

## **Study the Relationships Between Cloudiness and Meteorological Factors in Mosul City**

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### **ABSTRACT**

This research investigates the relationships between cloudiness and different meteorological factors in Mosul City during the period (1980-2000).

The result indicate that there is a significant variation of cloudiness during the period of study where the value of the coefficient variation (CV) is ranged between (15-81)%.

The results also showed that there is a clear oscillation of cloudiness during the months of the year.

The correlation coefficient (R) between cloudiness and the other meteorological elements (solar radiation, sunshine hours, relative humidity, air temperature and rainfall) are: (R= -0.82, R= -0.93, R= 0.97, R= -0.96, R= 0.92) respectively.

.(2000-1980)

%(81-15)

R

.(R= 0.92 R= -0.96 R= 0.97 R= -0.93 R= -0.82)

### **INTRODUCTION**

The study of cloudiness is important where it affects the performance of solar collector, solar cells, the performance and design of air condition system and solar supplying system.

Solar radiation is attenuated by the presence of clouds in its path, as well as by the various elements of cloudless atmosphere (Anthes, 1997). The depletion of the direct beam radiation by the clouds depends on the type of clouds, their thickness, height and the number of layers (Iqbal, 1983; Danielson et al., 2003).

An increase of the total amount of clouds without changing the fraction of the different cloud types is believed to give cooling of the earth, because they reflect solar radiation to space and reduce its amount reaching the surface (Ackeram and Konx, 2003; Svensmark, 1998).

Since clouds have a net cooling effect on climate this would imply that the estimated reduction of solar radiation during the 20th century might have been responsible for much of the observed warming (Svensmark, 1998; Marsh and Svensmark, 2000; Kristjanson, et al., 2002).

To study the clouds effect, the term cloud cover and cloudiness must be taken (Navra, 1979) which is measured in octa of the sky cover. For much of the time clouds affect the weather, they shade out sun light, reduce temperature and often bring rain (Park, 2003).

An increase of low altitude clouds; will result in a cooling (Svensmark, 1997). Where as an increase of high altitude clouds will warm the planet. An increase of the total amount of clouds with out changing the fraction of the different cloud types is believed to give cooling of the earth.

In this study the relationships between cloudiness and different meteorological factors (solar radiation, sunshine hours, humidity, temperature and rainfall) are examined, during the period (1980-2000) for Mousl City. The correlation coefficients between these parameters and cloudiness were also determined.

### Data Analyzed

1. Mean monthly values of the different meteorological parameters (cloudiness, sunshine hours, solar radiation, humidity, temperature and rain full) were determined for period (1980-2000) for Mousl City as shown in Table (1).

Table 1 : Mean monthly value of cloudiness and different meteorological factors.

Months Parameters	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	Cloudiness (C)	4.38	4.2	4	3.8	2.76	1.07	0.43	0.51	0.66	2.29	3.15
Solar radiation (w/m <sup>2</sup> )	1844	2646	3370	4541	5301	5943	5839	5465	4732	3389	2320	1718
Sunshine (hrs)	4.64	5.67	6.71	7.97	9.92	12.1	12	11.5	10.3	8.27	6.25	4.36
Relative humidity(%)	80.5	73.9	68.4	59.9	43	27.5	24.4	25.8	30.9	46.5	66	79.8
Temperature (C°)	6.84	8.44	11.7	17.7	23.9	29.6	34	32.7	28.3	22.4	14.1	9.3
Rainfall (mm)	60.8	63.3	70.1	39.5	17.7	2.3	0.3	0.0	0.45	14.8	55.5	63.8

2. The standard deviation and the coefficient of variation of the cloudiness during the period (1980-2000) were also calculated, as shown in Table (2).

Table 2: Monthly mean average of cloudiness and their standard deviation and coefficient variation.

Months Parameters	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
<b>Cloudiness</b>	4.38	4.2	4	3.8	2.76	1.07	0.43	0.51	0.66	2.29	3.15	4.9
<b>S.D.</b>	0.738	0.732	0.78	0.58	0.732	0.54	0.35	0.36	0.48	0.68	0.7	0.89
<b>C.V%</b>	16.8	17.4	19.5	15.2	26.5	50.4	81.4	70.5	72.7	29.7	22.2	18.1

3. Multiple regression equation between the cloudiness and all the meteorological parameters was found.

## RESULTS AND DISCUSSION

### 1. Study of the variability of cloudiness during the period (1980-2000).

Fig. (1) show the monthly mean values of cloudiness during the period (1980-2000) in Mosul City.

