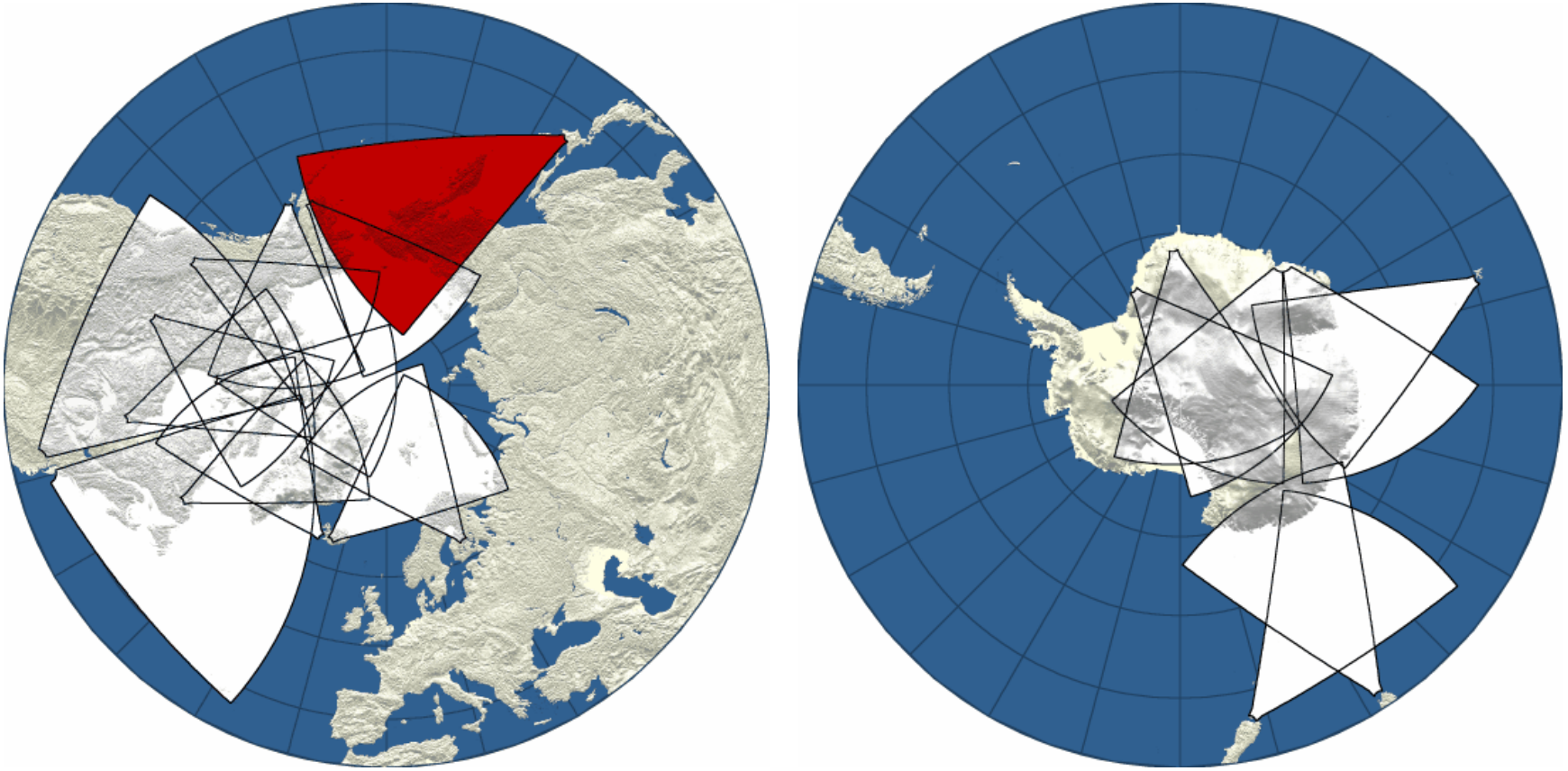
SuperDARN observation of equatorward progression of dayside merging flows during a geomagnetic storm

N. Nishitani[1], T. Kikuchi[1],
T. Ogawa[1], S. Watari[2], T. Hori[1],
and Hokkaido Radar Group

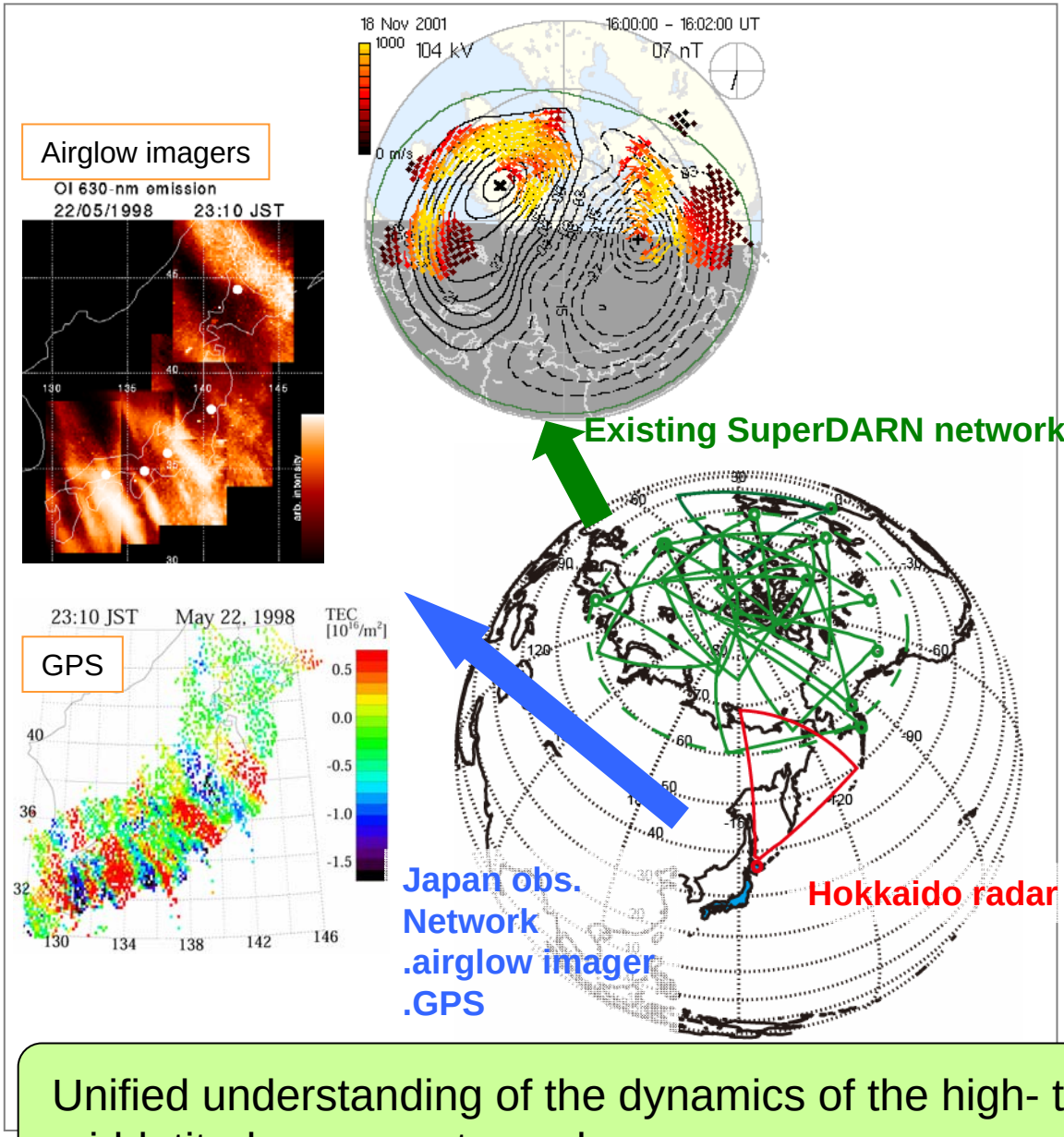
1. Solar-Terrestrial Environment Laboratory, Nagoya University
2. NICT

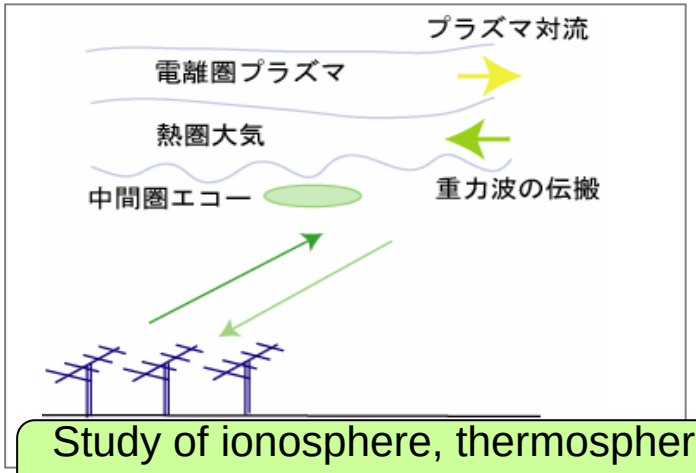
Super Dual Auroral Radar Network (SuperDARN)



Total: 21 HF radars (14 in the northern and 7 in the southern hemispheres)

SuperDARN Hokkaido radar (Nov. 2006 ~)



