PHYSICS AND ENGINEERING PHYSICS

SAPS: Observations with the Hokkaido and King Salmon SuperDARN radars and modelling

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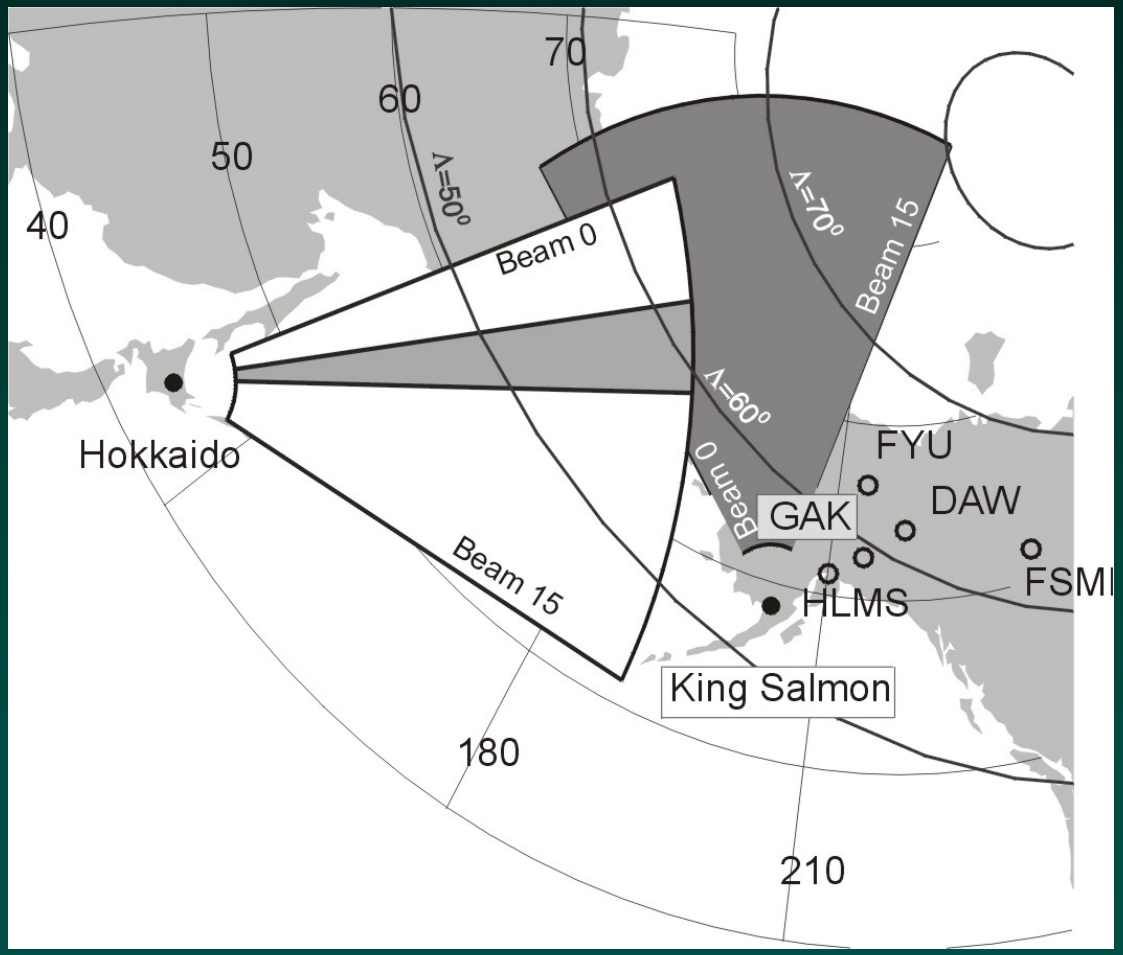
Initial thoughts

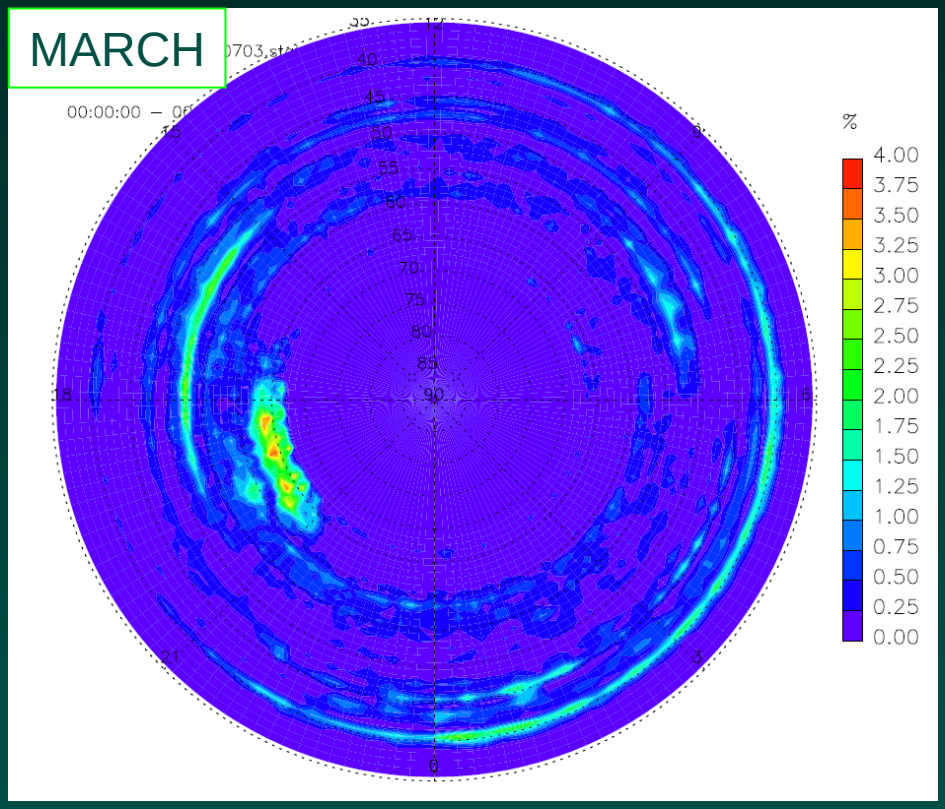
- Low-latitude location of Hokkaido should be advantageous for detection of PJ within SAPS flows, very fast streams outside the auroral oval
- Does Hokkaido see fast flows?
- If yes, do these flows show detached PJ features?
- Earlier I looked at fast flows seen by the King Salmon (KS) SD radar –close to Hokkaido FoV. I concluded that King Salmon sees fast flows at the equatorward edge of the oval. These flows were setup by the subtorm-related electrodynamics. Difficulty was that the KS radar cannot detect any echo below ~60 deg. So, is Hokkaido luckier?

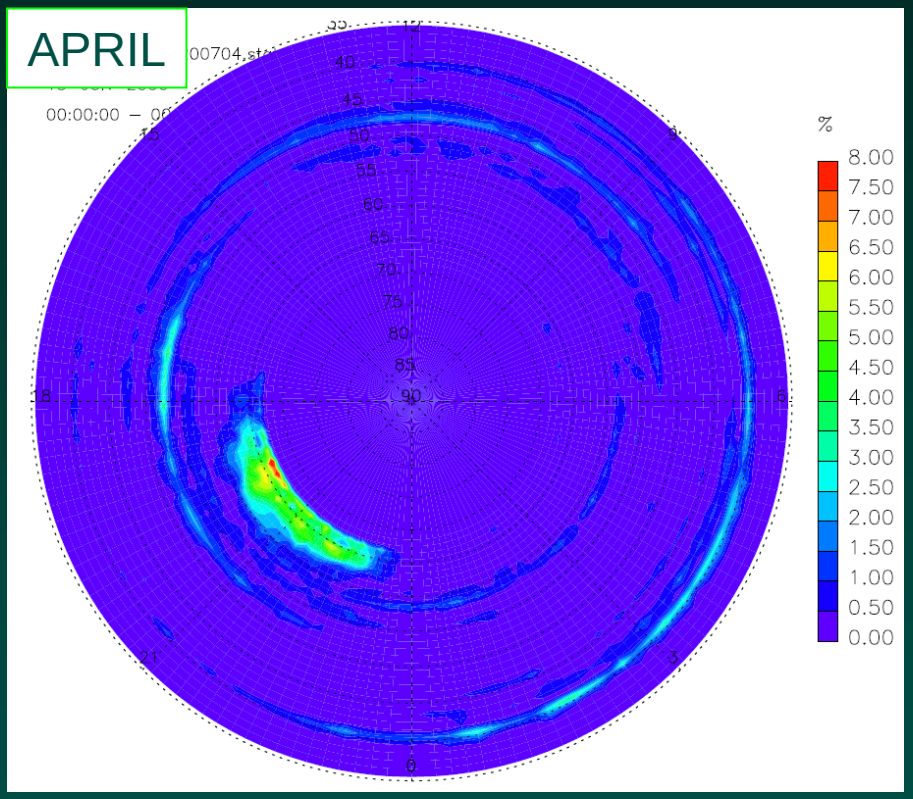
Hokkaido and King Salmon FoVs



Hokkaido can reach (for 2007) MLAT=70 in low number beams 0-7. There is overlap with King Salmon

