

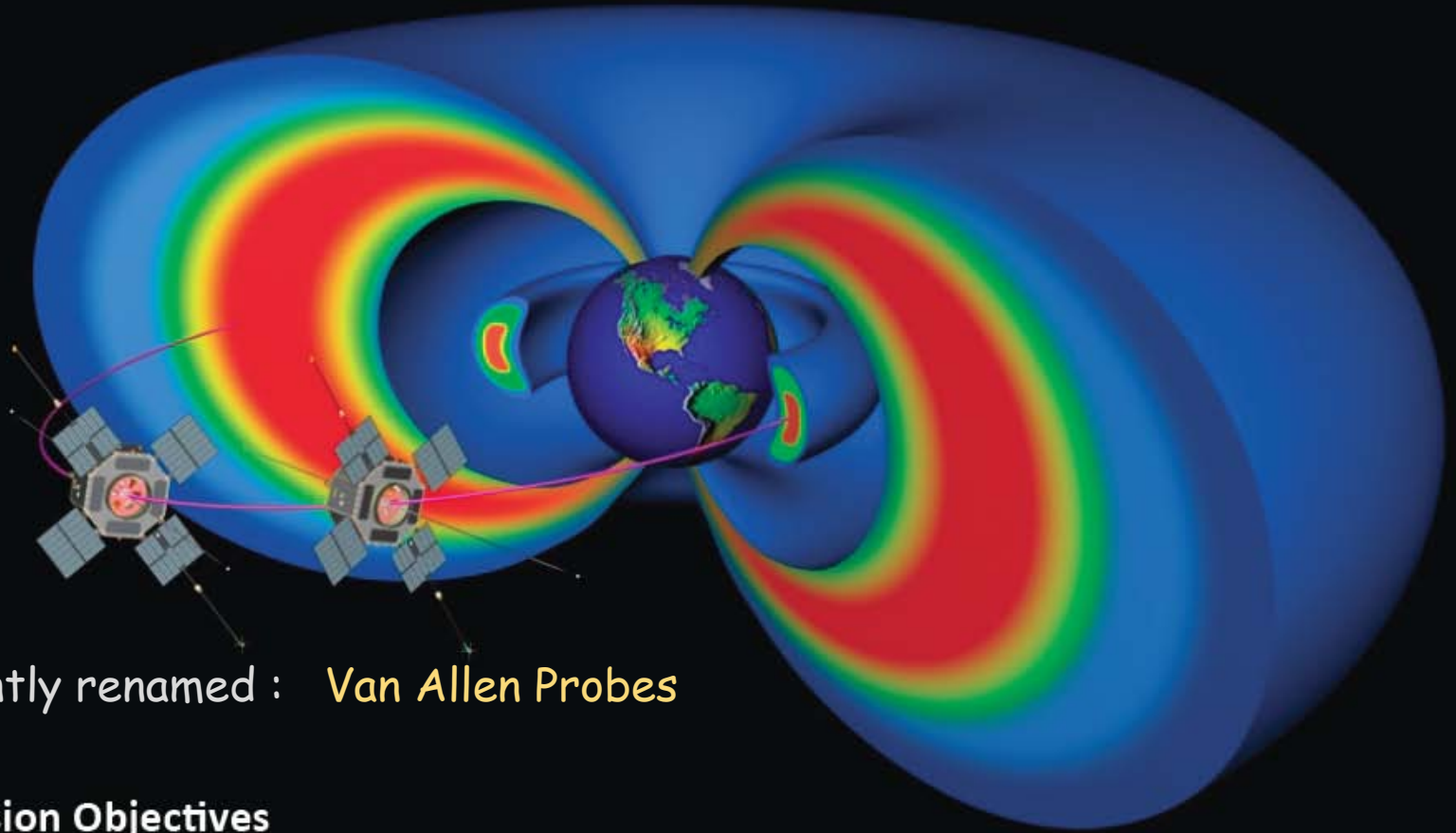


ULF studies by SuperDARN RBSP mode measurement

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- ▶ RBSP scan measurement
 - ▶ How the f-o-v is scanned?
 - ▶ How is this mode triggered/scheduled?



Recently renamed : **Van Allen Probes**

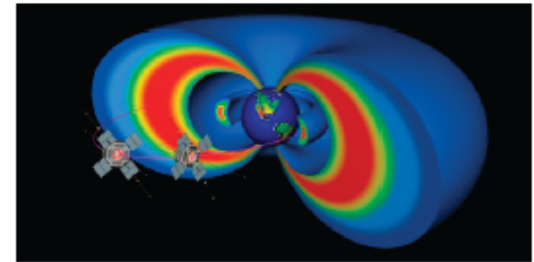
RBSP Mission Objectives

- Discover which processes, singly or in combination, accelerate and transport radiation belt electrons and ions and under what conditions
- Understand and quantify the loss of radiation belt electrons and determine the balance between competing acceleration and loss processes
- Understand how the radiation belts change in the context of geomagnetic storms

SuperDARN-RBSP Science

ULF wave activity and storms: SuperDARN can measure ULF wave fields, frequency, ionospheric electric field, azimuthal structure locally and globally. m up to ~ 100 , (attenuation factor of ~ 50 in ground magnetometer data) whilst RBSP measures energetic particles and chorus waves.

- **Pc3-5 band (1000 - 10s):** Direct measurement on a global scale from all radars. Ionospheric and ground scatter can provide information (direct measurement of electric field and Doppler shifts due to wave modulation of the reflection height). Covered by existing THEMIS mode or similar.

