

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



ERA22LA395

METEOROLOGY

Specialist's Factual Report

December 1, 2022

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A. ACCIDENT

Location: Orlando, Florida
Date: September 1, 2022
Time: 1700 eastern daylight time
2100 coordinated universal time (UTC)
Airplane: DA 42 NG; Registration: N43RG

B. METEOROLOGY SPECIALIST

Specialist Paul Suffern
National Transportation Safety Board
Washington, DC

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's Senior Meteorologist was not on scene for this investigation and conducted the meteorology phase of the investigation remotely, collecting data from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the Weather Prediction Center (WPC) and the National Center for Environmental Information (NCEI). This Specialist's Factual Report contains the meteorological factors pertinent to the weather surrounding the accident time. All times are eastern daylight time (EDT) and are based upon the 24-hour clock, where local time is -4 hours from UTC. Directions are referenced to true north and distances are in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles. NWS station identifiers use the standard International Civil Aviation Organization 4-letter station identifiers versus the International Air Transport Association 3-letter identifiers, which deletes the initial country code designator "K" for U.S. airports.

The accident site was located at latitude 28.54386° N, Longitude 81.33903° W, at approximate elevation of 110 feet (ft).

D. FACTUAL INFORMATION

1.0 Synoptic Situation

The synoptic or large-scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction and the WPC, located in College Park, Maryland. These are the base products used in describing synoptic weather features and in the creation of forecasts and warnings for the NWS. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC 00-45H.¹

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart centered over the southeastern United States for 1700 EDT is provided as figure 1 with the location of the accident site within the black circle. The chart depicted a stationary frontal boundary stretched from a low-pressure system off the South Carolina coast westward across central Georgia into another low over Alabama, and then southwestward into Louisiana. There were several low and high-pressure systems along the frontal boundary. The closest low-pressure system was in southern Alabama with a pressure of 1013-hectopascals (hPa) and the closest high-pressure system in the southeastern South Carolina coast with a pressure of 1017-hPa. The accident site was located south of the stationary front in a warm side of the front.

The closest station model near the accident site depicted a thunderstorm with light rain, a northerly wind at 10 knots, an air temperature of 81° Fahrenheit (°F), with a dew point temperature of 70°F, and overcast clouds.

¹ https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1030235

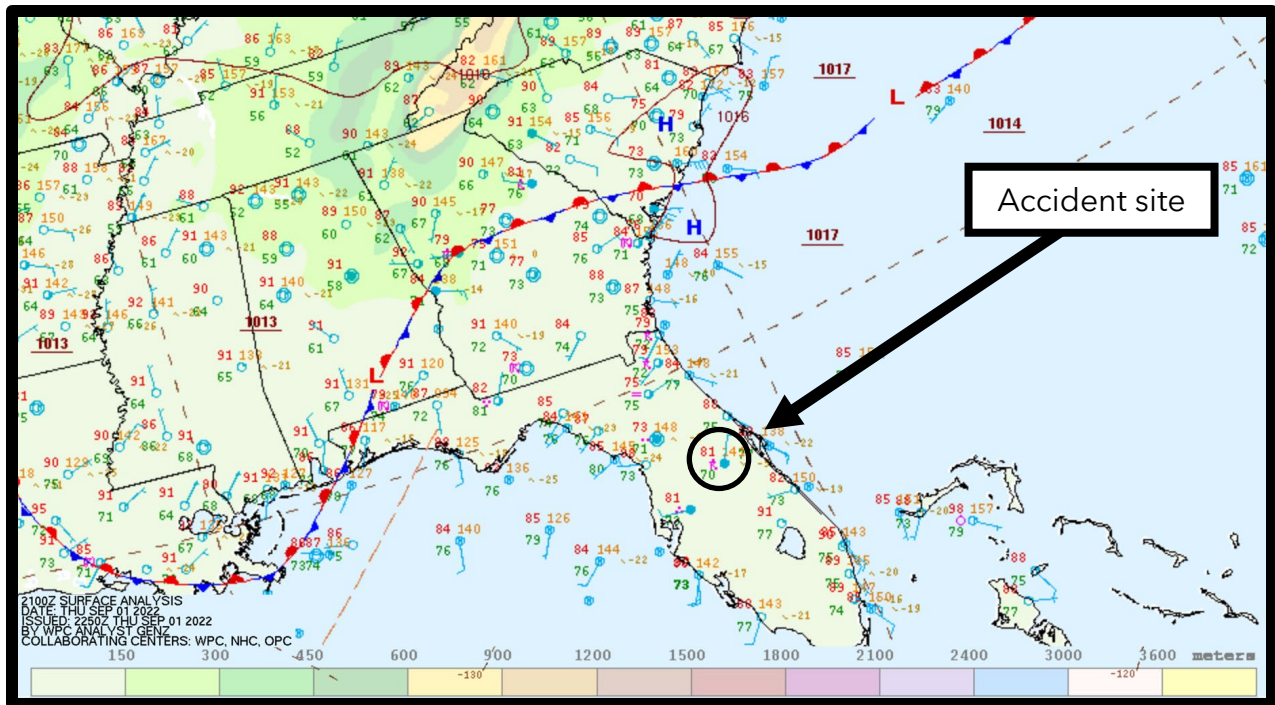


Figure 1. NWS Surface Analysis Chart for 1700 EDT.

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 2000 EDT at 925-, 850-, 700-, and 500-hPa are presented in figures 2 through 5. A low- and mid-level trough² was located above the accident at 925- and 700-hPa (figures 2 and 4). A mid-level low-pressure center was located north of the accident site (figure 5). Troughs and fronts can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present. The 925- through 500-hPa constant pressure charts depicted variable winds at or below 10 knots above the accident site at 2000 EDT.

² Trough - An elongated area of relatively low atmospheric pressure or heights.

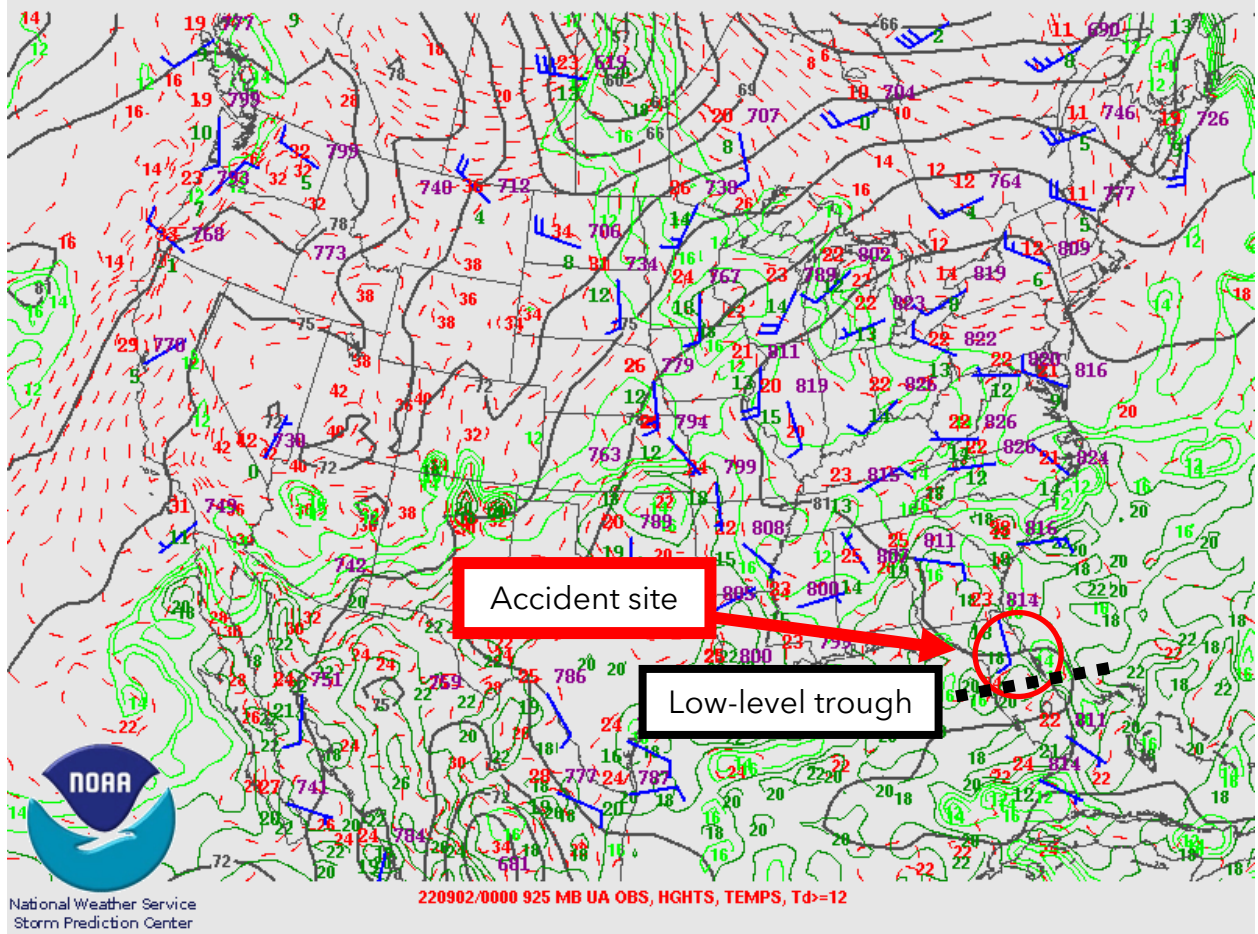


Figure 2. 925-hPa Constant Pressure Chart for 2000 EDT.

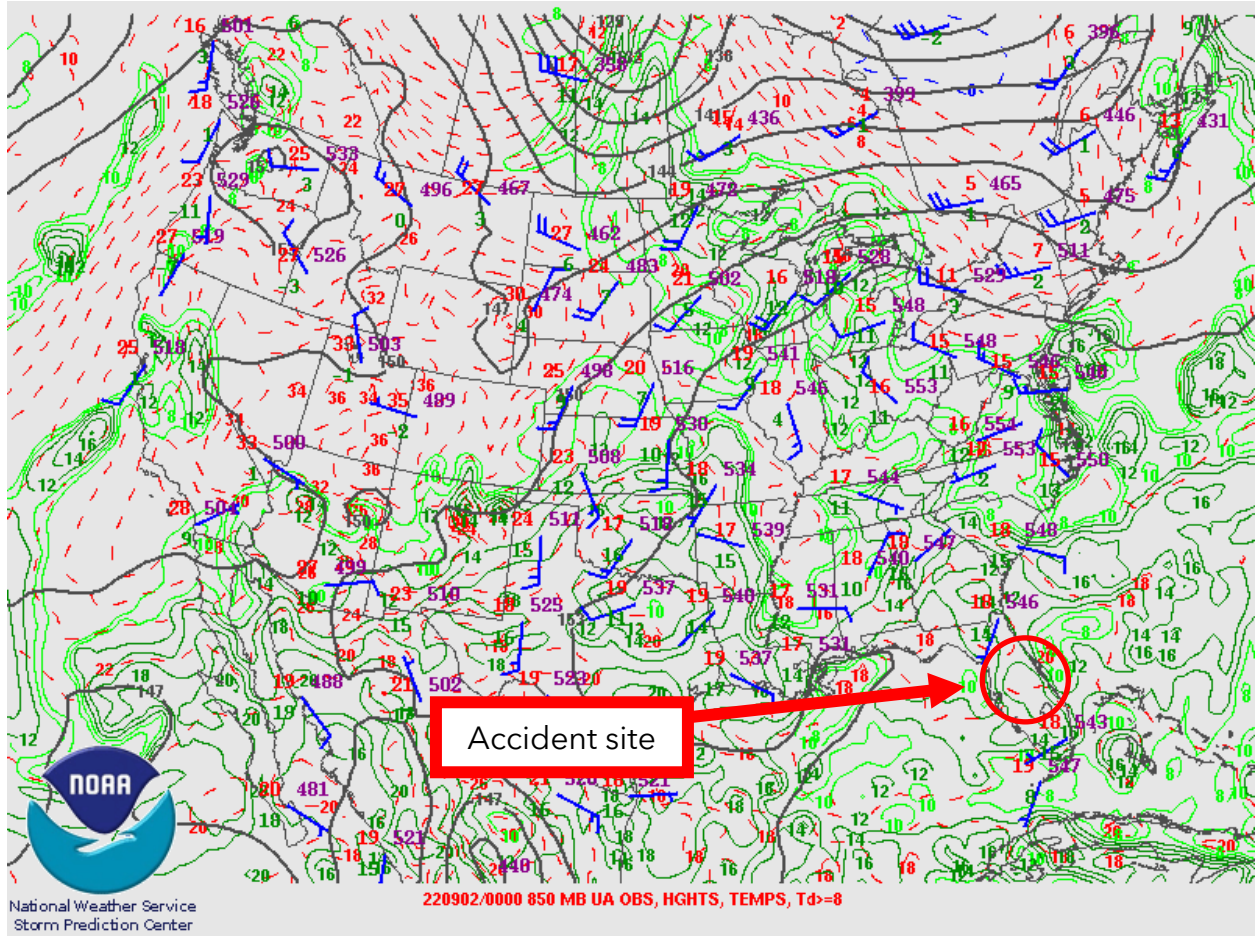


Figure 3. 850-hPa Constant Pressure Chart for 2000 EDT.

