Searching for Traveling Ionospheric Disturbances with the Poker Flat ISR

ISR School 2020: Group 4

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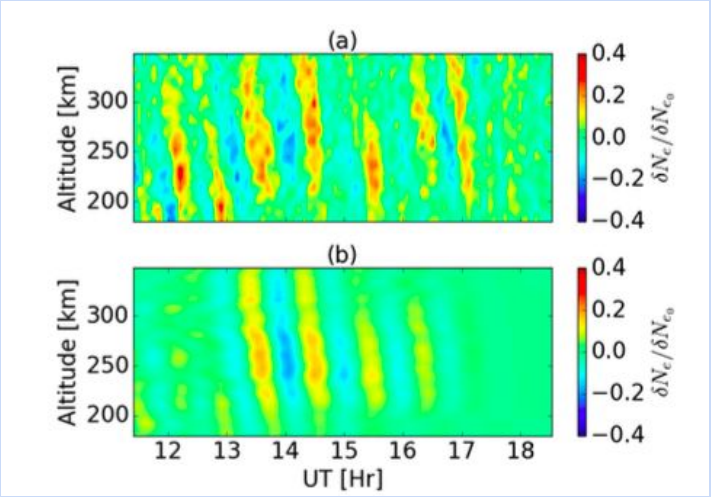
Outline

- Background on Traveling Ionospheric Disturbances.
- Atmosphere and Magnetic Conditions.
- PFISR and the Selected Mode.
- Data Processing Methods.
- Test on a Known MSTID.
- Other ISR detectors (Resolute Bay) Measurements.
- Results.
- Conclusions.
- Limitations.

Mid-Scale Traveling Ionospheric Disturbances (MSTIDs)

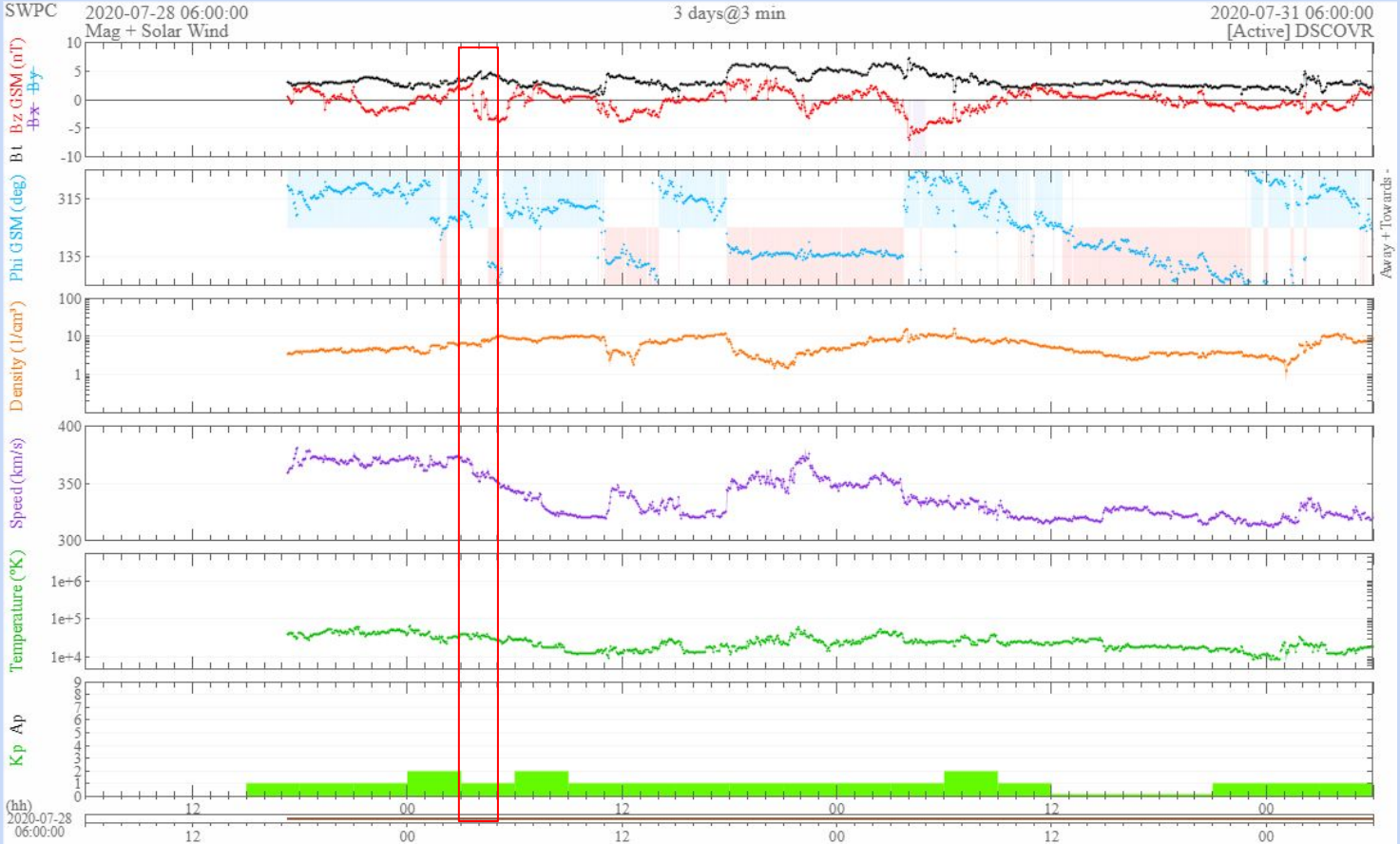
- Travelling ionospheric disturbances are plasma density fluctuations that propagate through the ionosphere.
- Observed on the dayside with PFISR during most times of year.
- Period less than 1 hour.
- Horizontal wavelengths range from 100-1000 km.



