

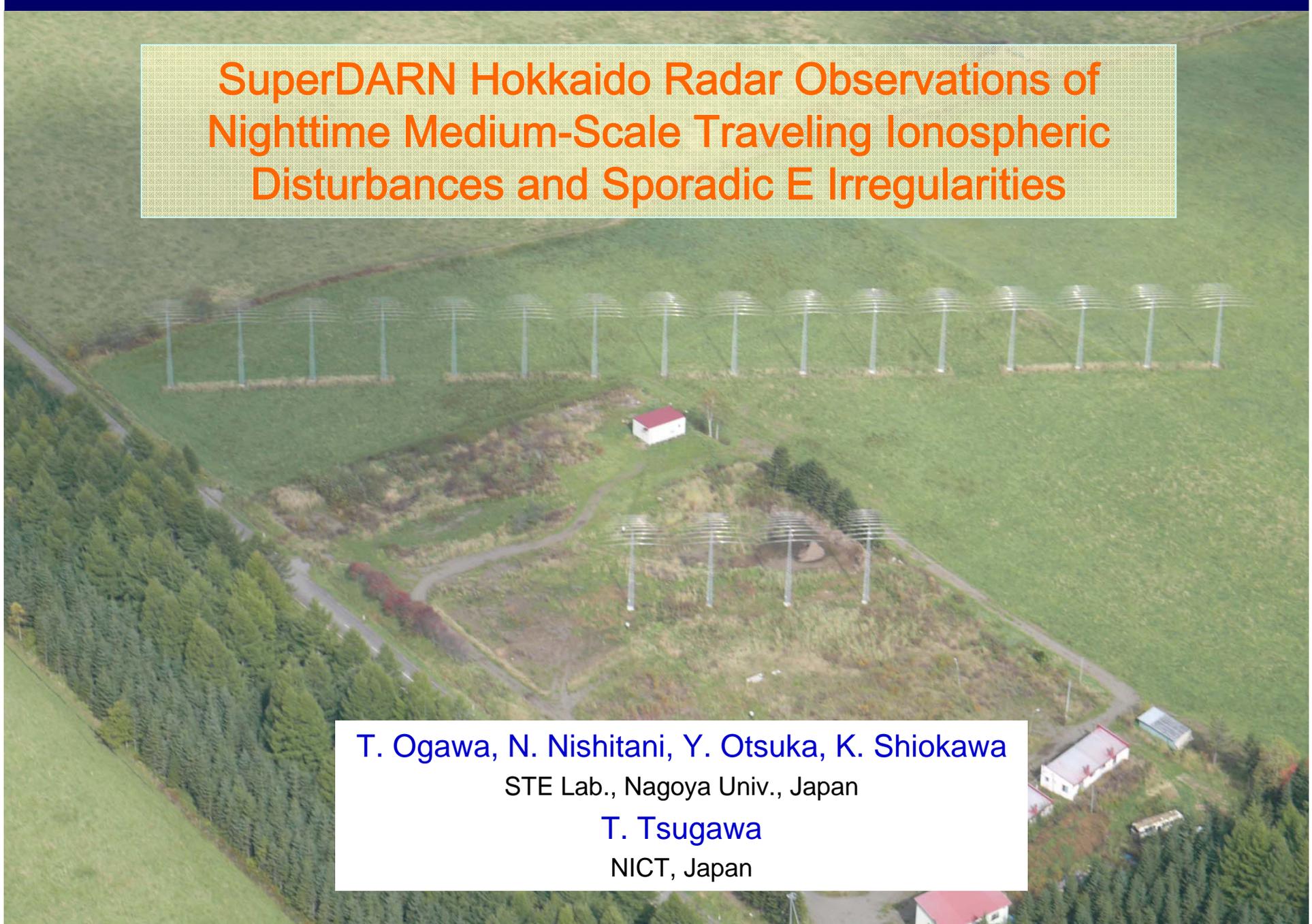
SuperDARN Hokkaido Radar Observations of Nighttime Medium-Scale Traveling Ionospheric Disturbances and Sporadic E Irregularities

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STE Lab., Nagoya Univ., Japan

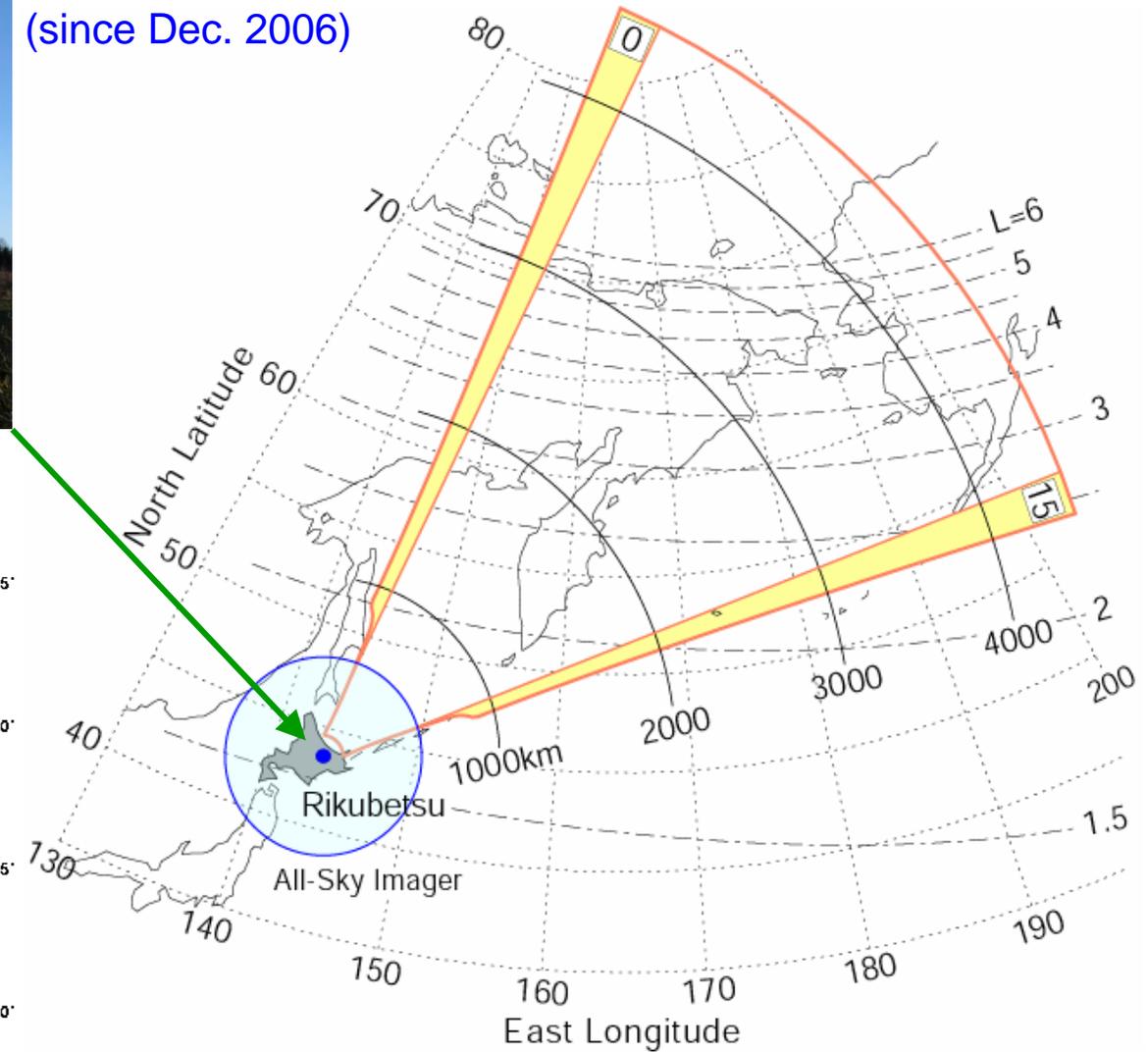
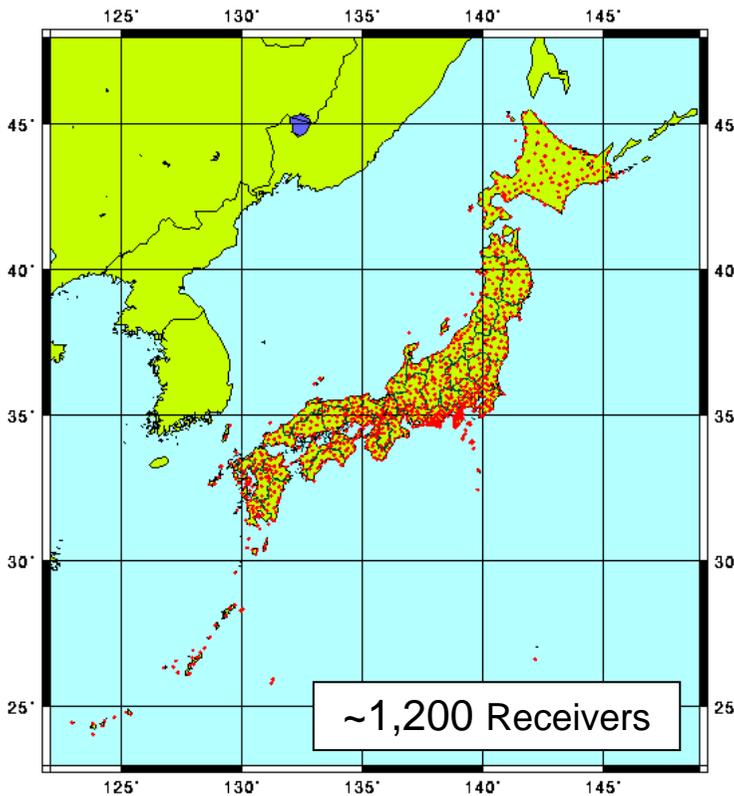
T. Tsugawa

NICT, Japan





SuperDARN
Hokkaido Radar
(since Dec. 2006)



Rikubetsu (43.53°N , 143.61°E ; geomag. 36.46°N)

GPS Network (GEONET)

