Variability of Space Weather over Africa from IHY/ISWI Observational Facilities between 2006 and 2012

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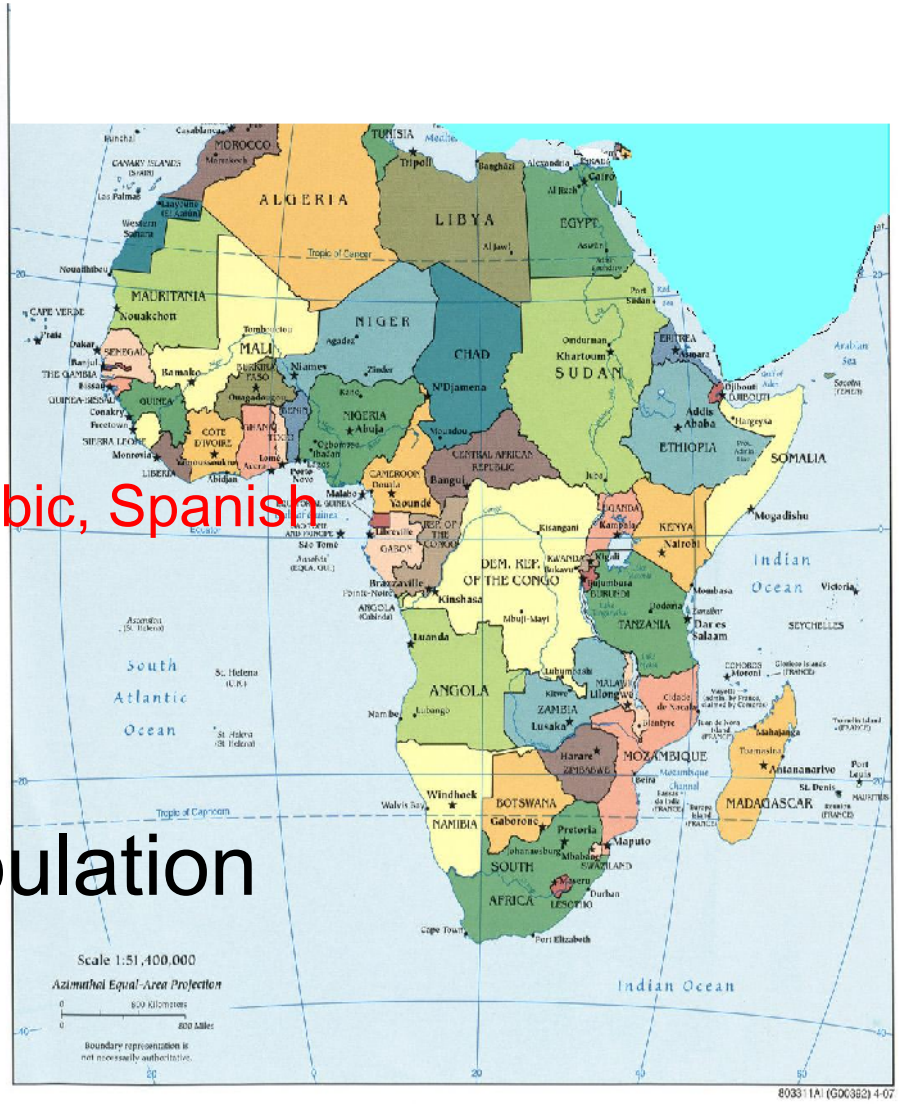
outline

- Africa
- Gains of UNBSSI/IHY/ISWI
- Infrastructural development
- Scientific results
- Conclusions

Africa !

- A continent
- 54 individual nations
- Multi-lingual structure
- English, French, Portuguese, Arabic, Spanish
- ~ 30 billion km^2
- ~ 850 million people
- ~14% of the World population

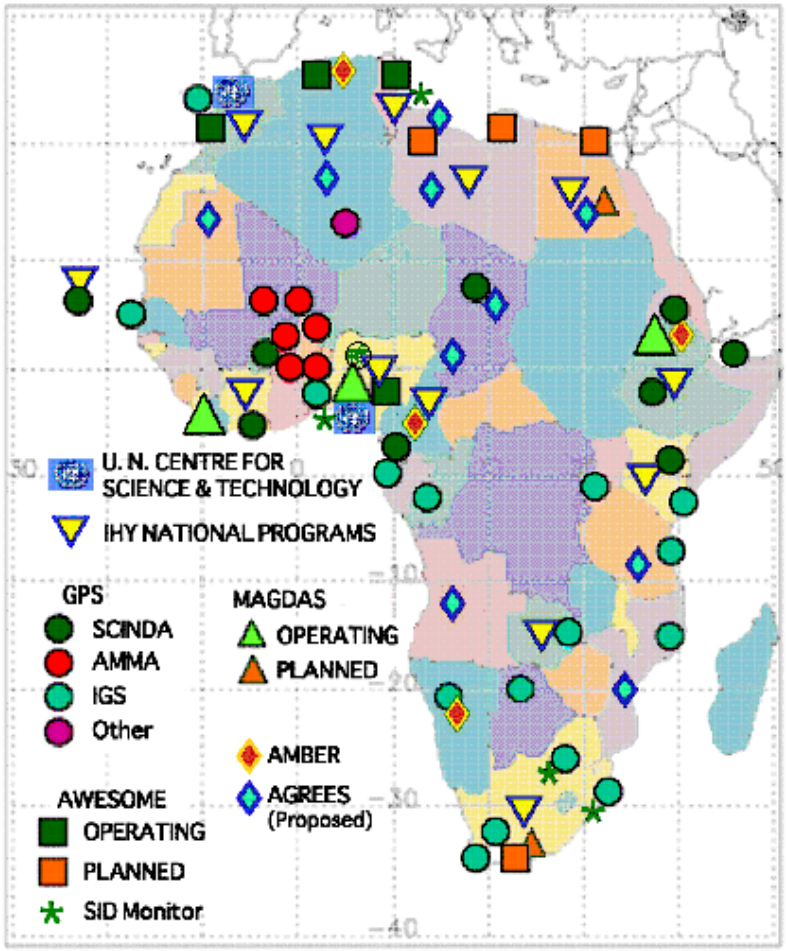


IHY/ISWI facilities in Africa

- Over 17 magnetometers (MAGDAS and AMBER)
- more than 25 GPS receivers (SCINDA and others)
- well over 50 ionospheric RF sounders (Ionosonde, SID monitor and AWESOME)

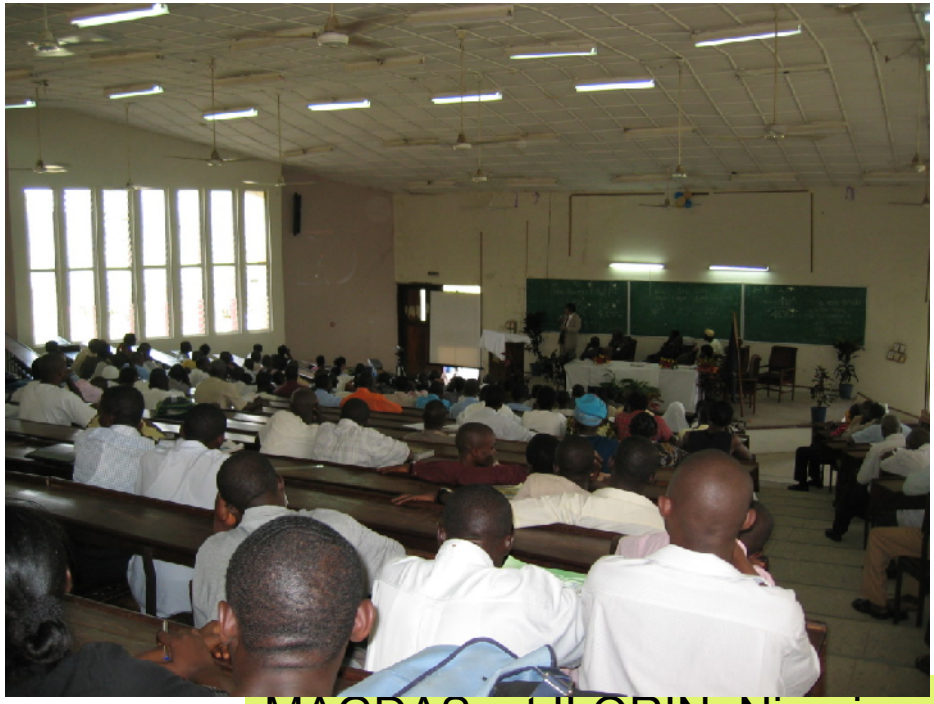
Signatures of UN and IHY in Africa

– strictly after Barbara Thompson 2007

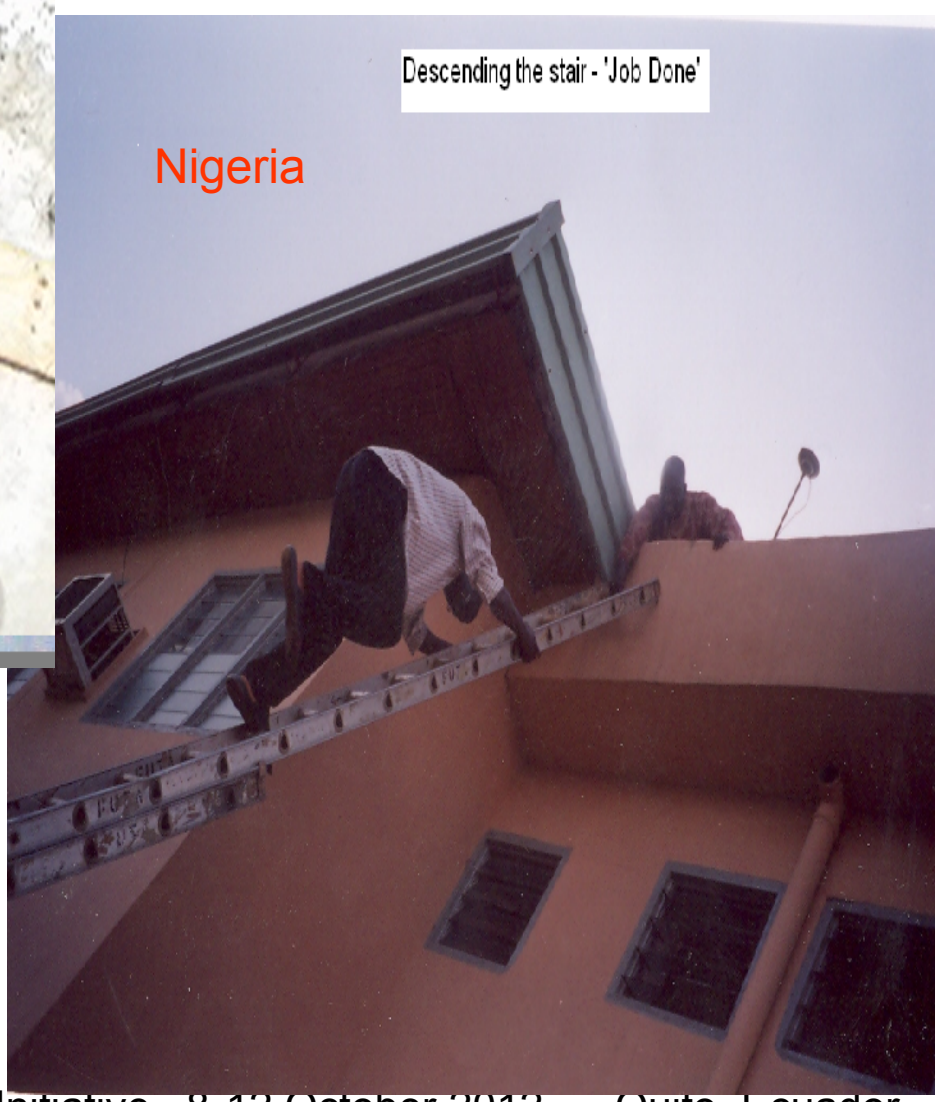


Gains of IHY/ISWI in Africa

- Knowledge & technological transfer
- Positive collaboration
- Availability of Research facilities for internationally competitive research.
- Publication of scholarly articles
- Windows of postgraduate opportunities
- Control of brain drain
- Development of Research in Basic Space Science
- Capacity building
- Bridge between North & South
- strong intra–continental partnerships amongst African scientists



