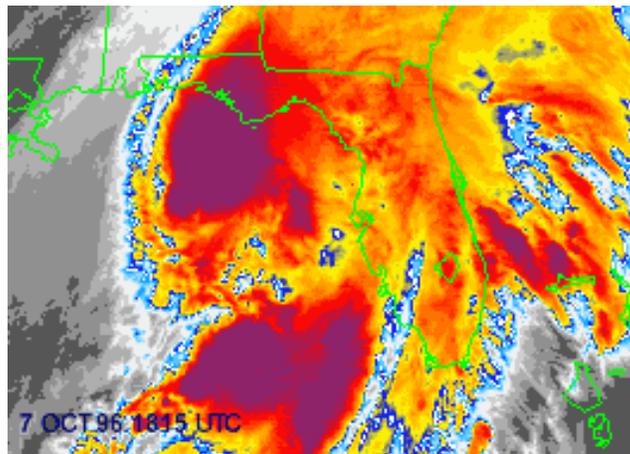


Tropical Storm Josephine Tornadoes
Lake and Volusia Counties, Florida

7 October 1996



1996-97

National Weather Service Southern Region's
Service Enhancement Project (SEP)

GOLD MEDAL WINNER

Submitted by
NEXRAD Weather Service Office
Melbourne, Florida
10 July 1997

EVENT SYNOPSIS

Tropical Storm Josephine made landfall over the extreme eastern Florida panhandle late on 7 October 1996 and moved into southeast Georgia by daybreak on 8 October. According to a detailed NWS Melbourne (MLB) research project, this track would place east-central Florida (ECFL) into a high tornado threat area. From mid morning to late afternoon on the 7th, seven tornadoes and a waterspout occurred across the [MLB county warning area \(CWA\)](http://www.srh.weather.gov/research.html). The majority of the tornadoes were short-lived and weak (F0; up to 73 mph), however one remained on the ground for six miles and produced substantial damage (F2;

113-157 mph). The Tornado Warnings issued by MLB provided unprecedented lead times for tropical cyclone (TC) tornado events. These warnings, in conjunction with precise short-term forecasts, contributed greatly towards preventing injuries and fatalities. The ability to provide significant advanced warnings can be credited to local MLB research, which has examined radar signatures from a number of Florida TC tornadoes and resulted in a strategy of tornadic cell "anticipation, identification, and reaction". The following discussion will show how this strategy was applied during this tornado outbreak.

As early as Sunday afternoon, 6 October, Melbourne forecasters began to mention the threat of severe weather for the following day in public products. A special hazardous weather outlook (HWO) was issued at 417 pm and headlined "severe thunderstorms possible Monday into Monday night." Several hours later, the likelihood of tornadoes was emphasized to the media and surrounding forecast offices in the 815 pm area forecast discussion (AFD), which headlined a "potential for severe weather this forecast period" and stated that "systems similar to this one...are known to be very proficient tornado producers." The subsequent AFD (315 am Monday) correctly refined the greatest severe weather threat to "the north part of the (county warning) area...near a surface boundary which should shift northward during the day," and the 636 am HWO again detailed the prospect of tornadoes during the day. With the tornado threat clearly communicated to the ECFL citizens, emergency managers, and the media, MLB forecasters then began to focus on more short-term and area specific forecast and warning products.

At 815 am, a short-term forecast (NOW) was issued specifically for Seminole and Volusia counties to highlight an "increasing severe weather threat" and to state that "a short-lived tornado may develop by 930 am." Based on the identification of radar signatures, a Tornado Warning was issued for Volusia county from 845 to 945 am. Although the radar signatures were subtle, they were similar to those documented in prior NWS Melbourne research of tornadic cells within tropical cyclone rainbands. As the severe cell moved across Volusia county, a NOW was issued to identify the areas most likely to be affected by a tornado through 10 am. Shortly thereafter, a severe weather statement (SVS) described a recent report of a tornado touchdown and property damage in the county and the threat of additional touchdowns until the cell reached the coast near Daytona Beach by 10 am. A final SVS was issued shortly after the Tornado Warning expired to state that the imminent threat for the county had passed. Delayed reports indicated that a second touchdown had occurred at Daytona Beach Shores as the warning expired at 945 am. Together, these products kept Volusia county residents and emergency officials fully apprised of the local tornadic potential and provided official warning lead times of 10 and 60 minutes, respectively, for the two touchdowns, and between 40 and 90 minute lead times when considering the 815 NOW issuance.

