An update on ion-scale current sheet distribution in the geomagnetic tail

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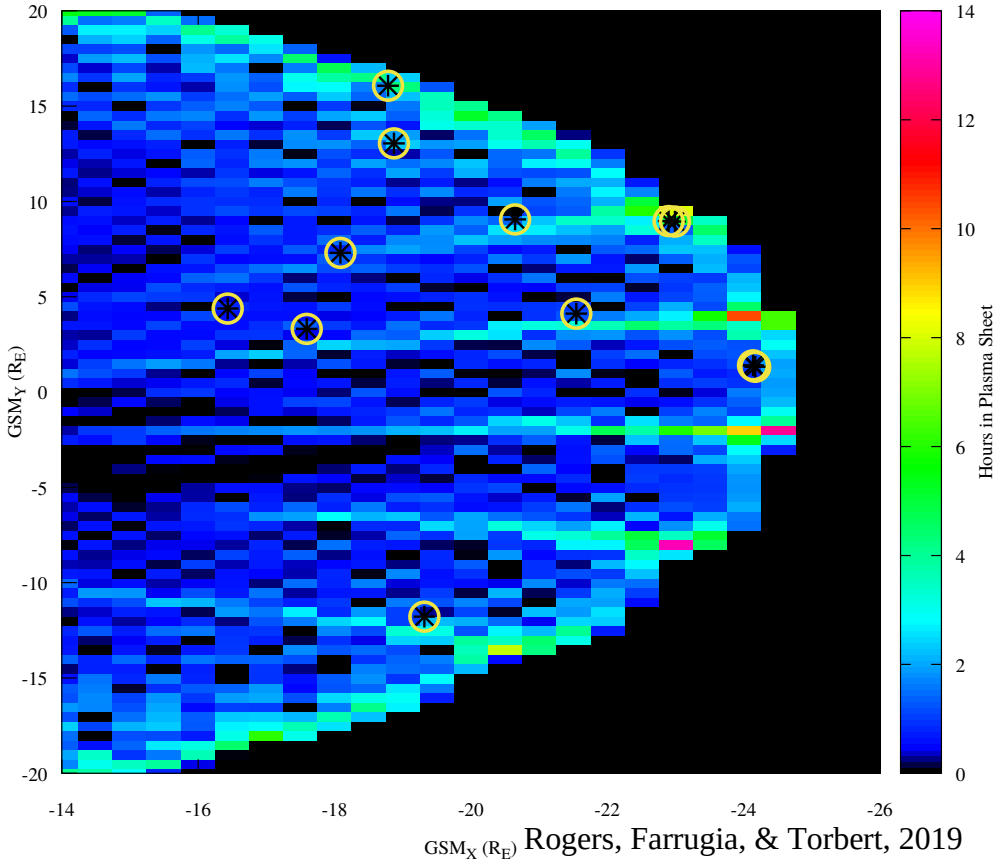
Motivation for study

- Using MMS Rogers et al. 2019 found Ion Diffusion Regions (IDRs) show a strong Dusk-side preference in tail, even accounting for possible observational bias (lamppost effect)
- MMS Plasma Sheet Dwell time:

  56.5% duskside – 43.5% dawnside
- IDR locations:

  91.7% duskside – 8.3% dawnside

- What is the reason for this IDR distribution? Non-uniform distribution of thin current sheets?



Rogers, Farrugia, & Torbert, 2019

MFL Curvature

- The curvature k of the unit vector b is:

