

High spatial resolution observations of ionospheric convection in the midnight sector during the growth of a geomagnetic storm

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Overview

- Introduction to 7th January 2005 1000 - 1400UT
 - Interplanetary Magnetic Field
 - AE Index
- Map Potential
 - Review of Map Potential
 - Modifications to Map Potential
- The 7th January 2005 1000 - 1400UT event in detail
 - Flow Stagnation
 - Harang “Banana”
 - Harang “Banana” Compression
 - Large Scale Flow Vortex
 - Auroral Eastward Flow Channel
 - Auroral Westward Flow Channel
- Summary and Questions



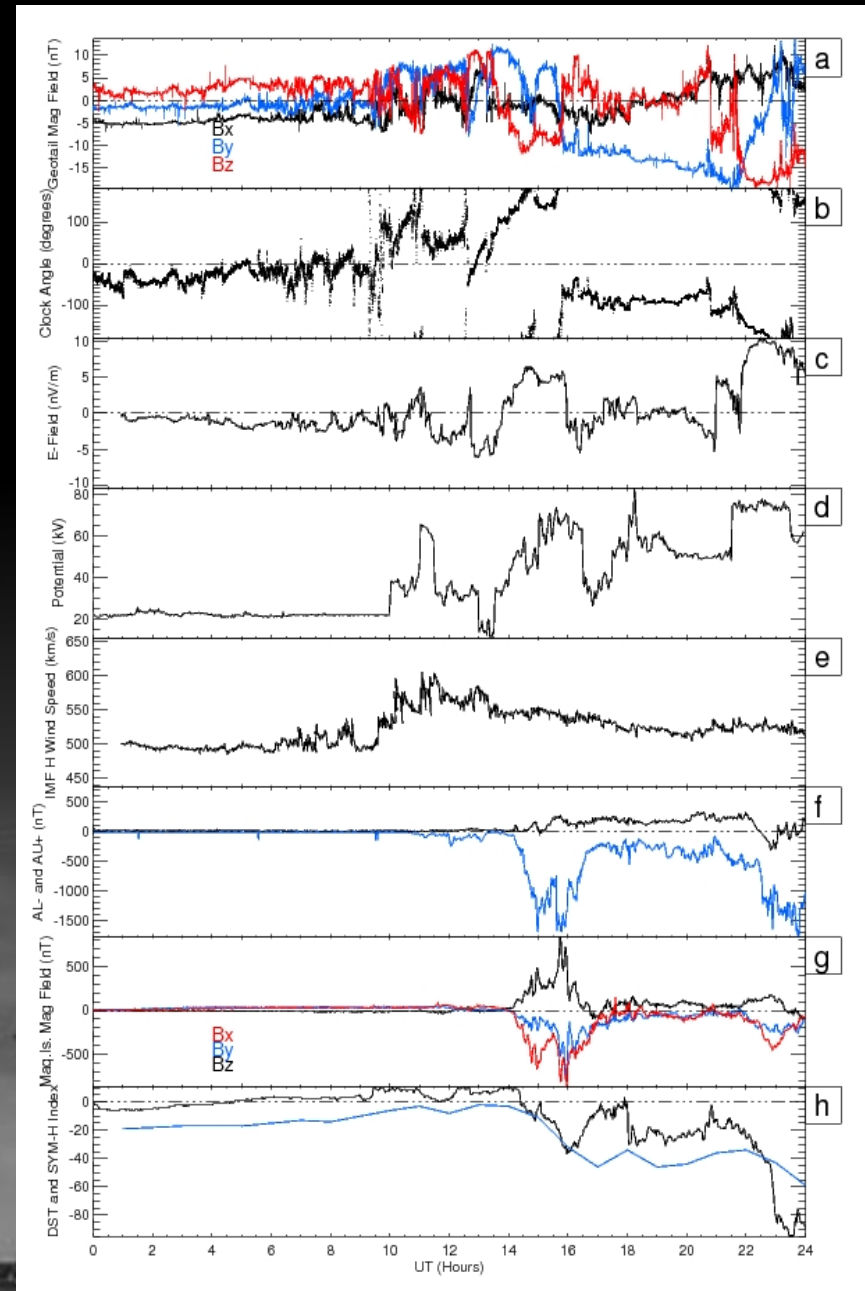
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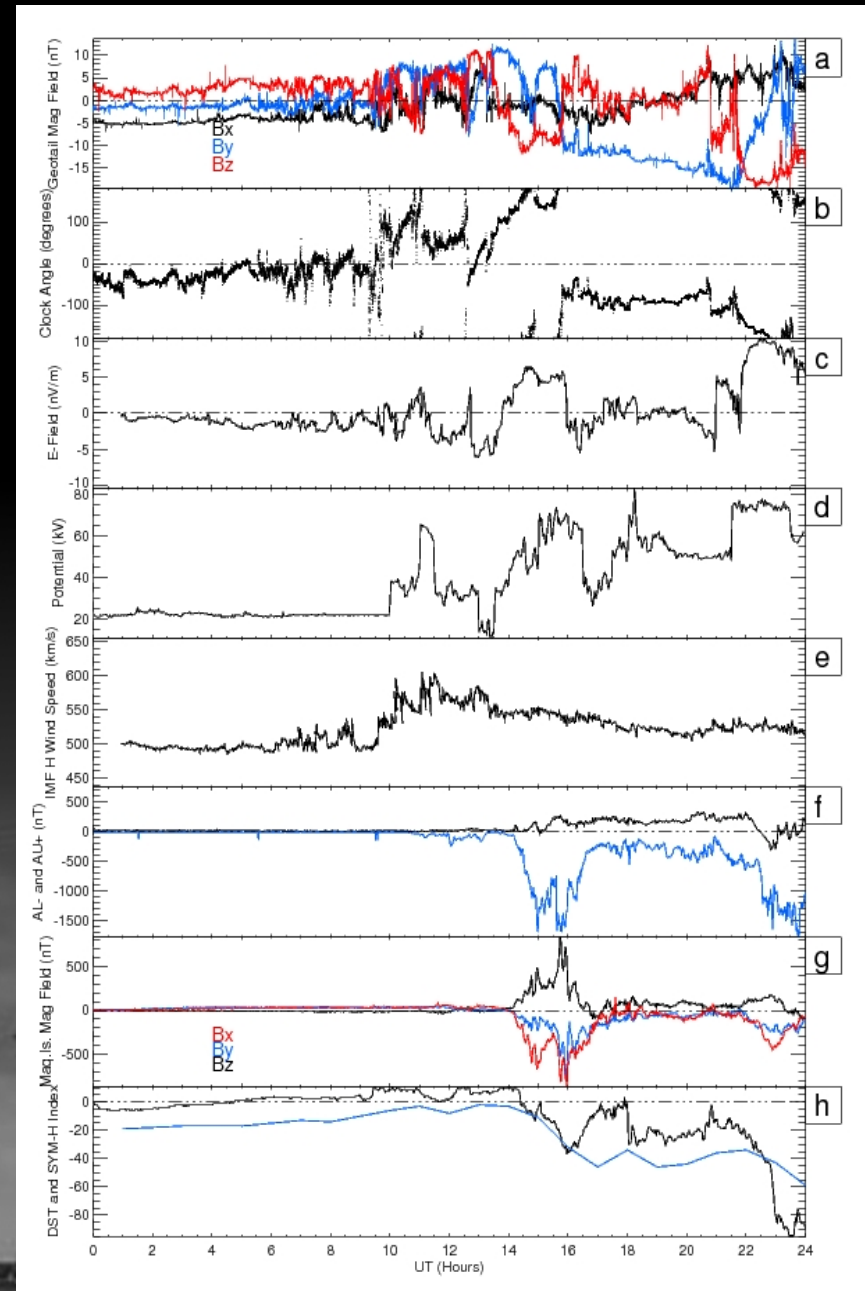
Summary of IMF and Geomagnetic Conditions

- IMF B_z , B_y , B_x
- IMF clock angle and E-Field
- IMF solar wind speed
- Polar Cap Potential (Map Potential analysis)
- AU and AL Index
- Macquarie Is. Magnetometer
- DST and SYM-H Index



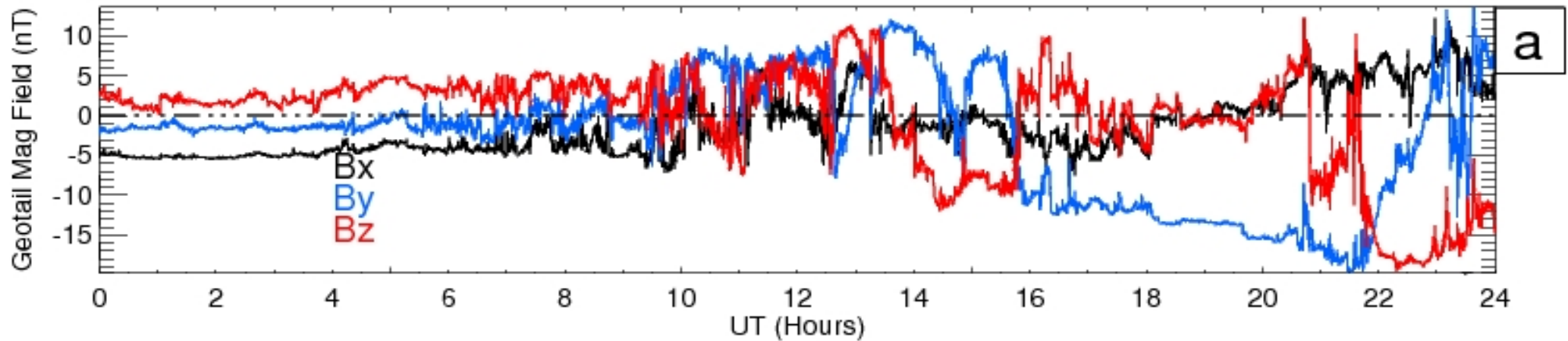
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Interplanetary Magnetic Field

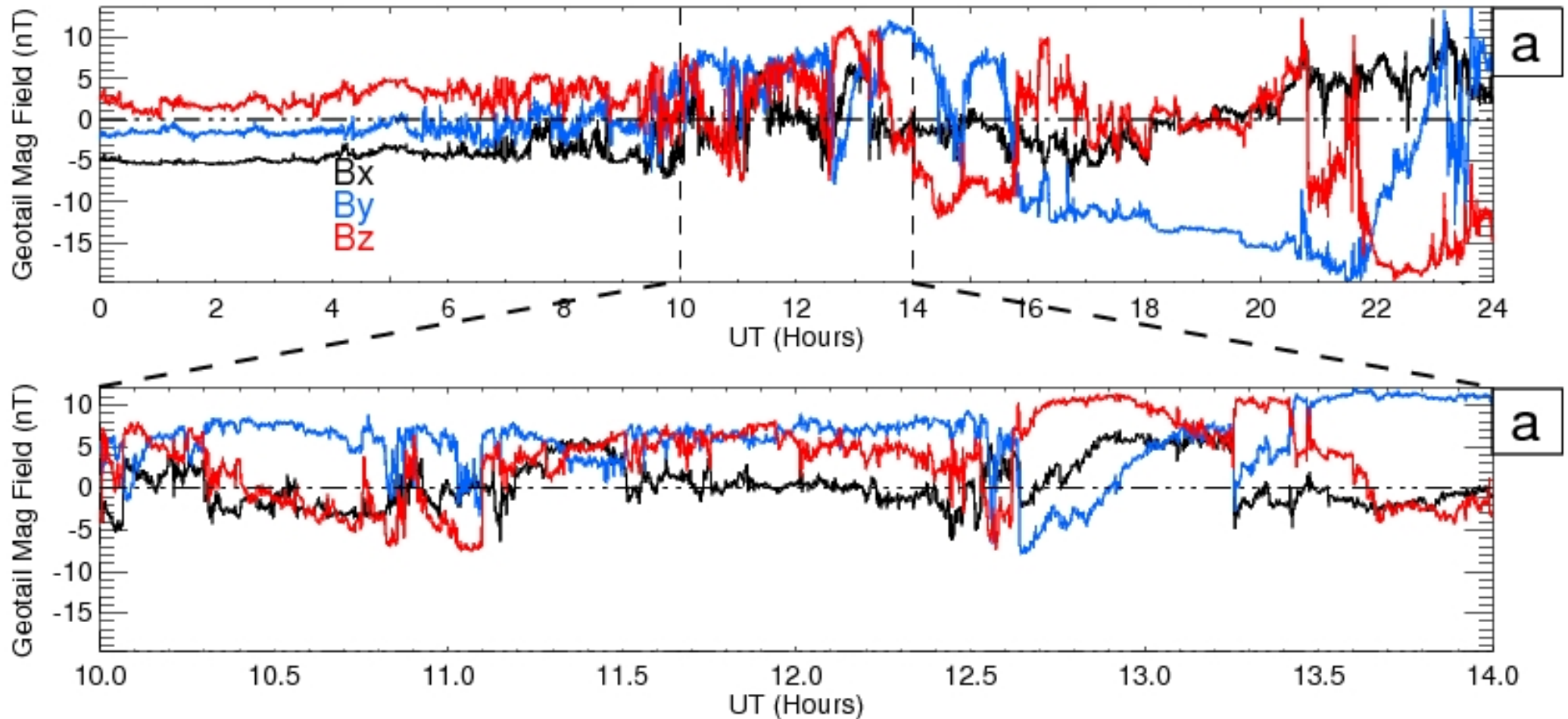
- Geotail-MGF instrument located sunward between bow-shock and magnetopause ($x_{GSE} \sim 10R_E$, $y_{GSE} \sim 25R_E$ and $z_{GSE} \sim 5R_E$)



- The IMF is fairly stable, with moderate variation, 0 – 5nT, until approximately 0600UT
- From 0600UT onward, a magnetic cloud begins to perturb prevailing IMF

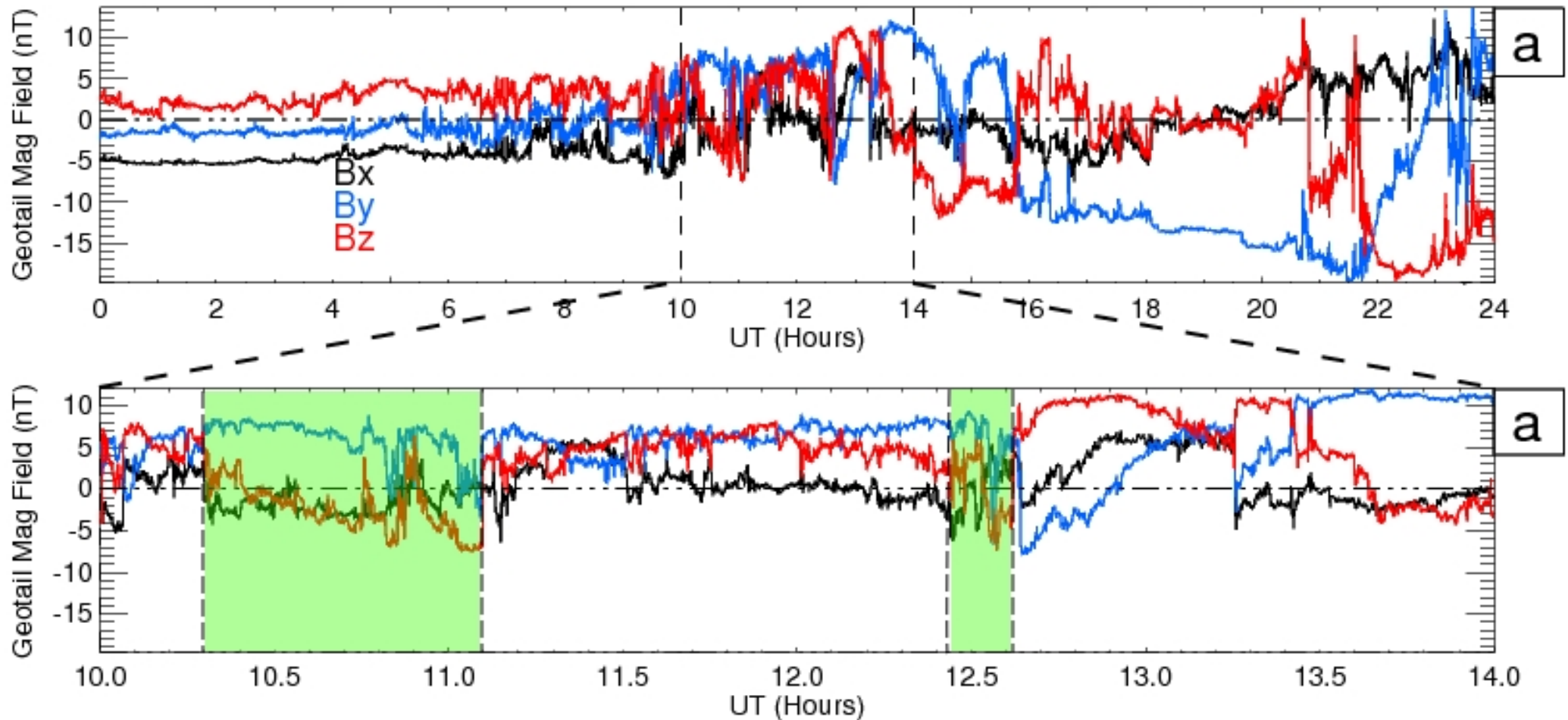
Interplanetary Magnetic Field

- We zoom in to the time interval 1000 – 1400UT



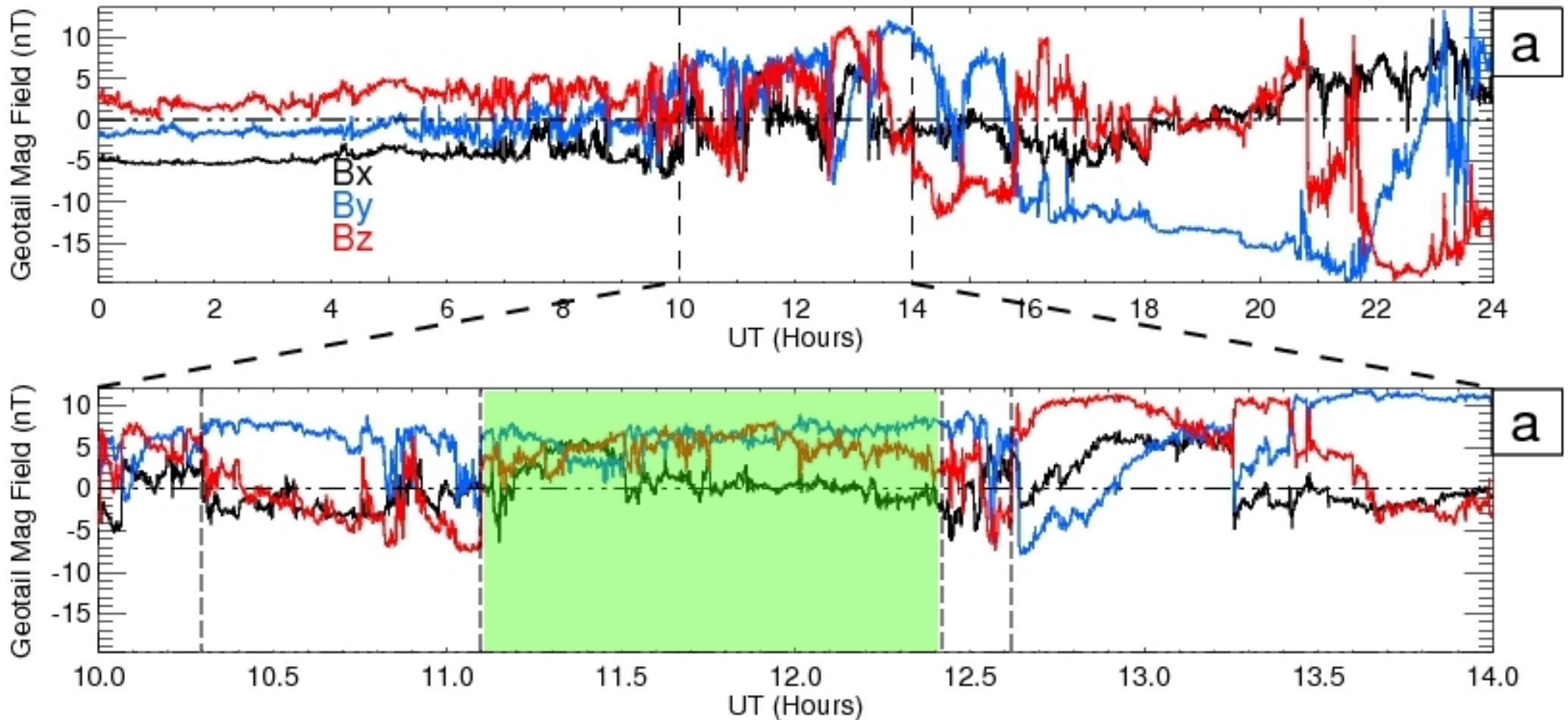
Interplanetary Magnetic Field

- Two intervals, 1015 – 1106UT and 1226 – 1238UT, where the IMF component B_z is negative (red curve) and B_y is positive (blue curve)



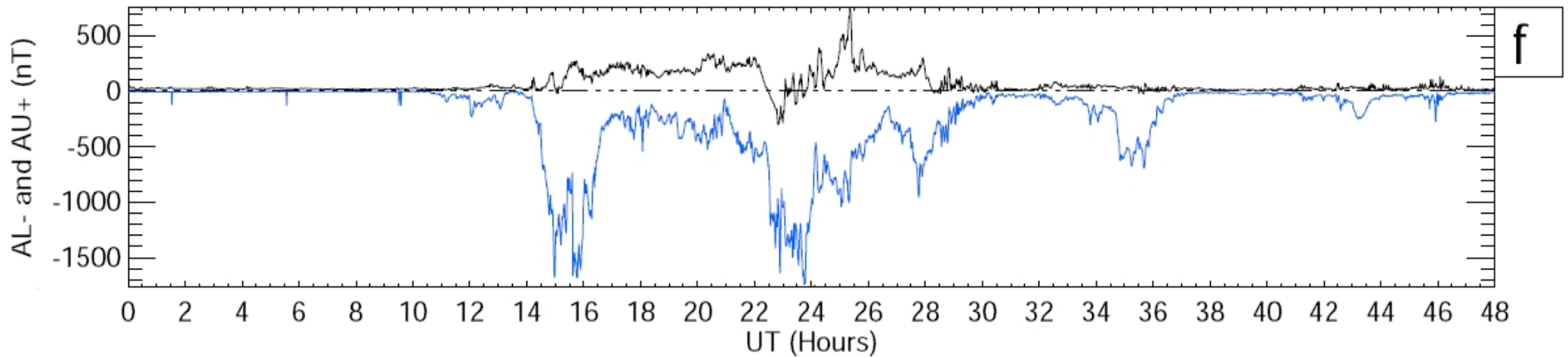
Interplanetary Magnetic Field

- And the interval 1106 – 1226UT has the component B_z positive (red curve) and B_y positive (blue curve)



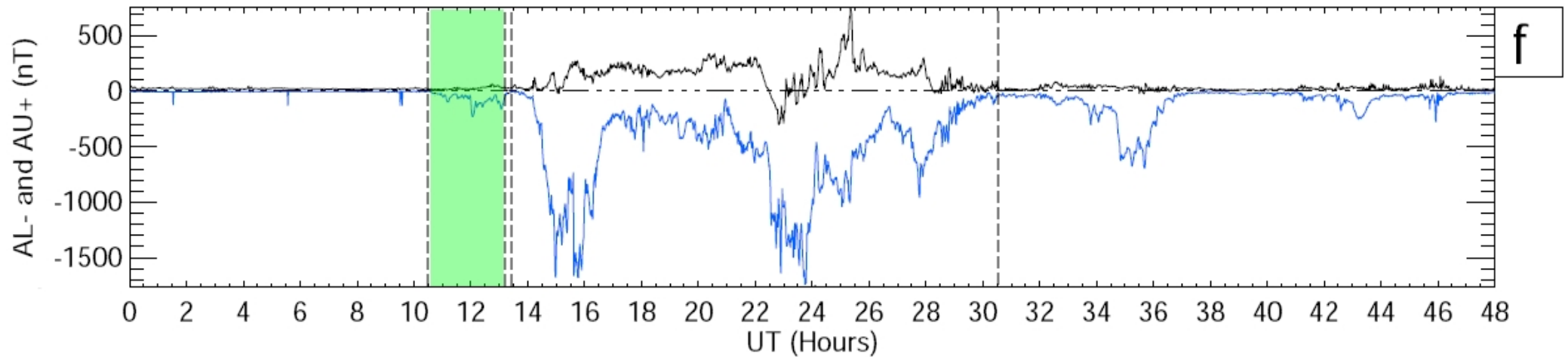
AE Index

- AU index (black curve) and AL (blue curve) over a time interval of two days, the 7th and 8th of January



