University of New Hampshire

Magnetosphere Ionosphere Research Lab

Comparing EISCAT cusp observations with in-situ drivers during active Poleward Moving Auroral Form Event

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Outline

- Introduction and motivation
  - The cusp and PMAFs
  - Upwelling/Neutral upwelling discussion
  - Description of RENU2 campaign event
- EISCAT Data
  - Time history/overview
  - Calculation of Ambipolar field
- In-situ Data from RENU2
  - Characterizing the drivers
- Comparison to electrodynamic model

Introduction

PMAFs/Cusp precipitation

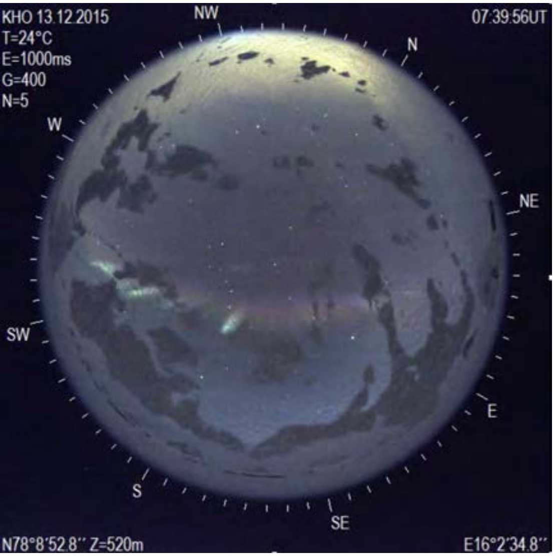
Open field lines allow direct entry of solar wind particles into ionosphere

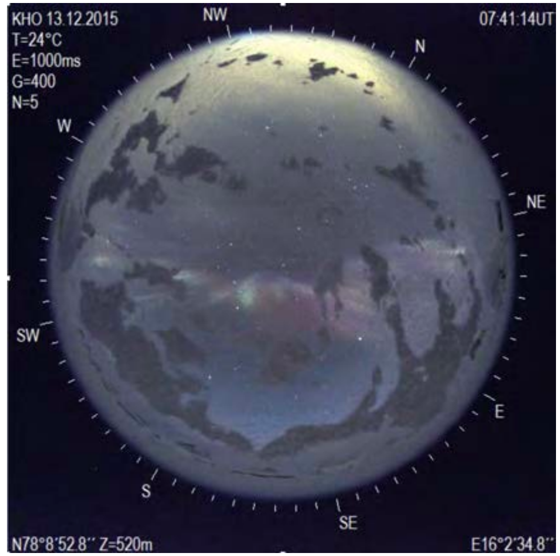
Collection of thin, wispy arcs which convect poleward as a general group