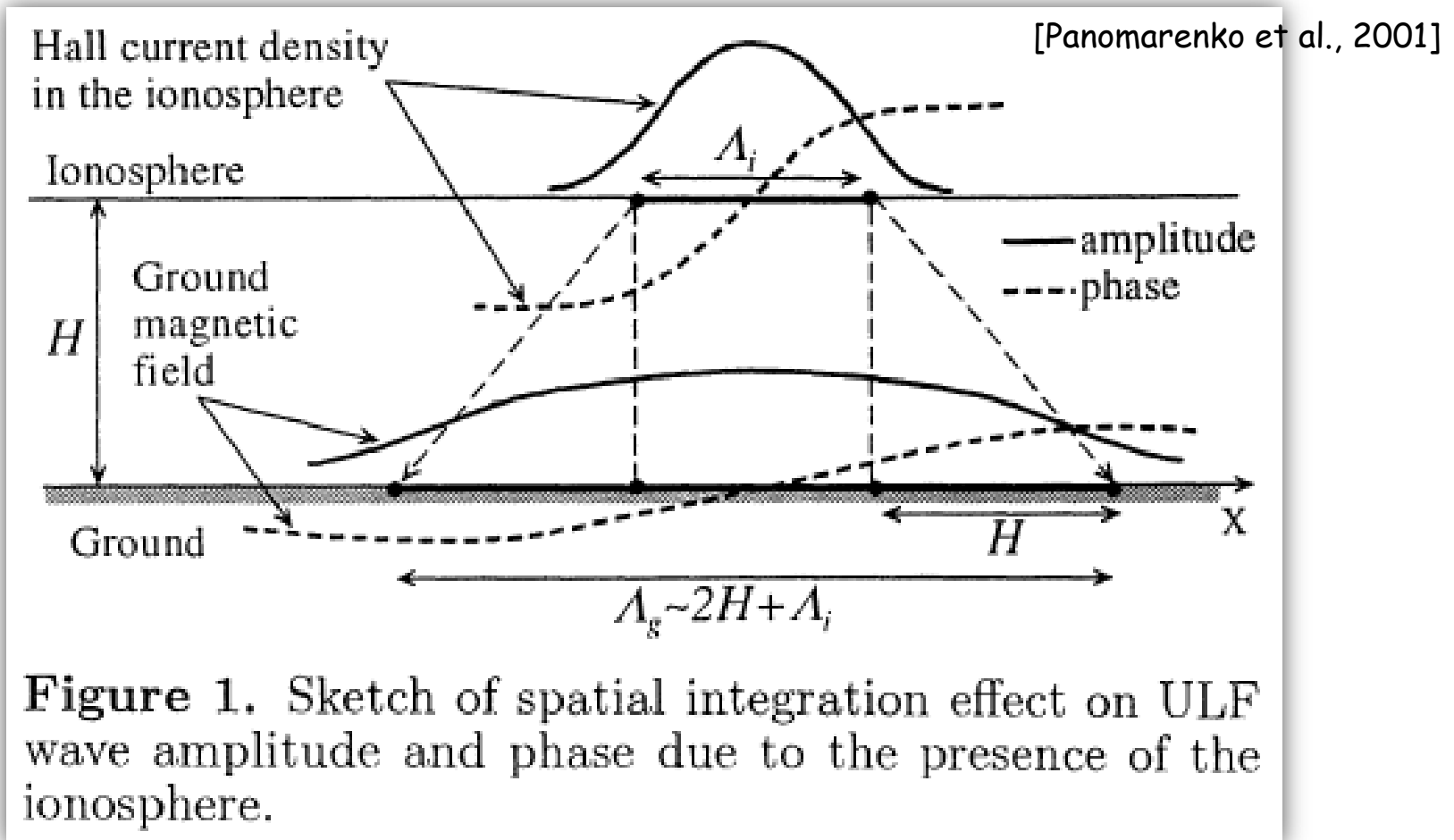


ULF waves

- Azimuthal structure?
- Integrated wave power in defined frequency bands?
- Global measurement or latitude/MLT distribution?

...

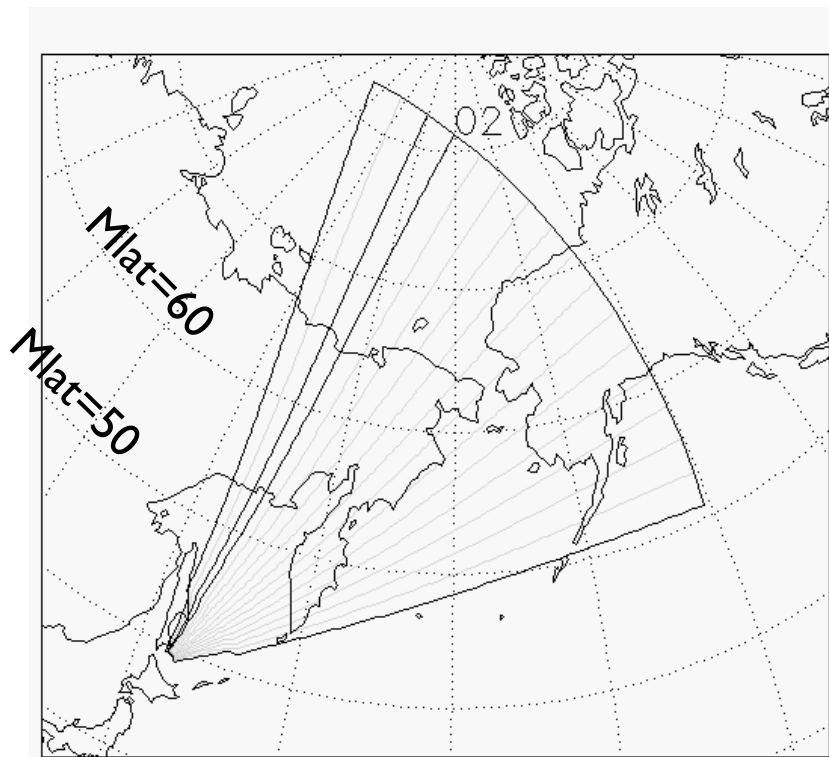
How a HF radar and ground magnetometer see an ionospheric E-field/current?



- Ground magnetometers cannot catch fine structures

What is RBSPscan?

Mini-scan with 3 beams (2, 3, and 5 for the example below)
+ conventional sequential scan skipping the 3 beams
= 2 - 0 - 3 - 5 - 1 - 4 - 2 - 6 - 3 - 5 - 7 - 8 - 2 - 9 - 3 - 5 - 10 - 11 - 2 - 12 - 3 - 5 - 13 - 14
- 2 - 15 - 3 - 5 - ...



Nominally 3.5 sec / beam

2D scan:

<2 min to complete

beam 2, 3, 5:

sampled **each 21 sec**

beam 2 and 3 combined:

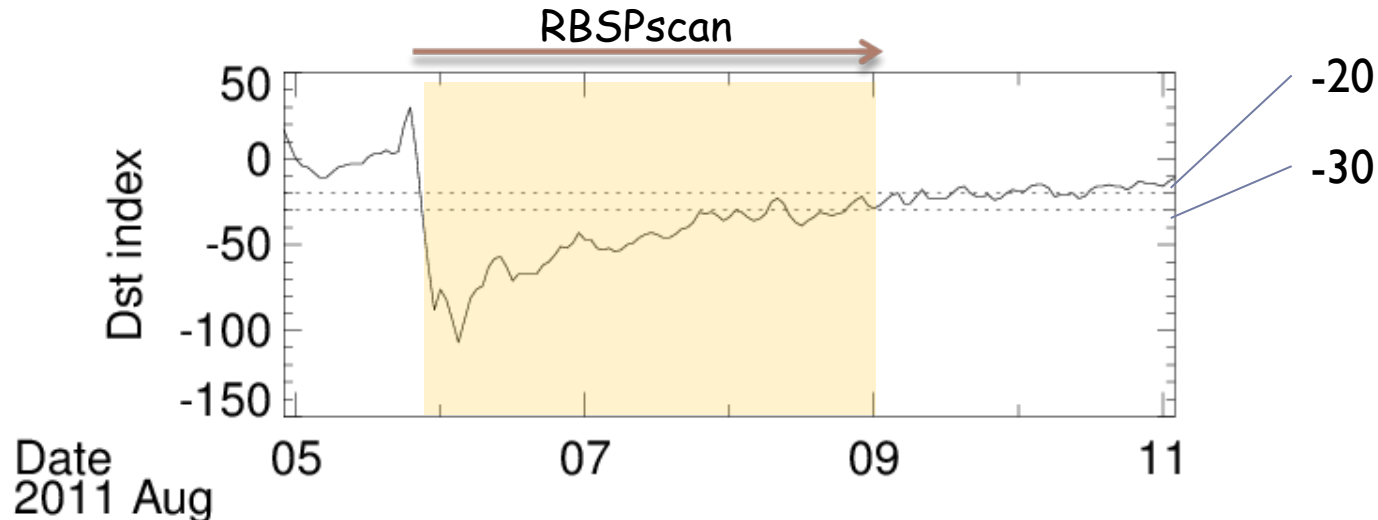
" at least **each 14 sec**

Nyquist freq. ~ 20-30 mHz

- ▶ To catch both the background convection and ULF wave fields.
 - ▶ The mini-scan with not equally spaced 3 beams is built in the conventional 2D scan sequence

When is RBSPscan invoked?

