

# Group 3: THEMIS36

## Observations

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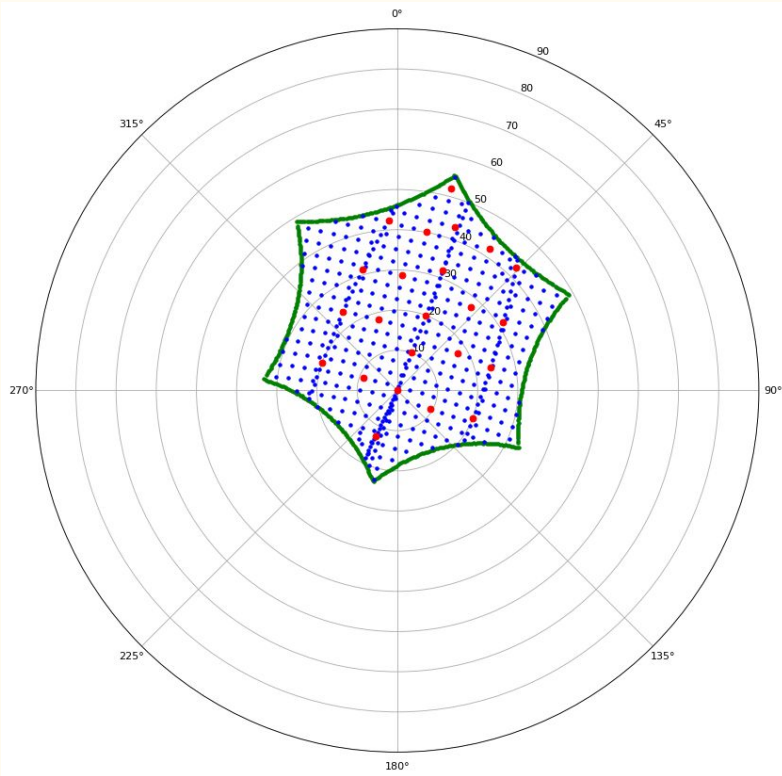
Observational  
Goals:

Can we catch the  
auroral oval?

# The Experiment

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# THEMIS36



- Time History of Events and Macroscale Interactions during Substorms
- 23 beams

# Hard Target Identification

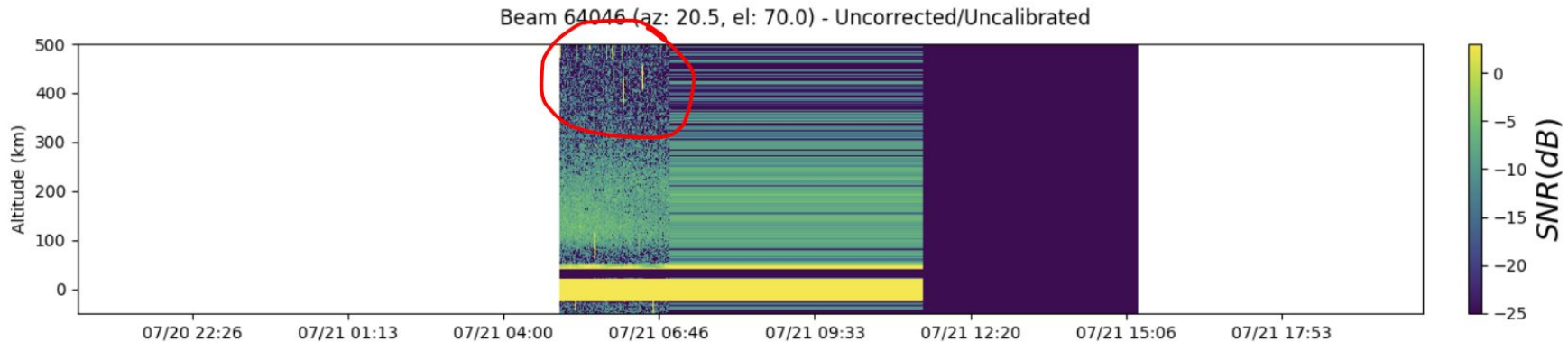
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We spotted some coherent echoes during our experiment.

**What were they?**

# Satellites spotted

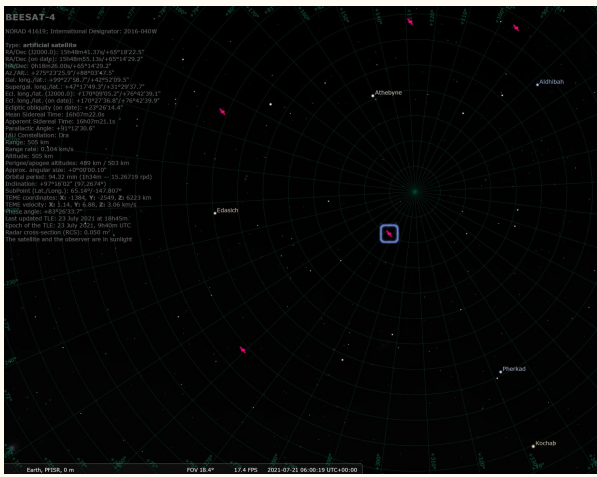
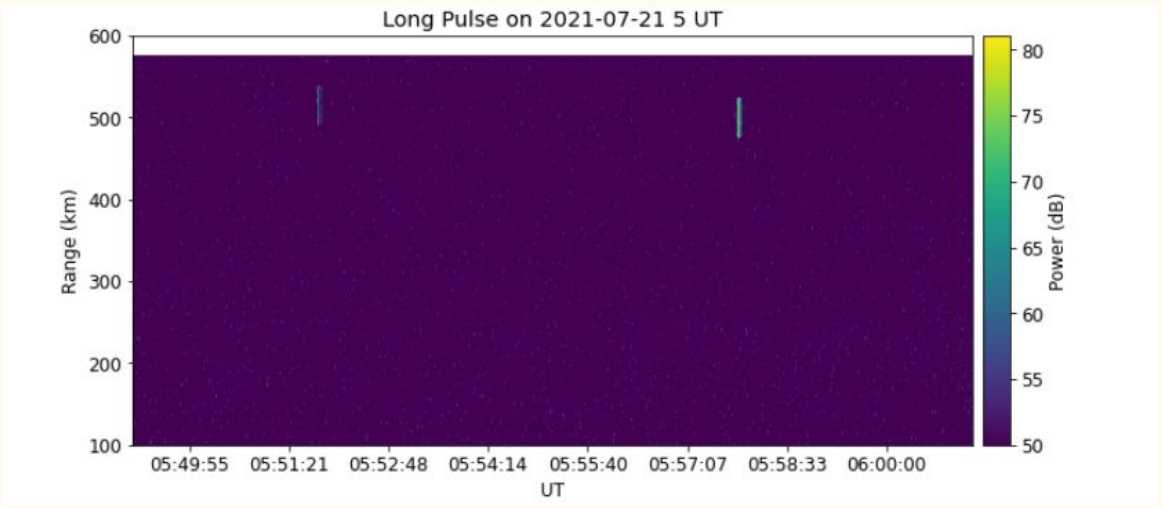
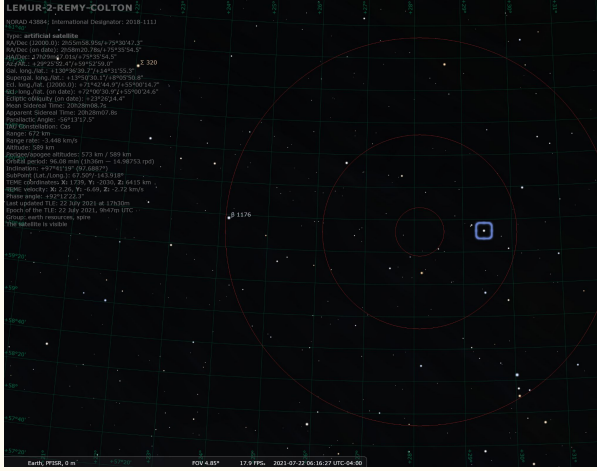
Coherent echoes are visible on the realtime diagnostic plot, but filtered out in the published data products.



