

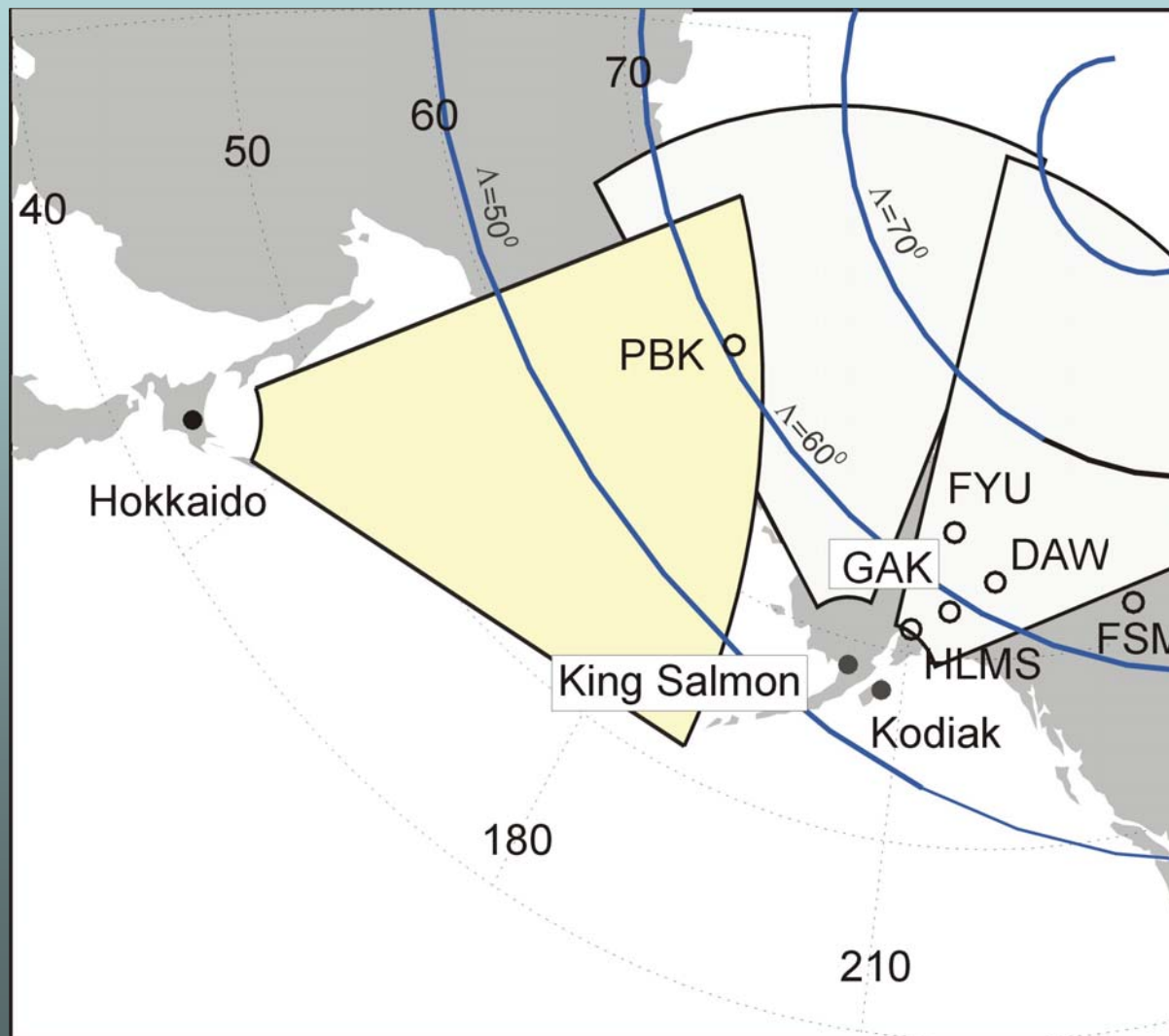
On the reasons for occasional high velocities of Hokkaido dusk echoes

S. Koustov and N. Nishitani
STELab, Nagoya U

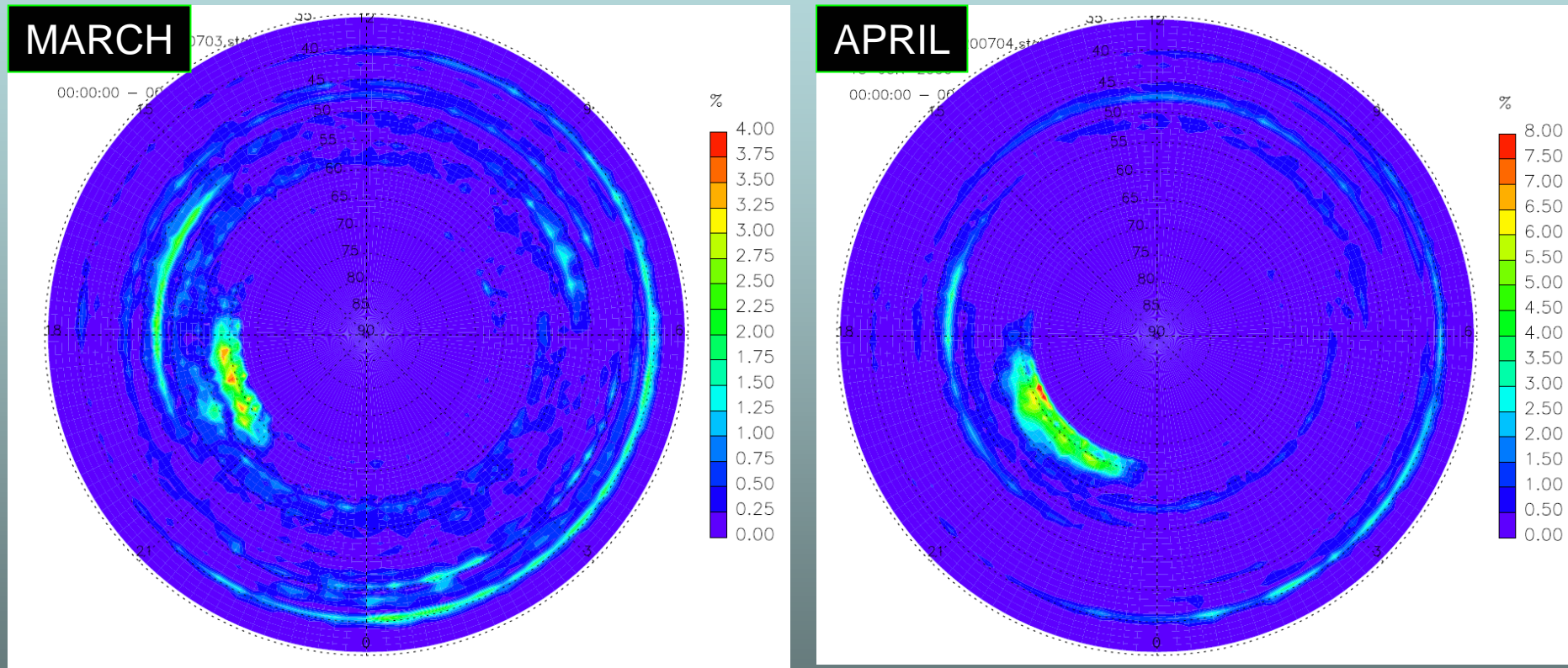
Initial thoughts

- Low-latitude location of Hokkaido should be advantageous for detection of PJ within SAPS flows, very fast streams outside the auroral oval
- Does Hokkaido see fast flows?
- If yes, do these flows show detached PJ features?
- Earlier I looked at fast flows seen by the King Salmon (KS) SD radar –close to Hokkaido FoV. I concluded that King Salmon sees fast flows at the equatorward edge of the oval. These flows were setup by the substorm-related electrodynamics. Difficulty was that the KS radar cannot detect any echo below ~ 60 deg. So, is Hokkaido luckier?

FoVs of Hokkaido, King Salmon and Kodiak SuperDARN radars

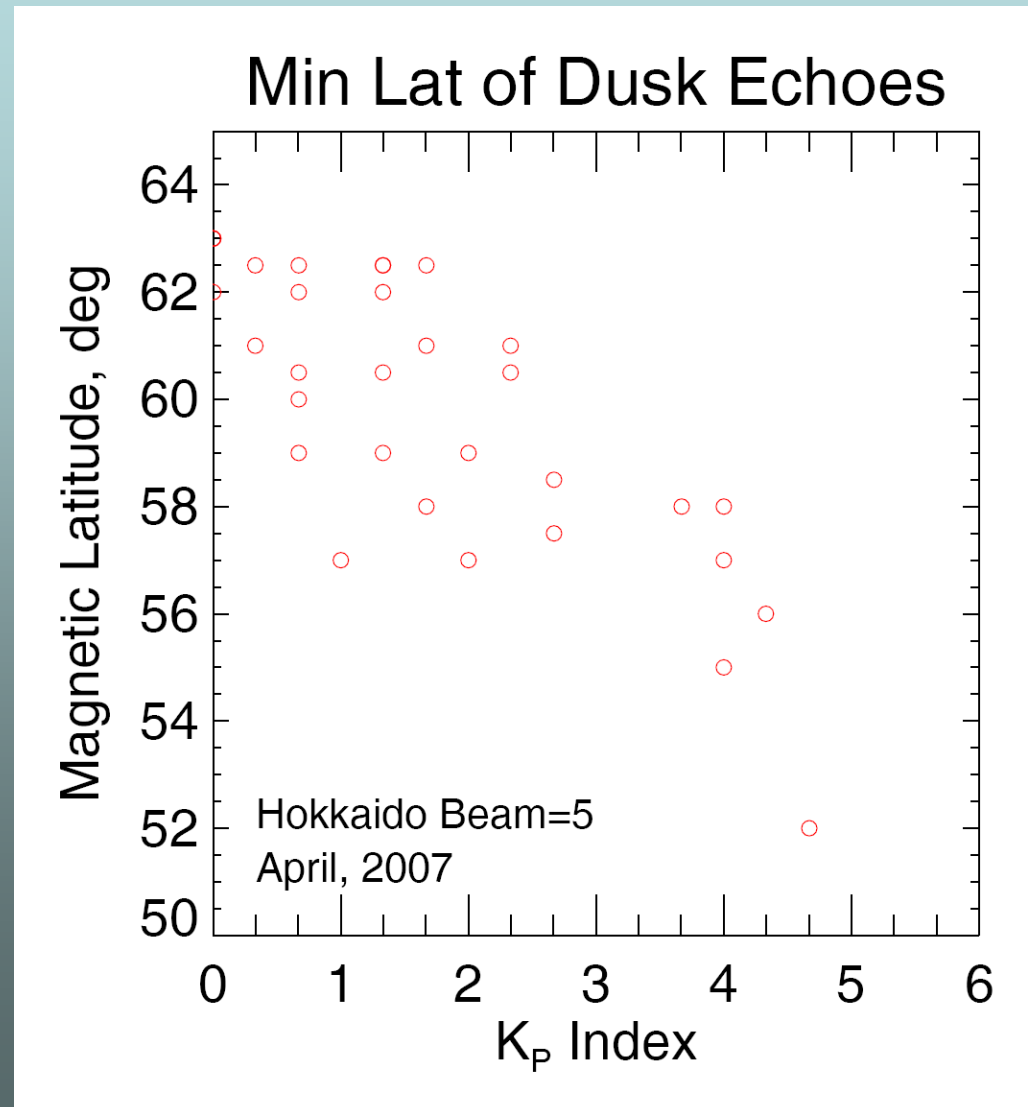


Hokkaido echo statistics for March/07 and April/07, beams 4,5,6



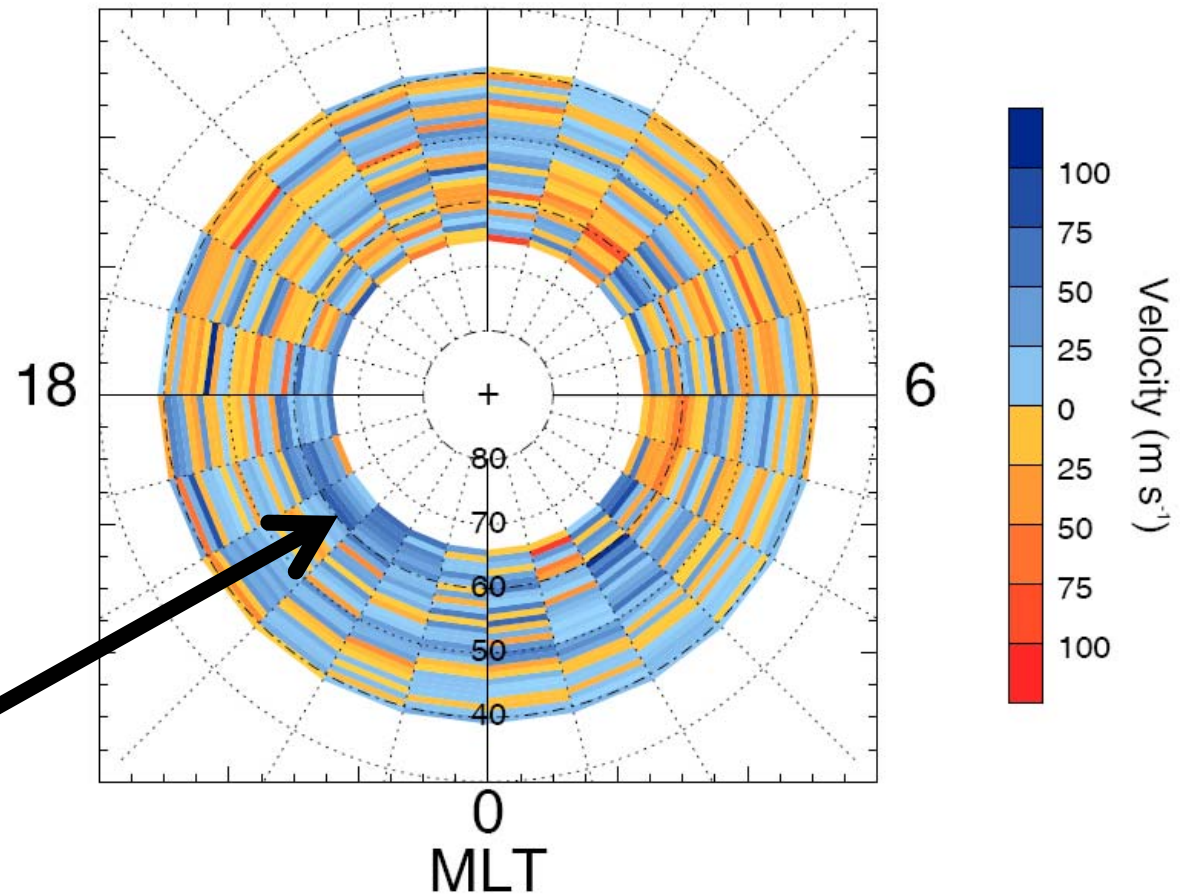
In beams 4-6, duskside echoes are quite frequent comparing to other types, ~ 5% of the time

Point #1: Hokkaido dusk echoes minimum latitude depends on Kp



Point #2: Typical velocity of Hokkaido dusk echoes is very low

Hokkaido SuperDARN
Doppler Velocity Average 03/2007 - 05/2007
12 beam 5



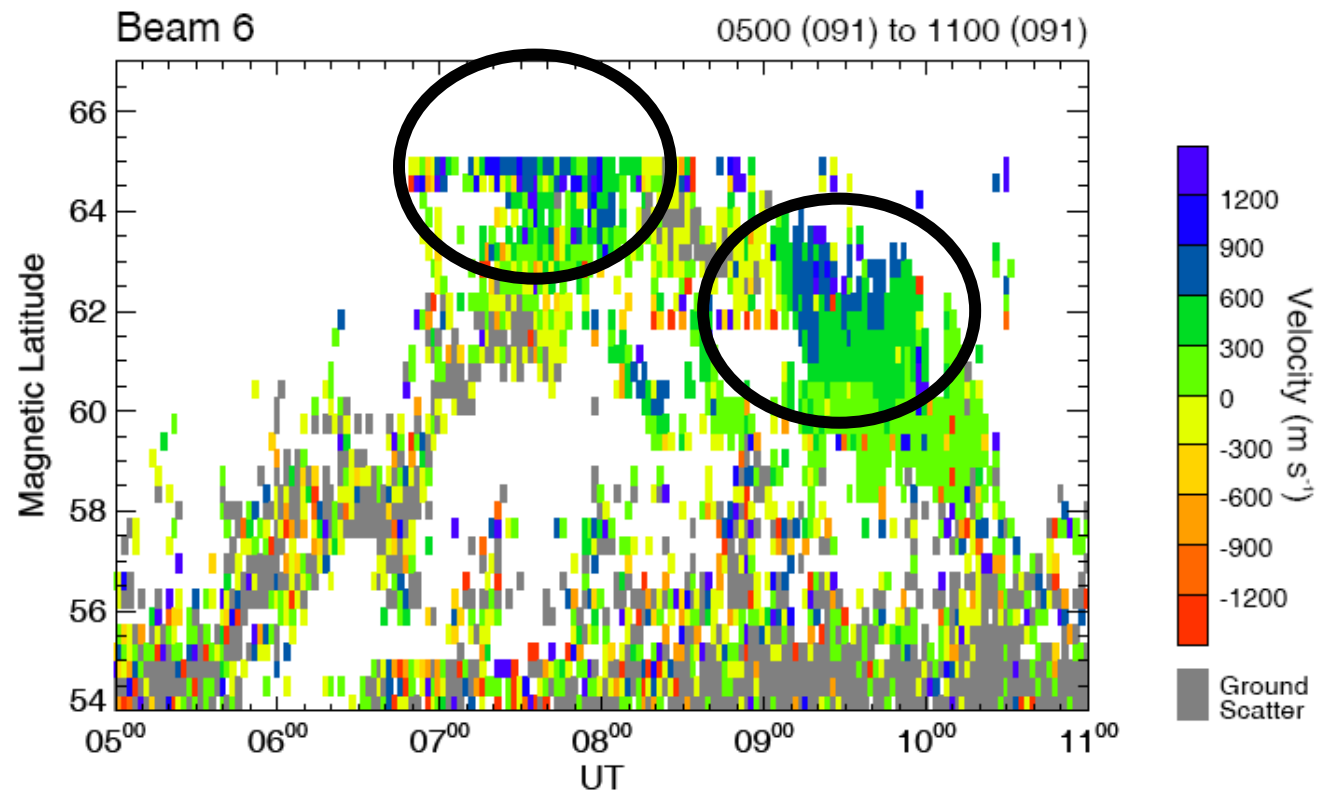
At the best, we have
150 m/s

Hokkaido: April 1, 2007

Unusually high-velocity dusk echoes

SUPERDARN PARAMETER PLOT
Hokkaido: vel

1 Apr 2007⁽⁹¹⁾
normal (cw) scan mode (150)



Are these PJ flows, streams outside the auroral oval?

