Investigating SWMIT Coupling with Global MHD Simulations

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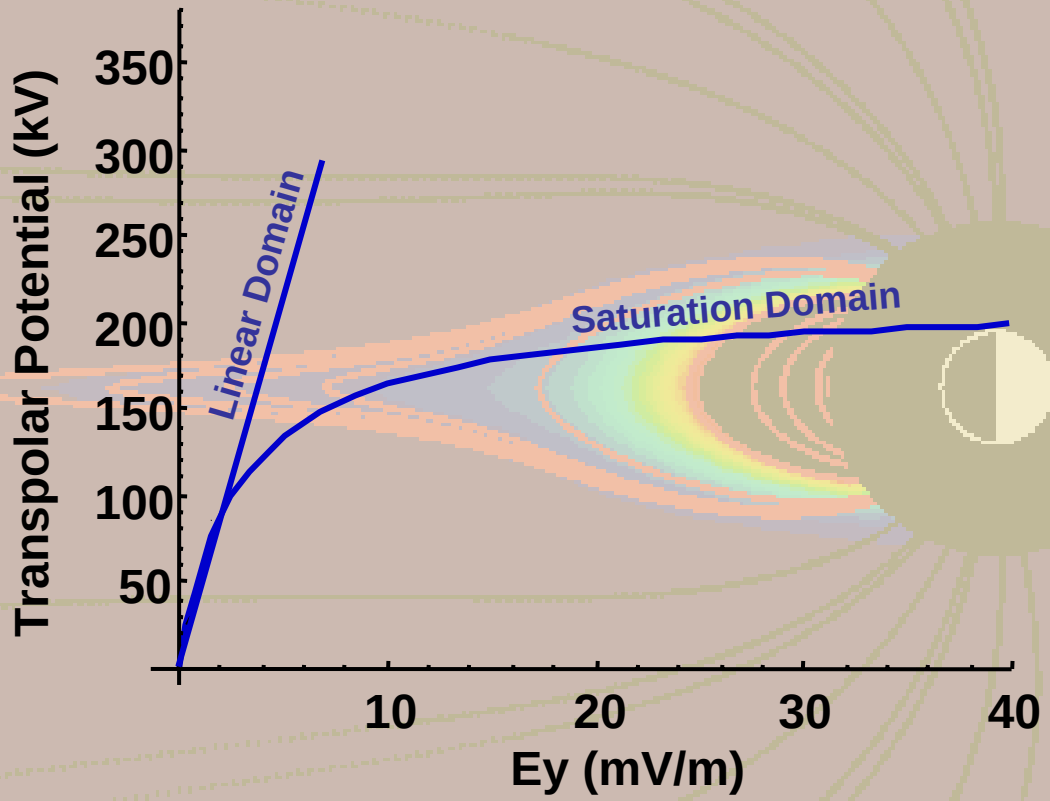
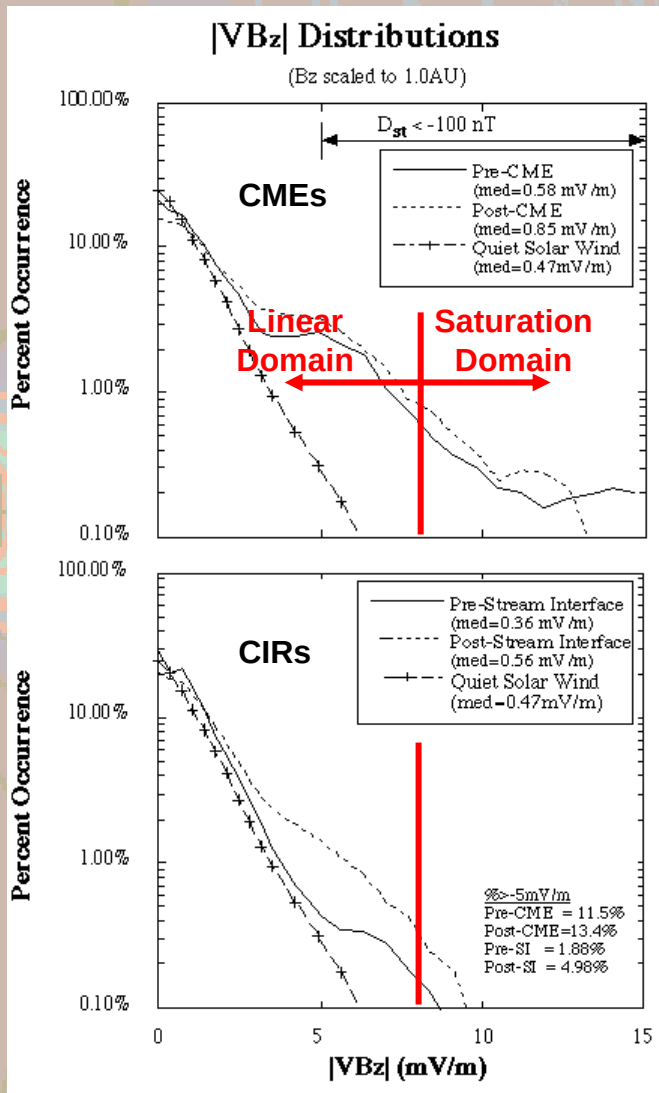
- Linear and saturated domains of SWMIT coupling
- Global forces
- Origins of the plasma sheets
- Polar cusp studies

BATSRUS/CCMC

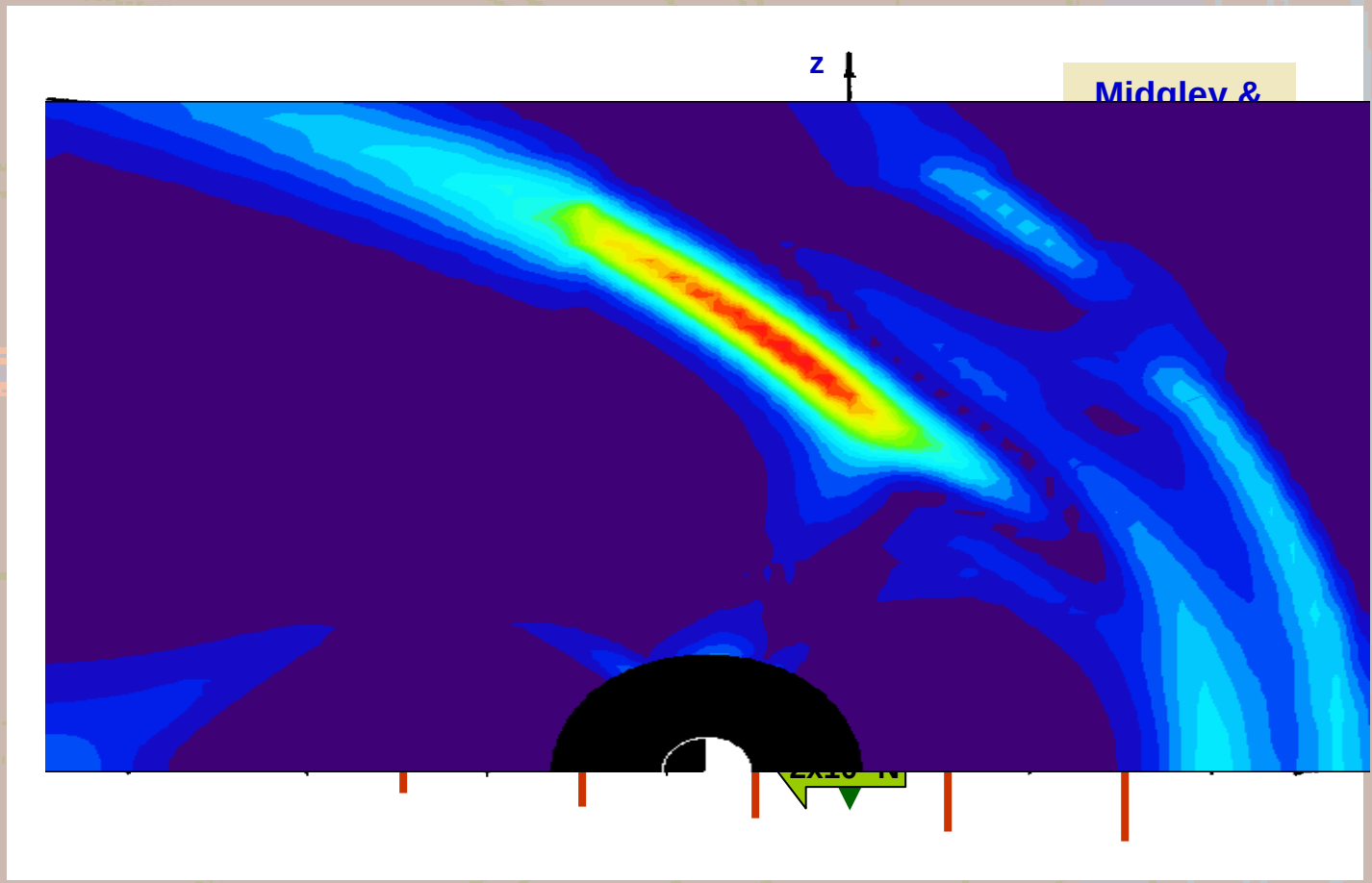
Linear and Saturated Domains of SWMIT Coupling



