

## SNOW IN THESSALONIKI - GREECE

by

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**Abstract :** *The frequency of snowfall, sheet, and snow lying in Thessaloniki - Greece is studied for the period 1945 - 1975. Results of these measurements are compared with results of previous observational series and conclusions are drawn.*

### PREVIOUS MEASUREMENTS.

The occurrence of snow in Thessaloniki has been the subject of a number of scientists in the past, either in general climatological surveys or in surveys of the climate of the city of Thessaloniki.

The Observational period between 1891-1929 has been studied by Hann<sup>4</sup>, Eredia<sup>2</sup>, Kuhlbrodt<sup>5</sup>, and also by Alexandrou<sup>1</sup> and by Mariolopoulos in his classical work on the Climate of Greece<sup>13</sup>. Kyriazopoulos, who

TABLE I

*Monthly mean number of days of snow in Thessaloniki.*

	O	N	D	I	F	M	A	M
Hann 1891 - 1908	0.1	0.3	0.7	1.4	0.7	0.4	0.1	3.7
Eredia 1893 - 1911	0	0.5	0.9	2.0	1.5	0.7	0.1	5.8
Kuhlbrodt	0.1	0.7	0.9	2.4	1.6	1.0	0.1	6.8
Alexandrou (composite series)	0.1	0.5	0.6	1.7	1.7	0.7	0.1	5.4
Mariolopoulos 1900 - 1929	0.1	0.4	0.6	1.7	1.4	0.7	0.1	5.0*
Kyriazopoulos 1930 - 1937 (University of Thessaloniki)	0	0.3	1.1	1.8	3.0	1.1	0.1	7.4

included in his own work<sup>6</sup> data of all previous research works on this subject, has studied more systematically the observations of the above period and also those from the meteorological station of the Aristotelian University of the pre-World War II period.

\*The same mean per year numbers of days with snow are also mentioned by Livathinos<sup>11</sup>

We have included in TABLE I the data published in the above mentioned works.

Studying in *Table I* the numbers of days with snow, we observe that the meteorological station of the University has the highest annual mean number than any other station that has been functioning in Thessaloniki between the years 1891-1937. *Kyriazopoulos*<sup>6</sup> attributes this to the fact of the more careful recordings of the phenomenon at the meteorological station of the University. We should however mention here that the observations of this last station amount to eight (8) years only. And if we add to those the two full years of 1938 and 1939, the mean per year number of days with snow is reduced to 7.2, approaching the number mentioned by Kuhlbrodt for another equally short period.

#### RECENT MEASUREMENTS

After the Second World War, the only publication containing data of snow days in Thessaloniki, is a research on precipitation by *Mariolopoulos - Karapiperis*<sup>14</sup>, but the data it mentions are the ones mentioned by *Alexandrou*<sup>1</sup> and included in *Table I*.

The Institute of Meteorology and Climatology of the Aristotelian University of Thessaloniki, within the frame of its climatological survey of the city of Thessaloniki, undertakes in the present research the study of the phenomenon of snow, based on data published in its "Annuaire"<sup>16,17</sup>, covering the period from 1945 to 1974, that is 30 full years of uninterrupted observations, an unprecedented event in the meteorological history of Thessaloniki.

The mean per year number of *days of snow*, that is days upon which snow is observed to arrive on the ground surface, during the 1945-1974 period, is

$$8,07 \text{ days} \pm 4,9 (\sigma)$$

The maximum was recorded in 1954, with 23 days of snow, and the minimum in 1951, with no single (0) day of snow throughout the year.

It is quite rare for a whole year to pass without any snow and this was recorded only in the years 1910<sup>1</sup>, 1934<sup>6</sup> and 1951. The years with the highest numbers of snowfalls, are 1905, 1907 with 12 days<sup>1</sup> for the period 1891 - 1929 (series with gaps - composite series), and also the years 1932 and 1933 with 14 days, for the period 1930 - 1937<sup>6</sup>.

The days of snow for the period 1945 - 1974 and also for 1930 - 1939, are given in *Table II*.

