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Leicester

Radio and Space Plasma Physics Group

**Cluster and SuperDARN observations
of flux transfer events from the
Cluster 10,000 km seasons**

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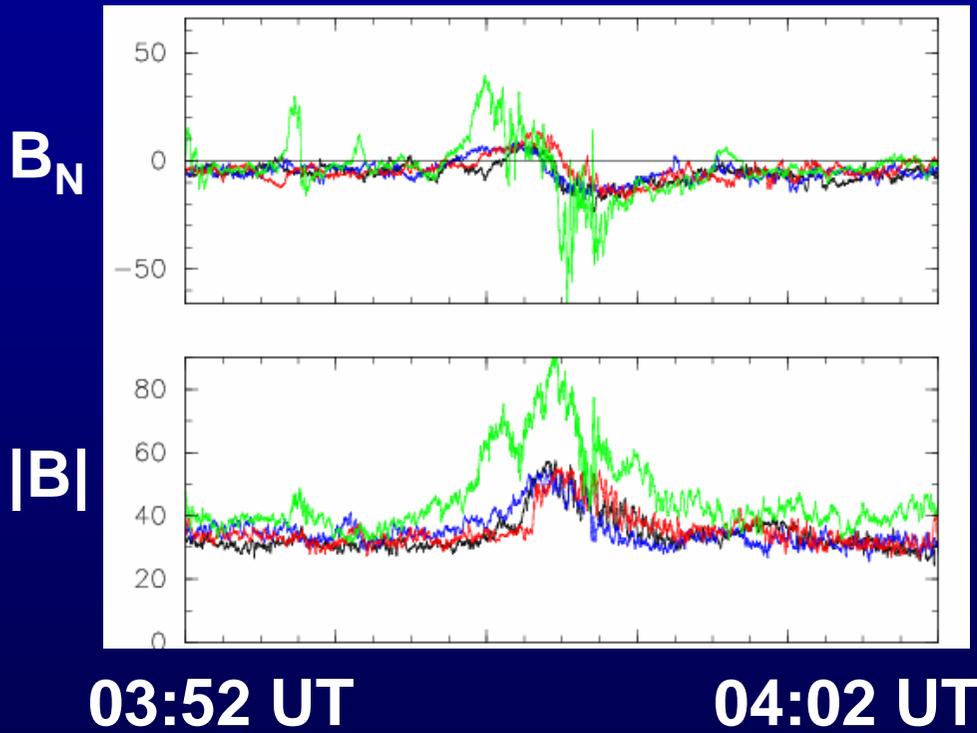
Overview

- Motivation
- Case studies
 - 27th January 2006
 - 27th March 2007
- Summary and Conclusions

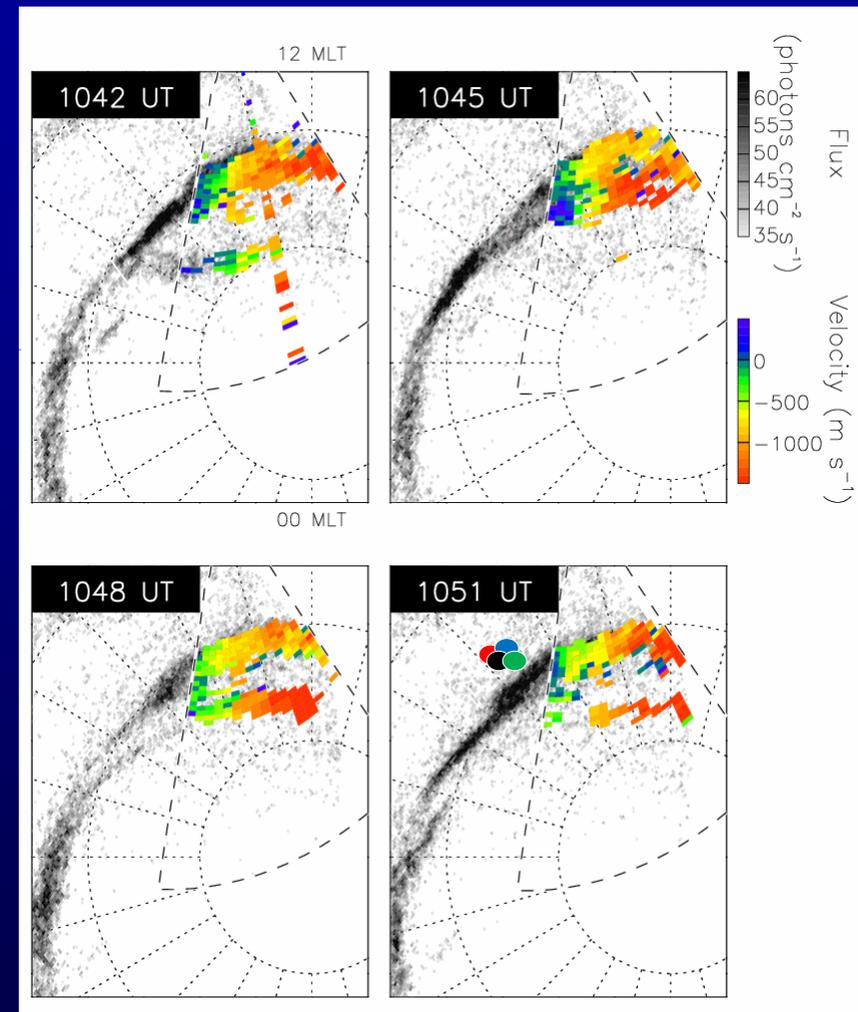


Motivation

Small scale



e.g. Fear et al. (2007)



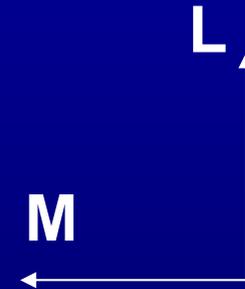
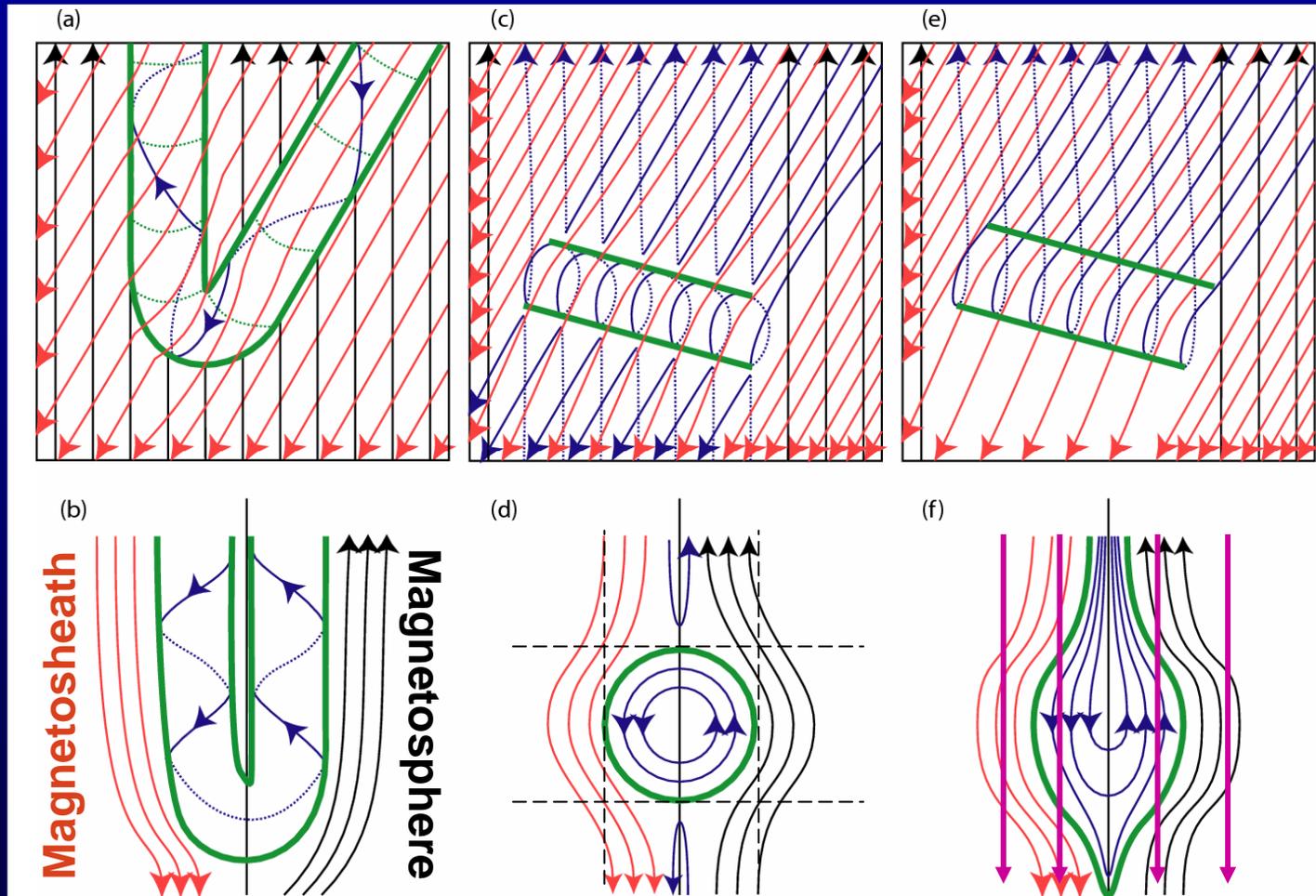
Large scale

after Milan et al. (2000)



