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Hour-to-hour & Day-to-day Variations of Ionospheric Absorption over Udaipur

B L ACHARYA & R K RAI
Department of Physics, Sukhadia University, Udaipur 313001

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Hour-to-hour and day-to-day variations at Udaipur (24°35'N) of ionospheric absorption during moderate and high solar activity periods (1978-80) are presented. The occurrence of two maxima in the diurnal variation of absorption due to solar flare, due to nearness of the working frequency to the critical frequency of the reflecting region and in the presence of sporadic-E (blanketing or flat type) is discussed. The day-to-day variations of absorption in the light of day-to-day variations of 10.7-cm solar flux, sunspot number and 1-8 Å X-ray flux have also been discussed.

Some investigators[1-4] have studied the diurnal variation of monthly median values of total and D-region absorption. The short-term, hour-to-hour and day-to-day fluctuations (caused by changes in the intensity of the solar radiations and of the atmospheric compositions) in the ionospheric absorption of the radio waves reflected from the ionosphere have now been investigated in this communication. The equipment, the method of recording, calibration and analysis of the data have already been reported[2-4].

Some typical graphs for the hourly variation of absorption along with the monthly median values of total and D-region absorption are shown in Fig. 1. The nature of the variation of absorption with time under quiet conditions (no solar flare, etc.) at all the frequencies in most of the cases is as follows. The absorption increases with the advance of the day, reaches its maximum value at local noon or sometime after the local noon and then decreases towards the sunset. The occurrence of maxima in the absorption after the local noon has been attributed to the relaxation time τ of the ionosphere. The value of τ has been estimated by recording the strength of the first order echo on a pen recorder from 1100 to 1300 hrs (75° EMT). The average value of τ in the case of total absorption at the working frequencies used has been found to be 27 min. The values of τ determined by various investigators[1,4-8] from absorption data for the wave reflected from the E and F-regions lie in the range 20-60 min.

On some occasions there are one or two maxima in diurnal variation curve of absorption, having their time positions quite different from that observed in the normal cases as referred to above. Some of the typical results are shown in Fig. 2. There may be various reasons for such typical behaviour. On going through the records of X-ray flux[9] on the dates of such typical behaviour, it was found that some of the maxima are due to excessive increase of X-ray flux (curves 2-4). Curve 2 (Fig. 2) shows two maxima, one at 1220 hrs and other at 1500 hrs (75° EMT) on 15 Sep. 1979 at 3.0 MHz. The maximum at 1220 hrs is the normal feature as shown in Fig. 1, but the maximum at

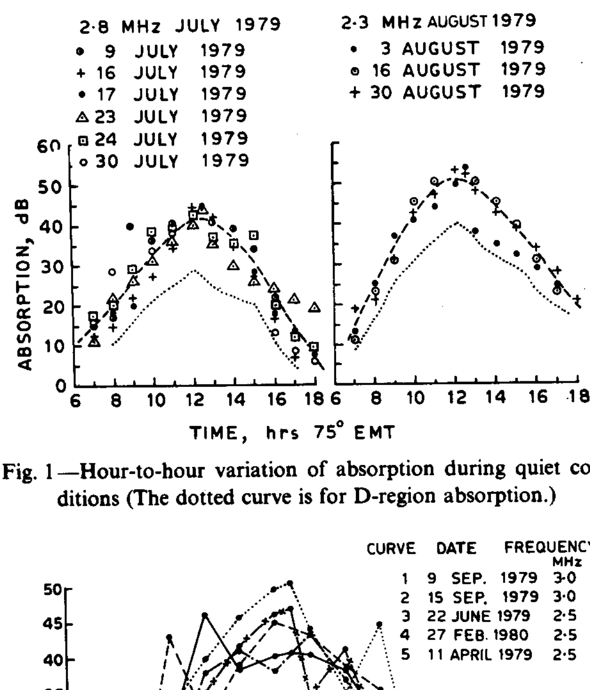

Fig. 1—Hour-to-hour variation of absorption during quiet conditions (The dotted curve is for D-region absorption.)

