



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 9, Issue 11, November 2020

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Ionospheric Parameter during Seasonal and Diurnal Variance: The Study

Brahmawale Kumarbabu Sidramappa, Dr. Sanjay Rathore

Department of Physics, University Teaching Department, Sri Satya Sai University of Technology & Medical Sciences,
Sehore, Madhya Pradesh, India

ABSTRACT: The ionosphere is an important region for radio communications. When electromagnetic signals travel in a media, they interact with objects. Due to this interaction radio signals can change their direction as they reflected, refracted or diffracted. The ionosphere is a region of the upper atmosphere with large concentrations of free ions and electrons, which affect the radio waves and radio communications. The ionosphere affects the signals on the short wave radio bands where it reflects the signals which were heard over vast distances. A number of empirical models have been proposed. Currently, the most popular one is the International Reference Ionosphere (IRI) model. The IRI is based on all available worldwide data sources such as ionosondes, incoherent scatter radars and instruments on the satellites and rockets. In this work the electron density is analysed while considering different profiles like time variation of a whole day, change of season, atmospheric height etc. The data of Delhi as an Indian geographical is taken show that the ionosphere exhibits annual, seasonal and diurnal variability. Data is compared with International Reference Ionosphere (IRI) for computation and plotting of parameters. It is observed that the diurnal variation reached its maximum value of electron density during the day time and mainly at afternoon. Similarly, the daily minimum is seen at the night time. The seasonal variation in electron density shows that the GPS reaches a maximum during the April, May June months and show a decreasing value in other months. The lower value of electron density during rest of the months is attributed to the low ionization densities, which are due to the reduced production rates (indicated by $O=N_2$ ratio), owing to the increased scale height of N_2 . It is further observed that Ionosphere is highly variable in space, seasonal and diurnal profile

KEYWORDS: Ionosphere, International Reference Ionosphere, Radio communication, GPS, Electromagnetic signal

I.INTRODUCTION

When we stare into the space, it seem like we are looking into a dark and vacant space. It shows emptiness everywhere above the earth. But the atmosphere is actually made of layers with different atoms, molecules, and types of energy. If we travel about 30 miles from Earth's surface up to the edge of space at about 600 miles from the surface, we'll encounter a layer of the atmosphere called the ionosphere. In the ionosphere, radiation from the sun is so powerful that it ionizes, or breaks electrons free from different atoms present in the atmosphere. Due to fluxes in solar radiation, temperatures in the ionosphere vary from 200 Kelvin (or -99 degrees Fahrenheit) to 500K (or 440 degrees Fahrenheit). Hence the ionosphere is defined as the layer of the Earth's atmosphere that is ionized by solar and cosmic radiation. It lies 75-1000 km (46-621 miles) above the Earth. Ionosphere is the region of the upper atmosphere with the sufficient amount of charged particles also referred to as plasma. Even though ionosphere is a small part of the atmosphere, it has a profound effect on the properties and behavior of the medium. The model result of vertical profile of electron density shows the different layers of the ionosphere, which depend on the day or night- time period as well as solar conditions. When the radio waves propagate through the ionosphere, they are affected by the phenomena of reflection, refraction, diffraction, absorption, polarization and scattering. So the ionosphere has practical importance as it influences radio wave propagation to distant places on the earth, which directly impacts on radio wave communication systems.[1]

During the daytime, the ionosphere separates into several layers or regions depending upon the local time of day. The main layers are D-region, E-region, F1-region, and F2-region. The layers are generally characterized by a density maximum at a certain altitude and a density decreases with altitude on both sides of the maximum. The D-region ranges from about 60 km to 90 km and is controlled by ionization of neutrals by solar X-Rays and Lyman alpha radiation, which cause two- and three-body recombination and electron attachment. The dynamics of the D-region are mostly dominated by the neutral

atmosphere. In this region, the plasma density range is 102-104 cm⁻³. The E- region extends from ~90 km to 150 km altitude with a plasma density ~105 cm⁻³. This region is chemically dominated and contains molecular ions such as N⁺, O⁺, NO⁺ as primary constituents. The F1-region ranges from ~150 km to 200 km altitude with plasma density range of ~105-106 cm⁻³. The F2-region extends from an altitude of ~200 km to 500 km and the plasma density maximum varies around 300 km up to 106 cm⁻³. This is the region of peak electron density of the ionosphere, which is usually over an order of magnitude greater than the E-region peak density. These F1- and F2- regions are dominated by monoatomic oxygen and the ions transported through diffusion. The D- and F1-regions vanish during the night and the E-region become much weaker. The daytime plasma densities are greater than that of the night-time and also larger during the solar maximum than in solar minimum. At solar maximum, the electron densities are greater by a factor of two to four than at solar minimum, especially in the F-region. The E-region and lower part of the F-region undergo relatively greater variations in electron density between day and nighttime than does the upper F-region. The F2-layer is the principle-reflecting layer for HF communications and is responsible for most sky wave propagation of radio waves. Thus, this region is of the greatest interest for radio wave propagation. Unfortunately, this layer is also the most anomalous, the most variable and the most difficult to predict.[4]The ionosphere is considered to be that part of the atmosphere that lies at about 80 kilometers altitude with the highest concentration of ions and free electrons. The most intense concentration is at about 100-300 km altitude. As a definition, the ionosphere is defined as a region in the atmosphere where a large number of free thermal electrons and ions are found. The ionosphere has practical importance because it influences the propagation of electromagnetic waves. The ionosphere also offers an added interest in that it is naturally occurring plasma and a study of it therefore enables us to gather information that can be useful in understanding the problems associated with manmade plasma and the problems of fusion reactors. The ionosphere generates natural resonators an example of which is the ionosphere waveguide formed around the plasma density maximum. Another resonator is the Alfvén resonator formed between the density maximum and an upper altitude at about 3000 km for Alfvén waves. The Schumann resonator is formed between the nearly perfectly conducting terrestrial surface and the ionosphere.

