DELAYED EFFECTS OF SUDDEN IONOSPHERIC DISTURBANCES ON 164 Kc/s TRANSMISSION BETWEEN TASHKENT AND AHMEDABAD*

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ABSTRACT

Continuous recording of the field strength of 164 Kc/s CW transmission from Tashkent (42° N, 69° E) has been going on at Ahmedabad (23° 01′ N, 72° 36′ E) since March 1960. The present communication deals with a delayed effect of S.I.D's which has been observed on the 164 Kc/s transmissions.

INTRODUCTION

BETWEEN March 1960 and March 1966, there were several occasions when the daytime field intensity of 164 Kc/s transmission from Tashkent was considerably higher than normal, the high value persisting for a few days before returning to its original normal level. Examining a number of such instances, it was found that these groups of days of high intensity were almost always preceded by a solar flare. Twenty-one such instances have been observed during the period 1960–66 and are listed in Table I.

METHOD OF ANALYSIS

An examination of the night-time field strengths on days on which the daytime intensity was higher than normal indicated no significant change, and the study was therefore restricted to the daytime changes only.

In order to bring out the delayed effect on the field strength of a solar flare, the field strength records of individual days showing high intensity were superposed on the corresponding monthly *mean* intensity curves. Days on which flares occurred, as also days showing abnormally high or low intensity were not taken into account in computing the normal-day curves.

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On an average, about twenty days in a month could be used for determining the normal curves.

TABLE 1

Flares which caused delayed S.I.D. effects observed at Ahmebabad on 164 Kc/s since 1960

S.C.N.A.—Sudden cosmic noise absorption

Date	Time of beginning of flare	Simultaneous S.C.N.A. 25 MHz
1960 July 1	0500 UT.	Yes
July 4	0200	Yes
July 15	0544	Yes
August 27	1106	No
November 15	0220	Yes
November 19	0230	Yes
1961 January 2	0839	No
May 14	1137	Instrument Failure
September 25	0307	Instrument Failure
1962 February 20	0557	Yes
March 16	0350	No
April 21	0203	No
June 17	0945	No
1963 April 15	1118	Yes
May 1	0507	Yes
August 11	1045	Yes
October 20	0754	Yes
1965 December 29	0645	Yes
1966 January 20	0502	Yes
February 28	0356	Yes
March 2	0314	Yes

SOME EXAMPLES OF DELAYED EFFECTS

Figure 1 shows an example of the effect produced by a flare which occurred at 0557 U.T. (1127 I.S.T.) on 20 February 1962. The dashed curve is the monthly mean curve and the full lines show the field strengths on individual days. The intensity on the 19th was normal as can be seen from the figure,

The level on the 20th, the day of the flare, also showed no significant change. On the 21st however, a very noticeable change did take place, the field strength remaining well above normal for the whole day. The level remained consistently high for two more days, decreased on the 24th and returned to normal by the 25th.

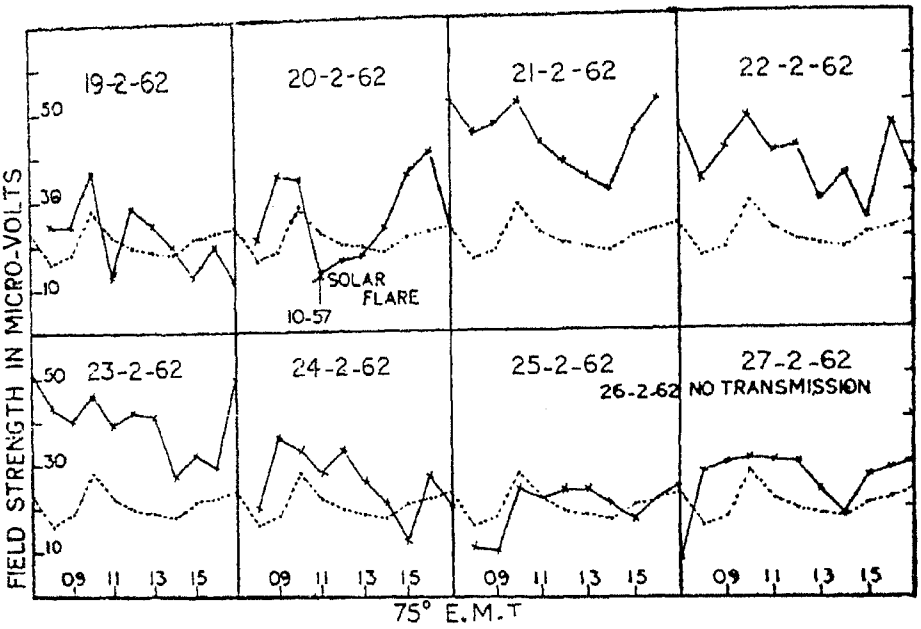


FIG. 1. Delayed effect of some flares on signal strength of Tashkent radio transmission on 164 Kc/s observed at Ahmedabad.

