Indian Journal of Radio & Space Physics
Vol. 2, June 1973, pp. 148-152

Night-time Changes in Field Strength of 11·8 MHz Radio Signals over Colombo-Ahmedabad Transmission Path

G. M. CHHIPA & B. M. PATEL

Department of Physics, Gujarat University, Ahmedabad 9

Received 7 *April* 1973

The results of a study of night-time records of the field strength of radio signals on 11·8 MHz transmitted from Colombo (6.9°N, 79.9°E, I=5°S) and obtained at Ahmedabad (23°N, 72.6°E, I=34°N) are reported. It is shown that the maximum strength is observed an hour after sunset in summer and almost at sunset in winter. This maximum is most pronounced in equinoctial months. The records show a fast fading of small amplitude on quiet days characteristic of spread-F. On magnetically disturbed days, the field strength undergoes large fluctuations with reduced fading rate and absence of flutter-type fading. On some occasions of high magnetic activity, signals become very weak. Such changes are believed to be caused by large-scale movements in the F2-layer and the accompanying changes in the electron density during the magnetic storm. Several instances of temporary sharp increases of field strengths over a duration of about 10 min have been recorded in the post-sunset to pre-midnight interval. Most of these are found to occur after solar radio bursts with a lag of 12-17 min. The observed effect of increased field strength may be due to a transient disturbance produced in the F2-layer due to the burst.

1. Introduction

REGULAR continuous recording of 'Radio Ceylon' 11·8 MHz signal is being done at Ahmedabad since July 1966 with a view to studying the SID and SWF phenomena and propagation conditions in the ionosphere for short waves. The transmission is interrupted for 2 hr in the forenoon and about 3 hr in the afternoon It has, therefore, not been possible to record SWFs which might have occurred during these day-time missing hours of transmission. However, the decay and recovery of the field strength owing to the appearance and disappearance of the absorbing ionospheric region below, spread-F effect, focussing effects, storm effects and so on, could be studied. As the signal strength is quite low around noon hours, the SID or SWF phenomena are generally not well-marked during this time interval. On Sundays and Saturdays we have recorded during mid-day also. The Colombo-Ahmedabad distance is about 2000 km and the transmission is believed to be by one-hop reflection from the F2-layer day and night, as the E-layer propagation would mean a very low angle transmission for this distance. The antenna used is a horizontal half-wave dipole and the field strength in mV/m is obtained by dividing the received signal in mV by the effective length λ/π of the antenna, $\lambda \approx 25.42$ m.

2. Mean Diurnal Variation of Signal Strength

The mean diurnal variation of the signal strength for each month of the year is shown in Fig 1. A dashed line running along the vertical for the morning period gives the time when the critical frequency f0E of the E-layer was equal to 2.1 MHz. In winter months, f0E approaches the equivalent vertical incidence signal frequency for one-hop E-layer reflection