The value of cloudiness (C) during January was high and then it begin to decrease till it arrive the minimum value in July ( $C=0.43$ ) and then the value of C increase till it arrive of 4.9 in December.

Fig. (2) show the effect of cloudiness on the amount of solar radiation reaching the earth surface during the months of the year. Where the value of solar radiation is between (4732-5943)  $w/m^2$  when the value of ( $C<2$ ).

While the monthly value of solar radiation is between (3389-2320)  $w/m^2$  when the value of ( $2<C<4$ ).

When the value of ( $C>4$ ) the mean monthly value of solar radiation is below 2000  $w/m^2$ . To explain the variability of cloudiness during the period (1980-2000) Fig. (3) show the standard deviation of cloudiness during the month of the year.

The figure show that the minimum value of SD equal to (0.35) which is obtain in July while the maximum value (0.89) obtain in December.

Fig. (4) show coefficient of variation of cloudiness during the months of the year for the period (1980-2000).

The figure show that the value of CV is ranged between (15-81)% which mean that there is an significant variation of cloudiness during the period of study.

Fig. (5) show the seasonal value of cloudiness which is logically show that the value of C in Winter > Spring > Autumn > Summer the value of C in Winter = 4.38, in Spring = 3.52, in Autumn = 2.03, in Summer = 0.67

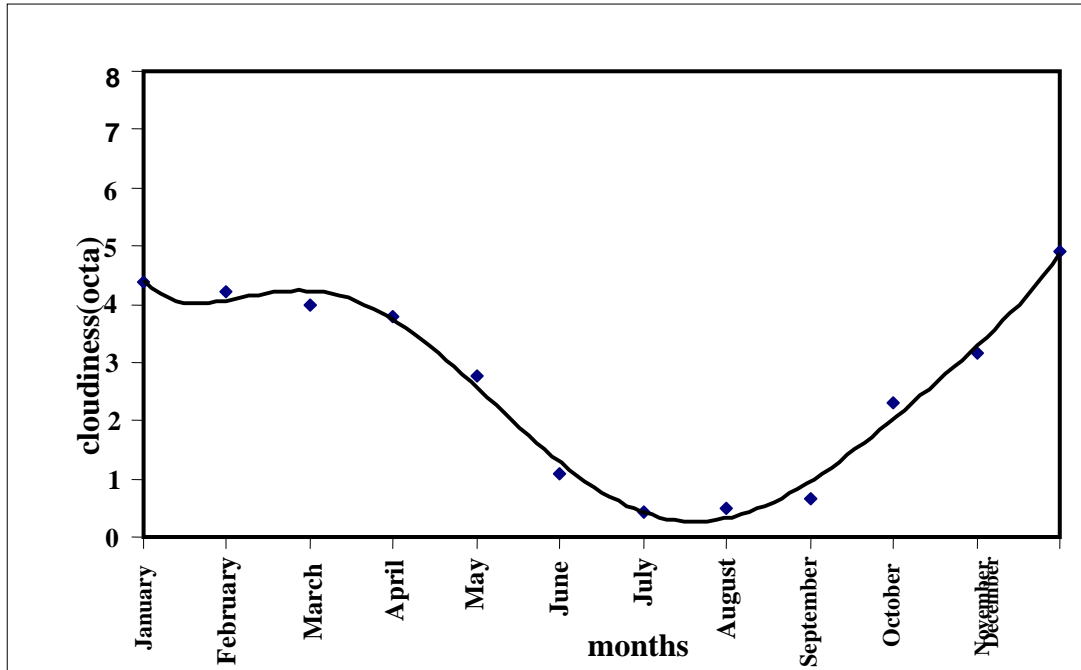


Fig. 1 : Mean monthly value of cloudiness during the period (1980-2000).

