International Journal of Advance Research in Science and Engineering
Volume No.06, Issue No. 10, October 2017
www.ijarse.com
IJARSE
ISSN: 2319-8354

COMPARISON OF VARIABILITY OF foF2 DURING 23^{rd} & 24^{th} HIGH SOLAR ACTIVITY PERIOD AT LOW LATITUDE STATION JICAMARCA

Anita Agrawal[1], Kalpana Maski[2], S.K Vijay[3], S.D Mishra[4]

[1]*Research Scholar, Barkatullah University Bhopal (India)*

[2]*Regional Institute of Education, NCERT Bhopal (India)*

[3]*Rashtriya Uchhatar Shiksha Abhiyan Bhopal(India)*

[4]*Atal Bihari Vajpayee Hindi Vishwavidyalaya Bhopal (India)*

ABSTRACT

*This paper presents comparison of variability of f oF2 during 23rd & 24th high solar activity period at low latitude station Jicamarca (12^{o}S, 76.90^{o}W). Jicamarca (12^{0}S, 76.90 ^{0}W) is an American station located near the dip equator. To compare the variability of ionosphere we have used the ionosonde measurements for critical frequency of F2 layer. The foF2 is an important and most widely used parameter for studying the ionospheric variability. The variability of ionosphere through foF2 has been studied annually. Hourly data for the year 2002 (High solar activity period for 23rd solar cycle) & 2014 (High solar activity period for 24th solar cycle) of foF2 are analyzed to study the diurnal variation. Two major peaks are evident from the plots: annual diurnal **of** foF2 during 23rd & 24th solar cycle for year 2002 and 2014. Pre sunrise peak is sharp and clear but after sunset peak is small. The variability is much more during night time than during daytime .The measurement of ionospheric critical frequency (foF2) shows the fact that variability has been significantly lower in the cycle 24, compared to the cycle 23.*

Keywords: Diurnal variation, High Solar Activity Period, Ionosphere, Low Latitude Station, Variability of foF2,

I. INTRODUCTION

The variation of the F-region electron density distribution greatly affects the propagation of the radio waves through the ionosphere. The critical frequency (foF2) is the limiting frequency at or below which a radio wave is reflected by ionosphere in HF radio propagation. The day-to-day variability in F-region parameters which is apparently unrelated to any specific solar or magnetic event is perhaps the biggest challenge for ionospheric forecasters and this problem is particularly severe in tropical latitudes. It is well known that the low latitude is a complex area of the ionosphere because it is simultaneously affected by dynamo electric fields and thermospheric winds.

The ionospheric F2-regions depends very strongly on solar activity so it suffers a large and persistent day-to-day (diurnal) and seasonal variations influenced by the variation of sunspot numbers represented by solar cycle [1]. The F2-layer of the ionosphere is subject to a number of influences such as solar ionizing radiation, solar wind, geomagnetic activity and neutral atmosphere electrodynamics effects [2]. [3] investigated the variability of F_2 layer critical frequency (foF2) over Jicamarca station along the equator anomaly trough during solar minimum period. The study shows that the night time downward reversal value in vertical plasma drift coincides with the enhanced foF2 variability. [4] focused on the GPS TEC and foF2 variability at equatorial station and showed the performance of IRI-model.

[5] have been analyzed variability of the ionospheric parameters [foF2and M (3000) F2] at three low latitude stations during low solar activity periods from January 2006 to December 2010, diurnal observation revealed that foF2 is more vulnerable to variability during night than the daytime having two maxima during the day, a little before (after) the sunrise (sunset) between .20 and .40 (normally). [6] studied day to day variability of the F region of the ionosphere at low latitude station Darwin (12^{o}S, 131^{o}E) of Australia during the high, moderate and low solar activity period of 23rd solar cycle. More variability during day time in comparison to night which is an abnormal behavior.

