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”
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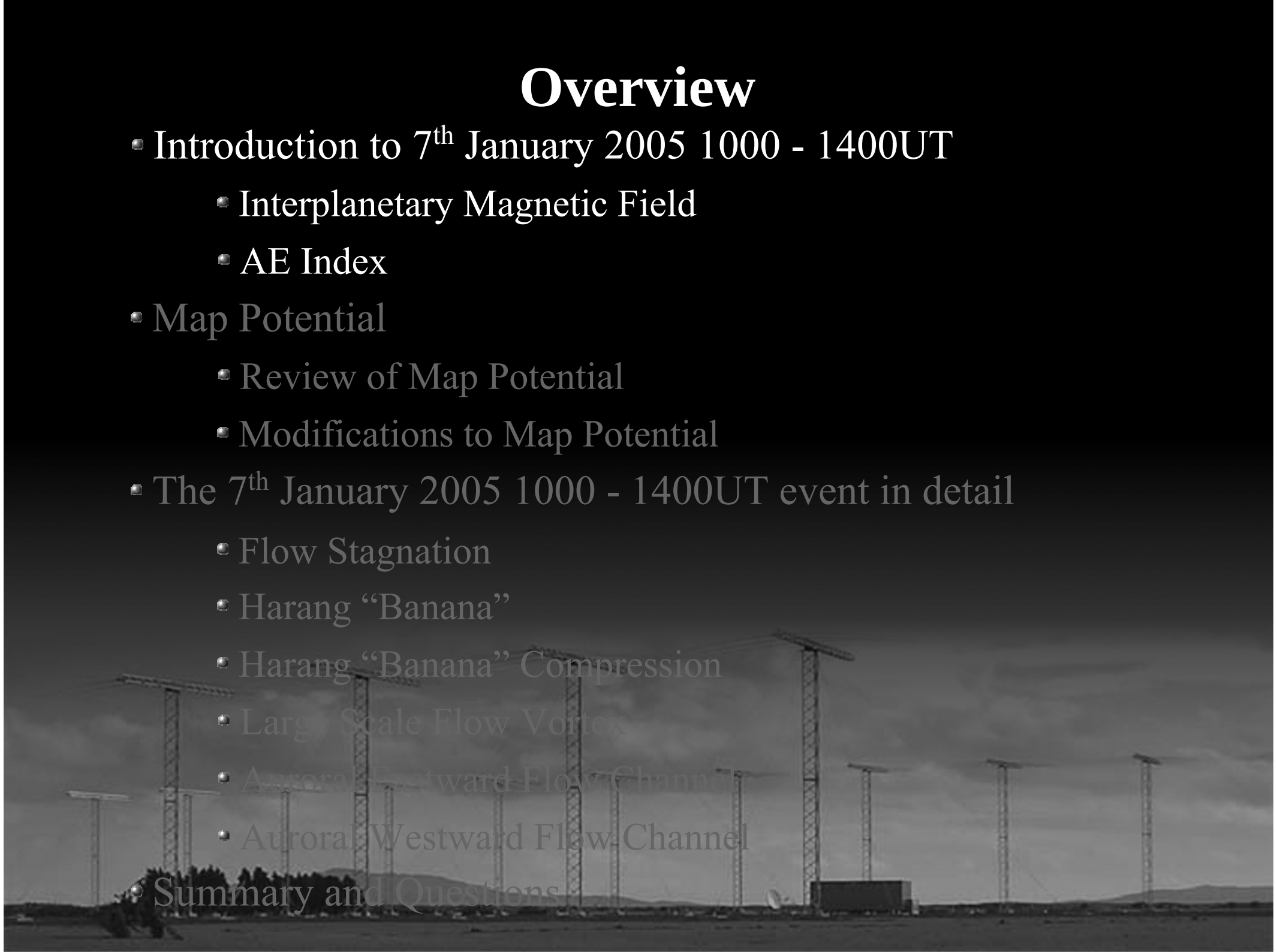
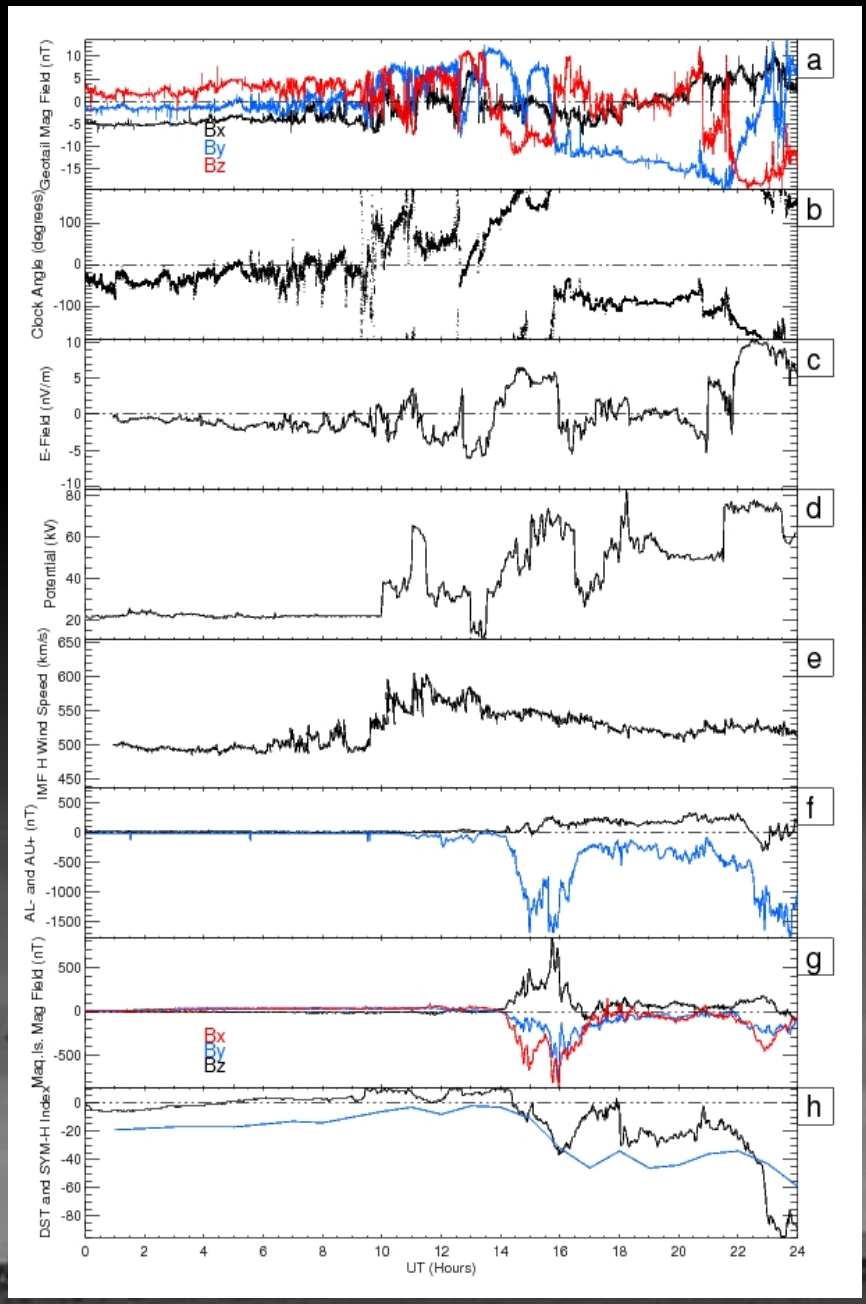


Summary of IMF and Geomagnetic Conditions

- 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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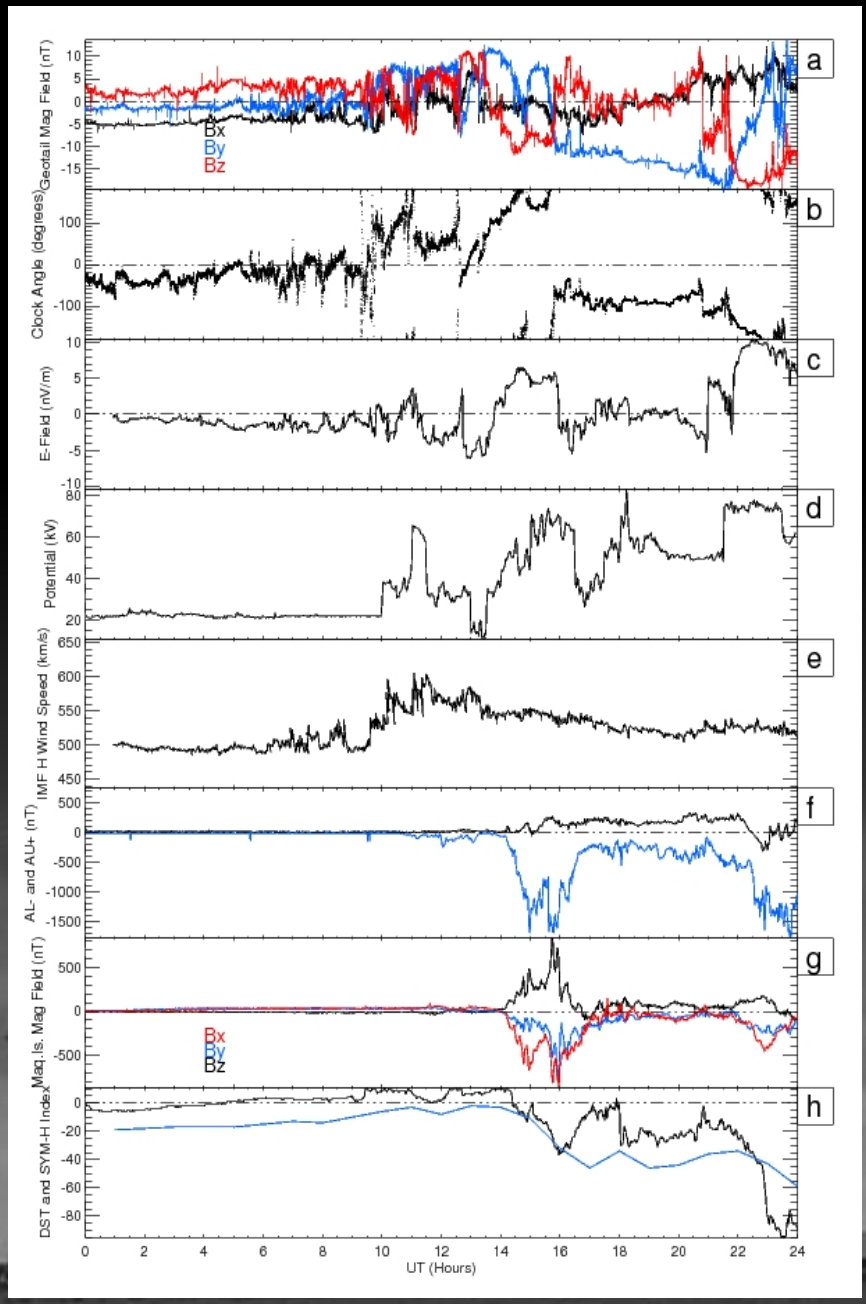
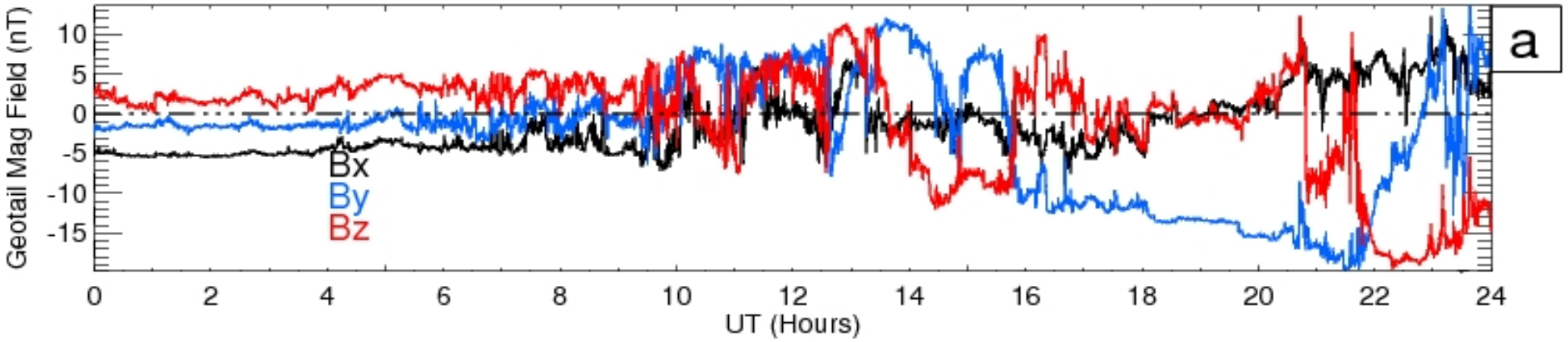


Interplanetary Magnetic Field

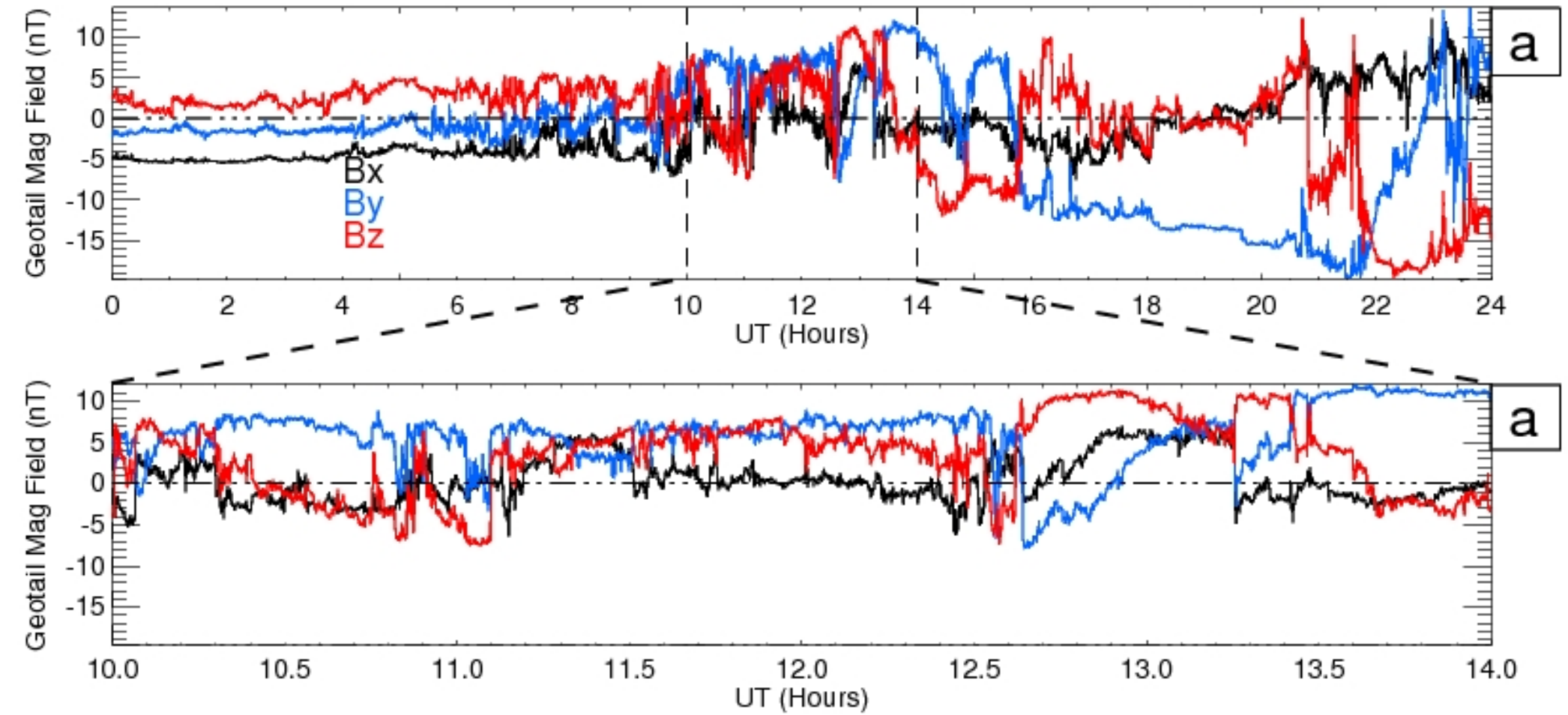
- Geotail-MGF instrument located sunward between bow-shock and magnetopause (x_{GSE}~$10R_E$, y_{GSE}~$25R_E$ and z_{GSE}~$5R_E$)



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

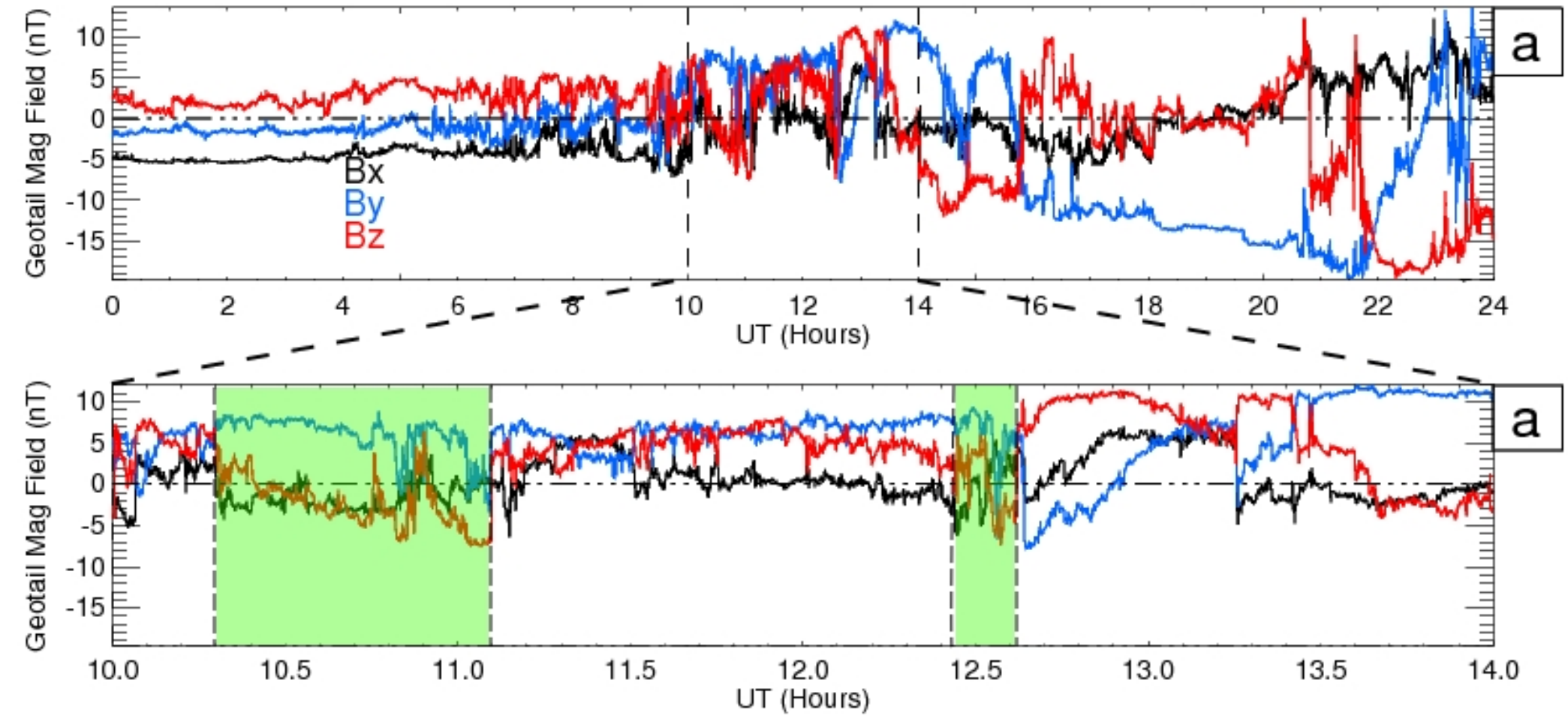
Interplanetary Magnetic Field

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



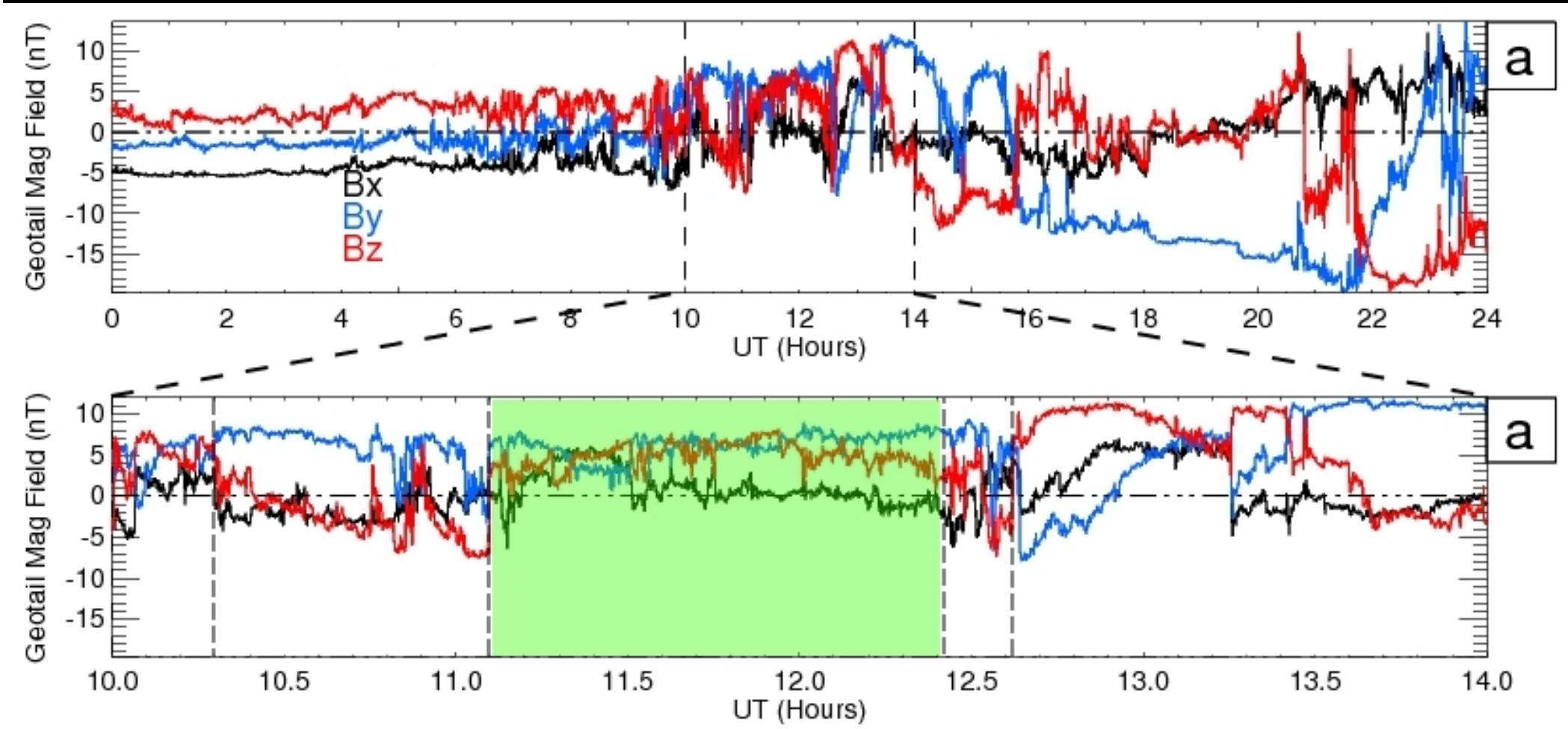
Interplanetary Magnetic Field

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



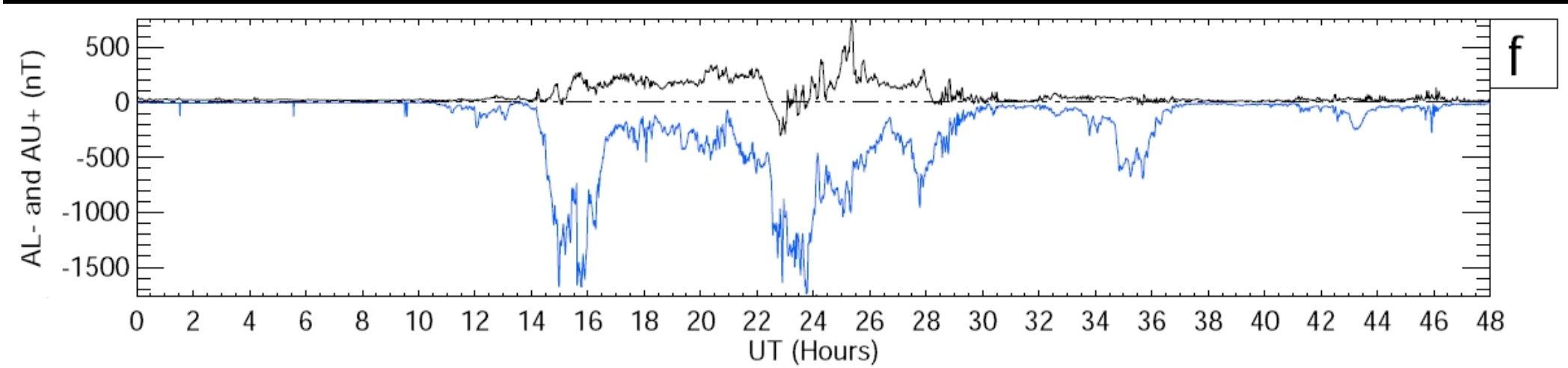
Interplanetary Magnetic Field

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



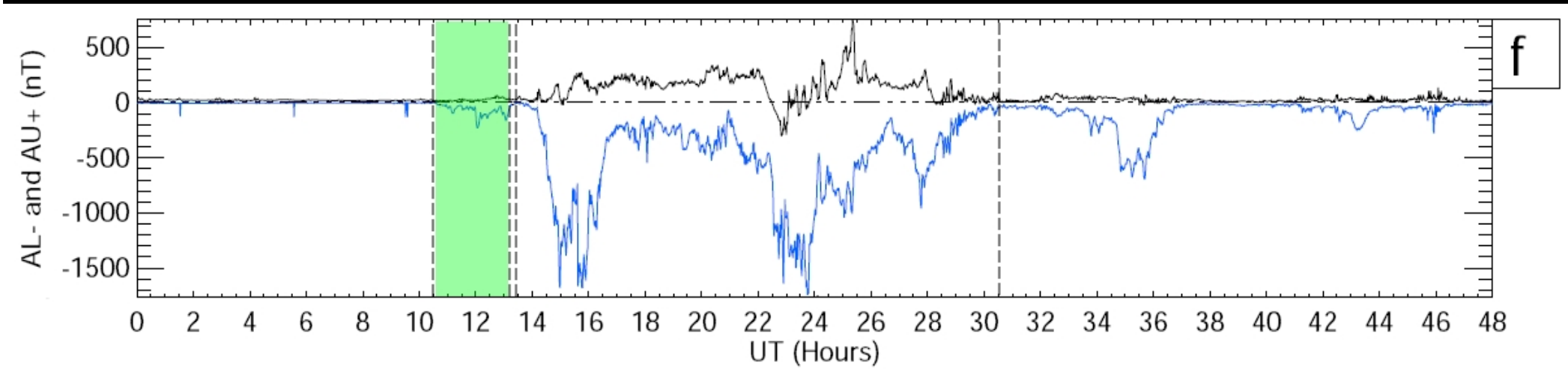
AE Index

- 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 preceeding an interval of successive major substorms, -1750nT



