Extraction of Equatorial electrojet data from Swarm satellites.

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Presentation Outline

- The Equatorial electrojet.
  - Definition
  - Mechanism of EEJ
- The Swarm satellites.
- Extraction of EEJ from the Swarm observations.
- Practical session.

Equatorial Elctrojet (EEJ)

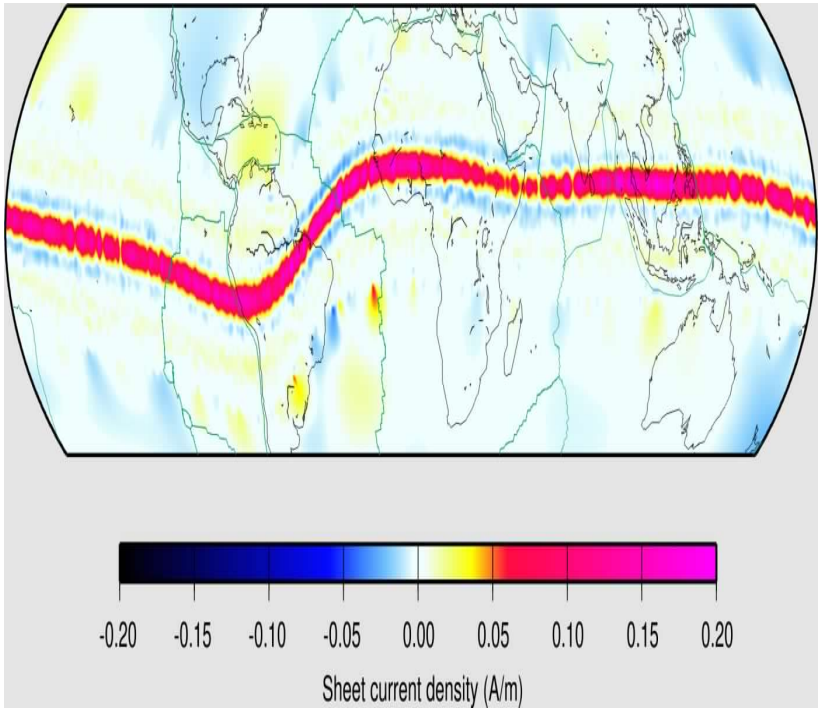
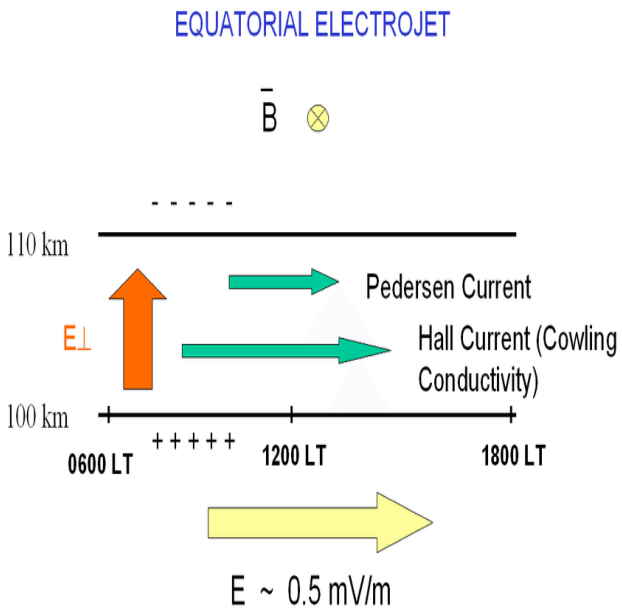


Figure 1: CHAMP observation of EEJ

- A strip of current that flows within $\pm 3^{\circ}$from the dip equator.
- Flows in the Equatorial ionosphere.
- Usually eastward during daytime, and at an altitude of 106-110 km (E-region).
- Manifests as enhancements in horizontal component H, of the geomagnetic filed at the dip equator.

- Eastward electric field is the primary driver of EEJ.
- Produced by a dynamo action in the ionospheric E region, where the thermospheric neutral winds cause the charged particles to move across the magnetic field lines, results to in an eastward electric field.

Mechanism of EEJ



- Eastward electric field is mutually perpendicular to the northward geomagnetic field lines.
- Leads to an upward movement of plasma, E×B drift.
- A large vertical vertical polarization electric field set prevents the further upward drift of electrons.
- There is a large Cowling conductivity which produces an enhanced eastward current (EEJ).

Figure 2: Mechanism of EEJ

- EEJ reverses direction called CEJ.
- Quiet time reversal: westward zonal winds, atmospheric gravity waves, lunar tides amplification during stratospheric sudden warming (SSW), and vertical upward winds.
- Disturbed time reversal: PPEF and DDEF.

