ANNUAL SUMMARY

The Tornado Season of 1984

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ABSTRACT

Tornado events of 1984 are reviewed. Significant and interesting aspects of the 907 reported tornadoes are noted. Synoptic patterns associated with four noteworthy tornado days are examined.

1. The year 1984 in statistics

The unusual became common during the tornado season of 1984. On 28 March an outbreak of killer tornadoes roared through South and North Carolina, resulting in 57 fatalities, over 1200 injuries and hundreds of millions of dollars in damage. This was the worst tornado outbreak to strike the Carolinas in the last 60 years. A violent tornado that struck Barneveld, Wisconsin on 7 June was only the second F5 (Fujita, 1981) tornado to occur in the United States since 1977. Monthly or annual frequency records were broken in many states.

A total of 907 tornadoes during 1984 represents a 2% decrease from the previous year, but it is still well above the 30-year (1954–83) mean of 756. Overall, seven months of 1984 had above-normal tornado activity. June had the highest number (242) of any month. This was the most tornadoes reported in June since reliable records began in 1950. A record number in June was followed by 72 tornadoes in July, the fewest for that month since 1974. In Utah, five tornadoes that occurred in August were the most ever in any month. A total of 36 tornadoes in Nebraska during June was also an all-time record for any month in that state. The national total of one tornado in January tied the record monthly low that last occurred in 1966. The seventeen tornadoes recorded in September were the smallest number for that month since 1957.

In 1984 the number of tornado-related fatalities rose sharply to 122. This was the greatest number of fatalities in one year since 1974, and it ranked as the seventh highest total in the past 30 years. The 64 fatalities recorded in March were the most for that month since 1952. North Carolina recorded its highest number of fatalities (42) for any year, greatly surpassing the previous record of 14 in 1936. South Carolina had its highest fatality total (15) since 1944. The monthly distributions of tornadoes and related fatalities are listed in Table 1.

Every state in the contiguous United States except New Jersey, Rhode Island, Vermont and West Virginia recorded at least one tornado during 1984. Texas was the state with the highest number (93), followed by Kansas with 63. Iowa (61) and Utah (6) had all-time annual maxima. Although Texas had the highest number of tornadoes of any state during 1984, the total of 93 was its smallest annual total since 77 occurred in 1966. Two was the smallest annual total for Ohio since 1952. For the second consecutive year, no tornadoes were reported in West Virginia. Geographic distributions of tornadoes and fatalities for 1984 are depicted in Fig. 1.

There were 33 killer tornadoes during 1984. Forty-seven percent of the yearly total of fatalities were caused by 10 tornadoes in the Carolinas on 28 March. Nine persons were killed by the tornado that struck Barneveld, Wisconsin on 7 June. Facts concerning these killer tornadoes are listed in Table 2.

The geographic distribution of strong and violent tornadoes in 1984 is depicted in Fig. 2. Although strong and violent tornadoes represented only slightly less than 21% of the annual total (Table 3), they caused 96% of the fatalities during the year. There were 15 violent tornadoes during 1984, the greatest number since 1976. Facts concerning these violent tornadoes are listed in Table 4. One of them, which struck McColl, South Carolina on 28 March, attained an incredible maximum path width of 4 km before it moved into North Carolina. Another was on the ground for a distance of 203 km as it traveled across northern Missouri and southern Iowa on 7 June.

2. Monthly summaries

a. January

The year 1984 began with three-fourths of the nation blanketed with snow and temperatures well below normal. These conditions, coupled with other factors that were unfavorable for severe thunderstorm develop-

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

	1984 Tornadoes	1983 Tornadoes	Mean (1954–83)	1984 Fatalities	1983 Fatalities	Mean (1954–83)	1984 Killer tornadoes	1983 Killer tornadoes
January	1	13	15	0	2	3	0	2
February	27	41	20	0	1	7	0	1
March	73	71	49	64	0	7	12	0
April	176	65	108	33	6	37	10	3
May	169	249	167	6	14	23	2	12
June	242	178	151	14	2	15	4	2
July	72	99	85	0	4	1	0	3
August	47	76	56	0	0	2	0	0
September	17	19	29	0	0	2	0	0
October	49	13	24	4	0	2	4	0
November	30	49	22	1	0	2	1	0
December	4	58	20	0	5	3	0	4
Totals	907	931	756	122	34	104	33	27

ment, resulted in January being a very inactive severe weather month.

The first tornado of 1984 and the only tornado in January occurred at Huntington Beach, California at 2019 CST 13 January. This twister formed in much the same way as the first tornado in 1983. That is, a waterspout developed and moved onshore. This tornado damaged a mobile home and ripped off the porch roof, which was carried aloft for about 1.6 km before it was deposited in a street. There were no fatalities or injuries reported with this tornadic storm.

One tornado in January (normal is 15) tied the previous all-time low tornado frequency record for January that was set in 1961 and repeated in 1966. The dearth of severe thunderstorm activity in January is further illustrated by the fact that only two other severe weather events were reported to the National Severe Storms Forecast Center (NSSFC) during the month. A strong thunderstorm produced wind that damaged trees and power lines about 6 km southeast of Savannah, Georgia on 18 January. Several sheds were blown over and awnings destroyed as a thunderstorm struck Greenacres in Palm Beach County, Florida on 19 January.

