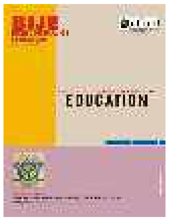
BIJE – Bichi Journal of Education
ISSN(Print): xxxx-xxxx ISSN(Online): 2734-3375
Vol. 10, No.1 2010; pp: 43-52.
Publisher: School of Education, F.C.E (T) Bichi.
URL: https://bijejournal.com/BIJE



DAY-TO-DAY VARIABILITY IN SOME IONOSPHERIC PARAMETERS IN THE QUIET EQUATORIAL IONOSPHERE (CASE STUDY: IONOSPHERIC CRITICAL FREQUENCY OF THE E-REGION, f_0E)

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ABSTRACT

Day- to -day variability in some ionospheric parameters in the quiet equatorial ionosphere, case study: foE is hereby presented. The diurnal variation of foE shows a symmetrical one with a peak value at noon. The seasonal variation curve of foE has two maximum points in the months of April and August. It is also shown that for short time variation, the day-to-day variability in the E - region of the ionospheric critical frequency, foE, is not due to season nor relative sunspot number Rz. The test of significance carried out between the standard errors of foE before and after correction shows no significant difference at 95% level of significance.

Introduction:

It has been shown that day-to-day changes in the F region critical frequency were closely related on an average to day-to-day changes in the noon values of Sq (rate of electron production) at the magnetic equator (Bates D,R and Massey H.S.W, 1997). They attributed this correspondence to day - to - day differences in the dynamo electrostatic field generated by winds near or within the E-region. There is little information about the E-region of the ionosphere because at night the critical frequency foE lies outside the working range of most ionosonades. It has been shown that at night foE varies so much from hour to hour and from night to night; that it is impossible to describe a regular behaviour (Yokoyama, 2004). This variability is probably evidence that at night the phenomenon of Es, is particular noticeable.

Also, no enough records of foE at night as a result of slow decay of ionization produced during the day by photo-ionization and due to slow recombination process. It therefore becomes necessary to study these behaviours in the E-region so as to provide the data needed for the description of the ionospheric E layer, which is essential for the maintenance of radio communication. The observation would make possible complex calculations of temperature, of composition of the air, and of properties of the earth's magnetic field.

Data collection:

The data used for this study were collected from the readings of an ionosonade which were recorded into booklets. The ionosonade is the ionospheric sounder used in Ibadan. The period covered by data is January to December 1996. An Ap indices (Ap <10) was taken as indicating a quiet day (arbitrary) and the results, therefore describe the behaviour of the undisturbed E-region.

Terminologies used:

Daytime: Hours between 0600 and 1800 hours
Night time: Hours between 1900 and 0500 hours
Seasons: Following the division of the year into seasons, by (Barry, 1945) the different seasons are given by March and April representing March equninox, May to August representing June solstice.
f_oE: Ordinary wave critical frequency of the E-layer.

Analysis/Results/Discussion:

foE daytime variation (Diurnal Variation) tables 1 and 2 are observed values of foE at each hour of the day for which observations were made.

Table 1

March Equinox (Month of April) foE VALUES (OBSERVED) MHz

Q.D	06	07	08	09	10	11	12	13	14	15	16	17	18	Rz
8	2.10	3.05	3.60	4.00	4.30	4.30	-	-	4.20	3.95	3.60	2.85	1.70	246
9	2.30	3.10	-	4.10	-	4.35	4.50	-	4.20	-	-	-	-	204
10	2.20	3.05	3.65	4.05	4.40	-	-	-	-	-	-	-	-	197
11	2.10	3.10	3.60	3.90	4.30	4.30	-	-	-	-	-	2.80	1.60	159
12	2.10	3.05	310	4.05	4.15	4.30	4.40	4.30	4.10	3.75	3.40	-	1.80	140
13	2.10	3.05	-	4.00	4.20	4.35	4.35	4.30	4.05	3.80	-	2.65	1.60	127
22	2.30	3.20	3.65	4.00	-	4.30	-	4.30	-	-	3.40	-	-	212
23	2.30	3.35	3.75	4.08	4.29	4.33	4.39	4.33	4.19	4.00	3.76	3.30	2.57	201