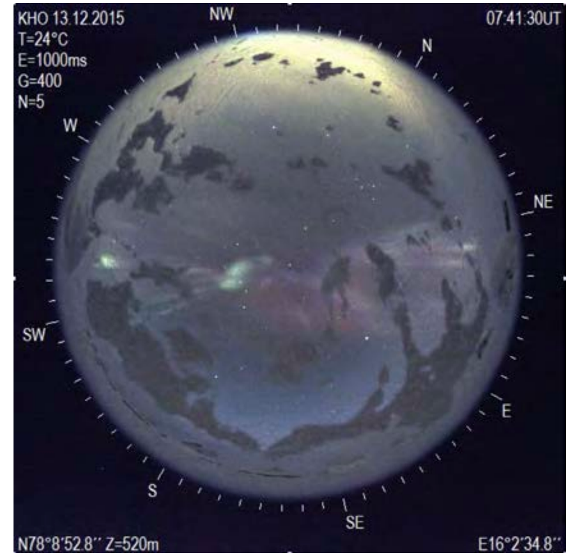
Highly structured spatially, temporally

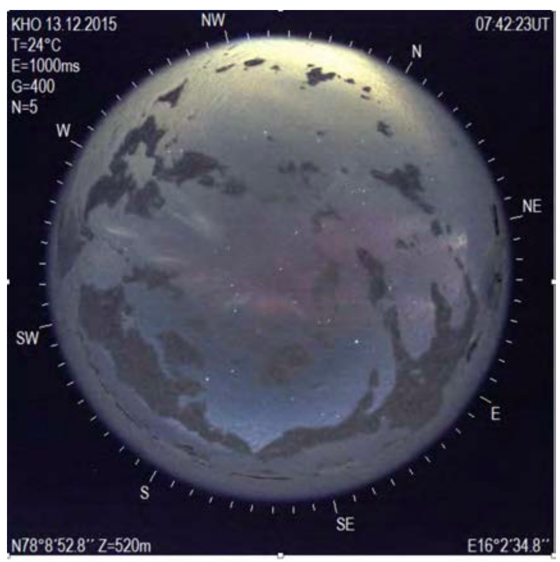
Introduction

PMAF frames – Evolution of one PMAF









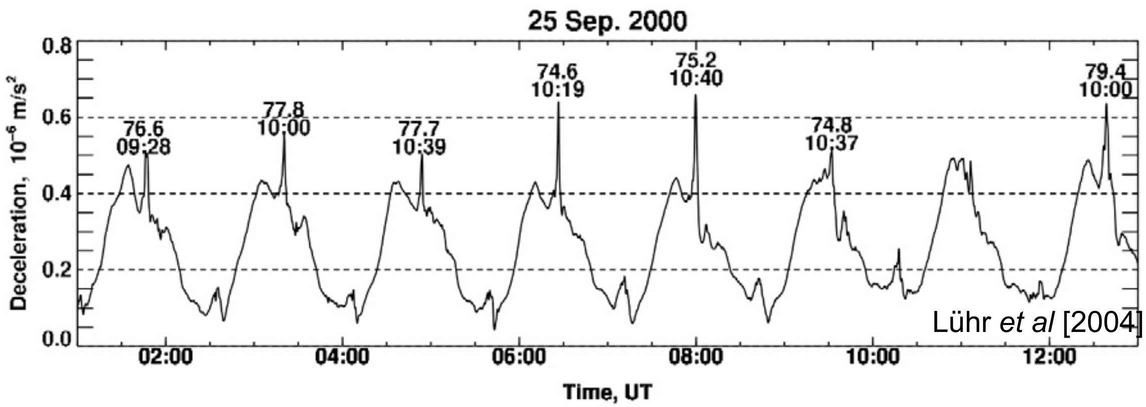
Neutral Upwelling

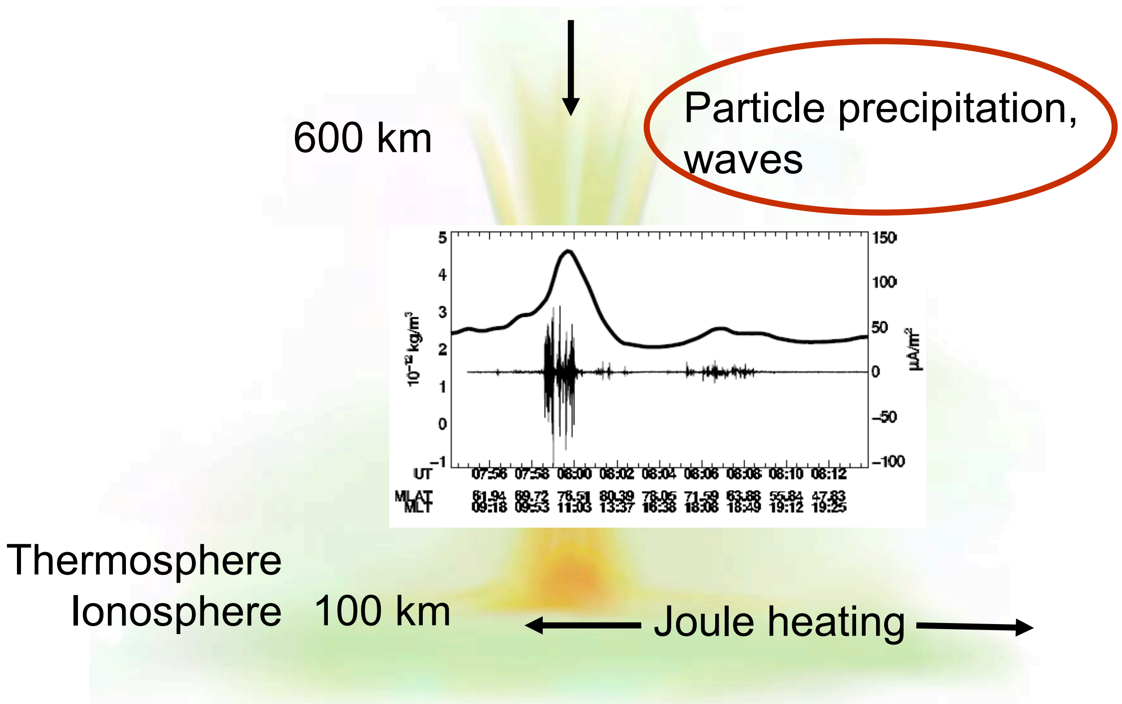
CHAMP
400 km, polar orbit

Deceleration spikes in cusp region

Observed in conjunction with small-scale currents

RENU2 Goal: Fully characterize the conditions during a PMAF event to better understand the driving mechanism behind neutral upwelling in the cusp





