**Variability of quiet time ionopheric irregularities over the crests and trough of the African Equatorial Ionization Anomaly (EIA) region**


## Abstract

The performance of Global Navigation Satellite System (GNSS) can be significantly degraded with hazardous consequences during space weather conditions associated with ionospheric irregularities. The effect is pronounced over the least studied African Equatorial Ionization Anomaly (EIA) region. Hence, adequate information about the actual state of the ionosphere is crucial for robust and reliable GNSS technologies, with potential applications in radar detection, air, land and sea navigation in Africa. This work thus, studied the variability of ionospheric irregularities over the African EIA during quiet period ($Kp \leq 3$) of year 2013. Total Electron Content (TEC) data obtained from 23 GNSS receivers located within $20.81^{o}$ E – $46.40^{o}$ E with latitudinal coverage of $30^{o}$ S – $30^{o}$ N have been used to reconstuct the EIA during post sunset. The rate of change of TEC index (ROTI) was computed and utilized to monitor ionospheric irregularities which were further quantified in terms of percentage irregularities occurrences over the crests and trough of the EIA. The anomaly strength and its asymmetry were estimated while their correspondence with irregularities occurrences was examined. Additionally, ΔH, the difference between the horizontal component of the Earth's magnetic field (H) measured by a pair of magnetometers, one located at the magnetic equator and the other away from it was computed. ΔH which is a good proxy of the equatorial electrojet (EEJ) was compared with values of the day-time equatorial electric field (EEF) predicted by the real time equatorial electric field model (EEFM). Correlation coefficient of 0.73 was obtained between ΔH and EEF hence, validating the model over Africa. Also, the time of occurrence of the pre-reversal enhancement (PRE) predicted by the EEFM varied within 19:00 – 20:00 LT while irregularities occurred from 19:30 to 22:00 LT with a time difference of 1 hour between the northern and southern crests. The activity lasted till about 03:00 LT but was protuberant during post noon to pre-midnight period. Monthly, April had the highest percentage irregularities occurrences of 91.67 %, 68.96 % and 88.89 % for the northern crest (NC), trough and southern crest (SC), respectively. This was followed by October (83.33 % for SC and 57.14 % for the trough), then September (77.67.3% for NC). Seasonally, equinox recorded the highest irregularities occurrences. This was consistent with concomitant highest seasonal values of PRE as well as the strongest anomaly. Irregularities occurrences were higher in summer than in winter irrespective

of the relatively higher PRE values and stronger anomaly registered in winter. Interestingly, the asymmetry of the anomaly was also stronger in this season suggesting that winds must have been responsible for the suppression of irregularities. These meridional winds were additionally responsible for the poleward expansion of the crests during winter. Generally, irregularities occurrences exhibited a north-south asymmetry (NSA) with SC having more occurrences than NC in equinoxes/summer, and the reverse being the case in winter. This NSA in irregularities depended on the location of the magnetic equator in the northern hemisphere over Africa.