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Motivation



After Russell & Elphic
(1978)

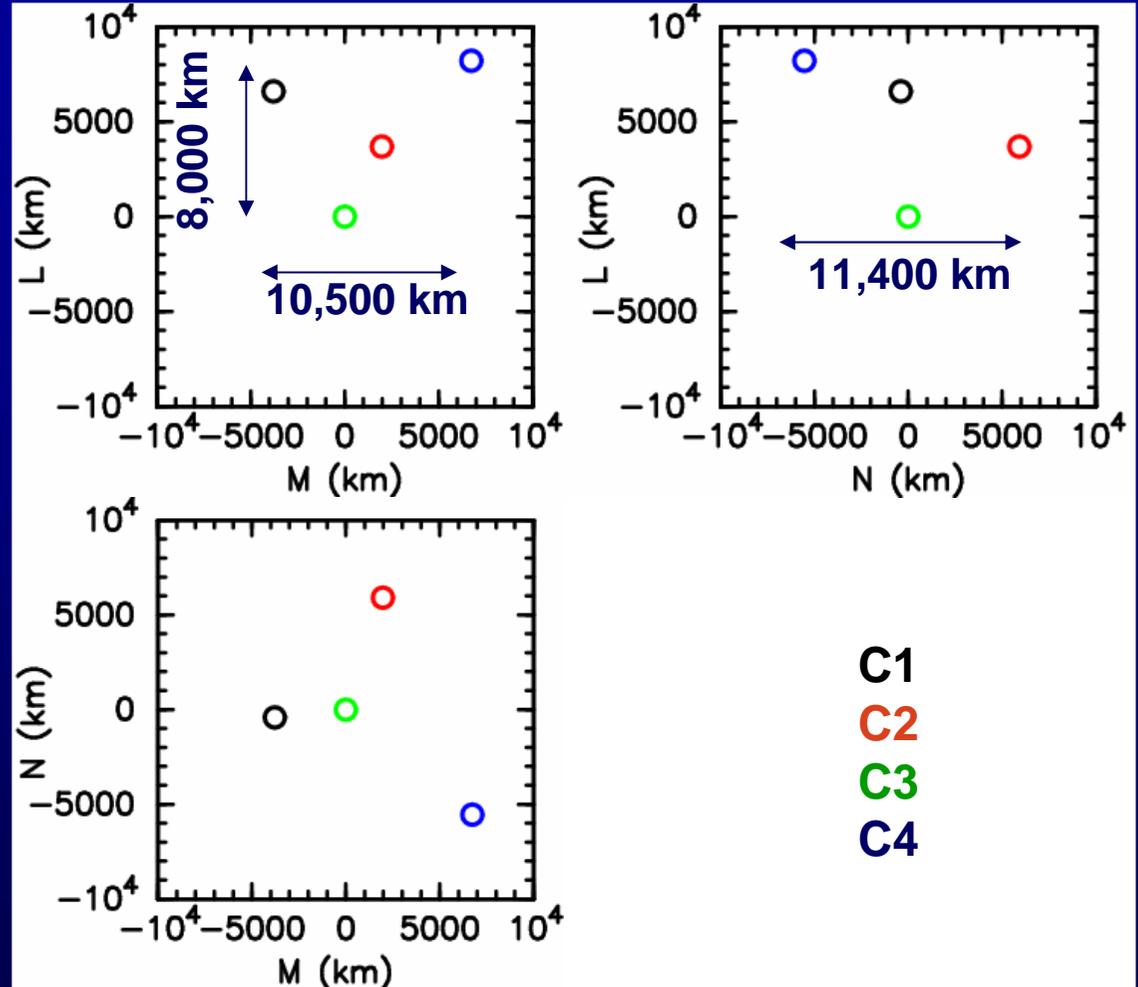
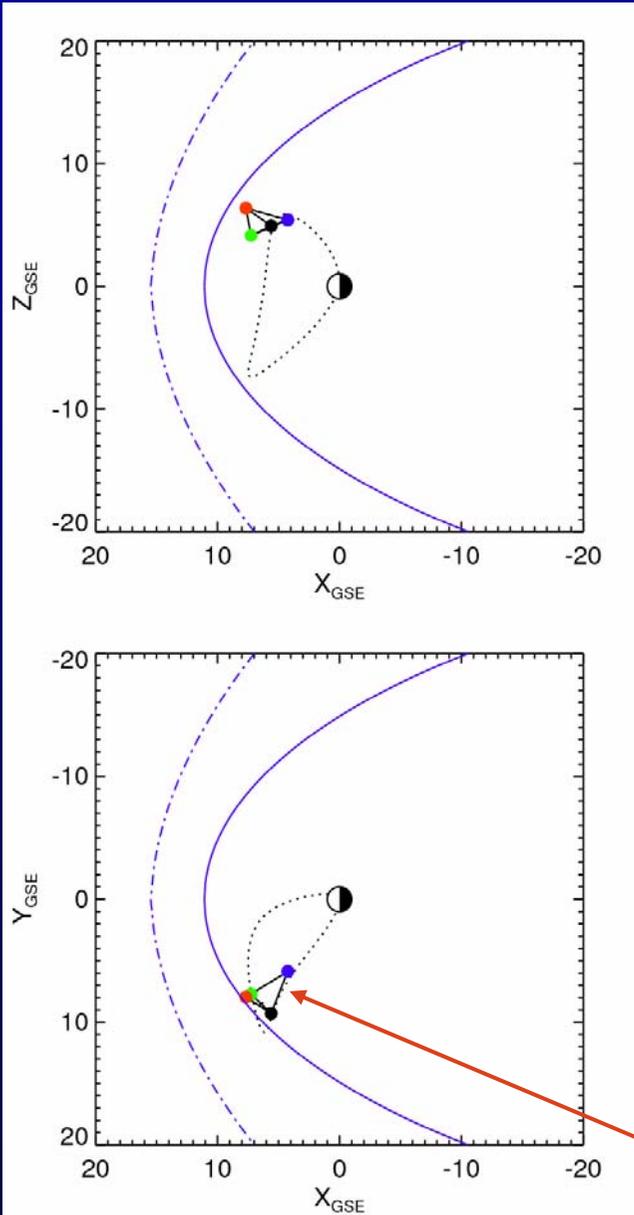
After Lee & Fu
(1985)

After Southwood et al
(1988)/Scholer (1988)