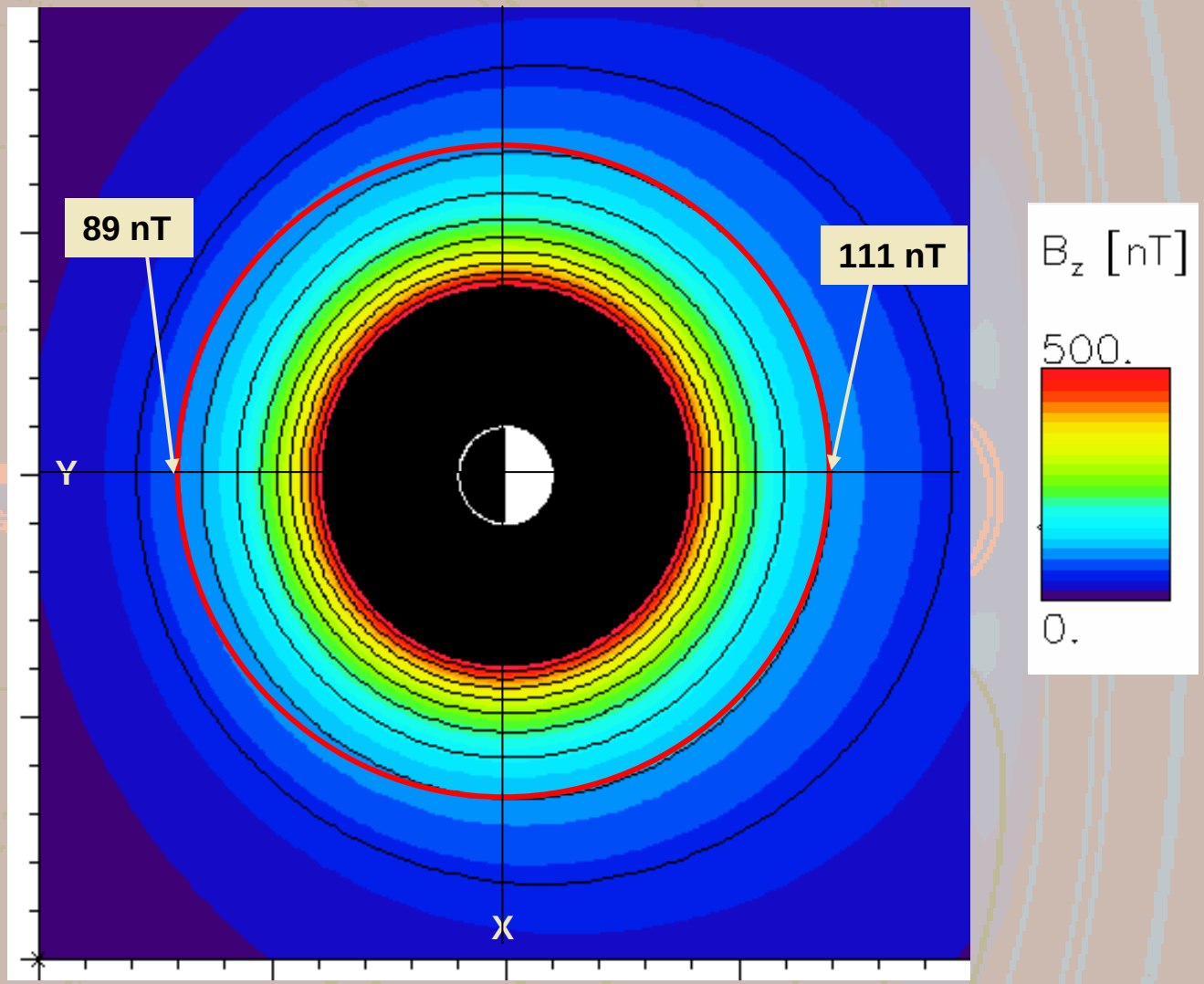


Lindsay et al., 1995

Force in Linear Domain

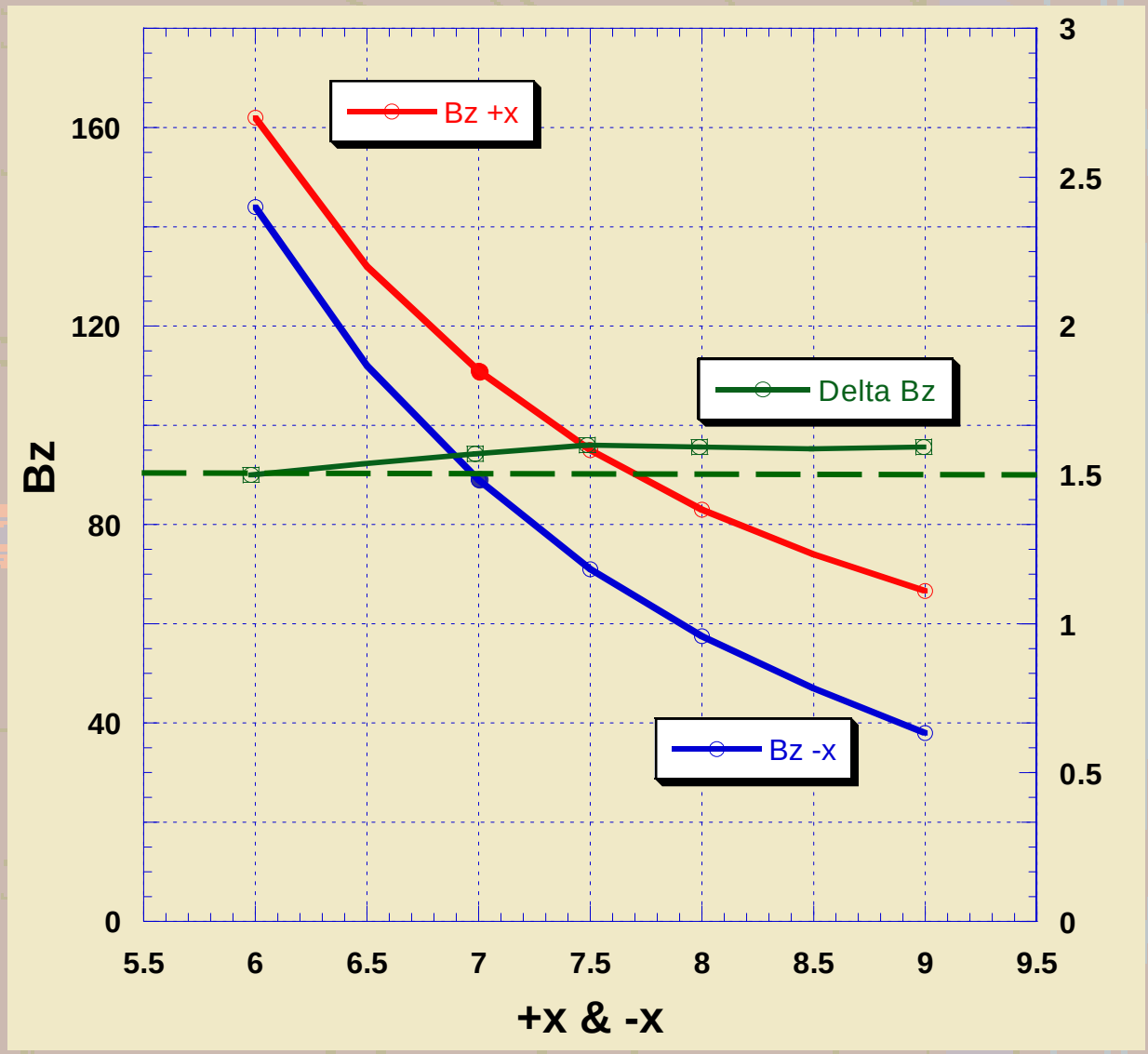


Equatorial B Contours offset sunward



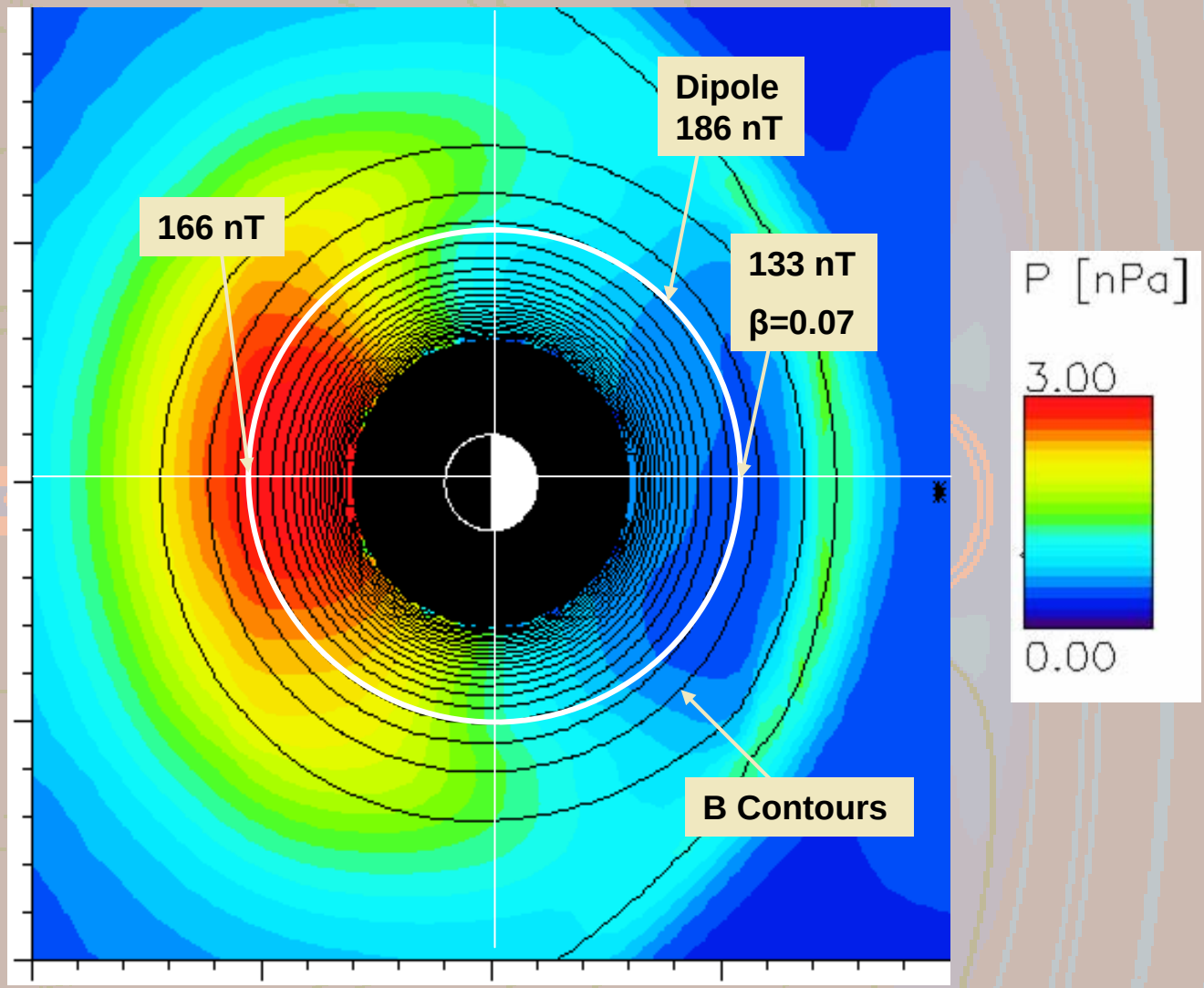
IMF = (0, 0, +5) nT

Magnetic gradient pushes Earth away from sun.



Model and theory agree.

