Sunspot cycle and seasonal variations in the position and intensity of the equatorial electrojet in the Indian region

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ABSTRACT

Recent views on the equatorial electrojet are briefly reviewed. Seasonal and annual values of the quiet day ranges of H and Z are calculated for the four Indian magnetic observatories, Alibag, Annamalainagar, Kodaikanal and Trivandrum for all the years for which data are available. Ranges H and Z on quiet days are shown diagrammatically for the years of sunspot maximum and sunspot minimum. Mean annual values of half-width of the equatorial electrojet have been calculated using Kodaikanal and Annamalainagar data. A comparison is made with earlier studies. It is inferred that the half-width is of the order of 300 km in the Indian region. The correlation between half-width and sunspot number is insignificant. The correlation coefficient between current intensity and sunspot number is very high, suggesting almost a linear relationship. Taking the rSq(Z) value, excess of the lowest daytime hourly value of Z, over its night-time value, on a local day nearest to the international quiet day, as an indication of the proximity of the station to the jet center, it is inferred that the jet moves opposite the sun, in agreement with the findings of PRICE & WILKINS (1963) and of Mason (1963). A comparison of the electrojet current intensity at different longitudes shows that the intensity is highest in the South American region and lowest in the Indian and Central Pacific areas.

1. Introduction

Opening of the geomagnetic observatory at Huancayo, Peru (South America) in 1922 in the magnetic equatorial region, soon brought to light a feature of considerable interest, viz., the abnormally large diurnal range in horizontal intensity. EGEDAL (1947) attributed this to a narrow band of intense current in the ionosphere. CHAPMAN (1951) called it—"The Equatorial Electrojet", in analogy with "Jet Stream" in meteorology. Later work has shown that the electrojet exists in other longitudes also, along the magnetic equator. BAKER & MARTYN (1953) theoretically explained the equatorial electrojet phenomenon and attributed it to the existence of anomalously large East-West conductivity at the base of the E-region resulting from the inhibition of the Hall currents caused by the insulative base. Recently however, OSBORNE (1964) has expressed that this interpretation may need further examination and consideration.

A detailed survey of the equatorial electrojet has been made by ONWUMECHILLI (1959) in Nigeria (Africa) and by FORBUSH & CASAVERDE (1961) in Peru (South America). OGBUEHI & ONWUMECHILLI (1962) also computed the enhancement due to high sunspot number, of the electrojet intensity from observations at Ibadan during 1957 and 1962 and over Peru (1964). MASON (1963) discussed the electrojet characteristics over Jarvis in the Central Pacific. A preliminary study of the electrojet over India has been made by YACOB & KHANNA (1963).

In the present paper, seasonal and sunspot cycle variations in the electrojet current intensity over the Indian area have been studied. It is inferred that the jet center moves opposite the sun seasonally, that is, when the sun moves north in June solstice, the jet center moves south and when the sun moves south in December solstice, the jet center moves north; but the movement is very small, of the order of 10 km. A comparison has been made of the electrojet intensity at various longitudes for the IGY period 1958.

2. Recent views on electrojet

ONWUMECHILLI (1959), FORBUSH & CASAVERDE (1961) and OSBORNE (1962, 1963), conceive the jet current as a superposition on the normal or worldwide Sq current system. There

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Table 1. *Data for Indian magnetic observatories.*

Observatory	Dip.	Geographic		Geomagnetic		Period of data	Dist from mag. equator km
		Lat.	Long.	Lat.	Long.		
Alibag	24°39′N	18°38′N	72°52′E	9°36′N	144°	1950–63	1 075
Annamalainagar	5°22′N	11°24′N	78°41′E	1°32′N	150°	1958–63	297
Kodaikanal	3°36′N	10°14′N	77°30′E	0°36′N	147°	1950–48	198
Trivandrum	0°43′S	8°29′N	76°57′E	1°05′S	146°	1958–63	40

might have been some strength in this contention in the early days of the electrojet study when observations in the electrojet region were meager and it was not known definitely that the electrojet enhancement was confined only to the daytime. It was then thought that the observed abnormally large diurnal range was far greater than the range obtained from theoretical considerations of the dynamo theory and hence it was necessary to think of an additional current system, apart from the dynamo currents, to explain the abnormality. The work of BAKER & MARTYN (1953) showed that the equatorial electrojet is consistent with the dynamo theory, as there is one abnormally large conductivity, the Cowling conductivity in the magnetic equatorial region, and there is no need to invoke an additional current system.