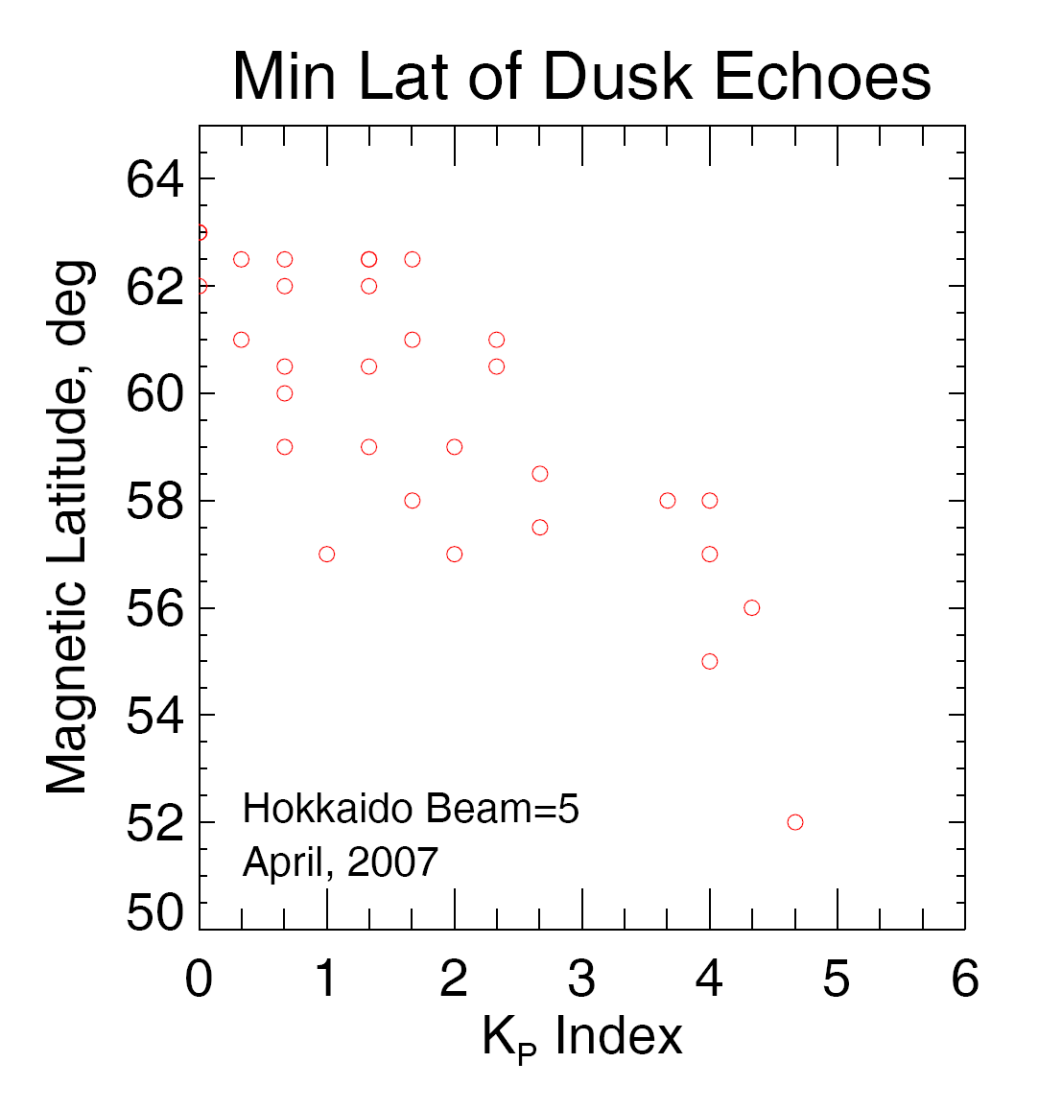
Hokkaido echo statistics for March/07 and April/07, beams 4,5,6





In beams 4-6, duskside echoes are quite frequent comparing to other types, ~ 5% of the time

Point #1: Hokkaido dusk echoes minimum latitude depends on Kp



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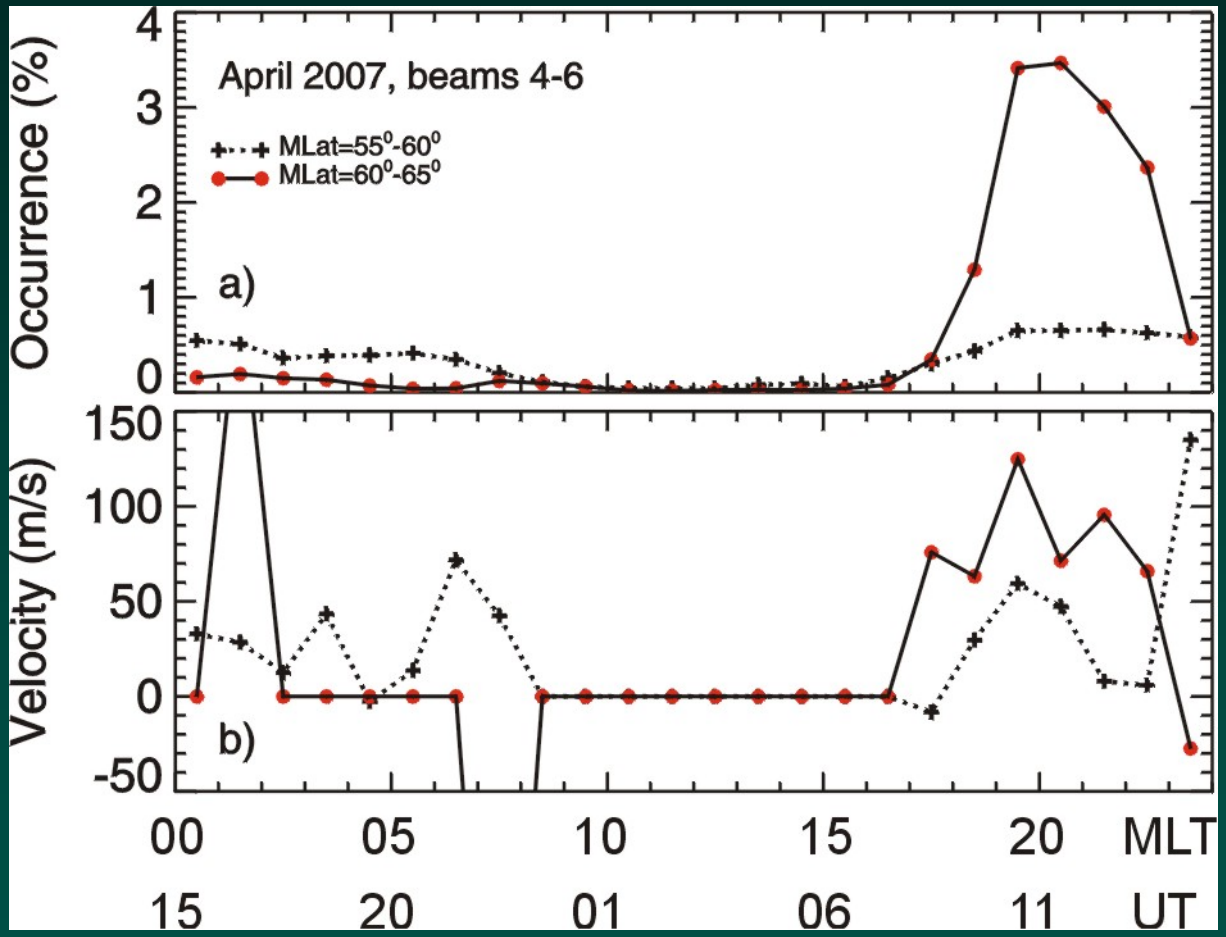
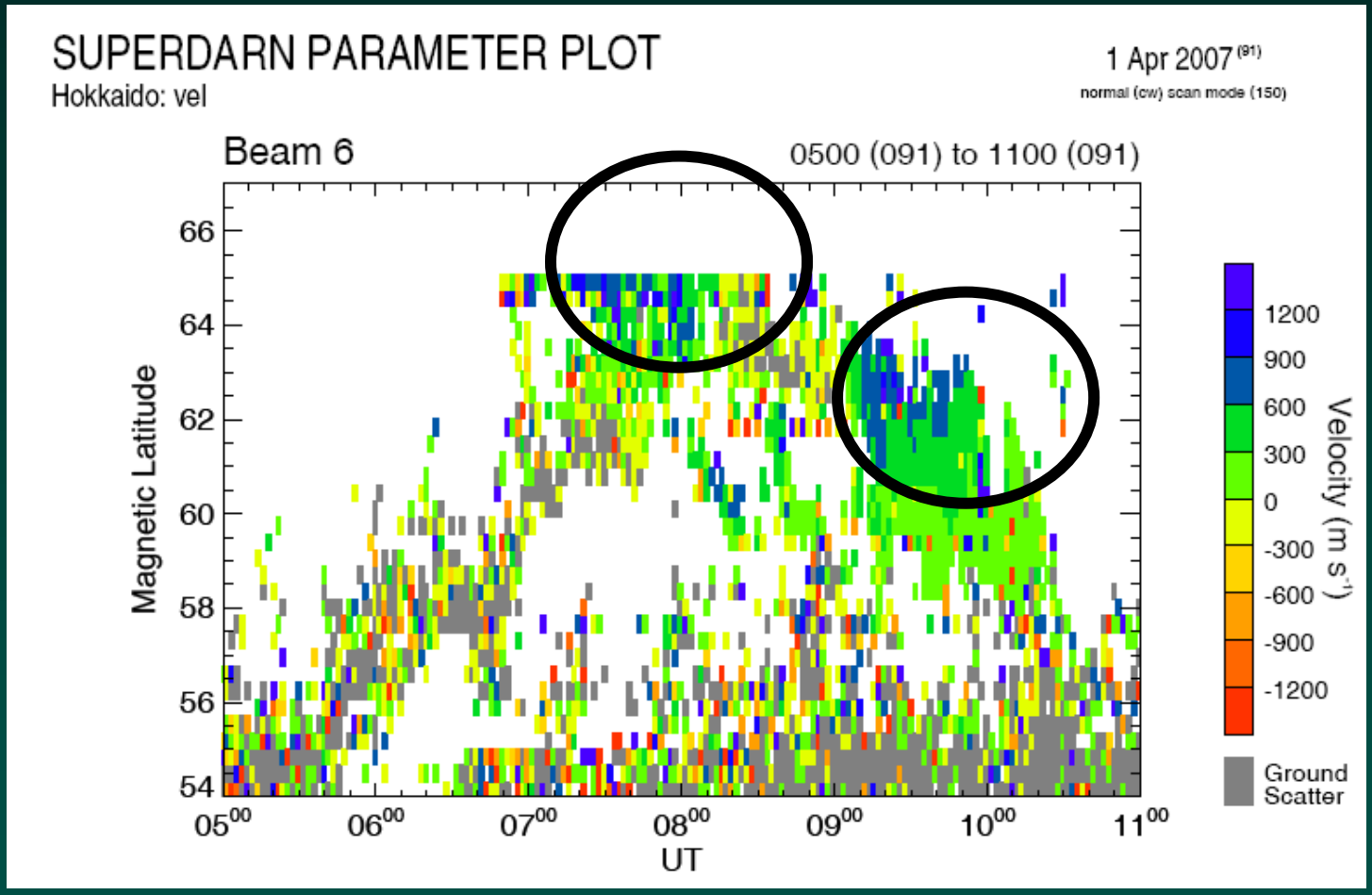
Hokkaido occurrence rate and velocities in two MLAT bands