Example of MSTIDs

Winter

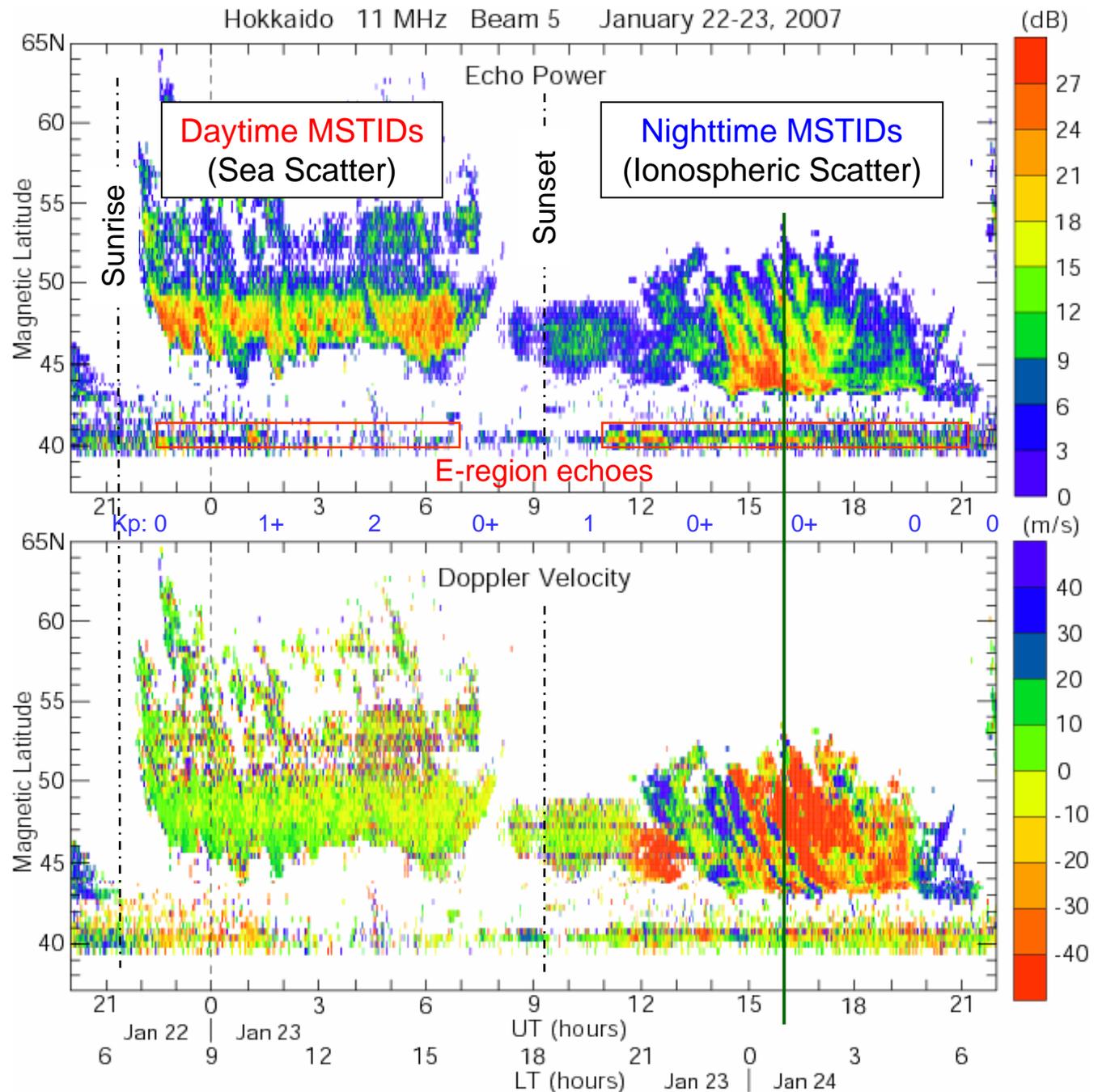
Daytime

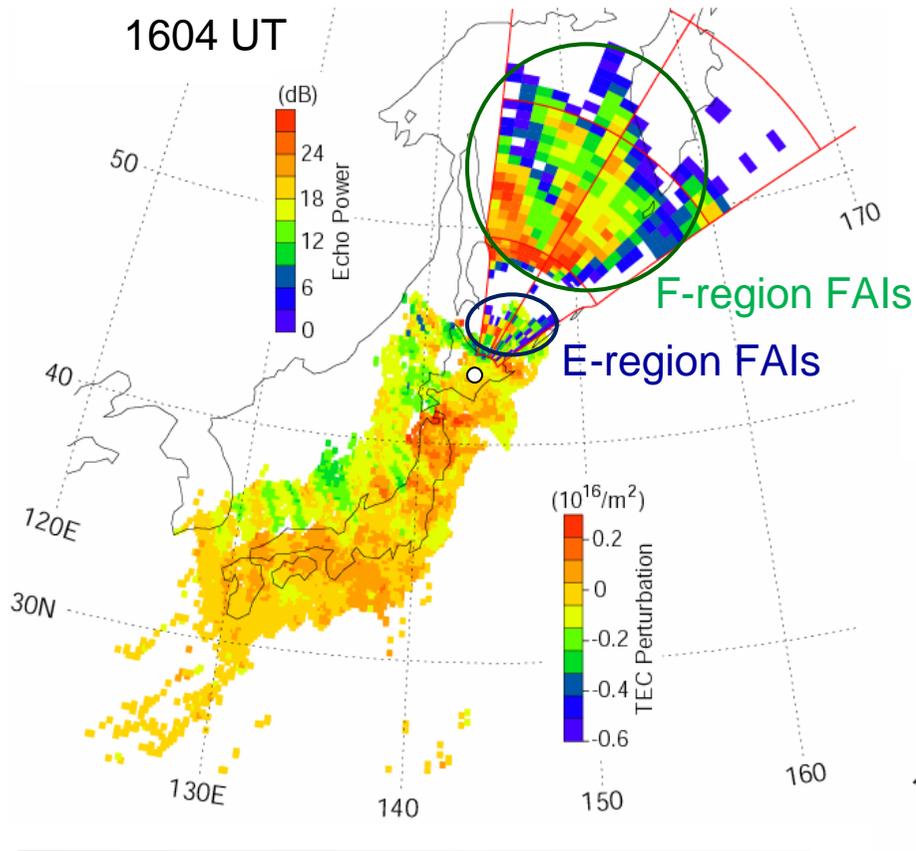
- Low Doppler velocity between ± 10 m/s
- Narrow spectral width (< 10 m/s)

Nighttime

- High Doppler velocity between ± 100 m/s
- Velocity modulation with periods between a few tens of minutes and a few hours
- Wide spectral width (< 50 m/s)