Force in Saturated Domain



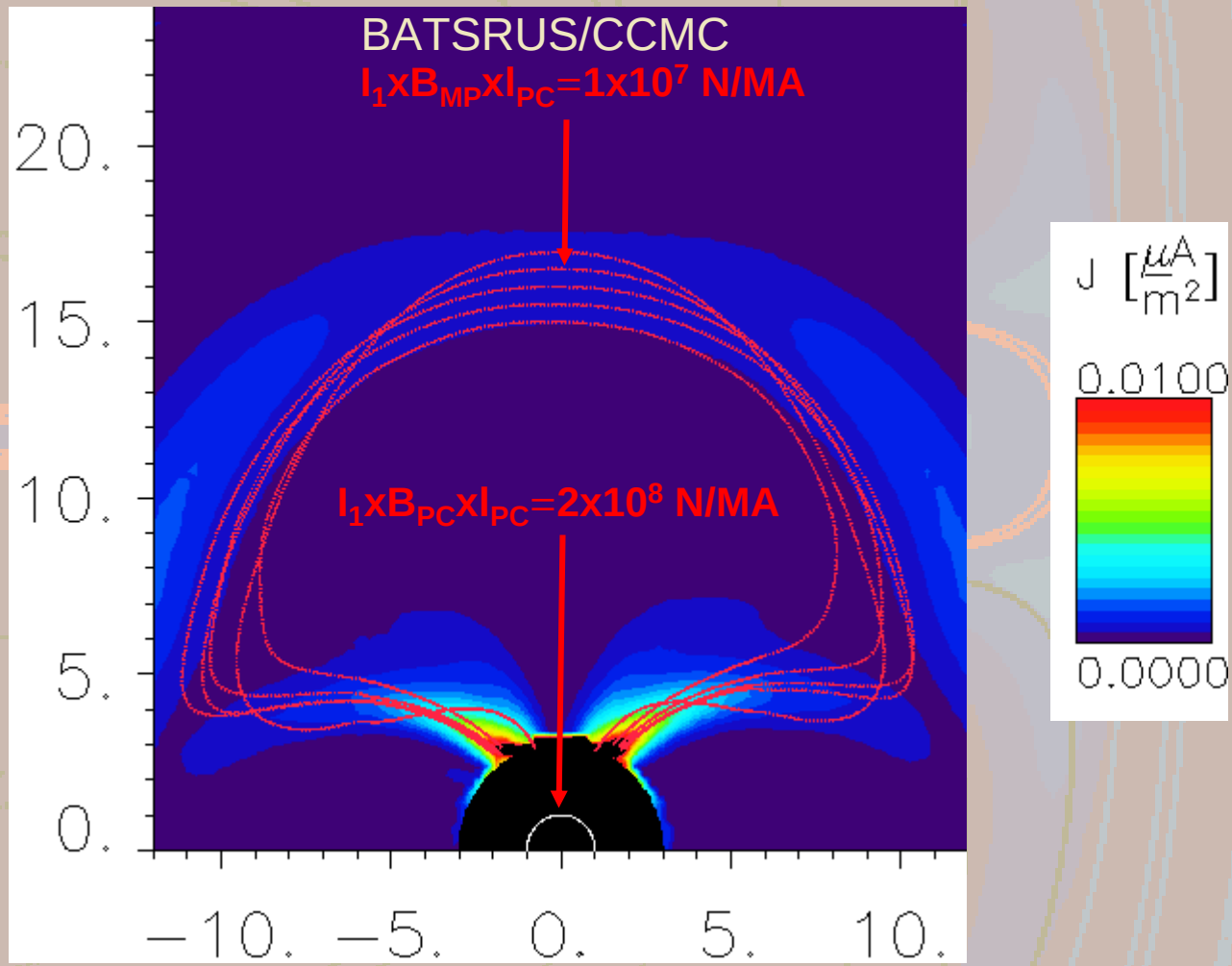
IMF = (0, 0, -20) nT

Magnetic gradient pushes Earth toward sun!

Magnetic Tension Dominates the Saturation Domain

J1-Dipole Force Exceeds Magnetic Tension

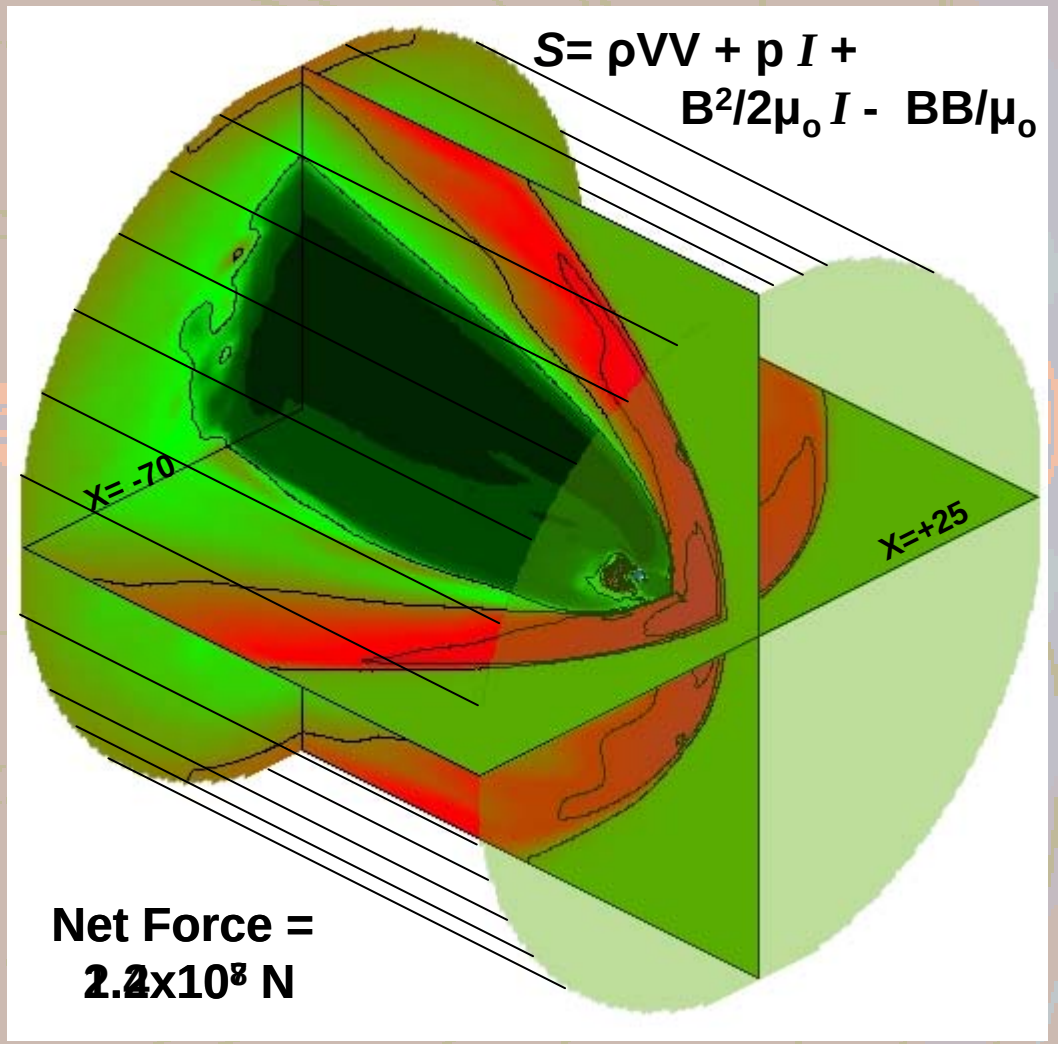
Back of the envelope estimate



i.e., roughly an order of magnitude bigger

Net Force on Terrestrial System

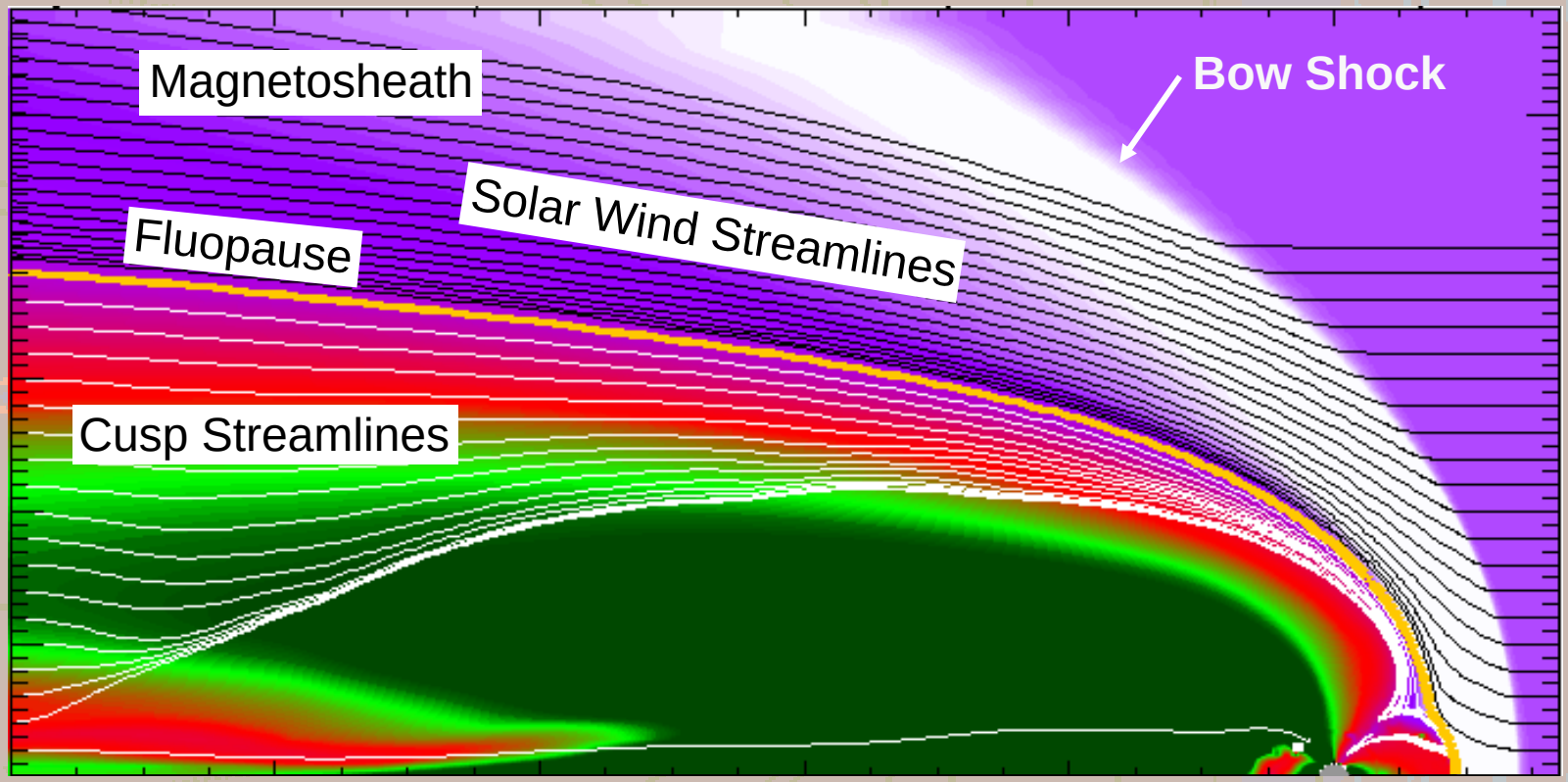
Integrate x-component of momentum stress tensor over a surface containing the terrestrial system



