς ἔρευνα. Ἐπίσης ἐξετάζονται οἱ ἡμερήσιες τιμὲς καὶ οἱ ὁμάδες διαδοχικῶν ἀνήλιων ἡμερῶν, τόσο κατὰ τὸ ψυχρὸ ἑξάμηνο, Ὀκτώβριος - Μάρτιος, ὅσο καὶ κατὰ τὸ θερμό, Ἀπρίλιος - Σεπτέμβριος.

Τέλος ἀπὸ ἕνα σύνολο συγκριτικῶν πινάκων καὶ διαγραμμάτων, ὅπου χαρακτηριστικὰ διαγράφεται ἡ αὔξηση τῆς ἡλιοφάνειας, ἀπὸ τὰ Δυτικὰ πρὸς τὰ Ἀνατολικά, μὲ μέγιστο τὴν Νοτιοανατολικὴ περιοχή, βγαίνουν συμπεράσματα καὶ δικαιολογοῦνται οἱ διαφορὲς ποὺ παρουσιάζονται μεταξὺ τῶν Σταθμῶν.