National Aeronautics and Space Administration

MESSENGER Observations of Reconnection and Its Effects on Mercury's Magnetosphere

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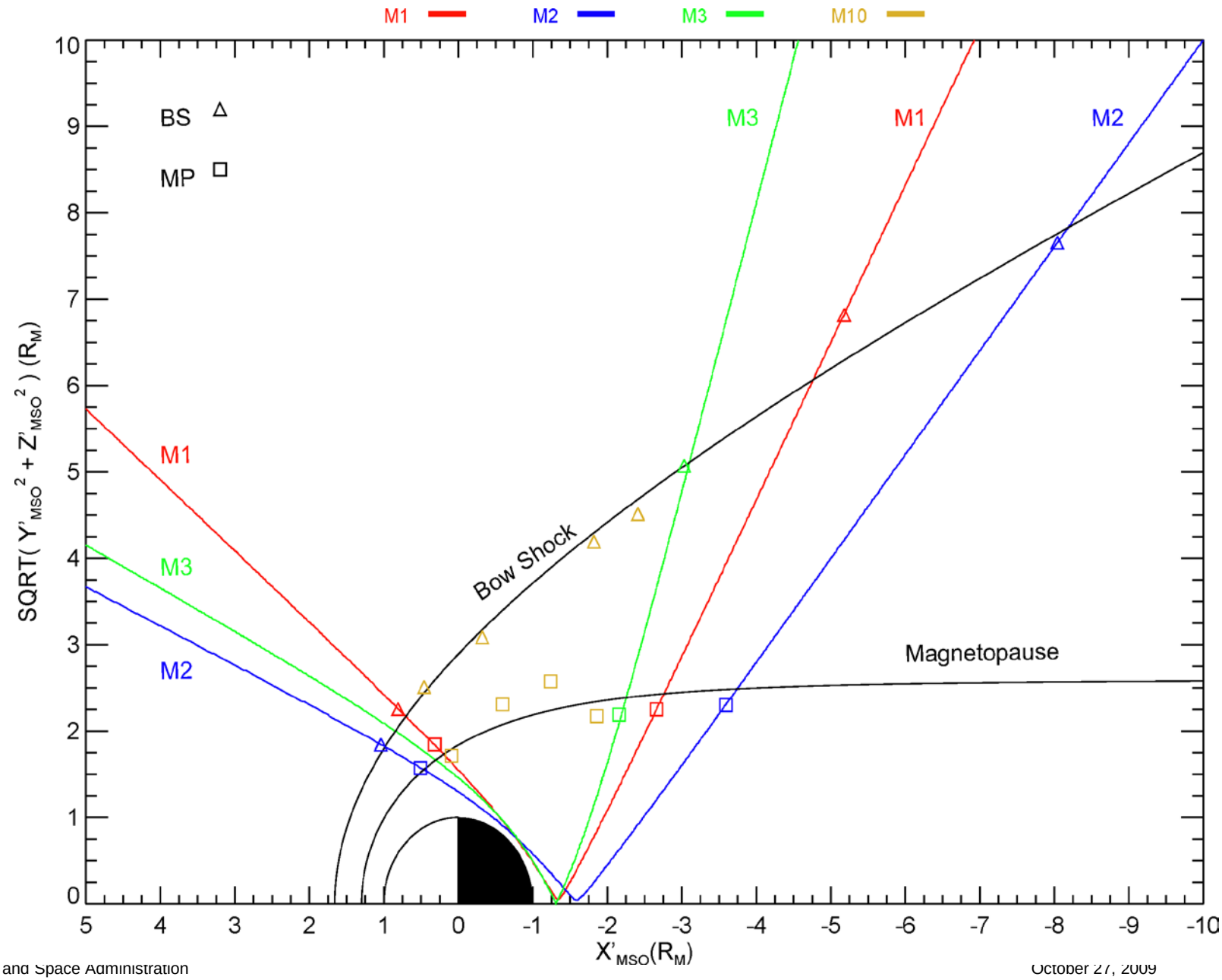
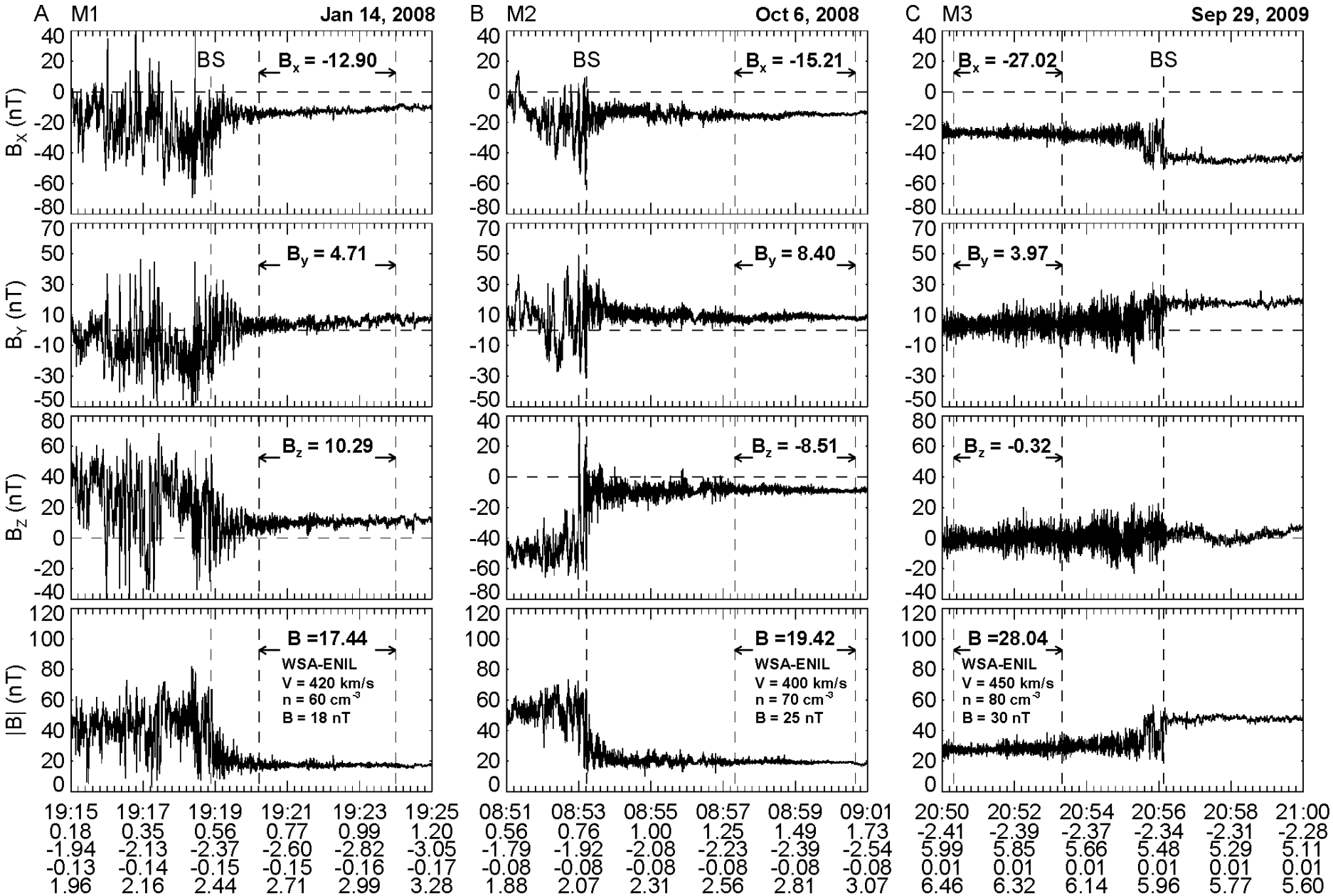
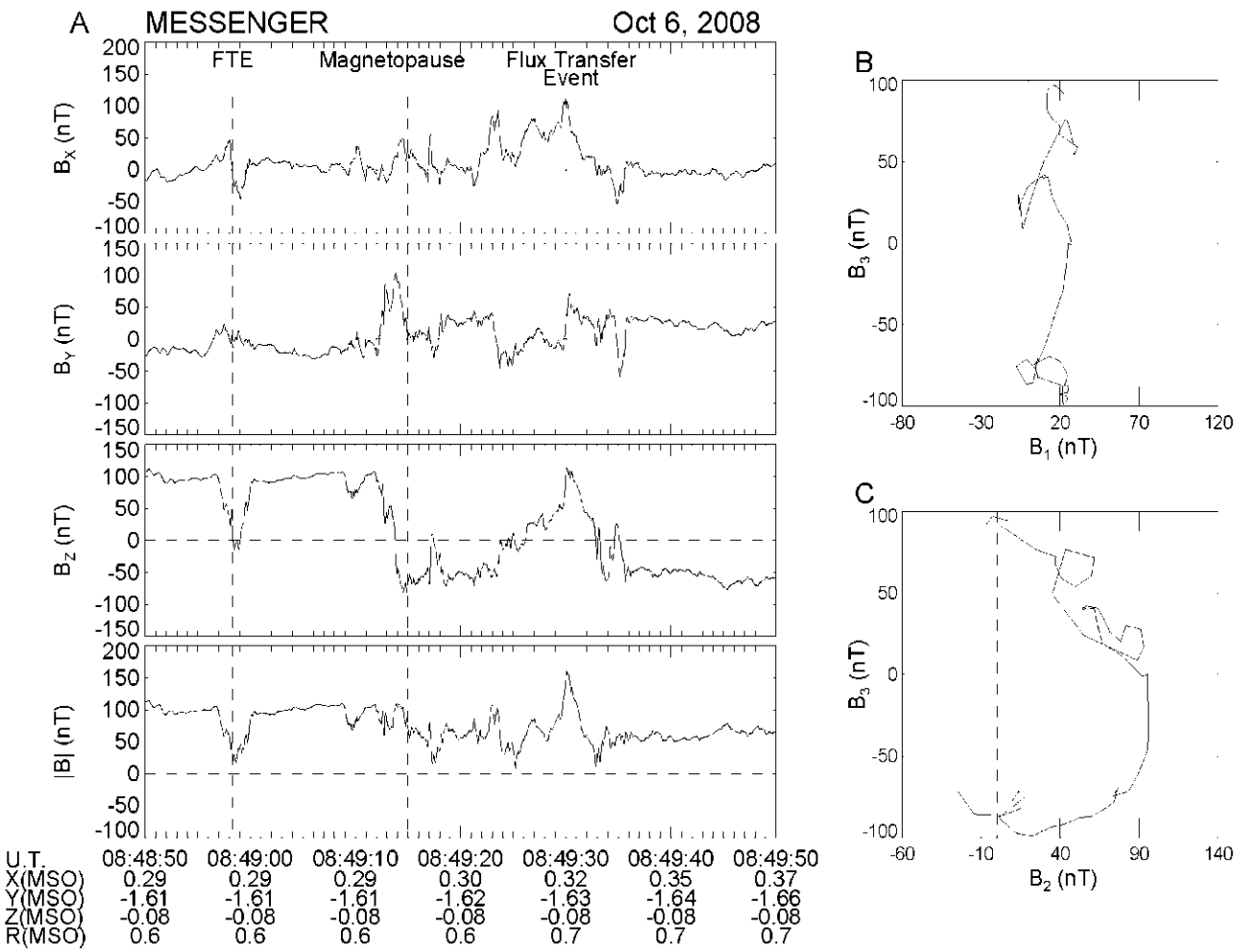
MESSENGER's Three Flybys

