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Empirical Equation to Estimate the Values of the Temperature Minimum and Maximum from of the Average

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Abstract
In this paper an empirical equation designed to estimate the values of the temperature minimum and maximum of the average for the city of Baghdad, for the months of January and July Depending on the ratio of the mean of increase and decrease of the temperature minimum and maximum from average. The correlation coefficient between the Observed and calculated values fro these equations was computed to test the accuracy of these equations, which gave reasonably very good results.
Keywords: empirical equation, maximum and minimum temperature, Baghdad.

1. Introduction

Temperature is one of the basic elements of weather and climate. air temperature is measure of heat content of air (David P.et al, 1982).WMO defines air temperature as "the temperature exposed to the air in place sheltered from direct solar radiation" (WMO,2014).Air temperature affects other weather elements including air pressure, cloud formation, humidity and precipitation , also affects on plants, soil and air pollution. for this reason there are many studies concerned with ways calculate or predict the air temperature by using statistical methods, mathematical equation and physical model.(Zachary A.et al,2011) developed empirical models from a set of short-term, high spatial resolution temperature measurements that once developed, could be used in near real-time applications or climate projections,(Wen Z.et al,2011) designed empirical models for estimating daily maximum, minimum and mean air temperature with MODIS of land surface temperatures,(Jerry F.,et al,1993) used regression analysis to develop a computer model based on those empirical relationships to predict diurnal air temperature ,(SteveK.,2009) discusses the development of an empirical model for air temperature prediction to evaluate the impact of estate development by means of Geographical Information System (GIS),(Wanqiu and Arun,2010) used global forecast system for the prediction of monthly mean air temperature ,and (Andreas P. et al,2008) provided the prediction skill for weekly averaged forecasts of surface air temperature in dependence of lead time, region, and season.

Most of studies focused on average air temperature so the aim of this study is to estimate the values of maximum and minimum temperature from the mean.

2-Data

In this study we used daily temperature of January as a cold period and July as a hot period for Baghdad from (2005-2014) these data were obtained from the website Underground Weather. Sample mean was computed where the daily mean temperature (T_{mean})is determined by averaging the 24 hourly readings . We used the maximum air temperature (T_{max}) where the temperature of the air is the hottest time of the day, be at noon. Minimum air temperature (T_{min}) is the coolest time of the day directly before sunrise(Dorian J. et al,2010). Some statistical methods have been used to explain the change and variety in temperature .Range is the difference between the maximum and minimum temperature while variance measures how far a set of numbers is spread out. A variance of zero indicates that all the values are identical. Variance is always non-negative: a small variance indicates that the data points tend to be very close to the mean (expected value) and hence to each other, while a high variance indicates that the data points are very spread out around the mean and from each other(J.Chapman and Charles B. ,1993).

3- Methodology

The time series of monthly temperatures (T_{max},T_{mean} and T_{min}) drawn for January in Fig(1) it refers that the three time series take the same form in the oscillation, although the general trend is on the rise with slope (2)this means that in January rise in temperature within the study period.the variance for T_{max} (5) and T_{min}(3) with range of (7) and (5) respectively. there is a clear variation in both two time series (maximum and minimum) but the range ($_{Tmax}$) is much higher than the range of (T_{min}).

