NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

August 3, 2017

Group Chairman's Factual Report

METEOROLOGY

ERA17FA145

Table Of Contents

A. ACCIDENT

Location: Near Micanopy, Florida
Date: April 4, 2017
Time: 0910 eastern daylight time
1310 Coordinated Universal Time (UTC)
Airplane: Pipistrel Virus SW, registration: N155CL

B. METEOROLOGIST

Paul Suffern
Senior Meteorologist
Operational Factors Division (AS-30)
National Transportation Safety Board

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist did not travel for this investigation and gathered the weather data for this investigation from the NTSB's Washington D.C. office and from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Centers for Environmental Information (NCEI). All times are eastern daylight time (EDT) on April 4, 2017, and are based upon the 24-hour clock, where local time is -4 hours from UTC, and UTC=Z (unless otherwise noted). Directions are referenced to true north and distances in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The accident site was located at latitude 29.4653° N, longitude 82.3750° W, at an approximate elevation of 90 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 Weather Prediction Center, 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 Surface Analysis Chart

The NWS Surface Analysis Chart for 0800 EDT is provided as figure 1 with the approximate location of the accident site marked within the red circle. The chart indicated that there was a cold frontal boundary located in northern Florida, with the boundary stretching northeastward into the western Atlantic Ocean. The front was depicted as a stationary front across the southern Panhandle of Florida stretched southwestward into the central Gulf of Mexico. There was a surface high pressure center located in southern Georgia with a pressure of 1013-hectopascals (hPa) (figure 1).

The station models around the accident site depicted air temperatures in the upper 60's to low 70's degrees Fahrenheit (°F), with dew point temperatures in the mid to upper 60's °F. The station models over central Florida indicated relatively clear skies with winds from the south at 5 to 10 knots over land and winds up to 20 knots along and coast and in the Gulf of Mexico. Over northern Florida near the frontal boundary overcast cloud cover and thunderstorms and rain showers were reported. In the immediate vicinity of the accident site, the Gainesville, Florida station model immediately north of the accident site depicted northerly wind at 15 knots, a thunderstorm and rain showers, overcast clouds with a temperature of 68° F, and a dew point of 64° F.

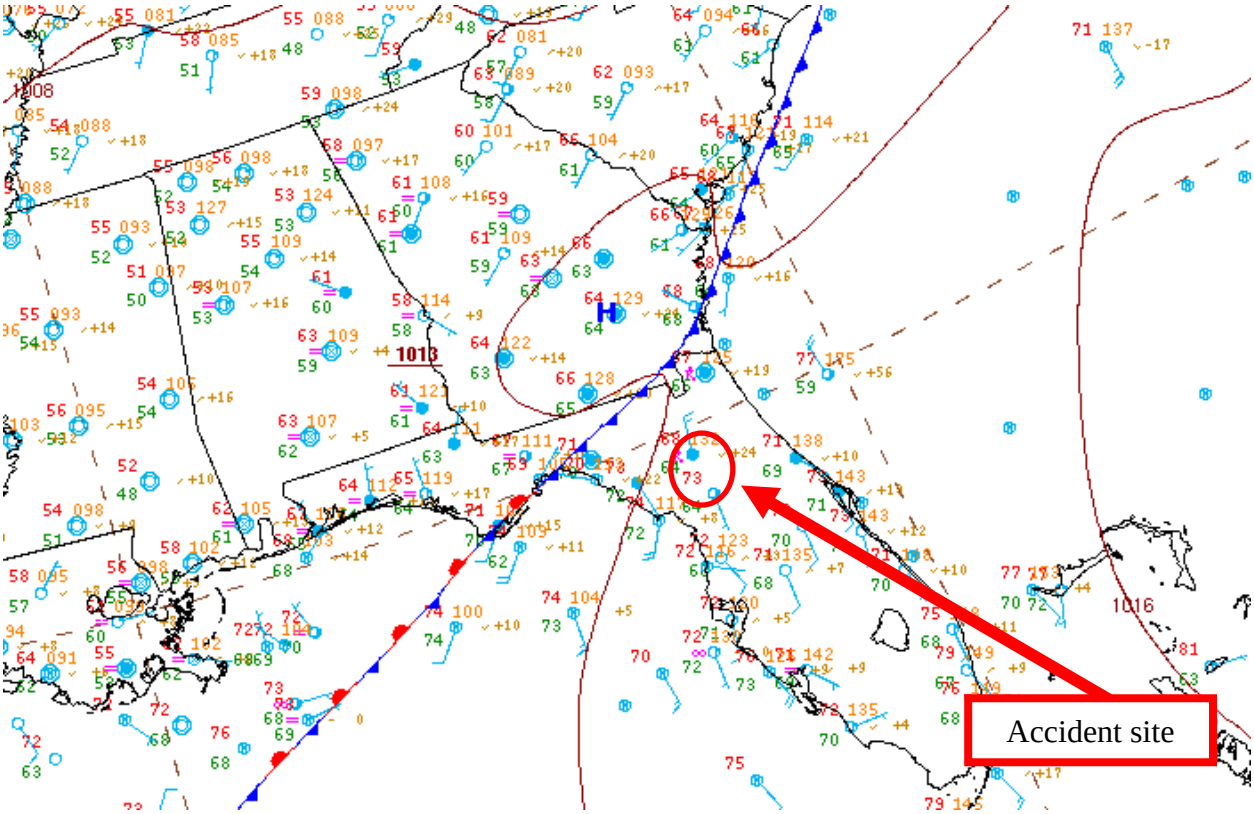


Figure 1 – NWS Surface Analysis Chart for 0800 EDT

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 0800 EDT at 925-, 850-, 700-, 500-, and 300-hPa are presented in figures 2 through 6. There was a low-level trough[1] located along the eastern United States coast from northern Florida northward into Georgia, South Carolina, and North Carolina, at 925- and 850-hPa. This low-level trough was associated with the cold front located in the southeastern United States (figure 1). There was a south wind of 20 to 25 knots at 925-hPa (figure 2) above the accident site. The wind became southwesterly by 700-hPa with a wind speed of 25 knots (figure 4). The 25-knot southwesterly wind at 700-hPa became a 40-knot west-southwest wind by 300-hPa (figure 6). Troughs and surface frontal boundaries (section 1.1) can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present.

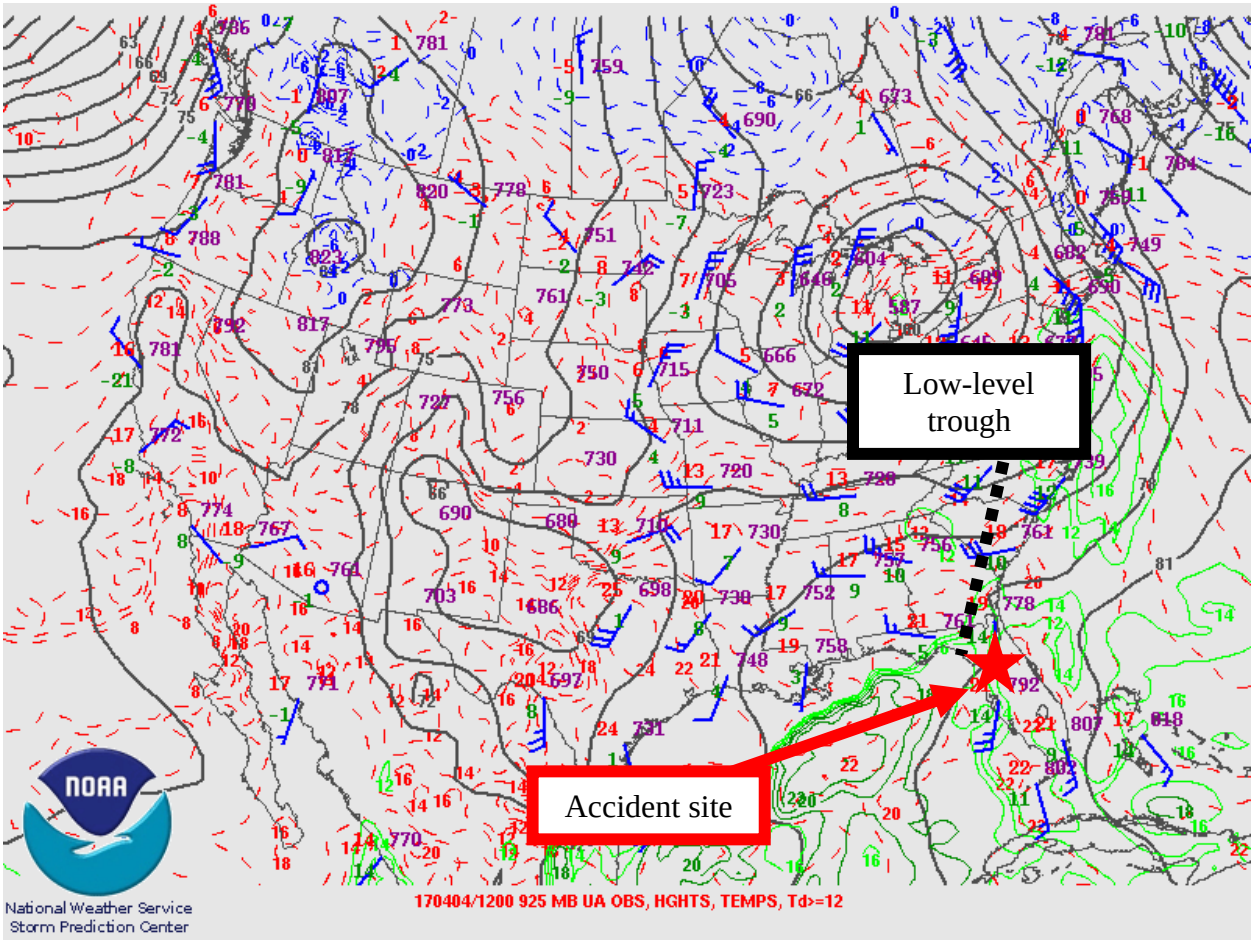


Figure 2 – 925-hPa Constant Pressure Chart for 0800 EDT

[1] Trough – An elongated area of relatively low atmospheric pressure or heights.