OSBORNE (1963) found very poor correlation (−0.04) between the jet and the normal fields. This lack of correlation between the 'normal' and the 'jet' fields does not imply that the jet is different from a worldwide Sq. For, the jet effect is due to the Hall polarization in the magnetic equatorial region where the vertical magnetic field is zero, and the polarization is much smaller, once the vertical field becomes significant. Therefore, the physical process taking place inside the narrow belt of the electrojet, is absent outside the belt. While it may be convenient to divide the observed geomagnetic daily ranges in the electrojet region into (*a*) the world-wide Sq part and (*b*) jet part (observed-world-wide) for certain computational purposes, the electrojet effect should however be considered as the daytime enhancement of the normal Sq field. PRICE & WILKINS (1963) have already discussed this view in their admirable analysis of the Sq field. We therefore consider in the present analysis, that the electrojet is only a daytime enhancement of the normal Sq field.

3. Range on quiet day (rSq)

As seen from observations, the electrojet is absent in the nighttime but most active during the local noon. To enable the calculation of the electrojet width and intensity, appropriate *H* and *Z* ranges at the observatories under the

Table 2. *Mean values in γ, of rSq(H) and rSq(Z) for the seasons j, e, d, during periods of sunspot minimum and maximum.*

Observatory	rSq (*H*)				rSq (*Z*)			
	j	*e*	*d*	Year	*j*	*e*	*d*	Year
Sunspot minimum								
Alibag (1963)	37	34	33	35	27	27	5	22
Annamalaingar (1963)	64	70	53	63	19	33	18	23
Kodikanal (1954)	53	73	55	62	16	25	8	17
Trivandrum (1963)	75	96	67	81	18	23	25	20
Sunspot Maximum (1958)								
Alibag	78	75	61	71	24	39	14	24
Annamalainagar	114	135	101	115	35	48	35	58
Kodaikanal	133	163	113	135	25	40	27	30
Trivandrum	142	180	125	146	40	49	37	41

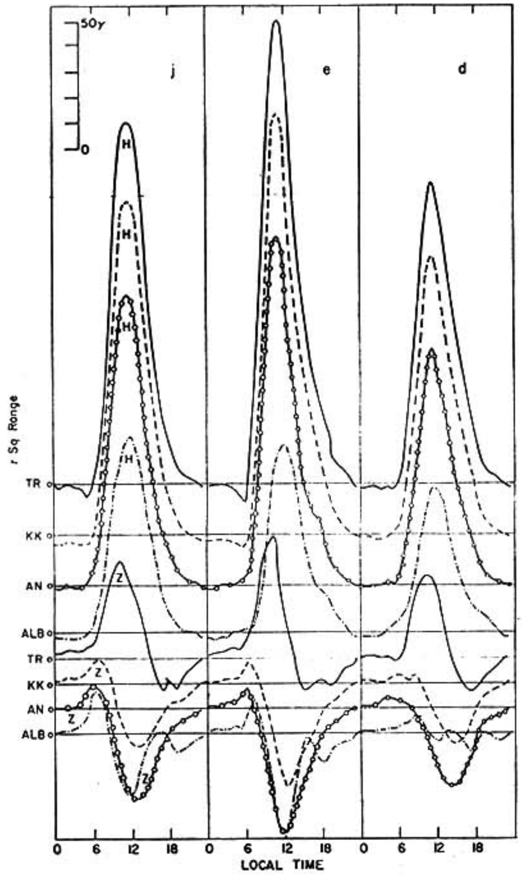

***Fig. 1.* Seasonal values of rSq(H) and rSq(Z) during the sunspot maximum year 1958. (j = May to August; e = March, April, September and October; d = November to February).**