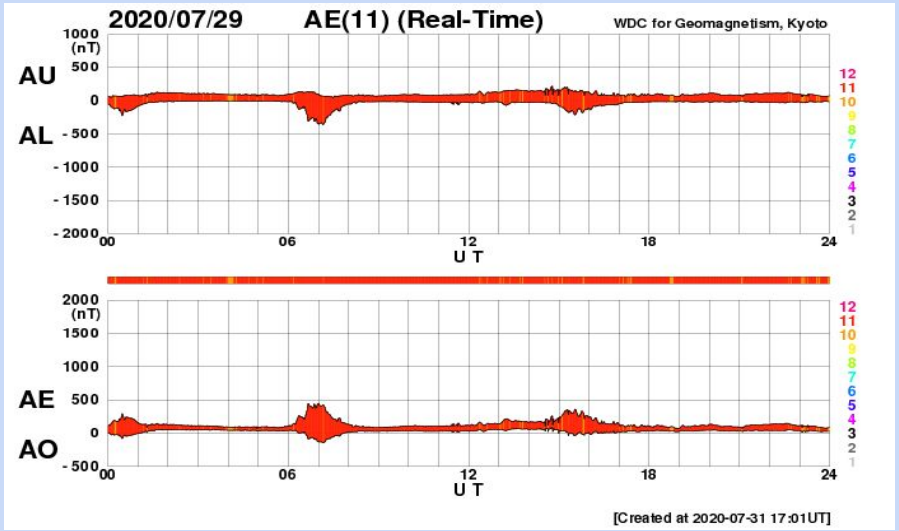
Negale et al. 2018

Atmospheric and Magnetic Conditions

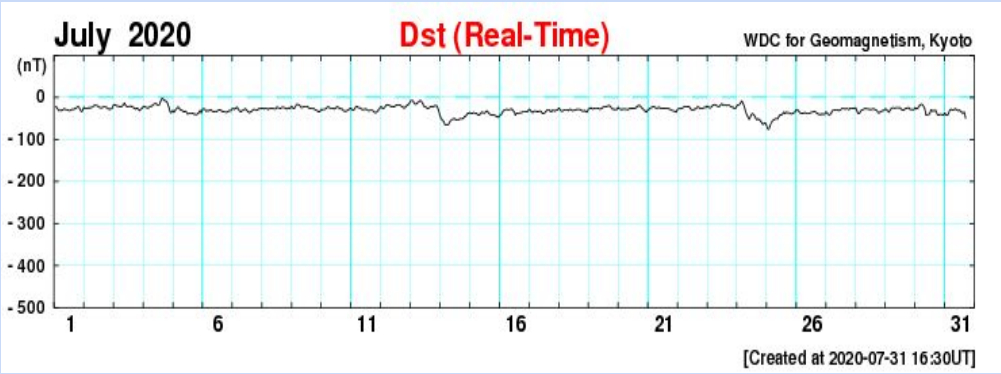
July 29, 2020, 3:00 to 5:00 UT highlighted in red box