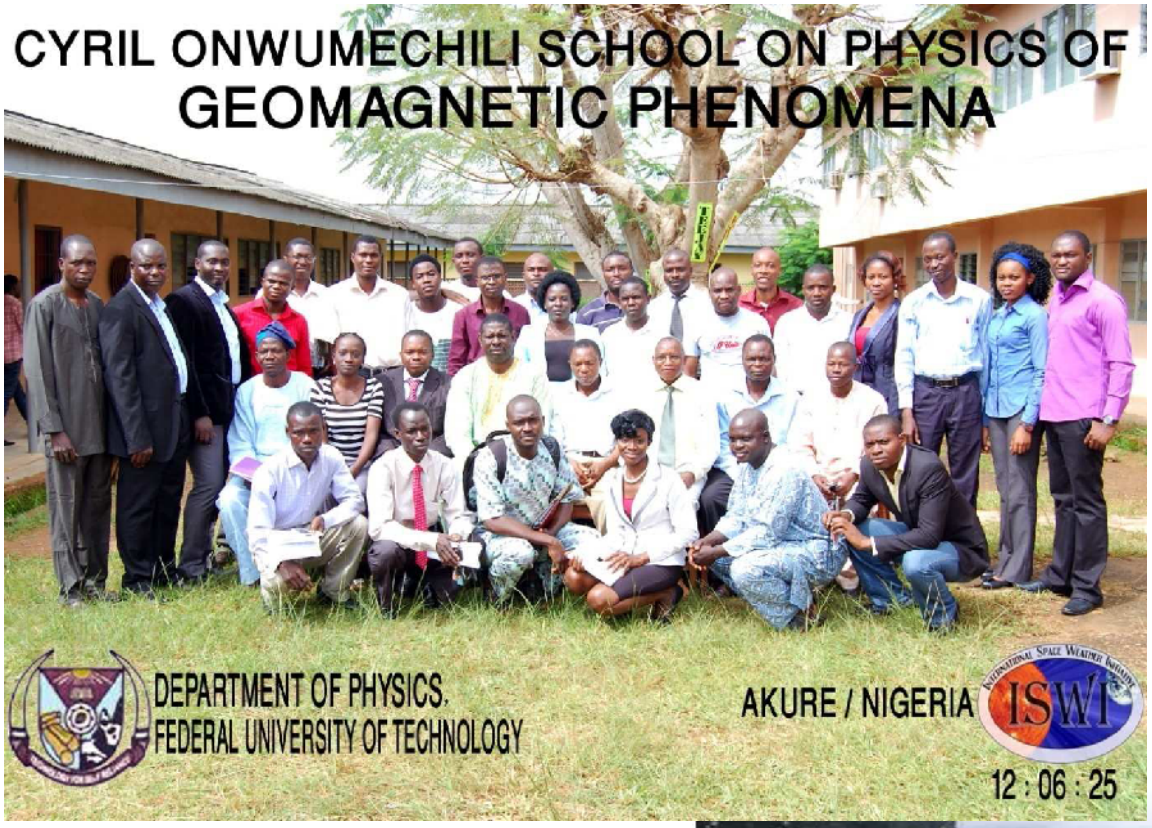
MAGDAS at ILORIN, Nigeria. August 2006



Climbing the stairs

Summer Schools

- 41 African graduate students & Postdocs
- From 14 African countries
- 15 Instructors



24 - 30 June 2012,
Akure, Nigeria

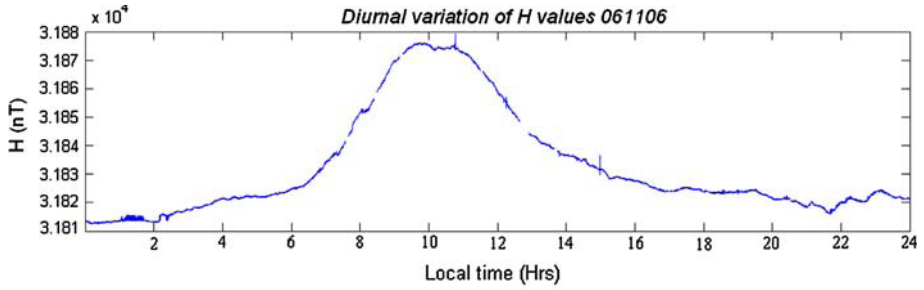
Some Results

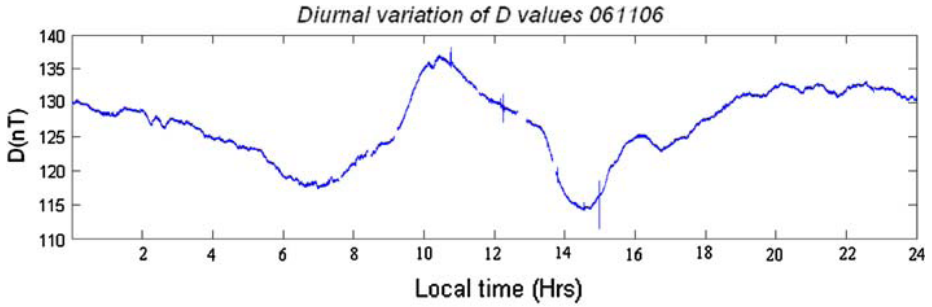
Earth Moon Planet (2009) 104:173–179
DOI 10.1007/s11038-008-9290-7

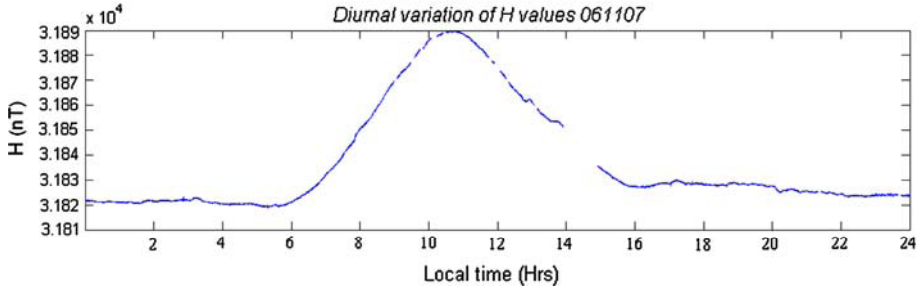
Preliminary Results from the Magnetic Field Measurements Using MAGDAS at Ilorin, Nigeria

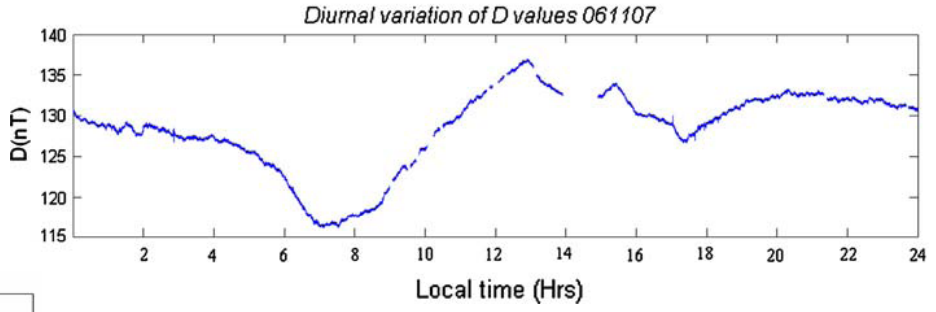
A. B. Rabiu · I. A. Adimula · K. Yumoto · J. O. Adeniyi · G. Maeda · MAGDAS/CPMN Project group

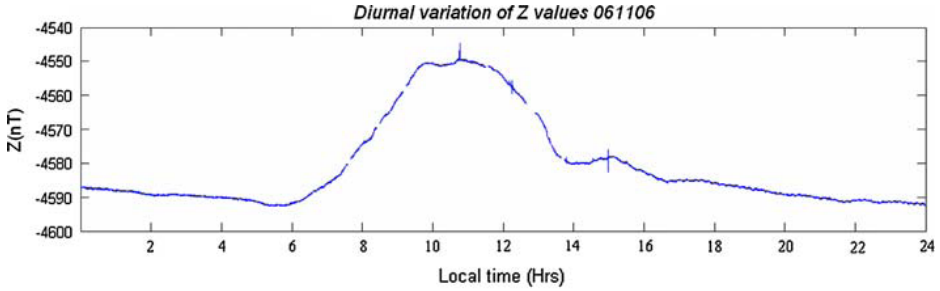
Diurnal variation of H D Z on 6 & 7 Nov 2006

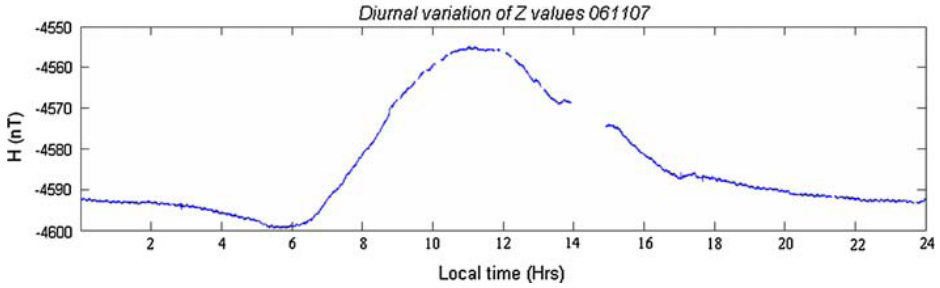












- Diurnal variations
- Day-to-day variability of ionospheric process etc
- Rabiu et al 2009

LETTER Earth Planets Space, 60, 785–790, 2008

A new index to monitor temporal and long-term variations of the equatorial electrojet by MAGDAS/CPMN real-time data: *EE*-Index

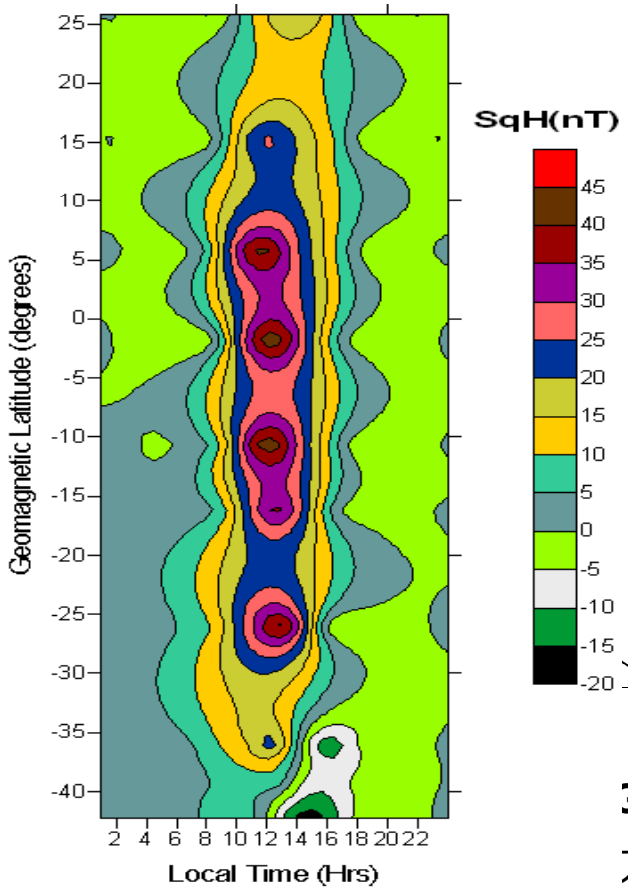
T. Uozumi[1], K. Yumoto[1], K. Kitamura[2], S. Abe[1], Y. Kakinami[1], M. Shinohara[1], A. Yoshikawa[1], H. Kawano[1], T. Ueno[3], T. Tokunaga[3], D. McNamara[4], J. K. Ishituka[5], S. L. G. Dutra[6], B. Damtie[7], V. Doumbia*[8], O. Obrou[8], A. B. Rabiu[9], I. A. Adimula[10], M. Othman[11], M. Fairos[11], R. E. S. Otadoy[12], and MAGDAS Group[1]

