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CLASSIFICATION OF WINTERS IN THESSALONIKI (1892-1973) AND LARISSA (1899-1973)

by

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Abstract : The well known method of calculating the deviation of the mean temperature of each winter (December-February) from the normal temperature of that season, has been followed for the classification of winters in the two cities of Thessaloniki and Larissa. According to their difference from normal temperatures, winters are classified in five categories (very mild, mild, normal, cold, severe).

From this classification, we arrived at the following conclusions:

— There is a strong correlation ($r = 0.92$) between winters in the two cities.

— In each of the two areas, there have been registered 5 severe winters, and 6 very mild ones.

— Possibilities for the occurence of every category of winter are almost equal in both cities.

Introduction

A classification of winters (December-February) aiming to determine their degree of coldness, is of high interest, since temperature anomalies of a certain area influence its vegetation and consequently the national finances of the land, having effects on every kind of human activity.

The subject has been examined at times by various research workers, each one suggesting his own special criteria. Such scientists have been in Greece: *Livathinos*[11], *Eginitis*[3], *Ph. Karapiperis*[8], *Kyriazopoulos*[9,10], and others.

Various methods have been proposed for the classification of winters, as for instance the one based on the monthly sum of minimal temperatures below zero[2,7],or on the deviations of the mean winter temperatures, from the normal temperature of that season[1,8], or on the absolute minima of temperature or on the frequency of frost days[11], and others[9,10].

Anyhow, the most accurate method for the classification of winters

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would require the introduction of other meteorological parameters too, and especially that of rain and sunshine duration.

Most recently *Rackliff*[13], *Hughes*[6], and *Poulter*[12], have calculated the winter and summer indices for various regions of Great Britain and Ireland based upon the meteorological data of temperature, rainfall and sunshine duration.

Material - Method

The method followed in this work for the classification of winters in the two cities of Thessaloniki and Larissa, is the one used by *Ph. Karapiperis*[8] in his classification of winters in Athens for the period 1859-1949. We, however do not introduce percentages of minimal temperatures below the normal minima, when speaking of cold or severe winters, or percentages of maximal temperatures above the normal maxima for mild or very mild winters, for lack of extreme daily values of air temperatnre during the whole period examined in the above two cities.

For working out this paper we have used basically the time-series of monthly mean air temperature values of Thessaloniki (1892-1973, *Flocas - Arseni*[4]), and of Larissa (1899-1973, *Flocas*[5]). After processing monthly mean air temperature values for the cities of Thessaloniki and Larissa, we can give the following data:

	Thessaloniki	Larissa
Normal winter temperature (Dec.-Febr.)°C	7.00	6.13
Normal winter deviation (irrespective of sign)°C	1.03	1.05

According to the values of number A, denoting how each winter's deviation is above or below normal, we give the following classification of winters:

Above the normal value			Below the normal value	
Very mild	Mild	Normal	Cold	Severe
$A \geqslant 2.1$	$1.1 \leqslant A \leqslant 2.0$	$0 \leqslant A \leqslant 1.0$	$1.1 \leqslant A \leqslant 2.0$	$A \geqslant 2.1$

Conclusions

According to the above classification, we give in Table I, separately for each city, the characterization of cold and severe winters together

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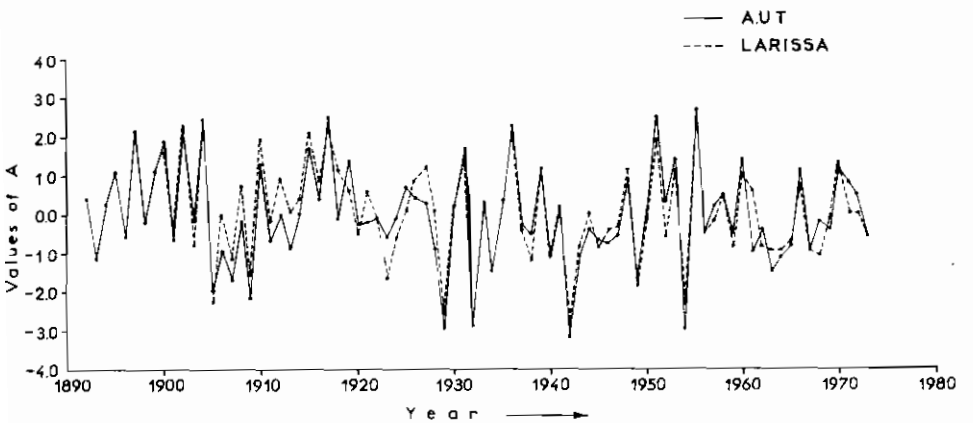
with their mean and extreme temperatures and their days of frost. Also according to the values of A for each year and city separately we have drawn *Graph I.*

