PICTURE OF THE MONTH

Visual Observations of Kansas Downbursts and their Relation to Aviation Weather Observations

MIKE SMITH

WeatherData, Inc., Wichita, Kansas 67203

20 July 1985 and 27 February 1986

1. Introduction

Since first documented by Fujita and Byers (1977), downbursts have been recognized as a hazard to aviation. In 1978, this author photographed the life cycle of a wet downburst southeast of Wichita. That series of six photographs was recently published by Fujita (1985). The purpose of this paper is to document the occurrence of a dry downburst northwest of Wichita, Kansas near the town of Bentley on 17 June 1985, to discuss the visual observations of two other Kansas downbursts during the summer of 1985, and to relate these observations to aviation safety.

2. Observations

During May and June, 1985, a meteorological research project known as PRE-STORM (the Preliminary Regional Experiment for STORM-Central) was operated in Kansas. As part of the project, the CP-4 radar from the National Center for Atmospheric Research was located at Lake Cheney, Kansas. It was operating during the evening of 17 June 1985, as was the NCAR CP-3 radar which was based at Nickerson, Kansas, about 45 km to the north-northwest. Both radars detected a small, weak radar echo near Mt. Hope, Kansas at 0129 GMT. (Unless otherwise indicated, all times given hereafter are GMT.) The reflectivity pattern from CP-4 is depicted in Fig. 1 with the echo greater than 1 dB*z* outlined. The echo intensity on CP-3 was greater with a maximum reflectivity of slightly more than 10 dB*z*. The echo moved east at 17 m s^{-1} reaching a position southwest of Bentley at 0134. Figure 2 is a photograph taken by the author looking west-northwest from a location in far northeast Wichita. It shows a small streak of virga corresponding to the echo shown in Fig. 1. From surveying the broadcast towers in the photograph and comparing the position of the virga echo on radar to the azmuth from the author's position, it was determined that the photograph was taken at approximately 0135. (Unfortunately, the author was not wearing a watch when these photographs were made.) A few minutes later, after moving to a higher vantage point about 200 m east-southeast, blowing dust was observed rising suddenly from the ground, appearing to originate from a central point. The dust appeared to be in the configuration shown in the photo taken by Fujita that is published on the frontispiece of Fujita (1985) and in the article by McCarthy and Serafin (1984; page 125, upper right corner). The dust had the general appearance of a slow motion movie of a water drop spattering. Realizing a few moments after the dust appeared that it was probably a downburst, a photograph (Fig. 3) was taken. Judging from the extrapolated movement of the radar echo, the downburst probably began around 0138, and the photograph would have been taken 1 to 2 min later. The diameter of the dust was estimated to be around 6 km, which would classify the downburst as a macroburst.

Within the overall movement of the dust, there seemed to be smaller motions that looked like "splashes," which were apparently microbursts. Two of these are shown in Figs. 4 and 5. These features have been labeled M1 and M2.

Unfortunately, the radar data from CP-4 was contaminated by second-trip echoes at the time of the downburst so it is not possible to see the pertinent details of the reflectivity pattern or the Doppler velocities at low elevations angles. CP-3 showed the echo disappearing during this period. At the time of the downburst, no virga was visible to the naked eye. There was extreme glare from the sun, however (note the artificial lights in Figs. 3–5), which may have masked the virga. There appears to be some virga backlit near the tops of Figs. 4 and 5. No lightning was observed from the cloud. Others have documented dry downbursts not associated with thunderstorms, for example, Brown et al. (1982).

