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Connection of the Mediterranean Oscillations with Temperature and Precipitation in Baghdad City

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Abstract

The aim of this research is to study the effects of the Mediterranean Oscillation Index: Algiers and Cairo (MOIAC) on the temperature and precipitation patterns in Baghdad city in Iraq. Data of the monthly means of the MOIAC index, the monthly means of temperature, and the monthly total of precipitation were analyzed for the period 1958-2000. Pearson's non-parametric test was used to investigate the correlations between these three variables. The time series of temperature and precipitation showed no distinct trends. The results indicated that there is a slight correlation between MOIAC and temperature and precipitation suggesting that MOIAC has no major effects on the temperature and precipitation patterns in Baghdad city.

Key words: Mediterranean Oscillation , Air temperature , Precipitation , Iraq.

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الخلاصة

يهدف هذا البحث الى دراسة تأثيرات ذبذبة البحر الأبيض المتوسط على أنماط درجة الحرارة والهطول لمدينة بغداد. تم تحليل بيانات المعدلات الشهرية لمؤشر ذبذبة البحر الأبيض المتوسط المحسوب بين مدينتي الجزائر والقاهرة ودرجة الحرارة والمجموع الشهري للهطول لمدينة بغداد للفترة 1958 الى 2000. تم استعمال الاختبار الإحصائي سبيرمان لفحص العلاقات بين المتغيرات أعلاه. لم تدل السلاسل الزمنية لدرجة الحرارة والهطول على وجود أي سلوك محدد. كما بينت النتائج وجود علاقة طفيفة بين مؤشر ذبذبة البحر الأبيض المتوسط مع درجة الحرارة والهطول مما يدل على عدم وجود تأثيرات كبيرة لمؤشر ذبذبة البحر الأبيض المتوسط على أنماط درجة الحرارة والهطول لمدينة بغداد.

الكلمات المفتاحية : ذبذبة البحر الأبيض المتوسط ، درجة حرارة الهواء ، الهطول ، العراق.

Introduction

Climate changes have been given a great attention by different countries and governments all over the world. They are thought to be as a result of natural processes and human interference as well. Of all climatic elements, temperature and precipitation play major role in detecting climatic changes brought about by urbanization and industrialization. Therefore, monitoring needs to be taken regularly so that naturally different climatic cycles as well as long term trends are to be recorded and identified. Many circulation indices such as North Atlantic Oscillation, NAO; ElNino, Southern Oscillation Index, SOI and the Mediterranean Oscillation Index, MOI are expected to play a major role in explaining the variability of surface air temperature. Also, they are believed to be related to the distinct climatic and geographic characteristics of the place of investigation [1]. In contrast to NAO and the other teleconnection indices, which have been extensively studied, only a few previous works focus on the MOI index. Suselj and Bergant (2006) [2] related the MOI to the activity of cyclogenesis in the Mediterranean, mainly in the bay of Genoa. They concluded that the positive phase of MOI, the cyclogenesis is anomalously intense while in the negative phase is anomalously weak. Lopez and Frances (2010) [3] studied the influence of NAO and western MOI in the maximum flow events in Spain. Berdon (2013) [4] examined the impact of 10 atmospheric oscillations and an oceanic oscillation including MOI on pressure anomalies, temperature anomalies and precipitation anomalies in Serbia. Tramblay et al., (2013) [5] investigated the trends and variability in extreme precipitation indices over Maghreb countries. Their results showed that The NAO and MO patterns are well correlated with precipitation indices describing precipitation amounts the number of dry days and the length of wet and dry periods. Tornros and Menzel (2014) [6] applied Empirical Orthogonal Function (EOF) analysis to 25 homogenous precipitation series in the Southern Levant in the middle east covering the years 1960–1993. It is shown that winter precipitation is associated with positive MOI phases and Cyprus lows. Ciarlo and Aquilina (2015) [7] focused on the representation of five teleconnections in and around the Mediterranean region and how they affect one another and the region.

