Geophysical Research Abstracts, Vol. 8, 09035, 2006
SRef-ID: 1607-7962/gra/EGU06-A-09035

Radio tomographic imaging of the ionosphere during strong geomagnetic storms in 2003-2005.

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It is well known that during strong solar-geomagnetic disturbances the ionosphere is highly structured and displays a rapid dynamics. Each geomagnetic storm shows a series of general features similar to another events and has its own unique pattern of specific manifestations, therefore the study of electron density distribution in the ionospheric plasma during stormy periods excites particular scientific interest. Results of radio tomographic imaging of the ionospheric structure during strong geomagnetic disturbances of 2003-2005 are present in the paper. Systems of low-orbital and high-orbital satellite radio tomography were used in the work. Images of low-orbital tomography are reconstructed from ground measurements of 150/400 MHz transmissions from Russian navigational satellites at Russian radio tomographic chain of Polar Geophysical Institute and Moscow State University. The chain is located along the geomagnetic meridian Svalbard-Kola Peninsula-Karelia-Moscow and covers a wide latitudinal range from the polar cap to midlatitudes. High-orbital radio tomographic imaging is based on ground measurements of GPS signals at a set of European receivers covering a region of 30N- 80N latitudes and (-10)E - 45E longitudes. High-orbital tomographic reconstruction was carried out using methods of space-time radio tomography developed by the authors. The analysis revealed a series of specific features in the ionospheric structure during periods of strong geomagnetic disturbances of 2003-2005. During the storm of 30-31 October, 2003, a strongly enhanced ionization was observed in the nighttime over the Western Europe; the electron density distribution within the region of enhanced ionization was extremely structured and changed rapidly. The appearance of the spot of enhanced ionization can be caused by

both the specificity of ionospheric plasma convection from the daytime ionosphere in the Western hemisphere across the polar cap to the night sector in the Eastern hemisphere, and by high-energy particle precipitation into the region under study. Diverse wavelike structures, traveling ionospheric disturbances, various manifestations of acoustic-gravity waves were detected by radio tomographic methods during intervals of strong geomagnetic disturbances. Wave effects of particle precipitation are analyzed, and ionospheric plasma fluxes are calculated. During highly disturbed periods, multi-extremal "spotted" structures and sharp wall-like gradients of electron concentration in the north were apparent in the reconstructions. Thin (with transverse dimensions of a few dozen kilometers) structures of increased electron density elongated in the direction of geomagnetic field lines spanning a few hundreds of kilometers in altitude were revealed. Complex structure of ionospheric trough with a sloped polar edge and its equatorial shift, and exfoliation of the trough were detected. Radio tomographic reconstructions of the ionospheric structure over Western Europe are compared with corresponding ionospheric images over Alaska calculated from NWRA experimental data. The work was supported by RFBR grants No.04-05-64671 and 05-05-65145.