

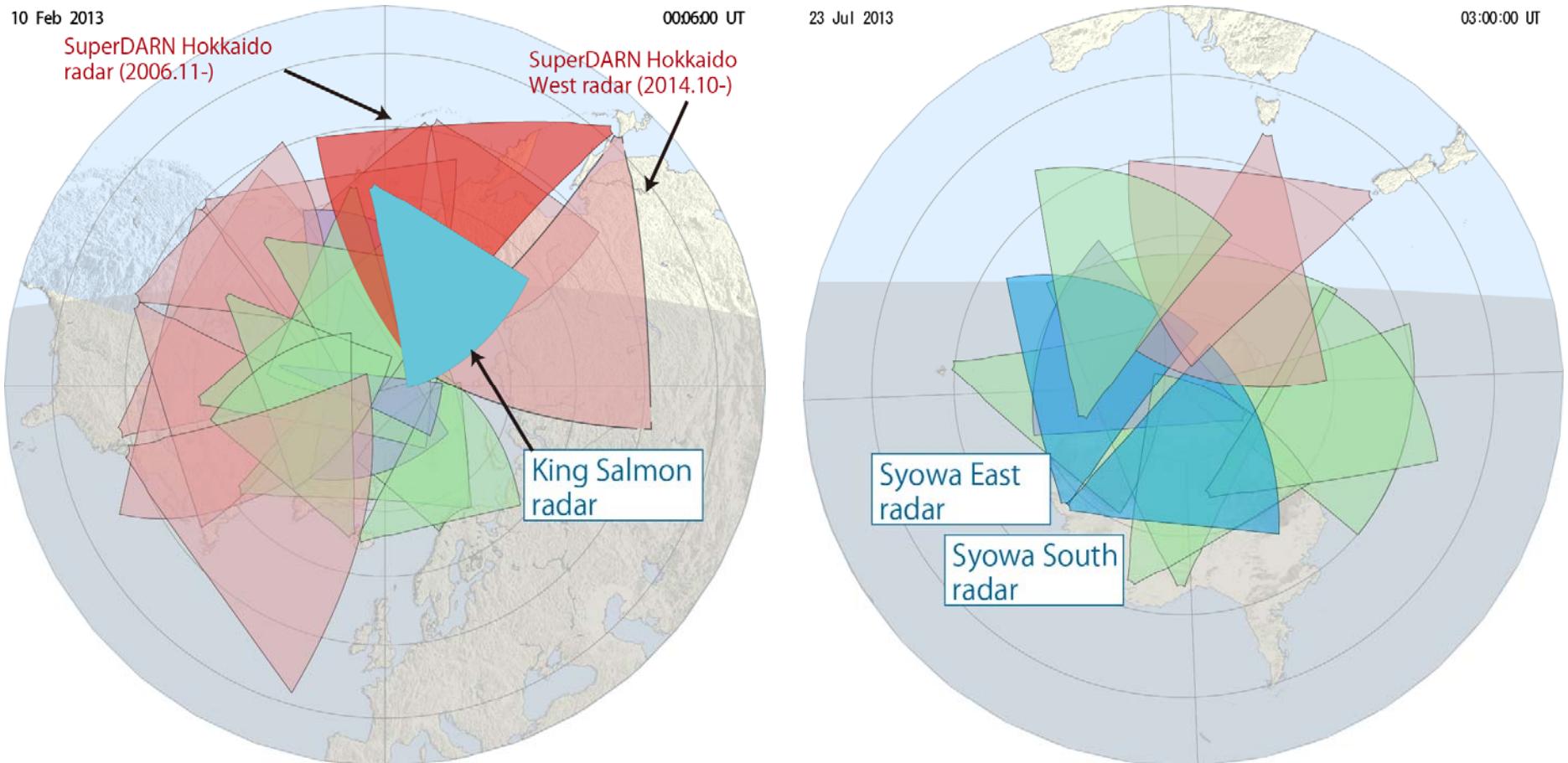
# Ionospheric convection observed by the SuperDARN Hokkaido Pair of (HOP) radars associated with low-latitude auroras

## 低緯度オーロラ発生時に観測された 電離圏対流の特性



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1. ISEE, Nagoya Univ. 2. NIPR 3. RISH, Kyoto Univ. 4. Meiji Univ. 5. ICSWSE,  
Kyushu Univ.

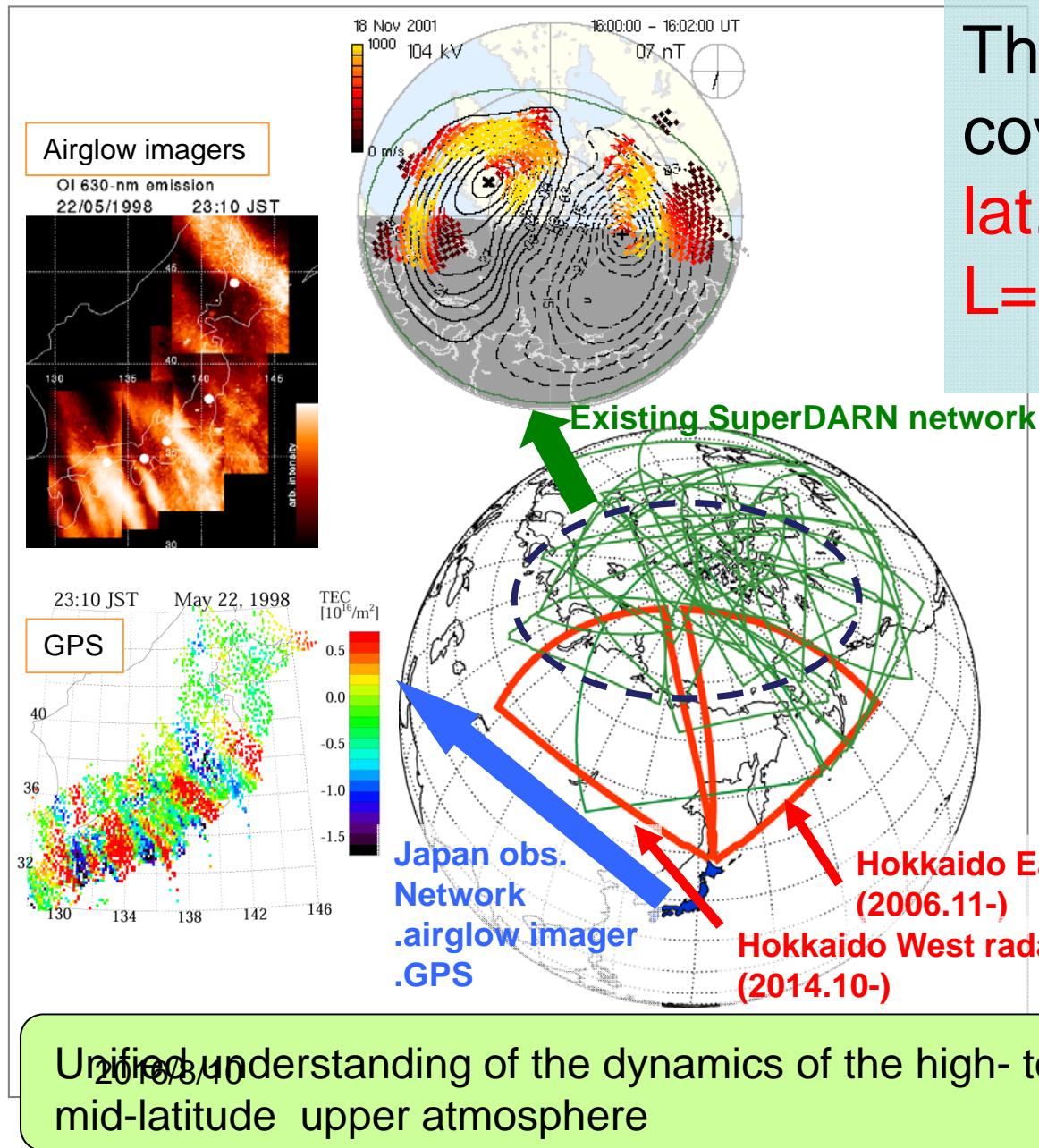
# Super Dual Auroral Radar Network (SuperDARN) (1995-present)



