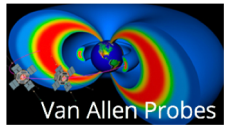

Azimuthally-propagating ionospheric flow fluctuations during storms

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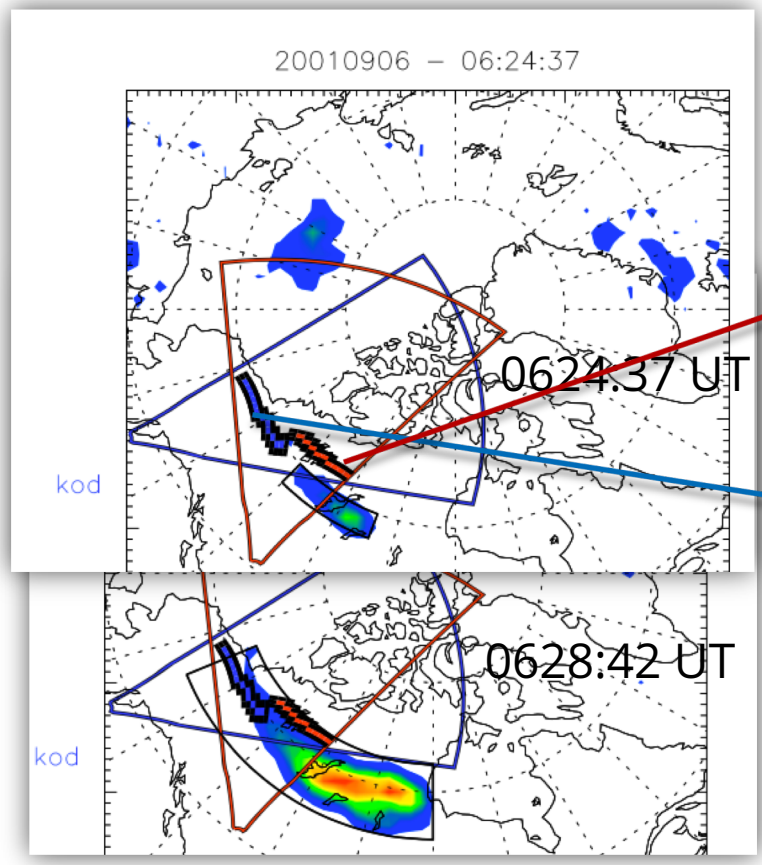
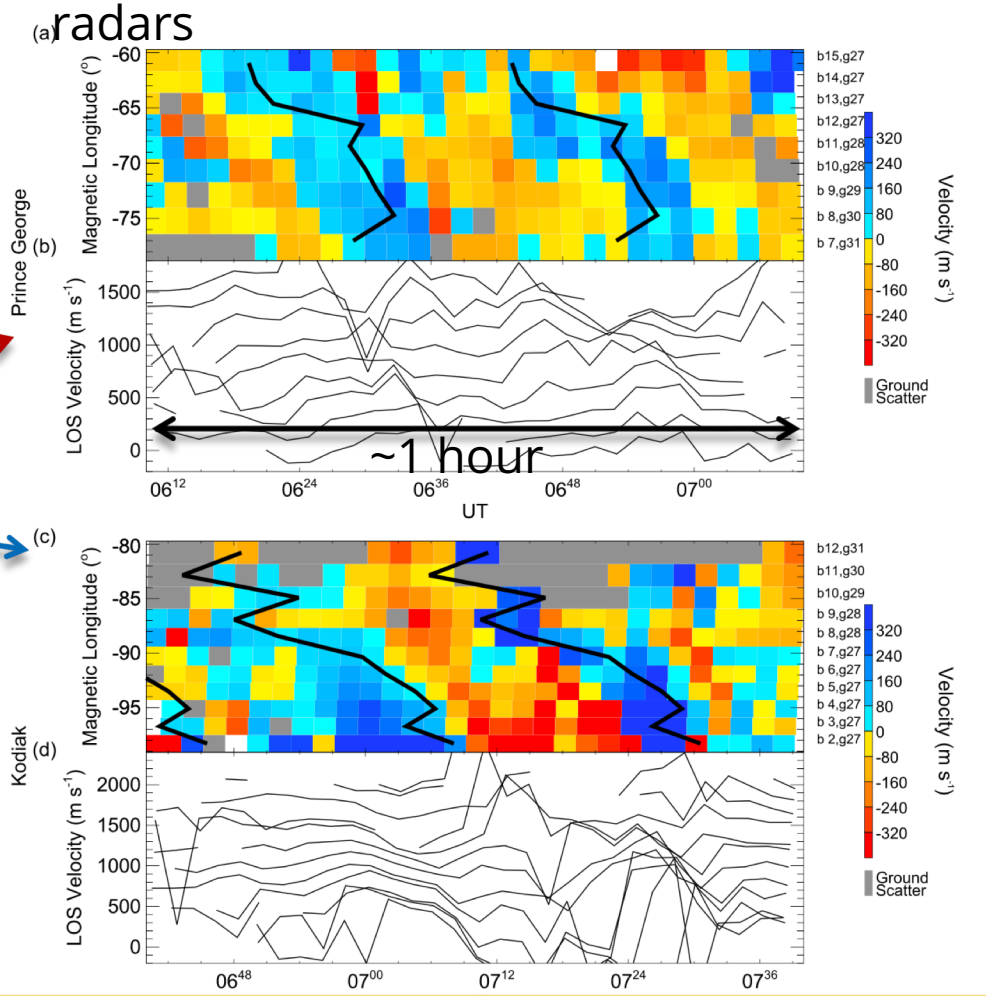
- Discussion
- Summary & Conclusions

Introduction: Substorm-injection-driven flow fluctuations at auroral latitudes

[James+2016]



