Ionosphere Over Africa: Results from Geomagnetic Field Measurements During International Heliophysical Year IHY

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Outline

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- MAGDAS over Africa
- Spatial/diurnal distribution of Sq
- Variability of the Seasonal sq
- Manifestation of the EEJ
- Summary
- Call for collaboration

Introduction

- It has since been observed that the geomagnetic field intensities vary from one sector to another even within the equatorial zone.
- Patil *et al., (1990a, b) estimated the ratios* of the EEJ strength at high solar activity to low solar activity at Indian and American sectors and found a discrepancy between the values at the two sectors.
- Doumouya *et al* (2003) studied the longitudinal variation of geomagnetic field intensities at equatorial zone using surface magnetic data recorded at 26 stations located in six different longitude sectors that were set up or augmented during IEEY.

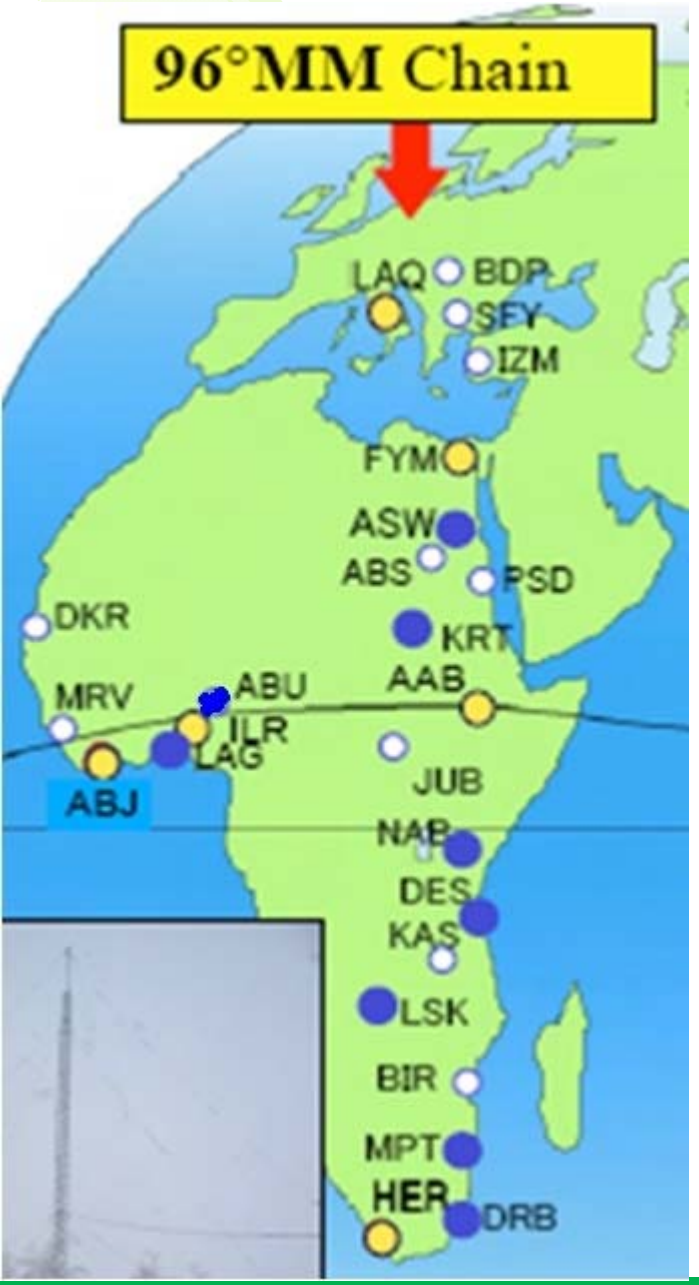
Introduction

- The nature of the longitudinal inequalities in the EEJ strength indicates that the equatorial electrojet was strongest in South America (80º–100ºW) and weakest in the Indian sector (75ºE) with a secondary minimum and a maximum centered, respectively, in the Atlantic Ocean (30ºW) and in western Africa (10ºE). (Doumouya *et al*, 2003)
- There is sectorial dependence of the EEJ
- The ionosphere demonstrates variability with longitudes and latitudes
- This works report the results obtained from probing the ionosphere along African 96 MM using MAGDAS data

Data analysis

- Hourly profiles of horizontal component (H) magnetic declination (D) and vertical component (Z) of 10 MAGDAS stations along 96° Magnetic meridian 'MM' in Africa were analysed for regular solar quietdaily variation.

- The solar quiet daily variation Sq in H (Sq H), D (Sq D), and Z (Sq Z) were obtained by correcting the hourly departures, obtained from the difference between the hourly values and the midnight baseline values, for non-cyclic variation



Coordinates of the Stations

STATN	Geog Lat.	Gmag Lat
AAB	9.04	0.18
NAB	-1.16	-10.65
ASW	23.59	15.2
DES	-6.47	-16.26
DRB	-29.49	-39.21
FYM	29.18	16.1
HER	-34.34	-42.29
KRT	15.33	5.69
LSK	-15.25	-26.06
MPT	-25.58	-35.98

