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WEATHER NOTE

A Rare Event of Intense Rainfall

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ABSTRACT

Data are presented for the most intense storm observed during a 3-yr recording period (1967–1969) on the Crawford Hill rain gage network at Holmdel, N.J. Point rain rates in excess of 270 mm hr^{-1} (10.6 in. hr^{-1}) were observed. A total of about 280 million gallons of water fell in a 15-min interval over an area of 32.3 km^2 (12.5 mi^2).

1. INTRODUCTION

Knowledge of the intensity and duration of rainfall is needed to permit design of reliable radio communication systems using frequency bands above 10 GHz (Hathaway and Evans 1959 and Hogg 1968). Since information on the temporal and spatial characteristics of rainfall very near the earth's surface is limited, an experiment was designed to obtain statistical data on both the temporal and spatial distributions of heavy rainfall.

The details of the rain gage (Semplak 1966), the rain gage network, and methods used to record the rain rate data have been published (Semplak and Keller 1969); however, a brief discussion of the network is included here for completeness. The rain rate data are collected from a network of 96 gages spaced about 1.3 km from each other and covering an area of 130 km^2. The rain rate, as measured in terms of frequency of an oscillator on each gage, is sampled for one-tenth of a second every 10 s, thus it takes 10 s to sample and record the entire network. Since the sampling is repetitive, one obtains fairly fine data on the structure of the rainfall over the network.

The northwestern portion of the rain gage network is shown in figure 1. The dot within each grid indicates the location of a rain gage mounted at the top of a telephone pole, approximately 7.6 m above the ground. The dashed

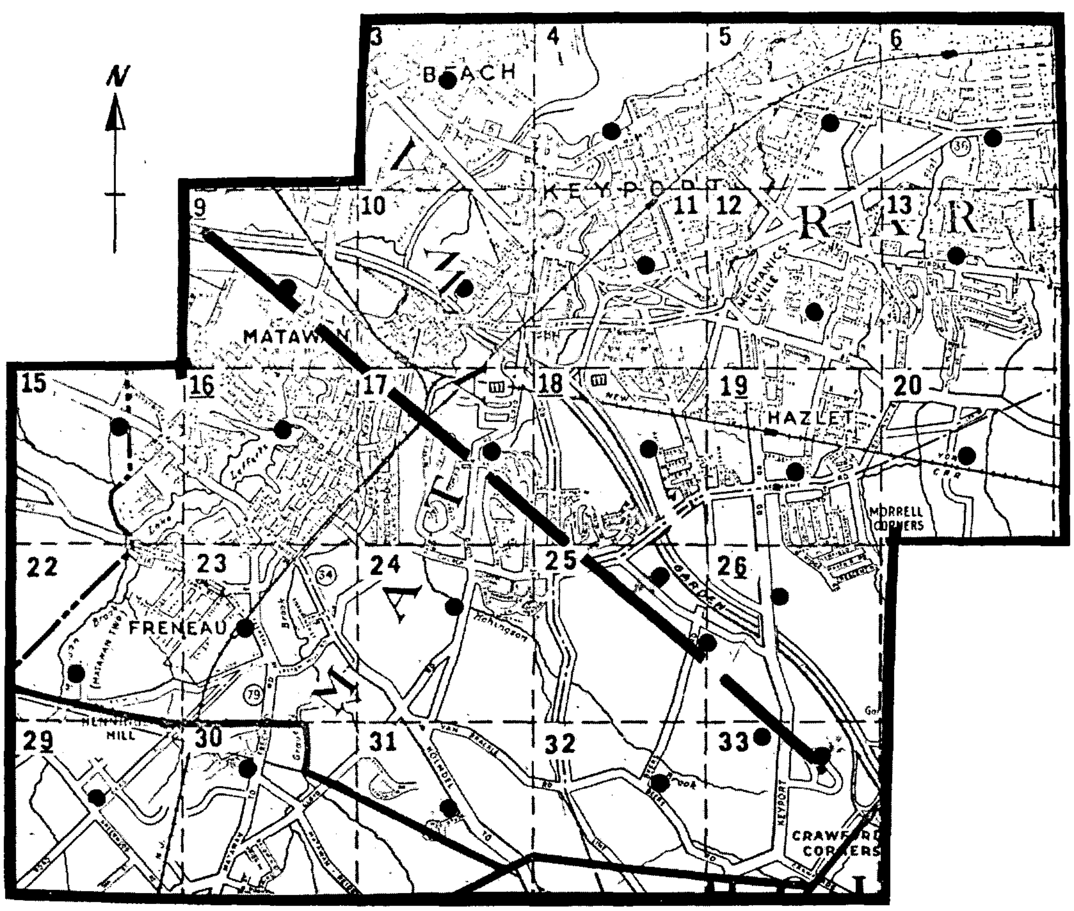

FIGURE 1.—Area map showing the northwest portion of the Crawford Hill, Holmdel, N.J., rain gage network.