"ewogram" of LOS velocity by SuperDARN radars

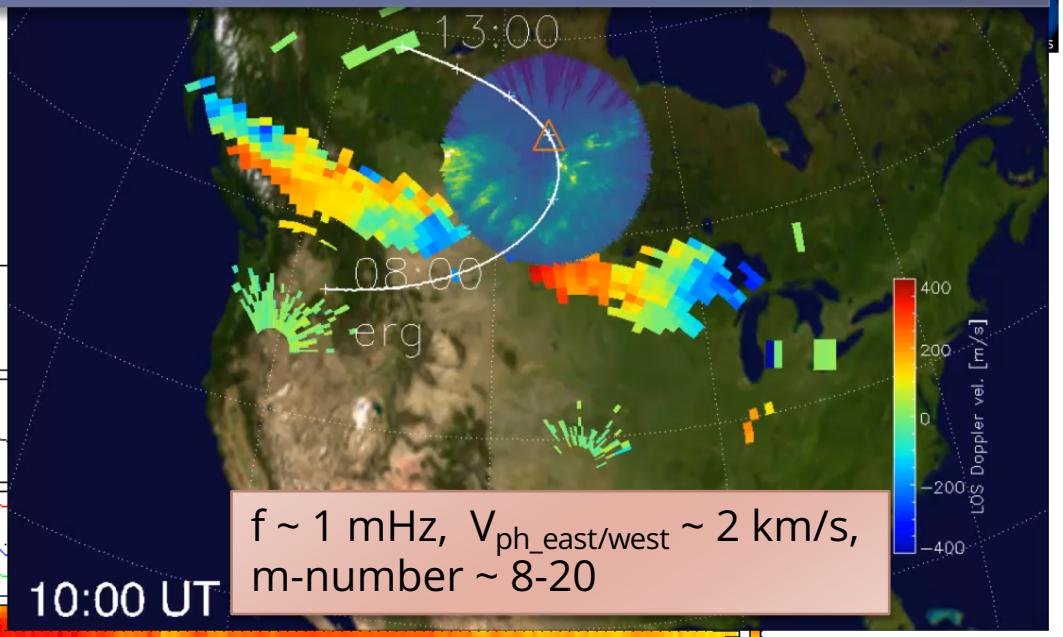


Past studies:
Baddeley+2004;2005, Yeoman+2010, James+2013; 2016, Hori+2018

f ~ mHz, $V_{ph\_westward}$ ~ 1-3 km/s, m-number ~ 10-40

Introduction:
Storm-time substorm-associated flow fluctuations at subauroral latitudes

- Bifurcated propagation of ionospheric flow fluctuations observed by SuperDARN and Arase satellite [Hori+, GRL, 2018]



f ~ 1 mHz, $V_{ph\_east/west}$ ~ 2 km/s, m-number ~ 8-20

Arase at L ~ 5.6, MLT ~ 3h

SYM-H

AL

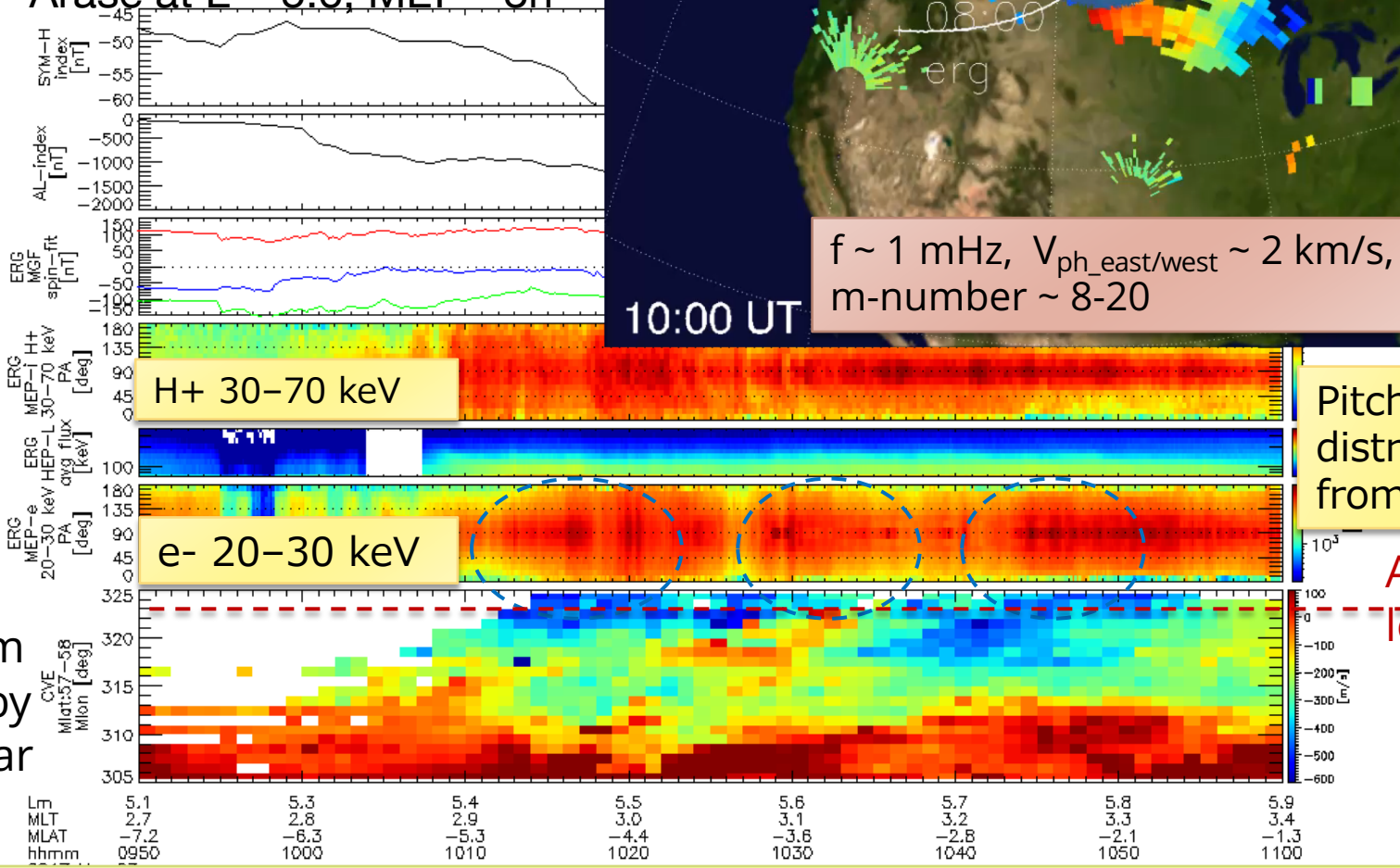
Arase B-field

MEP-i H+

HEP electron

MEP-e electron

Ewogram of flow by CVE radar



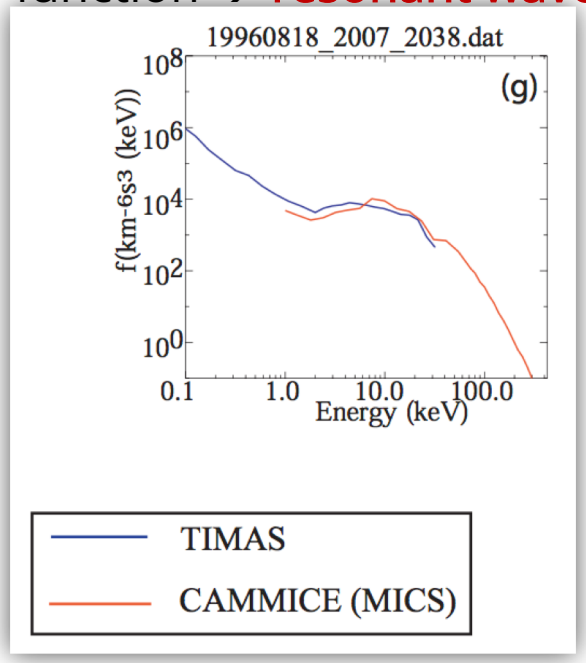
Pitch angle distribution from MEPs

Arase longitude

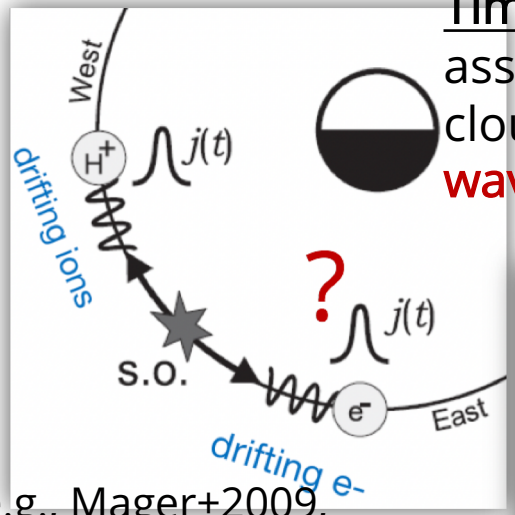
The nearly-conjugate observation by Arase has given first-ever evidence that eastward-propagating mHz fluctuations seen by SuperDARN radars are associated with drifting electrons.

