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Ionospheric Structures Detected by Radio Tomography during the Geomagnetic Disturbances

Abstract:
During the geomagnetic disturbances the dynamical regime of the ionosphere strongly changes and ionospheric parameters experience significant variations. In this presentation, we discuss the results of radio tomographic imaging the ionospheric structure with special emphasis on the results from low orbiting tomography (LORT). LORT methods are based on analyzing the radio signals from low-orbiting navigational satellites like the Russian Tsikada/Parus and American Transit. The satellites fly in nearly polar orbits about 1000 km above the Earth and transmit dual frequency signals at 150 and 400 MHz. The records of these signals by the ground based receiving chains provide the input for reconstructing two-dimensional distributions of the ionospheric electron density in the vertical plane above the chain. Due to sufficiently fast satellite velocities (~7.9 km/s), the LORT ionospheric imaging provides practically instantaneous (on the timescale of the studied ionospheric disturbances) snapshots of the ionosphere. Vertical and horizontal resolution of LORT images is 30-40 and 20-30 km, respectively. with the gaps between the neighboring images ranging from half an hour to a few hours depending on the number of the operating satellites. By taking into account the refraction of the sounding rays, one may improve the spatial resolution of LORT up to 10-20 km.

We present the examples of the ionospheric structures that were revealed by LORT in the northwestern Russia and Alaska during the periods of different geomagnetic activity in solar cycles 23 and 24 and verified by the independent ionospheric methods. We observed various wavelike disturbances, isolated spots of the increased or decreased electron density, sharp wall-like density gradients, blobs, and ionospheric troughs with widely varying depths and widths. We present the examples of the ionospheric structures that are probably associated with particle precipitation and present the independent arguments in support of this hypothesis. In order to more accurately locate the positions and trace the dynamics of the ionospheric irregularities, we use the results of high-orbiting radio tomographic imagery (HORT), which analyzes the radio transmissions from the high-orbiting global navigational satellite systems like GPS/GLONASS and provides the time series of 3D RT images of the ionosphere.

The analysis of the LORT and HORT reconstructions makes it possible in many situations to sufficiently accurately investigate the distribution of the ionospheric plasma and to trace its temporal evolution.