In the evening sector, typical velocities are ~ 150 m/s.

Hokkaido: April 1, 2007
Unusually high-velocity dusk echoes

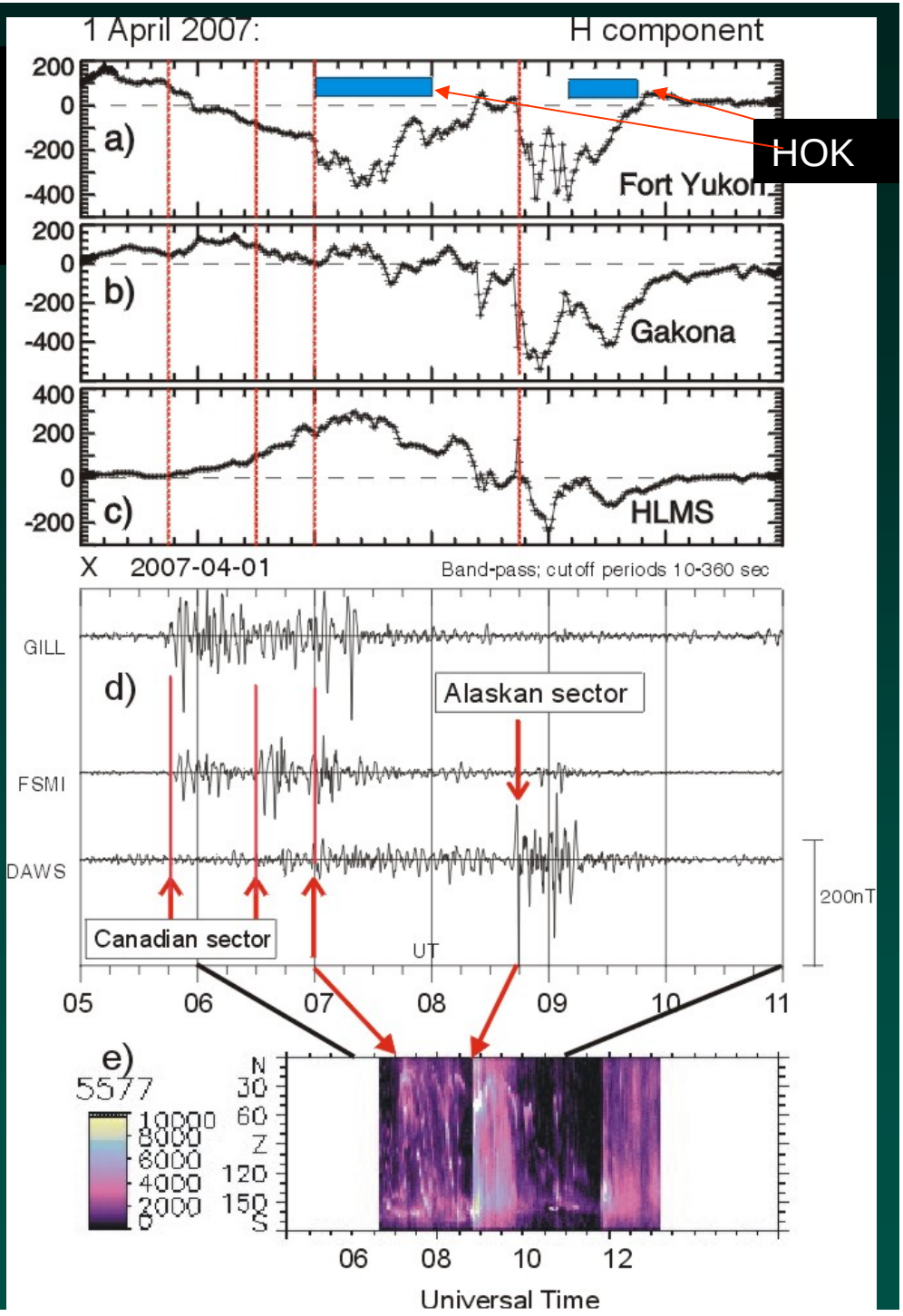


Are these SAPS flows, streams outside the auroral oval?