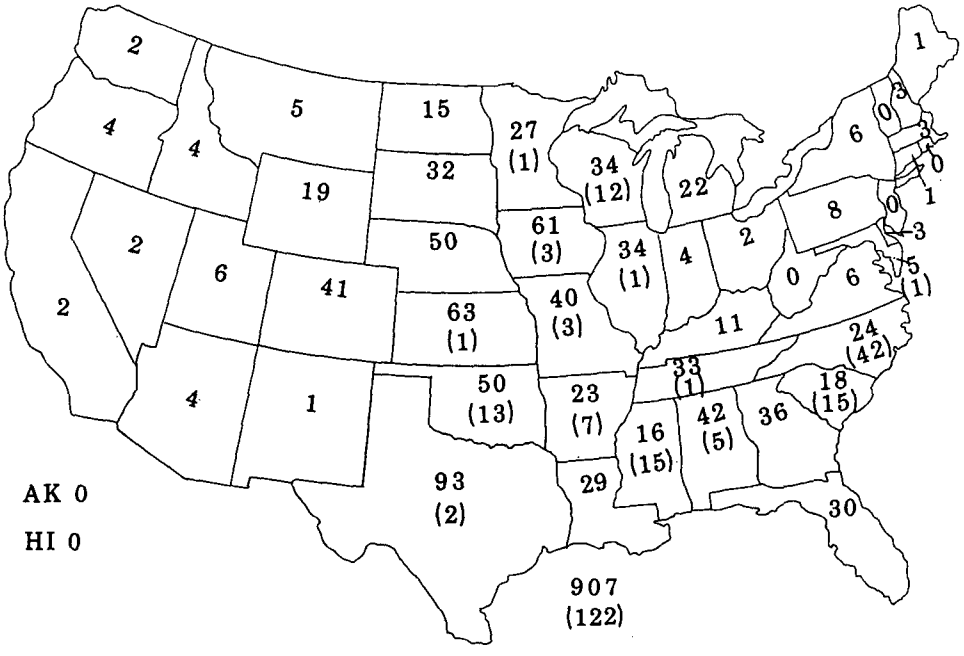

FIG. 1. Geographic distribution of tornadoes in 1984. Totals summed over states give 915 due to border crossers. Figures in parentheses are tornado-related deaths.

TABLE 2. Killer tornadoes during 1984.

Date	Time (CST)	Location	Deaths	Intensity	Remarks
15 Mar	1800	3 E Greers Ferry, AR	2	F4	
15 Mar	1920	Fisher, AR	5	F4	2 Mobile home
28 Mar	1620	Newberry, SC	1	F2	
28 Mar	1705	Winnsboro, SC	5	F4	5 Mobile home
28 Mar	1815	Bennettsville, SC	7	F4	7 Mobile home
28 Mar	1830	McColl, SC/Red Springs, NC	4	F4	1 Mobile home
28 Mar	1845	Roseboro/Clinton, NC	12	F3	3 Mobile home
28 Mar	1915	Mount Olive, NC	3	F4	
28 Mar	1945	Snow Hill/Ayden/Greenville, NC	16	F4	4 Mobile home
28 Mar	1955	Lewiston, NC	6	F3	3 Mobile home
28 Mar	2030	Bennetts Creek, NC	2	F3	
28 Mar	2115	Snug Harbor, NC	1	F2	1 Mobile home
20 Apr	1550	Canton Lake, OK	1	F1	
21 Apr	1600	Schlater/Philipp/Water Valley/Pinedale, MS	15	F3	3 Mobile home/1 vehicle
26 Apr	2033	St. Anthony, MN	1	F3	
26 Apr	2305	Terlton, OK	3	F4	
26 Apr	2345	Morris, OK	8	F3	
27 Apr	1500	Fawn Lake, WI	1	F3	
27 Apr	1540	Clayton, WI	1	F4	
27 Apr	1639	Wales, WI	1	F4	1 Mobile home
27 Apr	1739	Plainfield, IL	1	F3	
29 Apr	0943	Mannford, OK	1	F4	
3 May	0600	Montgomery, AL	5	F3	1 Mobile home/4 vehicle
8 May	1605	Hurlock, MD	1	F1	
5 Jun	2330	Orient, TX	1	F1	
7 Jun	1745	Eagleville, MO	1	F3	1 Mobile home
		Delta, IA	2	F4	2 Vehicles
7 Jun	2000	Kellerton, IA	1	F2	1 Mobile home
7 Jun	2347	Barneveld, WI	9	F5	
16 Oct	1905	Trezevant, TN	1	F1	1 Mobile home
18 Oct	1900	Argo, TX	1	F2	
18 Oct	2000	Winona, MO	1	F3	1 Mobile home
31 Oct	1823	Carbondale, KS	1	F1	1 Mobile home
9 Nov	1815	Potosi, MO	1	F2	

b. February

An extremely strong weather system moved into the Central Plains on 11 February and produced the first organized outbreak of severe weather in 1984. Three strong (F2) tornadoes struck the area midway between Houston and Dallas in Texas during the evening. The towns of Normangee, Centerville and Palestine sustained property damage of several million dollars, and six people were injured. The roof of a home in Palestine was taken off by a tornado and the family experienced minor injuries. After the storm had passed, a three-year-old girl was found uninjured among some rafters in the remains of the attic.

A second flurry of activity late in the month brought the February tornado total to 27. Almost half (13) of these occurred in Texas. Florida ranked second in the nation with four. Three tornadoes in Kansas on 11 February were unseasonably early for that state, and the first to occur in February since 1971.

c. March

The most deadly tornado outbreak to strike the nation in 10 years raked the Southeast on 28 March. During the afternoon and evening, 24 tornadoes produced path lengths that totaled 515 km from Georgia through the Carolinas, killing 57 people and injuring more than 1200. This was the most violent outbreak to strike South Carolina since April 1924 and the worst on record in North Carolina.

A low pressure system developed in Alabama during the morning and rapidly intensified as it moved east into Georgia and then took a northeast course through the Carolinas. The strength of this system was illustrated by the numerous accounts of record low pressure readings in Georgia and the Carolinas as the low raced northeast at speeds in excess of 80 km h^{-1}.

Although a child was injured when a tornado struck a mobile home in Winder, Georgia and a second tornado touched down briefly 5 km north of McDonough, Georgia, North and South Carolina bore the brunt of this devastating episode of severe weather.

Eleven tornadoes were reported in South Carolina. Fourteen tornadoes occurred in North Carolina, three of which roared out of South Carolina. Four of the eleven tornadoes in South Carolina were killer storms that claimed the lives of 15 people and half (7) of the tornadoes accounted for 42 deaths in North Carolina.