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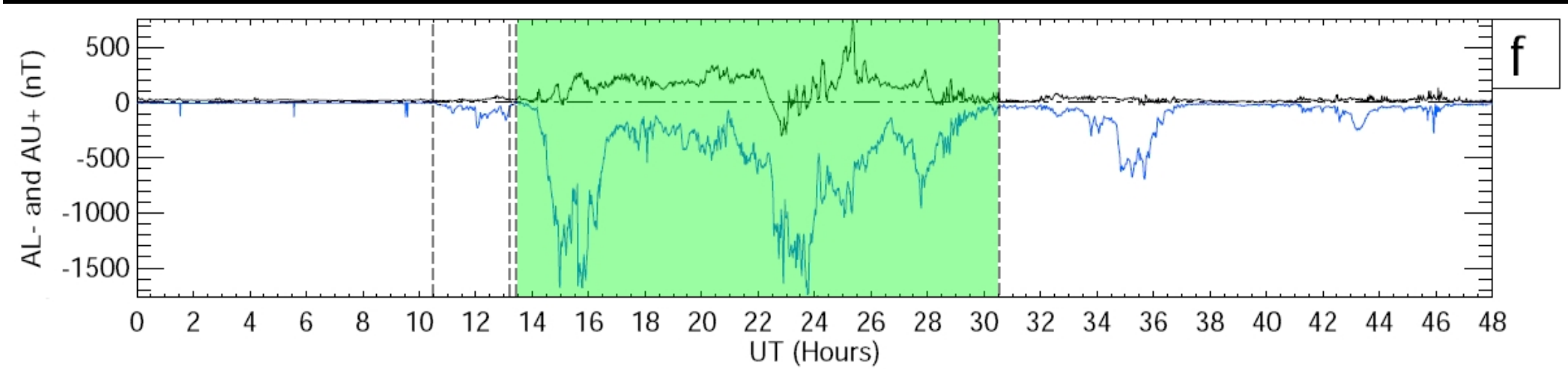
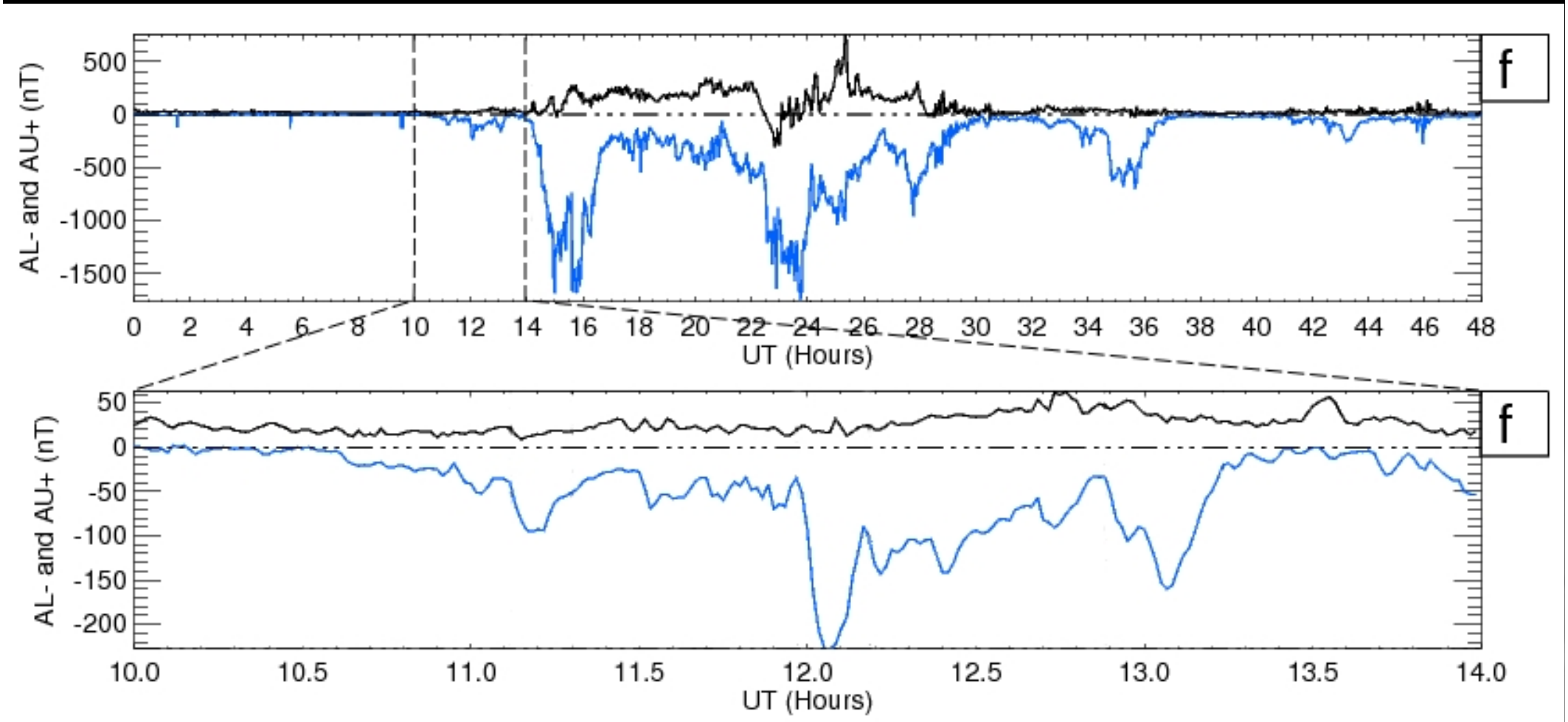


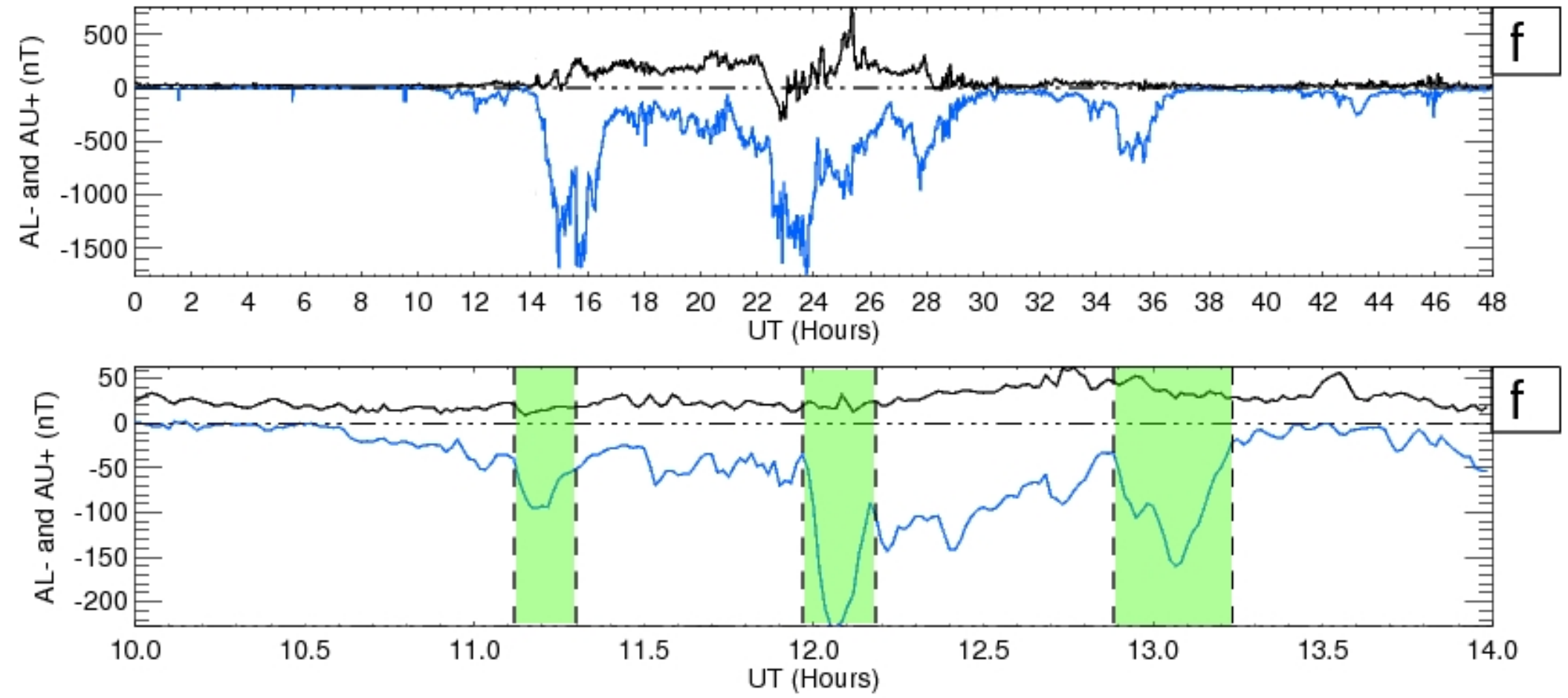
AE Index

- 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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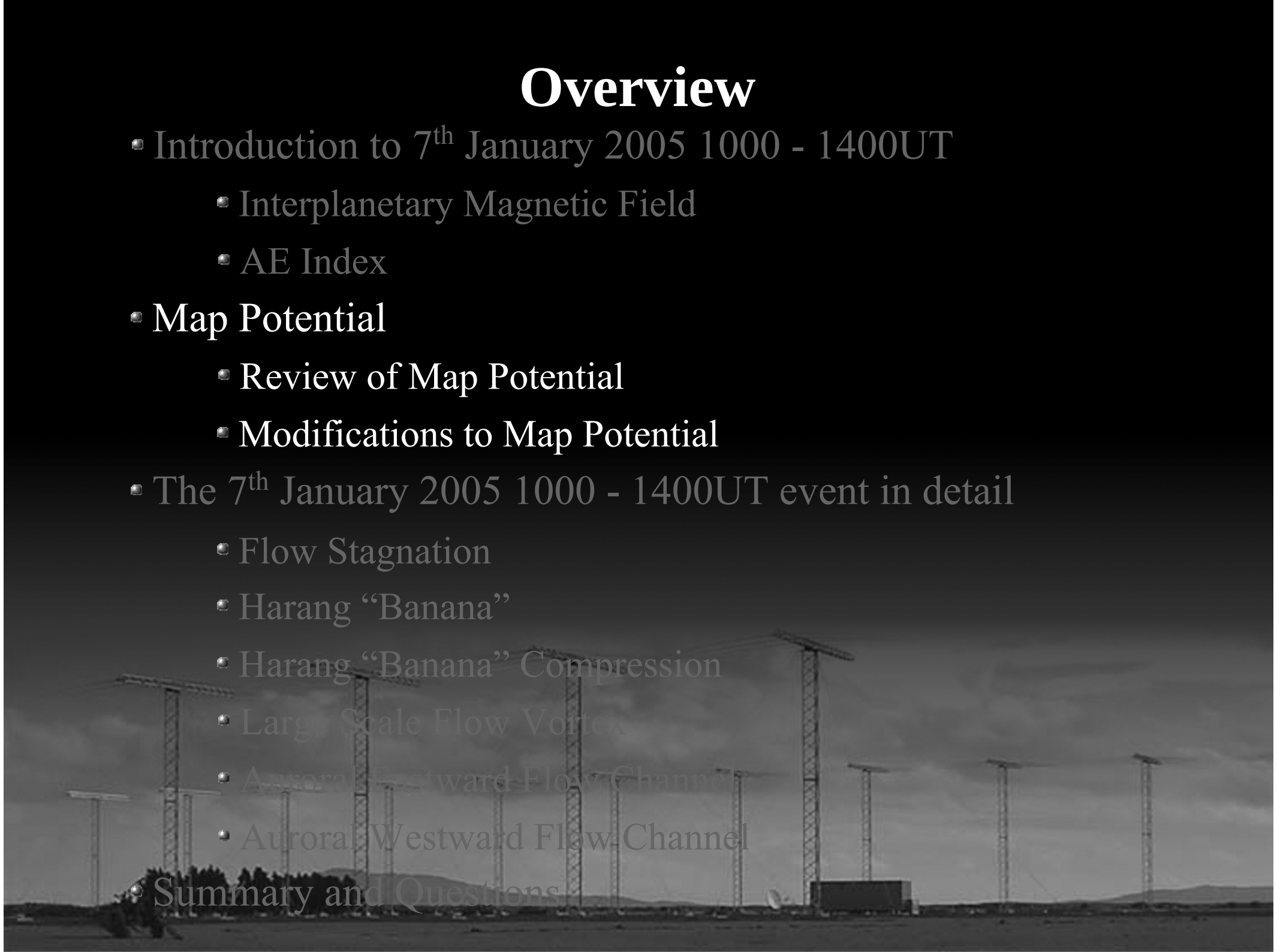
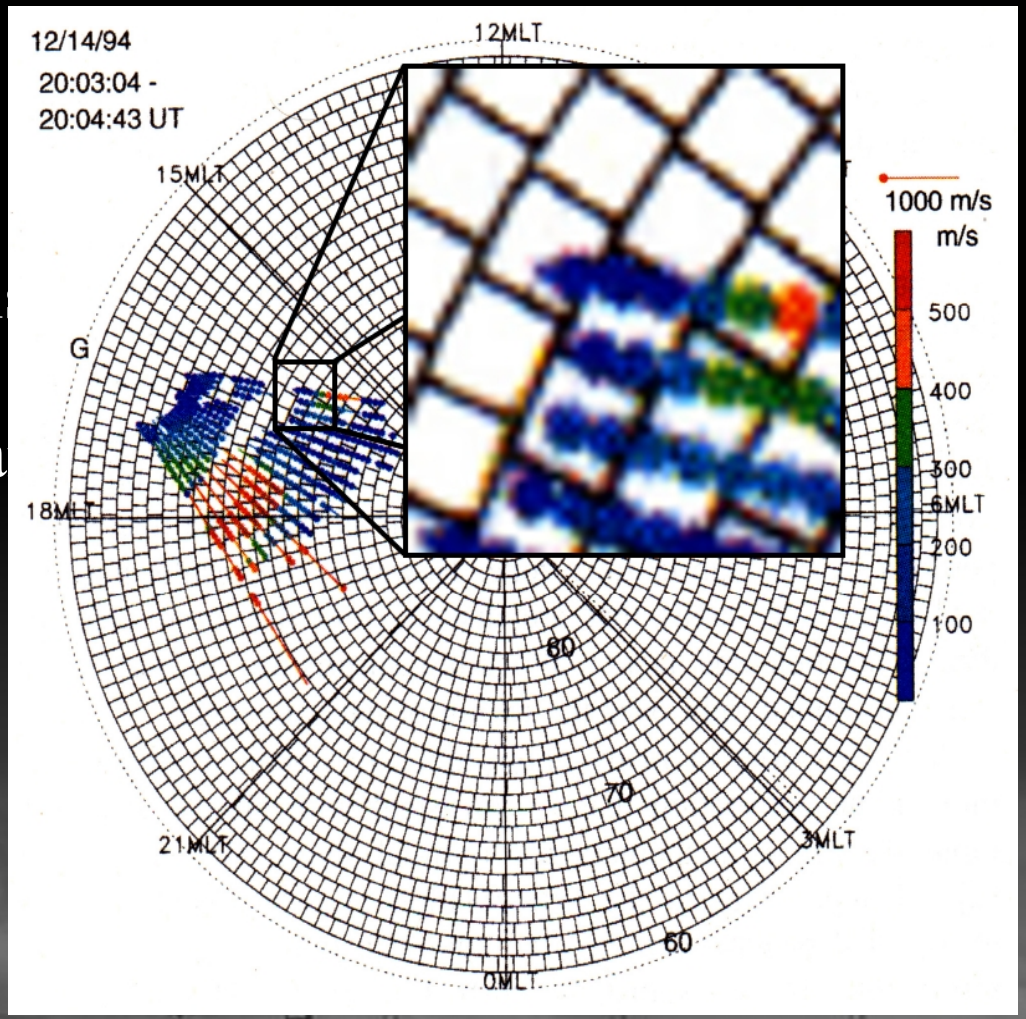


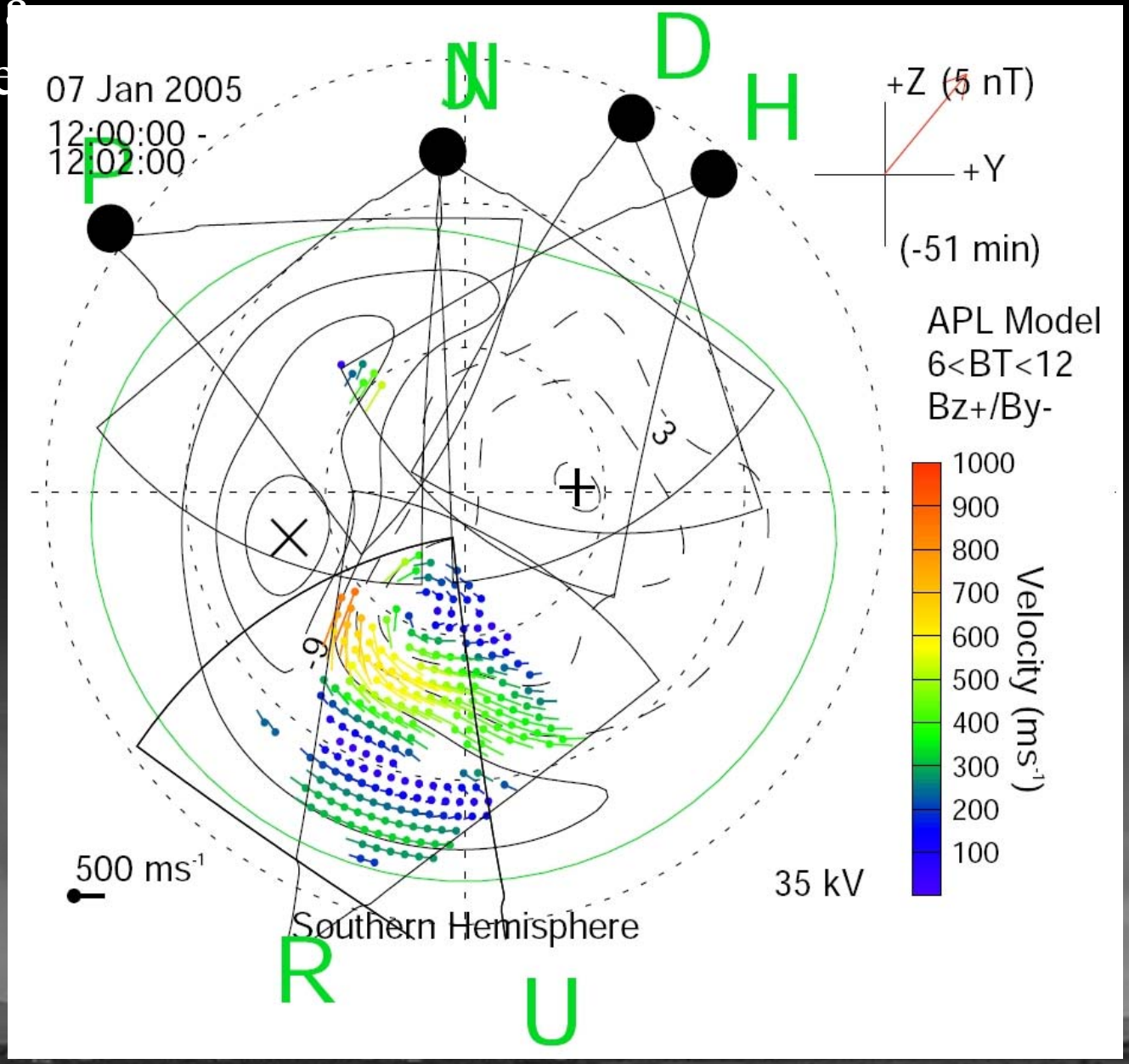
Review of current Map Potential analysis