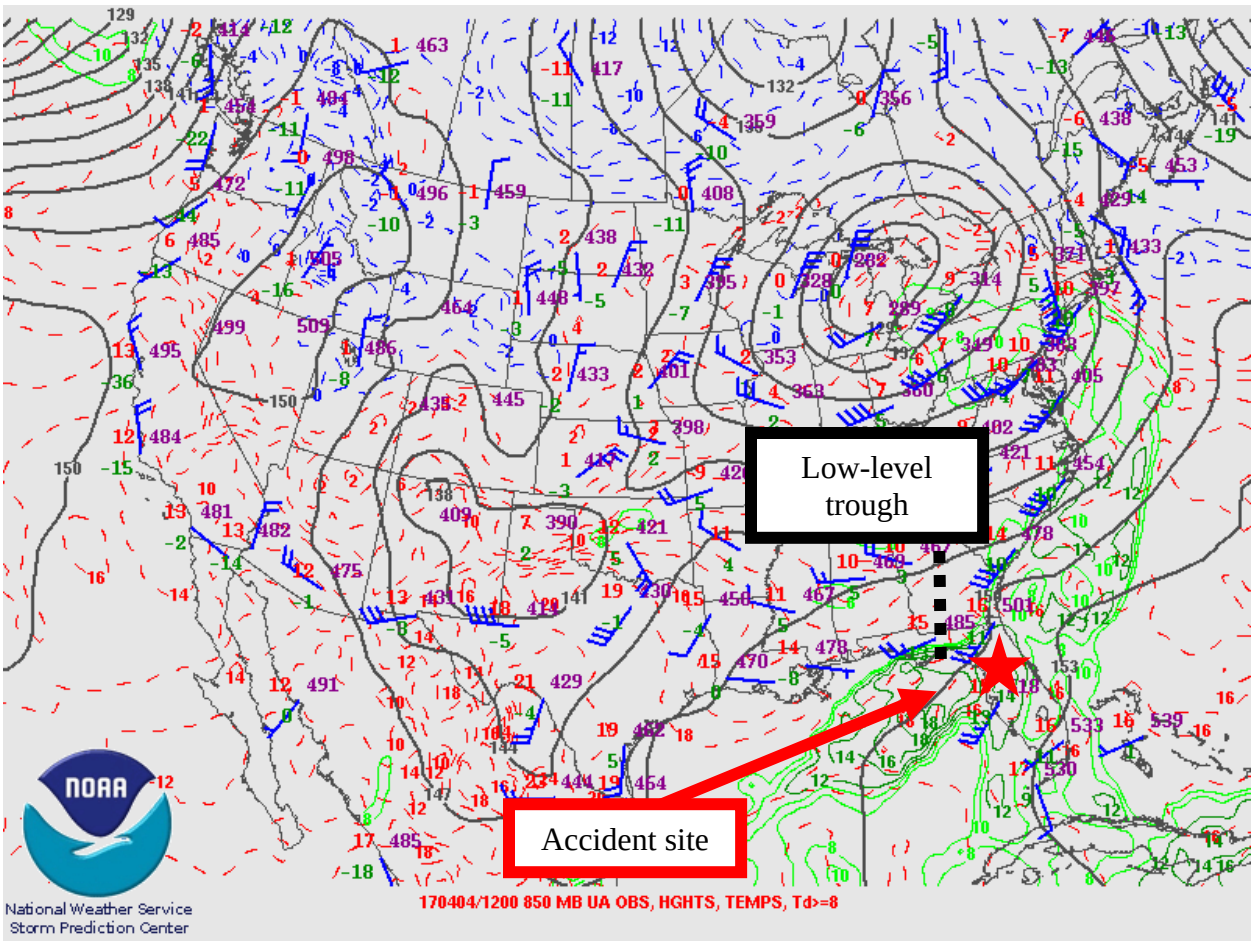


Figure 3 – 850-hPa Constant Pressure Chart for 0800 EDT

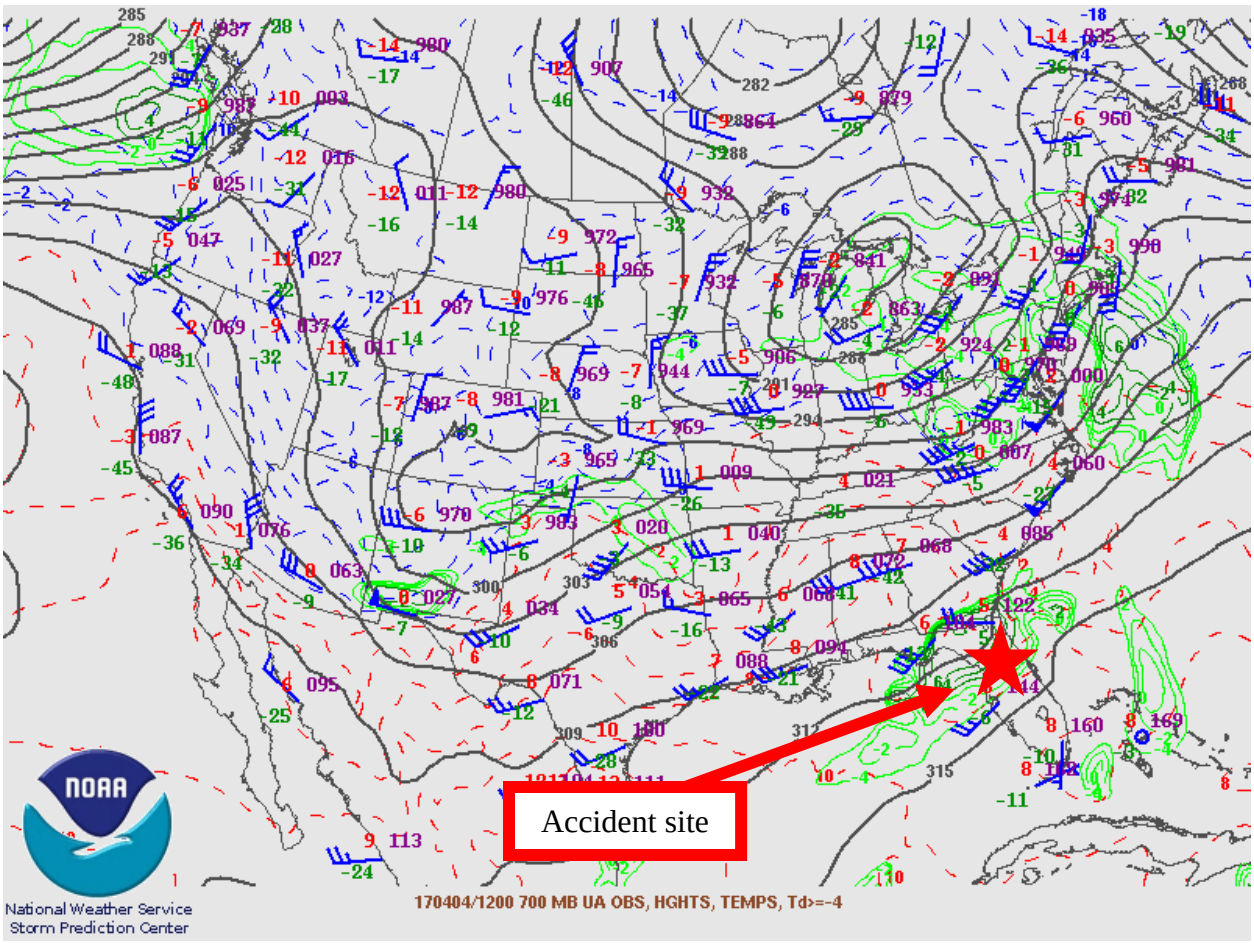


Figure 4 – 700-hPa Constant Pressure Chart for 0800 EDT

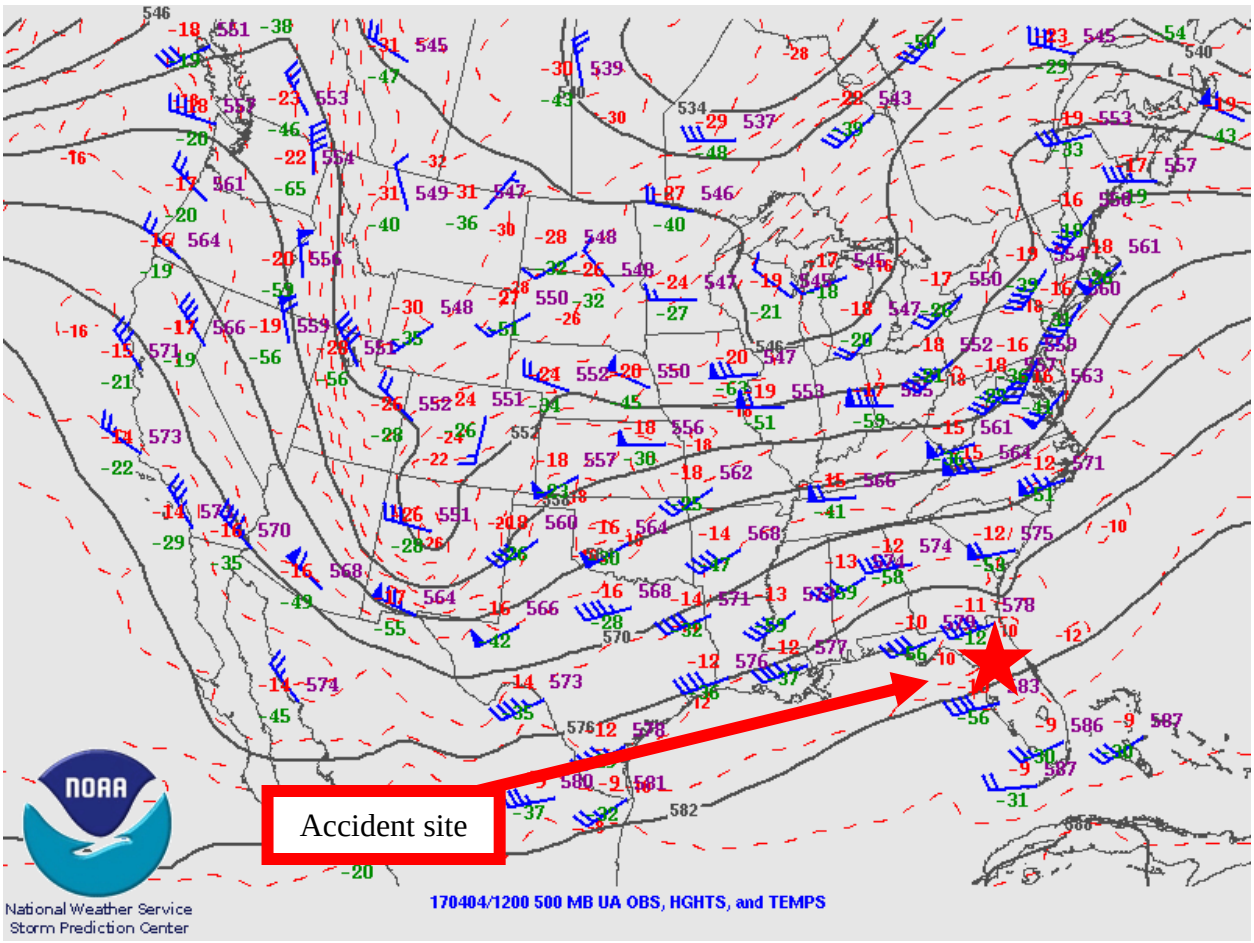


Figure 5 – 500-hPa Constant Pressure Chart for 0800 EDT

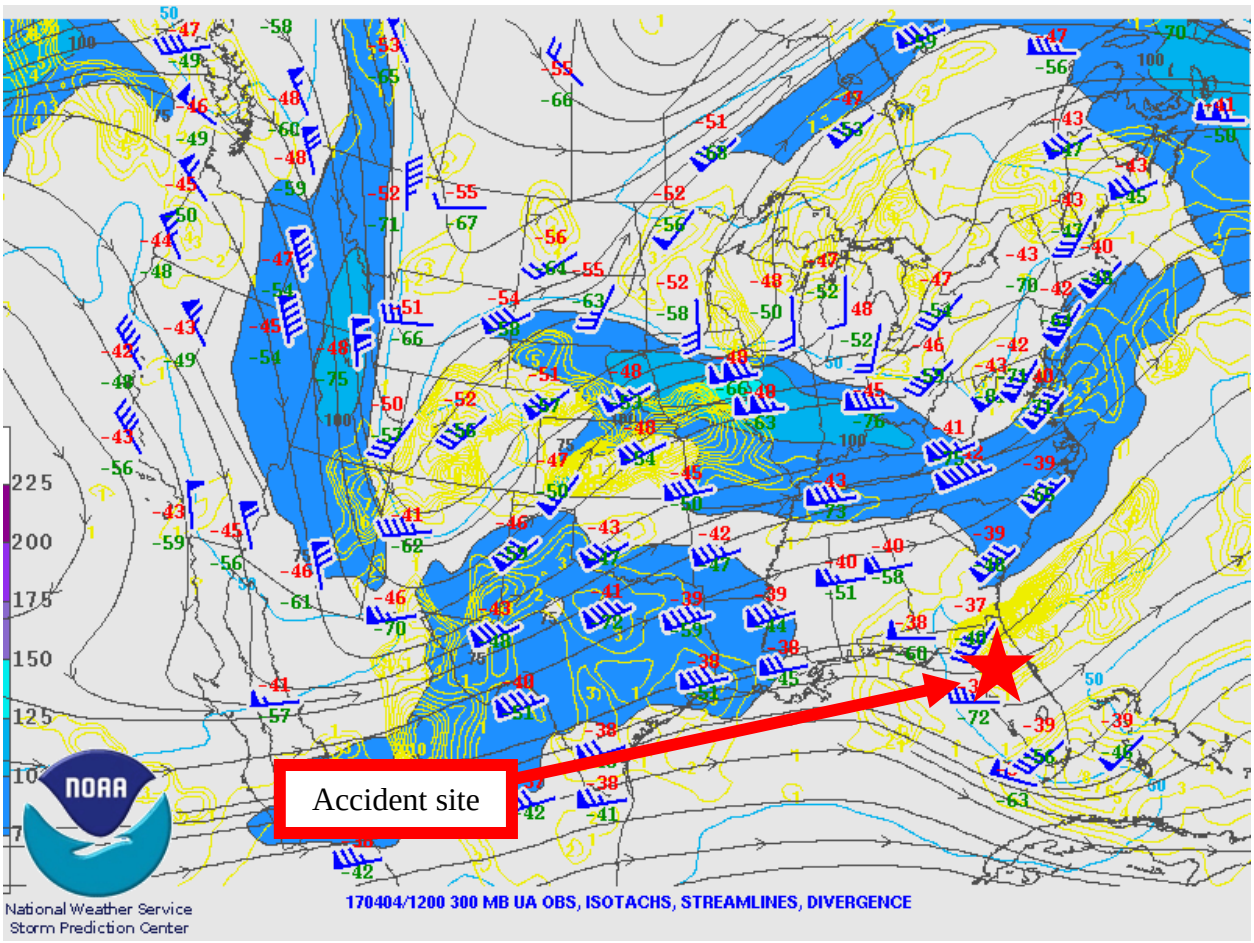


Figure 6 – 300-hPa Constant Pressure Chart for 0800 EDT

2.0 SPC Products

The SPC issued the following Day 1 Convective Outlook at 0849 EDT (figure 7) with areas of thunderstorms and a marginal risk for severe thunderstorm forecast for the accident site. The accident site was located in an area where SPC forecasted a 5 percent chance of damaging thunderstorm winds or wind gusts 50 knots or greater within 25 miles of a point (figure 9). The SPC Day 1 Convective Outlook (issued at 2057 EDT on April 3, figure 8) valid at the time of the Leidos weather briefings (section 17.0) had areas of thunderstorms with a slight risk for severe thunderstorms forecast for the accident site and northern Florida. The accident site and northern Florida were located in an area where SPC forecasted a 15 percent chance of damaging thunderstorm winds or wind gusts 50 knots or greater within 25 miles of a point and a 5 percent chance of one inch diameter hail or larger within 25 miles of a point (figures 10 and 11):

SPC AC 041249

Day 1 Convective Outlook
NWS Storm Prediction Center Norman OK
0749 AM CDT Tue Apr 04 2017

Valid 041300Z - 051200Z

...THERE IS AN ENHANCED RISK OF SEVERE THUNDERSTORMS THIS AFTERNOON/EVENING FROM NORTHEAST OKLAHOMA INTO SOUTHWEST MISSOURI...

...THERE IS A SLIGHT RISK OF SEVERE THUNDERSTORMS THIS AFTERNOON INTO TONIGHT FROM CENTRAL/EASTERN OKLAHOMA TO NORTHWESTERN ARKANSAS AND CENTRAL MISSOURI...

...THERE IS A SLIGHT RISK OF SEVERE THUNDERSTORMS LATE TONIGHT ACROSS PARTS OF THE NORTH CENTRAL/NORTHEAST GULF COAST...

...THERE IS A MARGINAL RISK OF SEVERE THUNDERSTORMS SURROUNDING THE PLAINS/OZARKS SLIGHT RISK...

...THERE IS A MARGINAL RISK OF SEVERE THUNDERSTORMS ACROSS NORTH FLORIDA TODAY...AND FROM SOUTHEAST LOUISIANA AND NORTHERN ALABAMA/NORTHWESTERN GEORGIA LATE TONIGHT...

...THERE IS A MARGINAL RISK OF SEVERE THUNDERSTORMS THIS AFTERNOON ACROSS EASTERN PENNSYLVANIA AND VICINITY...

...SUMMARY...
Scattered strong to severe thunderstorms will be possible across parts of the south-central Plains into the Ozarks this afternoon and early evening, and across parts of the central Gulf Coast states late tonight into early Wednesday morning. Isolated strong storms will also be possible today across part of north Florida and in the vicinity of eastern Pennsylvania.

...I-44 corridor from northeast OK into MO this evening...
A compact midlevel shortwave trough over northern NM this morning will progress eastward to central OK this evening and the Ozarks overnight. An associated surface cyclone initially in northwest TX will develop northeastward along a stalled front near I-44 in OK, in advance of the midlevel trough. Strengthening wind profiles and ascent will immediate precede the midlevel trough and surface cyclone and support strong-severe thunderstorm development this afternoon in OK, and the storms will spread into MO/AR overnight.

The primary limiting factor to a more robust severe-weather risk will be marginal moisture return in the warm sector of the cyclone. The maritime tropical air mass was shunted southward into the north central and northwest Gulf of Mexico by the system the prior two days. Residual boundary layer dewpoints in the low-mid 50s, aided some today by evapotranspiration but offset by vertical mixing, are expected up to the stalled front from central OK into southwest MO by mid-late afternoon. This moisture, along with afternoon surface temperatures in the 70s and midlevel lapse rates of 8 C/km or greater, will drive MLCAPE of 1000-1500 J/kg. This buoyancy, combined with effective bulk shear in excess of 50 kt, and relatively cool midlevel temperatures, will support a risk for supercells with large hail near and just ahead of the surface cyclone/triple point in beginning 21-23z in OK and continuing into MO through late evening. Storms may also develop southward along the cold front into eastern OK and northwestern AR, though the strongest/most persistent storms are expected along the path of the

cyclone along the I-44 corridor from northeast OK into southwest MO through early tonight.

The tornado risk is limited mostly by the marginal low-level moisture. There might be a narrow zone along the stalled front (immediately ahead of the surface cyclone) where moisture will be sheltered some from vertical mixing, and where low-level hodographs will by the largest with the most streamwise vorticity. A discrete storm moving along this narrow zone could produce a tornado before near-surface cooling/stabilization ends the threat just after sunset.

...North central Gulf coast into Dixie early Wednesday...
In response to cyclogenesis with the shortwave trough approaching the Ozarks, the maritime tropical air mass will return northward late tonight and early Wednesday in a strengthening warm advection regime. Elevated thunderstorm development is expected from 06-12z from southeast LA into at least central AL. Large hail will be the main risk early Wednesday across the northern parts of the Slight Risk area. Farther south near the surface warm front, some of the convection could become rooted near or at the surface. Deep-layer and low-level shear will favor supercells, and profiles will become supportive of some tornado and/or damaging wind risk from 09-12z. The main uncertainties will be the specific corridor of storm development and the narrow time window for surface-based storms. Thus, 5% tornado probabilities appear most appropriate within this outlook period.

...North FL today...
A lingering band of storms along a composite outflow boundary will sag southward through the day across north FL. Isolated strong gusts will be possible the first half of the day within this band, before the convection weakens.

...Eastern PA and vicinity this afternoon...
A midlevel trough and an associated/diffuse surface trough will cross PA during the day. Lingering low-level moisture and some surface heating will contribute to weak surface-based instability across this area by midday/early afternoon, and will be sufficient for at least isolated thunderstorm development. Given somewhat cool midlevel temperatures and effective bulk shear of 30-40 kt, a low-end hail/wind risk will be possible this afternoon with the stronger/more organized cells.

..Thompson/Goss.. 04/04/2017

CLICK TO GET WUUS01 PTSDY1 PRODUCT

NOTE: THE NEXT DAY 1 OUTLOOK IS SCHEDULED BY 1630Z

SPC AC 040057

Day 1 Convective Outlook
NWS Storm Prediction Center Norman OK
0757 PM CDT Mon Apr 03 2017

Valid 040100Z - 041200Z

...THERE IS A SLIGHT RISK OF SEVERE THUNDERSTORMS ACROSS NORTHERN FLORIDA...

...THERE IS A MARGINAL RISK OF SEVERE THUNDERSTORMS OVER SOUTHEAST GEORGIA AND NORTHERN AND EASTERN FLORIDA...

...SUMMARY...
Some threat for mainly strong to damaging wind exists mainly over northern Florida, but overall threat should gradually diminish through mid evening.

...North Florida...

Storms continue developing and training east across northern Florida to the north of a southward-advancing outflow boundary. Occasional semi-organized structures persist, and storms may pose a risk for isolated damaging wind and marginally severe hail next couple hours as they advance east. The outflow has surged south of the updrafts which should limit a more robust severe threat. There may also be some tendency for storms to weaken as they move deeper into the stable outflow over northeast FL.

..Dial.. 04/04/2017

CLICK TO GET WUUS01 PTSDY1 PRODUCT

NOTE: THE NEXT DAY 1 OUTLOOK IS SCHEDULED BY 0600Z

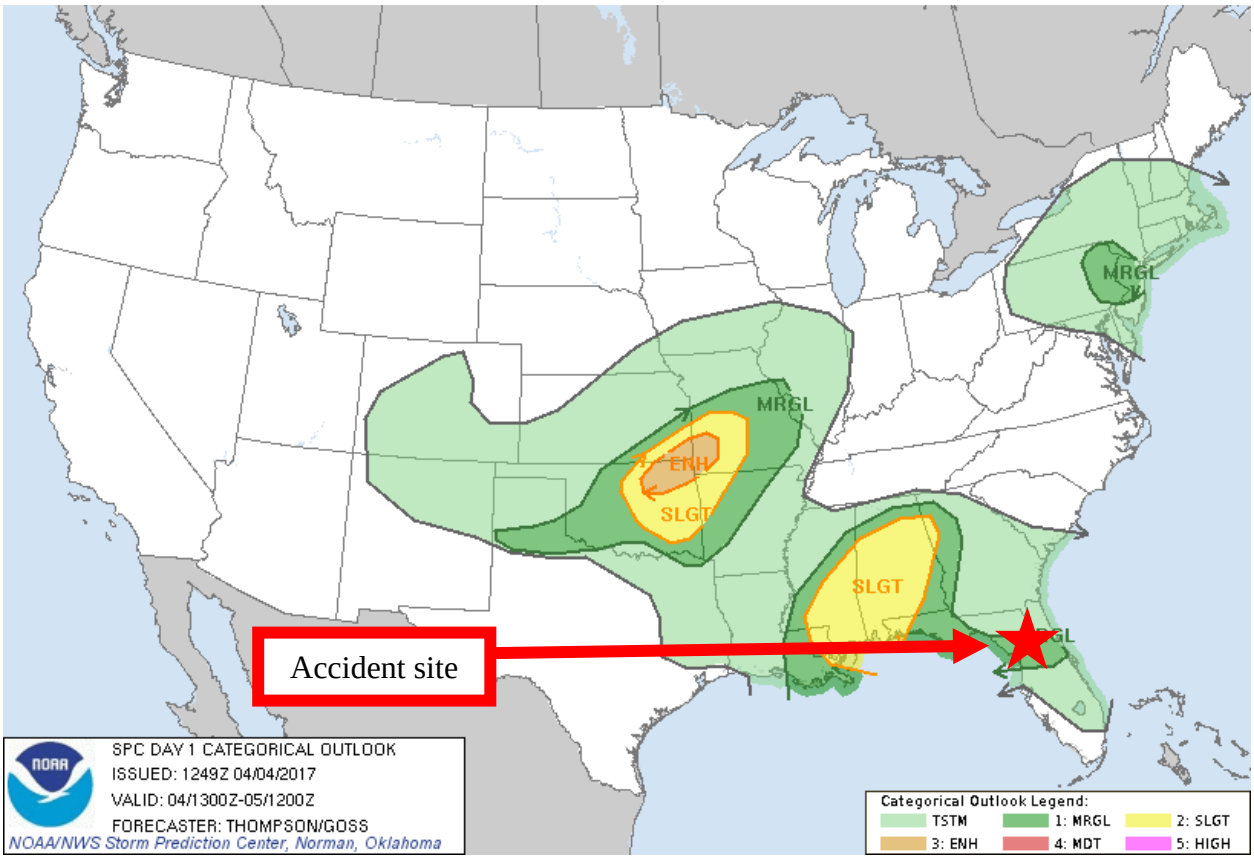


Figure 7 – SPC day 1 Convective Outlook valid at the time of the accident

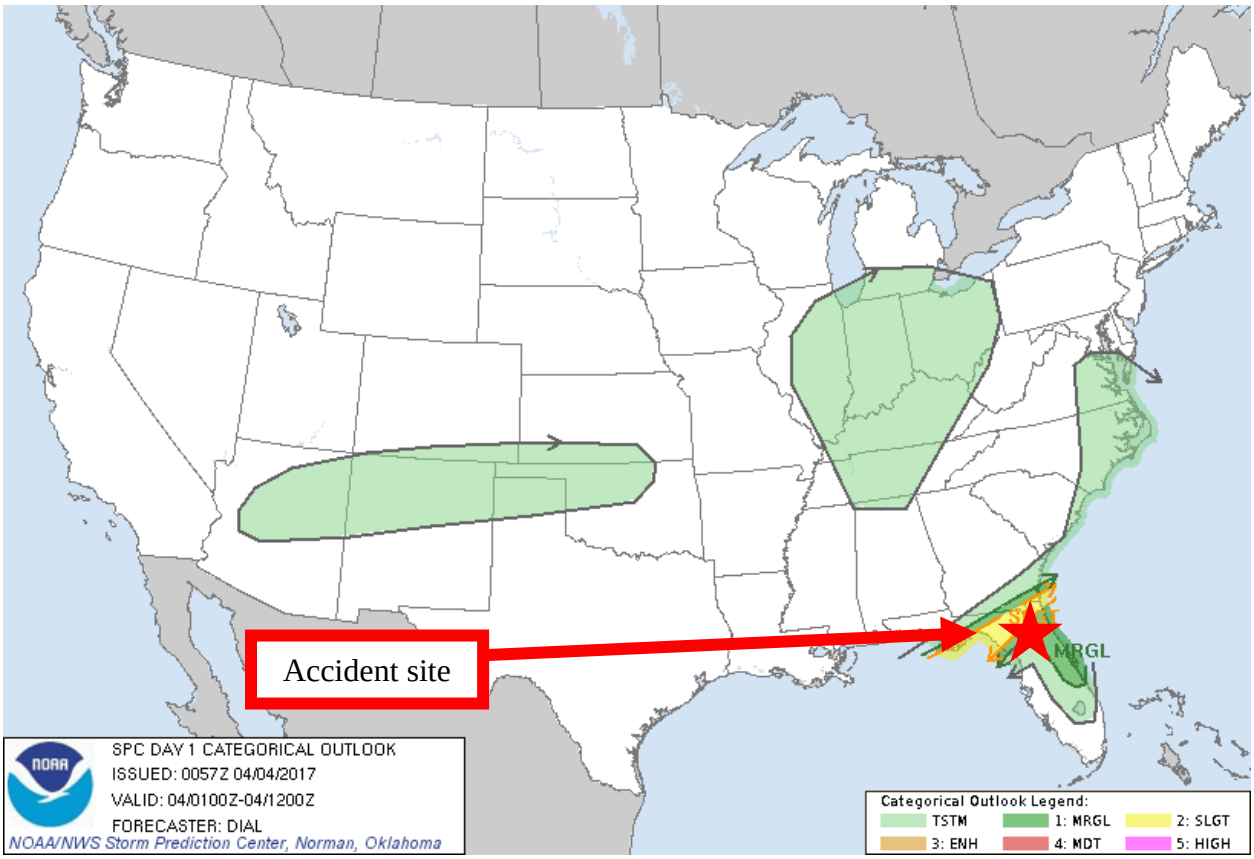


Figure 8 – SPC day 1 Convective Outlook valid at the time of the weather briefings