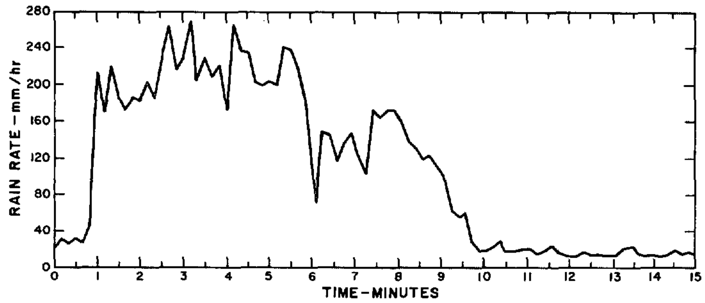

FIGURE 2.—Measured rain rates from gage 10. The solid curve represents the data obtained from the 10-s sampling scan of the entire network.

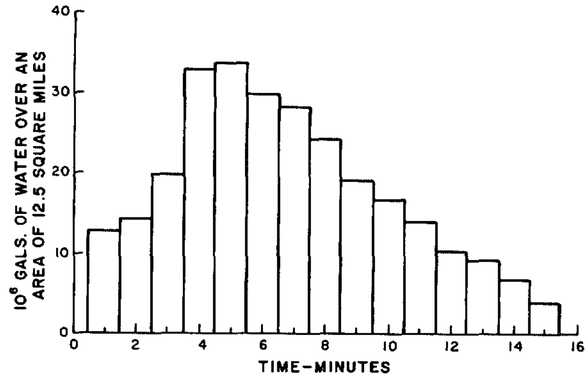

FIGURE 4.—Histograph of the total rainfall in millions of gallons of water for 1-min intervals of the storm of Aug. 22, 1968.