Idea on SAPS
from Galperin
(2002):

SAPS is often
enhanced after a
substorm onset

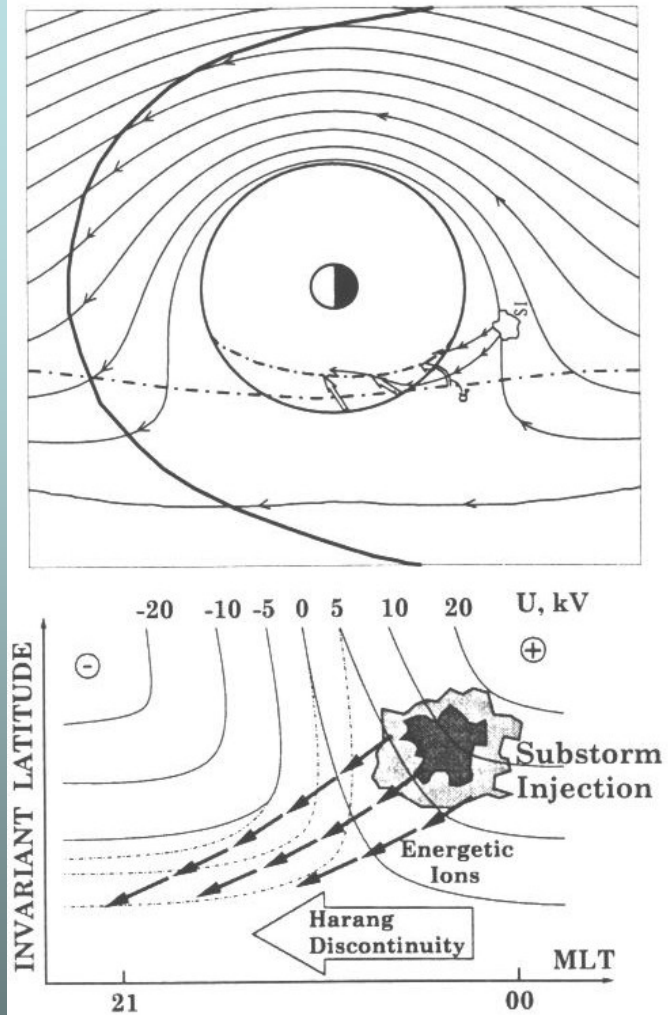
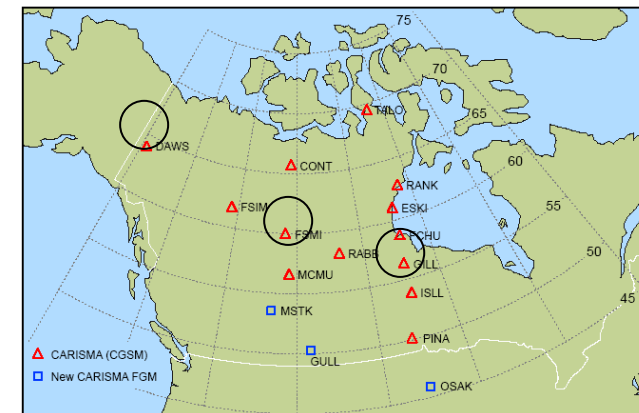
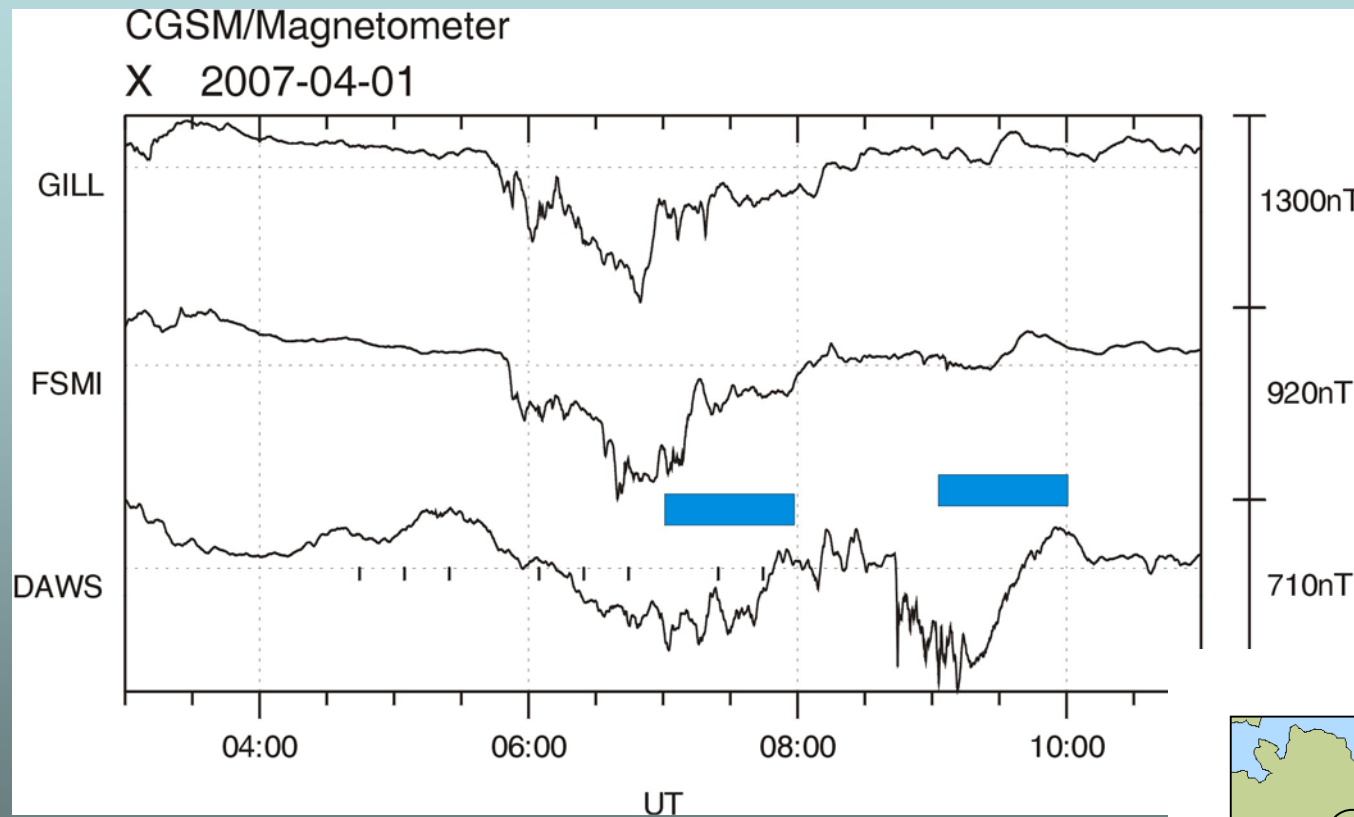


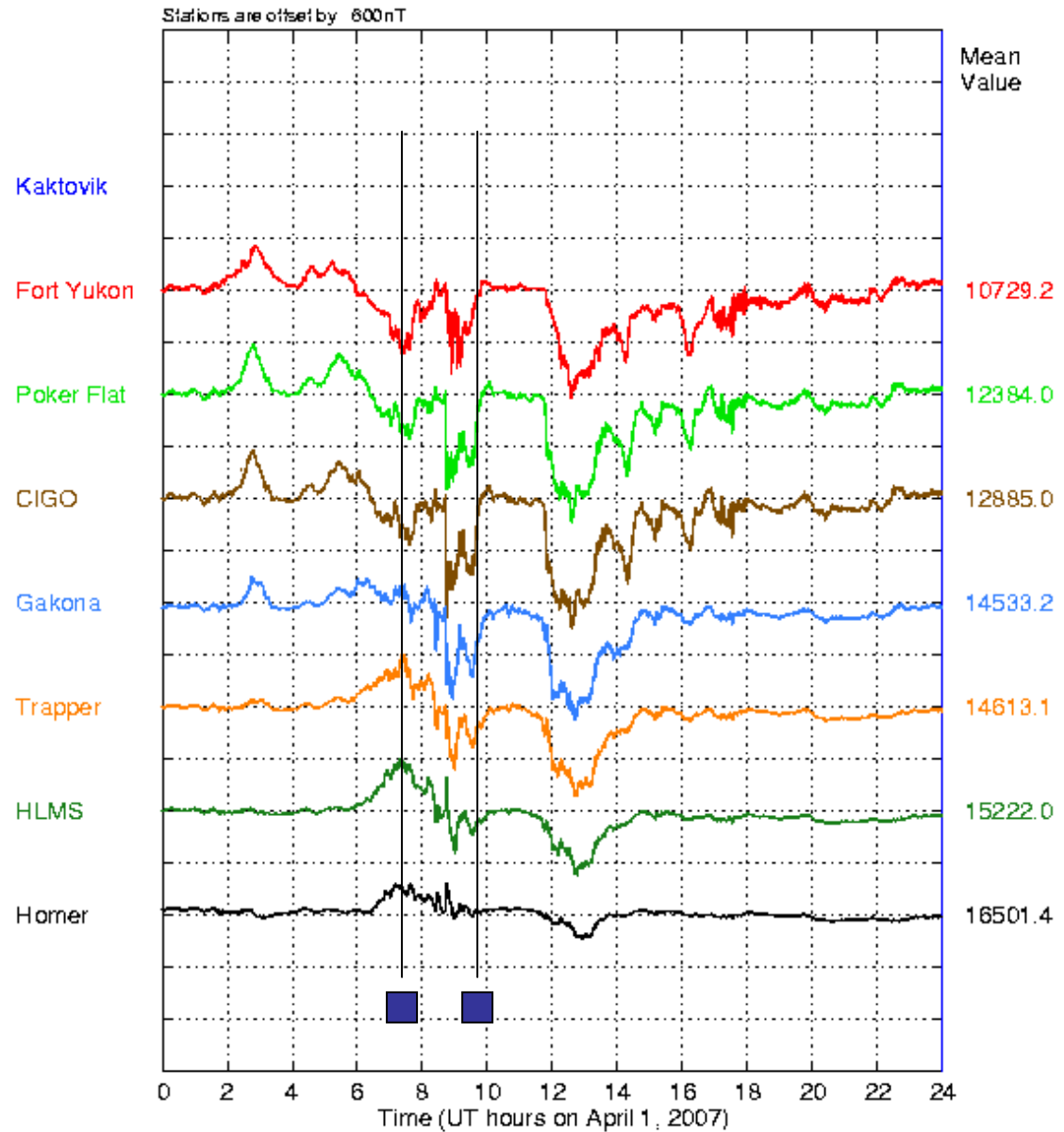
Fig. 1. Schematics of particle injection location, distortion of the Volland-Stern convection pattern at subauroral latitudes, and trajectories of injected energetic ions forming the Polarization Jet (not to scale). Thin lines - equipotentials before the injection, dot-dashed lines - after the injection. Hollow arrows show the inward and westward shift of the equipotential line in the evening sector, lines with arrows - trajectories of the drifting ions penetrating to lower L -shells (not to scale). (a) At the equatorial plane; (b) At ionospheric altitudes.

