Prediction of Ambient Weather Conditions of Alexandria Governorate by Mathematical Relationships

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ABSTRACT

As the most populated country in both North Africa and Middle East regions, Egypt is facing an up scaling demand in increasing its agricultural productivity. One of the main challenges which faces the production of plants in Egypt is the lack of information regarding the effect of microclimate on plant's productivity. The prediction of ambient weather conditions is essential for conducting further investigation to determine the effect of microclimate on plant's yield.

The current work presents the development of prediction equations that could simulate the trend of outside conditions. A computer program was employed to describe the trend of ambient-air conditions throughout an entire year in Alexandria Governorate, Egypt. Weather data of Alexandria governorate for five consecutive years was used in this analysis. Statistical analysis of daily hourly changes for air temperatures and relative humidities based upon metrological data revealed that the monthly average was the best descriptive measure to the month. Also an attempted to identify a representative day to simulate every season was investigated, however, results show that such indicator could not be introduced due to highly significant difference between weather conditions within the months of each season.

By employing a computer model based on Fourier series, mathematical expressions were developed to predict on an hourly basis outside air temperatures and air relative humidity throughout a representative day for each month within the year. Correlation coefficient for accuracy was taken into consideration as well.

The developed prediction equations can be used in future investigations in various areas which require weather conditions as inputs, such areas as environmental control, agriculture and food storage and handling

Keywords: Simulation, Prediction Equations, Ambient-Air Conditions, Air Temperature, Relative Humidity

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1 INTRODUCTION

With an increasing population which reached over 84.7 million Egypt is the most populated country in both North Africa and Middle East regions [1]. The importance of enhancing the agriculture industry for local supply and exportation is increasing constantly. Although the environmental conditions in Egypt are suitable to produce a large variety of plants throughout the year, optimal environmental conditions must be provided in order to obtain a fine production especially in controlled microclimates.

The lack of information about the environmental impact on plants production and how to control it is one of the main challenges which faces the agriculture industry in Egypt.

System simulations have been used for a variety of applications in agriculture science. Dent and Blackie [2] presented the concepts, development and use of simulation models when applied in an agricultural context. Moreover, various research works were done by developing and using simulation systems for investigating problems related to environmental conditions and microclimate control in greenhouses, such as [3], [4], [5], [6], [7], [8].

One of the main elements used in almost all system simulations related to microclimate control are ambient weather conditions. The present work was an attempt to mathematically simulate two ambient weather conditions: air temperature and relative humidity in an entire year for Alexandria governorate, Egypt, in order to use them in further research investigations in related areas.

2 MATHEMATICAL ANALYSIS AND FOURIER SERIES

Among the existing model methods for prediction equation, the most popular one is the model method by Fourier expansion [9]. Ibrahim [10] and Weltner *et al.* [11] agreed that Fourier's theorem related to periodic functions states that any periodic function can be expressed as the sum of sine functions of different amplitudes, phases and periods. Moreover, any periodic function can be represented by an infinite series of sine and cosine functions, such series is called "Fourier series". In case of representing a finite number of points in a periodic interval, a finite number of sine and cosine functions can be sufficiently used. Determination of such finite functions is known as the *harmonic analysis*.

Jordon *et al.*, [12] used Fourier series to establish a mathematical descriptive model for the diurnal changes in atmospheric temperature. Jone [13] developed a computer simulation program to determine heating and cooling degree days.

Furthermore, Albright and Scott [14] predicted, mathematically, the time-varying thermal environment in a building subjected to diurnal variations of external thermal conditions. The external conditions were described mathematically by a Fourier series

Fourier series was also used for estimating solar radiation as a function of air temperature by El-Shal and Mayhoub [15].

On the other hand, Dhar *et al.*, [16] developed a Fourier series model to predict hourly heating and cooling energy use in commercial buildings with outdoor temperature as the only weather variable. They also generalized a Fourier series approach to model hourly energy use in commercial buildings [17].

Cuesta and Lamúa [18] used Fourier series as well to develop a solution for heat conduction equation depending on temperature and applied to fruit and vegetables chilling.

In the current study Fourier series was used to mathematically simulate the hourly changes in air temperature and humidity within a unit time period of one day (24 hours). In addition a correlation coefficient for accuracy was taken into consideration.