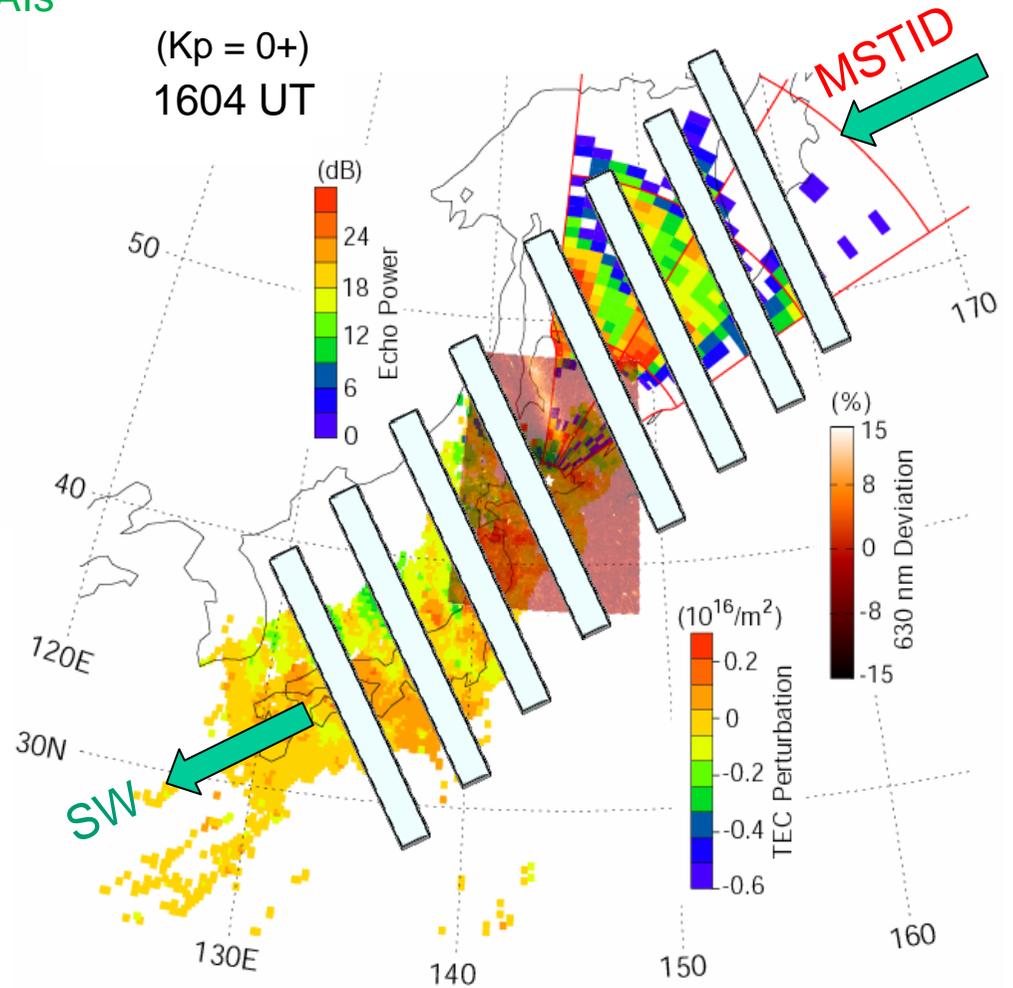
Accompanied by E-region echoes





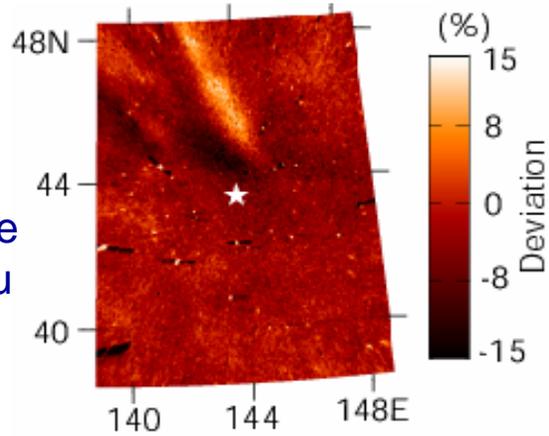
1604 UT January 23, 2007

Winter Night



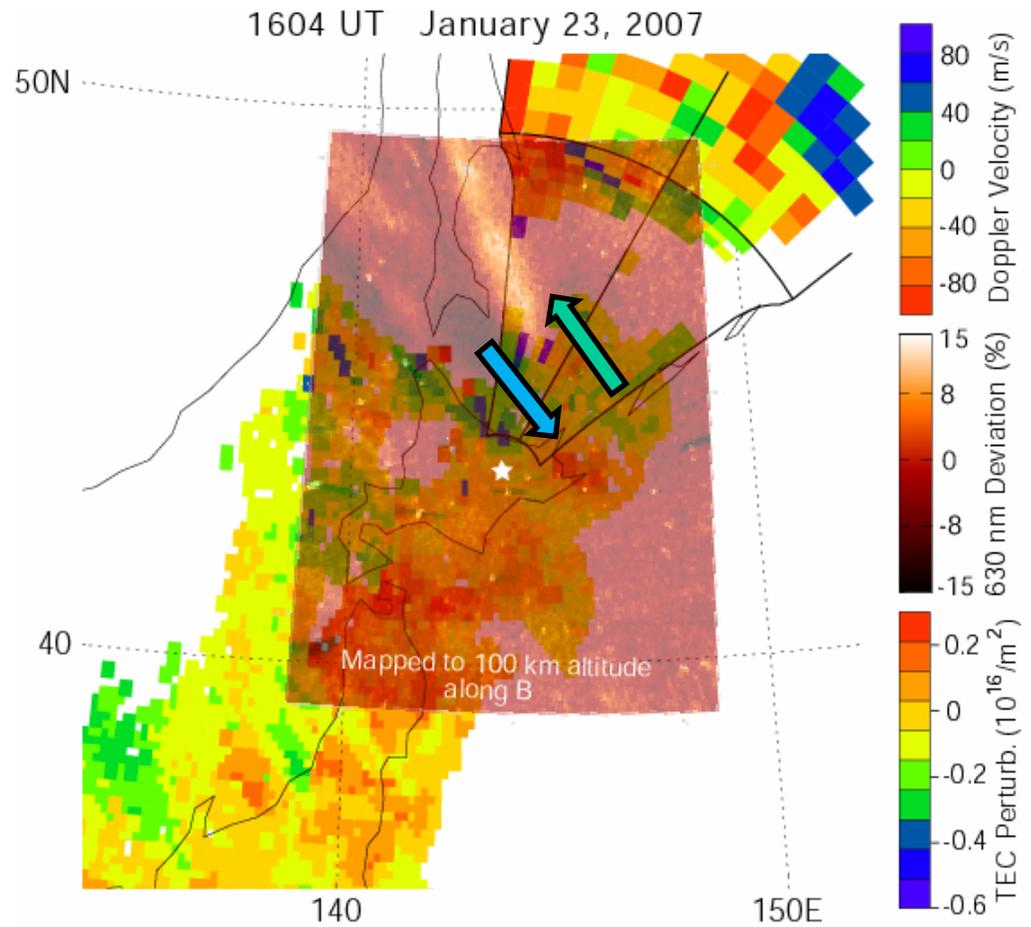
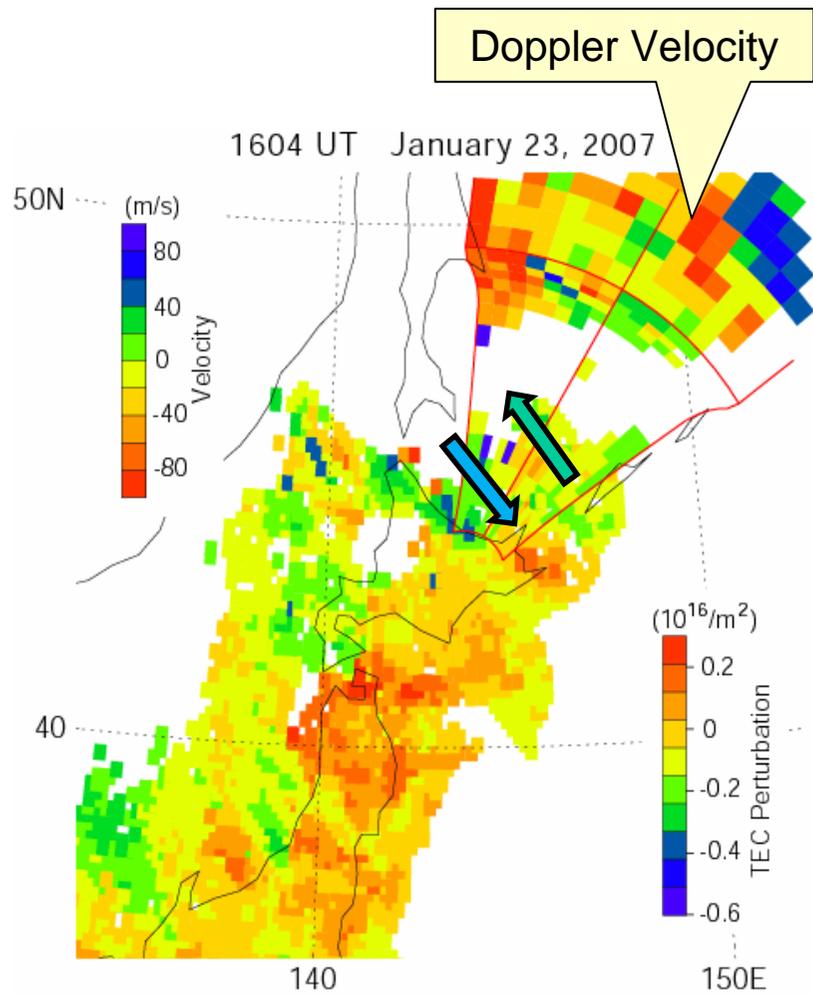
1603 UT

630-nm
all-sky image
at Rikubetsu



1604 UT January 23, 2007

Winter Night

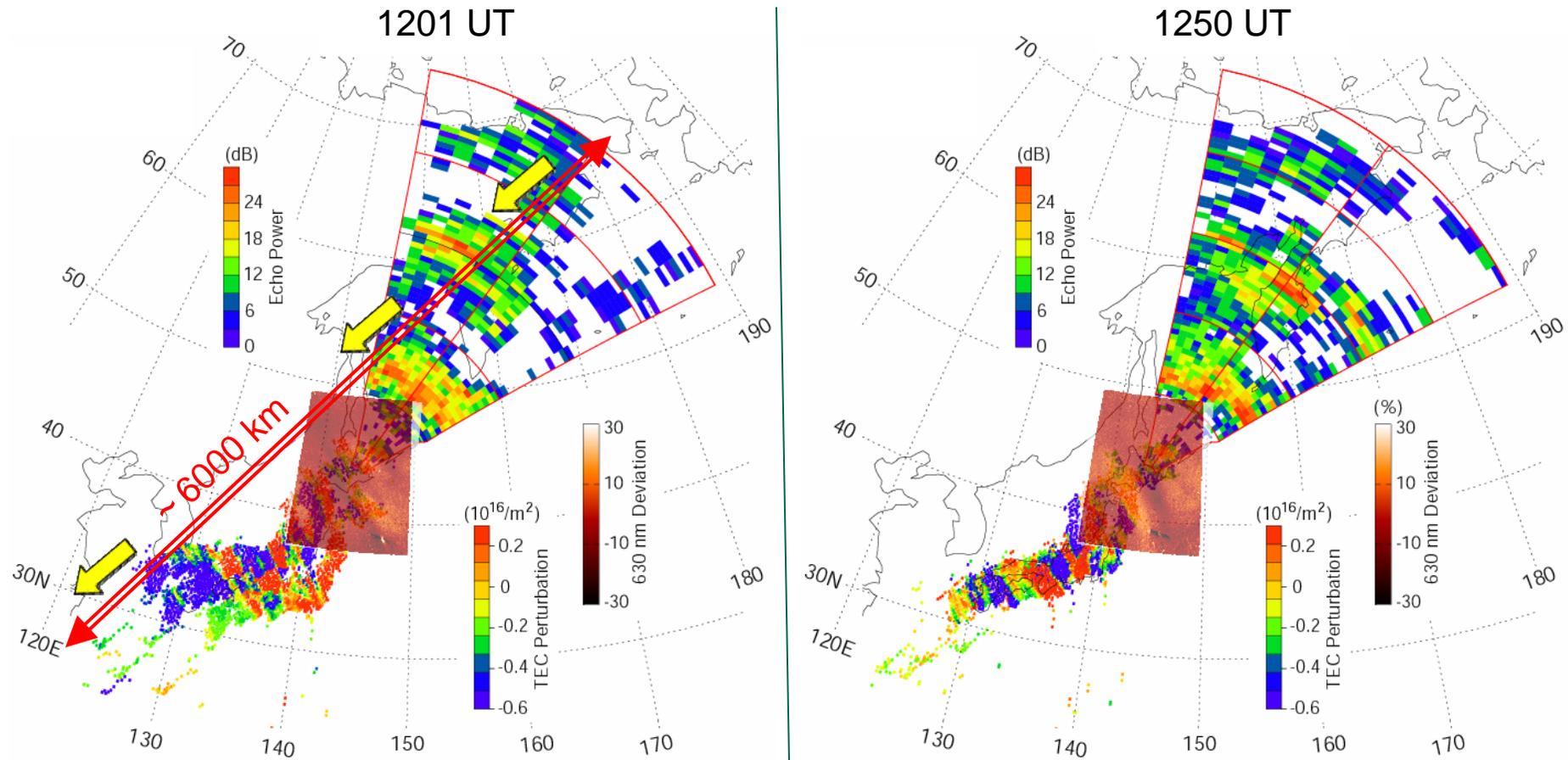


E-region plasma drifts align along phase fronts of airglow and TEC perturbations.

Summer
Night

Long-Distance Propagation of Nighttime MSTIDs

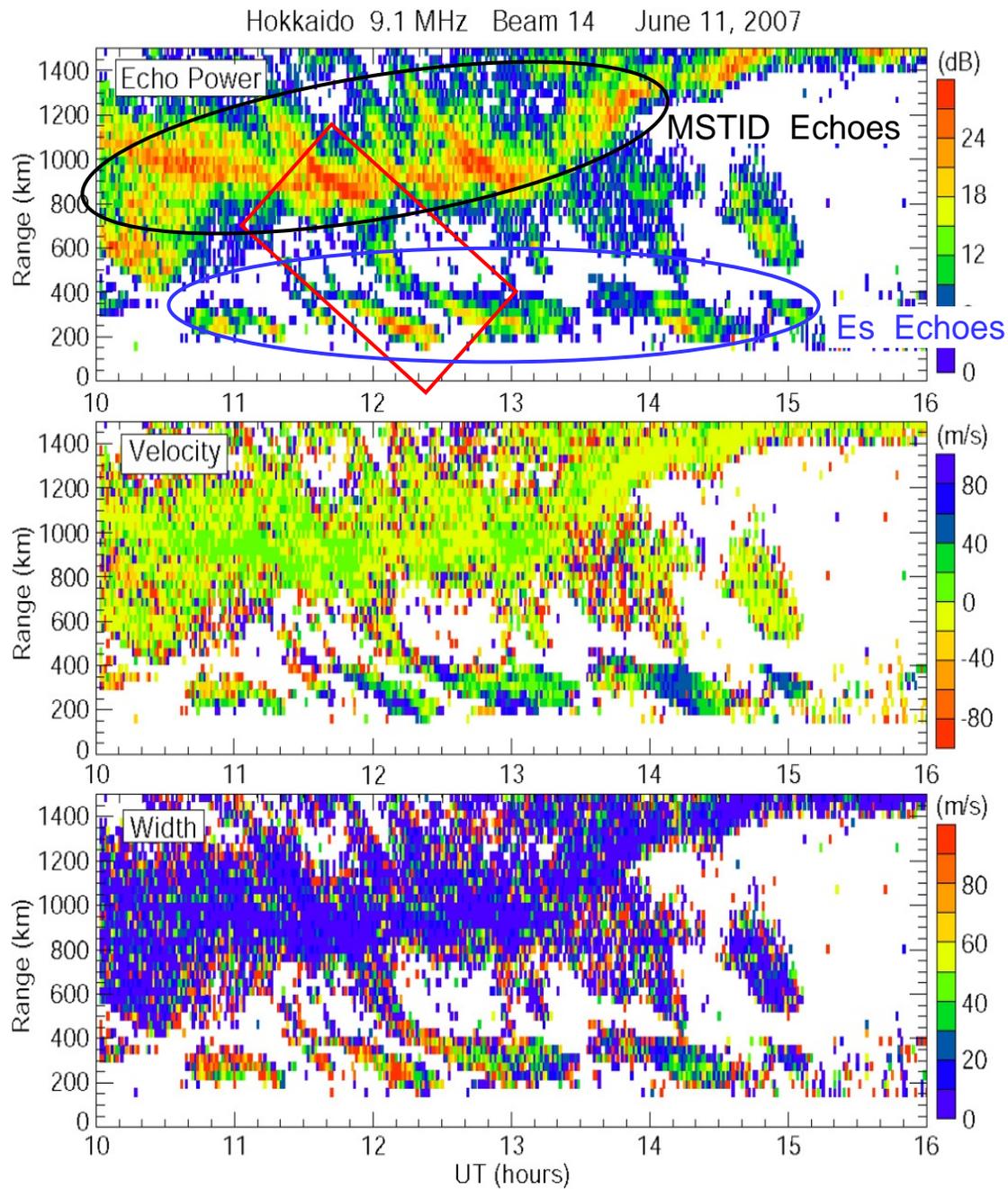
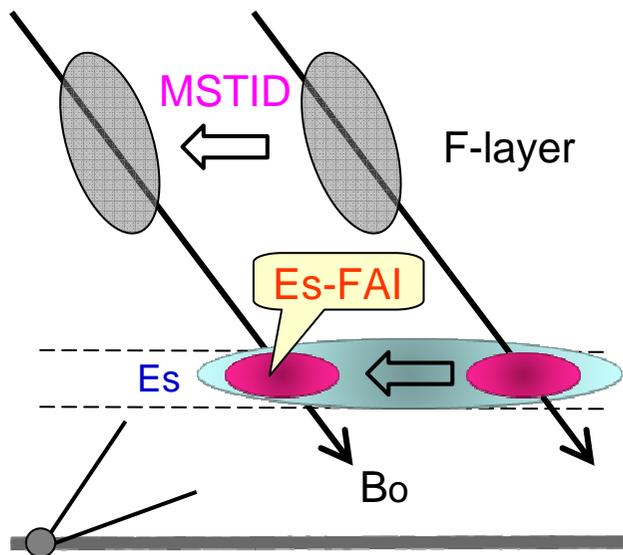
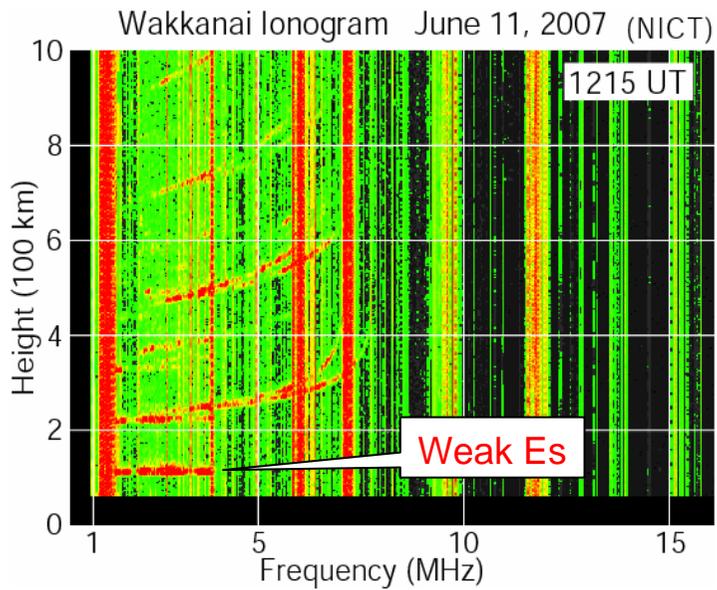
June 11, 2007 (Kp: 1 0 0+ 0+ 0+ 1 1- 1 5-)

