CLUSTER OBSERVATIONS OF A FLUX TRANSFER EVENT (FTE)

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On Jan. 26th, 2001, around 11:31 UT, Cluster crossed an isolated FTE.
Data from several instruments on Cluster (PEACE, CIS, EFW, FGM, WHISPER and STAFF) are used to investigate the structure and the dynamics of this FTE.

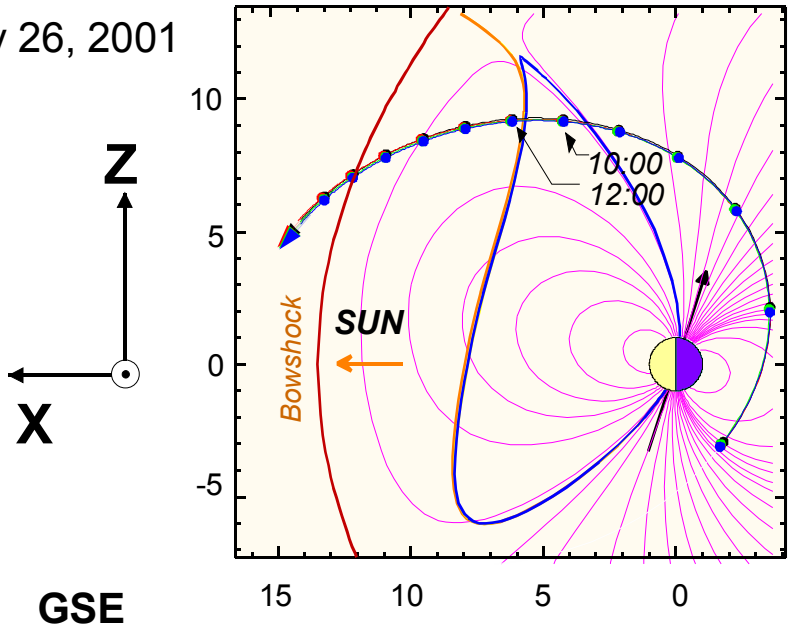
- Data from FGM are used to identify the FTE, determine the current density, and identify main discontinuities between different regions of space.
- Data from Particule experiment are used to identify the regions of space between the discontinuities.

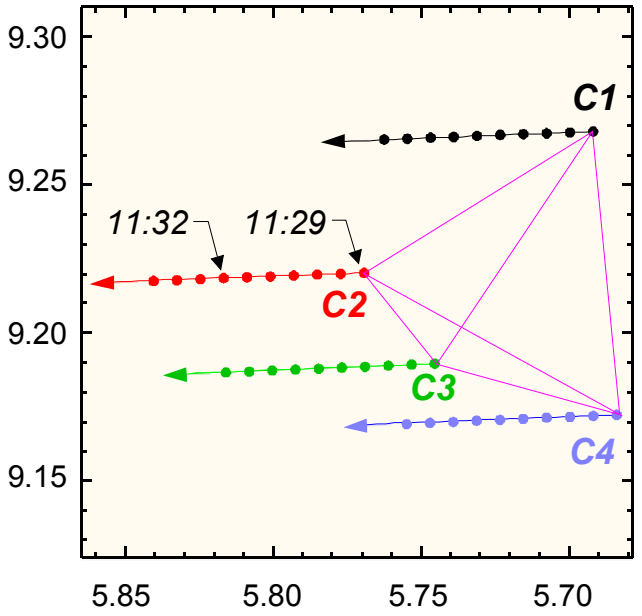
The analysis of Field and particules data suggest a scenario, different from previous interpretations, based on a bulge propagating along the magnetopause, and leaving behind it open magnetic field lines.

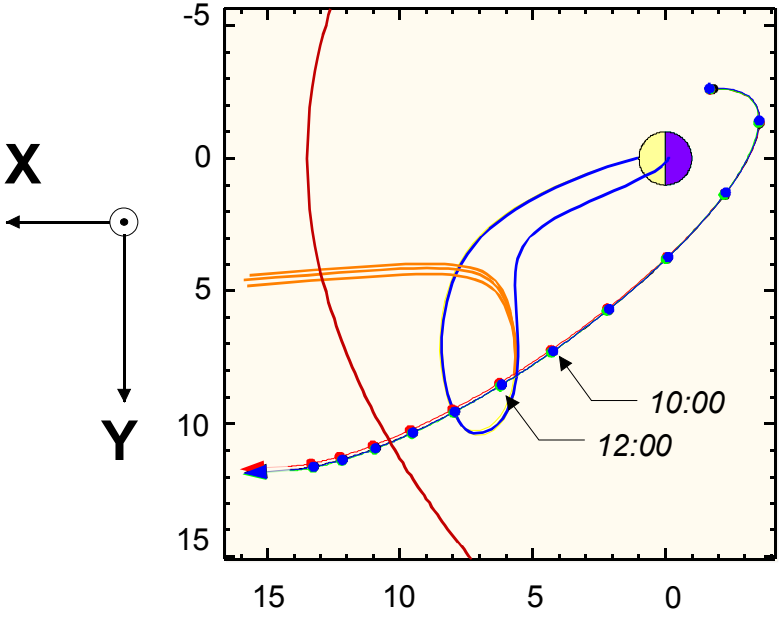
A Second FTE, occurring 40 s. later, is also studied and leads to similar conclusions.

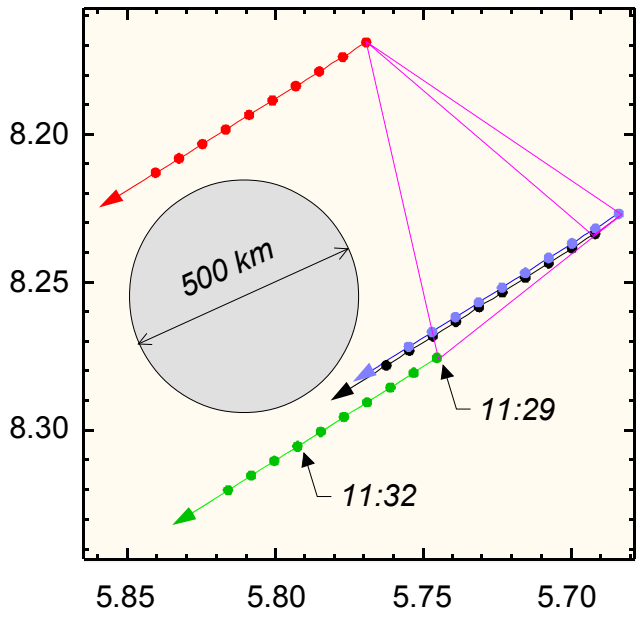
1 – Context of the event from orbital data

