Journal of Asian Scientific Research, 2013, 3(12):1148-1156

Journal of Asian Scientific Research

journal homepage: http://aessweb.com/journal-detail.php?id=5003

EVIDENCE OF CLIMATE CHANGE IN THE MIDDLE EAST

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ABSTRACT

Simple linear fitting of not less than fifty years monthly temperature data for thirty three weather stations in the Middle East extracted from the HadCRUT3 database shows an interesting monthly pattern. The fitted slope values tend to show oscillation type behaviors which are much similar to the monthly carbon dioxide atmospheric concentration due to the global change in vegetation level. The estimated rate of yearly temperature is also calculated.

Keywords: Climate change, Global warming, HadCRUT3

1. INTRODUCTION

It can be argued that Intergovernmental Panel on Climate Change IPCC 2007 report (Climate, 2007) was the warning bell to the potential dangers associated with effect of increasing CO_2 atmospheric concentrations on Global temperatures. Based on conclusion of huge numbers of research articles, the report concluded that the world temperatures may rise by as much as 4-5 ^oC by the end of this century. Chronic failures of world political leaders to reach agreement on how to contain and then reduce CO_2 emissions resulting from burning of fossils fuels has resulted in atmospheric CO_2 concentrations reaching the 400 ppm level for the first time in three million years during March 2013 (http://www.esrl.noaa.gov/gmd/ccgg/trends/). This is compared with only 280 ppm level prior to the start of the industrial revolution. The effect is simple. CO_2 while almost transparent to light, it is opaque to infrared (heat) radiation. Increase in atmospheric CO_2 levels will act to increase the opaqueness of the atmosphere to infrared radiation causing the trapping of heat within the earth's atmosphere. This is known as the "Green House effect (GW)". Many researchers argue that many if not all of climatological changes observed in many parts of the world in recent years are direct consequences of GW. This theory was confronted by some skeptics who argue that these climate changes can be accommodated within the natural trends of earth climate, and there are no conclusive evidences that they must be attributed to increasing CO_2levels (Balling, 2003; Bernaerts, 2009; Cunningham, 2010).

With the aims of aligning with one side or the other, researchers in most parts of the world have been trying to look for both global and local manifestations of climate change (Mall *et al.*, 2006; Busuioc *et al.*, 2007; Evans, 2010; Borna *et al.*, 2011). Efforts are also being paid by many workers in order to establish the direct and indirect consequences of such climate changes. Few of the main concerns include anticipated changes in water resources (Easterling *et al.*; Arnell, 1998; Roenberg *et al.*, 1999; Arnell and Delaney, 2006), agricultural croup productions(Thomson *et al.*; Brown and Rosenberg, 1999), spread of infectious diseases (Martens *et al.*, 1997; Ebi *et al.*, 2005), …etc. Investigations related to the establishment of a direct relation between most recent record heat waves and high degree hurricanes in some parts the world are gaining increased interest (Meehl and Washington, 1993; Meehl and Tebaldi, 2004).

Following the arguments surrounding the conclusions of the IPCC2007 report and the consequent Lord Russell's inquiry findings (Russell *et al.*, 2010), the British Metrological Office made the decision in 2010 to make all compiled world surface temperatures data freely available for all researchers.

These data are now available under the name HadCRUT3 (http://www.cru.uea.ac.uk/cru/data/temperature/#sciref).

It is the purpose here to use the part of these data related to Middle East temperatures to establish if there are any evidences of climate changes in this part of the world.

2. THE DATA

(The part associated with) The Middle East monthly temperature data are extracted from the HadCRUT3 world surface temperatures database which contains 3780 world data files. The Middle East region is defined in this work as the geographical region enclosed within the rectangle defined by latitudes and longitudes 20-40 North, and 35-52 East. This area includes regions from the east cost of Mediterranean Sea reaching the west of Iran, southern parts of Turkey to the Gulf. The over all number of data files related to this region contained in the HadCRUT3 data base belong to 72 weather stations. These were converted to Matlab data files. However, the analysis presented in this work is based on data from 33 stations only. Stations with temperature data covering less than 50 years are not included in the analysis.