IMF = (0, 0, -20) nT

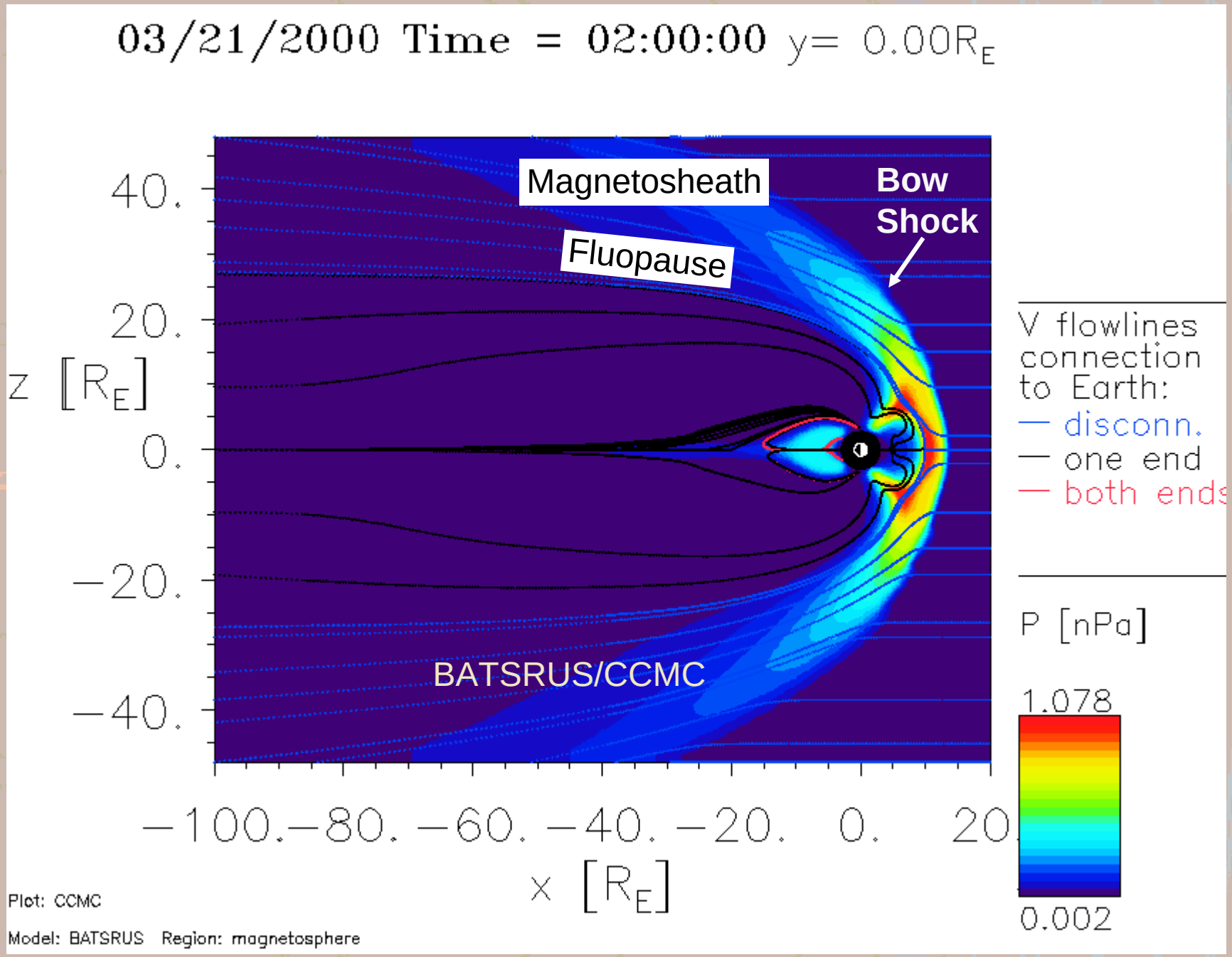
Change of Subject

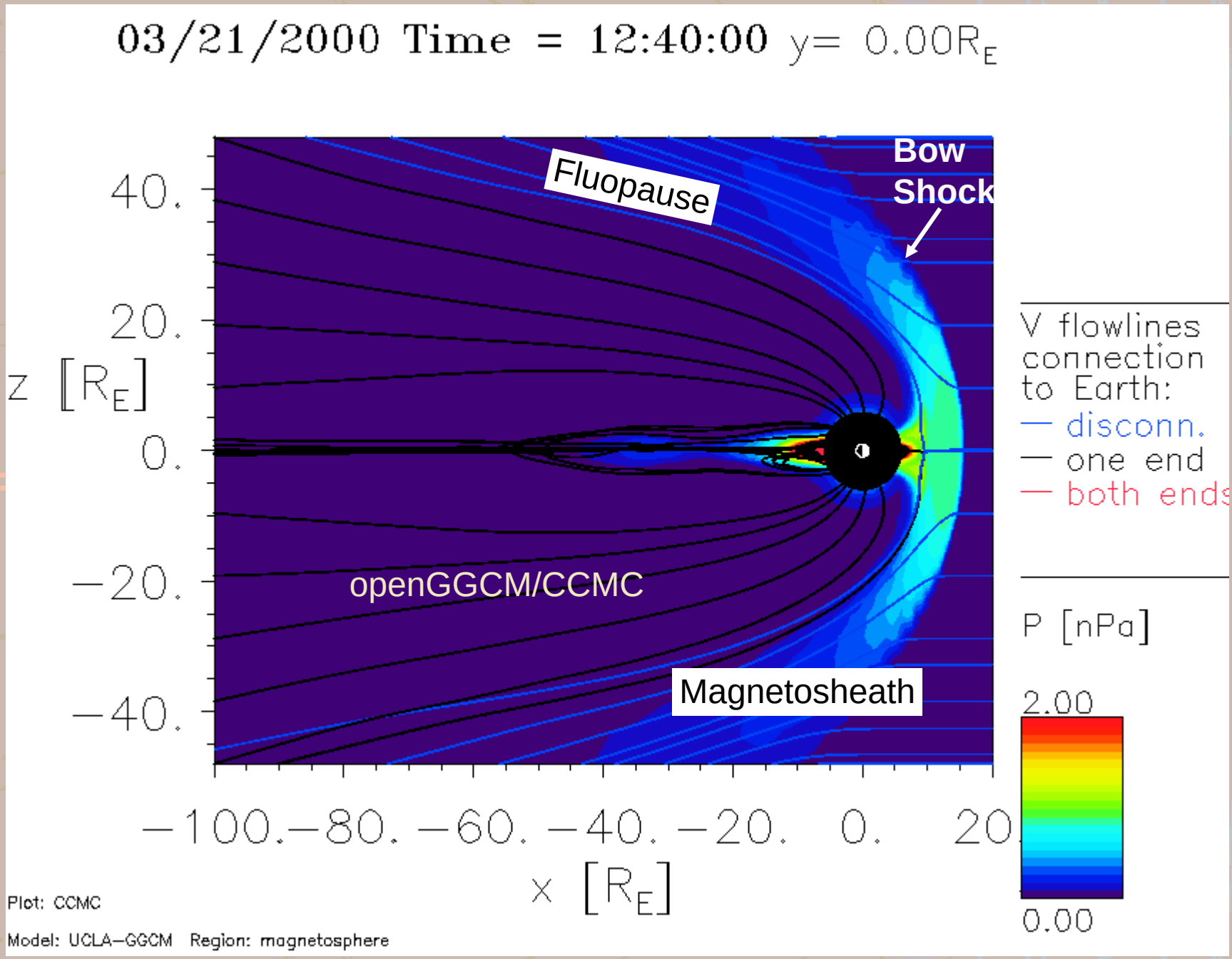
Origin of Plasma Sheet
A Linear Domain Problem



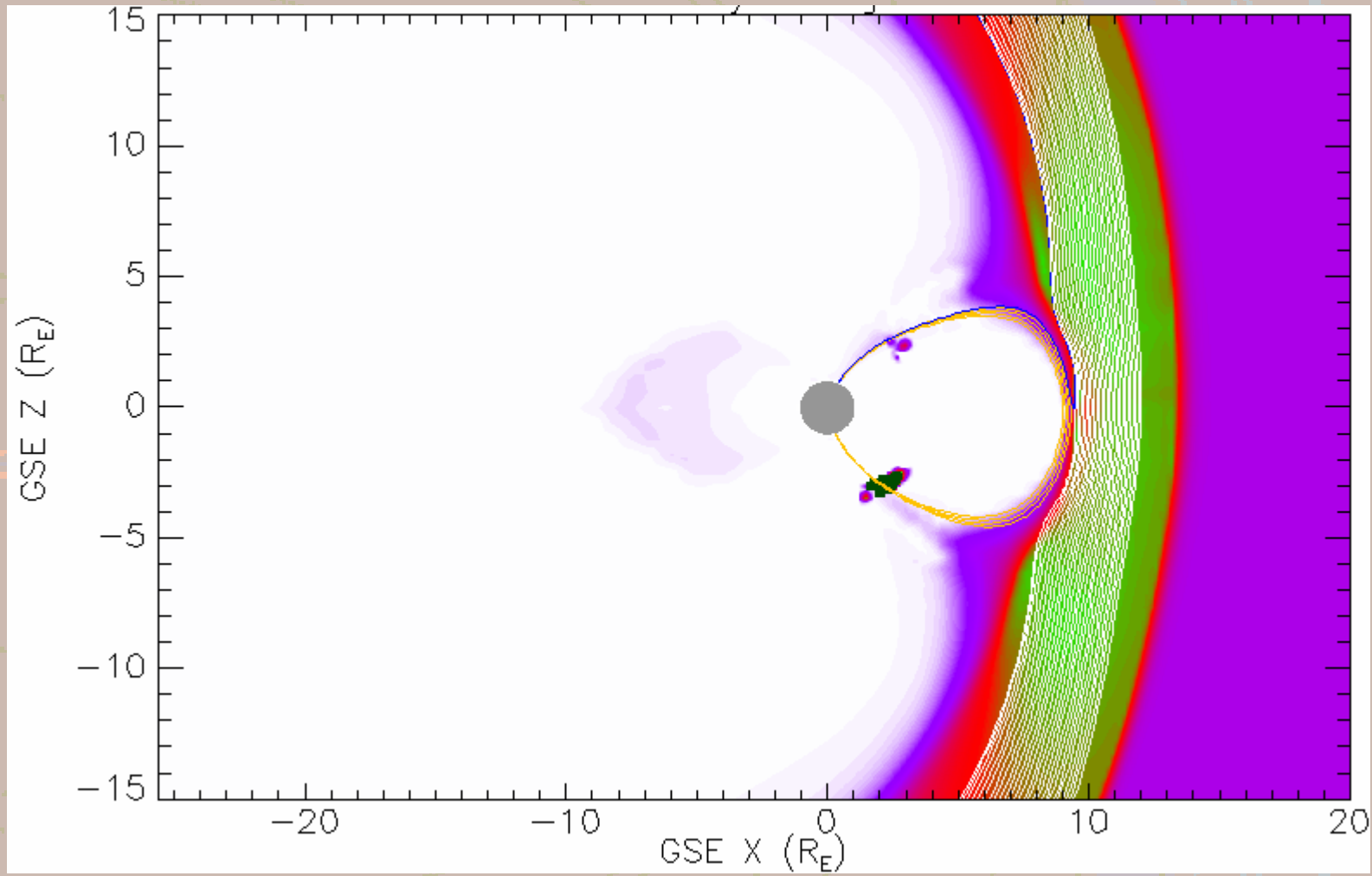
Magnetosheath through mantel doesn’t work.

