

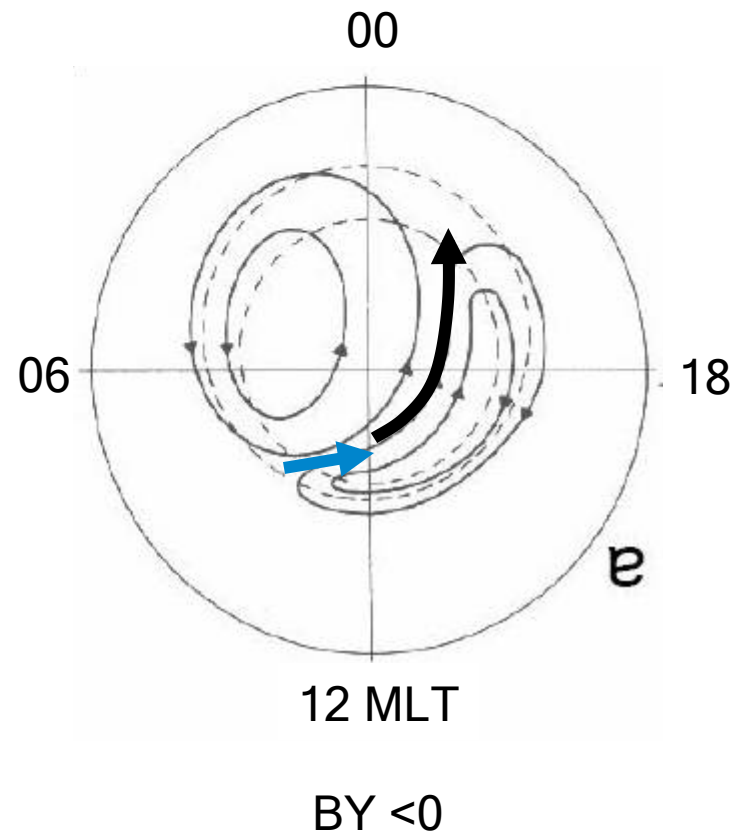
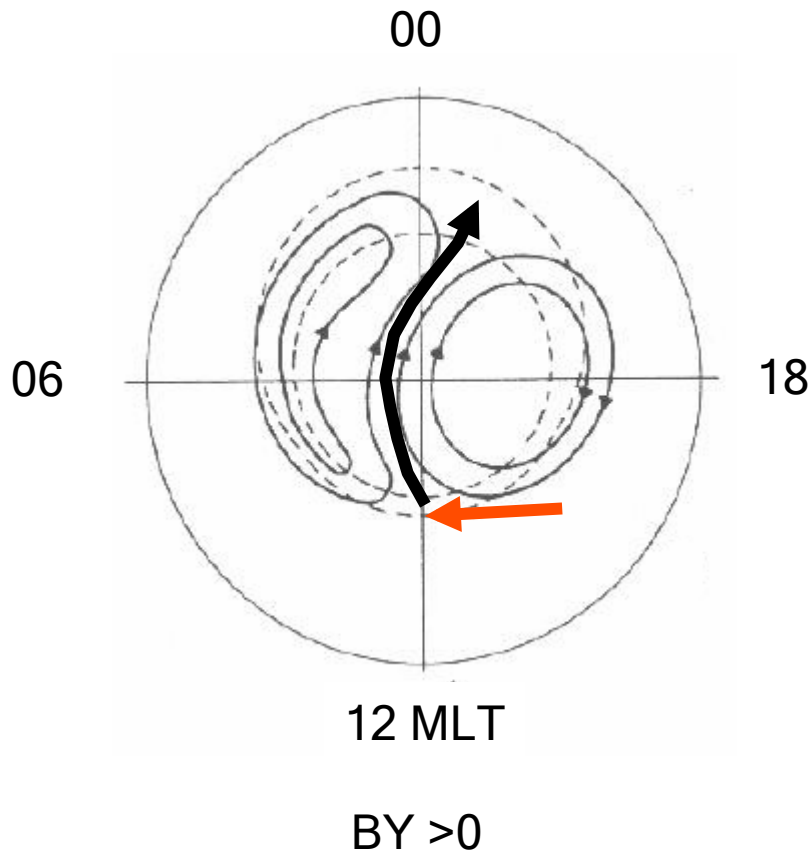
UiO : **Department of Physics**
University of Oslo

EISCAT Svalbard Radar studies of meso-scale plasma flow channels in the polar cusp ionosphere