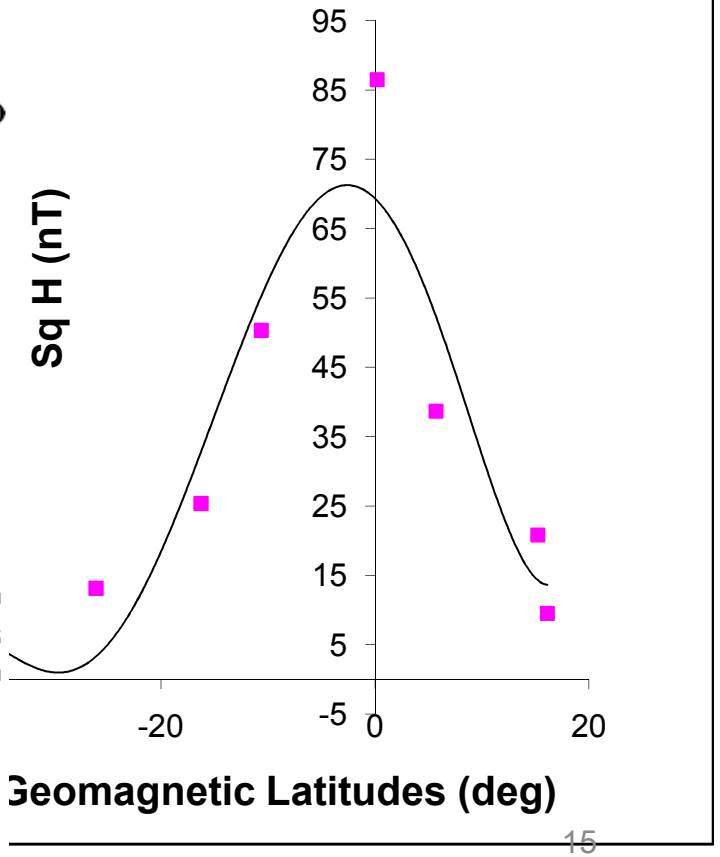
This index provides information that should clarify the situation of solar-geospace coupling and atmosphere-ionosphere coupling in the magnetic equatorial region

Sun and Geosphere, 2011; 6(2): 63 - 66 ISSN 1819-0839

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

A.B. Rabiu[1,2], K.Yumoto[3], E.O. Falayi[2,4], O.R.Bello[2], MAGDAS/CPMN Group[3]





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

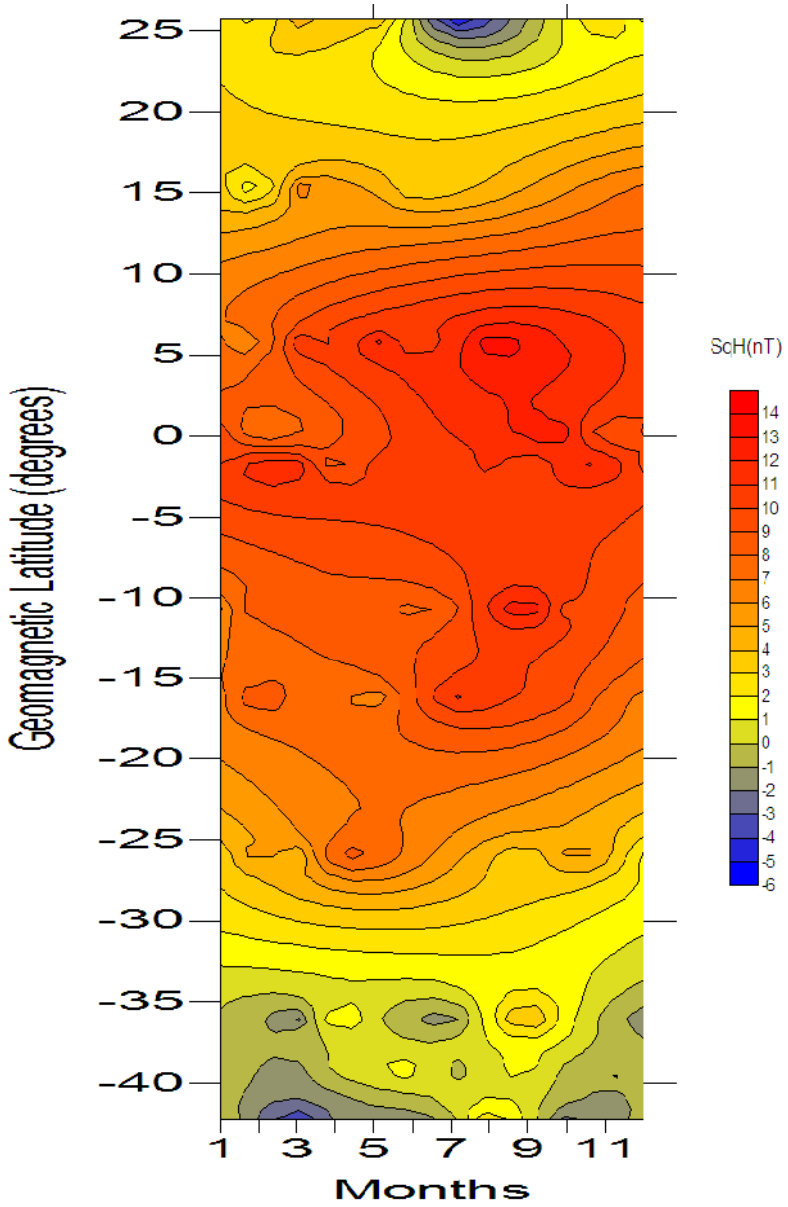
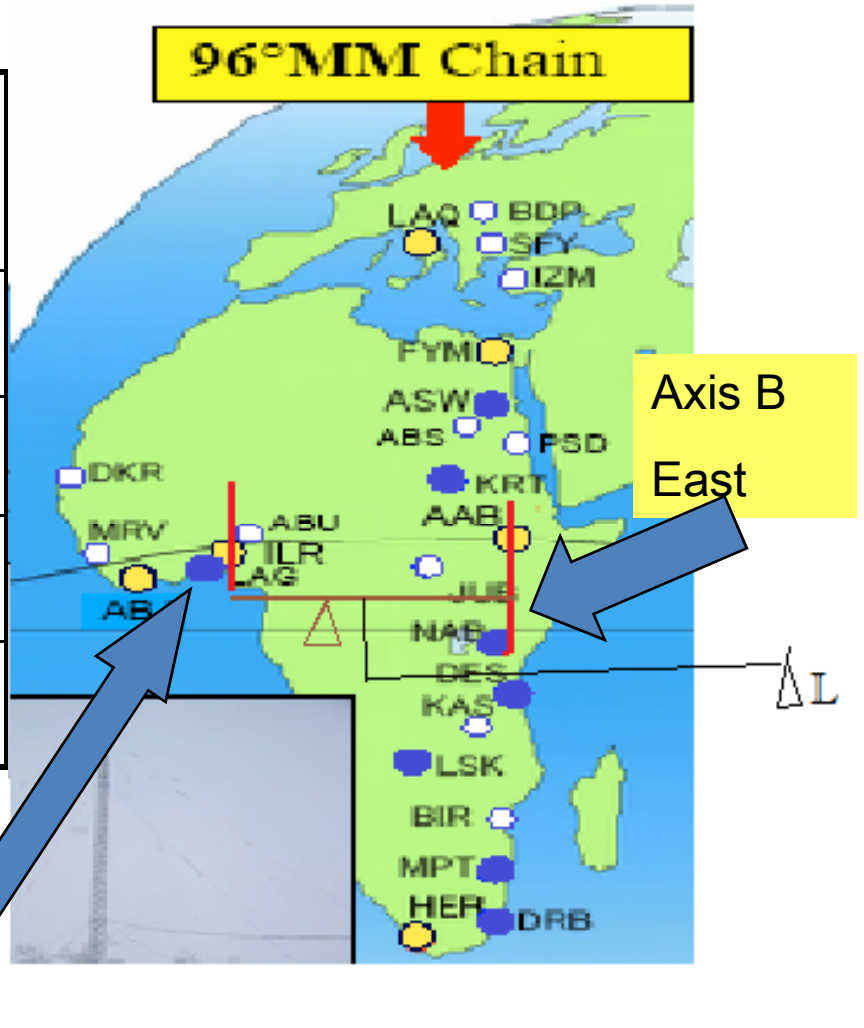


Figure : Seasonal Variation of SqH (nT)