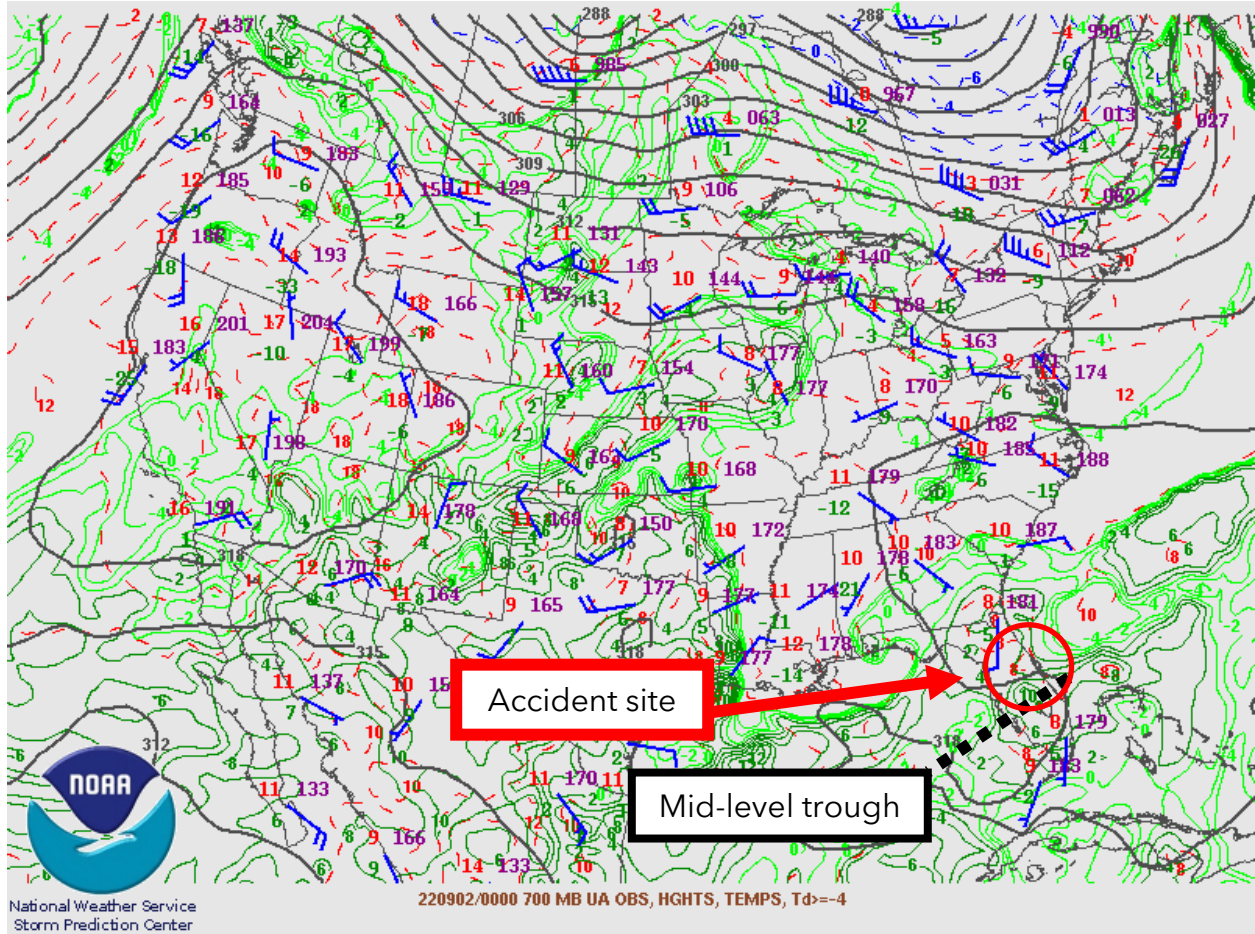


Figure 4. 700-hPa Constant Pressure Chart for 2000 EDT.

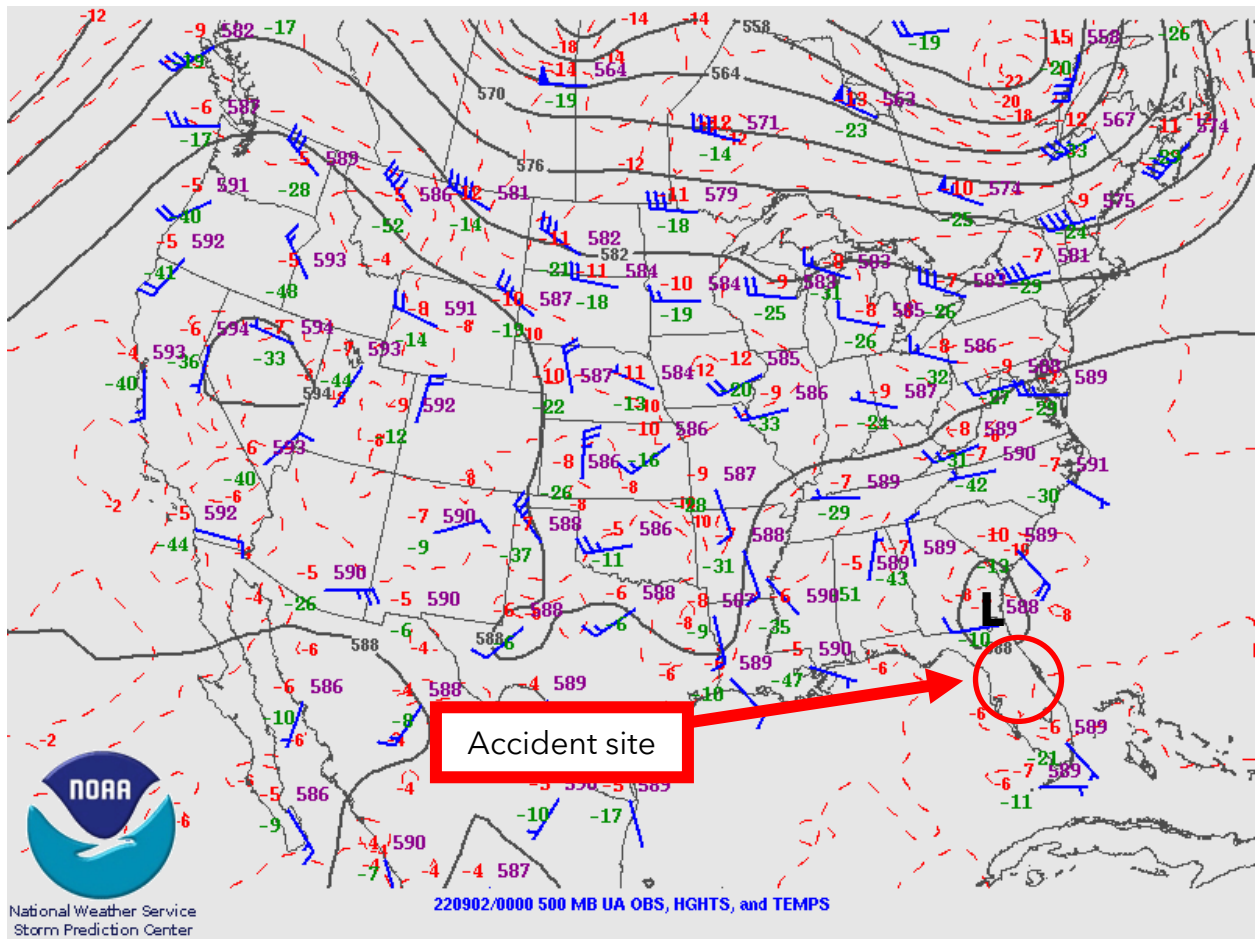


Figure 5. 500-hPa Constant Pressure Chart for 2000 EDT.

2.0 Storm Prediction Center Convective Outlook

The SPC issued a Day 1 Convective Outlook at 1555 EDT (figure 6) with areas of general thunderstorms forecast for the accident site. SPC defines the “TSTM” area as an area that encloses where a 10% or higher probability of thunderstorms is forecast during the valid period. The SPC text bulletin that was associated with the Convective Outlook text follows figure 6.

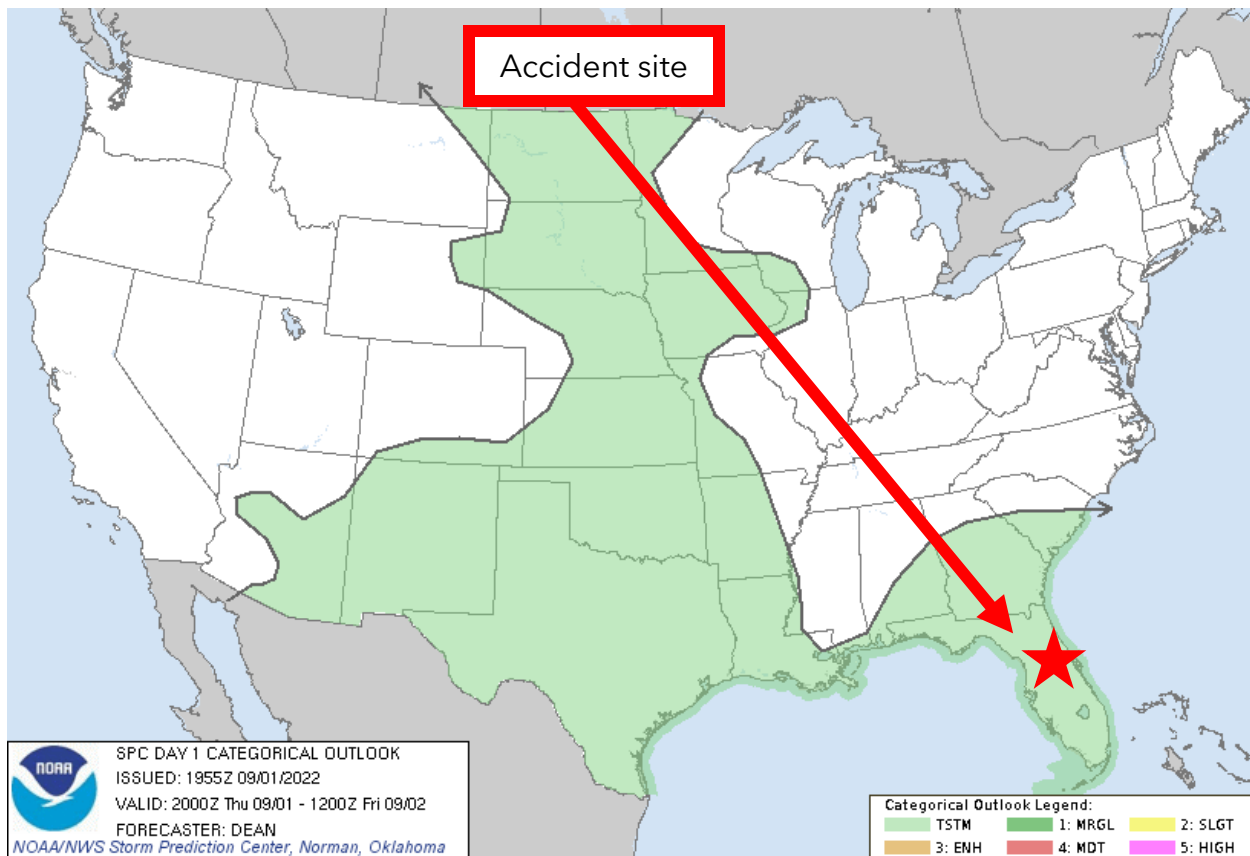


Figure 6. SPC day 1 Convective Outlook valid at the time of the accident.

SPC AC 011955

Day 1 Convective Outlook
 NWS Storm Prediction Center Norman OK
 0255 PM CDT Thu Sep 01 2022

Valid 012000Z - 021200Z

...NO SEVERE THUNDERSTORM AREAS FORECAST...

...SUMMARY...

Organized severe thunderstorms are not forecast across the contiguous United States through tonight.

...20Z Update...

No changes have been made to the outlook. A few strong storms will be possible along the periphery of extensive ongoing convection across the southern Plains, and also near/south of ongoing storms across GA/SC, wherever convective overturning has not occurred and stronger heating/destabilization is evident. While isolated downburst winds cannot be ruled out across these areas, weak deep-layer shear will tend to limit the organized severe-thunderstorm risk.

..Dean.. 09/01/2022

.PREV DISCUSSION... /ISSUED 1054 AM CDT Thu Sep 01 2022/

...Synopsis...

Tropical moisture, with boundary-layer dewpoints in the low-mid 70s and PW values greater than 2 inches, will persist across the Southeast. Primarily diurnal convection will be focused across south GA/north FL by a weak midlevel low and local sea breeze/differential heating zones. Farther west into the southern Plains, similar moisture exists with embedded/weak midlevel troughs over southwest OK and northern Mexico. The southwest OK wave will move slowly east-northeastward through tonight, in response to an upstream trough digging south-southeastward over KS. Embedded thunderstorms are expected across central OK with the ejecting wave, but lightning may be more prevalent around the northern-eastern-southern periphery of the midlevel trough, with diurnal convection in the zones of differential heating on the edge of the thicker clouds.

Otherwise, a larger-scale midlevel trough will move east-southeastward over AB/SK/MB, as a smaller-scale lead wave ejects generally eastward over MT today. Low-level moisture will be limited across the northern Plains, with only a small chance for thunderstorms with the ejecting shortwave trough and a cold front this evening into tonight.

CLICK TO GET WUUS01 PTSDY1 PRODUCT

NOTE: THE NEXT DAY 1 OUTLOOK IS SCHEDULED BY 0100Z

3.0 Surface Observations

The area surrounding the accident site was documented using official Aviation Routine Weather Reports (METARs) and Specials Reports (SPECIs). The following observations were taken from standard code and are provided in plain language. Figure 7 is a local sectional chart with the accident site and the closest weather reporting locations marked. The chart depicted the magnetic variation³ of 6.5° west over the area.

