Ionospheric electric field oscillation associated with sudden impulse seen by SuperDARN radars
SuperDARNによって観測されるSIに伴う電離圏電場変動

*Kouhei Iida[1], Nozomu Nishitani[1], Tomoaki Hori[1]

[1]Institute for Space-Earth Environmental Research, Nagoya University

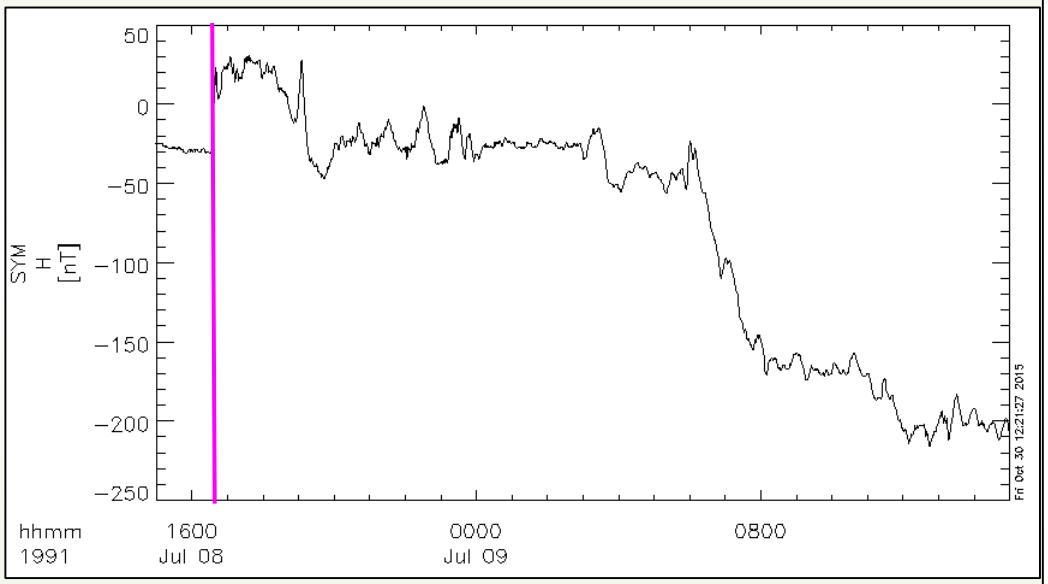
Sudden Impulse

quiet day

⇕

SI event day

Sudden Impulse (SI) is observed as a sudden increase of H-component often seen at low latitudes.



SYM-H index for July 8-9, 1991

Rapid compression of the magnetosphere caused by the passage of the interplanetary shock

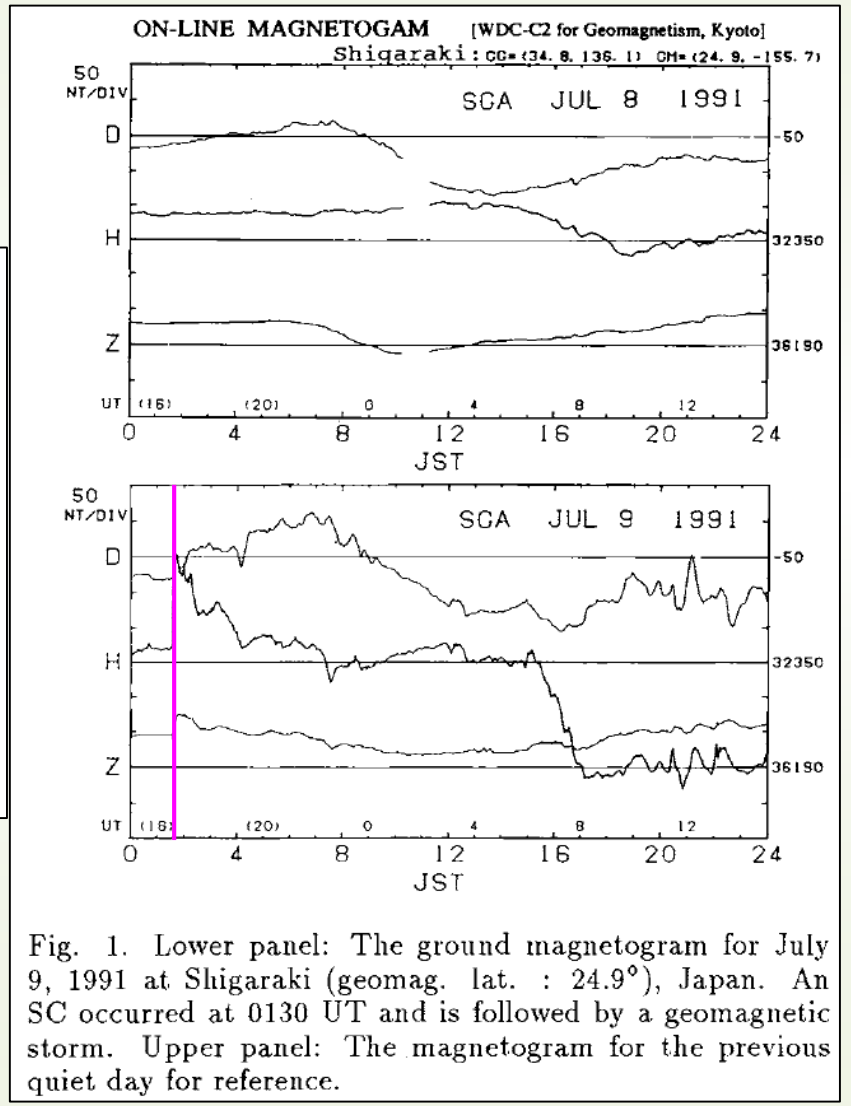
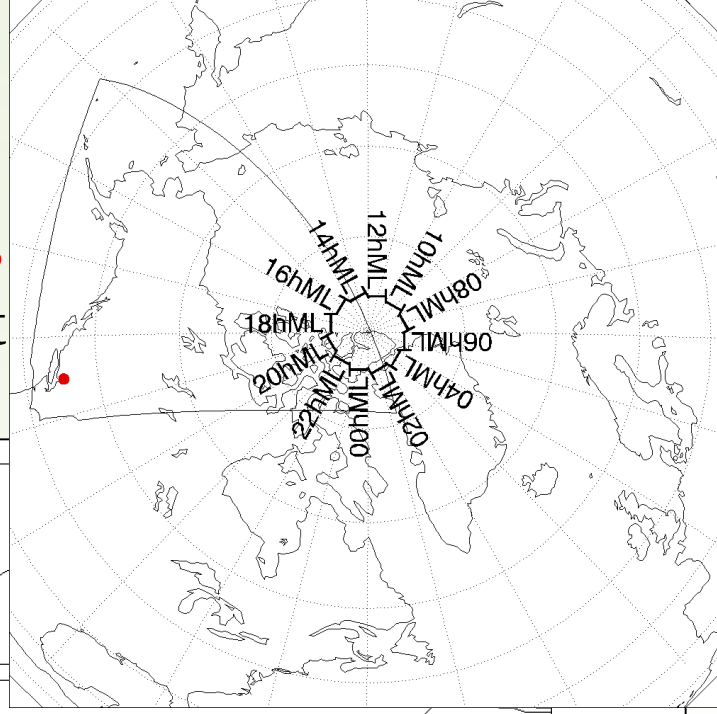


