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SUNSHINE DURATION IN NEOS MARMARAS-CHALKIDIKI

by

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Abstract: *Sunshine duration in the meteorologieal station of Neos Marmaras-Chalkidiki (φ : 40° 05′ 48″ N, λ = 23° 47′ 05″ E,* elev. *1m.) is studied for the 1968-1972 period. Sunshine duration values of this station are also examined in correlation with those of the National Observatory of Athens (N.O.A.) and the Institute of Meteorology and Climatology of the Aristotelian University of Thessaloniki (A.U.T.) and certain conclusions are drawn. Moreover, these same values are compared with those recorded at the French Riviera during the same period. Conclusions are drawn, concerning the general weather conditions that prevail during the whole year in southern Chalkidiki as well as in the areas of Thessaloniki and the French Riviera, that is regions which especially during the cold season, undergo the effects of katabatic winds blowing from the continent towards the Mediterranean (Vardaris in Thessaloniki, Mistral in Southern France).*

INTRODUCTION

The Tourist - Real Estate - and Exportations S.A. (Touristiki-Ktimatiki-Exagoghiki), in cooperation with the Institute of Meteorology and Climatology of the Aristotelian University of Thessaloniki, established in 1968 the meteorological station of Neos Marmaras-Chalkidiki (φ = 40° 05′48″ N, λ = 23° 47′05″ E, elev. 1m. Fig. 1).

In the present paper are initially examined the first data of sunshine duration obtained from five years of observations (1968-1972); these data are compared first with sunshine duration data of the two principal meteor. stations in Greece, namely those of the National Observatory of Athens (N.O.A.), and the Institute of Meteorology and Climatology of the Aristotelian University of Thessaloniki (A.UT.).

These basic two met. stations lie almost on the same meridian, at a direct distance of some 300 km from each other. The met. station of Neos Marmaras stands some 95 km to the SE of Thessaloniki, on the peninsula of Sithonia, inside the gulf of Kassandra. This is a coastal

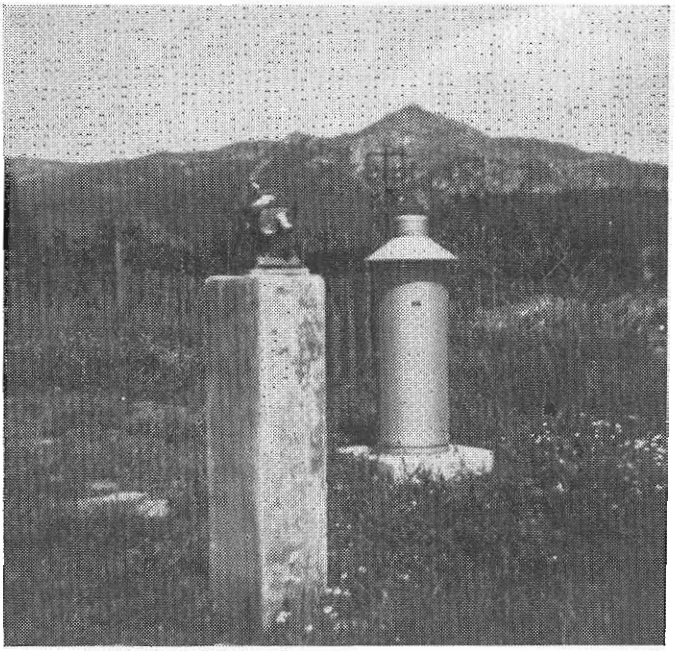
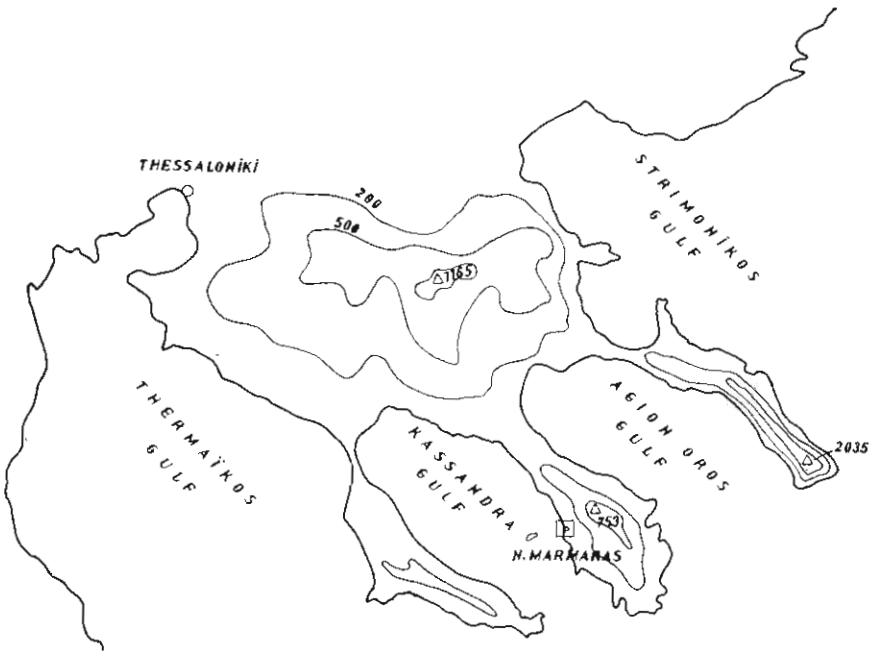


Fig. I



MAP I

station, standing upon the northern coasts of the Aegean Sea, but going far into this Sea, like the whole peninsula of Chalkidiki.

