

Night-time SCs, SIs and Bays in H at equatorial electrojet stations in India

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ABSTRACT. It is shown that while at Indian electrojet station Annamalainagar some night-time enhancement is seen, at Trivandrum also an electrojet station on the contrary some night-time diminution is seen for all the three phenomena SC, SI and Bay. It is also shown that in Indian zone the mean ratio decreases from north to south while in American zone the mean ratio increases from north to south.

1. Introduction

Onwumechilli and Ogbuehi (1962) in their study of sudden fluctuations at American and African stations have observed night-time enhancement of the amplitude of sudden fluctuations at and near magnetic equator. Although the daytime enhancement of fluctuations and SCs in H near the magnetic equator has been reported by Sugiura (1953), Ferraro (1954), Srinivasamurthy (1960), Maeda and Yamamoto (1960), Yacob and Khanna (1963) and other authors, the night-time enhancement observed by Onwumechilli and Ogbuehi is very interesting. Recently Rastogi *et al.* (1966) in their study of night-time SCs within equatorial electrojet region for American and Indian stations have also observed a distinct night-time enhancement in the American zone but not a very clear enhancement in the Indian zone. In this paper an attempt is made to study night-time behaviour of sudden commencements, sudden impulses and magnetic Bays separately for Indian stations to investigate more fully the existence or otherwise of the night-time enhancement at equatorial electrojet stations in India and to examine how far the three magnetic features agree at the Indian equatorial stations.

2. Station and Data

In Table 1 is given the co-ordinates of the stations whose data have been studied. The Indian stations are within a narrow belt of longitudes (of the order of 7°). While Alibag is outside and about 1000 km away from the centre of the electrojet, Annamalainagar and Kodaikanal are within but about 300 and 200 km away respectively from the centre of the electrojet and the dip equator. Trivandrum is very close to equatorial electrojet and just south of the dip equator. Thus this group of stations is ideally located for a study of electrojet and equatorial effects in equatorial geomagnetic phenomena.

(i) *Data for SCs*—The SC data comprise all the SCs occurring between 1800 to 0600 LT (IST) for the years 1958 to 1964 recorded at Alibag, Annamalainagar, Kodaikanal and Trivandrum. There are 65 SCs at Alibag, Annamalainagar and Trivandrum and 48 SCs at Kodaikanal. The data of Koror for 1958 which were also readily available are used for comparison. Although there is about four hours of difference between the LT at Indian stations and at Koror, only those SCs (9 in all) are studied for which there is night at Indian stations as well as at Koror.

(ii) *Data for SIs*—The SI data comprise all SIs occurring between 1800 to 0600 LT (IST) from October 1957 to December 1959 recorded at Alibag, Annamalainagar and Trivandrum. There are altogether 173 SIs which have been studied.

(iii) *Data for Bays*—The Bay data also comprise all Bays occurring between 1800 to 0600 LT (IST) from October 1957 to December 1959 recorded at Alibag, Annamalainagar and Trivandrum. There are altogether 132 Bays which have been studied.

Although the data for SIs and Bays are distributed over a shorter period than those for SCs their number is sufficiently large for a statistical study.

3. Analysis and Results

As mentioned earlier Alibag is outside and away from the equatorial electrojet while other stations are all close to the electrojet. For a study of the equatorial effects amplitude of each of the SCs in H at the three equatorial stations was normalized by dividing it by the corresponding amplitude in H at Alibag. The same procedure was adopted for SIs and Bays. A mean night-time ratio for each station and for each event was obtained. A mean ratio was also obtained for each of the

TABLE 1
Co-ordinates of the stations

Station	Geographic		Geomagnetic		Magnetic Dip
	Lat.	Long.	Lat.	Long.	
Alibag	18° 38' N	72° 52' E	9° 28' N	143° 36' E	24° 38' N
Annamalainagar	11° 22' N	79° 41' E	1° 32' N	149° 22' E	5° 25' N
Kodaikanal	10° 14' N	77° 29' E	0° 42' N	147° 30' E	3° 22' N
Trivandrum	8° 29' N	76° 57' E	0° 54' S	146° 18' E	0° 36' S
Koror	7° 20' N	134° 30' E	3° 12' S	203° 24' E	0° 05' S