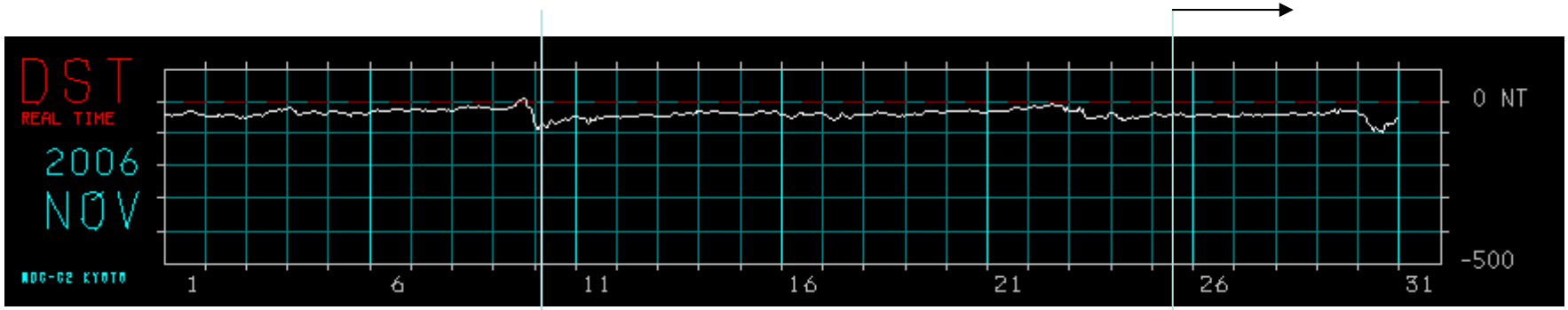


Study of ionosphere, thermosphere and upper mesosphere

Hokkaido radar system (Rikubetsu, Hokkaido)

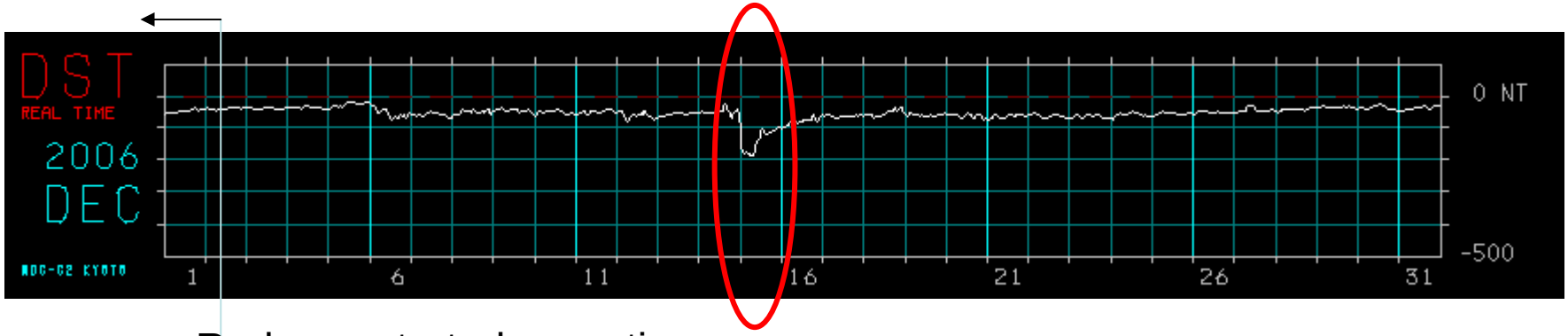
Unified understanding of the dynamics of the high- to mid-latitude upper atmosphere

2006/11-2007/01 Dst index

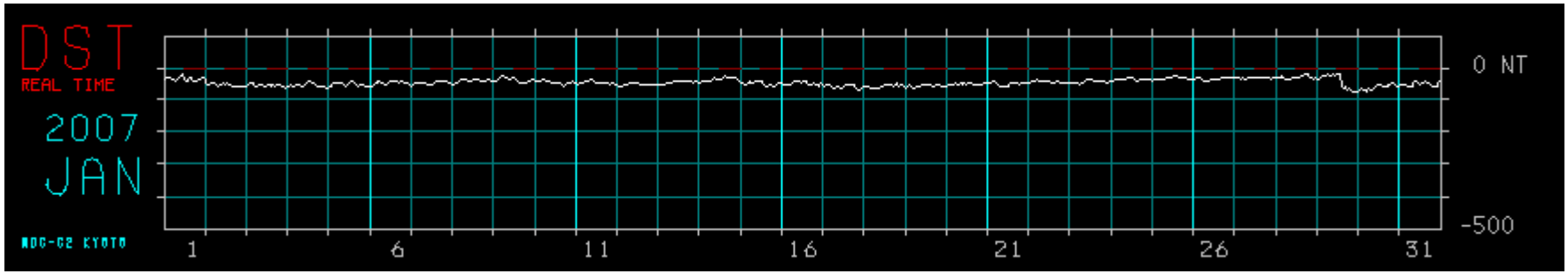


Radar started operation

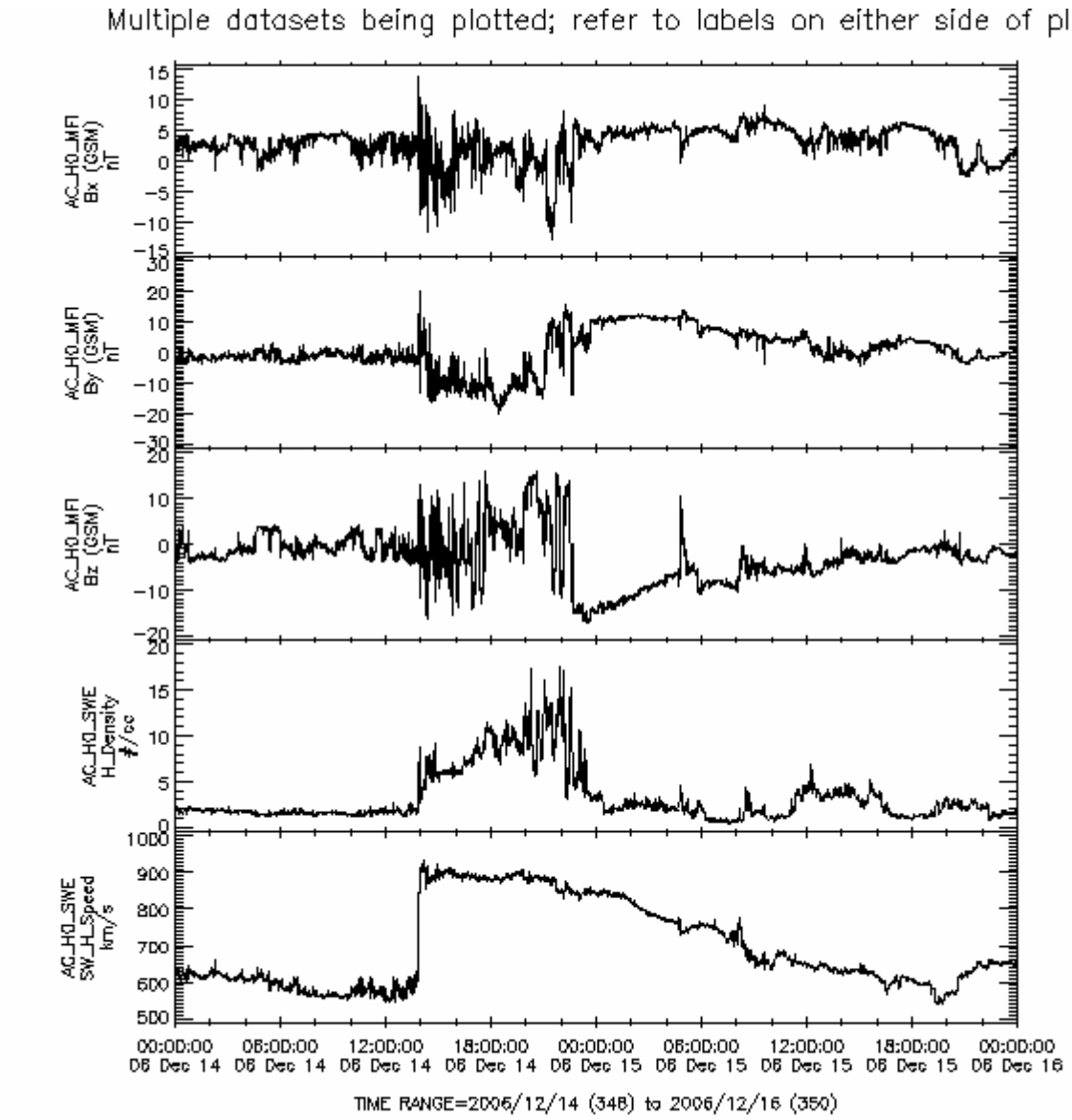
Stopped working owing to a trouble of synthesizer PTS-310



