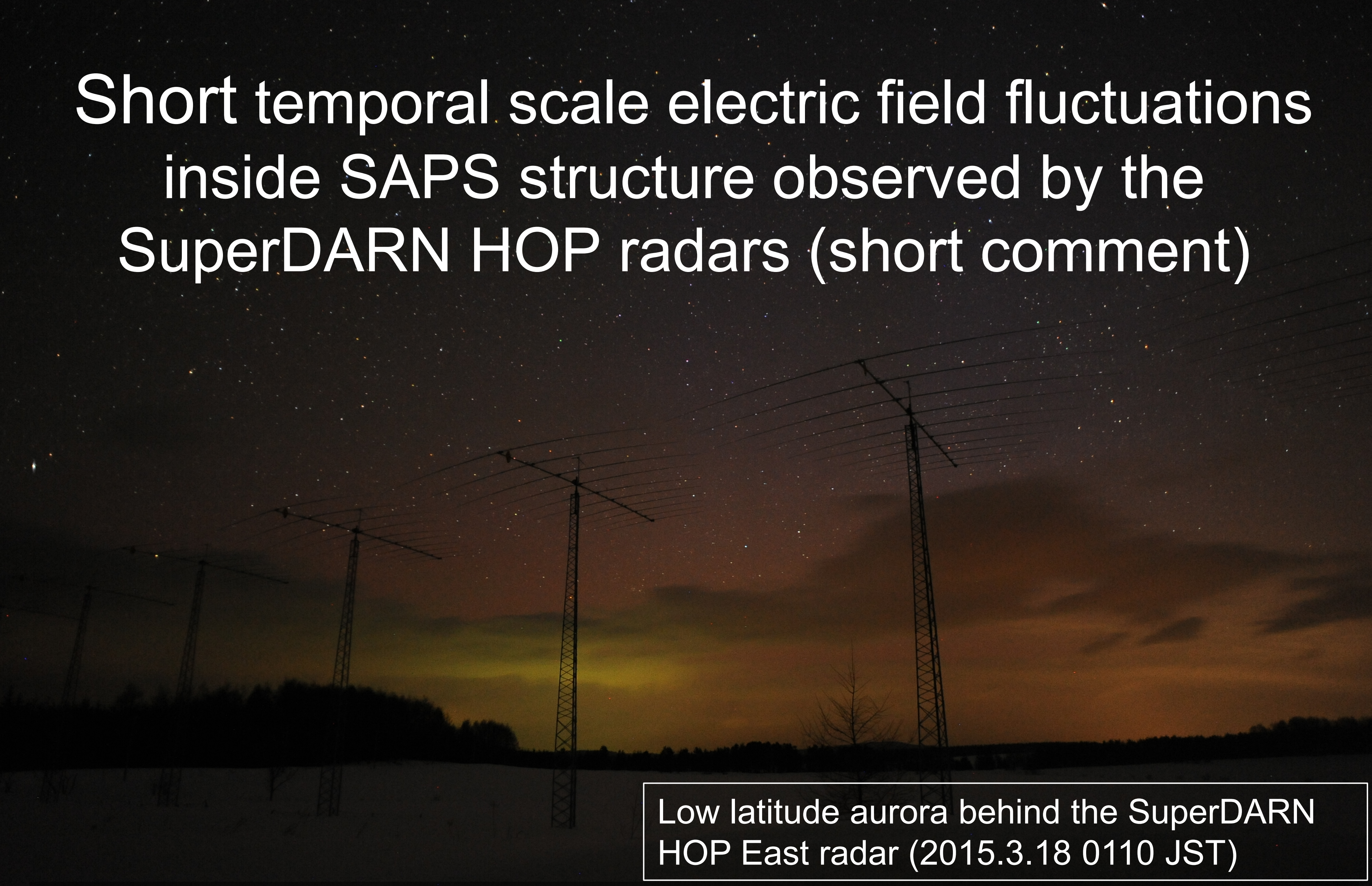
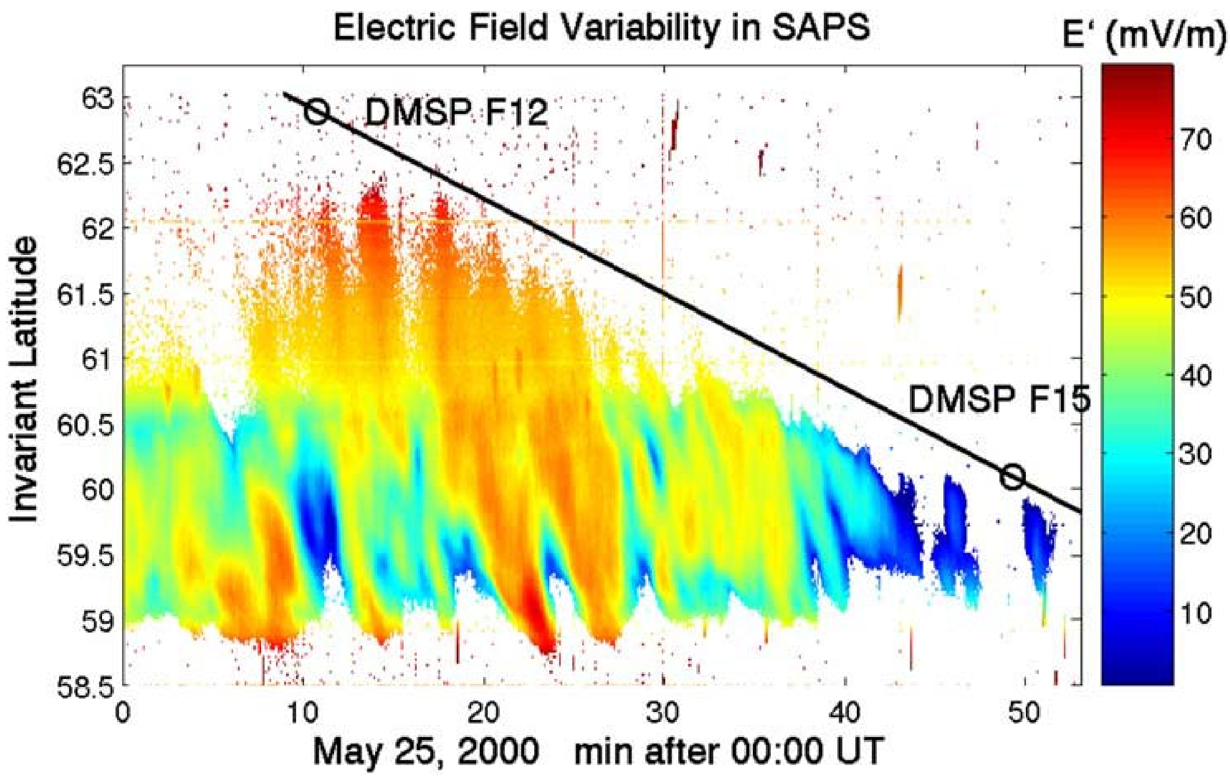
Short temporal scale electric field fluctuations inside SAPS structure observed by the SuperDARN HOP radars (short comment)



Low latitude aurora behind the SuperDARN HOP East radar (2015.3.18 0110 JST)

Nozomu Nishitani and Tomoaki Hori (ISEE, Nagoya Univ.)