Y. Dåbakk et al.



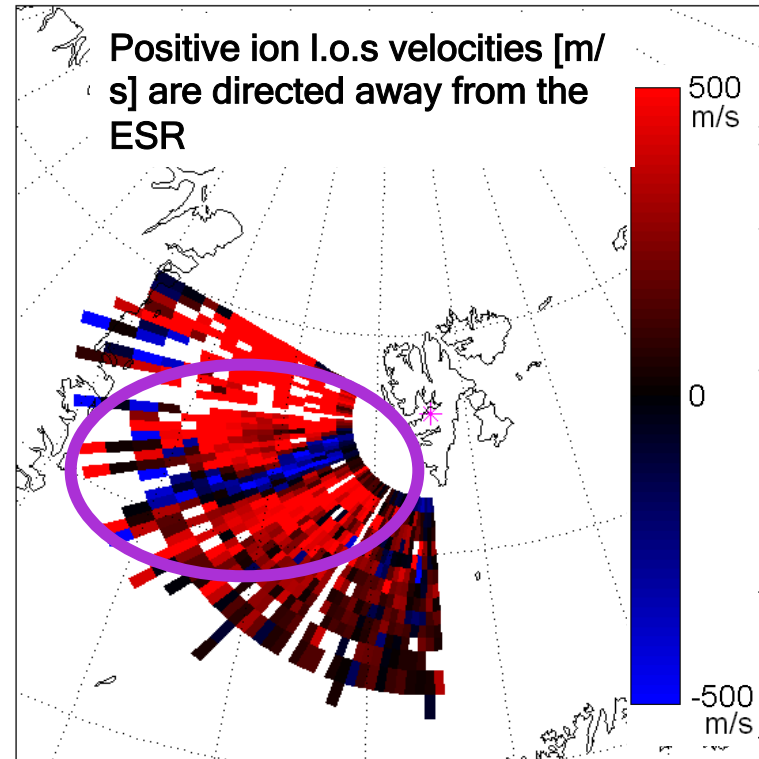
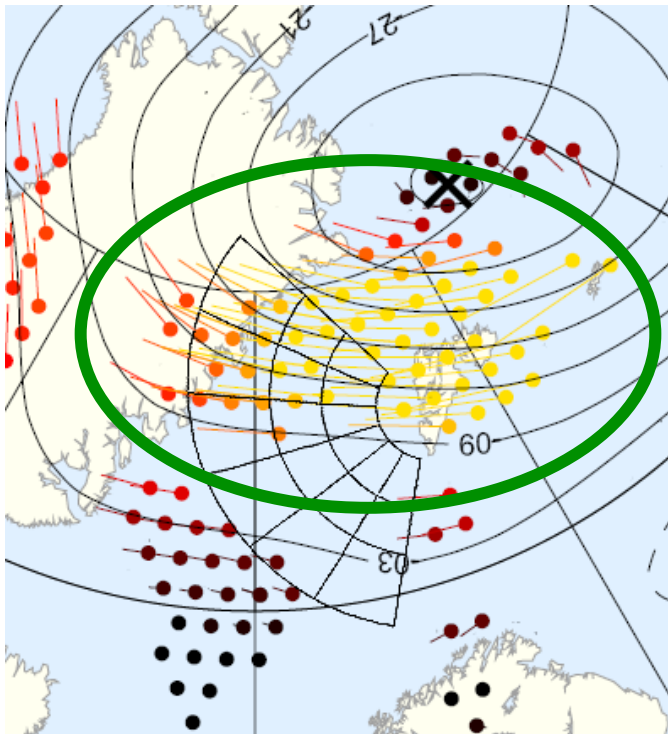
Recall - magnetic tension drag on newly opened field lines



The Eiscat Svalbard Radar



Finding of Reversed Flow Events in the ion velocity data

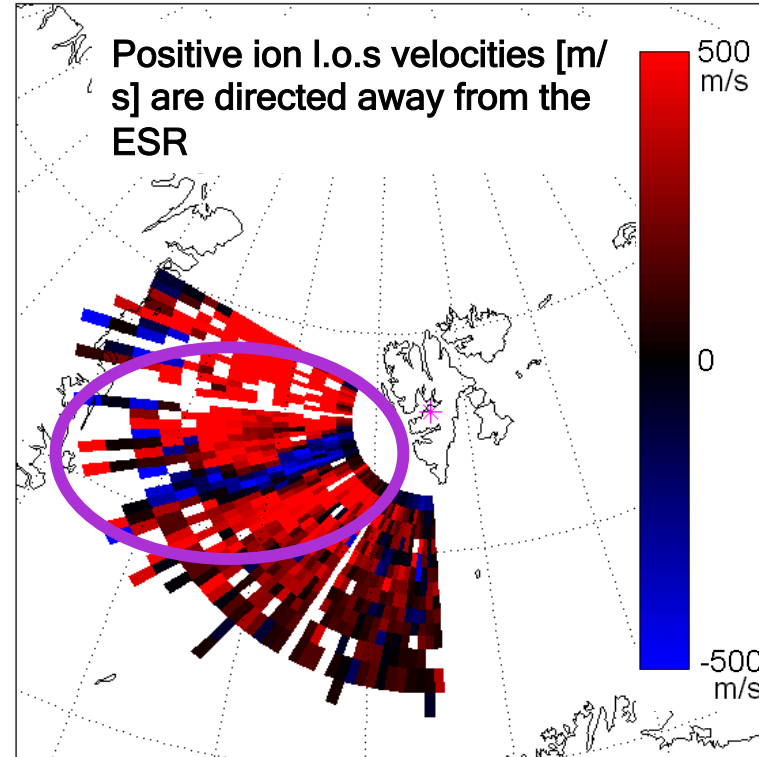
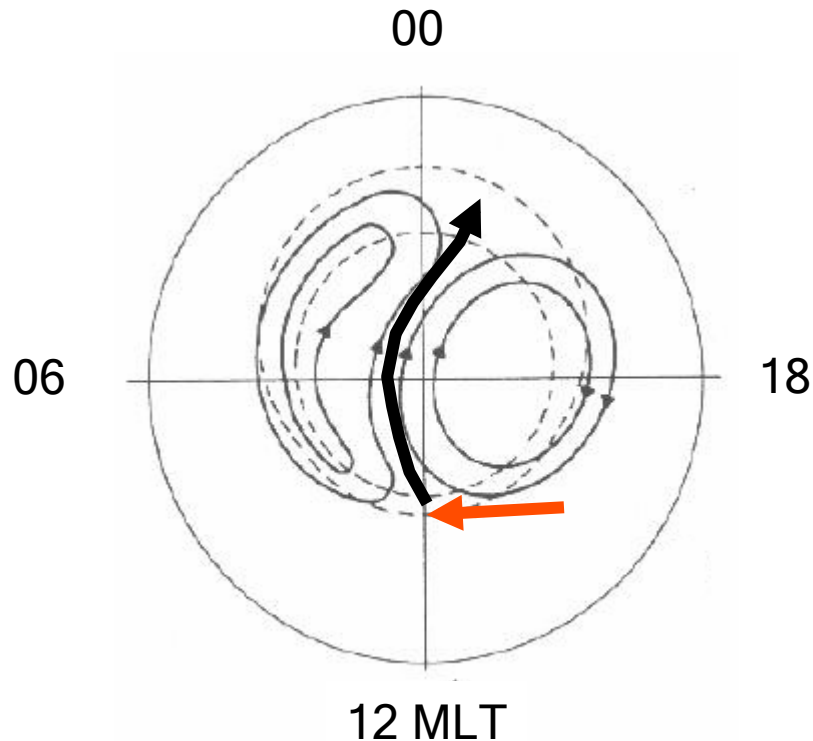


A Reversed Flow Event is an elongated segment of enhanced ion flow in the opposite direction of the background flow

