PHYSICS AND ENGINEERING PHYSICS

Parameters of short-range Hokkaido echoes: A statistical assessment

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Outline

1. Motivation

2. UT/MLT variation, seasonal change

3. "Torch" event

4. QP echo event

5. Current conclusions

Motivation

Hokkaido radar has been receiving quite a few short range echoes, below ~600 km. These could be of several kinds that are, unfortunately, difficult to distinguish in routine measurements:

Meteor-related
Due to low-height D region irregularities
Bottom-side F region irregularities (>120 km)
Genuine E region echoes

We would like to establish typical parameters of short range Hokkaido echoes and see if their properties would be similar to those at high latitudes

Question 0

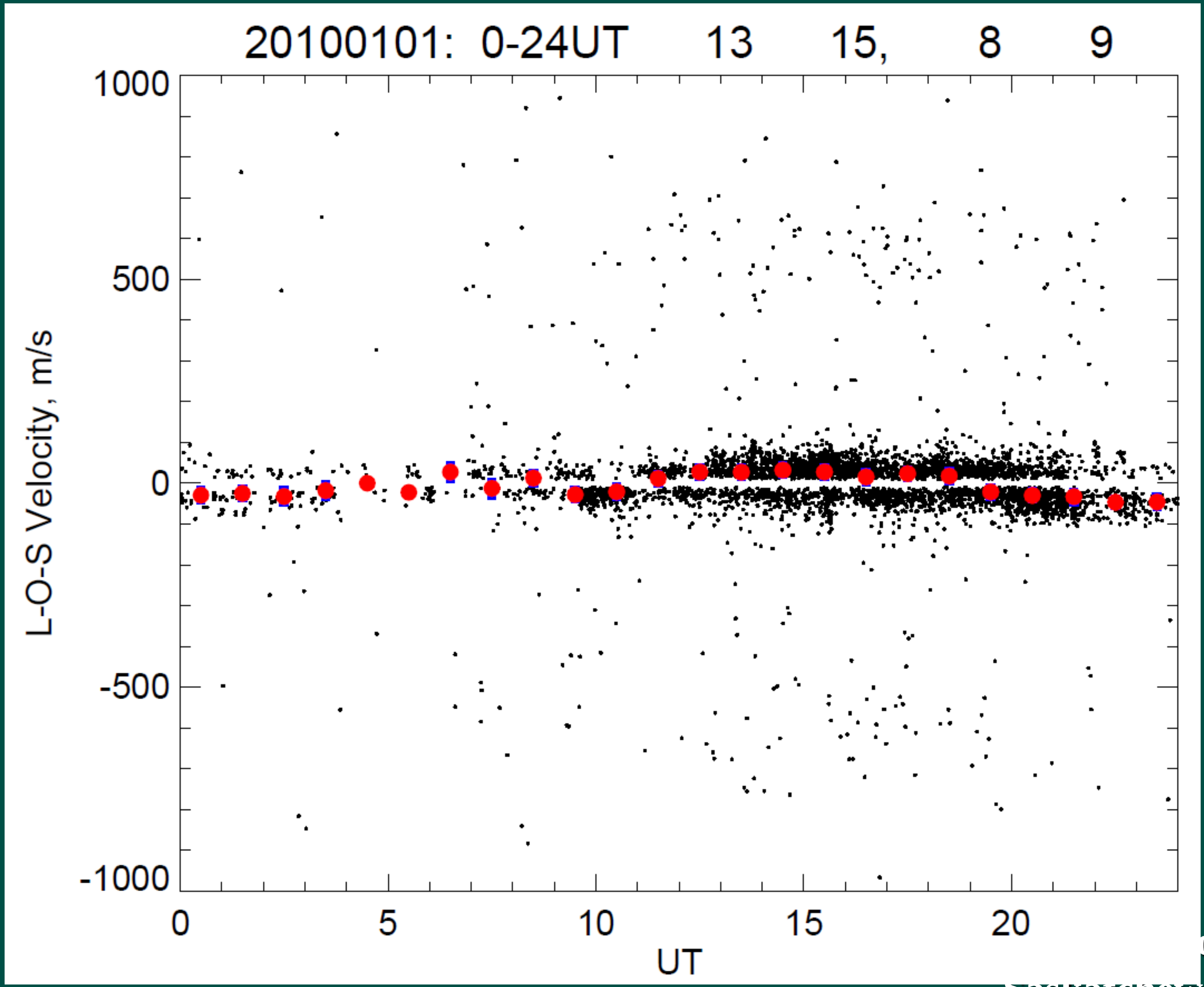
Does the Hokkaido radar see Farley-Buneman waves?

1. A number (~5) of mid-latitude publications with VHF radars reported detection of high-velocity E region echoes that were related to the Farley-Buneman plasma instability. Such echoes had velocities about ~300 m/s.

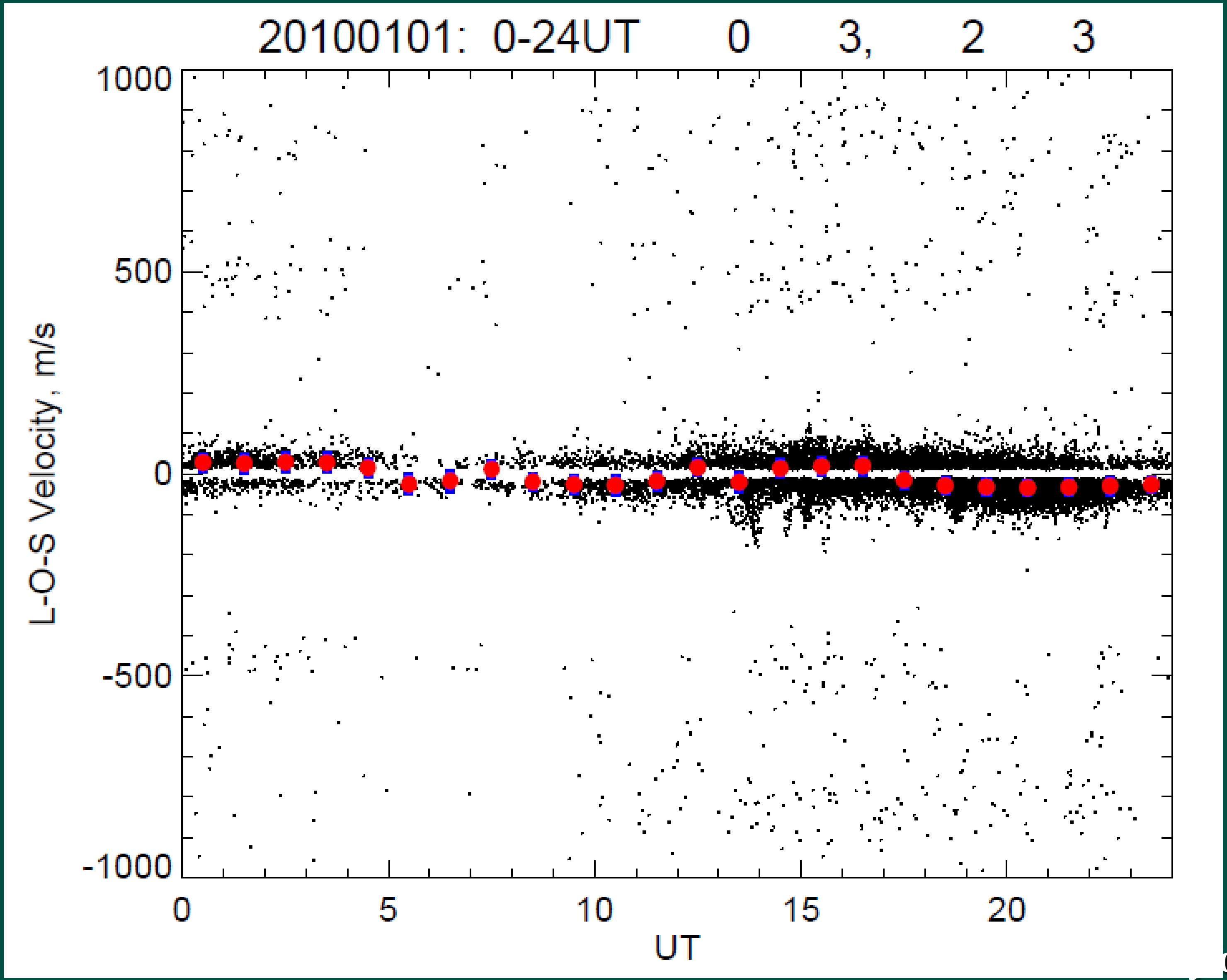
2. Manual search through Hokkaido data base for 2010 did not show even one single onset of such an event.

3. This does not mean that there are no high-velocity data in the data base.

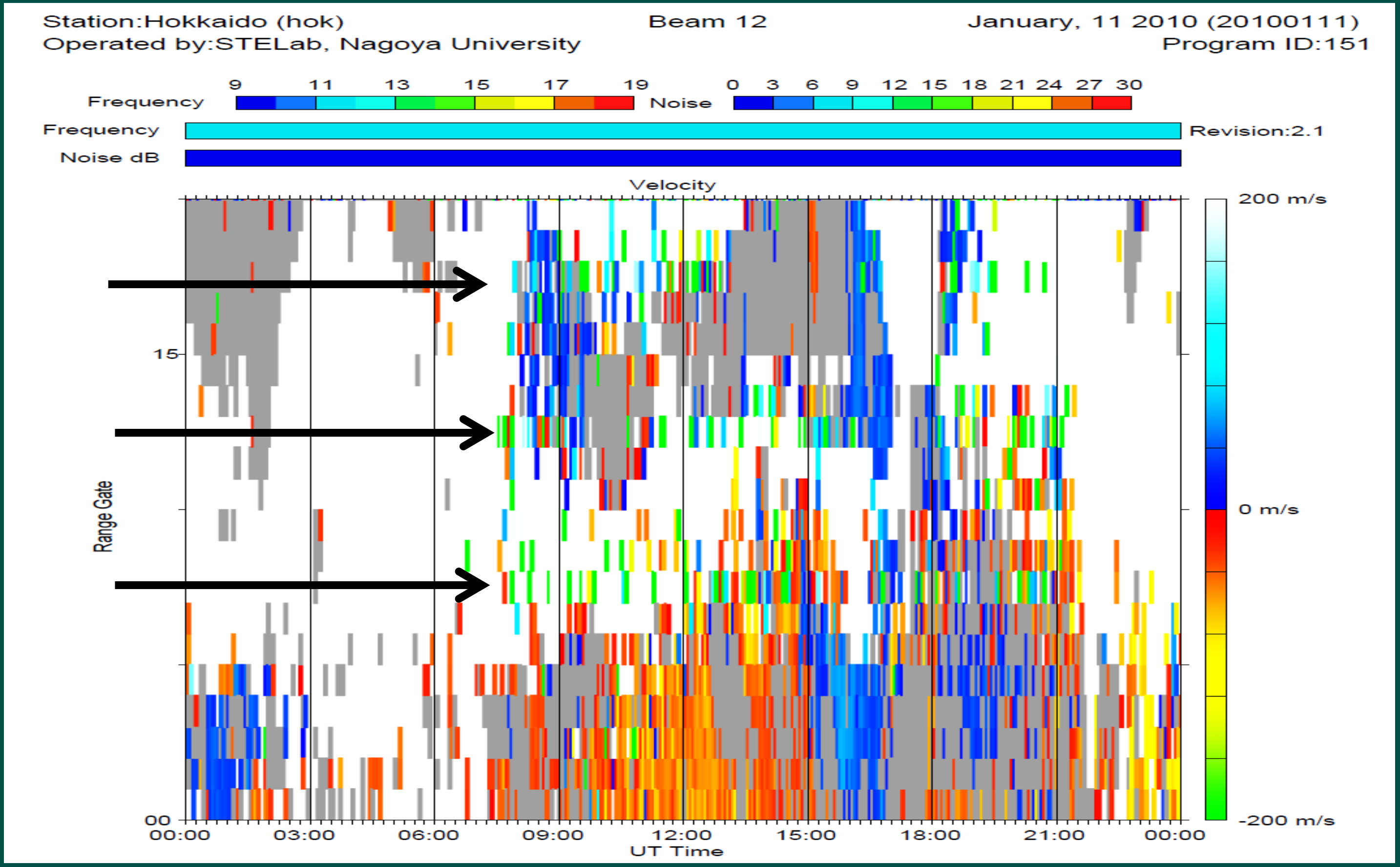
Hokkaido, Jan 2010, beams 13-15, gates 8,9



