International Journal of Pure and Applied Science
Published by Cambridge Research and Publications
Vol. 20 No.9
March, 2021.

ANOTHER MODEL EQUATION FOR CORRELATING UNAVAILABLE SOLAR RADIATION WITH RELEVANT CLIMATOLOGICAL PARAMETERS FOR METEOROLOGICAL STATIONS IN NIGERIA

UMAR W[1]., DAHUWA D[2] AND BITRUS B.M[3].
[1, 2]Department of Physics, School of Sciences, Aminu Saleh College of Education, P.M.B. 044, Azare, Bauchi State, Nigeria. [3]Department of Physics, Faculty of Science, Taraba State University, P.M.B. 1176, Jalingo Taraba State, Nigeria

Abstract:
In this paper, multiple linear regression has been applied to analyze the data of four meteorological stations in Nigeria viz: Bauchi, Bida, Kano and Nguru via a newly proposed five parameter model equation. The analysis was carried out for both yearly and seasonal variations. Regression coefficients, parameters and goodness-of-fit indices were obtained for each of the stations and an adjusted coefficient of determination, $R_a^2 > 0.95$ *was recorded for most stations. For the yearly and seasonal variations, the empirical model proposed in this work yielded the best-fit equation for all the stations, as opposed to similar empirical models in the literature. With the exception of Nguru were satisfactory fits are obtained with seasonal variation, the results obtained for Bauchi, Bida and Kano are good enough with yearly variation of input data. The results obtained in this research may find suitable applications in areas of agriculture, aviation and weather forecast*

***Keywords**: Empirical equation, cloud cover, relative humidity, relative sunshine duration, climatological parameter, solar radiation*

Introduction

Solar radiation is one of the most important forms of energy at the disposal of mankind (Angstrom and Roy, 1929). In many instances, it has been shown that all forms of energy in the universe originated from the sun (Prescott, 1940;

Aidan, Yadima and Ododo, 2005). Over the years, researchers have been occupied with how best the solar radiation reaching the earth can be harnessed and put to useful forms (Page, 1964; Swartman and Ogunlade, 1967; Fagbenle, 1990). This idea has led to the development of the pyranometer, a sophisticated instrument for measuring the amount of solar radiation received on the surface of the earth (Ododo, Sulaiman, Aidan, Yuguda and Ogbu, 1995a). A major problem with the pyranometer is that it is expensive and requires much skills on the part of the user, there is also the need for timely insolation data for its operation (Ododo, Agbakwuru and Ogbu, 1995b).

Over the years, empirical model equations have been proposed as substitute for the pyranometer. Empirical equation relates a dependent variable to one or more independent variables (Ojosu, 1990; Eyube, Alkasim and Najoji, 2018a; Eyube, Sanda and Wadata, 2018b). Commonly used dependent variable for an empirical equation are the daily solar radiation on a horizontal surface (H) and also the clearness index (H/H_0), H_0 being the extraterrestrial daily solar radiation on a horizontal surface (Ododo and Sulaiman, 1994a). Some few years ago, the unavailable solar radiation ($H_0 - H$) was considered by Aidan and co-workers as a useful dependent variable, the unavailable solar radiation represents the amount of solar radiation not received on the surface of the earth (Aidan, Yadima and Ododo, 2005). Various model equations incorporating unavailable solar radiation as dependent variable have been considered in the literature (Eyube, Tanko and Alkasim, 2018d).

Important climatological independent variables used to model solar radiation include relative humidity, maximum air temperature, cloud cover and relative sunshine duration amongst others (Ododo and Usman, 1996). Various forms of empirical equations have been used in the literature to model available data for different meteorological stations in Nigeria (Fagbenle, 1990; Ododo, Sulaiman, Aidan and Ogbu, 1994b).