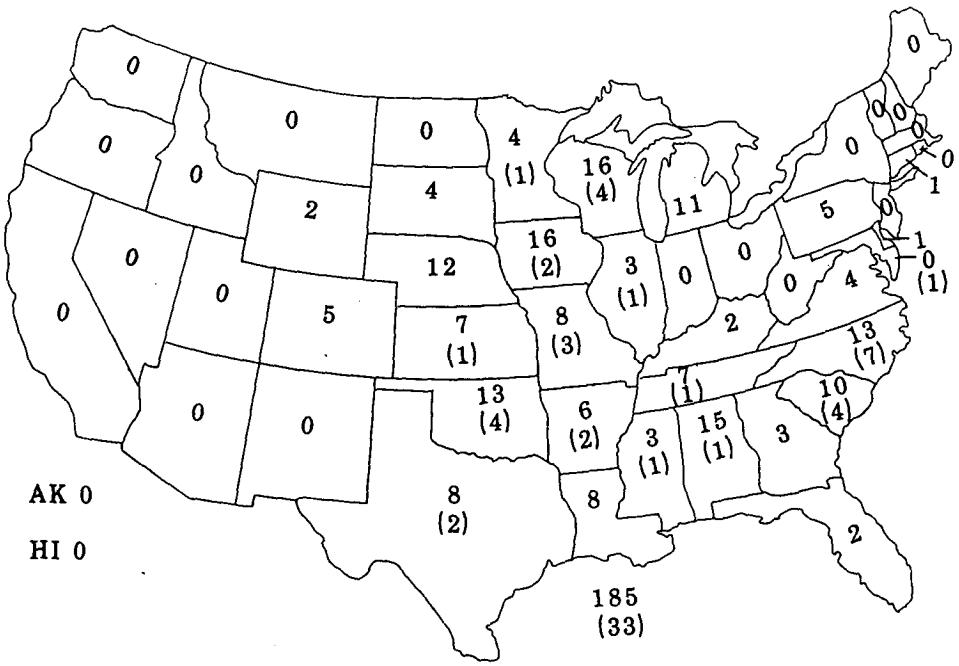

FIG. 2. Geographic distribution of strong and violent (intensity F2 or greater) tornadoes in 1984. Figures in parentheses are killer tornadoes. Totals summed over states give 189 and 35, respectively, due to border crossers.

A tornado that began near McColl, South Carolina and moved into North Carolina produced a 72 km long path that averaged 2.4 km in width with a maximum width of 4 km. This violent (F4) tornado resulted in four fatalities (two in South Carolina and two in North Carolina). Another tornado in North Carolina that traveled from just northeast of La Grange to east of Greenville killed more people (16) than any twister ever to strike that state.

Because the Carolina outbreak on 28 March was so violent and resulted in so many fatalities, it tended to overshadow a significant severe weather episode that developed in eastern Oklahoma on the 15th. This system produced more than 100 events of severe weather (large hail, wind damage and tornadoes) from Oklahoma to Tennessee. Two violent (F4) tornadoes in Arkansas killed a total of seven people. The first developed at 1740 CST 6.4 km southeast of Clinton and produced a 77 km track that stretched to 1.6 km north of Huff. As the tornado passed to the east of Greers Ferry, it became the first killer tornado of 1984 when a woman was killed as the storm struck her home. A boat occupied by three fishermen was overturned on Greers Ferry Lake. Two of the fishermen reached shore safely while the body of the third was never found. A 0.4 km-long bridge across Greers Ferry Lake was lifted by the tornado and tossed into the lake. The second tornado touched down about an hour and a half later near Shoffner, Arkansas and traveled 25.6 km to just northeast of Fisher. Five people were killed and 12 injured in Fisher as the tornado destroyed 18 homes, three businesses, the post office, the town hall and 10 mobile homes.

TABLE 3. Tornado frequency and deaths by intensity category 1984.

Category	F-scale	Number	Frequency (%)	Deaths
Weak	0–1	721	79.5	5
Strong	2–3	171	18.9	58
Violent	4–5	15	1.6	59

A total of 73 tornadoes was reported in the nation during the month. This is the most to be reported in March since 1976 and well above the monthly average of 49. North Carolina led the country with 14, which broke the previous March record of eight that was set in 1975. South Carolina ranked second with 12, which tripled the earlier record for March that was established in 1974.

This also tied the South Carolina monthly record that was set in May 1973. Idaho reported a rare March tornado on the 21st that tied a record that dates back to 1959. Sixty-four tornado fatalities were the greatest number of deaths in March since 1952.

d. April

One hundred seventy-six tornadoes during the month were the most reported in April in ten years

TABLE 4. Violent tornadoes in 1984.

Date	Time (CST)	Location	Intensity	Path length (km)	Mean path width (m)	Deaths	Injuries
15 Mar	1800	3 E Greers Ferry, AR	F4	76.8	402	2	13
15 Mar	1920	Fisher, AR	F4	25.6	402	5	12
28 Mar	1705	Winnsboro, SC	F4	33.6	915	5	49
28 Mar	1720	Kershaw, SC	F4	6.4	485	0	36
28 Mar	1745	Cash, SC	F4	11.2	640	0	24
28 Mar	1815	Bennettsville, SC/Scotland Co., NC	F4	25.6	1920	7	100
28 Mar	1830	McColl, SC/Maxton/Red Springs, NC	F4	72.0	2378	4	395
28 Mar	1915	Mount Olive, NC	F4	33.6	1287	3	149
28 Mar	1945	Snow Hill/Ayden/Greenville, NC	F4	60.8	1119	16	153
26 Apr	2305	Terlton, OK	F4	36.8	805	3	37
27 Apr	1540	Clayton, WI	F4	44.0	549	1	19
27 Apr	1639	Wales, WI	F4	10.4	91	1	14
29 Apr	0943	Mannford, OK	F4	41.6	183	1	60
7 Jun	2000	Delta, IA	F4	187.2	229	2	63
7 Jun	2347	Barneveld, WI	F5	57.6	412	9	200

and ranked third in the last three decades. Tornadoes were reported in 23 states, and fatalities occurred in Illinois, Minnesota, Mississippi, Oklahoma and Wisconsin.

