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EVAPORATION AND WEATHER TYPES

by

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Abstract: *Daily mean evaporation values in Thessaloniki, according to readings of Wild's evaporation balance and Piché evaporimeter, are examined for the periods between years 1931 - 1939 and 1951 - 1970, in connection with weather types prevailing in the area of Greece. Winter and summer season are examined separately, and daily mean evaporation values per weather type and for both types of evaporimeter are given for each season: from these we draw the conclusion that W.T. XI produces the highest amounts of evaporation in all seasons, while the smallest values result from W.T. III in winter and from W.T. VI in summer.*

We examine also the relation between readings of the two evaporimeters with weather types I and XI, and find that: the P/W ratio with W.T. I is $< 1,5$ in the summer and especially the June - July - August quarter; the P/W ratio with W.T. XI is $< 1,5$ for almost every month of the year, while during the above mentioned quarter it has its smallest values. We attribute this, mainly to the increase of dust in the atmosphere and the dry winds of high velocity, prevailing in the area of Greece.

INTRODUCTION

In this paper we examine data of evaporation in the area of Thessaloniki, obtained by to kinds of evaporimeters: Wild and Piché, in connection with the weather types prevailing in the area of Greece.

Data of evaporation measurements in Thessaloniki have been published in the past by: ALEXANDROU [1], who examined data of the years 1930 - 1932; KYRIAZOPOULOS [4] who examined a longer period (1930 - 1937); and LIVADAS - MACHAIRAS [8] who studied data of evaporation in the city of Thessaloniki for the period between years 1930 - 1940 and 1946 - 1970.

This last work has been based upon readings of both Wild evaporation balance and Piché evaporimeter: Annual mean, as well as monthly mean and extreme, and daily mean and extreme values have been tabulated. A correlation between readings of these two types of evaporimeters, indicates higher figures in the readings of Piché than those of Wild, the ratio of mean annual values being $W/P = 0.679$. Also a considerable variation of evaporation values from day to day has been observed, whenever there is a change in the prevailing weather conditions. This fact led to the question of a more thorough investigation of the problem of the rate of evaporation in connection with the weather type prevailing at the time in the area of Greece.

As it is known, all wether conditions that prevail in the area of Greece have been classified in 13 Weather Types (LIVADAS [6]). With this classification in mind, we have divided the daily sums of evaporation values in 13 groups, corresponding to the 13 weather types. Each group includes evaporation values that have been recorded with the same weather type.

Data of evaporation have been taken from the records of the Institute of Meteorology and Climatology of the Aristotelian University of Thessaloniki; the largest part of these data has already been published in the series «Observations Météorologiques de Thessaloniki» (MARIOLOPOULOS [9], KYRIAZOPOULOS [5], LIVADAS [7]).

The operational period of the two types of evaporimeters is different: we have found that the Wild evaporation balance has been functioning from 1.1.1930 till 31.10.1940, and from 10.4.1945 till to day, while the Piché evaporimeter has functioned from 18.3.1930 till 31.10. 1940 and from 13.10.1950 till today.

Weather types, as already mentioned, are based upon the classification of LIVADAS [6]. This classification corresponds fully to the 1930 - 1939 and 1951 - 1970 periods.

Finally, in this paper we examine evaporation data from both types of evaporimeters, in connection with the prevailing weather types (W.T.) from 1.1.1931 till 31.12.1939 (9 full calendar years), and from 1.1.1951 till 31.12.1970 (20 years), that is for 29 full calendar years in all.

EVAPORATION AND WEATHER TYPES

We examine herein daily mean evaporation values in connection with the weather types prevailing in the area of Greece, that is the five

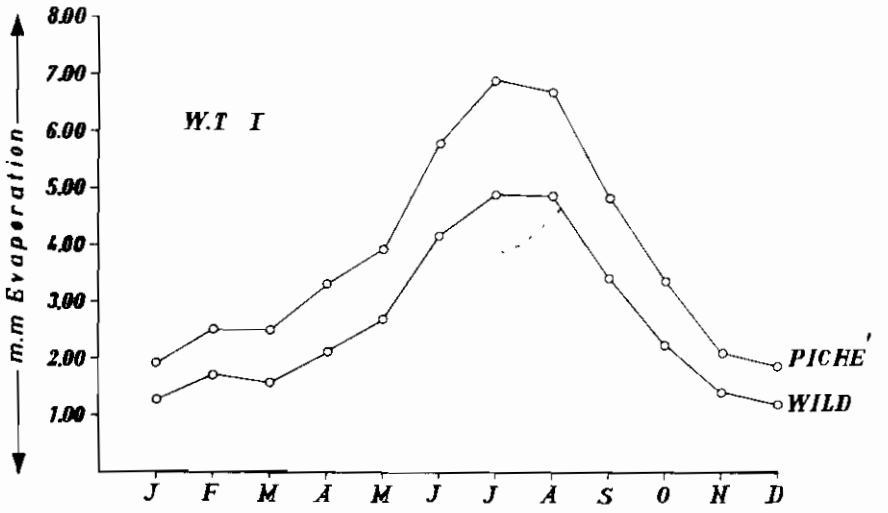
W.T. of high pressure (anticyclonic) systems (W.T.I., II, III, IV, V), the three weather types of low pressure (Cyclonic) systems (VI, VII, VIII), and the fice weather types consisting of two or more systems combined (W.T.IX, Xa, Xb, XI, XII).

Weather Type I.

In this weather condition, a high ridge extending over the Balkans and the area of Greece, favors the transport of cold and dry air masses over the area examined. Thus, during the warm season, this pressure pattern results in the etesian winds of the greek area.

Such weather conditions produce, as a rule, medium to high daily evaporation values, the whole year round.

Table I contains daily mean evaporation values of every weather type, from readings of hoth evaporimeters, and also their corresponding standard deviation (S.D.).



GRAPH I

An examination of the above Tahle and graph I, shows that the daily mean evaporation with W.T.I, has its minimum in December (Wild: 1,27 mm, Piché: 1.90 mm), and its maximum in July (Wild: 4.92 mm, Piché: 6.92 mm). We also find that, while the readings of Piché evaporimeter are the same for February and March, those of Wild's evaporation balance are slightly higher in February than in March.

