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The Electron Density Features Revealed by the GNSS-Based Radio Tomography in the Different Latitudinal and Longitudinal Sectors of the Ionosphere

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The ionospheric radio tomography is an efficient method for electron density imaging in the different geographical regions of the world under different space weather conditions. The input for the satellite-based ionospheric radio tomography is provided by the signals that are transmitted from the navigational satellites and recorded by the chains or networks of ground receivers. The low-orbiting (LO) radio tomography employs the 150/400 MHz radio transmissions from the Earth's orbiters (like the Russian Tsikada/Parus and American Transit) flying at a height of $\sim$1000 km above the Earth in the nearly polar orbits. The phases of the signals from a moving satellite which are recorded by the chains of ground receivers oriented along the satellite path form the families of linear integrals of electron density along the satellite-receiver rays that are used as the input data for LORT. The LO tomographic inversion of these data by phase difference method yields the 2D distributions of the ionospheric plasma in the vertical plane containing the receiving chain and the satellite path. LORT provides vertical resolution of 20-30 km and horizontal resolution of 30-40 km. The high-orbiting (HO) radio tomography employs the radio transmissions from the GPS/GLONASS satellites and enables 4D imaging of the ionosphere (3 spatial coordinates and time). HORT has a much wider spatial coverage (almost worldwide) and provides continuous time series of the reconstructions. However, the spatial resolution of HORT is lower ($\sim$100 km horizontally with a time step 60-20 min). In the regions with dense receiving networks (Europe, USA, Alaska, Japan), the resolution can be increased to 30-50 km with a time interval of 30-10 min.

To date, the extensive RT data collected from the existing RT chains and networks enable a thorough analysis of both the regular and sporadic ionospheric features which are observed systematically or appear spontaneously, whose origin is fairly well understood or requires a dedicated study. We present the examples of the both types of the structures. We show a collection of different ionospheric structures under different space weather conditions: the ionization troughs, with their widely varying shapes, depths, positions, and internal distributions of plasma; isolated spots of the increased or decreased electron density, sharp wall-like density gradients, blobs, wavelike disturbances on different spatiotemporal scales etc. We demonstrate the series of the local isolated irregularities which are observed during both the quiet and disturbed days. We show the examples of the ionospheric plasma distributions strikingly varying during the geomagnetic storms. Some of the RT data are compared to the independent observations by the ionosondes. We also present the examples of RT images comparison with the UV spectroscopy data.