A more recent instance is shown in Fig. 2. The flare occurred at 0502 U.T. (1032 I.S.T.) on 20 January 1966 and was followed by a pronounced increase in intensity on the 21st. The increase continued on the 22nd, reached a maximum on the 23rd and then started decreasing and came back to the undisturbed level by the 25th.

Figure 3 shows a number of events similar to those described above, represented in a slightly different manner. The ratio of the mean field strength at 11 to 13 hours on the days after the flare to the mean field strength at the same hours on undisturbed days in the month was taken as an index of disturbance. This ratio would be much in excess of unity on disturbed days. Figure 3 shows that practically in all instances the intensity remained high for 3 to 5 days after the flare, the increase beginning in the majority of cases a day after the flare. The event on 2–3–1966 is interesting in that the intensity remained normal for two days following the flare and then remained higher than normal for six days, the duration of the entire effect being eight days as compared to five or six days for the other instances.

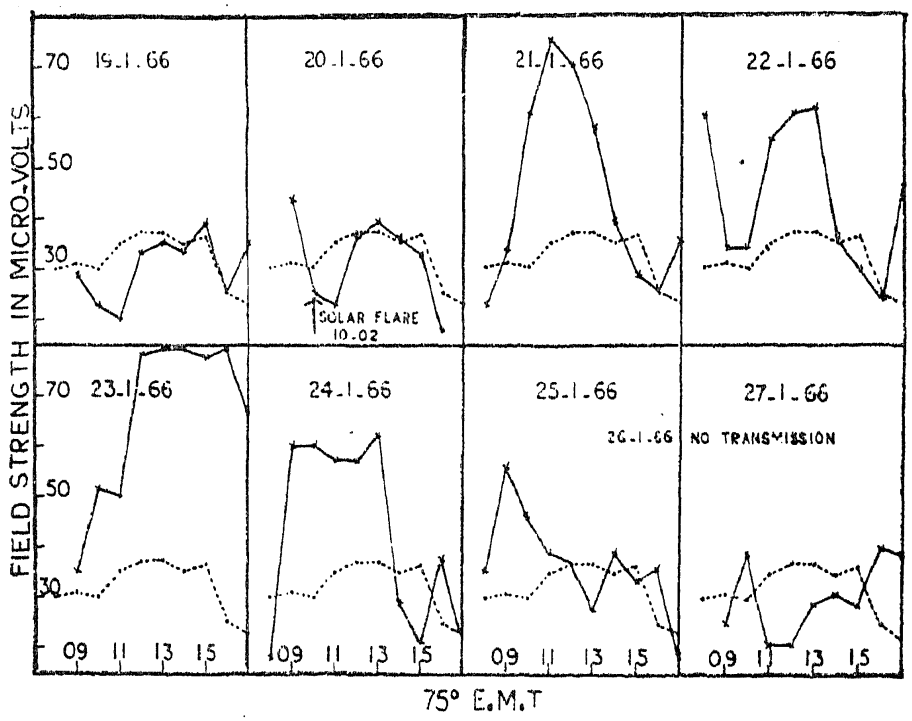


FIG. 2. Delayed effect of some flares on signal strength of Tashkent radio transmission on 164 Kc/s observed at Ahmedabad.