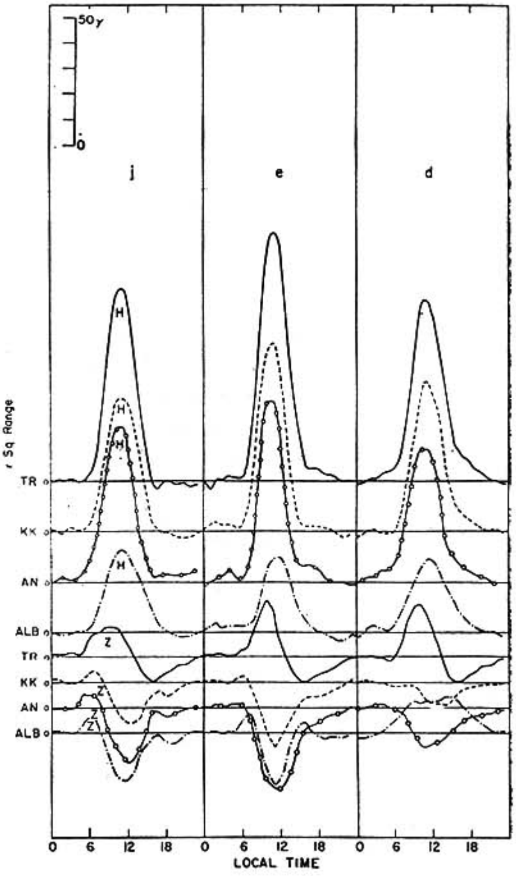

***Fig. 2.* Seasonal values of rSq(H) and rSq(Z) during the sunspot minimum. (j = May to August; e = March, April, September and October: d = November to February).**

equatorial electrojet will have to be used. The method of calculating the daily range of the magnetic elements has recently been discussed in detail by PRICE (1963) and CHAPMAN & RAJA RAO (1965). In the present paper, monthly mean Sq ranges in H and Z as defined by CHAPMAN & RAJA RAO (1965) have been used. The rSq ranges used are thus zero in the night, as the mean value for the local hours 1, 2, 3, 22, 23, and 24 has been taken as the datum and rSq is the excess of the highest noon mean hourly value over this datum value.

rSq is considered to be the most appropriate range for computations of width and intensity of the electrojet. On the contrary if the absolute ranges (maximum-minimum) of H and Z are used, the computations are likely to be in error by the appearance of the early morning minimum in H. Also it is much affected by magnetic disturbances. Hence it is not suitable as a measure for computing the electrojet intensity. Some workers (OSBORNE, 1963) used the average of 1000–1300 hours to represent the noon value. This method of computing the day value will smoothen the peak noon intensity. The errors involved in either of these two methods would be eliminated if the highest daytime hourly mean value is taken to represent the noon value.

rSq(H) and rSq(Z) have been computed for the Indian magnetic observatories listed in Table 1, for the period indicated against each observatory.

(The seasonal and annual means of rSq(H) and rSq(Z) during the sunspot minimum and the sunspot maximum for the years mentioned are given in Table 2; j = May to August, d =

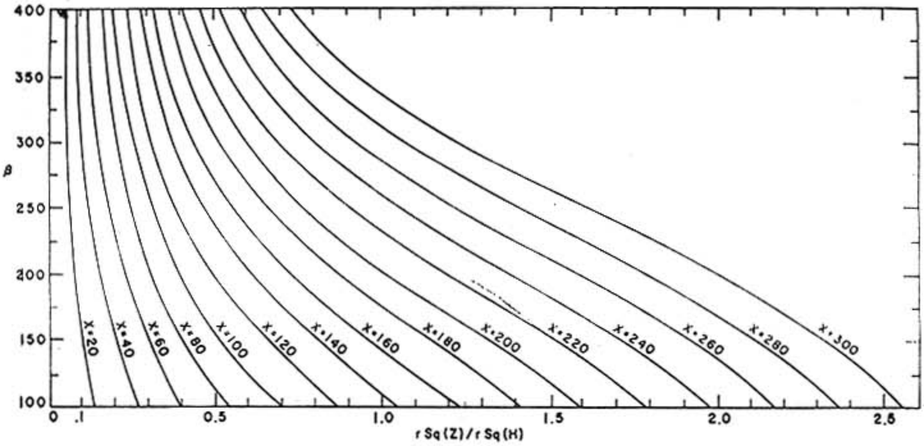

Fig. 3. Calculated rSq(Z)/rSq(H) against half-width β of the electrojet, for different distances (X) from magnetic equator.

November to February, e = March, April, September and October).

Figures 1 and 2 graph the seasonal Sq variations in H and Z in 1958, a year of maximum, and in 1963, a year of minimum sunspot activity, for the observatories Alibag, Annamalainagar, Kodaikanal, and Trivandrum. For Kodaikanal the year of minimum sunspot 1954 has been used. rSq(H) is maximum in the equinoctial season at all the equatorial stations.

