INTERRELATION BETWEEN MONTHLY MEAN VALUES OFIONOSPHERIC AND SOLAR PARAMETERS AND THEIR EFFECT ON 5577 Å NIGHT AIRGLOW EMISSION

S. K. MIDYA and D. MIDYA
Serampore College, Department of Physics, P.O.: Serampore, Pin.: 712 201, West Bengal, India

(Received 5 May, 1994)

Abstract. The paper presents the relations between different solar and ionospheric parameters. Variation of 5577 Å line intensity with the variation of solar and ionospheric parametersis also discussed. A study have been made and following important results are obtained:

(i) Virtual height of F layer is decreased exponentially with the increase of solar flare numbers, sunspot number and 10.7 cm solar flux.

(ii) Linear relations between critical frequency of F layer and different solar parameters are obtained.

(iii) Empirical relations between ionospheric and solar parameters are established.

(iv) It is concluded that airglow intensity will also be affected with the variation of different solar and ionospheric parameters.

(v) It is concluded that airglow intensity is mainly affected by 10.7 cm solar flux among different solar parameters and virtual height plays important role than critical frequency of F layer.

1. Notation and Symbols

AG	Air glow intensity of 5577 Å
CRFF	Critical frequency of F layer (Mcs)
MO	Month
SOLF	Solar flux (10.7 cm)
SOLFN	Solar flare number
SPNO	Sun spot number
VHTF	Virtual height of F layer (kms)

2. Introduction

Airglow is the self-luminescence of the upper atmosphere. Barbier (1959) proposed an empirical relation which connects the intensity of airglow lines, virtual height and critical frequency of F layer and the equation is given below.

$$Q = A + B(f_0F_2)^2 \exp\left\{-\frac{h'F - h_0}{H}\right\},$$

$Q \rightarrow$ Calculated intensity $in\ R$

$f_0F_2 \rightarrow$ Critical frequency of F_2 region (Mcs)

TABLE I

Different ionospheric, solar parameters and airglow intensity of 5577 Å line for the year 1987

MO	VHTF (Kms)	CRFF (MCS)	SPNO	SOLF (10.7 cm)	SOLFN	AG
January	312.60	62.50	10.4	70.2	36	186.25
February	310.10	60.25	2.4	69.8	7	147.50
March	330.70	63.90	14.7	73.3	52	181.25
April	358.50	80.00	39.6	85.5	192	207.50
May	299.10	73.00	33.0	89.8	205	200.00
June	289.00	73.50	17.4	80.4	61	180.00
July	283.10	63.00	33.0	87.0	132	156.25
August	282.75	83.30	38.6	92.2	185	137.50
September	278.40	67.80	33.5	87.0	172	178.75
October	276.90	76.20	61.1	97.4	198	213.75
November	272.30	77.20	40.0	99.0	273	248.75
December	273.70	56.20	27.1	91.5	114	231.25

TABLE II

General statistics of different ionospheric, solar parameters and airglow intensity of 5577 Å line for the year 1987

Variables	Mean	Standard deviation	Sum	Minimum	Maximum
VHTF	297.26	26.46	3567.15	272.30	358.50
CRFF	69.74	8.64	836.85	56.20	83.30
SPNO	29.23	15.97	350.80	2.40	61.10
SOLF	85.26	9.92	1023.10	69.80	99.00
SOLFN	135.58	82.03	1627.00	7.00	273.00
AG	189.06	33.21	2268.75	137.50	248.75

$h'F \rightarrow$ Virtual height of F_2 region (Km),

$h_0 \rightarrow$ Reference height,

$H \rightarrow$ Scale height of O_2

Ghosh and Midya (1990) has explained the observed diurnal variations of the 6300 Å line at Calcutta by this equation.