Atmospheric and Magnetic Conditions

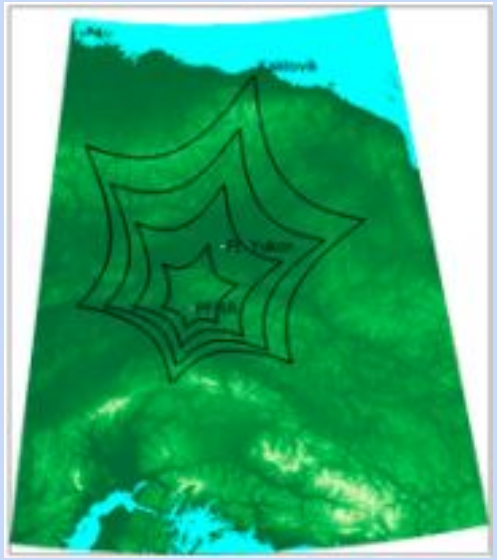


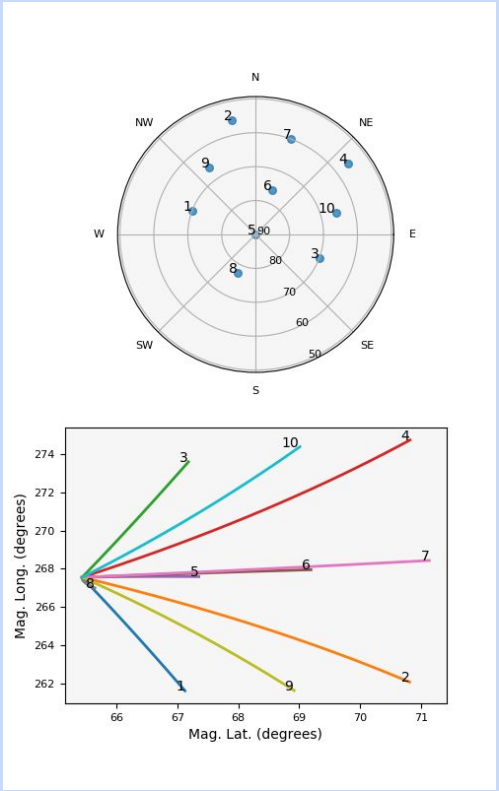
Quiet geomagnetic conditions



The Poker Flat ISR

- Phased array
- Northern, in the auroral oval (65° N, 147° W)
- 10 beams used, with one toward magnetic north and one vertical beam
- Optimized for electric field and ionospheric parameter measurements, following Nicolls & Heinselman 2007.
- F region focused
- 480 μs pulses





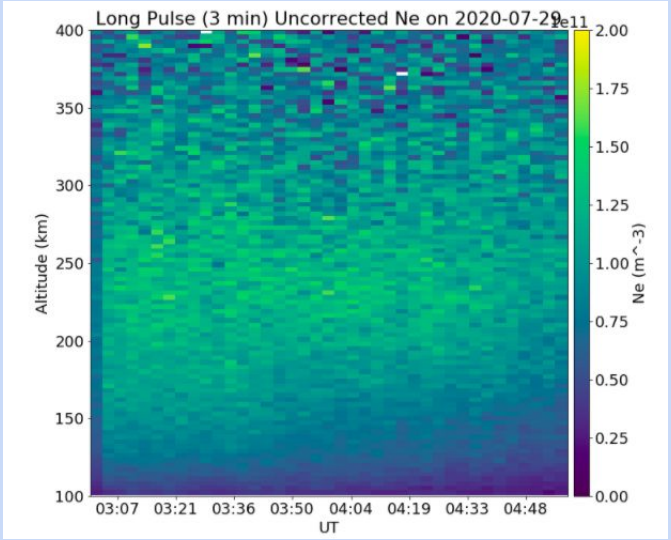
Data Processing Method

- Smoothed and subtracted background by computing a running averaging for each altitude.
- Relative density perturbations estimated by computing the following equation from Negale et al. 2018.

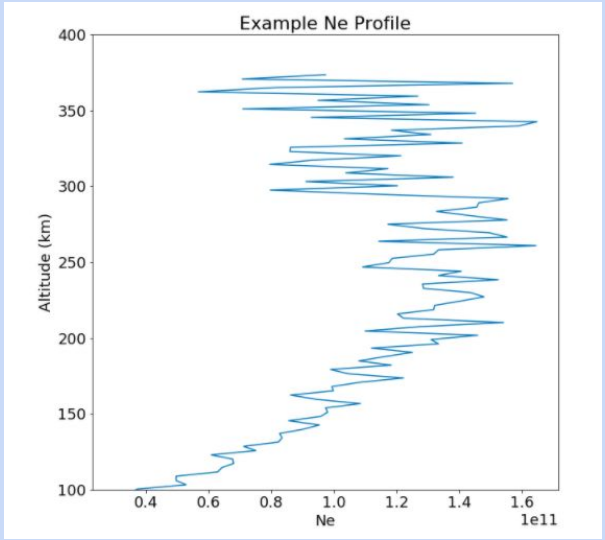
$$\frac{\delta N_e}{N_{e_0}} = \frac{N_e - N_{e_0}}{N_{e_0}}$$

- In order to know if the signal is geophysical we calculated the percent error for electron density.

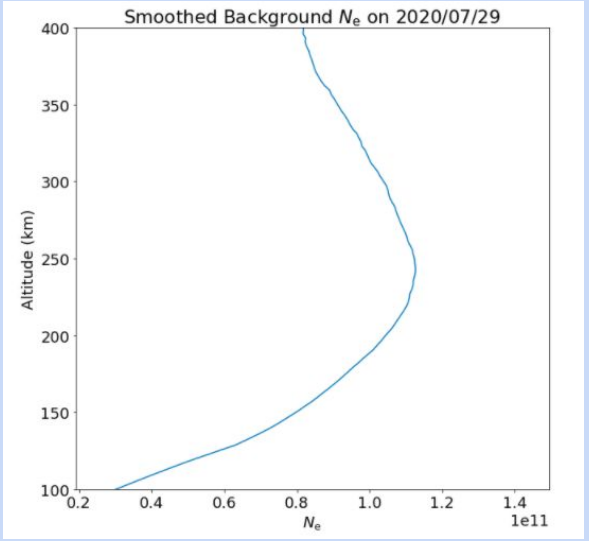
Data Processing Method



Original Data (3 min. integration)