4. Computation of width and intensity of the electrojet

We assume that the electrojet is a narrow band of half-width β and uniform current intensity "C" and that the height "h" of the electrojet over the earth's surface is 110 km (Cahill 1959). The euqations for the H and Z ranges are (Chapman, 1951):

$$H = 0.2\,C \tan^{-1}(2\beta h/[h^2 + x^2 - \beta^2]) \quad (1)$$

$$Z = 0.1\,C \log_e \{[(h^2 + (x+\beta)^2]/[h^2 + (x-\beta)^2]\} \quad (2)$$

Here x is the distance of the observatory from the magnetic equator. Fig. 3 graphs the values of Z/H for different β and x. β is given running values 100, 125, 150 ... 350 km and for each of these values, x is assigned values from 0 to 300 km at intervals of 20 km.

From the rSq(H) and rSq(Z) values computed

Table 3. *H and Z ranges, half width* (β), *current intensity* (C) *of the equatorial electrojet and sunspot number* (R).

Stations	Year	rSq (H) in γ	rSq (Z) in γ	β in kms.	C in amps/km	R
I. Kodaikanal	1951	91.1	23.3	282	151.2	69.4
	52	68.7	14.7	301	108.3	31.4
	53	70.1	17.4	287	114.6	13.9
	54	61.7	17.5	262	110.0	4.4
	55	75.0	19.7	278	126.1	38.0
	56	110.8	31.2	266	194.6	141.7
	57	131.1	29.6	305	204.1	189.9
	58	134.5	29.8	307	102.3	184.7
II. Annamalainagar	1958	114.5	38.3	340	199.5	184.7
	59	101.6	36.6	330	184.5	158.7
	60	90.1	29.3	344	158.1	112.3
	61	74.3	25.9	332	133.6	53.9
	62	65.3	27.9	310	130.3	37.6
	63	63.7	23.0	325	116.3	27.6

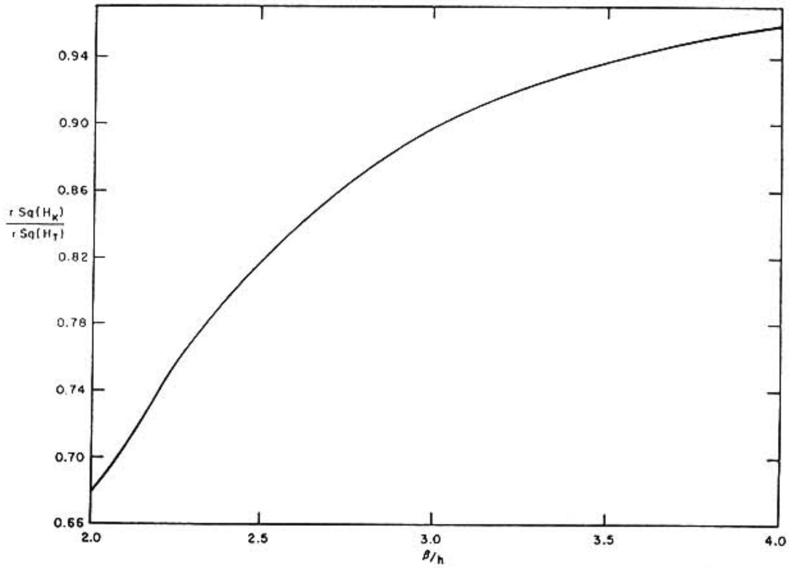

Fig. 4. Plot of $\mathrm{rSq}(H_k)/\mathrm{rSq}(H_T)$ against β/h.

for the Indian observatories the ratios Z/H are obtained. The ratios are corrected for induction effect by multiplying Z and H by 1.66 and 0.66 respectively. The value of β corresponding to this ratio, is picked out from Fig. 3 taking the value of x pertaining to each station (given in table 1). x is obtained by expressing in km, the dip latitude of a station. Substituting this value of β in equation (1), the current intensity is obtained. Table 3 lists the values of β and C, calculated from Z and H of Kodaikanal (1951–58) and of Annamalainagar (1958–63). The values of sunspot number R are also entered.

The half-width of the electrojet varied at Kodaikanal from 260 km, (during sunspot minimum 1954) to 310 km (during sunspot maximum 1958). For Annamalainagar it varied from 340 km (1958) to 310 km (1962). Kodaikanal values may be taken to be more correct as the station is well within the electrojet while Annamalainagar is on the edge of it. The value of the half-width here determined, lies within experimental error limits ±20 km.

5. Computation of width from H ranges

The width of the electrojet could also be calculated from the ratios of H ranges at two observatories in the electrojet region by using equation (1) suitably. Such an approach has been tried for the Indian region by Pisharoty & Sreenivasan (1962) and Yacob & Khanna (1963). This is now further considered.