[7] studied the day-to-day variability in the critical frequency of F-layer (foF2) over Ahmedabad situated near the anomaly crest. The result shows that the variability is much more during night time than during the day and also that while the daytime deviations are of the same order during different seasons the night-time deviations are least during equinoxes. Knowledge of the variation of F_2-layer critical frequency (foF2) is great importance to investigate the physical process responsible for the ionospheric behaviour and therefore their descriptions are included in ionospheric models such as the International Reference Ionosphere (IRI). We did comparison of variability of foF2 during 23rd &24th high solar activity period at low latitude station Jicamarca (12^{0}S, 76.9^{0}W; dip 0.28^{0}).

II. DATA AND METHOD

Hourly values of the critical frequency (foF2) parameter are taken over Jicamarca (12^{0}S, 76.9^{0}W; dip 0.28^{0}). Jicamarca is an ionospheric station along the anomaly trough in the American sector. Hourly values of the critical frequency (foF2) parameter are collected from the site NGDC Space Physics Interactive data Resource (SPIDR) website (http://spidr.ngdc.noaa.gov) during period (2002 & 2014).

The coefficient of variability (CV) is statistically obtained:

$$CV\ (\%) = (\sigma/\mu)*100 \ \ldots\ldots\ (1)$$

Where μ is the mean and σ is the standard deviation of foF2 values.

The coefficient of variability (CV) is statistical tool that describes the extend of spread of each data point from the calculated mean for the entire data set. This formula has been used by [8-12] to calculate variability for foF2.

International Journal of Advance Research in Science and Engineering
Volume No.06, Issue No. 10, October 2017
www.ijarse.com
IJARSE
ISSN: 2319-8354

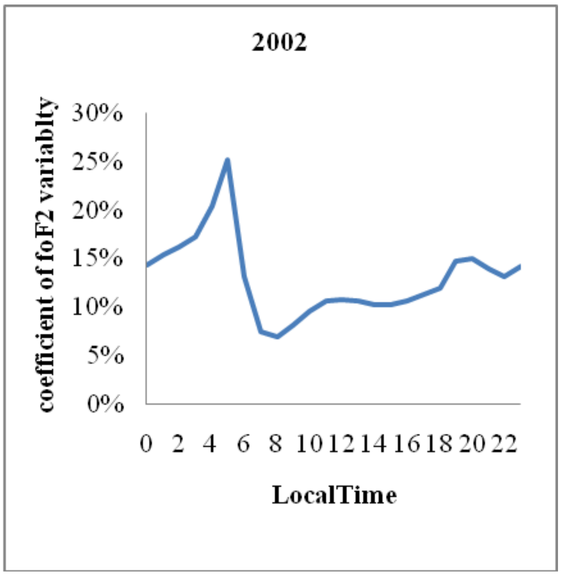
III. RESULT

3.1 Annual Diurnal Variation of foF2

For complete study of variability of foF2of ionosphere at low latitude station Jicamarca (12°S, 76.90°W) during high solar activity period of 23rd and 24th solar cycle, we have analyzed and compared annual diurnal variation of foF2 for the year 2002 & 2014. Because year 2002 is peak of 23rd solar cycle and year 2014 is peak of 24th solar cycle.

Figure 1 shows annual variation of foF2, in which the coefficient of variability (CV) is at Y-axis and local time is at X-axis for low latitude station Jicamarca (12°S, 76.90°W). Figure 1 (a) shows coefficient of variability of foF2 for year 2002. Fig.1 (b) shows coefficient of variability of foF2 for year 2014.

Fig. 1(a) shows the annual variation of coefficient of variability of foF2 and it indicates that the maximum coefficient of variability of foF2 is about 25% at 5:00 LT, while Fig.1 (b) shows CV about 18% at 5:00 LT. In both the figures 1(a) & 1(b) pre sunrise peak is sharp and clear but after sunset peak is small .The variability is much more during night time than during daytime. Thus it is clear that the coefficient of variability of foF2 is maximum for 23rd solar cycle than 24th solar cycle. It has also been observed that the daytime coefficient of variability of foF2 lies between 5-15% approximately during both solar cycles which is consistent with the result of [9] who recorded a value range of 5–15% over two African equatorial stations of Ouagadougou and Korhogo (lat. 9.3°N, long. 5.4°W, dip 0.67°S).