The meteorological station of Neos Marmaras may be considered a characteristic station in southern Chalkidiki, that is in the principal zone of touristic development in this part of the Balkans. It should be mentioned that, the northern coasts of the Aegean Sea have been little studied till today from the meteorological and climatological point of view. The reasons for this however, are out of the scope of the present work.

A few climatological data on Chalkidiki, especially air temperatures and precipitation, can be found in eight research papers on systematic botany and plant geography * of this area. However most of these papers regard the central mountainous area of Chalkidiki, and none mentions recorded data of sunshine duration.

SUNSHINE DURATION IN THE MET. STATION OF NEOS MARMARAS

Measurements of sunshine duration have been effected with a Campbell-Stokes sunshine-recorder (manufactured by R. Fuess-W. Berlin).

From the adjoined Map. I, one can see that sunhine duration is ifluenced by the local ground relief. As a matter of fact, we have made certain measurements and computations which proved that the hills forming the backbone of the Sithonia peninsula, rising up to 200 m elev. to the east of the met. station of Neos Marmaras, obstruct the sunrise by 9°, while the vegetation that stands to the west obstructs the sunset by 3°.

Monthly and daily mean sunshine duration values have been included in Table I.

The monthly maximum appears in July, as is the case in every meteorological station of the Greek network. On the other hand, the monthly minimum for this very short observational period (1968-72) occurs in January, instead of December, which is usually the month of minimum sunshine duration in most stations of the Greek network. We attribute this fact to the unusual weather conditions that prevailed these last years in the area of Northern Greece.

We mention for example the case of sunshine duration in Thessaloniki, which has been studied by LIVADAS[8], LIVADAS et al.[9], LIVADAS-FLOCAS[10]. Mean and extreme monthly values, resulting from these

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* GANIATSAS, K. ([1]), LAVRENTIADIS, G. ([2]), VOLIOTIS, D. ([3]), DAFIS, S. ([4]), DHROSOS, E. ([5],[6]), YANNAKOU, N. ([7]).