II .RELATED WORK

Eyelade et al. studied the diurnal and seasonal variations in total electron content (TEC) over Nigeria. It has been prompted by the recent increase in the number of GPS continuously operating reference stations (CORSSs) across Nigeria as well as the reduced costs of micro computing. The GPS data were recorded in the year 2012 at nine stations in Nigeria located between geomagnetic latitudes – 4.33 and 0.72° N. The GPS data were used to derive GPS TEC, which was analyzed for diurnal and seasonal variations. The results obtained were used to produce local GPS TEC maps and bar charts. The derived GPS TEC across all the stations demonstrates consistent minimum diurnal variations during the pre-sunrise hours 04:00 to 06:00 LT, increases with sharp gradient during the sunrise period (07:00 to 09:00 LT), attains post noon maximum at about 14:00 LT, and then falls to a minimum just before sunset.[5]

Araujo et al. determines the variability of the F region as a function of local time, latitude, season, and geomagnetic activity with an ionospheric F2 critical frequency database. The database comprises observations from 75 ionosonde stations covering a range of geomagnetic latitude and includes 43 storm intervals. The database was previously used to develop the Storm-Time Empirical Ionospheric Correction Model (STORM). The mean and standard deviation have been evaluated by sorting the data by local time, season (five intervals centered on equinox, solstice, and intermediate intervals), latitude (four regions each 20° wide in geomagnetic latitude), and up to eight levels of geomagnetic activity.[2]

Fatkullin et al determine the mean seasonal (summer 1963 and winter 1963-1964) daily variations of electron density in the middle latitude topside ionosphere. It is shown that the altitudinal extension of the seasonal anomaly in the topside electron density changes with local time. Maximum of the extension is observed at 1400-1500 hr (up to 500 km). As other possible mechanisms of the seasonal anomaly phenomenon the variation of the loss coefficient, neutral atmosphere composition changes and neutral wind flow from summer hemisphere to winter one have been argued. The time of the maximal development of these two phenomena coincides (about 1400-1500 hr LT). Therefore the seasonal anomaly in the electron density of the PB-region is more naturally to be interpreted from the point of the seasonal variations in the upper atmosphere parameters.[3]

Kuverova et al presented a detailed analysis of the influence of Rydberg states to the behavior of GPS signals in D and E layers of the ionosphere is presented. The main chemical reactions that lead to formation of the non-equilibrium two-

temperature plasma and highly excited Rydberg complexes are considered. A special attention is given to l-mixing reaction responsible for the formation of quantum resonance properties for radio wave propagation medium.. It is shown that the transition frequencies between the excited states of orbital degenerate Rydberg complex are resonant with respect to the carrier frequencies of GPS. That is why these states are the main cause of the GPS signal distortion. Solving the problem of calibration of instrumentation is impossible without monitoring the parameters of two temperature plasma in the E and D layers of the ionosphere.[6]

Kouris et al Studied the variabilities from day-to-day and from hour-to-hour of the ionospheric characteristics f_oF_2 , $M(3000)F_2$ and $MUF(3000)F_2$. They have determined statistical factors related to the state of the ionospheric plasma in time and space. It is found that the variability from day-to-day is greater than the variability from hour-to-hour and that an “intrinsic” variability of the order of less than 4% remains even if we evaluate variability levels that are not exceeded for the 30% or 20% or 10% of the time for each month and year at each location. It is also found that a different amount of disturbances exists at different geographical zones (continents) and at the same zone it varies with latitude.[7]

III. RADIO WAVE PROPAGATION VIA IONOSPHERE

When electromagnetic signals travel in a media, they interact with objects. Due to this interaction radio signals can change their direction as they reflected, refracted or diffracted. The ionosphere is an important region for radio communications. The ionosphere is a region of the upper atmosphere with is large concentrations of free ions and electrons, which affect the radio waves and radio communications. The ionosphere affects the signals on the short wave radio bands where it reflects the signals which were heard over vast distances. Radio stations have long used the properties of the ionosphere to enable them to provide worldwide radio communications coverage. The ionosphere is a continually changing area. It is obviously affected by radiation from the Sun, and this changes as a result aspects including of the time of day, the geographical area of the world, and the state of the Sun. As a result radio communications using the ionosphere change from one day to the next and even one hour to the next. Predicting how what radio communications will be possible and radio signals may propagate is of great interest to a variety of radio communications users ranging from broadcasters to radio amateurs and two way radio communications systems users to those with maritime mobile radio communications systems and many more.

Radio waves are affected by the phenomena of reflection, refraction, diffraction, absorption, polarization and scattering when traveling through the ionosphere as similar to the form of electromagnetic radiation, like lighting waves. Radio propagation is the behaviour of radio waves when they are transmitted, or propagated from one point on the earth to another, or into various parts of the atmosphere. When the radio waves are transmitted from the surface of the Earth, they are reflected back from the ionosphere and able to reach the transmitter. So the ionosphere has practical importance because, among other functions, it influences radio propagation to distant places on the earth. Radio wave was being used on a daily basis for broadcasting as well as for two-way radio communication systems. Radio waves, microwaves, infrared and visible light can be used for communication system. For instance, radio waves are used to transmit television and radio programs, while the microwaves are used to transmit satellite television and for mobile phones. Additionally, infrared wave can be used to transmit information from remote controls. The radio wave propagation is affected by many factors such as by the daily changes of water vapour in the troposphere and ionization in the upper atmosphere, due to the Sun. Understanding the effects of varying conditions on radio propagation has many practical applications, from choosing frequencies for international shortwave broadcasters, to designing reliable mobile telephones systems, or radio navigation, to operation of radar systems. Moreover, radio wave propagation is also affected by several other factors determined by its path from point to point. This path can be direct line of sight path or an over-the-horizon path added by refraction in the ionosphere, which is a region between approximately 50 and 600 km. In addition, factors influencing ionospheric radio signal propagation can include ionospheric variability such as sporadic-E, Spread-F and ionospheric layer tilts, and solar activities such as solar flares, geomagnetic storms, and solar proton events and so on. Radio waves of different frequencies propagate in different modes. At extra low frequencies (ELF) and very low frequencies have very much larger wavelength than the separation between the earth's surface and the D-layer of the ionosphere. Consequently, electromagnetic waves can propagate in this region as a waveguide. Actually, for frequencies below 20 kHz, the wave propagates as a single waveguide mode with a horizontal magnetic field and vertical electric field. The interaction of radio waves with the ionize regions of the atmosphere makes radio propagation more complex to predict and analyse than in free space. Radio wave propagation through the ionosphere, especially during the disturbed ionospheric conditions also referred to as ionospheric

irregularities, is more complex to predict and analyse than in free space. Ionospheric radio wave propagation has a strong association to space weather. A sudden ionospheric disturbance or shortwave fadeout is observed when the X-ray associated with a solar flare ionizes the D-region ionosphere. Consequently, enhanced ionization in that region increases the absorption of radio signals passing through it. During the active solar period, such as strongest solar X-ray flares complete absorption of virtually all ions spherically propagated radio signals in the sunlit hemisphere can occur. These solar flares can disrupt HF radio propagation, which disturb GPS (Global Position System) accuracy. Since radio wave propagation is not fully predictable, such services as emergency locator transmitter in flight communication for long distant such as with ocean crossing aircraft, and television broadcasting have been moved to communications satellites. A satellite link, through expensive, can offer highly predictable and stable line of sight coverage of a given area.