Magnetometer records, Canadian Sector

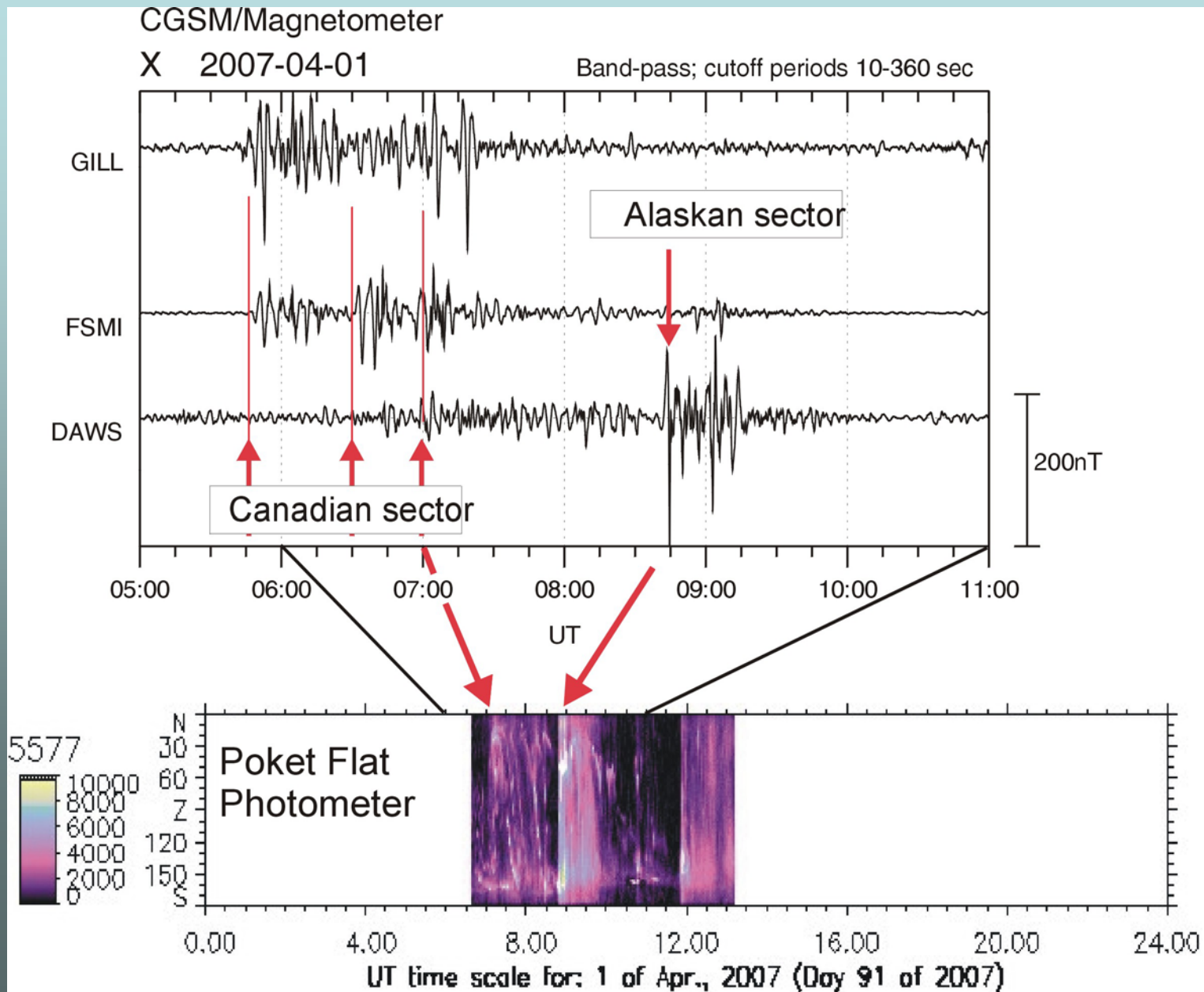


Magnetic H component over Alaska

Magnetometer trace, H-comp, in gammas for Day 091, 2007



Multiple substorm onsets over N America



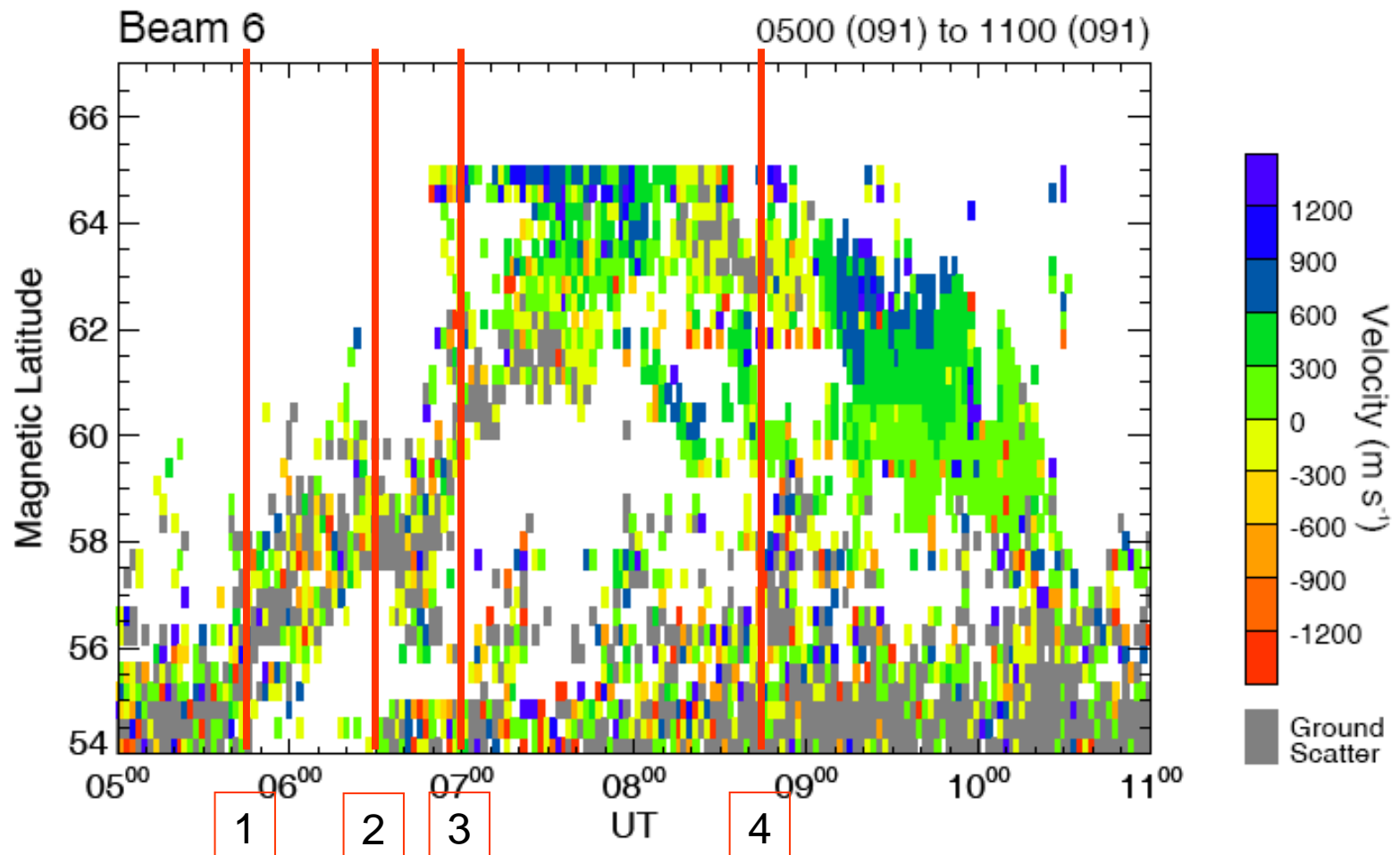
Hokkaido, Apr 1, 07: Fast flows and substorm onsets

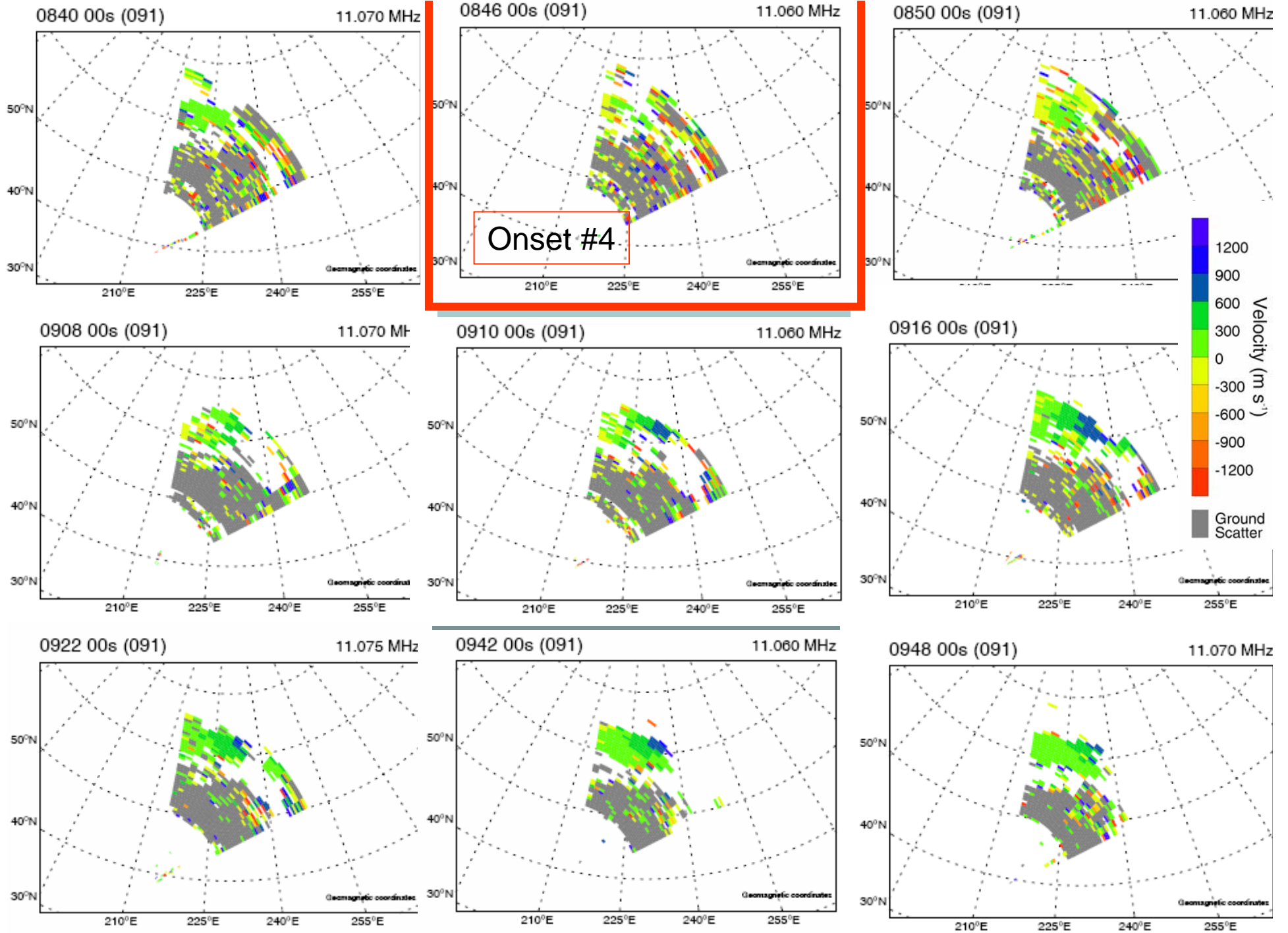
SUPERDARN PARAMETER PLOT

Hokkaido: vel

1 Apr 2007⁽⁹¹⁾

normal (cw) scan mode (150)





King Salmon: April 1, 2007, along L shells, low-velocity E-region echoes

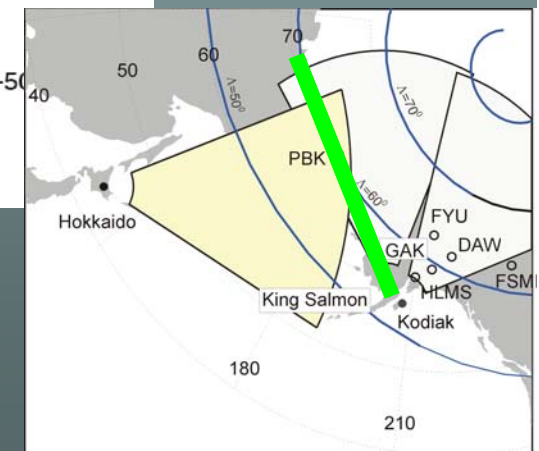
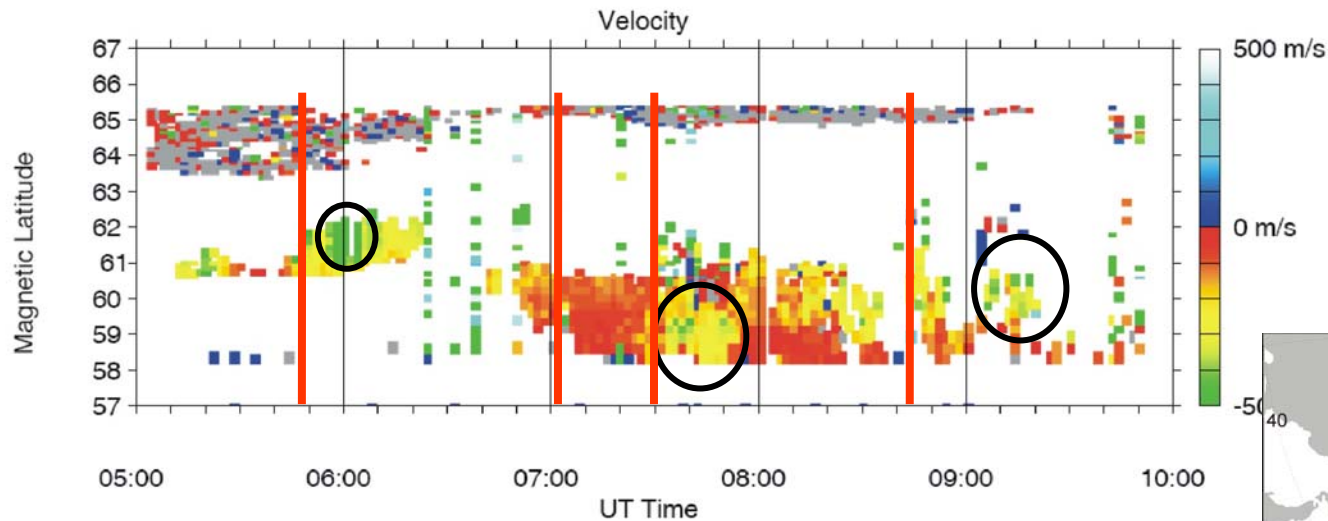
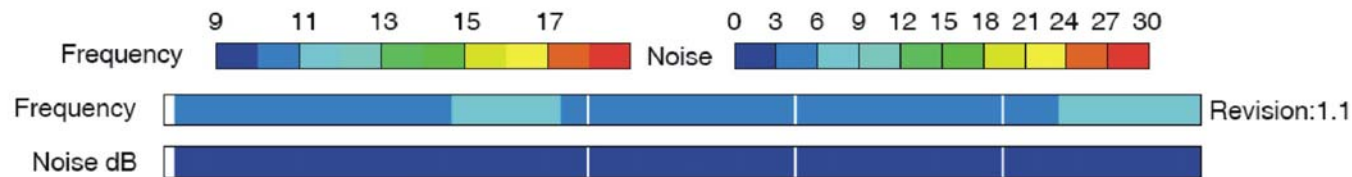
Station: King Salmon (ksr)

Beam 02

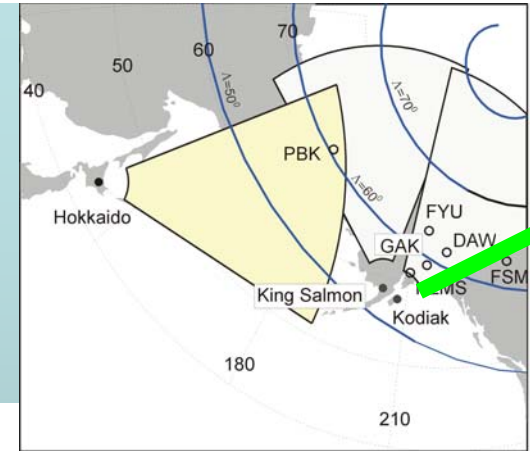
01, April 2007 (20070401)

Operated by: CRL

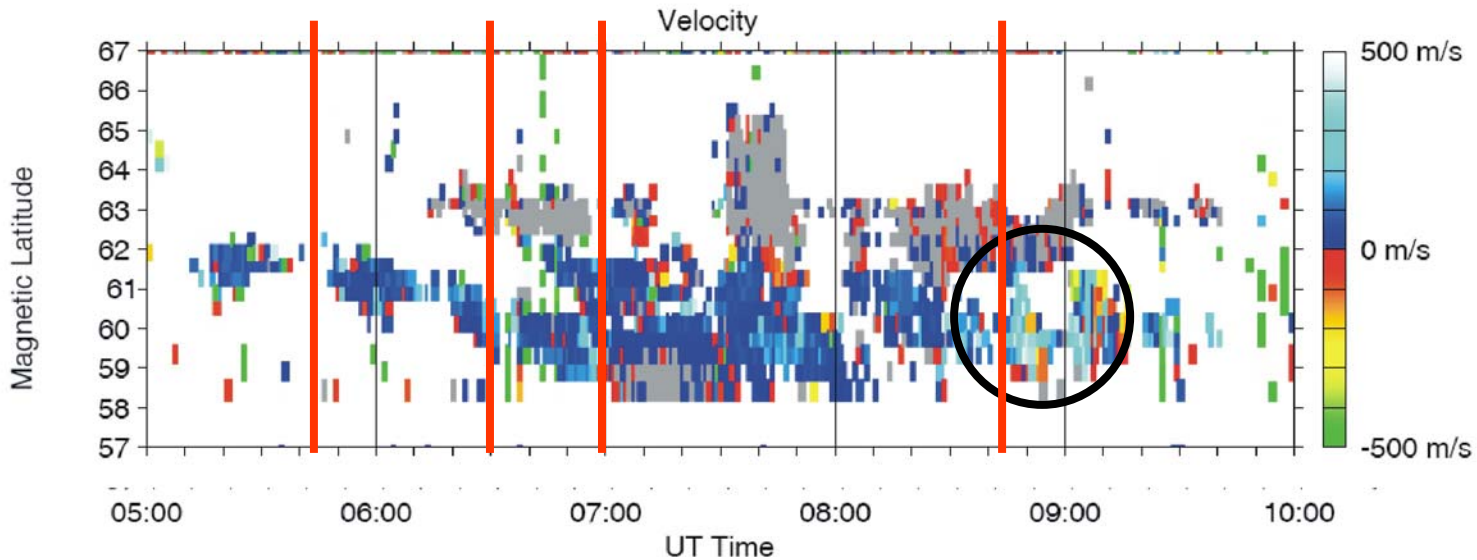
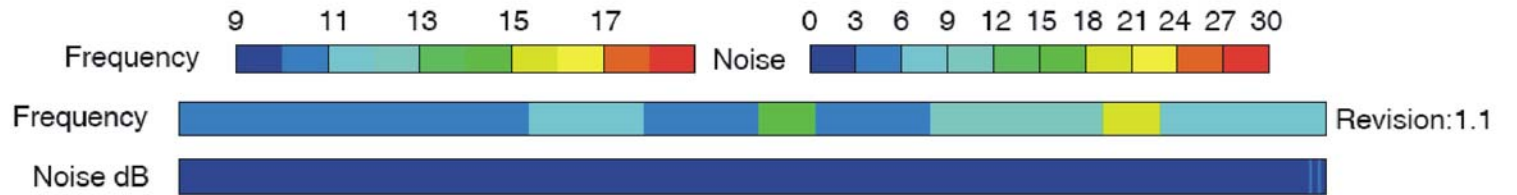
Program ID: 155



Kodiak: April 1, 2007, large flow angles, E-region echoes



Station: Kodiak (kod) Beam 15 01, April 2007 (20070401)
Operated by: University of Alaska, Fairbanks Program ID: 157



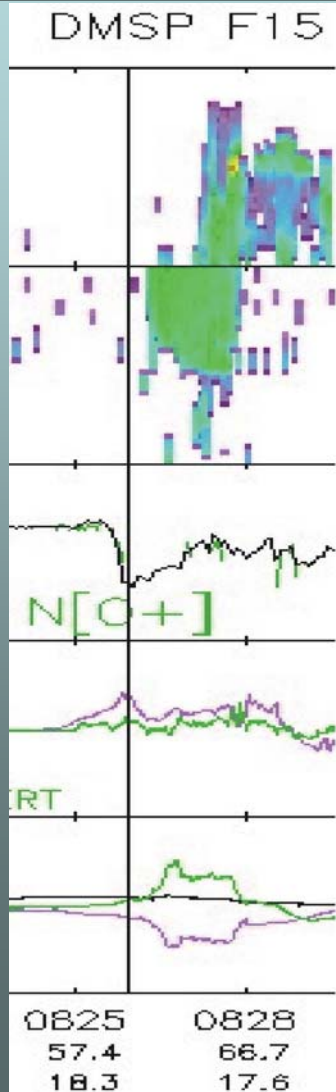
Conclusions from radar data

- Hokkaido detected very fast flows with a delay of ~30 min after the substorm onset
- Similar velocity enhancements were seen by King Salmon
- Fast flows were not seen by Kodiak; it looked perpendicularly to the flow and had E region echoes that are usually slower than ExB

Is the observed high-velocity flow channel PJ?