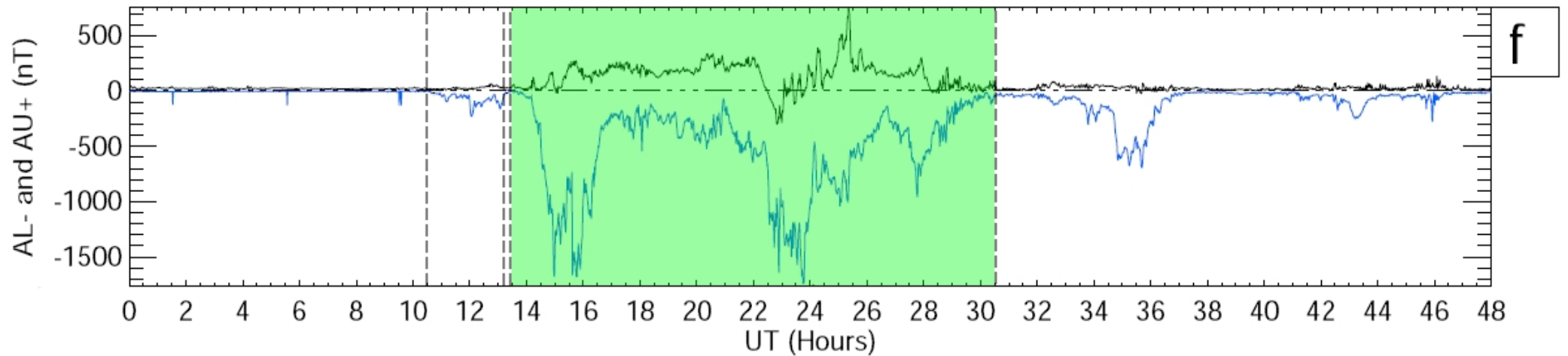
AE Index

- Interval of **minor magnetospheric activity** preceding an interval of successive major substorms, -1750nT



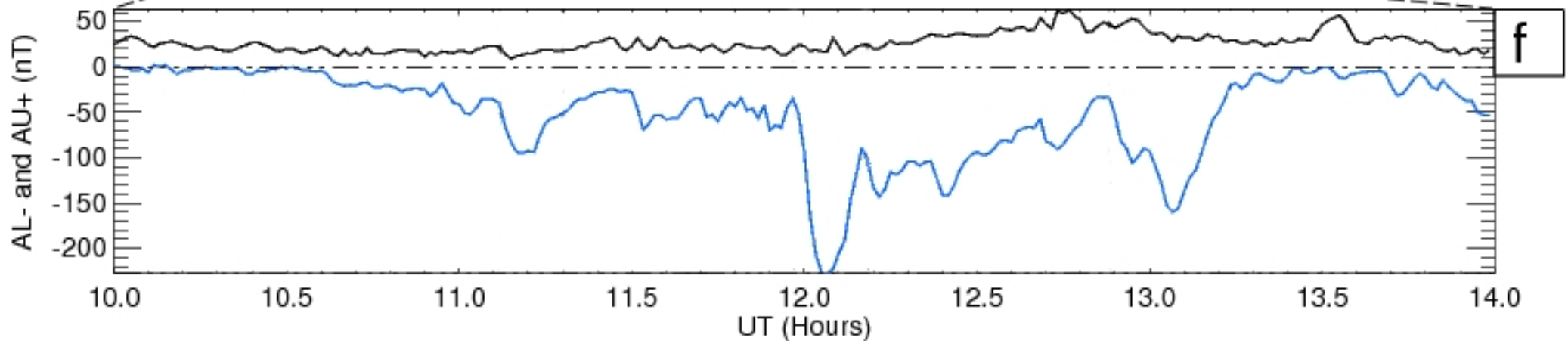
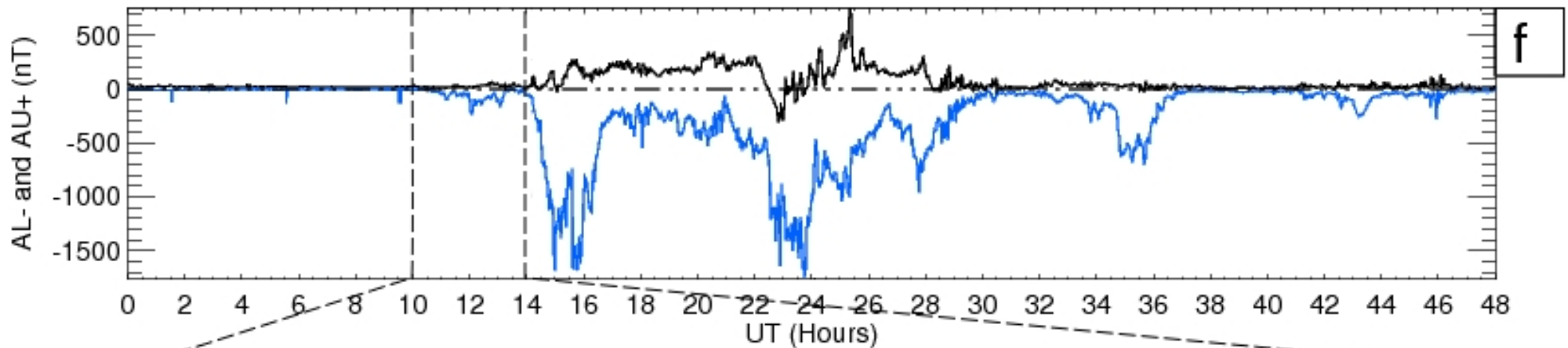
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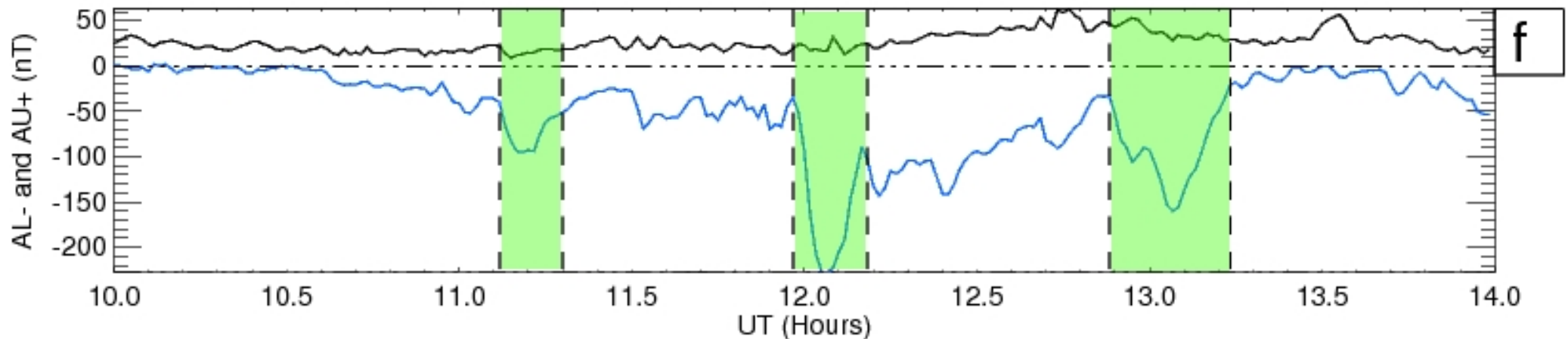
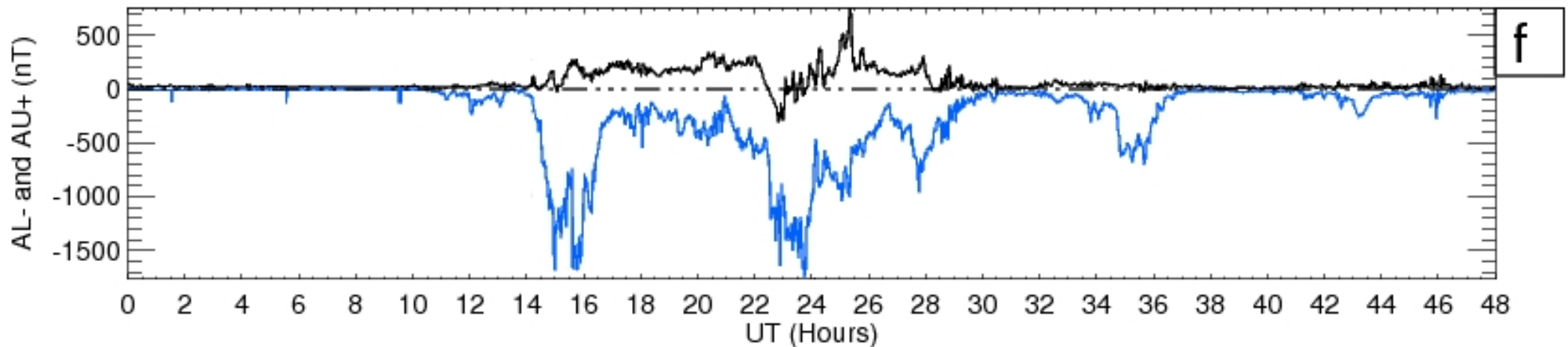
AE Index

- Zooming into 1000 – 1400UT period of minor intensifications



AE Index

- Three geomagnetic intensifications in AL-; 1107 – 1118UT, 1158 – 1211UT and 1253 - 1314UT



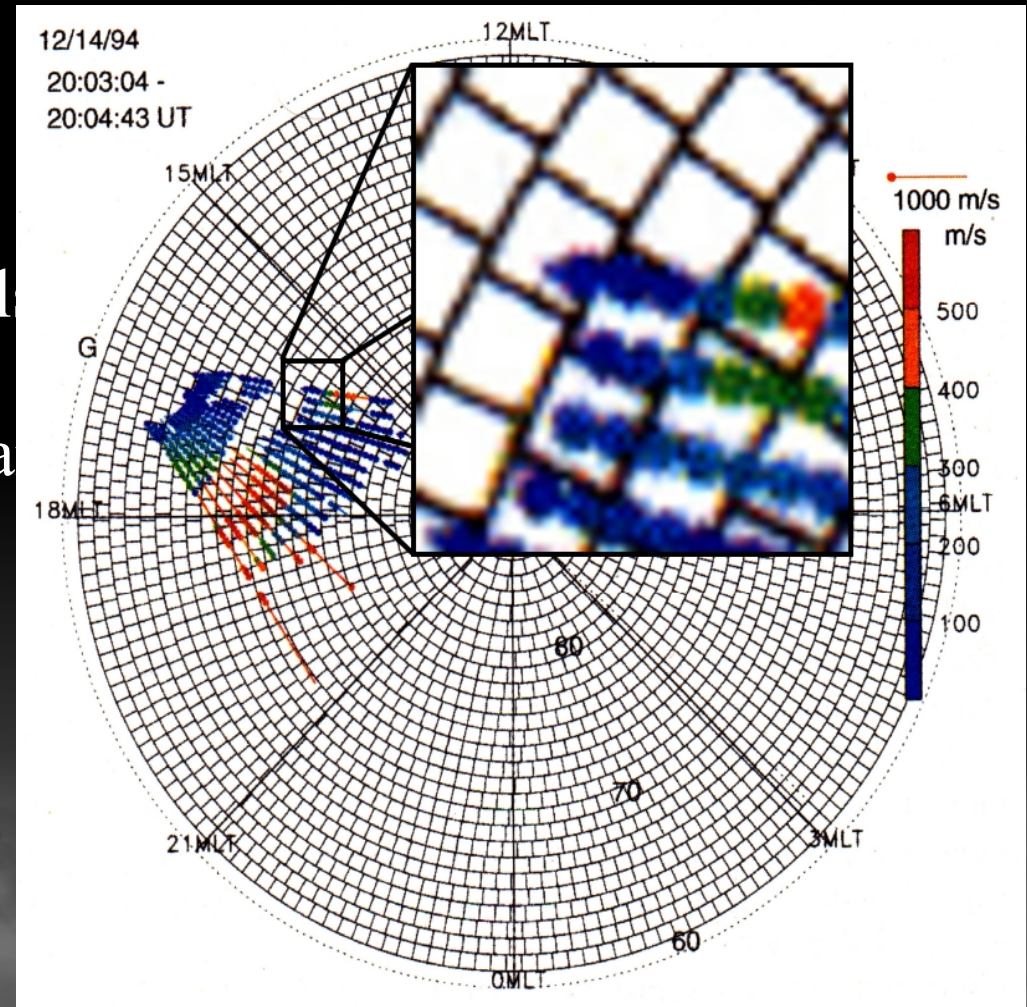
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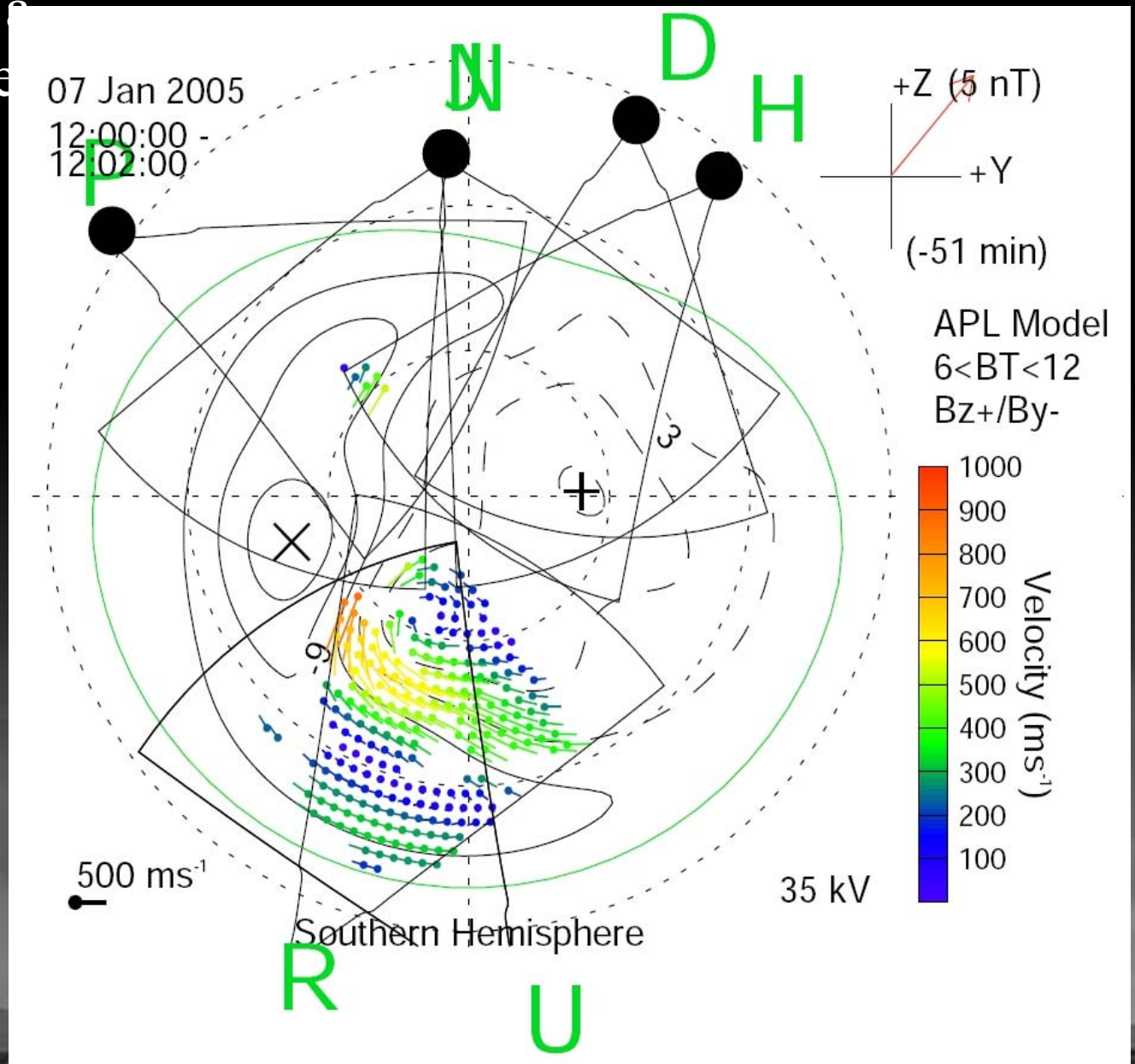
Review of current Map Potential analysis

- Map Potential Technique [Ruohoniemi and Baker, 1986]
- Radar range-gate line-of-sight velocity vectors spatially, 3 x 3 cell, and temporally, 2 min interval previous and next, averaged (median filter)
- The new velocity vector is then gridded based on 1° latitude spacing with longitude set to square the cells, approximating 111x111km cells in horizontal plane



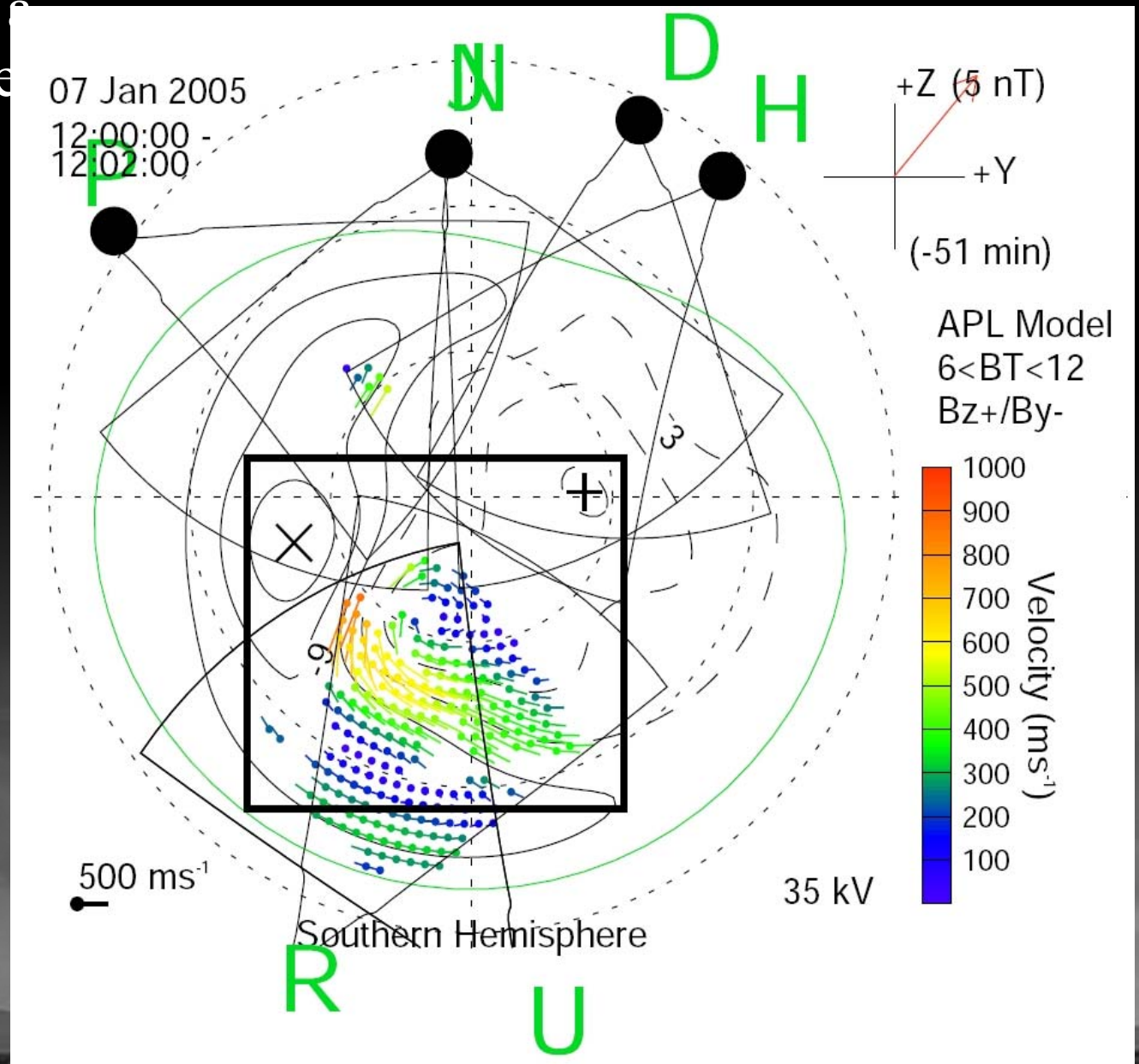
Could we use a more detailed picture?

- Map potential shows large scale vortex in the pre-midnight sector
- More detail required to define spatial extent and velocity of westward edge
- Potential contours not enough to answer, is there a convection cell splitting?