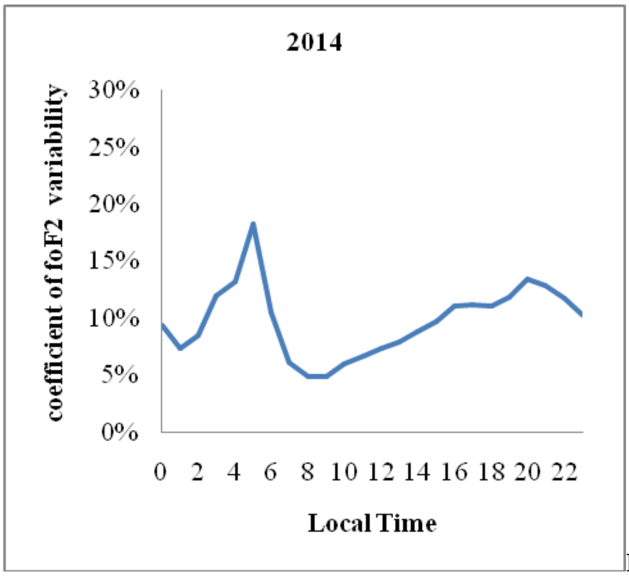


Fig: (a) Fig. (b)

Fig-1: Annual Diurnal Variation of foF2 during 23rd & 24th solar cycle for year 2002 and 2014 at Jicamarca (12°S, 76.90°W)

IV. DISCUSSIONS

Two major peaks are evident from the plots: annual diurnal of foF2 during 23rd & 24th solar cycle for year 2002 and 2014, the pre-sunrise peak and the post-sunset peak, which are caused by the onset and turnoff of solar ionization on the background electron density [13], as well as the vertical plasma drift. However, the pre-sunrise peak seems to be higher than the post-sunset peak during the both year 2002 and 2014.The daytime and nighttime disparity according to [9] is partly due to the lower mean value (μ) at night, which for similar absolute variability results in a higher variability percentage during the night.

[14] in a recent work had disclosed that the apparent surge (rise and fall motion) of the equatorial F-region peak at sunrise is produced majorly by photochemistry as against the general believed dynamics. They investigated the nature of the early morning ionosphere using a digisonde located at Trivandrum in India. They observed that as the peak rate of photo-ionization moves down in altitude and increases in magnitude, the newly formed charged particles (plasma) follow a comparable pattern. Subsequently, a jump, which was followed by a quick downward motion of the increasingly strong F-region peak altitude, was observed as the density becomes large enough to be detected by the digisonde. They concluded that the rationale behind the downward motion of the F peak. The daytime minimum variability of between 7 and 15% observed during 2002 is consistent with the result of [9] who recorded a value range of 5–15% over two African equatorial stations of Ouagadougou and Korhogo (lat. 9.3°N, long. 5.4°W, dip 0.67°S).

We observed that the strongest variation with solar activity is during nighttime. This is because at night, the ionospheric electron density is dependent on the recombination rate, which is influenced by the gas compositions [13] and equatorial electric field (EEF). At the equator, EEF causes vertical E × B plasma drift enhancement to altitude above F2-peak. The EEF is caused by the tidal winds in the E region, which drive ionospheric currents to higher latitudes. This current in turn interacts with the Earth's magnetic field and results in a building of positive and negative changes at the dawn and dusk terminal, respectively. It has also been suggested that gravity waves could be responsible for the nighttime ionospheric density gradient enhancement. Hence the reason for the observed higher variability in foF2 at nighttime rather than during daytime. As we have observed abnormal pattern of variability of foF2 parameter for high solar activity period of23rd &24th solar cycle.

We have found that variability of foF2 is more in 2002 than 2014 Actually, Solar Cycle 24 has appeared as an unusually weak cycle with very late start and slow ascending phases compared to precedent cycles [15] the Sun is much less active in solar cycle 24, resulting in significantly weaker ionization of the atmosphere, which may imply a continuing anomaly of the ionosphere around the solar maximum.