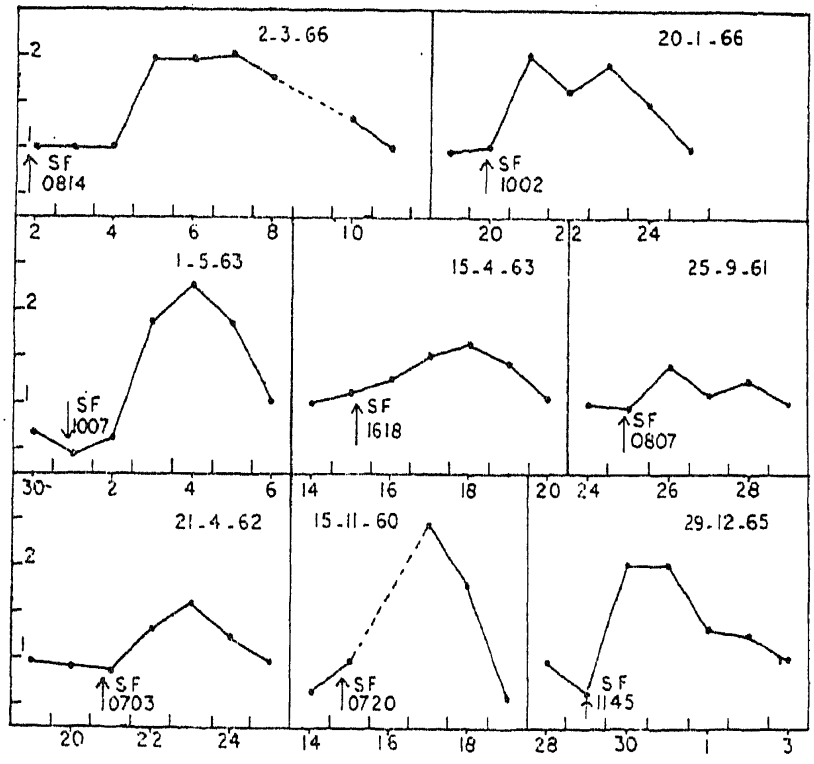


FIG. 3. Ratio of field strength at 11 to 13 hours on days after flare to mean field strength on undisturbed days in the month.

EFFECTS PRODUCED BY FLARES NOT OBSERVED AT AHMEDABAD

The nature of the phenomenon described above suggests that increases in field strength could also be caused by flares not observed at Ahmedabad, but might have been observed in other places when the transmission path between Tashkent and Ahmedabad was not sunlit.

Table II gives a list of increases in field strength produced by flares which were not observed at Ahmedabad. The flares which might have been responsible for the increase have also been listed.

TABLE II

Delayed effects observed at Ahmedabad preceding flares, which were not observed at Ahmedabad, but were recorded elsewhere during Ahmedabad night

Date of enhancement	Flare which might have caused the increase
1960 October 22–26	October 21, 2240 hr. UT.
1961 December 12–15	December 11, 1935 hr. UT.
1962 June 22–24	June 20, 2007 hr. UT.
1963 August 20–23	August 18, 1800 hr. UT.

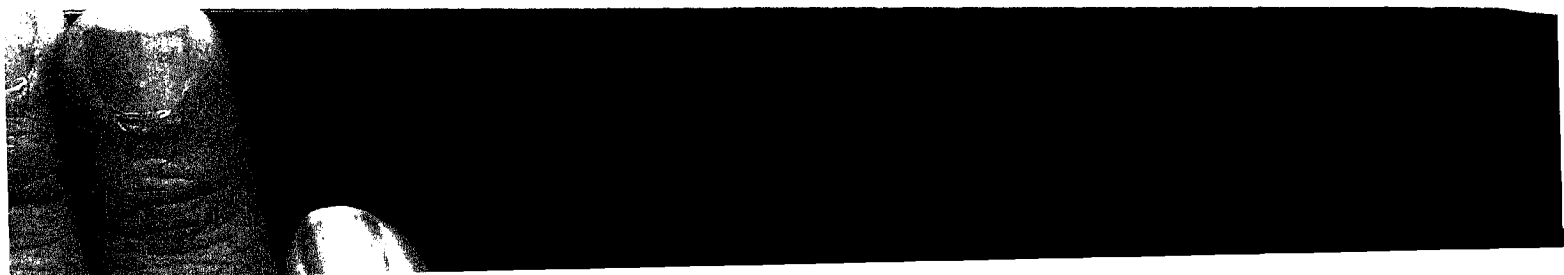
Figure 4 shows two of these instances, one on 12 to 15 December 1961 and the other on 22 to 24 June 1962.

INCREASES IN FIELD STRENGTH NOT CAUSED BY FLARES

At this stage, the question arises whether there were any such increases in field strength which could not be associated with a flare. A careful examination of the records revealed only one such instance. This was from 4 to 14 April 1964 when meteorological disturbances affected Afghanistan and N.W. Pakistan and the enhanced signal strength might have been due to this.

