Ionospheric irregularities observed with GPS scintillation monitors in the mid-latitude region

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Severe gigahertz scintillations have been observed during geomagnetic storm periods at mid-latitudes although radio wave scintillations are rather moderate and less frequent than in auroral and equatorial regions. We develop a GPS scintillation monitoring system based on a scintillation monitor of Cornel University to observe L-band scintillations over Japan from the end of 2002 through 2004. During this period three scintillation events were observed under the geomagnetically disturbed conditions. We choose typical two events from the tree. The first one was on November 4 2003, and the second one was on July 27 2004. We examined these events using Total Electron Content data from GPS Earth Observation NETwork (GEONET) of Geographical Survey Institute and International GPS Service's global network. Two characteristics of mid-latitudes GPS scintillations were clarified by these observations. One of the features is that there are at least two types of ionospheric structures of 100 km scale causing scintillations at mid-latitudes during geomagnetic storm times. One type of them drifts from low the latitude region to the high latitude region associated with poleward expansion of the equatorial anomalies. The other type has wave like structures and propagates from the high latitude regions to the low latitude regions. The other feature is that GPS scintillations were generated on the top of steep slope of electron density that has large westward gradient. This indicates that the ExB instability was generated by the eastward neutral wind. Then ionospheric irregularities caused scintillations detected by ground-based GPS receivers. This study revealed that the 100m-scale ionospheric irregularities at mid-latitudes that cause the GPS scintillation are generated inside of the 100 km-scale ionospheric structures that have steep westward density gradients during geomagnetic storm periods.