Upwelling Processes

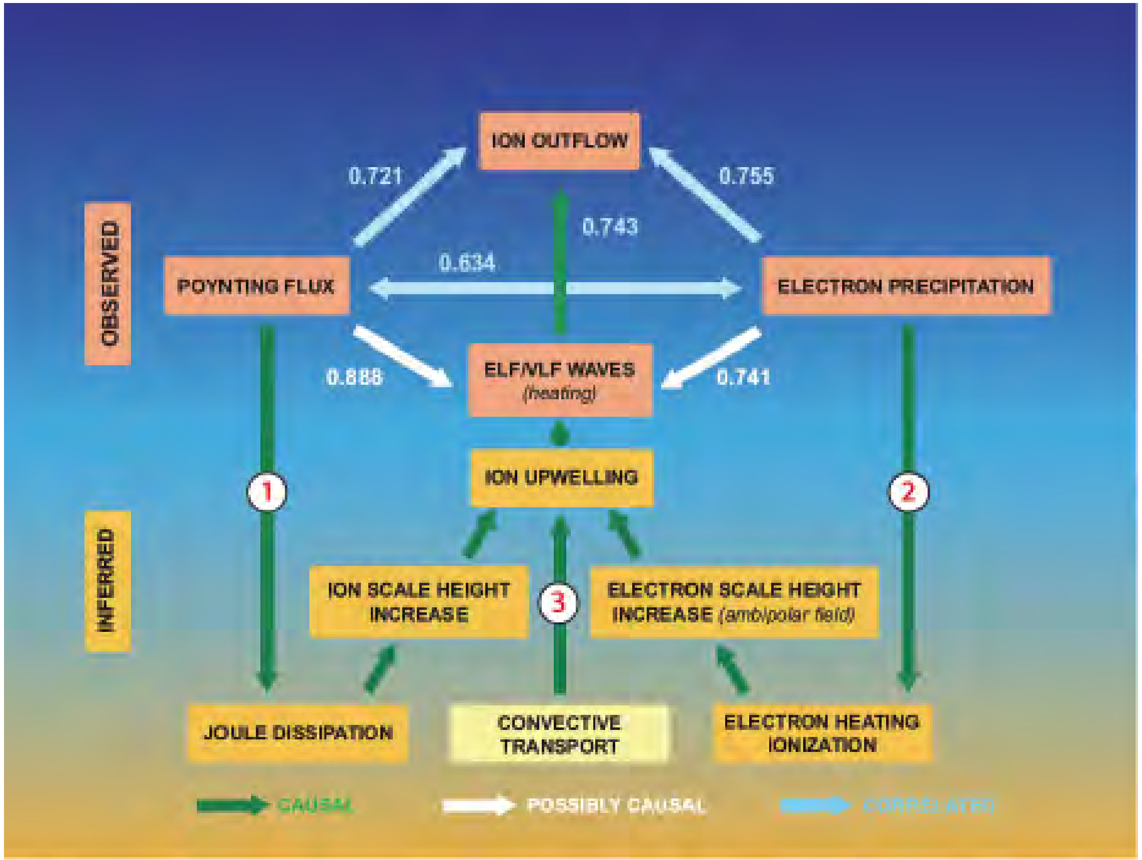
Type I

Large scale Poynting Flux and joule heating cause ion scale height increase

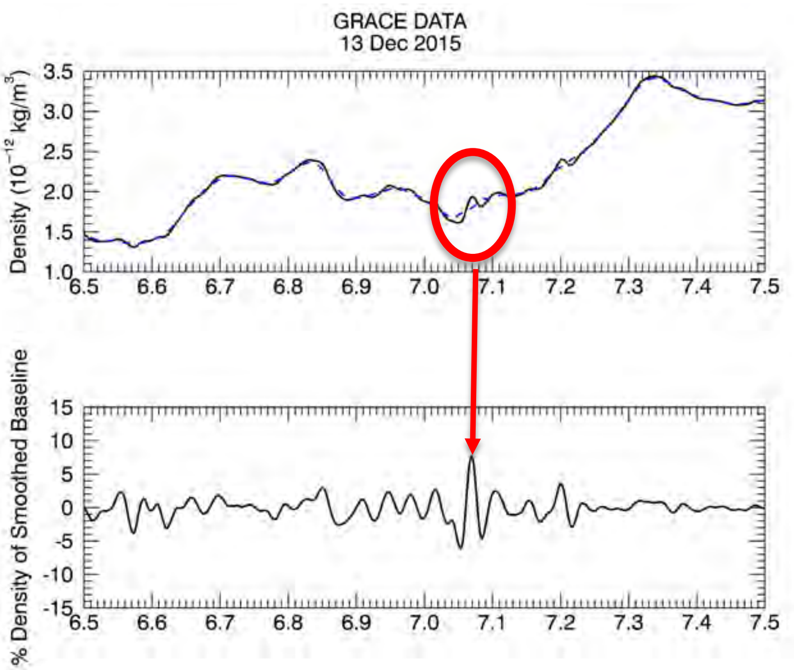
Type II

Soft electron precipitation heats the ambient ionosphere and causes electron scale height increase

