CHARACTERIZATION OF IONOSPHERIC DYNAMICS OVER THE EAST AFRICAN DIP EQUATORIAL REGION USING GPS-DERIVED TOTAL ELECTRON CONTENT

OLWENDO, JOSEPH OUKO

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Abstract

The structure of electron density in the ionosphere and ionospheric irregularities can be monitored using Global Position System (GPS) in near real time. Compared to other observation techniques, GPS satellites offers a wide coverage and with a single receiver located anywhere on earth, one can monitor between six to twelve satellite links simultaneously. Through a linear combination of GPS satellite range and phase measurement observed on two carrier frequencies by terrestrial based GPS receivers, the ionospheric total electron content (TEC) along oblique GPS signal path may be quantified. This work presents characterization of ionospheric behavior at different solar cycles using GPS derived TEC over dip equatorial region on the East African Sector. Using Adjusted Spherical Harmonic (ASHA) expansion of TEC observation from a network of IGS receivers, TEC mapping over the East Africa sector has been achieved. Ionospheric irregularities have been measured and the plasma drift velocity and the East-West extent of the irregularities have also been analyzed by using a Very High Frequency (VHF) receiver system. The observed TEC has been used as a basis for validation of IRI2007 model prediction of TEC over the Kenyan region. The ionosphere shows pronounced seasonal variations with the seasonal trend in diurnal TEC consistently having the largest diurnal peaks in daytime TEC during the equinoxes and the lowest peaks during the June solstice. The annual variation in daily TEC is characterized by biannual maxima appearing in March/April and September/October and biannual minima appearing in December/January and June/July. The hourly TEC images developed have shown that the Southern Equatorial Ionization Anomaly (EIA) crest lies within the Kenyan region, and the occurrence of scintillation is dependent on how well the anomaly crest forms; and scintillation occurs at and around the EIA crest. The presence of high ambient electron densities and sharp TEC depletions which are associated to ionospheric irregularities at the edges of anomaly crest are linked to the occurrence of scintillation. Scintillations at L-band is maximum during the post-sunset hours and are found to be higher in equinoxes and very low in solstice during the period of study. While scintillation occurrence as well as the intensity is strongly dependent on the sunspot number, it is however evident that the seasonal dependence is more dominant than that of the sunspot number dependency. Simultaneous recording of amplitude scintillations at VHF and L-band frequencies reveal two distinct types of scintillation namely; the Plasma Bubble Induced (PBI) and the Bottom Side Sinusoidal (BSS). The PBI scintillations are characterized by high intensity during the post-sunset hours of the equinoctial months and appear at both VHF and L-band frequencies. The BSS type are associated with VHF scintillation and are characterized by long duration patches and often exhibit Fresnel oscillation on the roll portion of the power spectrum, which suggest a weak scattering from thin screen irregularities. The zonal plasma drift velocities of the ionospheric irregularities lie between 50-130 ms-1 during post-sunset hours and their east-west
extent (size) vary between 100 and 500 km in the majority of the cases.