The Impact of Solar and Magnetospheric Conditions on High-Latitude Irregularity Spatial-Scales as Observed Using Advanced Radar Techniques

L. V. Goodwin and G. W. Perry

Email: lindsay.v.goodwin@njit.edu

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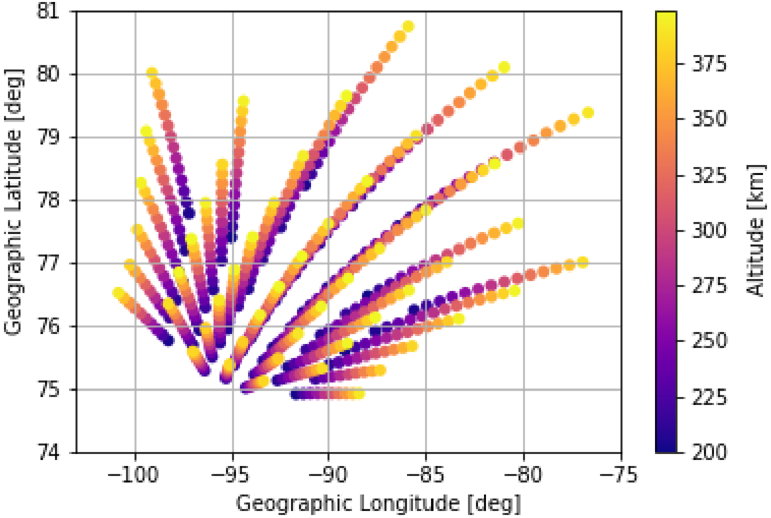
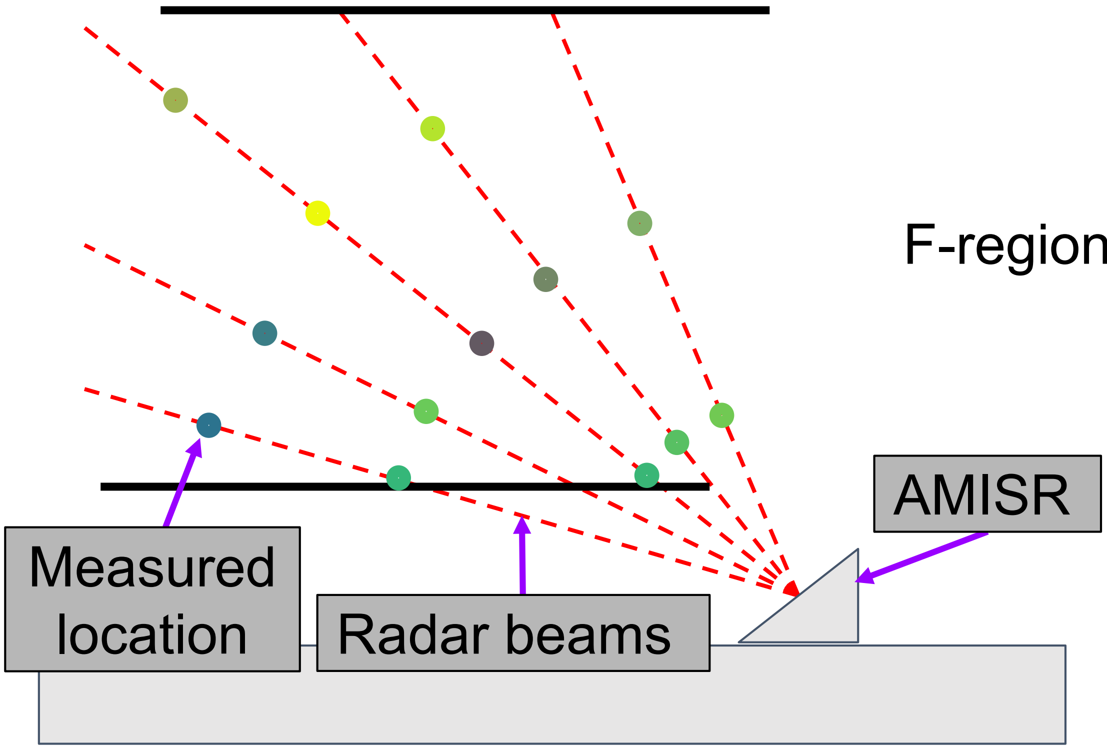
Advanced Modular Incoherent Scatter Radars (AMISRs) can examine multiple directions nearly simultaneously.



We measure a variety of field-aligned structures with an ISR, each with its own unique history.

