ANNUAL SUMMARY

The Tornado Season of 1986

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ABSTRACT

A review of tornado activity in the United States during 1986 is presented. Annual statistics are compared with both recent and long-term values. Month-by-month highlights of tornado events are summarized. Meteorological patterns associated with four noteworthy tornado outbreaks are examined.

1. The year 1986 in statistics

There was an unprecedented low number of tornado fatalities in the United States during 1986. A total of 15 tornado-related deaths shattered the previous record of 24 that was set in 1981 and was far below the 30-year average of 90. This was only the fifth time there were fewer than 30 tornado deaths in one year since fatality records began in 1916. The absence of a concentrated violent tornado outbreak of the type that struck Ohio and Pennsylvania on 31 May 1985 and the Carolinas on 28 March 1984 contributed to holding the death total low.

The total of 764 tornadoes during the year is close to the 30 year (1956–85) mean of 771. Of the total, 140 (18%) were strong or violent (see Figs. 1 and 2). Michigan, Indiana and Iowa led the nation in strong and violent tornadoes with ten each. Mississippi, Ohio and Texas followed closely with nine each. There were only three violent tornadoes in 1986. This was the fewest violent tornadoes in the past 36 years and all were F4 (Fujita 1981) in intensity. Such violent tornadoes have tremendous potential for loss of life and property. However, in 1986 violent tornadoes caused no fatalities and only nine injuries. While the small number of violent tornadoes and favorable circumstances played a part in the low death toll, there is no doubt that years of preparedness efforts on the part of the National Weather Service and other responsible agencies are paying off as the public becomes more aware and better equipped to deal with severe local storms.

There were 11 killer tornadoes in 1986. All of these were classified as strong (F2–F3). Four people were killed by tornadoes on one day (10 March), and a single tornado claimed the lives of three people near Jacksonville, North Carolina on 2 July.

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A new monthly record was set in January when no tornadoes were reported in the United States during the month. The previous record low of one had occurred in 1984, 1966 and 1961. The number of tornadoes was greater than normal during seven months of the year.

Texas had the highest annual total of tornadoes (132) followed by Nebraska with 54 and Florida with 53. Ten tornadoes in Idaho broke that state's annual record of five that had been set in 1967. Three tornadoes that occurred in Rhode Island in August set both monthly and annual records for that state. Previously, no more than one tornado had occurred in Rhode Island during any year. Five tornadoes in Tennessee were the fewest in any year since only two occurred in 1969. Two tornadoes touched down in Hawaii during 1986.

2. Monthly summaries

The following monthly summaries (Tables 1–4) of tornado activity during 1986 provide brief highlights of tornado events. More detailed information can be found in monthly issues of *Storm Data* (1986).

a. January

For the first time since reliable records began in 1950, there were no tornadoes reported in the United States in January. It is rare for an entire month to pass without a tornado and has occurred only three times (October 1952, December 1963, and November 1976) during the period of record extending back to 1950.

Not only were there no tornadoes, but no large hail was reported. A wind gust of 97 km h^{-1} at Whidbey Island Naval Air Station in northwest Washington State accounted for one of only three severe thunderstorm events in January. The remaining two events occurred on 10 January when a strong thunderstorm moved across Florida causing considerable damage at Zephyrhills (10 km northeast of Tampa) and Christmas (25 km east of Orlando).

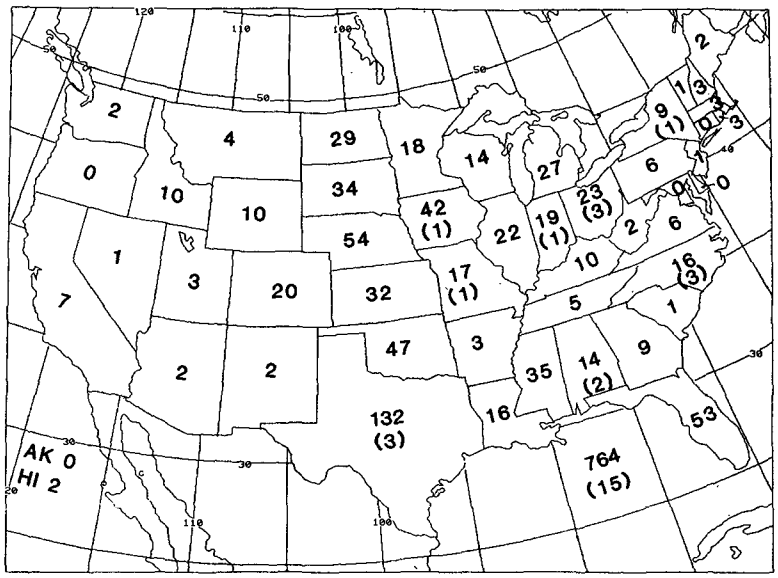

FIG. 1. Geographic distribution of tornadoes in 1986. Total summed over states gives 771 because of "border crossers." Numbers in parentheses are tornado deaths.

