Service Assessment

Central Florida Tornado Outbreak
February 22-23, 1998

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

Cover: Aerial view of the Ponderosa RV park in Kissimmee, Florida, showing a narrow path of nearly total destruction. Three permanent structures in the park (office, laundry, shower/bath house) provided safe shelter. However, numerous fatalities occurred in this park. Photo courtesy of Robert Sheets.

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U.S. DEPARTMENT OF COMMERCE
William M. Daley, Secretary

National Oceanic and Atmospheric Administration
D. James Baker, Administrator

National Weather Service
John J. Kelly, Jr., Assistant Administrator

Preface

The devastating tornadoes that struck central Florida the night of February 22-23, 1998, resulted in a decision by the National Weather Service (NWS) to conduct a Service Assessment. Service Assessments and their subsequent reports are used by the NWS to examine the performance of its offices in providing timely warnings, accurate forecasts and other services to enable the public to minimize loss of life and property damage.

The findings and recommendations developed by the Service Assessment Team will be incorporated into the ongoing process of improving NWS products and services to the citizens of the Nation.

John J. Kelly, Jr.
Assistant Administrator for
Weather Services

June 1998

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Service Assessment Team

The NWS assembled this Service Assessment Team to analyze the overall warning process and to evaluate the services provided by the NWS to the state, county and local governments; the media; and the public in Florida. The team traveled to Florida for the period February 25 - March 2, 1998. Team members collected information and interviewed the Next Generation Weather Radar (NEXRAD) Weather Service Office (NWSO) Melbourne staff; state, county and local emergency management personnel; law enforcement; other local officials; the media; and residents of the impacted areas. Additional information was collected from the Storm Prediction Center (SPC) and Weather Service Headquarters (WSH). All of the information was then compiled and evaluated culminating in this report.

The team was comprised of the following individuals:

Lynn P. Maximuk	*Team Leader*, Meteorologist in Charge (MIC), NWSO Pleasant Hill, Missouri
Donald W. Burgess	Chief, Operations Training Branch, Operational Support Facility (OSF), Norman, Oklahoma
Gary R. Woodall	Warning Coordination Meteorologist (WCM), Meteorological Services Division, Southern Region Headquarters, Fort Worth, Texas
James B. Lushine	WCM, NEXRAD Weather Service Forecast Office (NWSFO) Miami, Florida
Patrick J. Slattery	Public Affairs Specialist, Central Region Headquarters, Kansas City, Missouri
Walter G. Peacock, PhD	Associate Director for Research, International Hurricane Center, Florida International University, Miami, Florida

Other valuable contributors include:

William H. Lerner	WSH, Office of Meteorology, Silver Spring, Maryland
Rainer N. Dombrowsky	WSH, Office of Meteorology, Silver Spring, Maryland
Joseph T. Schaefer	Director, SPC, Norman, Oklahoma
Peter A. Browning	Science and Operations Officer (SOO), NWSO Pleasant Hill, Missouri
Linda S. Kremkau	Technical Editor, WSH, Office of Meteorology, Silver Spring, Maryland

Acronyms

AFOS	Automated Field Observing System
AWIPS	Automated Weather Interactive Processing System
CRS	Console Replacement System
CWA	County Warning Area
EAS	Emergency Alert System
ESATCOM	State Satellite Communication System
EST	Eastern Standard Time
FAA	Federal Aviation Administration
FAR	False Alarm Ratio
HWO	Hazardous Weather Outlook
ITWS	Integrated Terminal Weather System
MIC	Meteorologist in Charge
NEXRAD	Next Generation Weather Radar
NOAA	National Oceanic and Atmospheric Administration
NSSL	National Severe Storms Laboratory
NWR	NOAA Weather Radio
NWS	National Weather Service
NWSO	NEXRAD Weather Service Office
NWSFO	NEXRAD Weather Service Forecast Office
OSF	Operational Support Facility
PC	Personal Computer
POD	Probability of Detection
PUP	Principal User Processor
ROAMS	Remote On Air Monitoring System
RPG	Radar Product Generator
SOO	Science and Operations Officer
SPC	Storm Prediction Center
SPS	Special Weather Statement
SVS	Severe Weather Statement
TDA	Tornado Detection Algorithm
TDWR	Terminal Doppler Weather Radar
WCM	Warning Coordination Meteorologist
WDSS	Warning Decision Support System
WSH	Weather Service Headquarters
WSR-88D	Weather Surveillance Radar-1988 Doppler
WISE	Warning and Interactive Statement Editor

Event Summary

Overview

An outbreak of unusually strong tornadoes in east-central Florida during the late night and early morning hours of February 22-23, 1998, was the most deadly in the state's history. Between approximately 11 p.m. and 2:30 a.m. Eastern Standard Time (EST) (EST will be used throughout this report), seven tornadoes swept through the NWSO Melbourne county warning area (CWA), killing 42 people and injuring more than 260 others. The previous high tornado death toll in Florida was 17, which occurred on March 31, 1962, in the Florida Panhandle (Santa Rosa County). In terms of single-event, weather-related fatalities in Florida, this event ranks as the ninth greatest in loss of life. The largest number of single-event, weather-related deaths in Florida occurred during the 1928 hurricane that killed more than 1,842 people near Lake Okeechobee.

The tornadoes were unusually strong for the area and produced damage estimated in excess of $100 million. Three of the storms were rated in the F3 category (158-206 mph) on the Fujita Tornado Intensity Scale (see Appendix A). More than 3,000 structures were damaged and more than 700 destroyed. This Service Assessment focused on the NWSO Melbourne CWA, although there were two brief tornado touchdowns in the NWSO Tampa Bay CWA earlier in the evening.

Storm Summary

During the evening of February 22, the atmosphere over east-central Florida was primed for a devastating severe weather outbreak (Figure 1). A strong upper trough associated with a stronger-than-normal subtropical jet stream (wind speeds of 140 knots) was approaching the Florida Peninsula from the west. From a surface low near Mobile, Alabama, a surface cold front arced southeastward over the Gulf of Mexico, nearing the western Florida coast. A line of thunderstorms was moving eastward just ahead of the frontal boundary. Afternoon pre-frontal thunderstorms over southern Georgia and northern Florida had left behind a surface outflow boundary, stretching from near Daytona Beach on the east coast to northeast of Tampa on the west coast. The air mass south of the outflow boundary and east of the front was warm, moist, and very unstable. The formation of a strong, nocturnal, low-level jet (winds greater than 50 knots just 1,000 feet above ground level) was coupled with the subtropical jet further aloft to produce very strong vertical wind shear over the peninsula.

Three supercell thunderstorms formed as the storm line moved ashore from the Gulf of Mexico and interacted with the stationary outflow boundary, the instability, and the strong wind shear. Supercell storms are hazardous because they last for long periods of time, rotate, and are the parents of many strong and violent tornadoes. As the three supercells quickly moved across east-central Florida, they produced seven tornadoes in the NWSO Melbourne CWA (Figure 2).

