PFISR GPS tracking mode for researching high-latitude ionospheric electron density gradients associated with GPS scintillation

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Ionospheric behavior in the high-latitudes can significantly impact Ultra High Frequency (UHF) signals in the 300 MHz to 3 GHz band, resulting in degradation of Global Positioning System (GPS) position solutions and satellite communications interruptions. To address these operational concerns, a need arises to identify and understand the ionospheric structure that leads to disturbed conditions in the Arctic. These structures include electron density enhancements that exist along the path of the GPS signal in both the E and F regions of the auroral ionosphere. The primary sources of these enhancements are convection of plasma through the auroral zone and local enhancements due to auroral activity.

High-latitude ionospheric structures are known to change on the order of seconds or less, can be decameters to kilometers in scale, and elongate across magnetic field lines at auroral latitudes. Nominal operations at Poker Flat Incoherent Scatter Radar (PFISR) give temporal resolution on the order of minutes, and range resolution on the order of tens of kilometers, while specialized GPS receivers available for ionospheric sensing have a 100Hz observation sampling rate. One of these, the Connected Autonomous Space Environment Sensor (CASES) from Atmospheric & Space Technology Research Associates (ASTRA), is used for this study. We have developed a new GPS scintillation tracking mode for PFISR to address open scientific questions regarding temporal and spatial electron density gradients associated with ionospheric enhancements: what are the structures causing the greatest scintillation, and where and when do they occur? During this presentation, the radar mode will be described, a number of experimental campaigns will be analyzed, and results and lessons learned will be presented.