オーロラ爆発に伴う電離圏イレギュラリティ: 光学・GPS 受信機・短波レーダー同時観測

細川 敬祐 [1]; 大塚 雄一 [2]; 小川 泰信 [3]; 津川 卓也 [4]
[1] 電通大; [2] 名大 STE 研; [3] 極地研; [4] 情報通信研究機構

Ionospheric irregularities observed by optics, GPS scintillation and HF radar during substorm

Keisuke Hosokawa[1]; Yuichi Otsuka[2]; Yasunobu Ogawa[3]; Takuya Tsugawa[4]
[1] UEC; [2] STEL, Nagoya Univ.; [3] NIPR; [4] NICT

We report simultaneous observations of ionospheric density irregularities during a substorm by using an all-sky color digital camera (ACDC) and a GPS ionospheric scintillation and TEC monitor (GISTM) at Tromsoe (69.60N, 19.20E), Norway, together with the SuperDARN radar at Hankasalmi (62.32N, 26.61E) in Finland. A small substorm occurred at around 22 UT on November 19, 2009 in the northern Scandinavia and the ACDC captured its temporal evolution from the beginning of the growth phase to the end of the recovery phase. Amplitude scintillation as monitored by the S4 index from the GISTM did not increase during all the substorm phases which implies that the Fresnel diffraction is not a significant source of scintillation at the L-band during substorms. In contrast, phase scintillation as indexed by sigma_phi occurred when discrete auroral arcs appeared on the GPS signal path. In particular, phase scintillation significantly enhanced for a few minutes immediately after the expansion phase onset. During this period, bright discrete auroral forms covered the entire sky and moved very dynamically. At the same time, the SuperDARN radar observed spatially non-uniform distribution of the Doppler velocity over Tromsoe and detected an increase of the spectral width. These characteristic variations of the radar parameters imply that auroral structures of a few to a few tens of kilometer scale dominated the electron density distribution in the early stage of the expansion phase. Such an inhomogeneous electron density structure possibly produced a significant change of the refractive index and resulted in the enhancement of phase scintillation. The current observations suggest that the cause of phase scintillation during substorms is mainly refractive rather than diffractive; thus, relatively larger scale density structures (a few to a few tens of kilometer), directly created by individual auroral arcs, are the primary source of phase scintillation during auroral substorms. Even in the absence of amplitude scintillation, the simultaneously operated SuperDARN radar detected radar backscatter echoes from F region altitudes. That is, the L-band amplitude scintillation and HF radar backscatter do not always coexist at least during the current substorm interval. Such a non-coexistence of radar echoes and amplitude scintillation is probably because the amplitude of the irregularities causing diffractive scintillation at the L-band is smaller than that at lower frequencies; thus, such irregularities could not produce diffractive scintillation of detectable level.