



University of  
New Hampshire

Magnetosphere Ionosphere  
Research Lab



# The Rocket Experiment for Neutral Upwelling 2 (RENU2): Examination of Cusp Dynamics and Energization during Poleward Moving Auroral Forms Events”

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27 June 2018

- Introduction and motivation
- RENU 2
  - Mission description
  - Flight data
- Supplemental observations
  - GRACE
  - DMSP
- Summary

## Neutral Upwelling

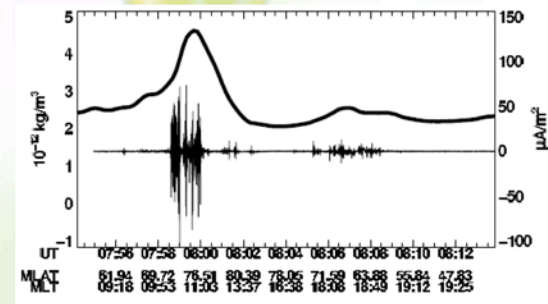
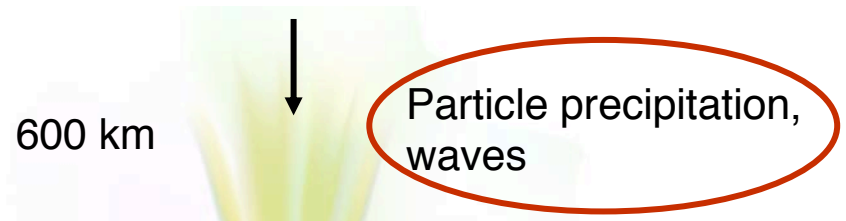
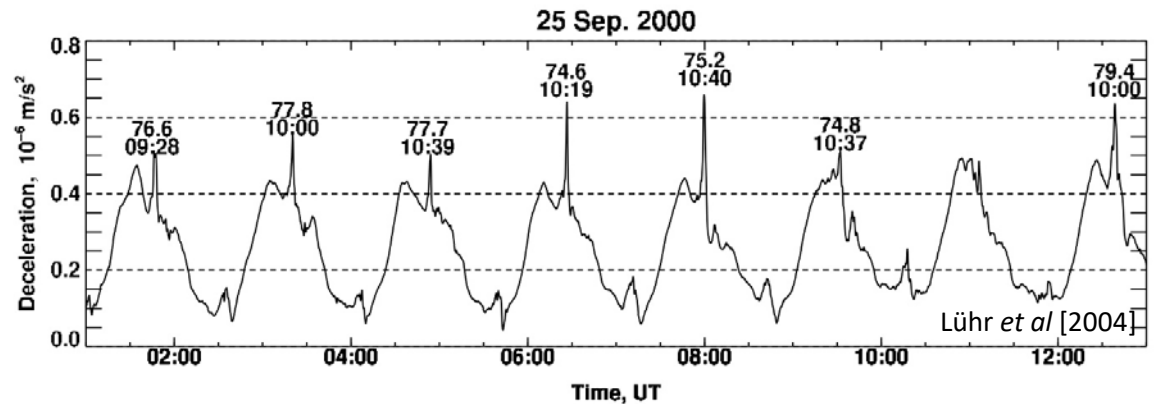
### CHAMP