GRAPH I.



From this Graph I and the calculated value of correlation r = 0.92 between winter temperatures in the two cities, we observe a strong correlation between winters in the two areas examined.

From Table I we arrive at the following conclusions:

During the common for the two cities period examined herein (1899-1973), we observe four cases of severe winters, that is in 1928-29, 1931-32, 1941-42, and 1953-54. It is worth noting that during the extremely severe winter of 1941-42, holding the first place among all winters in these two areas, 7 and 10 total-frost days have been recorded in the cities of Thessaloniki and Larissa respectively.

Of the above severe winters, the 1928-29 one is mentioned by *Rackliff*[13] as severe at Armagh and as cold in Athens by *Ph. Karapiperis*[8].

The 1904-1905 winter is characterized as severe in Larissa and cold in Thessaloniki, but with a very small difference from a severe one. This same winter has been characterized as severe in Athens *Ph. Karapiperis*[8], and the district of Thessalia *Livathinos*[11].

On the other hand, the 1908-09 winter, characterized as severe in Thessaloniki and cold in Larissa, is also characterized as cold by *Karapiperis*[8], and severe by *Livathinos*[11], in the areas studied by them respectively.

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TABLE I

Cold and Severe Winters in Thessaloniki (1892-1973) and Larissa (1899-1973).

Winters	A-Value		Classification		Order		Mean Temp. °C		Frost days		Abs. min. Temp. °C		Abs. max. Temp. °C	
	Thes.	Laris.	Thes.	Laris.	Thes.	Laris.	Thes.	Laris.	Thes.	Laris.	Thes.	Laris.	Thes.	Laris.
1892-1893	1.1		Cold		9th		5.83		33		—10.0		18.9	
1904-1905	2.0	2.3	Cold	Severe	5th	4th	4.98	3.70	*	63	*	—13.0	*	17.2
1906-1907	1.7	1.1	Cold	Cold	6th	10th	5.23	4.93	*	34	*	— 8.6	*	18.2
1908-1909	2.2	1.6	Severe	Cold	4th	7th	4.78	4.50	*	36	*	— 6.5	*	16.5
1922-1923	0.5	1.7	**	Cold	**	6th	6.35	4.37	*	34	*	—10.2	*	17.2
1928-1929	2.9	2.6	Severe	Severe	3th	3th	3.97	3.40	38	43	— 9.0	—11.3	18.0	19.1
1931-1932	2.9	2.7	Severe	Severe	3th	2nd	4.00	3.33	44	45	— 6.5	—11.0	16.4	17.8
1933-1934	1.5	1.5	Cold	Cold	7th	8th	5.48	4.57	35	47	— 5.0	— 8.2	17.7	19.2
1937-1938	0.4	1.2	**	Cold	**	9th	6.45	4.90	24	44	— 6.3	—11.8	21.0	21.7
1939-1940	1.1	1.1	Cold	Cold	9th	10th	5.84	5.00	32	41	— 7.4	—17.8	20.2	18.3
1941-1942	3.1	2.8	Severe	Severe	1st	1st	3.76	3.17	33	51	— 9.6	—17.5	17.3	17.0
1948-1949	1.7	2.0	Cold	Cold	6th	5th	5.20	4.07	35	58	— 5.2	—10.0	19.0	20.2
1953-1954	3.0	2.3	Severe	Severe	2nd	4th	3.89	3.67	39	42	—10.3	— 9.2	18.1	16.0
1962-1963	1.2	0.9	Cold	**	8th	**	5.43	5.13	24	27	—10.1	—10.6	18.6	20.2
1963-1964	1.1	0.9	Cold	**	9th	**	5.91	5.13	31	38	— 6.8	—10.2	20.3	20.5
1967-1968	0.2	1.1	**	Cold	**	10th	6.79	5.00	19	41	—12.6	—21.6	18.4	21.0

*No data of maximum and minimum thermometer.