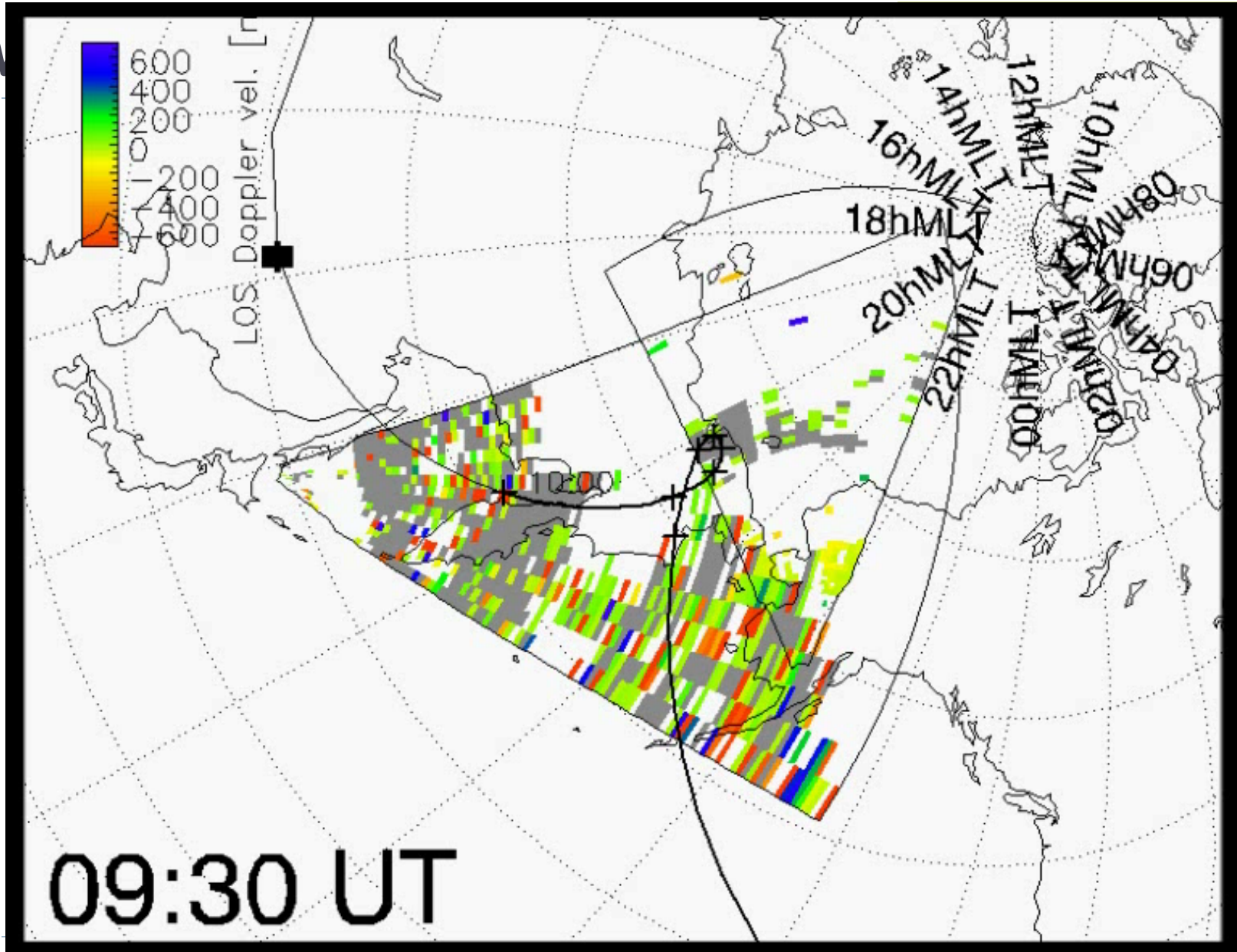
CT-TRIG mode



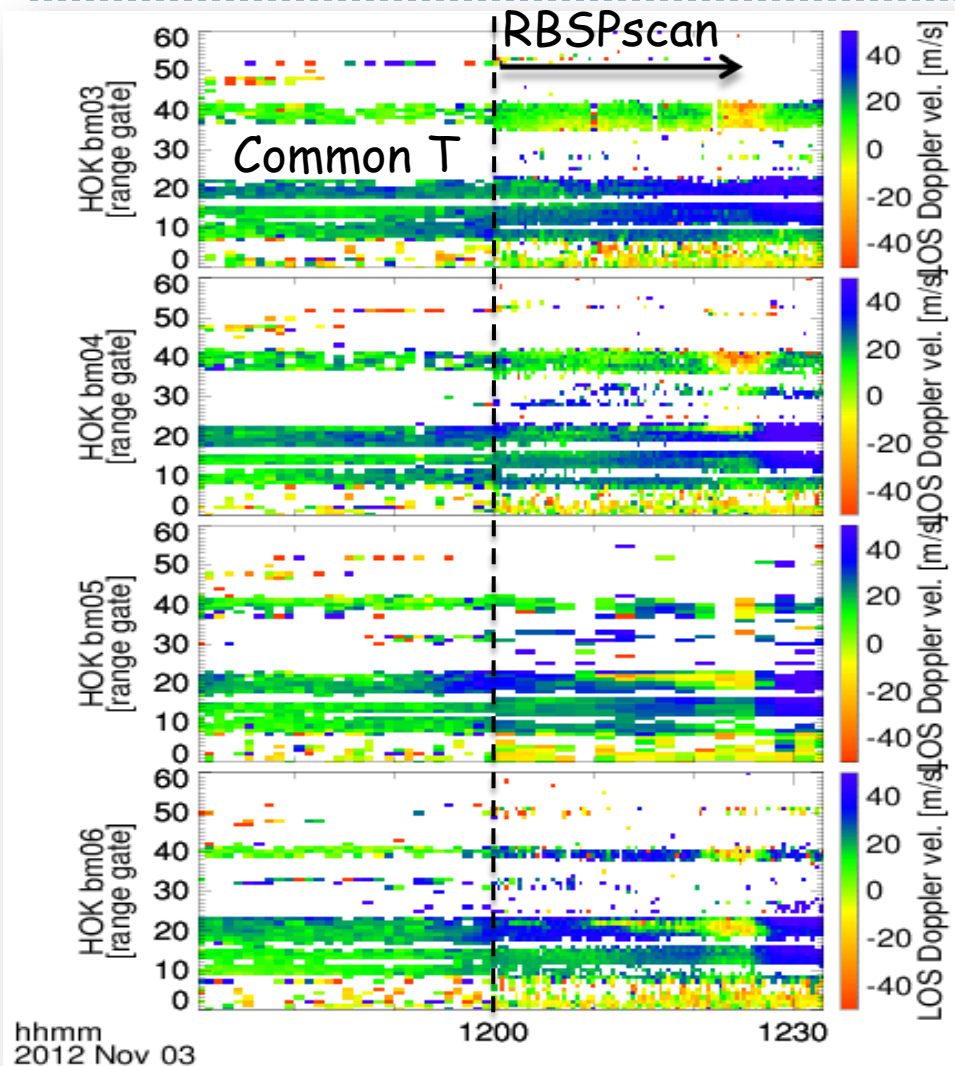
- ▶ All radars are automatically switched to RBSPscan when realtime **Dst** index goes **below -30 nT**, and run for an initial 6 hour period.
- ▶ The 6 hour period keeps updated every following hour **until Dst exceeds -20 nT**.

e

RBSP/

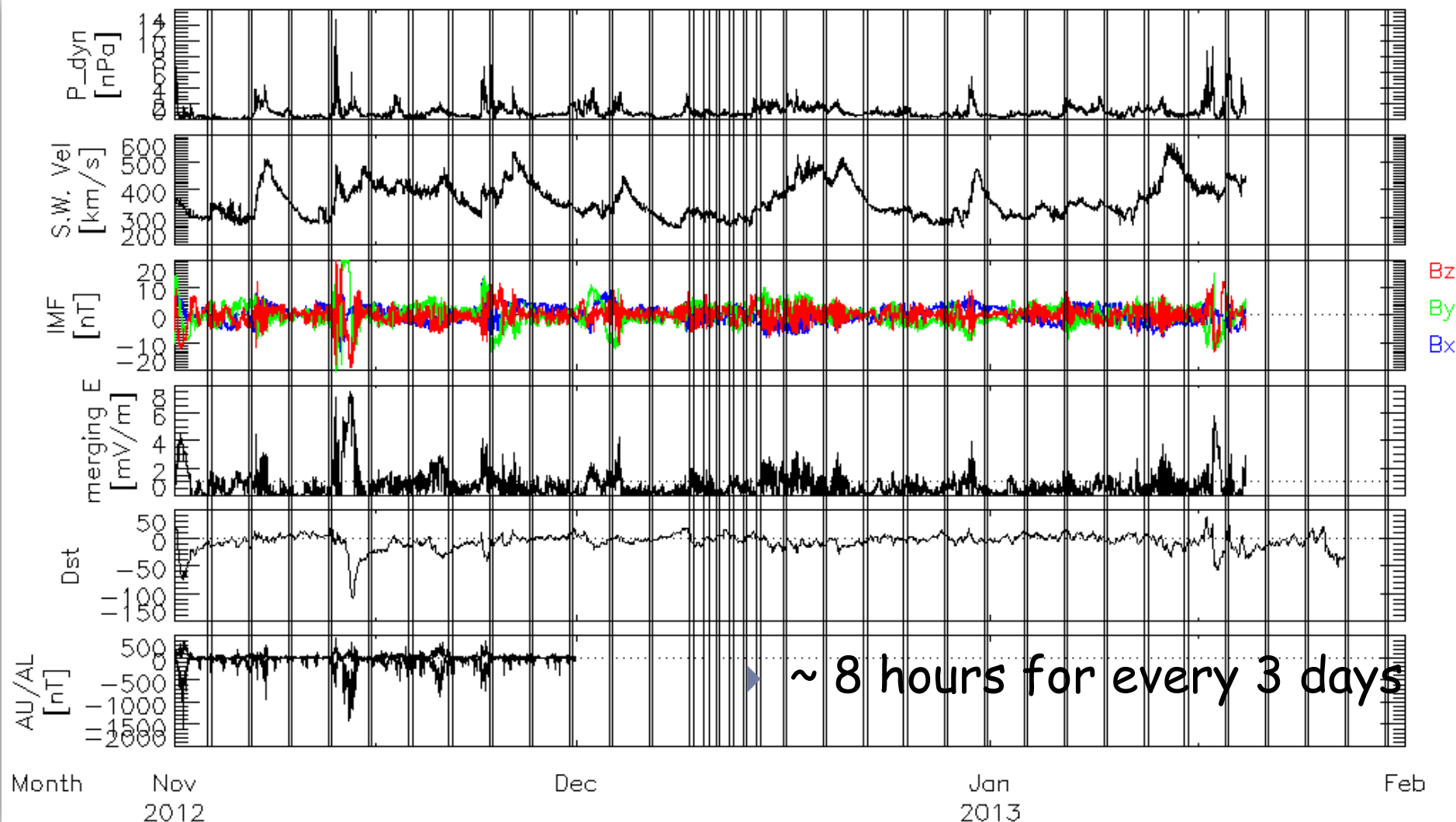


How RBSPscan data look like?