³ Magnetic variation - The angle (at a particular location) between magnetic north and true north. Latest measurement taken from <https://skyvector.com/>

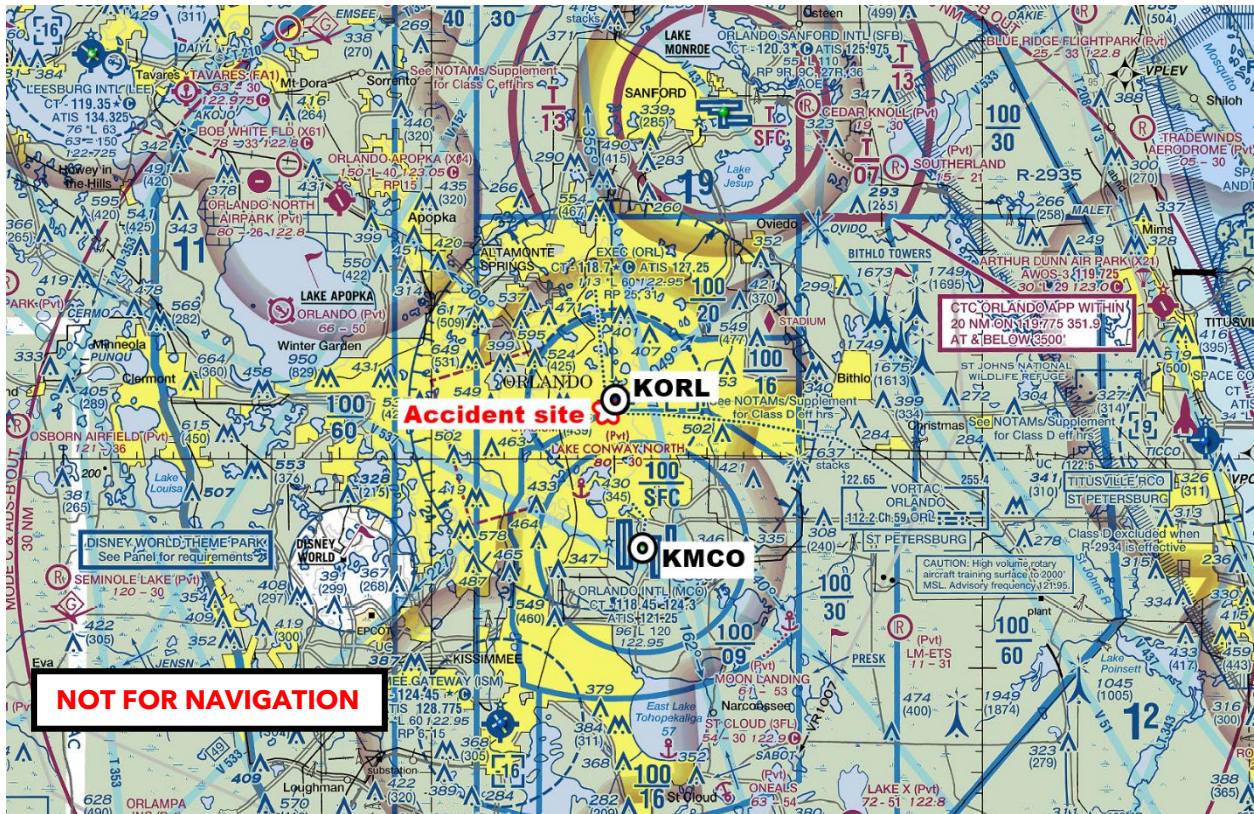


Figure 7. FAA sectional aeronautical chart of the accident area with the location of the accident site and surface observation sites.

The intended departure airport was Executive Airport (KORL) in Orlando, Florida, and KORL also had the closest official weather station to the accident site (figure 7). KORL had an Automated Surface Observing System (ASOS⁴) whose longline⁵ reports were augmented by air traffic control (ATC) when the tower was in operation⁶. The KORL ASOS was located a quarter of a mile northeast of the accident site, at an elevation of about 106 ft, and issued the following observations surrounding the period of the accident:⁷

⁴ ASOS - Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, weather phenomena, ceiling, temperature, dewpoint, altimeter, and barometric pressure. ASOS are maintained by the NWS.

⁵ "Longline" refers to the dissemination of weather observations with the intent that they are available in near-real time to national databases and accessible to the general global public from a large number of vendors. This does not include public accessibility to observations from a reporting station's Very High Frequency (VHF; line-of-site) or telephone broadcast, where applicable. Longline dissemination of weather observations is the primary vehicle through which the weather observations are distributed.

⁶ ATC operation hours between 0700 and 2200 local.

⁷ The bold sections in this NWS product and the rest of the products in this report are intended to highlight the text that directly reference the weather conditions that affected the accident location around the accident time. The local times in this section next to the METARs are provided for quick reference between UTC and local times around the accident time.

[1453 EDT] METAR KORL 011853Z 14005KT 10SM CLR 34/22 A2997
RMK AO2 LTG DSNT W SLP151 T03440222

[1553 EDT] METAR KORL 011953Z AUTO 15003KT 10SM FEW055
SCT075 34/22 A2994 RMK AO2 LTG DSNT S-W SLP140 T03390217

[1621 EDT] SPECI KORL 012021Z 06009KT 10SM VCTS FEW055
SCT090 32/23 A2994 RMK AO2 LTG DSNT ALQDS T03220233

[1641 EDT] SPECI KORL 012041Z 15011G16KT 110V180 10SM TS
SCT041 BKN060 BKN095 32/23 A2994 RMK AO2 LTG DSNT ALQDS
TSB35 T03170233

[1653 EDT] METAR KORL 012053Z 12029G38KT 2 1/2SM
R07/5500VP6000FT TSRA FEW020 BKN039 OVC060 27/22 A2995 RMK
AO2 PK WND 11038/2053 LTG DSNT ALQDS RAB51 TSB35 SLP142
P0009 60009 T02670222 55019

[1657 EDT] SPECI KORL 012057Z 10043G54KT 1/2SM
R07/2600VP6000FT +TSRA SCT022 BKN039 OVC060 24/21 A3002
RMK AO2 PK WND 12054/2055 LTG DSNT ALQDS PRESRR P0015
T02440211

**[1659 EDT] SPECI KORL 012059Z 10032G54KT 060V130 1/4SM
R07/0400VP6000FT +TSRA FG SCT017 BKN029 OVC060 23/21
A3000 RMK AO2 PK WND 12054/2055 LTG DSNT ALQDS PRESRR
P0039 T02280206**

ACCIDENT TIME 1700 EDT

**[1708 EDT] SPECI KORL 012108Z VRB05G49KT 1/4SM
R07/0400V6000FT +TSRA BKN016 BKN029 OVC040 26/19 A2995
RMK AO2 PK WND 12054/2055 WSHFT 2048 LTG DSNT ALQDS
P0067 T02560189**

[1712 EDT] SPECI KORL 012112Z VRB03G28KT 1SM
R07/1800VP6000FT +TSRA BKN024 BKN029 OVC040 27/20 A2996
RMK AO2 PK WND 12054/2055 WSHFT 2048 LTG DSNT ALQDS P0070
T02670200

The bold type observations decoded in plain language were as follows:

KORL weather at 1659 EDT, wind from 100° at 32 knots with gusts to 54 knots, wind varying between 060° and 130°, ¼ mile visibility, runway visual range on runway 07 varying between 400 ft and greater than 6,000 ft, thunderstorm and heavy rain, fog, scattered clouds at 1,700 ft above ground level (agl), broken ceiling at 2,900 ft agl, overcast skies at 6,000 ft agl, temperature of 23° Celsius (C), dew point temperature 21°C, and an altimeter setting of 30.00 inches of mercury (inHg). Remarks, automated station with a precipitation discriminator, peak wind at 1655 EDT from 120° at 54 knots, lightning distant⁸ all quadrants, pressure rising rapidly, 0.39 inches of precipitation since 1653 EDT, temperature 22.8°C, dew point temperature 20.6°C.

KORL weather at 1708 EDT, wind variable at 5 knots with gusts to 49 knots, ¼ mile visibility, runway visual range on runway 07 varying between 400 ft and 6,000 ft, thunderstorm and heavy rain, broken ceiling at 1,600 ft agl, broken skies at 2,900 ft agl, overcast skies at 4,000 ft agl, temperature of 26°C, dew point temperature 19°C, and an altimeter setting of 29.95 inHg. Remarks, automated station with a precipitation discriminator, peak wind at 1655 EDT from 120° at 54 knots, wind shift at 1648 EDT, lightning distant all quadrants, 0.67 inches of precipitation since 1653 EDT, temperature 25.6°C, dew point temperature 18.9°C.

The next closest official weather station to the accident site was at Orlando International Airport (KMCO, figure 7). KMCO had an ASOS whose longline reports were augmented by an official observer. The KMCO ASOS was located 7 miles south of the accident site, at an elevation of about 96 ft, and issued the following observations surrounding the period of the accident:

[1453 EDT] METAR KMCO 011853Z VRB03KT 10SM SCT045 SCT300 34/22
A2997 RMK AO2 LTG DSNT W SLP146 CB DSNT W T03440222=

[1553 EDT] METAR KMCO 011953Z 19006KT 10SM BKN055 BKN300 33/21
A2994 RMK AO2 LTG DSNT SE-W SLP135 CB DSNT SE-SW T03330211=

[1606 EDT] SPECI KMCO 012006Z 09006KT 10SM TS FEW025 BKN055CB
BKN300 34/22 A2993 RMK AO2 LTG DSNT SE-W TSE04B06 OCNL LTGICCG
SE W TS SE W STNRY VCSH SE W T03440222=

[1631 EDT] SPECI KMCO 012031Z 07016G36KT 030V090 3SM
R35L/1400V3500FT +TSRA SCT014 BKN044CB BKN095 OVC300 27/21
A2996 RMK AO2 PK WND 10036/2029 LTG DSNT ALQDS RAB15
TSE04B06 PRESRR FRQ LTGICCG ALQDS TS ALQDS STNRY P0023
T02670211=

⁸ Distant indicated that the lightning was beyond 10 miles but less than 30 miles from the center of the airport (or airport location point, [ALP]).

[1637 EDT] SPECI KMCO 012037Z 09023G36KT 3SM
R35L/1600V2400FT +TSRA SCT008 BKN044CB BKN095 OVC300 26/22
A2997 RMK AO2 PK WND 10036/2029 LTG DSNT ALQDS RAB15
TSE04B06 PRESRR FRQ LTGICCG ALQDS TS ALQDS STNRY P0048
T02560217=

[1641 EDT] SPECI KMCO 012041Z 05021G38KT 2SM
R35L/1600VP6000FT +TSRA SCT008 BKN040CB BKN095 OVC300
24/21 A2995 RMK AO2 PK WND 06038/2040 LTG DSNT ALQDS RAB15
TSE04B06 FRQ LTGICCG ALQDS TS ALQDS STNRY P0050 T02440211=

[1650 EDT] SPECI KMCO 012050Z 04013G26KT 4SM -TSRA SCT008
BKN043CB OVC095 27/21 A2995 RMK AO2 PK WND 06038/2040 LTG
DSNT ALQDS RAB15 TSE04B06 FRQ LTGICCG ALQDS TS ALQDS
STNRY P0076=

**[1653 EDT] METAR KMCO 012053Z 03008G25KT 7SM -TSRA
SCT008 BKN043CB BKN070 OVC300 27/21 A2995 RMK AO2 PK
WND 06038/2040 LTG DSNT ALQDS RAB15 TSE04B06 SLP141 FRQ
LTGICCG ALQDS TS ALQDS STNRY P0076 60076 T02720211
55005=**

ACCIDENT TIME 1700 EDT

**[1713 EDT] SPECI KMCO 012113Z 22011G22KT 1SM
R35L/P6000FT +TSRA SCT008 BKN043CB OVC070 25/22 A2997
RMK AO2 WSHFT 2059 VIS 1/2V5 LTG DSNT ALQDS FRQ LTGICCG
ALQDS TS ALQDS STNRY P0002 T02500222=**

[1723 EDT] SPECI KMCO 012123Z 26005KT 2SM TSRA BR SCT008
BKN043CB OVC070 24/23 A2997 RMK AO2 WSHFT 2059 LTG DSNT
ALQDS FRQ LTGICCG ALQDS TS ALQDS STNRY P0019 T02440228=

The bold type observations decoded in plain language were as follows:

KMCO weather at 1653 EDT, wind from 030° at 8 knots with gusts to 25 knots, 7 miles visibility, thunderstorm and light rain, scattered clouds at 800 ft agl, broken ceiling of cumulonimbus clouds at 4,300 ft agl, broken skies at 7,000 ft agl, overcast skies at 30,000 ft agl, temperature of 27°C, dew point temperature 21°C, and an altimeter setting of 29.95 inHg. Remarks, automated station with a precipitation discriminator, peak wind at 1640 EDT from 060° at 38 knots, lightning distant all quadrants, rain began at 1615 EDT, thunderstorm ended at 1604 EDT and began at 1606 EDT, sea level pressure 1014.1 hPa, frequent in-cloud and cloud-to-ground lightning all quadrants, thunderstorm in all quadrants stationary, 0.76 inches of precipitation since 1553 EDT, 6-hourly precipitation of 0.76 inches, temperature 27.2°C, dew point temperature 21.1°C, 3-hourly pressure decrease of 0.5 hPa.

KMCO weather at 1713 EDT, wind from 220° at 11 knots with gusts to 22 knots, 1 mile visibility, runway visual range on runway 35L of greater than 6,000 ft, thunderstorm and heavy rain, scattered clouds at 800 ft agl, broken ceiling of cumulonimbus clouds at 4,300 ft agl, overcast skies at 7,000 ft agl, temperature of 25°C, dew point temperature 22°C, and an altimeter setting of 29.97 inHg. Remarks, automated station with a precipitation discriminator, wind shift at 1659 EDT, visibility varying between a ½ and 5 miles, lightning distant all quadrants, frequent in-cloud and cloud to ground lightning all quadrants, thunderstorm in all quadrants stationary, 0.02 inches of precipitation since 1653 EDT, temperature 25.0°C, dew point temperature 22.2°C.

The observations from KORL and MCO surrounding the accident time indicated LIFR⁹ conditions due to the heavy rain and thunderstorms. Thunderstorms began at 1635 EDT at KORL with gusting winds reported at 1641 EDT.

⁹ As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories:

- Low Instrument Flight Rules (LIFR*) - ceiling below 500 ft above ground level (agl) and/or visibility less than 1 statute mile.
- Instrument Flight Rules (IFR) - ceiling between 500 to below 1,000 feet agl and/or visibility 1 to less than 3 miles.
- Marginal Visual Flight Rules (MVFR**) - ceiling from 1,000 to 3,000 ft agl and/or visibility 3 to 5 miles.
- Visual Flight Rules (VFR) - ceiling greater 3,000 ft agl and visibility greater than 5 miles.

* By definition, IFR is a ceiling less than 1,000 ft agl and/or visibility less than 3 miles while LIFR is a sub-category of IFR.

**By definition, VFR is a ceiling greater than or equal to 3,000 ft agl and visibility greater than 5 miles while MVFR is a sub-category of VFR.