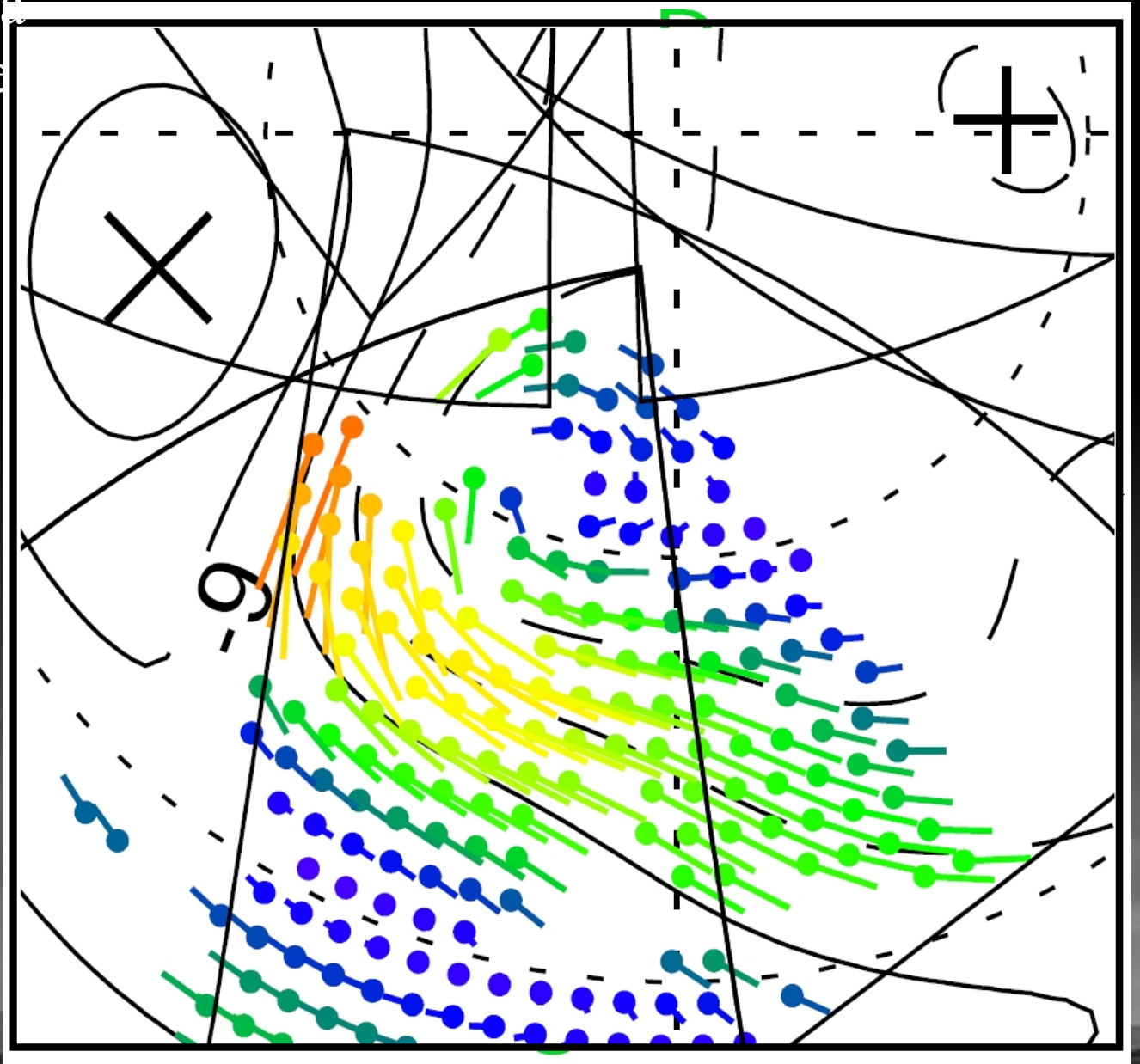
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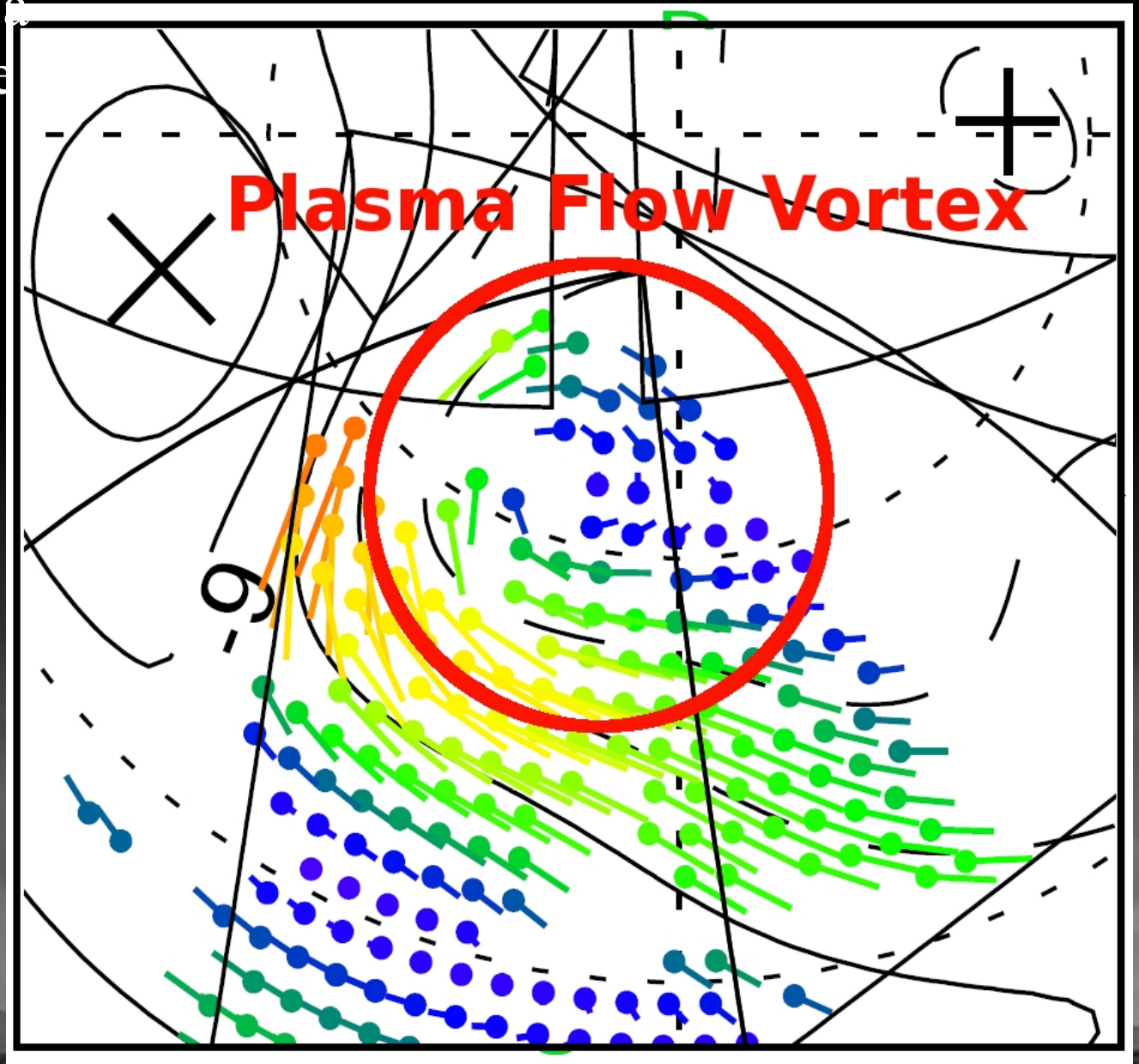
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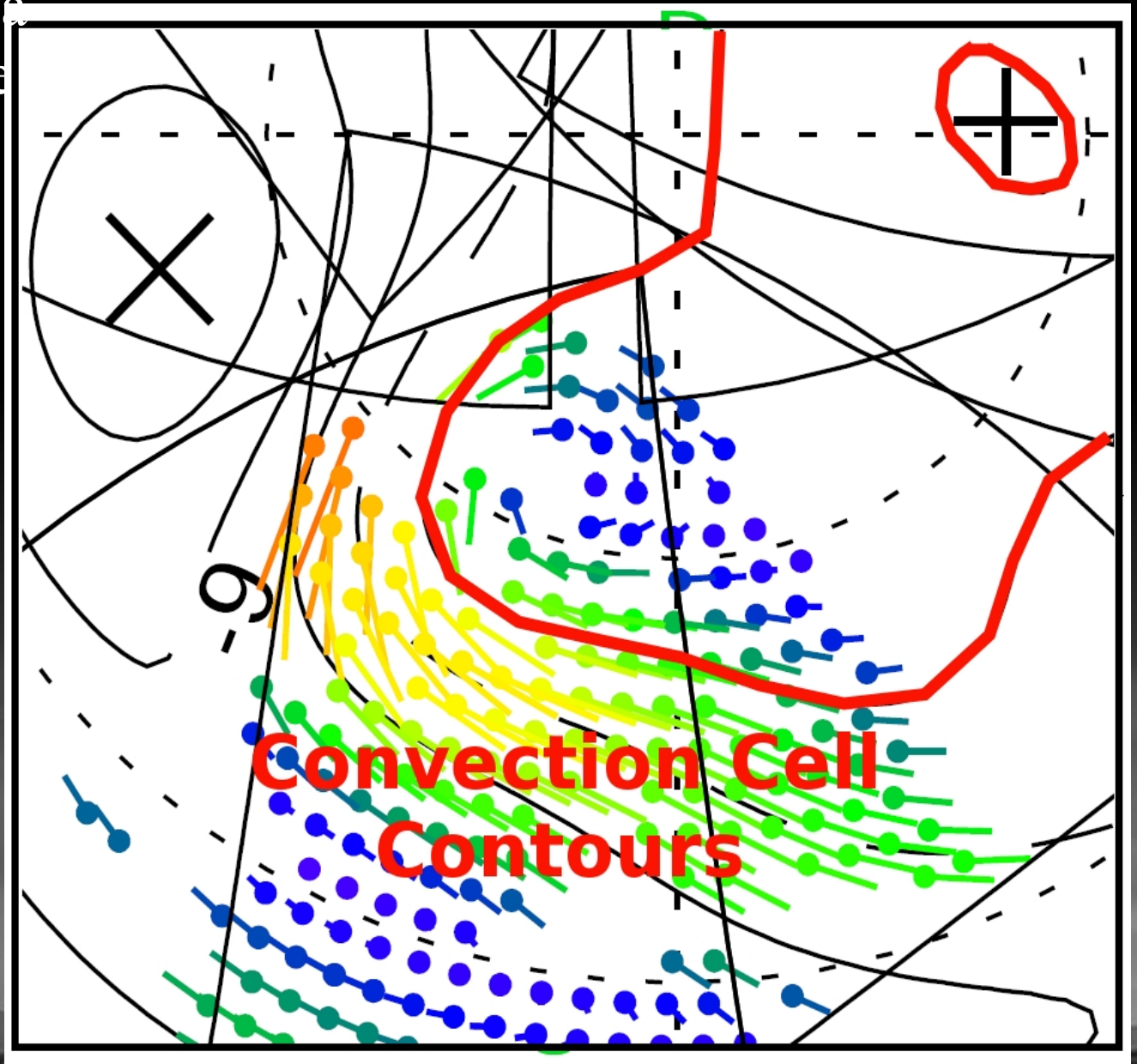
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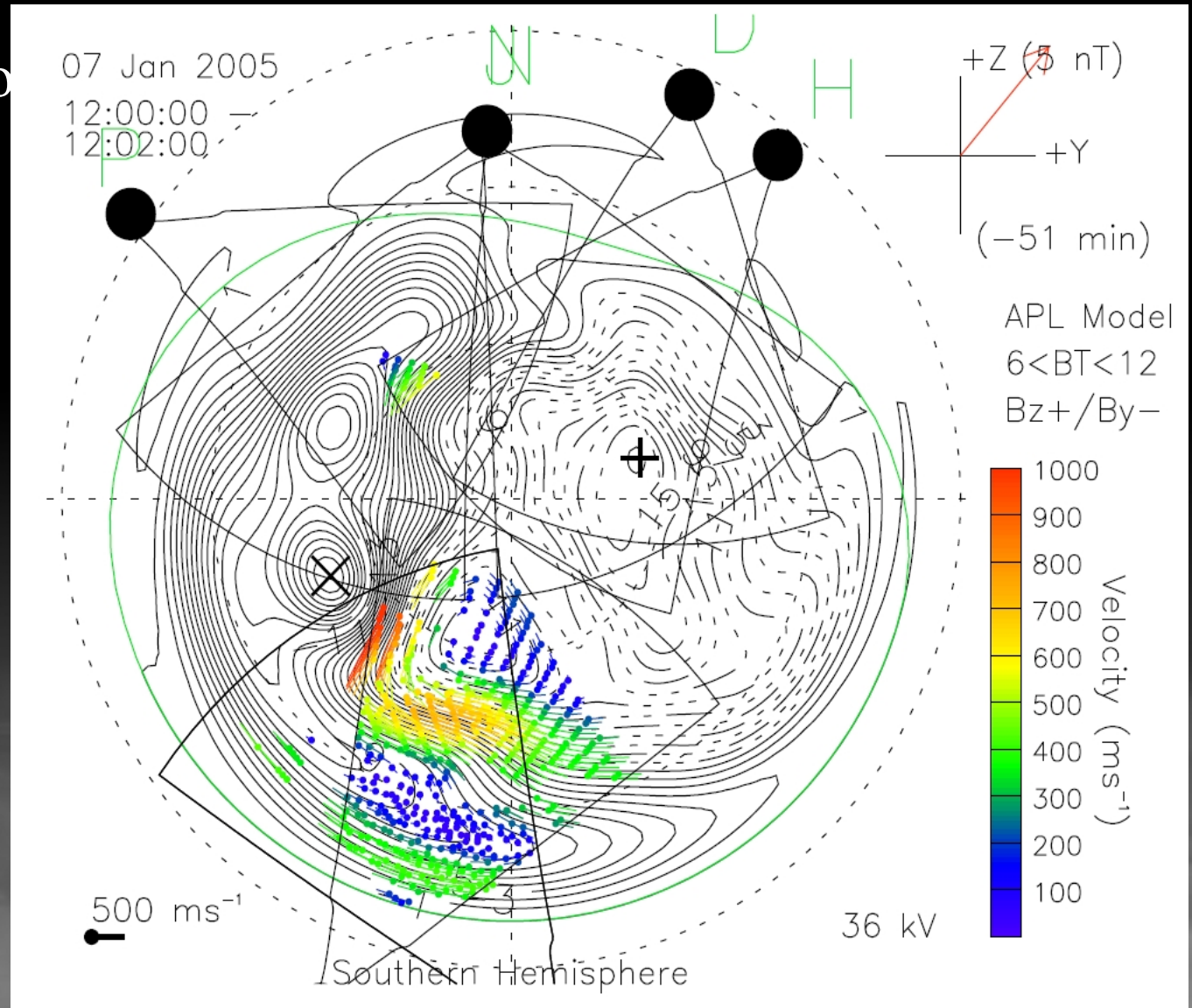
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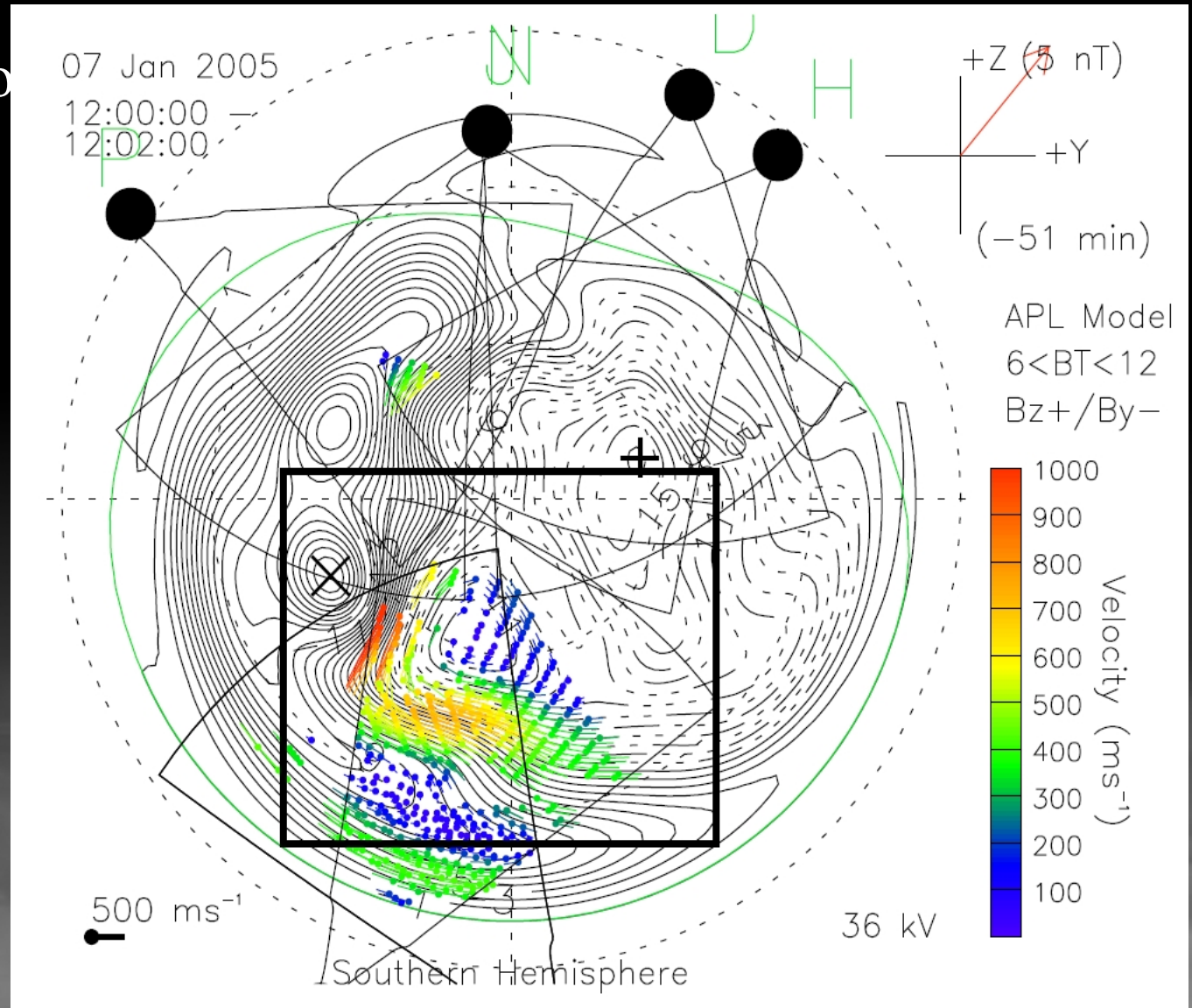
A modification to Map Potential

- Modified Map potential grids data into $\sim 1 \times 1$ km grid
- Radar range gate median filtering NOT modified
- All radar range gates are gridded
- Potential contours are defined by all the radar range gate data



