Note on Recording Hail Incidences

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A means of recording hail occurrences with existing field facilities has been found. Standard weighing-bucket raingages without evaporation funnels will record the incidence of hail, and dense networks of such gages can provide data for portraying the areal extent, movement, and the time of hailstorms and their cells. Likewise, useful climatological data on hail could be obtained through the less dense hydroclimatic network of recording raingages operated by the U. S. Weather Bureau throughout the nation.

The Illinois State Water Survey operates several dense raingage networks in Illinois (Huff and Changnon, 1966), one of which is a 95-gage network covering a 1200-mi^2 area in southern Illinois. This network comprises 72 standard weighing-bucket recording gages and 23 standard stick gages, all with 8-inch orifices. Trained field men service the recording raingages, and paid observers measure the 24-hr totals at the stick gages. These observers also report certain weather conditions such as thunder, hail and snowfall. As a standard operational practice in the cold season, the evaporation funnels below the orifice in the recording gages are removed to obtain more accurate measurements of snowfall.

On 28 March 1965 a series of hailstorms passed over portions of the southern Illinois network (Changnon, 1966). Their incidence was reported by several of the stick-gage observers as well as by U. S. Weather Bureau substation observers in the network area. During the routine rainfall analysis of the recording raingage charts for this period, interesting and unusual vertical marks, or 'spikes,' were found on the rainfall traces at several raingages. The time and location of these markings were compared with the time and location of the hail reports from the observers, and interestingly, a time-space agreement was found. This suggested that the vertical spikes on the recording charts were produced by hailstones which, in the absence of the evaporation funnels, had fallen directly into the weighing buckets. Thus, these spikes were a record of the time and incidence of the hail. Also, the deflection shown

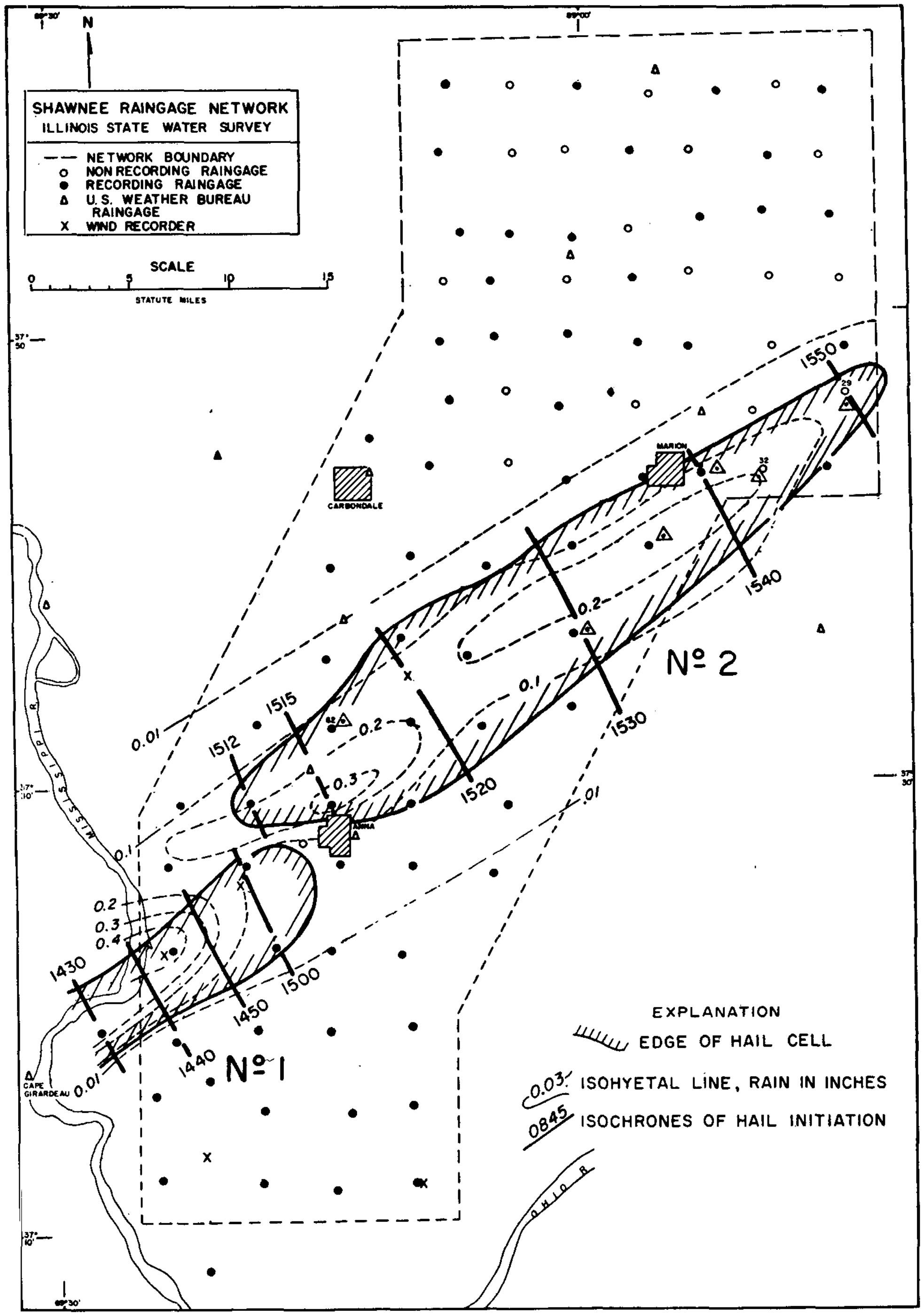

FIG. 1. Hail cells number 1 and 2 on 28 March 1965.

by the trace gave a measure of the impact velocity attained by the stones during the hailstorm. Further, it is possible that an estimate of the maximum impact velocity could be attained from this record on the basis of the gage calibration characteristics.