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

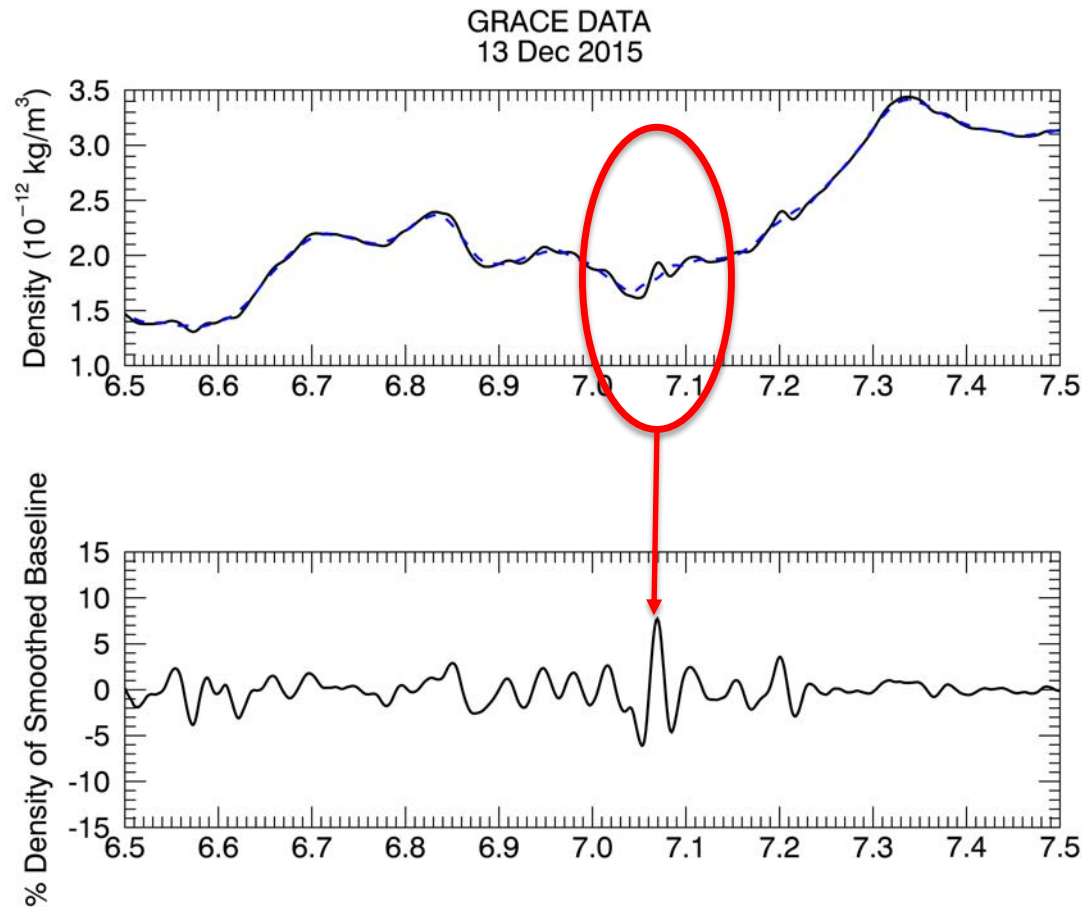


Thermosphere

Ionosphere 100 km

← Joule heating →

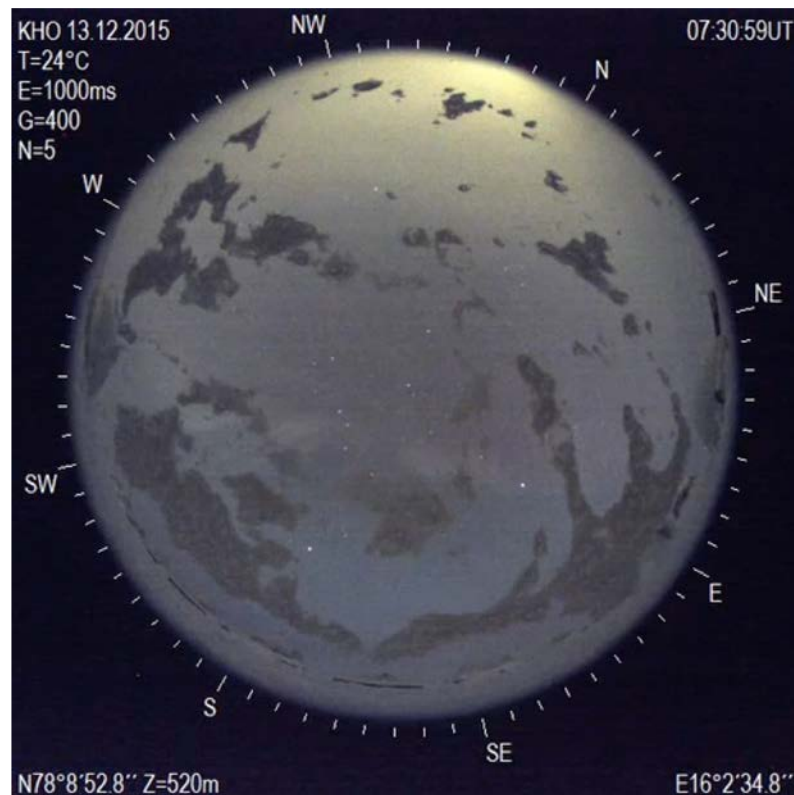
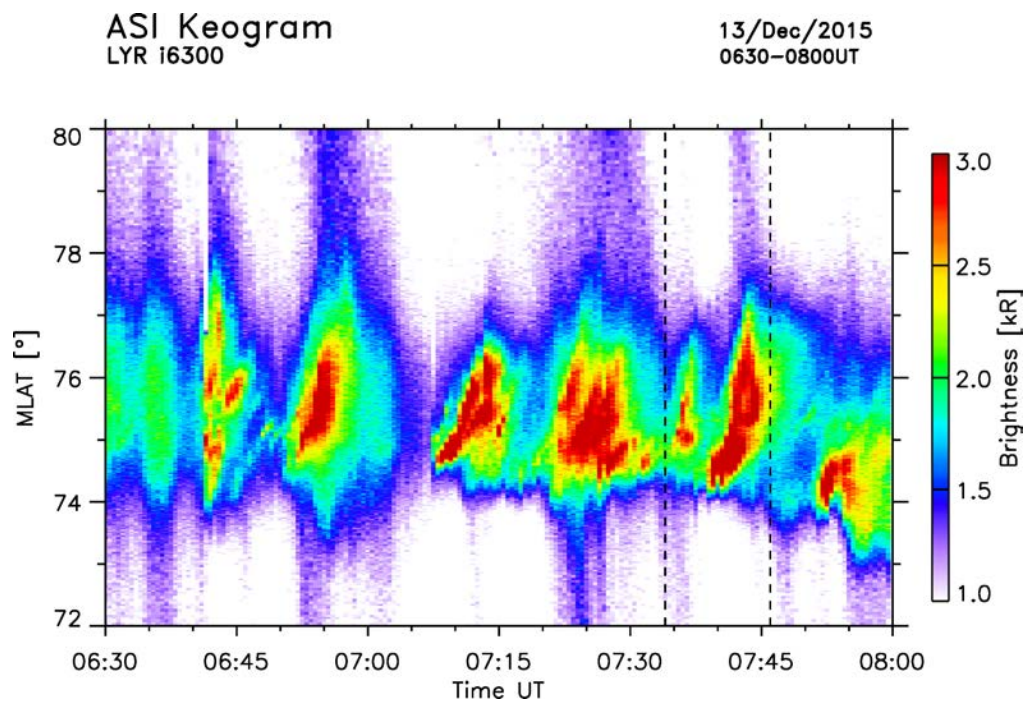
## Neutral Gas Density