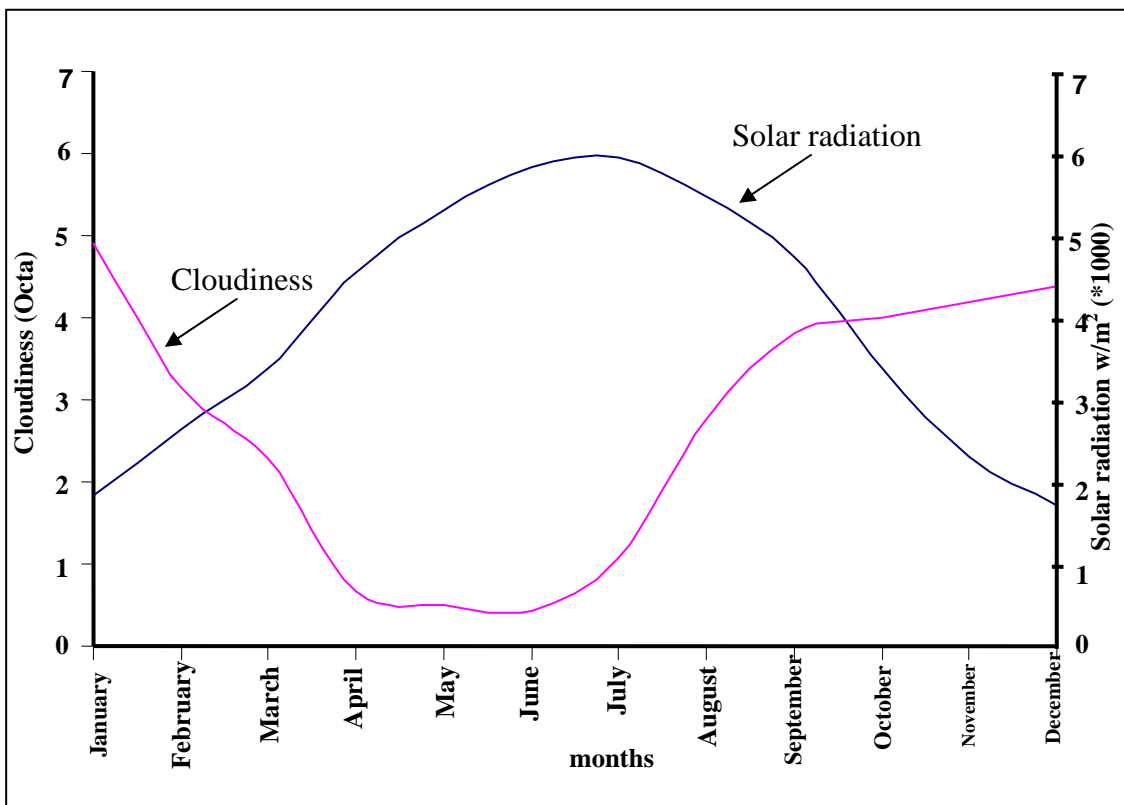


Fig. 2 : Relation between cloudiness and solar radiation during the months of the year.