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27th January 2006



27th January 2006 19:30 UT

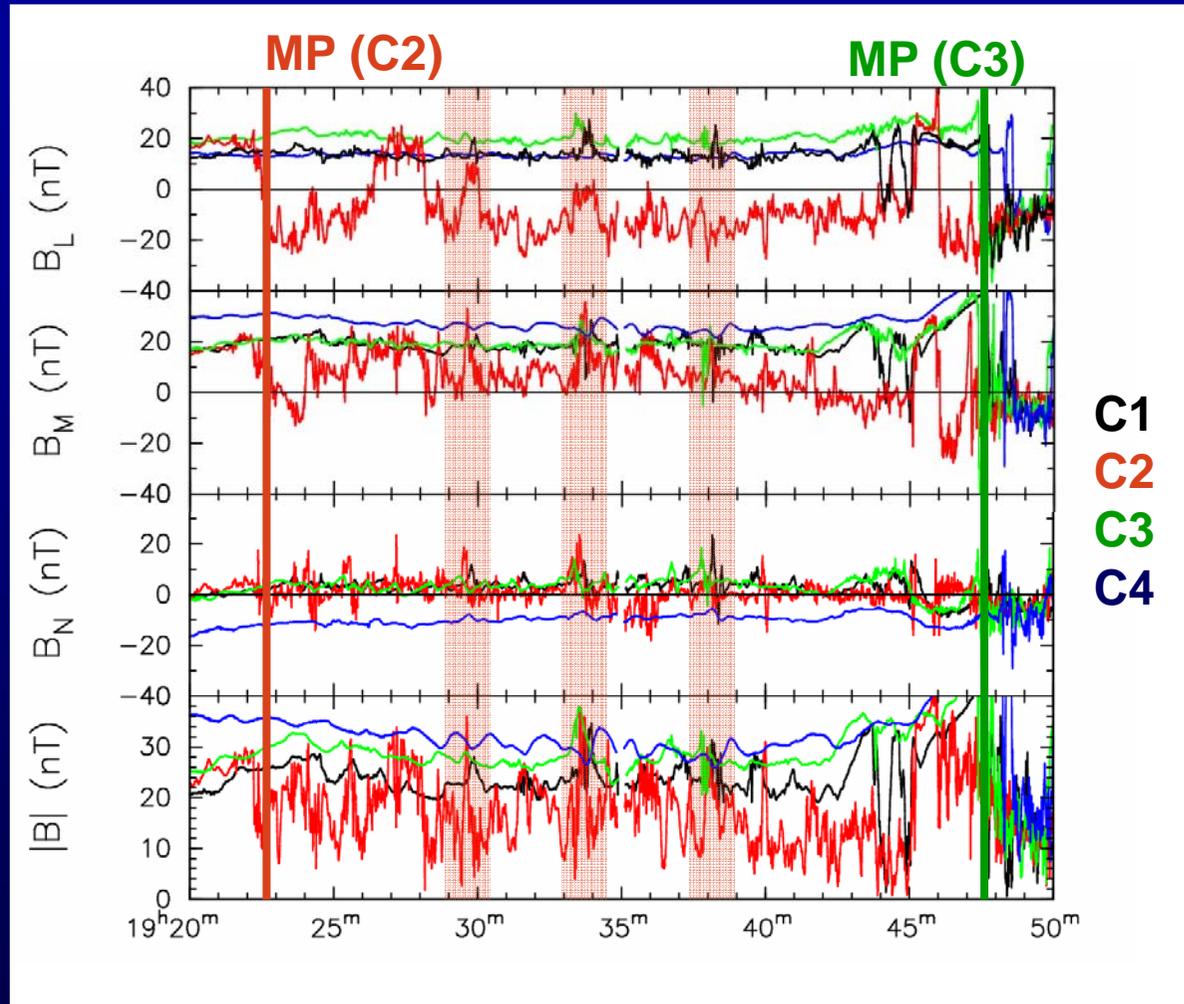
Tetrahedron expanded x2



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FTE signatures

- Several bipolar signatures are observed in B_N component
- These are 'standard' polarity (+/-) indicating northward motion
- Three FTEs are observed by all four spacecraft, although the C4 signatures are weak
- C2 observed magnetosheath FTE plasma signatures
- C1&3 observed magnetospheric FTE plasma signatures
- C4 observed no plasma signatures – draping only

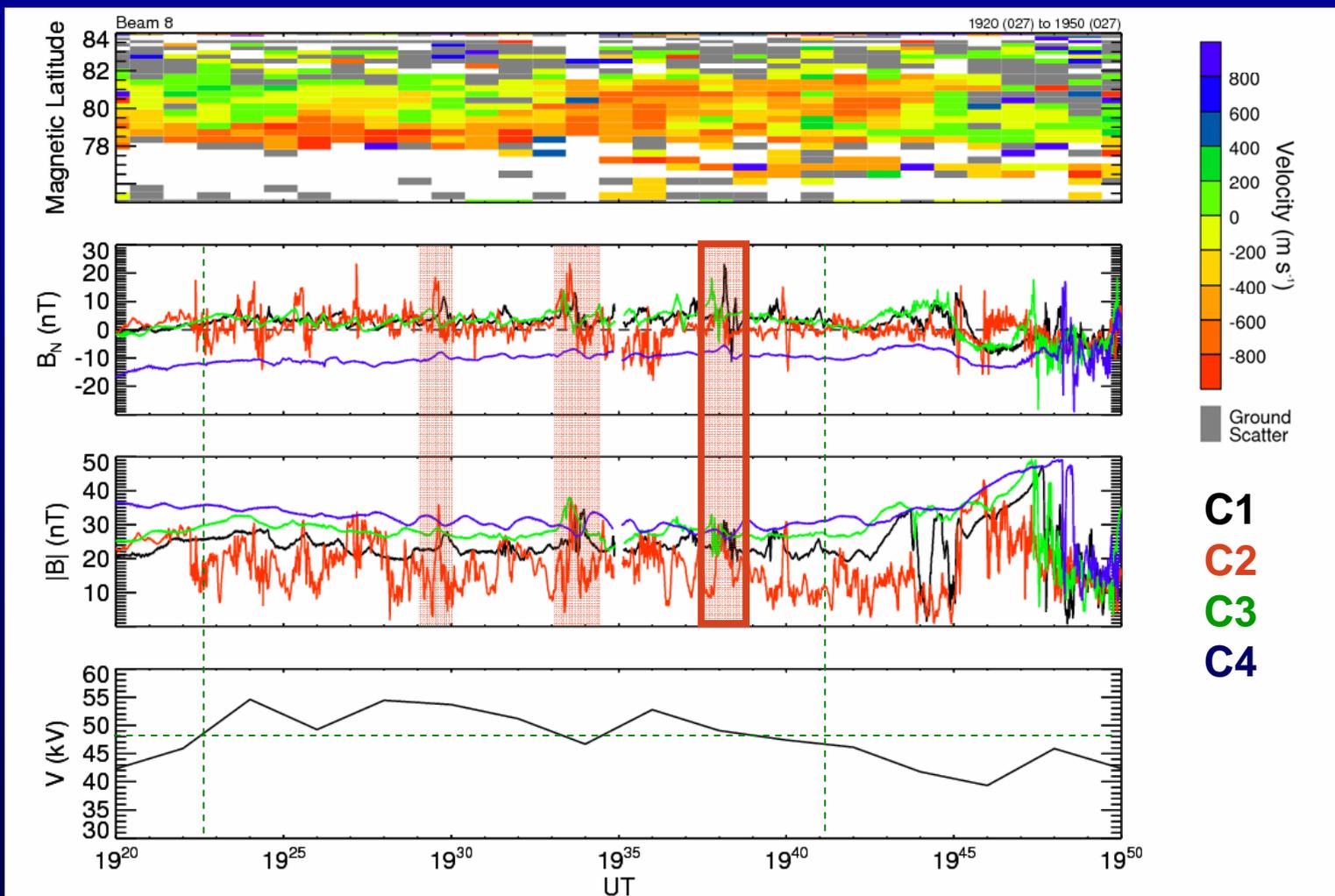


Fear et al., 2008a, in press



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Pulsed ionospheric flows

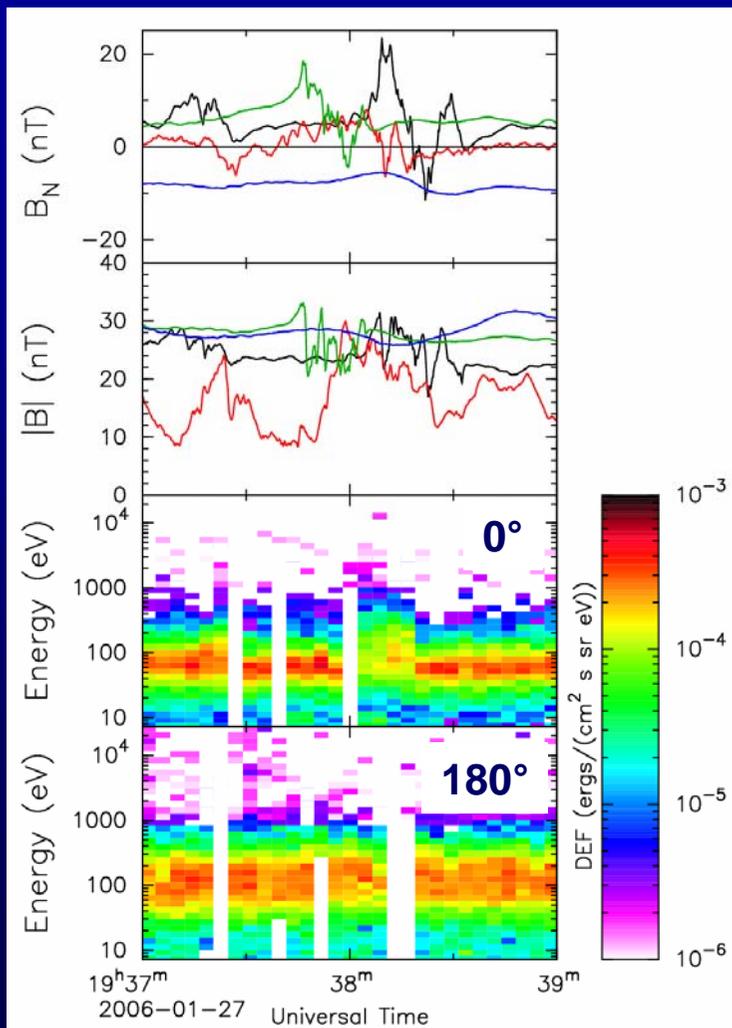


- Kodiak observed pulsed ionospheric flows (PIFs) in the convection throat at earlier local times