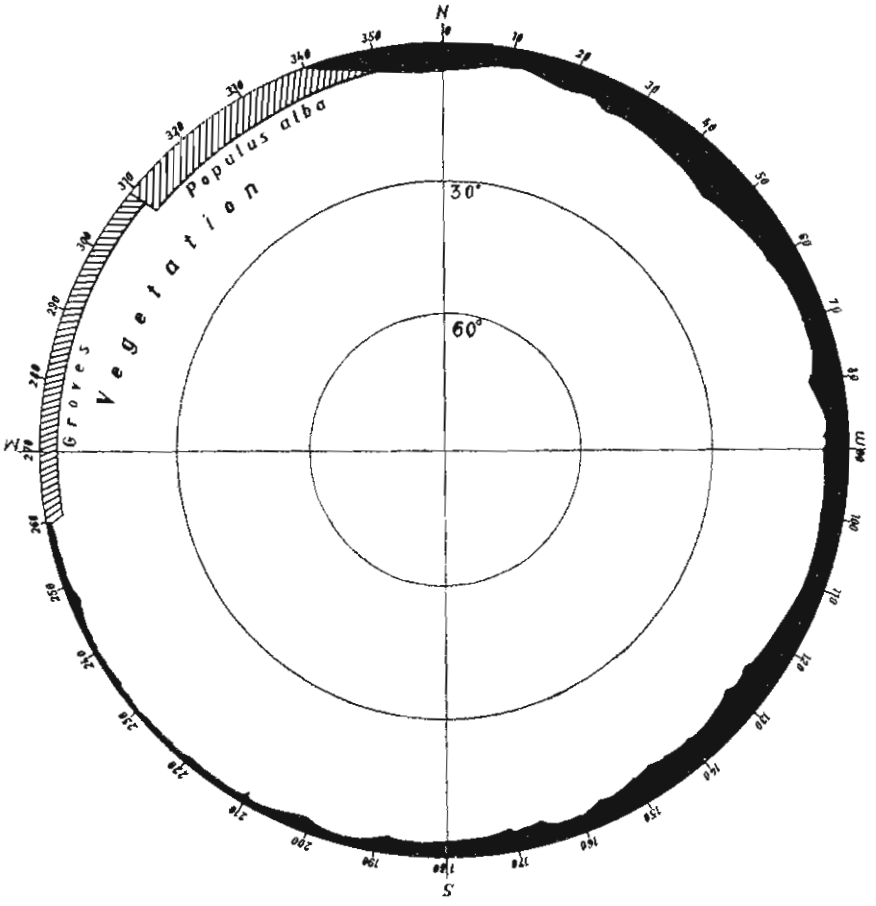


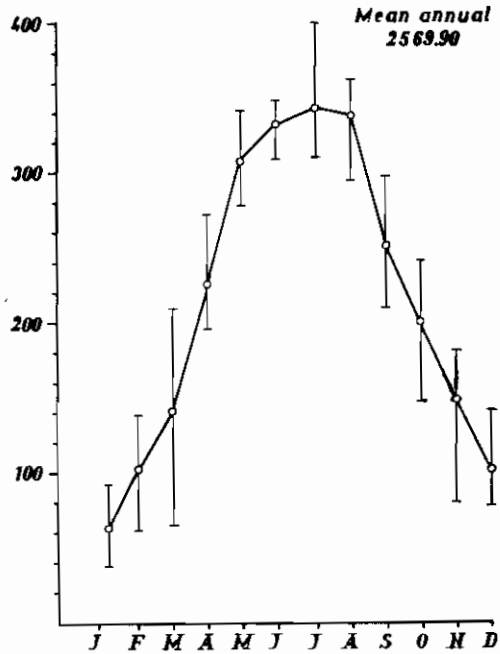
DIAGRAM I

TABLE I

Monthly mean and daily mean sunshine duration in the met. station of Neos Marmaras-Chalkidiki during the 1968-1972 period.

Month	*Monthly mean (hours)*	*Daily mean (hours per day)*
January	**63.00**	2.032
February	104.00	3.681
March	141.50	4.565
April	226.25	7.542
May	306.75	9.895
June	333.40	11.113
July	**354.60**	11.439
August	337.80	10.897
September	252.20	8.407
October	200.40	6.465
November	148.20	4.940
Deeember	101.80	3.284
Year	2.569.90	7.0217

studies, are mentioned in the first three columns of TABLE II. From this same Table II we find that, during the last five years, sunshine duration recorded as an average a decrease of 5 %. This decrease appears mainly during the three winter months: January, February,



GRAPH I

and March, but also during the July-September trimester, while on the contrary the interval between October to December has had more sunshine than average. Moreover, five absolute monthly minima have been recorded during this five-year period, while in the month of May the absolute maximum sunshine duration increased by 11 hours.

DAILY MEAN SUNSHINE DURATION

Besides the monthly mean values of sunshine duration, the study of daily mean ones is of particular interest. In the northern coasts of the Aegean Sea it is possible for one or more consecutive days with overcast sky, to be succeeded by a series of sunny days; or again one overcast day to be followed by a sunny one and then another overcast

TABLE II

Comparison between mean and extreme monthly values of sunshine duration in Thessaloniki during the 1931-1968 period and the 1968-1972 period.

Month	*Period 1931. - 1968*			*Period 1968 - 1972*			Δ *Mean* (1 - 2)
	Max.	*Mean*$_1$	*Min.*	*Max.*	*Mean*$_2$	*Min.*	
January	193.7	121.3	57.8	90	66.5	22	54.8
February	209.6	146.8	52.7	150	105.3	43	41.5
March	239.0	163.7	80.3	186	135.5	67	28.2
April	295.7	222.6	173.2	242	213.8	182	8.8
May	328.7	276.8	208.9	339	305.8	270	—29.0
June	378.1	313.8	271.7	326	307.4	274	6.4
July	393.2	363.4	322.9	340	340.4	307	23.0
August	378.0	346.5	313.2	338	323.2	298	23.3
September	294.5	252.6	184.1	267	240.6	203	12.0
October	235.0	179.5	52.4	229	194.0	139	—14.5
November	189.0	124.3	83.8	186	150.4	84	—26.1
December	162.8	109.2	41.4	162	109.8	74	— 0.6
Year		2620.5			2492.7		127.8
							4,88 %

TABLE III

Distribution of daily sunshine duration values.

Duration in hours	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Total*	
13.50-14.49	—	—	—	—	7	36	33	—	—	—	—	—	76	0.0453
12.50-13.49	—	—	—	9	26	31	48	32	1	—	—	—	147	0.0877
11.50-12.49	—	—	—	14	32	20	24	63	18	—	—	—	171	0.1020
10.50-11.49	—	—	14	23	11	19	14	18	36	10	—	—	145	0.0865
9.50-10.49	—	4	9	10	5	11	8	15	27	36	5	—	130	0.0776
8.50- 9.49	4	9	8	6	10	3	7	12	10	30	31	2	132	0.0788
7.50- 8.49	6	12	10	10	3	11	3	1	9	10	15	24	114	0.0680
6.50- 7.49	6	10	7	3	6	5	4	5	11	7	13	12	89	0.0532
5.50- 6.49	8	7	5	8	2	2	4	—	8	9	5	9	67	0.0400
4.50- 5.49	4	4	4	6	7	5	1	3	7	5	12	11	69	0.0412
3.50- 4.49	5	1	5	3	5	3	3	1	6	3	12	15	62	0.0370
2.50- 3.49	6	12	6	5	4	1	1	1	6	6	11	4	63	0.0377
1.50- 2.49	6	9	9	3	2	2	4	1	4	8	11	9	68	0.0406
0.50- 1.49	11	11	13	7	1	1	—	2	1	13	13	15	88	0.0526
0.01- 0.49	14	11	8	1	1	—	—	—	1	1	10	14	61	0.0365
0	54	23	26	12	2	—	1	1	5	17	12	40	193	0.1153
	124	113	124	120	124	150	155	155	150	155	150	155	1.675	1.0000

TABLE IV

Occurrence percentage of various sunshine duration values.