  $$\boldsymbol{k} = \boldsymbol{b} \cdot \nabla \boldsymbol{b}$$

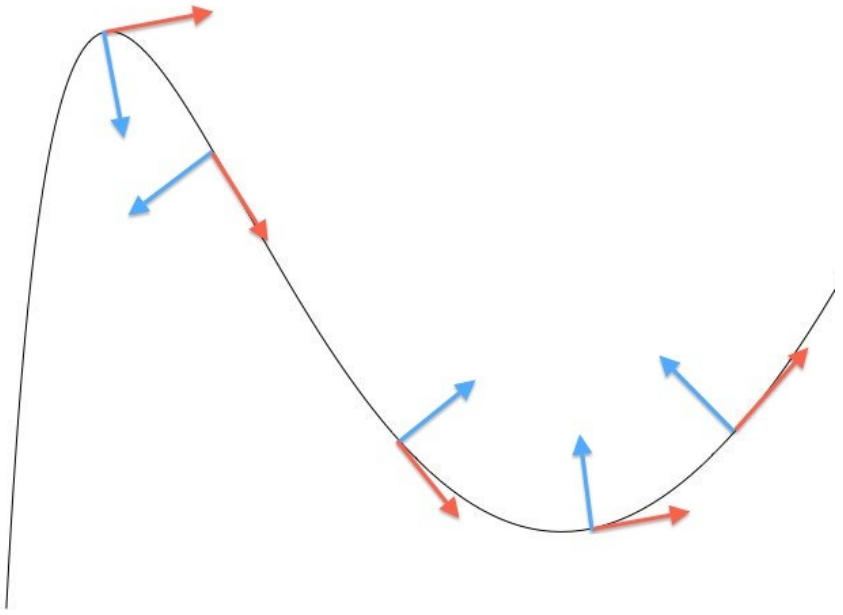
- Buchner & Zenanyi (1989)

  $\kappa = \sqrt{R_C / r_g}$

  Where $R_C = 1/|\boldsymbol{k}|$

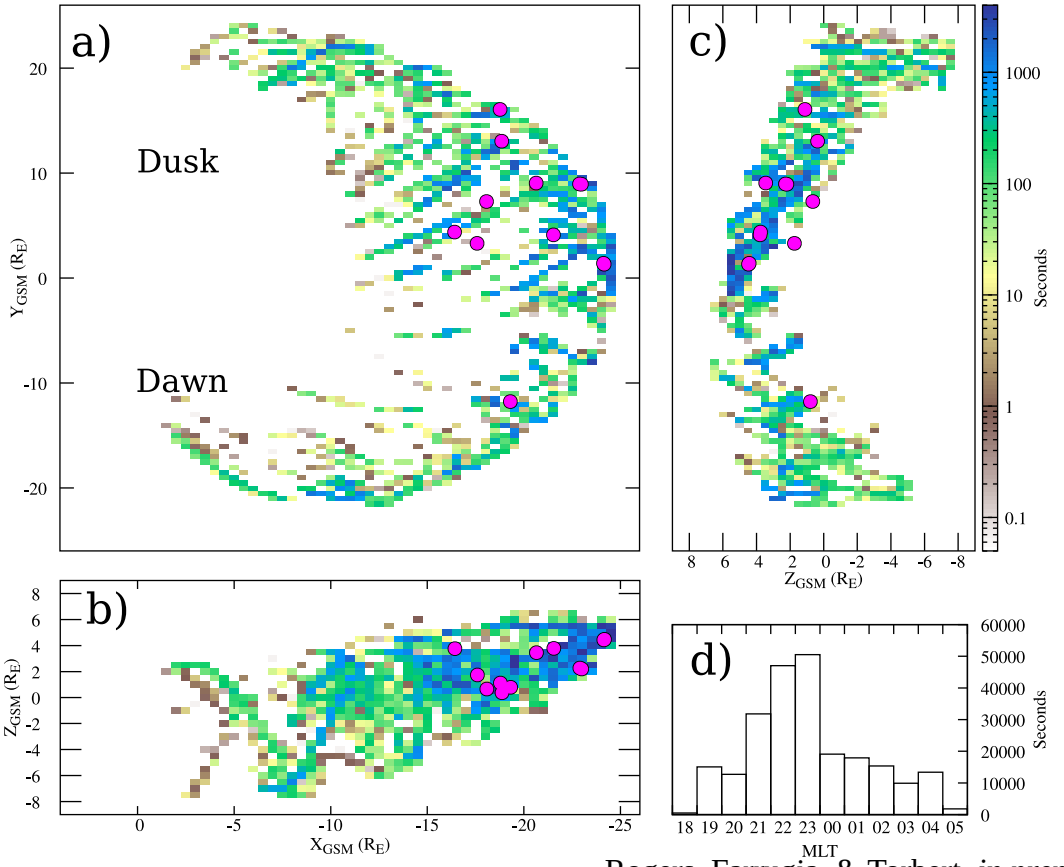
  - For $\kappa < 10$: scattering
  - For $\kappa < 3$: non-adiabatic motion

