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# The Greensburg Miracle – *Where There's Life, There's Hope*

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## Introduction

For a period of approximately 75 years, from 1880 through 1955, little or nothing was done in the United States to prevent death and injury from tornadoes[1]. In the late 1950's, meteorologists' attitudes began to change. The period from 1970 through 2000 was especially fruitful in mesoscale research with developments in basic understanding of severe storm morphology[2] and technology[3]. This array of science and technology was in place on Friday, May 4, 2007, when a devastating tornado struck the town of Greensburg, Kansas. This paper examines how fifty years of scientific advancement, along with an intriguing lightning signature, were used to prevent the deaths of more than 200 people.

## History

From a 2008 vantage point, it is difficult to imagine how tornadoes terrorized the United States in the middle of the 20th Century. A number of mega-tragedies occurred well after radio was was in every home, some outside of what we now think of as "Tornado Alley."

| Year | Location | Deaths | Injuries |
|---|---|---|---|
| 1925 | Missouri-Illinois-Indiana | 689 | 3,000 |
| 1936 | Tupelo, Mississippi* | 233+ | 700 |
| 1936 | Gainesville, Georgia | 203** | 1,600 |
| 1947 | Texas-Oklahoma (Woodward) | 181 | 1,500+ |
| 1953 | Waco, Texas | 114 | 600 |
| 1953 | Flint, Michigan | 115 | 844 |
| 1953 | Worcester, Massachusetts | 94 | 1,288 |
| 1955 | Udall, Kansas; Blackwell, Oklahoma | 102 | 540 |

During this period, the Weather Bureau (the name of today's National Weather Service prior to 1970) had an absolute ban on forecasting or warning of tornadoes for radio or the new technology of television (in the 1950s).

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* Young Elvis Presley was a survior. The official death toll of 233 is likely far too low. In the South, tornado deaths of black people were not counted until the 1950's. So, the true number of deaths will never be known.

** Not included are 40 missing and believed killed while trapped in a building collapsed by the tornado that was consumed by fire shortly thereafter.

While the entire history of severe weather forecasting and the development of severe weather detection and warning technology is outside the scope of this paper, it is appropriate to examine the Udall Tornado of May 25, 1955, which occurred in the radio and television era (indeed some of the victims watched the 10 o'clock news a half hour before the tornado struck) for any insight it might give us as to the effectiveness of the modern warning system.

## Udall

On May 25, 1955, a supercell thunderstorm developed over Oklahoma City and moved slightly east of due north. It produced the first of four tornadoes near the town of Stillwater with a second small tornado near Tonkawa. A third, larger and stronger, tornado touched down northeast of Tonkawa and moved across the east side of Blackwell, killing 20. That tornado crossed the Kansas border and lifted west of Arkansas City. At about the time the third tornado was lifting a fourth tornado from the supercell was touching down. This tornado moved nearly straight north. It struck a farm home northeast of Oxford, killing the five children inside. About 10:35pm, the tornado struck the town of Udall, killing 77 of the town's 505 residents. Udall became known as the "Town that died in its sleep" as there was no warning (as we think of them today) in effect for the area.

## Greensburg

Fifty years later, on May 4, 2007, a cluster of thunderstorms developed near and just north of the Oklahoma-Kansas border south southeast of Dodge City about 7:30pm. During the next hour, the activity consolidated so that, by 8:45pm a large supercell was located southeast of Dodge City along U.S. Highway 183 that was just beginning to produce tornadoes.

Figure 1 shows the Dodge City WSR-88D radar image from 8:03pm at right with a plot of cloud-to-ground lightning strikes from the National Lightning Detection Network™ (NLDN) at left. At that time, the polarity of the lightning was totally negative in the area of interest.