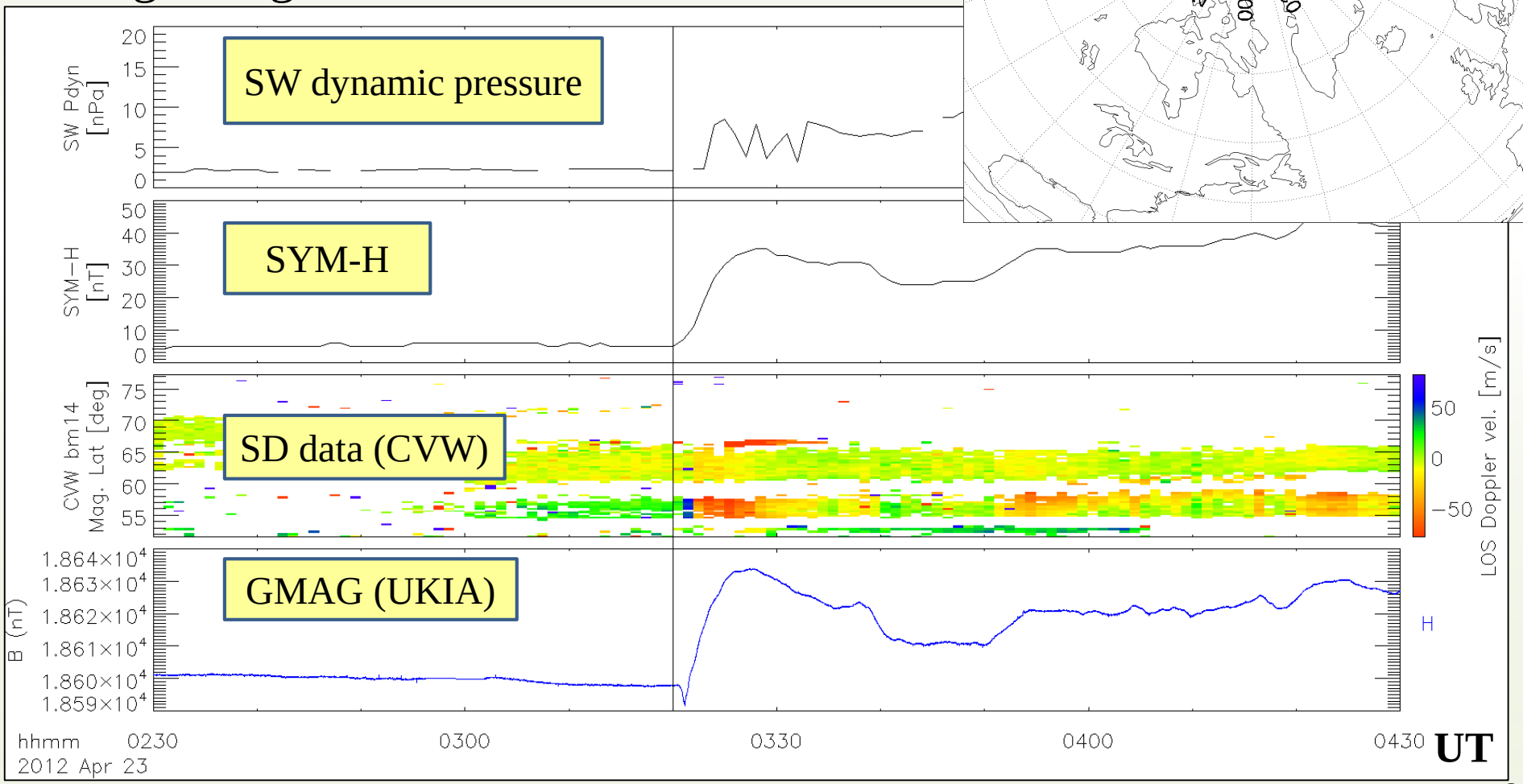
Fig. 1. Lower panel: The ground magnetogram for July 9, 1991 at Shigaraki (geomag. lat. : 24.9°), Japan. An SC occurred at 0130 UT and is followed by a geomagnetic storm. Upper panel: The magnetogram for the previous quiet day for reference.

[Araki, 1994]

- The typical reaction of SIs in the auroral and mid-latitudes

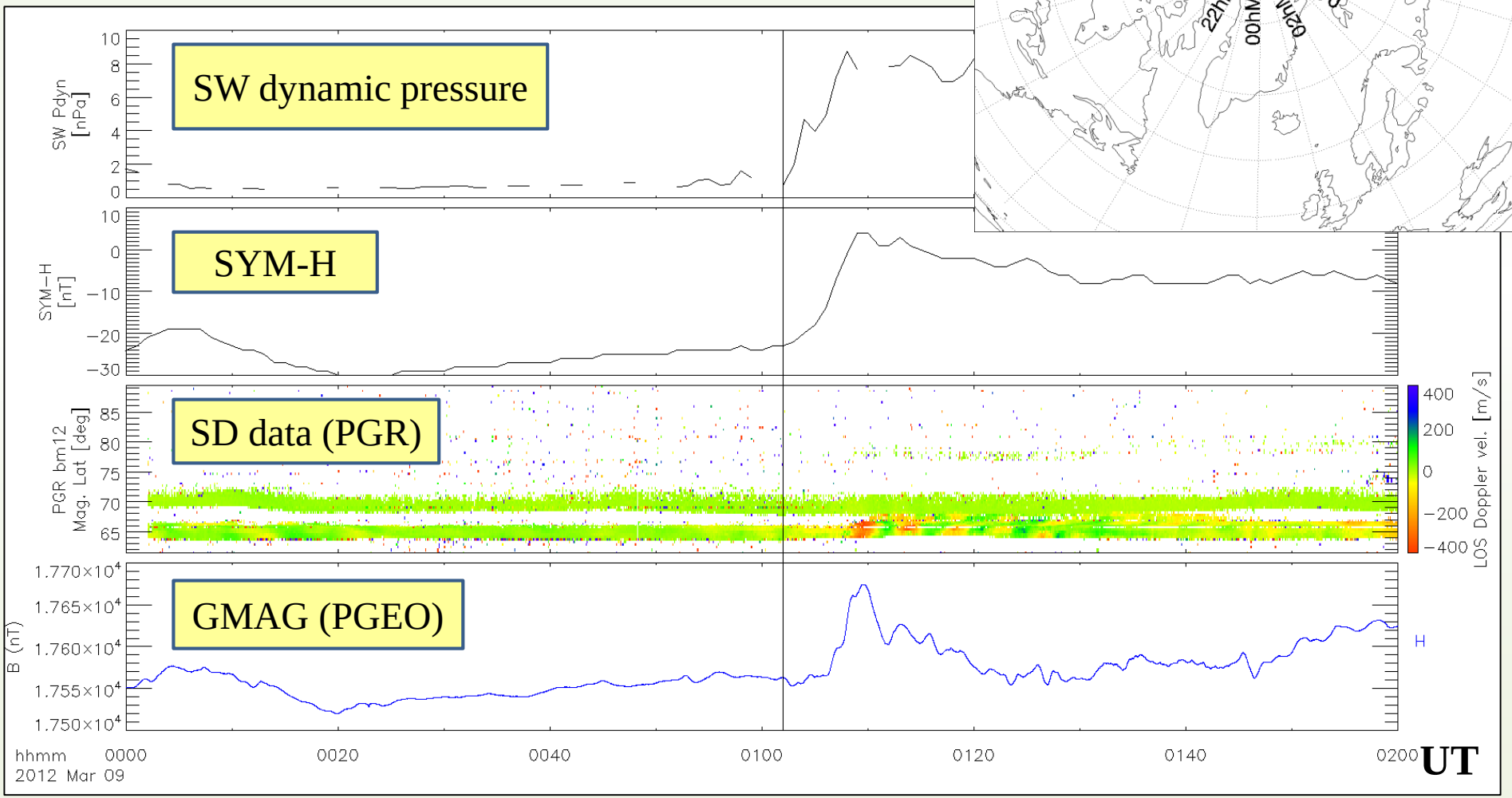
Most of SIs consist of (PI) and MI signatures in the ionospheric electric field, in agreement with geomag. observations.