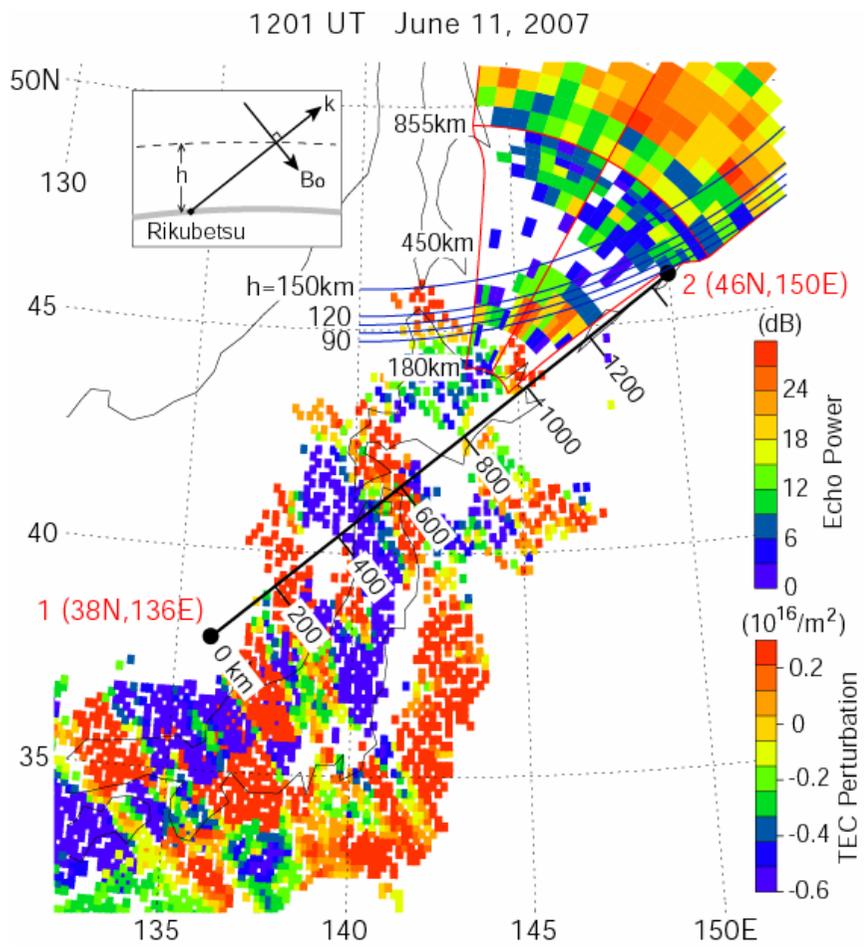


Nighttime MSTIDs, probably generated at high-latitudes, propagate southwestward through East Siberia, Kamchatk, the Sea of Okhotsk and Japan over 6000 km