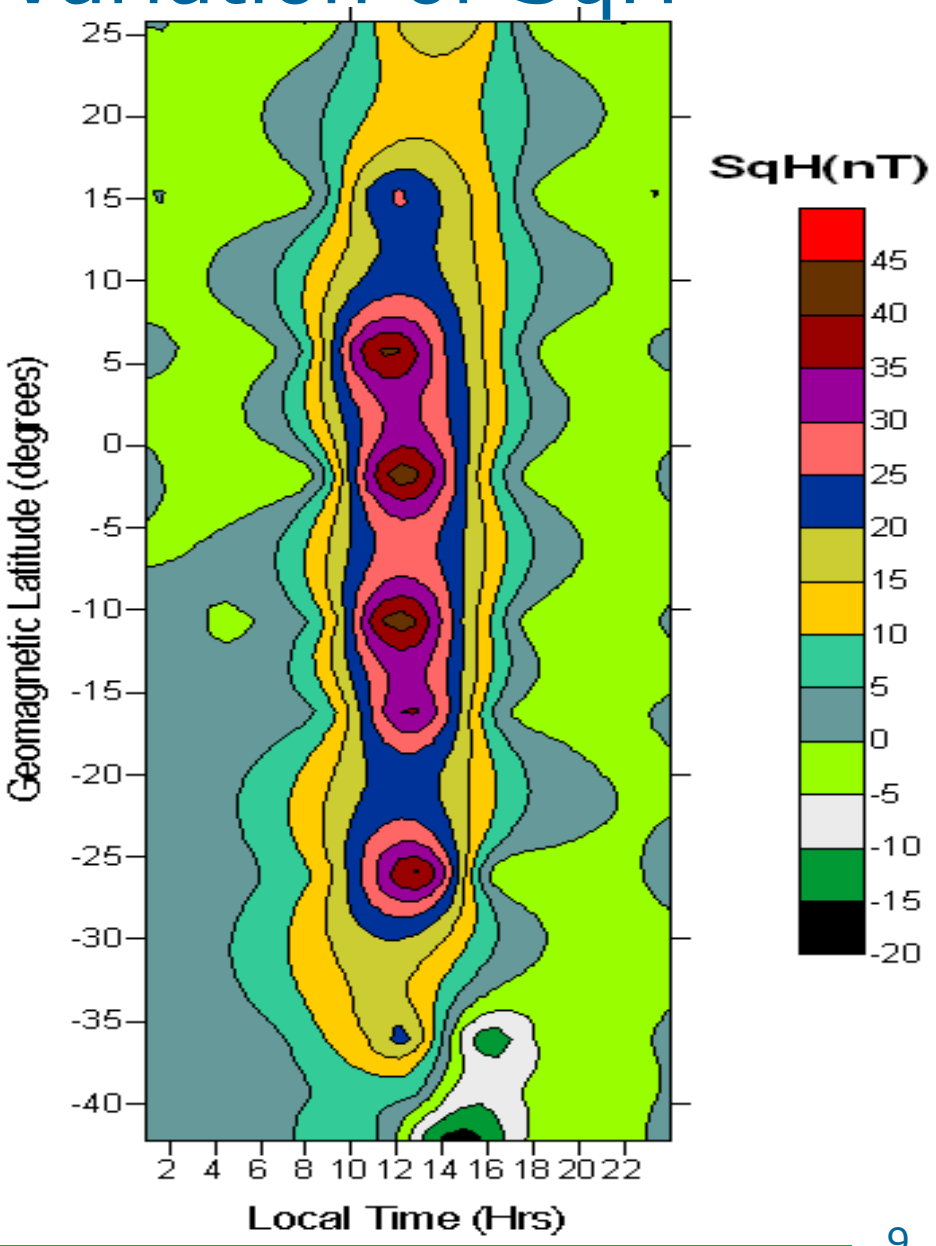
MAGDAS at Lusaka LSK

Geog Latitude	-15.25
Geog Longitude	28.16

MAGDAS at ILORIN, Nigeria. August 2006 & March 2010

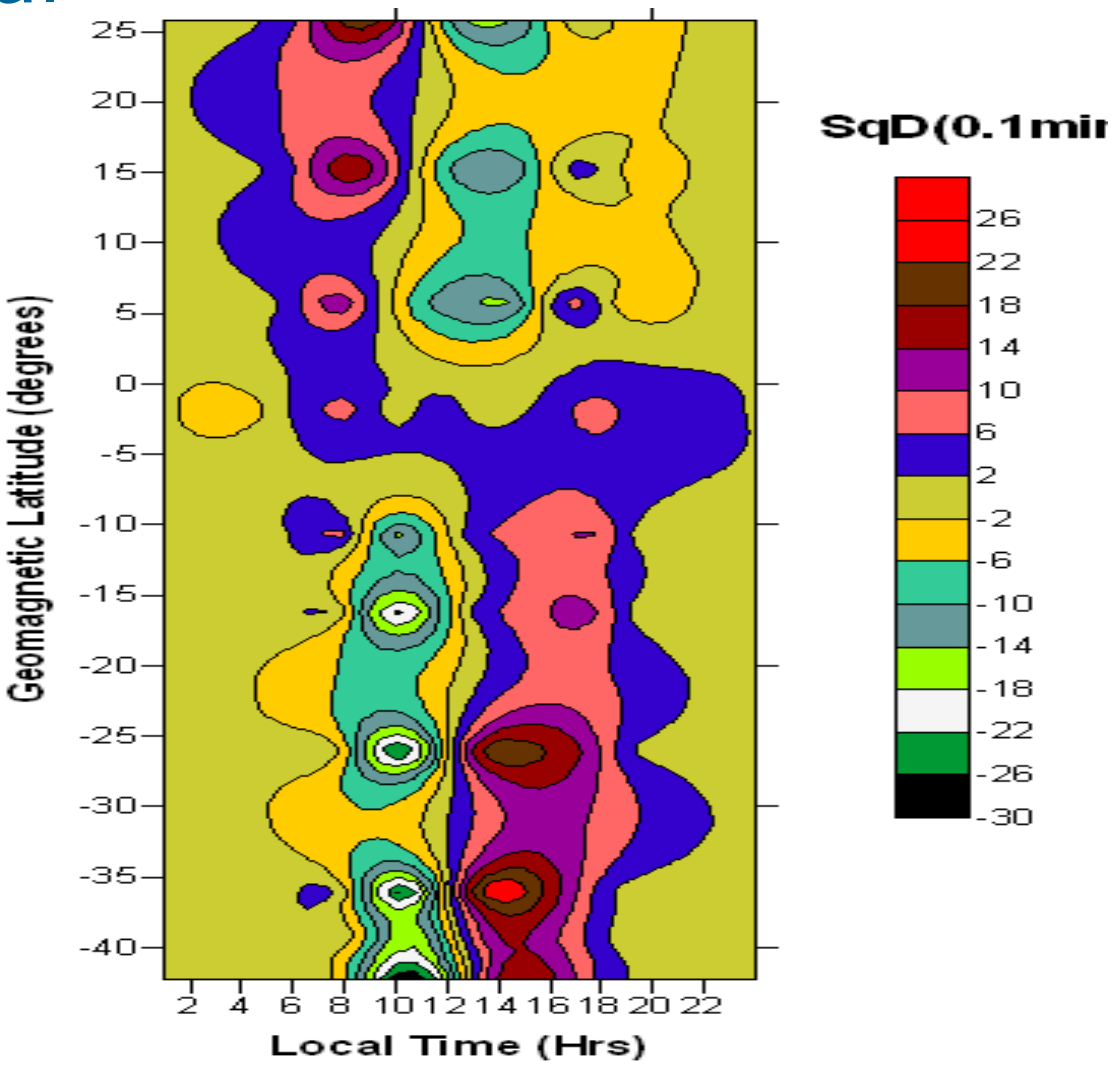
Latitudinal /Diurnal Variation of SqH along 96° MM

