

ESTIMATION OF GROUND SURFACE TEMPERATURE (GST) FROM METEOROLOGICAL RECORDS IN MAIDUGURI INTERNATIONAL AIRPORT

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ABSTRACT

The monthly and annual data averages of Ground Surface Temperature (GST) were estimated from the daily records of air temperature recorded at meteorological station in Maiduguri International Airport. The mean air temperature and ground surface temperature (GST) at the station was estimated to be $36.5\pm 3^{\circ}\text{C}$ and $36.5\pm 18^{\circ}\text{C}$ respectively. The variation of month-wise ground surface temperature (GST) estimates which vary between $24.4\pm 0.4^{\circ}\text{C}$ and $28.0\pm 0^{\circ}\text{C}$ is noted to follow the general weather pattern.

Keywords: Ground Surface Temperature (GST), Climate Change, Surface Air Temperature (SAT), Metrological Station.

INTRODUCTION

Background of the Study

The ground surface is the boundary of solid earth and has interaction with the atmosphere. Its temperature form an important boundary condition used in studies both in the earth and the atmospheric science. In the earth science it is used for determining the geothermal (heat of the earth) gradient and inferring temperature down into the subsurface. The history of the ground surface temperature (GST) began with the discovery of these natural geological processes we seek to understand which have been in operation for millions of years.

The earth long-term ground surface temperature (GST) is important in the study of climatic change, as energy balance variation of the land atmosphere interface is fundamental quantity to help determine changes in radioactive forcing. The total contribution of radioactive forcing associated with greenhouse gas emission (GHG) from anthropogenic activities to the energy balance at the earth surface is estimated to be $2.0\text{-}2.5 \text{ h/m}^2$ since 1765; about one-third of this direct radioactive heating of the surface and about 10% of this flow into the ground.

This study is intended to determine the ground surface temperature (GST) measured at Maiduguri International Airport Meteorological Station for ten (10) years, that is from 1999 – 2008. Attempt will be made to use the result to predict the monthly, month-wise and annual ground surface temperature (GST) or some years before 1999 and some years after 2008.

Aim and Objectives

The aims and objectives of this study are:

1. To determine the average of long-term annual ground surface temperature (GST).
2. To examine the variation in ground surface temperature (GST).
3. To speculate the relation of ground surface temperature (GST) to climatic change.
4. To estimate the monthly trend in ground surface temperature (GST) in Maiduguri International Airport.

Scope and Limitation

The research is restricted to the use of data collected at Federal Meteorological Agency at Maiduguri. The record was taken by the Federal Meteorological Agency at meteorological station in Maiduguri International Airport from 1999 – 2008. This data was used to obtain results.

METHDOLOGY

Data Collection

The data collected at the Federal Meteorological Agency, which consisted of records of daily maximum and minimum air temperature for ten (10) years. January, 1999 to December, 2008 from the station. Because the maximum and minimum air temperature are measured by thermometer located 1.29 and 1.16m above ground surface, then mean air temperature is assumed to be for a location midway. Even with an extreme value of 10°C/km for air temperature gradient, values of air temperature extrapolate to the ground surface different only in a proof place of decimal from values of the mean air temperature; hence the latter were assumed to have measured to have been measured of the ground surface.

Analysis

The Excel Spread Sheet was employed to analyse the data, the average daily temperature was calculated, and the mean of daily maximum and minimum temperatures. From these daily temperatures, will get the monthly averages and their error margin were also calculated. Each monthly average was then converted to the ground surface temperature (GST) using Howard and Sass (1964) observation. The table gives these ground surface temperature (GST) estimates. These averages for each month taken over the study periods is calculated as monthly and represent Fig. 3.1 gives a plot of these estimates were also calculated as month-wise averages ground surface temperature (GST) and their error margin while Fig. 3.2 gives the plot of month-wise averages ground surface temperature (GSTs) for each year and their error margin where calculated as annual averages and Fig. 3.3 gives a plot of annual averages.

REPRESENTATION OF RESULTS

The data obtained from the Federal Meteorological Agency Maiduguri Agency Maiduguri have been interpreted and the results are given below:

Monthly maximum ground surface temperature (GSM) and error in Maiduguri for the period of 1999 – 2008 estimated from air temperature entirely in table indicator either unavailable of the data for the month.