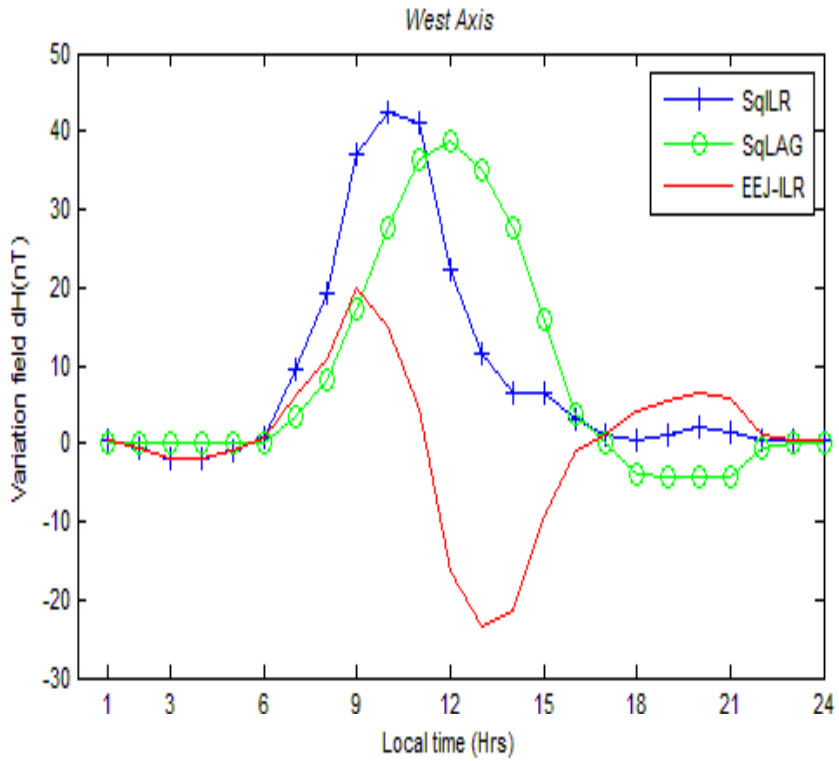
EEJ in Africa

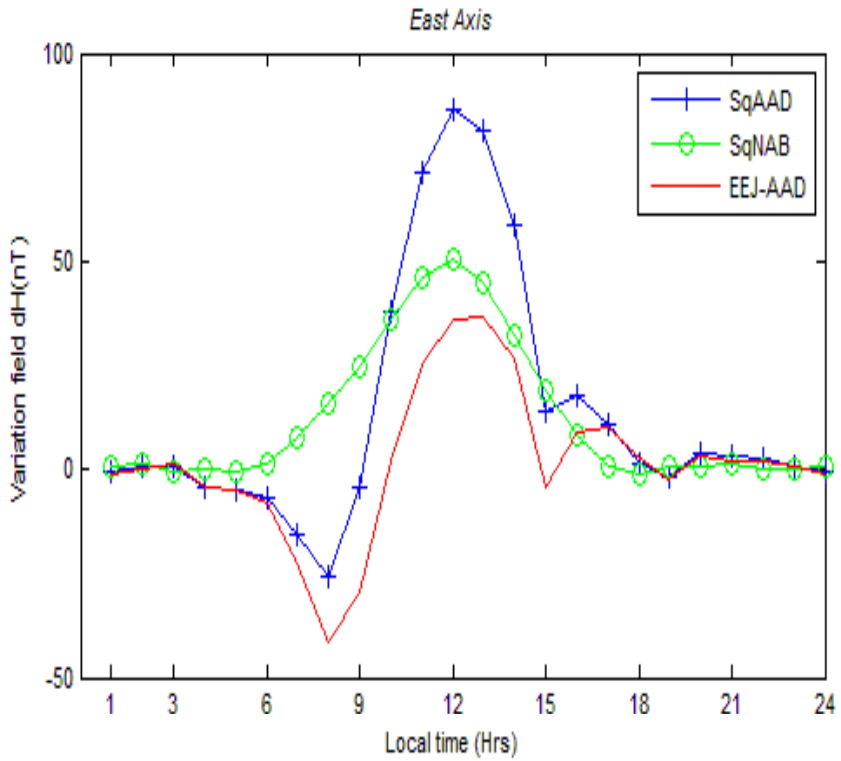
Coordinates of the Stations

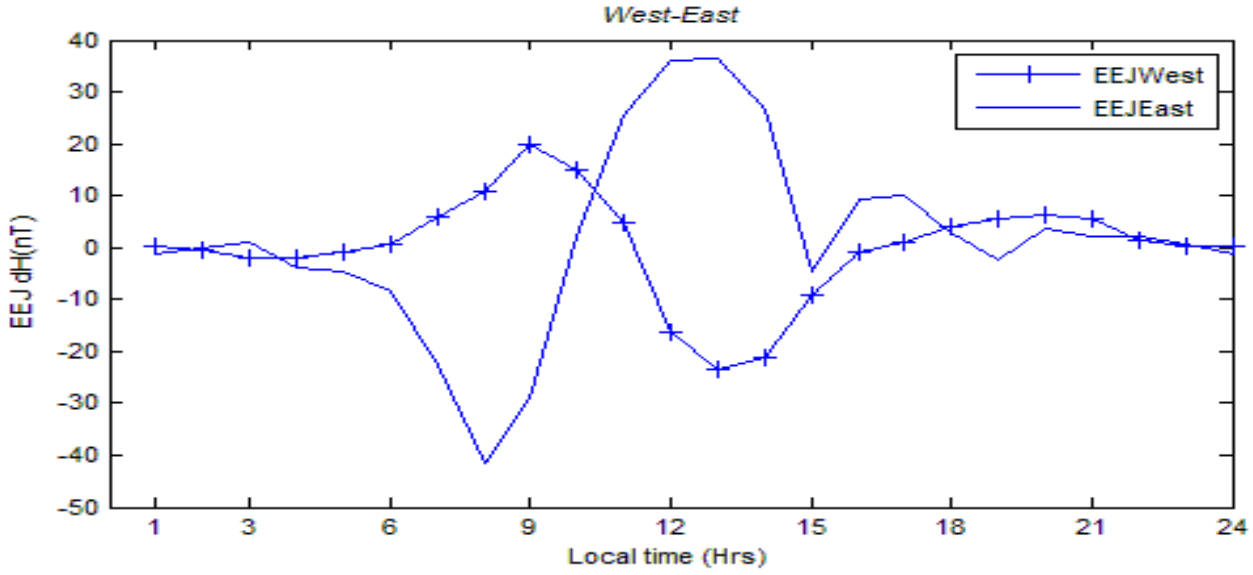
OBS	GMLat°	GLong ° E	GLat°
ILR	-1.82	4.67	8.50°N
LAG		3.43	3.42°N
AAB	0.18	38.77	9.04°N
NAB		36.80	1.16°S



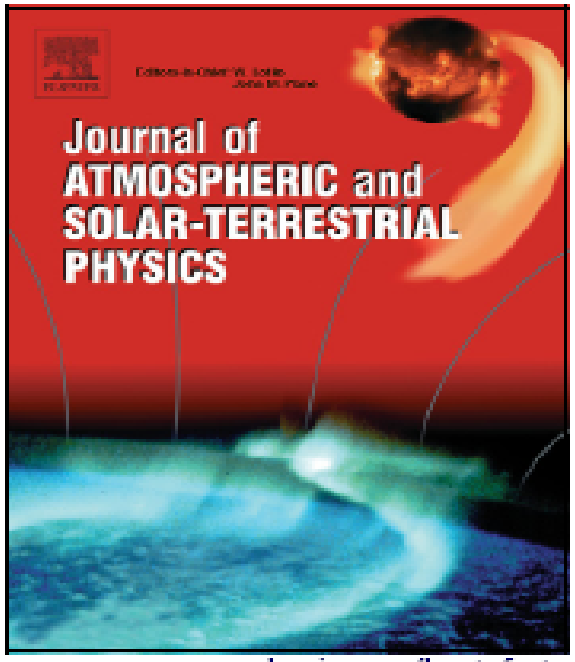
Separation of axes, Δ L = 33.735° = 3744.585 km







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



www.elsevier.com/locate/jastp

Climatology of the inter-hemispheric field-aligned currents system over the nigeria ionosphere

O.S. Bolaji, A.B. Rabiu, E.O. Oyeyemi, K. Yumoto

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Reference: ATP3656

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Author's Accepted Manuscript

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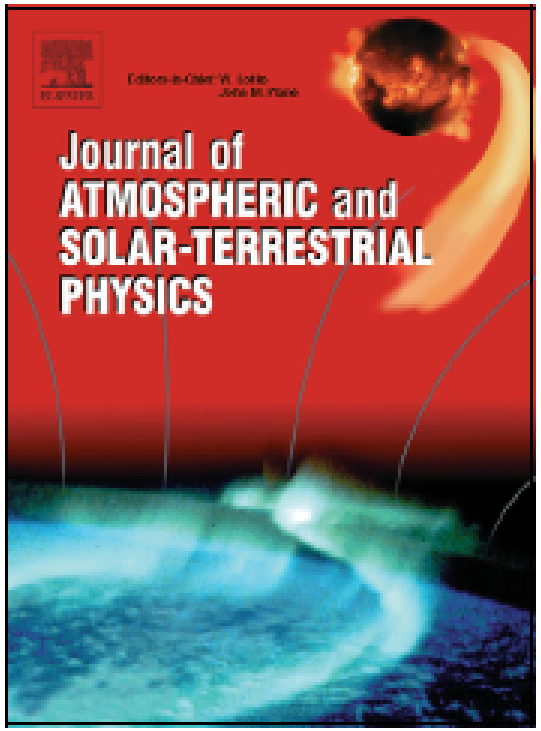


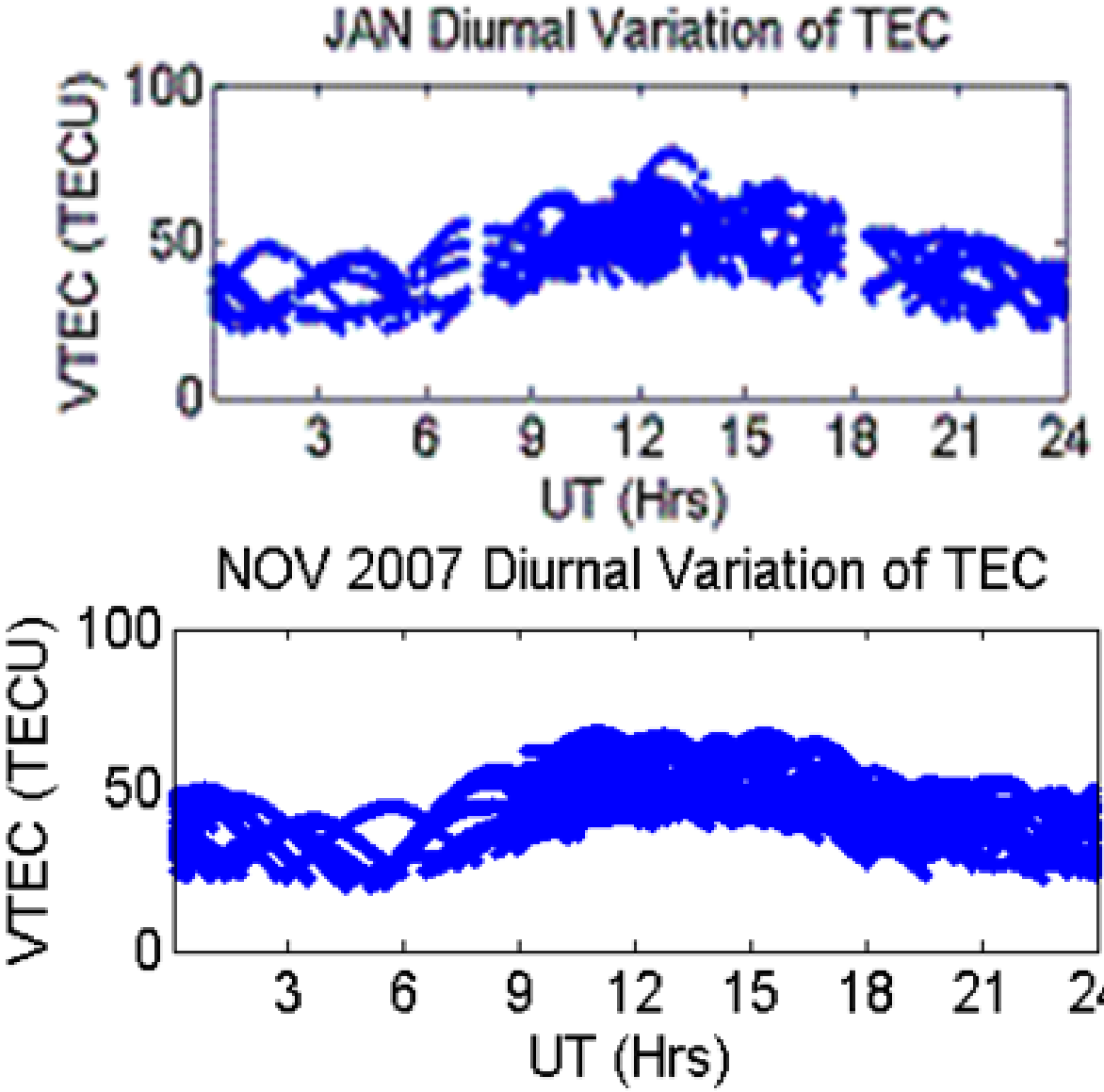
O.S. Bolaji, A.B. Rabiu, E.O. Oyeyemi and K. Yumoto, Climatology of the inter-hemispheric field-aligned currents system over the nigeria ionosphere, Journal of Atmospheric and Solar-Terrestrial Physics, http://dx.doi.org/10.1016/j.jastp.2012.07.008

IHFACs Climatology

- The IHFACs magnetic field variation flow in opposite direction of the winter northern-hemisphere.
- Dusk-side IHFACs was confirmed & are weakly northbound in all the seasons.
- Diurnal, monthly mean and seasonal variations of IHFACs exist and exhibit downward & upward inter-hemispheric field-aligned sheet current that appears as a pair at all local times.
- IHFACs exhibit longitudinal variability

TEC STUDIES

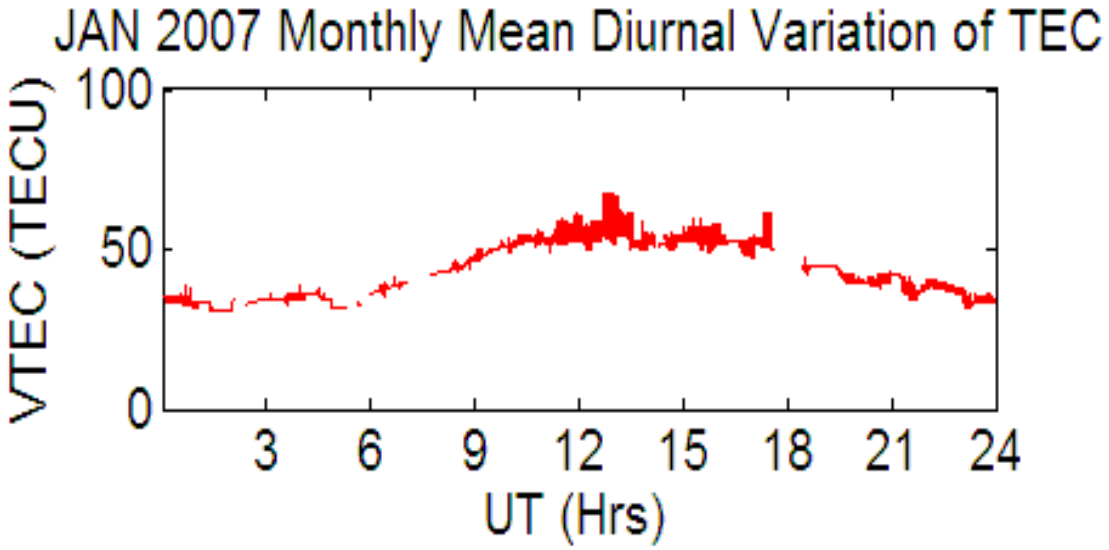
Mass plots of the Diurnal Variation of VTEC as observed from the data from all the visible PRN over Akure