At 1023 am, a NOW issued for all of ECFL stated that the potential for severe weather had temporarily decreased, but additional severe weather was likely after 12 noon ([Fig. 1](#)). This forecast proved accurate, as a 255 pm NOW again heightened awareness by emphasizing a strong cell was approaching Lake county which had similar radar appearances to earlier tornado-producing cells ([Fig. 2](#)), and stating that a tornado warning may soon be needed for Lake county. As with the earlier Volusia county tornado event, an initial NOW was used to provide a 30+ minute advance notice for a Tornado Warning. While the warning was in effect between 330 and 430 pm, numerous calls were placed to law enforcement and emergency management officials downstream from the radar-indicated tornado, allowing enough time for them to be strategically deployed to watch for the tornado. Feedback from police officials reporting funnel clouds and a tornado were quickly placed into SVS's which were transmitted at 353 and 408 pm. As the warning expiration time was nearing, the cell which had prompted the warning continued to display strong signs of rotation, and initial indications of tornado development were noted in downwind cells. Therefore, a new Tornado Warning was issued until 530 pm. During this warning, frequent communication continued between NWS MLB and local officials and promoted a nearly continuous exchange of information, much of

which was included in a detailed 448 pm SVS. Official warning lead times for three touchdowns were between 14 and 34 minutes, or between 49 and 69 minutes if the initial NOWs were counted.

Shortly after the second Lake county Tornado Warning was issued (above), another cell to the east prompted a Tornado Warning for Seminole county at 439 pm. As this cell reached Lake Harney (separating Seminole and Volusia counties), radar-based signatures provided forecasters with a very high degree of confidence that the cell was producing a tornado, or that a touchdown was imminent. A 453 pm SVS detailed the location of the radar-detected circulation and mentioned that the feature may reach Volusia county by 510 pm. At 504 pm, a Tornado Warning was issued for Volusia county until 6 pm, and emphasized that the tornadic thunderstorm indicated by radar ([Fig. 3](#)) would cross Lake Harney and would reach the coastal towns of Edgewater and New Smyrna Beach by 530 pm. A follow up SVS, along with phone calls to local authorities at 520 pm indicated that "two thunderstorms capable of producing tornadoes" were approaching Edgewater ([Fig. 4](#)) and Barberville. Within minutes tornadoes touched down near both locations. The most serious damage occurred at Edgewater ([Fig. 5](#)), where post storm surveys indicated \$2.4 million damage and justification for a tornado intensity rating of F2 (113-157 mph). Official warning lead times for both tornadoes was 16 minutes, or 27 minutes from the time of the 453 pm SVS.

From 8 am to 6 pm Monday, NWS MLB issued a total of 33 short-term forecast products and warnings, including 15 during the most eventful three hour period. This equates to a statement or warning issuance once every 12 minutes. To further heighten the awareness of the approaching tornadoes, nearly all post-warning SVS's were preceded by a NWR tone alert (not a routine practice), and numerous phone calls were initiated to local police departments, emergency management agencies, and amateur radio spotters within the direct path of the storms. The time provided between the Tornado Warning issuance and subsequent touchdown of the eight vortices averaged 26 minutes, or 45 minutes when considering precursor NOWs which stated increasing tornado risks for precise locations. These Tornado Warning lead times are unprecedented for tropical cyclone events, and even much better than the average for typical "midwestern supercells" which are often associated with much more well defined radar signatures. An article in the Daytona Beach News Journal the day after the storms described a Volusia county official who "praised a decision to cancel a soccer game Monday at a field that was later hit by a tornado" (the F2 at Edgewater). "Because of severe storm warnings...[we] prevented serious or fatal injuries...as a tornado swept through the park, hurling tree limbs, lamp poles and debris from buildings across the soccer field." Accordingly, the long lead times NWS MLB was able to provide during this event proved very beneficial to the the citizens of east central Florida.

[Forecast Team & Duties](#)

[Chronology of Events](#)

[Product Suite](#)



Map of MLB county warning area (CWA)

Fig. 1 Large scale radar reflectivity view of Tropical Storm Josephine rainbands (439 pm).