Occurrence of RFEs

- RFEs occurred 16% of the time throughout an existing dataset from 2001 (11 days)
 - Their average lifetime was 19 minutes
 - They exceeded the field of view in length (> 400-600 km) and are around 100-200 km wide
 - No preference was found for the IMF B_z and B_y polarity, and RFEs occurred for clock angles between 40 and 240°
- RFEs appear to be a regular feature of the active cusp

86% of the RFEs were characterized by ion flow opposite to the IMF By controlled magnetic tension pull on newly opened field lines



**ICI-3 LAUNCH from
Ny-Ålesund
(Svalbard)
3 DECEMBER 2011
07:21.31 UT**



ICI-3 Sounding Rocket Primary Objectives

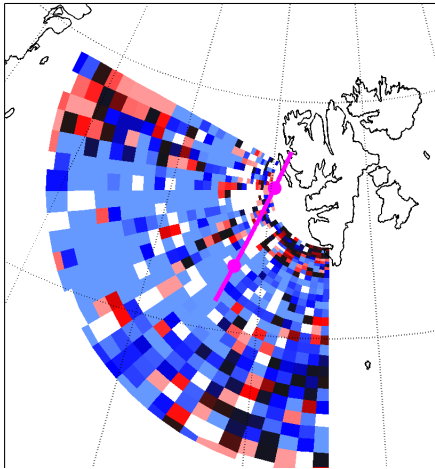
Investigate the RFE class of cusp flow events.

- i) Determine the physical explanation for RFEs
- ii) Quantify the Kelvin-Helmholtz Instability growth rate at the RFE flow boundaries (rapid development of shear-driven instabilities)

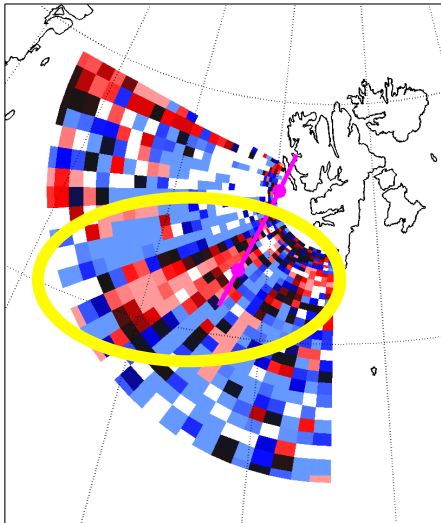


Launch: 07:21 UT - we intersected an RFE event!

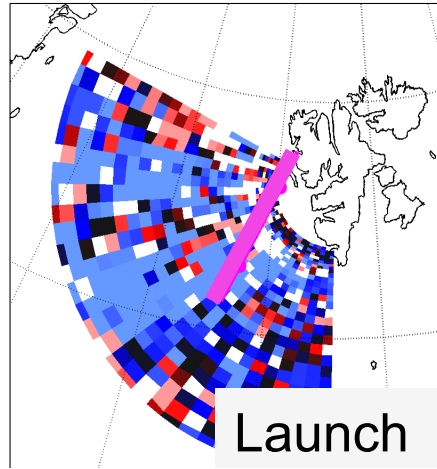
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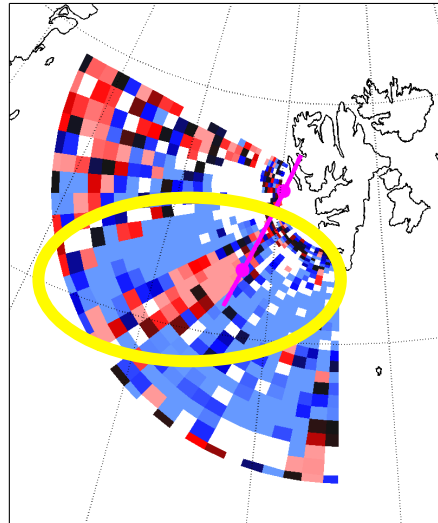
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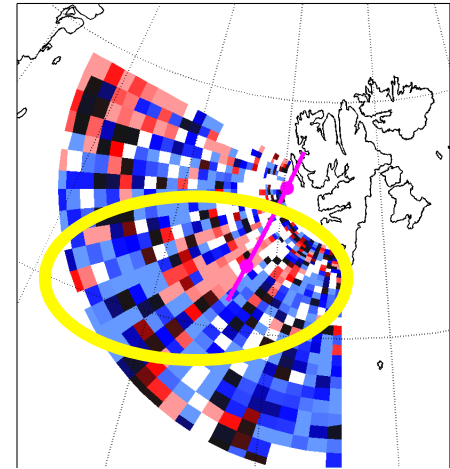
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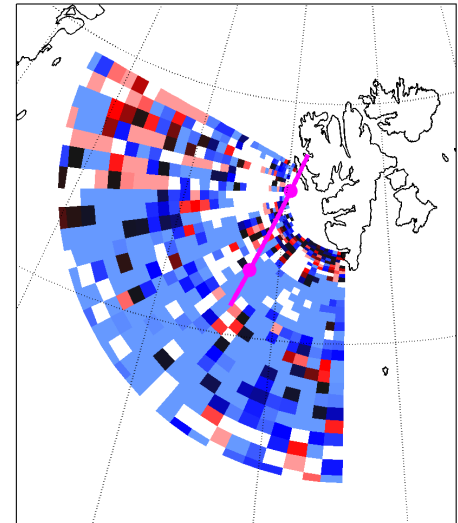
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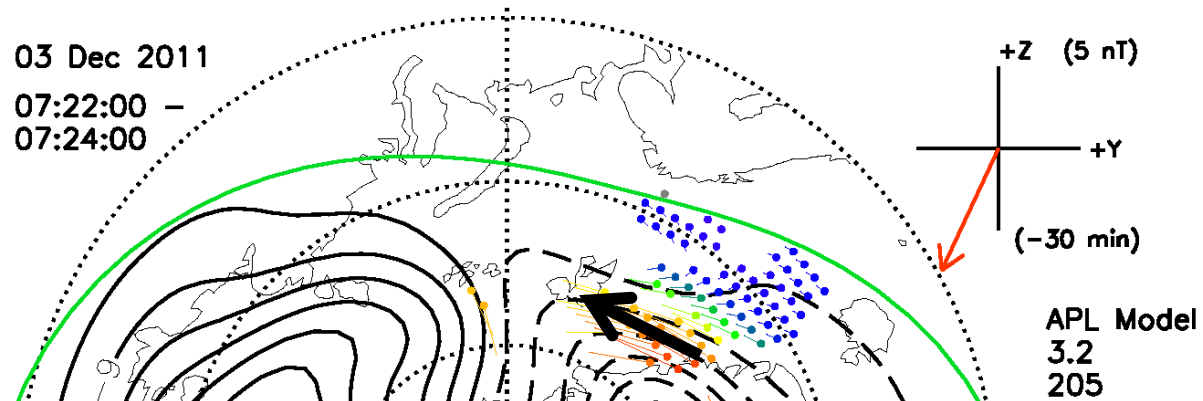
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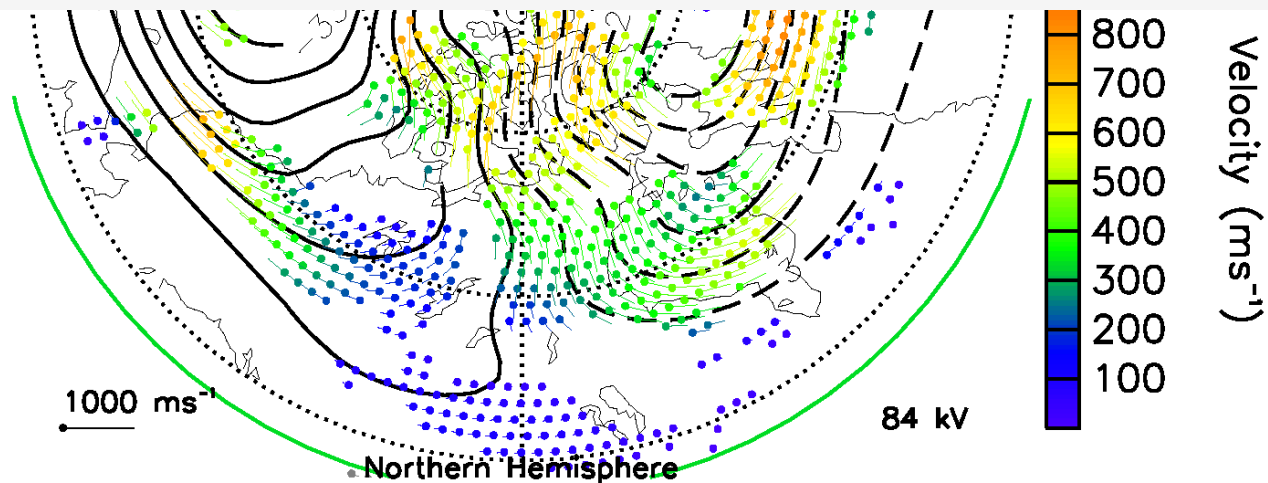
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SuperDARN

