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THE INFLUENCE OF THE CITY OF THESSALONIKI IN RESPECT OF THE SURROUNDING AREA, IN THE BEHAVIOR OF SOME BIOCLIMATOLOGICAL INDICES

By

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Abstract : *Discomfort index, Sensitive Temperature and air Enthalpy for the period 1977-1981 are studied at 06, 12 and 18 GMT as well as corresponding mean daily values for two Meteorological Stations which are located about 13 Km appart.*

This study shows that there is a significant difference, at 95% confidence limit (CL), between the mean values of the studied period for every tested quantity, while the march during this period of the above indices are significant similar.

On the other hand, Power Spectrum and Coherence analysis show a significant periodicitu of an order of one year, apparent in both Met. Stations and in all tested quantities.

Another periodicity, apparent only in the Met. Station of Thessaloniki is of an order of a week, whieh is the elue of this work.

INTRODUCTION

In this paper we try to study the influence of a large crowded city with aa industry under development, on the climatic modification, in respect of its surrounding area.

For this purpose, a period of the recent five years is chosen, namely 1977-1981, for the Meteorological Station of Thessaloniki (AUT) which is in the middle of the city of Thessaloniki, a large crowded city with population of the order of 700,000 people, living and working in it, some of 100,000 vehicles moving all day during the year, while five to six months during the cold season of the year these people consume a huge amount of oil as fuel in the central heating systems and the industry, which covers the west side of the city, uses, round the year, electricity and oil as energy sources.

On the other hand, Met. Station of Thermi at a distance of about 13 Km SSE from Thessaloniki's downtown is chosen, because it is a

small village with no more than 10,000 people, out of main national or country roads and also not affected by Thessaloniki 's industrial zone, so we easily could say that the Meteorological Station of Thermi does really represents the true Climatic condition of Thessaloniki's surrounding area, see fig. 1.

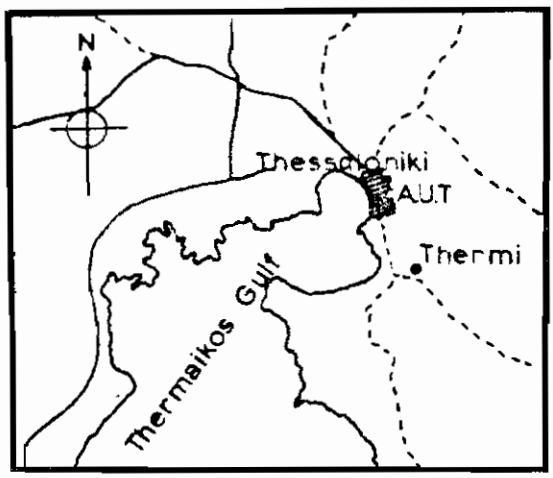

Fig. 1. Map of the city of Thessaloniki and Thermi with their surrounding areas.

For our study, air temperature (T), wet bulb temperature (T_w) and rel. humidity for 06,12 and 13 GMT are taken for both Met. Stations from which Discomfort Index (DI), Sensitive Temperature (TE) and air Enthalpy (E) are calculated according to the following formulas.

$$DI = 0.4(T + T_w) + 4.8$$

$$TE = T - 0.4(T - 10)(1. - h)$$

$$E = 0.24T + 0.622\, f\, (0.46T + 595.) \quad (755 - f)$$

Mean daily values ($\overline{X}$) have been computed using the formula

$$X = \frac{X_{06} + X_{12} + 2X_{18}}{4}$$

where X_{06}, X_{12} and X_{18} are the values of the above indices at the hours of observation on 06,12 and 18 GMT.

The chosen period contains 1826 days while missing data for each Met. Station does not exceed 15 observations, randomly distributed in the wbole period.

Missing data are filled using the mean value for that particular day and hour as it has been calculated from the corresponding values of the whole period.

ANALYSIS

To start with, for every time series, coefficients of skewness and kyrtosis have been calculated which show that, all formed time series, according to the above mentioned procedure, have values following very close the normal distribution at 95% CL, that is enough to proceed to more complicate analysis.

Each pair of corresponding time series of AUT and Thermi, i.e. Discomfort index at 06 GMT at AUT with Discomfort index at 06 GMT at Thermi, is used to calculate correlation coefficient and regression lines which are presented in fig. 2 which is self explanatory.

All, twelve, correlation coefficients are very significant, better than 99% CL, proving that the march during the tested period of any index computed at AUT is similar to that computed at Thermi.

