The Observations of Ionospheric Fluctuations at Midlatitudes During November 2004 Magnetic Storm

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Abstract

The midlatitude fluctuations are rather weakly relative to high latitude ones. The most intensive midlatitude TEC fluctuations are related with irregularities generated during strong geomagnetic storms. It was analyzed TEC fluctuations activity for quiet November 6, 2004 and disturbed days November 8-9. At November 9 the intensity of TEC fluctuations was higher 0.25 TEC/min near 20 UT at midlatitude permanent GPS stations. At the same time ionospheric irregularities registered by midlatitude incoherent scatter radar. The storm time midlatitude TEC fluctuations are phenomena associated with strong ionospheric gradients near the main ionospheric trough when it shifted to midlatitudes.

As known the most intensive phase fluctuations are observed at the high latitude and equatorial ionosphere. The strong phase fluctuations can influence on the performance of the different space communication radio systems. The midlatitude fluctuations are rather weakly relative to high latitude ones. But in the same time the midlatitude fluctuations can be caused by cycle sleep L1/L2 GPS signals, complicated the phase ambiguity resolution and coincidently can influence on a precision of navigation parameters determination. The low frequency fluctuations can be caused directly due to electron density changes along transionospheric radio ray path or the total electron content (TEC) time changes.

The most intensive TEC fluctuations are related with irregularities observed during strong geomagnetic storms. In past solar activity cycle during month of November 2004 was one of the most disturbed period. The sequence of geomagnetic storms took place at November 7-11. It was analised TEC fluctuations activity for quiet day on November 6, 2004 and most disturbed days on November 8 - 9. Diring quiet conditions the distribution of the TEC fluctuations are similar to regular winter variations with well-defined day-time maximum. At stormtime the strong TEC fluctuations were observed in evening, night and morning hours. During November 9 the intensity of TEC fluctuations was higher 0.25 TEC/min near 20 UT at midlatitude permanent GPS stations.

The effects were coincided with the strong GPS signal phase fluctuations at midlatitudes. As known the plasma irregularities can be existed with strong and sharp gradient of electron density. Main ionospheric troughs can be a source of ionospheric irregularities. During storms the main ionosphere trough can move to low latitude [7]. To clarify the location of trough during a November 2004 storm it was created TEC maps over Europe with high spatial and temporal resolution were constructed on the base of using multi-stations measurements provided by 150 GPS stations located in European region. At storm time the trough in TEC was founded at latitudes of 50°-56° N, and strong ionospheric gradients was observed at polar wall on 53°-54° N latitudes.

Variations of the ionosphere spatial configuration during this magnetic storm were also verified by midlatitude Kharkov incoherent scatter radar data. The anomalous signals, coherent backscatter from plasma irregularities at slant distances of 1,000 – 1,190 km, were observed by incoherent scatter radar measurements at night time of November 9 and day time of November 10. The measured Doppler velocity of registered plasma structures was reached the value of 500 m/s. These irregularities are generated close to the southern boundary of the auroral oval during strong geomagnetic storm and have large spatial scale (from hundred to thousand of kilometres). It is important, that these day-time events (coherent backscatters and considerable ROT variations) are occurred under the minimal value of Dst = -289 nT. All these effects were caused by dynamics of the auroral oval and midlatitudinal ionospheric trough.

Ionosphere irregularities are generated close to the southern boundary of the auroral oval during strong geomagnetic storm, the auroral oval can be extended up to midlatitudes. The storm time midlatitude TEC fluctuations is phenomena associated with irregularities excited strong ionospheric gradients near the main ionospheric trough when it moved equatorwards. These ionospheric plasma structures have caused the phase and amplitude scintillation of transionospheric VHF and UHF radio signals, particularly at lower radio frequencies.

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