Observations of the Ionospheric Response during Geomagnetic Disturbed Conditions

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Outline

1. Overview of our campaign;
2. Observation mode;
3. Typical storm time conditions (St Patrick's Day 2015);
4. Solar wind and PFISR;
5. MHO electron density;
6. Comparison - Arecibo & PFISR;
7. Error Analysis

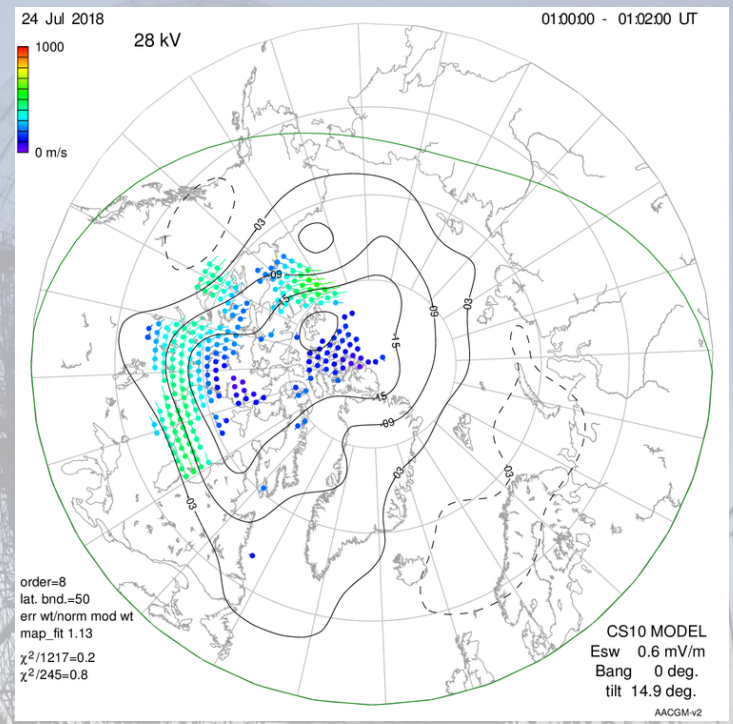

Figure: SuperDarn.

Overview of the Campaign

Proposed:

"(...)investigate the spatial gradient in electron density and electron temperature during geomagnetic disturbed conditions.(...)"

1 - Date: 07/24/2018 from 1-3 UT;

2 - Maximum Kp of 4;

3 - Instruments: MISA and Zenith;

4 - Supporting instruments: PFISR, Arecibo, JRO, SuperDarn...

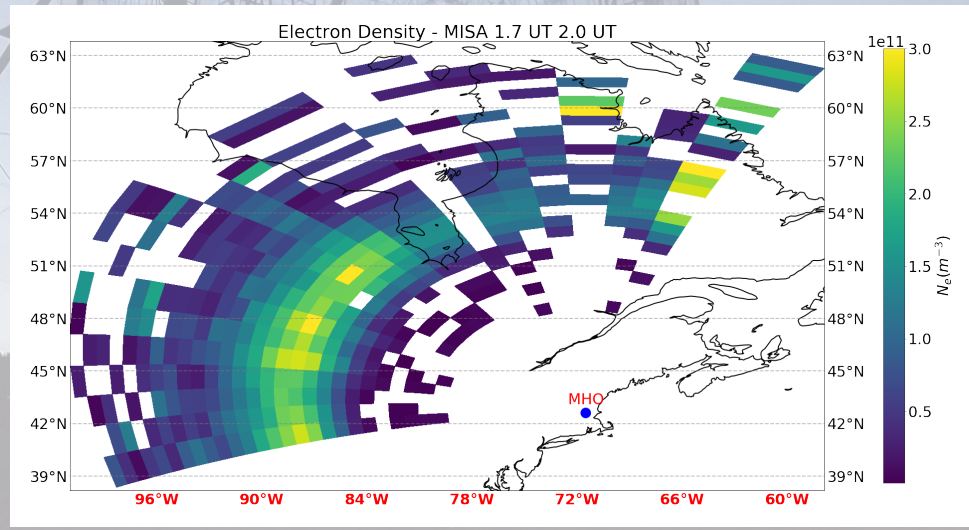

Figure: Observation mode.

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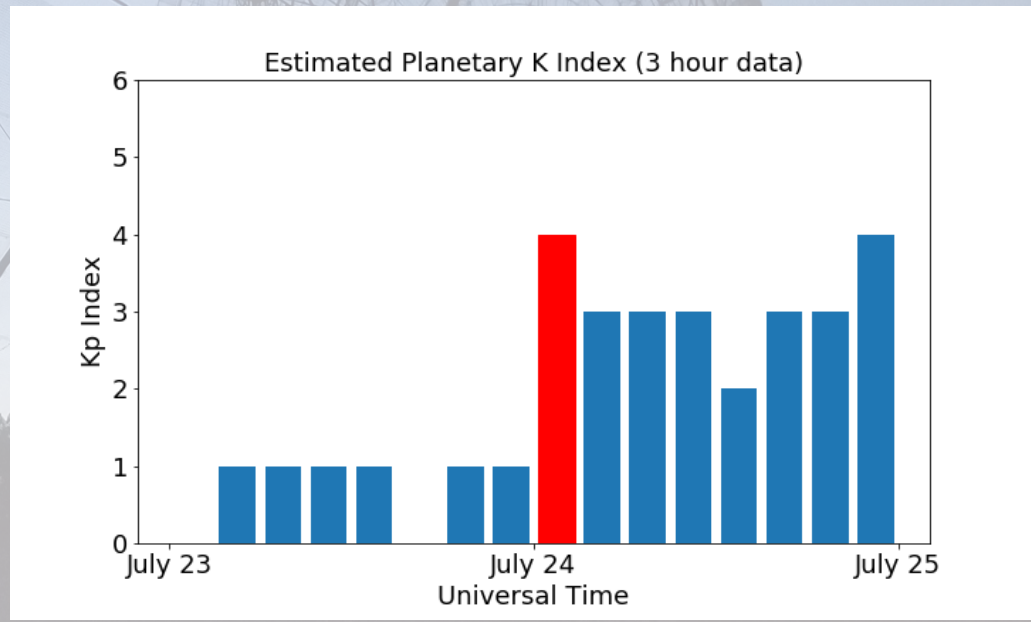


Figure: Kp index.

Observation Mode

Experiment Type A: Wide Field Scanning

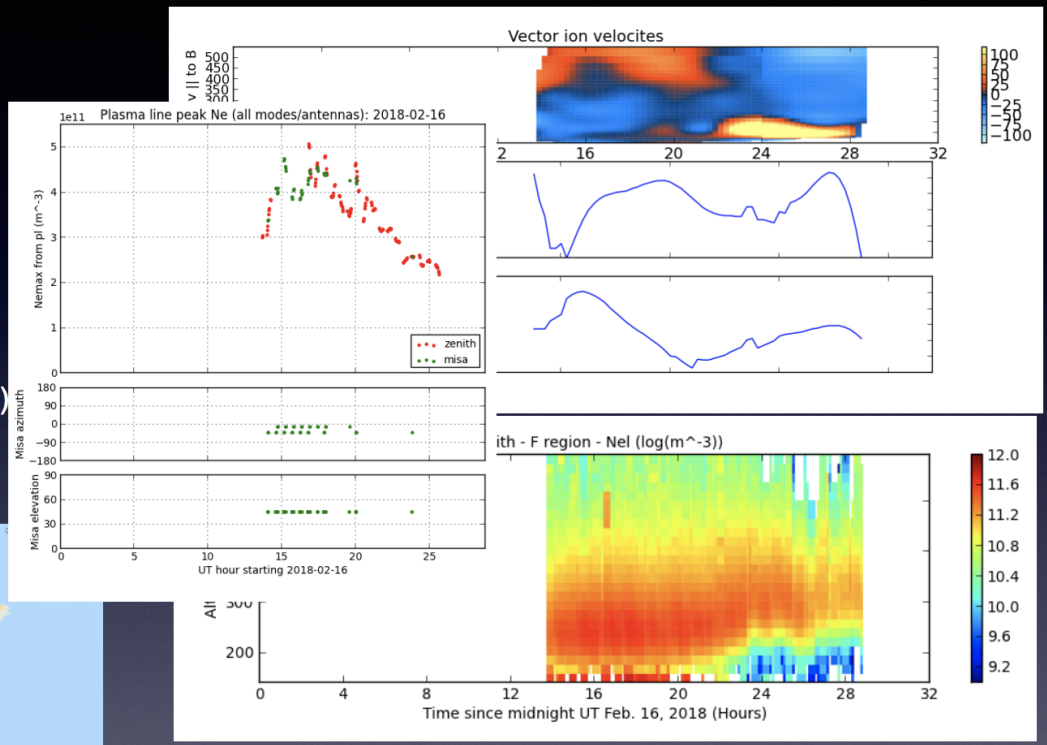
Vertical profiles [zenith],
regional vectors [45 deg elevation],
wide field scans [6 deg elevation)