4.0 Upper Air Sounding

A High-Resolution Rapid Refresh (HRRR)¹⁰ model sounding was created for the approximate accident site coordinates for 1600 EDT (figure 8) and 1700 EDT (not shown).¹¹ The 1600 EDT HRRR sounding was plotted on a standard Skew-T Log P diagram¹² from the surface to 600-hPa (or approximately 14,000 ft) using the RAOB¹³ software package and depicted the pre-storm environmental conditions. The 1700 EDT HRRR sounding is not included below as its data showed conditions within the thunderstorm environment with that environment already cooled at the surface without the wind gusts potential. The 1600 EDT sounding depicted an elevation of 105 ft over the grid point with a near surface temperature of 32.9°C and a dew point temperature of 23.2°C, with a relative humidity of 57%. The sounding depicted the lifted condensation level (LCL)¹⁴ and the level of free convection (LFC)¹⁵ at 4,176 ft, and the convective condensation level (CCL)¹⁶ at 4,573 ft. The freezing level was located at 15,932 ft. The precipitable water value at 2.13 inches.

¹⁰ The HRRR is a NOAA real-time three-kilometer resolution, hourly-updated, cloud-resolving, convection-allowing atmospheric model, initialized by three-kilometer grids with three-kilometer radar assimilation. Radar data is assimilated in the HRRR every 15 minutes over a one-hour period.

¹¹ HRRR sounding was created using NOAA Air Resource Laboratory:
<https://ready.arl.noaa.gov/READYamet.php>

¹² Skew T log P diagram - is a standard meteorological plot using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

¹³ RAOB - (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Eosonde Research Services, The Villages, Florida.

¹⁴ LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

¹⁵ LFC - The level at which a parcel of saturated air becomes warmer than the surrounding air and begins to rise freely. This occurs most readily in a conditionally unstable atmosphere.

¹⁶ CCL - The level in the atmosphere to which an air parcel, if heated from below, will rise dry adiabatically, without becoming colder than its environment just before the parcel becomes saturated.

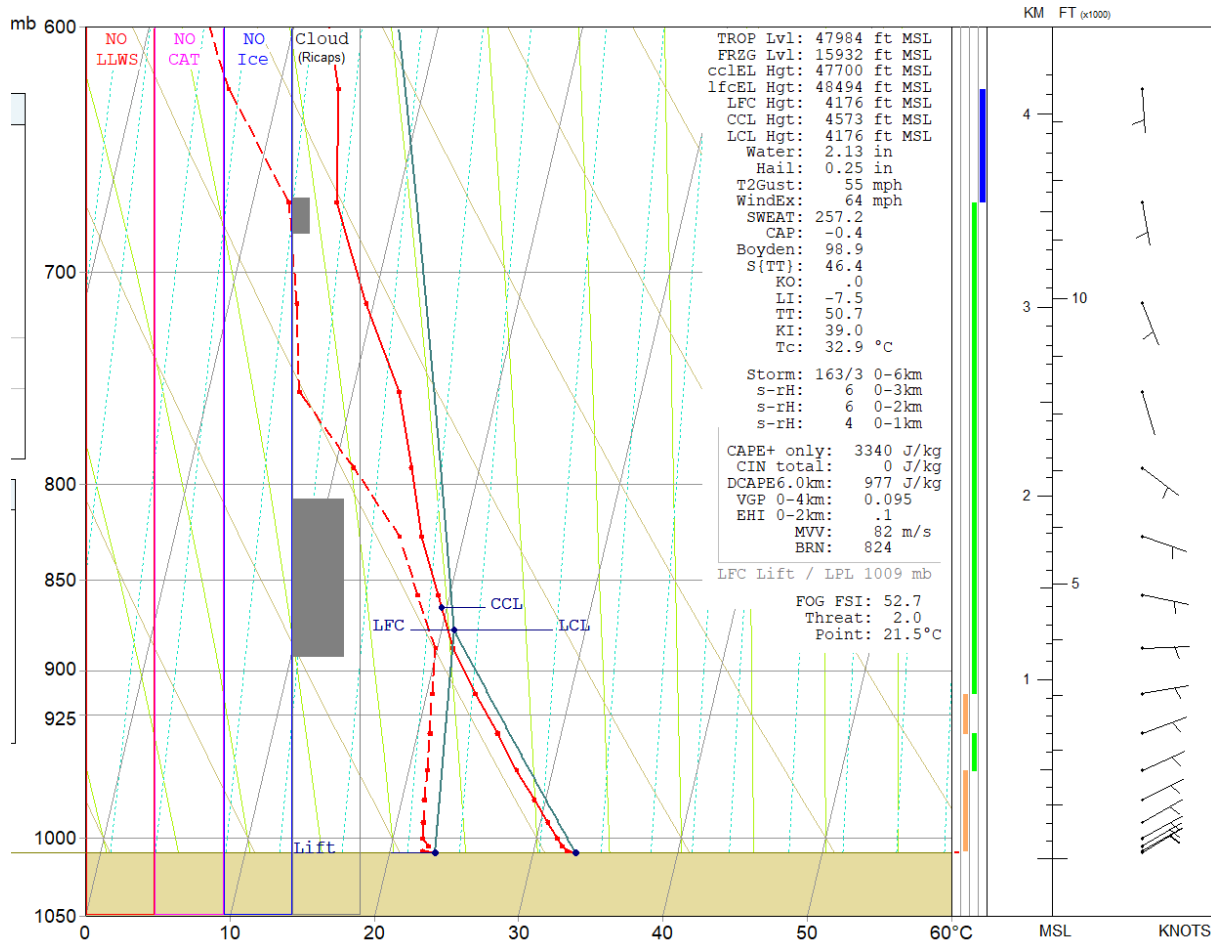


Figure 8. 1600 EDT HRRR sounding.

The 1600 EDT HRRR sounding indicated an unstable atmosphere based on the Lifted Index of -7.5 and the Convective Available Potential Energy (CAPE)¹⁷ of 3,340 Joules/kilogram (J/kg), with the maximum vertical velocity (MVV) for this atmosphere was calculated as 82 meters/second (about 16,141 ft per minute).¹⁸ Outside of cumulonimbus clouds, RAOB indicated cloud cover in two layers between 4,000 ft and 12,000 ft with no icing below 14,000 ft. The strongest surface wind gusts potential, due to microburst, downburst, or outflow, indicated by the RAOB's WindEx parameter was 56 knots or 64 miles per hour (mph).

¹⁷ Convective Available Potential Energy (CAPE) - CAPE is a measure of the amount of energy available for convection and is directly related to the maximum potential vertical speed within an updraft.

¹⁸ MVV is not usually considered a realistic estimate for maximum vertical velocity in a storm. Anecdotes suggest considering a value of MVV/2, however it is not well understood when or where such a half-value should be applied.

The 1600 EDT HRRR sounding wind profile indicated a near surface wind from 057° at 5 knots with the wind remaining variable and below 10 knots through 14,000 ft. RAOB did not indicate the possibility of low-level wind shear (LLWS) or clear air turbulence (CAT) outside of rain shower or thunderstorm activity. The 0 to 6 kilometer storm motion was from 163° at 3 knots.

5.0 Satellite Data

Geostationary Operational Environmental Satellite number 16 (GOES-16) visible and infrared data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System software. Visible and infrared imagery (GOES-16 bands 2 and 13) at wavelengths of 0.64 microns (μm) and 10.3 μm , respectively, were retrieved for the period from 1500 EDT through 2000 EDT and reviewed, and the closest images to the time of the accident were documented.

Figure 9 presents the GOES-16 visible imagery from 1700 EDT at 2X magnification with the accident site highlighted with a red square and cloud cover indicated above the accident site cumuliform in nature. The cloud cover was growing from southeast to northwest with time and the lightning¹⁹ activity was increasing (attachment 1). Figure 10 presents the GOES-16 infrared imagery from 1700 EDT at 6X magnification with the accident site highlighted with a red square. The lower cloud top temperatures (green and blue colors; higher cloud tops) were located above and surrounding the accident site at the accident time. The cloud cover had a radiative cloud top temperature of 206 Kelvin above the accident site which would have been near 48,000 ft based on the vertical temperature profile provided by the 1600 EDT HRRR sounding (not shown). It should be noted these figures have not been corrected for any parallax error.

¹⁹ Geostationary Lightning Mapper (GLM) reference: [GLMFactSheet_v11.pdf\(nasa.gov\)](#)

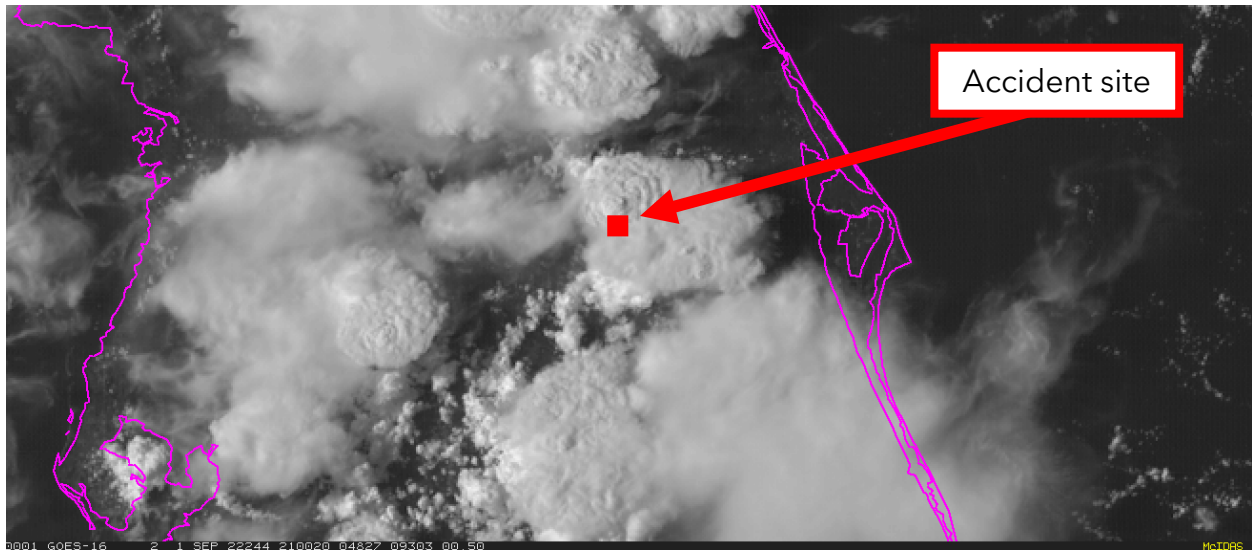


Figure 9. GOES-16 visible image at 1700 EDT.

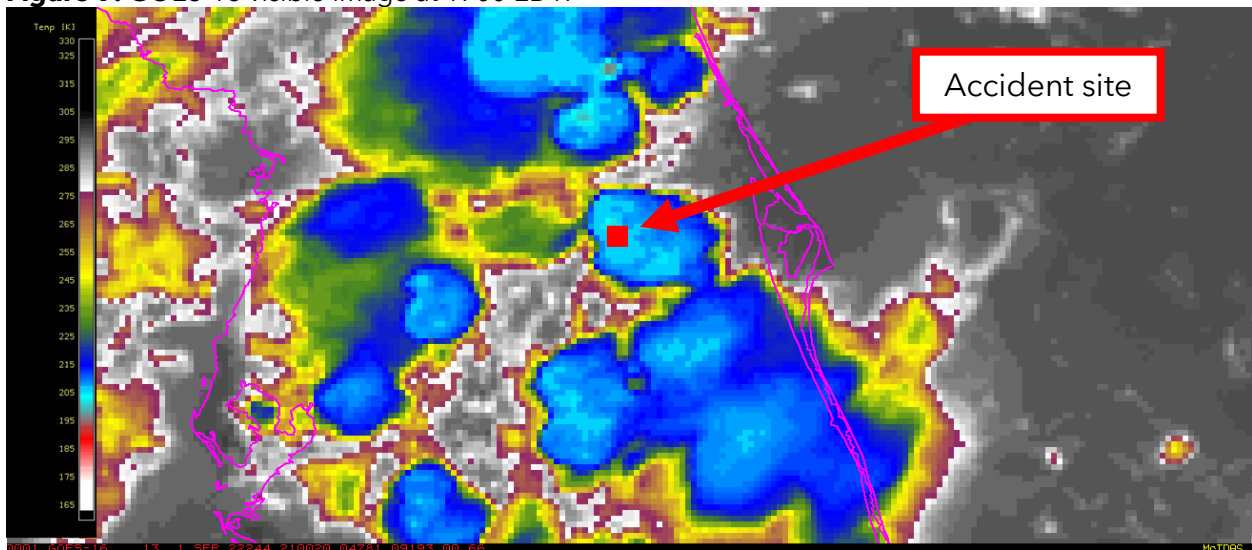


Figure 10. GOES-16 infrared image at 1700 EDT.

6.0 National Radar Imagery

A regional view of the NWS National Reflectivity Mosaic is included as figure 11 for 1700 EDT with the approximate location of the accident site marked by a black circle. The image depicted 40 to 60 dBZ²⁰ echoes above the accident site.

²⁰ dBZ - A non-dimensional "unit" of radar reflectivity which represents a logarithmic power ratio (in decibels or dB) with respect to radar reflectivity factor, Z.