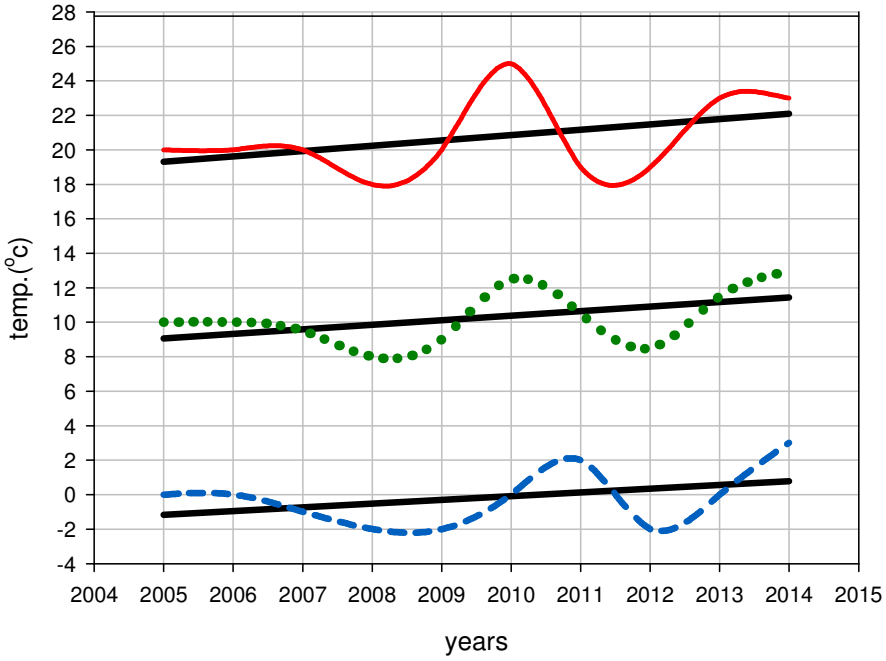


Figure 1. Time series of temperatures (T_{max},T_{mean} and T_{min}) of Baghdad (January)

Figure (2) shows the time series of (T_{max}, T_{min} and T_{mean}) for July with simple oscillation and little variation (T_{max}) (3) much higher than the variation for (T_{min}) (0.9). The range was a close relative where it was (5) for (T_{max}) and (3) for (T_{min}). The general trend is very simple rise with slope (0.2).This means that the temperatures of July are for ten years of study almost the same.

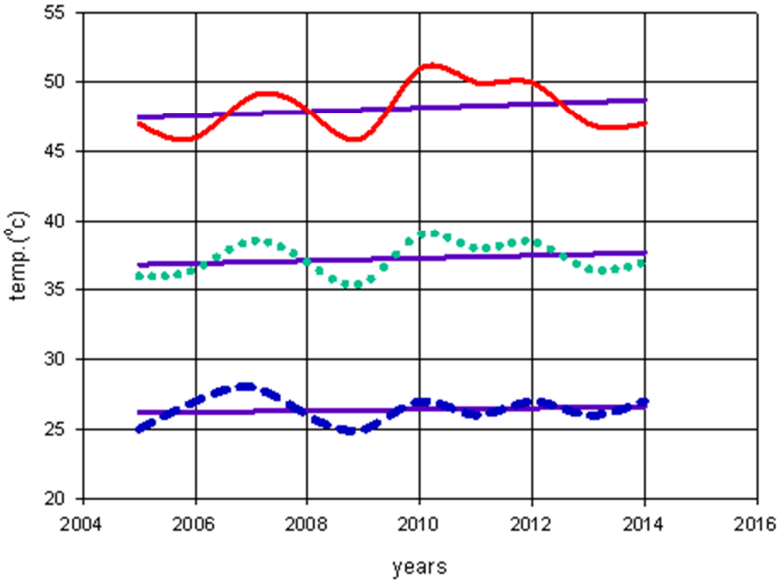


Figure (2): Time series of temperatures (Tmax,Tmean and Tmin) of Baghdad (July)

The monthly temperature range Was calculated for both months, where they were both so close (17-25) for January and (19-24) for July, as shown in Figures (3 and 4).