Density “bump”  $\approx 10\%$

Not large enough to register in statistical surveys

## Poleward Moving Auroral Forms

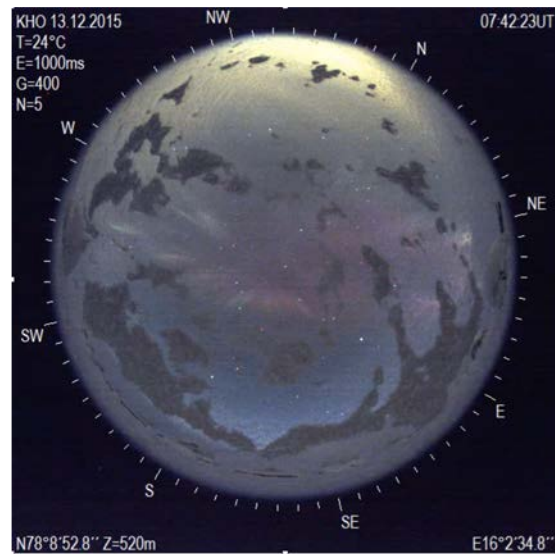
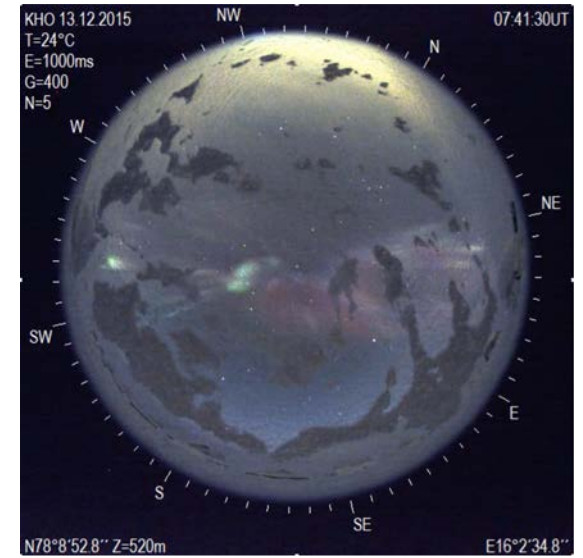
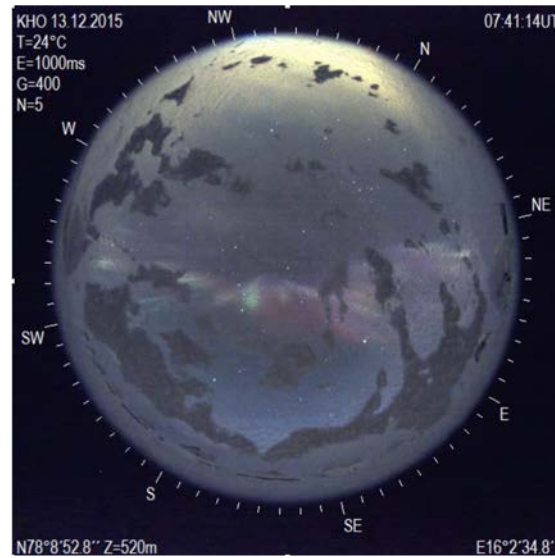
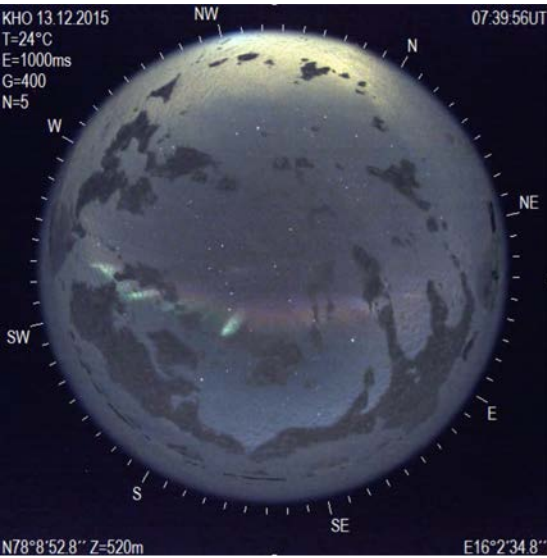


UiO All-Sky Imager (ASI) at KHO real-time monitor

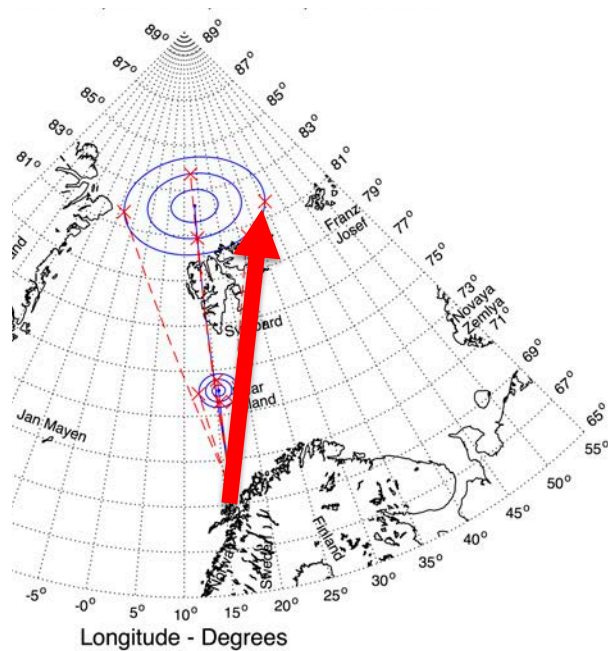
- O I 630.0 nm
- Mapped to MLAT (at 250 km)