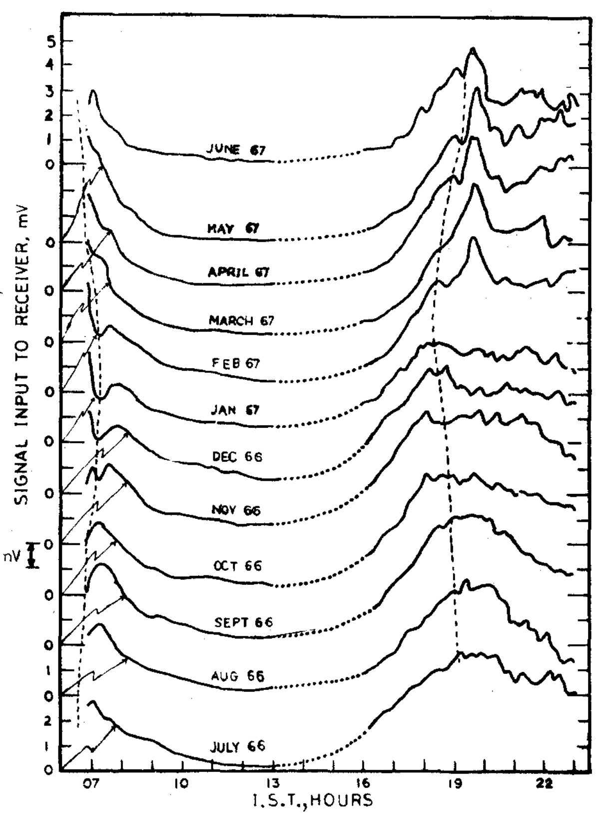

Fig. 1—Mean diurnal variation of signal strength on 11·8 MHz over Colombo-Ahmedabad transmission path for different months during 1966-67

after the transmission starts and, therefore, the depression in received signal during these months at the time shown by the dashed line is probably due to the contribution of deviative absorption in the E-layer. The increase that follows is largely due to decrease in deviative absorption as the E-layer becomes denser in ionization. As the D-layer builds up, the signal strength drops down. After 0900 hrs the signal stabilizes to a minimum value around 1 mV which varies with the season.

On the evening side, a dashed line is drawn to show the sunset time at 100 km altitude. The signal shoots up to a high value after sunset particularly in equinoxes. The dip-effect of the E-layer observed in the morning is obscured in the evening perhaps by the frequent occurrence of strong Es. Also the variation of signal strength is not so smooth and regular as in the morning hours. It may be seen that the rate of fall in the signal strength during the forenoon hours is most rapid in summer, about four times as rapid as that in winter and this fall commences later in winter than in other seasons. In the same way, the rate of increase of strength in the evening commences later and is rapid in summer. The post-sunset maximum occurring at about 1900-2000 hrs is larger in magnitude than the morning maximum and this maximum value is about 10 to 12 times the midday minimum value. It is believed that the post-sunset increase is caused by the focussing effect of the humped reflecting layer and F-Es irregularities.

3. Signal Strength Records on Disturbed Days

Under normal conditions in the ionosphere, the record of the signal strength shows small fluctuations with rapid fading and it stabilizes to more or less a constant level after the 2000 hrs maximum. The patchy dense record indicates flutter-fading due to the presence of spread-F or plasma noise. In Fig. 2 are reproduced some records of signal strength on days of