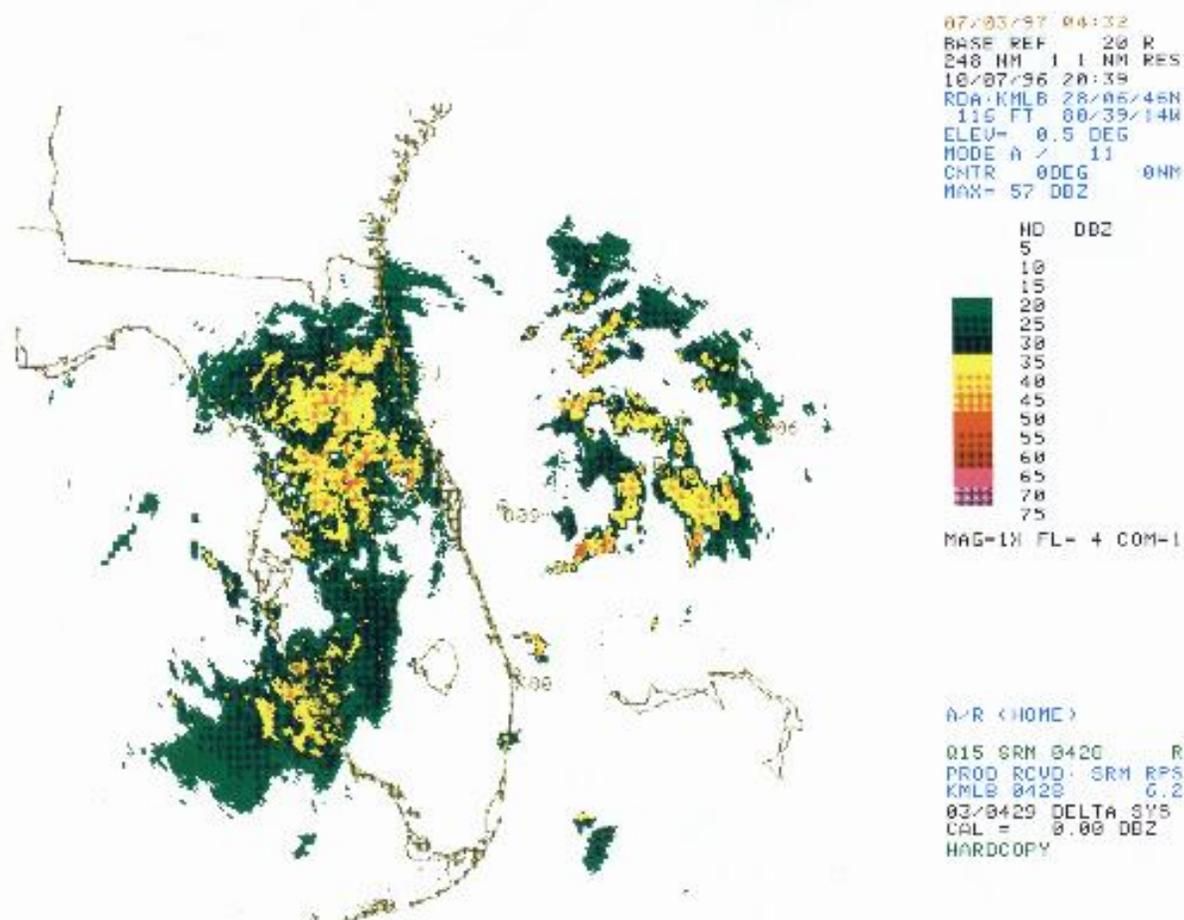