From equation (1)

$$H_{K/H_T} = \{\tan^{-1}(2\beta h/[h^2 + x_K{}^2 - \beta^2])\}/\{\tan^{-1}(2\beta h/[h^2 + x_T{}^2 - \beta^2])\} \qquad (3)$$

H_K and H_T are $\mathrm{rSq}(H)$ ranges at Kodaikanal and Trivandrum respectively and X_K and X_T are the distances of Kodaikanal and Trivandrum respectively, from the dip equator. Knowing h, x_K and x_T, the ratio H_{K/H_T} is calculated for different values of β. Fig. 4 graphs the variation of H_{K/H_T} with β. Using $\mathrm{rSq}(H)$ values of (1) Kodaikanal and Trivandrum and (2) Annamalainagar and Trivandrum, $\beta/_h$ is read off from the graph for the months and seasons of 1958. The annual value for half-width is about 350 km in both cases.

6. Comparison with other similar computations and discussion

Yacob & Khanna (1963) obtained 300 km for β using data for the period 1958–59. They compared the H ranges of Trivandrum and of Annamalainagar. It seems more appropriate to compare the range values of Trivandrum with Kodaikanal rather than of Annamalainagar as the latter is situated on the periphery of the electrojet. Also they took for the H range the excess of the instantaneous maximum value over the value at 0730 hours L.T. The importance of taking the rSq, values as defined earlier has been emphasized by CHAPMAN & RAJA RAO (1965). Further the observed H range has been split into the normal and jet effects, the normal one being represented by the H range at Alibag. The electrojet is only a daytime manifestation in the equatorial electrojet region, of the normal Sq field, as the large Cowling conductivity in the magnetic equatorial region is the only natural conductivity (PRICE and WILKINS 1963, BAKER & MARTYN 1953). The splitting up of the H range into jet and normal effects therefore appears to be inconsistent with the physical process causing the equatorial electrojet. Therefore, the rSq values used in the present computation are the observed ones at the observatories. Pisharoty and Sreenivasan's calculations are based on limited, nonsimultaneous and scattered observations spread over the period 1950 to 1954. They have also separated the ranges into jet and non-jet contributions. In view of all these, the different results are not strictly comparable.

Regarding the calculation of β using H variations only, it should be remarked that the electrojet is itself caused by the absence of the vertical magnetic field. The intensity of the electrojet current is proportional to the increased conductivity resulting from the Hall polarization. Also, the line along which the H range is a maximum, need not necessarily be the center of the elctrojet. It is therefore our view that in the computations involving the electrojet, the Z variation is very important and the ratio Z/H is a measure of the proximity of a station to the center of the jet. In this connection CHAPMAN's remarks (1951) "Any attempt to do this (estimate the height of the electrojet and it's total current intensity) on the basis of the Sq(H) data alone must be hazardous and uncertain" become, relevant.

In view of the above, a mean value for the half-width of the electrojet over the Indian region may be taken to be about 300 km. Similar estimates for other regions are as follows:

(1) South America (Peru) 330 km.
(2) Pacific (Jarvis) 300 km.
(3) Africa (Nigeria) 220 km.

7. Change of half-width (β) and current (C) in the course of the sunspot cycle

(Based on observations in Nigeria in 1956 and in 1962) OGBUEHI & ONWUMECHILLI (1963) discussed the changes of β and C during the sunspot cycle.

Period	β	C	Sunspot number R
December 1956	220	248 amps/km	141.7
June 1962	200	149 amps/km	37.6

Their computations showed an enhancement of 60 percent in current intensity and of only 10 percent in half-width from $R = 38$ to $R = 142$. It may be stated that 1956 was not the year of maximum, neither was 1962 the year of minimum sunspot number.

From the yearly values of β in Table 3, based on Kodaikanal data the following linear regression relations are obtained:

Kodaikanal $\beta = 276.9\,(1 - 0.00039\,R); r_{\beta R} = 0.48$
$C = 106.2\,(1 - 0.0045\,R);\ r_{CR} = 0.97$
Annamalainagar $\beta = 319\ (1 - 0.00036\ \mathrm{R});\ r_{CR} = 0.40$
$C = 106.8\,(1 - 0.0046\,R);\ r_{CR} = 0.995$

Here $r_{\beta R}$ is the correlation coefficient (cc) between the electrojet half-width β and sunspot number R; r_{CR} is the cc between the electrojet current intensity and the sunspot number. $r_{\beta R}$ is not statistically significant.