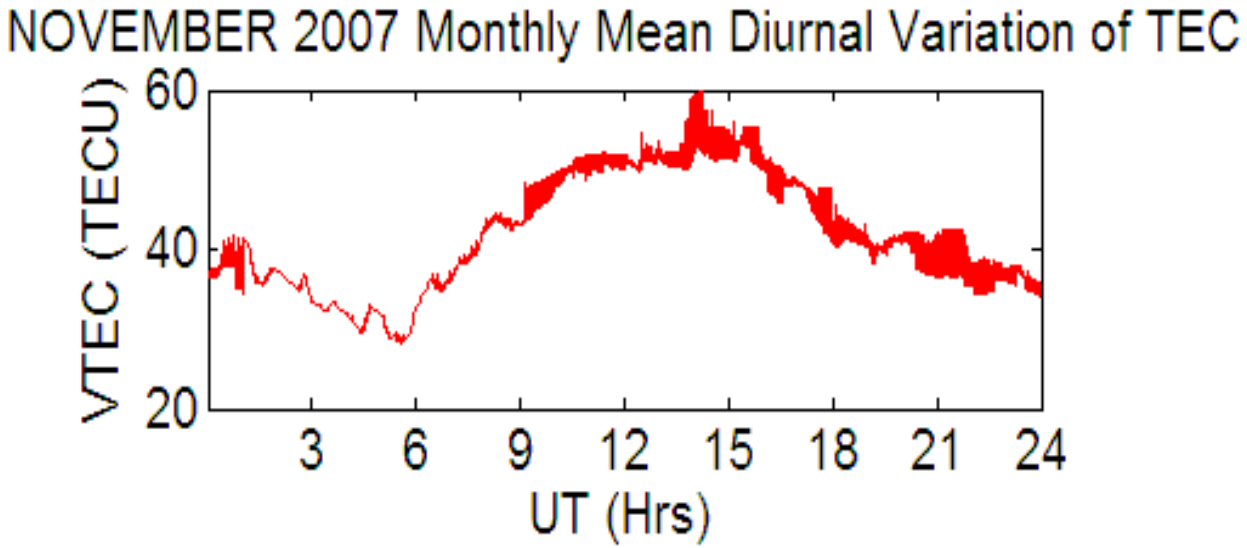


Diurnal Variation of VTEC over Akure

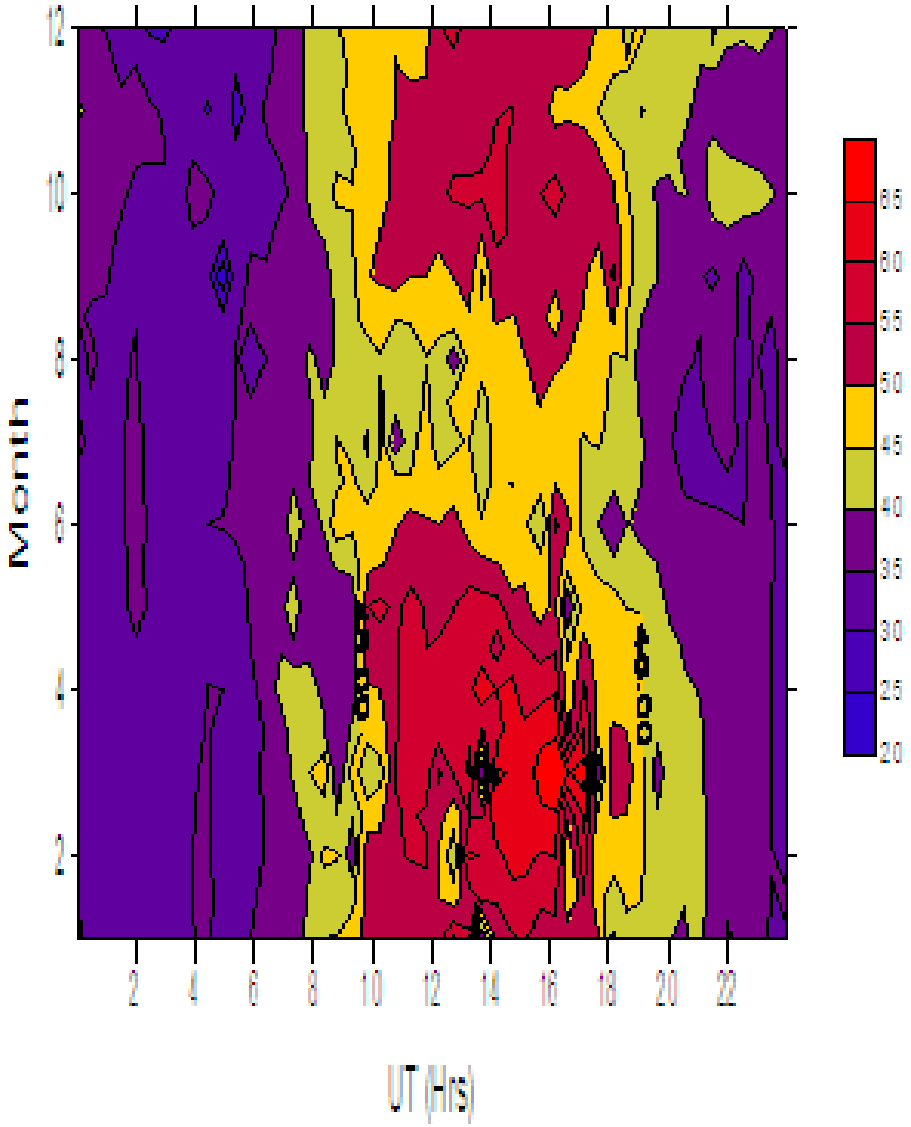
✓pre-dawn minimum for a short period of time followed by steep early morning increase.

✓TEC reaches maximum value between 1300UT (1400LT) & 1400UT (1500LT)



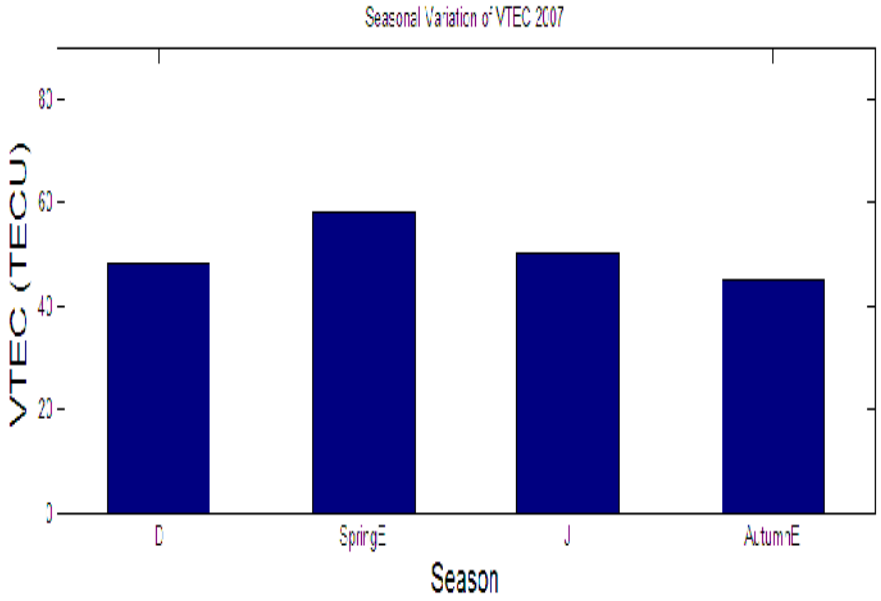


Annual VTEC variation at Akure, Nigeria



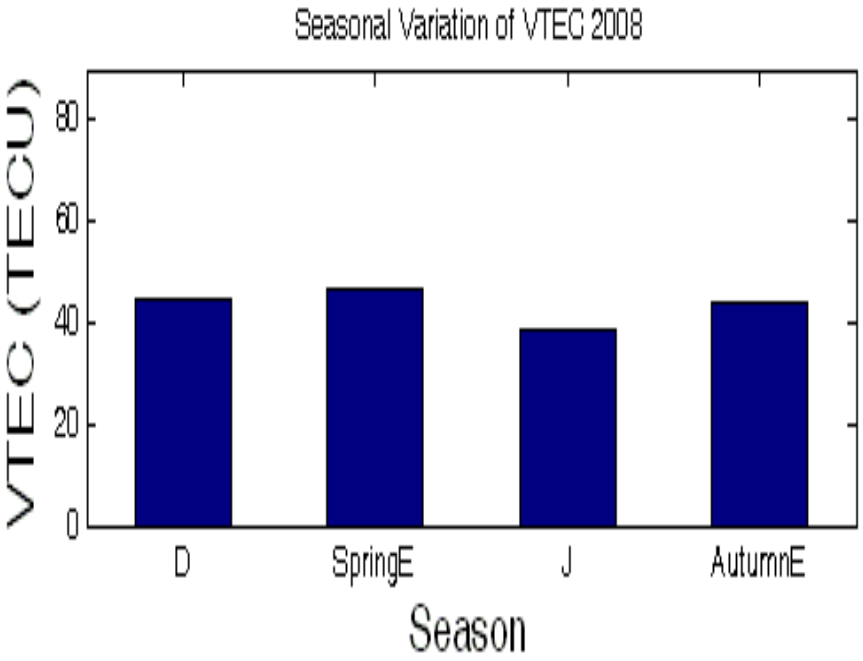
- **pre-dawn minimum for a short period of time followed by steep early morning increase.**
- **Attain maximum between 14.00UT and 16.00UT.**
- **maximizes during Equinox months, minimizes during winter months**
- **The semiannual variation of TEC is asymmetry with maximum in spring Equinox**

Rabiu et al 2011



Seasonal variation of TEC

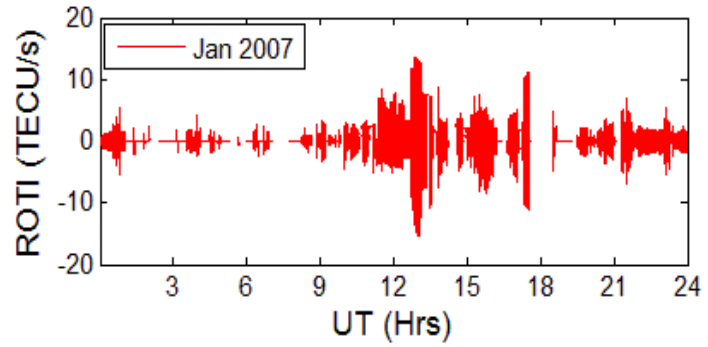
- **The semiannual variation of TEC is asymmetry with maximum in spring Equinox.**

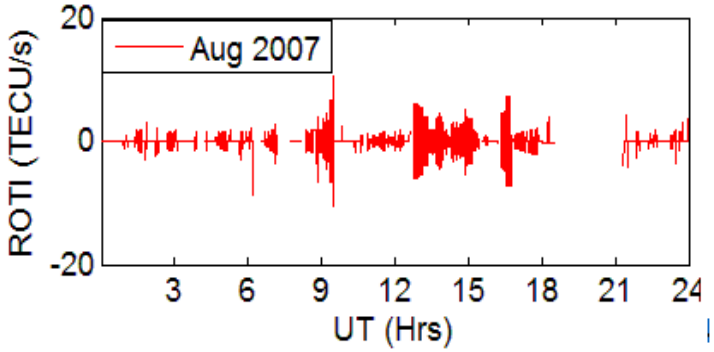


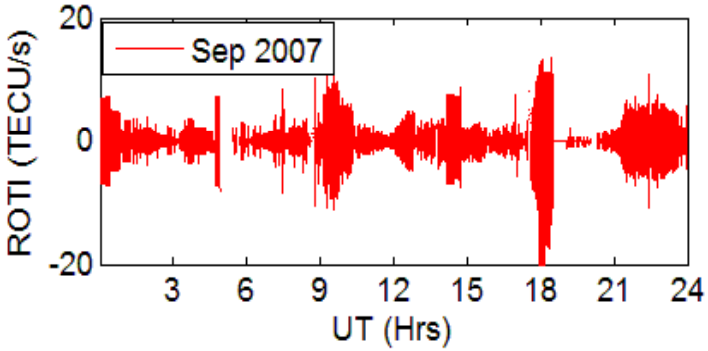
ROT

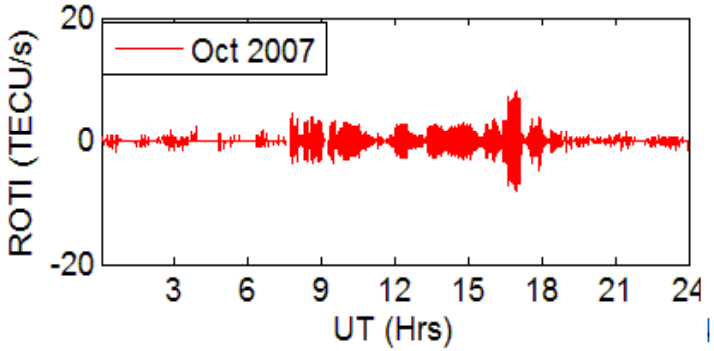
✓More TEC Fluctuations in daytime.