- Use R_C as scale length of **B**



Identifying Thin Current Sheets

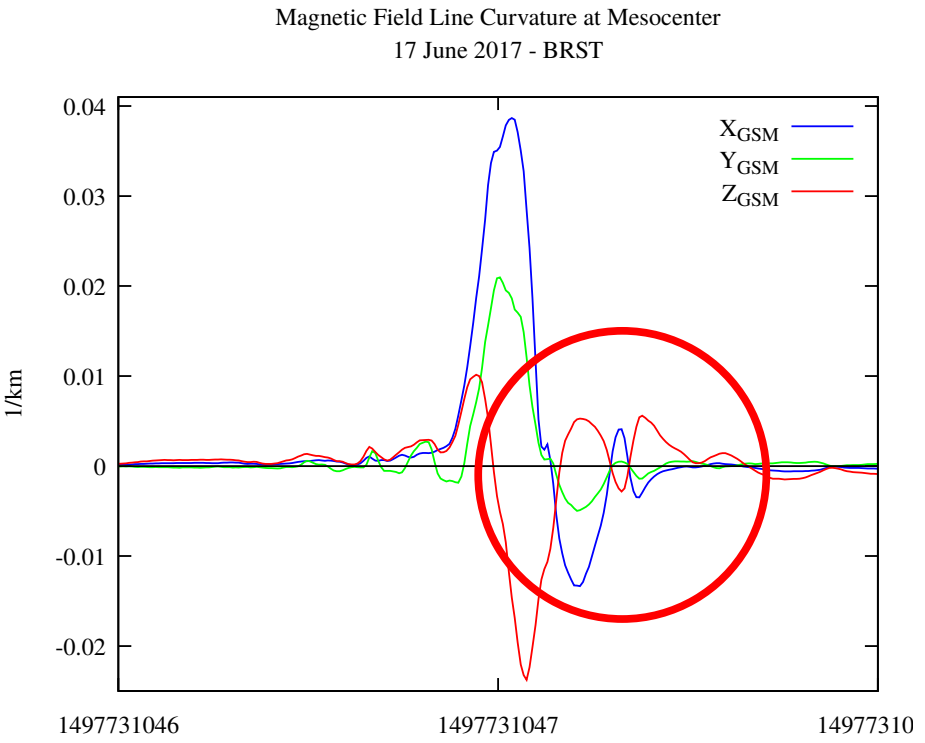
- $R_{C,min} \geq h$ (Shen et al., 2008)
- Use $\kappa \leq 1$ as proxy for ion-scale CS
- MMS Plasma Sheet:
  - Dusk: 56.5%
  - Dawn: 43.5%
- MMS TCS (K < 1):
  - Dusk: 67.1%
  - Dawn: 32.9%
- Distribution across MLT similar to previous studies of TCS, substorm onset, etc.



Rogers, Farrugia, & Torbert, *in prep*

Concerns

- Issue of uncertainty raised
  - Are small scale features real or a function of uncertainty?
  - Is $|\boldsymbol{k}|$ usable with the errors associated with it?
- Cluster era $\sigma_{\nabla \mathbf{B}}$ assumed interpolation between S/C dominant source of error (Shen et al. 2003; Paschmann & Daly 1998)
- Interpolation error dominates for $R_C <$ (S/C separation)/2
  - Not the dominant source for MMS



Solution

- Brute-force approach to propogate uncertainty associated with every vector measurement p_i involved with the calculation of $\nabla \boldsymbol{b}$

$$\sigma_{\nabla \mathbf{b}} = \sqrt{\Sigma(\nabla \mathbf{b}(p_i \pm \sigma_{pi}) - \nabla \mathbf{b})^2}$$