The equations indicate that the increase in β from sunspot minimum ($R = 4$) to sunspot maximum ($R = 190$) is about 20 km and it is 7 percent of its value during sunspot minimum. Therefore the change during sunspot cycle, of the width of the electrojet, is very small, and it is corroborated by the low and insignificant values of the correlation coefficient. KOTADIA (1962) inferred from study of E_s data that the half-width of the electrojet changes from 250 km in sunspot minimum to about 350 km in sunspot maximum. But our present study with rSq(H) and rSq(Z) does not indicate such a large change. On the other hand the current intensity C increases from sunspot minimum ($R = 4$) to sunspot maximum ($R = 184$) by 81 percent. This is also reflected in the very high correlation coefficient of 0.97 Fig. 5 (based on

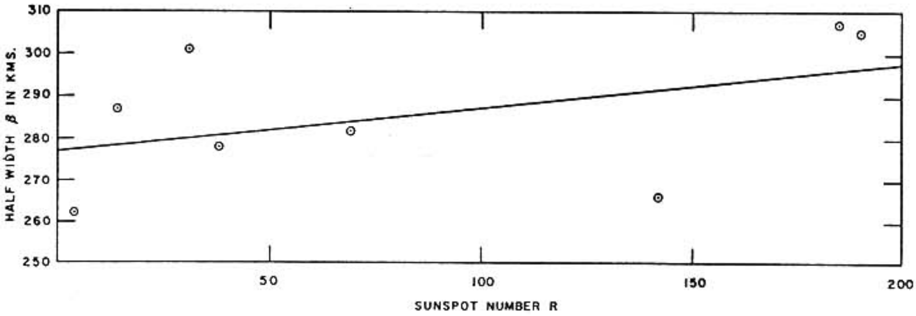

Fig. 5. Variation of half-width (β) of the electrojet with sunspot number (*R*).

Kodaikanal values) graphs the variations of β and *C*, with sunspot number *R*. Fig. 6 shows the regression lines and the scatter values of *C* and *R* for Kodaikanal.

We therefore infer that while the electrojet current intensity is very much enhanced during high sunspot activity, there is no significant alteration in the width of the band. This should be so, for during periods of high sunspot activity, the amount of solar ultra violet radiation incident on the ionosphere is very large and consequently, the electron density is very much enhanced. But there is no mechanism by which width of the narrow band in which Hall polarization takes place is extended. The correlation between the Sq range and sunspot number for the electrojet region is as close as the correlation between the two for the region outside the electrojet. For Kodaikanal and Annamalainagar (observatories under the electrojet) the correlation coefficients are 0.97 and 0.995 respectively and for Alibag (outside the electrojet) it is 0.991. The Sq field, under the electrojet as well as outside it, gets enhanced in about the same proportion. There is no physical process by which the boundary of the electrojet moves laterally during the changes in sunspot activity.

9. Seasonal variations of the jet center

Views are conflicting regarding the movement with respect to the sun, of the center of the electrojet. PRICE & WILKINS (1951) were the first to report from their analysis of the 1932–33 International Polar Year data, that the center moves opposite the sun. (That is, when

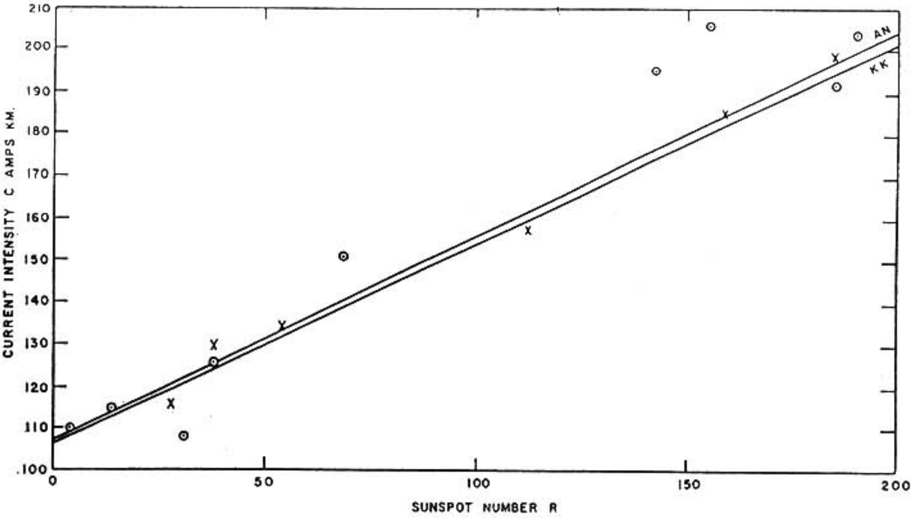

Fig. 6. Variation of electrojet current intensity (*C*) with sunspot number (*R*).