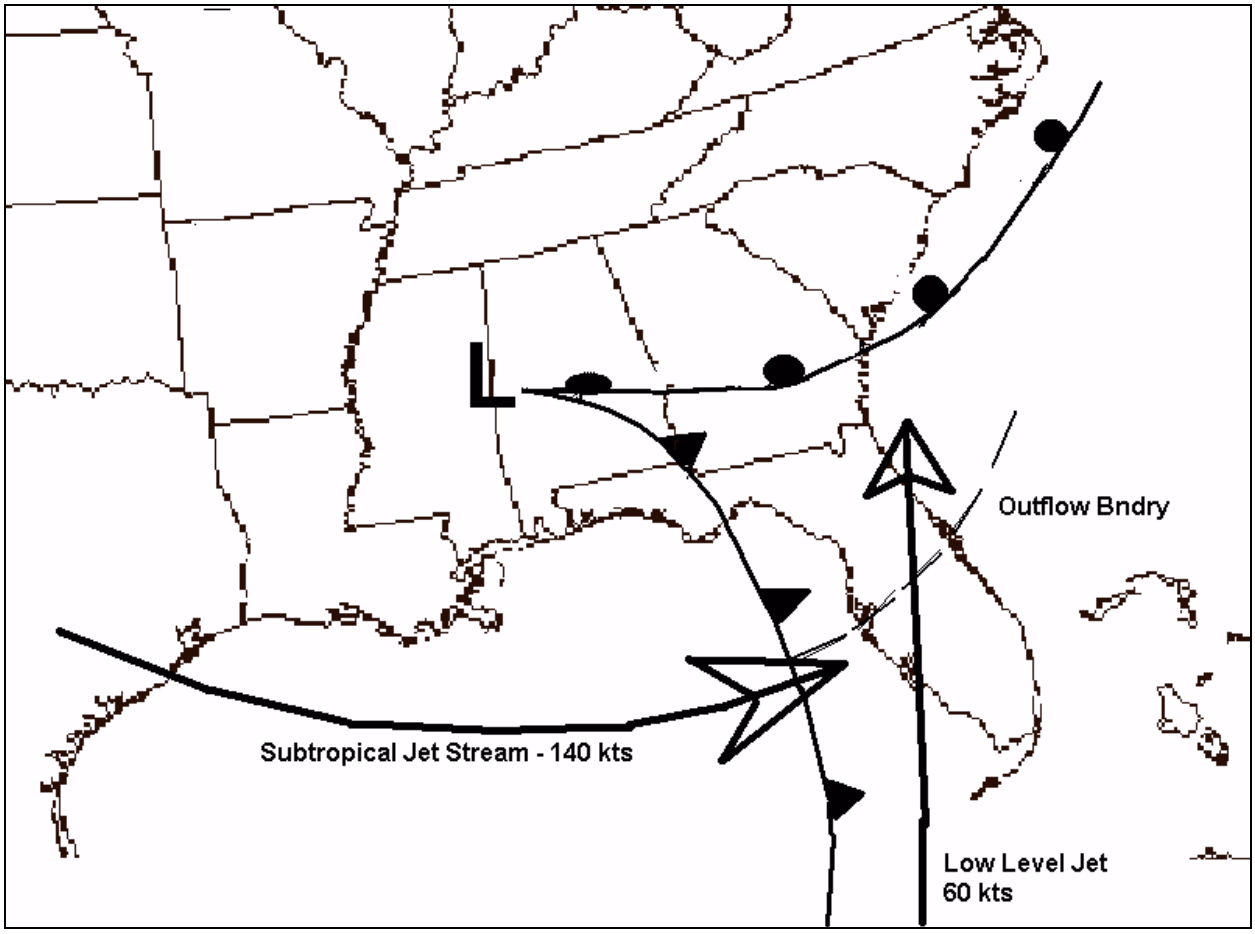
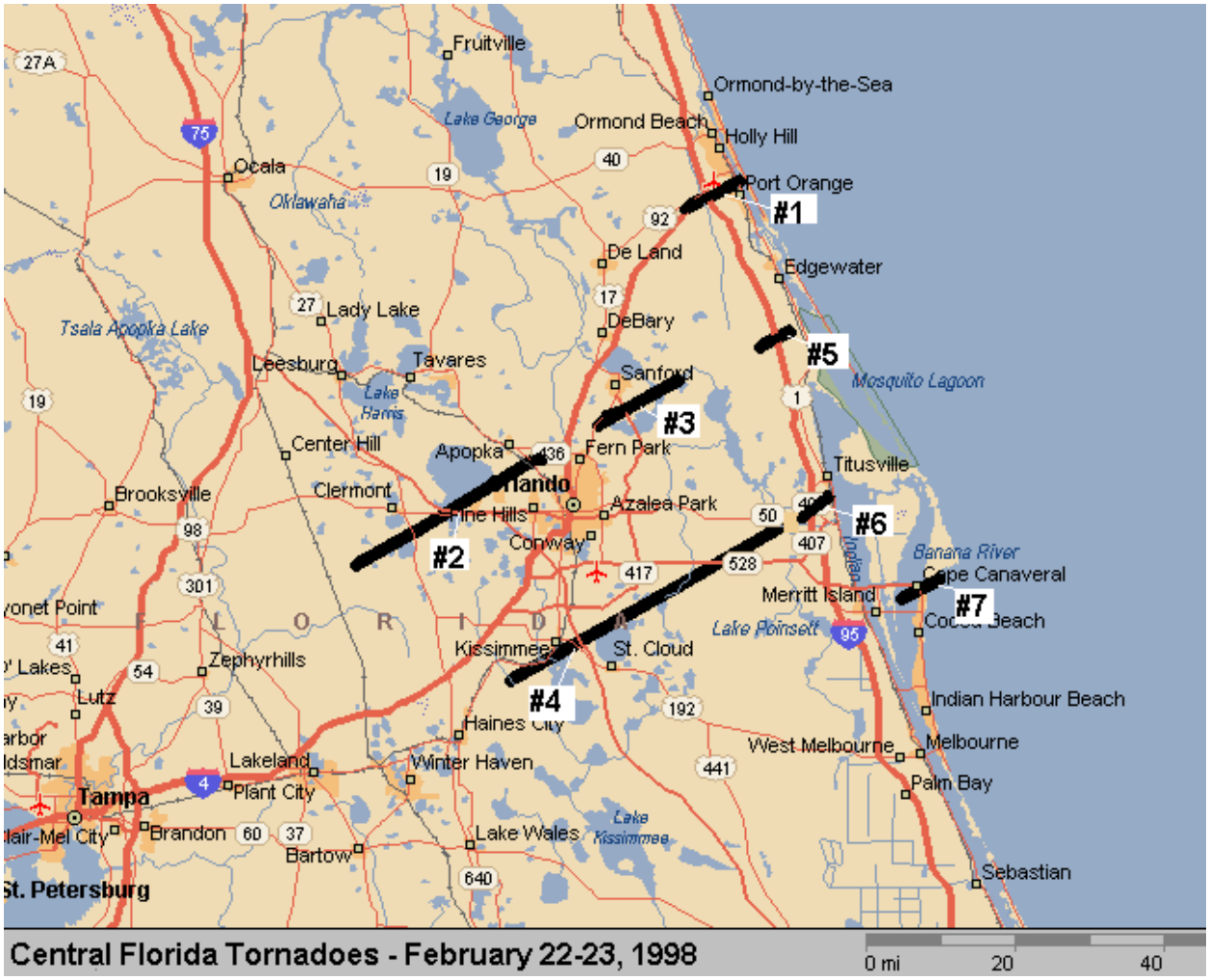


Figure 1. Synoptic Setting, 7 p.m. EST, February 22, 1998.



#1 F2 tornado touched down in Volusia County at 10:55 p.m.—1 fatality, 3 injuries.