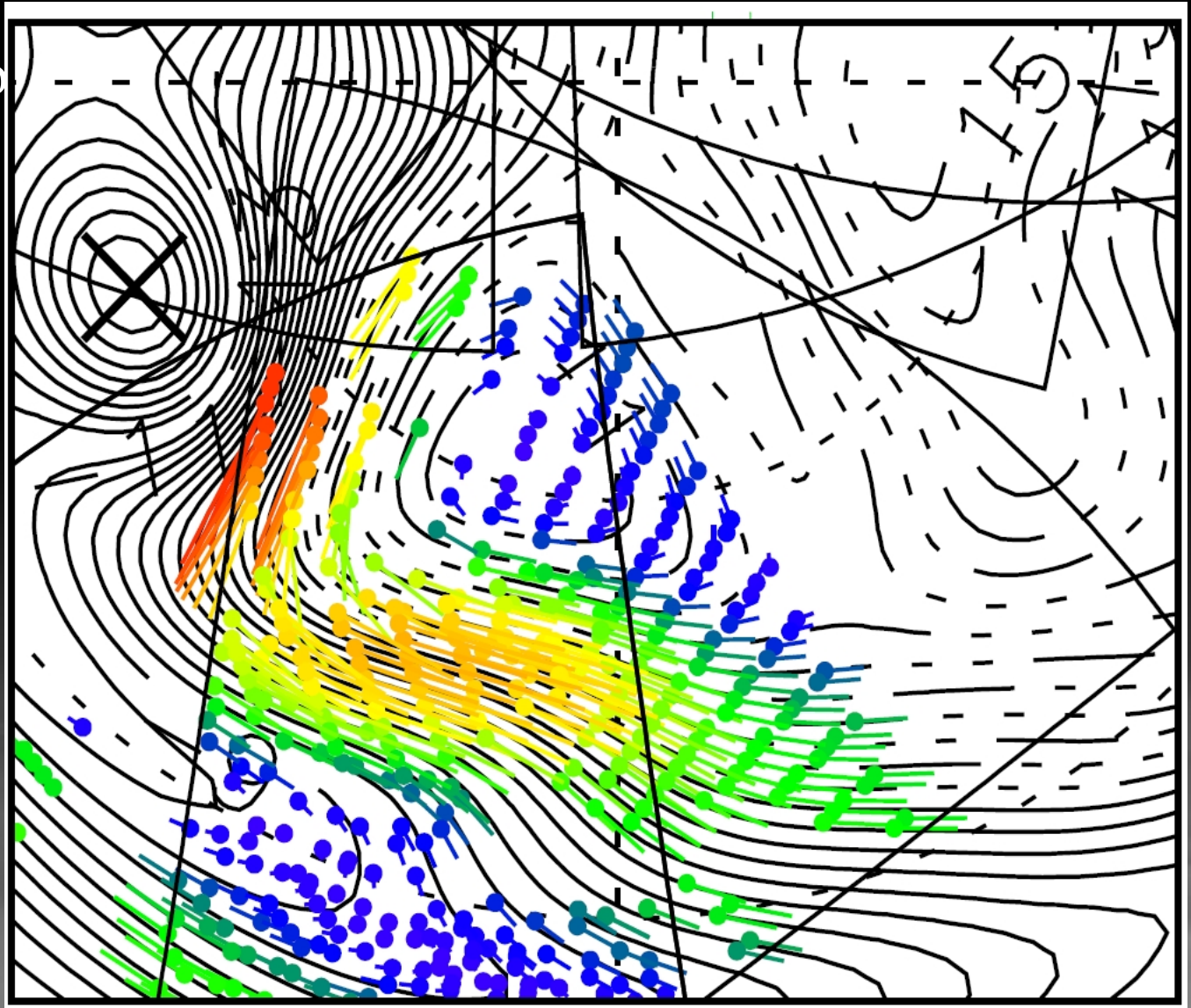
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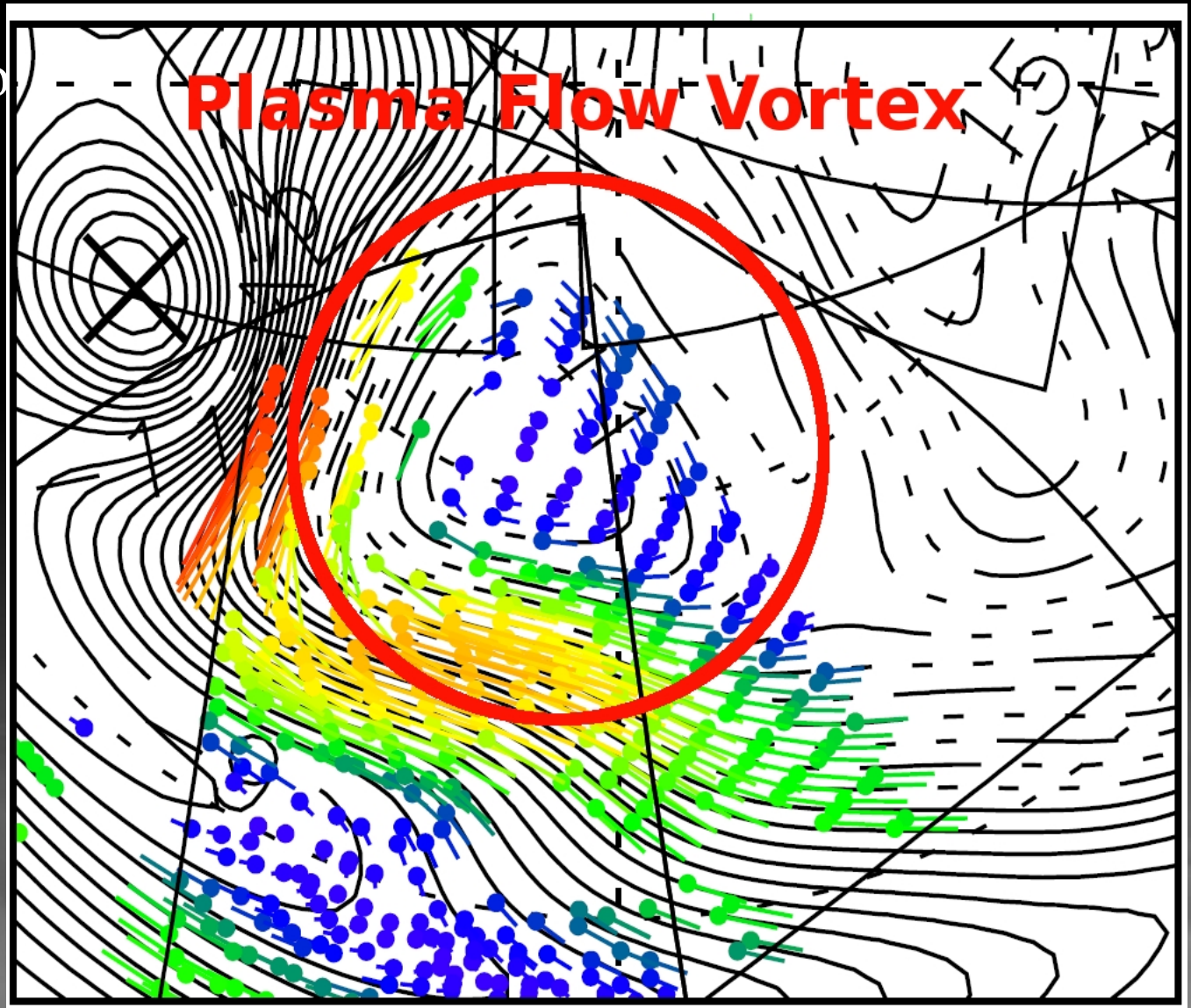
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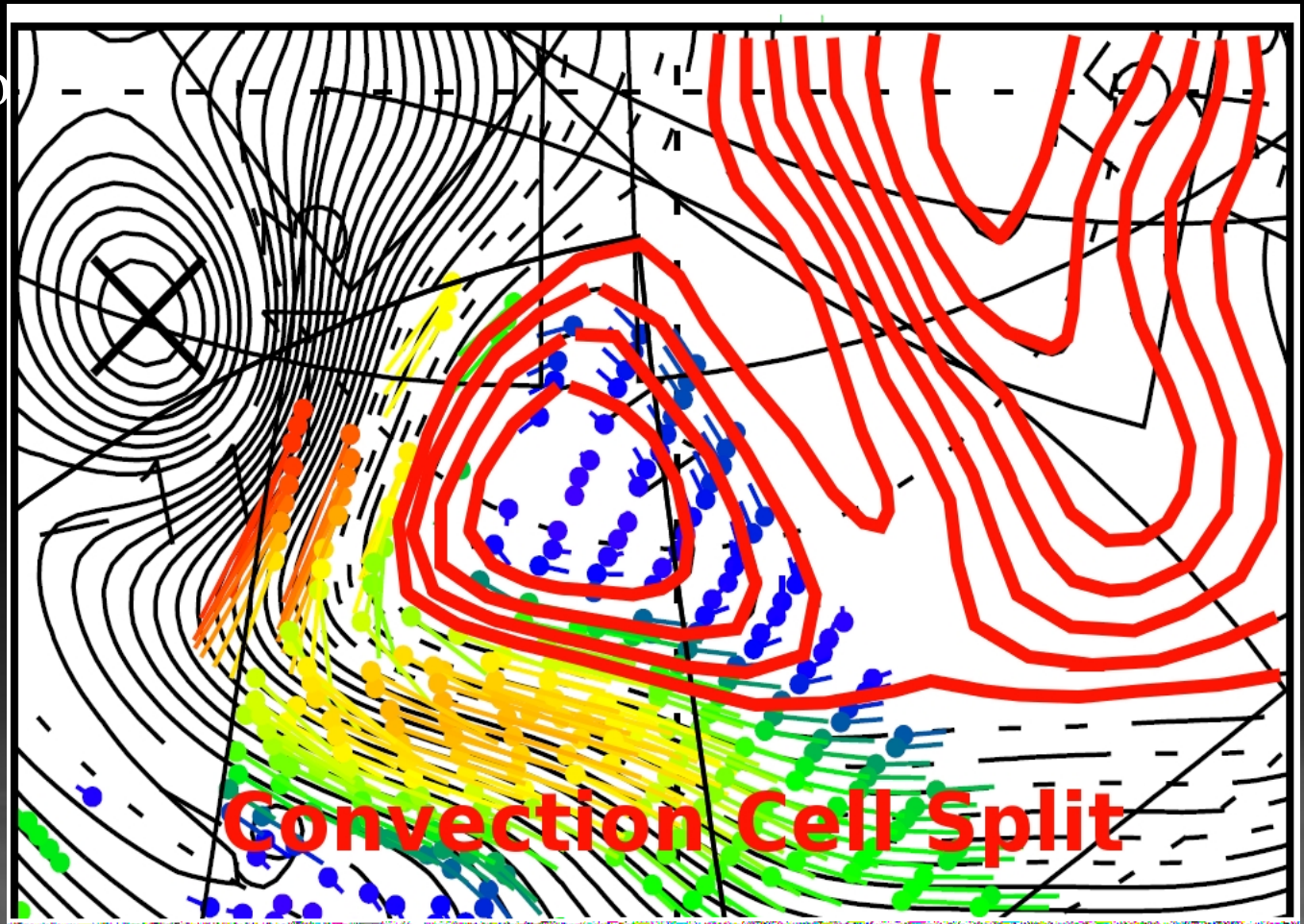
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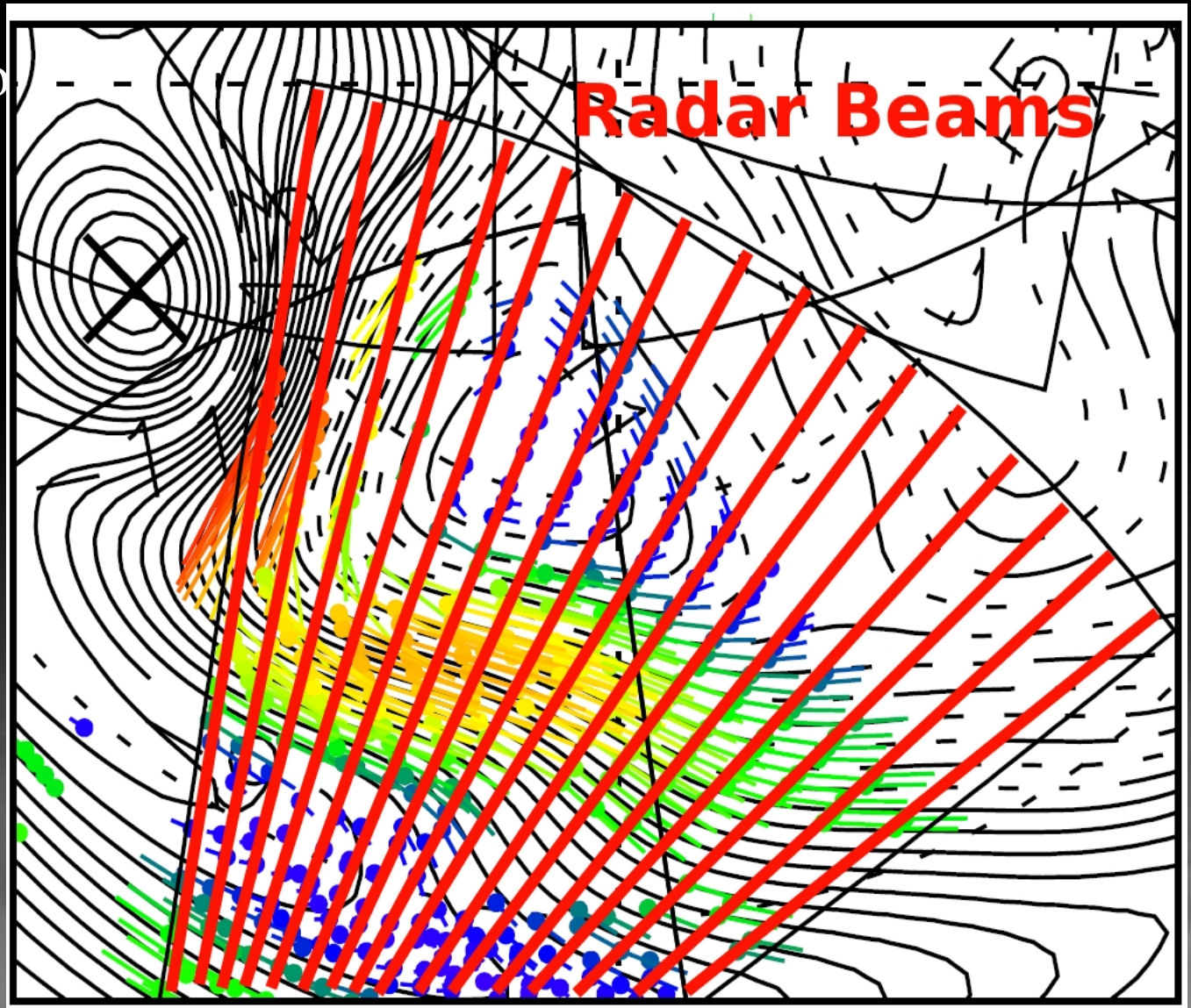
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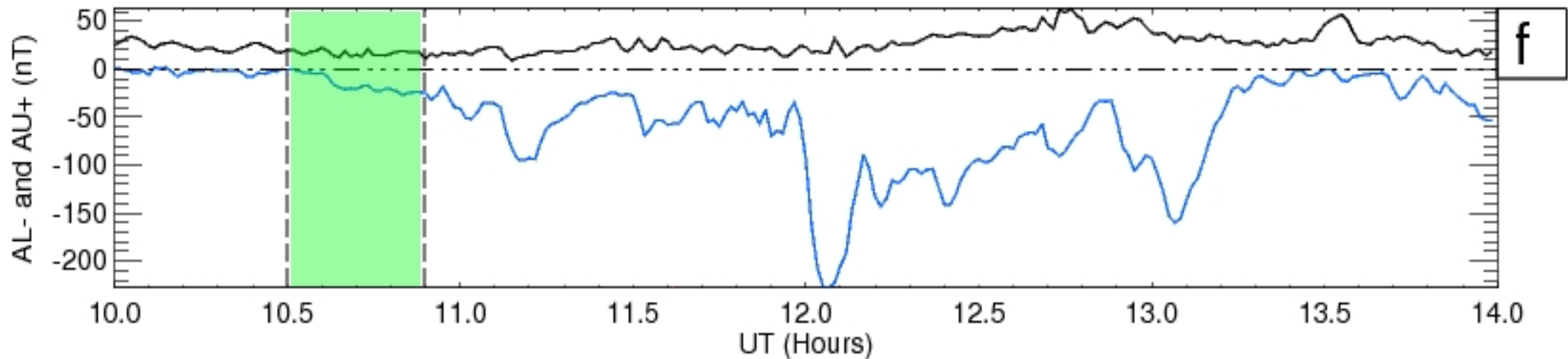
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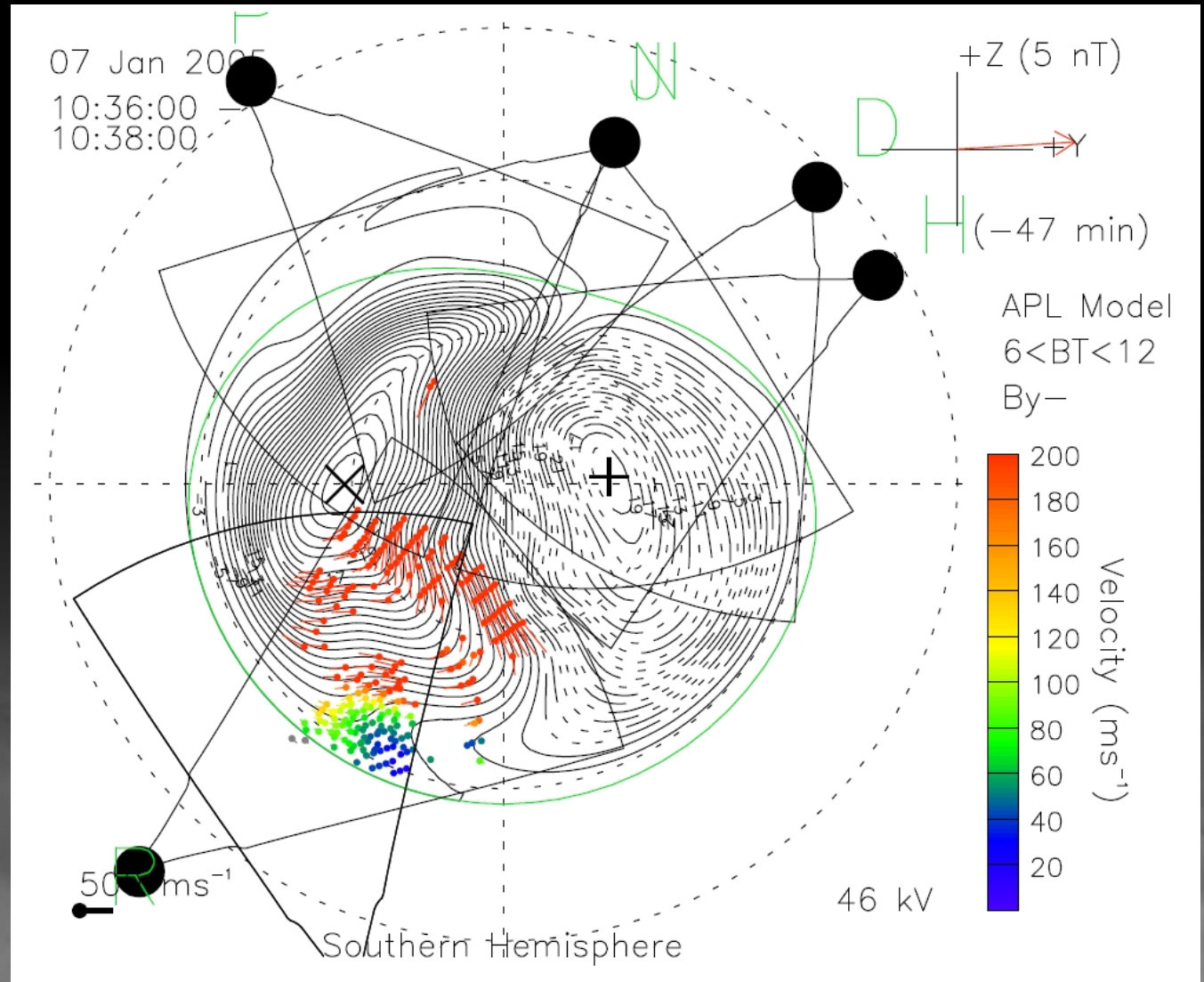
Flow Stagnation

- Flow stagnation begins with the first negative increase in AL- index, 1030UT, and diminishes towards the first substorm
- Plasma flow stagnation directly related to substorm onset



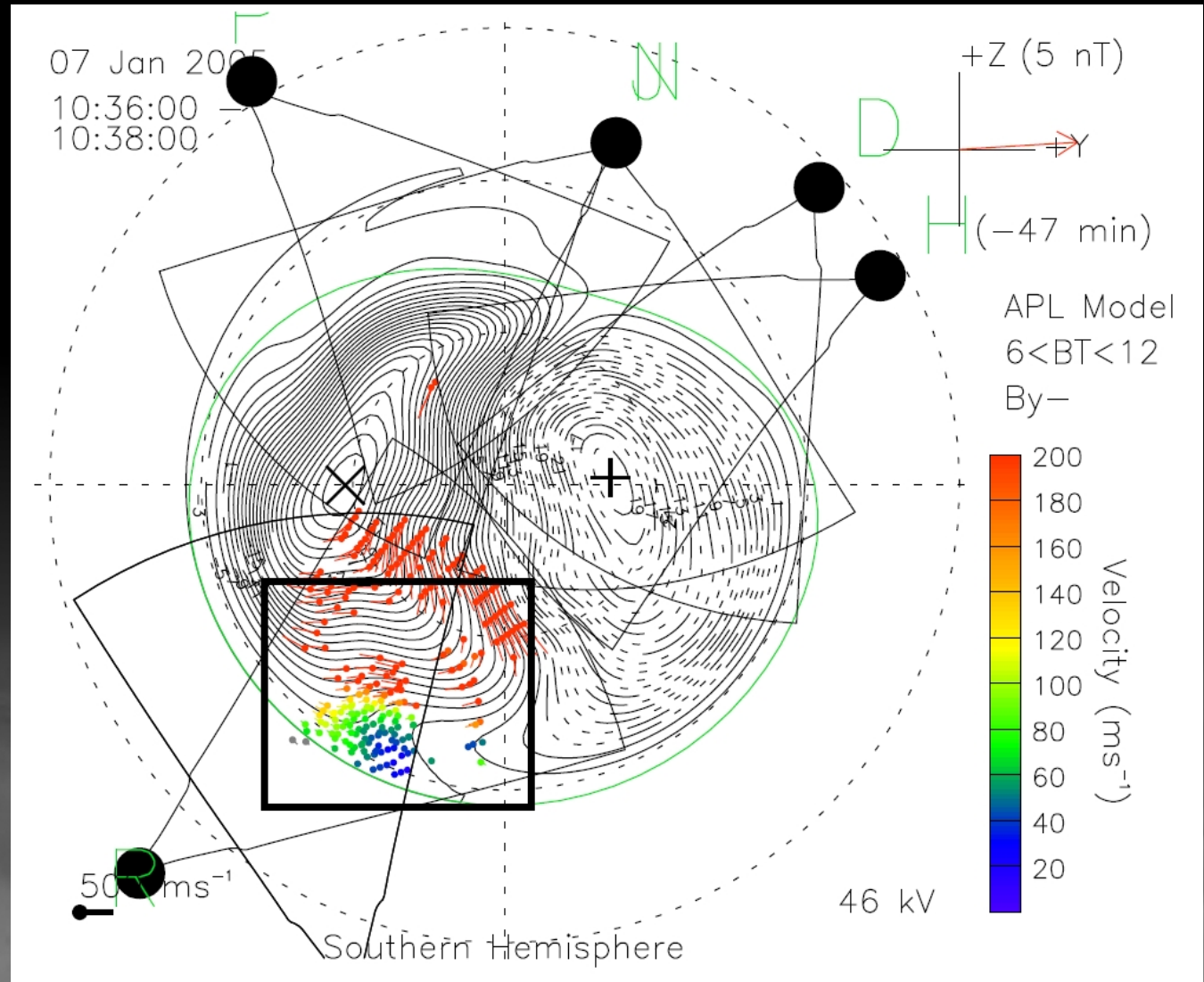
Flow Stagnation

- TIGER radars ideally located in the pre-midnight sector, and provide excellent back-scatter data
- Flow stagnation due to the high electrical conductivity, particle precipitation



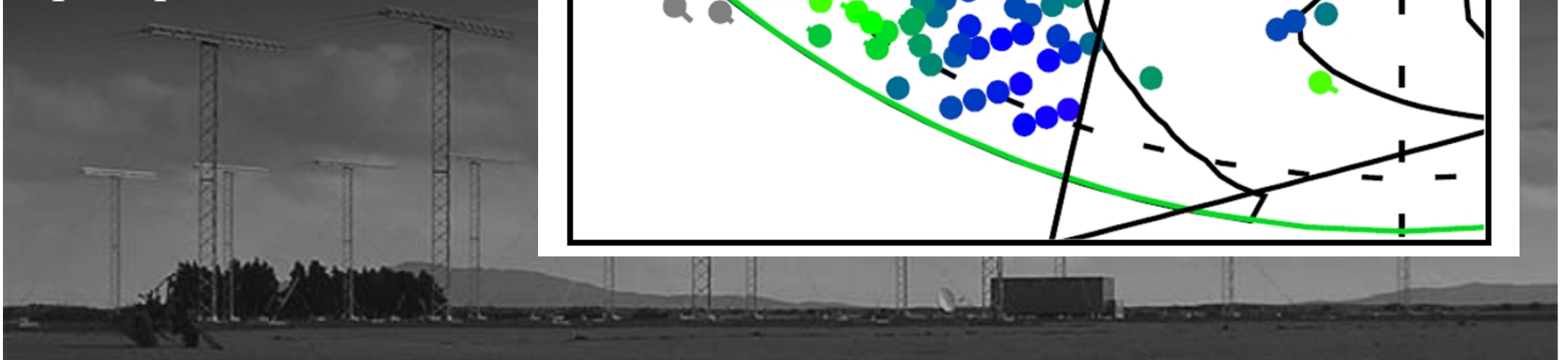
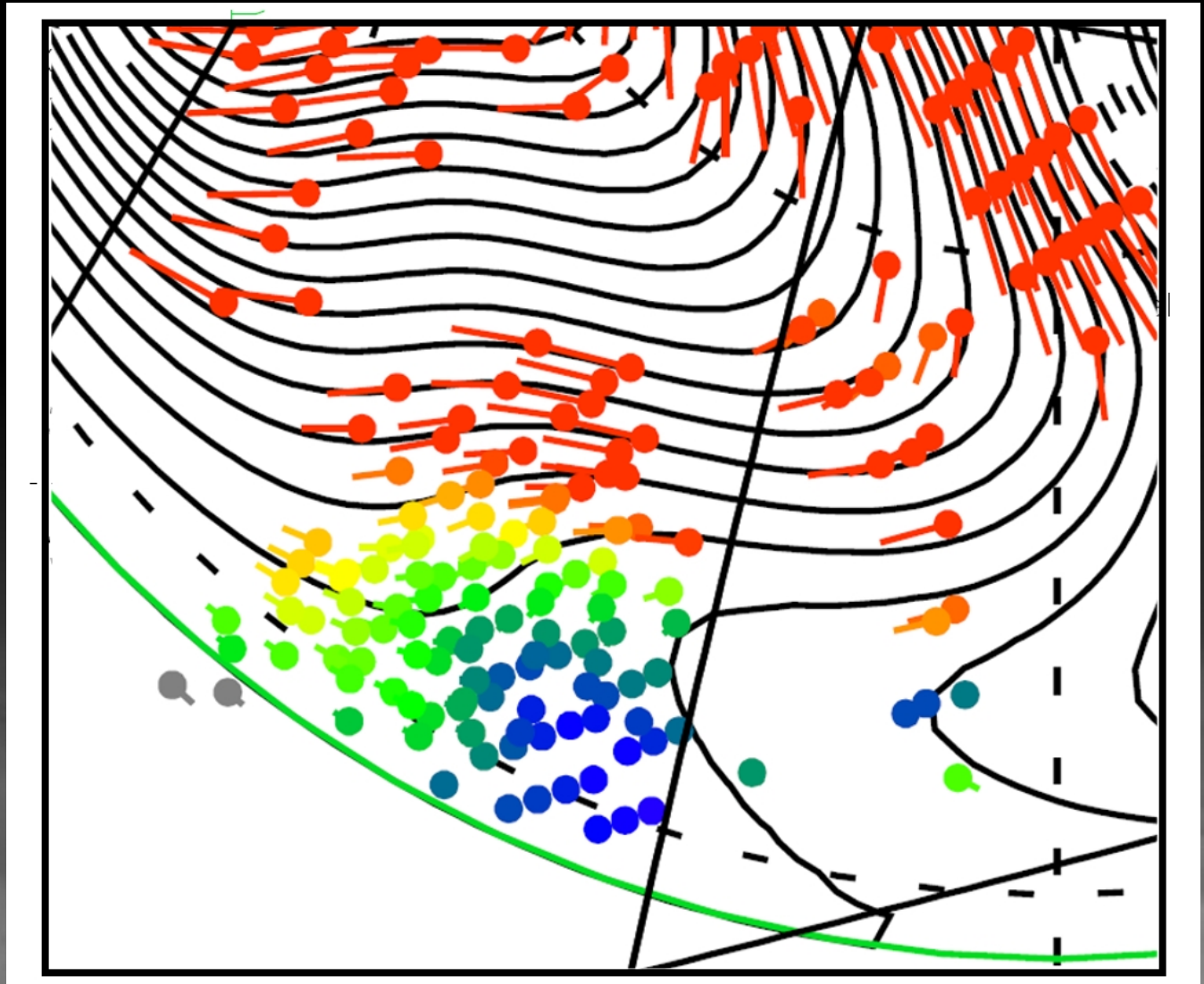
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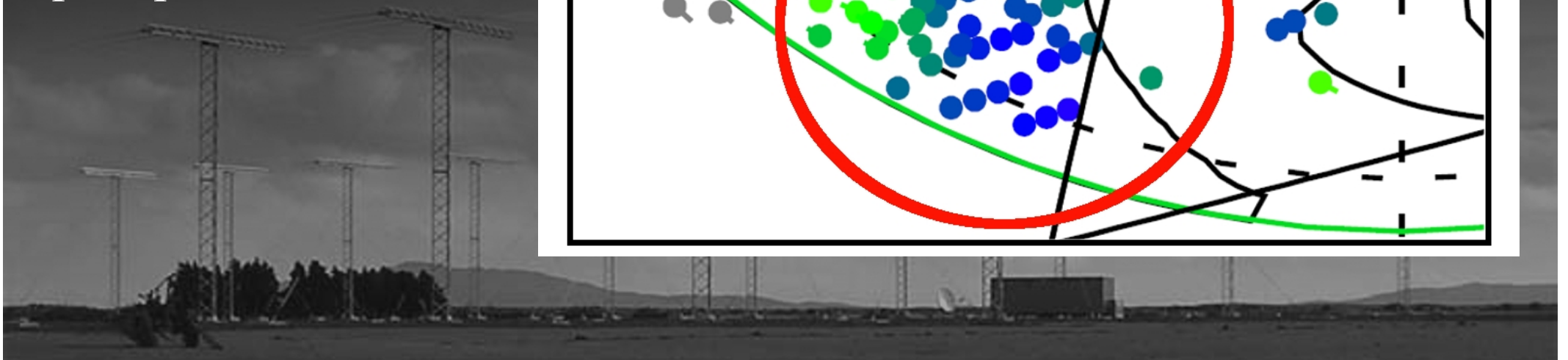
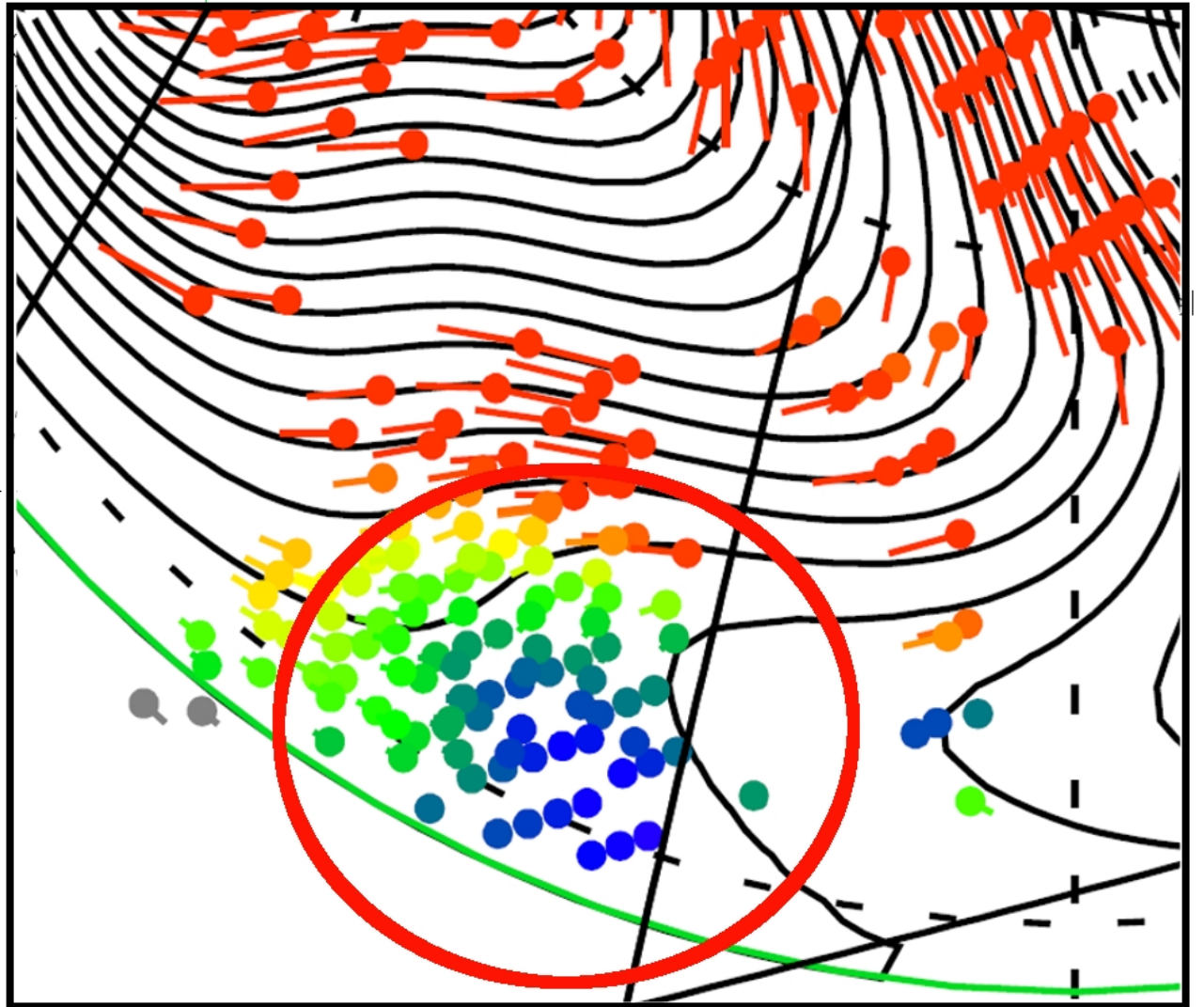
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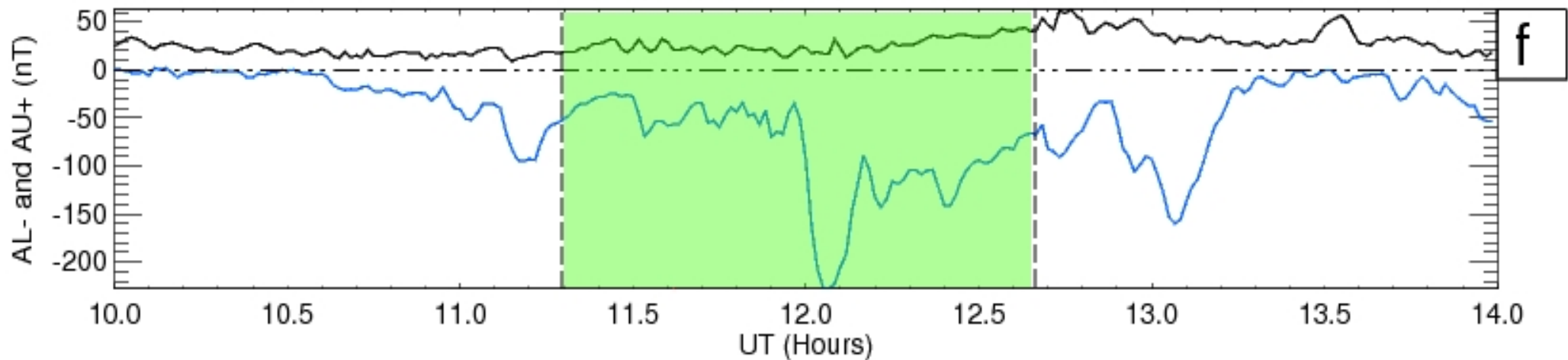
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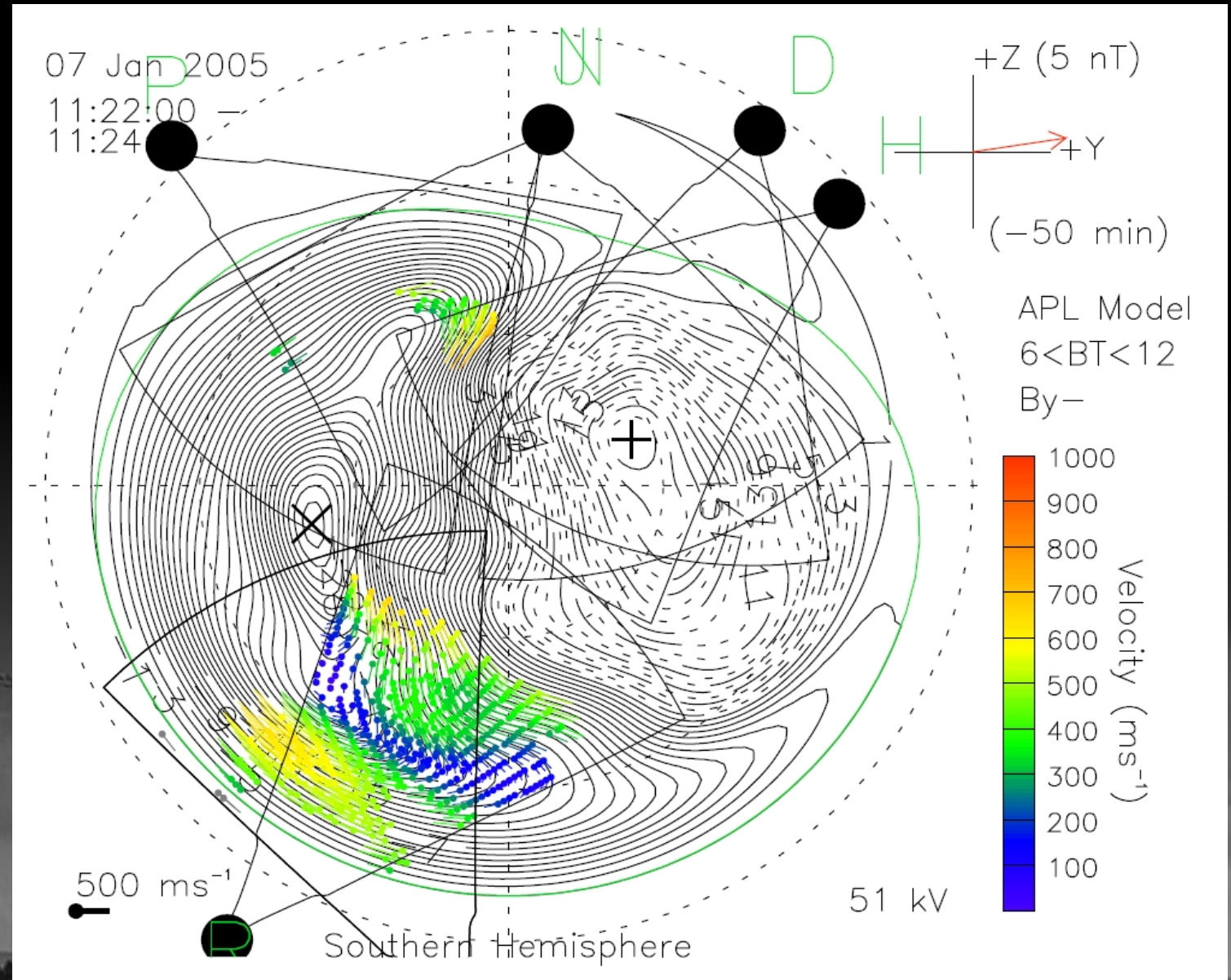
Harang “Banana”

