COMPARISON OF THE RESPONSE OF E AND F2 LAYER TO SOLAR ACTIVITY AT IBADAN

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ABSTRACT

Comparison of the response of E and F_2 –layer to solar activity during year of maximum, moderate and minimum solar activity 1958, 1973 and 1965 at Ibadan (7.40^{0}N, 3.90^{0}E, 6^{0}S dip) were studied. The critical frequencies of the E and F_2 layer (foE and foF_2) were used as Ionospheric parameters for the E and F_2 layers while Zurich sunspot number (Rz) was used as index of solar activity in this work. The monthly mean value of the critical frequency of the E and F_2 layer were computed and correlation analysis carried out. The critical frequency of the E layer is found to respond more rapidly to solar activity than the critical frequency of the F_2 layer. The E and F_2-layer have a maximum positive correlation coefficient value of 0.7 and 0.56 with R_z during year of maximum solar activity.

Key words: Critical frequency of E layer (foE), critical frequency of F_2 layer (foF_2), correlation coefficient and Sunspot number (Rz).

1.0 INTRODUCTION

The appearance of sunspot on the sun is unpredictable, but their number increases and decreases over a period of 11year.This periodicity of the sunspots have ignited scientific interest and many efforts have been made to correlate all sorts of terrestrial phenomena with the spots. According to Okunola (1984), as the sunspot number approaches a maximum the ionosphere becomes denser in direct correlation. The Zurich Sunspot number, Rz, is greatest at year of sunspot maximum and least at year of sunspot minimum (Okunola, 1984).

2.0 DATA AND METHODOLOGY

The data for this study were obtained from the monthly bulletins of Ionospheric station at Ibadan (7.40^{0}N, 3.90^{0}E, 6^{0}S dip). The critical frequencies of the E and F_2-layers (foE and f_oF_2) are used as Ionospheric parameters while Zurich sunspot number (Rz) was used as the index of solar activity.

Correlation coefficient (r) is a single number that describe the degree of relationship (comparison) between two variables. It shows how strongly pairs of variables are related. The value of a correlation coefficient varies from -1 to +1 only. (Rodgers and Nicewander, 1988). The most popularly used correlation coefficients is the Pearson Product Moment Correlation Coefficient (PMCC). It is denoted by (r).

$$r=\frac{n\sum x_i y_i-\sum x_i \sum y_i}{\sqrt{(n\sum x_i^2-(\sum x_i)^2)(n\sum y_i^2-(\sum y_i)^2)}} \quad (1)$$

where x_i and y_i represent the two variables and n is the number of variables present (Wilcox, 2005)
In this study x_i is the monthly mean value of sunspot number (R_z) and y_i is the mean monthly hourly values of f_oE and f_oF_2

The mean monthly hourly values of foE and f_oF_2 were obtained by computing their monthly mean values at each hour of the day. The resulting values are then correlated with the mean monthly values of Zurich sunspot number (R_z) using the Pearson Moment Correlation Coefficient (PMCC) equation above. The diurnal variation of the correlation coefficient of f_oE and f_oF_2 with Rz for year of maximum solar activity (1958), year of moderate solar activity (1973) and year of minimum solar activity (1965) were investigated by plotting the correlation coefficient values against the hours of the day.

3.0 RESULTS AND DISCUSSIONS

The correlation coefficient between f_oF_2 and Rz during 1958 is observed to alternate between negative and positive values. This result agrees with that of Somoye (2009) whose diurnal curve of correlation coefficient between NmF_2 variability and Rz is found to alternate. In the present result correlation between foF2 and R_z is positive during the night hours of 00hour to 0600hour and 2100hour to 2300hour.For the remaining hours (0700 to 20hour) correlation coefficient is negative except at 1100hour to 1400hour i.e. in the neighbourhood of noon .The maximum positive value of 0.56 occurred at 0500hour and the minimum negative value of -0.7 occurred at 1700hour. (Figure 2.) This shows that correlation coefficient of foF2 is generally positive at night and negative during the day due to noon bite out.

During 1973, correlation coefficient is positive between 2200 hour and 0600 hour. Correlation coefficient is negative for the remaining hours except at 1700hour (Figure 2). The maximum positive value of 0.45 occurring at 0200hour and the minimum negative value of -0.43 occurred at 2100hour implying a positive response of foF2 to solar activity.

Correlation coefficient during 1965 is negative from 1000hour to 1100hour and 1500hour to 2000hour but positive for the remaining hours with the maximum positive value of 0.41 occurring at 0400hour and the minimum negative value of -0.48 occurred at 1900hour (figure 2).This indicates that

Correlation coefficient is higher for foF2 during high sunspot number than during low sunspot number.

