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Magnetic reconnection signatures of dissipating flux ropes associated with dipolarization events: A MMS Case Study

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Three-dimensional global hybrid simulations and THEMIS observations have shown that earthward-moving flux ropes can undergo magnetic reconnection (or “re-reconnection”) with the near-Earth dipole field in the downtail region between the Near Earth Neutral Line and the near-Earth dipole field. Slavin et al., [2003] proposed that earthward flux ropes dissipate through reconnection as the flux ropes push up against the northward geomagnetic field in the inner tail. This “re-reconnection” causes the southward BZ field in the leading edge of the flux rope to “erode” while continuous reconnection of lobe magnetic flux at the X-line tailward of the flux rope causes a “pileup” of northward BZ field, resulting in the asymmetric south-north BZ signature in earthward flux ropes and approximately one-third of DFs with negative BZ dips prior to their observation. In this study, we analyzed magnetic reconnection signatures preceding three earthward-moving flux ropes embedded within DF encounters, which were observed sequentially during MMS Phase 2B tail season. We observed electron outflow jets of $\sim$ 1000 km/s for these events in the north-south direction consistent with the MMS location relative to the center of the cross-tail current sheet. The characteristic quadrupolar Hall magnetic field in the ion diffusion region and intense currents of $\sim$ 30 – 60 nA/m2 were also observed when MMS encounters the reconnection region. J$\bullet$E’ $>$ 0 in the reconnection region is consistent with magnetic reconnection being an energy dissipative process. Lastly, we will also discuss the electron distribution functions observed by the Fast Plasma Instrument and ionospheric responses due to dissipating flux ropes/DFs.