Variation of 40 kHz Signal Level in Relation to Sunrise, Sunset and Climatic Condition

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Abstract: *The sunrise effect, sunset effect, the diurnal and seasonal variations are the characteristic feature of low frequency (LF) radio wave propagated over a large distance. The normal character has been found to be perturbed during rainy days. The amplitude of 40 kHz signal transmitted from Miyakoji station, Japan and received in North-East India is remarkably attenuated after the commencement of rain. On the basis of nature of attenuation the observed records have been classified into two different forms viz., F1 and F2. An analysis in this regard is represented in this paper.*

1. Introduction

The Low Frequency (LF) radio wave travels round the earth via wave guide formed by the earth and lower surface of ionosphere. Ionospheric parameters such as electron density and collision frequency remaining constant, the propagation is dependent on cloud coverage, humidity and temperature [1]. The variation of attenuation of low frequency due to variation of tropospheric condition is so far neglected.
But large objects such as mountain of size comparable to wavelength of LF radio wave can diffract radio wave resulting in scattering [2]. Severe rain over region of linear dimension comparable to wavelength of LF wave may give rise to scattering of LF wave experiments also show that the index of refraction and conductivity of the path vary with seasons due to the change in the properties of the troposphere.

2. Experiment

Transmitter: This signal is transmitted continuously from Miyakoji station ($37^0 22^/$N,$140^0 51^/$E), Japan at a transmitting power of 50 kW, the Call Sign being JJY.
Receiver: Our laboratory is situated at West Tripura(23^0 N, 91^0 $24^/$ E), a hilly place of the North-East corner of India. The great circle distance between the receiving and transmitting stations is 4944 km. The propagation path is shown in Fig.1.

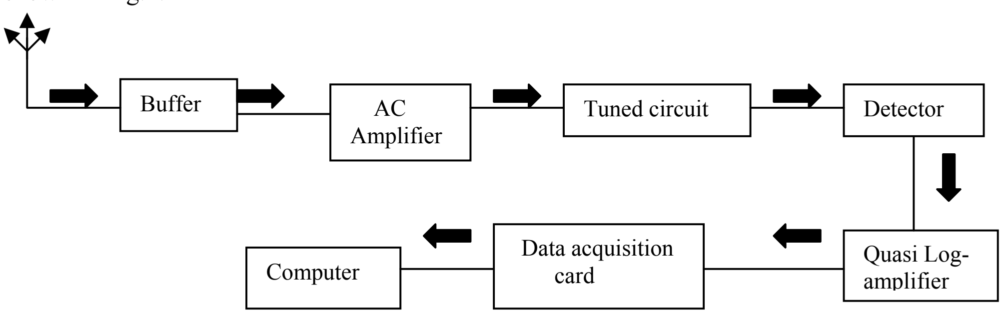

Fig.1.Block diagram of receiving system

Antenna: We used a inverted L-type antenna. The effective height of the antenna is 7.85m and the terminal capacitance is 35.42 pF. The receiving system is shown in Fig.1. *AC-amplifier:* A non-inverting amplifier of variable gain (1 to 20) is used. *Tuned circuit:* The receiver is tuned at 40 kHz by a L-C series resonant circuit of high selectivity. The Q-value of LC circuit is 146 and the bandwidth is 200 Hz. *Detector circuit:* A diode detector is used having RC time constant of 0.22 second. *Logarithmic amplifier:* A logarithmic amplifier is used to compress the scale and to increase the dynamic range up to 35 dB. *Data acquisition system:* A 8 channel 12 bit ADC type acquisition system is used and the data is finally stored in the computer using Radio Sky-pipe software(Licensed version).

3. Observation and Results

The amplitude of 40 kHz signal has been recorded since September,2005 as a part of ELF-LF propagation study. Detailed analysis shows that the signal level is attenuated during sunrise. This is known as sunrise fade or sunrise effect. The time and dept of sunrise fade varies form season to season with a good repetition in successive days. The sunrise effect is prominent in the month of February, March, May, September, October and November. After sunrise fade signal amplitude rises gradually and attains the maximum value in the afternoon periods. The signal level is high in midday and midnight during March, April, May and December. The midday level is significantly low in June, September, October and November. A typical record of LF band signal showing sunrise and sunset effect is shown in Fig.2.