The aim of this research is to correlate existing data of unavailable solar radiation with relevant climatological parameters through a newly proposed empirical equation. The specific objectives include: (1) Use multiple linear regression technique to obtain regression parameters for the input data of four meteorological stations in Nigeria viz: Bauchi, Bida, Kano and Nguru. (2) Compute goodness-of-fit indices (standard error of estimate, adjusted coefficient of determination, residual sum of squares, maximum percentage error and absolute average percentage error) and (3) compare results with similar empirical equation in the literature where they exist

Theoretical Formulation

Model equations

Model equations which correlates unavailable solar radiation to relative humidity (R), relative sunshine duration (S/S_0) and cloud cover (C) as the independent variables is of the form (Eyube, Najoji and Alkasim, 2018c)

$$H' = \sum_{i,j,k=0} \alpha_{ijk} \left(S/S_0\right)^i R^j C^k \,, \qquad (1)$$

where $H' = H_0 - H$ is the unavailable solar radiation, α_{ijk} are constant coefficients. Of the many equations deducible from equation (1), Aidan and collaborators (2005) have proposed a five-parameter model equation given as

$$H' = \alpha_{000} + \alpha_{100}\left(S/S_0\right) + \alpha_{010}R + \alpha_{001}C + \alpha_{101}RC \,. \qquad (2)$$

Equation (2) was applied to the data of seven meteorological stations in Nigeria viz: Bauchi, Jos, Kano, Maiduguri, Nguru, Potiskum and Yola. In another similar work, the meteorological data of fourteen (Bauchi, Bida, Enugu, Gusau, Ikom, Jos, Kano, Maiduguri, Minna, Nguru, Potiskum, Yelwa, Yola and Zaria) stations in Nigeria was modeled with an empirical equation incorporating S/S, R and C of the form

$$H' = \alpha_{000} + \alpha_{100}\left(S/S_0\right) + \alpha_{010}R + \alpha_{001}C + \alpha_{101}\left(S/S_0\right)C \,. \qquad (3)$$

Motivated by the excellent fits obtained through the use of equations (2) and (3), we are encouraged to consider the following empirical model of the form

$$H' = \alpha_{000} + \alpha_{010}R + \alpha_{001}C + \alpha_{110}\left(S/S_0\right)R + \alpha_{101}\left(S/S_0\right)C \,, \qquad (4)$$

to correlate existing data of four selected meteorological stations in Nigeria viz: Bauchi, Bida, Kano and Nguru. To the best of our knowledge, equation (4) has never been used in the literature to analyze the data of any climatological station.

Mathematical procedure

With the help of MATLAB programming software, a *multiple linear regression* will be carried out on equation (4) for yearly and seasonal variations. The yearly variation ranges from the months of January – December. Seasonal variation is classified as dry season (November, December, January, February March and April) and wet season (May, June, July, August, September and October) (Ododo and Sulaiman, 1994a). In order to analyze numerical data, the following goodness-of-fit indices are considered, these include the: *standard error of estimate* (seH′), *adjusted coefficient of determination* (R_a^2), *residual sum of squares* (Δ), *maximum percentage error* (MPE) and *absolute average percentage error* (AAPE), they are given by (Ododo and Sulaiman, 1994a)

$$\mathrm{SeH}' = \left\{ \frac{\sum_i \left(H_i' - H_{fit}'\right)}{n-k} \right\}^{\frac{1}{2}}, \quad (5)$$

seH′ > 1 is considered as high standard error, the smaller the value of seH′, the better is the correlation.

$$R_a^2 = \frac{(n-1)R^2 - (k-1)}{n-k}, \quad (6)$$

if $R_a^2 = 0$, there is no correlation between the dependent and independent variable, on the other hand, if $R_a^2 = 1$, a perfect correlation exits between the dependent and independent variables.

$$\Delta = \sum_i \left(H_i' - H_{fit}'\right)^2, \quad (7)$$

here also, the smaller Δ the better is the fit

$$\mathrm{MPE} = \max\left|1 - \frac{H_i'}{H_{fit}'}\right| \times 100\%, \quad (8)$$

$$\mathrm{AAPE} = \frac{1}{n}\sum_i \left|1 - \frac{H_i'}{H_{fit}'}\right| \times 100\%, \quad (9)$$

an MPE or AAPE greater than 5% is regarded as high. *n* is the number of experimental data points (*n* = 12 and 6 for yearly and seasonal variations respectively), *k* is the number of parameters in the empirical equation (*k* = 5 in each of equations 2, 3 and 4). H_i' and H_{fit}' are the observed i^{th} and fitted values of unavailable solar radiation