The evening of 21 July 1985, the author observed two wet downbursts over northeast Wichita. The first traveled southeast over the author's home about 2345, producing winds estimated at 20 to 25 m s^{-1}. As the

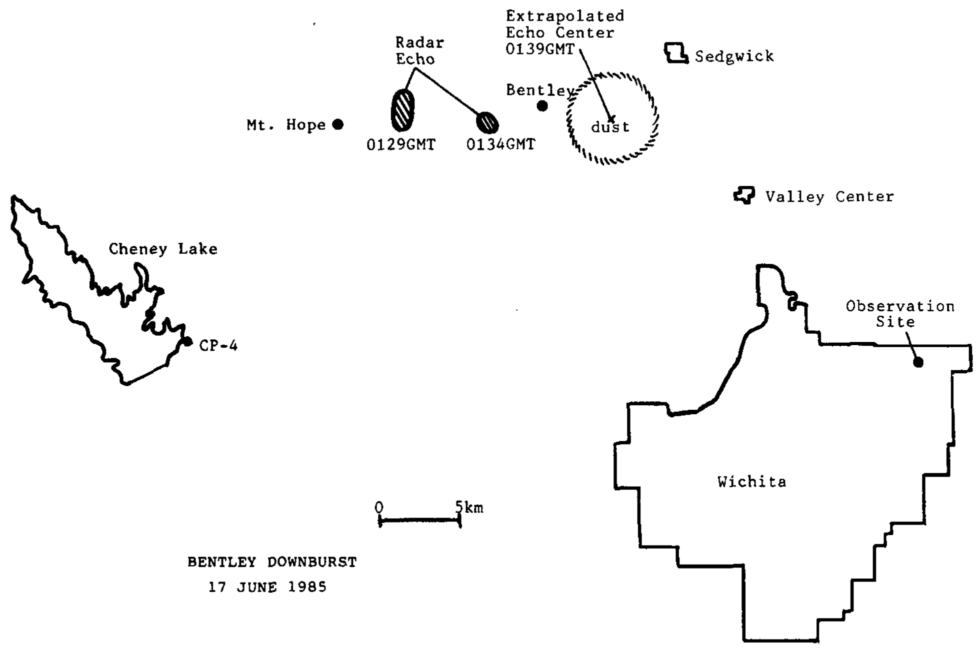

FIG. 1. Plan view of the radar echo with a reflectivity greater than 1 dB*z* as depicted by CP-4. The center of the macroburst was estimated by determining the azimuth of the center of the blowing dust from the author's location and comparing it to the extrapolated center of the radar echo. The time of intersection of the echo center with the azimuth is given as the approximate time of macroburst. The width of the macroburst was determined in a similar fashion.

downburst passed, the winds shifted from strong northwest to nearly calm, then almost as strong from the southeast over a period of approximately 4 to 6 min. The downburst was accompanied by torrential rain. Less than thirty minutes later (about 0015 on 22 July), a second wet downburst was observed about 2.7 km north-northwest of the author's location. This wet downburst exhibited the characteristic "curl" on both sides of the base of the rainshaft. Figure 6, which appears in Fujita (1985), gives a general idea of the appearance of this wet downburst.

As rapid changes in vertical motion in a short horizontal distance are required to cause raindrops to curl upward, significant wind shears are implied. In this sense, the curl could be considered a signature of a wet microburst. Curling motions have also been observed in association with dust rising from dry downbursts, for example, NOAA (1985) and McCarthy and Serafin (1984; photos by Fujita and B. Smith on page 126). It should be stated, however, that it is likely that some (possibly a majority of) wet downbursts occur without a visible curl.

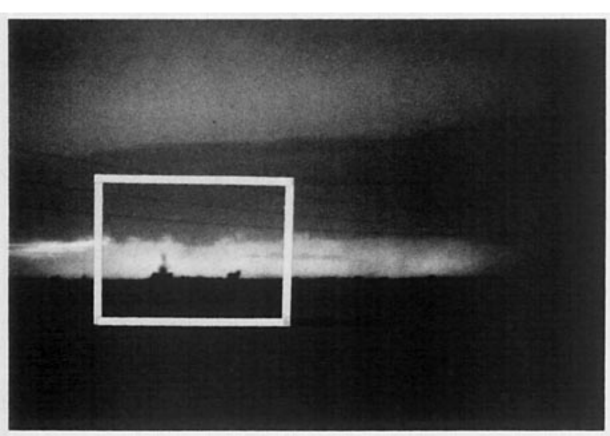

FIG. 2. Virga associated with the radar echo in Fig. 1. View is toward the west-northwest at approximately 0135 GMT 17 June 1985.

