

INTENSITY VARIATIONS OF MADRAS (FORT) RADIO STATION.

By K. Sreenivasan.

SYNOPSIS.

An analysis is given of the observations made on Madras (Fort) Radio (VWO) during the period March 1926 to May 1927. It supports to some extent the view that there is a rather sudden change in the altitude of the Kennelly-Heaviside layer and that this change is world-wide. Even at the short distances of 300 km. there are shown to be marked seasonal intensity variations of the long wave reception recorded.

1. INTRODUCTION.

In a previous paper (*J. Ind. Inst. Sc.*, 1926, 9 B, Part V, 37) the method of measuring the intensity of received radio signals, from long wave stations, adopted at the Indian Institute of Science has been described. The apparatus set up closely follows the description given by Hollingworth of that used by him at the National Physical Laboratory, England (*J. Inst. Elec. Eng.*, 1923, 61, 501).

The kind co-operation of the Wireless authorities of the Government of India in continuing the transmission of the experimental signal at 0750 I.S.T. has rendered possible the observations made hitherto. In the paper referred to above, some uncertainty was expressed regarding the aerial current at the transmitting station, and the effective height of the Madras aerial. Calibration of the ammeter by means of a laboratory sub-standard has revealed an error of about 3 per cent in the working part of the scale. Further, the current after June 1926 has never exceeded 60 amperes, so that any errors due to distortion are not so prominent as when the current goes up to 80 amperes.

Due to a number of difficulties, the measurement of the effective height of the Madras aerial has not been possible; so in the absence of an experimentally determined value, the conservative arbitrary figure of 0.5 of the aerial height has been retained. This, however, is of no great disadvantage in the discussion of results.

Two criticisms are raised with regard to the method itself. First, that the local calibrated oscillator has not been shielded and second, that deflectional methods, as in the present case, are reliable only when disturbances due to atmospherics are extremely weak compared with the signal itself.

• Lately, the calibrated mutual inductance method, involving the unshielded oscillator, has been replaced by the current transformer

method developed by Dye in the National Physical Laboratory (*J. Inst. Elec. Eng.*, 1925, **63**, 597). No great discrepancies have been observed between the two methods. The second criticism will be referred to later on. It has, however, to be observed that so far as the present measurements on Madras are concerned, there has been a marked absence of any trouble due to atmospheric disturbances, partly due to the wavelength of the station, 4 km., and partly because of the time at which the observations are made, *viz.*, 8 a.m.

2. SIGNAL STRENGTH GRAPHS.

There are three sets of curves obtained by the measurements:—

- (a) The weekly averages from March 1926 to May 1927;
- (b) The monthly averages between the same dates; and
- (c) The daily intensity values from September to December 1926 and those from March to May 1927.

In connection with these curves, it is to be noted that they are plotted for the value of the aerial current observed during the making of the test signal. These values are supplied every week by the officer-in-charge of the station and, probably, are reliable to within about 5 per cent.

No signals are transmitted on Sundays and a few public holidays, so that there are about 14 per cent less readings than would otherwise have been possible. During the early part of July and the whole of August 1926, observations were found impossible on account of high humidity which seriously affected the insulation of the measuring apparatus. During the latter part of January and the first two weeks of February 1927, no signals were transmitted owing to high traffic pressure at the transmitting station. In spite of these gaps, the results are of interest.

Weekly Averages.—Until about July (Fig. 1), the intensity does not show any marked departures from the mean value of 9.4 microvolts per metre per ampere in the aerial. The highest value reached is 11.1 $\mu v/m$ in the fourth week of May 1926 and the lowest 7.8 $\mu v/m$ in the middle weeks of April and May. Between September and December, the weekly variations are very considerable. The lowest value reached during these months is slightly higher than the highest value up to June. The highest weekly average reaches 19.8 $\mu v/m$ at the end of October and almost the same value again is reached in the middle of November. The weekly variations during this period are pronounced; the most prominent of these are the values of 19.8 $\mu v/m$ for the week ending 24th October and 12.3 $\mu v/m$ for the following week.