Hokkaido, Jan 2010, beams 0-3, gates 2,3



Nature of high-velocity Hokkaido echoes



The high-velocity echoes are probably interference signals in gates corresponding receiver shutdown:

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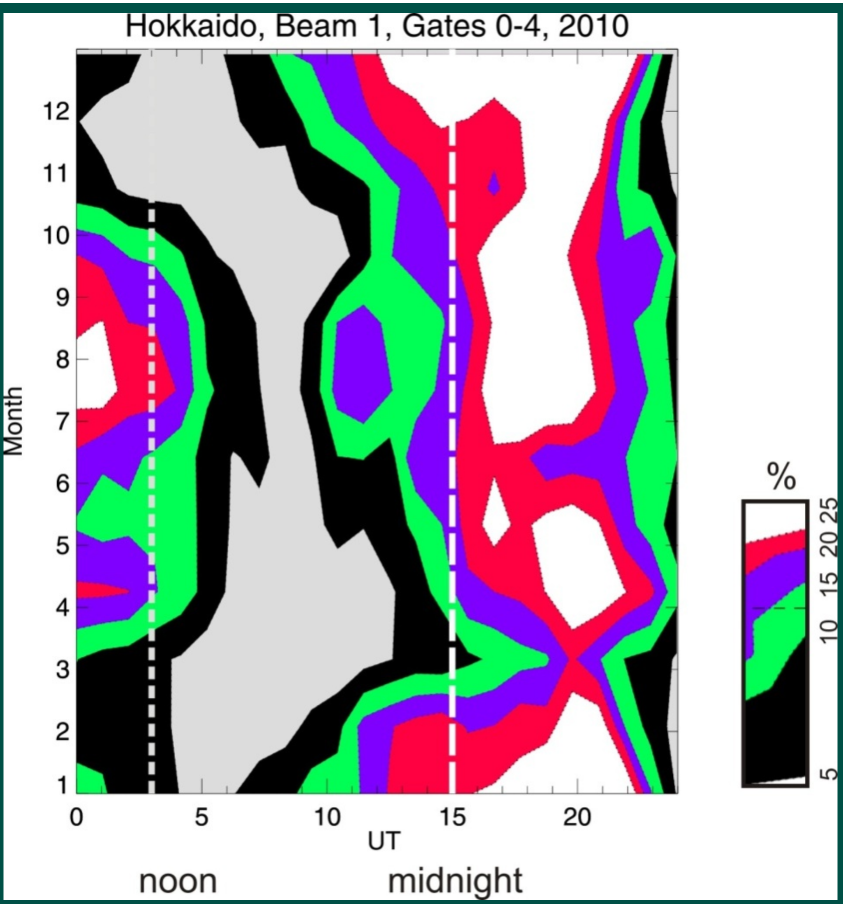
Question 1

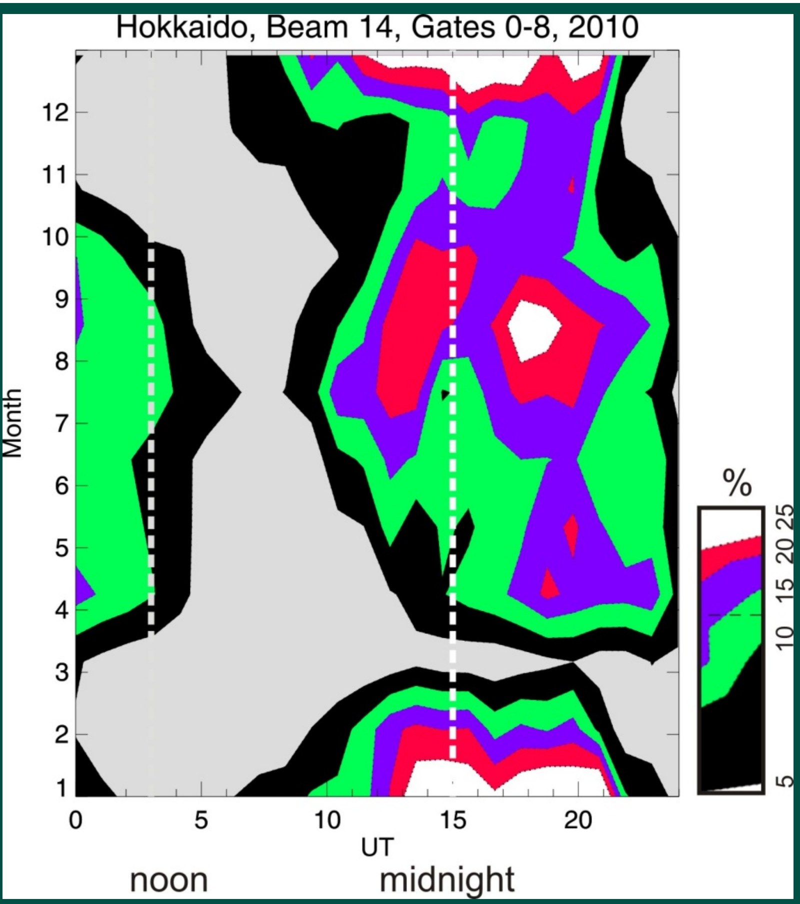
Parameters of short range Hokkaido echoes

Question 1

Echo occurrence

E-region echo occurrence. Normal scans MLT/Seasonal dependence

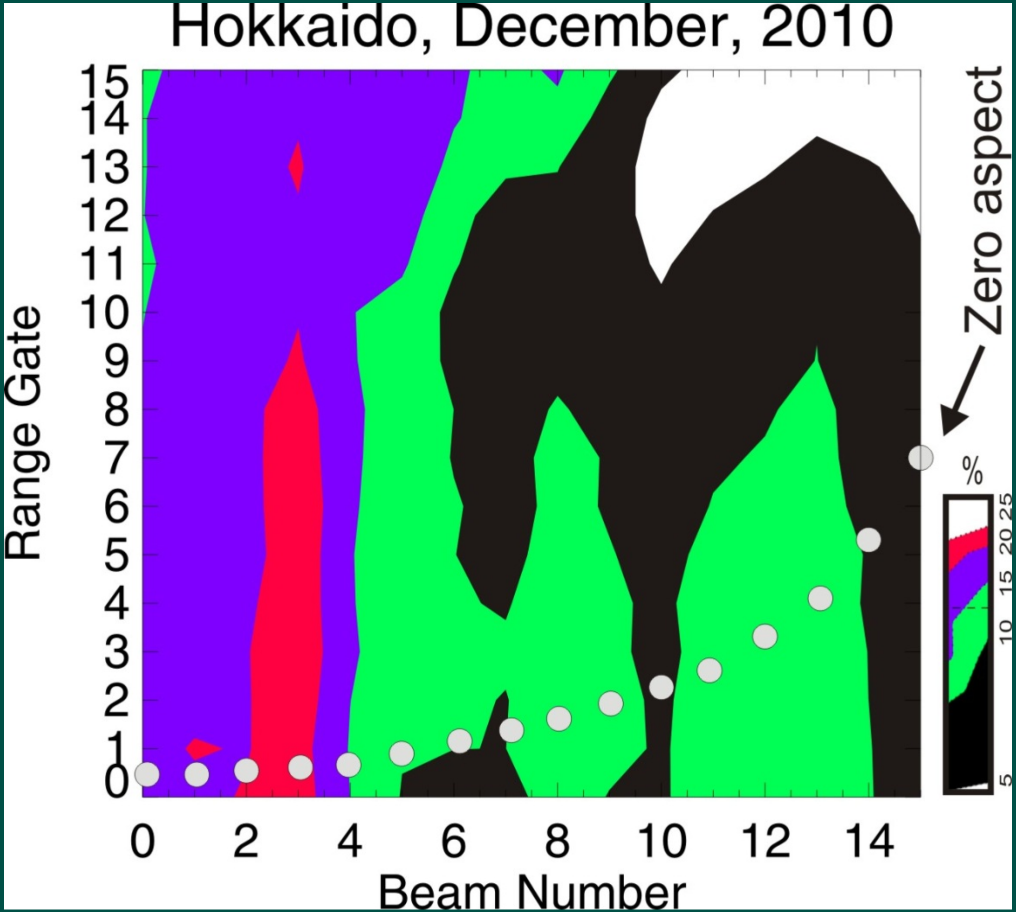




Echoes are more frequent

- **-midnight-early morning, for all seasons**
- **- additional near noon max for summer**