Duration in hours	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
13.50-14.49	—	—	—	—	5.65	24.00	21.29	—	—	—	—	—
12.50-13.49	—	—	—	7.50	20.97	20.67	30,97	20.64	0.67	—	—	—
11.50-12.49	—	—	—	11.66	25.80	13.33	15.48	40.64	12.00	—	—	—
10.50-11.49	—	—	11.29	19.17	8.87	12.67	9.03	11.61	24.00	6.45	—	—
9.50-10.49	—	3.54	7.26	8.33	4.03	7.33	5.16	9.67	18.00	23.23	3.33	—
8.50- 9.49	3.23	7.96	6.45	5.00	8.06	2.00	4.52	7.74	6.67	19.35	20.67	1.29
7.50- 8.49	4.84	10.62	8.06	8.33	2.42	7.33	1.93	0.64	6.00	6.45	10.00	15.48
6.50- 7.49	4.84	8.85	5.65	2.50	4.84	3.33	2.58	3.22	7.33	4.52	8.67	7.74
5.50- 6.49	6.45	6.19	4.03	6.67	1.61	1.33	2.58	—	5.33	5.81	3.33	5.81
4.50- 5.49	3.22	3.54	3.23	5.00	5.65	3.33	0.65	1.94	4.67	3.23	8.00	7.10
3.50- 4.49	4.03	0.88	4.03	2.50	4.03	2.00	1.93	0.65	4.00	1.93	8.00	9.68
2.50- 3.49	4.84	10.62	4.84	4.17	3.22	0.67	0.65	0.65	4.00	3.87	7.33	2.58
1.50- 2.49	4.84	7.96	7.26	2.50	1.61	1.33	2.58	0.65	2.67	5.16	7.33	5.80
0.50- 1.49	8.87	9.74	10.48	5.83	0.81	0.67	—	1.29	0.67	8.39	8.67	9.68
0.01- 0.49	11.29	9.74	6.45	0.84	0.81	—	—	—	0.67	0.64	6.67	9.03
0	43.55	20.36	20.97	10.00	1.61	—	0.65	0.65	3.33	10.97	8.00	25.81
	100.00	100.00	100.00	100.00	99.99	99.99	100.00	99.99	100.00	100.00	100.00	100.00

day; this alternating play lasting during almost the whole winter season. On the contrary, during the summer season a «monotonous weather» develops, with one clear day followed by another equally clear and warm one, and so on.

In TABLES III(frequencies) and IV (percentages of daily sunshine duration values) we have included 1675 days in all. Grouping these days in extremely favorable (sunshine duration $\geqq 11.50$ h/day) and extremely unfavorable ones (sunshine duration < 1.50 h/day), we have drawn the following TABLE V.

TABLE V

Percentage of days with various sunshine-durations during the April-September semester.

Daily duration (in Hours)	*A*	*M*	*J*	*J*	*A*	*S*
> 11.50	19.16%	52.42%	58.00%	67.74%	61.28%	12.67%
< 1.50	16.67%	3.23%	0.67%	0.65%	1.94%	4.67%
< 0.49	10.84%	2.42%	—	0.65%	0.65%	4.00%
= 0	10.00%	1.61%	—	0.65%	0.65%	3.33%

In this Table we observe that during the warm season from April to September, the «extremely sunny» days hold 12.67-67.74% of the days of each month, while during the main two summer months, July and August, the percentage is 67.7% and 61.3 % respectively. On the other hand, the percentage of extremely unfavorable (sunless) days is <5.0 % from May to September, and only in April does it rise to 16.7 % while overcast days hold 10.0 % of this month. This fact agrees with the view that April is a transitive month between the cold and the warm season.

DURATION OF GROUPS OF SUNLESS DAYS

The problem of whether sunless days occur at random, alternating with sunny ones, or if they appear as groups of consecutive sunless days, is of paramount importance, from the meteorological point of view as well as from that of touristic exploitation and technological applications (utilization of sunpower).

We give herewith TABLE VI, in which we have included data of sunless days, as a climatological feature of this area.

Figures of this Table prove once more the following conclusions:
(a) The warm season from May to September has practically no sunless days.
(b) January and December (in that order) are the months with the largest number of sunless (overcast) days.
(c) It is proved once more that March has more sunless days than February (LIVADAS and FLOCAS[10] have also come to similar conclusions).

TABLE VI

Mean monthly occurences of sunless days in N. Marmaras.
(1968-1972)

January	13.50
February	5.75
March	6.50
April	3.00
May	0.50
June	0
July	0.20
August	0.20
September	1.00
October	3.40
November	2.40
December	8.00
Year	44.45 Days

(The precedence of October over November, in sunless days, should rather be attributed to the short number of observational years).

In TABLES VII and VIII we have included groups of consecutive sunless days (sunshine duration = 0, Table VII) and groups of consecutive «practically sunless» days (sunshine duration $\geqq$ 0.49 hours/day).

In TABLE VII the 193 sunless days of the period, are examined as to the duration of each group of consecutive sunless days; this examination leads to the following conclusions.
(a) Sunless days in a percentage of 62.2 % appear in Neos Marmaras as groups of consecutive days.
(b) Sunless days appear in groups during the whole cold season from October to April.
(c) Almost 7/10 of these groups of sunless days consist of two consecutive days (28 cases out of 41).

