

Flux transfer event in the subsolar region and near the cusp: Simultaneous Polar and Cluster observations

Guan Le

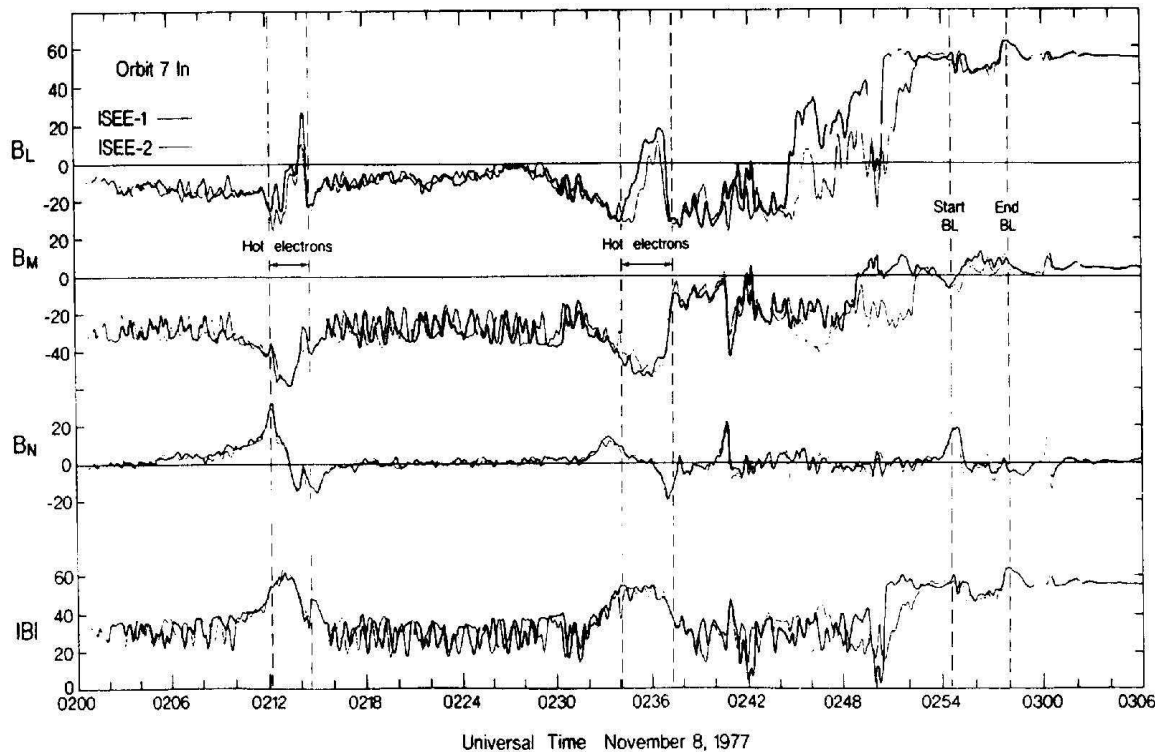
NASA Goddard Space Flight Center

In collaboration with

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F. Mozer, G. Parks, E. A. Lucek, and H. Rème

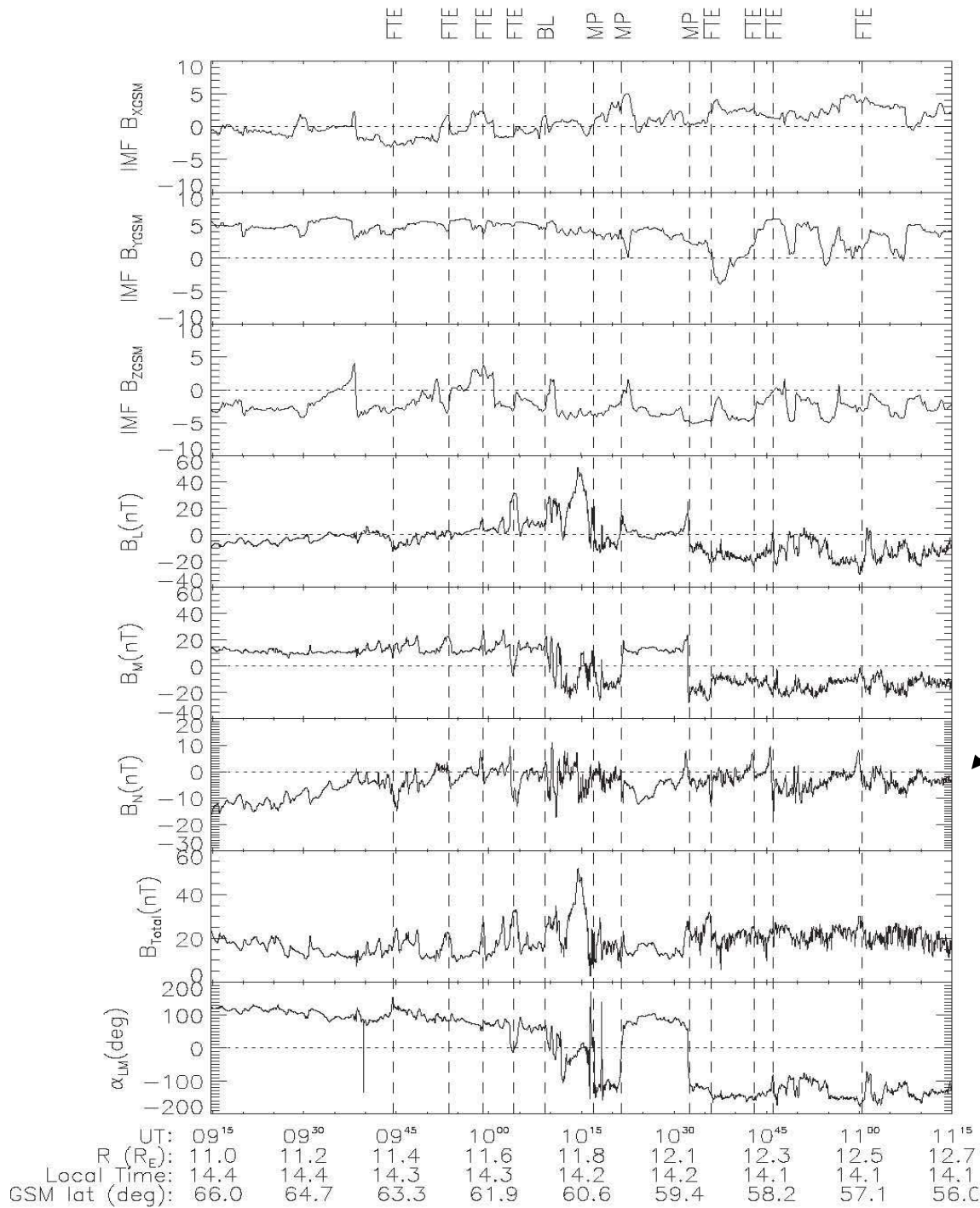
Flux Transfer Events

Russell and Elphic, 1978



- characteristic bi-polar signature in B_N
- signatures of moving flux tube
 - +/- northward
 - /+ southward
- Statistical studies of FTEs strongly suggest their association with time-varying reconnection

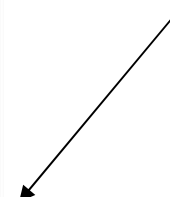
- The bi-polar magnetic signatures have been used as the working definition to identify FTEs in the data.
- It is not immediately obvious if high-latitude FTEs consistently exhibit similar signatures.



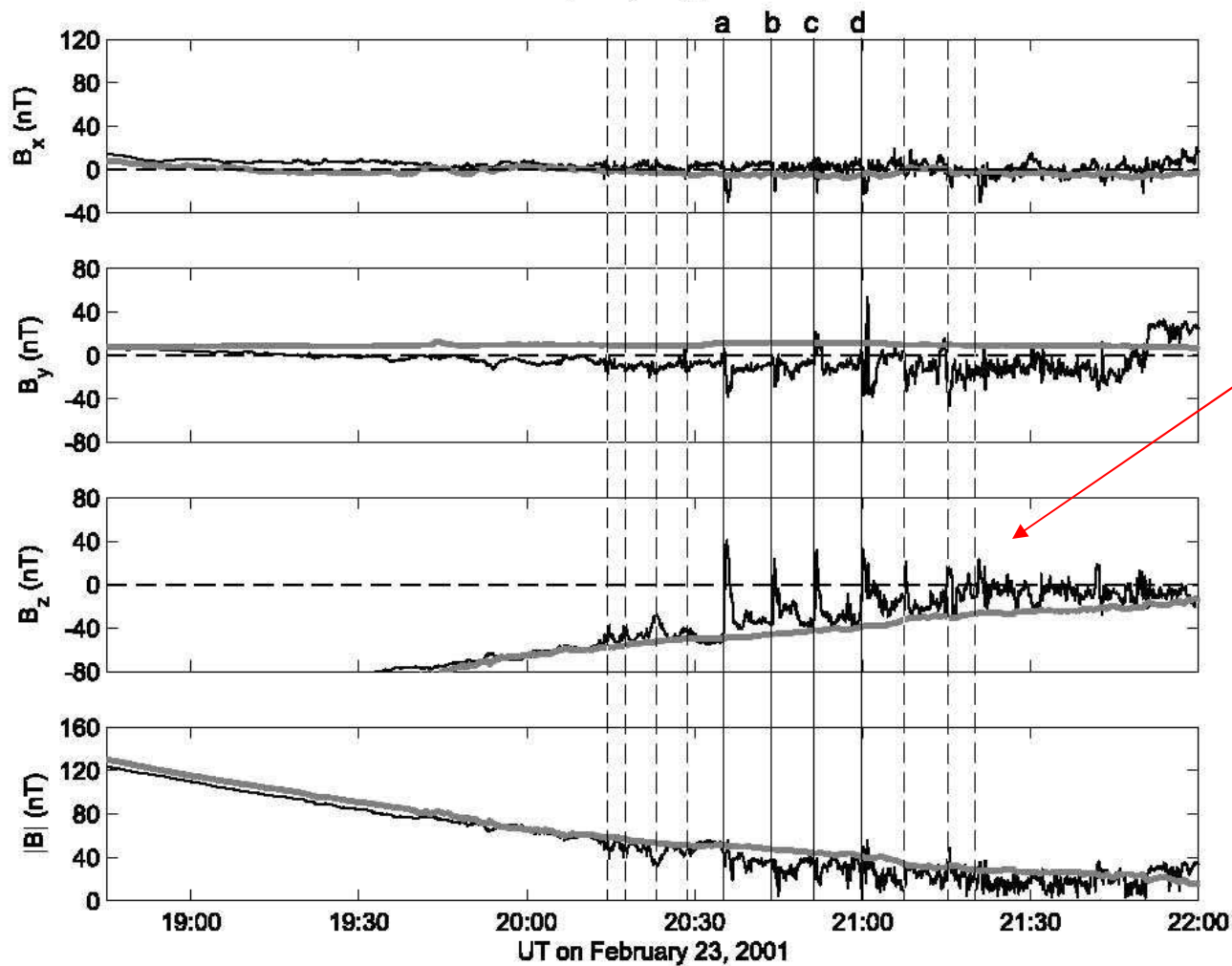
Wild et al., 2001

Cluster observations of high-latitude FTEs

Bi-polar B_N signature



Cluster-1 (GSM) Tsyganenko-1996



Thompson et al., 2004
Cluster Observed FTEs in the dayside northern lobe poleward of the cusp.

- A series of quasi-periodic reversals in GSM BZ

- The individual structures do not resemble low-latitude flux transfer events

- They proposed that the observed reversals are due to flux tubes reconnecting with closed field lines on the dayside.

X	1.03	1.79	2.54	3.27	3.99	4.69	5.36
Y	-0.53	-0.68	-0.82	-0.95	-1.05	-1.14	-1.20
Z	8.10	8.51	8.86	9.15	9.39	9.59	9.75
R	8.18	8.72	9.25	9.76	10.25	10.73	11.19

Lockwood et al., 2001

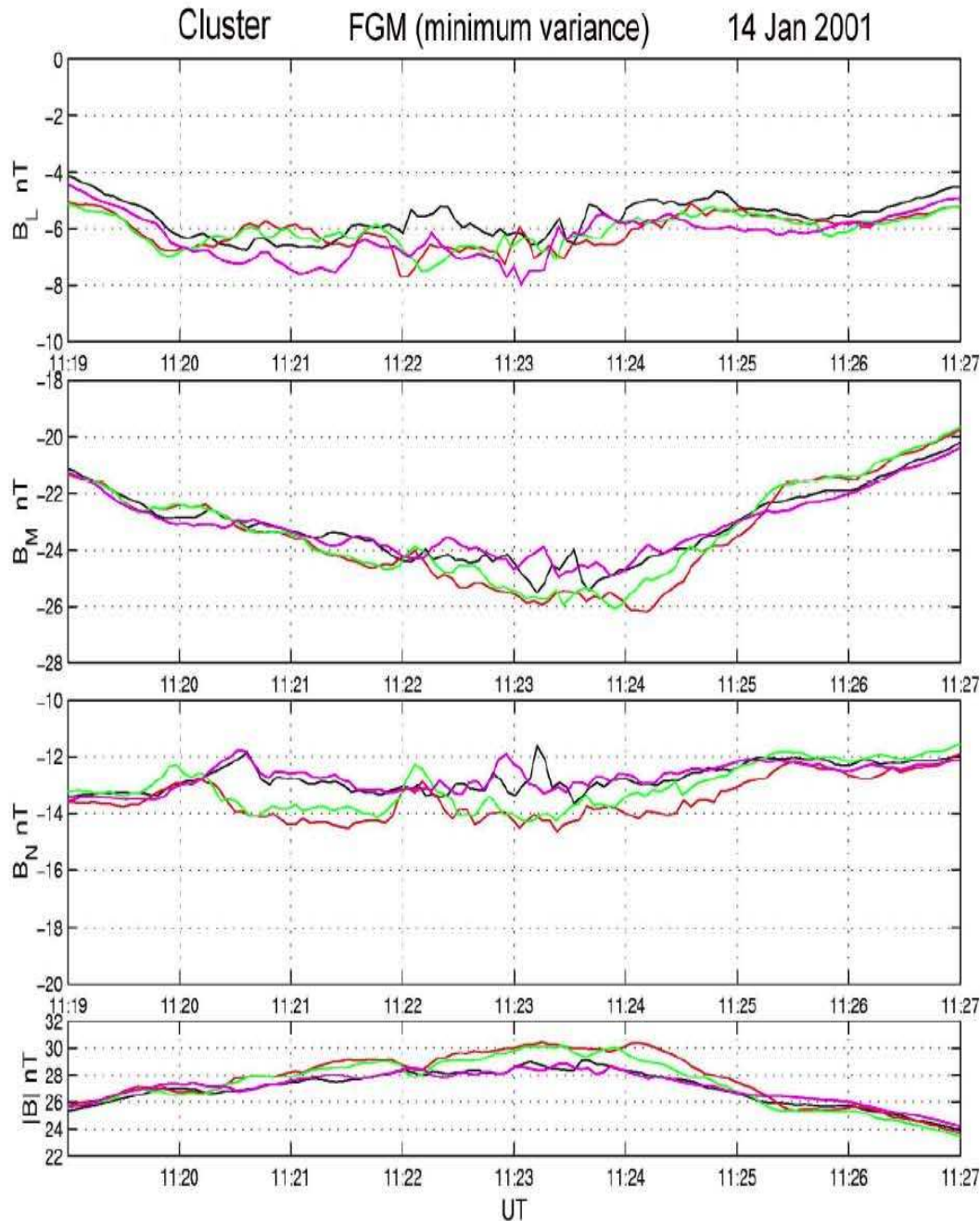
First observations of mid-latitude FTEs during close EISCAT Radar-Cluster conjunctions

The occurrence of an FTE was confirmed by ground-based observations.