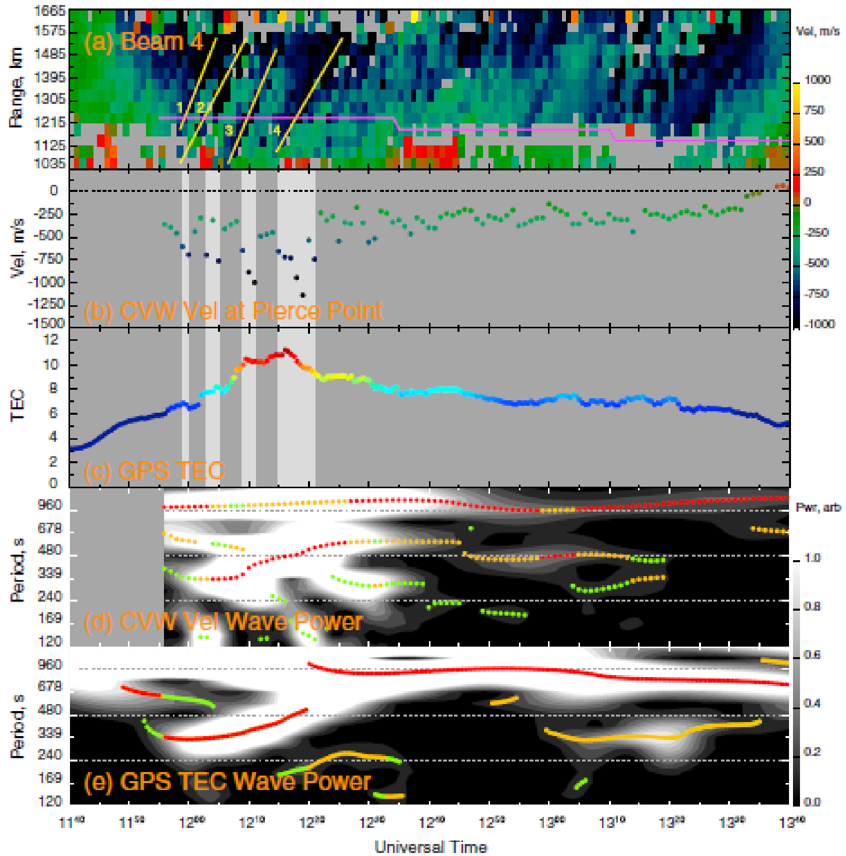
Foster et al. (2004, JGR)



In fact, the color-coded values in the left panel are not electric field vector component, but electric field variability based on the strength of backscatter echoes due to 2-stream instability.

They reported on the presence of SAPS perturbations with a period of about 5 mins. Due to the limitation of the Millstone Hill IS radar observations they could not discuss the direction of electric field / ionospheric convection. There are also SuperDARN observations (e.g., Makarevich and Bristow, 2014) although they could not discuss the details of vector electric field / ionospheric plasma convection.

Makarevich and Bristow (2014): mid-latitude SuperDARN observation of SAPS wavy structure (SAPSWS)



- Discussed the characteristics of SAPSWS (with 5-10 mins) signature together with GPS TEC variations.
- Reported on the relationship between TEC and flow velocities demonstrating the importance of ionospheric feedback process.
- Included as one of the main achievements of the mid-latitude SuperDARN in the forthcoming mid-latitude SuperDARN review paper (to be submitted very soon).

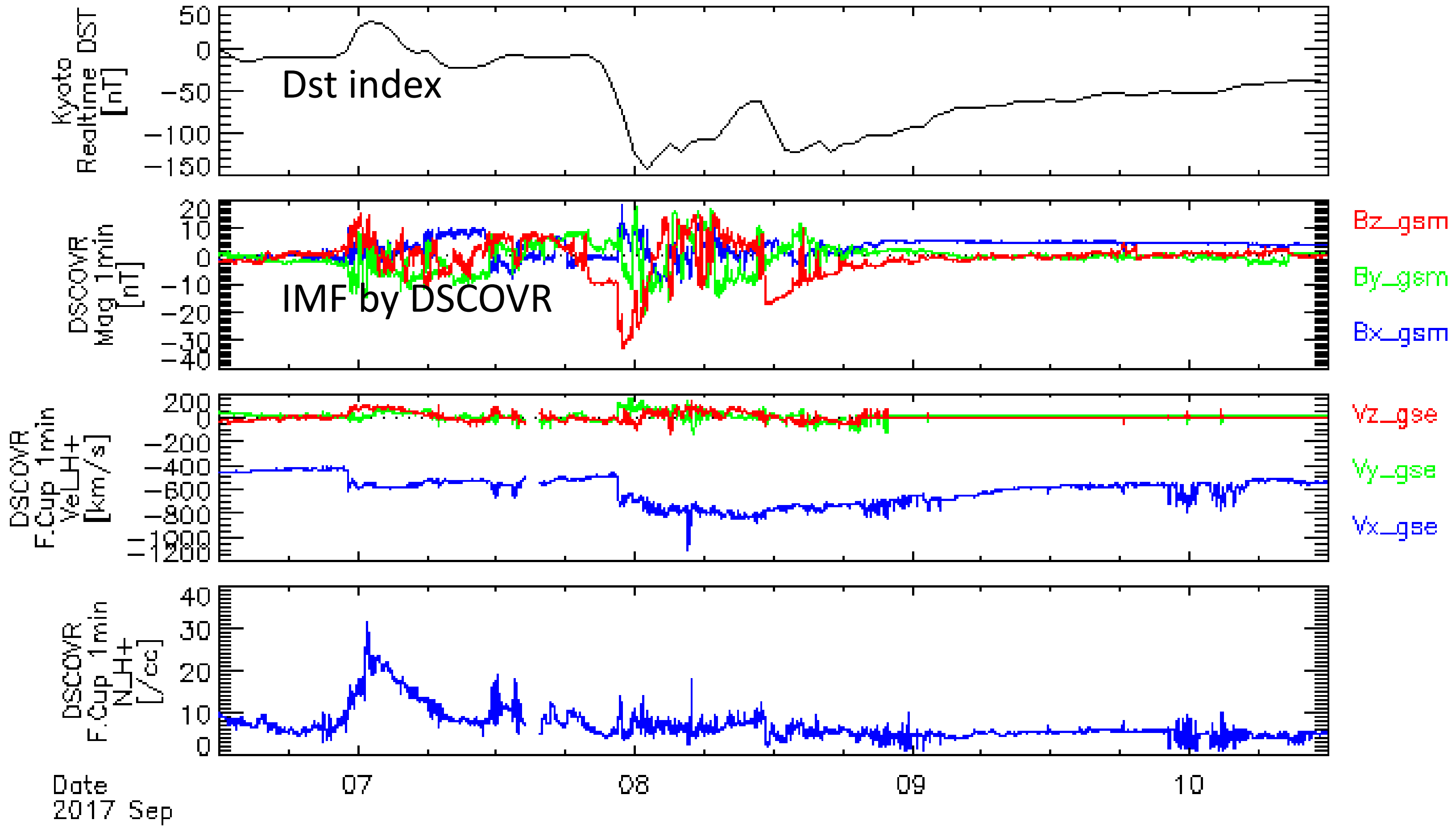
Possible parameters for determining SAPS intensity