January 26, 2001

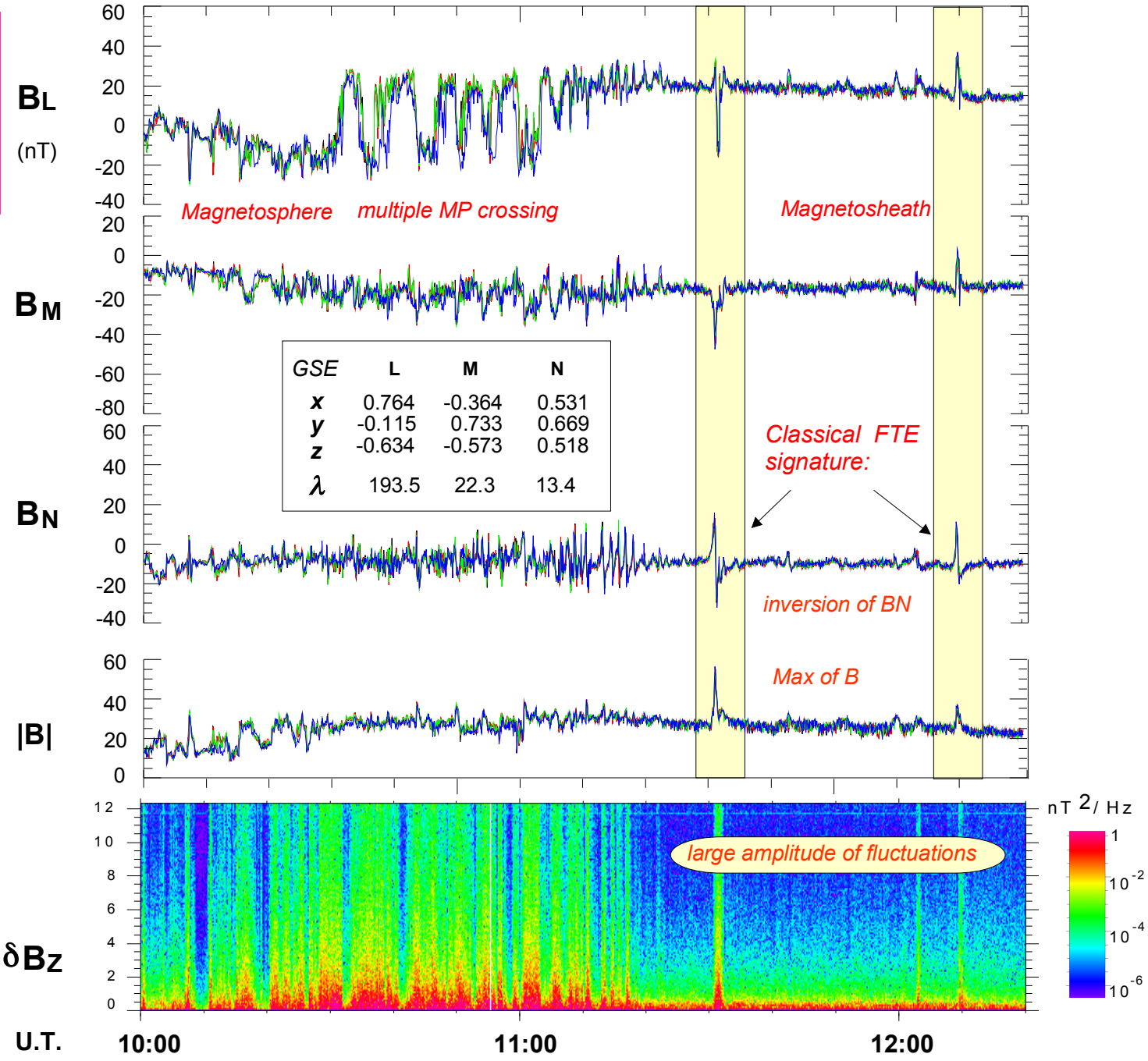








2
Identification of a FTE by magnetic signature

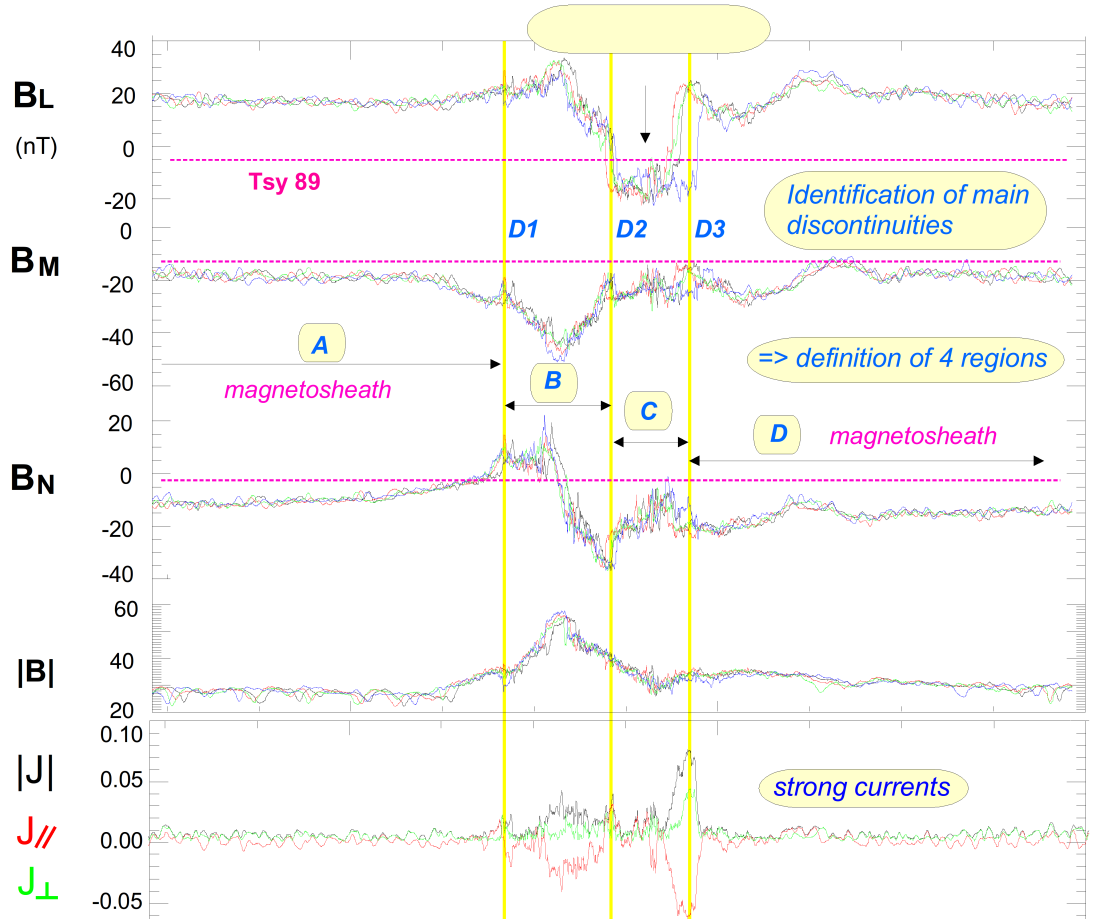


FGM
4 S/C

STAFF
Cluster 3

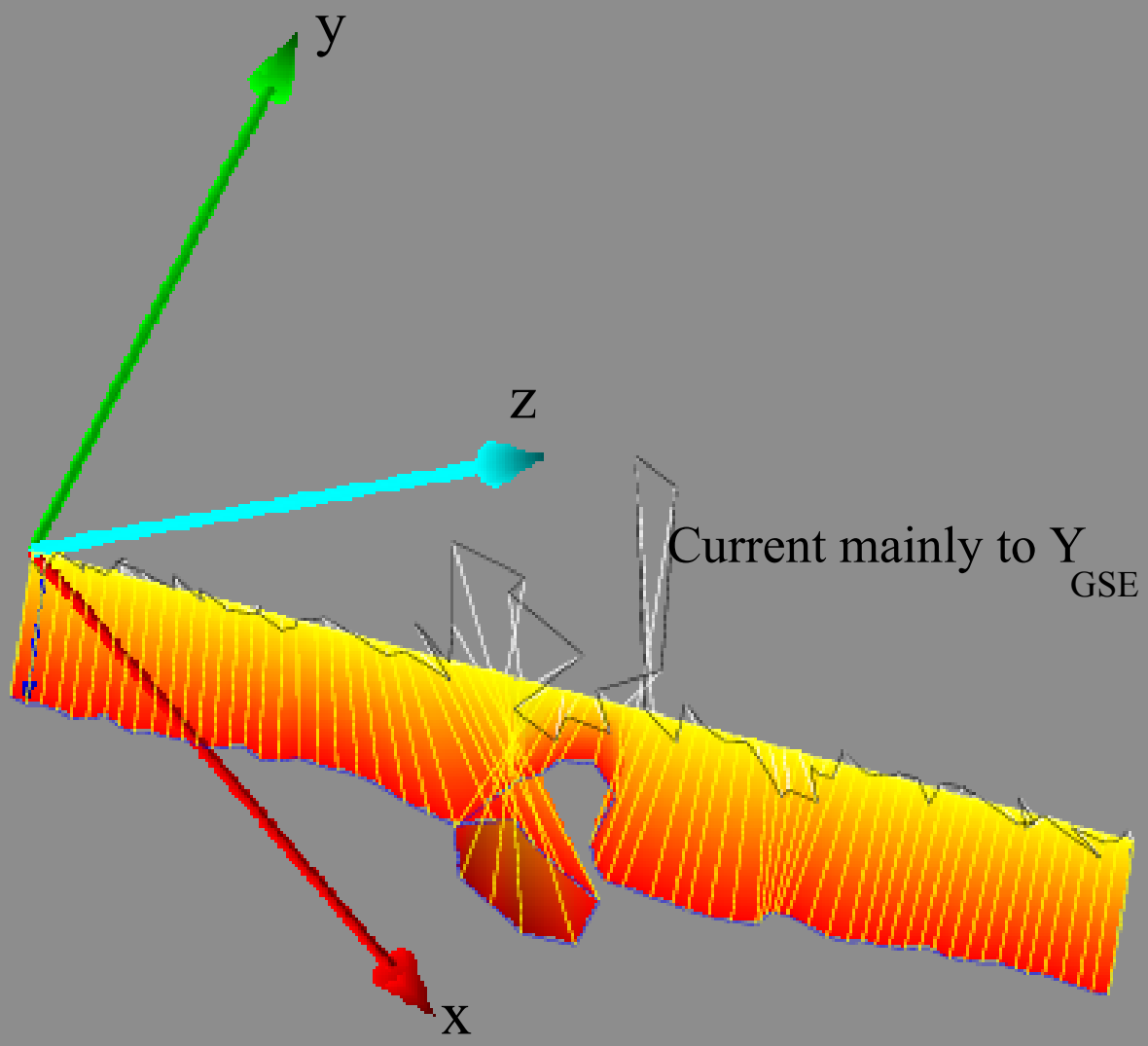
3
Zoom on field data: Identification of discontinuities

FGM
4 S/C



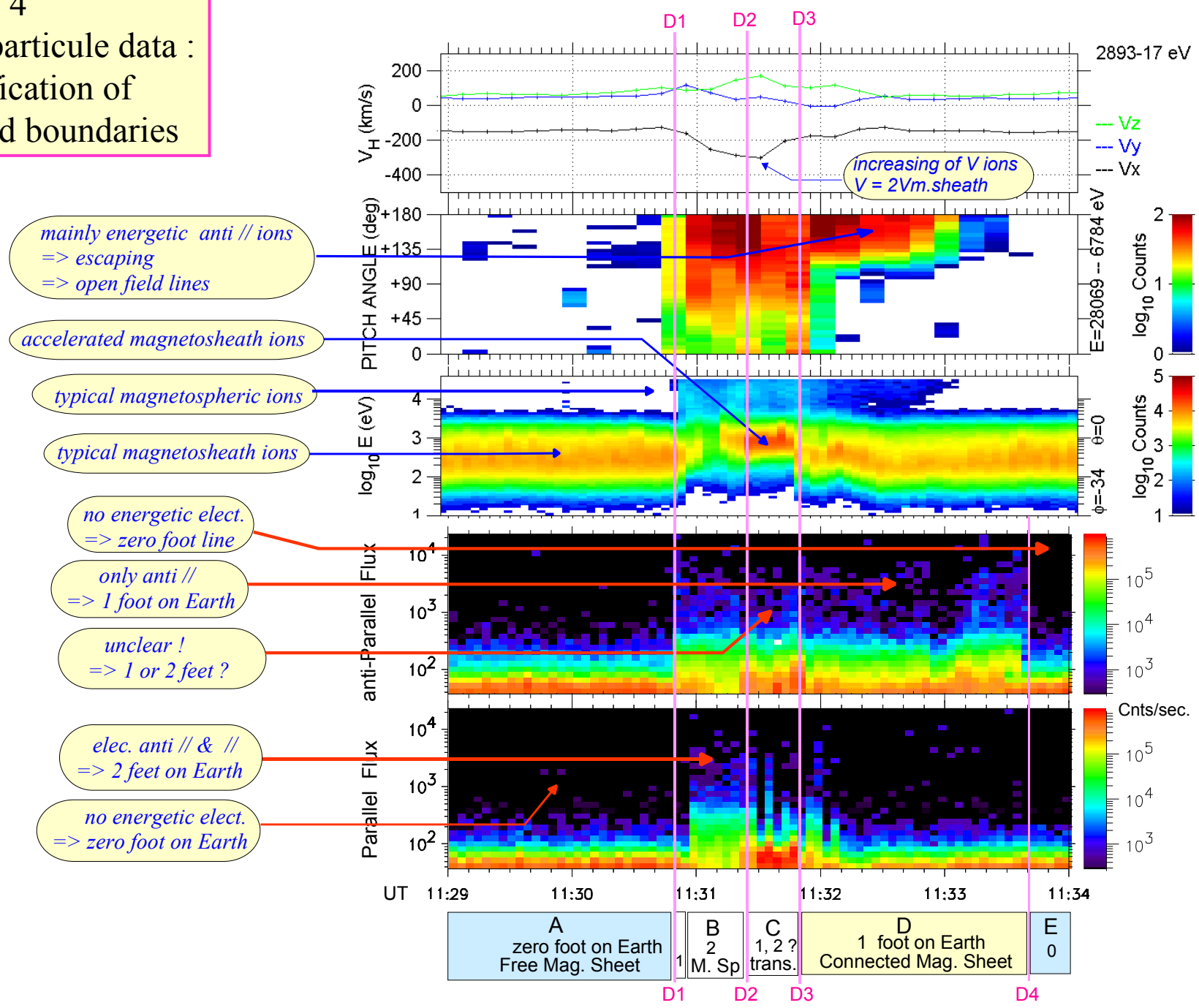
CLUSTER/FGM

2001_Jan_26_11:29:07.902



CETP

4
Zoom on particule data : Identification of region and boundaries



ions acceleration due to increasing Vi

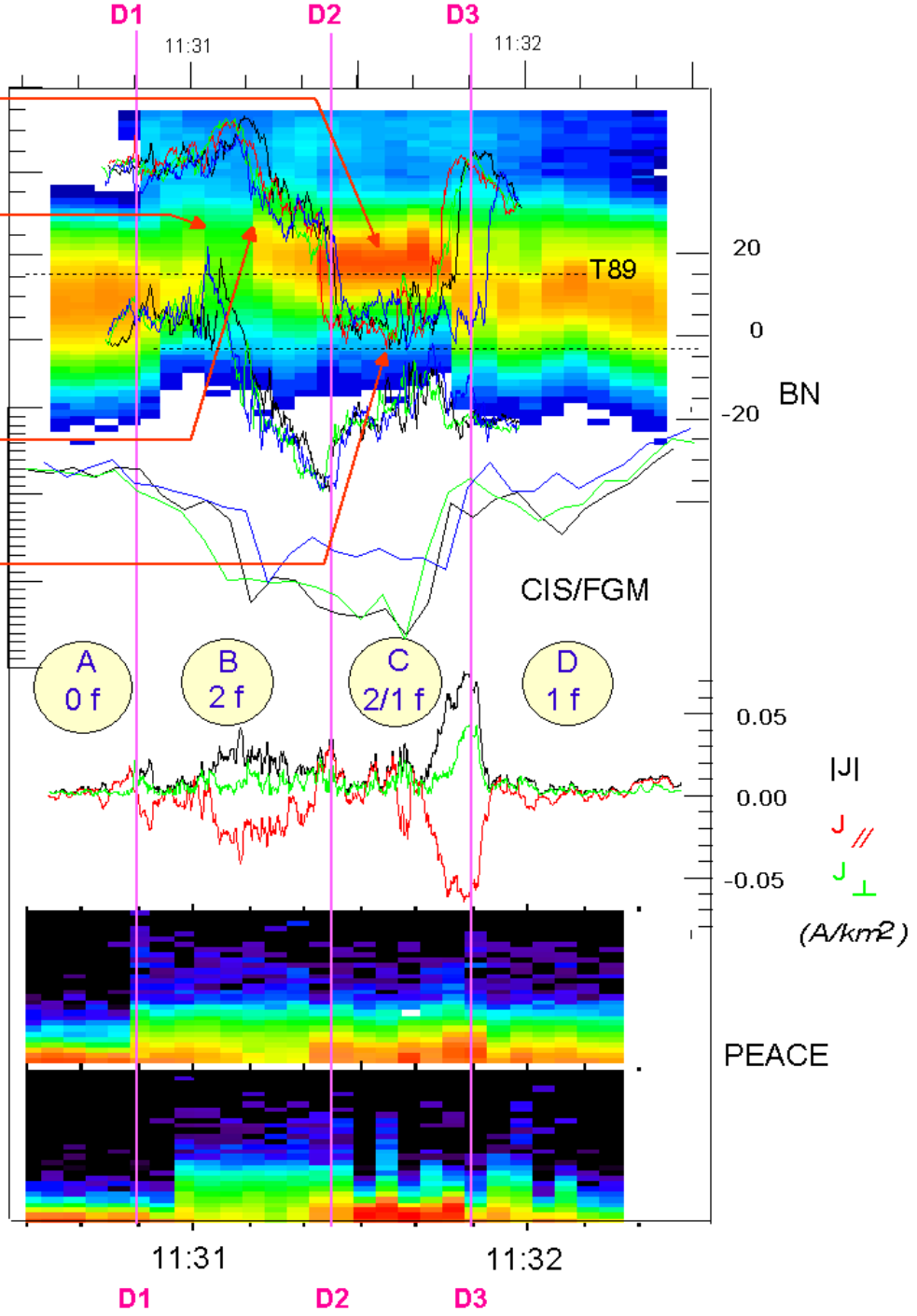
but acceleration on closed field lines, inside mag. sphere !! => penetration of ions on closed field lines

Mag field different from T89 but field lines closed !!