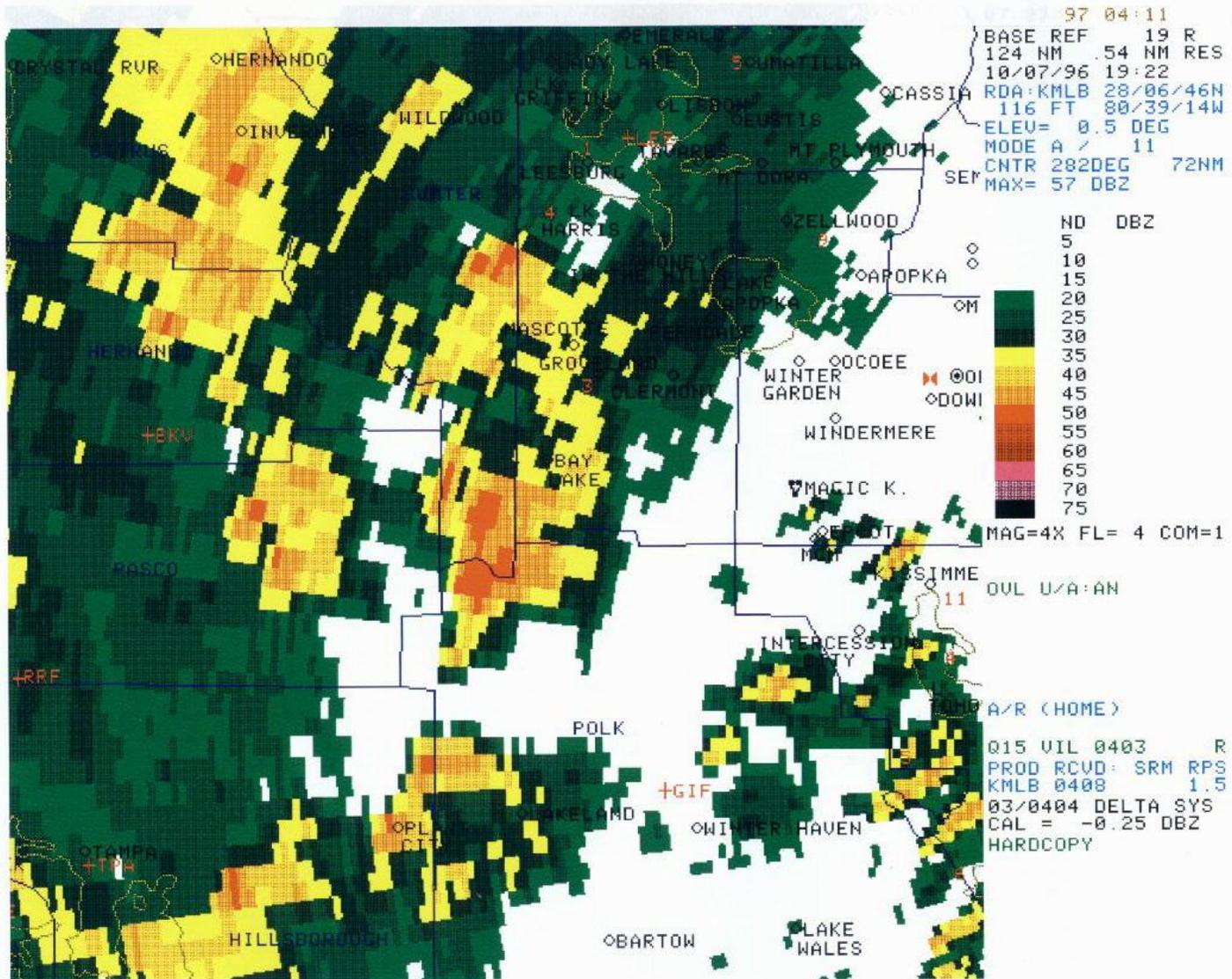