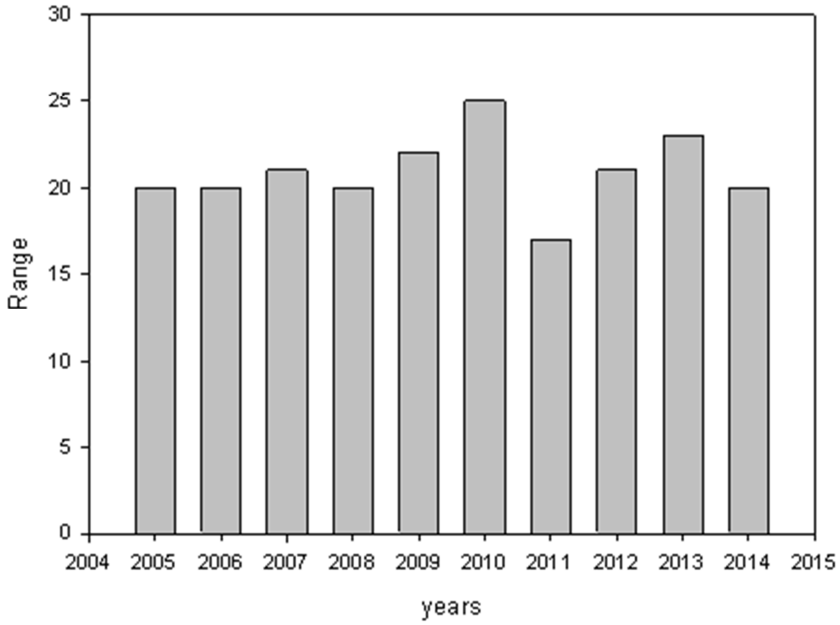


Figure 3: Monthly temperature range for January

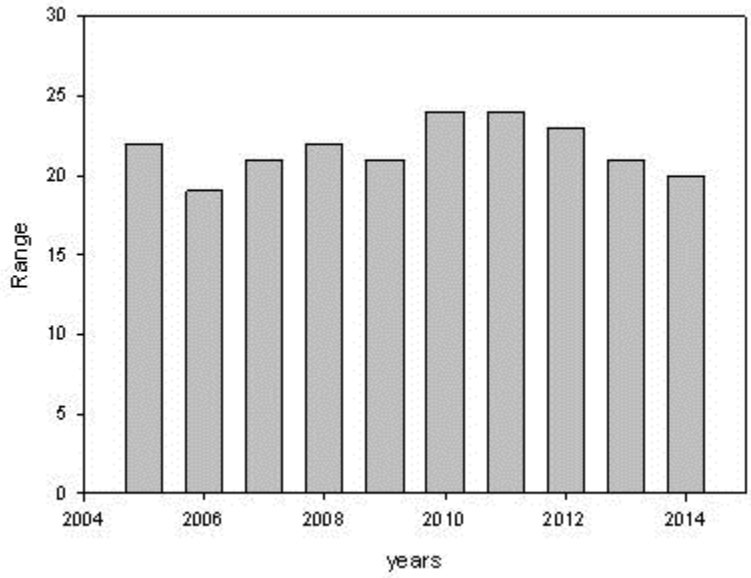
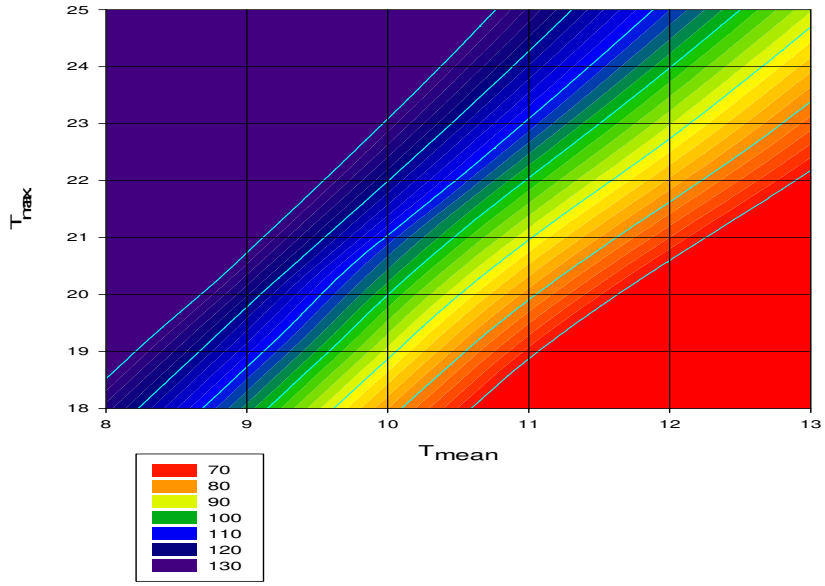


Figure 4: Monthly temperature range for July

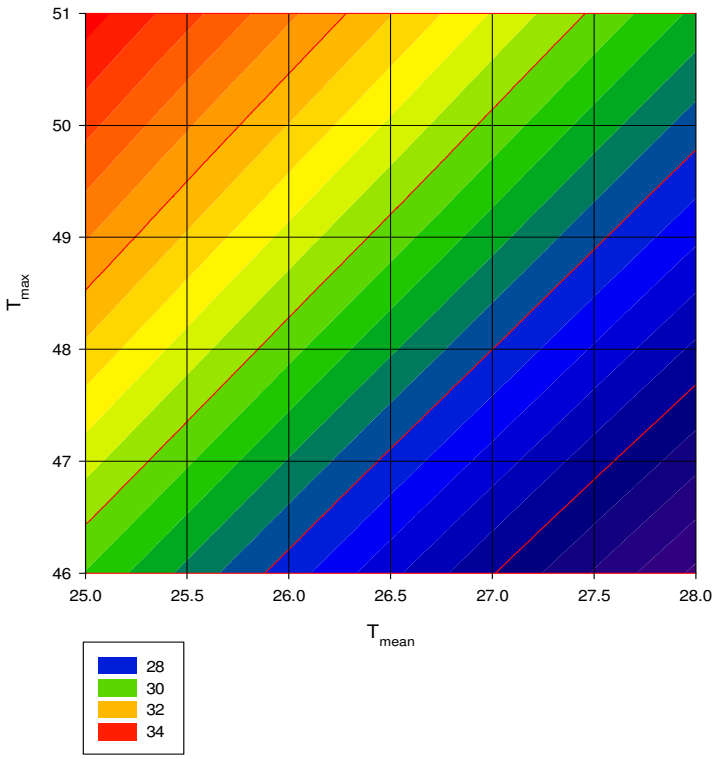
To design empirical equation to estimate the maximum temperatures ,we calculated the average rate of increase between (T_{max}) and (T_{mean}) through the relationship