- Sq H is expectedly consistently maximum within the electrojet zone as a result of EEJ
- Generally daytime Sq greater than night time
- ✓ Stations within the influence of EEJ tends to have more Sq variation
- ✓ Sq H maximize at about local noon
- ✓ The daytime maximum is due to ionospheric augmentation by solar activity in consistency with atmospheric dynamo theory



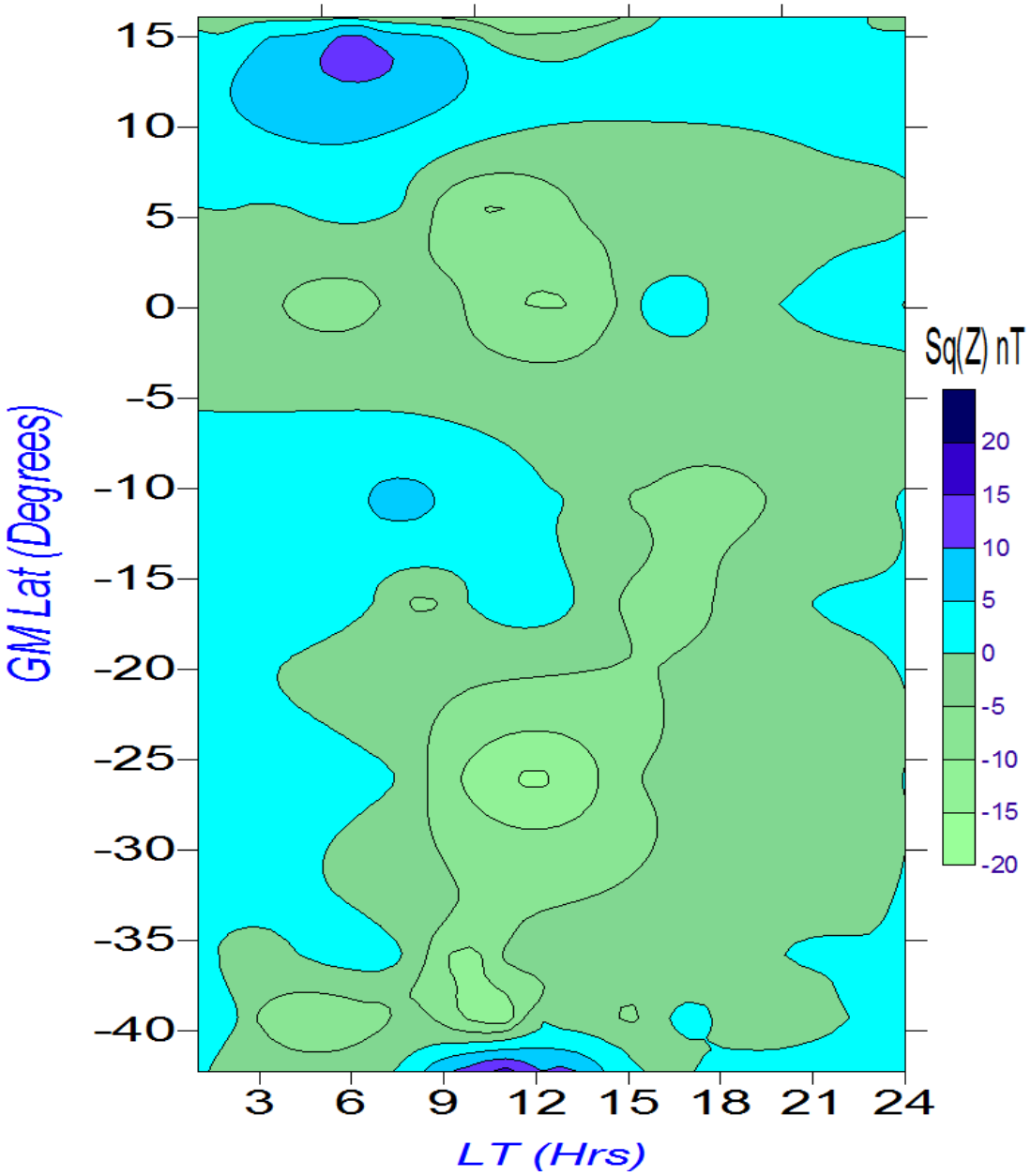
Latitudinal /Diurnal Variation of SqD along 96° MM

- Generally daytime Sq greater than night time
- Strongest focus at below 0° Geomagnetic latitude and at about local noon.
- Sq D has maximum values at about 15^{o} (sunrise), -5^{o} (noon time) and -25^{o} (sunset)



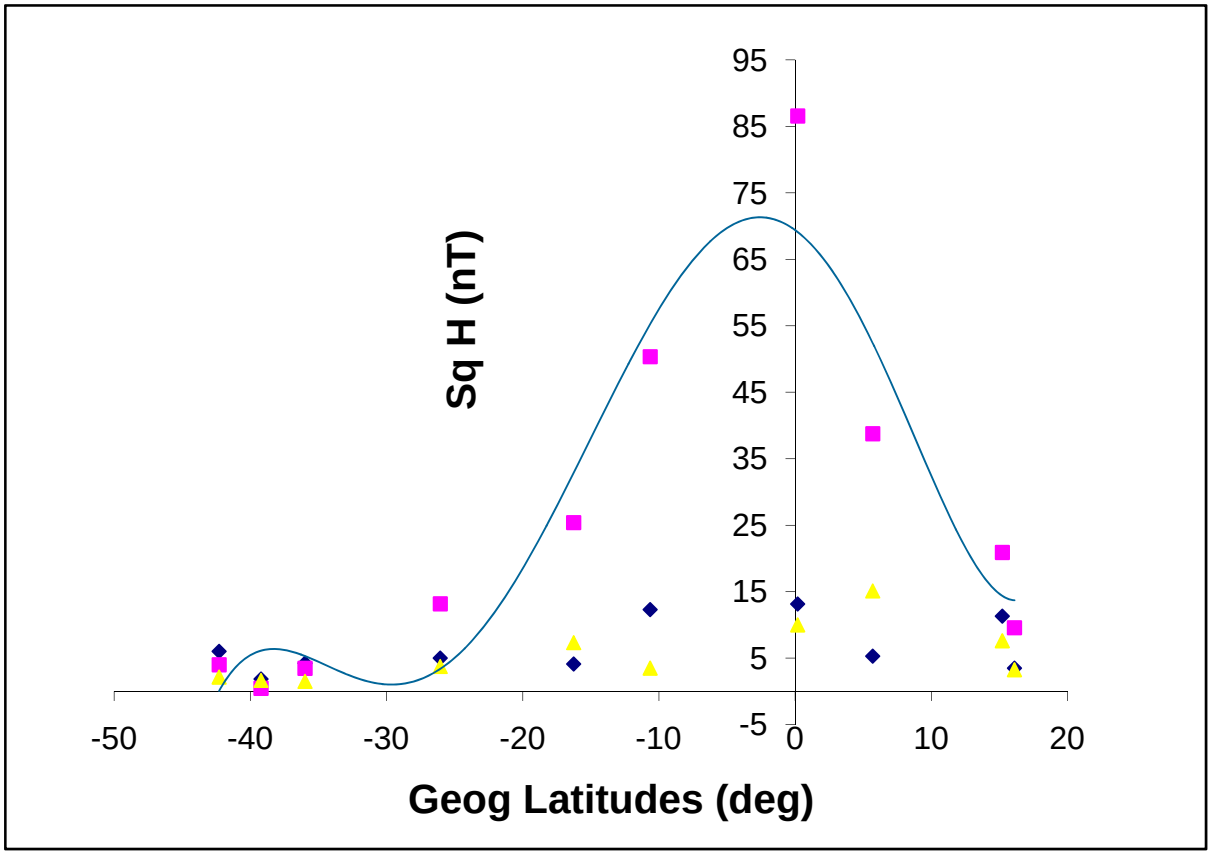
Sq Z demonstrates 2 sunrise maxima at about +13º and -15º Geomagnetic degrees. Maintain a single maximum at noon and sunset

