DAILY VARIATION OF TOTAL ELECTRON CONTENT NEAR MAGNETIC EQUATOR

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ABSTRACT

Mean daily variations of the total electron content (N_F) derived from the Faraday rotation measurements made at Ootacamund during October 20–November 5, 1975, are described and are compared with similar variation for Ahmedabad. The noon bite-out, observed in the daily variation of $f_0 F_2$ near magnetic equator, is absent in N_F. However, there is a sharp decrease in the rate of increase in N_F indicating ionization flow due to Fountain effect. It is suggested that the effect of noon bite-out in N_F is diluted because of its being an integrated parameter over the whole ray-path.

INTRODUCTION

THE F_2 region in the equatorial latitudes is marked by two distinct features. (1) Daily variation of the critical frequency (f_0F_2) shows peaks in the morning and late evening with a valley near noon, generally known as midday bite-out[1-2]. (2) Latitudinal plot of noon f_0F_2 against magnetic dip shows two maxima around 30° dip with a trough around magnetic equator[3], generally known as Appleton anomaly or Equatorial F_2 anomaly. Both the midday bite-out and the equatorial trough in f_0F_2 are explained in terms of the vertical uplift of the ionization at the magnetic equator due to E × B force and the subsequent diffusion down the field lines termed as Fountain effect[4-8].

With the advent of radio beacons aboard the artificial satellites, a new technique has emerged to study the columnar electron content (N_F) through the measurement of Faraday rotation of the signal at ground. The signals from the low orbiting satellites have been used extensively by different workers to study the latitudinal profiles of N_F at a particular instant of time. Combining such data for over a few months, one can also obtain a daily variation of N_F at a particular location. At a tropical latitude, Ahmedabad, close to the crest of anomaly, daily variations of N_F and N_m have been found to be similar[9]. In the equatorial region the latitudinal plots of N_F showed trough at the equator with crests around 20° dip latitudes consistently. However, there have been some discrepancies in the daily variations of N_F. Blumle[10] reported absence of bite-out at Huancayo, whereas for the same station from later observations Bandyopadhyay[11] inferred bite-out to be present. Observations at Ibadan, Thumba and Kodaikanal did not show any bite-out in N_F[12-14]. Rufenach *et al.*[15] reported that f_0F_2 at Bangkok showed the presence of bite-out in its daily variation but no corresponding bite-out was observed in N_F.

One of the difficulties in deriving a conclusive result about the daily variation of N_F from measurements from the orbiting satellites has been that a single daily variation curve can be obtained only from data of at least a few months. The beacons aboard a geostationary satellite therefore are being used these days as they provide continuous observations over a long period of time. Thus, a good time resolution is achieved.

With the positioning of ATS-6 satellite to 35° E in 1975, it was possible to record Faraday rotation continuously for nearly a year at several locations in India. Some of the results from multi-station observations have earlier been reported[16-19]. During this phase of ATS-6, a joint radio beacon experiment was conducted by the NOAA Laboratories, Boulder and the Physical Research Laboratory, Ahmedabad, at Ootacamund[20]. In the present article a comparison of the daily variations of N_F at Ootacamund has been made with N_F at Kodaikanal and also N_F at Ahmedabad. The results have also been critically discussed.

RESULTS

Mean daily variations of N_F at Ootacamund (subionospheric point 72·9° E, 10·6° N) and N_m at Kodaikanal (77·5° E, 10·0° N) for the period October 20 to November 5, 1975 for which simultaneous observations were available are shown in Fig. 1. The data have been plotted at an interval of 15 min, for a good time resolution. The error bars of some representative points are also indicated in the diagram. As expected, N_m shows very distinct bite-out at noon with maximum of magnitude $10 \cdot 2 \times 10^{11}$ el m^{-3} at 0915

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LT (75° EMT) in the morning and the other maximum of $11 \cdot 3 \times 10^{11}$ el m^{-3} at 1630 LT in the afternoon. The minimum value of N_m is $7 \cdot 2 \times 10^{11}$ el m^{-3} at 1145 LT. The standard error of these points is about $0 \cdot 5 \times 10^{11}$ el m^{-3} and therefore midday minimum is statistically highly significant. The curve for N_F does show a decrease in the rate of increase but no minimum around midday hours is noticed.