TABLE VII

Distribution of groups of consecutive sunless days in N. Marmaras-Halkidiki.

	2	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Total of groups* Σ_1	*Total of groups* Σ_2	Σ_1/Σ_2 %
J	10	2	—	—	1	—	—	—	1	42	54	77.7
F	4	—	—	1	—	—	—	—	—	13	23	56.5
M	4	—	1	—	1	—	—	—	—	18	26	69.2
A	1	—	—	1	—	—	—	—	—	7	12	58.3
M	—	—	—	—	—	—	—	—	—	—	2	—
J	—	—	—	—	—	—	—	—	—	—	—	—
J	—	—	—	—	—	—	—	—	—	—	1	—
A	—	—	—	—	—	—	—	—	—	—	1	—
S	1	—	—	—	—	—	—	—	—	2	5	40.0
O	4	1	—	—	—	—	—	—	—	11	17	64.7
N	2	—	—	—	—	—	—	—	—	4	12	33.3
D	2	1	1	—	2	—	—	—	—	23	40	57.5
Total of cases	28	4	2	2	4	—	—	—	1		193	
Total of days	56	12	8	10	24	—	—	—	10	120		

(d) The longest interval of sunless days belongs in the month of January, with a case of ten (10) consecutive days.

Besides the really sunless days, we consider as actually or practically sunless days those with daily sunhine duration of less than 0.50 hours; since the incoming solar radiation (insolation) in a day when the sun shone for only 30′ or even less, is so insignificant as to be practically useless for any application; especially from the touristic point of view this cannot be considered as a favorable day.

In TABLE VIII we have included every group of consecutive «practically» sunless days, for the period examined. These fifty five (55) groups include 175 out of the total of 254 practically sunless days that have been recorded during the 1968-1972 period.

An examination of these groups, leads to the following conclusions.
(a) Days characterized as «practically sunless», appear, at a precentage of 68.9 % in groups of consecutive days.
(b) Sunless days appear in groups during the whole cold season (October-March+April).
(c) A 60 % of these groups of sunless days, consist of two consecutive days (33 cases out of a total 55).
(d) The longest interval of practically sunless days, belongs again in January, with a case of fourteen (14) consecutive days.

DIURNAL VARIATION OF SUNSHINE - HOURLY VALUES

The daylight period continuously changes, and accordingly also changes the theoretical duration of sunshine from day to day, from month to month during the year. In the adjoined TABLE IX we observe that the length of actual daylight, as it is shown from the recorded sunshine duration, changes; thus it has its minimum during the two winter months of December and January, while the preceding autumnal months of October (and November) and the still wintry month of March have all daily sunshine duration of 12 hours (06:00-18:00 h). The actual daily sunshine duration is 15 hours from April till August.

The longest values of mean hourly sunshine appear around midday, although one cannot really speak about a diurnal variation of sunshine, since the mean hourly value rises sharply after sunrise and from then on remains steady, or with very slight variation during the whole day till sunset. Thus, between 09:00 and 16:00 hours the whole year through, «interhourly» variations are $\leqq 0.10$ h, that is almost invariable: This can be called a «sunshine duration plateau».

TABLE VIII

Distribution of groaps of «practically or actually» sunless consecutive days in N. Marmaras - Halkidiki.

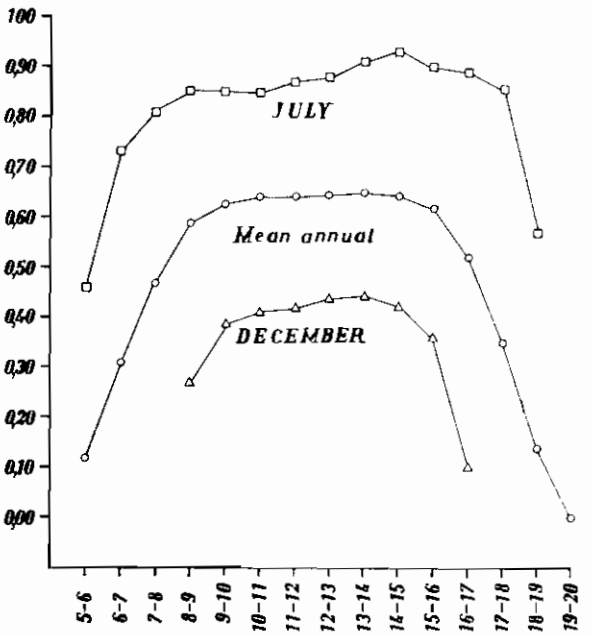
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Totol of groaps Σ_1	Total of groups Σ_2	Σ_1/Σ_2 %
J	6	2	2	1	1	—	1	—	—	—	—	—	1	—	59	68	86.7
F	7	1	—	1	—	—	—	—	—	—	—	—	—	—	22	34	64.7
M	7	1	1	—	1	—	—	—	—	—	—	—	—	—	27	34	79.4
A	1	—	—	1	—	—	—	—	—	—	—	—	—	—	7	13	53.8
M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—
J	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
S	1	—	—	—	—	—	—	—	—	—	—	—	—	—	2	6	33.3
O	3	2	—	—	—	—	—	—	—	—	—	—	—	—	12	18	66.6
N	2	1	—	—	—	—	—	—	—	—	—	—	—	—	7	22	31.8
D	6	2	—	—	2	—	—	1	—	—	—	—	—	—	39	54	72.2
Total of cases	33	9	3	3	4	—	1	1	—	—	—	—	1	—			
Total of days	66	27	12	15	24	—	8	9	—	—	—	—	14	—	175	254	

TABLE IX

Mean hourly values of sunshine duration, per hour and per month, in N. Marmaras - Halkidiki (in hours).

