Space Weather Services in Nigeria: A case of TEC Forecasting over Nigeria

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Introduction

- Space weather is fast becoming a global concern.
- Space weather refers to the conditions in space environment that have impact on space-borne technological systems caused by four main components.
  - Solar flares consisting of X-ray solar flashes,
  - coronal mass ejections (CME's),
  - high speed solar wind, and
  - solar energetic particles i.e. the effects that the Sun has on Earth and the planets of the solar system.
- This has been reported to have influence the performance and reliability of a variety of space-borne and ground-based technological systems and can also endanger human health and safety [Koons *et al.*, 1999]

Nigeria's Space Weather Services

- The NASRDA's Centre for Atmospheric Research has 'Space Weather' as one of her main agenda.
- A daily space weather nowcasts was set up for the benefits of the public and in particular patrons of space technology dependent systems/ operations.
- This platform started on the 16th January 2018 and it presents daily space weather nowcasts for global usage.

Motivation

- Over the years, the efficiency of space based technologies has been proven to be adversely affected by space weather activities
- Continuous dependence of people on space based technologies and their patronage of the technologies are the major motivation behind this platform.
- This is because the functionality and efficiency of space-based technologies are greatly affected by space weather

Objectives of the Services

- The Nigerian Space Weather services is to provide an important service to the nation by monitoring the sun and its activity to provide information, early warnings and Nowcast space weather conditions.

- The space weather products and services are required primarily for communication and navigation systems, in the defence, aeronautics, navigation and communication sectors and for academic purposes.

Our consumers

- Space-based service providers
- Satellite ground station operators
- Military
- Academic community

What we do

- Daily and monthly TEC forecast over Nigeria from July 2018

  - The forecast of TEC engaged a neural network model of the GNSS Vertical TEC (GNSS VTEC) over Nigeria.
  - The approach considered the IRI critical plasma frequency (fof2) parameter as an additional neuron for the network's input layer.
  - The daily forecasts in form of TEC maps and movies have been freely provided at www.carnasrda.com since 5th of July 2018.

Resources

- http://www.spaceweather.com/
- https://www.spaceweatherlive.com/
- http://wdc.kugi.kyoto-u.ac.jp/dst_realtime/

- https://carnasrda.com/

Daily Nowcasting

- provides daily nowcasting of space weather parameters such as the
  - Solar wind speed,
  - The solar wind density,
  - The sunspot number,
  - The 10cm solar radio flux (10.7cm flux),
  - the interplanetary magnetic field component (Bt, and Bz) and
  - the disturbance storm time index (Dst)

Obtained from established service providers such as NOAA Space weather prediction Center and WDC, Kyoto.

- This services started on the 16th January, 2018.

Daily Nowcasting

5/14/2019 Nowcasts – carnasrda

Centre for Atmospheric Research
National Space Research and Development Agency
CAR-NASRDA
Federal Ministry of Science and Technology

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Date: 13 May 2019; 09:51UT

Summary of Space Weather.

The sunspot AR2740 is rapidly decaying and poses no threat for solar flares.The geomamagnitic conditions at all levels are unsettled.The solar wind speed is increasing.

Space Weather parameters / observations;

Sunspot Number: 24

10.7cm Flux: 76 sfu

Solar wind speed: 354.7 km.s-1

Solar wind density: 6.5 protons.cm3

Kp: 1

Bz: -3.9 nT (South)

Bt: 7.7 nT

Dst: -1 nT

Download Data

Daily Nowcasting

Daily condition

Date: 10 May 2019; 09:51UT

Summary of Space Weather

The sunspot AR2740 is decaying and poses declining threat for solar flares.The geomamagntic conditions are quiet at all levels.The solar wind speed is declining.