Results and Discussion

Coordinates of the meteorological stations studied in this work

Table 1: Spherical coordinates (longitude, latitude and altitude) of the four stations considered in this work

Station	Latitude (θ^o N)	Longitude (ϕ^o N)	Altitude (m)
Bauchi	10.6371	10.0807	610
Bida	9.0797	6.0097	144
Kano	12.0022	8.592	472
Nguru	12.878	10.457	343

Input Parameters

The data in Table 1 shows the input parameters of the four stations: Bauchi, Bida, Kano and Maiduguri reported in this work (Ododo and Sulaiman, 1994a; Ododo, Sulaiman, Aidan and Ogbu, 1994b)

Results of regression analysis-parameters and goodness-of-fit indices

Using the input parameters given in Table 2, a multiple linear regression was carried out on equations (2) and (4) to obtain yearly and seasonal regression coefficients $\alpha_{i\,j\,k}$ (i, j, k = 0, 1) and coefficient of determination R^2. Inclusion of equation (2) is informed of the fact that it has not been applied to the data of Bida and to enable comparison with the proposed model in this work. Having obtained these parameters, equations (5) – (9) were subsequently employed to compute goodness-of-fit indices for each of the meteorological stations. Calculated regression parameters and goodness-of-fit indices are shown in Tables 3 and 4. To enable a comparison of results with existing data in the literature, we have included columns for corresponding results obtained by other similar model equations (Aidan, Yadima and Ododo, 2005; Eyube, Najoji and Alkasim, 2018c).

Bauchi

Regression parameters and goodness-of-fit indices are shown in Table 3. From the table, it is clear that for the yearly variation, equation (4) gives best-fit for the data with relatively smaller values of seH′, Δ, MPE and AAPE and a near perfect adjusted coefficient of determination of 0.9933 compared to equations (2) and (3) in the literature. If we consider seasonal variation, best-fit model is also provided by equation (4) for the dry season and equation (2) for the wet season. The fact that equation (4) holds for both yearly and seasonal variation (at least for the dry season) is an indication of the supremacy of the empirical model proposed in this paper over existing models in the literature.

Bida

Computed regression parameters and goodness-of-fit indices for the input parameters of Bida are shown in Table 3. For the yearly fits, model equation (3) gives the best-fit for the data. However, values of seH′, Δ and MPE are high for all the three empirical models. On the other hand, equation (4) gives best-fit for variation over dry and wet seasons, in particular, the goodness-of-fit indices are relatively smaller as required. It follows that climatological variables such as relative humidity, cloud cover and relative sunshine duration in Bida are best predicted via equation (4) in wet and dry seasons

Kano

Considering the data in Table 4 which shows, equation (4) has a relatively smaller values of seH′, Δ, MPE and AAPE when compared to equations (2) and (3) for yearly variation and for dry season variation. Similarly, equation (2) gives best model equation for the wet season (seH′ = 0.0973). It is obvious that yearly variation is quite satisfactory in modeling the iput data for this station.

Nguru

Regression parameters and goodness-of-fit indices for the input parameters of Nguru are shown by the data in Table 4, from the table it can be seen that equation (4) gives the best-fit but values of both Δ and MPE are too high for all three equations, this is an indication that the three model equations are unsuitable in modeling unavailable solar radiation over yearly variation. For the seasonal variation, equations (3) and (4) gives best-fit to the data Δ, MPE and AAPE are relatively low and $R_a^2 = 0.9319$ for the dry season and 0.7775 for the wet season. It is evident that seasonal variation is satisfactory for the input data of Nguru.