The Swarm satellites

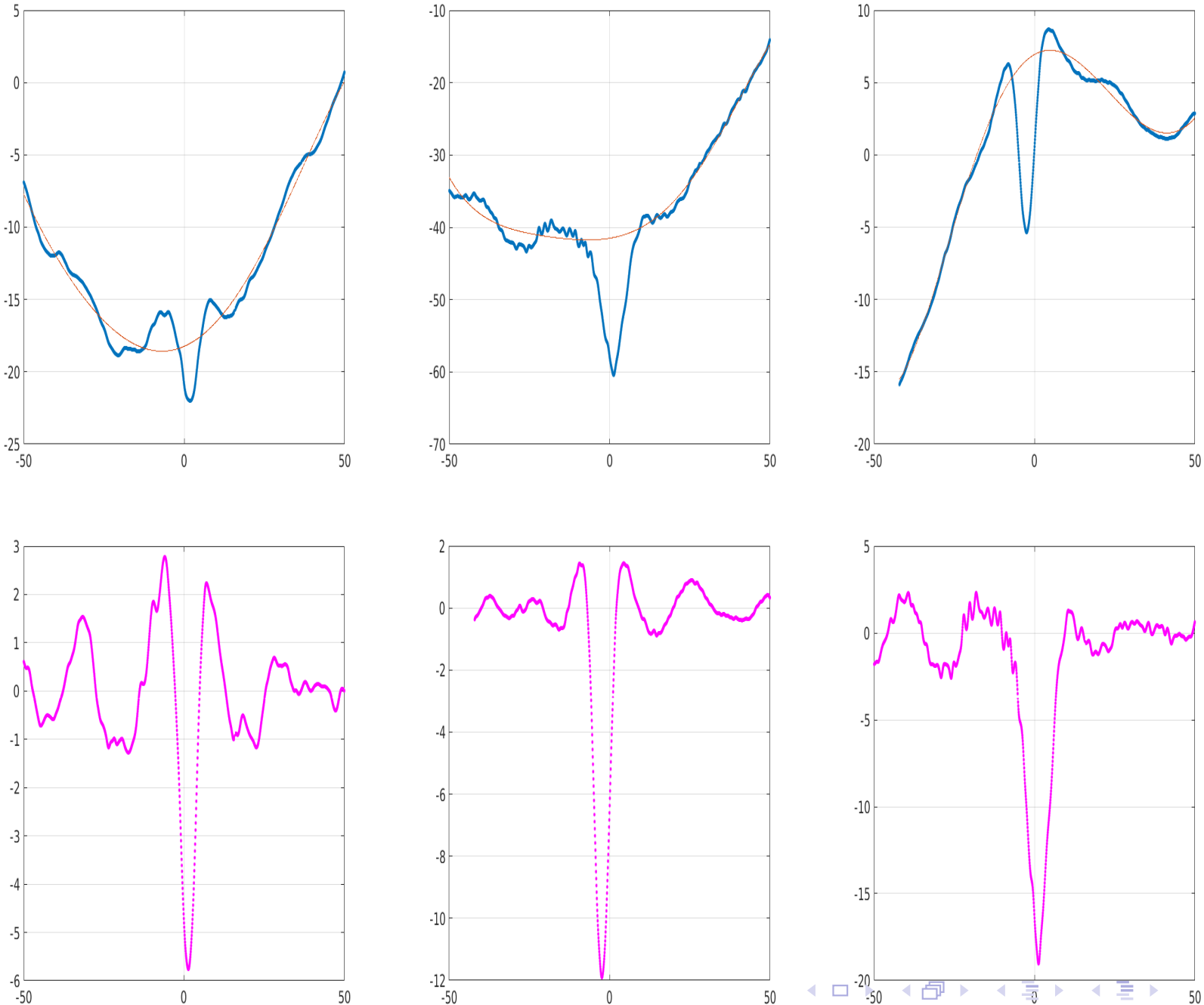
Figure 3: The Swarm satellites

- It is a multi-satellite mission launched by ESA, into a near polar near-polar orbit with an inclination of 87.5° in November 2013.
- Consists of three identical satellites, Alpha (Swarm-A), Bravo (Swarm-B), and Charlie (Swarm-C)
- Swarm A and C fly side by side at a longitudinal separation of about 1.4° (about 150 km) corresponding to 6 mins and an altitude of about 470 km.
- Swarm B, has a higher altitude of about 520 km and a slightly higher inclination.
- All three satellites complete one orbit in 90 minutes, resulting in nearly 15 passes in 24 hours.
- Each spacecraft is equipped with two magnetometers (ASM and Vector Field Magnetometer (VFM)) and other instruments.
- The ASM measures magnetic field strength, whereas the VFM measures magnetic field strength and direction.