**This winter has not been characterized either as cold or as severe

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Among the cold winters simultaneously recorded in the two cities (Thessaloniki, Larissa), the first place is held by the 1948-49 one, followed by those of 1906-07, 1933-34 and 1939-40.

The 1962-63 winter has been cold in Thessaloniki, (extremely severe in Manchester *Raybould*[14], and Armagh *Rackliff*[13]), and normal but very near to cold in Larissa, where it registered 29 frost days, 8 of which have been total-frost ones.

We also mention the cold winters of 1892-93 and 1963-64 in Thessaloniki holding 9th place among the 82 years, and those of 1922-23, 1937-38, and 1967-68 in Larissa. It is worth noting that during the cold 1922-23 winter in Larissa, 34 frost days have been recorded, 10 of which have been total-frost days; the same winter was characterized as severe by *Livathinos*[11].

Besides, the cold 1967-68 winter in Larissa,holding 10th place among the 74 years, registered 41 frost days, 6 of which have been total-frost days, while the absolute minimum air temperature has been —21.6°C (14.1.1968). This same winter has been chatacterized as normal in Thessaloniki, with 19 frost days (3 total-frost ones), and with the absolute minimum air temperature of the whole 1892-1973 period (—12.6°C on 15.1.1968).

Moreover it should be mentioned that a few of the winters classified in Table I, started early, from November, recording in this month monthly mean temperatures below its normal (12.14°C) by 1.4—3.6°C in Thessaloniki, and below the normal of Larissa (11.10°C) by 1.6—3.4°C. Such winters have been for both cities those of 1904-05, 1908-09, 1941-42, and 1953-54, and also the winter of 1892-93 for Thessaloniki and that of 1922-23 for Larissa.

There have also been certain winters that were prolongated till March, recording in this month mean monthly temperatures below its normal (10.39°C) in Thessaloniki by 1.0-3.8°C, and below the Larissa normal (9.64°C) by 0.8-3.6°C. Such winters, common for both cities, are the 1906-07, 1928-29, 1931-32, 1939-40 1941-42, 1948-49, 1962-63 ones, and the winter of 1892-93 for the Thessaloniki and that of 1967-68 for Larissa.

Finally, during some winters, such as 1906-07, 1939-40, 1941-42, and 1953-54 the monthly mean temperature registered in April has been below normal (14.89°C) by 0.9-1.8°C in Thessaloniki, and by 0.6-1.8°C of the corresponding Larissa normal (14.05°C). Also on the 1892-93 and 1928-29 winter temperature has been below normal by 2.4°C and 1.4°C respectively in Thessaloniki; and by 2.4°C and 1.4°C below normal in

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TABLE II

Mild and Very Mild Winters in Thessaloniki (1892-1973) and Larissa (1899-1973).