Fig. 2 Close up radar reflectivity image assessed as part of the decision to issue a Tornado Warning for Lake county (322 pm).



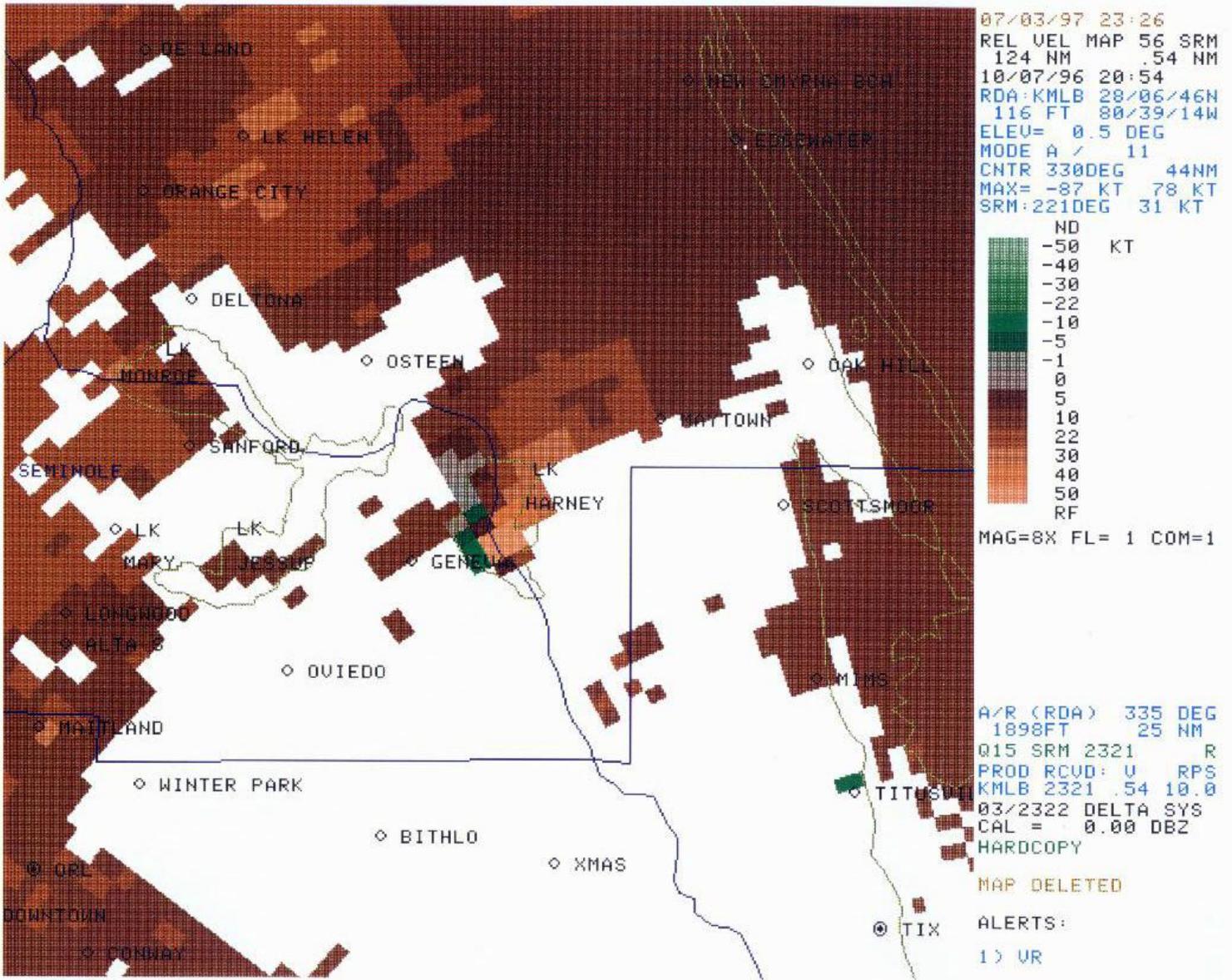


Fig. 3



Fig. 4



Fig. 5

The Forecast and Warning Team 7 October 1996

<u>duty</u>	<u>forecaster/HMT</u>	<u>shift</u> <u>hours</u> <u>(local</u> <u>time)</u>
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DAY SHIFT:

SHIFT LEADER severe weather coordinator@	<i>Scott Spratt</i>	0800- 1600
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assistant radar operator	<i>Bart Hagemeyer</i>	0800-1600
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aviation forecaster	<i>Dennis Decker</i>	0800-1600
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public service assistant NWR broadcaster*	<i>Mike Turner</i>	0800-1600
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NWR broadcaster* assistant public service	<i>Jackie Cartwright</i>	1000-1800
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EVENING SHIFT:

SHIFT LEADER aviation forecaster	<i>Tony Cristaldi</i>	1600-2400
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severe weather coordinator[@]	<i>Steve Hodanish</i>	1600-2400
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assistant radar operator	<i>Scott Spratt</i>	1600-2100
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public service NWR broadcaster*	<i>Bob Drummond</i>	1600-2400
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NOTE: [@]Individual was responsible for issuing warnings and was the primary radar operator.

*NWR represents NOAA Weather Radio.

CHRONOLOGY OF EVENTS

Below is the entire chronology of events associated with the tornado threat through the time of the last tornado. All events are listed to reveal the widespread effects of Tropical Storm Josephine upon the NWSO Melbourne county warning area, however the **events directly associated with the Lake and Volusia County tornadoes are highlighted in red.**

6 October 1996 (Sunday;
the day preceding the
tropical storm):

Day-shift The day shift forecaster called the meteorologist-in-charge (MIC) at home to advise him of the tornado potential for the following day.

