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Predicting Seasonal Temperature using Monthly Indices Model for Yola, Adamawa State, Nigeria

Glandu V.P.[1], Patrick, T.[2], Ogbaka D.T.[1]

[1]Department of Pure and Applied Physics, Adamawa State University, Mubi. Adamawa State, Nigeria
[2]Government Day Secondary School Mubi II, Mubi South Local Government Area. Adamawa State, Nigeria

Abstract Weather prediction is a vital application in meteorology and has been one of the most scientifically and technologically challenging problems in Nigeria and across the globe. Predicting the weather is essential to help preparing for the best and worst of the climate. The observed trend in measured and predicted temperature has demonstrated that temperature variations can be predicted and this is has indicated that the monthly indices model for seasonal temperature prediction is effective and reliable model. The monthly temperature prediction in Yola (Jimeta) for eleven (11) years (2008 – 2018) was carried out using monthly indices model. The measured and predicted temperature values were comparable with the overall average mean. The result shows that December is the month with highest temperature means values of 8.82 ºC and 11.49 ºC for measured and predicted temperature respectively in the years. The lowest temperature values 3.37 ºC and 4.38 ºC in the month of July were observed. The similar trend in the measured and predicted temperature values obtained in this work demonstrates the effectiveness of the monthly indices model in predicting atmospheric variable. The monthly indices model could be employed for prediction of weather and climate parameter, considering it simplicity.

Keywords Mutant rice, allele, SSR markers, genetic diversity

Introduction

Many features of our natural environment such as soil, natural vegetation and water resources are directly influenced by the weather and climate conditions. The changing condition of weather and climate has also affected human lives in many ways including agricultural activities, the design of our houses and the types of clothing that we wear. Hence, the weather and the climate condition of any geographical area are the major factors that determine its habitability. However, in order to have a clear picture of atmospheric condition of a particular place, scientist employed a simple model which is the measurement of parameters such as temperature, relative humidity, pressure, wind speed and direction and solar radiation [1]. Studies have revealed that, the prediction of weather and climate applying various dynamic and statistical models produce the same result as that of measurement of parameters models [1]. Most of the statistical models are centered on regression analysis [2]. The prediction models considering the less fragrant or periodic indices of climate parameter (elements) still remain a major challenge to researchers. Though few works have been published by concerned individuals, more is still needed to be done in this area to compliment the little effort of the few researchers who distinguished their selves to work on this aspect.

The seasonal temperature prediction using monthly indices model for Nigeria was carried out by Adeniyi, [3] considering selected stations scattered all over Nigeria. He discovered that monthly indices of temperature, though simple constitutes a very good prediction tool. For seasonal temperature as demonstrated in all stations. Long-lead-seasonal temperature prediction using optimal climate normal was carried out by Huang *et al.,* [4] in United States. They discover that in practices, the climate, normally with a variable averaging period is

somewhat problematic. Chauhan and Thakur, [5] carried out research on weather prediction using data mining techniques (i.e. computer assisted process) the data's were collected manually so the quantity was also small. The prediction discovers relationship between independent variables and relationship between dependent and independent variables. Deardorff, [6] worked on the efficient prediction of ground surface temperature and moisture, with inclusion of a layer of vegetation using numerical weather prediction model. (Surface energy balance equation). The result of the research was achieved successfully.

Hao *et al.,* [7] carried out statistical correlation for model prediction on winter circulation in the extra-tropical of Northern Hemisphere, using Anomaly correlation coefficient model (ACC). This is to evaluate and measure the inter-annual variation of two meteorological elements.

Liweijia *et al.,* [8] worked on improved seasonal prediction of temperature and precipitation over land in a high-resolution (GFDL) climate model, using two different models GFDL climatic and land model. The results obtained from this research were however, valid for usage. Mwalusepo *et al.,* [9] carried out analysis on predicting the impact of temperature change on the future distribution of maize stem Borers and their Natural Enemies along East African mountain gradients, using phenology models. The research work was situated in Tanzania (pangani river basin in north east) Eastern Africa. The research shows the relationship and differences between the annual rainfall, temperature and climatic condition. Omotosho *et al.,* [10-15] worked on prediction of monthly and seasonal rainfall, onset and cessation of the rainy season in West Africa, using only surface data. The analysis was carried out in Kano state, Nigeria, West African sahel using only synoptic data. The results of the experiment shows the variations in equivalent potential temperature, which occur as a result of the seasonal, monthly and daily variation of moisture in the summer monsoon flow over west Africa.

Nandozi *et al.,* [16] carried out performance and prediction of seasonal rainfall and surface temperature of Uganda, using Regional climate model (RCM). The results of this analysis were obtained and valid for usage. Gemalyn *et al.,* [17] worked on prediction of weather and climate, using climate prediction.net model and Hadley centre coupled model version 3. The model work as an application and the results of this analysis was obtained after completion of a complete run of the model; it needed a visualization package to view the results. Meory and Yeon, [18] in their work, "seasonal prediction of monthly precipitation in china using large-scale climate indices model" applied prediction to precipitation on china on monthly basis, based on a multivariate linear regression with an adaptive choice of prediction drawn from regularly update climate indices with a two to twelve month load time. The monthly Anomaly Correlation Coefficient (ACC) were evaluated, ranging between 0.4 and 0.50 in central China, 0,41-0.57 in East China and 0.41-0.60 in south China. However, in this work, the monthly indices model will be used to make some prediction of seasonal temperature in Jemeta (Yola) and its environs using the data collected from Airport Base Yola (Adamawa state).

Weather prediction is a vital application in meteorology and has been one of the most scientifically and technologically challenging problems in Nigeria and across the globe. Predicting the weather is essential to help preparing for the best and worst of the climate. Also accurate weather prediction has been one of the most challenging problems around the world. Many weather prediction like rainfall, temperature and cloud conditions are major challenges for atmospheric research. In this research work monthly indices model would be employed to resolve some of this problems. The study is aimed at predicting seasonal temperature using monthly indices model.

Methodology

Study Area

Yola is situated in latitude of 09° 13' 48"North and longitude 12° 27' 36" East, located in Adamawa state, North Eastern Nigeria. It is characterized by two seasons; the wet season (April- October) and dry season (November-March). This occurs as a result of two major air masses that influence the weather and climate of the area. The rain bearing south western wind that originates from the Atlantic Ocean and dry north eastern air masses (Harmattan) from the Sahara Desert. Since daily and monthly temperature variations are the major temperature variations in Nigeria. Yola (Jimeta), is not an exception, because the globe is affected by global warming, Yola situation will be considered for this research work.