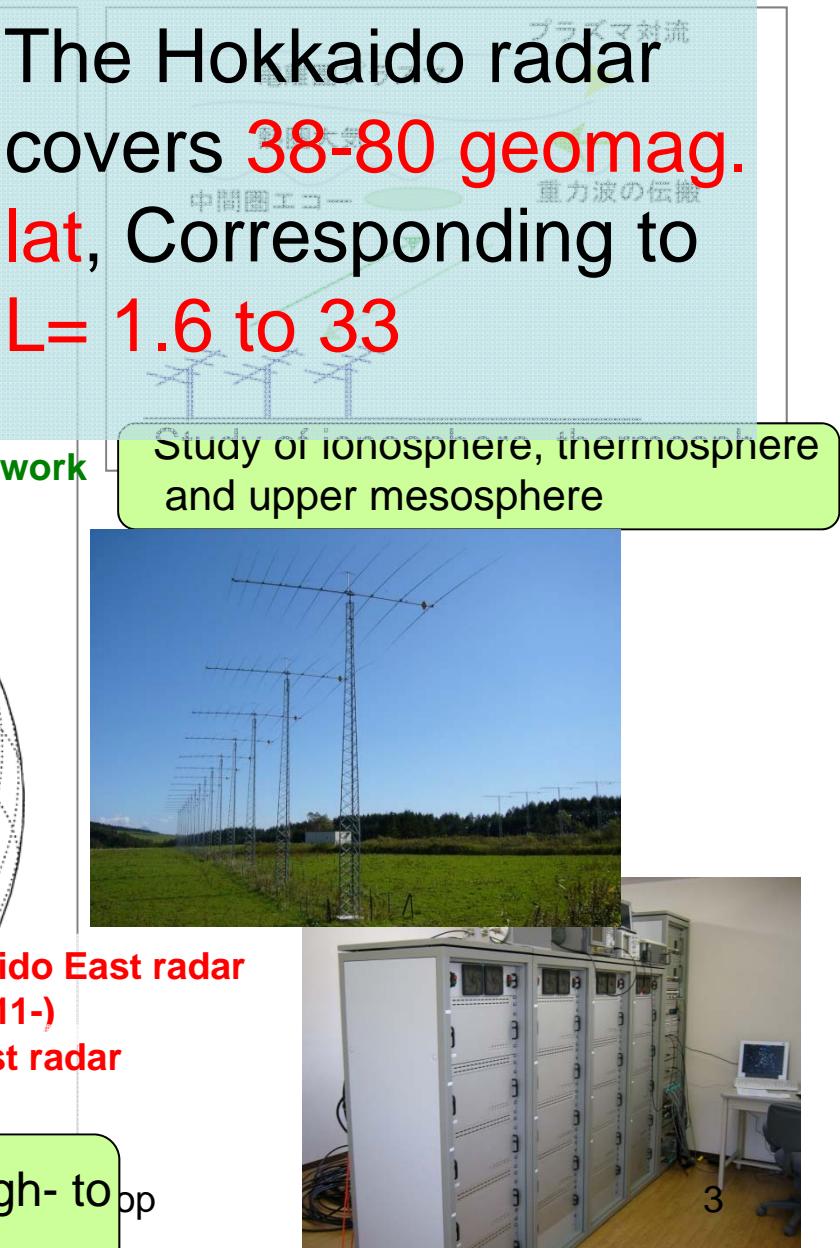
Number of operating HF radars: 35 (23 in the northern and 12 in the southern hemispheres) as of Jan 01, 2016

Standard temporal resolution: 1-2 min

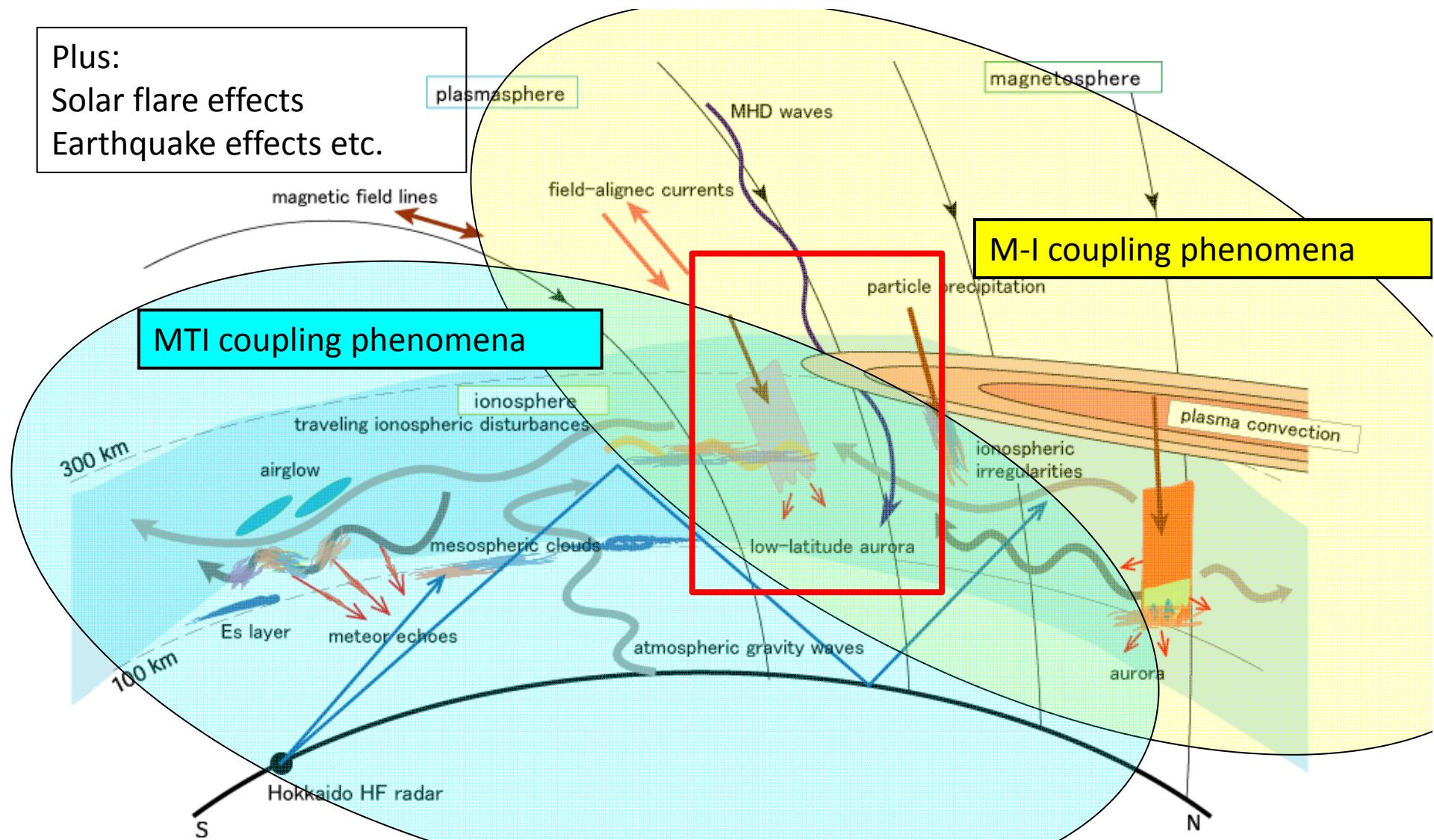
# SuperDARN Hokkaido radar (2006.11-) # of papers: 32



The Hokkaido radar covers 38-80 geomag. lat, Corresponding to L = 1.6 to 33



Plus:  
Solar flare effects  
Earthquake effects etc.



## Scientific targets of the SuperDARN radars

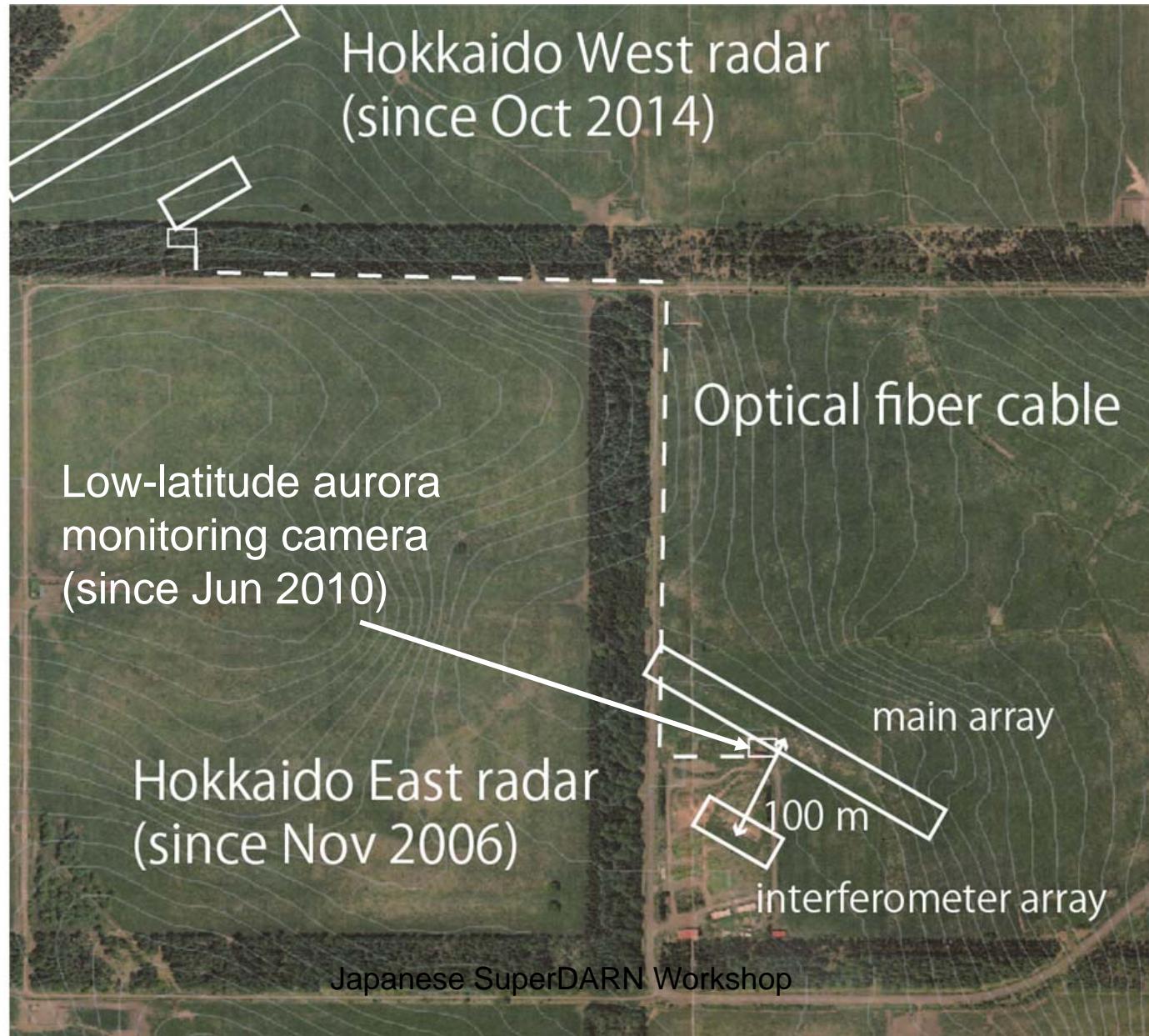
# Low-latitude auroras (mostly Stable Auroral Red arcs: SAR arcs) and ionospheric convection