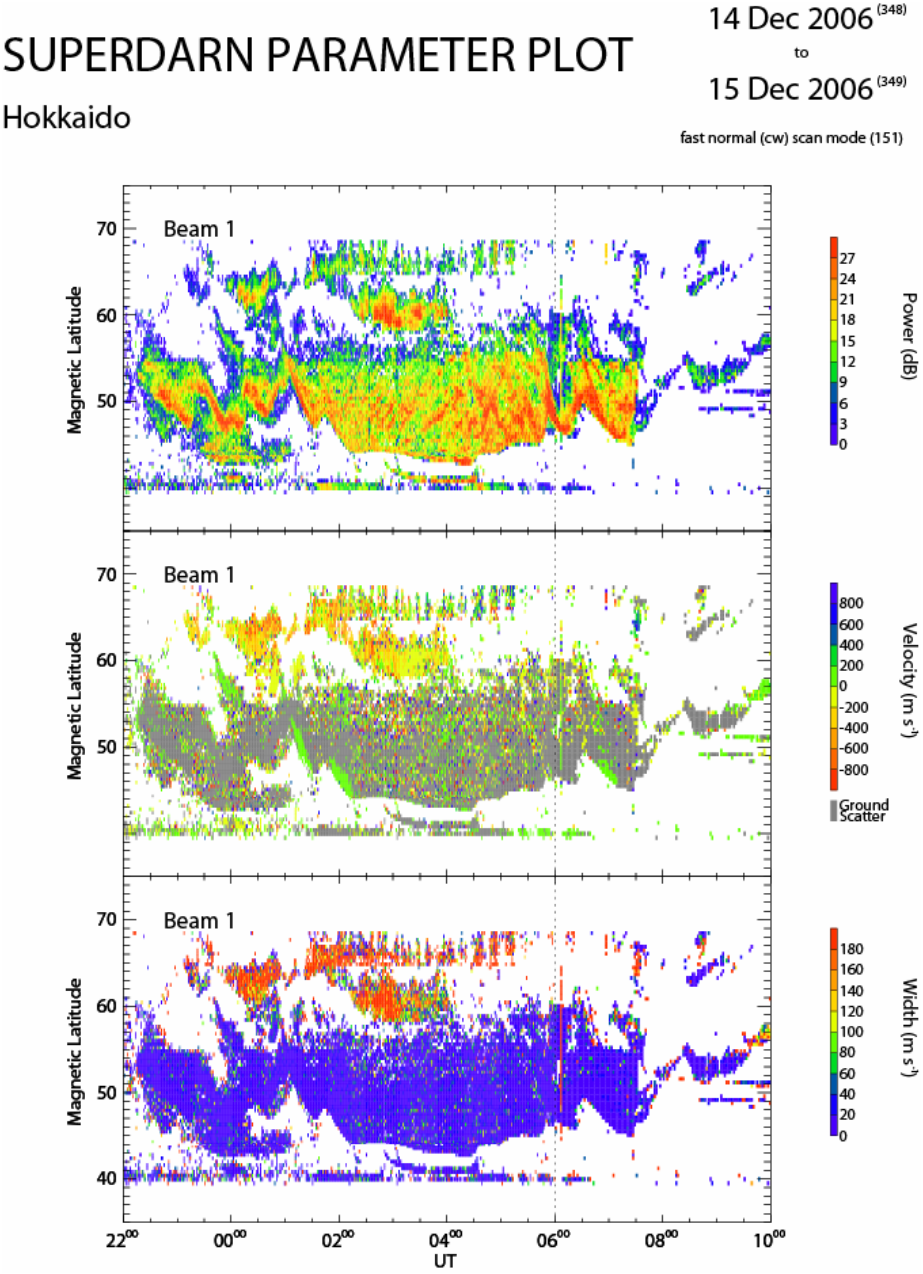
Radar re-started operation



ACE Level2 on Dec 14-15, 2006



2006/12/15(minimum Dst: -147 nT)



- Beam 1(approx. poleward)
- From the top: pwr_l, vel width_l
- 22 to 10 UT (07 to 19 LT)
- Vertical axis: geomag. lat.
- sea scatter for 40 to 55 lat.
- Ionospheric scatter between 23 and 04 UT
- Ionospheric echoes seen up to 58 geomag. Lat.

Summary of observation (Dec. 14 2300 UT – Dec. 15 0400 UT)

- Hokkaido radar observed poleward flows for 10 to 15 LT.
- The flow region was up to 58 geomagnetic latitude.
- The poleward flow is as high as ~ 1000 m/s.
- The flow region expands equatorward together with geomagnetic storm activity.
- The flow region seems to be in the bps region.
- The solar wind parameters does not change during the period of interest (Bz < 0, By > 0).

- Merging over 5 hours of MLT?

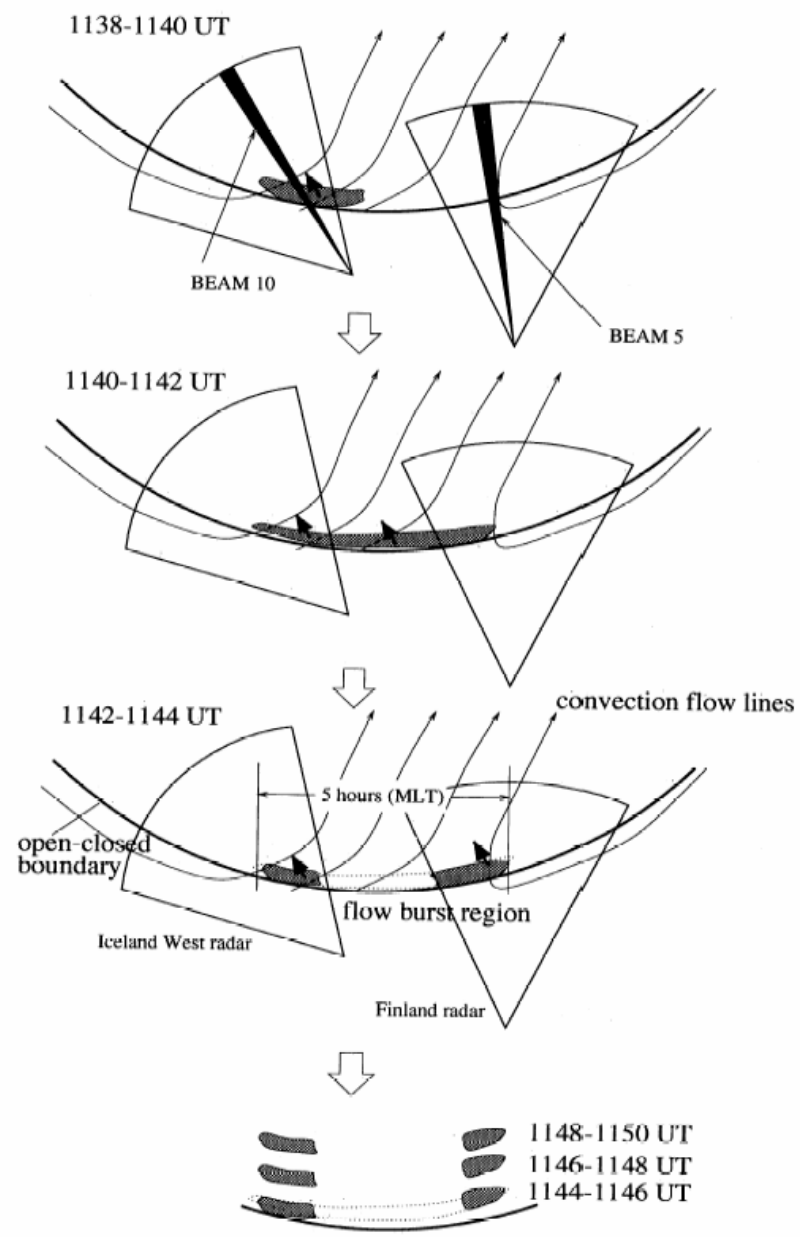


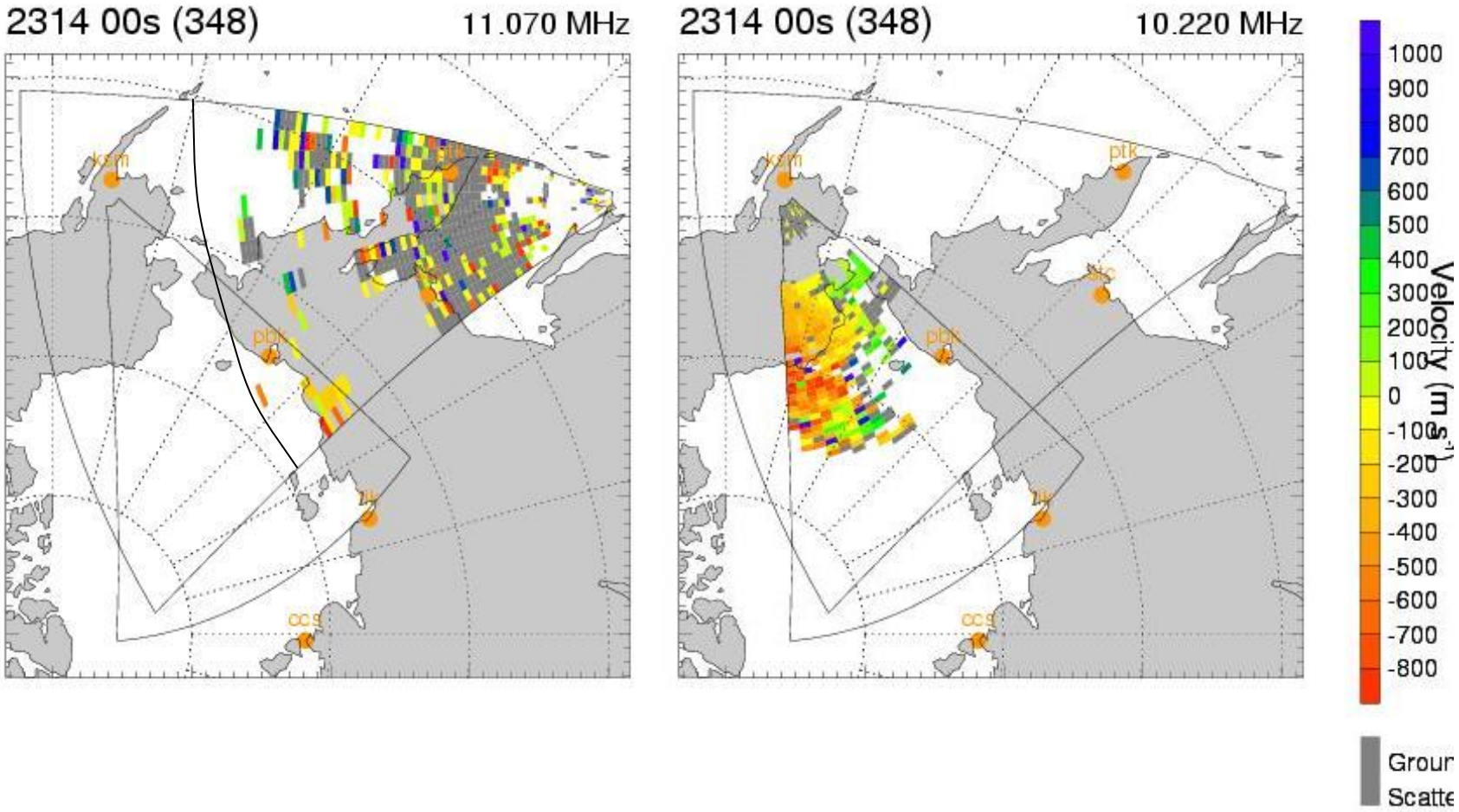
Figure 8. Schematic view of the large-scale poleward flow burst event.