Figure 1: Map of Nigeria showing the study area (Adamawa)

Sources of Data

The maximum and minimum temperature data were obtained from airport base Yola Adamawa State. The data used spans between the periods of 2008 to 2018.

Method of Data Analysis

In this model, the mean monthly temperature values were computed from the maximum and minimum temperature data using equation 1

$$Tmean = \frac{Tmax - Tmin}{2} \quad (1)$$

Where:

T_{mean} = monthly temperature

T_{max} = maximum temperature values

T_{min} = minimum temperature values

The annual monthly indices were computed in the following steps:

The corresponding annual averages for each year were computed following the relation below.

$$\text{Average for each year} = \frac{yearly\ \ total}{number\ \ of\ \ mont\ hs\ in\ a\ year} \quad (2)$$

The given data were divided by the corresponding annual averages for each month and the result expressed in percentage with the following expression.

$$\text{Annual averages for each month in \%} = \frac{Tmean}{annual\ \ average\ \ for\ \ each\ year} x \frac{100\%}{1} \quad (3)$$

Where;

The average of each month data were found for the given number of years, thus:

$$\text{Monthly average (monthly indices)} = \frac{mont\ hly\ total}{number\ \ of\ years\ involved} \quad (4)$$

The indices in percentage were then used with the mean January temperature of a year to predict the monthly temperature using the relationship [19]

Predicated temperature value for each month in a year =

$$\frac{mont\ hly\ index\ \ of\ the\ mont\ h\ of\ the\ year}{100}\ x\ \frac{mean\ \ jan\ \ temperature\ \ \ value\ \ for\ the\ year\ \ considered}{1} \quad (5)$$

Since twelve months are considered for a year, the total of indices should be 1200. This is because the indices were expressed in percentage; multiplying 100% with the number of months in a year gives the total indices as 1200. If the total of the indices were not 1200, the value could be adjusted by multiplying through by 1200 and dividing by the total of the indices to obtain the monthly indices.

Results and Discussion

Table 1 presents the input data for the temperature prediction, while Table 2 shows the predicted temperature values. Fig 2 (a-k) shows the variation of the computed temperature value with the predicted temperature values for the year 2008 to 2018. While annual variations for the both predicted and computed temperature values for the eleven years in Yola (Jimeta) are presented in fig 3.

Table 1: Measured T-mean values

Year	Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec
2008	7.9	7.1	7.8	5.35	4.45	4.2	3.45	3.9	4.05	4.3	6.25	8.7
2009	9.6	8.2	5.9	5.4	4.75	4	3.5	3.35	3.65	3.75	7.1	8.95
2010	8.05	7.65	5.6	4.65	4.55	4.25	3.85	3.35	3.9	4.75	7	8.8
2011	8.05	7.1	6.1	4.95	4.95	3.7	3.65	3.45	4	6	6.6	8.65
2012	7.75	7.8	6.4	5.2	4.5	3.95	3.7	3.35	4	4.7	5.8	8.85
2013	2.65	6.45	5.6	5.5	4.3	3.8	3.55	3.3	3.85	4.5	7.4	7.85
2014	6.5	5.7	5.35	5.5	4.75	3.6	2.1	3.45	3.7	4.6	7.35	10
2015	8.1	7.7	6.65	5.1	4.25	3.75	2.05	3.15	3.85	4.4	5.3	8.55
2016	6.65	8.25	5.7	4.7	4.3	4.6	3.5	3.35	3.8	4.55	6.45	7.35
2017	6.75	6.2	6.35	5.35	4.85	4.9	4.3	3.95	4.05	4.1	6.3	10
2018	8.85	6.2	7.5	5.45	4.45	3.7	3.45	3.4	3.75	4.25	5.3	9.35
Total	80.8	78.3	68.95	57.15	50.1	44.45	37.1	38	42.6	49.9	70.85	97.05
Avg	7.35	7.12272	6.26818	5.19545	4.5545	4.0409	3.3727	3.4545	3.8727	4.5363	6.44090	8.82272

Source: Jimeta meteorological unit airport base yola (2008-2018)

Table 2: Predicted T- mean values

Year	Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec
2008	10.28	9.97	8.77	7.27	6.37	5.65	4.72	4.83	5.42	6.35	9.01	12.34
2009	12.50	12.11	10.66	8.83	7.74	6.87	5.73	5.87	6.58	7.71	10.95	15.00
2010	10.48	10.15	8.94	7.41	6.49	5.76	4.81	4.92	5.52	6.47	9.18	12.58
2011	10.48	10.15	8.94	7.41	6.49	5.76	4.81	4.92	5.52	6.47	9.18	12.58
2012	10.09	9.78	8.60	7.13	6.25	5.55	4.63	4.74	5.32	6.23	8.84	12.11
2013	3.45	3.45	2.94	2.44	2.14	1.90	1.58	1.62	1.82	2.13	3.02	4.14
2014	8.46	8.20	7.22	5.98	5.24	4.65	3.88	3.98	4.46	5.22	7.41	10.16
2015	10.54	10.22	8.99	7.45	6.53	5.80	4.84	4.96	5.56	6.51	9.24	12.66
2016	8.66	8.39	7.38	6.12	5.36	4.76	3.97	4.07	4.56	5.34	7.59	10.39
2017	8.79	8.51	7.49	6.21	5.44	4.83	4.03	4.13	4.63	5.42	7.70	10.55
2018	11.52	11.16	9.82	8.14	7.14	6.33	5.29	5.41	6.07	7.11	10.09	13.83
Total	105.25	101.98	89.75	74.39	65.19	57.86	48.29	49.45	55.46	64.96	92.21	126.43
Avg	9.57	9.27	8.16	6.76	5.93	5.26	4.39	4.50	5.04	5.90	8.38	11.48

Source: Jimeta meteorological unit airport base yola (2008-2018)