Foster et al. (1994, JGR)

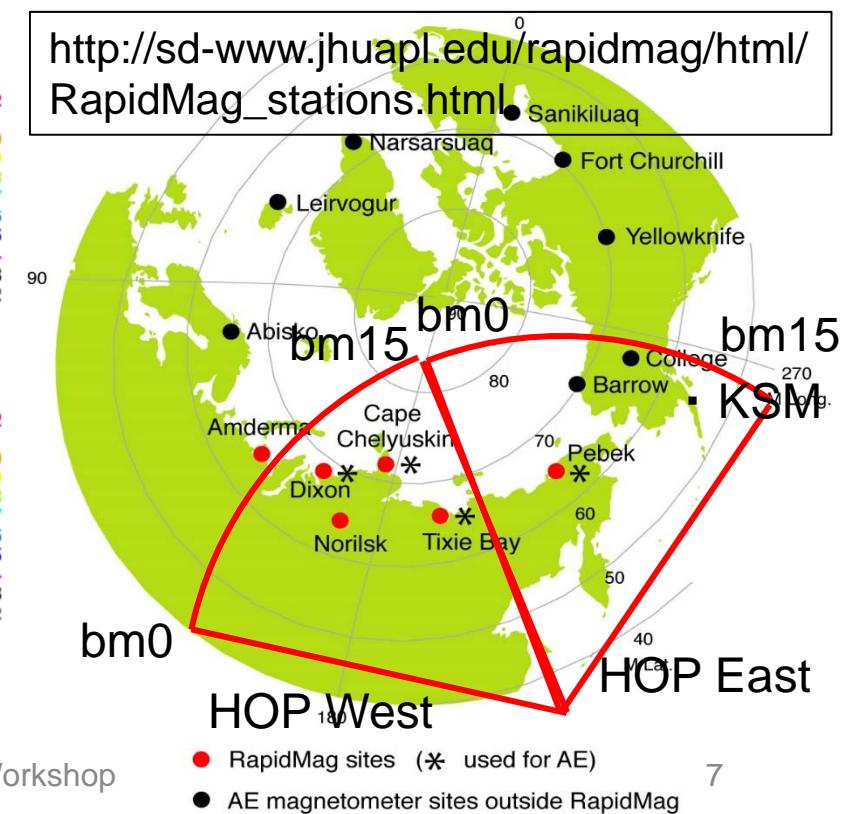
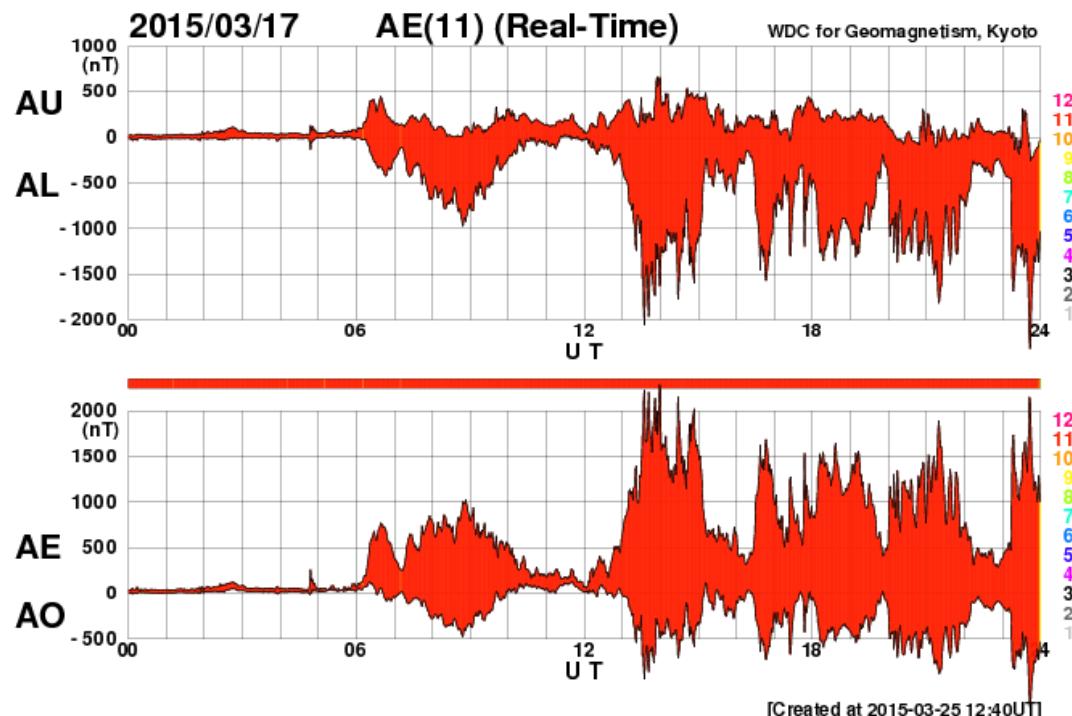
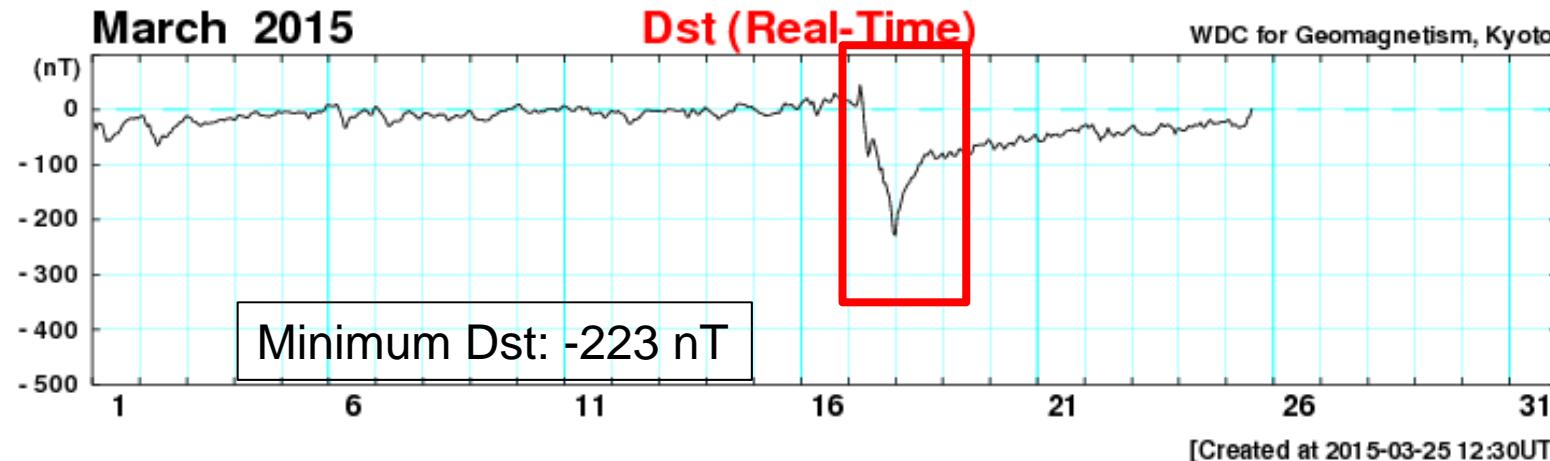
- Dusk to midnight sector (18-02 MLT): “The convection feature in association with the SAR ARC had many of the characteristics of a subauroral ion drifts (SAID) event.”
- Morning sector: “The optical / radar study of Mendillo et al. (1987) clearly showed that the SAR arc / trough association, but did not report any associated enhancement in the convection velocity. Millstone Hill azimuth scan data for that event (unpublished) showed that the faint, morning sector SAR arc (04 MLT) was collocated with a 3-degs wide residual region of 250 m/s westward convection, situated equatorward of the 500 m/s eastward (sunward) convection at auroral latitudes.

Detailed characteristics of convection associated with the growth / decay of the low-latitude auroras are still unknown.