Mag field near T89 but field lines alternatively open / closed !!

(Perfect fit with B in TPN system)

Apparent contratiction between Field and particle data



5

Zoom again on the FTE itself, both with field and particules data to try to understand…

6
Suggest a model based on propagation of a bulge along L

VDL : along the L axis

VDn : normal to the discontinuity plane

VDtg : tengent to the discontinuity plane

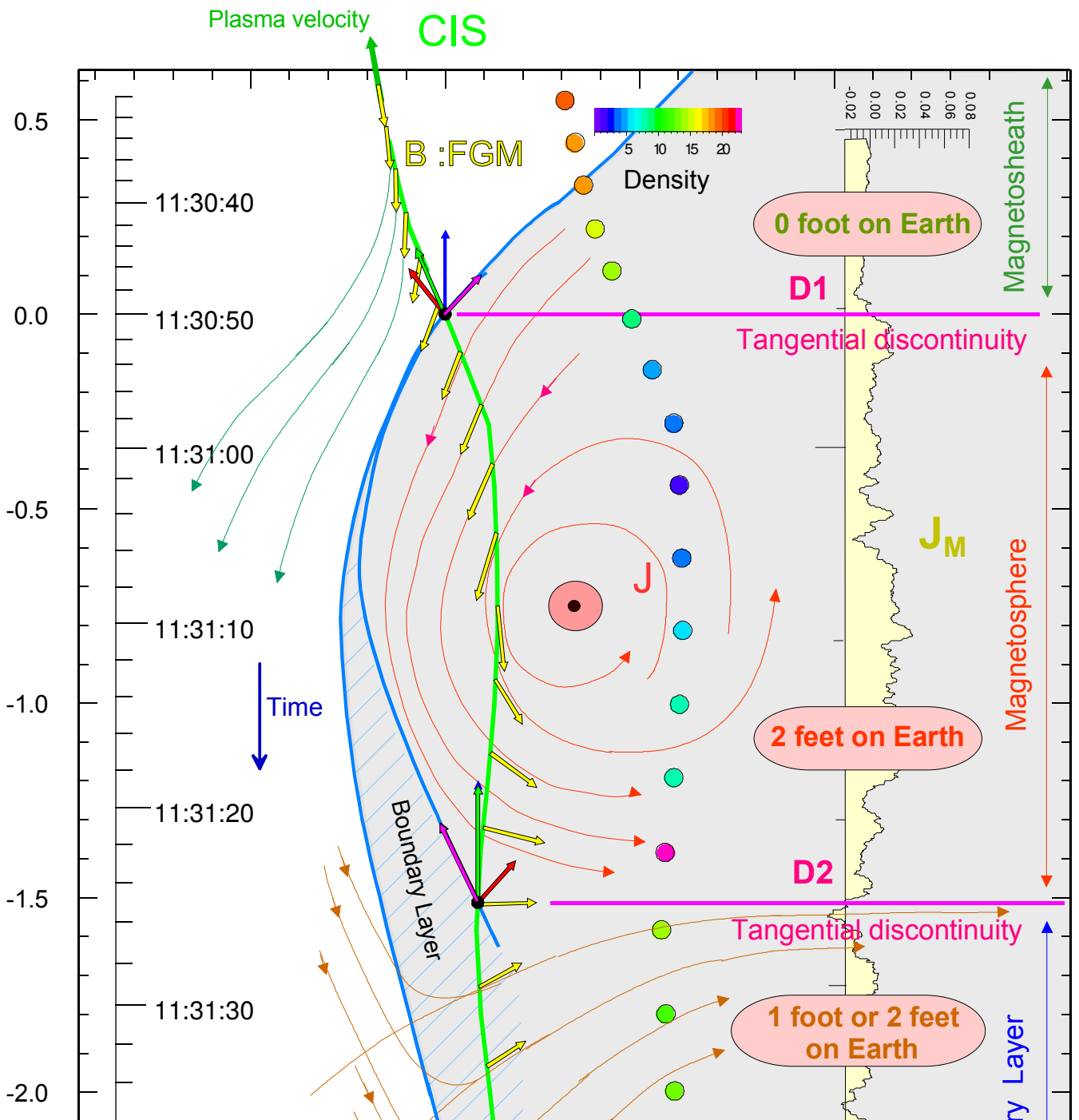
VP: Plasma

Tang. Discont. :

Vn=0
Bn=0
ΔBtg≠0

Rot. Discont. :

Vn≠0
Bn≠0
ΔBtg α Δ Vtg
Dens. n1=n2



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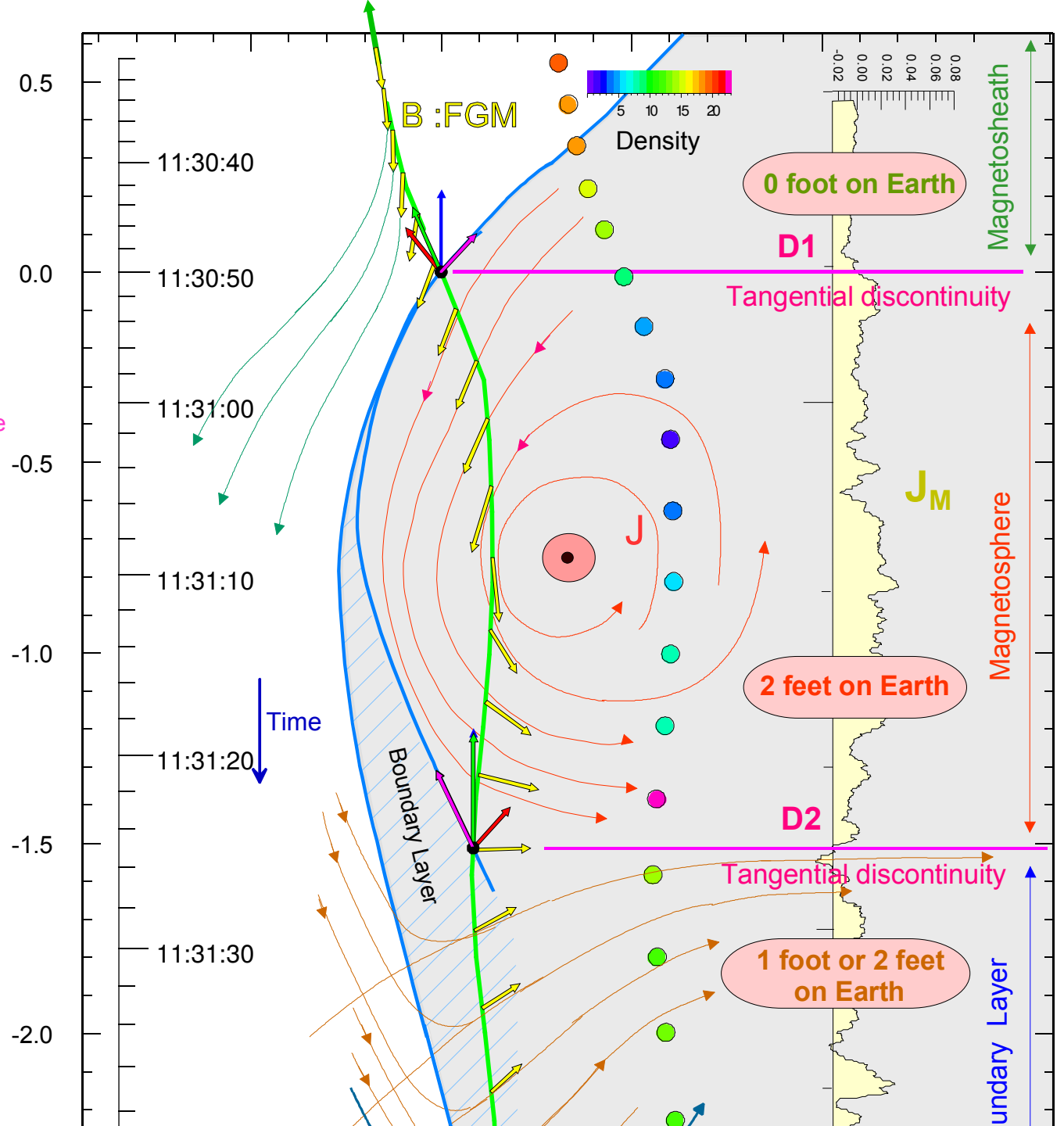

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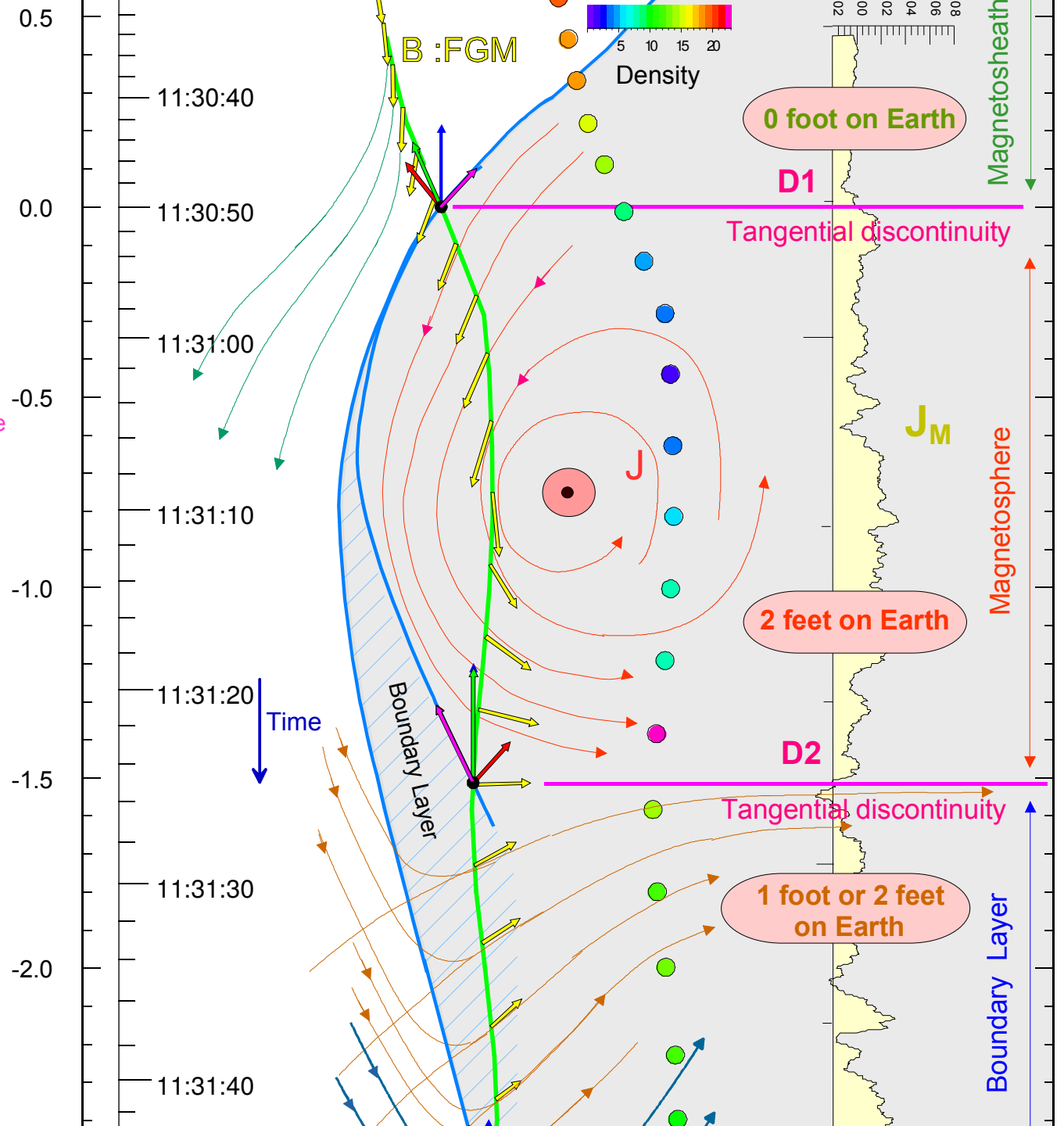