Table 2

June Solstice (Month of June) foE Values (observed) MHz

Q.D	06	07	08	09	10	11	12	13	14	15	16	17	18	Rz
3	2.50	3.20	3.20	4.00	4.15	4.30	4.30	4.20	-	3.80	3.35	2.85	1.80	181
4	2.50	3.20	3.20	4.10	4.40	4.40	4.45	-	-	4.05	3.45	2.80	1.90	195
5	2.45	3.30	3.70	4.00	4.30	4.45	4.40	4.35	4.15	3.80	3.35	2.95	1.85	195
13	2.25	3.15	3.65	3.65	4.20	4.20	4.20	4.25	4.15	4.00	3.85	3.40	2.90	176
16	2.30	3.15	3.65	4.00	4.20	4.30	4.30	4.30	4.00	3.75	3.30	2.70	1.80	100
17	-	-	3.80	-	4.20	4.35	4.35	4.20	4.00	-	3.45	2.95	1.90	113
18	2.20	3.10	3.35	3.85	-	4.25	4.25	-	3.90	3.60	3.35	2.70	1.80	100
20	2.20	3.20	3.65	3.95	4.15	4-	-	-	3.95	3.65	3.30	2.80	1.80	107

The day time variation curves are as shown in figure 1

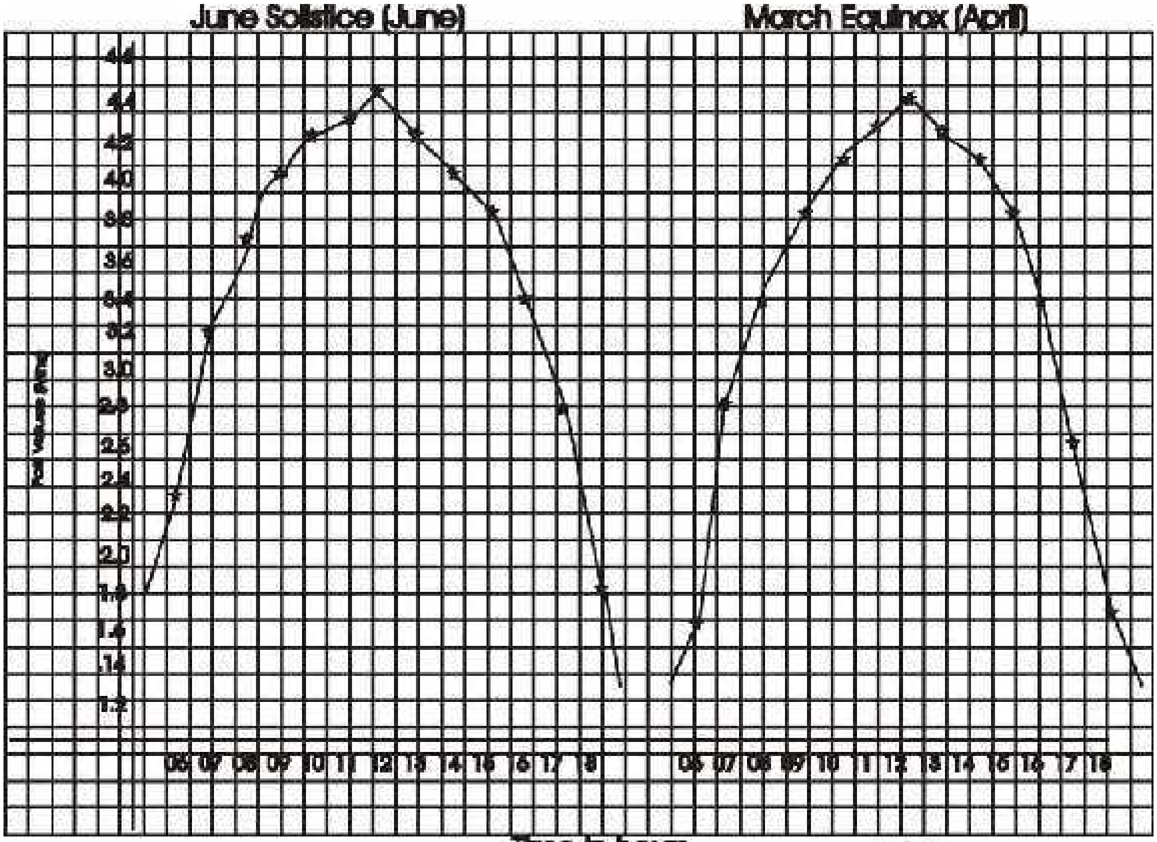


Fig 1

The curves show a symmetrical one with peak value at noon, it is important at this point, to mention that from the diurnal variation curve of foE, the recombination coefficient x, can be determined from.

Dt. = 1 (Appleton E,V 1959)

seasons are represented by the months that belong to the season and the standard errors determined at some chosen hours of the day.

Month of April (March Equinox)

Month of June (June Solstice)

<u>For example: March Equinox</u>

At 0700 hours

Mean foE = 3.10MHz

Standard deviation = 0.05

Standard error = 0.02

Hence foE = (3.10 + 0.02) MHz

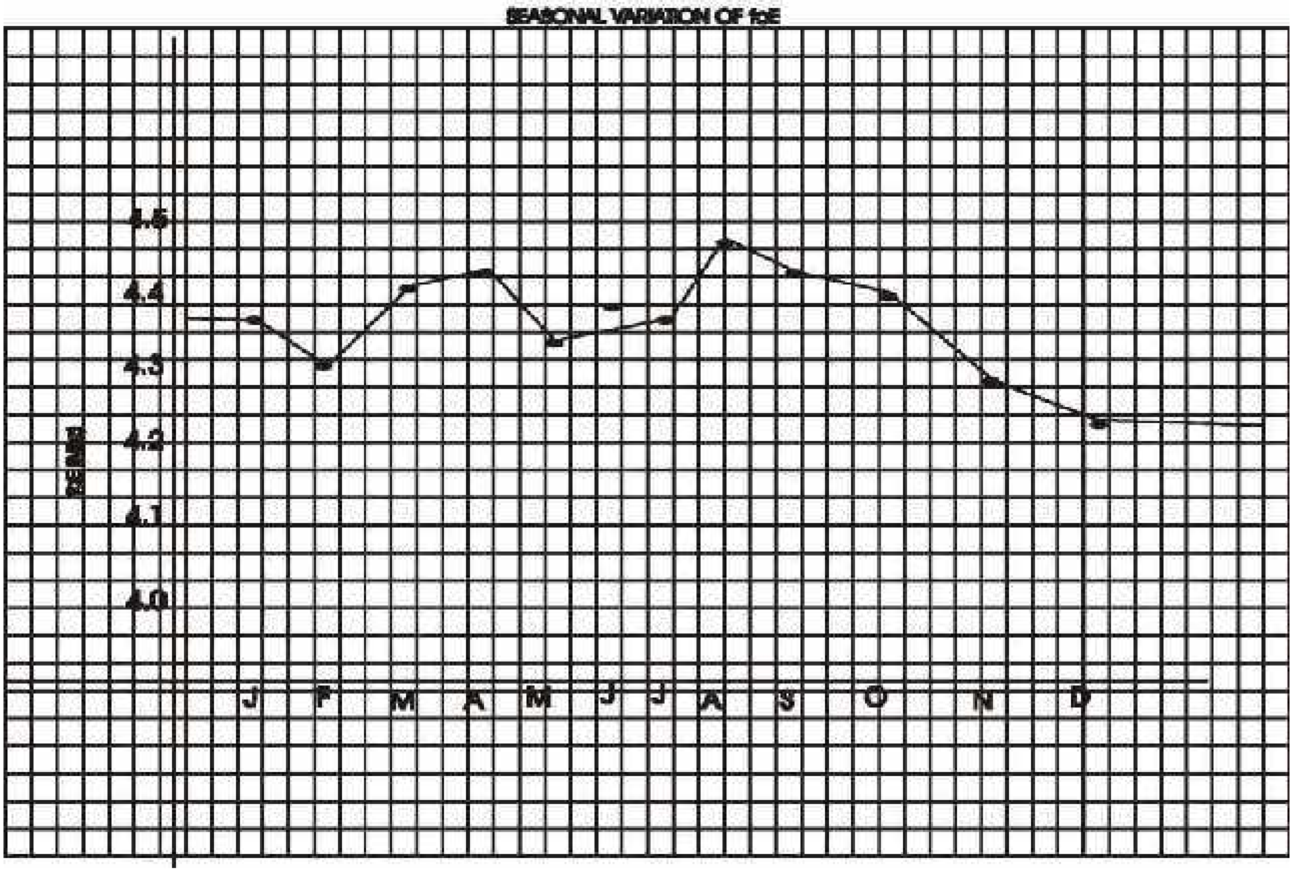
Similar analysis was carried out at various times of the day

