Nitric Oxide Ionospheric Integrated Conductivity Experiment (NIICE)

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Scientific Questions and *Hypothesis*

Nitric Oxide Ionospheric Integrated Conductivity Experiment (NIICE)

How does the Hall and Pedersen conductivity *change* with *particle precipitation*?

In the E-region (<150km)...we would expect NO-related cooling in response to particle precipitation (**hypothesis**)

- Do we observe particle precipitation? (necessary result)

- Did particle precipitation *show* NO-related cooling effect in response to Hall and Pedersen conductivity? (conjecture)

- Can we falsify this hypothesis with other hidden variables that *also* induce cooling effects? (hidden variable destruction)

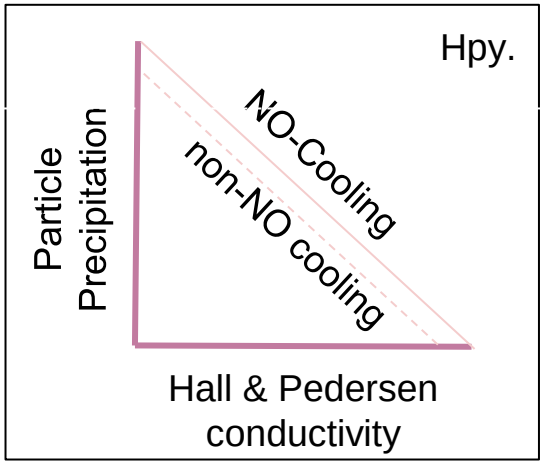
For examining this hypothesis, we show:

- Ion temperature enhancement

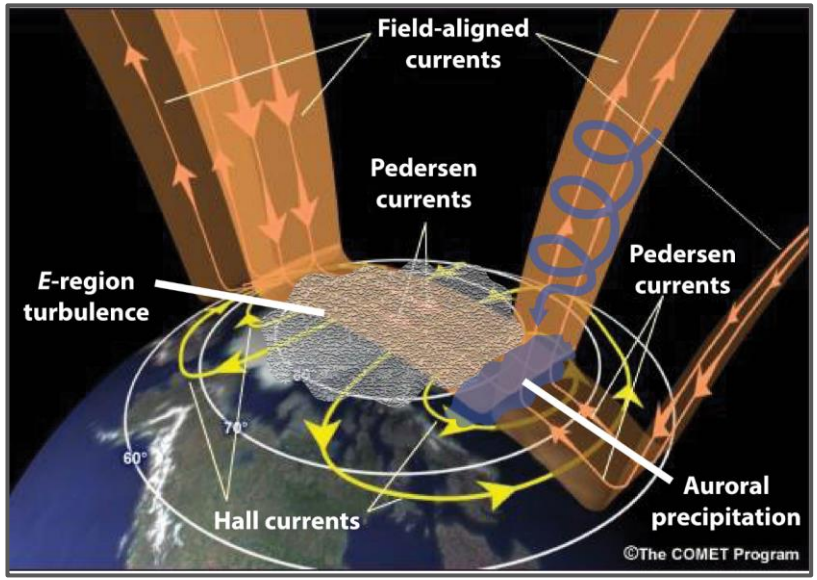
- Electron temperature and density

- Neutral-ion temperature and collision

We will first introduce the Hall and Pedersen conductivity and NO-related interactions in the ionosphere...