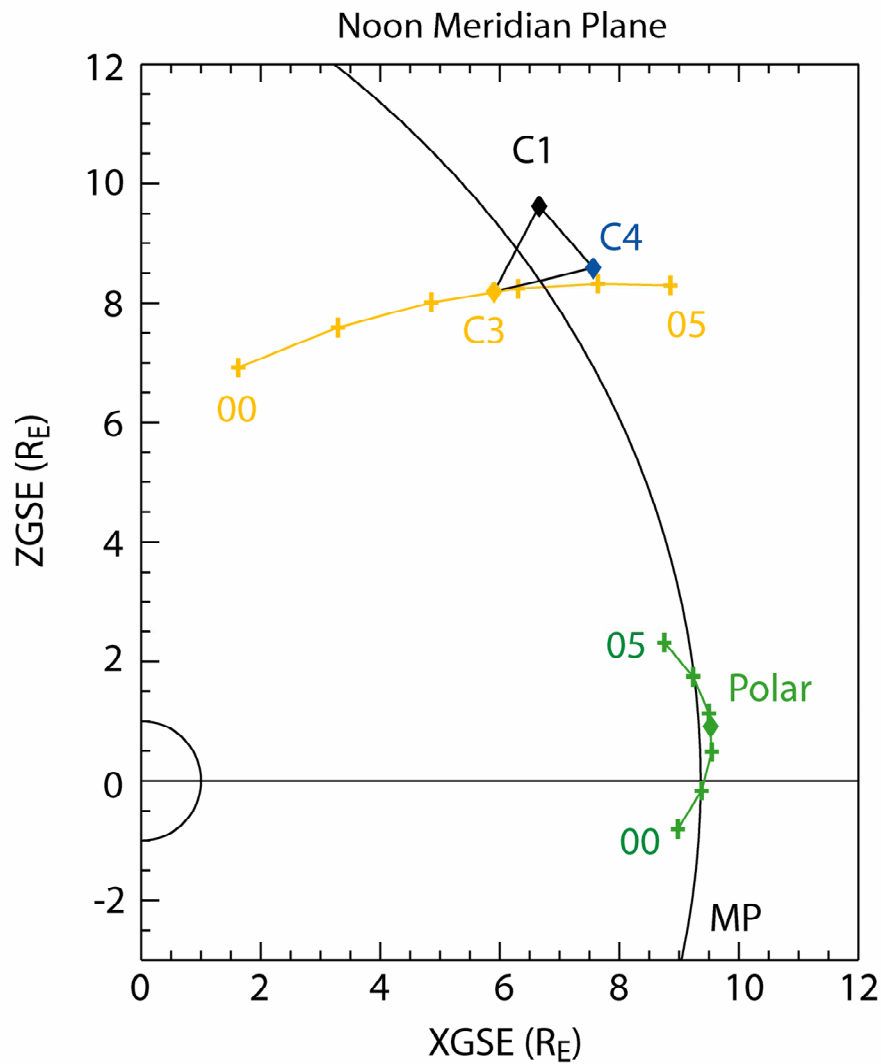
- transient erosion of (cusp/cleft) aurora to lower latitudes
- transient and traveling enhancements of the flow into the polar cap
- poleward-moving events moving into the polar cap

The coordinated in-situ observations by Cluster showed transient magnetic perturbation:

- enhanced core field
- $\sim 1 R_E$ scale size
- no bi-polar B_N signature

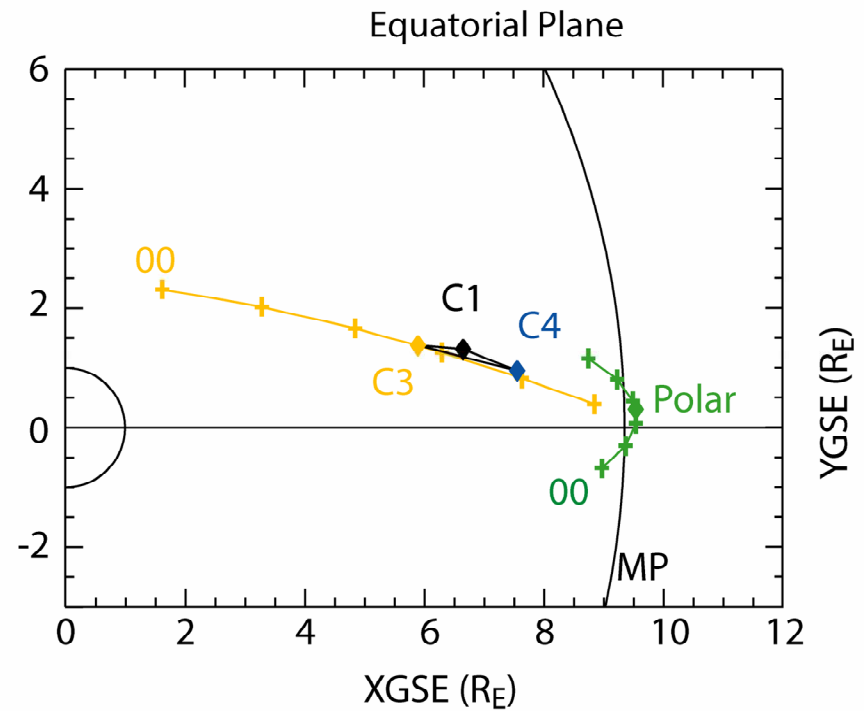


Simultaneous Observation of an FTE by Polar and Cluster

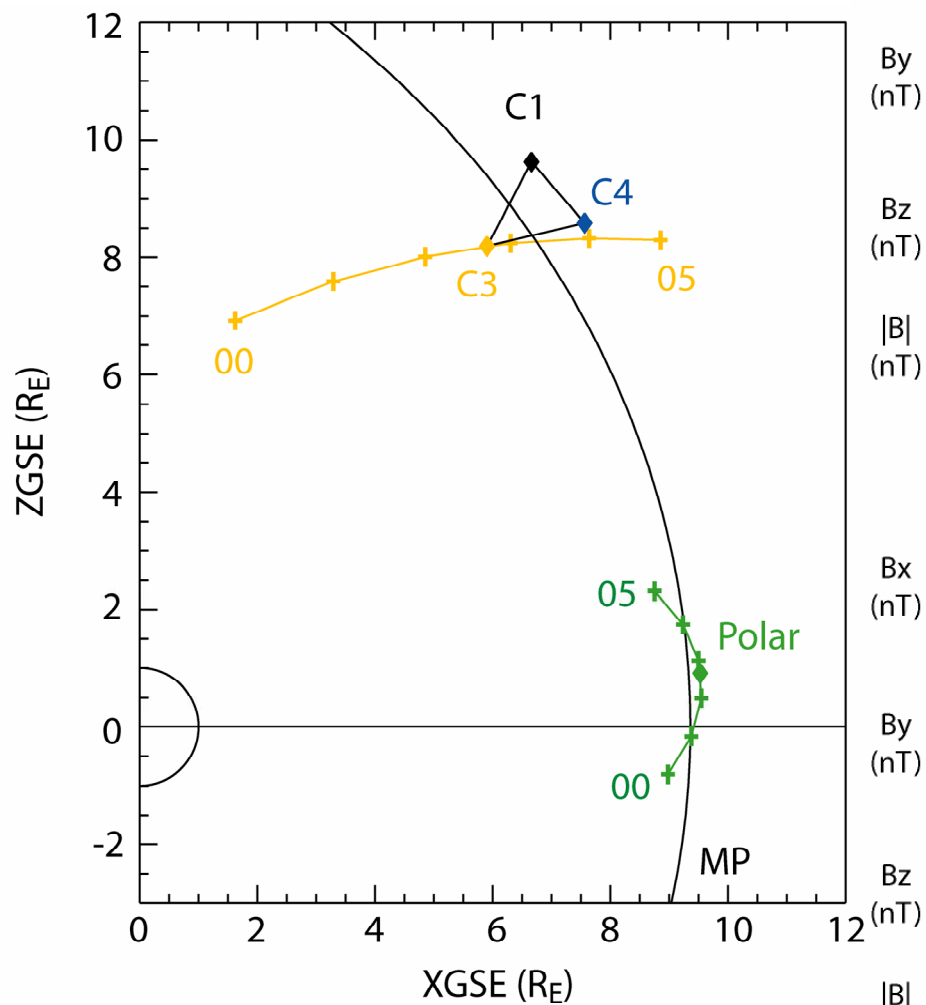


Event time:

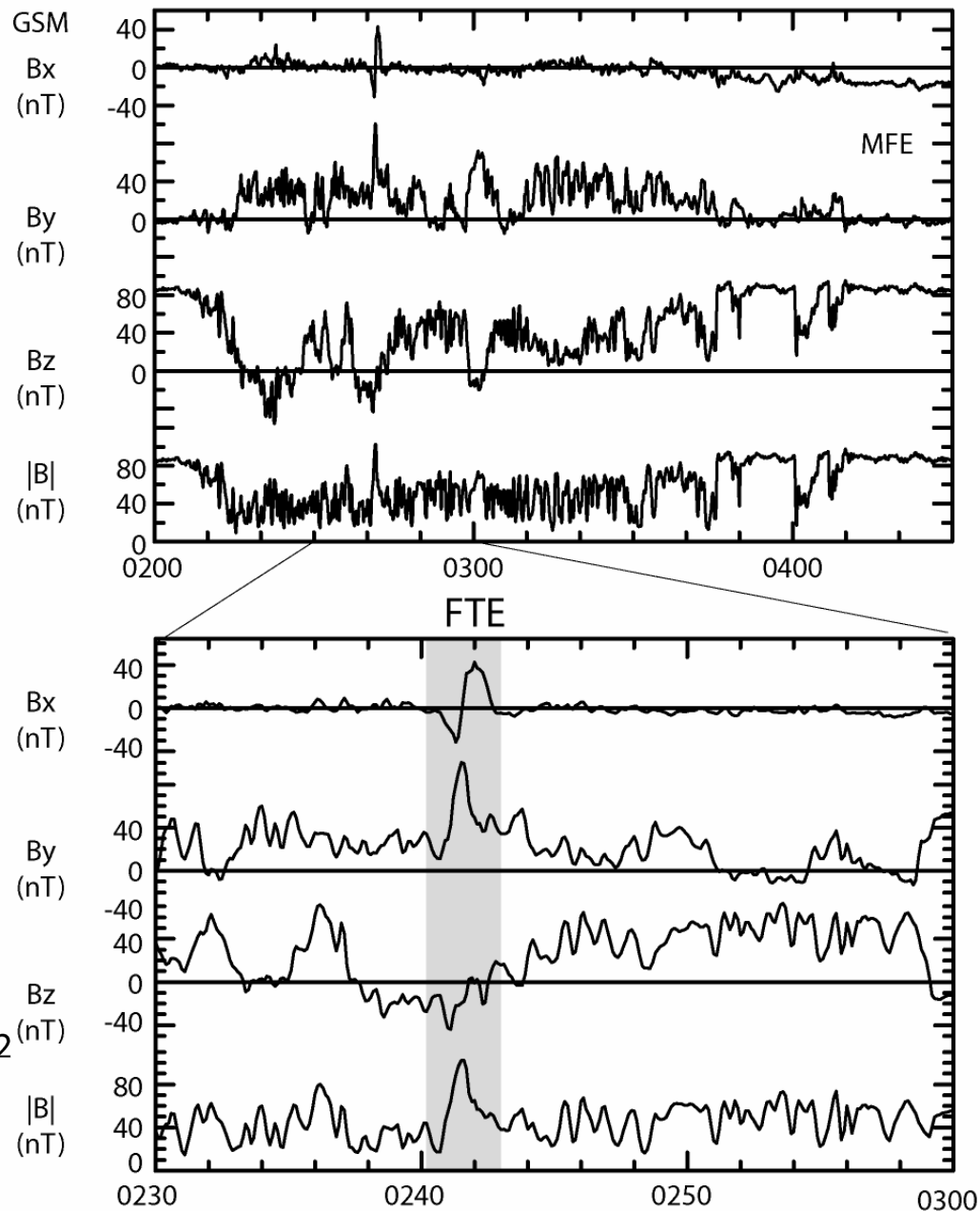
~ 0240 UT, March 21, 2002



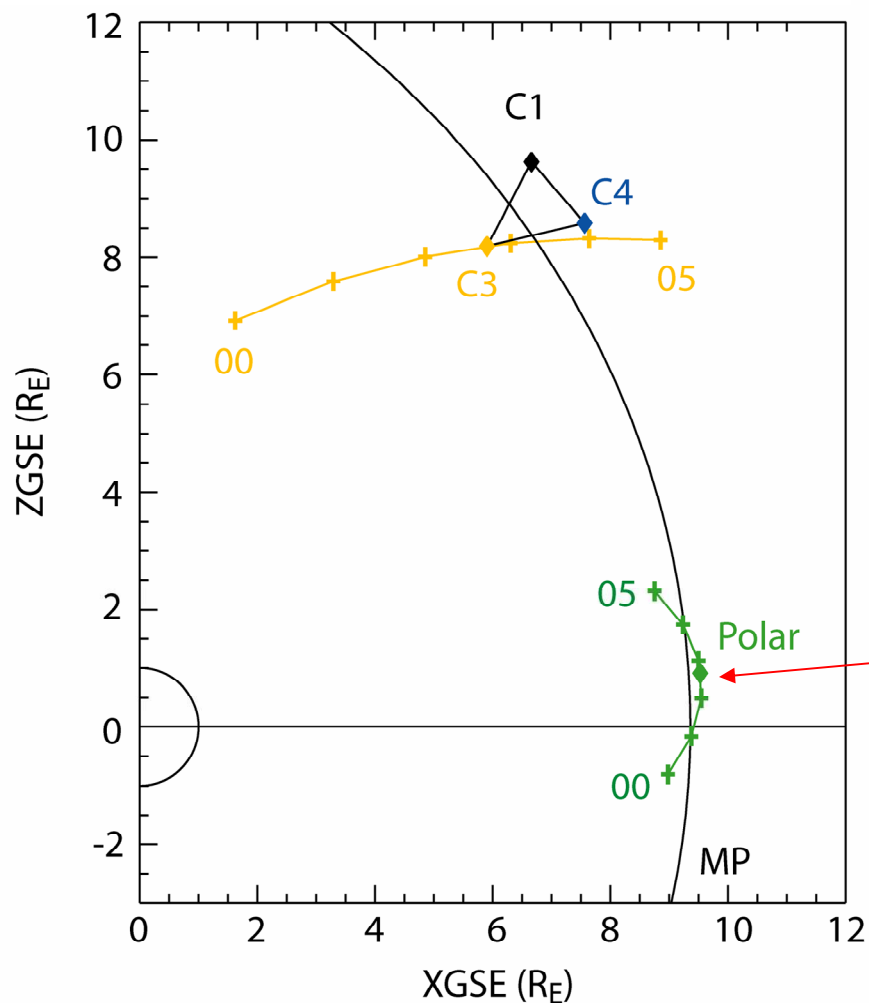
Polar Observations



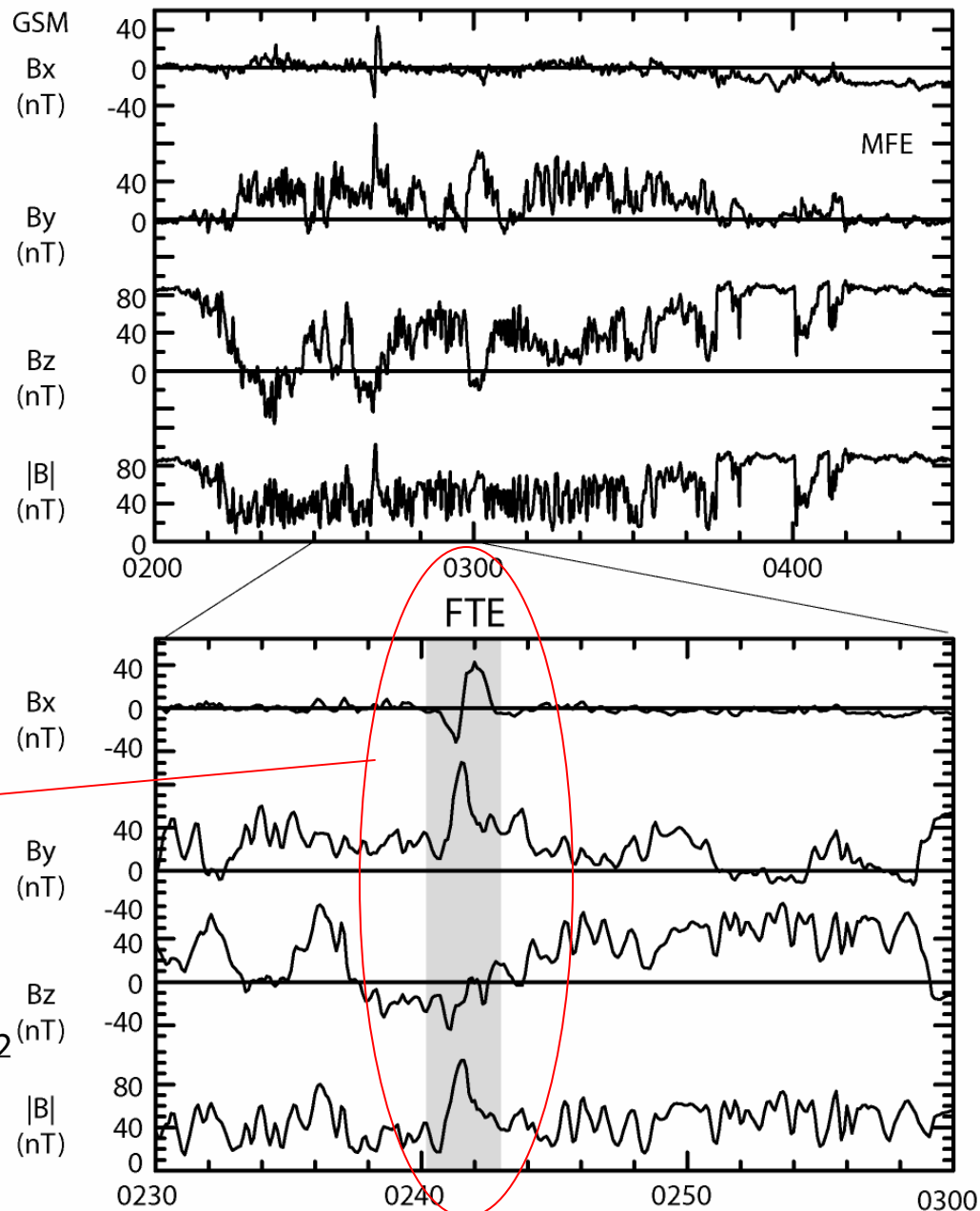
Polar Observation at Low Latitude



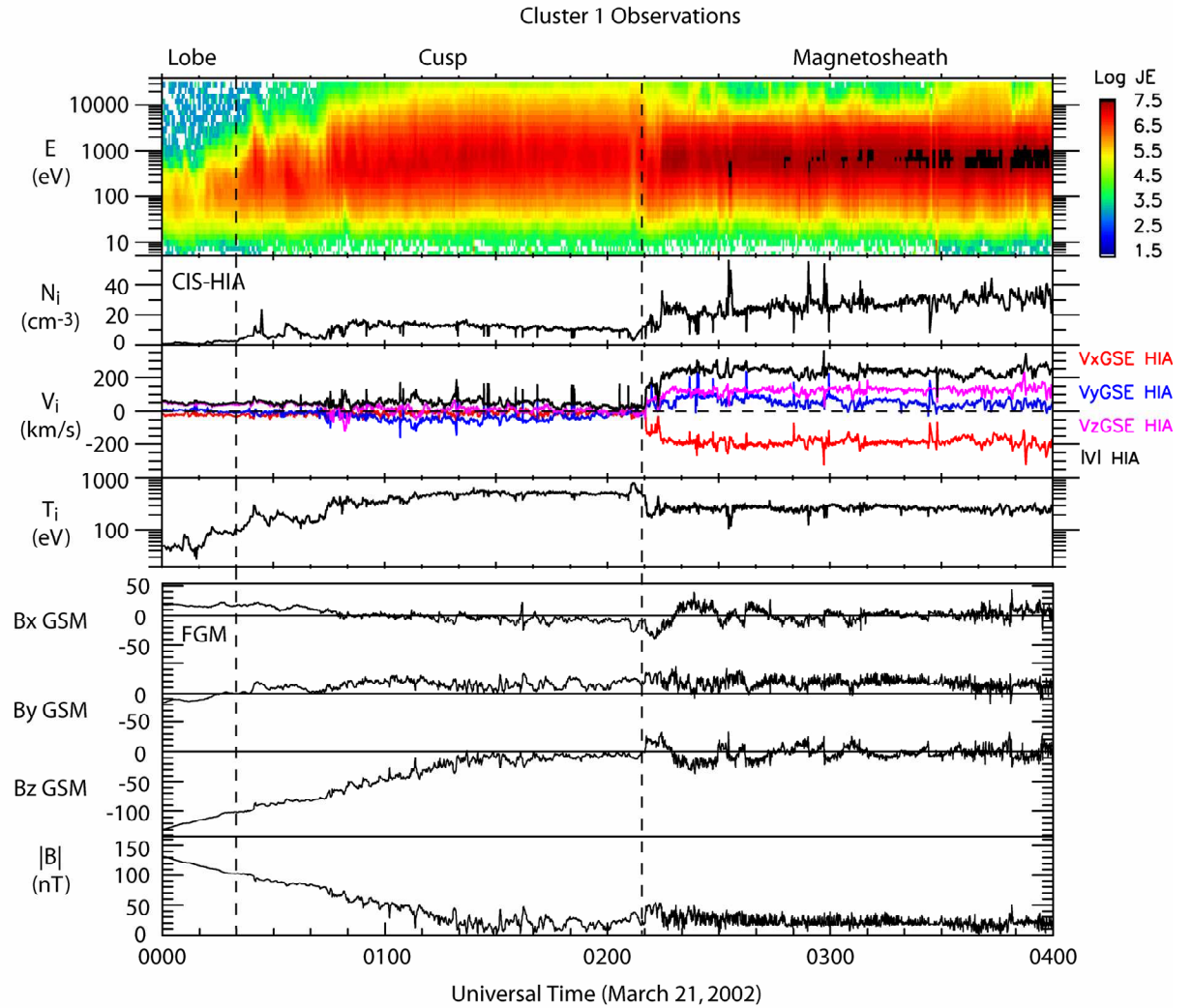
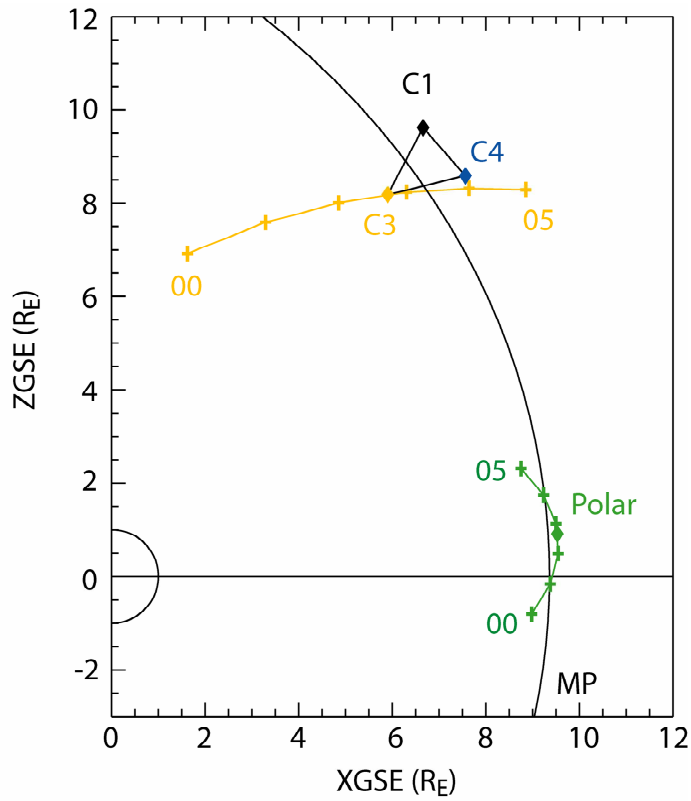
Polar Observations