Since diffusion is the dominant transport mechanism along magnetic field lines in the F-region ionosphere, we can artificially improve the spatial resolution if we resolve the vertical profile.



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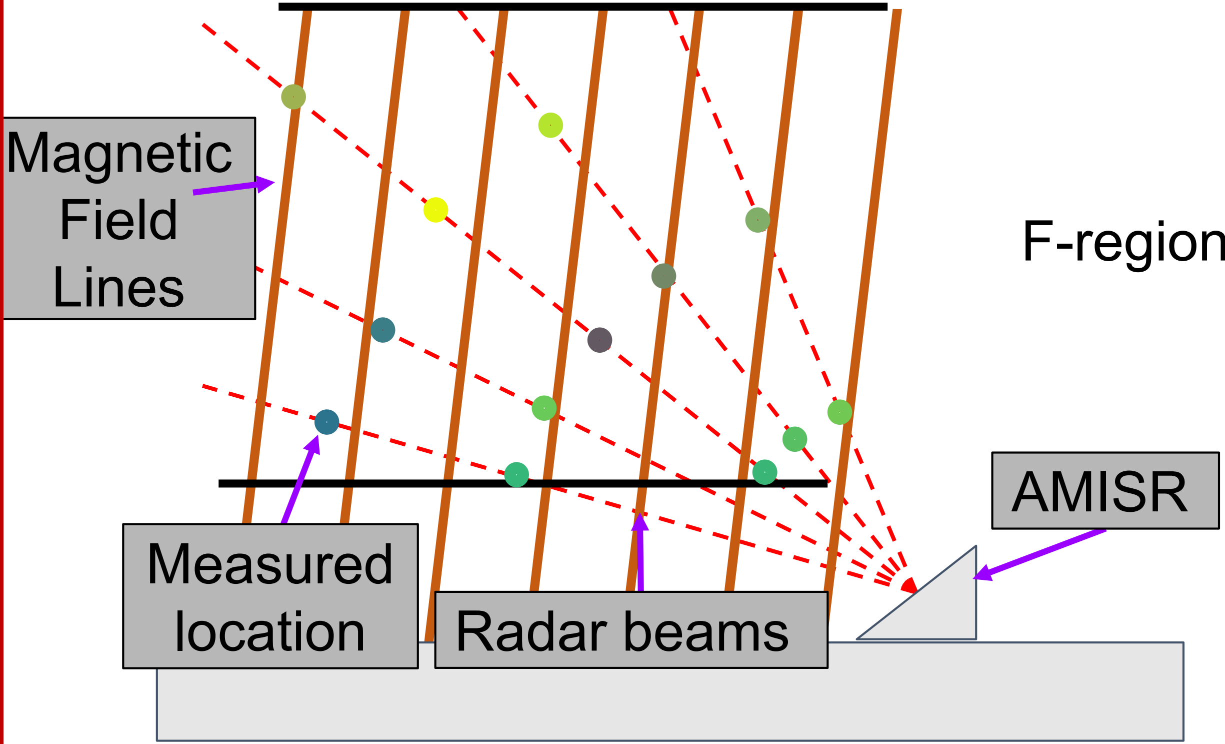