This result leads us to assume that there is not any apparent, at first, reason that air masses above AUT and Thermi are different. However, when we apply t-test for the difference of the means for each pair of corresponding quantities between AUT and Thermi, we have the result that the compared means are different at a better than 95% CL, so we have to take in mind that the city of Thessaloniki itself plays an important role on the behavior of the examined bioclimatic indices.

Now, our effort is to strengthen the ahove result and give a possible explanation.

Next step was to apply Power Spectrum analysis on each formed time series to see if there is any periodicity not caused by any known climatic - bioclimatic reason.

The results of the applied Power Spectrum analysis are presented in fig. 3 and fig. 4 in a form of a set of histograms.

For space consuming purposes only the parts of histograms containing significant periodicities are shown.

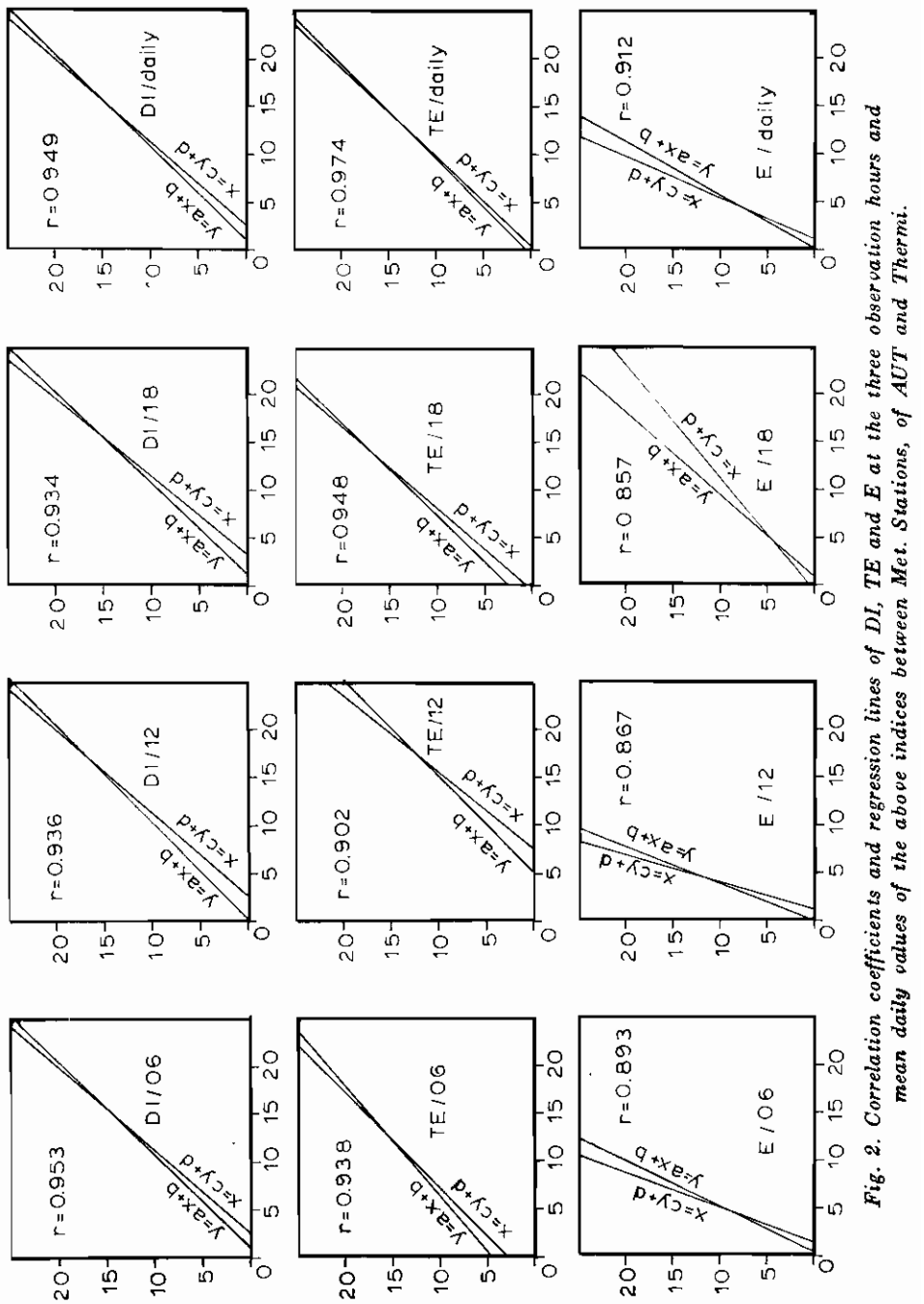

Fig. 2. Correlation coefficients and regression lines of DI, TE and E at the three observation hours and mean daily values of the above indices between Met. Stations, of AUT and Thermi.