- Ionospheric origin
  - Ionospheric conductivity due to
    - Solar radiation (EUV etc.)
    - Energetic particle precipitation
- Magnetospheric origin
  - IMF effect
  - Substorm / storm effects (particle injection, ring current)
- Question:

1. How do SAPS flows grow and decay in the framework of global convection?
2. What is the relationship between the SAPS / global convection and the IMF changes / substorms?
3. What are these SAPS /global convection changes associated with changes in the (inner magnetosphere)?
4. What are the relationship between the perturbations in the SAPS structure with different temporal scales?

Hori et al. [2018, in preparation]

Dst, Solar wind/IMF for 12:00, Sep. 6 – 12:00 Sep. 10



Event analysis on 8 Sep 2017

- During a moderate geomagnetic storm
- Two negative peaks in Dst
  - at ~1 UT (-124 nT) (USA sector near midnight) (Hori et al., 2018, in preparation)
    - RBSP / SD conjunction
  - at ~16 UT (-108 nT) (Japanese sector near midnight)
    - Possibility of Arase / SD conjunction

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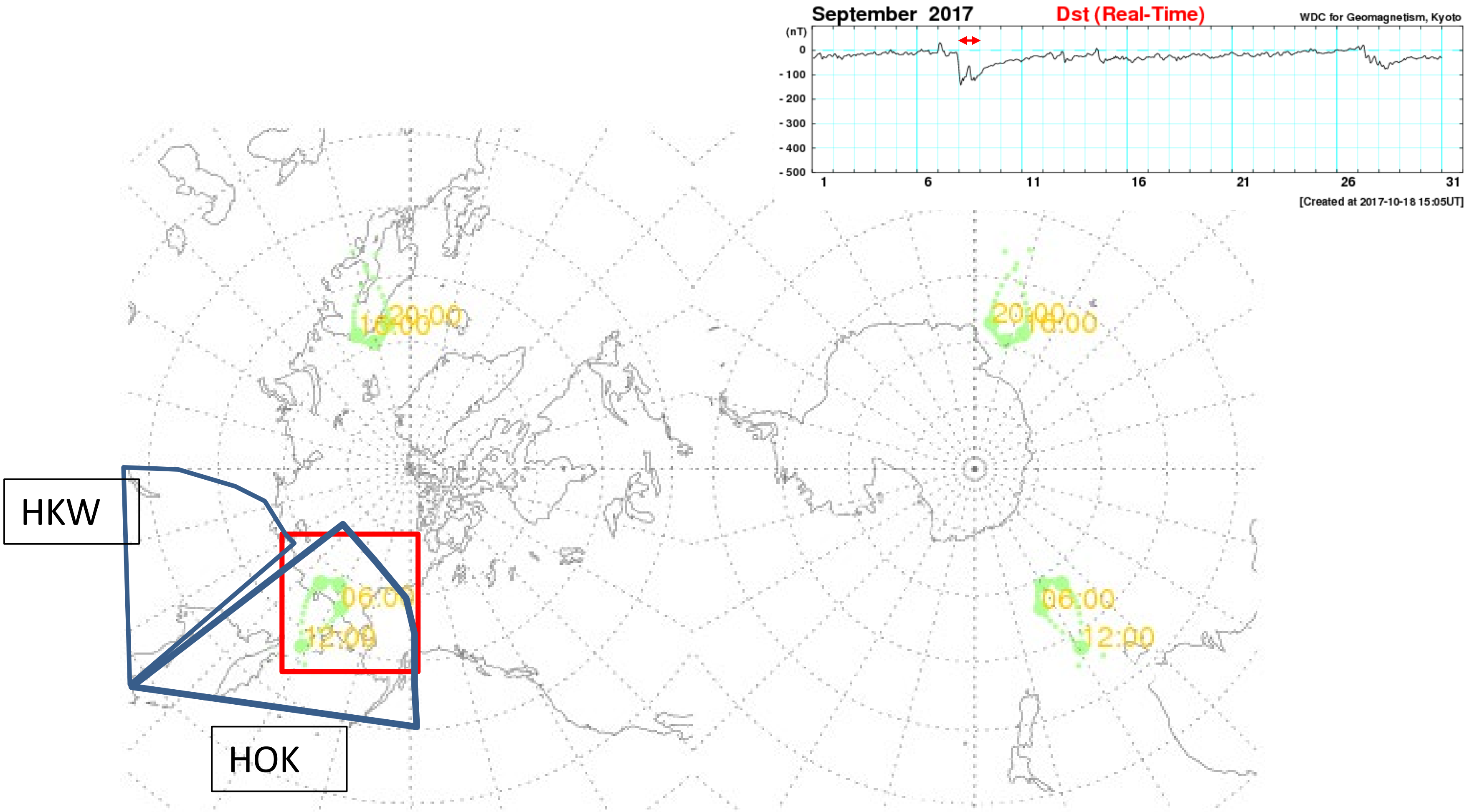
Event study

- Event on Sep 8, 2017 (Arase / SD conjunction)
- Hokkaido West (HKW) was operating with stereo mode, chA: normalscan at ~10.8 MHz, chB: fixed beam (beam 10) at ~9.56 MHz
- Both radar observed SAPS perturbations with a variety of temporal scales

- HKW stereo mode (with chA normalscan and chB fixed beam) has been fully operational since June 14, 2017 (it started operation in October 2014 but suffered several hardware / setting problems).