#2 F3 tornado touched down in Lake County at 11:37 p.m., entered Orange County at 11:41 p.m., first fatalities around 11:50 p.m., lifting at midnight—3 fatalities, approximately 70 injuries.

#3 F3 tornado touched down in Seminole County at 12:10 a.m., first fatalities around 12:15 a.m. near Sanford, lifting at Volusia County at 12:25 a.m.—13 fatalities (12 - Seminole County, 1 - Volusia County), approximately 36 injuries.

#4 F3 tornado touched down in Osceola County at 12:40 a.m., first fatalities at 12:50 a.m. in Kissimmee, crossed into Orange County at 12:55 a.m., lifting at 1:28 a.m.—25 fatalities, 150+ injuries.

#5 F2 tornado touched down in Volusia County at 12:45 a.m.—no fatalities or injuries.

#6 F1 tornado touched down in Brevard County at 1:38 a.m.—no fatalities or injuries.

#7 F1 tornado touched down in Brevard County at 2:30 a.m. near Port Canaveral—no fatalities or injuries.

Figure 2. Central Florida Tornadoes, February 22-23, 1998.

The northern supercell produced two brief tornado touchdowns in rural Sumter County in the NWSO Tampa Bay CWA shortly before 10 p.m. Later, that supercell produced a stronger tornado that struck just southwest of Daytona Beach (Volusia County) at 10:55 p.m. This tornado continued east-northeastward for approximately 8 miles, dissipating in southern Daytona Beach. Tornado #1 (Figure 2) resulted in one fatality along Route 92 east of Interstate 95, three injuries, and damage to or destruction of more than 600 structures (F2 category on the Fujita Tornado Intensity Scale).

The middle supercell produced the first of its tornadoes (#2 on Figure 2) at 11:37 p.m. in rural eastern Lake County. Tornado #2 was not very destructive until it moved into western Orange County at 11:41 p.m., severely striking Winter Garden and Ocoee between 11:47 and 11:55 p.m. Tornado #2 (approximately 18 miles long) ended about midnight near the Orange/Seminole County line. In all, tornado #2 was responsible for three fatalities in Winter Garden, approximately 70 injuries, and damage to or destruction of about 500 structures (F3 category).

The middle supercell's next tornado (#3) formed in Seminole County just northeast of Longwood at 12:10 a.m., February 23. It moved northeast for 14 miles, hitting several neighborhoods in the southeast portion of Sanford. Tornado #3 dissipated just after crossing the St. Johns River in Volusia County at about 12:25 a.m. Along the path of tornado #3, there were 13 deaths, 36 injuries, and damage to or destruction of more than 625 structures (F3 category). Twelve of the deaths were in Seminole County, and one was along Route 46 in Volusia County.

The last tornado (#5) from the middle supercell struck rural eastern Volusia County about 12:45 a.m., crossing Interstate 95 and damaging only a few structures (F2 category). No casualties were reported from tornado #5.

The southern supercell produced the longest tornado track of the outbreak (tornado #4). The tornado first touched down at 12:40 a.m. in northwest Osceola County just southwest of Kissimmee and moved northeastward for about 38 miles, dissipating in extreme eastern Orange County at about 1:28 a.m. The first tornado fatalities occurred at approximately 12:50 a.m. in the Ponderosa RV Park. The tornado's touchdown point was approximately 8 miles southeast of central Florida's popular area of theme parks, entertainment centers, and hotels/motels. Damage from tornado #4 was severe in southern, eastern, and northeastern Kissimmee and adjoining rural areas of Osceola County before the tornado crossed into Orange County (about 4 miles southeast of Orlando International Airport) at 12:55 a.m. In Orange County, the tornado mostly affected rural swampy areas, striking few structures except for lakeside neighborhoods on the shores of Lakes Hart and Mary Jane. Totals for tornado #4, coming mostly from Osceola County, were 25 fatalities, more than 150 injuries, and damage to or destruction of more than 1,000 structures (F3 category).

The last tornado (#6) from the southern supercell struck the southwest portion of Titusville in Brevard County just after 1:38 a.m. No casualties were reported from tornado #6, but more than 100 structures were damaged or destroyed (F1 category). The short, few-mile skip between tornado #4 and tornado #6 prevented damage at the Great Outdoors RV Park, one of the largest in the United States, housing 1,000 recreational vehicle lots.

Tornado #7 occurred at approximately 2:30 a.m. in Brevard County near Port Canaveral. The tornado formed over the Banana River and moved east-northeast for about 4 miles, crossing Port Canaveral and dissipating before reaching the Atlantic Ocean. No casualties were reported with this storm, but approximately 30 structures were damaged (F1 category).

All of the tornadoes were relatively narrow with a path width of 50-100 yards in most places. The widest damage areas in the paths of the tornadoes were approximately 200 yards at the Boggy Creek Shopping Center in Kissimmee, Osceola County, and in the Sanford area, Seminole County.

Analysis of Performance

This analysis focused on the three supercells that passed through the NWSO Melbourne CWA between approximately 10:30 p.m. Sunday, February 22, and 2:30 a.m. Monday, February 23.

The potential for severe weather in central Florida Sunday afternoon and evening, February 22, was evident to NWS meteorologists as early as Friday afternoon, February 20. The first alert to the potential for severe weather late in the weekend was a Special Weather Statement (SPS) issued by the NWSFO Miami at 2:33 p.m. Friday, after coordination with other NWS offices in Florida. This severe weather threat information was updated and relayed to media weathercasters and the emergency management community throughout the weekend.

At 2:45 a.m. Saturday, February 21, the SPC in Norman, Oklahoma, issued the Day 2 Convective Outlook, highlighting the potential for supercell storms and tornadoes moving through Florida Sunday evening, 45 hours before the tornadoes struck. The 6 a.m. Sunday SPC Day 1 Convective Outlook upgraded the threat for severe weather in northern and central Florida to a moderate risk, emphasizing again the threat for supercell storms and tornadoes. Subsequent Mesoscale Discussions and Watch Status Messages issued Sunday by SPC forecasters stressed the threat of supercell storms and tornadoes over central and northern Florida. The first tornado watch (No. 57) for the area was issued at 1:44 p.m., valid from 2:15 p.m. until 9 p.m. At 8:13 p.m., Tornado Watch No. 58 was issued for central Florida, valid from 9 p.m. to 3 a.m.

NWSO Melbourne forecasters were well aware of the severe weather threat and issued several products to alert their customers. A Hazardous Weather Outlook (HWO) was issued by the office at 4:08 p.m. Saturday, February 21, mentioning the potential for damaging winds, isolated tornadoes, hail and heavy rain on Sunday. The 5:25 a.m. Sunday, February 22, HWO

reinforced the threat for tornadoes during the afternoon and evening hours. An updated HWO was issued at 11:55 a.m. Sunday, headlining a "SIGNIFICANT THREAT OF DAMAGING THUNDERSTORM WINDS...HAIL...AND TORNADOES THIS AFTERNOON AND EVENING." At this point, the on-duty personnel began to assess the staffing requirements for later in the day and contacted off-duty staff to line up additional resources when the severe weather developed.

