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Babatunde Rabiu 30 July – 4 August 2017, UN/USA ISWI Workshop, Boston
Outline

• Africa

• IHY & ISWI in Africa

• Output of ISWI

• Some Scientific Results

• Conclusions/Recommendations
Africa

- 54 sovereign nations
- 30.2 million km$^2$
- 1.248 billion population (July 2017)
- 16.36 % of total world population
- More than half in ISWI

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Uniqueness of SW over Africa

- Broad range of magnetic equator over land
- EIA width can be studied in its full spectrum
IHY/ISWI IN AFRICA

- Capacity building
  - Intra-Continental training of MSc and PhD student (more than 30)
  - Short term visit to overseas partner institutions
  - Series of Space Weather schools

- UN Workshops
  - Magnetometers
  - GNSS receivers
  - All sky Optical Imager
  - FPI
  - Ionosonde
  - CALLISTO
  - More than 30 SIDs

- 30 July – 4 August 2017, UN/USA ISWI Workshop, Boston
Status of Space Weather Research facilities

- 54 sovereign nations
- African Professors
- Diligent students
- Research facilities

- Mostly foreign intervention
- National Participation

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Workshop/Schools/Conferences held in Africa

- IPY-IHY Regional Workshop, Somerset West, Cape Town, South Africa, 2006
- IHY Regional School, Enugu, Nigeria November 2008
- ISWI School, Bahir Dar, Ethiopia, 2010
- UN/Egypt Workshop on Space Weather, Helwan, Egypt 2010
- International MAGDAS School, Lagos, Nigeria, August 2011
Workshop/Schools/Conferences held in Africa

- UN/Nigeria Workshop on Space Weather, Abuja, Nigeria, October **2011**
- AGU Chapman Conference on Space Weather, Ethiopia, **2012**
- ISWI/SCOSTEP School on Space Sciences, Nairobi, Kenya **2013**
- ICTP/BC/ICG African School on Space Science, Rwanda **2014**
- International School on Equatorial & Low Latitude Ionosphere, Nigeria, **2015**
- International Symposium on Equatorial Anomaly, Ethiopia, **2015**
- UN CRASTE-LF Use of Global Positioning System (GPS) Data for Ionospheric Studies, Morocco, **2017**

2nd International School on Equatorial & Low Latitude Ionosphere, Nigeria, **Sept, 2017**

[www.carnasrda.com/iselli-2](http://www.carnasrda.com/iselli-2)
Output

- M.Sc. And PhD. Degrees
- Space Physics program at graduate levels
- Instrument/Data Availability
- Research Publications in Journals
- Increase in number of African based professors
- Positive Catalyzation of National government participation in SW
- Inter/intra-national cooperation
- Scientist / student exchange
- Brain drain control
- International competitive research in Africa

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A measure of their impact in Africa

Papers published by African scientists working in Africa on “equatorial ionosphere” from World of Science website.

Radicella & Nava, 2017
– Established Nov 2012, Addis Ababa, Ethiopia
– 1st conference June 2014, Abuja, Nigeria
– 2nd Conference, Nairobi 2015
– 3rd Conference, Abidjan, 2016
Some Results
Sq Studies
Seasonal variation of Sq(H) along the African 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

The northern focus = 33.16 ± 2.1° larger mean
the southern focus = -15.63 ± 1.4° over the year.
EEJ in Africa
### Coordinates of the Stations

<table>
<thead>
<tr>
<th>OBS</th>
<th>GMLat °</th>
<th>GLong E</th>
<th>GLat °</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILR</td>
<td>-1.82</td>
<td>4.67</td>
<td>8.50 °N</td>
</tr>
<tr>
<td>LAG</td>
<td>3.43</td>
<td></td>
<td>3.42 °N</td>
</tr>
<tr>
<td>AAB</td>
<td>0.18</td>
<td>38.77</td>
<td>9.04 °N</td>
</tr>
<tr>
<td>NAB</td>
<td>36.80</td>
<td></td>
<td>1.16 °S</td>
</tr>
</tbody>
</table>

Separation of axes, $\Delta L = 33.735^\circ = 3744.585$ km

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Longitudinal variation of EEJ

- the African stations registered the greatest % of occurrence of the CEJ than elsewhere
- The greatest % occurrence of MCEJ as found at Addis Ababa (eastern Africa)
- the greatest % occurrence of afternoon CEJ was found at Ilorin (western Africa).

activities that support strong EEJ do inhibit occurrence of the CEJ.

Rabiu et al, 2016, 2017
TEC STUDIES
Eyelade (2014) 
(Masters thesis)
The IRI simulations in the left column, the reconstructions based on all the available data in the middle column and the reconstructions based on just the IGS data in the right column. The first row, (a), is for 22:00 UT on 2 December 2012. The second row, (b), is for 17:00 UT on 3 December 2012. The third row, (c), is for 12:00 UT on 7 December 2012. The GPS receiver sites used to make each set of reconstructions are shown in white.

Chartier et al, 2014
Nighttime plasma drift over Ouagadougou using ionosonde data

- PRE peak in June solstice appears 1 h later than for other seasons and is attributed to a decrease in the equatorial zonal wind/conductivity gradient.
- The highest PRE magnitude and downward perturbation drifts near dusk appear during the equinoxes and lowest in June solstice for all cycles.
- There is semiannual asymmetry in the variation of $V_d$ during all cycles of the PRE event with peaks in March and September/October.

Adebesin et al, 2015
Nighttime plasma drift over Ouagadougou using ionosonde data

A remarkable feature is the consistent local presunrise drift enhancement for two SCs 20 and 21, which is not a regular feature of the equatorial ionosphere.

The rate of inhibition of scintillation effect increases with decreasing phase of sunspot activity and maximizes during the solstices.

Both the PRE and minimum reversal peak magnitudes are influenced by the phase of sunspot cycle.

Adebesin et al, 2015
Plasma bubbles over Nigeria using Optical imager data

Percentage Occurrence of Plasma Bubbles as observed on the Airglow and GNSS data for the period from June 2015 to January 2017.

Okoh et al, in press
Conclusions/Recommendation

• Occurrence of morning CEJ is much prevalent in East Africa longitude (90%) than the West Africa (80.9%), while the evening CEJ is dominant along the West African longitude (82.9%) than the East African longitude (50%)

• More occurrence of plasma bubbles in March/April over Nigeria

• TEC maximizes during the equinox months; lowest in solstice months

• In Nigeria, at 07:00 LT (sunrise) TEC decreases westwards across all the latitudes
Conclusions/Recommendation

• IHY & ISWI are productive ventures in Africa in terms of
  – Human Capacity development
  – Observational facilities / infrastructural development
  – Data availability

• Ground observations over Africa is fundamental to the understanding of global Space Weather and its monitoring

• Space weather is observed to be very dynamic over Africa
THANK YOU
Acknowledgements

• UNOOSA
• ISWI Secretariat
• BC
• ISWI Instrument providers