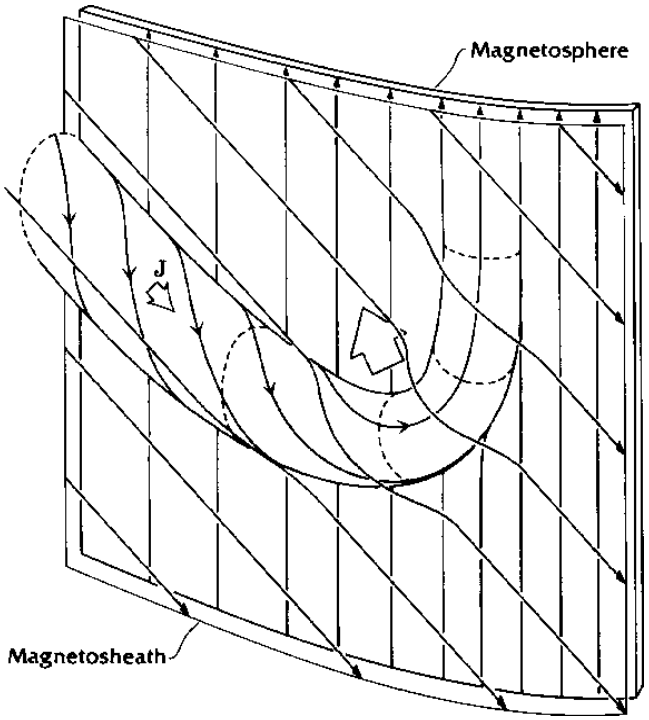


MESSENGER Flyby IMF Conditions



Magnetopause Reconnection: B_N and FTE's

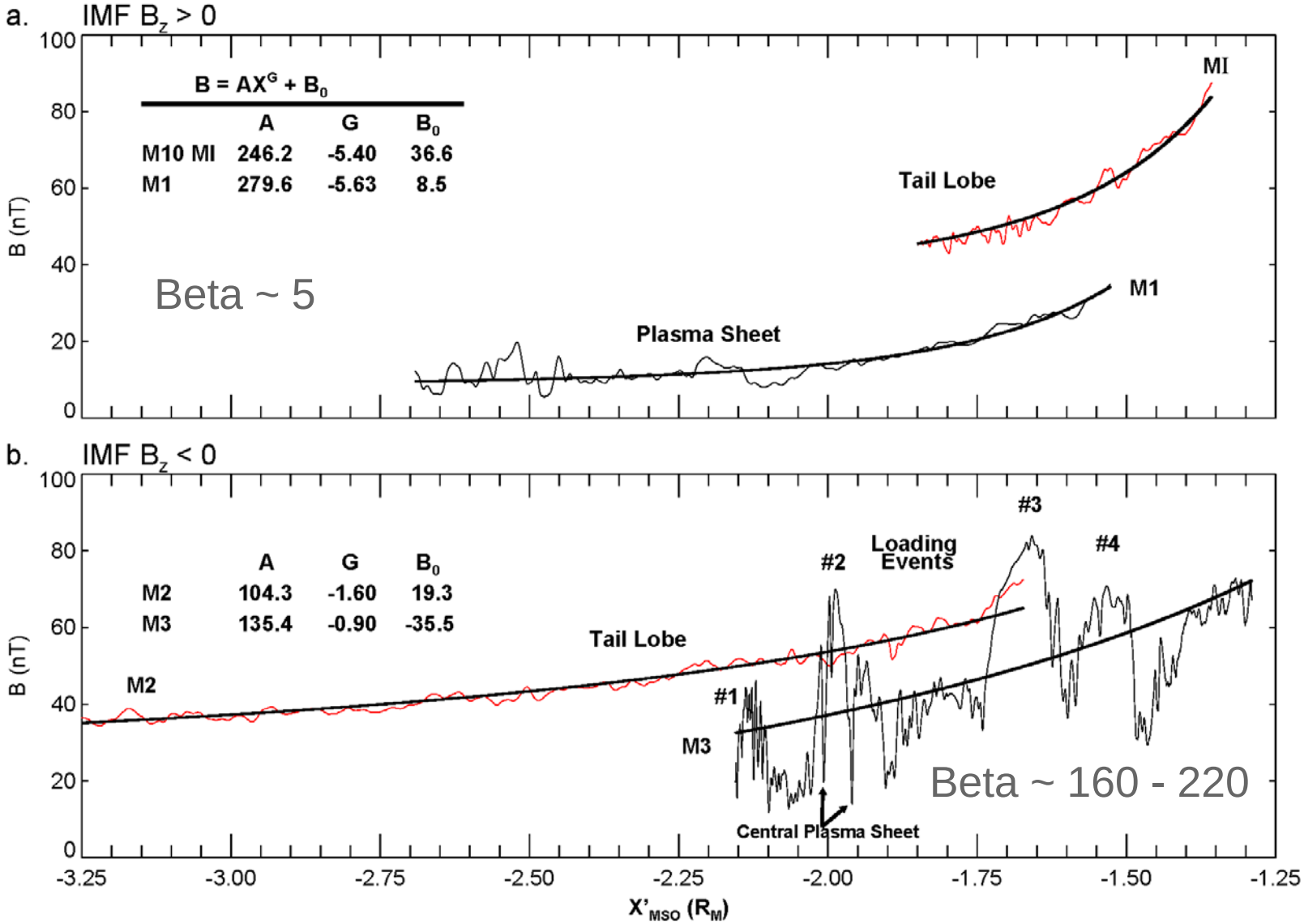




Russell and Elphic (1978)

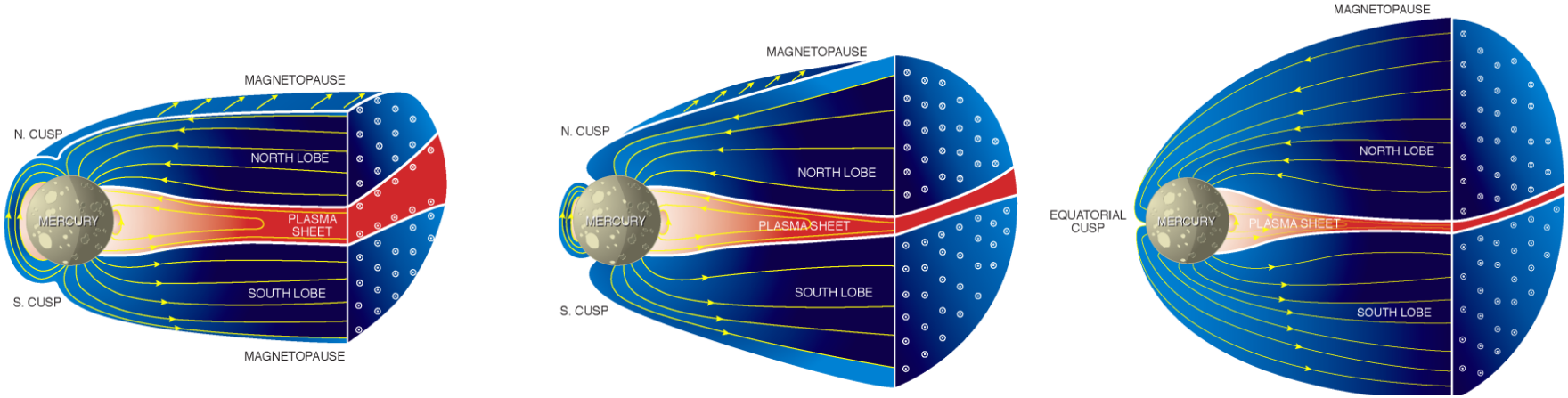
- **B_N /B at Earth is ~ 1 – 2% while for Mercury it is ~ 10 – 20%!**
- **Implied Magnetospheric Electric Potential ~ 30 kV and the Dungey Cycle Time ~ 2 min**
- **FTEs every ~ 30 s; Magnetic flux content ~ 10% Mercury Tail Lobes Vs 1% at Earth**

