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I. PHYSICS

Astrophysis (Ionosphere)

IONOSPHERIC EFFECTS OF THE TOTAL SOLAR ECLIPSE OF 16 FEBRUARY 1980

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CHANGES in the features of the ionosphere over Ahmedabad, during the total solar eclipse of February 16, 1980, as revealed by the ionosonde observations and Faraday rotation measurements using 136 MHz radio beacon on board the geostationary satellite ETS-II are given in this paper.

Keywords : Ionosphere; Ionosonde; Faraday Rotation Measurements; Ionogram Scaling.

EXPERIMENT

Equipment

The automatic ionosonde C_4 at Ahmedabad, was operated continuously during the hours 12 to 18 IST. The sweep time of the ionosonde is 2 minutes, hence operations with a time resolution of 2 minutes were possible to study the eclipse effects. The Faraday rotation measurements are made continuously on a paper chart recorder and the data have been scaled quarter hourly for this study.

RESULTS

The *f*-plots have been prepared on the eclipse day (February 16, 1980) and February 17, 1980 (control day) from the quarter hourly ionogram scaling. These give the

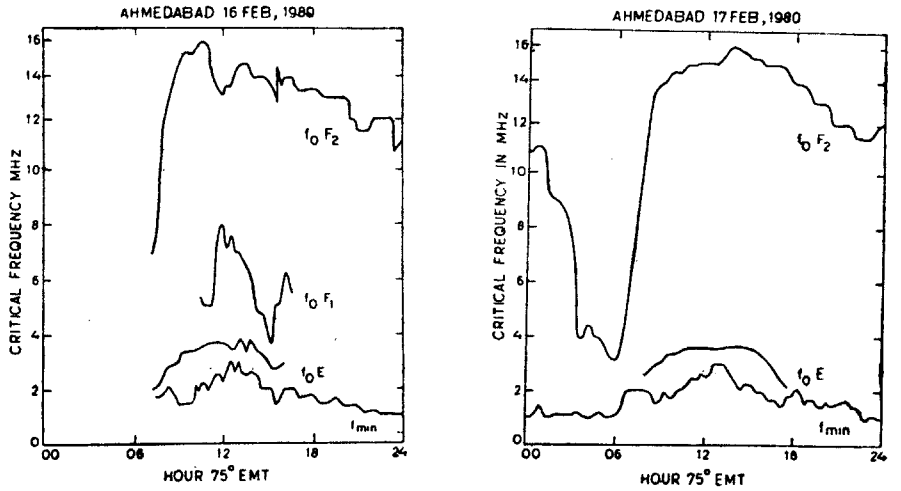

FIG. 1*a* & *b*

variation with time of the critical frequencies of E, F_1 and F_2 layers (f_0E, f_0F_1 and f_0F_2) and of the minimum frequency recorded by the ionosonde f_{min} and are shown in Fig. 1(*a*) and Fig. 1(*b*) on a normal day e.g., February 17, 1980, f_0E shows a flat mid-day peak with maximum f_0E value of 3.6 MHz. On eclipse day, however, there is a gradual decrease of f_0E from 1345 hrs and this drop continues till1530 hrs, when f_0E drops to 2.7 MHz. The f_0E increases again afterwards. Presence of E_s did not permit scaling of f_0E beyond 16hr, hence not shown in the figure. The drop from 3.5 MHz to 2.7 MHz comes out to about 40 per cent in terms of electron density. The time of the dip in f_0E matches with the time of the maximum phase of the eclipse. Similarly, decrease in f_{min} on February 16, 1980 is noted to be associated with the eclipse.

The critical frequency of the F_1 layer, f_0F_1, is hard to identify at low latitudes during the high sunspot years. Presence of an intermediate cusp between F_1 and F_2 layers known as $F_{1\cdot5}$ is usually present in high sunpot years. However, during the eclipse period, a clear cusp of F_1 layer was present and a composite f_0F 1.5 and f_0F_1 plot is drawn for eclipse day. A dip around the maximum phase of eclipse is clear.

The daily variation of f_0F_2 at Ahmedabad shows a well-defined peak centred around 14hr as seen on February 17, 1980, when peak value is about 16 MHz. The daily variation of f_0F_2 on February 16, 1980, however, does not show an afternoon peak but short period fluctuations are noted. It must be noted that a magnetic storm was recorded on February 14, 1980, and the unusual daily variation on February 16, 1980, could be the effect of storm conditions. A sudden decrease in f_0F_2 is, however, clearly seen associated with the eclipse. This is more clear in Fig. 2 where

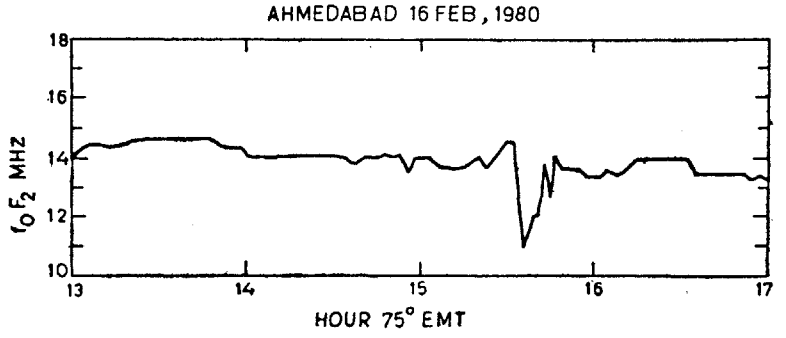

FIG. 2

f_0F_2 on February 16, 1980, is plotted during the period 13hr to 17hr from every 2 minute scalings. Values of f_0F_2 show a slow decrease from 13hr to 17hr when it drops from 14.5 MHz to 13.5 MHz. But at 1530hr it suddenly drops from 14.5 MHz to 11.0 MHz at 1535 hr which is little after (about 20 minutes) the maximum phase of the eclipse.