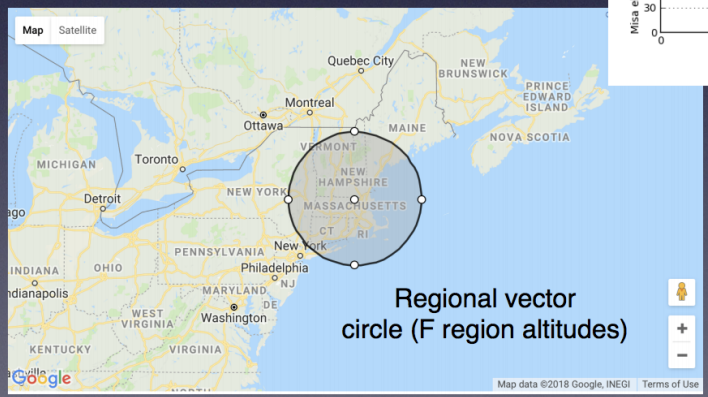
MISA fixed positions on either side of magnetic meridian

E, F region

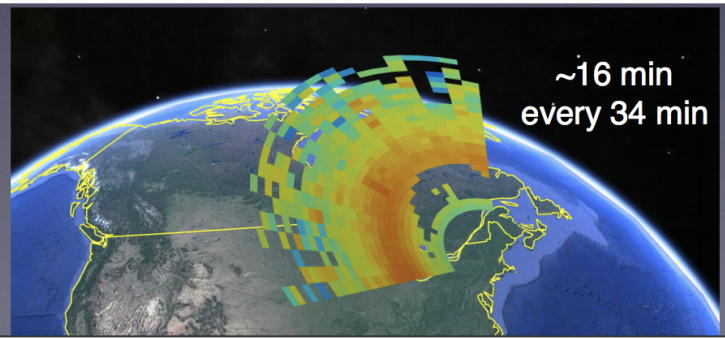
F2 peak high accuracy Langmuir mode electron density available (daytime ionosphere)

Experiment cycle time = ~34 minutes



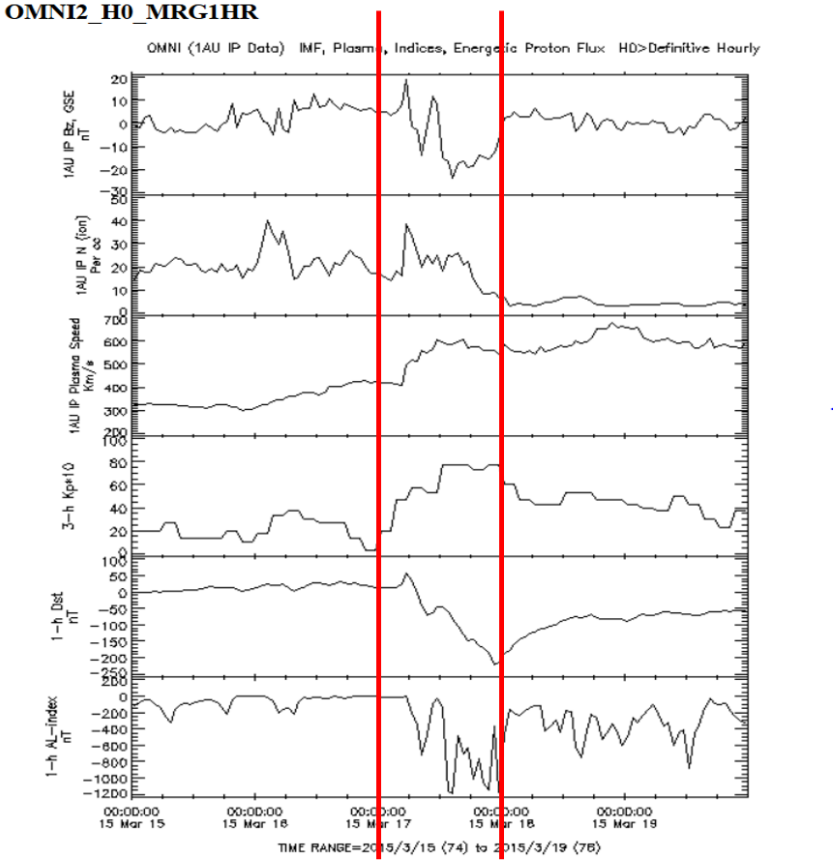


Regional vector circle (F region altitudes)



Zenith: 3 minutes
MISA scans: 35 seconds / 5 degrees
MISA fixed positions: 3 minutes

Typical Storm Time Conditions (St Patrick's Day 2015)



Main phase of the storm

Figure: Geomag. disturbed solar wind conditions.

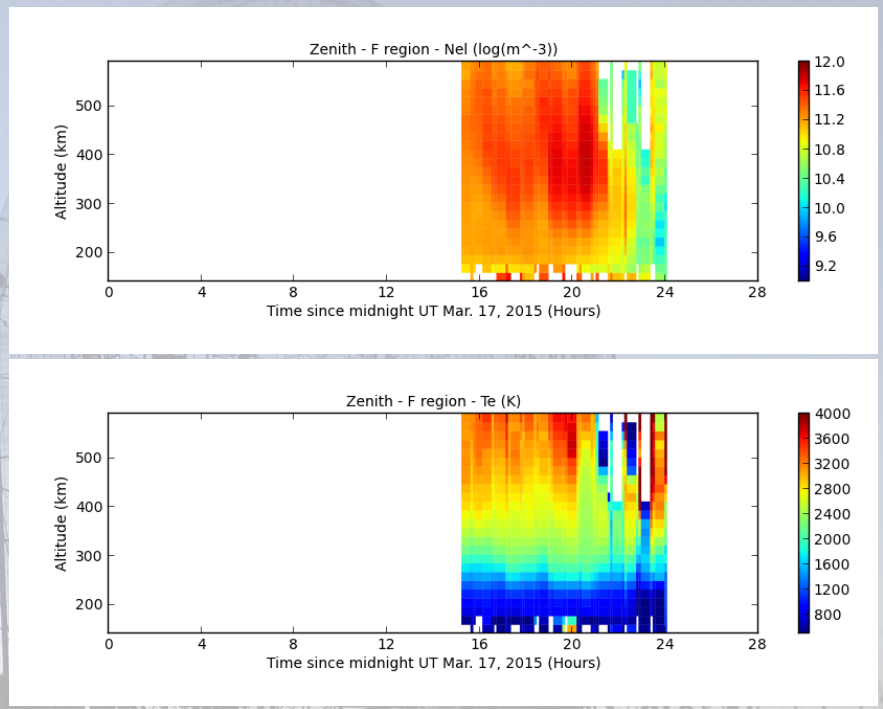


Figure: (a) F-region $log(N_e)$ and (b) T_e - Zenith.

Typical Storm Time Conditions (St Patrick's Day 2015)

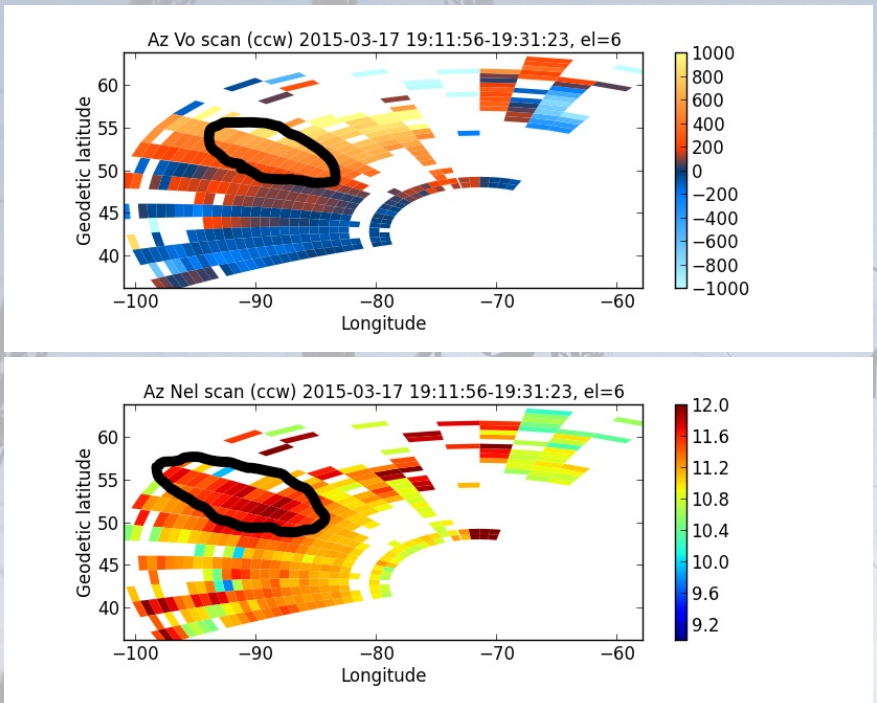


Figure: (a) Ion drifts (SAPS) and (b) $log(N_e)$ (SED) - MISA.