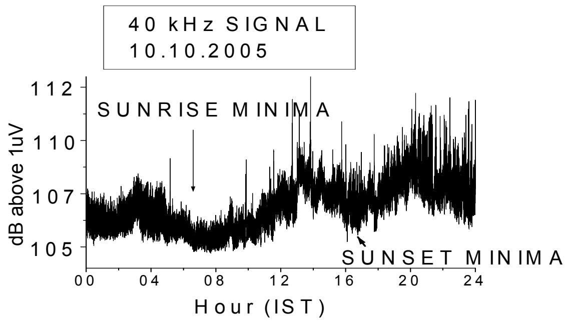

Fig.2. Diurnal variation of 40 kHz radio signal .The abscissa represents time in hour, Indian Standard Time,(IST) and the ordinate represents the amplitude of the signal in terms of induced voltage at the antenna in dB above 1uV.

The amplitude of the 40 kHz signal occasionally shows anomalous fading in relation to local heavy shower. We have considered 7 numbers of showers of duration 1 - 2.5 hours. It has been noted that the signal level is attenuated to a value which is far bellow the ambient level. The Figure 3 shows the time of onset of rain and the commencement of attenuation. The attenuation of signal strength is obtained in two different forms. From 1 (F1). In the case of heavy shower associated with thunder activity the signal attenuation is recorded as a sudden fall in amplitude. Form 2 (F2). If the thunder activity is less, the attenuation is observed in the form of gradual fall. The types F1 and F2 of attenuation are shown in Fig.3 The arrow mark indicates the onset of rain. In the case of form1 the signal level show large fluctuation due to overhead cloud discharge.

In Table 1 we show the rate of attenuation after the commencement of rain. In the case of F1 the attenuation rate varies from 0.06 dB/min to 0.32 dB/min and in the case of F2 the rate varies from 0.01dB/min to 0.04 dB/min.Short period rains are mainly associated with F1 whereas long term rains are associated with F2.

4. Discussion

Attenuation of LF radio wave has been repeated time to time in relation to solar activity, meteor shower and geomagnetic effect[3]. The effect of rain on LF propagation is neglected due to it's large wavelength. But localized

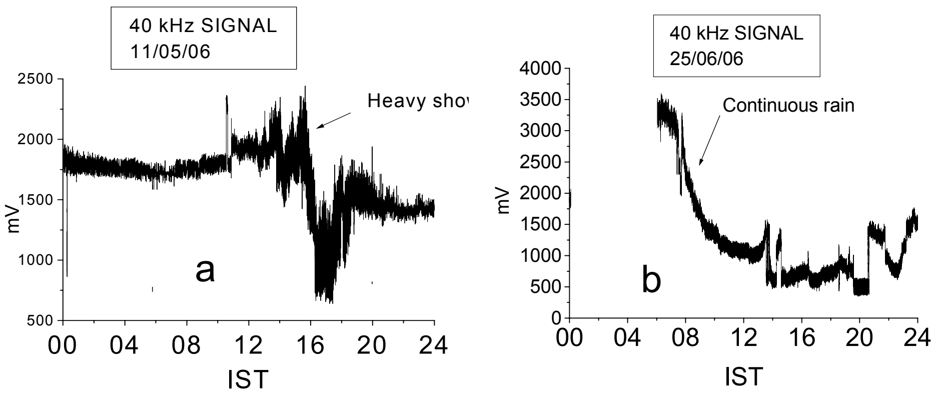

Fig.3.(a) Attenuation of 40 kHz signal amplitude during rain in the form of sudden fall, Type F1and (b) Attenuation in the form of gradual fall, Type F2. The abscissa represents the time in IST and the ordinate represents the signal strength in terms of output voltage of the receiver.

Table1: Rate of attenuation in various cases of F1 and F2

Form	Attenuation in dB	Attenuation rate in dB/min
F1	2	0.06
	5	0.06
	5	0.06
	3	0.16
	5	0.05
	3	0.08
	15	0.32
F2	2	0.02
	3	0.04
	10	0.03
	4	0.02
	5	0.01

rain in the path of radio wave may be considered as a diffracting object provided that linear dimension of the rain zone is comparable to wavelength and rain density is high. In the present analysis we have considered only those attenuations which are related to rain. Analysis of LF signal by considering large number of data of rain and it's density will reveal the optimum condition for the attenuation of LF wave by a heavy shower.

5. References

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