# Hokkaido East (hok) / West (hkw) radars



# Rikubetsu aurora Event: 17 Mar 2015



# Aurora photographed at Rikubetsu radar site (1400-2030 UT, 5 min int., 25 s exposure)

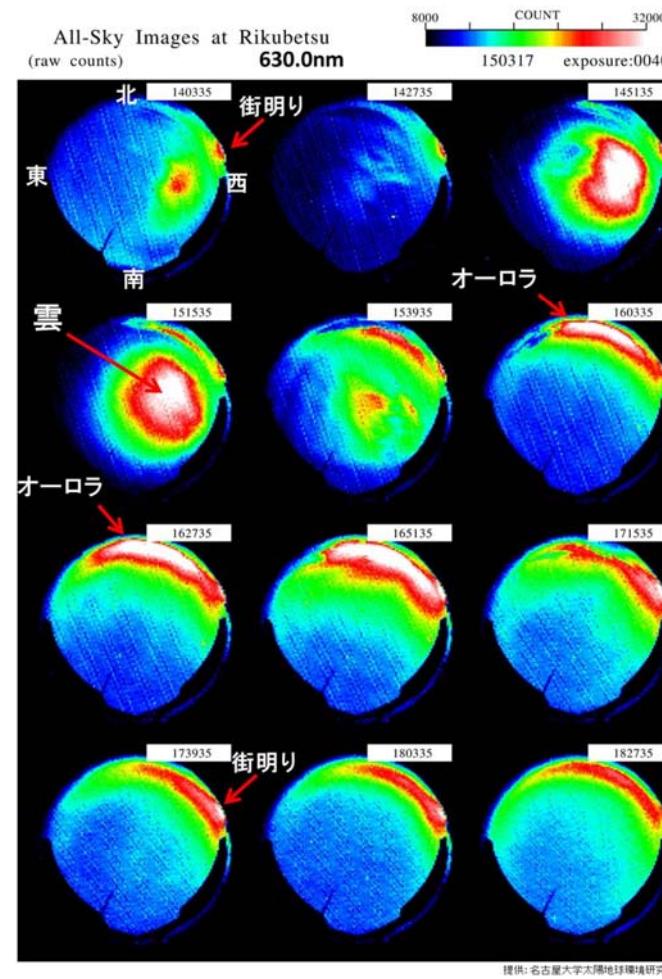
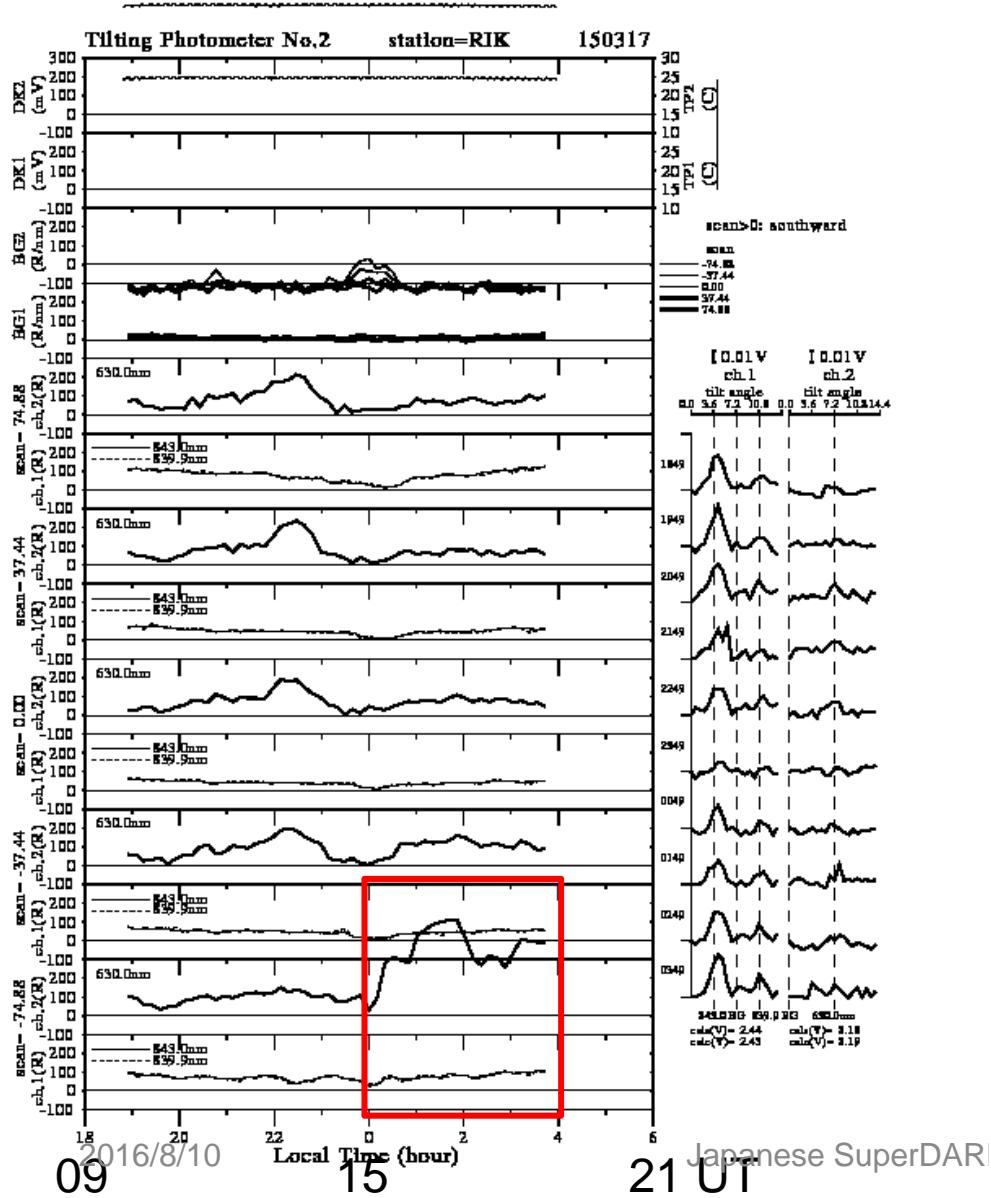


2016/8/10  
Camera: Nikon D700

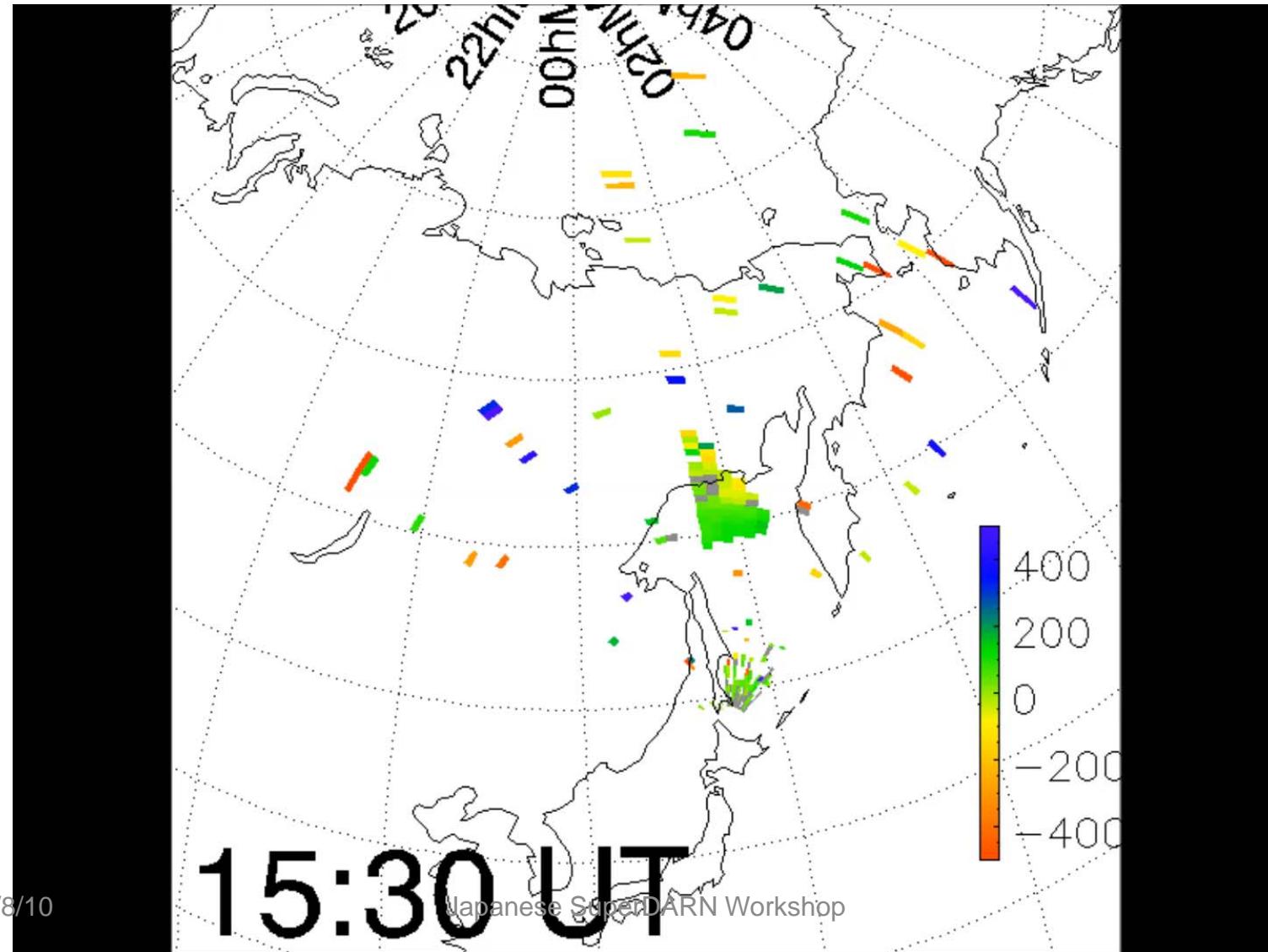
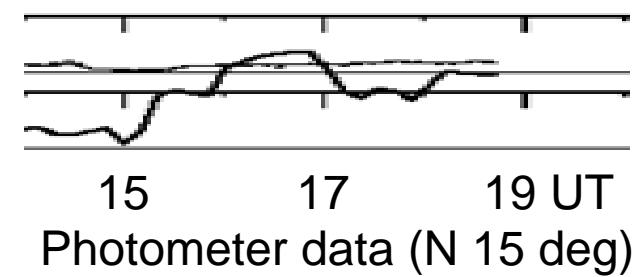
Japanese SuperDARN Workshop  
During the main phase of a storm with min.  $Dst = -223 \text{ nT}$  8