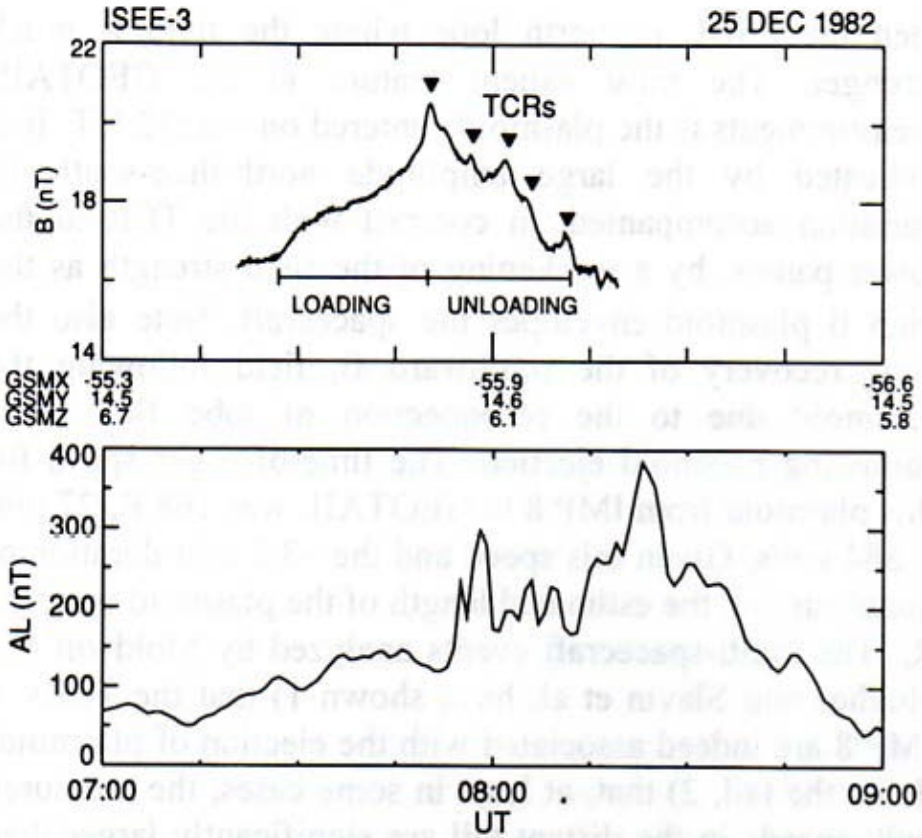
Northward and Southward IMF at Mercury

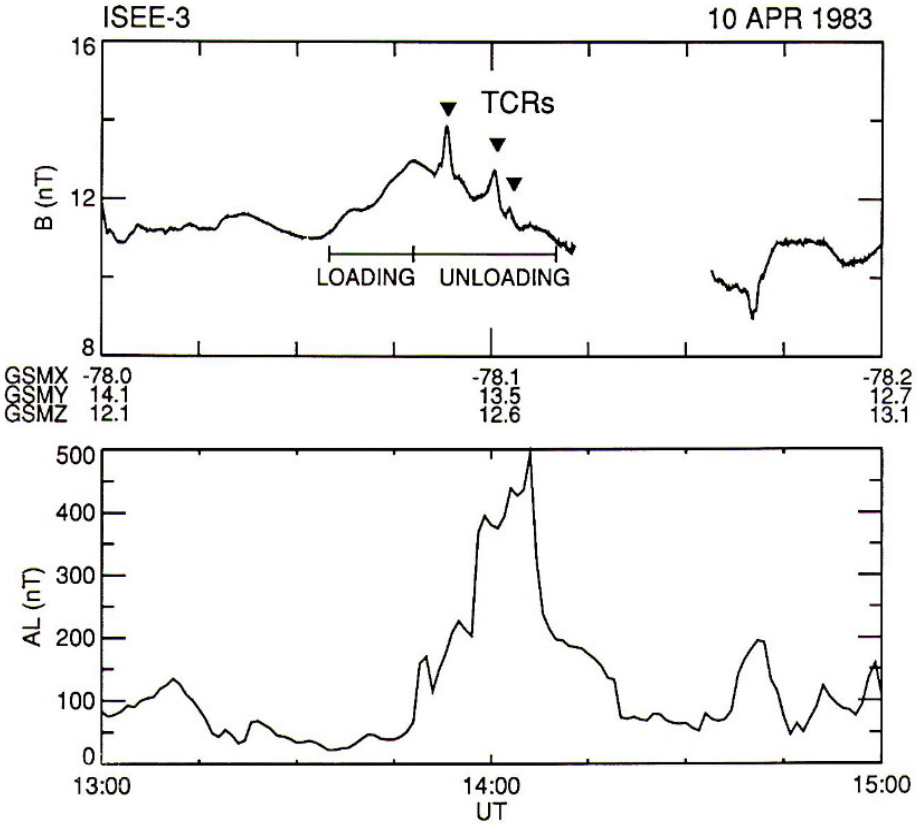


Plasma Beta = $nkT_i/(B^2/2\mu_o) = (B_L/B_{ps})^2 - 1$