- A Harang Discontinuity stretches the dawn potential convection cell between 1118UT and 1242UT



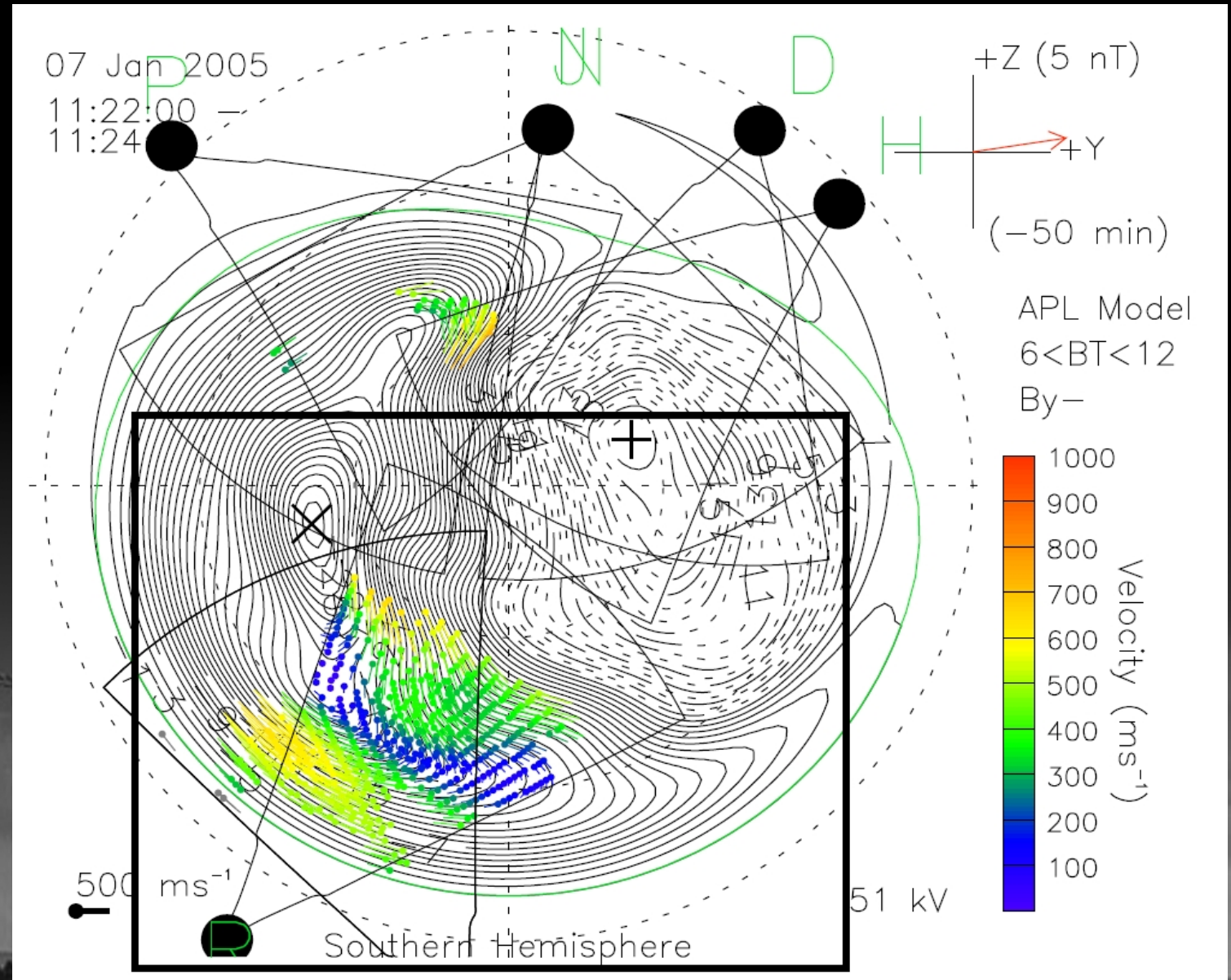
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- A Harang discontinuity condition causes “Banana-ing” of the dawn convection cell



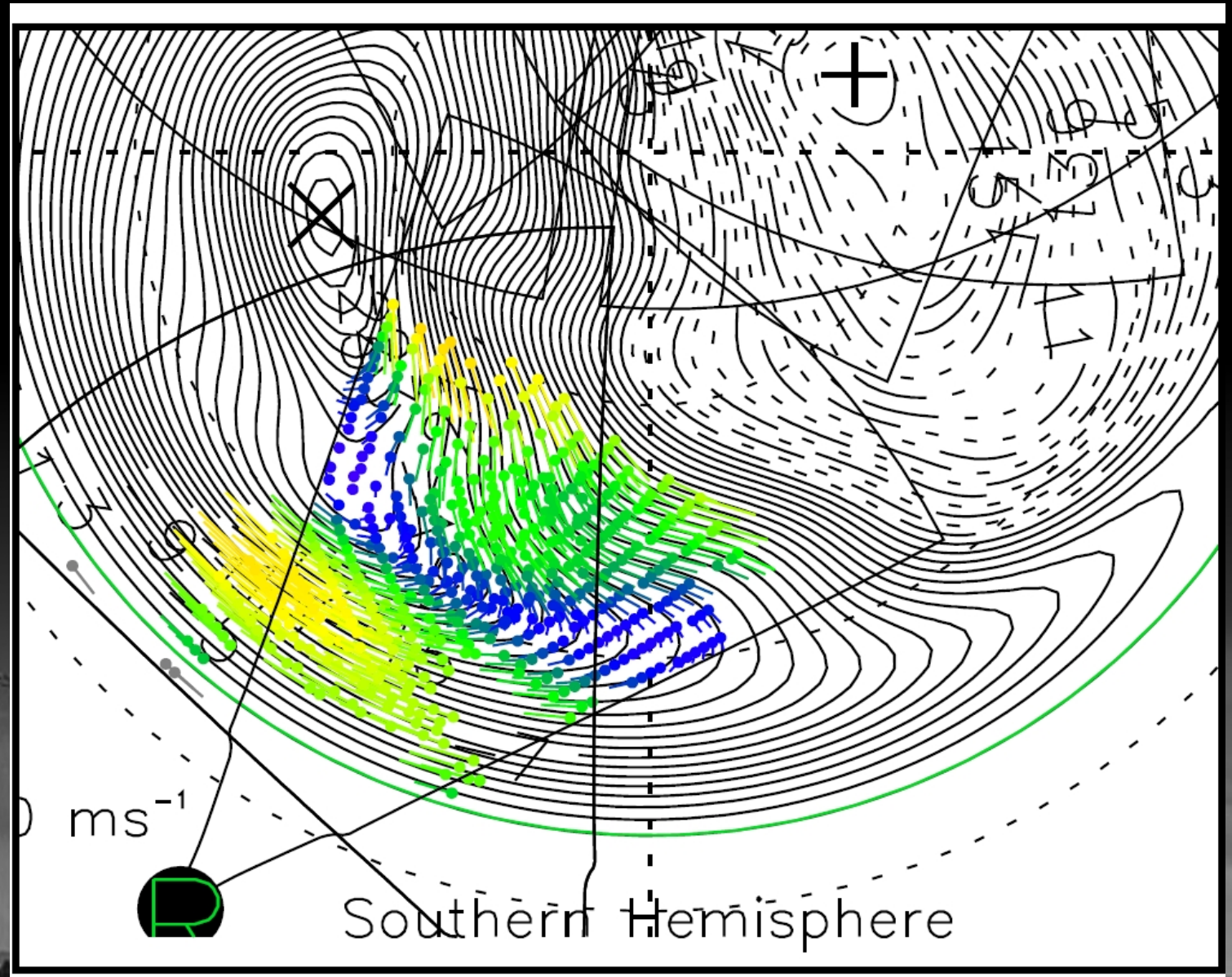
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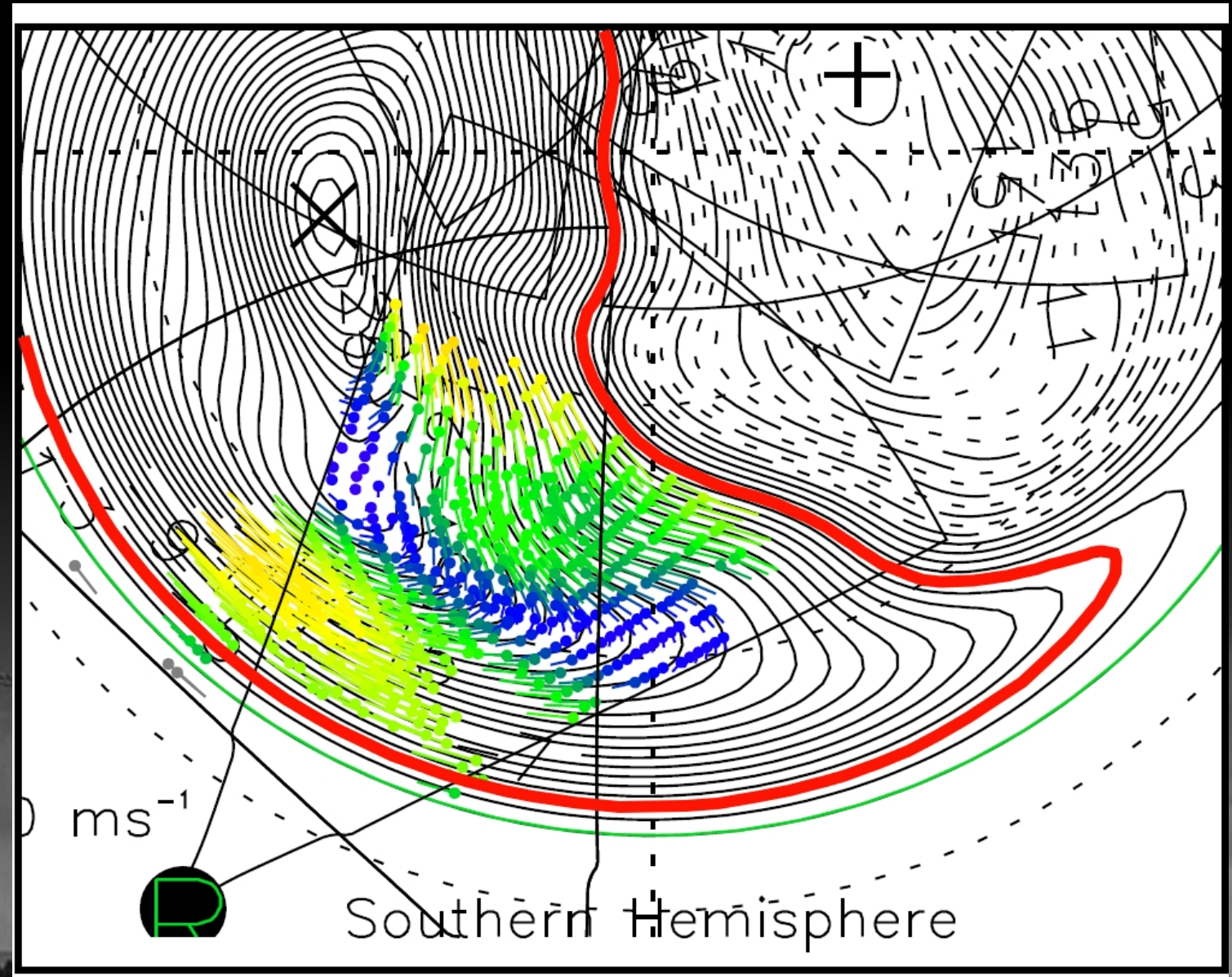
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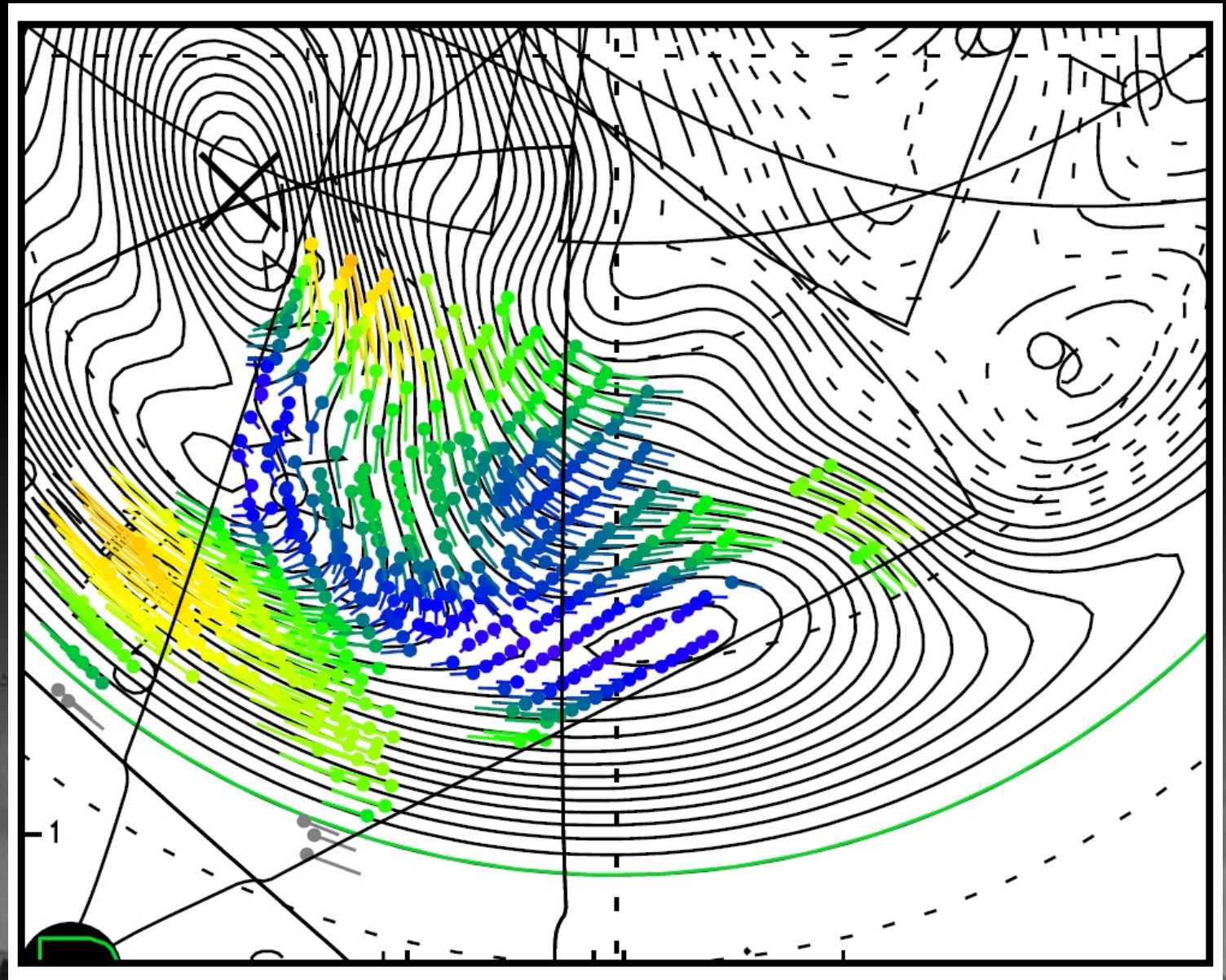
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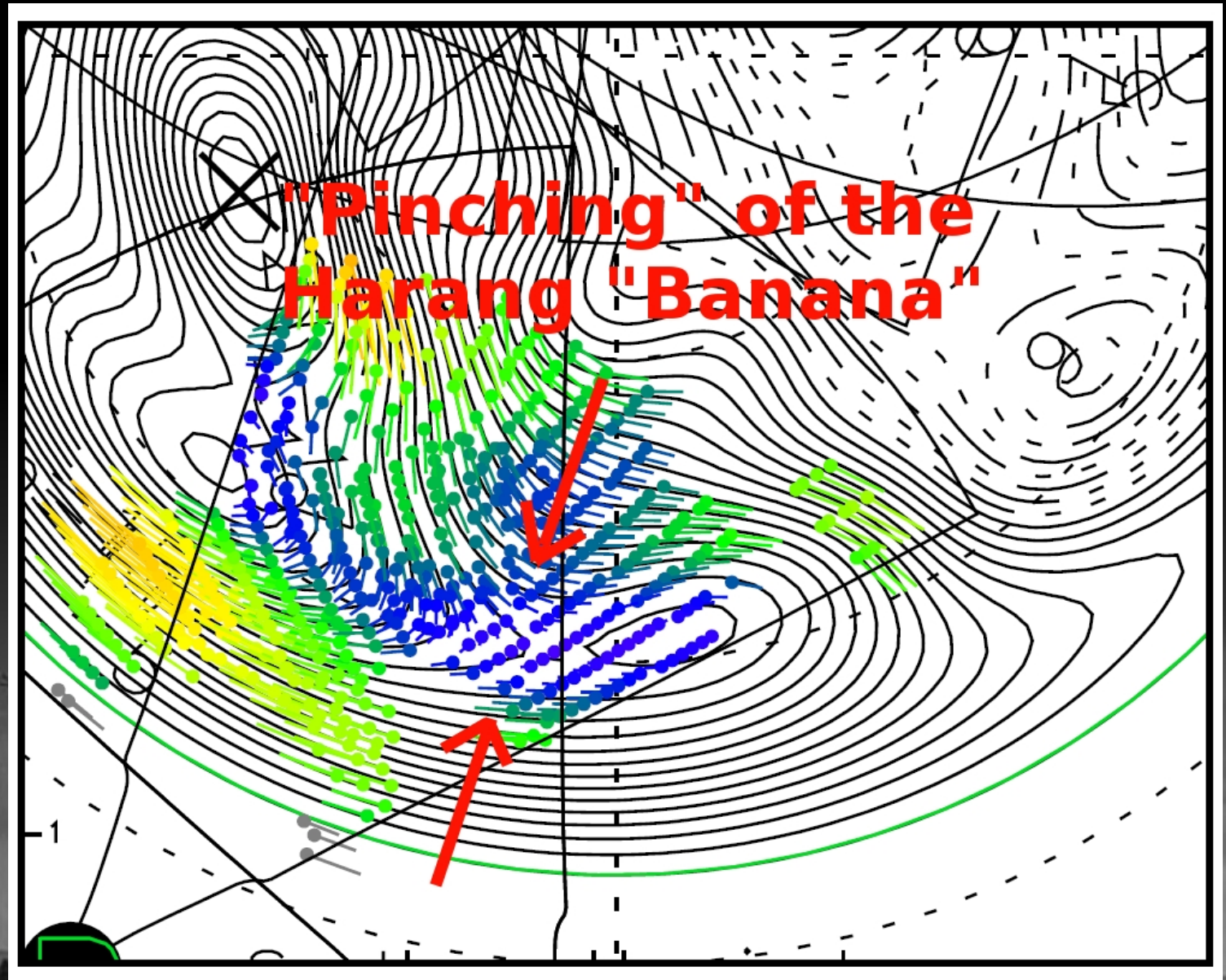
“Pinching off” of the Harang “Banana”