IV. METHODS

The techniques available for observing the geo-space can be divided into three, i.e. direct, indirect and remote sensing. In the direct sensor method, an instrument is placed in the medium to measure the properties of its immediate surroundings, and they respond only to that which is to be measured. Artificial satellites, rockets or balloon-borne measurements comprise the direct method. In the second method, an indirect sensor is placed within the medium but is not instrumented with a detector. The properties of the medium are monitored from afar by observing the motion of the sensor. In the remote sensing method, however, no instrument is placed in the medium. The properties are derived from observations of waves that have traversed the medium or those emitted from it. The most commonly used remote sensing techniques and devices for studying ionosphere are: ionospheric sounding, trans-ionospheric propagation, VLF propagation, whistlers, and partial reflections, coherent scatter radar, incoherent scatter radar, MST radar, etc.

TEC Measurement Using GPS

All modern TEC measuring techniques rely on the observation of signal phase differences or on pulse travel time measurements based on geostationary and orbiting satellite signals. A standard way of measuring TEC is to use ground-based receiver capable of processing signals from satellites in geostationary orbits and polar orbiting satellites. In the recent times, the Global Positioning System (GPS, or NAVSTAR), a satellite based navigation system is increasingly being used for all-weather precision navigation over land, sea and in air by both military and civilian users. In principle, it should be possible to get offset free TEC data from GPS by measuring the differential group delay instead of phase shift (or phase delay). The dual frequency GPS receiver system provides a means of monitoring the effect of the ionosphere on GPS signals. It is particularly intended to measure the integrated ionization content between satellite and receiver, and is also capable of detecting scintillations at L-band frequencies. Operation at the L1 and L2 frequencies simultaneously permits measurement of the relative phase delay between the two signals, producing an unambiguous determination of the slant TEC, or the total number of electrons in a column of cross-sectional area of one square meter along the signal path between the satellite and the receiver. For a single frequency GPS receiver, ionospheric delay cannot be determined uniquely, but must be estimated from a model, with an uncertain effect on the final navigation solution. Thus, TEC is of significant concern for users of single frequency GPS receivers and particularly for those located under the equatorial ionization anomaly region, where the reliability of the GPS provided model is in question.

The GPS navigation system comprises of three distinct "segments" of which the first one is the space segment that consists of a constellation of 24 satellites transmitting coded signals downward to receivers on the Earth's surface. The second is the control segment that includes ground stations used for monitoring satellites and sending upward signals for the engineering control of each satellite and its transmitted codes and waveforms. And the third one is the user segment which includes everyone with a GPS receiver who is making use of the transmitted signals. Satellites are equi-spaced around each of the six circular orbital planes inclined at 55° to the plane of the Earth's equator. The orbital altitude is $=20,200$ km, with an orbital period of 12 hours. The geometry in the location of the satellite constellation is such that, from any point on the Earth's surface with a reasonably unobstructed horizon, signals from at least four satellites will always be available in the line of sight and it will therefore be possible to solve for the four unknowns of the receiver, namely latitude, longitude, altitude and the combined satellite/receiver timing error. Each satellite continuously transmits frequencies in the L-band of the microwave spectrum, at $L1=1.57542$ GHz and $L2=1.2276$ GHz respectively. The L1 and L2 carriers are phase coherent, both being derived from a common 10.23 MHz oscillator. Both the frequencies are modulated by a common binary code called precision code (P-code), the use of which allows the delay error introduced by ionospheric refraction to be eliminated from the final position determination, permitting the determination of the total electron content (TEC) along the signal path. This encrypted P-

code is unavailable to the general user. The L1 frequency is also modulated by the coarse acquisition code (C/A code) and is used by single frequency receivers. The GPS receiver calculates its position by selecting the optimum configuration of four satellites and finding its range with respect to each satellite. The range is determined from the delay in the time taken for the signal to travel from each of the satellites to the receiver, as measured by the difference between the satellite transmit time, which is known, and the signal reception time which is measured by autocorrelation. However, this difference does not take into account any error in the receiver's clock relative to the satellite's clock and therefore the range is only approximate and is therefore called pseudo range.

IRI MODEL

The International Reference Ionosphere (IRI) is an international project sponsored by the Committee on Space Research (COSPAR) and the International Union of Radio Science (URSI). These organizations formed a Working Group in the late sixties to produce an empirical standard model of the ionosphere, based on all available data sources. Several steadily improved editions of the model have been released. For given location, time and date, IRI provides monthly averages of the electron density, electron temperature, ion temperature, and ion composition in the ionospheric altitude range. The major data sources are the worldwide network of ionosondes, the powerful incoherent scatter radars (Jicamarca, Arecibo, Millstone Hill, Malvern, St. Santin), the ISIS and Alouette topside sounders, and in situ instruments flown on many satellites and rockets. IRI is updated yearly during special IRI Workshops (e.g., during COSPAR general assembly). [8] The IRI model and software is updated according to the decisions of the IRI Working Group. The software package includes the FORTRAN subroutines, model coefficients (CCIR, URSI, IGRF), indices files (IG_RZ.DAT, APF107.DAT). Parameters like Electron density, electron temperature, ion temperature, ion composition (O^+ , H^+ , He^+ , N^+ , NO^+ , O^{+2} , Cluster ions), equatorial vertical ion drift, vertical ionospheric electron content, F1 probability, spread-F probability, auroral boundaries, effects of ionospheric storms on F and E peak densities can be determined from the IRI model. The international reference ionosphere (IRI) is the internationally recognized and recommended standard for the specification of plasma parameters in Earth's ionosphere. It describes monthly averages of electron density, electron temperature, ion temperature, ion composition, and several additional parameters in the altitude range from 60 to 1,500 km. A joint working group of the Committee on Space Research (COSPAR) and the International Union of Radio Science (URSI) is in charge of developing and improving the IRI model. As requested by COSPAR and URSI, IRI is an empirical model being based on most of the available and reliable data sources for the ionospheric plasma. The IRI parameters are most relevant to geodetic techniques and studies. Annual IRI meetings are the main venue for the discussion of IRI activities, future improvements, and additions to the model. A new special IRI task force activity is focusing on the development of a real-time IRI (RT-IRI) by combining data assimilation techniques with the IRI model. A first RT-IRI task force meeting was held in 2009 in Colorado Springs. IRI model 2011, includes significant improvements not only for the representations of electron density, but also for the description of electron temperature and ion composition. These improvements are the result of modeling efforts, since the last major release, IRI-2007. Electron density is the parameter of most interest for geodetic techniques and data analysis. One of the most important changes is the inclusion of new neural network-based models for the point of highest density. In the bottom side the IRI electron density profile is normalized to the E and F2 peaks and the shape of the profile is determined by the bottom side thickness parameter B0 and the shape parameter B1. Currently, two options are given for these parameters: (i) the standard option consisting of a table of values and associated interpolation scheme and (ii) the Gulyaeva option based on the model of utilizing the half-density point $h0.5$ where the topside density has dropped down to half the peak density. Shortcomings of these older models are their limited data base and the resulting misrepresentation of variations with season, latitude and solar activity. They applied spherical harmonic analysis to data from 27 globally distributed Ionosondes stations obtaining a new model for B0 and B1 that more accurately describes the observed variations with latitude, local time, month, and sunspot number. Overall, the improvements over the older IRI model are of the order of 15–35%.