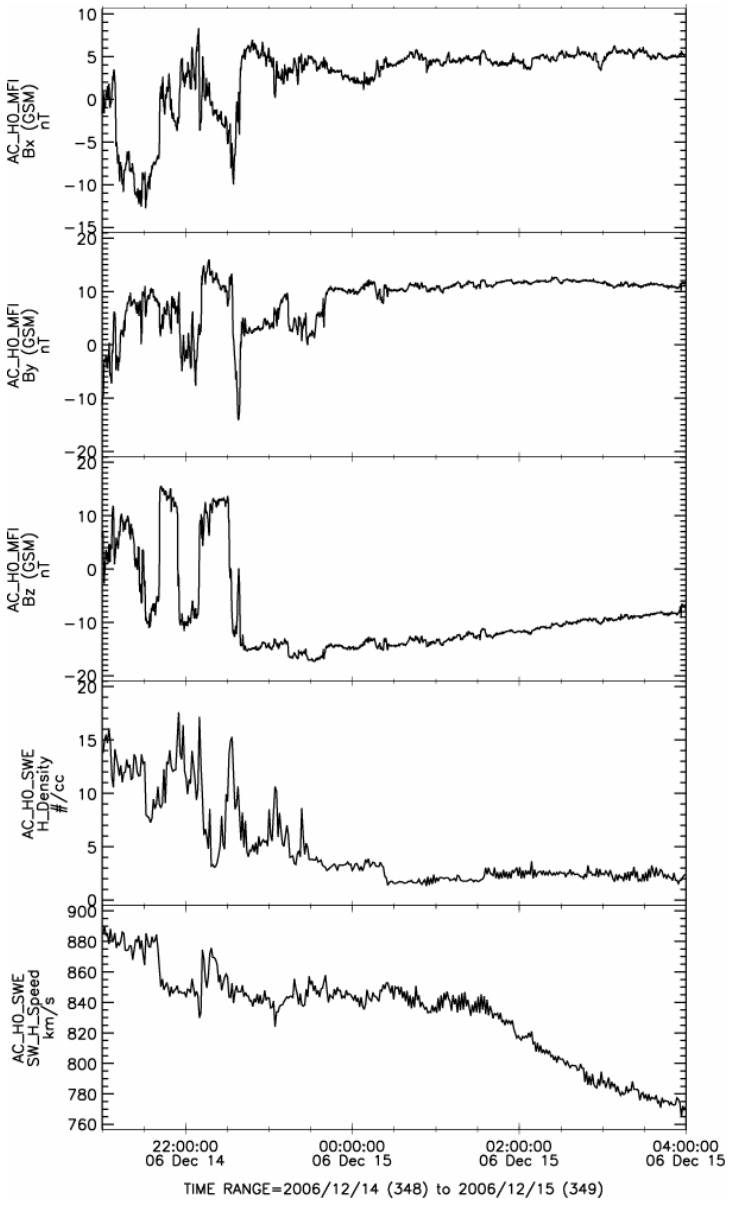
The present event is consistent with 1995/09/05 event

- 1138-1142 UT: longitudinal expansion of the flow burst
- 1142 UT: there is a gap in the center
- 1144-1150 UT: poleward movement of the flow burst region

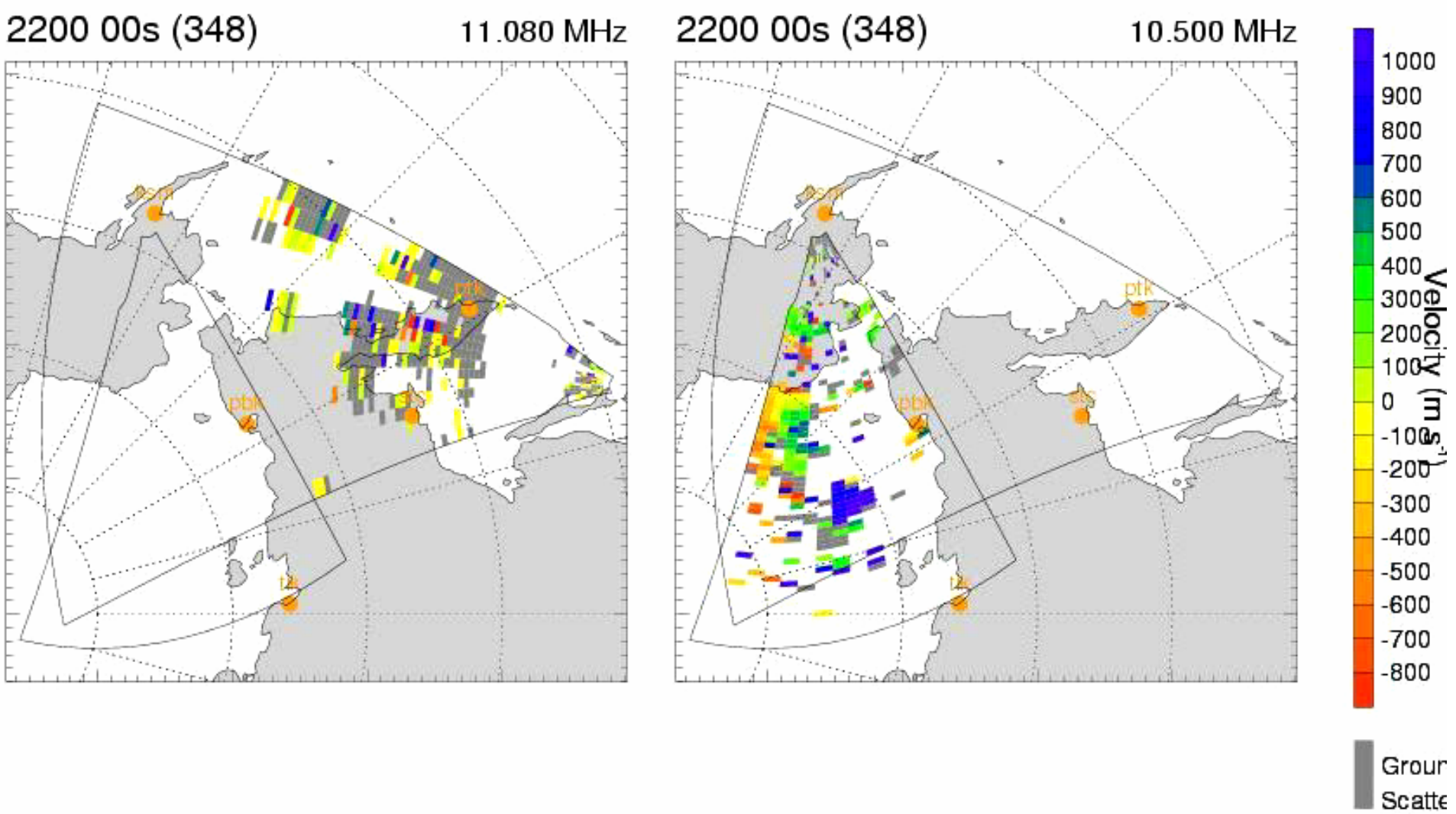
Nishitani et al., J. Geophys. Res. 1999

Hokkaido and King Salmon radars



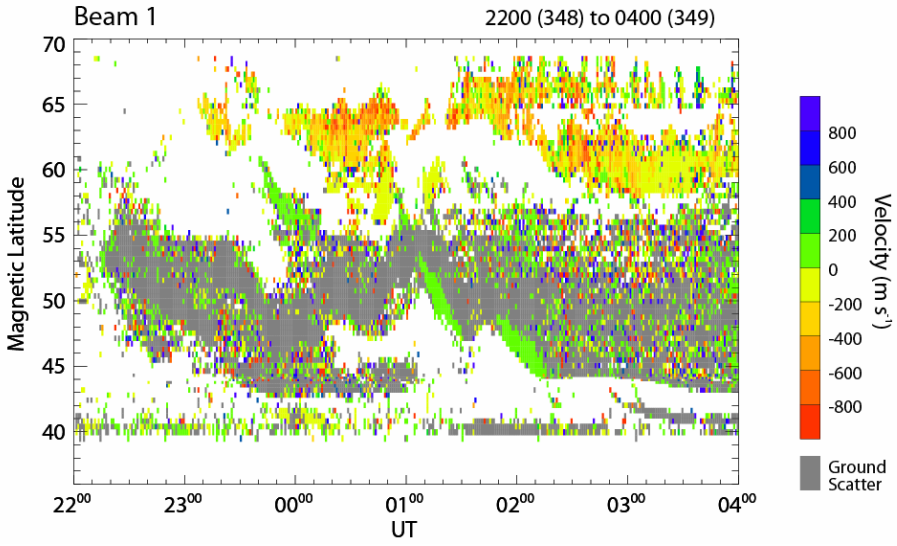


Expanded view of the IMF / solar wind parameters by ACE satellite


2200 00s (348)
11.080 MHz
2200 00s (348)
10.500 MHz
ptk
pbk
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
Velocity (m s-1)
Groun
Scatte