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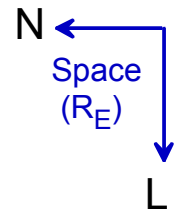

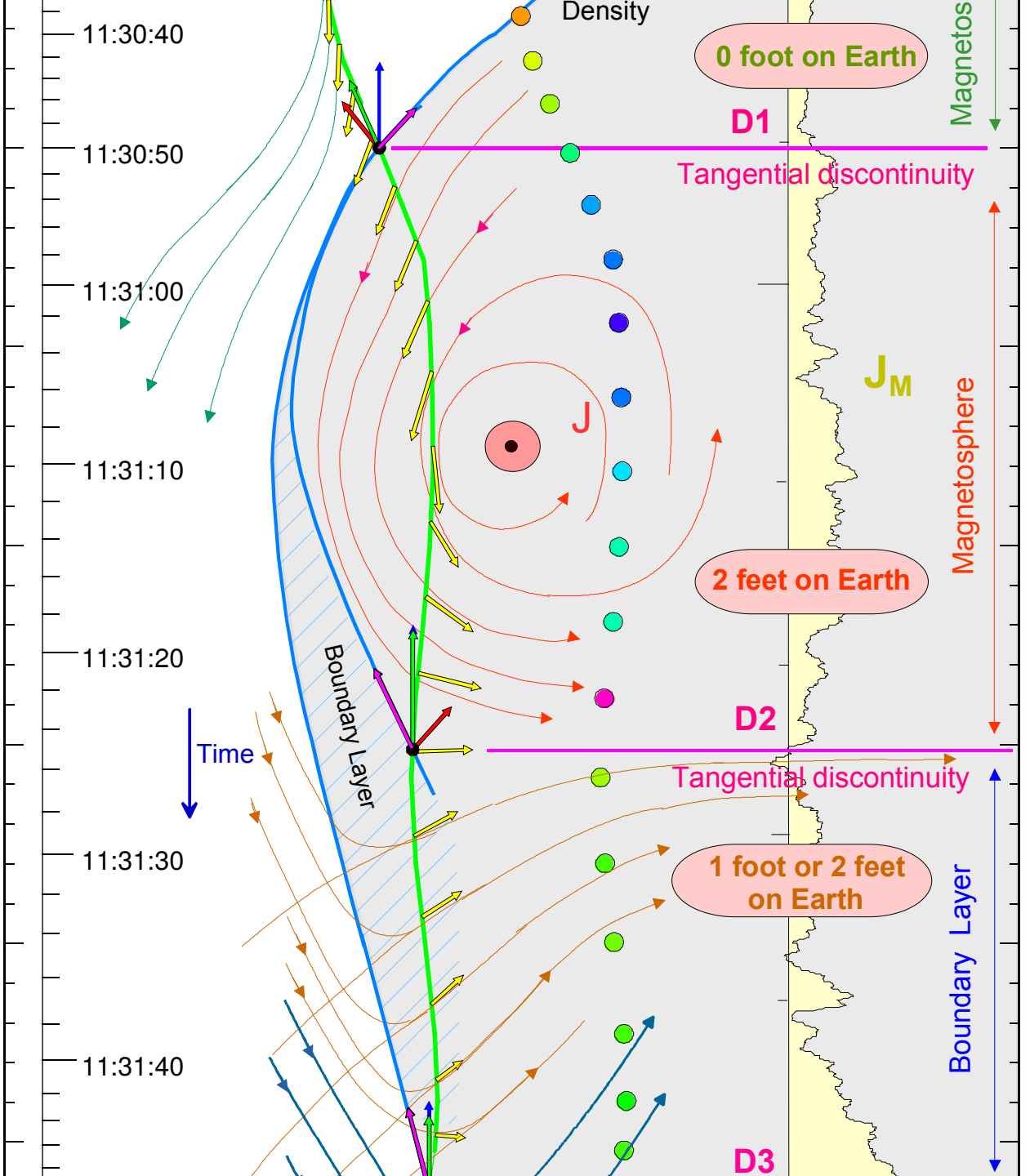

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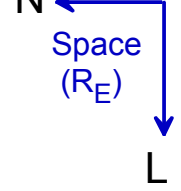

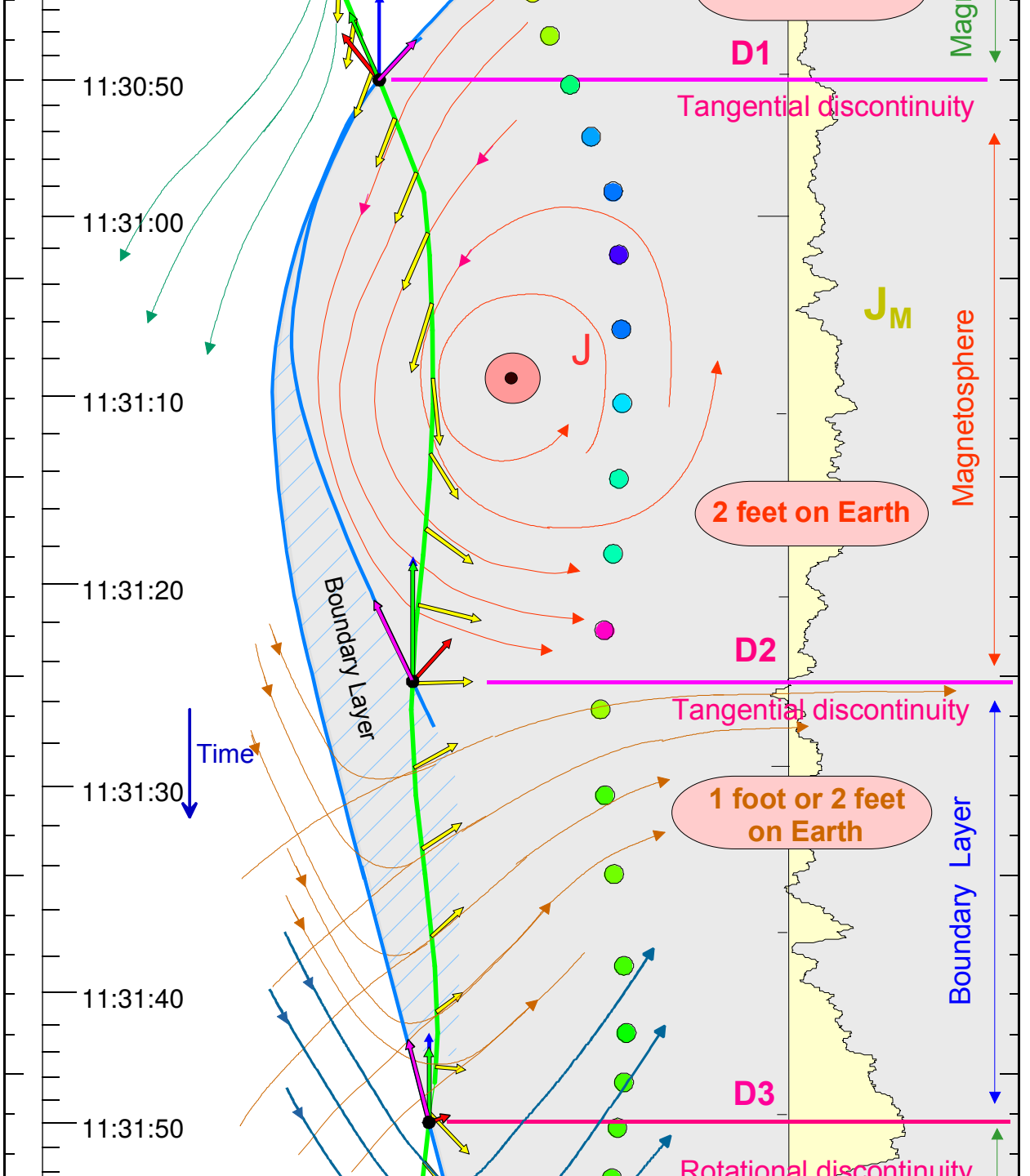

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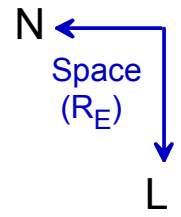

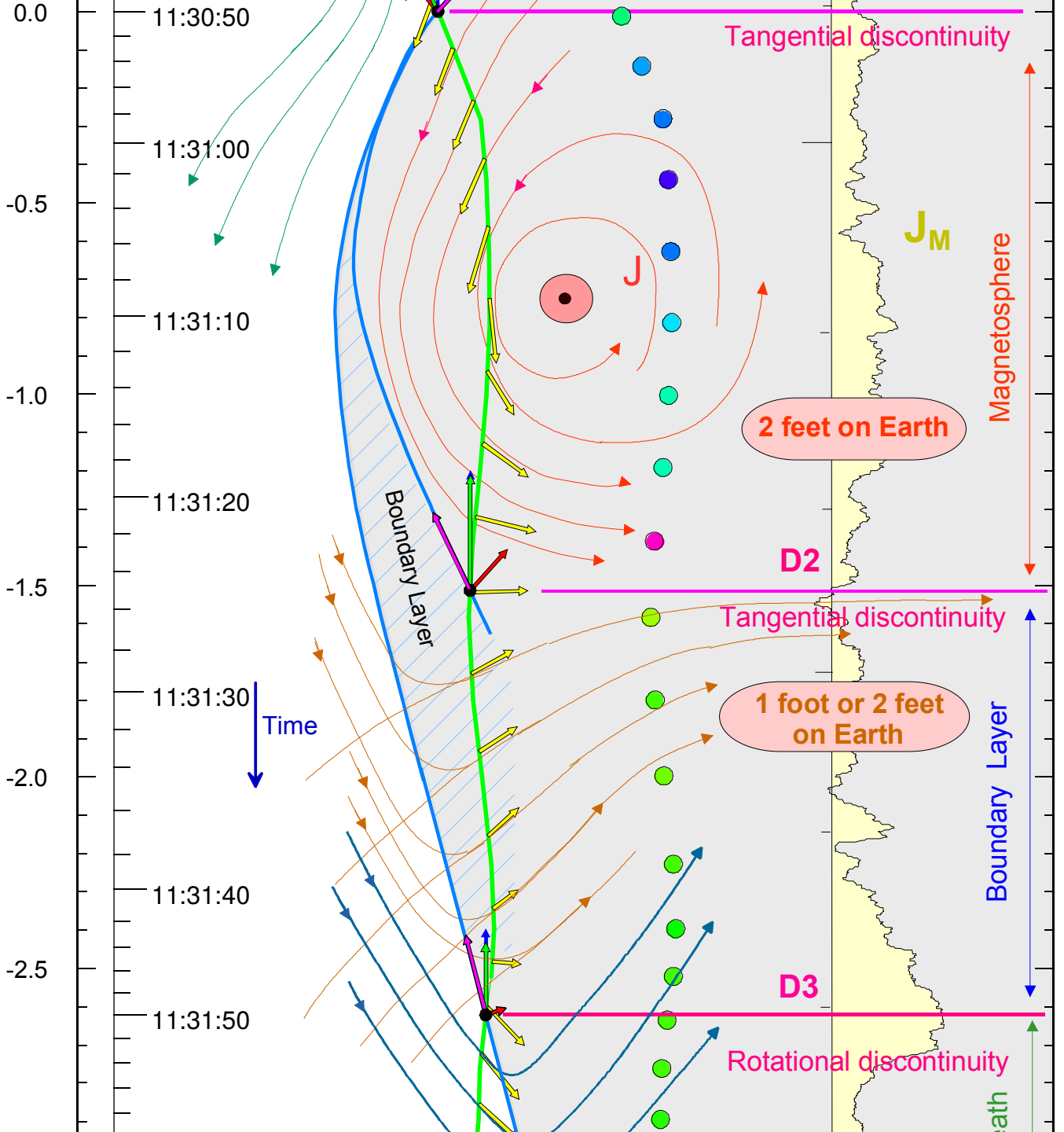

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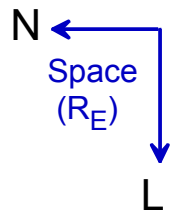