ERG footprints on September 08, 2017

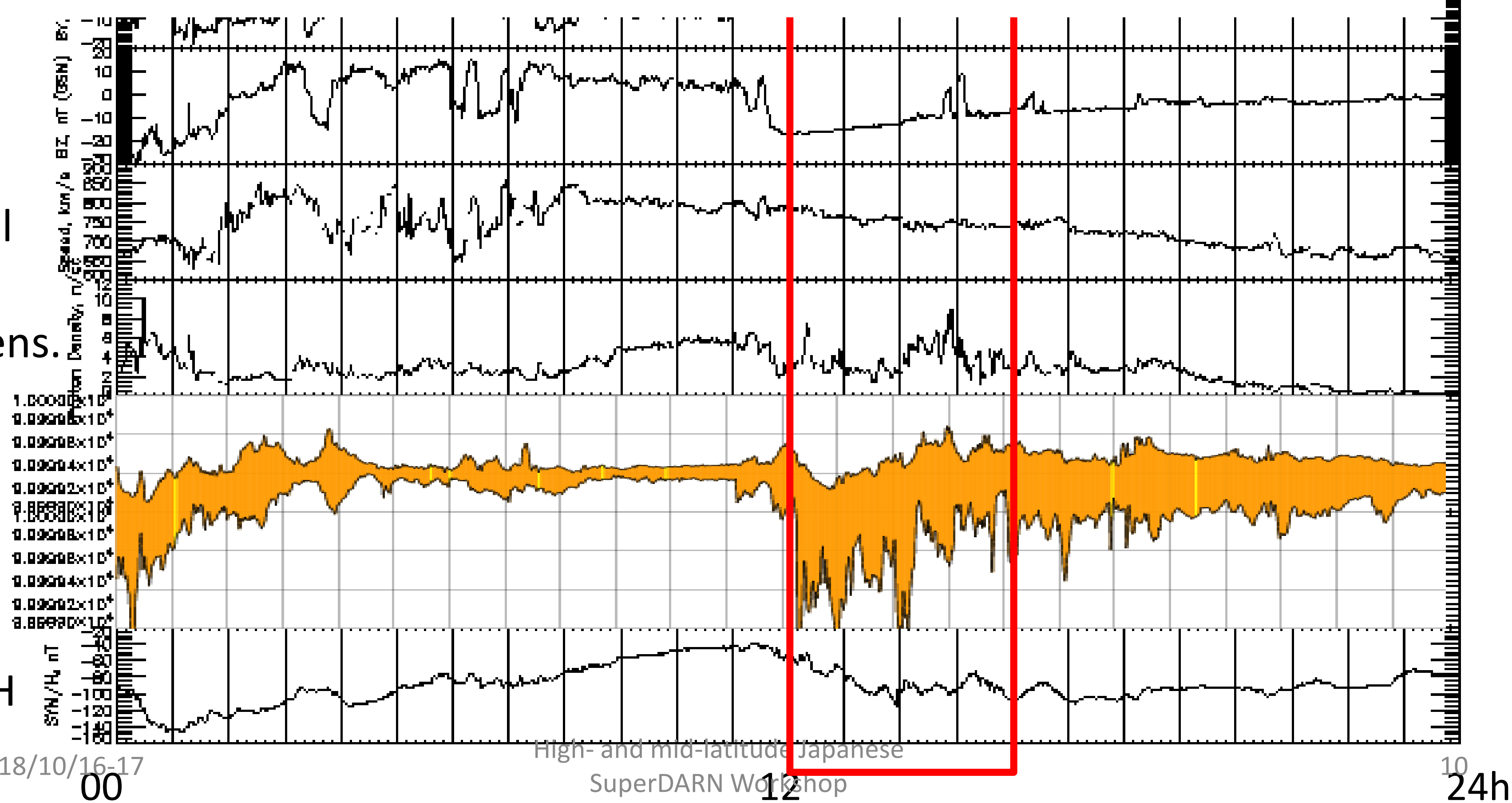


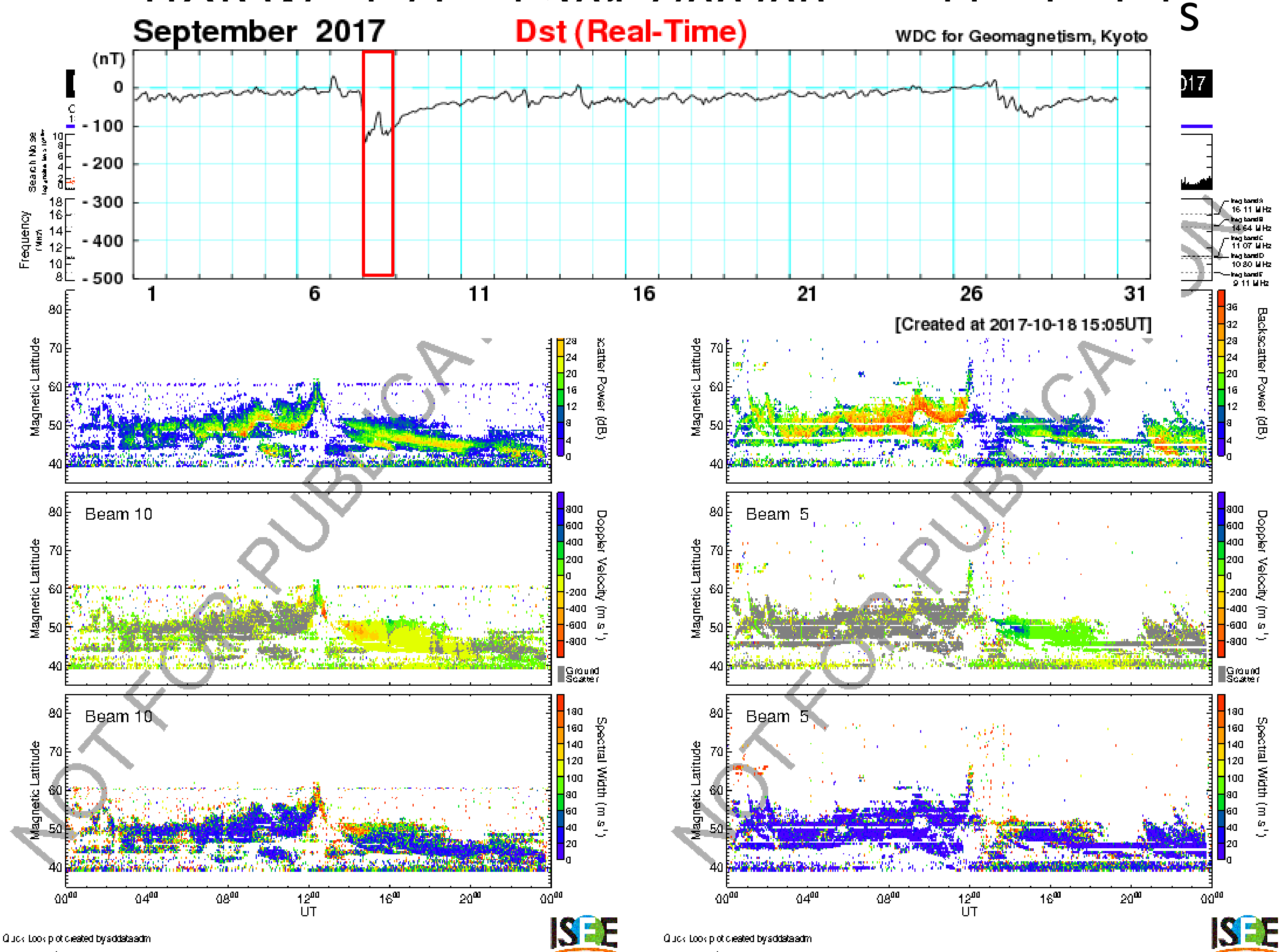
ERG / Arase footprint was located in the FOV of Hokkaido East: HOK (and near Hokkaido West: HKW), providing good opportunity for studying SAPS / wavy structures and its relation to geospace dynamics.

Sep 08, 2017: solar wind / geomagnetic activity

Period of interest: 12-16 UT on Sep 08 , 2017

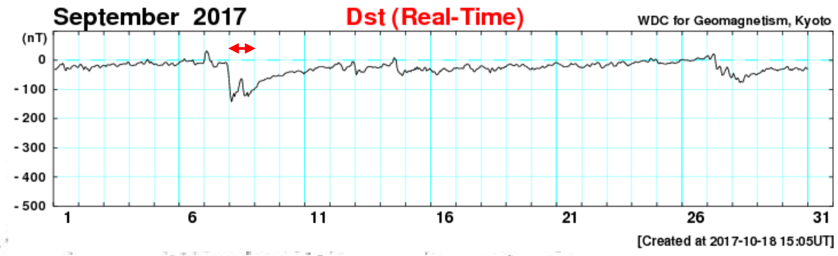
- Main phase of weak geomagnetic storm
- IMF was basically southward
- AL/AU were very active (min. AL ~ -2000 nT)

