COMPARISON OF THE RESPONSE OF NmE AND NmF2 TO VARIATION IN SUNSPOT NUMBER AT DIFFERENT LATITUDES.

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ABSTRACT

The seasonal and daily responses of NmF2 to variations in sunspot number is compared with corresponding variations of NmE at Ibadan(7.43ºN, 3.90ºE, dip 6ºS),Singapore (1.30ºN, 103.80ºE, dip18ºS) Slough (51.5ºN, 359.4ºE, dip 66.5ºN)
The results obtained and the diurnal plot of correlation coefficients shows the following::

(1) NmF2 responds better to solar activities than NmE at the three stations. The response of NmF2 to solar activities is better at Singapore and Slough than at Ibadan.This may be due to a more variable F region at the equatorial station of Ibadan than Singapore and Slough.

(2) The response of NmE to solar activities at Ibadan and Singapore is better than that f

(3) NmE responds better to solar activities towards sunset than at sunrise and noon,. especially at Ibadan and Slough.

INTRODUCTION

Sunspots are caused by very high magnetic activities taking place in the core of the sun , which hinders convection and as a result forms areas of decreased surface temperature. Whenever sunspots appear on the solar surface, the number of sunspots is a measure of the solar activity. If small number of sunspot is observed, the sun is said to be in a quiet state and has low solar activity while it has high solar activity when the sunspot is large.

Scientists have observed that the ionization that takes place in all the regions of the ionosphere is closely associated with variations in sunspot number. The ionizations are said to increase or decrease as the sunspot number increases or decreases in the course of a solar cycle. The response of NmF2 and NmE to variations in sunspot number is a function of location, latitude, time of the day year and phase of sunspot cycle.

The purpose of this study is to investigate how solar activity affects NmF2 as compared with its effect on NmE at Ibadan (7.43ºN, 3.90ºE, dip 6ºS),Singapore (1.30ºN, 103.80ºE, dip 18ºS) Slough (51.5ºN, 359.4ºE, dip 66.5ºN).

MATERIALS AND METHODS

It is assumed that the values of NmF2 = 1.24×10^{10}foF2 (where fof2is the critical frequency of f2 layer) and the values of NmE = 1.24×10^{10} foE (where foE is the critical frequency of E layer). Available values of foF2 and foE records were obtained using the Union Radio Mark 2 recorder type ionosonde developed at the Radio Research Station in Slough.

The transmitter and receiver of the ionosonde are separated sub units kept in tune by a frequency sensitive servo gerro system. Pulses are transmitted over a range of 0.7 to 25MHZ in a sweep time of 5 minutes duration. The interval between the transmitted pulse and the corresponding echoes are recorded photographically. The variation of apparent height ,with frequency, f of radio waves is shown on the records , referred to as ionograms.The variabilities of NmF2 and NmE in January to December for Ibadan in the years 1958-1973 represent the vriabilities for high and low solar activities respectively.

The variabilities of July NmF2 and NmE from 1960 to 1971(which are the available data) for Ibadan, Singapore,and Sloughwere also used for the purpose of latitudinal comparison.

RESULTS AND DISCUSSION

The extent to which the response of NmF2varies with sunspot number as compared with the response of NmE to sunspot variation at the three stations was determined by calculating the coefficient of correlation between NmF2 and sunspot number Rz, and that of NmE and Rz (see Table 1)

TABLE 1: Values of correlation coefficient between NmF2,NmE and Rz

	NmF2	NmE
IBADAN	0.88	0.81
SINGAPORE	0.96	0.82
SLOUGH	0.96	0.67

Regression equations were also obtained to analyze the nature of the relationship between the variables NmE , NmF2 and Rz . On the other hand, correlation coefficients calculated are used to measure the degree of association between the variables NmF2 and Rz, and between NmE and Rz. The Regression equations are :

(1) **Singapore** (a) $NmF2 = 69.765 + 0.7219Rz$ (1)

(b) $NmE = 9.6004 + 0.029\ Rz$ (2)

(2) **Ibadan** (a) $NmF2 = 61.471 + 0.907Rz$ (3)

(b) $NmE = 10.3316 + 0.03216Rz$ (4)

(3) **Slough** (a) $NmF2 = 26.167 + 0.30Rz$ (5)

(b) $NmE = 11.66 + 0.028Rz$ (6)

RESULTS AND DISCUSSIONS

Correlation coefficient values of NmF2 with Rz are higher than that of NmE with Rz at the three stations. Also the values of the slope from regression of Nmf2 on Rz is higher than that of NmE on Rz (see Table 1 and equations 1 to 6).

