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GNSS network observations of medium-scale traveling ionospheric disturbances

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Recently, GNSS (Glbal Navigation satellite system) receiver is widely used to measure total electron content (TEC). Using densely spaced GPS receivers in Japan, Northern America, Europe, Alaska, and New Zealand, we have investigated two-dimensional maps of TEC perturbations with a high spatial resolution to reveal the statistical characteristics of medium-scale traveling ionospheric disturbances (MSTIDs). We found that MSTIDs can be categorized into three groups: daytime, nighttime, and terminator MSTIDs. Daytime MSTIDs frequently occur in winter and tend to propagate equatorward and eastward in both northern and southern hemispheres. We speculate that daytime MSTIDs are caused by atmospheric gravity waves in the thermosphere. Nighttime MSTIDs frequently occur in December and June solstices and propagate southwestward in the northern hemisphere and northwestward in the southern hemisphere. This propagation direction supports the notion that polarization electric fields could play an important role in generating nighttime MSTIDs. Terminator MSTIDs frequently occur in summer and propagate eastward or north-northwestward. Comparing the MSTID occurrence rates at different longitudinal sectors, we have found that occurrence rate of the nighttime MSTIDs is high around December solstice at European longitudinal sector and around June solstice at Japan and American longitudinal sectors. From comparison with sporadic E activity, we can speculate that activity Es layer in summer hemisphere control occurrence of the nighttime MSTIDs in both northern and southern hemispheres through E and F region electrodynamical coupling. Longitudinal variation of the nighttime MSTIDs could be attributed to that of the sporadic E activity.

Keywords: GNSS, ionosphere, GPS, MSTID, ionospheric disturbance