Spatial and Temporal Variability of the Equatorial Electrojet Observed by the CSES Satellite

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Equatorial Electrojet (EEJ)

Sounding rocket measurement

Confined in the E-region

Satellite measurement

Swarm EEJ (15:30 UT, May-Jul)

Dip equator

Confinement to the dayside near the dip equator

Ground-based measurement

EEJ at Ponape, FSM

Confined to the dayside near the dip equator

Considerable day-to-day variability

[21 Sep 1994]

[J (μA/m²)]

Altitude (km)

[Liu et al., 2021]

[Pfaff et al., 1997]
Equatorial Electrojet (EEJ) Variability

[Image: Graph showing EEJ from CSES satellite]

[Image: Graph showing Seasonal variation]

[Image: Graph showing Solar flux]

[Lühr et al., 2008] [Yamazaki et al., 2011] [Matzka et al., 2017]
China Seismo-Electromagnetic Satellite (CSES)

CSES (since 2018)
Sun-synchronous

Inclination: 98°
Altitude: ~500 km
Local time: Fixed (2 PM)

Swarm (since 2013)
non-Sun-synchronous

Inclination: 87°
Altitude: ~460 km (A & C)
~530 km (B)
Local time: Slow precession (1.5 h/month)
CSES EEJ Data Set

EEJ = equatorial electrojet

2.5 years under solar minimum conditions

CSES EEJ (Jul. 2018–Apr. 2022)

Solar radio flux (day-to-day var.)
Conjunctions if: $\Delta t<15$ min, $\Delta \text{lon}<10^\circ$

Strong correlation ($R>0.9$) with EEJ from both Swarm A and Swarm B
Day-to-day and Longitudinal Variability (Ex. #1)


EEJ current intensity

All measurements come from 2 PM local time.
A westward-propagating wave?
A westward-propagating 6-day wave with zonal wavenumber 1
Day-to-day and Longitudinal Variability (Ex. #2)


EEJ current intensity

Longitude (deg)

Day of Year

EEJ (mA/m)

Y. Yamazaki

EEJ from CSES satellite
Day-to-day and Longitudinal Variability (Ex. #2)

A zonally-uniform oscillation?


EEJ current intensity

EEJ (mA/m)

Longitude (deg)

0 45 90 135 180

10 20 30 40

Day of Year

A zonally-uniform oscillation?
Zonally uniform oscillation with a period of 14-15 days
Average Spectrum of the EEJ at 2 PM

EEJ=equatorial electrojet

CSES EEJ (Jul. 2018 - May. 2021)

- Westward traveling
- Eastward traveling

Period (days)

Zonal wavenumber

Amplitude (mA/m)
Atmospheric wave signatures dominate the average spectrum of the EEJ at 2 pm.
Importance of Neutral Winds

CSES (since 2018)

- Inclination: 98°
- Altitude: ~500 km
- EEJ intensity (110 km)

ICON (2019-2022)

- Inclination: 27°
- Altitude: ~600 km
- Wind profile (95-180 km)
Wind Profiles during Eastward & Westward EEJ

CSES-ICON conjunctions (# Obs.=240+76)

Conjunctions if: Δt<15 min, Δlon<10°, Δlat<5°
Wind Profiles during Eastward & Westward EEJ

CSES-ICON conjunctions (# Obs.=240+76)

Zonal wind profiles are different between the times of eastward and westward EEJ
CSES results are consistent with earlier Swarm results (but w/o LT ambiguity)
Summary & Conclusions

1. Spatial and temporal variability of the equatorial electrojet (EEJ) was examined based on the magnetic measurements from the Sun-synchronous CSES satellite.

2. The EEJ intensities from CSES and Swarm are in good agreement during conjunction observations.

3. The following waves make a significant contribution to the longitudinal and day-to-day variations of the EEJ: ultra-fast Kelvin wave, quasi-6-day wave, semimonthly lunar tide.

4. Zonal wind profiles are different during the times of eastward and westward EEJ, underscoring the zonal wind effect on the EEJ.

Thank you for your attention!