The February observations show a return to comparatively low and steady values, averaging about 12.5 $\mu v/m$. The weekly averages

for March and April, 1927, show the following markedly small variations :—

Week ending, 6th March, 1927	..	12.2 $\mu v/m$.
" 13th "	..	12.6 "
" 20th "	..	12.1 "
" 27th "	..	12.8 "
" 3rd April, 1927	..	11.51 "
" 10th "	..	12.76 "
" 17th "	..	11.59 "

These values relate to the very dry months up to May 1927 after which the South-West monsoon approaches and breaks out in June. As against this the following were observed :—

Week ending, 26th September	..	17.76 $\mu v/m$.
" 3rd October	..	No readings taken.
" 10th "	..	15.3 $\mu v/m$.
" 17th "	..	16.66 "
" 24th "	..	19.84 "
" 31st "	..	12.23 "
" 7th November	..	13.27 "
" 14th "	..	15.59 "
" 21st "	..	19.64 "
" 28th "	..	15.77 "
" 5th December	..	12.9 "

Daily Values.—The daily readings shown in Fig. 2 have not been taken at random but have been selected to illustrate the nature of the changes which take place. As remarked earlier, the period between September and November is one of considerable change. The transition, so far as one can judge from these curves, does not seem to occur suddenly as Hollingworth concludes from his observations. Commencing about the middle of September, the daily value steadily increased to the maximum recorded strength of 21.7 $\mu v/m$ on the 16th November. While during a few weeks, the values show wide variation, the corresponding changes in other weeks are hardly so prominent as shown by the following :—

<i>Date</i>	<i>Intensity</i>	<i>Date</i>	<i>Intensity</i>
November 22nd	.. 19.5 $\mu v/m$.	November 15th	.. 20.4 $\mu v/m$.
" 23rd	.. 14.1 "	" 16th	.. 21.7 "
" 24th	.. 17.9 "	" 17th	.. 19.2 "
" 25th	.. 16.1 "	" 18th	.. 18.3 "
" 26th	.. 12.2 "	" 19th	.. 18.3 "
" 27th	.. 14.8 "	" 20th	.. 20.0 "

The greatest difference between any two values is 7.3 corresponding to 46 per cent of the average for the week.

The greatest difference between any two values is 3.4 corresponding to 17.3 per cent of the average for the week.

As against these values, there are the corresponding ones between March and May, over practically the same period of time, when the day-to-day consistency is much greater and the differences are not of a particularly striking character. The values themselves on the whole are considerably lower than those for the period September to November 1926.

Monthly Averages.—The monthly averages (Fig. 3) support the foregoing general conclusions. From February to July 1926 is a period of almost steady value; the absence of readings for August is regrettable, since it is then that changes appear to begin. During the three months September to December the values are about 70 to 80 per cent higher than the average value for the summer months. The values for January and February shown in Fig. 3 are, to some extent, misleading, since no signals were received from the middle of January to the middle of February and the plotted values are the averages, in each case, of only two weeks and not much reliance can be placed on them. In this connection, the considerable differences in the weekly and monthly averages of the months March, April and May for 1926 and 1927 is puzzling. Unfortunately there is no check possible so that it seems that continued observations for a few more years is the only way out.

In any attempt to interpret these curves, it is necessary to consider the results of other long wave observations. The valuable work of Austin, Mesny, Hollingworth and Marchant in addition to the Marconi investigations show marked seasonal intensity variations of long wave signals. Notable amongst these is that of Bordeaux (LY) in France, the intensity of which has been observed by R. Mesny in Meudon at a distance of 510 km., and by Austin at Washington at a distance of 6,160 km., from Bordeaux (*Proc. Inst. Rad. Eng.*, 1926, 14, 663). There is marked agreement in the two observations spread over the comparatively long period of four years from 1922 to 1925. This is specially noticeable after 1923, when the wavelength of Bordeaux was changed from 23.45 km. to 18.9 km. The intensity at both places increases almost suddenly about October and begins to fall by about January or February, the summer values being much lower than the winter ones. Hollingworth's results, however, show that the changes need not always be an increase, but may mean a decrease as well. Observations made at Slough, Glasgow and Aberdeen of the Nantes (UA) transmission give higher intensity during the period under question; but observations made at Manchester show a marked reduction. Again Oxford (GBL) shows an increase at Aberdeen and Slough and a smaller intensity at Glasgow (*J. Inst. Elec. Eng.*, 1926, 64, 581).