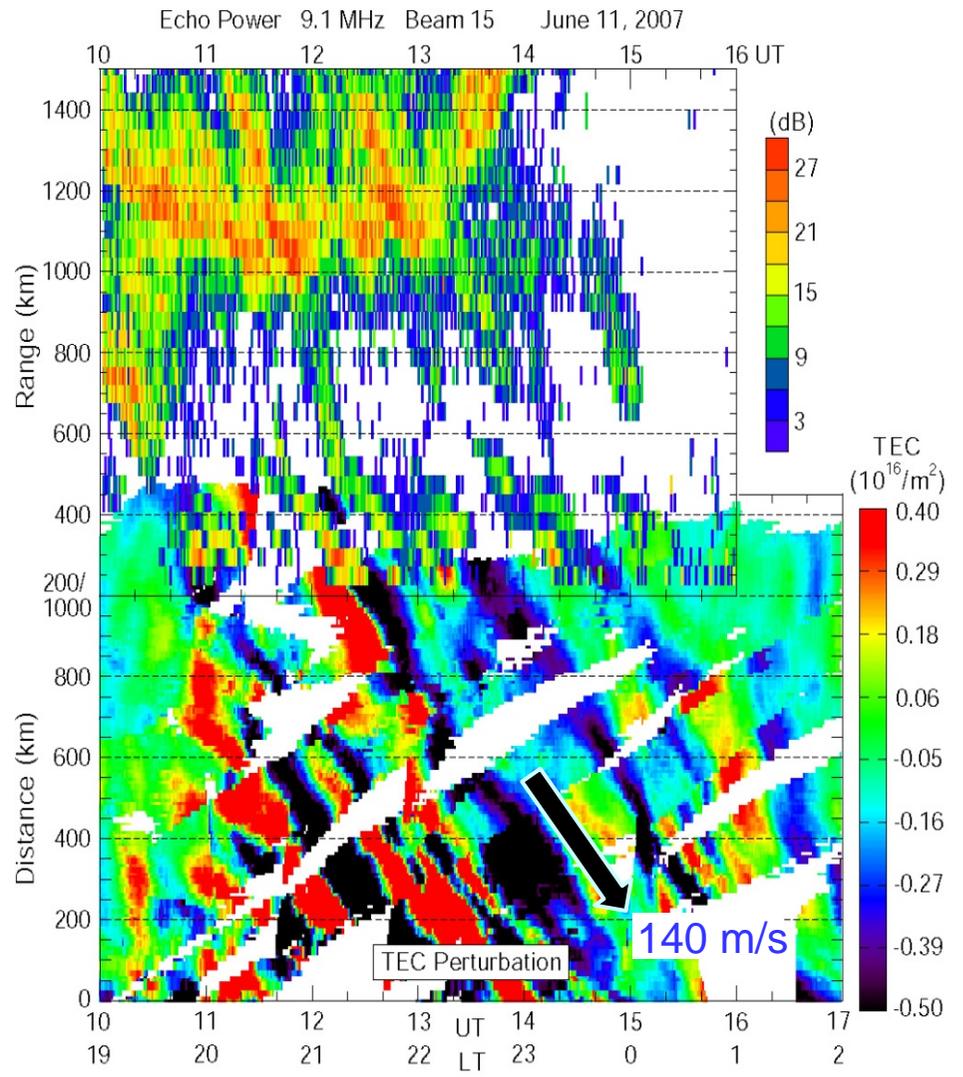
E- and F-Region Coupling

Summer Night



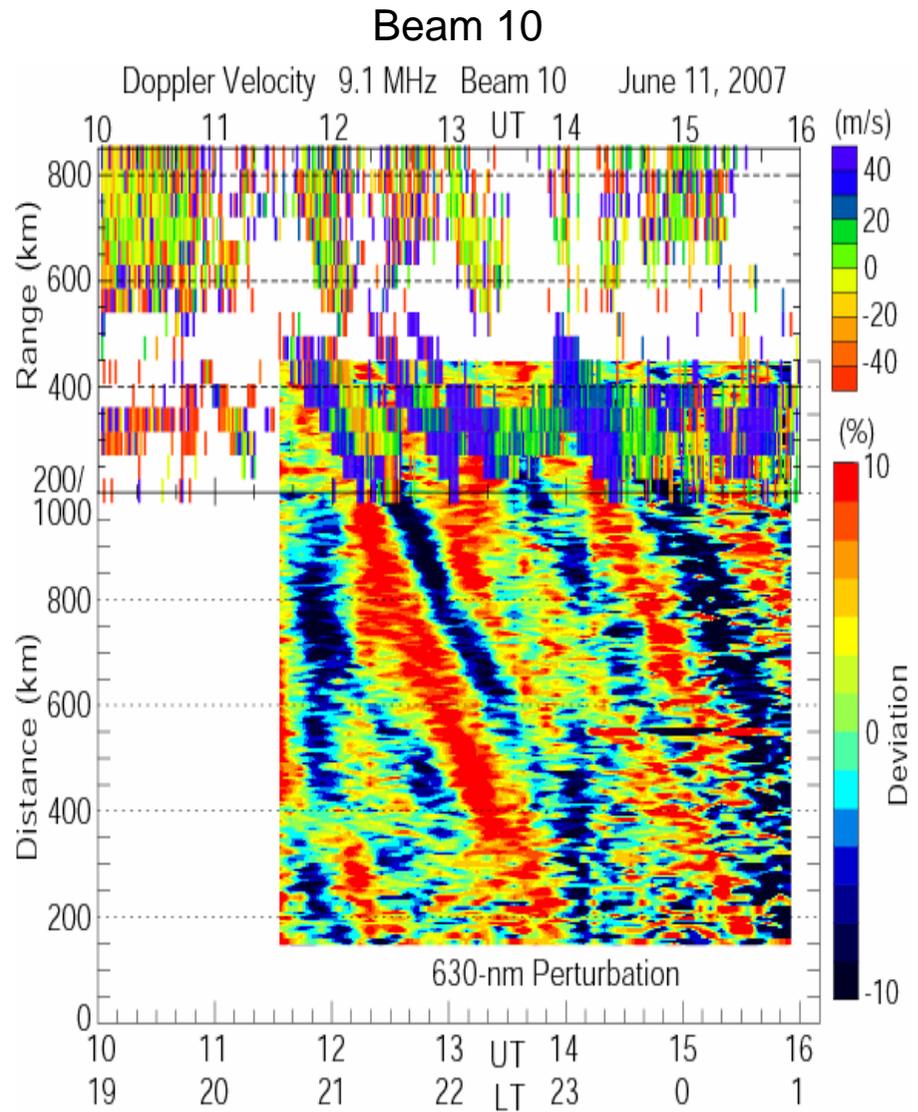
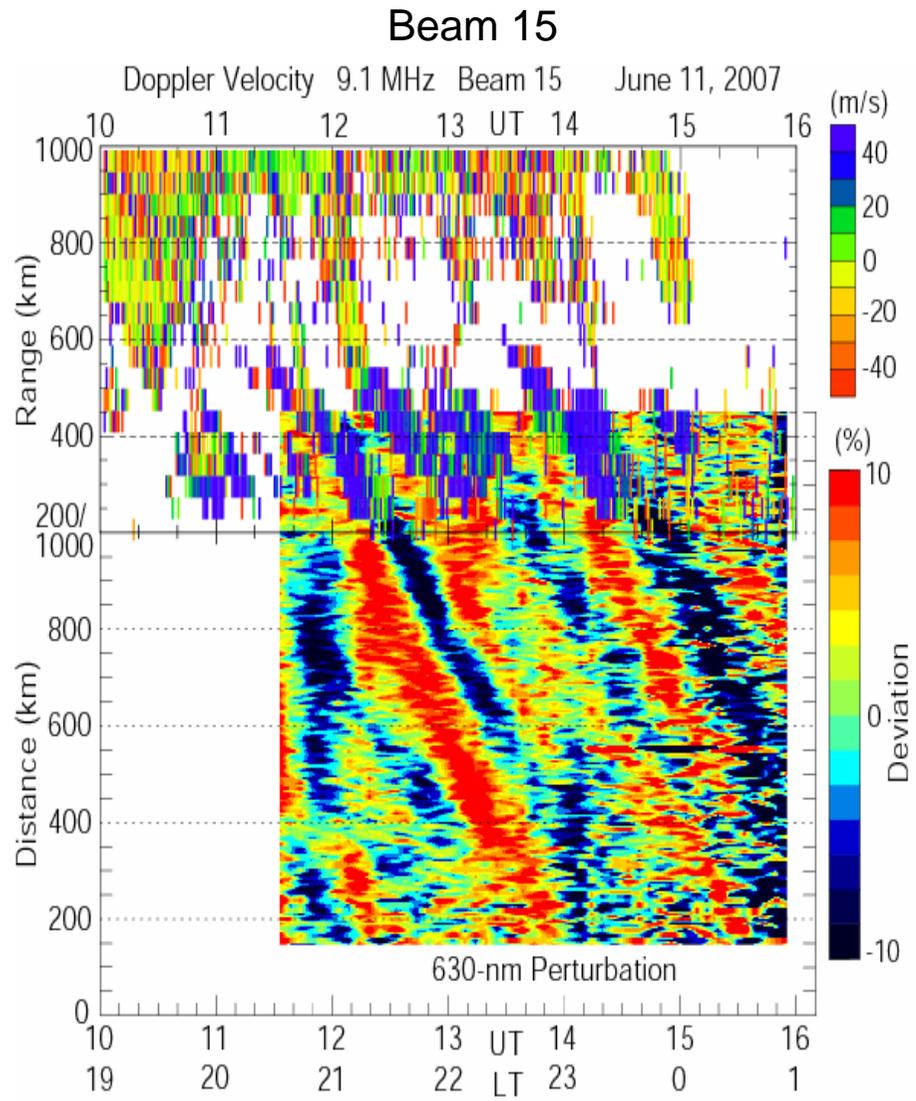


Keogram of echo power and TEC fluctuations along the oblique solid line

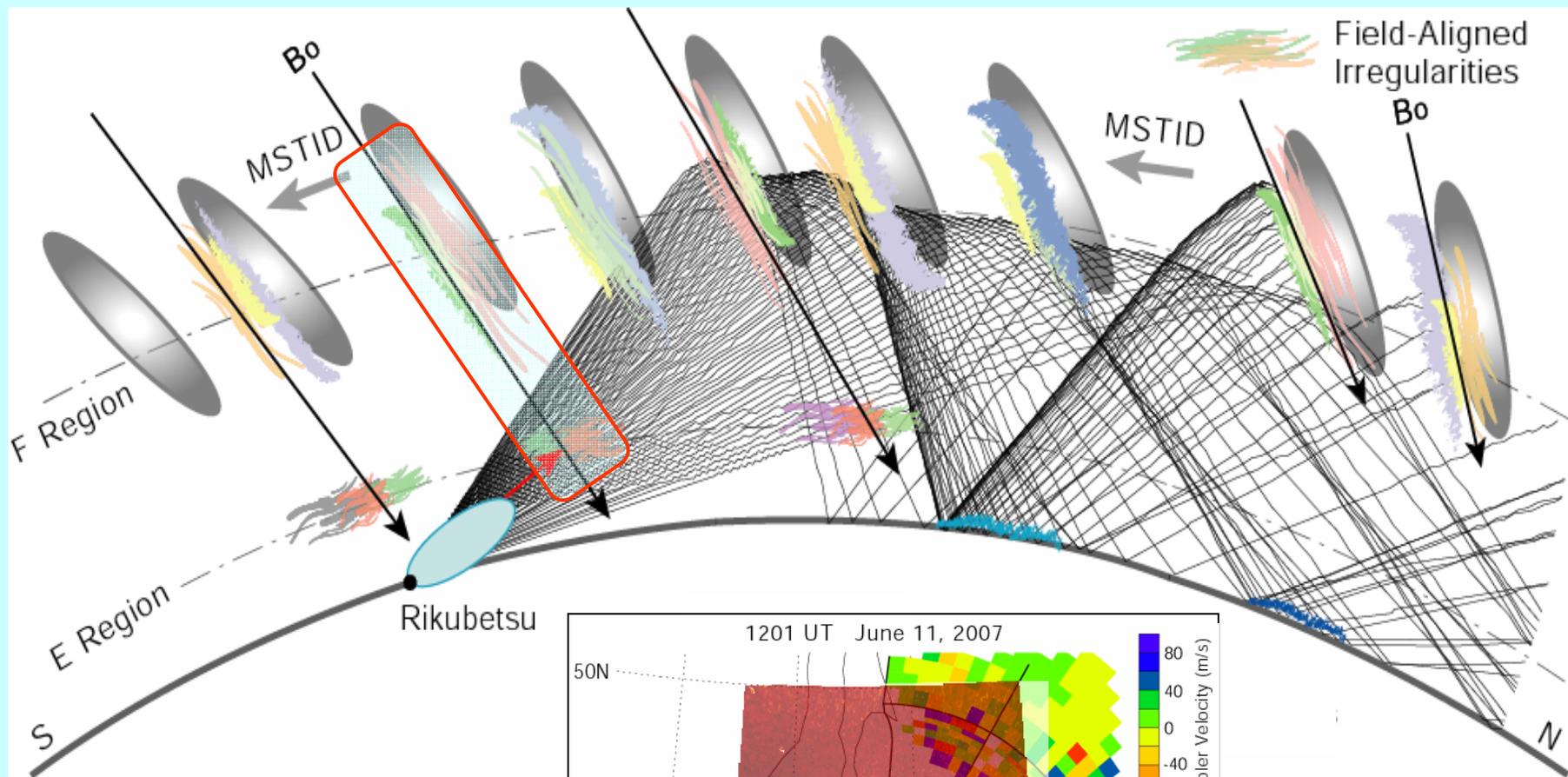


- Movement of E-region echo regions coincides well with that of TEC perturbations.
- E-region echo occurrence depends on the phase of TEC perturbations.

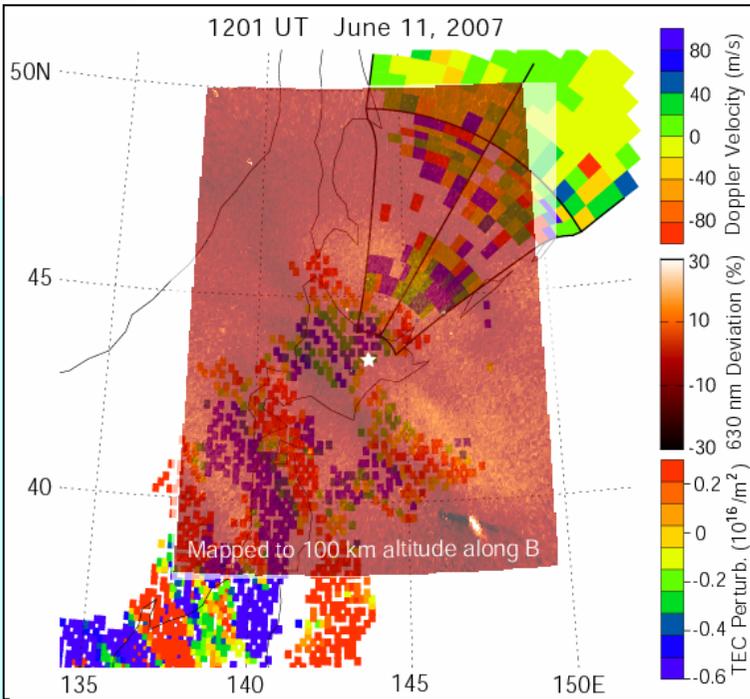
Keogram of Doppler velocity and 630-nm airglow fluctuations



Doppler velocity changes depending on the phase of airglow (also TEC) perturbations