- 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 (media 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 a 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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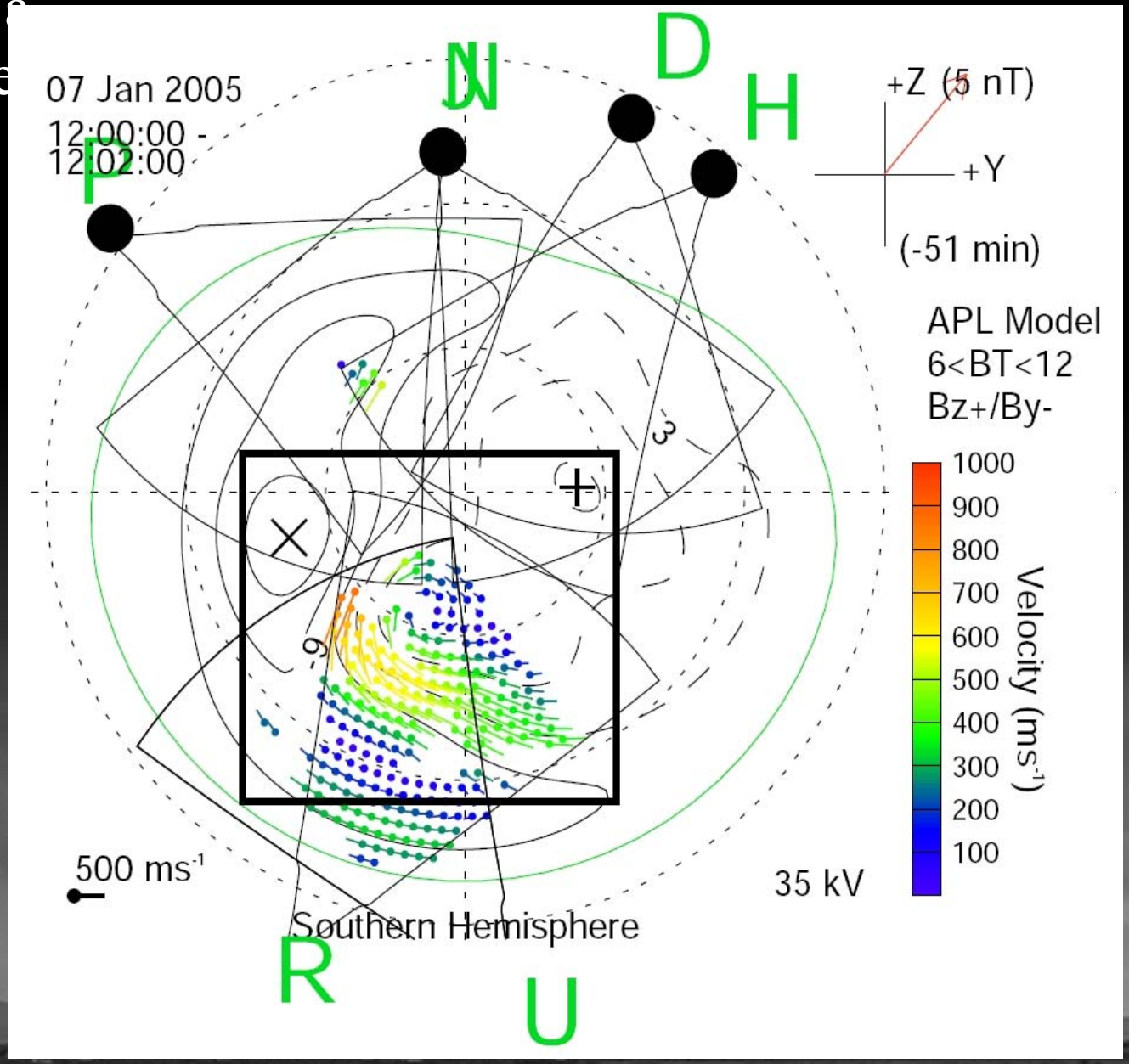

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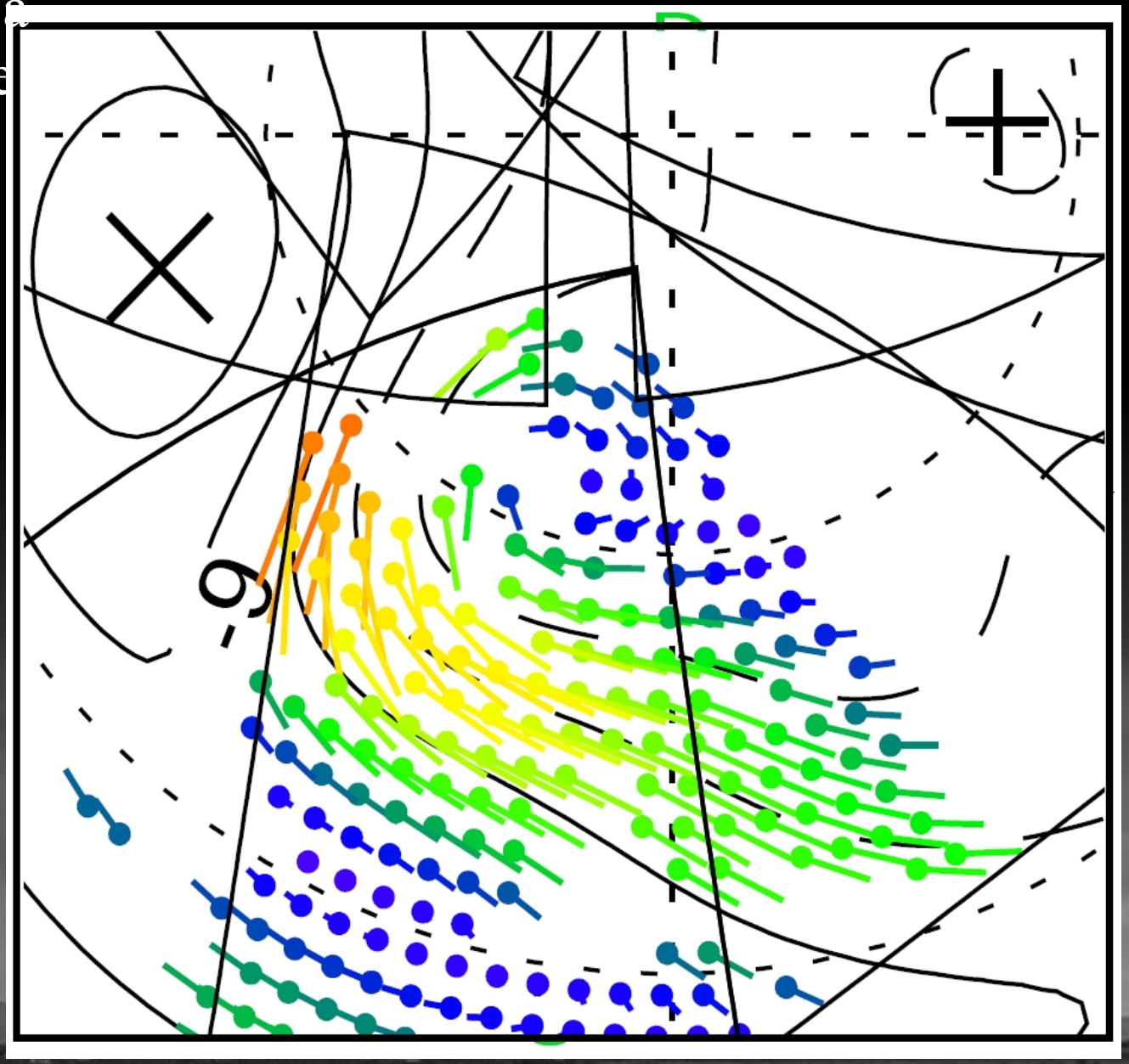

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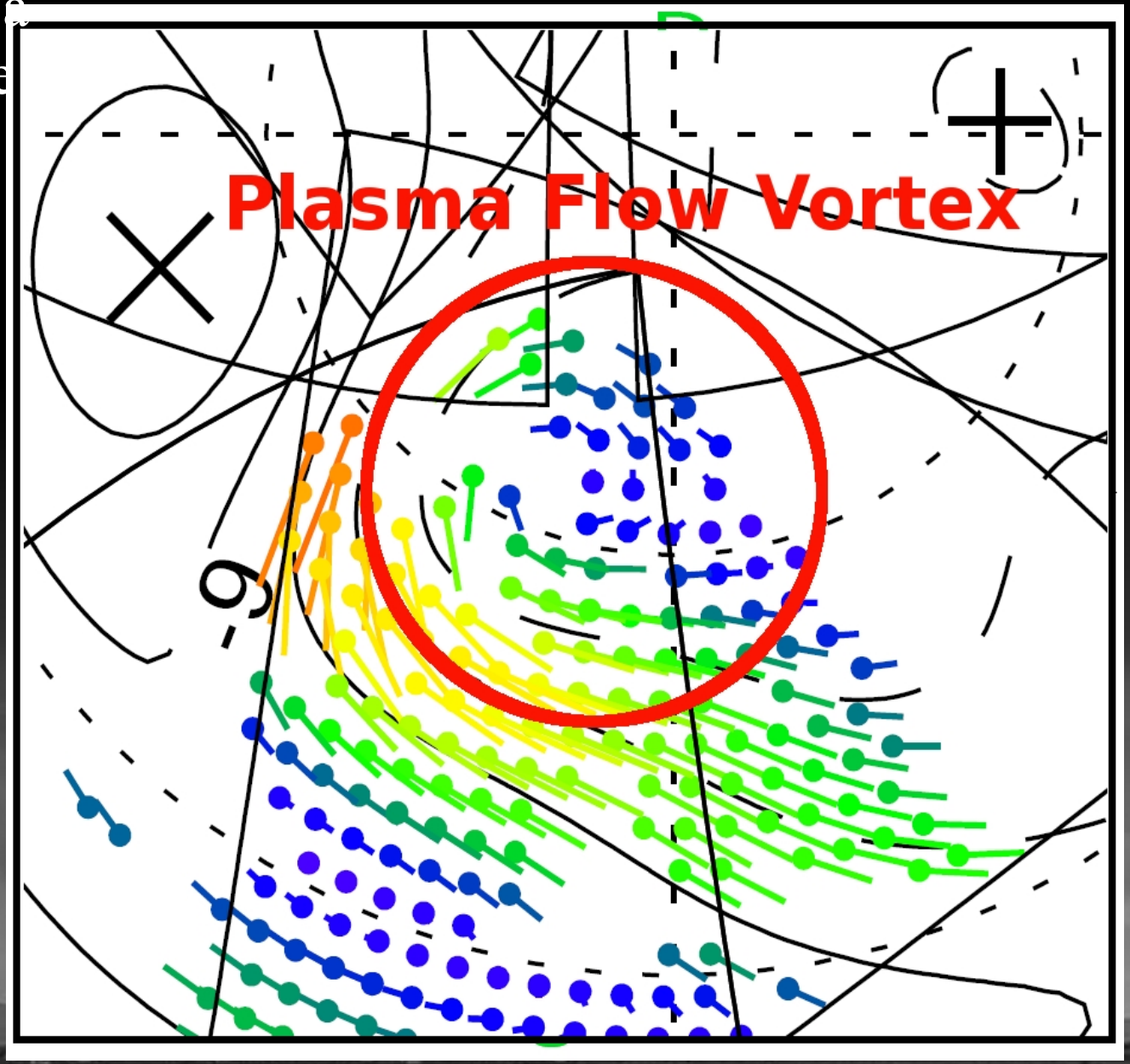

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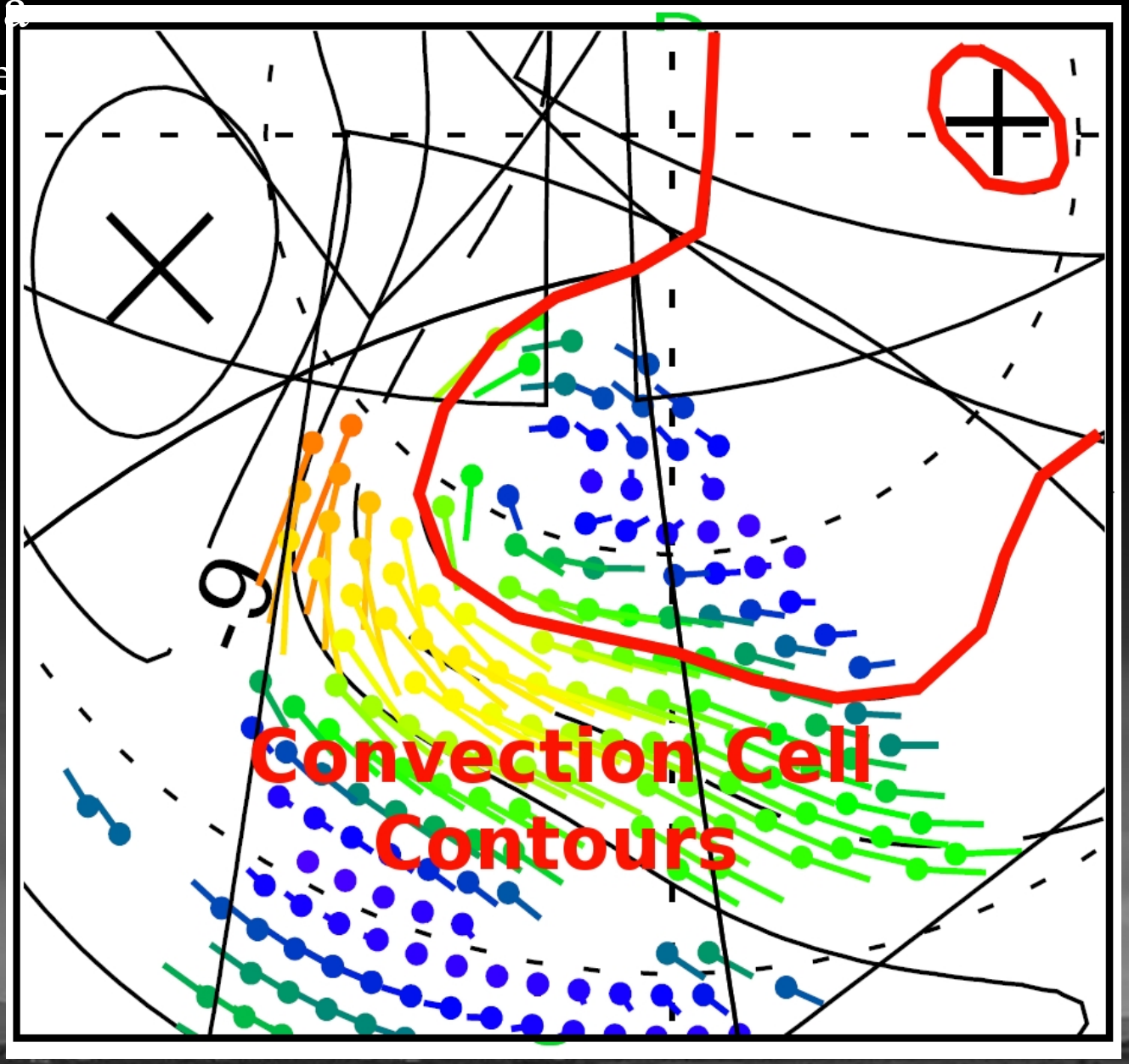
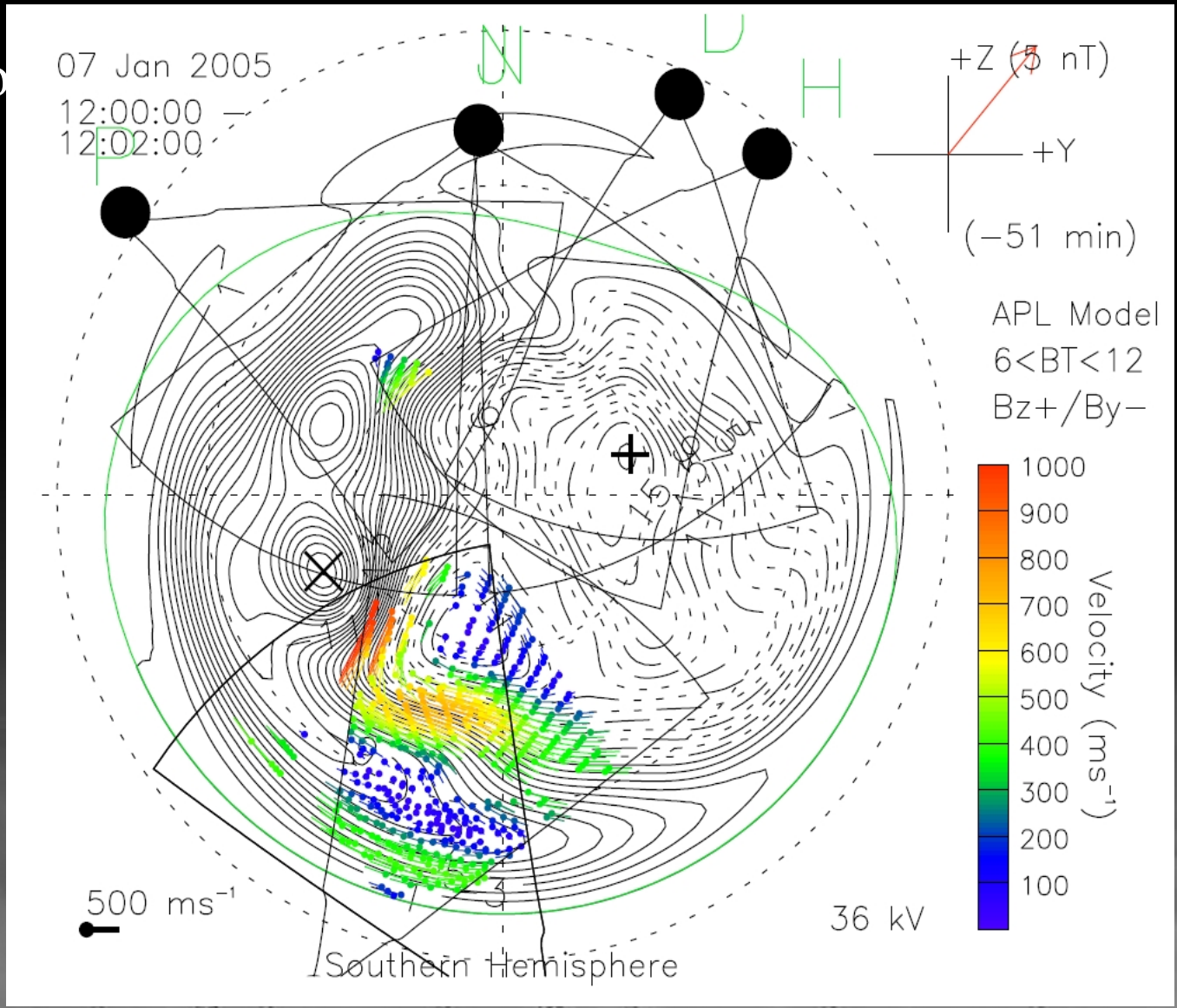


A modification to Map Potential

- Modified Map potential grids data into ~ 1 x 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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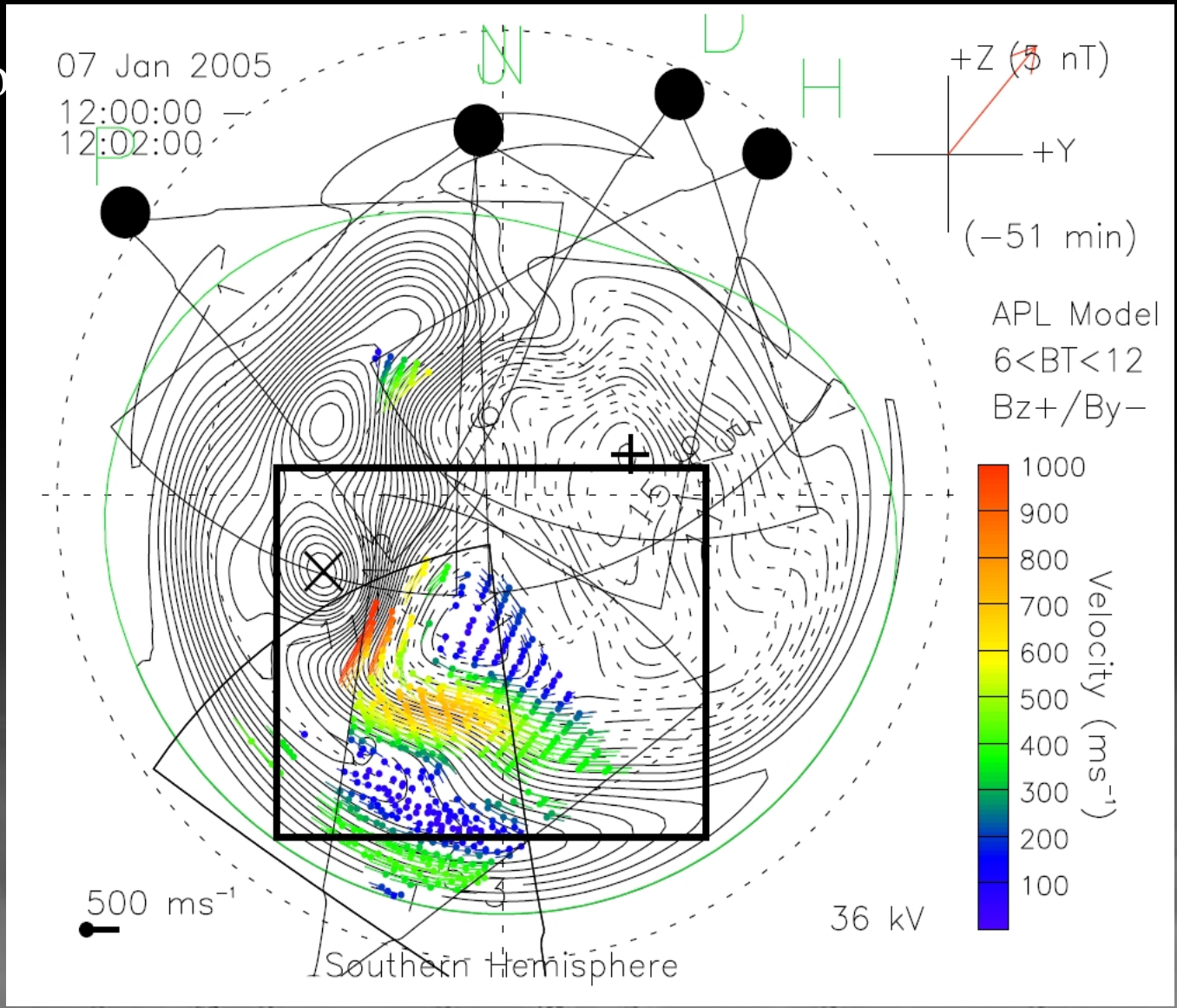

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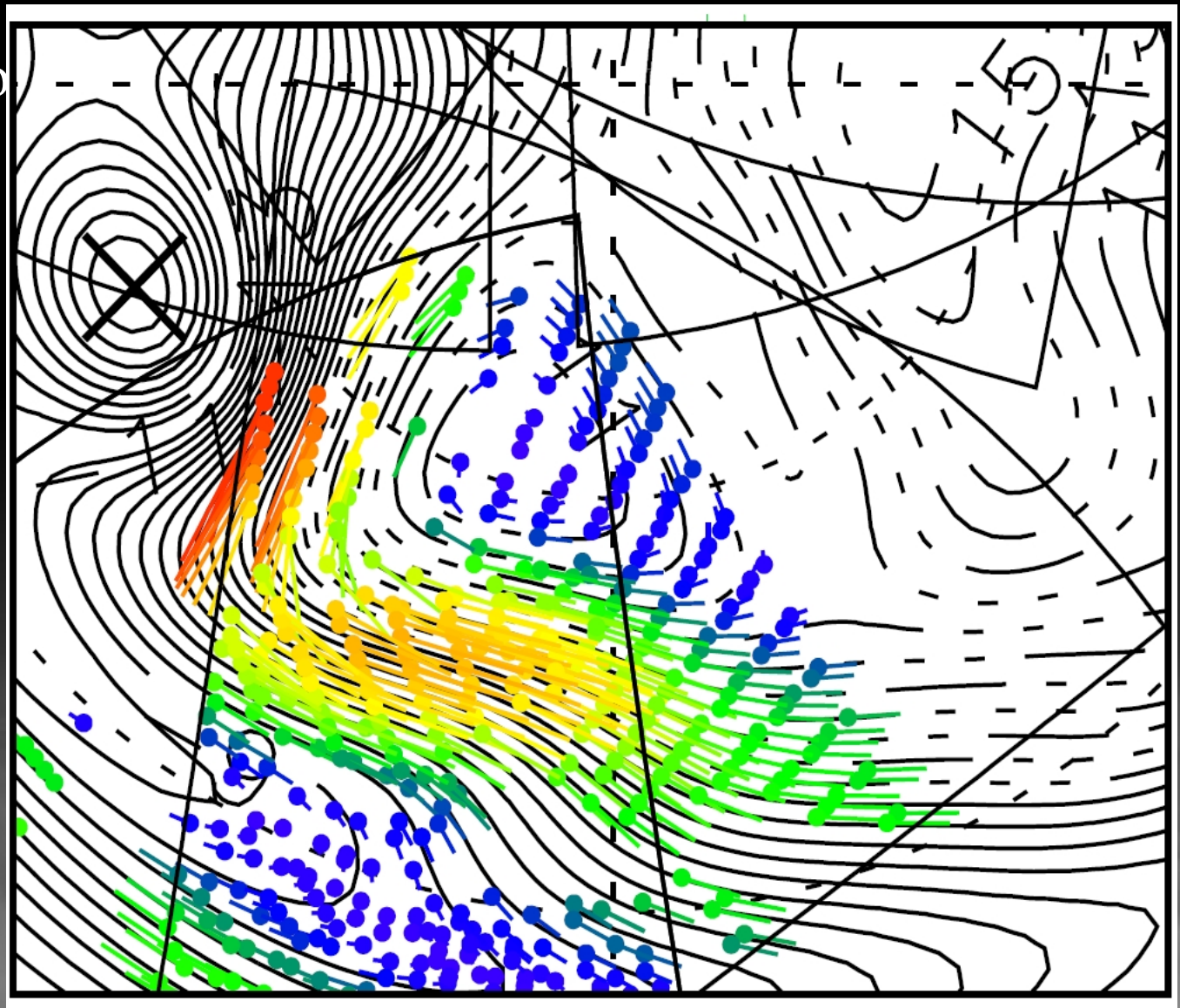