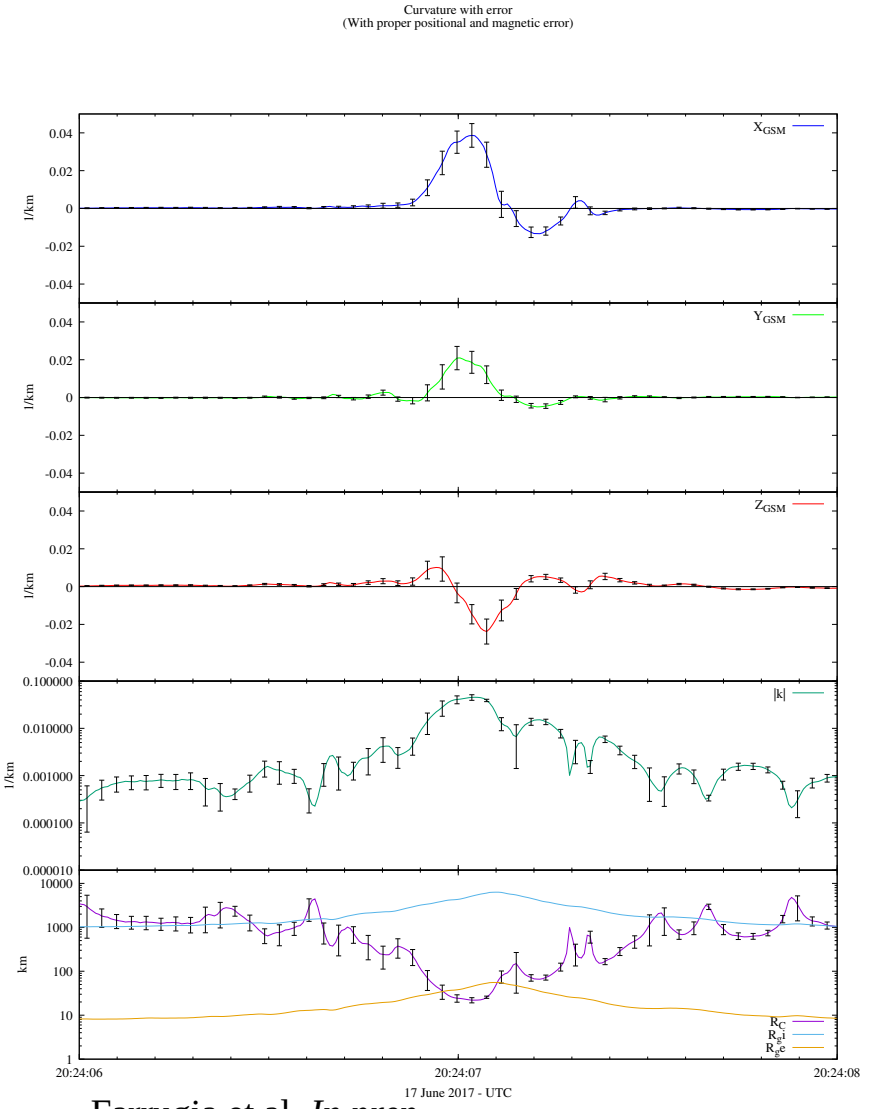
- Makes no assumptions regarding cross-correlation between parameters.

- Do the uncertainties invalidate the previous results?

Results

- No. ***k*** are trustable within reason – similar error as for curlometer (also calculated)

- R_C and κ similarly validated.