TABLE I *a) Mean evaporation values per Weather Type and per month from*

		I		*II*		*III*		*IV*		*V*		*VI*	
		W	*P*	*W*	*P*	*W*	*P*	*W*	*P*	*W*	*P*	*W*	*P*
J	Mean	1.27	1.90	1.15	1.77	0.48	0.89	1.22	1.89	1.87	2.70	0.81	1.27
	σ	0.85	1.19	0.84	1.05	0.32	0.55	0.92	1.20	0.74	0.78	0.66	0.92
F	Mean	1.73	2.49	1.59	2.40	0.74	1.38	1.70	2.64	2.58	3.08	1.19	1.93
	σ	1.12	1.41	1.04	1.27	0.45	0.68	0.93	1.29	1.28	1.59	0.91	1.40
M	Mean	1.56	2.50	1.75	2.69	1.19	1.84	1.92	2.94	2.09	3.20	1.22	1.92
	σ	1.00	1.34	1.03	1.27	0.54	0.77	0.93	1.22	1.28	1.46	0.87	1.26
A	Mean	2.12	3.30	2.19	3.29	1.66	2.48	2.48	3.75	3.10	4.51	1.70	2.62
	σ	1.07	1.46	0.89	1.07	1.15	1.55	1.04	1.39	1.37	1.66	0.87	1.23
M	Mean	2.69	3.89	2.92	4.27	2.21	3.51	2.74	4.15	3.30	4.79	2.12	3.07
	σ	1.07	1.33	0.98	1.21	0.66	1.02	1.05	1.26	1.52	1.77	0.94	1.16
J	Mean	4.19	5.80	3.88	5.47	3.23	4.18	3.98	5.70	3.87	5.36	2.45	3.66
	σ	1.84	2.09	1.46	1.68	0.77	0.79	1.51	1.78	1.44	1.66	0.94	1.00
J	Mean	4.92	6.92	4.38	6.37	3.30	5.70	4.99	7.03	4.42	6.36	3.68	5.41
	σ	1.80	2.14	1.39	1.89	0.93	0.61	1.51	1.68	1.04	1.42	1.34	1.49
A	Mean	4.86	6.73	4.65	6.60	4.02	5.85	4.55	6.16	4.20	5.99	3.07	4.64
	σ	1.87	2.15	1.74	2.01	1.19	1.15	1.89	2.16	2.19	2.09	1.10	1.28
S	Mean	3.39	4.85	3.26	4.84	3.85	5.09	3.28	4.24	4.00	5.06	2.19	3.30
	σ	1.49	1.83	1.28	1.70	1.41	1.08	1.31	1.36	1.88	2.11	1.03	1.30
O	Mean	2.24	3.37	2.01	3.04	1.35	2.01	1.82	2.77	2.23	3.09	1.74	2.54
	σ	1.08	1.43	0.94	1.26	0.68	0.97	0.98	1.20	0.92	1.08	1.11	1.39
N	Mean	1.41	2.12	1.32	2.08	0.85	1.41	1.19	1.81	1.78	2.59	1.19	1.76
	σ	1.05	1.30	0.81	1.16	0.41	0.66	0.76	1.34	1.28	1.37	0.91	1.30
D	Mean	1.21	1.88	1.03	1.68	0.70	1.21	1.24	1.88	1.40	1.90	0.98	1.47
	σ	0.80	1.05	0.68	0.95	0.52	0.85	0.79	1.20	0.43	0.50	0.64	1.05

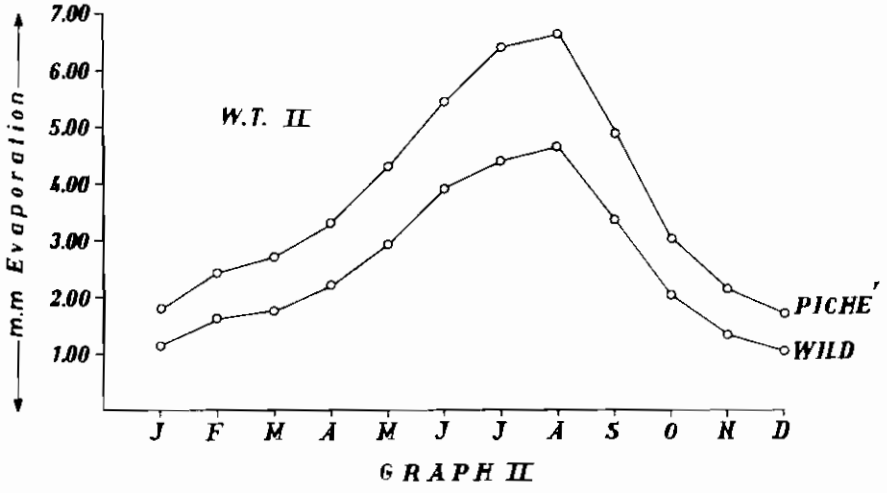
Wild and Piché evaporimeters. b) Standard deviation (σ) values for both evaporimeters.

VII		*VIII*		*IX*		*Xa*		*Xb*		*XI*		*XII*	
W	*P*	*W*	*P*	*W*	*P*	*W*	*P*	*W*	*P*	*W*	*P*	*W*	*P*
1.01	1.53	1.04	1.63	0.92	1.42	0.52	1.04	1.29	1.71	1.76	2.60	0.58	0.89
0.71	0.93	0.91	1.20	0.65	0.84	0.38	0.92	0.88	0.95	1.04	1.38	0.42	0.64
1.36	2.05	1.55	2.50	1.15	1.79	1.11	2.07	1.50	2.08	2.75	3.93	0.90	1.48
0.84	1.13	0.89	1.12	0.85	1.09	0.74	1.26	0.71	0.89	1.22	1.70	0.78	0.96
1.53	2.39	1.84	2.94	1.68	2.49	1.73	2.67	1.69	2.46	2.98	4.22	1.38	2.13
1.03	1.46	0.92	1.33	0.86	1.04	0.60	0.89	1.02	1.60	1.85	2.27	0.85	1.29
2.20	3.23	2.76	4.09	2.09	3.28	2.20	3.52	1.81	2.99	3.31	4.91	1.71	2.57
1.17	1.45	1.15	1.69	1.01	1.32	0.95	1.48	0.90	1.46	1.50	1.92	0.86	0.96
2.42	3.44	3.06	4.40	2.92	4.06	3.10	4.46	2.54	3.60	3.89	5.49	2.31	3.38
1.29	1.66	1.26	1.56	1.21	1.41	0.71	0.87	1.46	1.83	1.51	1.78	0.77	1.07
3.20	4.38	4.07	5.42	3.64	5.07	4.25	5.05	3.63	4.93	5.58	7.29	3.53	4.40
1.42	1.80	1.76	1.88	1.38	1.48	2.44	2.28	2.38	2.89	1.75	2.25	1.88	1.17
4.53	6.54	4.79	6.91	4.17	5.91	3.80	4.00	4.64	6.84	5.99	8.05	0	0
1.82	1.95	1.63	2.41	1.27	1.40	0	0	1.92	2.71	2.15	2.10	0	0
4.47	6.20	4.53	6.48	4.09	5.86	0	0	4.80	6.70	6.29	8.29	3.65	5.95
2.45	2.76	1.93	2.20	1.26	1.41	0	0	2.04	2.32	2.25	2.20	0.96	1.49
3.20	4.28	3.51	4.78	2.79	4.11	3.75	5.80	3.81	5.37	4.58	6.16	2.65	3.62
1.59	1.96	1.47	2.15	1.01	1.19	1.18	1.40	2.01	2.52	2.29	2.35	0.98	1.18
1.89	2.66	2.15	3.18	1.69	2.69	3.38	4.90	2.02	2.91	3.42	4.91	1.54	2.35
1.20	1.53	1.20	1.49	0.90	1.17	0.99	1.19	1.26	1.70	1.01	1.45	1.01	1.26
1.44	1.99	1.57	2.20	1.04	1.60	1.27	1.83	1.81	2.68	2.52	3.80	0.98	1.50
1.04	1.32	1.42	1.67	0.66	0.73	0.79	1.12	0.96	1.46	1.13	1.48	0.89	1.04
1.10	1.67	1.37	2.08	0.78	1.29	0.83	1.42	1.41	1.89	2.16	3.18	0.87	1.22
0.78	1.15	1.25	1.65	0.62	0.74	0.59	1.09	0.81	1.06	0.68	0.97	0.93	1.03

Weather Type II.

With this weather type, the high pressure center lies at latitudes < 45 N, usually over the northern part of Greece. The weather in the center of the anticyclone is generally calm and clear. As a rule, such weather conditions produce, the whole year round, medium and always steady daily evaporation values.

An examination of Table I and Graph II for W.T.II, indicates that the daily mean evaporation has its minimum value in December (Wild: 1.03 mm, Piché: 1.68 mm) and its maximum in August (Wild: 4.65 mm, Piché: 6.60 mm), while in both evaporimeters the readings of July differ only slightly from those of August.



