Indian Journal of Radio & Space Physics
Vol. 19, June 1990, pp. 166-170

Long distance TV receptions in bands I and III due to ionospheric and tropospheric paths

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Received 18 July 1989

Anomalous long distance TV receptions at Delhi for the period 1978-1986 have been analysed. The diurnal and seasonal variations of these TV signals during this period have revealed various modes of propagation.

1 Introduction

During 1950-53, in USA, the analysis[1] of long distance VHF television signals (TV-DX) showed that the propagation of these signals were due to sporadic-E (Es) layers for distances greater than 800 km mainly during summer months. European TV stations were identified in UK by considering the tropospheric and ionospheric paths[2]. The survey of the reception of TV transmissions from Europe[3] via various modes of propagation on bands I and II has been made from 10 years data collected in UK. Propagation of long distance TV signals has been studied[4] using Es data from USA, Europe and Japan. Similar studies[5], using Es data, have been attempted in India.

Systematic monitoring of anomalous long distance TV signals at Delhi on band I between early morning and midnight hours revealed various modes of propagation including artificially modified ionosphere[6,7]. Propagations of anomalous TV signals, via tropospheric paths were reported from relatively shorter distances in India[8]. In this paper an attempt has been made to study the propagation mechanisms responsible for anomalous TV signals using data between high and low solar activity.

2 Data collection and long distance TV photographs

Anomalous TV signals were systematically monitored at Delhi during May 1978-April 1986 for various channels of band I (47-68 MHz) and band III (174-230 MHz) between early morning and midnight hours. These TV signals were checked mainly around and middle of an hour. One TV reception means that it has been received any time during that hour.

Phillips' TV receiver (black and white) was used for most of the time with steerable folded dipole antenna. With the introduction of colour TV transmission in India from 1982, occasional monitoring on colour Phillips' TV receiver was also carried out during 1982-86 and some coloured TV pictures were observed.

Long distance TV pictures received in Delhi on channels 2, 3 and 4 of band I and on channel 5 of band III have been photographed and a set of them is shown in Fig. 1. Photographs in columns 1 and 2 of Fig. 1 were received from TV stations in USSR, China, south-east Asian and middle-east countries on channels 2 and 3. The photographs in column 3 were received from Indian stations on channel 4, while photographs in column 4 on channel 5 were received from Pakistani station.

3 Results and discussion

3.1 Monthly variation of anomalous TV reception in bands I and III

Variation of number of anomalous TV receptions on channels 2-4 of band I in each month during May 1979-April 1986 is shown in Fig. 2. Similar variations for the period May 1978-April 1979 were reported earlier[6]. It has been observed that the number of TV reception was more on lower channels than that on higher channels. There are no TV transmitters within tropospheric paths from Delhi on channels 2 and 3 and as such the TV signals received on these channels will be via ionospheric paths only. As most of the anomalous TV receptions are due to high values of f_oEs and f_oF2 at the middle of TV transmitter and receiver, more TV receptions are expected on lower channels. This is clearly seen in Fig. 2, where the number of TV receptions is higher on channel 2 than on channel 3. However, there are a number of TV transmitters in Indian subcontinent on channel 4 within