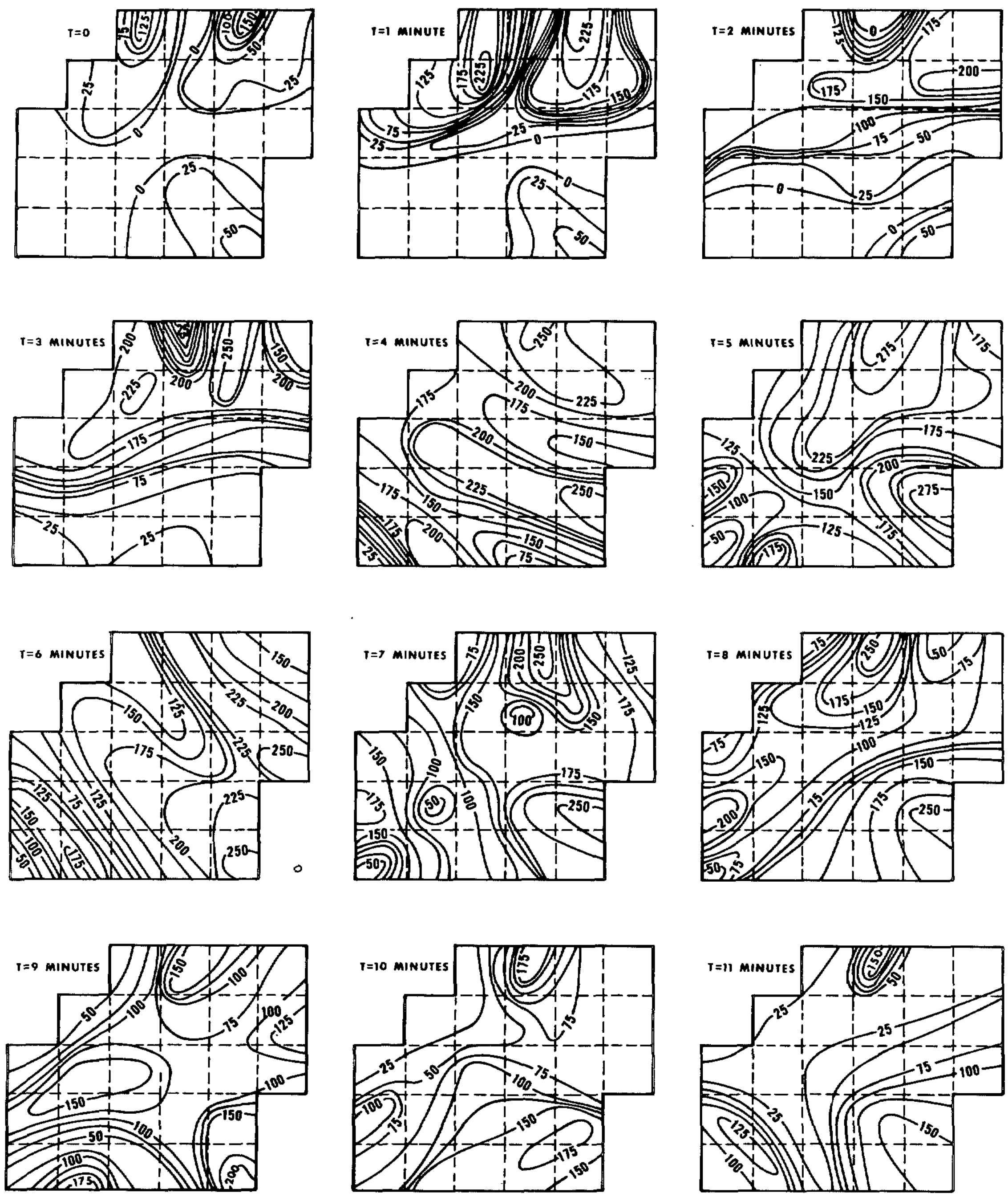

FIGURE 3.—Plot of the rain rate in 25 mm hr^{-1} contours for the storm of Aug. 22, 1968. Notice that there is only one gage per square and linear interpolation was used in obtaining the detailed contours. Each plot is generated from instantaneous rain rates taken every minute.

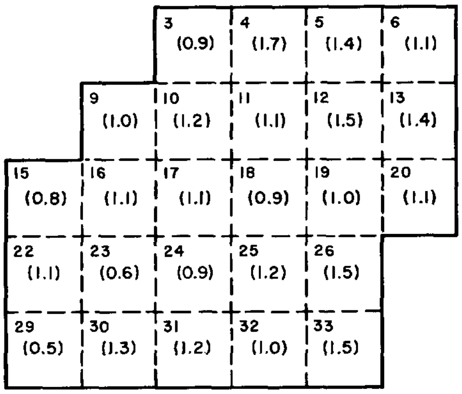

FIGURE 5.—Volume of water in ten millions of gallons (indicated by the number in parentheses in each square) that fell on each rain gage area for the 15-min interval of the storm of Aug. 22, 1968.

line extending between grids 9 and 33 is the transmission path used in the 18.5 GHz radio propagation studies which have been discussed elsewhere (Semplak and Turrin 1969). It should be noted, in view of the intimate relationship that exists between the attenuation of microwaves and high rainfall rates, that an examination of attenuation data provides a quick means of determining the intensity of a particular storm crossing the propagation path.

Intense rain rates, associated with shower-type storms, are events that occur with low probability. But in designing communication systems, one requires low outage times; a probability of outage of 0.001 percent (5 min out of the year) is significant. With the preceding as background, the most intense storm to cross the propagation path in a 3-yr period of recording will be discussed.

2. AN OCCURRENCE OF VERY INTENSE RAIN

On the evening of Aug. 22, 1968, shortly before 10 o'clock EST, intense rainfall appeared on the portion of the rain gage network shown in figure 1. The intensity of this storm is evidenced in figure 2 by the rain rate measurement from one of the gages in this area (the gage in grid 10, fig. 1). For simplicity, the time scale on the abscissa of figure 2 is shown in minutes beginning with zero. The plot shows the rain rate data obtained every 10 s (the scan period of the entire rain gage network). Notice that the rain rates frequently exceed 200 mm hr^{-1} (8 in. hr^{-1}) with peaks as high as 270 mm hr^{-1}. The onset of the rain is very rapid, almost a step function. Similar measurements were obtained on the other gages in the area.

In figure 3, the instantaneous rain rates from the gages shown in figure 1 have been used to generate a sequence of contour maps at 1-min intervals for this storm. For this presentation, a linear interpolation is used to produce 25 mm hr^{-1} rain rate contours between adjacent gages. Even with this large interval, the contours become crowded in some places simply because the rain rate at a given gage is so much higher than that of its nearest neighbor.

During the period of heavy rain, the wind as measured near gage 33 in figure 1 had a speed of about 42 km hr^{-1} (approximately 25 mi hr^{-1}) with peaks to 60 km hr^{-1} and changed direction from north to northeast. Thus, the storm approached the rain gage network from the north-northeast. This is evident in the sequence shown in figure 3.

An interesting question concerns the amount of water that fell over the area during the brief time interval of the storm. These data are shown in the histograph of figure 4 for 1-min intervals. An integration of the area of the histograph gives a total of about 280 million gallons of water in the 15-min period over an area of 32.3 km^2 (12.5 mi^2). The integrated value of the amount of water measured by each gage for this same period is shown by the values in parentheses in figure 5. From this presentation, one sees that the total rainfall was fairly uniform over the area; but both figures 4 and 5 conceal evidence of the intensity of this storm. Nevertheless, the incidence of almost 3×10^8 gal. of water over a relatively small area in a relatively short period of time might serve as a delta-function model for those interested in runoff problems, pollution of streams, and design of sewers.

ACKNOWLEDGMENT

The suggestion of D. C. Hogg that people additional to wave propagationists may be interested in these data is appreciated.

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