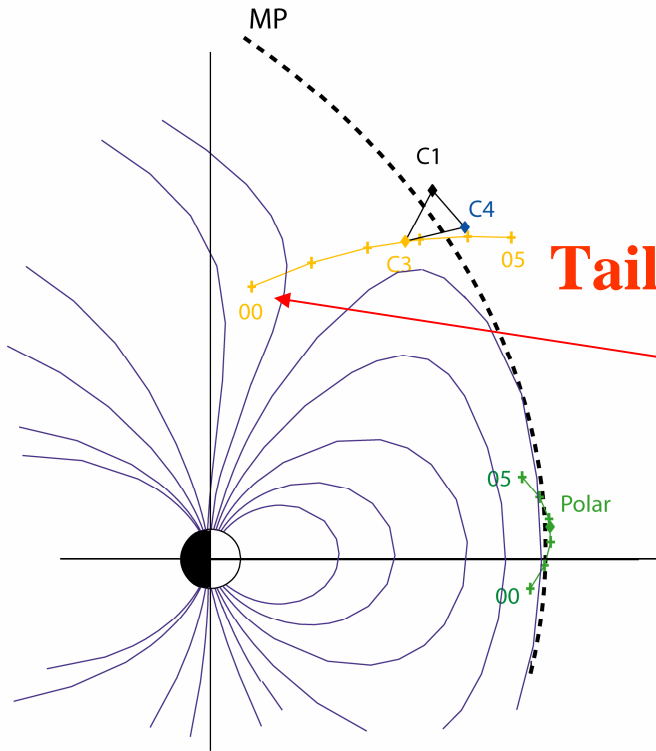
Polar Observation at Low Latitude



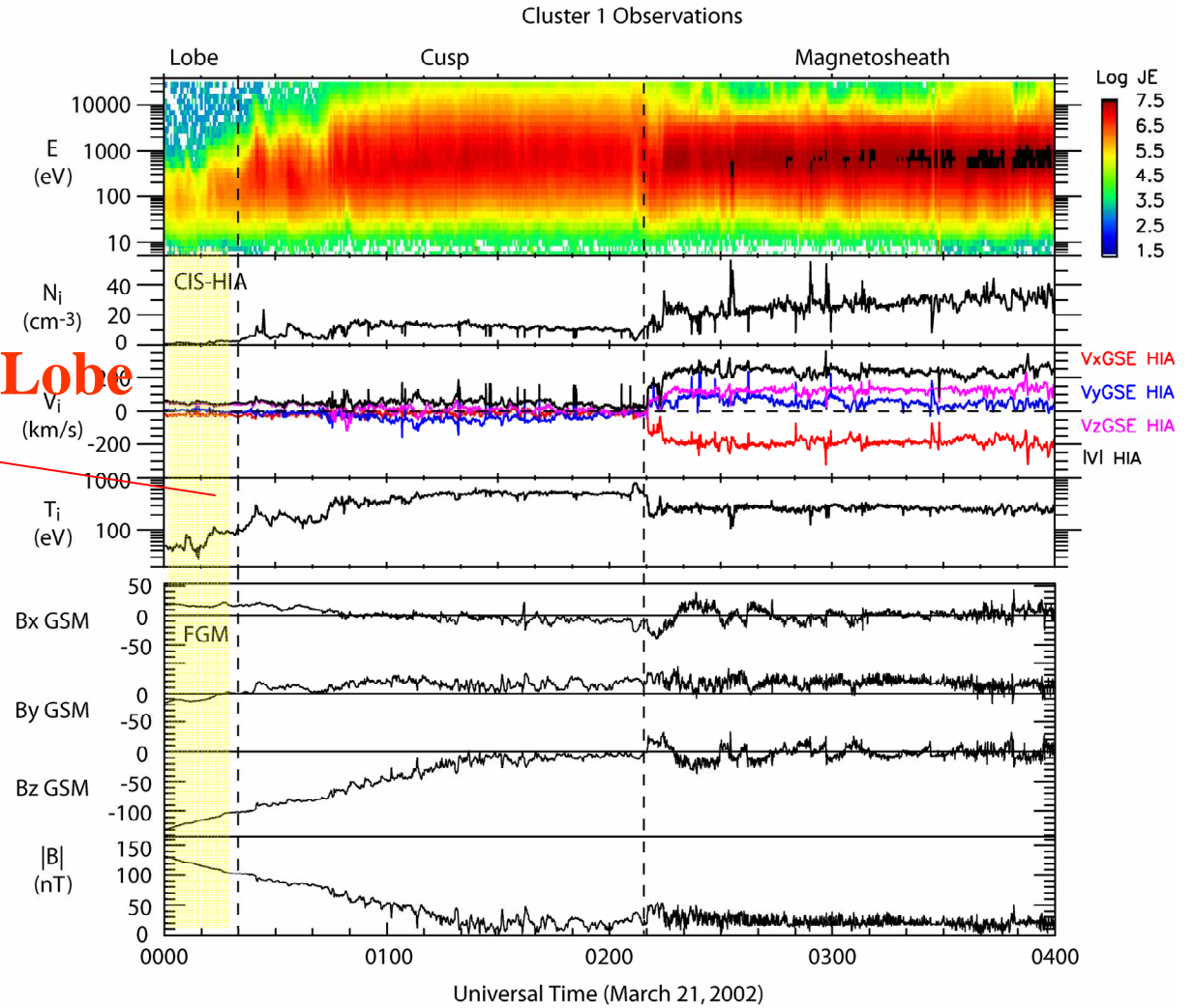
Cluster Observations



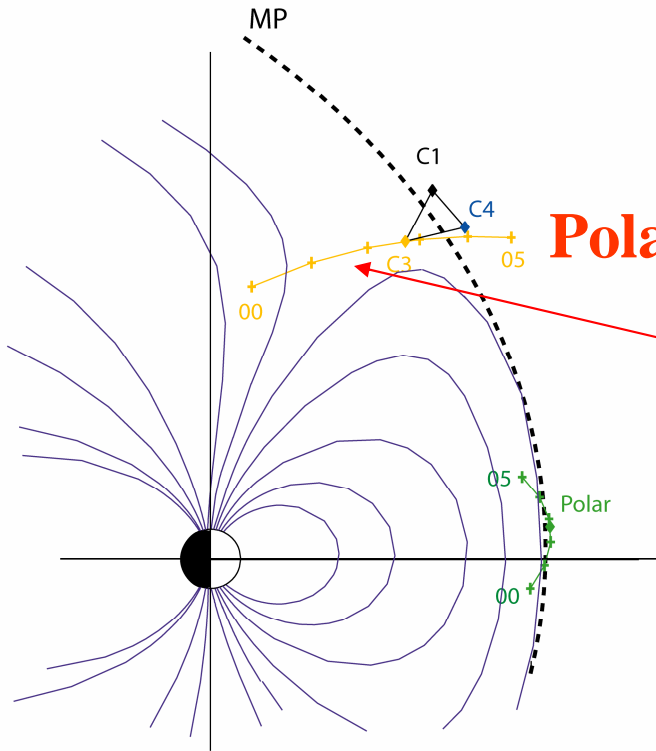
Cluster Observations



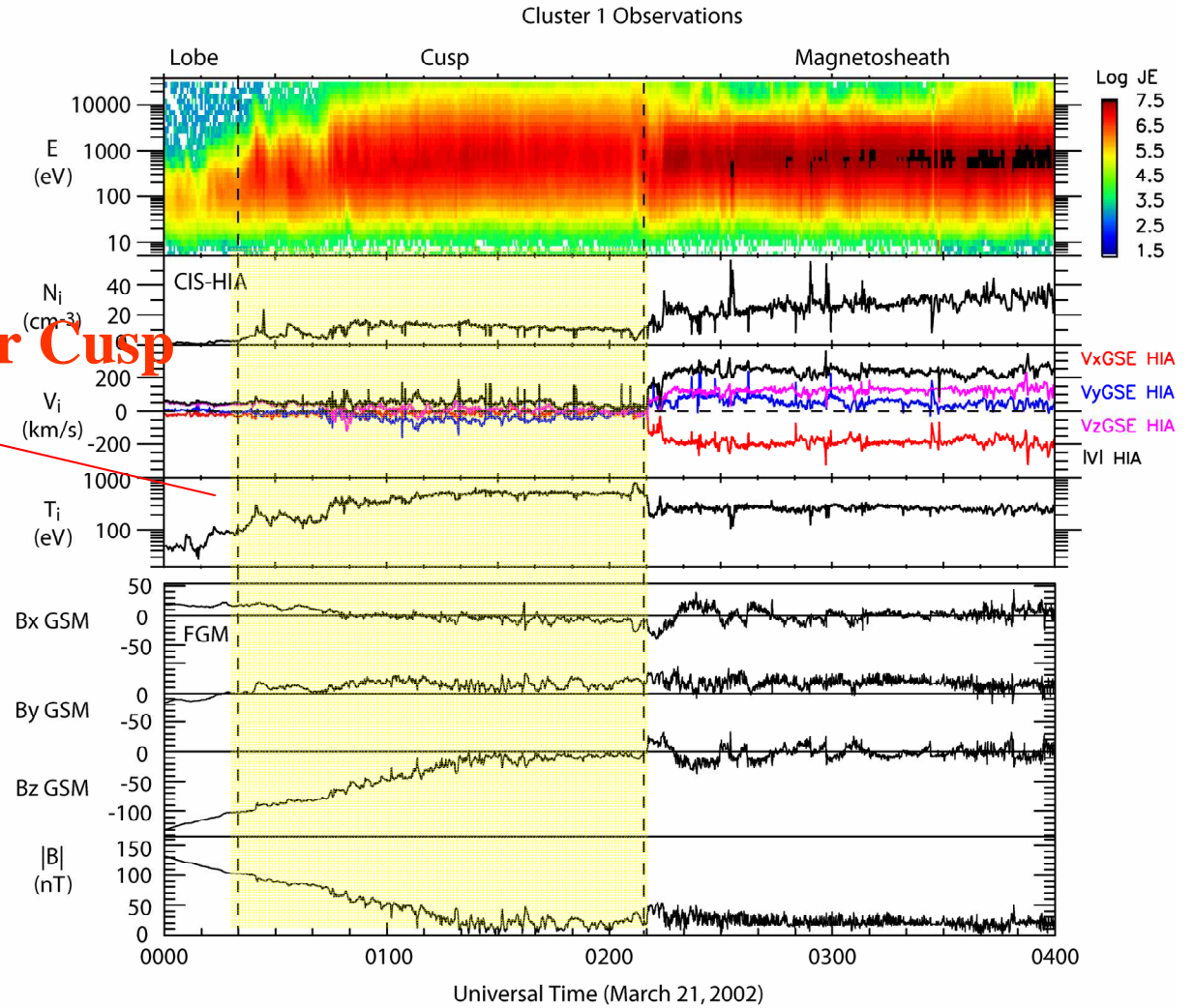
Tail Lobe



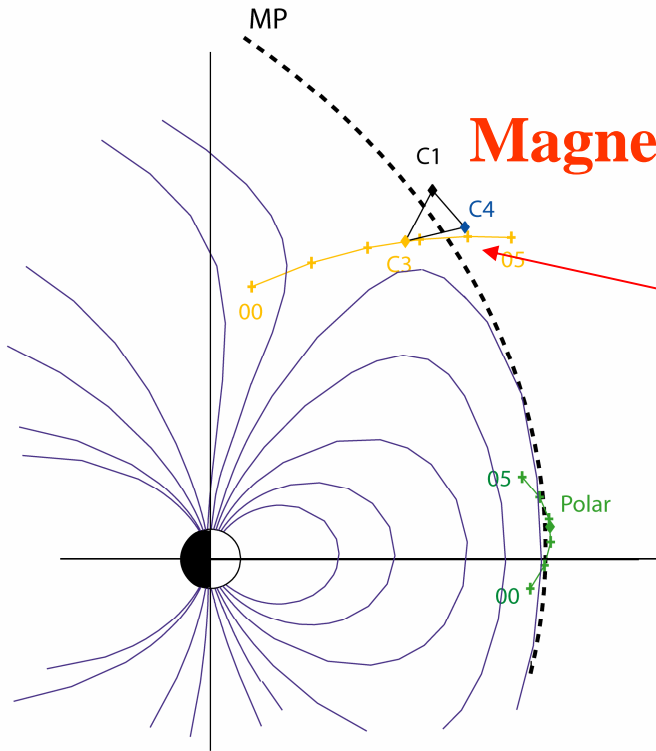
Cluster Observations



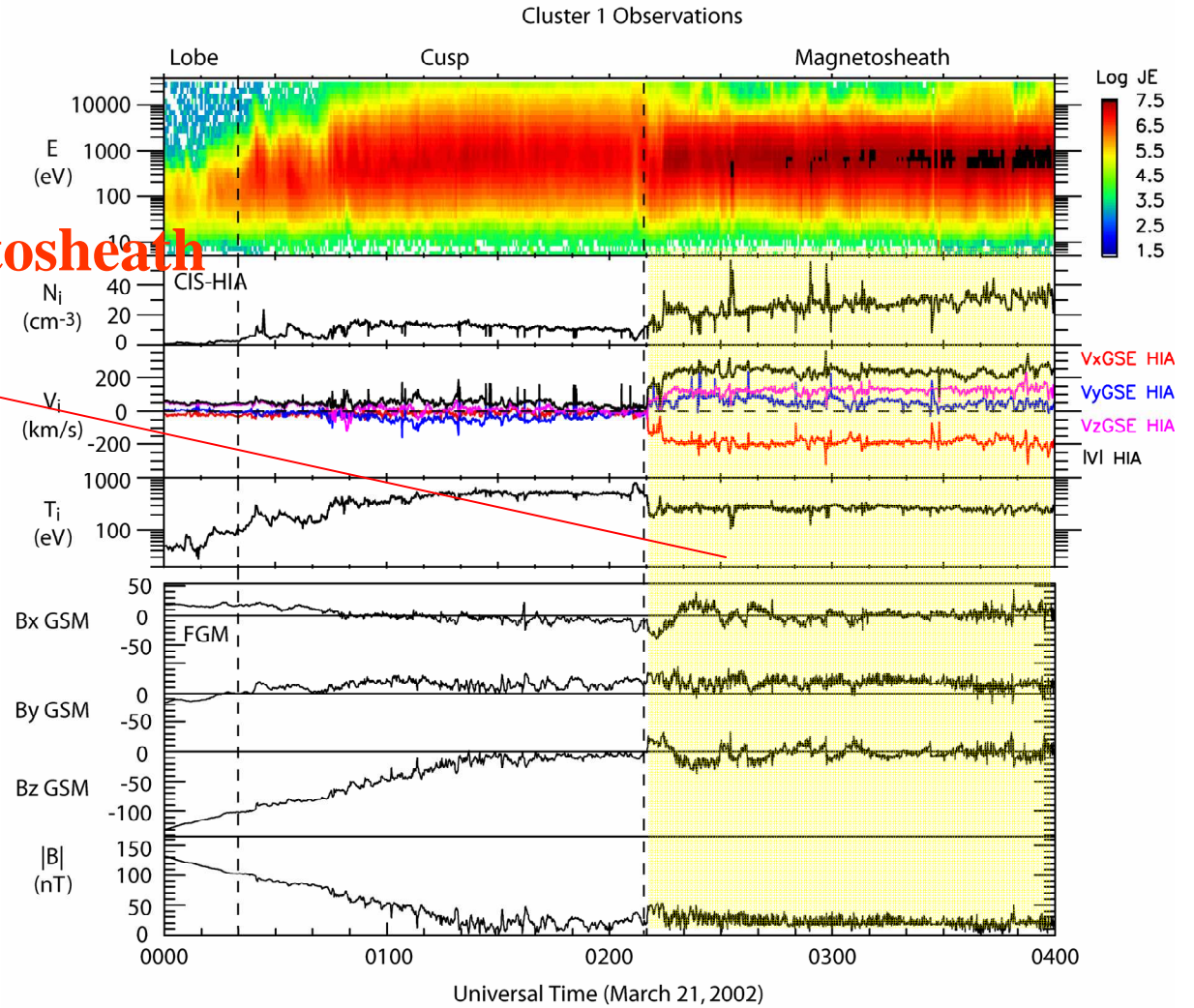
Polar Cusp



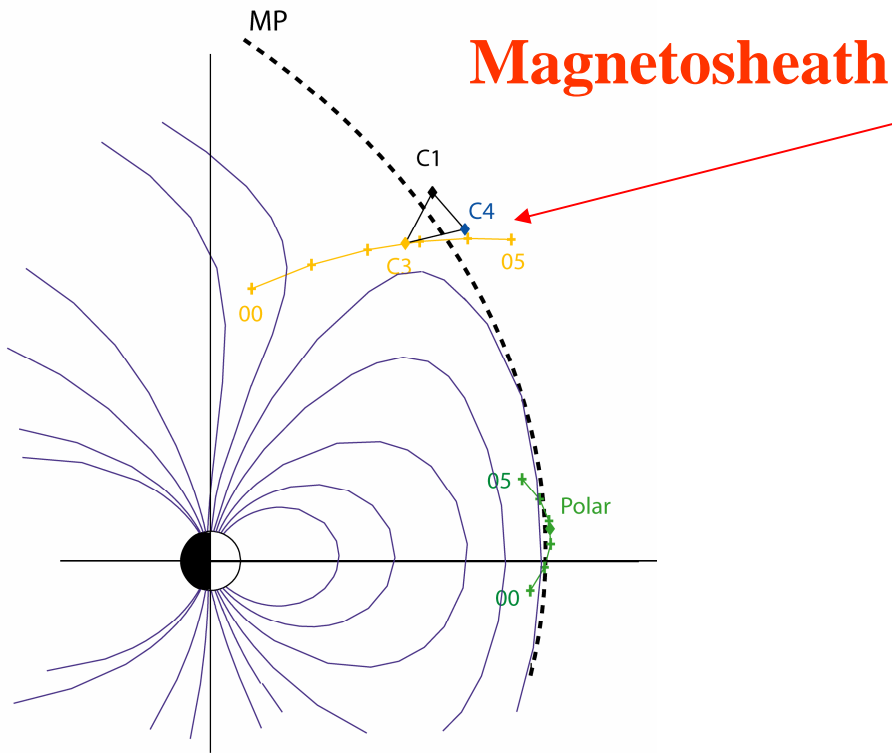
Cluster Observations



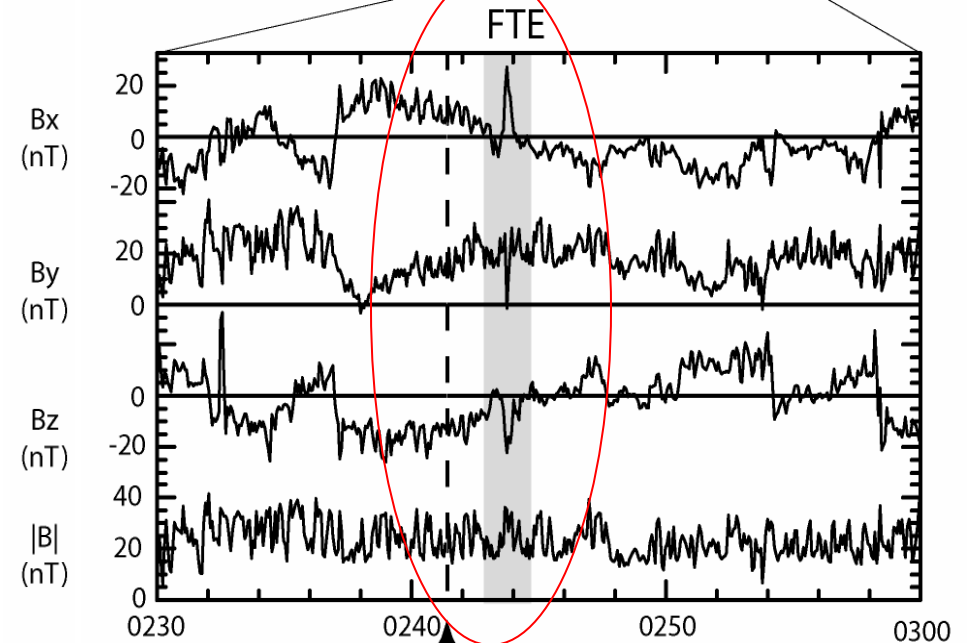
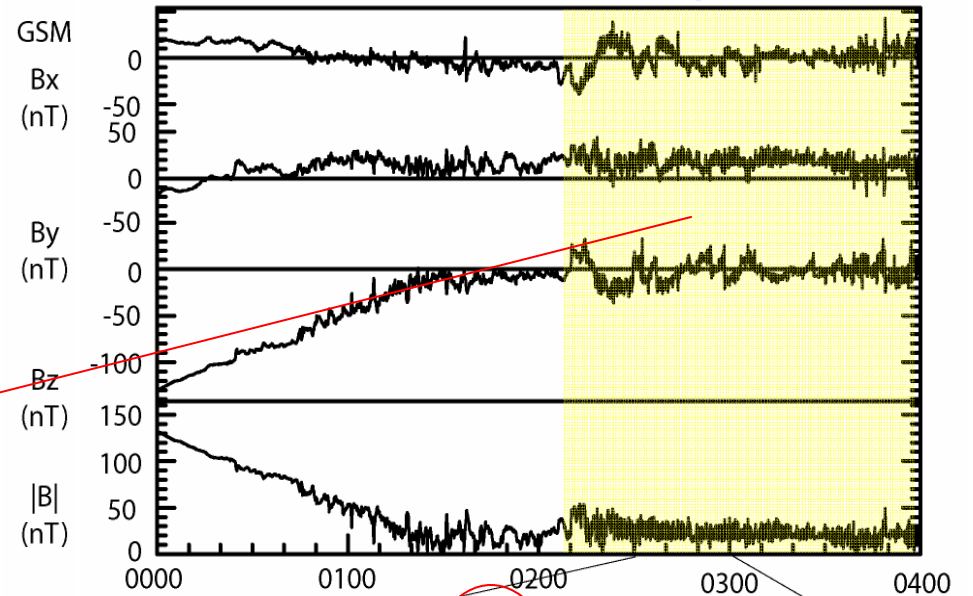
Magnetosheath