This dearth of activity resulted from a prevailing upper flow that steered most storm systems along the U.S./Canadian border. This type pattern fails to transport needed low level moisture northward from the Gulf of Mexico. As a result, much of the central part of the nation experienced abnormally warm, but excessively dry, conditions during the month.

b. February

After 52 consecutive days (12 December 1985 through 1 February 1986) without a tornado being reported in the United States, the first tornado in 1986 struck 16 km southeast of Mineral Wells, Texas at 2140 CST 2 February. This storm caused considerable dam-

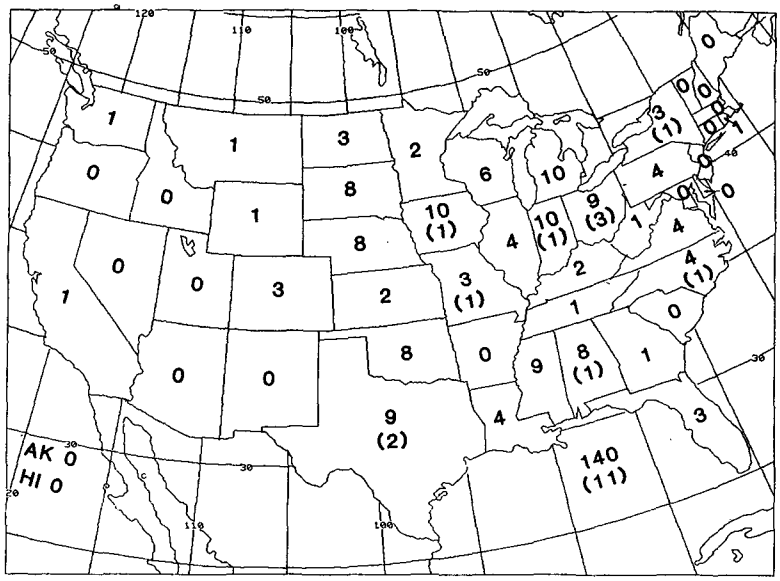

FIG. 2. Geographic distribution of "Strong" or "Violent" (intensity F2 or greater) tornadoes in 1986. Total summed over states gives 144 because of "border crossers." Numbers in parentheses are killer tornadoes.

TABLE 1. Monthly distribution of tornadoes, tornado fatalities and killer tornadoes.

	Tornadoes			Fatalities			Killer tornadoes	
	1986	1985	Mean 1956–85	1986	1985	Mean 1956–85	1986	1985
January	0	2	14	0	0	3	0	0
February	30	7	21	2	0	6	1	0
March	75	38	50	6	2	8	5	1
April	84	134	112	2	5	37	2	3
May	173	182	171	1	78	17	1	11
June	134	82	153	0	3	8	0	2
July	88	51	86	3	0	1	1	0
August	67	108	59	1	3	2	1	2
September	65	40	40	0	0	2	0	0
October	26	18	25	0	0	2	0	0
November	17	19	23	0	3	2	0	0
December	5	3	20	0	0	2	0	0
Totals	764	684	771	15	94	90	11	20

age as it produced a 16 km-long track from just south of Brock to near Weatherford. Two people were injured when a farm house and a mobile home were destroyed.

During the afternoon and evening of 5 February, the first significant outbreak of severe weather in 1986 struck east Texas and southwest Arkansas. A fast-moving storm system resulted in extensive damage from hail as large as tennis balls, strong thunderstorm winds and tornadoes. Texas recorded 11 tornadoes, and one occurred in Arkansas. A strong (F3) tornado that struck Tomball, Texas (59 km northwest of Houston) damaged 90 percent of the houses in the area, injured 33 people and killed an elderly woman when the twister roared through a mobile home park. A second fatality occurred when a tree was blown on the cab of a truck causing the driver to lose control of the vehicle and crash into trees along the roadside. Fifteen thousand homes were left without electric power as this storm downed lines by the hundreds. A total of 49 people were injured and damage was estimated at $50 million. A large part of this figure was attributed to damages incurred at an airport near Tomball where 90 percent of the buildings and 80 percent of 300 parked aircraft were destroyed.

Shortly after 2200 CST on 10 February, two tornadoes touched down almost simultaneously in southern Georgia. These tornadoes produced nearly parallel intermittent paths of damage as they moved northeast at 64 km h^{-1}. The tracks were about 300 m apart and although they were only 30 m wide, there was extensive property damage and numerous injuries. A total of 10 permanent homes and 24 mobile homes were either destroyed or heavily damaged and 21 people were injured.

The airport at Waycross, Georgia (128 km southwest of Savannah) was in the path of one of the tornadoes. Several hangars, warehouses and aircraft were destroyed. The National Weather Service Meteorological Observatory sustained considerable damage as well as water damage from rain that fell after the roof of the main building had been partially ripped off by the tornado. A pressure drop of 14 hPa was recorded at the Observatory as the tornado passed.

A total of 30 tornadoes was reported in February.

TABLE 2. Killer tornadoes in 1986.

Date	Time (CST)	Location	Deaths	Intensity	Remarks
5 Feb	1630	Tomball, TX	2	F3	1 Mobile Home
10 Mar	1430	Hancock City, IN	1	F3	
10 Mar	1645	Washington Court House, OH	1	F2	Mobile Home
10 Mar	1705	Olena, OH	1	F2	Mobile Home
10 Mar	1815	Norwich, OH	1	F2	Mobile Home
12 Mar	1415	Carrollton, AL	2	F3	Mobile Home
19 Apr	0717	Sweetwater, TX	1	F3	
26 Apr	1830	6 NW Little Rock, IA	1	F2	Pickup Truck
15 May	1830	Vanduser, MO	1	F2	
2 Jul	1930	Jacksonville, NC	3	F2	Mobile Home
15 Aug	1630	Somerville, NY	1	F2	

TABLE 3. Tornado frequency and deaths by intensity categories: 1986.

