Characterization of Atmospheric Responses during Solar Events from GNSS Measurements in the low Equatorial African Region

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ABSTRACT

The interaction between the upper atmosphere (Ionosphere) and the lower atmosphere (Troposphere) remains poorly explained, and must be clearly understood in explaining regional climate system and predicting climate change. The influence of solar activity and water vapour on atmospheric dynamics and their physical mechanisms is important as well in understanding the climate system. They radio signals transmitted from Global Navigation Satellite Systems (GNSS) satellites experience delays as they propagate through the upper and lower atmosphere. The delays in the radio signals of GNSS enable the estimation of Zenith Tropospheric Delay (ZTD) and Total Electron Content (TEC) in the lower and upper atmosphere, respectively. The variation of ZTD is mainly governed by corresponding variations in atmospheric water vapour. A clear relationship between ZTD and solar activity can thus explain some physical mechanisms of how solar activity influences terrestrial weather/climate changes. In this study attempt is made to quantify and characterise the influence of solar/geomagnetic activities on the upper and lower levels of the atmosphere through GNSS measurement at ten stations(ADIS, BJCO,MAL2,MBAR,MOIU,NKLG,NURK,RCMN,SEY1,YKRO) of the International GNSS service (IGS) in the low equatorial region of Africa for a 2 year period (2013-2014).

Thus, in this paper we present some results of GNSS ZTD and TEC measurement for short term major solar/geomagnetic storms during the years 2013-2014.Two days of data before and after the storm were analyzed together to give a clear signature of the storm(i.e., figures 2 & 3). The temporal variation in the ZTD and TEC estimates were evaluated at diurnal and seasonal scales, this analysis enables the characterisation of the nature of the upper and lower atmosphere in the region of study.

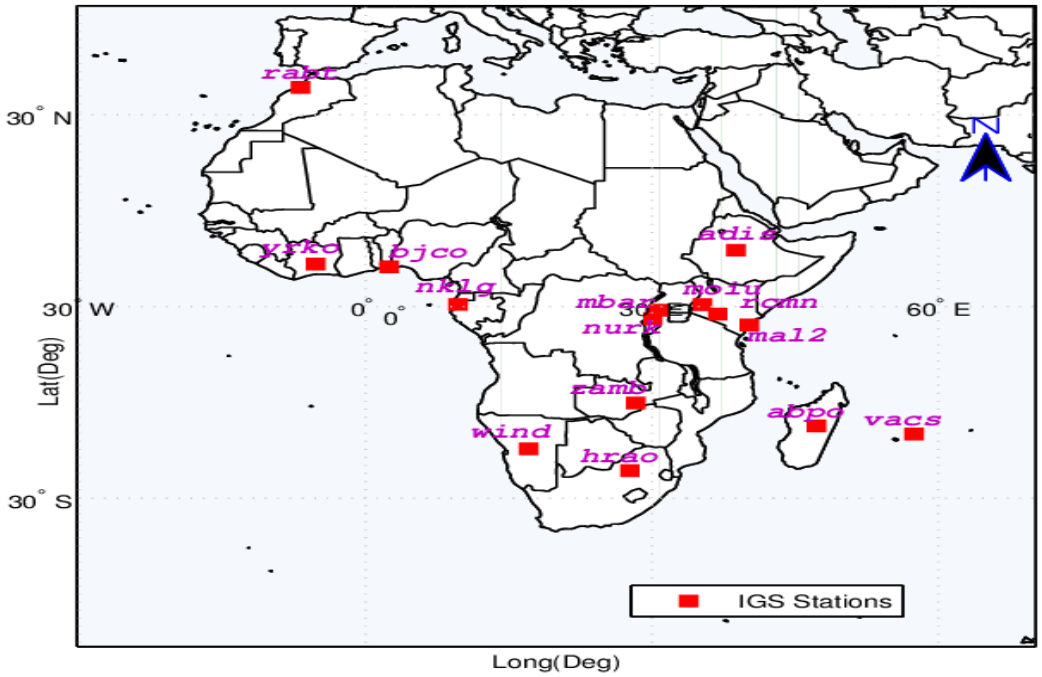

Figure 1: Map depicting the location of IGS stations in Africa

The results demonstrated the fact that the intensity of solar/geomagnetic activities is reflected in the ZTD and TEC measurements at GNSS sites, whereas, the ZTD and TEC estimates show an opposite relationship. The time series for both ZTD and TEC reveals the seasonal dependence of both, and this demonstrates their applicability in operational meteorology and climate analysis.