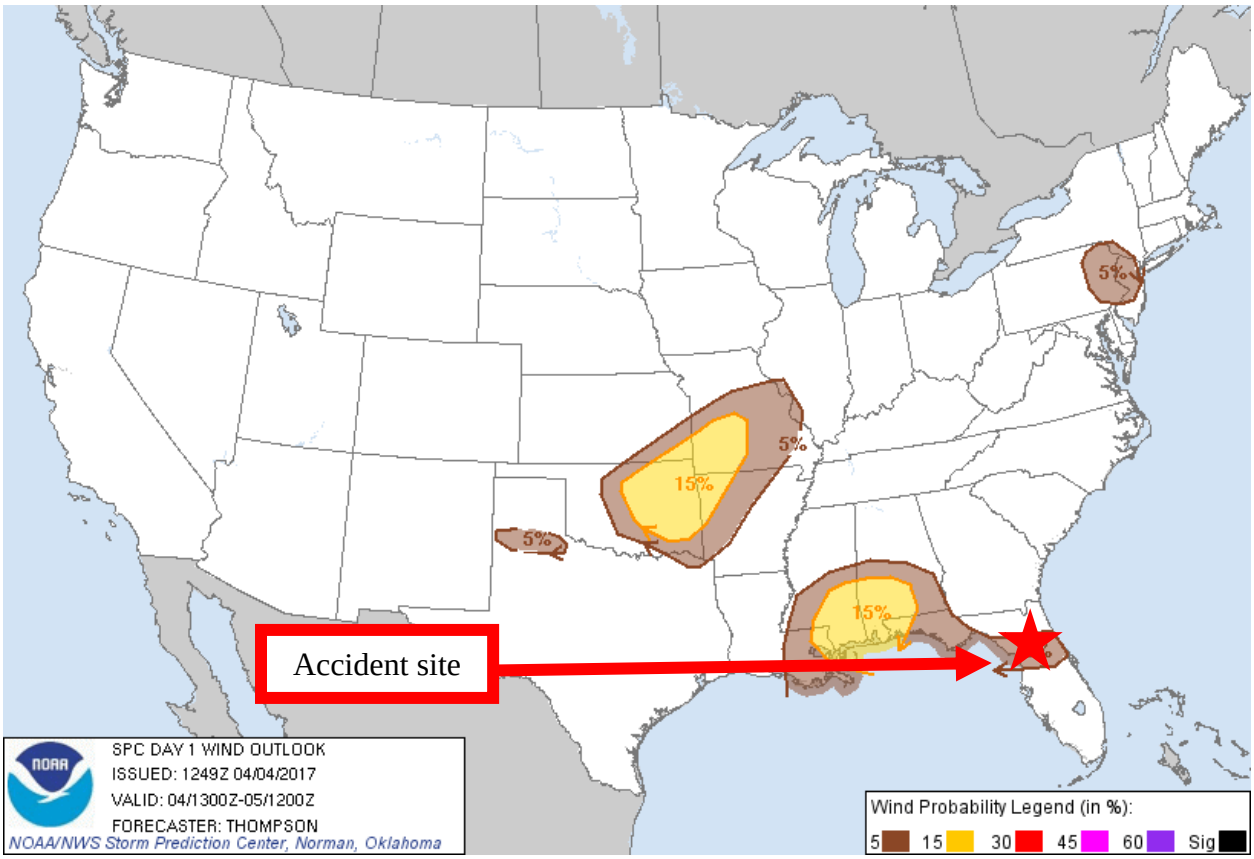


Figure 9 – SPC day 1 Wind Outlook valid at the time of the accident

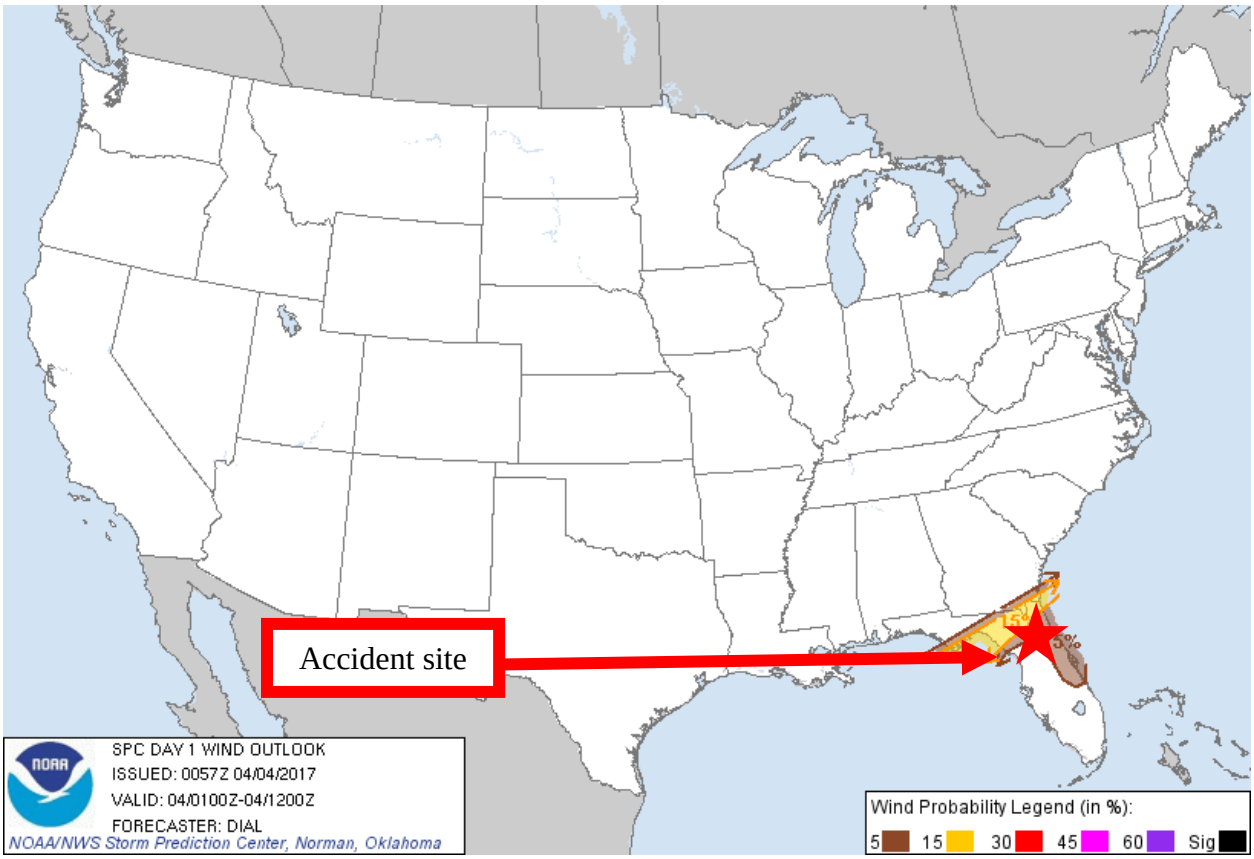


Figure 10 – SPC day 1 Wind Outlook valid at the time of the weather briefings

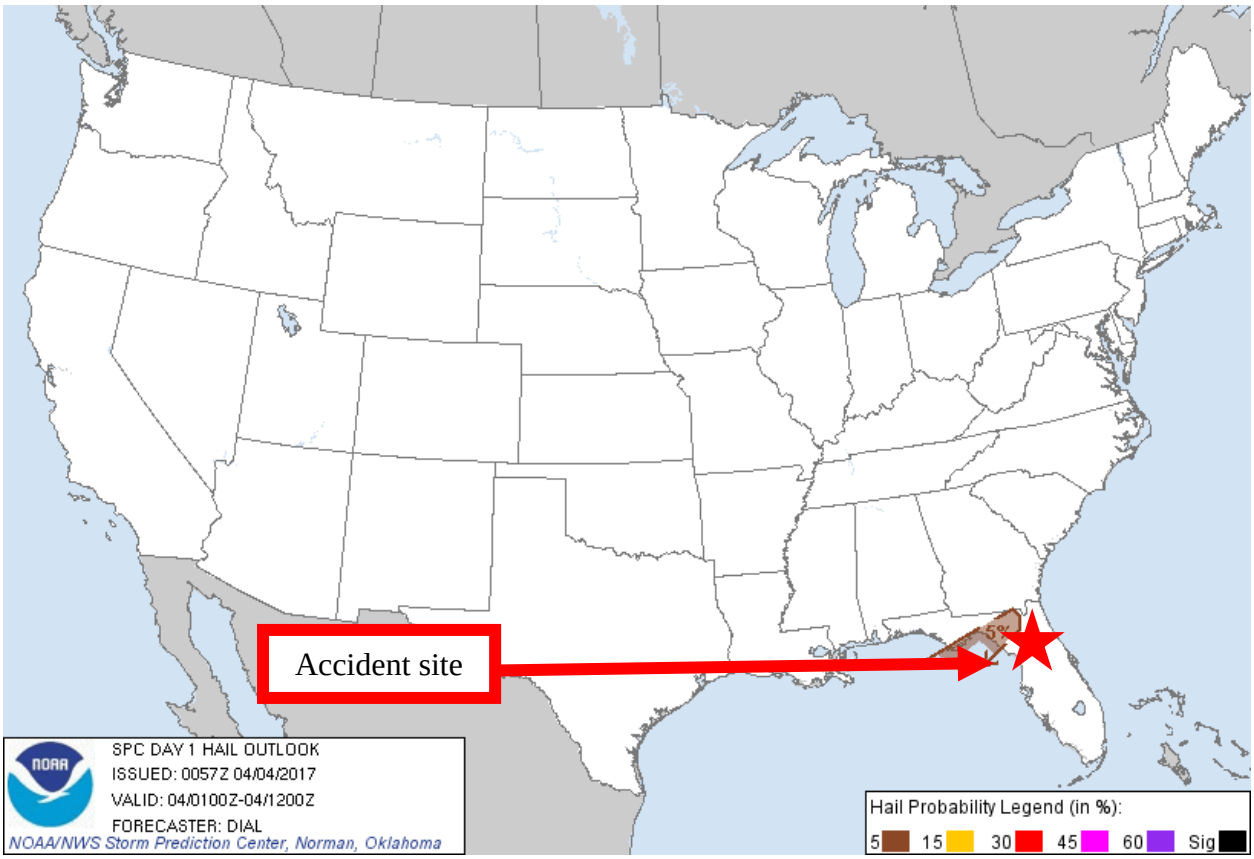


Figure 11 – SPC day 1 Hail Outlook valid at the time of the weather briefings

3.0 Surface Observations

The area surrounding the accident site was documented using official NWS Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). Figure 12 is a sectional chart with the accident site and the closest weather reporting locations to the accident site marked.

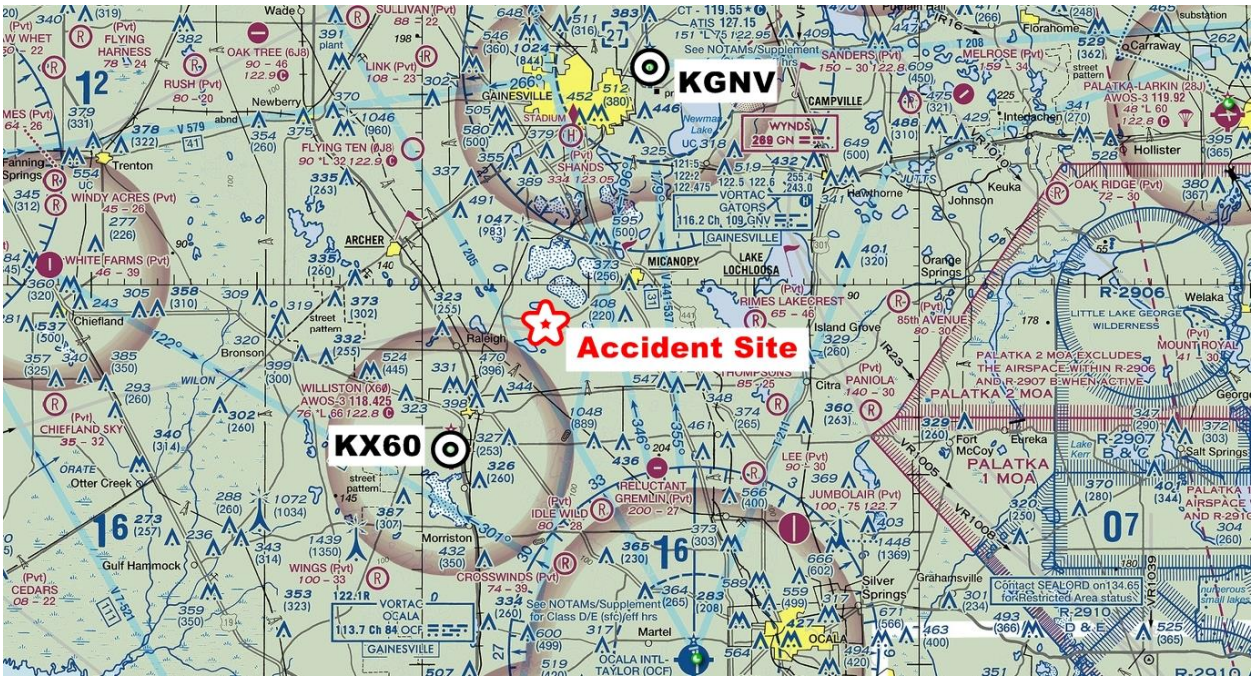


Figure 12 – Sectional chart of accident area with the location of the accident site and surface observation sites

Williston Municipal Airport (KX60) was the closest official weather station to the accident site, and was located 2 miles southwest of Williston, Florida. KX60 had Automated Weather Observing System (AWOS[2]) whose reports were not supplemented. KX60 was located 8 miles southwest of the accident site, at an elevation of 76 ft, and had a 4° westerly magnetic variation[3] (figure 12). The following observations were taken and disseminated during the times surrounding the accident:[4]

[0655 EDT] METAR KX60 041055Z AUTO 14006KT 10SM FEW045 23/19 A2986 RMK A01=

[0715 EDT] METAR KX60 041115Z AUTO VRB05G10KT 10SM FEW034 FEW045 23/19 A2988 RMK A01=

[0735 EDT] METAR KX60 041135Z AUTO 13007KT 10SM CLR 23/20 A2987 RMK A01=

[0755 EDT] METAR KX60 041155Z AUTO 13007KT 100V170 8SM CLR 23/20 A2987 RMK A01=

[2] AWOS – Automated Weather Observing System is equipped with meteorological instruments to observe and report temperature, dewpoint, wind speed and direction, visibility, cloud coverage and ceiling up to twelve thousand ft, and altimeter setting.

[3] Magnetic variation – The angle (at a particular location) between magnetic north and true north. 2000, latest measurement taken from http://www.airnav.com/airport/X60

[4] Bolded sections in this report highlight information that directly reference the weather conditions that affected the accident location around the accident time.

[0815 EDT] METAR KX60 041215Z AUTO 15007G13KT 8SM CLR 23/20 A2987 RMK A01=

[0835 EDT] METAR KX60 041235Z AUTO 14006KT 8SM CLR 23/21 A2989 RMK A01=

[0855 EDT] METAR KX60 041255Z AUTO 13006KT 8SM FEW013 SCT033 24/21 A2990 RMK A01=

ACCIDENT TIME 0910 EDT

[0915 EDT] METAR KX60 041315Z AUTO 31010KT 8SM BKN012 BKN032 24/21 A2996 RMK A01=

[0935 EDT] METAR KX60 041335Z AUTO 03007G15KT 320V070 9SM SCT013 BKN019 BKN023 22/19 A2995 RMK A01=

[0955 EDT] METAR KX60 041355Z AUTO 04008G15KT 1/4SM FG BKN001 OVC006 21/19 A2998 RMK A01 P0036=

[1015 EDT] METAR KX60 041415Z AUTO VRB06G14KT 3SM BR SCT001 SCT019 20/19 A2996 RMK A01=

KX60 weather at 0835 EDT, automated, wind from 140° at 6 knots, 8 miles visibility, clear skies below 12,000 ft above ground level (agl), temperature of 23° Celsius (C), dew point temperature of 21° C, and an altimeter setting of 29.89 inches of mercury. Remarks, station without a precipitation discriminator.

KX60 weather at 0855 EDT, automated, wind from 130° at 6 knots, 8 miles visibility, few clouds at 1,300 ft agl, scattered clouds at 3,300 ft agl, temperature of 24° C, dew point temperature of 21° C, and an altimeter setting of 29.90 inches of mercury. Remarks, station without a precipitation discriminator.

KX60 weather at 0915 EDT, automated, wind from 310° at 10 knots, 8 miles visibility, a broken ceiling at 1,200 ft agl, broken skies at 3,200 ft agl, temperature of 24° C, dew point temperature of 21° C, and an altimeter setting of 29.96 inches of mercury. Remarks, station without a precipitation discriminator.

KX60 weather at 0935 EDT, automated, wind from 030° at 7 knots with gusts to 15 knots, wind varying between 320° and 070°, 9 miles visibility, scattered clouds at 1,300 ft agl, broken ceiling at 1,900 ft agl, broken skies at 2,300 ft agl, temperature of 22° C, dew point temperature of 19° C, and an altimeter setting of 29.95 inches of mercury. Remarks, station without a precipitation discriminator.

Gainesville Regional Airport (KGNV) was the closest official weather station to the weather encountered by the accident aircraft. KGNV was located 3 miles northeast of Gainesville, Florida. KGNV had Automated Surface Observing System (ASOS[5]) whose reports were supplemented by air traffic control. KGNV was located 15 miles north-northeast of the accident site, at an elevation of 151 ft, and had a 4° westerly magnetic variation[6] (figure 12). The following observations were taken and disseminated during the times surrounding the accident:

[0753 EDT] METAR KGNV 041153Z 01013G25KT 7SM TSRA FEW013 OVC026 20/18 A2993 RMK AO2 WSHFT 1126 LTG DSNT ALQDS RAB24 TSB06E33B39 PRESRR SLP132 P0015 60015 70015 T02000178 10211 20194 53024=

[0801 EDT] SPECI KGNV 041201Z 03019G24KT 2 1/2SM +TSRA BR FEW014 BKN022 OVC036 19/18 A2992 RMK AO2 WSHFT 1141 LTG DSNT ALQDS P0004 T01890178=

[0809 EDT] SPECI KGNV 041209Z 04023G30KT 1SM +TSRA BR BKN015 OVC025 19/18 A2991 RMK AO2 PK WND 03030/1203 WSHFT 1141 LTG DSNT ALQDS P0029 T01890183=

[0819 EDT] SPECI KGNV 041219Z 01016G27KT 3/4SM +TSRA BR BKN013 OVC027 19/19 A2995 RMK AO2 PK WND 03030/1203 WSHFT 1141 LTG DSNT ALQDS PRESRR P0069 T01890189=

[0833 EDT] SPECI KGNV 041233Z 10015G25KT 3/4SM +TSRA BR VV015 19/18 A2990 RMK AO2 PK WND 03030/1203 WSHFT 1217 LTG DSNT ALQDS P0180 T01890183=

[0838 EDT] SPECI KGNV 041238Z 10015G22KT 2SM +TSRA BR BKN019 OVC080 19/18 A2992 RMK AO2 PK WND 03030/1203 WSHFT 1217 LTG DSNT ALQDS P0187 T01890183=

[0853 EDT] METAR KGNV 041253Z 10010G18KT 5SM TSRA BR BKN043 OVC075 19/18 A2993 RMK AO2 PK WND 03030/1203 WSHFT 1217 LTG DSNT ALQDS SLP133 P0194 T01890183=

ACCIDENT TIME 0910 EDT

[0953 EDT] METAR KGNV 041353Z 19007KT 8SM -TSRA FEW065 SCT095 OVC110 19/18 A2995 RMK AO2 LTG DSNT ALQDS TSE25B26 SLP140 P0031 T01940183=

[5] ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, ceiling, temperature, dewpoint, altimeter, and barometric pressure.
[6] Magnetic variation – The angle (at a particular location) between magnetic north and true north. 2005, latest measurement taken from http://www.airnav.com/airport/KGNV

[1012 EDT] SPECI KGNV 041412Z 10005KT 8SM VCTS -RA FEW060 OVC110 19/18 A2994 RMK AO2 LTG DSNT ALQDS TSE06 P0005 T01890183=

[1053 EDT] METAR KGNV 041453Z 15006KT 5SM VCTS RA BR BKN090 OVC110 19/18 A2998 RMK AO2 LTG DSNT ALQDS TSE06 SLP149 P0011 60236 T01890178 53017=

[1133 EDT] SPECI KGNV 041533Z 14003KT 4SM VCTS RA BR FEW009 BKN085 OVC100 19/18 A2998 RMK AO2 LTG DSNT SE-SW P0007 T01890183=

KGNV weather at 0838 EDT, wind from 100° at 15 knots with gusts to 22 knots, 2 miles visibility, heavy rain and thunderstorms, mist, broken ceiling at 1,900 ft agl, overcast skies at 8,000 ft agl, temperature of 19° C, dew point temperature of 18° C, and an altimeter setting of 29.92 inches of mercury. Remarks, station with a precipitation discriminator, peak wind from 030° at 30 knots at 0803 EDT, wind shift at 0817 EDT, lightning distant[7] all quadrants, one-hourly precipitation of 1.87 inches, temperature 18.9° C, dew point temperature 18.3° C.

KGNV weather at 0853 EDT, wind from 100° at 10 knots with gusts to 18 knots, 5 miles visibility, moderate rain and thunderstorms, mist, broken ceiling at 4,300 ft agl, overcast skies at 7,500 ft agl, temperature of 19° C, dew point temperature of 18° C, and an altimeter setting of 29.93 inches of mercury. Remarks, station with a precipitation discriminator, peak wind from 030° at 30 knots at 0803 EDT, wind shift at 0817 EDT, lightning distant all quadrants, sea level pressure 1013.3 hPa, one-hourly precipitation of 1.94 inches, temperature 18.9° C, dew point temperature 18.3° C.

KGNV weather at 0953 EDT, wind from 190° at 7 knots, 8 miles visibility, light rain and thunderstorms, few clouds at 6,500 ft agl, scattered clouds at 9,500 ft agl, overcast ceiling at 11,000 ft agl, temperature of 19° C, dew point temperature of 18° C, and an altimeter setting of 29.95 inches of mercury. Remarks, station with a precipitation discriminator, lightning distant all quadrants, thunderstorm ended at 0925 EDT, thunderstorm began at 0926 EDT, sea level pressure 1014.0 hPa, one-hourly precipitation of 0.31 inches, temperature 19.4° C, dew point temperature 18.3° C.

KGNV weather at 1012 EDT, wind from 100° at 5 knots, 8 miles visibility, vicinity[8] thunderstorms, light rain, few clouds at 6,000 ft agl, overcast ceiling at 11,000 ft agl, temperature of 19° C, dew point temperature of 18° C, and an altimeter setting of 29.94 inches of mercury. Remarks, station with a precipitation discriminator, lightning distant all quadrants, thunderstorm ended at 1006 EDT, one-hourly precipitation of 0.05 inches, temperature 18.9° C, dew point temperature 18.3° C.

[7] 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).
[8] In the vicinity of the airport is defined as a weather phenomenon within 5-10 miles of the airfield, but not over the airfield.

The observations from KX60 and KGNV surrounding the accident time indicated gusty surface winds with varying wind directions near the thunderstorm activity with LIFR[9] to IFR[10] visibility conditions within the thunderstorm activity. Outside of the thunderstorm activity the weather conditions remained VFR.[11]

4.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR)[12] model sounding was created for the accident site for 0900 EDT. The 0900 EDT sounding was plotted on a standard Skew-T log P diagram[13] with the derived stability parameters included in figure 13 (with data from the surface to 250-hPa, or 35,000 ft msl.) This sounding data was analyzed using the RAOB[14] software package. The sounding depicted the lifted condensation level (LCL)[15] at 1,634 ft msl, a convective condensation level (CCL)[16] of 3,889 ft, and a level of free convection (LFC)[17] at 8,448 ft. The freezing level was 13,673 ft. The precipitable water value was 1.75 inches.

[9] Low Instrument Flight Rules – Refers to the general weather conditions pilots can expect at the surface. LIFR criteria means a ceiling below 500 ft agl and/or less than 1 miles visibility.
[10] Instrument Flight Rules – Refers to the general weather conditions pilots can expect at the surface. IFR criteria means a ceiling below 1,000 ft agl and/or less than 3 miles visibility.
[11] Visual Flight Rules – Refers to the general weather conditions pilots can expect at the surface. VFR criteria means a ceiling greater than 3,000 ft agl and greater than 5 miles visibility.
[12] 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.
[13] 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.
[14] RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamopras, Pennsylvania.
[15] LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.
[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.
[17] 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.