On 20 April, a tornado touched down briefly, striking a recreation area at Canton Lake near Canton, Oklahoma. Seven people were injured, several campers and trailers were destroyed and a woman was killed when her trailer was demolished by the storm.

The following day, Mississippi was hit by four tornadoes. One of those, a powerful F3 tornado, killed 15 people, injured 76 and produced a path of destruction 176 km long that stretched from just west of Schlater to New Albany. This was an unusually long track as the twister was in nearly continuous contact with the ground for two hours and thirty-five minutes. Two people were killed in Leflore County where the tornado first hit, and five were killed in the town of Philipp. It was at maximum strength and a multivortex storm when it later passed through Water Valley and claimed the lives of seven people. In all, 249 houses, 25 mobile homes, 21 businesses, and one church were destroyed or damaged. This storm caused more tornado-related fatalities than had been recorded in Mississippi during the month of April since 1936.

Minnesota recorded its first April tornado fatality since 1967 when St. Anthony was hit on 26 April. Fifty-two people were injured and considerable property damage was incurred as the tornado traveled a distance of 8.8 km from just south of St. Anthony to New Brighton.

Later that evening, four tornadoes struck near Tulsa, Oklahoma. Two of these were killer storms that accounted for 11 fatalities. The town of Terlton, just west of Tulsa, was ravaged by a violent (F4) tornado that killed three people and caused an estimated damage of $2.5 million. About an hour and a half later, a 28 square-block area of Morris, Oklahoma was destroyed and eight people were killed as a tornado plowed a 35.2 km long path that resulted in $9 million in damage. The storm system that produced the outbreak in Oklahoma moved northeast and intensified. The following day it spawned nine tornadoes and numerous reports of large hail and wind damage in Wisconsin. Three of the tornadoes each caused one fatality. One man was killed in Fawn Lake after getting his family to safety. A woman in Clayton, Wisconsin was killed when a violent (F4) tornado demolished her home. Hail the size of tennis balls accompanied this storm and the force of the wind flipped a car 25 m into the air. A second violent (F4) tornado, pictured in Fig. 3, touched

FIG. 3. A killer tornado near Wales, Wisconsin on 29 April 1984. One woman was killed and her husband and son were seriously injured by this F4 tornado. Photo courtesy of AP/Wide World Photos.

down 1.6 km south of Wales, Wisconsin and killed a woman and seriously injured her husband when they were thrown from their mobile home as it was leveled by the storm. A fourth person was killed that day as a tornado destroyed or damaged 43 homes in Plainfield, Illinois.

On 29 April, the fourth violent (F4) tornado to strike the nation during the month produced a 41.6 km long track that was about 16 km east and nearly parallel to the path of the Terlton tornado that occurred only three days earlier. Mannford and New Prue sustained the most damage, and one fatality in Mannford brought the total deaths for the month in Oklahoma to 13. This was the most deaths there in April since 1947.

Kansas led the nation with 29 tornadoes. Twenty-three tornadoes in Oklahoma were the most to occur in the month of April since 1957. Oregon and South Dakota each reported the first tornado in April since 1974.

FIG. 4. This F1 tornado (near arrow) was photographed 1.6 km northwest of Watkins, Colorado on 14 May 1984. It damaged a farm and mobile home park. Photo by David Hoadley.

e. May

On the first day of the month, a tornado struck the south part of Matador, Texas. It destroyed a school while 15 persons who had sought safety in the basement escaped unharmed. The tornado then made a loop through a residential area and came back to strike the school a second time. Although this strong (F3) tornado caused an estimated $2.5–3.0 million in property damage, not one person was killed. No doubt, excellent warnings and preparedness contributed significantly to this success story.

On 3 May, an early morning tornado killed five people in Montgomery, Alabama. Four of the deaths and several of the 37 injuries occurred when the tornado damaged or destroyed about 25 vehicles that were traveling on a bypass. Some of the victims were thrown from their cars which were carried or rolled 92 m from the road. The fifth fatality was the occupant of a mobile home.

During the evening of 8 May, two separate tornadoes touched down in Maryland at about the same time and produced tracks that at one point resulted in a merging of the two funnels. One of these tornadoes lifted and then dropped a large, three-story chicken house near Hurlock, Maryland. One of the two men working inside was killed and the other injured when the top story crushed the lower two sections. Both tornadoes crossed the state line and became the first tornadoes to be reported in Delaware in May since reliable records began in 1950.

The month ended with a total of 169 tornadoes being reported in the nation. One of these was photographed (Fig. 4) near Watkins, Colorado on 14 May. Although this is only slightly above the normal of 167, Alabama (20), Georgia (16), Tennessee (24), Virginia (5) and Delaware (2) established records for May. California, Idaho and Oregon, with one tornado each, tied earlier records while five in Maryland were the most to occur in May since 1937.

f. June

June was the most active month for tornadoes in 1984. Almost half (23) of the states in the contiguous United States contributed to the total of 242 tornadoes reported during June. This was the most ever reported in June and exceeds the monthly normal of 151 by 60%. A total of 14 tornado fatalities during the month was double the 30-year average of seven and the most to occur in June in six years. Most of these deaths were caused by tornadoes that developed in late evening or during the night.

At 2330 CST on 5 June, a tornado struck northeast of San Angelo, Texas. Although this was a weak (F1), narrow (32 m), and short-track (1.6 km) tornado, it killed an occupant of a mobile home that was located on a ranch 6.4 km southeast of Orient, Texas.

On 7 June, a massive severe weather outbreak struck the Midwest and left death and destruction from Missouri to Wisconsin. A strong (F3) tornado touched down in northwest Missouri, 16 km south of the Iowa state line, and killed a man and injured his wife as it destroyed their mobile home in Eagleville, Missouri. The tornado strengthened to F4 intensity as it crossed into Iowa and swept out a swath of destruction that stretched 187 km through seven counties. This distance, when added to the 16 km the tornado was on the ground in Missouri, makes this the longest tornado track in 1984.

