SHORT COMMUNICATIONS

A METHOD OF OBTAINING THE MEAN ELECTRON COLLISION FREQUENCIES IN THE F_2 LAYER FROM COSMIC NOISE ABSORPTION STUDIES*

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In the previous paper (pp. 455–62 of the present issue) the authors have shown that the total ionospheric absorption of cosmic noise at 28·6 MHz can be expressed as a sum of three contributions: from the F_2 layer (including topside ionosphere), from the D and E layers, and from abnormal phenomena such as spread-F; and can be given by the expression

$$A = b(f_0 F_2)^2 + c f_{\min}^{2\cdot 2} + d, \tag{1}$$

where A is the total absorption (in dB), $f_0 F_2$ is the critical frequency of the F_2 layer (in MHz), $f_{\min}$ is the minimum reflected echo from the F layer (in MHz), b is a constant (0·11 dB/MHz²), c is a constant (in dB/MHz²), and d is the uncorrelated excess absorption due to any irregularities in the ionosphere (in dB). The correlation between the absorption and $f_0 F_2$ was established on the basis of observations during the late evening hours from 20 hr to midnight local time. This result has been used by the authors to determine the mean electron collision frequencies in the F_2 layer of the ionosphere.

Recent measurements (Johnson 1961) using rocket and satellite techniques have established that the topside ionosphere up to 800 km exhibits diurnal and seasonal variations similar to the F_2 layer. It is therefore reasonable to assume, as a first approximation, that the F_2 region is parabolic both below and above the layer of maximum ionization from $h = -2H$ to $h = +2H$, where $h = 0$ corresponds to the maximum ionization level and H is the scale height. Based on this assumption, it can be shown that the absorption at a frequency of 28·6 MHz can be expressed in the form

$$A = 1\cdot 427 \times 10^{-17} \int N\nu \, \mathrm{d}h, \tag{2}$$

where A is the absorption (in dB), N is the electron density per cubic metre, ν is the collision frequency per second, and the integration limits are from $-2H$ to $+2H$. For the parabolic model that has been assumed, N can be written as

$$N/N_{\max} = (1 - h^2/4H^2), \tag{3}$$

* Manuscript received March 8, 1967.

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where N_{max} is the electron density at the level of maximum ionization in the F_2 layer and is related to $f_0 F_2$ by the expression

$$N_{max} = 1\cdot 24 \times 10^4 (f_0 F_2)^2. \tag{4}$$

Using equations (3) and (4), we can obtain an expression for the absorption A in terms of $f_0 F_2$. In order to simplify the integration, ν is assumed to be fairly constant over the entire F_2 region. This assumption appears to be reasonable, as electron densities over the region under consideration vary by as much as a factor of 10, whereas the collision frequencies vary only by a factor of 2. Data for this assumption have been drawn from Johnson (1961).

TABLE 1

MONTHLY VALUES OF MEAN COLLISION FREQUENCY FOR F_2 LAYER

Month and Year	Constant b (dB/MHz^2)	Mean Collision Frequency for F_2 Layer (10^3/sec)
August 1962	0·0120	3·2
September	0·0096	2·5
October	0·0120	3·2
November	0·0130	3·4
December	0·0098	2·6
February 1963	0·0083	2·2
April	0·012	3·2
May	0·0087	2·3
June	0·0080	2·1
July	0·0110	2·9
August	0·0120	3·2
September	0·0110	2·9
January 1964	0·0110	2·9
February	0·0089	2·4
March	0·0100	2·7
April	0·0089	2·4

Assuming 80 km as a reasonable value of scale height for the period under investigation (derived from the true height analysis of the Kodaikanal ionospheric data) and combining equations (2), (3), and (4), after taking ν out of the integral as an average value equation (2) can be rewritten as

$$A = 3\cdot 773 \times 10^{-6} \nu (f_0 F_2)^2. \tag{5}$$

Comparing equations (1) and (5), we can write an expression for b as

$$b = 3\cdot 773 \times 10^{-6} \nu. \tag{6}$$

Using the above equation, the mean collision frequency for the F_2 layer at 20 hr Indian Standard Time has been computed. The constant b and the corresponding collision frequency for each month have been obtained from the monthly mean values of cosmic noise absorption and the results are given in Table 1.

The present work gives an approximate estimate of the mean collision frequency for the F_2 layer and this is compared in Table 2 with the results obtained by other authors. The values in Table 2 indicate the general agreement of the present result with those of the earlier investigations.

TABLE 2

COMPARISON OF PRESENT RESULT WITH THOSE OF EARLIER INVESTIGATIONS

Reference	Mean Collision Frequency for F_2 Layer (10^3/sec)
Whitehead (1959)	$3 \cdot 6 \pm 0 \cdot 6$ and $3 \cdot 0 \pm 0 \cdot 6$
Murty *et al.* (1959)	4·0
Ramana and Rao (1961)	2·4
Checcacci and De Giorgio (1963)	1·72 to 5·68
Present work	2·8

The authors wish to thank Dr. S. Bhagavantam, under whose guidance this work was initiated, and Professor R. S. Krishnan, who made available facilities to continue the observations at the Indian Institute of Science, Bangalore.

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