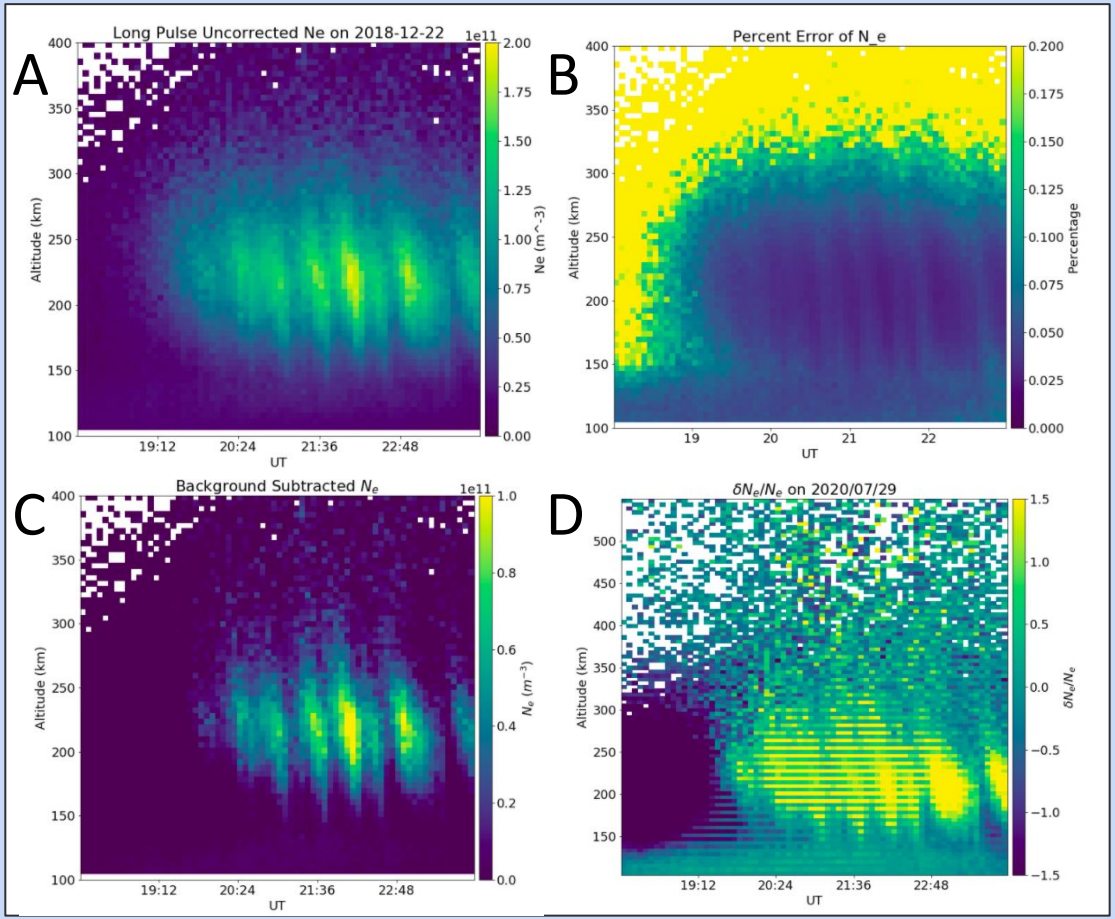


Density Profile Example



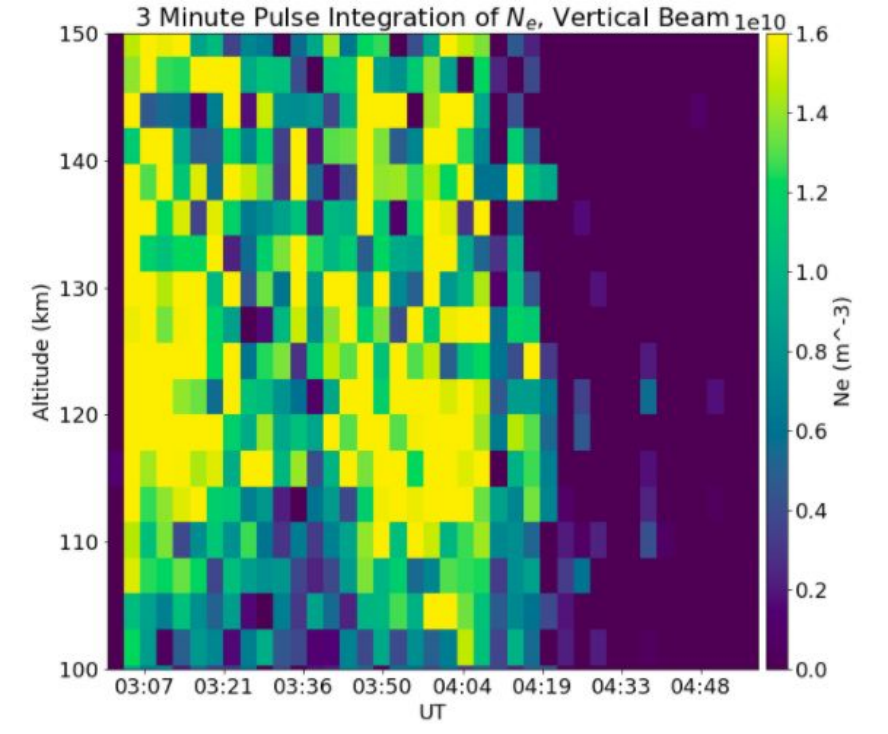
Smoothed background (Running average)