Back illuminated Sony Exmor IMX174 CMOS Fujinon F/1.4 fish-eye lens

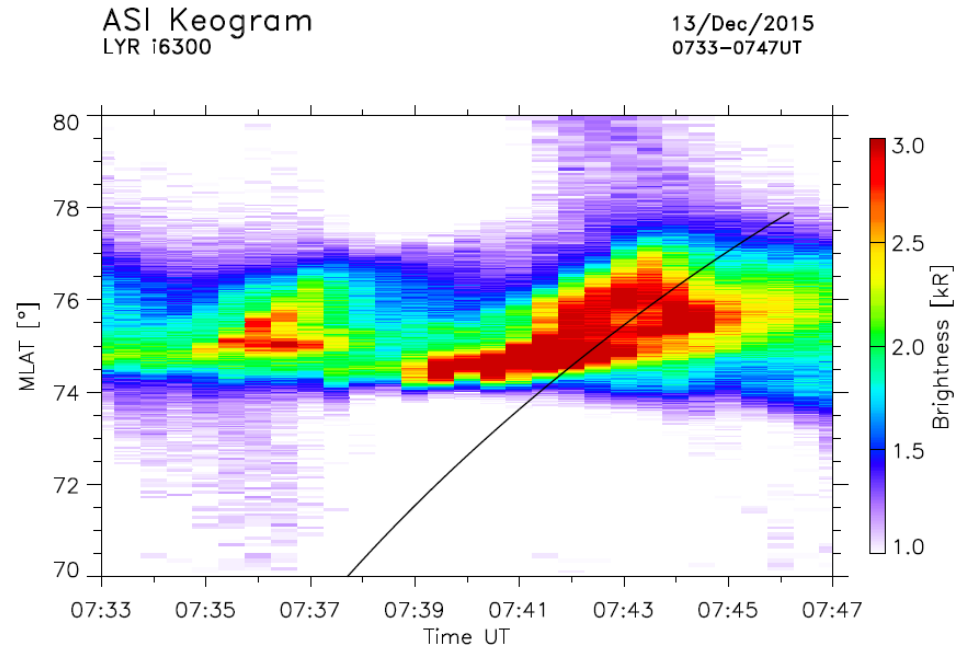
## PMAF frames – Evolution of one PMAF



## Launch profile



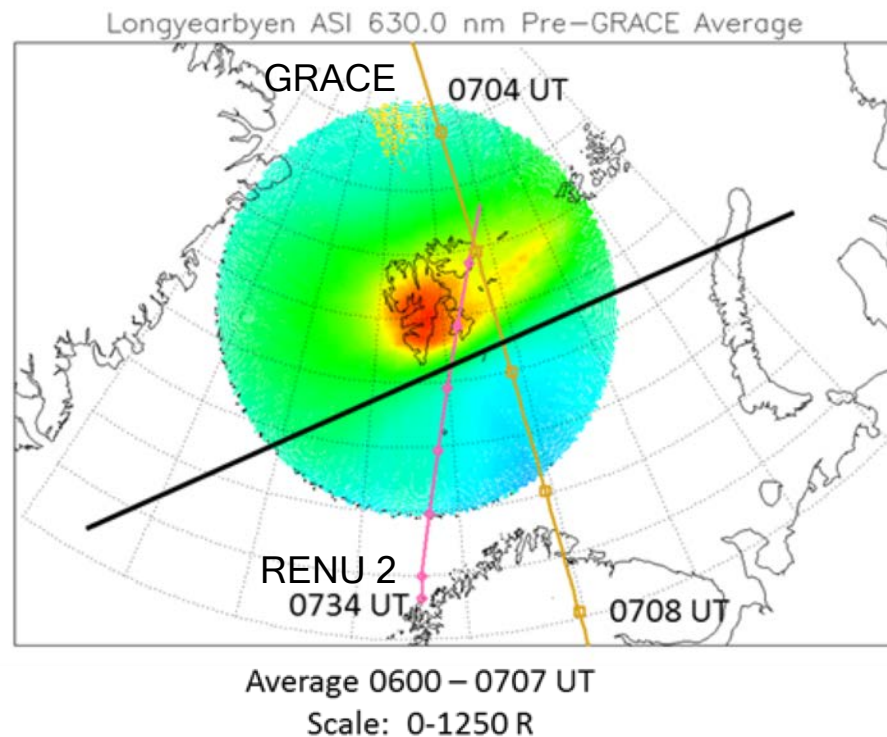
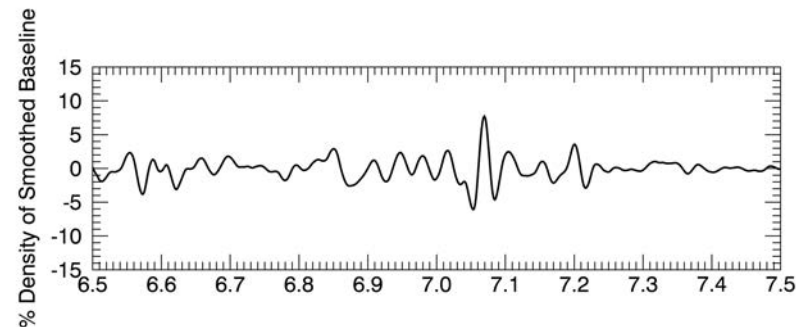
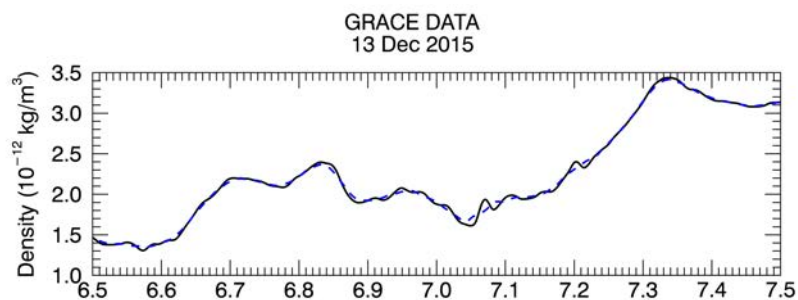
Trajectory east of nominal  
(within margin)