Open question: how the waves are excited?

A positive **bump-on-tail particles' distribution** function → **resonant waves**

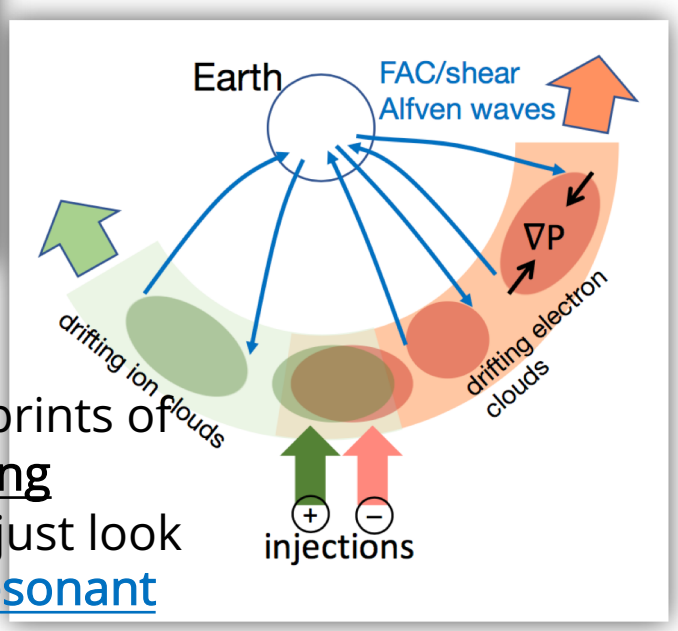


[e.g., Baddeley+2004]



[e.g., Mager+2009, James+2013]

Time-varying ring current assoc. with drifting particle clouds excites **resonant waves**.

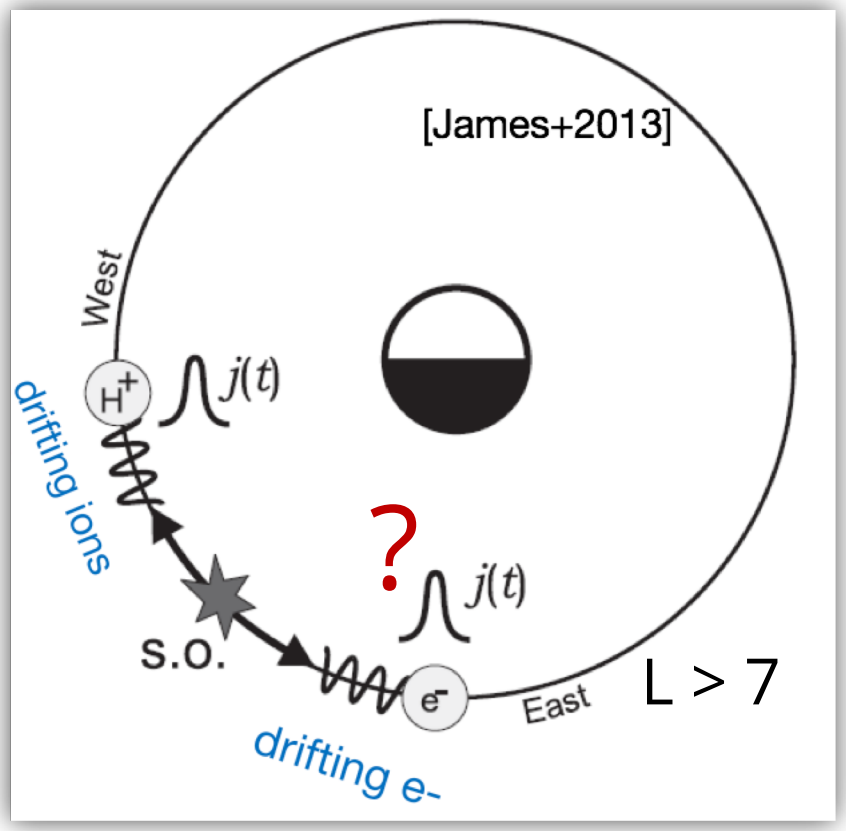


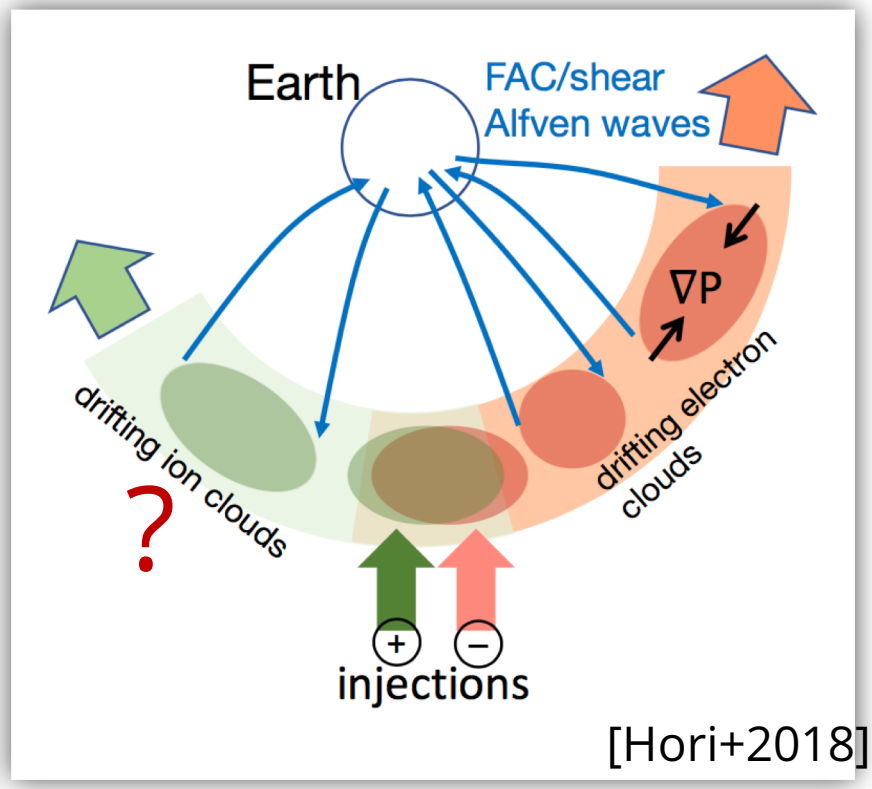
[e.g., Hori+2018]

Ionospheric footprints of **azimuthally-drifting pressure bumps** just look like waves (**not resonant waves**)

- Comparison with magnetospheric particle observations is key to addressing this issue.