Upwelling of ions transfers momentum to neutral thermosphere

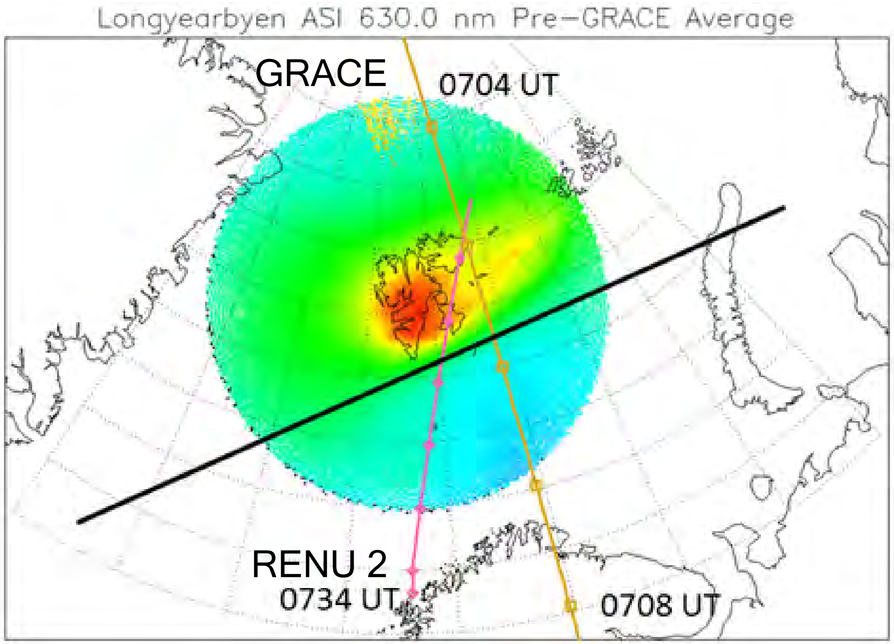


Neutral Gas Density



Density “bump” ≈10%

Not large enough to register in statistical surveys



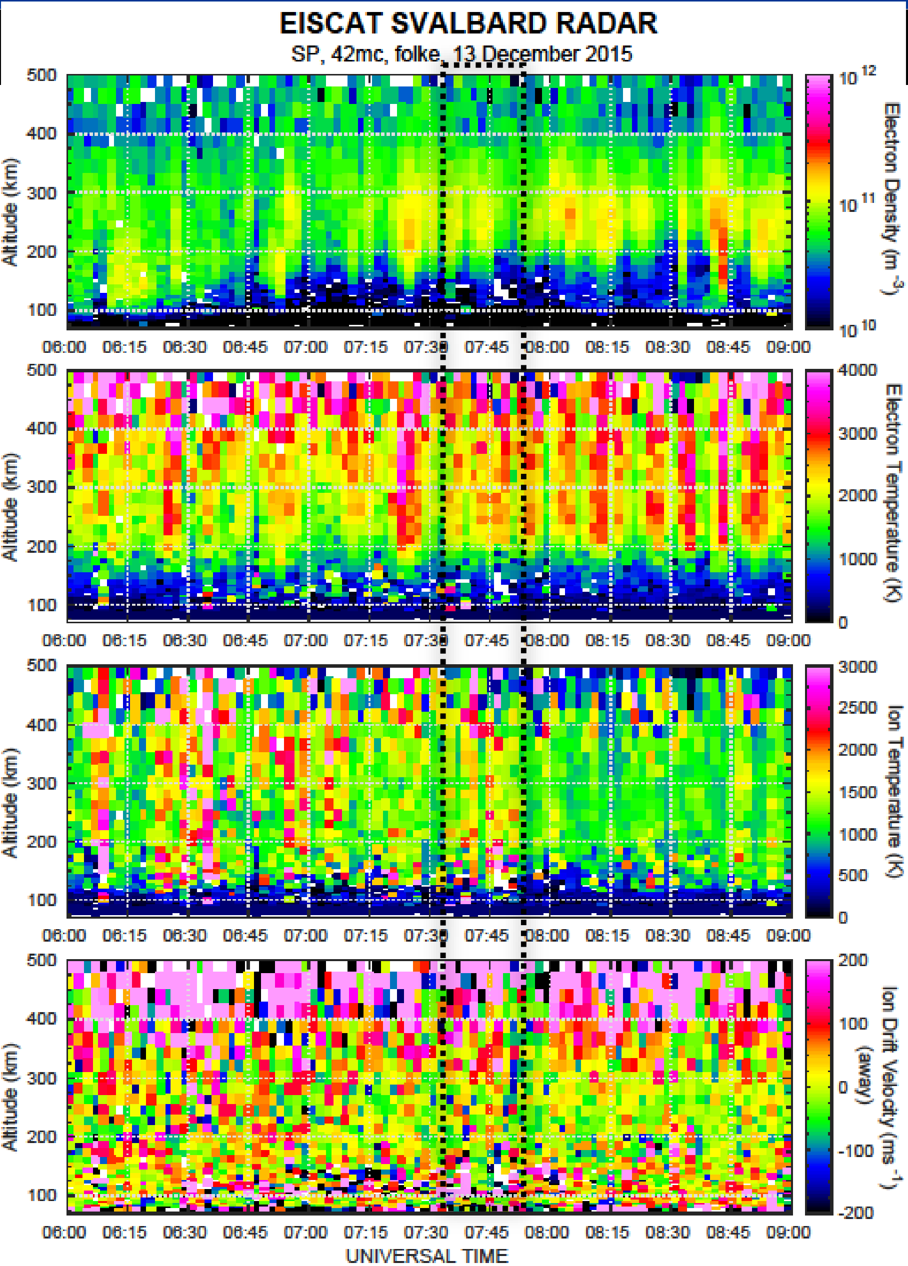
Average 0600 – 0707 UT
Scale: 0-1250 R

Average of OI 630.0 nm emissions acquired by the UiO ASI (67 min.)

Solid black line ≈ PMAF orientation

EISCAT

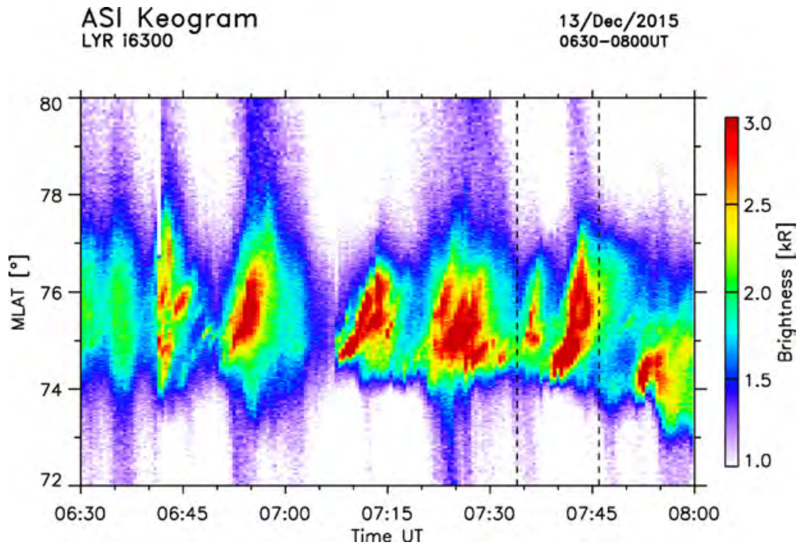
EISCAT



PMAFs are clearly visible in the electron density and temperature plots (top two plots)

Ion temperature enhancements also visible

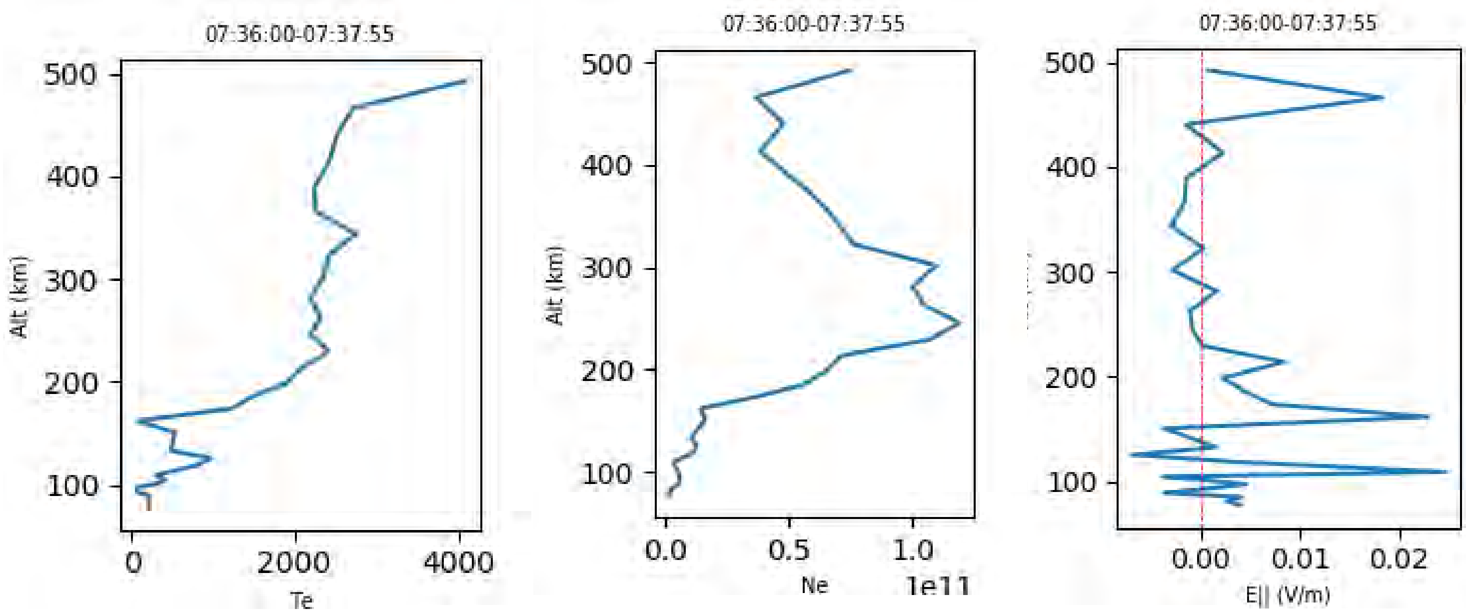
Some weak upwelling signatures throughout