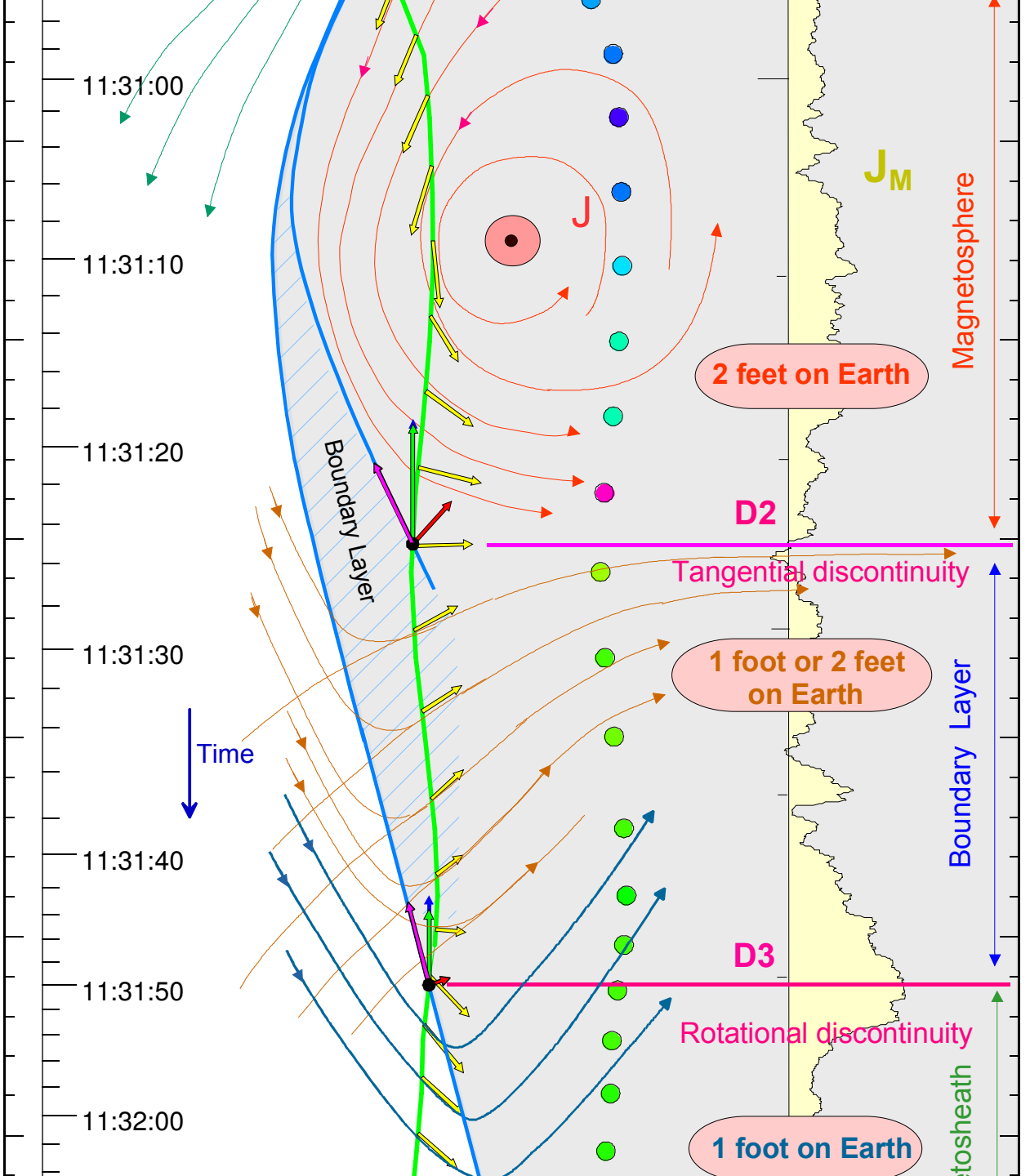

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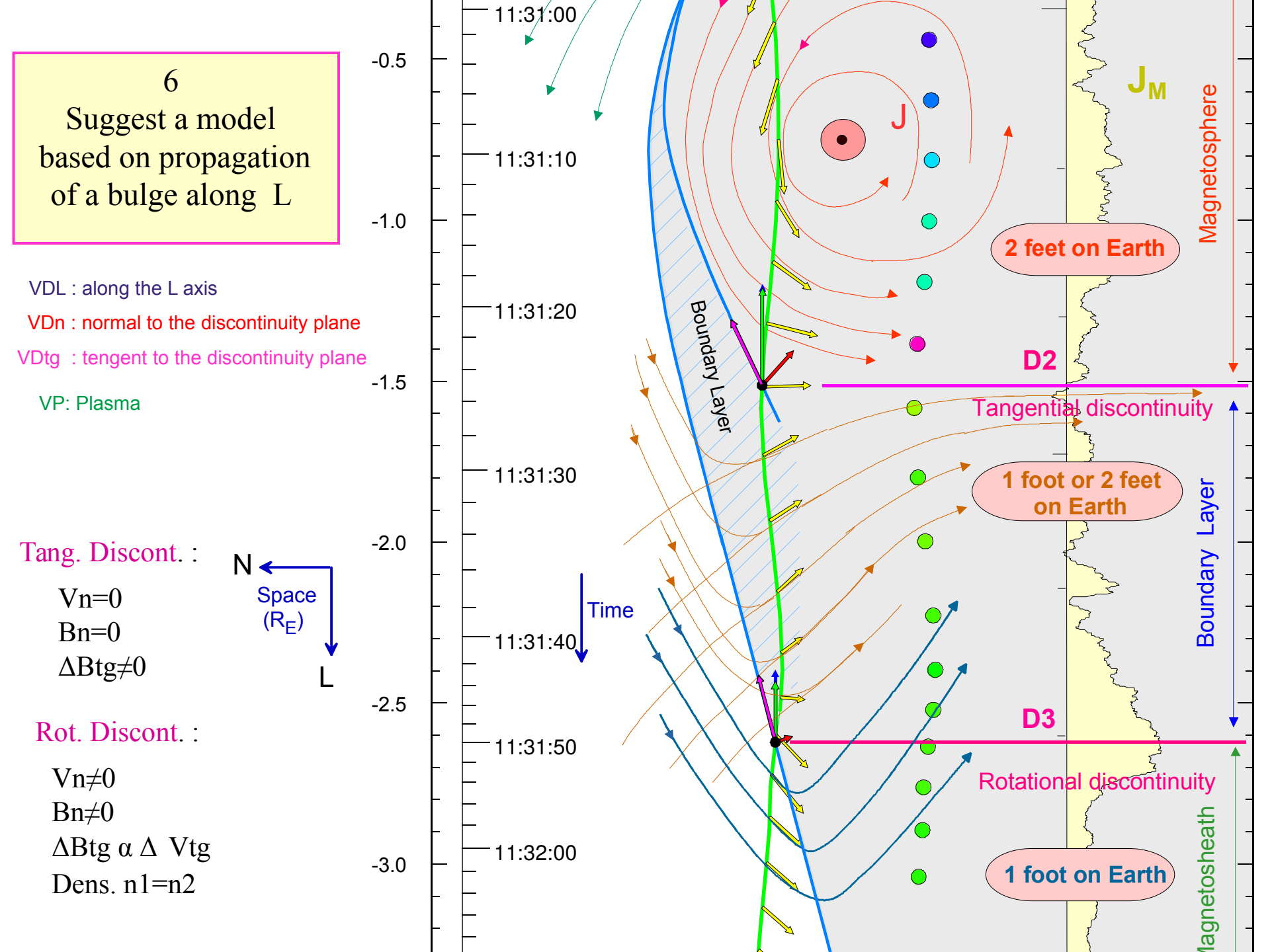