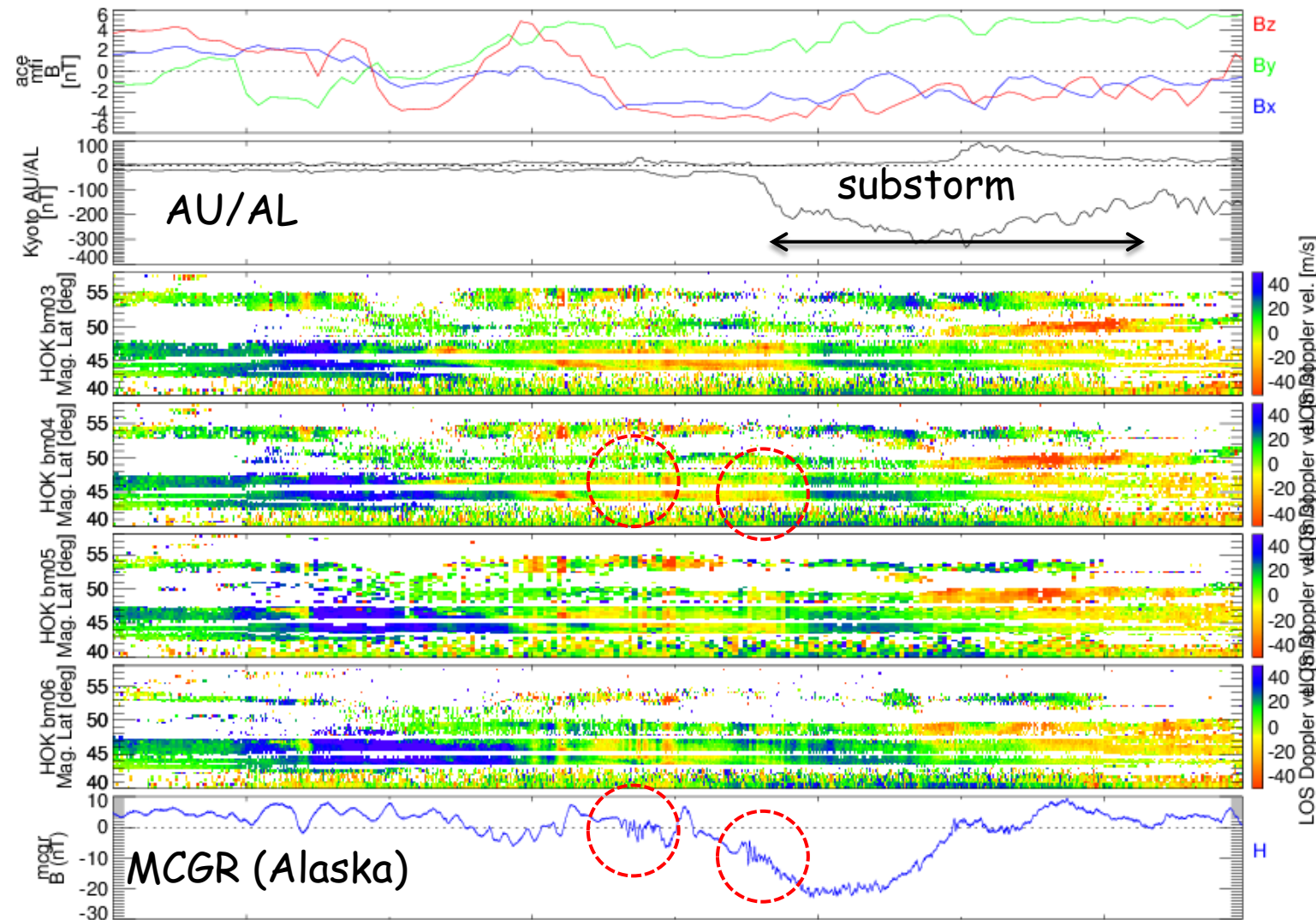


- ▶ Time resolution switches to **~21 sec** for the selected 3 beams, forming the **mini scan**. The **other beams** are sampled **every 2 min**.