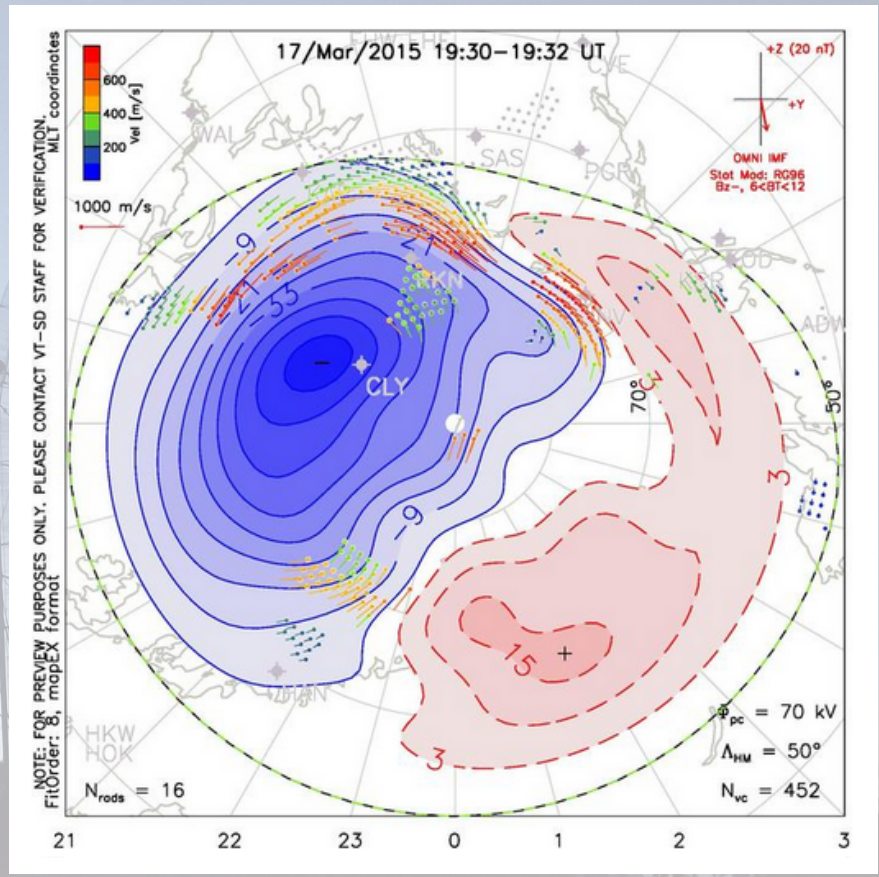
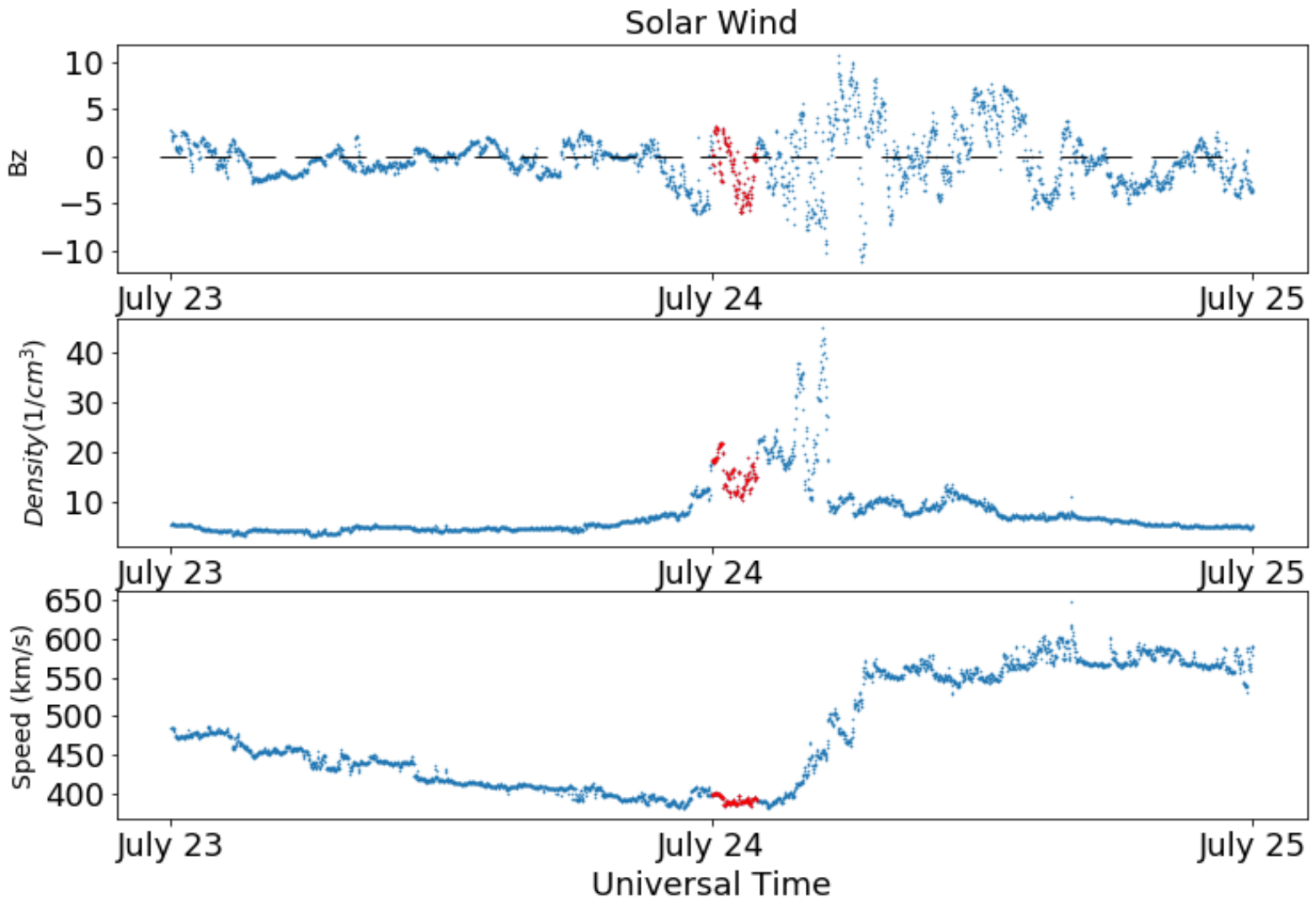
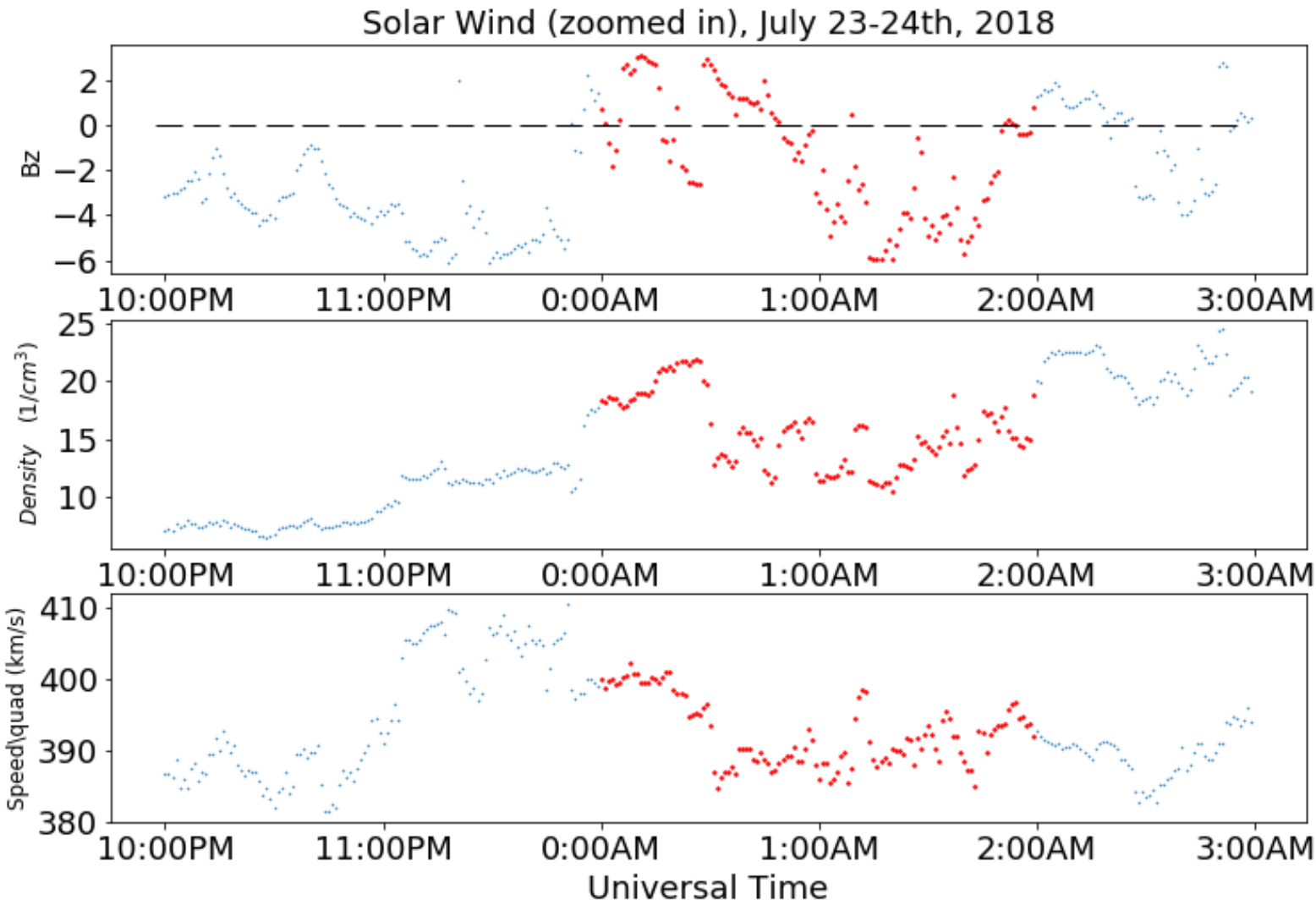


Figure: Geomag. disturbed solar wind conditions.