- We need to establish where the equatorward edge of the oval was
- As no optics available, we considered DMSP data
- Unfortunately, at the time of high-velocity echoes DMSPs crossed the auroral oval at earlier MLT times, but still not very far away

Hokkaido sees broad flow channel, but misses more intense equatorward edge. Observations after onset #3 prior to onset #4



SUPERDARN PARAMETER PLOT

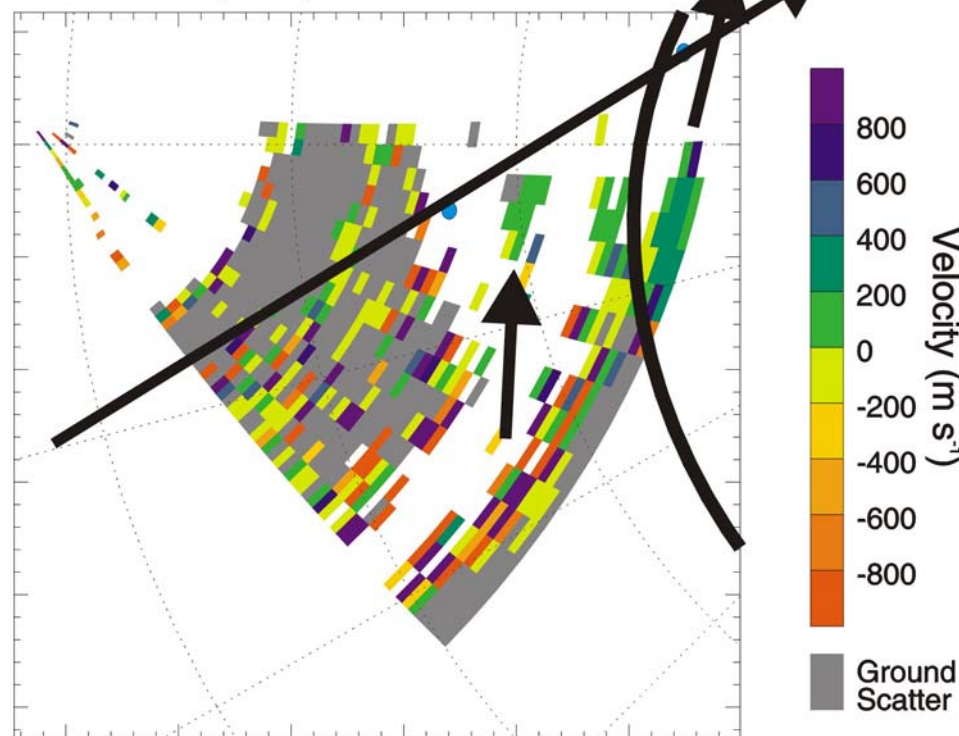
Hokkaido: vel

1 Apr 2007⁽⁹¹⁾

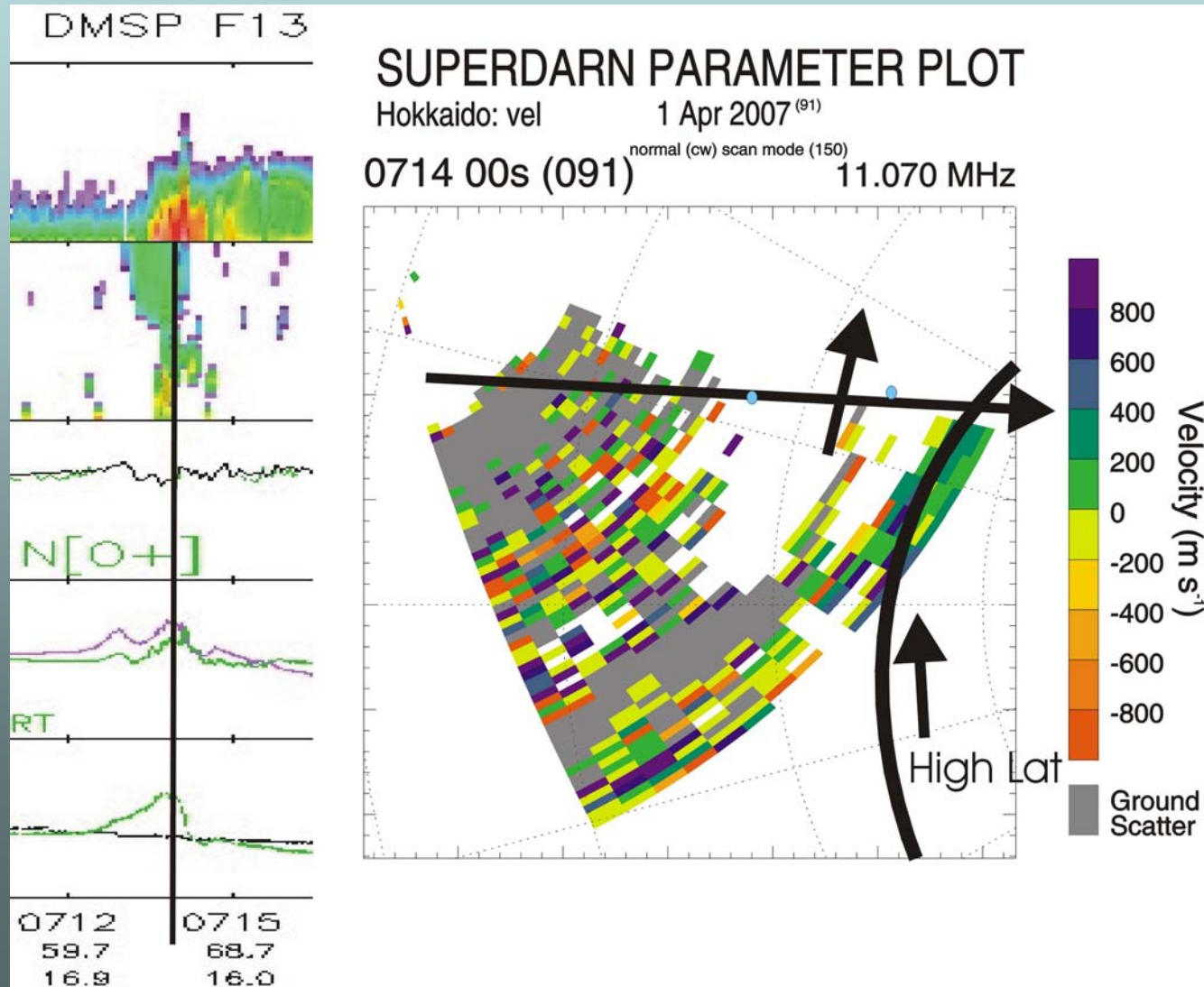
0828 00s (091)

normal (cw) scan mode (150)

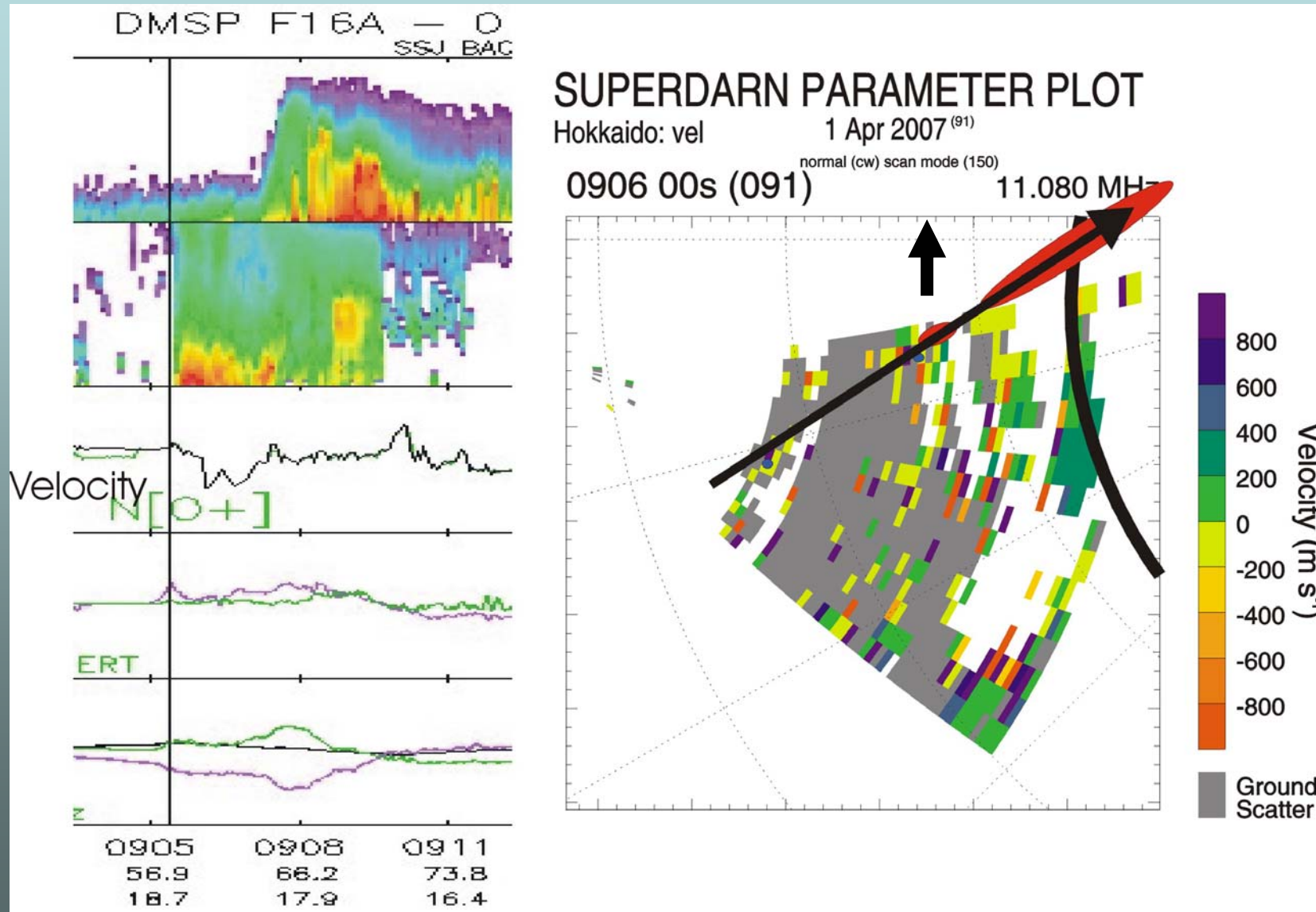
11.075 MHz



Hokkaido missed PJ set after substorm #3 (07:00 or 06:30)



Signatures of PJ seen by Hokkaido at 09:06UT?



Conclusion for April 1st case

- The fast flow was clearly seen at the equatorial edge of the auroral oval and perhaps there were signatures of PJ at lower latitudes

Is this event exceptional?

- We scanned through the entire database
- Yes, this is a very special event, although other ones, less intense, occur once in a while. Their nature is not so clear
- Let us consider another event, July 14, 2007. It seemed similar to the April 1st event

Another event: July 14, 2007

Strong magn. activity, Alaska

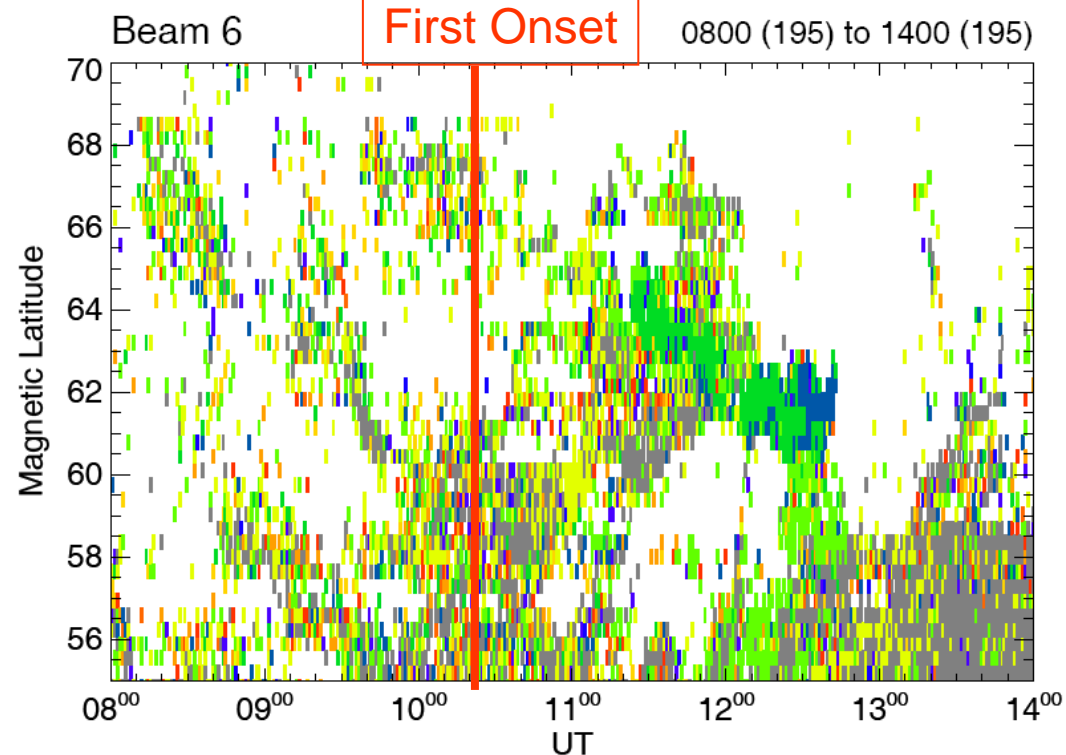


SUPERDARN PARAMETER PLOT

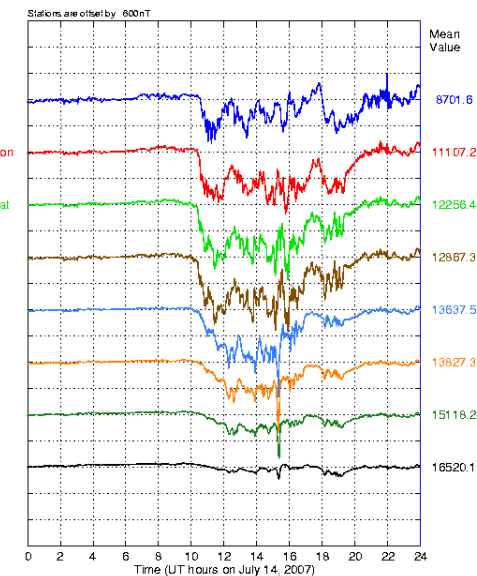
Hokkaido: vel

14 Jul 2007⁽¹⁹⁵⁾

fast normal (cw) scan mode (151)



Magnetometer trace, H-comp. in gammas for Day 195, 2007



July 14, 2007: Is this pre-substorm westward flow intensification?

