VARIATION OF ELECTRON DENSITY ABOVE INDIA OBSERVED BY DEMETER MICRO-SATELLITE AND THE CRABEX PROJECT

A.K.Gwal[(1)], M.Parrot[(2)], J.L.Pincon [(2)], J.P.Lebreton[(2)], A.Trigunait[(2)], Shivalika Sarkar[(1)], Kalpana Malhotra[(1)] and Neerja Sharma[(1)]

(1) Space Science laboratory, Department of Physics, Barkatullah University Bhopal 462026, India
Email: - splakg@sancharnet.in
(2) LPCE/CNRS, 3A Avenue de la Recherche, 45071,Orleans cedex 2, France
Email: - mparrot@cnrs-orleans.fr

ABSTRACT

DEMETER is a low altitude micro satellite (h=710km) with a nearly polar orbit. The payload of DEMETER is composed of several sensors, of which the Langmuir Probe Instrument will be used to measure the total density of plasma and the satellite potential. Data is available from the web server (http://demeter.cnrs-orleans.fr). The Coherent Radio Beacon Experiment (CRABEX) is the Indian tomography program to construct a two dimensional electron density profile of low latitude ionosphere. The relative phase between the two coherent frequencies 150MHz and 400MHz is calculated, which is directly proportional to the slant Total Electron Content (TEC) from the satellite to the receiver at ground. TEC data is also recorded from dual frequency GPS receiver at Bhopal (23.20ºN, 77.54ºE, Dip 18.5º). The CRABEX data is correlated with the measurement of electron density performed by DEMETER. GPS data will also be compared with DEMETER and CRABEX data.

INTRODUCTION

The ionosphere is the one of the most difficult region to make measurement, its ion and electron densities changes dramatically with time of day, season and variations in solar activity. For probing the ionosphere the satellites based observations have major advantage since it covers almost all areas throughout the world very quickly and are able to provide details on the structure, composition and dynamics of the topside ionosphere [1]. The ground reception of signal from satellite radio beacon is the most commonly used method [2], TEC that is the line integral of electron density along the propagation path of the radio waves from satellite to the ground receiver were deduced receiving the beacon transmissions. In the present analysis the ionospheric behaviour and its variability has been observed by Low Earth Orbiting Satellites (LEOS), which give much faster sweep across the ionosphere. The electron density profile has been observed by DEMETER micro- satellite launched on June 29, 2004 by a Dnepr rocket from Baikonur Cosmodrome, Kazakhstan. It is a low-altitude satellite (h = 710 km) with a nearly polar and sun synchronous orbit. The first scientific objective is to study emissions of EM waves observed during earthquakes, disturbances in the ionosphere and upper atmosphere, and the corresponding precipitation of particles, systematically. The second scientific objective is the global monitoring of the electro-magnetic environment around the earth. To achieve these objectives, the mission includes sensors designed to measure 6 components of the electromagnetic field (magnetic antenna, electrical antenna) in a wide frequency range, and sensors designed to analyze the plasma environment (particle detector, plasma analysis and Langmuir probe).
The Langmuir probe instrument (ISL) is designed to measure the electron density of plasma (in the range $10^2 – 5.10^6$ particles /cm^3, electron temperature (in the range 500K – 3000K) and the potential of the satellite (in the range +/- 5V). The ISL is made of two Langmuir probes: a cylindrical probe and a segmented spherical probe of 4cm in diameter. The fundamental parameters of thermal plasma (density and temperature) are determined mainly from current –voltage response curve of the main Langmuir probe, the cylindrical probe. The Total Electron Content (TEC) data have been carried out by CRABEX experiment. It is a national programme for tomographic study of low latitude ionosphere. The latitudinal distribution of TEC measured using phase coherent radio signals transmitted by LEOS of Navy Ionospheric Monitoring System (NIMS). Transmission from these satellites in the form of dual frequency, phase coherent signal at approximately 150MHz and 400MHz, that would be monitored by the chain of CRABEX receivers at ground. As LEOS passed behind the earth, the radio path of the signals would be systematically refracted by the virtual gradient of ionospheric refractivity. Then the differential Doppler shifted signals are used to estimate the ionospheric properties.

RESULTS AND DISCUSSION

There are various different parameters available for probing the different characteristics of the ionosphere. The ionospheric electron density and TEC are the most important parameters to study the ionospheric variability. In the present analysis we have used DEMETER and CRABEX data of dates 27-29 Jan 05. The observation of electron density and TEC plots from CRABEX and DEMETER data has been shown from Fig 1-3. The variation of electron density obtained from the ISL experiment of DEMETER has been plotted versus latitude, time and L value. The TEC plots of CRABEX data have been observed from the passes of Oscar 23 and Oscar 32 satellites of NIMS. The electron density observed from DEMETER has been recorded during morning hours and the TEC recorded from CRABEX data are from the afternoon time passes. As expected same has been found from all the observed variations the afternoon hours TEC obtained from CRABEX data are having much higher values as compared to electron density values obtained from DEMETER satellite.