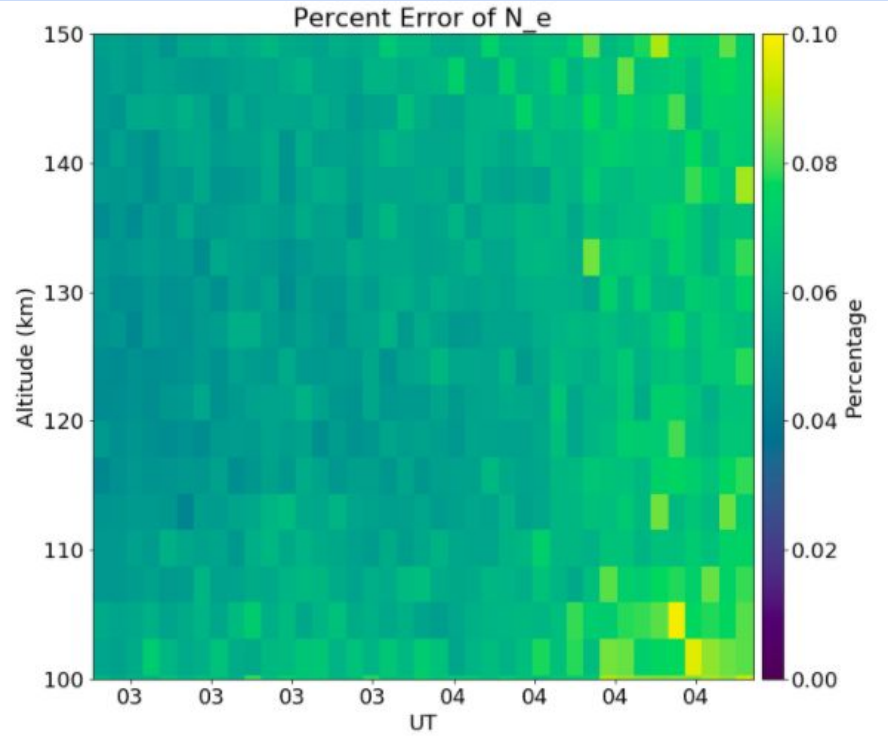
Background Subtraction on known MSTID



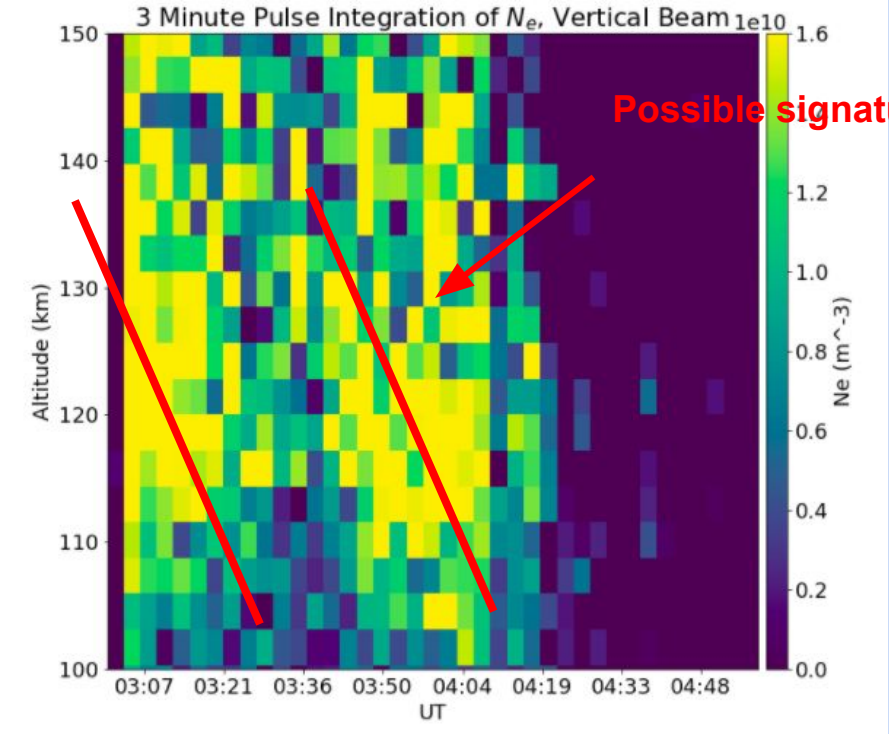
A. Original Signal with 3 min. Integration
B. Percent uncertainty in measurements (σ (Ne)/Ne).
C. Background subtracted signal
D. Density perturbations (δ (Ne)/Ne).