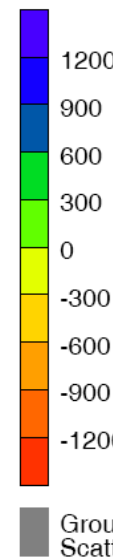
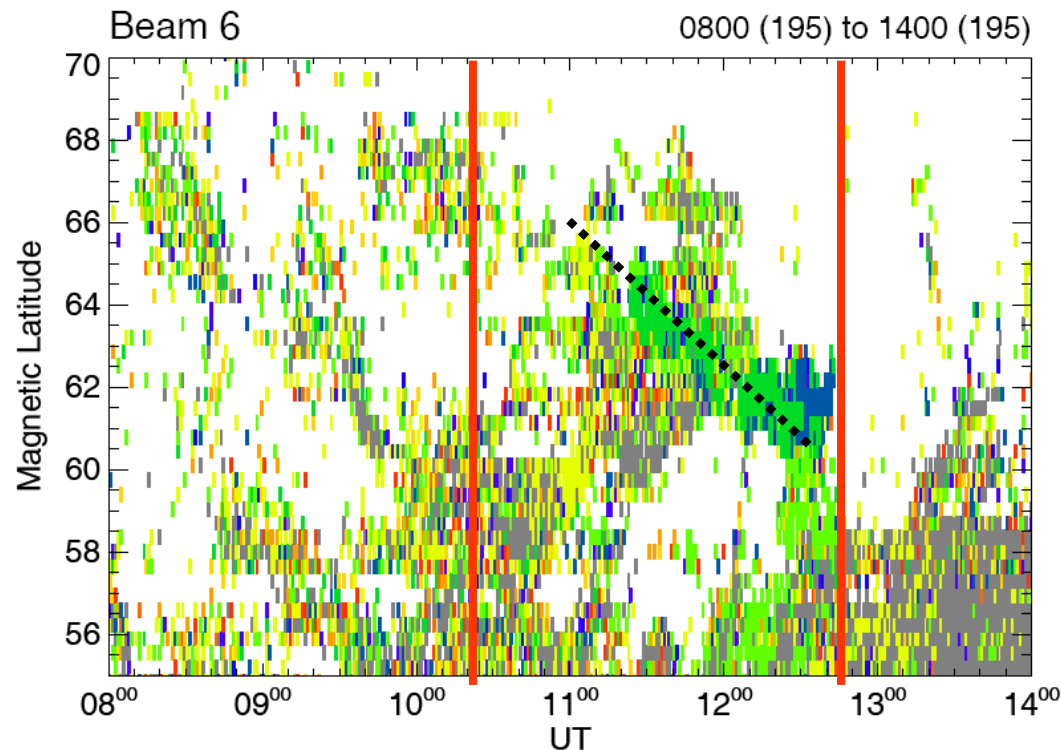
Strong magn. activity, Alaska

SUPERDARN PARAMETER PLOT

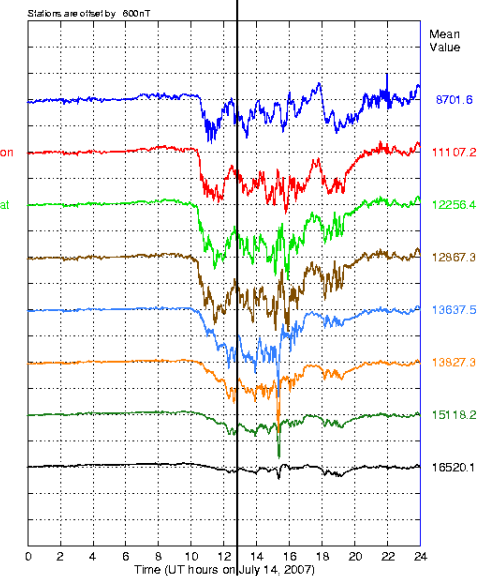
Hokkaido: vel

Onset?

14 Jul 2007⁽¹⁹⁵⁾
fast normal (cw) scan mode (151)

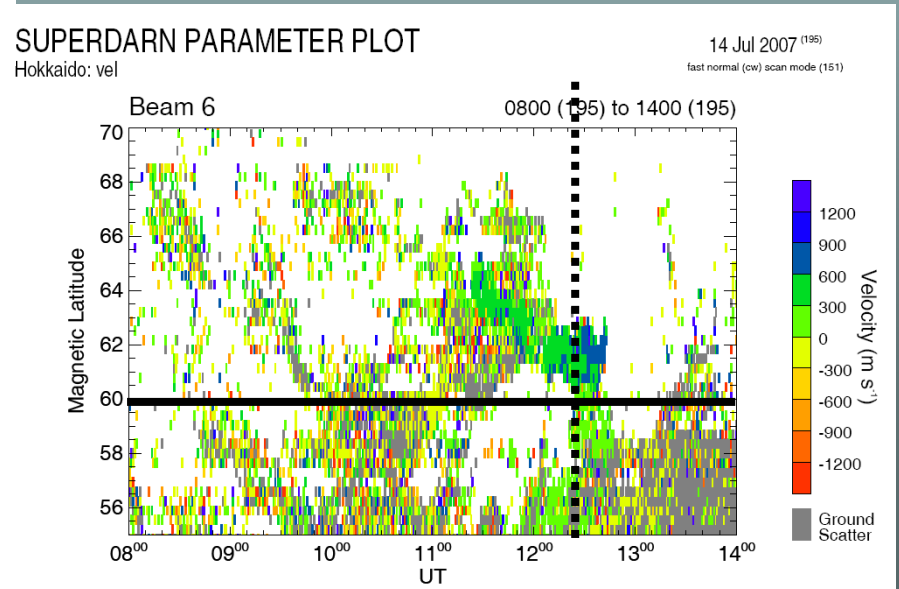
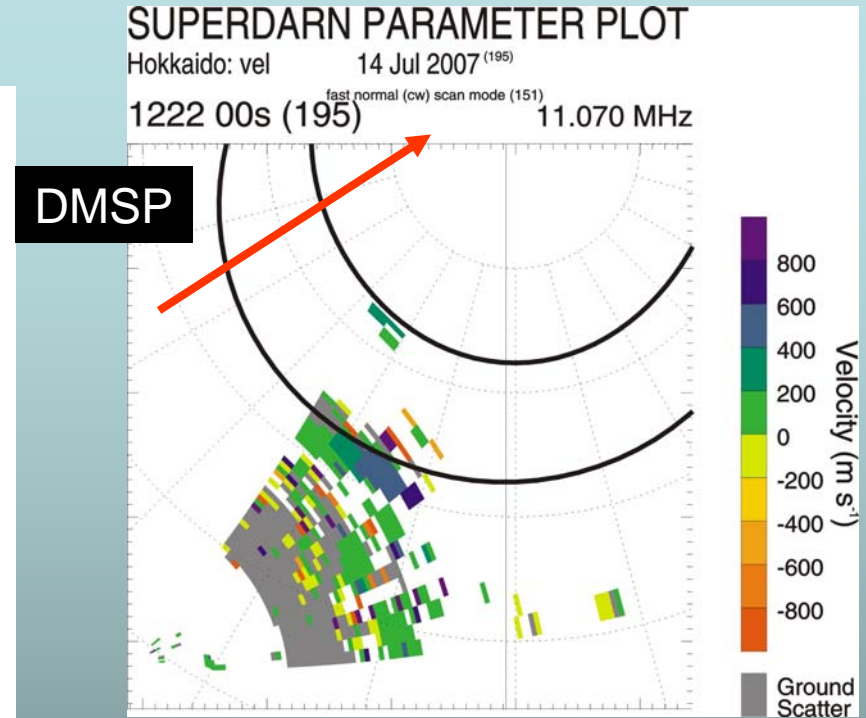
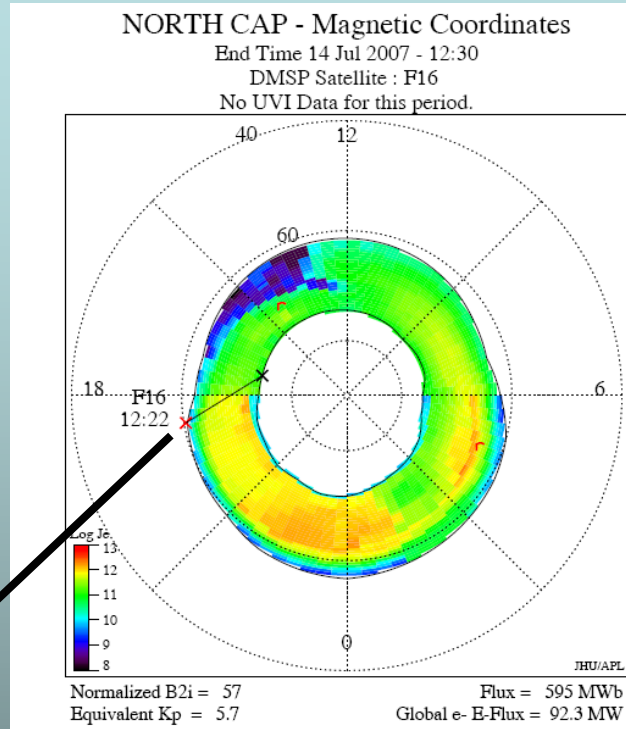
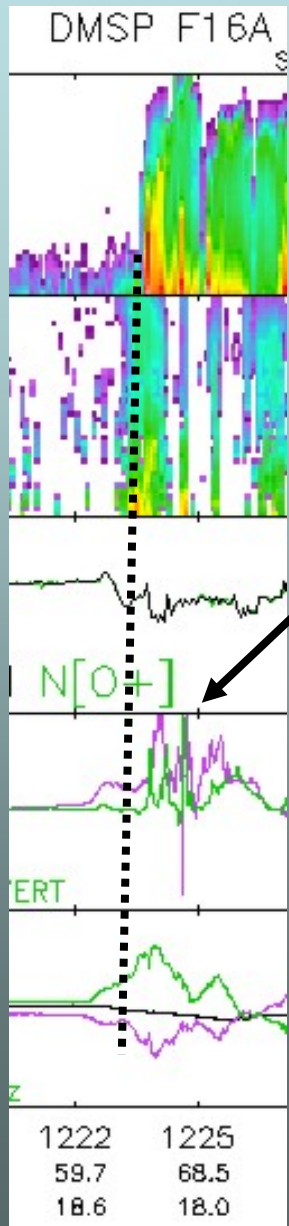


Magnetometer trace, H-comp. in gammas for Day 195, 2007



We hypothesize that in this event the fast flow was associated with the growth phase of a substorm, and not with after-substorm processes. The effect has been reported in past SuperDARN observations

July 14, 2007



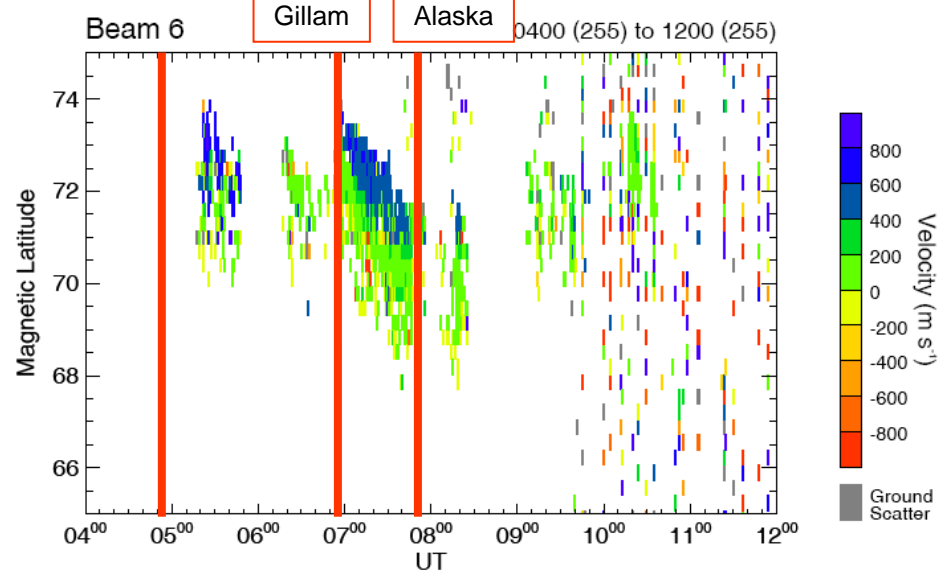
High-Lat Fast Flow Event: Sept 14, 2007

SUPERDARN PARAMETER PLOT

Hokkaido: vel

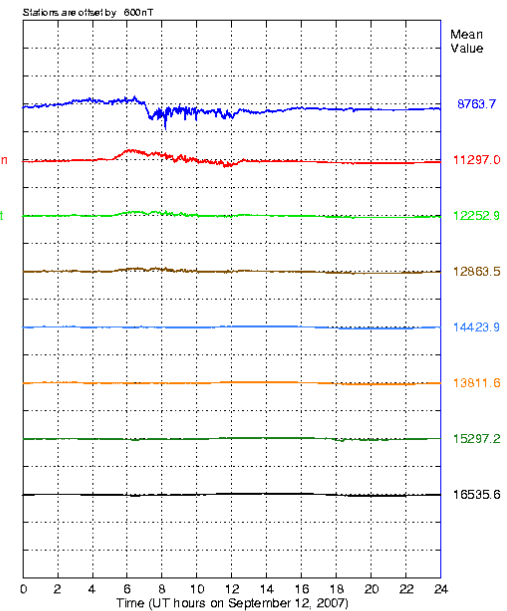
12 Sep 2007 (255)

fast normal (cw) scan mode (151)



Alaska: Low mag. activity

Magnetometer trace, H-comp, in gammas for Day 255, 2007



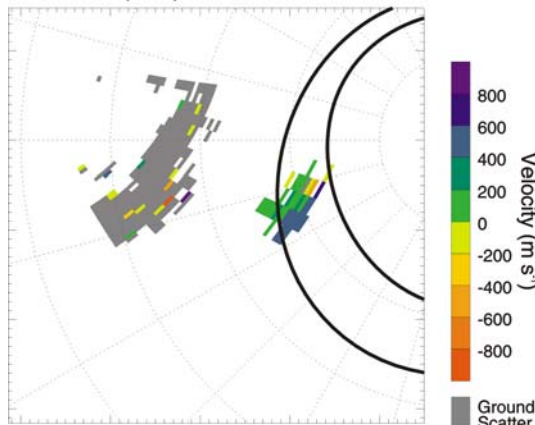
SUPERDARN PARAMETER PLOT

Hokkaido: vel

12 Sep 2007 (255)

fast normal (cw) scan mode (151)

0740 00s (255) 14.645 MHz



DMSPs show auroral-type flow at high latitudes of > 67 deg

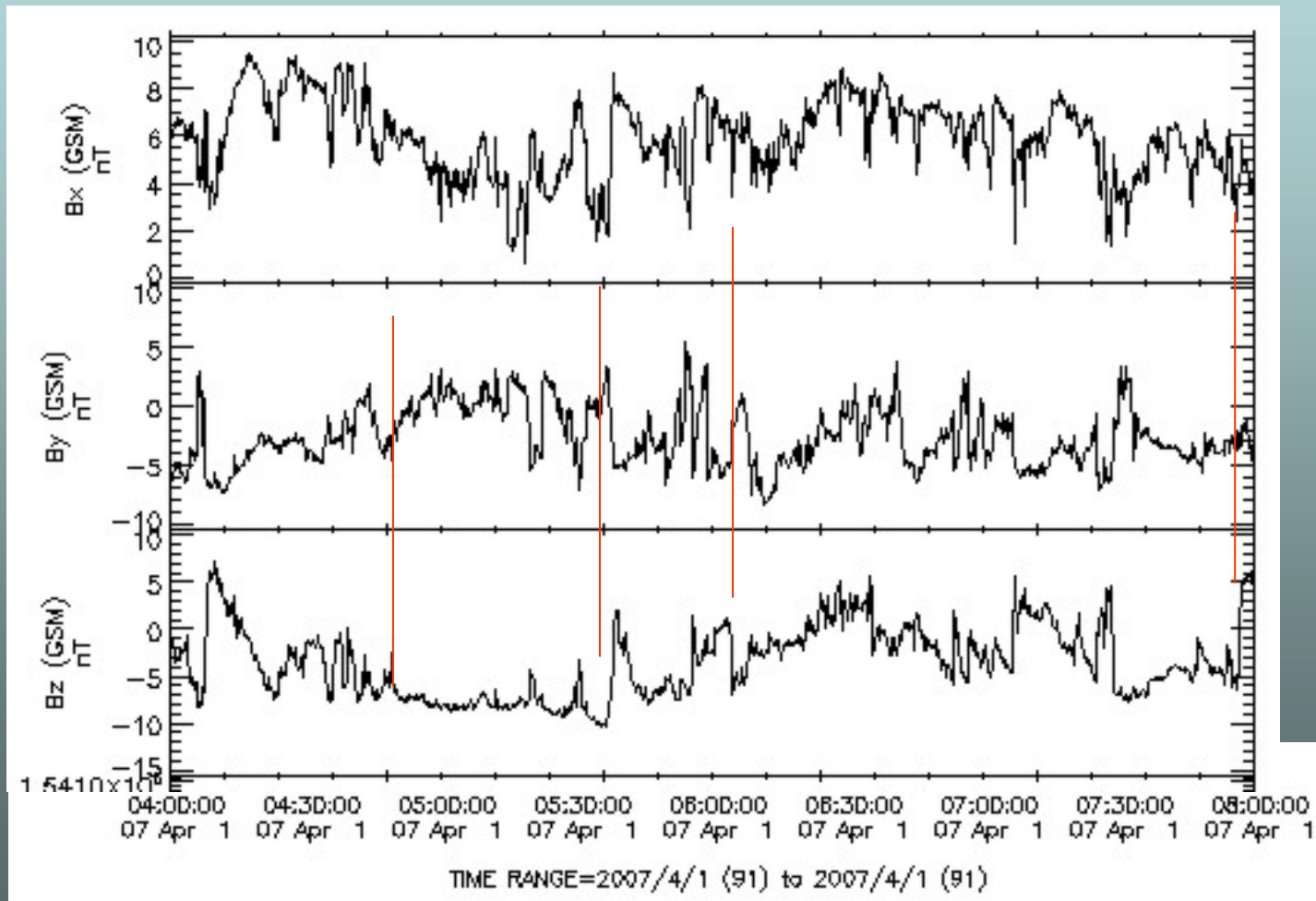
Not clear who was the driver of this flow intensification

Conclusions

- Occasionally Hokkaido detects fast dusk flows with velocities up to 1 km/s (beam 6 is the best, no information is usually available for beams >7)
- The fast flows are seen at the equatorward edge of the auroral oval; no cases with clear-cut detached flow channels outside the auroral oval have been identified so far
- In April 1st event, the flow occurred after the substorm onset in nearby auroral zone area, to the east from the Hokkaido FoV. The delay is ~30 min. This is consistent with Galperin's views. In this case, Hokkaido sees the same phenomenon what we reported with the King Salmon radar, except of at lower latitudes
- In July 14 event, the enhanced flow well might be the westward enhancement prior to a substorm
- There are at least two scenarios of high-velocity occurrence for Hokkaido. Which one works and when requires a tedious investigation on an event-by-event basis.