GRAPH II

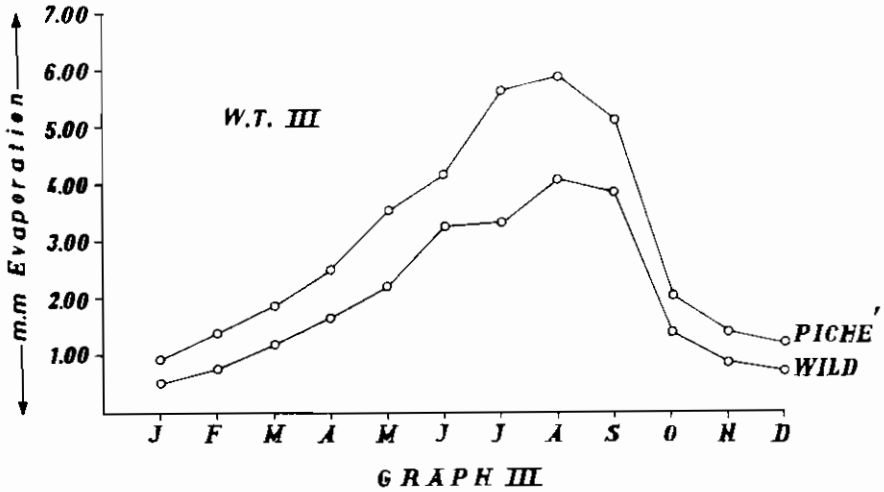
Weather Type III.

With this pressure system the air masses that are transported from the Aegean Sea over the area examined, are comparatively more humid and warmer, because of their maritime origin. Such conditions do not favor the rate of evaporation and result in very small evaporation values during the whole year, and especially so in winter.

An examination of Table I and Graph III for W.T.III shows that the daily mean evaporation has its minimum value in January (Wild: 0.48 mm, Piché: 0.89 mm), and its maximum in August (Wild: 4.02 mm, Piché: 5.85 mm), according to the readings of both evaporimeters.

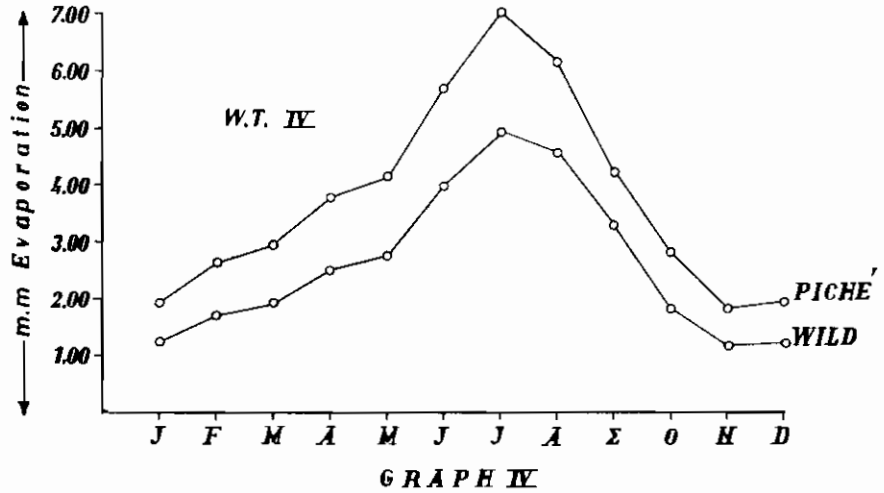
As a matter of fact, the daily evaporation values resulting from W.T.III can be characterized as the smallest of the cold season (Octo-

ber to April) in both evaporimeters. Whenever W.T.III prevails in the greek area, it results in an abrupt decrease of daily evaporation values, especially in winter.



GRAPH III

Weather Type IV.



GRAPH IV

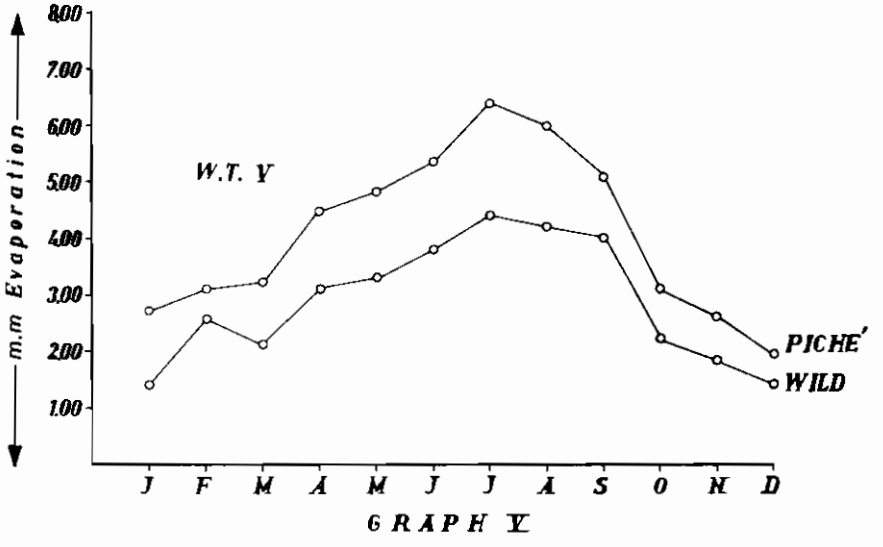
With W.T.IV a high ridge of african origin, transports warm cT air masses from the North - African high pressure center, over the area of Greece. This weather type is characterized hy clear days, indicating a stability of air masses and lack of convection. Such weather condi-

tions result as a rule in daily evaporation values above average during the winter season, and medium to small values during the summer.

From Table I and Graph IV we find that daily mean evaporation has its minimum value in November (Wild: 1.19 mm, Piché: 1.81 mm) and its macimum in July (Wild: 4.99 mm, Piché: 7.03 mm). The values of December and January differ only slightly from those of November; a fact that we attribute to the higher sunshine duaration values of December and January, as compared with those of November (November < December < January / FLOCAS - PENNAS [3]).

Weather Type V.

Weather conditions are almost identical with those of weather type IV. This is «par excellence» the weather type that produces intense nocturnal radiation, because of its extremely dry air masses.



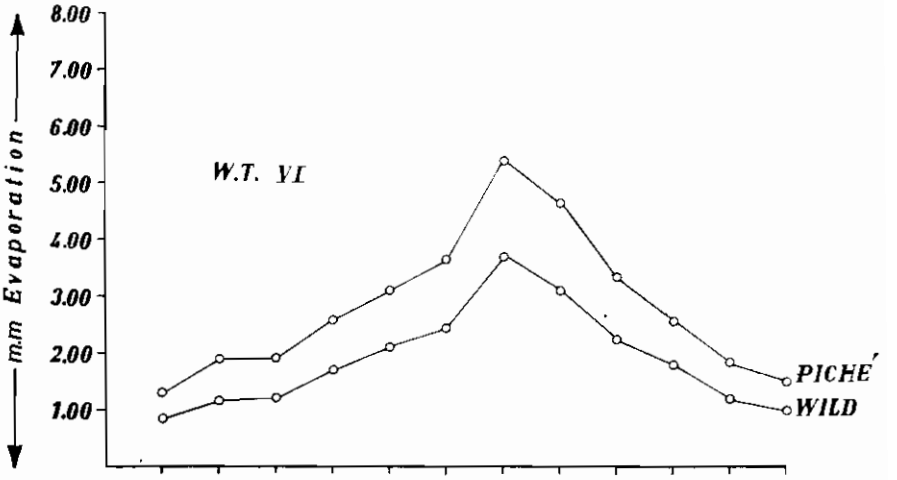
GRAPH V

Table I and Graph V indicate that W.T.V produces as a rule medium to high daily evaporation values, the whole year round, with a minimum in December (Wild: 1.40 mm, Piché: 1.90 mm), and a maximum in July (Wild: 4.42 mm, Piché: 6.36 mm). January slightly exceeds the value of November: we attribute this again to the longer sunshine duration of January against that of December and November. However, since W.T.V is very rare during the cold season, we cannot come to any conclusions with certainly.