- An example of “Pinching-off” of the Harang “Banana” at 1126UT
- Contour separation at the tip of the stretched convection cell



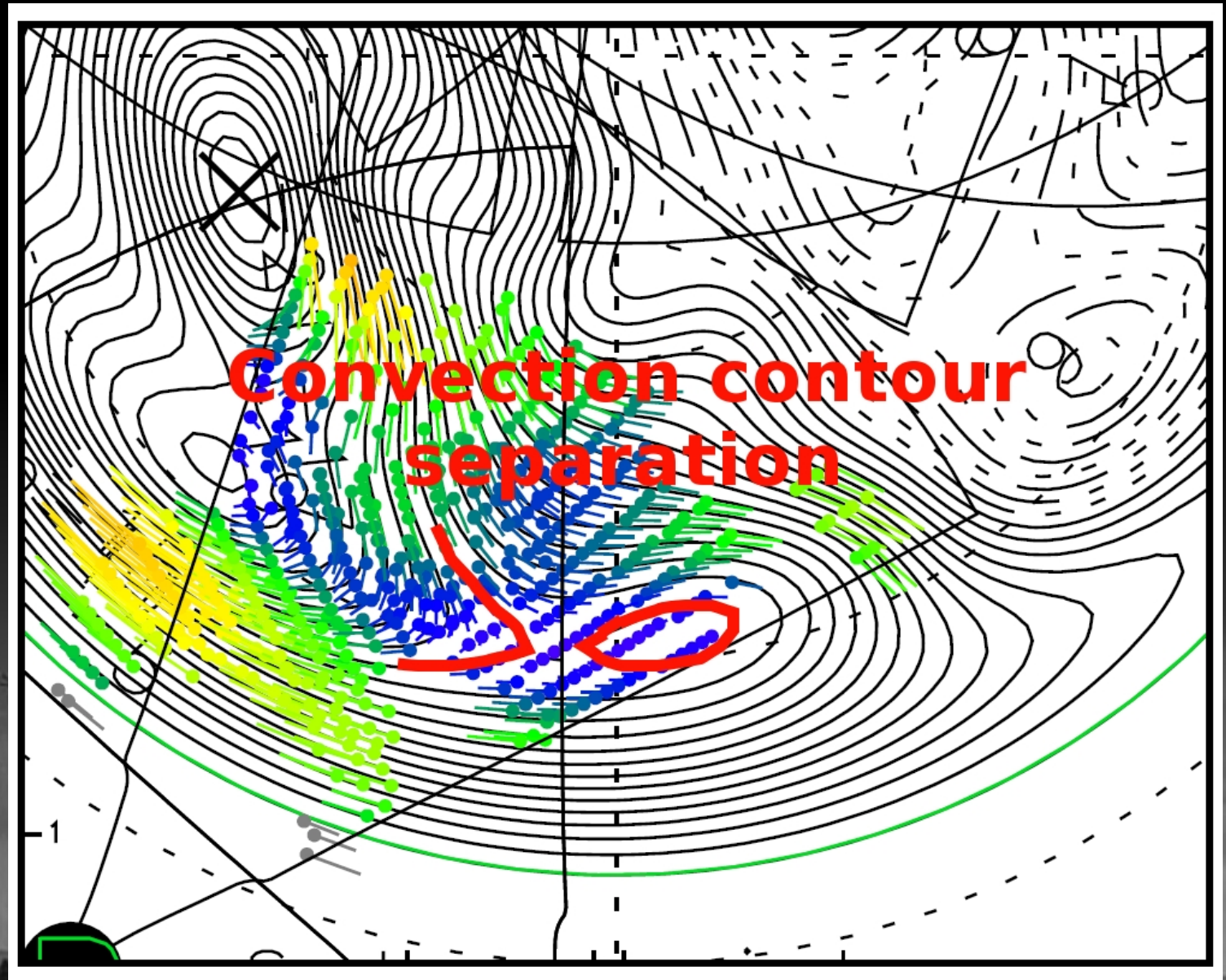
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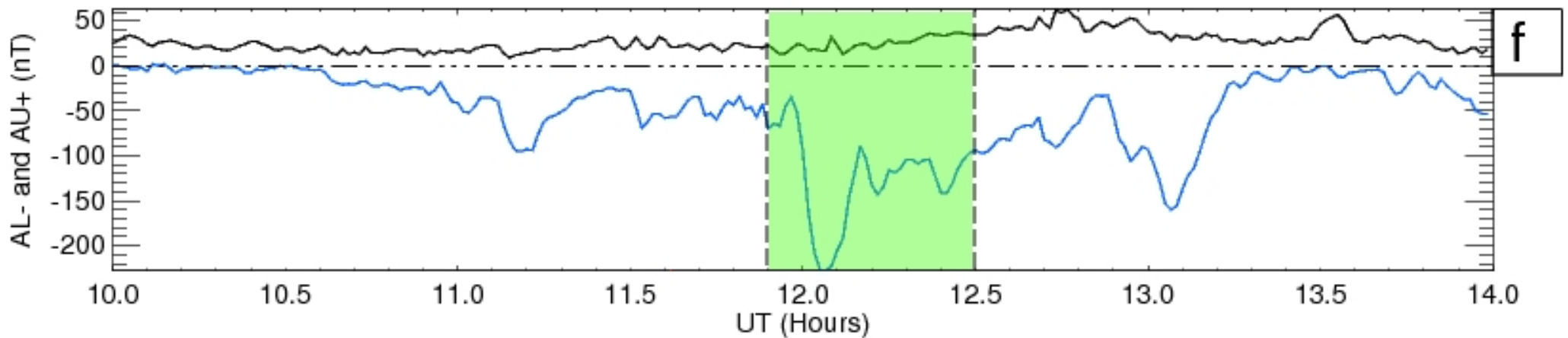
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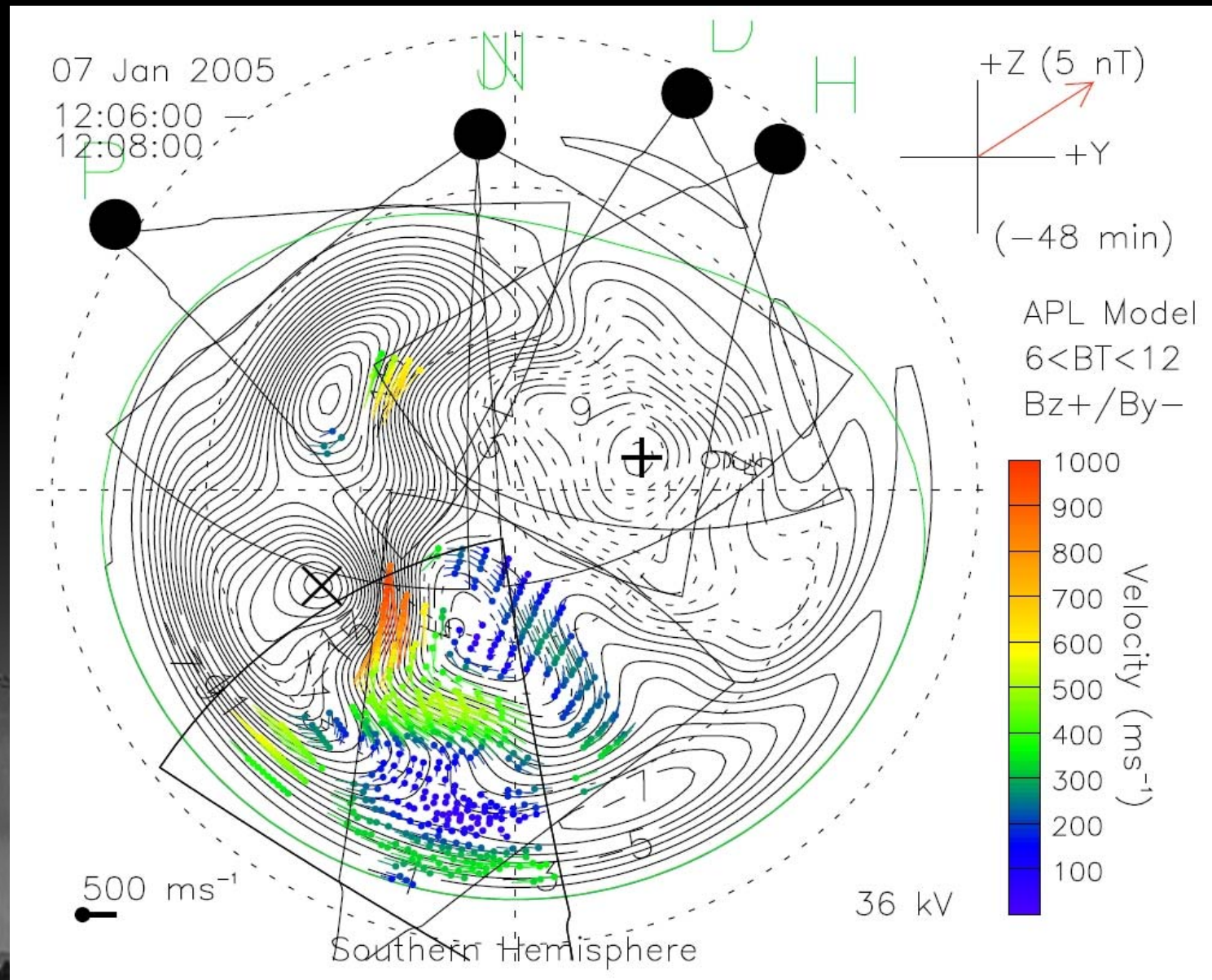
Polar Cap Flow Vortex

- A convection cell circulation forms in the pre-midnight sector, over the time interval 1156UT to 1230UT



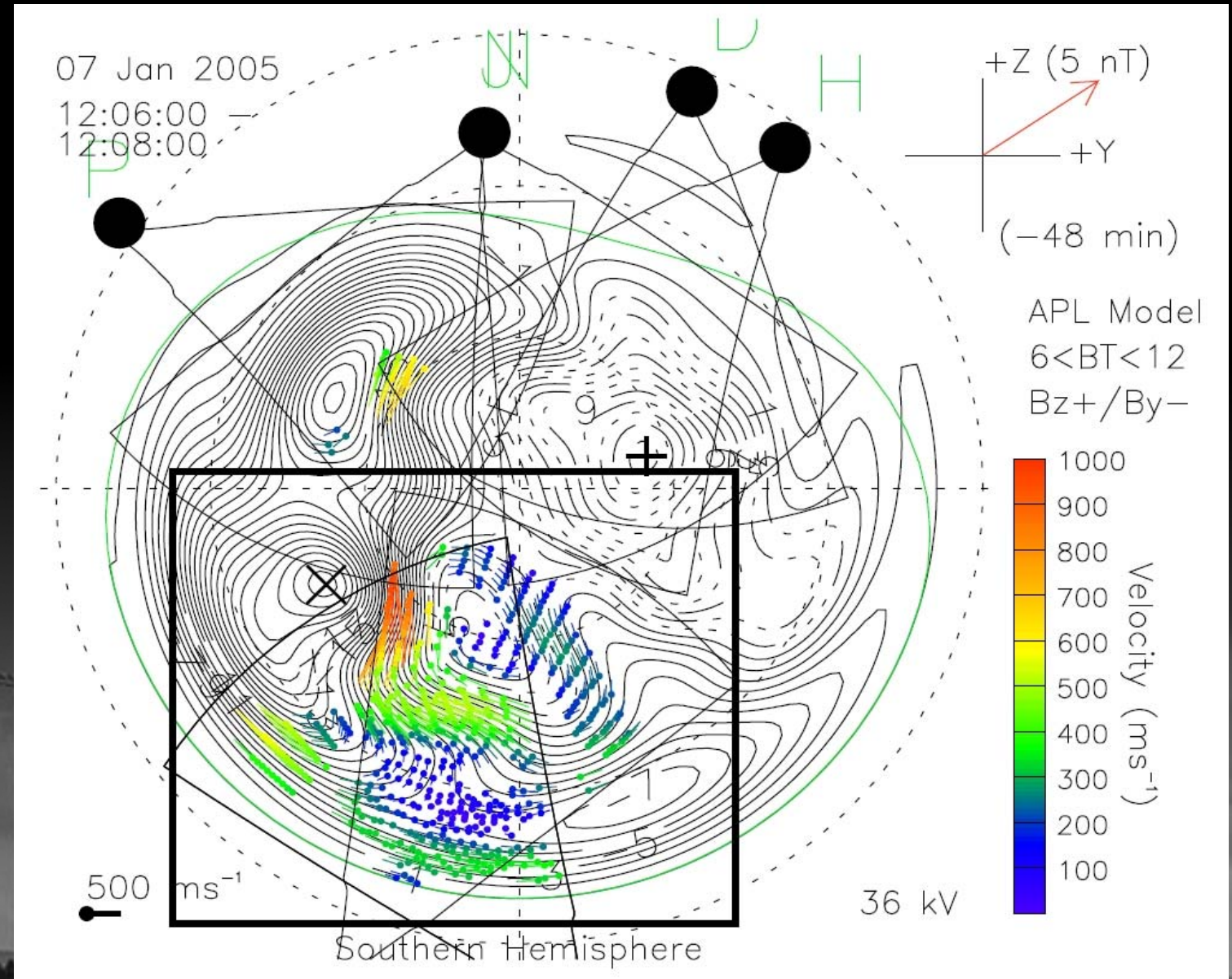
Polar Cap Flow Vortex

- A plasma circulation vortex forms in the pre-midnight sector, and travels towards dawn over 30min
- As a result we see contour separations



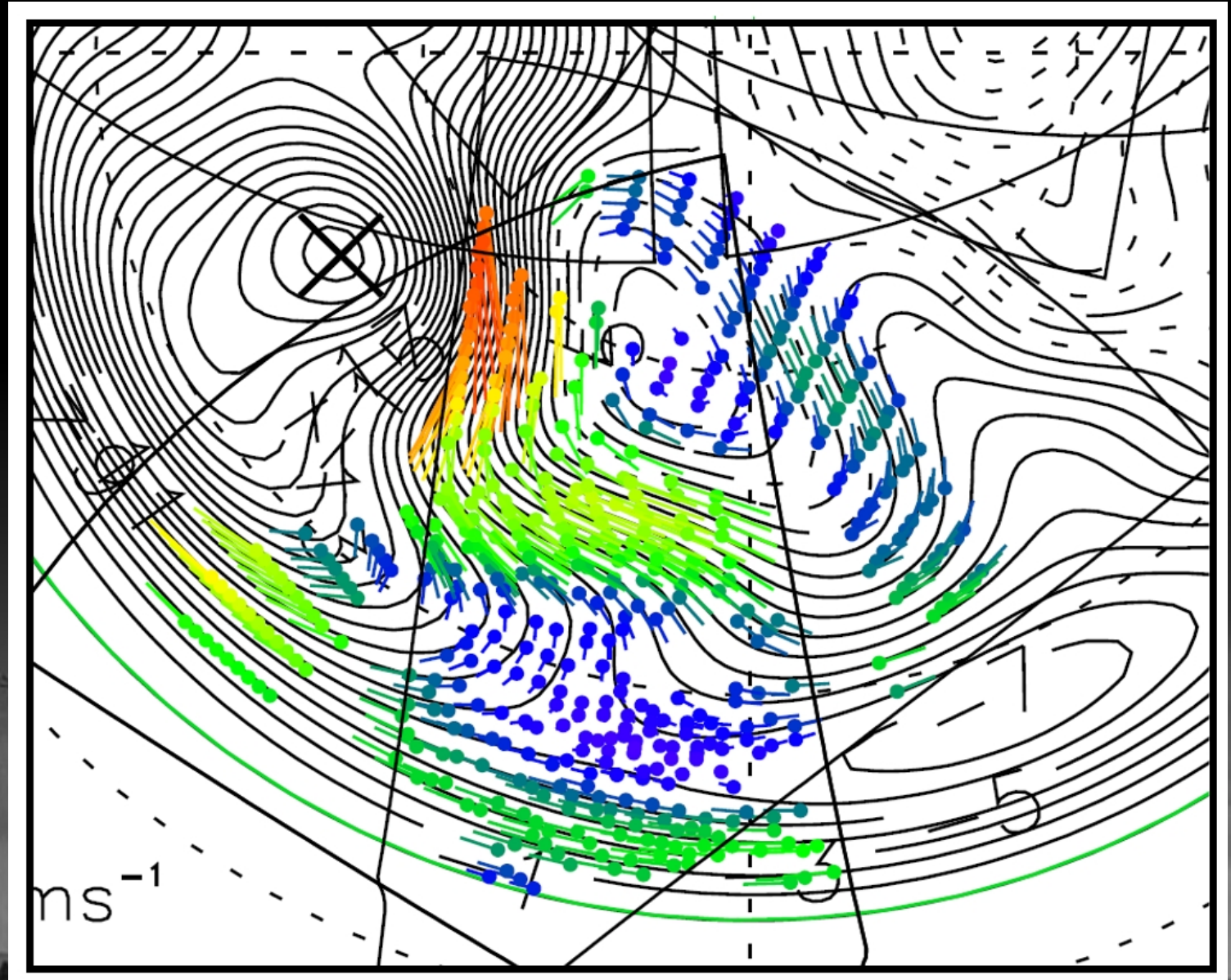
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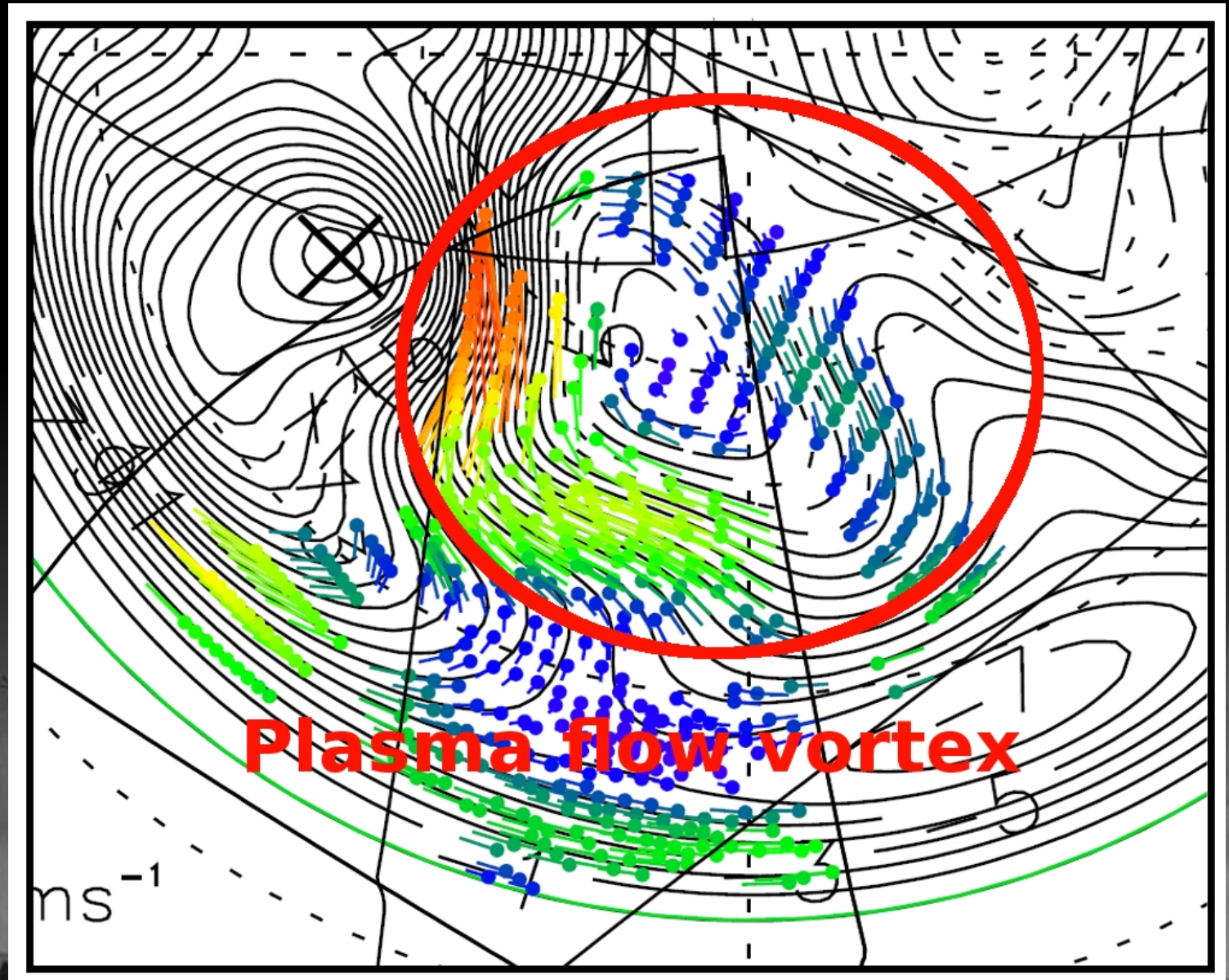
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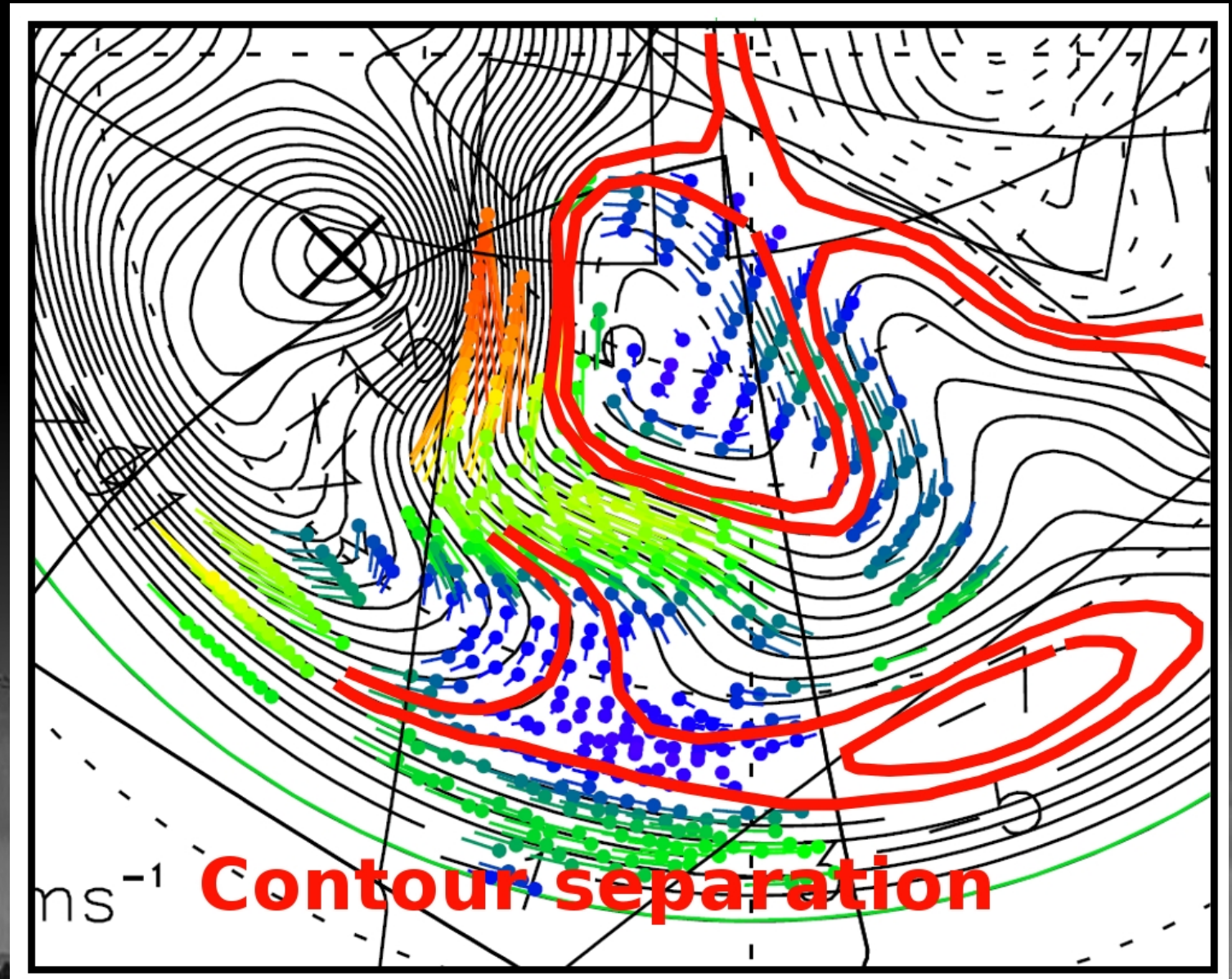
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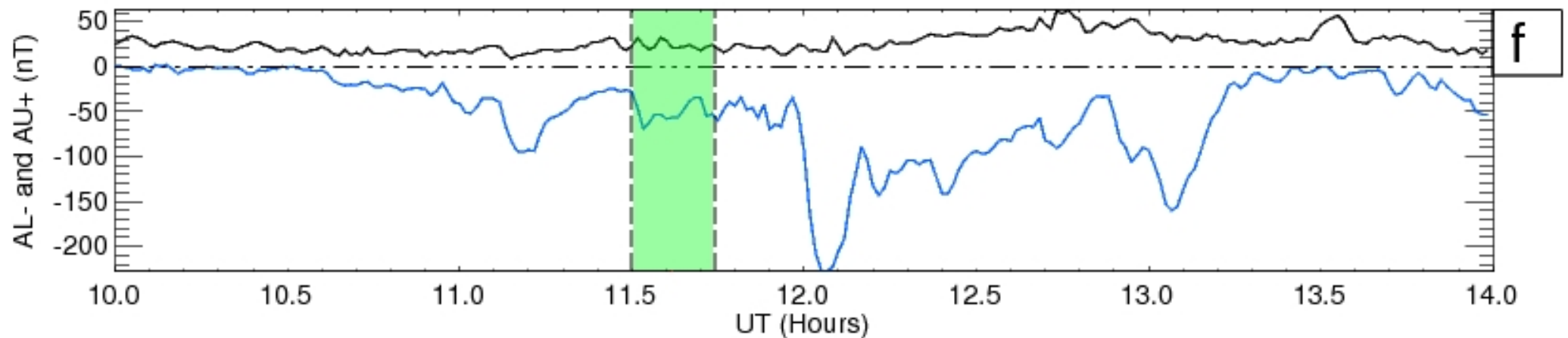
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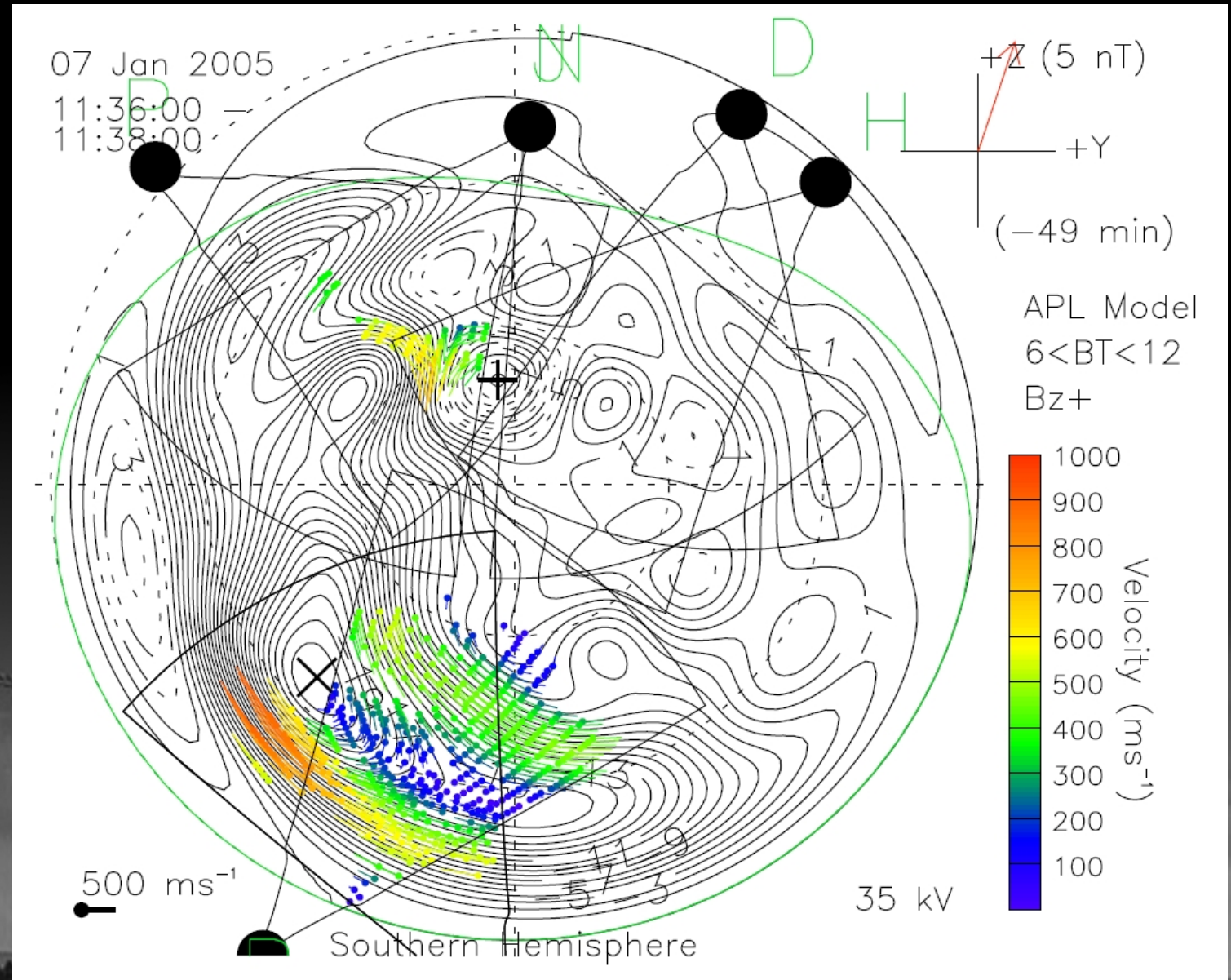
Auroral Westward Flow Channel