AT 8:30pm, Figure 2, shows near total negative polarity cloud-to-ground lightning in the vicinity of the thunderstorm near Greensburg that has raced north from the primary cluster. The developing supercell near Coldwater, while still predominantly producing negative polarity lightning, has just begun to produce positive polarity lightning, including one high-amplitude strike a miles southwest of the town. It was at this approximate time

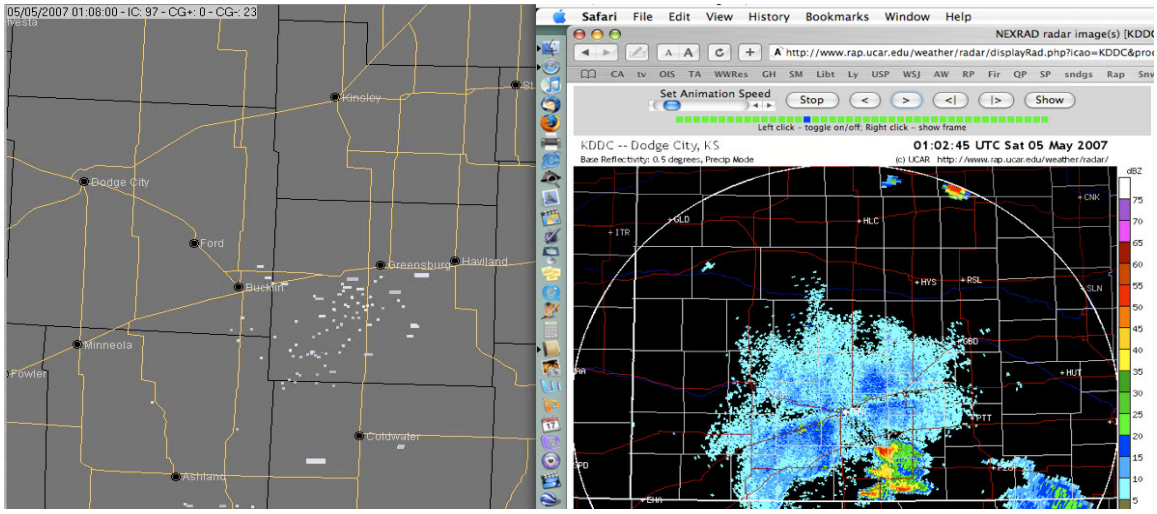
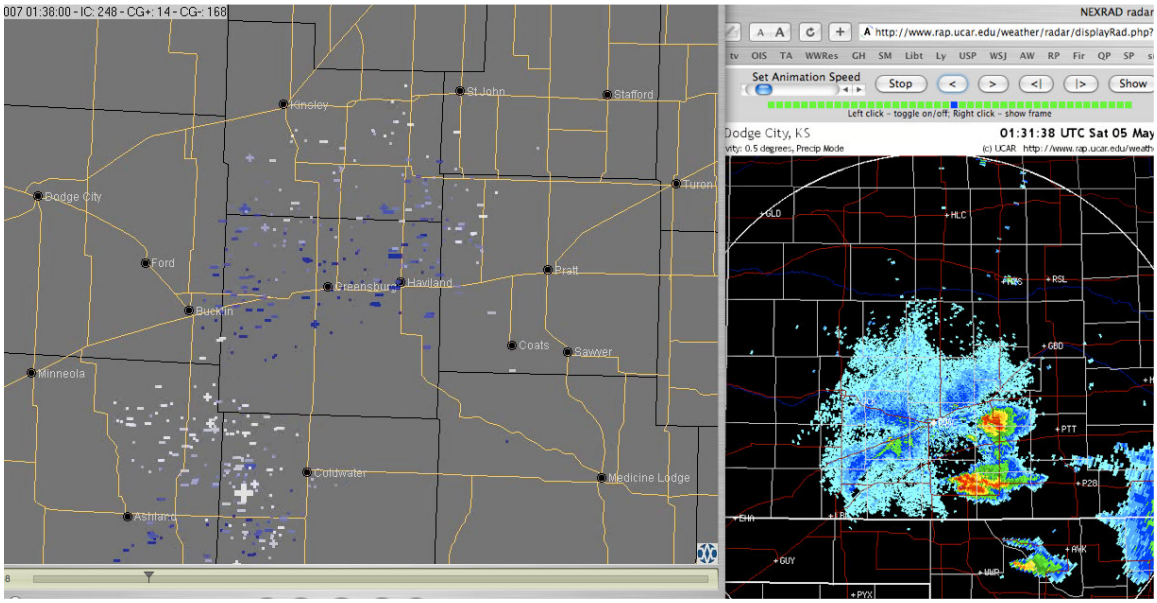



Figure 1. Cloud to ground lightning data at left, radar data at right. The intensity of the electrical current in each strike is indicated by the relative size of each symbol.




