Detection of small-scale plasma density irregularities with e-POP RRI

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The Enhanced Polar Outflow Probe (e-POP) Radio Receiver Instrument (RRI) measures naturally and artificially generated radio emissions over a frequency range of 10 Hz to 18 MHz. At HF, over 100 conjunctions have been conducted between e-POP RRI and the Super Dual Auroral Radar Network (SuperDARN) at Saskatoon and Rankin Inlet. RRI's 62.5 kHz sampling rate (over a bandwith of 31.25 kHz) and crossed-dipole antenna configuration make it an ideal tool for polarimetry experiments with SuperDARN systems. For example, the mode splitting and differential mode delay of SuperDARN's pulses have been verified with RRI (G. W. Perry et al., Radio Sci., submitted, 2016).

We present the first results of the detection of small-scale plasma density irregularities, using RRI's polarimetry measurements obtained during conjunctions with SuperDARN radars. The irregularities are detected by using RRI to measure the spatial variation in the Faraday rotation of SuperDARN's radar pulses. Variations in the Faraday rotation of the pulses are a function of variations in the plasma density along their propagation path through the ionosphere. This technique has been modeled in preparation for the e-POP mission (R. G. Gillies et al., J. Geophys. Res. Space Physics, doi: 10.1029/2011JA017457, 2012). Faraday rotation variations of less than 1000°/s for small-scale irregularities with magnitudes of the order of 10% of the background ionosphere and scale-sizes of tens of kilometers were predicted. We will discuss our results and compare them with the modeled predictions, and explore the technique's limitations. We will also discuss validating and calibrating the technique using measurements from the Resolute Bay Incoherent Scatter Radars (RISR-N and RISR-C), and e-POP Imaging and Rapid-Scanning Ion Mass Spectrometer (IRM).