- Increase in the SAPS stream flow intensity, pre-midnight, on the equatorward edge of the dawn potential convection cell
- An intensification, $800 - 1000\text{ms}^{-1}$, in the plasma flow velocity occurred between 1130UT and 1146UT



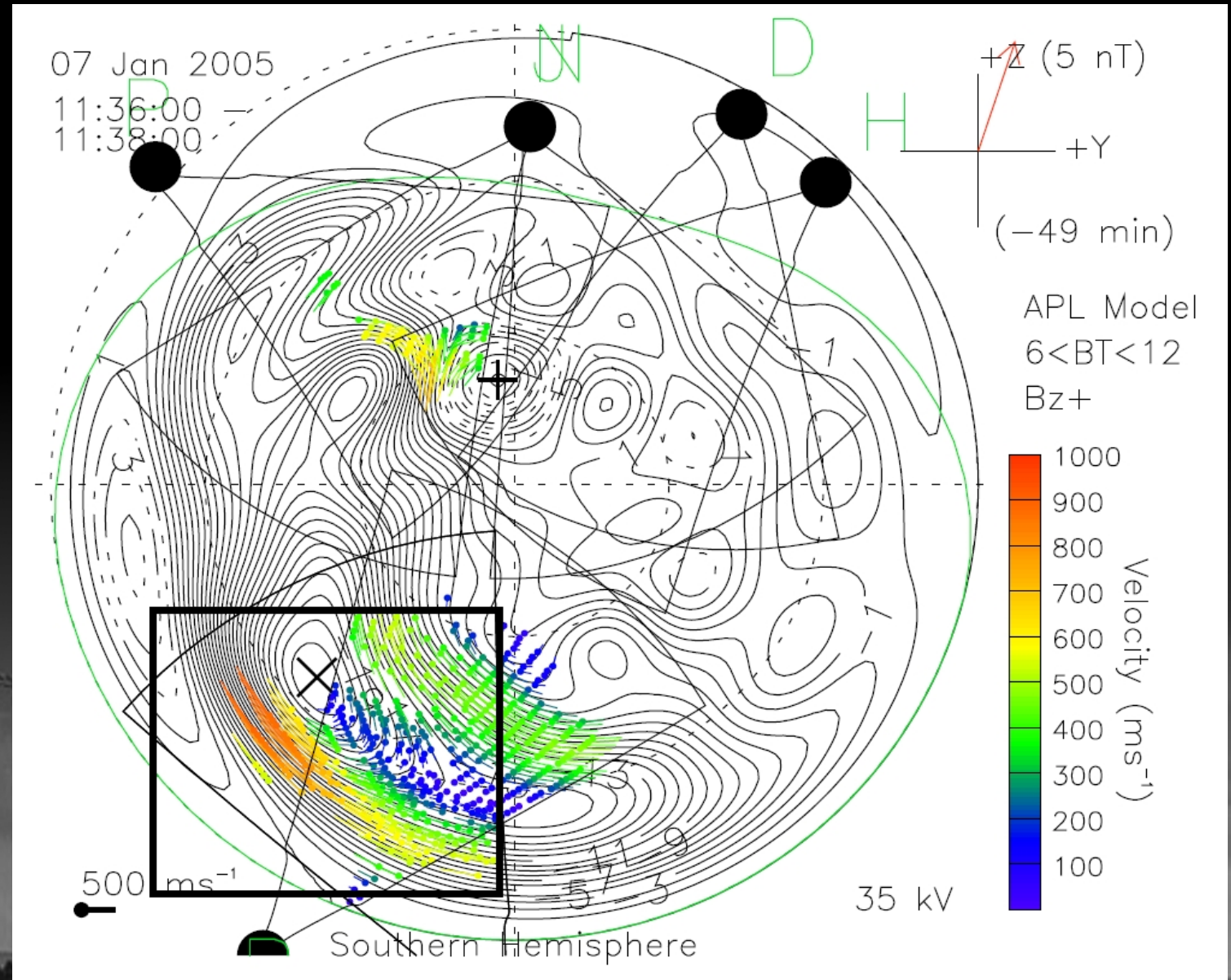
Auroral Westward Flow Channel

- An Auroral Westward Flow Channel forms 2100MLT
- It is located 67° MLat and is $2-3^{\circ}$ MLat wide
- There is clear compression of the convection cell contours



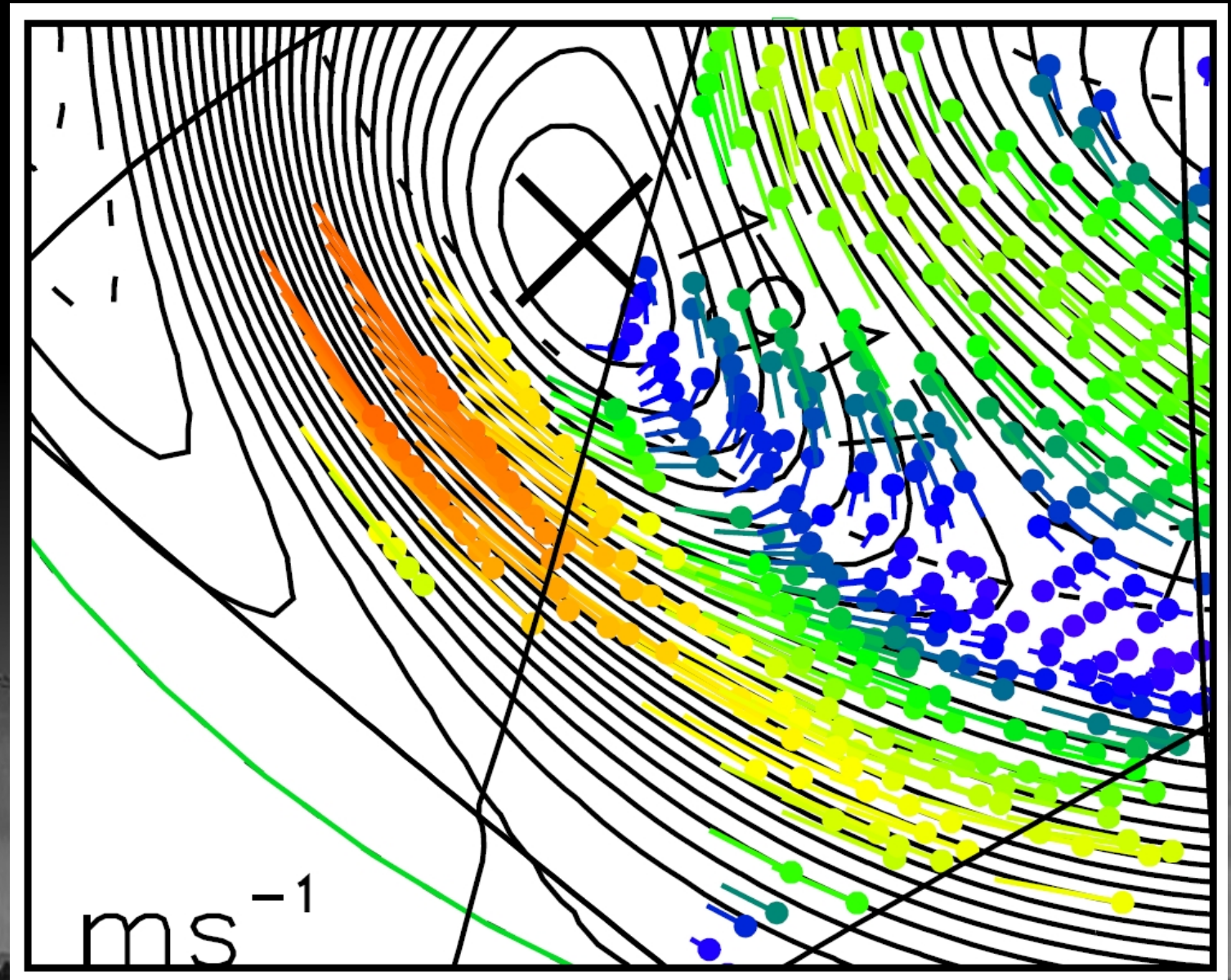
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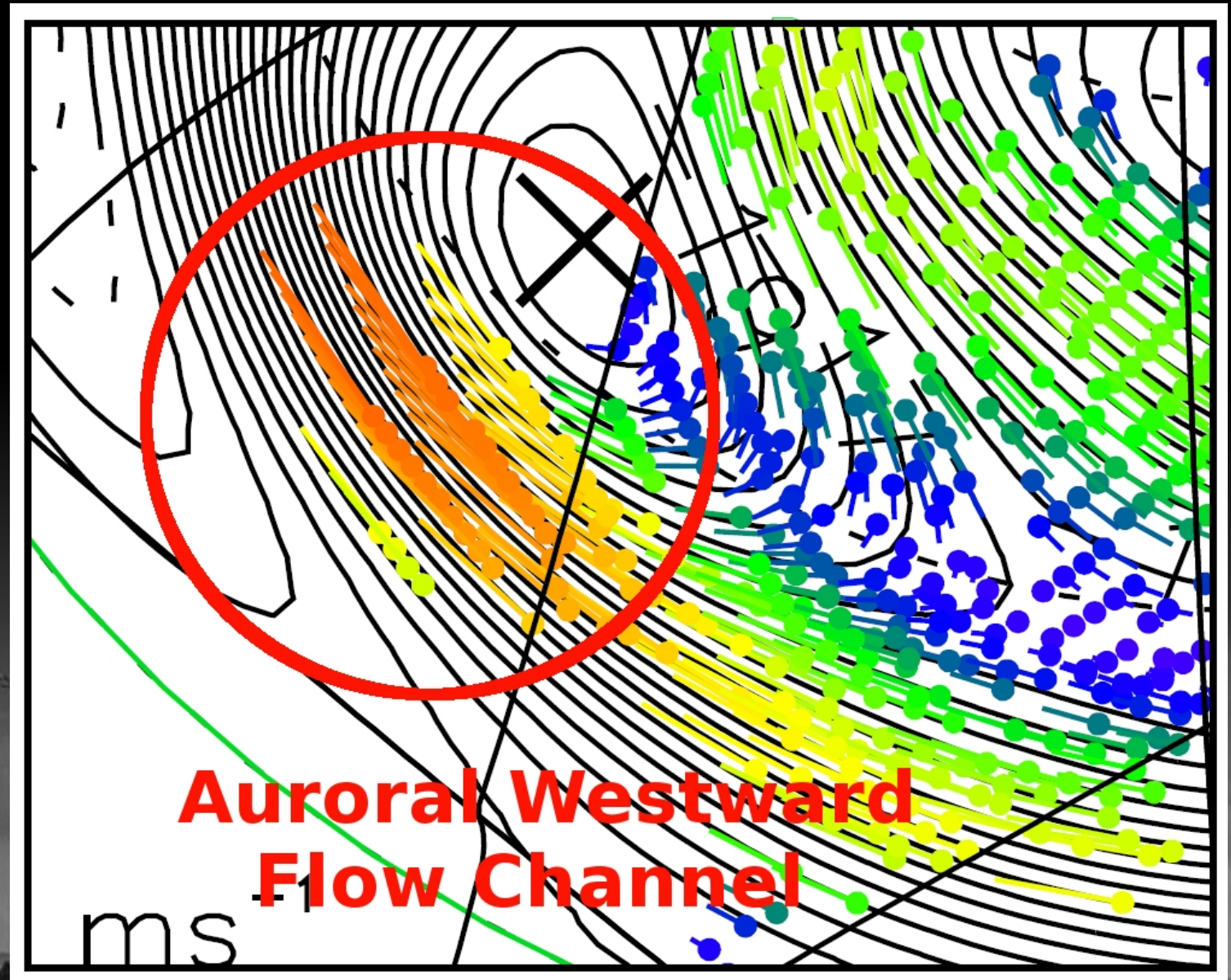
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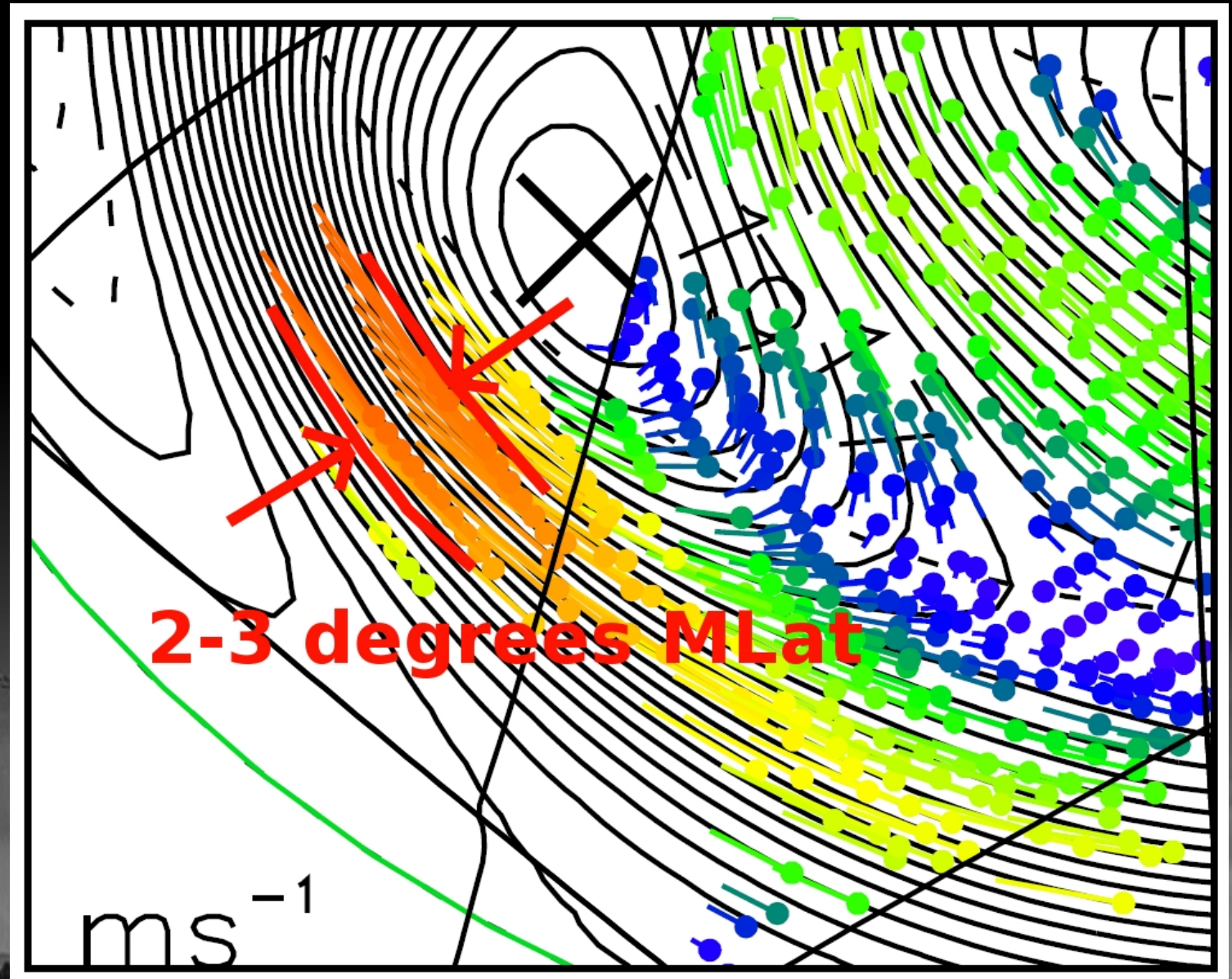
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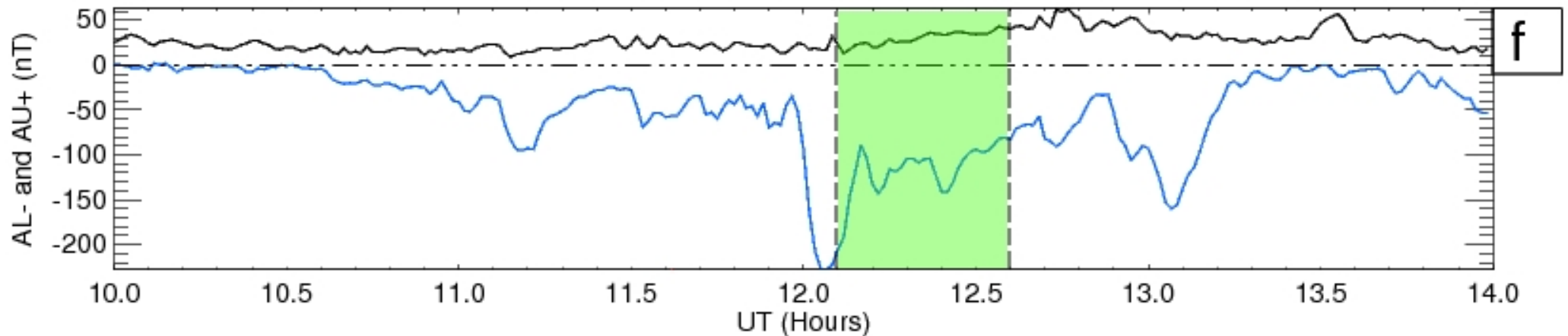
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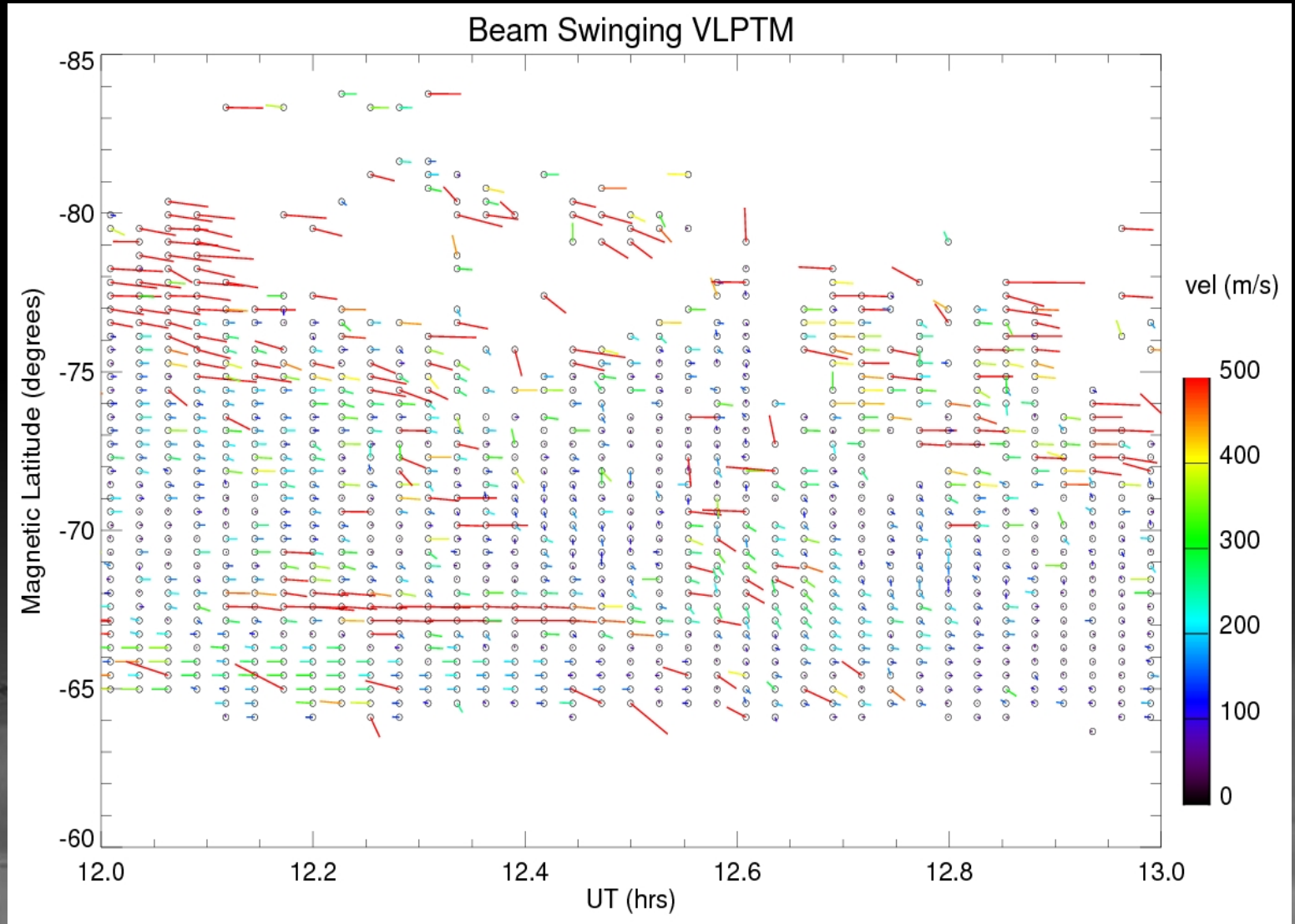
Auroral Eastward Flow Channel

