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Nightside High-Latitude Phase and Amplitude Scintillation during a Substorm using 1-second Scintillation Indices

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We examined evolution of Global Positioning System (GPS) scintillation during a substorm in the nightside high latitude ionosphere, using 1-second phase and amplitude scintillation indices from the Canadian High Arctic Ionospheric Network (CHAIN) network. The traditional 1-minute scintillation indices showed that the phase scintillation was dominant, while the amplitude scintillation was weak. However, the 1-second amplitude scintillation occurred more often in association with major auroral structures (polar cap arc, growth phase arc, onset arc, poleward expanding arc, poleward boundary intensification, and diffuse aurora) that were detected by the THEMIS all-sky imagers (ASIs). The 1-minute index missed much of the amplitude fluctuations because they only lasted ~10 seconds near a local peak or at the gradients of the auroral structures. The 1-second phase scintillation was concurrent with the amplitude scintillation but was much weaker than the 1-minute phase scintillation. The frequency spectral analysis showed that the spectral power above ~1 Hz was diffractive and below ~1 Hz was refractive. We suggest that the amplitude scintillation in the high-latitude ionosphere is much more common than previously considered, and that a short time window of the order of 1 second should be used to detect the scintillation. The 1-minute phase scintillation index is largely influenced by refractive effects due to total electron content (TEC) variations, and the spectral power below ~1 Hz should be removed to identify diffractive scintillation.