WESTWARD IONOSPHERIC CURRENTS OVER THE DIP EQUATOR DURING GEOMAGNETIC DISTURBANCES

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Abstract. During geomagnetic disturbed periods, the q type of sporadic E layer near the dip equator is shown to disappear with maximum error of five minutes during the period when the difference of the geomagnetic H field between the equatorial and non-equatorial stations decreases below the night level. These periods are identified with the reversal to westward direction of the electrojet currents at the base of the E region around 100 km level irrespective of the changes in the S, current system which might be produced by the disturbance.

Introduction

Although the equatorial sporadic E layer had been known to be associated with the equatorial electrojet currents, Cohen et al. (1962) were first to show a disappearance of Es-q at Huancayo during a decrease of the geomagnetic H field. This phenomenon of sudden disappearance of Es-q during the depression of the H field was shown to be associated with the reversal of ionospheric drifts measured by space receiver technique (Rastogi et al., 1971) and later with the reversal of the electron drift measured by VHF doppler shifts (Rastogi, 1973). Pambitakoye et al. (1973) showed that the disappearance of Es-q is not coincident with the time of H becoming negative (relative to the nighttime level) but with the reversal of the latitude profile of H and Z fields. Chandra and Rastogi (1974) have shown that the simple criterion for the disappearance of the Es-q is that the difference of the H field between the equatorial and non-equatorial station should decrease below the corresponding nighttime level.

During geomagnetic disturbances, the ground level measurement of the H field completely fails to give any idea of the overhead currents in the ionospheric E-region. In the present study, the author examined the ionograms of Kodaikanal taken at short intervals of every five minutes during geomagnetic disturbed period.

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Fig. 1: The variations of the geomagnetic H field at equatorial station - Kodaikanal, a station near the Sq focus - Tashkent, and the difference of the H field between Kodaikanal and Alibag compared with the foEs-q at Kodaikanal on 21 December 1957.

Discussion

Studying the temporal correlation between the intensity of VHF radio waves scattered from the irregularities associated with the electrojet and the horizontal intensity of the earth's magnetic field, a measure of the electrojet current, Cohen and Bowles (1963) found that the echo strength builds up along with the current as midday is approached but as the current decays in the afternoon, a phase lag is noted in the decay of the echo strength. They suggested that the geomagnetic field strength measured at the ground is being affected by currents other than those flowing within the electrojet. The hysteresis feature was eliminated when the difference between the geomagnetic H fields at Huancayo and Bogota was used to represent the strength of the electrojet current. Parley and Balseley (1973) have shown that the scattering cross section of the V.H.F. radio waves by the type II irregularities is linearly related to $\Delta H$ (Huancayo) - $\Delta H$ Bogota. Nair et al. (1970) suggested that the difference of $\Delta H$ at Trivandrum and Alibag is related to purely ionospheric currents. Rastogi (1974) has shown that even when the $\Delta H$ at an equatorial station is significantly positive, i.e. above the night level, there may exist counter-electrojet events as evidenced by the reversal of the latitudinal profiles of $\Delta H$ and $\Delta E$ fields. During such partial counter-electrojet events, the Es-q is shown to disappear and the ionospheric drift reverses to eastward direction. This has been interpreted by Rastogi (1975) as due to simultaneous flow of Sq currents around 107 km and of the counter-electrojet currents at a lower level around 100 km.
The present results indicate that during moderately or severely disturbed conditions there are brief periods during the daytime hours when the currents over the equator are definitely reversed to westward direction. These currents are precisely coincident with the time of Es-q disappearance and hence flow at the level of Es-q i.e., at the base of E layer around 100 km. Unlike during quiet conditions, it is not possible to estimate the changes in the Sq current system during geomagnetic disturbed periods. In the absence of an ionospheric station near the dip equator in any particular longitude zone, two geomagnetic observatories one within and other outside the electrojet current region can delineate these periods of equatorial substorms. In the absence of an ionospheric station near the dip equator in any particular longitude zone, two geomagnetic observatories one within and other outside the electrojet current region can delineate these periods of equatorial substorms. An examination of ionospheric storms in association with the changes in Es-q or with the variation of the difference of the H field between the equatorial and a non-equatorial station would help to isolate the effect of the changes of electrostatic field on the F2 region of the ionosphere during geomagnetic storms.

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References


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