UiO All-Sky Imager (ASI) at KHO real-time monitor

- O I 630.0 nm
- Mapped to MLAT (at 250 km)

Ambipolar field

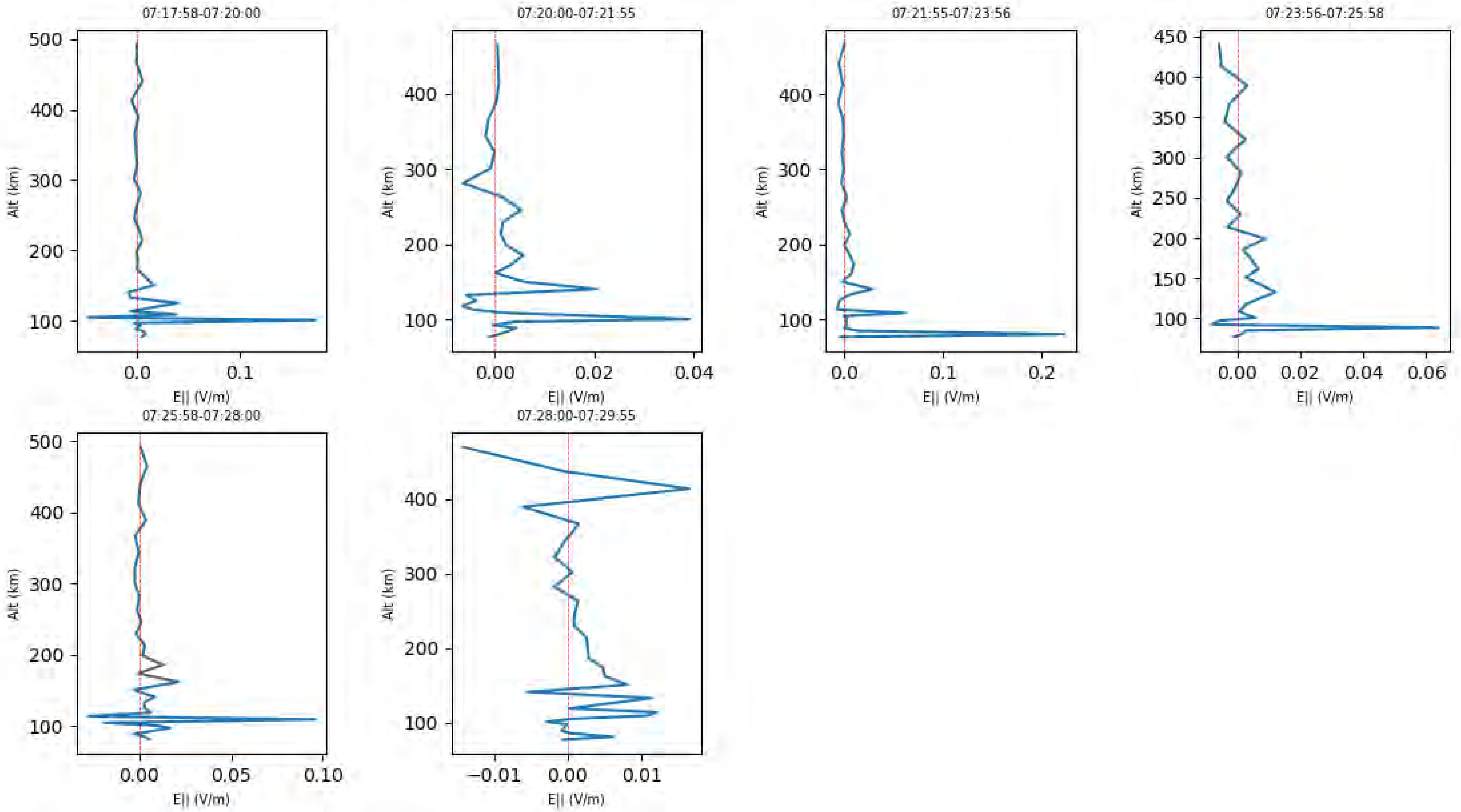


$$E_a = \frac{-1}{en_e}\nabla(k_B n_e T_e) = \frac{-k_B}{e}\left[\nabla T_e + T_e\frac{\nabla n_e}{n_e}\right]$$