V. SIMULATION AND RESULTS

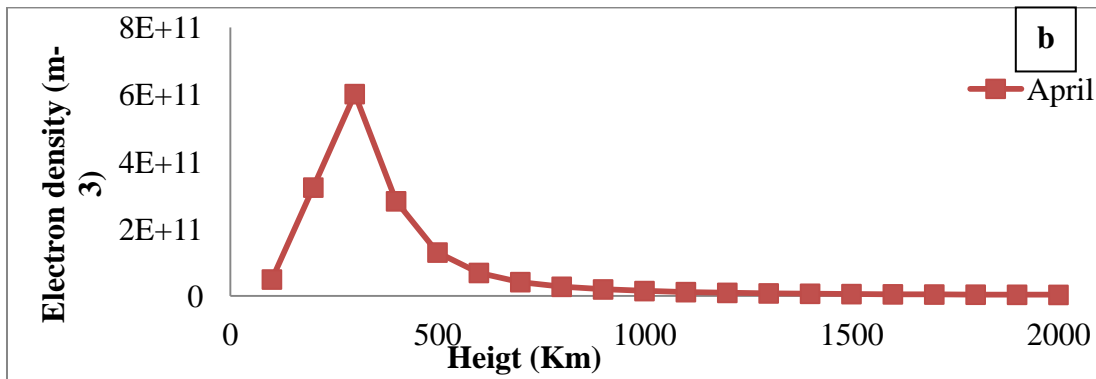
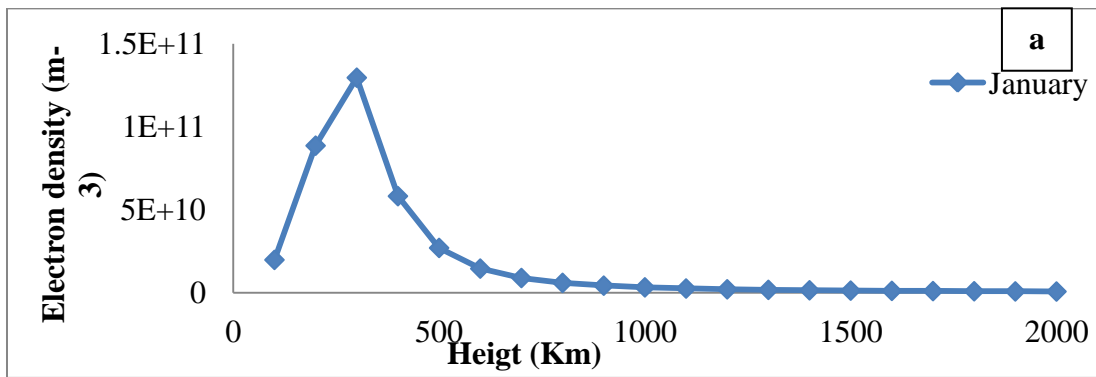
Ionosphere is highly variable in space (geographical location) and time (seasonal and diurnal) and with solar-related ionospheric disturbances. In this work the electron density is analyzed while considering different profiles like time variation of a whole day, change of season, atmospheric height etc. The data of Delhi as an Indian geographical is taken show that the ionosphere exhibits annual, seasonal and diurnal variability. Data is compared with International Reference Ionosphere (IRI) for computation and plotting of parameters. For experimental purpose following parameters are considered as shown in the Table 1:



Table 1: Experimental parameters and data

Parameters	Data	
Geographic Coordinates	Latitude	28.644800 N
	Longitude	77.216721 E
Geomagnetic Coordinates	Latitude	20.25 N
	Longitude	151.97 E
Height Profile	100 – 2000 Km, Step size 100	
Dirunal Profile	Range of 24 Hours, Step size 1	
Seasonal Profile	January, April, July, October	
Year Profile	2011 to 2019, Step size 1	

In our experiments GPS data Indian subcontinent with data of Height, Dirunal and Seasonal profile has been used. Details of the GPS sites and the data used are listed in Table 1. Data is sampled at various intervals and simulated for analysis.