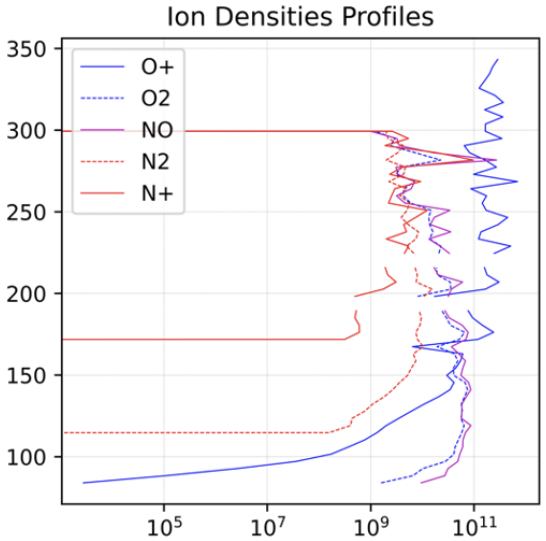
Introduction: Hall and Pedersen Conductivities



$$\vec{J} = \sigma \cdot \vec{E} = \sigma_P\left(\vec{E}_\perp + \vec{v}\times\vec{B}\right) + \sigma_H \frac{\vec{B}\times\left(\vec{E}_\perp + \vec{v}\times\vec{B}\right)}{B} + \sigma_{\parallel(i,e)}\vec{E}_\parallel$$

$$\sigma_H = -\sum \frac{\omega_{ci}\nu_i}{\nu_i^2 + \omega_{ci}^2}\sigma_i + \frac{\nu_e\sigma_e}{\omega_{ce}} \qquad \sigma_e = \frac{n_e e^2}{m_e \nu_e}$$

$$\sigma_P = \sum \frac{\nu_i^2}{\nu_i^2 + \omega_{ci}^2}\sigma_i \qquad \sigma_i = \frac{n_i e^2}{m_i \nu_i}$$



Assumptions:

- Plasma is quasi-neutral (electron density = ion density)

- Ion densities = Ion_fraction*(electron density)

Introduction: Nitric Oxide

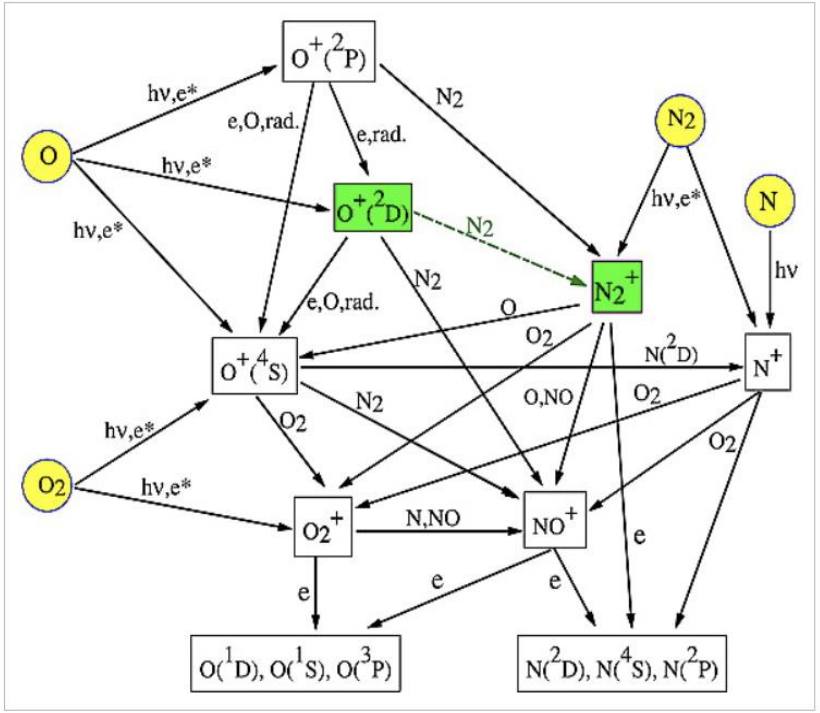
$e^* + N_2 \rightarrow N(^2D) + N(^4S) + e^*$ (R1)

$N(^2D) + O_2 \rightarrow NO + O$ (R2)