	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*	*19-20*	*Observed*
J	—	—	0.02	0.17	0.23	0.27	0.27	0.28	0.28	0.22	0.18	0.08	—	—	—	2.00
F	—	—	0.19	0.37	0.42	0.42	0.44	0.43	0.40	0.40	0.34	0.21	0.01	—	—	3.63
M	—	0.09	0.33	0.40	0.43	0.46	0.43	0.46	0.49	0.47	0.47	0.37	0.10	—	—	4.50
A	0.03	0.43	0.62	0.67	0.70	0.70	0.68	0.67	0.65	0.63	0.64	0.56	0.43	0.06	—	7.47
M	0.24	0.60	0.71	0.72	0.76	0.81	0.81	0.83	0.83	0.82	0.83	0.79	0.70	0.35	—	9.80
J	0.55	0.73	0.81	0.84	0.87	0.87	0.87	0.84	0.85	0.86	0.83	0.83	0.76	0.54	0.00	11.05
J	0.46	0.73	0.81	0.85	0.85	0.85	0.87	0.88	0.91	0.93	0.90	0.89	0.86	0.57	—	11.36
A	0.12	0.78	0.87	0.90	0.88	0.87	0.89	0.89	0.90	0.89	0.92	0.90	0.84	0.20	—	10.85
S	—	0.30	0.66	0.73	0.78	0.79	0.78	0.75	0.79	0.82	0.80	0.72	0.40	0.00	—	8.32
O	—	0.04	0.47	0.63	0.66	0.66	0.68	0.67	0.68	0.69	0.65	0.53	0.06	—	—	6.42
N	—	—	0.14	0.50	0.53	0.54	0.58	0.61	0.59	0.59	0.54	0.28	—	—	—	4.90
D	—	—	—	0.27	0.39	0.41	0.42	0.44	0.44	0.42	0.36	0.10	—	—	—	3.25
Year	0.116	0.308	0.469	0.587	0.625	0.637	0.643	0.645	0.650	0.615	0.621	0.521	0.346	0.143	0.00	6.962

A study of Group II leads to similar conclusions.



GRAPH II

Sunshine duration in a certain location, besides its climatological interest, consists an item for comparing this location with other locations of the same geographical region.

We compare first sunshine duration data of Neos Marmaras with data of the two principal weather stations of the Greek area. These stations are:

1. The Institute of Meteorology of the National Observatory of Athens (N.O.A.) (φ: 37° 58′ N, $\lambda = 23°$ 43′ E, elev. 107 m).
2. The Institute of Meteorology and Climatology of the Aristotelian University of Thessaloniki (A.U.T.) ($\varphi = 40°$ 37′ N, $\lambda = 22°$ 57′ E, elev. 49m).

These three stations form, in the area of the Aegean Sea, a triangle whose dimensions are given in the Introduction of this paper.

From Table X we see that sunshine duration in the area of Athens is longer than that of Northern Greece, exceeding that of Thessaloniki by 374,6 hours per year, and that of Neos Marmaras by 297.3 hours per year. Nevertheless, if we compare the two stations of the northern coast of the Aegean, we observe that the southernmost has 77.3 hours per year more than that of Thessaloniki. However the difference is

TABLE X*

Duration of sunshine in three met. st. of the Greek Aegean area.

	N.O.A.	*A.U.T.*	*N. Marmaras*	Δ_{1-2}	Δ_{1-3}	Δ_{2-3}
J	101.8	66.5	63.0	+35.3	+38.8	+ 3.5
F	147.5	105.3	104.0	+42.2	+43.5	+ 1.3
M	179.3	135.5	141.5	+43.8	+37.8	— 6.0
A	238.5	213.8	226.3	+24.7	+12.2	—12.5
M	329.8	305.8	306.8	+24.0	+23.0	— 1.0
J	337.4	307.4	333.4	+30.0	+ 4.0	—26.0
J	370.8	340.4	354.6	+30.4	+16.2	—14.2
A	363.0	323.2	337.8	+39.8	+25.2	—14.6
S	261.6	240.6	252.2	+21.0	+ 9.4	—11.6
O	223.0	194.0	200.4	+29.0	+22.6	— 6.4
N	186.4	150.4	148.2	+36.0	+38.2	+ 2.2
D	128.2	109.8	101.8	+18.4	+26.4	+ 8.0
Year	2867.3	2492.7	2570.0	+374.6	+297.3	—77.3

* Data of sunshine duration have been taken from the following publications:
a) For the met. station of N.O.A. from the «Climatological Bulletin» of the National Observatory of Athens.
b) For the met. station of AUT from the «Annuaire de l' Institut Météorologique et Climatologique-Observations Météorologique de Thessaloniki».

not negative throughout the year: it becomes positive during the main winter quarter, from November to February, when Thessaloniki has longer sunshine duration (by 15.0 hours). On the contrary, during the rest of the year, from March to October sunshine duration is longer in Neos Marmaras, exceeding that of Thessaloniki by 92.3 hours.