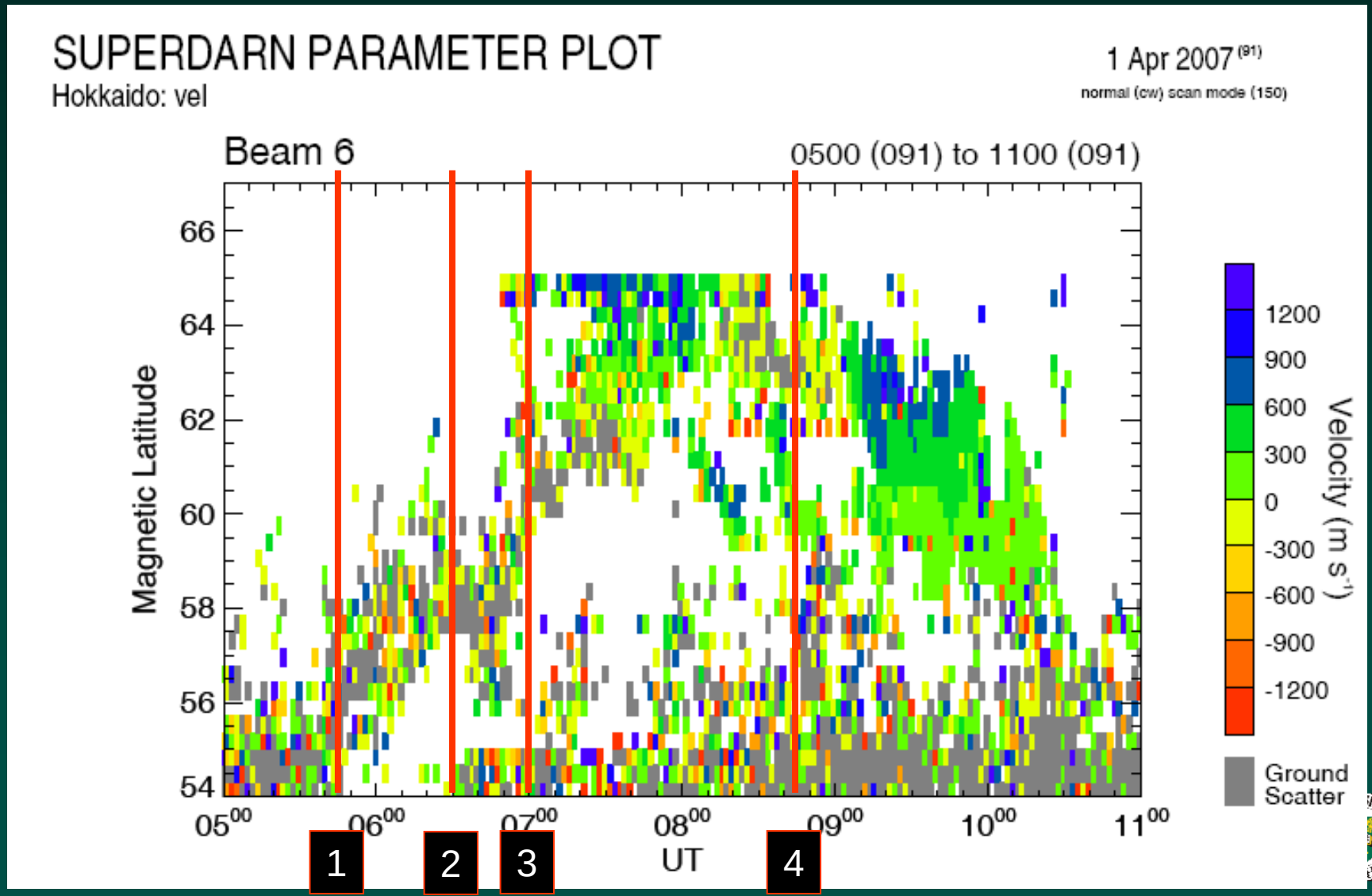
Magnetic perturbations over Alaska

Pi2s:
Multiple substorm onsets

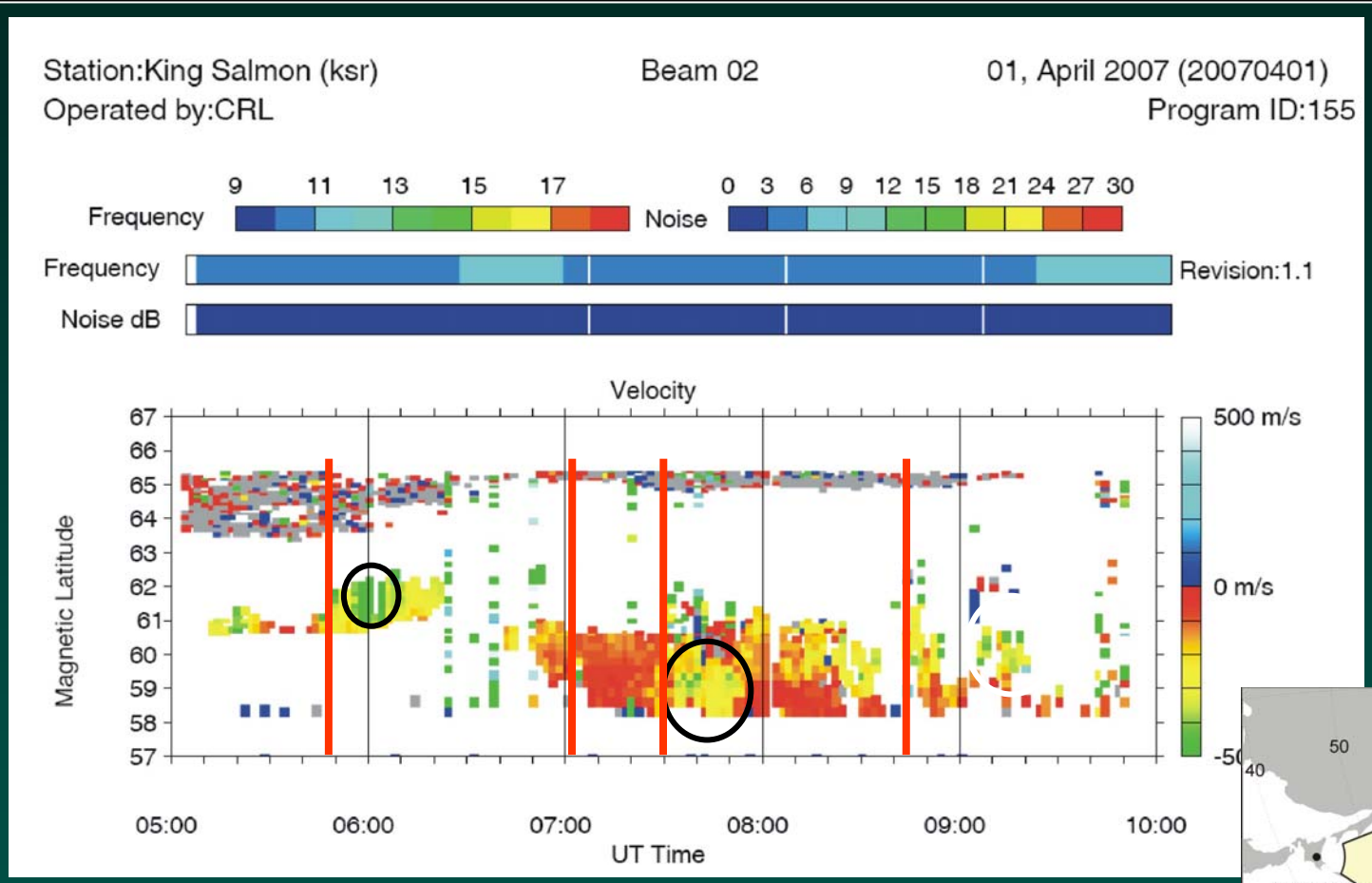
Poker meridional photometer

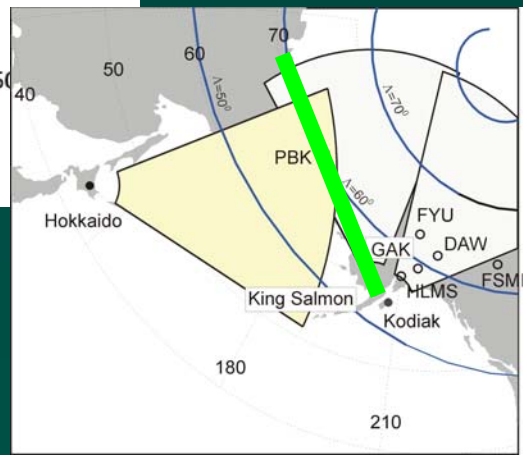


Hokkaido, Apr 1, 07:
Fast flows and substorm onsets



King Salmon: April1, 2007, along L shells, low-velocity E-region echoes



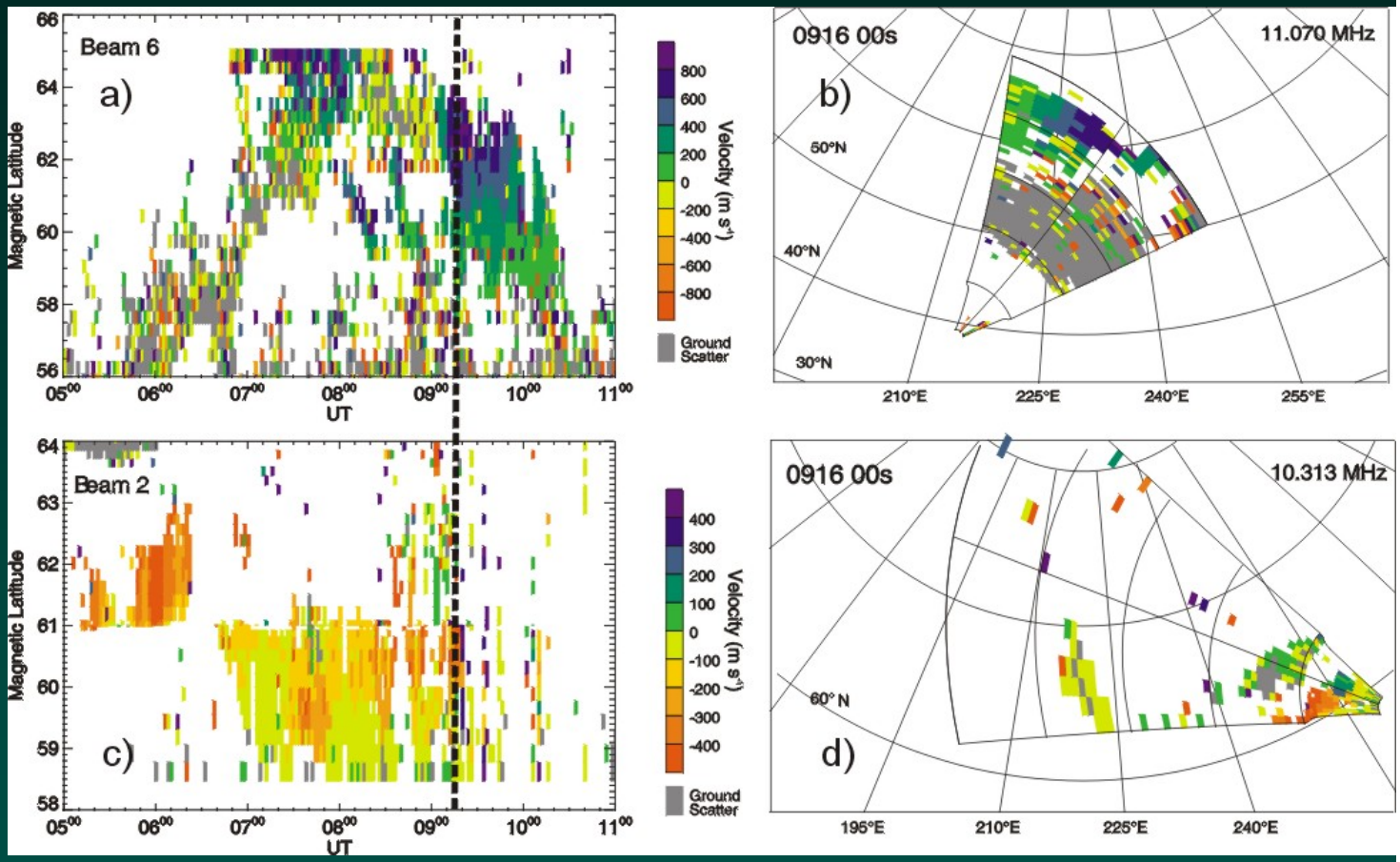


Time of Hokkaido echoes

HOK and KSR velocities: Temporal variations and maps

Hokkaido

King Salmon



Vertical line marks the time for the velocity maps

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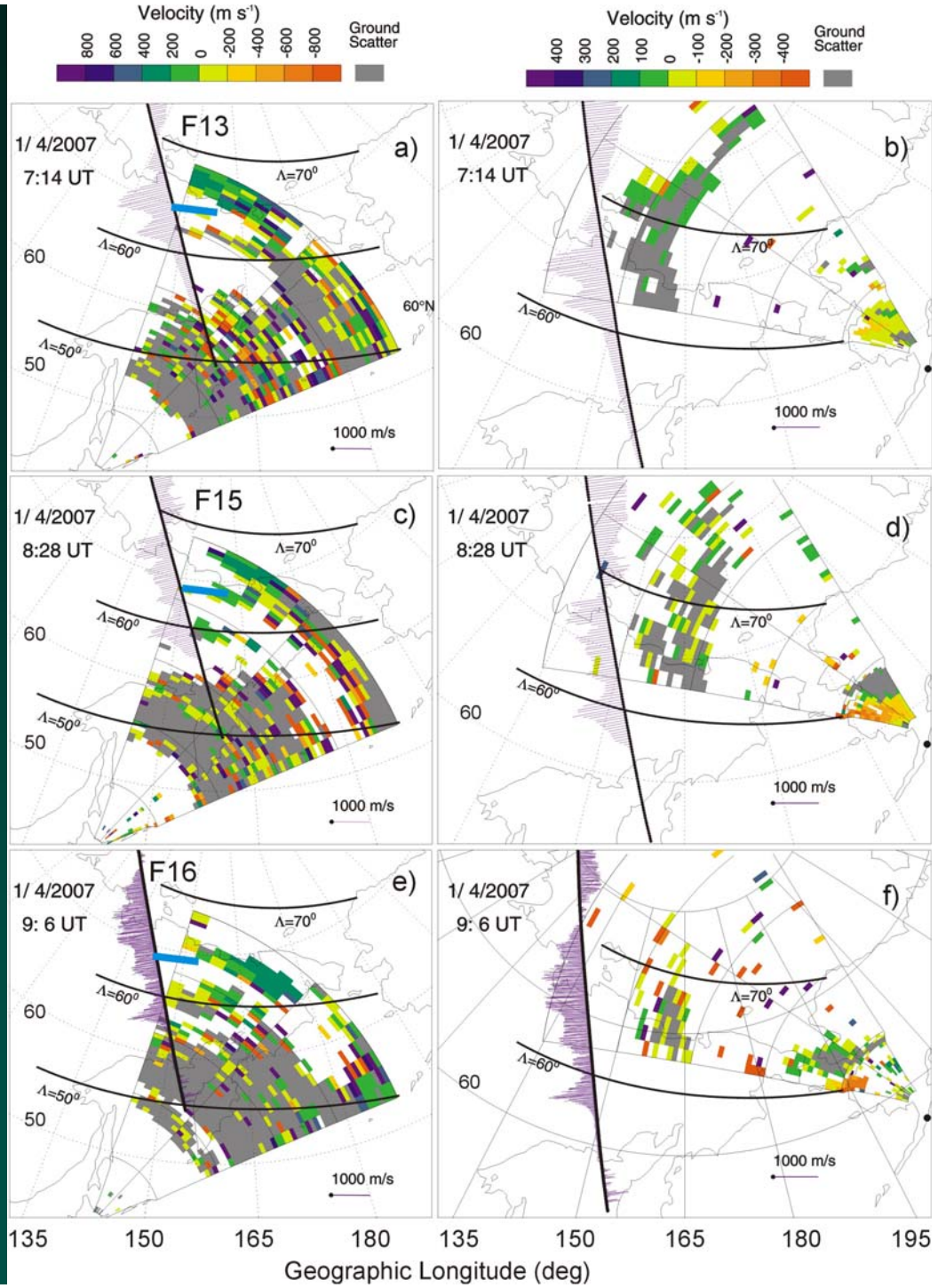
DMSP ion drift data and corresponding HOK maps

Signatures of SAPS can be identified, if you know where they are supposed to be from DMSP data