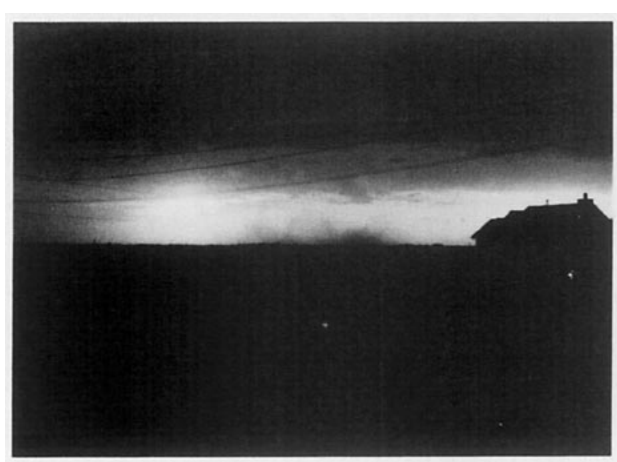

FIG. 3. Photograph of macroburst taken at approximately 0138–0140. The macroburst is approximately 30 km away.

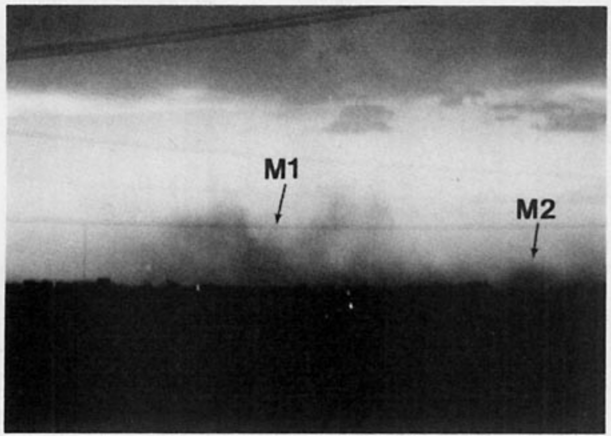

FIG. 4. Possible microbursts occurring within the macroburst. Mature microburst is labelled M1 while microburst just striking the ground is labelled M2. Some streaks of virga may be present at the top of the photograph, directly above the broadcast tower on the right.

FIG. 6. Photograph taken by this author and published by Fujita (1985). This photo is one of a series showing the life cycle of a wet downburst southeast of Wichita on 1 July 1978. The wet downburst observed on 22 July 1985, referred to in the text, had an appearance almost identical to this one. The primary difference is that there was a well defined curl on both sides of the base of the rainshaft with the 1985 downburst. (Photograph copyright; 1978, Michael R. Smith.)

The author surveyed the area where the second downburst was observed. Damage included a toppled tree and two toppled highway signs. A line crew from Kansas Gas and Electric Co. was found working on power lines that presumably had been damaged in the storm. The damage would have been rated F0 on the Fujita scale.

The third observation of a Kansas downburst during the summer of 1985 was made by Mr. Jack Janousek, an agribusinessman from Ellsworth, Kansas. In a letter to the author postmarked 1 August, he described a downburst he observed on his father's farmstead, 4 miles east of Ellsworth, the evening of 30 July 1985. Here are some excerpts from his letter (all times CDT):

> 1830: Southwest winds estimated at 40 mph and moderate rain.