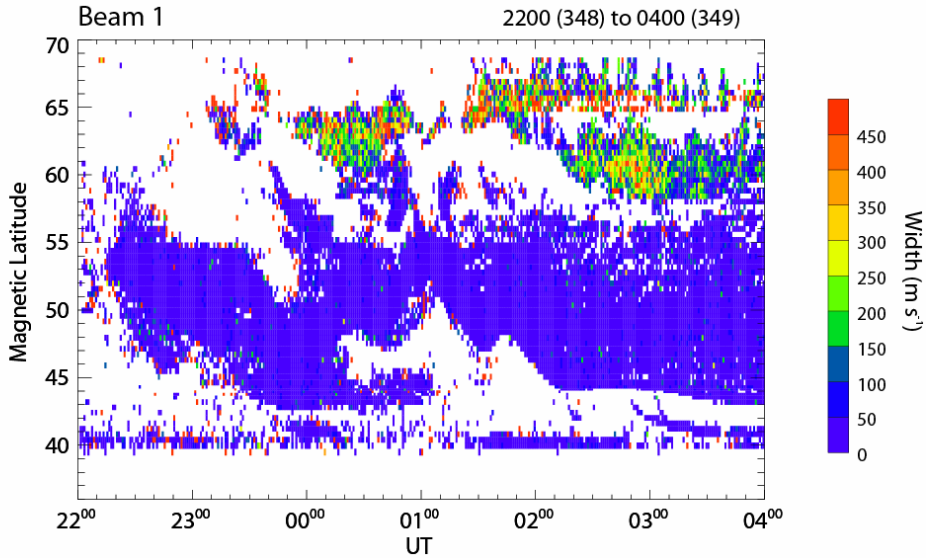
SUPERDARN PARAMETER PLOT
Hokkaido: vel

14 Dec 2006 (348)
to
15 Dec 2006 (349)
fast normal (cw) scan mode (151)



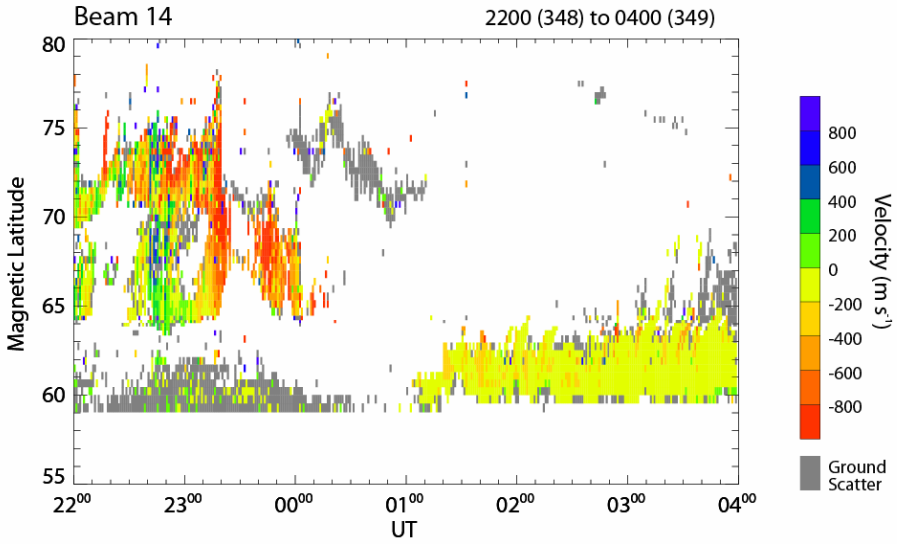
SUPERDARN PARAMETER PLOT
Hokkaido: width_l

14 Dec 2006 (348)
to
15 Dec 2006 (349)
fast normal (cw) scan mode (151)



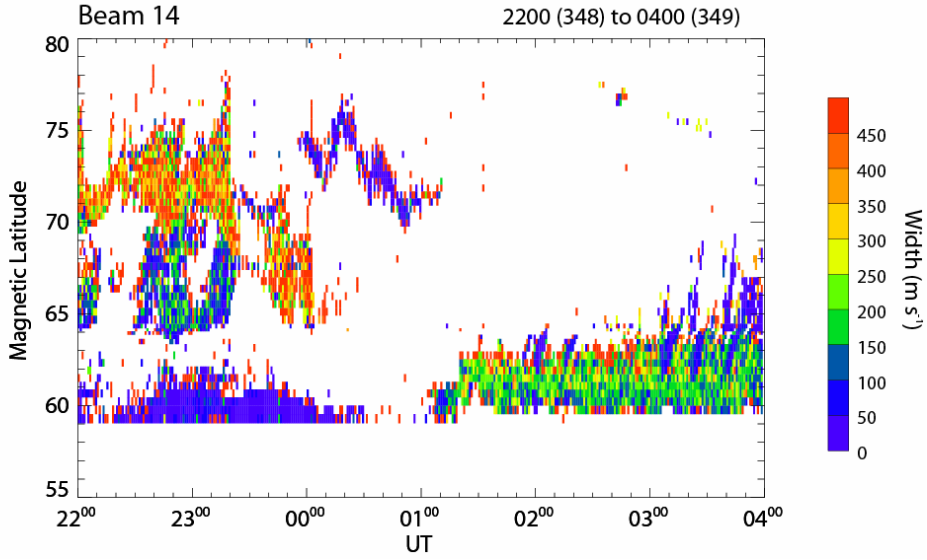
SUPERDARN PARAMETER PLOT
King Salmon: vel

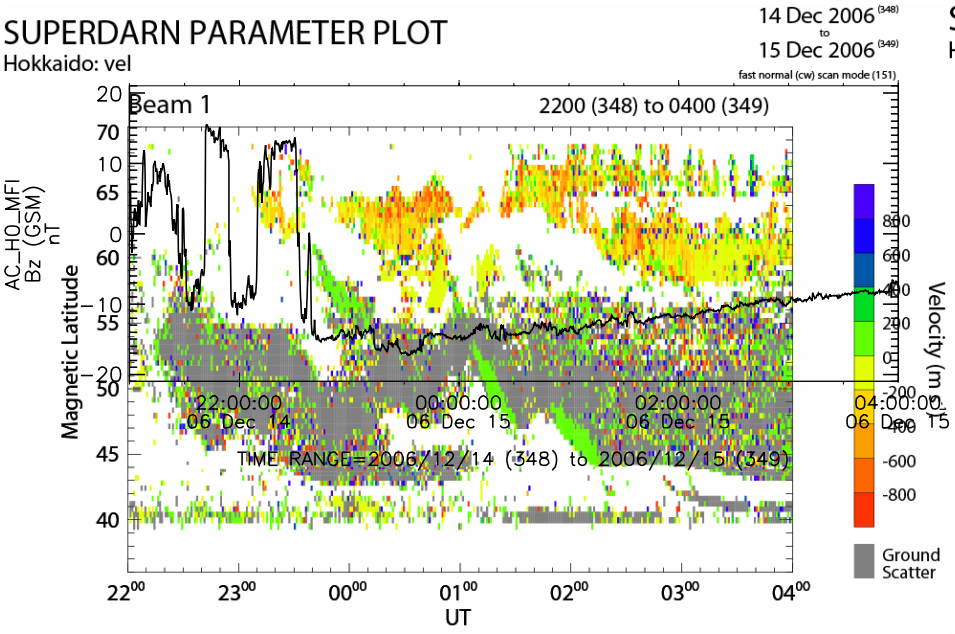
14 Dec 2006 (348)
to
15 Dec 2006 (349)
unknown scan mode (9060)