3 Materials and methods

An attempt was carried out to mathematically simulate the ambient air temperature and relative humidity in an entire year for Alexandria governorate, Egypt. Mathematical models were approached to simulate the hourly changes in air temperature and humidity within a unit time period of one day (24 hours). Micro meteorological data for the specified location were obtained on an hourly basis. Data available were for five consecutive years. This was to increase the accuracy of the predicted equations.

The cyclic behavior of air temperature and relative humidity under normal weather conditions are the basic phenomena for the mathematical approach. The most common type of mathematical analysis applied to a periodic variation is the harmonic analysis.

3.1 Fourier Approximation and harmonic analysis

An arbitrary periodic function *f(x)* may be written as follows:

$$F(x) = \frac{a_o}{2} + \sum_{J=1}^{\infty} (a_J \cos JX + b_J \sin JX) \quad (1)$$

Where

$a_o / 2$ the mean value of the function *f(x)*

a_J the amplitude of cosine

b_J the amplitude of sine

The amplitudes are determined as follows:

$$a_J = \frac{1}{\pi} \int_0^{2\pi} f(x) \cos JX dX \quad (2)$$

$$a_J = \frac{1}{\pi} \int_0^{2\pi} f(x) \sin JX dX \quad (3)$$

The quantity J is called the "number of harmonics". It means the number of waves in each harmonic. It takes an integer value between 1 and ∞. Considering a discrete set N equally-spaced points, the set of sine and cosine functions in the harmonic function may be written as follows:

$$1, \cos \overline{X}, \cos 2\overline{X}, \ldots\ldots\ldots\ldots, \cos(N-1)\overline{X}, \cos N\overline{X}$$

$$\sin \overline{X}, \sin 2\overline{X}, \ldots\ldots\ldots\ldots, \sin N-1)\overline{X}$$

$$\overline{X} = 0, \frac{\pi}{N}, \frac{\pi}{N}, \ldots\ldots\ldots, \frac{(N-1)\pi}{N}$$

Letting the equally-spaced points be

$$X_0, (X_0 + h), (X_0 + 2h)$$

and using the transformations

$$\overline{X} = \frac{\pi}{N} y \text{ and } y = \frac{X - X_0}{h}$$

By providing unit spacing with the functions in the form:

$$1, \cos \frac{\pi}{N} y, \cos \frac{2\pi}{N} y, \ldots\ldots\ldots\ldots, \cos \frac{(N-1)\pi}{N} y, \cos \pi y$$

$$\sin \frac{\pi}{N} y, \sin \frac{2\pi}{N} y, \ldots\ldots\ldots\ldots, \sin \frac{(N-1)\pi}{N} y, \sin \pi y$$

$$y = 0, 1, 2, \ldots\ldots\ldots\ldots\ldots\ldots(2N-1)$$

The harmonic function then becomes,

$$F(y) = \frac{a_o}{2} + \sum_{J=1}^{N-1} (a_J \cos(\frac{\pi}{N} JY) + b_J \sin(\frac{\pi}{N} JY) + \frac{a_N}{2} \cos(\pi Y) \quad (3)$$

where a_J and b_J are the coefficients of the expansion determined by using the orthogonally relations as follows:

$$a_J = \frac{1}{N} \sum_{y=0}^{2N-1} f(y) \cos(\frac{\pi}{N} JY) \qquad J = 0, 1, \ldots, N \quad (4.1)$$

$$b_J = \frac{1}{N} \sum_{y=0}^{2N-1} f(y) \sin(\frac{\pi}{N} JY) \qquad J = 0, 1, \ldots, N \quad (4.2)$$

Considering an odd number (2N+1) of equally spaced points, the analogous formulas are,

$$F(y)=\frac{a_o}{2}+\sum_{J=1}^{N}\left(a_J\cos\left(\frac{2\pi J}{2N+1}Y\right)+b_J\sin\left(\frac{2\pi J}{2N+1}Y\right)\right)\quad y=0,1,\ldots,2N$$

$$a_J=\frac{2}{2N+1}\sum_{y=0}^{2N}f(y)\cos\left(\frac{2\pi J}{2N+1}\right)Y\qquad J=0,1,\ldots,N \tag{6.1}$$

$$b_J=\frac{2}{2N+1}\sum_{y=0}^{2N}f(y)\sin\left(\frac{2\pi J}{2N+1}\right)Y\qquad J=1,2,\ldots,N \tag{6.2}$$

In case of time series, the first harmonic ($J = 1$) has a wave length equal to the whole simulated time interval. The second harmonic has a wave length equal to one half of the time interval and so on. The number of harmonics, used in the function, depends on the desired accuracy with which a periodic behavior is estimated. The minimum number of harmonics to give a sufficient accuracy may be determined using a statistical analysis [10], [11].