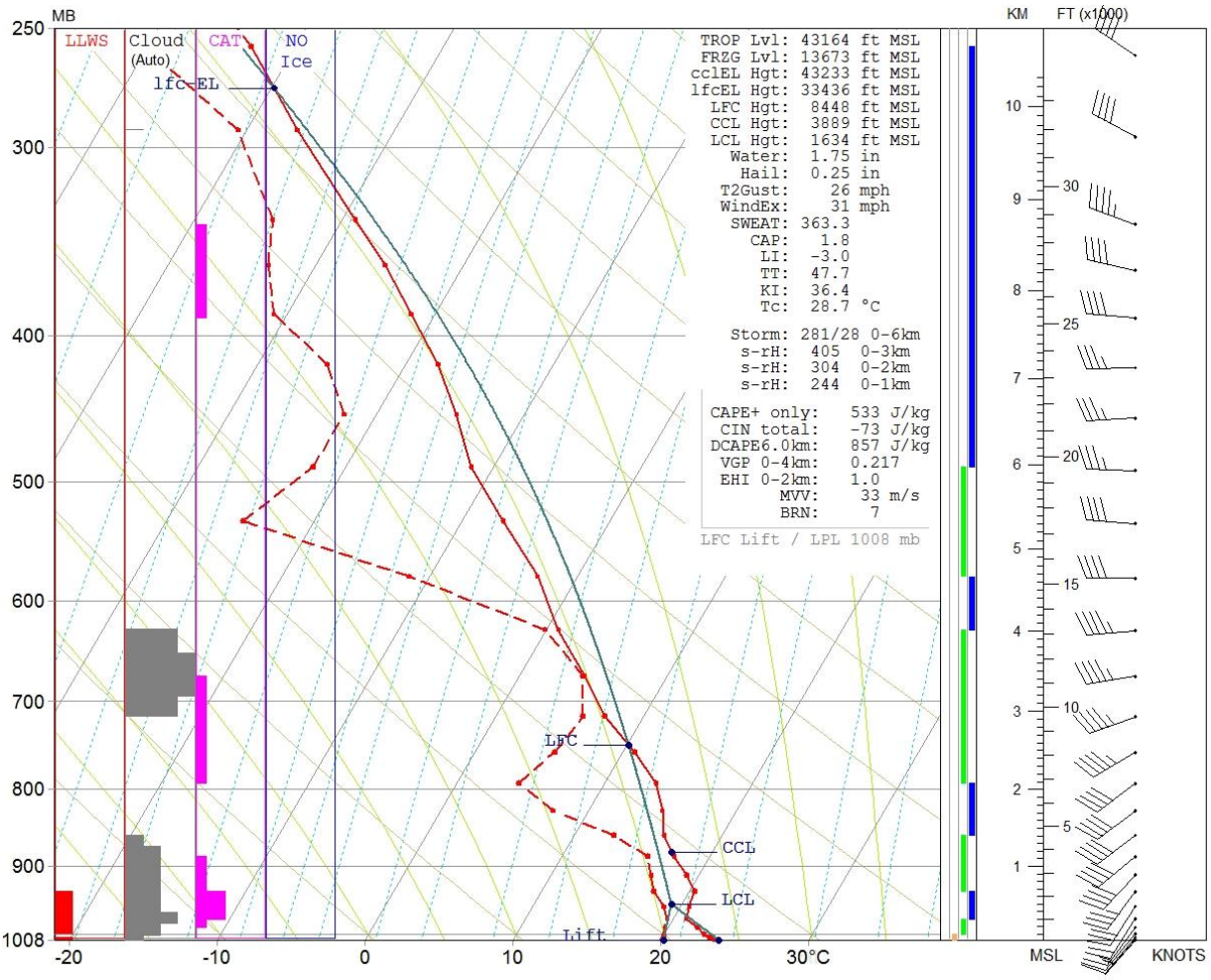


Figure 13 – 0900 EDT HRRR sounding for the accident site

The 0900 EDT HRRR sounding indicated a conditionally unstable environment with 533 J/kg of CAPE[18]. The Maximum vertical velocity (MVV) for this atmosphere was calculated as 33 meters/second (about 6,496 ft per minute).[19] Downdraft CAPE (DCAPE; 6 kilometers agl)[20] was measured at 857 Joules/kilogram. RAOB identified the possibility of clouds between the surface and 5,000 ft with another cloud layer between 10,000 ft and 14,000 ft. No areas of icing were indicated by RAOB outside of rain showers or thunderstorms. The 0900 EDT HRRR sounding indicated the strongest wind speeds possible with a microburst, outflow boundary, or gust front would have been 26 mph (23 knots) as indicated by the T2Gust parameter or 31 mph (27 knots) as indicated by the WindEx parameter.

The 0900 EDT HRRR sounding wind profile indicated a surface wind from 219° at 7 knots with the wind remaining southwesterly through 8,000 ft. The wind speed increased to 30 knots by

[18] 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.
[19] 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.
[20] The DCAPE can be used to estimate the potential strength of rain-cooled downdrafts within thunderstorm convection, and is similar to CAPE. Larger DCAPE values are associated with stronger downdrafts.

1,500 ft and 40 knots by 3,700 ft. Above 8,000 ft the wind was westerly with the wind speed between 35 and 45 knots through 35,000 ft. RAOB indicated the possibility of low-level wind shear between the surface and 2,000 ft. RAOB indicated the possibility of light to moderate clear-air turbulence in three layers between 1,000 ft and 30,000 ft.

5.0 Satellite Data

Visible and infrared data from the Geostationary Operational Environmental Satellite number 13 (GOES-13) data was 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-13 bands 1 and 4) at wavelengths of 0.65 microns (μm) and 10.7 μm, respectively, were retrieved for the period. Satellite imagery surrounding the time of the accident, from 0800 EDT through 1100 EDT at approximately 15-minute intervals were reviewed, and the closest images to the time of the accident are documented here.

Figures 14 and 15 present the GOES-13 visible imagery from 0900 and 0915 EDT at 2X magnification with the accident site marked with a red box. The visible imagery indicated cloud cover above the accident site at the accident time with the cloud cover cumuliform in nature moving from west to east (attachment 1). Figure 16 presents the GOES-13 infrared imagery from 0915 EDT at 6X magnification with the accident site highlighted with a red square. Inspection of the infrared imagery indicated cloud cover over the accident site with that cloud cover moving from west to east (attachment 2). The lower brightness temperatures (blue and green colors, higher cloud tops) were located above the accident site and in a band oriented from west to east across northern Florida. Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 0900 EDT HRRR sounding, the approximate cloud-top heights over the accident site were 41,000 ft at 0915 EDT. It should be noted these figures have not been corrected for any parallax error.

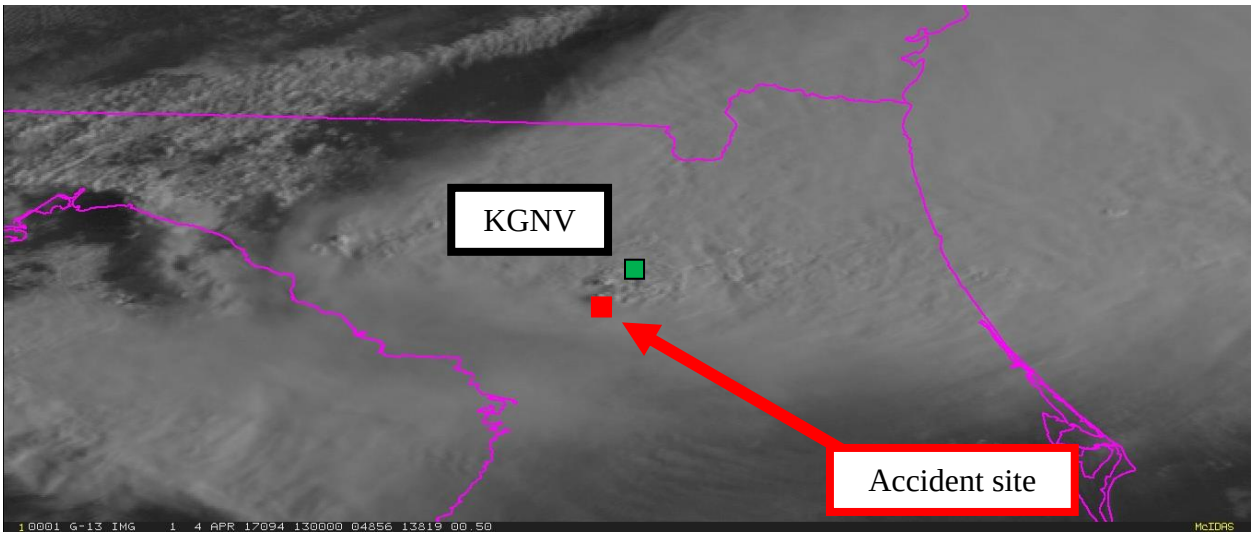


Figure 14 – GOES-13 visible image at 0900 EDT

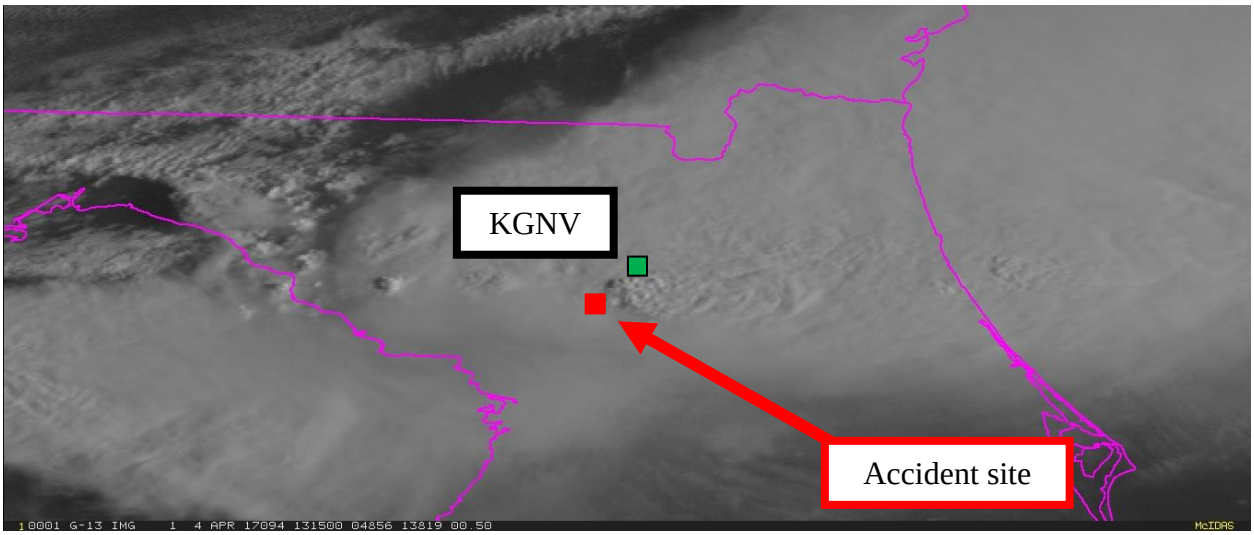


Figure 15 – GOES-13 visible image at 0915 EDT

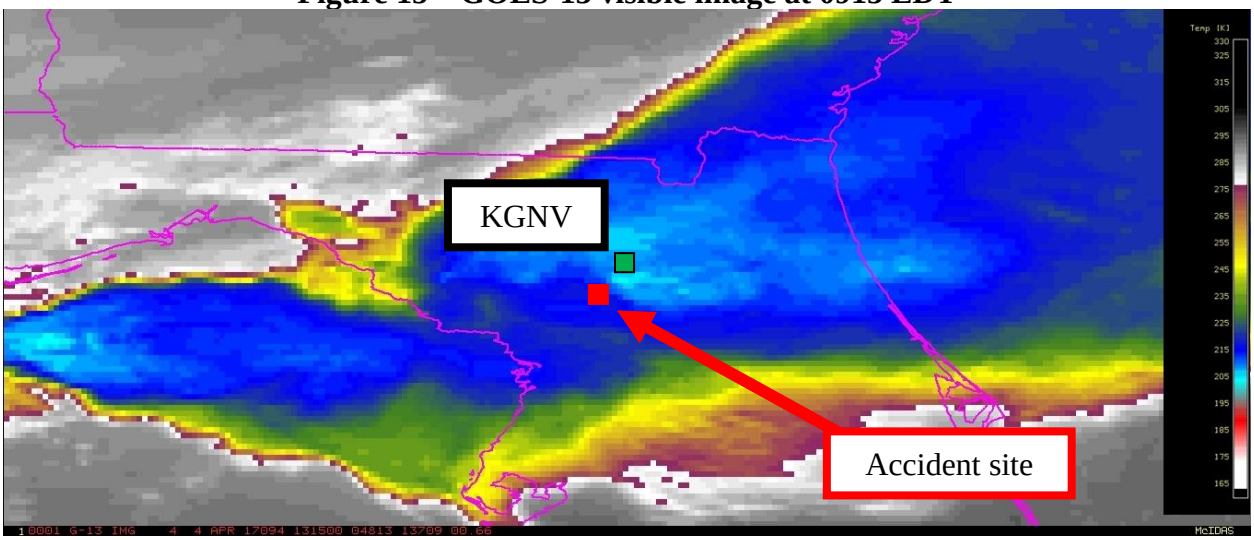


Figure 16 – GOES-13 infrared image at 0915 EDT

6.0 Radar Imagery Information

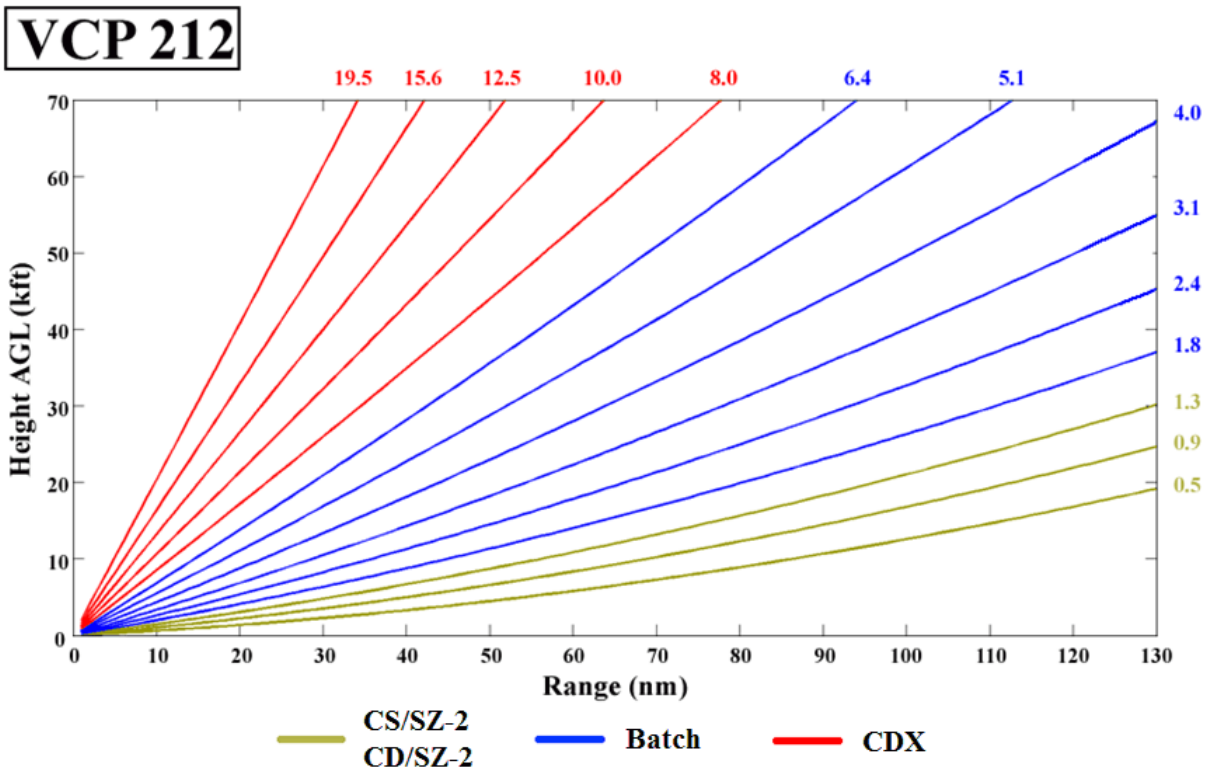
The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)[21] to the accident site was the Jacksonville, Florida, radar (KJAX), which was located 33 miles north-northeast of the accident site at an elevation of 33 ft. Level II and III archive radar data were obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

[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.

6.1 Volume Scan Strategy

The WSR-88D is a computer-controlled radar system, which automatically creates a complete series of specific scans in a specific sequence known as a volume scan. Individual elevation scans are immediately available on the WSR-88D's Principle Users Processor (PUP). Products that require data from multiple elevation scans are not available until the end of the five to ten minute volume scan.

The WSR-88D operates in several different scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has three common scanning strategies. The most common is where the radar makes 14 elevation scans from 0.5° to 19.5° every four and a half minutes. This particular scanning strategy is documented as volume coverage pattern 212 (VCP-212). Mode B is the clear-air mode, where the radar makes 5 elevation scans during a ten minute period. During the period surrounding the accident, the KJAX WSR-88D radar was operating in the precipitation mode (Mode A, VCP-212). The following chart 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.



VCP-212 Precipitation Mode Scan Strategy[22]

[22] Contiguous Surveillance (CS)--The low 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.

6.2 Beam Height Calculation

Assuming standard refraction[23] of the WSR-88D 0.95° wide radar beam, the following table shows the approximate beam height and width[24] information[25] of the radar display over the site of the accident. The heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP	BEAM WIDTH
0.5°	7,290 ft	3,840 ft	10,740 ft	6,900 ft

Based on the radar height calculations, the 0.5° elevation scan depicted the conditions between 3,840 ft and 10,740 ft msl over the accident site and these are the closest altitudes to the accident flight level before the accident occurred.[26]

6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[27] 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 decibels (dBZ[28]), and is a general measure of echo intensity. FAA Advisory Circular AC 00-24C, "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 but less than 50 dBZ, inclusive. Finally, any dBZ values above 50 dBZ shall be described as "extreme." From the NWS, precipitation conditions at the surface can be inferred from VIP Levels described in the chart below:

W – With range unfolding (W)
WO – Without range unfolding (WO)

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

[24] Beam width – A measure of the angular width of a radar beam.

[25] Beamwidth values are shown for legacy resolution products. Super resolution products would an effective beamwidth that would be approximately half these values.

[26] For more information, please see the air traffic control (ATC) data located in the docket for this accident.

[27] 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.

[28] 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.

- VIP 1 (Level 1, 18-30 dBZ) - Light precipitation
- VIP 2 (Level 2, 30-38 dBZ) - Light to moderate rain.
- VIP 3 (Level 3, 38-44 dBZ) - Moderate to heavy rain.
- VIP 4 (Level 4, 44-50 dBZ) - Heavy rain
- VIP 5 (Level 5, 50-57 dBZ) - Very heavy rain; hail possible.
- VIP 6 (Level 6, >57 dBZ) - Very heavy rain and hail; large hail possible.

6.4 Regional Weather Radar Summary

Figures 17 and 18 provide a radar summary image from 0845 and 0915 EDT with reflectivity values over the southeastern United States. The accident site was located in an area of 40 to 55 dBZ values at 0845 and 0915 EDT. These reflectivity values indicated heavy to extreme echoes at the accident site around the accident time with severe turbulence, lightning, large hail, extensive surface wind gusts, and turbulence all possible (section 6.3). The area of 40 to 55 dBZ values stretched across the entire width of northern Florida at 0845 and 0915 EDT.