There was near total destruction along the entire path of this storm. The business section of Wright, a small town in Mahaska County, Iowa, was leveled by the tornado. Two houses were totally destroyed and the remaining houses suffered significant damage. The fury of the tornado was at a peak when it hit Delta,

Iowa. Two deaths occurred when the occupants of a car were tossed from it as the tornado carried the vehicle more than 270 m from the road. A second killer storm struck Kellerton, Iowa and claimed the life of a man as the tornado reduced his mobile home to a pile of rubble. Shortly before midnight that evening, the most potent tornado of 1984 struck the small community of Barneveld in south central Wisconsin. This tornado was the first twister to reach F5 intensity since 1982 and only the second since 1977. Packing winds estimated in excess of 400 km h^{-1}, it virtually leveled the village's business district as 17 of the 18 businesses and public buildings were destroyed. Nine people were killed and one-third of the town's population of about 600 were injured. Total damage from this storm that tracked on the ground for 57.6 km exceeded $40 million.

Intense thunderstorms raked the Denver, Colorado metropolitan area during the afternoon of 13 June. Although no tornadoes were reported with these storms, heavy rain and large hail that ranged in size from golfball to baseball fell for about four hours. Some spots were pelted with a few hailstones the size of grapefruit. The storm produced an estimated total damage of $300 million, making this the most destructive natural disaster to strike Colorado on record. One person was drowned and 20 were injured by this relentless storm.

The northwest suburbs of Denver were hardest hit. Some areas reported hail 20 cm deep that was blown into drifts 1.8 m high. The walls of one home were so badly weakened by a combination of hail drifts and rain that the house had to be torn down. Damage to vehicles was estimated at $100 million as cars were battered and crumpled by the giant hailstones.

Removal of the huge piles of hail from streets and roads presented serious problems. Snow plows that were called out for this unseasonable task became stuck. Although the temperature climed into the 80s the next day, piles of hail remained along roadways and in shady spots.

Iowa reported 48 tornadoes during the month. That not only broke all records for June, but was more than double the previous record of 22 for any month that was established in May 1971. Nebraska ranked second in the nation with 36. This also set a record for the most in any month and this one month total actually exceeded the annual average of 34. Kansas and South Dakota each reported 20 tornadoes followed by Texas with 19. Sixteen tornadoes in Wyoming were the most ever recorded in June in that state. On the other hand, for the first time since 1978, Tennessee reported none.

g. July

This was the first month since January that the tornado count was less than the monthly average and for the first month since February there were no tornado fatalities. A total of 72 tornadoes were reported. This was the fewest in July since 1974 and well below the normal of 85. Florida, Minnesota and Pennsylvania led the nation with six tornadoes each, followed by five in Colorado and four each in Iowa, Kentucky, Nebraska and Wisconsin. Three tornadoes in Arizona tied the July record that was set in 1968. For the first time since 1972, Massachusetts reported three tornadoes during July, and three in New York tied the monthly record that had stood for 15 years. One tornado in Delaware tied the previous record for July, and Nevada reported the first July tornado since 1973. For the first time since 1957, Texas reported no tornadoes during the month.

h. August

The number of tornadoes continued below normal during August. Forty-seven were reported while 56 is average. Six tornadoes in Colorado tied the previous August record that was set in 1982. A rare August tornado in Idaho tied the monthly record for that state while Utah established an all-time record for any month with a total of five. Michigan had the most twisters during the month. Nine tornadoes tied its August record that was set in 1979.

i. September

Although only 17 tornadoes during the month were less than half the normal of 39 and the fewest in September since 1957, three were strong (F2, F3) in intensity. A F3 tornado produced a path of destruction that stretched over more than 24 km in Michigan on 2 September. A boy was slightly injured by falling debris in Sanilac County as the tornado ripped off the roof of the house in which he lived. On 25 September, an F2 tornado struck 11.3 km east–southeast of North Adams, Michigan and two people were injured as their mobile home was rolled over and crushed by the storm.

The evening before, a strong F2 tornado produced $2.2 million in damage near Wausau, Wisconsin. There were no injuries, but three homes and several farm buildings were leveled by this storm, which also produced hail as large as baseballs.

Kentucky, Louisiana and Michigan each reported two tornadoes in September. This tied the September record in Kentucky that was set in 1976.

j. October

After two months of below-normal tornado activity, October sprang to life and was a near record-breaking month. Forty-nine tornadoes were more than double the normal of 24, and only missed by one the October record of 50 that was set in 1970.

A short-lived, weak (F1) tornado struck the town of Trezevant northeast of Jackson, Tennessee, on 16 October and killed one of three occupants of a mobile home and injured the other two. Debris from the trailer was scattered downwind for nearly two kilometers and the floor and under-carriage were carried nearly one kilometer. This was the first tornado fatality in Tennessee in five years and the first October death since 1917.

On 18 October, a strong (F2) tornado produced an 8-km long path of destruction northeast of Dallas, Texas. Near the town of Argo, two homes were destroyed and one of two people inside was killed and the second seriously injured. About an hour later, this severe weather system spawned an F3 tornado southeast of Ft. Leonard Wood, Missouri that tracked 41.6 km and reached a width of 880 m at one point. As it passed east of Winona, Missouri, a man was killed and his wife injured when a turkey farm was hit. This was the first tornado-related death to occur in Missouri in October since 1958.

On 22 October, very strong thunderstorms produced two tornadoes that hit South Houston, Texas and the suburb of Pasadena. Two hundred units of a 498-unit apartment complex suffered extensive damage as 500 windows were broken by flying debris and hail. These apartments were the same buildings hit by Hurricane Alicia in August 1983.

On the last day of the month, a tornado claimed the life of a woman just south of Topeka, Kansas as the twister destroyed her mobile home and two-car garage. This was the first October tornado fatality in Kansas since 1919.

