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The influence of electron heating on plasma irregularities in the lower ionosphere

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An important consequence of the interaction between the ionospheric ions and the neutral atmosphere is formation of plasma structures of different scales in the ionosphere. For example, small-scale ionospheric irregularities below the homopause level are generated by the neutral air turbulence. Usually an approximation of isothermality is valid for the lower ionosphere, especially, at middle latitudes. However, the approximation may be broken due to electron heating by powerful radio waves. In the report we consider theoretically reaction of ionospheric irregularities created by the neutral turbulence on the increasing of electron temperature T_e due to the radio wave action. For this aim, expressions for the irregularity spectrum, the mean-square level of the plasma density fluctuations, and the radar backscatter cross-section per unit volume have been obtained. Using the expressions we have calculated the spectral form, the rms fluctuation level, and the cross-section σ for the case of the mid-latitude ionosphere at an altitude near 100 km when the ratio of the electron to ion temperature increased from 1 to 10. The spectrum has corresponded to the inertial range of turbulence, the rms level has been estimated for irregularity length-scales smaller than 500 m, and σ has been evaluated for the diagnostic radar frequencies from 5 to 50 MHz and the vertical direction of antenna beam. It was shown that an increase in T_e produces a decrease in both the fluctuation level and the backscatter cross-section. In our calculations this level reduced from 6.2 to 4.8 %; σ from $1.28 \cdot 10^{-8}$ to $9.06 \cdot 10^{-9}$ m^{-1} at 5 MHz and from $1.25 \cdot 10^{-11}$ to $8.93 \cdot 10^{-12}$ m^{-1} at 50 MHz. The rise in T_e has also resulted in an increase in the spectral slope (for the approximation of spectrum by a power law k^{-p}, the index p took values from 1.62 to 2.34). These changes are explained by a decrease in the cut-off wavenumber in the irregularity spectrum resulted from an increase in the ambipolar diffusivity due to the rise in T_e.