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Mid-latitude field-aligned ionospheric irregularities and its impact on GPS

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Strong scintillations of amplitude and phase of transionospheric radio signals occur due to signal scattering on intensive small scale irregularities. Scintillation can have an adverse effect on GPS signals and cause a GPS receiver to lose lock on the signal in some extreme cases. Although the plasma bubble is a common phenomenon and it has been studied for years, precise observed data of ionospheric scintillations and loss of lock to GPS receivers due to plasma bubble at mid-latitude are still limited. In most papers there are no data regarding the space geometry of field-aligned irregularities. For the first time, we propose a GPS method to detect mid-latitude field-aligned irregularities (FAIs) by line-of-sight angular scanning regarding the local magnetic field vector. We show that total GPS L2 phase slips over Japan during the recovery phase of the 12 February, 2000 geomagnetic storm (Ma and Maruyama, 2006, doi:10.1029/2006GL027512) were caused by GPS signal scattering on FAIs for the line-of-sight of both aligned to magnetic field line (the field of aligned scattering, FALS), and across it or at large angles to magnetic field line (the field of across scattering, FACS). Our FALS results confirm well with data of investigation of magnetic field orientation control of GPS occultation observations of equatorial scintillation during detailed LEO CHAMP, SAC-C and PICOSat measurements, realized by Anderson and Strauss (2005, doi:10.1029/2005GL023781). The role of large-angle scattering almost along the normal to the magnetic field line in GPS scintillation is determined by attenuation of the irregularity anisotropy factor as compared with the other factors. The work was supported by the Fundamental Research Program of RAS Physical Science Department (Project IV.12 “Modern problems of radiophysics”).