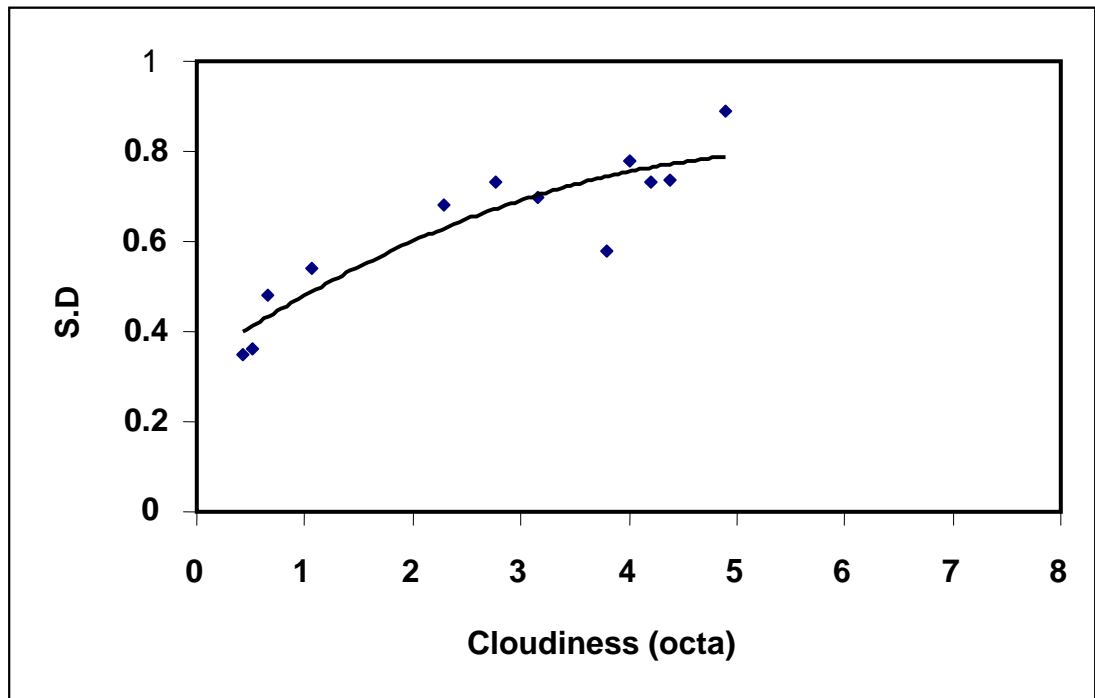


Fig. 3 : The standard deviation of cloudiness during the month of the year.

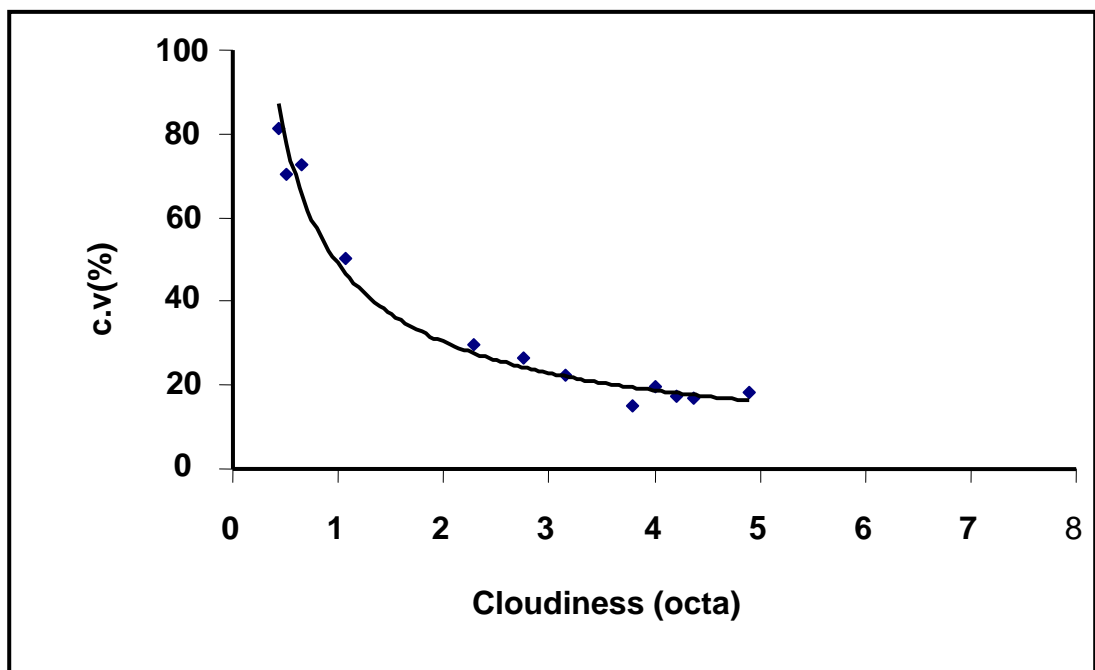


Fig. 4 : Coefficient of variation of cloudiness during the months of the year.