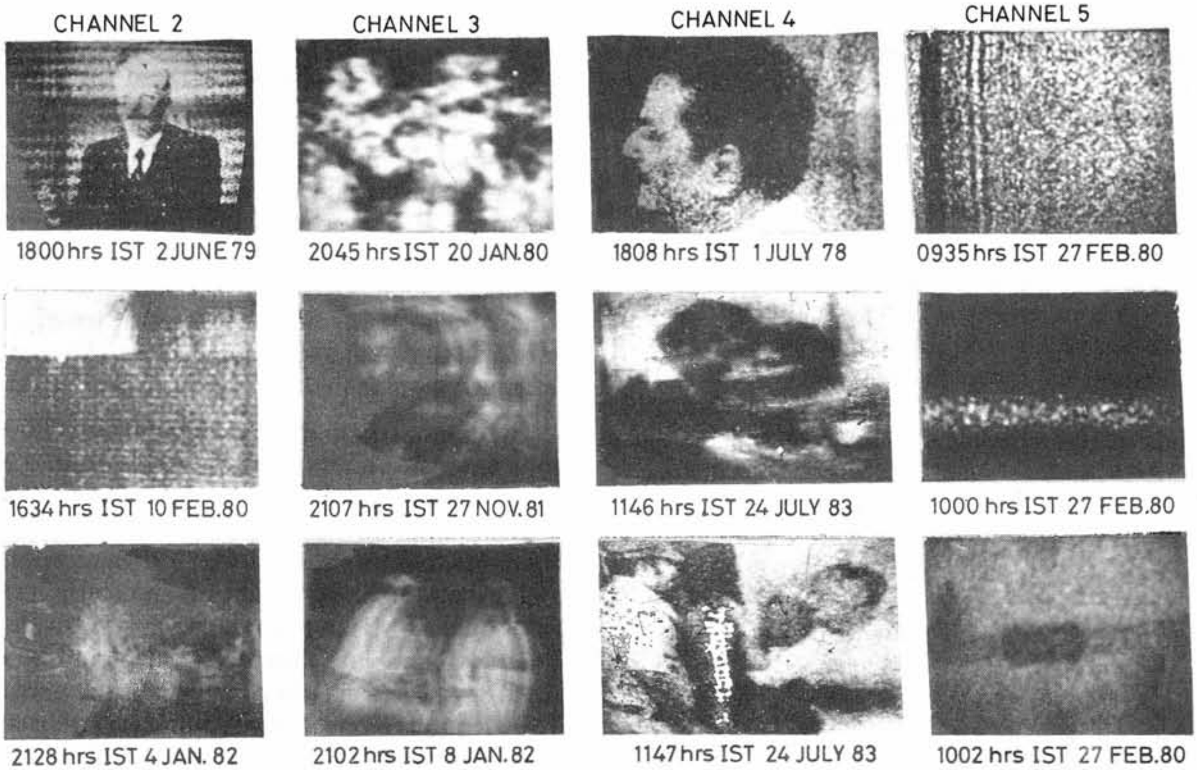

Fig. 1—Some long distance TV photographs received at Delhi

the tropospheric paths. Therefore, a number of TV receptions on channel 4 were received both via tropospheric and ionospheric paths. But the number of anomalous TV receptions were lost due to local broadcast on the same channel. As such anomalous TV reception numbers on channel 4 are not exact, which, otherwise, should have been possible in the absence of local signal.

Fig. 3 shows the number of anomalous TV receptions on channels 5-12 of band III for each month between May 1979 and April 1986. As the frequencies for these signals are high, ionospheric propagation can be ruled out. Therefore, anomalous TV signals were received through tropospheric paths from TV transmitters in Indian subcontinent. Some TV signals received on channels 5, 7, 9 and 10 were identified from Jaipur, Amritsar, Jullander and Mussoorie, respectively, and Pakistani TV signals have been identified on channel 5 during this period.