In figures 1 and 2, graphical plots representing equation (4) and observed unavailable solar radiation are shown for Bauchi meteorological station

Table 2: Input parameters of four meteorological stations studied in this work C (oktas), H′ (M J m^{-2} day^{-1})

Month	Bauchi				Bida				Kano				Nguru			
	S/S_0	R	C	H′	S/S_0	R	C	H′	S/S_0	R	C	H′	S/S_0	R	C	H′
Jan	0.7365	0.1662	4.11	13.4077	0.5068	0.3338	2.89	15.4885	0.6926	0.2059	2.13	10.3100	0.7492	0.1618	4.28	11.2243
Feb	0.7143	0.1343	4.05	13.6902	0.5905	0.3442	3.54	14.4702	0.7137	0.1655	2.13	10.1905	0.8061	0.1332	4.27	10.4915
Mar	0.6262	0.2449	4.99	15.4458	0.5227	0.4392	4.96	15.8842	0.6386	0.175	3.27	11.7016	0.6733	0.1268	4.93	12.0521
Apr	0.584	0.3032	5.84	16.8053	0.5532	0.544	5.39	17.7315	0.6325	0.268	4.23	13.3161	0.6413	0.1776	5.4	13.1584
May	0.5982	0.4648	5.94	17.4198	0.5646	0.6459	6.16	18.2347	0.6763	0.4232	4.93	14.0940	0.7067	0.299	5.26	13.7229
Jun	0.5858	0.5866	6.04	18.0464	0.4406	0.7032	6.66	19.8753	0.6786	0.5515	4.87	14.6363	0.7166	0.4221	5.4	14.5898
Jul	0.5084	0.6978	6.41	20.5267	0.3765	0.747	6.8	22.0960	0.5923	0.677	5.57	17.0736	0.635	0.5764	5.87	15.8169

Aug	0.5282	0.7335	6.69	20.1916	0.391	0.7505	6.78	23.7033	0.5563	0.7237	5.98	17.3428	0.6122	0.6712	6.35	17.3137
Sep	0.5764	0.6666	6.19	18.8618	0.4506	0.9419	6.78	20.9040	0.6547	0.6512	5.4	14.8668	0.6967	0.5939	5.79	14.2763
Oct	0.6925	0.4741	5.17	15.3579	0.5841	0.6712	6.03	17.0717	0.7145	0.4056	3.77	11.7828	0.7857	0.3394	4.93	11.8527
Nov	0.7734	0.239	4.18	13.3025	0.6867	0.475	3.87	12.8495	0.7581	0.2225	2.59	10.3897	0.8091	0.2007	4.7	10.6350
Dec	0.7586	0.1897	3.86	12.6442	0.6023	0.3814	2.45	14.1272	0.7339	0.214	2.31	10.0514	0.8207	0.1818	4.19	10.7213

Table 3: Parameters of regression analysis and goodness-of-fit indices

parameter	**Bauchi**			**Bida**		
	[(a)]Eq. (2)	[(b)]Eq. (3)	Eq. (4)	[(b)]Eq. (2)	[(b)]Eq. (3)	Eq. (4)
	yearly variation					
α_{000}	24.0364	15.2298	10.0931	21.9494	19.1365	11.8519
α_{100}	-15.5182	-3.8805	…	-23.0941	-13.2909	…
α_{010}	-2.4357	4.3051	10.9643	12.0052	3.2569	11.9785
α_{001}	0.0821	1.9687	1.9335	0.8887	1.4079	1.6383
α_{011}	1.1770	…	…	-1.1519	…	…
α_{101}	…	-2.6053	-1.6358	…	-1.4087	-1.4741

α_{110}	…	…	-12.5304	…	…	-19.5968
seH′	0.2391	0.2333	0.2246	0.9564	0.9451	0.9809
	0.9925	0.9928	0.9933	0.9201	0.9220	0.9160
Δ	0.40	0.38	0.35	0.40	6.25	6.74
MPE (%)	2.7	3.4	3.2	7.3	6.7	6.5
AAPE (%)	0.9	1.0	0.9	3.3	3.1	3.7
	dry season variation					
α_{000}	0.4884	20.8766	5.2572	39.7517	24.0809	9.6001
α_{100}	-1.5303	-23.5028	…	-11.1185	-24.5847	…
α_{010}	14.0669	-4.2787	-140.5345	-50.9109	12.5460	147.0373
α_{001}	3.6878	-0.8880	9.4882	-4.7496	-0.2569	-11.6824
α_{011}	-4.8506	…	…	12.7576	…	…
α_{101}	…	4.7298	-9.9724	…	0.4170	20.2734
α_{110}	…	…	185.1148	…	…	-230.4890
seH′	0.1888	0.1549	0.0633	0.3514	1.1724	0.2029
	0.9857	0.9904	0.9984	0.9562	0.5125	0.9854
Δ	0.04	0.02	0.00	0.12	1.37	0.04
MPE (%)	1.0	0.9	0.3	1.5	4.3	0.9
AAPE (%)	0.4	0.4	0.2	0.9	2.8	0.5
	wet season variation					
α_{000}	33.7065	24.8707	15.6571	406.7277	-2691.2593	61.0809