Extraction of EEJ from Swarm Satellites

- The LEO satellites provide a good opportunity for studying the spatial variation of EEJ and CEJ since they provide a global spatial coverage.
- Global EEJ can be extracted from the Swarm satellites using the Level 2 daily magnetic data products extracted from the Level 1b scalar magnetic data measured by the ASM at a frequency of 1 Hz.
- Magnetic contributions from other sources like the core, crust and magnetospheric are removed from the Level 1b scalar magnetic signatures, by subtracting it from it the appropriate models, to obtain only ionospheric contributions.
- Sq is removed by fitting a polynomial of a suitable degree to the latitudinal profile of the magnetic on the latitudinal profile of the residual fields excluding ± 15 dip latitudes.

Ionospheric magnetic signals from Swarm B observations on 8 December 2013



- The fitted polynomial is then subtracted from the data to obtain the magnetic field variations caused by equatorial ionospheric currents.
- The magnetic signal due to EEJ current is then inverted to a height integrated current density, for an estimate of the EEJ current density producing it.
- This is done based on a current model of line currents. This model represents the geomagnetically eastward flowing EEJ current which peaks in the E-region at about 110 km altitude.
- The linear currents flow along lines of constant quasi dipole latitude spaced 0.5° apart. Each of the linear currents are divided into 360 segments, where each segment is a straight line current spanning 1° of geographic longitude, and the endpoints of each segment are located at 110 km altitude.
- Produces to a latitudinal profiles of height integrated EEJ over a quasi dipole latitude in the range -20:0.5:20, which is one of the outputs of the Swarm Level 2 daily magnetic data products.

Practical session

- You will be provided with two files (.cdf) of Swarm satellite data.
- Reproduce the results below