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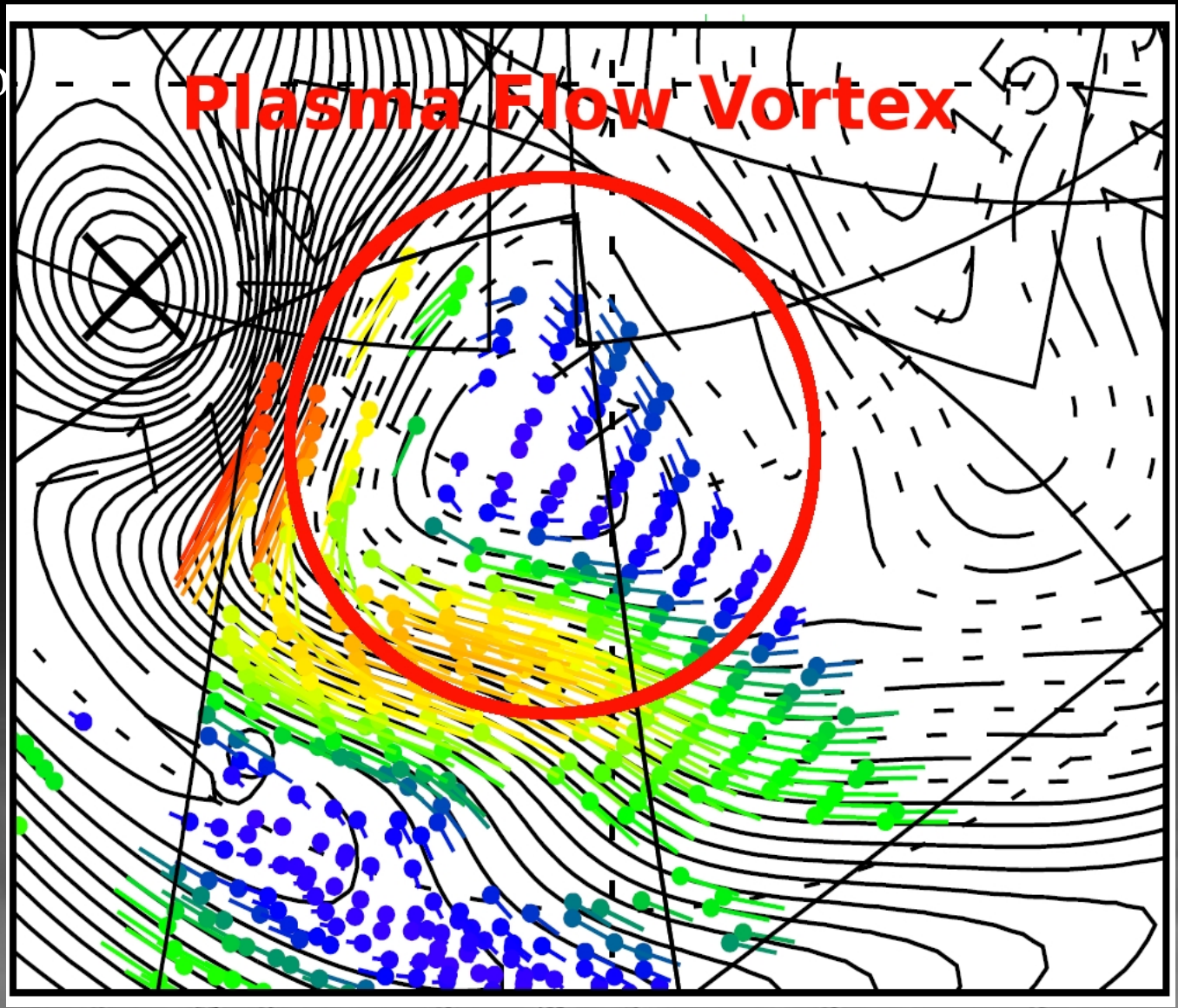

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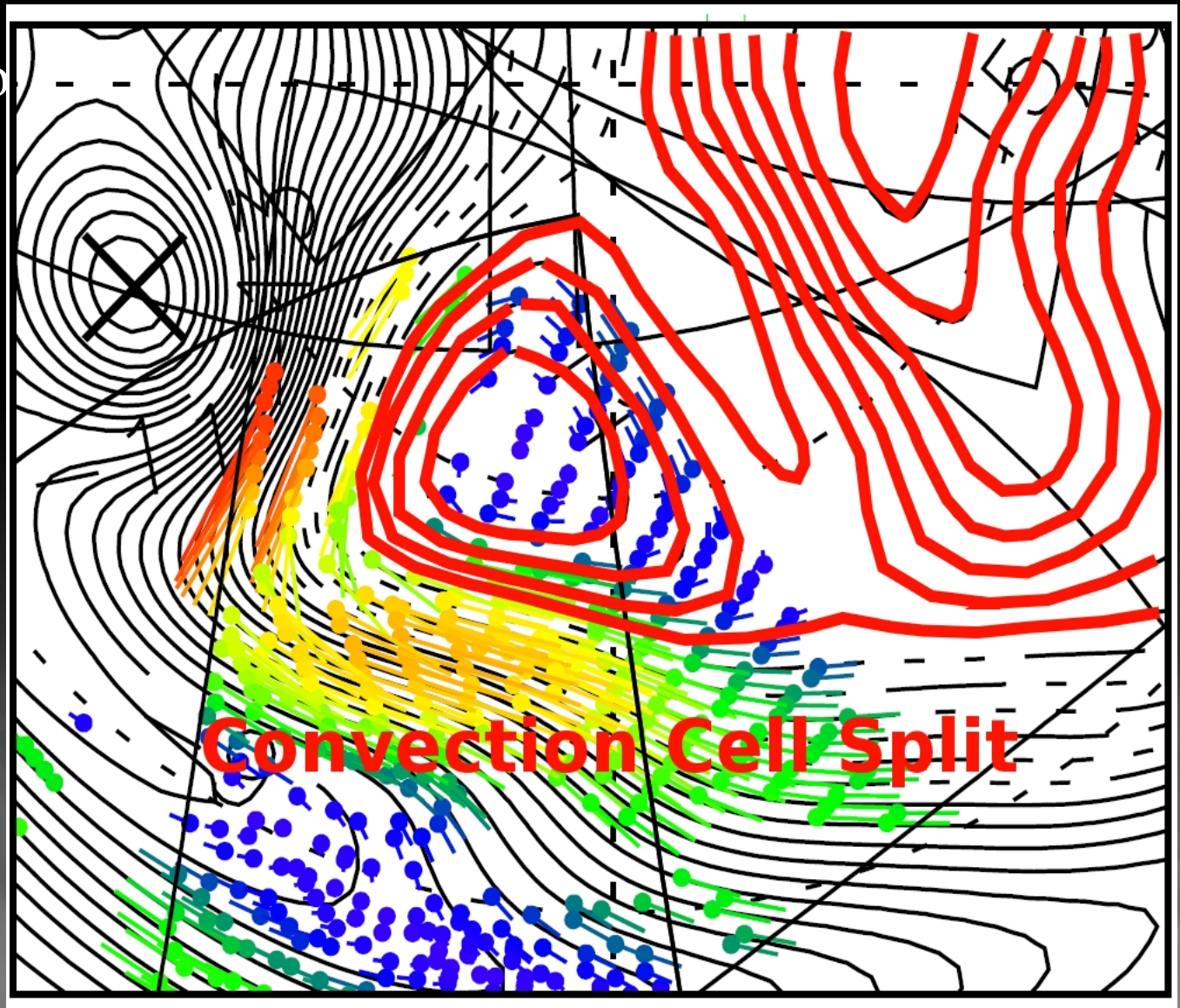

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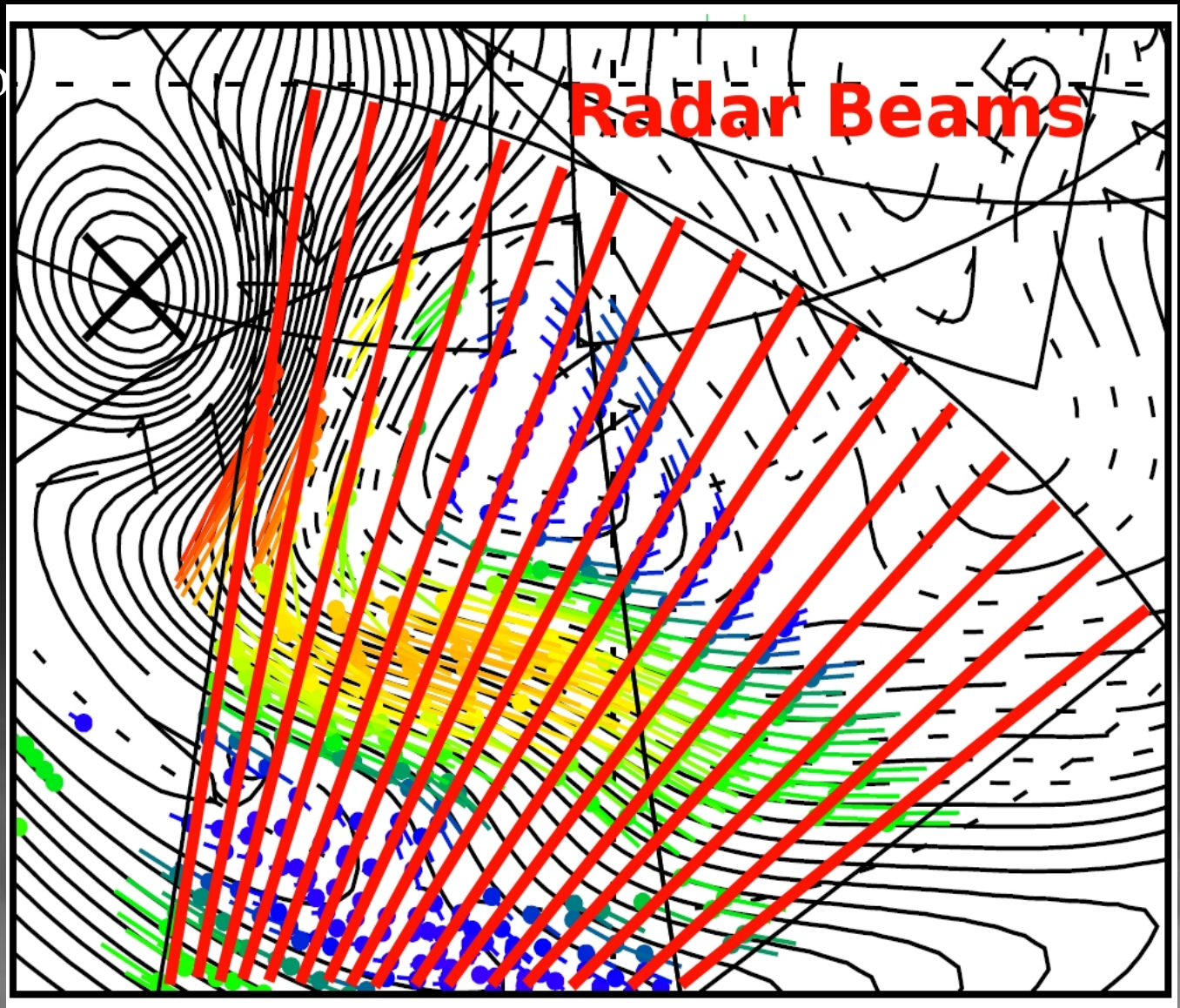

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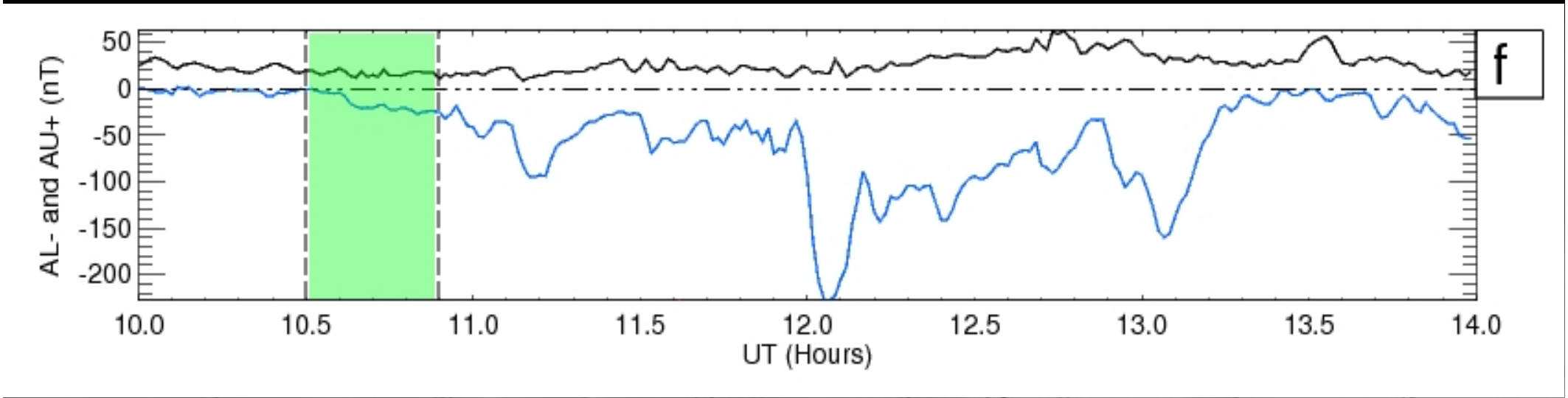
Flow Stagnation

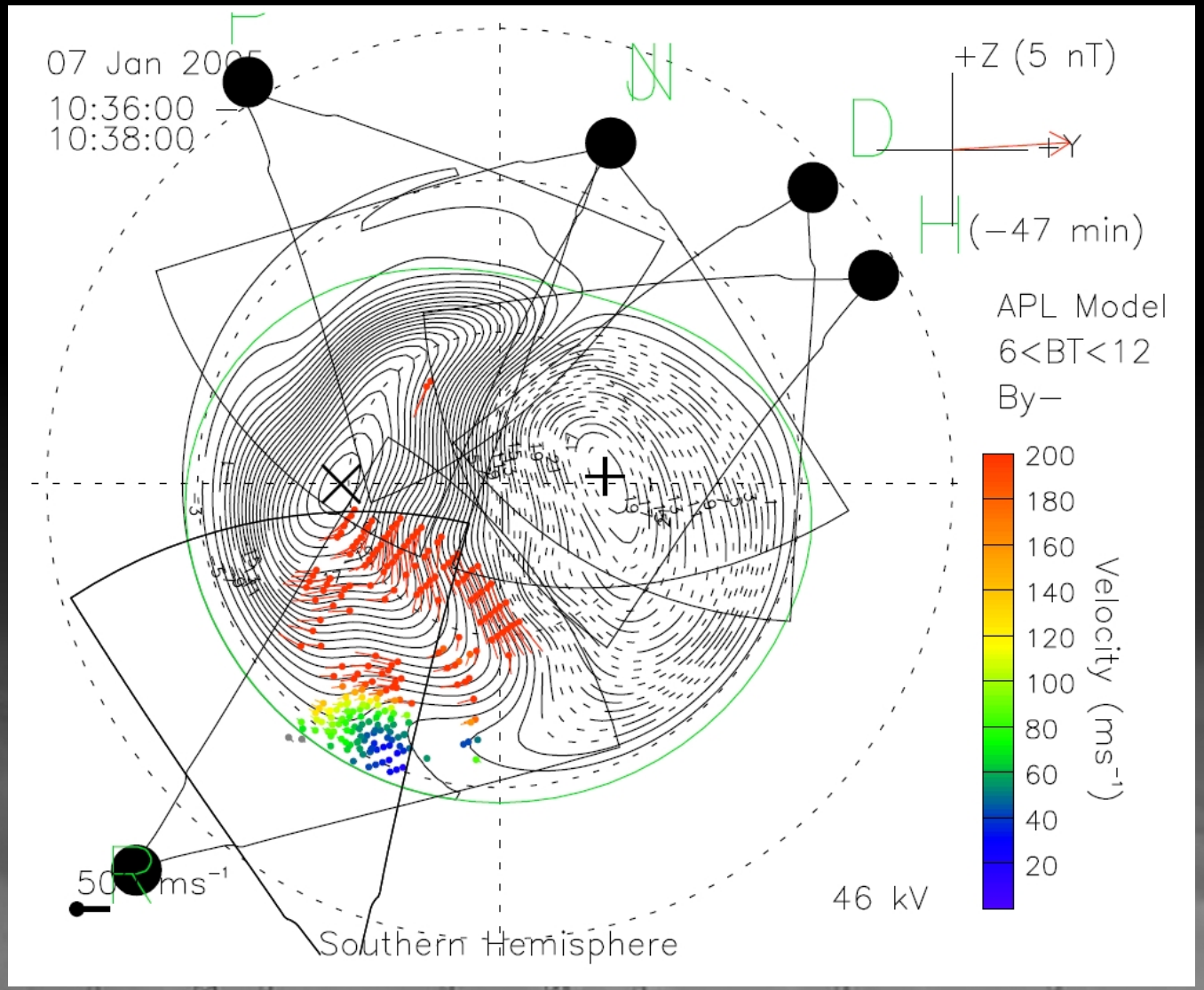
- Flow stagnation begins with the first negative increase in AL- index, 1030UT, and diminishes towards the first substorm
- Plasma flow stagnation directly related to substorm onset



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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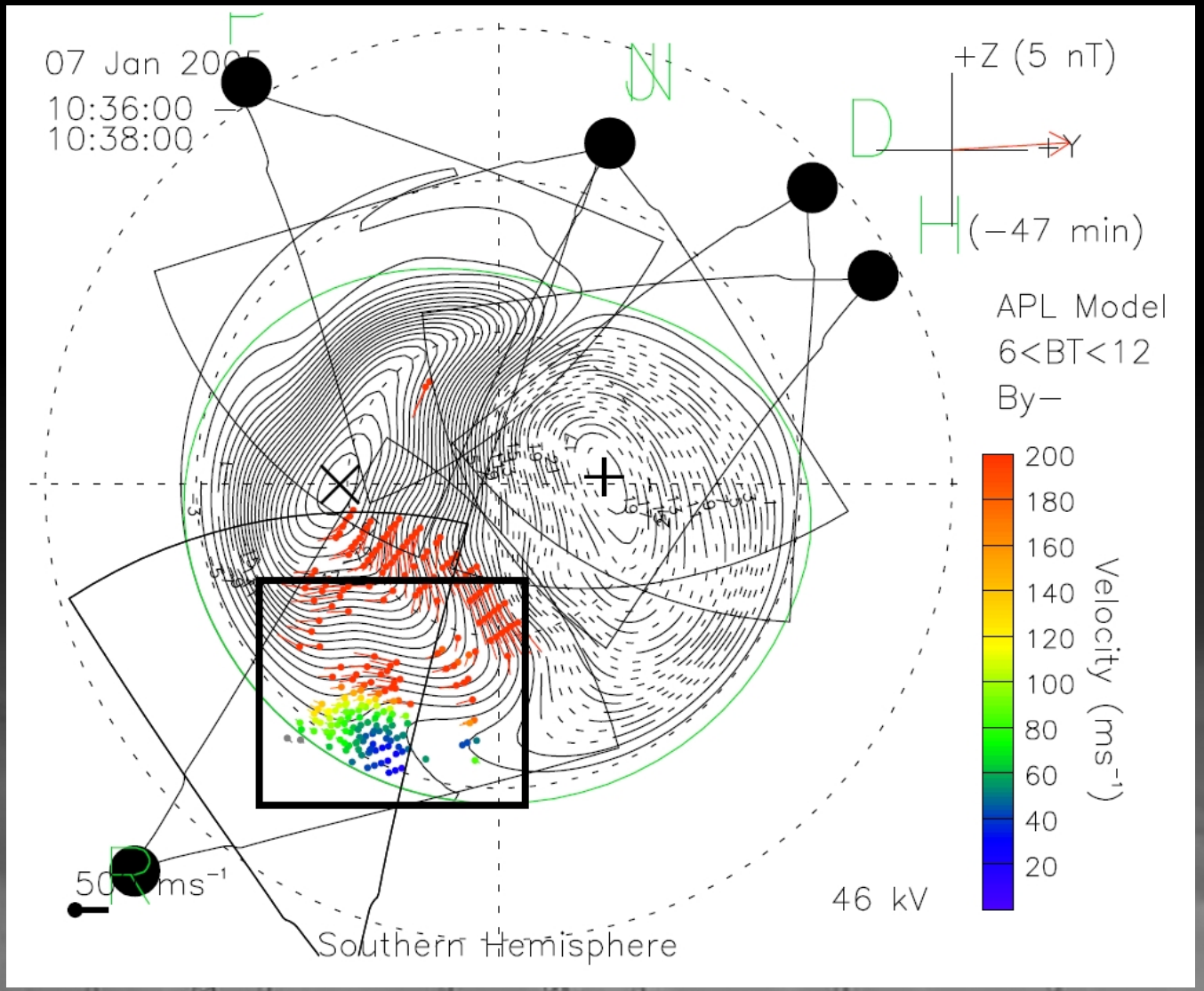

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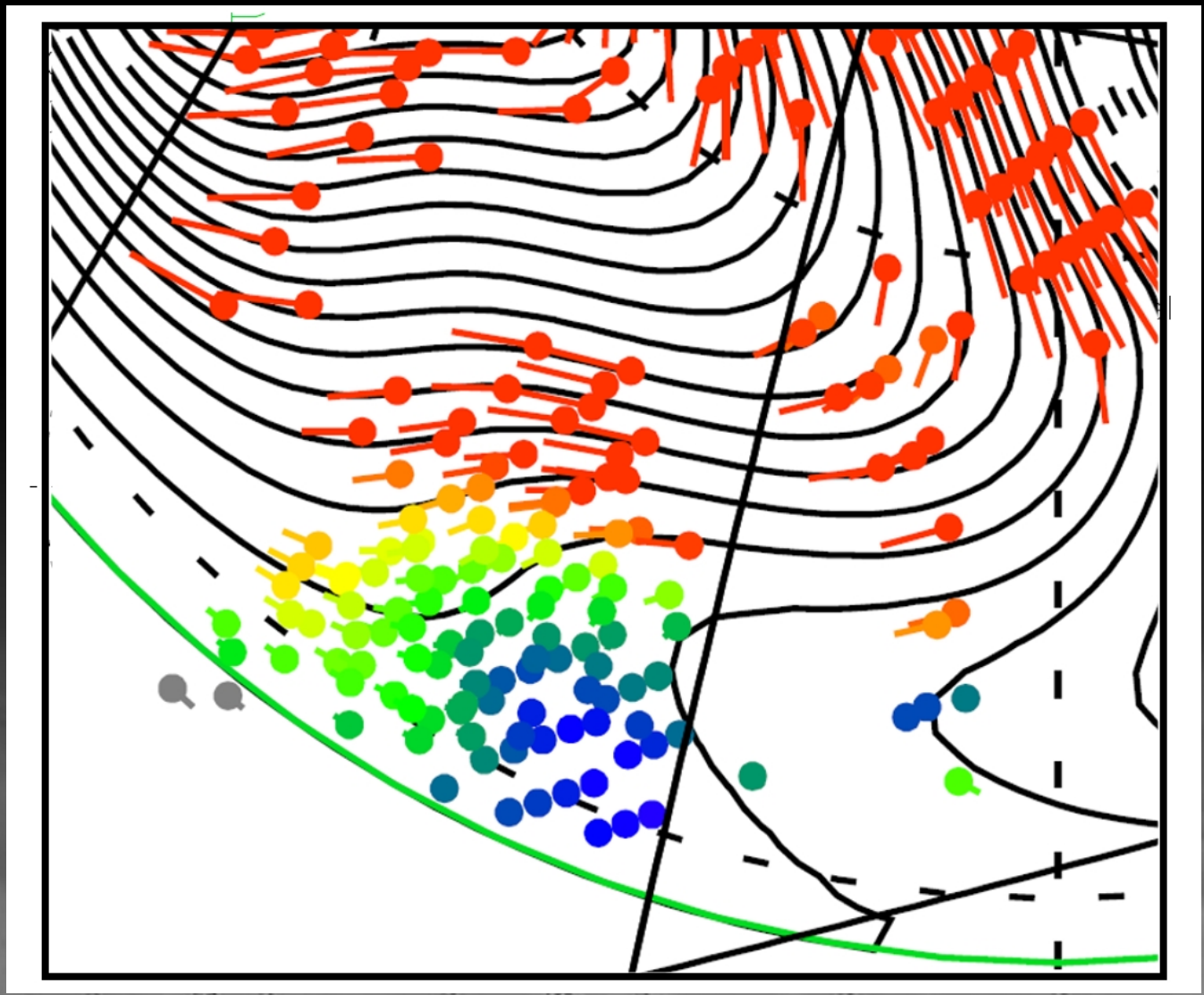