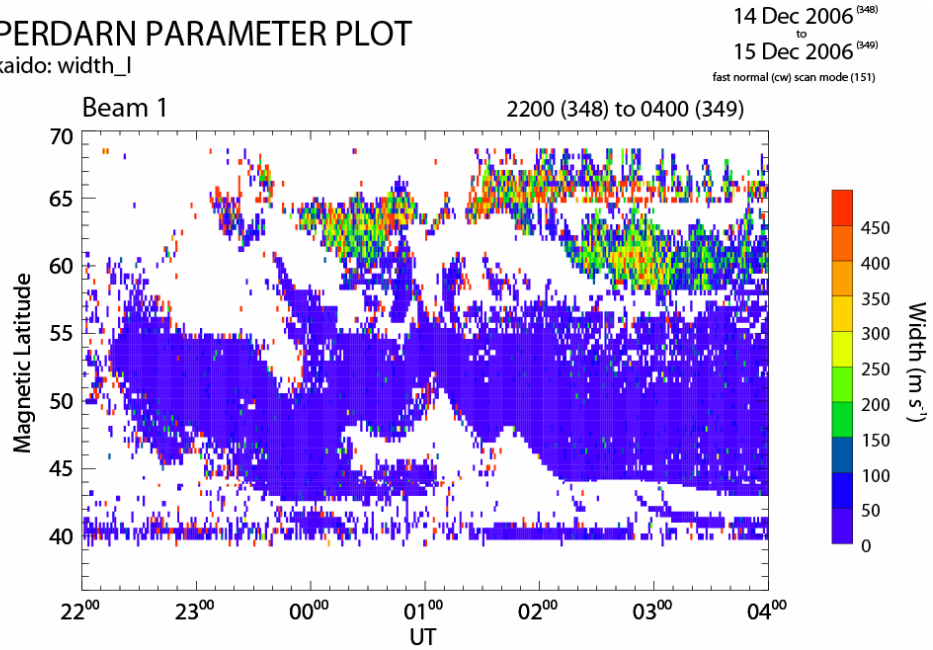


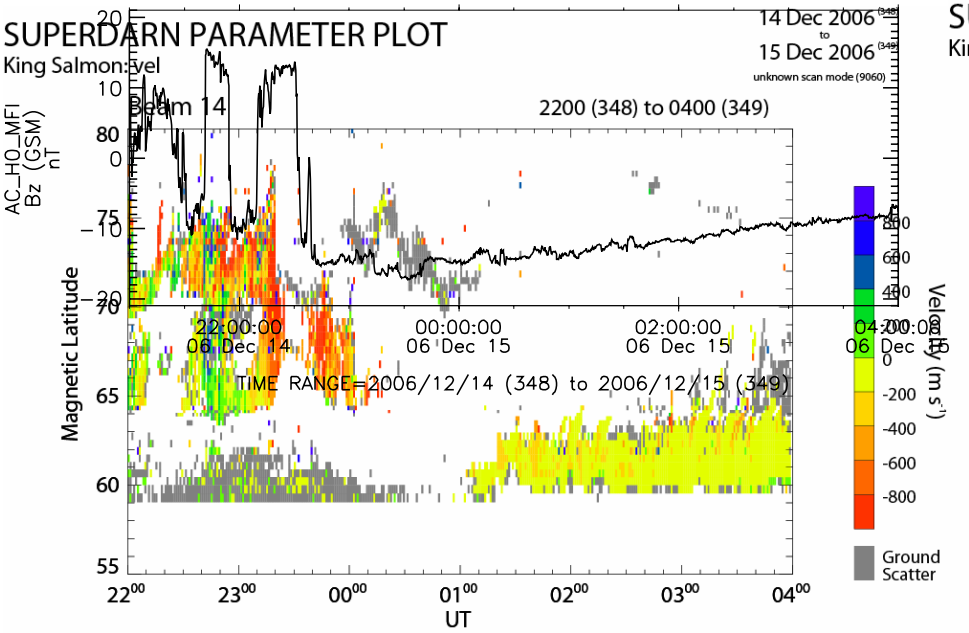
SUPERDARN PARAMETER PLOT
King Salmon: width_l

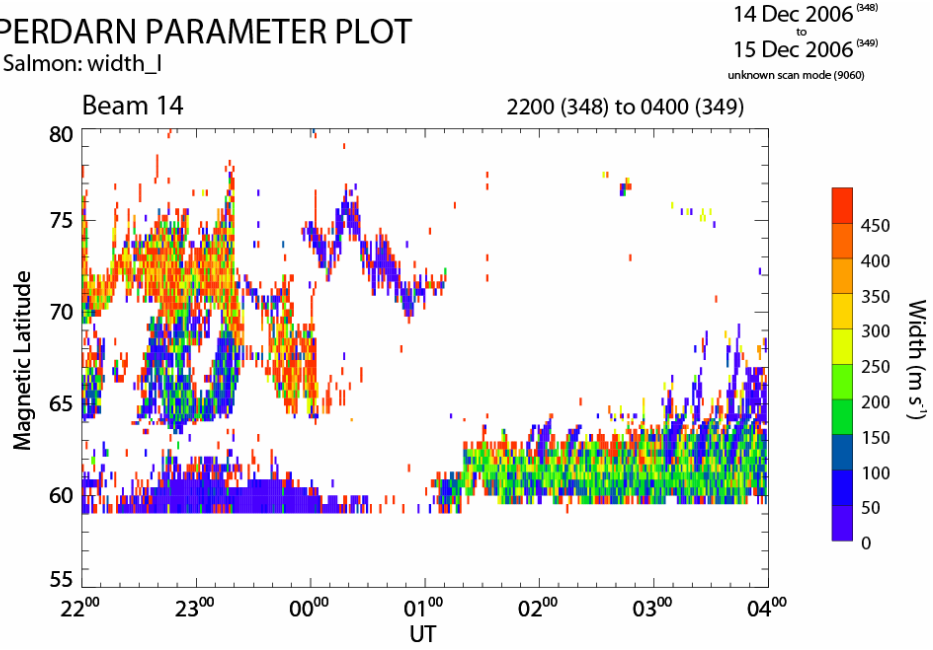
14 Dec 2006 (348)
to
15 Dec 2006 (349)
unknown scan mode (9060)




SUPERDARN PARAMETER PLOT
Hokkaido: vel
14 Dec 2006 (348)
to
15 Dec 2006 (349)
fast normal (cw) scan mode (151)
Beam 1
2200 (348) to 0400 (349)
AC_H0_MFI
Bz (GSM)
nT
Magnetic Latitude
22:00:00
06 Dec 14
00:00:00
06 Dec 15
02:00:00
06 Dec 15
04:00:00
06 Dec 15
TIME RANGE=2006/12/14 (348) to 2006/12/15 (349)
UT
Velocity (m s-1)
Ground
Scatter


SUPERDARN PARAMETER PLOT
Hokkaido: width_l
14 Dec 2006 (348)
to
15 Dec 2006 (349)
fast normal (cw) scan mode (151)
Beam 1
2200 (348) to 0400 (349)
Magnetic Latitude
UT
Width (m s-1)


SUPERDARN PARAMETER PLOT
King Salmon: vel
14 Dec 2006 (348)
to
15 Dec 2006 (349)
unknown scan mode (9060)
Beam 14
2200 (348) to 0400 (349)
AC_H0_MFI
Bz (GSM)
nT
Magnetic Latitude
22:00:00
06 Dec 14
00:00:00
06 Dec 15
02:00:00
06 Dec 15
04:00:00
06 Dec 15
TIME RANGE=2006/12/14 (348) to 2006/12/15 (349)
UT
Velocity (m s-1)
Ground
Scatter

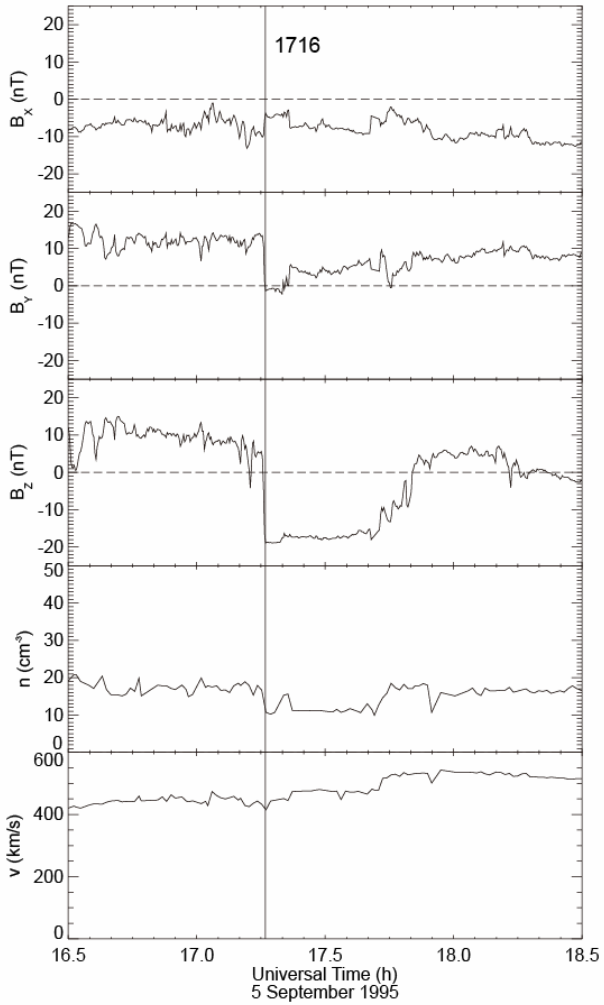

SUPERDARN PARAMETER PLOT
King Salmon: width_l
14 Dec 2006 (348)
to
15 Dec 2006 (349)
unknown scan mode (9060)
Beam 14
2200 (348) to 0400 (349)
Magnetic Latitude
UT
Width (m s-1)

Summary of observation (2200 – 2300 UT)

- Both King Salmon Hokkaido radars observed equatorward progression of poleward flows from ~70 to ~60 geomat. Lat.
- It is associated with IMF southward turning.
- At King Salmon radar, the expansion of poleward flow region is quick, whereas spectral width boundary motion is much slower.

