Service Assessment

Southeastern United States Tornadoes
April 8, 1998




U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service
Silver Spring, Maryland

Cover:

Tornado damage in Jefferson County, Alabama. Photographs courtesy of Bob Chartuk, Bohemia, New York.

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U.S. DEPARTMENT OF COMMERCE
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National Oceanic and Atmospheric Administration
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National Weather Service
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National Weather Service - Southern Region
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PREFACE

On the evening of April 8, 1998, tornadoes powerful as F5 on the Fujita Scale swept through the northern half of Mississippi, Alabama, and Georgia causing considerable loss of life, injuries and property loss. The National Weather Service's Southern Region Headquarters in Ft. Worth, Texas, coordinated a Regional Service Assessment Team to review the operations and effectiveness of products and services provided during the event by NWS offices at Memphis, Tennessee; Birmingham, Alabama; and Atlanta, Georgia.

The assessment team consisted of Team Leader Andy Anderson, Meteorologist in Charge of NWSFO Lubbock, Texas; NWS Eastern Region Public Affairs Officer, Bob Chartuk; NWSO Melbourne, Florida, Warning Coordination Meteorologist, Dennis Decker; Steve Hunter, Science and Operations Officer at NWSO Morristown, Tennessee; Jim Stefkovich, Warning Coordination Meteorologist, NWSFO Fort Worth, Texas; and Joe Baxter, Emergency Management Agency Director for Lawrenceburg/Lawrence County, Tennessee.

The National Weather Service thanks the Emergency Management and News Media personnel who generously assisted the Assessment Team during the trying and busy period that followed this disaster. Most of all, we appreciate the storm survivors for their willingness to relate their experiences; often while standing in their devastated neighborhoods. Thanks are also due the staff of NWSFOs Birmingham, Atlanta and Memphis for their help and support of this assessment. The team members are commended for their willingness to respond, and for the hard work both in the field and in the preparation of this Service Assessment Report.

X. William Proenza
Acting Director, Southern Region Headquarters

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ACRONYMS AND ABBREVIATIONS

AFOS	Automation of Field Operations and Services
ASOS	Automated Surface Observing System
AWIPS	Advanced Weather Interactive Processing System
CAPE	Convective Available Potential Energy
dBz	Decibels (with respect to reflectivity Z)
EAS	Emergency Alert System
EMA	Emergency Management Agency
FEMA	Federal Emergency Management Agency
HMT	Hydrometeorological Technician
J/Kg	Joules/Kilogram
Kg/M^2	Kilogram/Square Meter
mb	Millibar
MIC	Meteorologist In Charge
m/s	Meters per second
N-AWIPS	National Centers-Advanced Weather Interactive Processing System
NAWAS	National Warning System
nm	Nautical Mile
NOAA	National Oceanic and Atmospheric Administration
NWR	NOAA Weather Radio
NWS	National Weather Service
NWSFO	NEXRAD Weather Service Forecast Office
NWWS	NOAA Weather Wire Service
PRF	Pulse Repetition Frequency
PUP	Principal User Processor
RAMSDIS	(RAMM [Regional and Mesoscale Meteorology] Advanced Meteorological Satellite Demonstration and Interpretation System)
Rmax	Maximum Unambiguous Range
ROAMS	Remote On-Air Monitoring System
RPS	Routine Product Set
SAME	Specific-Area Message Encoder
SOO	Science and Operations Officer
SPC	Storm Prediction Center
UTC	Coordinated Universal Time
VCP	Volume Coverage Pattern
VIL	Vertically Integrated Liquid Water Content
WCM	Warning Coordination Meteorologist
WSR-88D	Weather Surveillance Radar-1988 Doppler (NEXRAD)