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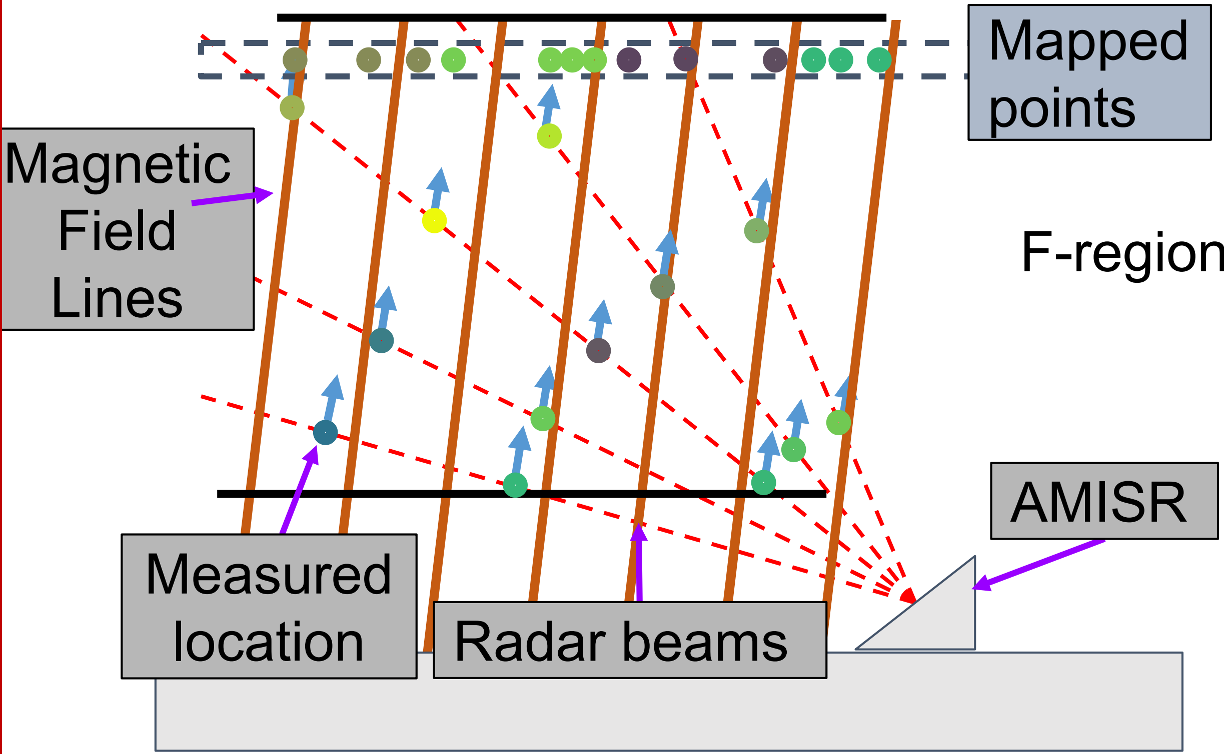
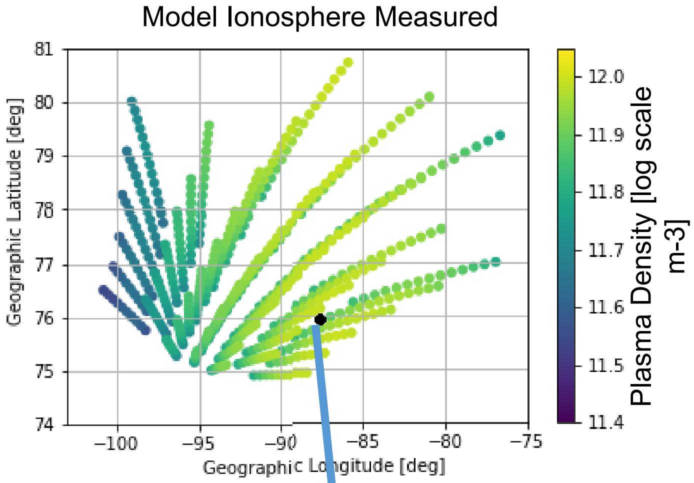
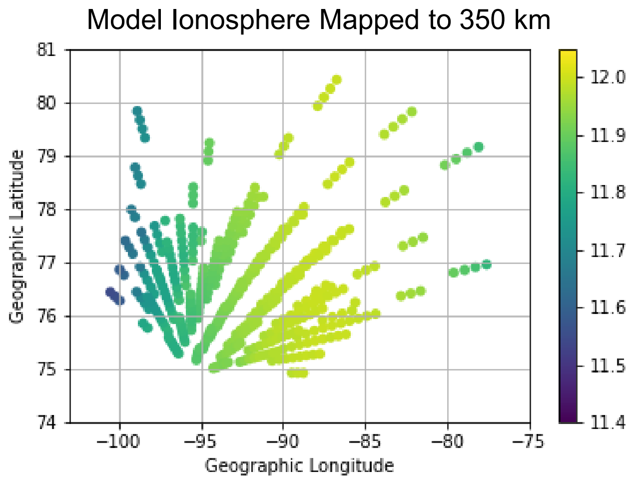
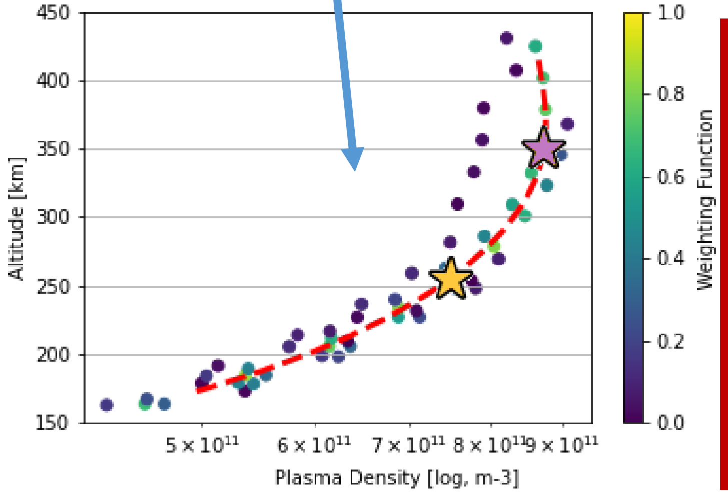