As in Figure 1, at 8:30pm. Note the presence of positive polarity strikes west of Coldwater.

that storm spotters in the area began reporting rotating wall clouds. Figure 3 is particularly intriguing in that the mesocyclone from which the Greensburg tornado would form is now well developed at approximately the same time as the percentage and magnitude of the positive polarity lightning increases rapidly. The first well-defined funnel clouds were reported around 8:45 with small tornadoes touching down between 8:45 and 9pm.

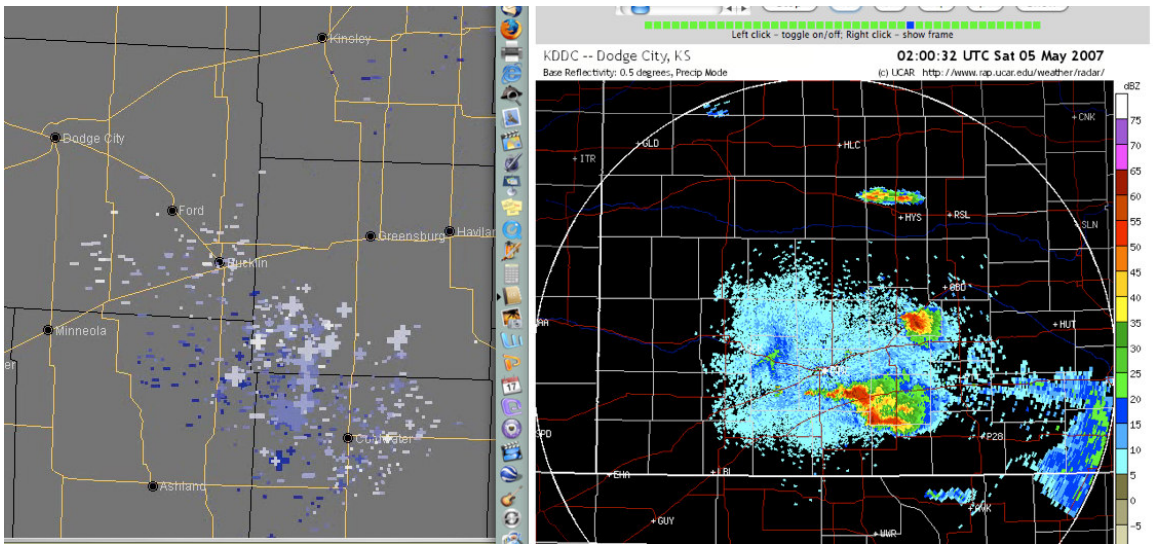



Figure 3. At 9pm a relatively high percent of the strikes are of positive polarity and of high amplitude. At this time funnel clouds are being produced by the supercell northwest of Coldwater.

Figure 4 is a photo, illuminated by lightning, of a tornado just touching ground shortly after 9pm. The tornado was illuminated by lightning. Many storm spotters reported continuous or nearly continuous lightning, consistent with the high number of strikes detected by the NLDN. This tornado was spawned by the same mesocyclone that caused the Greensburg tornado as well as other tornadoes for the next 4+ hours.

*See author for QuickTime Illustration

Figure 4. Tornado north of Protection, Kansas. Photo by Lance Ferguson.

At 9:25pm, a well-defined "hook" echo is in southern Kiowa County. The tornado that would later strike Greensburg is on the ground under the hook (mesocyclone) and was destroying farm homes at this time. See Figure 5.