Different chemical reactions are responsible for the emission of airglow lines. Intensity of different lines depend on the concentrations of different constituents

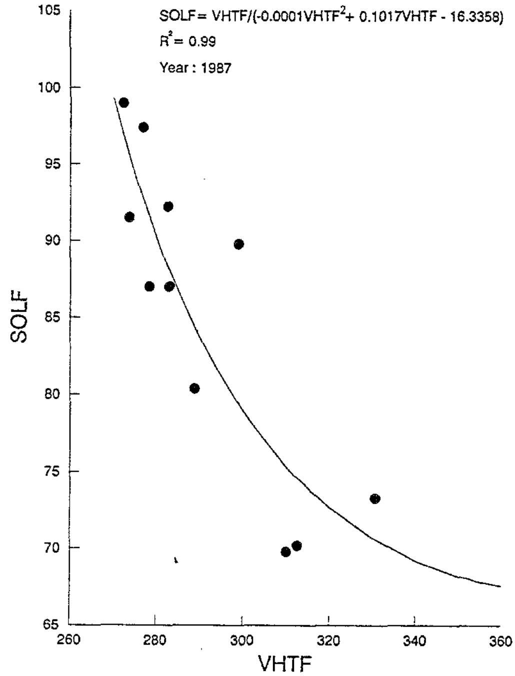

Fig. 1. Variation of solar flux (10.7 cm) with virtual height of F layer.

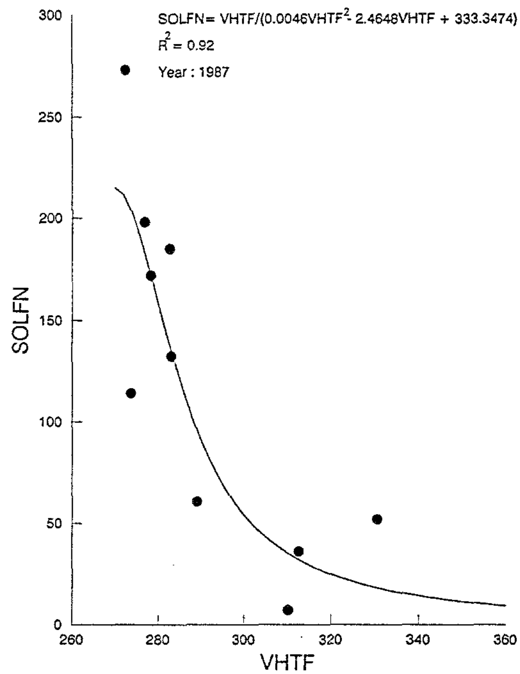

Fig. 2. Variation of solar flare number with virtual height of F layer.

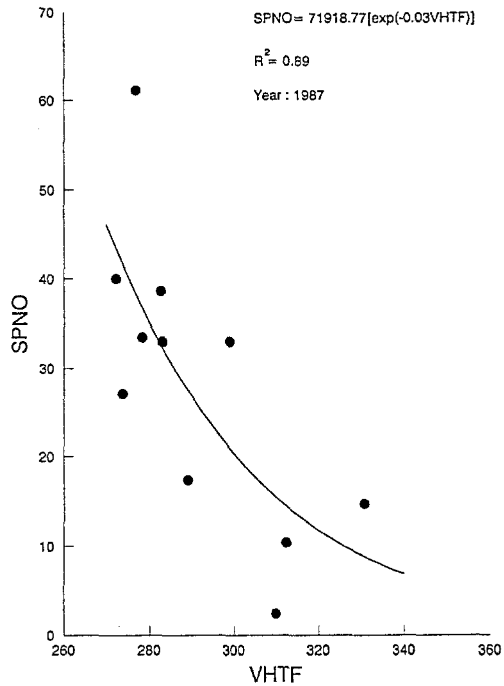

Fig. 3. Variation of sun-spot number with virtual height of F layer.