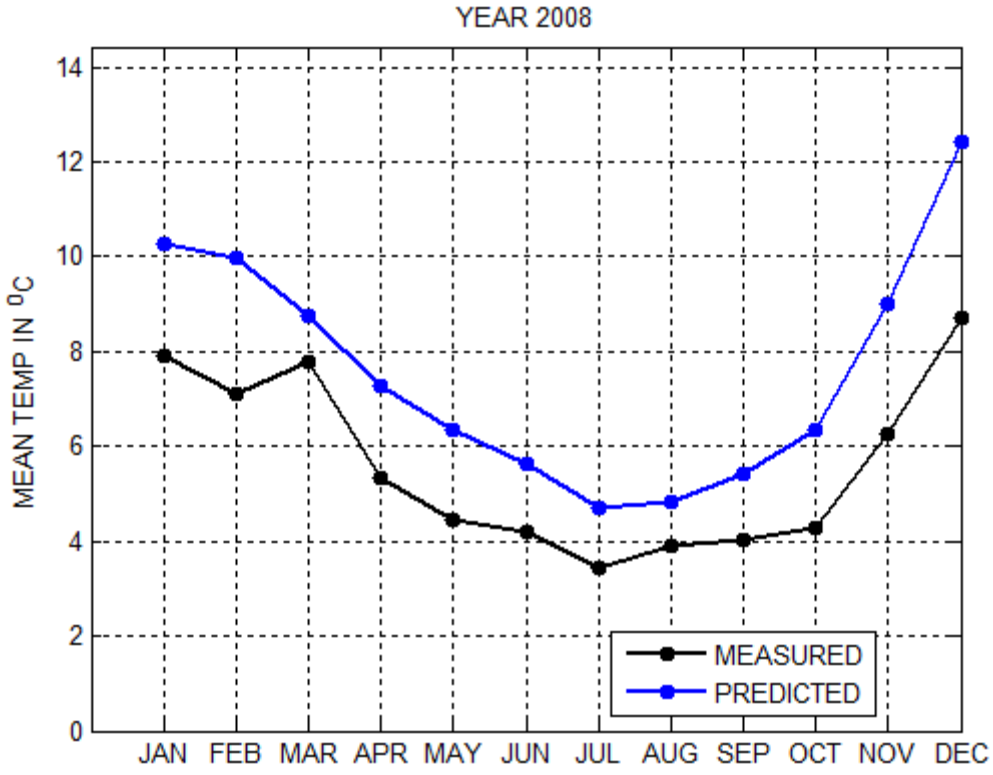

Figure 2a: Comparison of yola measured and predicted temperature in the year 2008

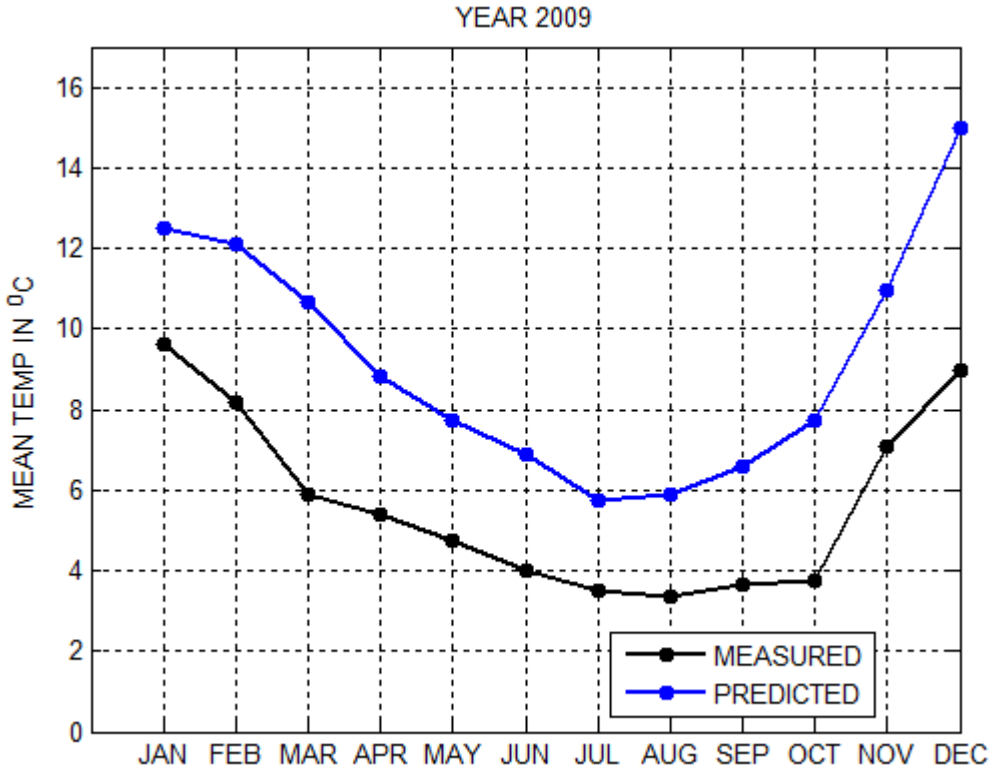

Figure 2b: Comparison of yola measured and predicted temperature in the year 2009