- Between 1206UT and 1236UT an Auroral Eastward Flow Channel manifests on the poleward edge of the Harang “Banana” within the TIGER radar field of view



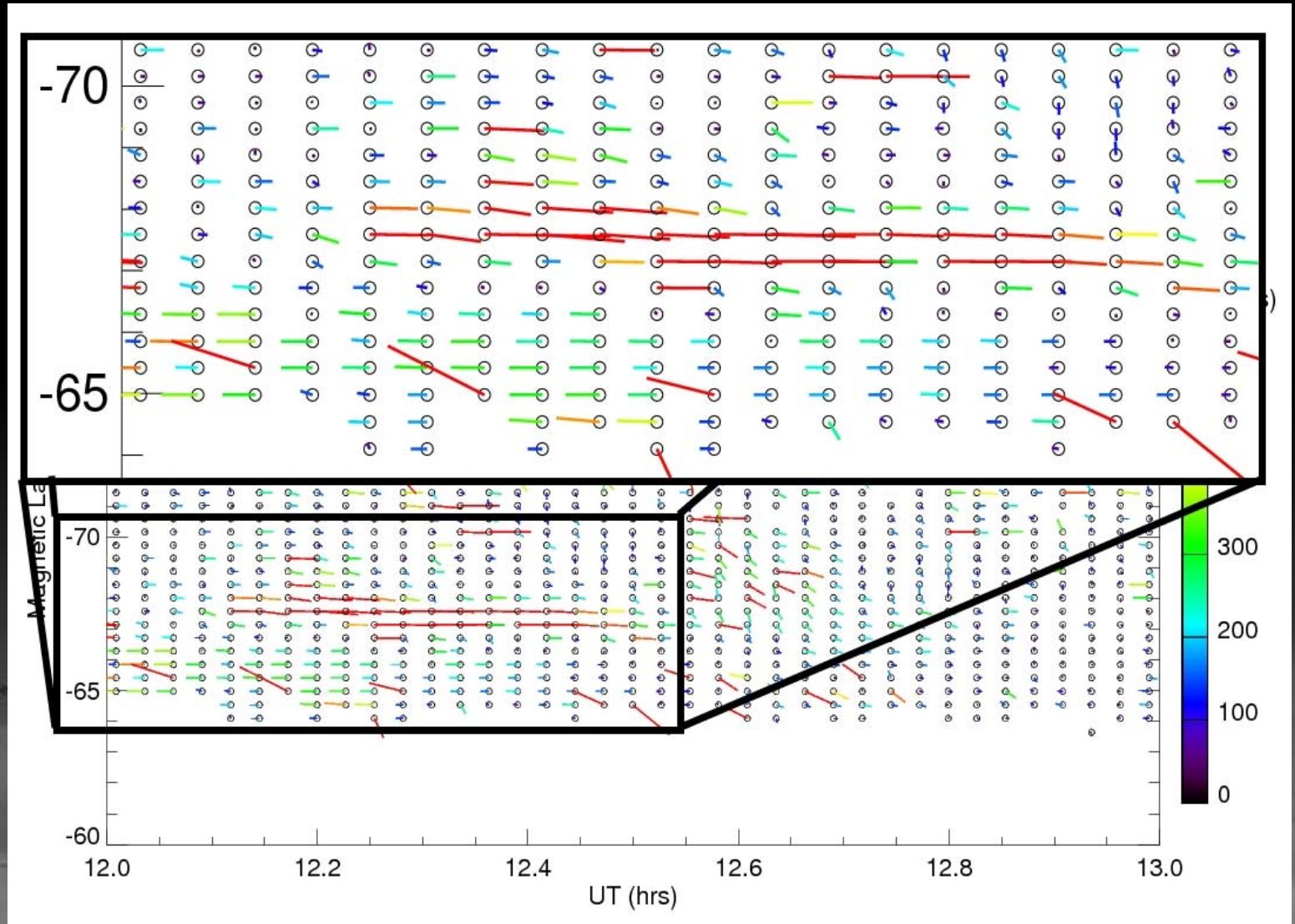
Auroral Eastward Flow Channel

- Beam swinging shows an Auroral Eastward Flow Channel from 1206UT to 1236UT in the pre-midnight sector at 68° Latitude



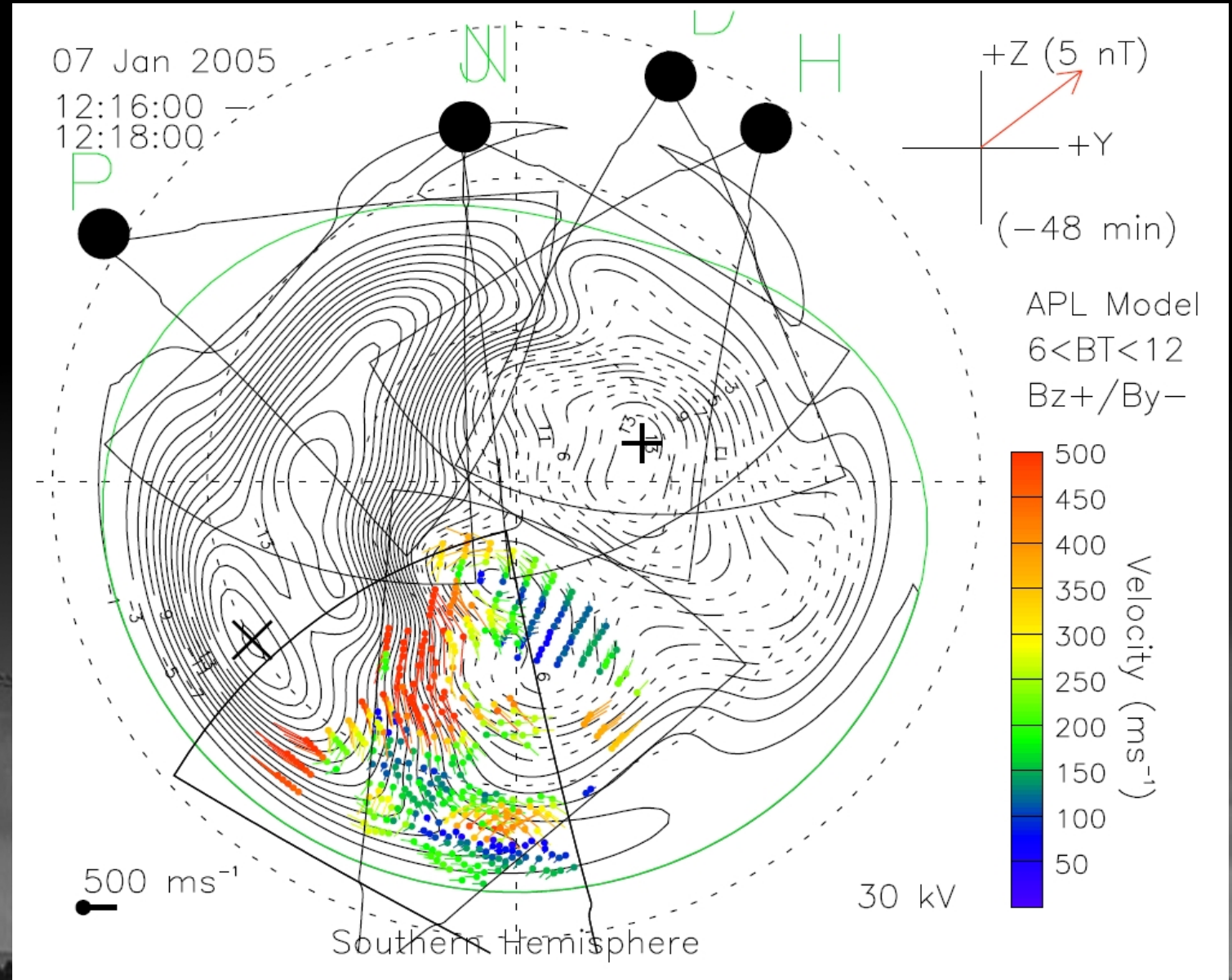
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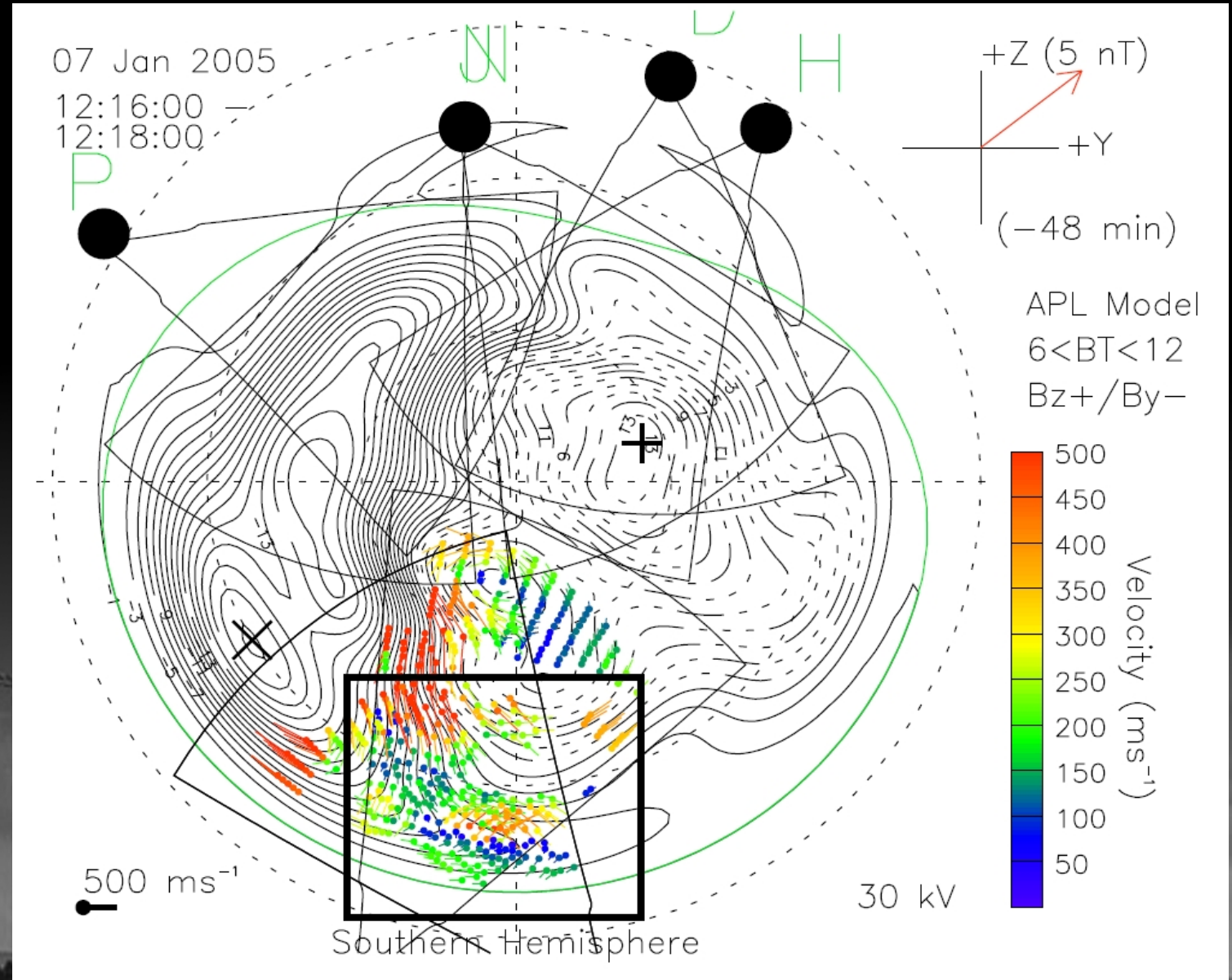
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- An Auroral Eastward Flow Channel at 67° MLat on the poleward edge of the Harang “Banana”



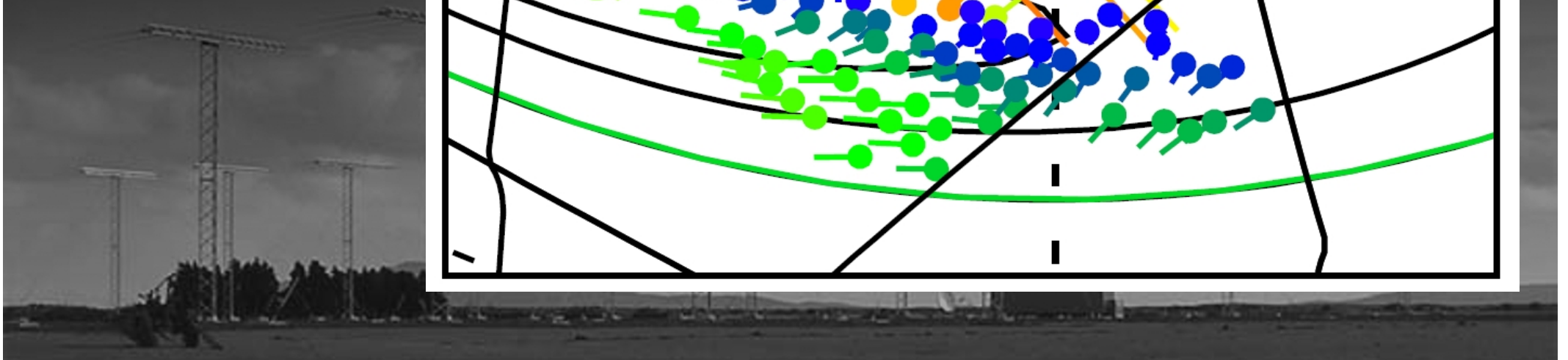
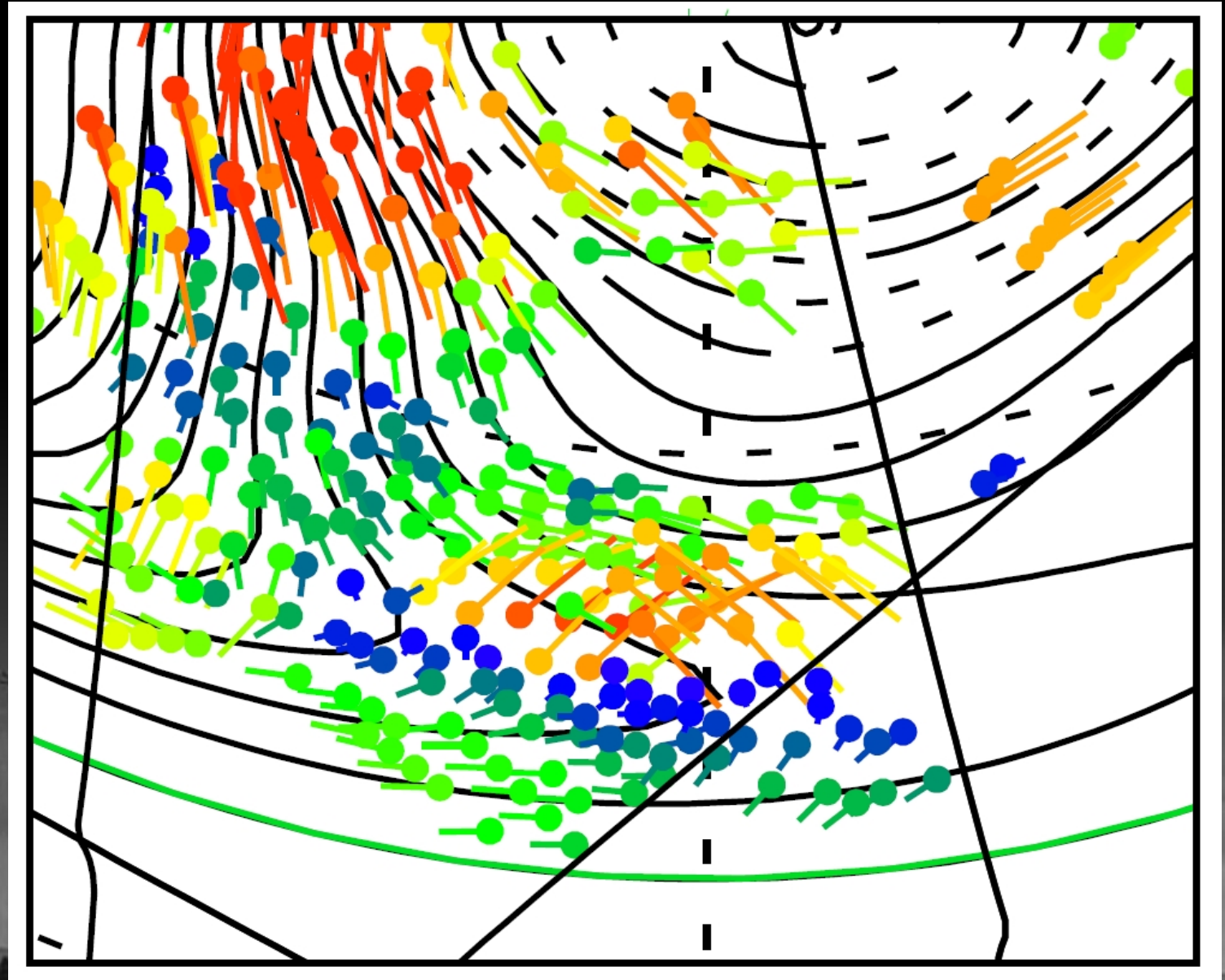
Auroral Eastward Flow Channel

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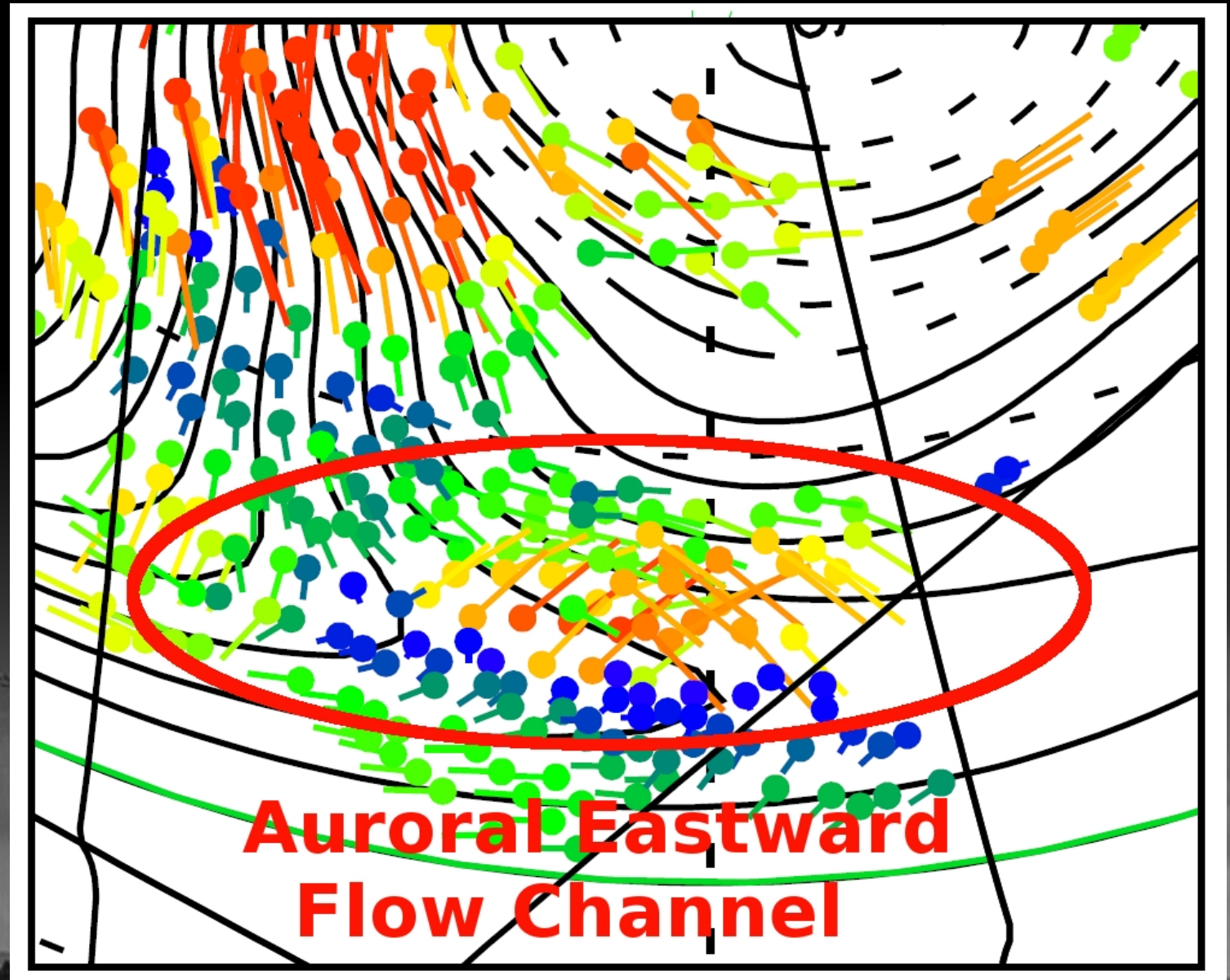
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Auroral Eastward Flow Channel

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Overview

- Introduction to 7th January 2005 1000 - 1400UT
 - Interplanetary Magnetic Field
 - AE Index
- Map Potential
 - Review of Map Potential
 - Modifications to Map Potential
- The 7th January 2005 1000 - 1400UT event in detail
 - Flow Stagnation
 - Harang “Banana”
 - Harang “Banana” Compression
 - Large Scale Flow Vortex
 - Auroral Eastward Flow Channel
 - Auroral Westward Flow Channel
- Summary and Questions



Summary & Questions



- TIGER observations of the 7th January 2005 1000UT to 1400UT showed fantastic details of phenomena associated with a Harang discontinuity “Banana-ing” of the convection cells
- Modifying was useful in exploring and understanding the details of these phenomena, the “Pinching off” of the harang “Banana”, the effects of a plasma flow vortex and the discovery of an AEFC