3.2 Test of adequacy of number of harmonics

The variance test was used to test the degree of adequacy of a limited number of harmonics in representing the total number of harmonics of a function. The variance of the total number of harmonics was calculated as follows:

$$\sigma^2=\frac{\sum_{y=0}^{2N-1}(f(y)-\bar{f})^2}{2N} \tag{7}$$

$\bar{f}$: the mean value of the function *f(y)*

It was determined for 24 points (2N). The total number of harmonics was 12. The variance of the limited number of harmonics was calculated as follows,

$$F^2=\frac{1}{2}\sum_{J=1}^{L}C_J^2 \tag{8}$$

L: the limited number of harmonics in consideration

C_J : the amplitude of the J^{th} harmonic

$$C_J=\sqrt{a_J^2+b_J^2} \tag{9}$$

The ratio of the two variances ($Z=F^2/\sigma^2$) was considered as the measure of adequacy and was designated by *Z*.

Therefore,

$$Z=\frac{F^2}{\sigma^2} \tag{10}$$

The employed computer program was written in a way that allows the calculation of the ratio to start with the first harmonic and proceed for the second, then the third and so on. The calculation stops when the ratio becomes equal or greater than 0.98. The least number of harmonics which acquires a *Z* ratio of 0.98 or greater was considered adequate [10].

3.3 Computation Procedure

Assumption was made that an odd number of observations (2N+1) is equally distributed through a time period. Assuming also that the observations are simulated by a continuous function *f(t)* and f_i is the value of the function at a time t_i. By recalling equation (Eq.6) which applies to this case, the cosine and sine amplitudes could be determined as follows:

$$a_J=\frac{2}{2N+1}\sum_{i=0}^{2N}f_i\cos(Jt_i)$$

$$\text{for } t_i=\omega_i \text{ and } \omega=\frac{2\pi}{2N+1}$$

$$a_J=\frac{2}{2N+1}\sum_{i=0}^{2N}f_i\cos(J\omega.i)\qquad J=0,1,\ldots,N \tag{11}$$

and

$$\begin{aligned}b_J&=\frac{2}{2N+1}\sum_{i=0}^{2N}f_i\sin(Jt_i)\\&=\frac{2}{2N+1}\sum_{i=0}^{2N}f_i\sin(J\omega.i)\qquad J=1,2,\ldots,N\end{aligned} \tag{12}$$

In order to create a recurrence relation, the following arbitrary function was introduced:

$$V(t_K)=\sum_{i=K}^{2N}f_i\sin(i-K+1)\omega\qquad K=1,2,\ldots,2N \tag{13}$$

and

$$V(t_{2N+1})=V(t_{2N+2})=0$$

A recurrence relation, according to Anthony's technique [19], was established in order to calculate the value of the function $V(t_K)$ as a function of the values of the same function at two successive points $V(t_{k+1})$ and $V(t_{k+2})$ as follows :

$$V(t_k)=f_k*\sin\omega+2\cos\omega*V(t_{K+1})+V(t_{K+2}) \tag{14}$$

Anthony's technique was applied to harmonic functions to solve a_J and b_J by defining the arbitrary function as follows:

$$V(t_k)_J=\sum_{i=K}^{2N}f_i\sin J(i-K+1)\omega \tag{15}$$

In which J is the harmonic number. The function $V(t_K)_J$ covers the total simulated time period, when K=1 and

$$V(t_1)_J=\sum_{i=K}^{2N}f_i\sin J(i\omega) \tag{16}$$

By comparing equations (12) and (16), the following holds:

$$b_J=\frac{2}{2N+1}V(t_1)_J \tag{17}$$

Therefore, the recurrence technique is mainly used to calculate $V(t_1)_J$ in order to determine b_J.