Space Weather parameters / observations;

Sunspot Number: 25

10.7cm Flux: 75 sfu

Solar wind speed: 341.2 km.s-1

Solar wind density: 4.4 protons.cm3

Kp: 1

Bz: -0.2 nT (South)

Bt: 3.3 nT

Dst: 7 nT

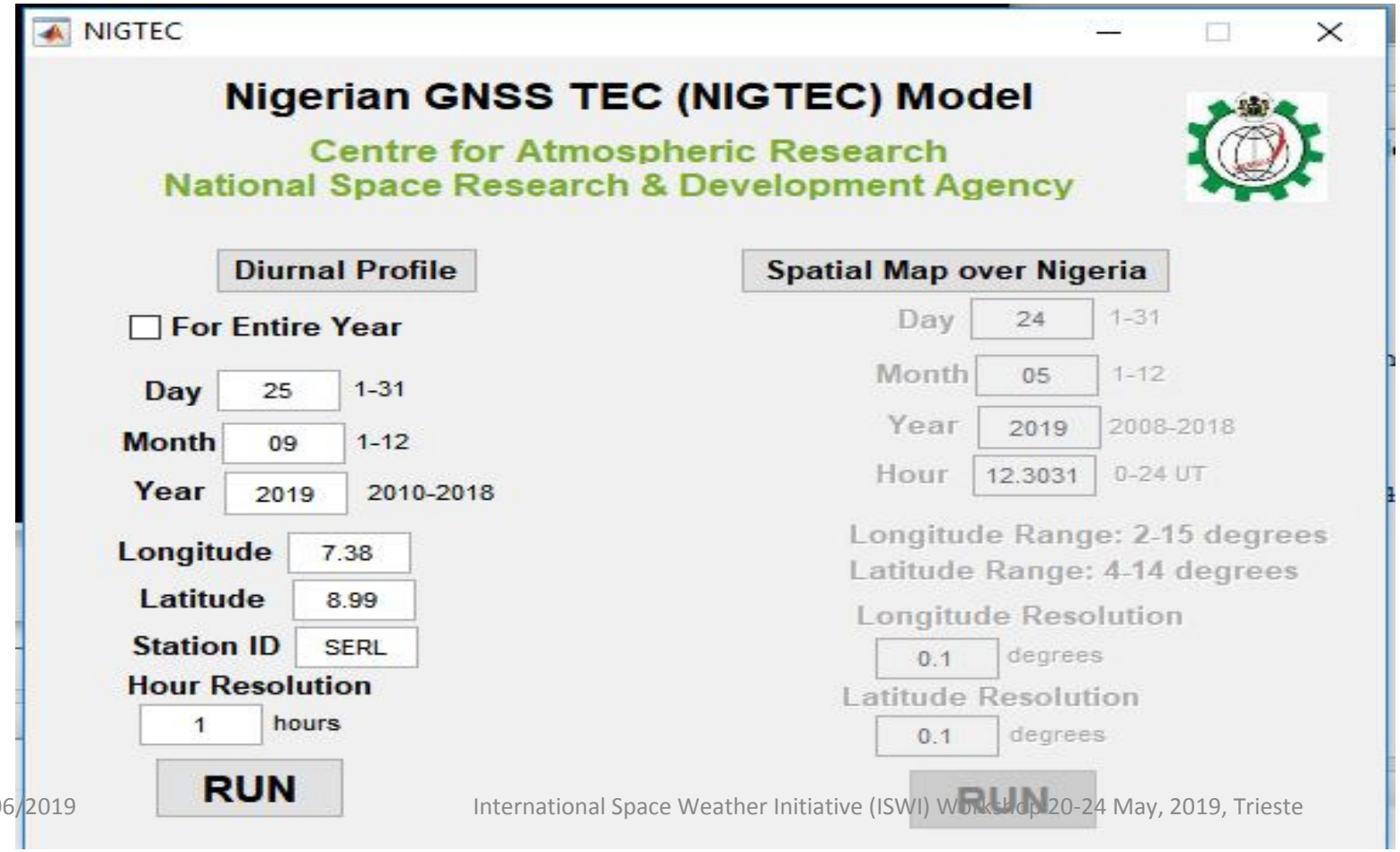
Download Data

Show all

The Model