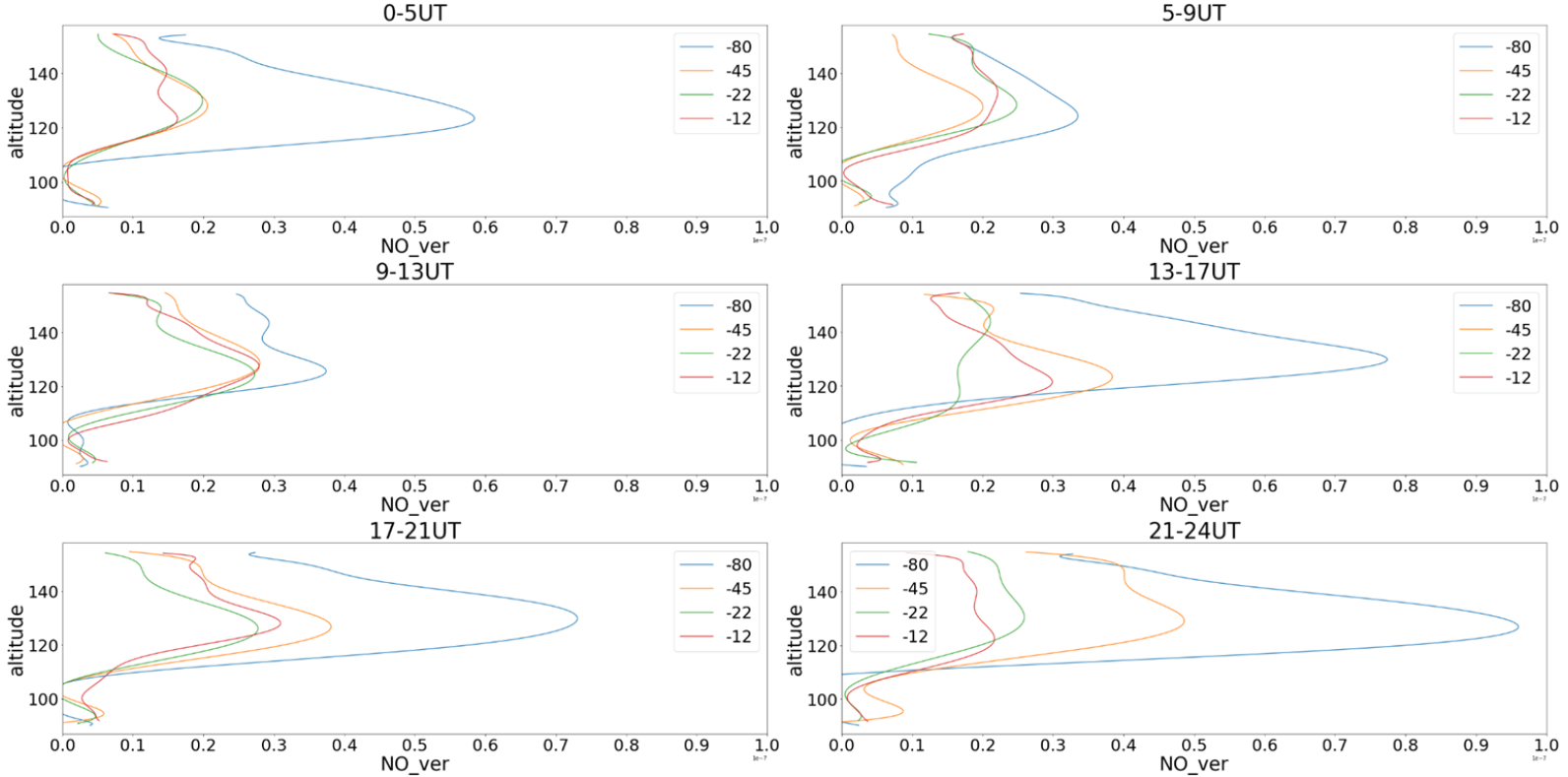
$N(^4S) + O_2 \rightarrow NO + O$ (R3)

$NO + O \rightarrow NO + O + h\nu 5{:}3\ \mu m$ (cooling) (R4)

where e* represents an energetic electron and N(2 D) and N(4 S) are the excited state/ground state of atomic nitrogen.