Plasma density structuring

Sun-earth coupling through ionospheric E-fields and plasma





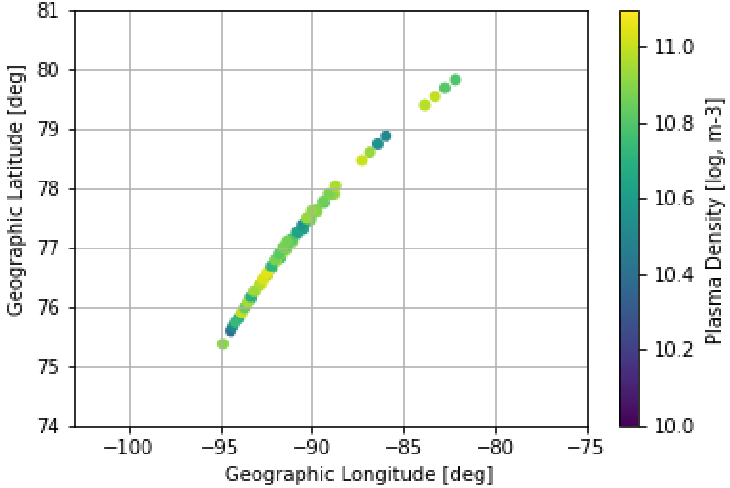


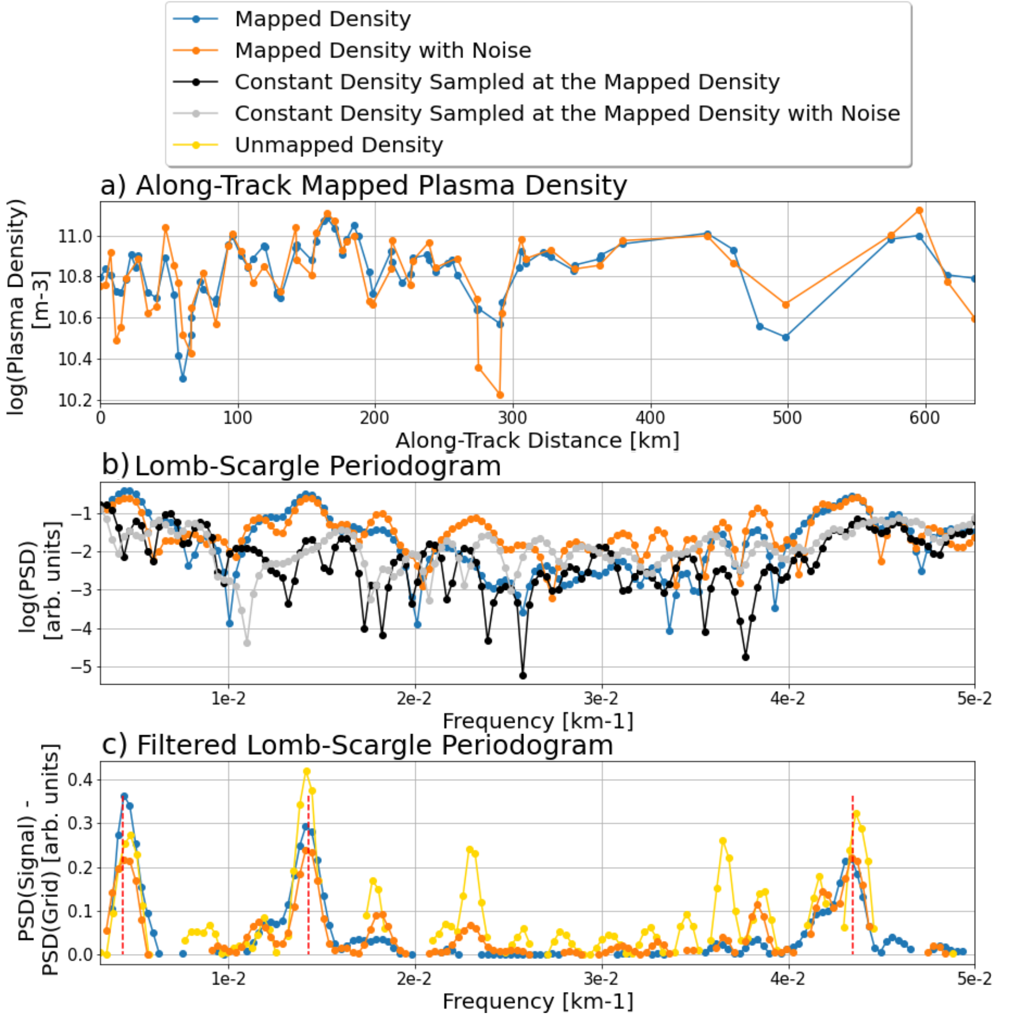
For every point between 200 km and 400 km, we take the nearby points (points within 50 km when mapped along magnetic field lines to 350 km) and resolve the plasma density profile of a given flux tube.

