(Courtesy Arizona Daily Star)

"It Rained Everywhere But Here!"— The Thunderstorm-Encirclement Illusion

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METEOROLOGISTS working in regions where rain cannot be taken for granted know how often despondent exclamations are made by disappointed farmers and ranchers who dolefully watch summer convective showers occurring on all sides of them as their own dry land goes unwetted by any rain. Experience suggests that the drier the ground underfoot, the greater the tendency to describe an occurrence of airmass showers in terms such as these: "It must have rained on every ranch in the county but ours!" Or, "We were completely surrounded by storms, but somehow or other they all veered around us and the farm didn't get a drop all afternoon."

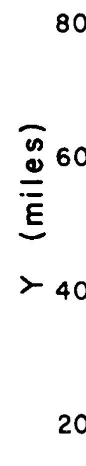

FIG. 1. Hypothetical "storm map" showing locations of 50 thundershowers and five "observers" randomly distributed over an area of 10,000 square miles. Circles of 25-mile radius centered on the observers' locations bound areas of shower detectability for each observer.

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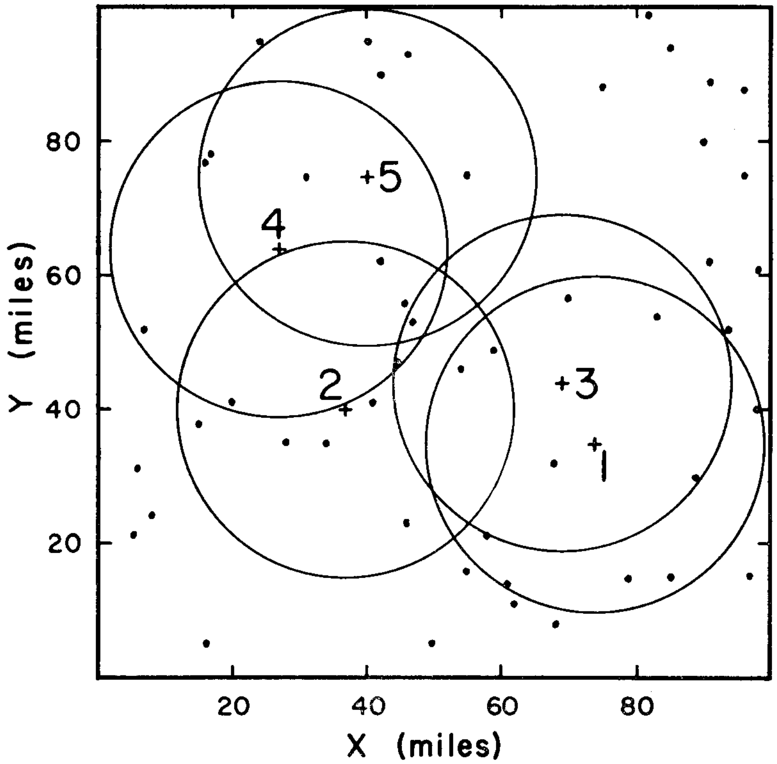

Of course there must be occasional cases wherein such gloomy imputations of nature's perversity happen to be essentially correct; but most of the time such comments constitute a grossly mistaken description of what is really taking place. Here I want to point out, through an example, how this "thunderstorm-encirclement illusion" becomes an almost inevitable accompaniment of those summertime synoptic situations that fit so well the weatherman's familiar phrase, "widely scattered thundershowers in the central part of the state."

Since the geometric and statistical nature of the illusion here in question is most convincingly illustrated with an actual graphical model, we may consider a model set up on the following basis: When true airmass thunderstorms break out in fairly level country, the locations of the storms may be regarded as almost randomly located. In an area of 10,000 square miles (a square 100 miles on edge), let there be 50 thunderstorms having rain areas one mile in diameter occurring during the period of observation. We will ignore their motion. We need not be specific as to whether these storms are occurring simultaneously and are observed all at one time, or whether they occur at randomly distributed times over the duration of, say, an afternoon; for our concern here is simply with the overall impression left in the observers' minds. We may assume, as an adequate approximation to reality, that each observer is able to detect a rainshower out to a distance of 25 miles from his location. To assign these 50 storms to chance locations typical of airmass thundershowers, a table of random numbers may be used. In the particular table that I employed, five-digit random numbers were listed, so I used the first 50 numbers, taking the first two digits of each for the x-coordinate (in miles) for a given storm, and the second pairs of digits of each for the associated y-coordinate. The fifth digits were simply ignored. Then, on the resulting "storm-map" (fig. 1), I located five "observers" by further use of the same random numbers table, requiring only that each observer be at least 25 miles from any boundary point of the square in order that all parts of each observer's circle of shower-detectability lay within the model area. Specifically, I used the first five cases (following the fifty already-used random numbers) wherein the x- and y-coordinates both fell between numerical values of 25 and 75. In the figure, these five observer-locations are indicated by the five numbered crosses. Concentric with each of these five points, a circle of 25-mile radius has been drawn in the figure to bound the area within which each observer is assumed able to detect active thundershowers.