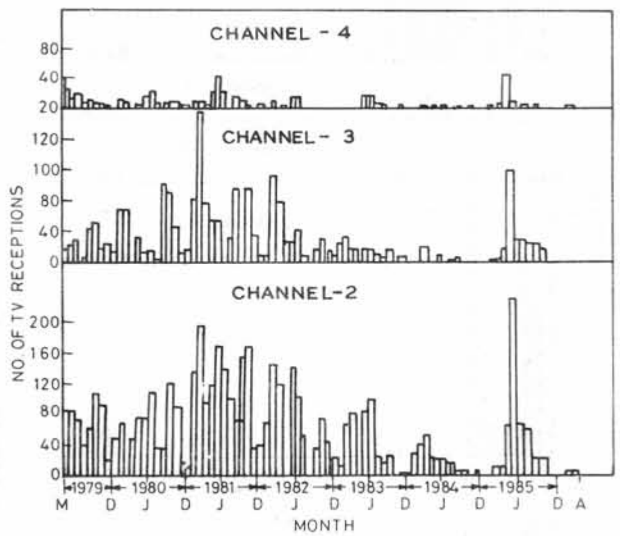

Fig. 2—Monthly variation of TV receptions in band I at Delhi

Higher number of TV receptions were observed around premonsoon months for almost all the channels as the conditions are favourable for tropospheric propagation during these months. Higher number of TV receptions have also been observed during high solar activity and some during low solar activity. However, absence of such TV signals were observed on almost all the channels during moderate solar activity. So, a detailed study has been undertaken by the present author with the field-strength measurements to explain various tropospheric paths, especially, when the number of TV stations in India on band III has increased enormously in the recent years and also the introduction of regular morning transmissions. Some results on field-strength measurements for anomalous TV signals on various channels of band I and III have already been reported[9].

3.2 Diurnal and seasonal variation of anomalous TV receptions on channels 2 and 3

It has been found that the percentage of anomalous TV receptions is much higher for channel 2 (47-54

MHz) and channel 3 (54-61 MHz) as compared to channel 4 (61-68 MHz) of band I and other channels of band III. Therefore, data for channels 2 and 3 recorded during 1978-86 are sufficient for a detailed analysis.

Diurnal variations of TV receptions during 1978-86 are shown in Fig. 4 for summer, equinoxes and winter, separately. But, the data during 1978-81 have been reproduced from the earlier work of Saksena[6,7] for comparison. A high percentage of TV receptions has been found for summer months between 1978 and 1985 except for 1984, on channel 2. However, the percentage of TV receptions on channel 3 is much less than that on channel 2. During equinoxes and winter, a high percentage of TV receptions on channels 2 and 3 can be noticed for the period 1978-83. Almost an absence of these TV receptions can be noticed for the period 1984-86.