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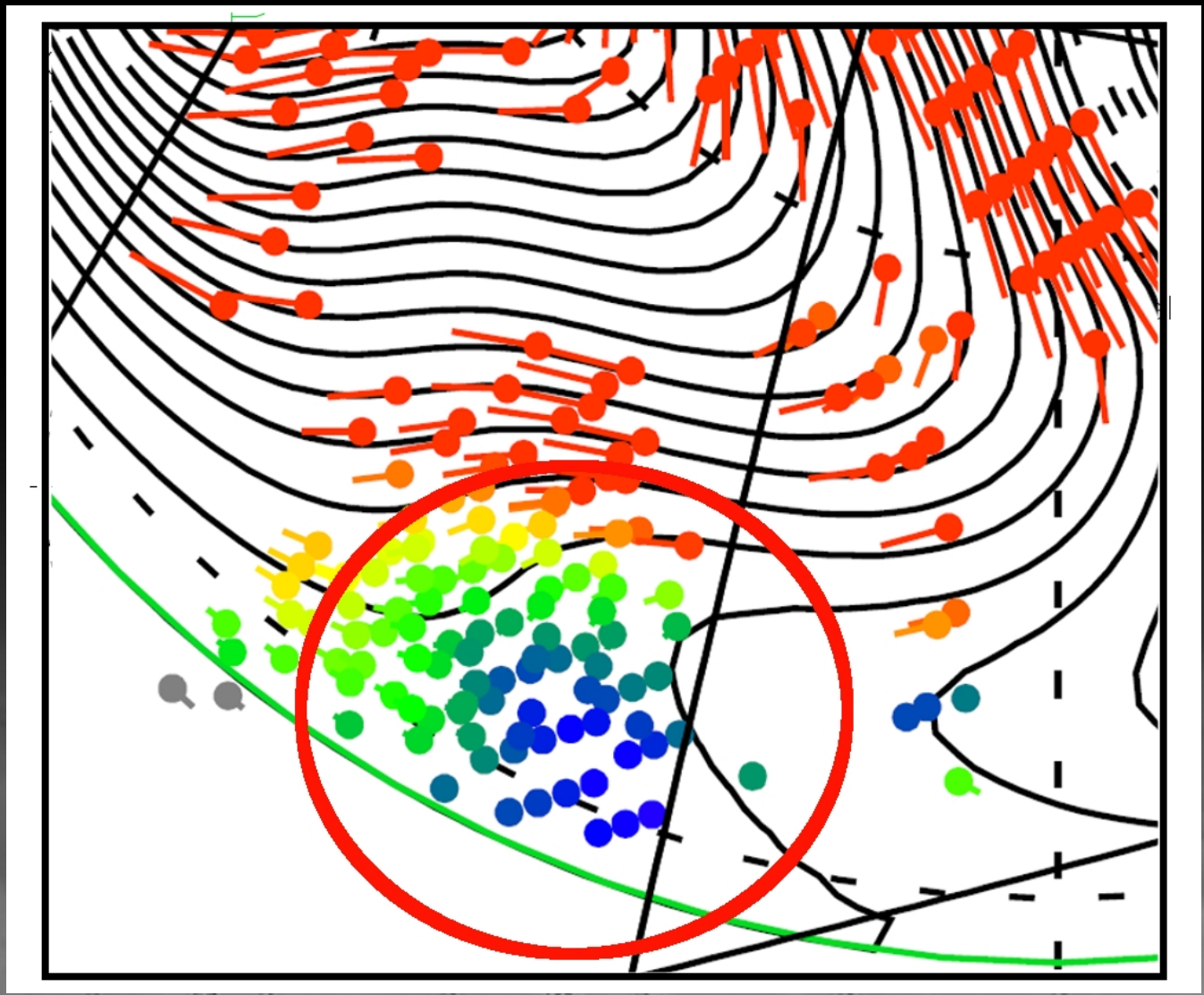
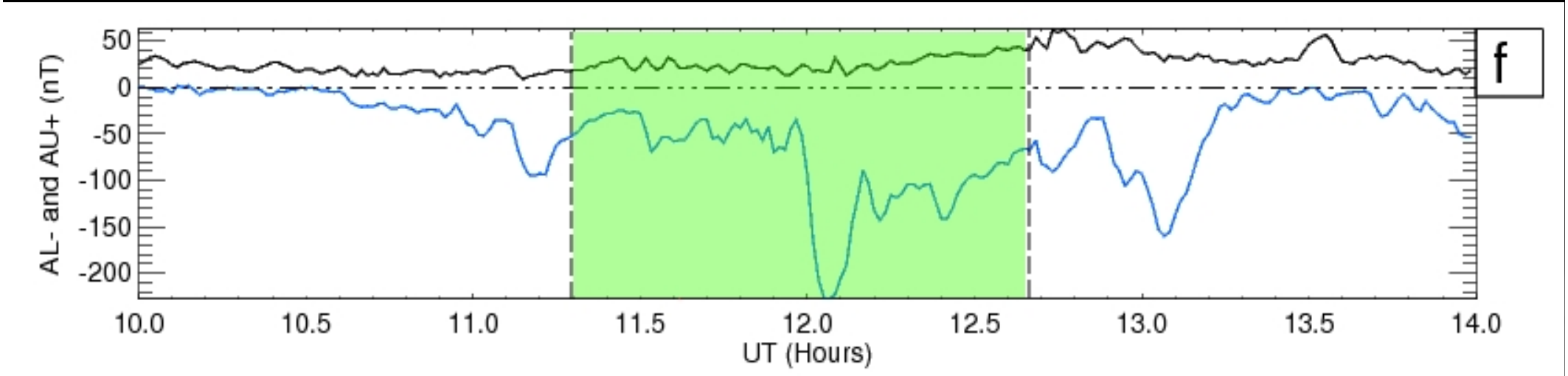


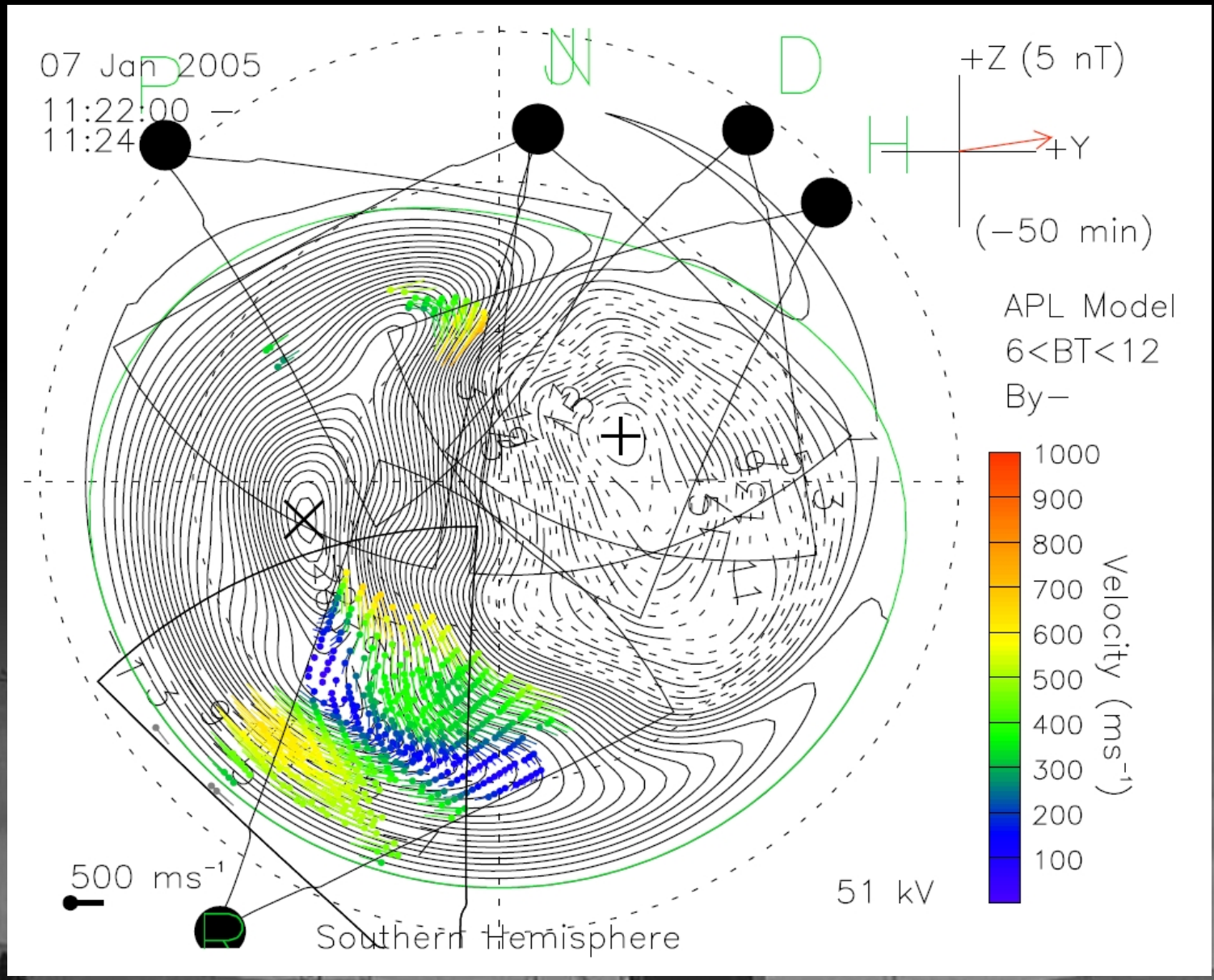
Harang “Banana”

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



Harang "Banana"

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



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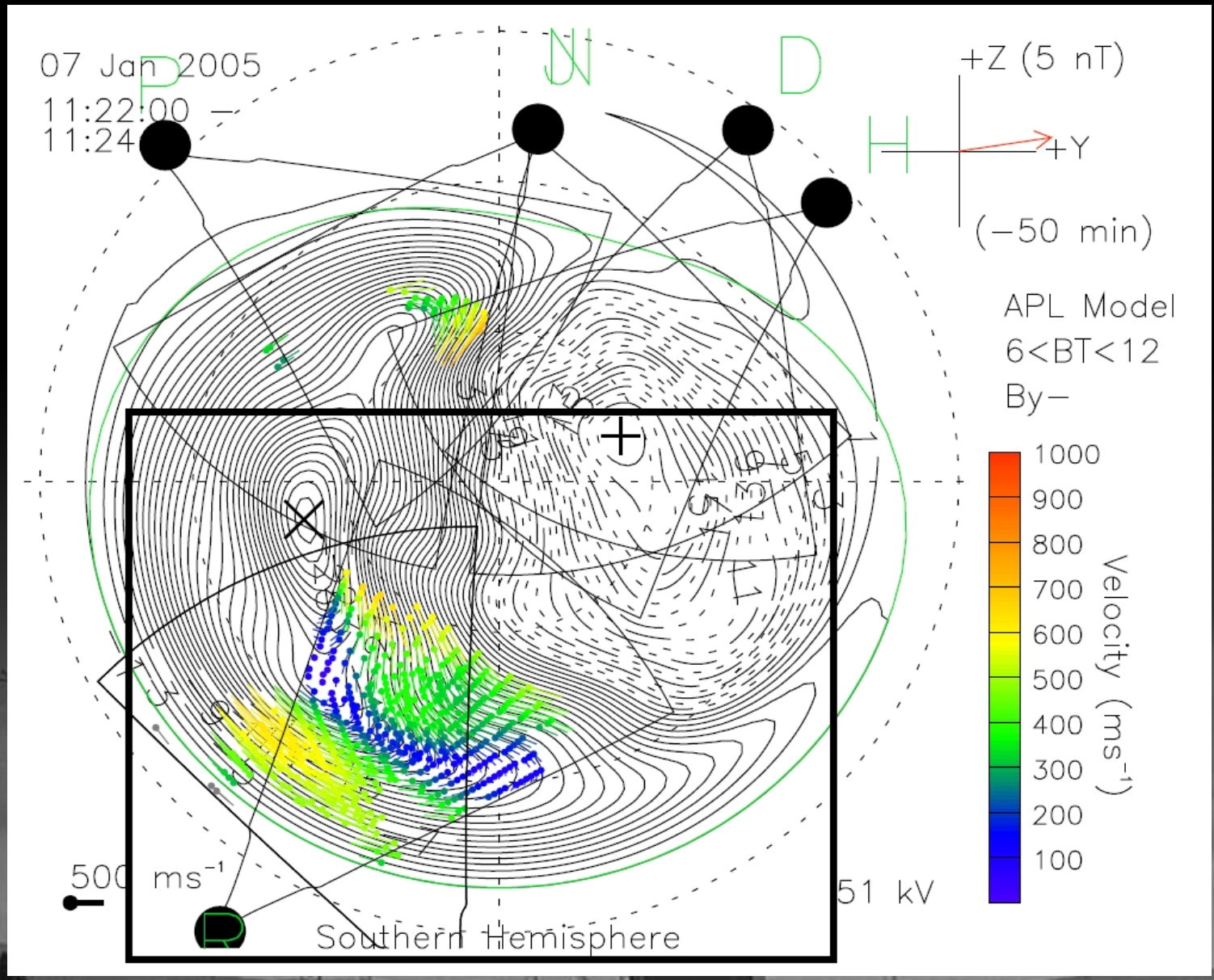

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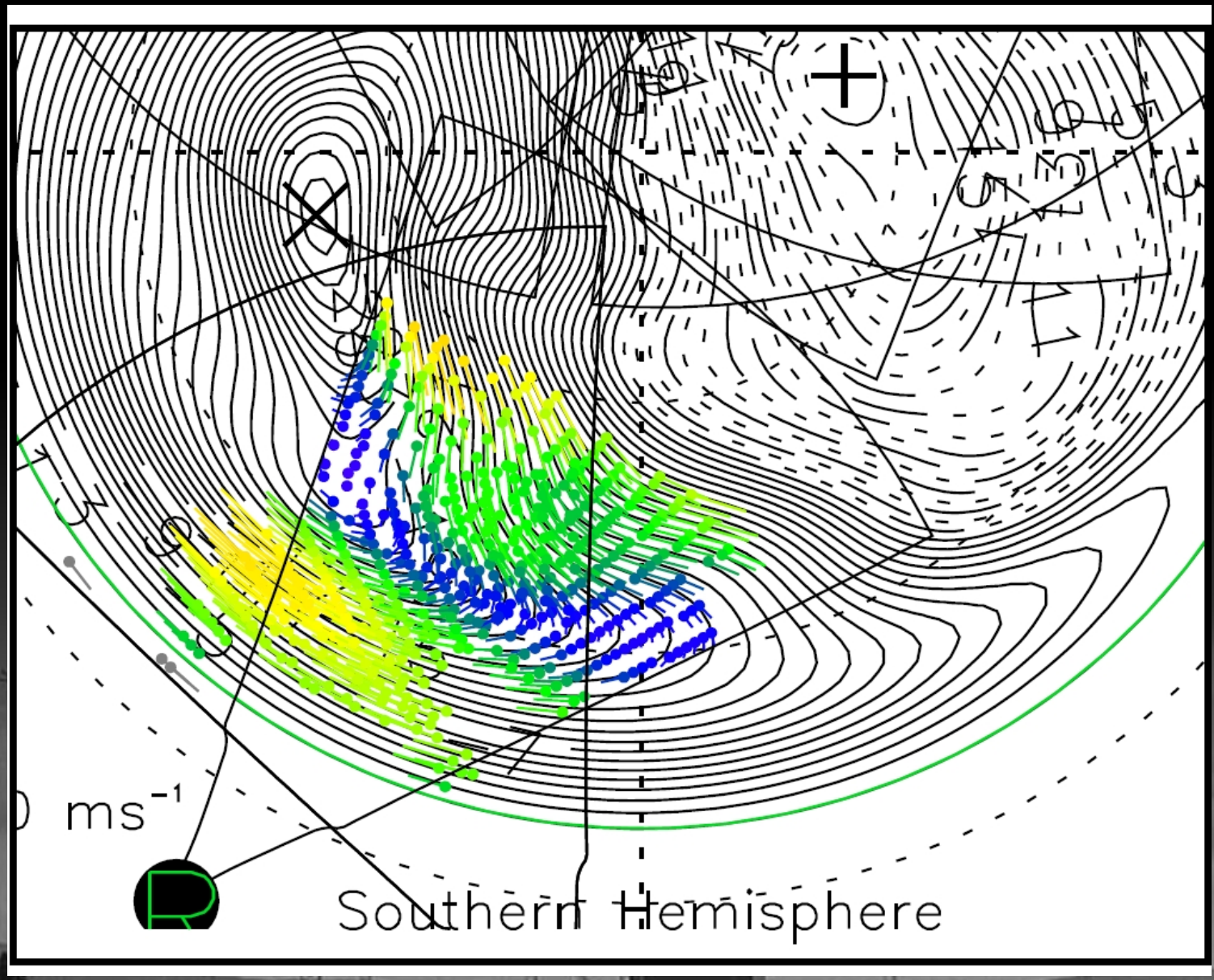

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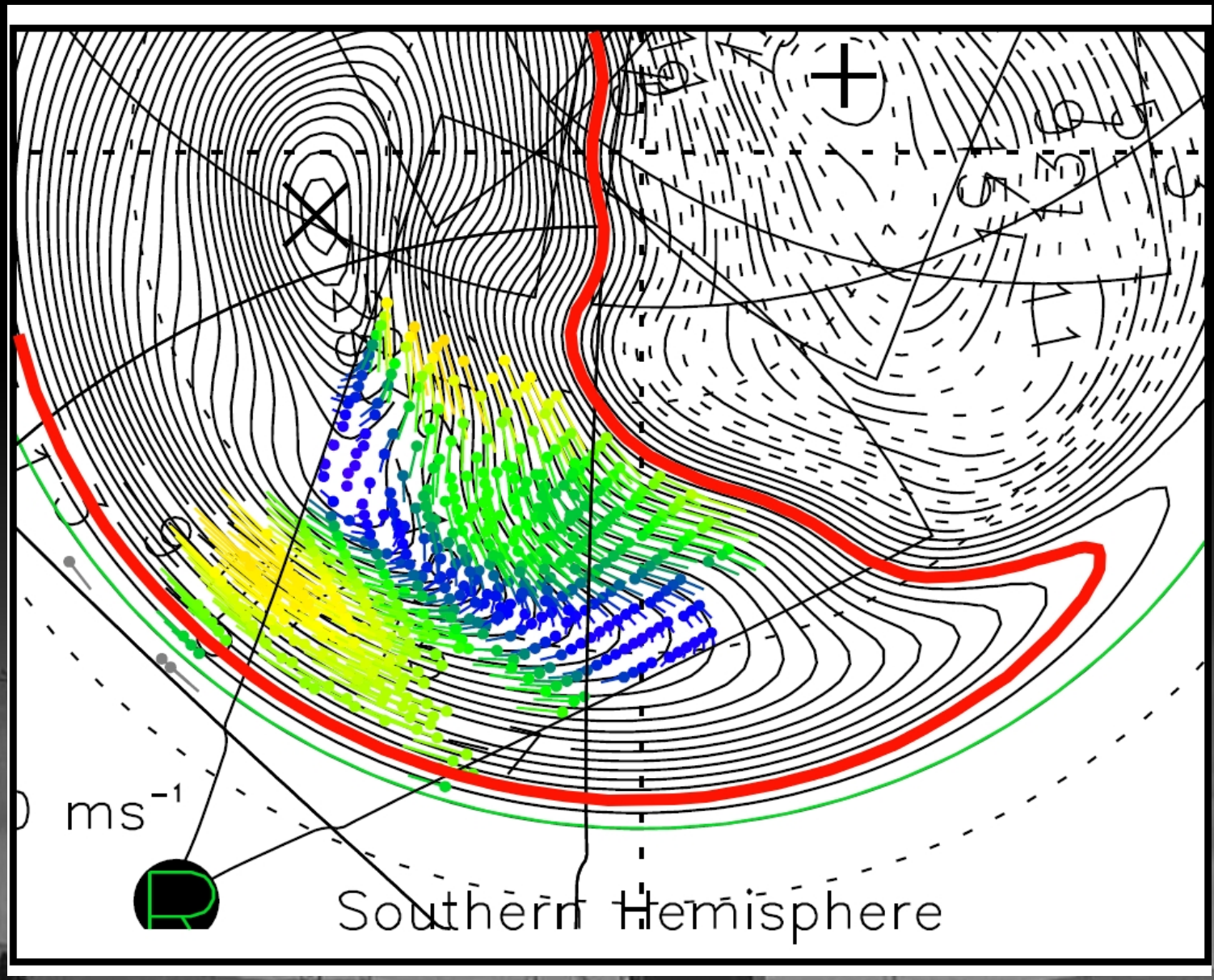
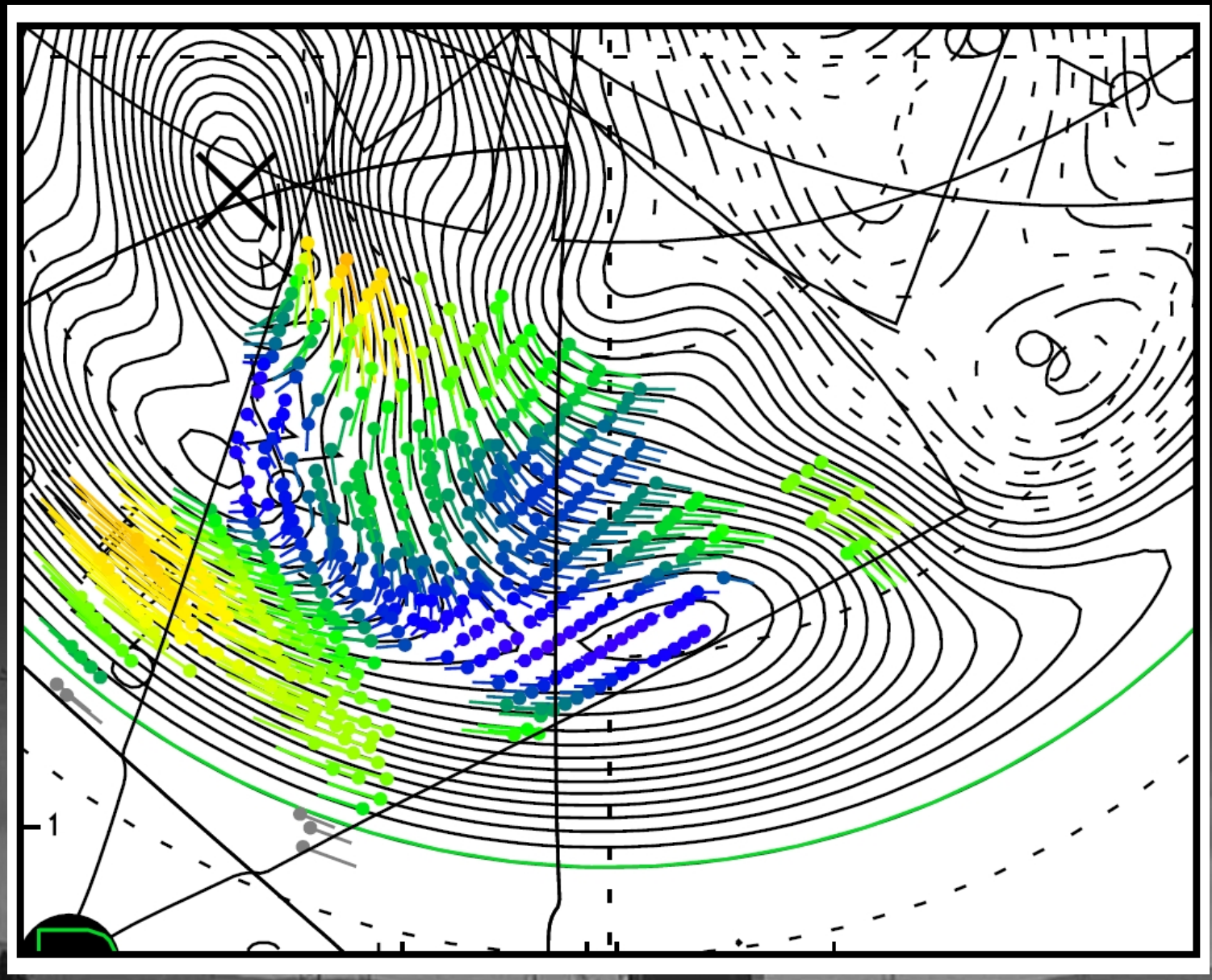