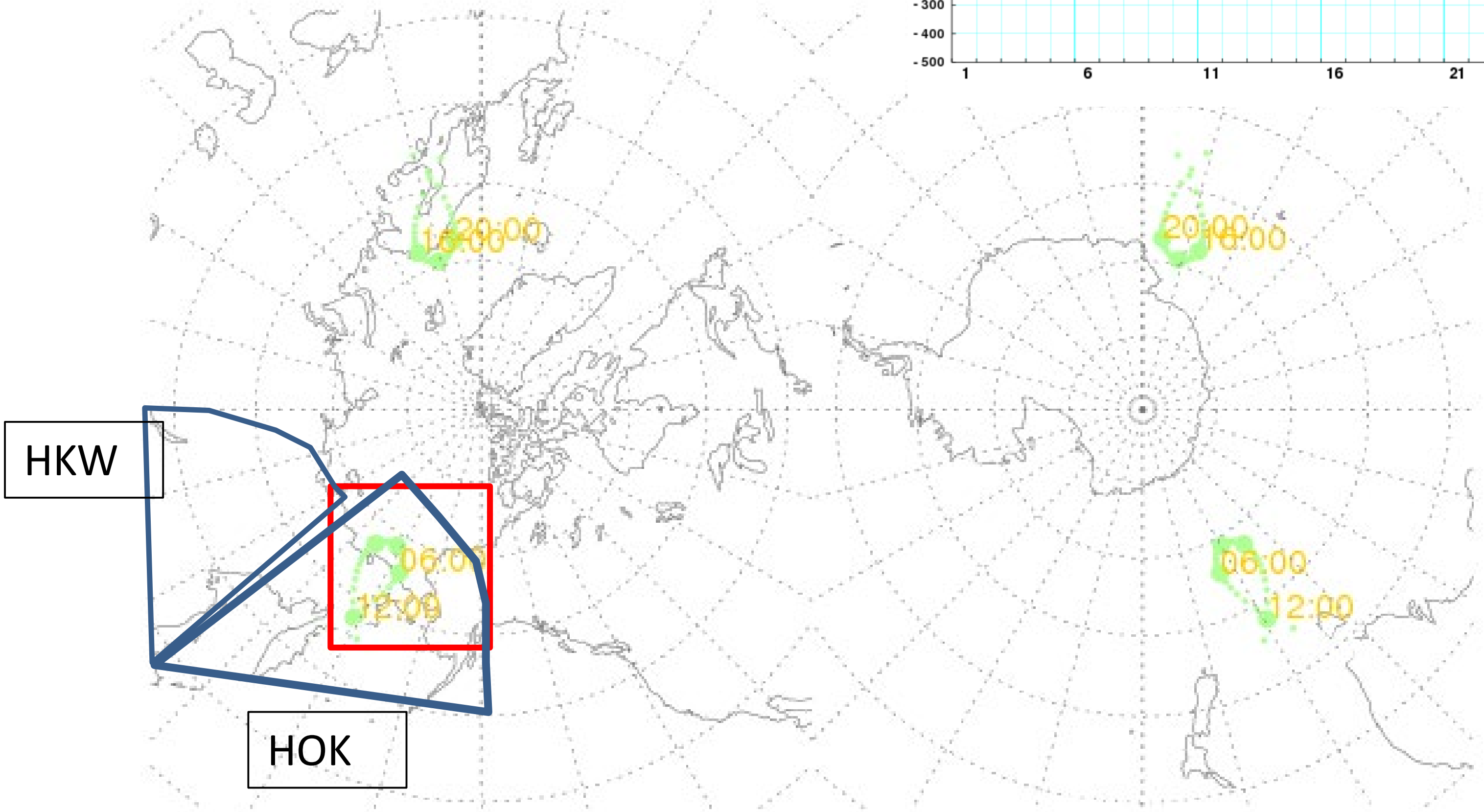




SuperDARN Quicklook plots at: http://cicr.isee.nagoya-u.ac.jp/hokkaido/

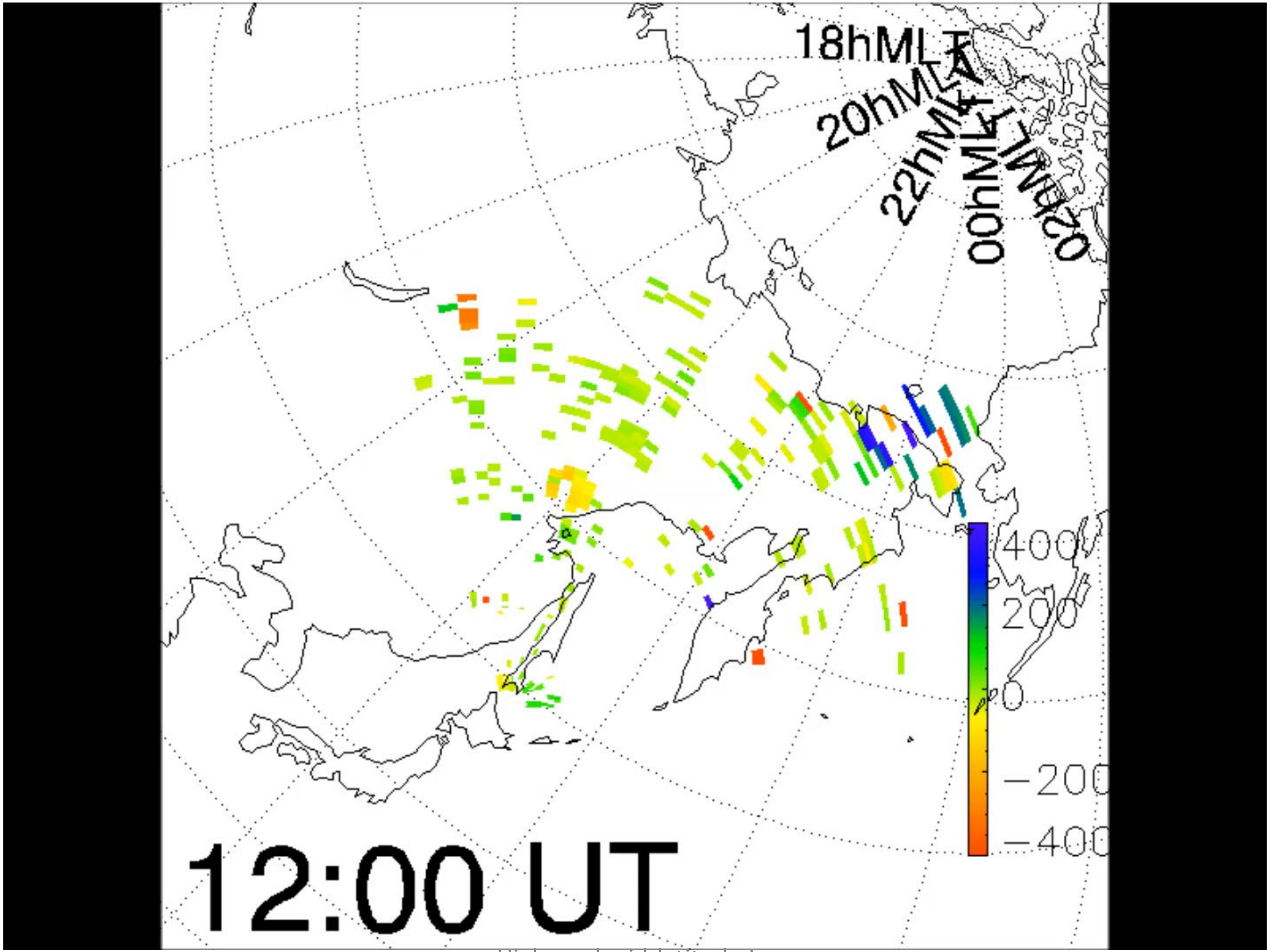
ERG footprints on September 08, 2017



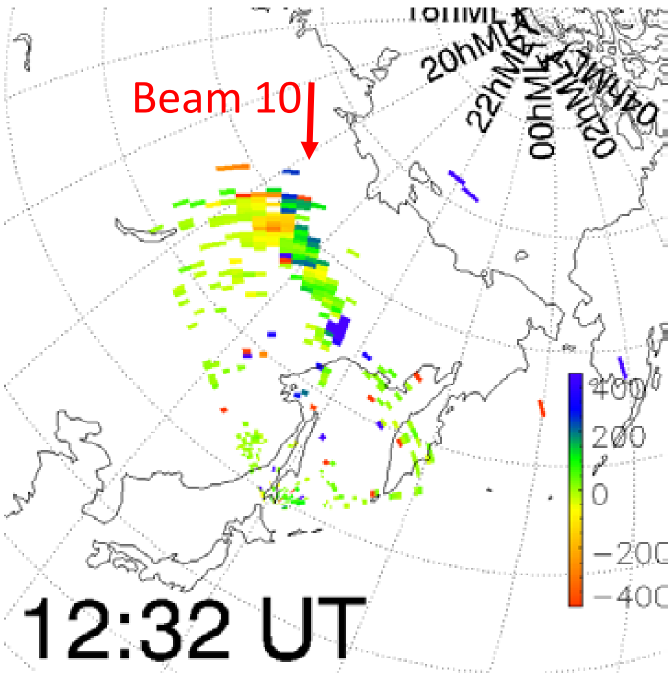


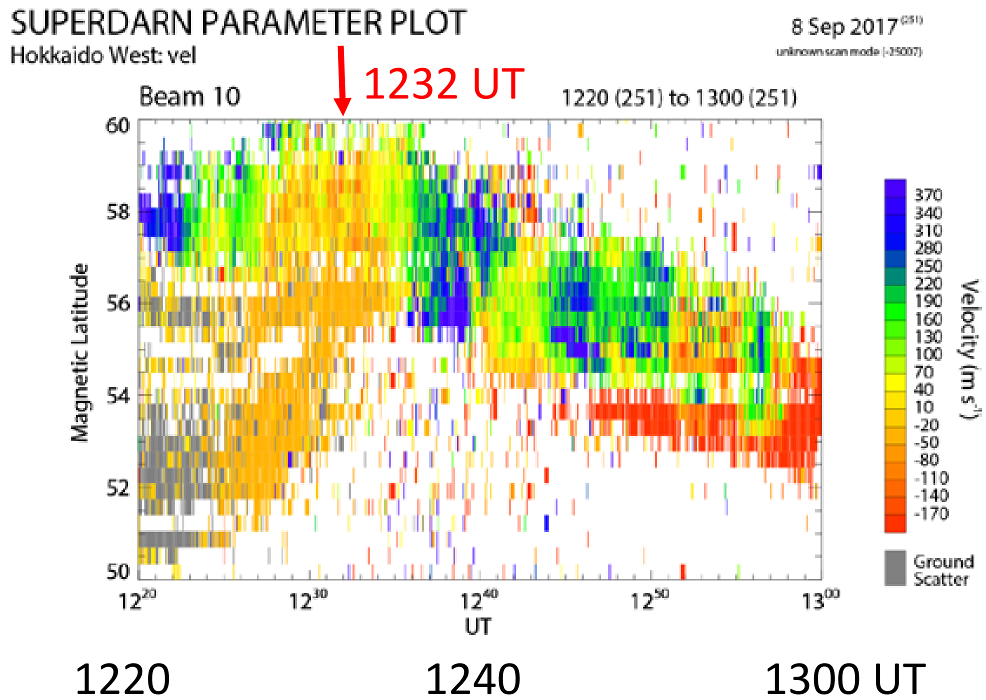