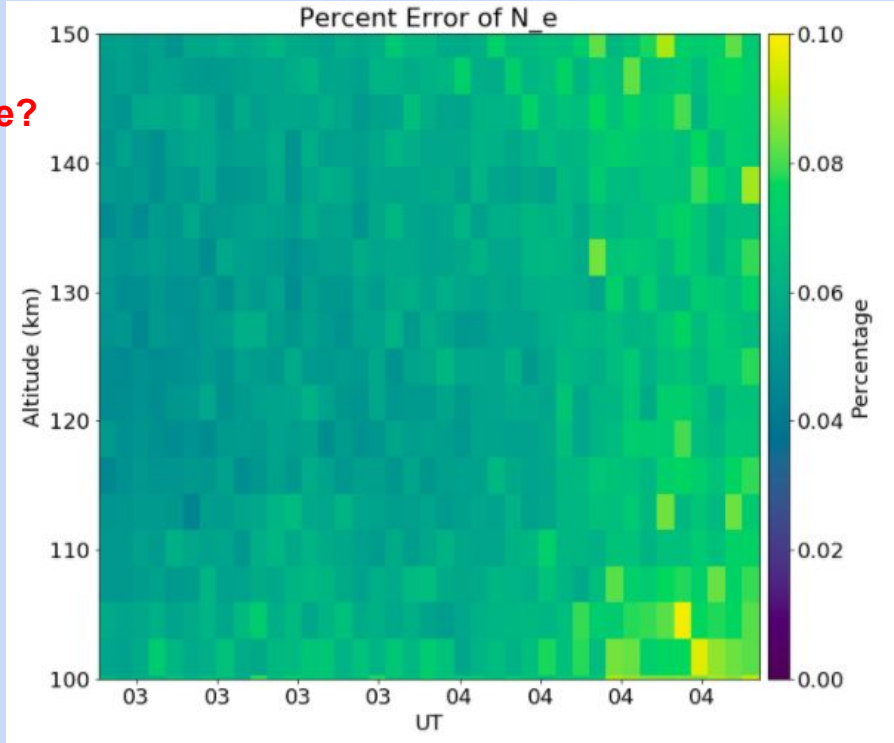
Initial Results



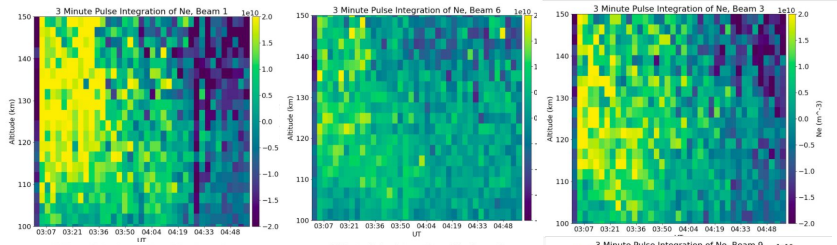


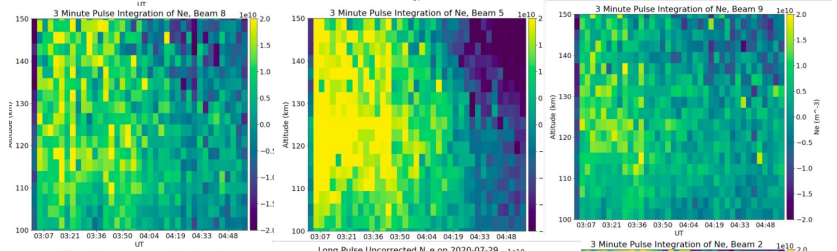
Initial Results

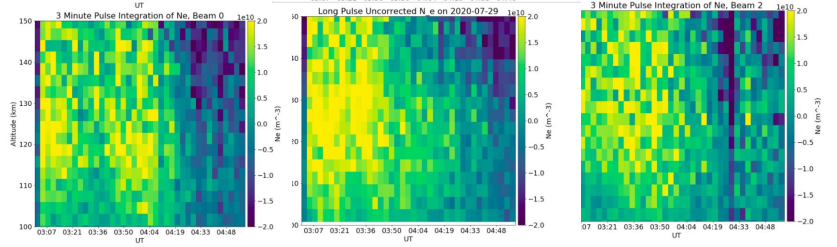




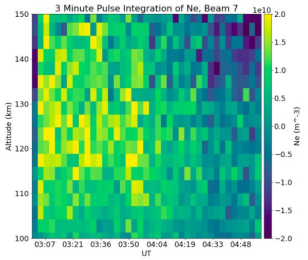
Processed Signal in 10 Beams