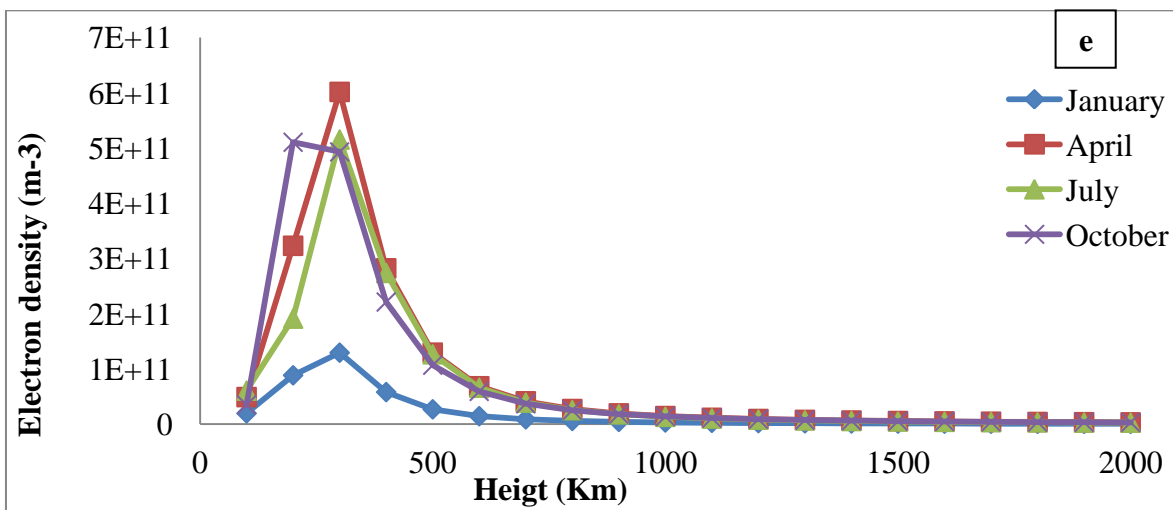
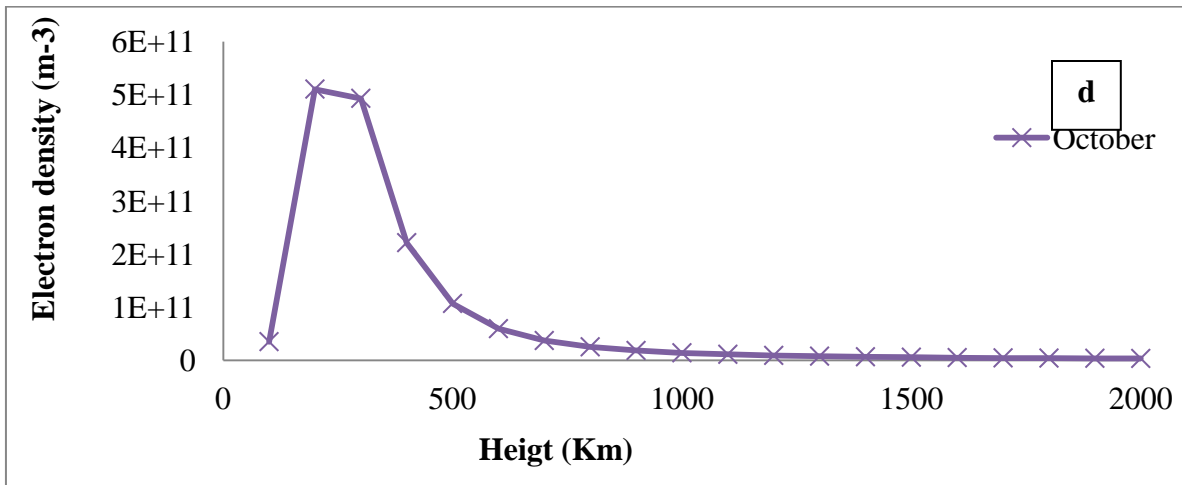
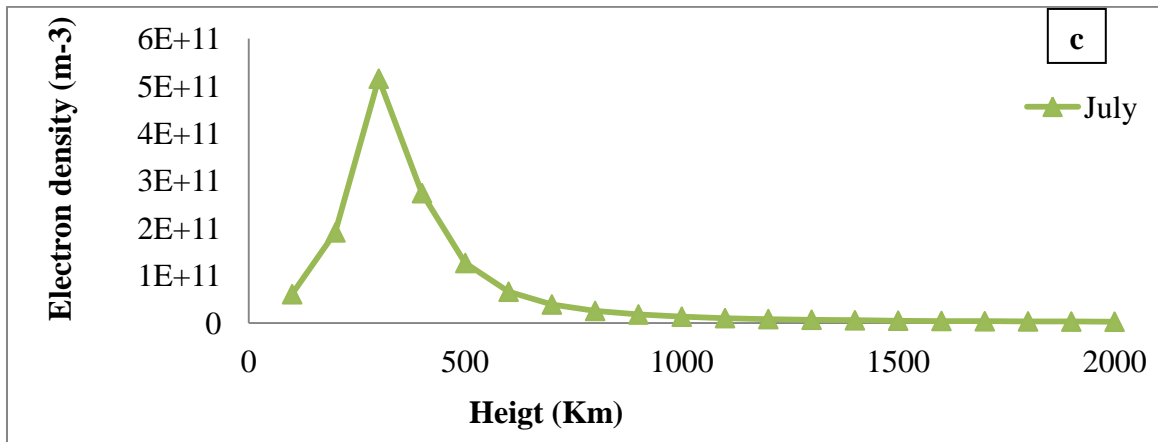
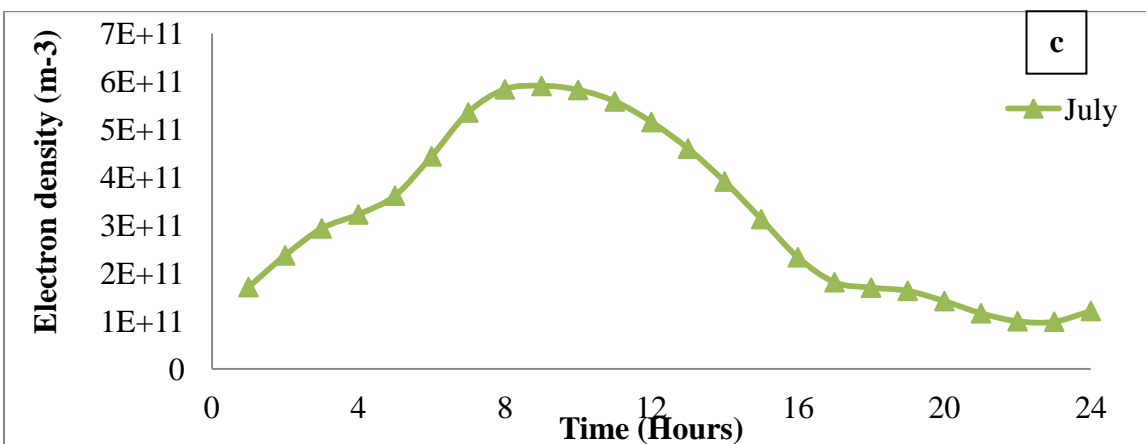
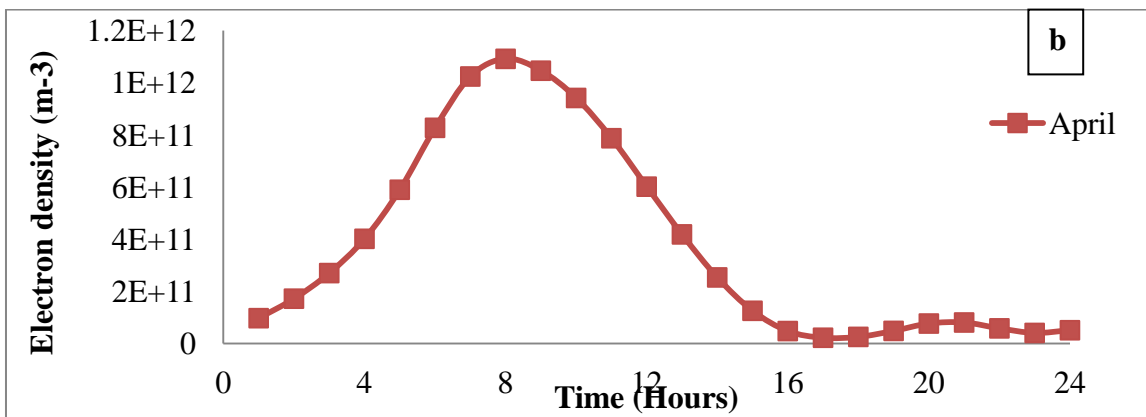
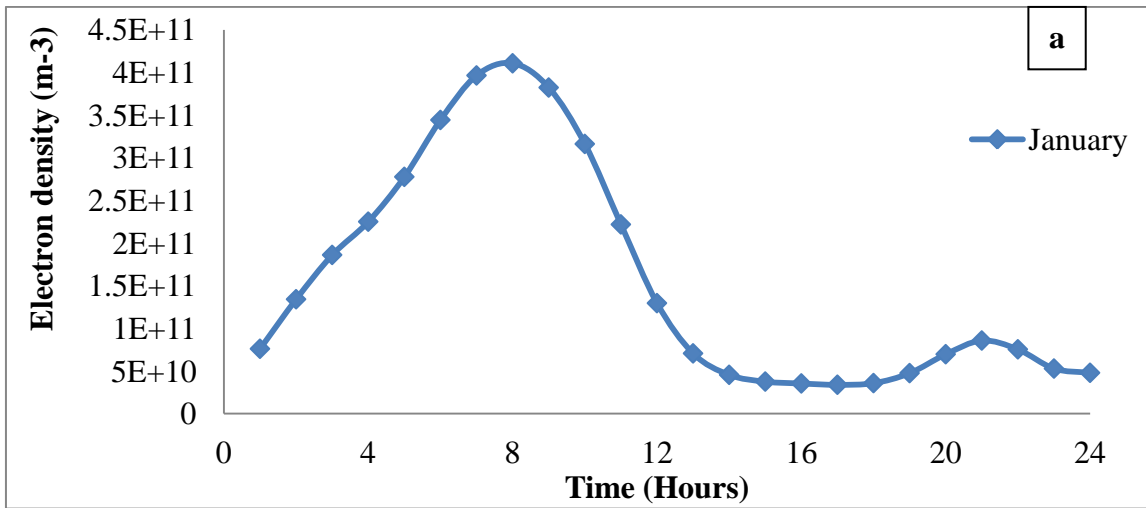