Hokkaido E region echo occurrence
Difference between the beams



Echoes are more frequent in beams 2-3. Detection rates deteriorate with range

Preliminary conclusions for occurrence

1. Mostly winter midnight –early morning phenomenon. Similar to other reports at HF and VHF

2. Summer daytime maximum

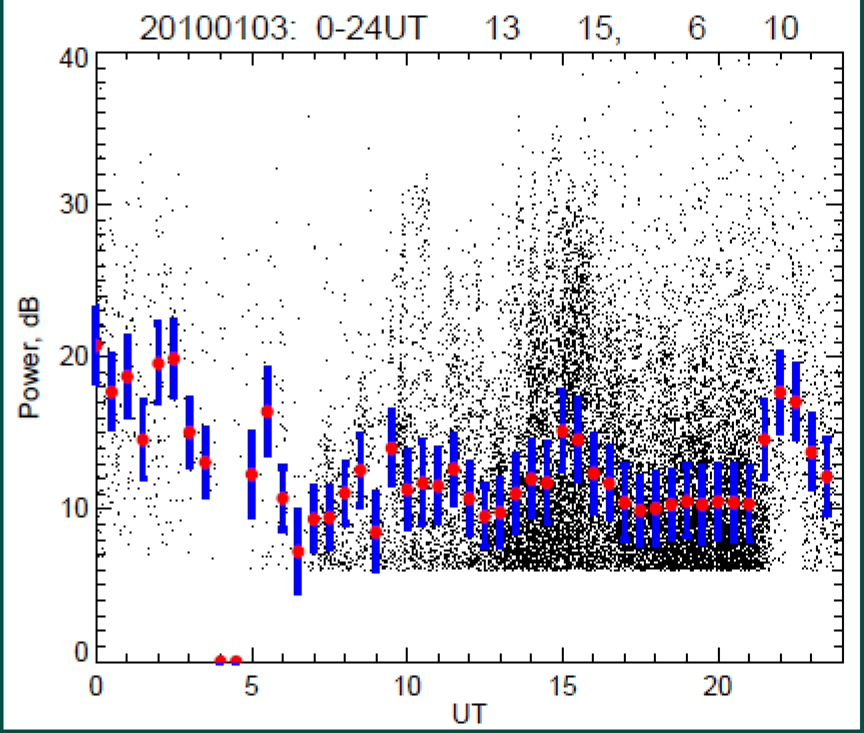
3. More echoes for observations perp to the ExB (L shells). Consistent with French Valensole radar. Syowa sees more echoes at directions in between ExB and perp to ExB

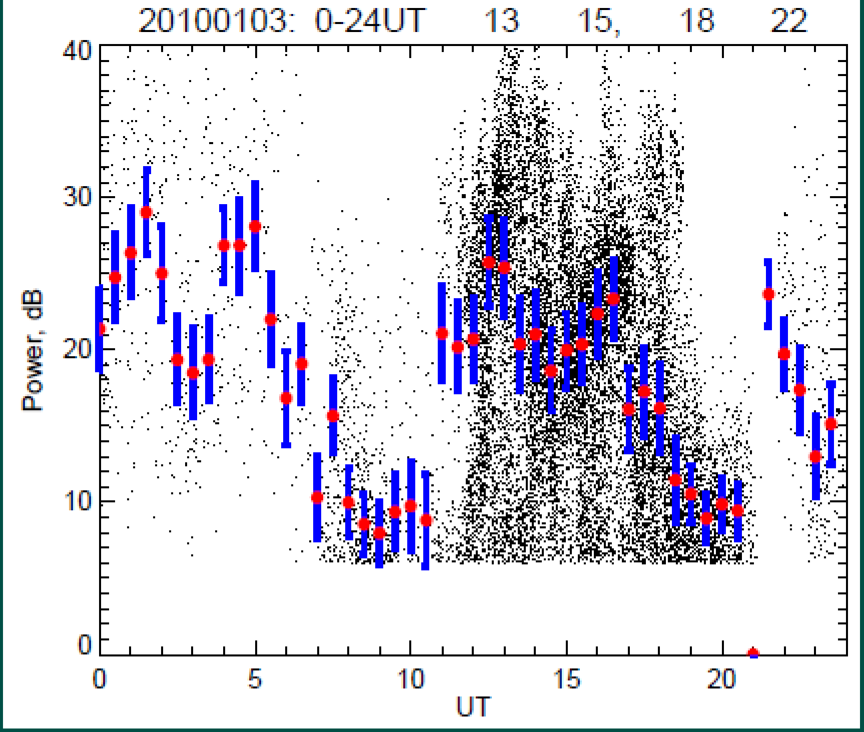
4. No strong “attachment” to zero aspect angle line

Question 1

Power of echoes

Power of Hokkaido echoes Beams 13-15, closest to L shells January 2010

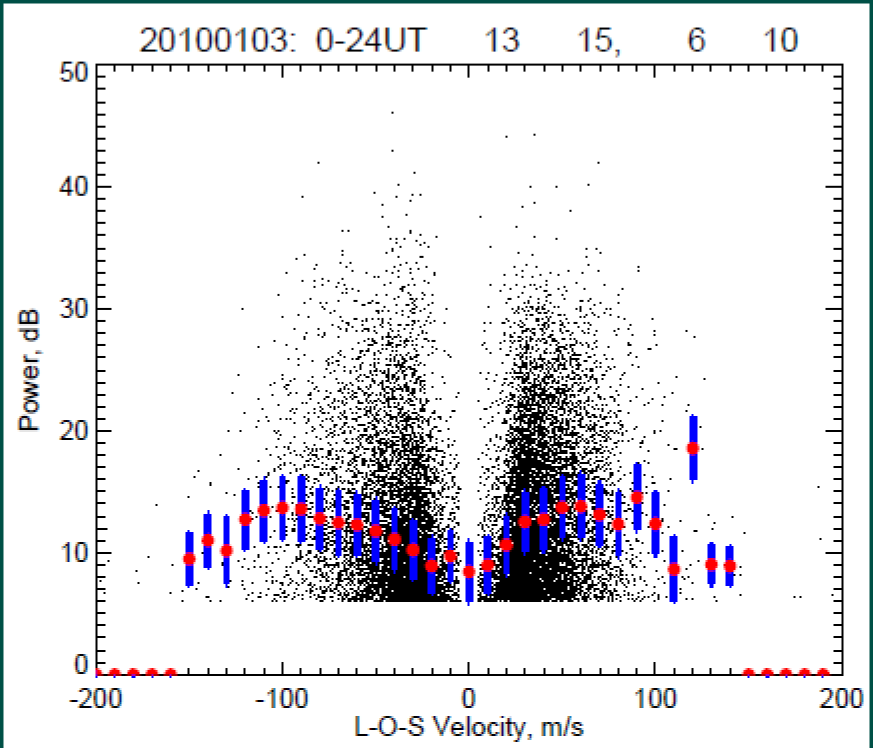


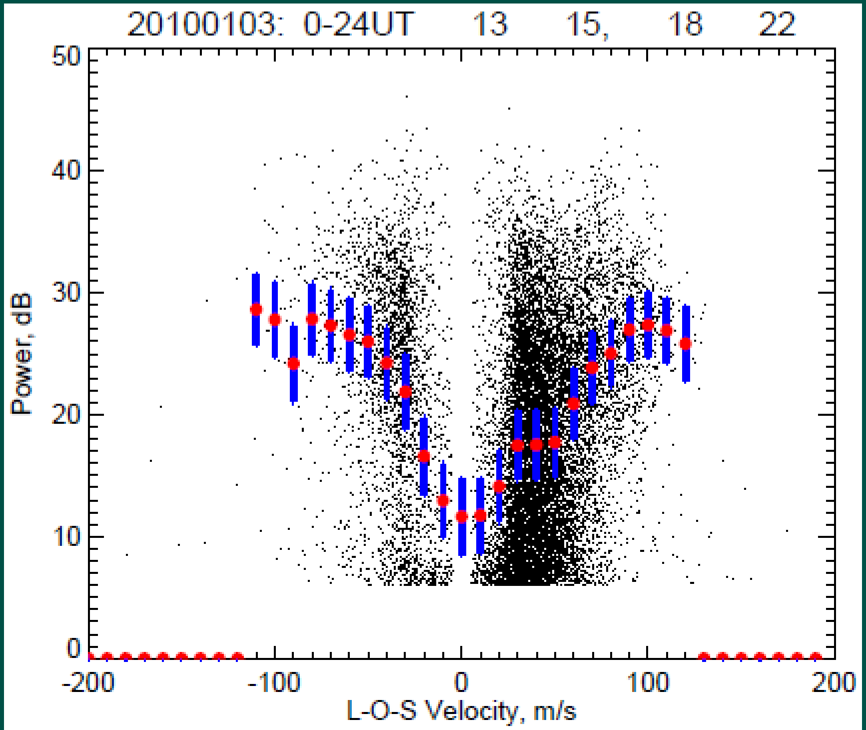


E region **F region**

Power of F-region echoes is consistently larger. Perhaps it reflects stronger densities in the F region.