# Tilting photometer / camera data

- Auroral emission enhancements at 15 elev occurred at about 1600 and 1800 UT

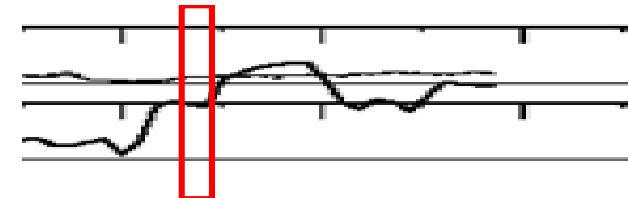


# Hok/hkw los velocities 1530-1900 UT



SAR arc: about 50-55 gg  
latitude

# 1542-1558 UT



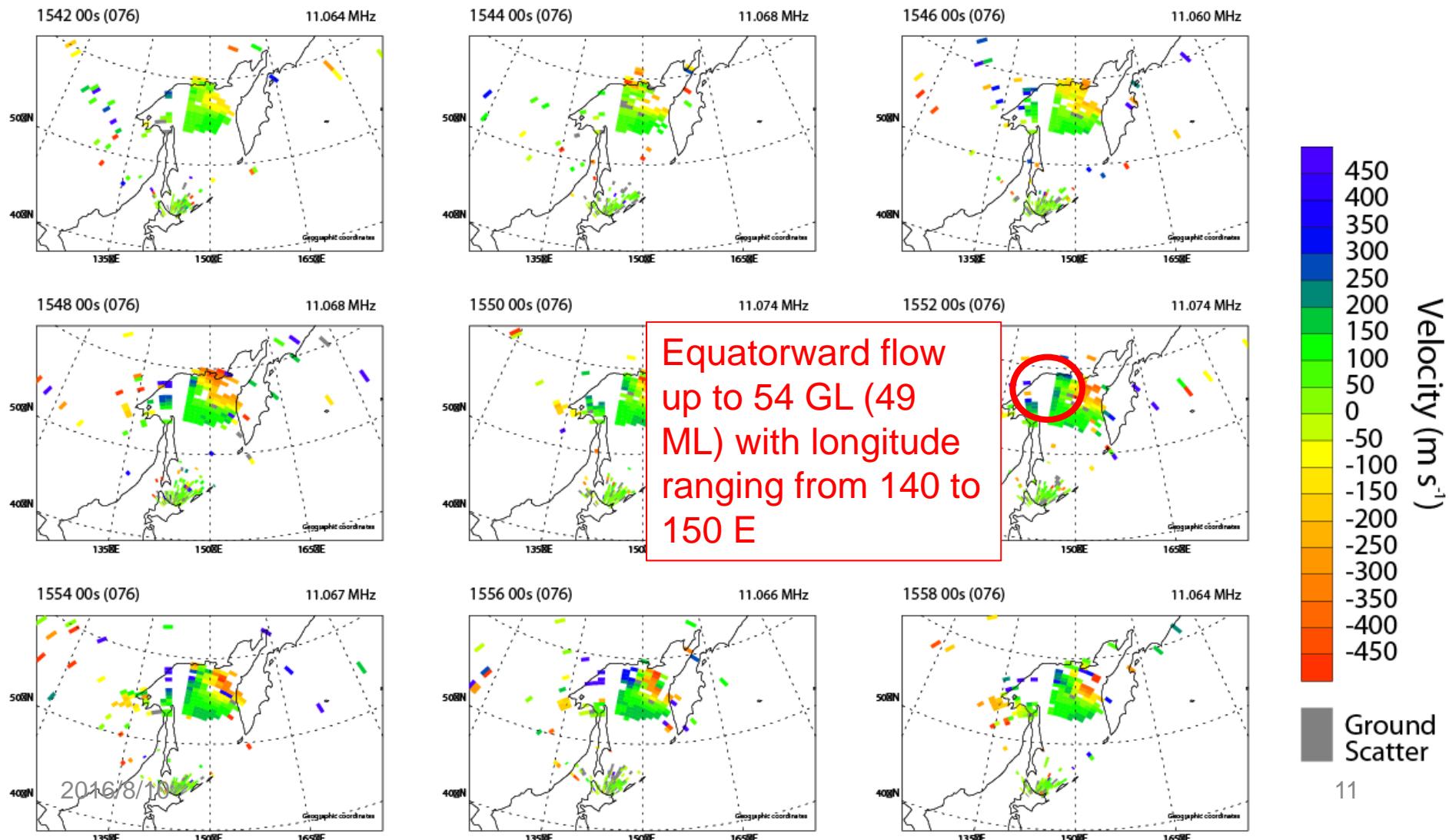
## SUPERDARN PARAMETER PLOT

Hokkaido: vel

Geog. Coord.

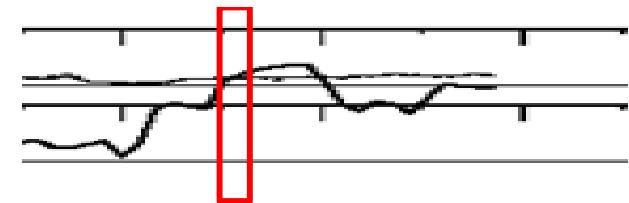
17 Mar 2015<sup>(76)</sup>

unknown scan mode (200)



SAR arc: about 50-55 gg  
latitude

# 1600-1616 UT

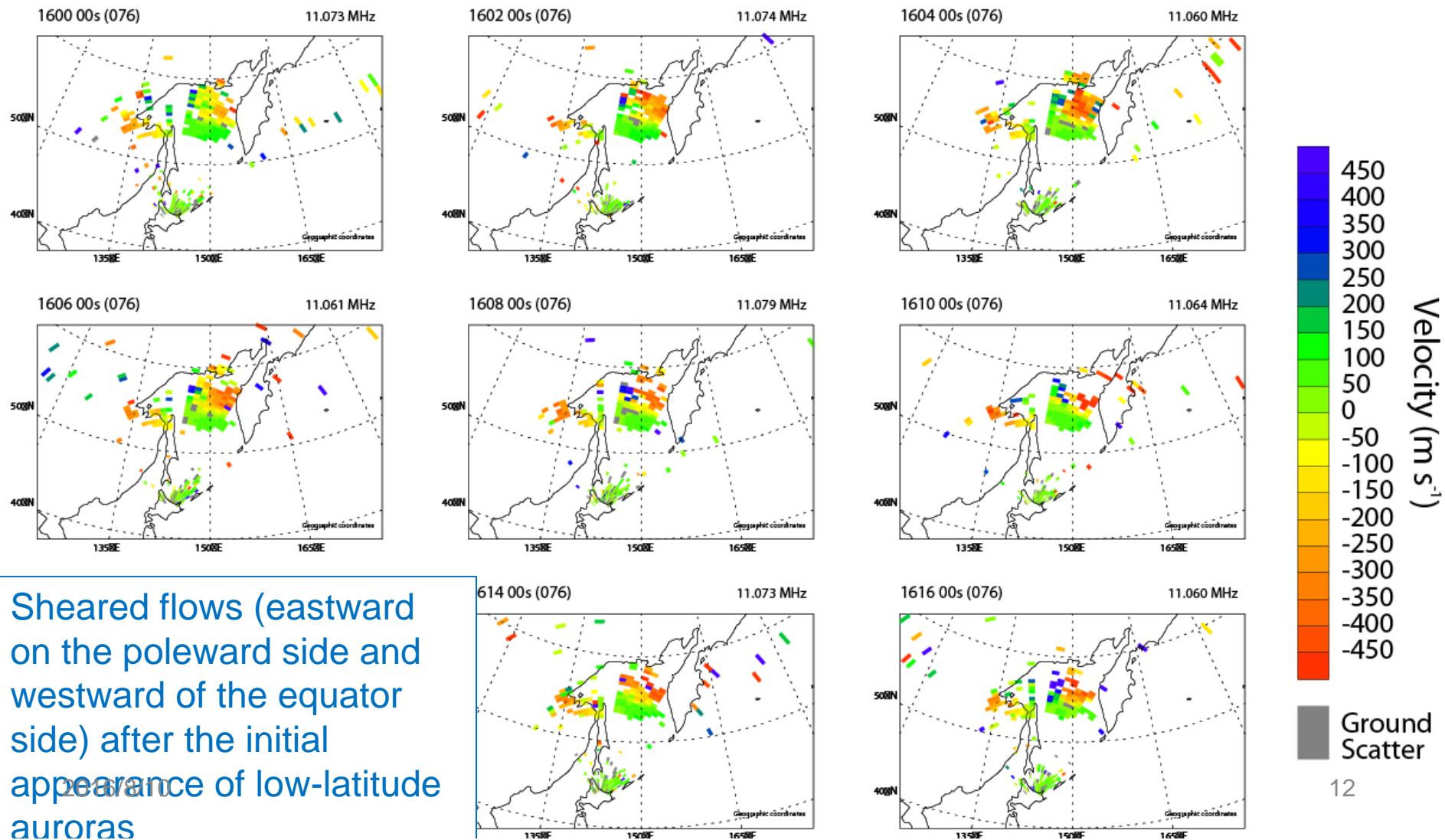


## SUPERDARN PARAMETER PLOT Hokkaido: vel

Geog. Coord.