FTE Velocity

Fear et al., 2008a, in press



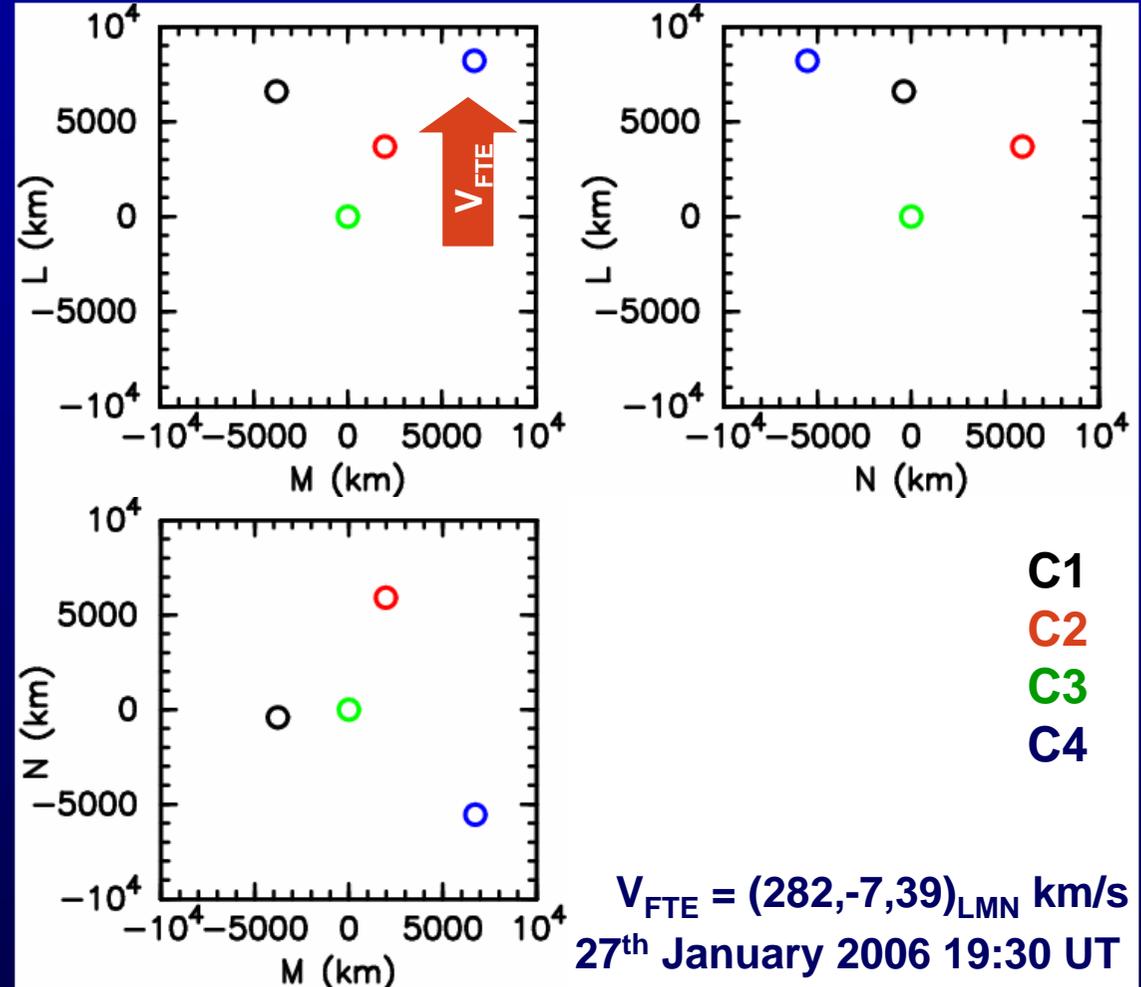
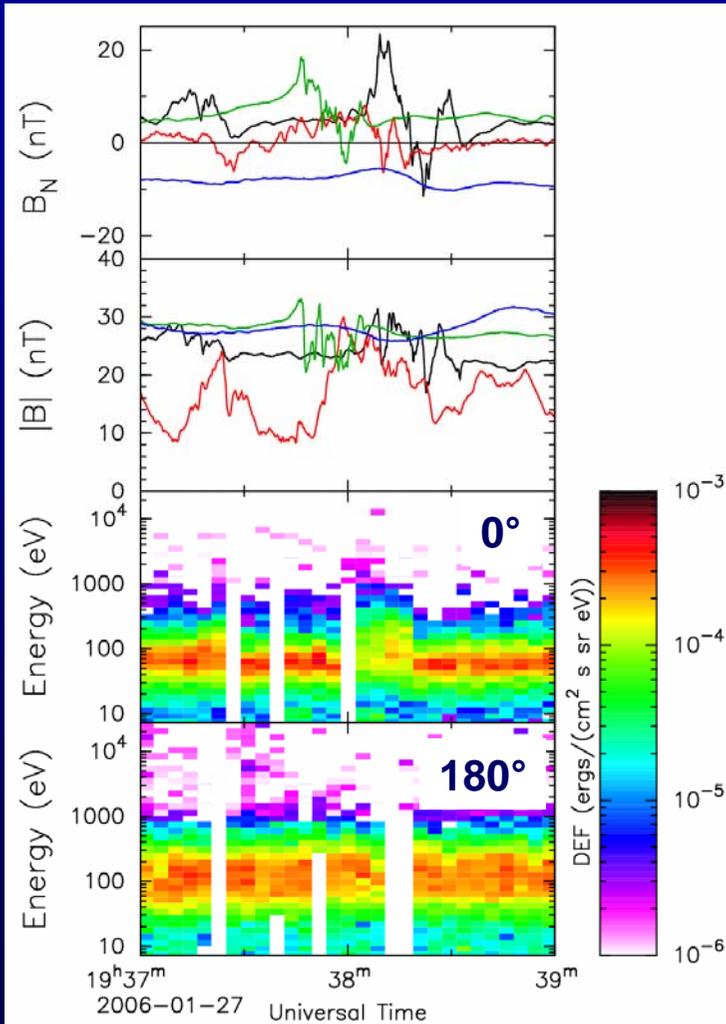
- Cluster 2 PEACE data shows that the FTE is connected to the southern hemisphere, despite being observed in the northern hemisphere



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FTE Velocity

Fear et al., 2008a, in press

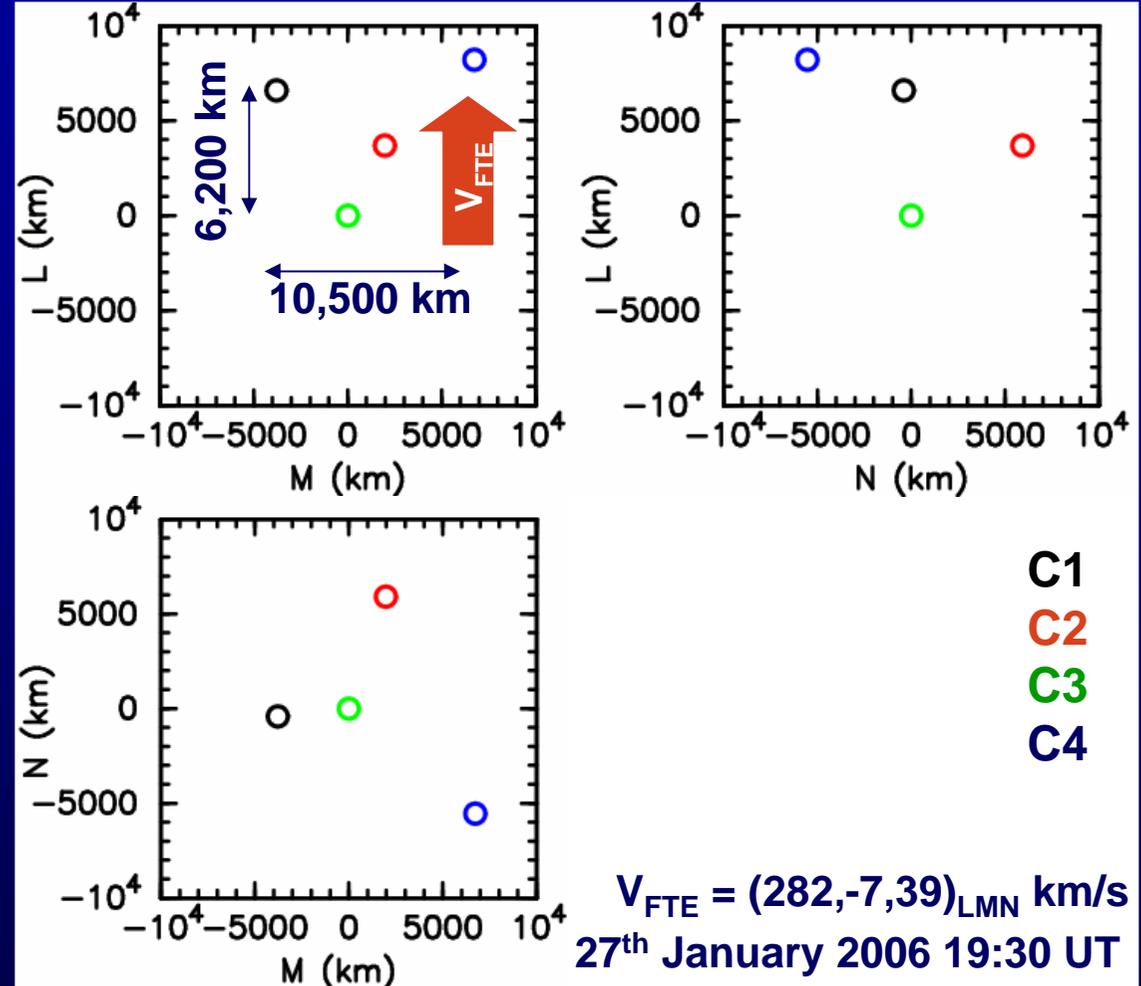
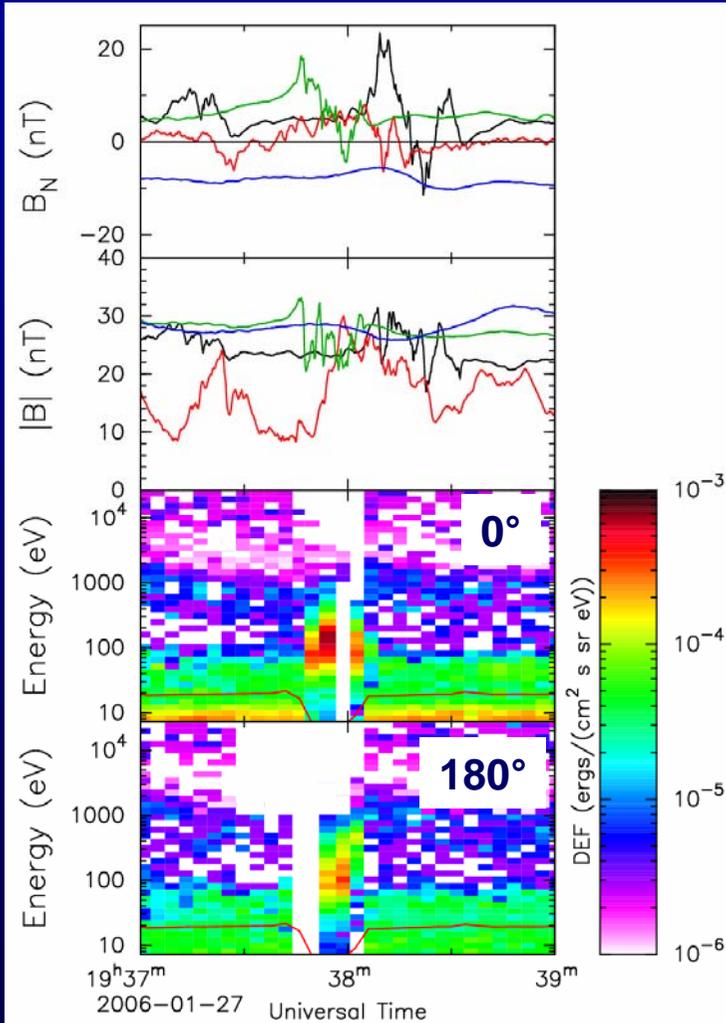