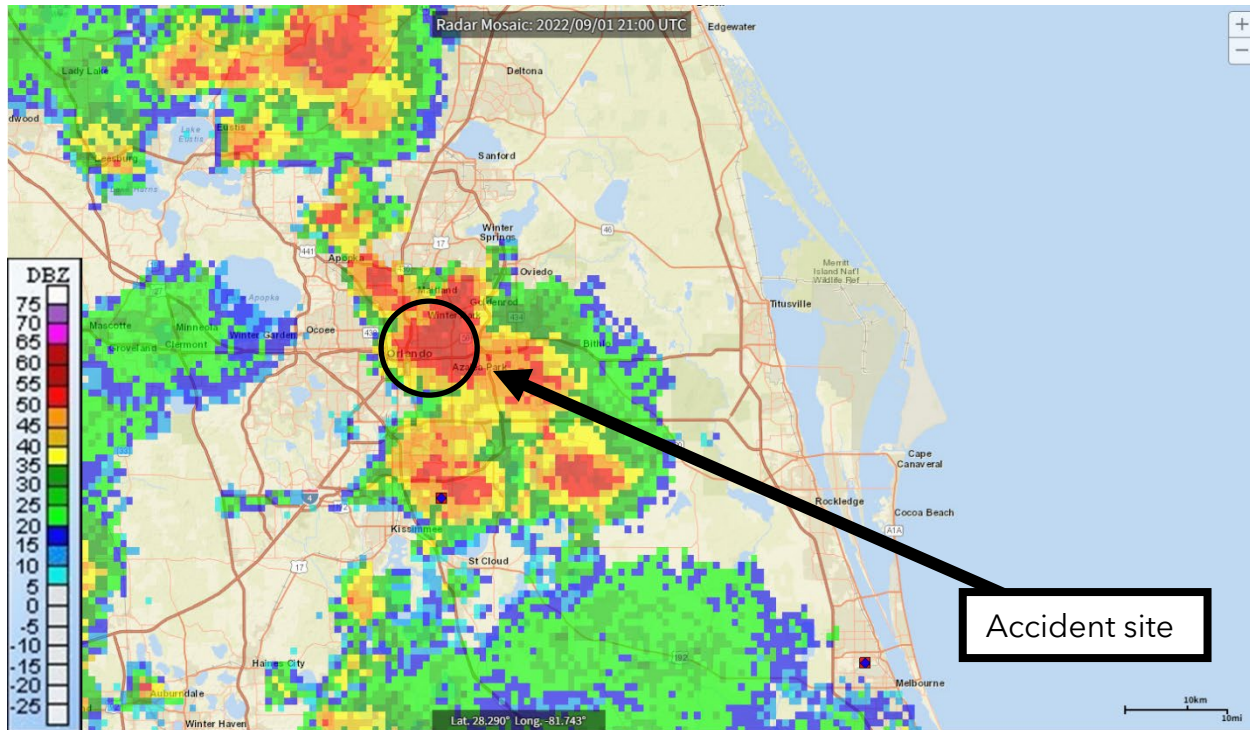


Figure 11. National Reflectivity Mosaic for 1700 EDT.

7.0 Weather Surveillance Radar Imagery

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)²¹ to the accident site was Melbourne, Florida, WSR-88D, (KMLB) located 44 miles southeast of the accident site. The Level II archive radar data were obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software. In addition, the Terminal Doppler Weather Radar (TDWR) data from Orlando (TMCO) was obtained and reviewed with TMCO located 12 miles south of the accident site.

7.1 Volume Scan Strategy

During the period surrounding the accident, the KMLB WSR-88D radar was operating in the precipitation mode VCP-212²² (figure 12). The following figure provides an indication of the different elevation angles in this VCP, and the approximate height and width of the radar beam with distance from the radar site.

²¹ The WSR-88D is an S-band 10-centimeter wavelength radar with a power output of 750,000 watts, and with a 28-foot parabolic antenna that concentrates the energy between a 0.87° and 0.96° beam width. The radar produces three basic types of products: base reflectivity, base radial velocity, and base spectral width.

²² Volume Coverage Pattern (VCP)-212.

VCP 212

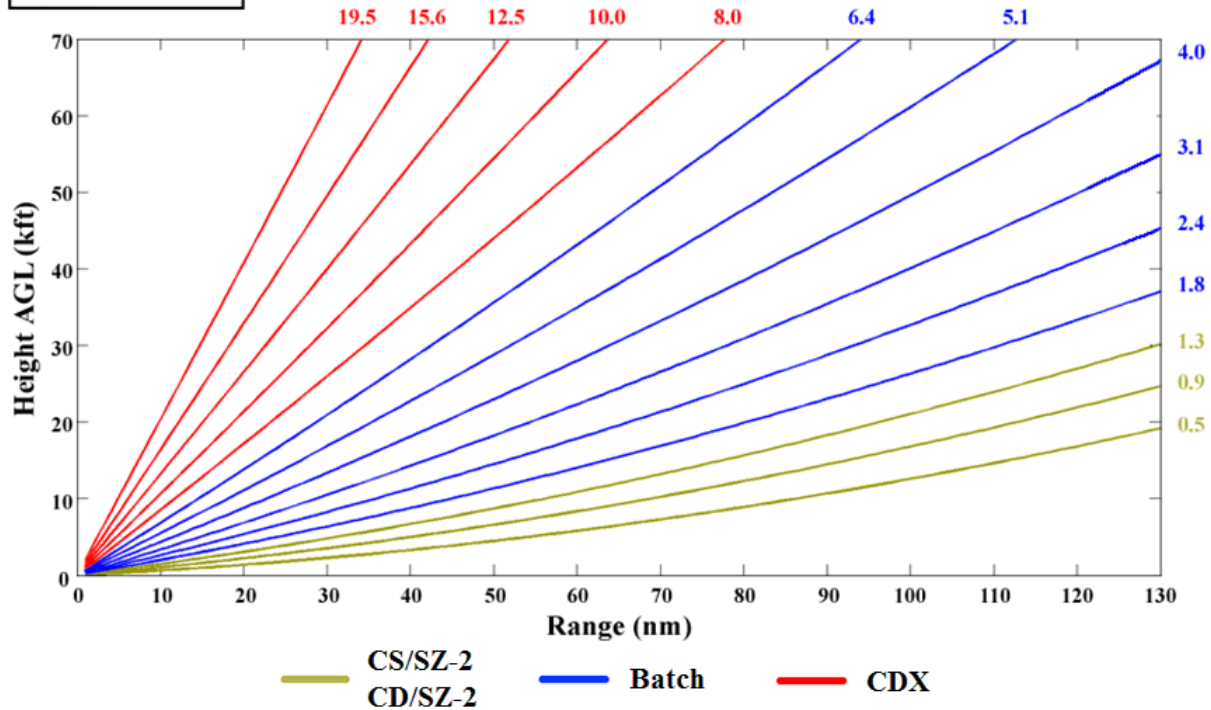


Figure 12. VCP-212 Precipitation Mode Scan Strategy²³.

7.2 Beam Height Calculation

Assuming standard refraction²⁴ of the KMLB WSR-88D radar beam with the antenna elevation at 149 ft, and considering a beamwidth²⁵ of 0.95°, the following table shows the approximate heights for the radar beam center, top and base for antenna elevations over the accident site. Additional calculations are also made for TMCO with antenna elevation around 230 ft. These heights have been rounded to the nearest 10 ft.

²³ Contiguous Surveillance (CS)--The low Pulse Repetition Frequency (PRF) scan of the split cut. Gives a high R_{max} value to determine proper target location and intensity, but a low V_{max} value limits the velocities that can be measured.

Contiguous Doppler (CD)--The high PRF scan of the split cut. Gives a low R_{max} value causing more range folded (multiple trip) echoes, but a high V_{max} value to get higher, more accurate velocity values. Batch Mode - Uses alternating low and high PRFs on each radial for one full rotation at each elevation angle. The two resulting data sets (low PRF and high PRF) are combined to resolve range ambiguity. Used in the middle elevation angles.

W - With range unfolding (W)

WO - Without range unfolding (WO)

²⁴ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

²⁵ Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
KMLB 0.5°	3,720 ft	1,500 ft	5,940 ft
TMCO 0.3°	660 ft	310 ft	1,010 ft

Based on the radar height calculations, the elevation scans reviewed from KMLB and TMCO listed in the above table depicted the conditions between 310 ft and 5,940 ft over the accident site and these elevation scans “saw” the closest weather radar information to the ground.

7.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²⁶ it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in dBZ and is a general measure of echo intensity. FAA Advisory Circular AC 00-24C²⁷, “Thunderstorms,” dated February 19, 2013, also defines the echo intensity levels and weather radar echo intensity terminology associated with those levels. For dBZ values less than 30 the weather radar echo intensity terminology should be “light.” For dBZ values between 30 and 40, the terminology should be “moderate.” “Heavy” terminology is used for dBZ values greater than 40 dBZ to 50 dBZ, inclusive. Finally, any dBZ values above 50 dBZ shall be described as “extreme.”

7.4 Base Reflectivity and Lightning Data

Figures 13, 14, and 15 present the KMLB WSR-88D base reflectivity images for the 0.5° elevation scan and TMCO base reflectivity images for the 0.3° elevation scans initiated at 1653:49, 1657:59, and 1659:23 EDT, with a resolution of 0.5° X 250 m. The image depicted reflectivity values between 50 and 60 dBZ above the accident site with the precipitation moving from southeast to northwest (attachments 2 and 3).

²⁶ Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at the earth’s surface; also, any water particles blown by the wind from the earth’s surface. Hydrometeors are classified as; (a) Liquid or solid water particles suspended in the air: cloud, water droplets, mist, or fog. (b) Liquid precipitation: drizzle and rain. (c) Freezing precipitation: freezing drizzle and freezing rain. (d) Solid (frozen) precipitation: ice pellets, hail, snow, snow pellets, and ice crystals. (e) Falling particles that evaporate before reaching the ground: virga. (f) Liquid or solid water particles lifted by the wind from the earth’s surface: drifting snow, blowing snow, blowing spray. (g) Liquid or solid deposits on exposed objects: dew, frost, rime, and glazed ice.

²⁷

https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1020774

There were 1,053 lightning flashes²⁸ reported within 25 miles of the accident site within 15 minutes prior to or following the accident time with the closest lightning flash occurring 800 ft south of the accident site at the accident time (figure 16).²⁹

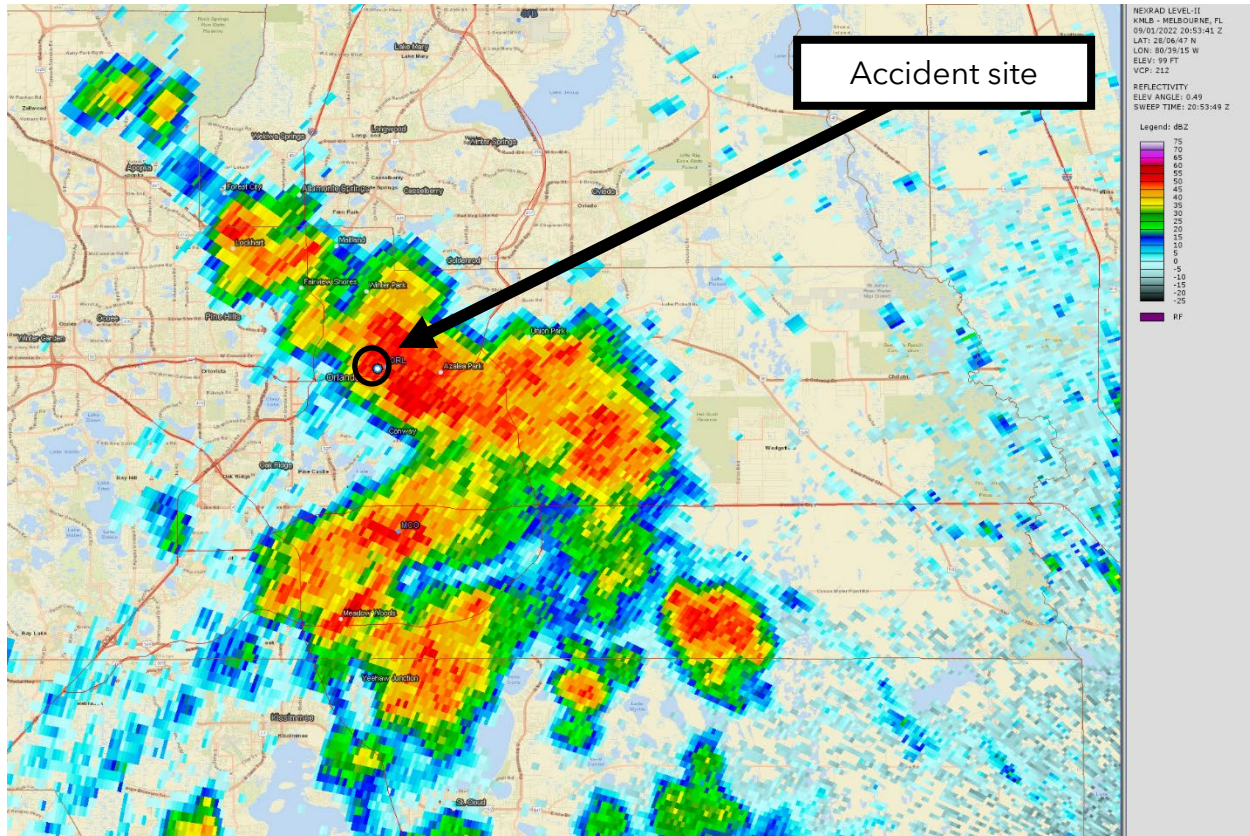


Figure 13. KMLB WSR-88D reflectivity for the 0.5° elevation scan initiated at 1653:49 EDT with the accident site marked within the black circle.

²⁸ Lightning Flash - This is one contiguous conducting channel and all the current strokes/pulses that flow through it. There are two types of flashes: ground flashes and cloud flashes.

²⁹ A review of Earth Networks Total Lightning network and GOES-16 Geostationary Lightning Mapper was done.

