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Counter-electrojet in the Indian Zone

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Contour maps of the percentage occurrence of daytime eastward drift in the E-region of the ionosphere over the equatorial stations, Tiruchirapalli (dip 5°N) and Thumba (dip 6°S), have been constructed from the spaced receiver drift measurements to investigate the time variations of counter-electrojet events. Maximum occurrence is noted during June solstices with the minima during equinoxes.

An abnormally large range in the solar daily variation of the geomagnetic $H$ component is observed at stations within a narrow band centred at dip equator.$^{12}$ This was explained as due to a belt of strong eastward current flowing in the E-region of the ionosphere caused by the enhanced conductivity,$^{8}$ later confirmed by rocket experiments.$^{4,8}$ Gouin$^{8}$ reported a case where the daily variation of $H$ at Addis Ababa was reversed around midday. Gouin and Mayaud$^{7}$ described this as due to a narrow band of westward current and named the event “counter-electrojet”. Such depressions were later reported for other equatorial stations and have been reviewed by Rastogi$^{8}$ and more recently by Mayaud.$^{9}$

Spaced receiver drift measurements at Thumba confirmed the westward electric fields at times of the counter-electrojet events and the ionograms recorded at the same time were marked by the disappearance of the equatorial type of $E_s$ ($E_s-q$)$^{[Ref. 10]}$. Similar conclusion was demonstrated by Fambetakoye$^{11}$ by studying the $H$ and $Z$ variations from a close meridian chain of nine magnetometers across the magnetic equator in Central Africa. In situ

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rocket measurements at times of counter-electrojet were later reported by Prakash et al.\textsuperscript{12}

The occurrence characteristics of the counter-electrojet, as explained by different workers,\textsuperscript{9} for the same location have problems associated with the individual judgement required in identifying such events. Further, there are partial counter-electrojet events when the $H$ field does not decrease below the nighttime level but electric field reverses and the $E_{\text{q}}$ disappears.\textsuperscript{8} Similarly counter-electrojet cannot be identified from the $H$ variation during the course of a magnetic storm. Chandra and Rastogi\textsuperscript{13} have used the quantity ($H_{\text{equator}}-H_{\text{away from equator}}$) for detecting counter-electrojet events whereas Kane\textsuperscript{14} had advocated for the quantity $S_d (=H_{\text{equator}}-H_{\text{away from equator}}+\overline{H}_{\text{equator}})$ in identifying counter-electrojet events. Thus the occurrence characteristics of counter-electrojet would greatly depend upon the criterion used in the study.

The spaced receiver drift experiment was conducted by the Physical Research Laboratory at Thumba (dip 0.6°S) during the period Jan. 1964-May 1969. Another station at Tiruchirapalli (dip 5°N) started functioning since Oct. 1972 and an extensive series of observations during the period 1973-75 are available. The data for the year 1964 at Thumba and during the period 1973-75 at Tiruchirapalli represent a low sunspot activity period, while the data for the period 1968-69 at Thumba represent a high sunspot activity period. Daytime eastward drifts are inferred as counter-electrojet events. Percentage occurrences of the eastward drifts in the E-region have been computed for the daytime hours and the contours of constant percentage mapped out in a grid of local time versus months. The E-region data are limited to 0700-1700 hrs. No attempt is made to remove the magnetically disturbed days and, therefore, quite a few counter-electrojet events associated with the magnetic storms would be present particularly for the period 1968-69.

The contours of the percentage occurrence of the eastward drift in the E-region over Tiruchirapalli for the period 1973-75 are shown in Fig. 1. The main features are: (i) eastward drifts are noticed to be maximum in the afternoon (1600-1700 hrs LT); (ii) seasonally maximum occurrence of eastward drifts is during the month of June with minima in equinoxes. Similar contours for Thumba during the year 1964 are shown in Fig. 2. The features are similar to those obtained for Tiruchirapalli. However, the counter-electrojets seem to be less frequent at Thumba than at Tiruchirapalli during 1973-75. Contours for the high sunspot activity period 1968-69.
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Fig. 3 — Same as in Fig. 1 but for Thumba during the period 1968-69

To the afternoon counter-electrojet a clear anticorrelation is noted with sunspot number. On the other hand there is no clear picture for the correlation between morning counter-electrojet and sunspot number. A maximum in June solstices with a secondary maximum in Dec. solstices is generally noted in the northern hemisphere for the afternoon events even though there are some contradictions. For the morning counter-electrojet event larger occurrence at the equinoxes than at the June solstices is noted. However, for Kodaikanal a maximum in Aug. is clear with low in equinoxes (Fig. 8 of Ref. 9). Thus the seasonal variations in the counter-electrojet events at Kodaikanal are similar to the seasonal variations of the eastward drifts reported here. However, the solar cycle variation reported here does not fit with the observations of the counter-electrojet events reported earlier. Since the counter-electrojet events reported in literature belong to quiet days only this may be one of the reasons for the observed discrepancy. Here we present the occurrence pattern of the westward electric fields during daytime as these are associated with the disappearance of Es-q, and the presence of blanketing type of Es, the latter giving rise to intense scintillations in the vhf range. The modelling of these daytime westward electric fields is, therefore, important from the radio communication point of view.

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