Cyclic Variation of the Rate of Flashing in Thunderstorms

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1. Introduction

Workman and Reynolds (1949, 1953) have studied the frequency of occurrence of lightning flashes (stroke frequencies) in active thunderstorms by using radar, by visual observations and by an analysis of cathode-ray oscilloscope and electrostatic field change records. They report a cyclic variation of the rate of flashing with a period lying between 10 and 30 min. The object of this note is to present results obtained by using the Aiya noise meter (Aiya, 1954; Aiya and Phadke, 1955; Aiya *et al.*, 1955; and Satyam, 1962) which appear to confirm the results of Workman and Reynolds as also the general observation, from direct and indirect experiments, that the life of the thunderstorm cell is about 30 min (Byers and Braham, 1953; Brook and Kitagawa, 1960).

2. Experimental work

The Aiya noise meter, as set up, consists of a vertical aerial of approximately 3 m effective height with a

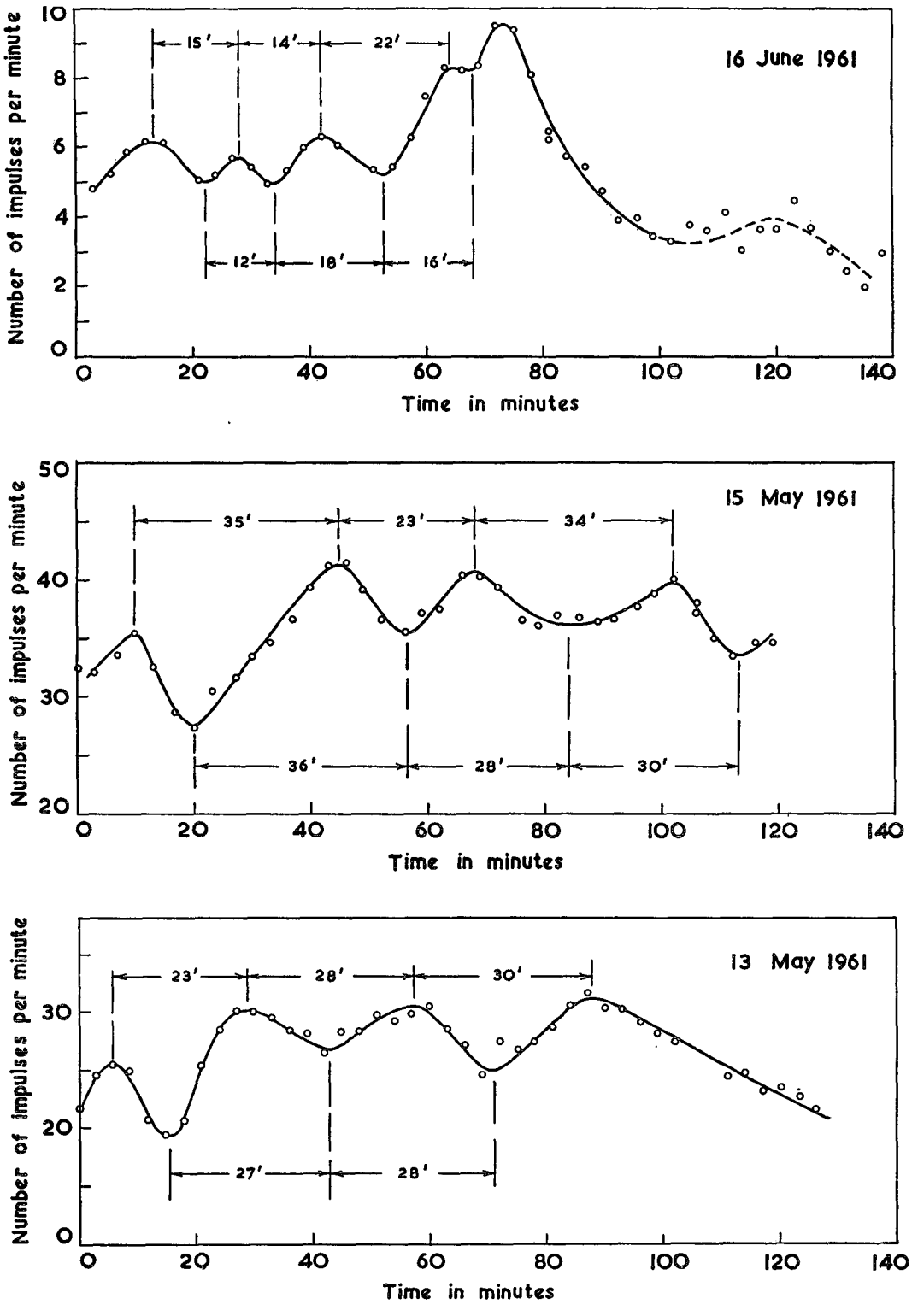

FIG. 1. Cyclic variation of the rate of flashing in thunderstorms.