“Pinching off” of the Harang “Banana”

- 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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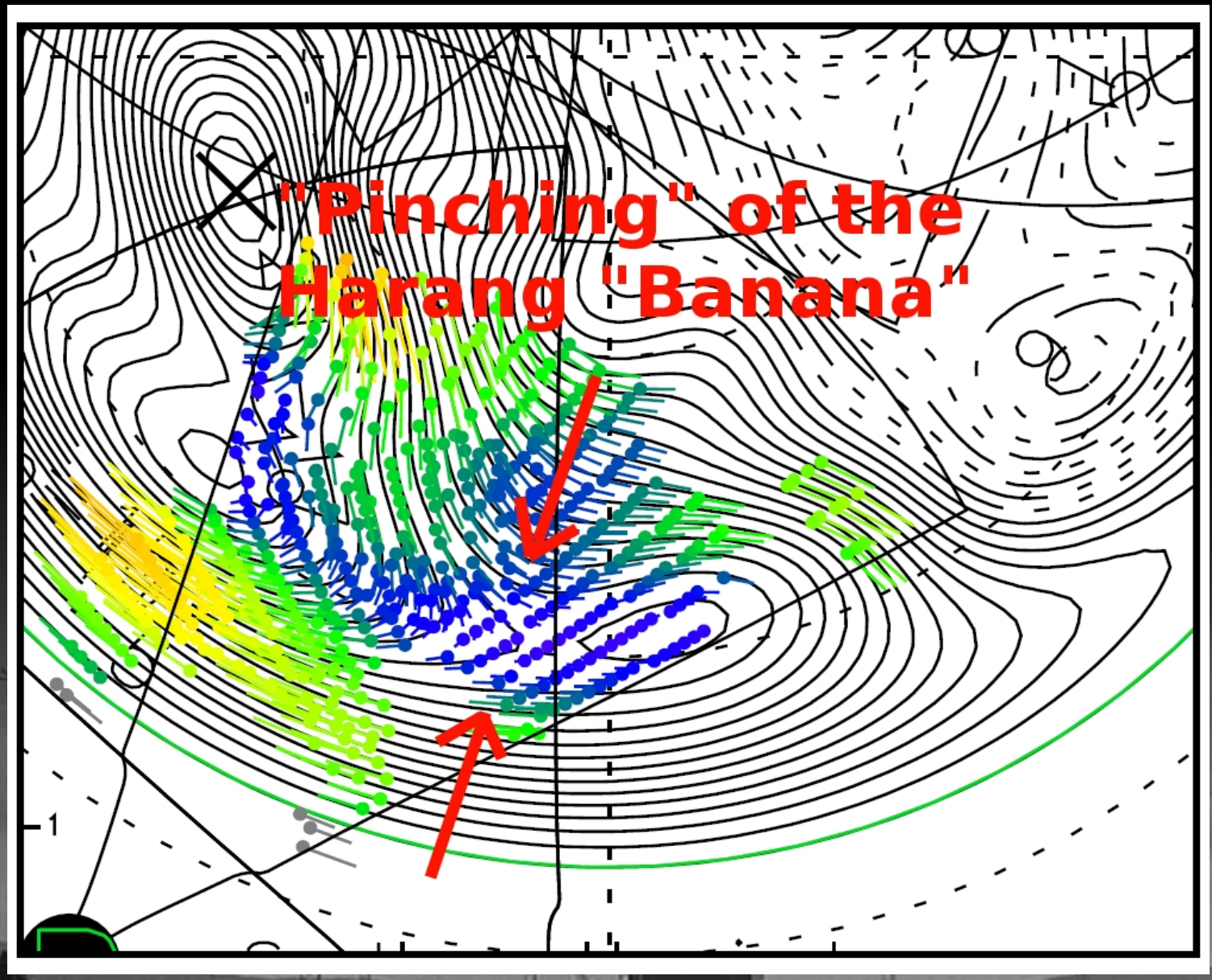

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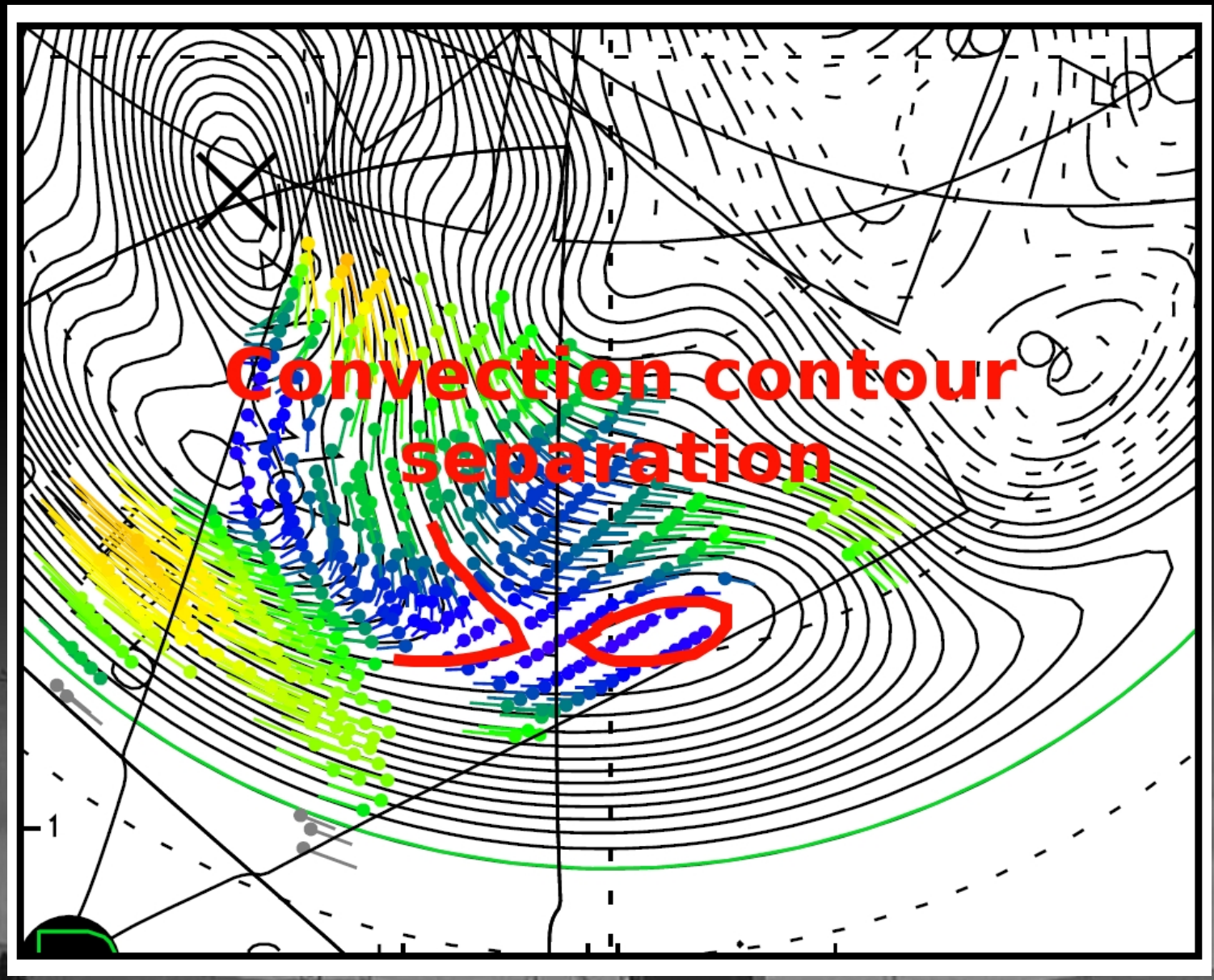
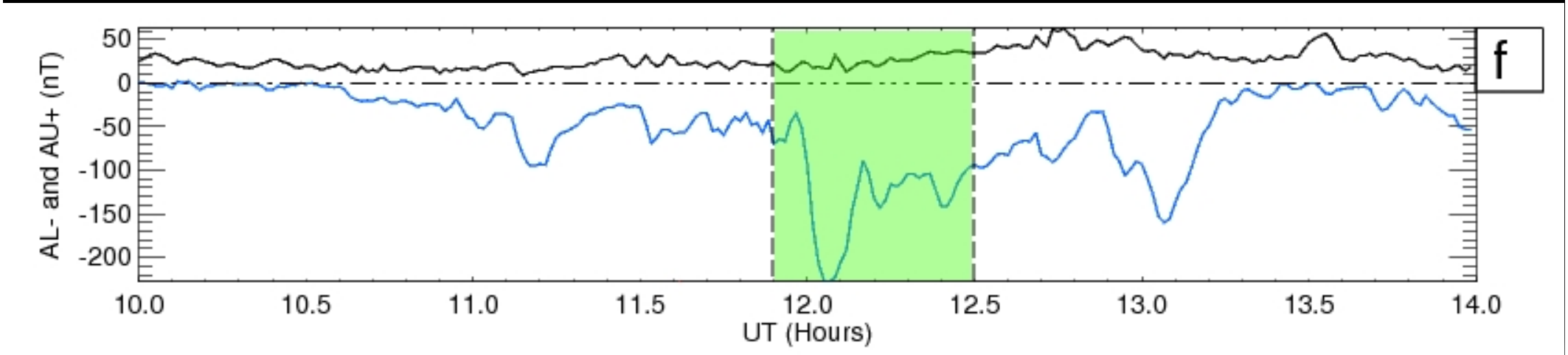


Polar Cap Flow Vortex

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

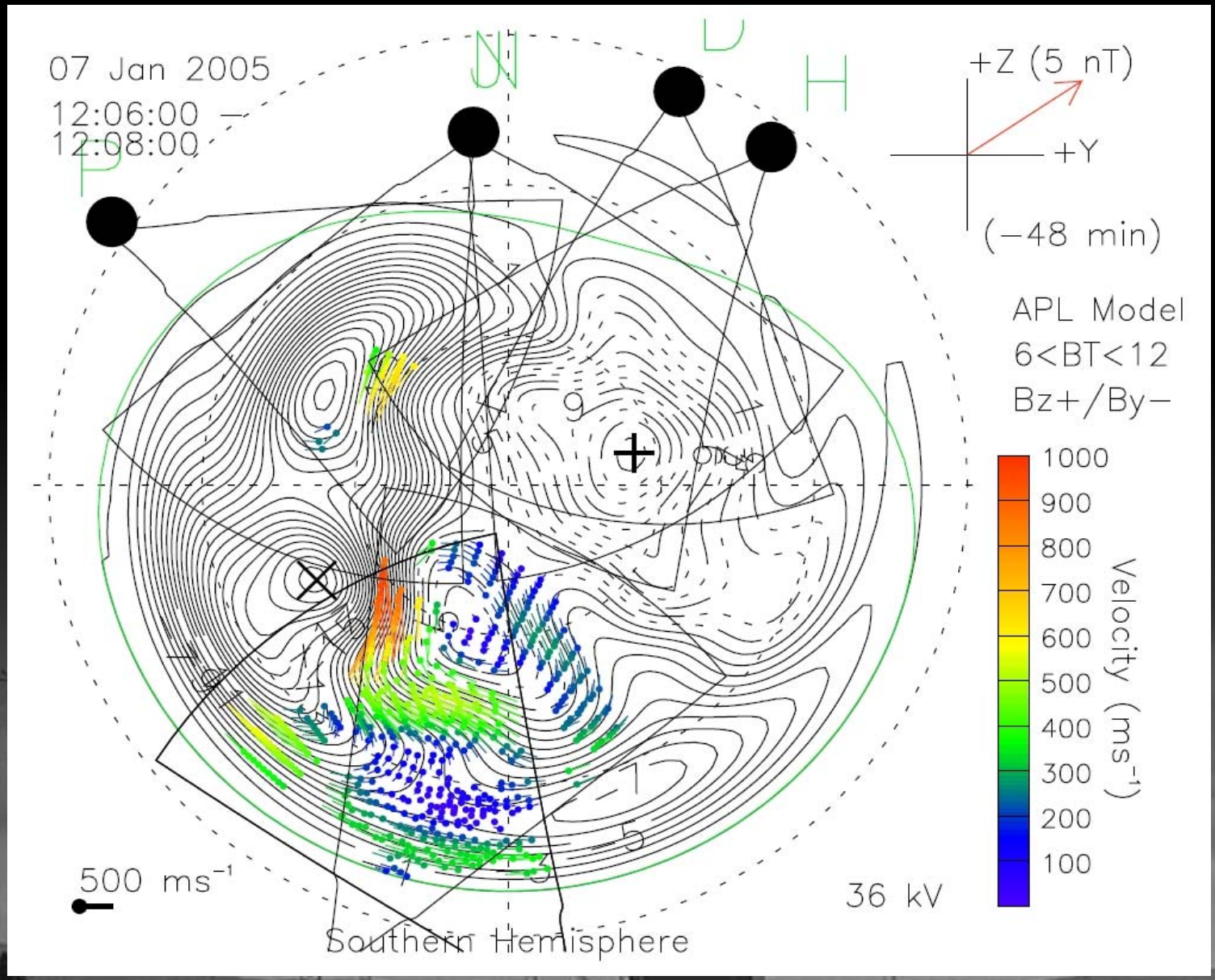


Polar Cap Flow Vortex

- 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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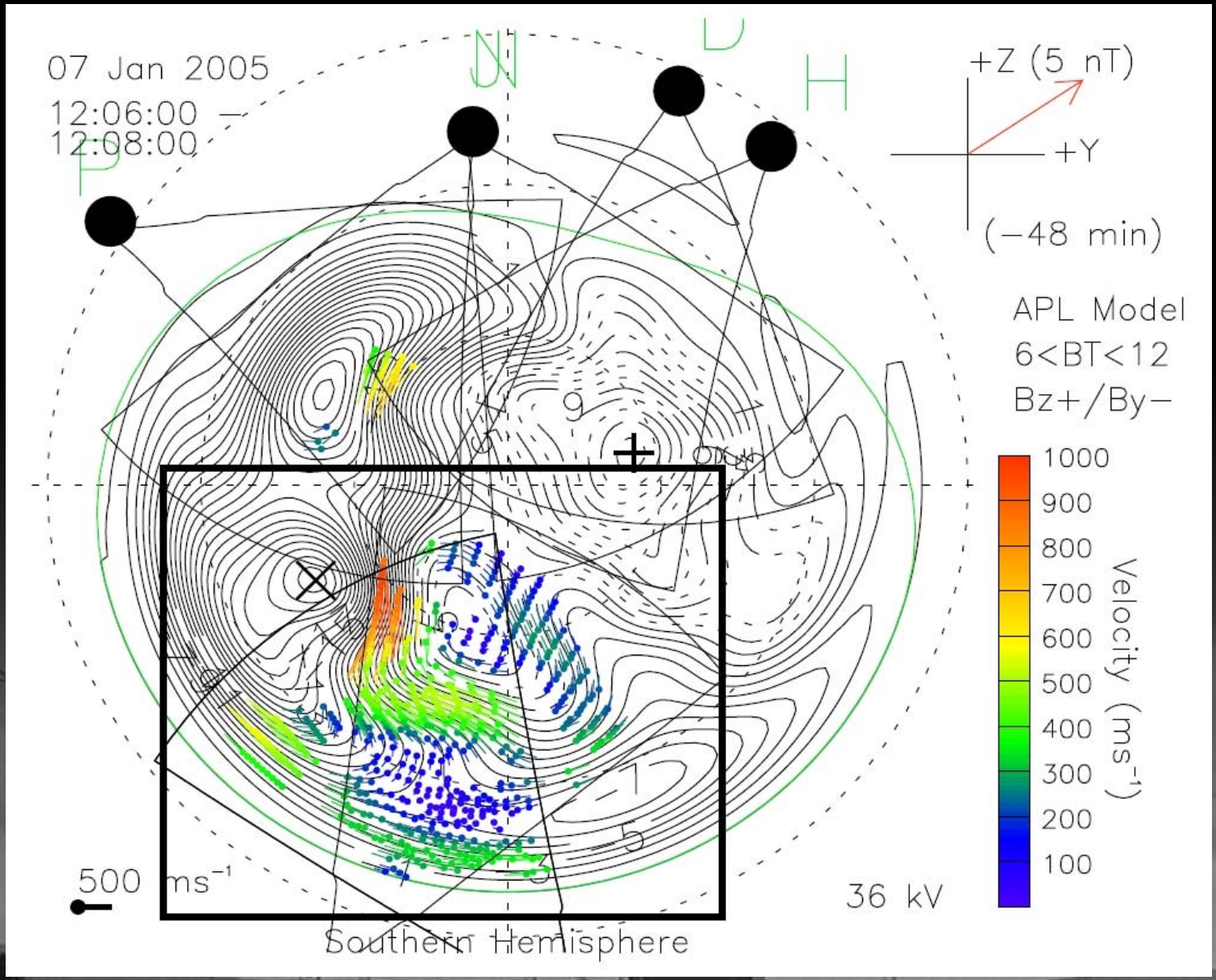

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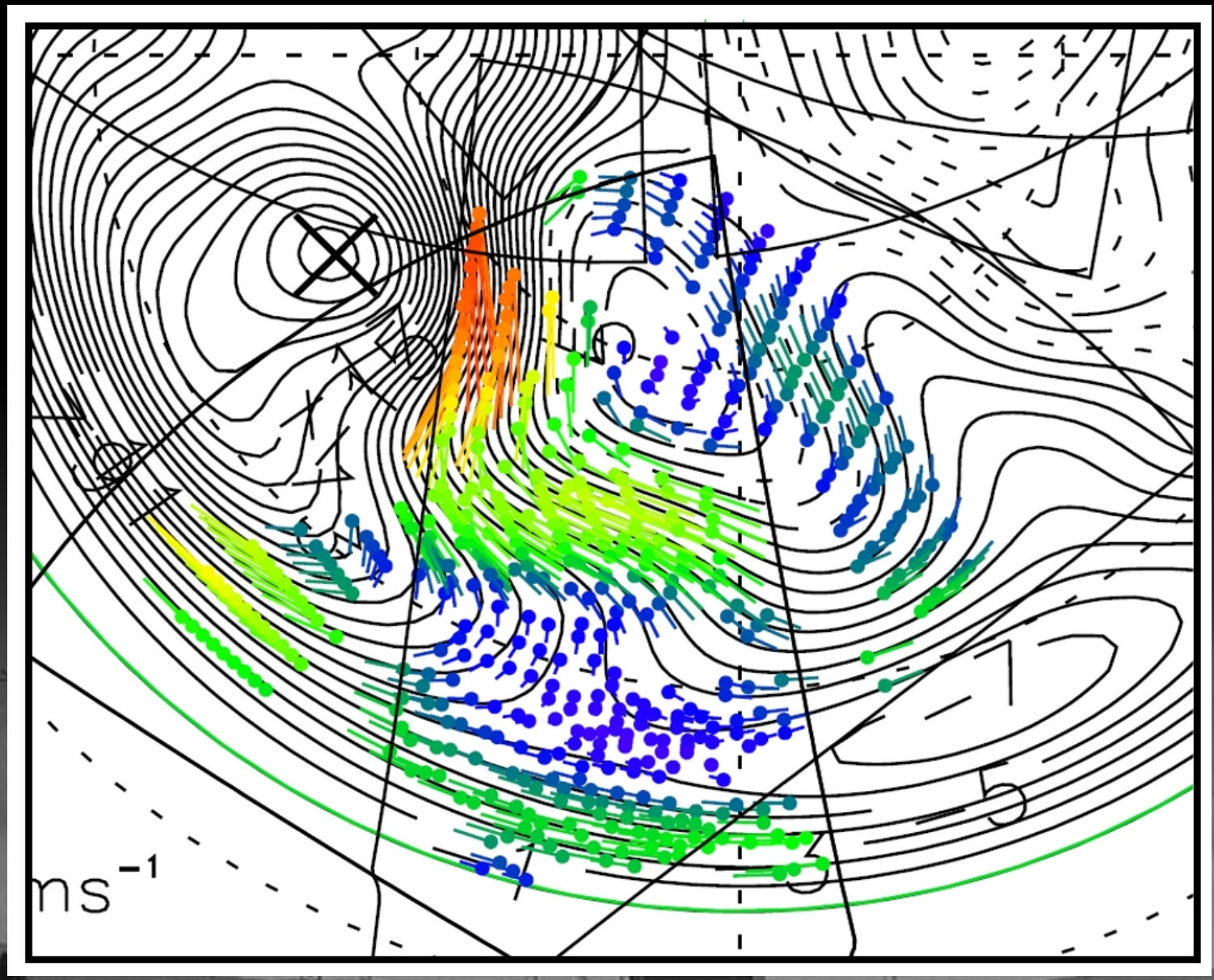