The map in Fig. 1 shows the outlines of two of the seven hail cells that occurred in the network on 28 March. These surface paths, or envelopes, were constructed using both the recording gage indications of hail and the observer reports of hail. All the gage charts from within these envelope areas indicated a hail spike. Times of hail occurrence allowed calculation of the forward motion of the cells, and the time data made it possible to identify and separate the hail incidences in a 6-hr period into seven hail cells.

Hail symbols are plotted on the map at those raingages where the spikes were quite pronounced indicating the likelihood of larger hail, more hail, and a greater impact velocity. Observers at stick gages numbered 29 and 32 (northeast end of cell 2) both reported falls of 1/2 to 3/4 inch diameter hail during a 1-min span.

An example of the hail spike recorded at gage number 62 (west end of cell 2) is shown in Fig. 2. The hail at this point fell at 1518 CST, which was also the onset of the rain that totaled 0.12 inch within about 2 min in this cell. The chart shows that subsequent rain began at 1536 and terminated at 1630. Rains that fell on days prior to 28 March are also partially depicted in Fig. 2. The deflections of the pen forming the spike occurred above and below the 1.22-inch trace, the position of pen at the start of the storm.

Also indicated on Fig. 1 are the isohyets of rainfall associated with these two hail cells. Comparison of the isohyetal patterns and the hail envelopes indicates that the hail fell along the main axis of cell number 2, but along the right flank of cell number 1, a condition commonly observed in Illinois hailstorms (Changnon, 1962; Changnon and Stout, 1964). The isohyetal and hail patterns indicate that cell number 1 was terminating as it entered the network from the southwest at a speed of 20 mph. These data also show that cell number 2, which apparently was a new cell developing downwind from cell number 1, moved from the southwest with a forward speed of 55 mph, as determined from the isochrones for the onset of hail. These storms were occurring in a warm air sector just south of an east-west stationary front.

After this initial discovery of hail spikes in the 28 March case, questions were raised as to whether the spikes were caused by hail, by the occurrence of strong downdrafts, or by both. To obtain more information, the evaporation funnels were not installed in the network raingages during the April–September period of 1965, and all the charts were examined for the occurrence of similar spikes when hail was not reported and when rain occurred. None were found. To further support the conclusion that these spikes were produced entirely or largely by hail, hailstorms on two other days as reported by the cooperative observers were found to have produced spikes in the nearby recording gages.

More conclusive proof of the reality of the spike as a measurement of hail was obtained during a hailstorm on 28 April 1966 in central Illinois. This hailstorm occurred where the State Water Survey had a recording raingage, a passive hail indicator (Wilk, 1961), and an Aerovane wind speed and direction recorder. The hail was visually observed, and two imprints of hailstones on the 1-ft^2 foil-covered indicator measured about 1/4 inch in diameter. The funnelless recording rain-

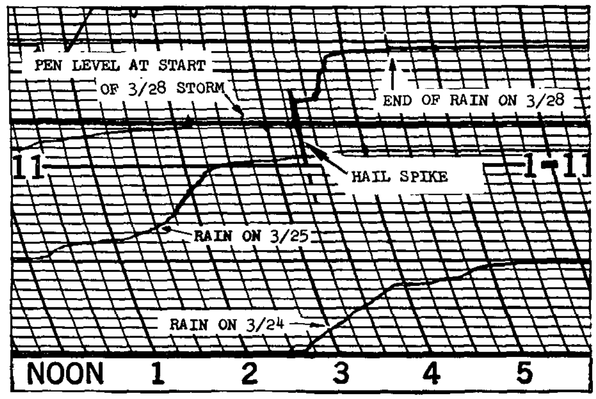

FIG. 2. Hail spike shown on the chart at raingage 62 on 28 March 1965.

gage with a 12-inch orifice recorded a hail spike, but it had a lesser deflection than that shown in Fig. 2. Of greatest significance was the fact that surface wind speeds before, during, and after the 1-min hailfall varied between 4 and 8 mph, further proving that the spike was entirely a hail-induced record. A gust to 40 mph occurred 30 min after the storm, but it made only a very slight fluctuation on the trace and was quite unlike the hail spike.

Increasing national interest in hail is causing an initiation of field programs that will require many detailed surface measurements of hailstorm parameters over large areas. Measurements in the near future will depend largely on detailed areal field surveys conducted after the storms, but eventually these research programs will certainly lead to the development of sophisticated recording hail gages. Until such instruments can be developed, perfected and installed widely, the recording raingages presently operating throughout the nation, including those in special dense networks, offer the possibility of collecting considerable information on the incidence of hail. Installation of the passive hail indicators near the raingages would provide additional hail data at very little added cost.

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