Missouri reported the most tornadoes with a total of 10, an October record for them. There were six in Texas and Oklahoma (the greatest number in October since 1970) and Kansas, five in Mississippi and four in Arkansas, which tied its previous record set in 1980. Two tornadoes in Wisconsin tied the 1962 record and a tornado in Idaho was the first to ever be reported in that state in October.

k. November

For the second consecutive month, Missouri led the nation in tornado activity. Nine reports during the month were the most tornadoes to strike Missouri in November since 1966. It is interesting to note that this near record breaking number occurred in a 3-hour period on one day—9 November.

One of these storms, a strong F2 twister, produced a 4.8 km track about 80 km southwest of St. Louis, Missouri. Two people in Potosi, who were trying to get from their house to the basement, were caught by the storm. The woman became the 122nd and final tornado fatality of 1984, and the man was seriously injured. This was the first November tornado death in Missouri since 1973.

The month ended with 30 tornadoes reported in the nation. Illinois ranked second with six tornadoes, followed by Alabama with five.

l. December

Only four tornadoes were reported in December. All four were in Texas. On 13 December, a strong thunderstorm produced a tornado that did considerable damage and injured several people in Mesquite, Texas, just east of Dallas. On the last day of the year, a severe weather outbreak in southeast Texas spawned three tornadoes. One of these was a small (45 m wide), but very intense (F2) tornado that hit Pasadena and La Porte. This was the second time Pasadena had been struck in less than three months. This tornado caused 53 injuries and extensive property damage. Gilley's Country and Western Club was directly in the center of the path of this storm. As it moved northeastward through Pasadena, an apartment complex and a medical building immediately southwest of the establishment suffered extensive damage as did the residential area just to the northeast. Miraculously, the tornado seemed to lift as it passed over Gilley's causing only minor damage to the structure. Although a total of four tornadoes for the month was well below the December normal of 20, no records were broken.

3. Noteworthy tornado outbreaks

Previous studies, such as those listed by Ferguson et al. (1983), have documented the importance of relative positioning of various meteorological fields prior to development of tornadoes. Accordingly, real-time depiction of these meteorological fields via composite charts provides a valuable forecasting aid. In the following review of four noteworthy tornado outbreaks that occurred during 1984, such composite charts are presented for times prior to tornado formation. Brief discussions of the progression of meteorological patterns are added.

a. 28 March 1984

The most deadly tornado outbreak of 1984 occurred during the afternoon and evening of 28 March in South and North Carolina. Fifty-seven fatalities and over 1200 injuries occurred as violent tornadoes moved northeastward across this area.

As is evident from the composite chart for 0600 CST on 28 March (Fig. 5), several important meteorological parameters indicative of severe thunderstorms were already in place. Very warm low-level air lay from the Gulf Coast northeastward across Georgia and South Carolina. Warm, dry mid-level air was moving eastward with a strong short-wave trough. Wind speeds (at

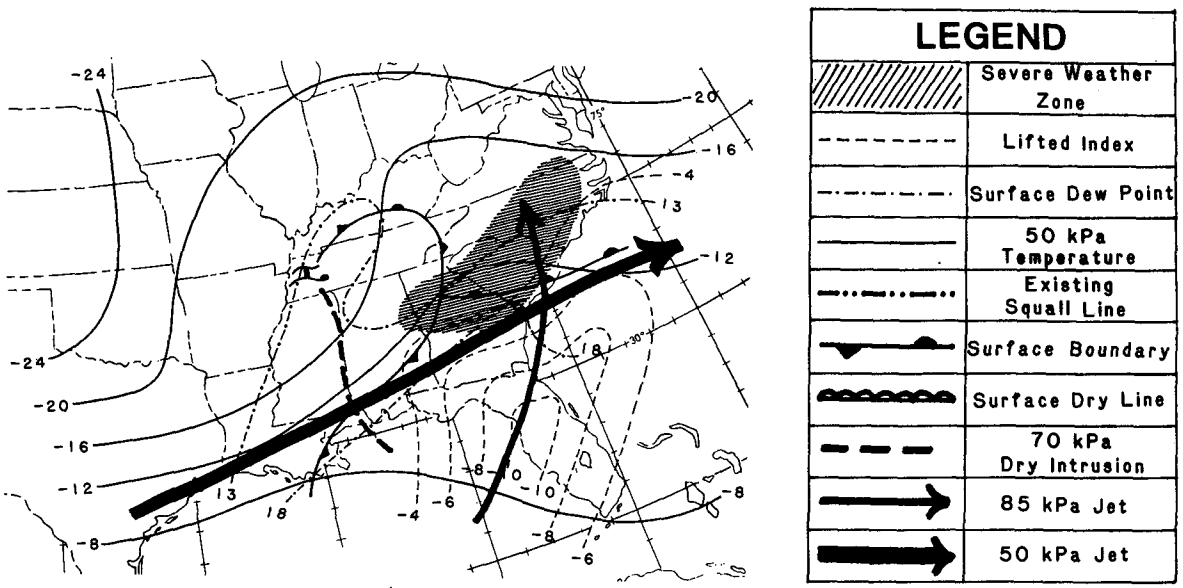

FIG. 5. Composite chart depicting significant synoptic features for 0600 CST 28 March 1984.

a level of 85 kPa) as high as 30 m s^{-1} were observed at Waycross, Georgia, and a polar jet of 75 m s^{-1} at upper levels was approaching from the southwest. Also, a well-defined surface outflow boundary, which had been left behind by previous thunderstorms, trailed westward across South Carolina through southern Georgia into southern Alabama.