FUJITA TORNADO INTENSITY SCALE

Category	**Definition-Effect**
(F0)	Gale tornado (40-72 mph): Light damage. Some damage to chimneys; break branches off trees; push over shallow-rooted trees; damage sign boards.
(F1)	Moderate tornado (73-112 mph): Moderate damage. The lower limit is the beginning of hurricane wind speed; peel surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads.
(F2)	Significant tornado (113-157): Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
(F3)	Severe tornado (158-206 mph): Severe damage. Roofs and some walls torn off well-constructed homes; trains overturned; most trees in forest uprooted; heavy cars lifted off ground and thrown.
(F4)	Devastating tornado (207-260 mph): Devastating damage. Well-constructed houses leveled; structure with weak foundation blown off some distance; cars thrown and large missiles generated.
(F5)	Incredible tornado (261-318 mph): Incredible damage. Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile-sized missiles fly through the air in excess of 100 yards; trees debarked; incredible phenomena will occur.

ASSESSMENT SUMMARY

The Event

In the late afternoon of Wednesday, April 8, 1998, severe thunderstorms quickly developed over Mississippi, Arkansas and southwest Tennessee. During the evening, some of the more powerful storms generated tornadoes that caused massive property damage and loss of life along a path from northeast Mississippi through central Alabama into northern Georgia. Hardest hit were Jefferson and St. Clair Counties in the Birmingham, Alabama, Metropolitan area. In the wake of these storms, 36 people lost their lives, 273 were injured and property damage was estimated at over $300 million.

While this Service Assessment documents events and services along this three state corridor, the bulk of the report is directed to the massive destruction and loss of life in Alabama and the services provided by NWSFO Birmingham.

The widespread catastrophic damage in Jefferson County, caused by winds in excess of 260 miles per hour and a damage path up to 3/4 of a mile wide, prompted visits to Birmingham from President Bill Clinton and Vice President Al Gore. The affected counties were declared disaster areas and drew emergency responses from the Federal Emergency Management Agency, Department of Labor, Small Business Administration, National Guard, Red Cross, numerous volunteers, and dozens of state and local agencies.

This path of destruction began about 6:30 p.m. CDT with one storm fatality in Pontotoc County, Mississippi, and ended near midnight with a death in De Kalb County, Georgia. The storms killed 34 people in Alabama—32 in Jefferson County and 2 in St. Clair County. Some of the tornadoes produced tracks greater than 30 miles long. The most intense tornado, an F5—one of the worst in Alabama history—moved through Jefferson County destroying more than 1,100 permanent homes and damaging almost 1,000 more.

This was a well forecast event. Widely disseminated NWS releases throughout the day increased public, local government and media awareness that there was an unusually high threat of severe weather. The Storm Prediction Center (SPC) forecast a high risk of severe storms for the northern half of Mississippi and Alabama, and northwest Georgia. Thunderstorm Outlooks from NWSFOs Memphis, Birmingham and Atlanta all emphasized the likelihood of a significant severe weather outbreak. Severe storms were also reflected in the Zone Forecasts throughout the day.

Emergency management and the media told the Service Assessment Team they were in a state of high alert and Emergency Operations Centers were open and functioning when storm warnings were posted. Some television meteorologists met with station management that afternoon to

advise that severe weather coverage was likely, as was the disruption of regular programming for on-air warnings and updates. One TV meteorologist visited the Birmingham NWS office on the way to work. He said when he left the office, "I felt part of the team," and upon arriving at work, briefed station management and prepared graphics on severe weather safety rules.

The SPC issued the first Tornado Watch (#188) at 2:00 p.m. CDT for northern and central Mississippi and northern and central Alabama, valid until 8:00 p.m. All meteorological ingredients were in place for supercell storms, but a strong 700 mb capping inversion delayed convection in the western part of the watch area until late in the afternoon. Once convection began, it was explosive and fast moving. Tornado Watch #188 was replaced by Tornado Watch #194 at 7:30 p.m. CDT for the same general area of Mississippi and Alabama, valid until 2:00 a.m. CDT. In Georgia, Tornado Watch #192, issued at 7:36 p.m. EDT, covered the northern half of the state until 2:00 a.m., April 9. At 1:15 a.m. EDT, it was replaced by Tornado Watch #196, which was valid for essentially the same area until 7:00 a.m. EDT.