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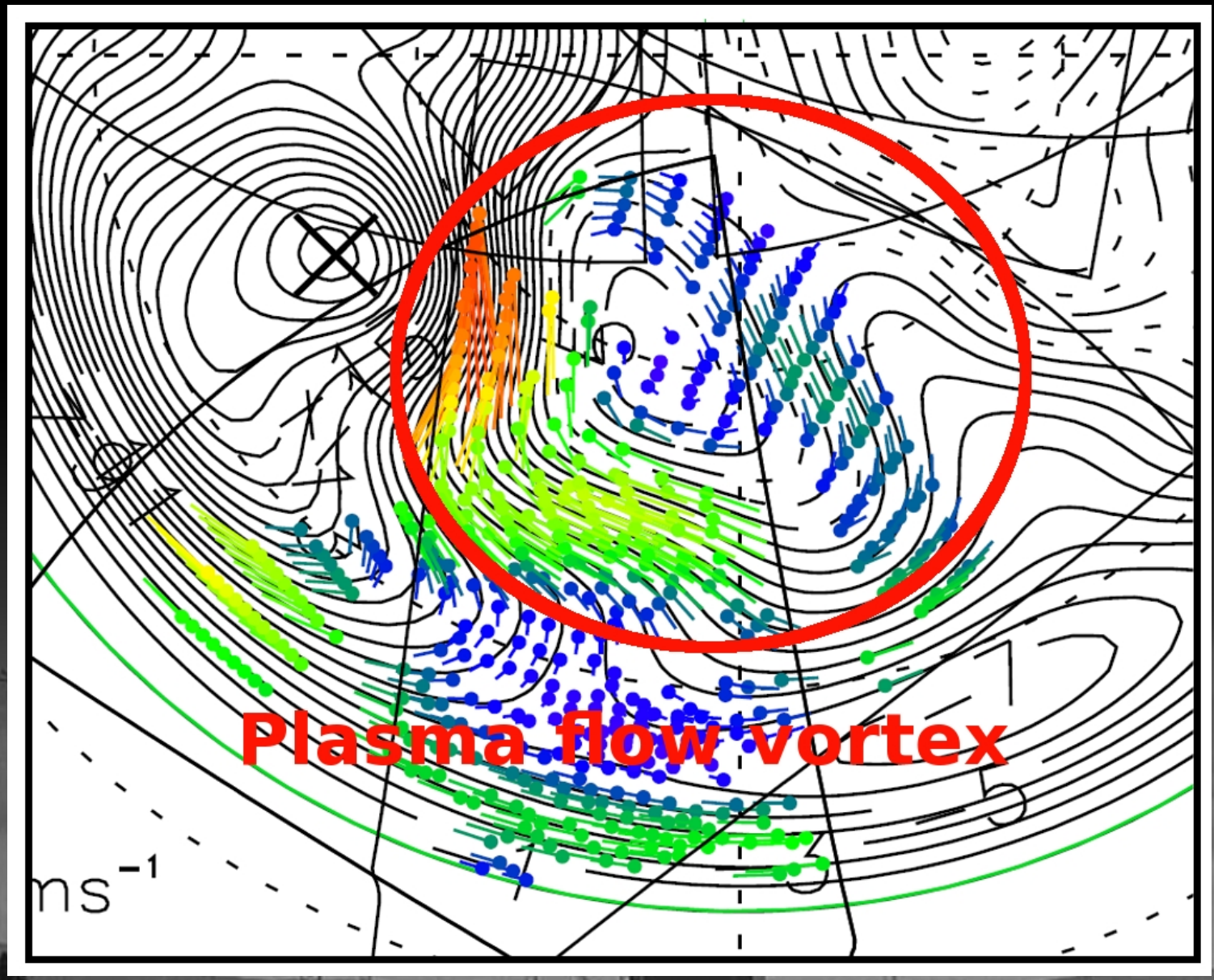
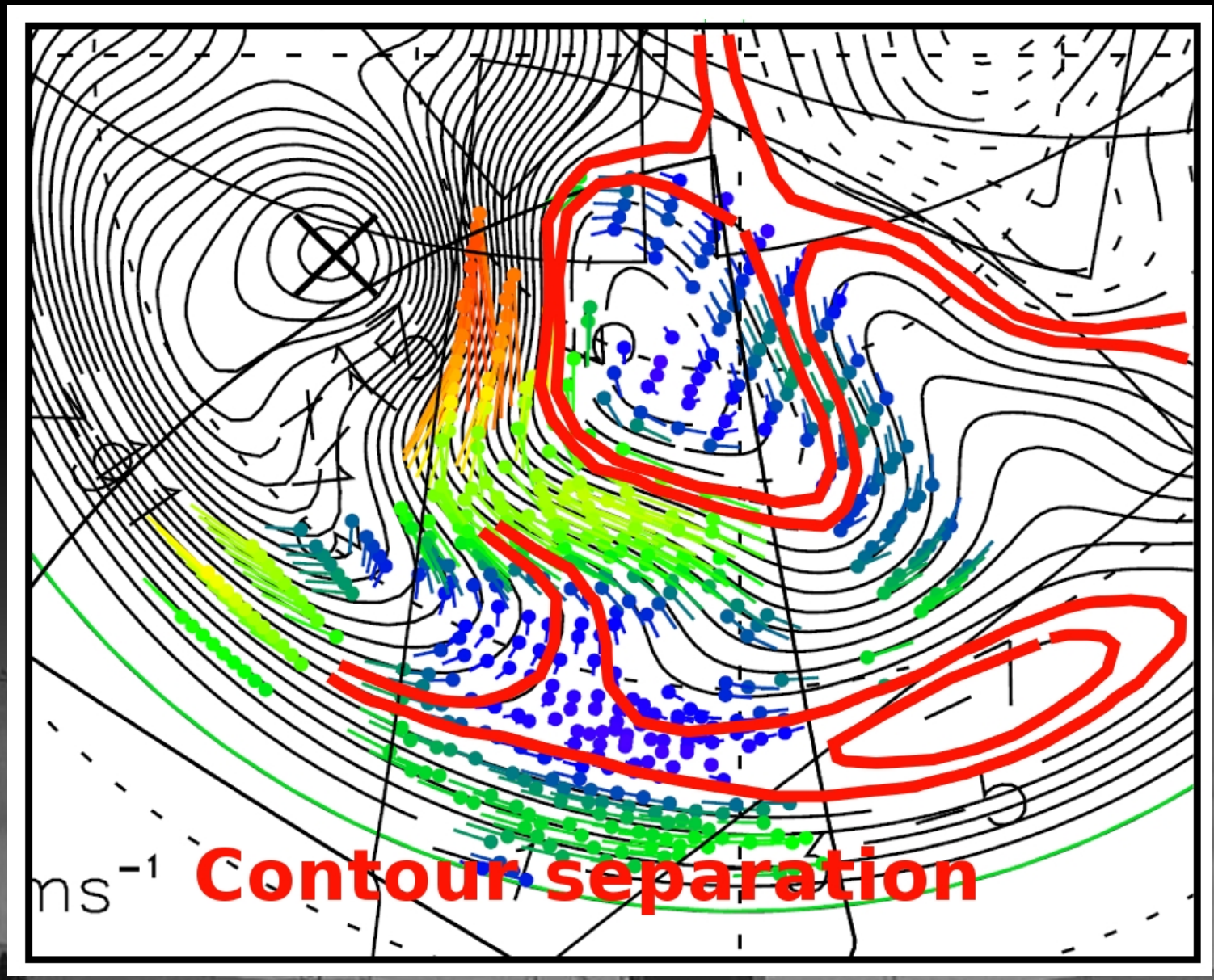


Polar Cap Flow Vortex

- A plasma circulation vortex forms in the

pre-midnight sector, and travels towards dawn over 30min

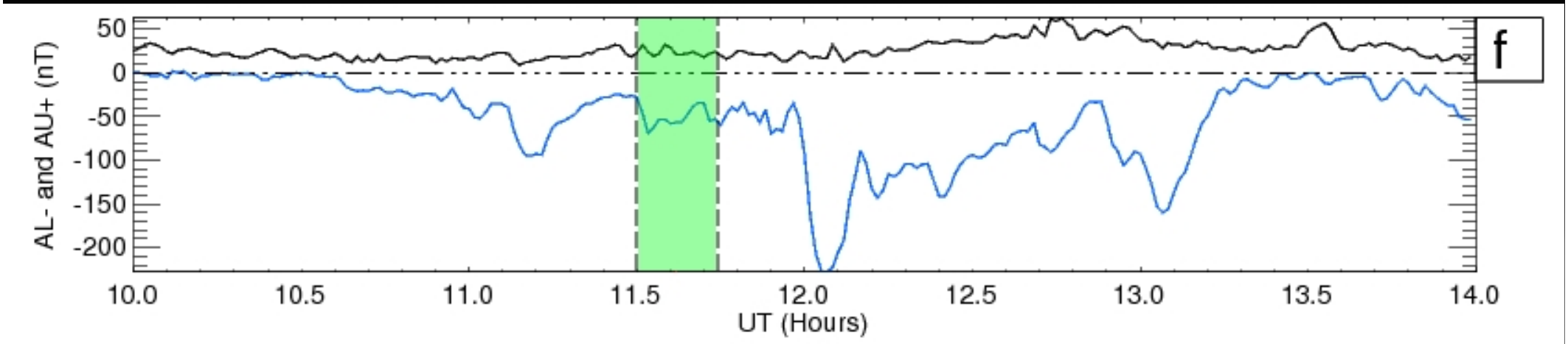
- As a result we see contour separations



Auroral Westward Flow Channel

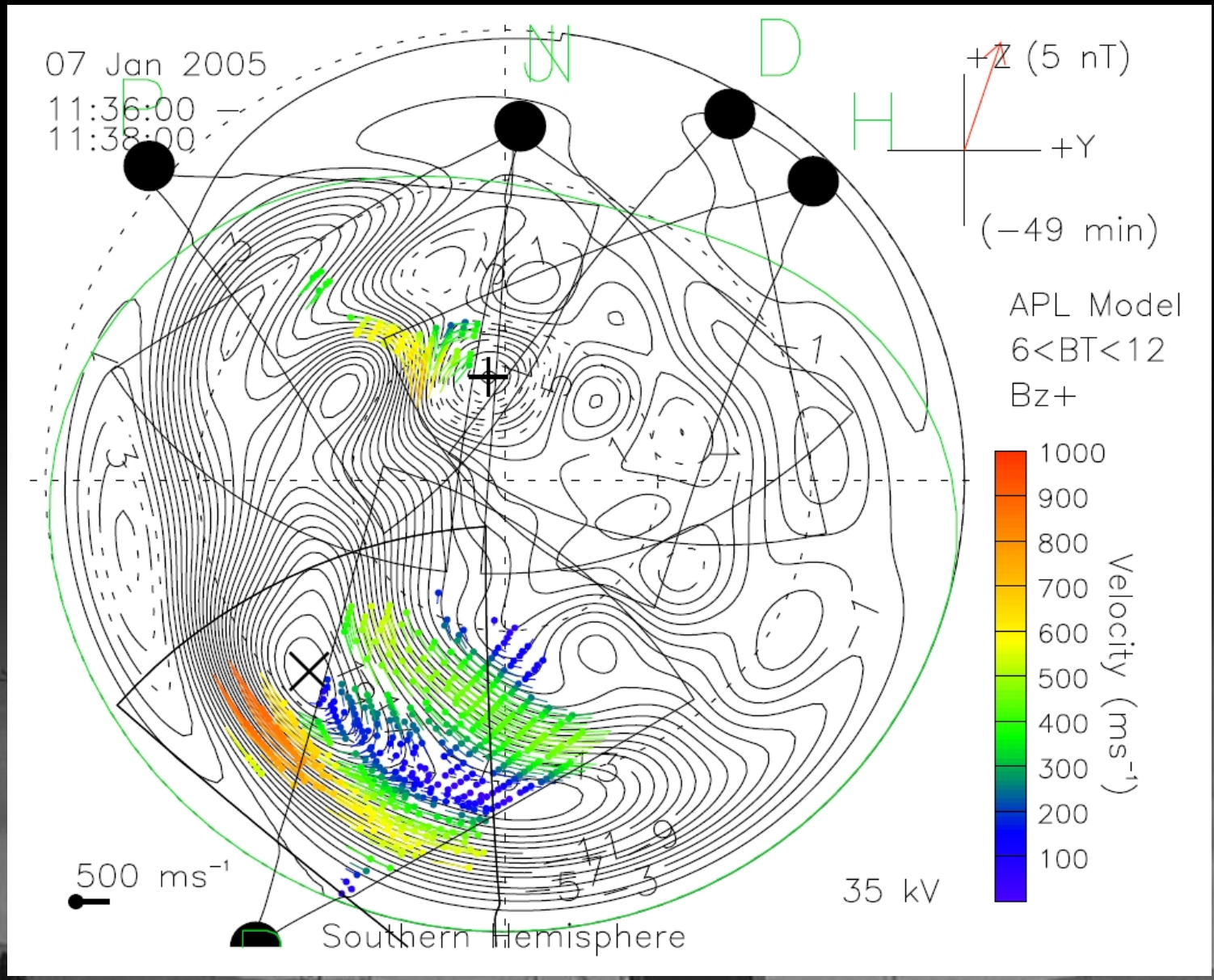
- Increase in the SAPS stream flow intensity, pre-midnight, on the equatorward edge of the dawn potential convection cell

- An intensification, 800 - 1000ms^{-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°MLat wide
- There is clear compression of the convection cell contours



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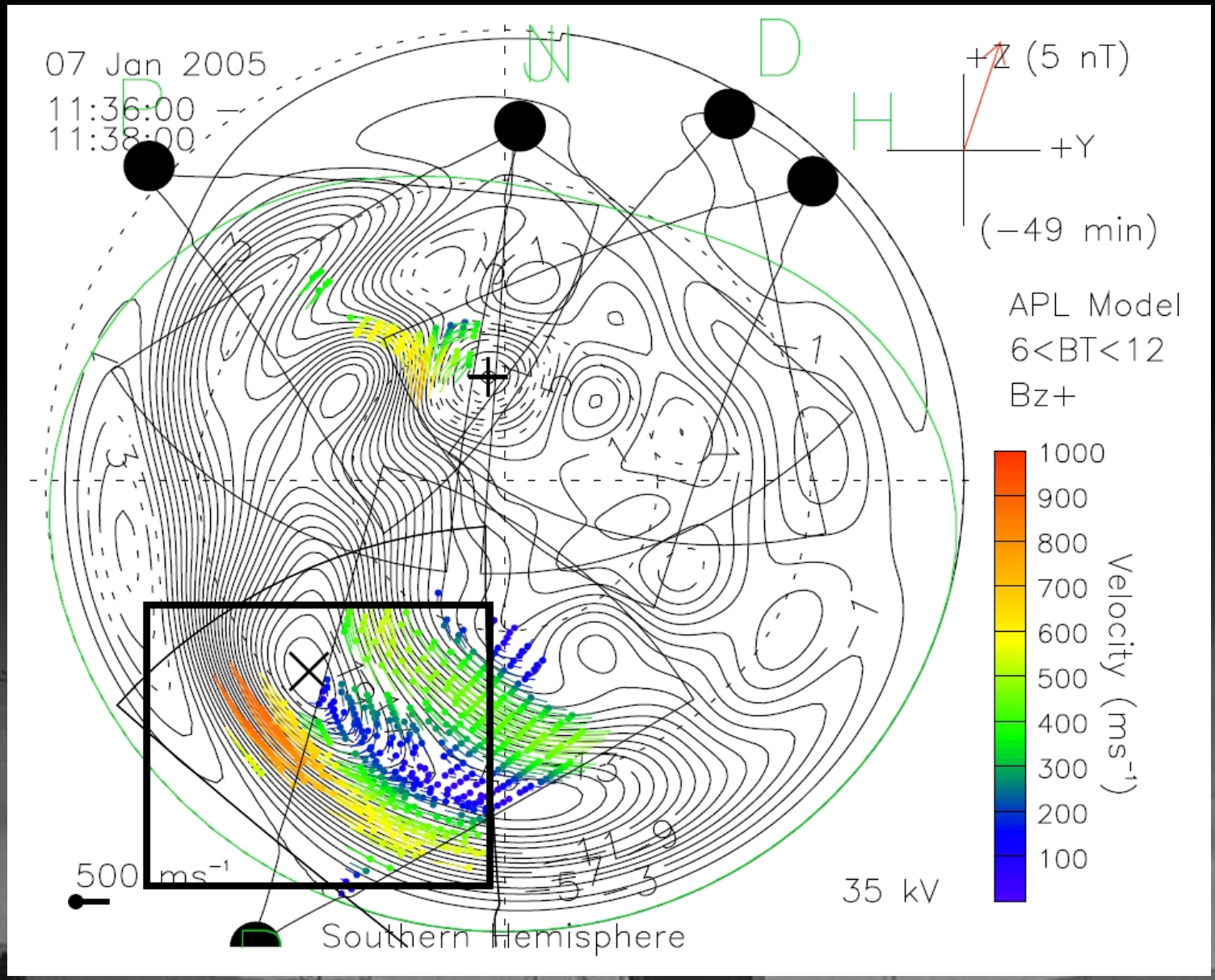

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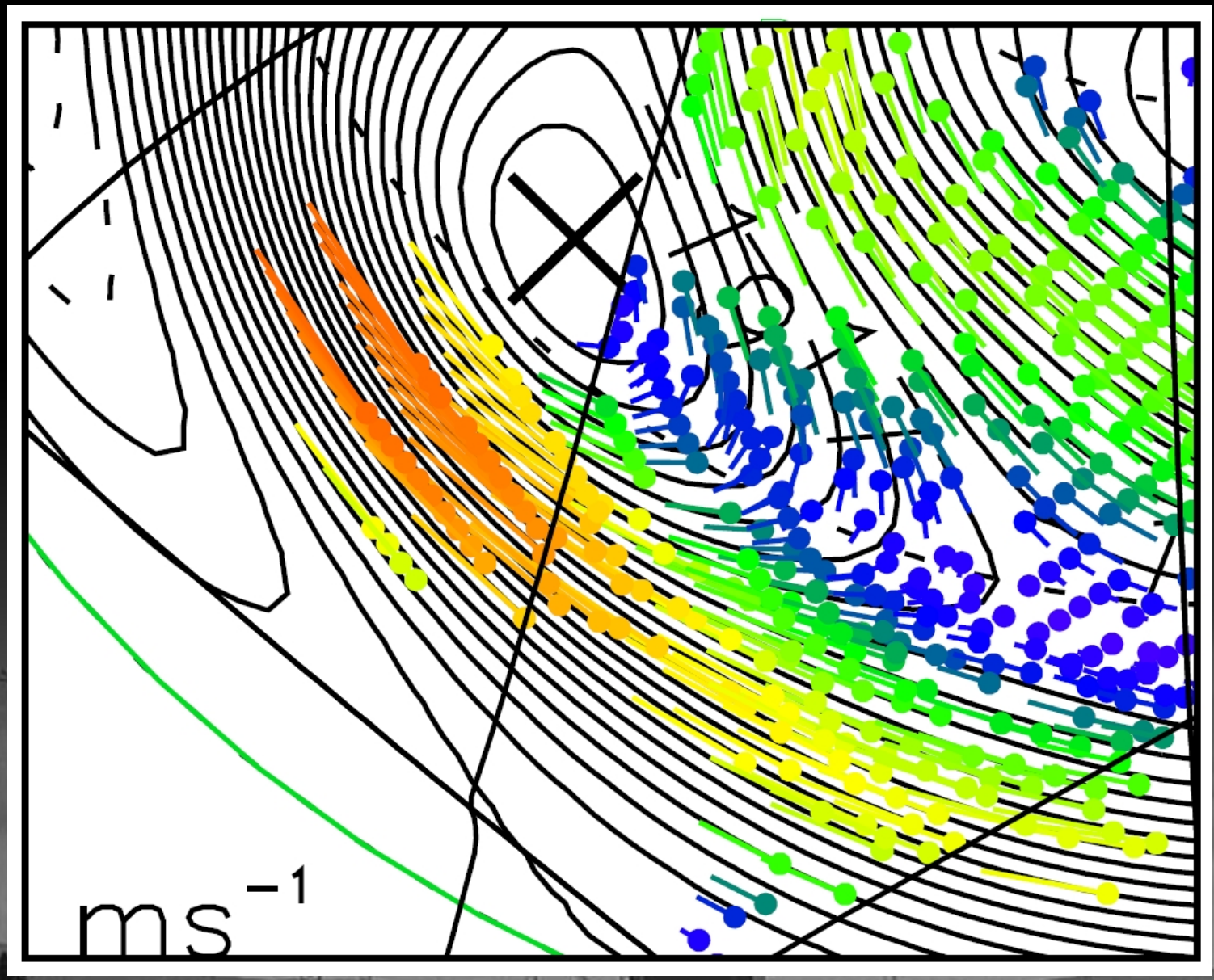

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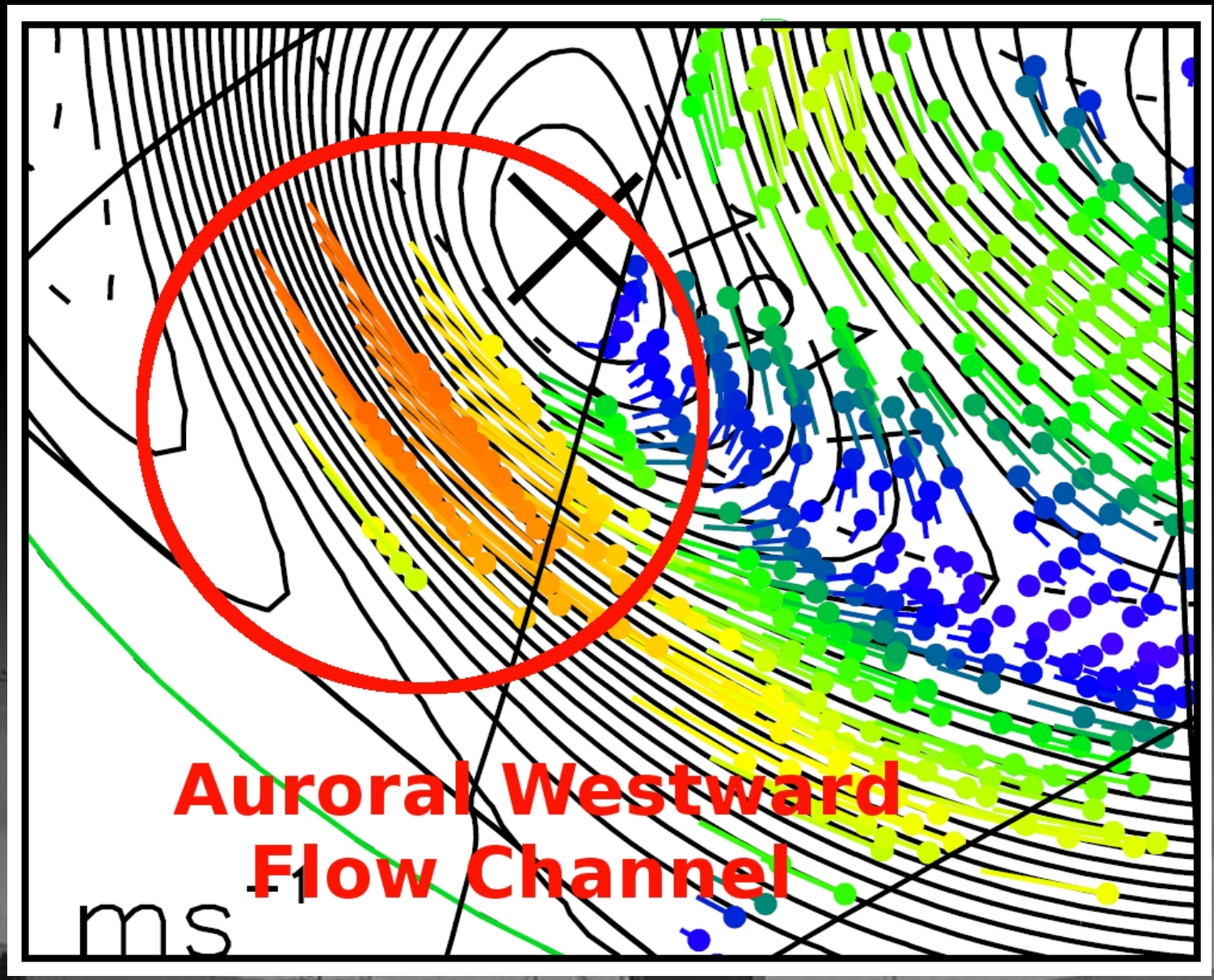

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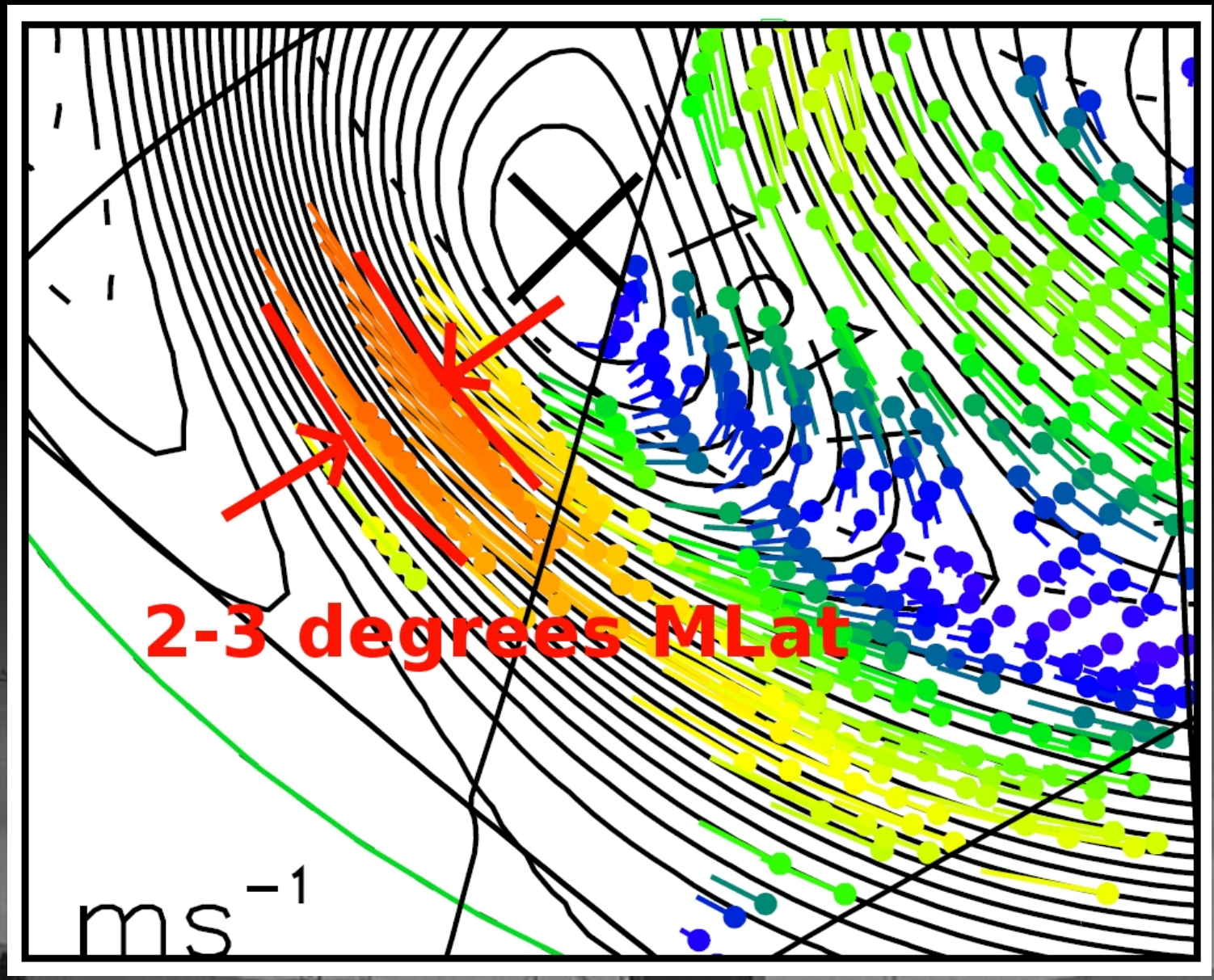
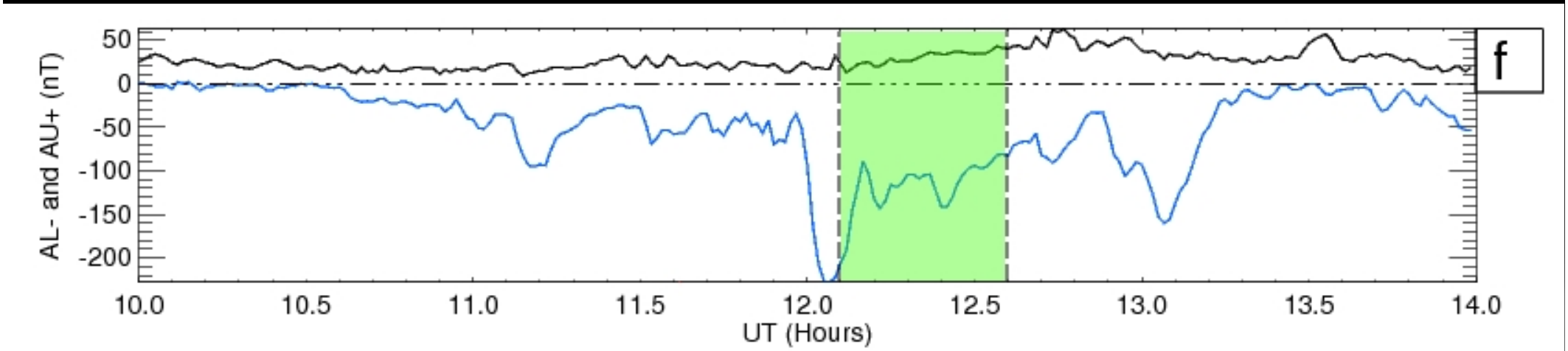