During the afternoon hours, severe storms moved through the NWSO Melbourne CWA. These storms produced wind damage and a weak tornado. Another updated HWO was issued at 10:40 p.m. Sunday, February 22, in time for the evening television newscasts, highlighting that "ANOTHER ROUND OF SEVERE WEATHER IS EXPECTED." This product was intended to heighten the level of awareness and contained the following paragraphs:

> "EMERGENCY MANAGEMENT OFFICIALS AND LAW ENFORCEMENT AGENCIES ARE URGED TO COORDINATE WITH THE LOCAL NATIONAL WEATHER SERVICE. THIS IS A DANGEROUS SITUATION! SPOTTERS ARE ENCOURAGED TO KEEP AN EYE TO THE SKY AND RELAY ALL INFORMATION BACK TO THE NATIONAL WEATHER SERVICE."
>
> "AREA RESIDENTS SHOULD BE READY TO REACT QUICKLY IF A TORNADO WARNING IS ISSUED FOR THEIR AREA. REMAIN INFORMED OF THE LATEST WEATHER SITUATION FOR YOUR COUNTY BY LISTENING TO NOAA WEATHER RADIO OR OTHER LOCAL NEWS MEDIA."

Interviews with local weathercasters, the emergency management community and the general public indicated that these SPC and NWSO products heightened awareness of the threat before the storms moved into the area. The updated HWO products were very effective, especially the product issued just before the 11 p.m. newscast.

Between 9:45 p.m., February 22, and 3:16 a.m., February 23, NWSO Melbourne issued 14 tornado warnings. In addition, flash flood warnings, special marine warnings, local airport advisories, numerous statements and hourly short-term forecasts were issued. Appendix B contains a listing of products issued by the office and significant storm reports. The Melbourne forecasters were well aware of the meteorological situation and the high threat of tornadoes with the supercells. As a result, all of the warnings issued during this time period were tornado warnings. All seven of the confirmed tornadoes during this time period were in areas covered by Tornado Watch No. 58 and were preceded by tornado warnings. The average warning lead time before a tornado occurred in a warned county was 15 minutes, ranging from 3 minutes for tornado #7 in Brevard County near Port Canaveral, to 33 minutes for tornado #1, touching down in Volusia County near Daytona Beach. In areas where fatalities occurred, the average warning lead time before the initial fatality was 23 minutes, ranging from 10 minutes for tornado #2 in Winter Garden and tornado #3 in Volusia County along Route 46, to 33 minutes for tornado #1 near Daytona Beach.

All available observation and analysis tools were used by the Melbourne forecasters. Weather Surveillance Radar-1988 Doppler (WSR-88D) radar data and storm spotter reports were the primary data used in the warning decision process. In addition to the WSR-88D Principal User Processor (PUP) workstation displays and baseline guidance algorithms, the NWSO had access to the National Severe Storms Laboratory's (NSSL) Warning Decision Support System (WDSS) with its enhanced display capabilities and experimental guidance algorithms. WDSS displays and algorithm outputs provided forecasters with excellent radar data displays that could be used quickly and interpreted easily. The Warning and Interactive Statement Editor-II (WISE-II) warning preparation software (running on a personal computer [PC]) was used to prepare and disseminate the warning messages. The staff switched to generator power for the office and radar during the afternoon hours, well before thunderstorms moved into the area. This ensured minimal disruption in case of a lightning strike or power outage.

Storm spotters played a vital role during the severe weather event. Melbourne staff alerted amateur radio operators to the threat of severe weather well in advance, and a radio operator was in the Melbourne NWSO throughout the event. Radio communication was established with all of the impacted counties during the evening. Eyewitness reports were received in the office almost simultaneously with tornado damage in several instances. The first eyewitness report via amateur radio was received at 11:50 p.m., February 22, as a deadly tornado struck the Winter Garden area. Within a minute of receipt, this report was disseminated in a Severe Weather Statement (SVS). This report also confirmed the threat and prompted issuance of a tornado warning for Seminole County at 11:56 p.m. In addition to gathering storm reports into the office, the radio operators also were able to provide warning and statement information from the Melbourne office to emergency management officials and other radio operators in the impacted areas. All of the Melbourne staff interviewed during the assessment had high praise for the amateur radio operator's contributions to the office.

Due to the perceived seriousness of the tornado threat Sunday evening, February 22, the Melbourne staff took the extraordinary step of calling the emergency management or communications centers in the threatened counties of the office's CWA prior to the onset of the storms. Station logs indicate contact with all of the affected counties, alerting them to the potential for severe storms. In Volusia County, the Melbourne staff contacted the sheriff's dispatcher at 10:33 p.m. and stayed on the phone, at her request, for several minutes giving scan by scan updates on the radar data. Shortly after hanging up, this dispatcher called the NWSO at 11:08 p.m. to report the 10:55 p.m. tornado touchdown near Daytona Beach. The additional advanced notice through these phone contacts was cited by some emergency management officials as allowing them to be better prepared for the recovery efforts after the storms hit.

All indications are that NWSO Melbourne provided an excellent warning service to its CWA. The media, county and local government agencies, safety force and emergency management personnel all acknowledged that the outlook, watch and warning information provided by the NWS allowed them to be better prepared to respond to this situation. They were especially appreciative of the advance notice in the HWO the day before the event took place. All of the television stations in Orlando provided excellent weather coverage during the 11 p.m. newscast and interrupted programming throughout the event to provide warnings and updates.

Several residents impacted by the tornadoes commented that they were made aware of the threat of tornadoes by viewing the television news coverage. A tornado watch and tornado warnings were issued by the NWS prior to the beginning of all of the tornadoes. No outdoor warning sirens systems were in place in the affected areas to further alert residents to the tornado threat.

Four problem areas in the warning system were identified during the assessment.

First, even though advance watch and warning information was available and a severe weather education effort has existed in the CWA, numerous residents failed to receive or respond properly to the warnings and approaching weather. The problem was made worse by the timing of the event. The tornadoes struck at a time when many of the residents had already gone to bed and had turned off commercial television and radio. Interviews with more than 50 residents in the path of the storms revealed that only one person knew of and had the National Oceanic and Atmospheric Administration (NOAA) Weather Radio (NWR). That person did not have a warning alarm receiver nor did he use it as the primary source of weather information.

Second, the Orlando NWR transmitter was off the air for a time most likely due to a power interruption near the transmitter location. Since the transmitter is outside of the listening range of the Melbourne NWSO and no Remote On Air Monitoring System (ROAMS) is in place, it took several minutes before the transmitter problem was identified and the broadcast put back on the air. During the outage, it appears that two tornado warnings and multiple SVSs were not broadcast over the air and into the Emergency Alert System (EAS).

Third, for some tornado warnings, there was a delay of up to 8 minutes from issuance time to the broadcast of warnings on the NWR.

Fourth, there was a communications line problem between the WSR-88D and the WDSS. The wideband line that delivered data to the WDSS failed at approximately 11:05 p.m., February 22, and could not be restarted through routine procedures. Because of the importance of the WDSS output, the Radar Product Generator (RPG) was brought down at about 11:30 p.m. and rebooted/restarted. This cleared the problem and data were restarted to the PUP and WDSS at approximately 11:45 p.m. During the time when the RPG was down, the PUP was operational and dialed into the WSR-88D radars at Tampa and Jacksonville as required to support warning operations. The staff also had access to the Federal Aviation Administration (FAA) Orlando Terminal Doppler Weather Radar (TDWR) data through a display in the Melbourne office.

These areas are addressed in more detail in the facts, findings and recommendations section of this report.

Extensive damage to mobile homes and recreational vehicles at the Ponderosa RV Park in Kissimmee, Florida. Main office building on extreme right of photograph received minor roof damage. Photograph courtesy of Lynn Maximuk.