This method is simple and reasonably accurate, and does not rely on the Chapman equation.

By applying a Lomb-Scargle periodogram to the mapped plasma density, we can resolve the input frequencies (1/23 km^{-1}, 1/70 km^{-1}, and 1/230 km^{-1}).

Peaks associated with sampling an irregular grid are removed.





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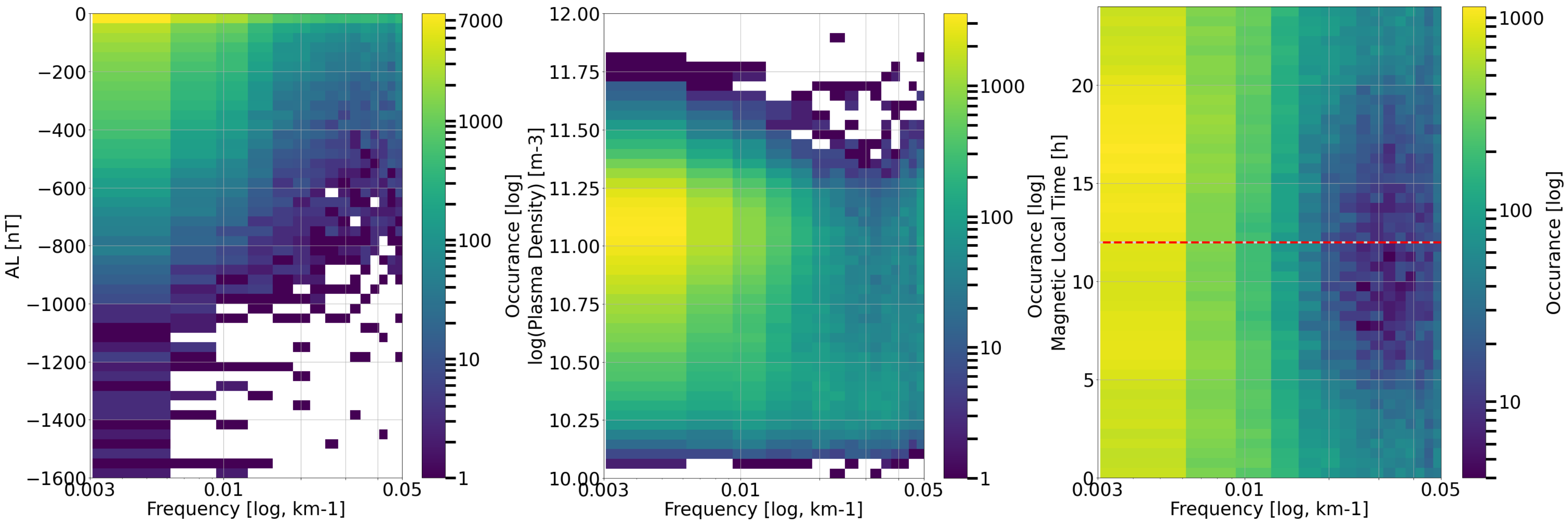

Between 2016 and 2018, a 52 beam imaginglp mode ran intermittently on RISR-N for approximately 4600 h.

Summary

- Using AMISR observations and flexible mapping techniques, it is possible to resolve high-resolution measurements of plasma density at a given altitude.
- This technique does not require the Chapman equation or quantifying plasma production and loss.
- This technique can be used to characterize density structures in the polar cap, which is important because models do not fully capture the structuring here, nor do they account for transient events.
- Large-scale structures (>100km) will be a “dominant” frequency under a variety of conditions
- Small-scale structures (<50km) become a “dominant” frequency during periods of quiet geomagnetic activity, at low densities, and from dusk to dawn (with some seasonal variation)

Future work

- Examine/correlate spectra with solar parameters and events
- Examine radio wave propagation data

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Thank you