$$T_{inc}\%=(T_{max} - T_{mean})/T_{mean})*100\% \quad (1)$$

Figures (5,6) describes the rate of increase for January and July, respectively, for the period of study.
The rang of increase of January recorded (77-124%) with mean (104%) which is higher than of July, which was(26-32%) with mean (30%).



Figure(5): rate of increase for the months of January



Figure(6): rate of increase for the months of July

The general formula is designed to estimate the maximum temperature of mean which takes the general form

$$T_{max\ p} = T_{inc}\% + T_{mean} \quad (2)$$

The empirical equation to estimate the maximum temperature of the city of Baghdad for January and July are respectively

$$T_{maxp}=(1.04T_{mean})+T_{mean} \quad (3)$$

$$T_{maxp}=(0.3T_{mean})+T_{mean} \quad (4)$$

To design empirical equation to estimate the minimum temperatures ,we calculated the average percentage decrease between (T_{min}) and (T_{mean}) through the relationship

$$T_{dec}\%=(T_{min}-T_{mean})/T_{mean})*100\% \quad (5)$$

We found that the percentage of decrease is equal to the percentage of increase but with opposite Signal for both months

The general formula is designed to estimate the minimum temperature of mean which takes the general form

$$T_{min\ p}=T_{dec}\%+T_{mean} \quad (6)$$

The empirical equation to estimate the minimum temperature of the city of Baghdad for the month of January and July are respectively

$$T_{minp}=(-1.04T_{mean})+T_{mean} \quad (7)$$

$$T_{minp}=(-0.3T_{mean})+T_{mean} \quad (8)$$

To test the accuracy of empirical equations designed in the study we calculated values of the temperature maximum and minimum of the equations for both months. Later the calculated values compared with the observer values as table (1,2) shows. The results have been tested statistically using the coefficient of correlation (r) and found it scored nearly the highest in the maximum temperatures of Minimum for both months and estimated coefficient of variation (c.v), as table (3) shows.

Table (1): the calculated values and observer values of January

years	T_{mean}	T_{min}	T_{minp}	T_{max}	T_{maxp}
2005	10	0	-0.4	20	20.4
2006	10	0	-0.4	20	20.4
2007	9.5	-1	-0.4	20	19.4
2008	8	-2	-0.4	18	16.4
2009	9	-2	-0.4	20	18.4
2010	12.5	0	-0.5	25	25.5
2011	10.5	2	-0.4	19	21.4
2012	8.5	-2	-0.3	19	17.5
2013	11.5	0	-0.5	23	23.5
2014	13	3	-0.5	23	26.5

Table (2): the calculated values and observer values of July

years	T_{mean}	T_{min}	t_{minp}	T_{max}	t_{maxp}
2005	36	25	25.2	47	46.8
2006	36.5	27	25.55	46	47.45
2007	38.5	28	26.95	49	50.05
2008	37	26	25.9	48	48.1
2009	35.5	25	24.85	46	46.15
2010	39	27	27.3	51	50.7
2011	38	26	26.6	50	49.4
2012	38.5	27	26.95	50	50.05
2013	36.5	26	25.55	47	47.45
2014	37	27	25.9	47	48.1

Table (3): the coefficient of correlation and coefficient of variation .

	r_{jan}	r_{julay}	$c.v_{jan}$	$c.v_{julay}$
Tmax	.89	.92	10.6%	3.5%
Tmin	.56	.72	840%	3.6%

Conclusion

It can estimate (T_{max} and T_{min}) from (T_{mean}) by using average rate of increase and decrease between them because empirical equations designed get very good results for estimate T_{max} and good results for estimate T_{min} ,that because the coefficient of variation for T_{max} is less than for T_{min} in January and July.

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