TABLE II

*Frequency of days with snow in Thessaloniki per year.  
(1945 - 1974) and (1930 - 1939)*

	1945 - 1974		1930 - 1939	
0 - 4 days	8	26.7 %	3	30.0 %
5 - 10 "	13	43.3 %	5	50.0 %
11 - 15 "	7	23.3 %	2	20.0 %
16 - 20 "	1	13.3 %	—	—
21 - 25 "	1	13.3 %	—	—
Total	30	99.9 %	10	100.0 %

*Notice:* It should be mentioned that the period 1940 - 44 cannot be included in this research because there are certain gaps in the observations of the intervals between November 1940 - June 1941, and July - December 1944. However during the years 1942 and 1943, 8 and 5 days of snow respectively have been recorded, while during the winter season of 1942 - 43 we have 4 days and in 1943 - 44, 5 days of snow.<sup>10</sup>

Comparing the percentages of days of snow at the meteorological station of the Aristotelian University during the 1930 - 39 period (10 years) with those of the 1945 - 74 (30 years) period, we observe that with the exception of two years (1954 with 23 days and 1956 with 16 days) the remaining ranges have almost the same percentages, while the mean per year number from 7.2 days of the first period, increased to 8.1 days in the second.

#### SNOW DURING THE WINTER SEASON

During the 30 years examined herein (1945 - 46 winter till 1974 - 75), 241 cases of days of snow have been recorded; these are distributed as per the following *Table III*.

TABLE III

*Days of snow during the cold season in Thessaloniki (30 winters)*

	No of cases	%	days of*
October	1	0.4	0.0
November	5	2.1	0.2
December	42	17.4	1.4
January	93	38.6	3.1
February	65	27.0	2.2
March	34	14.1	1.1
April	1	0.4	0.0
Total	241	100.0	8.0

*Notice:* The difference of 8.03 and 8.07 days is due to the difference between the sum total of 242 days of full calendar years to the 241 days of winter seasons.

The mean number of the winter season is given in *Table IV*.

TABLE IV

*Days of snow per winter season in Thessaloniki.*

Maximum	:	26 days (1953 - 54)
Winter mean	:	8.03 days $\pm$ 5.3 $\sigma$
Minimum	:	0 days (1950 - 51)

The measure of standard deviation (S.D.) is distributed as follows:

+ 2 $\sigma$	+ 1 $\sigma$	+ $\sigma$	- 1 $\sigma$	- 2 $\sigma$	- 3 $\sigma$	> - 3 $\sigma$
2	17	7	2	1	1(1953 - 54)	

The one case beyond  $-3\sigma$  corresponds to the 1953 - 54 winter, which has been severe for all Europe<sup>3,7,8</sup>, while the next in number of snow-days winter of 1962 - 63, has been one of the severest for the whole of Europe<sup>12,15</sup>.

#### CASES OF DAYS WITH SLEET

In some cases snow - flakes melt before they reach the ground sur-

face; then we register "sleet" (symbol★). Such cases are due to a certain point, to the rather warm atmosphere of the city itself, helping the melting snow flakes.

If we should add such cases of sleet to the days of snow of the winter seasons between 1945 - 75, then the number of these days or days with similar conditions, increases.

TABLE V

*Days of snow and sleet during the winter season in Thessaloniki.*

	✱ + ★	★
Maximum :	29 days (1953 - 54)	10 (1973 - 74)
Mean :	10.37 days $\pm$ 6.0	2.33
Minimum :	0 days (1950 - 51)	0 often

Nevertheless, maxima and minima of the winter season, remain the same, because while in severe winters cases with sleet contribute to the increase of cases with solid precipitation, in very mild winters with no snowfall, no sleet is reported either.

Yet, winter seasons with sleet maxima do not coincide with *severe* winters, but with winters characterized as *cold* or *mild* (e.g. 1973 - 74, 1955 - 56, 1971 - 72), according to *Flocas'* classification<sup>3</sup>.

#### SNOW LYING (☒)

Days on which the ground remains covered with snow, are important for a city, for if they do not wholly block, yet they impede the circulation of pedestrians and vehicles as well.