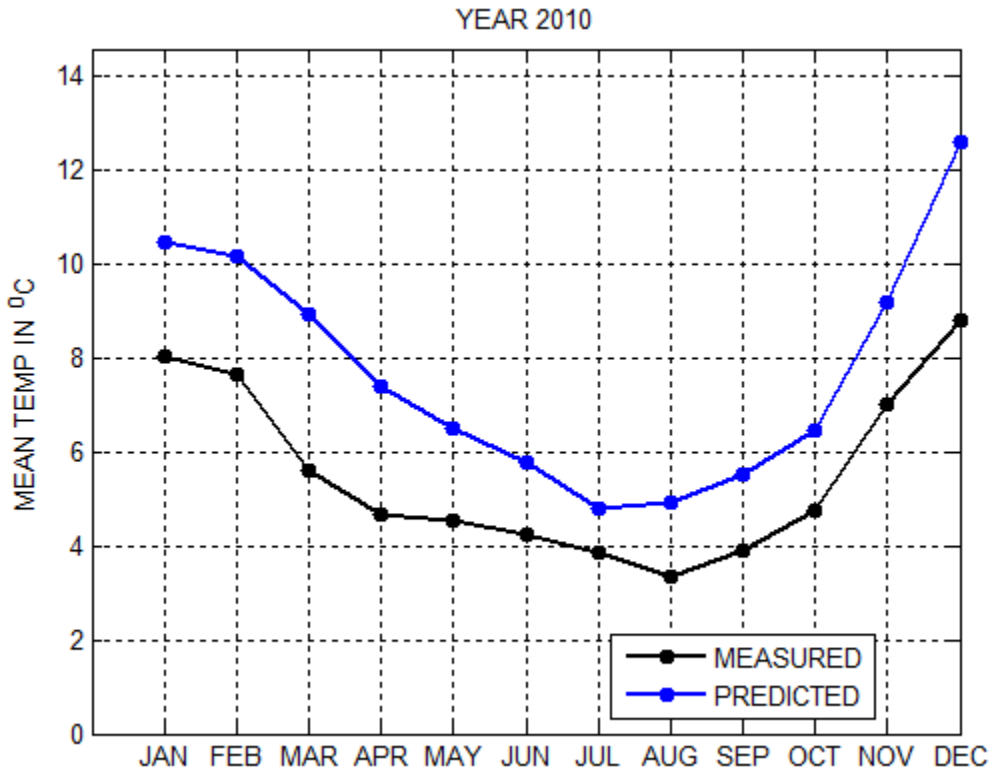

Figure 2c: Comparison of yola measured and predicted temperature in the year 2010

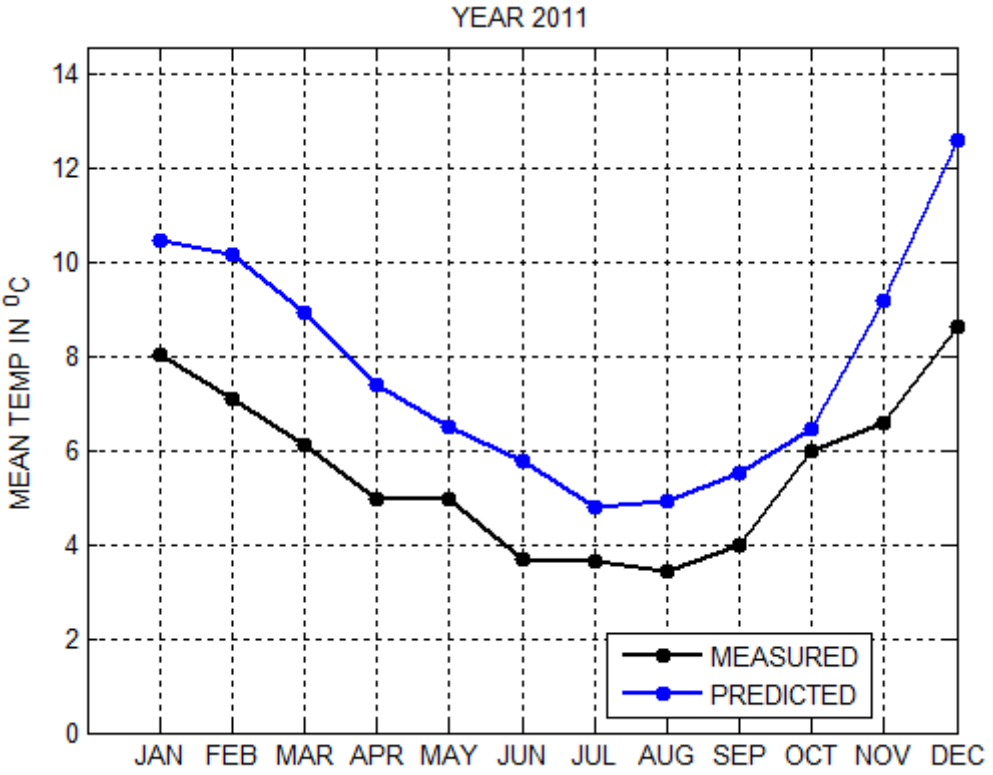

Figure 2d: Comparison of yola measured and predicted temperature in the year 2011

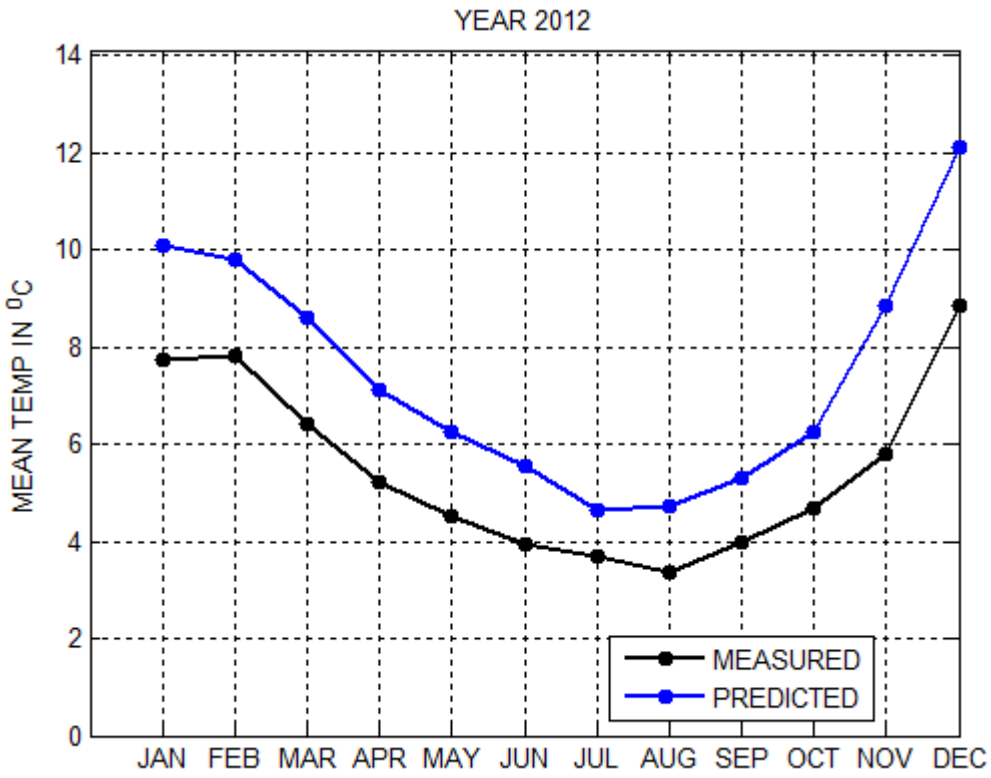

Figure 2e: Comparison of yola measured and predicted temperature in the year 2012

