Radio Noise Studies of Several Severe Weather Events in Iowa in 1971

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ABSTRACT

The purpose of this note is to show that not all tornadic storms yield the same radio-frequency noise behavior. One funnel cloud observed gave significant radio noise over a frequency range from 2.5 to 144 MHz.

1. Introduction

Reports that tornadoes might be detected with a television receiver have stimulated new interest in the high-frequency electromagnetic noise generated by severe thunderstorms. The most obvious interpretation of the television effect is that the storm is emitting unusual radio noise pulses in the VHF region of the spectrum. Several good review articles have appeared on investigation of general radio noise from thunderstorms. Several investigators have studied noise from tornado-bearing thunderstorms; some reported excellent correlation with tornadoes while others have found noise pulse rates which were quite variable with respect to severe weather events. A survey of recent work (along with relevant references) in this area is given in Stanford *et al.* (1971).

During the 1970 tornado season, we recorded 53-MHz radio noise from six severe convective storms in Iowa. The receiver bandwidth was limited to 3 kHz. The most pronounced data came from a brief but destructive tornado near Radcliffe, Iowa, 38 km from our apparatus at Ames. The pulse rate (i.e., the number of "static" pulses per second) at 53 MHz showed a sharp enhancement during the 5-min existence of the tornado. This event, one of the best documented 1970 Iowa tornadoes, is discussed in detail in Stanford *et al.* How representative its radio noise behavior is of most tornadoes is not yet known.

2. 1971 preliminary results

For the 1971 storm season, seven wide-band, high-sensitivity receivers were constructed to study storm noise at selected frequencies from 2 to 150 MHz. The receiver bandwidths were approximately 3% of their center frequency. The detected output is recorded in analog fashion on magnetic tape by a 7-track tape recorder. The system bandwidth was limited to that of the tape recorder, usually 60 kHz. The data were analyzed by counting all the pulses above a pre-set threshold level (system 1) or by counting all pulse peaks irrespective of pulse height (system 2). Radio-frequency noise studies from three different severe weather events in Iowa in 1971 will be discussed.[1]

At 1847 CDT on 29 June 1971, a highway patrolman reported a funnel near Stanhope, Iowa. The exact time was obtained from the tape recording of the Iowa Police radio records. Fig. 1 shows tracings of radio-noise pulse rates as a function of time for radio-frequency receivers centered at 2.5, 5.4, 8.8, 53 and 144 MHz for this period. The pulse rates depend sensitively on the exact method of data analysis and are given here in relative units.

The bandwidths for the data taken on 29 June were limited to that of the tape recorder, 60 kHz. The traces shown in Fig. 1 were obtained with further bandwidth reduction to 1.25 kHz during the analyzing process. It will be noted that a sharp enhancement of the counting rate occurs at the time the funnel was reported by the highway patrol. The funnel was described as "pencil-like" and extending down to the

[1] An earlier account of some of these data was given in "Radio-frequency noise studies of severe convective storms," J. L. Stanford, M. A. Lind, E. S. Takle, J. S. Hartman and M. R. Haas, *Preprints of Papers, Seventh Conf. Severe Local Storms*, Kansas City, Amer. Meteor. Soc., 83–85.