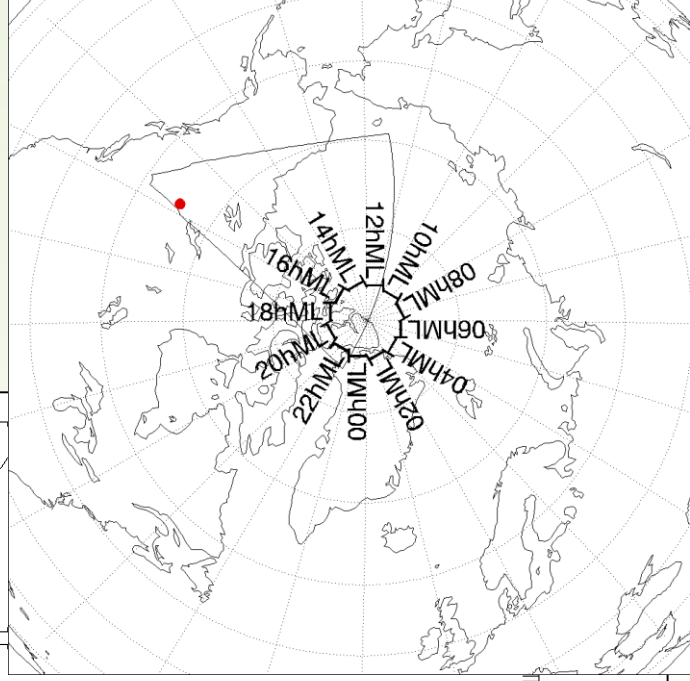




Ionospheric E oscillation associated with SI

Some SI events are occasionally accompanied by oscillations of the ionospheric electric field.





Purpose of this study

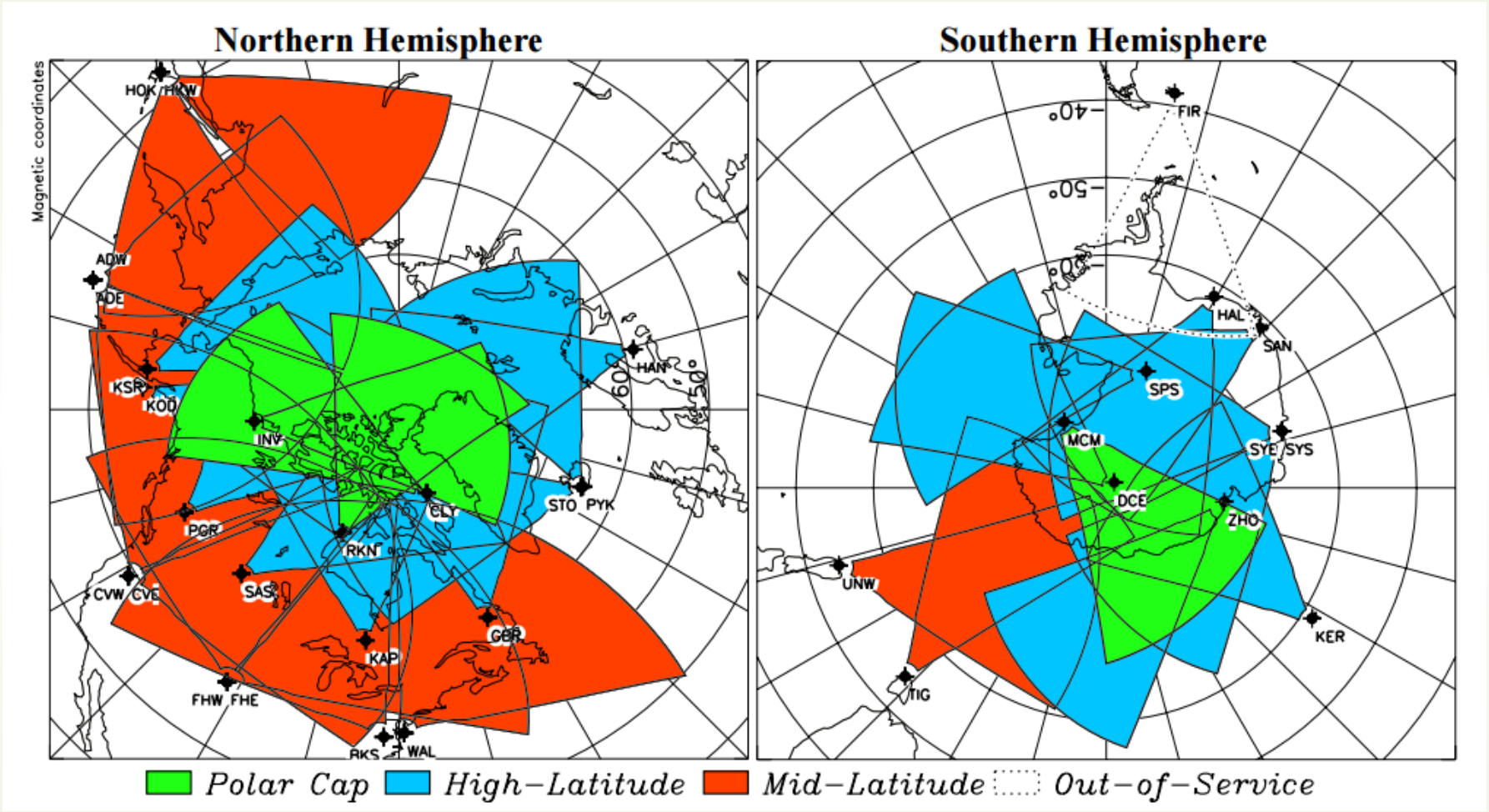
- Two types of SI event :
  - those followed or not followed by oscillations

- But triggering condition(s) of the difference has not been understood well.

We examine statistically the cause of the difference between the two kinds of SI events, using SuperDARN data.

Super Dual Auroral Radar Network

Operates between 8-20MHz



Number of operating HF radars: 34 (22 in the northern and 12 in the southern hemispheres) as of Feb 1, 2016