Motivation and objectives



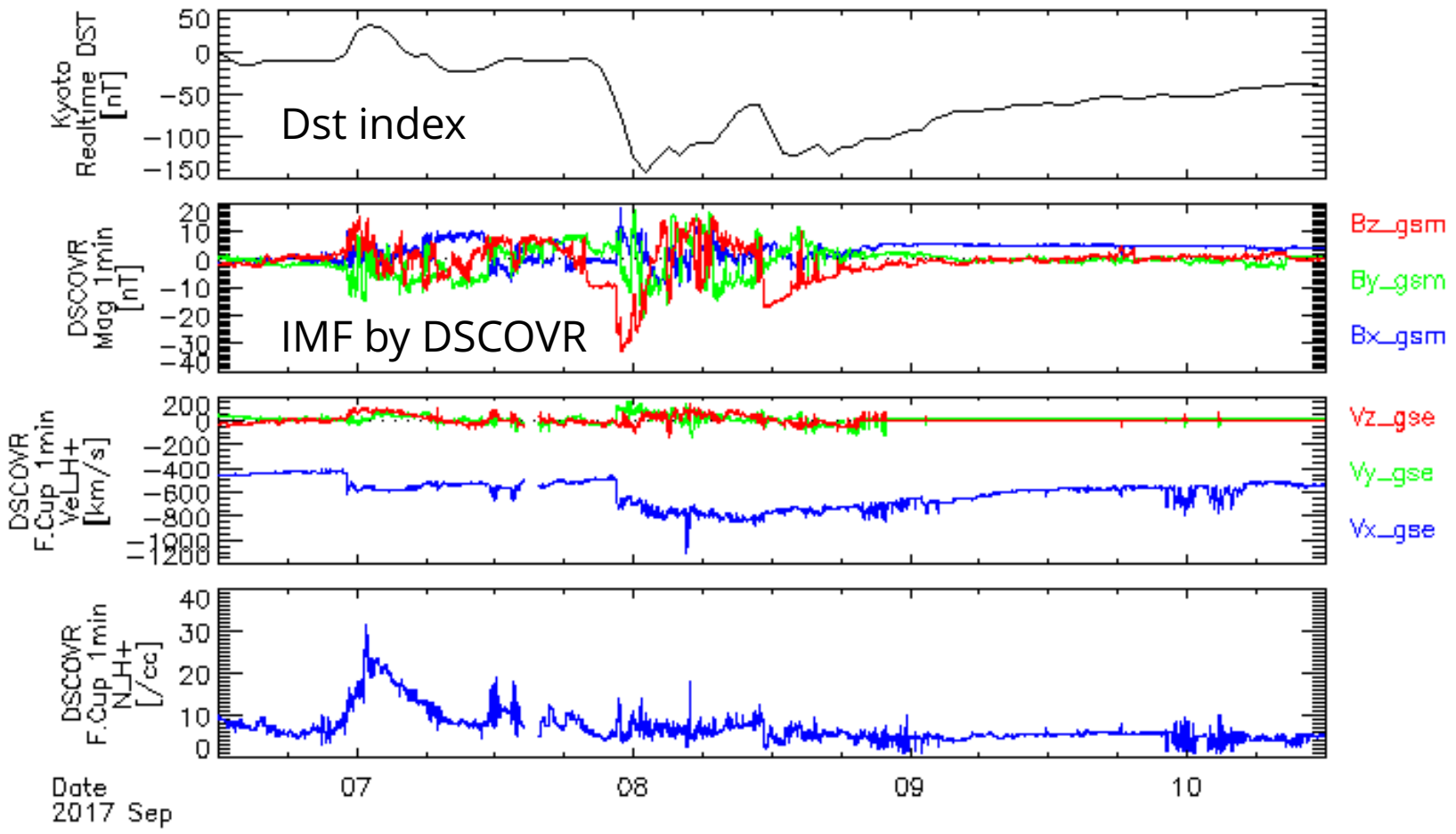


Further questions:

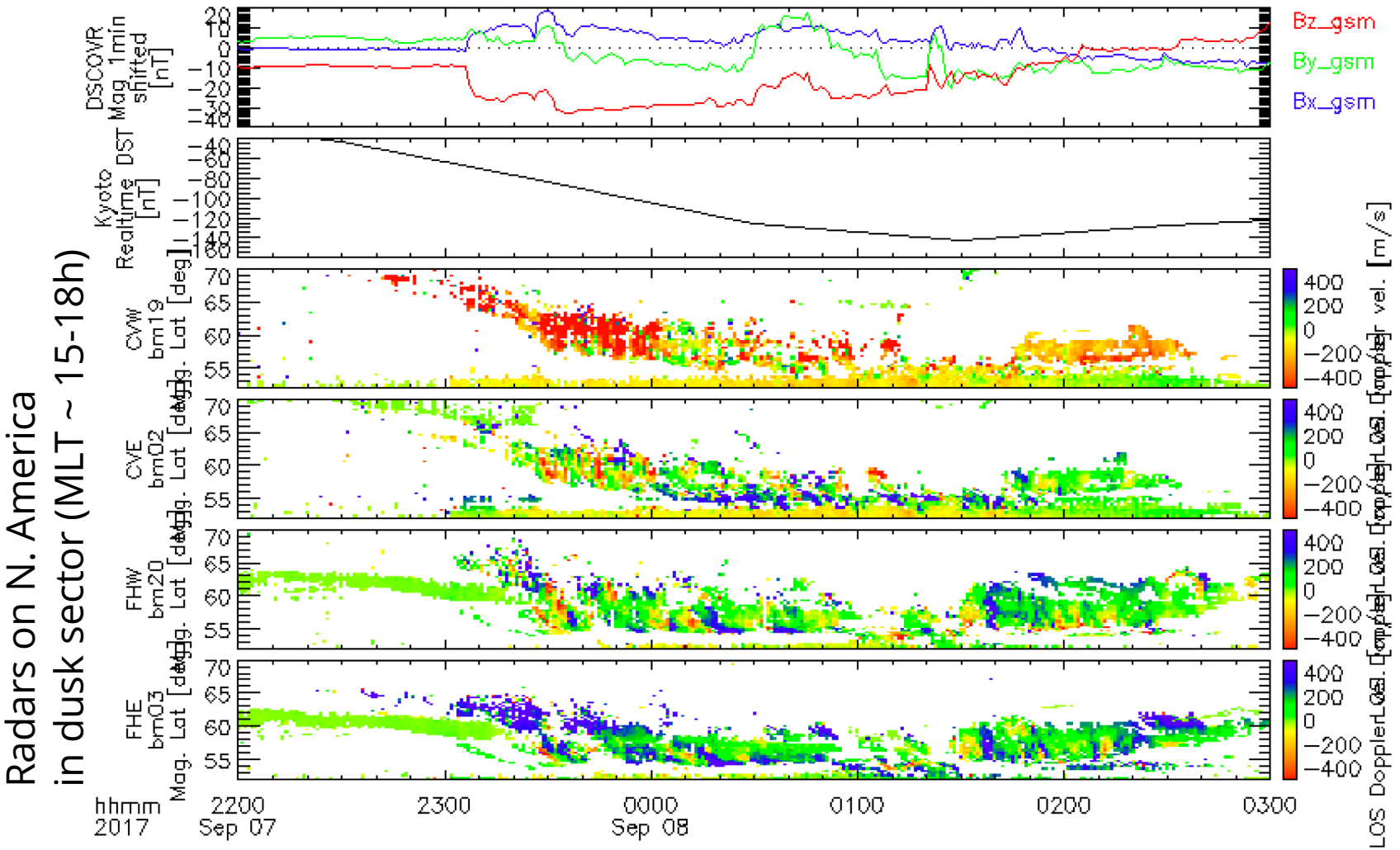
- How ULF-like flow fluctuations look like during other storm events?
- Are they accompanied by injected drifting populations?