These almost fall within the crest of magnetic anomaly



Latitudinal variation of Sq along 96° MM at noon

- ✓SqH has one outstanding peak almost at magnetic equator
- ✓Dip equator crosses the meridian somewhere between 10 and 15 degrees North



Seasonal variation of Sq(H) along the latitudes

- Sq (H) is greater in all seasons in the neighbourhood of dip equator
- Obviously due to EEJ effect
- Max effect at Autumn (Sept) Equinox

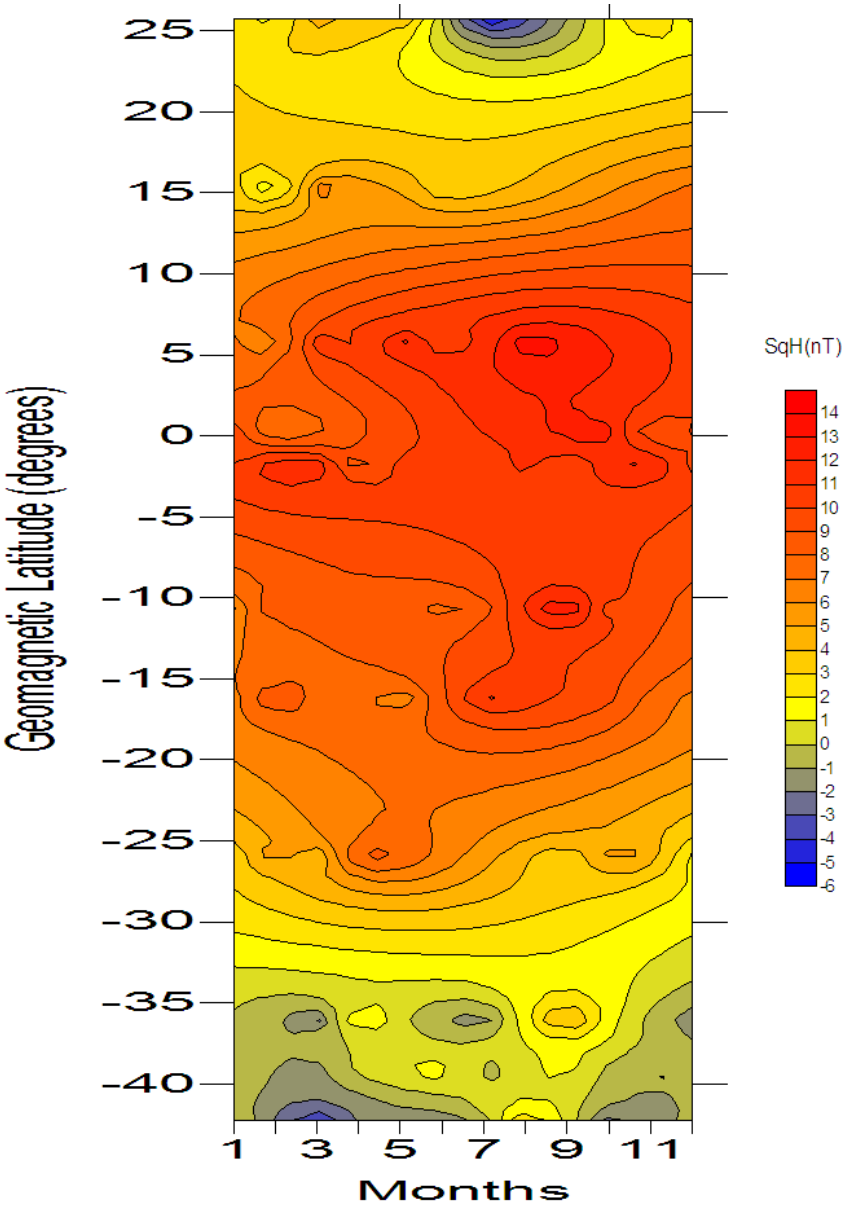
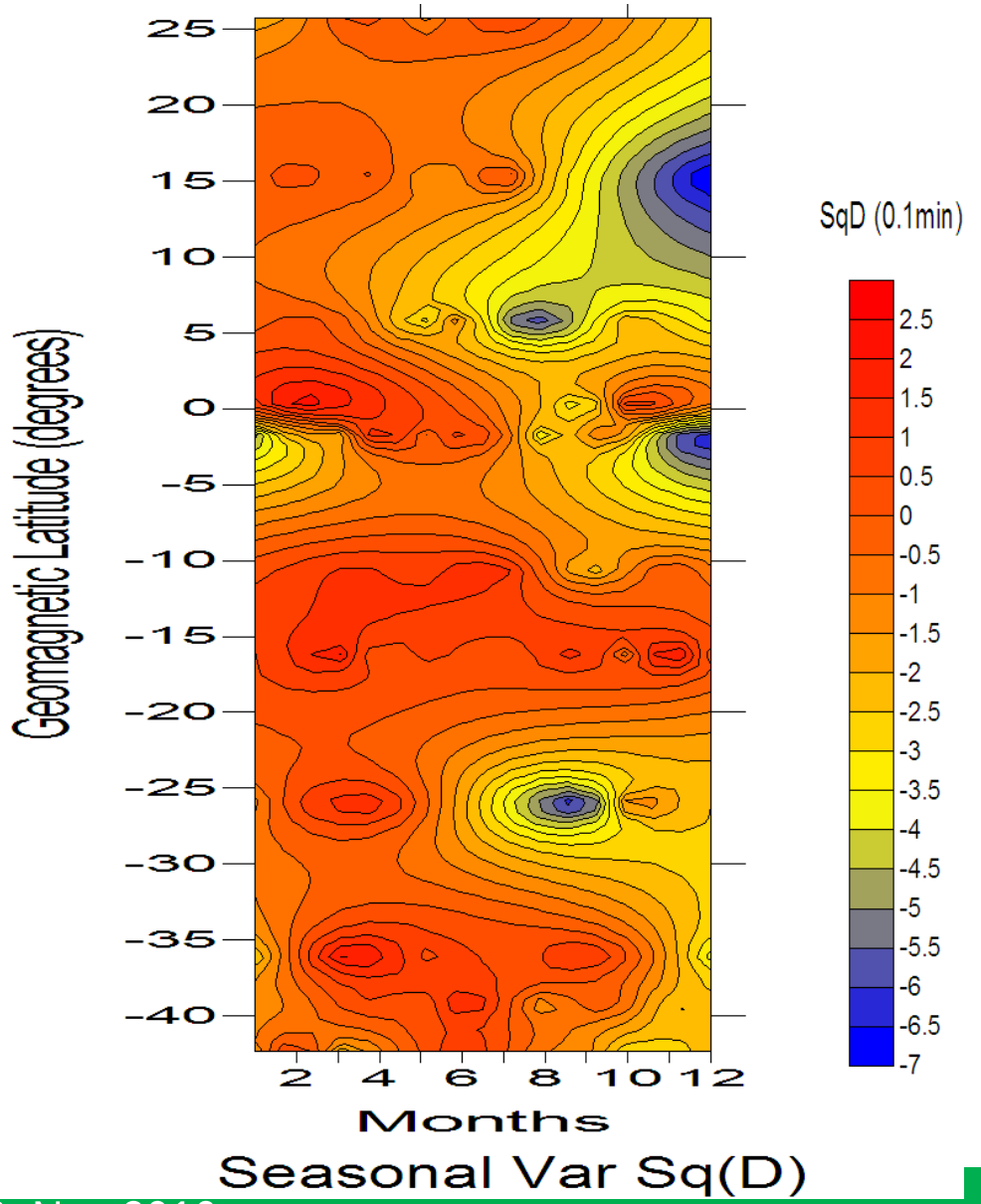