This was not an event where an office could focus on a few severe storms. Supercell thunderstorms were widespread, especially in central and northern Alabama. Almost 300 severe storm warnings were issued by NWSFOs Memphis, Birmingham and Atlanta on April 8. The offices' staffs were extremely busy. NWSFO Birmingham had been working severe weather periodically since mid-morning.

During the evening, warnings were required in Alabama for many areas outside of what later proved to be the main path of destruction through Tuscaloosa, Jefferson, and St. Clair Counties. At the height of the event, NWSFO Birmingham issued 28 warnings from 7:01 p.m. to 8:49 p.m. CDT. Fourteen warnings were required between the 7:01 p.m. CDT Tuscaloosa County Tornado Warning and the 7:45 p.m. Tornado Warning for Jefferson County. Another 14 warnings were issued between the Tornado Warning for Jefferson County and the 8:49 p.m. Tornado Warning for St. Clair County. Additional warnings for these same three counties were needed later in the evening as other severe storms moved across this already damaged area.

The heavy and fast-paced workload required call back and the granting of overtime for employees. During the peak of the event, staffing levels at NWSFO Birmingham and Atlanta rose to 10 people, a significant percentage of their total contingent of meteorologists and hydrometeorological technicians. Both MICs stated they could have used more people. Additional off duty people were called for assistance but could not be reached.

All three NWS field offices involved in this event performed very well. In the Birmingham area, a review of the mesocyclone track across county lines indicates approximately 4 minutes of lead time for the first Tuscaloosa County tornado—an F2— and 41 minutes for the second tornado that would move into Jefferson County. There were 8 minutes of lead time for the Jefferson County warning. Lead time for the area where the first fatalities occurred in Jefferson County

was approximately 15 minutes. For St. Clair County, the tornado warning lead time was 7 minutes, and for the two fatalities about 23 minutes.

Clearly, the warning system worked well. As one Birmingham weathercaster said, "Everyone was on board on this one and did an outstanding job," referring to Emergency Management, media and the NWS. In the Birmingham area, timely and accurate NWS warnings were widely disseminated by Emergency Management and the news media. Sirens were sounded where they existed. Some television stations preempted regular programming for "wall-to-wall" storm coverage for hours. Many radio stations carried the warnings and broke into programming with frequent updates. The NWS warnings, response by Emergency Management, and excellent media dissemination and coverage were credited with saving numerous lives.

Prior outreach and coordination efforts by the NWS were cited as important factors in helping residents and officials develop tornado response plans and react appropriately as the tornadoes approached. The team talked to many survivors who took the proper protective actions. Upon hearing the Jefferson County Tornado Warning on NWR and TV, one couple in a mobile home ran two doors down to a friend's wood frame home. They took shelter and survived unhurt, but their mobile home was completely destroyed. There were numerous other instances of people hearing the warnings, taking the proper protective actions, and surviving the storm with injuries. But for some, even taking the proper precautions was not enough because of the destructive power of the tornadoes that moved through Jefferson and St. Clair Counties.

Service Assessment Team Strategy

The Service Assessment Team assembled at NWSFO Birmingham, Alabama, on Monday, April 13. The Birmingham Warning Coordination Meteorologist (WCM) and Science and Operations Officer (SOO) had prepared information packages for each team member and presented an extensive overview of the Alabama event. Later, the team met individually with staff who had worked the event. Arrangements were made for a telephone briefing the following morning from the Atlanta NWS office.

Following the telephone briefing on the storms that moved through north Georgia, the team spent Tuesday examining the path of destruction through Jefferson County and talking to survivors. There were meetings with more Birmingham staff late in the day. A decision was made to send two team members to Georgia on Wednesday morning. At that time, five people were thought to have died in the tornadoes near Atlanta. During their visit, storm deaths were revised from five to one. The other four deaths were in a fire that officials decided was not storm related. The two team members returned to Birmingham Thursday evening.