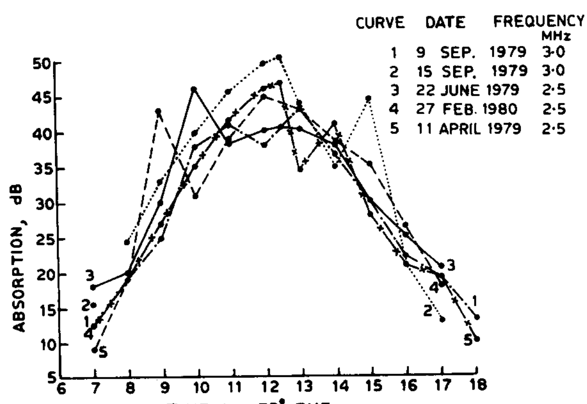

Fig. 2—Hour-to-hour variation of absorption during: (i) solar flare (curves 2-4); (ii) sporadic-E(curve-5); and (iii) hearness of the working frequency to the critical frequency of E-region (curve-1)

1500 hrs is due to solar flare. The beginning and peak of the flare occurred at 1440 and 1445 hrs, respectively. The type of the flare was A class (strong flare). The solar X-ray flux in the range 0.5-4 Å was found to be 3.8×10^{-2} ergs/cm^2/sec at 1500 hrs. The same in the range 1-8 Å was found to be 2.0×10^{-1} ergs/cm^2/sec. The normal value of X-ray flux at the same time is 5×10^{-5} for 0.5-4 Å and 1.0×10^{-3} ergs/cm^2/sec for 1-8 Å band. Curve 3 shows one maximum at 1000 hrs and another at about 1230 hrs. The maximum at 1230 hrs is the normal feature as discussed above, but the maximum at 1000 hrs is due to excessive increase in X-ray flux. The beginning and peak of the flare occurred at 0950 and 1006 hrs, respectively. The type of the flare was threshold one. The X-ray flux at that time was 5.2×10^{-3} ergs/cm^2/sec for 1-8 Å and 2.8×10^{-4} ergs/cm^2/sec for 0.5-4 Å band. The normal values of X-ray flux at the same time are about 4×10^{-4} and 1.2×10^{-5} ergs/cm^2/sec for 1-8 Å and 0.5-4 Å band, respectively.

The behaviour of curve 4 is the same as that of curve 3, but the first maximum is at 0900 hrs and other is as usual in the afternoon hours. In this case also the maximum at 0900 hrs is associated with increase in X-ray flux. The beginning and peak of the flare occurred at 0830 and 0900 hrs, respectively. The type of the flare was B class (moderate flare). The X-ray flux at this time was 1.8×10^{-2} ergs/cm^2/sec for 1-8 Å and 1.2×10^{-3} ergs/cm^2/sec for 0.5-4 Å band, whereas on normal day the flux at this time was 1.5×10^{-3} and 2×10^{-5} ergs/cm^2/sec for 1-8 Å and 0.5-4 Å, respectively.

On certain occasions, the presence of sporadic-E in the noon hours gives two maxima in the diurnal variation curve of absorption; curve 5 (Fig. 2) is an example of occurrence of *l*-type blanketing sporadic-E (Ebs) at about 1300 hrs. The absorption at this time was reduced by about 10 dB from the normal value. Thus, the occurrence of *l*-type Ebs at 1300 hrs has given two maxima, one at 1230 hrs and the other at 1400 hrs. The occurrence of two maxima is also due to nearness of the working frequency to the critical frequency of the reflecting layer (curve 1, Fig. 2).

When the reflection was observed from the *l*-type Ebs the absorption was found to be nearly equal to that of the D-region absorption. Fig. 3 shows a typical day's variation of absorption when *l*-type and flat type sporadic -E were present. The flat type Es is embedded within the E-layer and is generally a partially reflecting