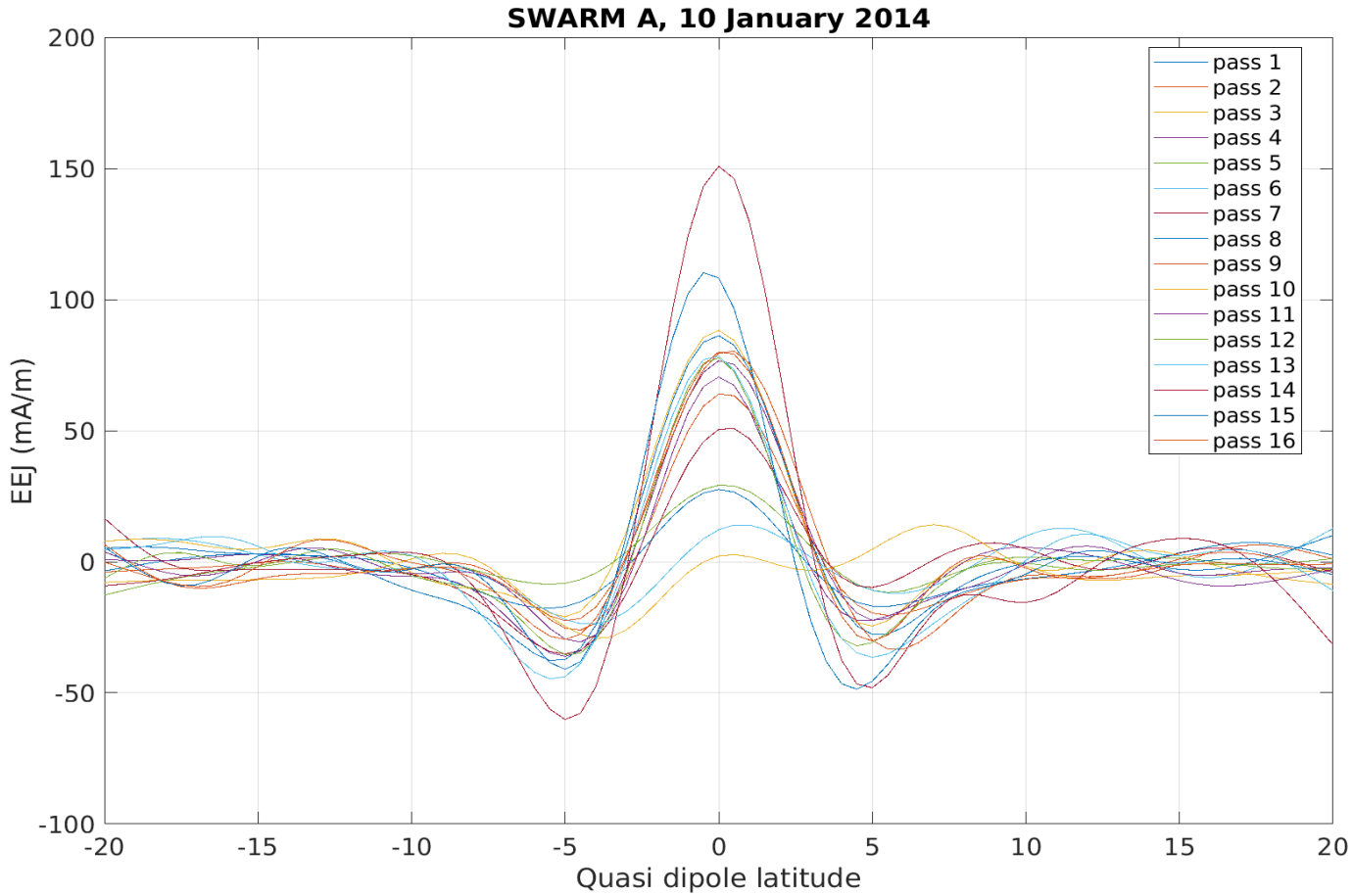


Figure 4: EEJ derived from Swarm A observation for all the passes on 10 January 2014

- link to download the Swarm satellite data is http://swarm-diss.eo.esa.int
- Navigate through /Level2daily/Entire_mission_data/EEF/TMS/Sat_A