Category	F-Scale	Approximate wind speed ($m\ s^{-1}$)	Tornado frequency	Tornado fatalities
Weak	0	<33	359 (81.7%)	0 (0%)
	1	33–50	265	0
Strong	2	51–70	116 (17.9%)	9 (100%)
	3	71–92	21	6
Violent	4	93–116	3 (0.4%)	0 (0%)
	5	117–142	0	0
Totals			764	15

Texas led the nation with 12 followed by seven in Florida, three in Georgia and California, two in Mississippi and Tennessee and one in Arkansas. Three tornadoes in California tied the February record that was set in 1980.

c. *March*

For the second consecutive month, there were more tornadoes than normal (75 vs 50). All 75 tornadoes occurred during the period 10–20 March and more than half the total (40) were recorded on the 10th and 12th, when 20 were reported on each of those dates.

On 10 March, the most deadly outbreak of tornadoes to strike the nation in 1986 ravaged northern Kentucky, central Indiana and Ohio. Three tornadoes in Indiana reached F3 intensity. One of these claimed a life in Hancock County as it and its twin produced parallel paths, 1.2 km apart for a distance of 16 km. These two twisters passed southeast Indianapolis missing the city by approximately 32 km. In all, eight tornadoes injured 48 people in Indiana.

Later that evening, the second of two tornadoes to strike Kentucky on 10 March produced a 5.6 km long path of destruction through a densely populated subdivision of southeast Lexington. Twenty people were injured and 900 homes were damaged or demolished by this disastrous tornado. Miraculously, there were no fatalities.

This violent weather system also spawned nine tornadoes in Ohio during the evening. Three of these were killer storms, with each claiming the life of a mobile home occupant at three different locations.

The following day, 11 March, strong thunderstorms moved through eastern Arkansas causing considerable wind damage and injuring a dozen people. These thunderstorms redeveloped and intensified the next day and produced a total of 19 tornadoes in Tennessee, Mississippi, Kentucky and Alabama. One of the nine tornadoes in Mississippi was the first of the year to reach F4 intensity. This violent tornado touched down on the northwest side of Meridian, where it began a 35 km track that was as much as 0.8 km wide in places. While damage was almost $600 000, the survey showed this figure would have been much higher had not the most devastating force of the storm occurred in unpopulated and undeveloped areas. All five tornadoes in Alabama on this day were strong (F2–F3). A tornado in the west-central part of the state killed two people just west of Carrollton when a house was struck causing the chimney to topple on the two victims. A third occupant of the home was in a hallway and escaped injury. These fatalities brought the total for the year to eight; nine below the thirty-year first quarter average of 17.

On 16 March, a small tornado hit Anaheim, California about 1.5 km from Disneyland. Windows were shattered, two trucks were flipped over and roofs were damaged in a four block area of the city.

Mississippi reported eight tornadoes on 18 March, bringing its total for the month to 17. This was the most reported in any state during the month and the second highest ever recorded in Mississippi in March. Florida ranked second with 11 tornadoes followed by 9 in Ohio, 8 in Indiana and 7 in Alabama. Six tornadoes in Kentucky broke its March record of five that was set in 1964. Ohio established a new record for the month when its monthly total of nine exceeded its previous record of six set in 1985.

d. *April*

The central part of the nation bore the brunt of the tornadic activity in April as 84 tornadoes occurred. Although the total number of tornadoes was 28 fewer than normal, Nebraska, with 17, broke its previous April record of 15 that had been established in 1985.

On 19 April, a major storm system produced 80 events of severe weather (large hail, damaging winds and tornadoes) in Texas. One of the ten tornadoes that

TABLE 4. Violent tornadoes in 1986.

Date	Time (CST)	Location (km)	Intensity	Path Length (km)	Path Width (m)	Deaths	Injuries
12 Mar	1305	6 NW Meridian, MS	F4	35	403	0	8
28 Jul	1849	8 SSE Sioux City, IA	F4	20	69	0	1
28 Sep	1634	6 SW Farrar, IA	F4	32	230	0	0

occurred that day stands out as being most significant. The town of Sweetwater was nearly annihilated when a strong (F3) twister swept through at the unlikely time of 0717 CST. Damage was extensive and 100 people were injured in this community of 12 000. An elderly man lost his life when the retirement complex in which he lived was totally destroyed.

The following account of a tragic event in northwest Iowa on 26 April confirms the notion that vehicles are extremely unsafe when a tornado strikes. A strong (F2) tornado touched down at 1830 CST just north of George, Iowa and produced a 13.6 km track before moving into Minnesota. It struck a dairy farm just northwest of Little Rock, Iowa where a small child was killed and an uncle and grandmother were injured. The family saw the storm approaching and instead of seeking shelter in the house, they attempted to outrun the tornado in a pickup truck. They were still in the barnyard when a fence post borne by the tornado crashed through the window of the truck and killed the child. The house, located nearby, incurred no major damage.

