Available online at www.scholarsresearchlibrary.com

Scholars Research Library

Archives of Physics Research, 2010: 1 (1) 108-111
(http://scholarsresearchlibrary.com/archive.html)

Height Variation of Drift and Pattern Parameters of Ionospheric Irregularities at Ibadan, Nigeria

E.O. Somoye

Department of Physics, Lagos State University,
Lagos, Nigeria.

Abstract

The drift velocity, ratio of random changes to drift, axial ratio (elongation) and pattern sizes (N-S extent) of ionospheric irregularities are observed to vary with virtual height at the equatorial station of Ibadan (7.4°N, 3.9°E, 6°S dip). The axial ratio and pattern size are found to reach peak values at about 270 km indicating that the N-S extent and the elongation of ionospheric irregularities peak at about the same height at which the electron density peaks. Also of note is the initial decrease of the ratio of random changes to drift in the height range of the electrojet current. The electrojet current has good correlation with drift, suggesting an increase in drift without corresponding increase in random changes of irregularities in this height range.

Keywords: Ionospheric irregularities drift and pattern parameters, ratio of random changes to drift, axial ratio, pattern size.

Introduction

Irregularities, i.e. inhomogeneities in the electron density of the ionosphere are known to cause fading of radio signals even when polarization fades and multipath fading are avoided by careful selection of frequency and a good choice of transmitting and receiving aerials respectively. The irregularities act as a diffracting screen thereby modifying the amplitude and phase of the radio wave [1, 7, 8].

The drift and pattern parameters of ionospheric irregularities e.g. drift velocity, ratio of random changes to drift, axial ratio (elongation) and size (N-S extent) are found to vary with height [6]. At Ibadan (7.4°N, 3.9°E, 6°S dip), only the drift velocity variation with height has been considered by Onolaja [10] who found that the drift velocity obtained during 1975, a low sunspot year, increases with height. In this study variation with height of other parameters including that of drift velocity during IGY i.e. a high sunspot year, not considered by Onolaja [10], is undertaken.

It is the purpose of this study to (i) confirm Onolaja's (10) result for low sunspot period and (ii) to find if his result is true for high sunspot period and (iii) to find if other ionospheric irregularity parameters increase with height.

Experimental set up, data and method of analysis

The "winds"' equipment used to obtain various drift and pattern parameters of ionospheric irregularities at different height is well described by Somoye, 2009 [8]. Fading records whose fading rates are within a modal range, in order to exclude records with extreme fading rates were reduced by the use of Dagma Super A (J.H. Mullens, N.V. Denlaag, Holland) projector which gave a good magnification of the records and with the aid of a plane mirror incorporated, conveniently projected the records on the table placed in front of it. The full correlation method of analysis by Briggs and Phillips [1] as extended by Phillips and Spencer [5] for anisotropic patterns is employed to obtain the drift velocity, V, the ratio of characteristics random changes to pure drift, V_C/V, the elongation or axial ratio, r, and the N-S extent or pattern size, L, of the irregularities.

The variation of each of these parameters with apparent heights corresponding to E-and F-region together is illustrated in Figures 1-4.