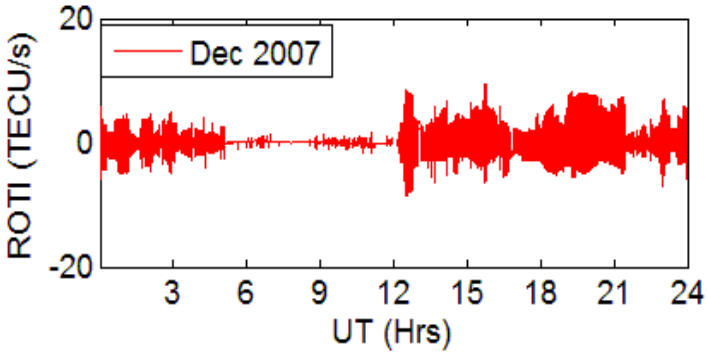
✓Seems to lack seasonal dependent





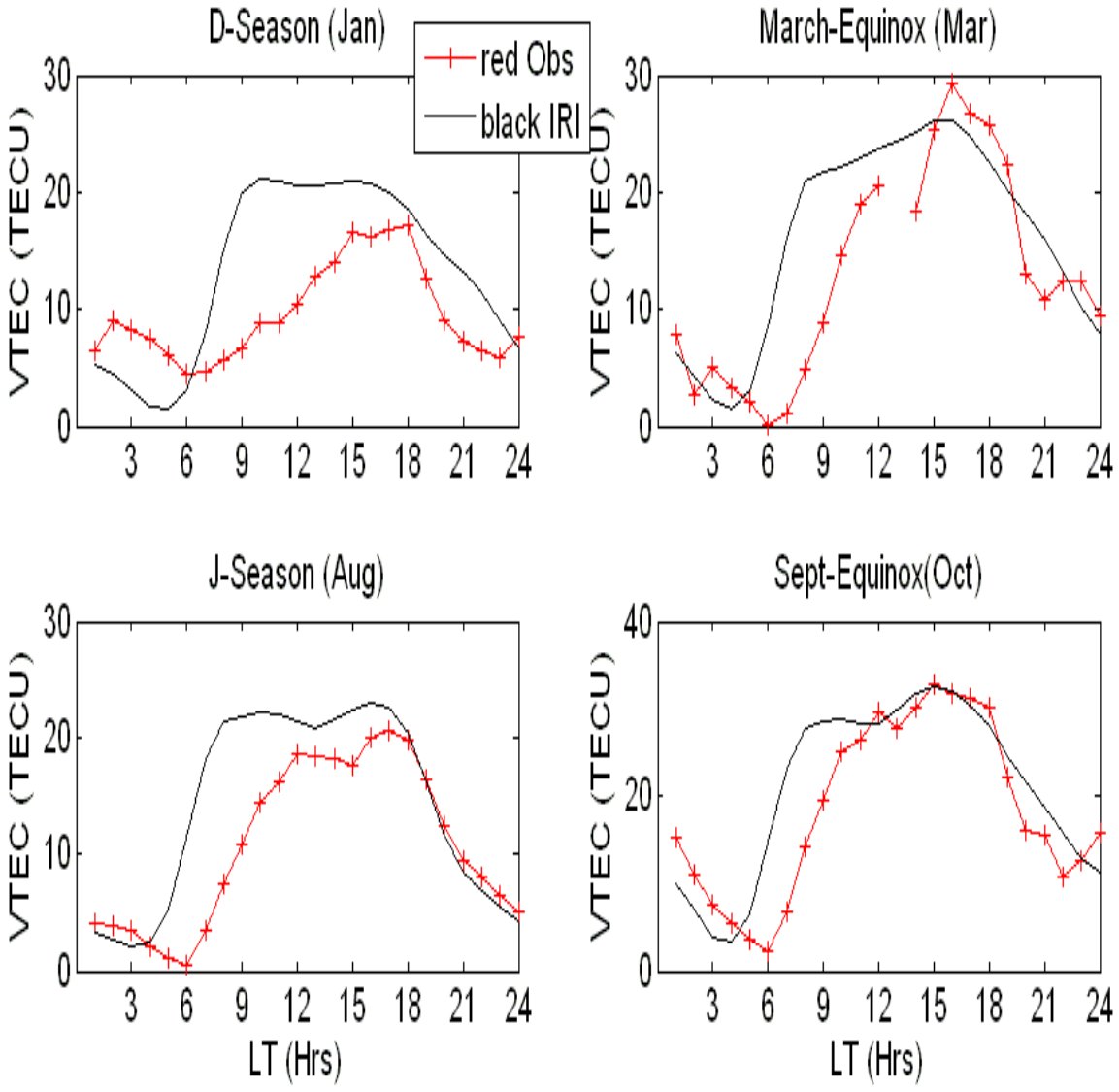






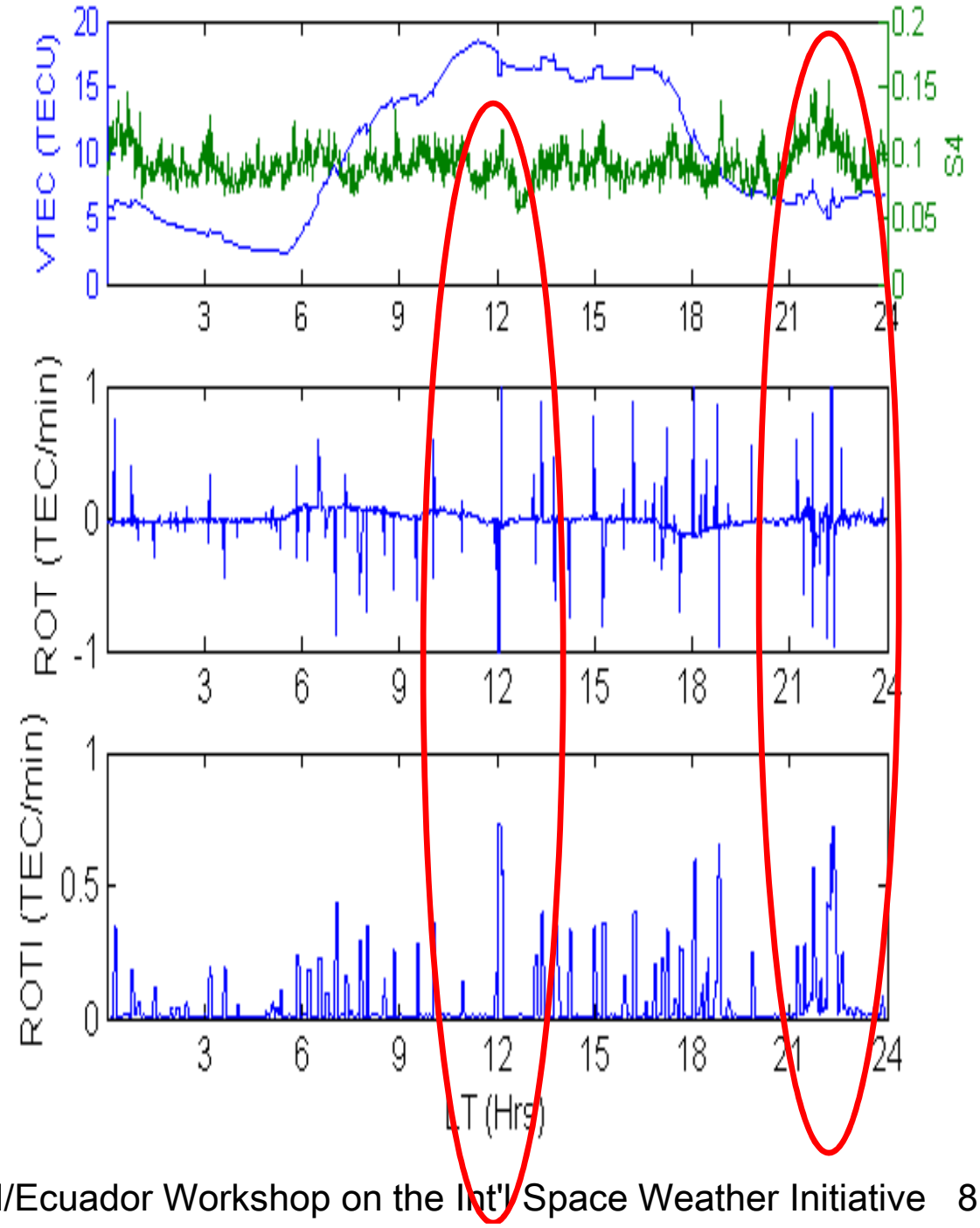
ROT = [TEC(t)-TECT(t+1)]/1

Unit TECU/sec



IRI & Observed TEC @ Akure 2010

IRI Under- & over- estimate the values of TEC at different times in all the seasons considered.