ST-APOG RBSPscan periods since Nov 2012



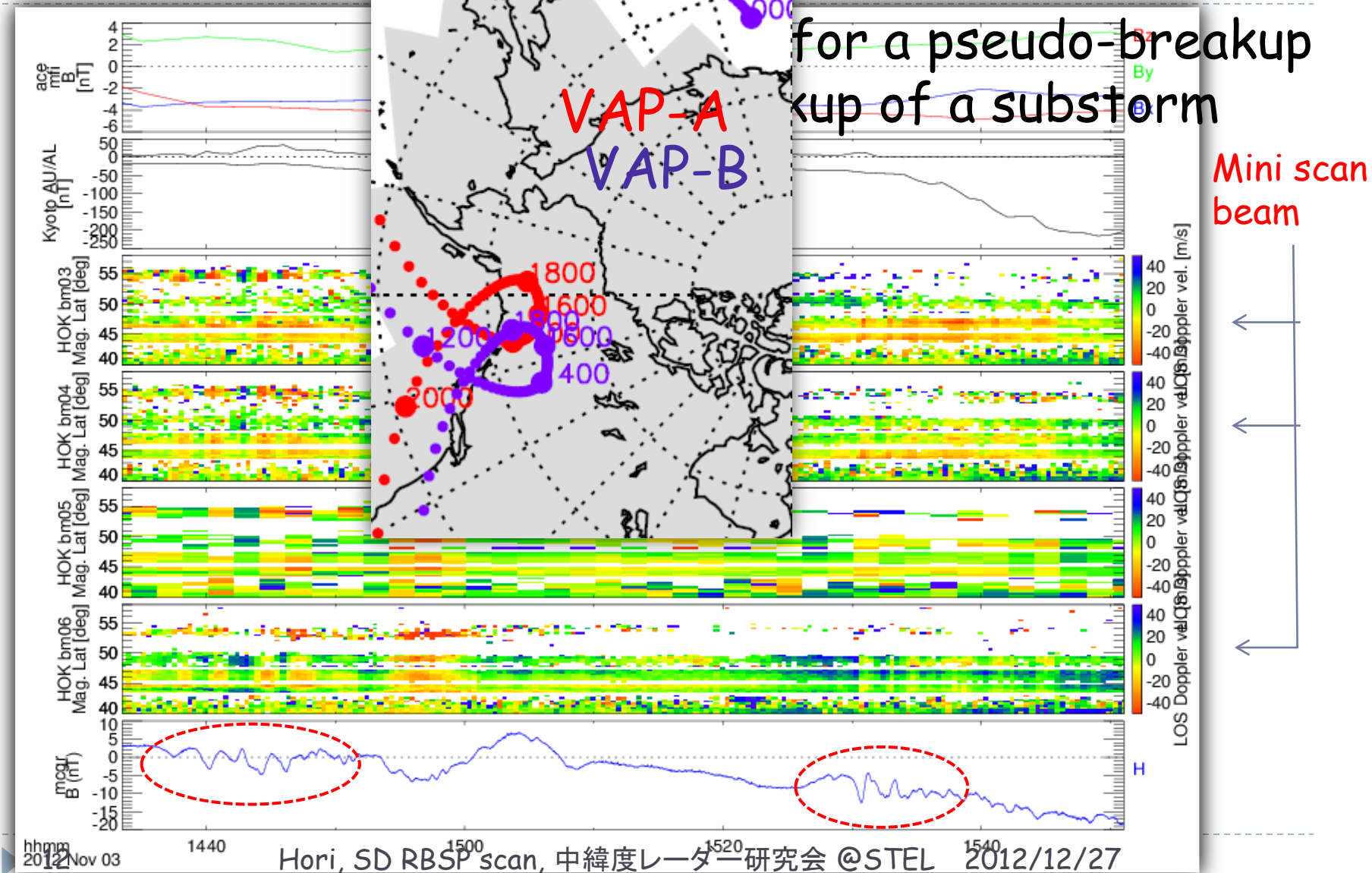
Example 1: 20121103 12-20 UT



Mini scan
beam

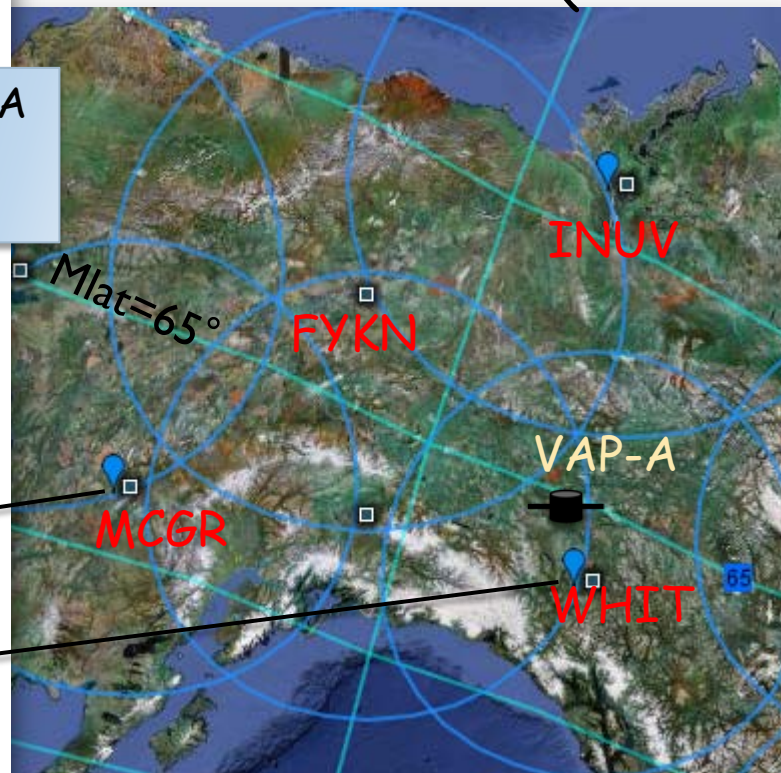
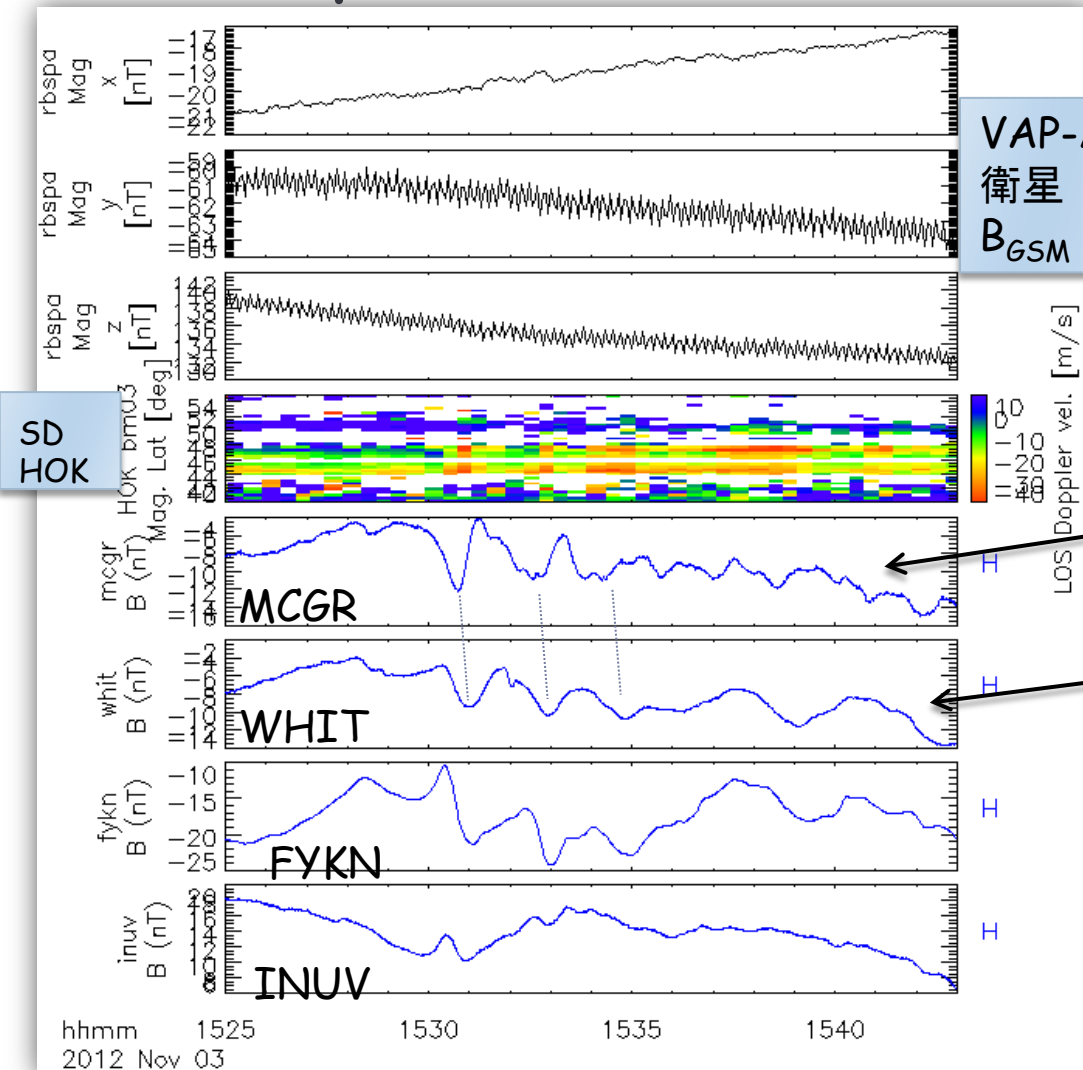
Example 1: 2000 UT

