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Multifrequency Vertical Incidence (A-1 Method) Absorption Measurements at Ahmedabad during Total Solar Eclipse October 1995

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Abstract

A vertical incidence multifrequency absorption experiment was conducted on 2.2, 2.5 and 2.8 MHz at Ahmedabad during TSE Oct. 24, 1995.

From start of Eclipse a wave like structure in absorption starts and grows to maximum amplitude sometime after the maximum of Eclipse on all the frequencies. Later it decays and dies towards end of Eclipse only on lower two frequencies.

On lowest frequency the reflection height was in E-layer as on control days while the absorption was slightly higher.

On the two higher frequencies the reflection height was in F-region on Eclipse day while it is in the E-region on control days. The absorption was also much reduced and the heights of reflection within the F-region also increased upto maximum of Eclipse.

Key Words : Ionospheric absorption, Solar eclipse

Introduction

A vertical incidence multifrequency absorption experiment is operational at Ahmedabad since 1972 using the equipment from GDR Germany. The three radio frequencies 2.2, 2.5 and 2.8 MHz are sent alternately; each with a repetition rate of 10 pulses of 100 μs duration. The experiment runs for five minutes and the average strength of echo of the reflected pulse is compared with the assumed night time loss less reflection to give the absorption. The height of ionosphere from where the pulse is reflected is obtained by measuring the time required by the pulse to come back.

The absorption measurements were made at half an hour intervals on control days and fifteen minutes intervals on eclipse day. The eclipse started at 7:23, maximum phase at 8:29 (83.4%) and ended at 9:45 IST at Ahmedabad (23°N, 72°E).

Observations and results

On all the frequencies echoes are from F-region heights 250 to 270 km on control days from 7:00 to 7:30 hrs. As the reflection shifts to E-region, the absorption rises steeply and there are large upheavals (undulations) in absorption which reduce at lower frequency 2.2 MHz at 8.30 hrs. while these persist up to 10.30 hrs, on 2.5 MHz. Generally the reflection height increases with increase in frequency.

From start of Eclipse (7:23 IST) a wave like structure in absorption starts and grows to maximum amplitude at 8 mts., 15 mts., and 30 mts. after maximum of eclipse (8.29 hrs.) on 2.2, 2.5 and 2.8 MHz respectively and dies towards end of eclipse (9.45 hrs.) at 2.2 and 2.5 MHz. However it never dies on 2.8 MHz.

During the progress of eclipse, the solar radiation incident is continuously reduced. This reduces the electron densities at all height regions. The foE at Ahmedabad remained above 2.2 MHz. Hence throughout the eclipse, the 2.2 MHz was reflected from the E-region. However as the eclipse progressed, the electron densities in the E-region reduced and thus the 2.2 MHz got reflected from higher heights within the E-region (110-165 km) (Fig. 1). Therefore a large deviative absorption also took place leading to overall increased absorption relative to control days. During this time the E-region was partially transmitting the 2.2 MHz which could reach F-layer and thus a much weaker echo was reflected from the F-region (260-305 km).

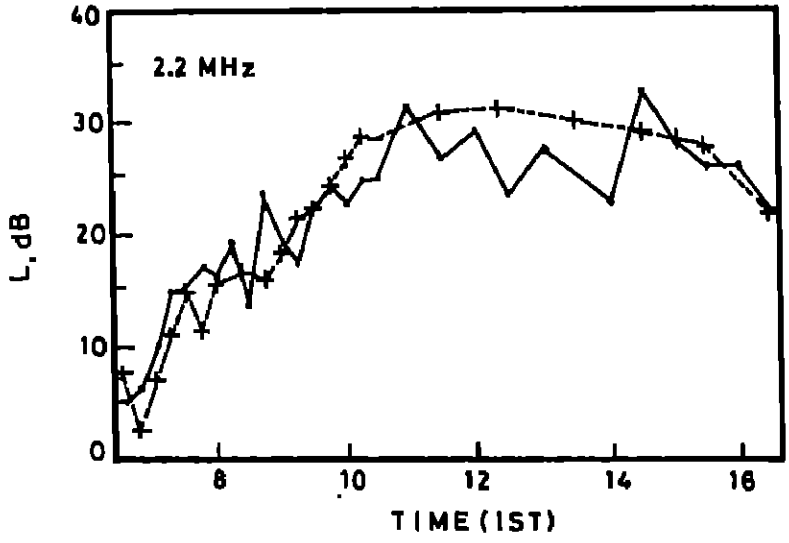

Figure 1 : Absorption of 2.2 MHz on 24th October, 1995. Eclipse day continuous line and control day dotted line.