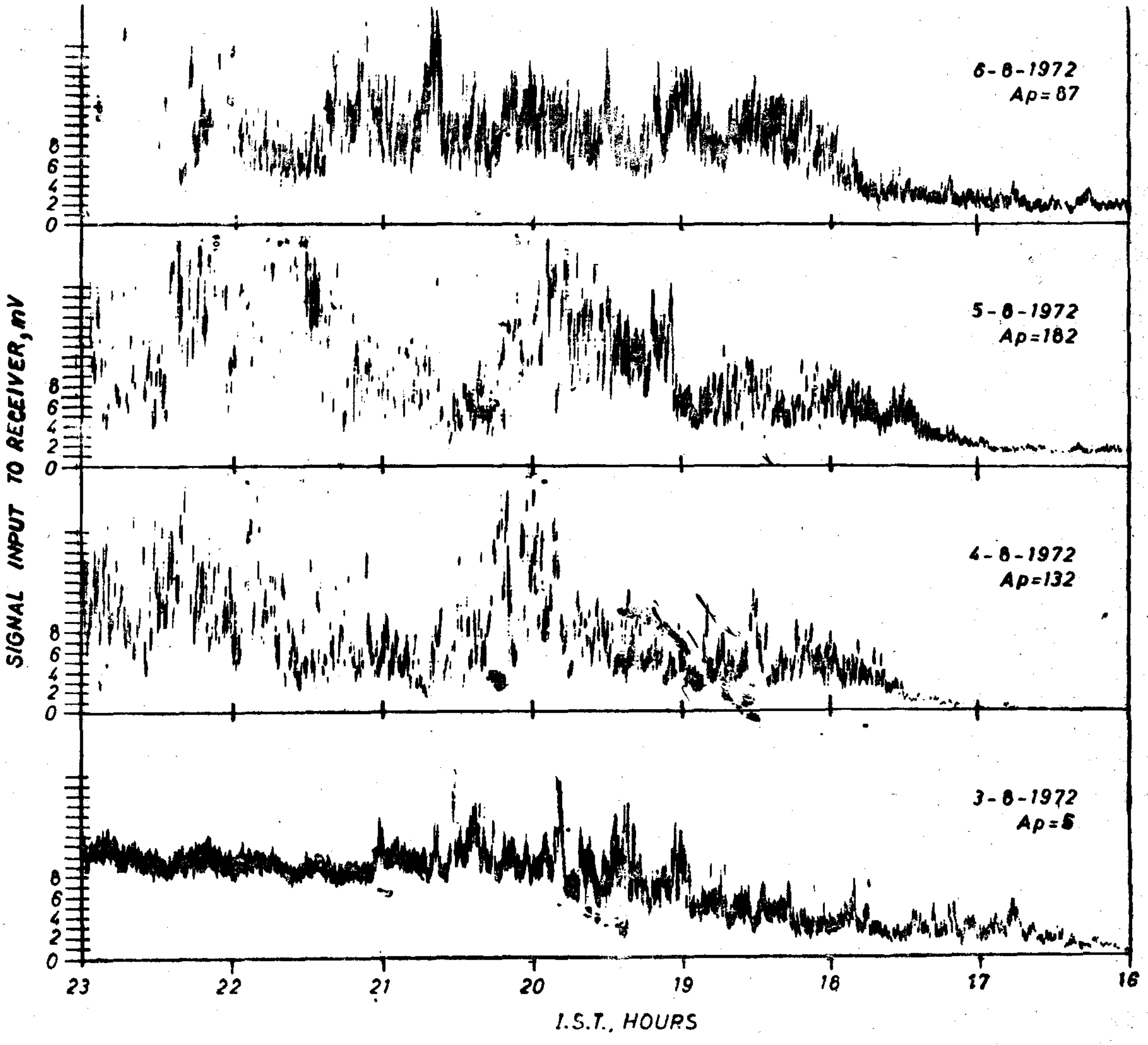

Fig. 2—Records of signal strength on magnetically disturbed days, viz. 4, 5 and 6 August 1972 compared with that on quiet day, viz. 3 August 1972

