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Recent developments in ionospheric turbulence: observations and theoretical explanations.

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Ionospheric turbulence is studied extensively with satellites and rocket instrumentation and with ground-based radars. There are two distinct regimes. One concerns the E region below 130 km altitude and the other the F region above 150 km. The E region is often subjected to intense Hall currents, which lead to various instabilities dominated by a modified two-stream instability. F region instabilities are more slowly growing and cover much greater scales. In recent years we have come to understand that the dominant structures evolve in such a way that their electric field is reduced compared to the ambient electric field in a way such that they match threshold electric field conditions, for which the growth rate is next to nihil. These structures also heat the electrons, sometimes to a point that the heating rate exceeds the local classical Joule heating rate. Exceptions to the rules have also been found with narrow radar spectra, where the Doppler shift of the structures actually matches expectations from linear growth rate theory owing to the peculiar directions at which said structures are generated. With modern radars we can now localize the location of decameter turbulence in relation to optical images related to the aurora boreales and find that they are parallel to auroral arcs but not inside, indicating stronger electric fields on the edges of aurora. For the F region, we often observe far larger structures generated by slowly growing instabilities like the generalized Rayleigh-Taylor instability. In the equatorial region where such structures are generated, we find that structures up to 70 km in size decay at an ambipolar diffusion rate associated with much smaller 500 m structures and conclude that the culprit is mode-coupling down to sizes for which classical diffusion is fast enough to offer a sink of wave energy. At higher latitudes we systematically observe steepening spectra but only when and where the plasma is connected to a large E region plasma density produced either by solar illumination or energetic auroral particles.

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Keyword-2

Ionospheric plasmas

Keyword-3

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