	A-Value		Classification		Order.		Mean Temp. °C		Frost days.		Abs. min. Temp. °C		Abs. max. Temp. °C	
Winters	Thes.	Laris.	Thes.	Laris.	Thes.	Laris.	Thes.	Laris.	Thes.	Laris.	Thes.	Laris.	Thes.	Laris.
1894-1895	1.1		mild		12th		8.14		17		—6.7		17.7	
1896-1897	2.2		very mild		5th		9.25		7		—2.0		21.0	
1898-1899	1.1		mild		12th		8.17		20		—5.5		21.2	
1899-1900	1.9	1.6	mild	mild	6th	7th	8.96	7.77	8	15	—2.5	—3.0	18.4	20.9
1901-1902	2.3	2.2	very mild	very mild	4th	2nd	9.38	8.43	11	20	—3.4	—4.0	21.5	22.2
1903-1904	2.4	2.5	very mild	very mild	3th	1st	9.50	8.73	6	24	—2.4	—5.0	22.0	23.3
1909-1910	1.3	2.0	mild	mild	10th	4th	8.35	8.20	6	15	—3.3	—4.5	17.5	23.1
1914-1915	1.7	2.1	mild	very mild	7th	3th	8.74	8.33	*	15	*	—4.0	*	22.6
1916-1917	2.5	2.2	very mild	very mild	2nd	2nd	9.58	8.43	*	8	*	—3.5	*	21.0
1917-1918	0.1	1.1	**	mild	**	10th	6.89	7.33	*	30	*	—6.5	*	21.0
1918-1919	1.4	0.7	mild	**	9th	**	8.45	6.87	*	17	*	—9.0	*	18.8
1926-1927	0.5	1.2	**	mild	**	9th	6.99	7.43	16	*	—3.8	*	19.0	*
1930-1931	1.5	1.7	mild	mild	8th	6th	8.52	7.93	2	6	—0.6	—4.0	20.4	18.1
1935-1936	2.3	2.1	very mild	very mild	4th	3th	9.32	8.33	6	13	—8.1	—5.4	19.2	20.6
1938-1939	1.2	1.0	mild	**	11th	**	8.20	7.15	7	19	—1.7	—3.0	18.6	21.2
1947-1948	0.7	1.1	**	mild	**	10th	7.92	7.33	16	20	—2.8	—4.0	19.9	
1950-1951	2.5	1.9	very mild	mild	2th	5th	9.59	8.10	2	13	—1.5	—4.0	18.8	21.0
1952-1953	1.4	1.1	mild	mild	9th	10th	8.43	7.27	13	22	—2.4	—4.0	19.8	21.8
1954-1955	2.7	2.5	very mild	very mild	1st	1st	9.74	8.73	4	13	—2.0	—4.5	23.3	22.3
1959-1960	1.4	1.1	mild	mild	9th	10th	8.44	7.23	9	34	—4.8	—9.5	22.2	23.2
1965-1966	1.1	0.8	mild	**	12th	**	8.18	6.93	12	33	—5.9	—17.0	22.0	21.8
1969-1970	1.2	1.3	mild	mild	11th	8th	8.23	7.53	11	16	—2.4	—3.4	20.3	22.8

*No data of maximum and minimum thermometer.

**This winter has not been characterized either as mild or as very mild.

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Larissa during the 1937-38 and the 1963-64 winters respectively.

Having classified winters in reverse order to the cold ones, we have drawn *Table II,* containing winters characterized as mild and very mild, with all their relative data.

From Table II we observe 5 very mild winters common in both cities, that is the ones of 1901-02, 1903-04, 1916-17, 1935-36, and 1954-55, the first place being held by that of 1954-55 for the whole period examined, while the 1935-36 winter has been characterized as very mild for the city of Athens too *Karapiperis*[8].

The winter of 1914-15 is characterized as mild in Thessaloniki and very mild in Larissa, while the winter of 1950-51 is the other way round.

In Thessaloniki during the 1892-1899 period the winters of 1894-95 and 1898-99 are characterized as mild and that of 1896-97 as very mild.

Finally we distinguish 9 mild winters in Thessaloniki and 10 in Larissa separately.

A comparison between the winters classified for Thessaloniki and Larissa (Tables I, II) and those classified by *Karapiperis*[8] for the city of Athens during the period 1899-1949, leads to the following observations:

I. The winters of 1904-05, 1906-07, 1908-09, 1928-29, 1931-32: 1941-42, and 1948-49 have been characterized as cold or severe for the three cities of Greece, Athens, Larissa, and Thessaloniki.

II. The winters of 1899-1900, 1901-02, 1903-04, 1909-10, 1914-15, 1916-17, 1930-31 and 1935-36 have been characterized as mild or very mild in all three cities, while those of 1918-19 and 1938-39 as mild in Athens and Thessaloniki only, and that of 1947-48 in Athens and Larissa.