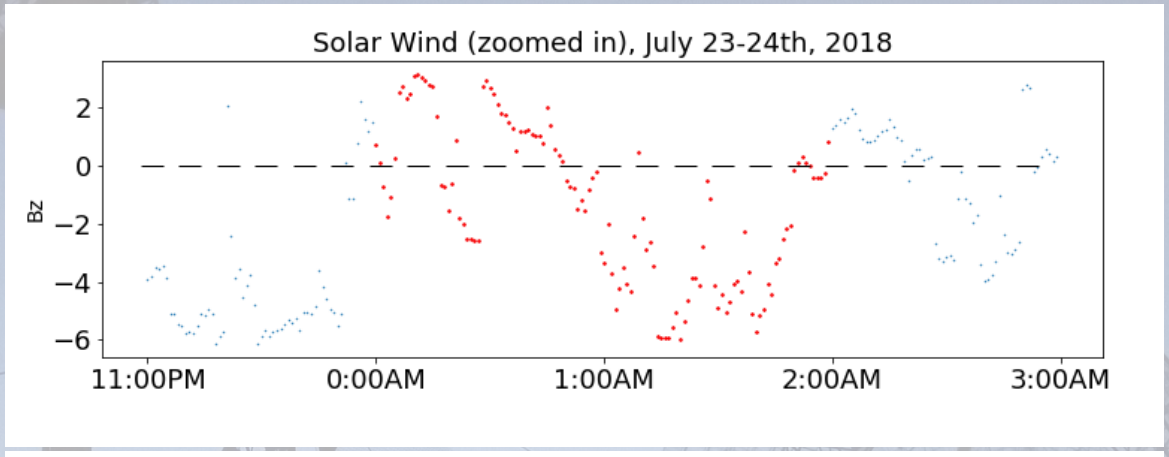
Solar Wind and PFISR

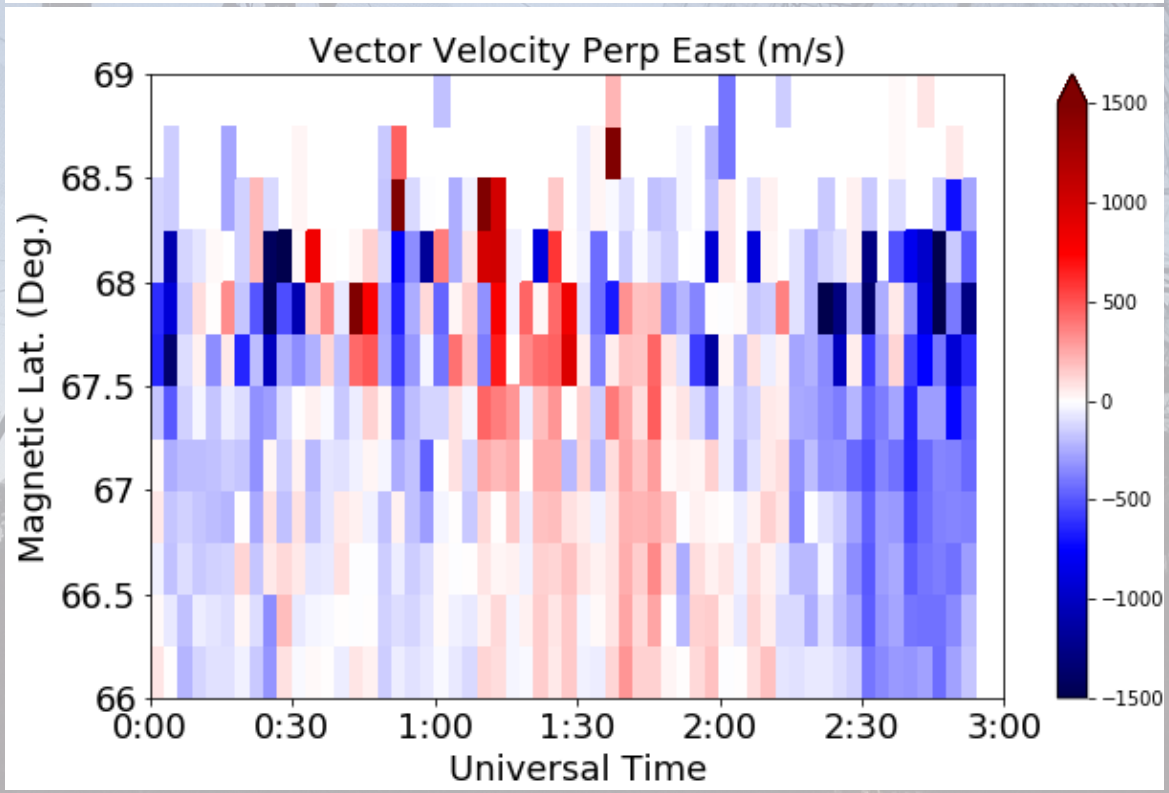


Solar Wind and PFISR



Solar Wind and PFISR





Electron Density

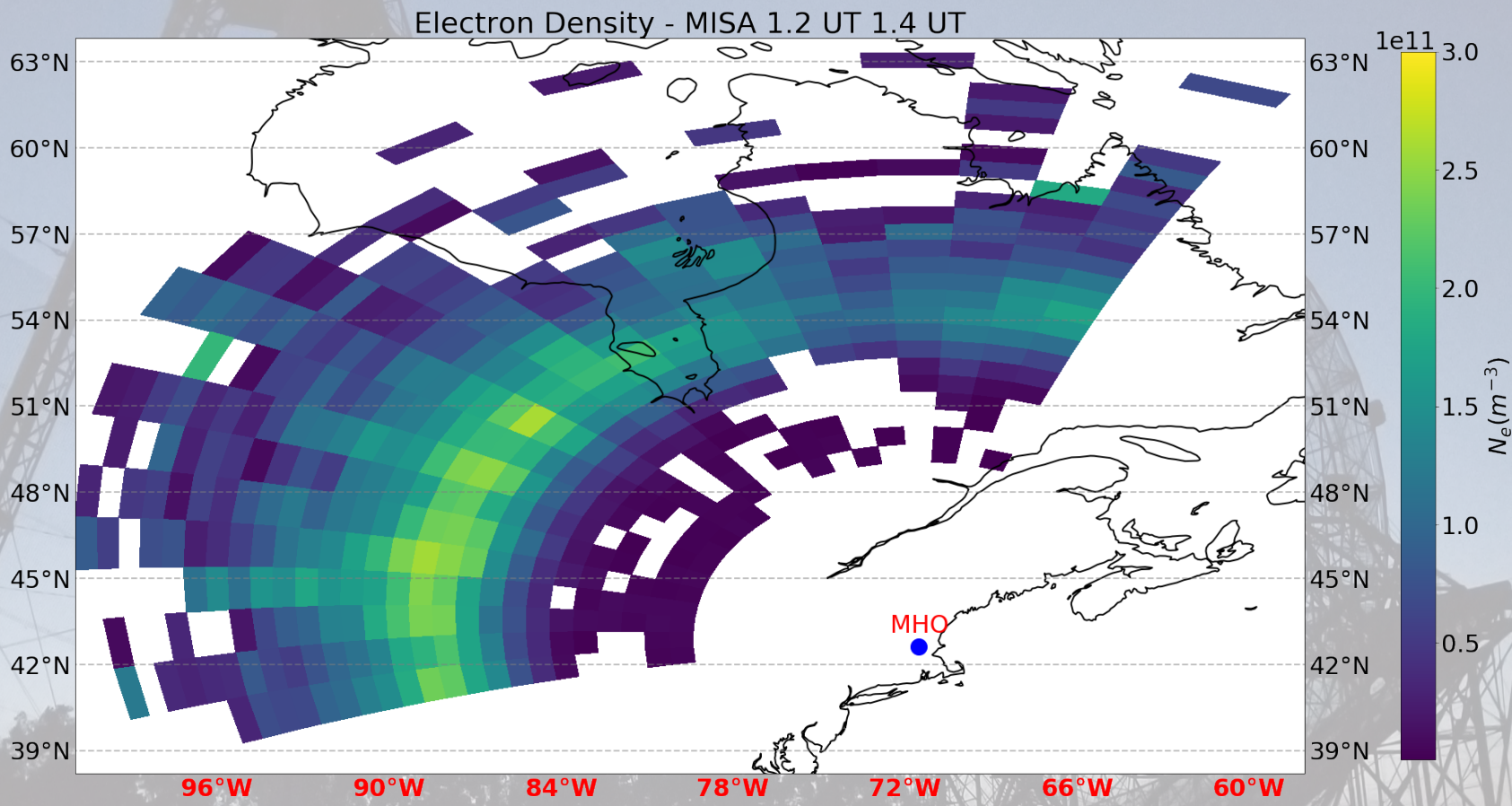


Figure: MISA N_e.