The end of the story

IMF and substorm triggers

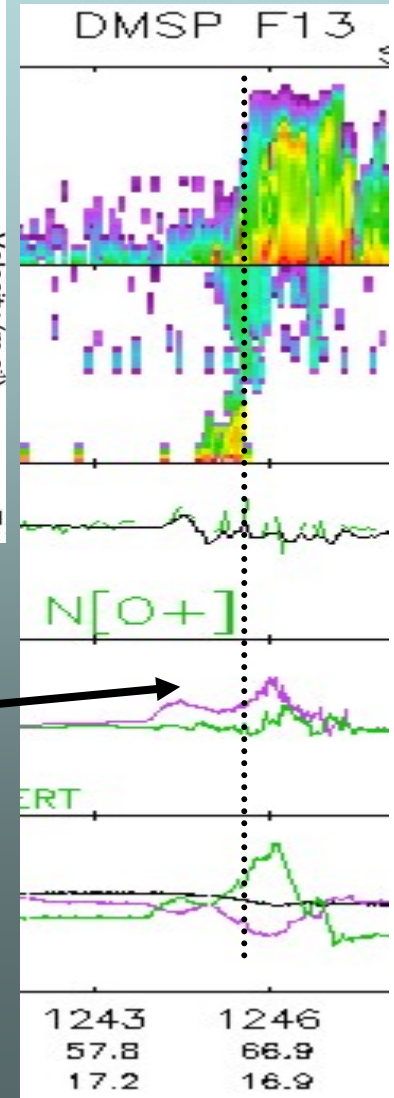
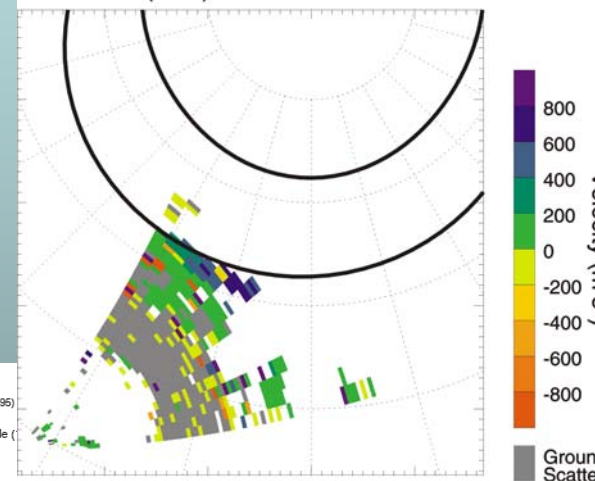


July 14, 2007: Hokkaido sees equatorward part of the flow band

DMSP

SUPERDARN PARAMETER PLOT

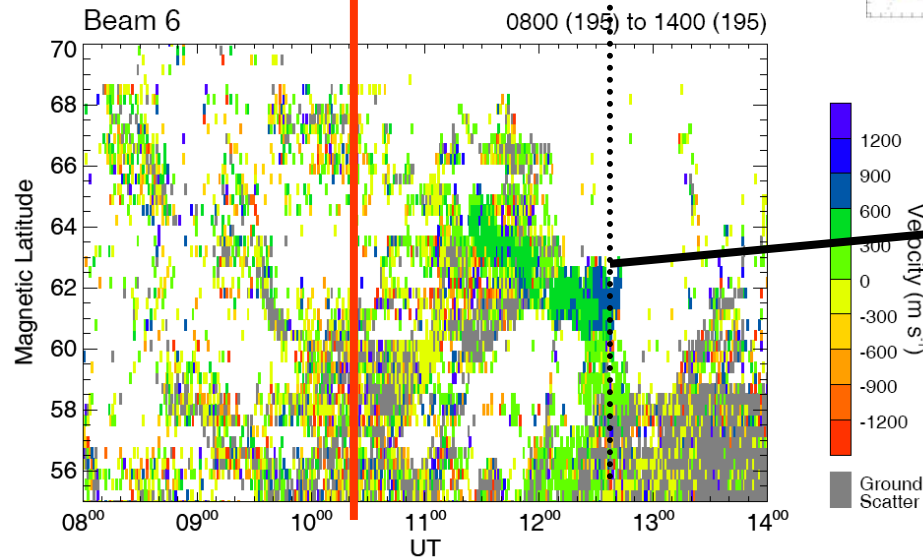
Hokkaido: vel
14 Jul 2007⁽¹⁹⁵⁾
1240 00s (195) 11.075 MHz



SUPERDARN PARAMETER PLOT

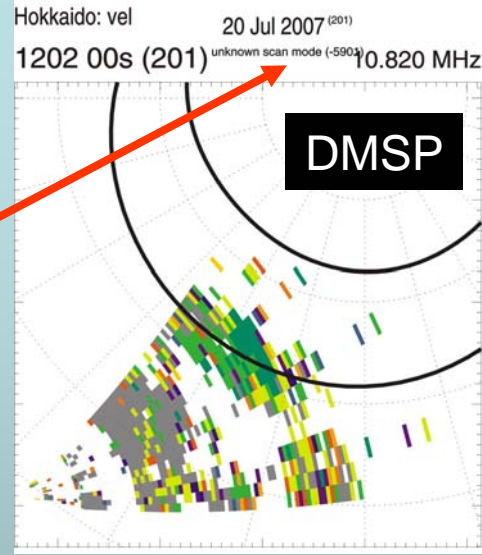
Hokkaido: vel

14 Jul 2007⁽¹⁹⁵⁾
fast normal (cw) scan mode

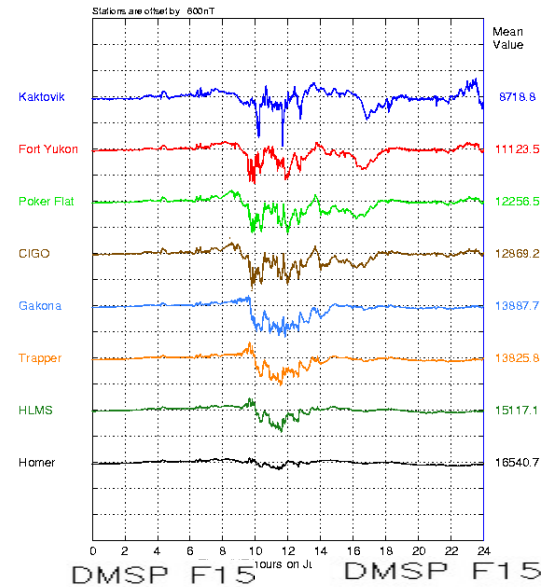


July 20, 2007:
Hokkaido sees
equatorward part
of a broad flow
band, no PJ

SUPERDARN PARAMETER PLOT



Magnetometer trace, H-comp, in gammas for Day 201, 2007

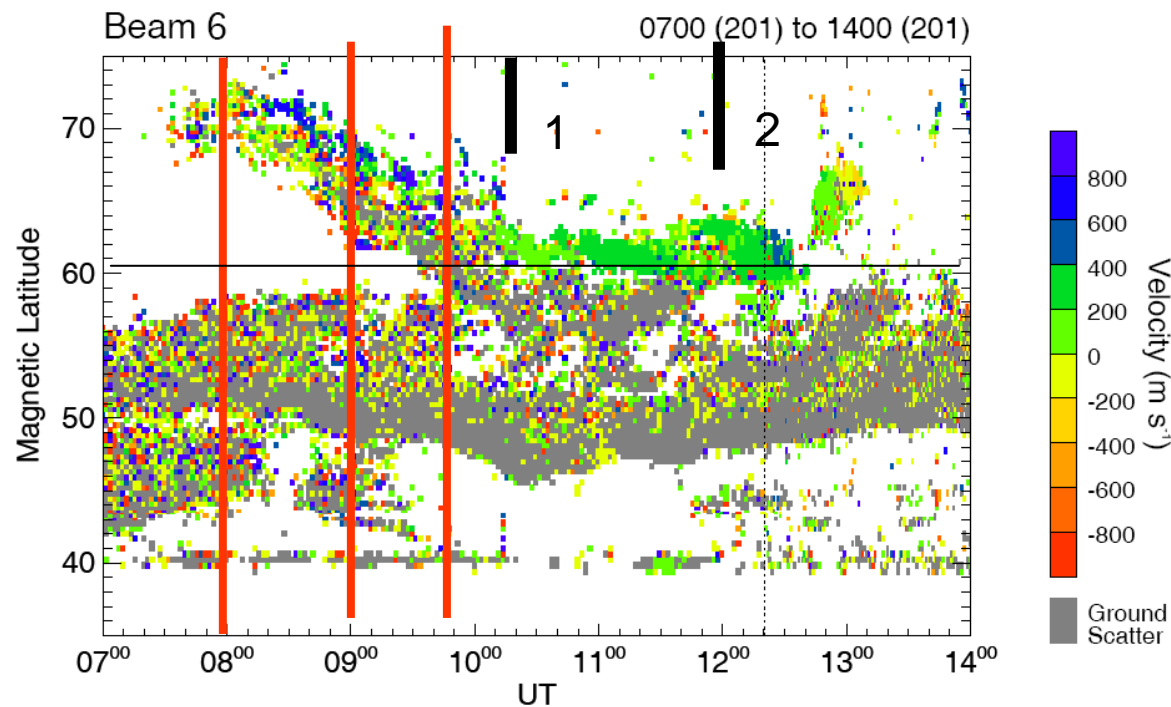


SUPERDARN PARAMETER PLOT

Hokkaido: vel

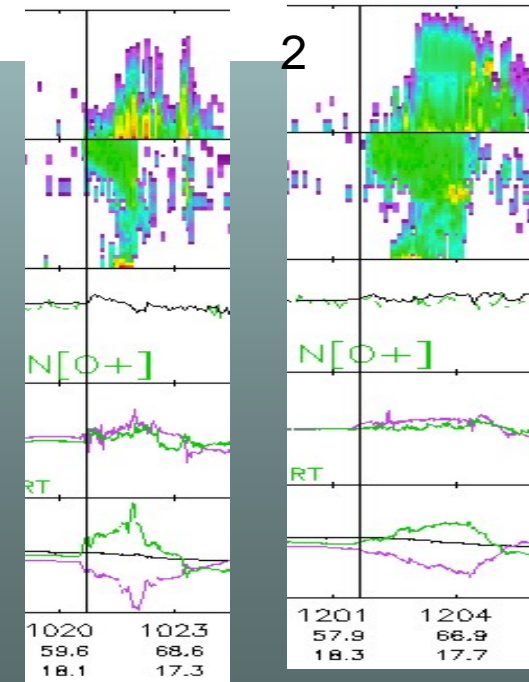
20 Jul 2007⁽²⁰¹⁾

unknown scan mode (-5901)