Nearly total devastation occurred in a narrow corridor through Ponderosa RV Park in Kissimmee, Florida. Multiple fatalities occurred at this location. Photograph courtesy of Robert Sheets.

Aerial view of damage to homes in Lakeside subdivision in Kissimmee, Florida. The tornado moved from the upper right to the lower left, narrowly missing a school. Photograph courtesy of Robert Sheets.

While there was significant structural damage to a block home in the Lakeside subdivision in Kissimmee, Florida, no fatalities occurred in this area. Photograph courtesy of Lynn Maximuk.

Facts, Findings and Recommendations

Observations

FACT 1: The NWSFO Melbourne used WSR-88D data as the primary tool for examining storm structure and issuing warnings. Each of the three supercell thunderstorms that produced the tornado outbreak were easily observable on the radar displays, producing well-defined velocity signatures and occasional reflectivity signatures.

FACT 2: Confirmation of massive destruction, injuries, and fatalities via information from storm spotters (Ham radio) and emergency managers was sought out and received by the Melbourne forecasters. This information influenced warning decisions and was relayed to customers in warning and statement messages. This helped to reinforce the seriousness of the tornado threat. Ground truth information is an important companion to radar information in tornado warning situations.

Finding A: In addition to the PUP workstation displays and baseline guidance algorithms, the NWSFO had access to NSSL's WDSS with its enhanced displays and experimental guidance algorithms. WDSS displays and algorithm outputs provided forecasters with considerably better information that could be more quickly and easily interpreted. For volume scans when tornadoes were occurring, the experimental NSSL Tornado Detection Algorithm (TDA) produced detections 100 percent of the time. This can be compared to the baseline TVS Algorithm which produced detections 22 percent of the time.

Recommendation A1: The NWS System for Convective Analysis and Nowcasting Program should continue its plan to integrate full WDSS capability into the design of future NWS Automated Weather Interactive Processing System (AWIPS) software.

Recommendation A2: The AWIPS Program Office should continue its plan to integrate limited WDSS capability into a near-future AWIPS software build.

Recommendation A3: The OSF should continue its plans to incorporate TDA into its next software build (Build 10; due in the summer of 1998).

Finding B: The Melbourne NWSO staff proficiently used the many weather data analysis and display systems available in its operations area:

- WDSS (with Radar Utilities and Doppler Radar Streams);
- Lightning Imaging Sensor and Data Application Demonstration;
- Lightning Detection and Ranging;
- National Lightning Detection Network;
- PUP;
- Meteorological Interactive Data Display System;
- WISE-II;
- Skew T/Hodograph Analysis and Research Program;
- Integrated Terminal Weather System (ITWS);
- Automated Field Observing System (AFOS);
- two PCs running miscellaneous software; and
- the Science Applications Computer.

However, operation and management of such a wide array of systems was time consuming and subject to possible error or misinterpretation. Integration of outputs from the various analysis/display systems would facilitate ease in interpretation and decision making.

Recommendation B: The NWS should continue deployment of AWIPS as rapidly as possible to provide integrated workstations that meet the needs of forecasters in stressful warning situations.

Guidance

FACT 3: The Melbourne NWSO alerted people in east-central Florida about the possible consequences of El Niño-enhanced severe weather as early as October 1997. This information was posted on the office's "Home page" (http://sunmlb.nws.fit.edu/mlbnino.html) and presented by the Melbourne MIC at a state of Florida-sponsored "El Niño Summit" in Tallahassee on December 15, 1997. Two subsequent messages were posted on the NWSO Melbourne Home page informing persons in east-central Florida about the hazards of El Niño-spawned severe weather.

FACT 4: Guidance products from the SPC forecast the threat of significant severe weather in Florida as early as 45 hours in advance. The Day 2 Severe Thunderstorm Outlook issued at 2:45 a.m. Saturday, February 21, placed the area in a Slight Risk Area. The Outlook stated that conditions were "MORE THAN SUFFICIENT TO

SUPPORT SUPERCELLS/TORNADOES." The Day 1 Convective Outlook updated at 6:59 a.m. Sunday, February 22, upgraded the risk over the area from Slight to Moderate. The Outlook stated that "ISOLATED SUPERCELLS COULD DEVELOP...AND A FEW TORNADOES WILL BE POSSIBLE."

FACT 5: Forecast model guidance packages were available and used by the forecasters. The packages were in good agreement in forecasting severe weather conditions in the area as early as 48 hours in advance.

Warnings/Predictions (Includes Watches, Statements and Warnings)

FACT 6: The potential for severe weather in central Florida was advertised well in advance. At 2:33 p.m. Friday, February 20, after coordination with other Florida NWSOs, including Melbourne, the Miami NWSFO issued a "Special Weather Statement" (SPS), alerting people that a strong weather system would affect Florida late in the weekend.

FACT 7: The head of the Florida Department of Emergency Management stated that one of the most valuable services the NWS can provide to the emergency management community is awareness of the threat of hazardous weather with the greatest lead time possible. The Orange County Emergency Manager and Winter Garden City Manager stated that they were alerted to the possibility of severe weather in this instance 2 to 3 days in advance.

FACT 8: Prior to the development of the three supercells and during their traverse across the peninsula, the Melbourne NWSO issued timely outlooks, short-term forecasts, and statements that highlighted the development and evolution of the outbreak. In particular, an East Central Florida Hazardous Weather Outlook issued at 10:40 p.m. contained a banner that mentioned "ANOTHER ROUND OF SEVERE WEATHER IS EXPECTED!" It also read in part "...MOISTURE AND ...SHEAR HAVE PRIMED THE ENVIRONMENT FOR THE POTENTIAL FOR TORNADOES." It issued a call for emergency managers and spotters to coordinate with the NWS office and said, "THIS IS A DANGEROUS SITUATION." The product was very timely since it was issued when information from it could be included in local television 11 p.m. news and weathercasts, a major source for public information.

FACT 9: The Melbourne NWSO issued very accurate and timely tornado warnings. During the outbreak, the NWSO issued 14 tornado warnings for 15 counties (some were new warnings for previously warned counties). Those warnings had a Probability of Detection (POD) of 1.0 and a False Alarm Ratio (FAR) of .31, both statistics much higher than national averages. On a county by county basis, the average lead time before tornado touchdown was 15 minutes (range from 3 to 33 minutes). Average lead time before fatalities in each of the four counties experiencing fatalities was even higher—at 23 minutes (range from 10 to 33 minutes). The 1997 national POD was .59, while the 1997 national FAR was .78.

Finding C: The SPC issued Tornado Watch No. 58 at 8:13 p.m. on February 22, valid from 9 p.m. until 2 a.m. for central Florida. This watch well covered the area and time period of the tornado outbreak. Tornado Watch No. 58 immediately followed Tornado Watch No. 57, which had been issued for the same area from 2:15 p.m. until 9 p.m. These watches followed several tornado watches for peninsular Florida in the days and weeks preceding the outbreak.

Recommendation C: The SPC is concerned that persons included in tornado watches for extended periods of time (13 consecutive hours on February 22-23) or several days in close proximity might become desensitized to the threats for which the watches are issued. How much "watch" is too much? Careful study of public response to continuous watches needs to be performed.

Service Coordination

Internal

FACT 10: The potential for severe weather in the CWA on Sunday was discussed by the NWSO forecasters early in the day. Plans for additional staffing were developed. The on-duty personnel called off-duty staff to determine availability should severe weather develop. The SOO checked with the office three times during the day to keep abreast of the situation. This early planning allowed for adequate staffing resources during the event.