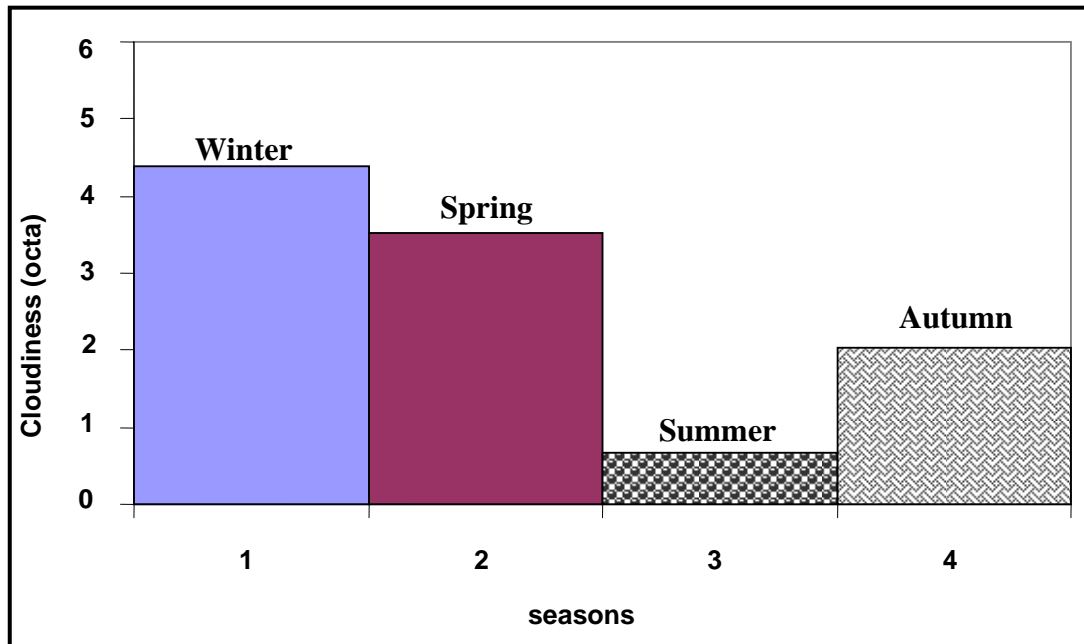


Fig. 5 : The seasonal value of cloudiness for period (1980-2000).

## 2. Study of the correlation between cloudiness and the different Meteorological factors:

Correlation coefficient between cloudiness and the different meteorological factor were obtained for Mosul City during the period (1980-2000), These correlations were:

1. Fig. (6) show the inversely correlation between cloudiness and solar radiation ( $w/m^2$ ).

The linear regression equation which is obtain for this relation was:

$$Y = -780.8x + 6017.8$$

The value of (R) between the two variable was (R= -0.82).

2. Fig. (7) show also the inversely correlation between cloudiness and sunshine hours.

The regression equation between the two variable was:

$$Y = -1.5922x + 12.573$$

The value of (R) obtain for the two variable was (R= -0.93).

3. Fig. (8) show the directly correlation between cloudiness and relative humidity.

The correlation was:

$$Y = 12.788x + 17.956$$

The value of R=0.97

4. Fig. (9) also show directly correlation between cloudiness and rain full. The correlation was:

$$Y = 17.762x - 16.602$$

The value of the correlation coefficient R = 0.920

5. Fig (10) show the inversely correlation between cloudiness and temperature.

The regression equation between the two variable was

$$Y = -5.74 + 35.294$$

The value of R = -0.96

6. The following equation was obtained which correlate the relation between cloudiness and the all meteorological factors

$$[C = a + bT_{\text{mean}} + c \text{RH} + d \text{Rad} + eN + f R]$$

$bT_{\text{mean}}$  = Monthly mean temperature

R.H = Relative humidity

Rad = solar radiation

N = sun shine hours

R = Rain fall

$$C = -3.74 + 1.770T_{\text{mean}} + 0.133 \text{RH} + 7.350 \text{Rad} - 0.275 N - 1.40 R$$

From these correlations we can able to estimate cloudiness from the different meteorological factors which is valuable in different meteorological applications.