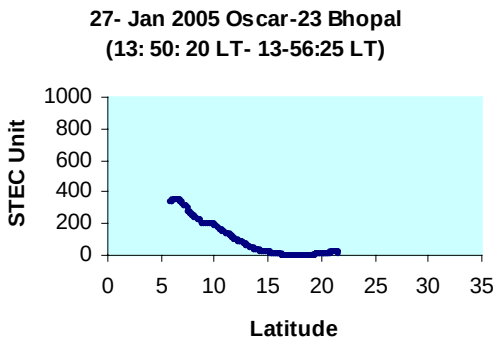

Fig. 1a

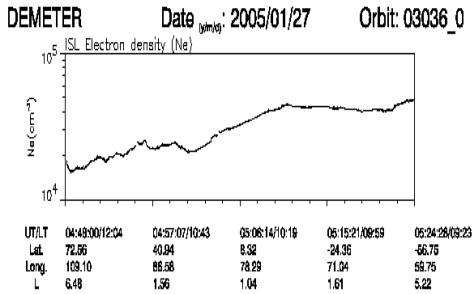

Fig. 1b

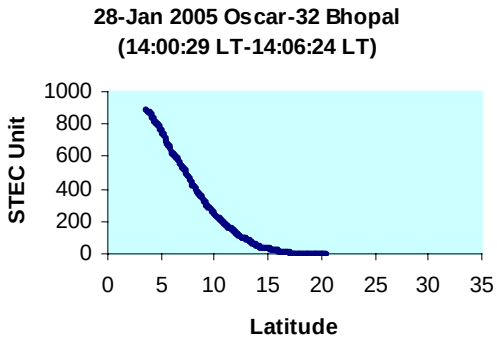

Fig. 2a

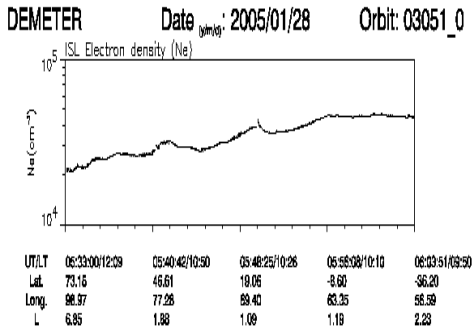

Fig. 2b

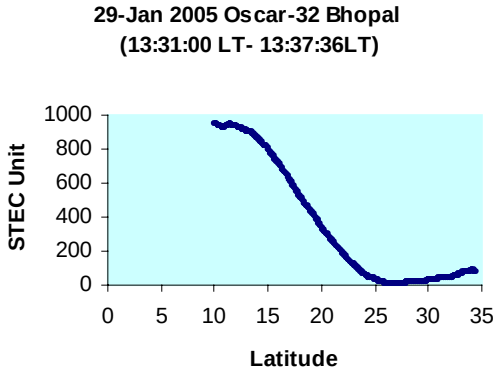

Fig. 3a

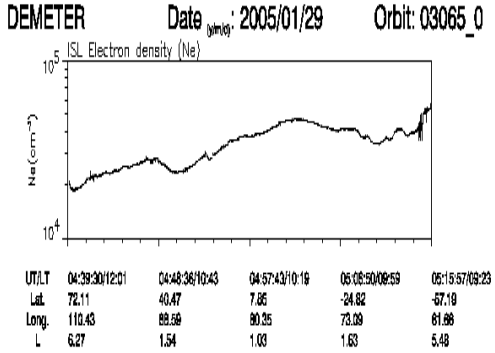

Fig. 3b

CONCLUSION

On summarizing the results, in this paper we have given variations observed in electron density and TEC during time period of 27 to 29 Jan 2005. The low latitude behavior of ionosphere can be very well studied with the help of these two parameters. LEO satellites have an advantage that they have passes at frequent intervals of time to study in depth the formation, growth and sustenance of ionospheric irregularities. These are the initial and preliminary observations that we found and observed. In future the TEC data collected from all the receiving stations of CRABEX programme and electron density from DEMETER satellite will help us to understand the low latitude characteristics of ionosphere during quiet and disturbed conditions.

REFERENCES

[1] A.R.Jacobson, G. Hoogeveen, R.C.Carlos, G.Wu, B.G. Fejer, and M.C. Kelley, (1996), "Observations of inner plasmasphere irregularities with a satellite-beacon radio-interferometer array", *Journal of Geophysical Researc*h, 101: 19665–19682, 1996

[2] Davies, K., Ionospheric Radio. Peter Peregrinus Ltd., London, UK, 1990

[3] F.F. Chen, "Introduction to Plasma Physics", Plenum Press, New York, 1974.

[4] A.Paul, S.Ray and A.Dasgupta, "First in situ observations of equatorial ionospheric bubbles by Indian satellite SROSS-C2 and simultaneous multisatellite scintillations", *Radio Science*, vol.37, No.5, pp. 1087, 2002.