Event 1 (Sep., 7–8, 2017)

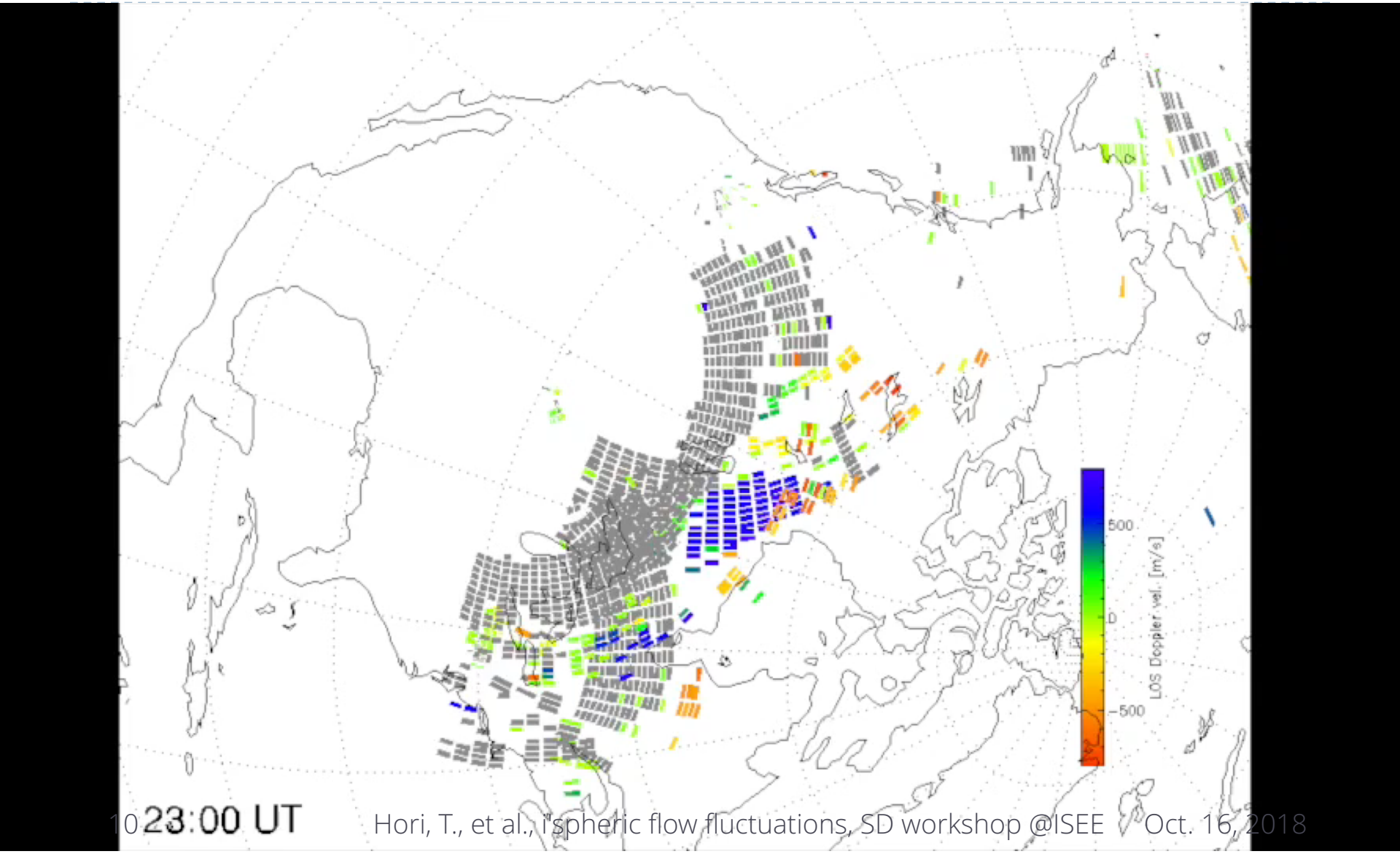
Dst, Solar wind/IMF for 12:00, Sep. 6 – 12:00 Sep. 10