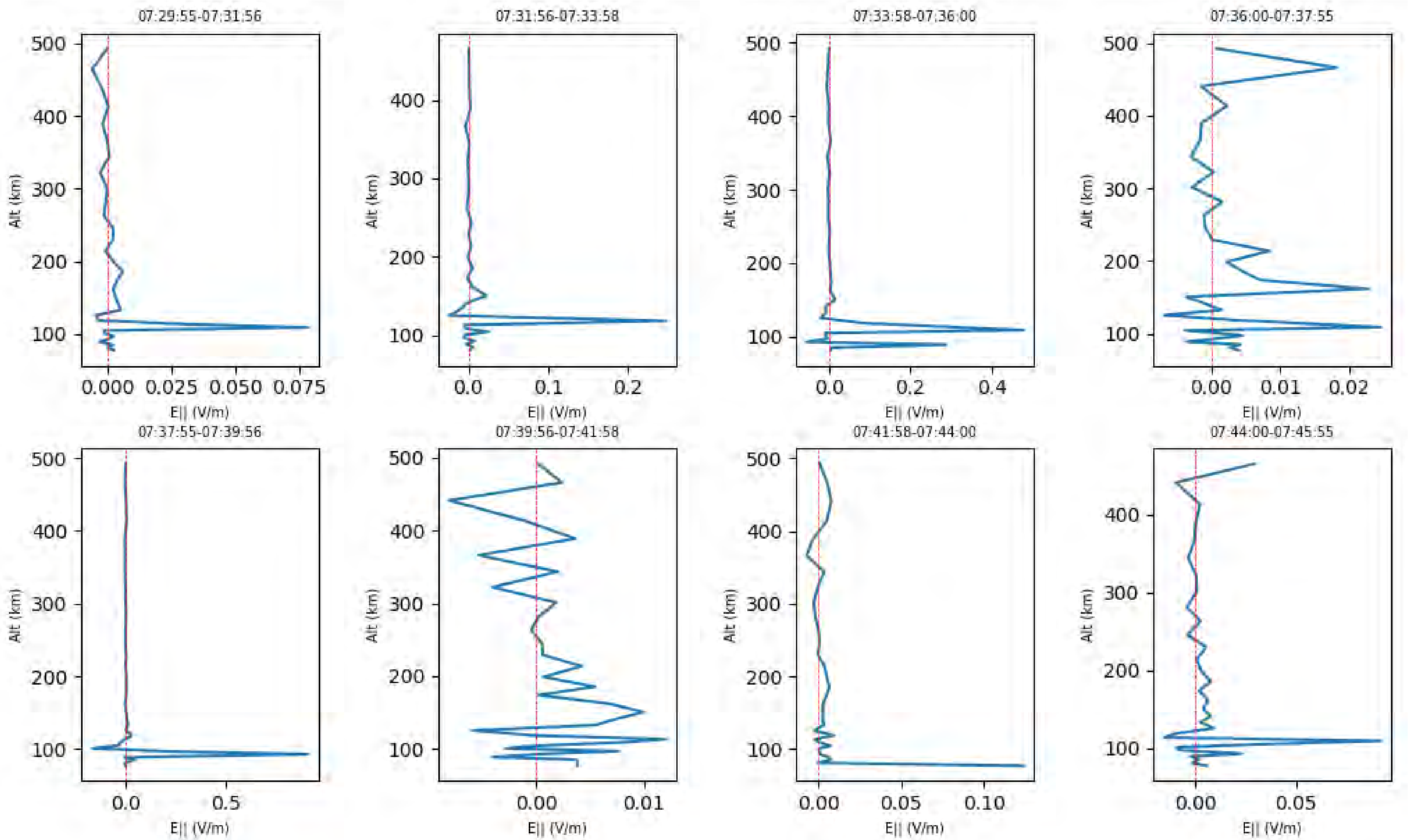
Ambipolar field more effectively driven by Te enhancements

At high altitudes Grad(Te) is small, so the density term dominates [Cohen et al, 2015]