α_{100}	-23.7924	-15.5053	…	-47.0911	3898.7826	…
α_{010}	-1.2337	4.4317	-12.7405	-487.7324	-86.1495	172.8760
α_{001}	-0.6986	0.7230	4.0583	-54.7613	395.3277	-21.5792
α_{011}	0.9486	…	…	72.9938	…	…
α_{101}	…	-1.2893	-6.8662	…	-538.0340	31.8614
α_{110}	…	…	28.4877	…	…	-362.7661
seH′	0.1823	0.1853	0.2069	1.6394	1.5288	1.5128
	0.9909	0.9906	0.9883	0.5527	0.6110	0.6191
Δ	0.03	0.03	0.04	2.69	2.34	2.29
MPE (%)	0.8	0.8	0.8	5.4	5.0	5.0
AAPE (%)	0.3	0.3	0.4	2.0	1.9	1.9

(a) = (Aidan, Yadima and Ododo, 2005); (b) = (Eyube, Najoji and Alkasim, 2018c)

Table 4: Parameters of regression analysis and goodness-of-fit indices

parameter	**Kano**			**Nguru**		
	[a]Eq. (2)	[b]Eq. (3)	Eq. (4)	[b]Eq. (2)	[b]Eq. (3)	Eq. (4)
	yearly variation					
α_{000}	15.2105	8.6950	7.3261	18.4572	8.0268	7.8113
α_{100}	-9.8210	-1.7324	…	-13.2209	0.2164	…
α_{010}	-1.4830	2.4226	12.6408	5.5434	5.2260	7.6934
α_{001}	0.8591	2.6379	1.7333	0.4299	2.4216	2.2650
α_{011}	0.8669	…	…	0.0402	…	…
α_{101}	…	-2.2792	-0.7361	…	-2.5411	-2.1967
α_{110}	…	…	-16.5288	…	…	-3.9059
seH′	0.4330	0.4167	0.4138	0.5908	0.5779	0.5767
	0.9731	0.9751	0.9754	0.9285	0.9316	0.9319

Δ	1.31	1.22	1.20	2.44	2.34	2.33
MPE (%)	4.3	3.9	3.7	6.2	6.6	6.7
AAPE (%)	1.9	1.9	1.8	2.7	2.4	2.4
	dry season variation					
α_{000}	14.7743	1.4861	7.2386	25.4950	-6.4313	10.5307
α_{100}	-6.4688	9.1246	…	-14.1507	22.9918	…
α_{010}	-11.0808	2.3739	114.9569	-19.9306	6.2625	17.1938
α_{001}	0.1499	4.9869	-6.0055	-1.0164	5.6071	1.7907
α_{011}	4.3861	…	…	5.8855	…	…
α_{101}	…	-5.8726	10.8507	…	-7.6644	-2.5061
α_{110}	…	…	-167.2334	…	…	-13.1248
seH′	0.1478	0.2594	0.0715	0.3754	0.0133	0.2390
	0.9868	0.9593	0.9969	0.8699	0.9998	0.9473
Δ	0.02	0.07	0.01	0.14	0.00	0.06
MPE (%)	1.2	2.0	0.5	2.2	0.1	1.3
AAPE (%)	0.4	0.9	0.3	1.2	0.0	0.8
	wet season variation					
α_{000}	16.8906	120.5964	23.0542	5.6379	4.377	1.2161
α_{100}	-42.8075	-154.7698	…	-13.0134	-4.7069	…
α_{010}	57.9475	1.4780	-1340.3416	1.0297	-3.3951	-7.9933
α_{001}	4.9731	-15.0041	164.7945	3.5640	3.9739	4.9662
α_{011}	-10.9639	…	…	-0.9001	…	…
α_{101}	…	21.4657	-247.0681	…	-1.8527	-3.3070
α_{110}	…	…	1989.9967	…	…	6.6115
seH′	0.0973	0.4775	0.8177	0.8799	0.8767	0.8765
	0.9978	0.9460	0.8416	0.7758	0.7774	0.7775
Δ	0.01	0.23	0.67	0.77	0.77	0.77
MPE (%)	0.4	2.6	3.9	4.4	5.0	5.0
AAPE (%)	0.2	1.1	1.5	1.9	1.9	1.9