Electron Density

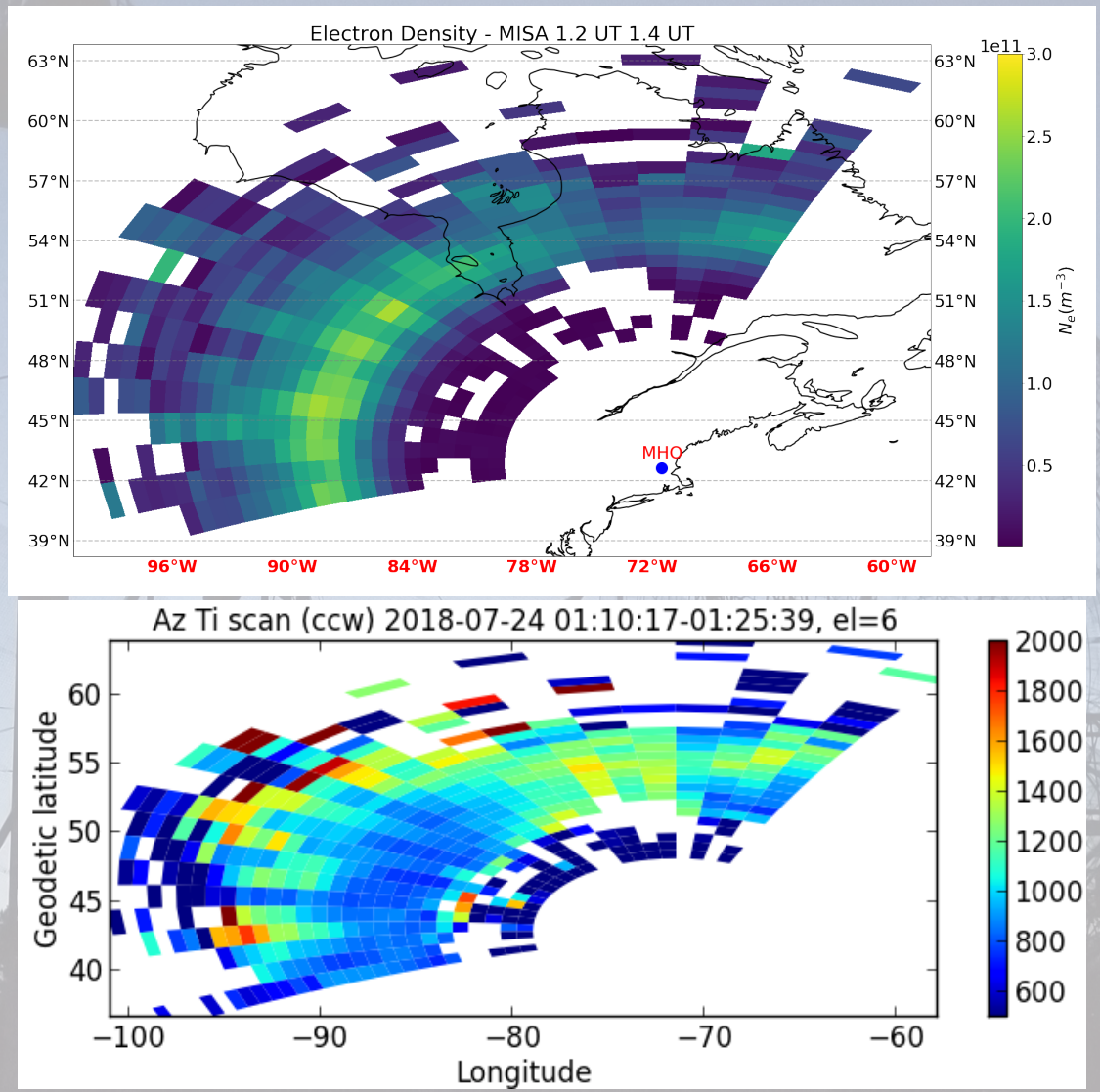
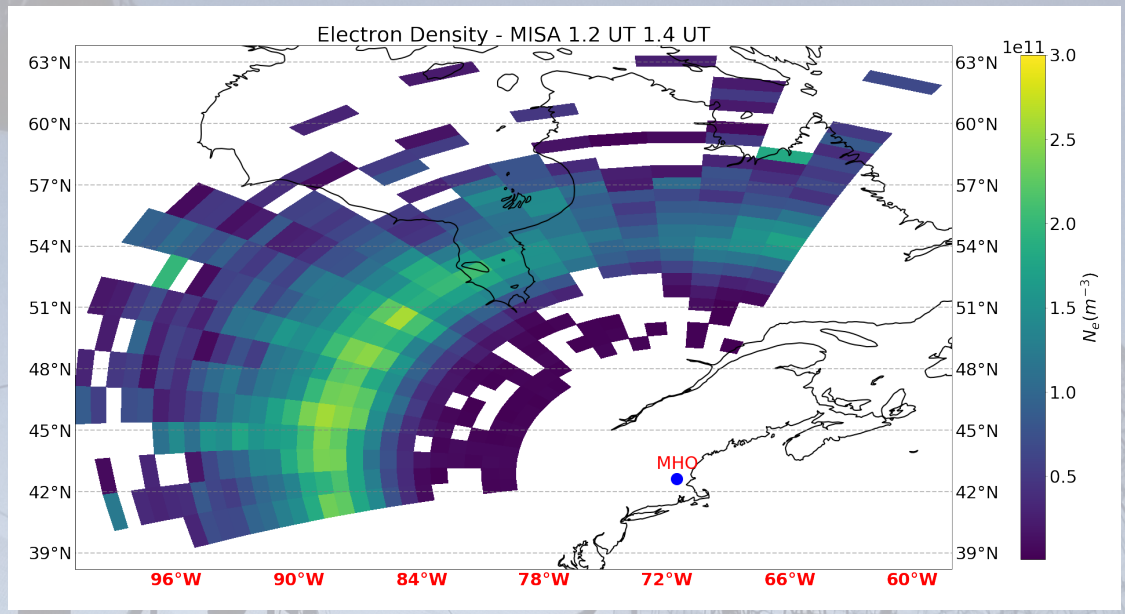


Figure: Millstone Hill - MISA electron density and T_i.

Electron Density



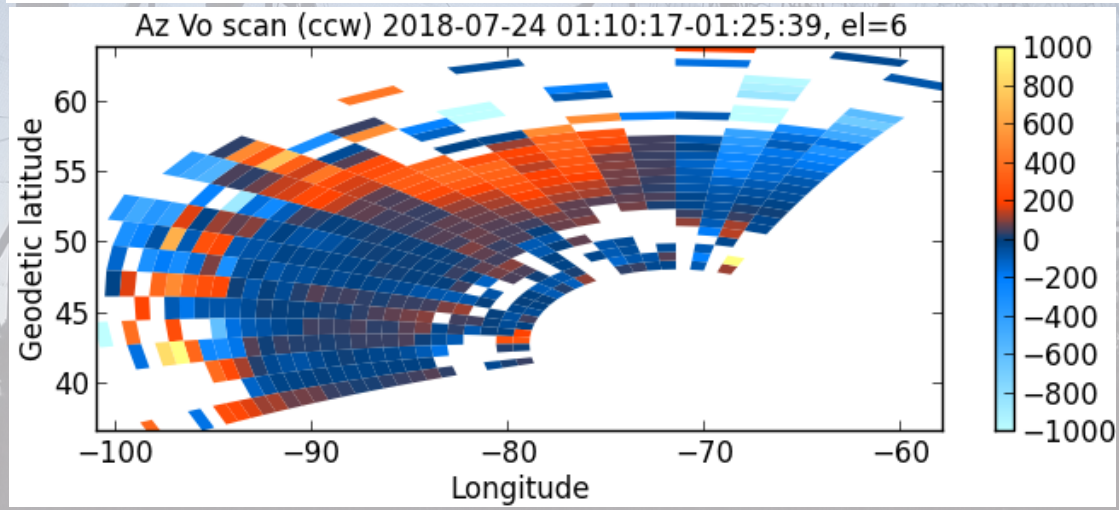


Figure: Millstone Hill - MISA electron density and V_{LOS}.

