Science World Journal Vol. 14(No 3) 2019
www.scienceworldjournal.org
ISSN 1597-6343
Published by Faculty of Science, Kaduna State University

Full Length Research Article

TEMPERATURE FORECAST USING A MATHEMATICAL FORMULATION

Magaji I. and Dogara M.D.

[1]Department of Physics, Kaduna State University, Tafawa Balewa Way, Kaduna, Nigeria

Corresponding Author's Email Address: imagaji05@gmail.com

ABSTRACT
This work, aimed at the calculation of monthly mean minimum temperature values for any given month. A mathematical equation $T_{min} = \frac{T_{max} - T_d}{4} + K$ was formulated, which was used to carry out the calculation based on the secondary factors that influence temperature change. The calculated values were compared with the actual values recorded by the Nigeria Meteorological Agency (NIMET). The highest percentage error was 14.14% while the lowest percentage error was -9.59%. Based on the result of the comparism, it shows that the formulated mathematical equation is sufficient to predict the monthly mean minimum temperature of a specific place at a particular time.

Keywords: Weather, Temperature, Actual, Calculated.

INTRODUCTION
Weather prediction deals with the application of science and technology to predict the state of the atmosphere for a future time and a given location. The study of the rates of climatic change and their impact on the environment and society is important and essential to predicting global and regional climatic variations; and to determining the extent of human influence on the climate. The increase in the global mean temperature by 0.7^0C within the last century is a clear evidence of a rapid global climatic change and a cause of concern especially, for climate scientists (Dogaraet al, 2017).
The concept of temperature originated during the early stage of human development. Perhaps we can appreciate that early development through watching changes taking place during the growth of a child, one of the first we were taught is that some things are too hot and others are too cold. Yet the sensual detection of temperature is deceiving. The concept of temperature has been the most difficult property of matter to define clearly (McGee, 1988).
Extreme temperature events through occurrence of prolonged hot or cold spells can have serious impact on our environment and society (Abdussalam, 2015). Weather warnings are important forecast because they are used to protect lives, properties and environment (Schiopuet al, 2009).
In recent years, investigations of observed temperature in many regions of the world have already shown some important changes in the extremes. Recent investigation of the trends in temperature indices has indicated a symmetric warming of the cold and warm tails of the daily maximum and minimum distributions during 1946-1999 (Abdussalam, 2015). The frequency of cold days decreased in northern china while the number of hot days also decreased in the eastern part of the country over the past 40years. Temperature is important for determining the extent of trend and variability in climate, as such; studying the behaviour may be of profound social and economic significance. Information on trends and variability of temperature is important for many applications such as agricultural activities, water resources management, aviation sector, and may help in improving the certainty of estimation about the future (Abdussalam, 2015).
Amadiet al. (2014) recommended in their paper that the provision of accurate and timely weather and climate information for planning in the sectors of the economy that are temperature sensitive such as agriculture, health, water resources management should be encouraged. This would prevent temperature extremes from becoming disasters and threats to livelihoods across Nigeria. Most of the observational and numerical simulation studies on climate are based on the instrumental records of about a century which are aimed at the understanding of the natural variability of climate system and to identify processes and forces that contribute to this variability (Akinsanola and Ogunjobi, 2014).
There are varieties of methods for weather forecast. The method used in this work is purely mathematical. The knowledge of climate variability over the period of instrumental records and beyond on different temporal and spatial scale is important to understand the nature of different climate systems and their impact on the environment and society.
Schiopu *et al*, (2009) use Statistical Package for the Social Sciences (SPSS) software for weather forecast. SPSS encapsulates advanced mathematical and statistical expertise to extract predictive knowledge that when deployed into existing processes makes them adaptive to improve outcomes. It is a reductive method in which new factors are built based on existing relationships between variables. A period of time, factor analysis was used only in psychology. After noticing the good results of this method, it was applied in the economic analysis and it has become an established statistical method. At the end, they concluded that the SPSS can forecast an unknown value, on the basis of some real, known values, using techniques that don't use too many scientific details.
The formula devised by Young **(**Allen, 1957) has been adapted for use in the orange belt of the southern San Joaquin Valley of California, in the majority of cases the indicated minimum is in error by less than $\pm 3^0$F. The formula used is as follows:

$$T_m = \frac{D-(H-30)}{4} + V + V' \quad \text{.....1}$$

Where; T_m is the indicated minimum temperature (°F), D is dew point (°F), H is relative humidity (%),
$V = \frac{-(D-28)}{3}$ and $V' = \frac{H-52}{6}$ **(**Allen, 1957).

Science World Journal Vol. 14(No 3) 2019
www.scienceworldjournal.org
ISSN 1597-6343
Published by Faculty of Science, Kaduna State University

METHODOLOGY

The Nigerian Meteorological Agency Kaduna records its maximum and minimum daily temperature values using the CASELLA London model thermometer in degree Celsius (^{0}C) which minima range between – 20^{o}C to + 20^{o}C and a maxima ranges from 0^{o}C to 100^{o}C. The thermometer for measuring the maximum temperature uses mercury as its thermometric substance, which has a convex surface or meniscus that pushes along a small piece of steel called an index, when the temperature rises and the mercury expands. When the temperature falls, the index stays in position. Therefore, the maximum temperature is observed to correspond to the lower or left side of the index at the end of the day. This index can be reset by tilting the thermometer or by using a small magnet. The thermometer for measuring the minimum temperature on the other hand, uses alcohol as its thermometric substance, which has a concave meniscus and an index below the meniscus. When the temperature falls, the index is pulled down the meniscus; when the temperature rises, the alcohol expands past the index, which stays in position; so that at the end of the day, the minimum temperature corresponds to the upper or right side of the index (Landis, 2009).

In this study, the following mathematical relation was formulated in order to be used to predict the value of monthly mean minimum temperature T_{min} from some giving set of data of a specific location at a particular time. The mathematical equation was formulated based on the secondary factors that influence the change in temperature which are the dew point temperature, the wind speed and the cloud cover.

$$T_{min} = \frac{T_{max} - T_d}{4} + K \quad \text{..... 2}$$

Where;
T_{min} is the calculated minimum temperature (^{0}C)
T_{max} is the actual maximum temperature (^{0}C)
T_d is the dew point temperature (^{0}C)
K is giving by summation of the wind speed in m/s and cloud cover Cc in %. Thus the value of K was used as constant in the equation.

METHODOLOGY

The formulated mathematical equation (Eqn 2) was used to calculate the monthly mean minimum temperature for the month of November from 2014-2018 (Table 2). The equation uses the monthly mean values of the maximum temperature T_{max}(^{0}C), dew point temperature T_d (^{0}C), wind speed in m/s, and cloud cover Cc in %. The result of the calculation shows that the equation is valid for computing the monthly mean minimum temperature in degree Celsius (^{0}C). The calculated monthly mean minimum temperature was compared with the actual monthly mean minimum temperature recorded by Nigeria Meteorological Agency (NIMET). It was observed that (table 2) the highest percentage error was 14.14% in 2018 while the lowest percentage error was -9.59% in 2014; it was also observed that 2015 and 2017 have less percentage error of -0.75% and 1.59% respectively. Figure 1 shows that the calculated values have same trend with the actual recorded and figure 2 shows a bar chart of the actual and calculated monthly mean minimum temperature.

Table 1: Monthly Mean Data Collected From the Nigeria Meteorological Agency (NIMET) for the Month of November from 2014-2018.