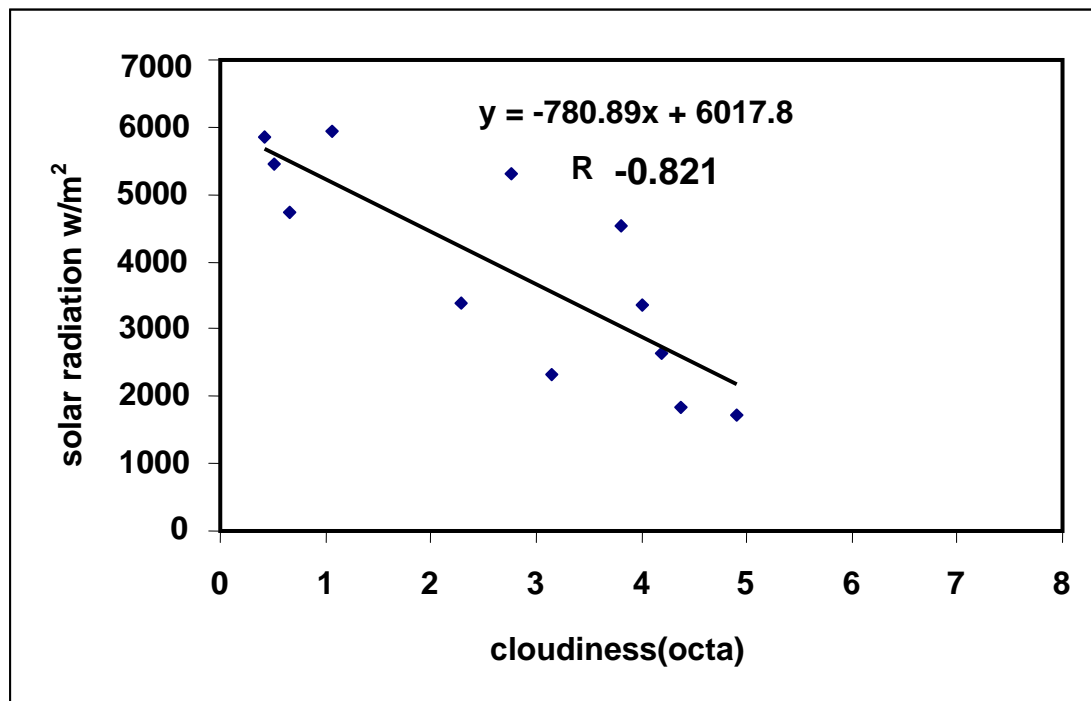


Fig. 6 : Correlation between cloudiness and solar radiation .

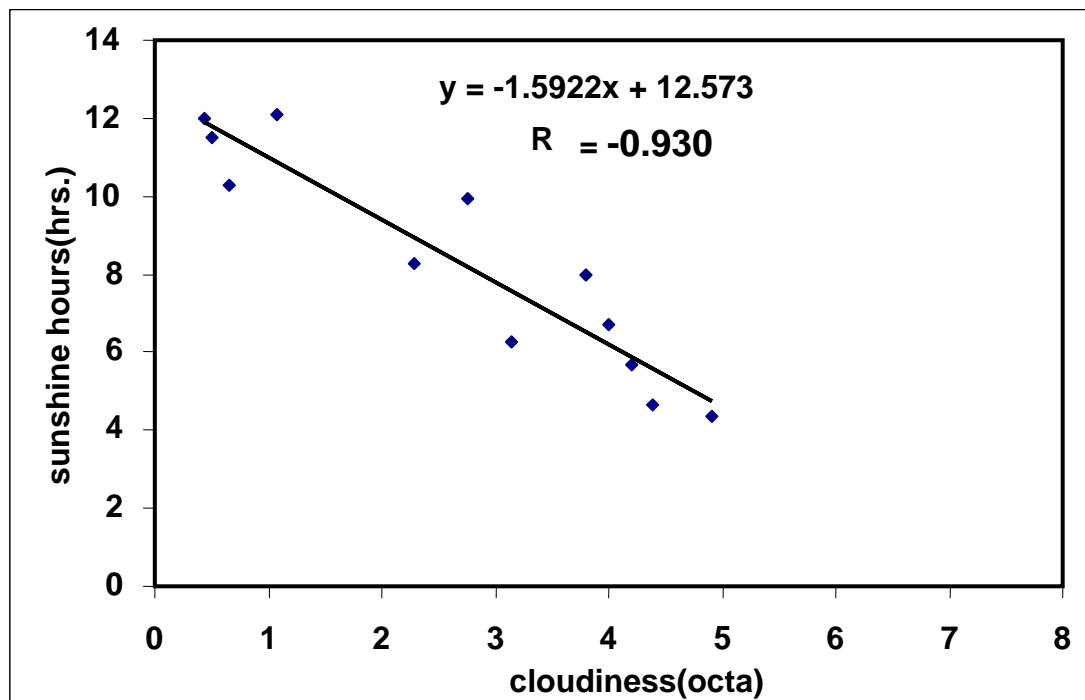


Fig. 7 : Correlation between cloudiness and sunshine.