Verification with CCMC


03/21/2000 Time = 02:00:00 y= 0.00R_E
Magnetosheath
Bow Shock
Fluopause
BATSRUS/CCMC
40.
20.
0.
−20.
−40.
z [R_E]
−100.
−80.
−60.
−40.
−20.
0.
20
x [R_E]
V flowlines connection to Earth:
disconn.
one end
both ends
P [nPa]
1.078
0.002
Plot: CCMC
Model: BATSRUS Region: magnetosphere


03/21/2000 Time = 12:40:00 y= 0.00R_E
Fluopause
Bow Shock
openGGCM/CCMC
Magnetosheath
40.
20.
0.
−20.
−40.
z [R_E]
−100.
−80.
−60.
−40.
−20.
0.
20
x [R_E]
V flowlines connection to Earth:
disconn.
one end
both ends
P [nPa]
2.00
0.00
Plot: CCMC
Model: UCLA–GGCM Region: magnetosphere

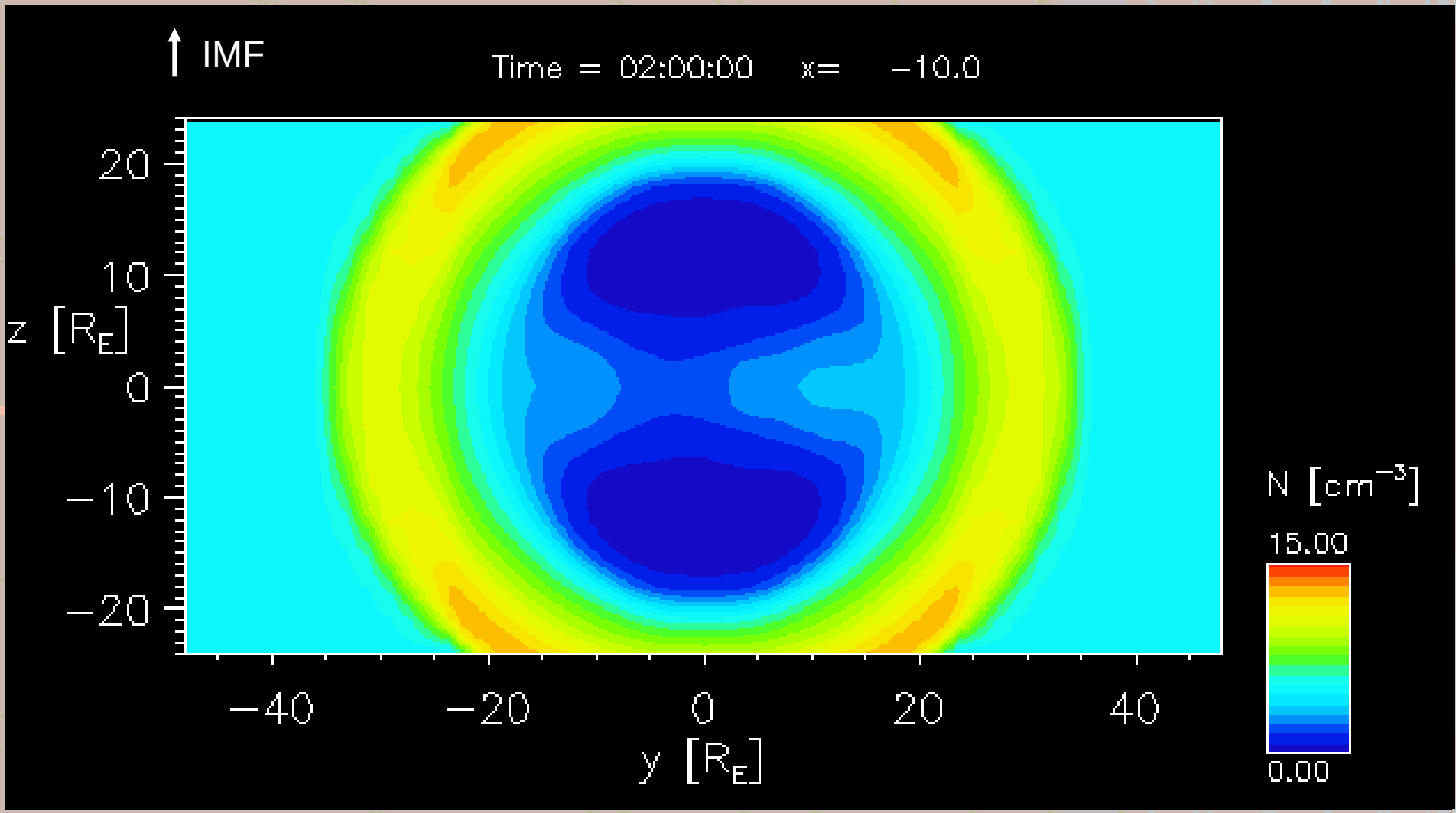
Song-Russell Mechanism for Cold Dense Plasma Sheet



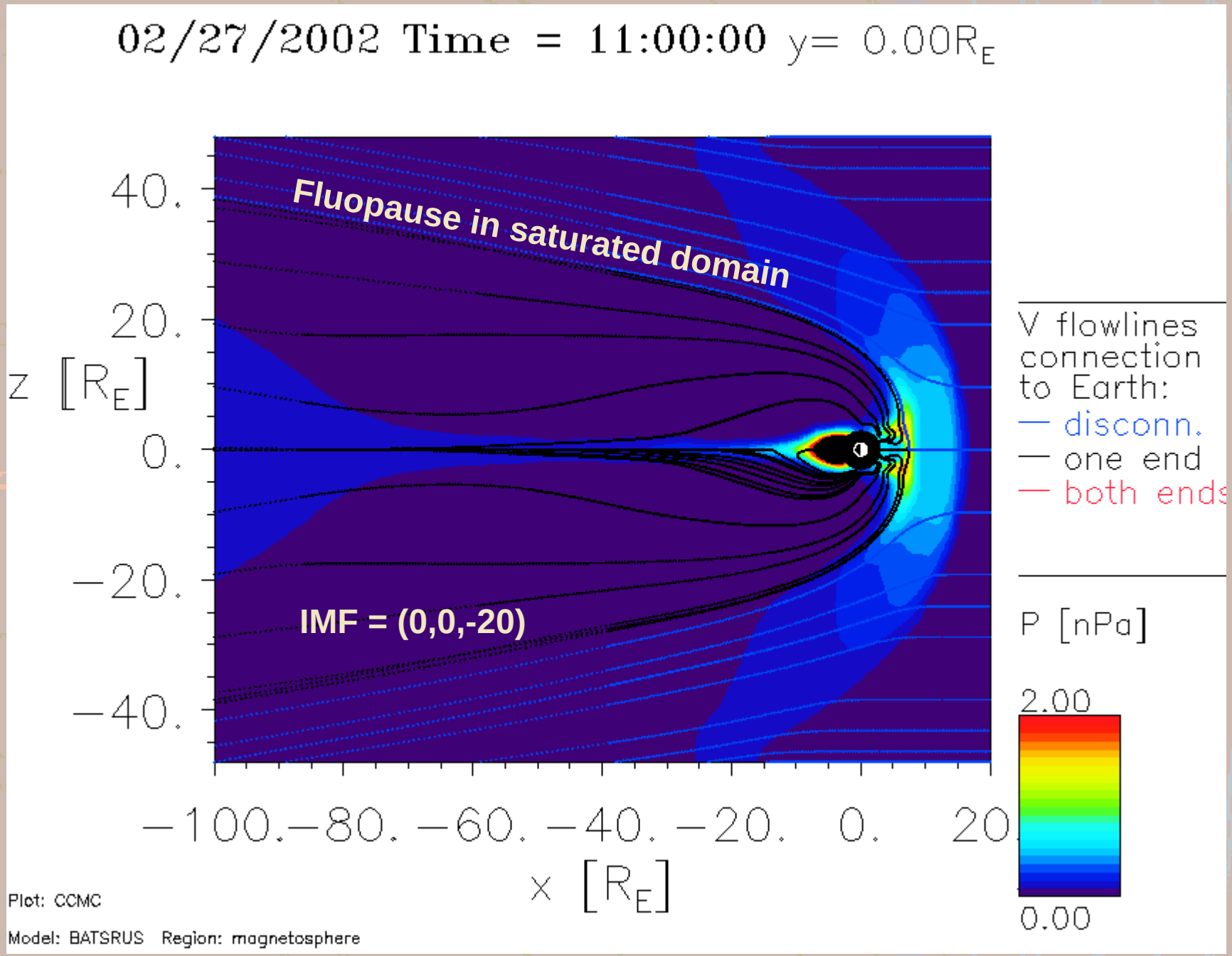
It turns magnetosheath plasma into LLBL.