Comprehensive Ring Current Model, can it predict SAPS flows?

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Comprehensive Ring Current Model (CRC Model)

Self-consistently solves the kinetic equation of ring current protons and the closure of the electric current between the magnetosphere and ionosphere

Uses:

1) Tsyganenko magnetic field model
2) Conductance distribution according to solar illumination (IRI) and precipitations (Hardy et al., 1987), Kp dependent
3) boundary condition of electric potential at 66.5 deg as a function of IMF (Weimer, 2001)

Comprehensive Ring Current Model

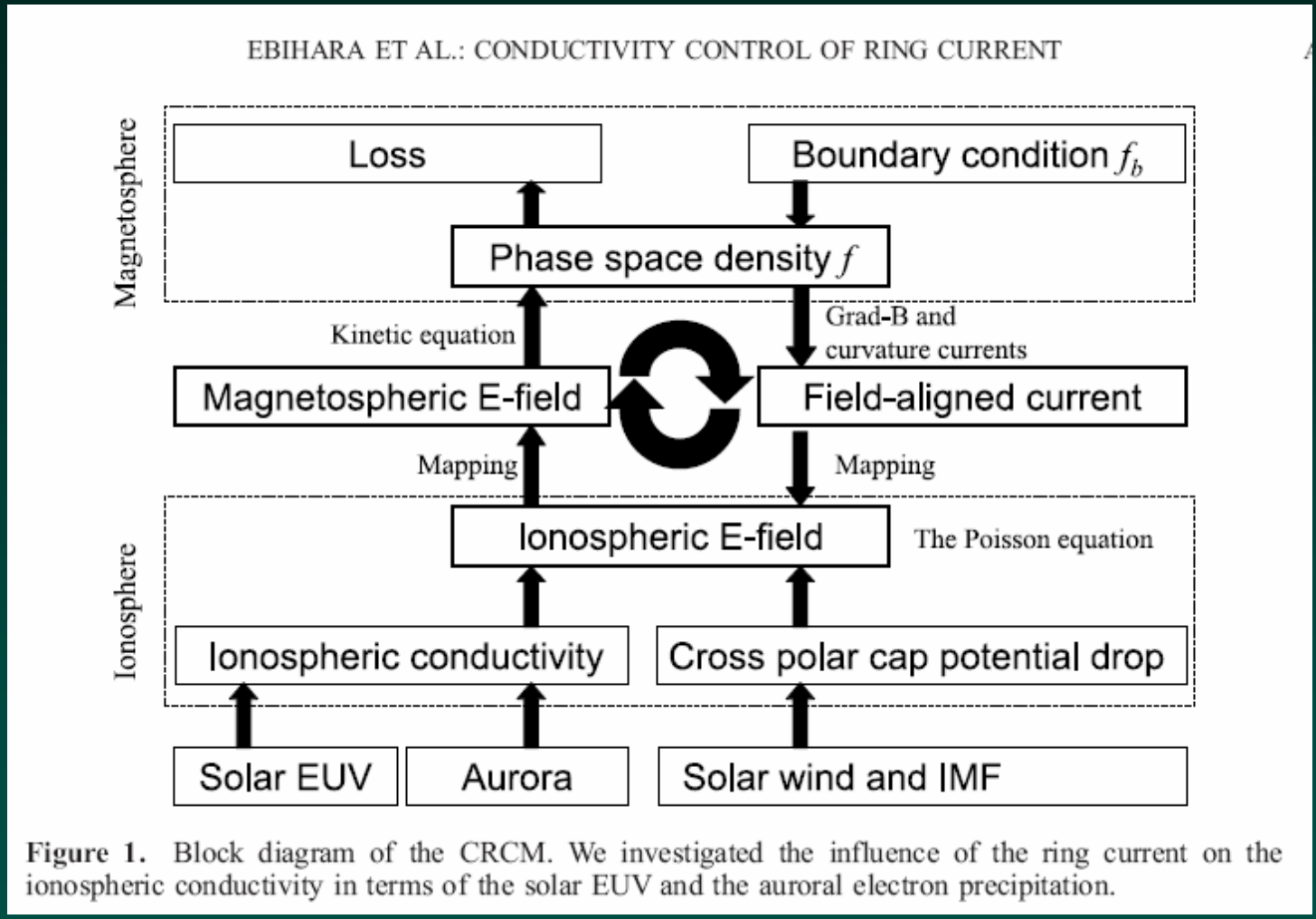

Figure 1. Block diagram of the CRCM. We investigated the influence of the ring current on the ionospheric conductivity in terms of the solar EUV and the auroral electron precipitation.