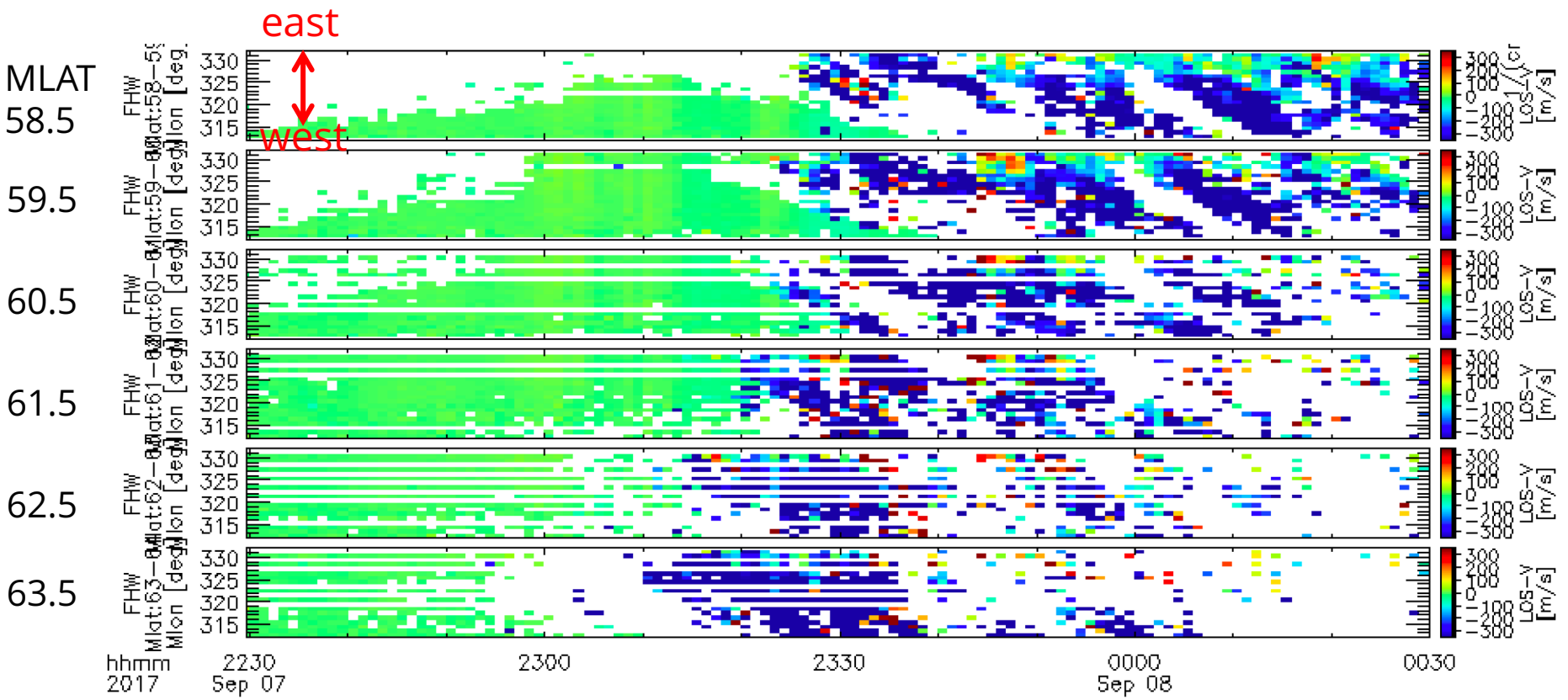
Sep. 7 22:00 – Sep. 8 03:00



2-D view of Doppler velocity distribution for Sep. 7 23:00 – Sep. 8 04:00 UT

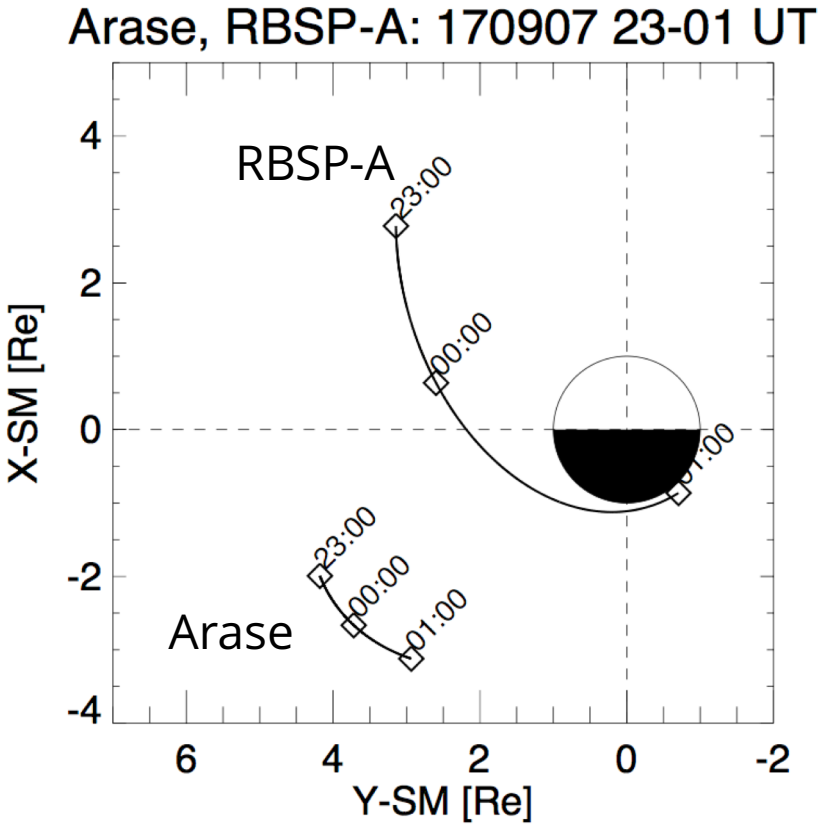


Ewograms (east-west cuts) of LOSVs of the FHW radar



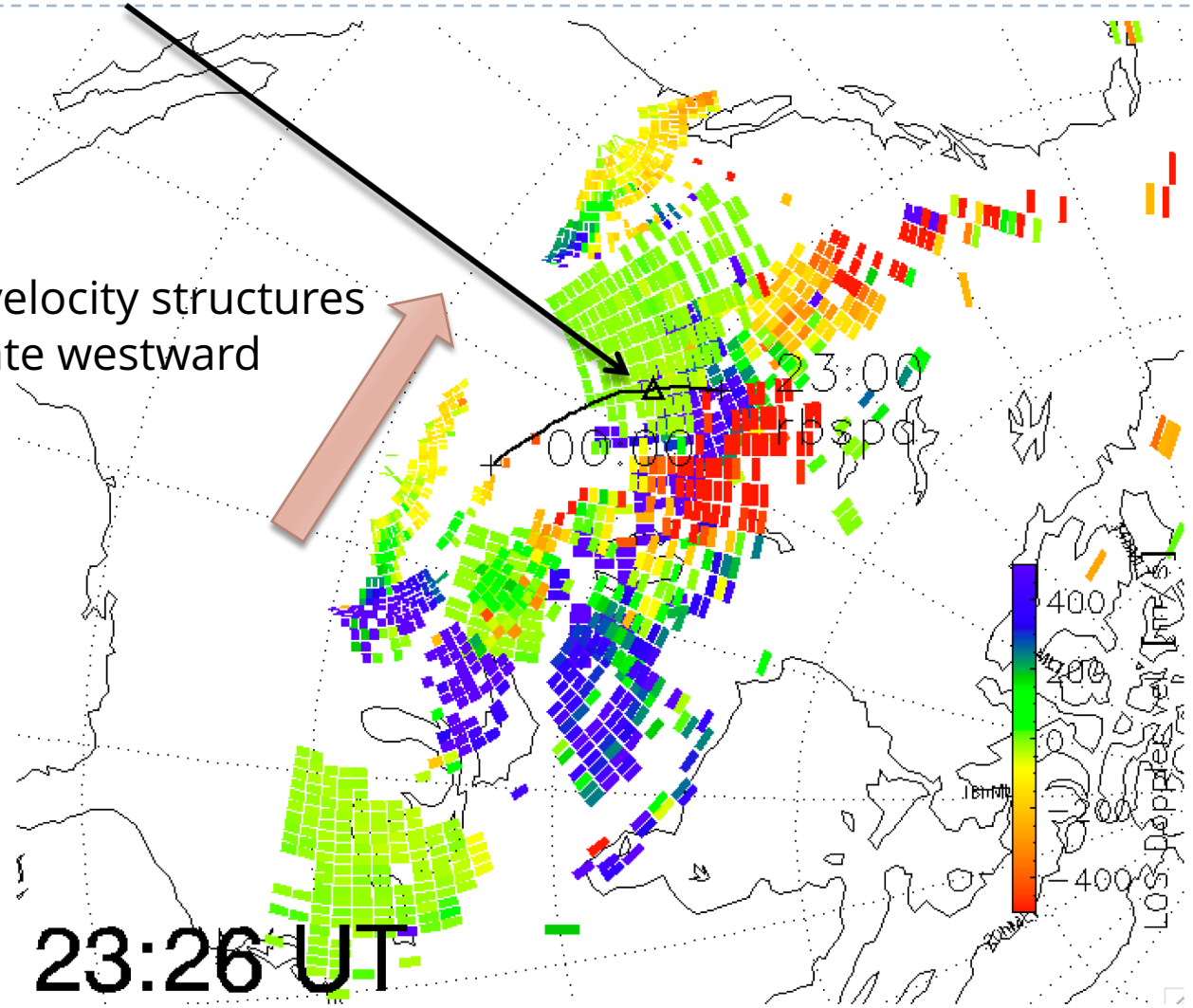
... showing westward phase propagation of ~2-3 km/s

