First Observations of Convective Flows in the Dusk-side Equatorial Magnetosphere by MMS.

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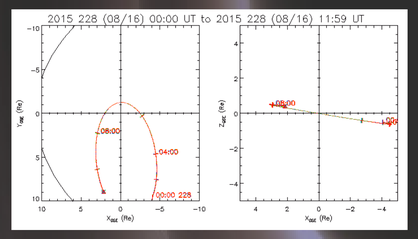
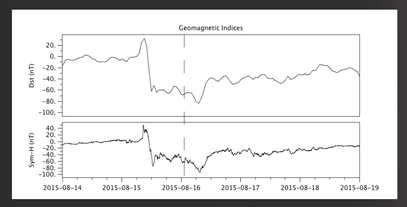
Abstract

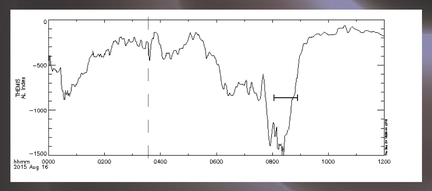
Energy is transported throughout magnetosphere by various convective processes. Convection is driven by the Dungey reconnection cycle during which the magnetospheric field lines reconnect with those of the interstellar magnetic field, are transported to the magnetotail, and may reconnect. These field lines then convect back to the dayside. Within this flow, dipolarization fronts, accompanied by bursty bulk flows, couple to the ionosphere via the substorm current wedge. The electron drift instrument (EDI) onboard the MMS satellites can measure the electric field perpendicular to B and the convection ExB drift velocity. We combine the EDI data with those of the 3D electric field measurements from the electric field double probes, and magnetic field data from a combined fluxgate and search-coil data product, to provide measurements of the subauroral ion drift (SAID) and the subauroral polarization streams (SAPS). A close conjunction of Van Allen Probes and MMS on 12 June 2015, provides an opportunity to have 6-point measurements of these phenomena.

Geomagnetic Activity on 2015-08-16

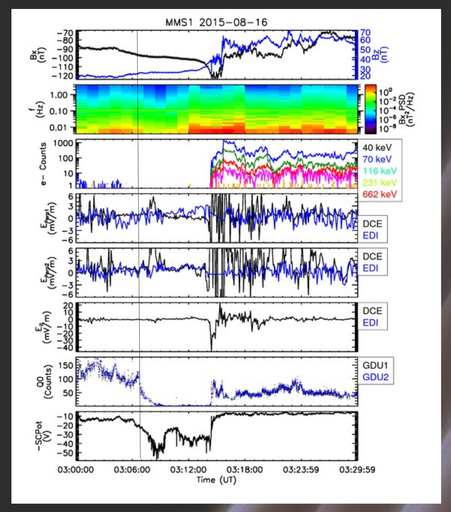
- A storm that began on Aug. 15, 2015
- A dipolarization on the 16th marked the beginning of a “double dip” storm.
- MMS observed DPF while inbound
- SAPS and Pc5 observed while outbound
- DPF & SAPS have corresponding dips in AL index