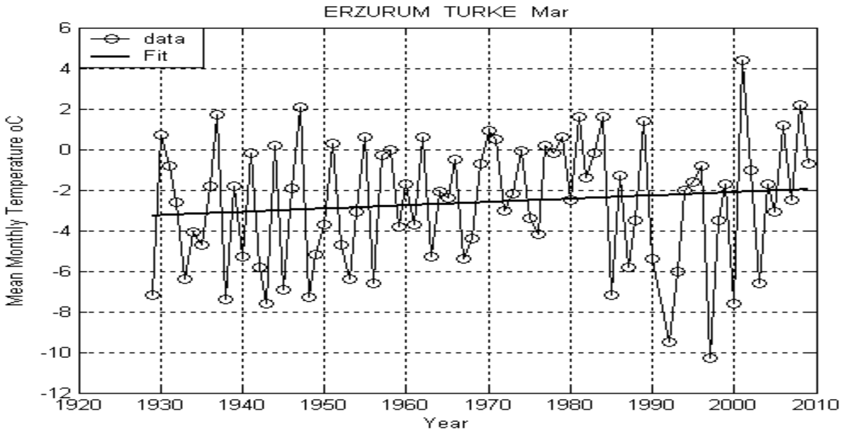
3. DATA ANALYSIS

In order to look for any systematic trends in climate changes in the above mentioned geographical boundary, all monthly mean temperatures T for every station over the available number of years from that particular station for the particular month under consideration are studied against the atmospheric year number.. Linear correlation fitting between the temperature and year number Y is carried out by attempting to fit the data to the equation:

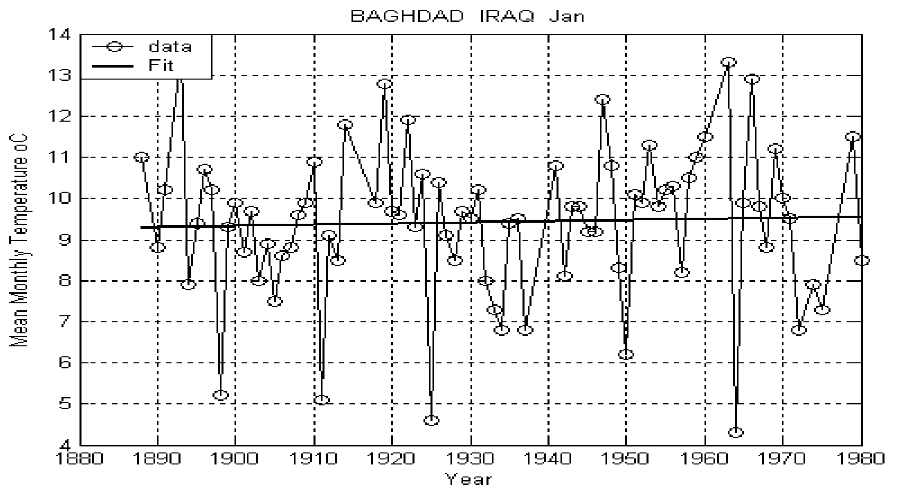
$$T = \alpha Y + \beta \qquad (2)$$

α and β being free fitting parameters. α, being positive, negative or zero is taken as indication that temperatures are increasing, decreasing, with time. Typical three such fits are shown in figure (1). These represent a sample from 396 similar such fits are carried out.

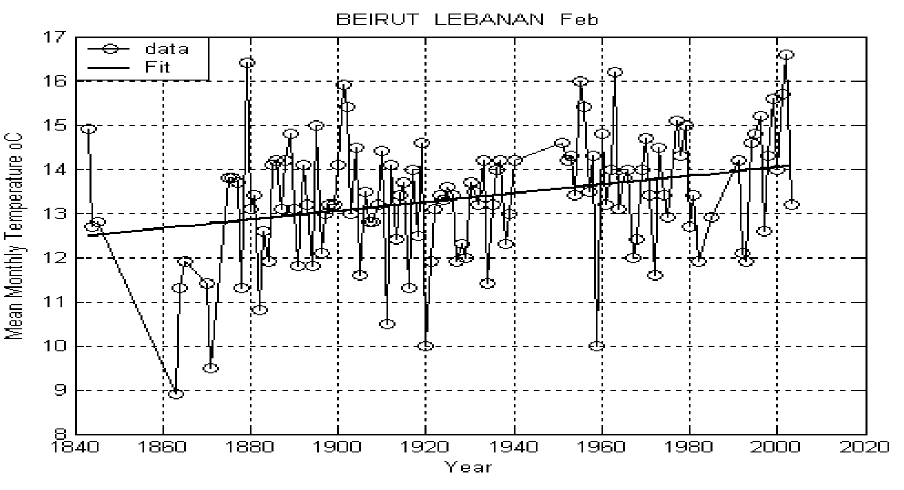
Figure-1. Three mean monthly temperature data samples. Circles are data points. Solid line is the result of fit to equation (1)