Figure : Seasonal Variation of SqH (nT)

Seasonal variation of Sq(D) along the latitudes

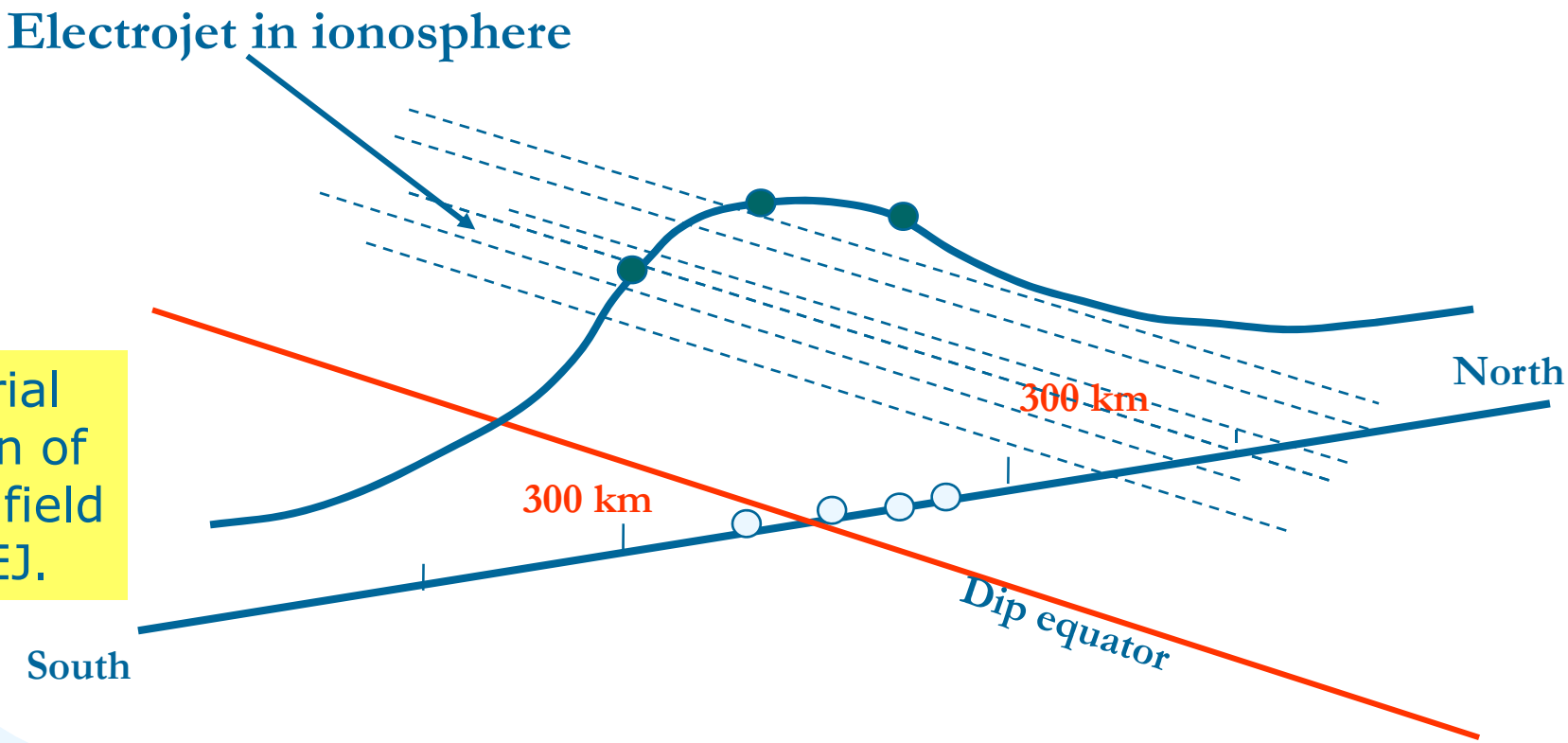
- Sq (D) is greater in Spring (March) Equinox across the latitudes
- Minimum values of Sq(D) were observed along 5°° & -25° at June solstice
- Semiannual (Equinoctial) max along dip equator



