Recent Studies and Some Outstanding Problems on Low Latitude Plasma Irregularities

P. Balarama Rao[1] and A. K. Patra[2]
[1]National Remote Sensing Centre, Balanagar, Hyderabad 500 625, India
[2]National Atmospheric Research laboratory, Gadanki, India

The intense exploration of low latitude ionospheric plasma irregularities using high power high resolution VHF radars over the past nearly two decades has led to detection of several new and fascinating patterns of plasma structures. The wide variety of plasma structures that manifest over low latitudes was seen to cover both classes of irregularities, one representing equatorial and the other mid-latitudes. The most intriguing of the low latitude plasma structures that attracted much attention in recent years include: 1. the widely known structures giving rise to the 150 km echoes that were originally believed to be confined to the magnetic equator; these echoes display a characteristic necklace-shaped pattern in time – height that shows significant forenoon – afternoon asymmetry ; the Doppler velocities of these echoes were found to be well correlated to the F region plasma drift velocities and hence could be used to derive the zonal electric fields; 2. the so called quasi-periodic (QP) echoes that extend above ~100 km and having periods ranging typically over ~5 – 15 min., and the low altitude quasi-periodic echoes (LQP) that are confined to a narrow height- band below 100 km and having periods ranging ~30 sec – 3 min.; 3. the low altitude field-aligned irregularities that were observed at altitudes extending down to as low as ~87 km ; the Doppler velocities of these echoes could be used to derive the meridional component of the neutral wind in the mesosphere-lower thermosphere (MLT) region. In parallel to the above, there have been equally impressive advances in the studies on low latitude F- region irregularities. The most striking of these studies include among others: 1. the storm-time observations on spread-F that offered new insights into the role of the prompt penetration electric fields on the occurrence and evolution characteristics of the post-sunset spread-F, and this led to the means of identifying for a given storm the longitude sector where the spread-F could potentially be generated; 2. the new observations on the late night summer spread-F irregularities under low solar activity conditions that, in many ways, are found to be qualitatively different from the conventional post-sunset equinoctial spread-F. In this paper, we present the highlights of new observations on the above aspects of the low latitude E- and F-region plasma irregularities and a critical discussion on the potential source mechanisms with a special focus on identifying the gap areas and suggesting accordingly new observational and theoretical efforts to gain further insights into the underlying processes.