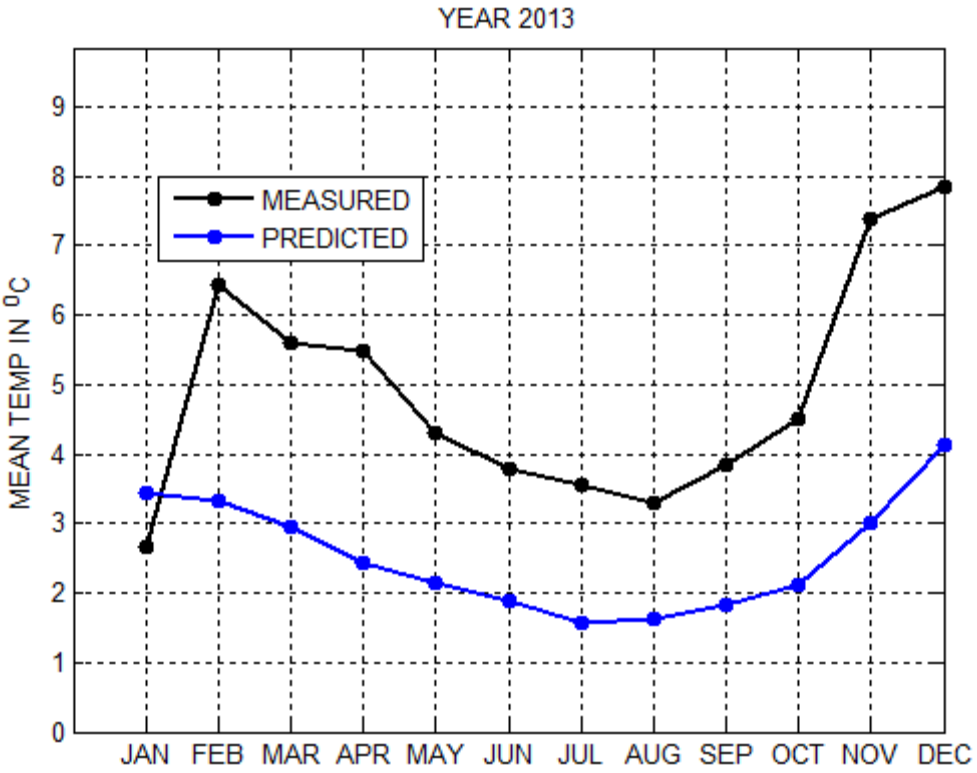

Figure 2f: Comparison of yola measured and predicted temperature in the year 2013

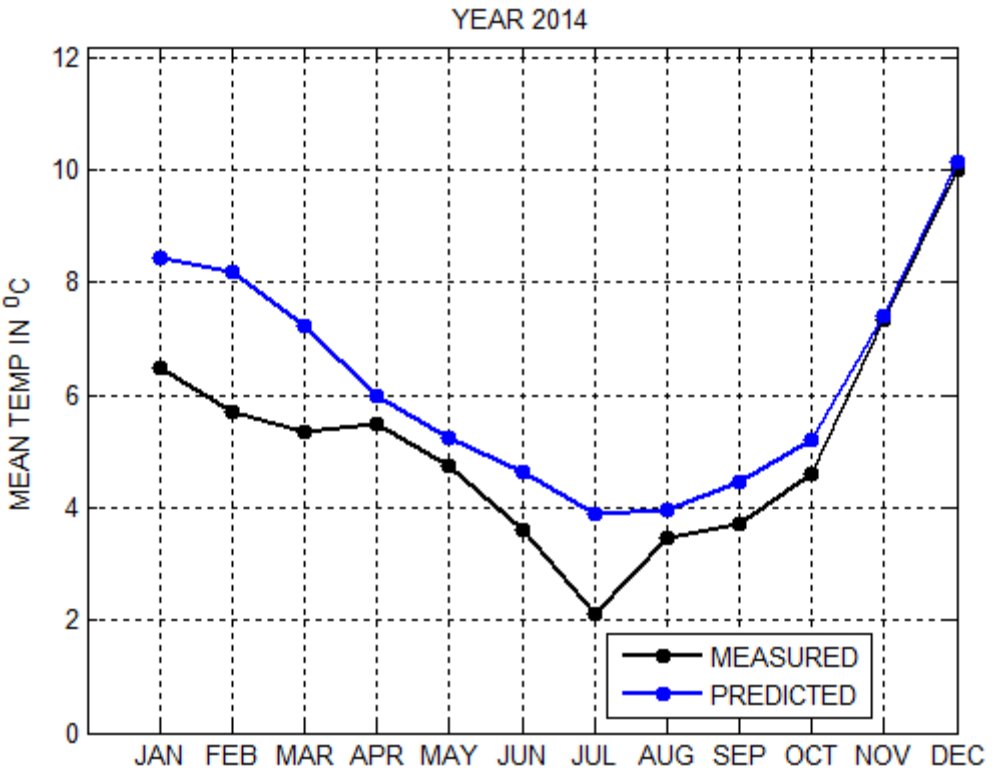

Figure 2g: Comparison of yola measured and predicted temperature in the year 2014