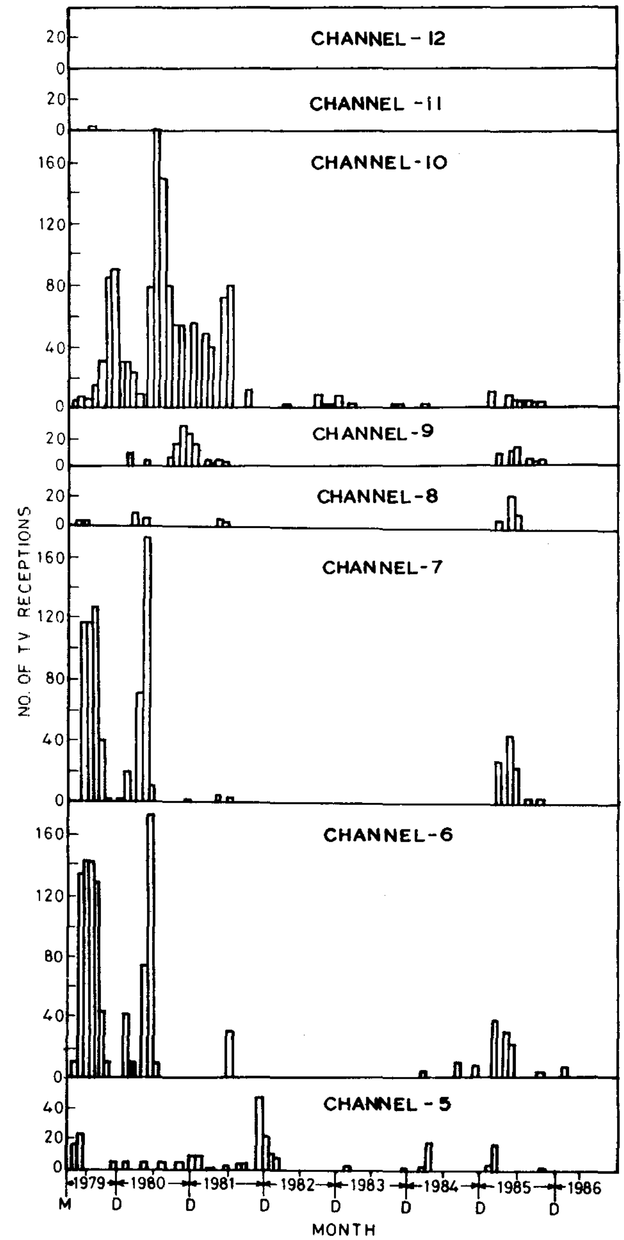

Fig. 3—Monthly variation of TV receptions in band III at Delhi

Sporadic-E layers between TV transmitter and receiver can propagate anomalous TV signals during summer and that too a maximum around noon. The percentage of occurrence of Es layers is almost independent of solar activity[10] in the non-equatorial region of India. It has been discussed at length in the earlier studies[6,7] that these anomalous TV receptions are much more than those expected due to Es layers.

The contour diagrams for MUF (4000) F2 for east zone have shown that there are peaks around 20° N geogr. lat. for most of the non-summer months' afternoons. Table 1 shows the MUF (4000) F2 peak values for each month between May 1978 and April 1986 and reveals that most of the non-summer afternoon values are 48 MHz or more (which is equivalent to channels 2 and 3 frequency) for the period May 78-April 83. Therefore, afternoon peaks of anomalous TV receptions received from south-east Asian countries at Delhi during this period can be explained as due to normal F-layer. However, between May 1983 and April 1986, MUF (4000) F2 values are found to be 48 MHz only during equinoxial months of October 1983 and 1984 and March 1985, and as such no afternoon peaks of anomalous TV receptions could be seen, particularly, in the winter months.

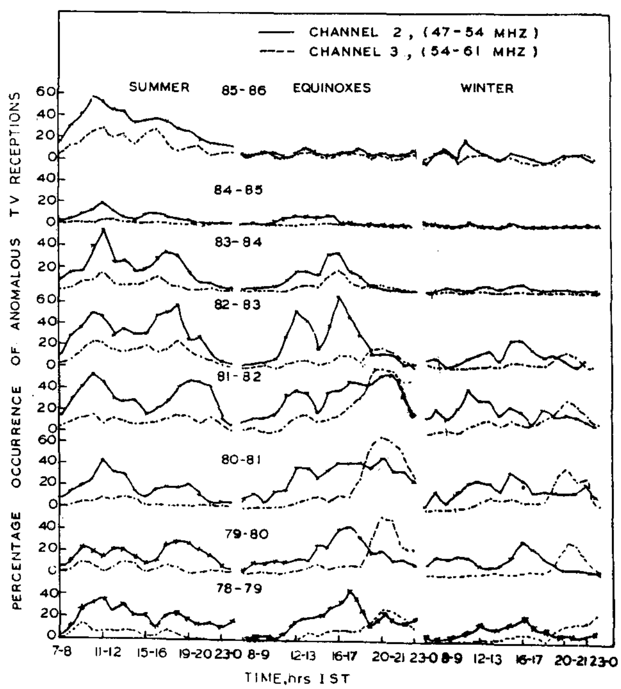

Fig. 4—Diurnal and seasonal variations of percentage of anomalous TV receptions on channels 2 and 3 at Delhi

Table 1—Peaks of predicted median values of MUF (4000) F2 (in MHz) around 20° N geogr. lat. (National Physical Laboratory, New Delhi)