Actually improved  
coverage of event!

## Average PMAF emission intensity

- GRACE may have missed the enhancement
- Background thermosphere density provides baseline for other models/measurements



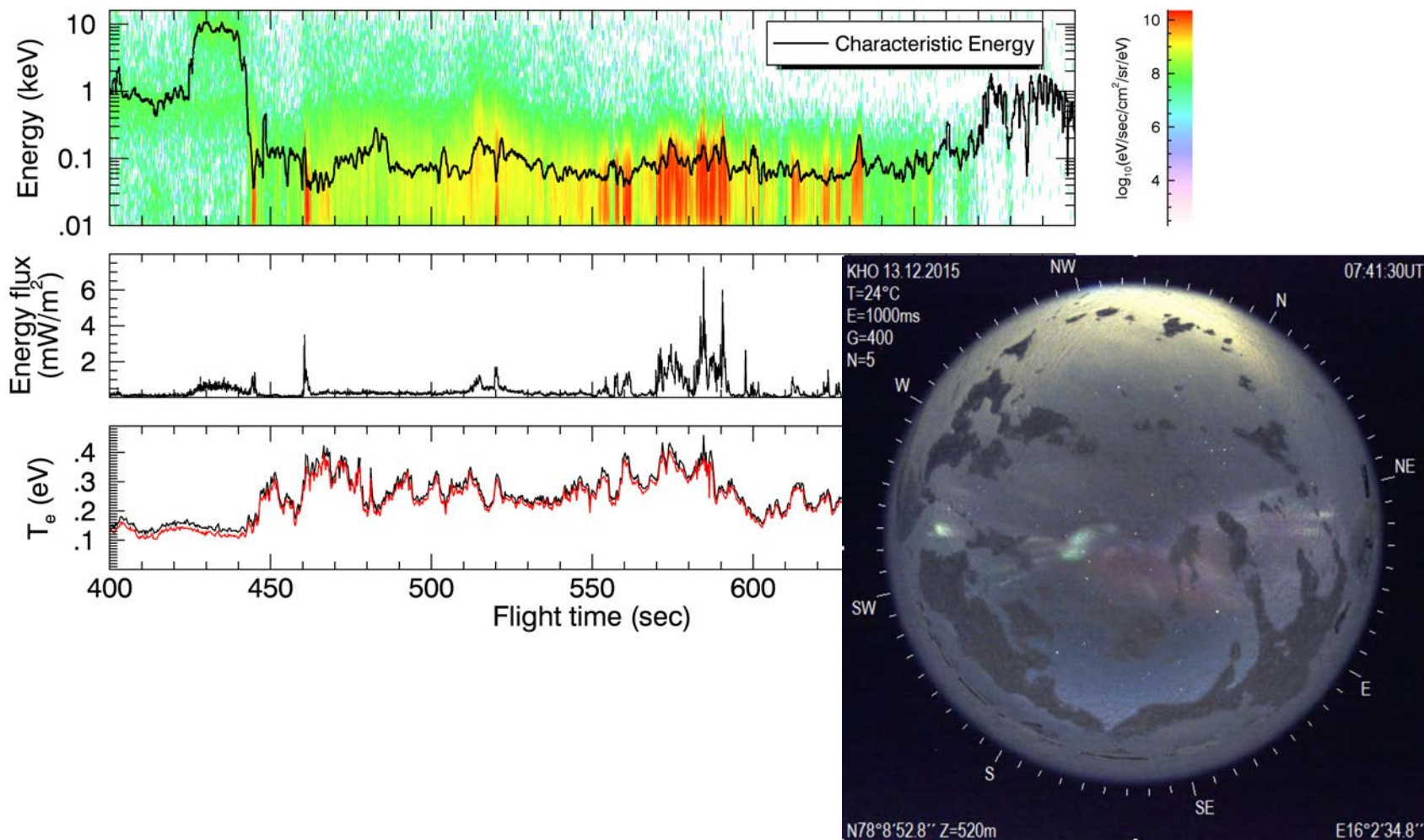
Average of OI 630.0 nm emissions acquired by the UiO ASI (67 min.)