On the hypothesis of the Kennelly-Heaviside layer, the explanation offered by Hollingworth for these changes during the period

October to December, is that the altitude of the layer suddenly increases from 75 km. to 90 km. It is to be observed that T. L. Eckersley (*J. Inst. Elec. Eng.*, 1925, **63**, 933) estimated the altitude to be 40 to 48 km. in summer and 56 km. in winter. The concordance of the observations of Austin, Mesny and Hollingworth, together with those made at Bangalore on Madras, indicate that whatever happens, the changes which take place are world-wide.

Austin, however, attributed (*Proc. Inst. Rad. Eng.*, 1926, **14**, 663) the similarity of the changes at Meudon and Washington to changes in the neighbourhood of the transmitter at Bordeaux. But later (*Proc. Inst. Rad. Eng.*, 1927, **15**, 157) he agreed that the changes might be due to changes in the average height of the layer or to the changes of ionization therein.

No attempt has as yet been made to estimate either of these changes from the observations recorded here. Analysis of daily values is in its nature very laborious. Weekly averages, though they have a tendency to hide interesting transient changes, are useful.

Foreign Stations.—Attempts are being made to measure the intensities of a few European and Far Eastern high-power long-wave stations. Measurements in the evening are very difficult on account of violent atmospheric disturbances which constantly subject the galvanometer needle to strong kicks. This rather confirms the idea that deflectional methods are not very reliable in the presence of strong atmospherics.

The Malabar (PKX) authorities have kindly agreed to co-operate in this work by transmitting an experimental signal at 2330 G.M.T. A few observations have been made; and it is hoped to report later on the results of the measurements at Bangalore.

It is with pleasure that I thank the Wireless authorities of the Government of India, and Mr. William Byrne, in charge at Madras, for their co-operation up to date. To Professor J. K. Catterson-Smith my thanks are due for his continued interest and kindly encouragement in the progress of these measurements.

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APPENDIX.

Discussion on Long Distance Receiving Measurements at the Bureau of Standards in 1925 (L. W. Austin).

Greenleaf W. Pickard: Mr. Sreenivasan's discussion of Dr. Austin's Paper (*Proc. Inst. Rad. Eng.*, 1927, **15**, 155) contains a short tabulation of weekly averages of Bangalore reception of Madras Radio, the distance being 295 kilometers and the frequency 75 kilocycles. Although the period of this tabulation is too short for a good comparison with terrestrial and cosmic elements, it may be of interest to contrast these measurements with sunspots for the same interval. Taking his weekly averages as ratios with the mean of the entire series, and plotting with inverted ordinates, the full-line curve in Fig. 4 is obtained. The dotted-line curve is made from the daily ratios of moving 7 and 27 day averages of the Wolfer Provisional Sunspot Numbers.

These curves suggest an inverse relation between Indian reception measurements and solar activity, such as that (*ibid.*, page 93) which I have found for Dr. Austin's day reception at Washington from distant low frequency stations during 1926. It would be very interesting if Mr. Sreenivasan would compare, by the method which I have indicated above, a longer series of his 1926 measurements with sunspots, to determine whether this apparent inverse relation persists throughout the year.

In view of an investigation now in progress, in which I have already analyzed Dr. Austin's reception data for 1917, 1922 and 1923, finding in each of these years a direct instead of an inverse relation between sunspots and day reception, it would seem that 1926 might in this regard be an exception to a general rule. [Extract from *Proc. Inst. Rad. Eng.*, 1927, **15**, 539.]

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It was hoped at one time that the observations on Madras Radio might be examined with respect to magnetic disturbances, but the difficulty of obtaining magnetic data, together with the assumption that at short distances (300 km.) such disturbances might not have a noticeable effect on reception, prevented this.

The important paper by Mr. G. W. Pickard on the correlation of radio reception with solar activity (*Proc. Inst. Rad. Eng.*, 1927, **15**, 83) shows that this assumption is not justifiable. An examination of the intensity variations in relation to solar activity and terrestrial magnetism on the lines suggested by Mr. Pickard has been commenced.

The curve (Fig. 4) obtained from the observations on Madras in October and November 1926 shows the marked influence of sunspot activity on reception and considering that during these months comparatively violent changes in intensity from day to day and week to week

were observed, the inverse relationship is of considerable interest. That the day observations at Bangalore are not an exception seems to be borne out by a similar relationship which Mr. Pickard has found in Dr. Austin's observations, made at Washington, on European Stations.