Table 3.1: Ground Surface Temperature (GST)

Months	1999	2000	2001
January	25.8±0.7	26.3±0.3	23.7±0.2
February	29.9±0.4	25.2±0.3	26.6±0.4
March	31.5±0.2	30.4±0.4	31.7±0.3
April	36.0±0.2	24.1±0.2	36.2±0.3
May	36.0±0.2	-	36.5±0.3
June	35.0±0.3	-	306.7±2.9
July	31.0±0.3	-	31.3±0.3
August	29.5±0.3	28.3±0.3	29.8±0.3
September	30.2±0.3	31.6±0.1	30.9±0.2
October	30.5±0.7	31.2±0.3	30.6±0.2
November	29.5±0.2	29.0±0.3	28.3±0.2
December	22.0±0.3	24.2±0.3	26.3±0.3
Average	30.6±7.3	27.8±3.8	53.2±41.5

Table 3.2: Ground Surface Temperature (GST)

2002	2003	2004	2005
-	25.6±0.3	25.6±0.3	24.4±0.4
27.5±0.5	29.4±0.3	27.9±0.5	31.6±0.4
32.5±0.3	31.1±0.3	31.3±0.4	34.1±0.3
37.0±0.3	36.6±0.5	36.2±0.2	35.7±0.3
37.4±0.2	36.0±0.3	35.8±0.4	36.0±0.3
33.8±0.3	33.0±0.3	33.8±0.4	32.3±2.4
32.8±0.3	31.2±0.3	31.0±0.2	31.3±0.3
30.7±0.2	29.9±0.3	30.3±0.2	30.2±0.3
31.0±0.3	31.1±0.2	31.5±0.2	31.6±0.4
31.3±0.4	32.4±0.3	32.4±0.2	31.6±0.3
31.3±0.4	32.4±0.3	32.4±0.2	31.6±0.3
29.5±0.3	30.2±0.3	29.8±0.3	28.9±0.3
25.3±0.4	25.0±0.3	26.5±0.3	27.4±0.3
31.8±6.1	31.6±5.8	31.0±5.1	31.3±5.8

Table 2.2: Ground Surface Temperature (GST)

2006	2007	2008	MONTH'S AVE
38.0±0.2	-	-	25.6±0.4
31.5±0.4	29.5±0.3	-	28.7±3.2
-	-	33.0±0.5	32.0±1.9
-	36.5±0.4	35.5±0.3	34.9±6.5
-	-	36.0±0.3	36.3±1.0
-	-	35.5±0.3	73.1±137.2
-	-	31.5±0.3	27.5±0.9
-	-	30.0±0.3	29.8±0.6
31.5±0.3	-	30.5±0.2	31.6±0.7
32.5±0.4	-	31.5±0.5	31.6±0.1
-	-	29.0±0.3	29.3±1.0
-	-	28.0±0.3	25.6±3.0
30.9±0.4	33.6±00.6	32.1±0.7	33.8±23.8

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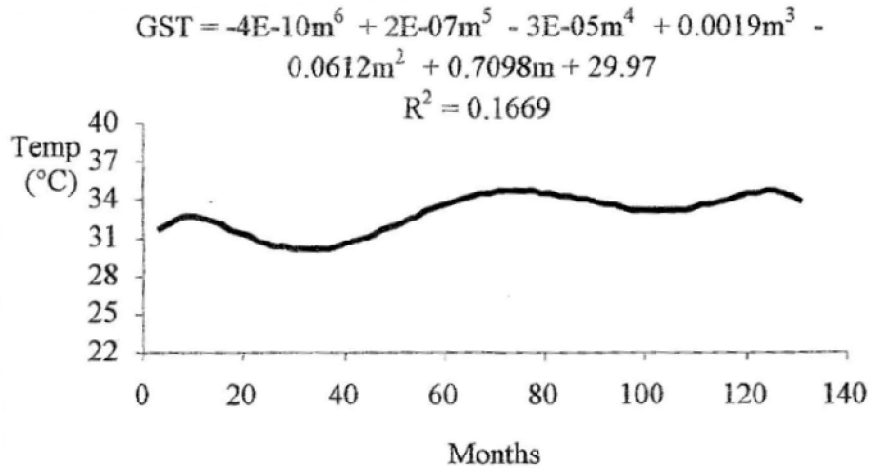