Fig. 1: Seasonal variation of Electron density with increasing height, (a) January, (b) April, (c) July, (d) October, (e) Comparative graph of above four months



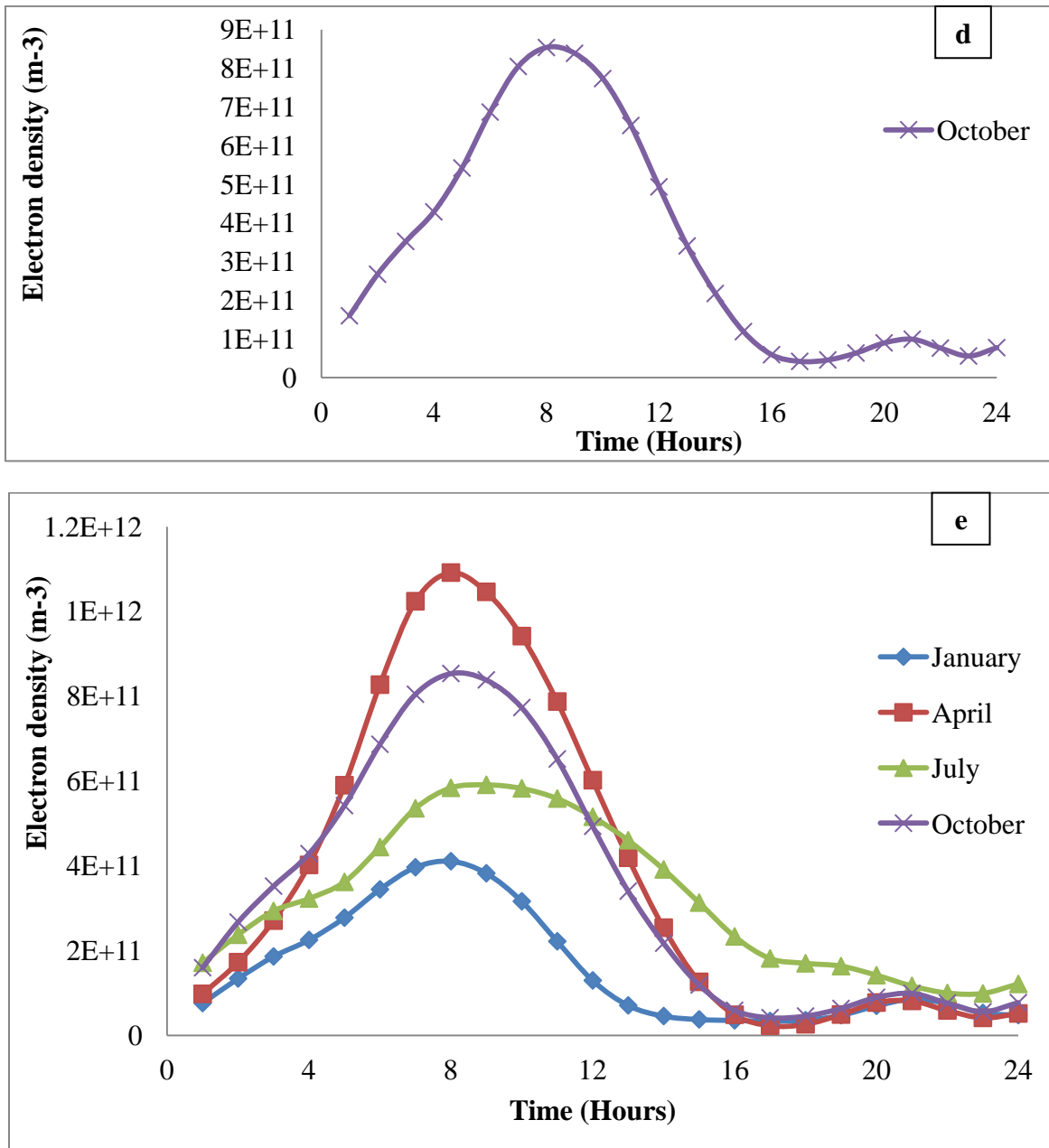


Fig. 2: Diurnal Variation of Electron density at a height of 300 Km (a) January, (b) April, (c) July, (d) October, (e) Comparative graph of above four months