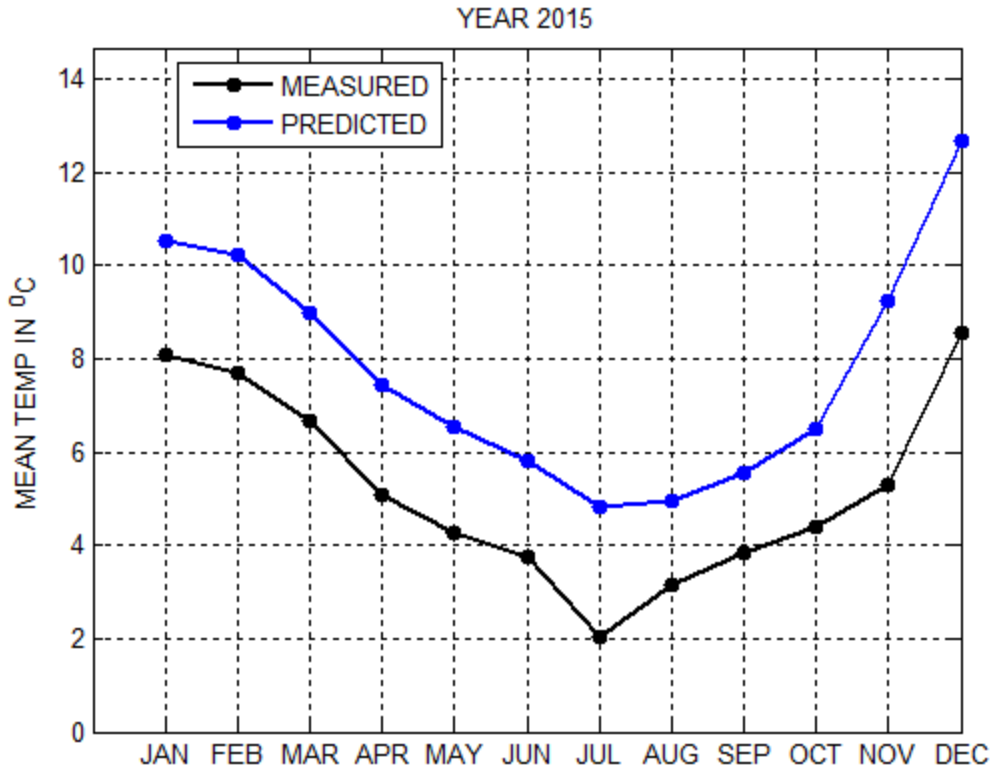

Figure 2h: Comparison of yola measured and predicted temperature in the year 2015

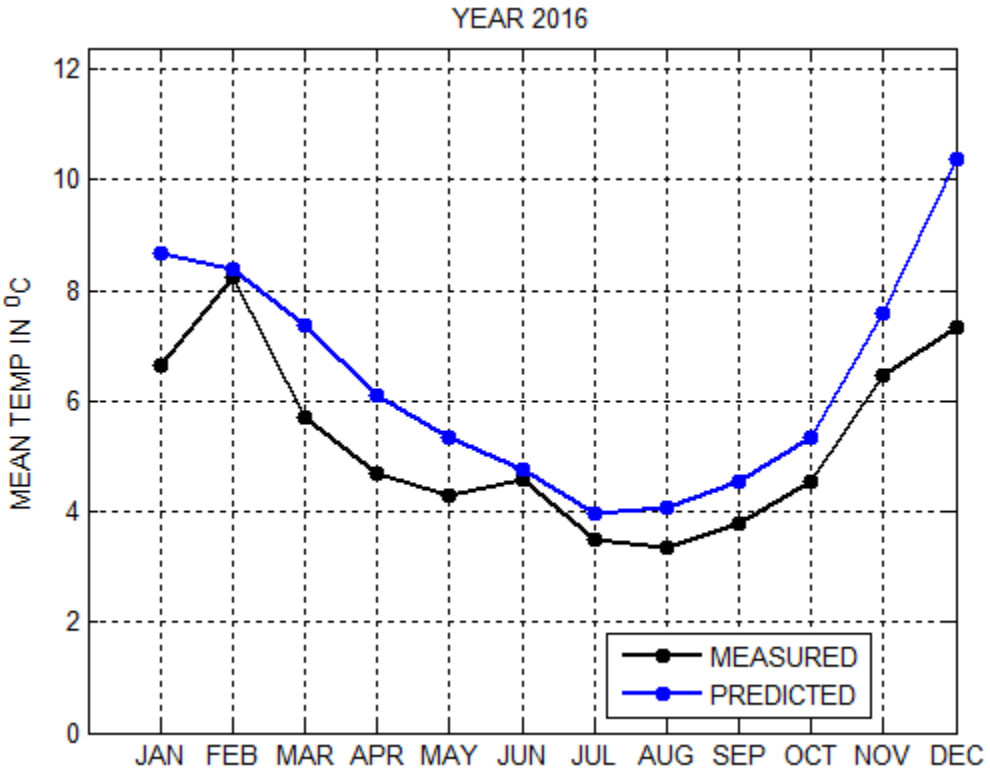

Figure 2i: Comparison of yola measured and predicted temperature in the year 2016

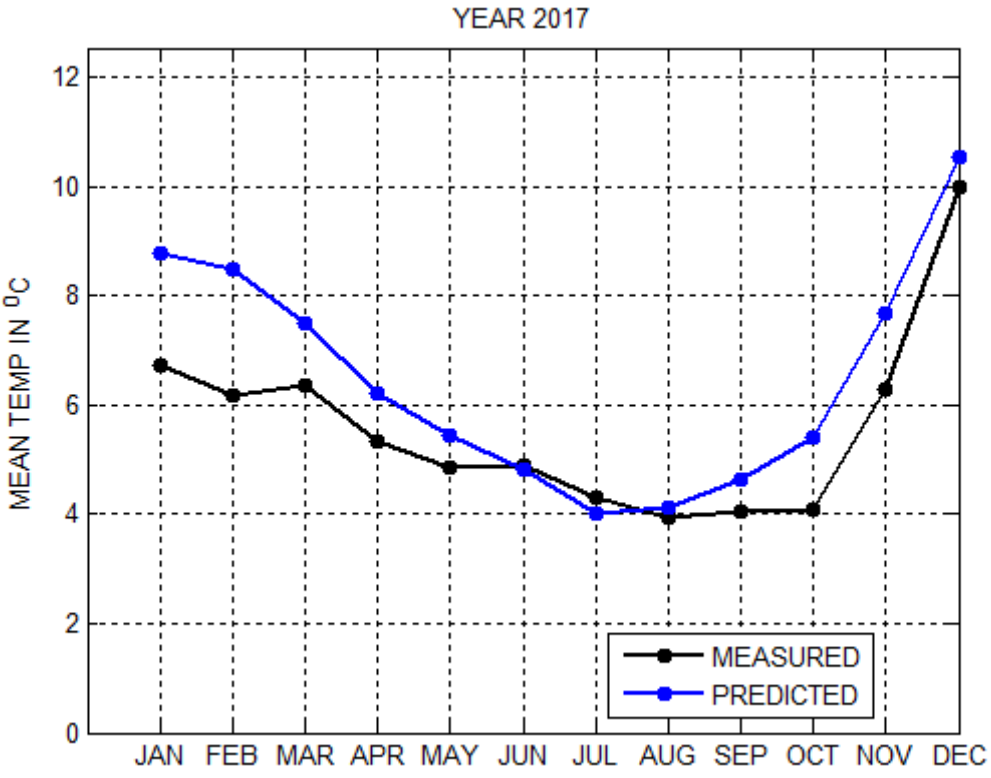

Figure 2j: Comparison of yola measured and predicted temperature in the year 2017