417 pm A hazardous weather outlook (HWO) was issued with the headline "severe thunderstorms possible Monday into Monday night".

815 pm The area forecast discussion (AFD) emphasized the "potential for severe weather and flooding during the forecast period". The text specifically stated that "systems like this one can be very proficient tornado producers". Although the AFD is not a public product, the local television media makes extensive use of it to convey important points to their viewers.

1000 pm An internal hurricane hotline call is initiated by the Tropical Prediction Center (TPC) to advise local weather offices that the tropical depression was being upgraded to Tropical Storm Josephine. The Melbourne forecaster advised hotline participants of the high tornado threat with these types of systems.

1030 pm The Melbourne forecaster called the Storm Prediction Center (SPC) to discuss the high tornado threat associated with the approaching tropical storm.

7 October 1996 (Monday,
the day of the tropical
storm landfall):

315 am The AFD again emphasized the approaching severe weather threat and correctly mentioned that the brunt of the activity would occur along a warm front over the northern half of the county warning area (CWA).

452 am A short-term forecast (NOW) was issued which mentioned several strong thunderstorms would reach western portions of the CWA within the next hour.

510 am The SPC called to discuss the near-term severe weather threat based upon the approaching cells which were displaying weak rotation.

636 am A HWO was issued which again headlined the severe weather threat (including isolated, short-lived tornadoes), and identified the area most likely at risk as that near the northward moving warm front through late in the day.

815 am A NOW was issued with a headline of "severe weather threat increasing for Seminole and Volusia counties. The NOW also stated that a short lived tornado may develop by 930 am and suggested to listen for possible warnings.

845 am A **TORNADO WARNING** was issued for Volusia county until 945 am. The warning stated that doppler radar indicated a potential for short lived tornadoes .

915 am A Volusia county emergency manager called to report structural damage from a tornado in Deltona at 855 am.

918 am A NOW restated the tornado threat for Volusia county and described the areas most likely to be affected through 10 am.

923 am A Severe weather statement (SVS) for Volusia county mentioned the recent damage in Deltona and stated that additional tornado touchdowns would be possible until the cell reached the coast by 10 am.

928 am The AFD mentioned a high likelihood of additional severe weather during the late afternoon.

956 am A SVS stated that the tornado warning for Volusia county had expired and described the damage which had occurred in Deltona.

1020 am A delayed report indicated that a second tornado touchdown occurred at the immediate coast as the warning expired at 945 am.

1023 am A NOW mentioned that although the severe weather threat had temporally decreased, additional severe weather was likely after 12 noon.

1025 am The assistant radar operator discussed the prospect of additional severe weather with the SPC and agreed on counties to be included in a Tornado Watch.

1029 am The SPC issued a tornado watch until 1100 pm, which covered the entire CWA.

1100 am A HWO was issued to further highlight the continued tornado threat and to emphasize that tornadoes have already produced damage across the area.

1140 am A hurricane local statement (HLS) was issued to address the newly issued tropical storm warning for the northern half of the CWA coast. The statement continued to mention an increased threat of tornadoes.

1148 am A NOW mentioned that a threat of tornadoes was increasing across central portions of the CWA.

1255 pm A NOW mentioned that the severe weather threat was increasing across the southern half of the CWA.

108 pm A NOW was issued for the northern half of the CWA which stated that although the severe weather threat had temporarily decreased, it would increase again later in the afternoon.