Weather Type VI.

When this weather type prevails, the area of Greece is under the influence of a Mediterranean low, with its center to the west. The south - southwesterly warm and humid air masses, of Mediterranean origin, produce the warm sector of the cyclone and also its warm front. The effects of these warm and humid air masses over the area of Greece are: extended rainfalls, with heavy cloudiness and high values of relative humidity, and consequently reduced daily evaporation values in all the area examined.

An examination of Table I and Graph VI for W.T.VI shows that,



GRAPH VI

daily evaporation has its minimum values in January (Wild: 0.81 mm, Piché: 1.27 mm) and its maximum in July (Wild: 3.68 mm, Piché: 5.41 mm). It also shows that, W.T.VI produces very small daily evaporation values during the warm season; sometime these are the smallest values recorded with any weather type.

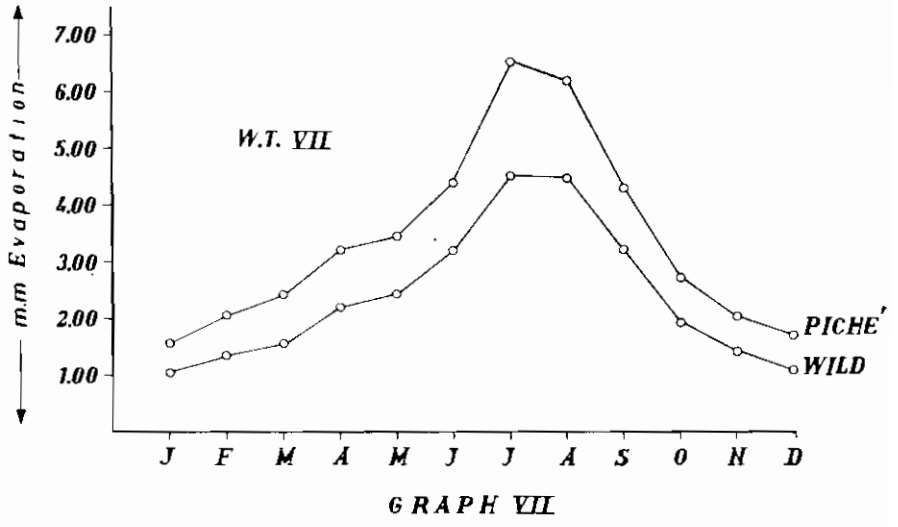
We attribute this to the following two factors: First to the small sunshine duration values, that result from the increase of cloudines, and then to the prevailing southerly winds, whose humid air masses maintain high relative humidity values.

Weather Type VII.

When this weather type prevails, the area of Greece is under the effect of a low centered over the Aegean Sea, with northwesterly winds prevailing, especially after the transit of the cold front; or it is under the effect of two lows, with their centers over the Ionian and the Aegean Sea respectively, when we have calm and temporarily clear sky.

Under such weather conditions, daily evaporation sums have medium or comparatively small values the whole year round; it is however possible for maximum evaporation values to occur with this weather type, especially during the summer season: Thus, on the 27th of August 1958, with weather type VII, has been recorded by both evaporimeters the absolute maximum of evaporation for the whole period examined (Wild: 13.4 mm, Piché: 15.6 mm). The wind blowing on that was north to northwesterly, its mean velocity was 6.3 m/sec, while the daily mean of relative humidity was 48.5 % and that of absolute humidity was 11.3 mm Hg (the month's minimum).

From Table I and Graph VII we find that the daily mean evapora-



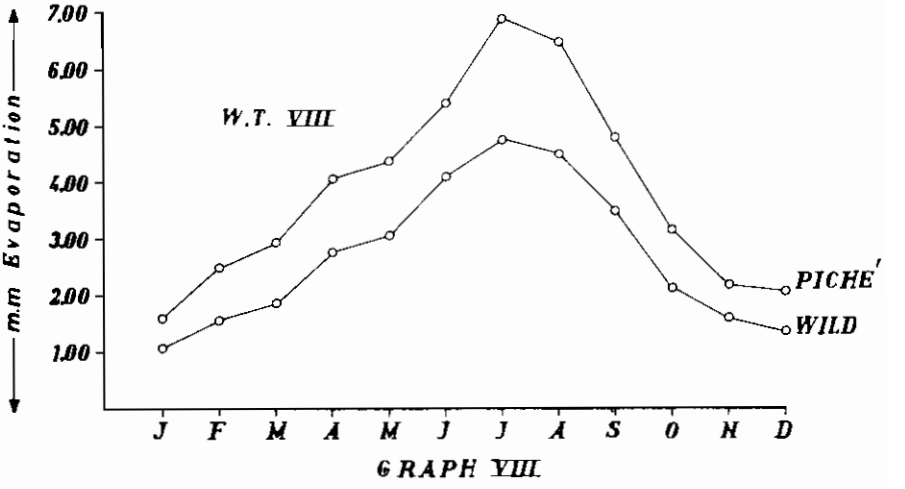
GRAPH VII

tion has its minimum value in January (Wild: 1.01 mm, Piché: 1.53mm), and its maximum in July (wild: 4.53 mm, Piché: 6.54 mm) according to both types of evaporimeters.

Weather Type VIII.

With this weather type, when the area of Greece is under the southern edges of a low, whose center is over the Balkans, the absence of a strong gradient results in calm or light winds, and clearings of the sky in Northern Greece.

Under such weather conditions, daily evaporation values are rather high to medium, the whole year round; it is however possible to record



GRAPH VIII

quite a number of extrem values, and especially minimum ones.

From Table I and Graph VIII, we find that with W.T.VIII the daily mean evaporation values have their minimum in January (Wild: 1.04 mm, Piché: 1.63 mm), and their maximum in July (Wild: 4.79 mm, Piché: 6.91 mm) with both evaporimeters.

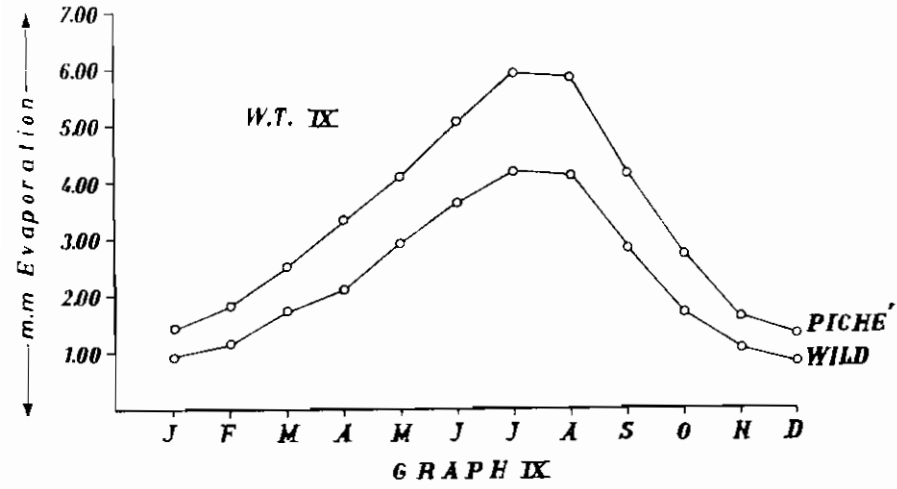
Weather Type IX

When this weather type prevails, the area of Greece is under the influence of a col, followed by light winds or calm. Such weather conditions result in steady, rather small to medium evaporation values, the whole year round, for both types of evaporimeters.