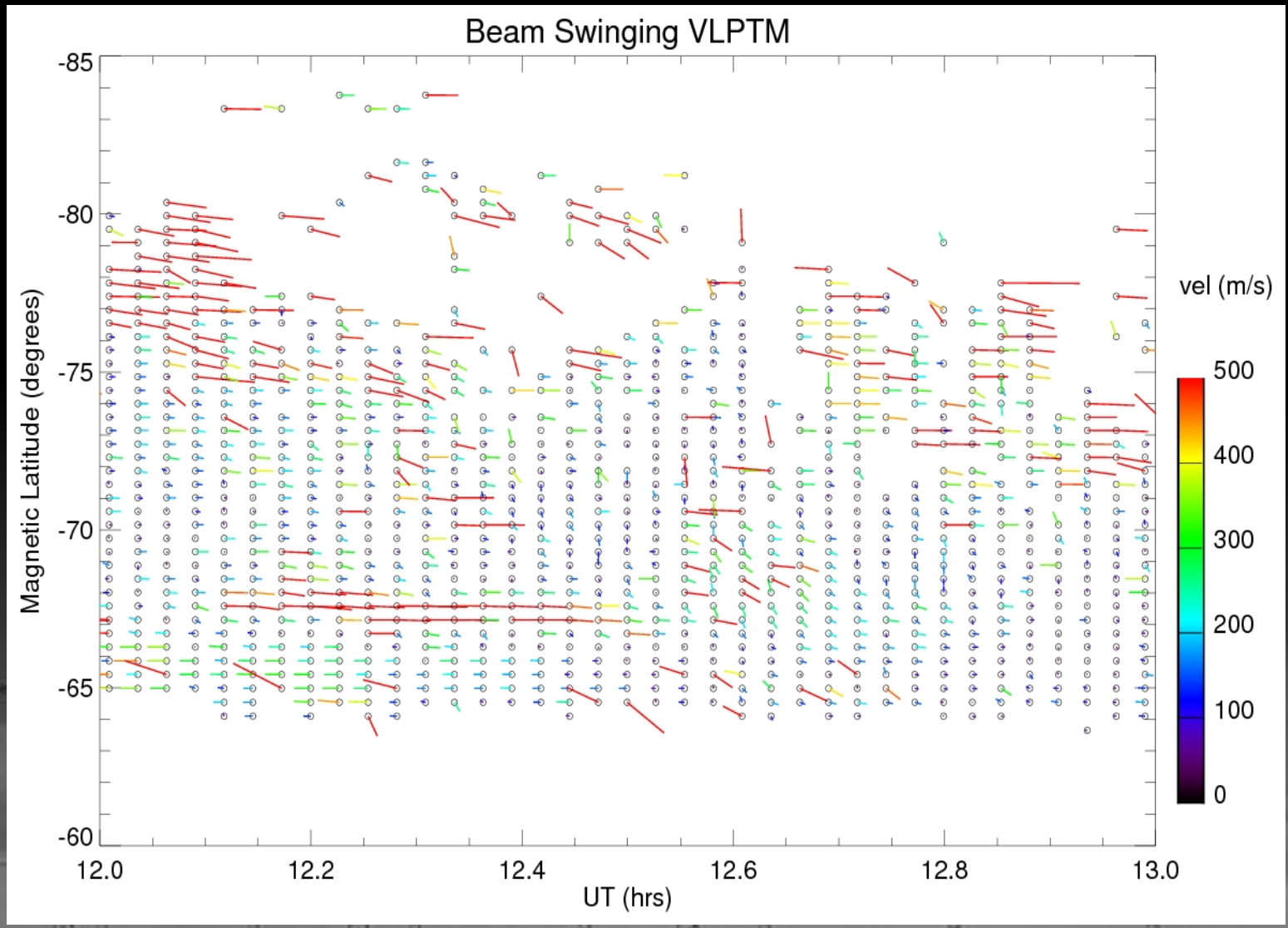
Auroral Eastward Flow Channel

- 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 68º Latitude



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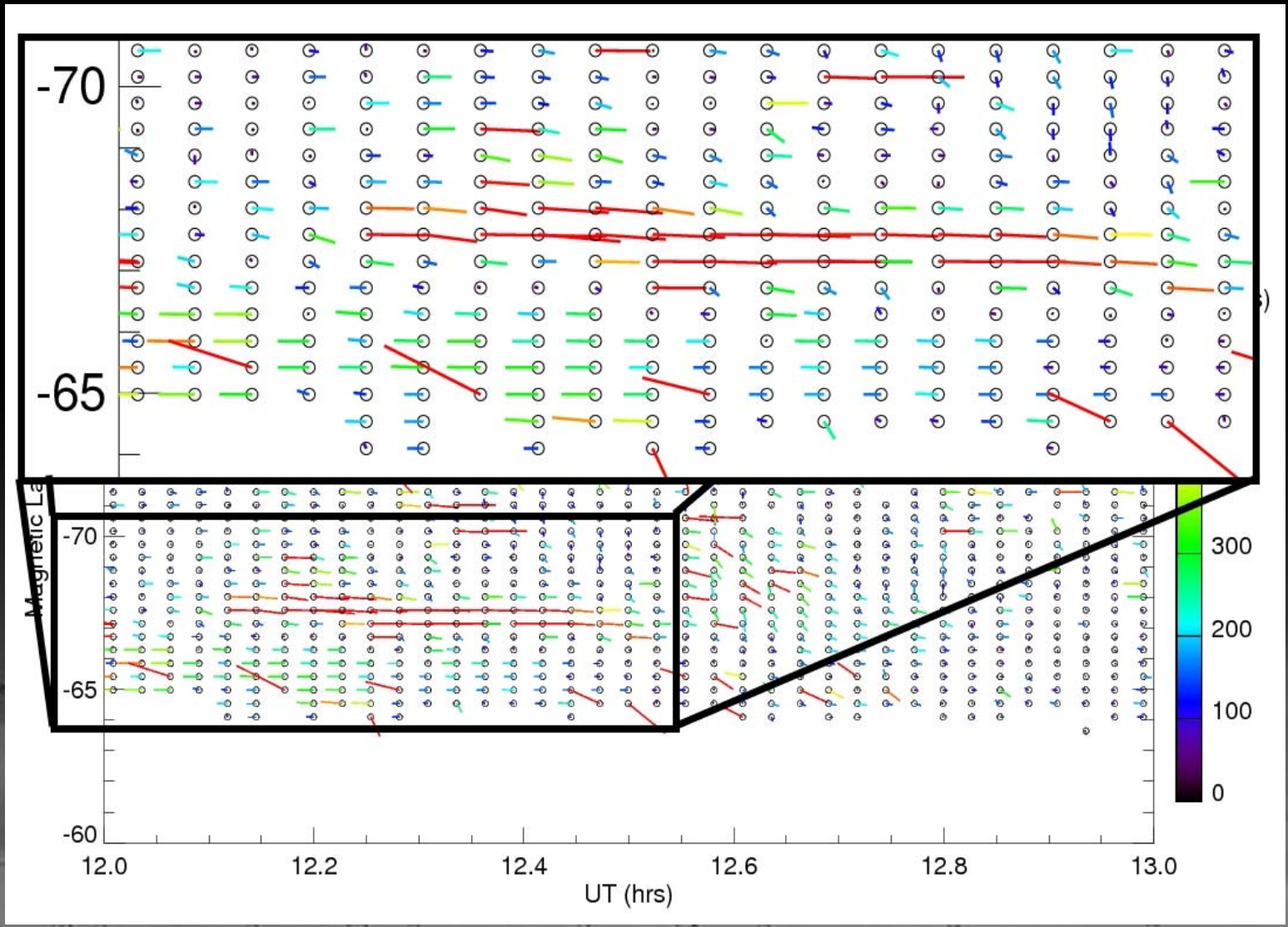
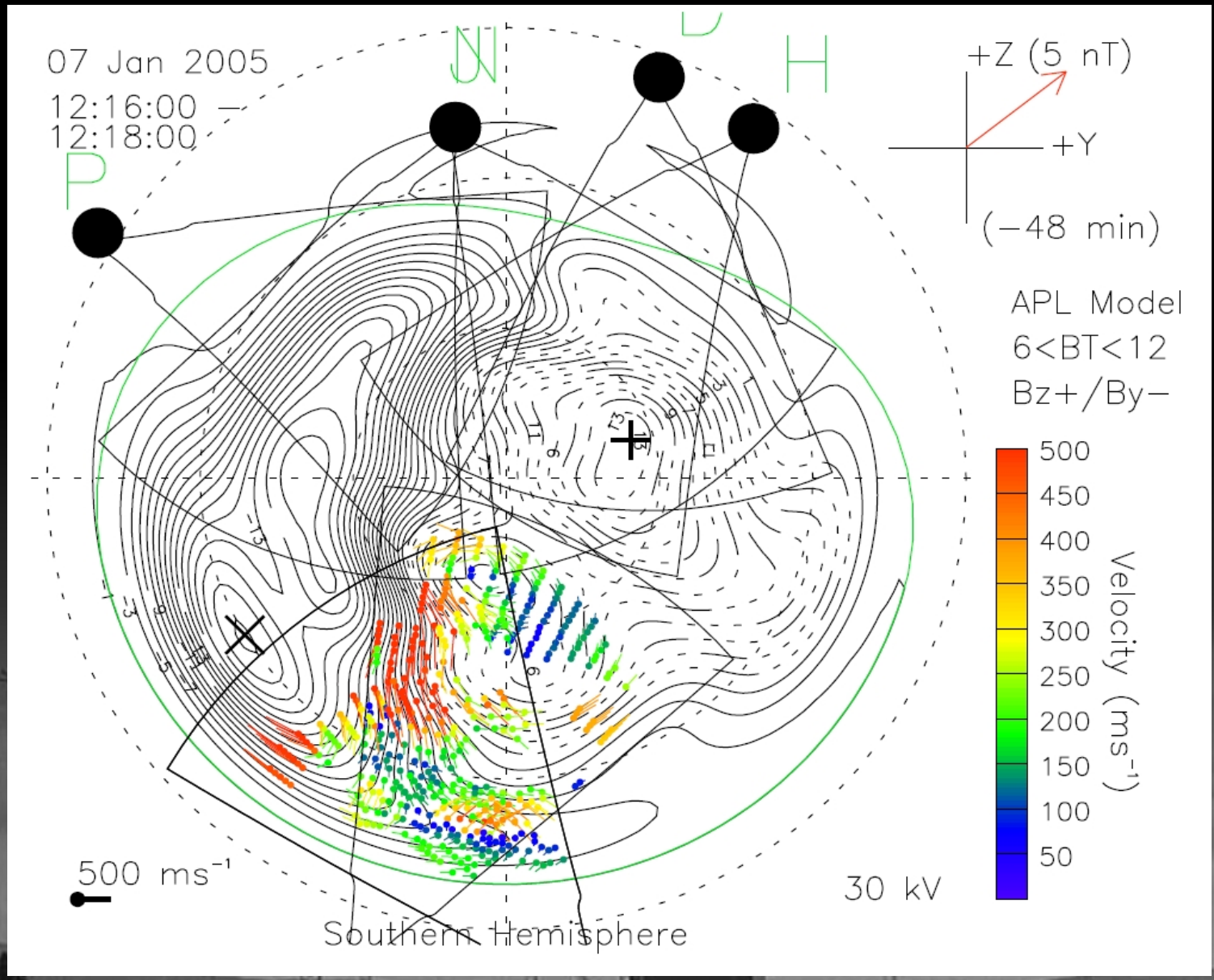


Auroral Eastward Flow Channel

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



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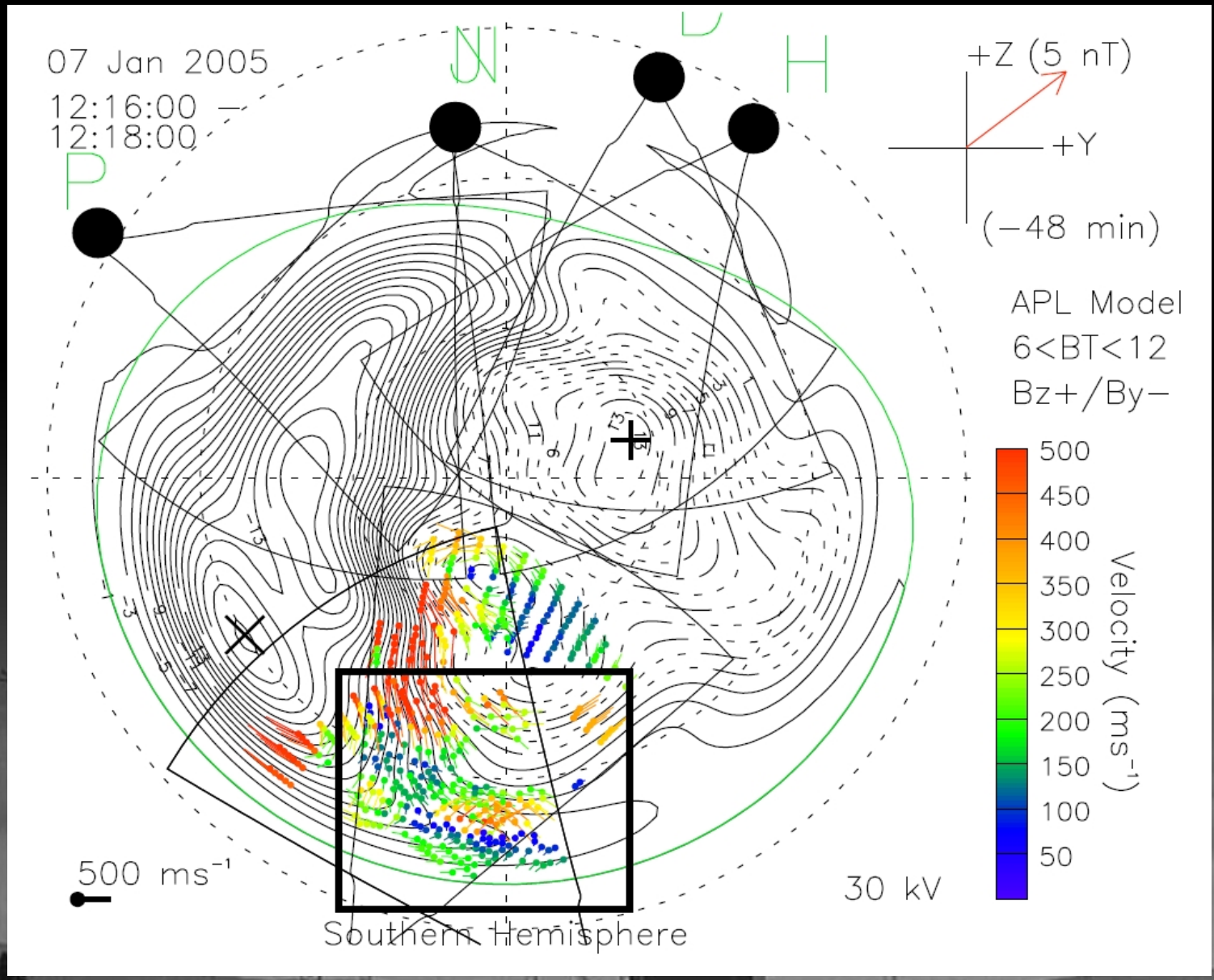

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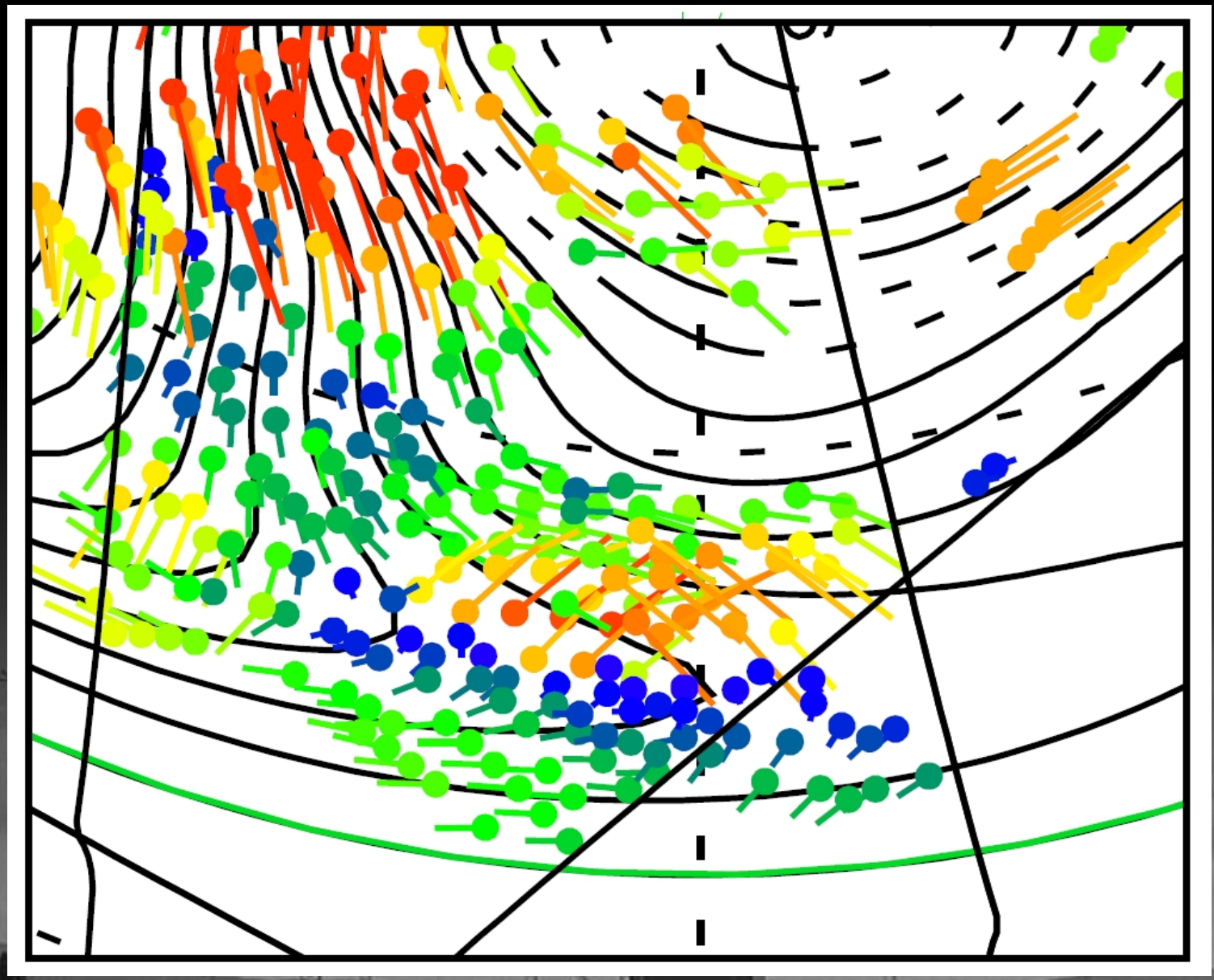

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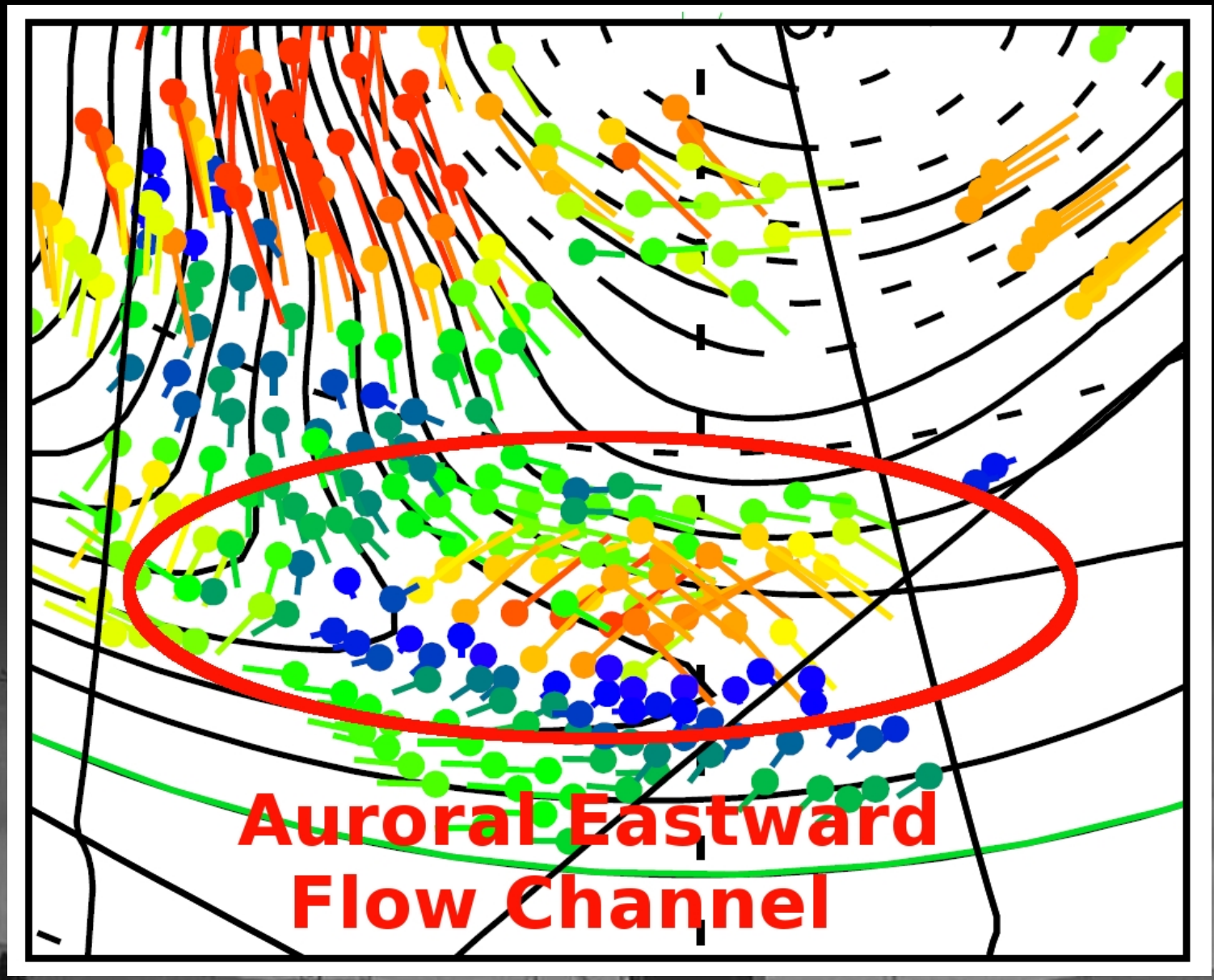

Overview

- 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