TABLE 2

Station	Total number	No. when ratio > 1	No. when ratio = 1	No. when ratio < 1	Mean ratio	Seasonal mean ratio		
						D*	S*	E*
<i>NIGHT-TIME SCs</i>								
Annamalainagar	65	61	2	2	1.19	1.28	1.12	1.18
Kodaikanal	48	18	24	6	1.00	1.10	0.98	0.97
Trivandrum	65	14	7	44	0.95	1.00	0.90	0.95
Koror	9	Nil	Nil	9	0.59			
<i>NIGHT-TIME SIs</i>								
Annamalainagar	173	145	19	9	1.18	1.17	1.15	1.18
Trivandrum	173	23	45	105	0.93	0.92	0.92	0.91
<i>NIGHT-TIME BAYS</i>								
Annamalainagar	132	79	38	15	1.06	1.06	1.11	1.05
Trivandrum	132	3	15	114	0.88	0.87	0.92	0.87

*D — Northern Winter

S — Northern Summer

E — Equinox

night hours (1800 to 1859, 1900 to 1959..... 0400 to 0459 and 0500 to 0600) for each of the stations and for each of the SC, SI and Bay event. The mean hourly values of the ratios are diagrammatically represented in Fig. 1. Monthly mean ratios are also worked out and shown in Fig. 2.

In Table 2 are shown the total number of SCs studied, number of SCs when the ratio is greater than one, less than and equal to one or in other words when the actual amplitude of SC in H at a equatorial electrojet station is greater than, less than or equal to that at Alibag, a station outside the effect of the electrojet. A mean ratio for all the SCs and seasonal mean of the ratios for each station is also depicted. The same

results for SIs and Bays for Annamalainagar and Trivandrum are also shown in Table 2.

From Table 2 it can be seen that for Annamalainagar out of 65 SCs the ratio is greater than unity for 61 SCs. The mean night-time ratio is 1.19. Annamalainagar thus shows a night-time enhancement. There seems to be a seasonal trend in the ratios. The ratio is greater in northern winter and least in northern summer.

At Kodaikanal out of 48 SCs, 18 show ratios greater than unity while 24 show ratios to be just unity and only 6 show ratios less than unity. The mean ratio is unity. Thus at Kodaikanal there is neither enhancement nor diminution. Kodaikanal also shows a winter maximum and summer minimum.

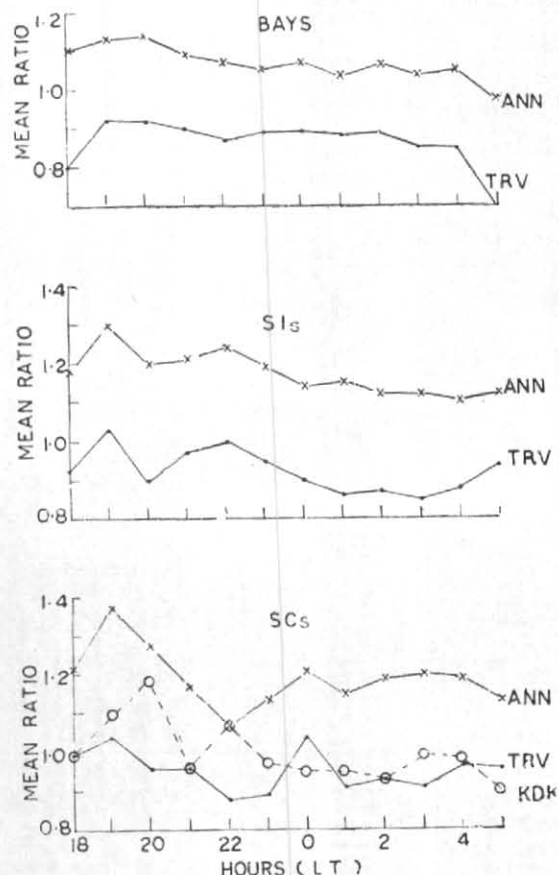


Fig. 1. Hourly variation of the mean ratio for Bays, SI and SC

(ANN — Annamalainagar, TRV — Trivandrum, KDK — Kodaikanal)