Again from Table I and Graph IX we find that with W.T.IX the minimum occurs in December (Wild: 0.78 mm, Piché: 1.29 mm), and the maximum in July (Wild: 4.17 mm, Piché: 5.91 mm).

Weather Type Xa.

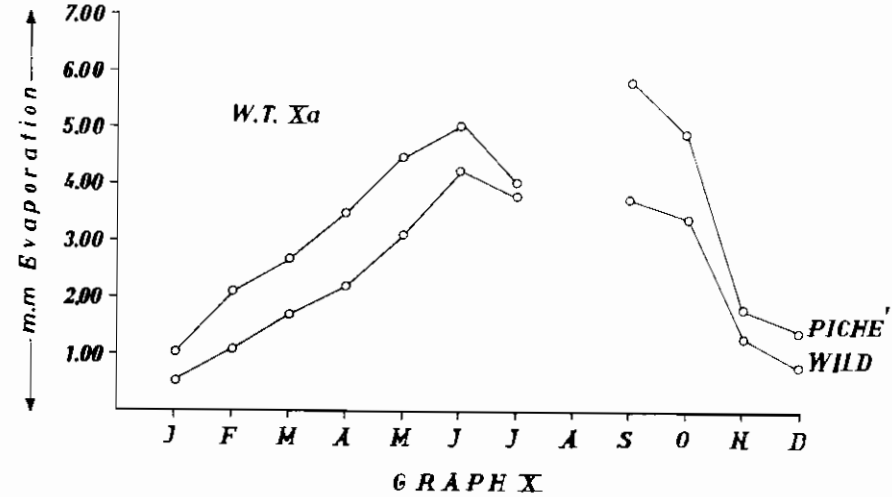
With this weather type the area of Greece is under the influence



GRAPH IX

of a depression over the Balkans on one side and a high over the Mediterranean on the other. W.T.Xa is a variety of W.T.VIII, but with pronounced characters of westerlies. Under such weather conditions, daily mean evaporation values are smaller than those of W.T.VIII. However, because of this weather type being very rare, especially during the summer, we cannot conclude with certainly as to its effect upon the development of daily mean evaporation values.

As a matter of fact, according to Table I and Graph X, the mini-



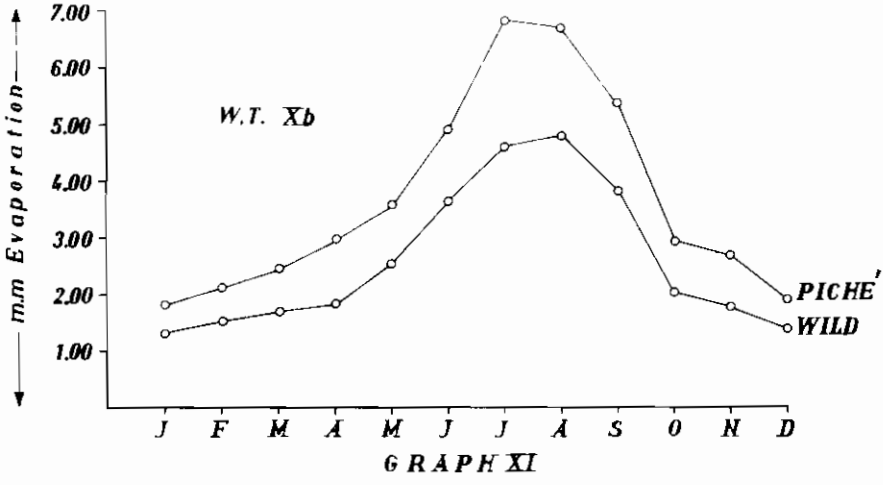
GRAPH X

mum of daily mean evaporation values occurs in January (Wild: 0.52 mm, Piché: 1.04 mm), and the maximum in June (Wild: 4.25 mm), or September (Piché: 5.80 mm).

Weather Type Xb.

The are of Greece is under the influence of the high pressure systems of SE Europe on one hand, and the Mediterrauean lows on the other. This strong gradient favors the flow of cold air masses, producing east - northeasterly winds of high velocity, with heavy cloudiness, rain and snow. Under such weather conditions, daily mean evaporation values are around medium, and this is due to the high wind velocities, in spite of the remaining unfavorable factors.

The minimum of daily mean evaporation values with W.T.Xb. according to Table I and Graph X1, occurs in January (Wild: 1.29 mm,



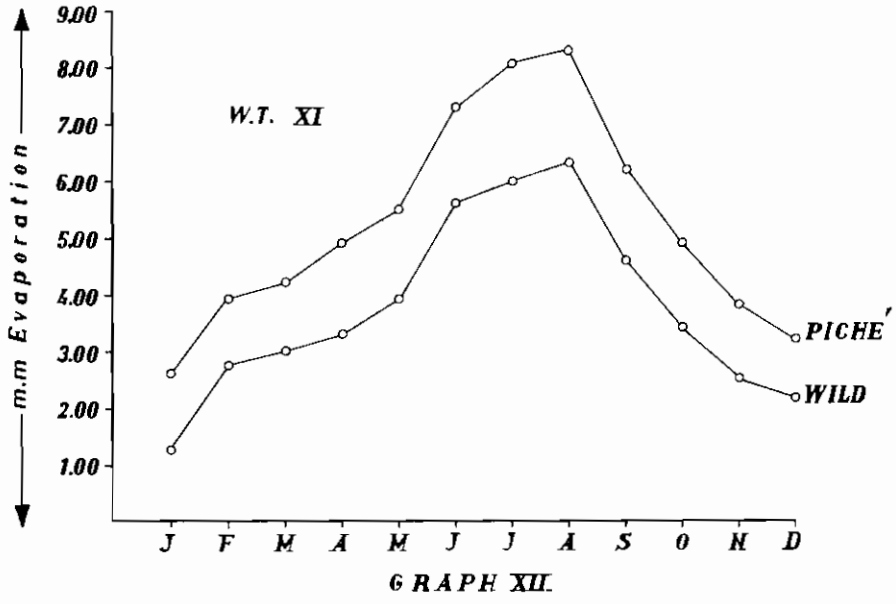
GRAPH XI

Piché: 1.71 mm), and the maximum in August (Wild: 4.80 mm), or July (Piché: 6.84 mm).

Weather Type X1

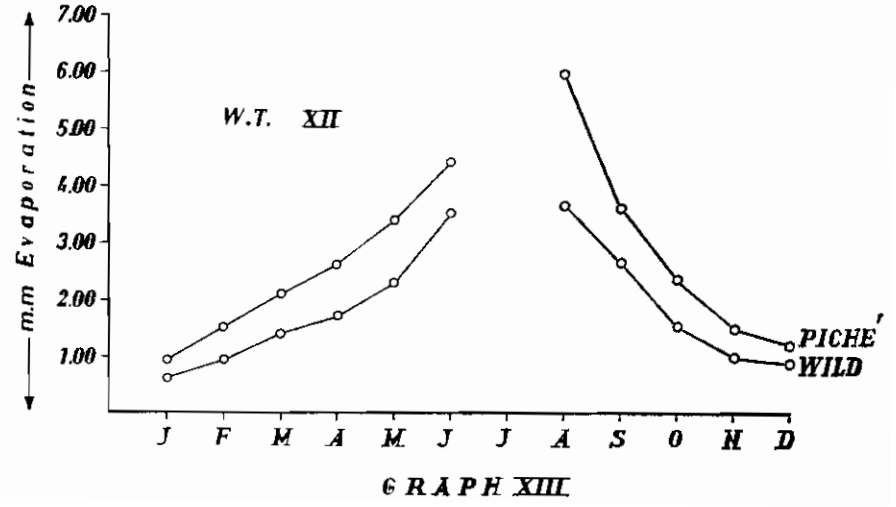
This weather type, with a high to the west of Greece and a low to the east, develops an isobaric pattern almost parallel to the meridians, resulting in northerly winds over the whole area. In Thessaloniki this wind is known as VARDARIS; it produces the dissipation of any pre - existing fog (ANGOURIDAKIS [2]), or clouds. Because of the great velocities and the dryness of this wind, the rate of evaporation increases considerably, while relative and absolute humidity decrease.