Even casual inspection of the figure shows that each observer will see showers well distributed about the compass. To display this more vividly, the azimuthal locations of all detectable storms have been read from the figure by means of a protractor and were then plotted (fig. 2) without regard to range from the observer.

Note that the number of observed showers ranges from eight (Observer 3) to twelve (Observer 2); and note that in the five cases, there is only a single instance wherein an observer has a storm-free quadrant (Observer 5 sees no storms in his SW quadrant). Imagining how the sky and horizon would look to each of these five randomly located observers, we must admit that each would have apparently good reason to assert that it was raining all around him. But it will be seen (fig. 1) that in this random sampling procedure it turned out that rain did not fall on a single one of the five observers' locations. In fact, the minimum distance from any observer to his nearest storm was 4 miles (Observer 2). Thus the model illustrates the high probability that when airmass showers develop, most farmers and ranchers will be inclined towards hydrometeorological paranoia.

From elementary probability considerations it is possible to supplement the above qualitative conclusions with quantitative statements that show even more convincingly how tempting it must be for a drought-stricken farmer or rancher to think that the rainclouds go out of their way to avoid his land: A circle of 25-mile radius covers 1,960 square miles, or 19.6 per cent of our model area's 10,000 square miles. Hence the expectation value for the number of detected storms per observer is 19.6 per cent of 50 or 9.8, which is surprisingly well approximated by our 5-observer sample mean (10.0). The distribution of number of detectable storms per observer will approximate closely to the binomial distribution, so statistical arguments predict a standard deviation of 2.8 about the mean detectable number of 9.8. Hence, almost 70 per cent of all randomly located observers may be expected to report a number of storms lying in the interval 7.0 to 12.6 storms.

All of these numerical values argue the likelihood that most observers will see a substantial total number of storms, but we must next consider the question of whether these will be fairly well distributed in azimuth.

(*Continued on page 174*)

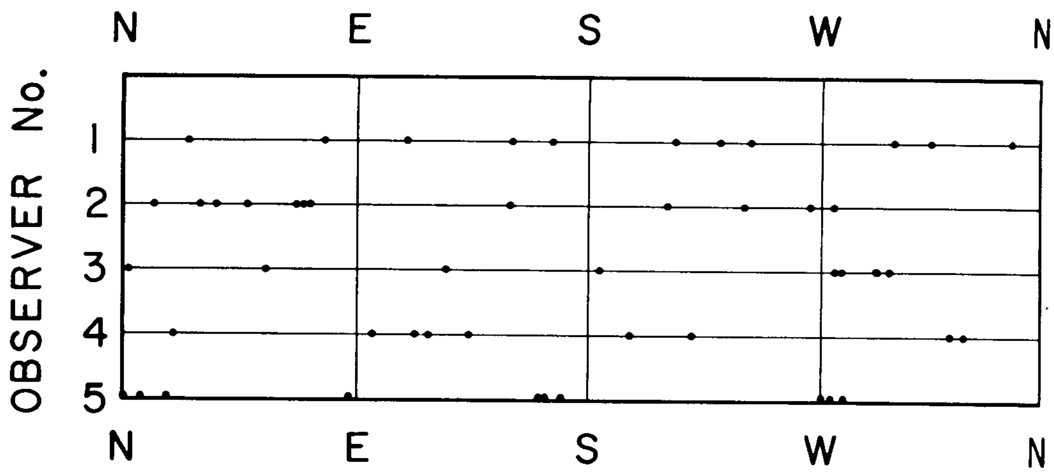

FIG. 2. Azimuthal locations of showers detected by each of the five observers in figure 1.