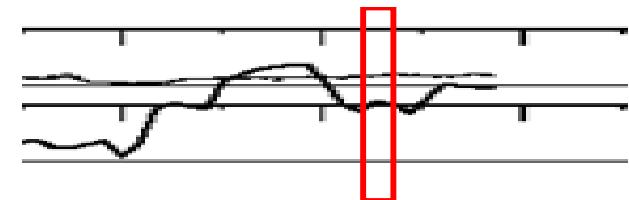
17 Mar 2015<sup>(76)</sup>

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SAR arc: about 50-55 gg  
latitude

# 1730-1746 UT



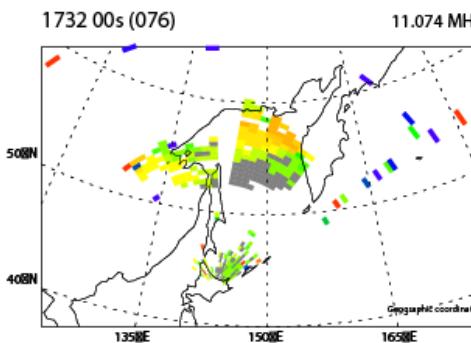
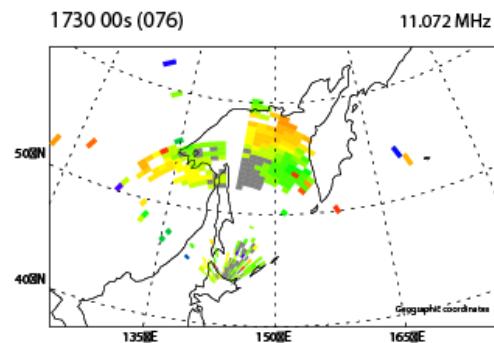
## SUPERDARN PARAMETER PLOT

Hokkaido: vel

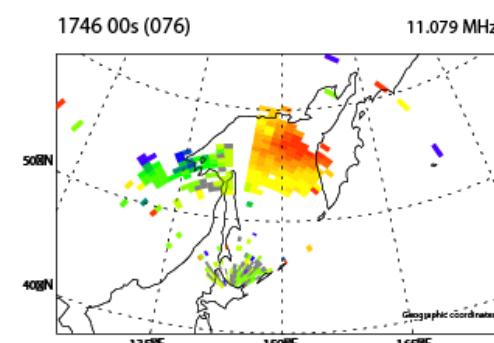
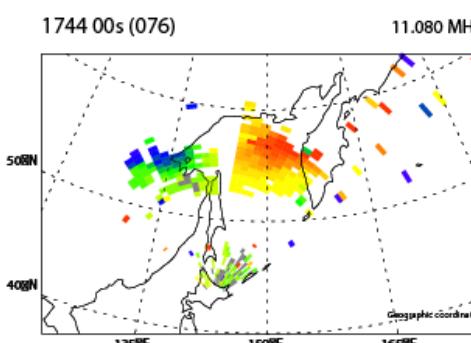
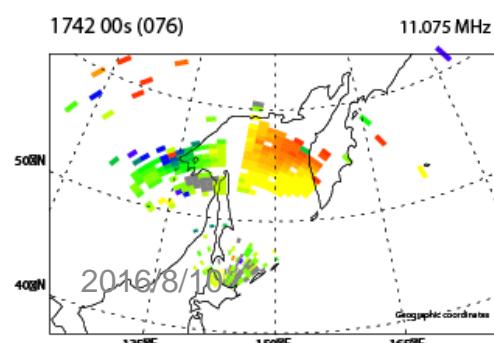
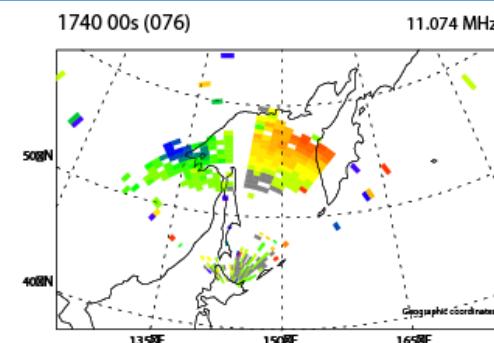
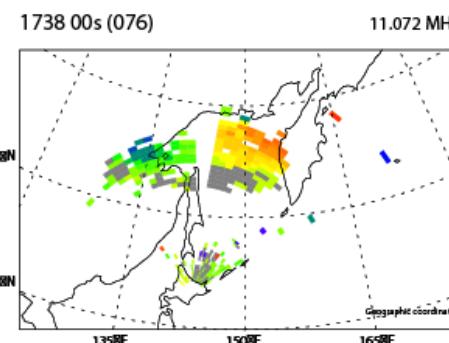
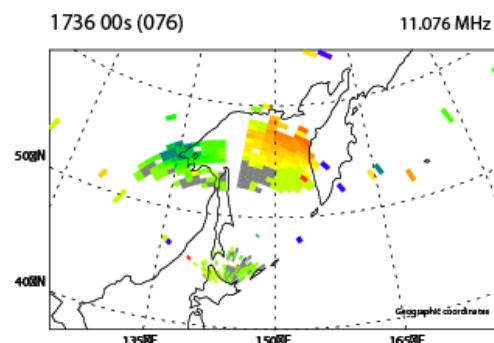
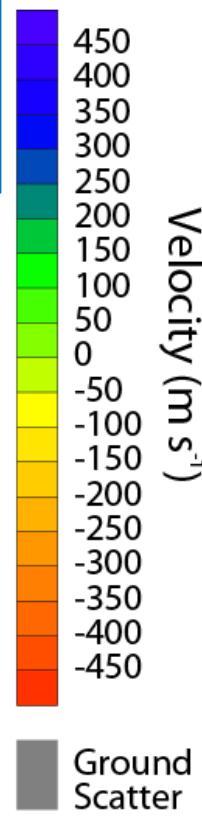
Geog. Coord.

17 Mar 2015<sup>(76)</sup>

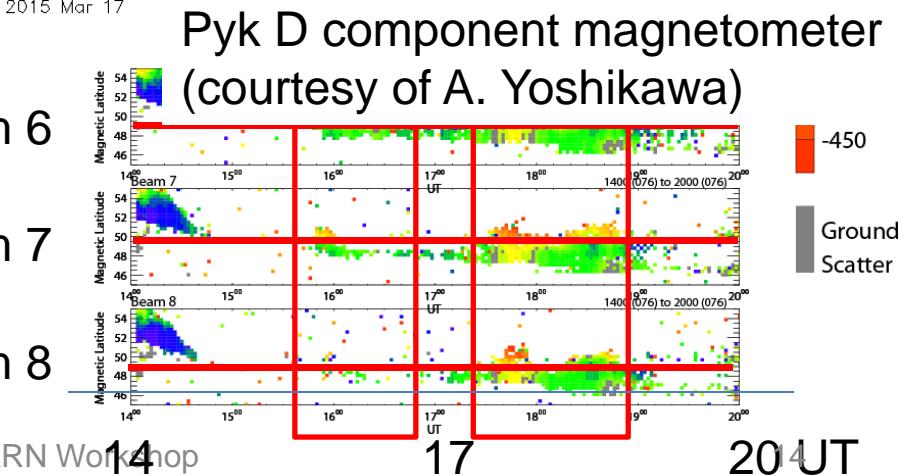
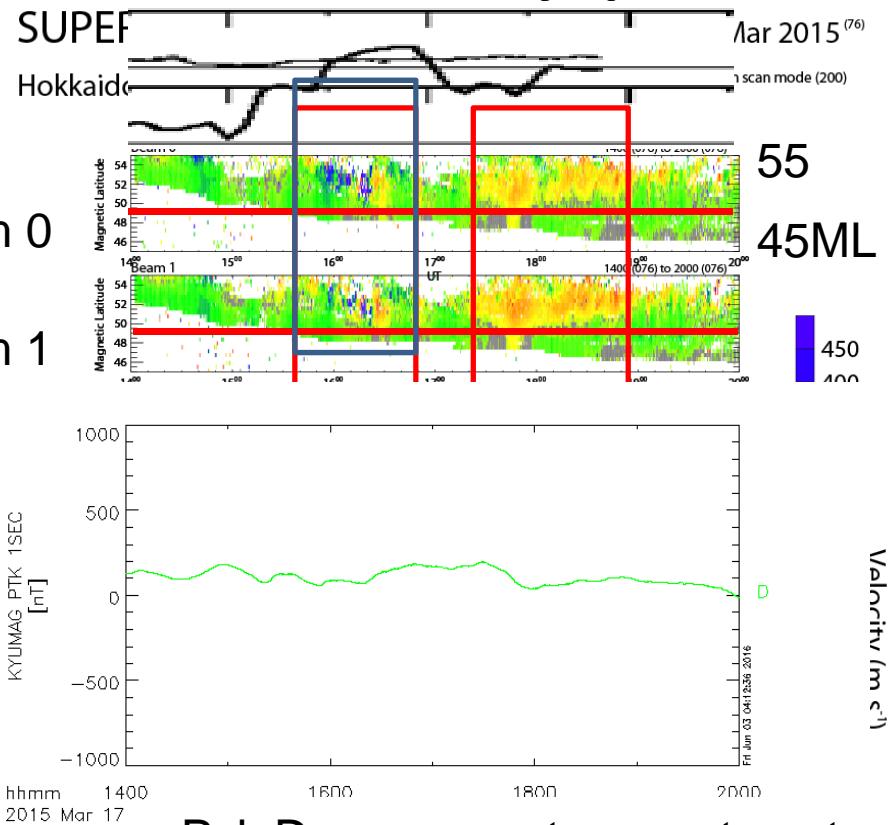
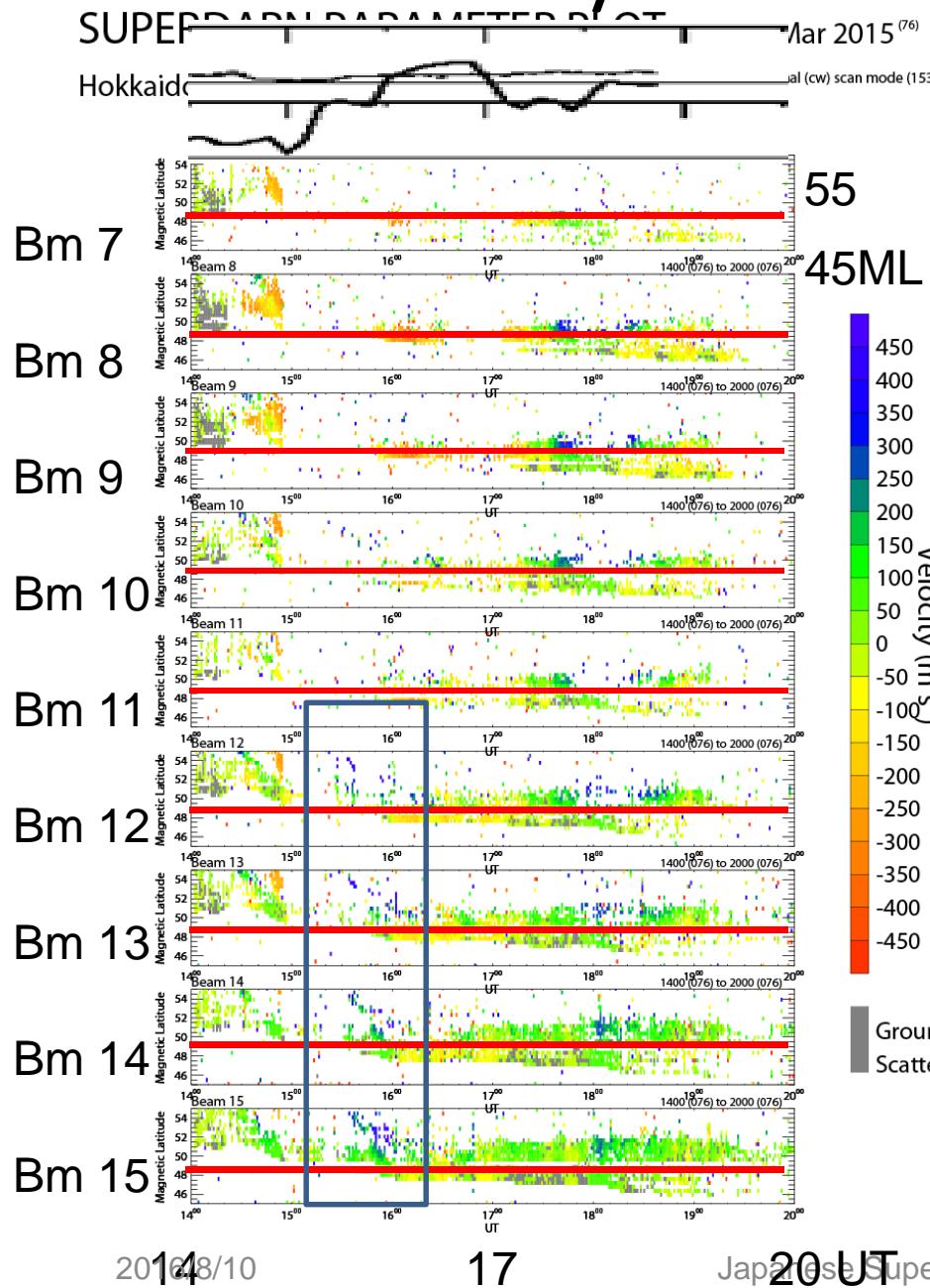
unknown scan mode (200)