(a)



(b)



(c)

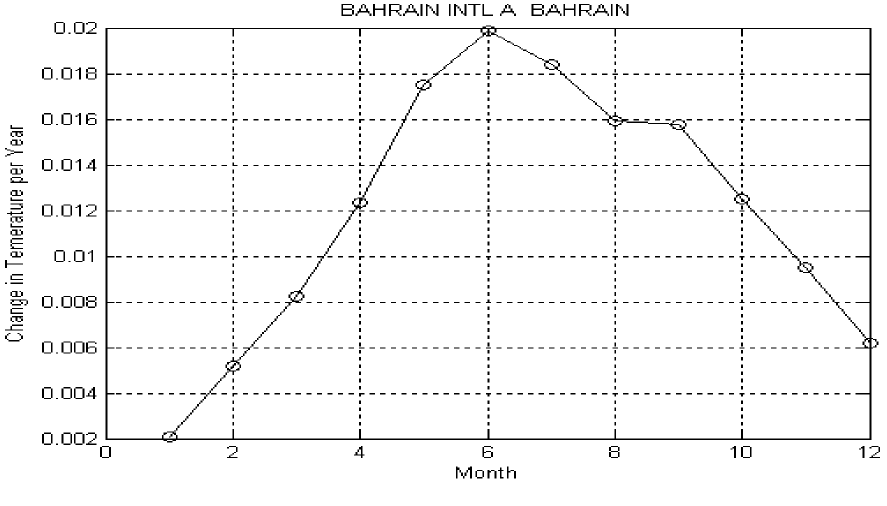
Every fitted value of the linear regression coefficient α obtained with over 95% confidence level is obtained and the monthly dependence of the slope parameter is plotted against month's number. Furthermore, each α value is considered to be a statistical event. Each station will thus contribute 12 non weighted events to the pool of all α values deduced after assigning a proper weight for each value obtained. These events are plotted on a histogram. .

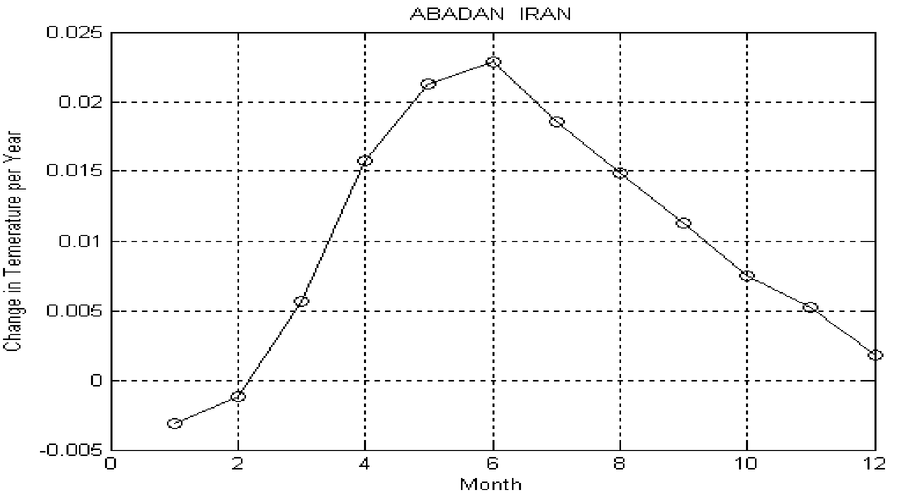
Beside, restricting the analysis to stations which have more than 50 years records, the α value number of events is weighted by the reciprocals of the mean of the fits residues. This ensures that not only data sets with larger time span coverage are given larger weight, but also more scattered data sets are given less weight.