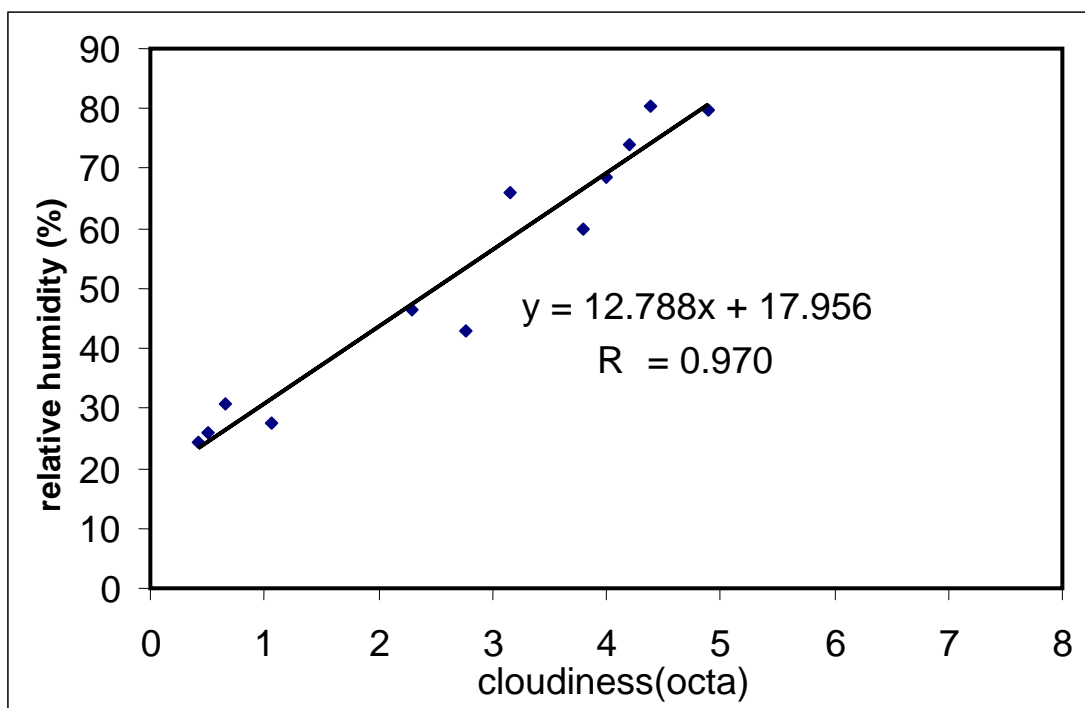


Fig. 8 : Correlation between cloudiness and relative humidity.