Power vs Velocity, P(V)
Beams 13-15, closest to L shells
January 2010





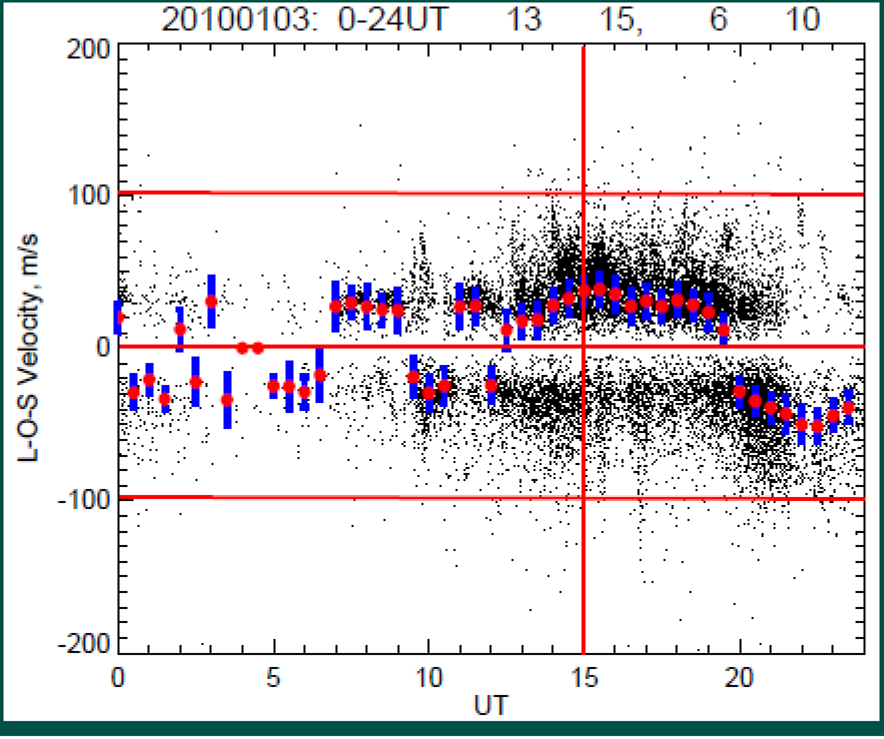
E region **F region**

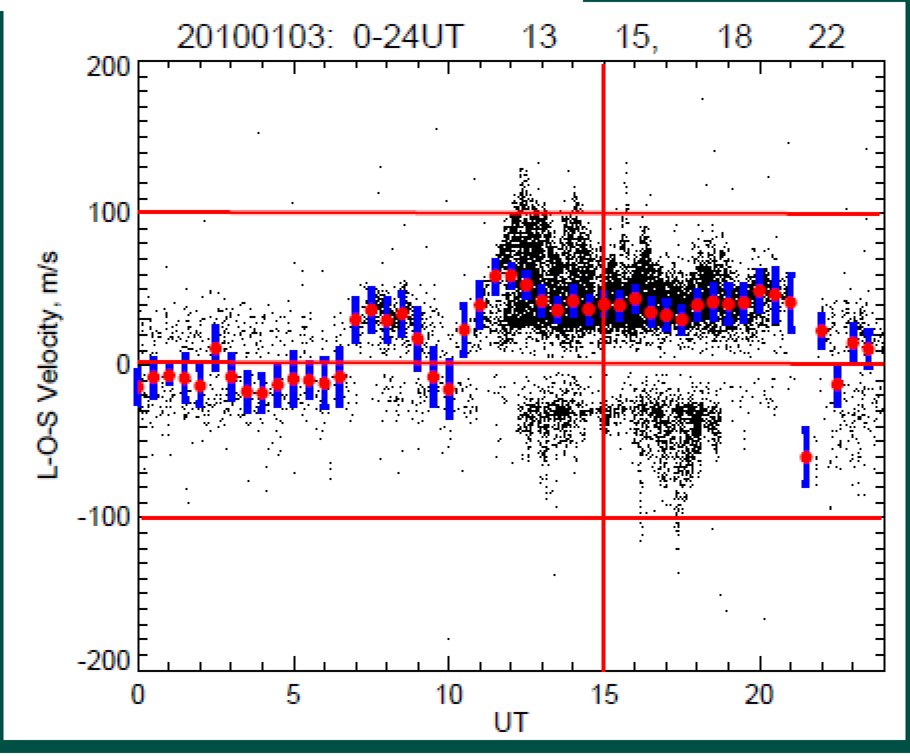
Both type of echoes show power increase and saturation.

Question 1

Velocity of echoes

Velocity of Hokkaido echoes Beams 13-15, closest to L shells January 2010





E region **F region**

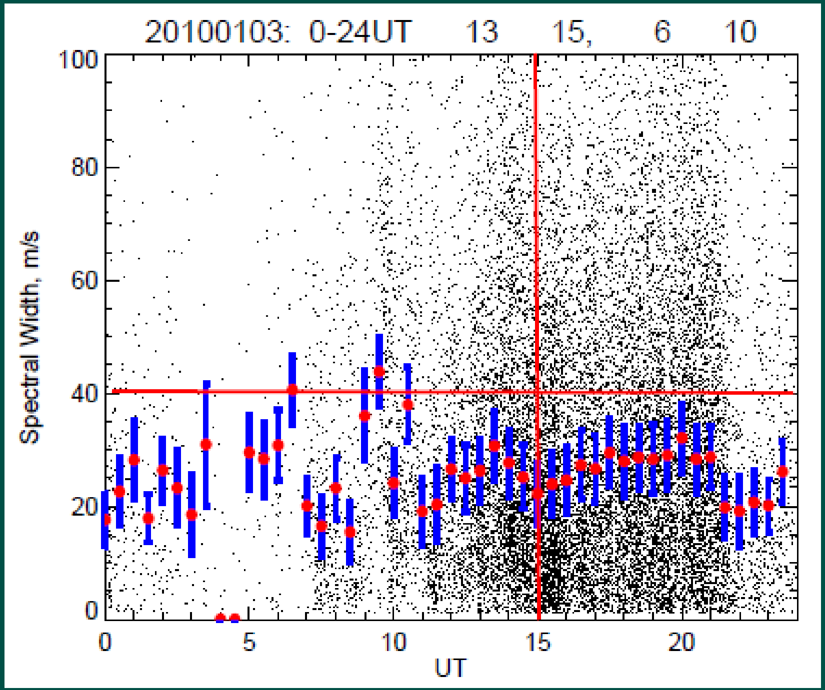
Velocities of E- and F-region echoes are comparable. There are periods when E region velocities are larger (smaller)