From Figure 1, it is observed that the correlation coefficient between foE and R_z is negative only at 0600hour and positive for the rest hour i.e. 0700hour to 1800hour during 1958. The maximum positive value of 0.70 occurred at 1300hour and the minimum negative value of -0.08 occurred at 0600hour. Also the correlation coefficient between foE and R_z in 1973 was observed to be positive from 0600hour to 1800hour but negative only at 1100hour.

The maximum positive value of 0.73 occurred at 1400hour and the minimum negative value of -0.44 occurred at 11hour as presented in Figure1.Correlation of foE is about same during 1958 and 1973 and generally positive.

During year of minimum solar activity i.e. 1965 correlation coefficient is positive only at 1000hour and 1100hour and negative between 0600hourr and 1800hour, with a minimum negative value of - 0.59 at 1400hour and a maximum positive value of 0.35 at 1000hour. Correlation coefficient of foE is generally negative during 1965. The correlation coefficient of f_oE is higher than correlation coefficient of f_oF_2 during 1958 and 1973. This agrees with the work of Friedman (1960) who pointed out that foE respond to changes in Rz than do f_oF_2, only during moderate and high sunspot number but not at low sunspot number. The foregoing may be as a result of foF2 which varies linearly as the square root of R_z while f_oE varies directly as Rz (Craig, 1965; Chattopadhyay, 2000).

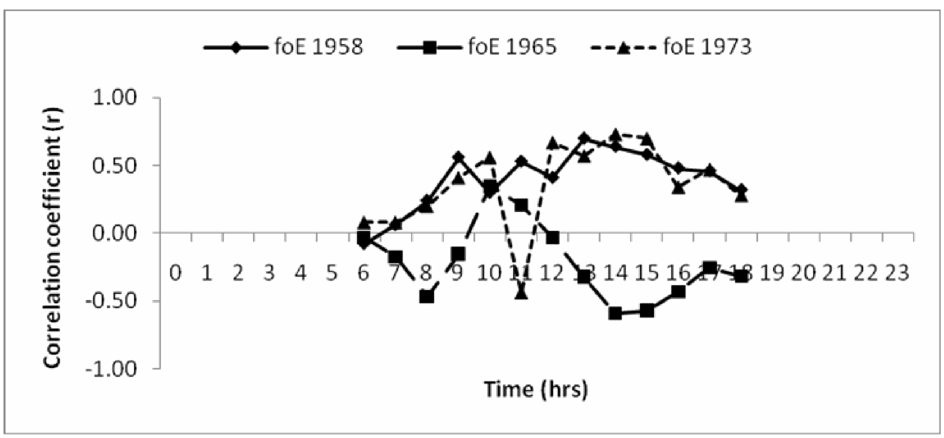

FIG.1 CORRELATION COEFFICIENT OF foE WITH Rz AGAINST TIME IN HOUR

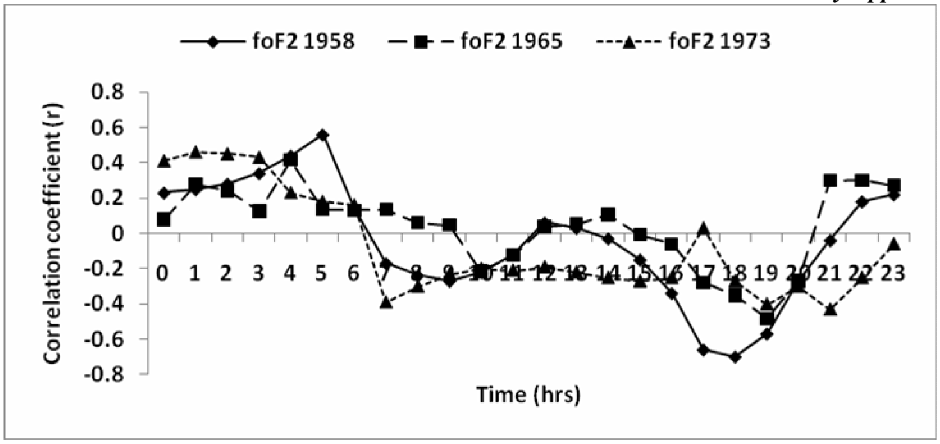

FIG.2 CORRELATION COEFFICIENT OF foF2 WITH Rz AGAINST TIME IN HOUR

CONCLUSION

The analysis and results from the comparison of the response of E and F_2-layer to solar activity have been presented. The results show that foE responds rapidly to changes in Rz than f_oF_2, its correlation coefficient being higher than that of f_oF_2's positive with the exception of 1965 where it is low. The E and F_2 layer have maximum positive correlation coefficient values of 0.7 and 0.56 in 1958, 0.73 and 0.46 in 1973 and 0.35 and 0.41 in 1965 respectively. This shows that there is a stronger positive correlation between the critical frequency of the E-layer with Sunspot number Rz during 1958 and 1973 than that of F_2 layer except in 1965 where correlation coefficient is higher for foF2 during high sunspot number than during low sunspot number.

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