Texas led the nation with 21 tornadoes in April. Other states in double digits were Nebraska (17), and Kansas (12). Two fatalities during the month were the fewest to be reported in April since 1976.

e. *May*

A total of 173 tornadoes in May was near the average of 171, but several facts were unusual. More than half (14) of the 27 states that reported tornadoes during the month exceeded their monthly average. For the second month in a row, Hawaii reported a tornado and Nevada experienced its first May tornado since 1970 when a weak rope-like funnel touched down in a dry lake bed near Desert Springs on the 28th. Three tornadoes in Idaho caused considerable damage on 19 and 21 May, setting a new record for the month. The previous record for May was one, last occurring in 1985. Only one tornado fatality during the month was far below the average of 17 for May.

Eight tornadoes were reported in Texas on 7 May. A slow moving supercell spawned five of these in less than two hours near the town of Canadian in the northeast Texas Panhandle. Although there were no people killed or injured, one tornado that reached F3 intensity downed electrical transmission towers and killed 32 head of cattle.

The following day, a strong (F3) tornado struck northern Oklahoma City and moved northeast into Edmond. Thirty-nine houses were destroyed, 171 damaged and 15 people injured as this storm produced damages of $6.5 million.

On 15 May, the worst outbreak of severe weather to strike Missouri in 1986, raked the southeast part of the state. One of the six tornadoes that occurred during the afternoon and evening caused extensive damage and 19 injuries in Sikeston. The sounding of a newly installed siren well in advance of the storm no doubt contributed to the low number of injuries and lack of fatalities.

A second strong tornado touched down an hour later near Vanduser (32 km south-southwest of Cape Girardeau) and traveled through the eastern part of the town. Injuries totalled 15 and an elderly man was found dead near his car after the tornado had passed.

Texas reported the most tornadoes during the month with 49, followed by 25 in Oklahoma and 11 each in Kansas and Illinois.

f. *June*

Although there were 134 tornadoes reported during June, there were no tornado fatalities and only 17 people were injured. Eighty-nine percent (119) were weak (F0–F1) and only one reached F3 intensity. The F3 tornado occurred in north central North Dakota near Bottineau on 26 May. Hail, the size of baseballs, accompanied this storm and a woman was injured when the tornado destroyed her mobile home.

After Hurricane Bonnie made landfall on the Gulf of Mexico coast near the Texas/Louisiana border on 26 June, five tornadoes associated with the remnants occurred in Louisiana on the 27th. These resulted in over $300 000 damage to property and seven injuries.

Texas, again, led the nation in number of tornadoes with 24 while North Dakota reported 12, and 10 occurred in Nebraska.

g. *July*

North Carolina had only three tornadoes in July, but one of these was the most deadly single tornado of the year. During the afternoon of 2 July, a vigorous line of thunderstorms formed in northeast North Carolina and gradually moved and developed southward before merging with severe storms that were moving east from the western part of the state. This system produced 16 separate events of damaging thunderstorm winds and one tornado. Although the tornado was short-lived and produced an intermittent path of only 2.4 km, a trailer park in Jacksonville was an unfortunate target. Three people were killed and 10 injured as the twister destroyed 10 mobile homes and damaged 20 others. Damage from this tornado was estimated at nearly a half-million dollars.

On 18 July, one of the most observed and photographed tornadoes ever to occur struck a Minneapolis suburb. The opportunity was made possible by the slow forward speed of the tornado. The funnel was visible for half an hour while it traveled a distance of only 6.4 km through an urban area. The footage acquired by a cameraman as a helicopter circled to within 0.4 km of the tornado was spectacular.

A massive and violent complex of thunderstorms developed in South Dakota during the afternoon of 28 July. This system grew in size and strength as it moved southeast into northeast Nebraska and northwest Iowa, leaving a broad swath of extensive damage from high winds, hail and tornadoes in its wake. At 1730 CST, a strong (F3) tornado touched down near Maskell in extreme northeast Nebraska. This tornado moved southeast for 88 km before crossing the Missouri river, where it strengthened to F4 intensity and continued on the ground for another 20 km in Iowa. This was the second of three F4 tornadoes to occur in 1986, and it produced the longest track (108 km) of any during the year. As this tornado entered Iowa it slammed into a coal-burning power plant and caused 25 to 50 million dollars damage to the facility. Although destruction was near total in the path of this ferocious storm, there were no fatalities and only two injuries as the twister spent much of its life in farmland areas.

This huge generator of severe weather moved southeast across Iowa producing numerous accounts of damage during the evening. One of the more noteworthy events occurred when a freight train carrying piggyback trailers loaded with cargo was struck by high winds as it crossed the Des Moines River just west of Boone, Iowa. Sixteen of the 18 trailers were blown from the train and plummeted 57 m to the river below.

The month ended with a total of 88 tornadoes being reported in the nation. Three states (Nebraska, North Dakota and South Dakota) tied for the most tornadoes with 12 each, and three tornadoes in New York state tied its previous monthly record set in 1984.

h. August

Sixty-seven tornadoes in August exceeded the thirty-year average of 59 and several tornado frequency records were tied or broken. Five tornadoes in Idaho set a record for the month and exceeded the previous August record by four. This figure equalled the most that had ever been reported in any month and tied its annual record that was established in 1967.