<https://amisr.com/realtime/viewer/dtc0/>

# Satellites spotted

With access to the raw data (thanks, Ashton!) we were able to plot the data, extract approximate timestamps for the echoes, then find the satellites in Stellarium.





## Suspects:

- 05:27 UT: LEMUR-2  
LUCYBRYCE, 495 km
- 05:57 UT: BEESAT-4, 505 km

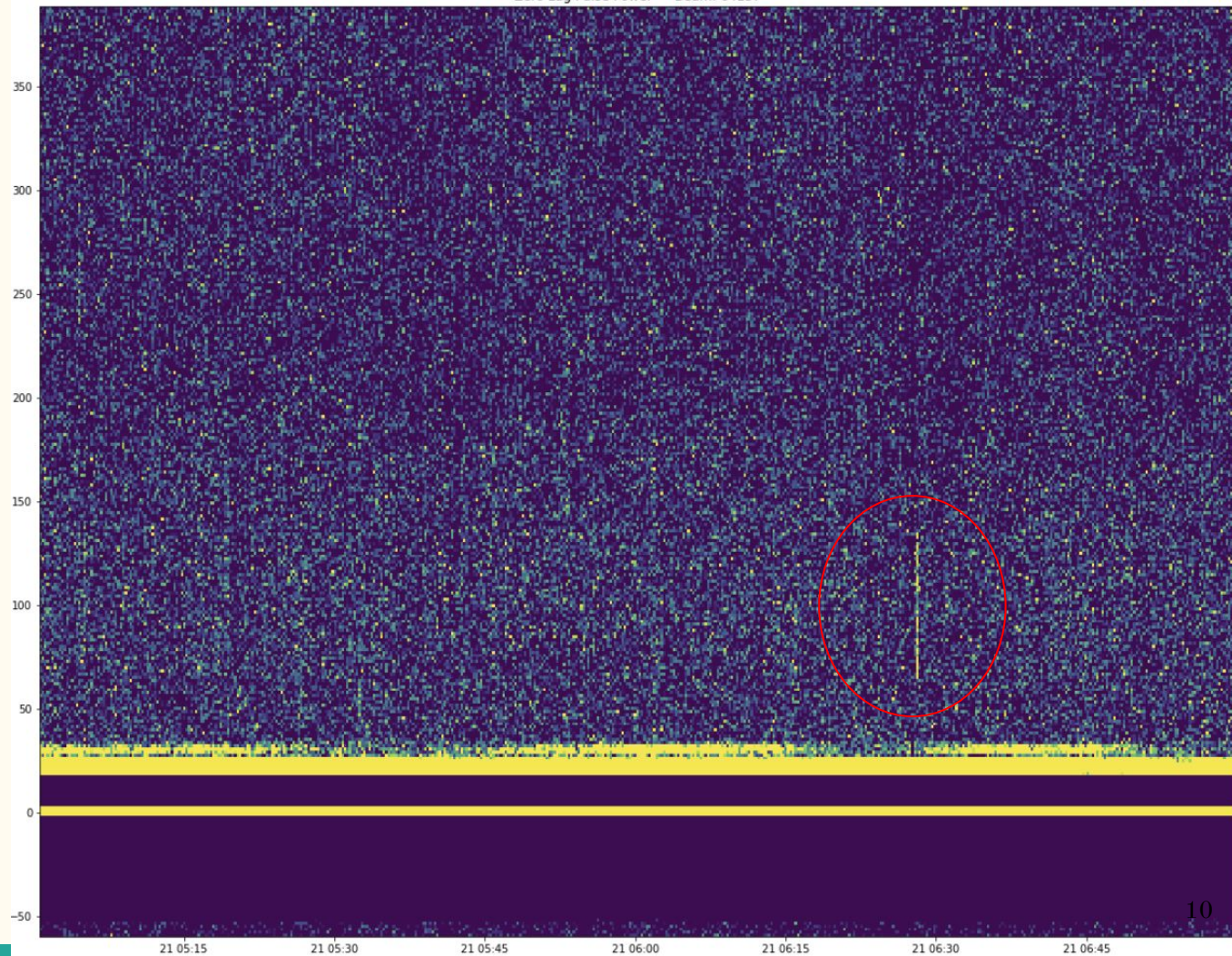
Not very scientific, but it was a good way to develop our understanding of PFISR as an instrument:

- Derived data != raw data
- Highlights spatial orientation of beams, distinctions between long pulse and alternating codes
- Good activity for a quiet night



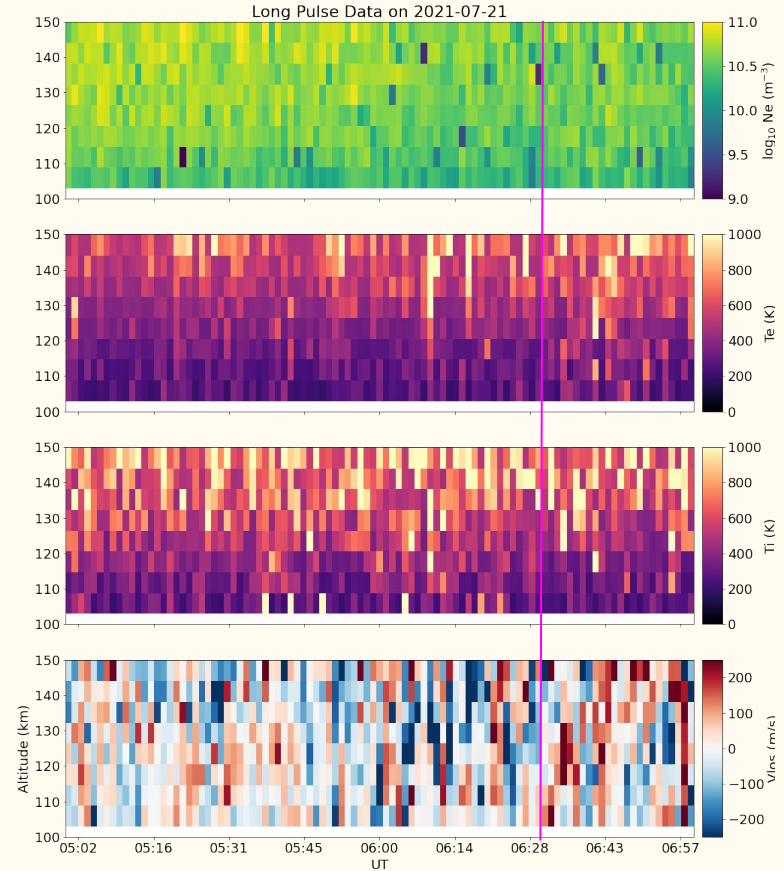
# Meteor trail?