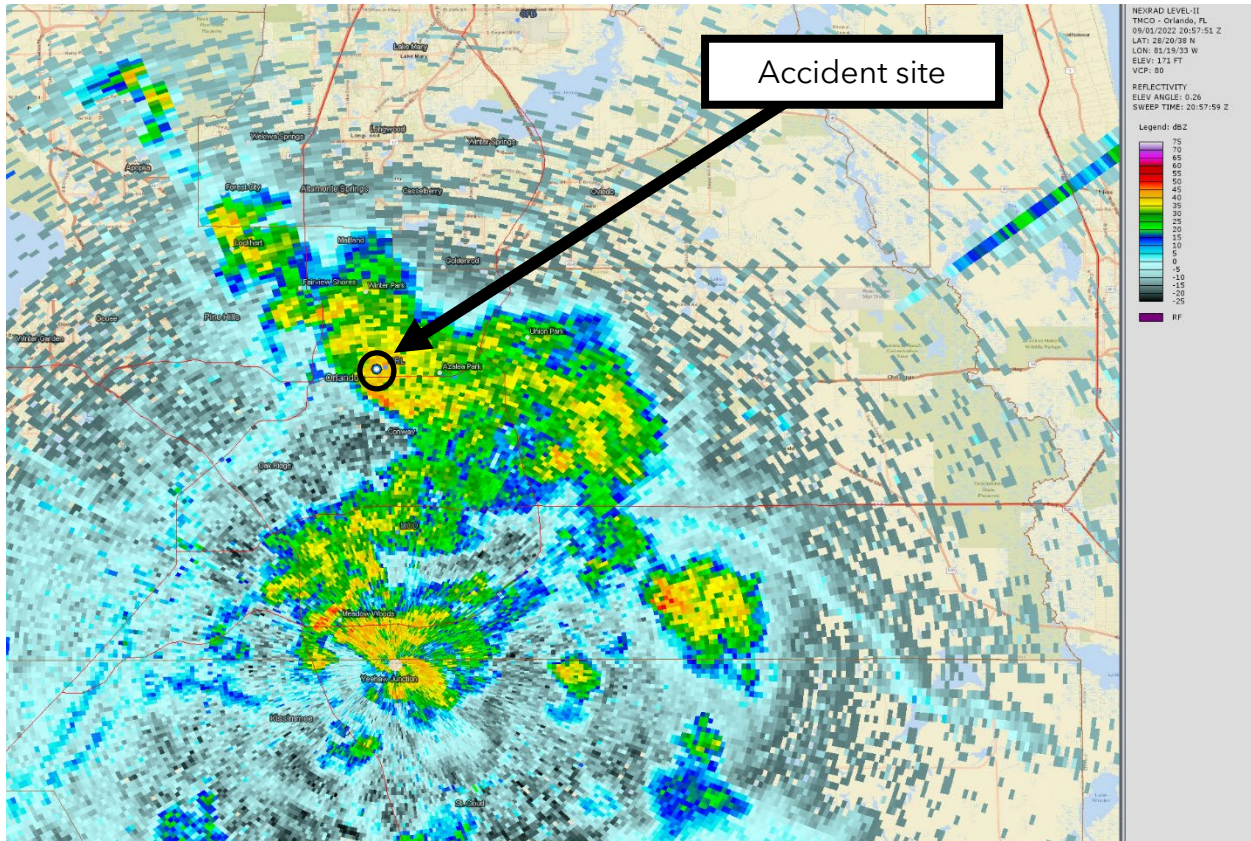


Figure 14. TMCO reflectivity for the 0.3° elevation scan initiated at 1657:59 EDT with the accident site marked within the black circle.

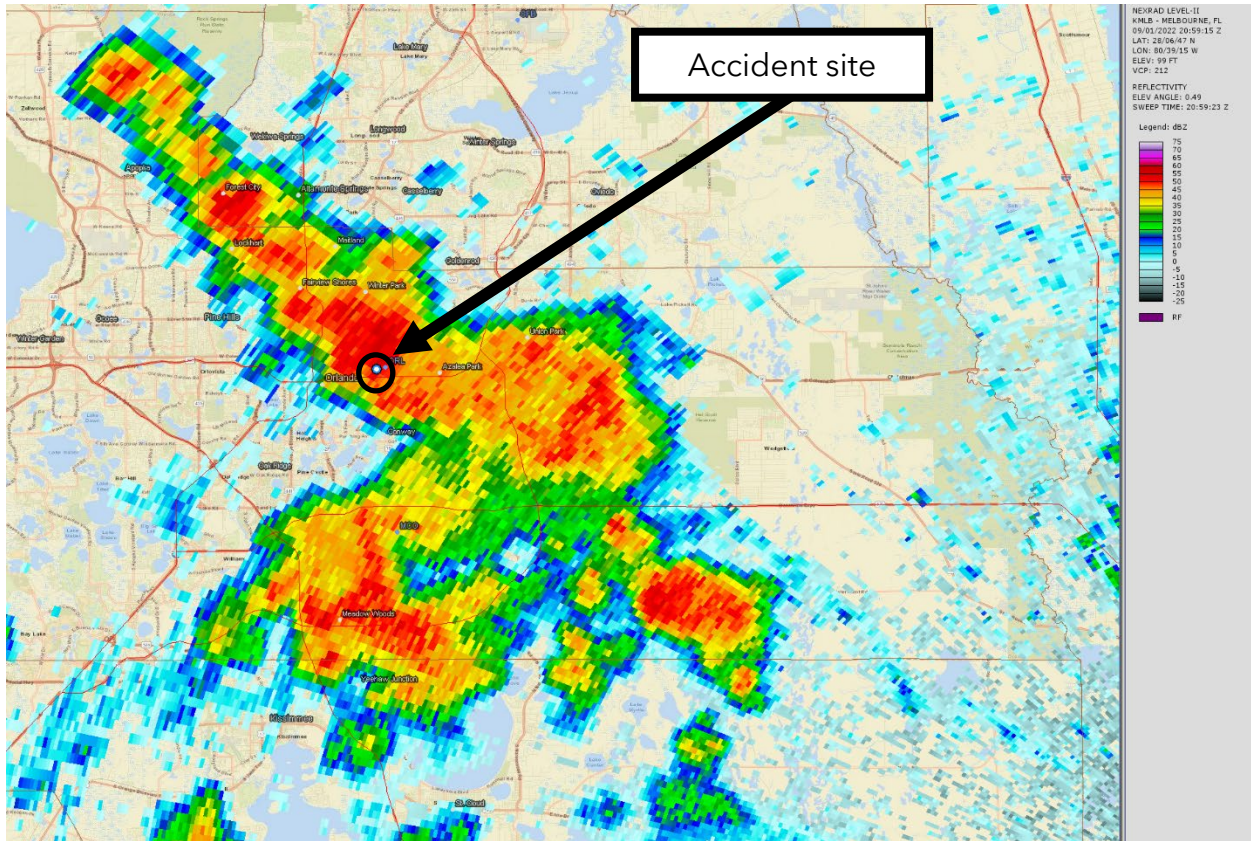


Figure 15. KMLB WSR-88D reflectivity for the 0.5° elevation scan initiated at 1659:23 EDT with the accident site marked within the black circle.

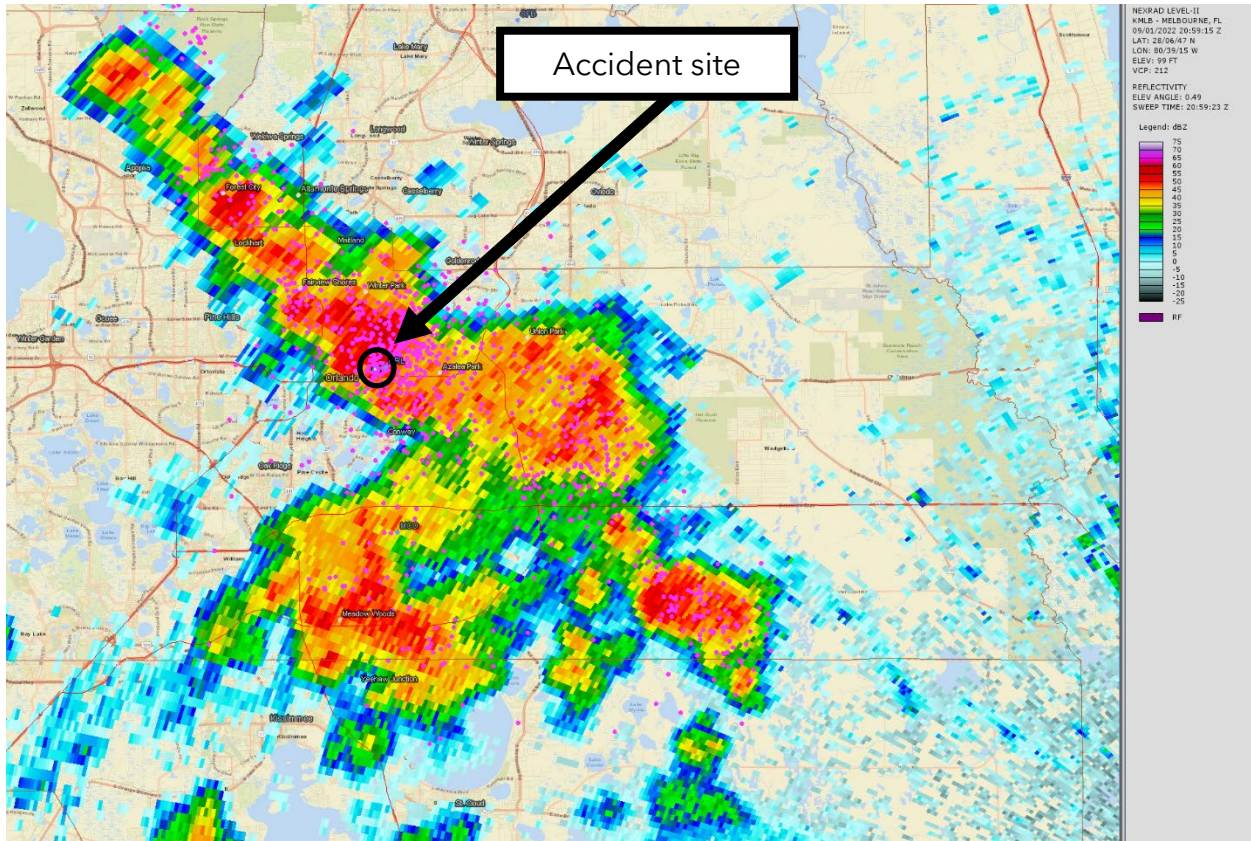


Figure 16. KMLB WSR-88D reflectivity for the 0.5° elevation scan initiated at 1659:23 EDT with the accident site marked within the black circle. Lightning flashes are marked with pink dots.

Convective clouds can produce downdrafts, outflow boundaries and gust fronts during the mature stage of their life cycle, which can create an environment favorable for unexpected changes in wind direction and speed. Figure 17 is a diagram of a downburst or microburst, which originate from convective clouds with precipitation. According to the Aeronautical Information Manual (AIM) section 7-1-24³⁰ on microburst, they are typically relatively small area less than 1 to 2 ½ miles in diameter of strong divergent winds and downdrafts that can reach 6,000 feet per minute. Microburst can be found in convective clouds, usually embedded in heavy rain or in benign appearing virga. When there is little or no precipitation at the surface accompanying the microburst, a ring of blowing dust may be the only visual clue of its existence. The TMCO velocity data indicated a divergent wind velocity signature to the east and above the accident site at the accident time (attachment 4).

³⁰ [Aeronautical Information Manual, Chap 7, Sec. 1. Microburst - Glossary of Meteorology \(ametsoc.org\)](#)

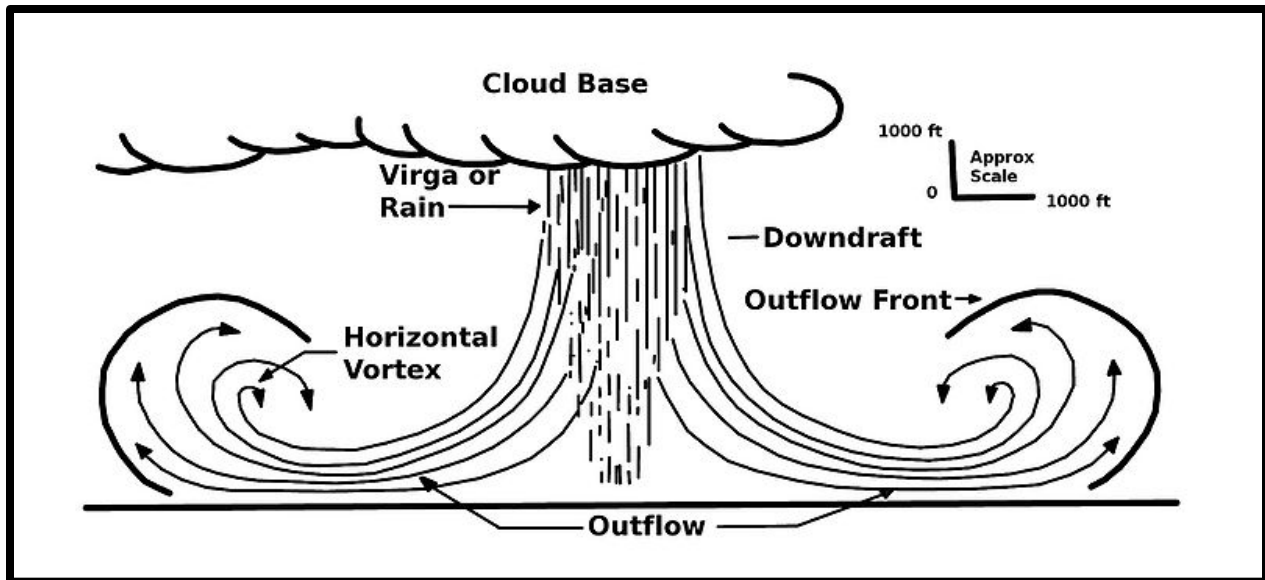


Figure 17. Exemplar diagram of a downburst and outflow.

8.0 Pilot Reports

The longline-disseminated pilot reports³¹ (PIREPs) distributed into the national airspace system (NAS) were reviewed for about two hours on either side of the accident time. The PIREPs issued into the NAS within 100 miles of the accident site for below 19,000 ft are shown below with 2 PIREPs from KORL before the accident time:

MCO UA /OV MCO360003/TM 1902/FLDURGD/TP B738/RM SMOOTH RIDE DURD
RWY17L

MCO UA /OV MCO360003/TM 1904/FLDURGD/TP B739/RM SMOOTH RIDE DURD
RWY18R

DAB UA /OV DAB045005/TM 1904/FL026/TP C172/RM VICINITY OF FIN BASES
SCT035

TPA UA /OV TPA315010/TM 1904/FL028/TP B738/SK BASES 028 BKN/WX 10/TB
SMOOTH

ORL UA /OV ORL250003/TM 1926/FL012/TP S22T/RM LIGHT CHOP ON FINAL

VRB UA /OV 3 N OF VRB/TM 1927/FL3000/TP C172/SK CLR

SFB UA /OV 270004/TM 1930/FL015/TP DA40/SK SCT040

JAX UA /OV GNV/TM 1940/FLDURGD/TP B717/WX 10

SFB UA /OV 36004/TM 2000/FL015/TP P28A/SK SCT035

MCO UA /OV MCO180002/TM 2010/FLDURGC/TP B744/RM SMOOTH RIDE DURC
RWY18L

³¹ Only pilot reports with the World Meteorological Organization headers UBFL** were considered. These do not include pilot reports only broadcast via radio.