Major severe storms raked New England on 7 and 8 August causing extensive property damage and injury to 20 people. A total of eight tornadoes was reported: Vermont (one), Massachusetts (two), Maine (two), and Rhode Island (three). A tornado in Rhode Island is a rare event and only two had been recorded in the period 1950–85. The first of the three tornadoes occurred at 1530 EST in Cumberland in northeast Rhode Island. Damage was confined to trees, power lines, houses and a construction project. The second, and strongest (F2), tornado touched down 45 minutes later in Cranston and began a 6.4 km track that ended in South Providence. Damage from this twister was in the millions of dollars and 20 people were injured. Cars were picked up, windows were blown out of businesses, roofs were taken off houses and streets were blocked by downed trees, power lines and debris. The severe weather story in Rhode Island became even more unusual when the next morning a third tornado struck Burrillville and produced a 11.2 km track as it moved east-northeast into Massachusetts. There were no injuries, but there was extensive damage to vehicles and buildings in North Smithfield.

A small, but deadly tornado struck the Somerville, New York area on 15 August, injuring three people and claiming the life of the 15th tornado victim in 1986. This was the 11th and final killer tornado of the year.

Although the national total for the month was above normal, no state reported figures in the double digits. Florida recorded the most with nine followed by seven in Michigan and five in Idaho and Texas.

i. September

The number of tornadoes in September exceeded the monthly average by a larger percentage (63%) than any month in 1986. Sixty-five were reported while 40 is normal. This ranks fourth for the most tornadoes ever recorded in September and five states broke or tied previous monthly records. Michigan reported eight, breaking the earlier record of five that had stood since 1974, and five in South Dakota was three above the prior record set in 1985. One in each of the states of Washington, Utah, and New Jersey tied previous records.

There were no tornado fatalities during the month, but several tornadoes produced significant damage and several injuries. On 18 September, a large tornado touched down near New Raymer, Colorado and produced a 40-km track across Weld County that resulted in major damage to farm buildings, vehicles and power lines. A short time later, a strong (F3) tornado moved across the border from Kansas and struck Hardy, Nebraska. More than 100 structures were destroyed or damaged and seven people were injured in Hardy.

The third and final tornado to reach F4 intensity in 1986 struck about 40 km northeast of Des Moines, Iowa. Seven houses were leveled and more than 30 were damaged. Fortunately, there were no injuries or deaths as this violent storm tracked for 32 km across parts of two counties.

Michigan led the nation with eight tornadoes followed by Illinois and Nebraska with six, while Iowa and South Dakota each reported five.

j. October

The number of tornadoes was slightly above normal in October (26 vs 25) and the count began soon after midnight on the first day of the month when a strong (F2) tornado struck about 64 km southwest of Albany, New York. The strength of this storm was demonstrated when the tornado hurled a farm wagon 500 m across a field and deposited it in a tree 3 m above the

ground. Later that day a person was injured by a tornado in Wabash, West Virginia. Three days later another tornado in West Virginia caused damage to the Rock Run area (about 10 km northeast of West Union). These were only the second and third tornadoes ever reported in West Virginia in October, going back to 1950. The first occurred in 1979.

Virginia averages less than one tornado in October, but during the early morning of 14 October, four strong (F2–F3) tornadoes struck the southeast part of the state. One tornado that touched down about 56 km southeast of Richmond picked up an oak tree that measured 1.2 m in diameter and hurled it on a residence that was occupied by five people. Luckily, no one was injured.

Texas reported the most tornadoes during the month (seven), while Oklahoma had six, and Virginia ranked third with four.

k. November

For the first time since July the number of tornadoes reported was below the monthly average. Five states recorded a total of 17 tornadoes while the national average is 20. More than one-third (six) of the total occurred in Mississippi. Two rare tornadoes occurred in Arizona on 18 November. One struck north of Eloy (southeast of Phoenix) and the second touched down about 40 km east of Phoenix. Sixty mobile homes were damaged as this tornado passed through the town of Apache Junction. The last tornado recorded in Arizona in November was in 1968, and only three had been reported in that month prior to 1986.

l. December

There were very few severe thunderstorms in December and all five of the tornadoes occurred in Florida. No severe events of any type were reported during the first 22 days of the month. On 23 December, a strong weather system moved eastward across the Gulf of Mexico and produced two tornadoes in Florida. The first touched down in Ocala, where it damaged 12 homes, destroyed a church, and overturned a semitrailer truck. Power lines were downed, leaving 3000 people without electricity.

The next week of December was free from severe weather, but on the last day of the year, Florida was struck by three tornadoes. At 1910 CST 31 December, the 764th, and last, tornado to occur in 1986 was reported just south of Fort Pierce at White City, Florida.