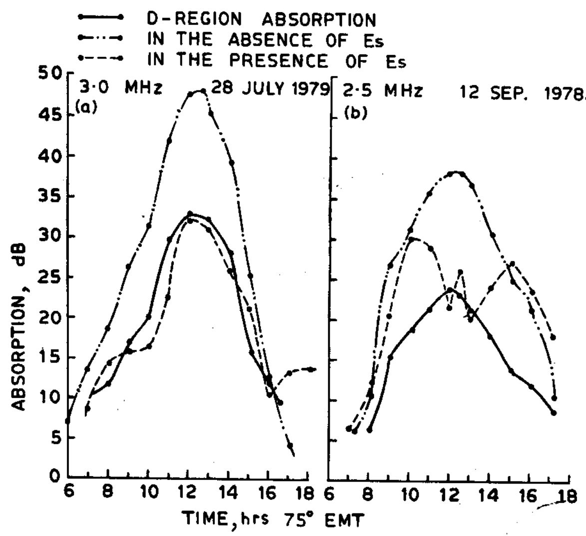

Fig. 3—Two examples of variation of absorption in the presence of Es

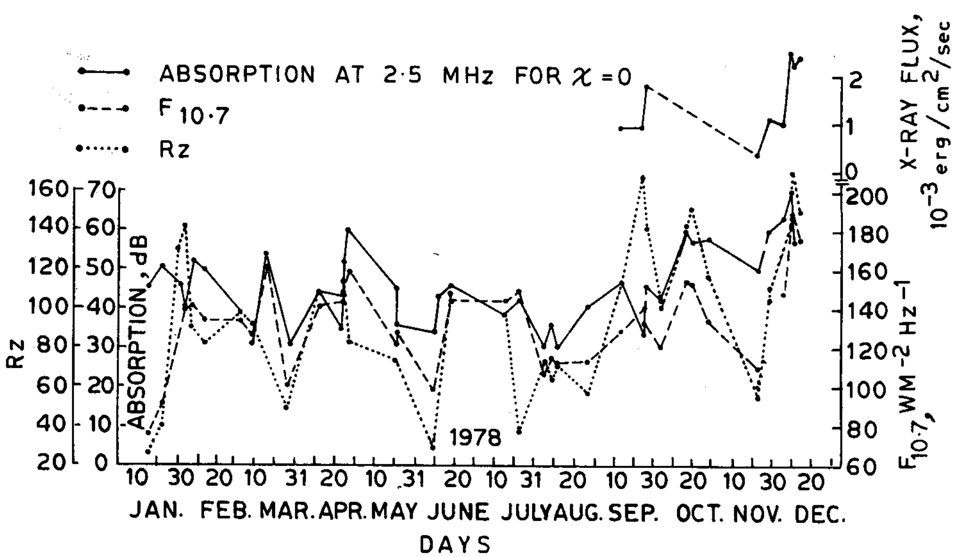

Fig. 4—Day-to-day variations of: (i) absorption at 2.5 MHz for $\chi = 0$ along with the day-to-day variation of X-ray flux(1-8 Å); (ii) Zurich relative sunspot number and (iii) 10.7-cm solar flux for the year 1978

