IRI-2016 evaluation of African low-latitude ionosphere during 2015 St. Patrick’s Day storm main phase

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OUTLINE

• INTRODUCTION
  ✓ International Reference Ionosphere (IRI) overview
  ✓ Description of 2015 St. Patrick’s Day storm
  ✓ Some geospace response to the storm

• DATA AND METHOD

• RESULTS
  ✓ African southern low-latitude TEC response to Main Phase event
  ✓ IRI storm-time model validation

• CONCLUSION
INTRODUCTION

• IRI is a data-based/empirical model.
• Limitations of theory-based models such as evolving theoretical understanding.
• Based on most of the available and reliable observations.
• About 50 international experts “Working Group” - IRI development & improvement.
• Extensive and excellent results.
• Standard Ionospheric Climatological model (ISO 16457:2014)
• Improvement on transient and near-real-time values.

• March 17, 2015 storm
  - Most intense in the 24th solar cycle, although underestimated by forecasters
    (Astafyeva et al. 2015, Jacobsen and Andalsvik 2016)
  - Severe scintillation in GNSS signal (Jacobsen and Andalsvik 2016)
  - Absence of PRE around the equator during main phase (Hairston et al. 2016, Kalita et al. 2016)
INTRODUCTION cont’d

Global map of IRTAM-foF2 and GIRO-foF2 deviation from IRI at 21:52UT on St. Patrick Day storm – March 17, 2015 (Galkin et al. 2016)

(giro.uml.edu)
METHOD

- March 17, 2015
  - $F_{10.7} = 113 \times 10^{-22} Wm^{-2}Hz^{-1}$
  - Minimum $SYM - H = -234nT$ (around 2300 UT)
  - Peak AE = 1570nT (at 1400 UT)
  - Daily $ap = 108nT$

List of Stations used for this work

<table>
<thead>
<tr>
<th>Location</th>
<th>Station ID</th>
<th>Country</th>
<th>Geographic</th>
<th>Geomagnetic</th>
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<tbody>
<tr>
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<td></td>
<td></td>
<td>Latitude</td>
<td>Longitude</td>
<td>Latitude</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>0.35° N</td>
<td>9.67° E</td>
<td>8.05° S</td>
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<td>NKLG</td>
<td>Gabon</td>
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<td>Kenya</td>
<td>2.70° S</td>
<td>40.19° E</td>
<td>12.10° S</td>
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</tbody>
</table>

- **IRI-2016**
  - Topside options - NeQuick
  - - IRI01corr
  - - IRI2001

  Bottomside options - URSI

Sept. 26, 2017

JOASEI-2017: Service to God and Humanity
RESULTS

Morphology of observed and modelled TEC data at the three African low latitude stations.

%Deviation of TEC from quiet time value during the Storm Main Phase at the three African low latitude stations.
% Deviation of modelled TEC values from Observed TEC values on 17 March 2015

Deviation of modelled TEC values from Observed TEC values on 17 March 2015
### RESULTS cont'd

RMSE for the three IRI topside options during the period of high deviation from observation

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<tr>
<td>0100 - 0800 UT</td>
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<td>52.9</td>
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RMSE for the three IRI topside options during the storm main phase

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<td>63.6</td>
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RDMM for the three IRI topside options during the storm main phase

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<td>IRI-2001</td>
<td>1.15</td>
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<td>1.32</td>
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CONCLUSIONS

- TEC response to the storm main phase is inconsiderable except towards the period of minimum SYM-H, which falls towards 2200UT.

- The three IRI options presented the general morphology, but could not reproduce the signature of the storm event as reflected on the observed TEC.

- The three model options overestimated for the larger part of the day except between 0900 and 1700 UT, where there is underestimation.

- Deviation of modelled from observed TEC values is higher around the SSC and the minimum SYM-H, which falls around post-midnight and post sunset periods respectively.

- The NeQuick option performed better than others across the three low-latitude stations with a Root-Mean-Square Error (RMSE) value of 3.5TECU and Relative Deviation Module Mean (RDMM) of 0.48 at NKLG.

- With the lowest RDMM of 0.48, which is >0.06, even the best of the IRI options has poor agreement with observations.
Professor J.O. Adeniyi

-Father
-Mentor
-Role model
-Giant
-Angel

THANK YOU!
References