Figures

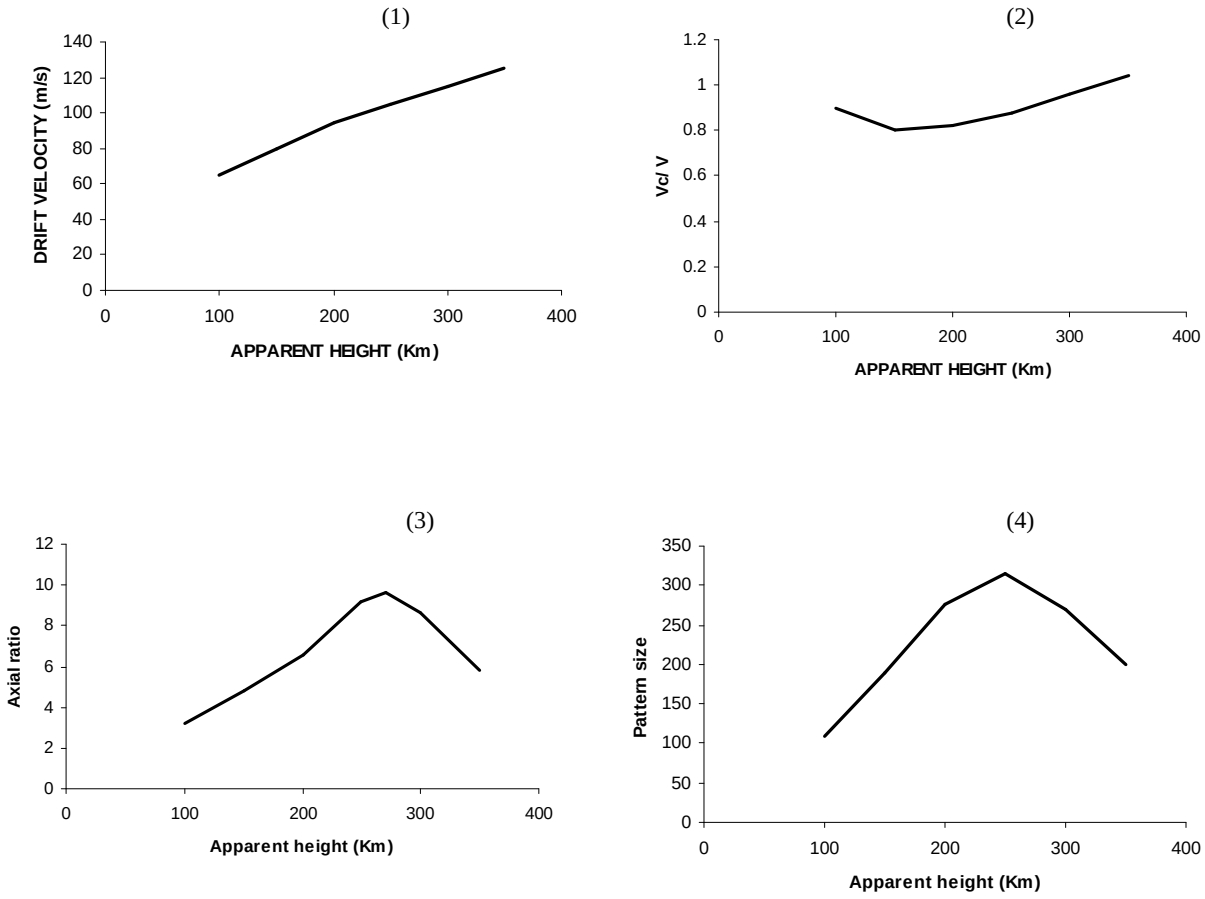

FIGURE (1) Variation of Drift Velocity with E- and F-region apparent heights
(2) Variation of Vc / V with E- and F-region apparent heights
(3) Variation of Axial ratio with E- and F-region apparent heights
(4) Variation of Pattern size with E- and F-region apparent heights

Results

Figure 1 show that drift velocity, V, increases with height within the range of 100 to 350km. This agrees with the result of Onolaja [10] who reported that the drift speed obtained in 1975, increases with apparent height of reflection within the range of 100 to 360km. The increase in drift velocity with height by Rao and Rao [6] at Waltair (dip 9.5˚N) is in the range of 160 to 210 km. A fluctuation is observed by them after 210km. While their initial result agrees with the present result, no fluctuation in the variation of drift velocity with height is observed in the present result.

The ratio of random changes in irregularities to drift velocity, V_C/V, decreases with height till the virtual height of 160km. It then increases afterward. See Figure 2. The initial decrease is in agreement with the observation of Rao and Ramana [6], although the decrease observed by them terminates at 190km. Also, the peak of V_C/V at 270km obtained by them is not observed in the present result.

The axial ratio, r, a measure of the elongation of pattern irregularity in the present result is observed to increase in the height range of 100 to 270km after which it decreased. See Figure 3. Rao and Ramana [6], working at Waltair (dip 9.5˚N), observed a decrease in the elongation of pattern irregularity with height up till 190km. An increase was observed afterwards till a maximum value of 7 was reached at the virtual height of 290km. above this height they found the axial ratio to decrease rapidly.