Electron Density

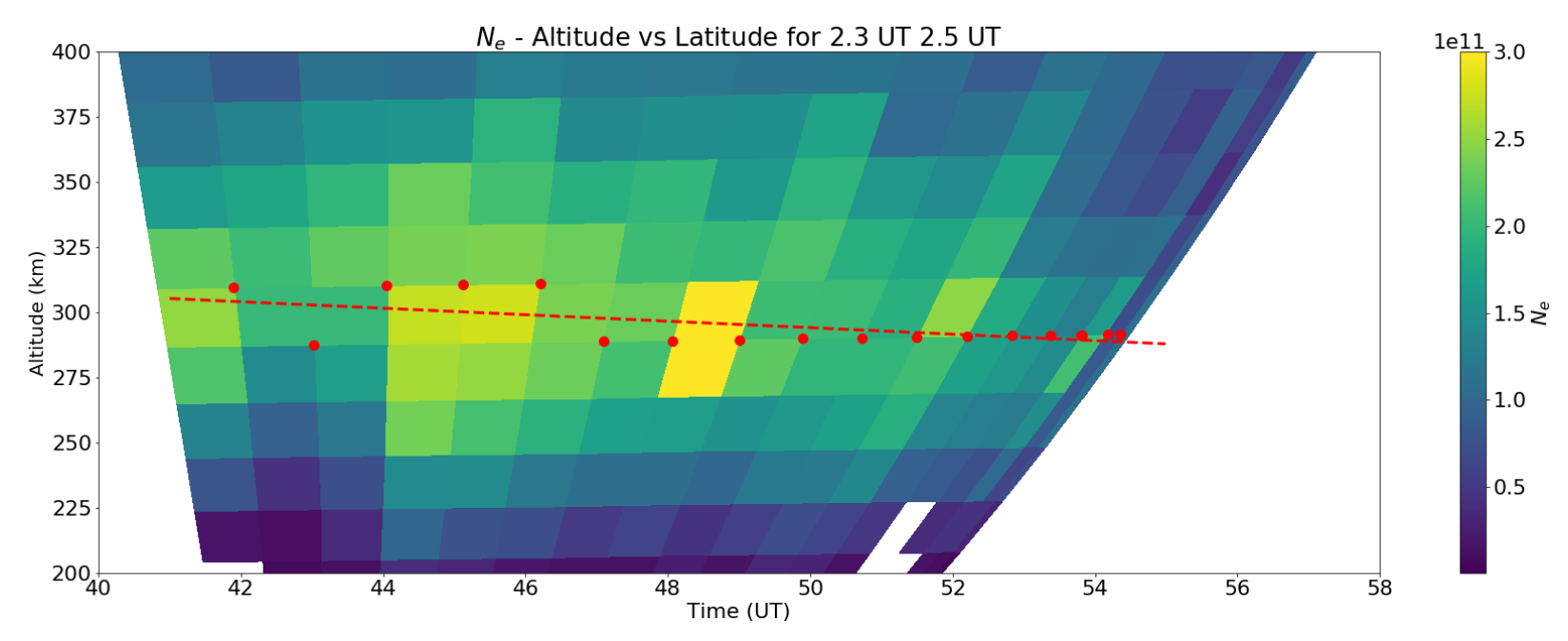


Figure: Millstone Hill - MISA electron density and V_{LOS} different perspective.

Comparison - Arecibo

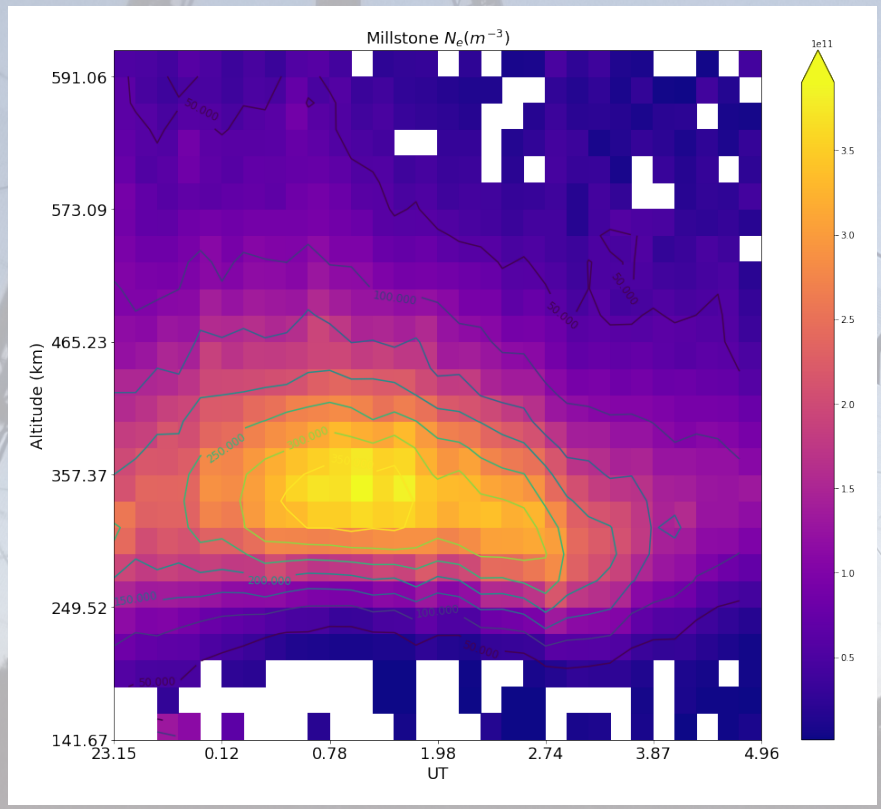


Figure: Millstone Hill Zenith N_e.

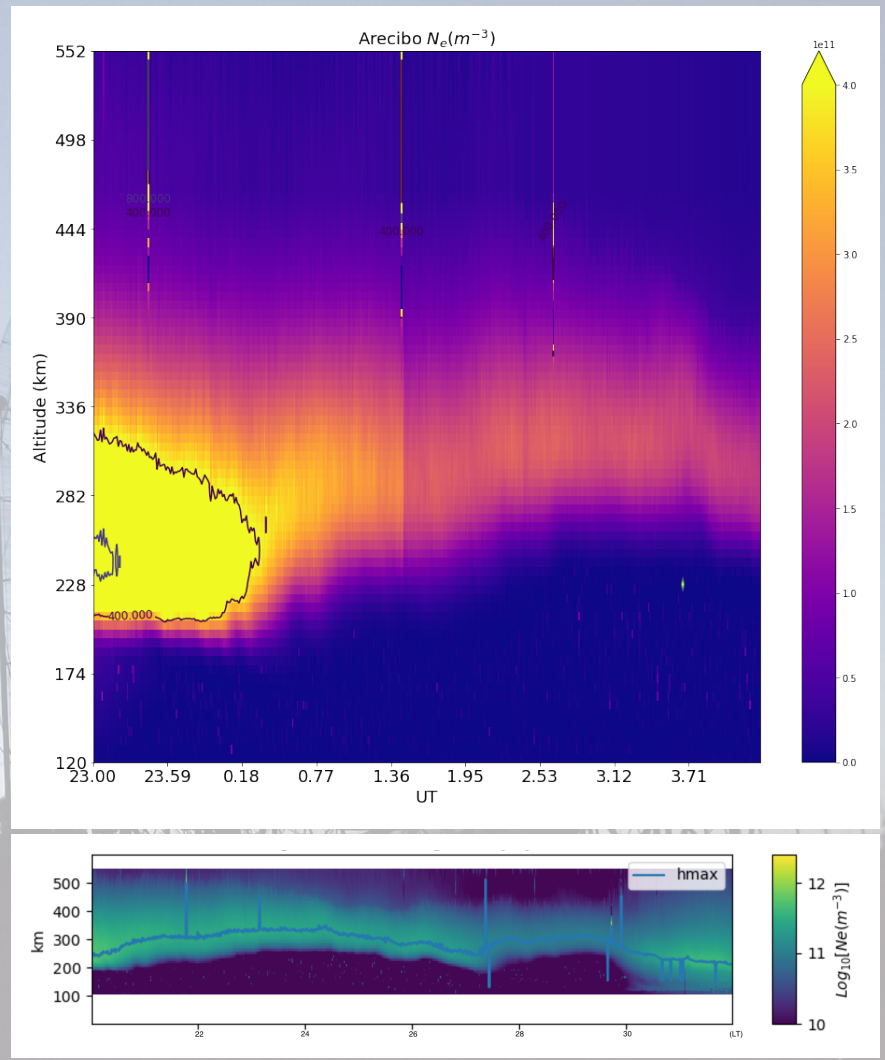


Figure: (a) Arecibo N_e.