And the bulge leaves behind it open field lines…

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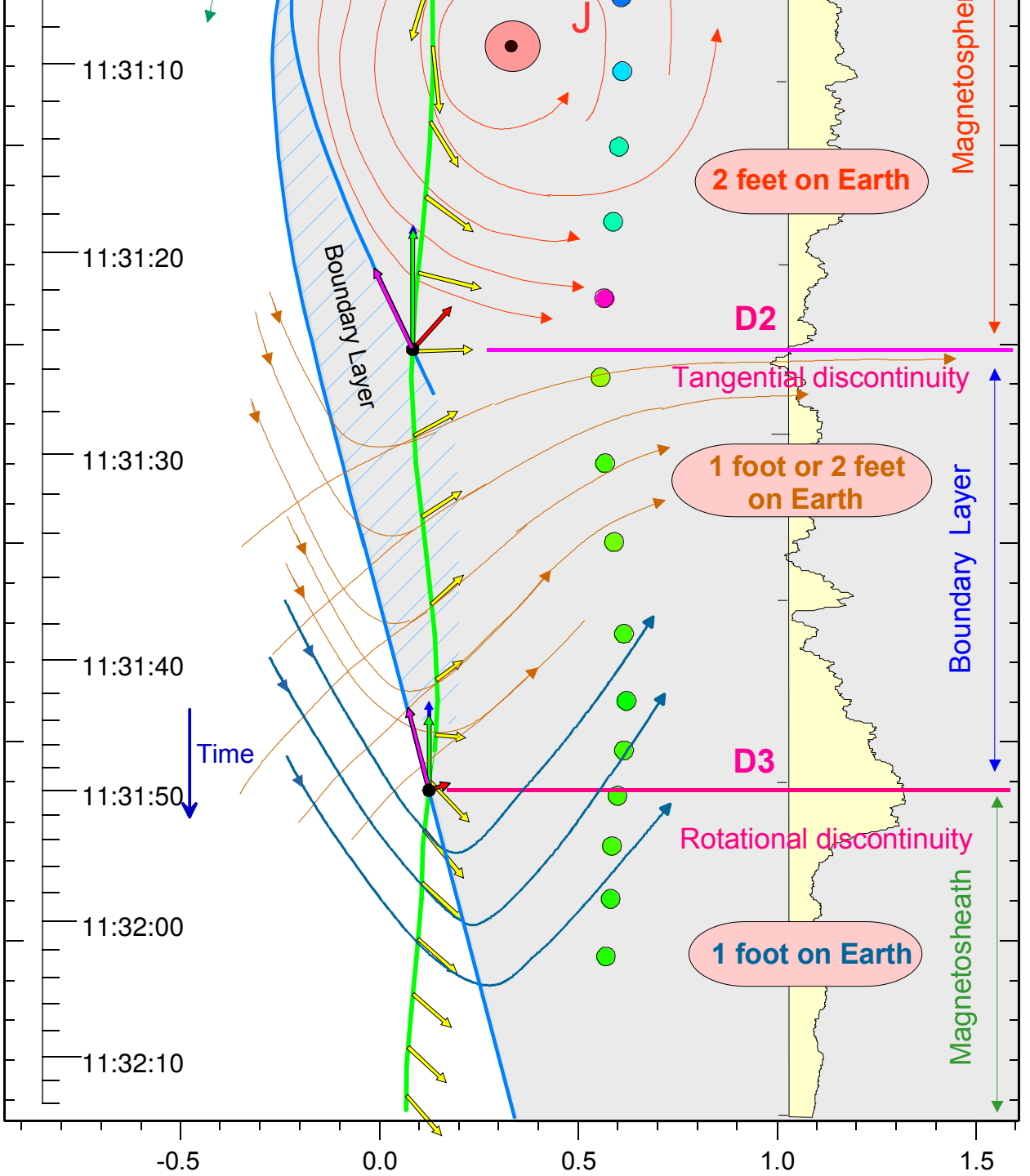
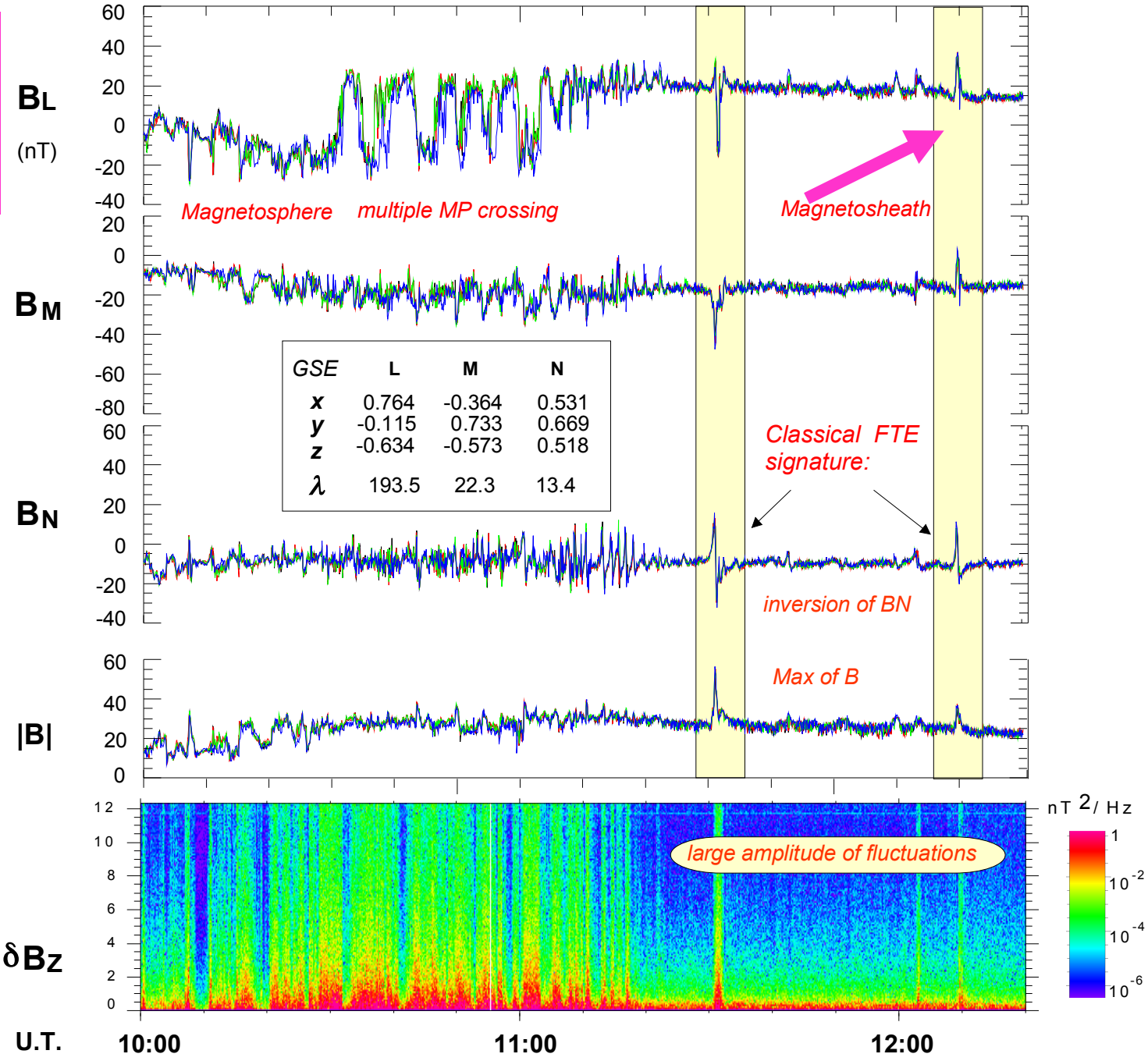


7

Identification of a 2nd FTE by magnetic signature

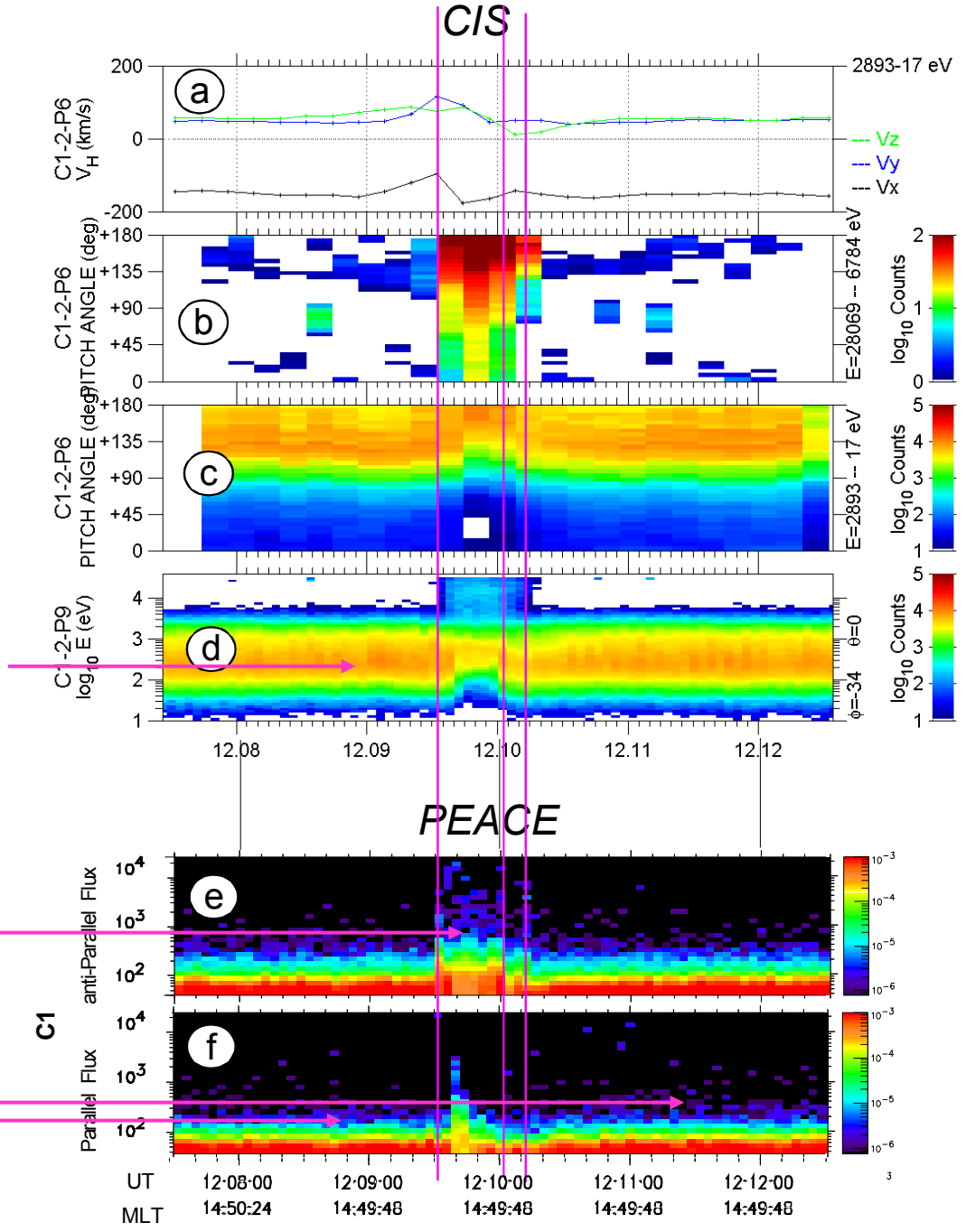


FGM 4 S/C

STAFF Cluster 3

8

Case 2:
Zoom on particule data :
Identification of
region and boundaries



Typical magnetosheath ions

Elect. // and anti//
⇒2feet on the Earth
⇒ magnetosphere

No energetic electr.
=> zero foot on Earth
=> Mag. Sheet

9

Same model
applied to case #2

VDL : along the L axis

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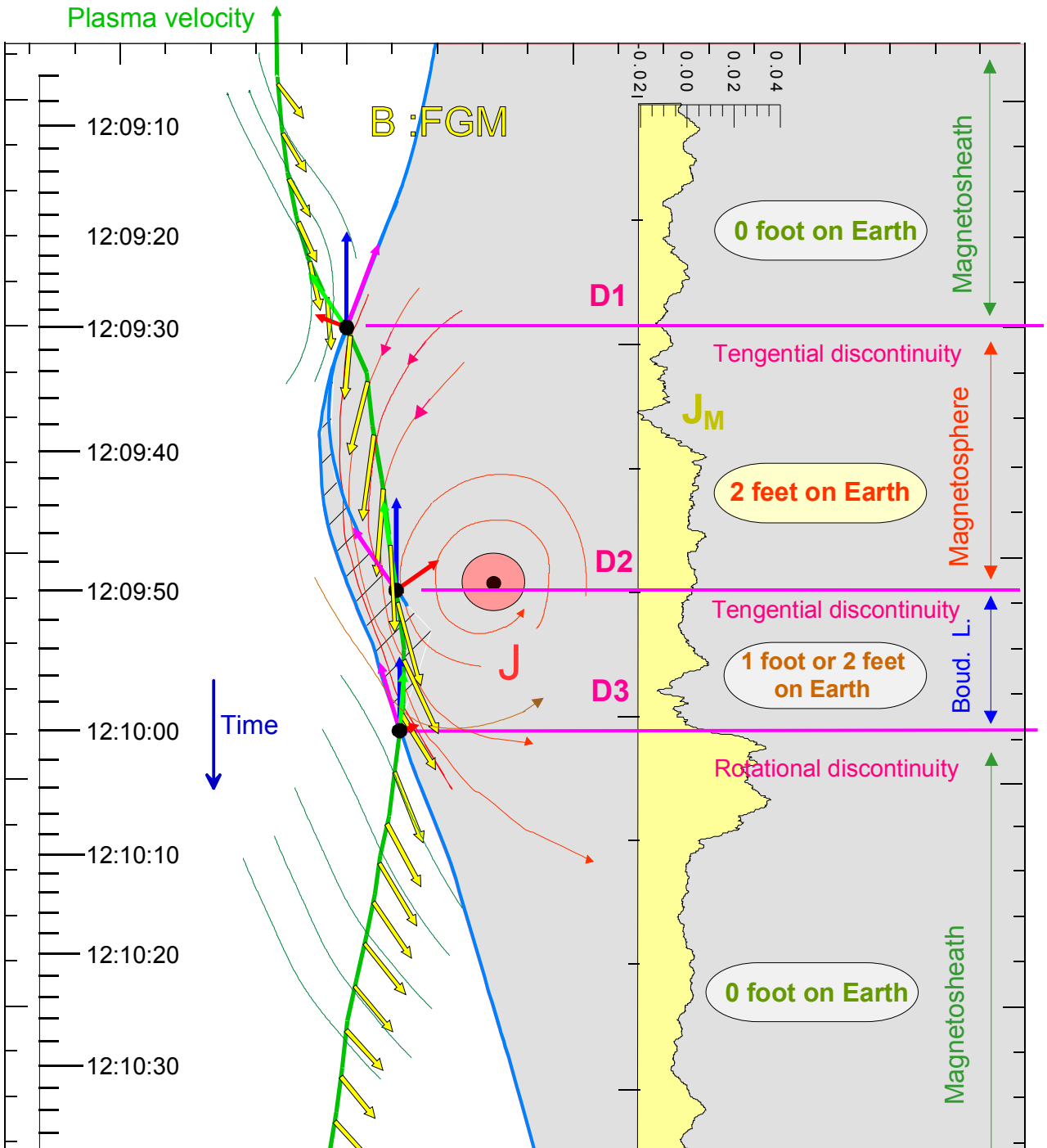