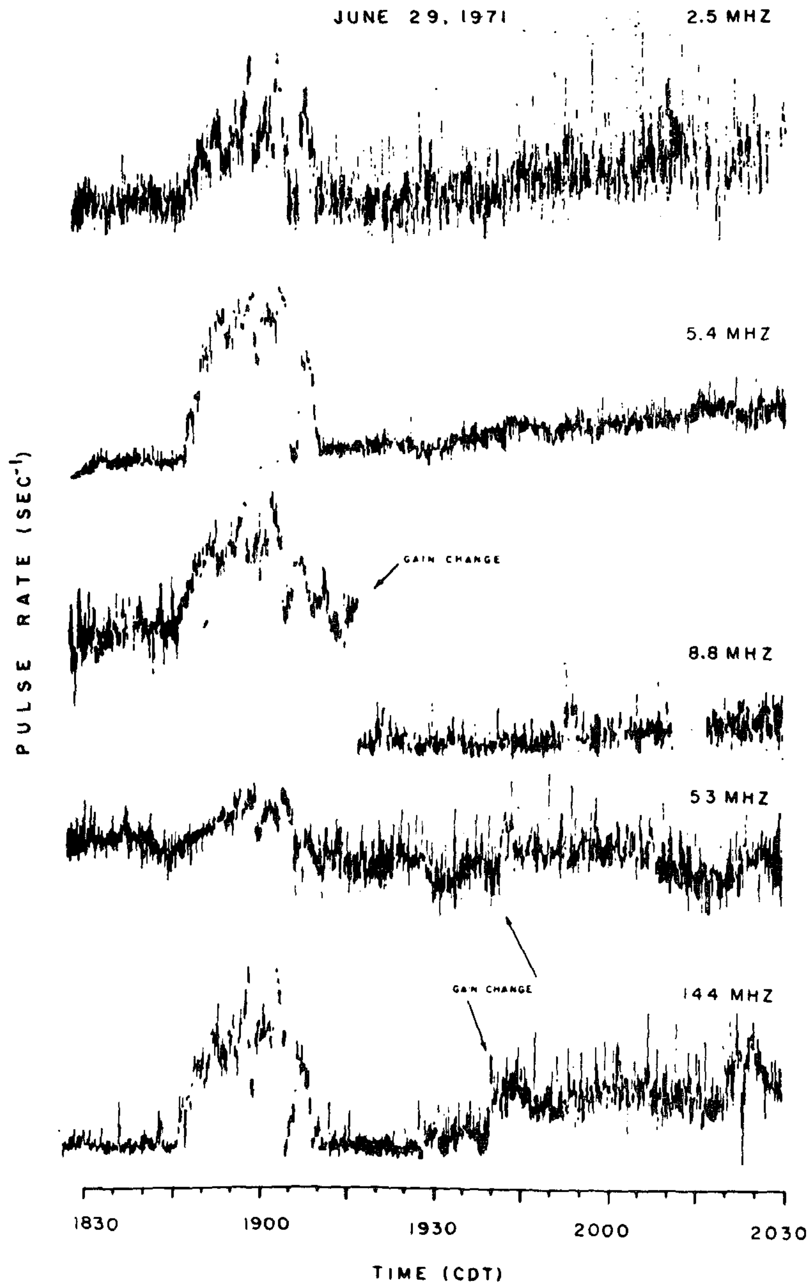

FIG. 1. Electromagnetic pulse rates (relative units) averaged over 4 sec for five radio frequencies between 2.5 and 144 MHz for the period covering the Stanhope funnel. The pulse rates were obtained using system 1. The 144-MHz data are horizontally polarized while the others are vertically polarized.

ground. The observer, however, was some miles from the funnel and later newspaper accounts did not mention any damage reports, so it is not known whether the funnel actually touched down or not. This event occurred about 35 km north-northwest of our apparatus.

On the night of 6 June 1971, an observer at Slater, Iowa (15 km south of Ames), reported observation of a funnel at 2313 CDT which lasted for about 5 min. Fig. 2 shows our radio-frequency noise data at 53 MHz covering this time period. These data were obtained by counting pulse peaks at 60 kHz bandwidth. It will be noted that no clear enhancement of the noise pulse rate occurs at the time of the funnel, even though the funnel was reasonably close to our apparatus.

The other data channels recorded at this time (see below) also do not show any clear enhancement of the noise count rate around the time of the Slater funnel (2313 CDT).

The same storm system produced a long, narrow

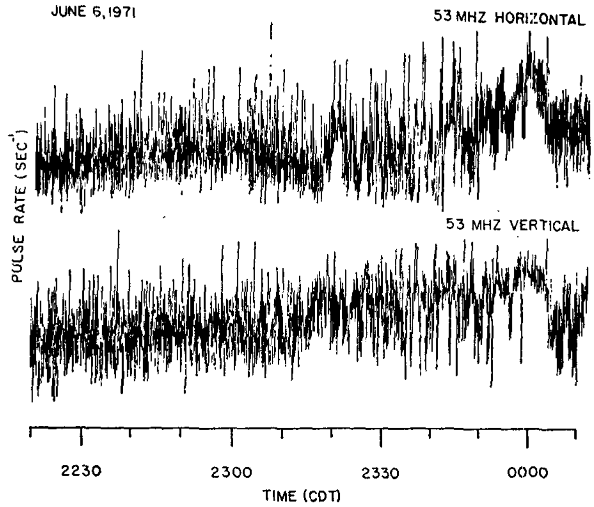

FIG. 2. Noise pulse rates (relative units) averaged over 4 sec for the two 53-MHz data tracks on the night of 6 June 1971. The two systems have identical receivers and recording tracks, but one six-element Yagi is horizontally polarized while the other is vertically polarized. The pulse rates were obtained using system 2.

path (~3 km by ~25 to 50 m) of light damage near Nevada, Iowa (15 km east of Ames). Personal inspection of damage areas and interviews with witnesses led us to conclude that the event was probably a weak tornado, perhaps not quite on the ground. A farm family described it as being like a "stack of burning auto tires with smoke billowing upwards" silhouetted against the city lights and moving across a nearby field. This event was reported at 2333 CDT. Fig. 3 gives more details of the noise spectrum for 6 June 1971, and shows pulse rate data obtained using system 1 at full tape recorder bandwidth. The 6, 9 and 13 MHz data tracks of Fig. 3 contained serious man-made interference and the traces shown were obtained by raising the threshold level significantly. The pulse-rate scales for the various traces in Fig. 3 thus should not be compared with each other.