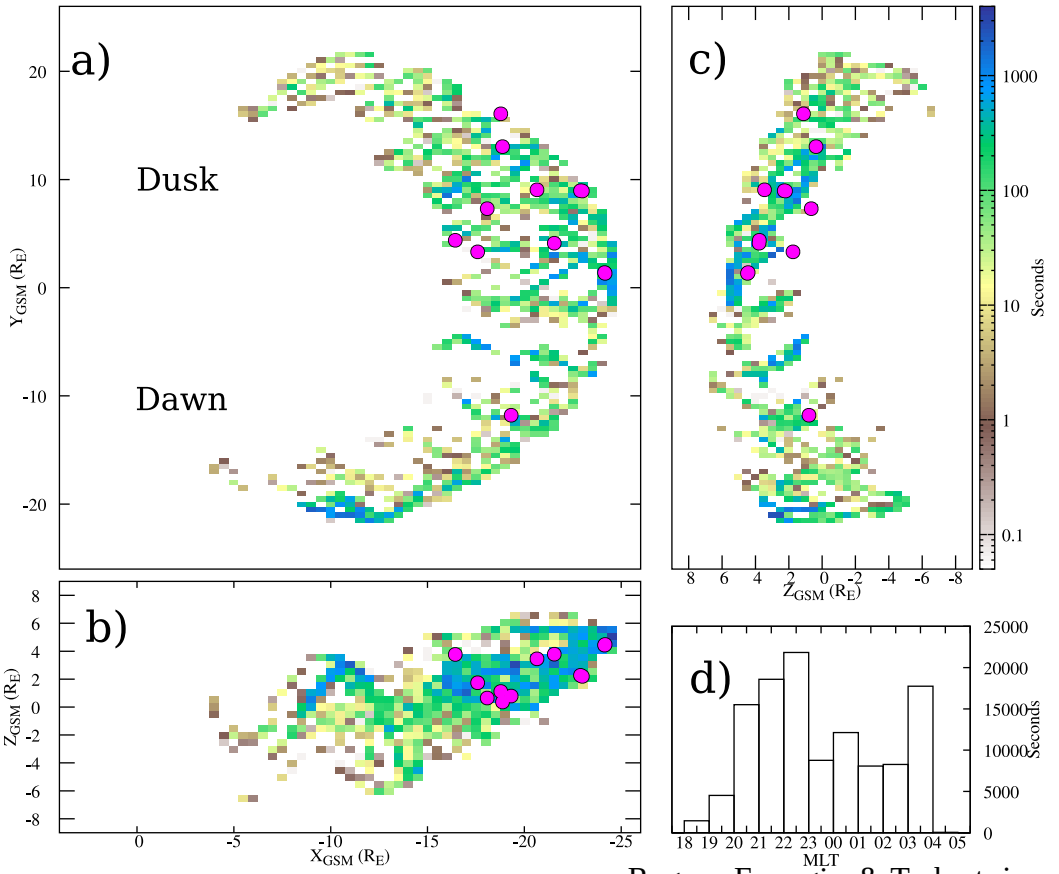


Farrugia et al. *In prep.*

Results

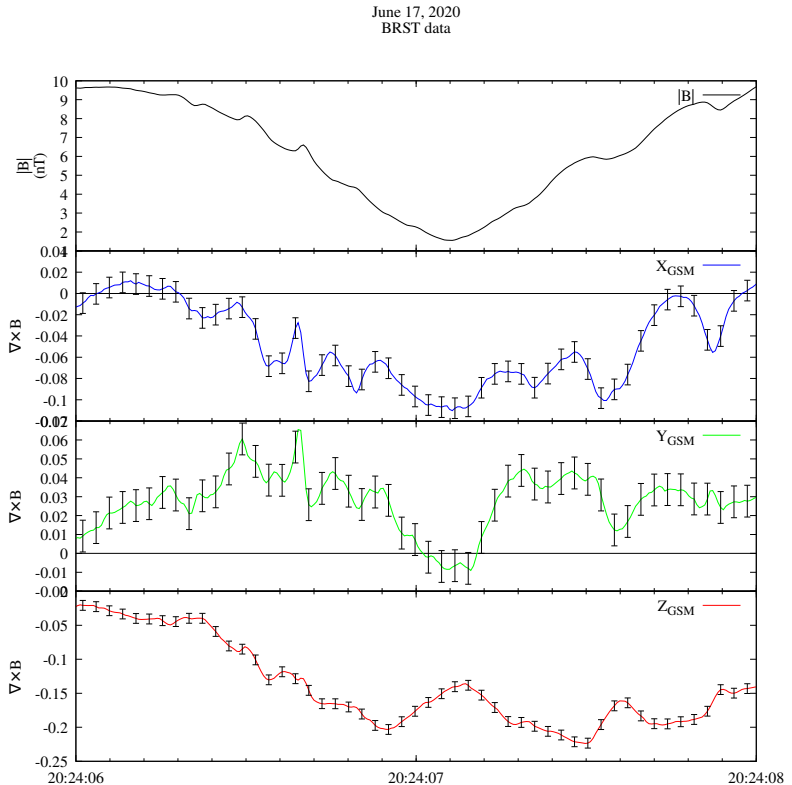
- Ion-scale current sheets in tail maintain similar distribution when requiring