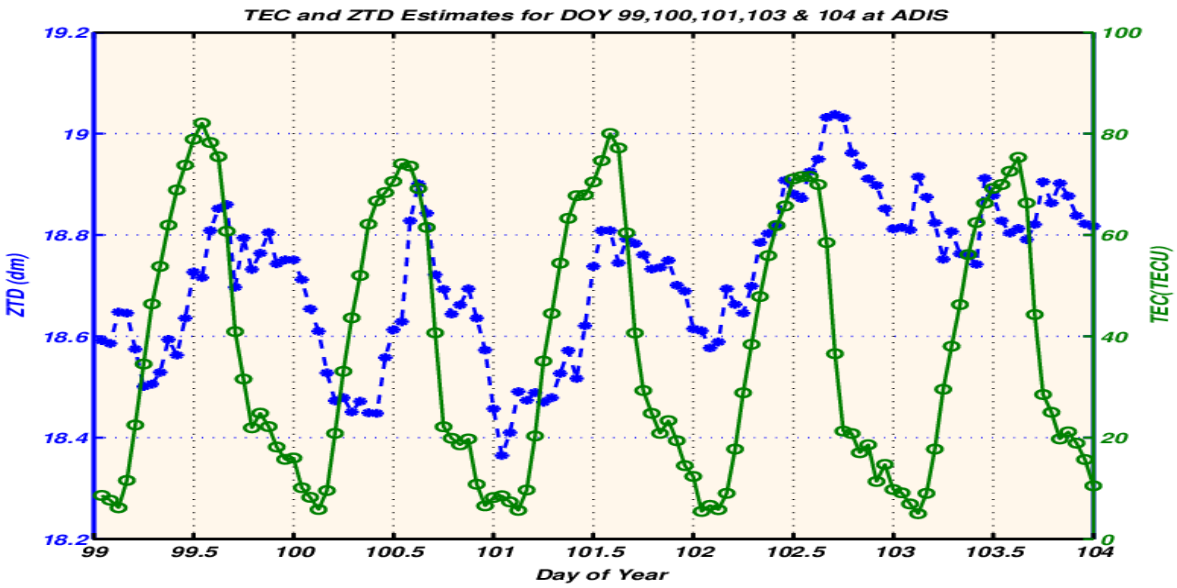

Figure 2: Plot of TEC and ZTD at ADIS for DOY 99, 100, 101, 102 and 103.

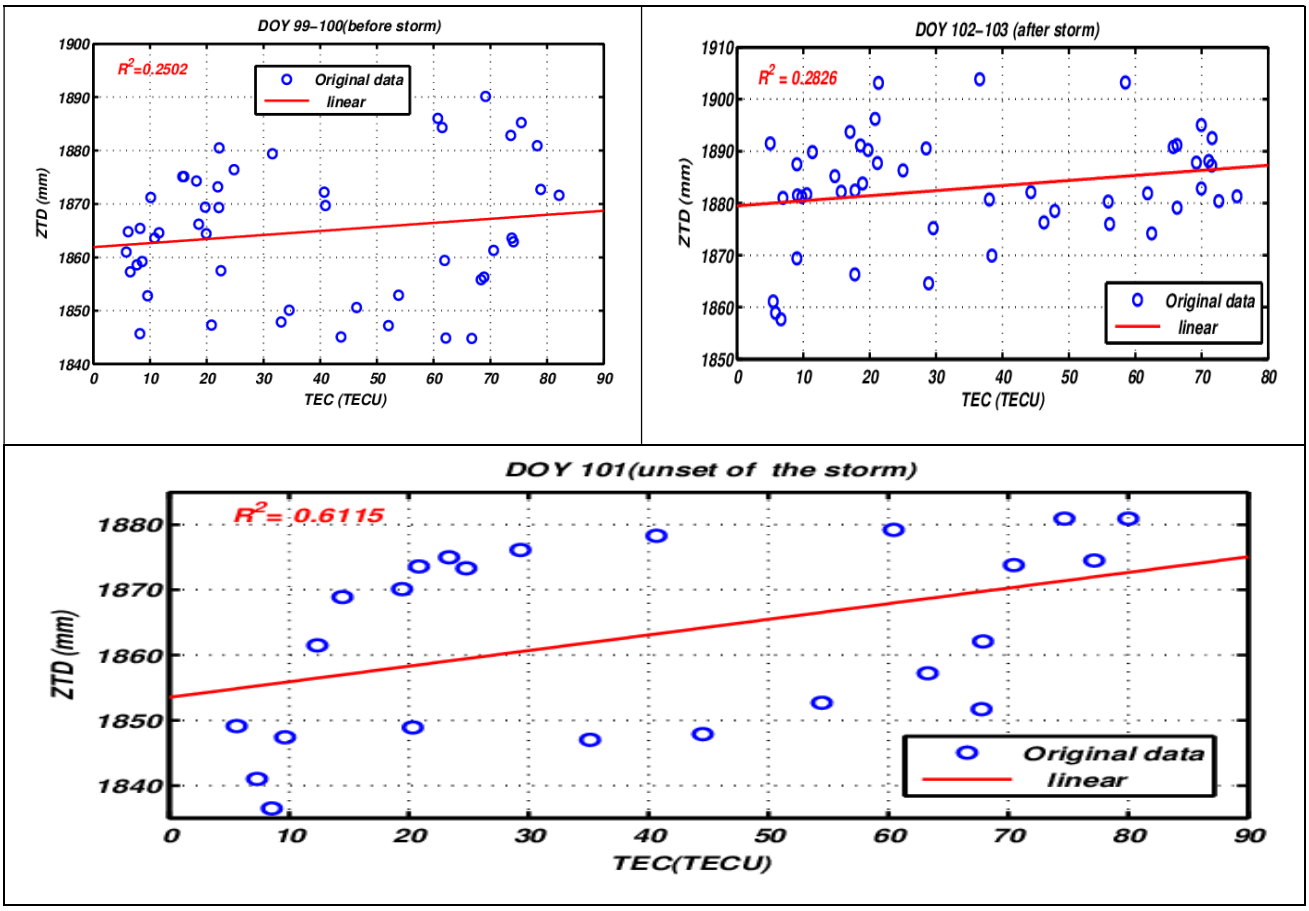

Figure 2: association between ZTD and PWV variations at ADIS for April 11, 2013 Geomagnetic storm before, during the onset day and after the storm

Keywords: *Global Navigation Satellite System (GNSS), Zenith Tropospheric Delay (ZTD), Total Electron Content (TEC), Water vapour, Climate change*