Data and Methodology

The MOI is defined by Palutikof et al. (1996) [8] and Conte et al. (1989) [9] as the normalized pressure difference between Algiers (36.4°N, 3.1°E) and Cairo (30.1°N, 31.4°E). Monthly means of MOIAC Monthly data for the period of 1958 to 2000 were obtained Climatic Research Unit of the University of East Anglia in the UK. [10]. The monthly mean of air Temperature and monthly total of precipitation for the same above period were obtained from the University of Delaware [11]. The geographical parameters for Baghdad city is longitude 44.39 °E, latitude 33.33°N and elevation 34m. MATLAB programs were written for the analysis of the MOIAC temperature and precipitation time series. The analysis includes plotting the original data, the monthly averages, the corrected data (i.e. removing the seasonal effects) and the autocorrelation coefficient. An autocorrelation coefficient tells how similar the time series is to itself. If it is highly autocorrelated, past values can be used to forecast future ones. An auto correlation coefficient close to zero indicates low correlation, and a coefficient far from zero indicates high correlation.

Pearson non-parametric test was performed to see how the MOIAC, temperature and precipitation time series are correlated. Pearson's correlation coefficient when applied to a sample is commonly represented by the letter r and may be referred to as the sample correlation coefficient or the sample Pearson correlation coefficient. That formula for r is [12]:

$$r = \frac{\sum_{i=1}^{n}(X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{(X_i - \overline{X})^2 (Y_i - \overline{Y})^2}}$$

An equivalent expression gives the correlation coefficient as the mean of the products of the stander scores. Based on a sample of paired data (X_i, Y_i), the sample Pearson correlation coefficient is:

$$r = \frac{1}{n-1}\sum_{i=1}^{n}\frac{(X_i - \overline{X})}{s_X}\frac{(Y_i - \overline{Y})}{s_Y}$$

where:

$\frac{(X_i - \overline{X})}{s_X}$ is stander scores, $\bar{X}$ is a sample mean, and s_X is a sample standard deviation.

Table 1 gives the degree of correlation and interpretation for the coefficients [13].

Table (1): The degree of correlation and interpretation of the test Coefficients.

Coefficient	Correlation	Interpretation
Less than 0.2	Slight correlation	Almost no relationship
0.2 to 0.4	Low correlation	Small relationship
0.4 to 0.7	Moderate correlation	Substantial relationship
0.7 to 0.9	High correlation	Marked relationship
0.9 and above	Very high correlation	Solid relationship

Results and Discussion

Figure 1 shows the results of analysis for the MOIAC time series. Parts (a), (b), (c), and (d) of this figure show the original data, the monthly average values, the corrected data i.e. seasonal effects are removed, and the autocorrelation coefficient (corrleogram) respectively. It can be seen that the MOIAC data does not show a trend and the time series is stationary. This is evidenced by the fact that the corrected data looks very similar to the uncorrected data, and the whole series simply oscillates back and forth around zero. The correlogram shows these coefficients plotted for different time separations between measurements (lags). It is seen that for this data set, the coefficients decrease from one at zero lag time to near zero at large lag times, exhibiting a damped oscillation. This indicates that the MOIAC values tend to be highly correlated with those measured a short time later, and less correlated with those measured a long time later. This is typical for earth science data sets, which are frequently autocorrelated close together because of inertia or carryover process in the physical system.

Figures 2 illustrates the results of analysis of the monthly mean temperature time series for Baghdad city. It is seen that the data look stationary and does not appear to be showing a trend. The correlogram exhibit the same damped oscillation behavior that the MOIAC correlogram did. However, the amplitudes is smaller, indicating a small over autocorrelation of temperature variance. In other words, if the temperature is abnormally high or low one month the chances are not very high it will be abnormally high or low the next month.