FACT 11: The NWSO Melbourne forecaster called the SPC Lead Forecaster at 6:10 p.m. to coordinate the possibility of severe weather the remainder of the night. Around 8 p.m., the SPC Lead Forecaster

contacted the Melbourne NWSO (as well as Tampa, Jacksonville and Miami) to discuss the need for another tornado watch after Watch No. 57 expired. The SPC forecaster was concerned about the area being under a Tornado Watch since 2:15 p.m., but all offices agreed that a new Tornado Watch (No. 58) should be issued. The coordination between the SPC and the NWSOs/NWSFO worked well.

FACT 12: The NWSO Melbourne forecasters contacted NWSOs Tampa and Jacksonville to exchange storm report and radar information throughout the event. The Melbourne NWSO dialed into the Tampa WSR-88D to view storms from a different angle.

FACT 13: The NWSO Melbourne staff communication seemed adequate. All staff on duty during the event felt that they were informed of what was going on and clearly understood their roles and responsibilities.

External

FACT 14: A long-term relationship between the NWS and local media weathercasters led to a very good working relationship between the media, in general, and the NWS. The media broadcast NWS information immediately and stressed the importance of messages to listeners and viewers. Some of the media weathercasters stayed on the air live for long periods of time relaying warnings, statements and radar information to viewers.

FACT 15: The NWSO Melbourne forecasters began as early as Friday, February 20, to emphasize the potential of the approaching storm in outlooks and routine forecasts. This potential was stressed to media and emergency management agencies, which relayed that information to the public, warning residents to be prepared to take necessary actions to protect themselves from severe weather.

FACT 16: Early on Sunday, February 22, the NWSO Melbourne forecasters discussed the potential for severe weather in the CWA with local amateur radio storm spotter groups. An amateur radio operator came into the office before the onset of severe weather, and operators remained on-station throughout the event. Their presence provided a nearly continuous flow of information to and from the office to spotter groups and emergency management personnel.

Finding D: Due to the unusually high threat of tornadic activity, the NWSO Melbourne forecasters took the time to call emergency managers or sheriffs' offices in the affected counties prior to the onset of tornado activity. Some of the conversations with these offices were detailed and lengthy. The direct phone contact allowed forecasters to impart the seriousness of the threat and provide detailed information on the location of the severe storms. Several of the emergency managers and sheriffs' offices noted that this contact undoubtedly enabled them to respond to the storm damage areas more quickly. While telephone contacts of this nature are extremely effective during large-scale severe weather events, there may be insufficient resources to guarantee this service consistently. Telephone, or other localized direct contacts, are encouraged to the extent possible within NWS office staffing resources available.

Recommendation D: The potential limitations of this type of contact due to high activity levels, or minimal staffing, should be made clear to emergency management and safety forces personnel. WCMs should work to ensure that existing mass communication systems are identified and fully utilized and work with local emergency management personnel to develop new or enhanced mass communication systems.

Dissemination

FACT 17: The NWSO Melbourne's AFOS dissemination system functioned well during the event. Warning and statement messages were prepared utilizing the WISE-II software on the LAN and transmitted through AFOS communications without a problem.

FACT 18: According to emergency management and safety forces personnel and interviewed members of the public, local television weathercasters did a good job of relaying NWS warnings and augmenting them with radar and storm report information. Presentations ranged from crawls to warning map overlays to live interruptions of programming. Feedback from interviews indicate that the live interruptions of programming were the most effective for relaying information and confirming the threat. In addition, several interviewees stated that they tuned to The Weather Channel on their cable system to receive watch and warning information once they were aware of the severe weather threat.

FACT 19: Emergency management agencies and safety forces utilized multiple methods for receiving severe weather information. These methods include: NOAA Weather Wire Service, Emergency Management Weather Information Network, private sector vendors, Internet, pagers, ESATCOM (state satellite communication system), and NWR. These systems functioned properly during the event, with the exception of the NWR (see Finding F below).

FACT 20: The Service Assessment Team was unable to locate any outdoor warning siren systems in the impact areas.

FACT 21: The NWSO Melbourne NWR operators effectively utilized the Warning Alarm Tone when broadcasting SVSs that contained specific information about tornado locations and projected paths. This technique enhanced the dissemination of critical information.

Finding E: According to broadcast media, the EAS functioned during the event. Local broadcast stations monitor the NWR and/or the LP1 station (WDBO) for EAS activations. Station logs from WXXL-FM radio showed that EAS activations from NWR were received about a minute after they were transmitted. The LP1 station (WDBO) captures the NWR activation, then manually relays the broadcast through the EAS. To expedite dissemination when messages are relayed, they are keyed to all counties in the EAS area. Stations primarily monitoring WDBO commented that there was a delay in the EAS activations and that having all warnings keyed to all counties in the service area was problematic.

Recommendation E: The local EAS committee should review operating and monitoring procedures to ensure timely activation during weather emergencies. The Melbourne WCM should work to ensure that broadcast media receivers are properly tuned and programmed to receive NWS warning products.

Finding F: The Orlando NWR transmitter was off the air for several minutes during the Orange/Seminole County tornadoes. The transmitter was apparently knocked off the air at approximately 11:39 p.m., February 22, due to a power outage or fluctuation. The transmitter site is in the vicinity of the Winter Garden tornado. The outage was not discovered by the NWSO Melbourne staff until reported by amateur radio storm spotters in the area at approximately 11:50 p.m. The outage report was relayed to the NWR operator shortly after midnight, at which time he immediately took corrective actions to return the broadcast to the air. He remotely switched transmitters at

the site, and the broadcast returned to the air on low power at 12:04 a.m., February 23. During the outage, before the NWR operator was aware of the outage, two tornado warnings and two SVSs were programmed on the NWR console. None of these products were disseminated via the Orlando NWR during the outage. The messages were in the program cycle after the broadcast resumed, however, the warning alarm and the Weather Radio Specific Area Message Encoding tones were not retransmitted. NWS offices need capability to monitor on-air NWR broadcasts at remote transmitter locations. This system should contain a feature to alert the programming office when the broadcast goes off the air. Such a system, ROAMS, is being evaluated on some NWR transmitters.

Recommendation F: The NWS should proceed with deployment of a functional ROAMS-type system as quickly as possible.

Finding G: Broadcast of tornado warnings on NWR took an average of 4.2 minutes from the time of warning issuance, ranging from 2 to 8 minutes. There are multiple variables which could lead to a delay in NWR transmission, including available staff, delay in getting warning information to the broadcaster, broadcast methods and location of NWR programming consoles. Interviews with staff indicated that during this event the staff waited for a hard copy of the warning message, then took the message to the NWR broadcaster, who recorded the warning message before activating the warning tones and broadcasting the recorded message. This procedure has several potentials for delay, including the need to wait for printed copy. The remote broadcast console location led to delay in getting information to the NWR broadcaster. Also, recording the messages before activation of warning tones and broadcast added time to dissemination. Deployment of the NWR Console Replacement System (CRS) is underway, and this system provides capabilities for broadcast of warning messages with minimal delay. These capabilities include: simplified operator procedures for manual broadcast of warning tones and recorded or live voice messages; and the ability to automatically broadcast warning tones and synthesized voice messages of warning text simultaneously on multiple transmitters immediately upon receipt of warning text.