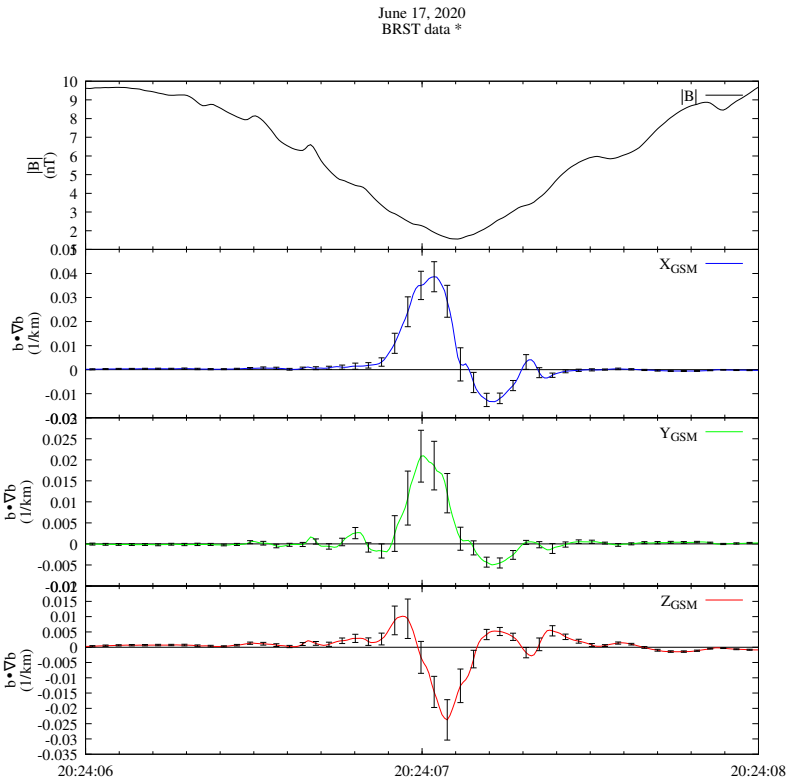
$$r_{g,i} \geq (R_C + \sigma_{Rc})$$



Rogers, Farrugia, & Torbert, *in prep*

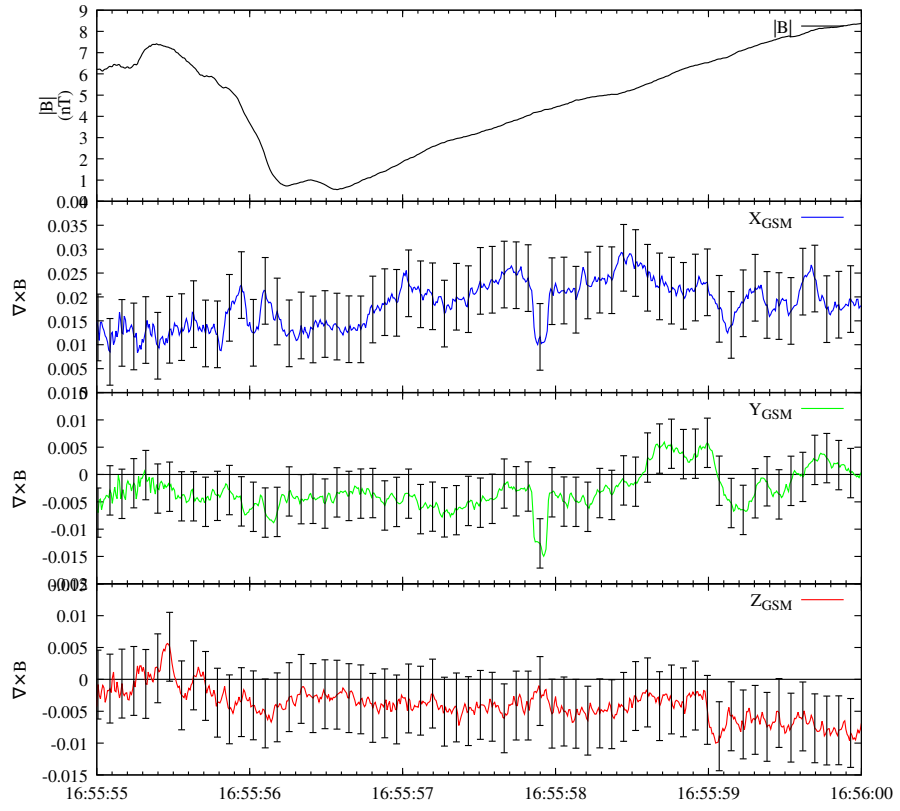
Backup


June 17, 2020
BRST data
|B|
|B| (nT)
X_GSM
Y_GSM
Z_GSM
∇×B
20:24:06
20:24:07
20:24:08