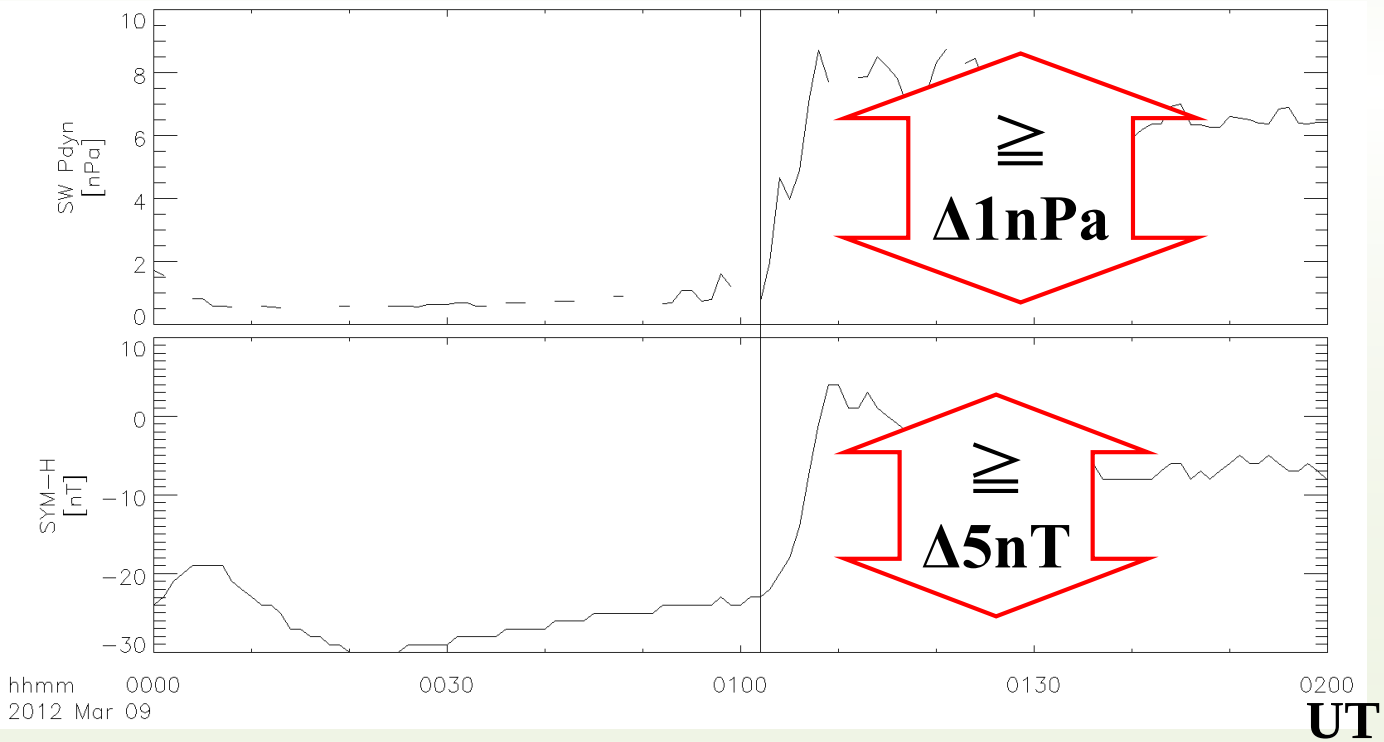
Standard temporal resolution: 1-2 min

Identification of Sudden Impulse

- Criteria
  - Check both sudden increase of the solar wind dynamic pressure and SYM-H
  - Rise time less than 10 minutes

solar wind dynamic pressure

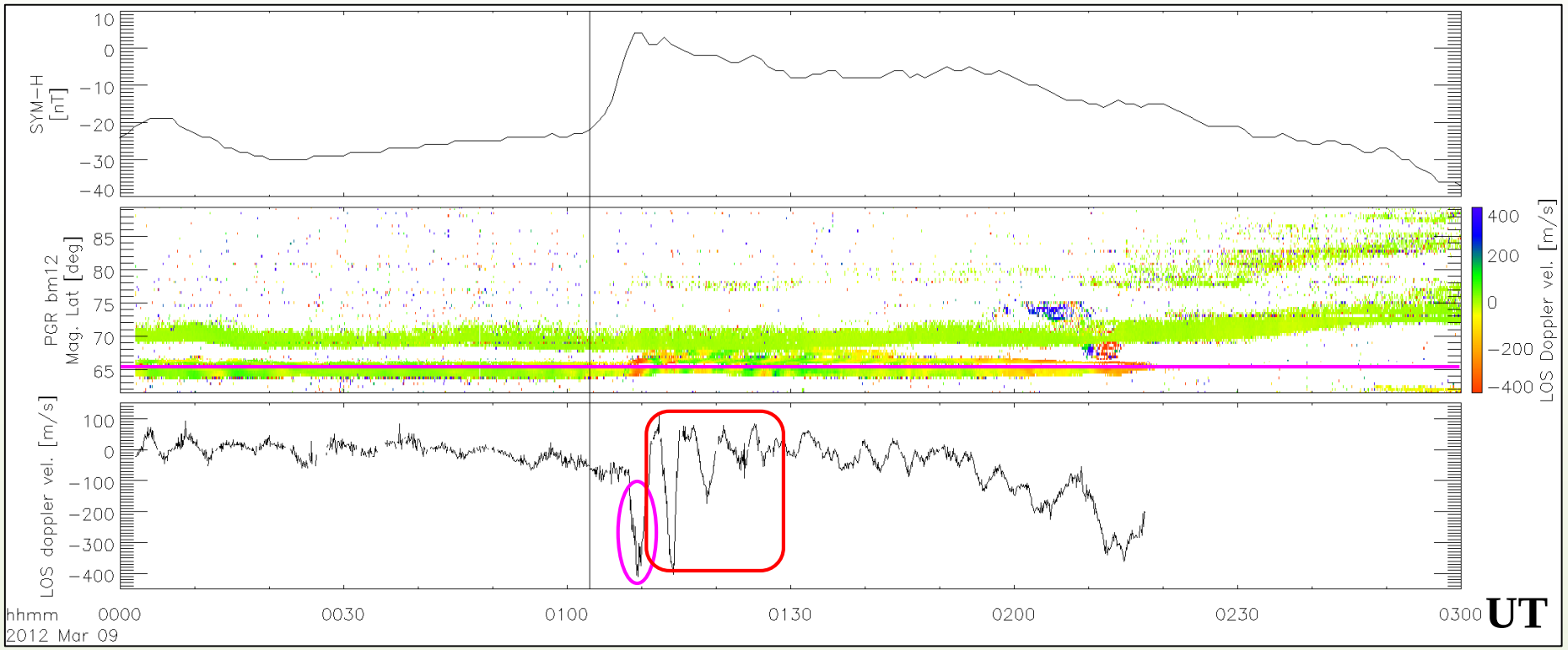
SYM-H



Identification of the ionospheric electric field oscillation seen by SuperDARN radar

- Criteria
  - Line-of-Sight Doppler Velocity
    - Oscillation amplitude > $\frac{1}{5}$ × MI's amplitude
  - Needs at least two cycles of oscillation

We call this type of SI "SI oscillation event" identified separately for each radar.