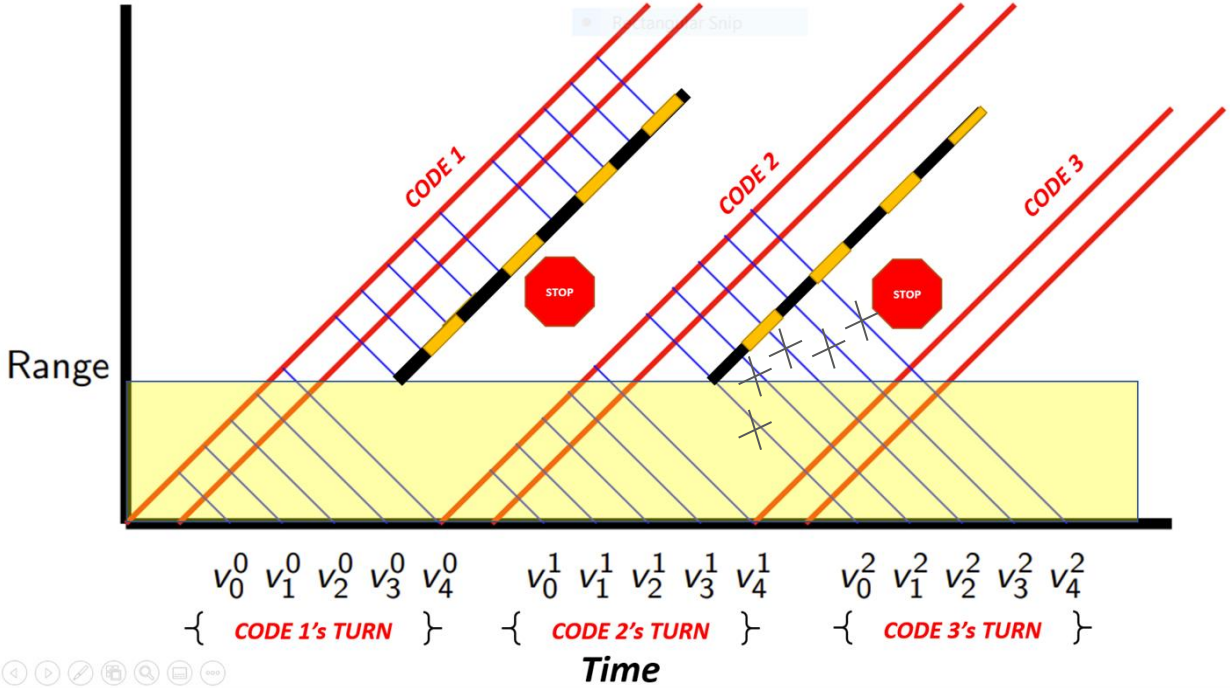


Introduction: Nitric Oxide Cooling Example with SABER Satellite Measurements

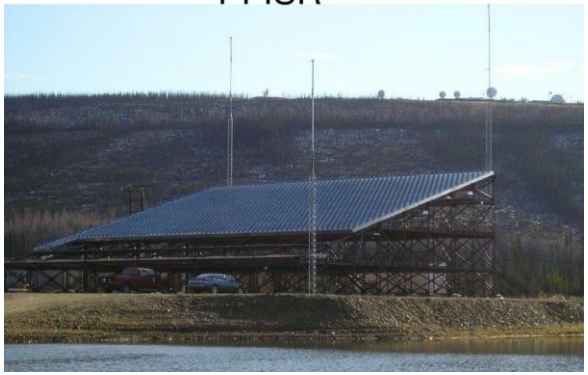


Methodology: PFISR Experimental Set-Up (*WorldDay35)*

- ❏ 480 us pulse, alternating code, **30** us bauds, 10 us samples
- ❏ 330 us uncoded long pulse, 20 us samples
- ❏ F-region ion velocity field reconstruction and E-region neutral winds