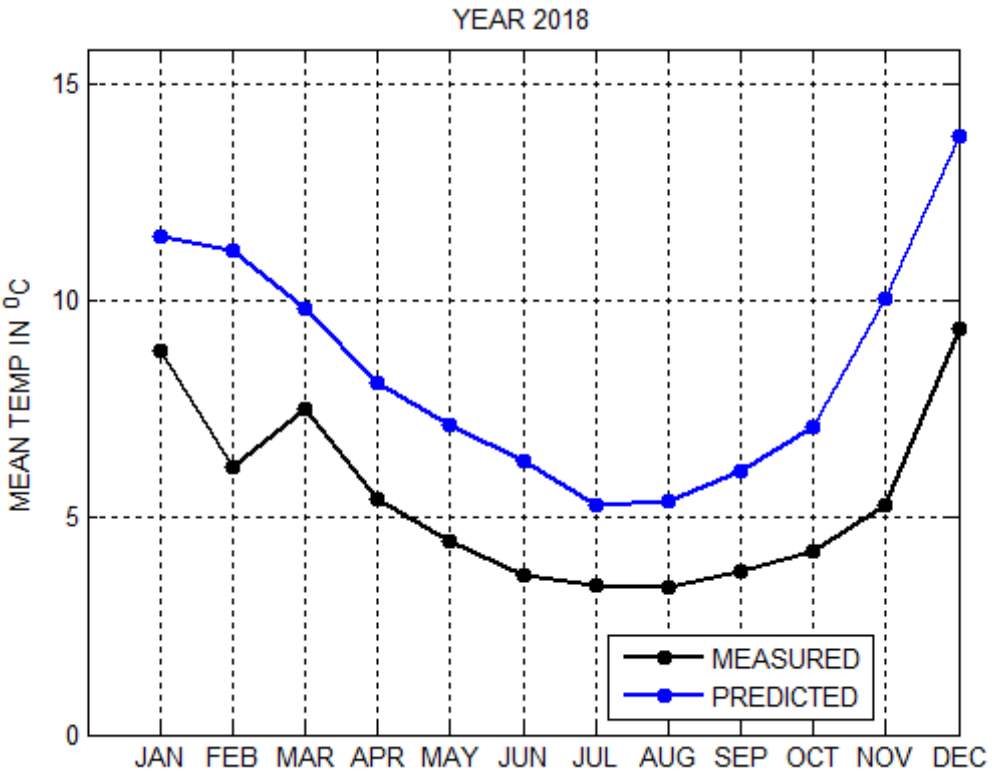

Figure 2k: Comparison of yola measured and predicted temperature in the year 2018

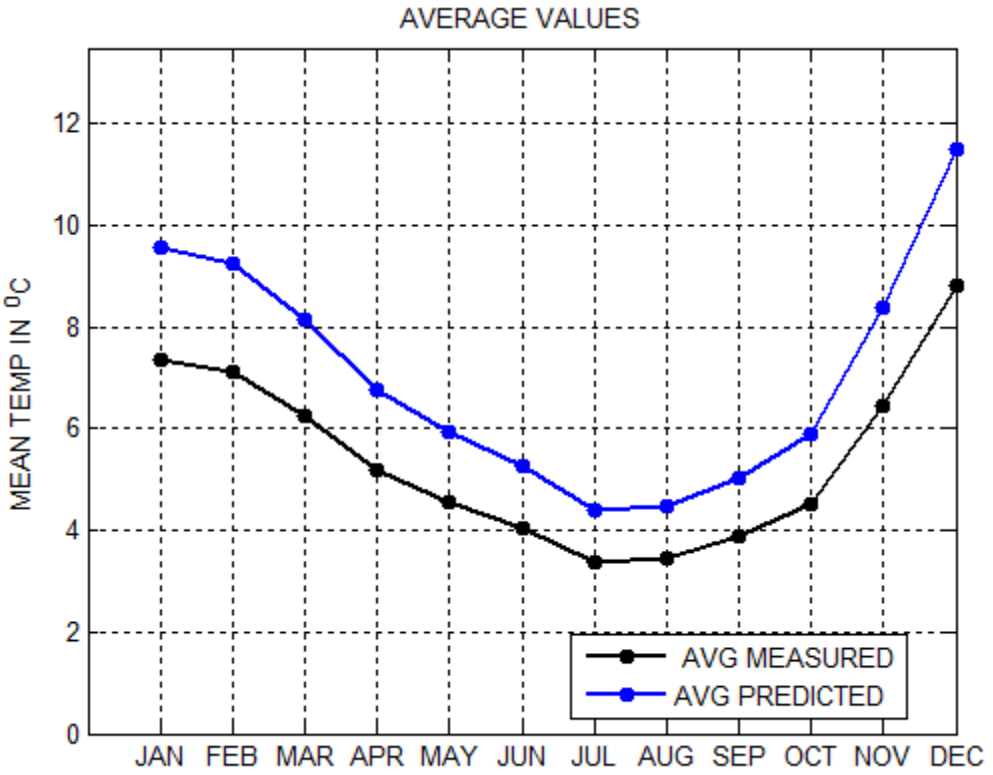

Figure 3: Comparison of yola average measured and average predicted temperature in the year 2008 - 2018

Discussion

It was observed, that the temperature values for both the measured and predicted temperatures were higher for the months of November, December, January, February march (dry season) than the months of April, May, June, July, August, September and October (rainy season) The monthly totals have highest values of 97.05 °C in December, 80.35 °C in January and 78.35 °C in February, for the measured temperature. Similarly for the predicted, December has the highest value of 126.33 °C, 105.24 °C in January and 101.99 °C in February. The monthly average which has 8.82 °C in December followed by 7.33 °C in January and 7.12 °C in February for the measured temperature. The predicted average temperature values are of the same manner as December having the largest value of 11.48 °C with 9.57 °C in January and 9.27 °C in February.

On the other hand the rainy season months have lower temperature values formation and predicted temperatures both shown in tables 1 and 2 of the measured temperature and table 2 of the predicted temperature. The lowest value can be seen in July for both parameters with 37.1 °C for the measured temperature and 48.29 °C for the predicted. Similarly the average follow similar trend with July having the lowest in both Measured and predicted temperatures the value of 3.37 °C for measured and 4.39 °C for predicted temperatures.

