Electron density fluctuations in the ionosphere below the turbopause

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Neutral gas motions play a very important role in dynamics of the ionospheric plasma especially below the turbopause level (100-120 km). In particular, neutral gas turbulence can produce electron density irregularities at these altitudes. Because of strong collisional damping at the ionospheric levels, not always theory of plasma instabilities can be used to explain generation of fluctuations in electron density even at high latitudes if the electric field is below the threshold for excitation of the instabilities. In this report we discuss small-scale electron-density fluctuations in the mid-latitude ionosphere resulted from turbulent mixing of the gas. The fluctuation length-scales were restricted to the inertial range of turbulence and were smaller than the local scale of mean plasma-density gradient, which was chosen about 10 km. Sounding rocket in-situ measurements are most suitable for study of these plasma fluctuations. We considered the fluctuation spectra expected from in-situ measurements during rocket experiments and their dependence on rocket trajectories. The consideration was based on an analytic expression for the 3D spectrum of the fluctuations. The derivation of this expression from three-fluid equations is briefly described in the report. The expression gives opportunity to write a formula for evaluation of the intensity of electron-density fluctuations in the given wave-number range. Variability of the 1D spectra expected from the experiments was analysed for fixed parameters of the ionosphere and the neutral turbulence at 95 km altitude when the magnetic dip angle was about 45°. Two set of possible parameters of the parabolic rocket trajectories were chosen: (1) an apogee of 115 km altitude and a distance of 83 km between start and final points; and (2) 125 km and 134 km, respectively. The trajectories were considered for two geomagnetic directions: eastward and northward. It was shown that a systematic difference between the spectra measured during the upleg and downleg portions of rocket trajectories has to exist in the case of their northward direction. This difference takes place in the range of large wave numbers of the fluctuations and is more notable for the second trajectory. Plasma fluctuations in this range are mainly generated through the interaction of quasineutral plasma involved in the turbulent motions of neutral gas with the magnetic field. The expected rms level of the fluctuations was estimated too. The level was about 4% for the irregularity length-scales smaller 400 m and 1.4% for the scales smaller 30 m.