Cluster Observations

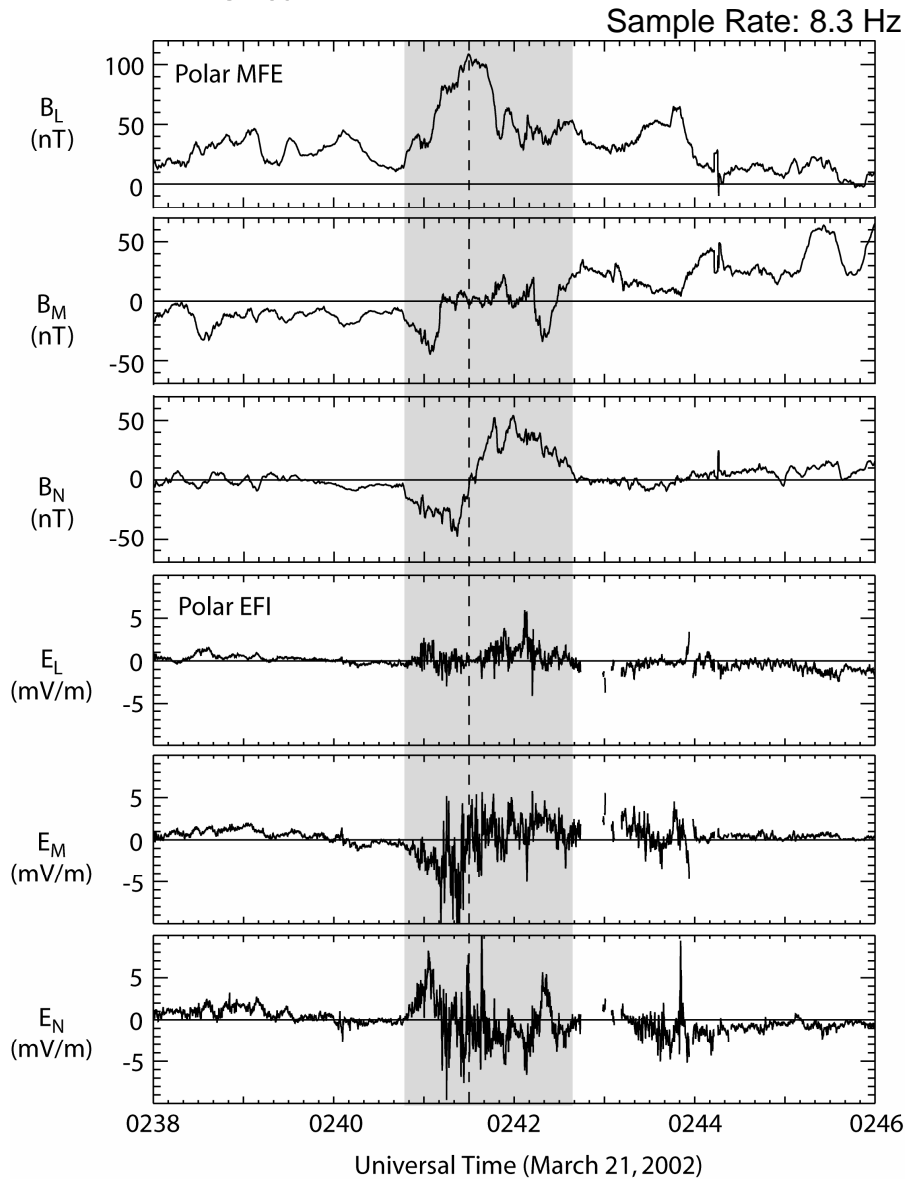


Cluster 1 Observation at High Latitude



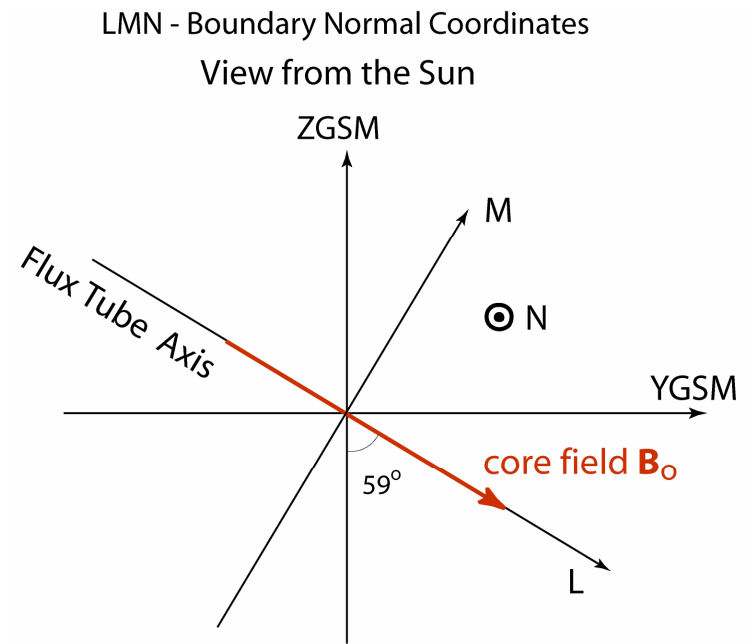
Polar FTE Time

Polar

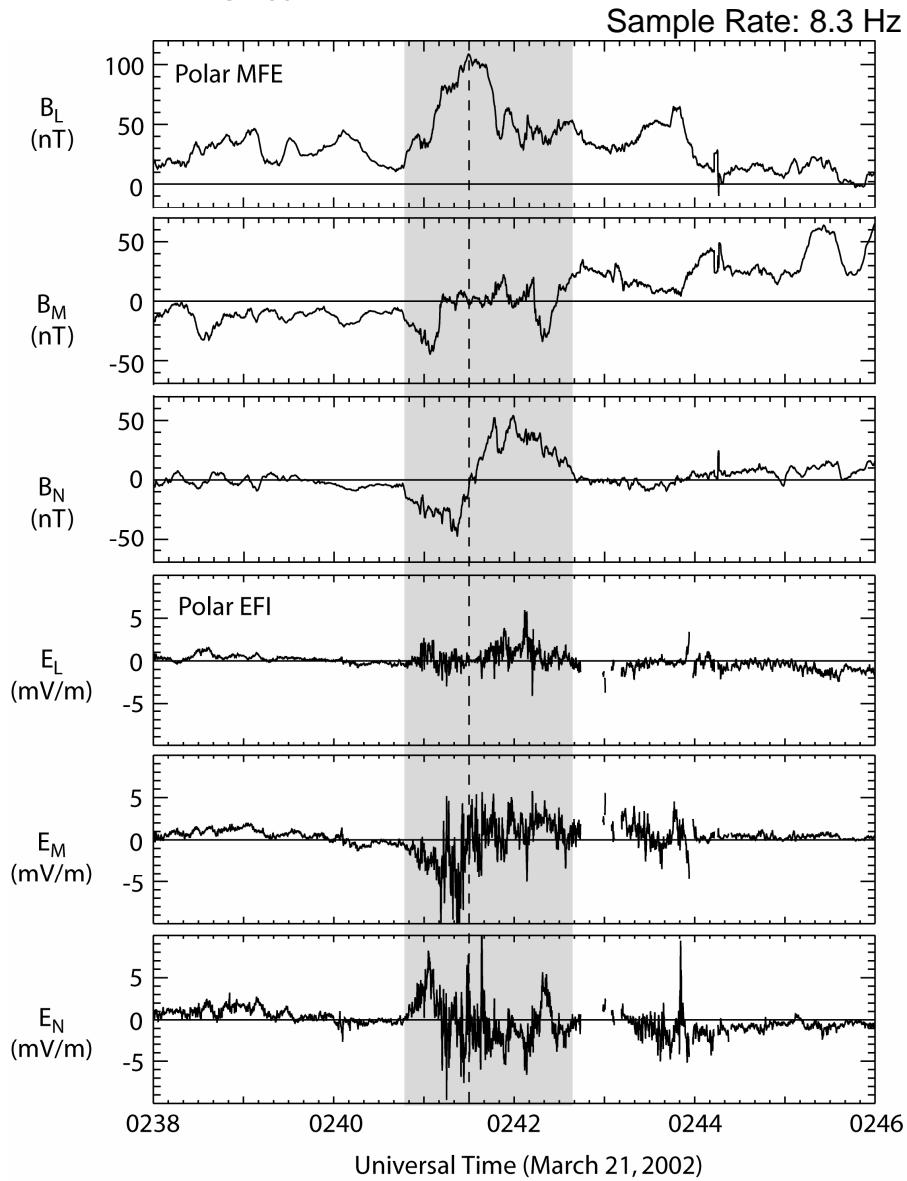


Polar Observations:

- Enhanced core field (~ 100 nT)
- Reverse polarity ($-/+ B_N$): Southward moving flux tube
- Enhanced high-frequency electric field fluctuations within the core region with amplitude up to ~ 10 mV/m

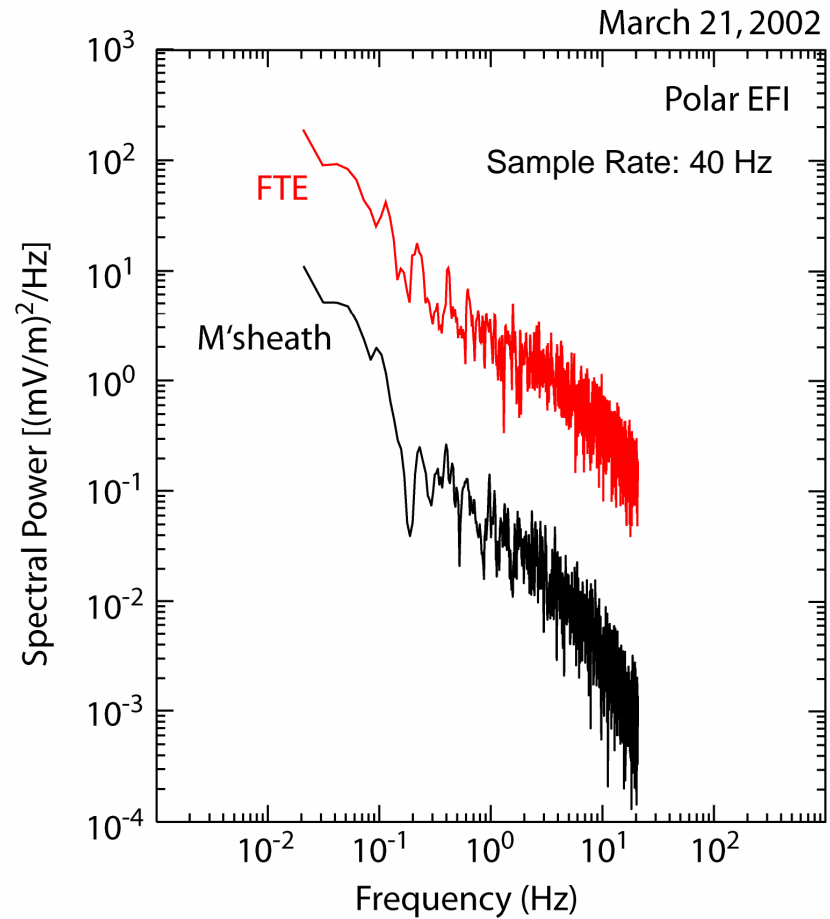


Polar

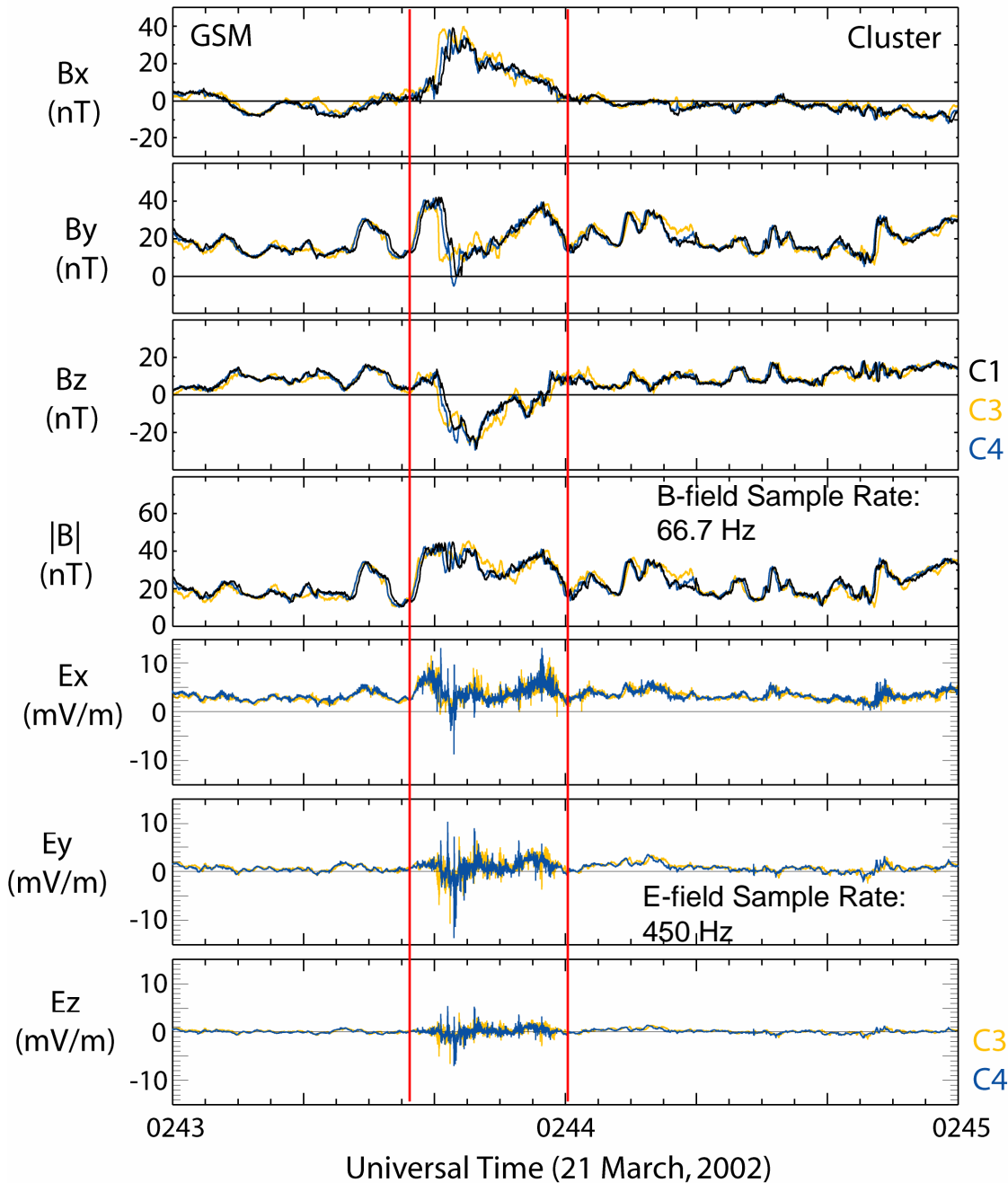


Electric field fluctuations within the low-latitude FTE:

- Fluctuations appear to be electrostatic
- Fluctuations are broadband

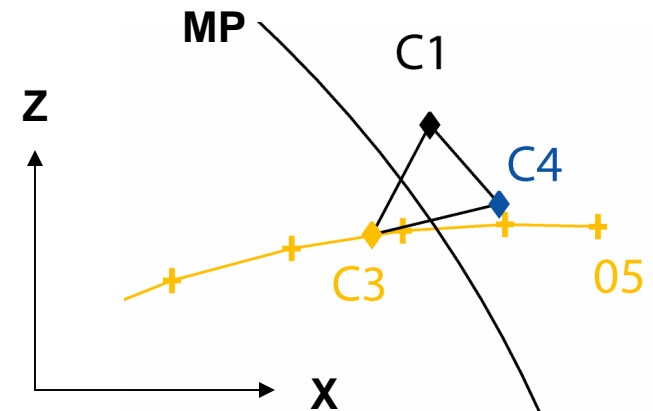


Cluster

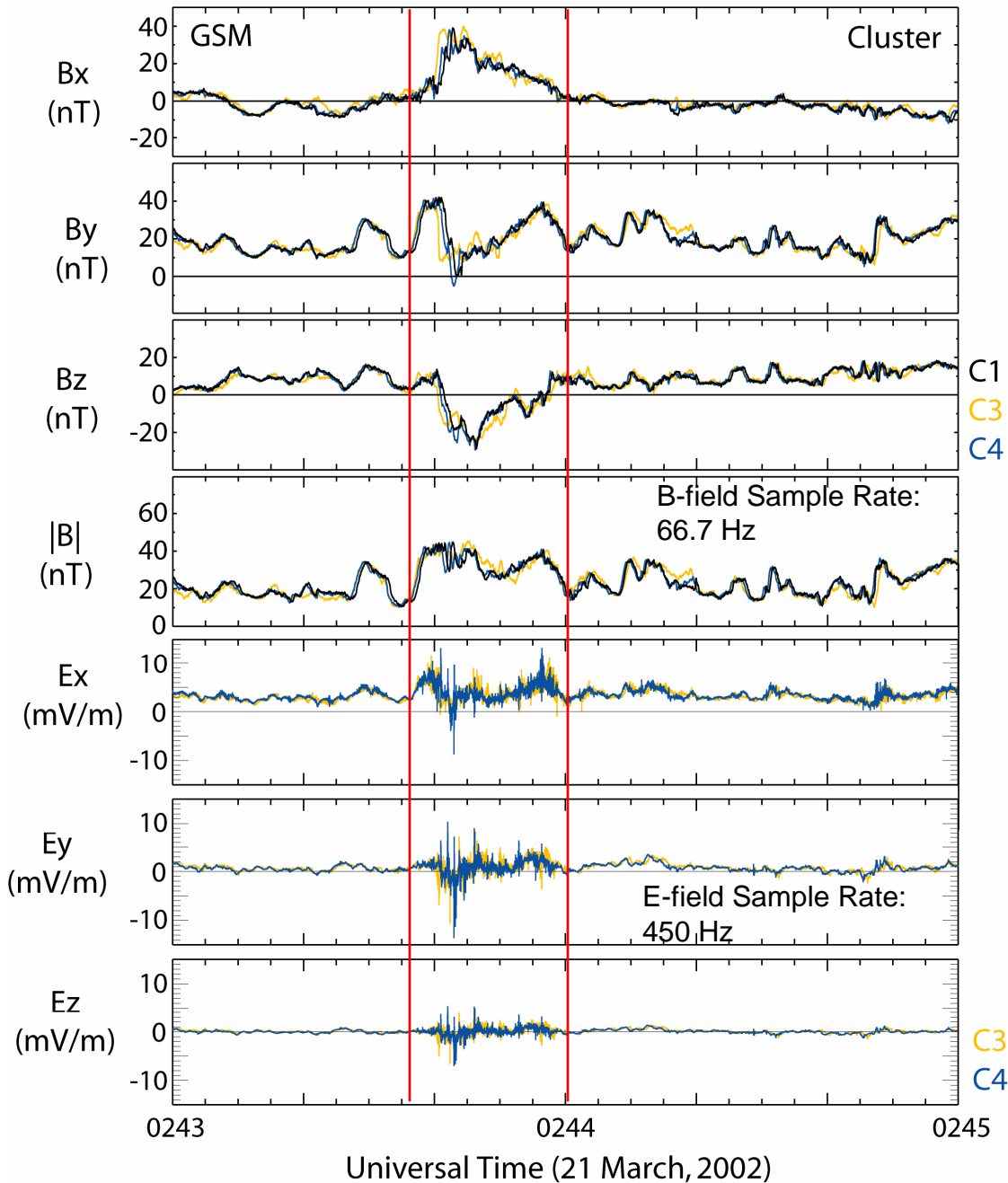


Cluster FTE:

- No bi-polar B_N
- Enhanced core field
- Moving northward
- Enhanced electric field fluctuations