Year	Actual T_{max}(^{0}C)	Actual T_{min}(^{0}C)	Dewpoint (^{0}C)	Windspeed (m/s)	Cloudcover (%)
2014	33.60	17.20	7.40	5.3	7
2015	32.90	16.60	10.8	4.2	7
2016	33.40	17.70	8.40	4.1	6
2017	32.93	16.80	6.80	4.0	6
2018	32.60	19.80	4.20	3.9	6

Table 2: Actual Monthly Mean T_{min}, Calculated Monthly Mean T_{min}, and Percentage Error for the Month of November from 2014-2018

Year	Actual T_{min} (^{0}C)	Calculated T_{min} (^{0}C)	Error (^{0}C)	Error %
2014	17.2	18.850	-1.650	-9.593
2015	16.6	16.725	-0.125	-0.753
2016	17.7	16.350	1.350	7.627
2017	16.8	16.532	0.268	1.592
2018	19.8	17.000	2.800	14.141

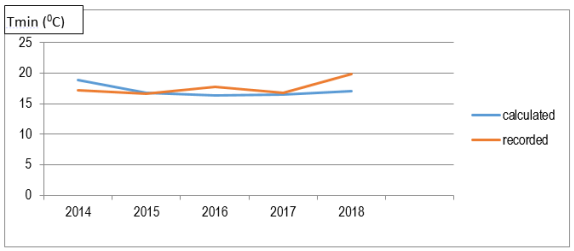

Figure 1: Measured Minimum Temperature against Calculated Minimum Temperature

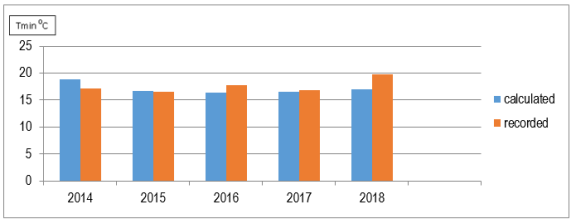

Figure 2: Measured minimum temperature against Calculated Minimum Temperature

Conclusion

A mathematical equation was formulated which was used to carry out calculations based on the secondary factors that influences the change in temperature (dew point temperature, wind speed, cloud cover). The calculated values were compared with the actual values recorded by the Nigeria Meteorological Agency (NIMET). The graph of the calculated values fits in the curve of the actual values. The highest percentage error was 14.14% while the lowest percentage error was -9.59%. Based on the result achieved, the mathematical formulation used could be seen as a reliable means of minimum temperature value prediction for a specific place at a particular time based on the secondary factors.

REFERENCES

Abdussalam A. F. (2015). Changes in Indices Of Daily Temperature And Precipitation Extremes in Northwest Nigeria. Science World Journal, 10(2), 18-26.

AbdussalamA. F. (2015) Trend and Variability in Temperature and Rainfall for Northwest Nigeria Between 1971 & 2010, Science World Journal, 21-33.

Akinsanola A. A &Ogunjobi K. O. (2014): Analysis of Rainfall and Temperature Variability over Nigeria Global Journals Inc. (USA) Online ISSN: 2249-46x

Allen C. Charles (1957). A Simplified Equation for minimum Temperature Prediction. Weather Bureau office, Pomona, Calif.

Amadi S.O., Udo S.O., Ewona I.O. (2014). Trends and Variations of monthly mean minimum and maximum temperature data over Nigeria for the period 1950-2012. International Journal of Pure and Applied Physics (UK). 2(4),1-27.

Dogara M. D., Onwumere M.K.O., Turang S., Joshua P. and Joseph I. A (2017). The Trends in Temperature And Solar Irradiance For Zaria Between 1986 and 2015.Science World Journal

Landis F (2009). "Thermometer." Microsoft® Encarta® [DVD]. Redmond, WA: Microsoft Corporation, Microsoft ® Encarta ®.

McGee T. D. (1988). Principle and methods of temperature. Wiley Interscience Publication.

Schiopu D., Elia G. P., Negoita C. (2009). Weather forecast using SPSS statistical methods. Gas University of ploisti, Romania.