磁気嵐中に発生したサブストームに伴う GPS シンチレーション

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GPS scintillation during storm-time substorms

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We report simultaneous observations of ionospheric density irregularities during substorms by using an all-sky color digital camera (ACDC) and a GPS ionospheric scintillation and TEC monitor (GISTM) in Tromsø (69.60N, 19.20E), Norway. Successive substorms occurred during a relatively large magnetic storm on January 22-23, 2012 in the European sector and the ACDC in Tromsø captured their temporal evolutions. Amplitude scintillations as monitored by the S_4 index from the GISTM increased very slightly (maximum S_4 was 0.2) only in a few minutes immediatelly after the expansion phase onsets which implies that the Fresnel diffraction was not a significant source of scintillations at the L-band during the substorms. In contrast, phase scintillations as indexed by σ_φ were much more prominent when discrete auroral arcs appeared on the GPS signal path. In particular, phase scintillations significantly enhanced in a few minutes immediately after the expansion phase onsets. During this time interval, bright discrete aurora forms covered the entire sky and moved very dynamically, which implies that auroral structures of a few tens to a few hundreds of kilometer scale dominated the electron density distribution in the early stage of the expansion phase. Such an inhomogeneous electron density structure possibly produced significant changes in the refractive index and resulted in the enhancement of phase scintillations. The current observations suggest that the cause of phase scintillations during substorms is mainly refractive rather than diffractive; thus, relatively larger scale density structures (a few tens to a few hundreds of kilometer), directly created by individual auroral arcs, are the primary source of phase scintillations during auroral substorms.