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Modelling of the Ionosphere and Comparison of the Calculated and Observed Cosmic Radio Noise Absorption over Delhi

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Abstract. Making use of the latest available information, the collision frequency and the electron density profiles, appropriate for the latitude of Delhi, for sunspot maximum and minimum conditions are constructed and the absorption coefficients at the riometer operating frequencies are evaluated. From these the expected absorption is evaluated and compared with the observed absorption over Delhi. The observed and calculated absorptions are in agreement within the limits of the observational errors.

Key words: Ionospheric modelling electron density – Collision frequency – Absorption coefficient – Riometer absorption – Cosmic radio noise

1. Introduction

In recent years theoretical modelling of the ionosphere has become important for the studies of prediction of radio wave propagation like absorption. Development of these models to match the observed cosmic radio noise absorption in the VHF range over Delhi has been described in this investigation. These models will be useful in the propagation calculations in the VHF range for any system designer. Shortcomings of these models are judged directly to the extent to which the absorption calculated from these models match with the observed absorption from riometers.

2. Methods of Computation

2.1. Collision Frequency Model

The neutral atmospheric model of Groves (1970) combined with collision frequency calculations of Itikawa (1971) are employed in deriving the collision

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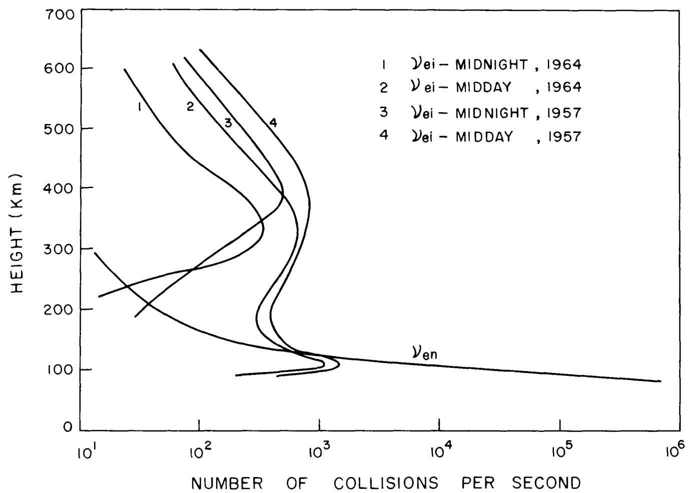

Fig. 1. Collision frequency model profiles

frequency profile below 100 km. We also made use of the equations given by Jacchia (1971) for deducing the number densities of major neutrals in calculating the collision frequency (Itikawa, 1971). The effect of electron ion collisions was neglected in this region and the electron and ion temperatures were assumed equal to the neutral temperature. It was observed that the derived collision frequency is in agreement with that obtained by Thrane and Piggot (1966). Further, the electron-ion collision frequency is calculated using the equation suggested by Anderson and Goldstein (1955). The electron collision frequency with neutrals is assumed to be the same for both the minimum and maximum solar epochs (Beynon and Rangaswami, 1969). Figure 1 shows the derived profiles for daytime and nighttime for both epochs of the solar cycle.

2.2. Electron Density Models

In developing the electron density profiles a major effort is put in to obtain profiles which are internally consistent and match with the observational data, at this latitude, in various regions of the ionosphere. In this process we made use of the International Reference Ionosphere (Rawer et al., 1975), ionosonde and satellite observations over Delhi and the semi-empirical D-region profiles. The electron density up to 100 km is taken from Chakrabarty and Mitra (1974). From h_mE to h_mF_2, the true height electron density profiles are derived from ionosonde data over Delhi. From h_mF_2 to 600 km (riometer absorption from heights above about 600 km is within the experimental accuracies of the system), maintaining the shape of the IRI profile, normalization with IRI profile is carried out with the observed foF_2 values. Thus we have developed N_e profiles for Delhi at intervals of every 2 h which are shown in Figures 2 and 3.