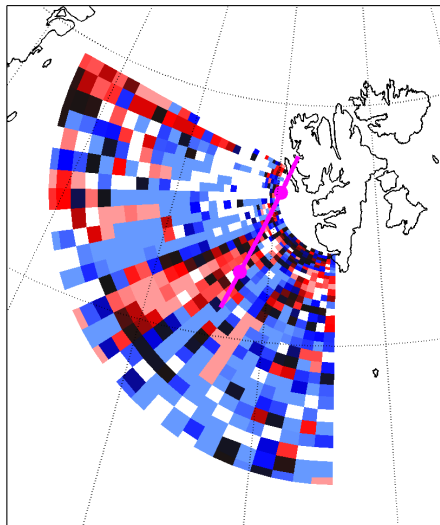


Predominant eastward convection inside the ESR f.o.v consistent with IMF $BY < 0$ during the rocket flight

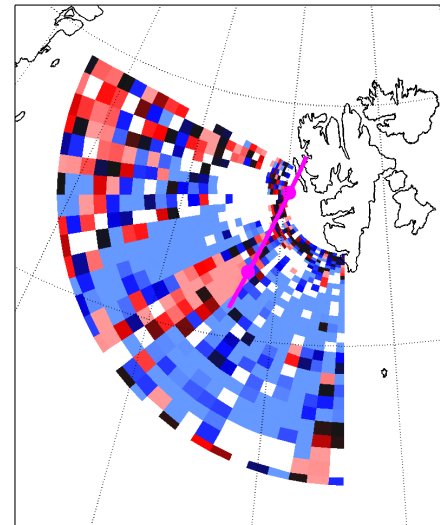


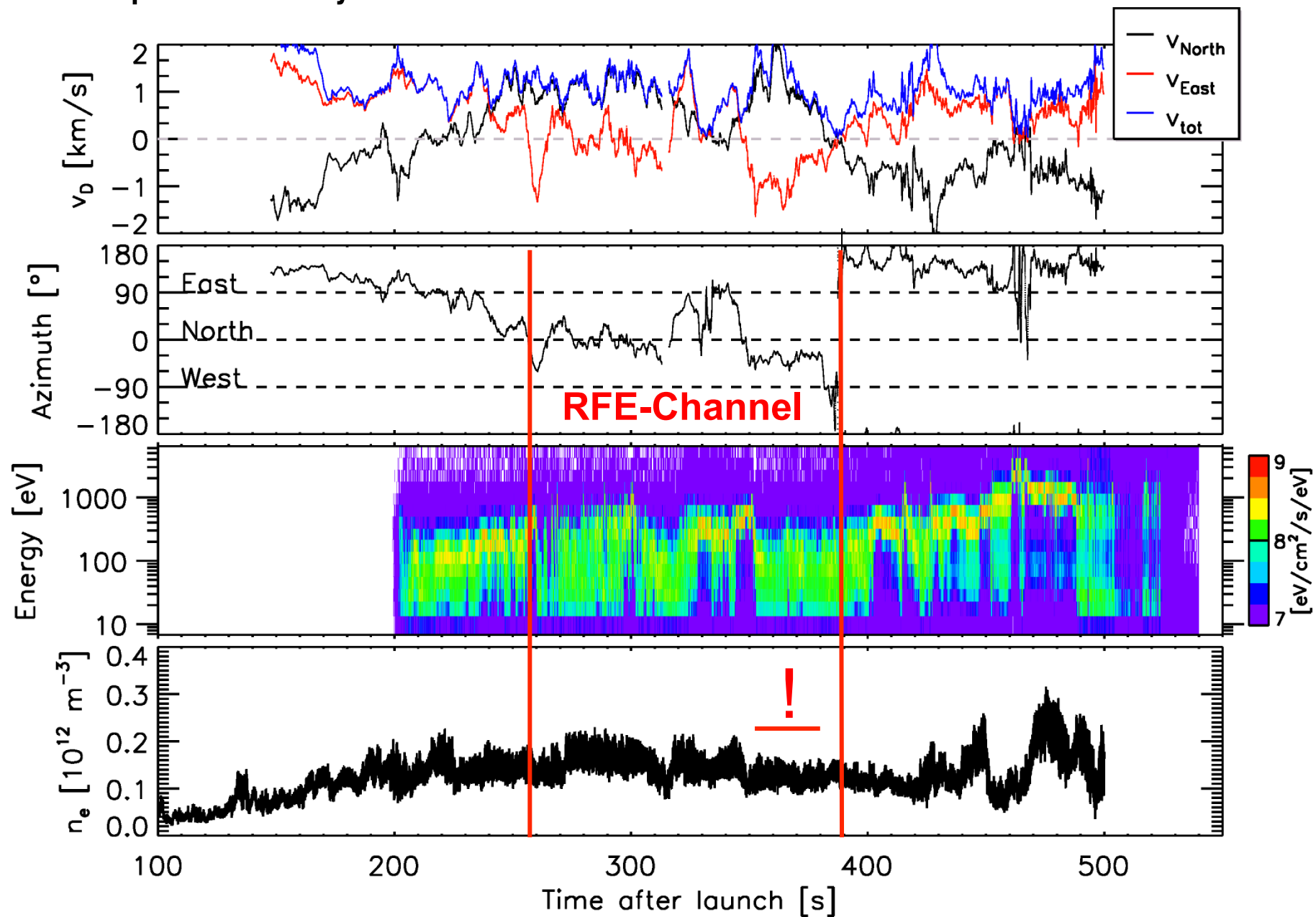
- IMF BY < 0 \rightarrow we see an eastward convection inside the ESR f.o.v. (also confirmed by SuperDARN).
