Characterization of Ionospheric Total Electron Content on radio frequency in Ghana equatorial region under the SKA project site

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Abstract

Introduction: It has been realized that signals of the radio telescope at Kutunse, Ghana under the Square Kilometer Array systems (SKA) project, can be affected by natural processes occurring on the sun and in the space environment around earth. This paper reports a research on space weather events that can affect the radio signals of the radio telescope in Ghana. Consequently, the study of the characteristics of total electron content (TEC) in the ionosphere over the equatorial region of Ghana. The TEC characteristics is significant in determining the scintillation and phase delays of a radio wave through a medium. Ionospheric TEC will be characterized by observing carrier phase delays of received radio signals transmitted from satellites located above the ionosphere using Global Positioning System satellites. Further study on how the solar activities affect the TEC in the ionosphere over Ghana equatorial region is reported.

Method: The vertical TEC (VTEC) is determined by the integration of the electron density perpendicular to the ground standing route, and the slant TEC (STEC) is obtained by integrating over any straight path. Data was obtained from the international reference ionosphere model IRI-2012 parameters[1].

Results: The electron density was studied between altitude 60 to 155 km over Ghana (latitude 5N and longitude 0) for the 2010 peak of winter season (January) and the peak of the summer season (July) at 12midnight.

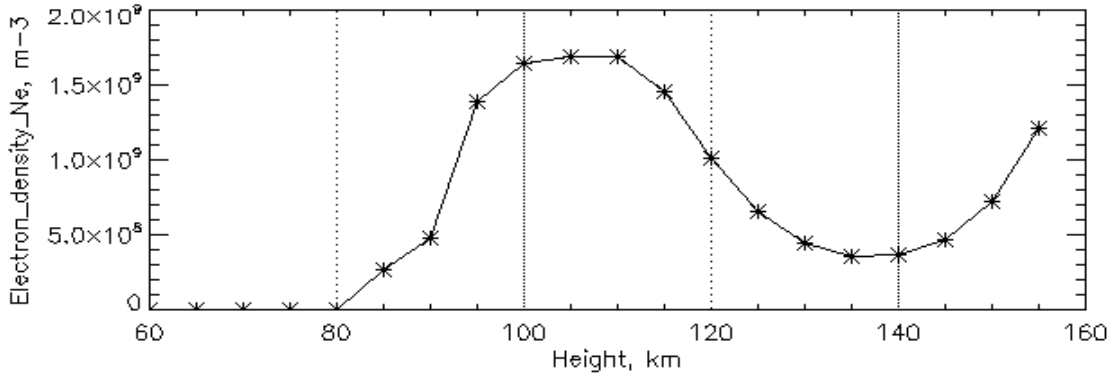

Figure 1: Electron density profile over latitude 5N and longitude 0 up to 155km altitude on 1st January 2010 at 12 o'clock midnight local time.

On 1st January 2010 (Figure 1) the electron density increases from latitude 80km, peaks at 100km to 110km and decreases from 115km until 140km. The highest value recorded was $1.7x10^{9}m^{-3}$ and the lowest after 100km altitude was $4x10^{8}m^{-3}$. On 1st July 2010 (Figure 2), a similar pattern is observed but the highest peak is $1.8\ x10^{9}m^{-3}$ and the lowest after 100km remains the same.

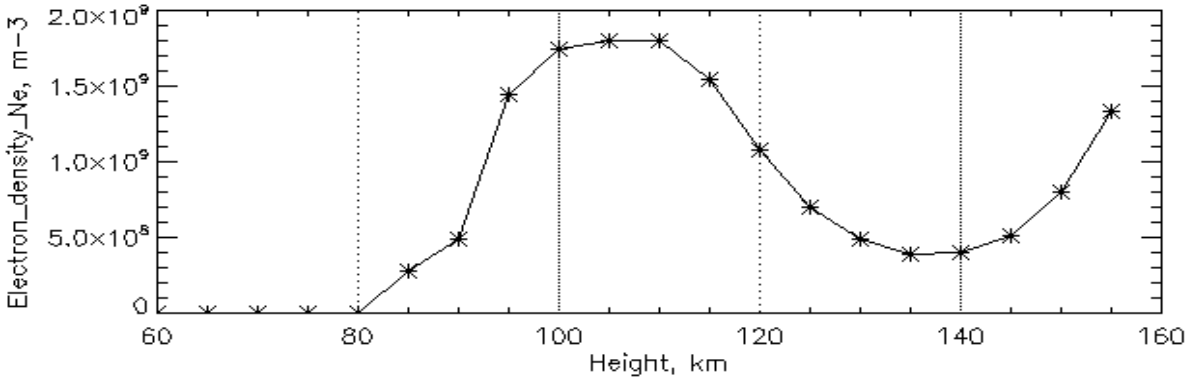

Figure 2: Electron density profile over latitude 5N and longitude 0 up to 155km altitude on 1st July 2010 at 12 o'clock midnight local time.

Discussion and Conclusion: The ionospheric radio effect is also proportional to TEC and inversely proportional to the radio frequency at the study site. However, the equatorial spread F pose challenging problems to our understanding of the ambient ionosphere–thermosphere interactive processes and the electrodynamics that are basically responsible for their development. Further studies will investigate the characteristics of the electron density and probability of equatorial spread F.

Reference

[1] D. Bilitza, B. Reinisch, and J. Lastovicka, Progress in Observation-Based Ionospheric Modeling: Space Weather, 6, S02002, doi:10.1029/2007SW000359, 2008

Keywords: Total Electron Content, Ghana, Kuntunse, Radio Frequency, Ionosphere