Compared to above, picture on 2.5 & 2.8 MHz was totally different (Figures 2 & 3). Here since foE fell below 2.5 MHz strong echoes from F-layer were observed. Within F-region also the height of reflection increased till the maximum of eclipse (2.5 MHz - 245 to 275 km and 2.8 MHz – 245 to 285 km). This shows that the electron densities in the F-region decreased leading to more penetration and increased accompanied absorption. At the same time very weak reflections were observed from the E-region (2.5 MHz - 112 to 150 km & 2.8 MHz - 180 to 195 km).

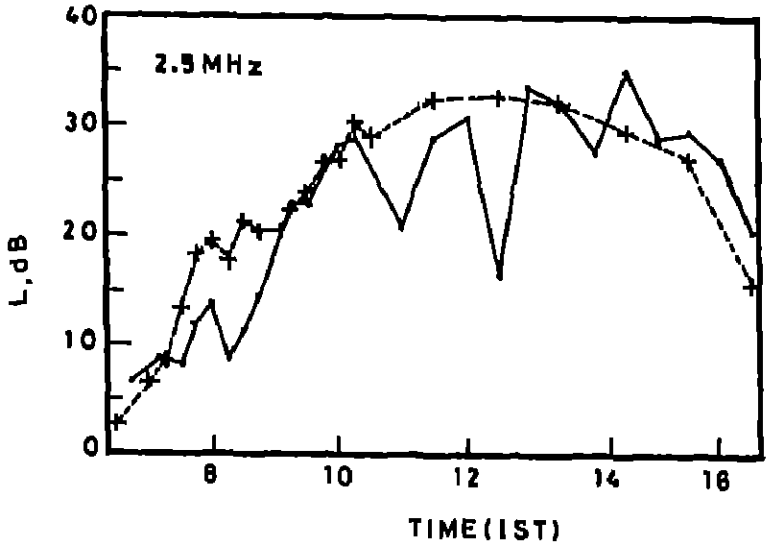

Figure 2 : Same as for Figure 1 except that it shows absorption for 2.5 MHz.

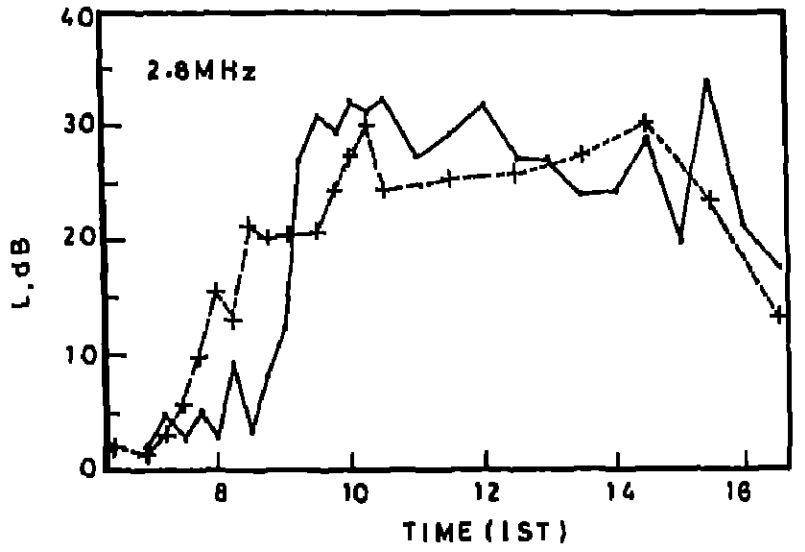

Figure 3 : Same as for Figure 1 except that it shows absorption for 2.8 MHz.

During 16th Feb. 1980 total solar eclipse similar work has been done which also includes electron density - height profile modelling (Patel *et al.* 1986 Jani *et al.*, 1982).

In the post eclipse period on all three frequencies from 9:00 hrs. (end 9:45 hrs.) the E-layer reflections are there. Initially the reflections came from larger heights. The layer then descends and stabilizes around 11 to 12 hrs. The heights of reflection again decrease in late afternoon upto 16.30 hrs. accompanied by large growing wave like undulations on the eclipse day. Large amplitude variation in absorption is observed but with reduced absorption compared to control days on 2.2 MHz throughout 9.00 to 16.30 hrs. While on 2.5 MHz reduced absorption from 9.00 to 14.00 hrs. and later from 14.30 to 16.30 hrs. slightly higher absorption than control days was seen. On the other hand on 2.8 MHz from 9.00 to 13.00 hrs. large amplitude variations but much larger absorption compared to control days and later also from 15.30 to 16.30 larger absorption than control days was observed.

The spurious peak in absorption at 14.30 IST is observed on all the frequencies, the heights of reflection being 112, 115 and 120 km as the frequency increases. Similarly at 15:30 IST a large absorption peak is there on 2.8 MHz, a very small peak on 2.5 MHz while no peak on 2.2 MHz. The height of reflection for all frequencies is at 110 km. This also shows large deviative absorption on 2.8 MHz and lesser deviative absorption on 2.5 MHz.

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