Sheared flows (eastward on the poleward side and westward of the equator side) after the initial appearance of low-latitude auroras



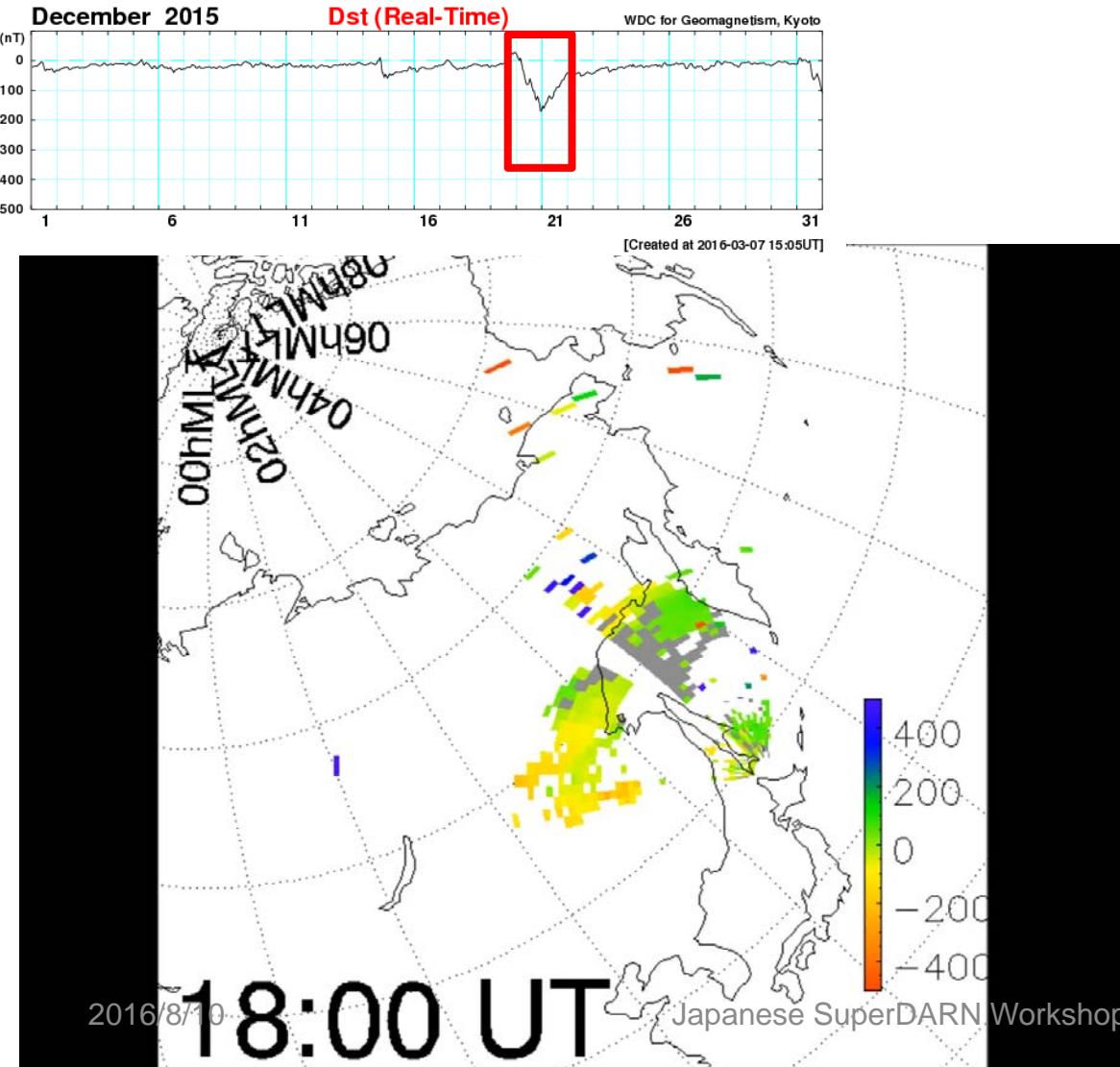
# HOP West / East radar rti velocity plot



# Discussion

- Fast (500 – 1000 m/s) equatorward flow during the first appearance of low-latitude aurora
  - Dawn-dusk electric field penetration to < 50 ML
    - Energetic (including ring current) particles penetrating into plasmaspheric regions (e.g., Tanaka and Ohtaka, 1996; Shiokawa et al., 2005)?
- Auroral emission boundary is located around the boundary between moderately fast (~500/s) westward flow region (equatorward side) and fast (1000 m/s) eastward flow (poleward side), sometimes accompanied by another westward flow further poleward of the eastward flow
  - Electric field structure maintained to keep the auroral emission?
  - Similar to the description by Foster et al. (1994, JGR) for ionospheric convection associated with SAR arcs in the morning sector

hok/hkw movie (2015/12/20 18-21 UT, near the peak stage of the geomagnetic storm: Min Dst=-170 nT at 20 UT) low latitude aurora at 1900-2030 UT



北側の夜空の雲の上部で、うっすらと輝く低緯度オーロラ。雲の下の明るい部分は市街地の明かり(21日午前4時29分、30秒露光、銀河の森天文台提供)