Arase and RBSP-A during 23–01 UT

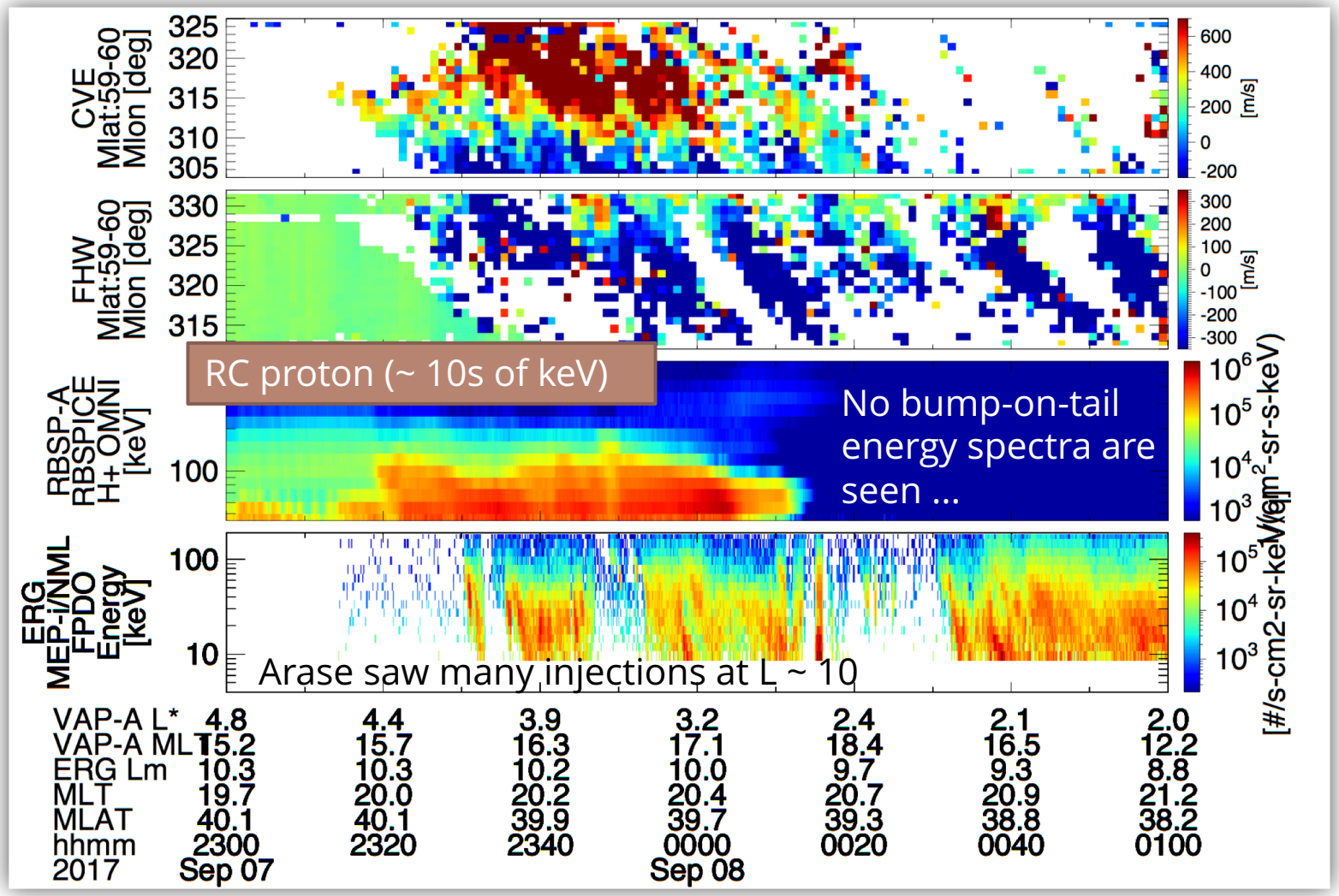


- RBSP-A: inbound at MLT ~ 16–18h
- Arase: apogee at MLT ~ 20–21h, L ~ 10 (MLAT > 30°)

RBSP-A's footprint was right at the ULF region



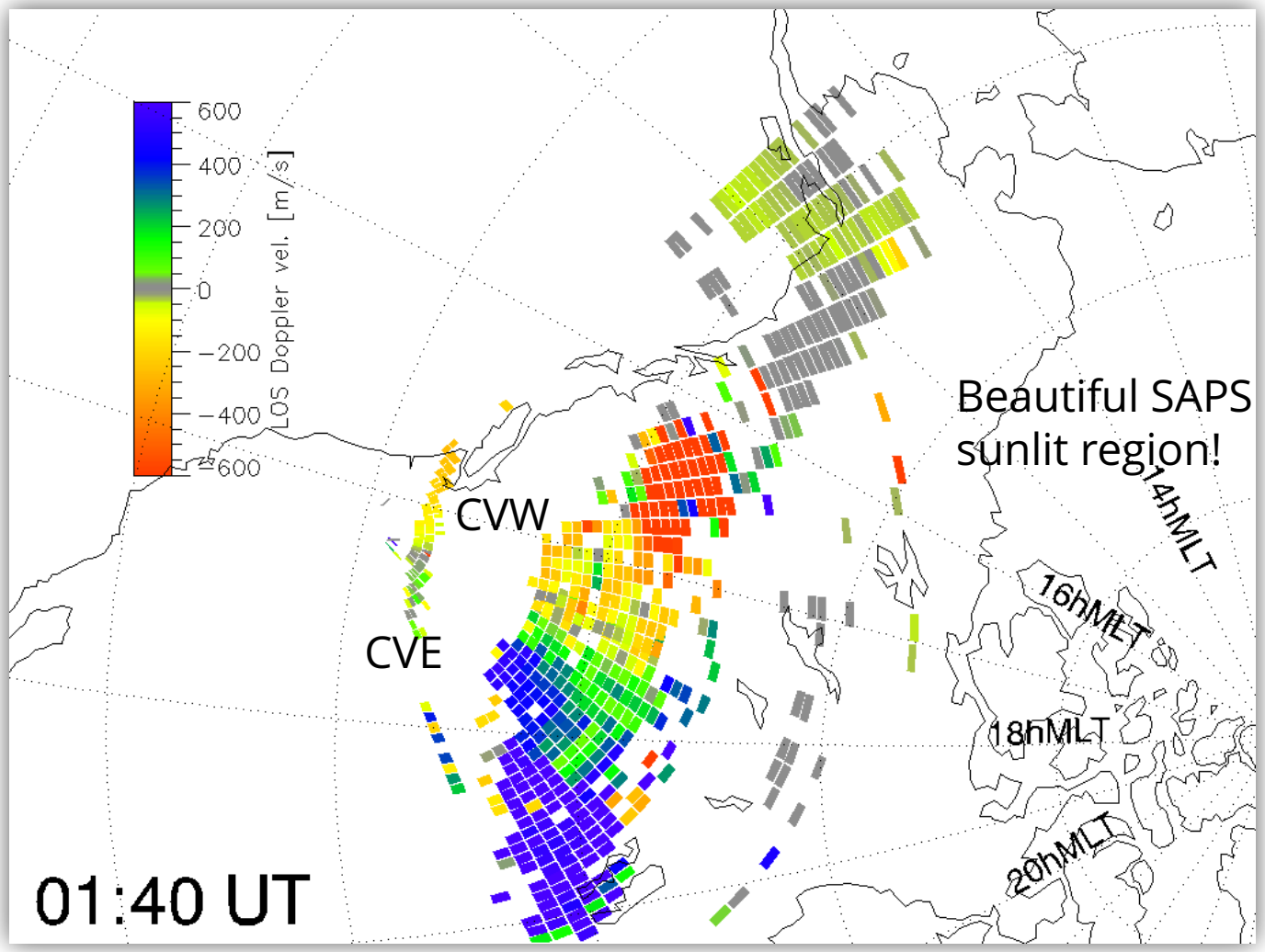
Westward-propagating flow fluctuations and drifting energetic ions