- Multi-spacecraft timing gives us a velocity predominantly poleward



FTE Velocity

Fear et al., 2008a, in press

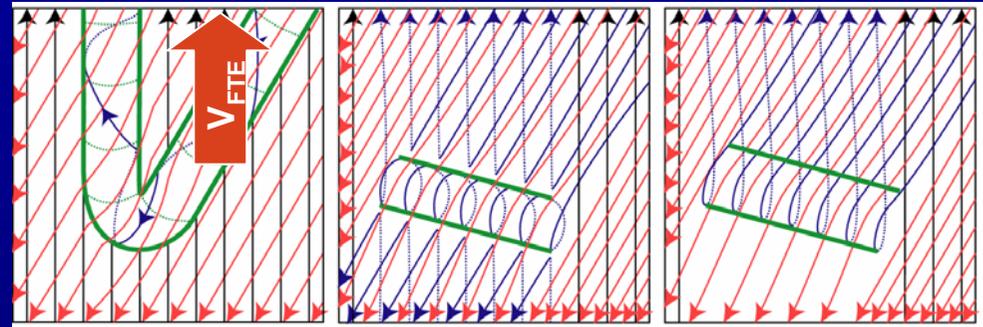


- Multi-spacecraft timing gives us a velocity predominantly poleward
- Duration of electron signature at Cluster 3 gives us poleward scale
- This structure extends further azimuthally than poleward



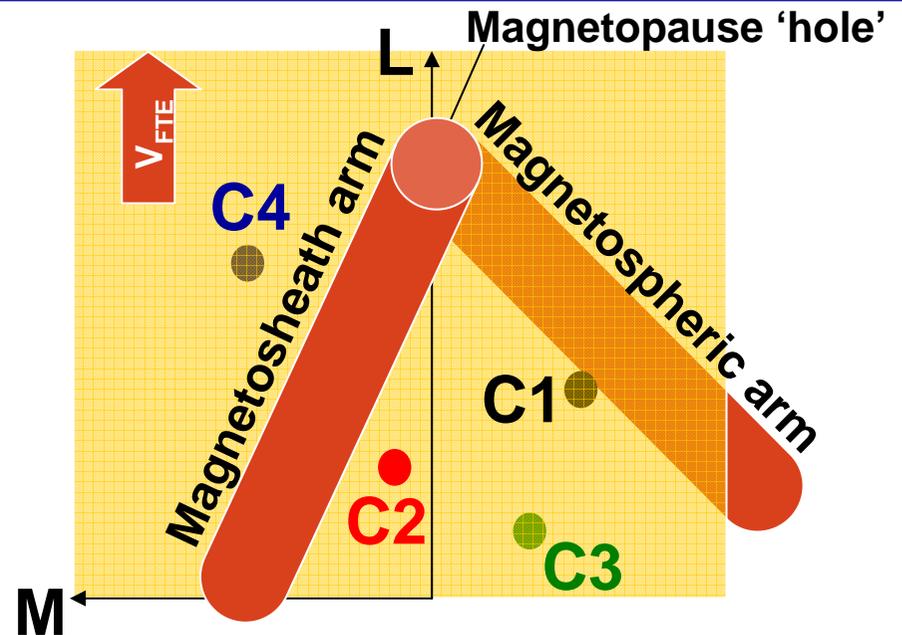
FTE shape: model comparison

- The FTE shape is suggestive of the single or multiple X-line models, rather than the elbow-shaped flux tube proposed by Russell & Elphic



FTE shape: model comparison

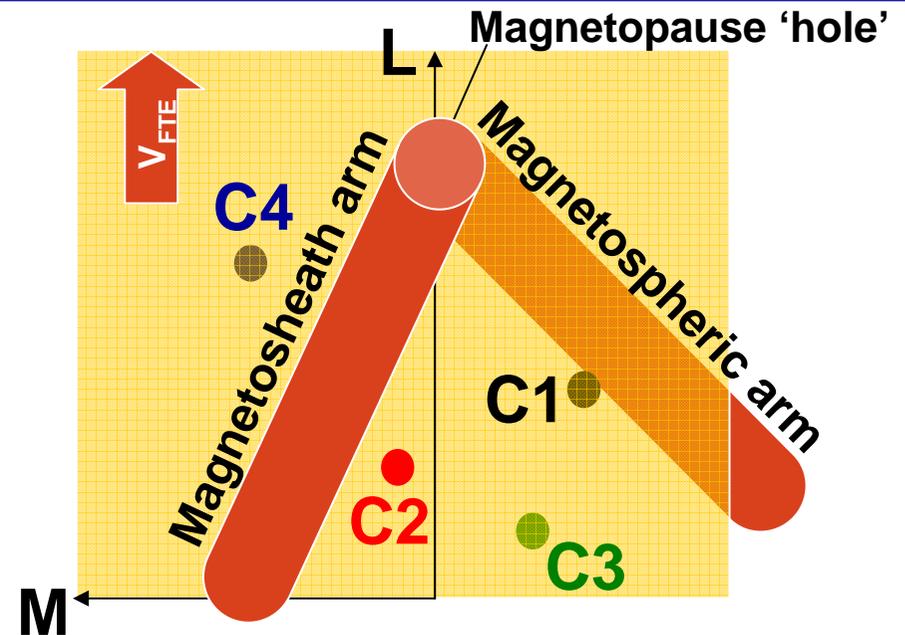
- The FTE shape is suggestive of the single or multiple X-line models, rather than the elbow-shaped flux tube proposed by Russell & Elphic
- Furthermore, since there is a B_M field component both sides of the magnetopause, a Russell & Elphic flux tube would form a 'V'
 - The location of Cluster 4 is not consistent with observing the magnetospheric 'arm'