The pattern size is observed to increase with height reaching a maximum value at about 260km. The curve of variation of pattern size with height (see Figure 4) is similar to that of elongation (Figure 3). The present result for pattern size (N-S extent) could not be compared with other results as there is paucity of data in the variation of pattern size of irregularity with height. Generally, variation of drift and pattern parameters of ionospheric irregularities with height at equatorial and low latitude areas has been studied by a few workers.

Discussion

The variation of drift and pattern parameters of ionospheric irregularities with height at the equatorial station of Ibadan (7.4˚N, 3.9˚E, 6˚S dip) agrees fairly well with that of the low latitude station of Waltair (dip 9.5˚N). At Waltair, all the four parameters i.e. drift velocity, V, ratio of characteristics random changes to drift, V_C/V, axial ratio (elongation), r, and pattern size (N-S extent), L, decreased initially, increased and then decreased gradually or fluctuated. At Ibadan, the initial decrease is only observed in the ratio of random changes to drift. Also, only in the elongation and pattern size is a peak value followed by gradual decrease observed.

That few differences are observed in the results of these parameters at the two stations could be due to the fact that both stations are not too far apart latitudinally. More differences in the results of these parameters at stations separated by great latitudinal difference may be expected.

The initial decrease of V_C/V with height is in the neighbourhood of 100km where the electrojet current flows [3]. This decrease could be as a result of increase in drift, V, with no corresponding increase in characteristic random change,Vc, or decrease in random change,Vc, with no corresponding decrease in drift, V. A good correlation has been reported between equatorial electrojet current and drift of irregularity [2]. Thus the decrease of Vc /V with height in the

height range of the electrojet current at the equatorial station of Ibadan may be due to increase in the drift with no corresponding increase in random changes.

Conclusion

The variation of drift velocity, ratio of random changes to drift, axial ratio (elongation) and pattern size (North-South extent) of ionospheric irregularities at Ibadan with virtual height is studied. While the last two are observed to increase, reach a peak in the height range of 250-270 km, the height range corresponding to that of maximum electron density, the drift velocity is found to increase generally with height. The ratio of random changes in irregularities to drift velocity is found to initially decrease with height reaching a minimum at about 150km before increasing with height. The decrease is in the height range of the electrojet current. Comparison with the results of other workers, especially those of Rao and Ramana (1961) at Waltair indicates that the few differences observed in the present result and theirs may be latitudinal.

References

[1] Briggs, B.H. and Phillips, G.J. **1950**. A study of horizontal irregularities of the ionosphere. Proceedings of Physics society, 63, 907-923
[2] Chandra, H; Misra, R.K. and Rastogi, R.G. **1971**. *Planetary Space Science*, 19, 11497-1503.
[3] Cohen, R. **1967**. The equatorial ionosphere in "Physics of Geomagnetic Phenomena.□□ (S. Matsushita and W.H. Campbell, eds.), chapter III- 4. Academic Press, New York.
[4] Oyinloye, J.O. and Onolaja, G.B. **1977,** *Journal of Atmospheric and Terrestrial Physics* 39, 1353-1356.
[5] Phillips, G.J. and Spencer, M. **1955**. The effect of anisometric amplitude pattern in the measurements of ionospheric drifts. Proceedings of Physics society (London), B68, 481-492.
[6] Rao, B.R. and Ramana, K.V.V. **1961**. *Nature*, London, 190, 706-707.
[7] Ratcliffe, J.A. **1948**. *Nature*, London, 162, 9-11.
[8] Somoye, E.O. **2009**. *International Journal of Physical sciences* 4(3) 107-110.
[9] Bamgboye, D.K. **1969**. Horizontal ionospheric drifts in the neighbourhood of the magnetic equator. Ph.D Thesis, University of Ibadan, Nigeria.
[10] Onolaja, G.B. **1977**. Studies of ionospheric drifts at Ibadan, Ph.D Thesis, University of Ibadan, Nigeria.