The team spent the remainder of the week in the Birmingham area, meeting with news media, Emergency Management, and NWS staff, visiting Jefferson and St. Clair Counties and working toward a rough draft. The team departed for home Saturday afternoon, April 18.

FACTS, FINDINGS AND RECOMMENDATIONS

Observations

FACT A: The Birmingham office used data from four WSR-88D radars. These are at Alabaster (KBMX), Hytop (KHTX), and Maxwell AFB (KMXX), Alabama, and Columbus AFB, Mississippi (KGWX). The Atlanta office utilized the Peachtree City (KFFC), and Robins AFB (KJGX) Georgia radars, as well as KHTX. The Memphis office used KGWX and the Memphis WSR-88D (KNQA). These were the primary sources of data for the issuance of warnings. All radars were fully operational throughout this event. Major supporting data systems, including N-AWIPS, ASOS, AFOS, and RAMSDIS, were also operational.

FACT B: The signatures of rotation on all the radars were strong, persistent, and unmistakable across Alabama and Georgia. These signatures included intense and deep mesocyclones, gate-to-gate shears, bounded weak echo regions, and hook echoes. The supercells that produced the tornadoes were long-lived and had long tracks. NWSFO Memphis also noted strong rotation and reflectivity in the storm that produced deadly straight-line thunderstorm winds in Mississippi.

Finding 1: At NWSFO Atlanta, narrowband load shedding developed on the KJGX Principal User Processor (PUP), leading to the loss of some radar data. This was solved by changing the Volume Coverage Pattern (VCP) from 11 to 21. An abbreviated Routine Product Set (RPS) and dialup macro for load shedding situations were available but not used.

Recommendation 1: Ensure the NWSFO Atlanta staff is aware of the abbreviated RPS and dialup macro so that they may be used during load shedding, without resorting to VCP 21 (which has decreased vertical sampling).

Guidance

FACT C: NCEP numerical model performance accurately highlighted the severe weather threat, indicating moderate-strong instability (e.g., CAPE up to 1500 J/kg) and extremely high environmental potential for rotating supercells and tornadoes (e.g., storm relative helicity up to 700 $[m/s]^2$). Although other models located the threat area well, the Eta model forecast the strongest parameters related to the intensity of severe weather.

FACT D: Early on the afternoon of April 8, the SPC followed up by issuing a **high risk** of severe thunderstorms for most of the northern and central parts of Mississippi, Alabama and Georgia during the evening. A large moderate risk area surrounded the high risk zone, covering most of the rest of the named states.

Predictions

FACT E: The three NWSFOs portrayed the seriousness of the event early and accurately. NWSFO Memphis communicated an early awareness of the threat, noting the high risk area in their 4:51 a.m. CDT Hazardous Weather Outlook. They notified emergency managers who opened emergency operations centers early on April 8. NWSFO Birmingham issued a Hazardous Weather Outlook as early as 5:15 a.m. CDT, stating that "...INGREDIENTS ARE COMING TOGETHER FOR AN EXTENDED SEVERE THUNDERSTORM EPISODE OVER PORTIONS OF NORTHERN AND CENTRAL ALABAMA TODAY AND TONIGHT." A subsequent Special Weather Statement at 6:30 a.m. CDT mentioned the likelihood of supercells and accompanying strong tornadoes.

Forecasts issued by NWSFO Atlanta also clearly indicated the severe threat well in advance. The zone forecasts for northern Georgia, issued about 4:00 a.m. CDT, mentioned "TONIGHT... SHOWERS AND THUNDERSTORMS LIKELY. SOME STORMS MAY BE SEVERE." The accompanying State Forecast Discussion alluded to the SPC outlook of severe storms, and the high risk in northwest Georgia, in the forecast reasoning. At 9:38 a.m. EDT, the NWSFO issued a Hazardous Weather Outlook that stated "THERE IS A MODERATE TO HIGH RISK OF SEVERE THUNDERSTORMS FOR NORTH AND WEST CENTRAL GEORGIA TODAY INTO TONIGHT."