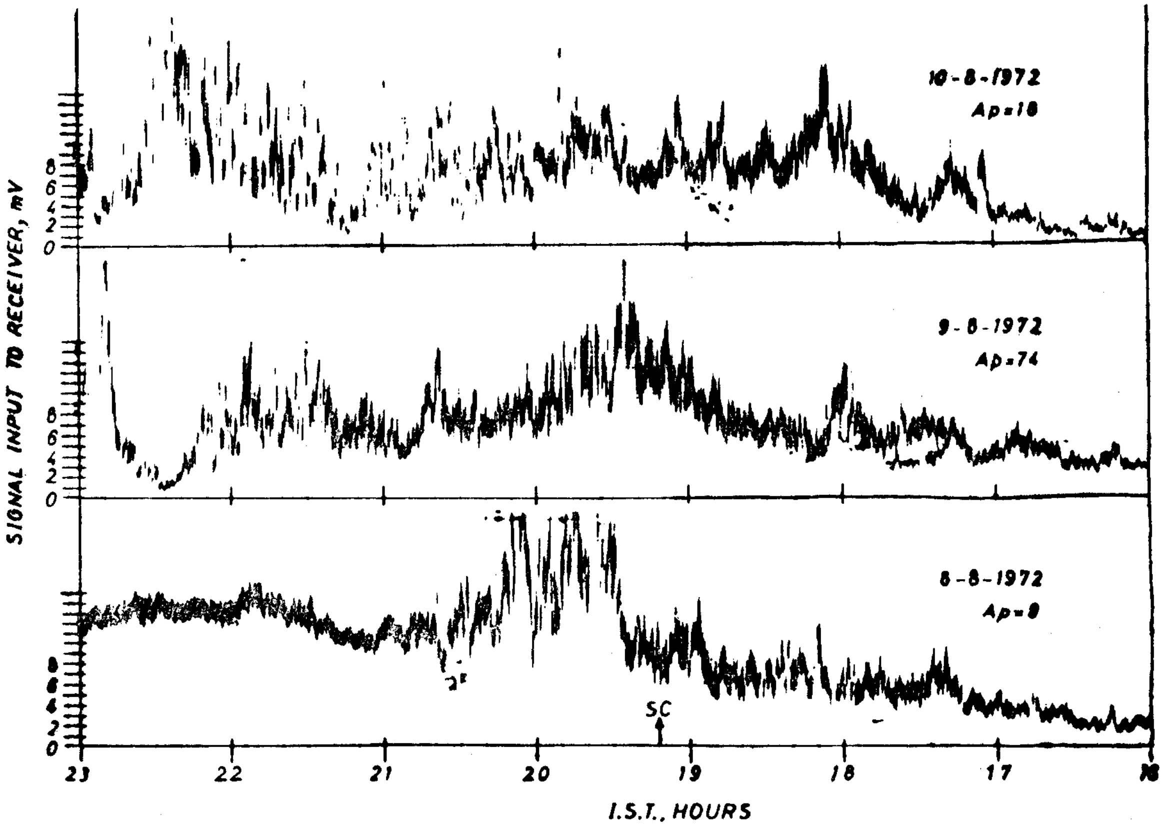

Fig. 3—Records of SW signal strength on magnetically disturbed days, viz. 9 and 10 August 1972. [A short-lived disturbance could also be seen on 8 August 1972]

unusual magnetic activity in the first week of August 1972. The record on 3 August 1972 represents a quiet condition of the F2-layer. Two severe magnetic storms occurred with SCs at 0649 hrs and 0750 hrs IST on 4 August 1972 and one with SC at 0224 hrs IST on 5 August 1972. Values of A_p were 132, 182 and 87 respectively on 4, 5 and 6 August. It will be noticed that the signal strength on disturbed days underwent large fluctuations with decrease in the fading rate in contrast to the steady values recorded on quiet days. The flutter-type fading was absent which might be the result of no spread-F occurrence on disturbed days. At times, the signal strength fell to very low values, almost to blackout level.

Another example of records obtained on magnetically disturbed days is given in Fig. 3. On 8 August 1972 the magnetic storm commenced at 1912 hrs IST. In about 10 min after the SC, the record deviated from its normal trend giving large undulations in the signal strength. The effect was only short-lived for about an hour and then quiet condition prevailed. Two major storms occurred on the next day at 0524 hrs and 0606 hrs IST. Large changes were noticed only after 2100 hrs and the disturbed condition prevailed on the following day, i.e. 10 August. These large fluctuations with signal sometimes falling down to blackout level are attributed to violent movements in the reflecting level and the accompanying changes in the electron density of the F2-layer. The reduction

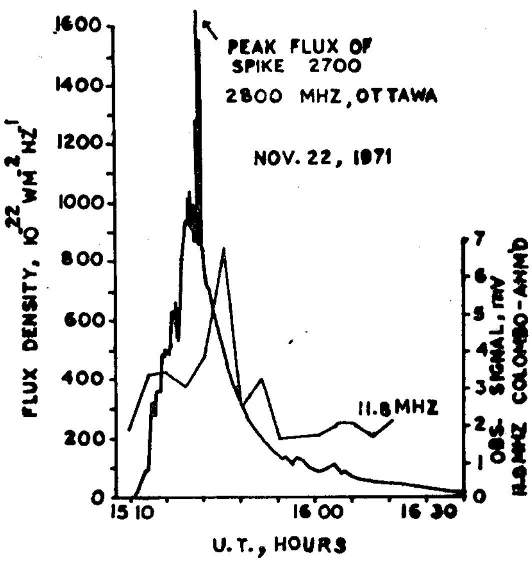

Fig. 4—Coincidence of a temporary increase of night-time SW signal strength with an outstanding solar radio event of 2800 MHz on 22 November 1971