As will be noted from Figs. 2 and 3, no sharp enhancement of the pulse rate is observed around the time of the Nevada event (2333 CDT). Instead, a more gradual buildup and decay are noted, broadly peaking around the time of the event. Narrow-bandwidth (3 kHz) data recorded at a frequency of 0.6 MHz for this time period are qualitatively the same as the traces in Fig. 3. It appears that the gradual buildup and decay observed were associated with the parent thunderstorm cell buildup and decay, rather than with the severe weather event itself. The peak in the count rate around 0000 CDT in Fig. 2 and in some of the channels in Fig. 3 is unaccounted for. An unconfirmed tornado was reported near Alden, Iowa (60 km from Ames) about this time, but whether the unknown data peak is associated with the Alden event is not known.

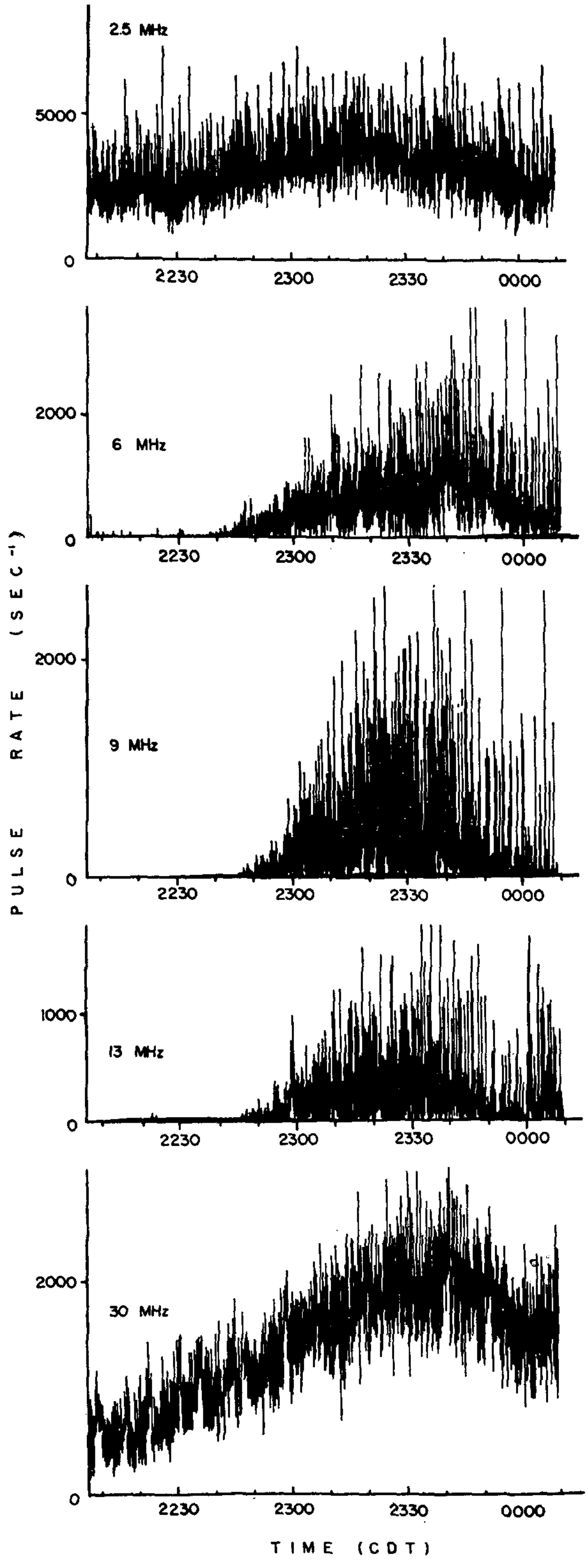

FIG. 3. Noise pulse rates averaged over 4 sec for radio frequencies of 2.5, 6, 9, 13 and 30 MHz on 6 June 1971. As discussed in the text, the counter threshold was varied between the frequencies to eliminate interference, so that the pulse rate scales should not be compared for the various traces.

3. Conclusions and future work

In the 1971 data presented so far, three severe weather events have been studied. The Stanhope funnel yielded radio noise behavior similar to that exhibited by the Radcliffe tornado of 1970, an enhanced radio-noise pulsing rate during the brief existence of the severe weather event itself. The severe weather event at Nevada, Iowa (believed to have been a weak tornado) showed a slow buildup in pulsing rate, peaking around the time of the severe weather event and then slowly falling off afterward. This behavior is distinctly different from that of the Stanhope and Radcliffe events. The Slater funnel showed little or no unusual radio noise enhancement. Because of the relatively close proximity of the Slater funnel (15 km) and the sensitivity of our apparatus, we believe that the lack of noise from this event was real.

A summary of the analysis of some of our 1971 data has been presented. We are in the process of implementing a more efficient and complete data analysis system utilizing computer techniques and hope to present a more detailed report at a later date.

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REFERENCE

Stanford, J. L., M. A. Lind and G. S. Takle, 1971: Electromagnetic noise studies of severe convective storms in Iowa: The 1970 storm season. *J. Atmos. Sci.*, **28**, 436–448.