UPWARD MOVING IONOSPHERIC IRREGULARITIES OVER KODAIKANAL

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ABSTRACT

The occurrence of upward moving kinks first found on ionograms at Thumba (Rastogi, 1970) has been confirmed to occur at another equatorial station, Kodaikanal. These kinks have been found in many records and they occur mostly during local summer months. The occurrence of the kink is shown to be closely associated with horizontal F-region drifts, occurrence of intermediate cusp between $F_1$ and $F_2$ layers, bite-out effects of $f_0F_2$ and rise of $h_pF_2$, all being most pronounced around 10 hr. The upward movement of the kink is due to $\mathbf{E} \times \mathbf{B}$ drift, while its initiation is probably due to a sudden change in the electrostatic field of the equatorial electrojet.

The study of the upward moving kink gives a direct measure of the height variation of the vertical upward drift of ionization over the magnetic equator.

INTRODUCTION

The critical frequency $f_0F_2$, at low latitude stations, shows anomalous behaviour both in its diurnal as well as in its latitudinal variations; the values of $f_0F_2$ at an equatorial station being lower during midday than during forenoon or afternoon hours. Moreover, the values of $f_0F_2$ around midday hours are lower near the magnetic equator than at latitudes around 20° north or south of it.

The first attempts to explain the equatorial bite-out of $f_0F_2$ were in terms of thermal expansion of the ionosphere (Appleton et al., 1935) but this idea was later shown to be untenable by Martyn and Pulley (1936). Norton and VanZandt (1964) have tried to explain the daytime equatorial ionospheric $N(h)$–$t$ variation in terms of photo-ionization and recombination.
in a time-varying neutral atmosphere whose temperature increases rapidly in the morning hours, and is roughly constant during the afternoon.

S. K. Mitra (1946) suggested that the ionization formed in the equatorial ionosphere above $h_{\text{max}}$ diffuses polewards and downwards along the magnetic lines of force and gives rise to enhanced critical frequencies at lower heights to the north and south of the equator. However, it was pointed out that there would not be enough ionization above the equatorial $F_2$ region to produce the observed increase of ionization at about $20^\circ$ north or south of the magnetic equator.

Martyn (1947) showed that the electron density distribution with height at any station would be greatly modified by the vertical transport of ionization with velocity varying with height and time. The vertical forces in the F-region were suggested to arise from the interaction of the horizontal geomagnetic field with the horizontal (eastward) polarization electric field of the dynamo region (Martyn, 1949). The equatorial $F_2$ region is thus lifted upward due to electro-dynamic forces and the increased ionization could diffuse horizontally north and south along the magnetic lines of forces (Martyn, 1955).

Rastogi (1959) studied the diurnal development of the equatorial anomaly and showed that the mid-latitude maximum in $f_o F_2$ first develops at low-latitudes and shifts poleward with the progress of the day. Further, the two maxima in the daily variation of $f_o F_2$ at low-latitude stations are less separated with increasing latitude, finally converging into a single maximum at $25^\circ$ dip. He suggested that these two anomalies in $f_o F_2$ are due to vertical drift of ionization over the magnetic equator together with its motion towards the poles along the magnetic lines of forces, causing $f_o F_2$ peaks around $20^\circ$ latitude. This suggestion explained the variation with solar cycle of the latitude of maximum $f_o F_2$ as well as the differences in the latitudes of maximum $f_o F_2$ and $f_o F_1$ during years of high solar activity. The same suggestion was given later by Duncan (1960) comparing the daily variation of the critical frequencies at an equatorial station Chimbote and the tropical latitude station, Panama. Quantitative calculations of electron density distribution with height and latitude using the above suggestion, generally called the “fountain effect”, were made by Moffett and Hanson (1965) as well as by Bramley and Peart (1965). Further detailed calculations, using time-dependent electro-dynamic term, have been computed by Baxter and Kendall (1968).