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Radiotomographic observations of corpuscular ionization in the ionosphere

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Along with the antisunward cross-polar convection of the ionospheric plasma and the field-aligned electric currents, the corpuscular fluxes play an important role in the magnetosphere-ionosphere coupling. Being more tightly coupled with the magnetosphere, the subauroral and auroral ionosphere noticeably differs from the midlatitude ionosphere. It experiences much stronger and faster variations in space and time. The particle fluxes and the electric fields of magnetospheric origin penetrate into the ionosphere and substantially affect the production, loss and transport of charged particles. The rate of ionization in the midlatitude ionosphere is controlled almost solely by the X-ray and UV/EUV solar radiation, whereas in high latitudes the fluxes of particles precipitating from the magnetosphere are significant sources of ionization. Moreover, they are probably the single source during the polar night. Typically, the contribution of the magnetospheric corpuscular fluxes into the ionization is small compared to the contribution of electromagnetic radiation; however, during the geomagnetic storms, it may prove significant, especially if these fluxes are sufficiently strong and act in the nighttime when the solar electromagnetic radiation is absent.

The present work is devoted to radio tomographic imaging of the ionospheric effects of particle precipitation using the data from low-orbital navigational satellite systems. The ionospheric radio tomography is actively developed during the past two decades. It provides images of the 2D distribution of electron density in the vertical plane (latitude-altitude cross-sections) (averaged over an interval of 10-15 minutes) for the spatial sector covering several thousand kilometers. The horizontal and vertical resolution of the RT method is 20-30 km and 30-40 km, respectively. In the present work, the particle precipitation events are identified from the particle flux measurements onboard DMSP satellites. We present and discuss the examples illustrating the comparison of the RT images of the ionosphere with the fluxes of ionizing particles measured by DMSP satellites as well as with the auroral oval data and UV emissions.

During the geomagnetic storms, the RT imaging reveal multiple extrema in the distribution of the ionization and the wavelike disturbances with the spatial scales ranging from tens to hundreds kilometers. The spatial scales of the corpuscular precipitation widely vary from few to ten degrees in latitude. The spatial structure of the corpuscular ionization in the RT images rather well agrees with the latitudinal distributions of the precipitating particle fluxes. Generation of the wave disturbances in the ionospheric plasma by the particle precipitation is another remarkable phenomenon. We also consider generation of acoustic gravity waves (AGW) by corpuscular injections.

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