- The velocity inside the flow channel is directed westwards (hence opposing the direction of magnetic tension), in the opposite direction as expected from IMF BY

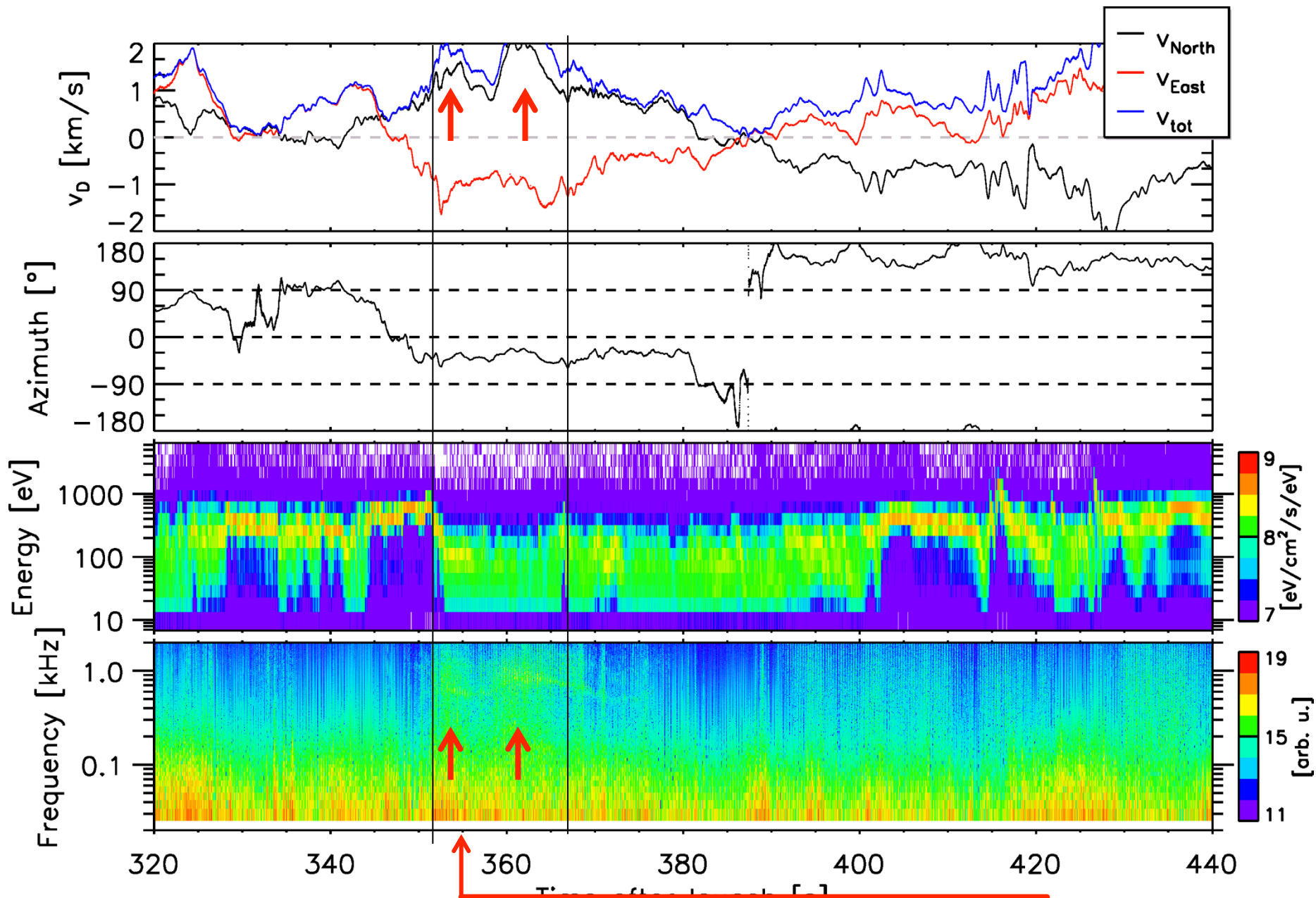
Vi 2011-12-03 07:27:23 (start) ccw



Vi 2011-12-03 07:30:35 (start) cw







Strong plasma irregularities

The Observations:

- ICI-3 intersected a Reversed Flow Event as intended
- Strong plasma irregularities associated with 2 km/s «high-speed streams» within the RFE

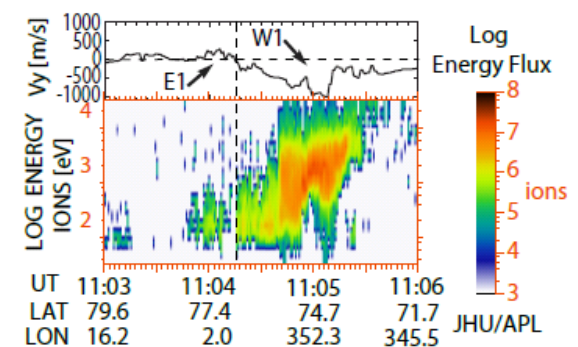
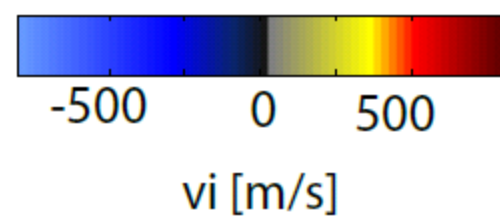
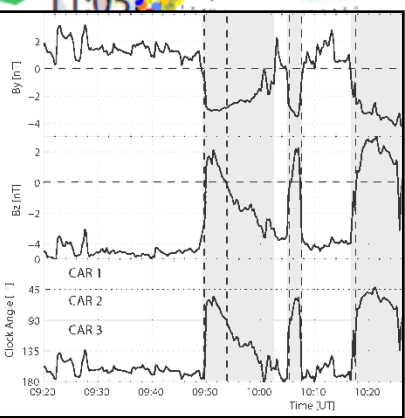
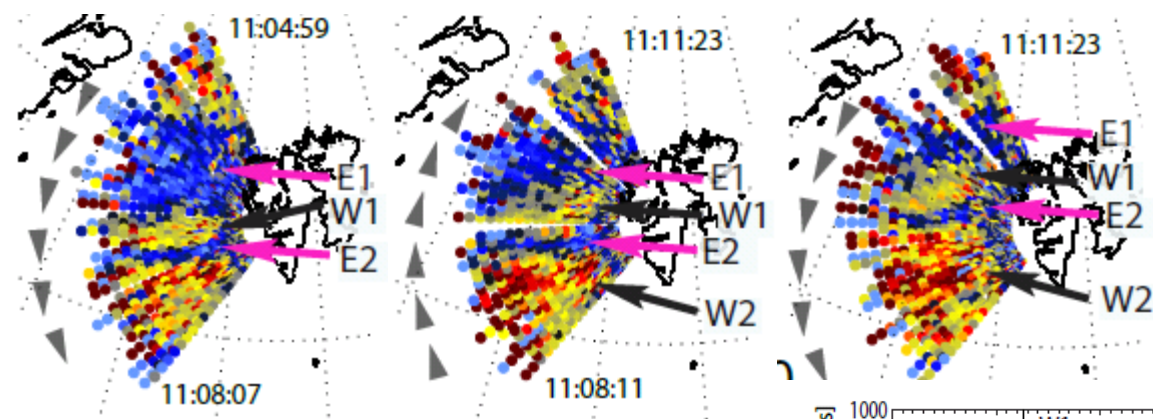
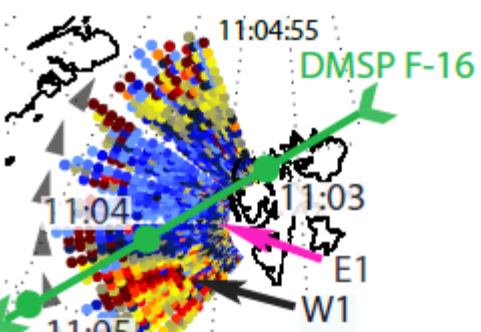
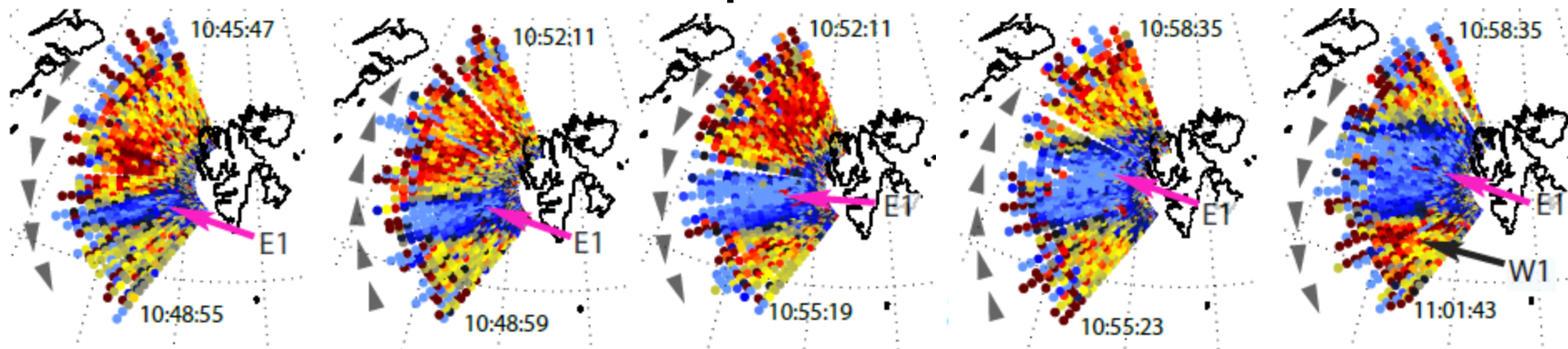
There was