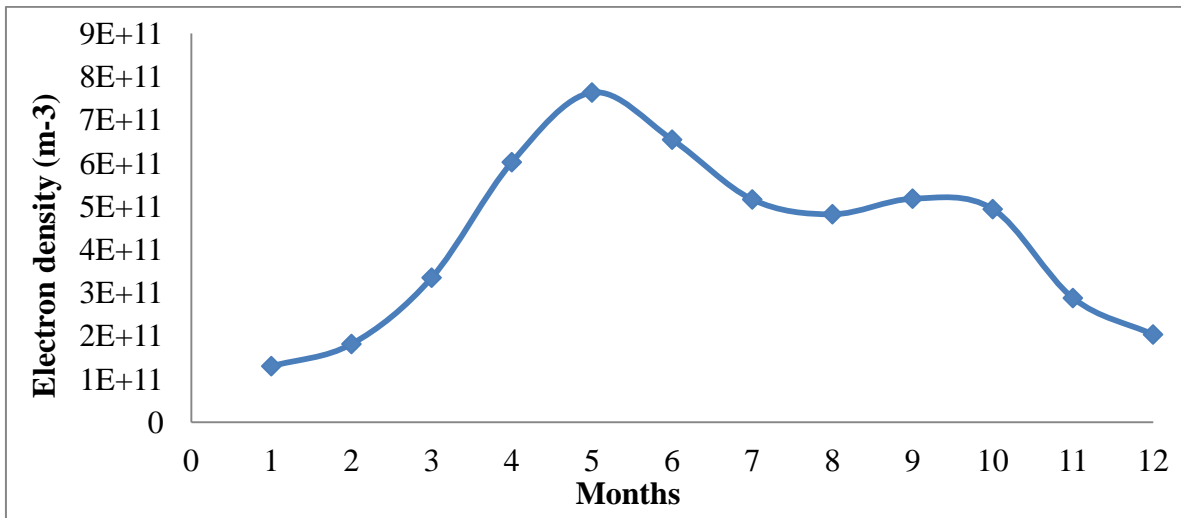


Fig. 3: Seasonal variation of Electron density at a height of 300 Km

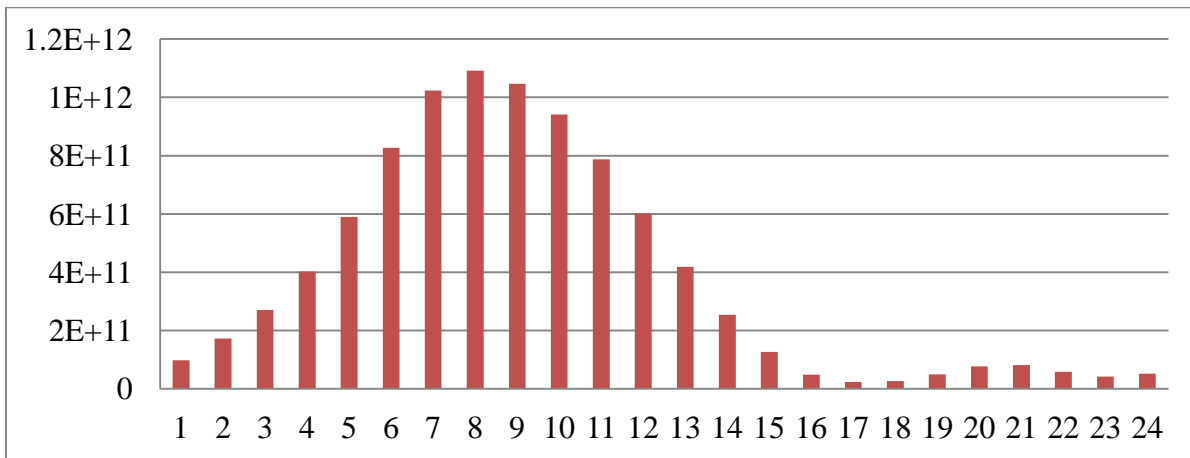


Fig. 4: Chart of Diurnal Variation of April of Electron density at a height of 300 Km