Only visible on  
the field-aligned  
beam



# E-region parameters

- No sporadic E detected
- Slight decrease in the electron density after 6 UT
- Increase in electron temperature after 6:30 UT



# Aurora in July

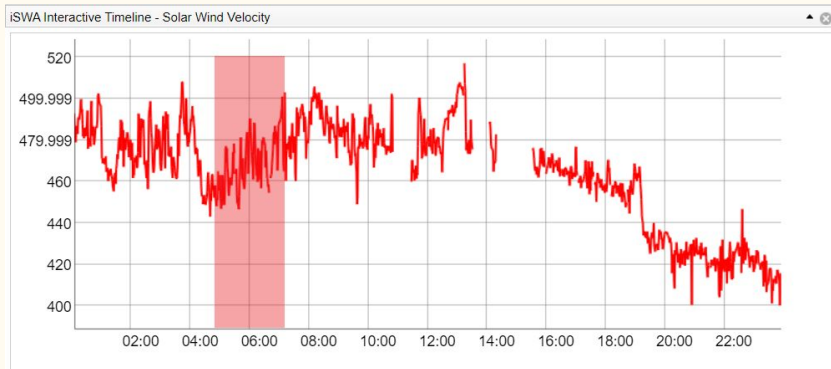


Our measurement objective was to observe auroral precipitation. Instead we recorded good control period.

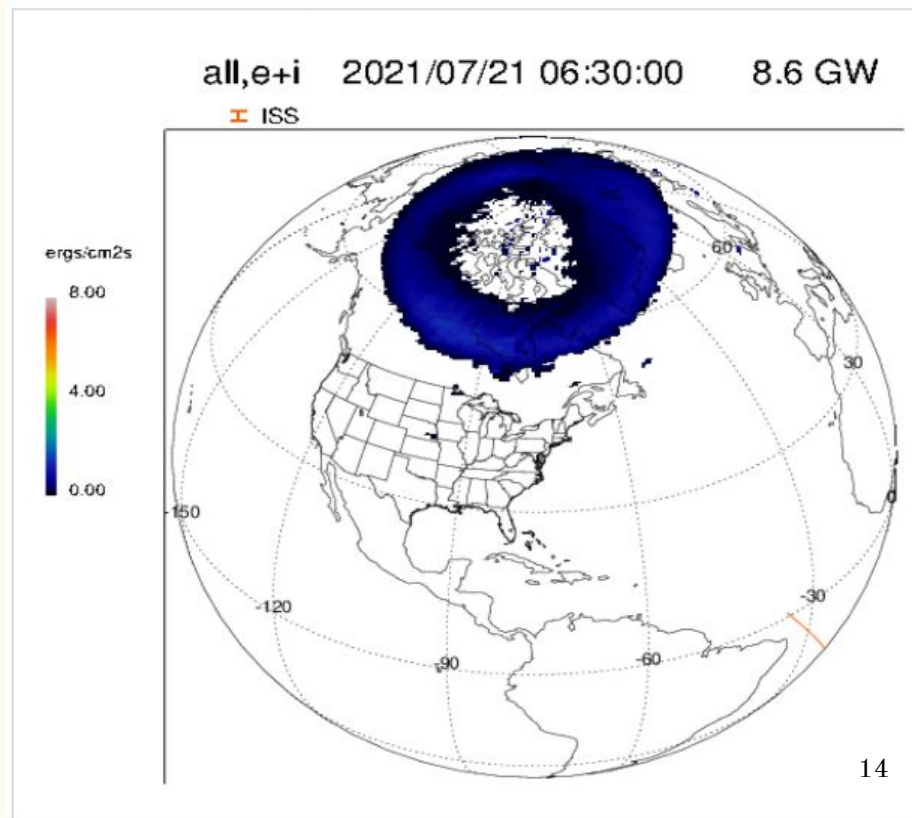
**Looking at historical data, when is aurora most likely at this point in July?**

# Our experiment → 21 July 2020

- 5-7 UTC
- Max AE below 250 nT
- $K_p=1$
- HSS → max 500 km/s
- No significant flares
- Quiet Night
- PFISR running Themis36



Ovation Prime Energy Flux: Electrons and Ions 10 Re above Earth



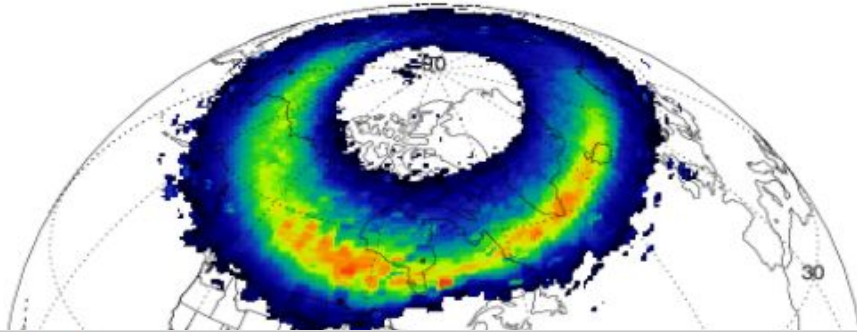
all,e+i 2017/07/17 06:35:00 53.3 GW

ISS

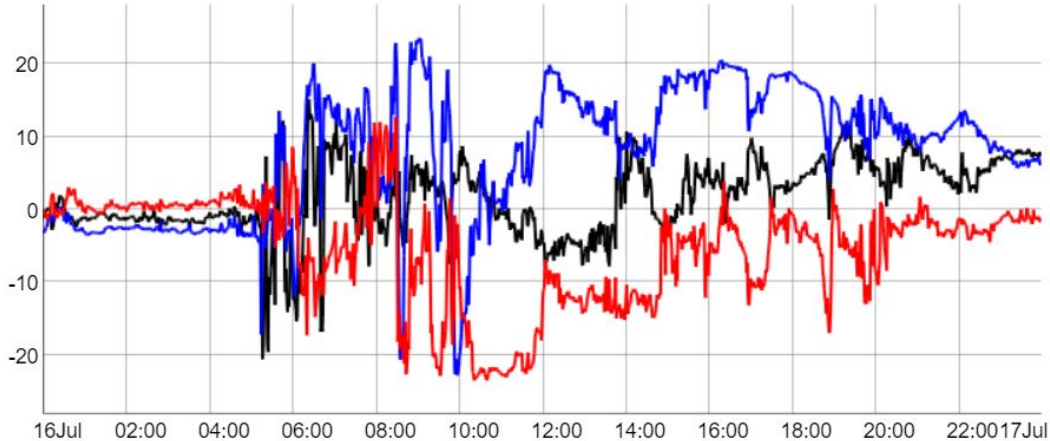
ergs/cm<sup>2</sup>s

8.00

4.00



12  
11  
10  
9  
8  
7



## 17 July 2017

- Max AE 1096 nT
- Kp=4
- *Lots* of aurora
- CME Arrival
  - 750 km/s
  - M2.4 Flare
  - Hit Earth 16 July 21.42 UTC
  - Bz -23 nT