Figure 1

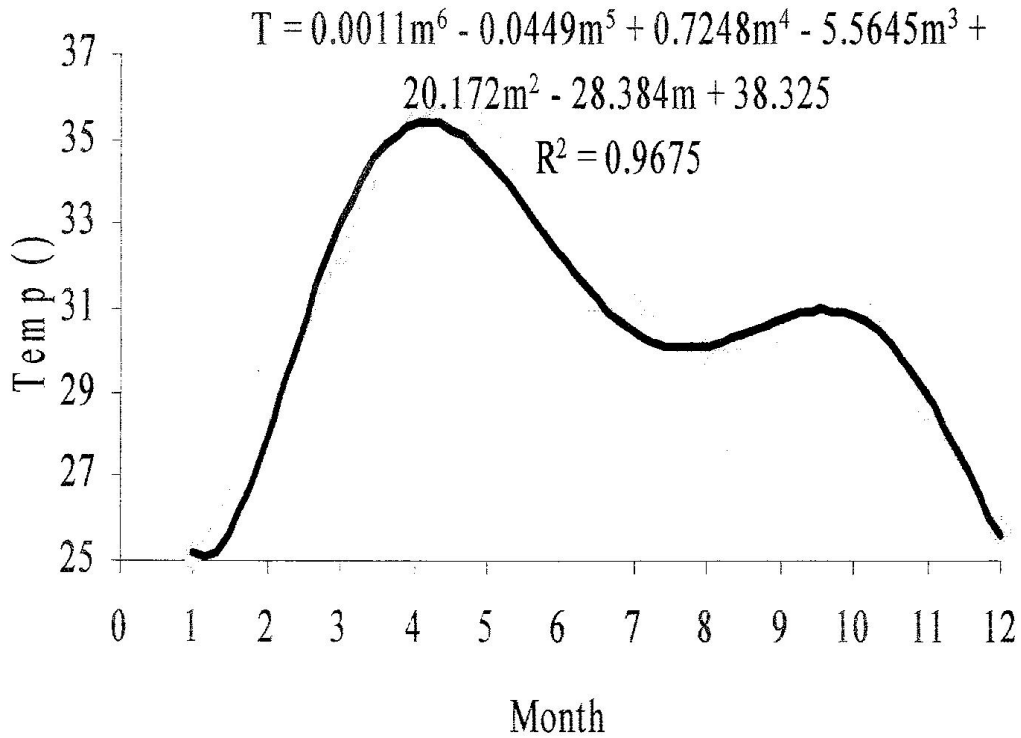


Figure 2

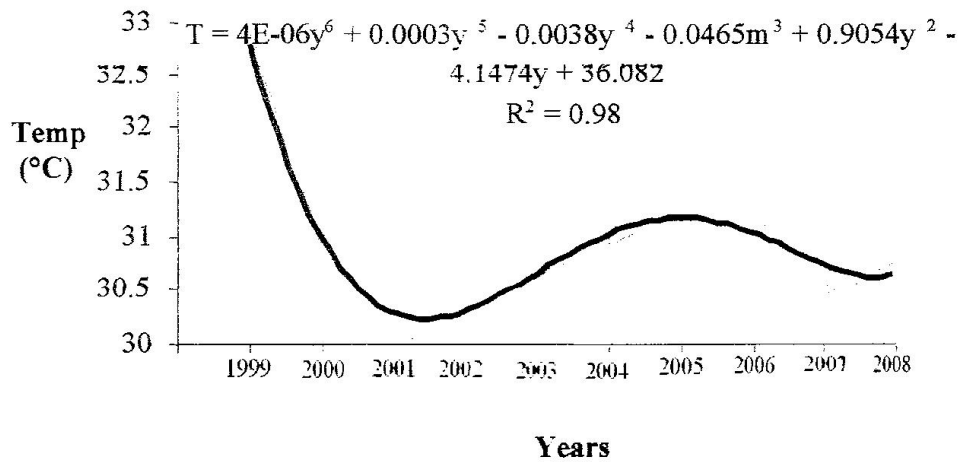


Figure 3

INTERPRETATION OF RESULTS

Monthly Average Ground Surface Temperature (GST) Estimate

From all the monthly average ground surface temperature (GST) value of the study period calculated. The plot monthly average ground surface temperature (GST) estimates curve constructed by using monthly average temperature. The curve consists of two (2) lines: the pink like saw-teeth structure and the dark thick line so called regression line showing the ground surface temperature (GST) variation of months from January, 1999 to December, 2008 the quantity steadily increasing from the first month to about 10th month and then decreasing to 40th month, start rising to about 80th month where it reached a pick and decreasing between the month of 80th and 100th month. The increase resumed between the month of 100th and 120th month where it reached the second peak and fall in 140 month.

