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The Challenge of Predicting Low Latitude Ionospheric Scintillations

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Two regions of the globe, which are most affected by ionospheric scintillations are the high latitude region and the low latitude region encompassing the dip equator. Our present-day dependence on satellite-based communication and navigation has led to a resurgence of interest in the prediction of ionospheric scintillations. In the low latitude ionosphere, the genesis of intermediate scale (~100m – few km) irregularities, which cause the most severe scintillations on VHF to L-band trans-ionospheric radio signals, is in the growth of the Rayleigh-Taylor (R-T) plasma instability on the bottom-side of the post-sunset equatorial F layer. Theoretical developments and observations by various ground-based instruments as well as in-situ measurements by instruments on board satellites, have identified the parameters of the ambient ionosphere, which play key roles in the occurrence of these irregularities. However, the presence of basic conditions for the linear growth of the R-T instability fails to explain the day-to-day variability in the characteristics of these irregularities, which determine the latitudinal distribution and strength of scintillations, and are a result of the non-linear evolution of the R-T instability. In this talk, the present status of the efforts at prediction of low latitude scintillations on the basis of a multitude of observations and numerical simulation of the development of the R-T instability in the equatorial ionosphere, shall be reviewed. Main focus of the talk would be on how observations of ionospheric scintillations may be used to obtain information about the non-linear evolution of the R-T instability under different ambient conditions, which is yet to be explored through numerical simulation of the phenomenon.