Simulation of ISR Data and Application to Spatial Sampling of the Ionosphere

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New phased array incoherent scatter radars such as the AMISR systems are allowing unprecedented views into the ionosphere. These systems enable researchers to create experiments with a large but limited number of beams to explore the ionosphere and outer atmosphere. Still there are many questions relating to how well these systems can image a highly dynamic environment such as the high latitude ionosphere. Phenomena such as polar plasma patches, particle precipitation events, and sub-auroral polarization streams can produced highly ephemeral ISR targets, characterized by extreme density gradients and attendant variations in SNR. As yet, there seems to be no optimal methodology for sampling the physical space with an electronically steerable radar.

In order to tackle this problem we will simulate ISR data by taking a discretized set of plasma parameters from a three-dimensional field. From these plasma parameters spectra are created using known formula for ion line spectrum. This simulator creates I/Q-level ISR data by sending all white Gaussian noise through filters that are derived from the ion line spectrum. Further signal processing is done to add spatial ambiguity inherent in the radar operation such as finite beams widths. Simple methods of parameter estimation and fitting will be done to project our measurements back to the plasma parameter space.

In order to demonstrate the simulator we will study a set of cases that show structure similar to what is seen in the high latitude ionosphere. The instances chosen will simulate phenomena such as high density gradients. This methodology will give an idea as to the resolving capability of electronically steerable ISR systems and allow new methods to invert the data to be proposed.