To examine the eclipse effects in the ionization at different real heights, quarter hourly ionograms on the two days have been reduced for true height analysis using Budden's matrix method. The time variations of the electron densities at fixed

real heights starting from 160km upto N_{max} level during the hours 13hr to 17hr have been studied. On February 17, 1980, there is a smooth decrease in the electron densities at all heights from about 14hr to 17hr. On February 16, 1980, in addition to this smooth decrease, there is a sharp decrease in electron densities at all heights, associated with the eclipse. This decrease is seen first at 1445hr at lower altitudes and gradually delayed to 1515hr at higher altitudes (around 400km). The minimum in electron density is seen at 1515hr for 160 km and gradually delayed to about 1545hr for higher altitudes.

The electron density distributions with height for few selected times on February 16, 1980, are shown in Fig. 3. For comparison, few profiles on February 17, 1980,

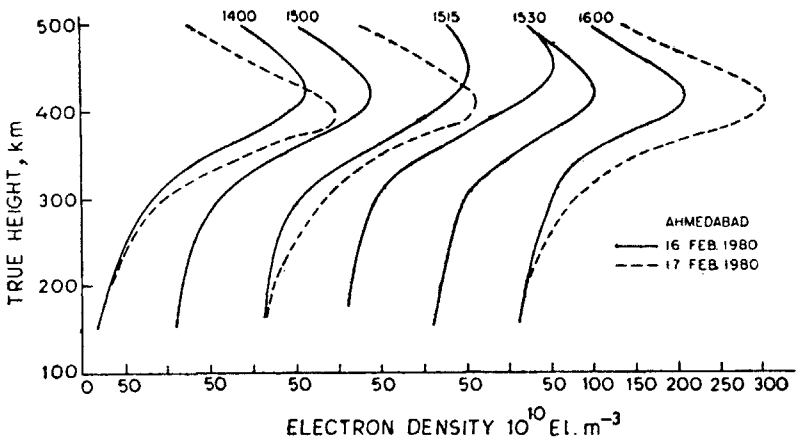

FIG. 3

are also shown in the same figure with dotted lines. The electron densities above the N_{max} level have been obtained by extrapolation using an exponential decrease. It is interesting to note that the distributions at 1515hr and 1530hr on February 16, 1980, show higher values of $h_{max}F_2$ and y_m. Thus the eclipse effects include the thickening of the F_2 layer as well as a raise in the F_2 layer itself.

Effects in TEC and Slab Thickness

Continuous recording of the Faraday rotation measurements were made at Ahmedabad, using the radio beacon at 136 MHz on board the geostationary satellite ETS-II. Quarter hourly values of the Faraday rotation angle have been converted into TEC using 350km as mean field height. The variation of TEC on February 16, 1980, is shown in Fig. 4. As pointed out earlier due to the storm condition, the prevailing TEC does not show a smooth variation with afternoon peak. There are fluctuations with a periodicity of few hours. Nevertheless, the dip in TEC at around 1530hr is associated with the eclipse. The change amounts to roughly (10–15) per cent. No evidence of eclipse induced gravity wave effects in TEC is noted. For comparison variation of N_mF_2 on this day is also shown in the figure along with the slab-thickness (TEC/N_mF_2). The N_m shows much sharper decrease

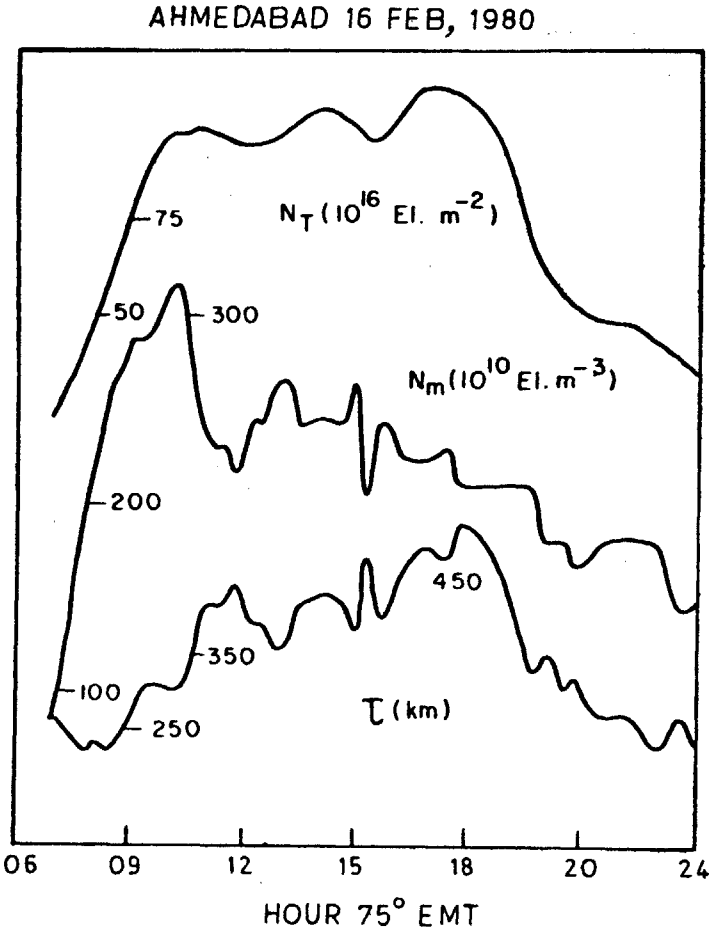

FIG. 4

than does the TEC, which is probably because TEC is an integrated effect. Sharp increase in the slab-thickness is seen around 1530hr which is also associated with the eclipse.

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