Recommendation G: The NWS should evaluate the NWR warning broadcast methodologies employed at field offices and develop more efficient means to provide quicker broadcast of warning messages. Until the CRS is fully deployed and utilized, the NWS offices should consider

interim methods for reducing the lag time in the broadcast of warning messages.

Finding H: While emergency management agencies and the media were aware of and utilized NWR to receive information and warnings, the survey team encountered only one person who owned or used an NWR receiver. Most people interviewed had no, or limited, knowledge of the NWR broadcasts and warning alarm features. Due to the time of this tornado outbreak when many people were in bed sleeping, the warning alarm feature of the NWR had great potential to reduce the number of deaths and injuries.

Recommendation H: The NWS should work with the emergency management community, NWR receiver manufacturers, and the media to renew efforts in developing a comprehensive public education effort with respect to NWR alerting capabilities.

Finding I: Some cable viewers watching "out-of-region" stations did not have access to warning information since some local cable providers either do not have or do not use all-channel override capabilities.

Recommendation I: NWS offices should coordinate with cable providers to educate them on the life-saving potential of all-channel override.

Finding J: A number of people impacted by the tornadoes said they felt outdoor warning sirens would have improved their ability to be alerted to the storms, especially those in recreational vehicles and manufactured housing units. Some out-of-state visitors stated that they took no protective action, even though they were aware of warnings for their county because they expected outdoor sirens to alert them to imminent danger.

Recommendation J: The NWS should work with local governmental and emergency response officials to explore several methods of communicating warning information to the general public.

Response

FACT 22: The day of the week and time of occurrence (Sunday around midnight) made people more vulnerable to death and injury, as most were at home and many were asleep or in bed, not watching television or listening to commercial radio.

FACT 23: Of the 42 tornado fatalities, 40 were in recreational vehicles, mobile homes or manufactured housing; one was in an automobile; and one was in a permanent framed structure.

FACT 24: There was wide variation among the interviewees regarding the perceived amount of warning lead time received; however, most households were aware that threatening weather was in their area and that a tornado watch was in effect. Some people received warning that a tornado was heading their way several minutes before impact, while others were seemingly less informed. Still others who were asleep had no idea that a threat existed until being awakened by debris hitting their homes or accommodations.

FACT 25: Residents of permanent homes who were interviewed stated that even if they received little or no advanced warning for the tornadoes, they generally took proper safety actions, moving to lower floors and interior rooms or hallways.

Finding K: Some people in recreational vehicle parks stated that they received NWS warnings. However, they took no protective action because they were unaware of their location in relation to the warned areas.

Recommendation K: Due to the large number of visitors and seasonal residents in high tourist areas, the NWS should work with local emergency management, state, county and city officials, and the private sector to encourage and assist in the development of information that can be provided to new arrivals, or posted at recreational vehicle parks, campgrounds, and hotels, motels and resorts.

Finding L: While there was extensive destruction to recreational vehicles and mobile homes in one recreational vehicle park, three permanent buildings suffered only minor damage. Several park residents escaped serious injury by taking shelter in these buildings. Many out-of-state visitors stated that they made no effort to seek adequate shelter because they did not know where that shelter could be found.

Recommendation L: The NWS should work with Federal, state, county, and city officials to develop policies promoting the creation, or identification, of “safe refuge” structures, or areas, within highly vulnerable neighborhoods, such as recreational vehicle parks and mobile home parks. Information about these locations should be provided upon check-in, and safe locations should be clearly identified.

Preparedness

FACT 26: The Melbourne NWSO staff had prepared, both internally and externally, for a significant winter severe weather season, possibly enhanced by the presence of El Niño and an unusually strong sub-tropical jet stream over the Gulf of Mexico and Florida. Special studies of potential severe weather occurrence and its meaning for east-central Florida were developed and shared with the media, the preparedness community and the public. The staff prepared internally by developing specialized tornado warning guidance for Florida (in part based on general tornado warning guidance prepared by the OSF and NSSL). Training modules and review exercises were placed on the local intranet, and all forecasters studied the information prior to the beginning of significant severe weather episodes in January. The staff was well trained and well drilled on severe weather operations.

FACT 27: The Melbourne NWSO has an active outreach program, and the staff has a good working relationship with emergency management officials and the media in the CWA. An annual Florida Hazardous Weather Awareness Week is held as a cooperative effort among the NWS and state, county and local governments. An activity during that week is a statewide tornado drill. In 1998, the awareness week was February 22-28 with the statewide drill occurring February 25. Three of the four counties in which deaths and injuries occurred had received at least one formal spotter training session within the past year.

Finding M: Fewer than half of the people interviewed by the Service Assessment Team had a pre-defined family action plan to be used in the event of a tornado. Statements indicated that public preparedness planning in the area revolves more around the threat of hurricanes than the threat of tornadoes/severe weather. A tornado drill earlier in the year is recommended for central and south Florida.

Recommendation M: The NWS should work with concerned national, state, county and local agencies to discover ways to increase public awareness of life-saving actions to be taken during tornadoes.

System/Infrastructure

Finding N: One problem occurred with the WSR-88D communications lines. The wideband line that delivered data to Radar Interface Data Distribution System/WDSS (WIDEBAND 3) failed at approximately 11:05 p.m. Sunday, February 22, and could not be restarted with simple RPG commands. Because of the importance of WDSS output to the office severe weather operations, the RPG was brought down at about 11:30 p.m. and rebooted/restarted. This cleared the problem, and data were restarted to the PUP and WDSS at approximately 11:45 p.m. During the time when the RPG was down, the PUP was up and dial-ins to WSR-88Ds at Tampa and Jacksonville were accomplished. In addition, forecasters had access to the FAA's ITWS system with input from the Orlando-area TDWR and ASR9 radars. The Melbourne staff advised the Service Assessment Team that the WIDEBAND 3 line has failed during other severe weather episodes and is considered a "chronic" problem. Although the Melbourne staff used resourcefulness in solving the communications line problem, and there is no evidence that severe/tornadic events were missed during the RPG reboot, the potential for missed warnings is large during a data outage—as long as 15 minutes in a critical weather situation.

Recommendation N1: The OSF should continue to search for ways to prevent WIDEBAND 3 problems for those sites where that communications link is installed and in operational use.

Recommendation N2: The NWS and the entire NEXRAD Program should continue the NEXRAD Product Improvement initiative.

Finding O: As part of an FAA radar development project, the Melbourne NWSO had available a display of FAA radar data (TDWR and ASR9) from Orlando-area radars. In addition to near-range reflectivity and velocity data, algorithm output (Tornado Detection and Gust Front) was available to the forecasters as guidance information. This radar display proved valuable as a back-up to the WSR-88D during the time when the RPG was down for a restart/reboot. Consideration should be given to the use of appropriate FAA radar data as back-up to the WSR-88D in the event of radar outages. Although not a consideration in the current case, FAA radar data might also be used in areas where WSR-88D radars have beam blockage or some other sampling limitation that prevents full cover of the CWA.

Recommendation O: The NWS should continue its study into the use of FAA radar data in NWS offices.

Substantial damage to the Boggy Creek Shopping Center on the east side of Kissimmee, Florida. Photograph courtesy of Robert Sheets.

Several apartment buildings were damaged in the Country Garden Apartment complex in Winter Garden, Florida. Photograph courtesy of Robert Sheets.

Appendix A

Fujita Tornado Intensity Scale

The Fujita Tornado Intensity Scale is a scale of wind damage intensity which wind *speeds* are inferred from an analysis of wind *damage*.