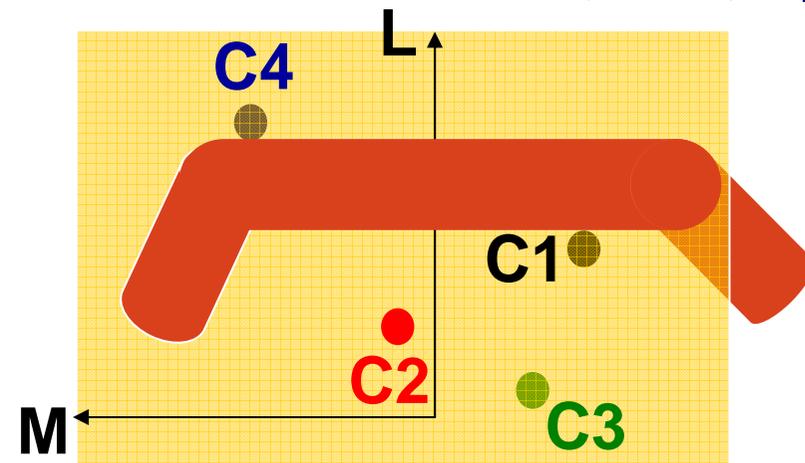
Fear et al., 2008a, in press

FTE shape: model comparison

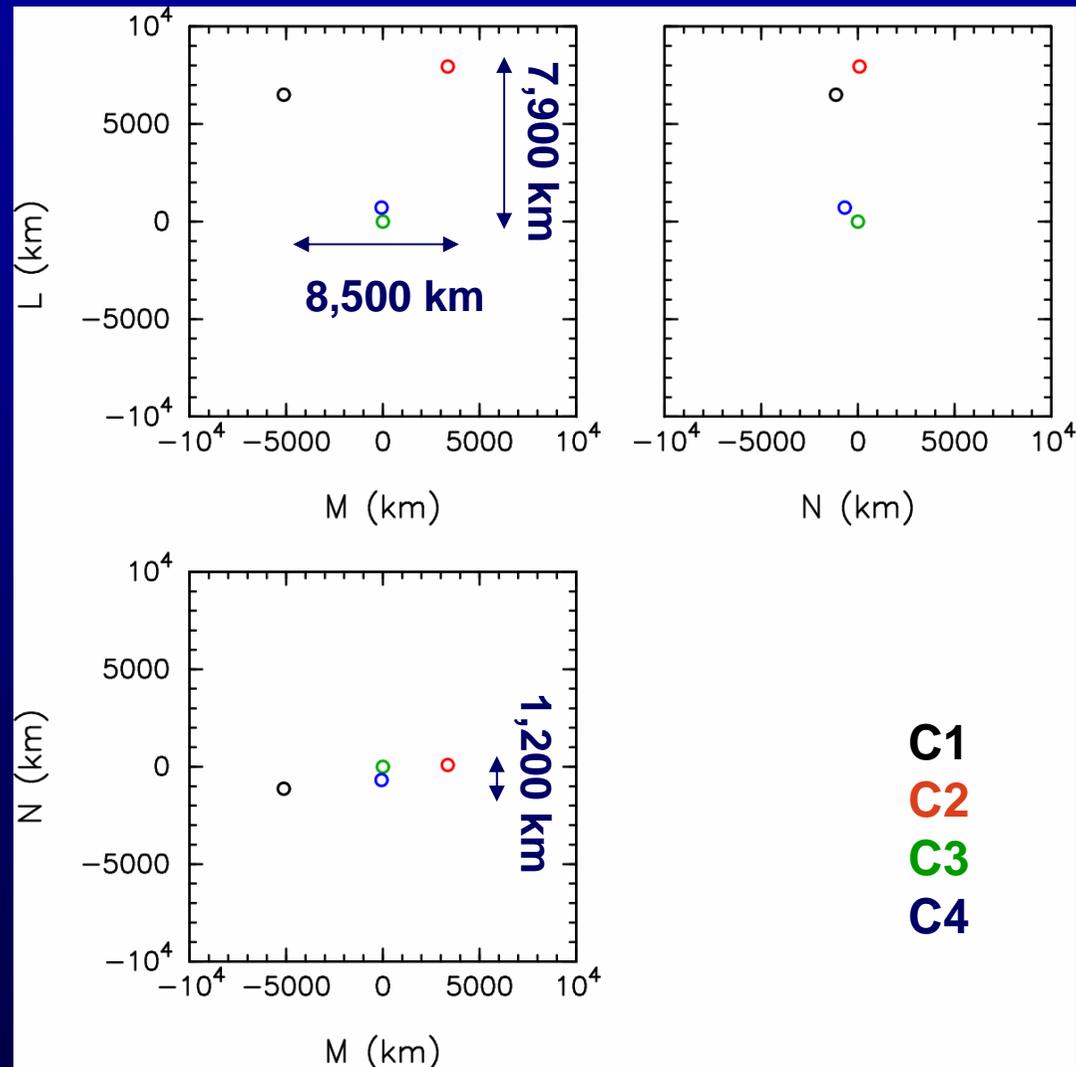
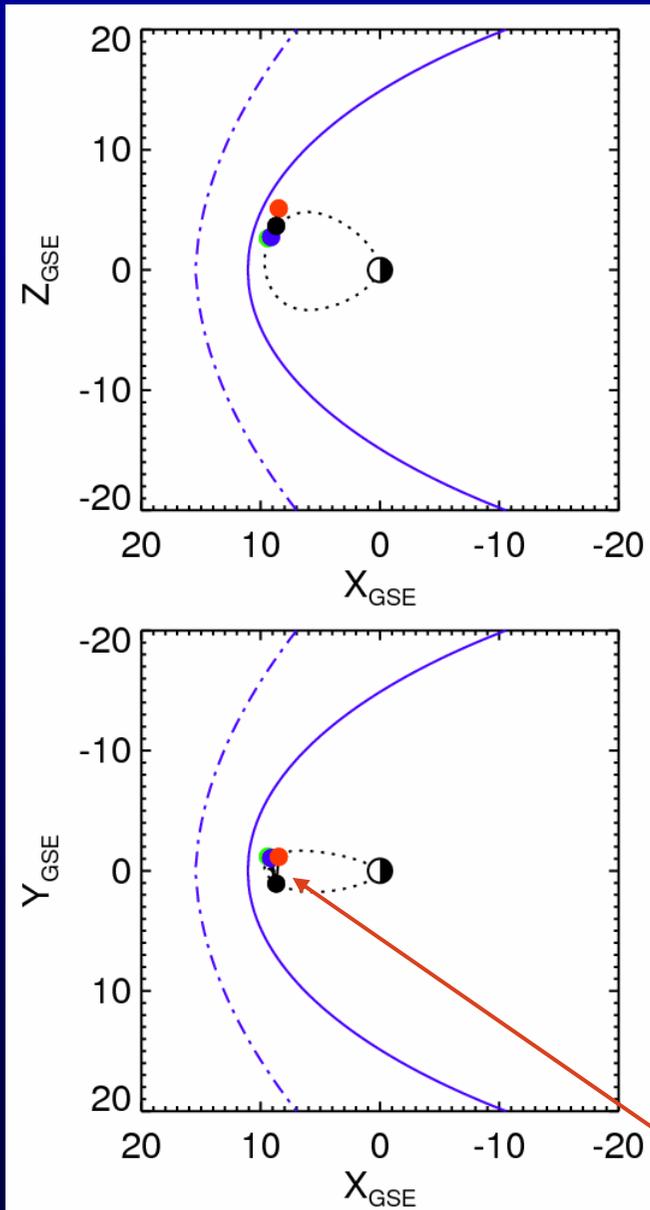
- The FTE shape is suggestive of the single or multiple X-line models, rather than the elbow-shaped flux tube proposed by Russell & Elphic
- Furthermore, since there is a B_M field component both sides of the magnetopause, a Russell & Elphic flux tube would form a 'V'
 - The location of Cluster 4 is not consistent with observing the magnetospheric 'arm'
- However, the Russell & Elphic model could still apply if the flux tube relaxed into a 'U'.
- To investigate this further, we need an event with no azimuthal field either side of the magnetopause, near local noon