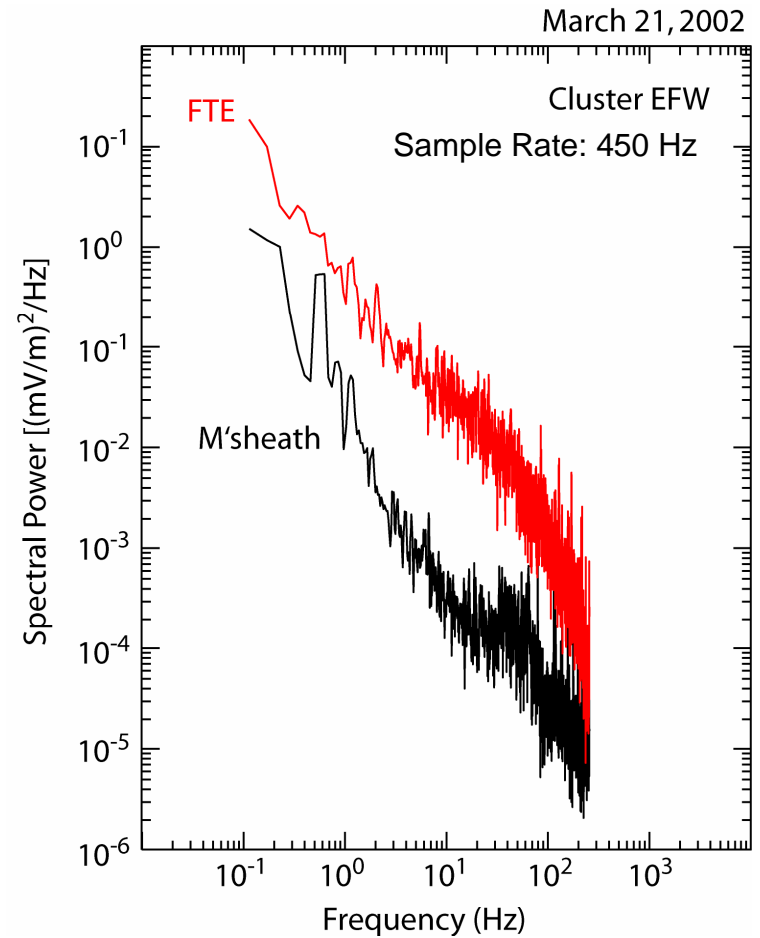


Cluster

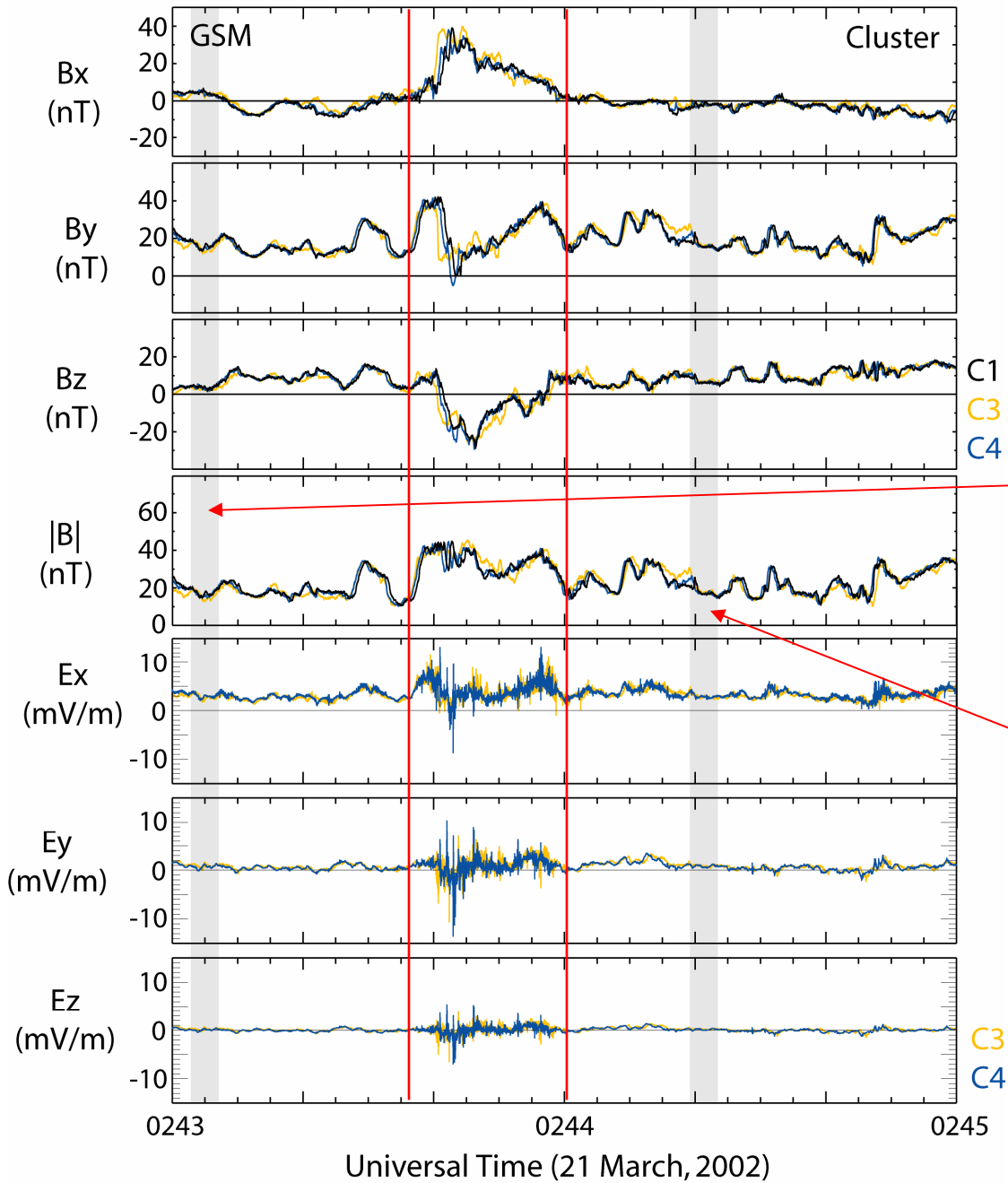


Electric field fluctuations:

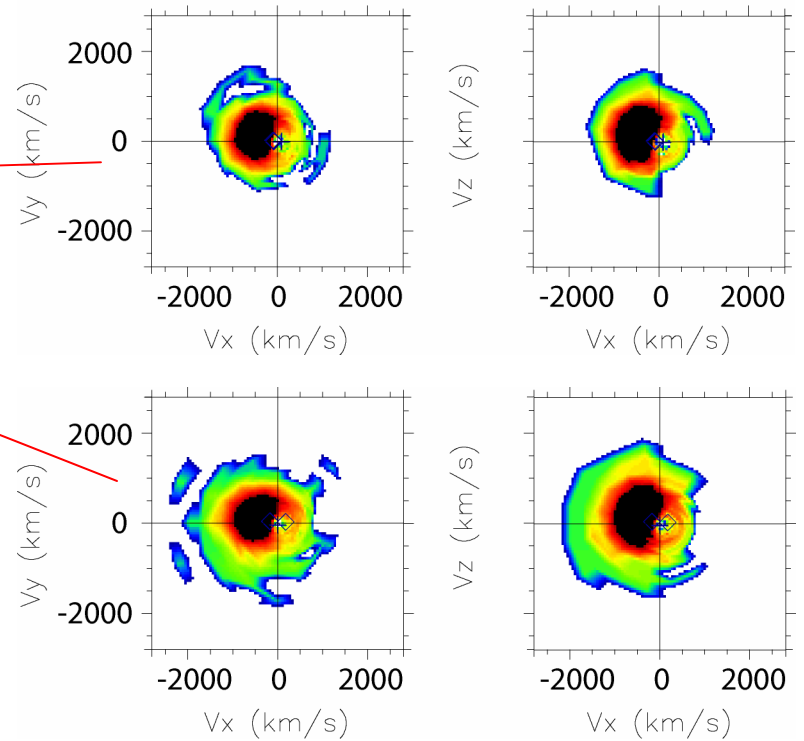
- Fluctuations are broadband
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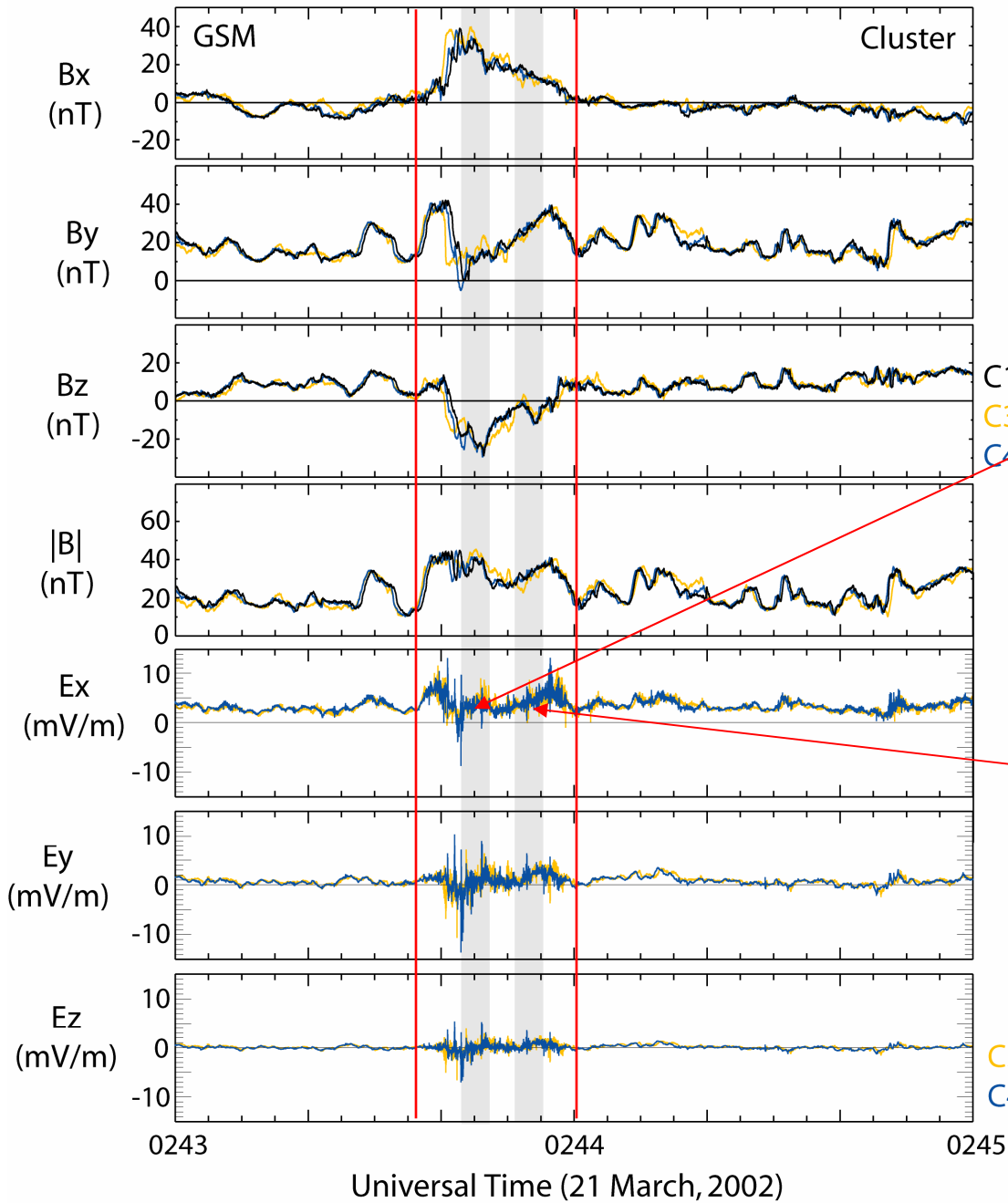
Cluster



Cluster 1 - CIS/HIA Ion Distribution Functions Magnetosheath

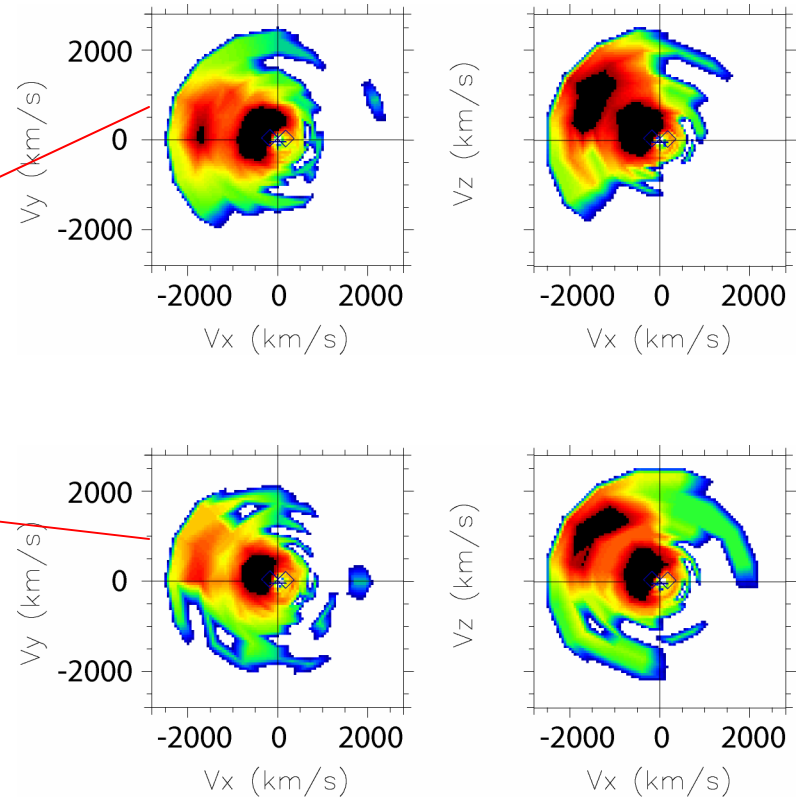


Cluster



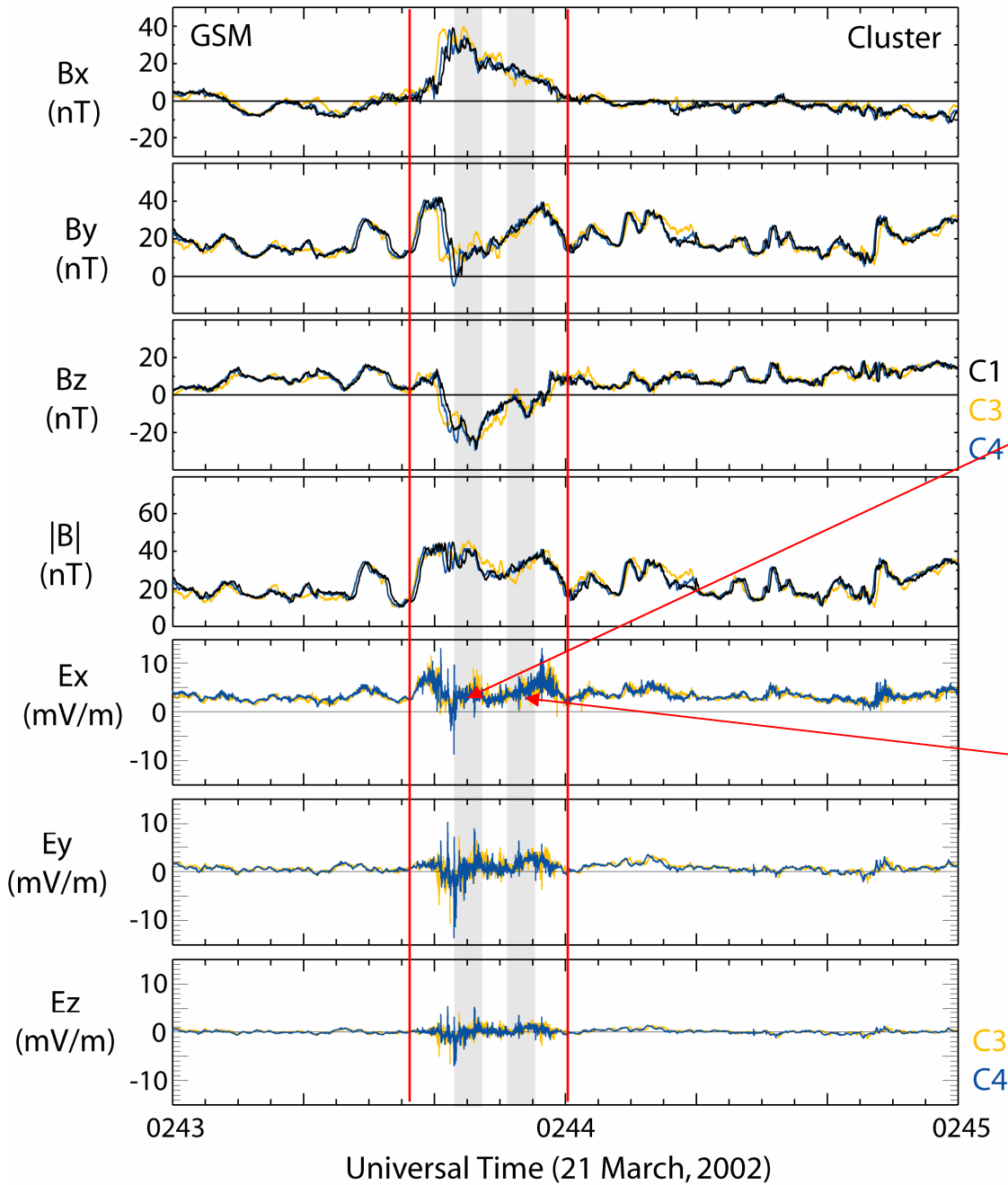
Cluster 1 - CIS/HIA Ion Distribution Functions

FTE Core



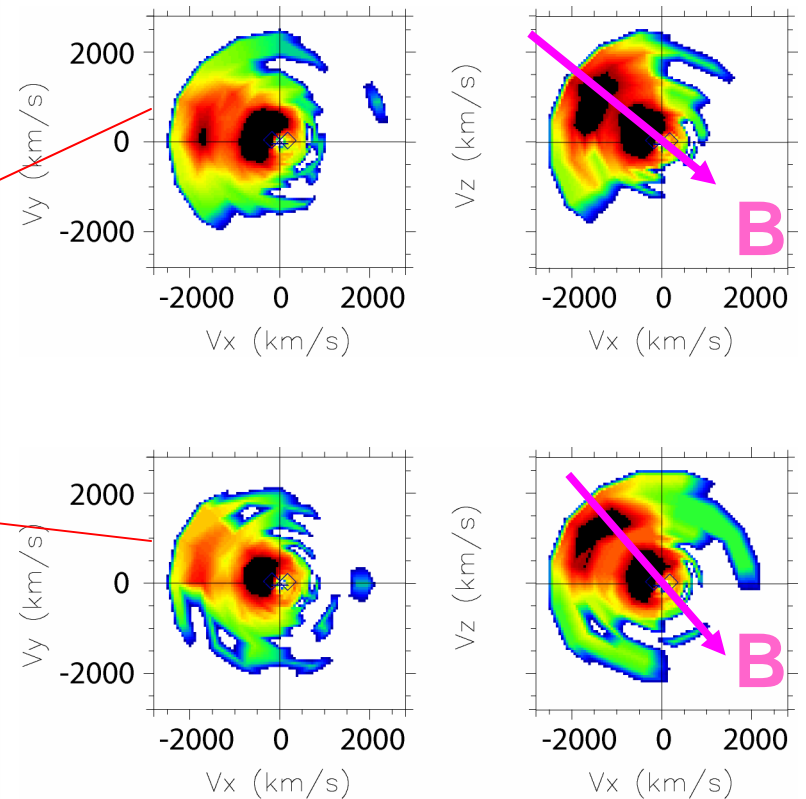
C3
 C4
 Presence of hot magnetospheric ions
 ⇒ open flux tube