(a) = (Aidan, Yadima and Ododo, 2005); (b) = (Eyube, Najoji and Alkasim, 2018c)

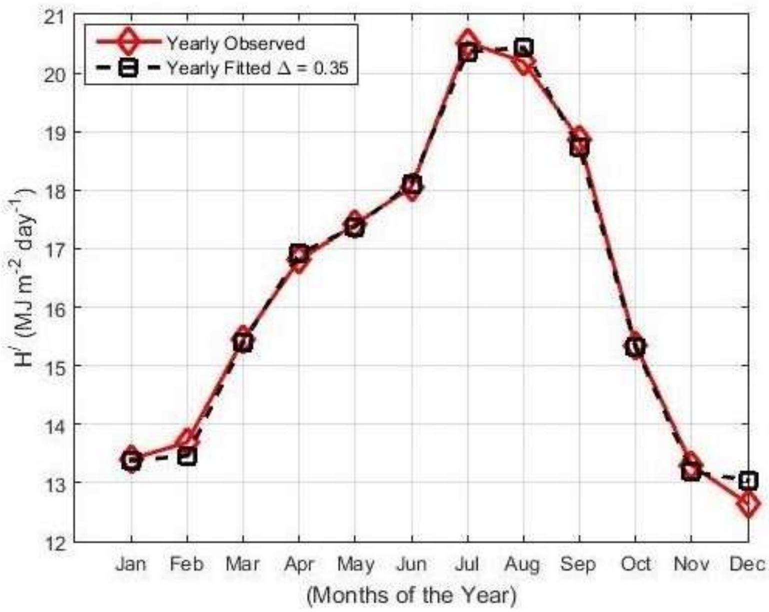

Figure 1: Graphical representation of yearly observed and fitted H′ vs. months of the year

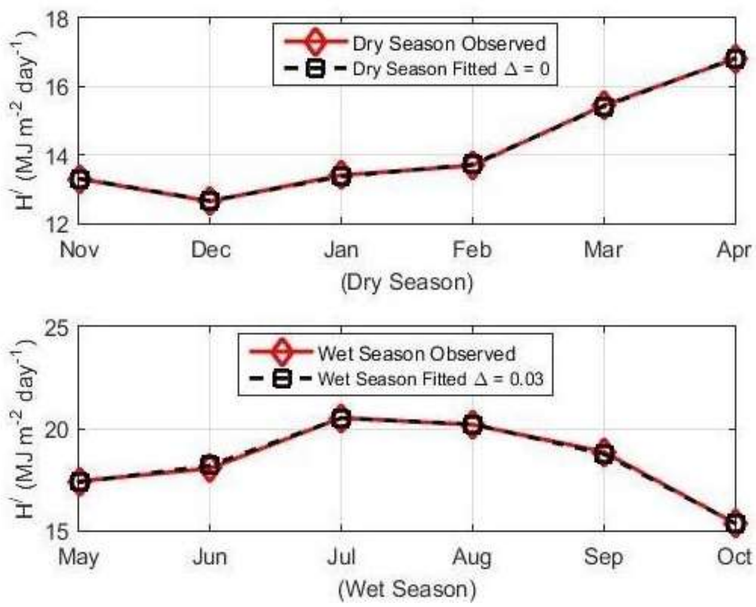

Figure 2: Graphical representation of seasonal observed and fitted H′ vs. months of the season