Month	Peak values of MUF (4000) F2 for the year								
	1978	1979	1980	1981	1982	1983	1984	1985	1986
January	—	48	44	48	48	40	40	36	32
February	—	44	44	40	52	48	44	40	32
March	—	52	48	48	56	48	44	48	40
April	—	48	52	52	52	48	40	44	40
May	40	44	40	40	48	44	—	40	—
June	36	36	36	44	30	40	32	32	—
July	32	40	36	44	32	36	32	36	—
August	40	40	36	40	40	44	40	44	—
September	44	52	44	48	44	40	40	40	—
October	52	44	44	52	48	48	48	44	—
November	52	48	48	48	48	44	44	36	—
December	52	52	48	44	48	40	36	28	—

As reported earlier[6,7], various modes of propagation could not explain the high percentage of TV receptions. The possibility of these unexplained TV signals was considered to be due to artificial modification of ionosphere in the F-layer due to heating by high-power short-wave transmitters. An almost-absence of anomalous TV receptions during 1984-86 may look like solar activity effect. But consideration of artificial modification of ionosphere will reveal no such solar activity effect.

High-power short-wave transmitters can modify the ionosphere in the form of spread-F, provided power flux density in the F-region is at least 0.1 μWm^{-2} and f_oF2 is around the operating frequency[11]. Some 250 kW high power short-wave transmitters with 9 dB antenna gain located at Aligarh can heat up the ionosphere and modify it under favourable conditions at the control points. Considering the south-east beam of these transmitters heating the ionosphere and modifying it around 20° N (south of Calcutta) in the Bay of Bengal, long distance TV propagations from south-east Asian countries receivable at Delhi are found to sustain.

Fig. 5 shows the variation of mean predicted f_oF2 values at 20° N with operating frequency of Aligarh high-power short-wave transmitters for winter 1981-82 and 1984-85. It can be seen that the f_oF2 values are nearer the operating frequency for 1981-82 winter than for 1984-85 winter. As such modification of ionosphere in the form of spread-F was only possible during 1981-82 winter, but not during 1984-85 winter. Therefore, an almost-absence of anomalous long distance TV receptions at Delhi can be explained for 1984-85 winter, while some percentage of anomalous long distance TV propagation via artificially modified ionosphere during 1981-82 winter was possible. As such it can be reasonably assumed that any unexplained anomalous long distance TV signals are propagated via artificially modified ionosphere at the control point caused by high-power short-wave transmitters operating in the neighbourhood.

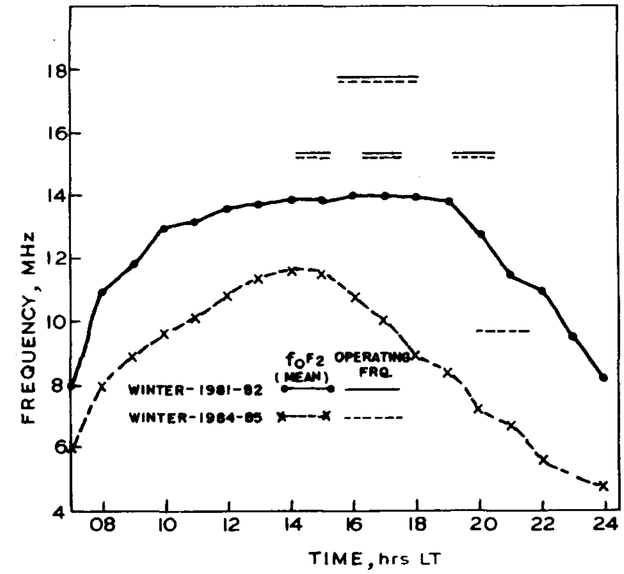

Fig. 5—Diurnal variations of predicted f_oF2 and operating frequency during 1981-82 and 1984-85 winters

Acknowledgement

The author is grateful to Dr A P Mitra, Dr A K Saha and Dr B M Reddy for their helpful suggestions. He is also thankful to Dr S L Jain, Shri A R S Vashisht and Shri A K Ghoghar for their help in the maintenance of TV receiver on a number of occasions.

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