f_oE seasonal variation.

Table 3 shows the mean values of f_oE by month for the year under consideration

MONTHS	**foE (MHz)**
January	4.35
February	4.31
March	4.40
April	4.41
May	4.33
June	4.36
July	4.35
August	4.46
September	4.42
October	4.38
November	4.28
December	4.24

This was used to plot the seasonal variation curve shown in fig 2



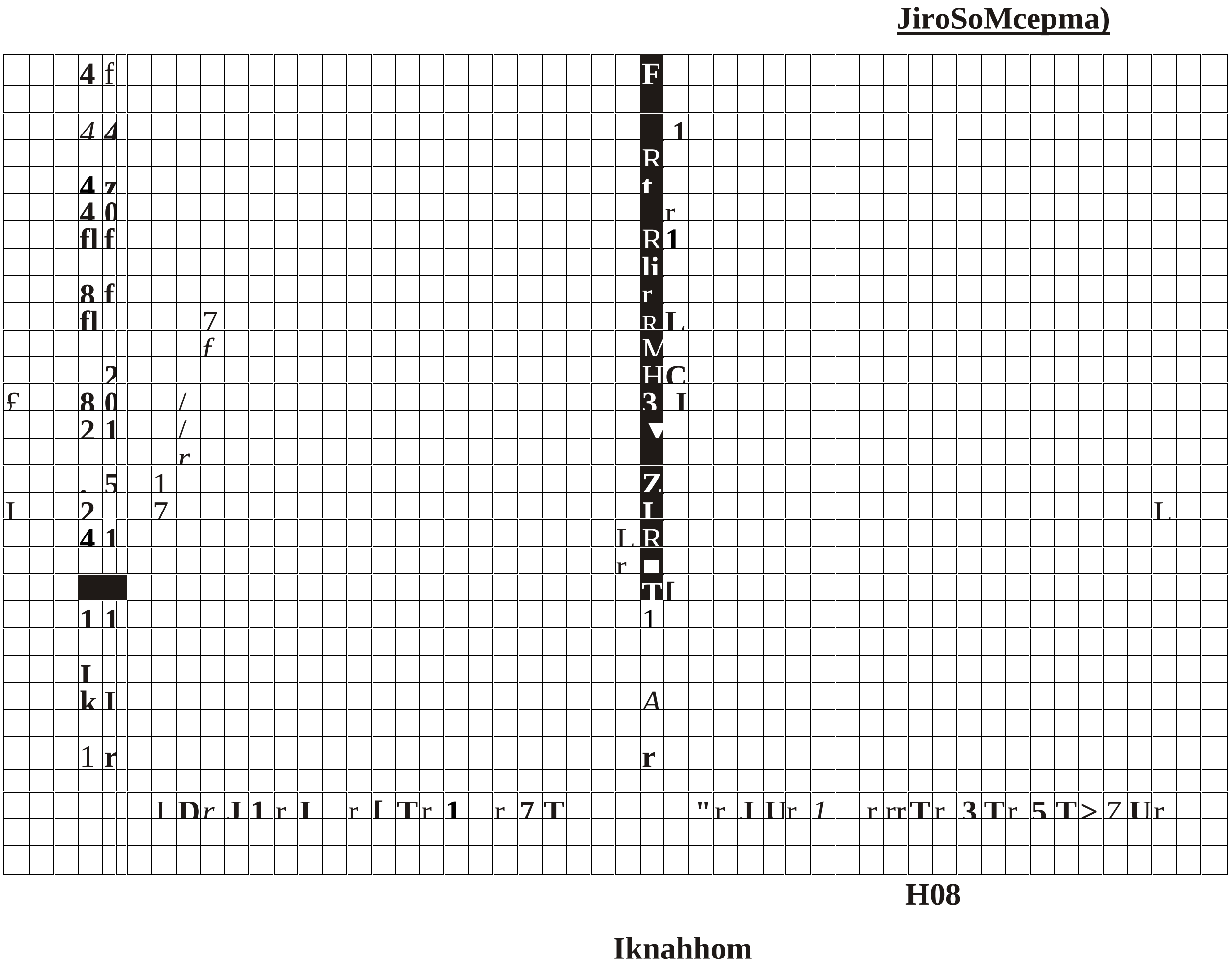
Mor*w

Hg2

The curve has two maximum points in the months of April and August. It is important to note that the concentration of oxygen in the E layer is largest in summer. Also the E layer is influenced by drift, solar tide motion as well as layer distortion.

Effect of season and Rz on the critical frequency of the E layer: It is essential to examine the effect of Rz and season on foE. Based on the latter, the seasonal variation curve, fig. 2 above was used to correct for season. Lyon (1964) found that variation of noon time f_oE at Ibadan with sunspot number Rz was given by $f_oE = 3.47\ (1+0.0014Rz)$.

The above equation was used to correct for Rz. The corrected diurnal variation curves are as shown in fig. 3 for the solstice and equinox.



From the corrected fE curves the standard errors were obtained as shown in the example below.

(i) March equinox (Month of April)

At 0700 hours

Means foE = 2.61 MHz

If d = deviation from the mean

n = number of observations then, standard deviation 6 = \\d^2

n= 0. 25MHz

Standard error 6m = 6 = 0.08MHz

Vn

Similar analysis was carried out at various time of the day. Table 4 below shows the result obtained.

Table 4 **MARCH EQUINOX (APRIL)**

TIME	07	09	12	14	16	18
6	0.25	0.08	0.06	0.09	0.30	0.89
6m	0.08	0.02	0.03	0.04	0.15	0.44
36m	0.24	0.06	0.09	0.12	0.45	1.32

JUNE SOLSTICE (JUNE)

6	0.12	0.10	0.07	0.09	0.18	0.48
6m	0.04	0.03	0.02	0.03	0.06	0.016