Figures 3 shows the results of analysis of the monthly total of precipitation time series. It can be noticed that there is no trend in the data and the correlogram indicates that there is a damping behavior similar to that of the MOIAC and temperature correlograms but a much smaller amplitude. This result is expected since precipitation is more variable than temperature

To study the relationship between MOIAC, and the monthly means of temperature and precipitation, Pearson correlation coefficients was computed. The results are given in Table (2). This table shows that the values of the correlation coefficients between MOIAC and the monthly mean temperature time series are comparable and slightly greater than 0.2 for the months Jan, Feb, Apr, June, Sep, and Dec, and the three correlation coefficients are less than 0.2 for the rest of the months. This slight correlation suggests that there is low correlation between MOIAC and the monthly mean temperature in Iraq. The results in Table (2) also shows that the values of the correlation coefficients for the MOIAC and monthly total precipitation time series are comparable and are less than 0.2 for all the months except for the months of May, Oct, and Nov the three correlation coefficients are slightly greater than 0.2. This slight correlation suggests that there is almost no correlation between MOIAC and the monthly total of precipitation in Baghdad, Iraq.

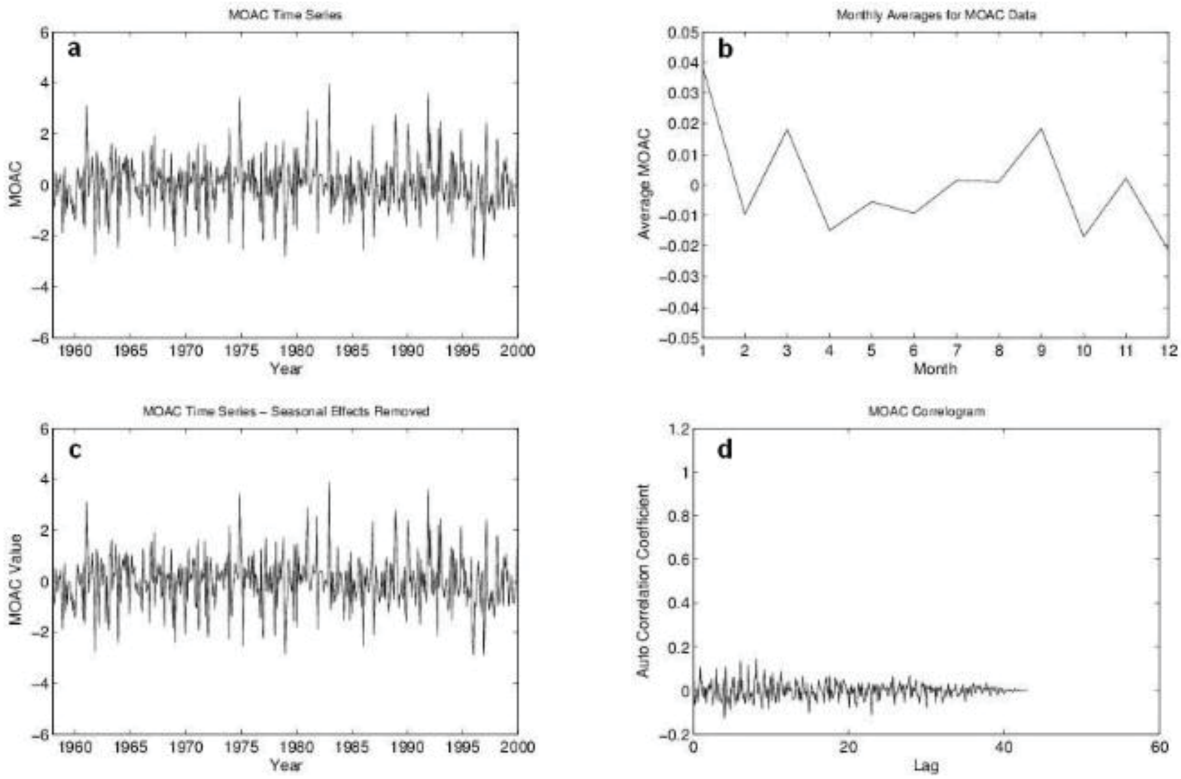
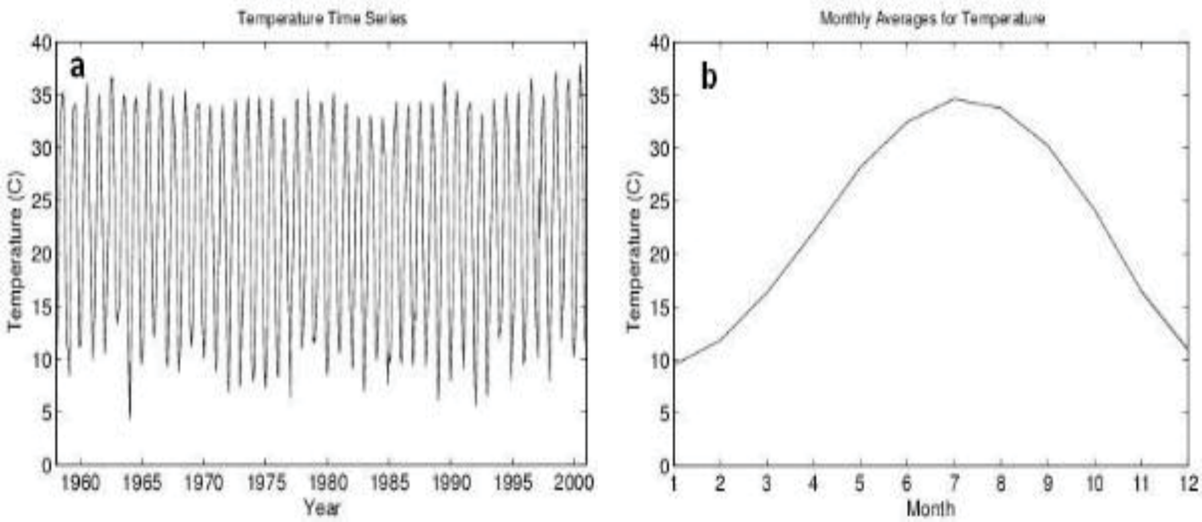