Ambipolar field – preflight

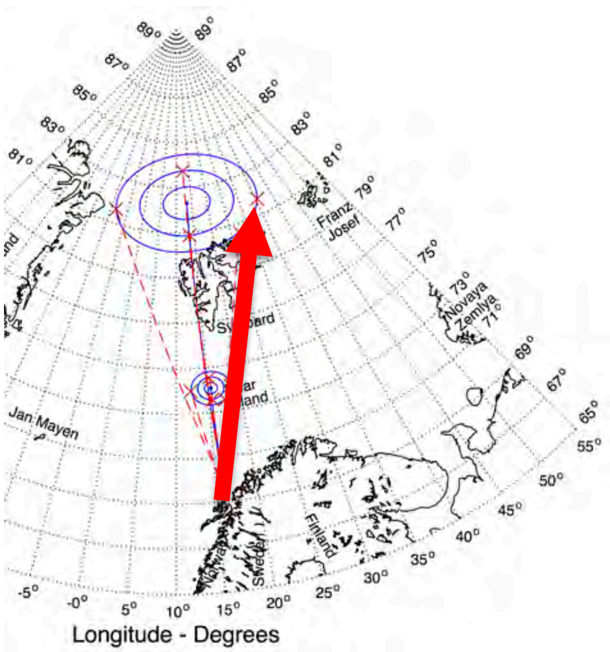


Ambipolar field

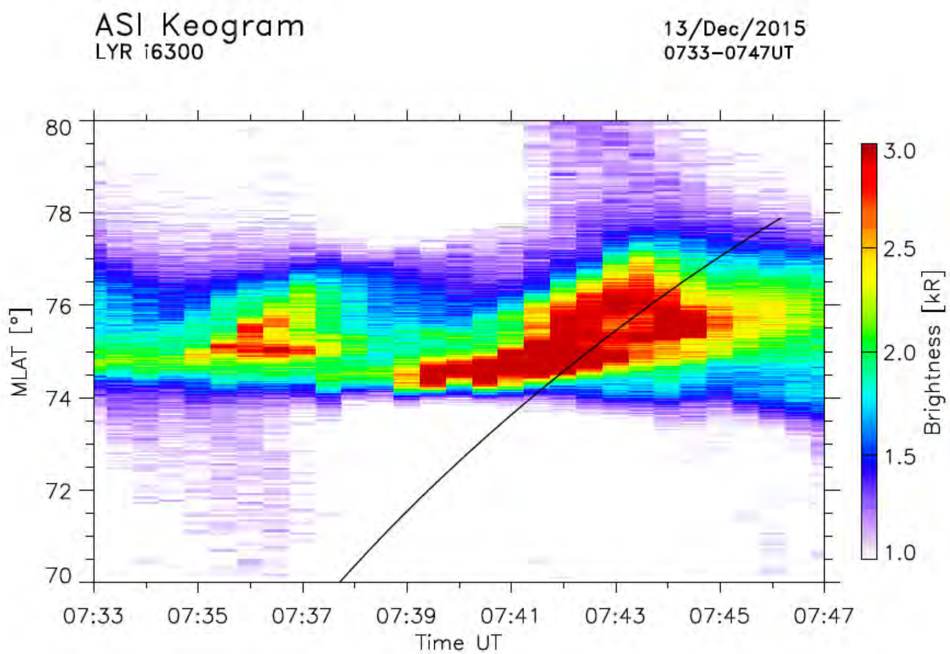


RENU2

Launch profile

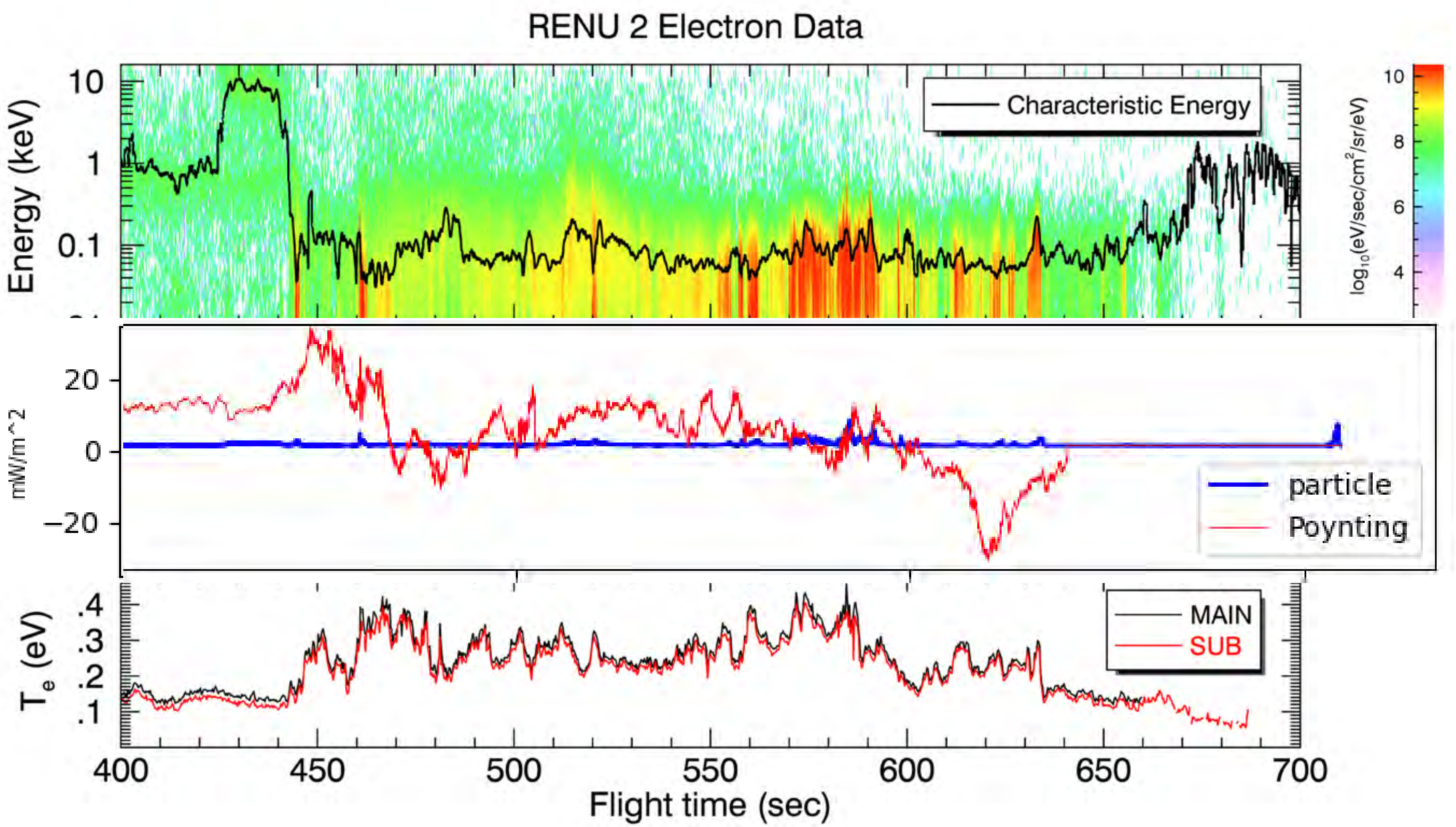


Trajectory east of nominal (within margin)



Actually improved coverage of event!

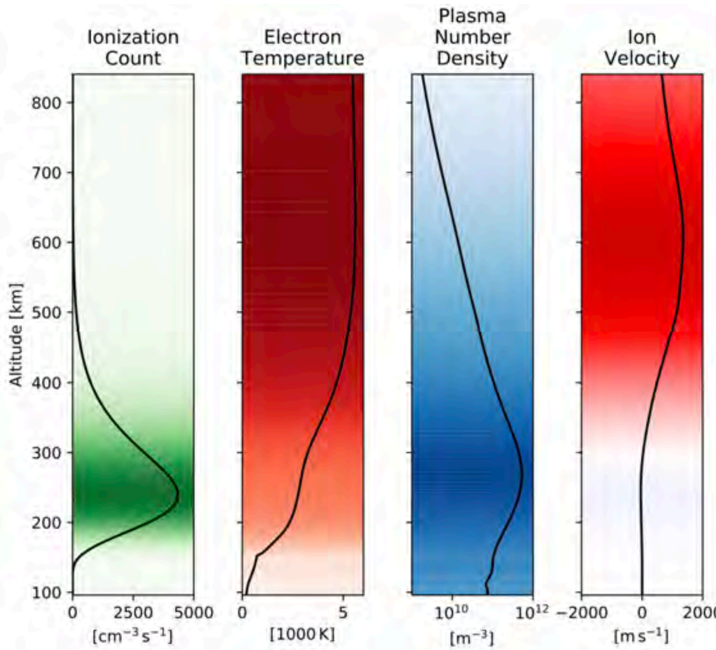
In-situ drivers – electron precipitation