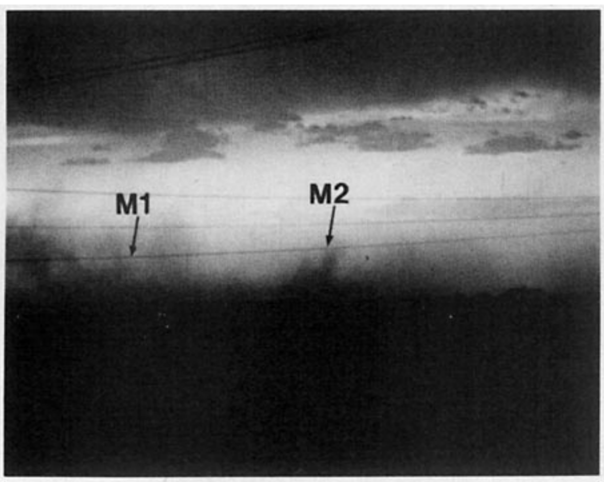

FIG. 5. Photograph taken shortly after Fig. 4. Microburst M1 is becoming less well organized while M2 is starting to splash upward.

> 1835: Southwest winds estimated at 60 to 70 mph with moderate to heavy rain. For the first time in my life I noticed downburst columns of wind and rain. There were many of these columns angled to the northeast. The rain inside and outside these columns was blown to the ground super hard and it spread out like dust would.
>
> 1840: Winds estimated 20 to 30 mph and super heavy rain with big drops. Then we had a couple of minutes of marble size hail.
>
> 1845: The next 1 to 2 min I was really confused as the wind picked up to an estimated 40 to 50 mph from the east-northeast blowing rain back toward the original direction?? (Really strange). . . . Total rain amounted to 0.80 inches.

Mr. Janousek drew a picture of the columns which is reproduced in Fig. 7. Mr. Janousek's observations are corroborated by a local storm report issued by the National Weather Service office in Concordia, Kansas at 0419 GMT 31 July 1985. It says: "6:38 pm CDT: Winds of 50 to 60 mph and very heavy rain 6 miles east of Ellsworth. Visibility 10 feet."

The author telephoned Mr. Janousek and asked where he had heard about downbursts. Mr. Janousek replied that he had learned about them from watching television weathercasts. This was a period when downbursts had not particularly been in the news.

3. Discussion

The observations cited herein, along with the visual and photographic observations made of downbursts as part of the JAWS project in Colorado (McCarthy and Serafin, 1984) and the CLAWS project in Colorado (McCarthy and Wilson, 1985) lead one to ask if downbursts should be classified as "observable meteorolog-

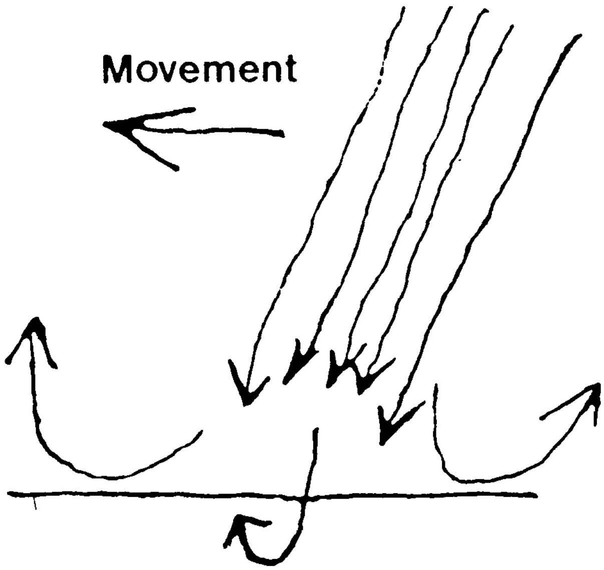

FIG. 7. Reproduction of the sketch by Mr. Jack Janousek of a downburst observed near Ellsworth, Kansas on 30 July 1985. The sketch was made on notebook paper and has been annotated by the author with the word "movement."