On the other hand, if we consider the monthly differences between sunshine duration in Athens and Thessaloniki, we observe a marked superiority in the values of Athens, except December, the difference being

$\Delta > 20.0$ hours per month during every month. The differences between sunshine duration in Athens and Neos Marmaras are $\leqq 25.0$ hours per month from April to October (included). This means that the southern part of Chalkidiki during the summer - touristic season has high sunshine duration values, which can be favorably compared with those of southern Greece; we could not say the same thing about Thessaloniki, where during the main warm trimester, from June to August, sunshine duration values are shorter, by $1^h.0$ per day or $\geqq 30.0$ hours per month, than those of Athens.

The marked superiority of sunshine duration values in Thessaloniki over those of Neos Marmaras during the cold season (November - February) is due to the fact that in the area of Thessaloniki (Axios river valley - Thermaikos Gulf) blows during the cold season the local wind *Vardaris* (Βαρδάρης) having all the characteristic features of cold katabatic winds of the northern coasts of the Mediterranean, cloud dispersion being one of these features. The Vardaris wind has no effect whatsoever in the Gulf of Kassandra and especially the Sithonia peninsula and the district of Neos Marmaras.

An effort has been made to compare sunsine duration values of Neos Marmaras with those of another region on the northern coasts of the Mediterranean, which should have topographic similarities corresponding to the north - western Aegean coasts. The area of the French Riviera and Corsica is such an area.

From TABLE XI we come to the following notable conclusions:

—The meteorological station of Neos Marmaras has shorter annual values of sunshine duration than all the french stations examined, differing by 24.8 - 276.5 hours per year.

—While this difference exists for the mean annual sunshine duration, during 4 - 6 months of the summer season (April - September) sunshine duration is longer in Neos Marmaras.

Thus, we observe that, with the exception of Toulon, which during the summer semester has 10.8 hours more sunshine duration than Neos Marmaras, all the remaining stations have shorter durations, the difference being 181.8 hours minus in Nice.

On the contrary, during the winter season, the french coast surpasses the northwestern coast of the Aegean by >200 hours (see: second column of Table XII). Even the corsican stations have >160 hours more sunshine duration than N. Marmaras.

TABLE XI*

Sunshine duration in Neos Marmaras and in five met. stations of the Mediterranean coosts of Franee (1968-1972).

	1	*2*	*3*	*4*	*5*	*6*					
	Marmaras	*Toulon*	*S. Raphael*	*Nice*	*Bastia*	*Ajaccio*	Δ_{1-2}	Δ_{1-3}	Δ_{1-4}	Δ_{1-5}	Δ_{1-6}
J	63.0	137.0	134.0	133.0	124.3	114.0	—74.0	—71.0	—70.0	—61.3	—51.0
F	104.0	169.5	160.3	158.8	146.0	136.8	—65.5	—56.3	—54.8	—42.0	—32.8
M	141.5	190.3	180.5	175.0	159.8	160.8	—48.8	—39.0	—33.5	—18.3	—19.3
A	226.3	243.3	236.5	220.5	210.8	218.3	—17.0	—10.2	+ 5.8	+15.5	+ 8.0
M	306.8	302.0	275.3	257.0	265.5	227.5	+ 4.8	+31.5	+49.8	+41.3	+79.3
J	333.4	316.0	299.8	269.0	289.6	318.8	+17.4	+33.6	+64.4	+43.8	+14.6
J	354.6	383.8	366.6	349.4	356.0	365.2	—29.2	—12.0	+ 5.2	— 1.4	—10.6
A	337.8	327.0	312.6	300.8	297.8	328.0	+10.8	+25.2	+37.0	+40.0	+ 9.8
S	252.2	249.8	241.8	232.6	231.2	265.4	+ 2.4	+10.4	+19.6	+21.0	—13.2
O	200.4	219.6	211.0	211.6	232.6	238.2	—19.2	—10.6	—11.2	—32.2	—37.8
N	148.2	164 4	162 0	162 4	158 4	148 6	—16 2	—13 8	—14 2	—10 2	— 0 4
D	101 8	143 8	143 8	151 2	122.8	124.8	—42.0	—42.0	—49.4	—21.0	—23.0
Year	2570.0	2846.5	2724.2	2621.3	2594.8	2646.4	—276.5	—154.2	—51.3	—24.8	—76.4

* Data of sunshine duration have been taken from the «Résumé Mensuel du Temps en France» (Bulletin Décadaire) of the Météorologie Nationale.

Conclusions

From the study of sunshine duration in the meteorological station of Neos Marmaras - Chalkidiki, we have drawn the following conclusions:

(a) First we should note that the period examined between the years 1968 - 1972, has been one of the worst in the area of Northern Greece, from the view-point of weather conditions. This is made clear if we examine sunshine duration in Thessaloniki of the 1931 - 1968 and 1968 - 1972 periods from Tahle 11.

(b) As we advance from the north southwards, mean annual sunshine duration values increase systematically, i.e.