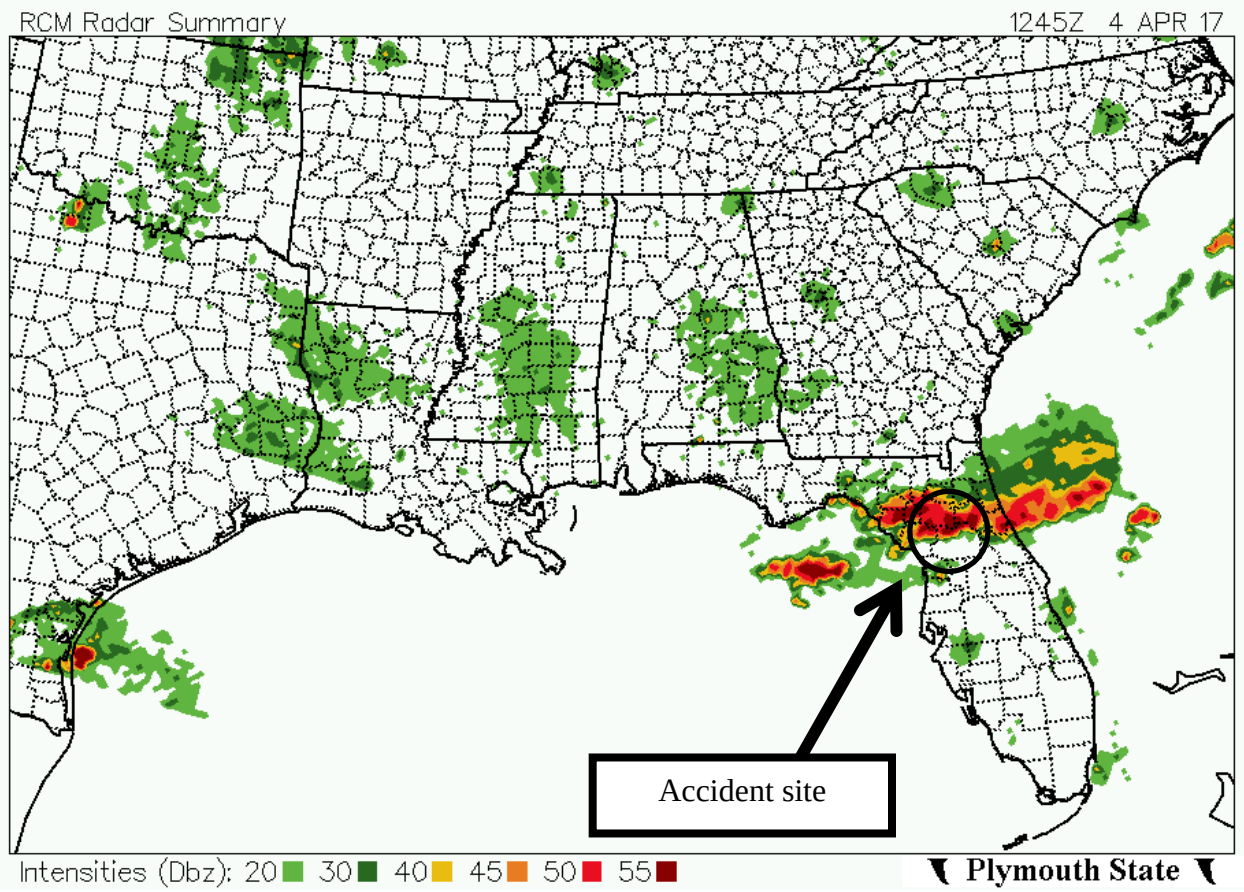


Figure 17 – Radar summary image for 0845 EDT with the accident site

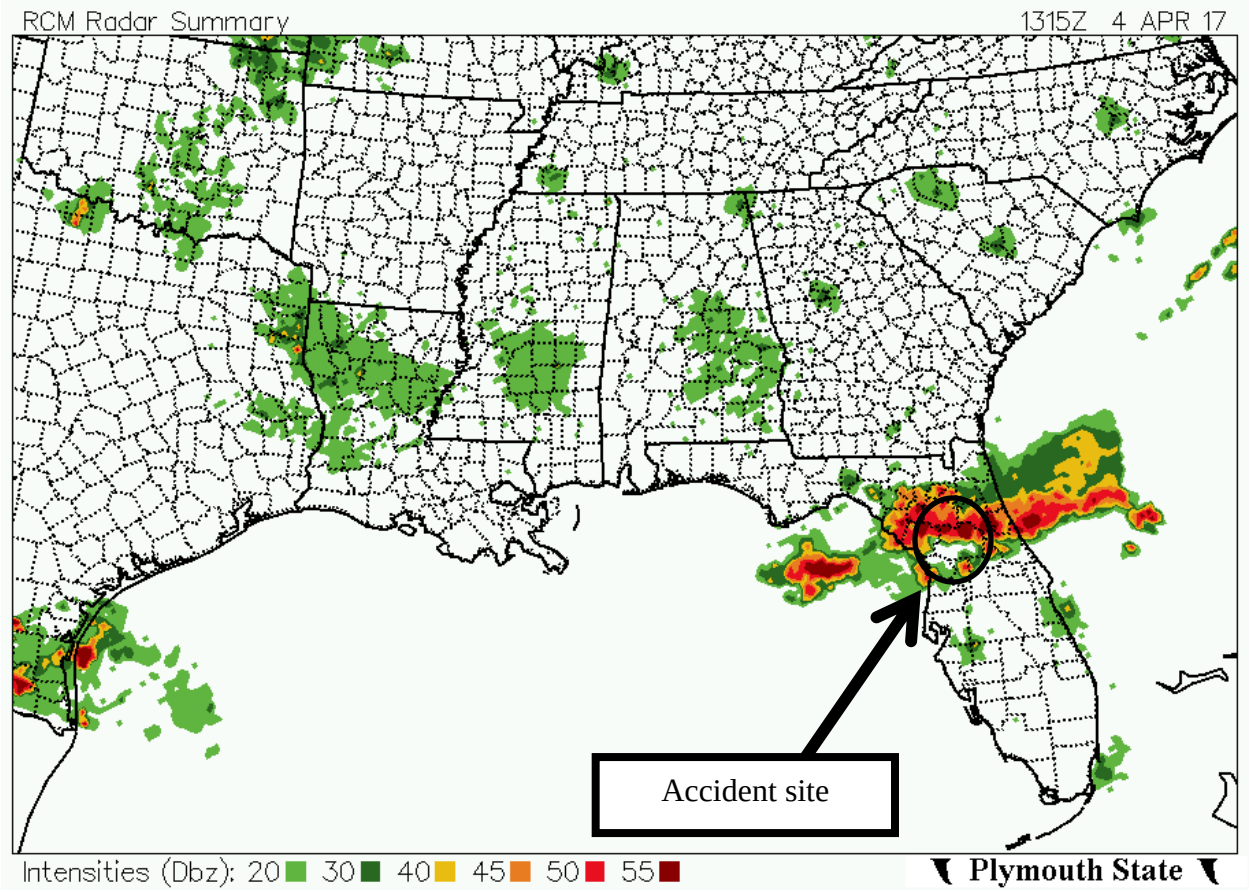


Figure 18 – Radar summary image for 0915 EDT with the accident site

6.5 Base Reflectivity and Lightning Data

Figures 19 through 24 present the KJAX WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 0900, 0903, 0905, 0908, 0911 and 0914 EDT with a resolution of 0.5° X 250 meters. The ATC flight track is also included with the arrows pointing in the direction of travel. The accident flight track depicted the flight entering the southern edge of the area of convection and into echoes of 10 to 30 dBZ between 0905 and 0908 EDT (figures 21 and 22). With echoes of 40 to 60 dBZ over the accident site at 0908 and 0914 EDT (figures 22, 23, and 24). The reflectivity values above the accident site at the accident time would correspond to very heavy rain with hail possible (section 6.3). The base reflectivity images depicted a large convective cell which had a sharp rainfall gradient. There were lightning flashes[29] and strikes surrounding the accident site around the accident time with over 4,800 lightning flashes associated with the thunderstorms between 0855 and 0915 EDT (figure 25).[30] The accident flight was located within 510 ft of one of the lightning flashes at 0907:30 EDT (attachment 3).[31] The KJAX WSR-88D base velocity data indicated that a combination of outbound wind (away from KJAX, red colors) and inbound wind (towards KJAX, green colors) was located above the accident site at 0908 and 0911 EDT (figures 26 and 27).

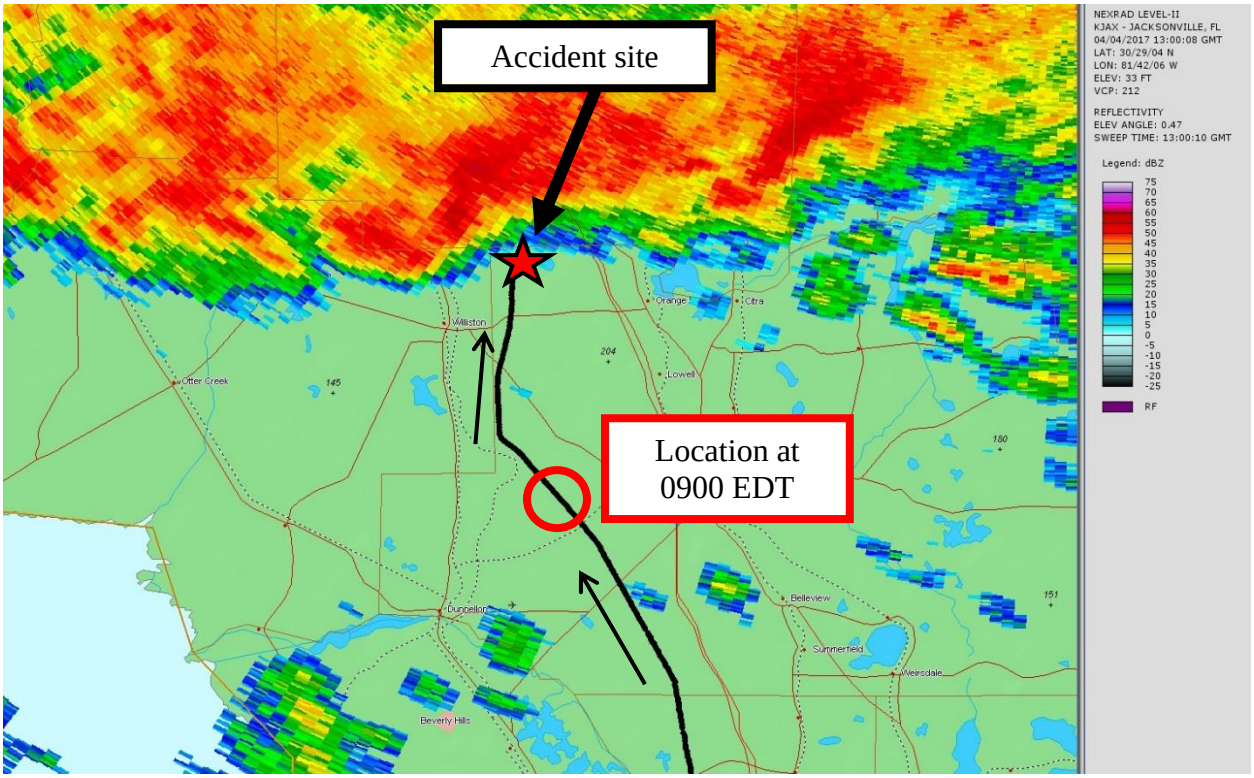


Figure 19 – KJAX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0900 EDT with the ATC flight track (black dots) and arrows pointing in direction of travel

[29] 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.
[30] A review of Earth Networks Total Lightning network was done.
[31] For more information, please see the ATC track data located in the docket for this accident.

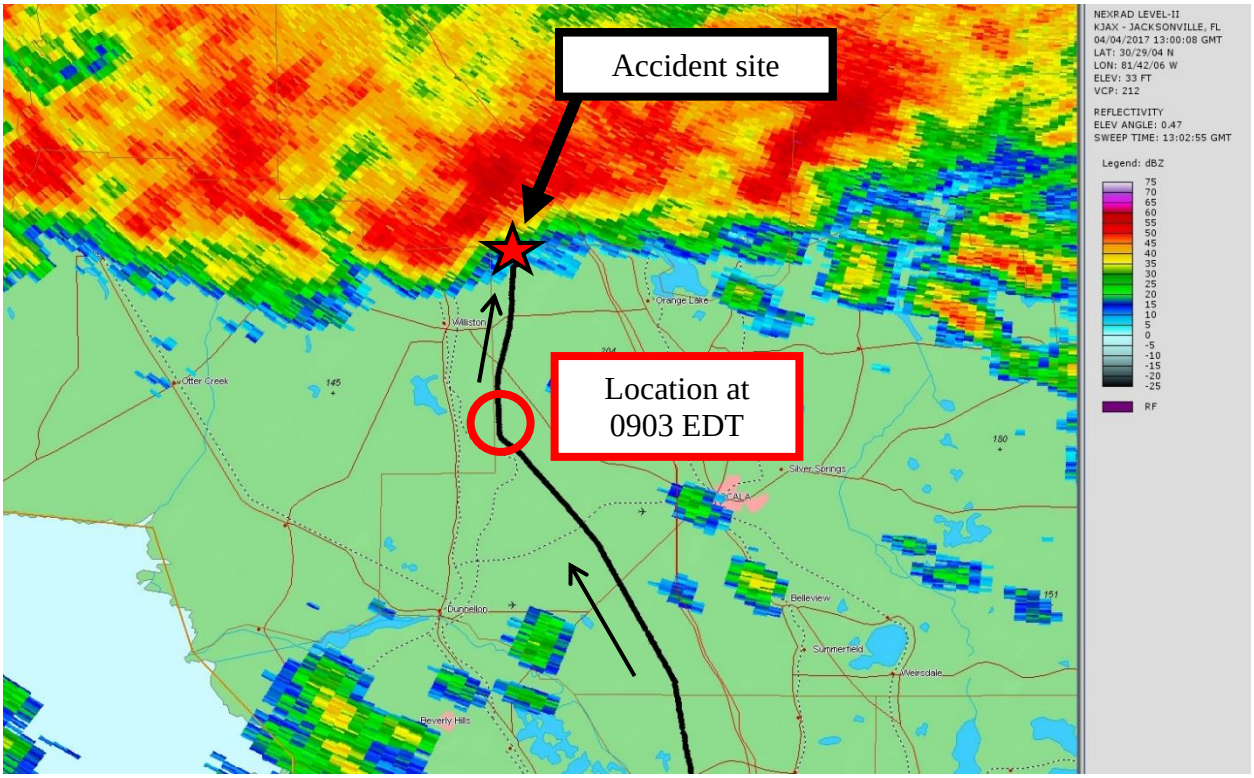


Figure 20 – KJAX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0903 EDT with the ATC flight track (black dots) and arrows pointing in direction of travel

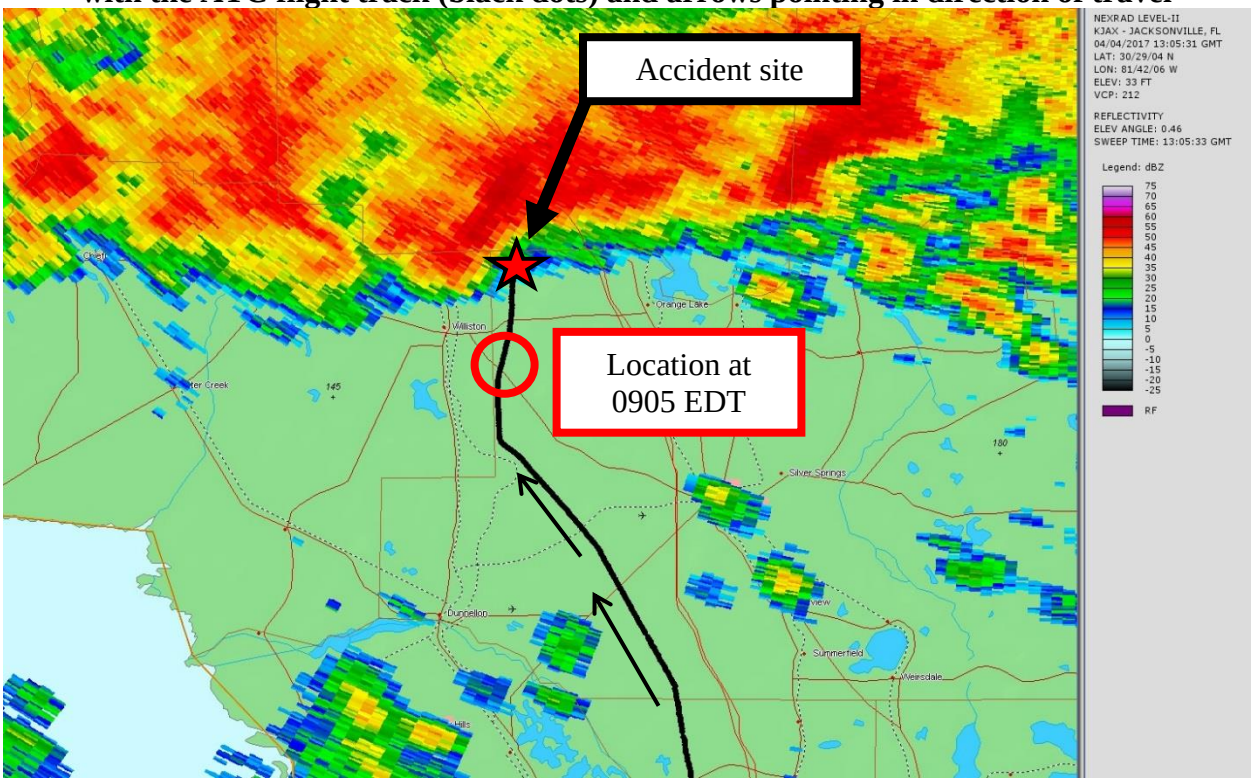


Figure 21 – KJAX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0905 EDT with the ATC flight track (black dots) and arrows pointing in direction of travel

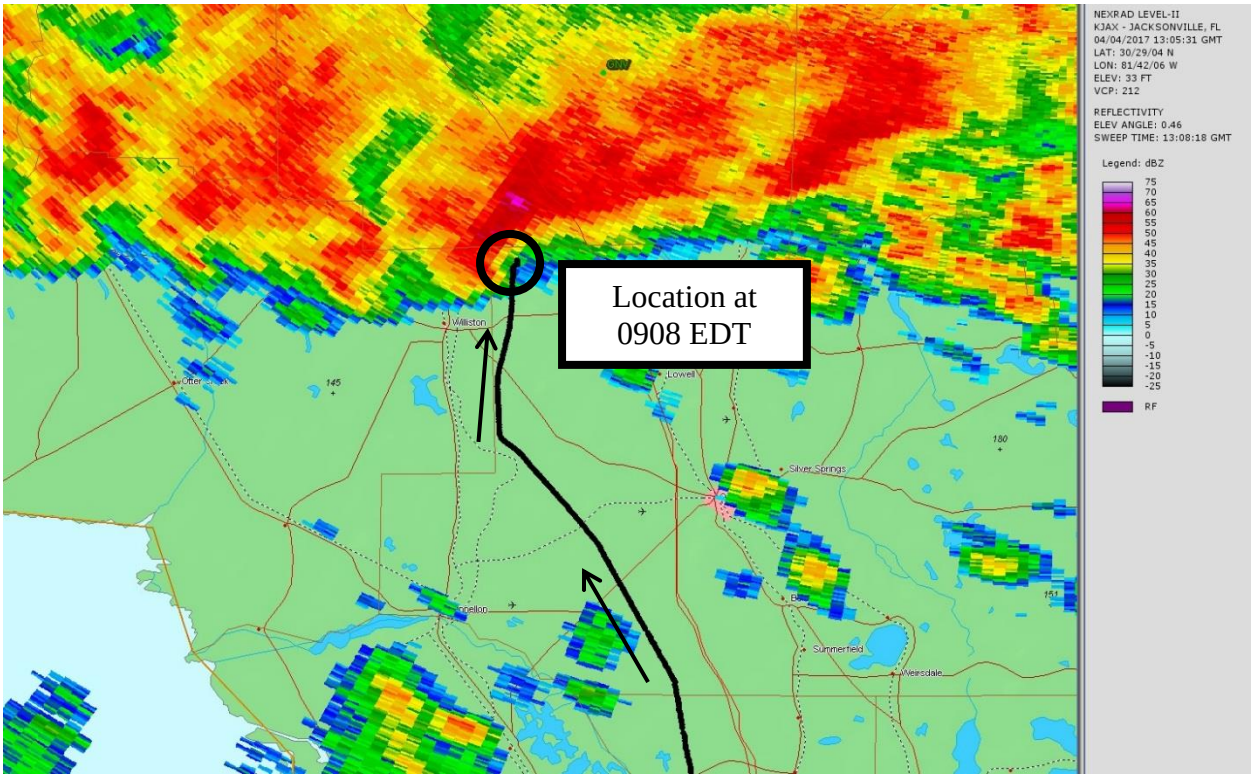


Figure 22 – KJAX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0908 EDT with the ATC flight track (black dots) and arrows pointing in direction of travel

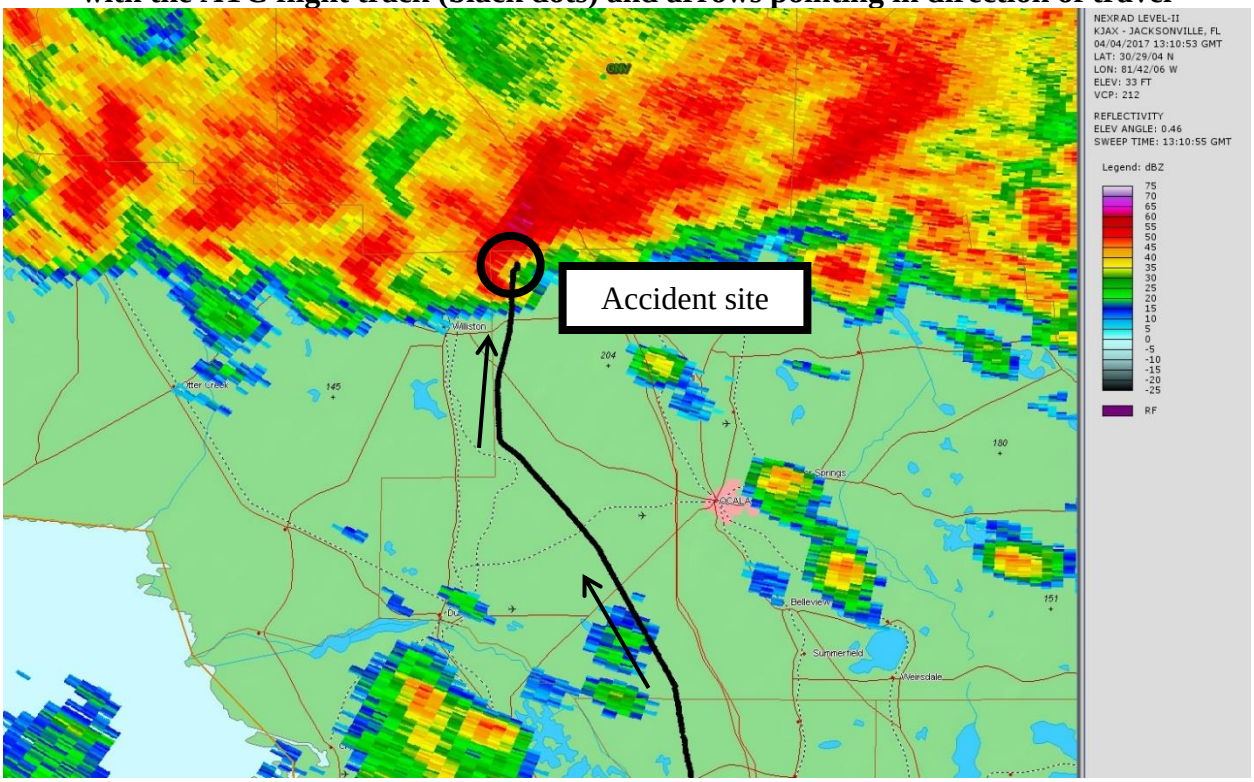


Figure 23 – KJAX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0911 EDT with the ATC flight track (black dots) and arrows pointing in direction of travel