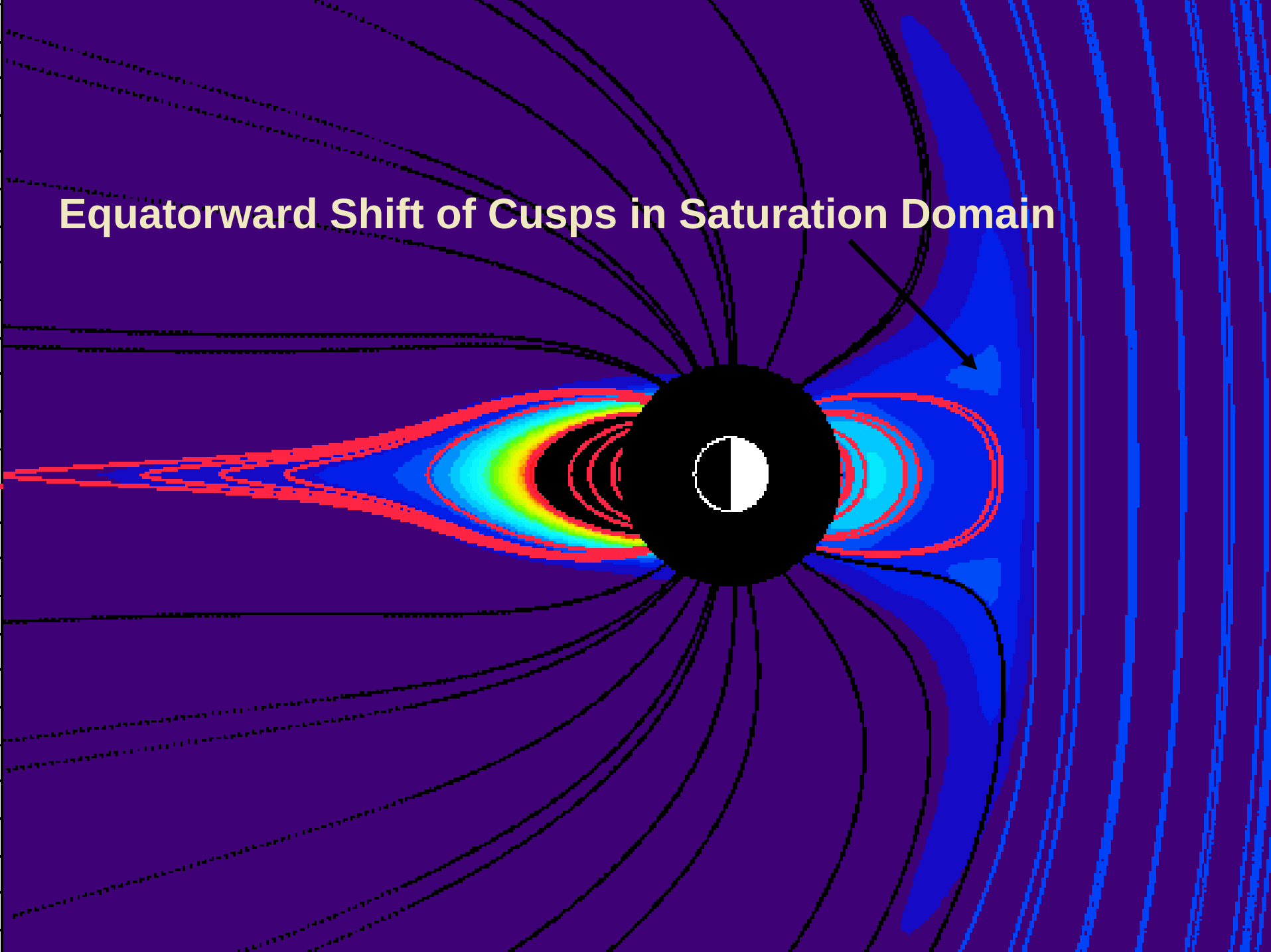
Must now turn LLBL into plasma sheet.

Verification with BATSRUS/CCMC

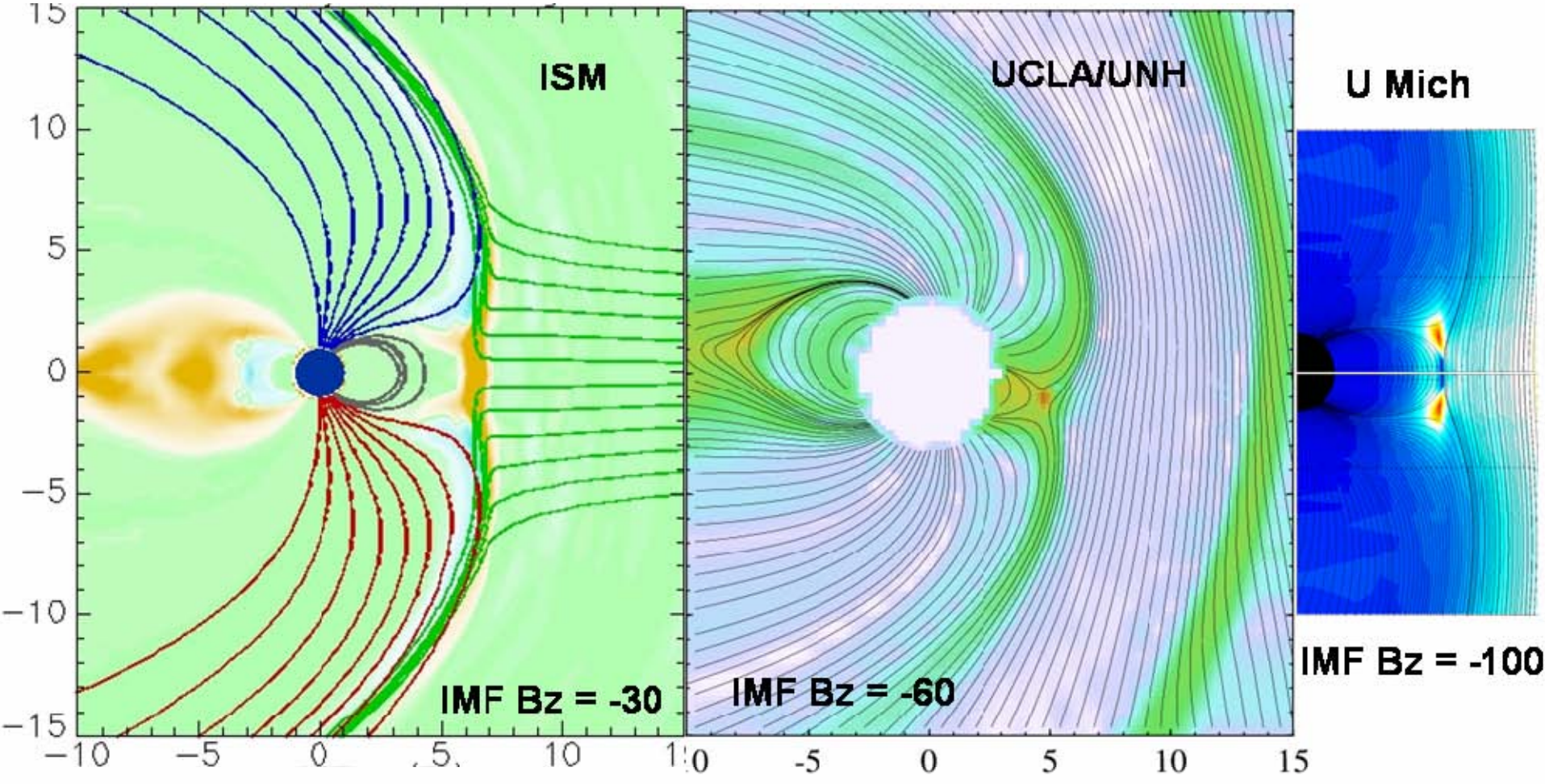


Origin of the cold-dense plasma sheet.


02/27/2002 Time = 11:00:00 y= 0.00R_E
Fluopause in saturated domain
IMF = (0,0,-20)
40.
20.
0.
−20.
−40.
z [R_E]
−100.
−80.
−60.
−40.
−20.
0.
20
x [R_E]
V flowlines
connection
to Earth:
disconn.
one end
both ends
P [nPa]
2.00
0.00
Plot: CCMC
Model: BATSRUS Region: magnetosphere


Equatorward Shift of Cusps in Saturation Domain

All Codes Agree on This



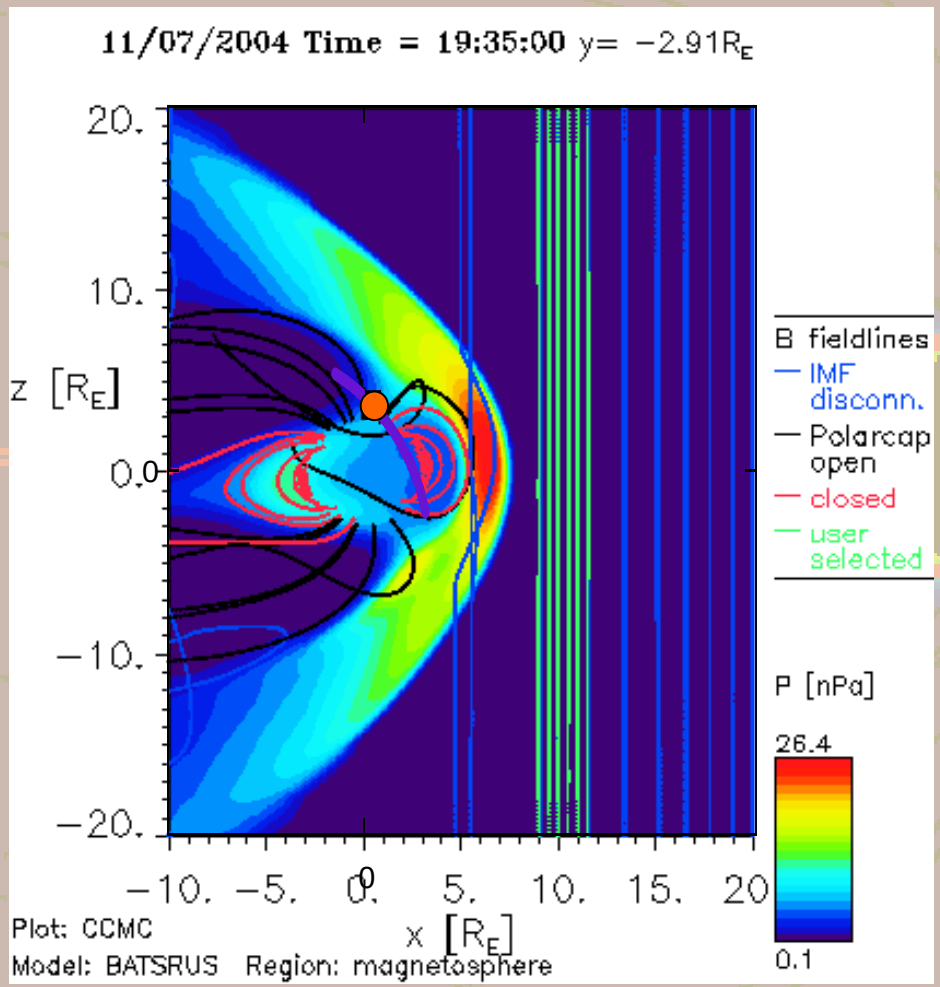
Mullard Workshop on Sun-Earth Connections

- Comparisons with CCMC models (with Zerefşan Kaymaz & Yulia Bogdanova)
- Batsrus Model
- Open GGCM model (UCLA GGCM)

