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Equatorial Spread F Variability and Forecasting Studies in Brazil

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Abstract:
Studies on equatorial spread F irregularity phenomenon (ESF) has been in progress at the Instituto Nacional de Pesquisas Espaciais – INPE, in Brazil since the 70's. The investigations have been based on ionospheric observations at Brazilian equatorial and low latitude sites utilizing ground based ionosondes/digisondes, optical imagers and photometers, rocket borne sensors, and satellite beacon monitors. In recent years the diagnostic network has been extended to include GPS TEC and irregularity receivers, and VHF back-scatter radars. The extensive data sets already available has been used in investigations aiming at establishing important characteristics of the phenomenon, such as the development, dynamics, morphology and spatial and temporal distributions of the irregularities, in the Brazilian sector.
It is to be noted that the South American region possesses important peculiarities in geomagnetic field configuration that is known to cause ESF development features to differ significantly, with the rapid variation of the magnetic declination angle, from the western to the eastern sector of this region. This fact has highlighted the need to pursue ESF investigation focusing on comparing the ESF phenomenology between Peruvian and Brazilian sectors. Such studies have produced valuable results pointing to longitudinal and seasonal patterns in ESF occurrence.
It is well known that the occurrence and intensity of ESF F events, present variabilities that are of short (hours to day), medium (month and season), long (solar activity) term scales. ESF development conditions are also highly responsive to transient disturbance electric fields and wind systems stemming from space weather disturbances. Theoretical prediction based on observed ambient ionosphere-thermosphere conditions seems to explain their occurrence, in an average situation. But they do not so far predict the intensity of a spread F event on a day-today basis. The ongoing ESF studies at INPE focus on identifying major causes of the day-to-day variability of ESF in terms of their development conditions defined by 1- linear growth rate for the generalized Rayliegh-Taylor (R-T) instability process that is dependent on the sunset zonal prereversal electric field (PRE) and associated F layer height, and the bottomside density gradients; 2- field line integrated conductivities that control the Item-1 as well as the nonlinear bubble development that could follow; and 3- a density perturbations as a seeding source due possibly to gravity waves originating at lower atmospheric domains, or other possible mechanisms. New results related to the Items 1 and 2, in terms of the competing influence of the zonal and meridional components of the thermospheric wind and field line integrated conductivity will be presented. A conjugate point spread F observational campaign in Brazil planned for Oct-Nov. 2002 period has the objective to clarify some of these questions. Longitudinal variation arising from anomalous conductivity distributions due SAMA (South Atlantic Magnetic Anomaly) and magnetic declination angle will also be discussed.