Characteristics of travelling ionospheric disturbances observed by Kharkiv and Millstone Hill radars

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Travelling ionospheric disturbances (TIDs) represent a key dynamic process of energy transfer in horizontal and vertical directions, and one of the important sources of ionospheric variability. Acoustic gravity waves (AGWs) play a key role in coupling of different atmospheric regions through momentum and energy transfer, and TIDs are thought to be the manifestations of AGWs at ionospheric heights. The incoherent scatter method is well suited for TID studies as it enables TIDs detection in multiple ionospheric parameters (electron density, ion and electron temperatures, plasma velocity), and thus provides critical information needed to examine different hypothesis about association of TIDs with their sources.
In 2016, two coordinated measuring campaigns have been held near the vernal equinox and summer solstice using Kharkiv (49.6 N, 36.4 E) and Millstone Hill (42.6 N, 288.5 E) IS radars. The goal of joint observations was to detect TIDs and estimate their characteristics during these geophysical periods as well as to find similarities and differences in results obtained at various longitudes.
During the vernal equinox, the prevailing TIDs are observed near the sunrise and sunset solar terminators by both Kharkiv and Millstone Hill. The TID periods generally fall within the ranges of 40 –80 mins and 20 –40 mins. Relative TID amplitudes over Kharkiv are usually 3–15% and 2–10% of background electron density and plasma temperatures, respectively. At Millstone Hill, these values are greater and reach 10–35% for TIDs in electron density and 5–15% for TIDs in electron and ion temperatures. Larger values of TIDs amplitudes over Millstone Hill may indicate the longitudinal differences.
As for summer solstice, the overall wave activity was weaker. Despite the absence of solar terminators over Kharkiv at the heights above 250 km, TIDs occurred near the periods of terminator passage at lower heights. These results confirm the hypothesis that observed TIDs are caused by AGWs generated in the middle and lower atmosphere and propagating upward. The TIDs over Millstone Hill are mainly observed around solar terminator periods, similarly to the vernal equinox. Prevailing periods for TIDs over Kharkiv and Millstone Hill are of 40 –80 and 20 –40 mins. The values of relative amplitudes over Kharkiv are 8–20% and 3–8% of background electron density and plasma temperatures, respectively. These values are similar for Millstone Hill.
Conducting systematic long-term observations of wave processes in the ionosphere using all facilities available at Kharkiv and Millstone Hill observatories will enable to reveal longitudinal variability in TID characteristics, provide a better understanding of the mechanisms of TID generation and propagation, and improve regional and global ionospheric models.

Keywords: traveling ionospheric disturbances, gravity waves