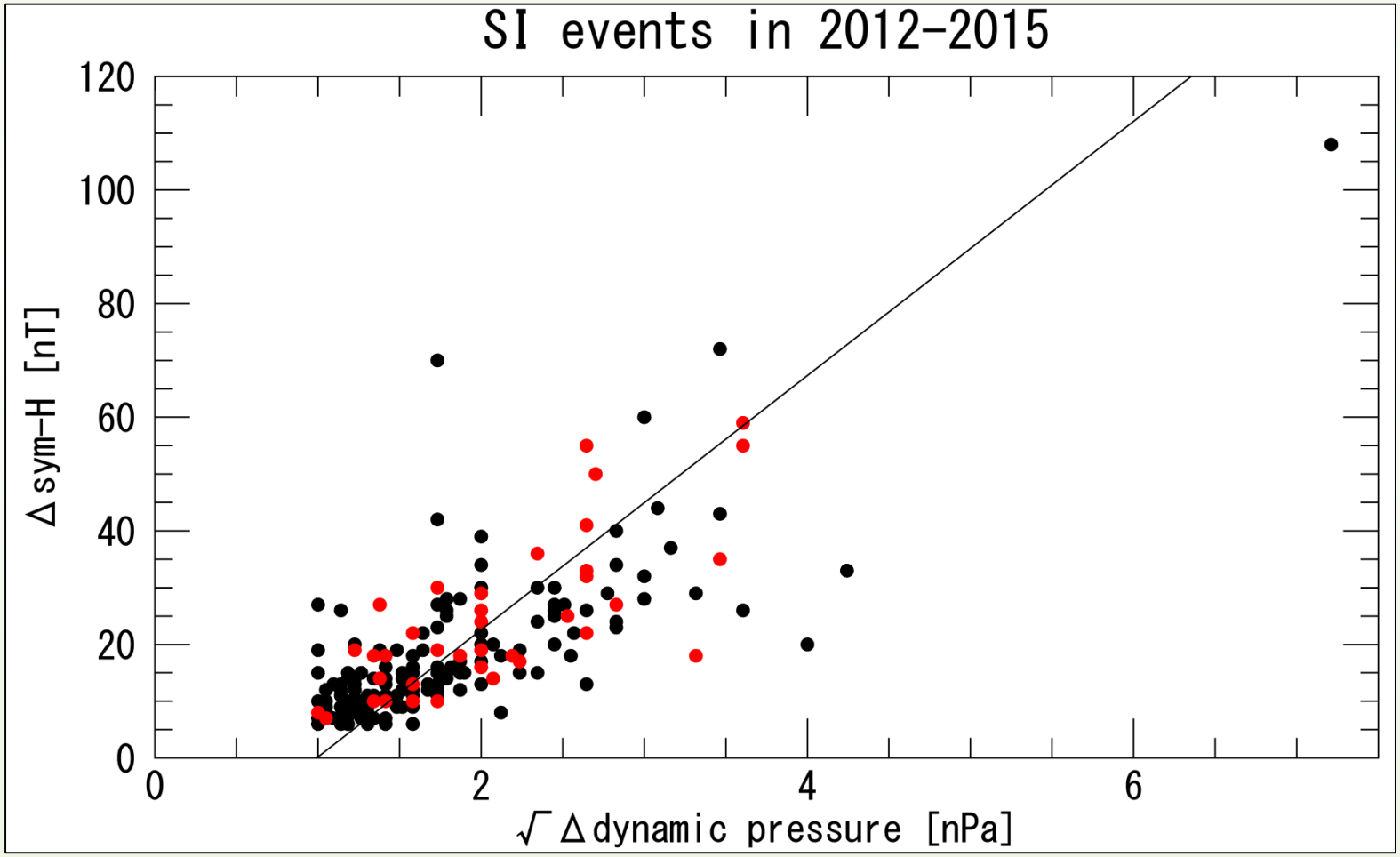


SI events in 2012-2015 (199 events)

- The relation between ΔSYM-H and the square root of

Δsolar wind dynamic pressure

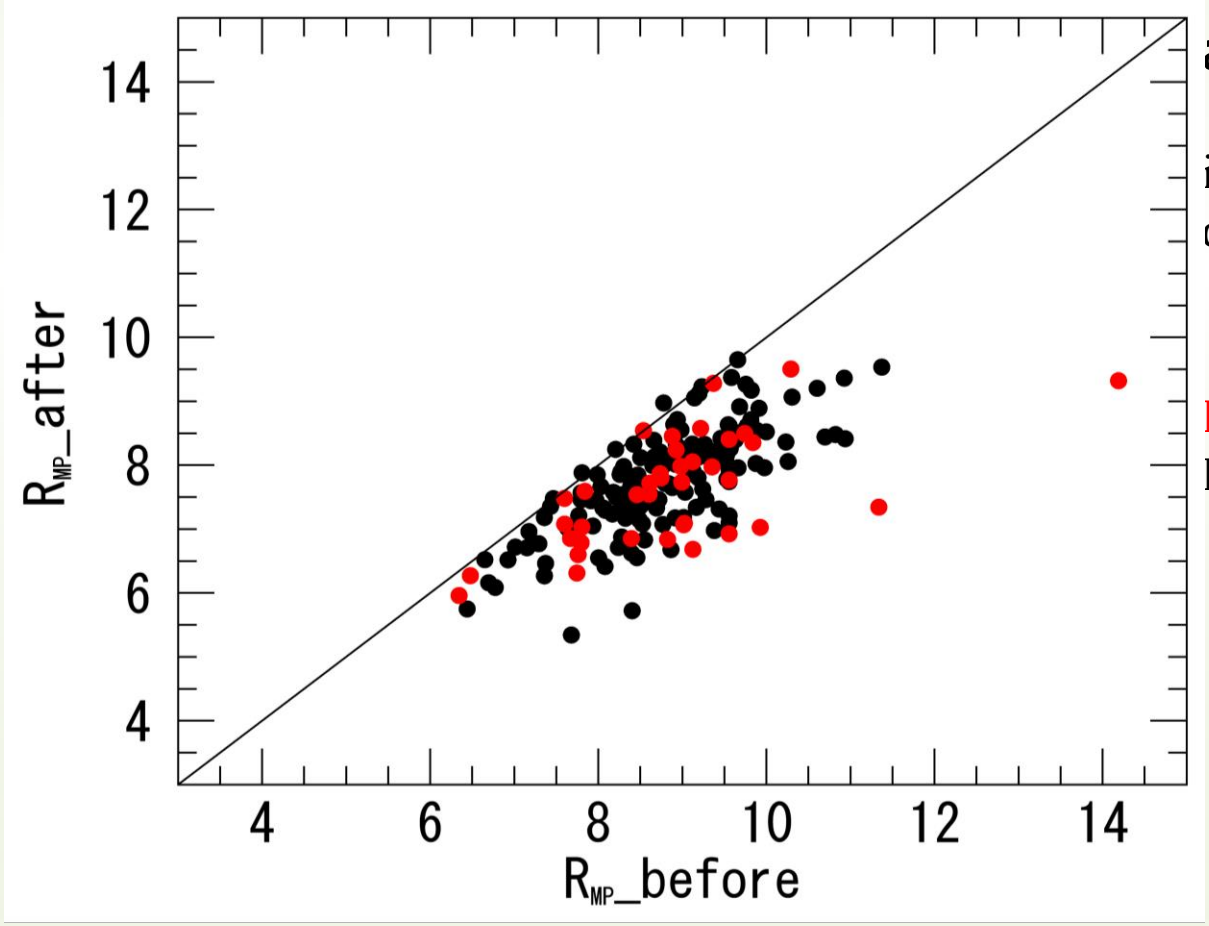
Red dots : SI oscillation event
Black dots : Only (PI) and MI seen by SD



Variation of the magnetopause position, R_{MP}

- $R_{MP} = \left(\frac{2M^2}{\mu_0 Knmv^2}\right)^{1/6}$ [Nishida, 1978]
  - $M = 8 \times 10^{15}$ [Wb · m^2]
  - $\mu_0 = 4 \times 10^{-7}$ [H/m]
  - $m = 1.673 \times 10^{-27}$ [kg]

199 samples in 2012-15



assumption

- The incidence of the solar wind is perpendicular to the earth's dipole.
- K = 2 (elastic collision)

Red dots : SI oscillation event

Black dots : Only PI and MI seen by SD

Difference of ΔR and ΔSYM-H

ΔR

	only PI and MI	oscillation
samples	161	38
average of ΔR	−1.03	−1.28
standard deviation of ΔR	0.61	1.01
variance of ΔR	0.37	1.02

