An updated vision of availability of TEC GNSS derived ground observations in Africa

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ABSTRACT

This paper presented a chronological evolution of GNSS ground infrastructure, capable of monitoring space weather over Africa. Ionospheric data gap is getting closed down in Africa with numerous interventions that have led to the densification of GNSS infrastructure over Africa. Contributions of programs such as International Heliophysical Year IHY, International Space Weather Initiative ISWI, International Center for Theoretical Physics-Boston college GNSS ICTP-BC program, African Array and African Reference Frames AFREF are presented. Analysis of TEC derived from ground based GNSS observations offered corrective contributions to existing models. The paper highlighted the ongoing effort at stimulating National governments participation in densification of GNSS ground infrastructure capable of improving availability of GNSS derived TEC. National programs such as NigNET, SWONON, Ghana LAP, South African TRIGNET etc are discussed. The need for continuous deployment of ground based GNSS infrastructure is emphasized.

Key words: TEC, Ionosphere, GNSS, Africa. (Up to six)

The United Nations – endorsed programs tagged International heliophysical Year IHY (2004-2009) and International Space Weather Initiative ISWI (2009 – date) combined with some other initiatives to expose the data gaps in ionospheric measurements in Africa [1,2]. These programs facilitated deployment of GNSS receivers from which TEC could be estimated to Africa from interested donor groups. Other programs running concurrently with IHY/ISWI include *African Reference Frames AFREF, National Reference Frames, International GNSS Service* IGS, AfricaArray, International Center for Theoretical Physics and Boston College ICTP-BC joint GNSS program among others. These programs have led to tremendous increase in the number of GNSS data points available for TEC derivation for ionospheric studies.

Furthermore, national participation in densification of GNSS infrastructure is yielding positive result as some African nations already established national networks of CORS, although for mapping purposes, but usable for space weather studies. Figure 1 show the

spatial variation of TEC derived from GPS ground observations over Nigeria using data from eleven stations whose coordinates are given in Table 1. Figure 2

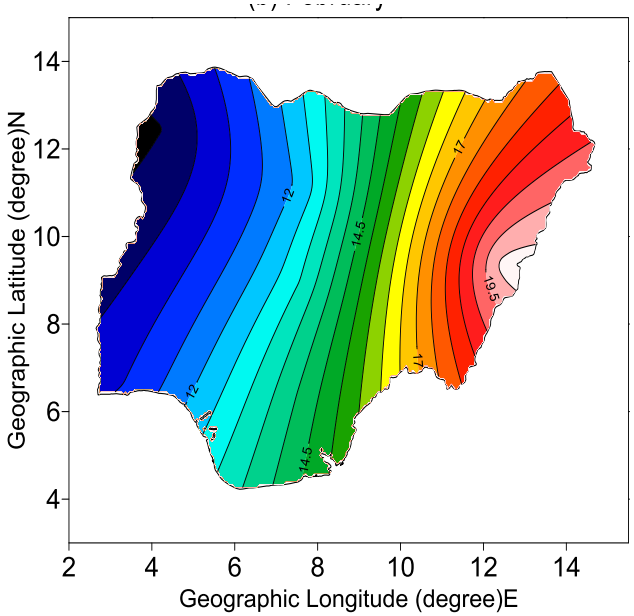

Figure 1. Spatial variation of TEC at 07:00 LT hr over Nigeria using NIGNET data. (*Source: Eyelade, 2014)*

Table 1: The list of stations used and their respective geographical and geomagnetic coordinates

ID	Location	Geo. Lat (°N)	Geo. Lon (°E)	Mag. Lat (°N)	Mag. Lon (°E)
RUST	Port-Harcourt	4.80	6.98	-4.33	78.76
CLBR	Cross-River	4.95	8.35	-4.29	80.09
FPNO	Imo	5.43	7.03	-3.89	78.85
UNEC	Enugu	6.42	7.50	-3.25	79.36
ULAG	Lagos	6.52	3.40	-3.03	75.45
GEMB	Taraba	6.92	11.18	-3.00	82.94
OSGF	FCT	9.03	7.49	-1.51	79.50
FUTY	Yola	9.35	12.50	-1.32	84.31
CGGT	Bauchi	10.12	9.12	-0.96	81.09
ABUZ	Kaduna	11.15	7.65	-0.13	79.75
BKFP	Kebbi	12.47	4.23	0.72	76.62

Geo: Geographical co-ordinate; Mag: Geomagnetic co-ordinate; Lat: Latitude; Lon: Longitude

Simulations of TEC obtained using data derived from ground based observation showed better representation with improving data assimilation as reflected in Figure 3. There is need to ensure appropriate data sharing policy among stakeholders as we densify the GNSS infrastructure over Africa.

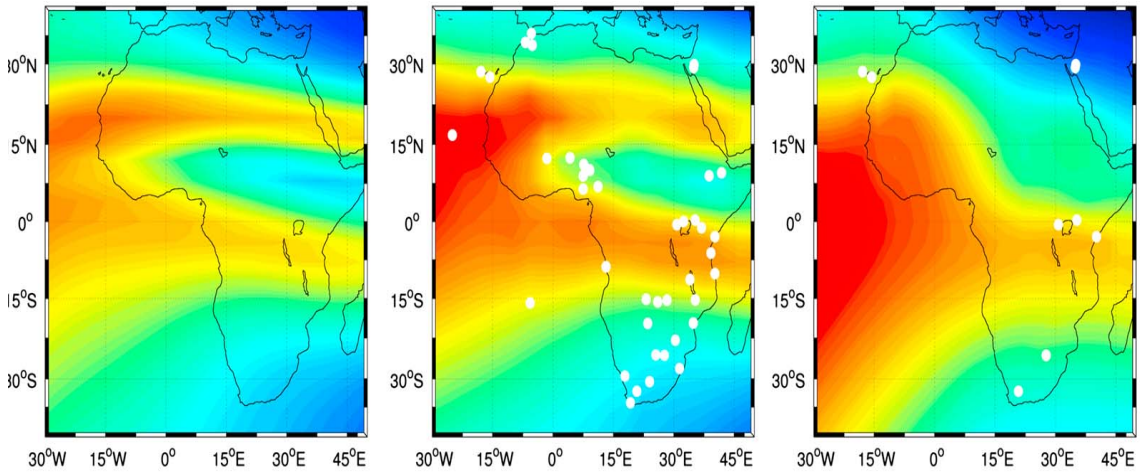

Figure 2. (left) The IRI simulations, (middle) the reconstructions based on all the available data, and (right) the reconstructions based on just the IGS data, at For 17:00 UT on 3 December 2012. The GPS receiver sites used to make each set of reconstructions are shown in white. *(Source: Figure 5b of Chartier et al, (2014); [3])*

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