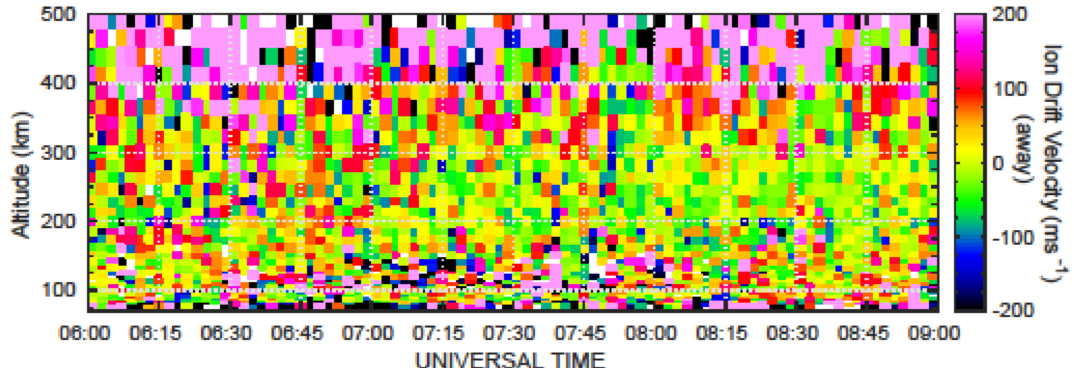


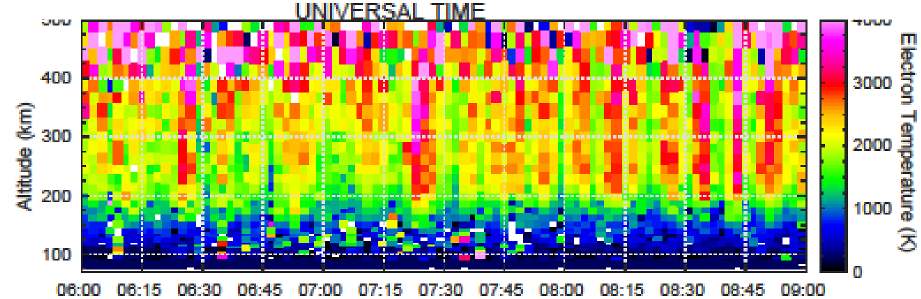
Electrodynamic Model

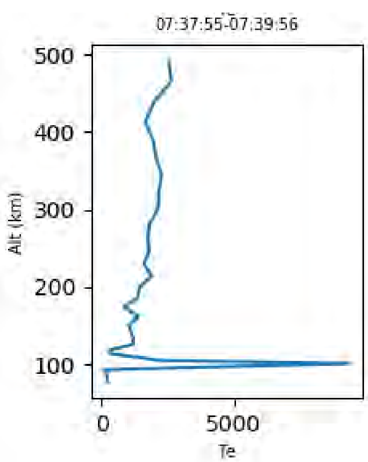
Modeling

Comparisons

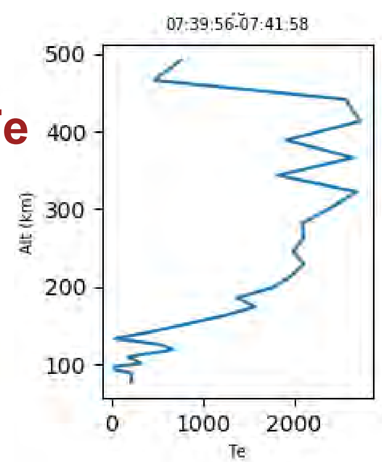


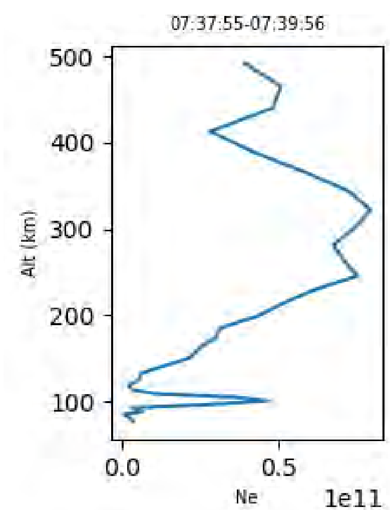




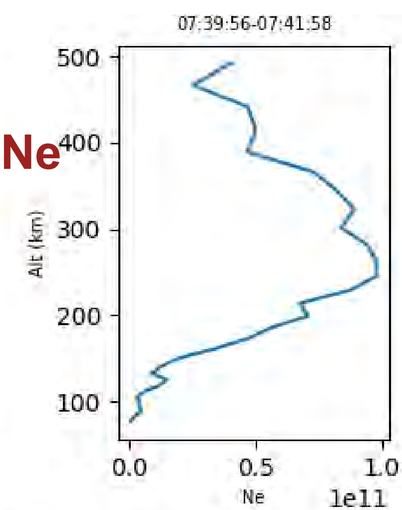


Te





Ne



Conclusions

- PMAFs are highly structured both temporally and spatially and present an ideal event type for cross-scale coupling studies
- Ionospheric response to PMAF drivers shows two time scales: rapid, localized temperature enhancements and more widespread, integrated heating effects
- Modeling this type of response based only on electron precipitation shows similar behavior to observed; inclusion of Poynting flux data should bring this closer

Questions?

- GRL Special issue this winter on RENU2 results

- AGU Special Session — SA016: Observation and modeling of high latitude thermosphere phenomena driven by magnetospheric forcing.