ITIT-12

Analysis of Substorm Auroral Electrojet Signatures in EZIE Observations using Ground-Based Instruments

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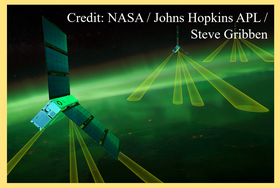
EZIE Mission

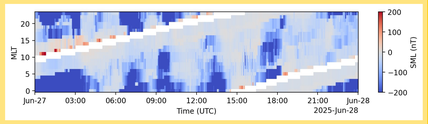
- 3-satellite constellation to study the mesoscale structure of the ionospheric substorm electrojets
- Remote-senses Zeeman splitting of the 118 GHz oxygen line
- Four Microwave Electrojet Magnetogram (MEM) instruments per satellite aligned cross-track



L1 data: Spectral radiances / L2 data: Magnetic fields / L3 data: 2-D current maps

Ground Observations

SuperMAG Lower-Local Time (SML-LT) index
- **Resolution: 1 min. UTC x 1 hr. MLT**



Case Studies

During EZIE AEJ #1 Campaign (2025-05-15 to 2025-08-31)

Type	Metric	Total # of Days	Example Day
Geomagnetic Storm	SYM-H < -40 nT	31	May 29, 2025
Intense Substorm	SME > 700 nT	40	June 27, 2025
Moderate Substorm	400 nT < SME < 700 nT	28	July 02, 2025
Quiet	SME < 400 nT	10	N/A

Future Steps

- **Further validate EZIE data using instruments more closely collocated with the satellite track (e.g., individual ground magnetometers and SWARM magnetometers)**
- **Analyze more substorm events to systematically describe mesoscale electrojet variability in both space and time**

Acknowledgements

We acknowledge the NASA EZIE mission team (Johns Hopkins Applied Physics Laboratory and NASA Jet Propulsion Laboratory) for use of data products obtained from the EZIE Science Gateway.
We also acknowledge the SuperMAG collaborators for use of the SuperMAG indices.
Thanks to Frank Werner and the EZIE MEM team for very helpful discussions on data retrieval.
A portion of research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with NASA. Support of JPL R&TD Strategic University Research Partnership Program is acknowledged.
Grants: JPL SURP RSA 1724898 and NASA FINESST 80NSSC24K1858

Methodology

1. **Select substorm events and identify the electrojet signature in EZIE L2 data**
2. **Validate EZIE data using ground magnetometer measurements (during various levels of geomagnetic activity)**
3. **Use additional datasets (VISTA Total Electron Content, AMPERE Field Aligned Currents) for supplementary validation and ionospheric context**

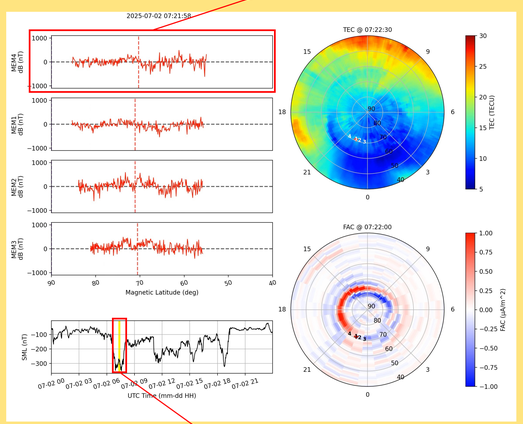
Results + Key Conclusions

Note: All EZIE MEM data are still preliminary

July 02, 2025 (Moderate Substorms)	June 27, 2025 (Intense Substorms)	May 29, 2025 (Geomagnetic Storm)

Single orbit chosen from each day to show representative characteristics

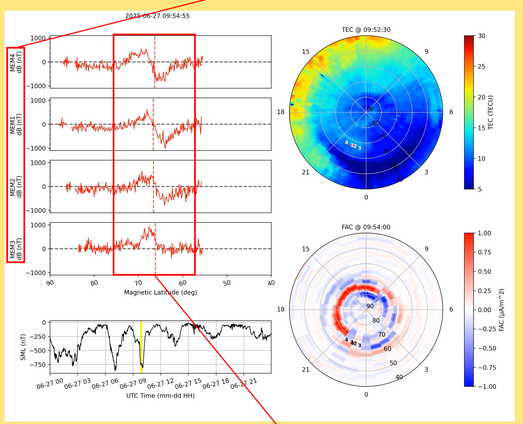
Data only from satellite A (B and C omitted from plot for simplicity)



Time of observation highlighted on daily SML plot

Weak sinusoidal perturbation in some MEMs, unclear in others. Difficult to separate electrojet from noise.

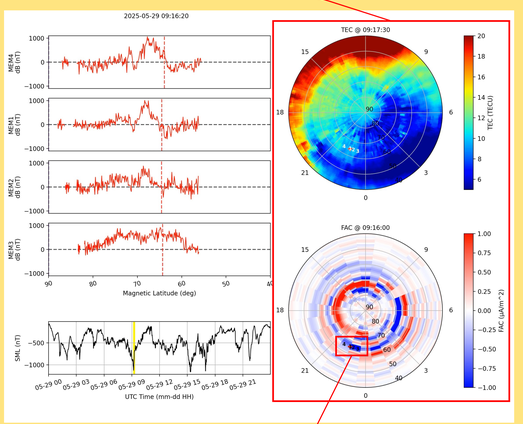
Look directions aligned from westmost (4) to eastmost (3)



Example of westward-flowing electrojet signature (sinusoidal positive-to-negative perturbation)

Large sinusoidal perturbation centered around zero nT. Clear electrojet signature.

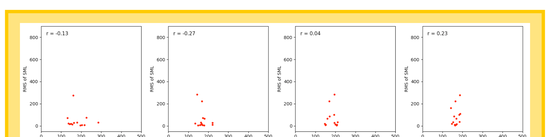
Total Electron Content (top) and Field-Aligned Current (bottom) maps



Satellite (cross) and MEM measurement locations (numbers) at time of observation

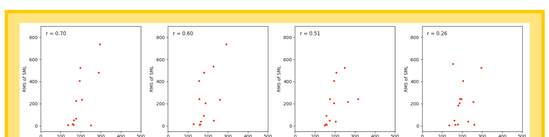
Multiple perturbations with large magnitudes. Electrojet signature is visible among other activity.

Root-Mean-Square value of each orbit compared to SML-LT index



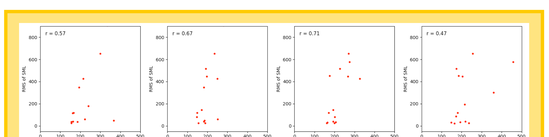
No clear correlation
Noise covers electrojet signature when current is weak

Electrojet current during smaller substorms is localized and temporally transient.



Stronger correlation for MEM 4 and MEM 1
Possibly due to westward current displacement

During intense substorms, electrojet current spans several hours in MLT and is temporally stable.



Moderate correlation with some scattering
Currents may be more complex, not fully captured by SML

Enhanced geomagnetic activity during storm times creates complicated multi-current system.