Sea level pressures were abnormally low across the Southeast, with a small center of 98.6 kPa located in western Tennessee. The first indication that dramatic changes were occurring was an area of rapid surface pressure falls that moved across central Mississippi into Alabama. A new surface low center formed in early afternoon and deepened rapidly. Around 1300 CST it was near Atlanta, Georgia, which recorded an all-time record low sea level pressure of 97.8 kPa. As this low accelerated rapidly northeastward, a three-hourly pressure fall of 1 kPa was observed at Athens, Georgia. Also, a mesolow formed near the center of the synoptic-scale low. Such an occurrence is rare, but it was also observed during the classic Tri-State tornado in 1925 (Ludlum, 1982). This intense mesolow continued its northeastward movement through North and South Carolina at an unusually high speed. Violent tornadoes developed in its vicinity until it moved off the Atlantic Coast south of Norfolk, Virginia around 2300 CST.

b. 26 April 1984

A widespread outbreak of 30 tornadoes occurred across the Great Plains on 26 April. This outbreak included an F4 tornado at Terlton, Oklahoma that caused three fatalities. A trio of F3 tornadoes occurred. One killed eight persons at Morris, Oklahoma, and another killed one person at Minneapolis, Minnesota. Although the third caused no fatalities, it destroyed or damaged practically every structure in the town of Effingham, Kansas.

During the day a strong north–south cold front was moving slowly eastward across the Great Plains. Several small low-pressure centers moved northeastward along this frontal boundary. As shown by the composite chart for 1800 CST 26 April (Fig. 6), a very strong wind field was evident at all levels, with a wind of 50 m s^{-1} observed at 50 kPa at Amarillo, Texas. The strong low-level southerly winds had transported moist air northward to a warm front across central Minnesota. A broad area of sea level pressure below 99.6 kPa extended from Texas northward to South Dakota and Minnesota, with lowest values of 99.3 kPa and 99.0 kPa in South Dakota and northern Oklahoma, respectively. As a vigorous short-wave trough at 50 kPa rotated northeastward during this period, severe thunderstorms developed in the unstable air ahead of the front. All four of the strong and violent tornadoes occurred well after sunset as the maxima in the vertical motion field associated with the short-wave trough moved over the maximum low-level convergence in the vicinity of the frontal boundaries.

c. 8 May 1984

One of the stronger outbreaks of tornadoes to occur in recent years in the Middle Atlantic states occurred during late afternoon and evening of 8 May. A dozen tornadoes were reported in Maryland (5), Virginia (4), Delaware (2) and North Carolina (1). A killer tornado struck Hurlock, Maryland and other fatalities resulted from high thunderstorm winds in Virginia and New

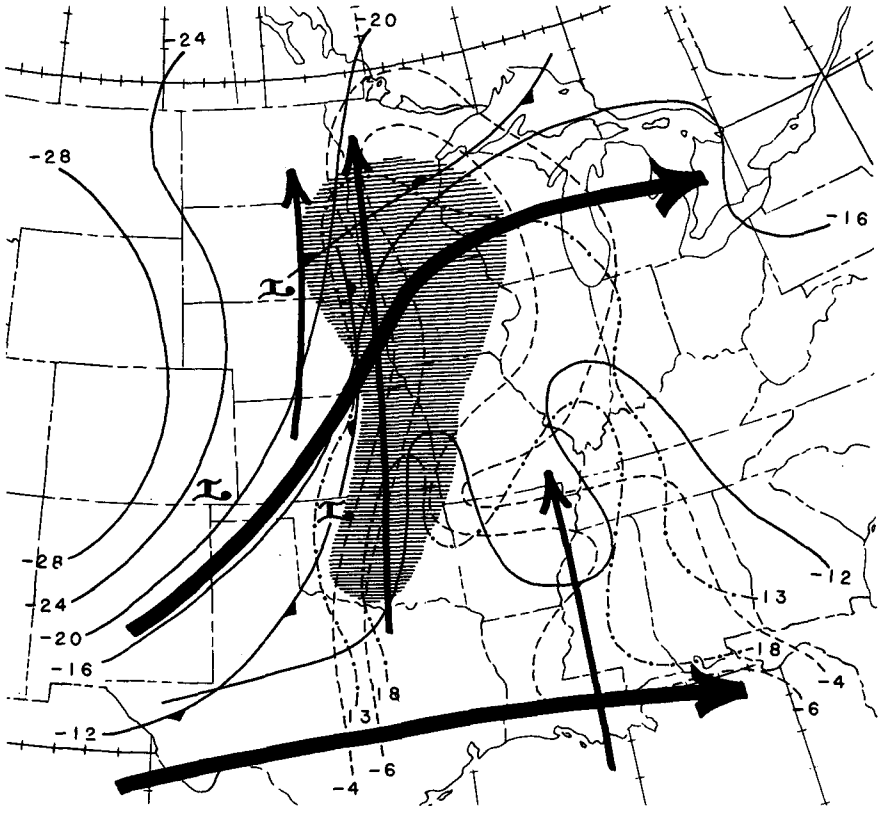

FIG. 6. As in Fig. 5, but for 1800 CST 26 April 1984.

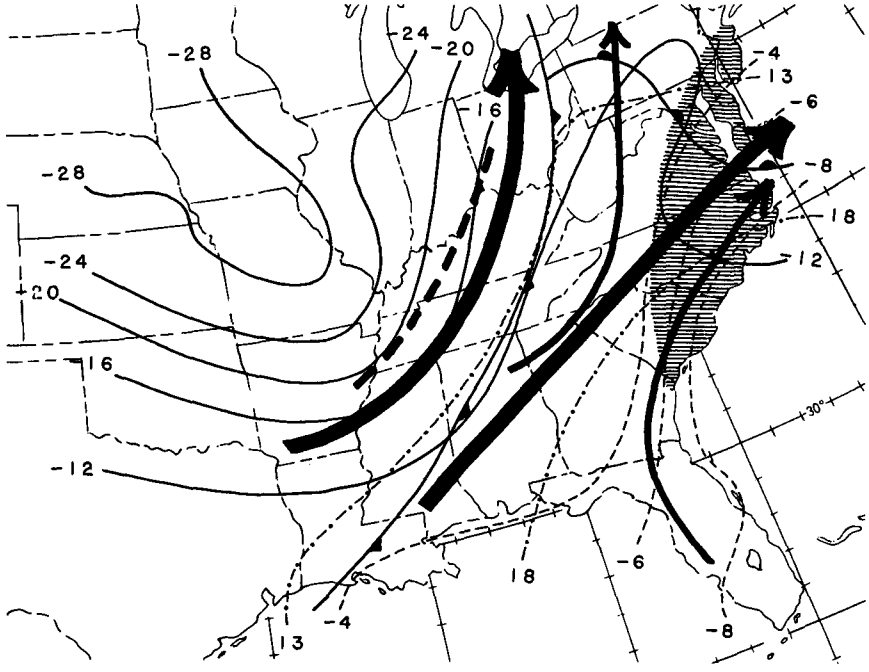

FIG. 7. As in Fig. 5, but for 0600 CST 8 May 1984.