From Figure 1, temperature is at its pick in the month December for all both measured and predicted temperature curves. It is observed that there a sharp rise in temperature for the month of September which repeat in all the temperature predicted curves (a-k).

Figure 2a, July is the month with the lowest temperature; August is the month with the lowest temperature in Fig 2b-2e for the measured and predicted temperature curves. Figure 2f the situation changed with measured temperature curve as lowest value occur in the month of January while the predicted temperature curve still maintain July with lowest value. Figures 42g and 2h have their 'lowest temperature drop in the month of July for measured and predicted temperature curve.From fig 2i – 2k they have their lowest temperature drop in the month of August for both measured and predicted values while, their highest temperature is around November.

Figure 3 in the plot of average mean over the eleven years 2008 to 2018. This is to enable us know the overall month with the highest temperature as well as the month with least temperature. It is clearly observed that in both average measured and the average predicted temperature curves, December has the highest temperature value of 8.82 ºC on the average measured curve with 11.48 ºC was observed on the predicted average curve. The mean of 3.37 ºC and 4.38 ºC are the lowest values on both measured and predicted curves.

Conclusion

Monthly indices model for temperature prediction though simple, constitutes a very good prediction tools for seasonal temperature as demonstrated in Yola (Jimeta).

In this paper, December has the highest temperature with the mean temperature values of 8.82 ºC and 11.48 ºC respectively. The mean of 3.37 ºC and 4.39 ºC which are the lowest values in both the measured and predicted curve are found in the month of July. This show that July is the month with lowest temperature in Yola for the years under study.

The observed trend in measured and predicted temperature has demonstrated that temperature variations can be predicted and this is has indicated that the monthly indices model for seasonal temperature prediction is effective and reliable model. The monthly temperature prediction in Yola (Jimeta) for eleven (11) years (2008 – 2018) was carried out using monthly indices model. The measured and predicted temperature values were comparable with the overall average mean. The result shows that December is the month with highest temperature means values of 8.82 ºC and 11.49 ºC for measured and predicted temperature respectively in the years. The lowest temperature values 3.37 ºC and 4.38 ºC in the month of July were observed. The similar trend in the measured and predicted temperature values obtained in this work demonstrates the effectiveness of the monthly indices model in predicting atmospheric variable.

Recommendations

Based on the findings from this research work the following recommendations are proffered. The monthly indices model could be employed for prediction of weather and climate parameter, considering it simplicity.

Since temperature is important for weather forecasting, aircraft and maritime operation, meteorologist could adopt this model which is the simplest way of determining temperature at a particular region.

References

[1]. Nympas, C.F. Adeniyi, M.O., Ogolo, C.O and Oladifat, M. (2004): Lighting Signature as an index for the Determination of the Beginning of Planning Section in Nigeria, Africa Journal of Science and Technology. 5(2): 28 – 33.

[2]. Blind, M. and Mgillietta, F. A. (1999): Estimating daily Global Radiation from the temperature and Rainfall Climate Research. 1:113 – 124.

[3]. Adeniye M.O. (2010) http://cosagenph5iciptriesteit/full.display.php?ida=a9163

[4]. Huang, J., van den Dool, H. M., & Barnston, A. G. (1996). Long-lead seasonal temperature prediction using optimal climate normals. Journal of Climate, 9(4), 809-817.

[5]. Chauhan, D., & Thakur, J. (2014). Data mining techniques for weather prediction: A review. International Journal on Recent and Innovation Trends in Computing and Communication, 2(8), 2184-2189.

[6]. Deardorff, J. W. (1978). Efficient prediction of ground surface temperature and moisture, with inclusion of a layer of vegetation. Journal of Geophysical Research: Oceans, 83(C4), 1889-1903.

[7]. Hao D., Guirong T. and Hong-Li R. (2011). Statistical Correlation for Model Prediction on Winter Circulation in the Extra-tropical of Northern Hemisphere. Article. International Conference on Information Science and Technology.

[8]. Liweijia, Gabriel A. V., Richard G.G., Thomas L.D. and Anthony R. (2015). Improved Seasonal Prediction of Temperature over land in a high-resolution (GFDL) Climate model. *Journal of Climate*. 28: 2044-2062.

[9]. Mwalusepo, S., Tonnang, H. E., Massawe, E. S., Okuku, G. O., Khadioli, N., Johansson, T., Calatayud, P.A. & Le Ru, B. P. (2015). Predicting the impact of temperature change on the future distribution of maize stem borers and their natural enemies along East African mountain gradients using phenology models. PloS one, 10(6).

[10]. Omotosho, J. B. (1985). The separate contributions of squall lines, thunderstorms and the monsoon to the total rainfall in Nigeria. *Journal of Climatology* 5: 543–552.

[11]. Omotosho, J. B. (1989a). Equivalent potential temperature and dust haze forecasting at Kano, Nigeria. *Atmosphere Research* 23: 163–178.

[12]. Omotosho, J. B. (1989b). Energetics study of West African dust haze. Internal Report IC: 881332, ICTP, Trieste, Italy. 22pp.

[13]. Omotosho, J. B. (1990). Onset of thunderstorms and precipitation over Northern Nigeria. *International Journal of Climatology* 10: 849–860.

[14]. Omotosho, J. B. (1992). Long-range prediction of the onset and end of the rainy season in the West African Sahel. *International Journal of Climatology* 12: 369–382.

[15]. Omotosho. J. B. (1996). The validation of prediction models for onset of rainfall and prospects for West African Sahel. Report. A contribution to the ACMAD Demonstration period (96), ACMAD, Niamey, Niger.

[16]. Nandozi C. S., Majaliwa J. G. M., Omondi P., Komutunga E., Aribol and Isubikau P. (2012). Performance and Prediction of Seasonal Rainfall and Surface Temperature of Uganda using Rgional Climate Model. *African Crop Science Journal*. 20(2): 213 – 225.

[17]. Gemalyn A., Ahiduzzaman Md, Retcher C., Krismianto and Zhang L. (2009). Prediction of Weather and Climate using Climate Prediction .net Model. Unpublished Article. Institute for Mathematical Science, National University of Singapore.

[18]. Meoy, K. and Yeon, H. (2010): Seasonal prediction of monthly precipitation in China Using Large. Scale Climate Indices Model. Journal of Advance Atmospheric Science. 27(1): 47 – 57.

[19]. Enoh, C.O.E. (2005): fundamentals of social Science statistics, First edition Longman group Ltd. Uyo. 343.