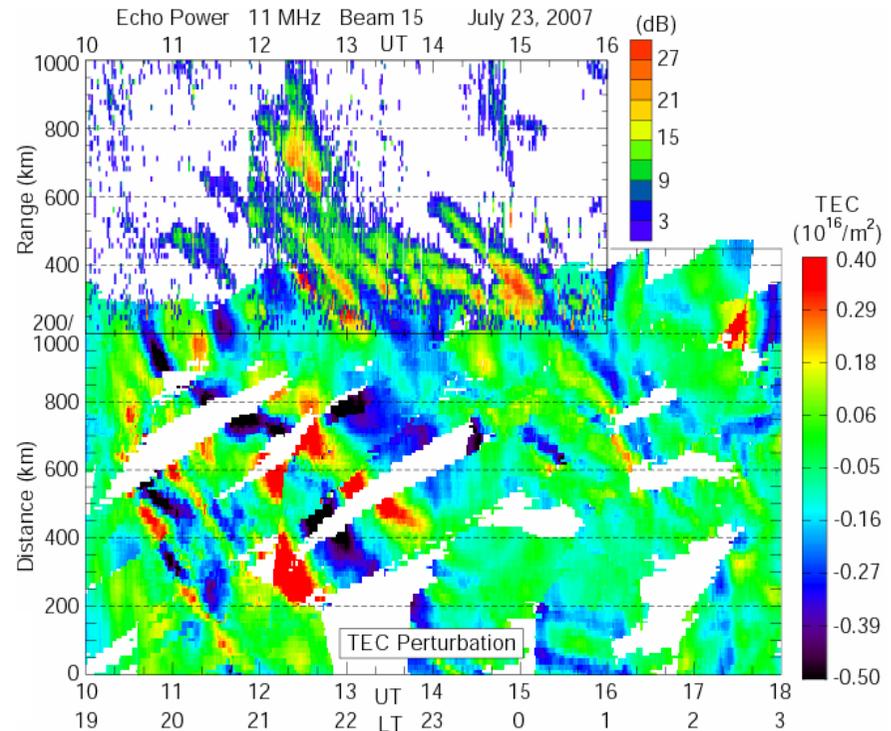
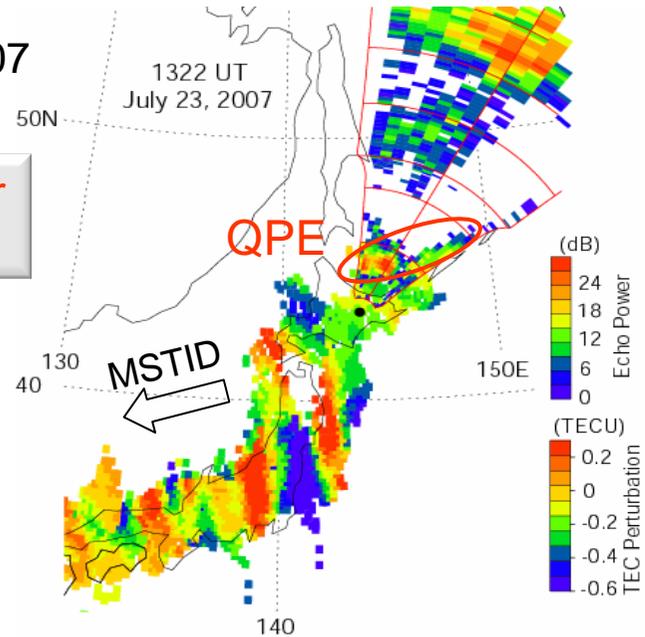
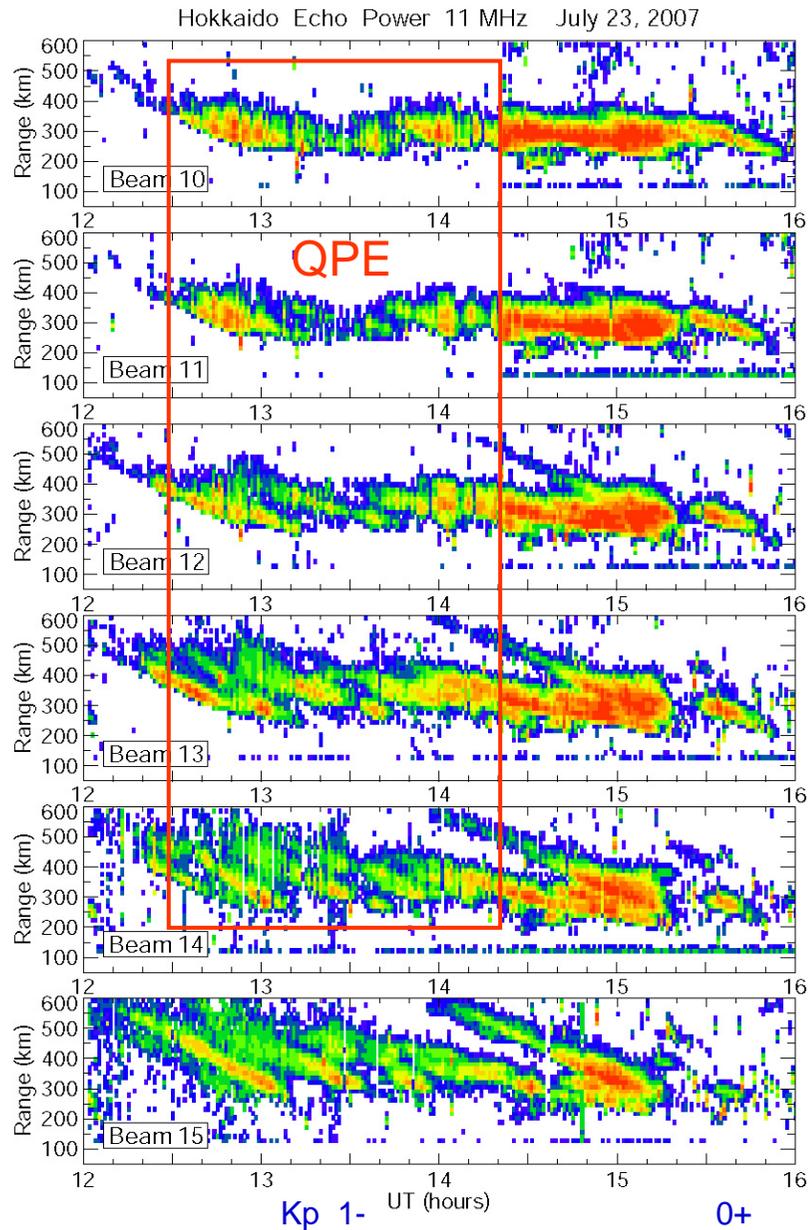
E- and F-Region Coupling at Night

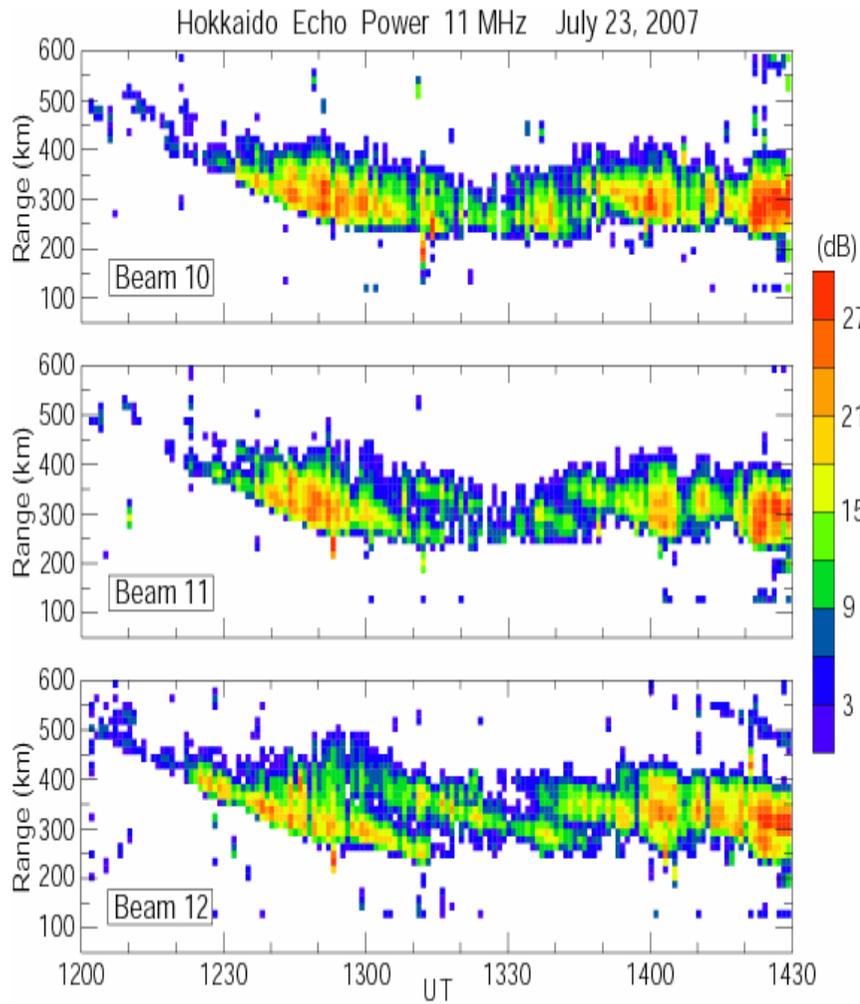


Quasi-Periodic Echoes due to MSTID-Associated Strong Es (foEs~7MHz)