Such weather conditions result in the highest daily evaporation values, in both types of evaporimeters, the whole year round.



GRAPH XII.

As we find from Table I and Graph XII, the minimum of daily mean evaporation values with W.T.XI, is recorded in January (Wild: 1.76 mm, Piché: 2.60 mm), and the maximum in August (Wild: 6.29 mm, Piché: 8.29 mm).



GRAPH XIII.

Weather Type XII

This weather type is characterized by south component winds. A high to the east and a low to the west of Greece, produce these southerly winds and the increase of relative humidity and cloudiness.

Under such weather conditions, daily evaporation values remain quite small; however, because of this weather type occuring rarely during the warm season, we cannot pronounce with certainly on the effect it has on daily evaporation values during the whole year. Thus, according to Table 1 and Graph XIII, the minimum of daily evaporation occurs in January (Wild: 0.58 mm, Piché: 0.89 mm) and the maximum in August (Wild: 3.65 mm, Piché: 5.95 mm).

CONCLUSIOMS.

Examination of the results of evaporation measurements in Thessaloniki, effected with Wild's evaporation balance and Piché evaporimeter, during the 1931 - 1939 and 1951 - 1970 periods, in connection with the weather types prevailing, leads to the following conclusions:

1. The rate of evaporation during the main summer season exceeds by far the rate of the main winter season. This is due to the coexistence in summer of the three basic factors that affect favorably the rate of evaporation: that is high wind velocities, dry air masses of north - continental origin, and high daily mean sunshine duration values, the principal dynamic condition for the above being the Etesian Winds.

2. Factors that affect unfavorably the rate of evaporation are: calm, high values of relative humidity, and cloudiness and fogs. The coexistence of the above, results in evaporation values around zero.

3. It is possible to classify the 13 weather types in groups, according to how each affects the rate of evaporation, producing high, medium, or small daily evaporation values.

The adjoined Table II includes the total sum of each weather type's occurence per month. Most weather types however have a different frequency in winter than in summer, while a few of them sometimes produce high and sometimes small evaporation values. Consequently the classification in groups, has been made separately for the winter and separately for the summer season. The winter season includes 7 months, from October to April, and the summer season 5 months, from May to September. April has been included in the winter season, because the amount (in mm) of water evaporated during this month, for all the 29 years examined, was smaller than the monthly mean of the same period as recorded by both evaporimeters.

This classification of the 13 weather types is not based upon an absolute criterion, because of the reasons stated above.

TABLE II

Total number of each weather type's occurence during the 1931 - 1939 and 1951 - 1970 period (29 years).

	I	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*Xa*	*Xb*	*XI*	*XII*	*Total*
J	235	136	33	32	3	120	103	49	46	5	55	39	43	899
F	225	99	21	36	4	102	106	46	42	22	32	39	45	819
M	257	87	27	49	8	101	91	50	74	26	39	44	46	899
A	163	65	5	71	24	110	127	44	92	13	38	55	63	870
M	216	71	10	90	40	60	132	45	116	8	22	55	34	899
J	255	112	6	66	47	24	79	42	136	4	21	72	6	870
J	353	151	5	28	41	11	28	37	133	1	27	84	0	899
A	381	130	6	23	31	13	37	44	125	0	31	74	4	899
S	357	140	8	20	16	40	62	23	105	2	52	24	21	870
O	294	125	21	38	14	79	96	30	61	4	52	15	70	899
N	206	108	23	35	8	110	112	44	50	11	47	26	90	870
D	207	132	24	21	3	133	115	47	38	19	57	21	82	899
To-tal	3149	1356	189	509	239	903	1088	501	1018	115	473	548	504	10592

Table III includes the mean daily evaporation of the winter and

TABLE III

Mean Daily Evaporation Values per Weather Type during the Winter and Summer Season

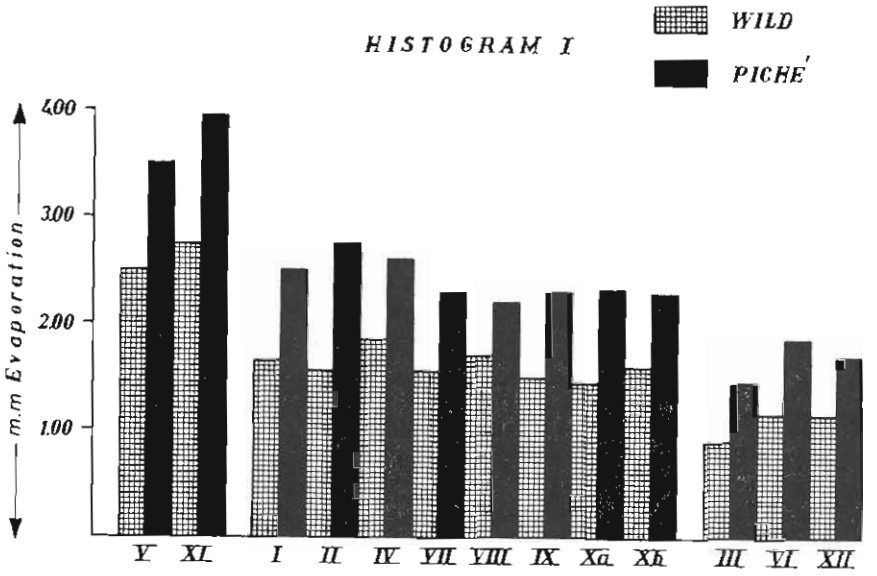
	WINTER SEASON		*SUMMER SEASON*	
W.T.	*Wild*	*Piché*	*Wild*	*Piché*
I	1.66	2.52	4.13	5.80
II	1.51	2.33	3.91	5.65
III	0.89	1.46	3.23	4.70
IV	1.80	2.75	3.61	5.17
V	2.45	3.50	3.94	5.57
VI	1.23	1.88	2.39	3.54
VII	1.52	2.23	3.15	4.37
VIII	1.72	2.62	4.01	5.64
IX	1.47	2.28	3.56	5.06
Xa	1.44	2.33	3.54	4.77
Xb	1.64	2.36	3.95	5.58
XI	2.73	3.97	5.48	7.33
XII	1.15	1.74	2.61	3.71
Seasonal Mean	1.56	2.36	3.91	5.50

summer season, per weather type, for both evaporimeters.