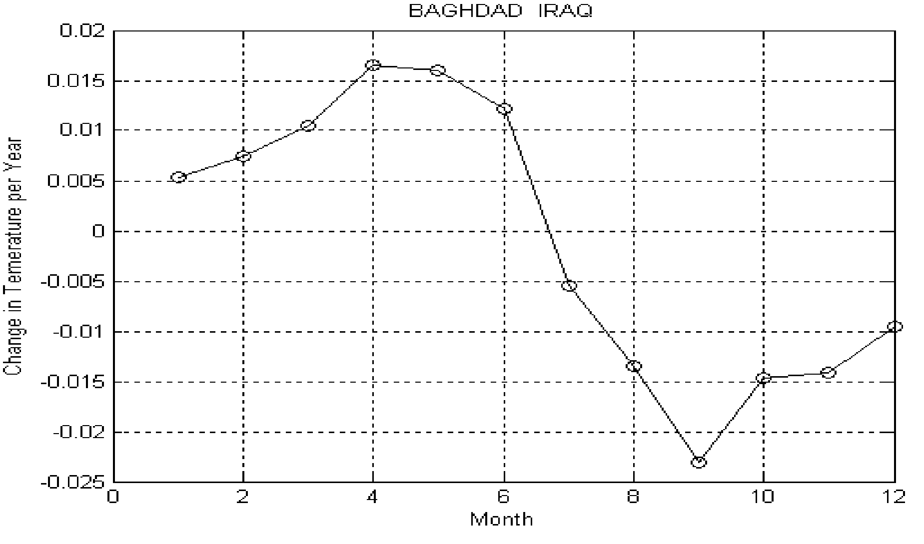
4. RESULTS AND DISCUSSION

The fitted values of the slope parameter α in equation (1) for each month's set of data from each of the 33 weather stations considered are plotted. These 33 stations are distributed over nine courtiers in the region. For reasons related to space considerations, results for one station from each country are selected for presentation here. These are shown in figure (2). All other figures produced are much similar. Including both costal and non costal locations was a consideration in this selection. The first interesting feature observed in all plots is the seasonal variation of the rate of the yearly temperature increases. The value of α tends to be systematically peak up during the period between May and August. The effect seems to be highly systematic with all other stations, not presented here. It may be interesting to attempt to link this almost cyclic effect with the annual atmospheric CO_2 concentration cycle which is usually attributed to changes in vegetation activity during spring season. For such purpose, numerical CO_2 monthly data for the period 1975-1986 obtained from reference (CO2) are plotted in figure (3). Apart from a time lag of about two months, the similarity between the monthly behaviors of both α and CO_2 concentration is striking. This similarity may be worth further investigation with more global sets of data.

Figure-2. Samples of monthly variations of the fitting slope parameter in equation (1) for data from stations in nine Middle East countries as indicated




ABADAN IRAN
Change in Temerature per Year
Month
0.025
0.02
0.015
0.01
0.005
0
-0.005
0
2
4
6
8
10
12


BAGHDAD IRAQ
Change in Temerature per Year
Month
0.02
0.015
0.01
0.005
0
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-0.01
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-0.02
-0.025
0
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4
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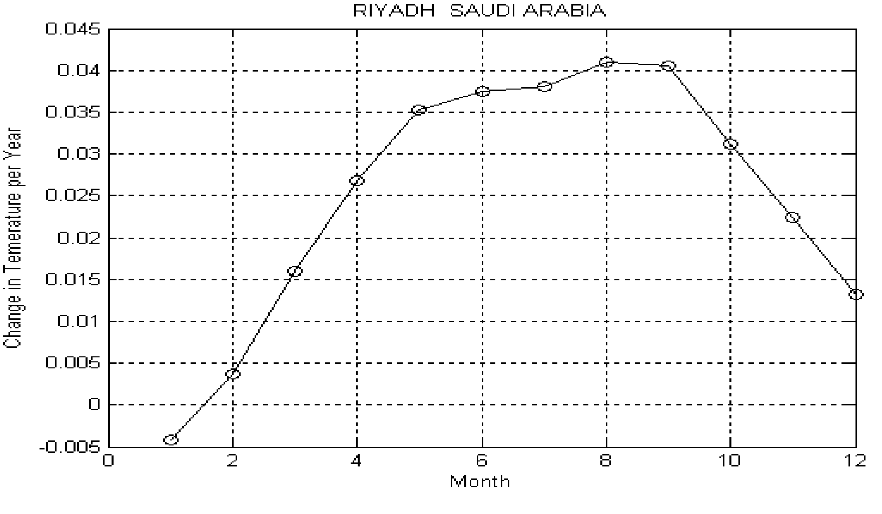
8
10
12


