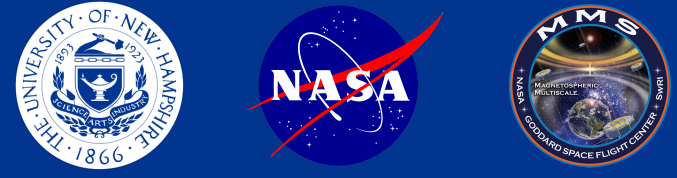


Evolution of Dipolarization Fronts from the Magnetotail to Inner Magnetosphere Observed by MMS

Tyler J. Metivier, Hiroshi Matsui, Charles J. Farrugia, Roy B. Torbert
University of New Hampshire, Space Science Center, Durham NH



Introduction

- The goal of our ongoing study is to examine how dipolarization fronts (DFs) evolve during their earthward propagation with MMS.
- 318 fronts were collected between 2017 and 2025 from $X \sim -5 R_E$ to $-30 R_E$.
- We present an example of a DF in the transition region, statistical results on velocities (bulk ion velocity, ExB motion, and structure velocity), and a superposed epoch analysis of the SME index during transition region DFs.

Transition Region Dipolarization Front

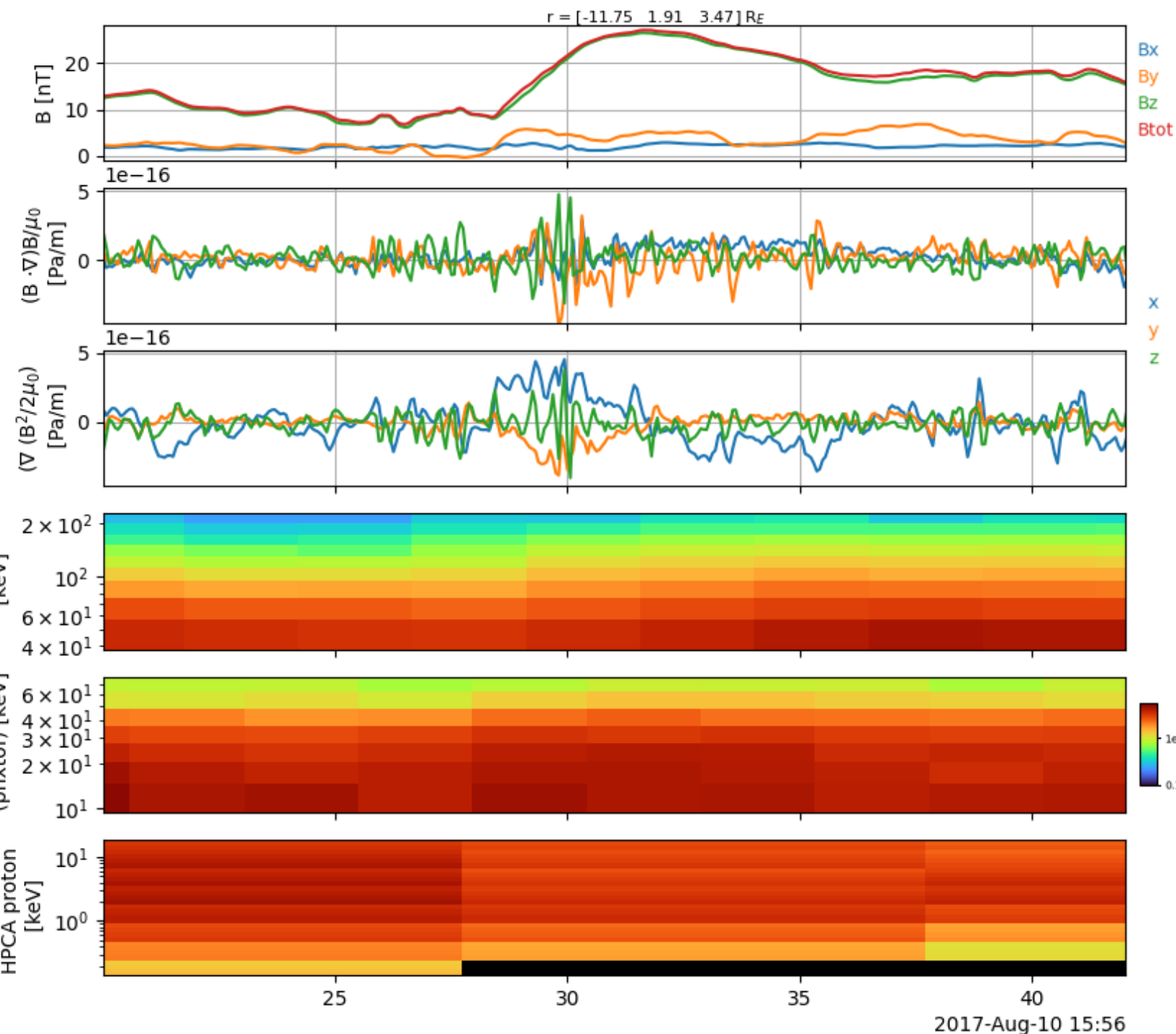


Figure 1

- Figure 1 shows the FGM B field data, magnetic tension force, magnetic pressure force, FEEPS electron flux, EIS proton flux, and HPCA ion flux.
- The magnetic pressure and tension forces are roughly equal in magnitude for this event.
- High energy (keV) ion and electron flux increases following the arrival of the DF. In contrast, the flux of ambient, lower energy ions (eV) decreases as the front arrives.