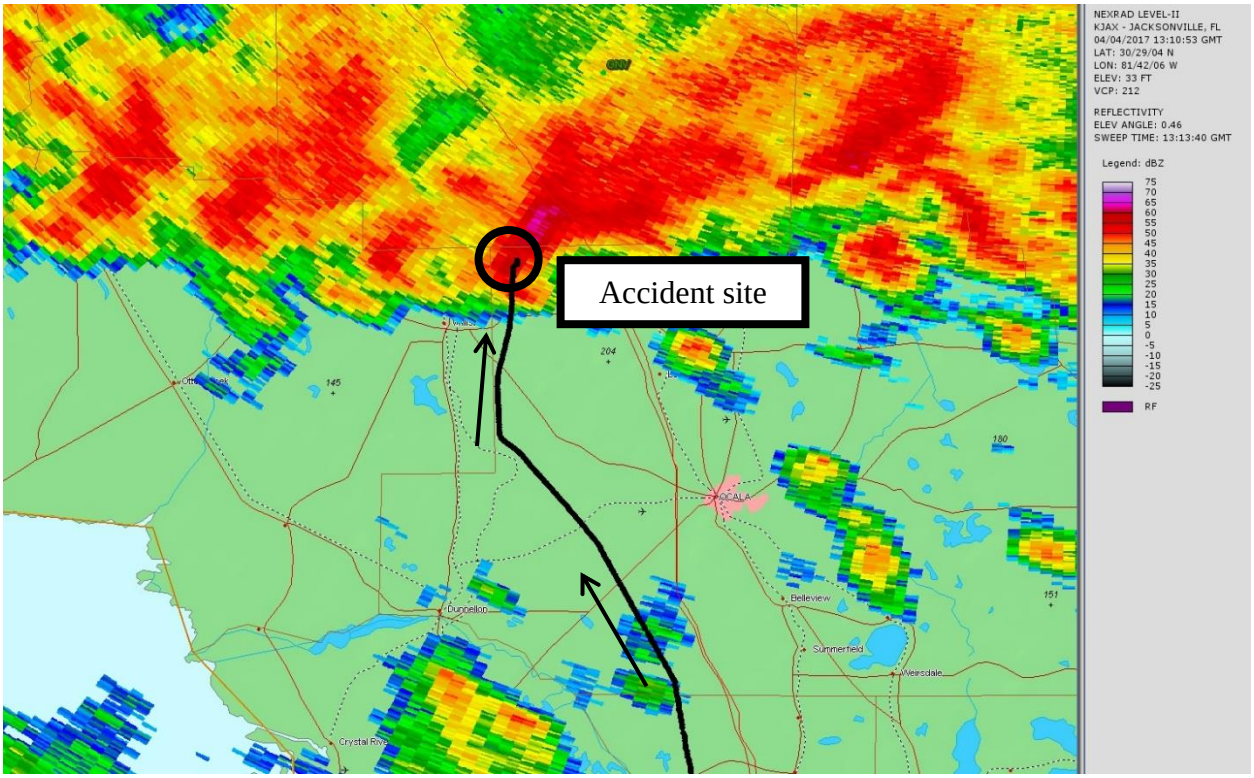


Figure 24 – KJAX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0914 EDT with the ATC flight track (black dots) and arrows pointing in direction of travel

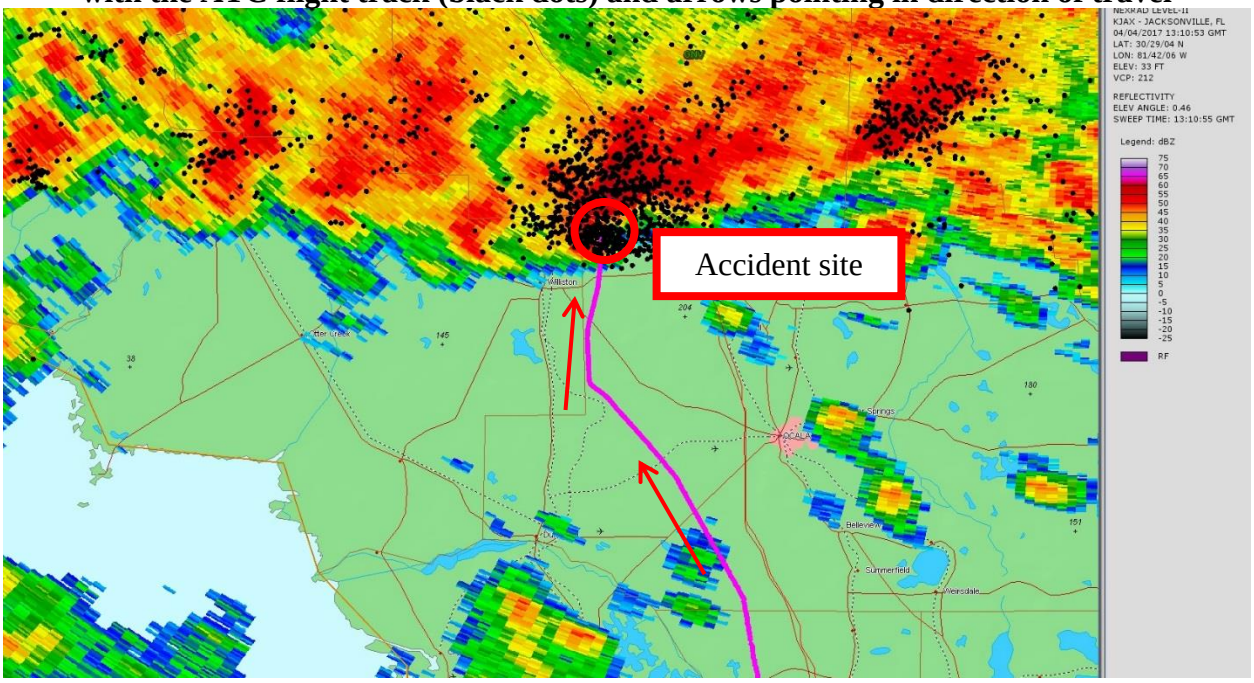


Figure 25 – KJAX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0911 EDT with the ATC flight track (pink dots) and arrows pointing in direction of travel and lightning flashes (black dots) from 0855 to 0915 EDT

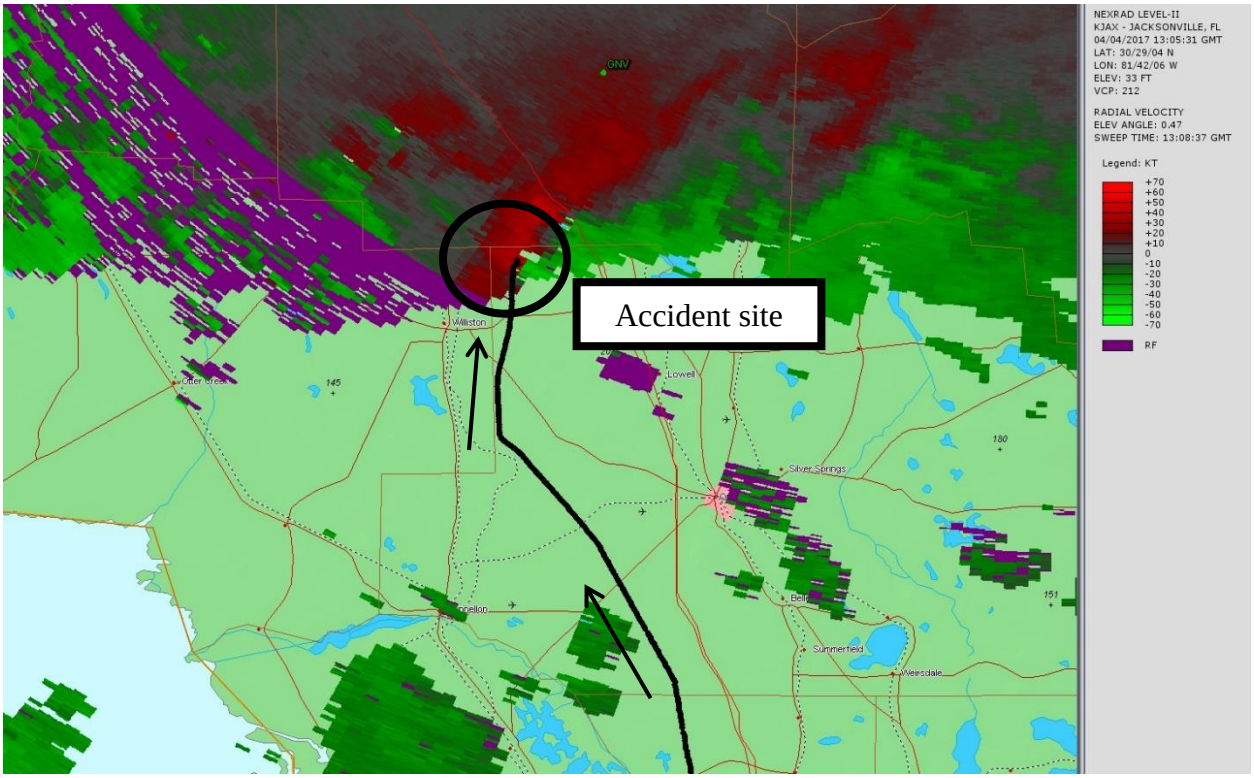


Figure 26 – KJAX WSR-88D velocity for the 0.5° elevation scan initiated at 0908 EDT with the ATC flight track (black dots) and arrows pointing in direction of travel

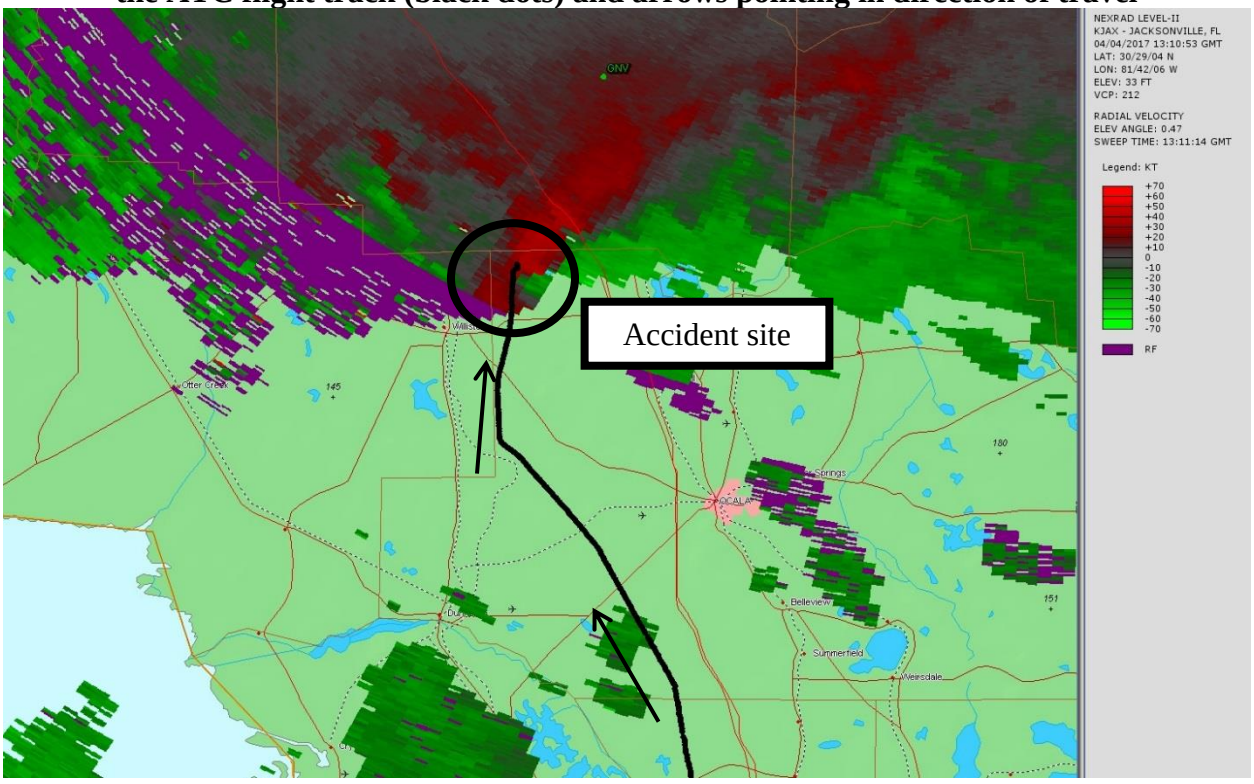


Figure 27 – KJAX WSR-88D velocity for the 0.5° elevation scan initiated at 0911 EDT with the ATC flight track (black dots) and arrows pointing in direction of travel

6.6 Base Reflectivity Comparison N88GA and N155CL Flight Tracks[32]

Figures 28 through 32 present the KJAX WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 0849, 0852, 0855, 0857, and 0900 EDT with a resolution of 0.5° X 250 m. The ATC flight track is also included with the arrows pointing in the direction of travel. The ATC data and audio indicated that N88GA, on approach into KGNV about 20 minutes before the accident time, deviated west of the 40 to 60 dBZ cell that N155CL encountered. On approach into KGNV, N88GA reported "a pretty good downdraft" around 0851 EDT. By 0853 EDT, N88GA reported that "got pretty rough there for a minute, but now picking up some heavy rain." None of the information provided by N88GA to ATC was reported into the National Airspace System (NAS) in the form of a pilot report (PIREP). Another PIREP for KGNV included, microburst and lightning strike information, was provided to ATC by 0904 EDT, but this PIREP was not distributed into the NAS. The ATC recordings revealed that ATC did provide PIREP and weather information to N88GA and N155CL before the accident time, but checking the PIREPs available in the NAS, no PIREPs were issued into the NAS from the weather information provided by N88GA or N155CL in accordance with the FAA JO Order 7110.65, Air Traffic Control.[33] A review of the radar images indicated that N88GA flew through dBZ values as high as 50 on approach into KGNV (figures 28 through 32).

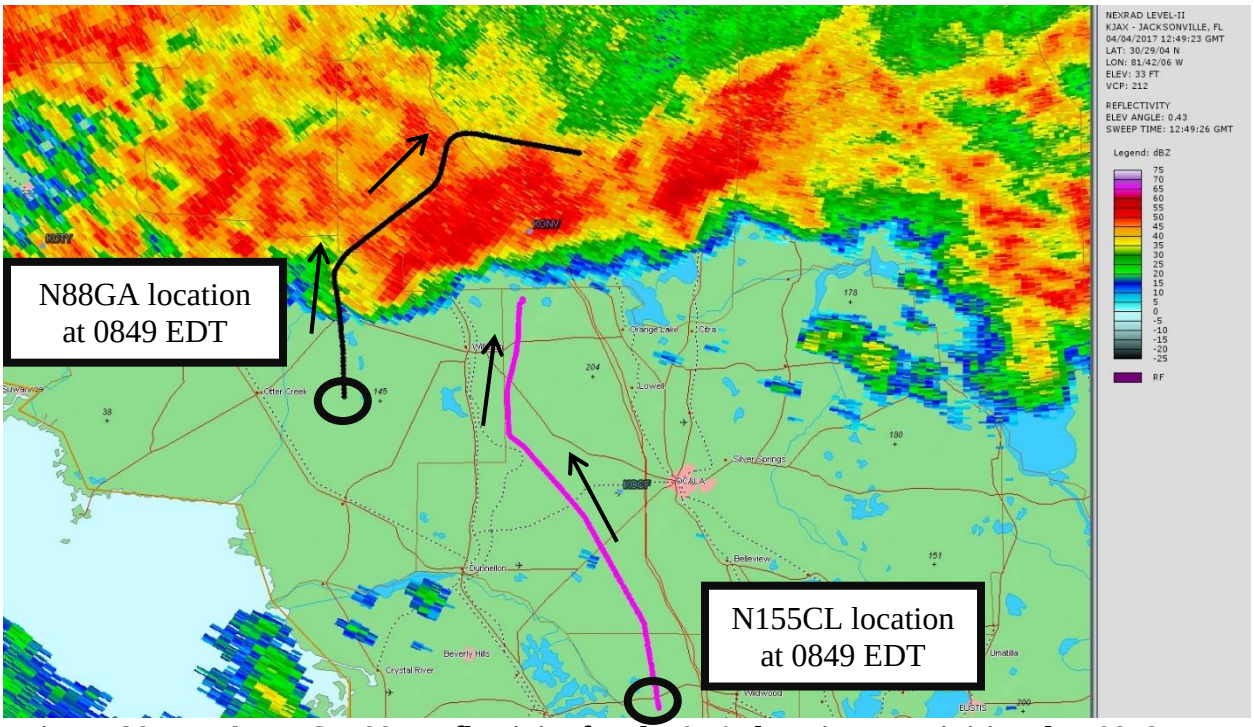


Figure 28 – KJAX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0849 EDT with the ATC flight track of N88GA (black dots) and ATC flight track of N155CL (pink dots)

[32] For more information, please see the ATC data located in the docket for this accident.
[33] For more information see the ATC data contained in the docket of this accident.

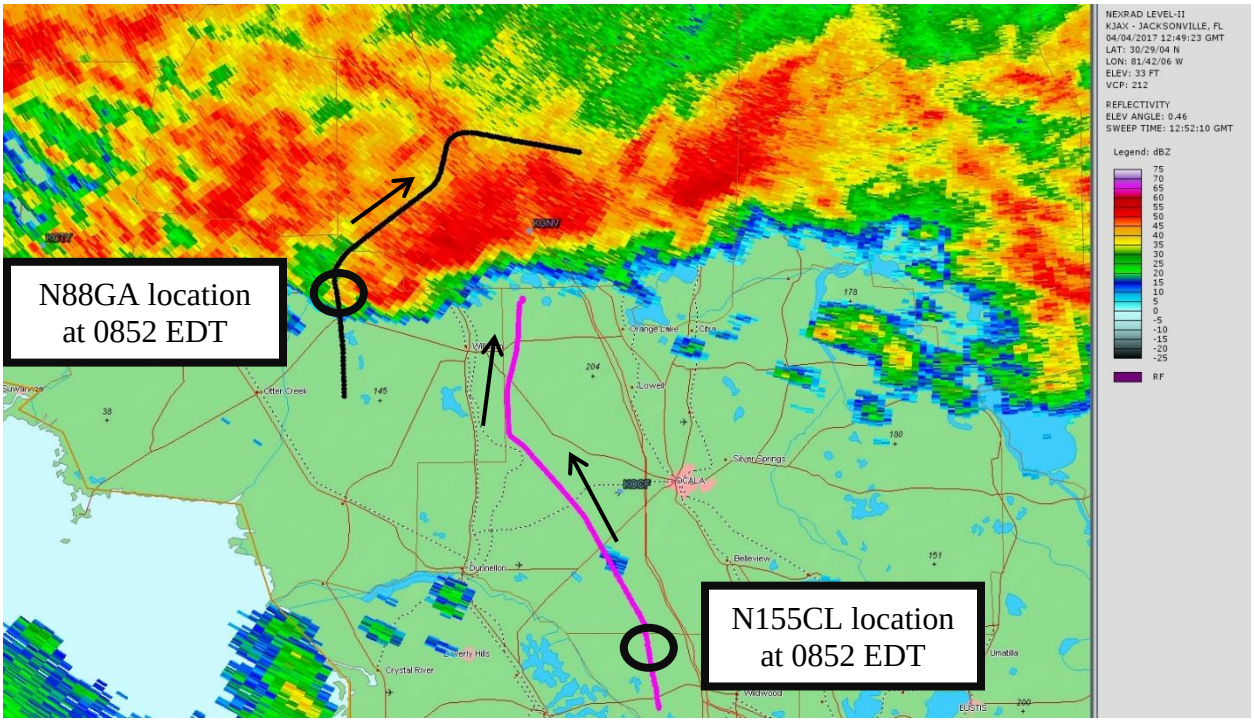


Figure 29 – KJAX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0852 EDT with the ATC flight track of N88GA (black dots) and ATC flight track of N155CL (pink dots)