3. Noteworthy tornado outbreaks

There were few widespread tornado outbreaks in 1986. However, tornadoes caused loss of life and extensive damage in several instances. Four noteworthy tornado outbreaks were selected to characterize the tornado season of 1986 in the United States. On 10 and 12 March separate outbreaks occurred in association with strong synoptic-scale cyclones. Tornadoes occurred across Texas on 19 April as a short-wave trough destabilized a warm, moist air mass lying to the south of a quasi-stationary front. The strongest tornado outbreak of the year struck Nebraska, Iowa, and South Dakota on 28 July within a northwest flow setting. For each of these cases, a composite chart depicts the relative positions of pertinent meteorological features. Brief descriptions of the progression of events in each case are also included.

a. 10 March 1986

At 0600 CST 10 March a large surface low pressure system extended from northeastern Oklahoma northeastward to northwestern lower Michigan. Low pressure centers were located in western Missouri (996 hPa) and northeastern Iowa (993 hPa). A squall line extended from eastern Iowa to eastern Missouri then south-southwestward to southern Arkansas. Strong southwesterly flow was evident at 850 hPa across the Ohio Valley region. Winds greater than 25 m s^{-1} were widespread, with a maximum of 35 m s^{-1} observed at Salem, Illinois. These features are depicted in the composite chart for 0600 CST in Fig. 3. During the morning the southern surface low weakened, and the northern low became the dominant surface feature. Winds at 850 hPa remained strong. Surface dewpoints rose to above 10°C across Illinois, Indiana, and Ohio. The cold front and the strong squall line moved eastward. Seventeen tornadoes developed during a five-hour period, which began in early afternoon. These tornadoes caused four fatalities and 81 injuries.

b. 12 March 1986

Within 48 hours of the tornado outbreak in the Ohio Valley, tornadoes struck the southern states from extreme eastern Louisiana to Kentucky and eastward to Alabama. By 0600 CST on 12 March (Fig. 4) a strong surface low (995 hPa) was centered in extreme northern Oklahoma. A warm front extended eastward and a cold front trailed southward to extreme eastern Texas. A short line of thunderstorms was moving across Kentucky, while other lines extended from southern Tennessee to southern Mississippi and from northeastern Louisiana to the coastal regions of southern Texas. At 850 hPa a southerly jet flowed from the Mississippi Delta northeastward to southern Tennessee. Maximum wind speed in this jet was observed to be 33 m s^{-1} at Nashville, Tennessee. A cold trough at 500 hPa extended from Arkansas southeastward across Mississippi to southern Alabama. This feature, together with warm, moist low-level air, produced unstable conditions. Values of Lifted Index (Prosser and Foster 1966) were −8 at Jackson, Mississippi and Centerville, Alabama.

Tornadoes formed during the early morning hours in Kentucky, Tennessee, and Mississippi. A violent

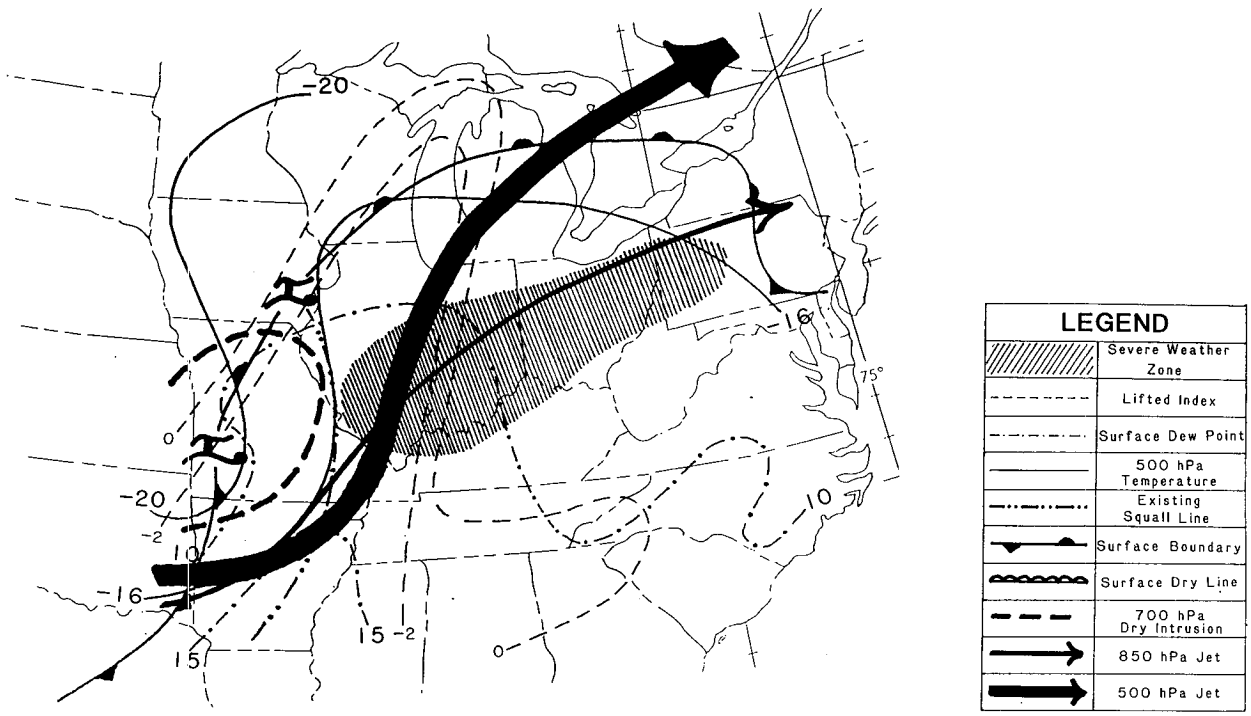

FIG. 3. Composite chart for 0600 CST 10 March 1986.