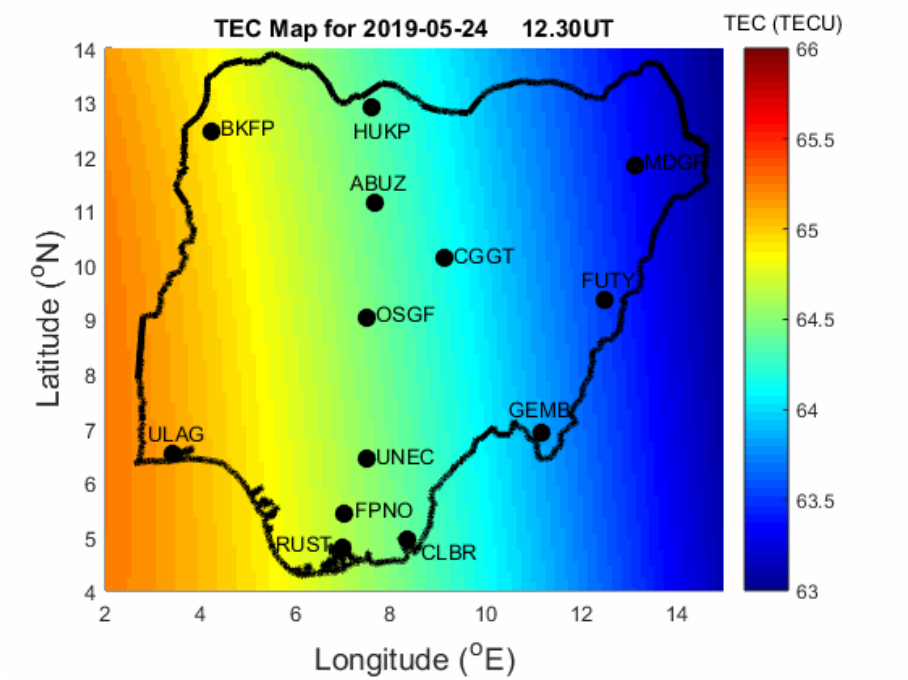
https://carnasrda.com/

Generating the daily maps, videos and the diurnal plots

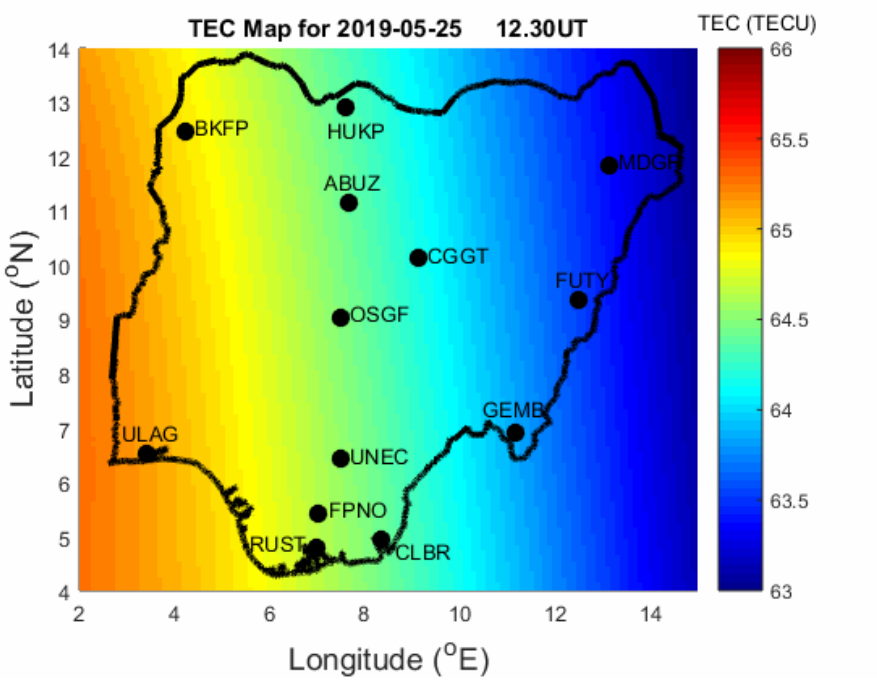


TEC FORECAST OVER NIGERIA
Daily Spatial Map

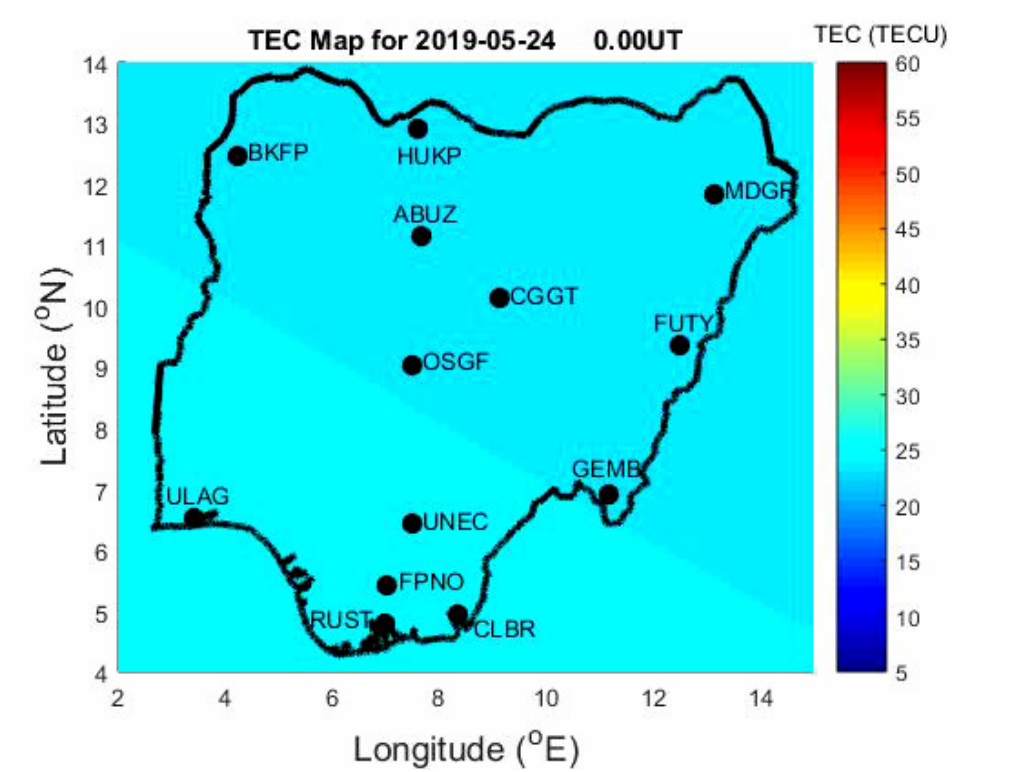
24/05/2019

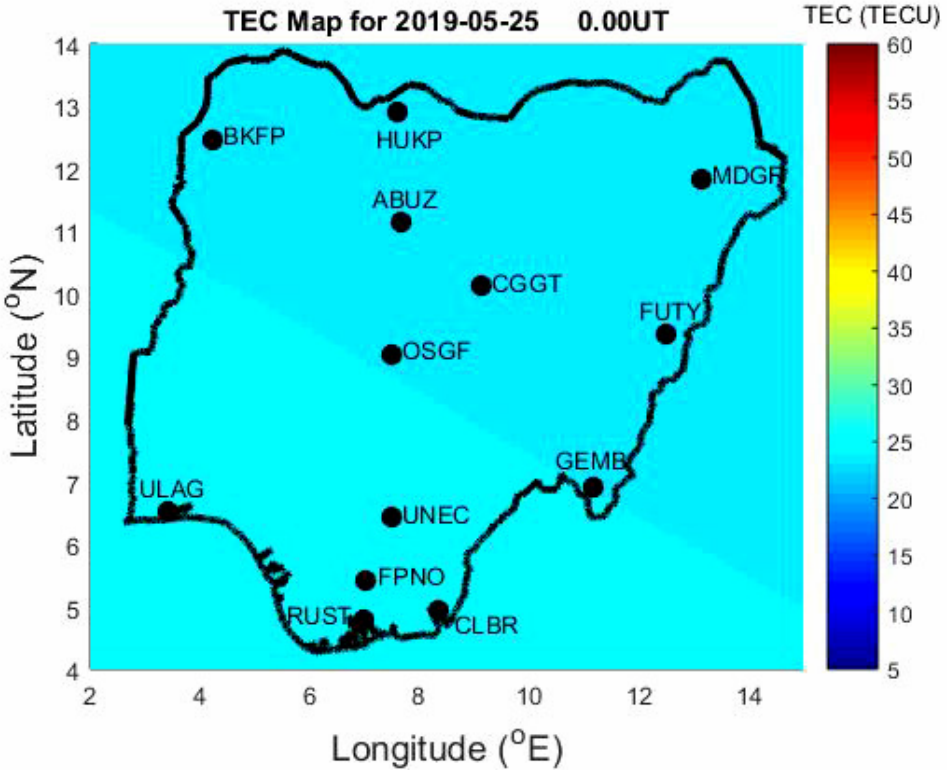