Statistics - Velocities

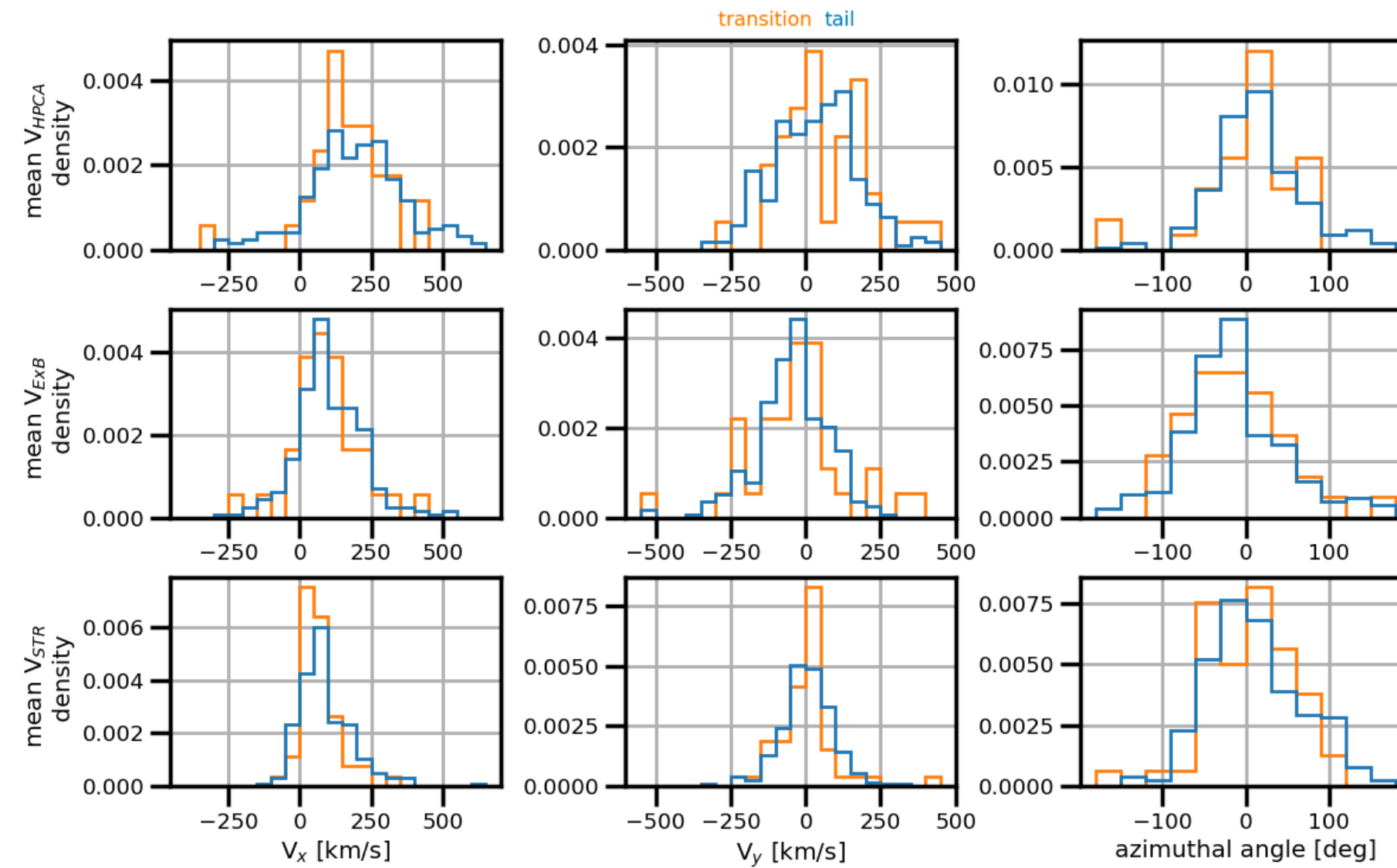


Figure 2

- In Figure 2, each row represents mean velocities from HPCA (bulk H⁺), ExB motion, and the spatio-temporal difference method (STD). The first column represents X_{GSM} velocities, the second Y_{GSM} velocities, and the third shows the azimuthal angle of the velocity components.
- The tail cases often possess a larger earthward velocity than those in the transition region. This deceleration may be attributed to flow-braking as DFs enter the transition region.
- For $V_{HPCA,y}$, both tail and transition region distributions have a slightly duskward shift, which may be due to the effect of Hall electric fields on the ions. For $V_{ExB,y}$, the distributions are shifted more to the dawnside (which is closer to the average electron distributions, not shown here).
- For $V_{STR,y}$, the transition region and tail distributions are more symmetric around $Y = 0$. However the magnitude of the y components for all speeds (ion, ExB, and STD) become more comparable to the X component in the transition region.
- The increase in the transition region Y-components is seen a bit more clearly in the expansion of azimuthal angles in the third panel.