- no precipitation
- and no steep density gradients,
- but high flow streams

associated with the strong plasma irregularities -> probably intersected a region of KHI

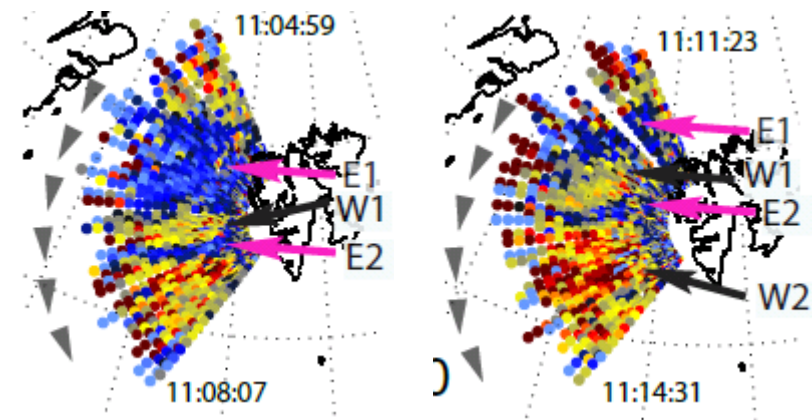
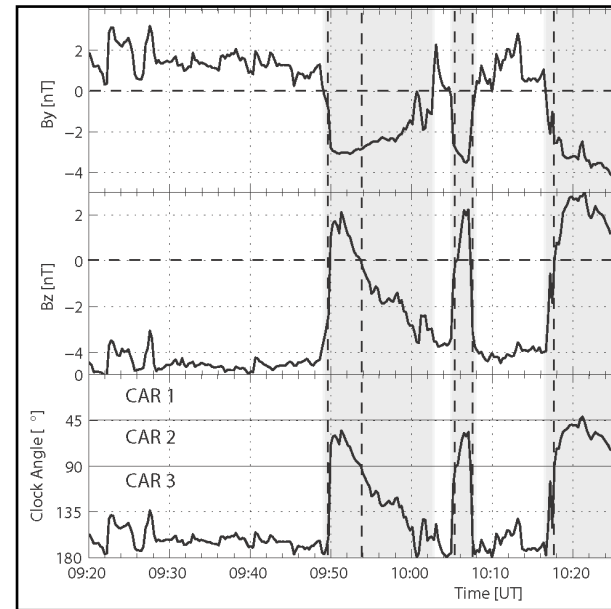
- Unfortunately (as of today) no new insight into the generation mechanism of RFEs

Stacked cusp flow channel events



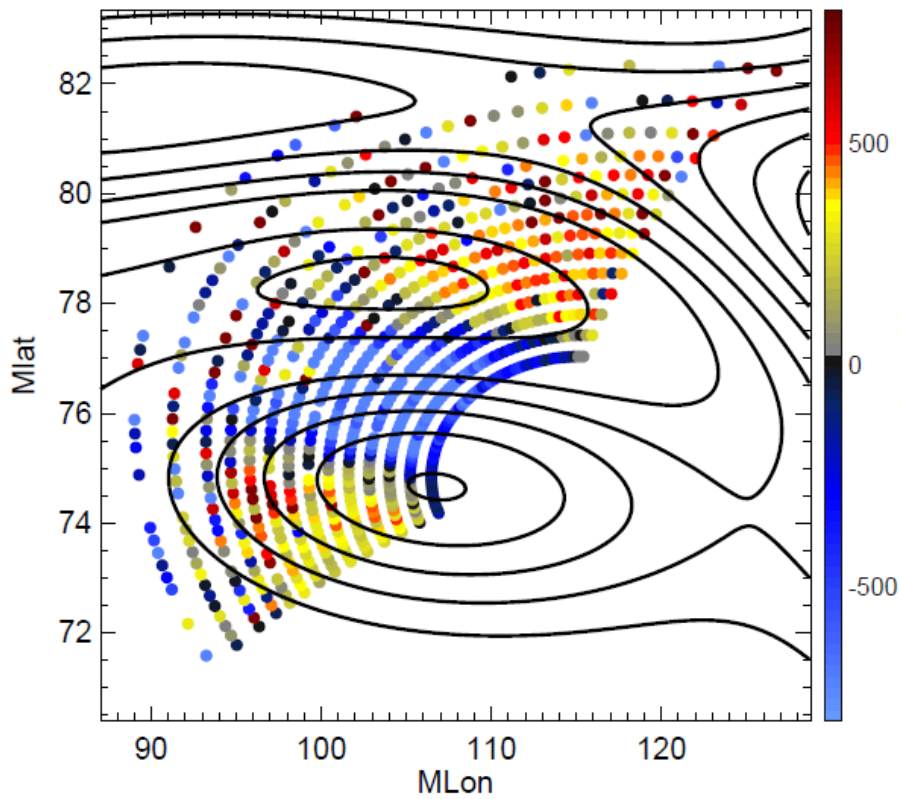
2005 event interpretation

- Sequence of three eastward flow channels formed in response to three sudden IMF rotations to BY negative and BZ positive.
- The observations are consistent with the view that a new region of reconnected flux develops as a distinct flow channel near the polar cap boundary, and successive events remain separated while pushing each other into the polar cap (Lockwood et al. 2001).
- Each flow channel will remain separated from neighboring channels mapping to different reconnection sites as long as the magnetic tension force with its associated field aligned current systems is maintained.