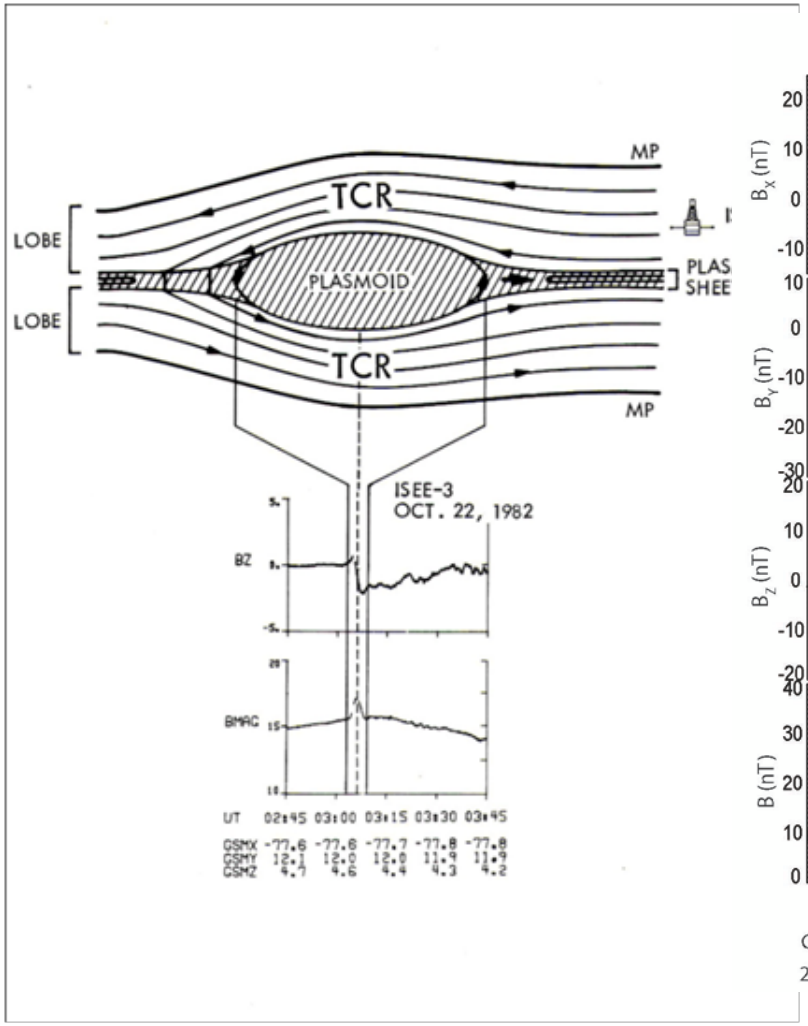
Extreme Tail Loading at Mercury

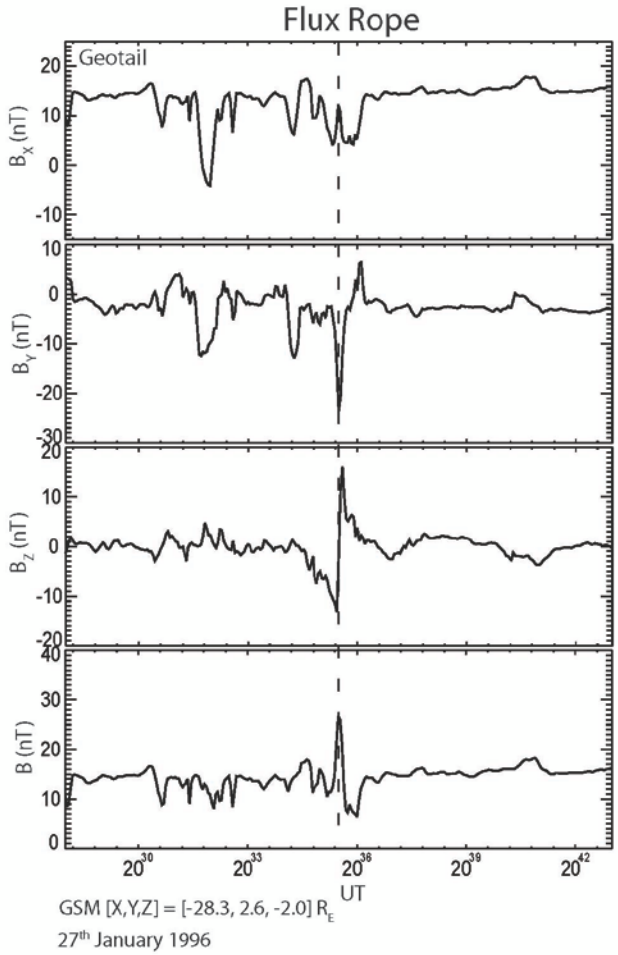


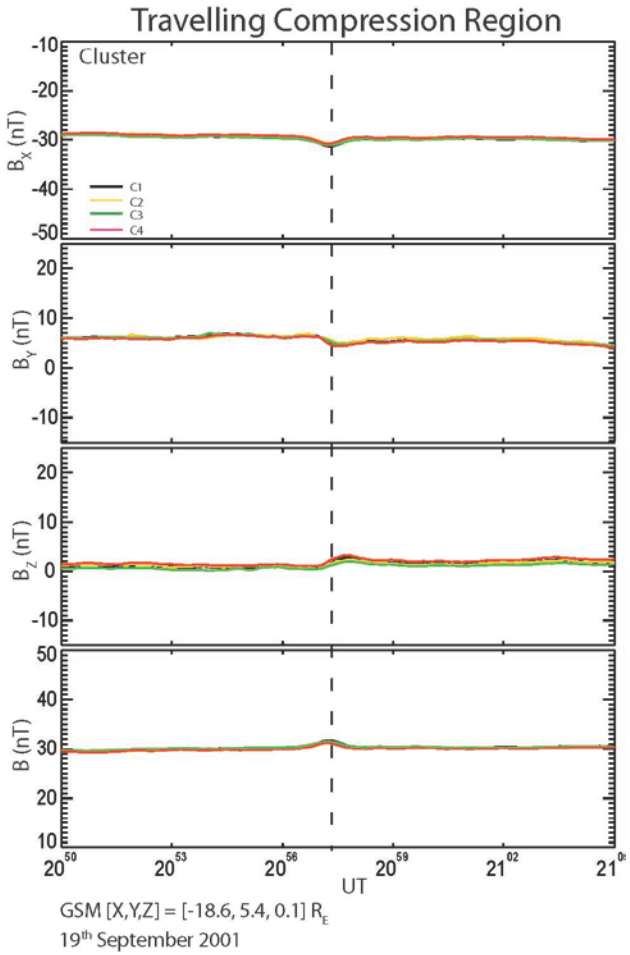