Category	Definition and 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 mph): 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 houses; 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; steel-reinforced structures badly damaged; incredible phenomena will occur.

Appendix B

Central Florida Tornado Outbreak
February 22-23, 1998
Chronological Log

VALID TIME EST	PRODUCT TYPE	COUNTIES AFFECTED	NWR LOG TIME	EAS LOG TIME	REMARKS
2100-0300	SEL8	ALL	2031	2033	TOR WATCH #58
2130-2230	TORTBW	SUMTER	2136	?	
2145-2250	TORMLB	LAKE	2147	2148	NO TOR-BGNG OF DAYTONA TOR CELL
2158	SVSMLB	LAKE	2200	2202	EAS TONED
2210	SVSMLB	LAKE	2213	2214	EAS TONED
2222-2315	TORMLB	VOLUSIA	2225	2226	W OF DAYTONA TOR
2233-0000	FFSMLB	LAKE VOLUSIA	2238	?	URB FLOOD ADVISORY
2240	SPSMLB	ALL	NA	NA	WATCH UPDATE-EM ALERT
2241	SVSMLB	LAKE VOLUSIA	2243	2244	EAS TONED STRONG WORDS-TRNG TO DAB
2245-2330	TAPMLB	DAB	NA	NA	LCL AIRPORT ADVISORY
2249-0050	SMWMLB	FLAGLER BCH-MOSQUITO LAGOON	NA	NA	SPCL MARINE WARNING

VALID TIME EST	PRODUCT TYPE	COUNTIES AFFECTED	NWR LOG TIME	EAS LOG TIME	REMARKS
2255	**TORNADO HIT**	**VOLUSIA**			**TCHDWN SW DAB APPROX 1ST DEATH**
2259	SVSMLB	LAKE VOLUSIA	2301	2303	EAS TONED MNTN TOR
2308	SVSMLB	VOLUSIA	2310	2311	TOR MVG THRU DAB
2320-0005	TORMLB	VOLUSIA	2321	2323	REISSUE FOR CNTY 5 MIN AFT 2222 WRNG EXPIRED
2327-0030	TORMLB	LAKE	2330	2333	BGNG OF 2ND CELL
2337	**TORNADO HIT**	**LAKE**			1ST TCHDWN SW OF WNTR GRDN
2337-0040	TORMLB	WRN ORANGE	2339	NO RECORD	MNTND WNTR GRDN-PSBL TOR CLRMT
2339 APPROX	**ORLANDO NWR OFF AIR**				**EAS LOGS SHOW NO RCPT**
2341	**TORNADO HIT**	**ORANGE**			**CROSSED COUNTY LN**
2346	SVSMLB	LAKE ORANGE VOLUSIA	2350	NO RECORD	NR WNTR GRDN-WRNG UPDATE
2347	**TORNADO WINTER GARDEN**	**ORANGE**			**TOR IN AREA OF DEATHS**
2348	LSRMLB				**VOLUSIA TOR RPRTS**
2350	**NWR REPORTED OFF AIR BY HAMS**				**REPORTED ON EVE SHIFT LOG**

VALID TIME EST	PRODUCT TYPE	COUNTIES AFFECTED	NWR LOG TIME	EAS LOG TIME	REMARKS
2351	SVSMLB	ORANGE	2357	NO RECORD	SPOTTER RPT FM WNTR GRDN
2356-0055	TORMLB	SEMINOLE	0003	NO RECORD	CONT WNTR GRDN TOR MNTND LONGWOOD
0004	**NWR OPERATOR NOTIFIED MCO NWR OFF AIR**				**SWITCHED XMTRS AND IT CAME BACK UP**
0000-0045	TORTBW	POLK	0005	0006	NO REPORTS
0010	**TORNADO HIT**	**SEMINOLE**			**FIRST TOUCHDOWN IN COUNTY**
0011	SVSMLB	LAKE ORANGE SEMINOLE	0015	NO RECORD	MNTND LONGWOOD AND RPRTS
0014-0115	TORMLB	VOLUSIA	0021	0023	MOVG OUT OF SANFORD
0015	**TORNADO SANFORD**	**SEMINOLE**			**FIRST DEATHS IN COUNTY**
0021-0330	FFWMLB	VOLUSIA	0027	NO RECORD	FLOOD RPRTS
0022-0120	TORMLB	NORTHERN OSCEOLA	0025	0028	MNTND KISSIMMEE
0024	**TORNADO HIT**	**VOLUSIA**			**TOR ENTERED COUNTY**
0029-0230	TAPMLB	MCO	NA	NA	LOCAL AIRPORT ADVISORY

VALID TIME EST	PRODUCT TYPE	COUNTIES AFFECTED	NWR LOG TIME	EAS LOG TIME	REMARKS
0037	SVSMLB	ORANGE SEMINOLE VOLUSIA OSCEOLA	0056	NO RECORD	SVRL RPRTS
0040	**TORNADO HIT**	**OSCEOLA**			**1ST TCHDWN SW OF KISSIMMEE**
0040-0340	FFWMLB	SEMINOLE ORANGE	0048	NO RECORD	PSBL FLOODING
0045	**TORNADO HIT**	**VOLUSIA**			**RURAL I-95**
0040-0125	TORMLB	ORANGE	0045	0046	XTND ERLYR WRNG KISSIMMEE TOR MOVG TO ORANGE CNTY
0053	SVSMLB	SEMINOLE VOLUSIA OSCEOLA ORANGE	0056	NO RECORD	WRNG UPDATE
0055	**TORNADO HIT**	**ORANGE**			**KISSIMMEE TOR MOVD INTO COUNTY**
0108	SVSMLB	VOLUSIA OSCEOLA ORANGE	0111	NO RECORD	WRNG UPDATE
0119-0220	TORMLB	ORANGE OSCEOLA	0127	0125	EXTND ERLYR WRNGS
0123-0225	TORMLB	BREVARD	0130	0129	WRNG FOR KISSIMMEE TOR NR XMAS
0138	**TORNADO HIT**	**BREVARD**			**NR OUTDOOR WORLD WEST OF I-5**

VALID TIME EST	PRODUCT TYPE	COUNTIES AFFECTED	NWR LOG TIME	EAS LOG TIME	REMARKS
0134	SVSMLB	BREVARD	0137	NA	UPDATE MNTND TITUSVILLE
0150	SVSMLB	BREVARD	0153	NA	WATCH/WRNG UPDATE
0201	FFSMLB	BREVARD	0205	NA	URB FLOOD STMNT
0225	SVSMLB	BREVARD	0228	NA	XPIRE ORANGE OSCEOLA, BREVARD WL BE EXTND
0227-0315	TORMLB	BREVARD	0230	0230	MERRITT ISLAND
0230	**TORNADO HIT**	**BREVARD**			**BANANA RVR PORT CANAVERAL**
0246	SVSMLB	BREVARD	0248	NA	WRNG UPDATE
0253	SNWMLB	FLAGLER TO MELBOURNE	0255	NA	SPCL MARINE WARNING
0304-0400	TORMLB	OSCEOLA	0307	0308	NO RPRTS
0313	SVSMLB	OSCEOLA	0315	NA	WRNG UPDATE
0316-0415	TORMLB	BREVARD	0321	0321	NO RPRTS
0334	FFSMLB	BREVARD	0338	NA	
0401	SVSMLB	OSCEOLA BREVARD	0406	NA	WRNGS EXPIRED