suitable counterpoise. The output from the aerial is fed to a wide-band amplifier. The output from the latter is fed into a superheterodyne receiver through a matched feeder. The superheterodyne receiver is aligned for a bandwidth of 6 kc at 6 db down. The gain of the receiver can be controlled by changing the values of the bias voltage of the tubes in the HF stages. The audio output from the second detector in the receiver is fed to a logarithmic amplifier cum valve voltmeter as previously described (Aiya, 1954; Aiya and Phadke, 1955; Aiya *et al.*, 1955; Satyam, 1962). It has a charging time constant of 10 milliseconds and a discharging time constant of 500 milliseconds. This meter records the lightning discharges in the form of kicks. Each kick in the micro-ammeter is the result of radiations from one lightning flash at the frequency to which the receiver is tuned (over a bandwidth of 6 kc at 6 db down). This kick is commonly referred to as a flash impulse or impulse. The reading of the micro-ammeter corresponding to the kick is a measure of the quasipeak value of the radiation arising from one complete flash. The experimental results utilized for the discussion in this note are from atmospheric noise measurements at 3.0 and 4.5 mc during the hours 1200–1800 IST.

Extensive investigations on atmospheric noise using the Aiya noise meter, supplemented by aural recordings of thunder and visual observations of lightning have conclusively shown that whenever the noise field strength exceeded 200 μV/m in the 3.0-mc band, a thunderstorm did occur locally, i.e., within about 20 km from the point of observation. This experimental result provides the required criterion for classifying a thunderstorm as local.

Three local thunderstorms were followed by using this noise meter at Bangalore (12°58′N, 77°35′E). The range of the noise meter was so adjusted that only the impulses arising from flashes in the local thunderstorms could be received. All the impulses received were recorded continuously throughout the period of activity of the storm. The number of impulses received in a 3-min period was computed. This value is taken as the rate of flashing in a time unit of three minutes.

3. Results

The rate of flashing obtained as above was plotted against time from the commencement of the activity of the thunderstorm. In actually plotting the results, the data obtained have been smoothed by the method of moving averages using a moving average of three. The results are shown in Fig. 1.

An examination of the figure shows a distinct cyclic component from the commencement of the activity till the decay period. The period of the cyclic component as revealed from the figure together with the average values of the same and other relevant data are given in Table 1.

TABLE 1. Period of the cyclic component of the rate of flashing in thunderstorms.

Date	Period determined from crests in min: Individual periods	Period determined from crests in min: Average period	Period determined from troughs in min: Individual periods	Period determined from troughs in min: Average period	Average period for the thunderstorm in min
13–5–1961	23, 28, 30	27.0	27, 28	27.5	27.2
15–5–1961	35, 23, 34	30.7	36, 28, 30	31.3	31.0
16–6–1961	15, 14, 22	17.0	12, 18, 16	15.3	16.1

It has to be pointed out that the thunderstorm of 15th May could not be followed during its decay period. But the other two, viz., those on 13 May and 26 June 1961, which were followed till the decay, show that there is no evidence of cyclic variation in the decay portion.

4. Conclusion

The data appear to generally support the results of Workman and Reynolds. The period of cyclic activity of the storms of 13th and 15th May roughly correspond to the approximate life of a thunderstorm cell as previously reported by others (Byers and Braham, 1953; Workman and Reynolds, 1953; Brook and Kitagawa, 1960). It has also been reported by these authors that a decaying cell gives rise to new cells and that such a process goes on till the thunderstorm itself finally decays. It is, therefore, highly probable that the cyclic component is to be associated with the growth and decay of such cells. Since no new cells are formed during the final decay of the thunderstorm itself, it is to be expected that there should be no cyclic component during this period.

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