for a pseudo-breakup
of a substorm



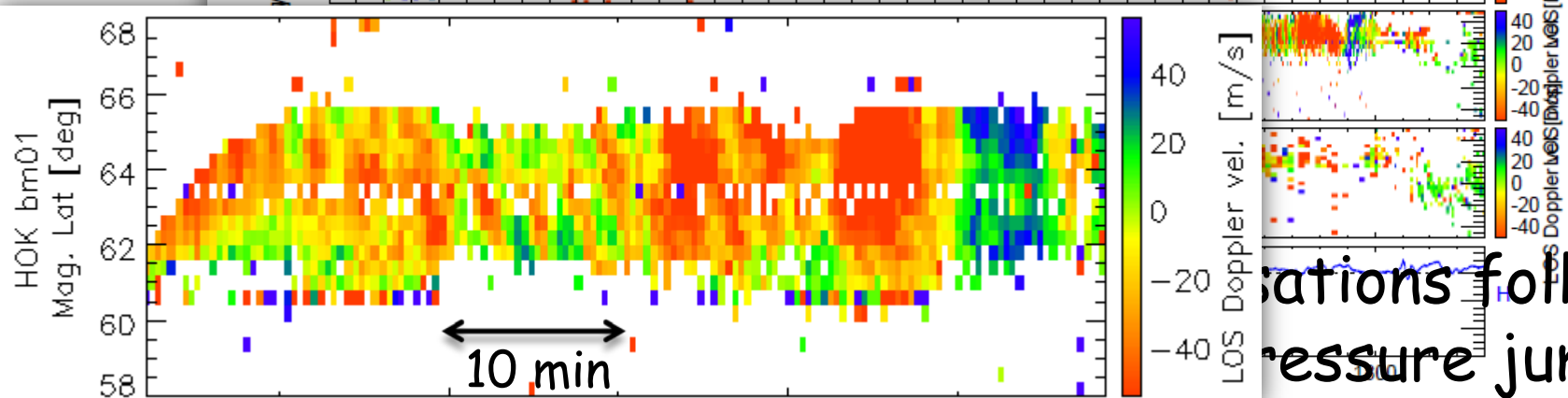
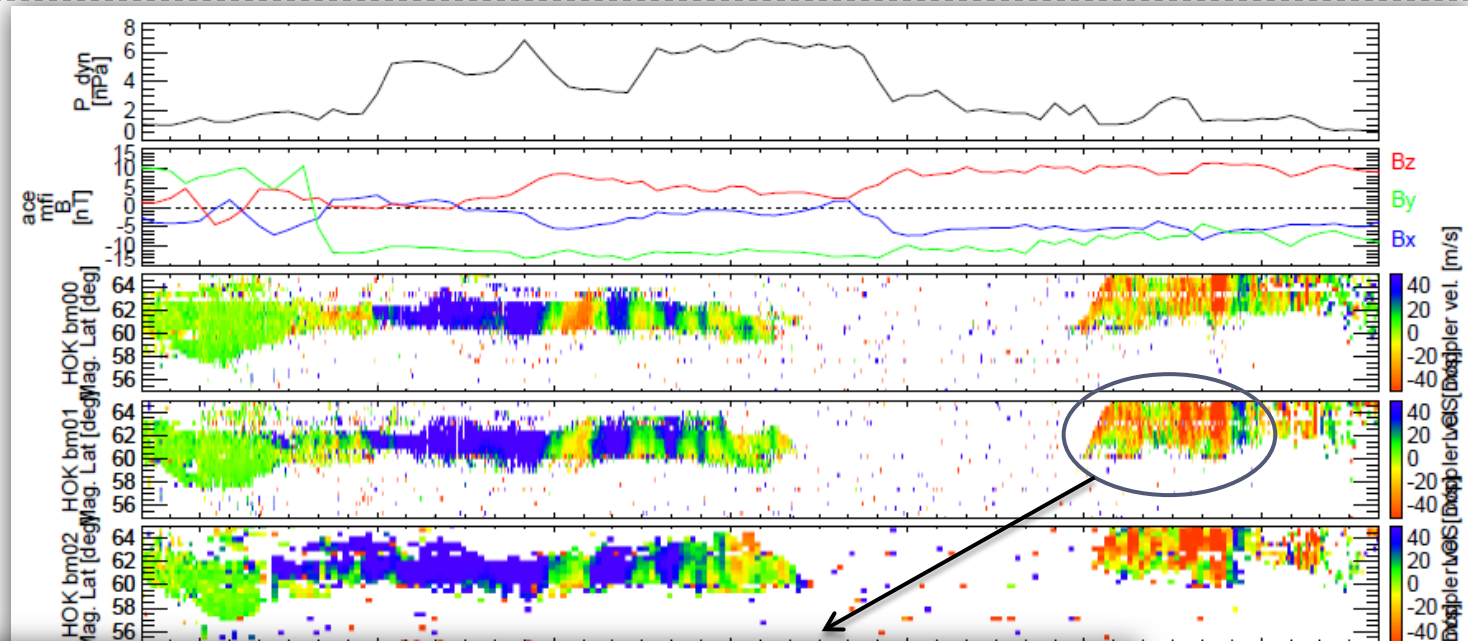
Example 1: 20121103 12-20 UT