RIYADH SAUDI ARABIA
Change in Temerature per Year
Month
0.045
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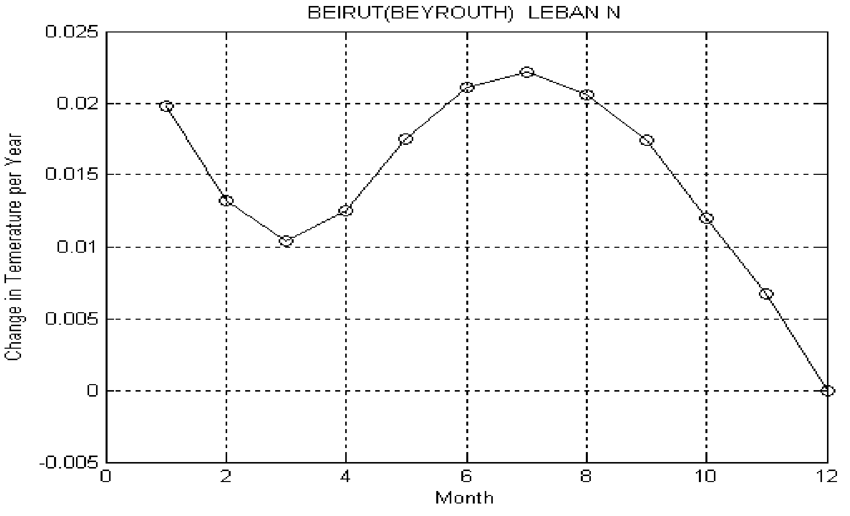
BEIRUT(BEYROUTH) LEBAN N
Change in Temerature per Year
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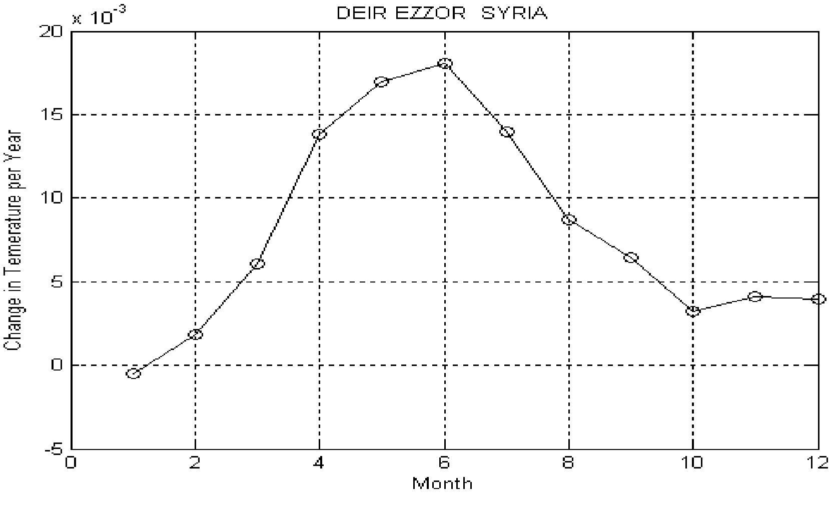
DEIR EZZOR SYRIA
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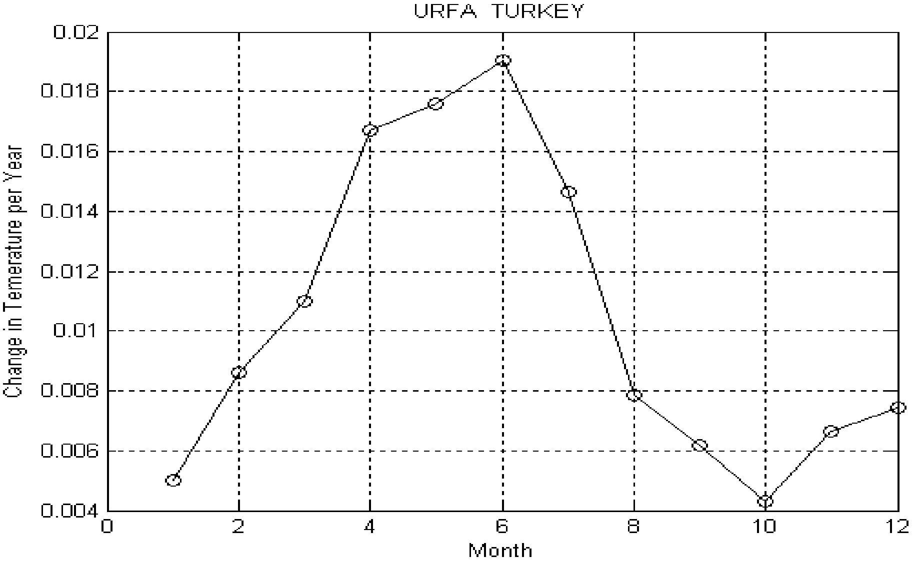
URFA TURKEY
Change in Temerature per Year
Month
0.02
0.018
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0.01
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4
6
8
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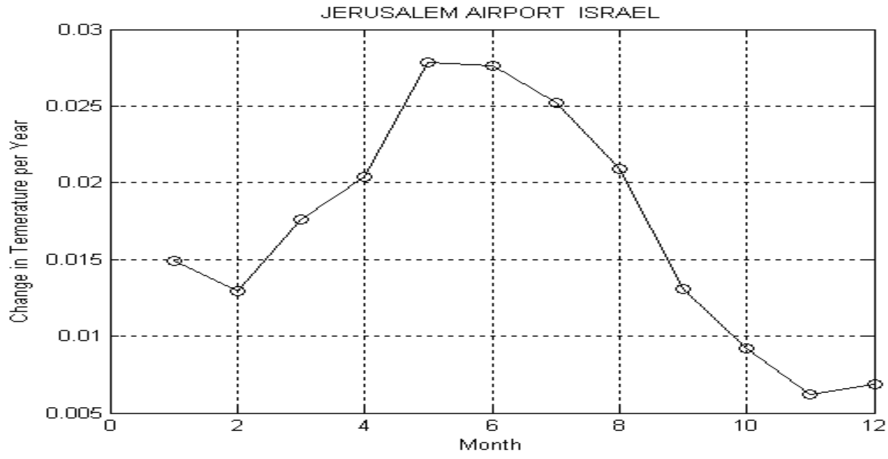