Statistics - Geomagnetic Activity

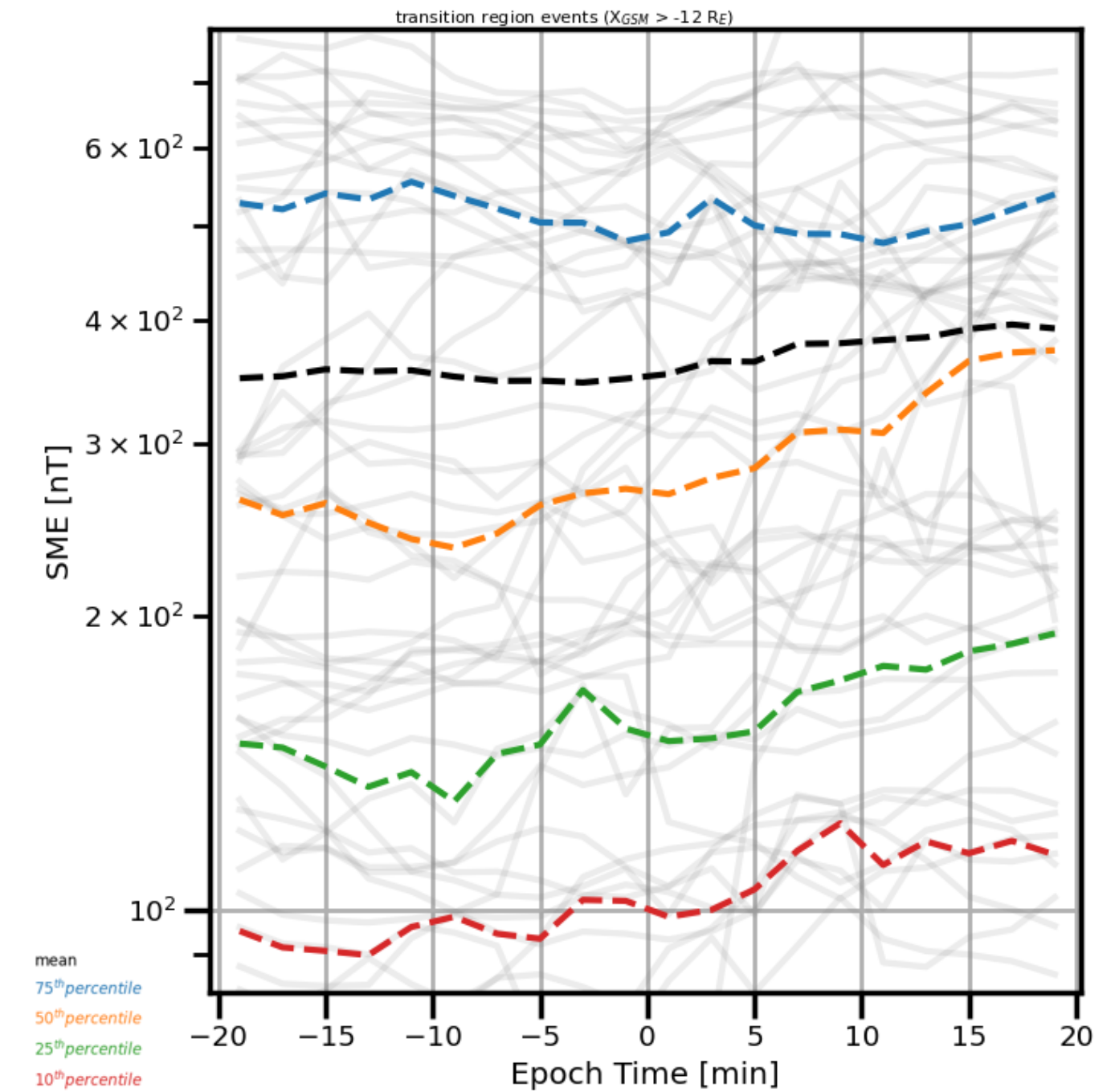


Figure 3

- Figure 3 shows a superposed epoch analysis of the SME index for transition region DFs, from 20 minutes prior to detection to 20 minutes after. The mean (black), 75th (blue), 50th (orange), 25th (green), and 10th percentiles (red) are shown.
- Transition region DFs are often correlated with a sustained increase in the SME index in a +/- 20 minute window, particularly for the 50th percentile or lower (events that begin with a lower SME index).

Discussion

As DFs propagate earthward, we observe:

- An increase in magnetic tension force (in comparison to the magnetic pressure force).
- A decrease in earthward velocities and flow diversion indicated from azimuthal expansion.
- A higher correlation with auroral electrojet activity.