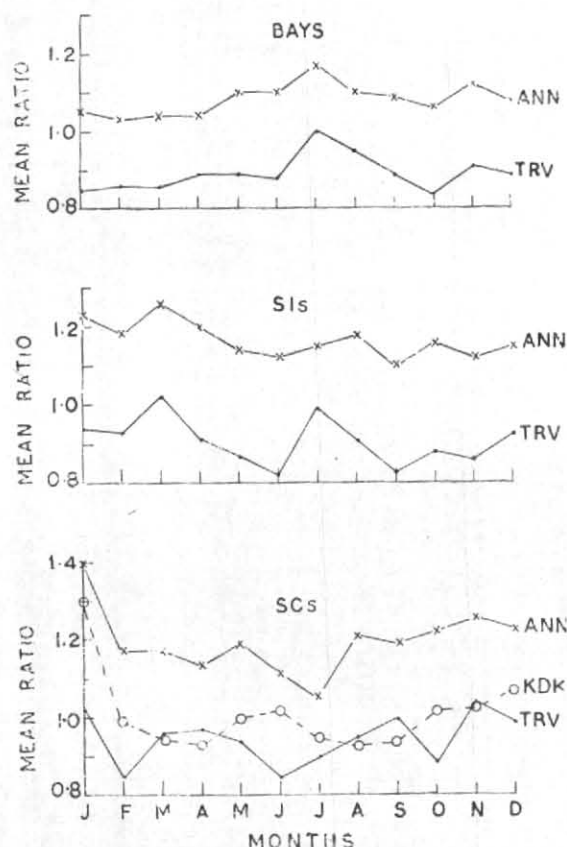


Fig. 2. Monthly variation of mean ratio for Bays, SI and SC

At Trivandrum out of 65 SCs, 44 show ratios less than unity, 7 show ratios equal to unity and 14 show ratios greater than unity. The mean ratio is 0.95. Thus at Trivandrum also an equatorial electrojet station, during night in majority of cases a diminution, instead of enhancement, predominates. Trivandrum also shows the seasonal trend. The ratios are greater in winter than in summer.

At Koror all the nine SCs show ratios less than unity. The mean ratio is 0.59. Thus Koror also shows a night-time diminution instead of enhancement. The seasonal mean is not worked out as the data are meagre for it. It can also be seen from column 6 of Table 2 that the mean ratios show a gradual decrease from north to south within equatorial electrojet region in India.

For SIs and Bays the Kodaikanal data are not available, but here also night-time enhancement at Annamalainagar and diminution at Trivandrum is quite apparent. It can also be seen from Table 2

that seasonal trend of the ratios is not observable for SIs as was seen for SCs. But this table shows that for Bays the seasonal maximum of the ratios is observed in summer.

Another important feature which is observed is that while for SCs and SIs the mean ratios are of the same order for respective stations for Bays the mean ratios are smaller than those for SCs and SIs. This shows that the night-time enhancement of the amplitude in *H* for Bays is comparatively smaller at Annamalainagar but the night-time diminution of amplitude in *H* is more at Trivandrum for Bays.

4. Discussion

The night-time enhancement of the SC, SI and Bay in *H* at Annamalainagar, which is about 297 km north of the magnetic equator (Yacob and Khanna 1963) is quite similar to the night-time enhancement observed by Onwumechilli and Ogbuehi (1962) for sudden fluctuations and by

Rastogi *et al.* (1966) for SCs at Huancayo. The overall ratio of Kodaikanal/Alibag for SCs is quite similar to that of Addis Ababa/Ibadan of Onwumechilli and Ogbuehi for sudden fluctuations. The overall ratio for Trivandrum/Alibag is less than one and hence unique, because it shows diminution instead of enhancement as reported for other equatorial stations and specially those in American zone. The diminution is still clearer for Bays where a mean ratio of 0.88 is observed for Trivandrum.

As mentioned earlier in Indian zone of equatorial electrojet stations a gradual decrease is seen in the normalized ratios from north to south or in other words from Annamalainagar to Trivandrum. If this result is compared with the variation of the normalized ratios in the American zone it is observed that there the normalized ratios increase from north to south. Thus for an example if we consider the normalized ratios (Test station Alibag) for 17 July 1959 SC between 21 and 22 hours LT graphed in the paper of Rastogi *et al.* (1966) we obtain a ratio of 1.02, 0.91 and 0.89 for Annamalainagar, Kodaikanal and Trivandrum respectively. For a similar SC of 19 August 1959 the normalized ratios (Test station San Juan) are 1.16, 1.30, 1.34, 1.46 and 1.68 for Talara, Chiclayo, Chimbote, Yauca and Huancayo respectively. It is quite possible that in the American zone the electrojet current may still be present during night in some form (probably

the return current mode) but it may not be present in Indian zone. Also there may be a rapid depletion of ionization during night at Trivandrum than at Annamalainagar. While there is no current observation for Annamalainagar, Maynard and Cahill (1965) utilizing rocket data at Trivandrum report that there is no indication of any distinct night-time current there. If at all a diffuse layer of current existed between 100 and 170 km it is too weak to produce a displacement of magnetic field by as much as 10 %.

It is difficult at present to account for the seasonal variation of the ratios which are maximum in different seasons for different features SC, SI and Bay. Thus as SCs show maximum in winter and minimum in summer, the Bays show maximum in summer and minimum in winter and equinox. No clear seasonal variation is observed for SI. The SC data although cover all SCs from 1958 to 1964 the total number of SCs may not be sufficient to confirm the seasonal trend observed here. We have to wait till data for more years accumulate.

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