EEJ in Africa

Spatial variation of EEJ

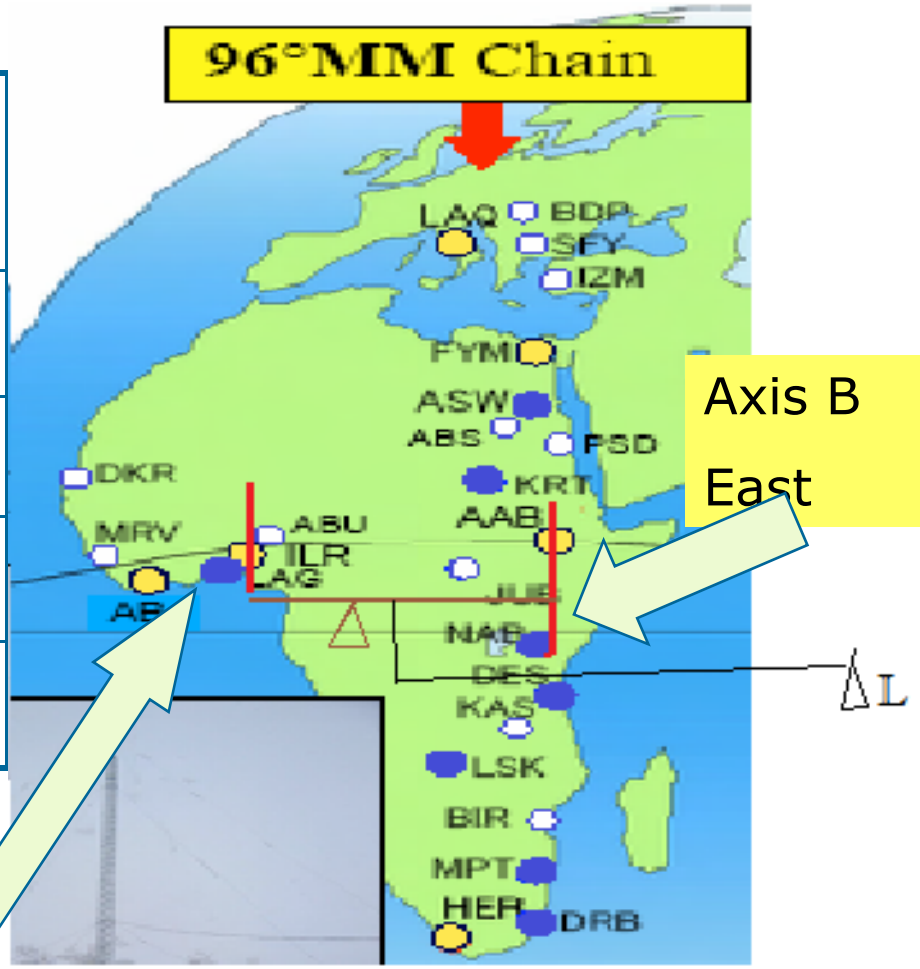
The equatorial intensification of the magnetic field is due to EEJ.



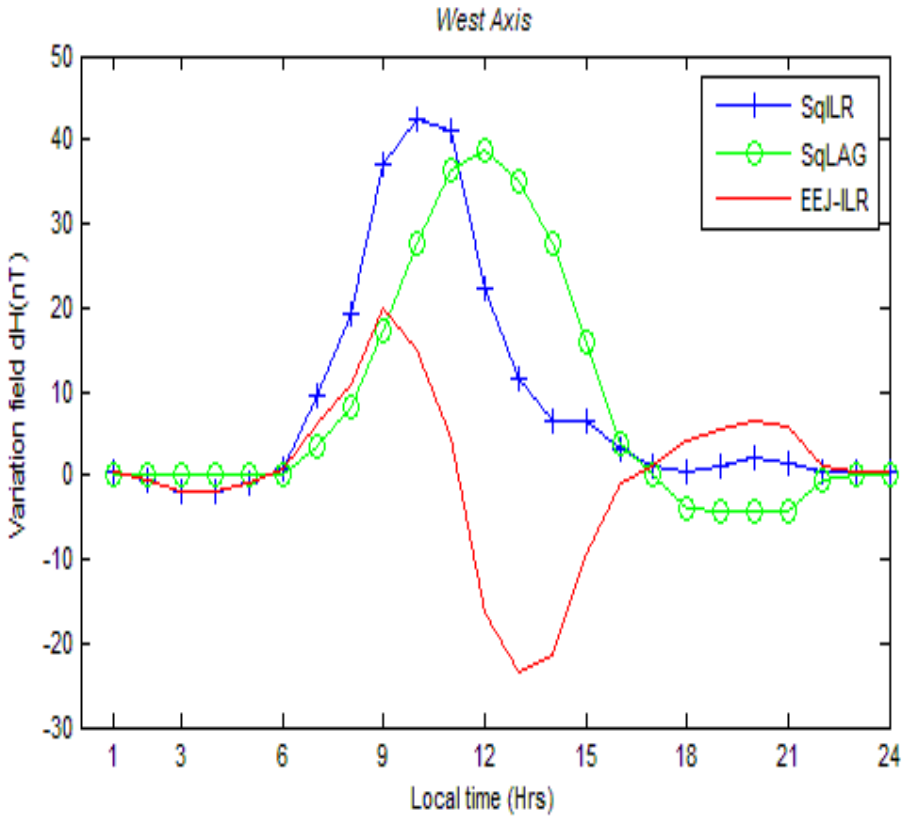
Geometry of measurement of EEJ as observed on ground