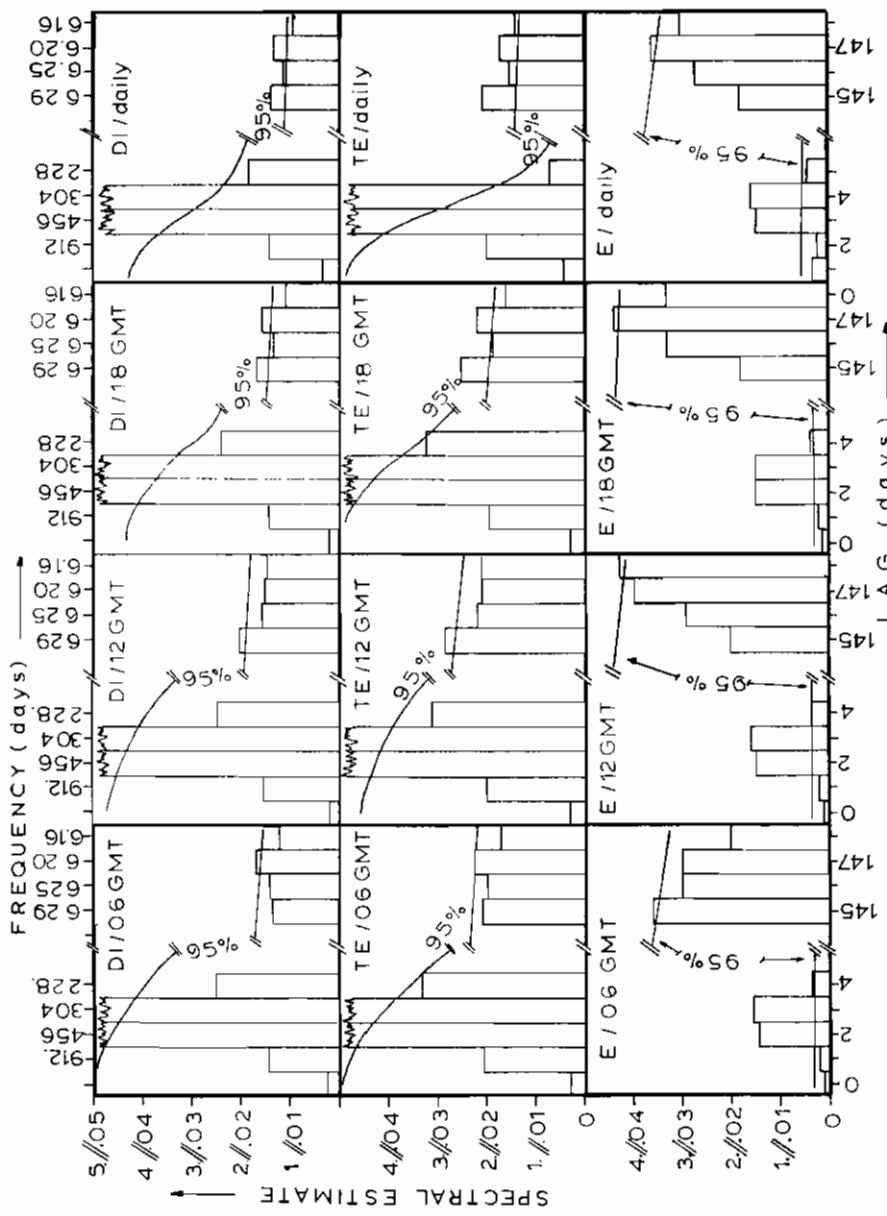

Fig. 3. Power Spectrum analysis of DI, TE and E at the three observation hours and mean daily values of the Met. Station of AUT.