July 23, 2007

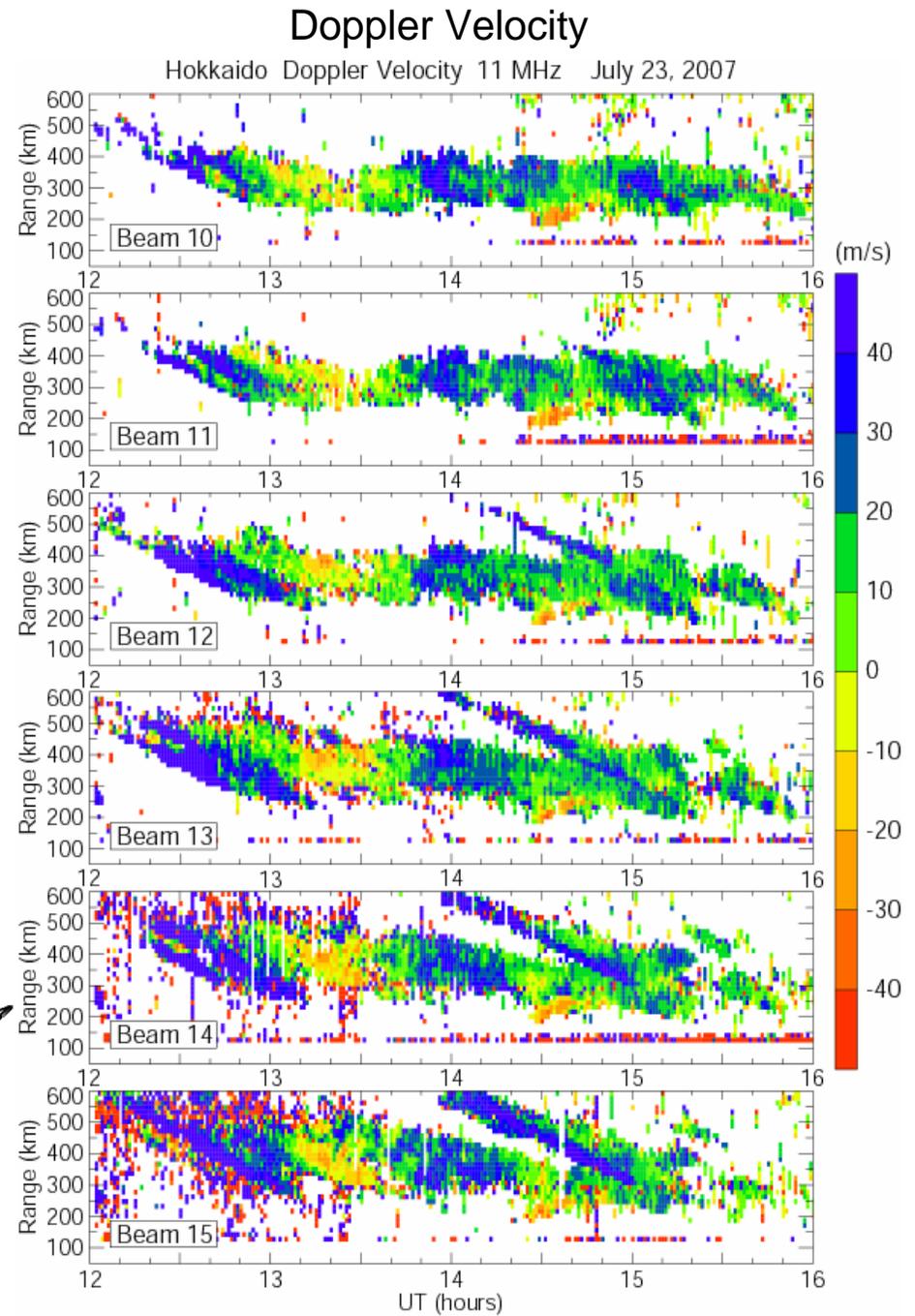
Summer Night





Periods of a few to 10 min

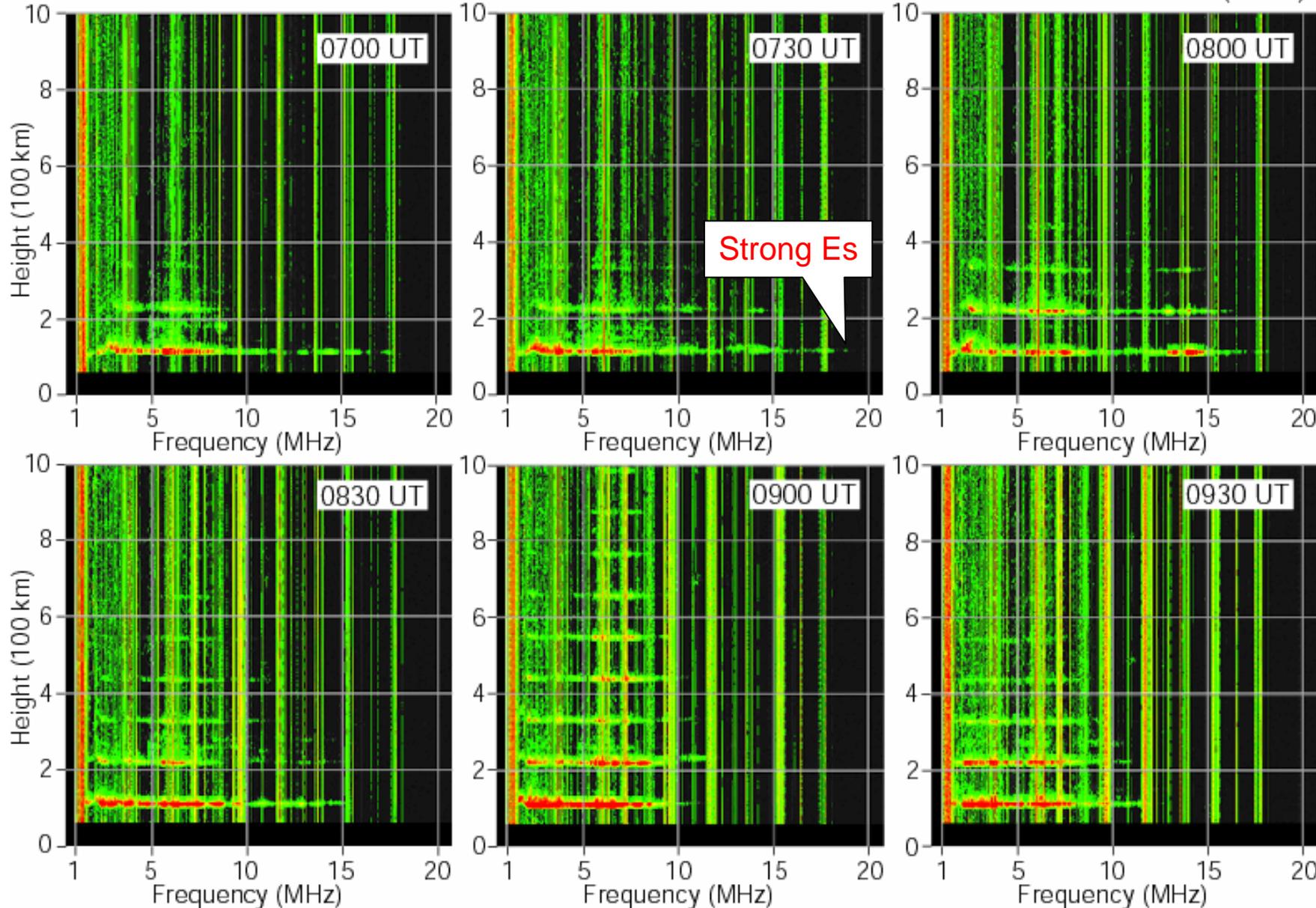
Velocities are modulated with a period (about 40 min) of MSTIDs



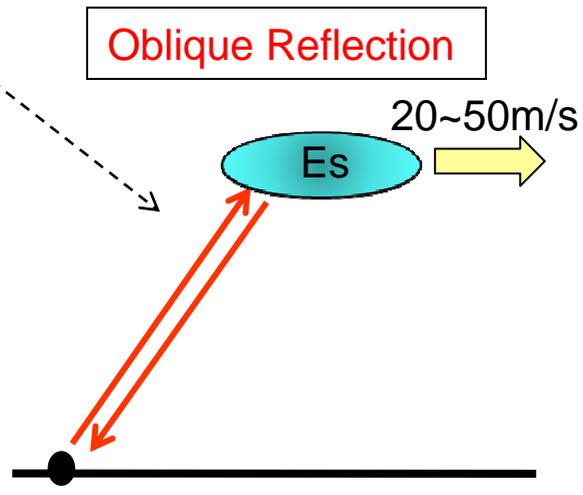
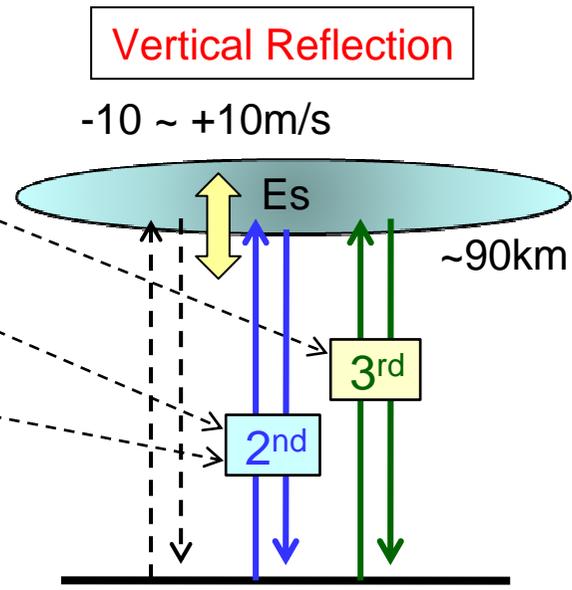
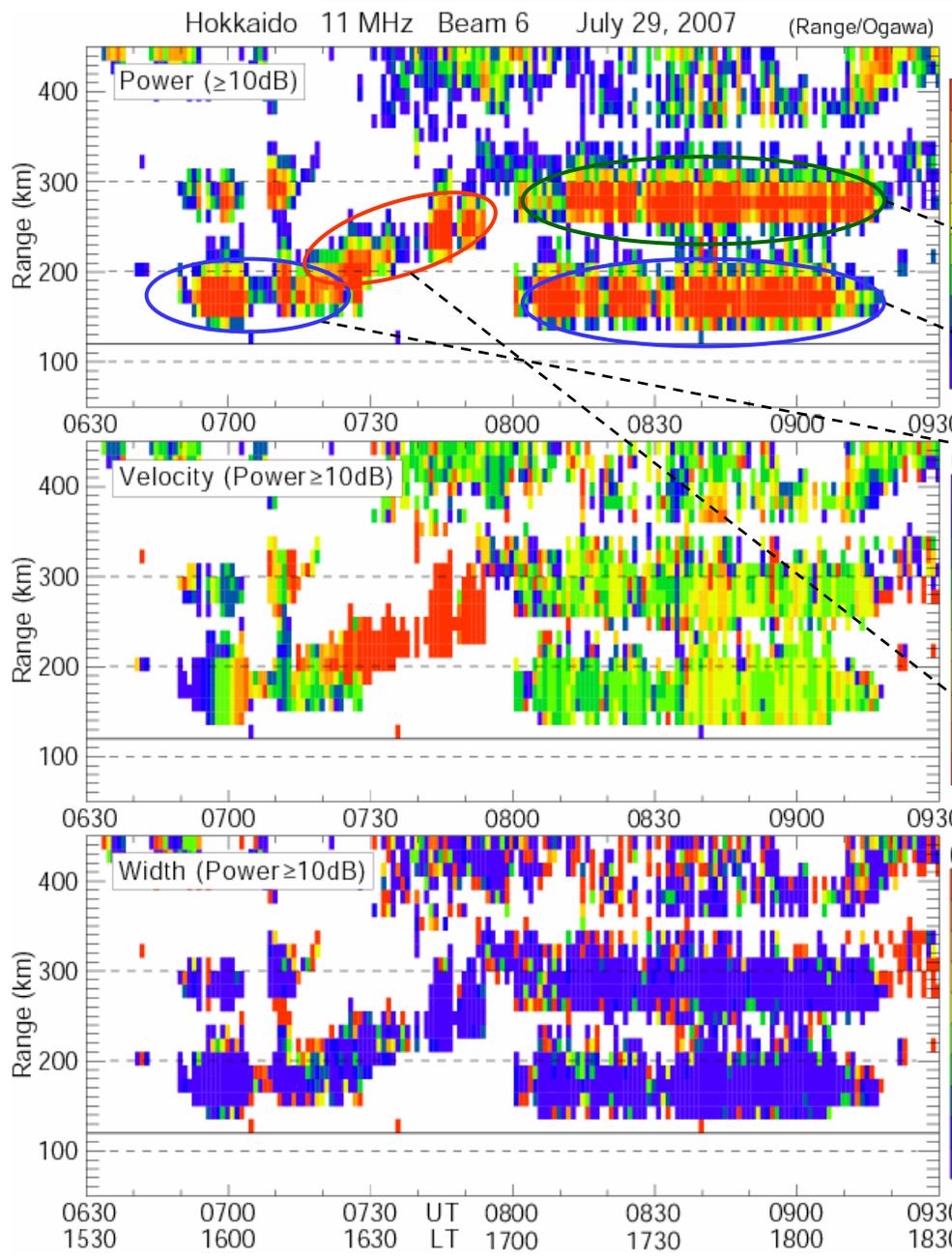
Summer Evening

Wakkanai Ionogram July 29, 2007

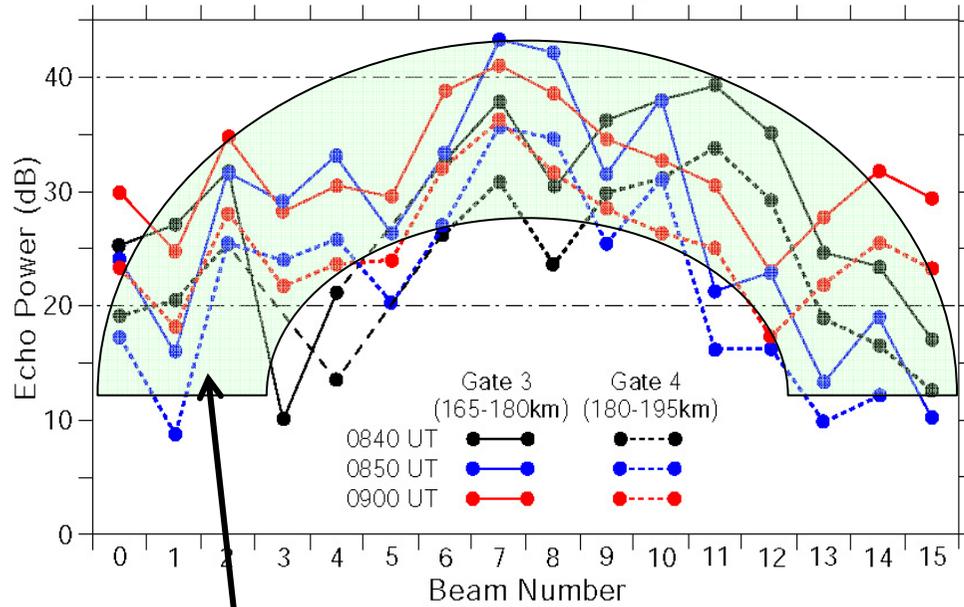
(NICT)