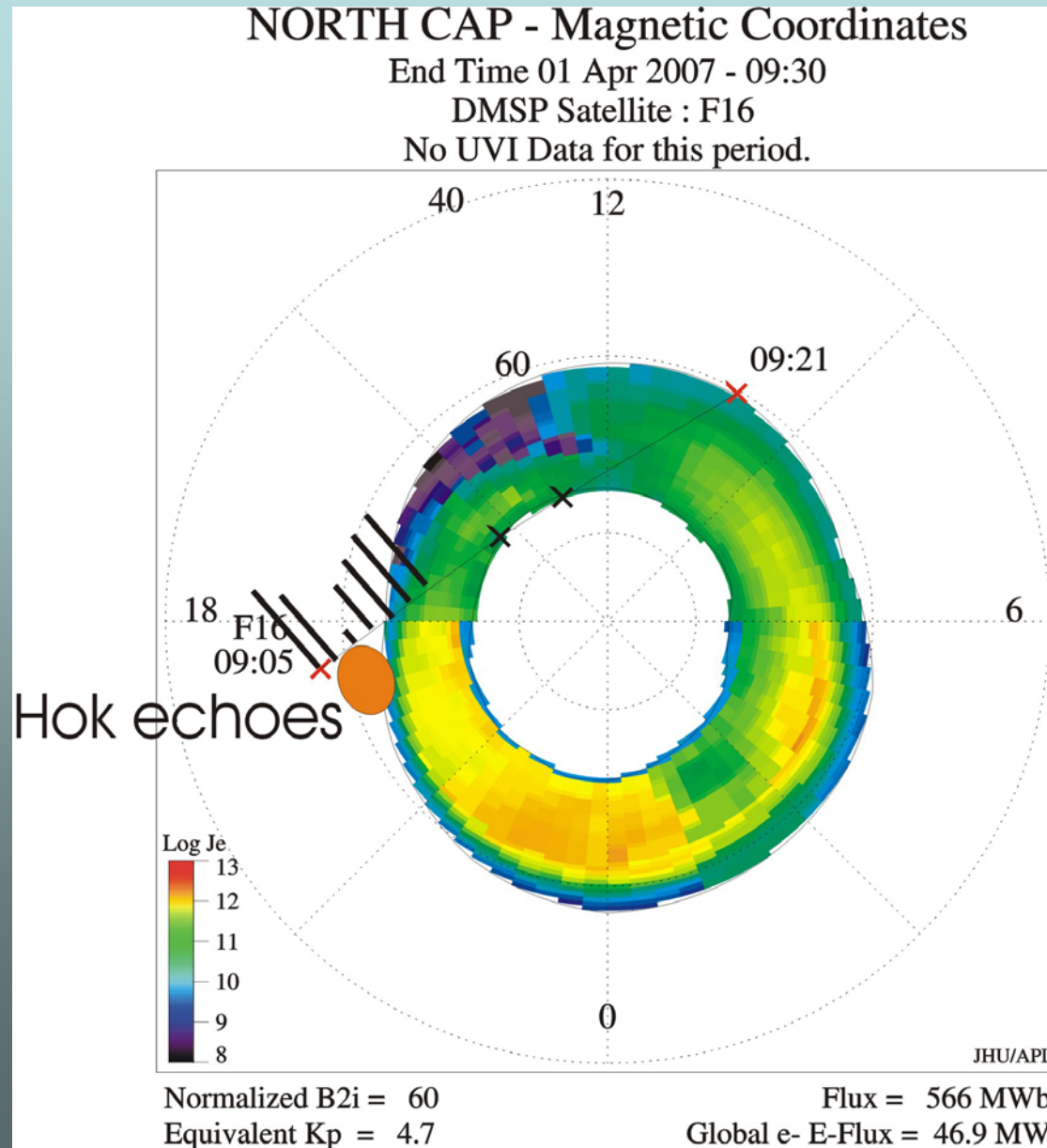


1

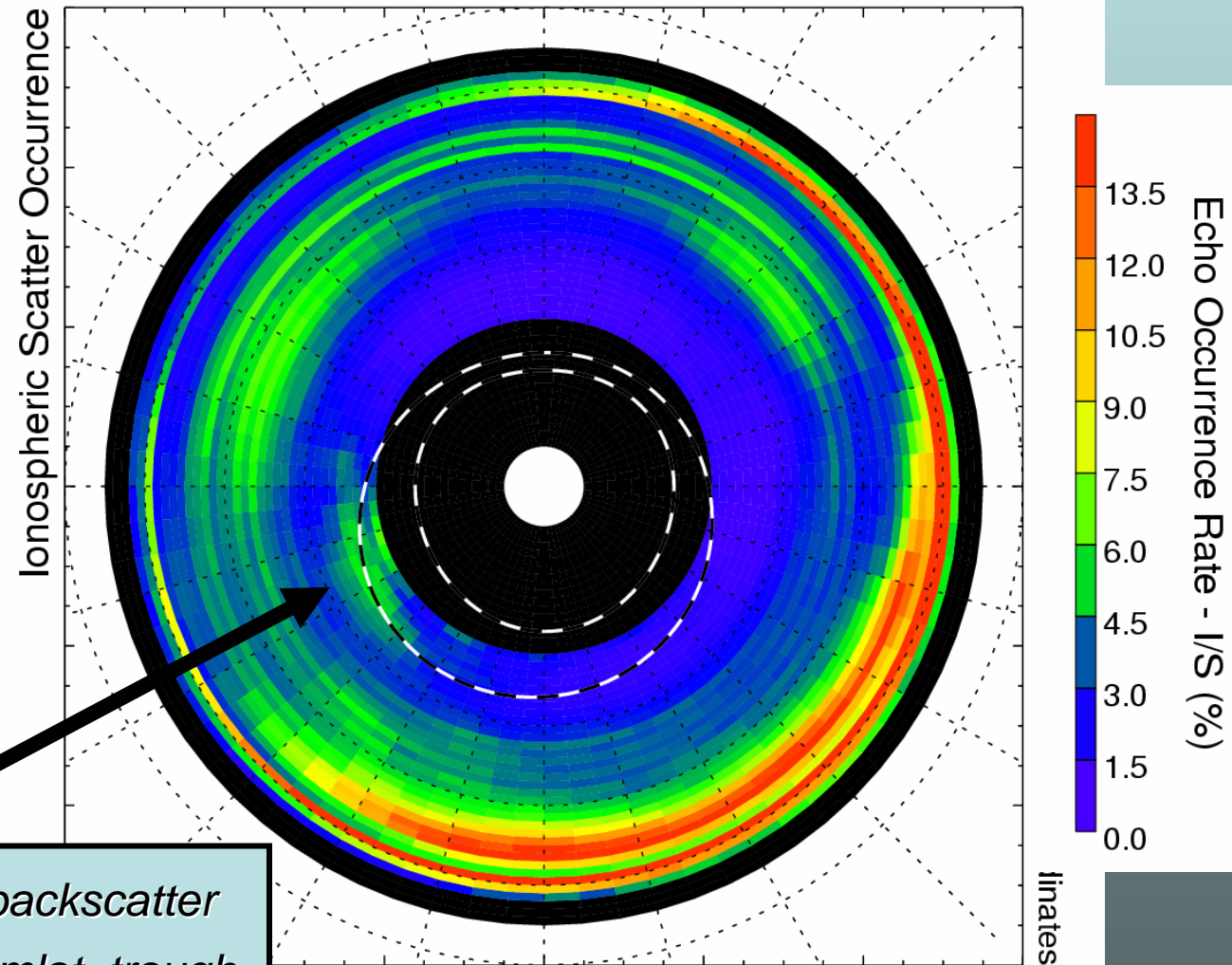
2



Oval and PJ after onset #4.



K. Hosokawa: Hokkaido echo statistics Dec/06-May/07



*Duskside ionospheric backscatter
- FAIs in the vicinity of mlat. trough*

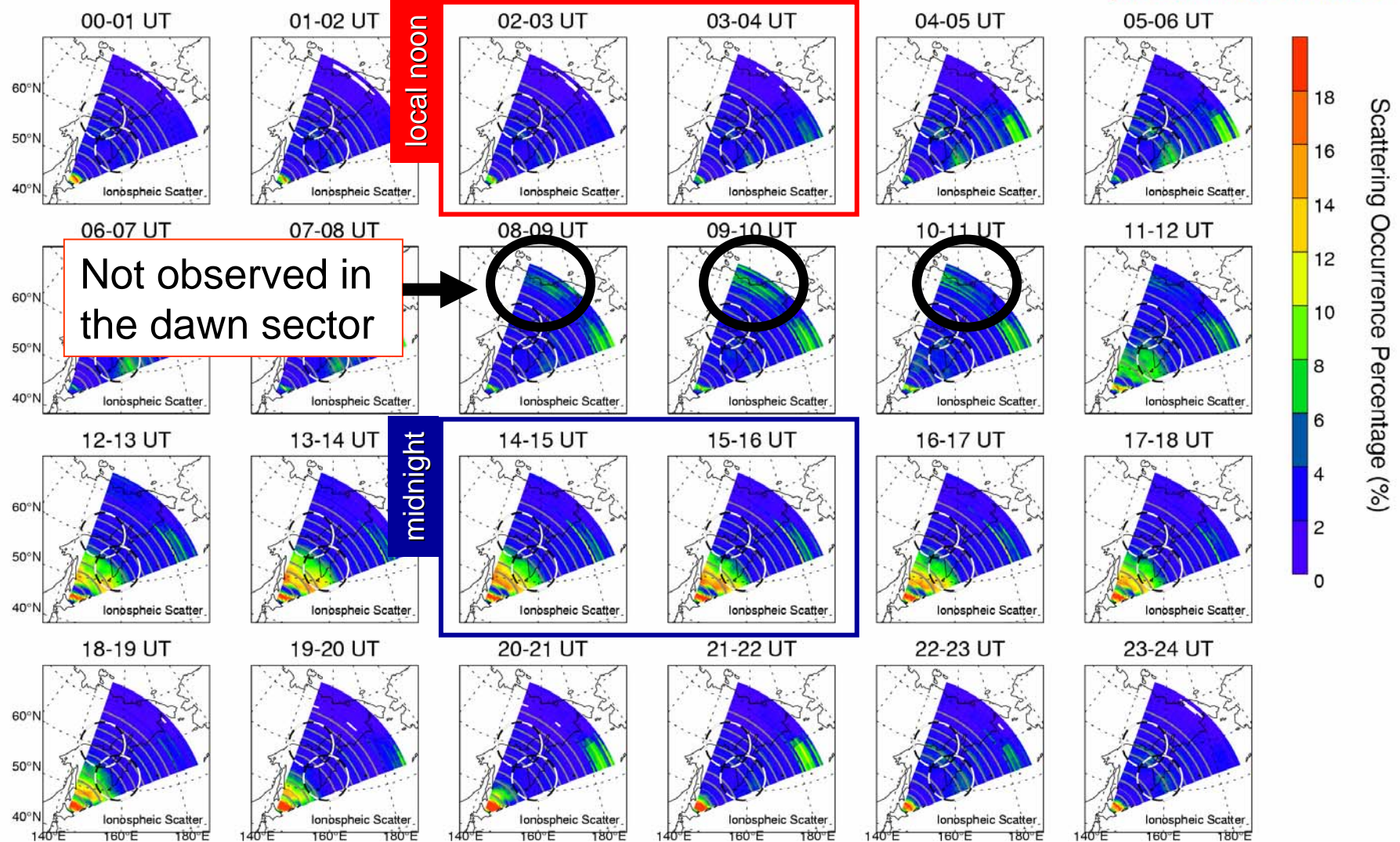
K. Hosokawa: Ionospheric backscatter – Dec

2006 to May 2007

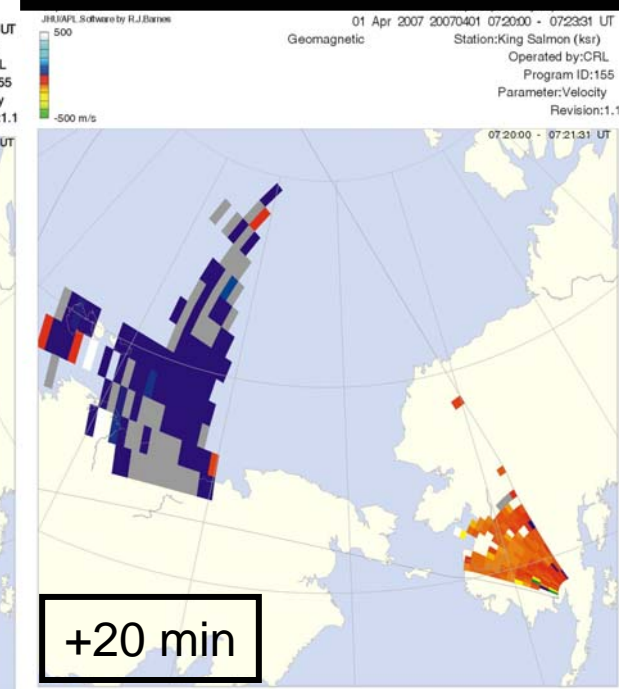
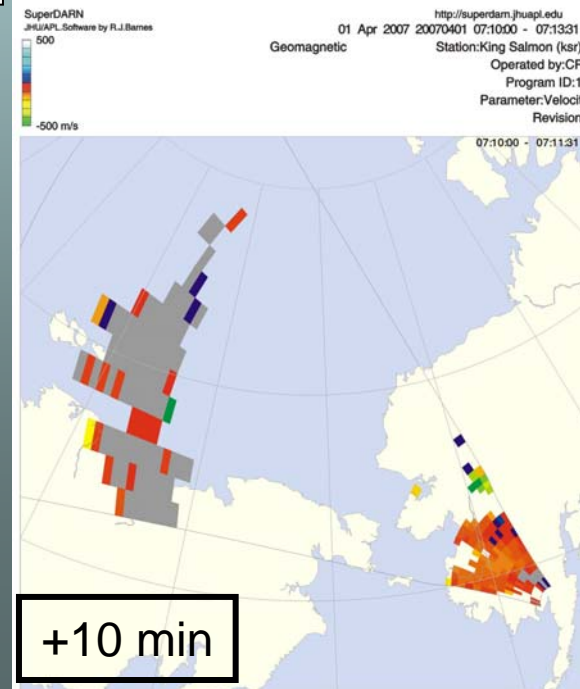
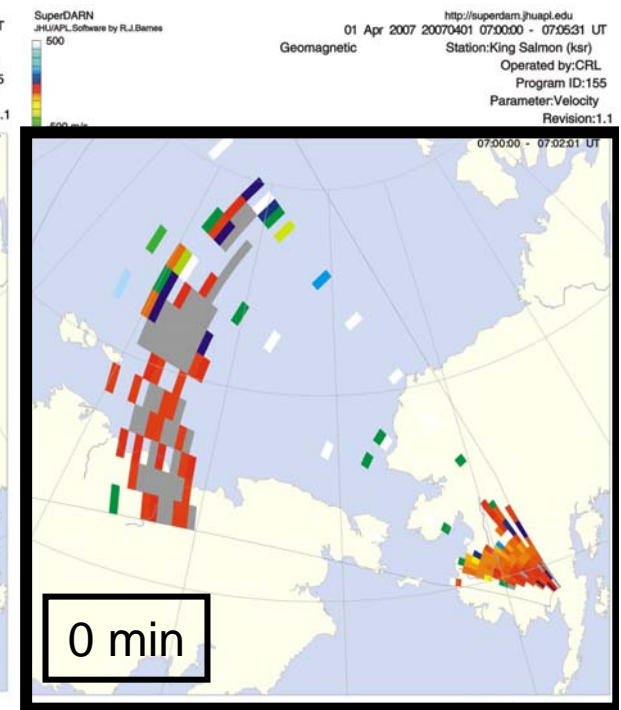
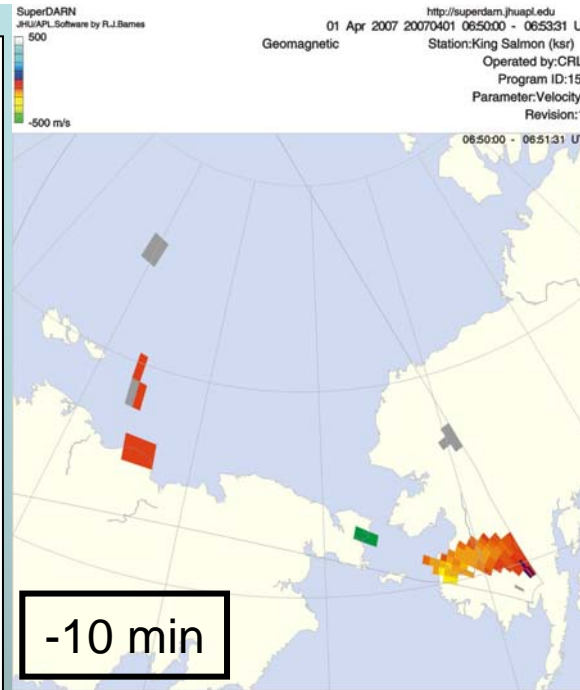
Hokkaido Radar Backscatter Statistics Ionospheric Scatter (projection height 400 km)