For J harmonics ($2 \le J \le N$), where the number of harmonics is variable, as well as the time, the function $V(t_K)_J$ can be written as follows:

$$V(t_k)_J = V_{KJ} \sin J\omega = \sum_{i=K}^{2N} f_i \sin(i-K+1)J\omega \quad (18)$$

K : number of points k = 1, 2, ……….2N

J : number of harmonics J = 1, 2 , ……….N

$$V_{(2N+1,J)} = V_{(2N+2,J)} = 0$$

The recurrence relation can be generalized for more than a single harmonic in the following form:

$$V_{(K,J)} = f_K + 2\cos(\omega J) * V_{(K+1,J)} - V_{(K+2,J)} \quad (19)$$

$V_{K,J}$ is the function evaluated at the point K and for the J^{th} harmonic.

The calculation starts by solving $V_{(2N,J)}$ using the initial conditions,

$$V_{(2N+1,J)} = V_{(2N+2,J)} = 0$$

$$V_{2N,J} = f_K \quad (20)$$

The value of $V_{(2N-1,J)}$ is readily solved by knowing $V_{2N,J}$ and $V_{(2N+1,J)}$. The calculations then proceed successively until the value of $V_{(1,J)}$ is solved. Accordingly, the sine and cosine amplitudes can be determined for any number of harmonics as follows:

$$b_J = \frac{2}{2N+1} V_{1,J} \sin(J\omega) \quad (21)$$

and

$$a_J = \frac{2}{2N+1} (f_0 + V_{1,J} \cos J\omega - V_{2,J}) \quad (22)$$

The mean value ($\frac{a_0}{2}$) in the harmonic function *f(t)* can be determined using equation (22) by substituting *J* by zero.

In case of an even number of points (2N), the same formulae will be used, as if, 2N is simply equal to (2N+1) and the values (2N+1) in the equations will be replaced by the even number (2N).

The value of Z indicates how much the specific approach represented the total number of harmonics. Using the second harmonic improves the representation by a certain percentage over the first [14].

4 Results

A computer program was employed to predicted equations that could simulate the changeable patterns of both ambient air temperature and relative humidity via an entire year for Alexandria governorate, Egypt. The developed mathematical equations were approached to simulate the changes in air temperature and humidity within a chosen period of one day, 24 hours. Micro meteorological data for the specified location were obtained on an hourly basis per day throughout an entire year for five consecutive years.

In order to simplify data usage in the program and obtain accurate results, monthly representative data for both air temperature and relative humidity had to be identified as described in the below section. Consequently, the representative data were used in the simulation model to obtain the required prediction equations, correlation coefficient was taken into consideration as well to achieve accurate prediction for the developed weather formulas.

4.1 Monthly description of ambient-air condition

For identifying which set of data (day 15^{th} or the monthly average per month) were more accurate and could be used as a representative data for the month. Data for air temperature and relative humidity for day 15^{th} and the monthly average per month were statistically compared by t-test, This was done to obtain accurate predictions of the simulated results.

Data for day 15^{th} and the monthly average per month were plotted and compared for the twelve months. (Figure 1) shows the actual patterns of changes in ambient air temperature and relative humidity for the day 15^{th} and the monthly average per month during January.

Presented in Tables (1 and 2) the differences between means of air-temperatures and relative humilities, for day 15^{th} and the monthly average, respectively.

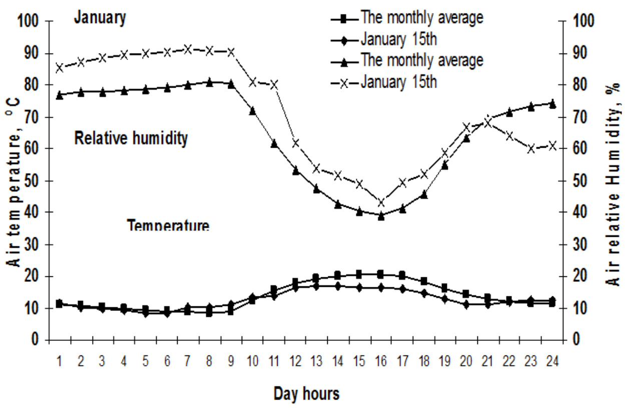

Figure 1 Actual patterns of changes in ambient air temperature and humidity for January 15th and the monthly average

Table 1 Differences between means of air-temperatures for the day 15^{th} and the month

Month	Means		Differences	Significance
	Day 15^{th}	Monthly Avg.		
Jan	2.61	13.68	1.07	ns
Feb	11.07	12.38	1.31	ns
Mar	13.50	13.74	0.24	ns
Apr	16.08	18.50	2.42	*
May	19.48	21.35	1.87	ns

Jun	26.05	24.53	1.52	*
Jul	25.73	26.05	0.32	ns
Aug	27.47	26.95	0.52	ns
Sep	26.23	25.63	0.60	ns
Oct	19.89	22.72	2.83	**
Nov	18.03	19.13	1.10	**
Dec	17.13	17.23	0.10	ns

ns non significant

* Significant at 0.05 probability level.