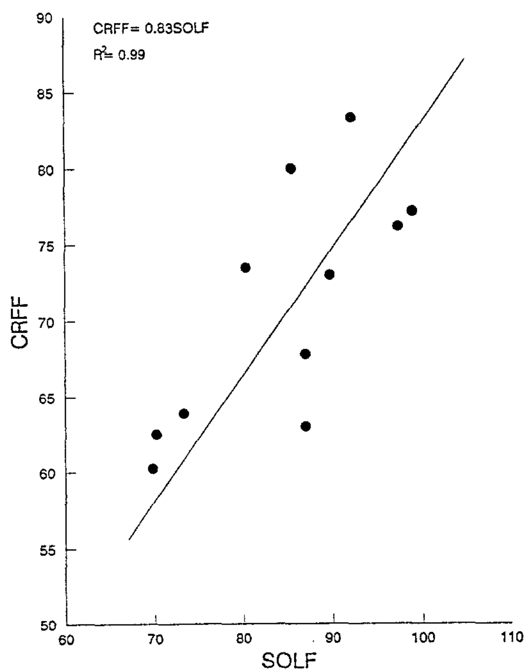

Fig. 4. Variation of critical frequency of F layer with solar flux (10.7 cm).

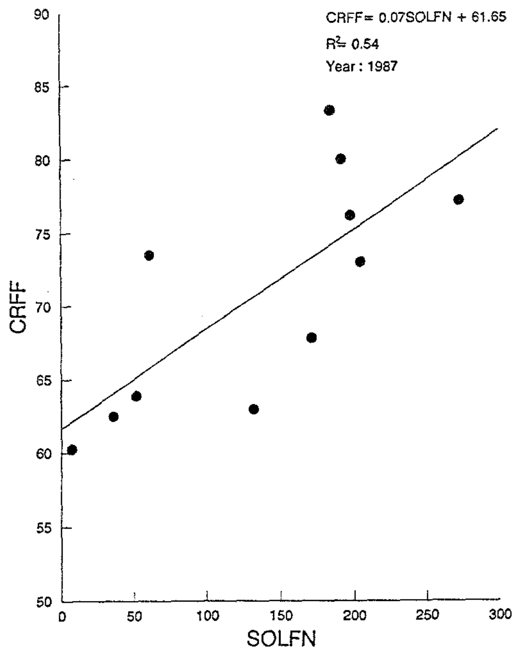

Fig. 5. Variation of critical frequency of F layer with solar flare number.

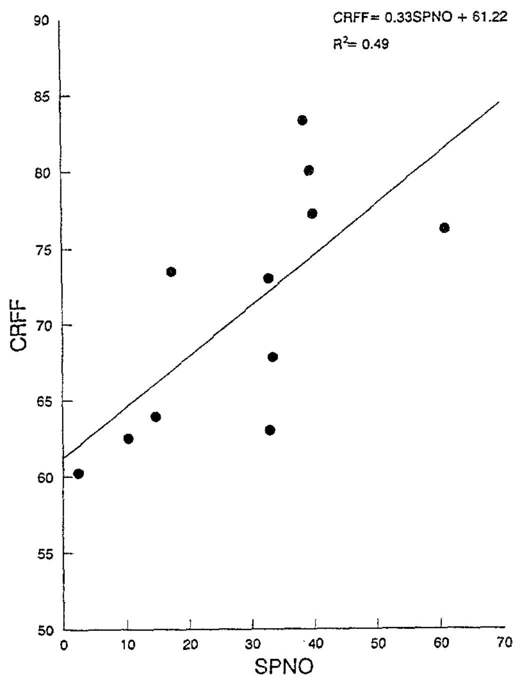

Fig. 6. Variation of critical frequency of F layer with sun-spot number.

TABLE III
Correlation table

	VHTF	CRFF	SPNO	SOLF	SOLFN	AG
VHTF	1.00	0.04	−0.33	0.58	−0.31	−0.12
CRFF	0.04	1.00	0.63	0.53	0.68	0.07
SPNO	−0.33	0.63	1.00	0.89	0.86	0.40
SOLF	−0.58	0.53	0.89	1.00	0.90	0.50
SOLFN	−0.31	0.68	0.86	0.90	1.00	0.49
AG	−0.12	0.07	0.40	0.50	0.49	1.00

of the upper atmosphere. It is expected that solar parameters play important role to control the concentrations of different constituents. Thus critical frequency and virtual height will be changed and airglow intensity will be affected.

