STEEPENING OF THE BACK FRONT OF A FAST MOVING INHOMOGENEITY IN THE IONOSPHERIC E-REGION

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No theory explains the fact that the reflected radio signal is strongest when the primary radio wave propagates in the direction of the electron drift [*N.Mattin and T.V. Jones, J.Atmos.Terr.Phys.* 1987, 49, 115). It seems that the wave reflects predominantly from the back fronts of ionospheric inhomogeneities. A nonlinear wave equation for a solitary one-dimensional inhomogeneity was obtained. It is similar to the diffusion one and can be written as follows:

$$\left(\partial/\partial t + V_{ph}\,\partial/\partial x\right)\ln n = D(\partial^2/\partial t^2)\ln n$$

where $D = (v_e/\omega_e\omega_i)\left(c_s^2 - V_{ph}^2\right)$ is the effective diffusion coefficient, $V_{ph} = V_{dx}n_0/n$ is the phase velocity, V_{dx} is the electric drift velocity, c_s is the sound velocity, n_o is the undisturbed number density, v_e is electron collision frequency, ω_e and ω_i are the gyrofrequencies of electrons and ions. If the inhomogeneity moves slowly ($V_{ph}<c_s$) the diffusion is positive (D>0), and the inhomogeneity gets wider. A fast moving inhomogeneity ($V_{ph}>c_s$) suffers negative diffusion (D<0). As a result, the inhomogeneity becomes thinner and its density grows.

The velocity of a solitary wave V_{ph} depends on the electron density. When the disturbed density is close to the ambient one ($n \approx n_o$), the wave velocity is approximately equal to that of electrons. If the density increases, the wave velocity becomes smaller. Hence, the center of the inhomogeneity moves slower than the edges, so the back edge steepens, while the frontside becomes smoother and unstable. Besides, several inhomogeneities merge and form a single inhomogeneity after weaker inhomogeneities overtake a stronger one. In stationary regime the ionosphere will be filled with rarely located but strong ($\delta n > n_o$) inhomogeneities with sharp back fronts. A space-averaged level of density fluctuations $\langle \delta n/n_o \rangle$ may be small (2-10%) in accordance with observations [*B.G.Fejer and M.C.Kelley, Rev.Geophys. Space Phys.*, 1980, 18, 401]. The velocity of the strong inhomogeneities V_{ph} is smaller than the electron drift velocity V_{dx}, which is also in agreement with observations [*E.Nielsen and K.Schlegel, J.Geophys.Res.*, 1983, 88, 5745].