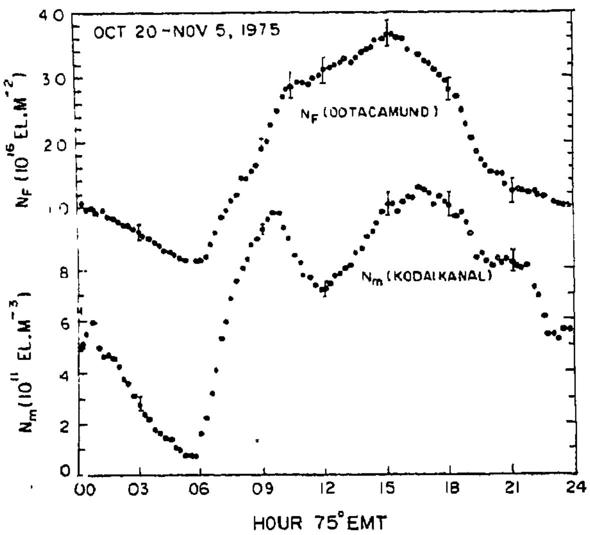

FIG. 1. Mean daily variations of the Faraday content N_F at Ootacamund and of peak F_2 region electron density N_m at Kodaikanal, for the period October 20–November 5, 1975.

The mean daily variation of N_F and the rate of change of N_F at Ootacamund has been compared with that at Ahmedabad in Fig. 2. Some of the important features to be noted are as follows :

(1) During night time (1900–0600 h LT) the N_F values for Ootacamund are higher than the corresponding values for Ahmedabad.

(2) Even during prenoon hours (0600–1200 h LT), the Ootacamund values are higher than the values at Ahmedabad which indicate that the crest has not yet reached the latitude of Ahmedabad.

(3) During afternoon hours (1400–1600 h LT) the N_F values at Ahmedabad are higher than the Ootacamund N_F values showing the presence of well-developed equatorial anomaly.

(4) The mean daily variation of N_F at Ahmedabad shows a sharp peak around 1500 h LT whereas for Ootacamund, one notices a flat maximum during noon hours.

(5) One clearly notices a sharp decrease in the rate of increase of N_F at Ootacamund, around 1000 h LT, which is thought to be a manifestation of the Fountain effect which is responsible for the noon bite-out.

(6) Around sunset, one observes an enhanced rate of decrease of N_F, the peak rate of decrease being sharper for Ootacamund.

(7) During the post-midnight hours, N_F at Ootacamund decreases by a factor of 5 whereas at Ahmedabad, N_F remains more or less constant at a low value.

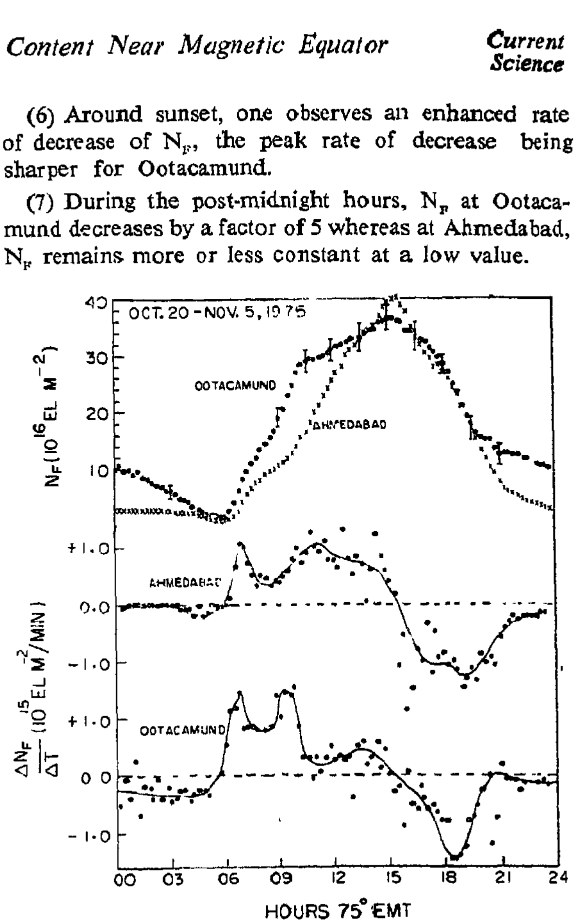

FIG. 2. Mean daily variations of N_F at Ootacamund compared with N_F at Ahmedabad. The lower part of the diagram gives the rate of change of N_F at two stations.

Discussions

The increase of N_F during daytime at Ahmedabad shows the dumping of the ionization due to Fountain effect, but corresponding to it, the decrease in N_F at the equatorial station Ootacamund, is not that marked. It is to be noted that the Fountain effect is most effective between the altitudes 400 and 600 km[21], whereas N_F contains the electron content upto an altitude of approximately 1500–2000 km[20,22]. Also it is found that the equatorial F-region becomes thick during noon time[23]. In view of the above two factors, it is suggested that the effect of the noon bite-out, which is present very prominently in f_0F_2, gets diluted in N_F. The conclusions of the present study are based on the observations of the period October–November, 1975.

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