NmF2 is found to respond better to sunspot number than NmE (see Figures 1a and 1b and Figures 2a to 2d).This is not a contradiction to Friedman (1960), who mentioned that foE responds better to sunspot than foF2. If we remember that NmF2 is proportional to (Rz)½. In this case NmF2 is expected to respond to Rz better than NmE .On the other hand foE is proportional to Rz while NmF2 is proportional to (Rz)½. Thus foE will respond to it better than fof2.

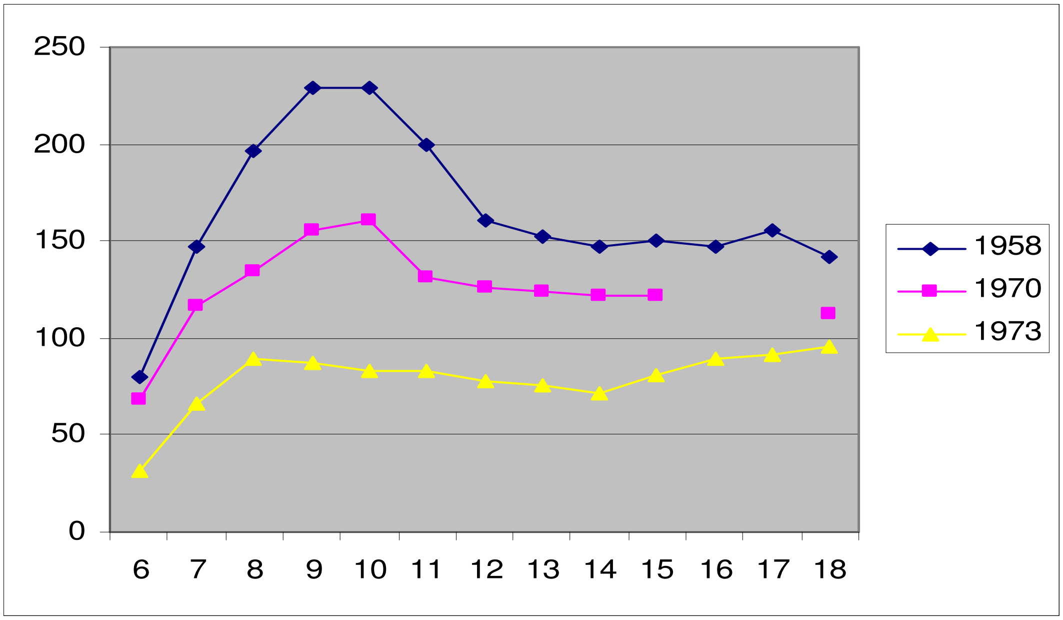

FIG.1a The diurnal variation of NmF2 in July 1958,1970 and 1973 at Ibadan

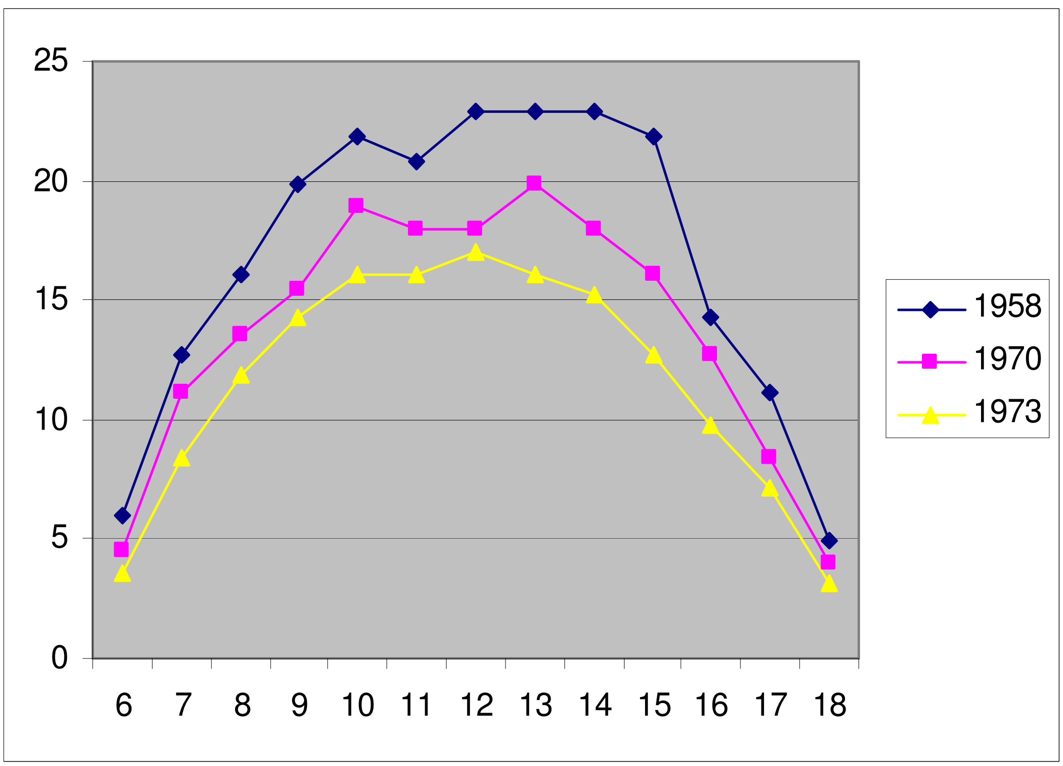

FIG. 1b. The diurnal variation of NmE in July 1958,1970 and 1973 at Ibadan

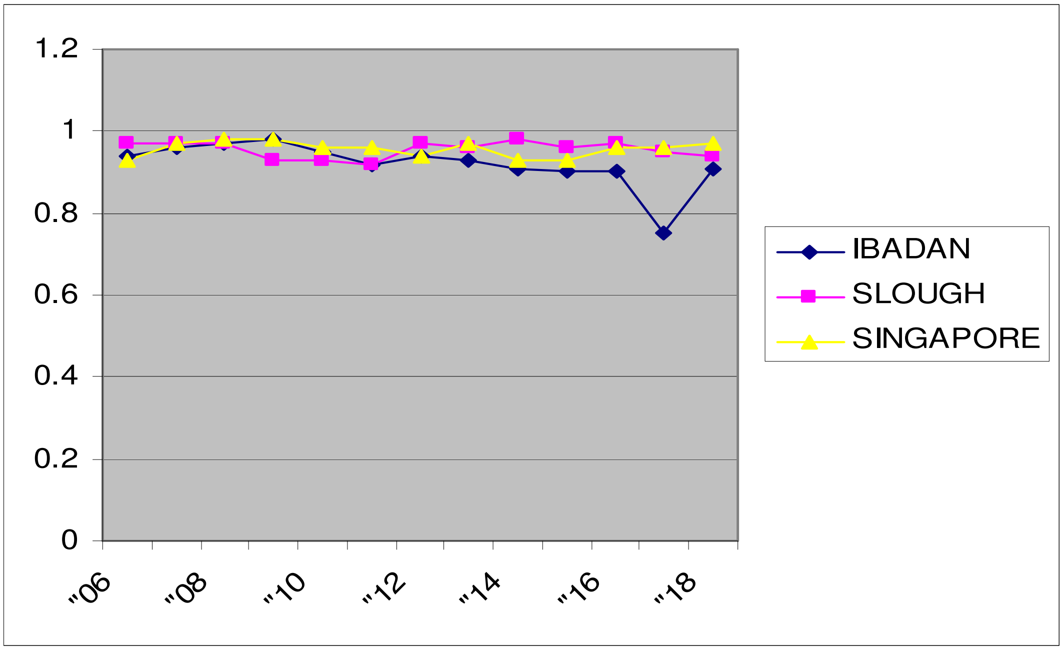

Fig.2a Diurnal correlation coefficient between NmF2and Rz of Ibadan,Singapore and Slough during the June solstice.