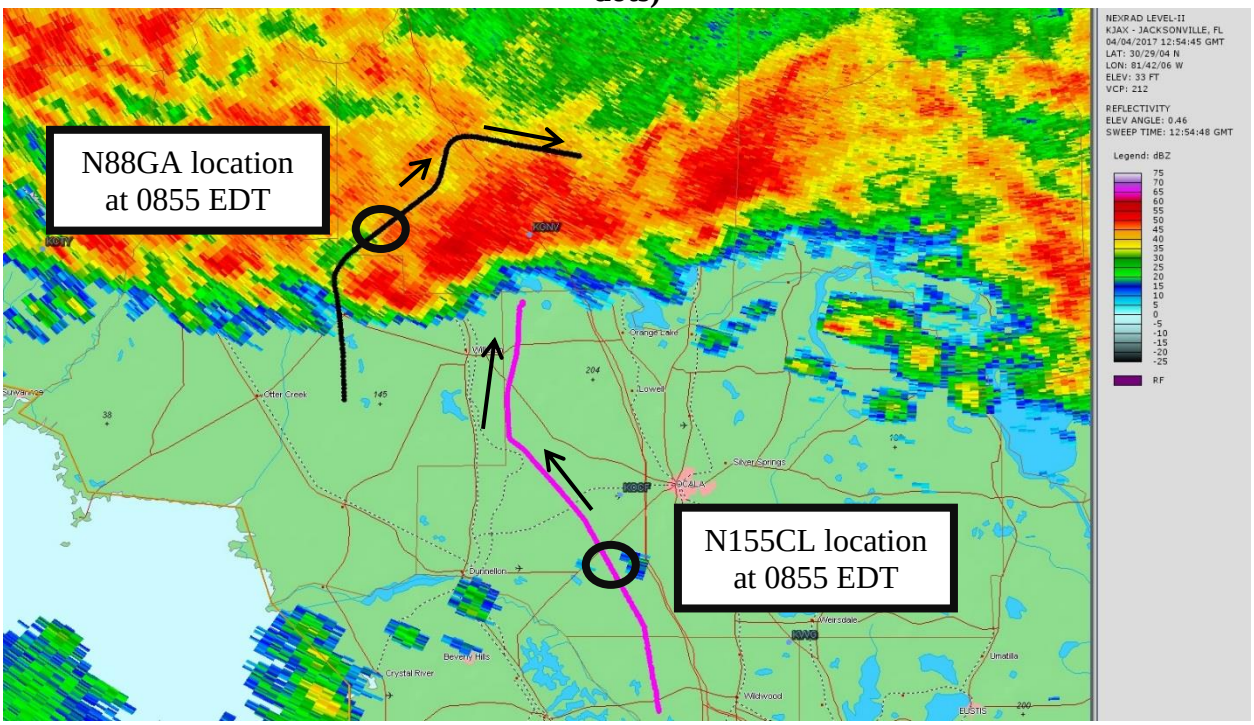


Figure 30 – KJAX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0855 EDT with the ATC flight track of N88GA (black dots) and ATC flight track of N155CL (pink dots)

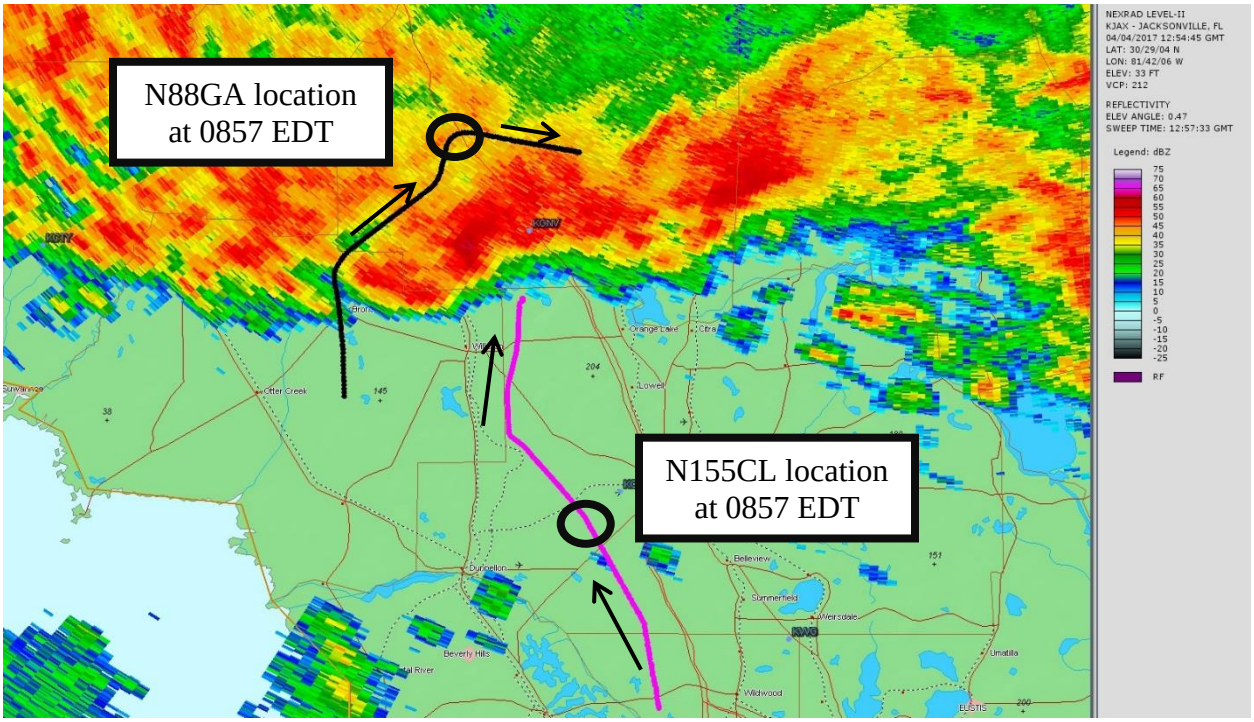


Figure 31 – KJAX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0857 EDT with the ATC flight track of N88GA (black dots) and ATC flight track of N155CL (pink dots)

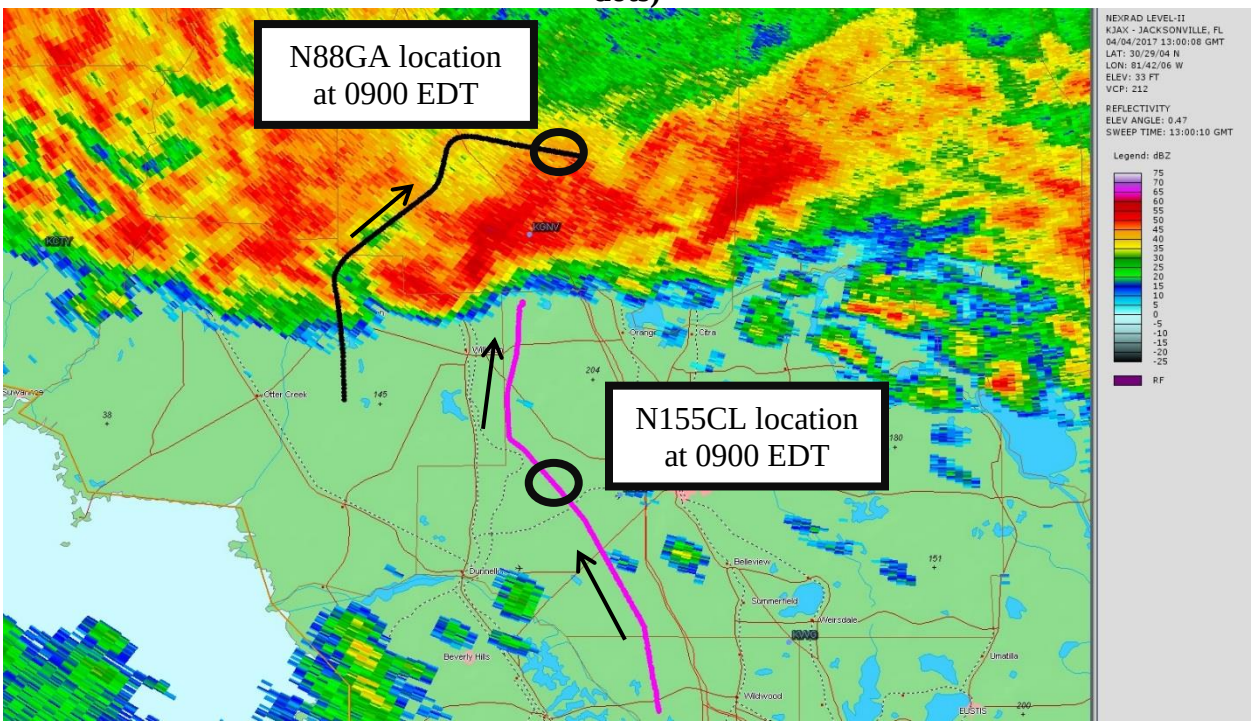


Figure 32 – KJAX WSR-88D reflectivity for the 0.5° elevation scan initiated at 0900 EDT with the ATC flight track of N88GA (black dots) and ATC flight track of N155CL (pink dots)

7.0 Pilot Reports[34]

All PIREPs close to the accident site from about two hours prior to the accident time to about four hours after the accident time were reviewed. Only PIREPs for below FL180[35] are provided below:

JAX UA /OV 10 S GNV/TM 1147/FL010/TP B717/SK BASES OVC 010 TOPS 070

JAX UA /OV JAX/TM 1151/FL065/TP B350/SK OVC063/TB SMOOTH RIDE

JAX UA /OV GNV 085/025/TM 1206/FL100/TP BE65/SK BKN/TB LIGHT/RM MODERATE PRECIPITATION

EVB UA /OV EVB/TM 1207/FL045/TP P28A/RM FROM SHORE LINE TOWARDS COI BASES 008-TOP020

EVB UA /OV 3 EAST OF EVB/TM 1235/FL2000/TP C172/SK BKN008/WX 7/TA 23/WV 16011/RM TOPS REPORTED EAST OF EVB 2000

SFB UA /OV SFB130007/TM 1241/FL020/TP PA34/SK BKN016

JAX UA /OV JAX/TM 1245/FL060/TP C525/SK OVC052

ZPH UA /OV INF135018/TM 1347/FL030/TP B407/SK SCT045/TB NEG/RM SCT BLW HIGH OVC ABV

CGC UA /OV INF245018/TM 1347/FL030/TP B407/SK SCT045/TB NEG/RM SCT BLW HIGH OVC ABV

JAX UA /OV SGJ150010/TM 1417/FL090/TP P28R/WX RA/TB MOD

JAX UA /OV GNV315010/TM 1421/FL065/TP CRJ9/SK BASES OVC 065/TB LT TURB/IC LGT RIME

DAB UA /OV DAB270007/TM 1432/FL020/TP C172/WX -RA/TB MOD/RM IMC

CTY UA /OV CDK270040/TM 1438/FL060/TP SR22/TB MOD/RM MOD PCPN DEVIATE AROUND WX

CTY UA /OV CDK270040/TM 1438/FL050/TP SR22/TB MOD/RM MOD PCPN DEVIATED AROUND WX

DED UA /OV DED/TM 1440/FLUNKN/TP C172/SK OVC006/RM LT

JAX UA /OV JAX/TM 1500/FL010/TP C560/SK BKN BASES 010 TOPS 016

TIX UA /OV TIX360010/TM 1505/FL050/TP BE90/RM BASES OVC050-TOPS OVC080 BASES OVC100-TOPS OVC120

Routine pilot report (UA); 10 miles south of Gainesville, Florida; Time – 0747 EDT (1147Z); Altitude – 1,000 ft; Type aircraft – Boeing B717; Sky – Bases overcast ceiling at 1,000 ft with tops at 7,000 ft.

[34] Only pilot reports with the WMO header UBFL** identifier were considered.

[35] 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 average 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.

Routine pilot report (UA); Over Jacksonville, Florida; Time – 0751 EDT (1151Z); Altitude – 6,500 ft; Type aircraft – Beech 350 Super King Air; Sky – Overcast ceiling at 6,300 ft; Turbulence – Smooth ride.

Routine pilot report (UA); 25 miles from Gainesville, Florida, on the 085° radial; Time – 0806 EDT (1206Z); Altitude – 10,000 ft; Type aircraft – Beech 65 Queen Air; Sky – Broken ceiling; Turbulence – Light; Remarks – Moderate precipitation.

Routine pilot report (UA); Over New Smyrna Beach, Florida; Time – 0807 EDT (1207Z); Altitude – 4,500 ft; Type aircraft – Piper PA-28 Cherokee; Remarks – From shoreline towards Merritt Island Airport bases at 800 ft with tops at 2,000 ft.

Routine pilot report (UA); 3 miles east of New Smyrna Beach, Florida; Time – 0835 EDT (1235Z); Altitude – 2,000 ft; Type aircraft – Cessna 172; Sky – Broken ceiling at 800 ft; Weather – 7 miles visibility; Temperature – 23° C; Wind – From 160° at 11 knots; Remarks – Tops reported east of New Smyrna Beach at 2,000 ft.

Routine pilot report (UA); 7 miles from Orlando, Florida, on the 130° radial; Time – 0841 EDT (1241Z); Altitude – 2,000 ft; Type aircraft – Piper PA-34 Seneca; Sky – Broken ceiling at 1,600 ft.

Routine pilot report (UA); Over Jacksonville, Florida; Time – 0845 EDT (1245Z); Altitude – 6,000 ft; Type aircraft – Cessna 525 Citation Jet; Sky – Overcast ceiling at 5,200 ft.

Routine pilot report (UA); 18 miles from Inverness, Florida, on the 135° radial; Time – 0947 EDT (1347Z); Altitude – 3,000 ft; Type aircraft – Bell 407; Sky – Scattered clouds at 4,500 ft; Turbulence – Negative; Remarks – Scattered below with high overcast ceiling above.

Routine pilot report (UA); 18 miles from Inverness, Florida, on the 245° radial; Time – 0947 EDT (1347Z); Altitude – 3,000 ft; Type aircraft – Bell 407; Sky – Scattered clouds at 4,500 ft; Turbulence – Negative; Remarks – Scattered below with high overcast ceiling above.

Routine pilot report (UA); 10 miles from St. Augustine, Florida, on the 150° radial; Time – 1017 EDT (1417Z); Altitude – 9,000 ft; Type aircraft – Piper PA-28 Cherokee; Weather – Rain; Turbulence – Moderate.

Routine pilot report (UA); 10 miles from Gainesville, Florida, on the 315° radial; Time – 1021 EDT (1421Z); Altitude – 6,500 ft; Type aircraft – Bombardier CRJ-900; Sky – Bases overcast at 6,500 ft; Turbulence – Light turbulence; Icing – Light rime.

Routine pilot report (UA); 7 miles from Daytona Beach, Florida, on the 270° radial; Time – 1032 EDT (1432Z); Altitude – 2,000 ft; Type aircraft – Cessna 172; Weather – Light rain; Turbulence – Moderate; Remarks – Instrument meteorological conditions.

Routine pilot report (UA); 40 miles from Cedar Key, Florida, on the 270° radial; Time – 1038 EDT (1438Z); Altitude – 6,000 ft; Type aircraft – Cirrus SR22; Turbulence – Moderate; Remarks – Moderate precipitation deviate around weather.

Routine pilot report (UA); 40 miles from Cedar Key, Florida, on the 270° radial; Time – 1038 EDT (1438Z); Altitude – 5,000 ft; Type aircraft – Cirrus SR22; Turbulence – Moderate; Remarks – Moderate precipitation deviated around weather.

Routine pilot report (UA); Over DeLand, Florida; Time – 1040 EDT (1440Z); Altitude – Unknown; Type aircraft – Cessna 172; Sky – Overcast ceiling at 600 ft; Remarks – Light.

Routine pilot report (UA); Over Jacksonville, Florida; Time – 1100 EDT (1500Z); Altitude – 1,000 ft; Type aircraft – Cessna Citation V; Sky – Broken bases at 1,000 ft with tops at 1,600 ft.

Routine pilot report (UA); 10 miles from Titusville, Florida, on the 360° radial; Time – 1105 EDT (1505Z); Altitude – 5,000 ft; Type aircraft – Beechcraft King Air; Remarks – Bases overcast at 5,000 ft with tops overcast at 8,000 ft, bases overcast at 10,000 ft with tops overcast at 12,000 ft.

8.0 SIGMET and CWSU Advisories

There were Convective Significant Meteorological Information (SIGMET) advisories valid for the accident site at the accident time. SIGMET 31E (figure 33) was valid for the accident site at the accident time and warned of areas of severe thunderstorms moving from 250° at 30 knots. Thunderstorm tops were forecast to FL450 with wind gusts to 50 knots possible. Convective SIGMETs, due to thunderstorm activity, had been valid for the accident site as early as 0555 EDT with the convective SIGMETs valid for the accident site updated every hour (SIGMETs 27E, 28E, and 29E) through the accident time (figures 34, 35, and 36):

WSUS31 KKCI 041255
SIGE
-MKCE WST 041255
CONVECTIVE SIGMET 31E
VALID UNTIL 1455Z
FL GA AND FL CSTL WTRS
FROM 50S AMG-220E OMN-80NE TRV-130S CEW-50S AMG
AREA SEV TS MOV FROM 25030KT. TOPS ABV FL450.
WIND GUSTS TO 50KT POSS.

WSUS31 KKCI 041155
SIGE
-MKCE WST 041155
CONVECTIVE SIGMET 29E
VALID UNTIL 1355Z
FL GA AND CSTL WTRS
FROM 80SE SAV-100ENE OMN-150SSW TLH-100SSE CEW-80SE SAV
AREA SEV TS MOV FROM 25030KT. TOPS ABV FL450.
WIND GUSTS TO 50KT POSS.

WSUS31 KKCI 041055

SIGE
-MKCE WST 041055
CONVECTIVE SIGMET 28E
VALID UNTIL 1255Z
FL GA AND CSTL WTRS
FROM 80SE SAV-100ENE OMN-150SSW TLH-100SSE CEW-80SE SAV
AREA TS MOV FROM 25030KT. TOPS ABV FL450.

WSUS31 KKCI 040955
SIGE
-MKCE WST 040955
CONVECTIVE SIGMET 27E
VALID UNTIL 1155Z
FL GA AND CSTL WTRS
FROM 40S SAV-50NE OMN-150SSW TLH-100SSE CEW-40S SAV
AREA TS MOV FROM 25030KT. TOPS ABV FL450.

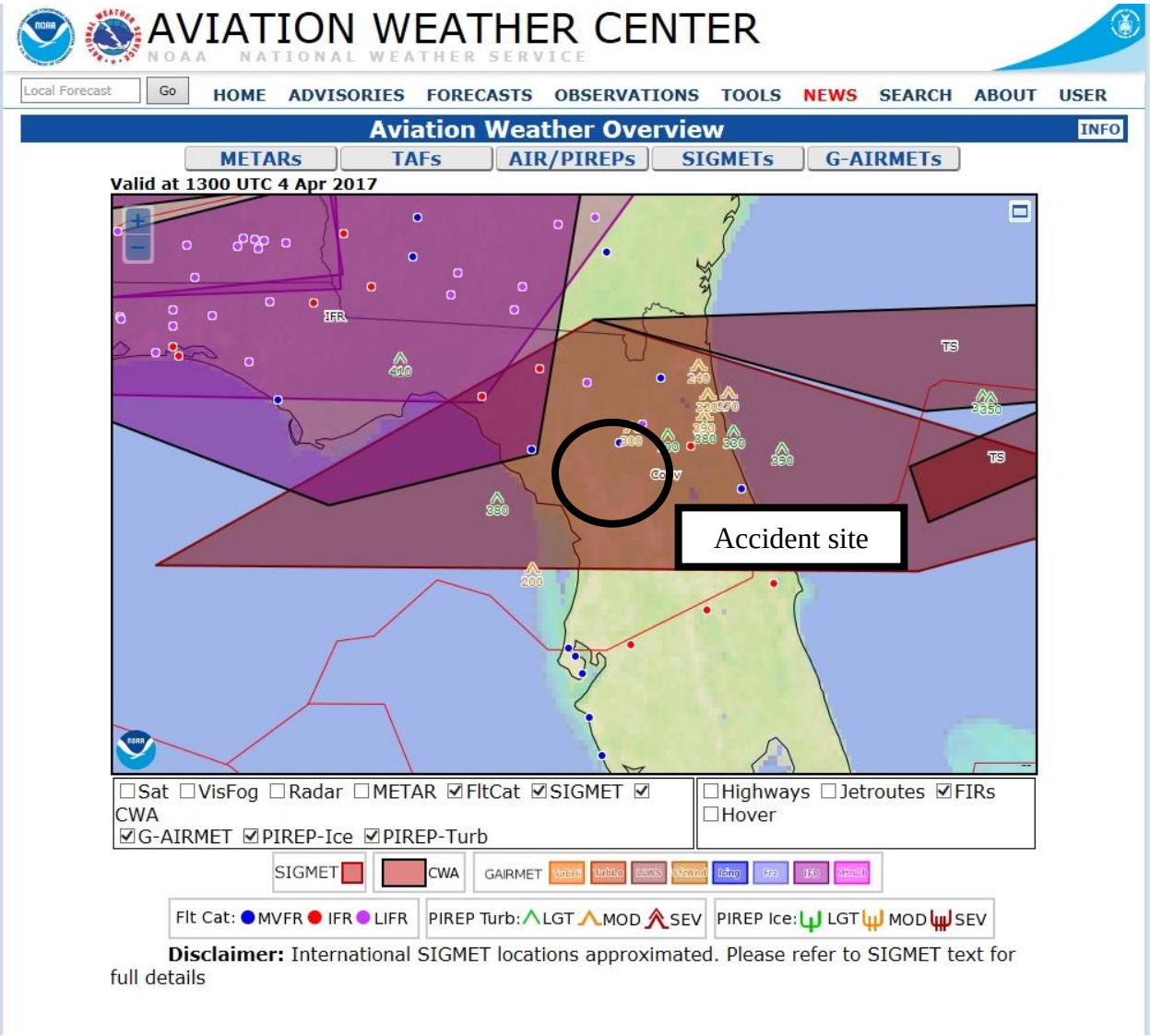


Figure 33 – SIGMETs and CWAs valid at the accident time (after 0900 EDT)