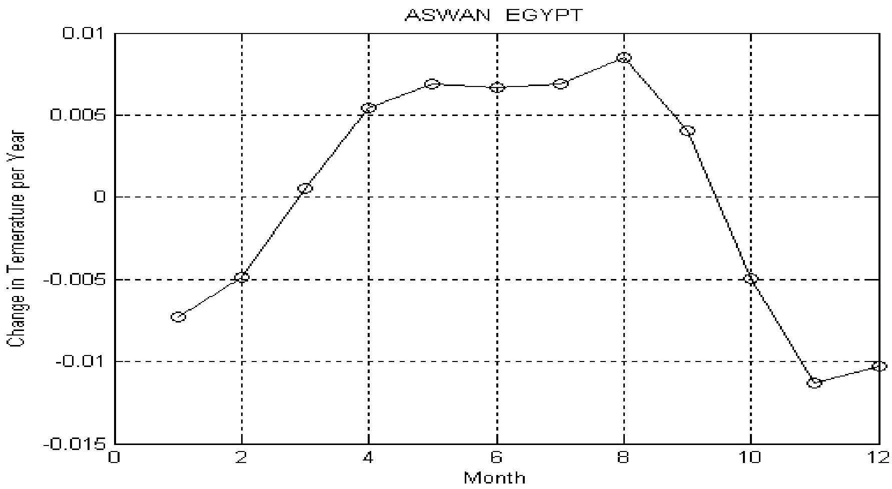
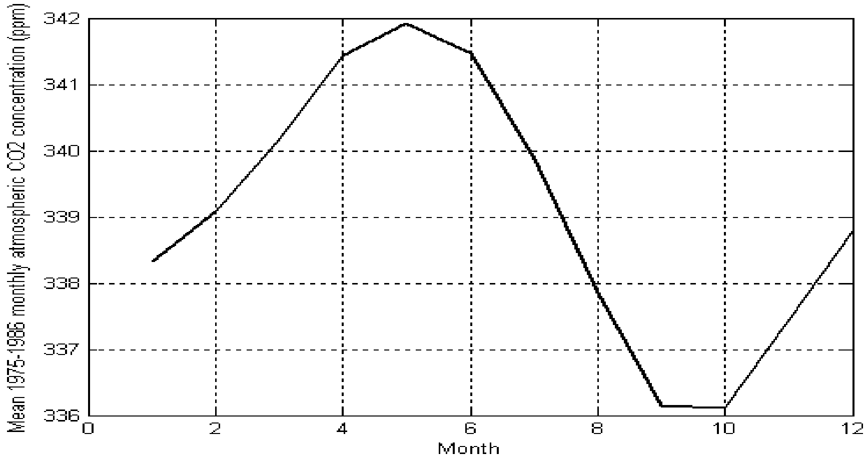
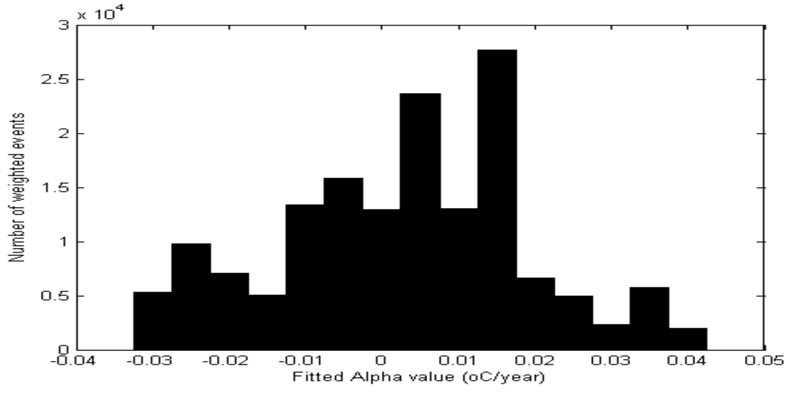


