Electron Densities to 5 Earth Radii Deduced from Nose Whistlers[1]

R. L. SMITH AND R. A. HELLIWELL

Radioscience Laboratory
Stanford University, Stanford, California

Abstract. Whistlers appear to propagate in columns of enhanced ionization aligned with the earth's magnetic field. From nose whistlers a value of 100 electrons/cm^3 is calculated at 5 earth radii.

Our study of nose whistlers has yielded new information on the structure and electron content of the outer ionosphere. The fine structure of whistlers can be attributed principally to the presence of field-aligned columns of enhanced ionization. The theory of propagation in these columns requires that the enhancement be of the order of 50 per cent of the background ionization. The lifetime of the columns is of the order of a few hours.

From each nose-whistler trace we can determine fairly accurately the effective latitude of the path of propagation along a particular tube of magnetic flux. The time delay of the whistler then gives the integrated plasma frequency weighted inversely with respect to the square root of magnetic field strength.

Nose-whistler data covering the years from 1955 to 1959 have been obtained from ten different stations. They clearly indicate an annual variation of about 30 per cent in electron density in the outer ionosphere. An attempt was made to fit the data to various proposed models of the outer ionosphere. The Dungey model, $N = K \exp (2.5/R)$, for a temperature of 1500°K is clearly inconsistent with the data. One way to force the Dungey model to fit the data is to require the base level of ionization to vary more than 4 to 1 over 15° of latitude (50° to 65°).

Another possibility is that the temperature of the outer ionosphere is only 500°K. The same remarks apply to the model at present proposed by F. S. Johnson.

Two other models, electron density proportional to gyro frequency ($N = Kf_H$), or to the product of gyro frequency and the Dungey factor ($N = Kf_H \exp [2.5/R]$), fit the data fairly well. Figure 1 shows the resulting electron distribution for the gyro-frequency model.

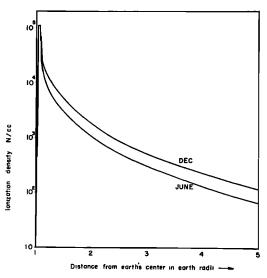The data and a more complete discussion of the results will be published in the near future.

Fig. 1.

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