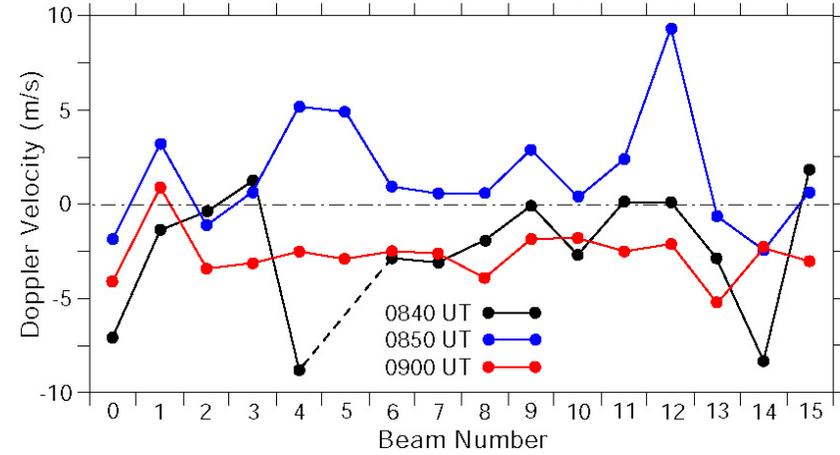
HF Reflection due to Very Intense Evening Es



Hokkaido 11 MHz July 29, 2007



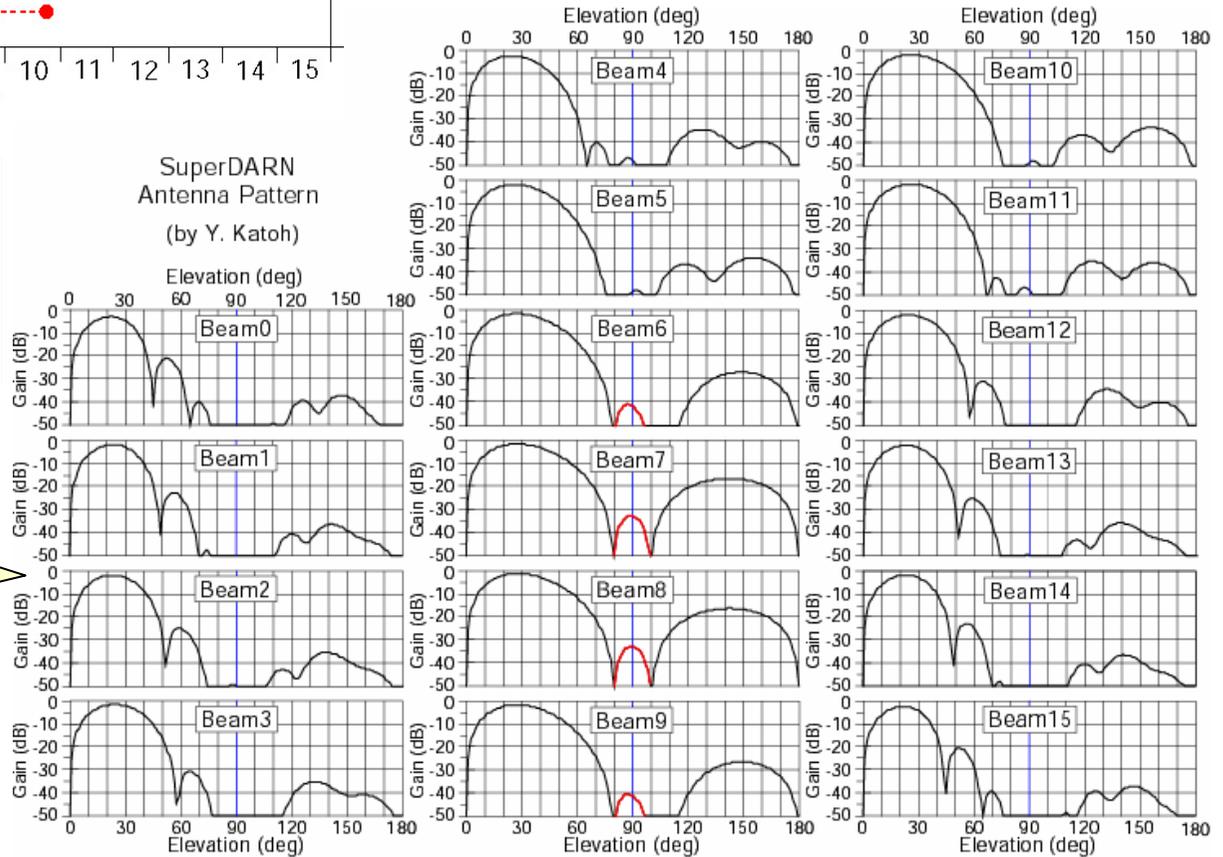
Hokkaido 11 MHz Gate 3 (165-180km) July 29, 2007

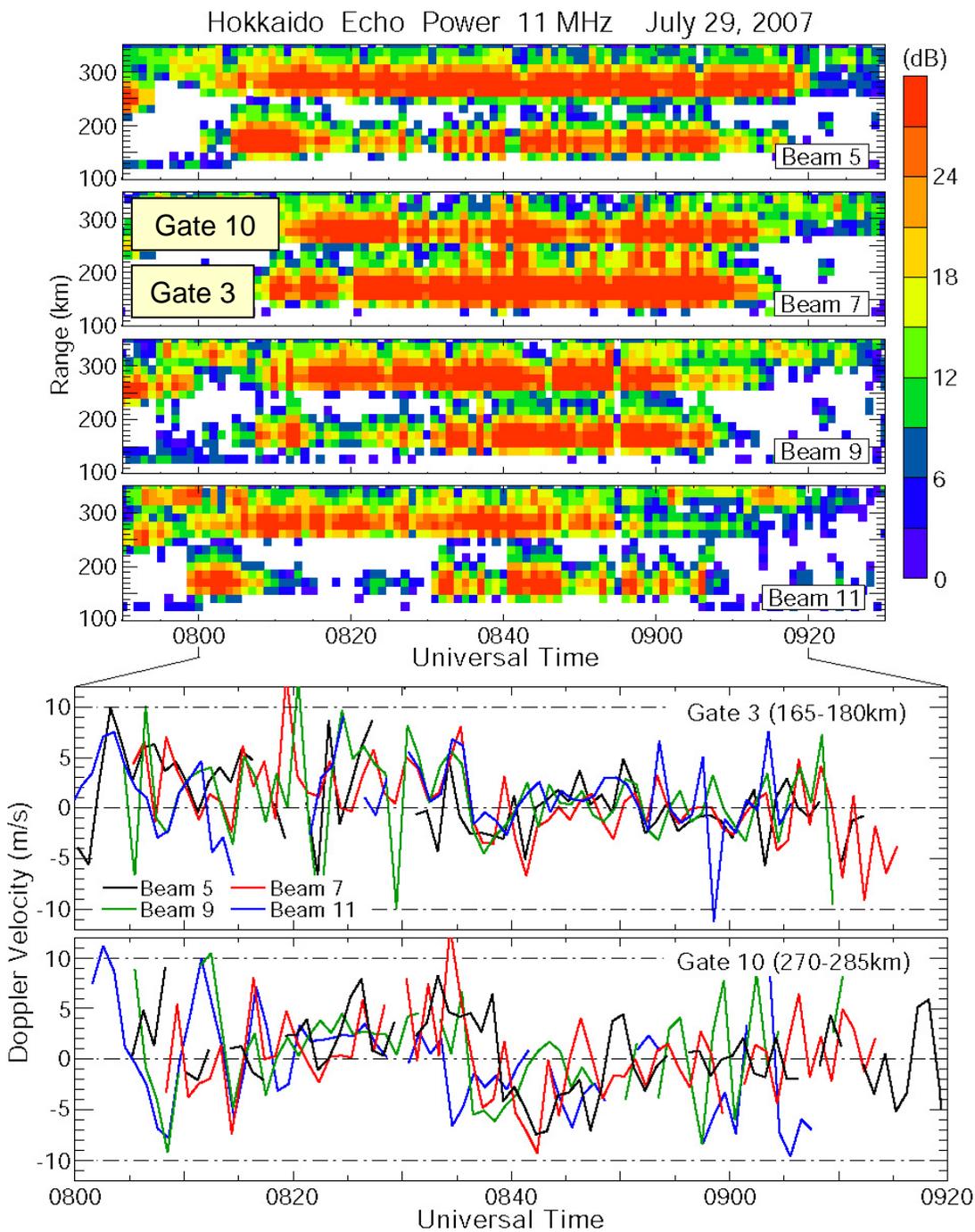


Power changes depending on beam number, in line with a beam number dependency of vertical antenna gain

SuperDARN Antenna Gain Pattern (Simulation)

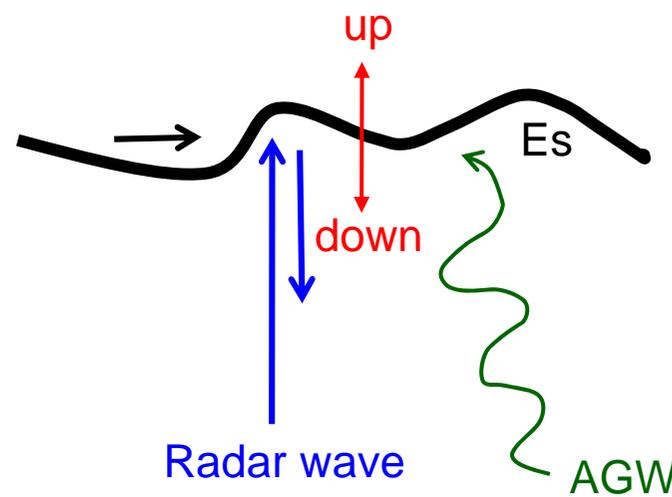
SuperDARN Antenna Pattern (by Y. Katoh)





Spatiotemporal variation of
Doppler velocity due to AGWs

Atmospheric Gravity Waves
(AGW)



Summary

- 1) Echoes from nighttime MSTIDs are due to F-region field-aligned irregularities (FAIs) and sea scatter.
- 2) Some nighttime MSTIDs, maybe generated at high-latitudes, propagate from Kamchatka to the southwest of Japan through Hokkaido over 6000 km or more. Such a feature is consistent with previous observations over Japan.
- 3) The radar can also observe nighttime and daytime coherent echoes from Es-FAIs to the northeast of Hokkaido.
- 4) In some cases, it observes echoes simultaneously from MSTIDs in the F-region and Es-FAIs. MSTID-associated echoes during the night can be closely related to Es-FAI echoes, suggesting a strong electrical coupling between the E- and F-region along the geomagnetic field. The existence of such coupling has been recently found over the central Japan.
- 5) Peculiar quasi-periodic echoes (QPE) from nighttime mid-latitude Es, first observed by the MU radar, were also detected by the Hokkaido radar. QPE are closely associated with MSTIDs.
- 6) Interestingly, the Hokkaido radar detected multiple Es reflection echoes under very strong Es conditions in summer.