# Aurora Observations, 17 July 2017



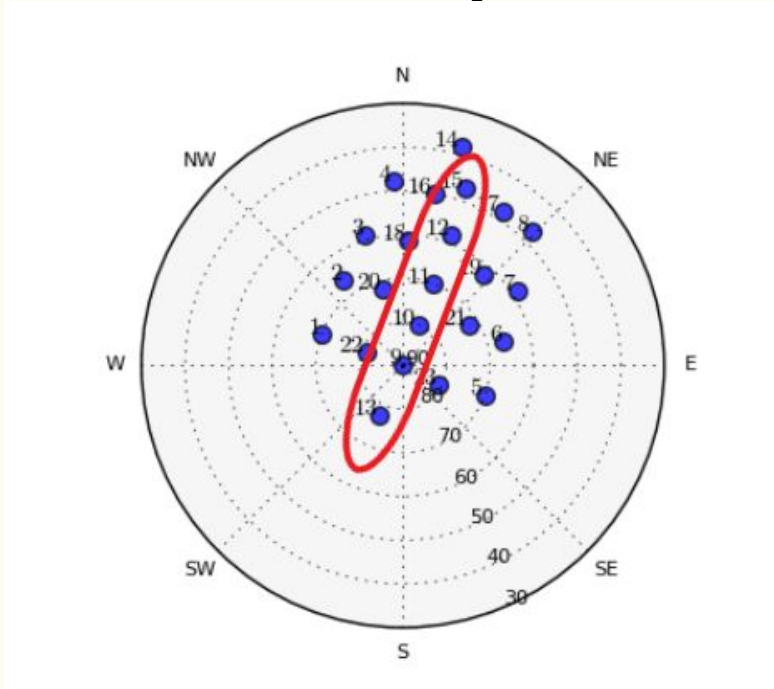
*Citizen science footage from Avonlea, Saskatchewan*  
<https://www.youtube.com/watch?v=OALiNs78hpo>