From the above Table and Histograms I and II, we draw the following conclusions:

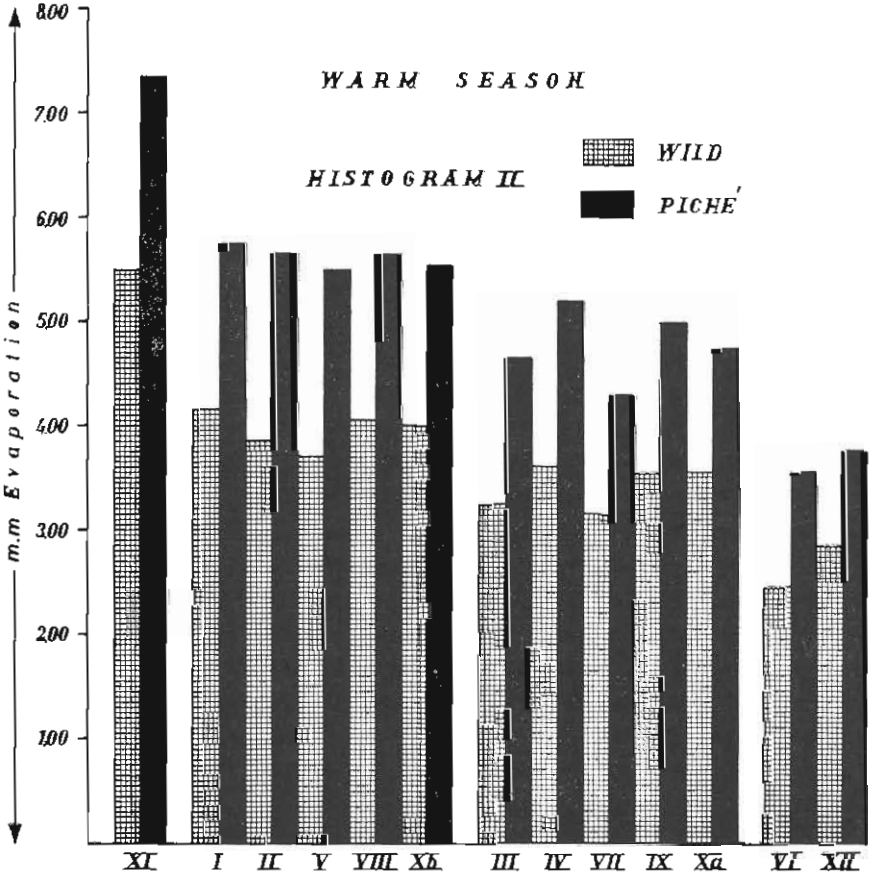
COLD SEASON

HISTOGRAM I



WARM SEASON

HISTOGRAM II.



A. Cold Season (3 groups).

a. *Favorable Weather Types.* This group includes W.T.V and XI; when these weather types prevail, they produce the highest amounts of daily evaporation, with W.T.XI always leading, in both types of evaporimeters. As a matter of fact, W.T.XI produces not only the highest but also the most steady values of daily evaporation.

b. *Group of medium values.* This group includes W.T.I, II, IV, VII, VIII, IX, Xa, Xb. Of them all, the values of weather types II, IV, and VIII are higher than the mean daily of the cold season, while the remaining weather types have values below this mean. However, the differences of all the above W.T.I from the mean daily of the season are so slight (either plus or minus), that they have all been classified in the same group.

c. *Unfavorable Weather Types.* The group includes W.R.III, VI, and XII.

All three weather types have high values of relative humidity, because of the prevailing south component currents of Aegean origin· W.T.III and XII have the greatest frequency of fogs (ANGOURIDAKIS[2]) while W.T.VI and XII are characterized by extremely small daily sunshine duaration values (FLOCAS - PENNAS [3]).

B. Warm Season (4 groups).

a. *Favorable W. T.* This group includes W.T.XI only, because values recorded by both evaporimeters when it prevails exceed by far the values of all the remaining weather types.

b. *Group of medium values.* This group includes W.T.I, II, V, VIII, and Xb. Values of the above weather types are slightly above the mean daily for the summer season, or very near it.

c. *Unfavorabel Weather Types.* In this group belong W.T.III, IV, VII, IX, and Xa, which produce daily evaporation values quite below the mean daily of the season. It should be mentioned that W.T.III and Xa were included in this group with some reservations, because of. their rarity.

d. *Extremely unfavorable Weather Types. This group includes W.T. VI and XII, whose weather conditions are the most* unfavorable for the rate of evaporation, since their values are extremely small. Especially W.T.VI, because of the southerly - humid air masse of Mediterranean origin that it transports over the area of Greece, produces rains, heavy cloudiness and increase of relative humidity values. Besides, this weather type is also characterized by small daily mean sunshine duration, specially in Northern Greece.

We have classified the 13 weather types in 4 groups for the summer season, instead of the 3 groups of the winter season, for the following reasons:

As already mentioned, some weather types produce sometimes high and sometimes small daily evaporation values, according to the season of the year. However, during the summer season the rate of evaporation being by far greater than that of winter, we have observed an unequality between values of the various weather types, which does not exist in winter. Thus, while values of W.T.IV, VII, IX, and Xa of the second winter group, stand at almost the same levels with those of the remaining W.T. of the same group (I, II, VIII, and Xb), their values during the summer considerably differ from the remaining types; as a consequence, we had to classify these types into a separate group.

Moreover the two weather types V and III, classified into the two extrem groups of the winter season, (a) and (c) respectively, have been classified into the two medium summer groups, (b) and (c) respectively, their effect on the rate of evaporation being quite different in this season.

It should also be noted that, W.T.IV manifests the greatest diversity of values between the winter and summer reason. Thus, while in the summer it produces values that are quite below the mean of this season, on the contrary its values in winter are quite higher than the corresponding mean.

Dissimilarities in its behavior are also manifested by W.T.III; nevertheless, because of its rarity, these are not worth mentioning.

4. In Table IV we compare the mean daily evaporation values in Thessaloniki, as recorded by Piché evaporimeters and Wild evaporation balance, under the influence of weather types I and XI.

From it we find that the P/W ratio is <1.5 for W.T.I, during the summe season and esecially the June - July - August quarter.

With weather type XI the P/W ratio is < 15 for almost every month of the year, having its smaller values during the above three - months.

We attribute this to the fact that W.T.XI the year round, and W.T.I especially in the above mentioned three - months, are characterized when they prevail in the area of Greece, by dry and strong northerly winds, which because of their drynes and high velocities, increase the amount of dust in the atmosphere, which is in turn deposited upon the filter paper of Piché evaporimeter. Thus the evaporative surface is reduced and consequently is also reduced the quantity of water

TABLE IV

Comparison between monthly mean evaporation values of Wild and Piché evaporieters, with weather types I and XI.

	W. T. I			*W. T. XI*		
	Piché	*Wild*	*P/W*	*Piché*	*Wild*	*P/W*
J	1.90	1.27	1.496	2.60	1.76	1.477
F	2.49	1.73	1.493	3.93	2.75	1.429
M	2.50	1.56	1.603	4.22	2.98	1.416
A	3.30	2.12	1.557	4.91	3.31	1.483
M	3.89	2.69	1.446	5.49	3.89	1.411
J	5.80	4.19	1.384	7.29	5.58	1.306
J	6.92	4.92	1.406	8.05	5.99	1.344
A	6.73	4.86	1.385	8.29	6.29	1.312
S	4.85	3.39	1.431	6.16	4.58	1.345
O	3.37	2.24	1.504	4.91	3.42	1.436
N	2.12	1.41	1.503	3.80	2.52	1.508
D	1.88	1.21	1.554	3.18	2.16	1.472

evaporated through the instrument. That is why we think that the filter paper should be replaced frequently when north winds prevail.

5. Examination of Table V, containing distribution of standard deviations of daily evaporation values from both types of evaporimeters, and with every weather type in Thessaloniki, shows that between deviations $\pm \sigma$ is included the largest percentage of values, varying between 65.87 % (W.T.VIII and XI) and 75.79 % (W.T.XII) for Wild's evaporation balance, and between 66.24 % (W.T.XI) to 76.99 % (W. T. XII) for Piché evaporimeter.