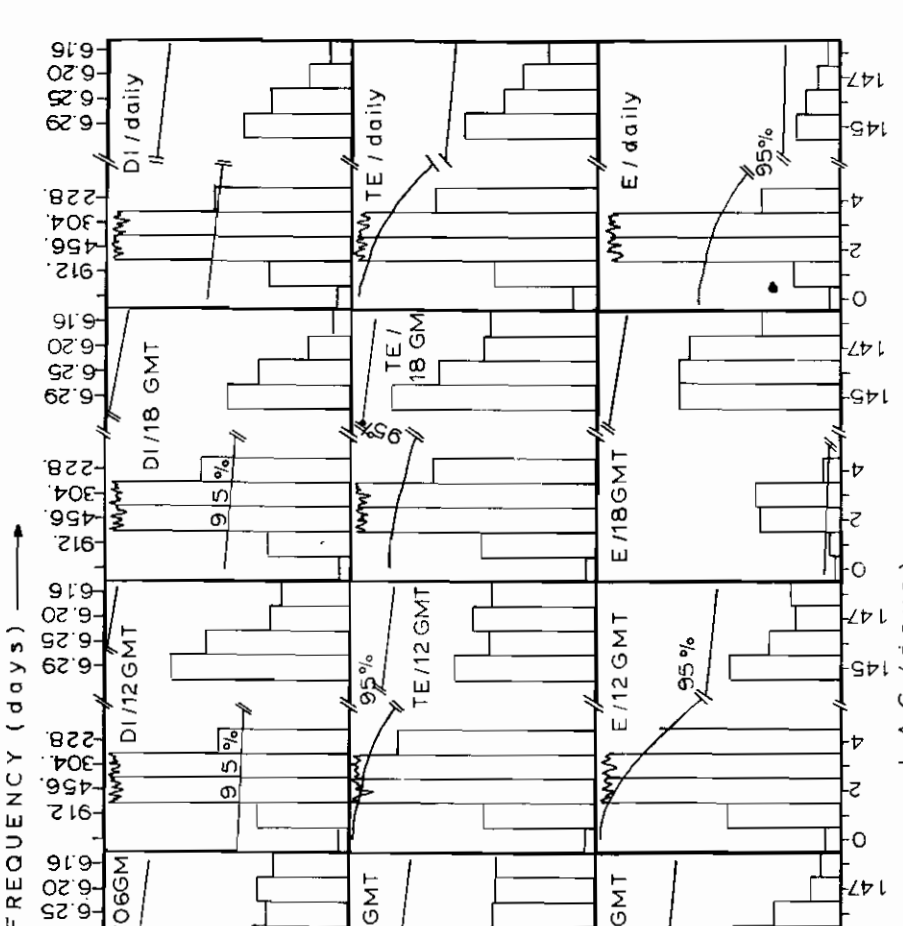

Fig. 4. Power Spectrum analysis of DI, TE and E at the three observation hours and mean daily values of the Met. Station of Thermi.