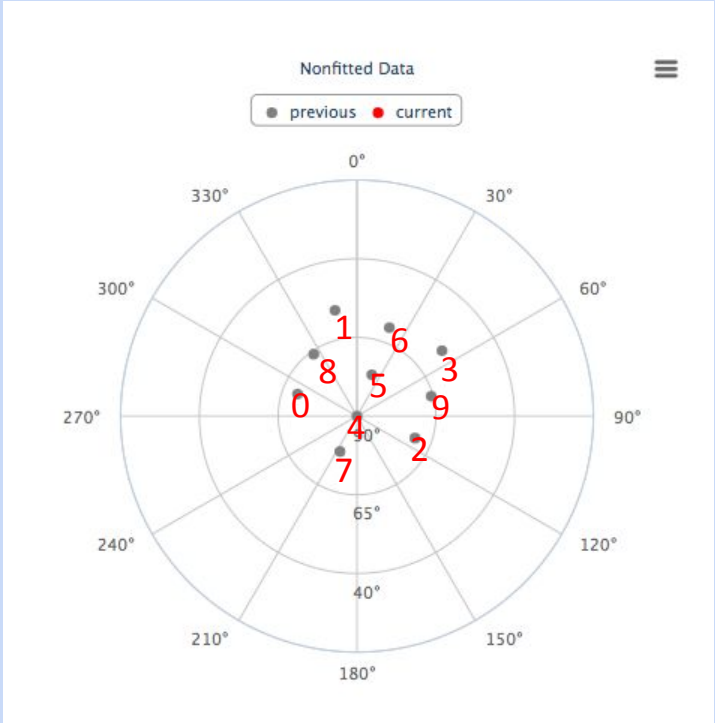


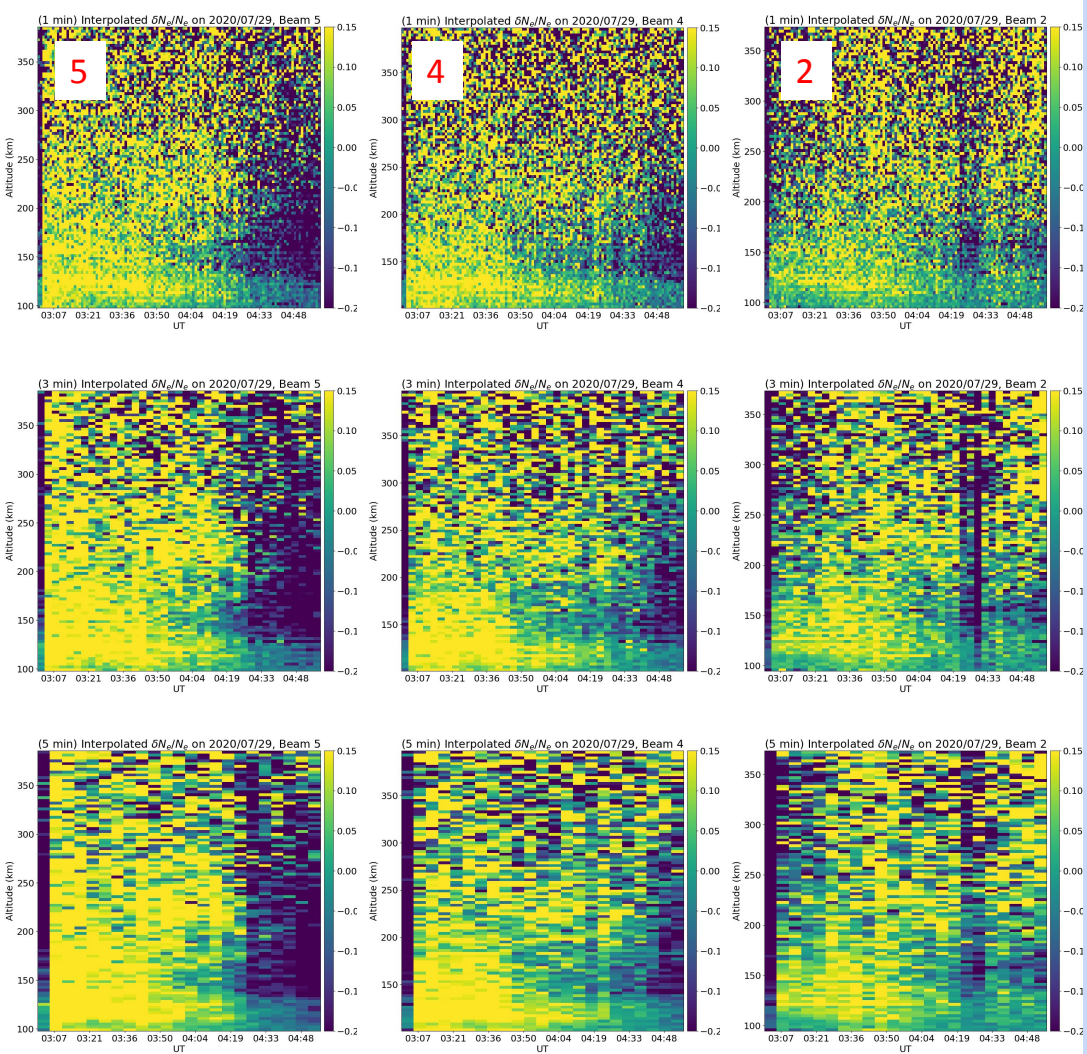




63149.0 -69.5 70.0
63251.0 -11.73 55.6
63317.0 110.5 70.0
63413.0 52.73 55.69
64016.0 14.04 90.0
64037.0 20.5 76.0
64061.0 20.5 60.0
64157.0 -154.3 77.5
64964.0 -34.69 66.0
65066.0 75.03 65.56