TPA UA /OV TPA19010/TM 2019/FL030/TP C56X/WX BASE 030/TB LGT
VRB UA /OV TRV020010/TM 2037/FL120/TP BE20/RM SMOOTH AND CLEAR
**ORL UA /OV ORL/TM 2039/FL000/TP PA32/RM LIGHT RAIN/ SMOOTH/ AND
CLEAR VIS**
**ORL UA /OV ORL250002/TM 2044/FL008/TP TBM9/WV STIFF CROSSWIND
STARTED AS A TAILWIND/TB BUMPY**
JAX UA /OV GNV180010/TM 2045/FLDURGD/TP CL30/RM FIS OUT OF 3000
SRQ UA /OV SRQ080040/TM 2054/FL160/TP AT46/SK SKC/TB NEG
DAB UA /OV DAB225002/TM 2058/FL016/TP C172/RM VMC
DAB UA /OV 8 MI FINAL 7L/TM 2101/FL20/TP C172/WX VMC/RM PRECIP NORTH OF
THE FINAL
TPA UA /OV RPA18005/TM 2110/FL040/TP B757/SK BASES 030/TB SMOOTH
SRQ UA /OV SRQ095048/TM 2111/FL120/TP BE9L/SK SKC/TB NEG
JAX UA /OV OCF/TM 2114/FL025/TP F900/WX 10M
ISM UA /OV ISM27003/TM 2114/FLUNK/TP TBM8/SK VMC/WX LT RA/RM DURC
SFB UA /OV SFB270004/TM 2114/FL012/TP C172/WX 10SM TO THE EAST/TB NEG
MCO UA /OV MCO160003/TM 2115/FLUNKN/TP A321/SK VMC/WX MOD RA/RM
DURC
MCO UA /OV MCO/TM 2115/FL065/TP B737/SK OVC065/TB CHOP
MLB UA /OV MLB200015/TM 2126/FLDURGD/TP C421/SK BASE 160/TB NEG
DAB UA /OV DAB270007/TM 2134/FL016/TP C172/WX RA W OD DED/RM CLR ON
FINAL 7L
MLB UA /OV MLB270010/TM 2136/FL020/TP SR20/SK BASES 045
OCF UA /OV OCF180002/TM 2147/FL150/TP A320/TB NEG/RM SMOOTH
MCO UA /OV MCO360003/TM 2201/FLDURGD/TP A321/RM SMOOTH RIDE DURD
RWY17L
DAB UA /OV DAB270005/TM 2203/FL035/TP C172/SK VFR
SFB UA /OV SFB/TM 2205/FL010/TP A320/TB LGT
TPA UA /OV TPA220005/TM 2208/FL040/TP F900/SK SKC
JAX UA /OV X60/TM 2210/FL030/TP BE55/WX VMC
TPA UA /OV PIE020010/TM 2213/FL070/TP B757/SK SKC/TB SMOOTH
MCO UA /OV MCO/TM 2235/FL040/TP B739/TB SMOOTH
SFB UA /OV SFB/TM 2247/FL030/TP SR20/SK VFR
VRB UA /OV VRB270012/TM 2258/FL170/TP A320/WX VMC/RM SMOOTH ZMAFD

9.0 Significant Meteorological Information

There was a Convective Significant Meteorological Information (SIGMET) advisory valid for the accident site at the accident time. SIGMET 04E (figure 18), which was issued at 1655 EDT, warned of an area of severe thunderstorms with cloud tops above FL450³² with the Convective SIGMET box moving little and wind gusts to 50 knots possible. In addition, a convective SIGMET was issued at 1555 EDT that was valid for the accident area (SIGMET 01E), but SIGMET 01E was superseded by 04E:

WSUS31 KPCI 012055
SIGE
-MKCE WST 012055
CONVECTIVE SIGMET 04E
VALID UNTIL 2255Z
FL GA AL AND FL GA CSTL WTRS
FROM 40S SAV-40SE MIA-40ENE EYW-60WSW PZD-40S SAV
AREA SEV EMBD TS MOV LTL. TOPS ABV FL450.
WIND GUSTS TO 50KT POSS.

WSUS31 KPCI 011955
SIGE
-MKCE WST 011955
CONVECTIVE SIGMET 01E
VALID UNTIL 2155Z
FL GA AND CSTL WTRS
FROM 40NNE CRG-30SE OMN-40SW SRQ-60ENE TLH-40NNE CRG
AREA TS MOV LTL. TOPS ABV FL450.

³² Flight Level - A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of ft. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the standard sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

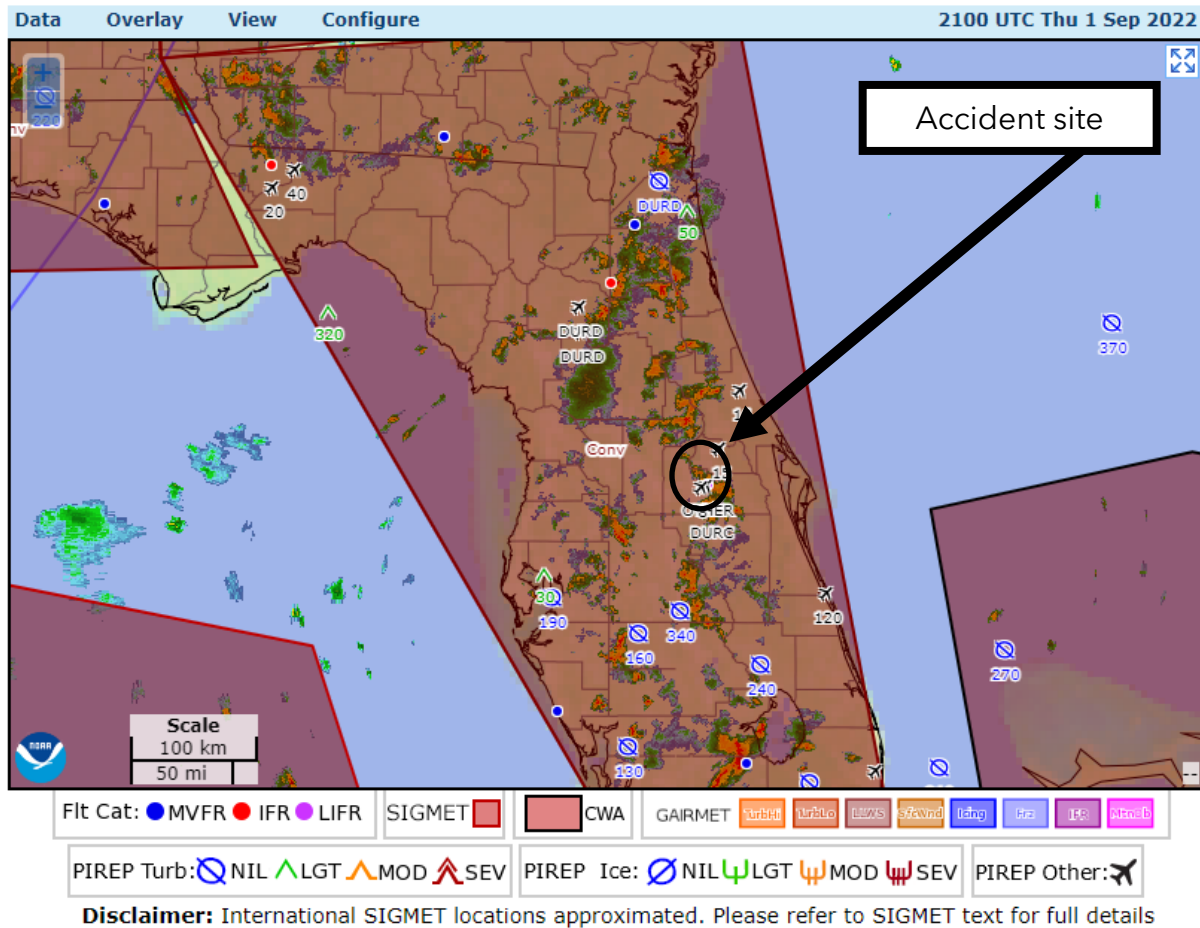


Figure 18. Aviation Weather Center graphic valid at 1700 EDT with valid convective SIGMETs, AIRMETs, and PIREPs with the accident location marked.

10.0 Center Weather Service Advisories

The Jacksonville (ZJX) Air Route Traffic Control Center (ARTCC) Center Weather Service Unit (CWSU) was responsible for the accident region. There was no Center Weather Advisory (CWA) valid from ZJX CWSU at the accident time.

11.0 Airmen’s Meteorological Information

There were no text Airmen’s Meteorological Information (AIRMET) advisories valid for the accident site at the accident time.

12.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products issued before the accident flight and valid at 1700 EDT are shown in attachment 5. The GFA surface forecast applicable to the accident site that was valid before the accident flight's departure for times surrounding the accident time indicated VFR surface visibilities, numerous (between 60 to 100 percent chance) thunderstorms, and a light and variable surface wind. The GFA cloud forecast applicable to the accident site that was valid before departure for times surrounding the accident time indicated, outside of thunderstorm activity, scattered cloud coverage with bases at 4,000 to 5,000 ft. There were no Graphical AIRMETS³³ (G-AIRMET) valid for the accident site at accident time. The only human-generated information reflected in the two GFA products were the G-AIRMETS. For more information, please see attachment 5.

³³ **Graphical AIRMETS (G-AIRMETS)**, found on the Aviation Weather Center webpage at <http://aviationweather.gov>, are graphical forecasts of en-route weather hazards valid at discrete times no more than 3 hours apart for a period of up to 12 hours into the future (for example, 00, 03, 06, 09, and 12 hours). Additional forecasts may be inserted during the first 6 hours (for example, 01, 02, 04, and 05). 00 hour represents the initial conditions, and the subsequent graphics depict the area affected by the particular hazard at that valid time. Forecasts valid at 00 through 06 hours correspond to the text [AIRMET](#) bulletin. Forecasts valid at 06 through 12 hours correspond to the text bulletin outlook.

G-[AIRMETS](#) are snap shots at discrete time intervals as defined above. The text [AIRMET](#) is the result of the production of the G-[AIRMET](#) but provided in a time smear for a 6hr valid period. G-[AIRMETS](#) provide a higher forecast resolution than text [AIRMET](#) products. Since G-[AIRMETS](#) and text AIRMETS are created from the same forecast "production" process, there exists perfect consistency between the two. Using the two together will provide clarity of the area impacted by the weather hazard and improve situational awareness and decision making. Interpolation of time periods between G-AIRMET valid times: Users must keep in mind when using the G-AIRMET that if a 00 hour forecast shows no significant weather and a 03 hour forecast shows hazardous weather, they must assume a change is occurring during the period between the two forecasts. It should be taken into consideration that the hazardous weather starts immediately after the 00 hour forecast unless there is a defined initiation or ending time for the hazardous weather. The same would apply after the 03 hour forecast. The user should assume the hazardous weather condition is occurring between the snap shots unless informed otherwise. For example, if a 00 hour forecast shows no hazard, a 03 hour forecast shows the presence of hazardous weather, and a 06 hour forecast shows no hazard, the user should assume the hazard exists from the 0001 hour to the 0559 hour time period.

13.0 Terminal Aerodrome Forecast

The closest Terminal Aerodrome Forecast³⁴ (TAF) to the accident site was from KMCO. The KMCO amended TAF was issued at 1659 EDT and was valid for a 27-hour period beginning at 1700 EDT. The 1659 EDT TAF for KMCO was as follows:

AMD TAF KMCO 012059Z 0121/0224 **09007KT P6SM VCTS SCT045CB SCT250**
TEMPO 0121/0123 VRB20G40KT 3SM TSRA BKN035CB
FM020100 VRB03KT P6SM FEW040 SCT250
FM021500 11007KT P6SM SCT030 SCT250
FM022000 10009KT P6SM VCTS SCT040CB SCT250=

Between 1700 EDT and 2100 EDT, the forecast expected a wind from 090° at 7 knots, greater than 6 miles visibility, thunderstorms in the vicinity³⁵, scattered cumulonimbus clouds at 4,500 ft agl, scattered clouds at 25,000 ft agl. Temporary conditions³⁶ were forecast between 1700 and 1900 EDT with variable wind of 20 knots with gusts to 40 knots, 3 miles visibility, thunderstorms and moderate rain, and a broken ceiling of cumulonimbus clouds at 3,500 ft agl.

Additional KMCO TAFs were issued including the amended KMCO TAF issued at 1632 EDT and was valid for a 28-hour period beginning at 1600 EDT. The 1632 EDT TAF for KMCO was as follows and was made available to the pilot before the accident:

AMD TAF KMCO 012032Z 0120/0224 **09007KT P6SM VCTS SCT045CB SCT250**
TEMPO 0120/0123 VRB20G40KT 3SM TSRA BKN035CB
FM020100 VRB03KT P6SM FEW040 SCT250
FM021500 11007KT P6SM SCT030 SCT250
FM022000 10009KT P6SM VCTS SCT040CB SCT250=

Between 1600 EDT and 2100 EDT, the forecast expected a wind from 090° at 7 knots, greater than 6 miles visibility, thunderstorms in the vicinity, scattered cumulonimbus clouds at 4,500 ft agl, scattered clouds at 25,000 ft agl. Temporary conditions were forecast between 1600 and 1900 EDT with variable wind of 20 knots with gusts to 40 knots, 3 miles visibility, thunderstorms and moderate rain, and a broken ceiling of cumulonimbus clouds at 3,500 ft agl.

³⁴ According to NWS Instruction 10-813: "An NWS TAF consists of the expected meteorological conditions significant to aviation at an airport for a specified time period. For the U.S., this is the area within five (5) statute miles (SM) of the center of an airport's runway complex."

www.nws.noaa.gov/directives/sym/pd01008013curr.pdf

³⁵ In the vicinity of the airport is defined as a weather phenomenon within 5-10 statute miles of the airfield.

³⁶ The TEMPO group is used for any conditions in wind, visibility, weather, or sky condition which are expected to last for generally less than an hour at a time (occasional), and are expected to occur during less than half the time period.

