



Alcantara Initiative

**Total Electron Content Characterization Study  
over Africa and Application to BIOMASS mission  
(TECA)**

**Executive Summary**

Authors: **S.M. Radicella<sup>1</sup>, B. Nava<sup>1</sup>, Y.O. Migoya-Orue<sup>1</sup>, A. Kashcheyev<sup>1</sup>, B. Rabiu<sup>2</sup>, O. Obrou<sup>3</sup> and E. Oladipo Abe<sup>4</sup>**

Affiliation: <sup>1</sup> ICTP-T/ICT4D, <sup>2</sup> National Space Research and Development Agency, Abuja, Nigeria, <sup>3</sup> Physic Department, University of Cocody, <sup>4</sup> Department of Physics, Federal University Oye-Ekiti, Oye-Ekiti, Ekiti State, Nigeria

Date: December, 2017

**Contacts:**

Prof. Sandro M. Radicella  
Telecommunications/ ICT for Development (ICTP)  
Tel: +390402240331  
e-mail: [rsandro@ictp.it](mailto:rsandro@ictp.it)

Dr. Nicolas Flory  
ESA Technical Responsible  
Tel: +31 71 53581  
Fax: +31 71 54999  
e-mail: [Nicolas.flory@esa.int](mailto:Nicolas.flory@esa.int)

**Alcantara Study Reference No.: 15/P15  
Study Type: Pilot  
Contract Number: 4000117288/16/F/MOS**

This contract was carried out within ESA's General Studies Programme and funded by the European Space Agency. The view expressed herein can in no way be taken to reflect the official opinion of the European Space Agency.

## Picture:

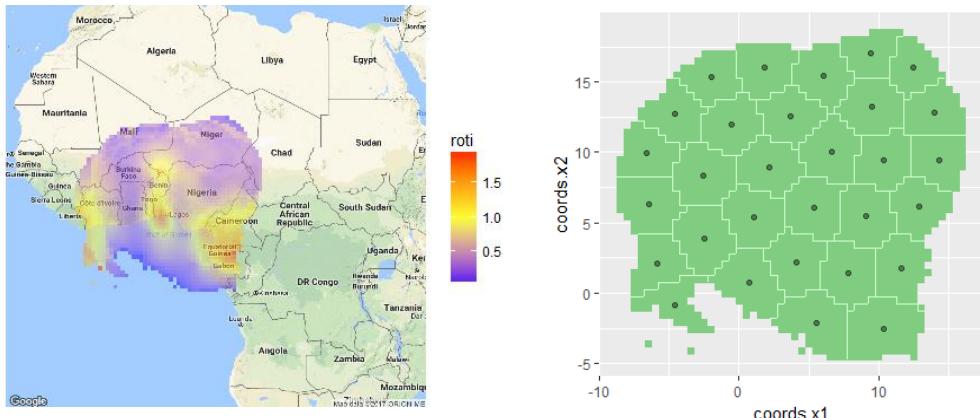


Figure 1. ROTI map projected for one epoch (doy 275, 2013 at 20.20 UT, left) and example of spatial coverage sampling of the region (right).

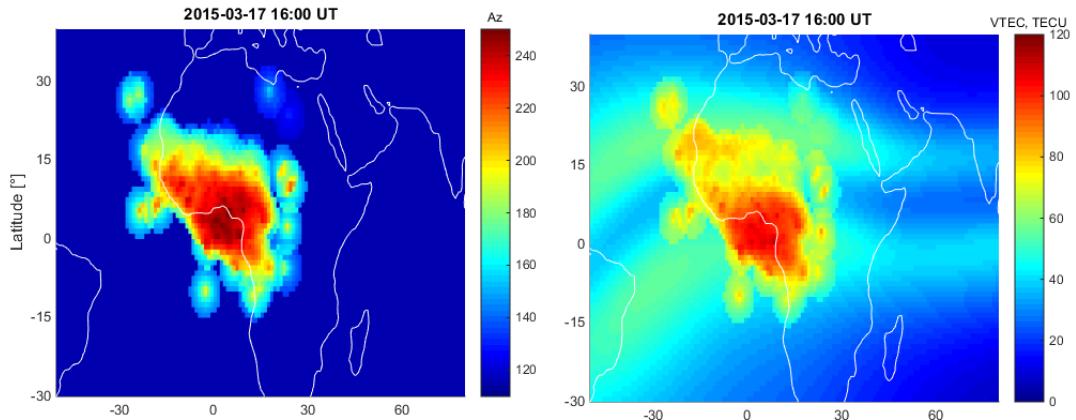


Figure 2. Az grids obtained as a result of data ingestion procedure (left) and VTEC maps computed using these grids as input (right) with 8 ground station receivers.

## Motivation:

To investigate a feasible regional TEC temporal fluctuations product derived from ground-based monitoring stations Western Sub Saharan African region.

To assess how the existing ionospheric monitoring capabilities in that region can satisfy related requirements, for a selected science application and for Biomass external calibration.

## Methodology

Considering that TEC rate of change (ROT) is a useful parameter to describe time-fluctuations of the ionosphere electron density, a regional index based on ROT to characterize and monitor the occurrence of irregularities in Sub-Saharan Africa has been proposed in the present Pilot Study. The more efficient way to process the data from available stations has been investigated in order to map

spatial and temporal structures of the ionospheric irregularities in the region considered.

An assessment of the performance of a model-based data ingestion technique in retrieving VTEC has been performed. The technique accuracy as a function of the number and space distribution of GNSS stations used for data-ingestion procedure has been estimated.

An evaluation of the performance of different ground-based GNSS derived TEC calibration techniques has been performed for selected locations and given solar and geophysical conditions.

## Results

1. As a regional indicator of the presence of ionospheric irregularities, a spatial mean based on ROTI, together with a series of locations and ROTI values of clusters in the mapped area is proposed. The size of the clusters could also be reported as part of the indicator. Regarding the spatial mean, the relevant threshold should be determined. The product mentioned could be generated in near-real time every 15-20 minutes, taking into account the availability of the stations, time to compute ROTI (every 5 minutes) and computational processing. A Demonstration Project could be carried out in Nigeria.
2. The selected data ingestion technique can be considered sufficiently accurate for ionospheric studies and related applications. The accuracy of the selected data ingestion technique in reconstructing VTEC depends on the number and distribution of the ground-based GNSS stations
3. The selected calibration techniques are sufficiently accurate and can be used for ionospheric studies and related applications. The performance of the selected calibration techniques differ depending on the location of the station. However, in general all of them perform with the same level of accuracy.

## Publications

The following papers are in preparation for submission:

- O. E. Abe, Y. O. Migoya-Orué, S. M. Radicella, B. Nava, A., A. Kashcheyev and B. Rabiu, O. K. Obrou, *The significance of interrelationship between ROTI and ionospheric amplitude scintillation as observed over the stations within EIA African sector.*
- Y. O. Migoya-Orué, O. E. Abe, S. M. Radicella, B. Nava, A. B. Rabiu, O. K. Obrou, A. Kashcheyev. *Regional indicator to monitor ionospheric irregularities within West African EIA sector based on ROTI.*

**¡Error! Nombre desconocido de propiedad de documento.**

## **Highlights**

A spatial mean based on ROTI, together with a series of locations and ROTI values of clusters in the mapped area is proposed as a near real-time regional indicator of ionospheric irregularities. The product mentioned could be generated in near-real time every 15-20 minutes; taking into account the availability of the stations, time to compute ROTI (every 5 minutes) and computational processing. A Demonstration Project could be carried out in Nigeria based on this scheme.