Fear et al., 2008a, in press



27th March 2007

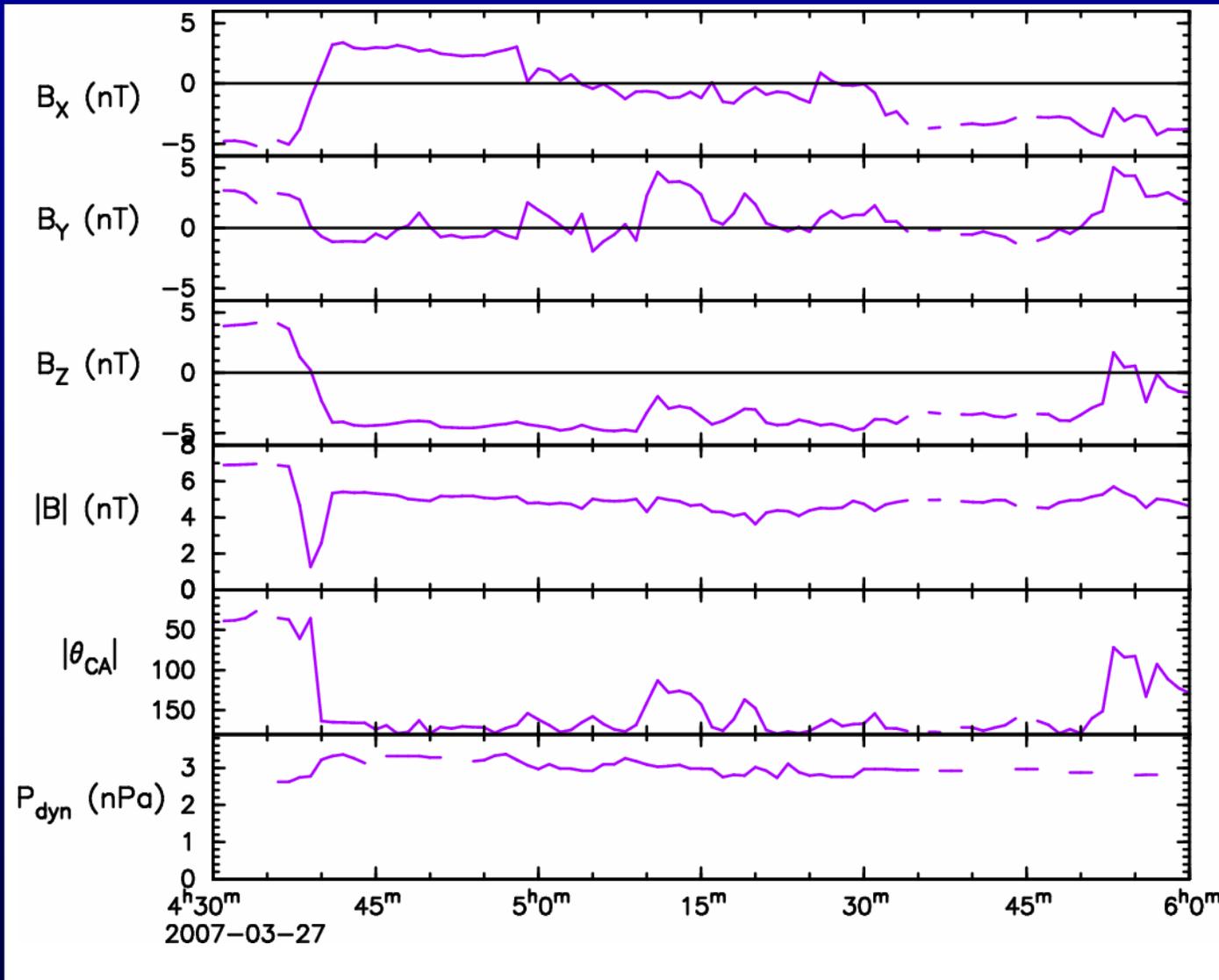


Tetrahedron expanded x2

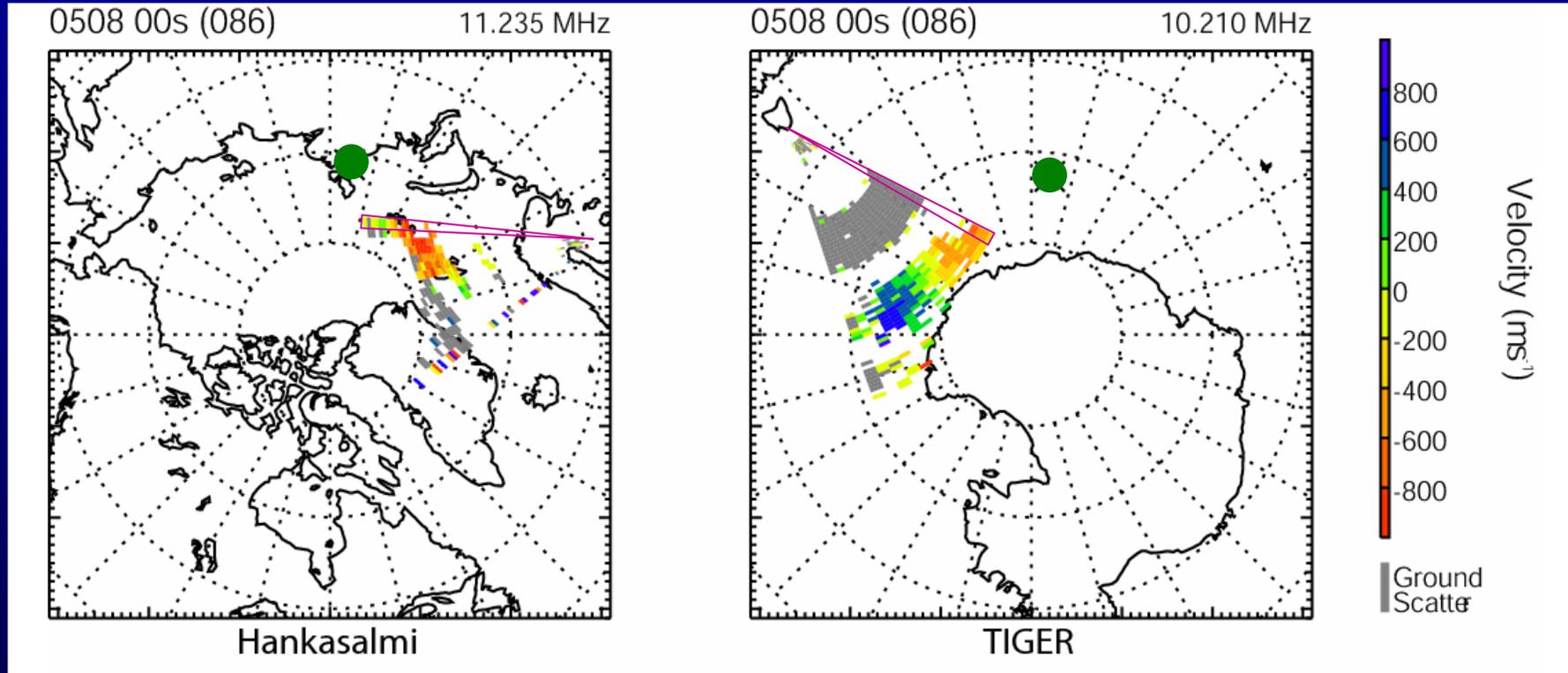


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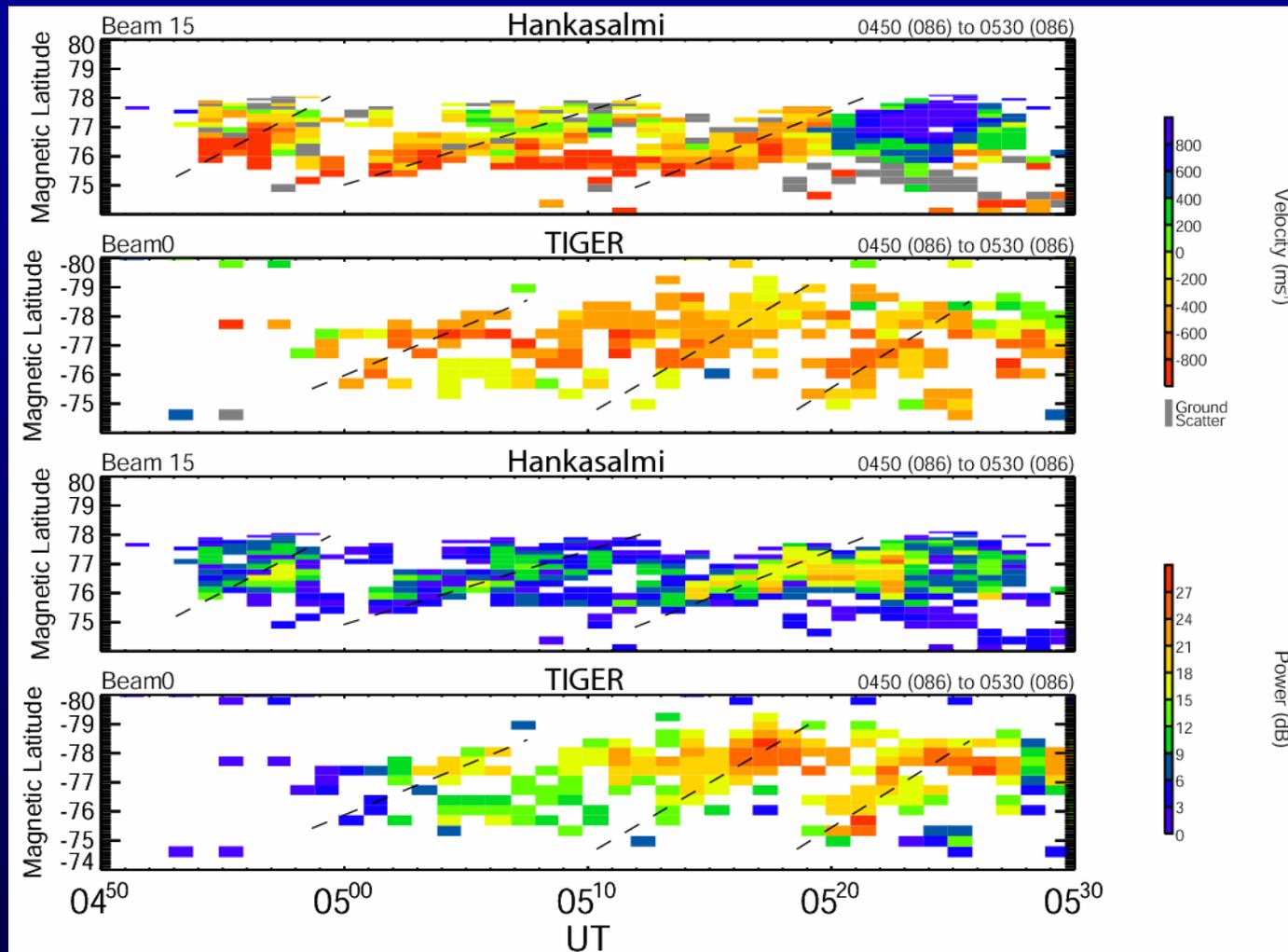
Solar wind conditions



