The gradual rise and fall of the level of atmospherics during rain and various cloud activities

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Abstract: *The variation of atmospheric noise field strength(ARNFS) at VLF have been reported time to time to various research works. The variation of ARNFS with rain activity has been reported only in a few paper .In this paper we report the findings in the variation of ARNFS in relation to a number of rain activity. The level of ARNFS increases prior to the rain and falls after the on set of the rain .According to the structure of rise and fall they can be divided into three types viz. TI, TII and TIII. Type I and II are of single peak where as type III is of double peak. The rate of rise and fall of them have been compared.*

1. Introduction

The electromagnetic radiations originated by cloud discharge known as *atmospherics or sferics* are significant in regard to electric phenomenon going on in different types of clouds during meteorologically active periods. During clear period atmospheric radio noise field strength (ARNFS) measurement provides the study of ionospheric propagation [1,2]. Here we report step rise and step fall in relation to various cloud activities such as overhead clouds, neighbouring clouds (within 10 km) and distant clouds.

The variation of electric field ΔE can be expressed as Fourier transform: $\Delta E(d,t) = \int a(d,\nu) \exp(i\nu t)\, d\nu$, where the inverse FT is given by $a(d,\nu) = \int \Delta E(d,t) \exp(-i\nu t)\, dt$, the amplitude of Fourier component due to thunder electric pulse at a distance d. The received Fourier component $a_r(d,\nu)$ at frequency ν at distance d can be expressed as: $a_r(d,\nu) = G(\nu)\, W(d,\nu)$, where $G(\nu)$ is the function of spectral source and $W(d,\nu)$ is the wave guide transmission function. The fraction $G(\nu$ t) depends upon the electrical state of the cloud source. During growth, the potential difference between various parts viz For this purpose we have investigated 11 numbers of cases of rains. top and bottom go on increasing. Hence power flux of radiation the source increases. In this case magnitude of ARNFS is also expected to increase Prior to the rain, the level of atmospherics exhibit gradual rise followed by sudden fall. The slope of rise has been investigated with respect to clouds of various distances and season in 1 kHz, 6 kHz and 9 kHz

2. Experiment

In order to study the characteristic features of VLF propagation, we are recording ARNFS at 1,6,9,12 and 15 kHz Sferics in our laboratory round the clock.

Source: The electromagnetic radiations originated by cloud discharge is the source of the atmospherics radio noise.

Receiving Station: Our laboratory is situated at West Tripura (23^0 N, 91^0 $24^/$ E), a hilly place, at the north-east corner of India.

Receiver: An *inverted-L type antenna* has been used to receive pre-dominantly vertically polarized *sferics* in the ELF band from near and far sources.

Antenna:- We are using a L-type vertical antenna whose effective height is 7.85m and the terminal capacitance is 35.42 pF.

The receiving system has be designed and constructed in the laboratory using IC 741 of gain-bandwidth product 1MHz. The tuned circuit consists of ferrite core of high magnetic permeability in order to obtain narrow bandwidth. The block diagram of the complete receiver is shown in Figure 1. AC-amplifier:-Type: We are using a non-Inverting. type low noise amplifier with adjustable gain Tuned Circuit:-Type: L-C Series Resonant circuit of Q-value 31 for 1 kHz, 37 for 6 kHz and 39 for 9 kHz and 102,96 &78 are the band width respectively

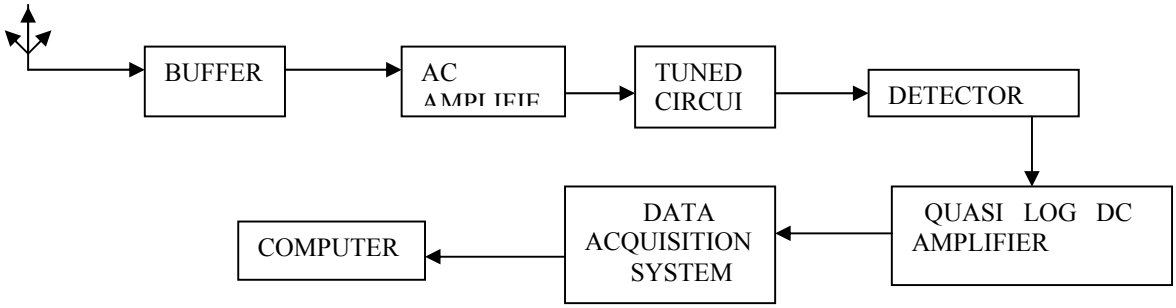

Figure1. Block diagram of a receiver used to record the Sferics ARNFS

Detector: Type: Simple Diode detector RC tuned circuit of time Constant: equal to 0.22 second is used. Amplifier: Q*uasi-logarithmic* DC amplifier has been used to increase the dynamic range upto Variation of 40 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. Observations and Results

For the study of VLF band propagate continuous monitoring of the1kHz, 6kHz, 9kHz, 12kHz and 15KHz signal have been done for the period for May October 2005 except some power failure problem. Apart for normal variation viz. diurnal and seasonal variations , the ARNFS exhibits typical variations related to local shower within the radius of 10- 15 km before the rain, the level of ARNFS rises and after the onset of rain the levels falls.The nature of variation can be classified into three types. Type-I (TI): gradual rise prior to the rain and sudden fall with the commencement of rain. Type-II (TII): Fast rise before the rain and fast fall after the rain. Type-III (TIII): Double-peak variation. These three types are shown in Figure1, 2 and 3.