V. CONCLUSION

The main conclusions of our analysis can be summarized as follows:

1. Annual diurnal observation revealed that foF2 is more susceptible to variability to night time then day time having two characteristics peaks: pre sunrise and post sun set. However, the pre-sunrise peak seems to be higher than the post-sunset peak during the both year 2002 and 2014.

2. We have found that maximum variability of foF2 is more in 2002 than 2014.

VI. ACKNOWLEDGEMENTS

The author (Anita Agrawal) would like to thank Space Physics Interactive Data Resource (SPIDR) website (http://spidr.ngdc.noaa.gov) for providing data of ionospheric parameters foF2.

REFERENCES

[1] S.S. Kouris, The solar cycle variation of M(3000)F2 and its correlation with that of foF2, *Ann. Geophysics., 41 (4),* 1998, 583-590.

[2] .Risbeth and M.Mendillo, "Patterns of ionosphericvariability*". J. Atmos. Terr. Phys., 63(15),* 2001.doi: 10.1016/s1364-68266(01)00036-0, 1661-1680.

[3] BO Adebesin B J Adekoya, S O Ikubanni, S J Adebiyi , O A Adebesin, B W Joshua and K O Olonade, Iononspheric foF2 morphologyand response of F2 layer height over Jicamarca during different solar epochs and with IRI-12 model, *Earth Syst. Sci. 123 (4),* 2014, 751–765

[4] Adebiyi S.J ,I.A.Adimula, O.A.Oladipo, S.O.Ikubanni, B.O.Adebesin and B.W. Joshua, "GPS derived TEC and foF2 variability at an equatorial station and the performance of IRI model*", Adv. Space Res., 54, (4), 2014,* . doi: 10.1016/j.asr.2014.03.026 , 565-575.

[5] Nagar, Anju Satyadeo Mishra, Surendra Kumar Vijay Day-to-Day Variability of Low Latitude F-Region Ionosphere during Low Solar Activity. *International Journal of Astrophysics and Space Science 3,(3),* 2015, 30-41

[6] Khoobchandani, Geeta, S.D Mishra S.K Vijay Variability of foF2 at Low Latitude during High, Moderate and Low Solar Activity. *International Journal of Engineering Trends and Technology 44 (2)* , 2017

[7] H Chandra., S. Sharma and S.W. Aung, "Day to day variability in the critical frequency of F2 layer over the anomaly crest region, Ahmedabad", *J. Ind. Geophys.Union, 13, (4),* 2009, 217-226

[8] J.M., Forbes, Palo, S.E. and Zhang, X. (2000). Variability in the ionosphere. *J. Atmos. and Solar-Terr. Phys. 62*, 2000, 685-693

[9] BilitzaD,Obrou O K, Adeniyi J O &Oladipo O, Variability of foF2 in the equatorial Ionosphere.*Adv Space Res(UK), 34,* 2004 1901-1906.

[10] A O Akala, Oyeyemi E O, Somoye E O, Adeloye AB &Adewale A O,Variability of foF2 in the African equatorial ionosphere, *Adv Space Res(UK), 45*, 2010, 1311-1314.

[11] E.O Somoye,., Akala, A.O. (2010) NmF2 Variability at Equatorial and Low Latitude Stations: A review, *Research Journal of Physics 4 (2)* 2010, 50–55.

[12] E.O Somoye,., Akala, A.OComparison of diurnal, seasonal and latitudinal effect of MUF VR and NmF2 VR during some solar cycle effect. *Advances in Space Research, 47, 2011, 2182–2187.*

[13] Y.T. Chou, Lee, C.C. Ionospheric variability at Taiwan low latitude Station: Comparison between observations and IRI- 2001 model, Adv. Space Res. 42, 2008, 673–681.

[14] Ambili K M, St-Maurice J-P and Choudhary R K 2012 On the sunrise oscillati,on of the F region in the equatorial ionosphere; Geophys. Res. Lett. 39 L16102, doi: 10.1029/2012GL052876.

[15] K. J, Li, Feng, W., Liang, H. F., Zhan, L. S., and Gao, P. X.: A brief review on the presentation of cycle 24, the first integrated solar cycle in the new millennium, *Ann. Geophys*., doi:10.5194/angeo 2011, 29, 341–348,