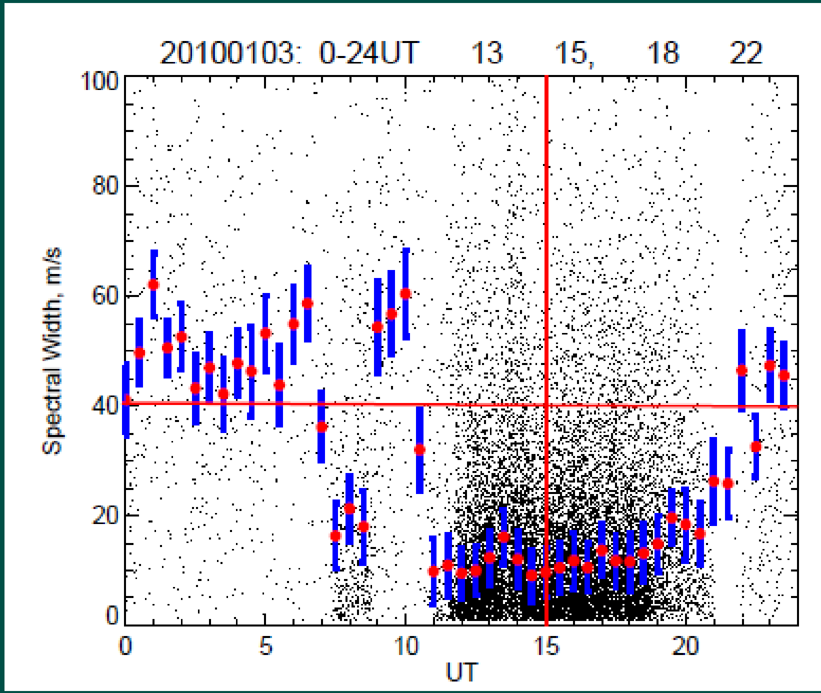
Question 1

Width of echoes

Width

Beams 13-15, closest to L shells
January 2010

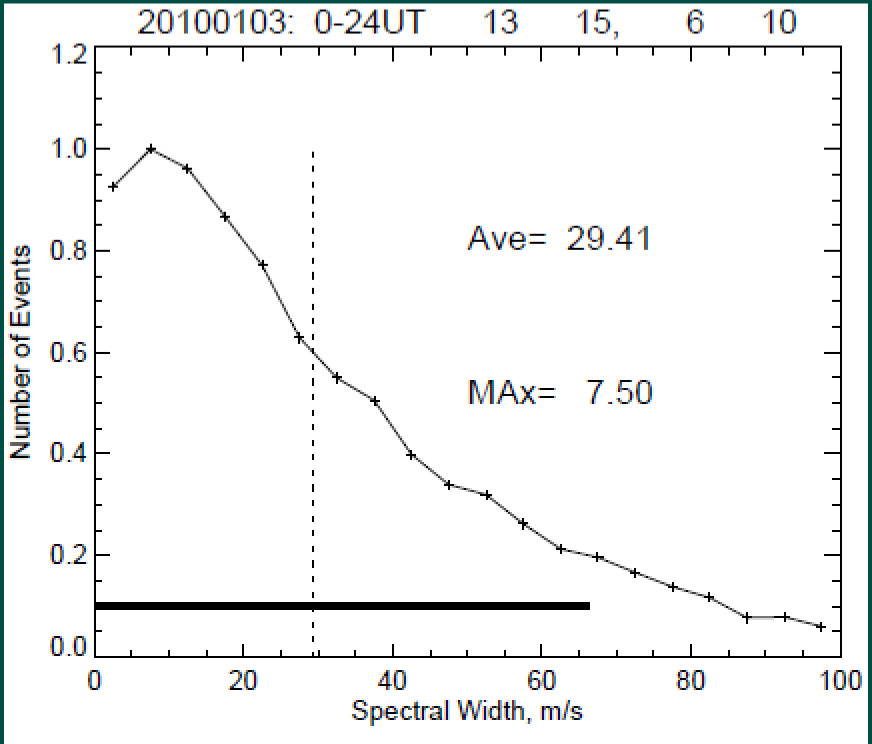


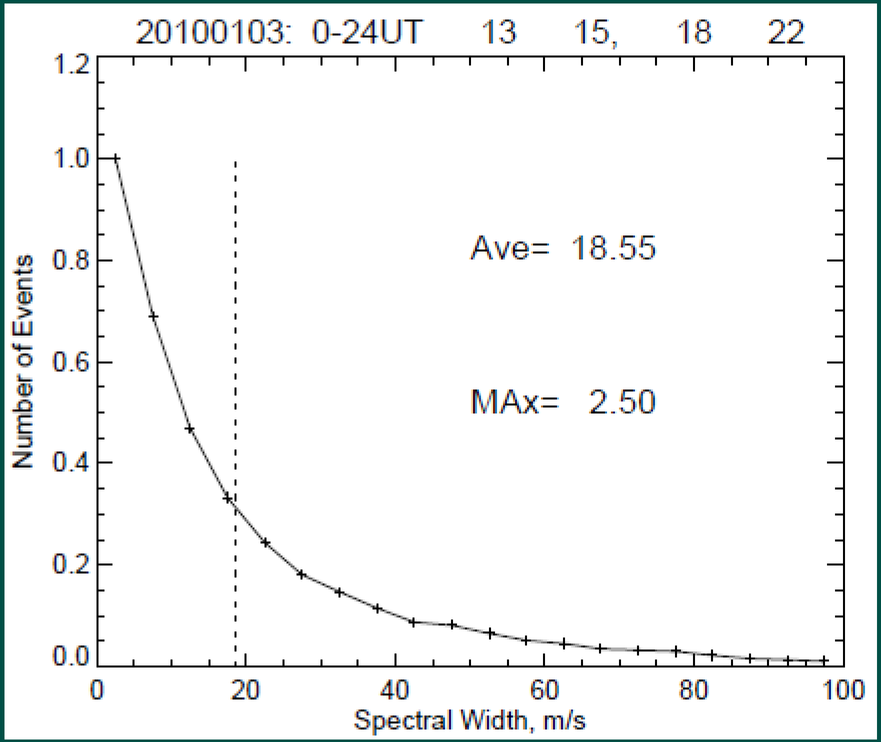


E region **F region**

E-region echoes are broader at night
F-region echoes are broader near noon

Width of Hokkaido echoes
Beams 13-15, closest to L shells
January 2010

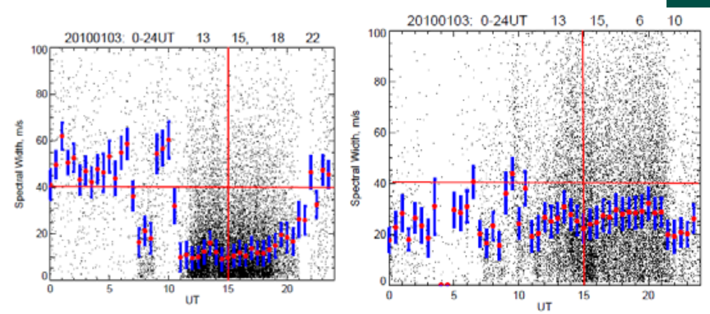




E region **F region**

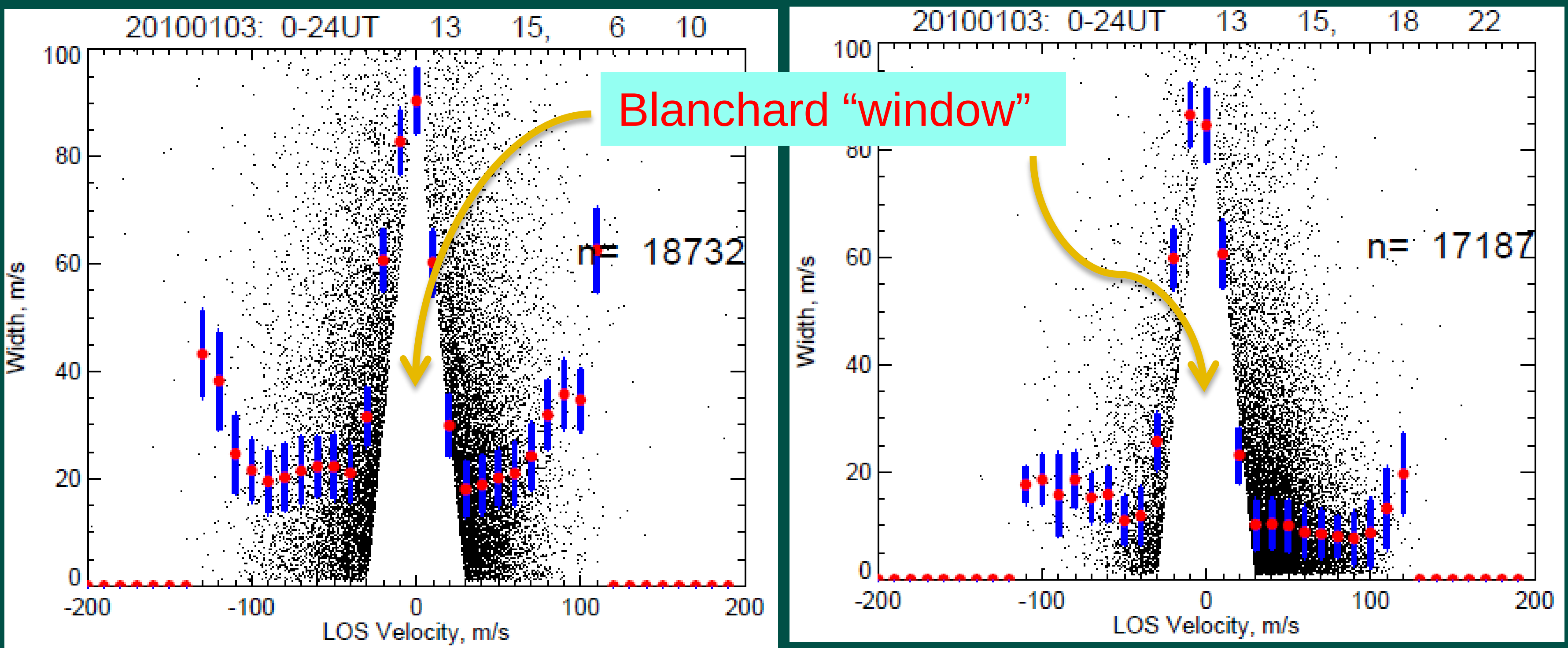
Overall: E-region echoes are broader
For some months, the widths are comparable !

Relative Width of E and F echoes, bb 13-15, 2010 (normal scans)



	Noon (3 UT)	Midnight (15 UT)
Jan	F>E	F<E
Feb	F>E	F<E
March	F>E	F~E
April	F>E	F<E
May	F>E	F<E
June	F>E	F>E
July	F>E	F~E
August	F>E	F~E
September	F>E	F>~E
October	F>E	F~E
November	F>E	F<E
December	F>E	F<E

Width vs Velocity
Beams 13-15, closest to L shells
January 2010



E region **F region**

The dependences are not stable, the slope of the trend changes from one month to another.

Conclusions for echo parameters

1. E region echoes are weaker and broader than concurrent F region echoes

2. Power increases with velocity. The rate of increase is faster than expected from the high-latitude data. There is a saturation effect; reasons are not clear

3. Typical velocity is 50 m/s. This is down by a factor of ~5-8 from high latitudes. Velocity ratio V_E/F_F ~ 1, it was ~0.3 at high latitudes.

4. Typical widths is 20-30 m/s. This is smaller by a factor of 6-8 from high latitudes. We expected width "propto Vel^2". It looks like we have "Width propto Vel". Scatter plots are somewhat confusing – mixup of signals?

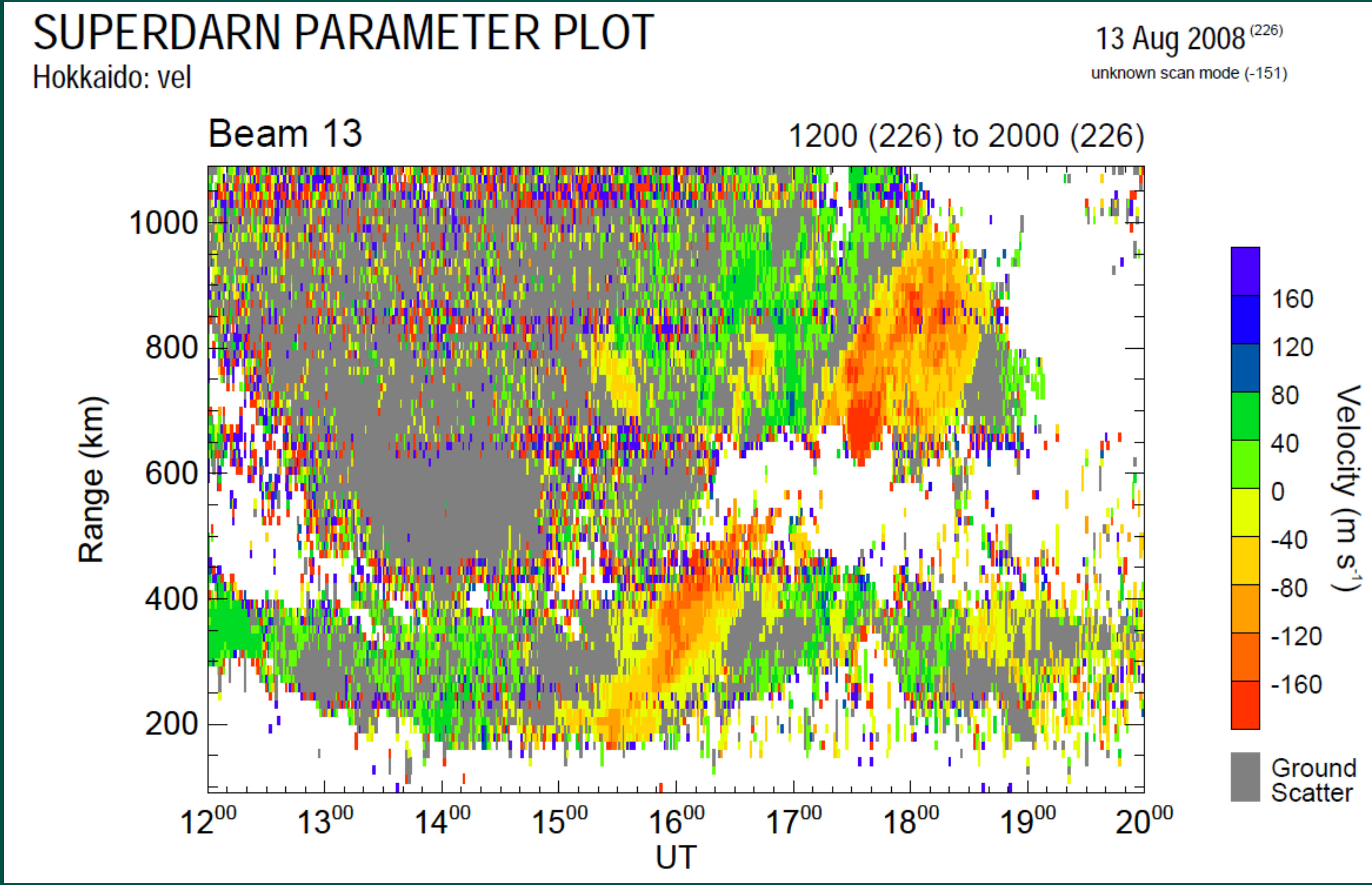
Question 2

Case studies:

A "torch" event

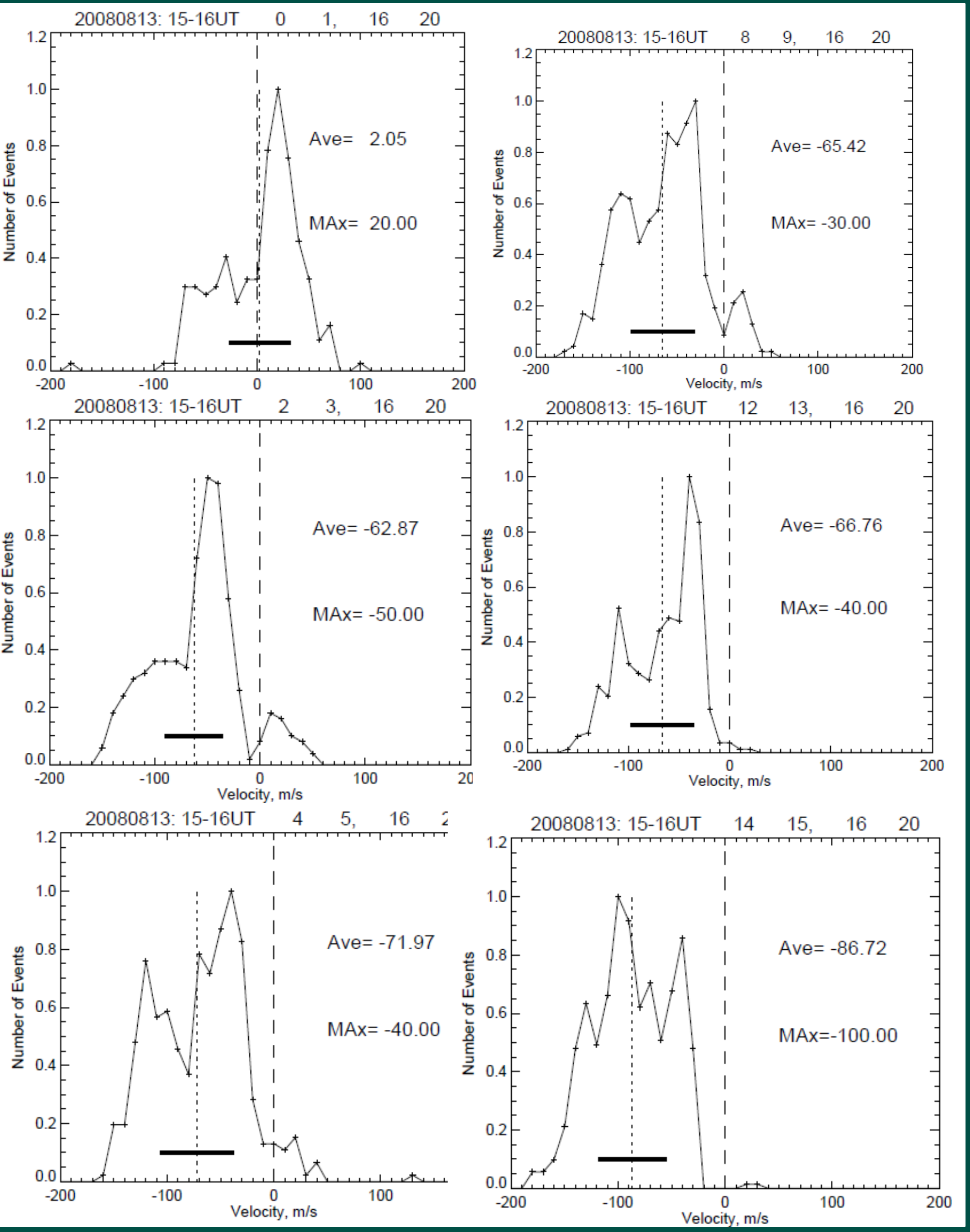
August 13, 2008

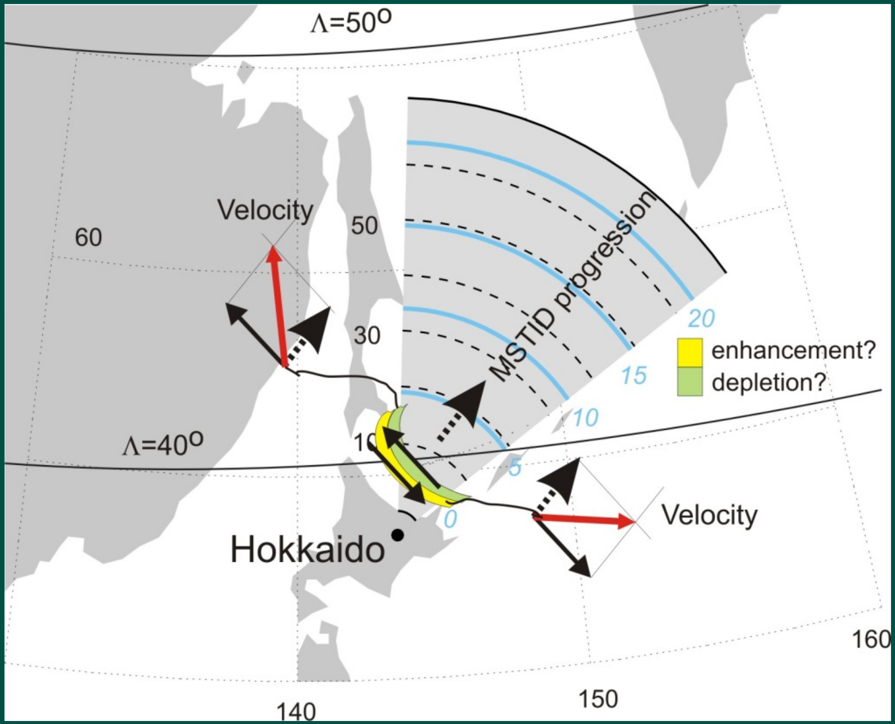
Interesting Hokkaido event



Sporadic E layer of ~6.5 MHz at Wakkanai, h`~100 km
Vel_F = Vel_E

Possible scenario?





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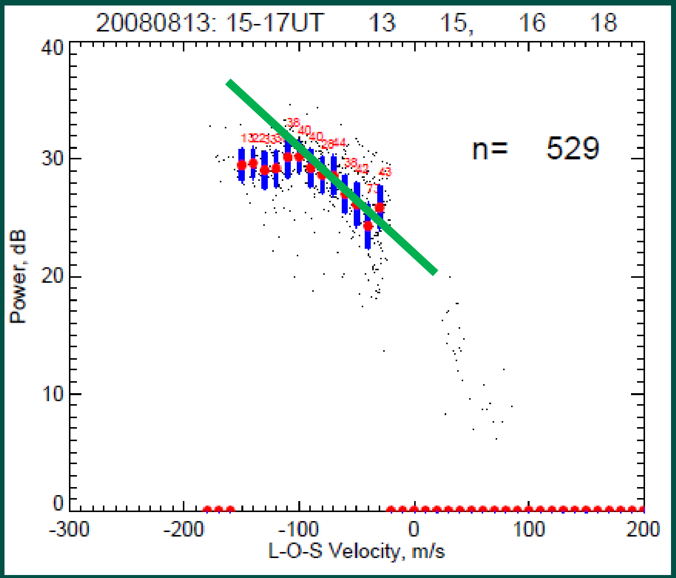
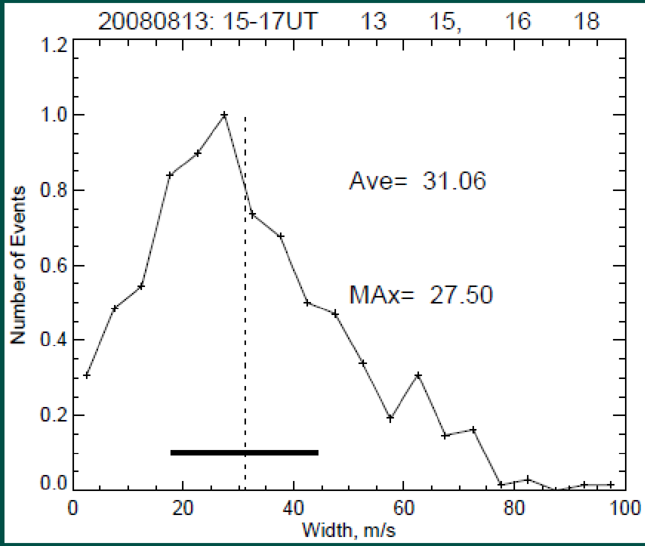
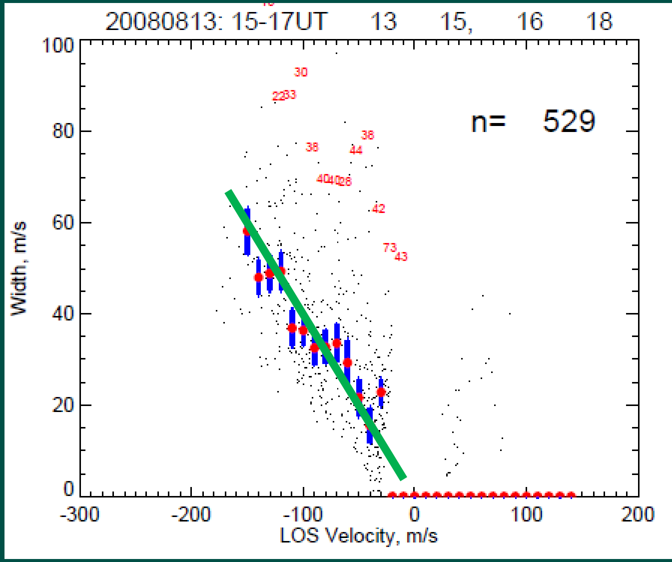
E region echoes



P(vel) has saturation
Very typical

W~ 30 m/s





W(vel) high linearity
Very typical

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Question 3

Case studies:

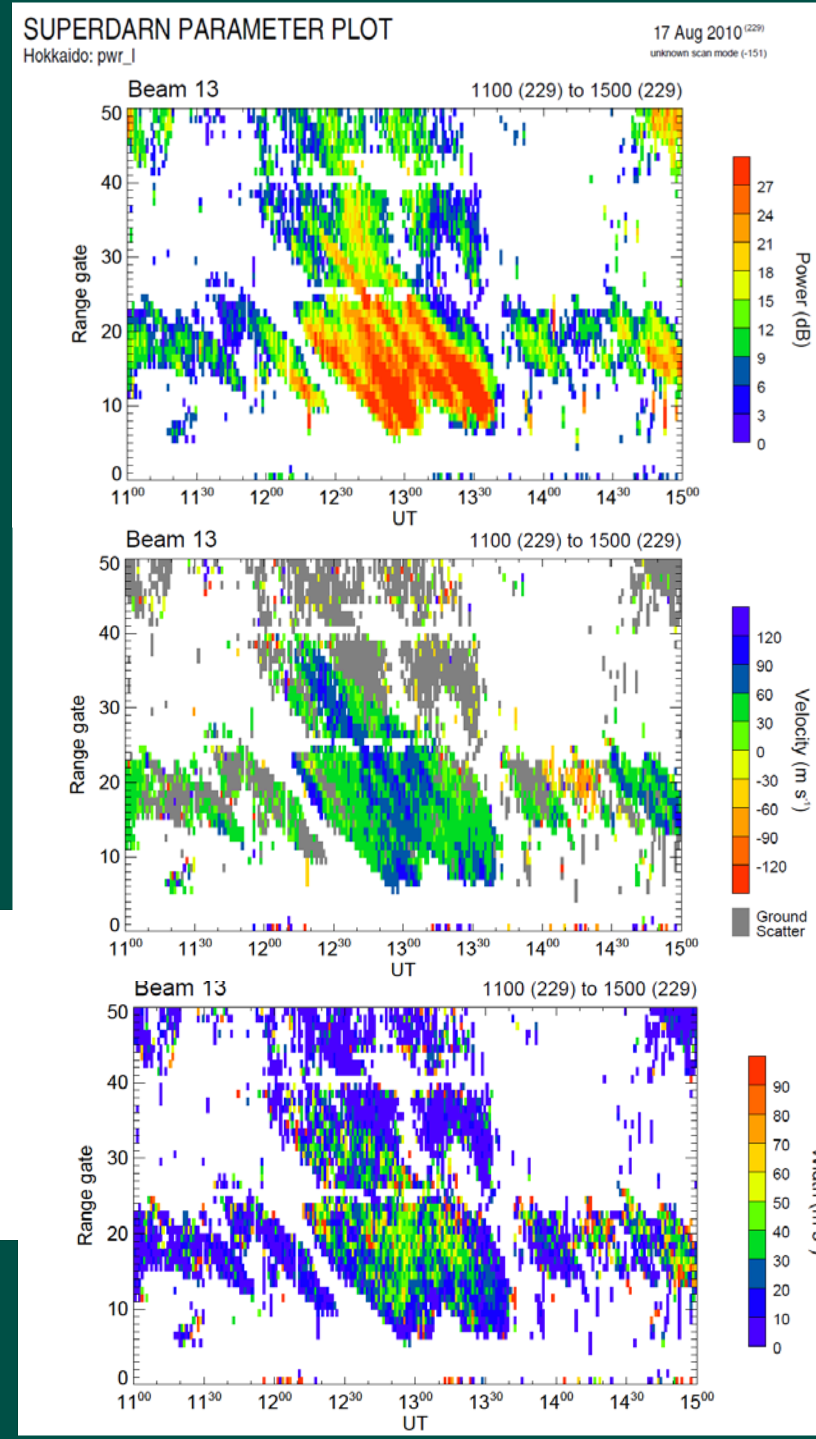
A QP echo event

August 17, 2010

Beam 13 data:

Striations are clear in echo power, less clear in Doppler velocity, and fuzzy in spectral width
Periodicity T~15 min

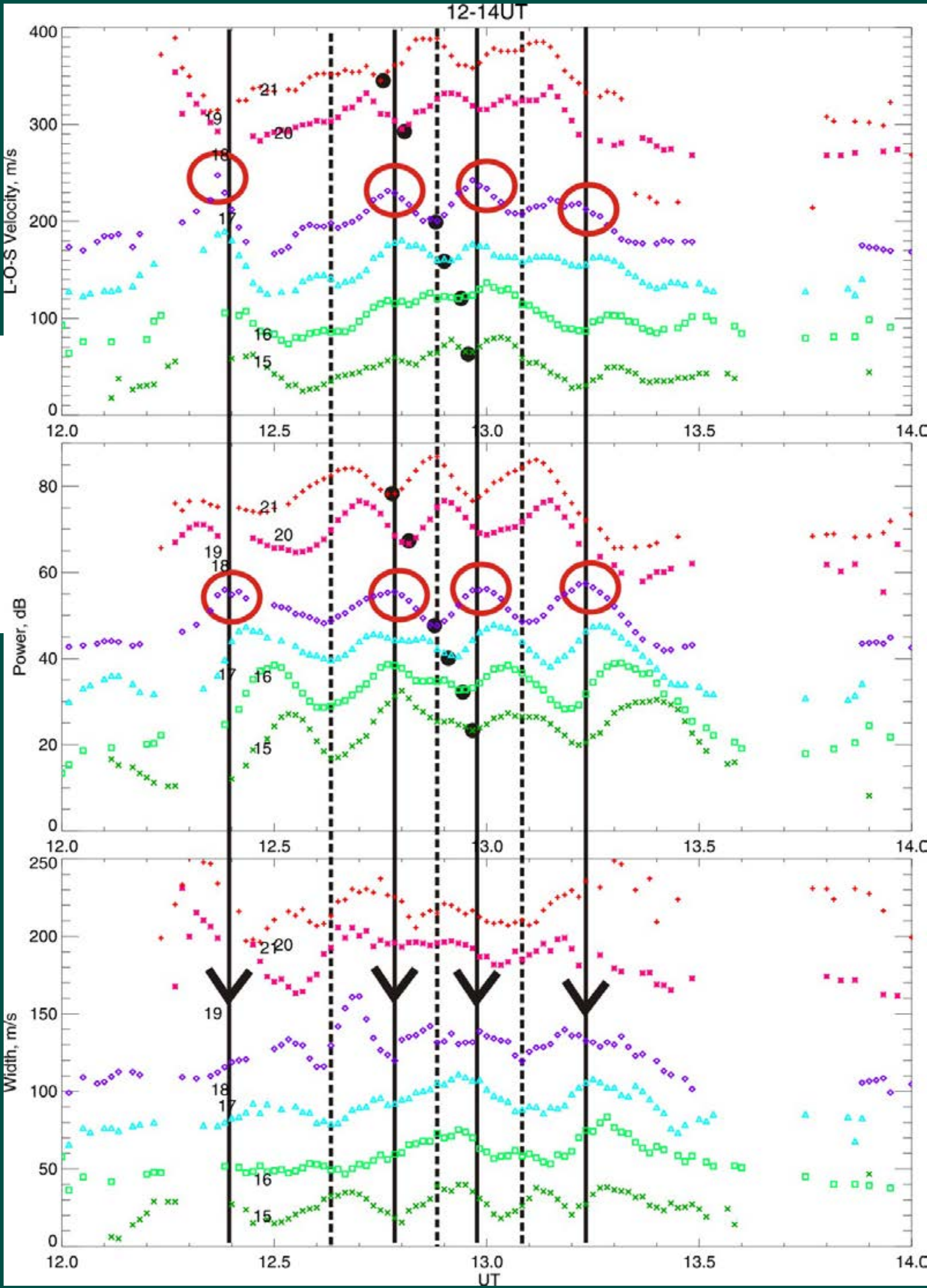
Wakkanai:
Sporadic E,
FbEs=5.1(1200UT);3.2(1300UT), 5.1(1400UT). h`=110,104,104 km



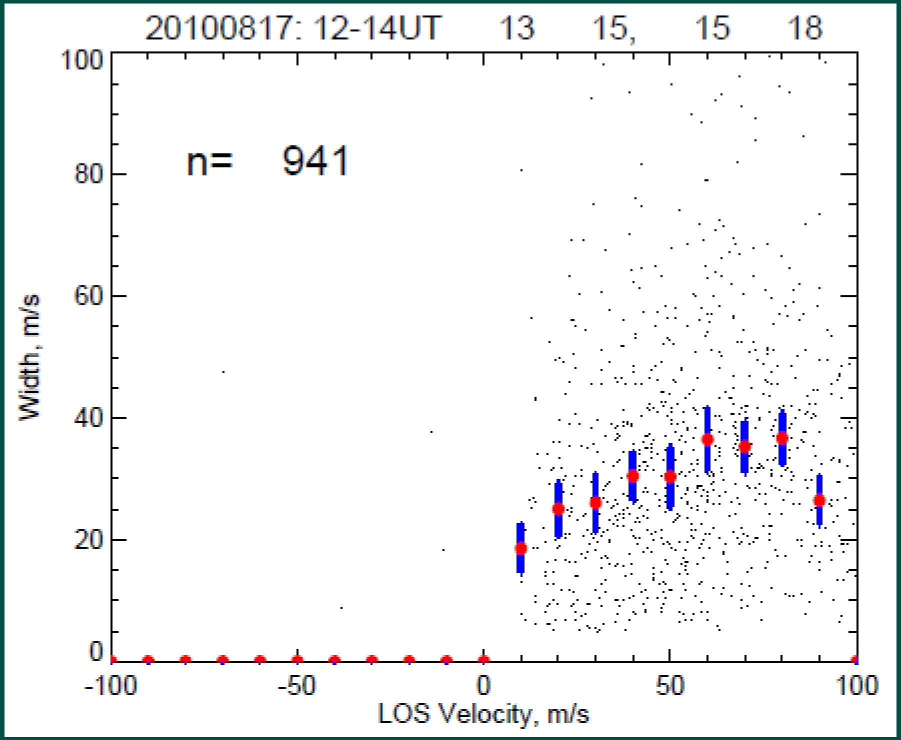
Beam 13 data:

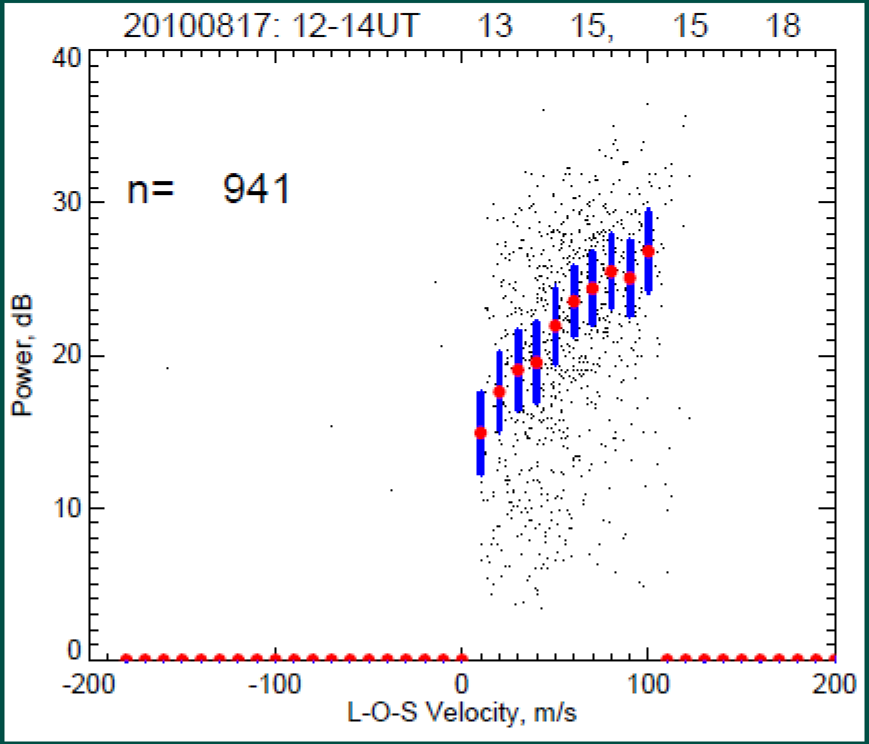
Echo power and velocity correlate well

Spectral width – not clear



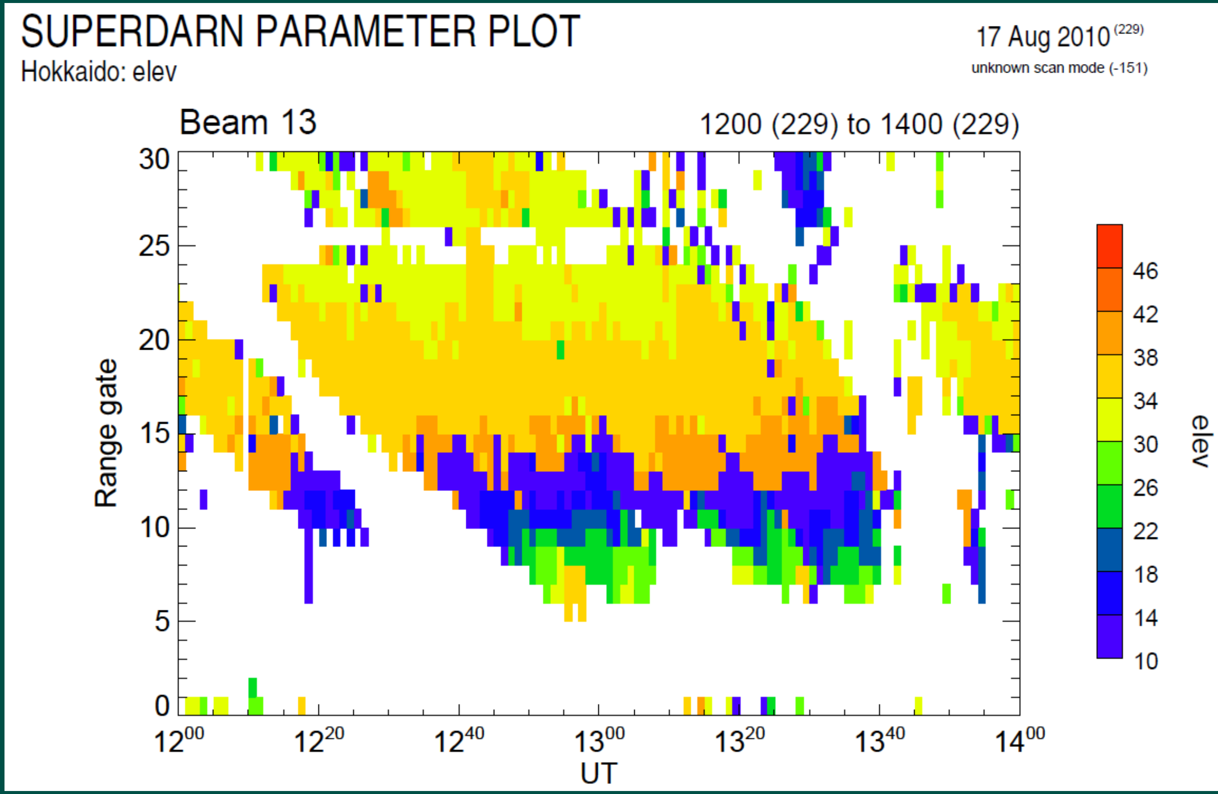
Width and power dependence on velocity





W(V) is slow, but there. P(V) is linear

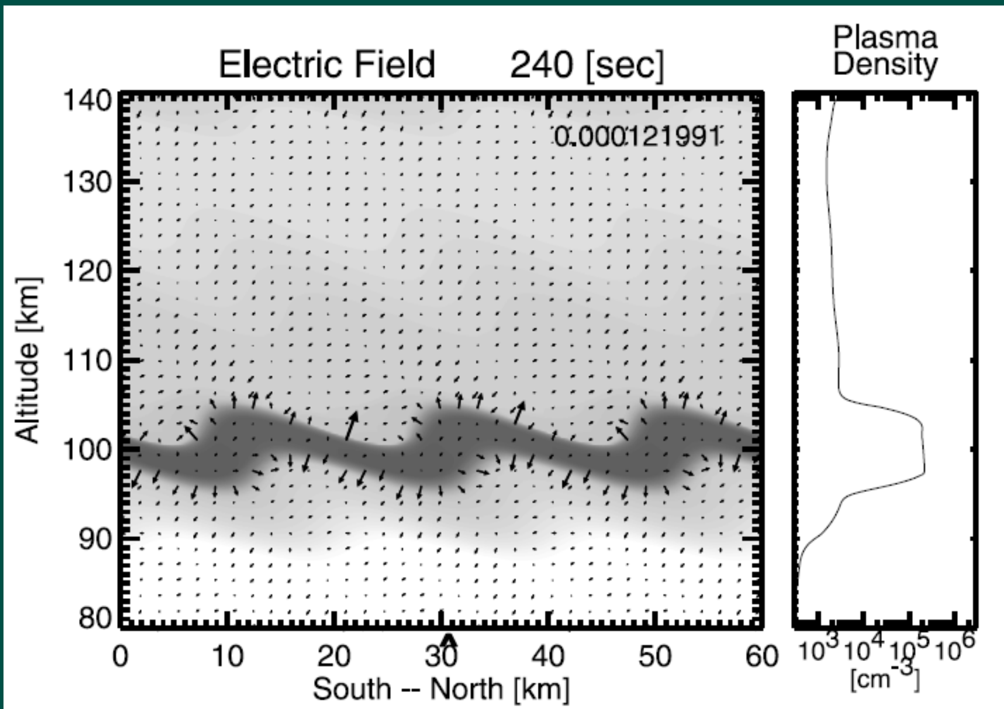
Issue to investigate:
What is variation of the elevation angle?

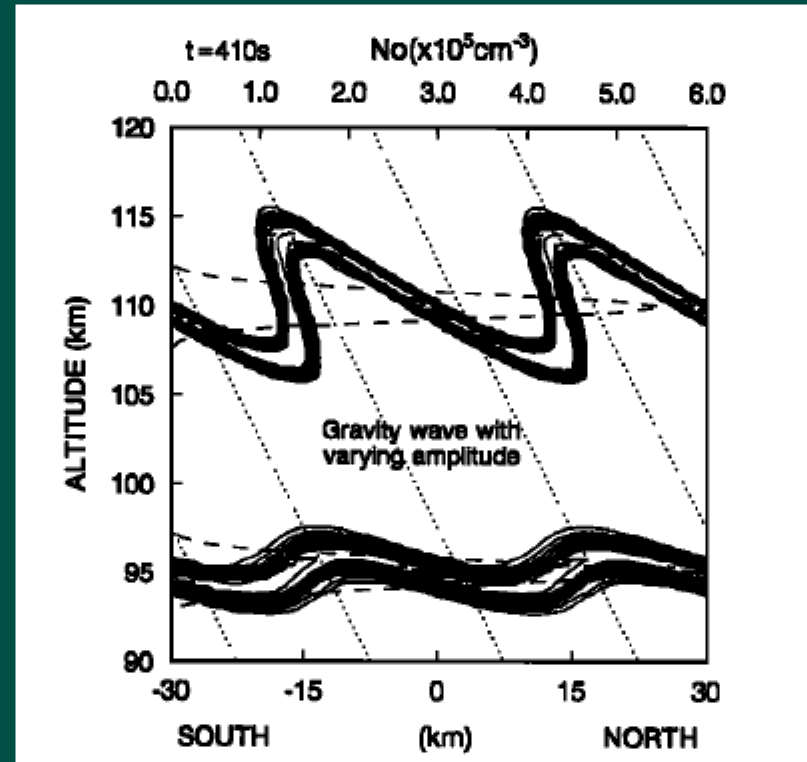


Measurements need to be "fixed".

Horizontally, angles are about the same, but not everywhere. In gates ~ 12-15, angles are different for the moments of velocity (or power) max and min.

Issue to investigate:
What is variation of the elevation angle?





Computer simulation of polarization electric fields as a source of midlatitude field-aligned irregularities

2003

T. Yokoyama, M. Yamamoto, and S. Fukao

Numerical simulations of gravity wave modulation of midlatitude sporadic *E* layers

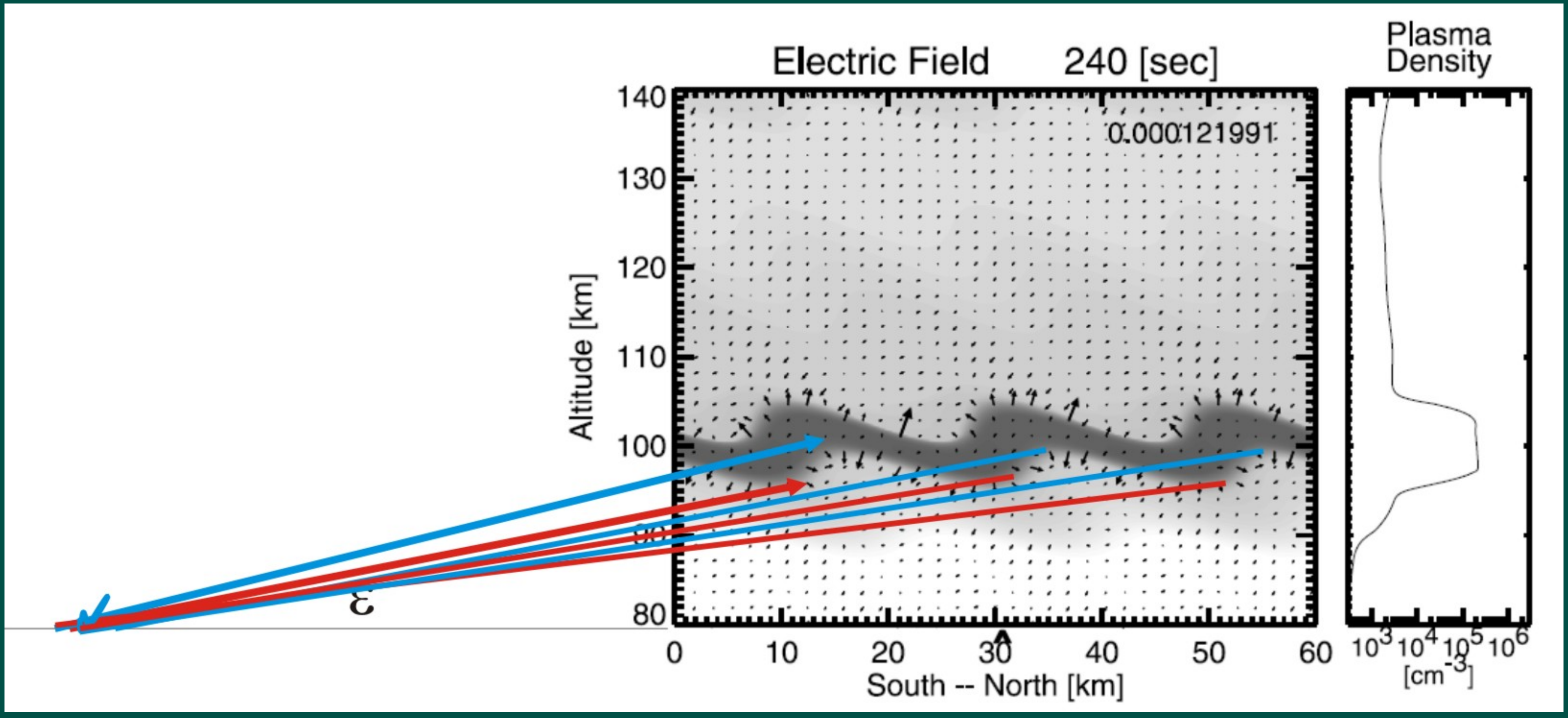
1995

Chao-Song Huang[1] and Michael C. Kelley

University of Saskatchewan

Issue to investigate:

What is variation of the elevation angle?



Hokkaido data show:

1) **ε decrease with range**
2) **ε variation (might be), from striation max to striation min. If this is the case, the Hokkaido elevation data are suggesting modulation of the Es height! Ogawa et al., 2002 reported observations with no modulation**

Interesting news for me

1. No FB waves

2. Near noon summer maximum of echo occurrence

3. Velocity of E and F region echoes are nearly the same

4. Saturation in P(V) dependence at such low velocities

4. Width is often proportional to velocity

5. Is there any aspect angle effect for Hokkaido echoes?

Thank you for attention

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