- Cusp Events on
  - Nov. 7, 2004 Strong Northward IMF
    - 19:35-20:10
  - Nov. 10, 2004 Southward IMF
    - 04:20-04:40

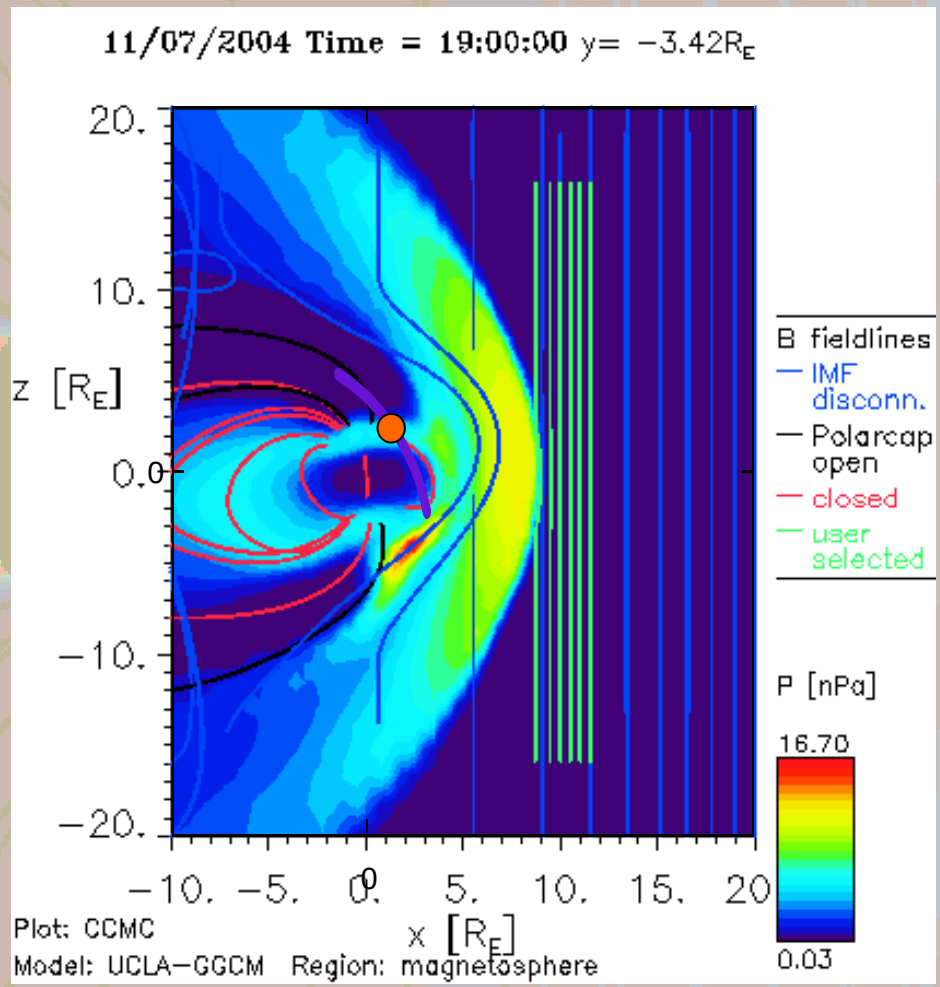
NORTH IMF, Nov 07, 2004

BATSRUS: Time:19:35, y=-2.915



NORTH IMF, Nov 07, 2004

OPEN GGCM: Time:19:00, y=-3.42

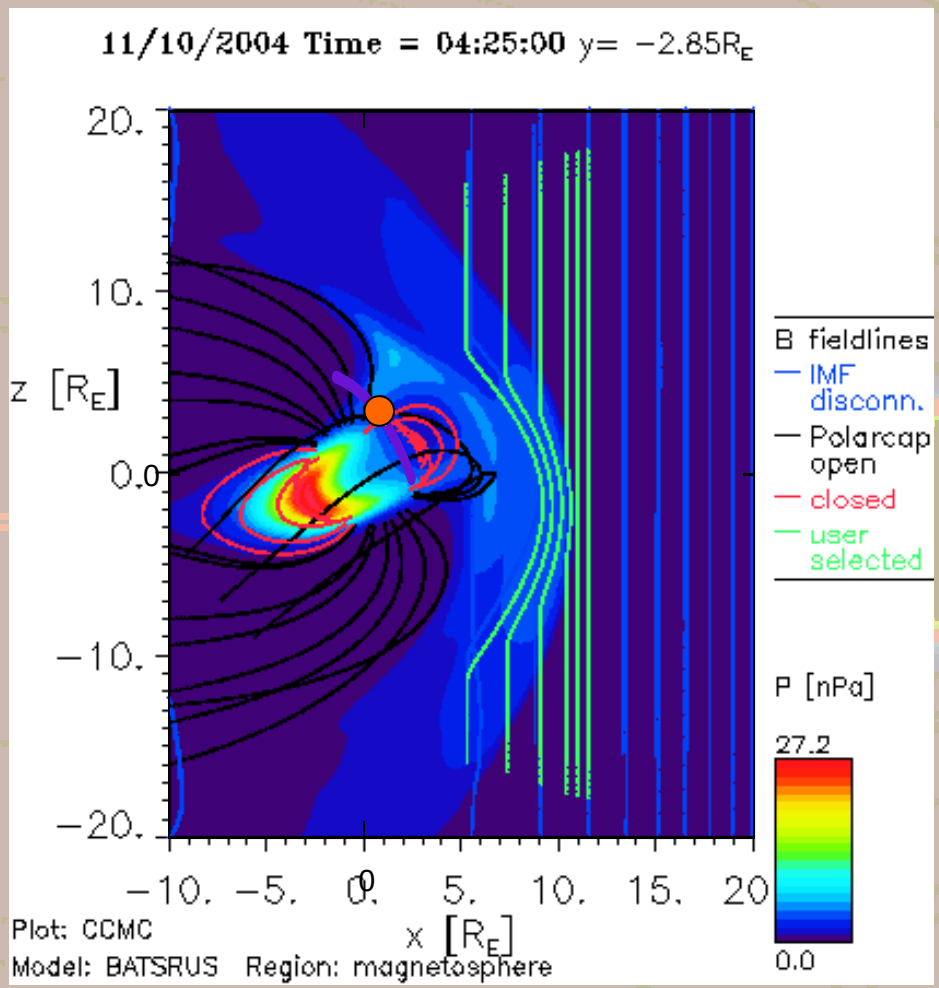


Cluster-1 position

Cluster-1 trajectory

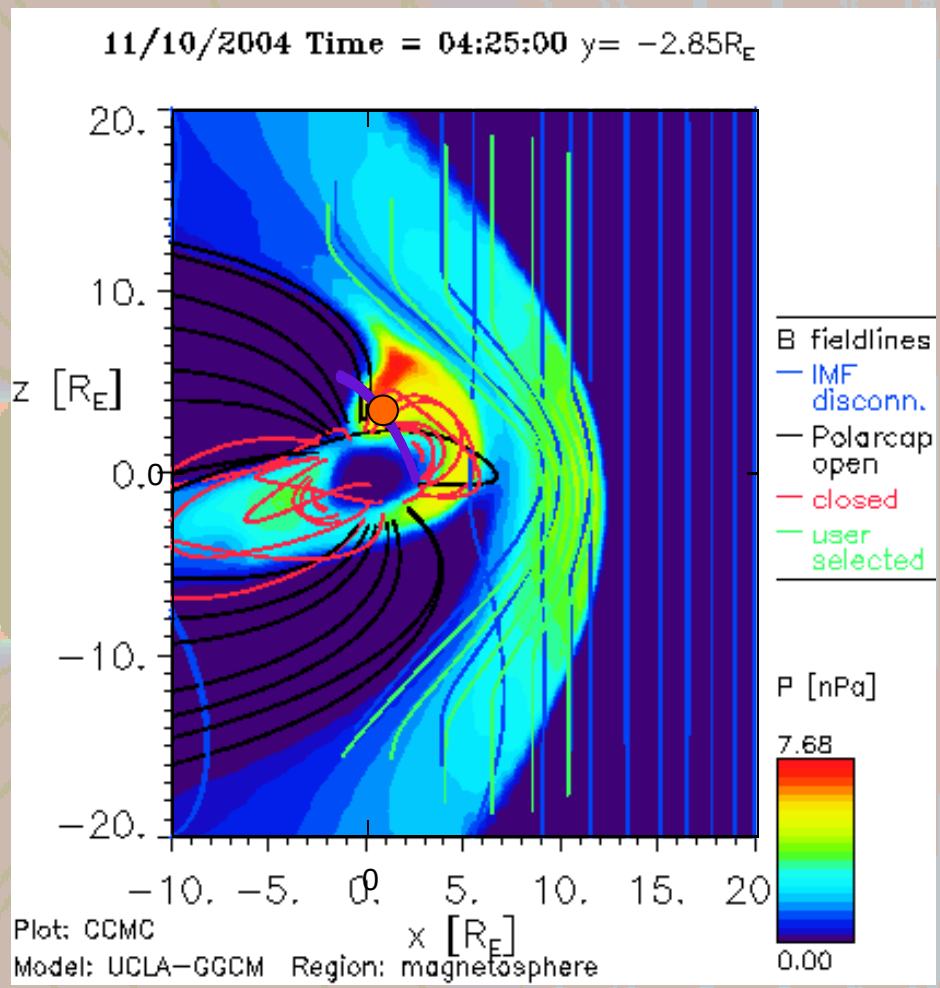
SOUTH IMF, Nov 10, 2004

BATSRUS: Time:04:25, y=-2.85



SOUTH IMF, Nov 10, 2004

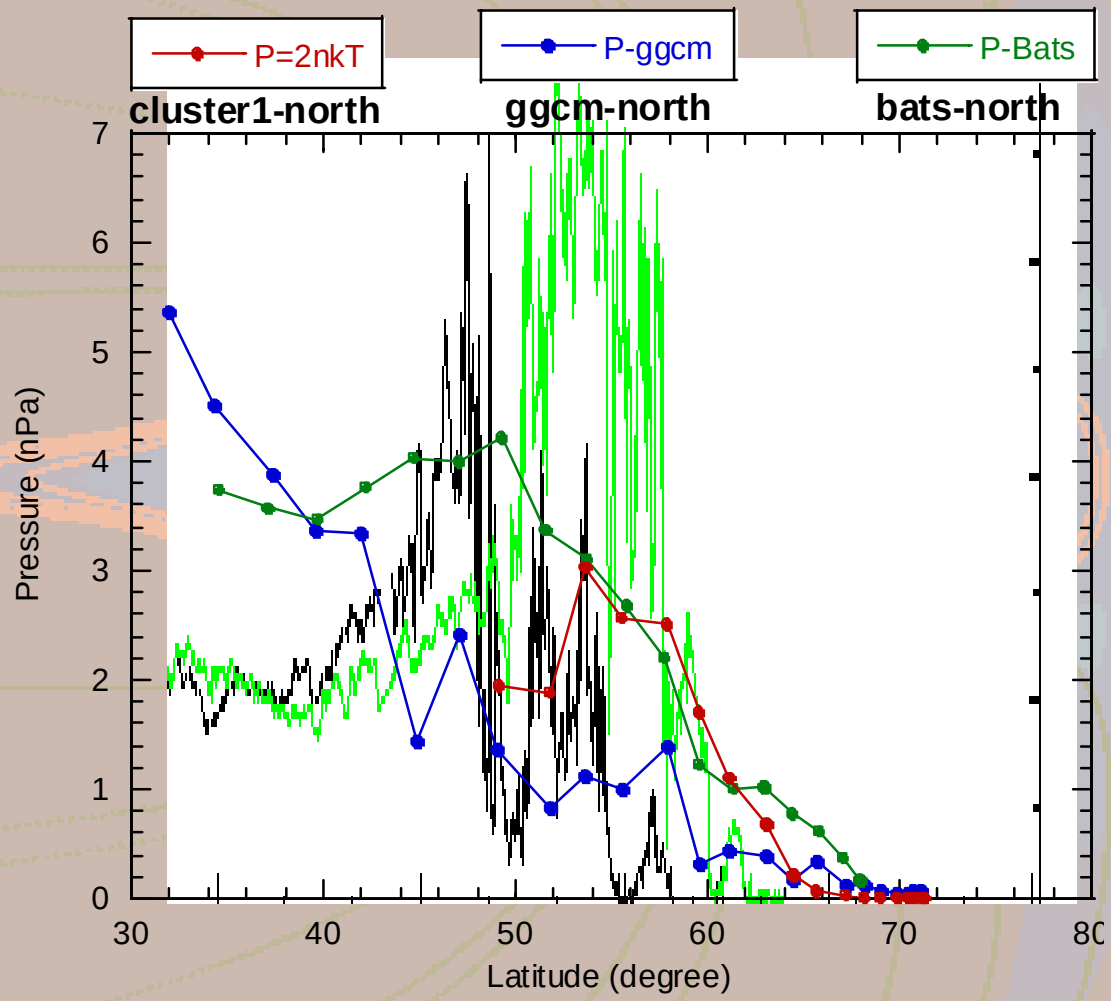
OPEN GGCM: Time:04:25, y=-2.85



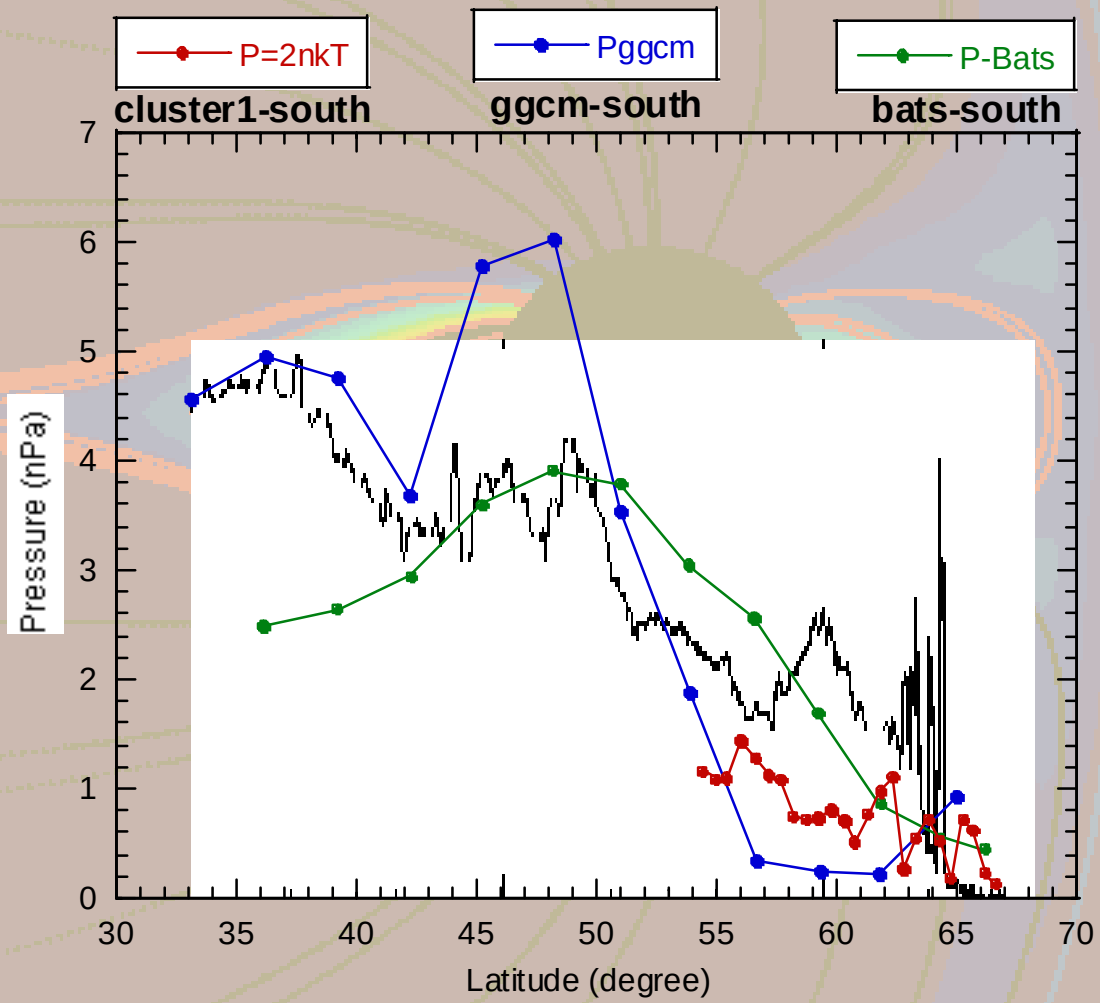
Cluster-1 position

Cluster-1 trajectory

MOLLARD CUSP, IMF Bz > 0, Nov 7, 2004: 19:35-20:10



