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Comparative Multi-instrument Analyses of Auroral L-band Scintillations

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Ionospheric scintillation, the fluctuation of a radio signal amplitude and/or phase due to scattering in the ionized layer of the upper atmosphere, is a significant space weather concern, particularly for communications and satellite-based navigation systems. Scintillation occurs due to plasma density structures in the ionosphere, so its occurrence and physical causes differ by magnetic zone. In the high-latitude auroral zones magnetospheric coupling in the form of electrodynamic forcing as well as particle precipitation may cause structuring with different properties such as scale size; altitude, whether E layer (altitude less than 150 km) or F layer (above 150 km); anisotropy; and drift velocity.

In order to compare and contrast the scintillations caused by E layer versus F layer irregularities, we have collected observations of scintillation and sought to categorize the scintillation events observed. Previous work surveyed multiple years of Global Positioning System (GPS) L-band scintillations from the scintillation auroral GPS array (SAGA) [1] in the context of a collocated incoherent scatter radar (ISR) at Poker Flat Research Range, Alaska [2]. Based on the ISR, the GPS receivers are sensitive to both E layer and F layer auroral irregularities.

In this work we use collocated keograms and optical all-sky images of the red (630.0 nm), green (557.7 nm), and blue line (428.7 nm) auroral emissions to hypothesize which events might be due to E-layer irregularities versus F-layer irregularities based on the ratio of emissions and associated characteristic energy, independently of the ISR. We compare the "E versus F" layer hypotheses based on all-sky images to those using the ISR, for the subset of events for which both data sets are available, which, in the case of the camera, requires nighttime cloud-free conditions and for scintillation to have occurred on a GPS line-of-sight near magnetic zenith. We extend the SAGA scintillation survey database to additional years and analyze statistics of occurrence.

References

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