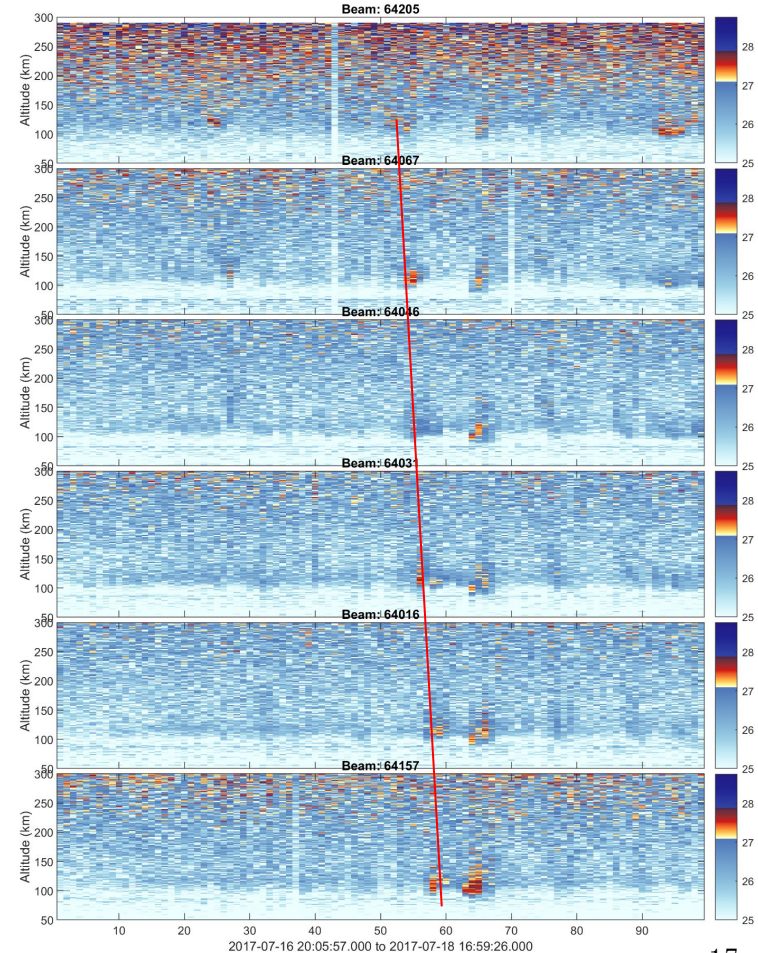
2017/07/14 00:00

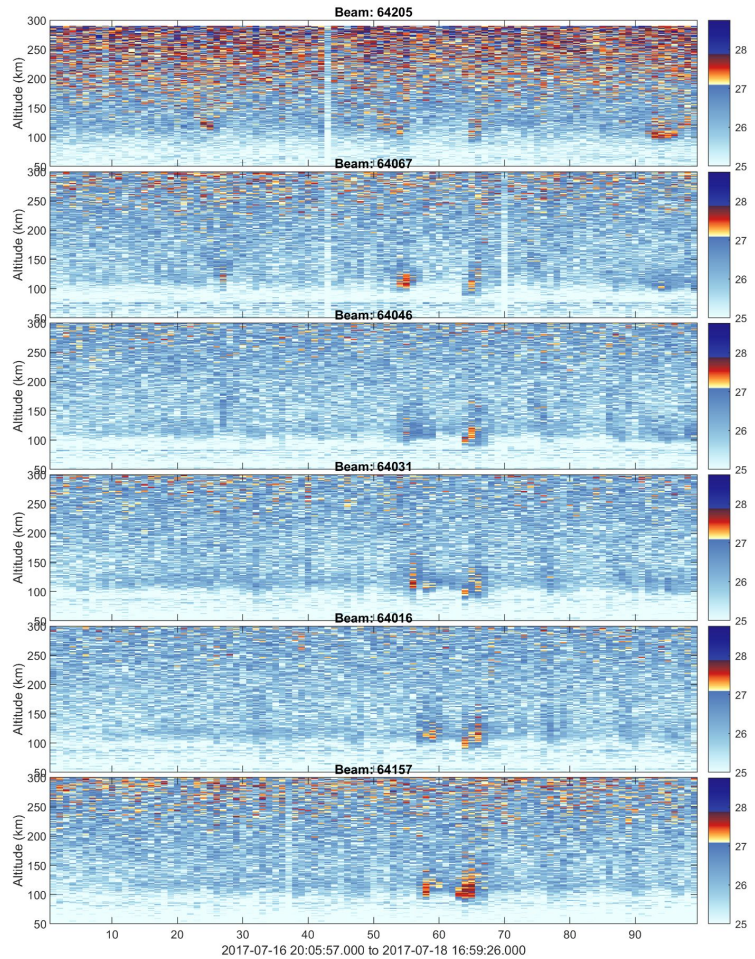


# Electron density variations

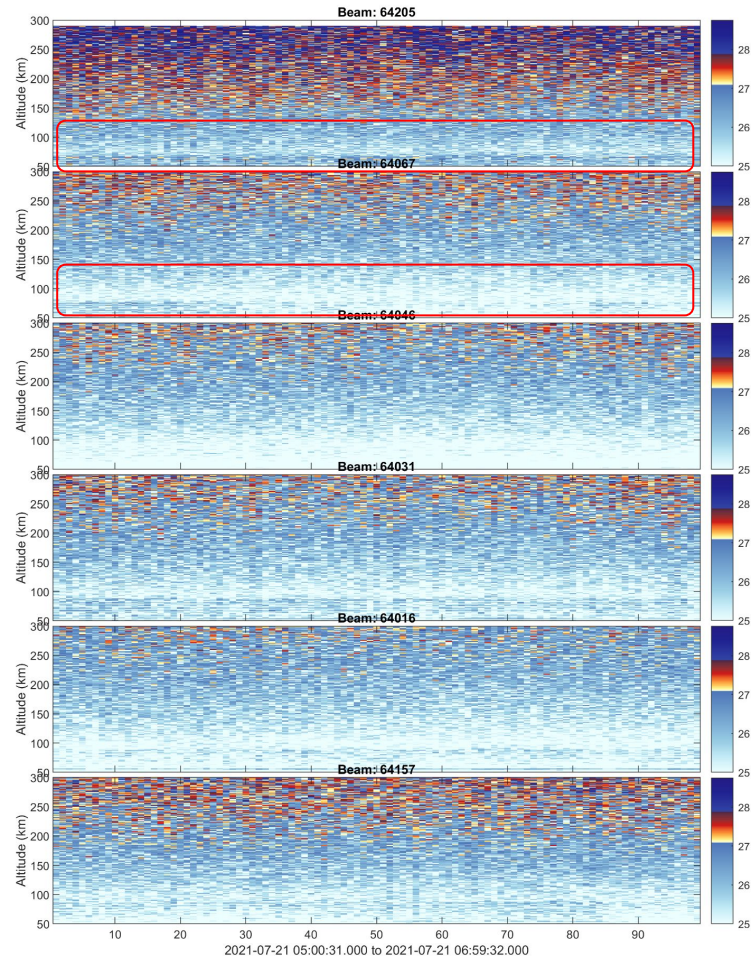


- Density structure propagating southwards
- Related to the passage of the auroral structure
- Vertical beam shows density enhancement in F-region too





2017-07-16 20:05:57.000 to 2017-07-18 16:59:26.000



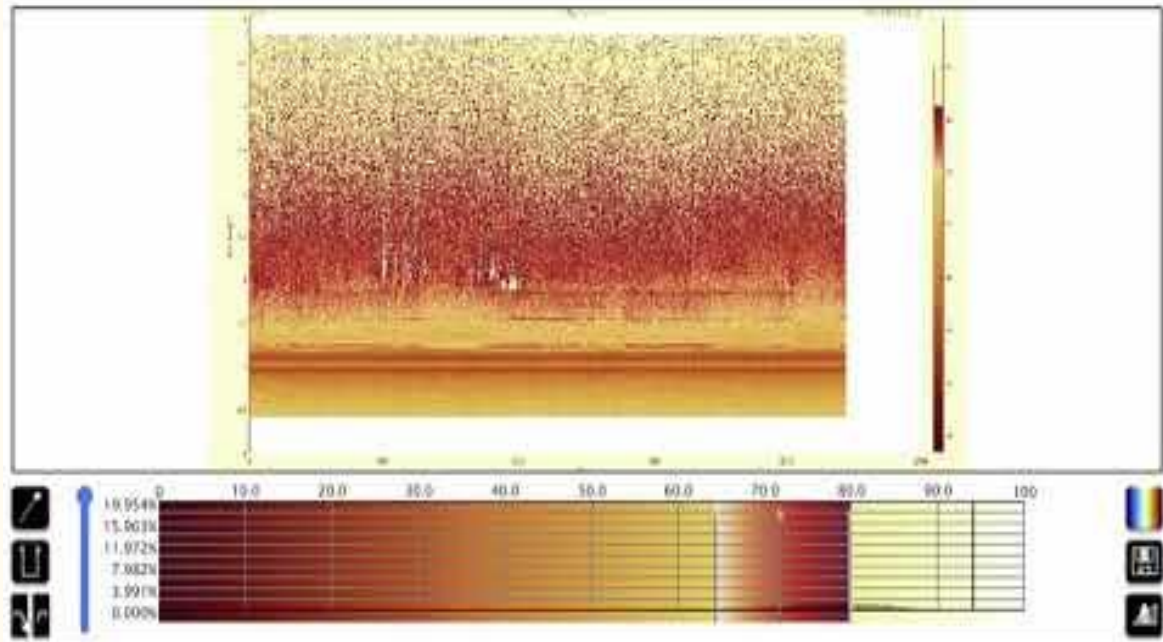
2021-07-21 05:00:31.000 to 2021-07-21 06:59:32.000

# Colormap Design

The features in the E-layer are obscured by the linear colormaps MATLAB uses by default.

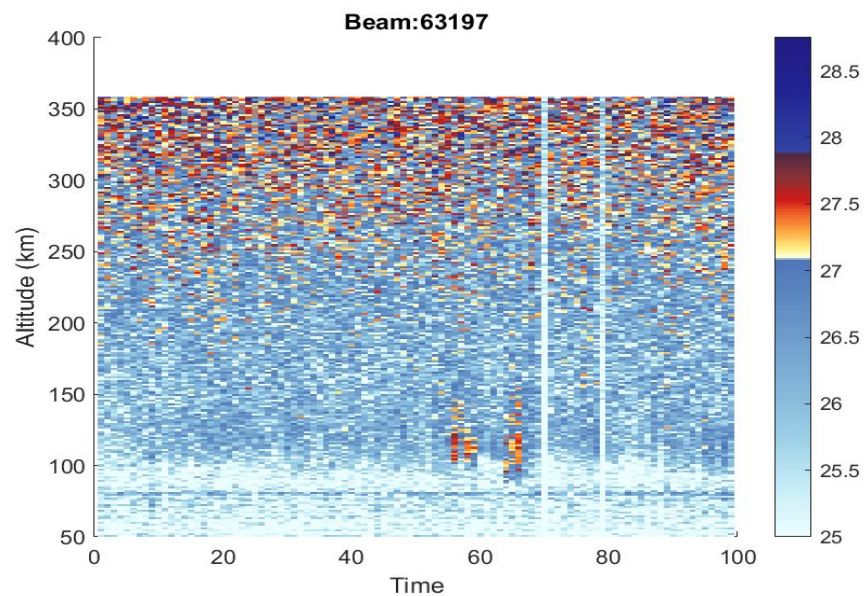
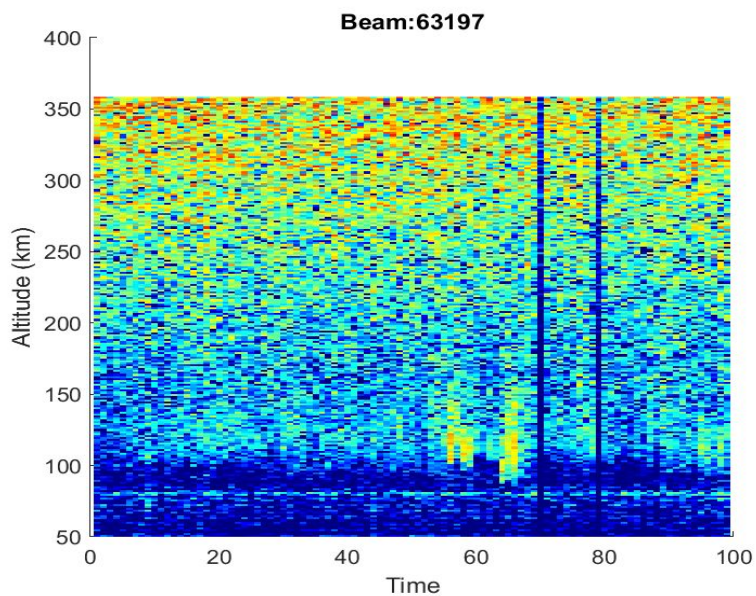
We used ColorMoves to design a false color scheme that highlights them.