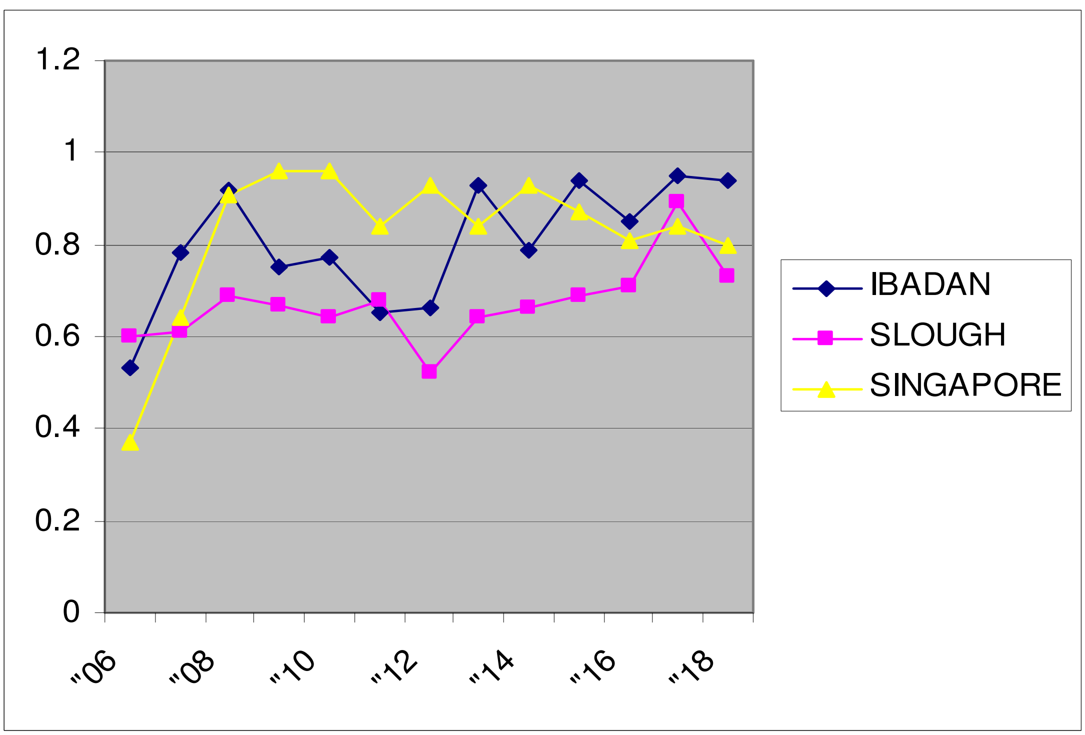

FIG.2b Diurnal correlation coefficient between NmE and Rz of Ibadan,Singapore and Slough during the June solstice.