Another additional KMCO TAF was issued at 1356 EDT and was valid for a 30-hour period beginning at 1400 EDT. The 1356 EDT TAF for KMCO was as follows:

KMCO 011756Z 0118/0224 **09007KT P6SM VCTS SCT045CB SCT250**
TEMPO 0120/0123 3SM TSRA BKN035CB
FM020100 VRB03KT P6SM FEW040 SCT250
FM021500 11007KT P6SM SCT030 SCT250
FM022000 10009KT P6SM VCTS SCT040CB SCT250=

Between 1400 EDT and 2300 EDT, the forecast expected a wind from 090° at 7 knots, greater than 6 miles visibility, thunderstorms in the vicinity, scattered cumulonimbus clouds at 4,500 ft agl, scattered clouds at 25,000 ft agl. Temporary conditions were forecast between 1600 and 1900 EDT with 3 miles visibility, thunderstorms and moderate rain, and a broken ceiling of cumulonimbus clouds at 3,500 ft agl.

14.0 National Weather Service Area Forecast Discussion

The NWS weather forecast office in Melbourne, Florida, (WFO MLB) was responsible for the public forecast in the region of the accident site. WFO MLB issued the following Area Forecast Discussion (AFD) at 1540 EDT, the closest AFD to the accident time with an aviation section:

FXUS62 KMLB 011940
AFDMLB

Area Forecast Discussion
National Weather Service Melbourne FL
340 PM EDT Thu Sep 1 2022

...New DISCUSSION, MARINE, AVIATION...

.DISCUSSION...
Issued at 340 PM EDT Thu Sep 1 2022

Rest of This Afternoon-Tonight...As of 3PM, the east coast sea breeze has moved west of I-95, with scattered lightning storms developing along and ahead of the sea breeze. Expect coverage of storms to gradually increase through the afternoon, for areas west of I-95, with most of the strongest storms developing along the main sea breeze boundary collision. Rain chances are around 70pct for inland areas west of I-95, and conditions remain east of I-95 through this evening. A few storms may push back toward the Volusia and northern Brevard coast later this evening.

Locally heavy rainfall remains a prime concern as steering flow remains light/variable at 5 mph, so expect some erratic storm motion, especially with larger/stronger boundary collisions late in the day. Frequent lightning strikes and wind gusts of 40-50mph

will accompany a few stronger storms.

Scattered storms are likely to linger after sunset across the Orlando Metro and parts of Lake/Osceola/Okeechobee Counties. This activity should then dissipate by late evening. Remaining muggy and warm overnight as lows settle in the low to mid 70s.

Friday...A weak mid-level disturbance over north FL/SE GA will steadily lift northward and away from our area on Friday. Some slightly "drier" air is forecast to move over the adjacent Atlantic waters tomorrow (PWATs as low as 1.6"), which should lead to a 10-20pct decrease in rain chances overall. Unfortunately for coastal areas, that means little to no rain as the sea breeze develops and moves inland in the early afternoon. Even for inland locations, rain chances are forecast at 40pct, and up to 50pct in Lake County. The strongest of these scattered showers/storms could produce frequent lightning, gusty winds up to 40mph, and torrential downpours. Afternoon temperatures in the upper 80s to around 90 degrees along the coast, and low 90s inland. Lingering rain and thunderstorm activity will quickly dissipate/move west of the area by late afternoon.

&&

.PREVIOUS DISCUSSION...

Saturday-Thursday..To start the weekend, model guidance introduces lower moisture content over east central Florida. PW on Saturday of 1.6- 1.7" will still be sufficient for afternoon storm development along the east coast sea breeze, but coverage will be more isolated, even across many parts of the interior. As upper level ridging builds and strengthens across the Florida Peninsula Sunday into early next week, atmospheric moisture looks to increase within the low-level easterly flow. Generally 40-50 PoP is expected each afternoon from Sunday through Tuesday with the highest rain chances over inland locations.

Medium range solutions diverge mid week with distinct differences in the timing and magnitude of the upper level pattern. One possibility is a faster, deeper trough regime over the southeastern U.S. that dives southeast across Florida Wednesday and Thursday. The other, less aggressive outcome depicts a slower dissipation of the Atlantic ridge on Wednesday and Thursday. A faster upper level pattern would support higher rain chances on Wednesday into the latter half of the week, while a slower advance of mid level troughing over the southeastern U.S. would gradually increase rain chances Thursday and beyond.

Temperatures each afternoon will be in the upper 80s to mid 90s with Tuesday being one of the warmer days. Heat indices of 100-105 are possible Sunday through Wednesday. Nighttime lows in the mid to upper 70s with dew points in the low to mid 70s will keep the muggy feel to the air in place.

&&

.MARINE...

Issued at 340 PM EDT Thu Sep 1 2022

Rest of Today-Tonight...The east coast sea breeze has already moved west of I-95, as of 3PM, and most of the shower and lightning storm activity for the rest of this afternoon will remain over the peninsula. A few showers will develop over the offshore Atlantic waters, and a few storms might move toward the Volusia coast this evening, though otherwise expect dry conditions over the waters. Favorable boating weather through tonight, with seas 2 feet and light/variable winds overnight.

Friday-Tuesday...Boating conditions are forecast to remain favorable, outside of any isolated afternoon lightning storms. East-southeast winds continue on Friday, then winds gradually become more east-northeast Sunday and into next week as the Atlantic ridge strengthens over the waters. Winds generally 10 knots with an occasional gust to 15 knots. Seas generally 2 feet nearshore and up to 3 feet offshore on Friday, building to around 3 feet Sunday into next week.

&&

.AVIATION...

(18Z TAFS)

Issued at 340 PM EDT Thu Sep 1 2022

VCTS conditions across the area today as showers and storms develop along the sea breeze as it pushes inland towards the interior. VCTS ending along the Space Coast and Treasure Coast at 20Z and across the interior and KDAB at 01Z. TEMPOS 20-23Z across the interior and 19-21Z at KDAB for TSRA and reduced CIGs/VIS. Some gusty winds are also possible due to boundary collisions. Outside of convection, winds primarily S-SE at 7-12 kt. Once conditions improve later tonight, winds become light and variable to calm at all sites. Friday morning, winds pick up around 15Z out of the SE at 7-10 kt.

&&

.PRELIMINARY POINT TEMPS/POPS...

DAB 75 90 76 90 / 30 20 20 40
MCO 75 93 76 92 / 40 40 20 40
MLB 76 90 78 90 / 20 20 10 20
VRB 74 91 75 92 / 20 20 10 20
LEE 74 91 75 91 / 40 50 20 60
SFB 74 92 75 91 / 40 40 20 40
ORL 77 93 78 93 / 40 40 20 40
FPR 73 90 75 90 / 20 20 10 20

&&

.MLB WATCHES/WARNINGS/ADVISORIES...
FL...None.
AM...None.
&&

\$\$

15.0 National Weather Service Severe Weather Products

WFO MLB issued several products warning of hazardous conditions, thunderstorms, and gusting winds at KORL and KMCO. Airport Weather Warnings (AWW) were issued at 1629 and 1701 EDT for KORL and KMCO. A special weather statement (SPS) was issued at 1640 EDT warning of winds in excess of 40 mph and frequent lightning. A severe thunderstorm warning (SVR) was issued at 1646 EDT warning of wind gusts to 60 mph. The NWS text products, which include the accident site, follow:

WWUS82 KMLB 012029
AWWMLB

Airport Weather Warning
National Weather Service Melbourne FL
429 PM EDT Thu Sep 1 2022

FLZ045-012100-
Orange FL-
429 PM EDT Thu Sep 1 2022

...AIRPORT WEATHER WARNING...

The National Weather Service in Melbourne has issued an Airport Weather Warning for...

Orlando International Airport and Orlando Executive Airport.

* Until 500 PM EDT.

For the following threat...

* Wind gusts of 35 knots or higher.

LAT...LON 2862 8134 2860 8127 2854 8125 2850 8127
2846 8123 2840 8123 2835 8130 2838 8137
2844 8139 2848 8137 2852 8141 2858 8141
\$\$

WWUS82 KMLB 012101
AWWMLB

Airport Weather Warning
National Weather Service Melbourne FL
501 PM EDT Thu Sep 1 2022

FLZ045-012115-
Orange FL-
501 PM EDT Thu Sep 1 2022

...AIRPORT WEATHER WARNING...

The National Weather Service in Melbourne has issued an Airport
Weather Warning for...

Orlando International Airport and Orlando Executive Airport.

* Until 515 PM EDT.

For the following threat...

* Wind gusts of 35 knots or higher.

LAT...LON 2862 8134 2860 8127 2854 8125 2850 8127
2846 8123 2840 8123 2835 8130 2838 8137
2844 8139 2848 8137 2852 8141 2858 8141
\$\$

WWUS82 KMLB 012040
SPSMLB

Special Weather Statement
National Weather Service Melbourne FL
440 PM EDT Thu Sep 1 2022

FLZ045-046-012115-
Orange FL-Seminole FL-
440 PM EDT Thu Sep 1 2022

...A strong thunderstorm will impact portions of southwestern
Seminole and south central Orange Counties through 515 PM EDT...

At 440 PM EDT, Doppler radar was tracking a strong thunderstorm near
Avalon Park, moving northwest at 15 mph.

HAZARD...Winds in excess of 40 mph.

SOURCE...Radar indicated.

IMPACT...Gusty winds could knock down tree limbs and blow around
unsecured objects.

Locations impacted include...
Orlando, Altamonte Springs, Oviedo, Winter Springs and Winter Park.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

If outdoors, consider seeking shelter inside a building.

Torrential rainfall is also occurring with this storm and may lead to localized flooding. Do not drive your vehicle through flooded roadways.

Frequent cloud to ground lightning is occurring with this storm. Lightning can strike 10 miles away from a thunderstorm. Seek a safe shelter inside a building or hard-topped vehicle. Remember, when thunder roars, go indoors!

&&

LAT...LON 2872 8114 2843 8111 2835 8140 2835 8142
2865 8145

TIME...MOT...LOC 2040Z 156DEG 14KT 2851 8122

MAX HAIL SIZE...0.00 IN
MAX WIND GUST...40 MPH

\$\$

WUUS52 KMLB 012046
SVRMLB
FLC095-117-012115-
/O.NEW.KMLB.SV.W.0089.220901T2046Z-220901T2115Z/

BULLETIN - IMMEDIATE BROADCAST REQUESTED
Severe Thunderstorm Warning
National Weather Service Melbourne FL
446 PM EDT Thu Sep 1 2022

The National Weather Service in Melbourne has issued a

* Severe Thunderstorm Warning for...
Southwestern Seminole County in east central Florida...
Central Orange County in east central Florida...

* Until 515 PM EDT.

* At 446 PM EDT, a severe thunderstorm was located over Azalea Park,
moving northwest at 15 mph.

HAZARD...60 mph wind gusts.

SOURCE...Radar indicated.

IMPACT...Expect damage to roofs, siding, and trees.

* Locations impacted include...
Orlando, Altamonte Springs, Oviedo, Winter Springs and Winter Park.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

For your protection move to an interior room on the lowest floor of a building.

Large hail and damaging winds and continuous cloud to ground lightning is occurring with this storm. Move indoors immediately. Lightning is one of nature's leading killers. Remember, if you can hear thunder, you are close enough to be struck by lightning.

&&

LAT...LON 2853 8119 2848 8130 2865 8145 2871 8120
TIME...MOT...LOC 2046Z 156DEG 14KT 2855 8127

HAIL THREAT...RADAR INDICATED
MAX HAIL SIZE...<.75 IN
WIND THREAT...RADAR INDICATED
MAX WIND GUST...60 MPH

\$\$

16.0 Pilot Weather Briefing

Title 14 CFR 91.103 states that "Each pilot in command shall, before beginning a flight, become familiar with all available information concerning that flight." FAA AC 91-92 "Pilot's Guide to a Preflight Planning" (dated March 15, 2021) provided pilot guidance on preflight self-briefings, including planning, weather interpretation, and risk identification/mitigation skills. The AC further stated in part:

Pilots adopting these guidelines will be better prepared to interpret and utilize real-time weather information before departure and en route, in the cockpit, via technology like Automatic Dependent Surveillance-Broadcast (ADS-B) and via third-party providers.³⁷

A search of archived information indicated that the accident pilot did not request weather information from Leidos Flight Service. The accident pilot did request weather information via ForeFlight at 1542 EDT with all the standard weather information provided for a departure time of 1620 EDT (attachment 6). Updated 1641 EDT KMCO and KORL METARs were provided to the weather briefing package (that was initially requested by the accident pilot) along with the 1632 EDT KMCO TAF by 1641 and 1632 EDT, respectively. It is unknown if the accident pilot viewed the updated 1632 or 1641 EDT information. It is unknown what, if any, additional weather information the accident pilot viewed before departing the ramp.

³⁷ https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_91-92.pdf. The AC also listed multiple online FAA resources for aviation flight planning services for adverse weather.

17.0 Integrated Terminal Weather System

Integrated Terminal Weather System (ITWS)³⁸ information was requested in time³⁹ to be retrieved for the accident timeframe. The ITWS graphical data from 1615 through 1745 EDT in 5-minute increments can be found in attachment 7. The ITWS reference sheets for TDWR locations is provided in attachment 8.

18.0 Astronomical Data

The astronomical data obtained for the accident site on September 1, 2022, indicated the following:

SUN

Begin civil twilight	0640 EDT
Sunrise	0703 EDT
Sun transit	1325 EDT
Accident time	1700 EDT ⁴⁰
Sunset	1947 EDT
End civil twilight	2011 EDT

At the time of the accident the Sun was located at an altitude of 35.61° and azimuth of 258.85°.

³⁸ https://cdm.fly.faa.gov/?page_id=176
<https://ral.ucar.edu/sites/default/files/public/events/2008/friends-and-partners-in-aviation-weather/docs/deans-fpaw-2008.pdf>

³⁹ ITWS data is stored for 14 days, then the data is overwritten.

⁴⁰ Inserted accident time for reference and context.

E. LIST OF ATTACHMENTS

Attachment 1 - GOES-16 visible imagery animation from 1521 to 1721 EDT with GLM data overlaid

Attachment 2 - KMLB base reflectivity animation between 1615 and 1711 EDT

Attachment 3 - TMCO base reflectivity animation between 1633 and 1710 EDT

Attachment 4 - TMCO base velocity animation between 1633 and 1710 EDT

Attachment 5 - GFA information valid at the accident time

Attachment 6 - ForeFlight information

Attachment 7 - ITWS information surrounding the accident time

Attachment 8 - ITWS quick reference sheet

Submitted by:

Paul Suffern
Senior Meteorologist