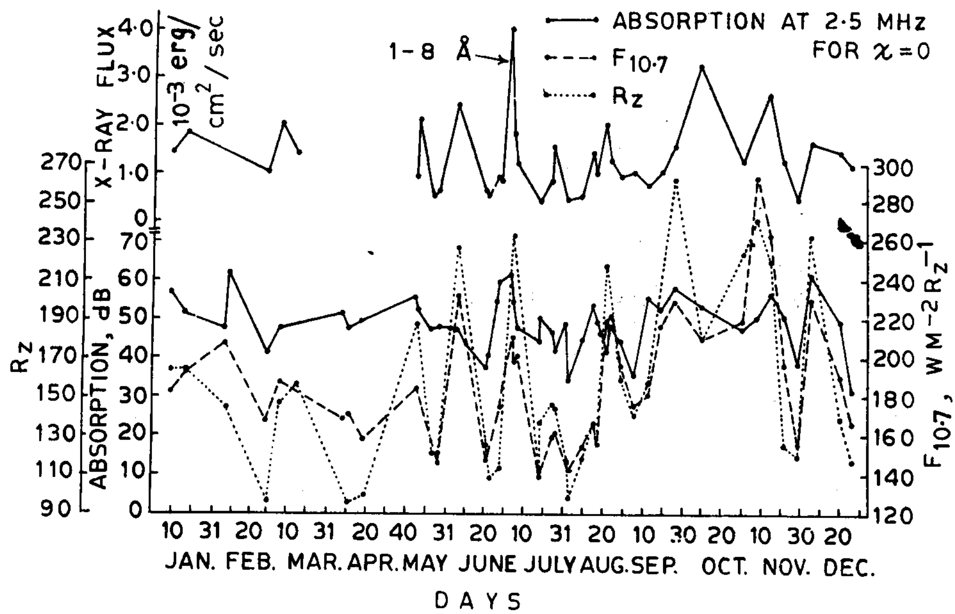

Fig. 5—Same as Fig. 4 but for the year 1979

layer. Fig. 3(a) shows the diurnal variation of absorption in the presence of *l*-type Ebs on 28 July 1979. On that day the duration of the occurrence of *l*-type Ebs was from 1000 to 1400 hrs. The monthly median values of total and D-region absorption are also plotted in Fig. 3. It is observed that the total absorption in the presence of *l*-type Ebs is nearly equal to that of the D-region absorption. Fig. 3(b) is another example of the presence of Es. At 1200 and 1300 hrs *l*-type Ebs was present. At 1100 and 1230 hrs the nature of Es was flat type and reduction in absorption is not to the extent as expected for Ebs. Analyzing a large number of absorption data in the presence of *l*-type blanketing sporadic-E during noon hours, it has been found that the absorption is reduced by about 25-30% of the normal value.

Figs 4 and 5 are the plots of day-to-day variations of absorption at 2.5 MHz for $\chi=0$, X-ray flux (1-8 Å) (Ref. 9), Zürich relative sunspot number (R_z) (Ref. 10) and 10.7-cm solar flux ($F_{10.7}$) (Ref. 11) for the years 1978 and 1979, respectively. From Fig. 4 it is observed that the day-to-day variation of absorption very closely follows the 10.7-cm solar flux rather than the sunspot number. It shows that 10.7-cm solar flux is a more accurate index of solar activity for ionospheric absorption than sunspot number. Hinteregger[12] has shown that the 10.7-cm solar flux is closely associated with the flux of EUV which ionizes the lower absorbing region. The curve of X-ray flux (1-8 Å) has been drawn only for those months for which X-ray flux was available. On comparing the results of 1978 and 1979, it is found that in the year 1979 the absorption curve

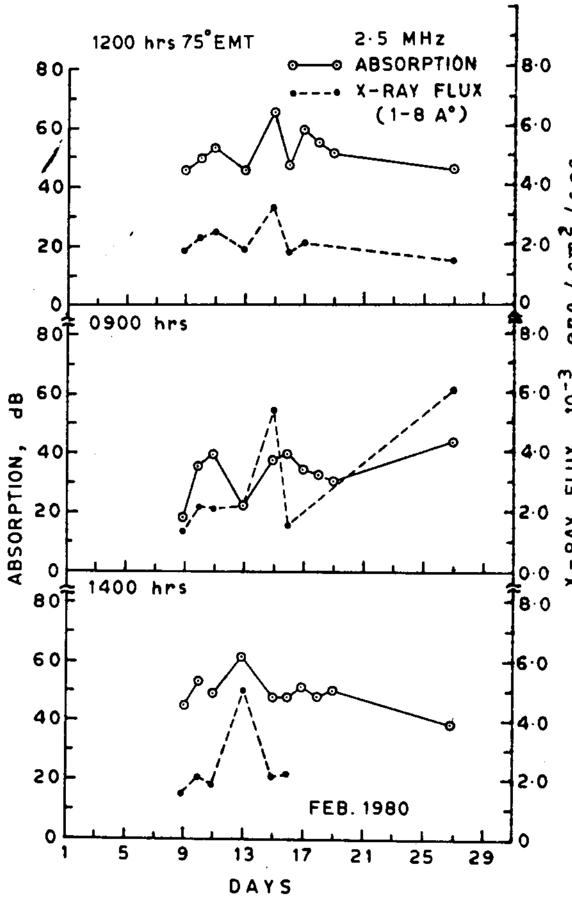

Fig. 6 – Day-to-day variation of absorption at different hours in the month of February 1980 at 2.5 MHz along with the X-ray flux (1-8 Å) at that time

does not very closely follow the 10.7-cm solar flux or R_z. Fig. 6 shows the day-to-day variation of absorption in the month of Feb. 1980 at different hours along with the X-ray flux at these times. The nature of absorption at different hours is similar to that of Fig. 5 except at solar flare times. The excessive enhancement of absorption in Figs. 5 and 6 are due to enhancement of X-ray flux, i.e. solar flares at such occasions.

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