ΔSYM-H

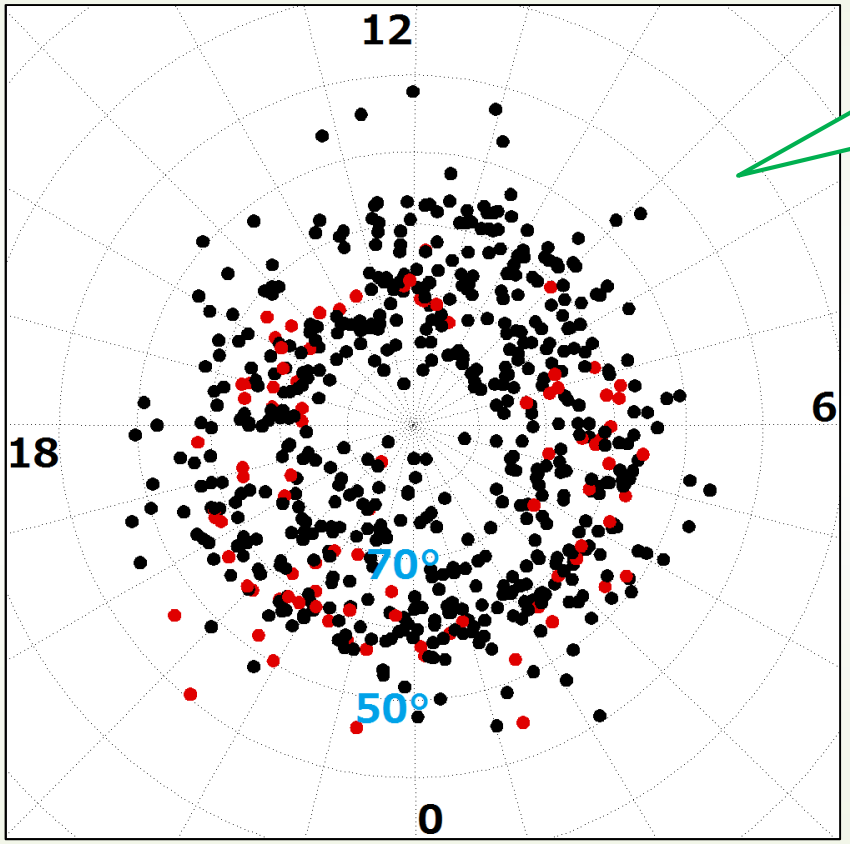
	only PI and MI	oscillation
samples	161	38
average of ΔSYM-H	17.9	24.0
standard deviation of ΔSYM-H	13.1	13.3
variance of ΔSYM-H	172.3	176.2

- Result of the t-test
  - ΔR difference was statistically insignificant
  - ΔSYM-H difference was statistically significant