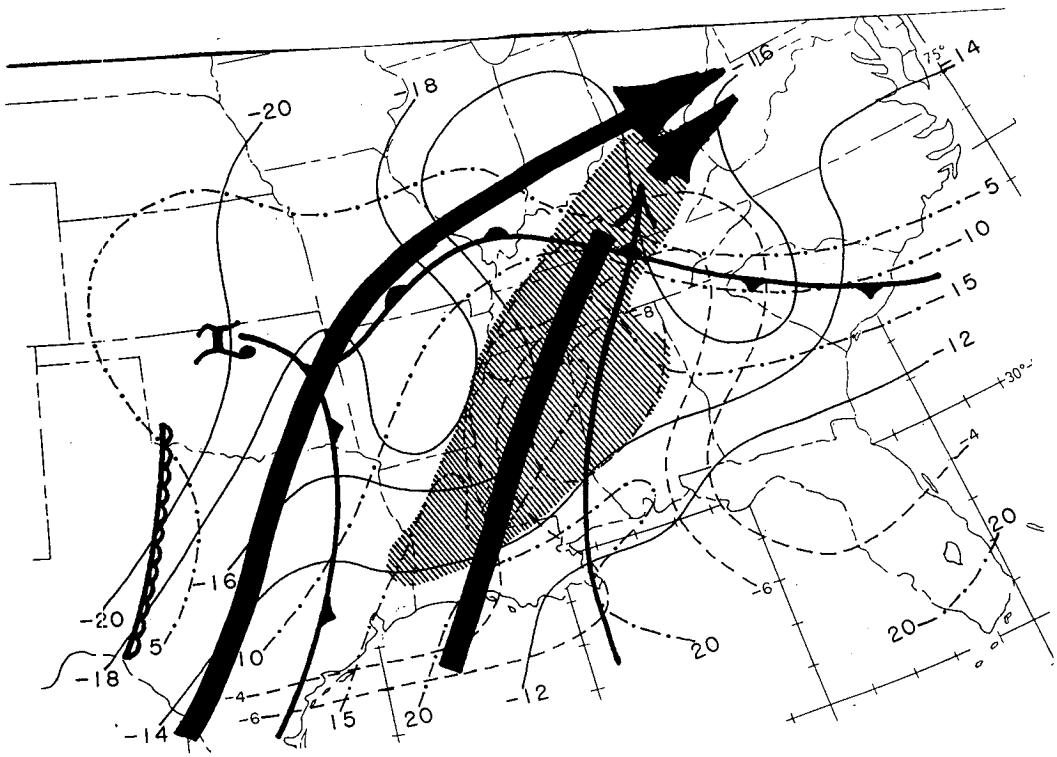

FIG. 4. As in Fig. 3, but for 0600 CST 12 March 1986.

(F4) tornado formed in early afternoon just to the northwest of Meridian, Mississippi as an intense squall line moved eastward. In total, 19 tornadoes occurred in this outbreak, causing two fatalities.

c. 19 April 1986

This tornado outbreak had an early beginning on the morning of 19 April. As shown in Fig. 5, a composite chart for 0600 CST, a weak surface low was forming in west Texas. To the south of a quasi-stationary front that extended across northern Texas warm, moist air lay across central and southern Texas. A strong dryline (Schaefer 1974) separated the moist air mass from dry continental tropical air over extreme western Texas. Greatest contrasts existed near the center of the surface low. The 850 hPa wind at Midland was 17 m s^{-1}, but lighter winds covered the remainder of the region. A short-wave trough in the 500 hPa flow was approaching from the west.

Intense thunderstorms developed during early morning near the surface low. The first tornado touched down just before 0700 CST west-southwest of Abilene. Shortly thereafter, a multiple-vortex tornado struck Sweetwater, causing one fatality. As the upper trough moved eastward over the unstable air mass, severe thunderstorms redeveloped across northern Texas and northern Louisiana during the remainder of the day. Eleven additional tornadoes, hail as large as 7.5 cm in diameter, and wind gusts as high as 34 m s^{-1} were observed.

d. 28 July 1986

Synoptic-scale features were rather weak across the central Plains at 0600 CST 28 July. At 850 hPa very warm air that was centered over southwestern Kansas was being advected northeastward. Maximum 500 hPa winds were 17 m s^{-1} across South Dakota and Iowa above a quasi-stationary front at the surface. A cold trough was evident at 500 hPa over western Kansas and Nebraska. Unstable air lay to the south of the surface front, as evidenced by Lifted Index values of −10 at both Omaha and North Platte, Nebraska. These conditions are definitive of an unstable northwest flow situation discussed by Johns (1982).

