Development of Turbulence in the Equatorial Ionosphere

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Turbulence in Earth's equatorial ionosphere arises due to the non-linear development of various plasma instabilities in which the geometry of Earth's magnetic field plays a crucial role. In the nighttime equatorial F region of the ionosphere, non-linear growth of the Rayleigh-Taylor (R-T) instability gives rise to irregular variations in electron density and hence in the ionospheric refractive index. Some of these irregularities are effective in scattering radio wave signals used in satellite-based communication and navigation systems such as the Global Positioning Sytem (GPS) thereby degrading the operation of such systems. From a simplistic point of view, the basic condition for the growth of the R-T instability is present every night, but the equatorial ionosphere does not become turbulent every night. Hence, it is important to identify the parameters which control the development of turbulence in the nighttime equatorial ionosphere. A simple model for the R-T instability has been developed taking into account the coupling of the equatorial F region with the conjugate E regions of the ionosphere in the two hemispheres through currents that flow along the geomagnetic field lines. It is this physical process which prevents the equatorial ionospheric F region from showing any signs of turbulence during daytime. For a 3-mode system, the non-linear equations for this model yield a condition for unstable fixed states. This condition shows for the first time how the height of the F-layer and E region electrical conductivity combine to yield a parameter, which sets a condition for the development of turbulence in the nighttime equatorial ionosphere.