- 132 pm** A NOW was issued for Osceola county which stated that an approaching storm has had a history of being tornadic (west of the CWA).
- 145 pm** A NOW for Brevard and Indian River counties mentioned several strong storms approaching.
- 210 pm** A NOW was issued for the entire CWA to headline the tornado watch and to provide a general description of the current situation ("severe weather not imminent...however the threat of short-lived tornadoes will likely increase later today).
- 227 pm** A HLS continued to emphasize the tornado threat.
- 237 pm** The AFD indicated no changes to the previous forecast philosophy (tornado threat continues).
- 255 pm** A NOW was issued for the northern half of the CWA and emphasized a strong cell approaching Lake county and that "similar cells had produced tornadoes earlier". The NOW also stated that a tornado warning may be needed soon for Lake county.
- 330 pm** A **TORNADO WARNING** was issued for Lake county until 430 pm. The warning described the tornado threat for the communities of Bay Lake, Clermont, Ferndale, and the Lake Apopka vicinity.
- 334 pm** The severe weather coordinator requested activation of Lake county Skywarn.
- 350 pm** The severe weather coordinator placed a telephone call to the Lake county Sheriff s Office to advise them of the approaching tornado.
- 353 pm** A SVS was issued to highlight the tornado warning for Lake county and to mention the threat to Groveland...Clermont...Ferndale...and Lake Apopka by 415 pm. This SVS was tone-alerted on NWR to further emphasize the threat.
- 400 pm** A phone call was made to the Clermont Police Dept. to advise them to be on the lookout for the approaching tornado.
- 404 pm** A report indicated a tornado sighting in Clermont.
- 405 pm** A report indicated a funnel cloud sighting in southern Lake county, moving northeast.
- 407 pm** A report relayed from the Lake county Sheriff's Office indicated a tornado touchdown in a mobile home park just west of Clermont.
- 408 pm** A SVS restated the tornado warning for Lake county, provided the current location of the tornado and mentioned areas which would likely be affected. This SVS was tone-alerted.
- 415 pm** A phone call was again placed to the Lake county Sheriff s office to update the progress of

the tornado.

420 pm A NOW was issued for all counties except Lake, to re-address the continued severe weather threat.

427 pm A **TORNADO WARNING** was re-issued for Lake county until 530 pm. The warning mentioned that a strong tornado would move towards the towns of Tavares...Oakland Park...Eustis...and Umatilla. The warning also mentioned recent tornado touchdowns and associated damage.

439 pm A **TORNADO WARNING** was issued for Seminole county until 545 pm. The warning highlighted the threat to the towns of Chuluota and Geneva.

441 pm The Lake county Sheriff's Office reported a tornado between Clermont and Groveland.

448 pm A SVS was issued for Lake county which headlined the tornado warning until 530 pm and described radar indications of two tornadic storms...one near Eustis moving towards Umatilla and Altoona, and the second near Ferndale moving towards Howey in the Hills and Astatula. The SVS stated that both storms have history of producing damaging tornadoes.

449 pm Seminole county SKYWARN was briefed.

452 pm Lake and Seminole county emergency officials were briefed on the movement of the tornadoes.

452 pm A spotter report indicated the town of Eustis (Lake county) was hit by a tornado.

453 pm A SVS was issued for Seminole and Volusia counties. The SVS headlined the tornado warning for Seminole county until 545 pm and discussed radar indications of a tornado just east of Oviedo which may reach Volusia county by 510 pm.

456 pm Public reports indicated tornado damage just west of Mt. Dora (Lake county). A post-storm survey indicated the tornado occurred at 445 pm.

459 pm State warning point communications relayed a report of damage in Mt. Dora (Lake county).

501 pm Telephone call reported a tornado touchdown in Eustis (Lake county).

503 pm Unconfirmed report of a tornado touchdown near Geneva (Seminole county).

505 pm Lake county Sheriff's Office reported a tornado touchdown in Mt. Dora.

504 pm A **TORNADO WARNING** was issued for Volusia until 600 pm. The warning stated that a tornadic thunderstorm was indicated by radar near Lake Harney (Seminole/Volusia county line) and would reach the towns of Edgewater and New Smyrna Beach by 530 pm.

A delayed report from weather spotter indicated he observed of a waterspout/tornado over/ across Lake Harney between 505 and 510 pm (the spotter looked for tornado after seeing the Seminole county Tornado Warning on TV).

513 pm A NOW for the southern half of the CWA mentioned that the severe weather was expected to remain west and north of the local area...however a tornado watch remained in effect.

520 pm A SVS was issued for Volusia county. The SVS updated the location of "two thunderstorms capable of producing tornadoes", one 6 miles southwest of Edgewater and the second near Astor Park. The statement stated that one tornado would cross Interstate I-95 and move towards Edgewater and New Smyrna Beach...and the second would reach Barberville. The severity of the situation was emphasized by revealing that tornado touchdowns had occurred during the past hour in association with both storms. This SVS was tone-alerted on NWR.

520-530 pm Numerous reports indicated a tornado hit Edgewater, producing significant damage.

520 pm A public report indicated tornado damage in Pierson (Volusia county).

521 pm A Phone call was made to Volusia county emergency management to update tornado locations.

536 pm A SVS for Lake county indicated the tornado warning had expired.