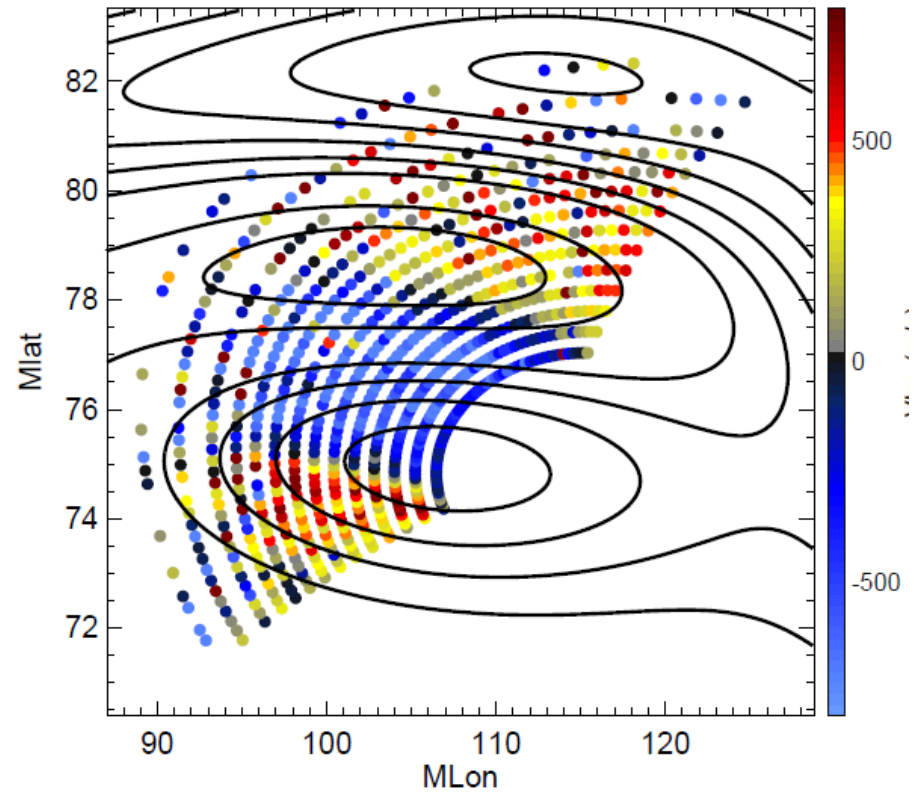


Flow in the vicinity of the ESR f.o.v

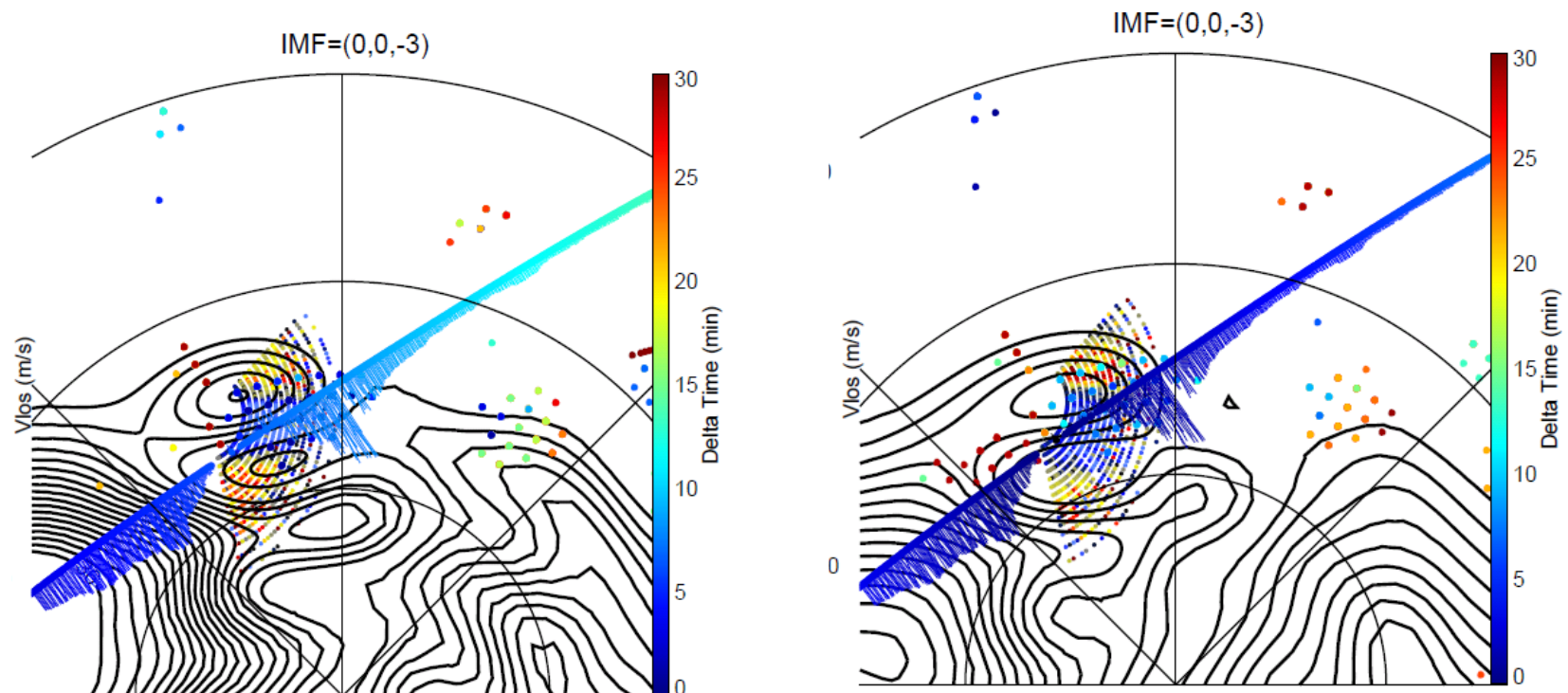
20050906 1055-1058 UT



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Large scale flows



The channels analyzed in this study contributed significantly to the overall polar cap potential with 24 and 33 kV. They represent strong velocity shears and backscatter, which in turn leads to plasma instabilities and may be a patch formation mechanism.

Future work

- Planned campaign to run polar cap ISR's (ESR, Sondrestrom, PFISR, RISR) in order to investigate the physical driver mechanisms of Reversed Flow Events
- Track how RFEs and meso-scale flow channels in general propagate into and across the polar cap and monitor their spatial and temporal evolution on their way
- Similar campaign attempted in 2012 – ESR 32m antenna could not perform fast scans and Sondrestrom was not operating