In *Table VI* we give the monthly mean and the winter maxima of days with snow lying in Thessaloniki, for the period 1945 - 75,

TABLE VI

*Days with snow lying in Thessaloniki during the period  
1945 - 1975 (30 winters)*

	Mean	Abs. Maximum	Minimum	
November	0.0	1	1955 - 56	0
December	1.2	10	1957-58	0
January	2.9	14	1962-63	0
February	1.7	10	1953-54 1955-56	0
March	0.6	5	1951-52	0
April	0.0	1	1955-56	0
Year	6.4	24	1962-63	0
	$\pm 5.9$			

29 winters  
20 "  
11 "  
17 "  
22 "  
29 "  
1950-51, 1956-57,  
1960-61, 1974-75

The measure of standard deviation (S.D.) is distributed as follows:

+ 2 $\sigma$	+ 1 $\sigma$	$\pm \sigma$	- 1 $\sigma$	- 2 $\sigma$	- 3 $\sigma$
4	18	3	3	3	
	⏟				
	21				

This means that 70% of winter cases stays in the range of  $\pm 1\sigma$ .

The frequency distribution of days with snow lying and days of snow are given in *Table VII*.

TABLE VII

*Frequency of days of snow and days with snow lying during the winter  
season in Thessaloniki (1945 - 1975 / 30 winters)*

No of days	✱	☒
26 - 30	1	—
21 - 25	1	1
16 - 20	—	2
11 - 15	3	3
6 - 10	16	2
0 - 5	9	22
Total	30	30

From Table VII and also from annual values of days of snow and days with snow lying, it arises that days of snow are more numerous than days with snow lying.

## CONCLUSIONS.

From the entire study of snow in Thessaloniki, we arrive at the following conclusions:

a. Days of snow in Thessaloniki, during the period 1945 - 75, amount to  $8.07 \pm 4.9$  days per year; meaning that the annual mean of this period is higher than every other mean, resultant from previous surveys.

This, to a certain point, may be attributed to the accuracy of observations. The personnel of the meteorological station at our Meteorological Institute is well trained and specialized; while during the 1900 - 1929 period, observations were effected by observers who did this as a secondary job.

It is however our belief that, this increase of days of snow in the area of Thessaloniki is to a certain point a real one, being due to meteorological factors.

If moreover we take into account the number of days with sleet, the above increase amounts to 10,4 days per year.

We ascribe the increase of days with sleet to the warming effect of the city upon snowfalls.

b. January, the coldest month of the year, is also the month with the highest number of snowfalls, a fact that emphasizes this month's severity.

TABLE VIII

*Frequency of days of snow and days with snow lying in Thessaloniki.*

	Days of snow	Days of snow lying	*/☒
December	1.4	1.2	1.17
January	3.1	2.9	1.07
February	2.2	1.7	1.29
March	1.1	0.6	1.83

c. Days with snow lying are rather few per year ( $6,4 \pm 5,9$ ), as compared with the number of such days in other cities of the Balkans. While the ratio between mean number of days of snow and mean number of days with snow lying at the meteorological station of the University (standing in an open space of green, among public buildings, at the center of the city) varies between 1,07 in January the coldest month, to 1,83 during the rather warm month of March.

The superiority of days of snow is due to the relative warmth of the ground.

d. The maxima of "days of snow" and "days with snow lying" have been recorded during the very cold winters of 1953 - 54 and 1962 - 63; these two winters have been severe for almost all Europe (*Raybould*<sup>15</sup>, *Mc Naughton*<sup>12</sup>, *Flocas*<sup>3</sup>, or for the whole area of Greece (*Livadas*<sup>9</sup>).

This shows that only during the really cold European winters does Thessaloniki experience many days of snow or days with snow lying, producing a sensation among the inhabitants of the area, who are accustomed to milder weather conditions.



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## ΠΕΡΙΛΗΨΙΣ

### ΤΟ ΧΙΟΝΙ ΣΤΗ ΘΕΣΣΑΛΟΝΙΚΗ

Ἑ π ὶ

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Μελετᾶται ἡ συχνότης ἐμφανίσεως χιόνος, χιονολύτου καὶ ἐδάφους χιονοσκεποῦς εἰς τὴν Θεσσαλονίκην διὰ τὴν χρονικὴν περίοδον μεταξύ 1945-1975. Συγκρίνονται τὰ ἀποτελέσματα τῶν μετρήσεων μὲ τὰ ἀποτελέσματα παλαιότερων σειρῶν παρατηρήσεων καὶ ἐξάγονται συμπεράσματα.