Low latitude ionospheric scintillation climatology around the equatorial anomaly crest over Kenya and its contribution to errors in GPS.

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ABSTRACT

In this study we have used a VHF and GPS-SCINDA receiver located at Nairobi (36.8^{o}E, 1.3^{o}S, dip -24.1^{o}) in Kenya to investigate the climatology of ionospheric L-band scintillation occurrences for the period 2009 to 2012; and seasonal variation of the zonal plasma drift irregularities derived from a VHF receiver for the period 2011. The annual and diurnal variations of L-band scintillation indicate occurrence at post sunset hours and peaks in the equinoctial months. However VHF scintillation occurs at all seasons around the year and is characterized by longer duration of activity and a slow fading that continues till early morning hours unlike in the L-band where they cease after midnight hours. A directional analysis has shown that the spatial distribution of scintillation events is mainly on the Southern and Western part of the sky over Nairobi station closer to the edges of the crest of the Equatorial Ionization Anomaly. The distribution of zonal drift velocities of the VHF related scintillation structures indicates that they move at velocities in the range of 20 to 160 m/s and their dimension in the East-West direction is in the range of 100 to 900 km. The December solstice is associated with the largest plasma bubbles in the range of 600 to 900 km. The contribution of scintillation events to positioning errors is evident during intense scintillation; an issue which remains a great challenge to precise positioning applications of GPS particularly during nominal times.

The most significant observation from this study is the occurrence of post- midnight scintillation without pre-midnight scintillations during magnetically quiet periods. The mechanism leading to the formation of the plasma density irregularity causing scintillation is believed to be via the Rayleigh Tailor Instability; it is however not clear whether we can also attribute the post-midnight plasma bubbles during magnetic quiet times to the same mechanism. From our observations in this study, we suggest that a more likely cause of the east ward zonal electric fields at post-midnight hours is the coupling of the ionosphere with the lower atmosphere during nighttime. This however needs a further investigation based on relevant data.

Key words: Ionospheric scintillation, zonal drifts velocity, GPS-SCINDA, VHF receiver.

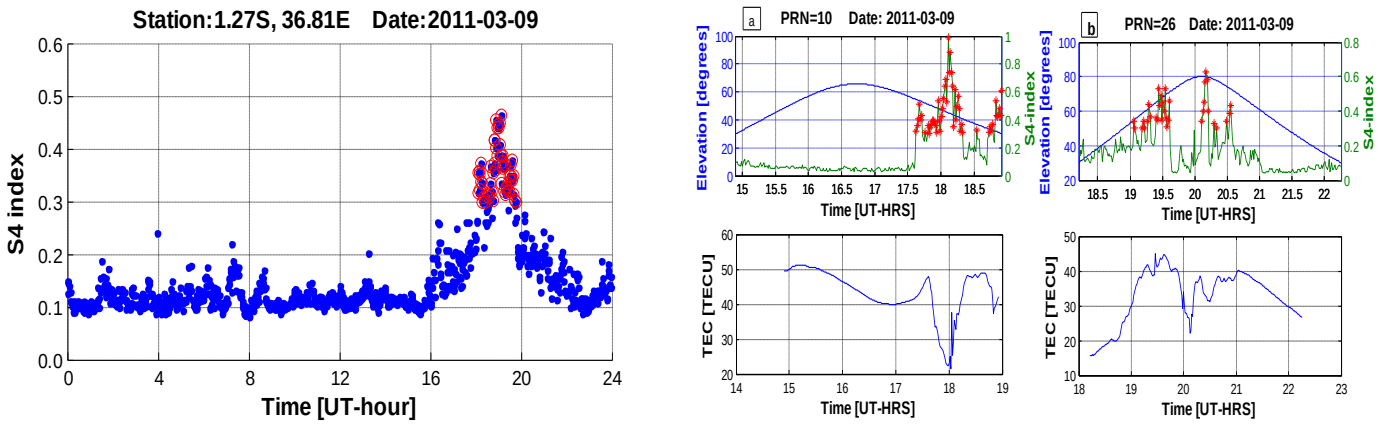

Figure 1: Diurnal variation of scintillation events on 9th March 2011 and the individual PR showing scintillation during the events alongside their total electron contents.

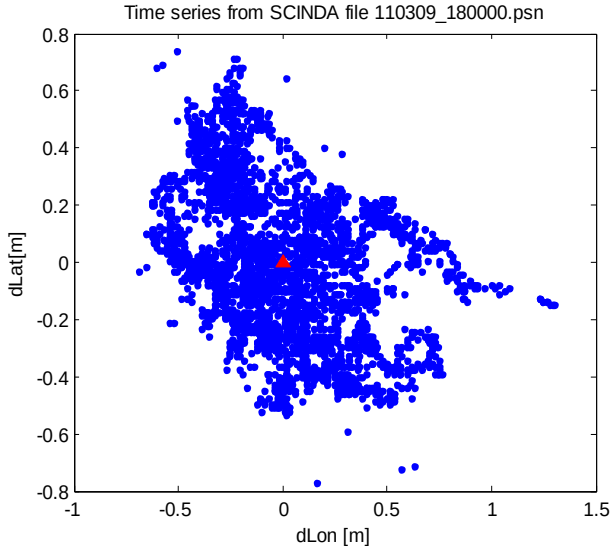

Figure 2: Positioning errors along the latitudes and longitudes at 18:00 during intense scintillation events that is depicted in Figure 1.

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