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Output of the CRC model

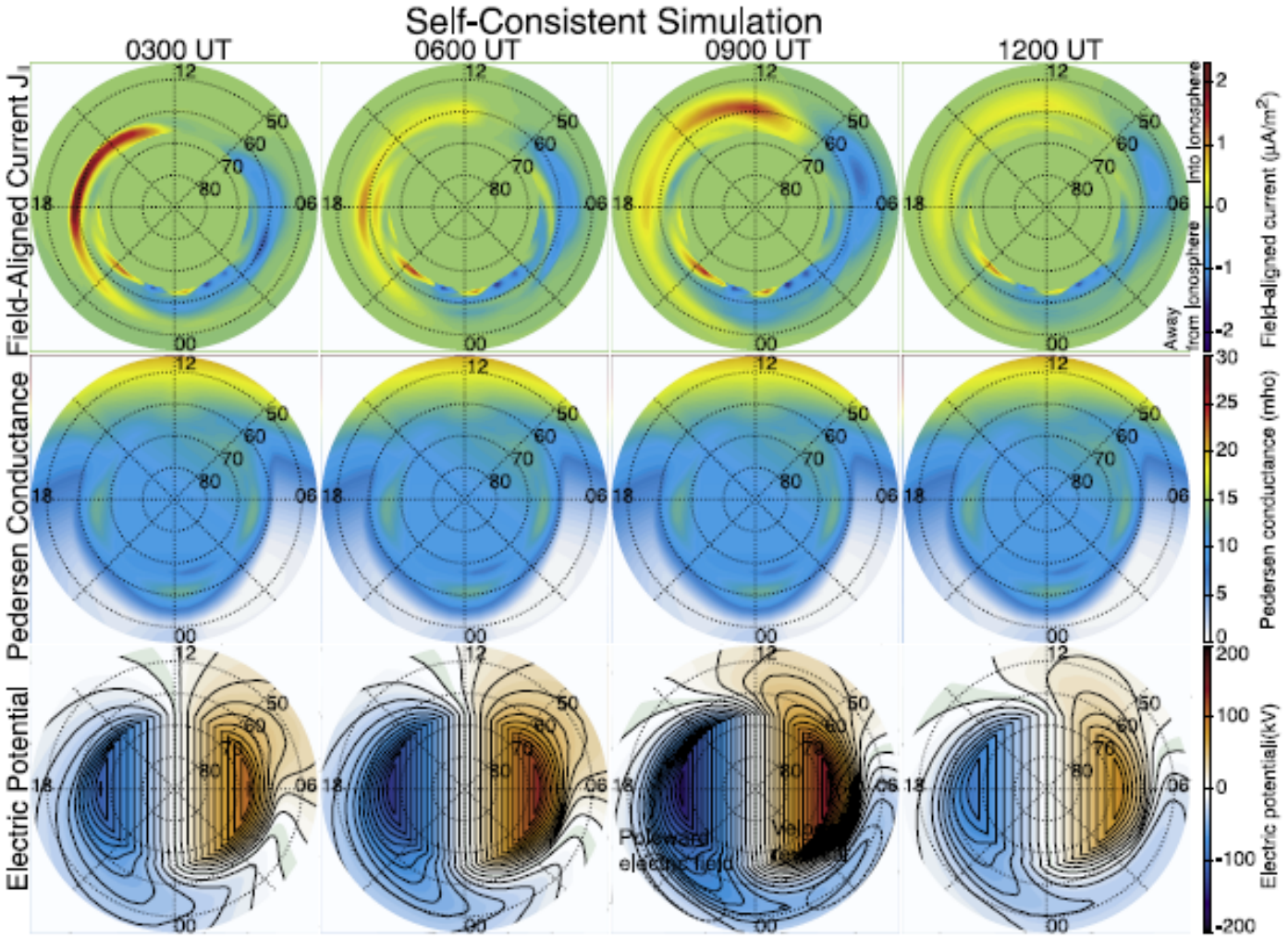
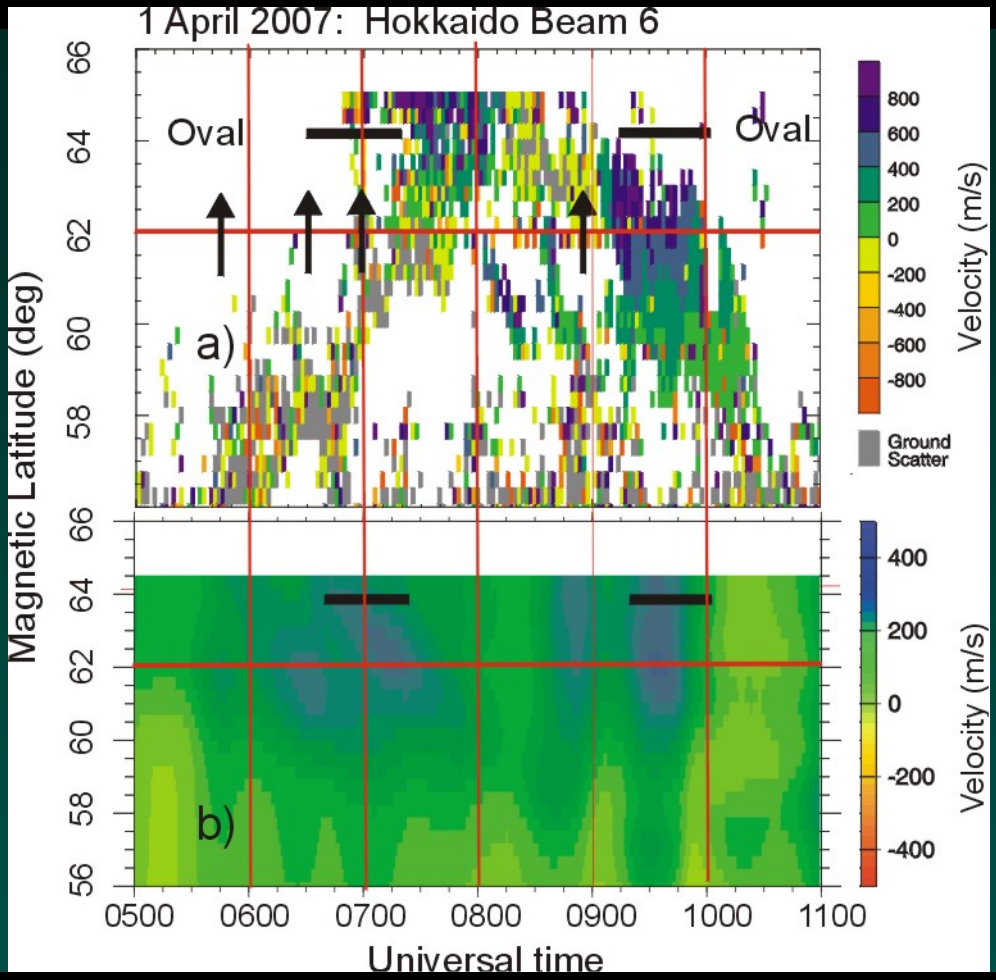


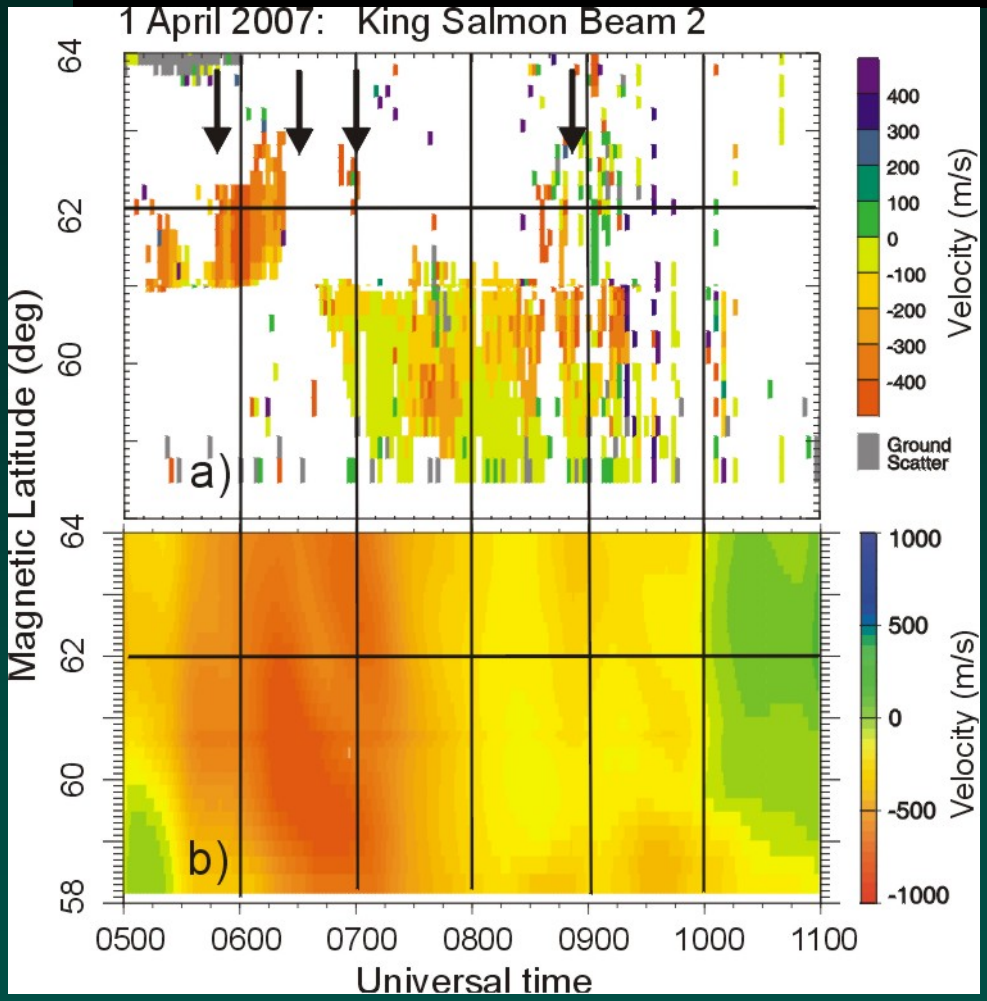
Figure 4. (top) Field-aligned current ($J_{\parallel}$), (middle) half of the two-hemisphere Pedersen conductivity (Σ_P), and (bottom) the electric potential (Φ) in the ionosphere at 100 km altitude in MLT and magnetic latitude coordinates.