in the spread-F occurrence on disturbed days may account for the absence of flutter-fading. The two disturbed periods described above fall in the Retrospective World Interval 26 July-14 August 1972.

4. Night-time Signal Strength and Solar Radio Bursts

The solar radio bursts are generally accompanied by solar flares, and are followed by short wave fadeouts in about 10 min in the sunlit hemisphere. The Colombo transmission on 11·8 MHz is on the air only upto 2300 hrs. However, some interesting instances of short duration increases of field strength were recorded on some days in the pre-midnight hours in contrast to day-time SWF effect. A reference to the outstanding solar radio events listed in the Solar-Geophysical Data published by the Environment Data Service, NOAA, Boulder, Colorado, showed that a 10·7 cm radio burst occurred about 15 min before the commencement of the increase in the signal strength. An example of this event is shown in Fig. 4 which gives the plots of radio flux on 2800 MHz at Ottawa and the Colombo-Ahmedabad signal strength of 11·8 MHz observed on 22 November 1971. The difference of 15 min is also seen between the times of maxima in the solar radio flux and the short-wave signal strength. The total duration of radio flux above 500 units was also the duration of SW signal increase. This observation raised a curiosity for investigation of past records. It was possible to trace out a dozen of such instances of temporary increases of signal strength which followed the outstanding events in solar radio flux occurring in the pre-midnight hours. A typical record of the signal strength obtained on 30 August 1971 showing the commencement of its sudden increase about 17 min after the start of 10·7 cm radio flux event is given in Fig. 5. The broken line drawn through the record prior to and after the event would have been the normal trend for the short-wave signal. Somehow the level of signal strength on 29 August 1971 was exceptionally low on the whole and the increase observed at about 1815 hrs is a normal feature. All these days were magnetically quiet.

There is no immediate explanation for this observed phenomenon and also it could not be maintained that the temporary night-time increases in short-wave signal strength are associated with the solar radio bursts. Here only the coincidence between the two phenomena is reported, but this may not be treated as a mere chance coincidence. However, it could be said that the night-time increase reported here might have been due to the passage of a travelling ionospheric disturbance, may be that it was excited by the solar burst.

5. Conclusions

The following are some of the conclusions drawn from a study of night-time records of signal strength