FACT F: A tornado warning was in effect for Pontotoc County, Mississippi, prior to the time of the lone fatality. Eyewitness accounts vary as to when the storm struck, but warning lead time for the severe thunderstorm was between 6 and 20 minutes. The fatality occurred in a mobile home with the damage attributed to severe thunderstorm winds near 85 miles an hour.

Finding 2: At the Birmingham office, 110 county warnings were issued in 21 hours. Several staff members worked beyond their scheduled shifts to help. In addition to their regular duties, the Atlanta office issued 183 county warnings from April 8 through the morning hours of April 9, with a number of the staff interpreting WSR-88D data for 8 hours or longer. Additional off-duty staff members were called for assistance but could not be reached. There was consensus at both offices that their current "bulge staffing" levels were barely adequate to handle such a severe weather outbreak. Further staff reduction would greatly limit the pool of people to recall to duty. The Southeast United States is such an area where severe convective weather may strike during any season.

Recommendation 2: The NWS should continue the careful review of the end-state staffing required to achieve an adequate workforce, especially in areas of the country that are prone to numerous severe weather episodes.

FACT G: Listed below are the tornado warnings and lead times for counties relevant to this report in Alabama and Georgia.

ALABAMA

COUNTY	TYPE	START	END	LEAD TIME
Pickens	TOR	6:26 p.m.	7:15 p.m.	35 min

An F2 tornado touched down about 1 mile south of Gordo in Pickens County at 7:01 p.m. CDT.

Tuscaloosa	TOR	7:01 p.m.	7:50 p.m.	4 min
Tuscaloosa	TOR	7:01 p.m.	7:50 p.m.	41 min

The F2 tornado moved from Pickens County into Tuscaloosa County about 2 miles north of Highway 82 at 7:05 p.m. The tornado lifted, and an F5 tornado touched down in the eastern part of Tuscaloosa County about 5 miles northwest of Kellerman at 7:42 p.m. Lead time on this second tornado was 41 minutes.

Jefferson	TOR	7:45 p.m.	8:35 p.m.	8 min

At 7:53 p.m., the F5 tornado moved into Jefferson County along Highway 15/59 about 9 miles west southwest of Oak Grove. The tornado remained on the ground for 30.6 miles. It lifted at 8:30 p.m. in Jefferson County in the north part of Birmingham, 3 miles north of Interstate 20 along Highway 78. Path width was up to 3/4 mile.

St. Clair	TOR	8:49 p.m.	9:35 p.m.	7 min

An F2 tornado touched down in St. Clair County near Twin Lake and Highway 411 at 8:56 p.m. The tornado moved east northeast for 14.4 miles and lifted about 8 miles north of Riverside. The average width was 200 yards. The two fatalities occurred at 9:12 p.m. near Mt. Mariah and Highway 231 with a warning lead time of about 23 minutes.

GEORGIA

Haralson	TOR	11:29 a.m.	12:00 a.m.	1 min

At 11:30 p.m. EDT, an F1 tornado touched down just west of Tallapoosa and traveled 3.5 miles damaging 30 buildings, including mobile homes, churches and a strip mall.

Cobb	TOR	12:07 a.m.	12:45 a.m.	13 min
Fulton	TOR	12:23 a.m.	1:00 a.m.	12 min

At 12:20 a.m., an F2 tornado touched down in Cobb County near Smyrna and moved into Fulton County at 12:35 a.m. The tornado produced a 3-mile-long track and damaged 30 buildings, including heavy damage to a service station.