Solid black line  $\approx$  PMAF orientation

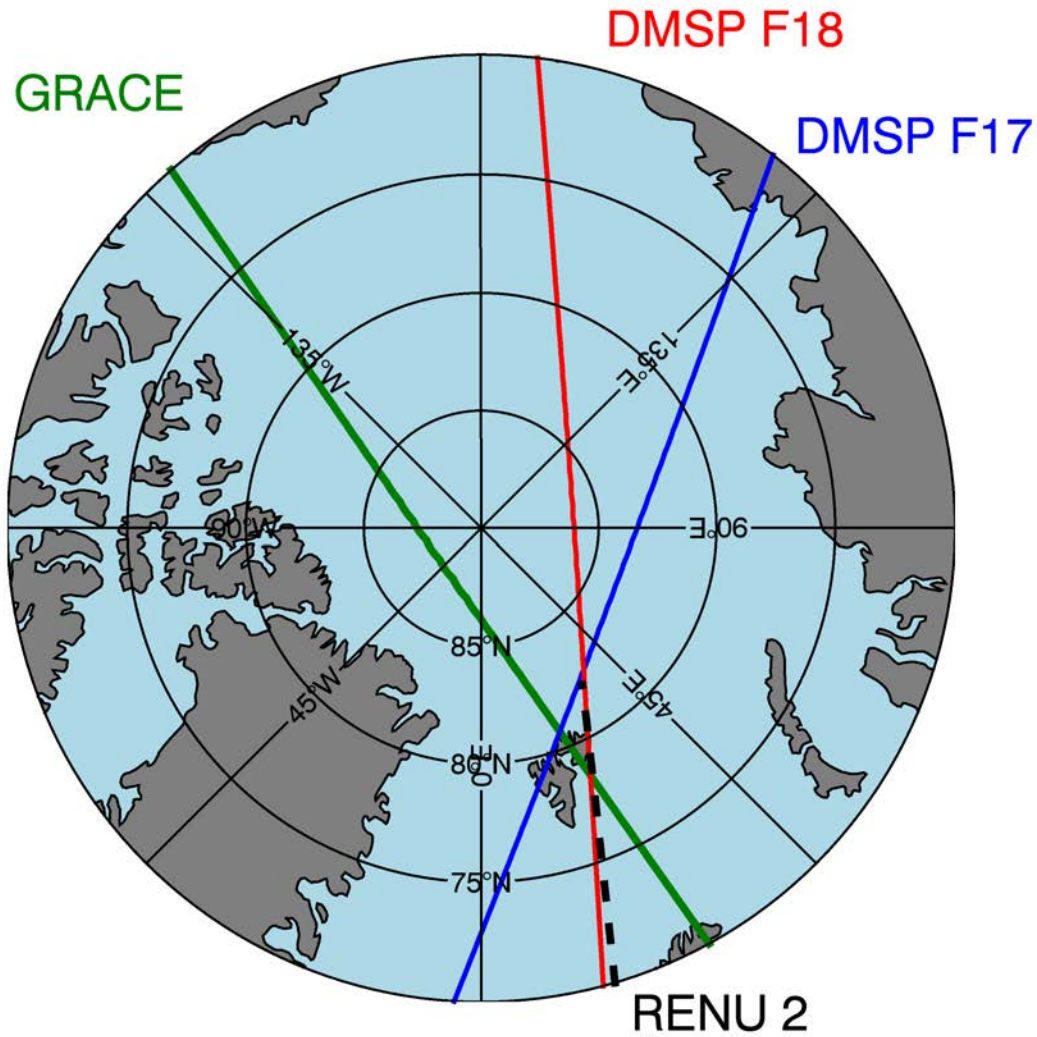


## RENU2 precipitating electrons

RENU 2 Electron Data

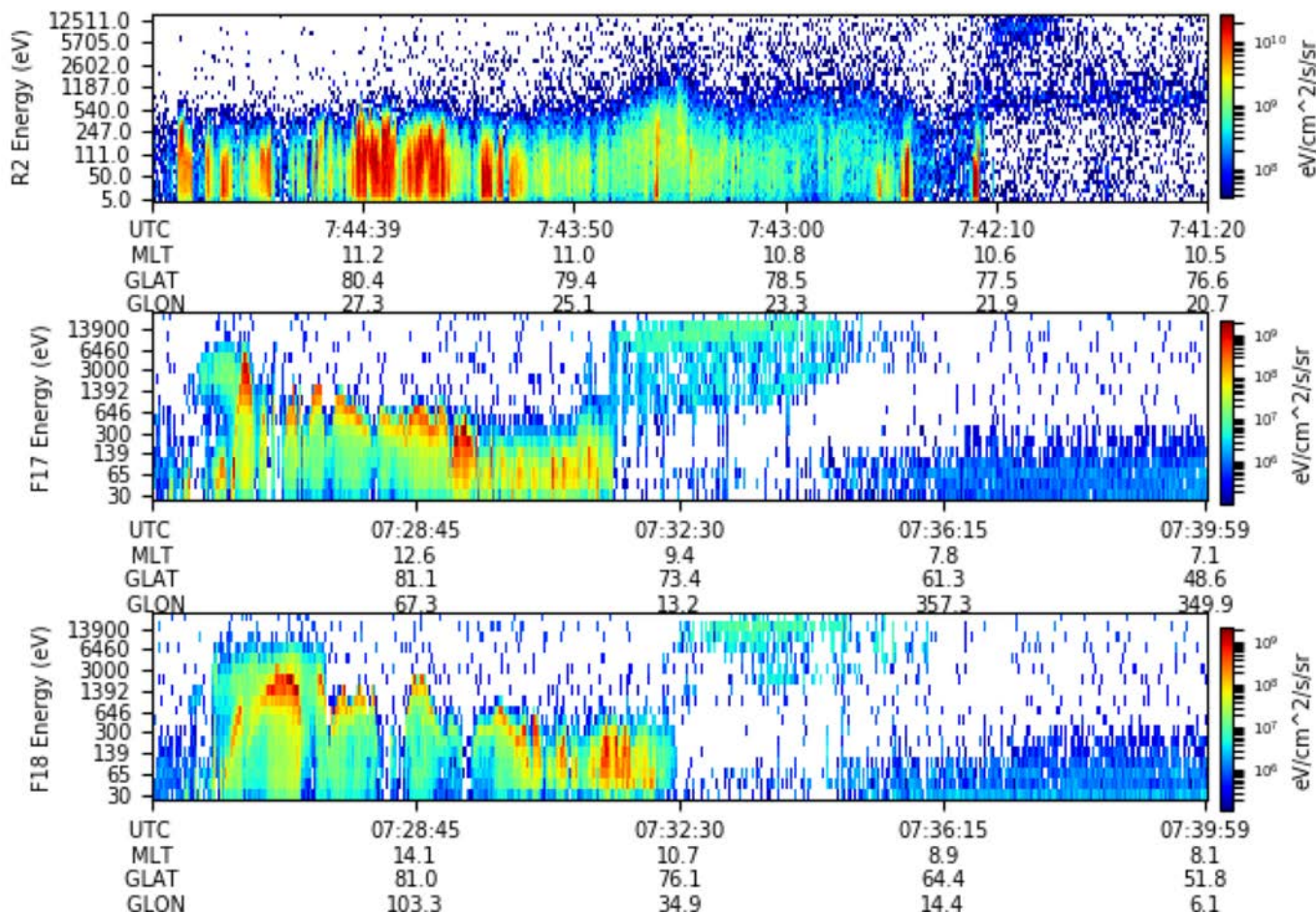


## Spacecraft trajectories



## Precipitating Electron Observations – comparison

Electron Precipitation from RENU2, DMSP F17, F18

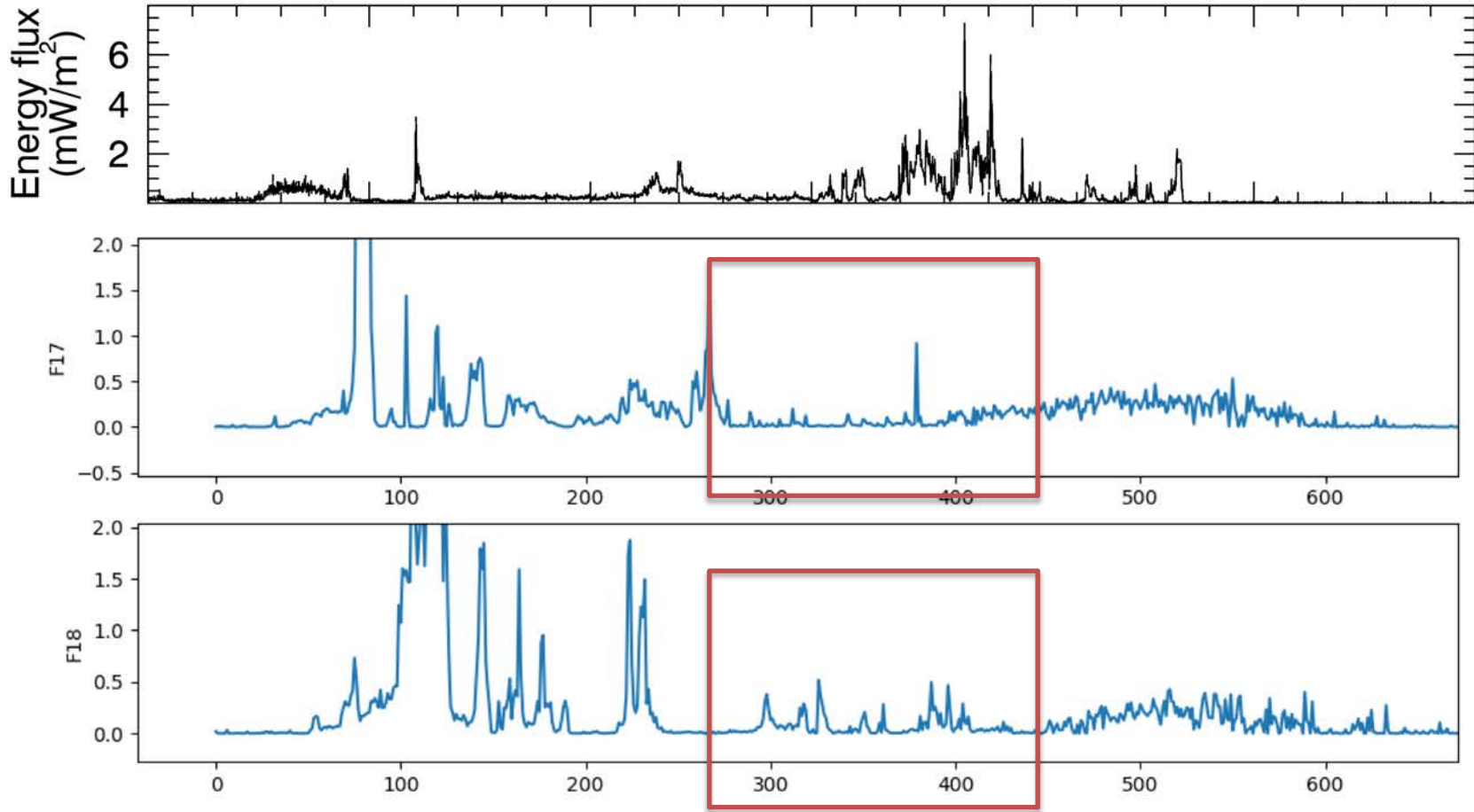


RENU data reversed to match trajectory direction of DMSP

~400 km of vertical separation between DMSP and RENU2

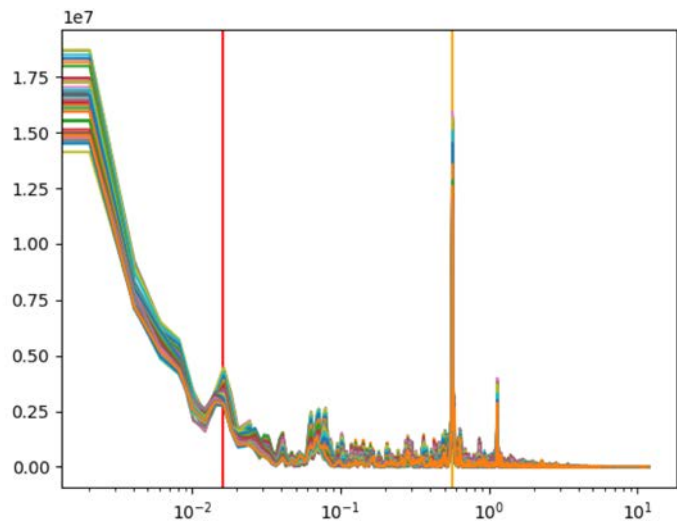
RENU sees ~order of magnitude higher particle flux than DMSP

## Energy carried by electrons



Red box denotes cusp precip in the DMSP data.

## Wave - Particle interactions (preliminary)

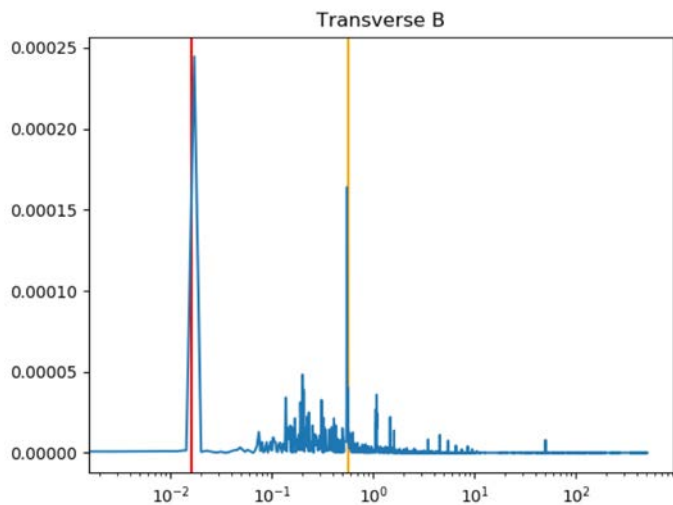


Fourier transform of all EPLAS energy channels  