** Highly significant at 0.01 probability level.

TABLE 2 DIFFERENCES BETWEEN MEANS OF RELATIVE HUMIDITIES FOR THE DAY 15TH AND THE MONTHLY AVERAGE

Month	Means		Differences	Significance
	Day 15th	Monthly Avg.		
Jan	70.94	65.04	5.90	ns
Feb	69.78	59.24	10.54	*
Mar	73.49	65.58	7.91	ns
Apr	65.12	69.05	3.93	ns
May	74.34	77.79	3.45	*
Jun	65.87	74.17	8.30	ns
Jul	73.08	77.69	4.61	ns
Aug	80.25	74.76	5.49	ns
Sep	72.28	70.29	1.99	ns
Oct	54.13	66.32	12.19	**
Nov	57.08	64.37	7.29	**
Dec	77.35	72.16	5.19	**

ns non significant

* Significant at 0.05 probability level.

** Highly significant at 0.01 probability level.

4.2 Seasonal description of ambient-air conditions

Since the hourly changes within a day based upon data represented the monthly average were the best descriptive measure to the month, another attempt was carried out to determine an expressing day to every season within the year. A statistical analysis was accomplished to test the differences among months within every season. Months in this analysis were simulated by days responded to the monthly averages. Four seasons per year and three months per season were considered in this analysis. The patterns of the monthly averages for the air temperatures and relative humidities are illustrated in (Figures 2,3,4 and 5). Data in each figure show the hourly changes within a day representing the monthly average. A day expressing the season was also added to each figure. It was the average of the three months within the season. The analysis, is listed in (Tables 4 and 5).

4.3 Mathematical analysis

Fourier series was used in order to describe the trend of the ambient-air conditions throughout an entire year. The employed computer program used the previously described mathematical models to develop predicted equations. Micro meteorological data for five consecutive years were used as the input data to the model.

The output results of the computer program implied the mean and amplitude coefficients with their correlations, Z. The coefficients for each month were achieved and the predicted equations were developed. The predicted equations for air temperature and relative humidities were respectively in the form:

$$T(t) = \frac{a_0}{2} + a_1 \cos(\omega t) + b_1 \sin(\omega t) + a_2 \cos(\omega t) + b_2 \sin(\omega t) \quad (23)$$

$$RH(t) = \frac{a_0}{2} + a_1 \cos(\omega t) + b_1 \sin(\omega t) + a_2 \cos(\omega t) + b_2 \sin(\omega t) \quad (24)$$

The coefficients of the previous equations were attained in (Tables 6 and 7).

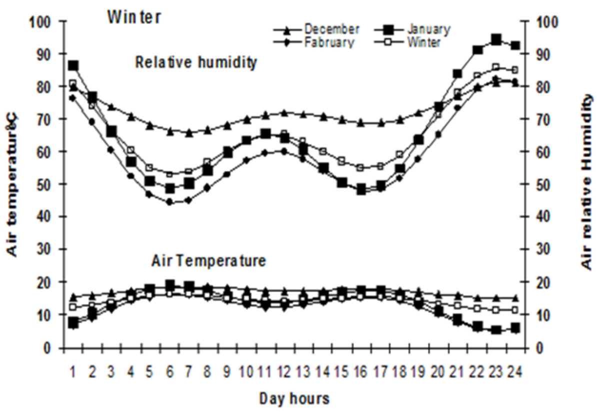

Figure 2. Monthly averages of ambient air temperature and relative humidity for winter season

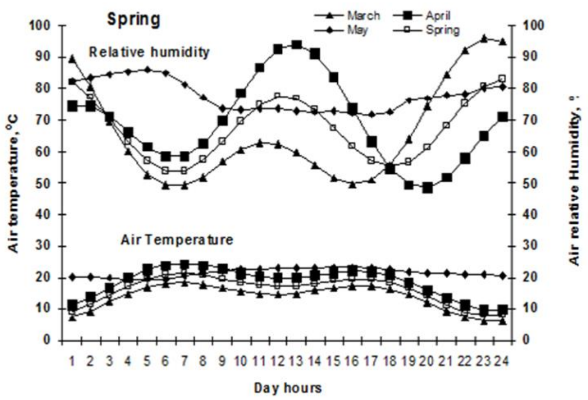

Figure 3. Monthly averages of ambient air temperature and relative humidity for spring season