ERG / Arase footprint was located in the FOV of Hokkaido East: HOK (and near Hokkaido West: HKW), providing good opportunity for studying SAPS / wavy structures and its relation to geospace dynamics.

2017.9.8 hok/hkw movie



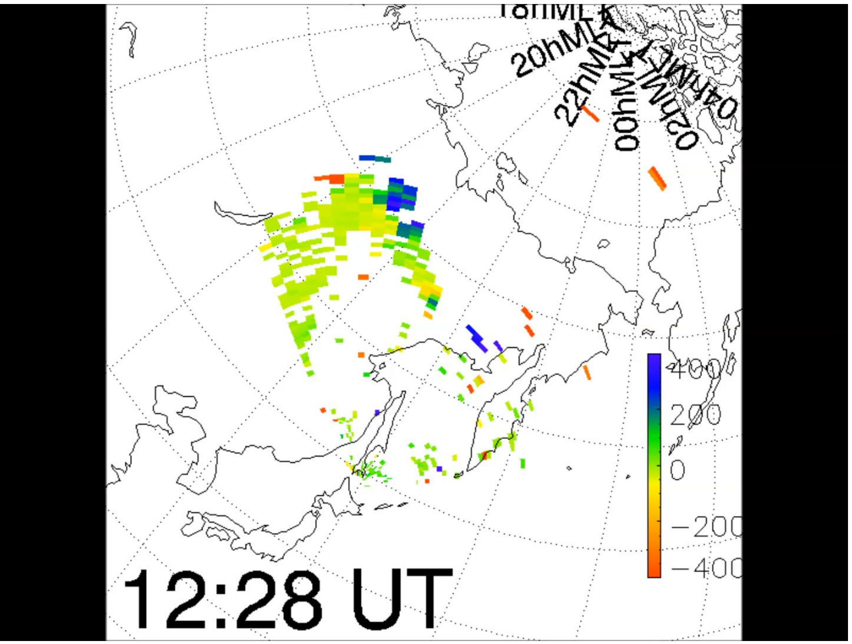
Stereo-mode observation of SAPS structure using the SuperDARN Hokkaido West radar (8 Sep 2017)

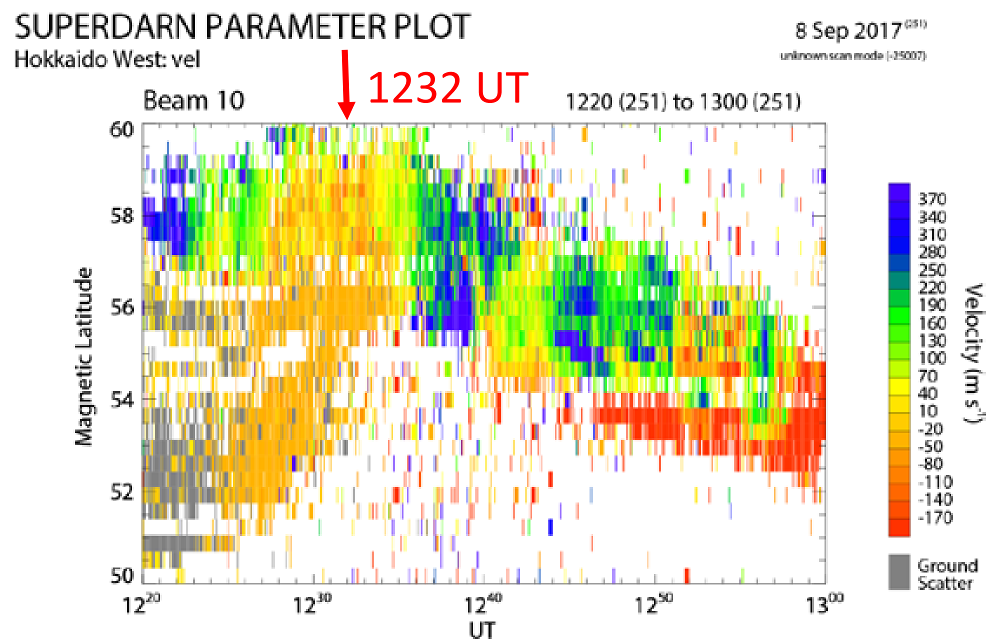




- Hkw observed SAPS variations with temporal scale ranging from 1 minute to a few tens of minutes.