The colormap can be generated in a WYSIWIG system in your browser, then exported and used in MATLAB or python code.



Before: jet

After: custom



# Ion Velocity Measurements

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Science Question:

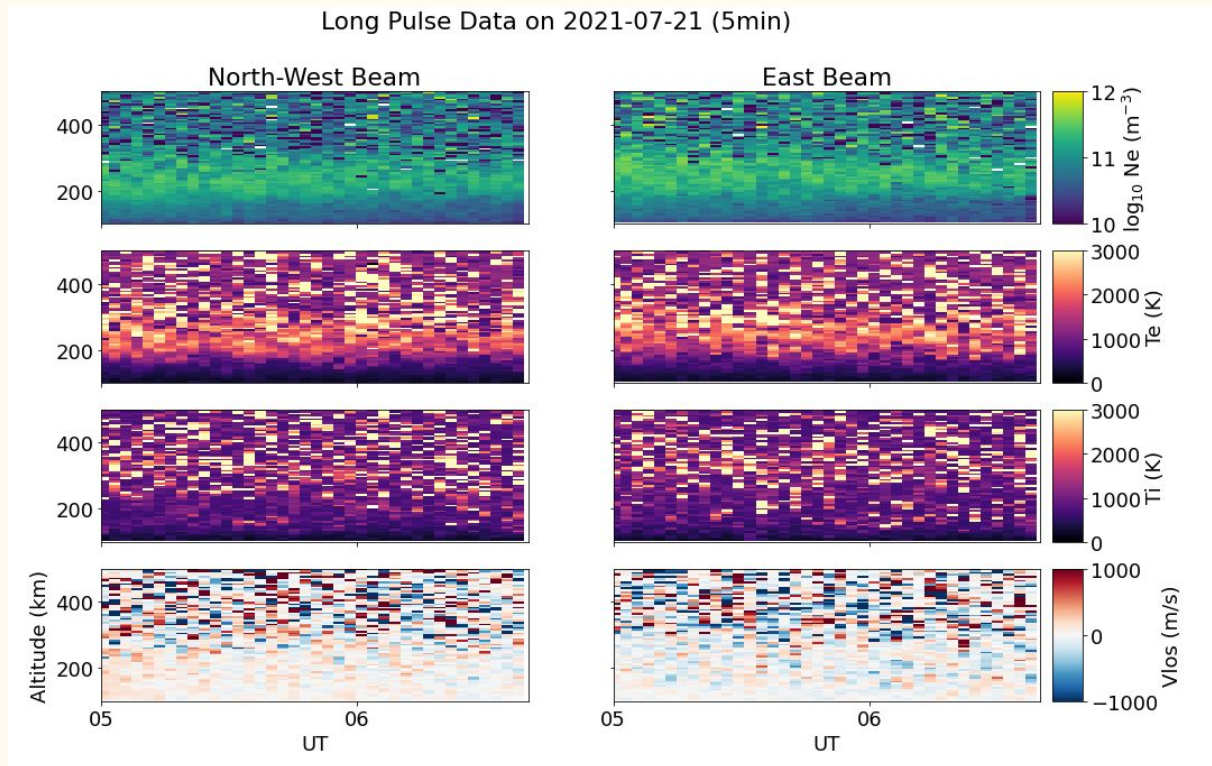
How can we combine **SuperDARN** and **(PF)ISR** to derive a more detailed description of the **ionospheric drift velocities** to characterize plasma flow?

# Velocity observations SuperDARN vs. PFISR

- HF radar (over-the-horizon)
- Tuned to F-region heights
- Especially sensitive to GDI (gradient-drift-instability)  $\rightarrow$  ExB drift plasma flows
- Computes velocities acc. to vacuum propagation assumption

# Our experiment day:

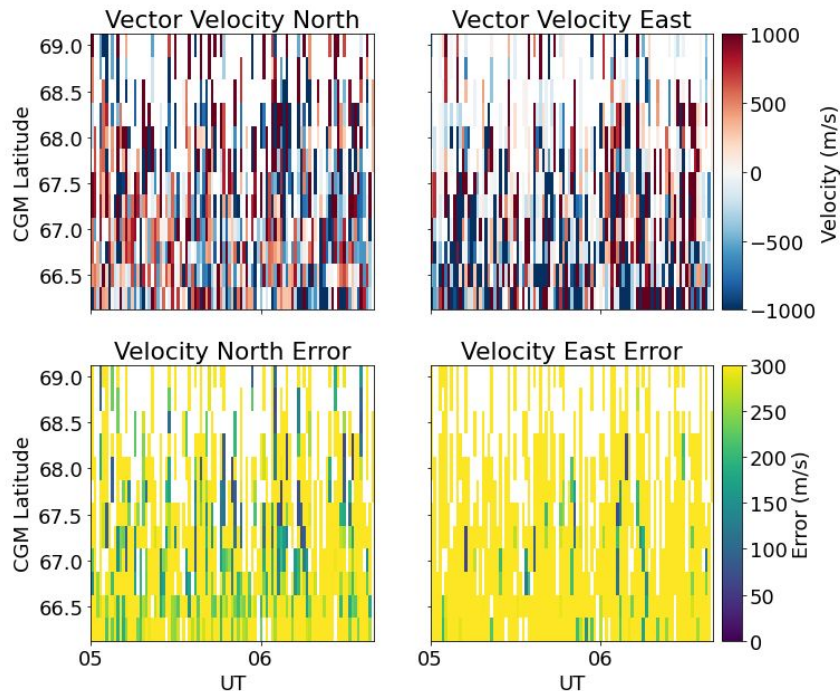
- Pretty calm
- No major change in the velocities
- Slight decrease in velocity overall
- This is a good time window for the case study since the E-region processes are slowly winding down at the end of the day and no aurora yet



