Detecting tornadoes by radio

Some tornadoes apparently produce distinctive electromagnetic radiation, and scientists are trying to understand and apply the phenomenon

by Louise Purrett

The tornado season is now at its peak, and Plains and Midwestern States are being swept by dozens of the destructive funnels. Each year, more than 600 tornadoes materialize in the United States, taking more lives than February's San Fernando earthquake. Last year, a total of 650 tornadoes caused 73 deaths. This toll is comparatively mild: On March 18, 1925, one of the great killers of all time ripped a 200-mile path through Missouri, Illinois and Indiana, killing 700 people.

Several years ago, a number of observers—both amateur and professional—reported that by tuning their television sets to a channel for which there was no local station and turning the screen dark, they had picked up distinctive signals from tornadoes in the vicinity.

The most obvious interpretation of this ability of television sets to "tune in" a tornado, point out three scientists at Iowa State University, is that the storms emitted radio noise pulses in the very-high-frequency (VHF) range of the electromagnetic spectrum. Dr. John L. Stanford, Michael A. Lind and Gene S. Takle therefore embarked upon a study, supported by the university's physics department, of the electromagnetic pulses generated by severe storms. It has been known for years that thunderstorms create electromagnetic noise; this is the cause of radio static during a storm. But the Iowa State scientists hoped to find identifiable differences between the signals emitted by different types of severe weather.

The chief goals of the study are to find out if some fraction of tornadoes (or other severe weather such as hailstorms and windstorms) does indeed produce electromagnetic radiation different from that of ordinary thunderstorms, and if so, how this tornado radiation may be distinguished. The Iowa scientists also want to discover what fraction of tornadoes do not emit characteristic radiation, and, conversely, what fraction of tornado-like signals would be false indicators of a tornado. Finally, the three hope to uncover the physics of the phenomenon.

Thunderstorms producing tornadoes often display unusually intense lightning, and a number of authors have discussed the electrical phenomena associated with tornadoes. There are many reports on electromagnetic noise generation at very low frequencies, and it has been shown that storm noise energy in this region of the spectrum is due primarily to large-scale electrical strokes and is not as good an indicator of tornadic activity as higher frequencies.

The researchers therefore set up an antenna system to monitor higher electromagnetic frequencies—670 kilohertz, 53 megahertz and 144 megahertz. The researchers recorded the electromagnetic signals received by the antenna on magnetic tape and then counted the pulse rates and charted them against time to give pulse rate per second. The results of their first year of observations, from six storms of the 1970 tornado season, were summarized recently in the JOURNAL OF THE ATMOSPHERIC SCIENCES.

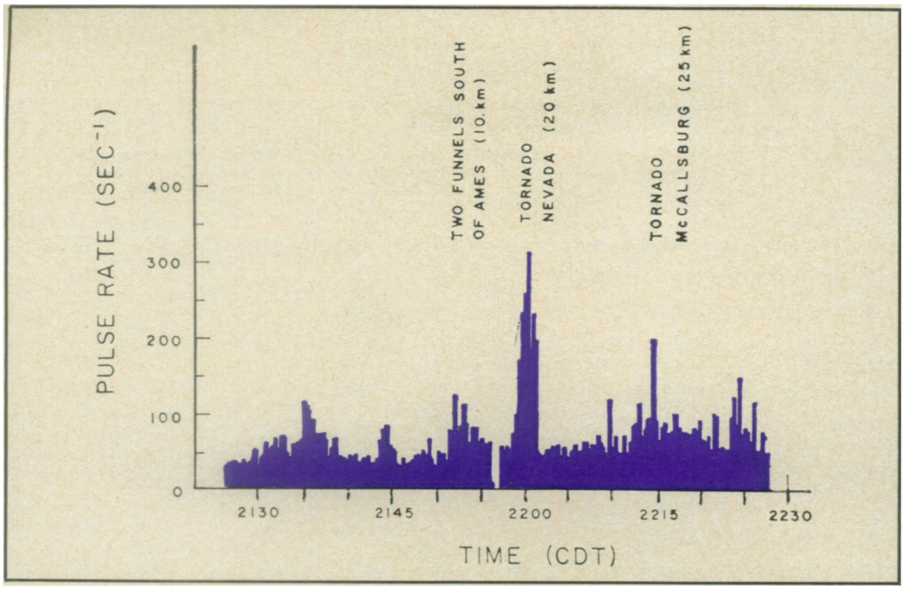
The data reveal several possibly different types of electromagnetic radiation phenomena from storms:

Radiation from "ordinary" lightning strokes creates isolated, high-amplitude peaks in pulse rate.

Another type is a gradual build-up in pulse rate over a 15- to 30-minute period. This is probably connected with convective processes occurring while the storm is building.

In a third type, pulse-rate peaks occur almost periodically at intervals of about 10 minutes. These patterns appeared to be associated in time with observed severe weather events and

The research may lead to improved warnings of tornadoes, but for now the best detector is still the human eye.



Iowa State Univ.

Electromagnetic pulse rates coincided with funnels observed on Iowa plains.

are probably related to unusually severe convective motions in the storm, the scientists said.

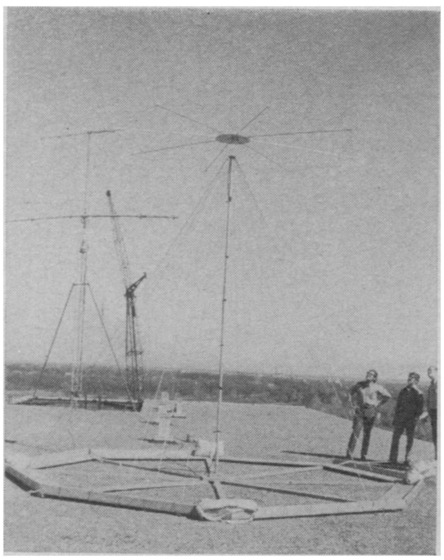
Then there are the pulse-rate peaks directly associated with tornado activity. The scientists believe these peaks may be due to corona-type discharges within a highly electrified funnel cloud. In the presence of intense electrification, points at the ground and water drops in clouds may develop corona, a continuous succession of minor electrical discharges that result from ionization of a gas surrounding a conductor. Each tiny discharge radiates electromagnetic energy. A rotating funnel cloud could build up an electrical charge resulting in lightning strokes from one side of the funnel to the other, Dr. Stanford speculates. The pulse rates observed would be consistent with this explanation, and two persons have reported nearly continuous lightning within the tornado bore. "There is no way of knowing what percentage of funnels exhibit this effect, since not many people have looked up into the bore of a funnel cloud and lived to tell about it," the scientists point out.

In addition, there are sharply defined pulse-rate peaks occurring frequently during storms that do not appear to correlate with known events. They are yet unexplained.

Their observations lead Dr. Stanford, Lind and Takle to suggest that the majority (but not all) of tornadoes do emit electromagnetic noise at high radio frequencies which is distinguishable from that emitted by ordinary thunderstorms.

But the study will continue for several more years. Even if very good data are obtained on a single tornado, Dr. Stanford explains, there is no way of knowing if the observations are typical of all tornadoes. This year the scientists have added a new receiver and tape recorder to their equipment. They are monitoring a number of frequencies between one and 53 megahertz. These frequencies, says Dr. Stanford, appear to be the most useful. So far this season, there have been few tornadoes close to the antenna, except for one in early June too close for comfort—a mile away.

There are some serious problems to solve, as well. For example, if a storm is very close, the antenna itself may develop corona, and these signals may be mistaken for signals from a storm. The researchers have found distinguishing characteristics for some tornadoes, but the question now is how reliable these would be as tornado detectors. Dr. Stanford is optimistic, but at the moment, he says, "the best tornado-detector is still the human eye." □



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The group's omnidirectional antenna.