It is expected that there must be some relations between solar and ionospheric parameters. From statistical study, we have obtained good correlation between these two types of parameters. Empirical equations are also fitted between monthly mean values of solar and ionospheric parameters. Virtual height decreases exponentially with the increase of solar parameters and critical frequency increases linearly with the increase of solar parameters.

3. Results and Discussion

Seasonal variation of 5577 Å line was studied during 1983–1987 at Calcutta (Ghosh and Midya, 1989). In experimental set-up Dunn-Manring type photometer was used (Ghosh and Midya, 1986). The telescope was pointed towards west with an angle of elevation 45° W. The observations were taken at Ramakrishna Mission Residential College, Narendrapur (lat. 22°35′ N, long. 88°21′ E) about 18 kms south from central Calcutta. Half-hourly intensity for dark hours of nights are averaged. The monthly mean is obtained from the average intensity having more than 8 hours observation in a night. The average intensity of each month of the year 1987 is given Table I. Monthly mean of ionospheric data of Kodaikanal Observatory are taken for analysis. Solar flare numbers, relative Sun-spot numbers and 10.7 cms solar flux data are taken from solar geophysical data, prompt Report. Monthly mean of solar and ionospheric parameters are given in Table I and general studies are presented in Table II. Correlation coefficient among monthly mean values of airglow intensity, different solar and ionospheric parameters are presented in Table III. It is observed from Table III that solar and ionospheric parameters are highly correlated. Empirical equations between solar and ionospheric parameters are also established. Their graphical representation are produced in Figures 1–6. The empirical equations are as follows:

$$\mathrm{SOLF} = \mathrm{VHTF}/(-0.0001 * \mathrm{VHTF}^2 + 0.1017 * \mathrm{VHTF} - 16.3358), \tag{1}$$

$$\mathrm{SOLFN} = \mathrm{VHTF}/(0.0046 * \mathrm{VHTF}^2 - 2.4648 * \mathrm{VHTF} + 333.3474), \tag{2}$$

$$\mathrm{SPNO} = 71918.77 * \mathrm{EXP}(-0.03 * \mathrm{VHTF}), \tag{3}$$

$$\mathrm{CRFF} = 0.83 * \mathrm{SOLF}, \tag{4}$$

$$\mathrm{CRFF} = 0.07 * \mathrm{SOLFN} + 61.65, \tag{5}$$

$$\mathrm{CRFF} = 0.33 * \mathrm{SPNO} + 61.22. \tag{6}$$

From Table III, it is concluded that different solar parameters are positively correlated with 5577 Å airglow line. SOLF (10.7 cm solar flux) is highly correlated with 5577 Å line intensity (correlation coefficient=0.50) than other solar parameters. Critical frequency of F layer is very poorly correlated with the line emission (correlation coefficient=0.07). Virtual height is negatively correlated with the emission line. From the result, it is clear that virtual height of F layer plays more important role than critical frequency of F layer. Van Zandt and Peterson (1968) also obtained similar result for oxygen red line (6300 Å) emission.

Acknowledgements

We acknowledge with thanks Mr. D. Karunakaran for supplying us ionospheric data of Kodaikanal Observatory. Thanks are also due to Mrs. S. Midya for rendering help for preparation of manuscript of this paper.

References

Barbier, D.: 1959, *Ann. Geophys.* **15**, 179–217.
Ghosh, S. N. and Midya, S. K.: 1990, *Ind. J. Phys.* **64B**, 10–21.
Ghosh, S. N. and Midya, S. K.: 1986, *Ind. J. Phys.* **69B**(4), 413–417.
Ghosh, S. N. and Midya, S. K.: 1986, *Ind. J. Radio and Space Phys.* **15**, 53–56.
Solar Geophysical Data, Prompt Report, Published by NOAA, U.S. Dept. of Commerce.
Van Zandt, T. E. and Peterson, V. L.: 1968, *Ann. Geophysics* **24**, 747–749.