De Kalb	TOR	12:31 a.m.	1:00 a.m.	4 min
Gwinnett	TOR	12:31 a.m.	1:00 a.m.	8 min

At 12:35 a.m., an F2 tornado touched down in De Kalb County 1 mile southeast of Dunwoody and moved into Gwinnett County at 12:39 a.m. The tornado traveled 19 miles and damaged 5,000 homes. Path width was .4 of a mile. One person was killed in De Kalb County when a tree fell on a home.

Finding 3: Personnel at NWSFO Memphis made at least one telephone call to NWSFO Birmingham as the severe storms in Mississippi approached the Alabama state line. The Memphis office usually maintains a telephone log during severe weather, but some calls were not logged in this event.

Recommendation 3: NWSFO Memphis should reemphasize the policy of maintaining telephone logs during severe weather events.

FACT H: Severe weather operations plans were in place at the three NWS offices. Everyone interviewed indicated that they were followed closely prior to, and during, this episode. The plans contain information for different staffing levels depending on the severity of the outbreak.

FACT I: There were at least three coordination calls from/to NWSFO Birmingham prior to the tornadic storms moving into Georgia from Alabama. NWSFO Birmingham informed the Atlanta office that a supercell storm with a history of tornadoes and casualties in Alabama was moving toward western Georgia. Moreover, dialup data requests from Alabama WSR-88D radars (KHTX and KMXX) clearly showed a mesocyclone and other tornadic signatures with these storms, giving NWSFO Atlanta a clear picture of the tornadic potential well before the storms moved into Georgia.

FACT J: The Southeast River Forecast Center (SERFC) and NWSFO Atlanta are co-located. Two SERFC staff members assisted the NWSFO during this event, constructing dialup user functions at their PUP in the RFC for acquisition of WSR-88D data from two eastern Alabama radars (KHTX and KMXX). These data helped provide early warning of the tornadic potential of storms just crossing from Alabama into the NWSFO Atlanta County Warning Area, particularly for the storm that produced a tornado in Haralson County near Tallapoosa. This is an excellent example of an RFC and NWSFO working effectively as a team during an emergency event.

External Coordination and Dissemination

FACT K: All surveyed counties affected by tornadoes in northern Mississippi, northern Alabama and northern Georgia are covered by NOAA Weather Radio (NWR) broadcasts from the Memphis, Birmingham and Atlanta NWS offices, respectively. Warnings are coded on the Specific Area Message Encoder (SAME) for input into the Emergency Alert System (EAS) and are given the 1050 MHZ tone.

FACT L: Emergency management agencies and the electronic media affected by the event in northern Mississippi, northern and central Alabama and northern Georgia were aware of the threat of severe weather well before it occurred and received warnings in a timely manner. This included information received through both private vendors and/or NWR.

FACT M: All of the television stations interviewed that serve north Mississippi, north Georgia and central and north Alabama received and disseminated severe weather information in a timely manner. They had high praise for the Memphis, Birmingham and Atlanta NWS offices.

FACT N: NWR broadcasts were available for Pontotoc County, Mississippi. Local television stations carried the tornado warning, and the SKYWARN spotter net was activated.

FACT O: A number of spotter training sessions were held in northern Mississippi during the past year, including two sessions in Pontotoc County between December 1997 and March 1998.

FACT P: The Pontotoc Emergency Management Agency (EMA), Rescue personnel, American Red Cross and media all commended NWSFO Memphis for their performance during this event.

Finding 4: Use of the EAS system in an automatic override mode allowing the NWR voice on radio or television is done on a volunteer basis. The Service Assessment Team was told by the personnel at almost every interviewed radio and television station in Alabama that they were pleased with the human voice broadcasts but would not allow the synthetic voice to override their system. They found it too offensive and difficult to understand.

Recommendation 4: The NWS should procure an artificial voice for CRS that is more acceptable to the media and general public.

FACT Q: Amateur Radio Operators are incorporated into the Birmingham NWS warning and verification process. They are able to receive incoming reports via UHF and VHF repeater systems as well as through a packet radio Internet system.

