# Tidal forcing variability on F-region parameters at the equatorial ionosphere

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**Abstract**

The effects of tides on the upper ionosphere in the equatorial region of African continent are relatively less investigated. However, the understanding of the effects of tides on ionospheric characteristics and on low-altitude electrodynamics is fundamental for the formulation of realistic models and for forecasting the low-latitude ionospheric weather.

Geomagnetically quiet daytime ground-based ionosonde data obtained at Ibadan, Nigeria (geographic latitude $7.4^0$N, geographic longitude $3.9^0$E; dip latitude $6^0$S) during the 1957/58 International Geophysical Year (IGY); corresponding to a year of high solar activity has been used for the study. The ionospheric data analyzed are the F-region parameters such as electron density, $N_e$ (obtained from ionogram), critical frequency ( $f_oF_2$), peak height ( $h_mF_2$), virtual height of F-layer ($h'F$), and vertical drift, $V_z$ (derived from ionosonde data using an approximate model). The spectra structures are obtained with Fast Fourier Transform (FFT) for one full year (January-December 1958) and the results are smoothed using the Hamming Window function.

Our results display several peak structures such as flat peak, sharp peak, and double peak. It is found that besides the dominant 36-, 24-, and 12-hour tidal periodicities (in $N_e$, $f_oF_2$, and $h'F$) there is a weaker terdiurnal (8-hour) oscillation present in $f_oF_2$ data. 22-, and 11-hour tidal components are also observed in $h_mF_2$ data. Furthermore, tidal amplitudes above Ibadan are highly variable with a large modulation at a period close to 12-hour. It is also noticed that 12-hour tidal components in $N_e$, $f_oF_2$ and $h'F$ have spread periodicities. There is indication of 2-day wave in $N_e$, $f_oF_2$, and $h'F$. 24-hour tidal wave are found to have comparable amplitude with dominant planetary wave present in the $N_e$. The annual spectrum of the vertical **ExB** drift is additional evidence of 12-hour modulation of tidal waves. The amplitude of dominant tidal component is about 5.5 m/s. While planetary wave with a 2-day period is found in $N_e$, a longer period, 7.5-day oscillations are observed in both $f_oF_2$ and $h'F$ measured from the F-region ionosphere at Ibadan station. The slopes relating the Power Spectral Den-

sity (PSD) to periods of the tidal and planetary waves are estimated to be nearly –0.20, -0.33, -0.43, -0.54, and –1.34 in $N_e$, $h_m F_2$, $h'F$, $f_o F_2$ and $V_z$ respectively; with an average of about 0.38. This result indicates that the vertical drift is a sensitive diagnostic of tidal wave activity in the equatorial F-region ionosphere.

In conclusion, the predominance of the tidal and planetary wave is apparent in F-region parameters, but in addition there is a distinct peak near the 12-hour frequency. Our results therefore suggest that the ionosonde data can be used as an alternative means of studying tidal and planetary wave characteristics and their climatology at thermospheric heights which are not covered by convectional meteor and medium frequency) radar methods. Finally, even though the dataset is rather limited, but our results contain evidence for tidal impact effects upon the daytime quiet ionospheric profiles. Lower atmosphere-thermosphere-ionosphere coupling due to tides are also confirmed. Nonetheless, there is still great need for coordinated campaigns, which attempts to investigate tidal variability simultaneously at various locations around the world.

**Keywords:** Atmosphere-ionosphere coupling; Equatorial F2-region parameters; Tides