Plasmoids and TCR's

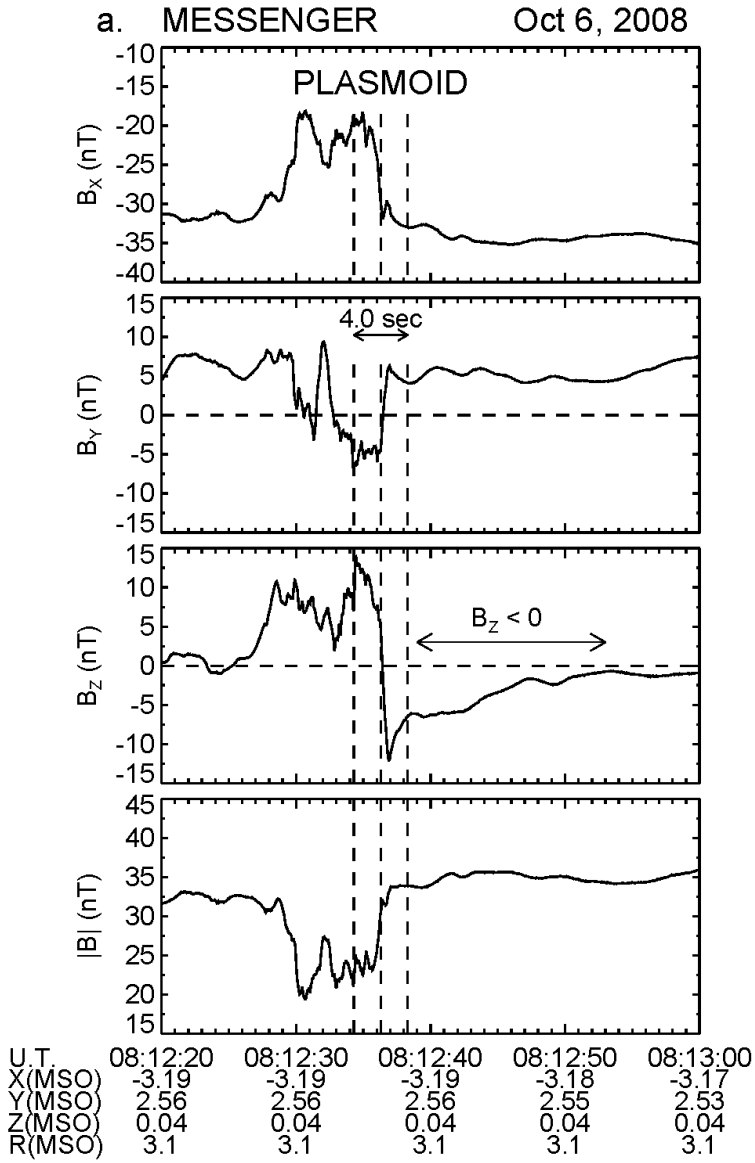


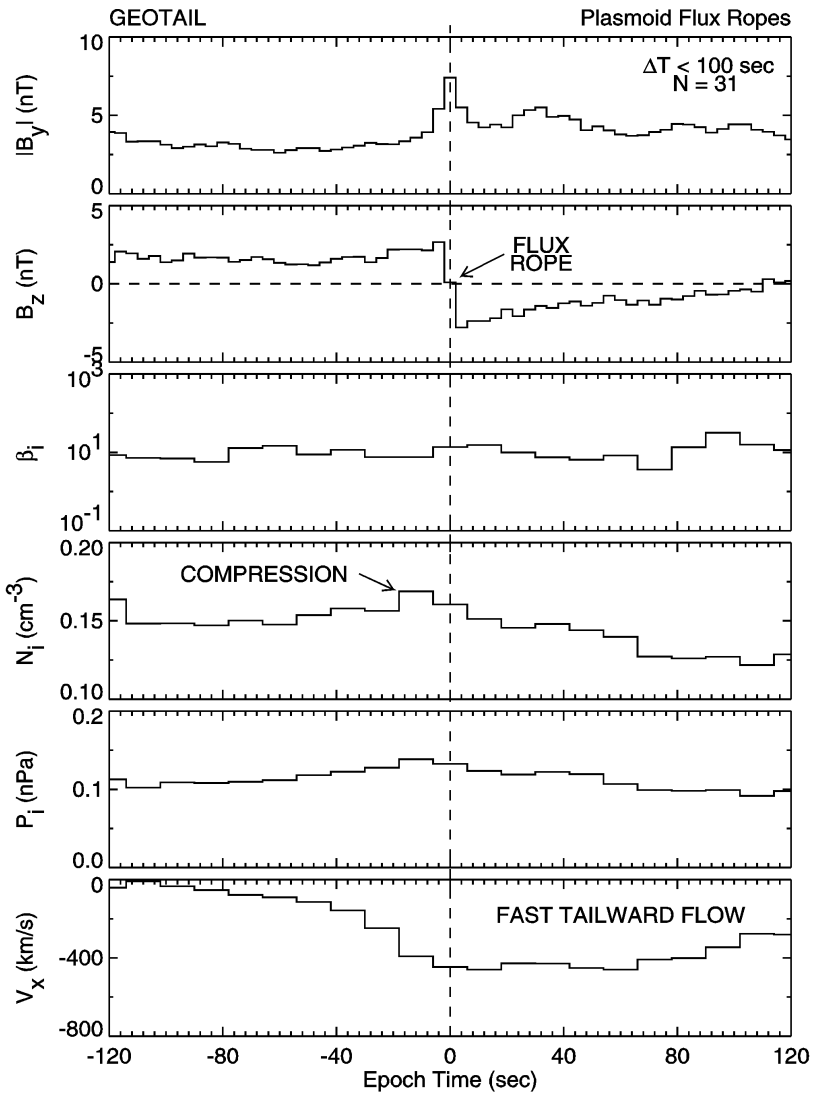




+/- B_z Plasmoids and TCR's move tailward; -/+ B_z move sunward.