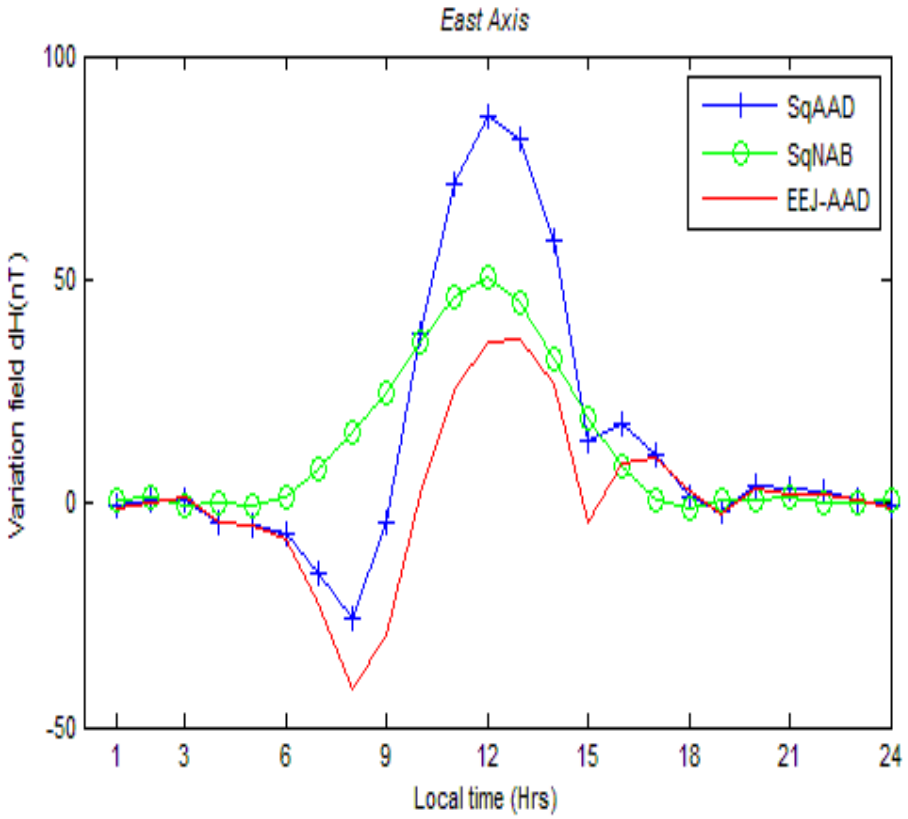
Coordinates of the Stations

OBS	GMLat°	GLong ° E	GLat°
ILR	-1.82	4.67	8.50°N
LAG		3.43	3.42°N
AAB	0.18	38.77	9.04°N
NAB		36.80	1.16°S