542 pm A call was made to the Edgewater Police Dept. for an update on damage. The dispatcher was very busy and suggested to call back later.

544 pm A HLS was issued to describe the overall severe weather situation.

556 pm A **TORNADO WARNING** was issued for northwest Volusia county until 700 pm. The warning explained that radar signatures indicated developing tornadoes near De Leon Springs and in the vicinity of Deland.

614 pm A SVS was issued for Volusia county. The tornado warning for Volusia county until 700 pm was headlined and the text stated that a tornado may affect the town of Ormond by the Sea by 630 pm.

620 pm A HWO was issued to indicate that the severe weather threat had temporarily ended, however, additional severe storms were possible later in the evening, especially across the southern portion of the CWA.

TORNADO WARNING STATISTICS

<u>County</u>	<u>Lead time (minutes)</u>	<u>Touchdown location (identified in warning?)</u>	<u>Fujita damage scale</u>
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Volusia ¹	10	Deltona; Yes	F0
	60	Daytona Beach; Yes	F0
Lake ²	34	Clermont; Yes	F0
Lake	14	Mt. Dora; Yes	F0
	34	Eustis; Yes	F0
Seminole	21	Lake Harney; No	Waterspout
Volusia ³	16	Edgewater; Yes	F2
	16	Pierson; No	F0
Volusia	False alarm		

¹ A NOW issued 30 minutes prior to the warning stated a "short-lived tornado" may form by 930.

² A NOW issued 35 minutes prior to the warning stated a "tornado warning" may be needed soon.

³ A SVS issued issued 11 minutes prior to the warning stated "a tornado may reach Volusia county by 510 pm.

Acronyms:

AFD	area forecast discussion	MIC	meteorologist in charge
HLS	hurricane local statement	CWA	county warning area
SVS	severe weather statement	NWR	NOAA weather radio
HWO	hazardous weather outlook	SPC	storm prediction center
NOW	short-term forecast ("nowcast")	TPC	tropical prediction center

END TO END PRODUCT SUITE

6 OCT.
96

<u>Issuance Time:</u>	<u>Product Type:</u>	<u>Counties Affected:</u>
417 pm	Hazardous Weather Outlook	All
815 pm	Area Forecast Discussion	All

7 OCT. 96

<u>Issuance Time:</u>	<u>Product Type:</u>	<u>Counties Affected:</u>
315 am	Area Forecast Discussion	All
452 am	Short Term Forecast	Okeechobee
636 am	Hazardous Weather Outlook	All
815 am	*** Short Term Forecast	Volusia/Lake/Orange/Seminole
845 am	*** Tornado Warning	Volusia
918 am	*** Short Term Forecast	Volusia/Lake/Orange/Seminole/ Brevard
923 am	*** Severe Weather Statement	Volusia
928 am	Area Forecast Discussion	All

956 am	*** Severe Weather Statement	Volusia
1023 am	Short Term Forecast	All
1100 am	Hazardous Weather Outlook	All
1140 am	Hurricane Local Statement	All
1148 am	Short Term Forecast	All
1255 pm	Short Term Forecast	Southern half of county warning area
108 pm	Short Term Forecast	Volusia/Lake/Orange/Seminole
132 pm	Short Term Forecast	Osceola
145 pm	Short Term Forecast	Brevard/Indian River
210 pm	Short Term Forecast	All
227 pm	Hurricane Local Statement	All
237 pm	Area Forecast Discussion	All
255 pm	*** Short Term Forecast	Volusia/Lake/Orange/Seminole
330 pm	*** Tornado Warning	Lake
353 pm	*** Severe Weather Statement	Lake
408 pm	*** Severe Weather Statement	Lake
420 pm	Short Term Forecast	All except Lake
427 pm	*** Tornado Warning	Lake
439 pm	*** Tornado Warning	Seminole
448 pm	*** Severe Weather Statement	Lake
453 pm	*** Severe Weather Statement	Seminole
504 pm	*** Tornado Warning	Volusia
513 pm	Short Term Forecast	Southern half of county warning area
520 pm	*** Severe Weather Statement	Volusia
536 pm	*** Severe Weather Statement	Lake
544 pm	Hurricane Local Statement	All
556 pm	Tornado Warning	Volusia
616 pm	Severe Weather Statement	Volusia
620 pm	Hazardous Weather Outlook	All

Products preceded by *** indicate those directly related to the Lake and Volusia county tornado events.