Table 4.

Station	Geographic longitude	Electrojet current intensity in amp/km			
		j	*e*	*d*	Year
Jarvis	160°02′E	175	266	—	200
Huancayo	76°18′W	246	291	239	259
Ibadan	3°54′E	233	293	218	248
Addis Ababa	38°46′E	241	247	172	220
Kodaikanal	77°30′E	186	259	161	202
Annamalainagar	77°41′E	185	241	160	195

the sun moves north from December to June solstice, the electrojet center moves south.) FORBUSH & CASAVERDE (1961) did not find evidence of seasonal movement of the jet center. OSBORNE (1964) concluded that the seasonal changes in the jet position in Peru and Ghana were within error limits. MASON's (1963) study of the electrojet in the central Pacific suggested that the jet center moved opposite the sun. OGBUEHI and ONWUMECHILLI (1964) found that in Nigeria the center moved with the sun.

Taking the rSq(Z) value as an indication of the proximity of an observatory to the jet center, we infer from the seasonal variations of rSq(Z) at Kodaikanal, Annamalainagar and Trivandrum that in the Indian region, the jet moves opposite the sun, in agreement with the earlier findings of Price and Wilkins and of Mason, but the magnitude of this movement is small, being 10 km. It is possible that as we have not split the observed ranges into jet and normal ranges, we have not got results similar to those of OGBUEHI & ONWUMECHILLI (1964). It is, however not known if the seasonal variation inside the electrojet viz. equinoctial maximum is confined only to the electrojet region, and that outside the electrojet, the seasonal variation of normal Sq is different. As discussed earlier, our view is that the electrojet is daytime enhancement of the normal Sq field. If this view is correct, the jet center moves opposite the sun, seasonally.

10. Comparison of the electrojet intensity at different latitudes

Using the seasonal values of rSq(H) and rSq(Z) for 1958 we have calculated the electrojet current intensity over Jarvis, Huancayo, Ibadan, Addis Ababa, Kodaikanal and Annamalainagar.

(For Jarvis the value of the ratio rSq(Z)/rSq(H) for d season was too small and the corresponding β value could not be picked up from Fig. 3.) Taking the year as a whole, the jet intensity appears to be highest in the South American Zone and lowest in the Indian and in the Central Pacific Zones. The electrojet intensity has an equinoctial maximum and minimum in December solistice.

11. Summary

(1) The range rSq(H) is a maximum in the equinoctial season in the equatorial electrojet in Indian region, as at many other observatories in the equatorial region.

(2) The electrojet intensity is maximum in equinoctial season in Indian region as well as at other longitudes.

(3) The half-width of the electrojet in the Indian region varied from 260 to 310 km based on the Kodaikanal data during the period 1951–58. The average value of half-width in the Indian region may be taken to be 300 km.

(4) The correlation coefficient between the half-width of the electrojet and sunspot number, is not statistically significant. The change of width is less than 10 percent during a sunspot cycle.

(5) The current intensity increases with the sunspot number; the correlation coefficient between the two is positive and very highly significant. An almost linear relationship is suggested.

(6) By the trend of vertical force variations it is concluded that the center of the electrojet moves opposite to the sun seasonally.

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REFERENCES

BAKER, W. G., and MARTYN, D. F., 1953, Electric currents in the Ionosphere. *Phil. Trans. Roy. Soc. Lond. A.*, **246**, pp. 281–293.

CAHILL, L. J., 1959, Investigation of the Equatorial Electrojet by Rocket Magnetometer. *J. Geophys. Res.*, 64, pp. 489–503.

CHAPMAN, S., 1951, The Equatorial Electrojet as detected from the abnormal electric current distribution above Huancayo, Peru and elsewhere. *Arch. Met. and Bioclimatology, Vienna*, *A*4, pp. 368–390.

CHAPMAN, S., and RAJA RAO, K. S., 1965, The *H* and *Z* variations along and near the equatorial electrojet in India, Africa and the Pacific, *J. Atmos. Terr. Phys.*, 27, pp. 559–581.