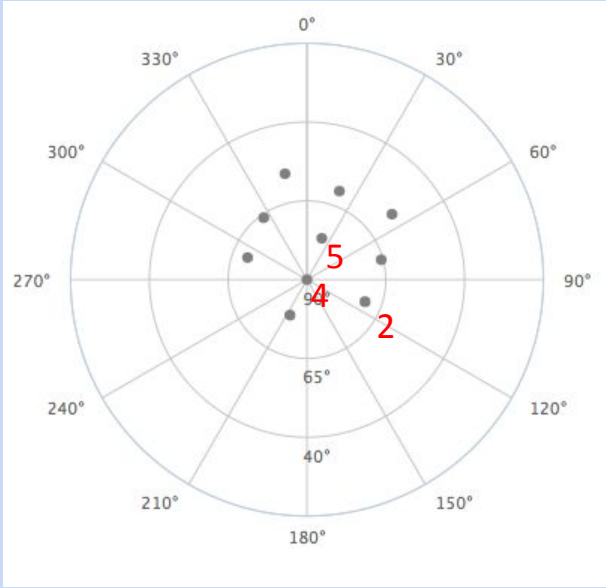




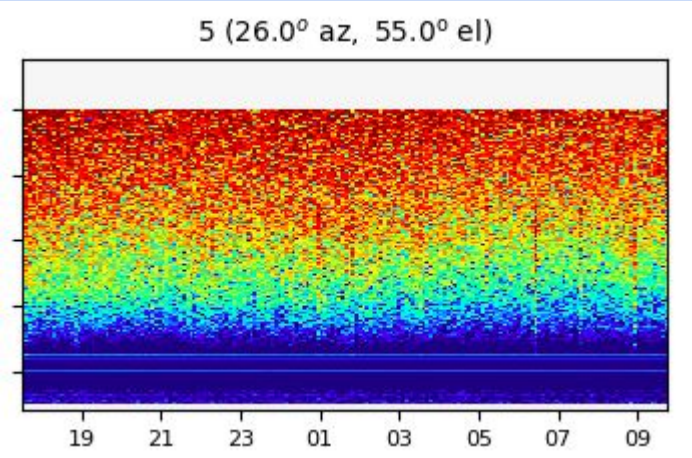
1 Minute Int.

3 Minute Int.

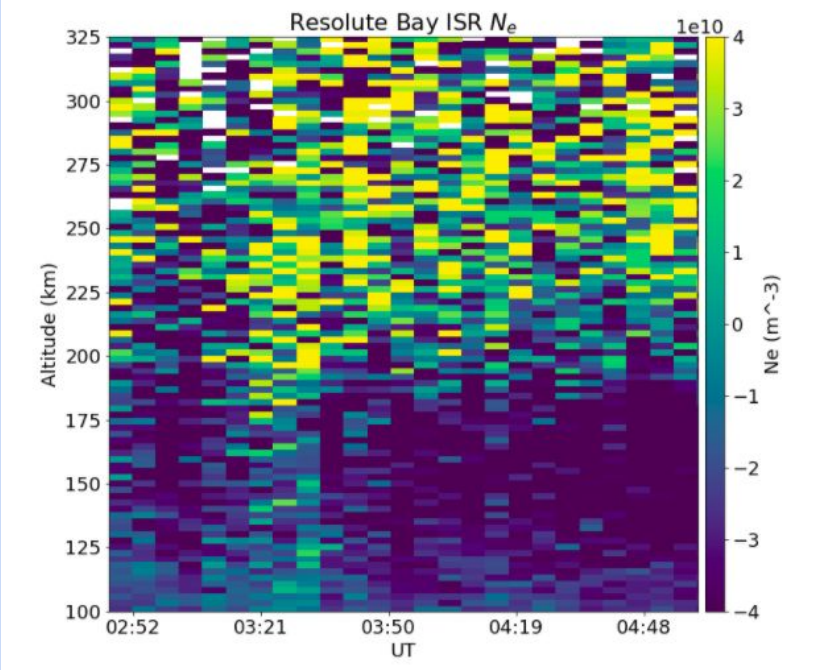
5 Minute Int.



Resolute Bay ISR Measurements on 7/29/20



- Possible electron precipitation in RISR in a few beams.
- Similar signals throughout the day.



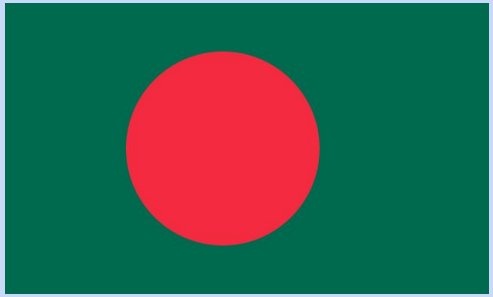
Conclusions

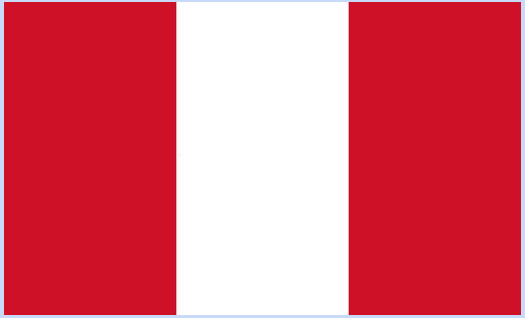
- We detected a structure that propagates eastward from 5 → 4 → 2, but we don't have enough evidence to claim that we detected a MSTIDs.
- Based on error measurements and the data processing on a known MSTID, we can infer that the signal is geophysical.
- Our results showed that in order to detect MSTIDs a more rigorous approach must be taken.

Limitations

- The signal was quite noisy, limiting our ability to conclude a MSTIDs observation.
- Our background calculation is not suitable to filter high frequency density perturbations. Negale et al. 2018, suggested a low-pass filter approach.

THANKS





Questions?