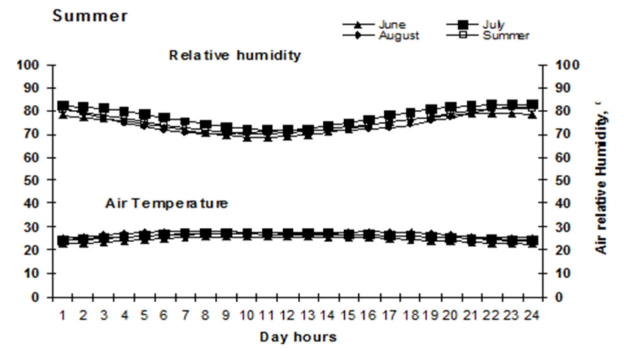

Figure 4. Monthly averages of ambient air temperature and relative humidity for summer season

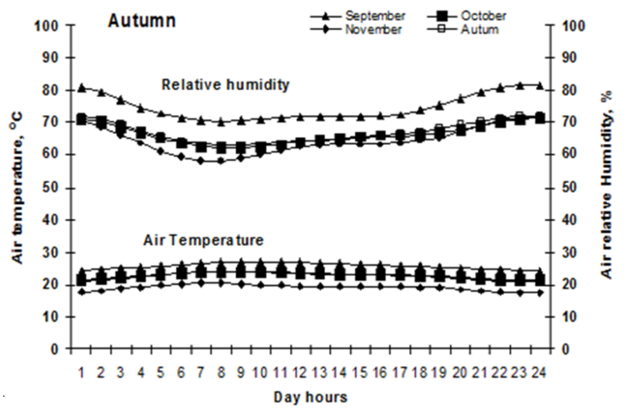

Figure 5. Monthly averages of ambient air temperature and relative humidity for autumn season

TABLE 3 DIFFERENCES AMONG MEANS OF BOTH THE MONTHS AND THE SEASONAL AVERAGE FOR AIR TEMPERATURES.

Month	**Mean**	
December	17.22	A
Winter	14.40	B
January	14.21	B
February	12.25	C
May	21.39	A
April	18.51	B
Spring	16.13	C
March	13.75	D
August	26.98	A
July	26.06	B
Summer	25.86	B
June	25.54	C
September	25.62	A
October	22.71	B
Autumn	22.49	B
November	19.13	C

TABLE 4 DIFFERENCES AMONG MEANS OF BOTH THE MONTHS AND THE SEASONAL AVERAGE FOR RELATIVE HUMIDITIES.

Month	**Mean**	
December	72.16	A
January	71.48	A
February	59.24	B
Winter	48.38	C
May	77.66	A
April	69.05	B
Spring	67.31	B
March	65.57	B
July	77.69	A
Summer	75.49	A
August	74.61	B
June	74.17	B
September	70.29	A
Autumn	66.98	B
October	66.31	B
November	64.36	C

TABLE 6 THE COEFFICIENTS OF THE AMPLITUDES REQUIRED FOR AIR TEMPERATURE HARMONIC FUNCTIONS.

Month	a_0	a_1	b_1	a_2	b_2	Z
Jan	27.36	-3.91	-3.80	1.35	1.49	0.98
Feb	24.49	-3.31	-3.35	1.12	1.11	0.98
Mar	27.49	-4.23	-3.42	0.92	0.69	0.98
Apr	37.01	-4.98	-3.67	1.66	0.55	0.97
May	42.78	-1.40	-0.74	0.24	-0.22	0.97
Jun	49.08	-1.40	-0.26	0.21	-0.08	0.98
Jul	52.11	-1.41	-0.23	0.20	-0.09	0.99
Aug	53.95	-1.11	-0.73	0.26	0.14	0.98
Sep	51.25	-1.24	-0.20	0.25	-0.12	0.97
Oct	45.44	-1.09	-0.32	0.38	-0.17	0.98
Nov	38.27	-1.13	-0.67	0.51	-0.08	0.97
Dec	34.46	-1.10	-0.86	0.49	0.12	0.97

TABLE 7 THE COEFFICIENTS OF AMPLITUDES REQUIRED FOR AIR RELATIVE HUMIDITY HARMONIC FUNCTIONS.