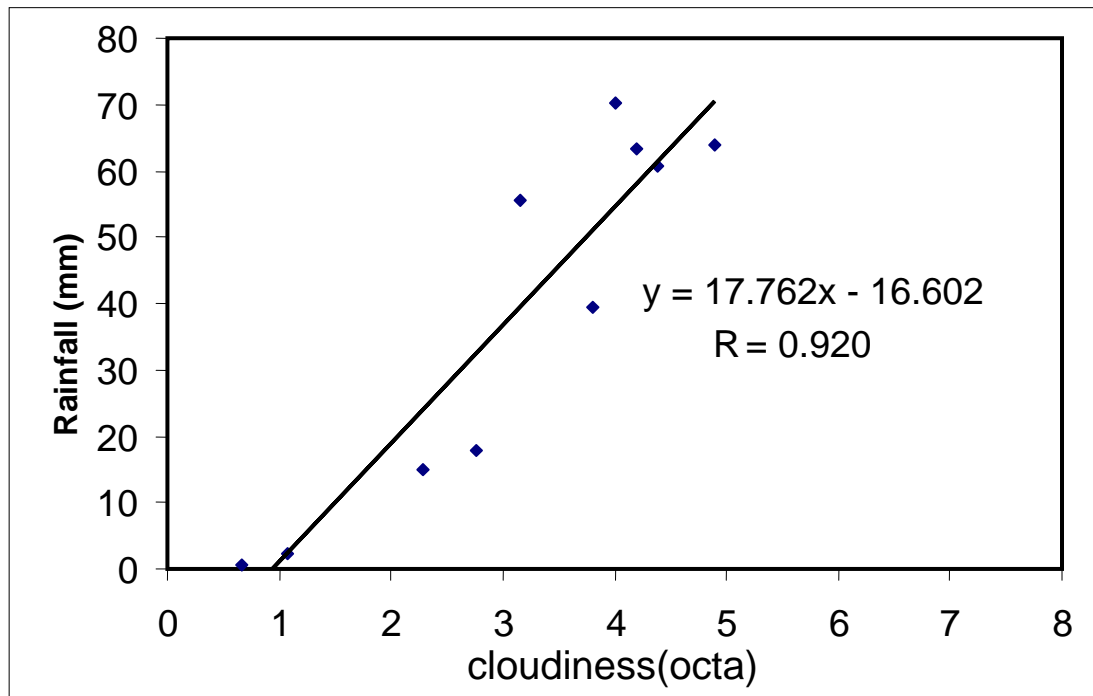


Fig. 9: Correlation between cloudiness and rainfall  $R = 0.920$ .

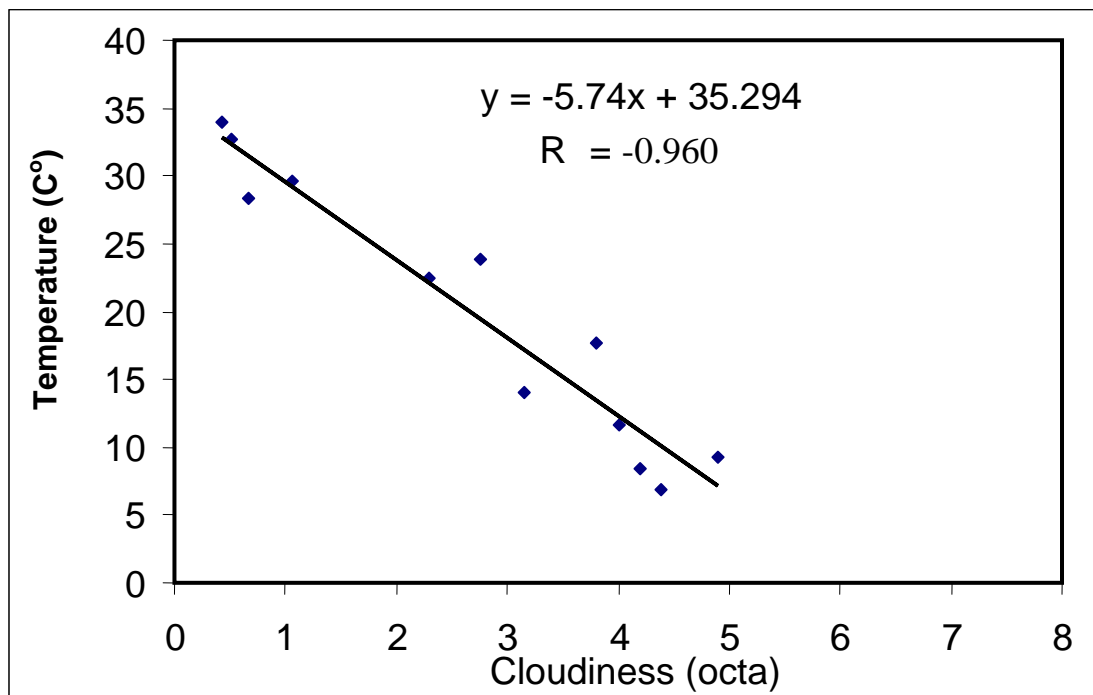


Fig. 10 : Correlation between cloudiness and temperature.

### CONCLUSIONS

1. The coefficient of variation of cloudiness during the period of study is ranged between (15-81)%.
2. The results also showed that the standard deviation of cloudiness is ranged between (0.35-0.89).
3. Different mathematical models were obtained which correlate the relationships between cloudiness and each of the other meteorological elements (solar radiation, sunshine hours, relative humidity, air temperature and rainfall).
4. A relationship also found between cloudiness and all the meteorological elements which is:

$$C = -3.74 + 1.770T_{\text{mean}} + 0.133 \text{ RH} + 7.350 \text{ Rad} - 0.275 \text{ N} - 1.40 \text{ R}$$

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