Should show rates at which particles are arriving

'Bumps' at .016, .07, .566, 1.1 Hz

.566 Hz corresponds to payload spin (orange line)

.016 Hz — red vertical line



Fourier transform of transverse B component  
from Billingsley mag shows large spike at .016  
Hz (payload spin signature also visible)

- ✓ RENU2 campaign did not see “canonical high % neutral density enhancement” but provides perhaps the most complete data available to understand ionospheric/thermospheric response of the cusp region during PMAF event
- ✓ PMAFs are highly spatially, temporally structured
- ✓ RENU2 provides very high degree of spatial resolution of electron precip: <100m scale, with 42ms time scale
- ✓ Significant differences in electron flux/energy flux between DMSP and RENU2 is compelling, but needs further study – need to look at Poynting flux
- Work in progress...

For more information...

- Recent approval for GRL Special Issue on RENU2 results.
- AGU Special Session — SA016: Observation and modeling of high latitude thermosphere phenomena driven by magnetospheric forcing.

A big thank you to the small army of people who have made this project possible

UNH

Marc Lessard

Mark Widholm, Paul Riley, Phil Demaine,  
Aaron Bolton, Stan Ellis, Todd Jones, Mark  
Chutter

Ian Cohen , Brent Sadler, Kristoff Paulson,  
Hyomin Kim

Chrystal Moser, Matt Blandin, John  
Heavisides, Meghan Fisher, Tyler Chapman,  
Anthony Velte, Maria Panacopoulos, Phil  
Fernandes, Matt Young

RENU 2

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Meghan Harrington, Spencer Hatch,  
Tim Cook, Supriya Chakrabarti, Larry  
Paxton, Ken Dymond