Severe thunderstorms began to form just north of the frontal boundary in South Dakota during early afternoon. An indication of the intensity of this situation was given by the reports of hailstones the size of baseballs (7 cm in diameter) in southeastern South Dakota and hailstones more than 12 cm in diameter in extreme southwestern Minnesota. The first tornado touched down at 1613 CST in southeastern South Dakota. A composite chart for 1800 CST is shown in Fig. 6. By this time a strong thunderstorm system was moving south-southeastward across the Nebraska–South Dakota–Iowa junction. This system was taking on bow echo characteristics that led to a derecho (Johns and Hirt 1987). The cold trough at 500 hPa had moved to eastern Nebraska and Kansas. Wind speeds at Omaha, Nebraska had increased to 23 m s^{-1} at 500 hPa and 42 m s^{-1} at 250 hPa with strong vertical directional

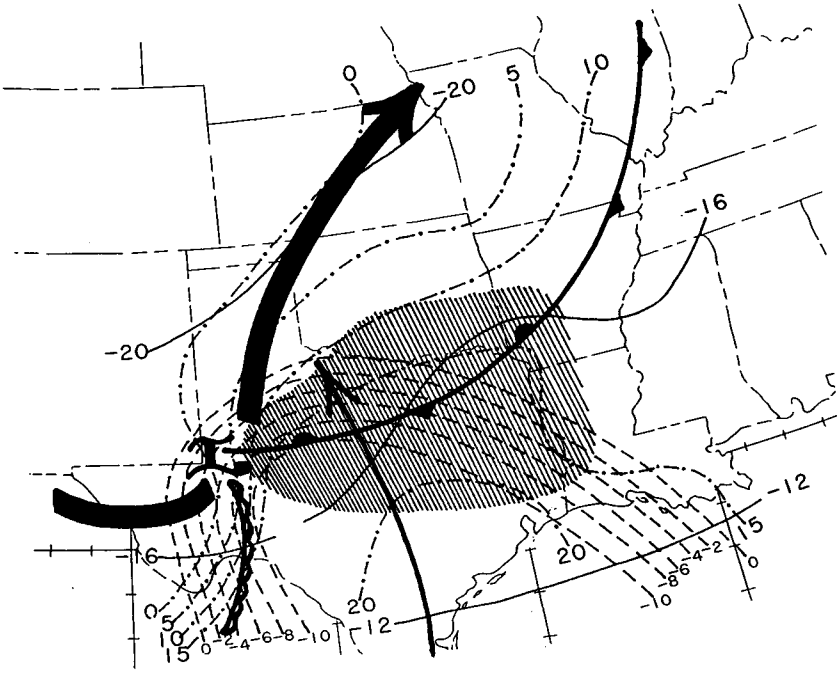

FIG. 5. As in Fig. 3, but for 0600 CST 19 April 1986.

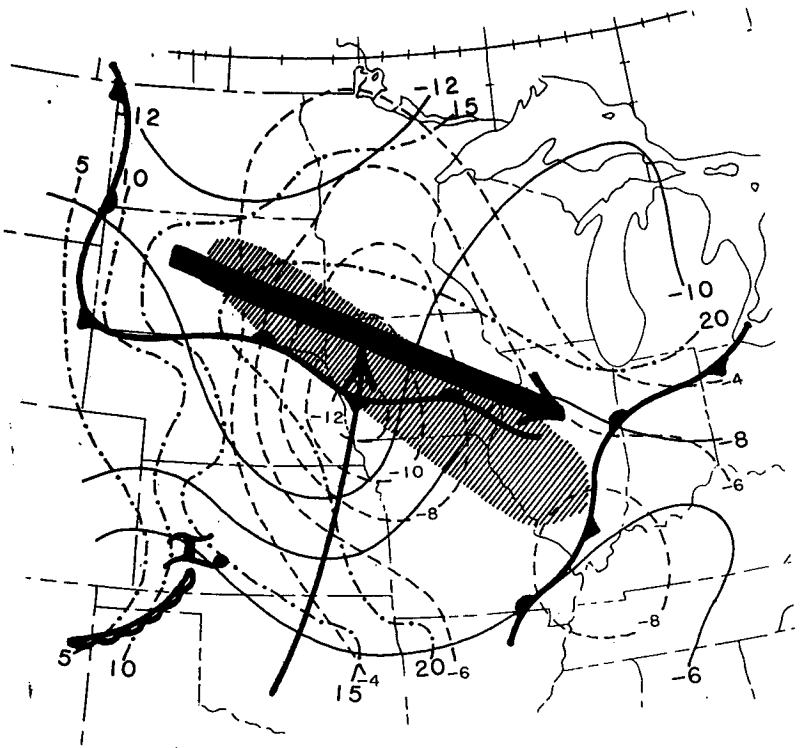

FIG. 6. As in Fig. 3, but for 1800 CST 28 July 1986.

shear below those levels. At 1800 CST a strong (F3) tornado was on the ground northwest of Sioux City, Iowa. Within the next hour this tornado reached violent (F4) intensity and caused millions of dollars in damage (*Storm Data,* July 1986). Twelve other tornadoes formed with this convective system. The last tornado occurred just before 2000 CST in western Iowa. Severe thunderstorms continued to produce damaging winds and large hail into the early morning hours of 29 July as they moved across eastern Missouri and central and southern Illinois.

Acknowledgments. The authors thank Patricia Palmerin for technical assistance in preparing the manuscript. John E. Hales and Robert H. Johns contributed information concerning the noteworthy tornado outbreaks. Hugh G. Crowther drafted the composite charts.

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