SI oscillation event samples

633 samples in 2012-15

Disturbance location



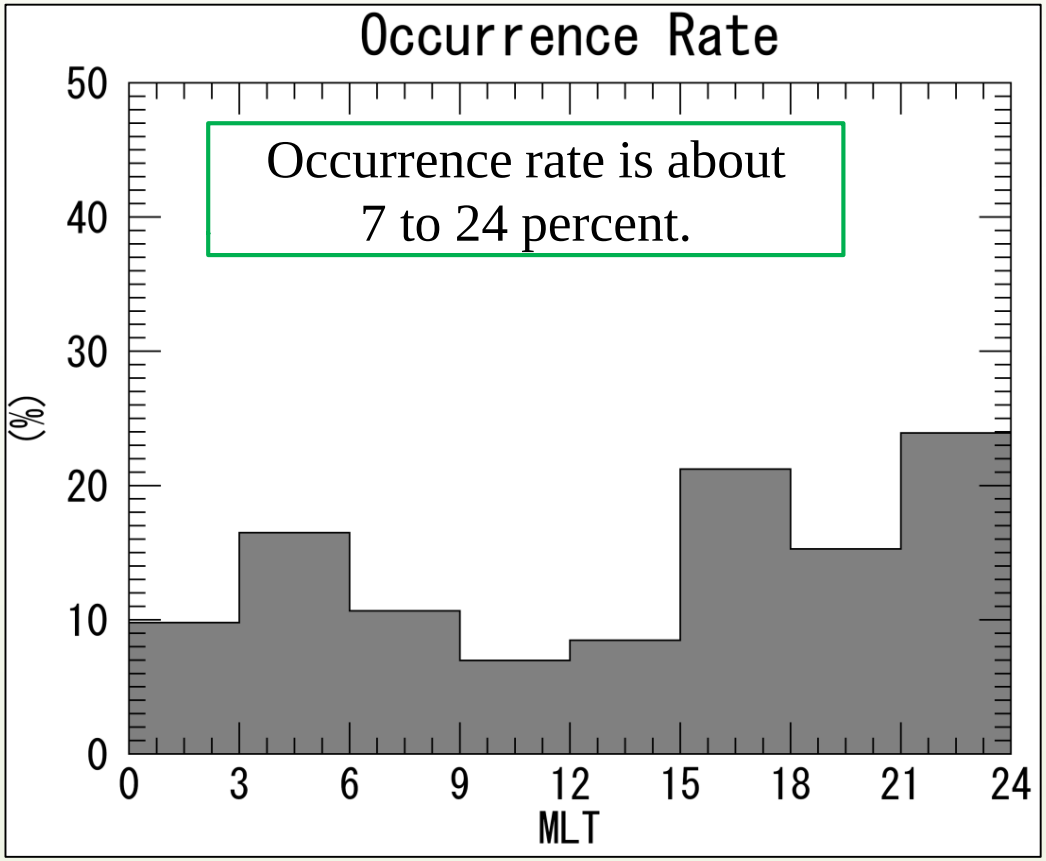
including ground scatter events

geomagnetic coordinates

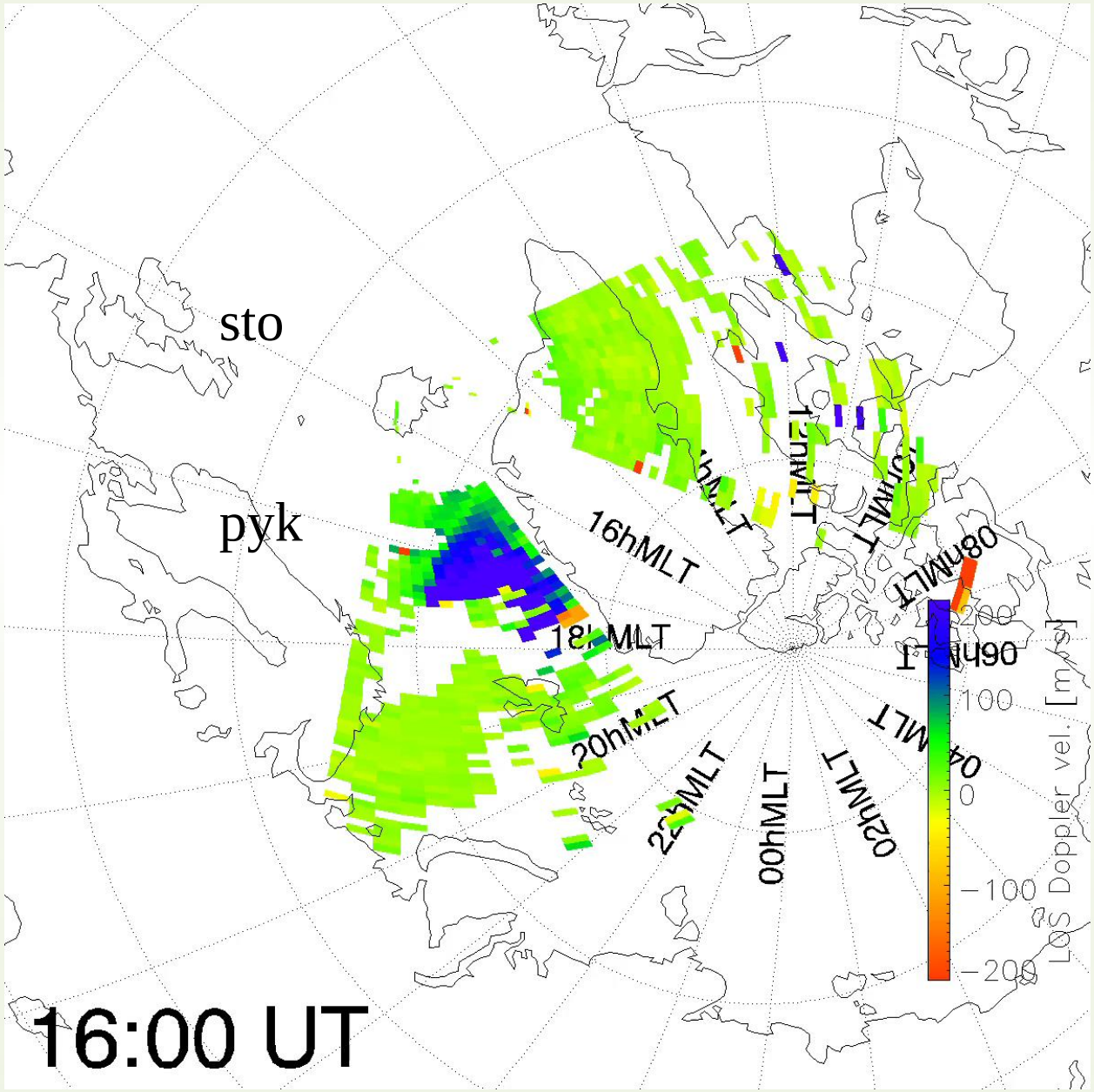
Red dots : SI oscillation event samples

Black dots : Only PI and MI seen by SD

SI-associated E oscillations do not depend on MLT.



Two-dimensional distribution of the E-field oscillation



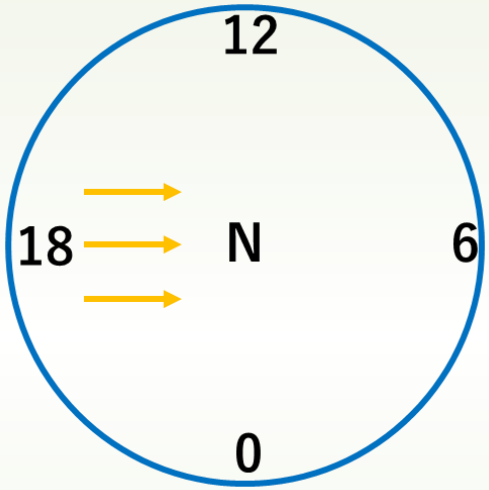
January 15, 2012

SI event : 16:20 UT

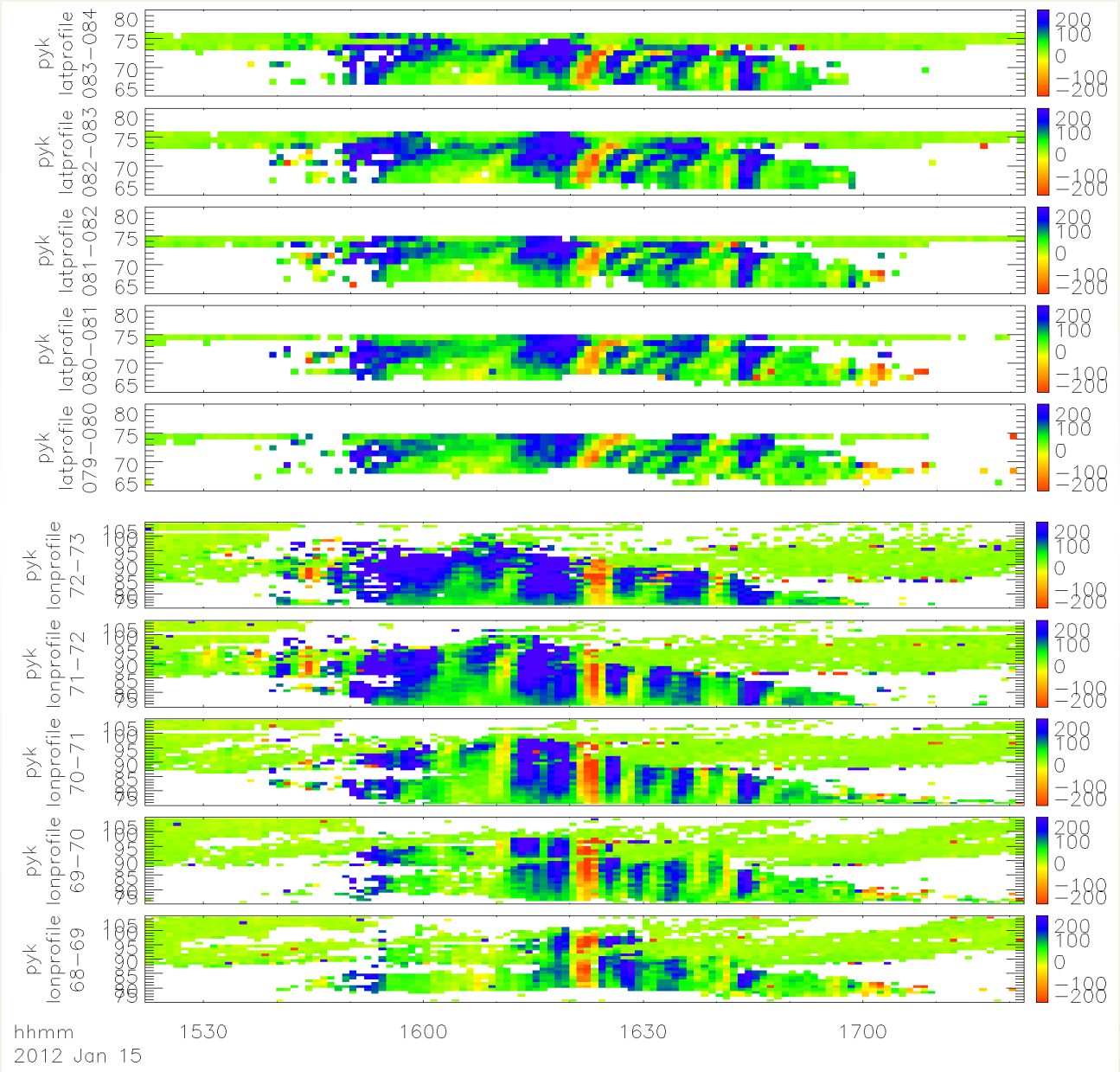
pyk: poleward propagation
sto: not seen

Latitudinal and longitudinal variation (pyk)