Figure 1. Analysis of MOIAC data. (a) MOIAC Time Series, (b) Monthly Averages for MOIAC Data, (c) MOIAC Time Series- Seasonal Effects Removed, (d) MOIAC Correlogram.



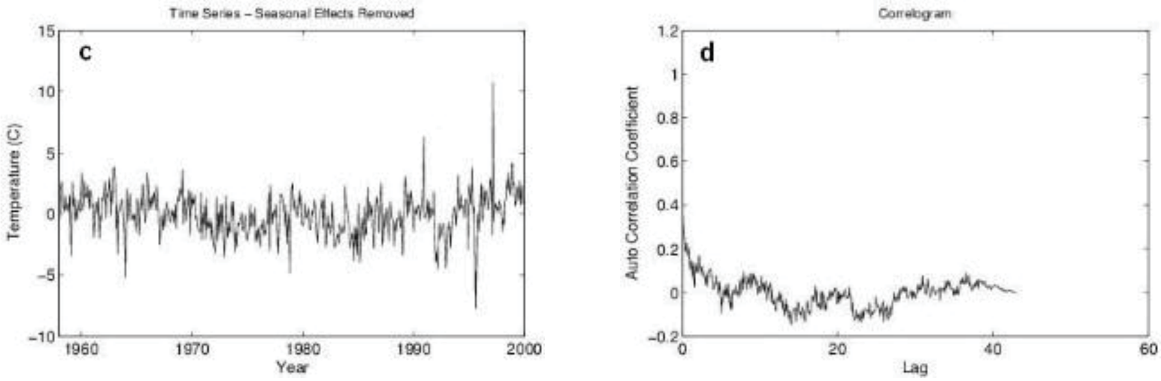


Figure 2. Analysis of Monthly Mean Temperature data for Baghdad. (a) Bag. Temperature Time Series, (b) Bag. Monthly Averages for Temperature, (c) Bag. Time Series-Seasonal Effects Removed, (d) Bag. Correlogram