DISCUSSION AND CONCLUSION

In the preceding sections, a number of instances of delayed effects of flares on 164 Kc/s CW transmission between Tashkent and Ahmedabad have



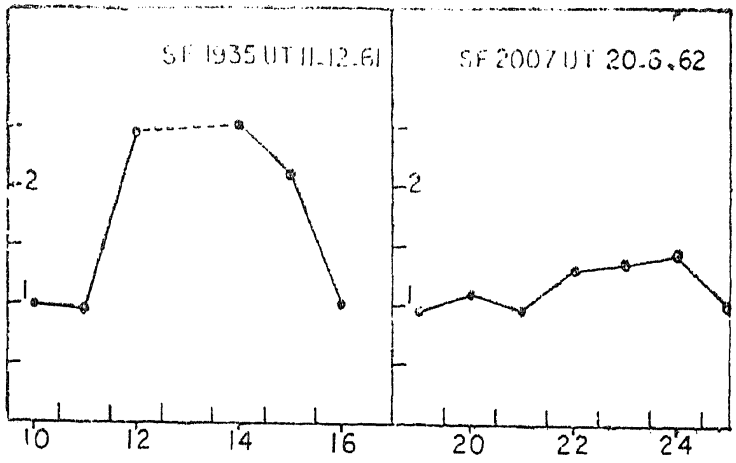


FIG. 4. Ratio of field strength at 11 to 13 hours on days after flare to mean field strength on undisturbed days in the month. (Flares which occurred during night-time at Ahmedabad.)

been described. In seeking an explanation of this delayed effect, two important points have to be borne in mind (*a*) Not all flares produce abnormal increases in field strength; out of a total of 75 flares which immediately affected the 164 Kc/s transmission and were recorded between March and December 1960, only six showed a delayed effect of this type, (*b*) The delayed increase in field strength produced by a flare did not depend on the importance of the

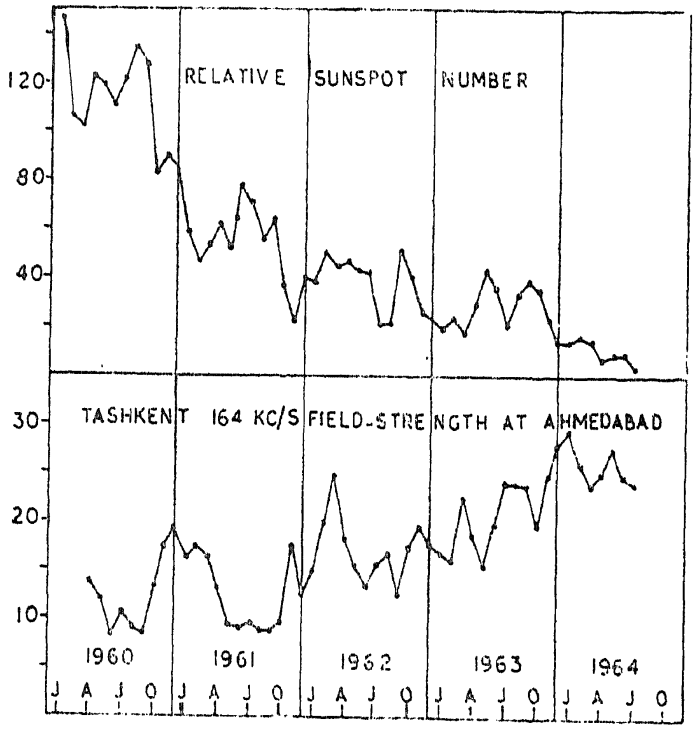


FIG. 5. Relative Sunspot Number and field strength of Tashkent 164 Kc/s transmission at Ahmedabad between April 1960 and July 1964.

flare; even a relatively weak flare could produce a noticeable increase in field strength.

A possible explanation of the phenomenon is suggested by the following related observation. Comparing the signal strengths of 164 Kc/s transmissions observed at Ahmedabad from month to month during the years 1960 to 1964, it is noted that they show a steady *increase* with *decrease* in solar activity (Fig. 5). This can be due either to a decrease in absorption in the lower part of the D region of the atmosphere or the formation in the D region of a long-lived ion, like O_2^-, O_3^-, or NO_2^- which is photo-decomposed by sunlight into neutral particles and electrons.[1, 2, 4]

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