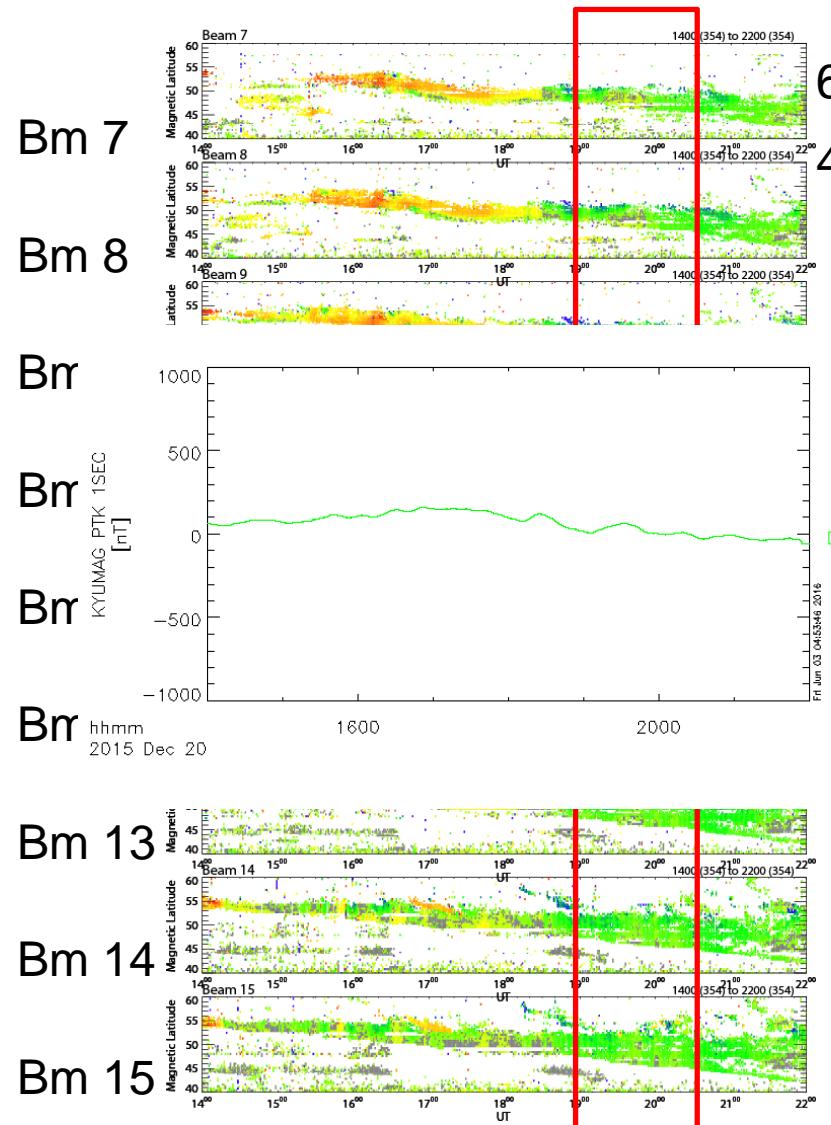
Low-latitude aurora:  
1900-2030 UT

# HOP West / East radar rti velocity plot

SUPERDARN PARAMETER PLOT

20 Dec 2015<sup>(354)</sup>

Hokkaido West: vel

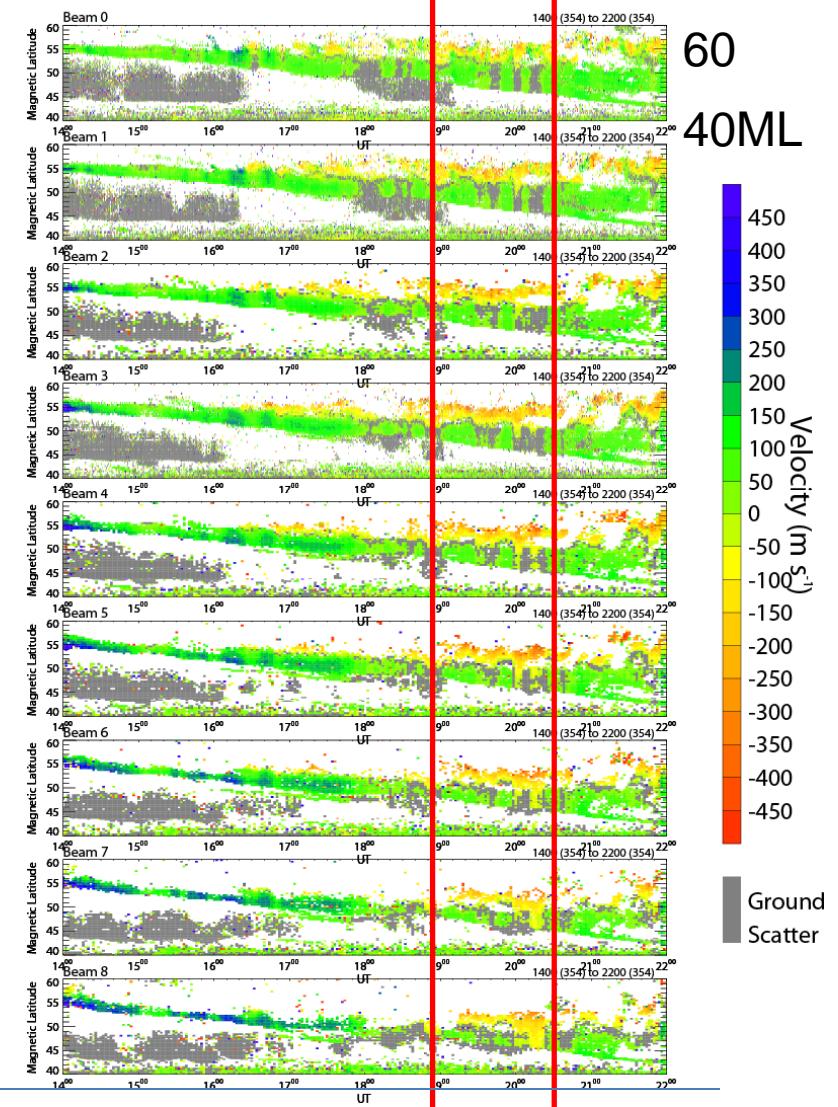


SUPERDARN PARAMETER PLOT

20 Dec 2015<sup>(354)</sup>

Hokkaido: vel

unknown scan mode (3300)



2014/10/14

18

Japanese SuperDARN Workshop

14

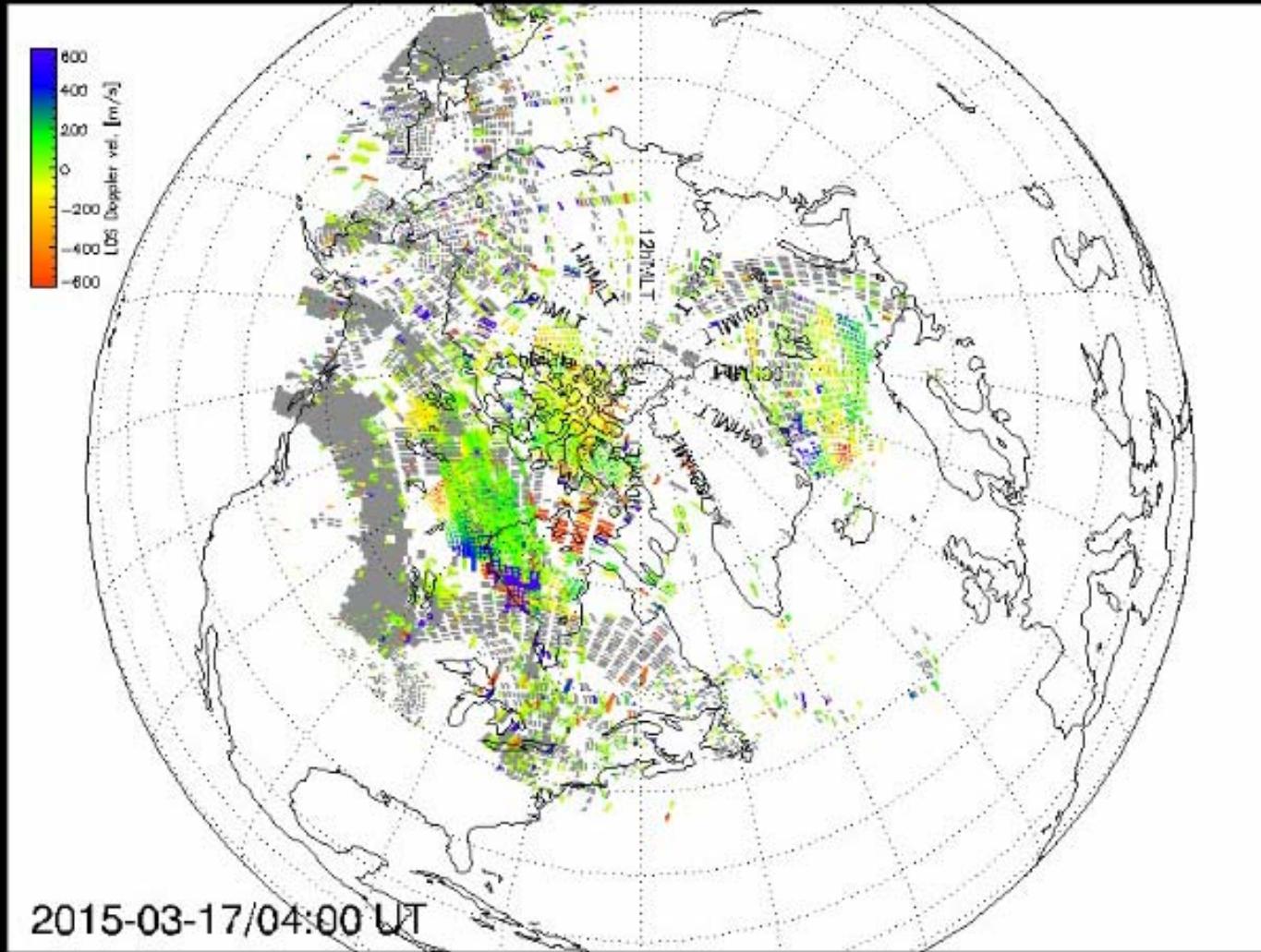
18

22UT

# Summary

- Ionospheric / magnetospheric disturbances during the storm event (March 2015, December 2015) accompanied by low-latitude aurora in Hokkaido
  - Fast(500-1000 m/s) equatorward flow around the initial appearance of low latitude aurora, consistent with the ground magnetometer observation
    - Dawn-dusk electric field penetration to < 50 ML to cause inward transport of auroral regions
  - Flow shear structure near the auroral emission boundary (equatorward side:~500 m/s westward flow, poleward side: ~1000 m/s eastward flow, sometimes accompanied by westward flow on the poleward side)
    - Electric field structure maintained to keep the auroral emission?
  - Fast (> 200 m/s) flows up to 48 ML ( $L=2.23$ )
  - Etc.
- Detailed comparison with geomagnetic data is ongoing
- Global dynamics of ionospheric convection (in combination with other SuperDARN radars and other ground-based observations, satellite observation and modeling) provides important information for understanding global magnetosphere-ionosphere system

# Global LOS map movie on 17-18 Mar 2015





# IMF / solar wind data for 17-18 March 2015