The percentage of values included between $\pm 2\sigma$ varies between 19.32 % (W.T.XI) to 30.66 % (W.T.II) for Wild's evaporation balance, and between 18.24 % (W.T.XI) to 29.93 % (W.T.XII) for Piché evaporimeter.

The percentage of values between -2σ and -3σ varies between 0.0% P.f. to 1.18 % (W.T.IV) for Wild's evaporation balance, and to 0.91 % (W.T.XI) for the Piché evaporimeter; while values between $+2\sigma$ and $+3\sigma$ have percentages between 2.98 % (W.T.XII) and 5.26 % (W.T.Xa) for Wild and between 2.67 % (W.T.VII) to 5.26 % (W.T.Xa) for Piché.

Besides the above, there are cases with values $>$ mean $+3\sigma$ whose percentage varies between 0 % P.f. to 1.33 % (W.T.VI) for Wild and to 1.22 % (W.T.VI) for Piché.

TABLE V

Percentage of standard deviations (± σ) from the mean evaporation values per W. T., in both evaporimeters (Period 1931 - 1939 & 1951 - 1970).

	— 3σ		— 2σ		— σ		+ σ		+ 2σ		+3σ		*Total*	
W.T.	W	P	W	P	W	P	W	P	W	P	W	P	W	P
I	0	0	2	8	380	419	2275	2240	343	358	125	110	24	14	3149	3149
%	0	0	0.06	0.25	12.07	13.31	72.25	71.13	10.89	11.37	3.97	3.49	0.76	0.44	100.00	99.99
II	0	0	0	7	125	154	1020	1013	137	127	60	43	14	12	1356	1356
%	0	0	0	0.52	9.22	11.36	75.22	74.71	10.10	9.37	4.42	3.17	1.03	0.88	99.99	100.00
III	0	0	1	0	20	28	138	132	21	20	8	9	1	0	189	189
%	0	0	0.53	0	10.58	14.81	73.02	69.84	11.11	10.58	4.23	4.76	0.53	0	100.00	99.99
IV	0	0	6	1	71	65	356	357	51	65	21	16	4	5	509	509
%	0	0	1.18	0.20	13.95	12.77	69.94	70.14	10.02	12.77	4.13	3.14	0.79	0.98	100.00	100.00
V	0	0	0	1	28	31	174	170	25	25	10	10	2	2	239	239
%	0	0	1	0.42	11.72	12.97	72.80	71.13	10.46	10.46	4.18	4.18	0.84	0.84	100.00	100.00
VI	0	0	0	0	125	107	650	665	71	88	45	33	12	10	903	903
%	0	0	0	0	13.84	11.85	71.98	73.64	7.86	9.63	4.98	3.65	1.33	1.22	99.99	99.99
VII	0	0	0	3	149	147	774	777	113	120	38	29	14	12	1088	1088
%	0	0	0	0.28	13.69	13.51	71.14	71.42	10.39	11.03	3.49	2.67	1.29	1.10	100.01	100.01
VIII	0	0	0	0	82	72	330	341	66	65	19	20	4	3	501	501
%	0	0	0	0	16.37	14.37	65.87	68.06	13.17	12.97	3.79	3.99	0.80	0.60	100.00	99.99
IX	0	0	0	7	116	126	755	743	104	99	35	31	8	12	1018	1018
%	0	0	0	0.69	11.39	12.38	74.17	72.99	10.22	9.72	3.44	3.05	0.79	1.18	100.01	100.01
Xa	0	0	0	0	12	14	82	83	15	11	6	6	0	1	115	115
%	0	0	0	0	9.65	11.40	71.93	72.81	13.16	9.65	5.26	5.26	0	0.88	100.00	100.00
Xb	0	0	0	2	68	67	327	333	52	48	21	18	5	5	473	473
%	0	0	0	0.42	14.38	14.16	69.13	70.40	10.99	10.15	4.44	3.81	1.06	1.06	100.00	100.00
XI	0	0	2	5	89	91	361	363	79	73	17	16	0	0	548	548
%	0	0	0.36	0.91	16.24	16.61	65.87	66.24	14.42	13.32	3.10	2.92	0	0	100.00	100.00
XII	0	0	0	0	56	52	382	383	43	40	15	19	8	10	504	504
%	0	0	0	0	11.11	10.32	75.79	76.99	8.53	7.92	2.98	3.77	1.59	1.98	100.00	99.99

The above values have undergone further examination. Results of this examination show that in the days when extreme evaporation values were recorded, weather conditions were characterized by strong winds, mainly of north component, and extremely small values of relative humidity: all these factors account for the high evaporation values.

The fact that considerable deviations are, as a rule, recorded by both types of evaporimeters on the same dates, with the readings of Piché always leading of course, is characteristic.

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ΕΞΑΤΜΙΣΙΣ ΚΑΙ ΤΥΠΟΙ ΚΑΙΡΟΥ

ὑπὸ

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ΠΕΡΙΛΗΨΙΣ

Μελετῶνται αἱ τιμαὶ τῆς μέσης ἡμερησίας ἐξατμίσεως εἰς τὴν πόλιν τῆς Θεσσαλονίκης κατὰ τὰς χρονικὰς περιόδους 1931 - 1939 καὶ 1951 - 1970, τόσον ἐκ τῶν ἐνδείξεων ἐξατμισιμέτρου Wild ὅσον καὶ ἐξ ἐξατμισιμέτρου Piché ἐν σχέσει μετὰ τοῦ ἑκάστοτε ἐπικρατοῦντος τύπου καιροῦ εἰς τὸν ἑλληνικὸν χῶρον. Γίνεται διάκρισις μεταξὺ χειμερινῆς καὶ θερινῆς περιόδου καὶ δίδονται τὰ μέσα ἡμερήσια ὕψη ἐξατμίσεως, ἑκάστης περιόδου κατὰ Τ.Κ. καὶ διὰ τὰ δύο ἐξατμισίμετρα, ἐξ οὗ προκύπτει ὅτι, τὰς μεγαλυτέρας τιμὰς διαμορφώνει ὁ Τ.Κ. XI καὶ διὰ τὰς δύο περόδους, ἐνῶ τὰς μικροτέρας ὁ Τ.Κ. III (χειμερινὴ περίοδος) καὶ VI (θερινὴ περίοδος).

Μελετᾶται ἐπίσης ἡ σχέσις τῶν μέσων ἡμερησίων τιμῶν ἐξατμίσεως ποῦ διαμορφοῦνται ὑπὸ τὴν ἐπίδρασιν τῶν Τ.Κ. I καὶ XI διὰ τῶν δύο ὡς ἄνω ἐξατμισιμέτρων, καὶ προκύπτει ὅτι διὰ τὸν Τ.Κ. I ὁ λόγος P/W εἶναι $<1,5$ κατὰ τὴν θερινὴν περίοδον καὶ δὴ διὰ τὸ τρίμηνον 'Ιουνίου - 'Ιουλίου - Αὐγούστου, διὰ δὲ τὸν Τ.Κ. XI ὁ P/W εἶναι σχεδὸν δι' ὅλους τοὺς μήνας τοῦ ἔτους $<1,5$ διὰ τὸ ἴδιο δὲ τρίμηνον παρουσιάζει τὰς μικροτέρας τιμάς. Τοῦτο ἀποδίδεται κατὰ κύριον λόγον, εἰς τὴν αὔξησιν τοῦ κονιορτοῦ τῆς ἀτμοσφαίρας, κατὰ τὴν ἐπικράτησιν ἐπὶ τῆς 'Ελληνικῆς περιοχῆς Βορείων ξηρῶν ἀνέμων, μεγάλης ἐντάσεως.