Comparison - Arecibo

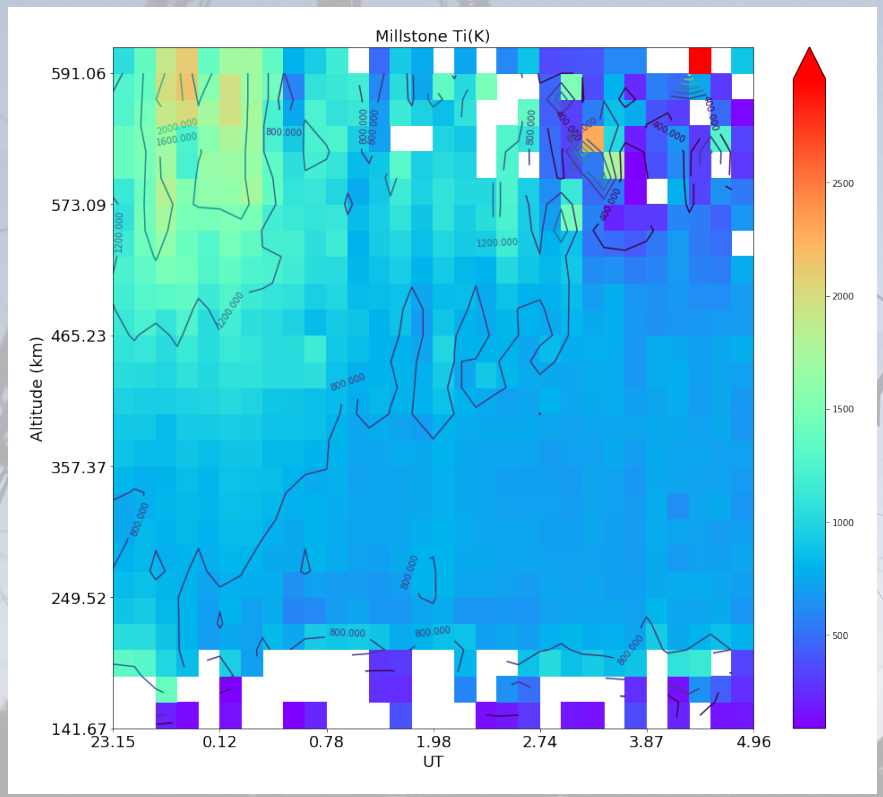


Figure: Millstone Hill Zenith T_i.

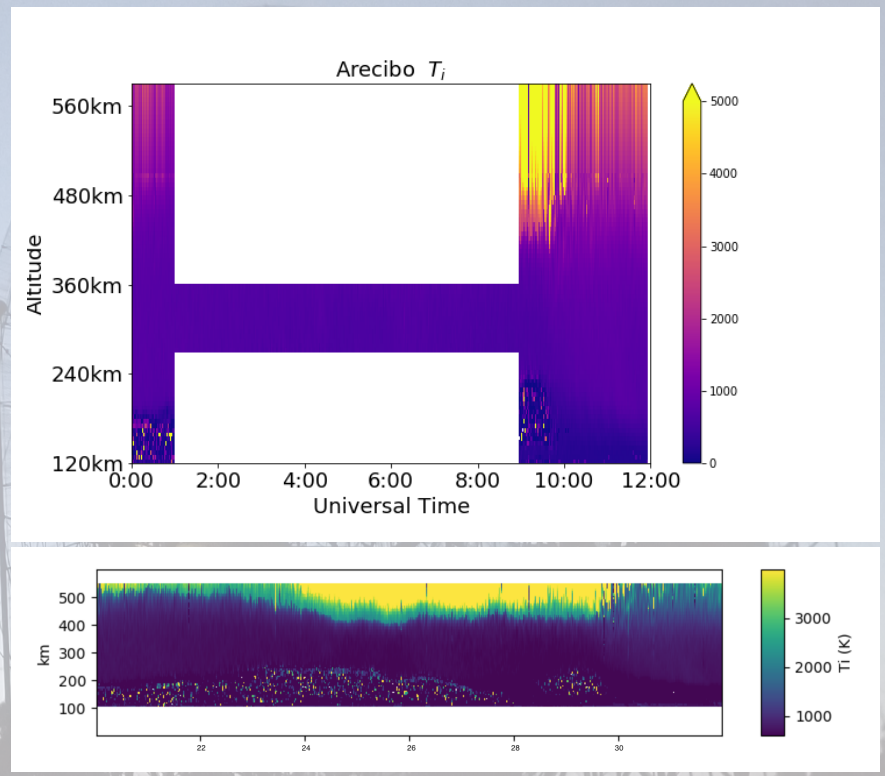


Figure: (a) Arecibo T_i.

Comparison - PFISR

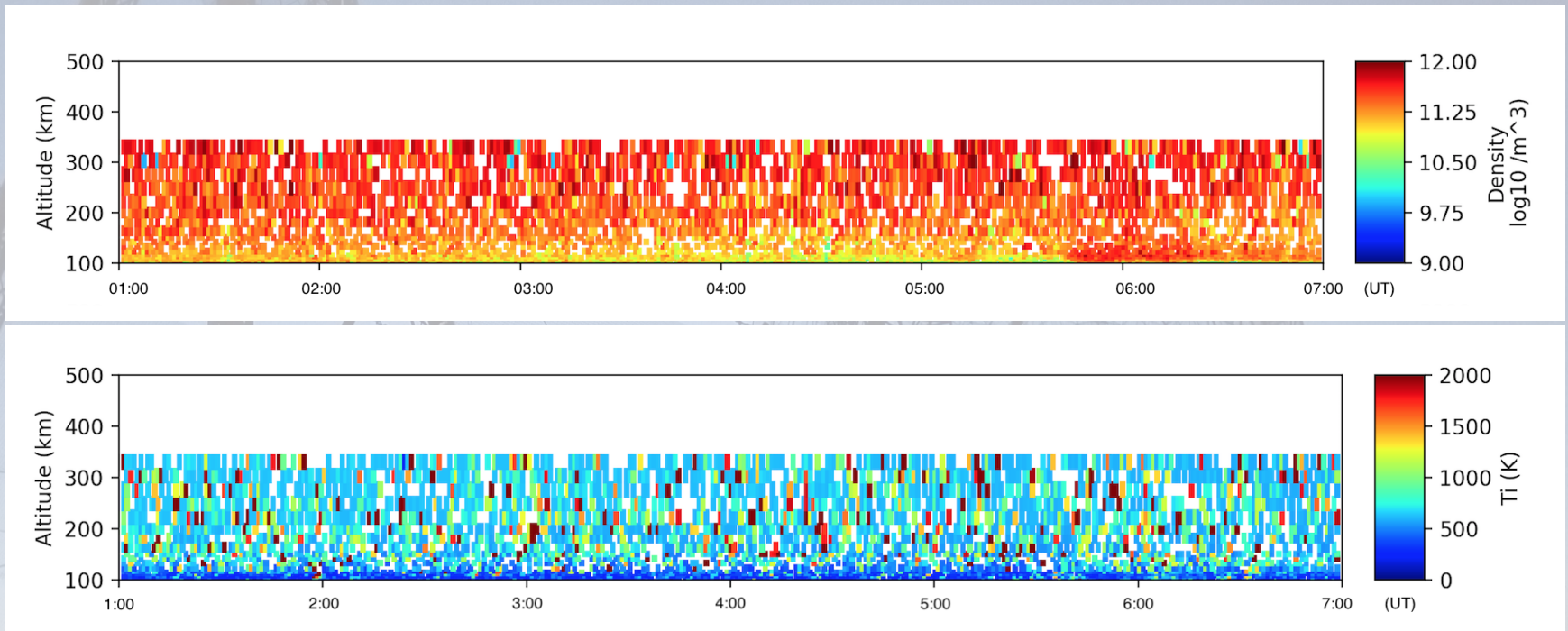


Figure: (a) PFISR N_e and T_i.

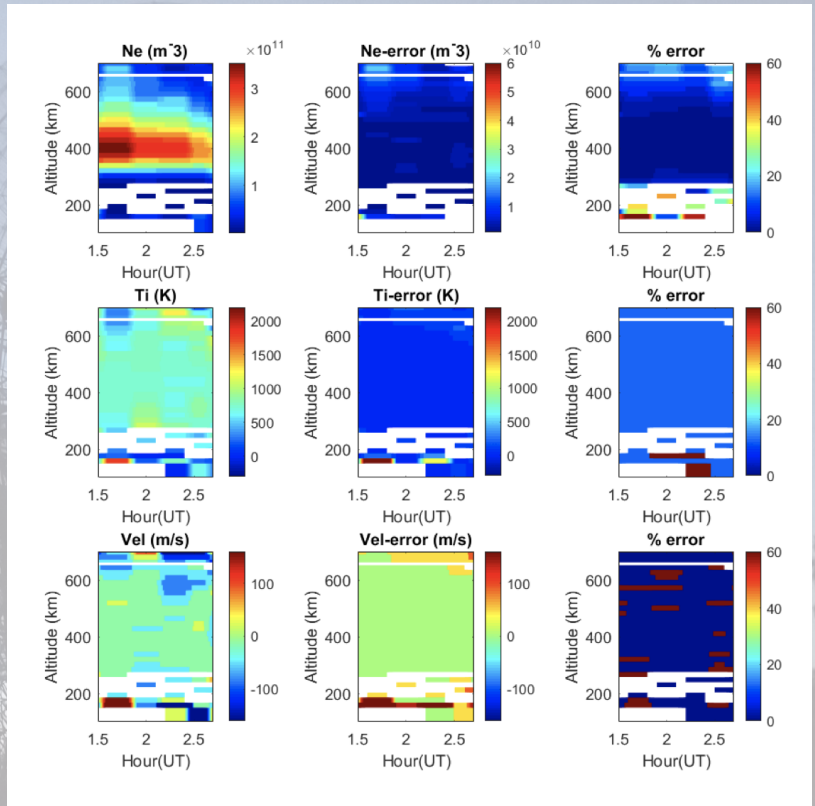
Error Analysis

1 - The Figure shows electron density, Ion temperature, and ion velocity with corresponding error estimate and percentage error during quiet condition;

2 - Electron density shows decrease with time as a result of recombination due to sunset;

3 - Temperature and velocity are proportional as expected;

4 - Where we have both measurements and error to be high, the percentage error is also high and vise visa.