Mercury and Earth Plasmoids



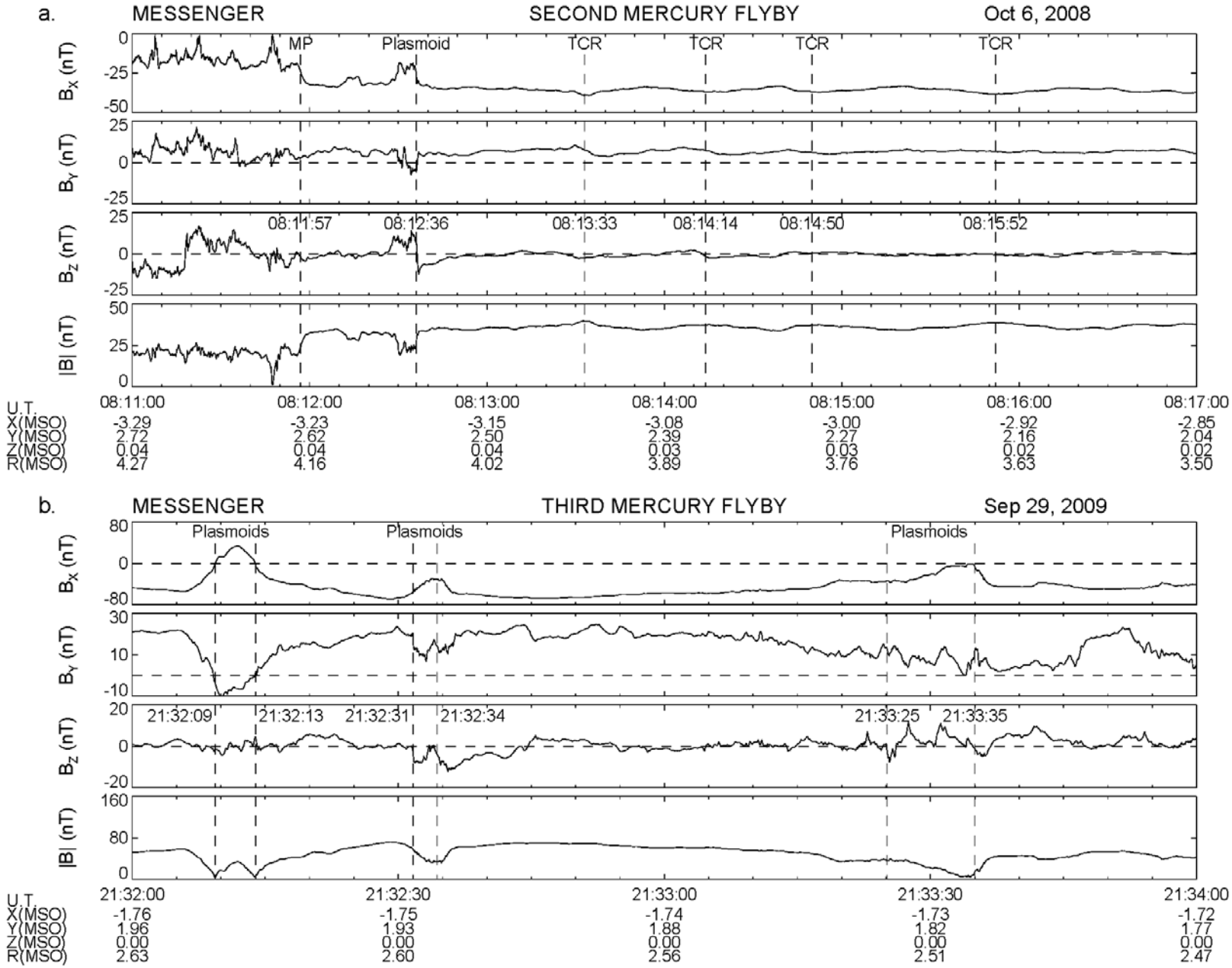


Mercury Plasmoid ~ 4 sec; Earth Plasmoid ~ 30 sec

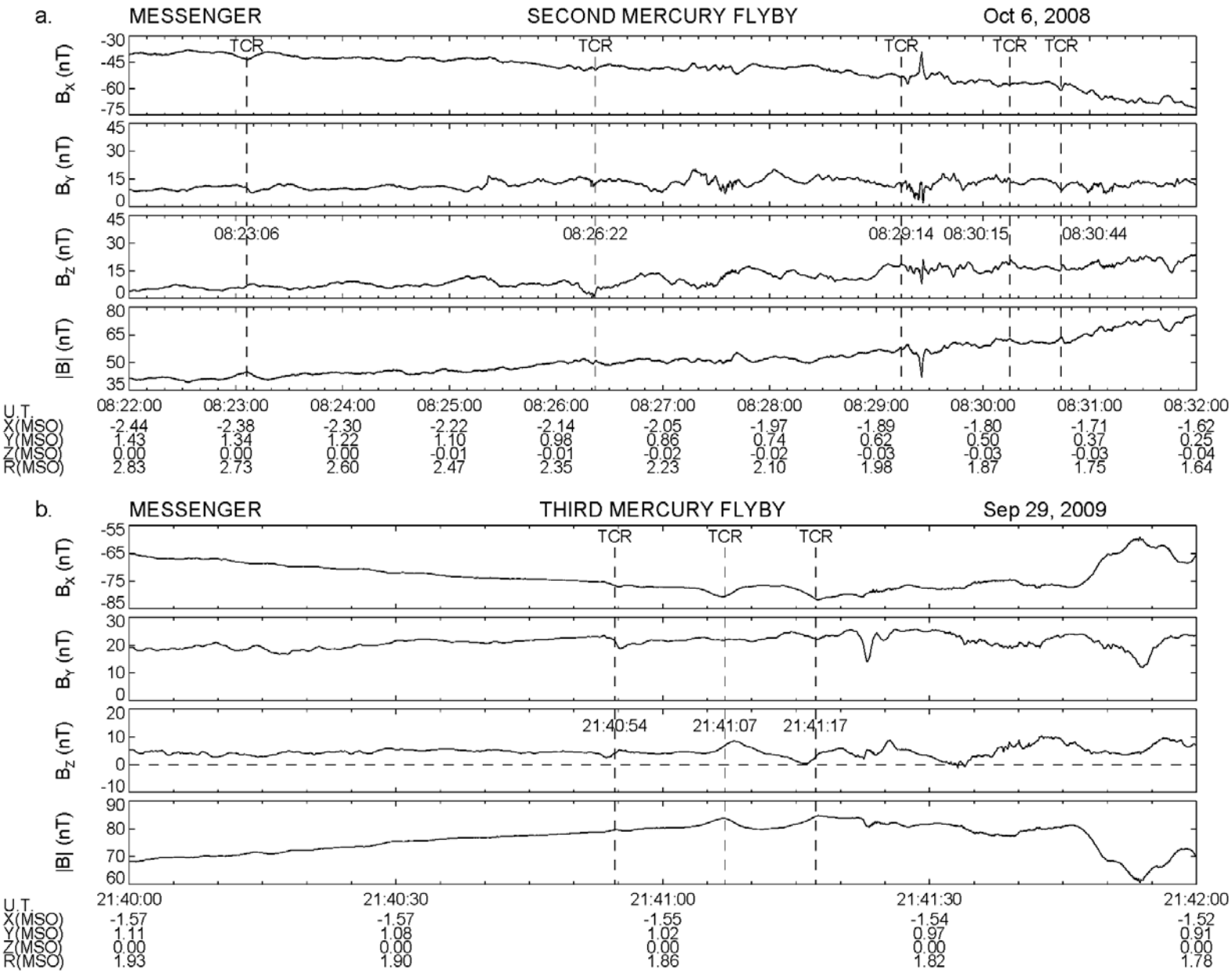
Plasmoid Properties

Planet	R_{mp}	Φ_{lobe}	L_{pmd}	PPPS Flux Transfer
Mercury	1.3 R_m	2.5 MWb	3 s/0.7 R_m	0.25 MWb (10%)
Earth	10 R_e	500 MWb	30 s/ 3 R_e	15 MWb (3%)
Jupiter	60 R_j	500 GWb	20 m/10 R_j	1 GWb (0.02%)
Saturn	25 R_s	40 GWb	10 m/ 6 R_s	0.1 GWb (0.5%)

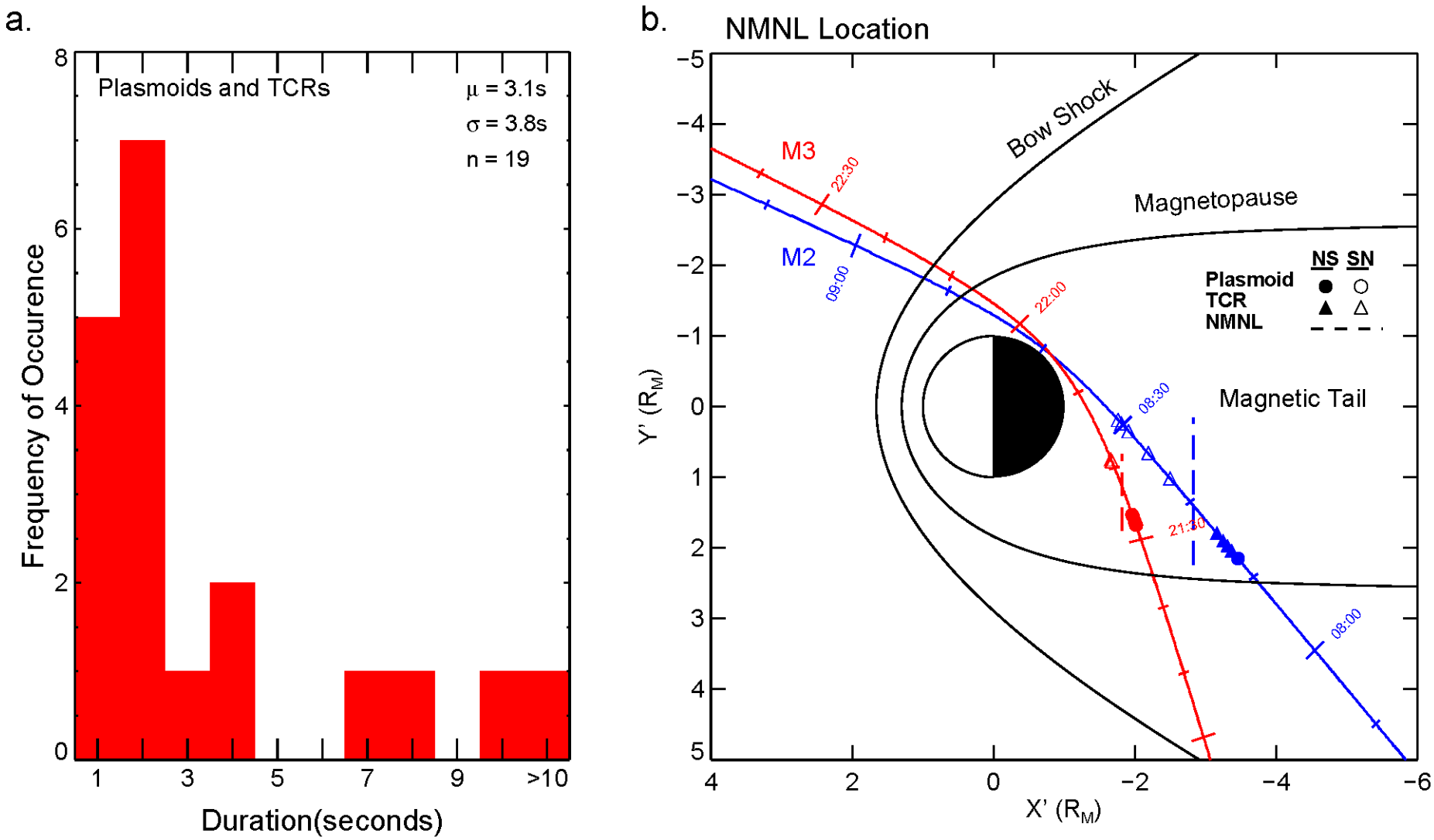
M2 and M3 Plasmoids



Sunward Moving TCR's



Near Mercury Neutral Line Location



Last Closed Field Line crosses equatorial plane at X ~ - 1.8 to 2.8 R_M

Conclusions

- Mercury's magnetosphere is the more responsive to IMF direction than any other in the Solar System due to high Reconnection Rate and Fast Dungey Cycle.

- Individual Flux Transfer Events, occurring every ~ 30 s, can increase the open flux providing SW access to the surface by ~ 10% for the duration of their ~ 10 s life spans.

- Variable IMF B_z on timescales comparable to the Dungey cycle time appears far more effective in opening magnetospheric flux tubes than flux transfer events or strong southward IMF alone.

- Southward IMF results in planetary ions on flux tubes crossing the equatorial plane more than ~ 2 – 3 R_M anti-sunward of the Mercury's terminator plane being lost to flow down the tail.