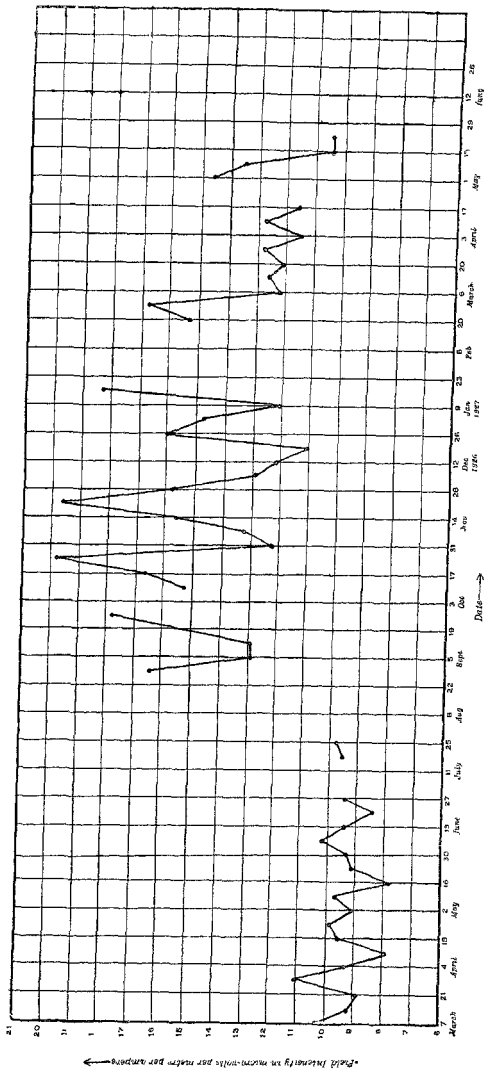
Mr. Pickard's remark that 1926 is an exception to the general rule of direct relationship between sunspots and day reception is of particular interest. The year 1926 was characterized by a violent magnetic storm during the latter part of October which completely blocked the beam system of transmission between England and Canada but, according to published information, there was practically no abnormality, during the severest part of the storm, in the reception of long-wave signals.

This indicates some kind of selective action. Without laying too much stress on the observations on Madras, the weekly averages seem to suggest an explanation which may be worth some attention, although, at present, it can only be in the nature of a conjecture. Is it possible that short waves, on account of their penetration to a greater height into the ionized atmosphere, respond more readily than lower frequency waves to such phenomena as magnetic storms? Is it not likely that any violent disturbances above will reach the lower "turbid" layers rather slowly and as a consequence that long wave reception shows less marked changes, beginning some time after the storm has started and assuming normal values comparatively long after it has ceased?

If there were sufficient data on reception over a number of years throughout the radio spectrum from short waves through the broadcast band to long waves, the above suggestion might have been examined for what it is worth.

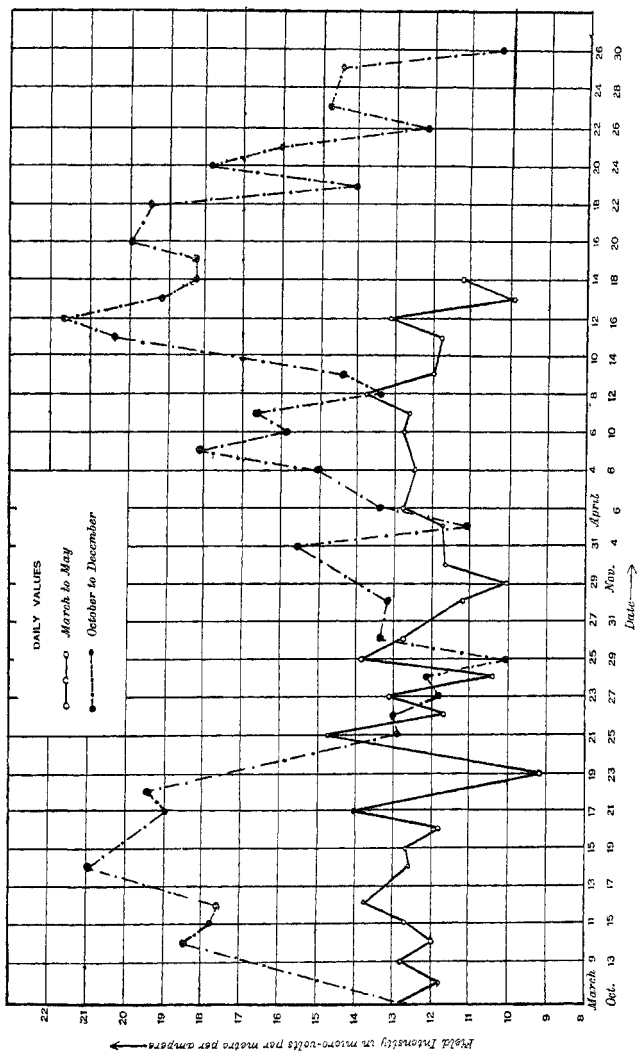
Besides the observations on Madras the intensity of the British Post Office Station at Rugby (GBR. 16 Kc/sec.) has been measured daily, due to the kindness of Mr. E. H. Shaughnessy who readily agreed to the transmission of special test signals twice daily for two months from 10th July 1927. Each signal consisted of a three minute dash, the morning signal lasting from 0115 to 0118 G. M. T. and the afternoon signal from 1115 to 1118 G. M. T. With a time difference of $5\frac{1}{2}$ hours between Rugby and Bangalore, the path of the morning signal lies mostly in darkness. During the evening the path of the signal is in daylight throughout.