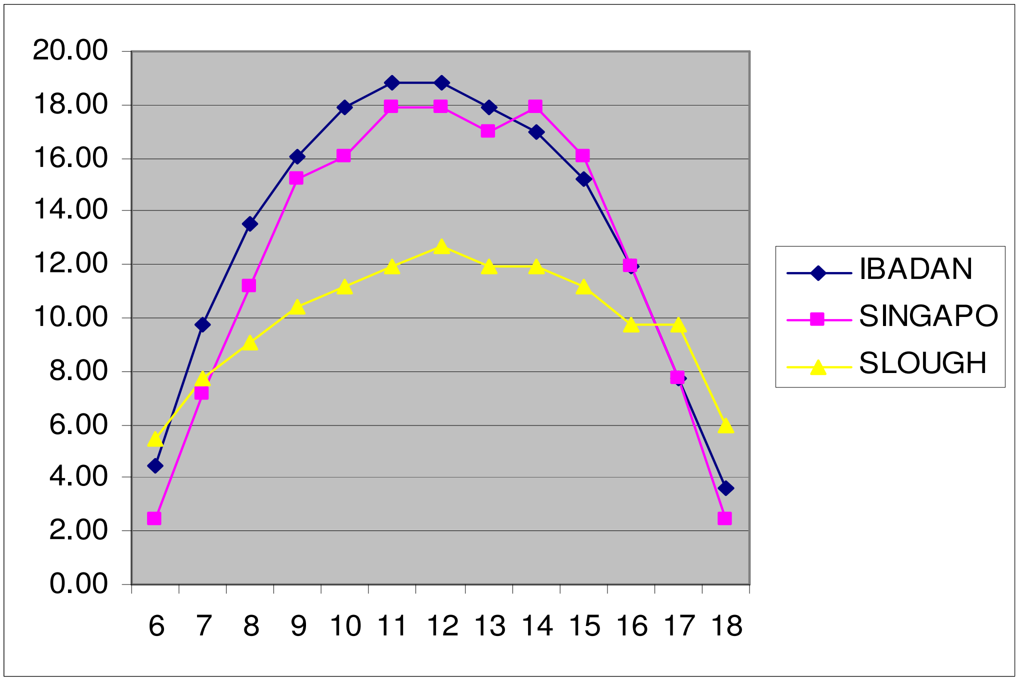

FIG.2c Latitudinal Variation of NmE in July 1968

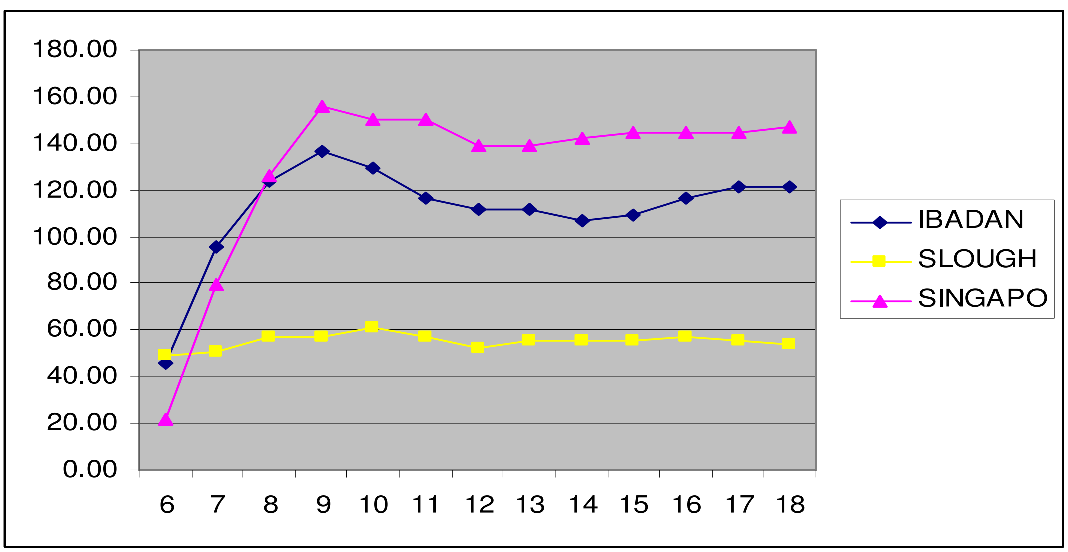

FIG .2d Latitudinal Variation of NmF2 in July 1968

The response of NmF2 to solar activities is better at Singapore and Slough than at Ibadan. This is probably due to the more variable F region electrodynamics at the equatorial station (Rishbeth and Mendillo 2001) of Ibadan, which is closer to the equator than the other two stations.

NmE responds better at Ibadan and Singapore than Slough. This may be due to slight decrease of NmE at temperate latitude and a slight enhancement of NmE at equatorial latitude by Sq current (Beynon, W.J.G and Brown. G.M 1959).

CONCLUSSION

1. For Slough, Ibadan and Singapore, NmF2 response to solar activity is greater at noon and sunset than in the morning and at other hours.
2. In the three stations the response of NmE to solar activity is greatest around noon.
3. NmF2 was found to respond to solar activity better than NmE at the three stations. This does not contradict Friedman (1960) who said that foE responds better to sunspot number than fof2.
4. NmF2 responds better to solar activity at Singapore and Slough than at Ibadan. This is probably due to the more variable F- region at equatorial station of Ibadan
5. NmE responds better at Ibadan and Singapore than Slough. This may be due to slight decrease of NmE at temperate Latitude and a slight enhancement of NmE at equatorial Latitude by Sq current (Beynon, W.J.G and Brown. G.M 1959).

Enhancement in equatorial NmE is due to vertical drift of electrons as a result of E-W electric field present in the E region (Adeniyi, 1980). The Sq current is known to increase with solar cycle.

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