Evaluation of GIMs of TEC as indicators of ionospheric variability at low latitudes

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ABSTRACT

The effectiveness of the GIM to specify the ionosphere over the African region has been assessed by a series of analysis that takes into account the day-to-day variability seen by the maps and by specific receivers' ground stations.

The African region affected by the EIA, for example, has a highly uneven distribution of locations from where ionospheric data can be obtained and these data are not continuous. The validity of using TEC global maps to study the regional day-to-day variability of the ionosphere was investigated. The day-to-day variability of vertical TEC obtained from GNSS observations from specific receivers' stations was compared with the corresponding data from vertical TEC global maps. A linear correlation analysis and Fast Fourier Transform (FFT) pointed out the presence of the same dominant periodicities of the data series at the daytime maximum value of vertical TEC (13-14 LT) and at the critical post-sunset time (19 LT).

The analysis done put in evidence some features that are common for both, GIMs and individual stations data. No clear differences between the diurnal peak of the median TEC values found over stations under the trough and under the crest of the EIA are seen for low and high solar activity, particularly in the eastern sector. The day-to-day variability is higher for stations under the crest of the EIA than for stations under the trough of it, mainly in equinoctial months and in the western sector of the Sub-Saharan region.

The results justify the use of global maps of vertical TEC to study the day-to-day variability of the ionosphere in terms of vertical TEC, supported by the analysis of station data from selected locations.

Keywords: Total Electron Content – Equatorial Anomaly – GNSS – GIM

Data and Methodology

In this work, TEC is used to study the evolution of the Equatorial Ionospheric Anomaly (EIA) in order to identify the diurnal, day-to-day, monthly, seasonal and solar cycle variation of the ionosphere over the African Sub-Saharan region.

Global Ionospheric Maps (GIM) of vertical TEC (VTEC) generated bihourly by different Analysis Centers for the period 2008 to 2014 is used.

Publically available data from ground-based GNSS receiver stations located within ±20˚ geomagnetic latitude of the African region for the period from 2008 to 2014 is also used.

To estimate the total electron content (TEC) over the region, Ciraolo technique [1] was utilized.

Linear correlation analysis and Fast Fourier Transform (FFT) was used for the daytime maximum value of VTEC (13-14 LT) and for the critical post-sunset time (19 LT).

Results

We found in general a high correlation between the VTEC data of the stations and those derived from the global maps. This result justifies the use of GIMs to study day-to-day variability particularly in regions where data are scarce or present uneven distribution.

An example of the outcomes obtained is shown in Figure 1, which shows clearly that the day-to-day variations of VTEC obtained from the global maps follow well the variations observed in the data of the two stations indicated on them: mal2 (2010).

However, the analysis done with CODE maps, for example, have shown that the VTEC derived from the GIMs presents a systematic but not necessarily constant positive offset with respect to the corresponding data obtained from individual stations.

REFERENCES

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Acknowledgements

The authors of the present study want to acknowledge the IGS Community for making available GNSS data and the IGS Analysis Centers: CODE (Center for Orbit Determination in Europe) and UPC.

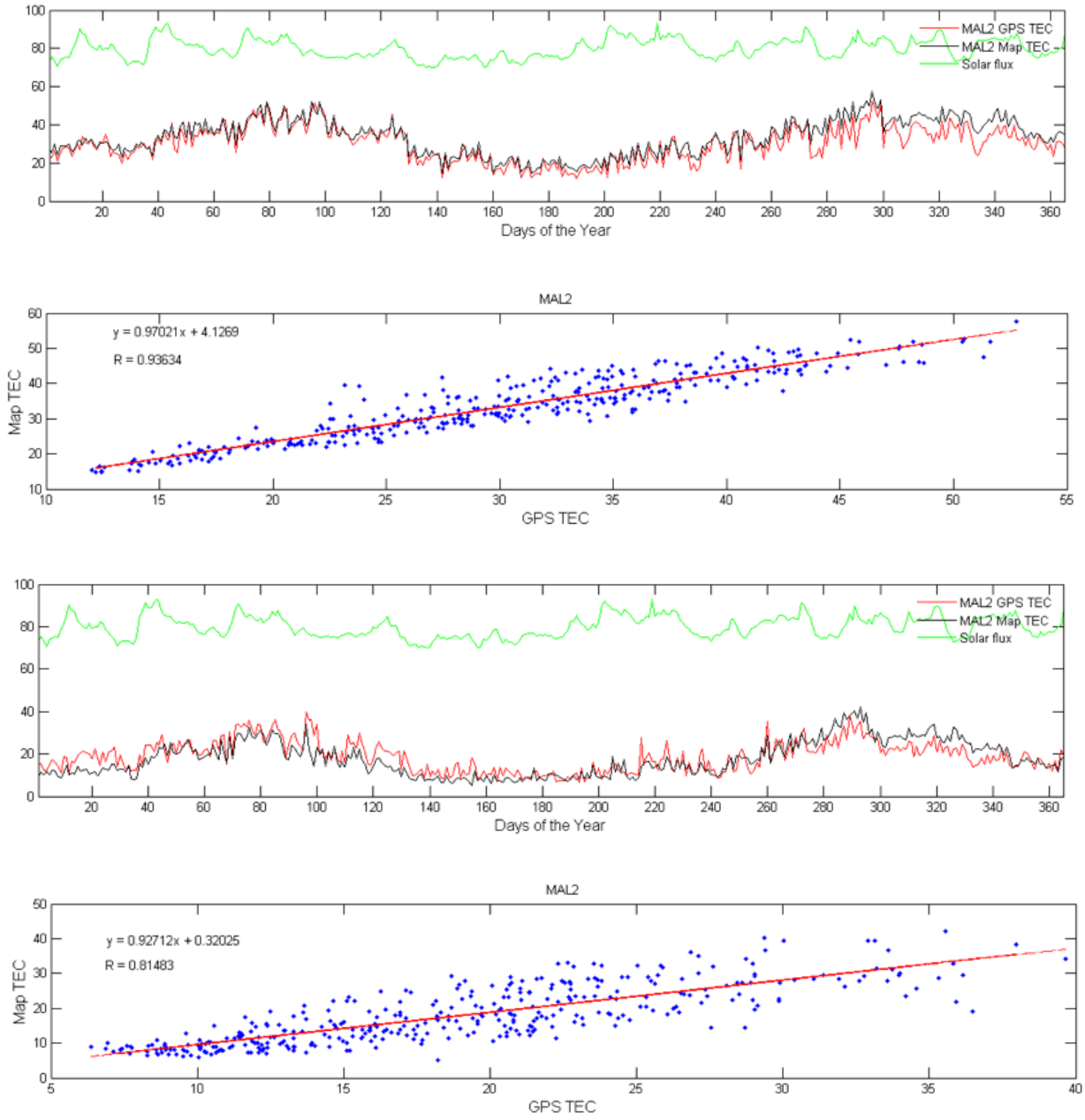

Figure 1: First and third panels: Comparison between GNSS derived TEC estimates for the station mal2 at 13-14 LT and at 19 LT and the equivalent global maps TEC estimates for the full year 2010. The plots show also the progression of the daily values of 10.7 solar flux. Second and fourth panels: regression lines between station and map TEC with correlation coefficients and linear regression equations.