Thessaloniki	(: 40°37′ N)	2492.7	hours per year
Neos Marmaras	(: 40°05′ N)	2570.0	» » »
Athens	(: 37°58′ N)	2867.3	» » »

(c) The met. station of Athens (N.O.A.) surpasses the two stations on the northwestern coast of the Aegean Sea, not only as to the mean annual sunshine duration, but also as to every monthly mean value (Table X).

(d) During the main winter season, from November to February, the met. station of Thessaloniki (A.U.T.) has longer sunshine duration than Neos Marmaras. This is due to the fact that the area of Neos Marmaras is not affected by the katabatic wind *Vardaris*, which blows more frequently during the cold season.

TABLE XII

	Summer semester (April - September)	*Winter semester (October - March)*
Toulon	— 10.8 hours	—265.7 hours
S. Raphael	+ 78.5 »	—232.7 »
Nice	+181.8 »	—233.1 »
Bastia	+160.2 »	—185.0 »
Ajaccio	+ 87.9 »	—164.3 »

(e) Comparing sunshine duration values in Neos Marmaras with those of the French Riviera, we observe that, while these last stations have higher mean annual values, during the warm season, that is the main touristic season, Neos Marmaras surpasses the french stations, the difference between its summer values and those of the French Riviera becoming as high as 181.8 hours (N. Marmaras - Nice/Table XII).

(f) During the cold season, from October to March, the french sta-

tions examined exceed by far the sunshine duration of the northwestern coasts of the Aegean Sea (Thessaloniki - N. Marmaras). The same however, does not apply for the NOA station, standing south of the 39° N parallel: sunshine duration values (Table XIII) of this station are higher

TABLE XIII

Sunshine duration in Athens (N.O.A.) and met. stations of the French Riviera (1968-1972).

Month	N.O.A.	Toulon	St. Raphael	Nice
J	101.8	137.0	134.0	133.0
F	147.5	169.5	160.3	158.8
M	179.3	190.3	180.5	175.0
A	238.5	243.3	236.5	220.5
M	329.8	302.2	275.3	257.0
J	337.4	316.0	299.8	269.0
J	370.8	383.8	366.6	349.4
A	363.0	327.0	312.6	300.8
S	261.6	249.8	241.8	232.6
O	223.0	219.6	211.0	211.6
N	186.4	164.4	162.0	162.4
D	128.2	143.8	143.8	151.2
Year	2867.3	2846.5	2724.2	2621.3

than those of Corsica, even during the cold season. The only stations that have higher values than Athens, especially during the cold season (December - February), being the classical «Riviera» stations, that is Toulon, St. Raphael, and Nice.

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ΔΙΑΡΚΕΙΑ ΗΛΙΟΦΑΝΕΙΑΣ ΕΙΣ ΤΟΝ ΝΕΟΝ ΜΑΡΜΑΡΑΝ ΧΑΛΚΙΔΙΚΗΣ

Ὑπὸ

ΓΕΩΡΓΙΟΥ Κ. ΛΙΒΑΔΑ καὶ ΠΕΤΡΟΥ ΠΕΝΝΑ

ΠΕΡΙΛΗΨΙΣ

Μελετᾶται ἡ διάρκεια τῆς ἡλιοφανείας, διὰ τὸ χρονικὸν διάστημα 1968-1972, εἰς τὸν μετεωρολογικὸν σταθμὸν Νέου Μαρμαρᾶ Χαλκιδικῆς, ($\varphi = 40^0\ 05'\ 48''$ N, $\lambda = 23^0\ 47'\ 05''$ E, ὑψομ. 1 μ.). Ἐπίσης γίνεται σύγκρισις τῶν τιμῶν τῆς διαρκείας τῆς ἡλιοφανείας τοῦ ὡς ἄνω μετεωρολογικοῦ σταθμοῦ, μὲ τὰς τιμὰς τῶν μετ. σταθμῶν τοῦ Ἐθνικοῦ Ἀστεροσκοπείου Ἀθηνῶν καὶ τοῦ Ἐργαστηρίου Μετεωρολογίας - Κλιματολογίας τοῦ Ἀριστοτελείου Πανεπιστημίου Θεσσαλονίκης, καὶ ἐξάγονται ὡρισμένα συμπεράσματα. Περαιτέρω, αἱ τιμαὶ τῆς διαρκείας τῆς ἡλιοφανείας συγκρίνονται μὲ τὰς τιμὰς τῆς ἀντιστοίχου περιόδου, τῆς Γαλλικῆς Ριβιέρας. Ἐξάγονται συμπεράσματα, ἀφορῶντα εἰς τὴν γενικὴν καιρικὴν κατάστασιν, τὴν ἐπικρατήσασαν τόσον εἰς τὴν Νότιον Χαλκιδικήν, ὅσον καὶ εἰς τὰς περιοχὰς Θεσσαλονίκης καὶ Γαλλικῆς Ριβιέρας, ἤτοι εἰς περιοχὰς δεχομένας κατὰ τὴν διάρκειαν τῆς ψυχρᾶς κυρίως περιόδου, ἀνέμους καταβατικοὺς ἐκ τῆς χέρσου πρὸς τὴν Μεσόγειον (Βαρδάρης εἰς Θεσσαλονίκην, Μιστρὰλ εἰς Νοτ. Γαλλίαν).