FACT R: The victims interviewed in Alabama received the tornado warning information by various methods. Most people were aware of the approaching tornado by seeing warnings on television. All of the television stations serving the area carried the basic warning information. Several stations stopped all regular programming and commercials and were totally dedicated to severe weather coverage. Many people took shelter when they heard the outdoor sirens or an

alarm from NOAA Weather Radio. There were numerous instances where the warning was relayed to others by a telephone call from a relative or friend.

FACT S: At every Alabama media and emergency management location the Service Assessment Team visited, we found evidence of an excellent and long-standing working relationship between the organization and the Birmingham NWS WCM. Many counties have spotters who receive dual spotter certification: one from the local county EMA office and one as an NWS SKYWARN spotter.

FACT T: From interviews by the Service Assessment Team with the Birmingham NWS staff, it was apparent that the Console Replacement System (CRS) played a large part in the office's success during the event in the following ways:

(1) CRS automatically selected the proper consoles to be alerted for each individual and multiple county warning. The Birmingham NWS operates 13 transmitters.

(2) At the height of the severe weather event, both CRS consoles were staffed, which allowed two warnings to be recorded at the same time. This enabled the staff to stay on top of the rapidly changing warning situation.

(3) CRS automated the removal of outdated warnings as they expired.

Finding 5: Individual tornado warnings issued by the Birmingham NWS office for Chambers, Cleburne, Jefferson, Marshall, Pickens, Shelby, Tuscaloosa, Walker, and Winston Counties stated a "possible tornado" in the body of the text. Numerous other tornado warnings issued by the office stated, "developing tornado" or "tornado." The Weather Service Operations Manual discourages the use of "possible tornado" which implies a degree of uncertainty that may lead to complacency by the customer.

Recommendation 5: The phrase "possible tornado" should not be used in a warning.

FACT U: Amateur Radio Operators are incorporated into the Atlanta NWS warning and verification process and provide pertinent information to the staff. The Amateur Radio Operation area has a color monitor slaved to the WSR-88Ds that allows visual identification and efficient placement of field spotters. This is especially important for fast moving storms, as was the case in this event.

Finding 6: With the exception of Haralson County, NWR reception in the northwest Georgia counties is good. NWR broadcasts for Haralson County originate from the Birmingham NWS through the transmission tower located at Mt. Cheaha, Alabama. Haralson County is not within range of a transmission tower operated from the Atlanta NWS. Due to NWR tower locations and hilly terrain features, most of Haralson County has spotty NWR reception.

Recommendation 6: Review NWR service to Haralson County, assess what NWS office would be the most logical to provide programming, and charge that office with exploring local partnerships to expand service.

Finding 7: Two transmitters in north Georgia, located at Athens and Chatsworth, broadcast on a frequency of 162.400 MHZ, with broadcasts tailored for each specific site. In the area between both transmitters, some weather radios receive broadcasts not intended for their location. Thus, some people are not receiving relevant information for their particular county. Possible fixes include the NWR Expansion Program and technical adjustments at the Athens and/or Chatsworth transmitter and antenna sites.

Recommendation 7: SRH/NWSFO Atlanta should explore possibilities to resolve the problem of overlapping transmissions.

FACT V: The victims interviewed in Georgia were aware that storms were moving into their area. However, due to the time of this tornado outbreak, many people were in bed sleeping, and neither owned a weather radio nor had extensive knowledge of the NWR broadcasts and warning alarm features.

FACT W: The Peachtree City NWS has aggressively promoted NWR for a number of years in a variety of outreach initiatives.

Finding 8: Even if they personally received little or no advanced warning for the tornadoes, proper safety actions were generally taken by moving to the lowest floors and interior rooms or hallways. In this instance, the warning alarm feature of NWR had great potential to alert people of the oncoming storms.