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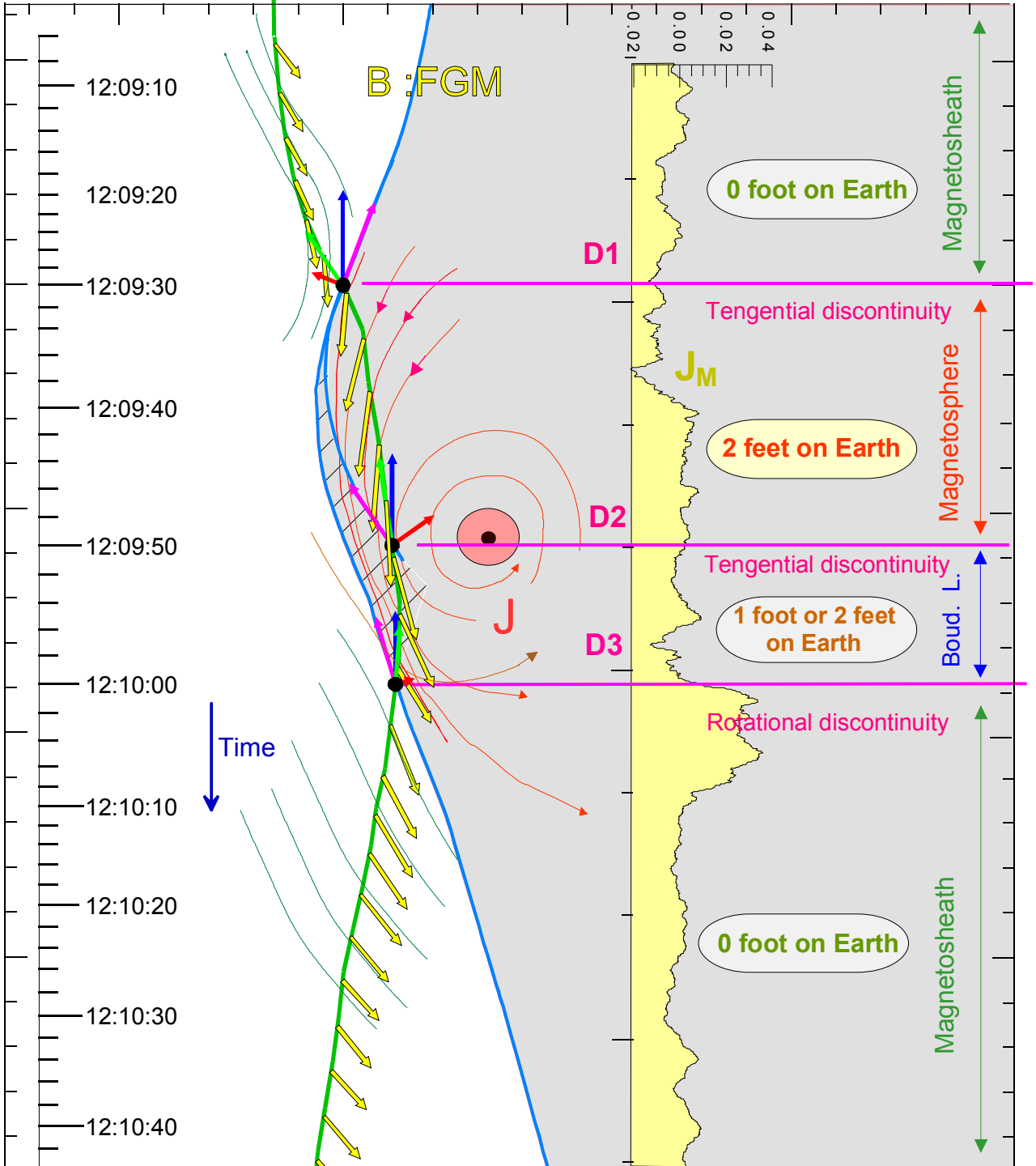

9
Same model
applied to case #2
leads to
the same conclusions

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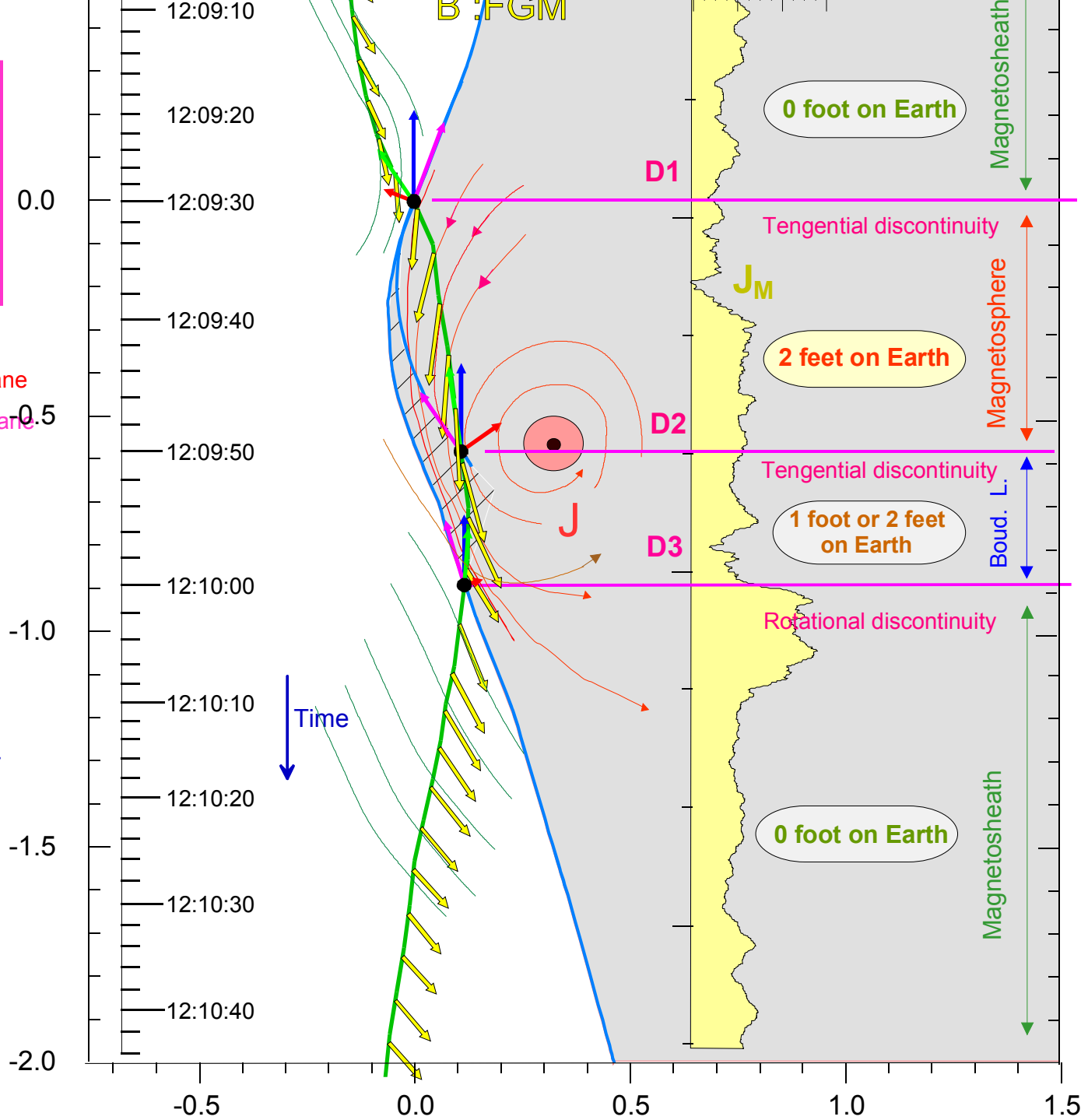
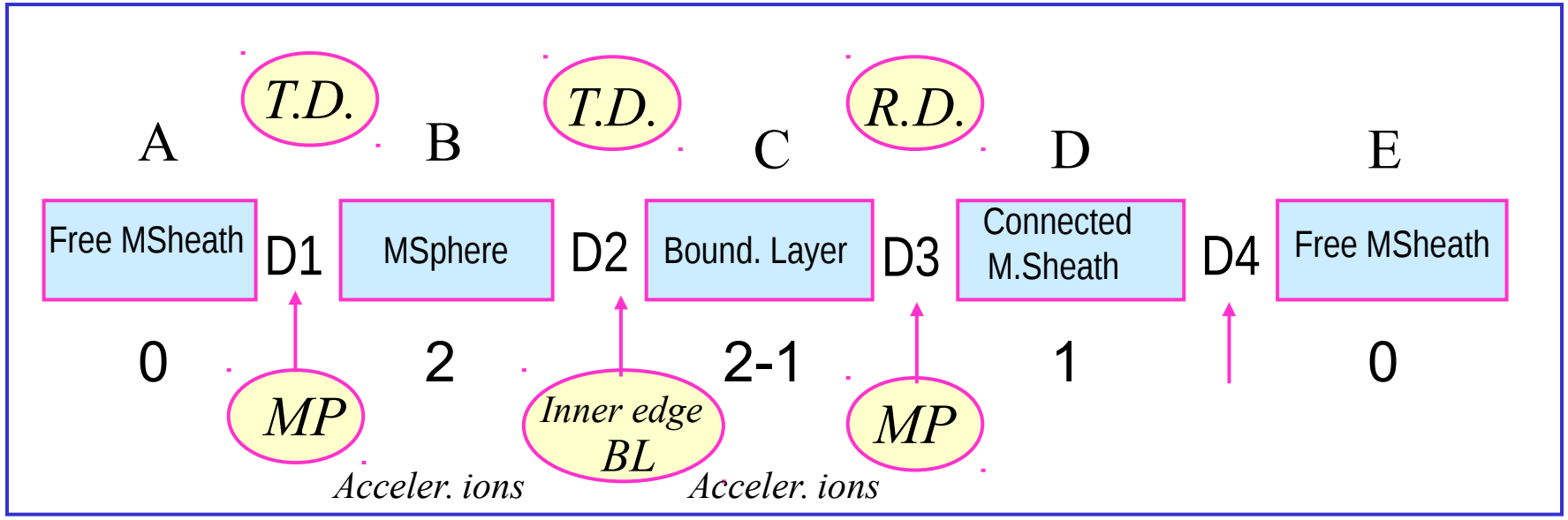


SUMMARY

1. The FTE is a force free current density structure (J~Jy). Signatures of sharp discontinuities are superimposed.
2. As expected from standard FTE model, accelerated magnetosheath ions are observed on open field lines (with 1 magnetic footprint on Earth), in region C
3. Against expectation, accelerated magnetosheath ions are also observed on closed field lines, in region B. This is not consistent with standard FTE model.