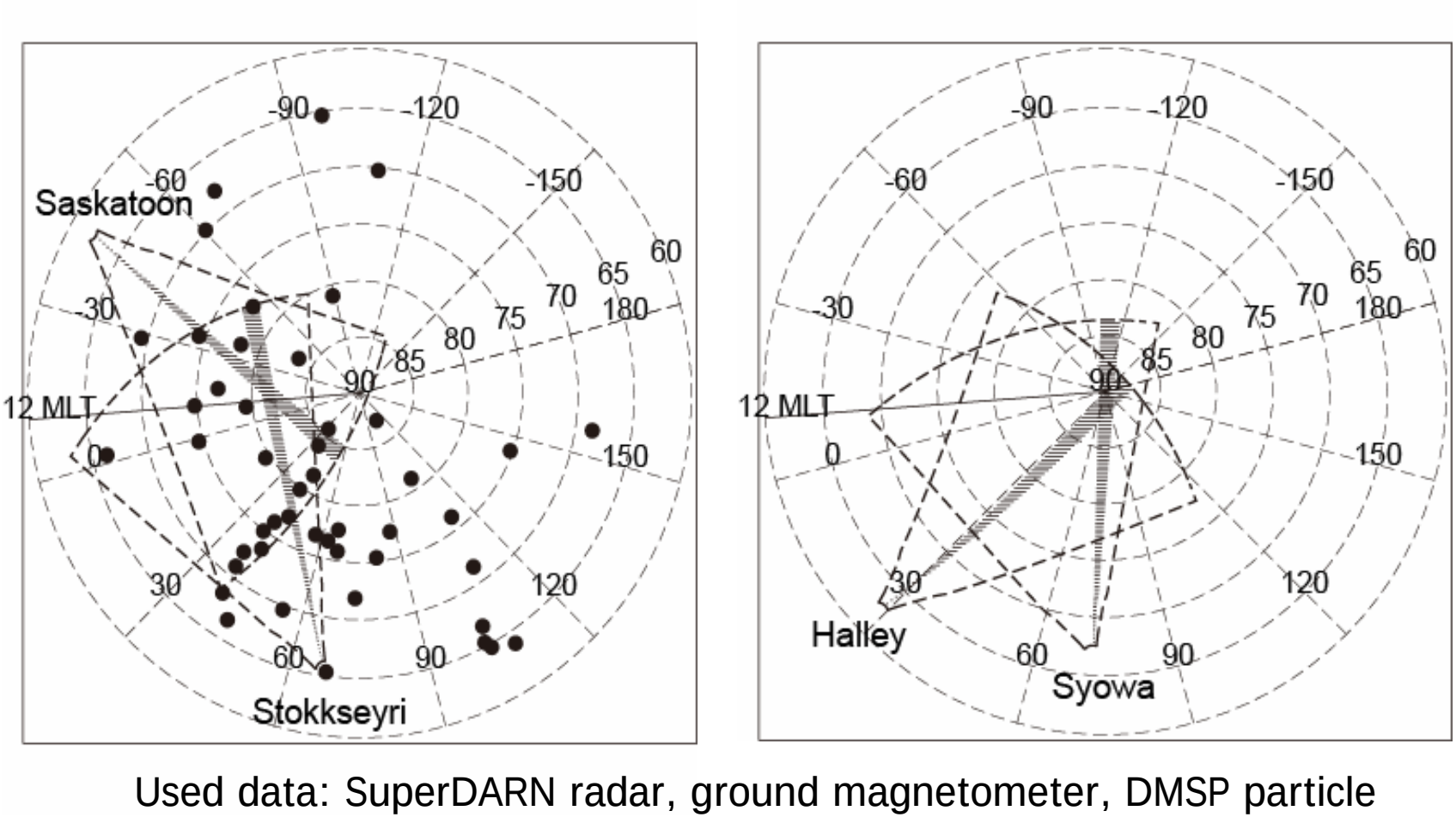
- Two-step response?

A study of the dusk convection cell's response to an IMF southward turning (Nishitani et al., J. Geophys. Res., 2002)



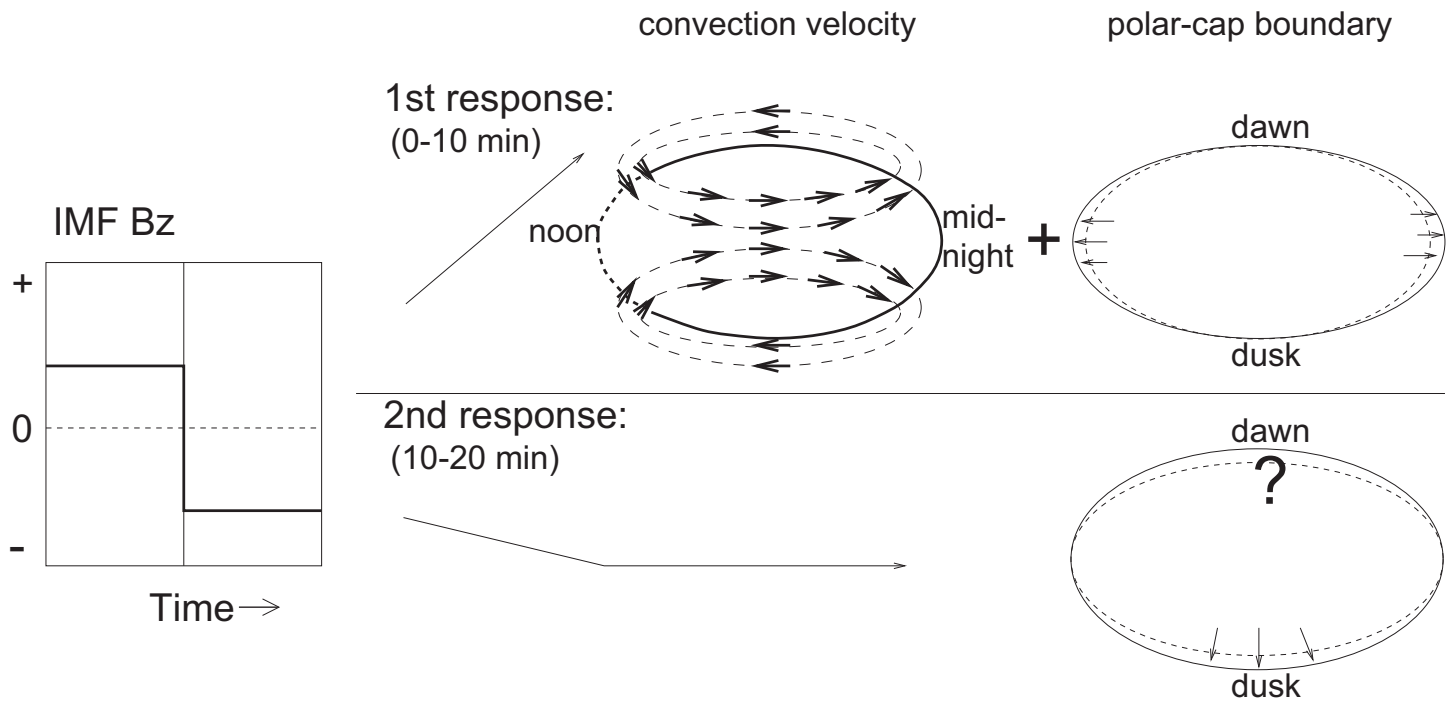
IMP-8 IMF/solar wind data

A study of the dusk convection cell's response to an IMF southward turning (Nishitani et al., J. Geophys. Res., 2002)



Used data: SuperDARN radar, ground magnetometer, DMSP particle precipitation

A study of the dusk convection cell's response to an IMF southward turning (Nishitani et al., J. Geophys. Res., 2002)