Month-wise Ground Surface Temperature (GST) Estimate

Plot of the month-wise ground surface temperature (GST) against month (fig. 2) shows the quantity steadily increasing from the lowest value in the month of January through may where its reached a peak while between the month of June and August, the ground surface temperature (GST) estimates dropped. Between the months September, October and December, the ground surface temperatures (GST) rise and fall. Plot of the month-wise ground surface temperature (GST) (fig. 2) consist of two (2) lines: the pink line and dark line called the regression fit line shows the quantity increasing between the months of January and May where it reached a peak and decreasing between the June and August. The increase resumed between the months of September through to November and again fell in December.

During the rainy months of September both soil and air temperature fall, but on the accounts of its smaller heat capacity motion and lowest moisture content, the ground surface temperature (GST) reached a second peak in the month of October. By the month of November, the soil has lost sufficient moisture for its temperature to reach second peak.

Annual Ground Surface Temperature (GST) Estimate

From all the annual averages values of the study periods calculated. The plot of annual averages ground surface temperature (GST) against the year (fig. 3) showing the annual average ground surface temperature (GST) start decreasing from zenith point in 1999 through 2000 and 2001 to 2002 the quantity resumed increasing in 2003 through 2004 to 2005. From to 2006 ground surface temperature (GST) fall and then rise in 2008. This shows that the annual ground surface temperature (GST) rises and falls for every two (2) years.

DISCUSSION

Table 3.1 indicates annual average ground surface temperature (GST) for ten (10) years estimates to be $33.3 \pm 1^{\circ}\text{C}$ in Maiduguri international airport metrological station. The meteorological data shows the warming and cooling trends, the meteorological studies have verified its phenomena and has been consisted that Around 1999 Maiduguri warming trend has observed change in average year temperature has not exceeded over 1°C according to meteorological data.

The plot of month-wise ground surface temperature (GST) has the trend equation which can be used to predict the month-with ground surface temperature (GST) of few years before 1999 and few years after 2008. Where T in the equation represents the ground surface temperature (GST) and M is the month-wise respectively.

The plot of monthly trend also has the trend equation that used to predict the monthly ground surface temperature (GST) of the station of some years before 1999 and after 2008, and the plot of annual averages has the trend equation that can be used to predict the yearly annual average temperature. Where T in the equation represents ground surface temperature (GST) and Y is the years.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The analyses recorded the maximum and minimum air temperature from the meteorological station of the Maiduguri International Airport revealed the mean annuals ground surface temperature (GST) from the period of ten (10) years at the station is $33.8 \pm 23.8^{\circ}\text{C}$ while annual variation of ground surface temperature (GST) rises for every two (2) years, the analyses also revealed that the variation of ground surface temperature (GST) agreed with general weather pattern, the difference between annual average temperature for the Maiduguri International Airport from 1999 to 2008 is found that to be 2.46°C .

Conclusion

Based on the result of air surface temperature data recorded at Maiduguri international airport for the evaluation of ground surface temperature (GST). I have arrived at the following conclusion:

1. Climate in Maiduguri characterized by increase and decrease alternation of ground surface temperature (GST).

2. Temperature recorded in Maiduguri international airport meteorological station confirmed excessive climatic warming.
3. This warming can also be demonstrated by deep borehole data temperature.
4. The annual average ground surface temperature (GST) indicates decrease and increase for every two (2) year.

Recommendation

I wish to recommend that more trees should be planted within the premises of Maiduguri International Airport so that the amount of solar radiation reaching the earth surface will be reduced and also that the management of Maiduguri International Airport to provide more facilities for measuring weather changes such as ground surface temperature (GST) and surface air temperature (SAT) with earth thermometer. In general, the discharge of harmful and poisonous chemicals or gases which should be removed properly before being discharged to the atmosphere as it causes deflection of ozone (O₃) layer in the atmosphere that allow the direct passage of ultraviolet radiation to reach the earth surface and causes the earth surface to warm up which in turn causes increase in temperature.

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