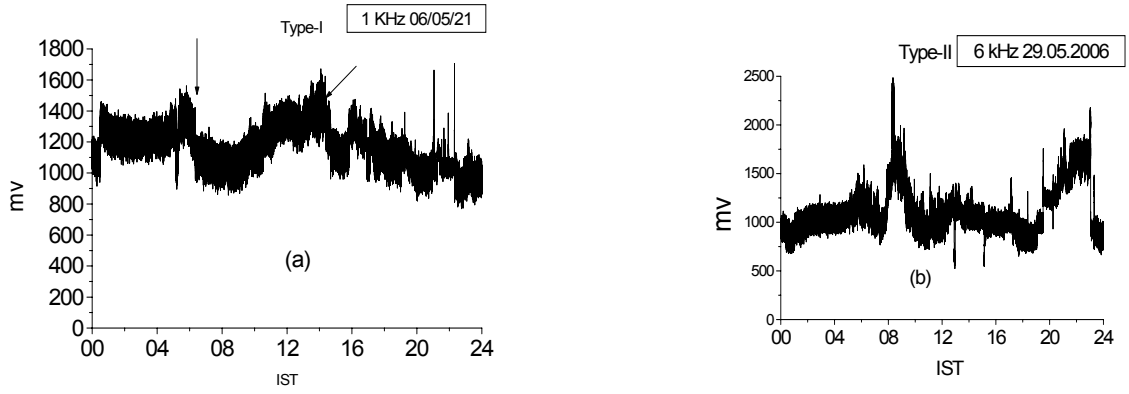

Figure1.(a) TypeI: A sudden absorption in ARNFS associated with rain. The arrow marks indicate the time of on set attenuation. (b) TypeII: variation of gradual rise and gradual fall type. The arrow head indicate the time of on set of shower.

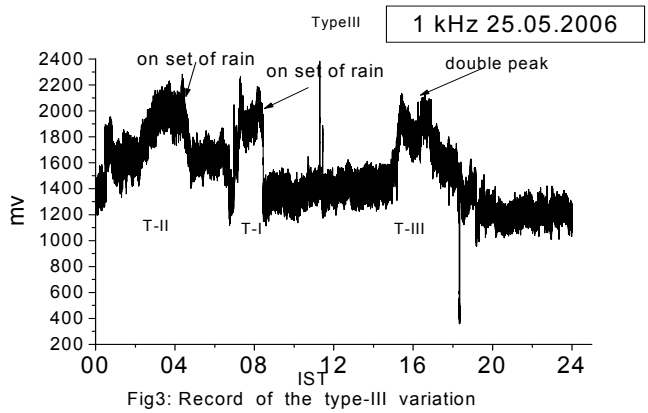

Fig3: Record of the type-III variation

The rate of rise and rate of fall of different types of variation are shown in Table 1.

TABLE 1 :Rate of rise and rate of fall of ARNFS at 1kHz associated with rain with various types of effects

Type	Average rate of rise in(mv/min in terms of output voltage)	Average rate of fall in(mv/min in terms of output voltage)
I	1.14	4.16
II	15.15	7.75
III	3.04	6.04

4. Discussion

Discussion: Anomaly in VLF atmospherics has been studied occasionally in relation to heavy rain and cloud activity [3].The unusual behavior of atmospherics has been studied from eastern part of India in relation to tornado [4,5].However the typical type observed in this paper will through some new light on the electrical state of cloud which can not be directly explored**.** The rate of rise in type I is lowest and it is height in type2. The type2 affect is mainly observed in the case of rain where thousands and storm activities is highest. Cloud related to type2 events possess highest growth rate of electrification and so the rate of rise is very high.Type1 effect are related to cloud sources in which growth rate of charge is low. Rate of growth of charge is moderate in the case of clouds related to type3 effect. Since the rate of growth of charge is dependent of nature of cloud, at various season of the year.

5. References

[1] Clilverd M A, Watkins N W, Smith A J et. al. "Diurnal and annual variations in 10 kHz radio noise", *Radio. Sci.*, **34(4),** 933-938, (1999

[2] De B K and Sarkar S K :Regular and seasonal Behavior of Atmospheric Radio Noise Field Strerig (ARNFS) over Low Latitude Station, Calcutta,Meteorol.Atmosphys.,vol.61,pp 107-114, 1996

[3] Sen A K, Sarkar S K & Bhattacharya A B, "Anomaly in VLF atmospherics during flood rainy days over Calcutta during 27-30 September 1978", *Ind. J. Rad. Space Phys.,* **82,** 139-142, 1979

[4]. Saha A., De B.K., Sarkar S. K., Spectral Charateristics of Gaighata Tornado of 12 APR.-1983, Ind.J. Rad. Space Phys., **13**, s.98-102, 1984.

[5]. Saha A., De B. K., Sarkar S.K., Case Study of Gaighata Tornado of 12 April, - 1983, Ind. J. Phys., Vol.583, s.154 -160, 1984