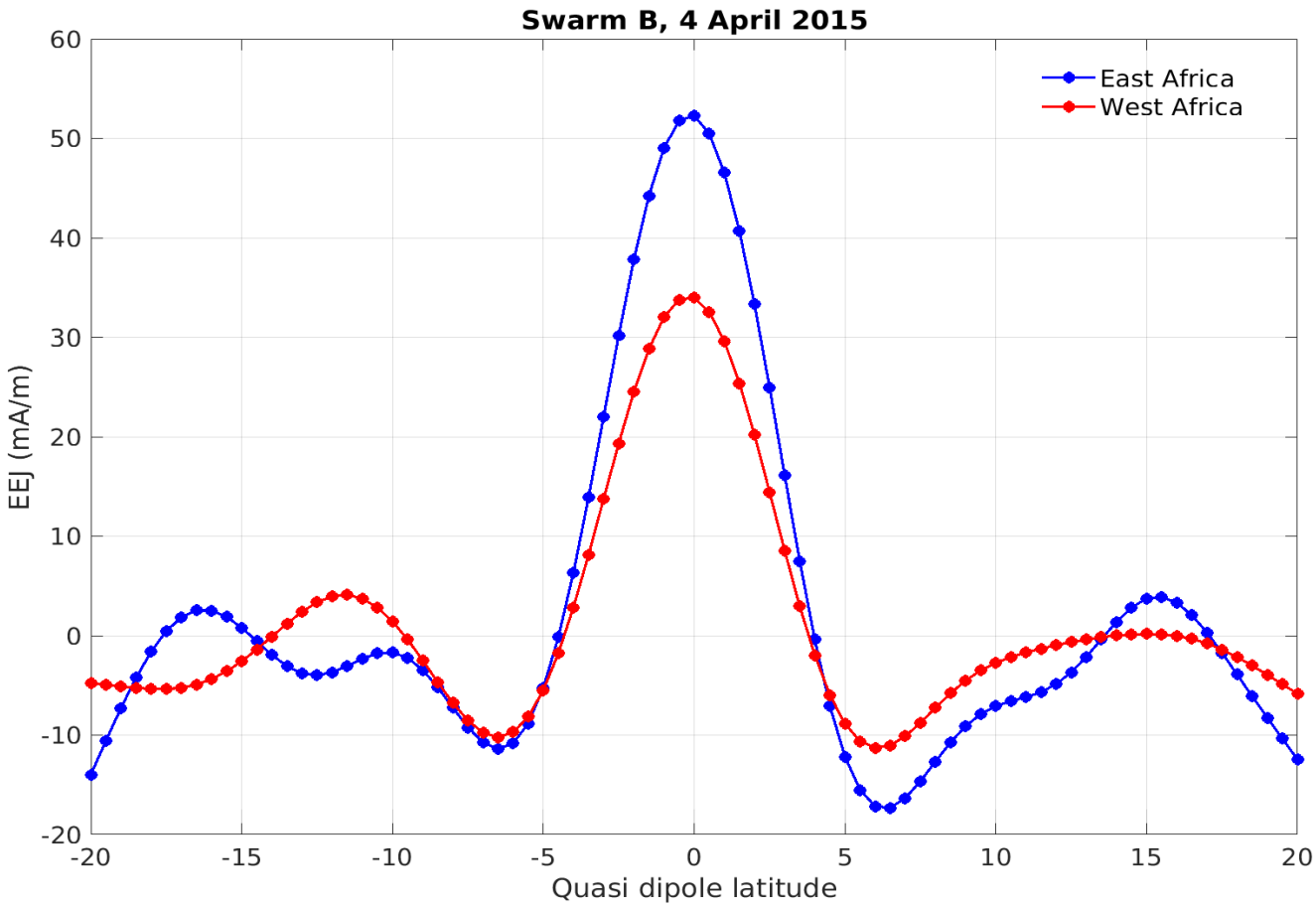


Figure 5: EEJ derived from Swarm B observation on 4 April 2015 over East and West Africa.

The longitudinal wave 4 pattern from the Swarm observations

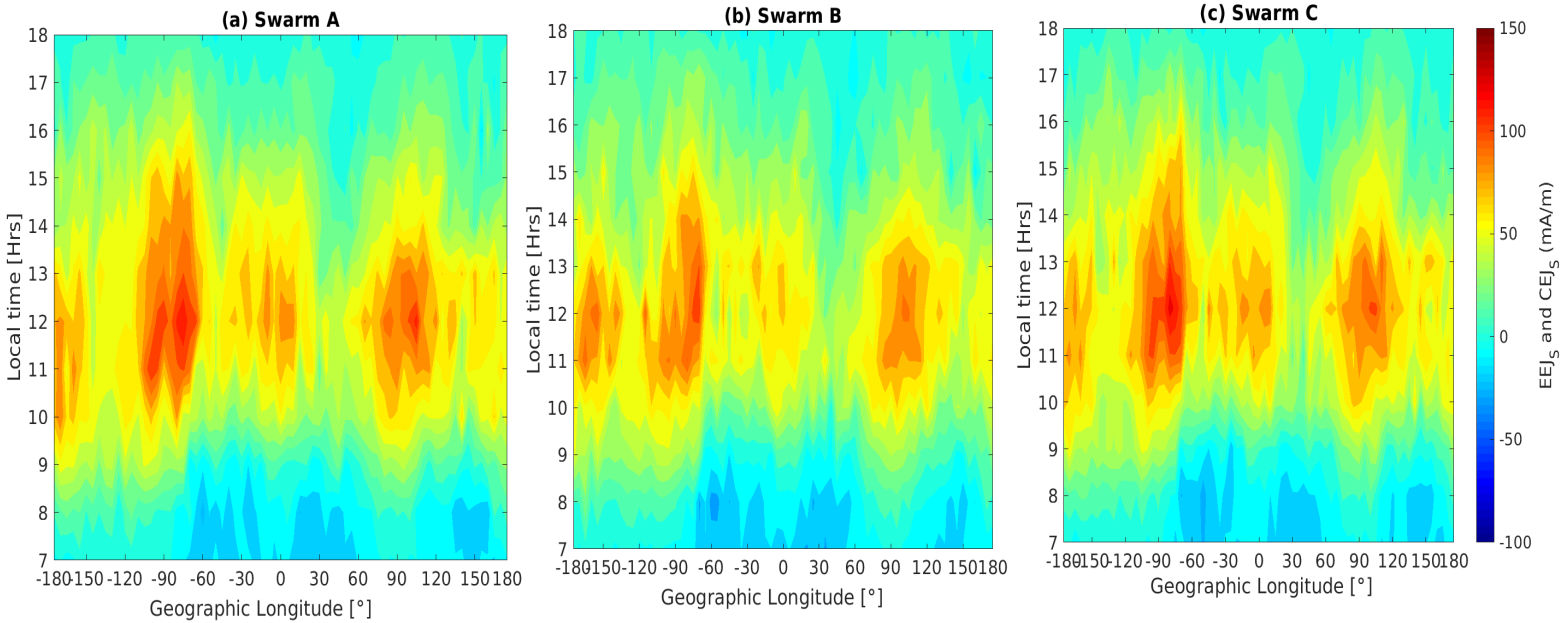


Figure 6: Four peak structure of EEJ called the longitudinal wave-4 (WN4) pattern.

- It is due dominant non-migrating Diurnal Eastward tide of wave number 3(DE3), combined with other non-migrating tides leads to this WN4 structure.
- It is responsible for the longitudinal and seasonal variability of EEJ and CEJ.

THANK YOU FOR LISTENING.