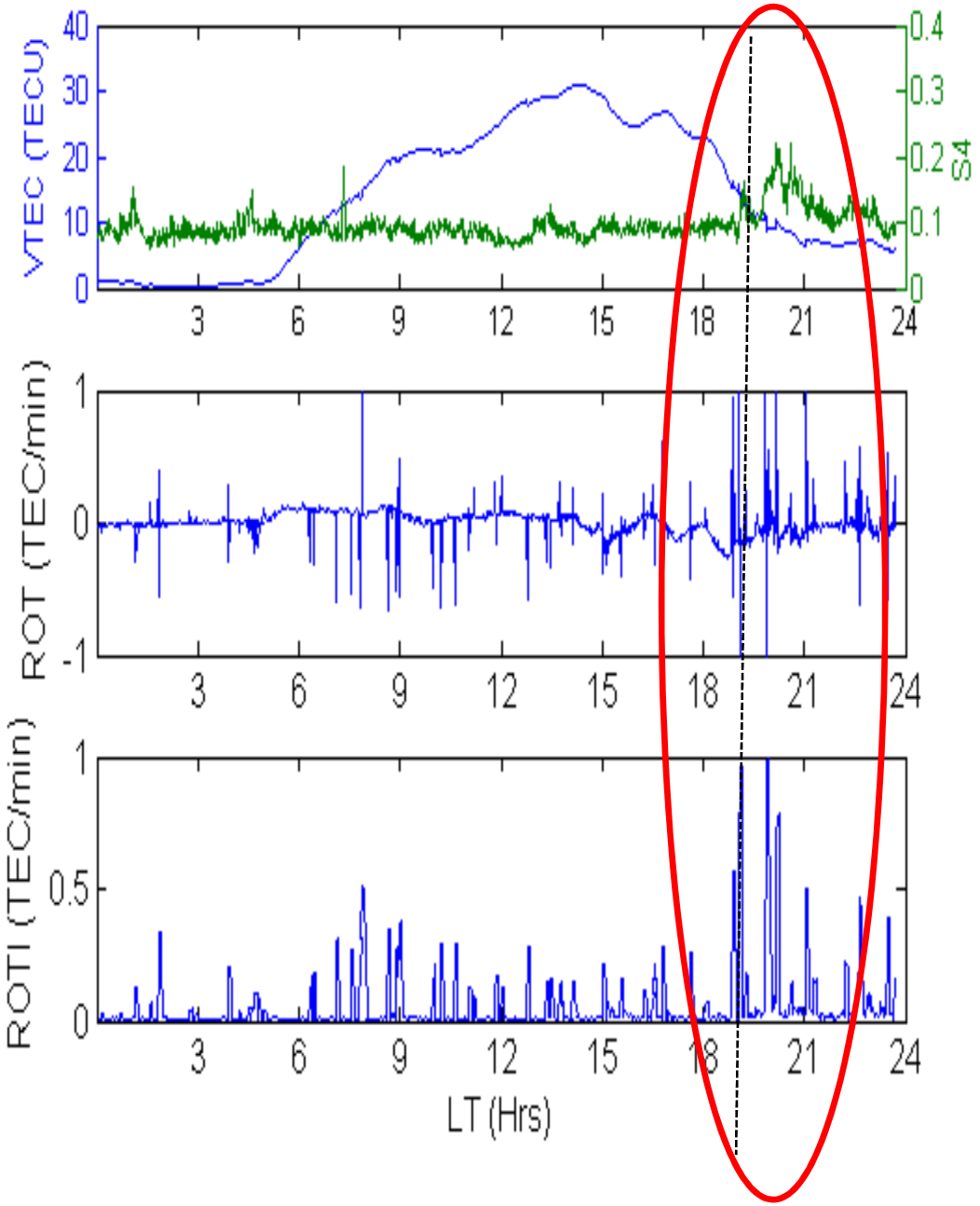


VTEC, S4, ROT & ROTI,
17th Jan 2010
Ap = 1

S4, ROT and ROTI give s information on the di mension of irregularities

S4 is sensitive to scale < the Fresnel scale

ROTI>0.5 corresponds to scale lengths of few km

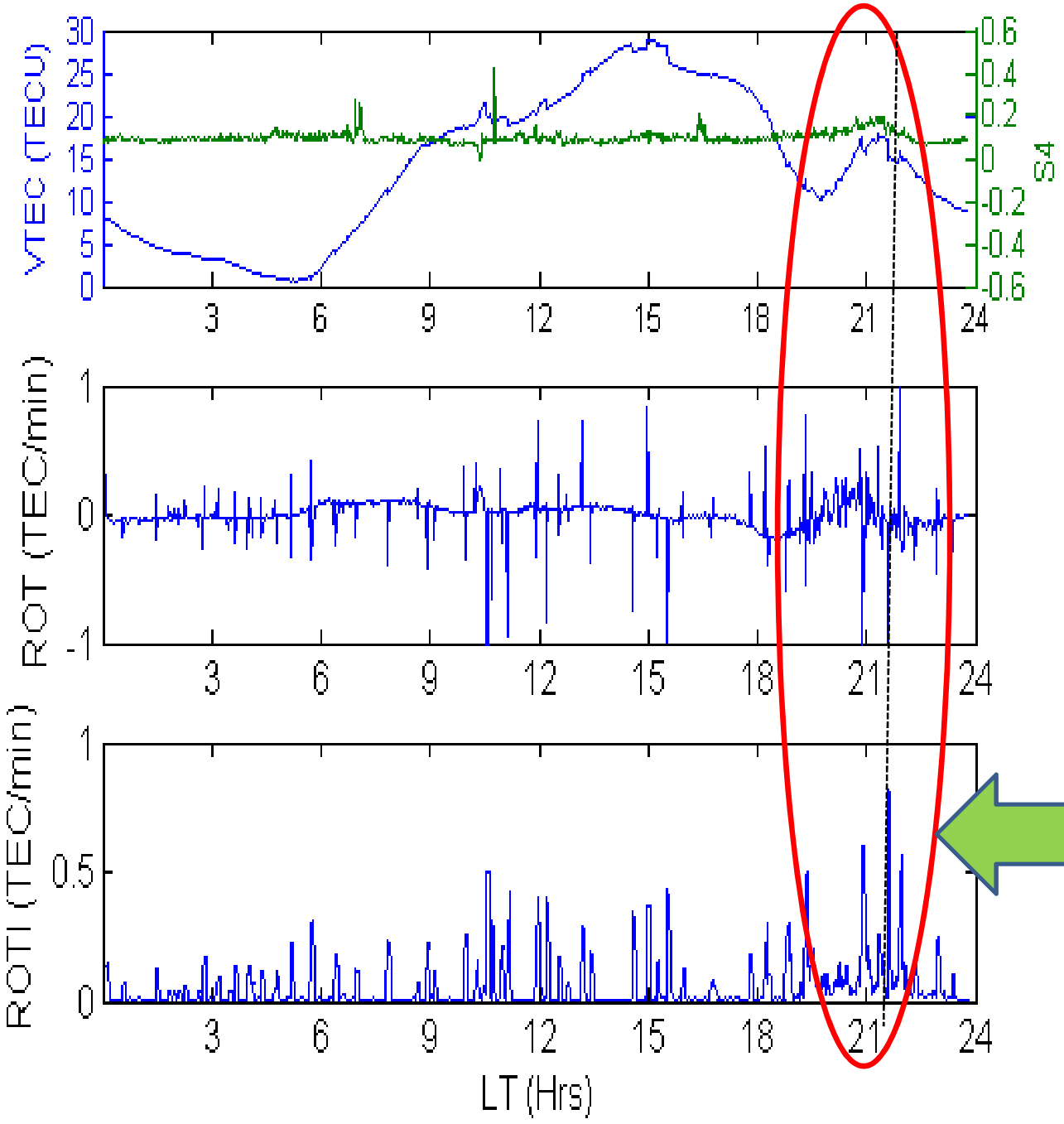


VTEC, S4, ROT & ROTI,

27th August 2010

Ap= 14

ROTI : standard deviation of ROT at 5 mins interval



VTEC, S4, ROT & ROTI, 3rd March 2010

Ap = 8

ROTI gave a more pronounced representation of TEC fluctuation than S4

Equivalent ranges of TEC & Dst at Akure, Nigeria. April 1-15, 2010

Activity Level	Dst (nT)	Mean TEC (TECU)
Low	Dst > -20	16.713
Medium	-20 > Dst > -50	16.851
High	-50 > Dst > -100	20.138

TEC increases with increasing magnetic activity.

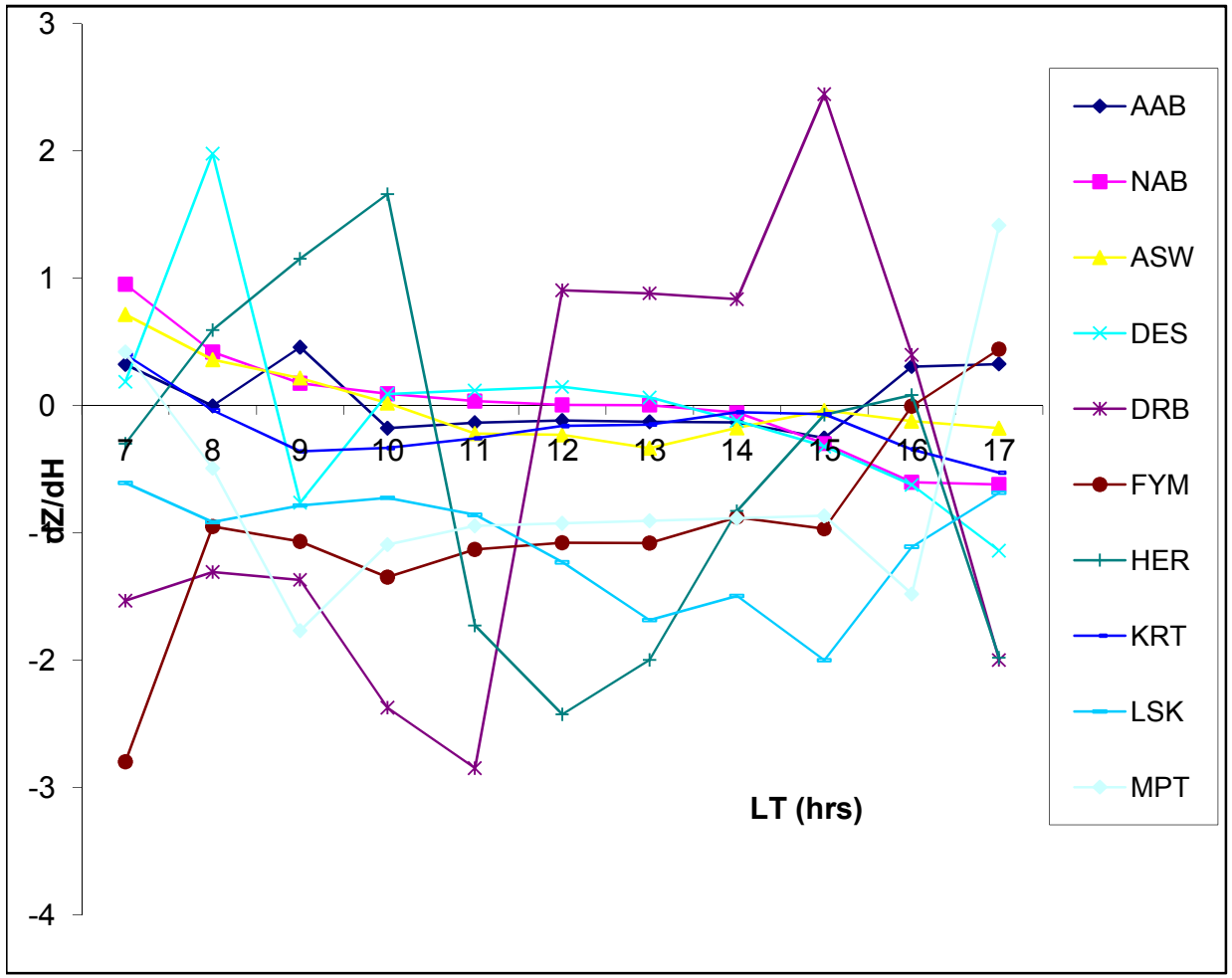
Measured TEC could serve as proxy for monitoring ionospheric responses to magnetic activity

Rabiu & Abdulrahim (2012): PAPER ID: IAC-12, D5,3,6,x12869 , IAF, Naples, Italy

A STUDY OF ELECTROMAGNETIC INDUCTION DUE TO GEOMAGNETIC EFFECT AT AFRICAN 96° MAGNETIC MERIDIAN

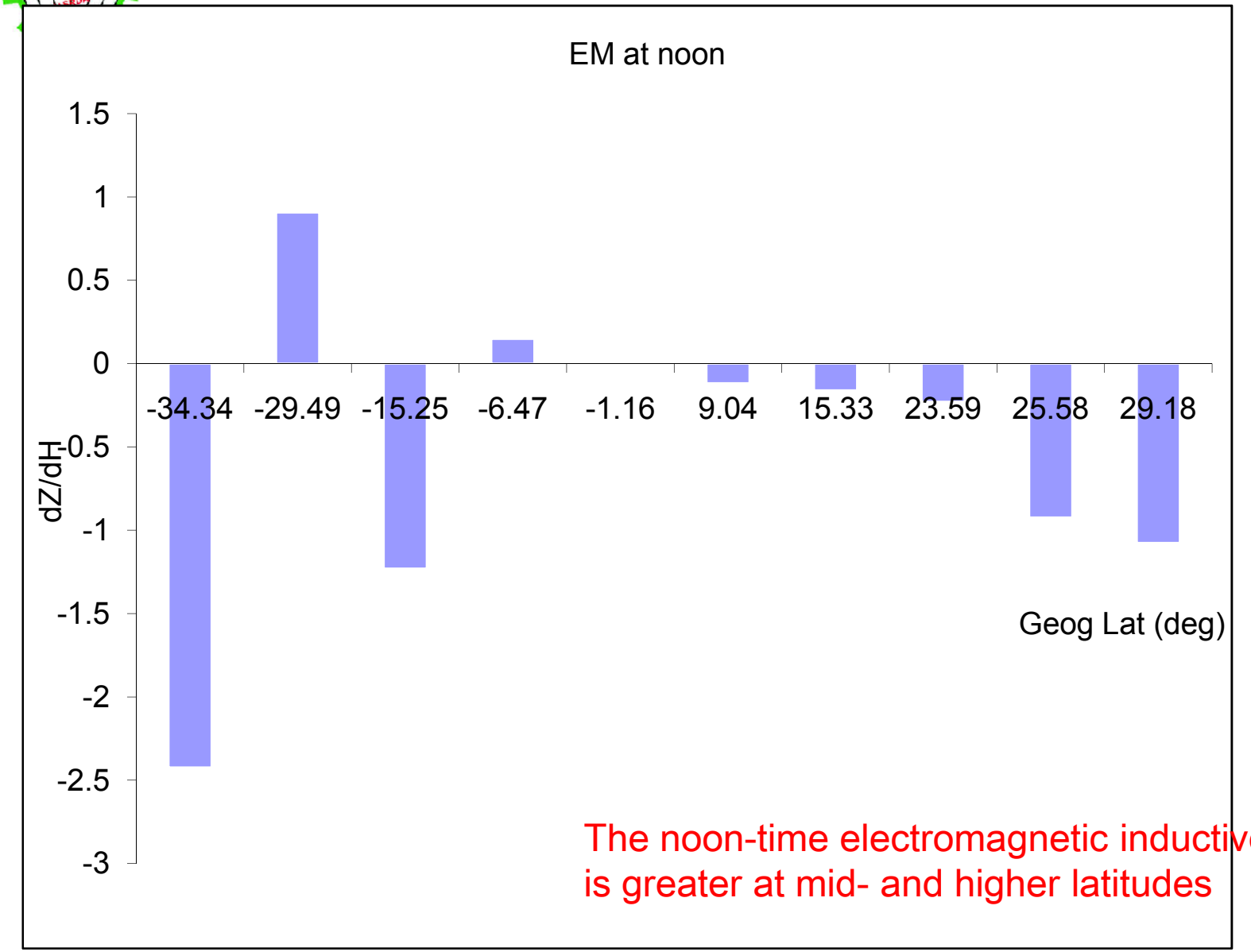
Rabiu, Yumoto, Yamazaki, Cardinal, MAGDAS/CPMN Group (2009)