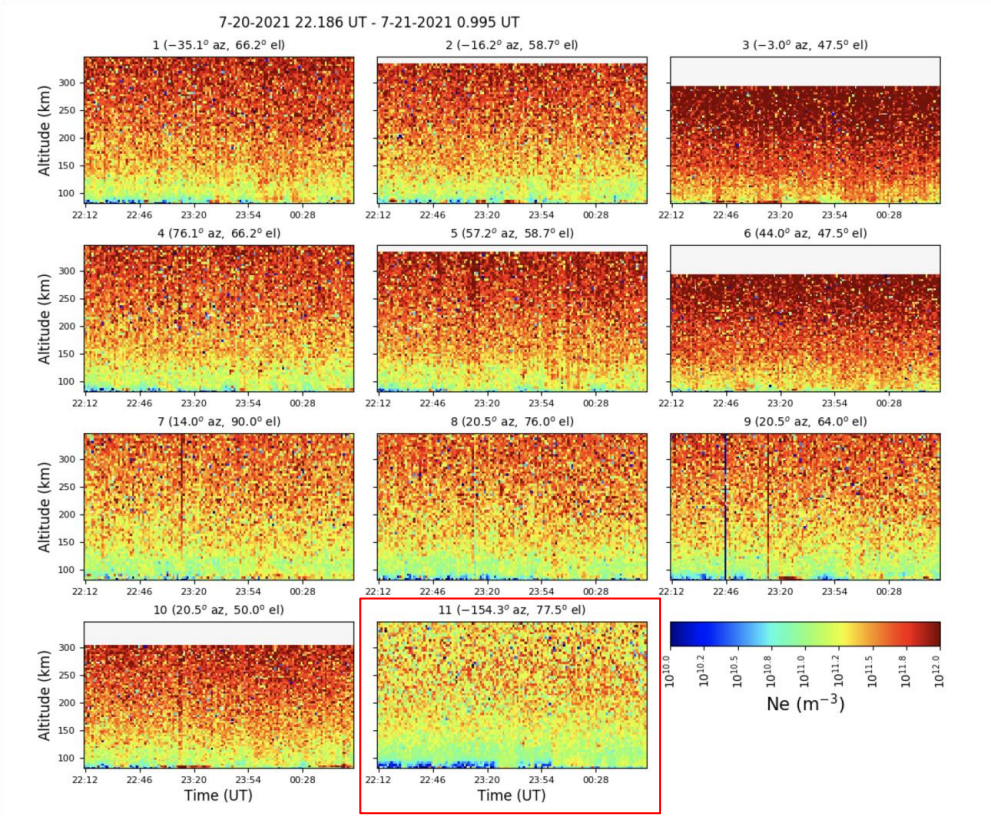


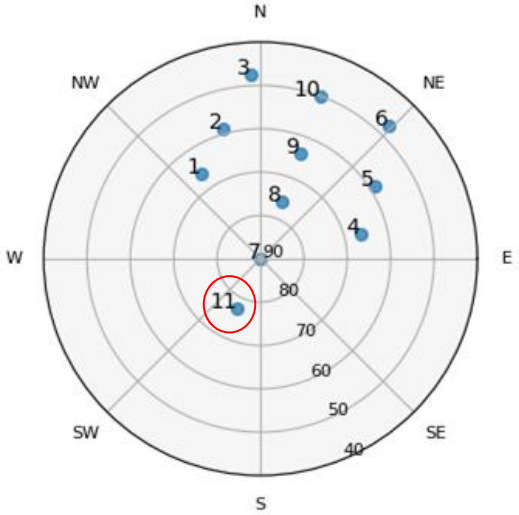
AMISR – Poker Flat, AK
PFISR



Alternative Code Range
res = Tn.c /2
=**30**[us].3e8/2
= ~ 4.5 Km

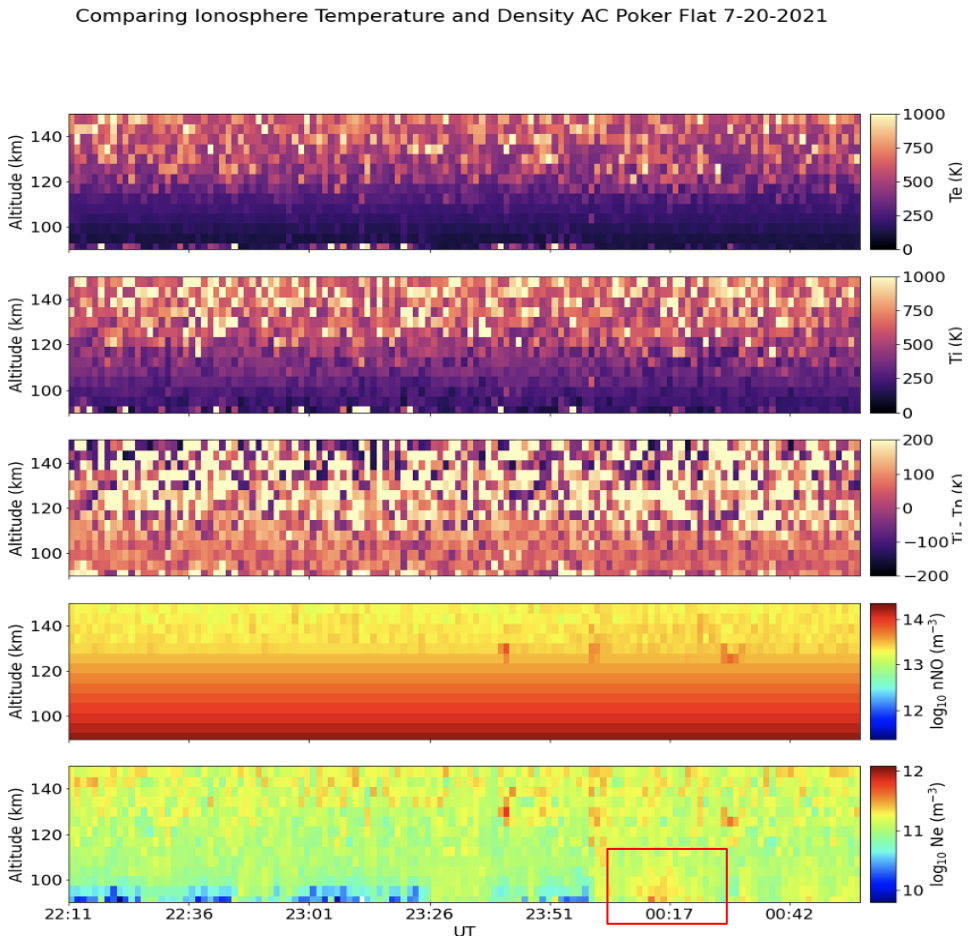
Methodology: PFISR Experimental Set-Up





Results

- An increase in electron density is shown in a region below 100 km.
- Ion temperature is on average greater than neutral temperature.
- According to (R1) we observe the increase in nitric oxide density very much similar to the electron density pattern.
- Temperature values are lesser at higher nitric oxide density region.