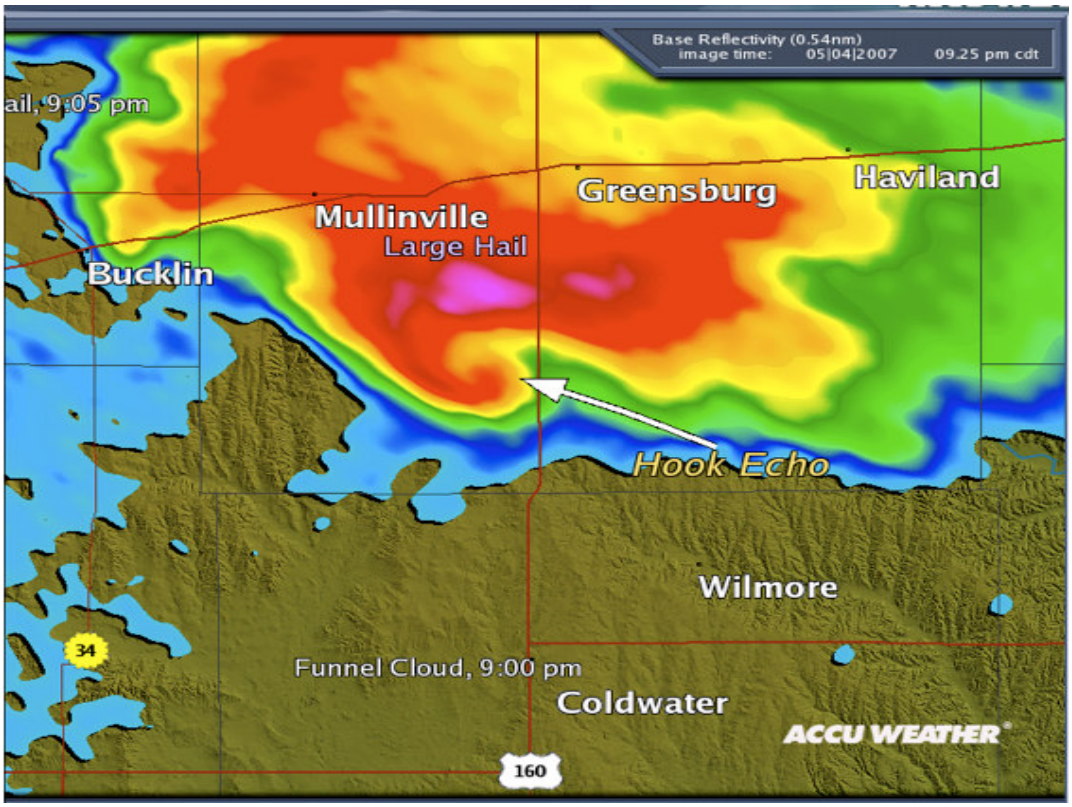



Figure 5. Hook echo just west of U.S. Highway 183 associated with the Greensburg tornado. At this point, the tornado is striking an electrical tranmission line toppling tens of poles in a cyclonic orientation (i.e., poles fell toward the east to the south of the tornado's encounter with the lines).

A few minutes later, Figure 6 indicates the high percent of positive polarity lightning