Daytime variation of dZ/dH at different stations along 96°MM



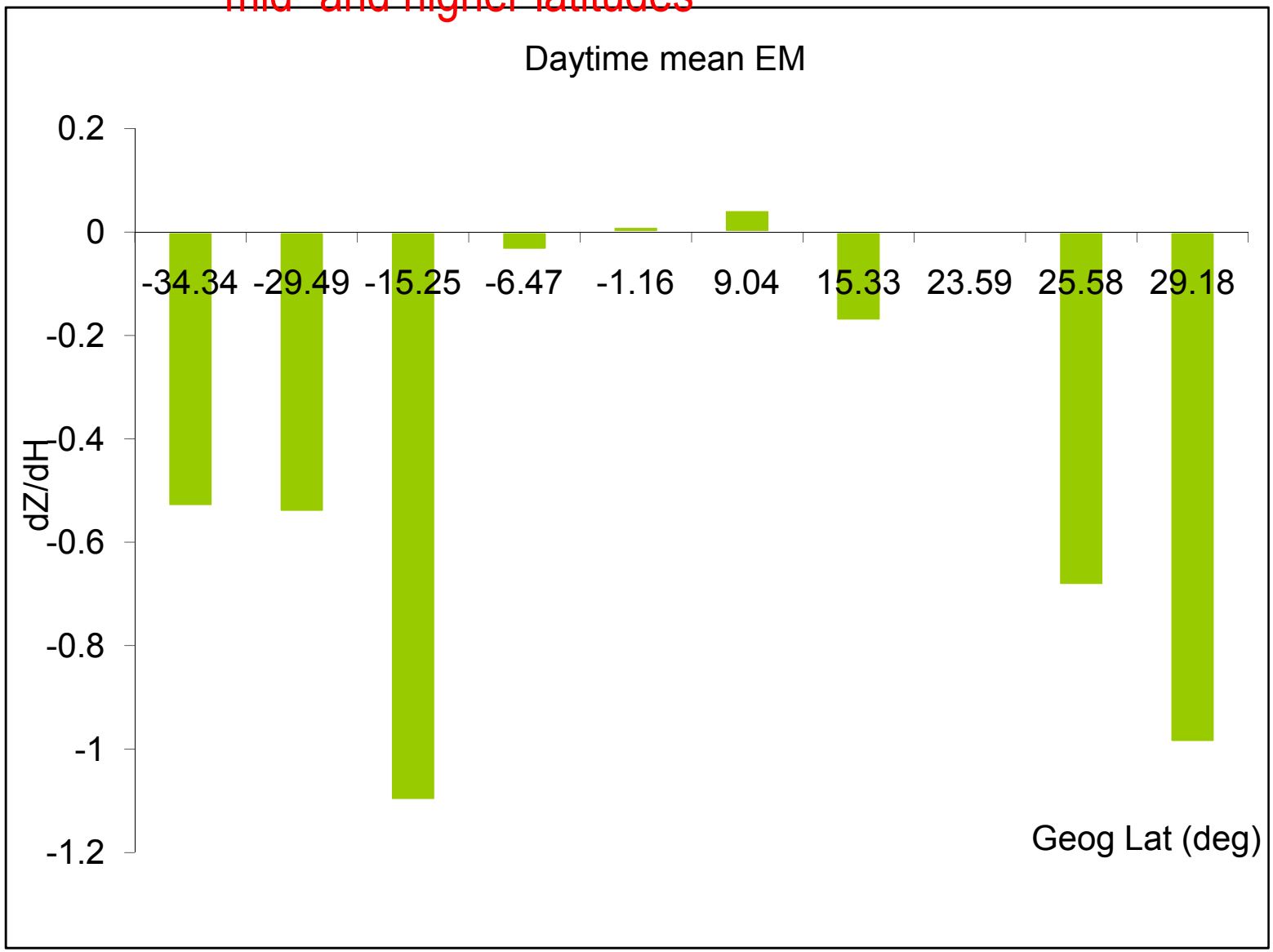
- ✓Stations outside EEJ tends to have more EM induction effects
- ✓The EM induction is minimal at all stations at about local noon
- ✓More effect at sunrise and sunset periods
- ✓Return currents could explain this observation. (Rabiu & Nandini, 2008)

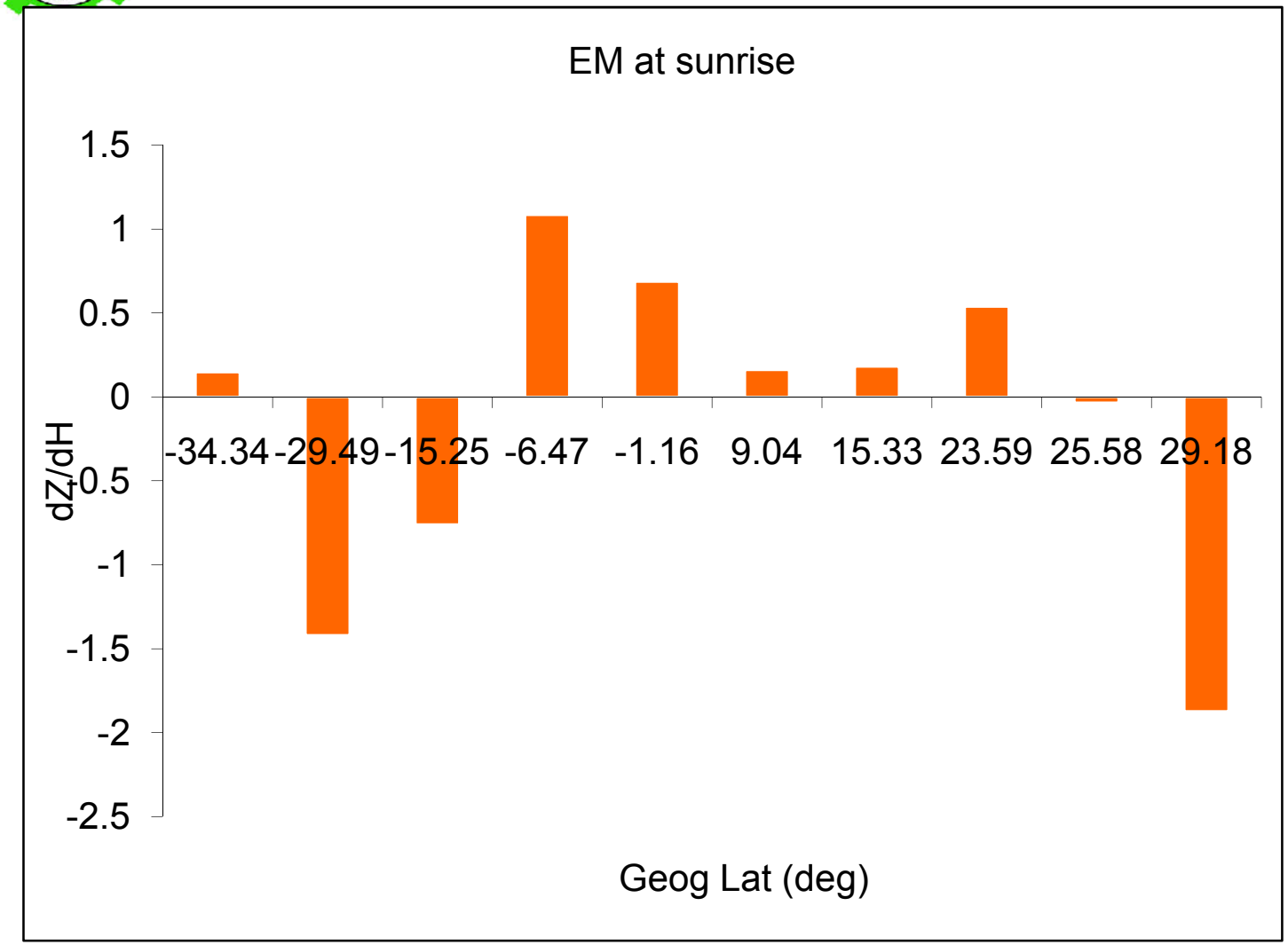
The electromagnetic inductive response is negligible around local noon, when the electrojet source field has zonal symmetry, in all sectors



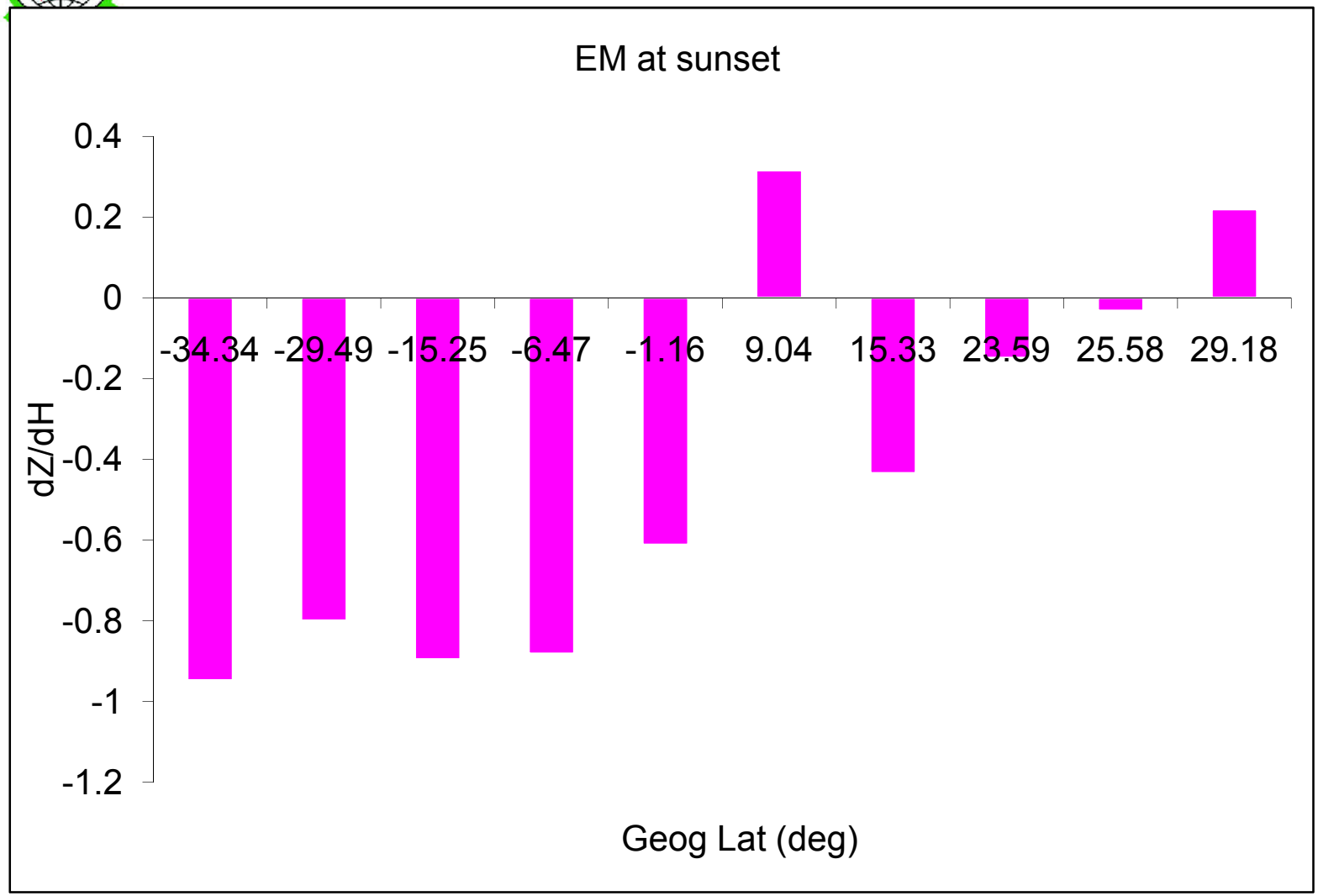
The noon-time electromagnetic inductive response is greater at mid- and higher latitudes

The day-time electromagnetic inductive response is greater at mid- and higher latitudes





The sunrise electromagnetic inductive response is greater at mid- and higher latitudes



The sunset electromagnetic inductive response is greater at southern hemisphere?

Conclusions

- We highlighted the contributions of UN BSSI (1992-2006), International Heliophysical Year IHY (2007-2009) and International Space Weather Initiative ISWI (2009-2012) to Africa
- Over 17 magnetometers (MAGDAS and AMBER), more than 25 GPS receivers (SCINDA and others), and well over 50 ionospheric RF sounders (Ionosonde, SID monitor and AWESOME) are now operational in Africa
- Some scientific results have been presented

Thank You