Cluster



Cluster 1 - CIS/HIA Ion Distribution Functions

FTE Core

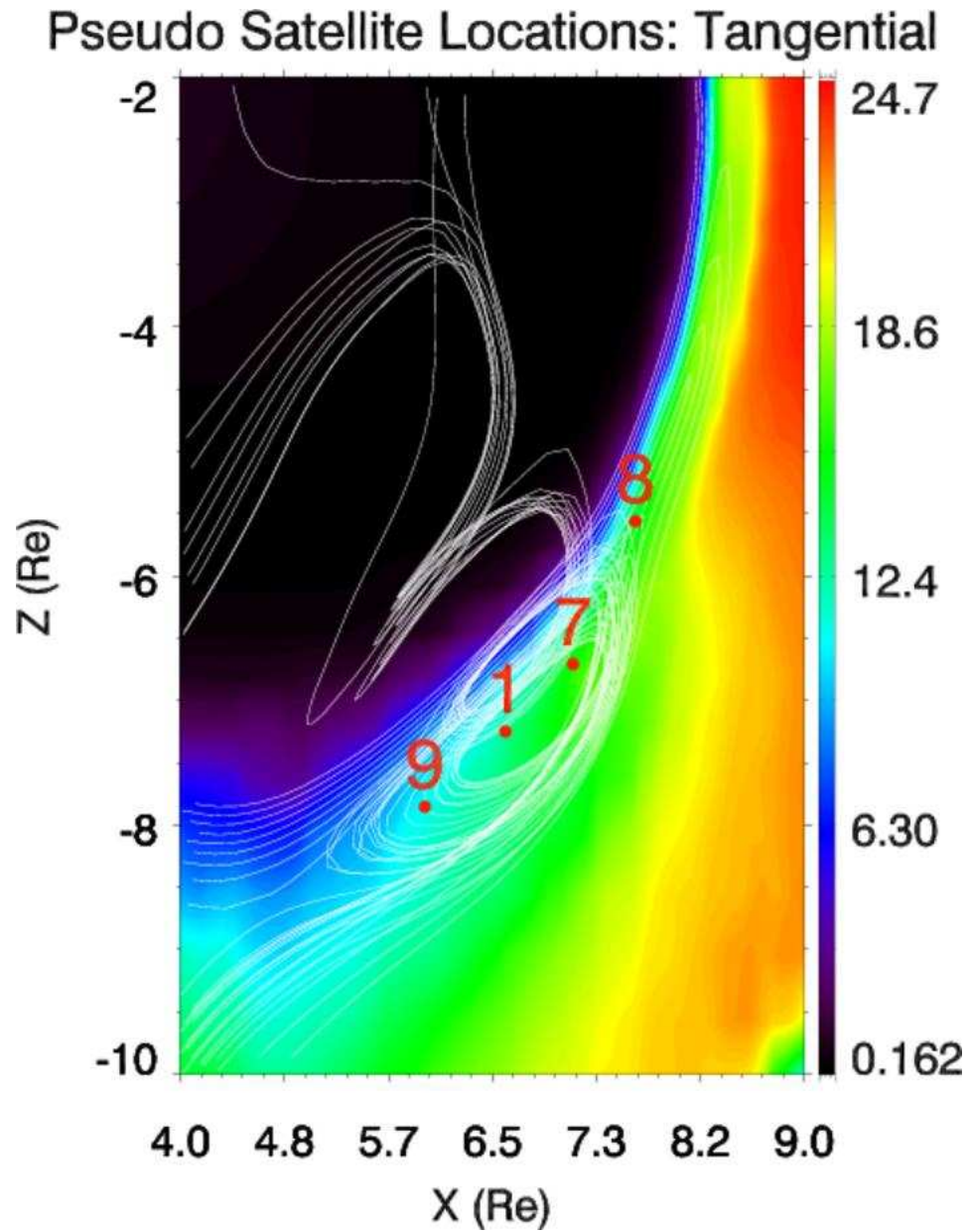


Hot ions flow anti-parallel to **B**
⇒ Flux tube connects to the
northern ionosphere

Summary

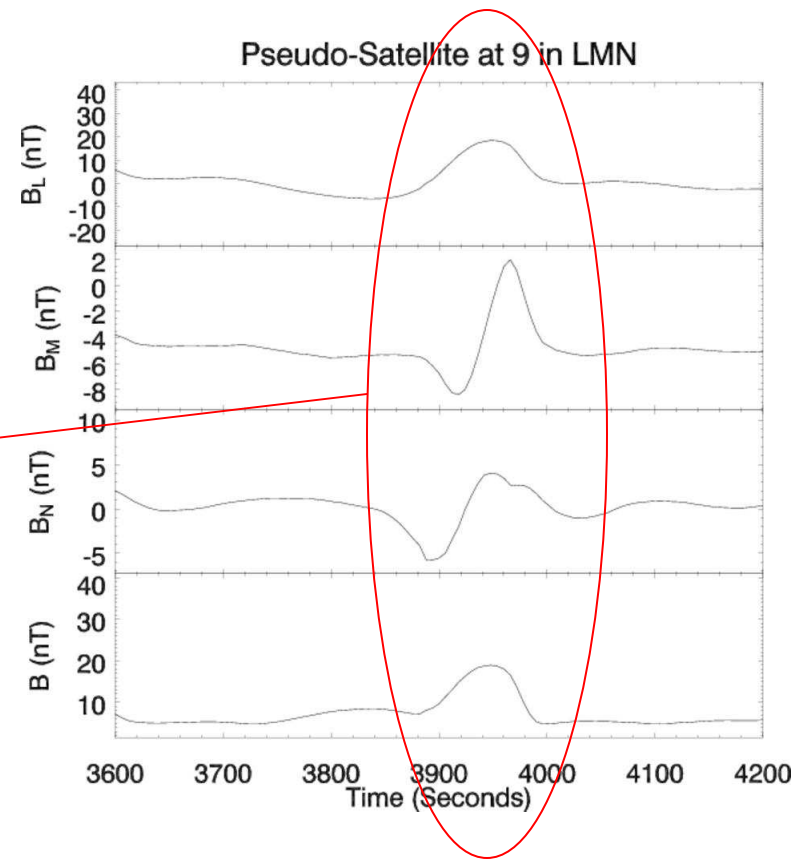
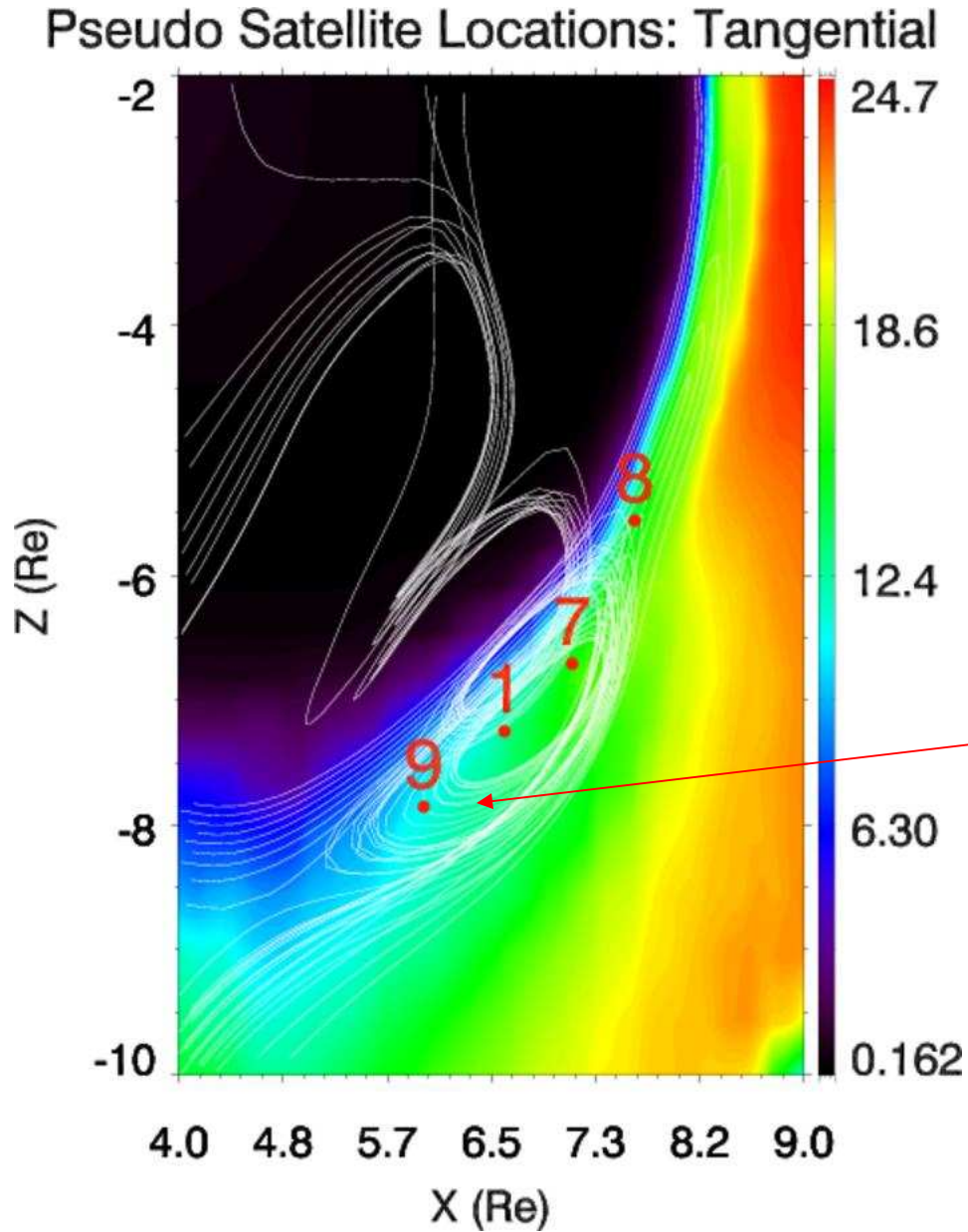
- The flux transfer event was formed between the equator and the northern cusp. Polar and Cluster observed the FTE's two open flux tubes:
 - Polar: southward moving flux tube near the equator
 - Cluster: northward moving flux tube at high latitude
- Unlike the low-latitude FTE, the high-latitude FTE did not exhibit the characteristic bi-polar B_N signature. But the plasma data clearly showed its open flux tube configuration.
- Enhanced electric field fluctuations were observed within the FTE core, both at low- and high-latitudes. The fluctuations are broadband and appear to be electrostatic.

Backup Charts

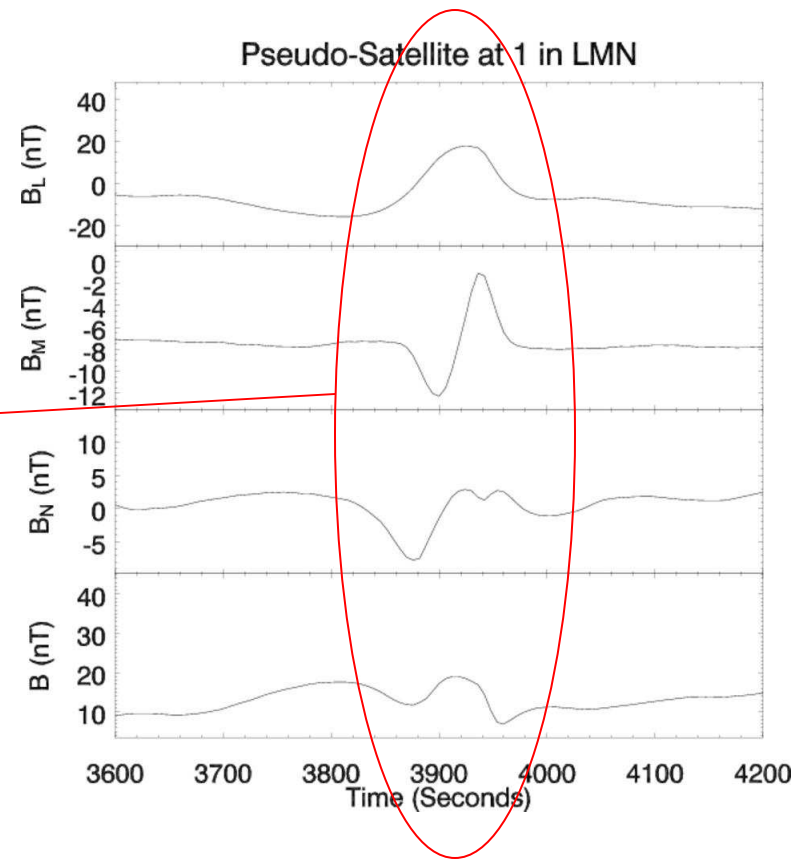
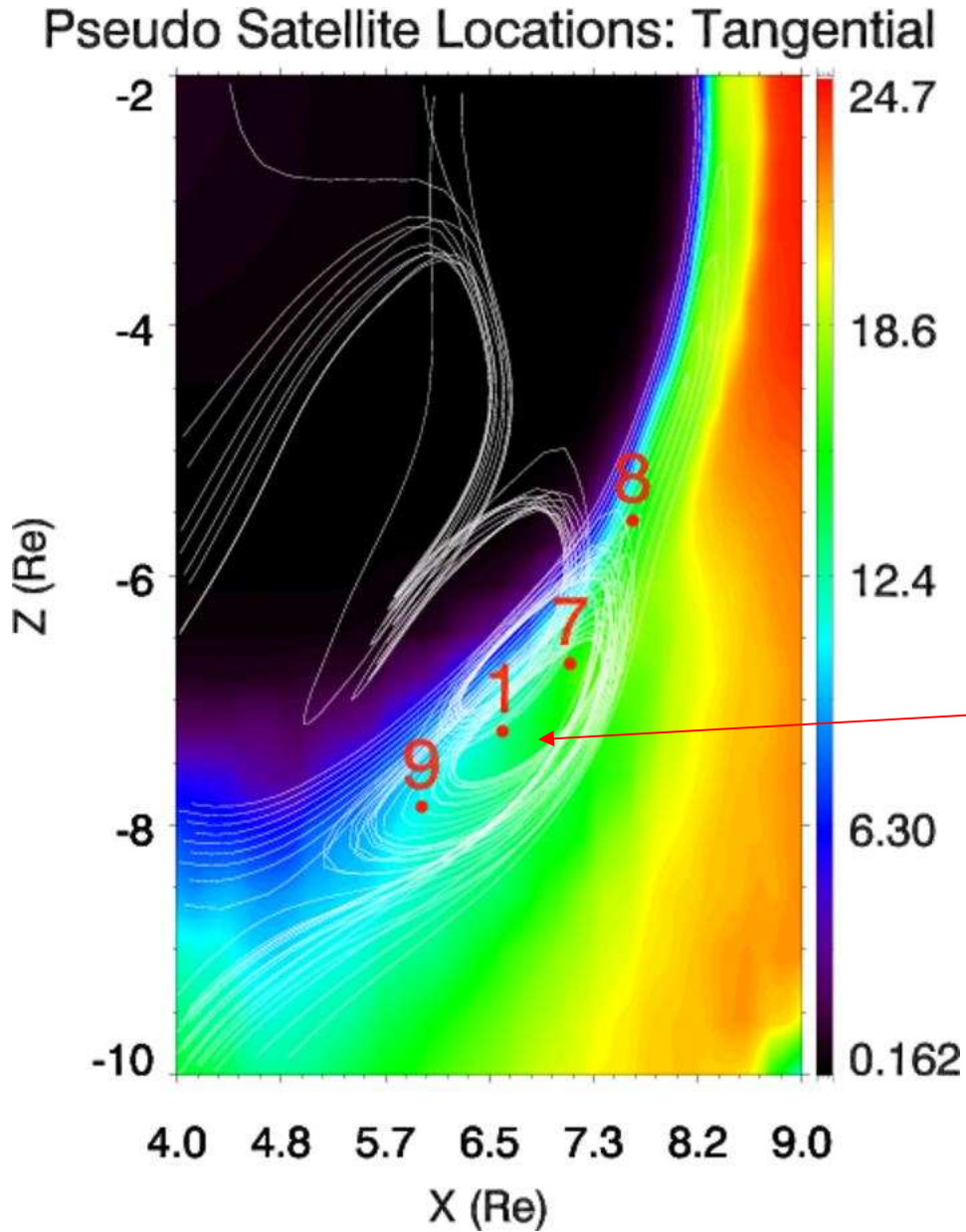