Dec 2006
to
May 2007

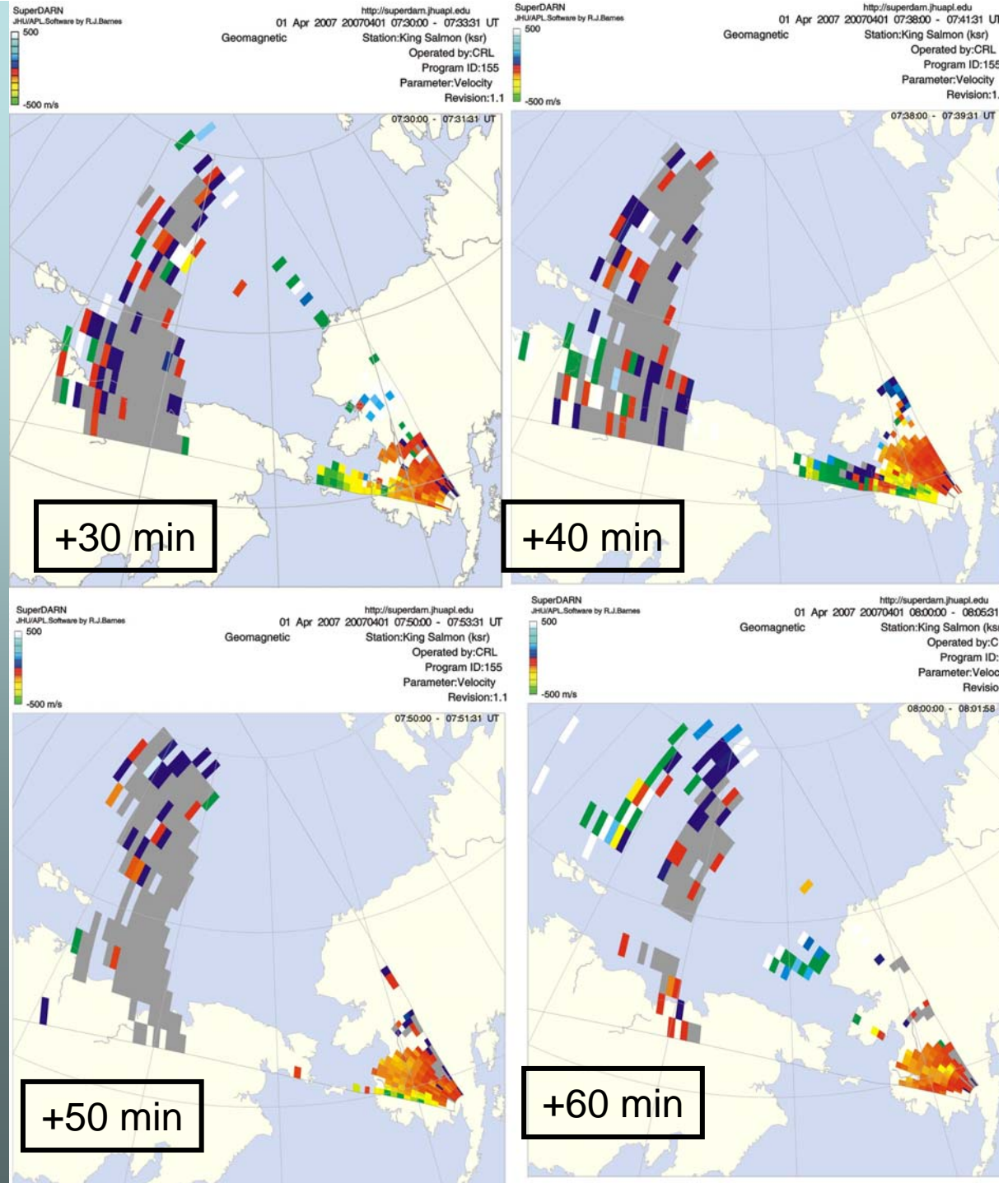
processed with FitACF version 2.00



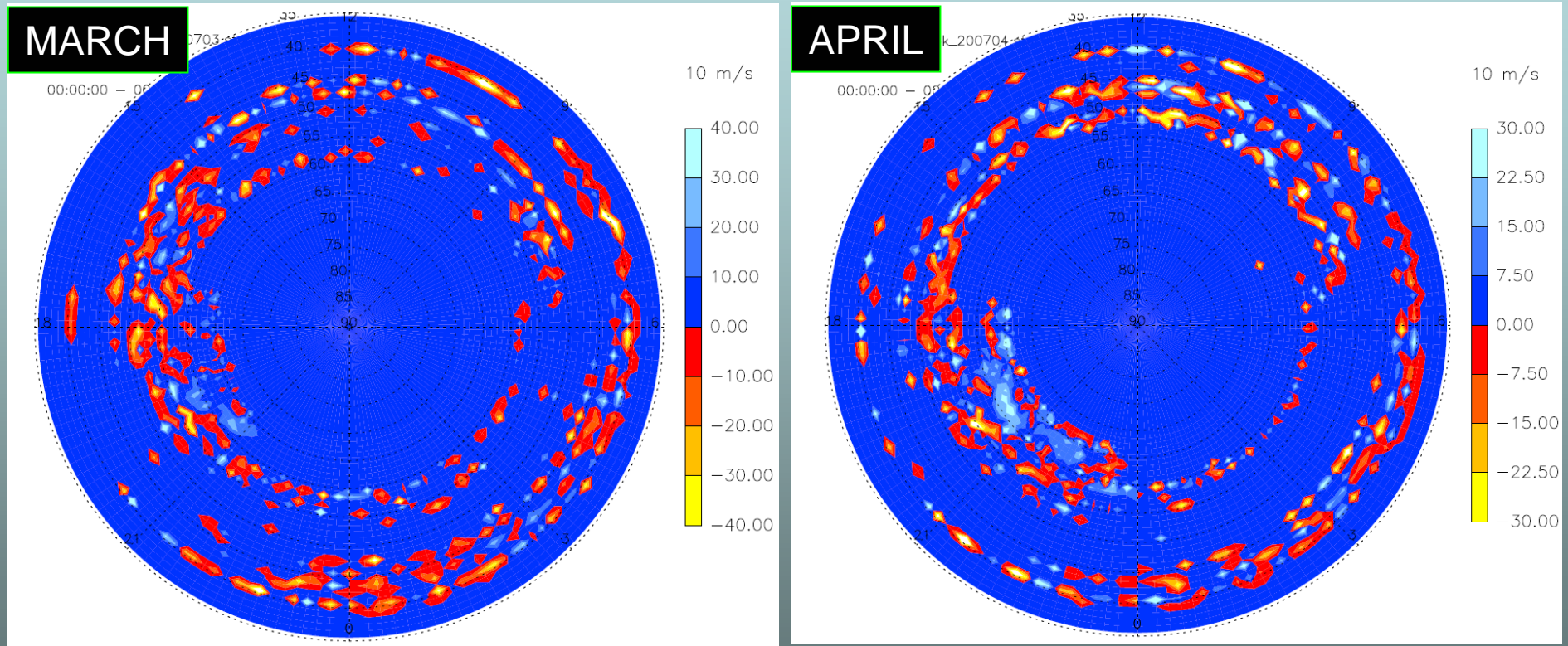
Substorm-related velocity intensification seen by the KS radar. Observations near substorm #3:



Substorm-related
velocity
intensification
seen by the KS
radar.
Observations near
substorm #3:

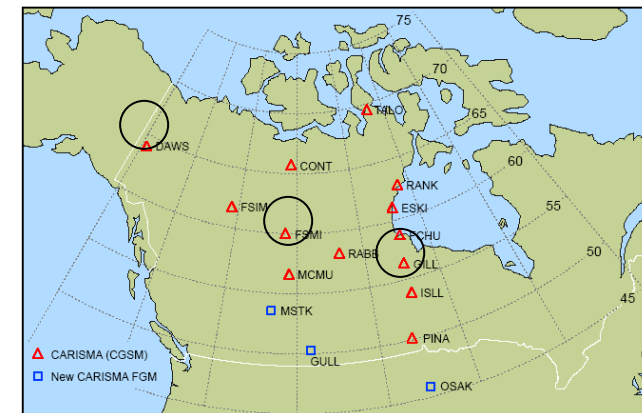
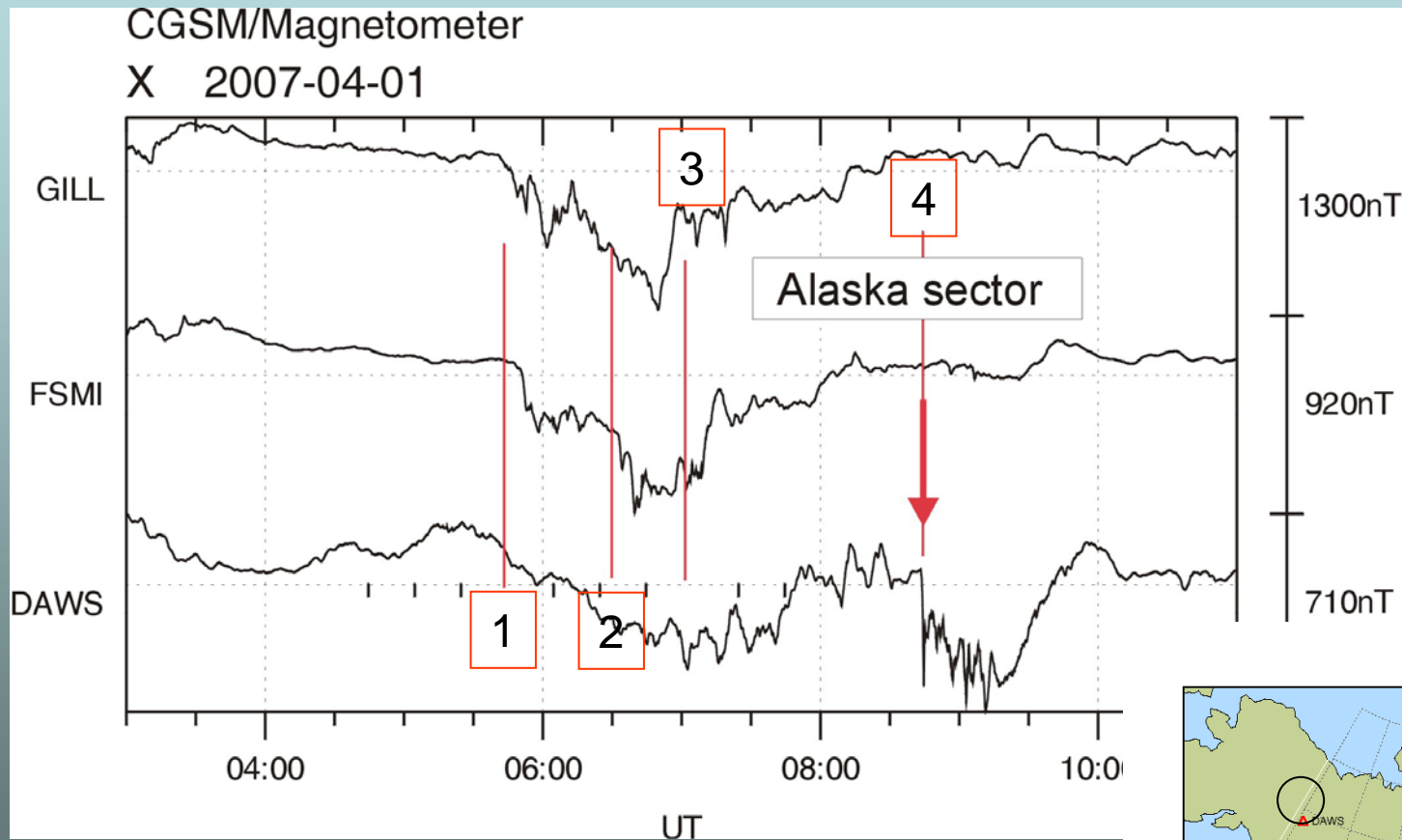


Hokkaido echo statistics for March/07 and April/07, beams 4,5,6



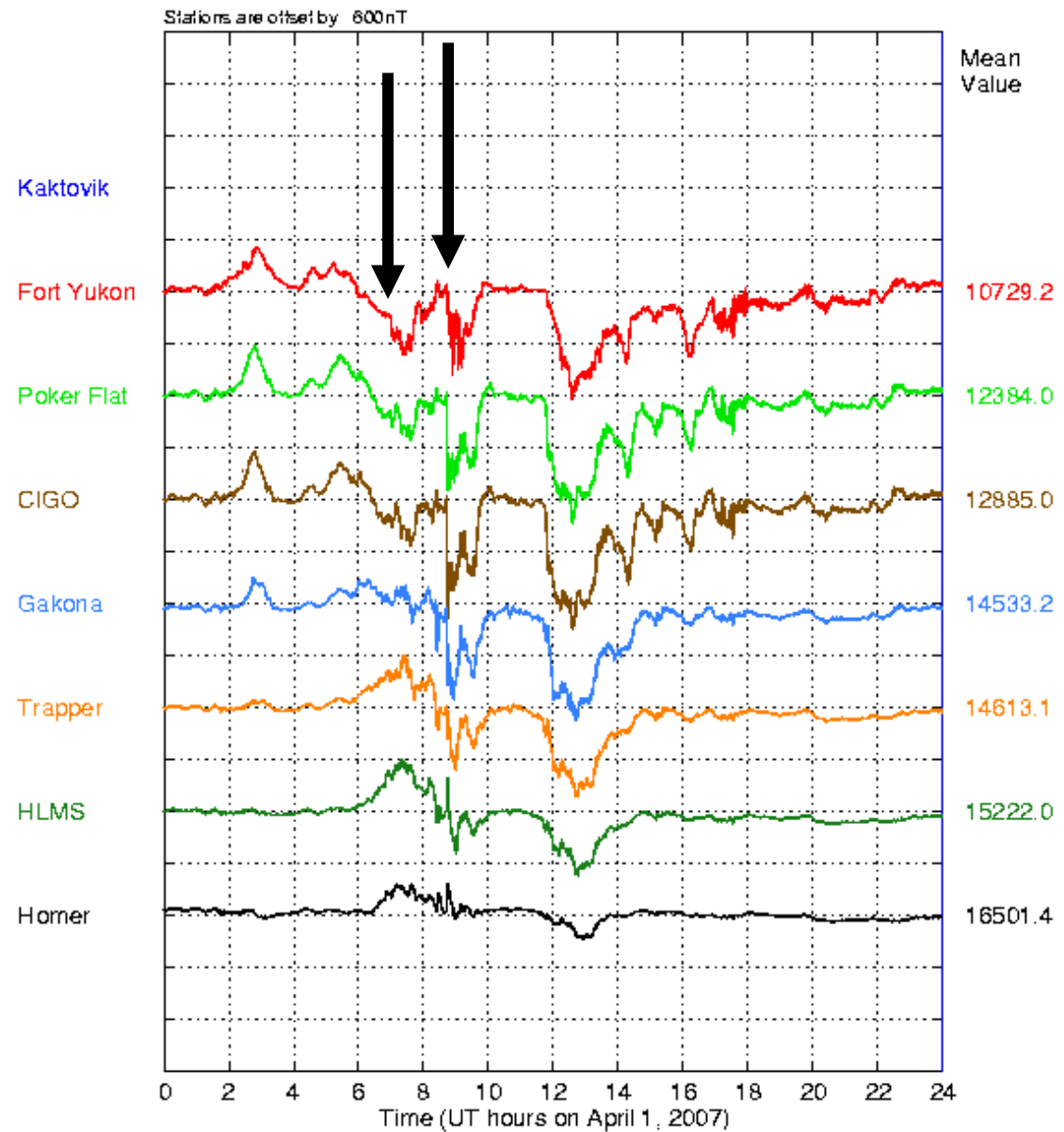
Typical velocities are difficult to see!

Magnetometer records, Northern Canada



Magnetic H component over Alaska

Magnetometer trace, H-comp, in gammas for Day 091, 2007

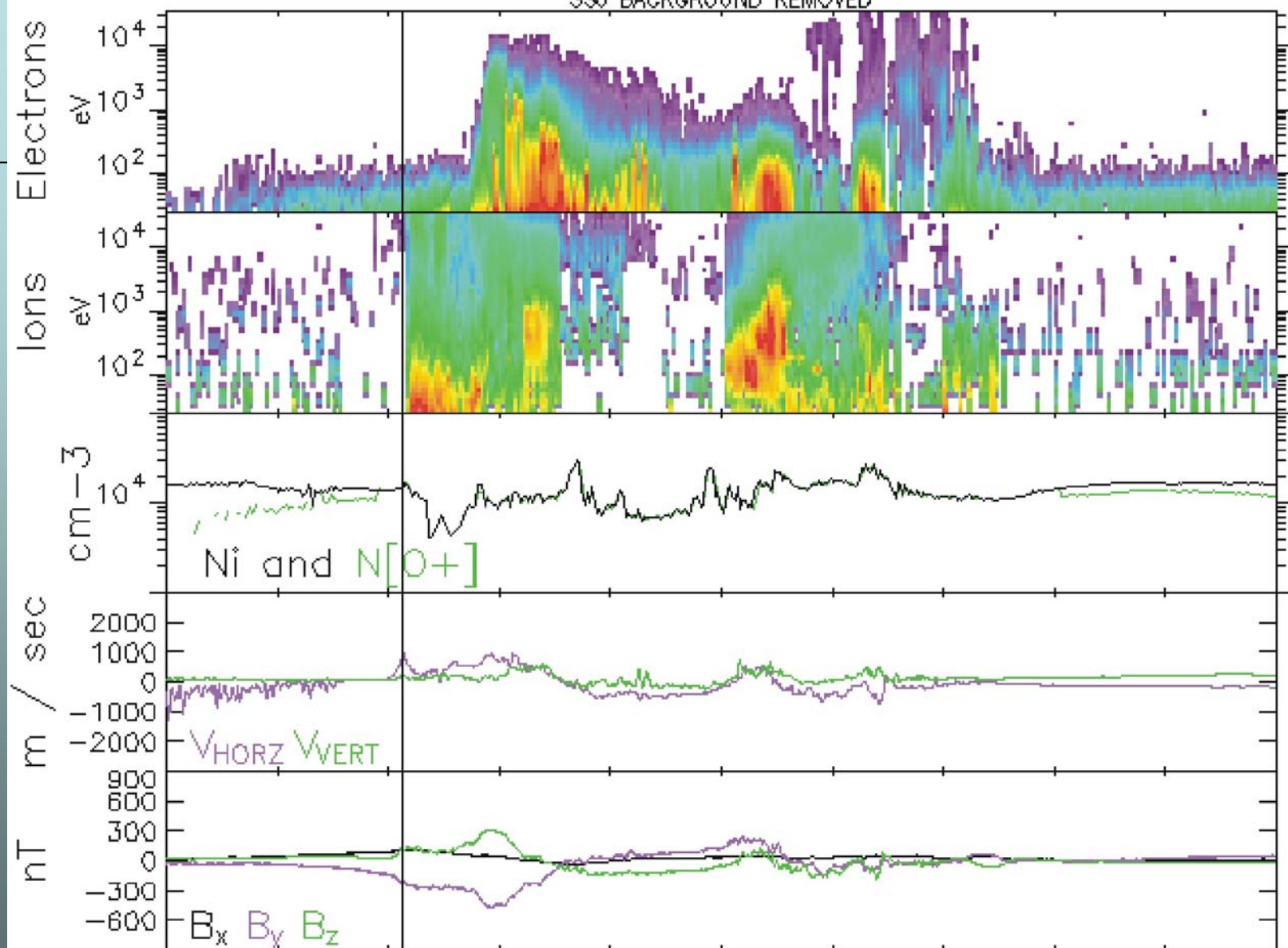


DMSF F16A - 01-Apr-2007 (Day 091)

SSJ BACKGROUND REMOVED

Previous

Next



Time	0859	0902	0905	0908	0911	0914	0917	0920	0923	0926	0929
MLat	38.1	47.3	56.9	66.2	73.8	76.2	71.8	63.6	53.8	42.9	31.4
MLT	19.3	19.1	18.7	17.9	16.4	13.7	11.3	10.1	9.4	9.0	8.8

Run Apr 2 2007