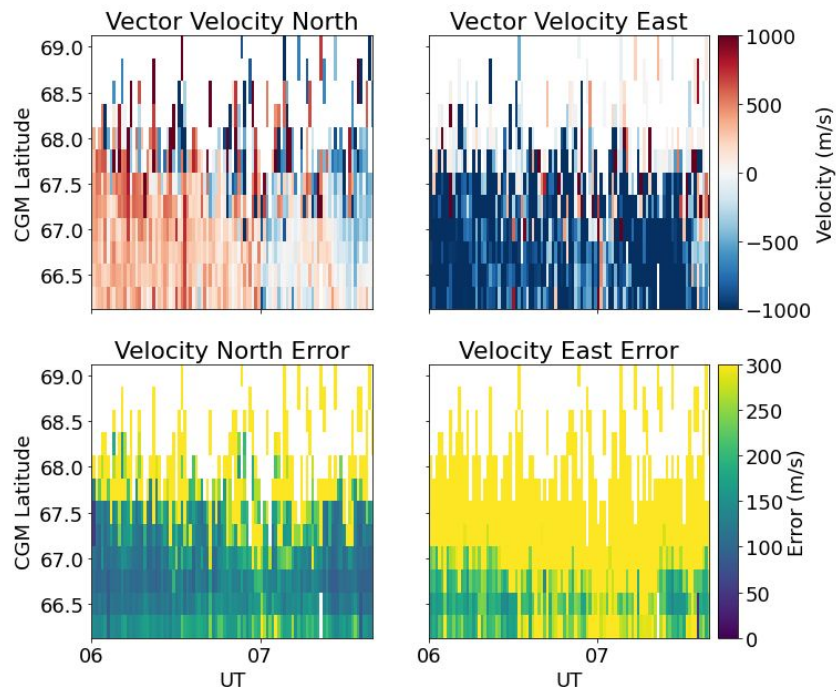


# Case study: 2018-07-21

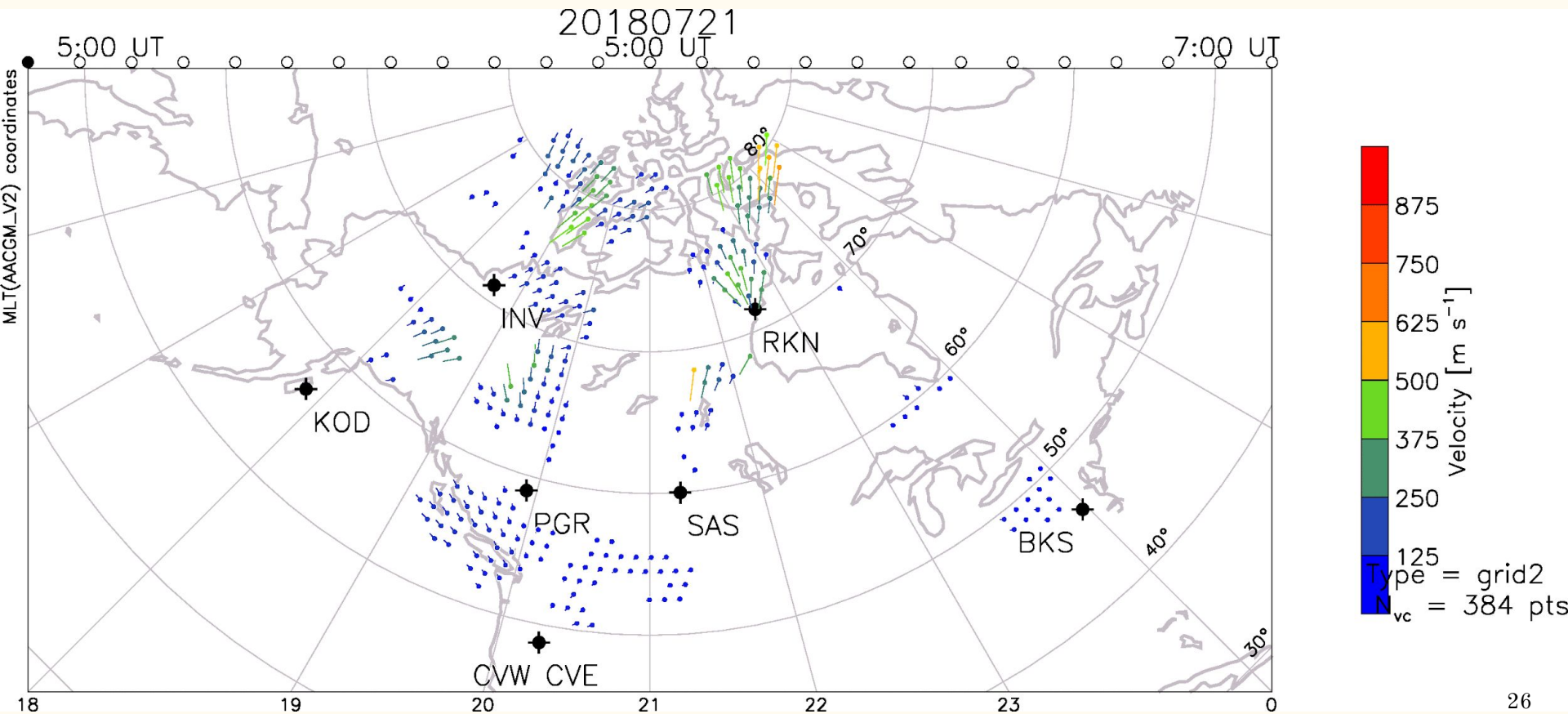
Vector Velocities from Long Pulses on 2021-07-21