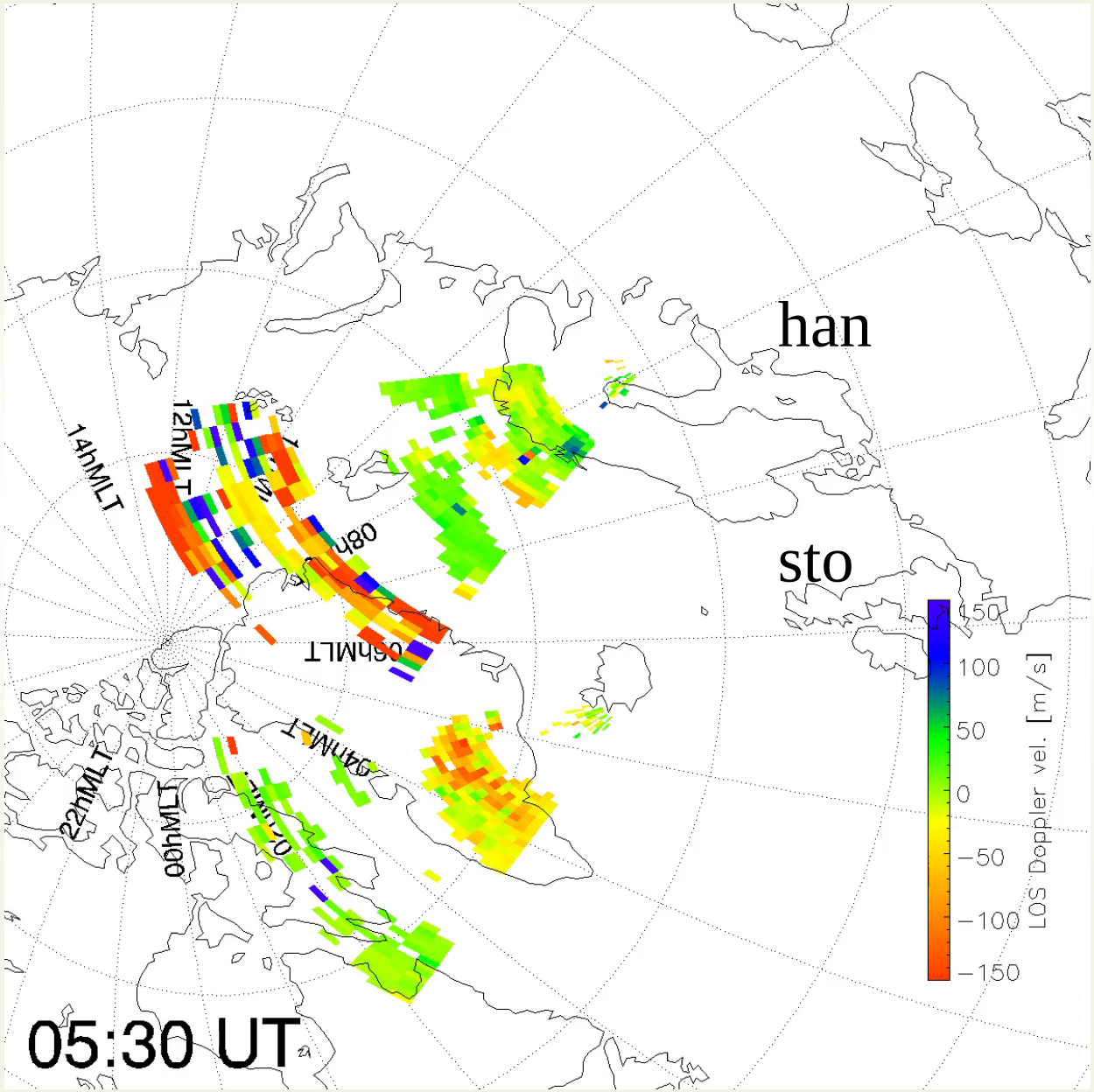
Latitudinal profile



Longitudinal profile



Two-dimensional distribution of the E-field oscillation



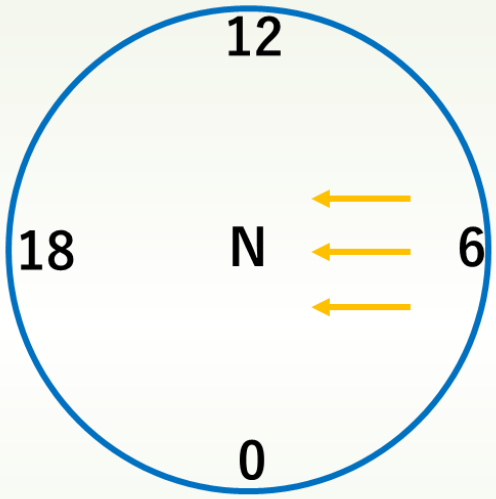
November 14, 2014

SI event: 05:49 UT

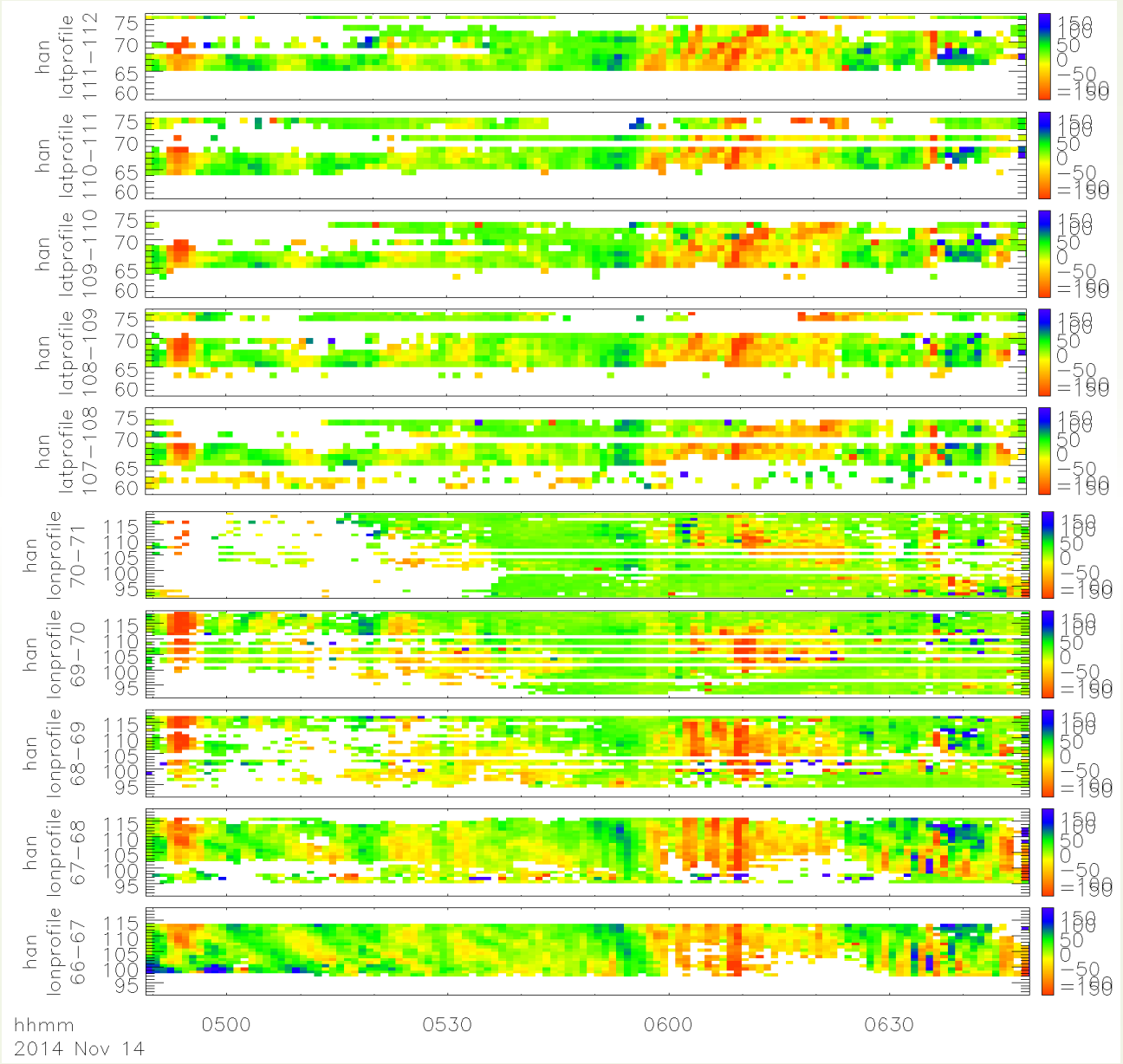
han: poleward propagation
sto: not seen

Latitudinal and longitudinal variation (han)

Latitudinal profile



Longitudinal profile



Summary

- We analyzed statistically SI-associated electric field oscillations observed by the SuperDARN radars in 2012-15.

- For the two types of SI events, ΔR difference was statistically insignificant, while ΔSYM-H difference was statistically significant.
- Occurrence of SI-associated E oscillations seems not to depend on MLT.
- Some SI oscillation event samples have usually local structure and latitudinal variation.

Future work

- More further investigation into the remarkable SI event
- To examine statistically two-dimensional structure of SI oscillation events