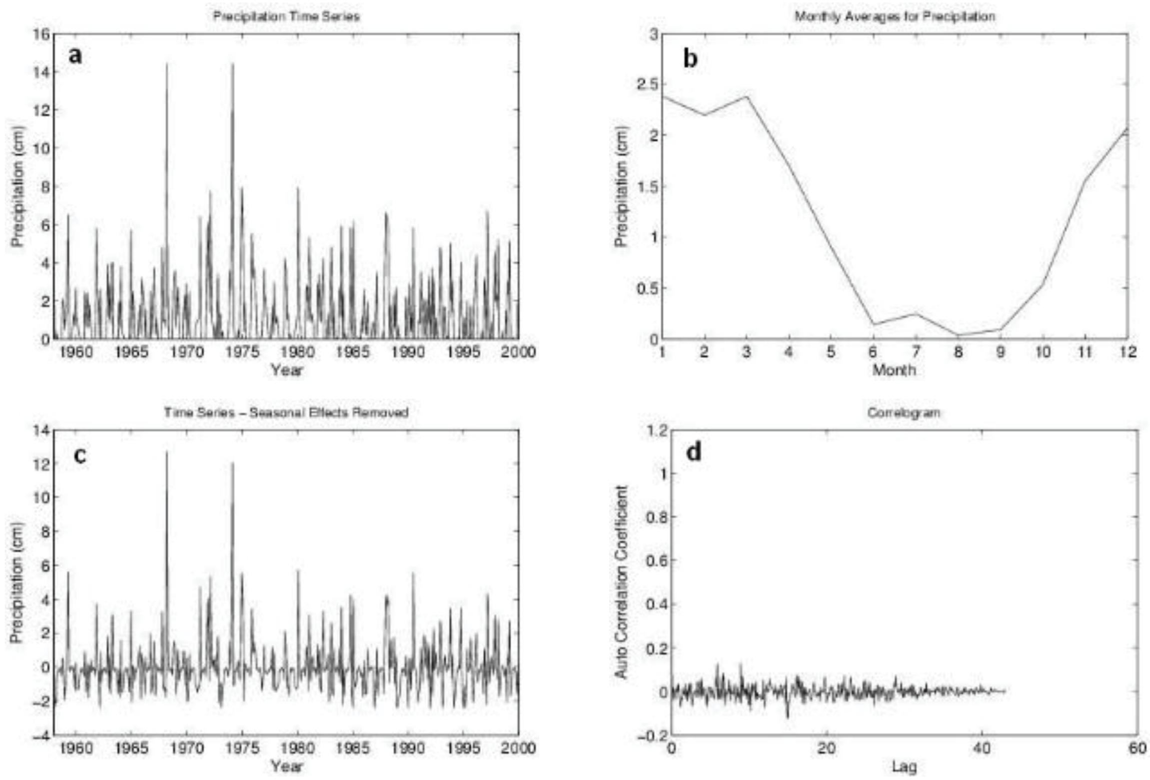


Figure 3. Analysis of Monthly Mean Precipitation data for Baghdad. (a) Bag. Precipitation Time Series, (b) Bag. Monthly Averages for Precipitation, (c) Bag. Time Series-Seasonal Effects Removed, (d) Bag. Correlogram

Table (2): Pearson correlation coefficient of MOIAC with temperature and precipitation for Baghdad city.

Month	Pearson Correlation Coff.	
	Temperature	**Precipitation**
Jan	-0.3301	-0.0691
Feb	-0.2668	-0.0048
Mar	0.0973	0.0064
Apr	0.2511	0.0305
May	-0.0504	0.1449
June	0.3011	-0.0882
July	0.1834	0.0618
Aug	0.2029	0.0350
Sep	-0.1096	-0.1528
Oct	-0.0055	-0.2595
Nov	-0.1875	-0.3463
Dec	-0.2053	0.0423

Conclusion

Monthly data of MOIAC and monthly mean temperature and monthly total of precipitation for Baghdad city, Iraq for the period of 1958 to 2000 were analyzed. The results indicated that the time series of MOIAC and temperature do not show a distinct trend. The slight correlation coefficients suggested that there is low correlation between MOIAC and the monthly mean temperature in Baghdad, Iraq. The results for the MOIAC and precipitation time series indicated that there is no trend. The slight correlation coefficients suggested there is almost no correlation between MOIAC and the monthly total of precipitation in Baghdad. From these results, one can conclude that the MOIAC has almost no effects on the temperature and precipitation patterns in Baghdad city.

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