36m	0.12	0.09	0.06	0.09	0.18	0.48

Test of Significance for Diurnal Variation: A statistical test was carried out to test the significance between the standard errors of the variation curves of f_oE before and after correcting for season and Rz at 95% level of significance. The results obtained are as shown

(1) Month of April (Daytime)

1200 hours

Before = 0.03

After = 0.03

t 95% = 2.31

t = 0

t 95% > t (t = 0)

(2) Month of June (Daytime)

12 hours

Before = 0.03

After = 0.02

t 95% = 2.31

t = 0.16

Hence no significant difference at 95% level. These results above show that the day-day variation in the E-region of the ionosphere is neither due to seasonal variation nor relative sunspot number Rz.

Discussion

The normal behaviour of the E layer of the Ionosphere obtained in this study agrees with that developed by Chapman (1971) in the classical theory of ionized layer production. The seasonal variation of foE has two maximum points in the months of April and August. The test of significance carried out shows that the day-day variability in the E region of the ionosphere is neither due to seasonal variation nor relative sunspot number Rz.

Conclusion

In the E region, dynamo electrostatic fields are generated by winds. It could therefore be said that changes in some parameters such as ionospheric diffusion, winds as well as electrodynamics drift, vertical or horizontal could be responsible for the day-day variability in that region. Other causes could be solar tides and layer distortions. It is therefore suggested that these variables be investigated for the disturbed E layer so that the result established be proposed as equatorial in-put values for the development of a variability model for the international reference ionosphere.

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