ical phenomena." Currently, there is no provision in the Federal Meteorological Handbook No. 1, *Surface Observations* (U.S. Department of Commerce et al. 1982) for reporting downbursts. It is suggested that this be changed to require the reporting of downbursts observed visually and that downburst sightings be treated in a similar manner to tornadoes, funnel clouds and waterspouts in aviation weather observations. The hazards presented to aviation by downbursts are well known and may in fact be greater than the threat posed by tornado-related storms. It would seem that training official aviation weather observers to recognize downbursts and act on those observations (including the issuance of urgent special weather observations over meteorological communication circuits) would have several important benefits. First, the observations would alert tower personnel of a potential hazard to air traffic in the terminal area and alerts could be issued to pilots in much the same way that they are issued now with information from the Low-Level Wind Shear Alert System (McCarthy and Serafin, 1984). Second, these observations would allow aviation forecasters to amend terminal forecasts downstream of the observed downburst. This is especially important since it has been shown that downbursts often occur in families with several downbursts occurring in the same general area, such as in the 21 July 1985 case described here or in the cases cited by Fujita and Byers (1977) and Fujita and Wakimoto (1981). Visual observations of the first downburst in a family would not only allow some warning to pilots flying toward it, it would alert all concerned of the potential of downbursts from radar echoes still approaching the airport complex. These same observations could be used by other meteorologists to warn the general public of damaging winds. The third benefit is that these observations could be the start of a climatological data base of downbursts since aviation weather observations are archived by the National Climatic Data Center.

At most airports, the aviation weather observer works closely with the tower personnel. The tower personnel report such parameters as tower visibility to the weather observer and the observer makes his or her observations available to the tower for air traffic management and for relay to pilots. At some less heavily used airports, the tower personnel actually take the official observations. With their elevated viewing location, tower personnel would be in a seemingly ideal position to observe downbursts. While the primary function of the tower has to be air traffic control, it is further suggested that tower personnel be trained to recognize visually obvious downbursts and be allowed to advise pilots of their observations. A similar approach was taken using meteorologists in the tower during the CLAWS project with good results.

It could well be argued that not all downbursts are recognizable visually and this is almost certainly the case. But not all tornadoes that occur near airports are observable either. It could also be argued that by the time a downburst is identifiable visually, it is already in progress. Nonetheless, pilots approaching the affected area could still be warned. It has been documented by Wilson et al. (1984) that most downbursts increase in intensity after first reaching the surface, typically taking approximately 5 min to reach maximum intensity. The first visual clues to the downburst would likely allow alerts to be issued to pilots with a positive lead time before the downburst reaches maximum intensity.

Given the characteristic patterns of blowing dust and precipitation that have been shown here and by previous studies, it would seem quite feasible to train aviation weather observers and air traffic controllers to recognize downbursts. Undoubtedly, there would be isolated instances of false alarms, which would cause needless delay in aviation operations. There would possibly also be occasional failures to detect them as it is likely that many downbursts are not recognizable visually. But the visual observation of downbursts by aviation weather observers and tower personnel, in addition to the previously suggested training of pilots to visually recognize downbursts (McCarthy and Serafin, 1984), could fill an important need until NEXRAD and other technology-based solutions to the downburst hazard are developed (Nautilus, 1985). Visual observations might continue to play a supplemental role in the downburst warning process even after NEXRAD is deployed.

Acknowledgments. The author appreciates the time and effort given by Mr. Brad Smull of the University of Washington in providing data and guidance on this paper. The author is also indebted to Dr. Bob Houze of the University of Washington for permission to use the PRE-STORM radar data, and to Ms. Cathy Kessinger of NCAR for making photographs of the radar data and providing additional reference material. Special thanks to Mr. Jack Janousek for his excellent observations and his permission to allow their use in this paper. Ms. Virginia Covalt-Fisher helped prepare the figures. WeatherData, Inc. supported this project.

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