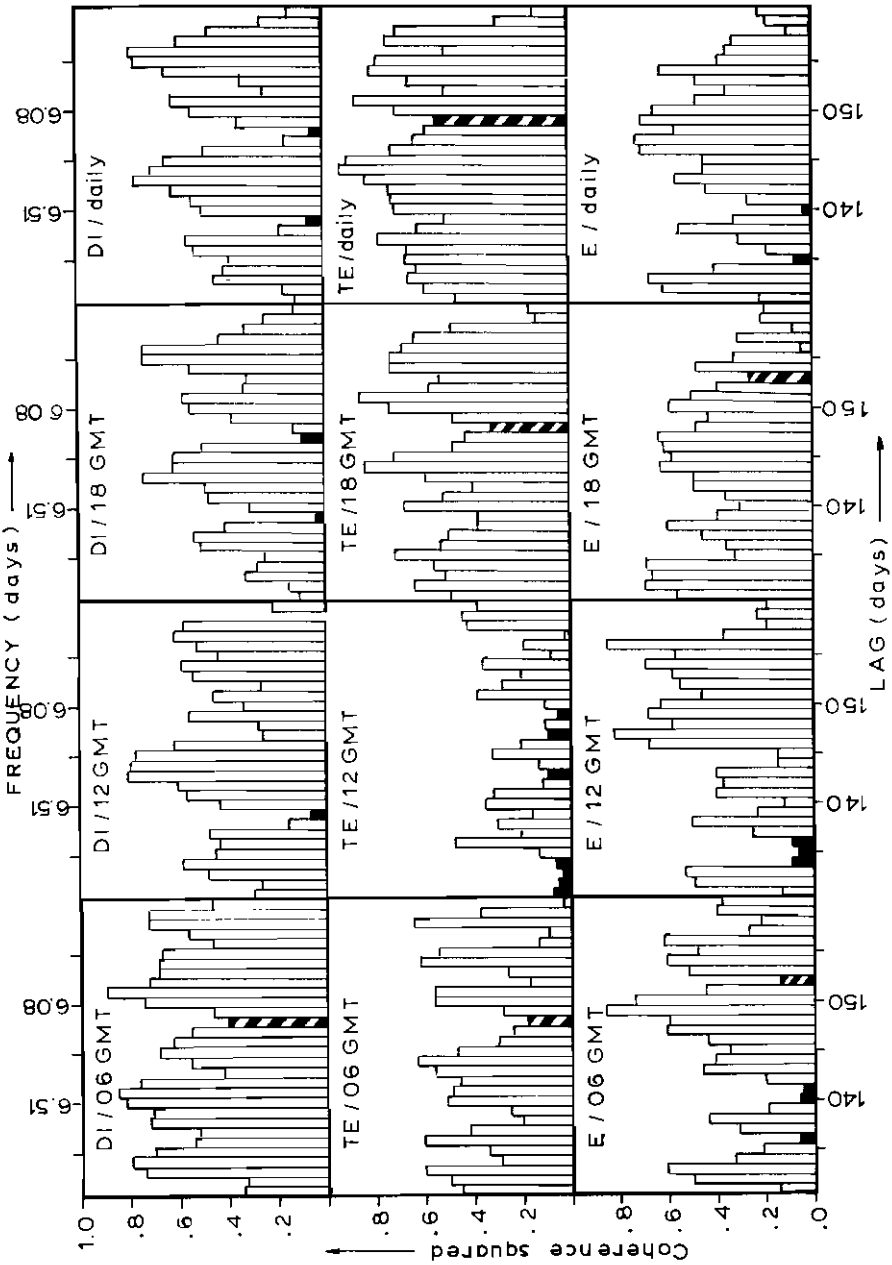

Fig. 5. Coherence test analysis of DI, TE and E at the three observation hours and mean daily values between the Met. Stations of AUT and Thermi. Black strips shows not significant at 95 % CL, while black and white strips shows significant at 95 % CL but rel. minima in this region of frequencies.

In histogram of fig. 3 which contains the results obtained by Power Spectrum analysis of AUT values, two significant periodicities are apparent, the annual and another one of an order of a week.

On the contrary, in histogram of fig. 4, produced by values of Thermi only the annual oscillation is apparent.

As far as we know, there is not any physical reason that triggers a weekly oscillation, so we should attribute this periodicity only to the human activity.

The weekly oscillation found above only in the Met. Station of AUT, encourage us to apply another test to be sure that this difference really exists.

For this purpose the Coherence analysis has been applied between the corresponding pairs of time series, the pairs like those taken to calculate correlation coefficients, an estimate that measures a kind of correlation between the two time series for every frequency.

The results obtained by this procedure are shown in the set of histograms of fig. 5, where also the part of histograms containing the most interest part of the Coherence procedure are presented, which also locate in the range of frequencies of the order of a week.

Coherence estimate s values for each frequency are significant at 95% CL except for these frequencies which correspond to an oscillation of an order of a week, which in the histograms have been drawn by full black strips.

Black and white strips in the histograms of fig. 5, although are significant they are also relative minima in that region of frequencies so we can easily say that really something is going on at this particular frequency.

The results of the Coherence analysis described above, proves that comparing corresponding time series between the chosen Met. Stations, we find them similar except for these frequencies of an order of a week which is apparent only in the time series formed by values of the most crowded city.

CONCLUSION

The indices studied above, although they show a similarity in their march during the scanned period 1977-1981, or in their behavior cause by known Meteorological factors, they do show a great difference in their behavior in respect of some other peculiarities caused by human activity.

First of all, there are great differences, at 95% CL, between the means of the Met. Stations in all examined indices at 06, 12, 18 GMT and mean daily values.

Second, a periodicity of an order of a week is apparent only in all tested time series of the most crowded city, Thessaloniki, while there is not any suspicion of existence a similar periodicity in the time serie formed by observations of the other, Thermi.

It is therefore assumed that the weekly oscilation could be attributed only to the human activity whieh decreases during weekends in the city of Thessaloniki.

In this paper it has not been studied whether the absolute values of the indices are decreasing or not during weekends but it should be a further field of research.

Last, but not least, is the warning message that Nature send us, telling what the inconsiderable human activity could affect the environment where the human life spred its activity.

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