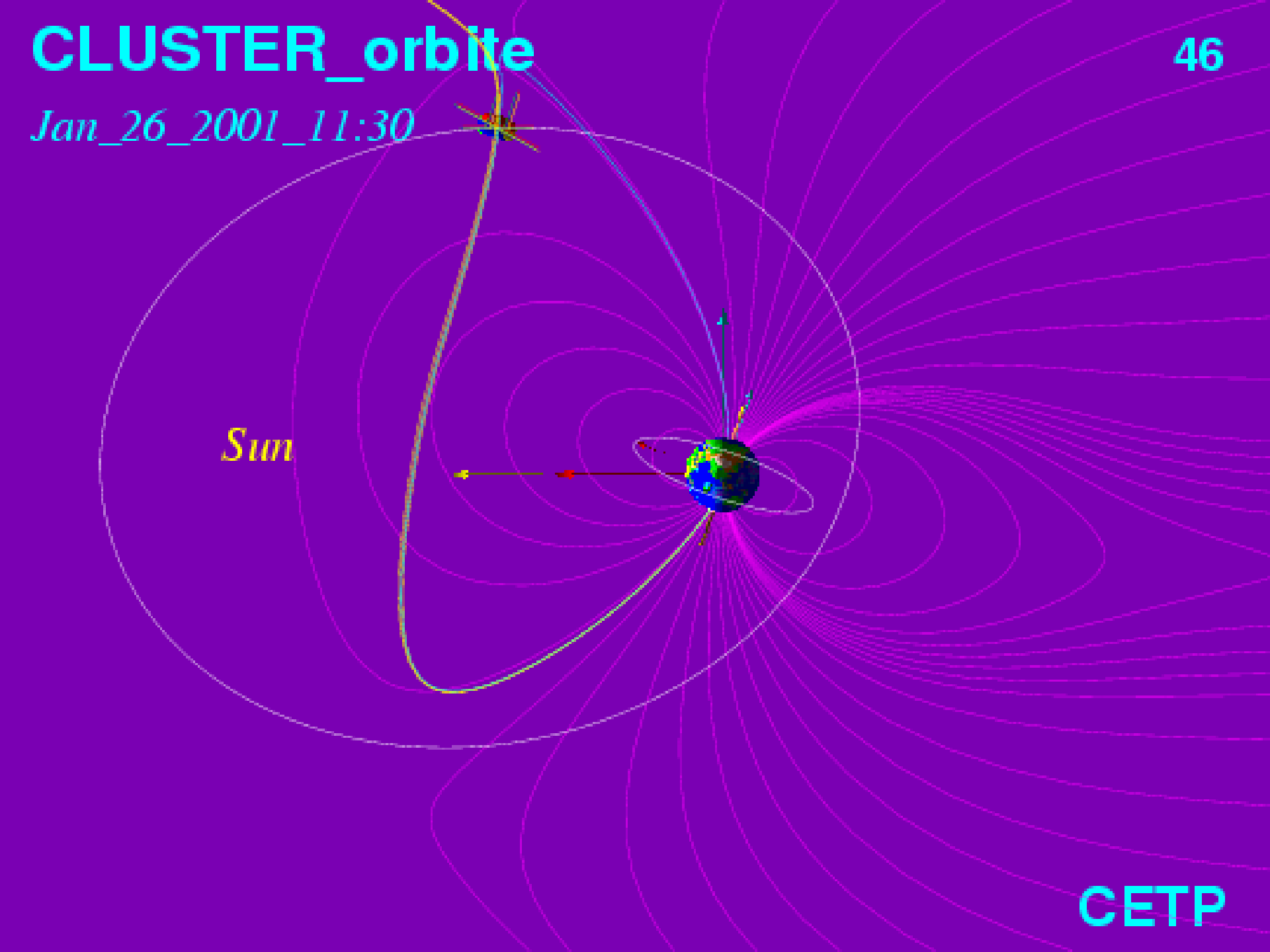
4. Penetration of magnetosheath plasma through Tangential discontinuity (D1 and D2) is consistent with diffusion. Vdiff ~ 30 km/s at D2, computed from the observed level of fluctuations (~ 3-5 nT).

CONCLUSIONS

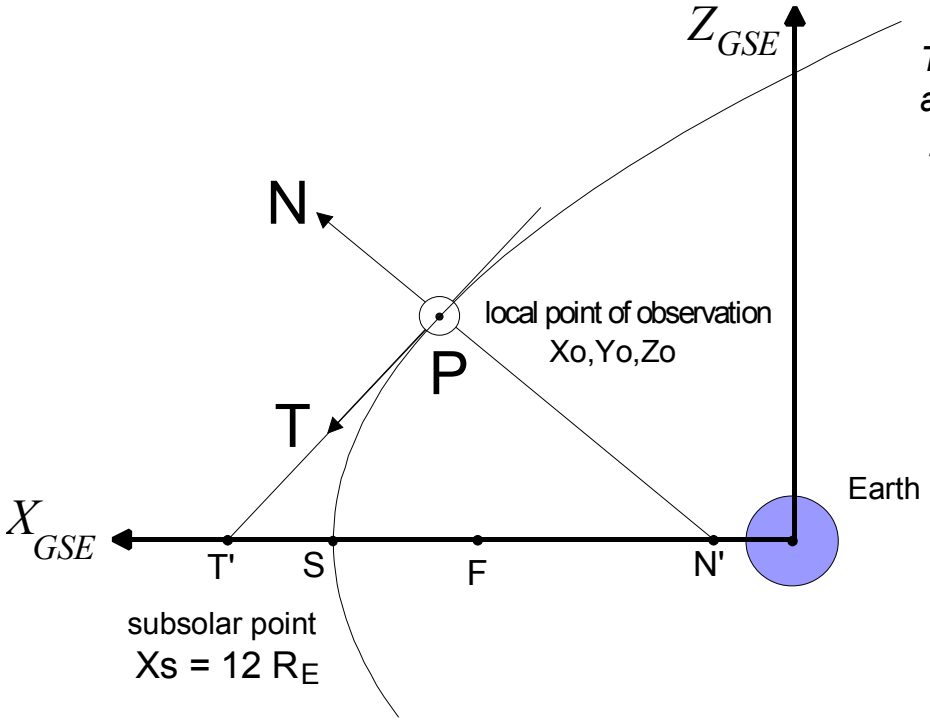
Two cases has been studied in details, and lead to similar conclusions:
FTE is not simply a reconnected flux tube moving along magnetopause ; it is more complex. A possible scenario is:

- A magnetic pressure pulse moves along magnetopause (as in Sibeck's model)
- At its training edge, magnetosheath plasma penetrates diffusively on closed field lines
- Fast diffusion might lead to the opening of magnetospheric field lines:
  Indeed, opening of FL is easy because Bx and By change sign at D2, while By (guide field) is constant.
- Field line bending (at D3) accelerates ions, as in standard FTE model.

The bulge propagating along the magnetopause, and leaving behind it open magnetic field lines, plays role of a field line cutter


CLUSTER_orbite
46
Jan_26_2001_11:30
Sun
CETP

3 - Remark : LMN coordinate system is close to TPN system



The paraboloid is defined by its summit and the point of observation

The TPN system is defined as:

$\vec{T}$= local tangent toward the summit

$\vec{P}= \vec{N} \times \vec{T}$

$\vec{N}$= outward normal

GSE	L	M	N	T	P	N
x	0.764	-0.364	0.531	0.713	0.000	0.701
y	-0.115	0.733	0.669	-0.467	0.746	0.475
z	-0.634	-0.573	0.518	-0.523	-0.666	0.532
λ	193.5	22.3	13.4			

(L,T)= 21.5°

(M,P)= 15°

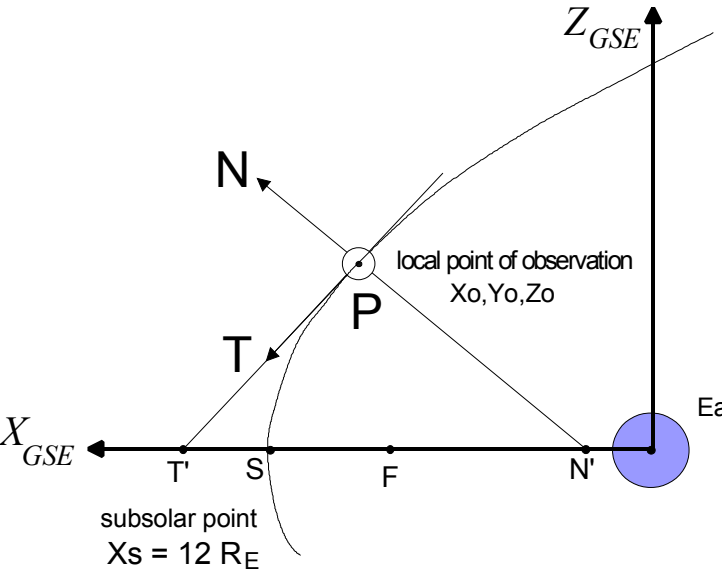
(N,N)= 21.8°

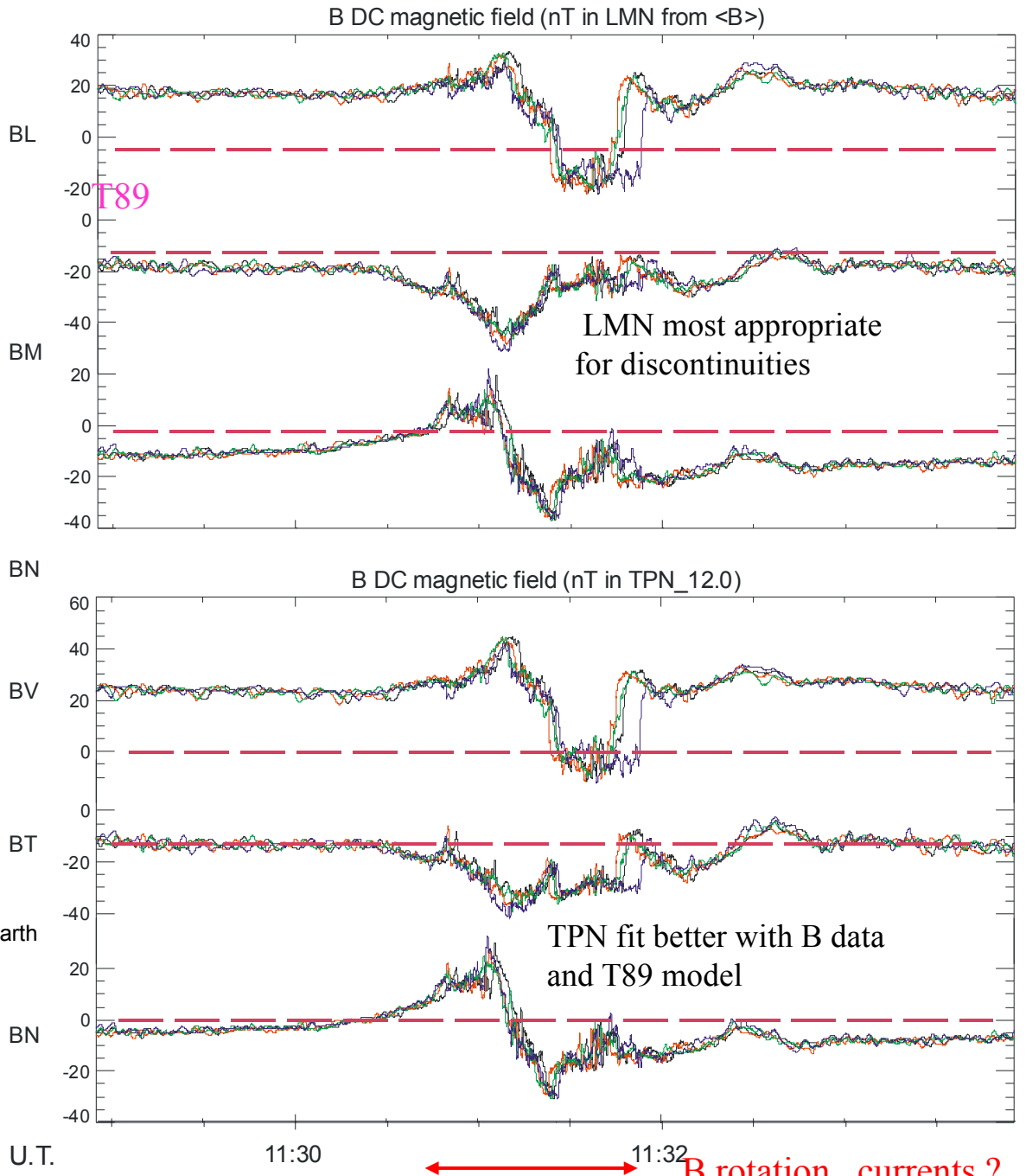
LMN or TPN?

(L,T)= 21.5°

(M,P)= 15°

(N,N)= 21.8°





CLUSTER/FGM

2001_Jan_26_12:10:13.890