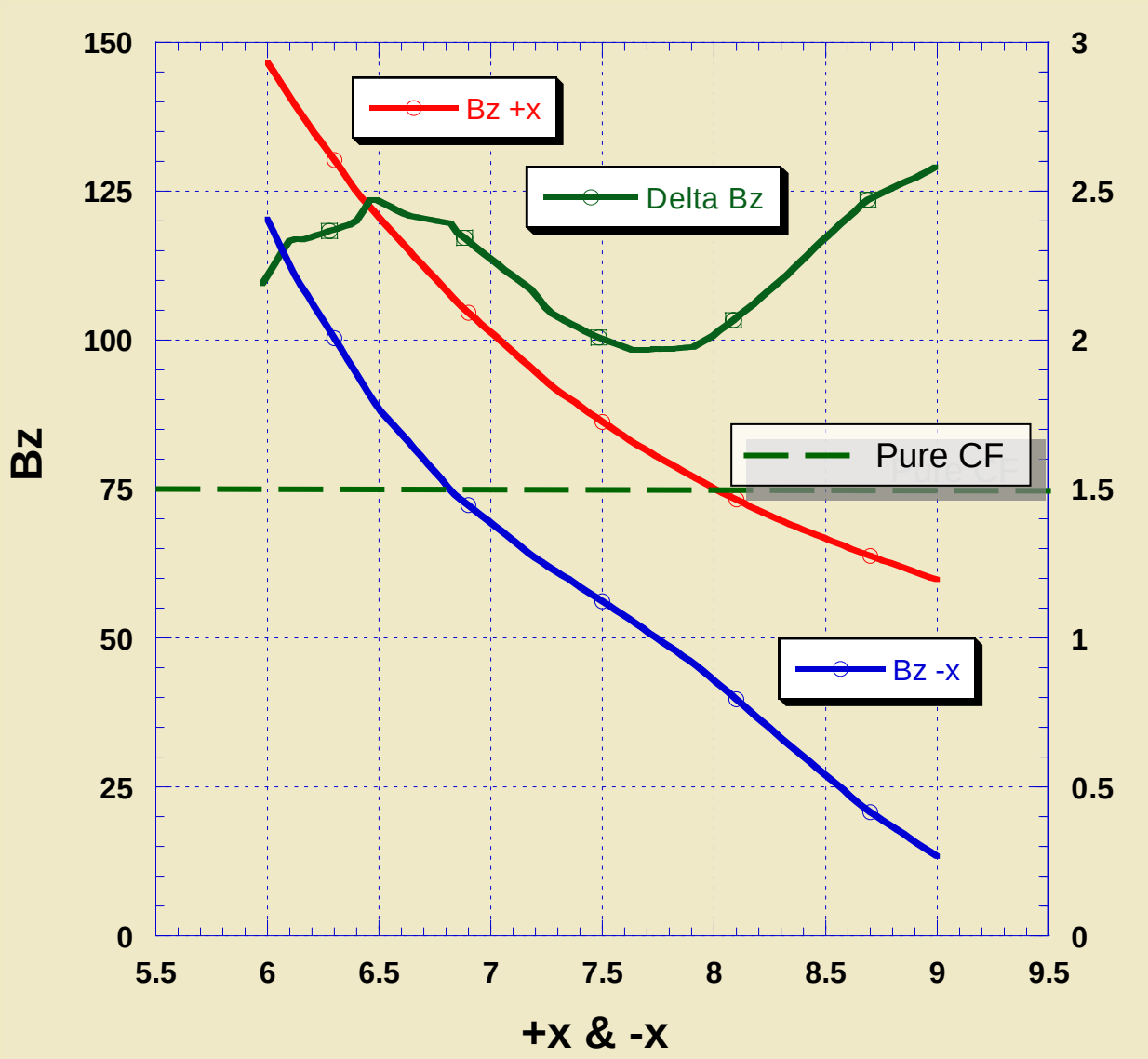
MOLLARD CUSP, IMF Bz < 0, Nov 10, 2004: 04:20-04:40



Could be closure on the "Origin of the Plasma Sheet" problem.

Summary

- **Global MHD simulations essential in investigating the globally coherent properties of SWMIT coupling.**
- **Point illustrated with examples from the bimodal, linear/saturated nature of the coupling.**
- **Also with a set of investigations to determine the origin of the plasma sheet.**
- **Examples illustrate that CCMC models give the community powerful tools with which to carry out such investigations.**


Bz +x
Delta Bz
Pure CF
Bz -x
Bz
+x & -x
150
125
100
75
50
25
0
3
2.5
2
1.5
1
0.5
0
5.5
6
6.5
7
7.5
8
8.5
9
9.5