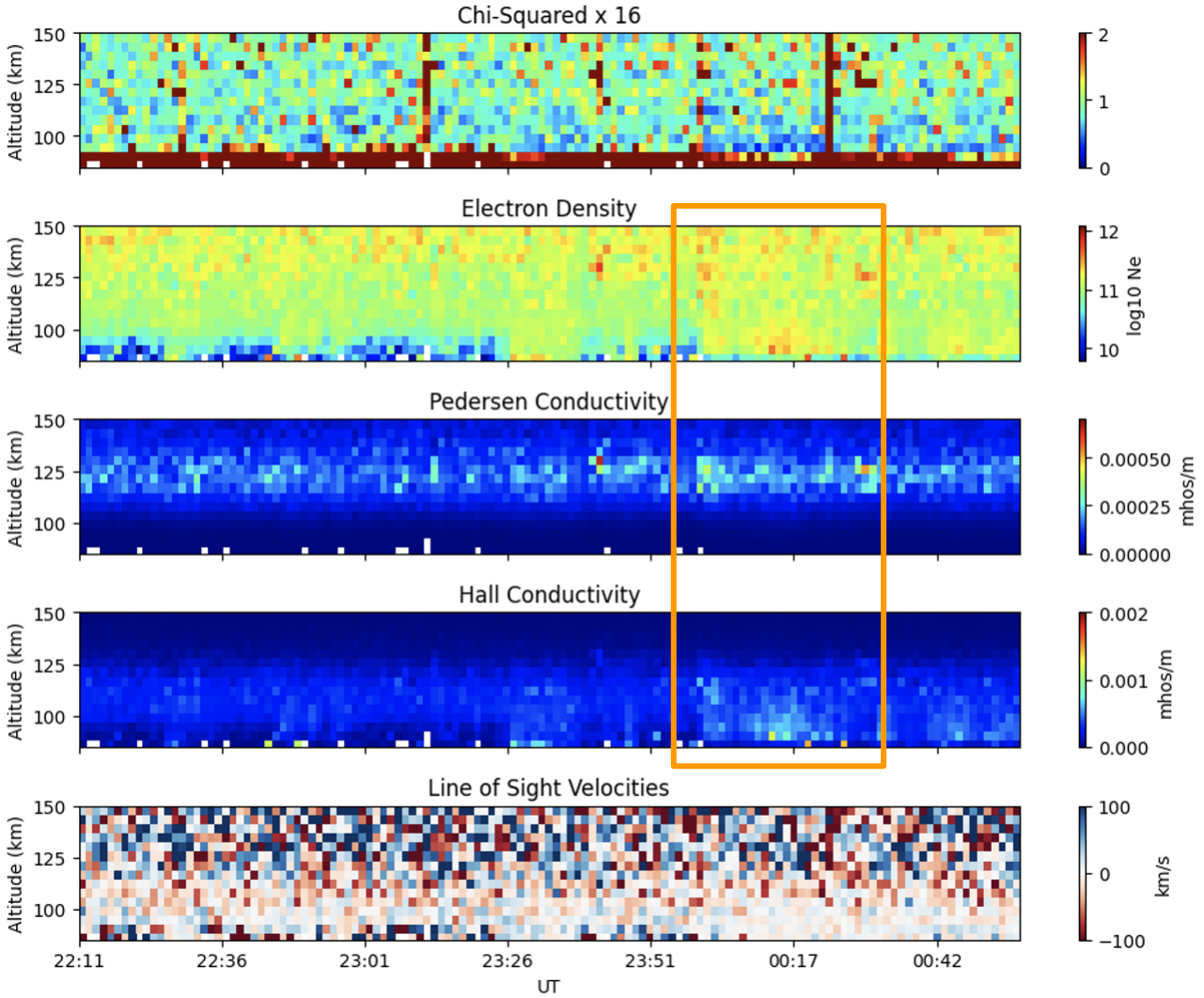


Results

Remember: Data from beam 11 (pointing along the magnetic field line)

Takeaways:

1. Increase in Pedersen conductivity is artificial
2. Low altitude electron density precipitation corresponds to the increase in the Hall conductivity
3. # of precipitating electrons too low to see significant change in line-of-sight velocities



Conclusions

- Hypothesis examined observables
- Support
- Uncertainty (e.g. Solar zenith E-region)
- Conclusion

Future work recommended

- Investigate the 3-D velocity vectors to determine the flow of the increased density region
- Look at the uncertainties in the line-of-sight velocities
- Compare SABER satellite NO measurements (when available) to our event

Questions?