A report on these measurements will be made soon after the transmission is concluded on 10th September. Unfortunately, the measurements on the test signals from Malabar (PKX 15. 6 Kc/sec.) at 2340 G. M. T. was discontinued from 10th July 1927. Even while this transmission lasted, there were so many breaks due to one reason or another, that the number of observations is far too small to be of use.



Weekly Averages of Intensity of Madras (VWC) at Bangalore

FIG. 1



Daily Values of Intensity of Madras (VWO) Radio at Bangalore

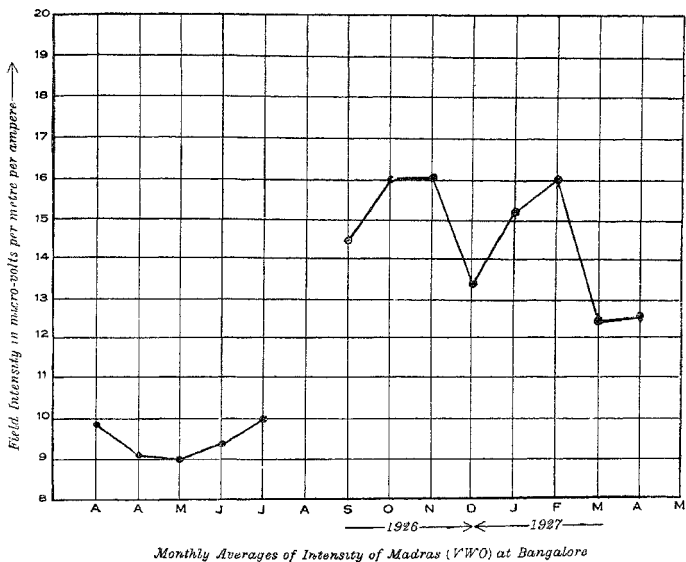


FIG 3

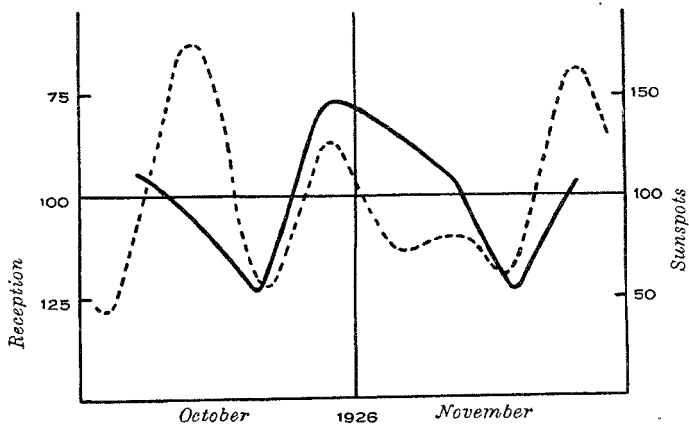


FIG. 4. Mr. G. W. Pickard's Graph.