Figure -3. Atmospheric averaged monthly CO_2 concentration variations for the years 1975-1986 from reference (CO2),

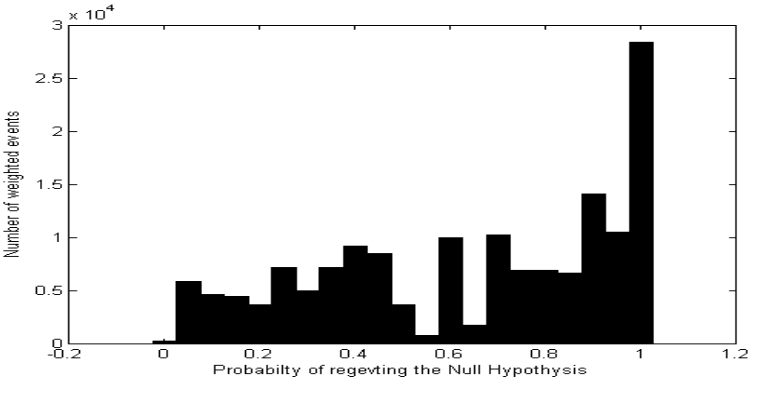


All 396 weighted values of α from all 33 stations are plotted on a histogram in figure (4-a). The histogram clearly shows that the majority of values falls to the right of the zero position which clearly indicates that the Middle East region weather is moving towards higher temperatures. Although this is not new in its self, the final result of the overall average value of α obtained from this weighted histogram is $\alpha = 0.005$°C/year, with about 70% overall probability of acceptance. This can be translated to indicate that the global temperatures in the Middle East have risen by as much as 0.75 °C since the start of the industrial revolution. This is in good agreement with the value of 0.076 °C/year suggested in the IPCC2007 report based on data for the whole world.

Figure-4. (a) Histogram showing the distribution of α values for all stations. (b) Distribution of probabilities of accepting the fitted values in (a)



(a)



5. CONCLUSIONS

Analysis of available historical temperature data for the Middle East region indicates that the region has been moving towards a higher temperature climate with an average of 0.0036 °C/year. This rate of increase, tend to show monthly trends similar to a delayed CO_2 atmospheric concentration variation. Further more detailed studies of this effect may produce a first hand strong direct evidence of the relation between CO_2 and recent year's climate changes

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