Determination of the phase fronts vertical slopes of midlatitude MSTIDs by GNSS satellites

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The paper deals with the problems of the mid-latitude MSTIDs detection with low intensity of electron density, $\Delta N/N$, using the GNSS transionospheric sounding method. To collect data, a dense network of GNSS receivers located on the territory of the Russian Federation (more than 150 pcs.) has been used. On the basis of the obtained experimental data, the selectivity of the method of transionospheric sounding towards the MSTIDs, depending on the satellite-receiver line-of-sight orientation, is shown. Thus, the use of two-dimensional maps of TEC perturbations allowed to simultaneously observe the MSTIDs signatures using the satellites R03, G18 (which have similar geometric conditions of observation) and not observe them using the satellite R18. For this spatial layout of the MSTIDs, the maximum amplitudes of the TEC perturbations were observed at the elevation angles of the satellite-receiver line-of-sight being approximately 50 degrees, and a sharp drop in amplitude was observed at elevation angles of more than 70 degrees. The summation of the phase shift from the neighbouring zones of enhanced and depleted electron density becomes critical for the MSTIDs detection, and a band structure in two-dimensional TEC maps disappear. Using the data of GNSS receiver’s network and ideas about the spatial shape of MSTID (obtained by the researches using incoherent scatter radar), a schematic model explaining the reason for the preferred aspect angles in GNSS transionospheric sounding was constructed. The proposed model made it possible to create a method for determining the vertical inclination of MSTIDs according to GNSS data.