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AN intense storm covering a re small area moved inland on 1 1959 from the Atlantic Ocean in a nor erly direction over the Maritime Pr adjoining Cabot Strait and Northum Strait in the southern Gulf of St. La area. The accompanying gales cre very hazardous wave situation which some fifty salmon boats out on the area where the high waves swamped s the boats with a considerable loss of sulting.

From June 14th to 18th the East weather had been of a stable repetitiv

Path of Northumberland Strait Storm on June 1959 as plotted by U. S. Weather I Circles indicate position at 0700 EST o shown.

the coast and very light falls inland. This proved to be the last general rain for the state as a whole as cloudless day succeeded cloudless day during May and June. On 14 May most coastal points from San Francisco northward experienced their only measurable May rainfall—0.04″ at the Airport and 0.02″ downtown. The rains did not reach across the Bay as Oakland recorded only a trace during the month to make 1959 the driest May of record. Inland at Sacramento it was the same story as only a trace fell at the State Capital to tie the May record for least rainfall. There has never been a rainless May at Sacramento, but on only five other occasions has a trace been recorded, the most recent previous to 1959 being just 50 years ago. Traces were also recorded at Los Angeles and San Diego. These did little to check the record-approaching deficits for the 1958–59 rainfall season which runs annually from July 1st to June 30th.

June followed the example of May over all of California. Only a trace was recorded at downtown Los Angeles to bring the seasonal total to only 5.58″, the lowest figure in Weather Bureau records at the southern California city where tabulations commenced in 1877–78. The normal season rainfall is 14.54″—in 1957–58 a total of 21.13″ fell.

Thunderstorms

(*Continued from page 160*)

To get at this, we need some measure of "fairly well distributed in azimuth." A reasonable criterion might be that the observer has no storm-free quadrant. Since one quadrant of a circle of 25-mile encloses 490 square miles, any one observer-quadrant contains the fraction 0.049 of the total 10,000-square-mile model area. If we then imagine for the moment that no storms have appeared anywhere within the 10,000-square-mile area, the probability that the first of fifty randomly located storms to appear will *not* fall within any one quadrant of a given randomly located observer's circle of detectability is 1 − 0.049 or 0.951; hence the probability that not a single one of fifty such randomly located storms will fall within that quadrant is 0.951 raised to the fiftieth power, or 0.08 approximately. Thus, for a very large sample of observers, probability theory predicts that only about 8 per cent of all observer-quadrants will be entirely storm-free in the present model. (By similar methods, one can show that less than 1 per cent of all observers will have two storm-free quadrants.) Thus, a very heavy majority of observers will, even with the sparse storm distribution considered here, have *at least* one storm in each quadrant of their circle of detectability. We may safely conclude that the encirclement illusion will be quite common among persons who are better observers than they are statisticians.

Finally, we may note that each shower area, specified to be a mile in diameter, covers only 0.79 square mile. All fifty storms then cover 39.4 square miles, or 0.39 per cent of the entire model area. Hence the probability that rain will actually be falling upon any randomly located observer is 0.0039, which is impressively low.

We may summarize these probability considerations by nothing that, if a meteorologist were to tour our 10,000-square-mile area immediately after outbreak of our fifty airmass thunderstorms and if he were to interview, say, 1,000 farmers, ranchers, or other observers interested enough to pay close attention to the storms occurring over the countryside, he must expect to find only about four observers upon whom rain had actually fallen; the other 996 would be intervewed on dry ground. Of these 996 disappointedly dry observers, some 920 could be expected to stress that they had seen showers in every one of their four quadrants. Clearly, then, such a meteorologist-interviewer would be overwhelmed by bitter assertions that "It rained everywhere but here"; so he should go prepared to explain how airmass meteorology and simple probability theory account for so many dashed hopes when convective showers appear in an area where rain is at a premium.

Ice Falls Data Requested

Editor:

Our Committee would appreciate any information, references and, particularly, conclusions that you may have concerning the phenomenon of "ice falls," i.e. large pieces of apparently natural ice, ranging in weight from approximately 10 pounds to possibly 150 pounds or more, that have reportedly fallen to earth for more than a century.

We realize that you are familiar with the Pennsylvania episode in which there were at least seven "falls" of ice in that state between July 30, 1957 and January 18, 1958.

Undoubtedly you possess account
"falls" both preceding and subsequ
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1958 in California and that of Se
1958 in Madison Township, N. J.

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Specifically, we are interested in
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