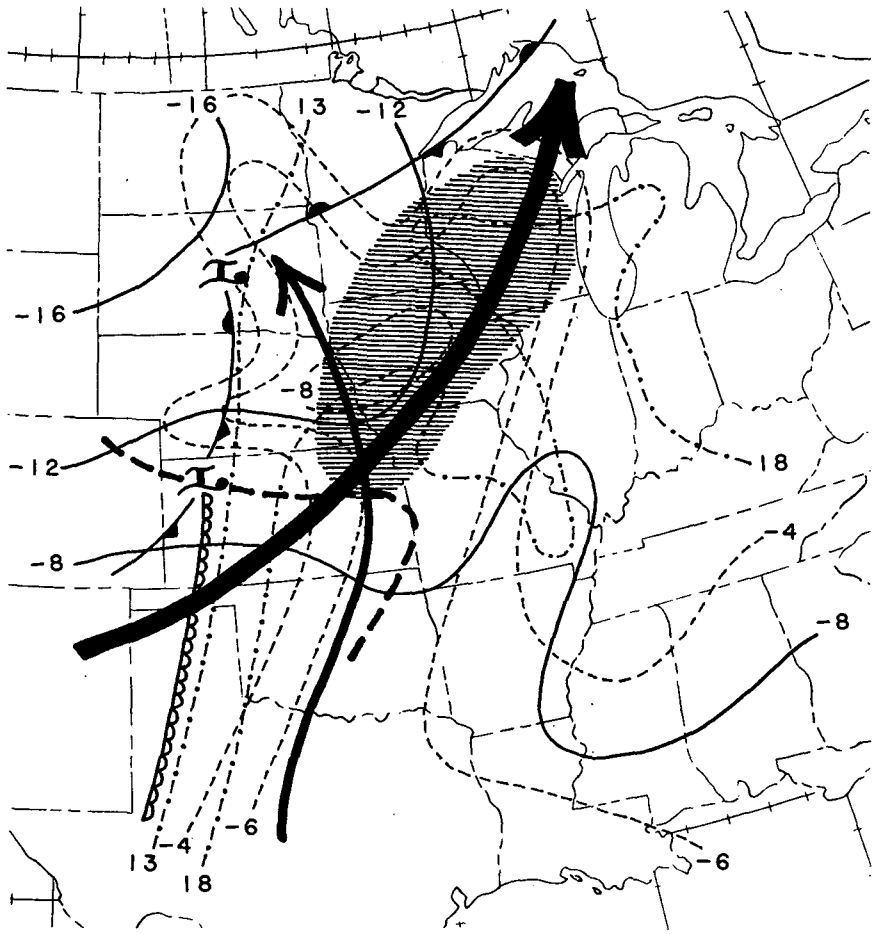

FIG. 8. As in Fig. 5, but for 0600 CST 7 June 1984.

Jersey. Strong F3 tornadoes struck at Petersburg and Hopewell, Virginia. Additionally, over 90 reports of damaging hail or winds were received from South Carolina to New Jersey.

A composite chart for 0600 CST on 8 May is shown in Fig. 7. An intense upper low was moving eastward across the Great Lakes, while a strong trough at 50 kPa was approaching the Atlantic coastal region. At 30 kPa, a southwesterly jet of 75 m s^{-1} lay across western Pennsylvania. A strong low-level jet was indicated by 85 kPa winds of 25 m s^{-1} at Greensboro, North Carolina. Low-level moisture was plentiful over North Carolina and southern Virginia as surface dew points exceeded 15°C. Severe thunderstorms developed as afternoon heating further destabilized the airmass ahead of the strong cold front as it moved eastward from the Appalachian mountains.

d. 7 June 1984

From midafternoon on 7 June until the early morning hours of 8 June, severe thunderstorms produced 43 tornadoes in the upper Midwest. These tornadoes occurred across seven states: Iowa (21), Wisconsin (9), Minnesota (7), Missouri (3), South Dakota (1), Nebraska (1) and Kansas (1). Most of these tornadoes occurred in two clusters. One extended from northwest Iowa into south-central Minnesota, while the other extended from northwestern Missouri to south-central Wisconsin. Included among these tornadoes was one of F4 intensity that traveled along the ground for over 200 km from near Eagleville, Missouri to about 45 km southwest of Iowa City, Iowa. Another was the F5 tornado that devastated Barneveld, Wisconsin. Altogether, these tornadoes caused 13 fatalities and 319 injuries.

A strong, fast-moving short-wave trough moved into the Central Plains during the morning of 7 June. An associated surface low deepened to a pressure of 99 kPa in eastern Nebraska and moved to northern Minnesota by 2400 CST. As depicted in Fig. 8, the composite chart for 0600 CST on 7 June, the air mass drawn northward ahead of the surface low and trailing cold front was very unstable. Lifted index values of less than

−6 covered a large area of the Central Plains, the lowest being −9 at Omaha, Nebraska. At 85 kPa a southwesterly jet of 25 m s^{-1} at Topeka, Kansas continued to advect warm moist air northward. Dew points (at 85 kPa) at Omaha, Nebraska and Green Bay, Wisconsin were 16°C and 15°C, respectively. Surface dew points exceeded 18°C as far north as central Wisconsin. Afternoon heating produced strong convection in the unstable air mass ahead of the cold front. These storms were further enhanced by the approach of an intense upper level jet (55 m s^{-1} at 25 kPa over Colorado) and a diffluent wind pattern from Nebraska to Wisconsin.

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