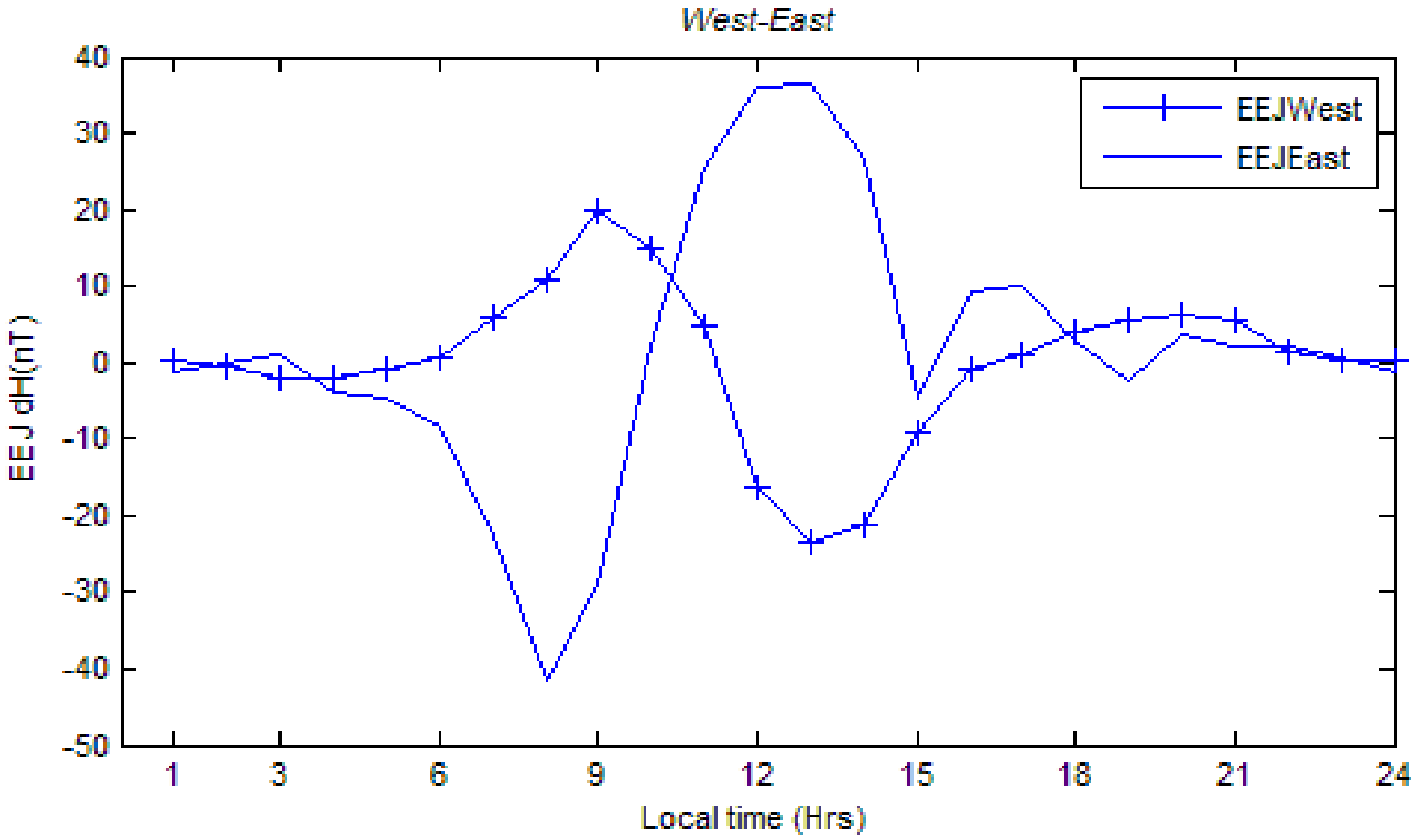


Separation of axes, Δ L = 33.735° = 3744.585 km

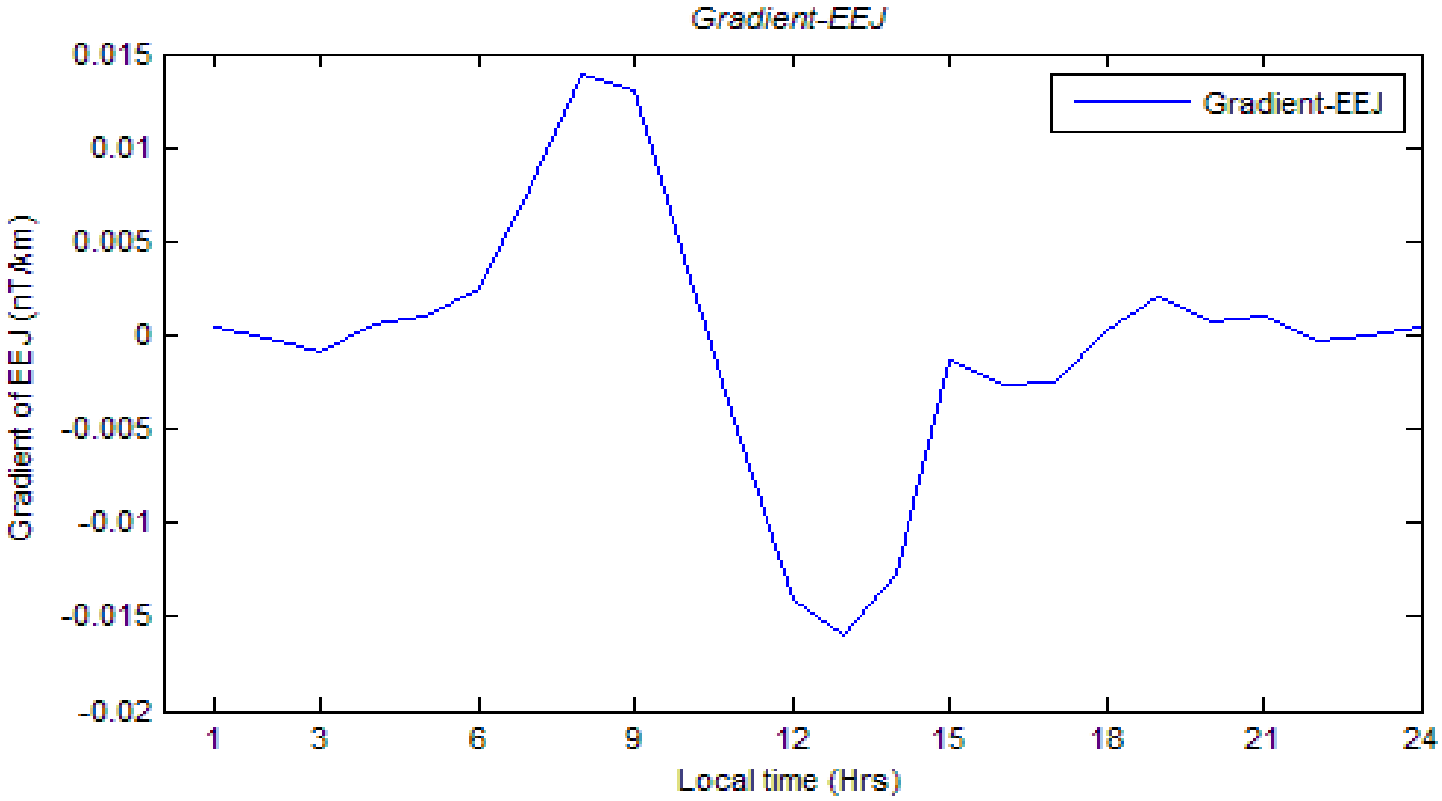




Enhanced Sq at EEJ stations is due to EEJ field



- Western EEJ appears weaker than Eastern EEJ!
- It is as if there is a process of re-injection of energy as Jet flows eastward



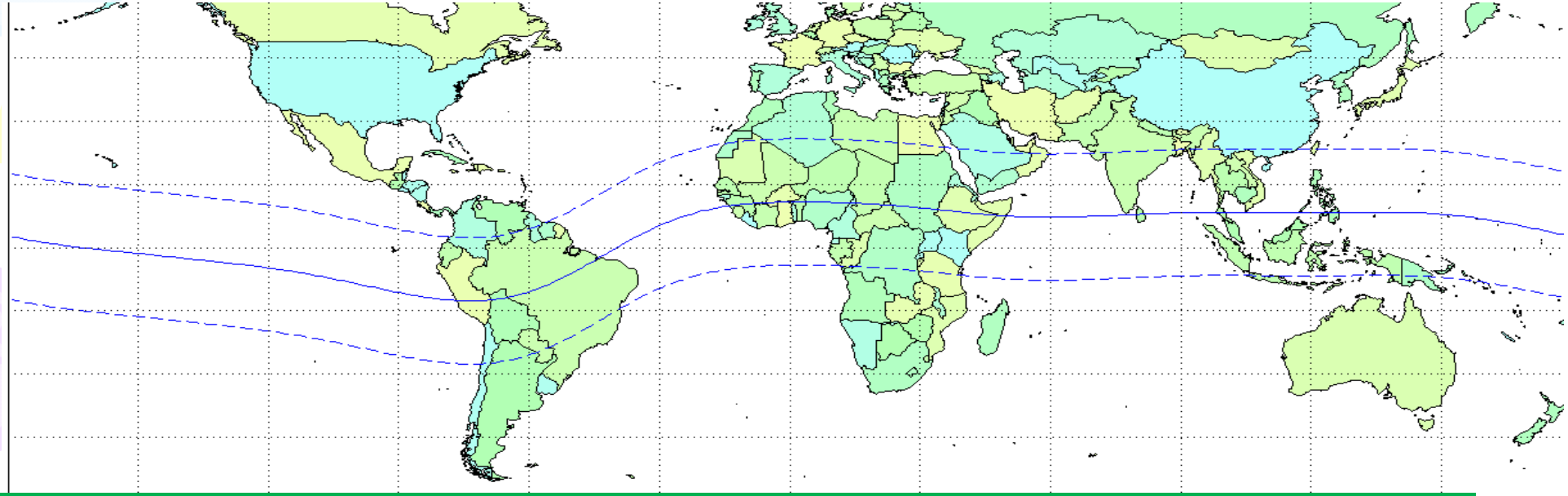
- Non constant flow gradient with time
- Flow gradient do not follow a definite diurnal pattern
- Drastic fluctuation at rising of the Sun/jet
- More fluctuations in daytime

Summary

- There is variability in the ionospheric processes over African even along same meridian
- The enhanced field variation at equatorial region is due to the EEJ current
- There is a variation in the behaviour of EEJ at the West and East Africa
- The EEJ appear stronger in East than West Africa
- It is as if there is a process of re-injection of energy as Jet flows eastward

Africa: Window of Opportunities

- Clear tropical sky
- Manpower available for observational work
- Universities and research institutes ready for collaboration
- Graduate and independent researchers available



THANK YOU

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