Error Analysis

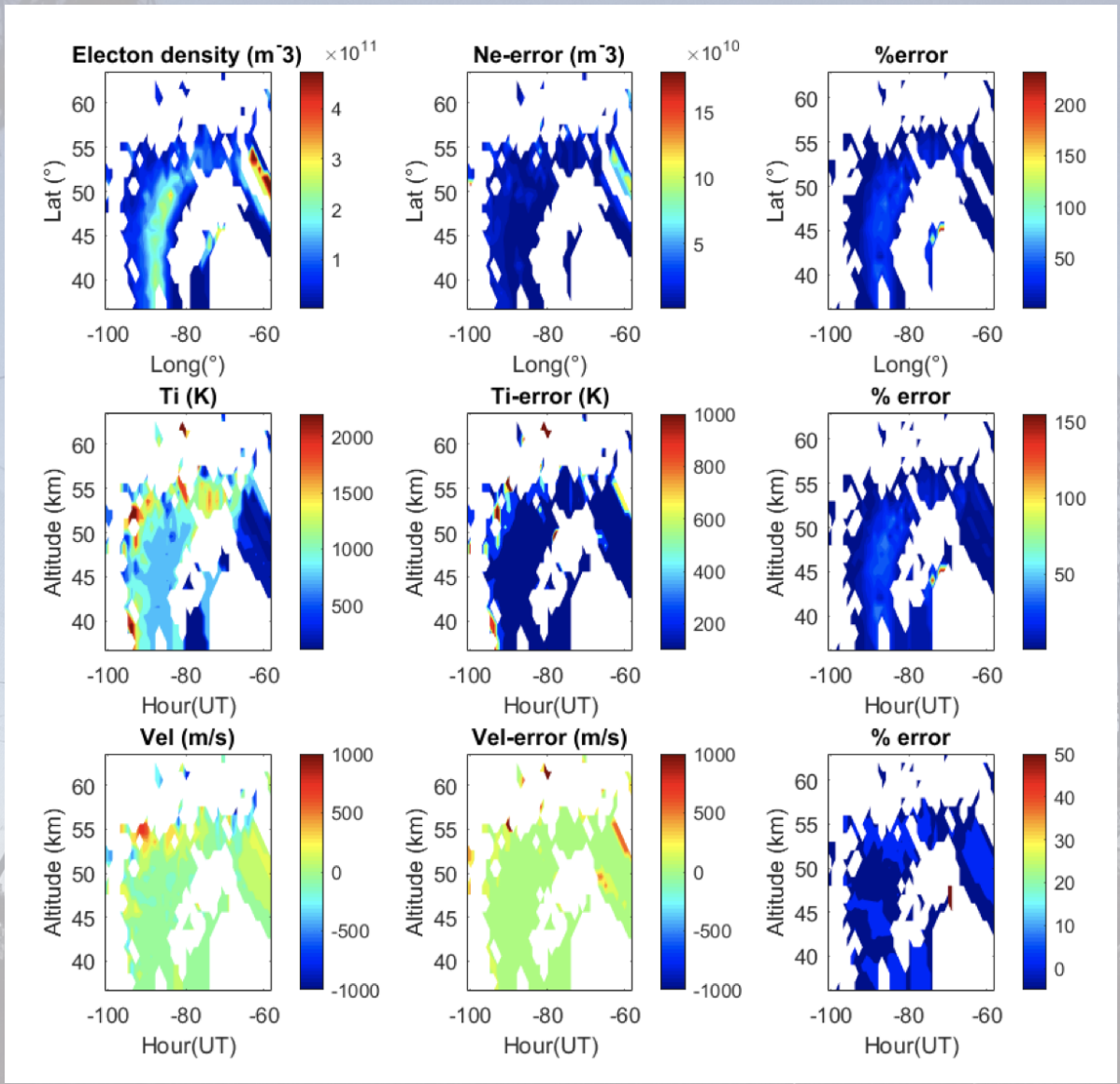


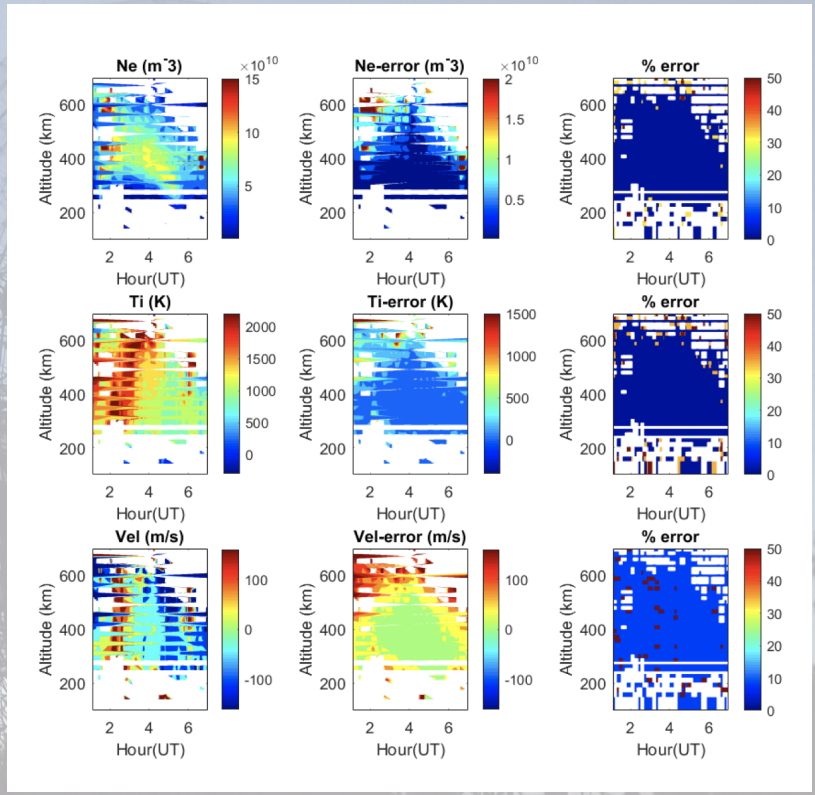
Figure: Similar behavior is observed in the plasma line.

Error Analysis

1 - The large gradient in the electron density shows a negative storm effect during geomagnetic storm condition;

2 - It also obvious that temperature and velocity are proportional;

3 - Error is generally low at the peak range, which shows radar has very good measrement at this region.



Error Analysis

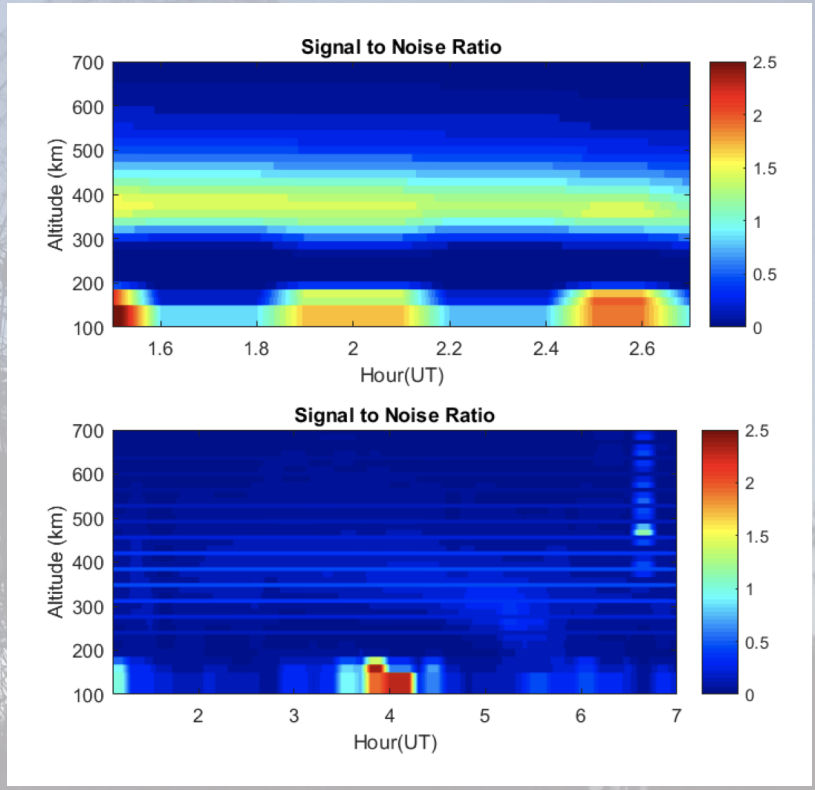
1 - The SNR during quiet time is general higher than during disturbed time, which has to do with the negatuive storm effect;

2 - Substituting the SNR ratio in the expression:

$$\frac{1}{\sqrt{K}}\left(1+\frac{1}{S/N}\right) \qquad (1)$$

3 - We would see that the approximate error for both case is 1.5 and 1, which show that there is good acuracy in radar measurement in both cases;

4 - As electron density increases, SNR reduces (suggest that the radar works better with more electron density).




THANK YOU!!