Month	a_0	a_1	b_1	a_2	b_2	Z
Jan	130.1	14.18	13.38	-3.08	-6.59	0.99
Feb	118.5	10.65	11.17	-3.59	-3.91	0.97
Mar	131.2	16.29	13.19	-3.41	-4.89	0.98
Apr	138.1	-10.70	12.69	1.98	8.24	0.87
May	155.3	5.62	2.91	-0.23	1.34	0.93
Jun	148.3	4.88	-0.47	-1.81	0.06	0.94
Jul	155.4	5.52	-0.68	-1.04	0.21	0.97
Aug	149.2	5.03	2.02	-1.20	-0.24	0.97
Sep	140.6	3.70	-0.18	-0.43	0.35	0.89
Oct	132.6	3.54	1.26	-1.38	0.767	0.95
Nov	128.7	4.56	2.54	-2.54	0.35	0.97
Dec	144.3	4.67	4.18	-1.65	-0.44	0.97

5 Discussion

5.1 Monthly description of ambient-air condition

It was noticed that the amplitudes of the relative humidity wave functions were always greater than the amplitudes of the air temperature wave functions. Moreover, the air temperature wave functions were much more flat during the summer months than the rest of the year. The air temperature fluctuation per day in summer was quite often ±2ºC. However, this oscillation reached the maximum of ±4ºC in winter per day. The alternation of the wave functions for air relative humidities were within ± 15% and ± 20% in summer and winter seasons, respectively.

A statistical analysis, T-test, was carried out to detect the significant means between each pair of data. The significant differences were tested between the data of day 15th and the monthly average. Tests were conducted for both air temperature and relative humidities throughout the twelve months of the year. The results were concluded in (Tables 2 and 3). No significant differences of air temperature were found between data of day 15th and the monthly average for most of the months throughout the year, as revealed in (Table 2). However, the differences for April and June months were significant (at 0.05 probability level), while October and November had highly significant differences (at 0.01 probability level).

Meanwhile, (Table 3) represents the differences of relative humidity between data of day 15th and the monthly average. As shown, there were significant differences for both February and May months. Furthermore, the results revealed high significant differences also for October, November and, December months. Moreover, the results indicated no significant differences for the rest months of the year.

Accordingly, data of the monthly average were chosen instead of day 15th as the more appropriate measure to represent each month for both air temperature and relative humidity.

5.2 B. Seasonal description of ambient-air conditions

The statistical method, least significant difference (L.S.D.), was employed to detect the differences among the means of both the three months within each season and the seasonal average. The analysis was conducted and the results were achieved for both the air temperatures and relative humidities. The analysis, as listed in (Tables 4 and 5), indicated significant differences among the means of both the months and the seasonal average. Therefore, representative days for air temperatures and relative humidities to simulate every season could not be introduced.

5.3 Mathematical analysis

The correlation coefficient, Z, represented the accuracy of the equation coefficients. In other words, it declared how the actual data could be precisely expressed by these formulas. Based upon the previous discussion, the two preceding equations could be employed to predict, on an hourly basis, the air temperature and relative humidity throughout an entire year for Alexandria Governorate, Egypt. The prediction was on an hourly basis for 24-hour. The day was considered afterwards repetitive with no change within each month. The required amplitudes for the harmonic functions and their correlation coefficients (Z) of each month during the year are presented respectively in (Tables 6 and 7). The results were determined for both the air temperature and air relative humidity.

6 Conclusion

The current work presents the development of prediction equations that could simulate the trend of outside conditions using metrological data for five consecutive years. A computer program was employed to describe the trend of the ambient-air conditions throughout an entire year in Alexandria Governorate, Egypt.

Statistical analysis of the hourly changes within a day based upon data revealed that the monthly average was the best descriptive measure to the month. In the same time, the statistical analysis indicated that data representative days for air temperatures and relative humidities to simulate every season could not be introduced.

Furthermore, the developed equations can predict on an hourly basis outside air temperature and air relative humidity throughout a representative day for each month within the year. Correlation coefficient was taken into consideration as well to achieve accurate prediction for the developed weather formulas.

The developed equations can be used in future investigations in various areas which require weather conditions as inputs, such areas as environmental control, agriculture and food storage and handling.

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