Stereo-mode observation of SAPS structure using the SuperDARN Hokkaido West radar (8 Sep 2017)





1220 1240 1300 UT

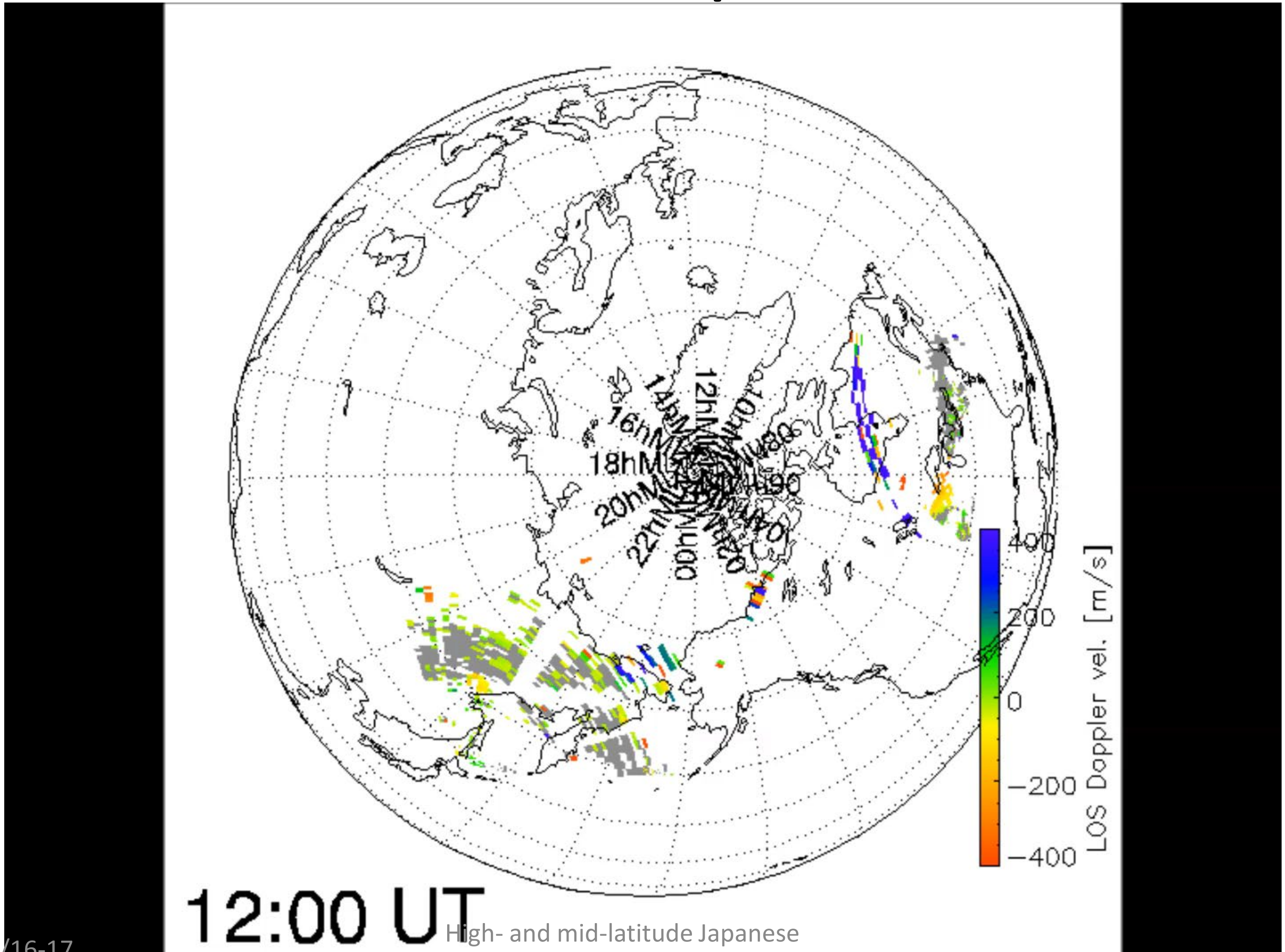
- Hkw observed SAPS variations with temporal scale ranging from 1 minute to a few tens of minutes.

Discussions

There are various temporal scales of the subauroral flow variations, with main scales at ~10 min and ~1 min.

- 10 min variations
  - Probably same as Foster et al. (2004) and Makarevich and Bristow (2014) SAPSWS
- 1 to 1.5 min variations
  - Very similar to Pi2 pulsations, but…
    - The longitudinal wavelength (~ 10 degrees: m-number ~ 36, corresponding to propagation speed of 0.85 km/s) is much smaller than the typical Pi2 pulsations.
    - The Pi2 pulsation peak in the geomagnetic data is about 10 minute earlier (Norlisk magnetometer data, courtesy of Alexey Pashinin at ISTP RAS SB).
  - High m-number poloidal waves (e.g., Le et al., 2017 GRL and references therein)?
    - Similar period (>~ 100 s) and m-number (>~15), whereas their event continues longer (up to ~45 min) than the present event (~ 10 min).
  - Giant pulsations?
    - Located at too low geomagnetic latitude (~58 degrees)
  - The generation mechanisms of these variations have not been fully understood.

Overall SuperDARN activity during 12-16 UT on Sep 08, 2017



Summary of observations (2017/09/08 storm event)

- The storm contained 2 negative peaks in Dst (at 1 UT and 16 UT)
- During the first peak, the US sector SD radars observed westward propagating wavy structures (results by Hori et al.).
- During the second peak, the SuperDARN Hokkaido East / West radars observed wavy / propagating SAPS structure during 12-13 UT, followed by steady SAPS structure for 13-15 UT.
- With the 'stereo' mode it is possible to investigate short-time (3 sec) variation of the SAPS structure and two-dimensional wave SAPS structure (every 1 min), which will provides clues to understanding the generation mechanisms of SAPS perturbations with various temporal scales, ranging from ~ 1 min to ~10 mins.
- Origin of ~1 to 1.5 min variation is still not understood yet (Pi2? High m-number poloidal waves?).
- Further analysis, including the collaboration with the Arase ERG data, is now in progress.