Equatorial rising structure in nighttime upper E-region: a manifestation of electrodynamical coupling of spread F

E.A. Kherania, R. Raghavarao, R. Sekar

Abstract

In order to understand the recent radar observations of rising structures in the plasma densities in the upper E-region during nighttime at equatorial and low latitude stations, an investigation is made to explore the possible relation between the E- and F-region structures. The investigation revealed that the fringe fields associated with the development of equatorial spread-F (ESF) structures initiated by large-scale waves in the zonal direction, can penetrate well below the E-region. These fringe fields pull the structures upward and tilt them left- or right-hand side to generate rising tilted structures in the E-region. The depth of the penetration of the fringe fields from F-region altitudes mainly depends on the wavelength of the initial perturbation. The fringe fields can move the E-region structures upward with varying speeds, even when the background drift during nighttime is downward, depending on the strength of ESF development.

Keywords: Equatorial spread F; Equatorial ionosphere; Plasma irregularities

1. Introduction

The simultaneous observations obtained using high power VHF radars from both E- and F-region of the equatorial ionosphere are important in studying the possible relations between the structures observed at those regions during nighttime. The VHF radar observations in the equatorial F-region reveal a variety of structures such as plumes extending from bottomside to topside, multi-plume structures and moderate bottomside structures confined to localized altitude region during nighttime. On a few occasions, these multiplumes are observed to be modulated by a large-scale bottomside wave-like structures (Kelley et al., 1981; Hysell et al., 1990; Basu et al., 1996). On many other occasions, such large-scale modulating structures are found to be absent in the F-region (Woodman and La Hoz, 1976). Simultaneous measurements of 3-m irregularities from the E-region during nighttime on those occasions reveal that the structure is confined to a narrow altitude region. These irregularities are identified as due to the gradient drift instabilities in the nighttime associated with the negative gradients of the electron densities in the valley region. On occasions, when the large-scale modulations are observed on the F-region irregularities, the E-region irregularities are observed to be pulled upward (Kelley et al., 1981; Hysell et al., 1990; Basu et al., 1996) and the E-region structures are tilted towards right-hand side on the RTI (range time intensity) map. Similar structures have been observed by the Indian MST radar located at Gadanki (dip latitude 6.2°N) during I-STEP campaign (P.B. Rao, personal communication) wherein the E-region structures are pulled upward. However, they are tilted towards left side on the RTI map in contrast to the Jicamarca observations. On many other occasions, such plume like structures from E-region are not observed. Recent measurement by Woodman and Chau (2001) reveals that the structures from E- and F-region are connected. Thus, an explorative investigation, to understand the connection between E- and F-region structures, is required in terms of the plausible interactions of the fringe fields emanating from the F-region irregularities and penetrating to the E-region altitudes.

*Corresponding author. Tel.: +91-272-462-129; fax: +91-79-460-502.
E-mail address: rsekar@prl.ernet.in (R. Sekar).