EGEDAL, J., 1947, The magnetic diurnal variation of the horizontal force near the magnetic equator. *Terr. Mag. Atmos. El*, 52, pp. 449–451.

FORBUSH, S. E., and CASAVERDE, M., 1961, Equatorial Electrojet., *Carnegie Institution of Washington* 620.

KOTADIA, K. M., 1962, The equatorial sporadic-E layer and the electrojet. *J. Atmos. Terr. Phys.*, **24**, pp. 211–218.

MASON, R. G., 1963, The Equatorial Electrojet in the Central Pacific. *Marine Phys. Lab. Scripp Inst. of Oceanography*, 63–13, 1.

OGBUEHI, P. O., and ONWUMECHILLI, C. A., 1963, Recent measurements of the magnetic field of the equatorial electrojet in Nigeria. *J. Geophys. Res.*, 68, pp. 2421–2424.

— 1964, Daily and seasonal changes in the equatorial electrojet in Nigeria, *J. Atmos. Terr. Phys.*, 26, pp. 889–898.

ONWUMECHILLI, C. A., 1959, A study of the equatorial electrojet II. *J. Atmos. Terr. Phys.*, **13**, pp. 235–257.

OSBORNE, D. G., 1962, Position and movement of the equatorial electrojet over Ghana. *J. Atmos. Terr. Phys.*, 24, pp. 491–502.

— 1963, Daily variability in strength of the equatorial electrojet. *J. Geophys. Res.*, 68, pp. 2435–2439.

— 1964, Daily and seasonal changes of the equatorial electrojet in Peru. *J. Atmos. Terr. Phys.*, 26, pp. 1097–1105.

PISHAROTY, P. R., and SREENIVASAN, P. K., 1962, Width of the electrojet over south India (75°E–80°E). *Indian J. Met. Geophys.*, **13**, pp. 554–556.

PRICE, A. T., 1963, The noncyclic variation during quiet days. *J. Geophys. Res.*, **68**, pp. 6383–6389.

PRICE, A. T., and WILKINS, G. A., 1951, The daily magnetic variations in the equatorial region. *J. Geophys. Res.*, **56**, pp. 259–263.

— 1963, New methods for the analysis of Geomagnetic fields and their application to the Sq field of 1932–3. *Phil. Trans. Roy. Soc. Lond. A* **256**, pp. 31–98.

VESTINE, E. H., LAPORTE, L., 1947, The Geomagnetic Field, its description and Analysis, *Carneigie Institution of Washington, Publication* 580.

YACOB, A., and KHANNA, K. B. K., 1963, Geomagneti Sq Variations and Parameters of the Indian Electrojet for 1958, 1959. *Indian J. Met. Geophys.*, **14**, pp. 470–477.

ЦИКЛ СОЛНЕЧНЫХ ПЯТЕН И СЕЗОННЫЕ ВАРИАЦИИ В ПОЛОЖЕНИИ И ИНТЕНСИВНОСТИ ЭКВАТОРИАЛЬНОЙ СТРУИ ТОКА НАД ИНДИЕЙ

Кратко обсуждаются последние взгляды на экваториальную струю тока. Для четырех индийских обсерваторий Алибаг, Аннамалайнагар, Кодайканал и Тривандрум вычисляются сезонные и годовые интервалы изменений *H* и *Z* для спокойных дней за все годы, для которых имеются данные. Интервалы изменений и для спокойных дней представлены на диаграммах для годов максимума и минимума солнечной активности. Средние годовые величины полуширины экваториальной струи тока были вычислены при использовании данных обсерваторий в Кодайканале и Аннамалайнагаре. Проводится сравнение с результатами более ранних исследований. Получено, что над Индией эта полуширина имеет порядок 300 км. Корреляция между полушириной и числом солнечных пятен оказывается незначительной. Коэффициент корреляции между плотностью тока и числом пятен очень велик, что предполагает почти линейную зависимость между ними. Рассматривая величину *rSq*(*Z*), превышение наименьшего значения дневных часовых величин *Z* над ночными для дня, близкого к международному спокойному дню, в качестве указания на близость станции к центру струи, находится, что струя движется в направлении, противоположном солнцу, что соответствует результатам Прайса и Уилкинса (1963) и Мэйсона (1963). Сравнение плотностей силы тока в струе для различных широт показывает, что плотность тока наибольшая над Южной Америкой и наименьшая над Индией и Центральной частью Тихого океана.