Recommendation 8: Even with extensive local promotion of NWR, it is evident that many of the public still do not know of this potentially life-saving tool. Assistance is needed at the NWSH/Public Affairs level to ensure that the NWR program, and its promotion, is a high priority.

Finding 9: Very few of the Severe Thunderstorm Warnings issued by the Atlanta NWS contained information on the specific threat from the storms. This information can help customers better gauge the degree of impact from a particular storm.

Recommendation 9: NWSFO Atlanta should make every attempt to provide information on the hail size and/or straight-line wind speeds that the storm is expected to produce.

FACT X: The Atlanta NWS has 93 counties in its County Warning Area (CWA). Since it is very difficult for one individual such as the WCM to provide personalized service for each county, the office has set up an "Adopt-A-County" program. A number of forecasters and HMTs are each responsible for being the main contact point for a subset of the CWA, allowing for personalized customer service.

Response

FACT Y: The team talked with many Emergency Management and news media personnel in Tuscaloosa, Jefferson and St. Clair Counties. Without exception, all were very complementary of the services and performance of NWSFO Birmingham during this event.

FACT Z: A 16-year-old and his sister heard the tornado warning for Pontotoc County, Mississippi, on a Memphis television station. The sister took shelter next door in the grandparents permanent home. Her brother remained in the mobile home and was killed.

FACT AA: As tornado warnings were issued for Pickens and Tuscaloosa Counties, EAS messages were scrolled on the Tuscaloosa television station. The Tuscaloosa County EMA Director called the Birmingham NWS office for tornado track information so he could activate the proper siren systems in the county.

FACT BB: A man in a double wide mobile home heard the tornado warning for Tuscaloosa County, Alabama, on NOAA Weather Radio. He moved to a shelter buried near his home. The home was destroyed, but he was not injured.

FACT CC: Bethany Baptist Church was practicing for their Easter services. They heard the tornado warning for Tuscaloosa County over NWR and a County Emergency Management Agency radio warning system. Everyone moved to the basement. The building was badly damaged, people were injured and many were trapped for a period of time. No one was killed.

FACT DD: The University of Alabama Campus Police had time to notify campus dormitories, and many students were moved to safer sections of the buildings. The tornado passed a few miles to the north of the campus and the City of Tuscaloosa.

FACT EE: Services were ongoing at the Gary Wood Assembly Church in Jefferson County. A member watching television at home called the church about the tornado warning. The people moved to the basement about 15 minutes before the tornado destroyed much of the building. There were some injuries, but no one was killed.

FACT FF: A man was at his father's house when he heard the Jefferson County Tornado Warning on television. He took shelter in a dugout under the house his father had constructed. As a child, he and his family took shelter there during threatening weather, but he always went under protest. After riding out the storm in the shelter, he pulled three neighbors from the wreckage. One woman likely would have bled to death without his help.

FACT GG: Six people were in a café. They heard the Jefferson County Tornado Warning on a Birmingham radio station and took shelter in the part of the building they believed afforded them the most protection. The tornado hit 10 minutes later and all survived.

FACT HH: The two fatalities in St. Clair County occurred in a mobile home. The survivor, a 3-year-old girl, was found inside a clothes dryer more than 250 yards from her home. Her parents apparently placed her in the dryer before attempting to ride out the storm in their home.

Finding 10: The Service Assessment Team was at the location where the President was to visit the following day. The FEMA advance team was on-site making preparations for the visit. The Service Assessment Team suggested the NWS should be included with those whom the President would recognize. The following day when the President appeared, FEMA had arranged for survivors, all chief TV weathercasters, emergency managers, utility crews and volunteers to be recognized. No NWS representative was present.

Recommendation 10: In future similar events, the NWS should be represented and identified as playing a key role in the warning process. NWS Public Affairs should call this to the attention of FEMA Public Affairs. If this does not prove successful, a meeting between NOAA/NWS and FEMA senior managers should be arranged to discuss the issue.