PLASMA TURBULENCE IN LOWER EARTH'S IONOSPHERE: THEORY AND IMPLICATIONS

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For more than forty years, radars and rockets have observed plasma turbulence in the lower ionosphere. In the weakly ionized, highly collisional plasma of the lower E/upper D-region ionosphere, electrons are strongly magnetized while ions are demagnetized by frequent collisions with the neutral atmosphere. Near the geomagnetic equator and high latitudes, strong DC electric fields, $\mathbf{E}$, perpendicular to the geomagnetic field, $\mathbf{B}$, often occur in the E region. They result in high Hall currents due to the $\mathbf{E} \times \mathbf{B}$ drift of electrons. These currents are often named electrojets. The strong electric fields there may drive low-frequency plasma instabilities which in turn give rise to irregularities of electron density and turbulent electric fields. Relevant instabilities include the modified two-stream (Farley-Buneman) and gradient drift instabilities. In the last decade, new thermal instabilities have been also predicted and supported by observational evidence and kinetic simulations. Ionospheric irregularities in the lower Earth's ionosphere have been observed and studied for many years by radars and rockets. In the high-latitude electrojet, during strong magnetospheric perturbations (storms or sub-storms), radars observed strong anomalous electron heating caused presumably by turbulent electric fields that developed as a result of instabilities. A combination of similar low-frequency instabilities may also play a significant role in plasma trails left behind meteoroids that routinely enter the Earth's atmosphere. The instabilities give rise there to $\mathbf{B}$-field-aligned irregularities that result in so-called 'non-specular' radar echoes observed by high-power large-amplitude radars. In our talk, we will review the physical nature of E-region plasma instabilities and related ionospheric effects, as well as our continuing efforts to simulate and theoretically model these phenomena.