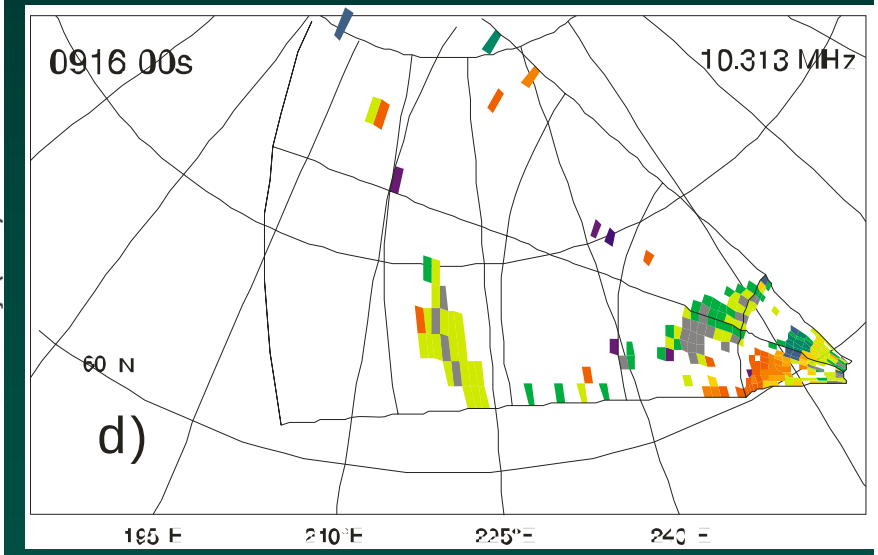
HOK velocity (beam 6) and predictions of the CRC Model



Model predicts well the onset time and rough latitudes. Additional intensifications are expected but they did not occur. The predicted velocity is below the observed one.

KSR velocity (beam 2) and predictions of the CRC model



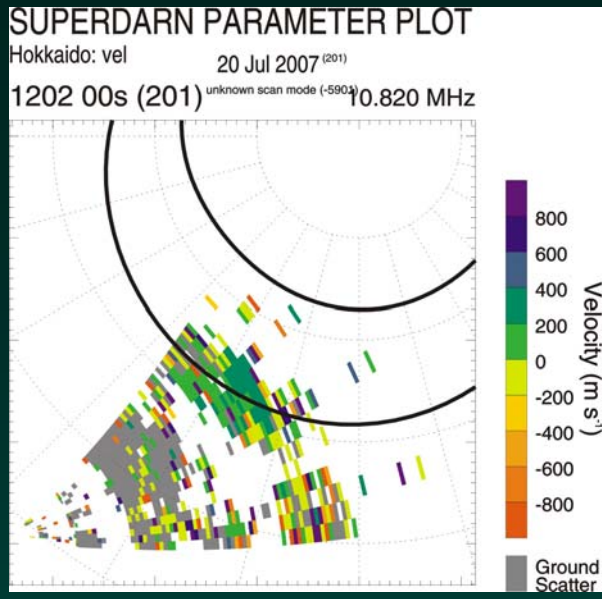


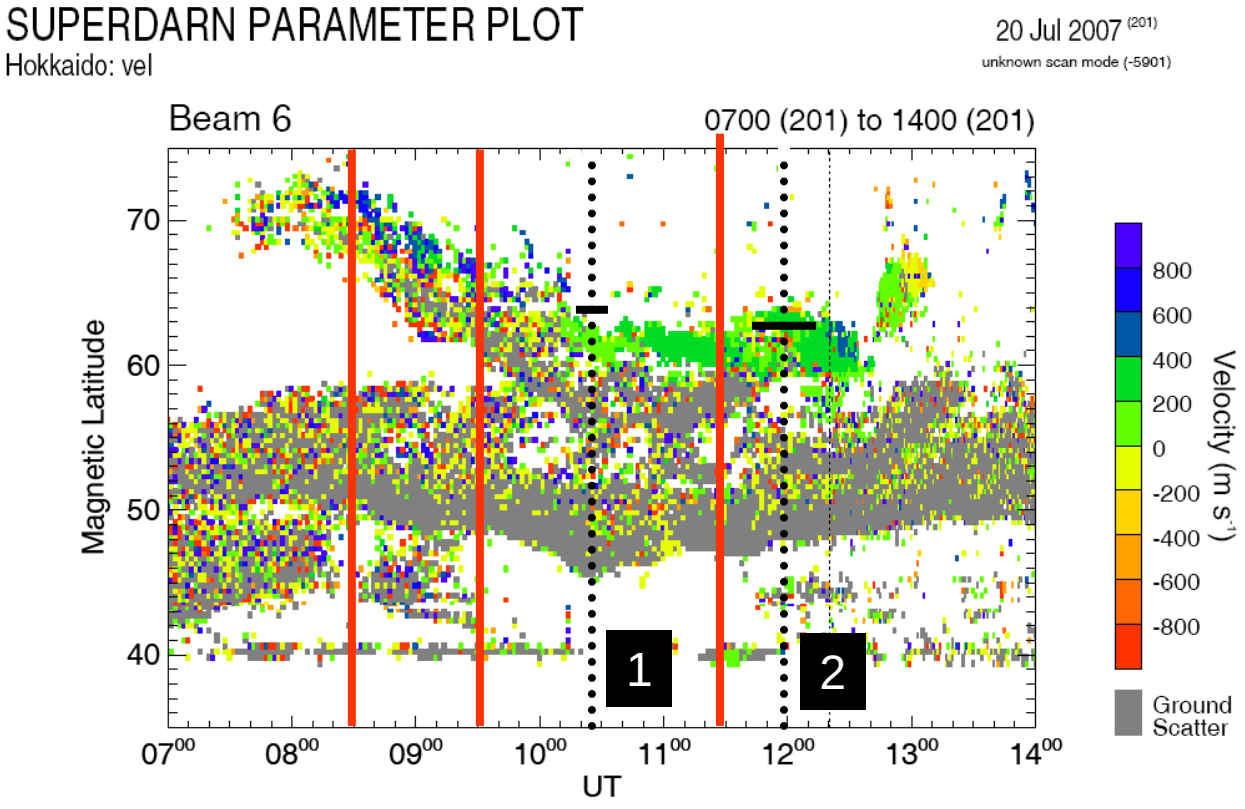
Predicted velocities are too high as compared with observed ones.

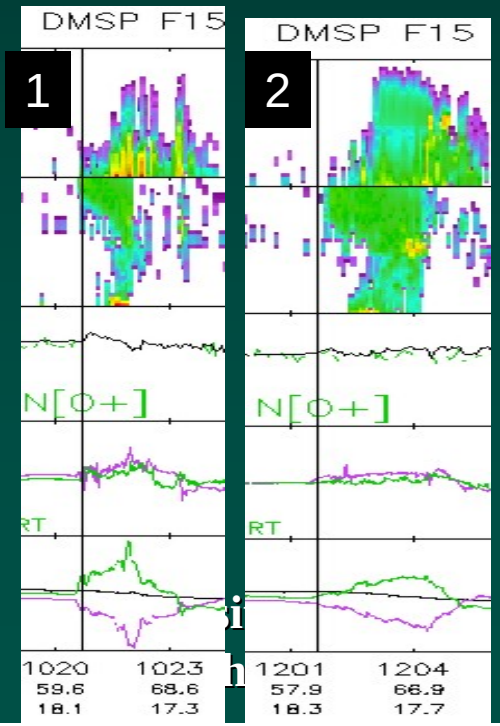
Conclusions for the April 1 event

- The Hokkaido radar shows enhanced echo occurrence rate of up to ~ 4% in the dusk sector and at MLAT= 60-65. A typical velocity of these echoes is 100-150 m/s.
- Occasionally, echoes with velocity of more than 400 m/s are observed. Some of these echoes occur at latitudes within the auroral oval while the others occur outside of it (SAPS).
- For the 1 April 2007 event, the SAPS velocities of > 600 m/s were identified ~ 25 min after the substorm onset. The high-velocity Hokkaido echoes were mostly seen close to the equatorial edge of the auroral oval. The radar did show signatures of relatively low-latitude flows that were certainly SAPS, but their identification from the radar data alone was not obvious.
- The SAPS Hokkaido flows of > 600 m/s lasted for ~45 min. For this specific flow intensification, both the period and the latitudinal extent were in good agreement with the predictions of the CRC model. The measured velocity magnitudes were about 2 times larger than the predicted ones. In SAPS studies, the Hokkaido and King Salmon radars act as the complementary instruments.
- The Hokkaido data for the 1 April 2007 show that the velocities within the SAPS channel can start to increase near or even prior to the substorm onset, but the maximum velocity is achieved with a delay of the order of 30 min.