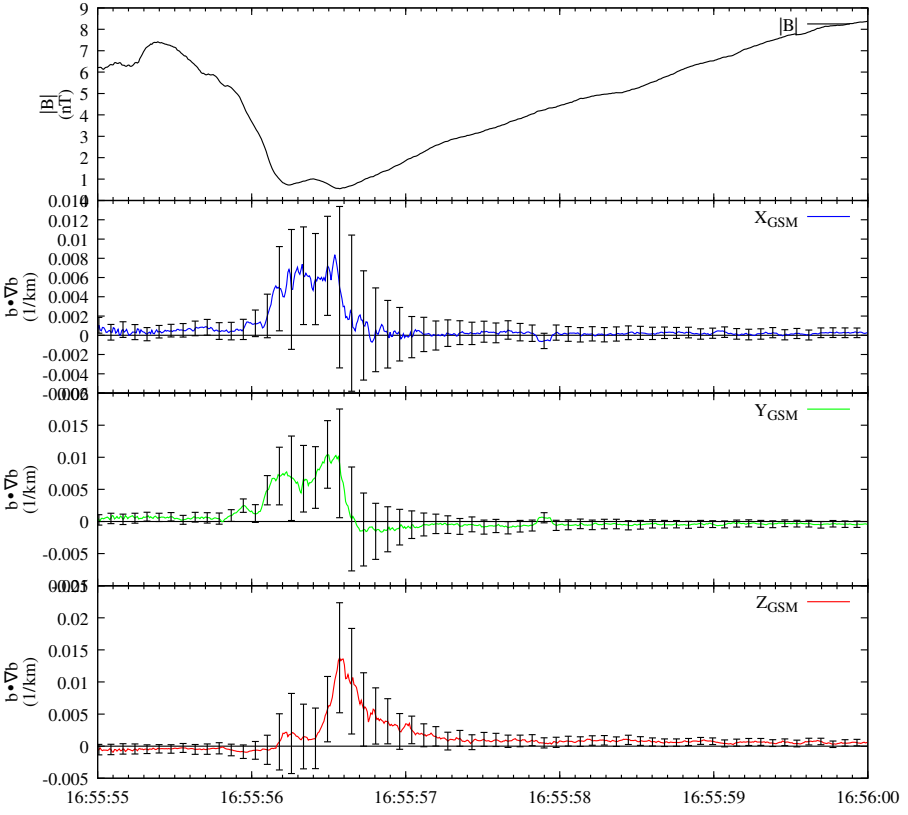

June 17, 2020
BRST data *
|B|
|B| (nT)
X_GSM
Y_GSM
Z_GSM
b•∇b (1/km)
20:24:06
20:24:07
20:24:08

Backup

August 02, 2020
BRST data



August 02, 2020
BRST data



Backup

Dwell Time in TCS By Radial Distance