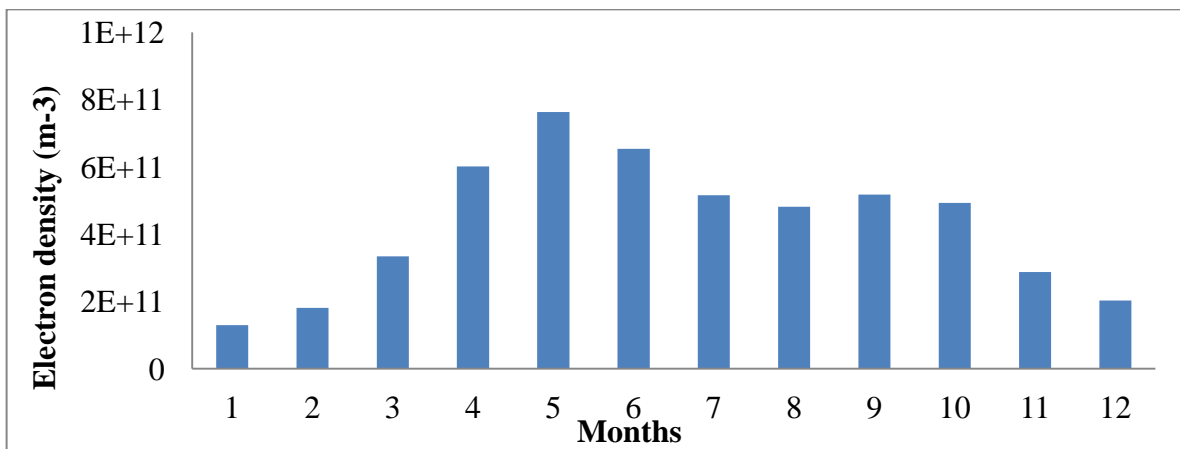


Fig. 5: Chart of Seasonal variation of Electron density at a height of 300 Km

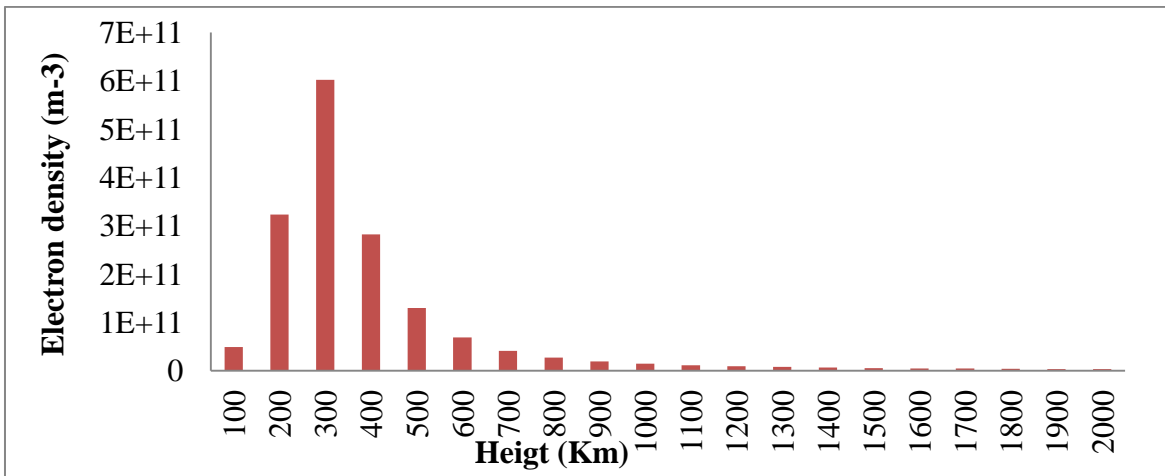


Fig. 6:Chart of Electron density of April month with variable height

Result Analysis

As analyzed from the results, Figure 1 shows the variation of electron density with the increasing height with seasonal variation. It shows that the highest electron density is achieved in summer. It also reflects that the electron density attains higher value at a height of 200 to 400 Km range. Figure 2 shows the diurnal behaviors of the ionosphere with electron density variation throughout 24 hours for 4 different months. It shows that electron density increases with time until noontime; post noon maximum is observed in all the months. Electron density decreases gradually and reaches minimum at about sunset as intensity of the solar radiation decreases. Electron density values are highest in summer and lowest in winter during the daytime. At nighttime, density values exhibit a much weaker seasonal variation. It tends to a higher value with increasing solar flux. The magnitude of GPS is generally high during daytime at all locations. The early morning increase in GPS is relatively faster than the evening decrease. The daytime GPS values are generally greater than the nighttime values. This can be attributed to the absence of solar radiation at nighttime. It is observed that during the equinoctial days the late afternoon decrease in GPS TEC is equally steep, with occasional post sunset peaks at all the stations. The time varies from a predawn minimum to an afternoon maximum and then decreases to attain minimum. Figure 3 shows the seasonal effects were investigated by measuring the electron density in all the months of the year 2019. The seasonal values of GPS are plotted in Figure. The seasonal variation in electron density shows that the GPS reaches a maximum during the April, May June months and show a decreasing value in other months. A distinct annual variation of electron density is observed at daytime. Electron density has a higher value in summer and a lower value in winter during the daytime. This annual variation becomes much weaker or disappears at the time interval from late night to pre-sunrise.

From the analysis of data it is also clear that the highest electron density is available at a height of 300 km. After this height the value of the electron density start to decrease and at a height of 2000km its value is going to negligible. It is observed that the diurnal variation reached its maximum value of electron density during the day time and mainly at afternoon. Similarly, the daily minimum is seen at the night time. The seasonal variation in electron density shows that the GPS reaches a maximum during the April, May June months and show a decreasing value in other months. The lower value of electron density during rest of the months is attributed to the low ionization densities, which are due to the reduced production rates (indicated by $O=N_2$ ratio), owing to the increased scale height of N_2 . It is further observed that Ionosphere is highly variable in space, seasonal and diurnal profile.

VI. CONCLUSION

This study presents the diurnal and seasonal variation of GPS-measured electron density for some selected days on season by season at Indian geographical location. In our experiments we analyze the electron density while considering different profiles like time variation of a whole day, change of season, atmospheric height. We take and analyze the data of Indian geographical area to show that the ionosphere exhibits annual, seasonal and diurnal variability. The diurnal and seasonal variations in were studied and from the simulated results, it is observed that:

1. The diurnal variation reached its maximum value of electron density during the day time and mainly at afternoon. Similarly, the daily minimum is seen at the night time.
2. The seasonal variation in electron density shows that the GPS reaches a maximum during the April, May June months and show a decreasing value in other months. The lower value of electron density during rest of the months is attributed to the low ionization densities, which are due to the reduced production rates (indicated by $O=N_2$ ratio), owing to the increased scale height of N_2 . Thus revealing an asymmetric semi-annual pattern.
3. It is further concluded that Ionosphere is highly variable in space, seasonal and diurnal profile. It is also clear that the highest electron density is available at a height of 300 km.

In this study, we have obtained diurnal and seasonal variation features of the ionospheric parameter from the received data. There are various parameters that can be analyzed at different geographical locations. Different profile gives a variation in the received data. And it can be analyzed with increasing location. The work can be further enhanced with the calculation of additional data at different location of India. It can show different features around the different latitudes. The features at different latitudes differ from those of foF_2 and hmF_2 , and can be helpful in understanding the different mechanisms in the ionosphere at different latitudes.

REFERENCES

- [1] Victor AdetayoEyelade, (2017) Studying the variability in the diurnal and seasonal variations in GPS total electron content over Nigeria, Copernicus Publications.
- [2] E. A. Araujo-Pradere, T. J. Fuller-Rowell, and M. V. Codrescu. (2005). Characteristics of the ionospheric variability as a function of season, latitude, local time, and geomagnetic activity. *Radio Science*, 40.
- [3] M. N. Fatkullin, (1970) Diurnal development of the seasonal anomaly phenomenon in the middle latitude topside F2-region, *Journal of Atmospheric and Terrestrial Physics*, 3, 1989-1994.
- [4] RajkumarHajra, Shyamal Kumar Chakraborty, Bruce T. Tsurutani, Ashish Das Gupta, EzequielEcher, Christiano G.M. Brum, Walter D. Gonzalez, and José Humberto Andrade Sobral. (2016). An empirical model of ionospheric total electron content (TEC) near the crest of the equatorial ionization anomaly (EIA). *SWSC*.
- [5] Eyelade, V. A., Adewale, A. O., Akala, A. O., Bolaji, O. S., and Rabi, A. B. Studying the variability in the diurnal and Seasonal variations in GPS total electron content over Nigeria, *Ann. Geophys.*, 35, 701–710, 2017.
- [6] V.V. Kuverova, S.O. Adamson, A.A. Berlin, V.L. Bychkov, A.V. Dmitriev, Y.A. Dyakov, L.V. Eppelbaum f, G.V. Golubkov, A.A. Lushnikov, M.I. Manzhelii , A.N. Morozov, S.S. Nabiev, V.L. Shapovalov, A.V. Suvorova, M.G. Golubkov, (2019), *Chemical physics of D and E layers of the ionosphere*, Elsevier, 64, 1876–1886.
- [7] S.S. Kouris and D.N. Fotiadis, (2002), *Ionospheric Variability: A Comparative Statistical study*, Elsevier.



INNO  **SPACE**
SJIF Scientific Journal Impact Factor

**Impact Factor:
7.512**

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details