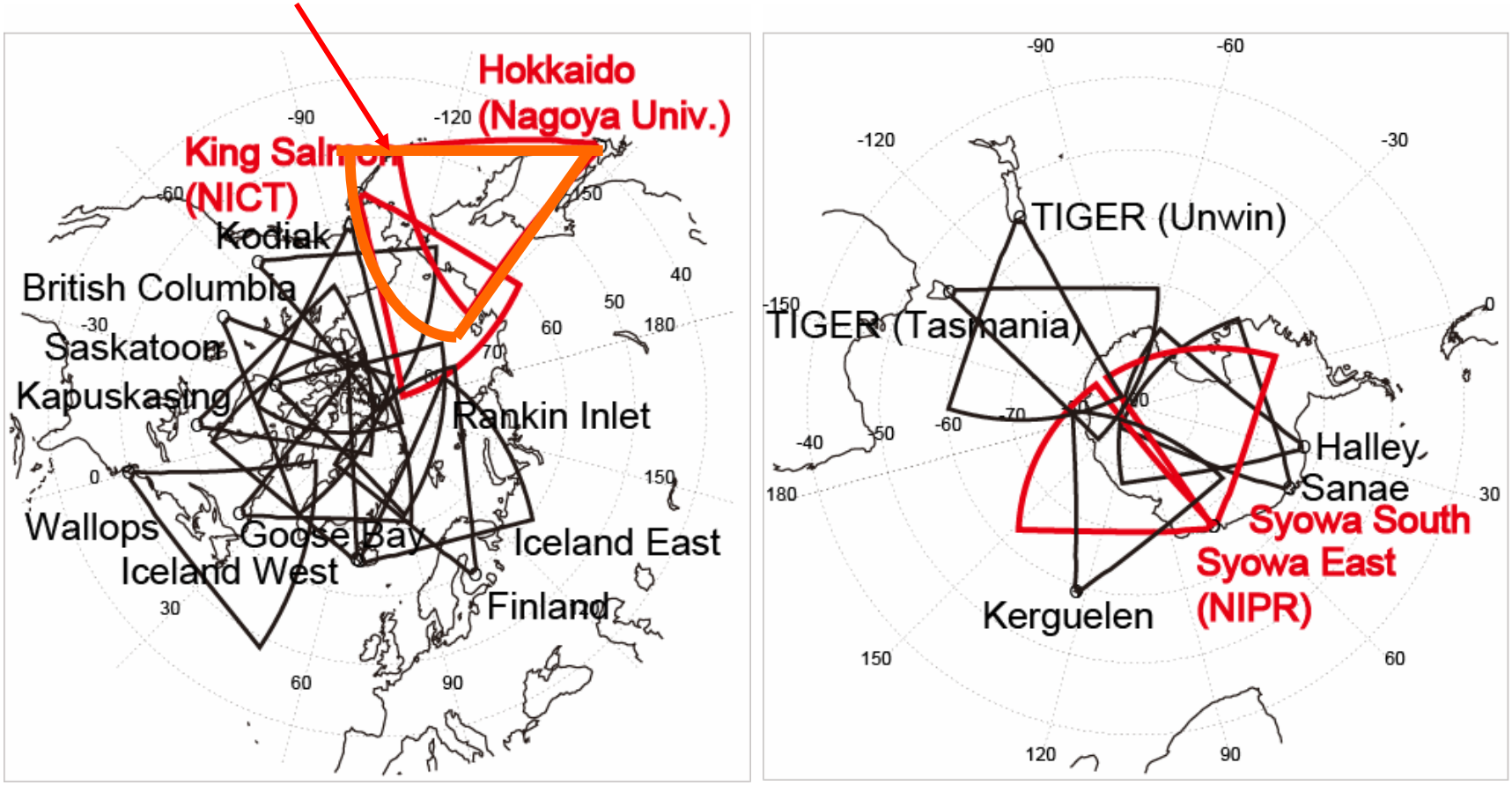


Summary

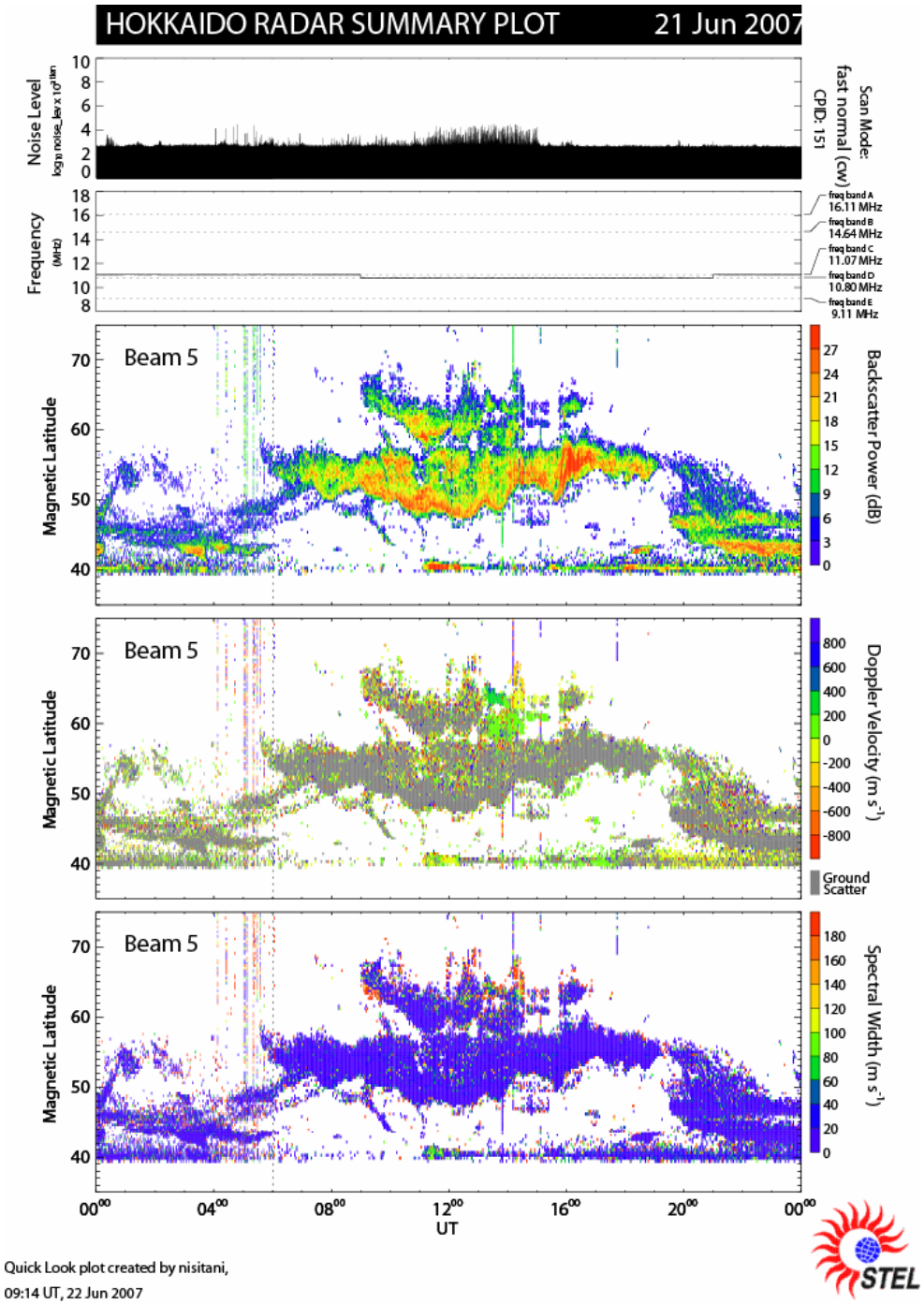
- Hokkaido radar observed a poleward flow at 58 to 65 geomagnetic latitude during the daytime for 5 hours, during a large geomagnetic storm event (minimum Dst = -147 nT).
- Before that, King Salmon and Hokkaido radars observed equatorward progression of the fast flows from 70 to 60 geomagnetic latitude within 1 hour.
- With the King Salmon data it is shown that the flow expansion is very rapid whereas expansion of the spectral width boundary is slower. It is consistent with the two-step mechanism of the IMF southward turning response proposed by Nishitani et al. (JGR, 2002).
- 110 range gates mode, which started June 13, 2007 will hopefully provide us with more examples.

Super Dual Auroral Radar Network (SuperDARN)

110 range gates mode



Total: 21 HF radars (14 in the northern and 7 in the southern hemispheres)

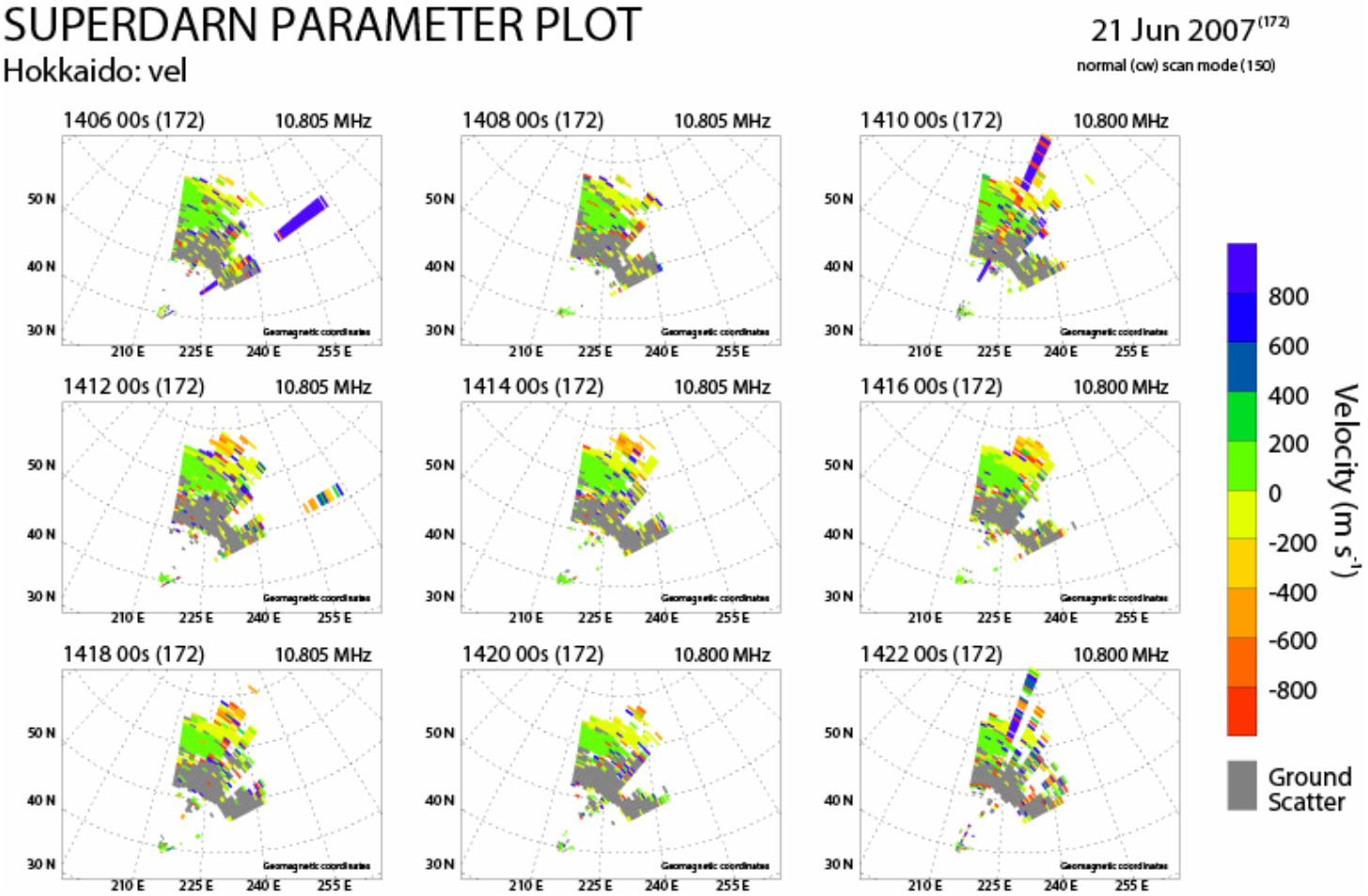


Example of 110 range gates mode (2007.6.21)

We cannot see red (away velocity) region beyond 65 degrees with the traditional 75 range gates mode.

2-D observation with110 range gates mode

We cannot see red (away velocity) region beyond 65 degrees with the traditional 75 range gates mode.



Merging flow observation with 110 range