Vector Velocities from Long Pulses on 2018-07-21



# SuperDARN Velocity Measurements: 21 July 2018

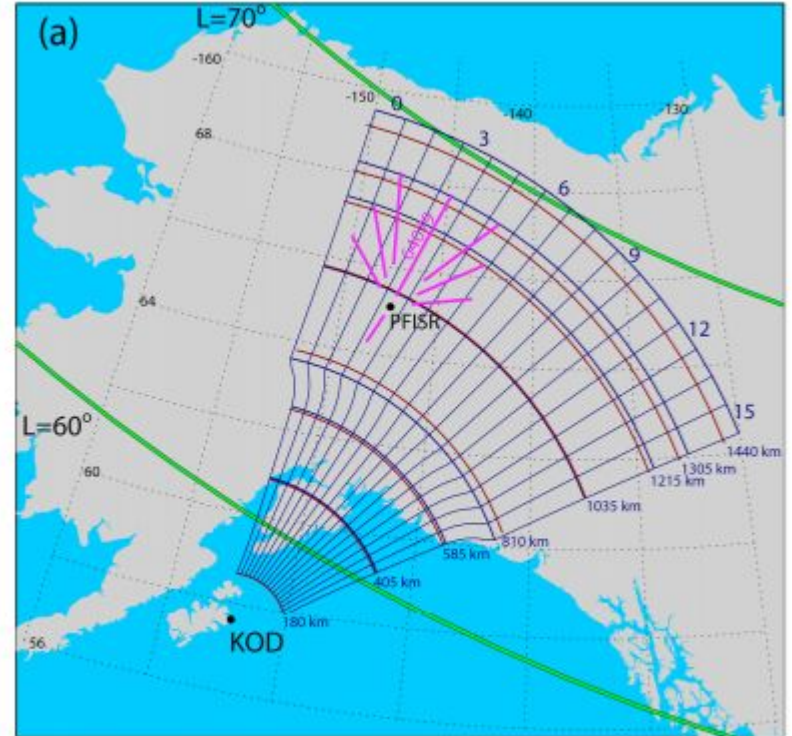


# Field of View

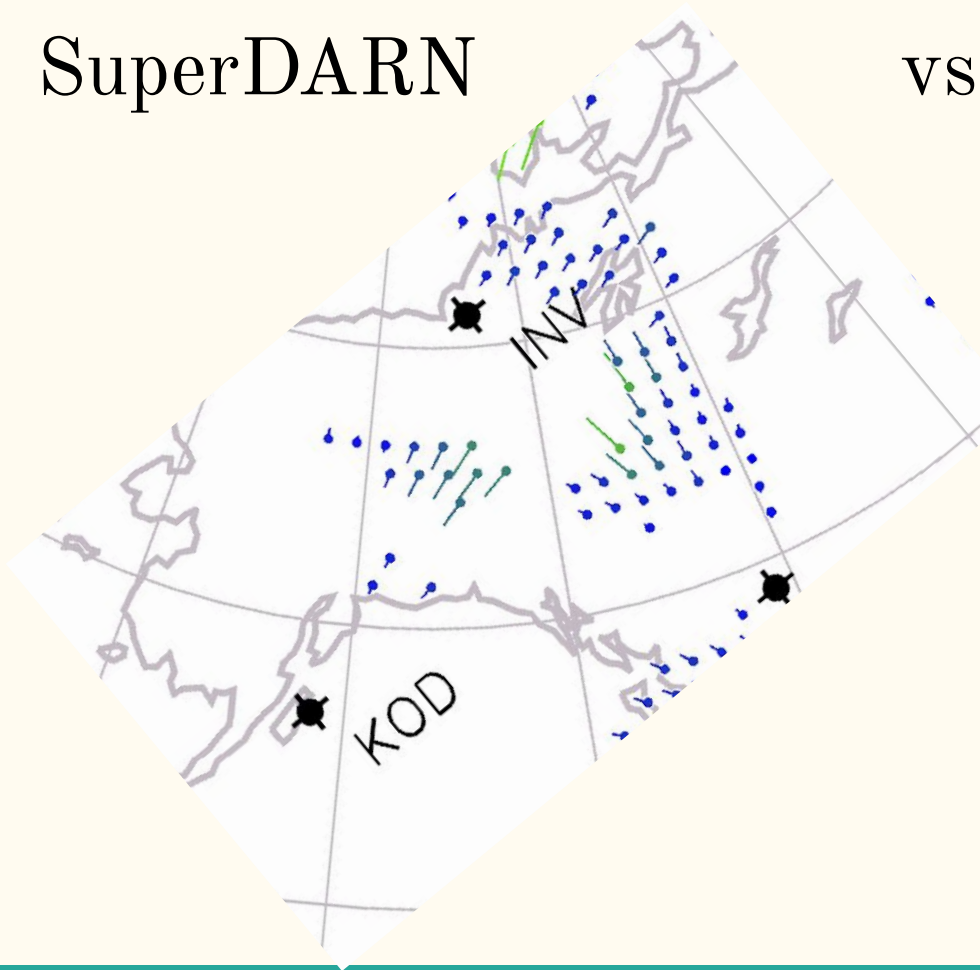
PFISR

Kodiak (SuperDARN station)

<https://angeo.copernicus.org/articles/32/875/2014/angeo-32-875-2014.pdf>

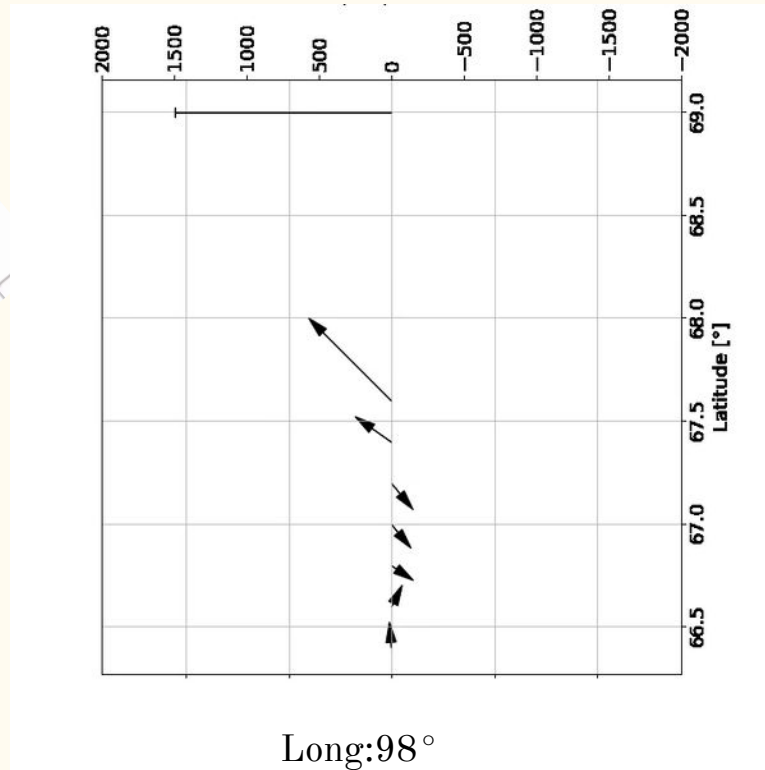


# SuperDARN

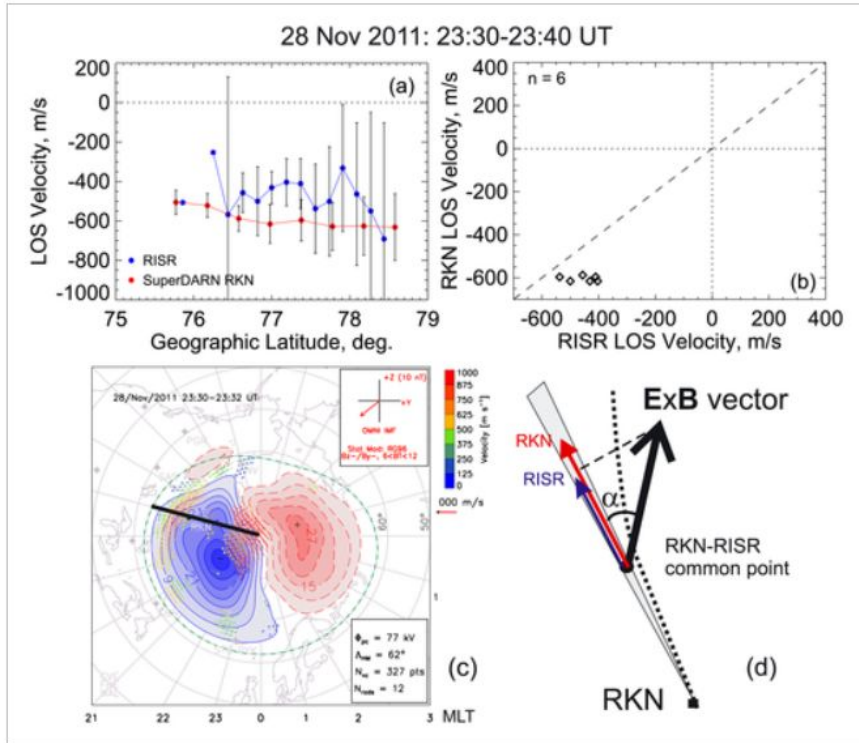


vs.

# PFISR



# Comparison for historic case



- Overestimated velocities in SuperDARN
- Less LOS velocity variation over latitude
- Deviation of SuperDARN beam path due to longer travel time

<https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2016RS006134>

# More reading material...

<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2007RS003805>

<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2016JA023839>

<https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2016RS006134>

<https://angeo.copernicus.org/articles/36/1657/2018/>

# ISR SUMMER SCHOOL 2021



- we cannot hear you...
- you are using the wrong file
- there is a comma missing in line 128
- ...szszsz... internet...szzzss... very bad
- what time is it over there?
- we would prefer the last slot, the last slot and the last slot
- I cannot find the tab anymore
- What is the plan right now?
- Let me connect the jupyter notebook to the google colab to the onedrive storage to my university account to all of your google accounts to access the local files that we share on Discord... and then we can talk on zoom
- just choose a freakin beam already
- the vaccine just reached my right arm
- this might be a quiet day...nothing to see as you can see
- hardcore data analysis

*THANK you so much to everyone for this amazing and eye-opening experience!!*