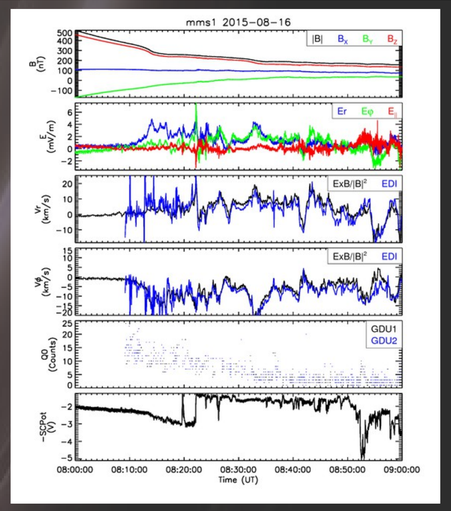


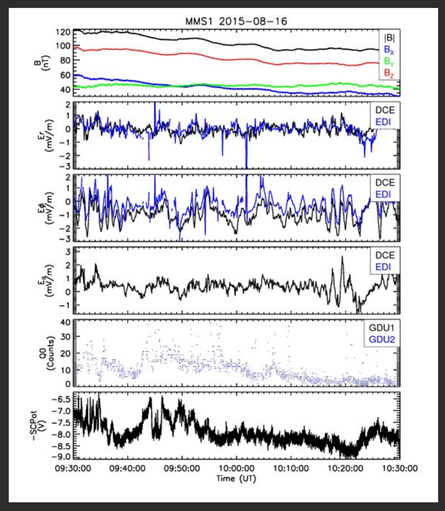




EDI E-field and Drift Velocities Observed on 2015-08-16







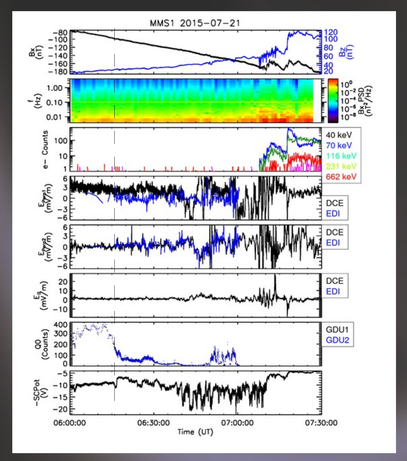
Outbound: Dipolarization & BBF

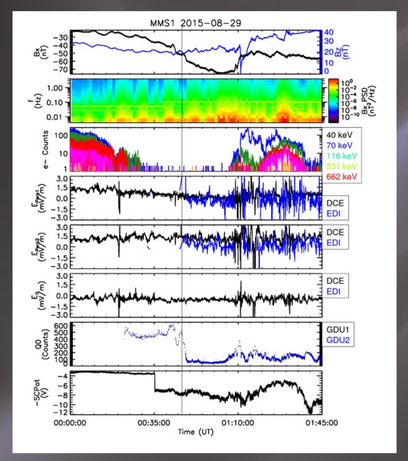
- The tail began to stretch from 03:05 – 03:13
- Convection shifted from earthward to tailward (vertical line)
  - Density cavity marks entrance into lobe
  - Reduction of 500eV 90 degree electron counts
- Initial dipolarization at 03:14:00
  - High energy electron counts increase
  - Enhanced E-field fluctuations & Pi2 fluctuations indicate BBF
- Full dipolarization at 03:14:30
  - Convection turns earthward and duskward

Inbound: SAPS & Pc5 Waves

- On the outbound pass, EDI observes a SAPS event
  - Electron plasma sheet boundary crossed 08:21:15
  - Plasma drift is duskward
  - High density region is probably the plasmaspheric plume
- Pc5 waves are poloidal
  - E-field fluctuations are (anti-) parallel to drift of radiation belt particles.
  - Potential to accelerate electrons

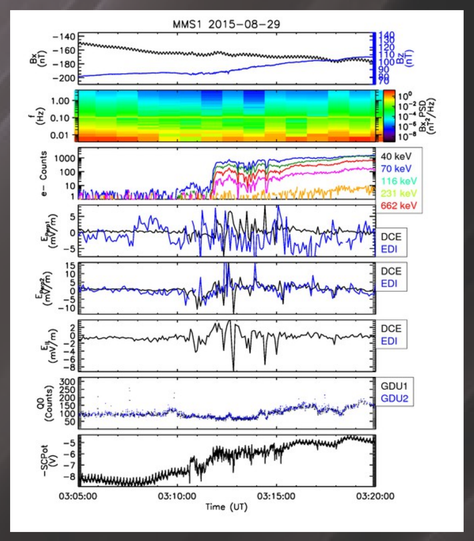
Convection & Dipolarization





- Before dipolarization, convection reverses from earthward to tailward (black line)
  - Decrease in 500 eV 90° electrons
  - Gradual decrease in density until DPF
- Dipolarization is accompanied by:
  - Pi2 and Pi1B waves
  - Bursty bulk flows
  - High energy particle injections
- Afterward, convection is earthward and duskward.

Electric Field Measurements in the Ring Current



- Entry into the ring current
  - High energy electrons
  - Electrons modulated by E-field waves
  - Convection is toward dusk

Conclusions

- EDI can measure the electric field and v_{ExB} drift velocity under a variety of geomagnetic activities, including dipolarization fronts, SAPS and SAIDS, and Pc5 oscillations.
- Except for known offsets and scaling factors, EDI and EDP agree well in the majority of cases.
- Convection reversal prior to dipolarization fronts could be a result of field line stretching drawing plasma into the tail, or causing entry into the lobe.
  - Spacecraft moves into a region of low density and depleted flux
- After dipolarization, convection returns earthward and duskward.
- Pc5 waves are poloidal and may interact with radiation belt particles.
- SAPS convective flows are duskward, in agreement with previously reported events.

Acknowledgements

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