MLT ~ 5h

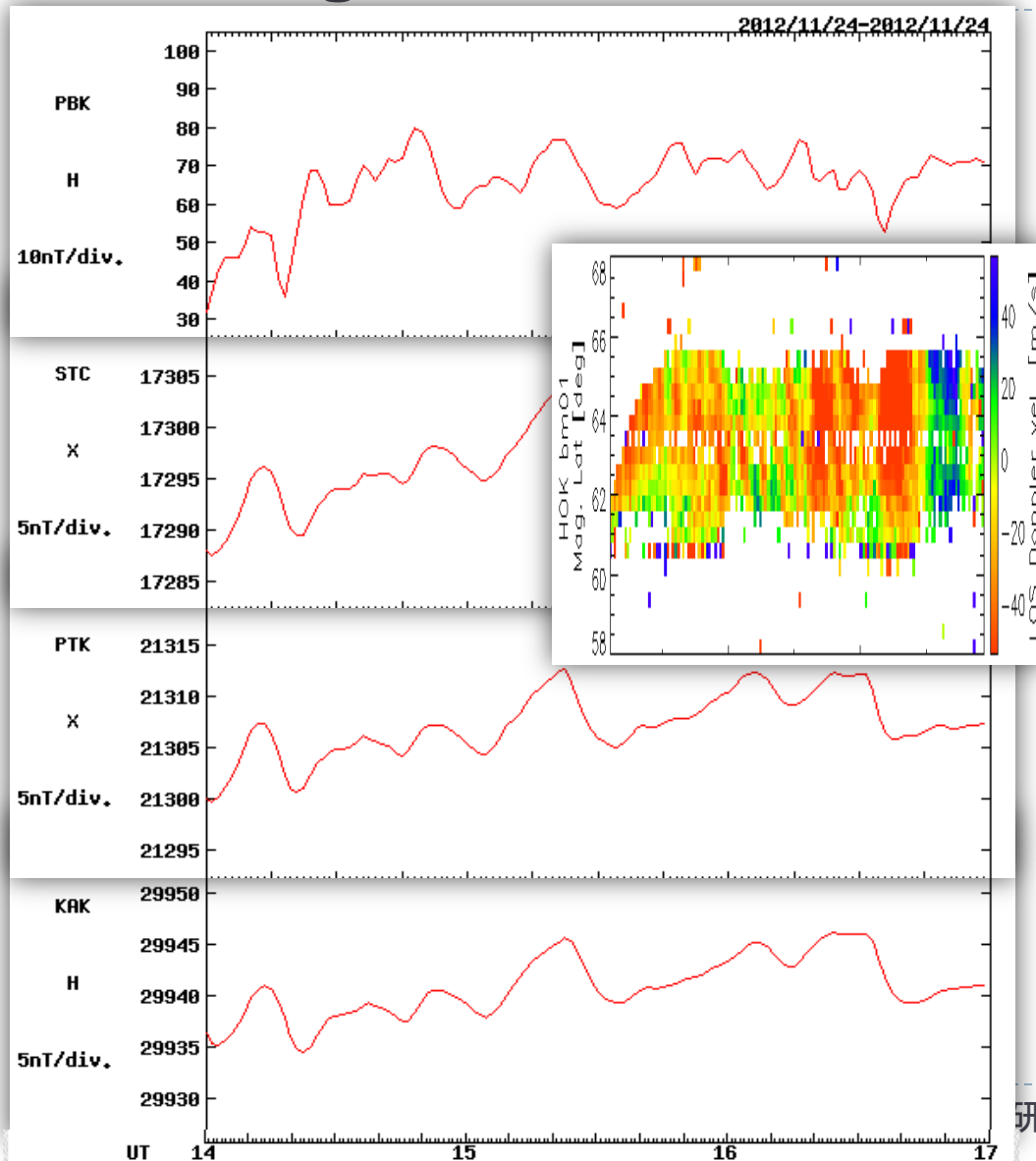


- ▶ VAP-A, SD-HOK, and Alaskan ground B

Example 2: 20121124 12-20 UT



Geomag. around the HOK sector

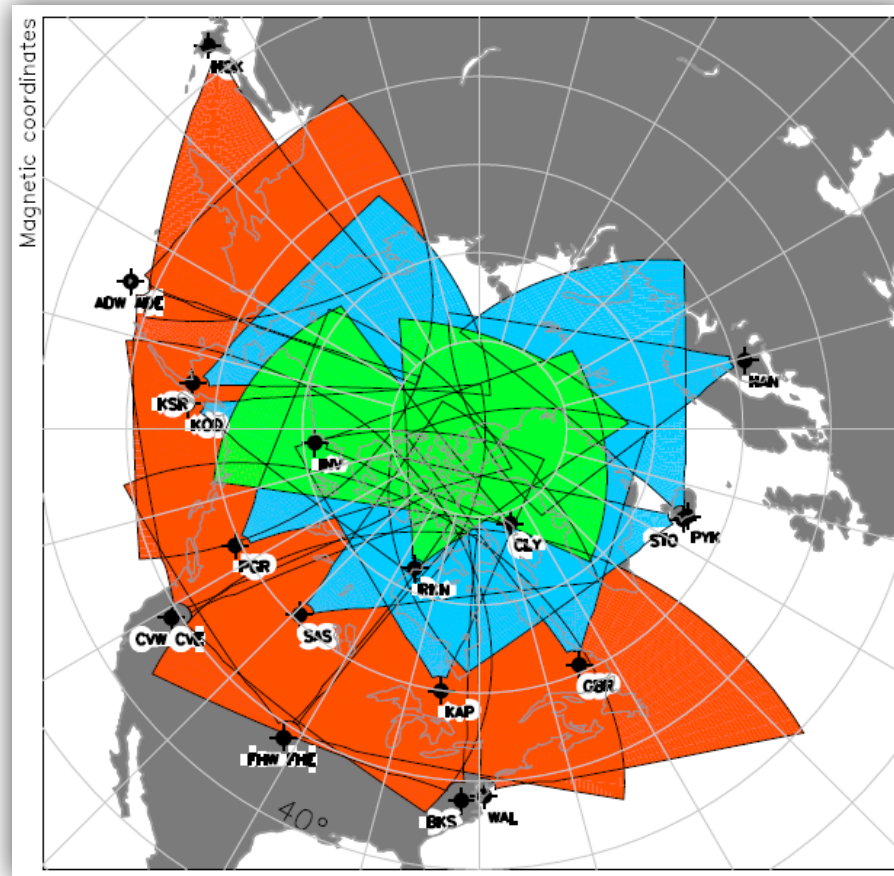


► PBK, STC, PTK, KAK
(1 min resolution...)

How to analyze SD RBSPscan data?

- ▶ Data plot is available at JHU/APL site
<http://superdarn.jhuapl.edu/>
- ▶ Data is distributed under **full open policy**. You can contact any SD PI close to you to get data.

- ▶ One of the easiest ways is to use ERG-SC plug-in with THEMIS software.
http://gemsissc.stelab.nagoya-u.ac.jp/erg_socware/bleeding_edge/



Summary

- ▶ SD radars run **RBSPscan** in collaboration with RBSP satellites.
- ▶ Combination of 3-beam mini-scan and conventional sequential scan allows us to resolve ULF waves spatially and temporally as well as background convection.
- ▶ RBSPscan is triggered automatically during storms (**CT-TRIG** mode) and also pre-scheduled for conjunction with RBSP apogee (**ST-APOG** mode).
- ▶ ERG-SC, in collaboration with SD community, provides a useful data analysis platform for the SD data.