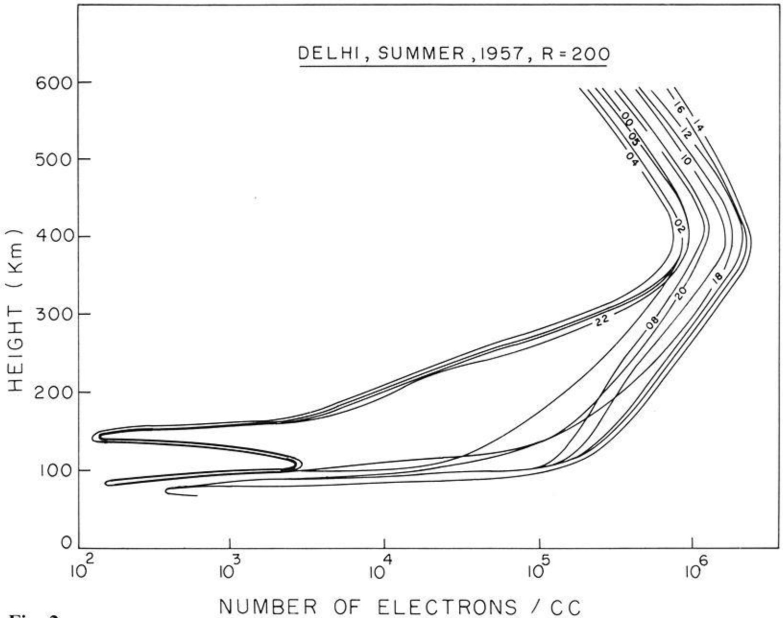

Fig. 2

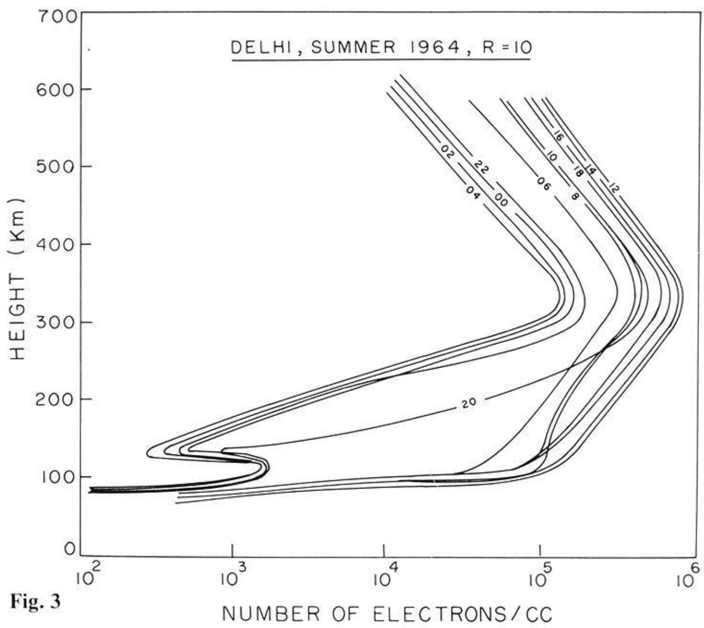

Fig. 3

Figs. 2–3. Electron density model profiles

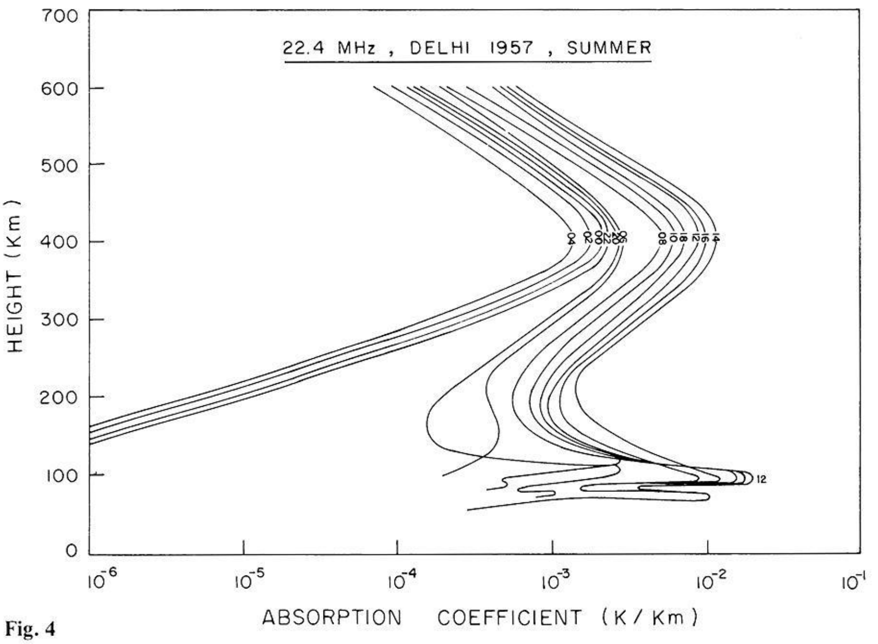

Fig. 4

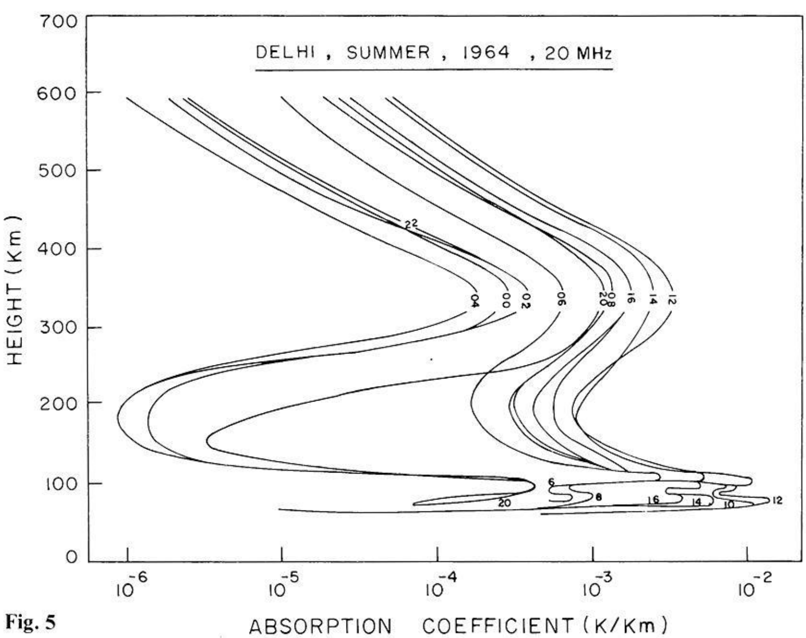

Fig. 5

Figs 4–5. Absorption coefficient versus height

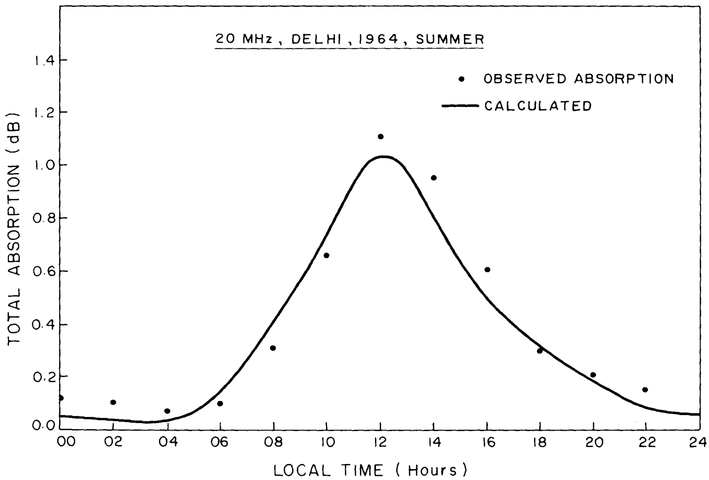

Fig. 6. Comparison of calculated and observed absorption

2.3. Absorption Coefficient Evaluation

From the above models the absorption ceofficient at various height intervals is calculated for different hours of the day both for solar minimum and maximum conditions and are shown in Figures 4 and 5. The absorption coefficients are summed up using the Simpson rule to get total absorption. Absorption from 60–100 km is termed as lower region contribution and from 100–600 km is named as F region contribution.

3. Comparison of Riometer Absorption with Model Calculations

The calculated absorption (at 20 MHz) discussed above is compared with that of the measured riometer absorption for low solar activity. Figure 6 indicates the diurnal variation. It can be seen that the calculated absorption is generally in good agreement with the observed absorption within the limits of the experimental errors (in case of riometer absorption accuracy is limited to ± 0.1 db). A similar result is observed for high solar activity (Sharma, 1976).

4. Conclusions

During the low solar activity the observed and calculated absorptions are in agreement within the limits of observational errors indicating that the models of collision frequency and electron density profiles developed for this latitude can be considered to be consistent with the observations. The internal consistency in the observations and the general agreement with model absorption calculations suggests that the riometer method of determination of normal absorption at low and temperate latitudes is dependable.

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