The above indicate a mostly simultaneous occurence of the various categories of winters in the three cities and consequently in a large part of the area of Greece.

Ending, we give below the probabilities for each category of winter, separately for each city.

	Very mild	Mild	Normal	Cold	Severe
Thessaloniki	0.08	0.15	0.61	0.10	0.06
Larissa	0.08	0.14	0.61	0.10	0.07

We observe that the probabilities are almost equal in both cities.

It is also worth mentioning that the probabilities for a mild or very mild winter in Thessaloniki or Larissa are quite the same with the ones calculated for Athens *Karapiperis*[8] from the 1859-1949 period.

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ΠΕΡΙΛΗΨΙΣ

ΤΑΞΙΝΟΜΗΣΙΣ ΤΩΝ ΧΕΙΜΩΝΩΝ ΕΙΣ ΘΕΣΣΑΛΟΝΙΚΗΝ (1892-1973) ΚΑΙ ΛΑΡΙΣΑΝ (1899 - 1973)

Ὑπὸ
Λ. Α. ΦΑΟΚΑ

Πρὸς ταξινόμησιν τῶν χειμώνων (Δεκέμβριος - Φεβρουάριος) εἰς Θεσσαλονίκην καὶ Λάρισαν, ἐχρησιμοποιήθη ἡ γνωστὴ μέθοδος τῶν ἀποχῶν τῆς θερμοκρασίας ἑκάστου χειμῶνος ἀπὸ τῆς κανονικῆς τιμῆς τῆς χειμερινῆς θερμοκρασίας. Ἡ χρησιμοποιουμένη τιμὴ τοῦ Α, ὁρίζεται ὡς ὁ λόγος τῆς ἀποχῆς τῆς μέσης θερμοκρασίας ἑκάστου ἀπὸ τῆς κανονικῆς τιμῆς τοῦ χειμῶνος, πρὸς τὴν κανονικὴν τιμὴν τῆς ἀποχῆς ἀδιακρίτως σημείου, κεχωρισμένως δι' ἑκάστην ὑπὸ μελέτην πόλιν.

Ἀναλόγως τῆς τιμῆς τοῦ Α, διακρίνομεν τοὺς χειμῶνας εἰς γλυκεῖς, ἠπίους, κανονικούς, ψυχροὺς καὶ δριμεῖς.

Ἐκ τῆς ταξινομήσεως ταύτης διαπιστοῦνται τὰ ἑξῆς:

— Ὑπαρξις ἰσχυρᾶς συσχετίσεως ($r = 0.92$) μεταξὺ τῶν χειμώνων εἰς ἀμφοτέρας τὰς πόλεις.

— Βάσει τῆς τιμῆς τοῦ Α ($A \geqslant 2.1$) ἐχαρακτηρίσθησαν ὡς πλέον δριμεῖς χειμῶνες καὶ διὰ τὰς δύο πόλεις συγχρόνως, οἱ τῶν περιόδων 1928-29, 1931-32, 1941-42 καὶ 1953-54, ὡς καὶ οἱ τοιοῦτοι τῶν ἐτῶν 1904-05 καὶ 1908-09 διὰ Λάρισαν καὶ Θεσσαλονίκην ἀντιστοίχως.

— Οἱ χαρακτηρισθέντες ὡς γλυκεῖς χειμῶνες ($A \geqslant 2.1$), παρετηρήθησαν συγχρόνως καὶ εἰς τὰς δύο πόλεις, οἱ τῶν περιόδων 1901-02, 1903-04, 1916-17, 1935-36 καὶ 1954-55, ὡς καὶ ἐπὶ πλέον οἱ χειμῶνες 1914-15 (Λάρισα) καὶ 1950-51 (Θεσσαλονίκη).

— Τέλος, ὑπάρχει ἡ αὐτὴ σχεδὸν πιθανότης ἐπικρατήσεως μιᾶς ἑκάστης κατηγορίας χειμῶνος καὶ εἰς τὰς δύο πόλεις.

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