Conclusion

In the present study, through MATLAB programming software, a, multiple linear regression has been considered in the analysis of existing data of four meteorological stations in Nigeria to correlate existing data of four meteorological stations in Nigeria. The analysis was done the yearly and seasonal fits. Regression coefficients, parameters and goodness-of-fit indices were obtained for each of the stations (Bauchi, Bida, Kano and Nguru) where an adjusted coefficient of determination, $R_a^2 > 0.95$ was obtained for majority of the stations. The empirical model proposed in this work gave best-fit equation for all the stations for the two variations considered, as against similar empirical models in the literature. Seasonal fits are best for the input data of Nguru, on the other hand, fits for yearly variation are satisfactory for the data of Bauchi, Bida and Kano. This work and results obtained may find suitable applications in areas of agriculture, aviation and weather forecast

References

Aidan J., Yadima, A. and Ododo, J.C. (2005). Modelling Unavailable Solar Radiation Using Climatological Parameters. *Nigerian Journal of Solar Energy* **15**, 118-126

Angstrom A.J. and Roy Q.J. (1929). Solar and Terrestrial Radiation. *Meteorol* **50**, 121-126

Eyube E.S., Alkasim A. and Najoji S.D. (2018a). Prediction Equations for Parameterization of Clearness Index and Unavailable Solar Radiation in Terms of Some Climatological Parameters for Some Nigerian Stations. *International Journal of Applied Physics* **71**-77

Eyube E.S., Sanda, A. and Wadata, U. (2018b). Empirical Formulae for Parameterization of Unavailable Solar Radiation in Nigeria. *International Journal of Applied Physics* **3**, 32-48

Eyube E.S., Najoji S.D. and Alkasim A. (2018c). Correlation of Unavailable Solar Radiation Using Some Nigerian Stations. *International Journal of Renewable Energy Sources* **3**, 60-70

Eyube E.S., Tanko P.U. and Alkasim A. (2018d). Use of Relative Sunshine Duration and Cloud Cover for the Prediction of Solar Radiation in Nigeria. *International Journal of Renewable Energy Sources* **3**, 41-59

Fabgenle R.O. (1990). Estimation of Total Radiation in Nigeria Using Meteorological Data. *Nigerian Journal of Renewable Energy* **1**, 1-10

Ododo J.C., Sulaiman A.T., Aidan J., Yuguda M.M. and Ogbu F.A. (1995a). The Importance of Air Temperature in the Parameterization of Solar Radiation in Nigeria. *Journal of Renewable Energy* **6**, 751-763

Ododo J.C. and Sulaiman A.T. (1994a, May). Angstrom's Regression Coefficient for Nigerian Stations. Paper Presented at the 2nd OAU/STRC Symposium of New, Renewable and Solar Energy Organized in Collaboration with UNESCO/ROSTA, Bamako, Mali

Ododo J.C., Sulaiman A.T., Aidan J. and Ogbu F.A. (1994b, May). Modelling of Solar Radiation in North-Eastern Nigeria. Paper Presented at the 2nd OAU/STRC Symposium of New, Renewable and Solar Energy Organized in Collaboration with UNESCO/ROSTA, Bamako, Mali

Ododo J.C. and Usman A. (1996). Correlation of Total Solar Radiation with Common Meteorological Parameters for Yola and Calabar. *Energy Convers. Mgmt*. **37**, 521-530

Ododo J.C., Agbakwuru J.A. and Ogbu F.A. (1995b). Correlation of Solar Radiation with Cloud Cover and Relative Sunshine Duration. *Energy Convers. Mgmt*. **37**, 1555-1559

Ojosu J.O. (1990). A Correlation of Global Solar Radiation with Cloud Cover and sunshine Hours. *Nigerian Journal of Solar Energy* **9**, 133-142

Page J.K. (1964). Estimation of Monthly Mean Values of Daily Short-Wave Radiation on Vertical and Inclined Surfaces from Sunshine Records for Latitudes 40° N - 40º S. *Prac. UN Conf. on New Sources of Energy* **4**, 378

Prescott J.A. (1940). Evaporation from Water Surface in relation to Solar Radiation. *Trans. R. Soc. Austr*. **64**, 114-118

Swartmann R.K. and Ogunlade O. (1967). Solar Radiation Estimates from Common Parameters. *Solar Energy* **11**, 170-172