Event 2 (May 28, 2017)

if time permits ...

~01:40 UT on May 28, 2017

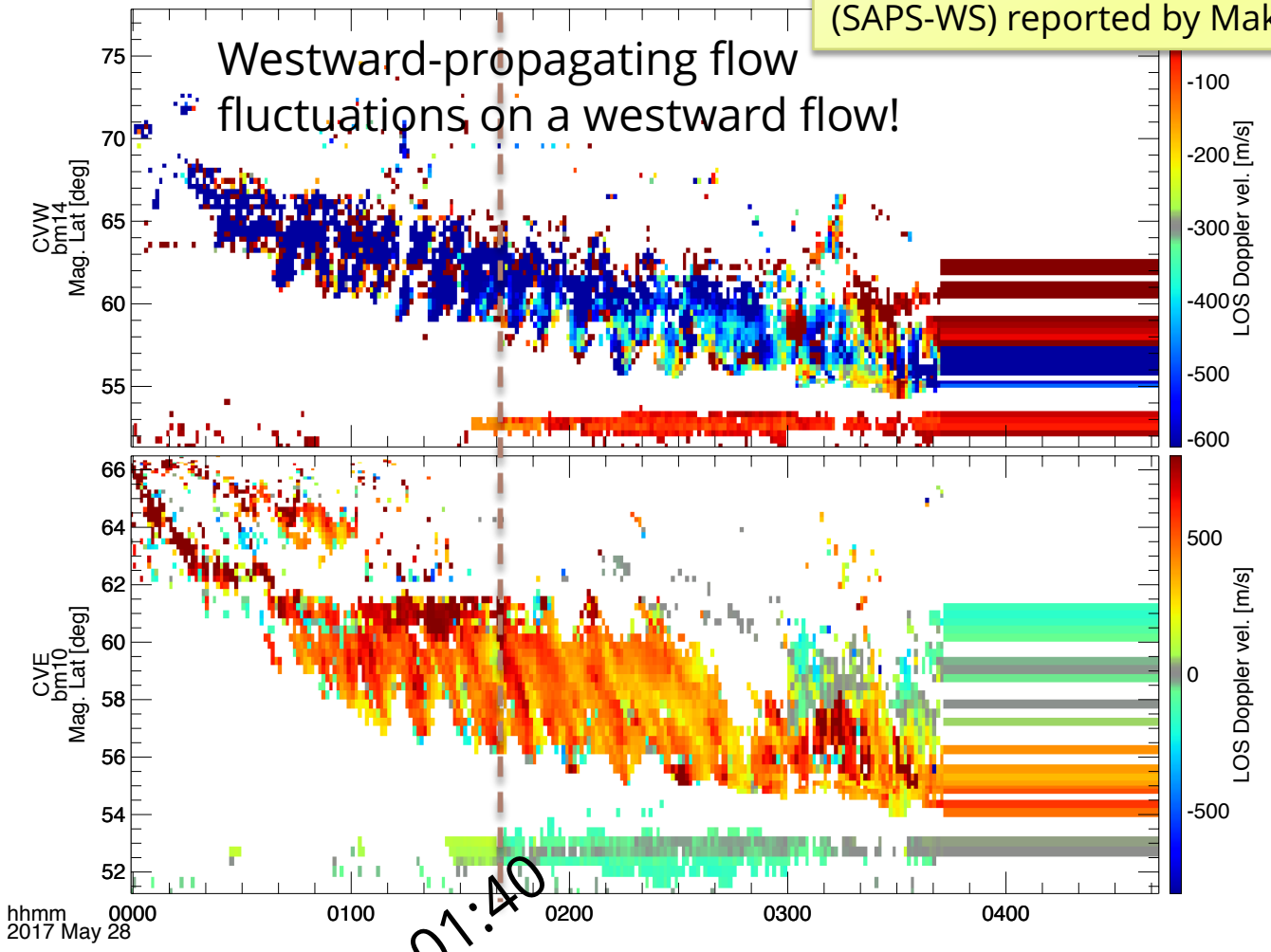


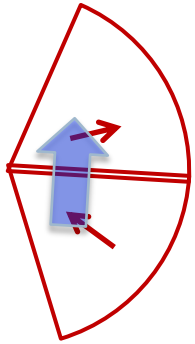
typical period of the fluctuations ~ 10 min

Quite similar to the SAPS wave structures (SAPS-WS) reported by Makarevich+2014.

CVW bm14

CVE bm10





Summary & Conclusions

- How ionospheric flow fluctuations look like during other storm events?
  - Similar, azimuthally-propagating fluctuations are also found for 4 magnetic storms so far. M-number is ~10–20, and the propagation speed is consistent with several tens of keV ions.
- Are they accompanied by injected populations?
  - Yes they are, but without any bump-on-tail distribution.

- Implications:
  - The propagating flow fluctuations can be seen at mid-latitudes only during storm times?
  - The fluctuations are associated with drifting particle populations.
    - ~~Driven wave: Bump-on-tail distribution? ($\partial f / \partial W$)~~
    - Driven wave: Radial gradient ($\partial f / \partial L$)
    - Non-wave: Pressure bumps of ring current (ions)