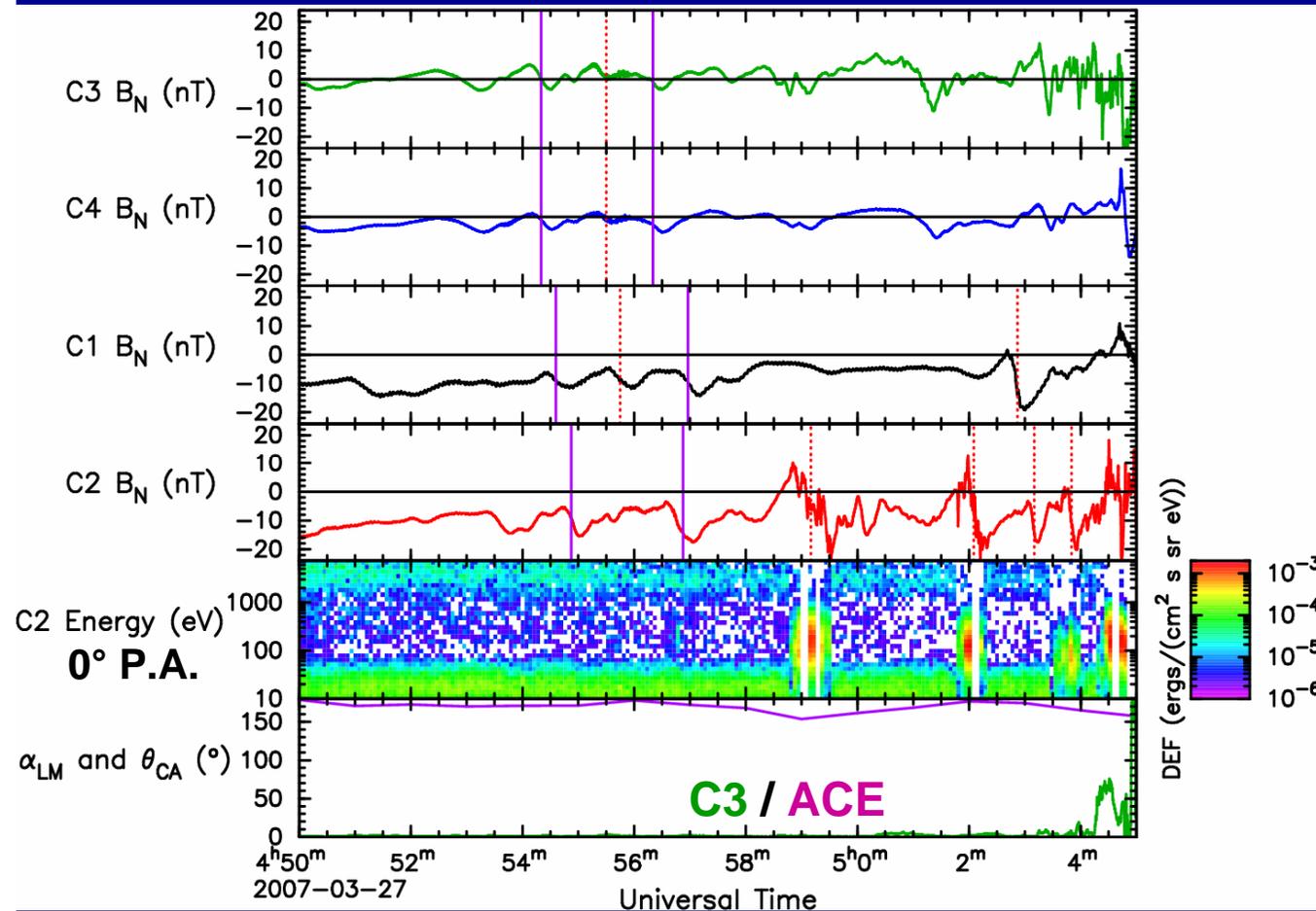
Strong poleward flows



Poleward Moving Radar Auroral Forms



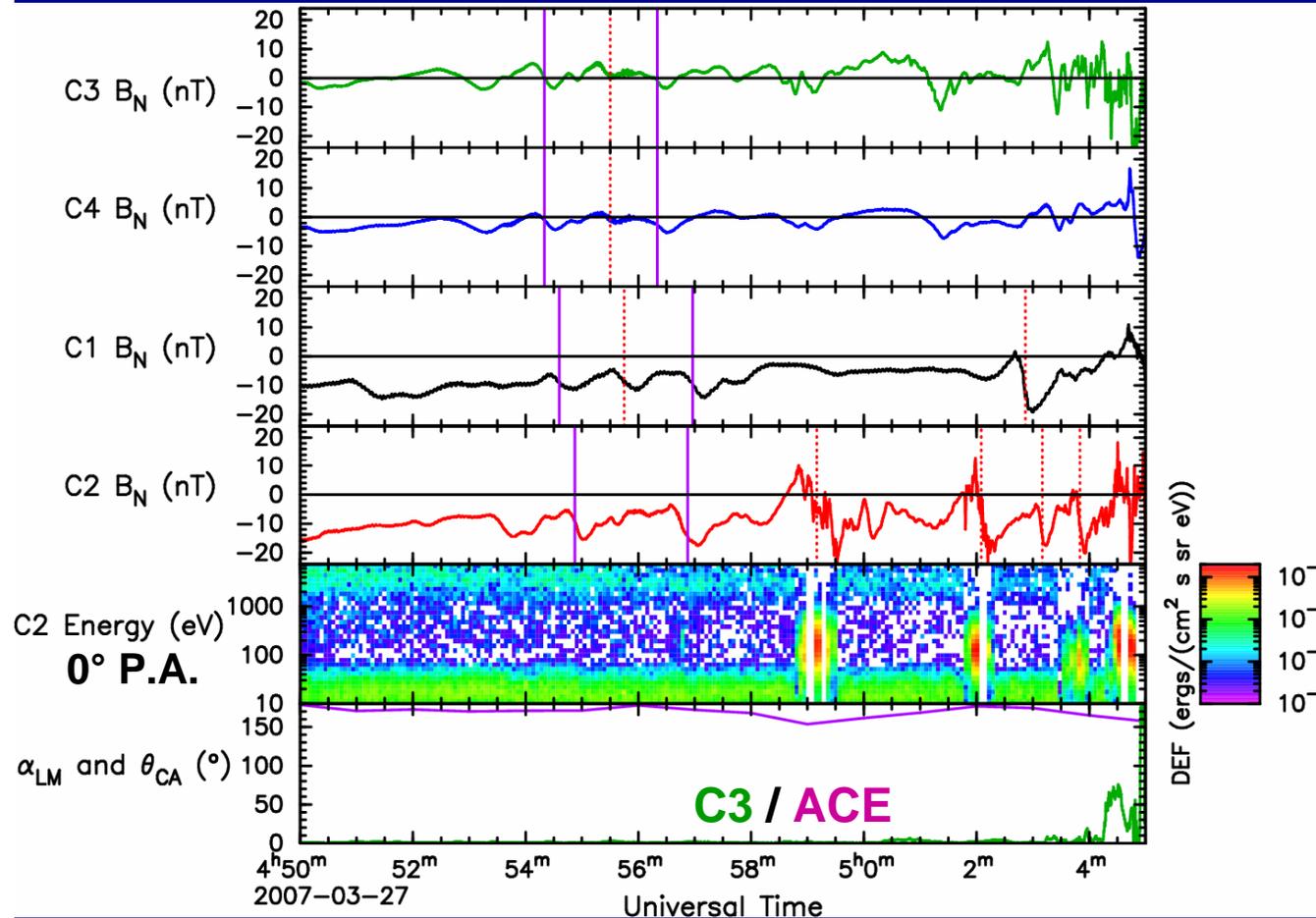
Magnetospheric FTEs



- Use “characteristic time” (peak-to-peak of B_N)
- 0454 UT:
 - 257 km s⁻¹
 - (0.932, 0.363)_{LM}
 - 26s duration (C1)
 - 6700 km
- 0456 UT:
 - 197 km s⁻¹
 - (0.959, -0.285)_{LM}
 - 29s duration (C2)
 - 5700 km
- Any FTE observed by all four spacecraft must extend azimuthally by 8,500 km



Magnetospheric FTEs



- Also significant differences between C1 and C2
- Most azimuthally separated spacecraft
- C2 nearer MP than C1, but normal separation of tetrahedron only 1200 km
- Implies some more spatially patchy FTEs



Summary and Conclusions

- SuperDARN observations show that dayside reconnection was occurring over a significant section of the magnetopause
 - Large Cluster separation allows in situ structure to be investigated
- Cluster observations from the 27th January 2006 (Fear et al., 2008a, in press) provide the first evidence that an FTEs azimuthal scale can be significantly larger than its poleward scale
 - Inconsistent with a simple interpretation of the Russell & Elphic model, it is not possible to rule out this model completely
- On the 27th March 2007, (Fear et al. 2008b, in preparation) the cross-magnetopause shear was much closer to 180°, allowing this ambiguity to be removed
 - 2 azimuthally extended FTEs
 - Several more spatially patchy FTEs