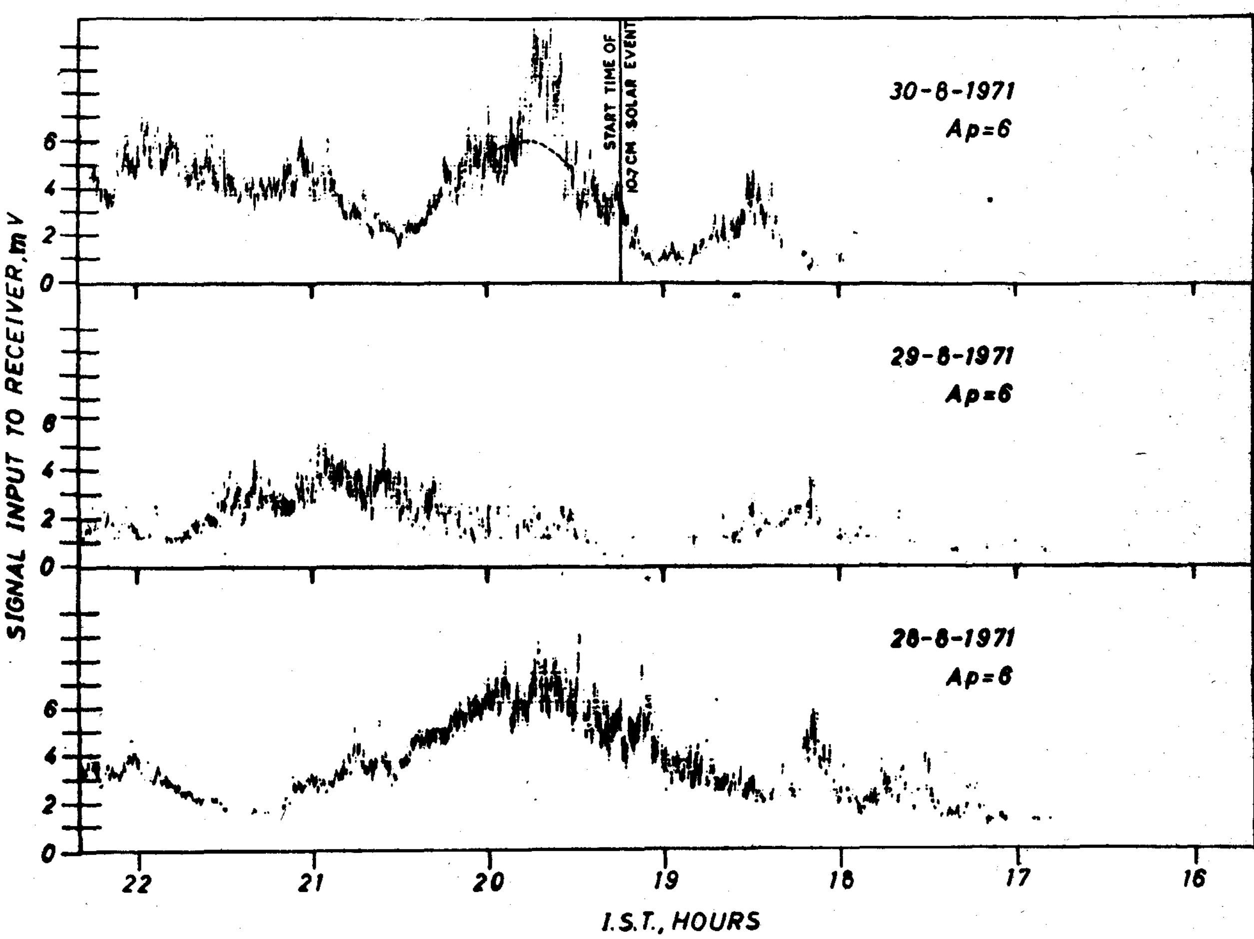

Fig. 5 — Record showing short-duration increase of SW signal strength after occurrence of 10·7 cm solar radio burst on 30 August 1971

on 11·8 MHz over a nearly north-south transmission path of about 2000 km from Colombo to Ahmedabad.

1. A sharp post-sunset maximum in signal strength about 10-12 times the midday value, is observed at 1900-2000 hrs in equinoxes more specifically in the February-June period.

2. The quiet-day signal shows steady rapid fluctuations of small magnitude characteristic of small ripple-type plasma-noise or spread-F phenomenon during night.

3. On magnetically disturbed days, slowly fading large fluctuations are observed in the signal, which occasionally falls to almost black-out level. The nature of records indicates the absence of spread-F.

4. Some typical short-duration increases in the signal strength found in the post-sunset to midnight interval are detected to have followed the occurrence of solar radio bursts with a time-lag of 12-17 min in contrast to day-time SWF effect. However, the connection between these two night-time phenomena is not understood. Only thing that one can say is that the temporary increase in signal strength might have been caused by the passage of a transient ionospheric disturbance at the reflecting level.

Acknowledgement

The authors are grateful to Dr K.M. Kotadia for suggesting the problem and taking interest in this investigation. The authors also wish to thank the Council of Scientific and Industrial Research, New Delhi, for granting financial assistance.