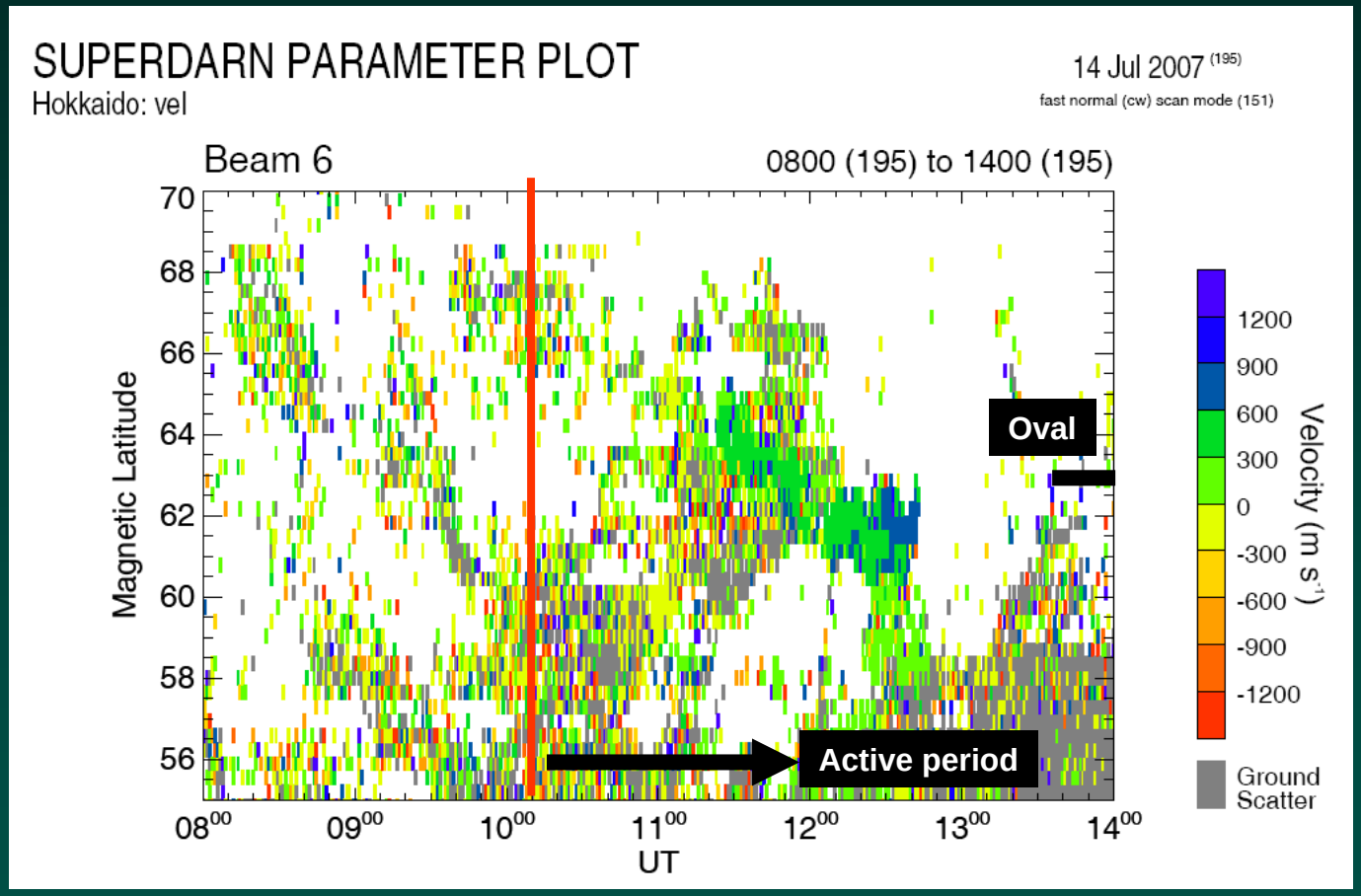
July 20, 2007: Hokkaido sees equatorward portion of a broad flow band







July 14, 2007: Hokkaido sees equatorward portion of a broad flow band



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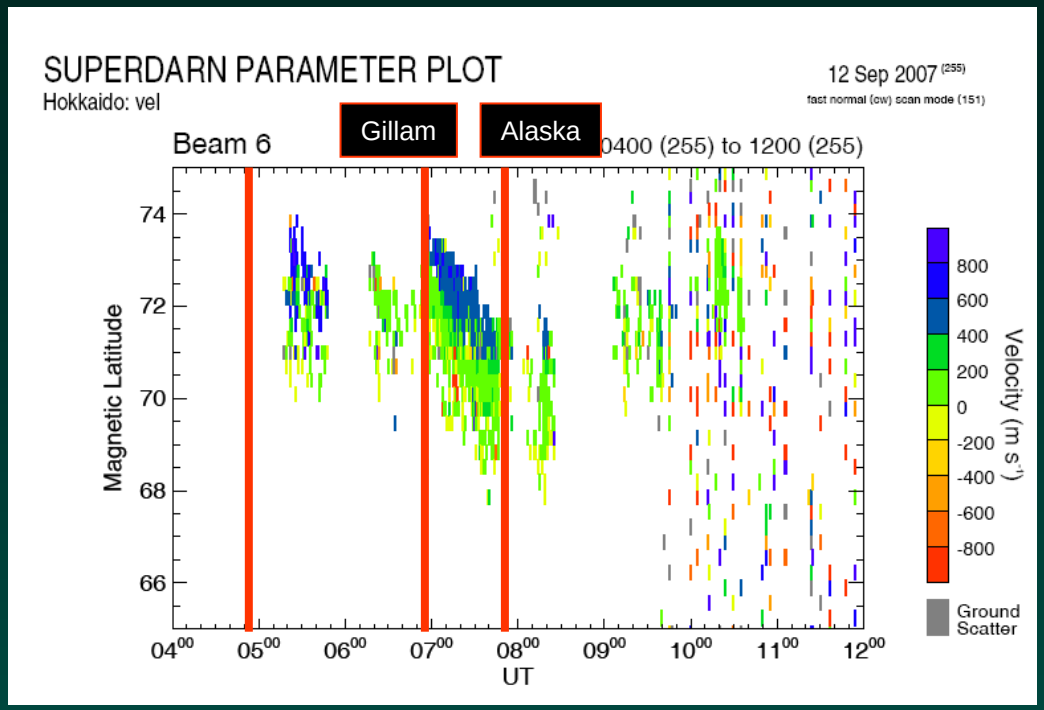
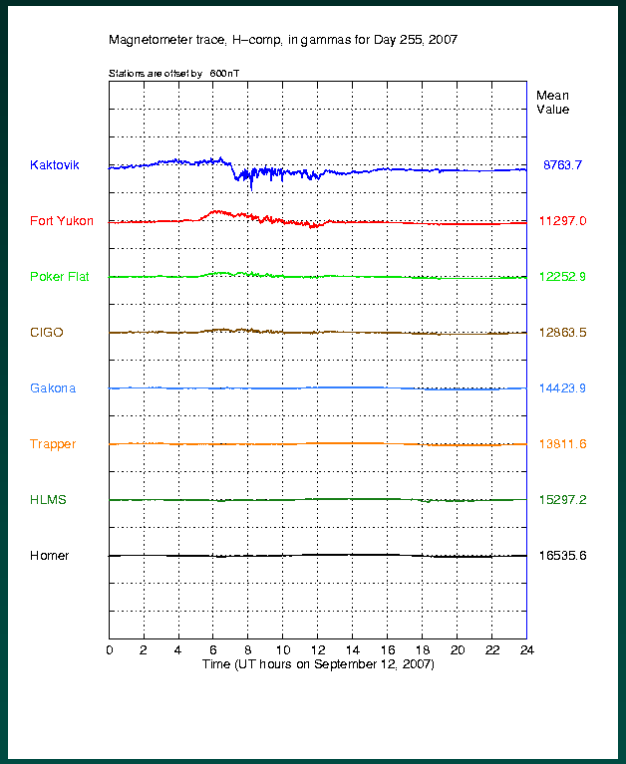
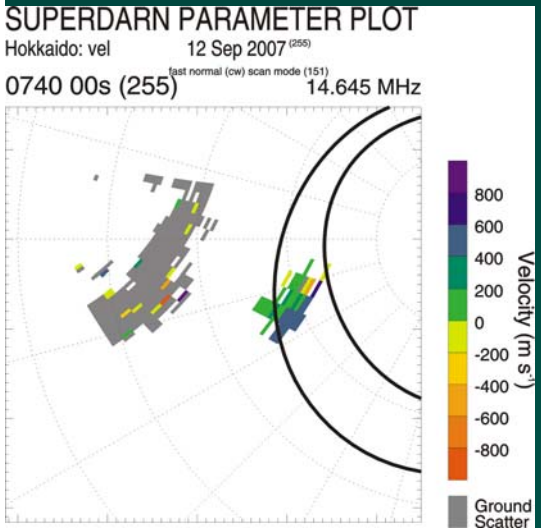
High-Lat Fast Flow Event: Sept 14, 2007



Alaska: Low mag. activity





DMSPs show auroral-type flow at high latitudes of > 67 deg

The driver of this flow intensification is unknown

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Thank you all for patience

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