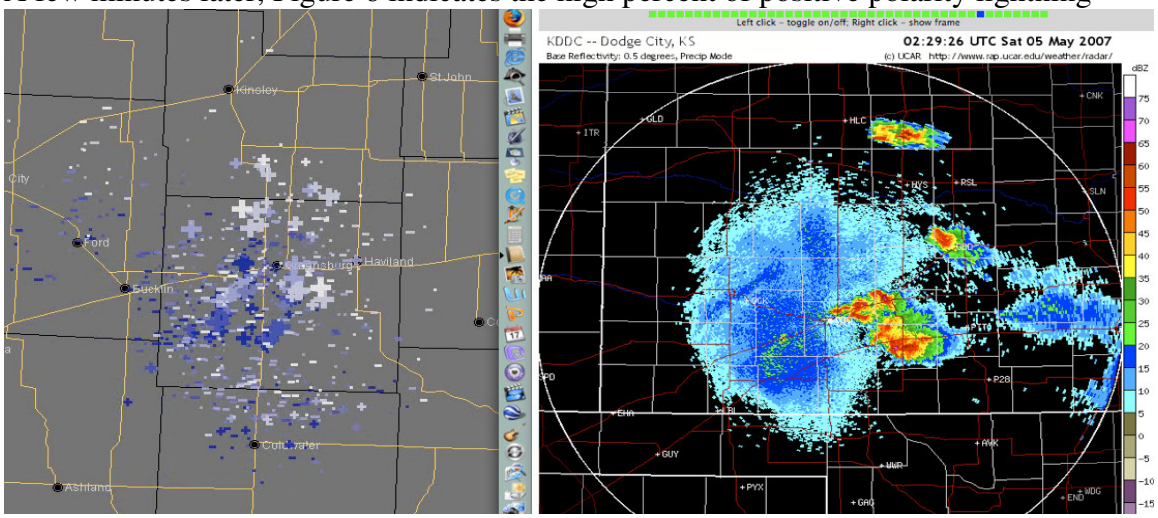



Figure 6. The high percentage of high amplitude positive polarity lightning continued.

continues at a very high rate. However, the non-tornadic thunderstorm northeast of Dodge City does not contain high levels of positive polarity lightning.

Throughout this period, the electronic media was broacasting the excellent tornado warnings issued by the National Weather Service in Dodge City and supplementing those warnings with credible live spotter reports from the field. The tornado warning for the City of Greensburg was issued at 9:19pm, more than 30 minutes before the tornado struck at 9:54. The tornado siren in Greensburg was activated at approximately 9:30. Normal practice for a tornado warning was to sound the siren once for five minutes then turn it off. Local emergency management, alarmed by the reports of damage in rural areas to the south, radar, and blow-by-blow reports from media allowed the siren to continue to sound until power was cut to the siren as the tornado arrived.

The tornado destroyed 95% of the buildings in Greensburg and damaged the other 5%. Total fatalities in the vicinity were 12 (including two outside the city which I am including, so the ratio numbers with Udall will be conservative as to number of lives saved).

According to news reports, minutes after the tornado departed Greensburg, Kiowa County emergency management put in a request for three refrigerated "reefer" trucks to the Kansas Adjutant General's Office in Topeka because, in the darkness, they were expecting to find "hundreds" of bodies.

**Comparing Udall and Greensburg**

While Greensburg had triple the population of Udall, the other aspects of the tornadoes were remarkably similar:

- Both were in Kansas with similar building codes and building construction
- Both occurred in complete darkness
- Both supercells approached from the south (unusual in Kansas) with rain and hail masking the approach of the tornado even if someone had been out looking for it
- Both supercells had nearly the same shape and configuration on radar
- Both were strong F5 tornadoes with remarkably similar damage

*The only significant difference was there was zero warning for Udall and timely, effective warnings for Greensburg.*

This rare "apples-to-apples" pair of tornadoes allows for a measure of the effectivness of the tornado warnings the night of May 4, 2007.

Because of some uncertainty in the tornado data in 1955, I have chosen to attribute *all* of the May 4 fatalities to the Greensburg tornado even though the "Greensburg" tornado had

lifted and been replaced by another tornado when the two deaths northeast of Greensburg occurred. This has been done to keep the comparison "conservative." I elaborate on that below.

The Udall Tornado killed 82 and injured 260. The population exposed to the tornado was 505. So, 68% of the exposed population was killed or injured.

The Greensburg Tornado killed 12 and injured 59. The exposed population was 1,500.

Since these two tornadoes were practically identical, we can take the fatality rate of the Udall Tornado and apply it to Greensburg. In Udall, 16.3% of the population was killed. So,

1,500 exposed population **X** 0.163 fatality rate **=** 243 potential fatalities in Greensburg

**243 Potential Fatalities**
(Minus) **12 Actual Fatalities**
**231 Lives Saved by the Warning System!**

**Conclusion**

Greensburg has a long way to go to recover from this disaster. But, the lives saved give cause for hope. If nearly 250 people had been killed and hundreds more injured, it is unlikely any meaningful recovery could occur.

Today's integrated storm warning system has been remarkably successful at saving lives in tornadoes, hurricanes and other storms at very low cost to society.

**References**

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3. David Atlas, *Radar in Meteorology: Battan Memorial and 40th Anniversary Radar Meteorology Conference*, published by the American Meteorological Society, Boston, 1990, 806 pages