25/05/2019

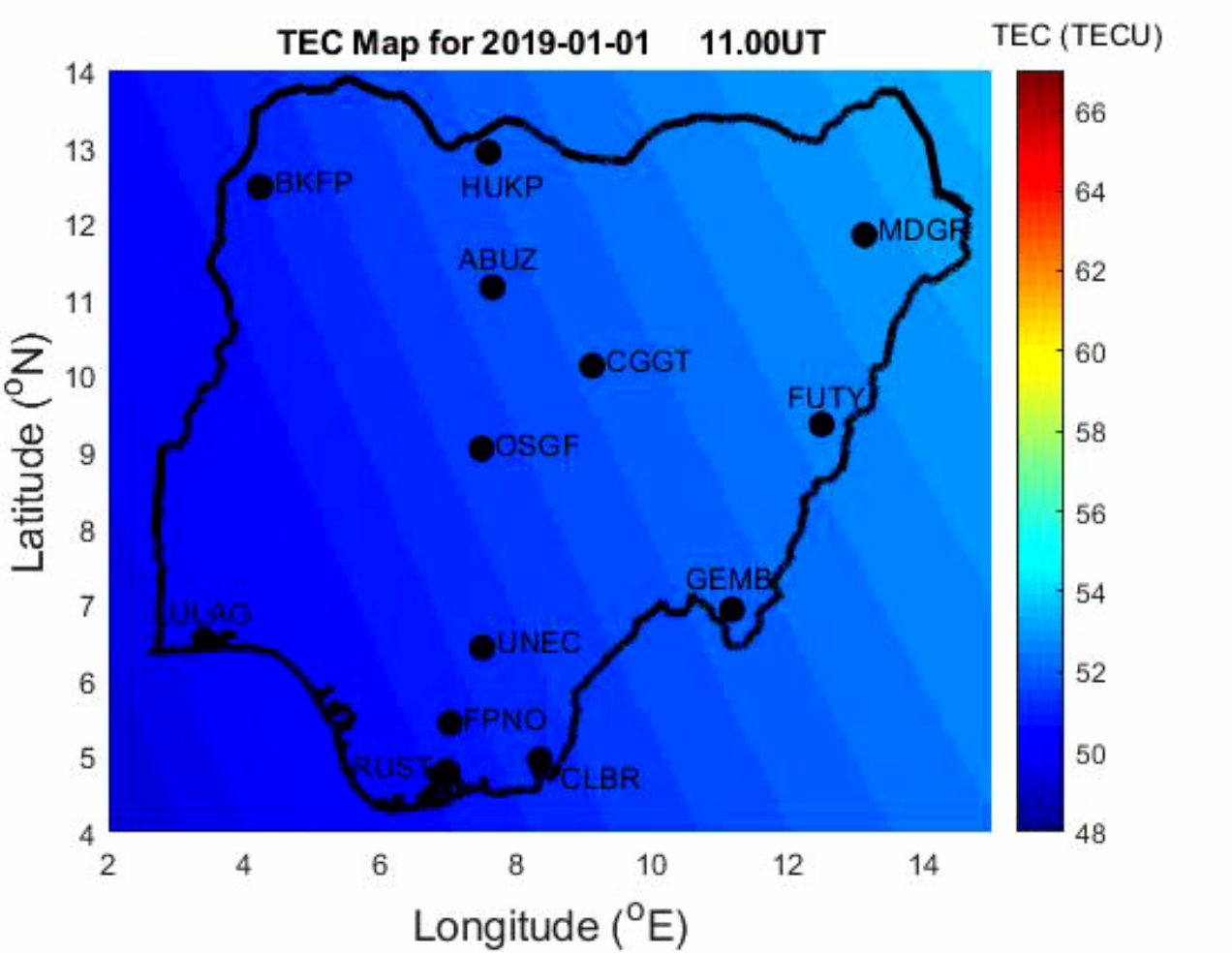


TEC FORECAST OVER NIGERIA
Daily Spatial Map Video





Seasonal Variation of TEC



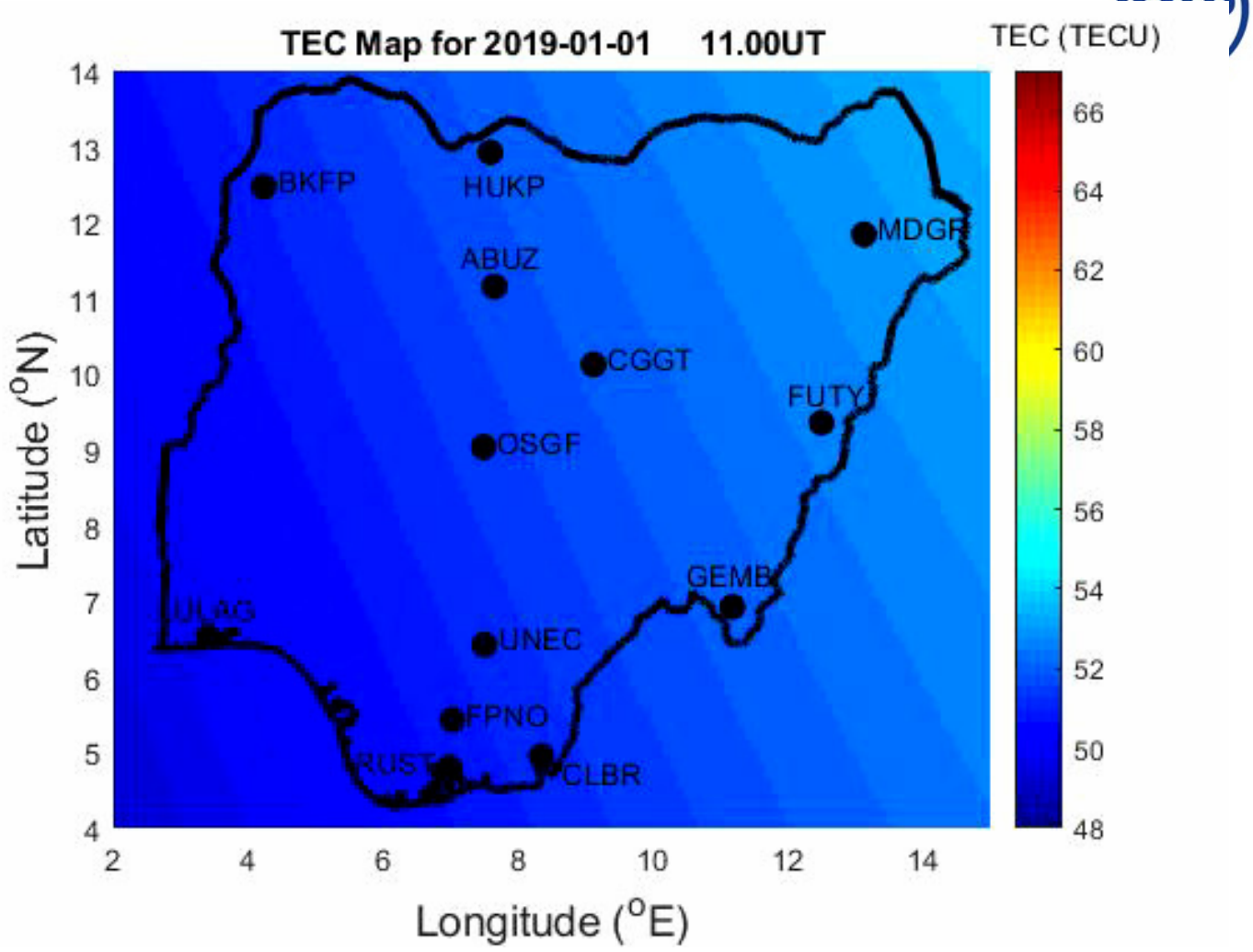
Conclusion

- A daily forecasts in form of TEC maps and movies
- Daily nowcasting of space weather parameters
- Available at www.carnasrda.com

Conclusion Contd.

- .....So far the platform has served as a catalyst to national participation in GNSS/Space Weather research
- It has also promoted both local and international involvement in research capacity the understanding of global Ionosphere/Space Weather and its monitoring.

Thank you fo Listening



After (Rolando, 2015)

Acknowledgements

- National Space Research And Development Agency/Centre For Atmospheric Research
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- ICTP
- **NOAA WDC.**