Raeder, 2002, 2005, Wang et al., 2004
MHD Simulations of FTEs

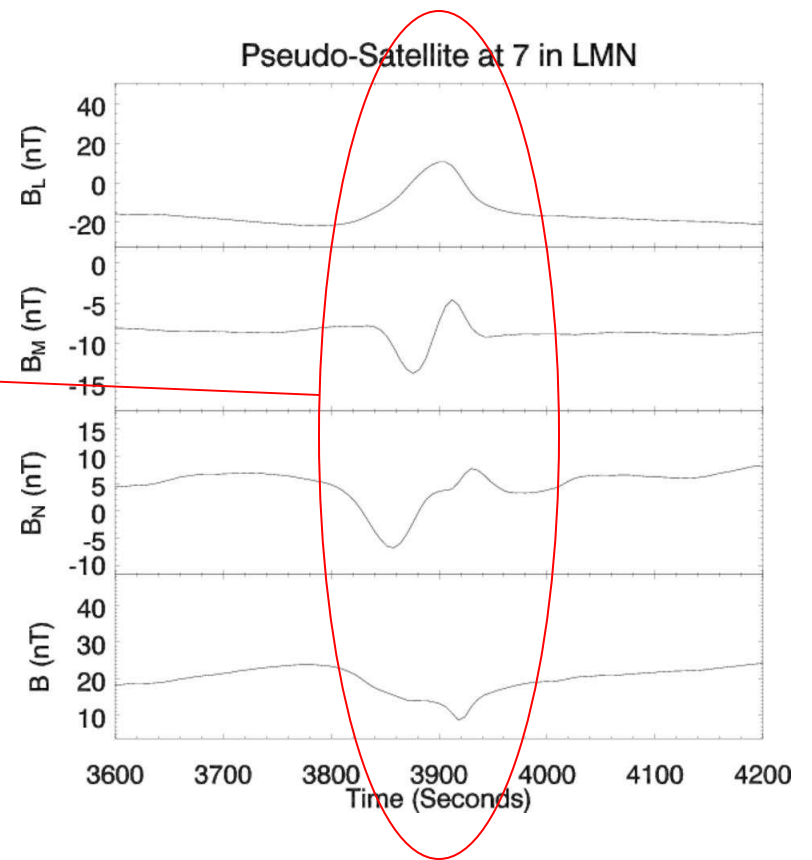
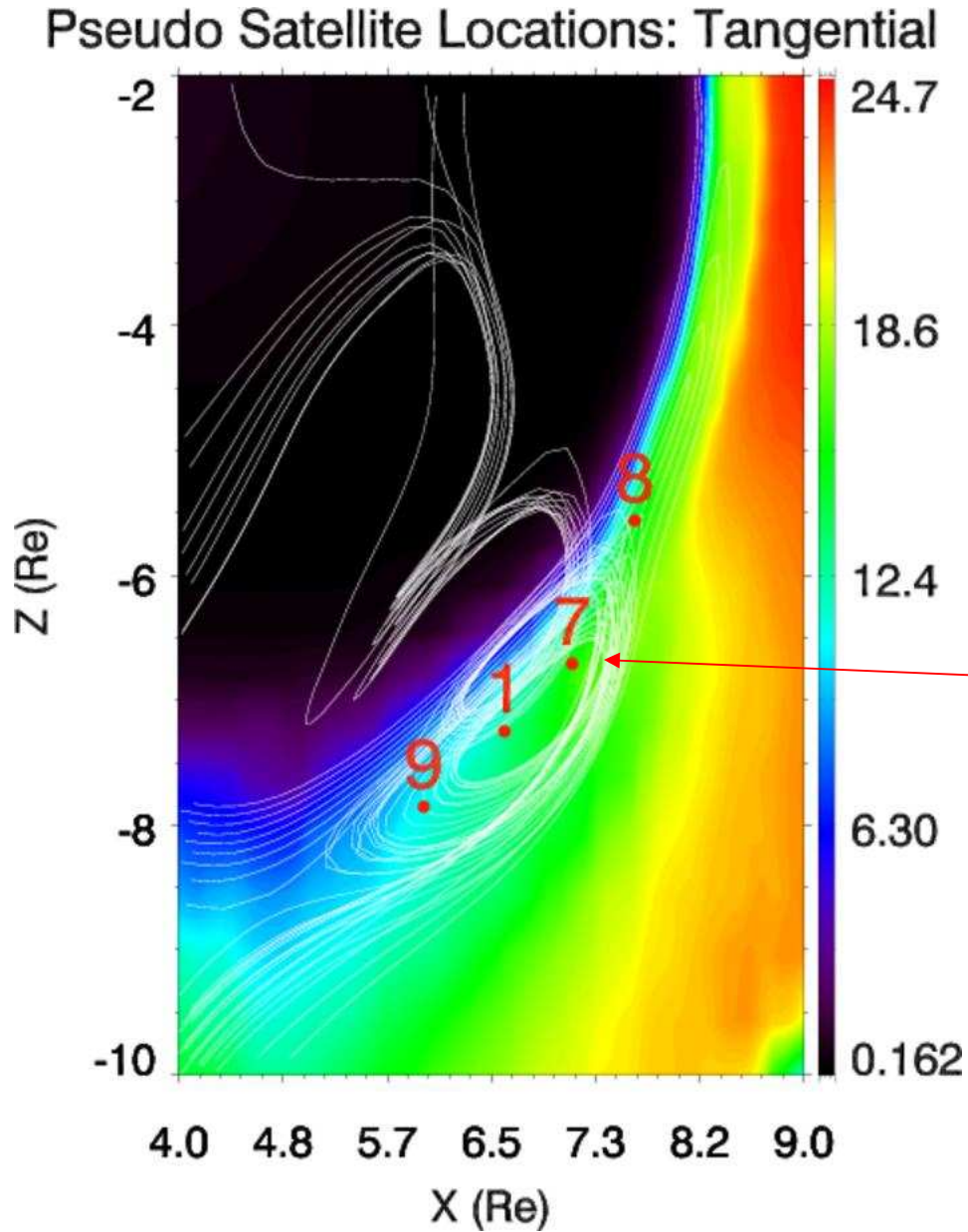
Raeder, 2002, 2005, Wang et al., 2004
MHD Simulations of FTEs



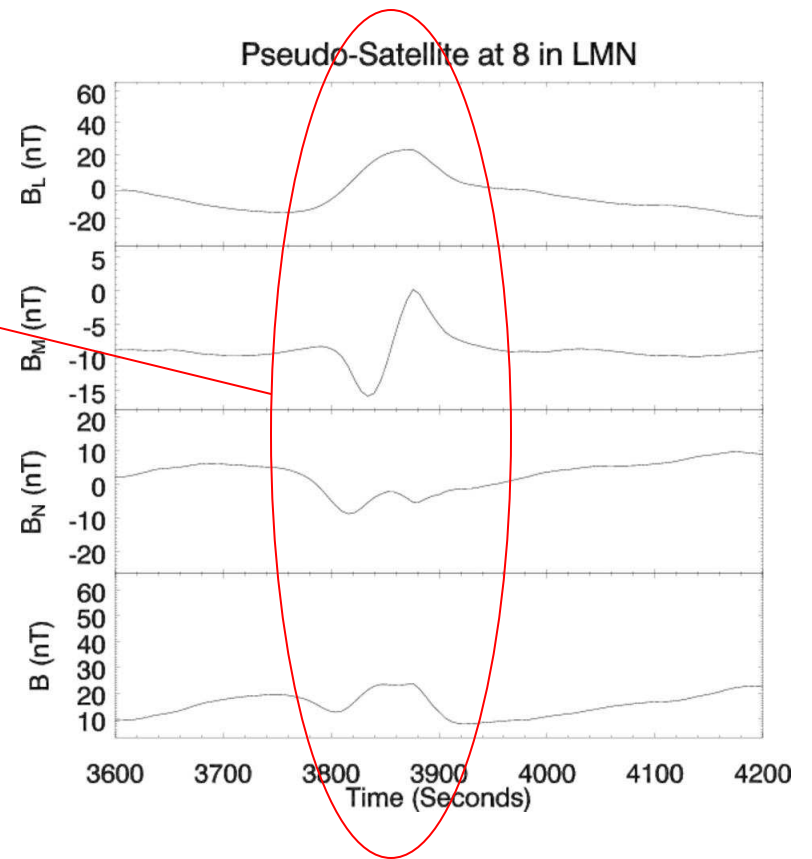
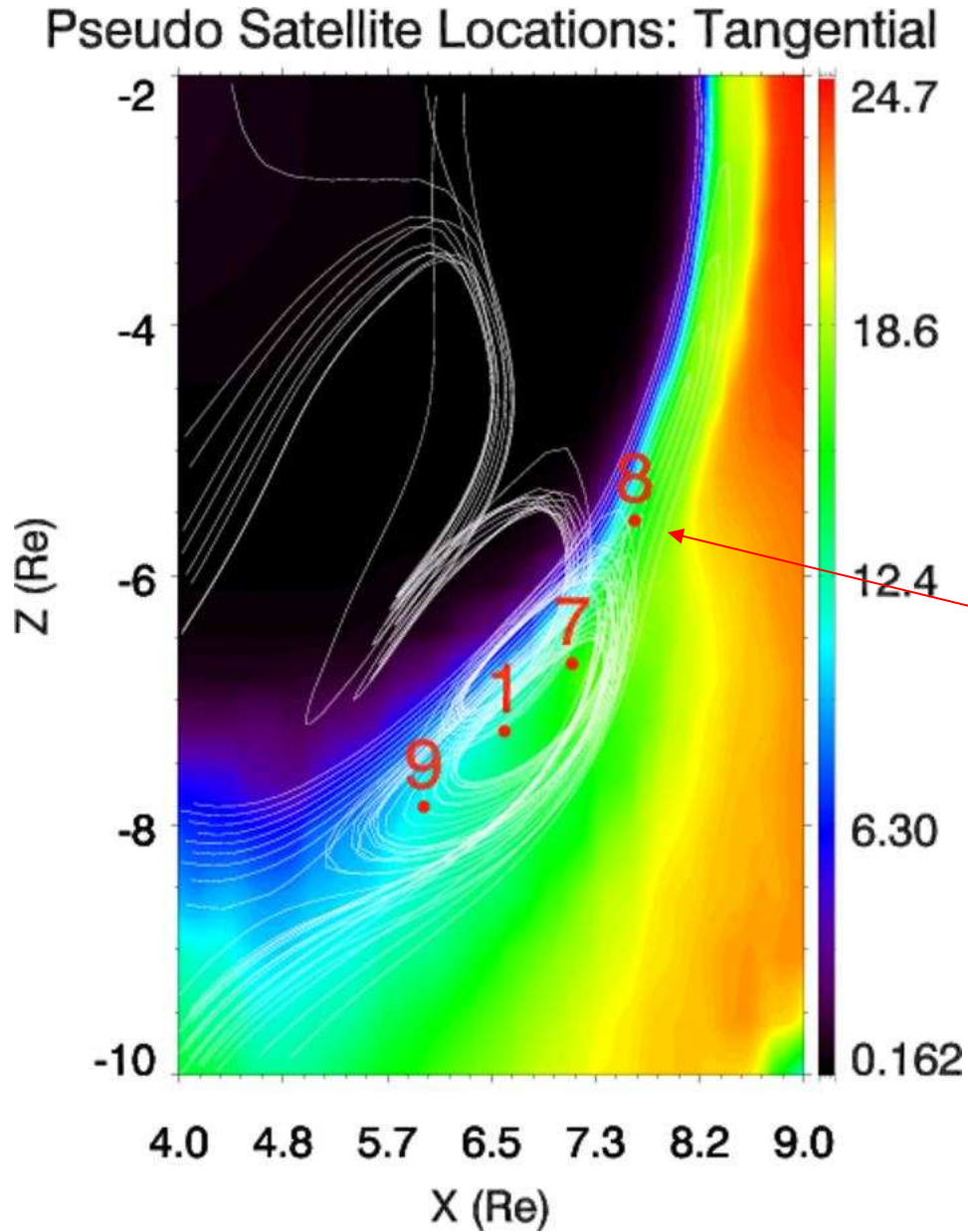
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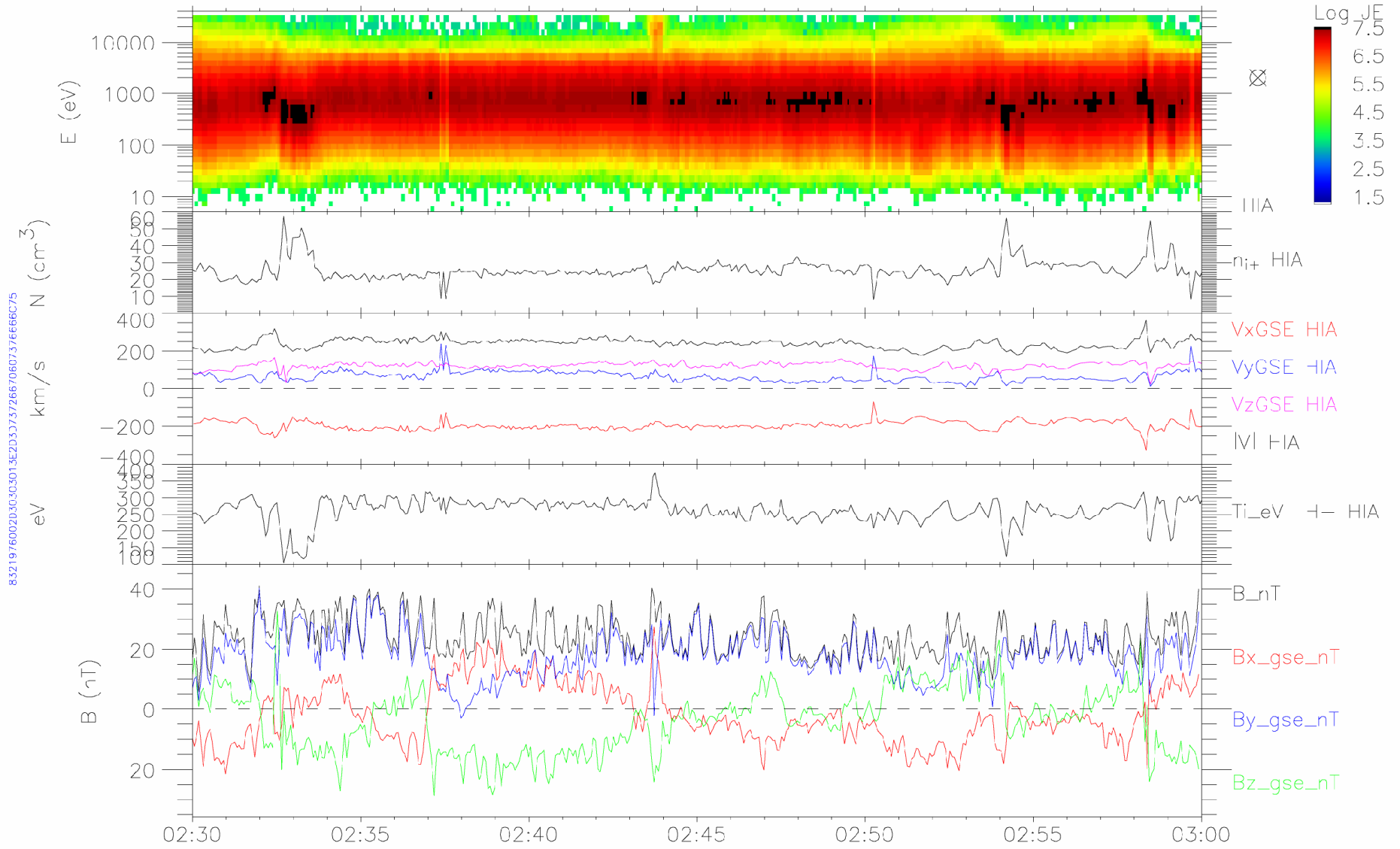
Raeder, 2003, 2005, Wang et al., 2004
MHD Simulations of FTEs



CIS-HA

RUMBA (SC 1)

21/Mar/2002



8321976002030303013E2D3373726670607376E66C75

XGSE	5.58	5.75	5.94	6.10	6.29
YGSE	1.46	1.42	1.36	1.31	1.26
ZGSE	8.15	8.17	8.20	8.22	8.24
DIST	9.98	10.09	10.21	10.32	10.44