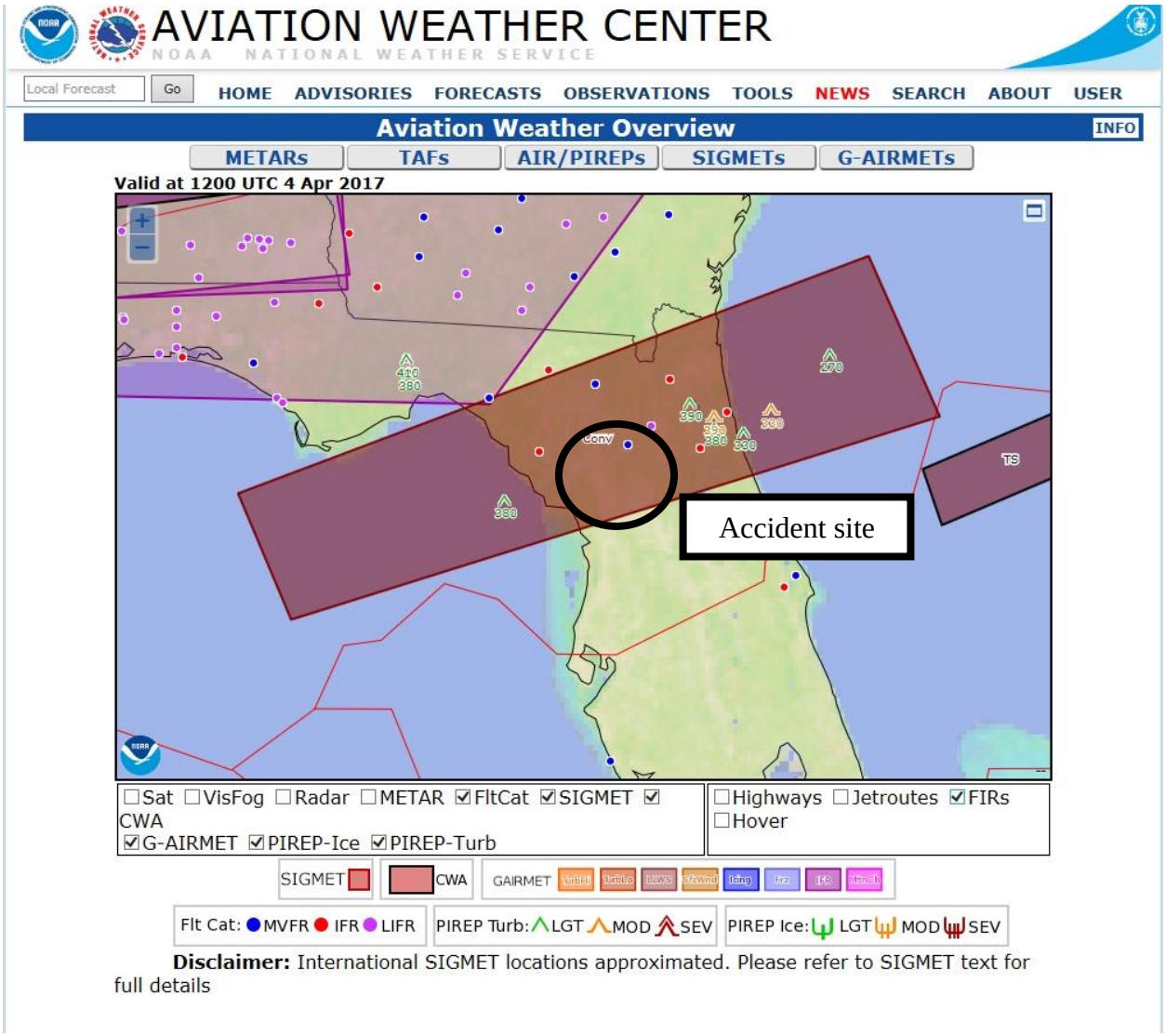


Figure 34 – SIGMETs and CWAs valid at 0800 EDT

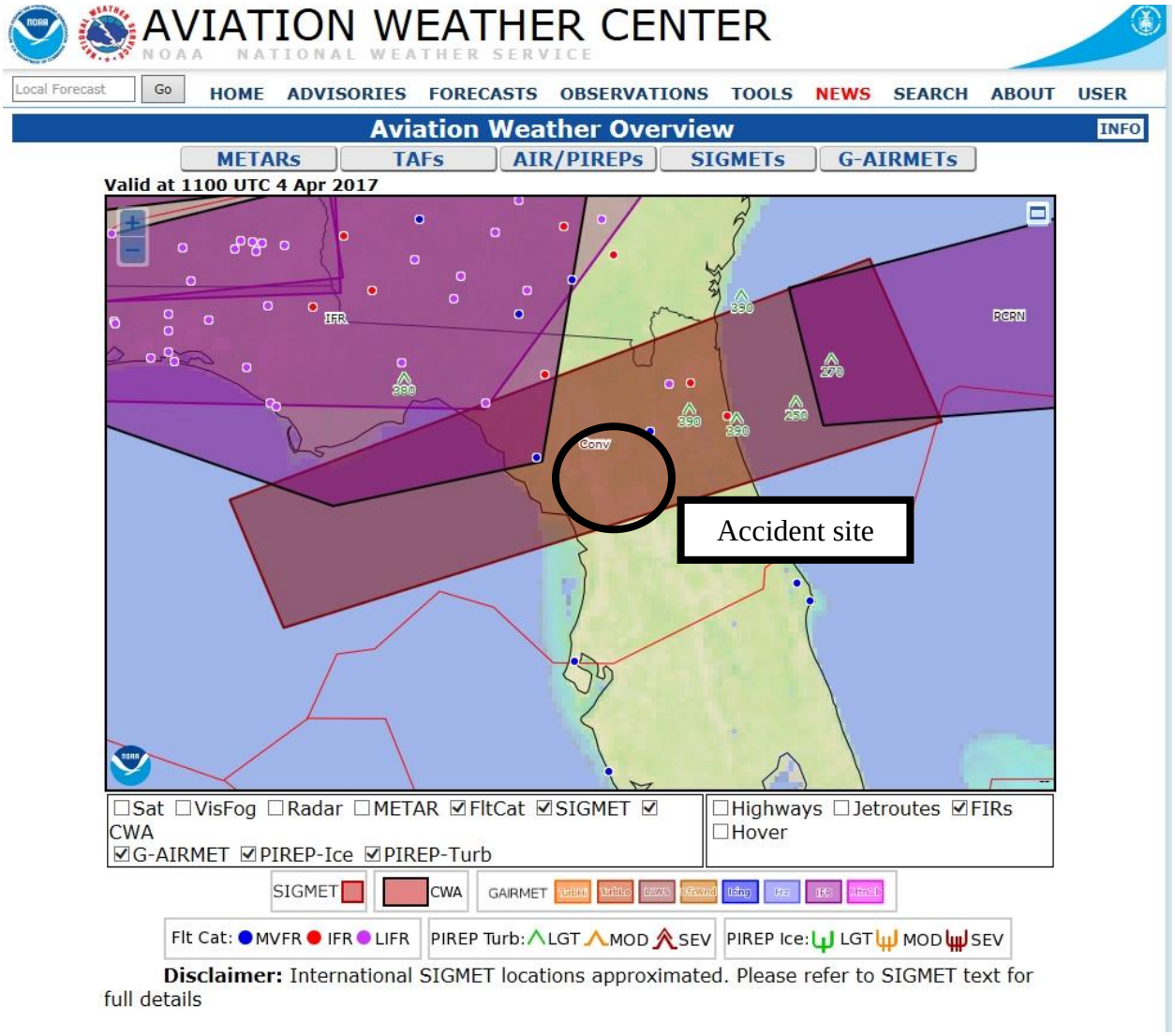


Figure 35 – SIGMETs and CWAs valid at 0700 EDT

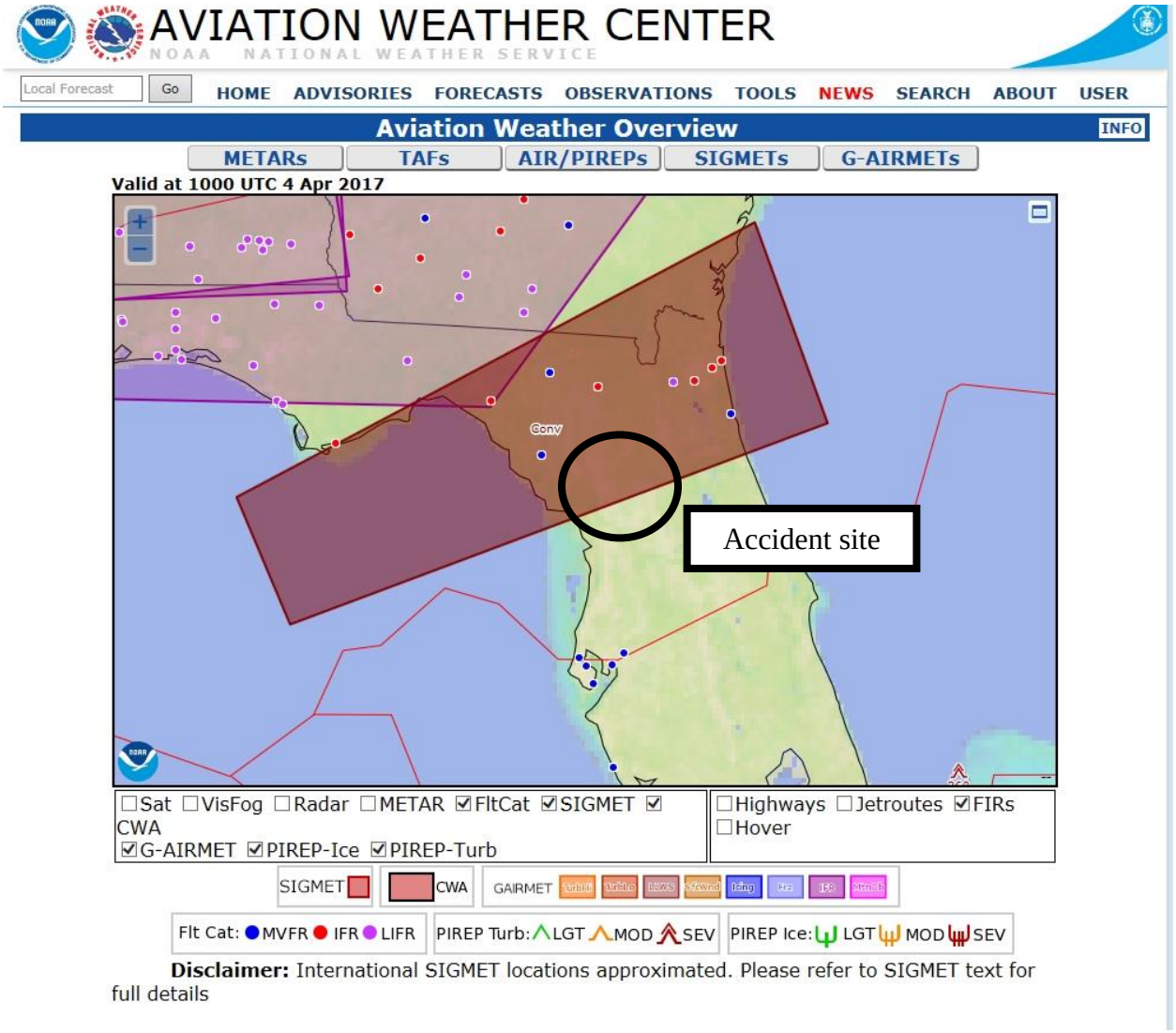


Figure 36 – SIGMETs and CWAs at valid 0600 EDT

A Center Weather Service Unit (CWSU) Meteorological Impact Statement (MIS) was valid for the accident site at the accident time. The MIS was issued at 0820 EDT and warned of numerous thunderstorms moving from 260° at 15 knots with thunderstorm tops to FL450 to FL500. Isolated severe thunderstorms were possible with thunderstorms spreading over all of the central Florida Peninsula by 1500 EDT:

589
FAUS20 KZJX 041220
ZJX MIS 01 VALID 041230-042030
...FOR ATC PLANNING PURPOSES ONLY...
OVR ERN FL PNHNDL/FL PEN/ADJ GULF/ATLC WATERS NMRS TS MOV FM 26015KT. TOPS FL450-FL500. ISOLD SEV TS POSS. TS SPRDG OVR C. FL PEN BY 19Z. OVR SC/GA MOD TURB FL300-FL410 AND BLW 140.
OVR SRN GA/FL PNHNDL LIFR CIGS/VIS IN FG BCMG MVFR AFT 16Z.
=

No CWSU Center Weather Advisories (CWA)s were valid for the accident site at the accident.

9.0 AIRMETs

No Airmen's Meteorological Information (AIRMET) advisories were valid for the accident site at the accident time.

10.0 Area Forecast

The Area Forecast issued at 0445 EDT, valid at the accident time, forecasted a broken ceiling at 4,000 ft, with cloud tops at 15,000 ft, scattered light rain showers, and thunderstorms. Cumulonimbus cloud tops were forecast to reach FL400 with severe thunderstorms possible through 1300 EDT:

564
FAUS42 KKCI 040845
FA2W
-MIAC FA 040845
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 050300
CLDS/WX VALID UNTIL 042100...OTLK VALID 042100-050300
NC SC GA FL AND CSTL WTRS E OF 85W
.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG.
.
SYNOPSIS...WRMFNT WRN NY-ERN MD-VA CSTL WTRS. CDFNT WRN PA-SWRN
VA-NERN GA-FL PNHDL GLFMEX WTRS. 18Z OCFNT NERN NY TO LONG ISLAND
BECMG WRMFNT SEWD TO RI CSTL WTRS. CDFNT NY CSTL WTRS-ERN NC
BECMG WRMFNT OVR SWRN GA TO FL PNHDL GLFMEX CSTL WTRS. 03Z LOW
PRES MA CSTL WTRS WITH OCFNT SEWD TO INTL WTRS. CDFNT NERN
NY-SERN PA-SERN VA BECMG WRMFNT SWRN VA.
.
NC
APLCNS...BKN060 TOP 090. 14Z SCT CI. OTLK...VFR.
PIEDMONT...BKN010 TOP 070. VIS 3SM BR. 16Z SCT040 SCT CI.
OTLK...VFR.
CSTL PLAINS...BKN015 TOP 090. WND SW G25KT. BECMG 1517 SCT050.
OTLK...VFR.
.
SC
APLCNS...BKN030 TOP 060. BECMG 1214 SCT030. 18Z SCT CI.
OTLK...VFR.
PIEDMONT...OVC010 TOP 070. 15Z SCT040. 18Z SCT CI. OTLK...VFR.
CSTL PLAIN...BKN015 TOP 070. 11Z BKN010. 17Z SCT050. OTLK...VFR.
.
GA
NRN...BKN030 TOP 060. 12Z SKC. 14Z SCT CI. OTLK...VFR.
SW...OVC010 TOP 030. BECMG 1214 SCT025 SCT CI. 18Z SCT CI.
OTLK...VFR.
SE...OVC020 TOP 040. 15Z BKN015. BECMG 1820 SCT050. OTLK...VFR.
.

FL
PNHDL...OVC010 TOP 020. VIS 3SM BR. 16Z BKN CI. 20Z SCT050 BKN
CI. OTLK...VFR.
**NRN PEN...BKN040 TOP 150. SCT -SHRA/TSRA. CB TOP FL400. TS POSS
SEV. 17Z BKN CI. OTLK...VFR 02Z MVFR CIG.**
CNTRL PEN...BKN015 TOP 020. 15Z SCT040. OTLK...VFR.
SRN PEN...SCT025. 20Z SCT CI. OTLK...VFR.
.
CSTL WTRS
ATLC WTRS...
NC...BKN015 TOP 090. SCT -SHRA/ISOL TSRA. CB TOP FL300. 18Z
SCT025. OTLK...VFR.
SC/GA/NRN FL...BKN015 TOP FL180. SCT -SHRA/TSRA. CB TOP FL450.
14Z SCT100 BKN CI. OTLK...VFR.
SRN FL...SCT025 SCT060. OTLK...VFR.
GULF WTRS E OF 85W...
PIE NWD...OVC015 TOP FL240. SCT -SHRA/ISOL TSRA. CB TOP FL450.
18Z OVC015 TOP 100. OTLK...MVFR CIG.
S PIE...FEW020 SCT CI. OTLK...VFR.
....

11.0 Terminal Aerodrome Forecast

KGNV was the closest site to the accident site with a NWS Terminal Aerodrome Forecast (TAF). The TAF valid at the time of the accident was issued at 0748 EDT and was valid for a 24-hour period beginning at 0800 EDT. The TAF for KGNV was as follows:

KGNV 041148Z 0412/0512 VRB12G22KT 5SM -TSRA OVC030CB
TEMPO 0412/0413 VRB30G50KT 1SM +TSRA OVC015CB
FM041300 VRB08G17KT 5SM -TSRA OVC030CB
TEMPO 0413/0416 VRB20G30KT 1SM +TSRA OVC015CB
FM041800 24012G18KT P6SM VCSH SCT025 BKN050 OVC100
FM050000 22006KT P6SM OVC015
FM050300 20004KT P6SM OVC006=

The forecast expected a variable wind of 8 knots with gusts to 17 knots, 5 miles visibility, thunderstorms and light rain, and an overcast ceiling at 3,000 ft agl in cumulonimbus clouds. Temporary conditions were forecast between 0900 and 1200 EDT with variable winds of 20 knots with gusts to 30 knots, 1 mile visibility, thunderstorms and heavy rain, and an overcast ceiling of 1,500 ft agl in cumulonimbus clouds.

12.0 NWS Area Forecast Discussion

The NWS Office in Jacksonville, Florida, issued the following Area Forecast Discussion (AFD) at 0345 EDT (closest AFD to the accident time with an aviation section). The aviation section of the AFD discussed that the complex of thunderstorms across the Jacksonville metro region would shift southward to near KGNV by 0800 EDT and thunderstorms impacts would remain at KGNV through 1200:

301
FXUS62 KJAX 040745

AFDJAX

Area Forecast Discussion
National Weather Service Jacksonville FL
345 AM EDT Tue Apr 4 2017

...SEVERE THUNDERSTORMS POSSIBLE ON WEDNESDAY...

.NEAR TERM /Today-Tonight/...

This Morning...Much needed rainfall occurring along the FL/GA border and I-10 corridor of NE FL although the band of convection will continue to contain a few stronger to possibly severe storms with gusty winds and small hail through the mid-morning hours as it slowly shifts to the south and shifts to the GNV/SGJ corridor by late morning and weakens in intensity. Normally this would be a more significant flood threat but the lack of rainfall this year should allow only temporary/minor flood problems as expecting area-wide amounts of 1-2 inches with isolated higher totals to 4 inches across the Suwannee River Valley. Gusty S/SW winds will continue in and around convection through the morning at 15-25G35 mph at times.

This afternoon...Band of convection across NE FL should become more disorganized as it loses upper level support with just scattered shower/storm activity while only isolated activity is expected through the day across SE GA. Mostly Cloudy to overcast skies will limit heating with generally highs in the lower 80s and gusty S/SW winds at 15-20G25-30 mph will slowly weaken towards late afternoon.

Tonight...Band of deep moisture will lift slowly to the north across SE GA and approaching storm system will begin to trigger scattered showers/storms across that region while overcast skies will remain across NE FL early, then low level SW flow out of the GOMEX will spread low stratus across NE FL/inland SE GA after midnight with very low ceilings but surface winds remaining at 5 mph or greater should keep visibilities generally greater than 3 miles or so. Another mild night ahead with lows in the upper 60s to near 70.

.SHORT TERM /Wednesday and Wednesday Night/...

Wednesday will be windy and hot in northeast Florida, with the warmest temps (Lower 90s) expected along the I-95 corridor of northeast Florida, thanks to gusty southwest winds and plenty of sunshine. A wind advisory may be needed on Wednesday.

Warm front should be positioned near the northern border of our forecast area (Altamaha River Basin) on Wednesday and this coupled with a warm southwesterly flow and a series of upper level disturbances should support at least scattered storms across portions of southeast Georgia on Wednesday, and a few of these storms may become severe with damaging winds and large hail.

Still appears as though a squall line on the leading edge of a fairly strong late season upper trough will approach our area Wednesday afternoon, and then move through our area Wednesday night. Model soundings continue to indicate an environment with high effective bulk shear values and decent MUCAPE (even in the middle of the night).

The large scale ascent and upper level support coupled with these shear/cape values would be supportive of organized severe thunderstorms Wednesday night. The GFS is still not quite as robust but still shows at least some potential for severe weather. Damaging winds, large hail, heavy rainfall and even isolated tornadoes could become legitimate threats in our area, especially across southeast Georgia. Later forecasts will continue to refine the threat for our area. All interests should continue to closely monitor the situation.

.LONG TERM /Thursday through Monday/...

A strong cold front will push south of our forecast area Thursday morning, bringing an end to the threat of showers and storms. Significantly drier air will filter into the region during the day on Thursday and max temps will be about 15 degrees cooler than recent days. Min temps will become significantly cooler Thursday night, which will be almost a 25 to 30 degree change, with ensemble guidance still suggesting potential for inland temps dropping down into the 30s Friday night.

Windy conditions will prevail Thursday and Friday with cold air advection continuing into Friday as the upper trough digs into the southeast. Another wind advisory may be needed on Thursday. Max temps Friday and Saturday will be below normal despite plenty of sunshine. Temps will quickly rebound on Sunday and Monday as the trough pulls away and ridging builds in.

&&

.AVIATION...
Wide range of weather at the TAF sites as main TSTM complex will continue to track into the JAX metro TAF sites this morning with gusty winds and TEMPO MVFR/IFR CIGS/VSBYS at times, then shift southward and should impact the GNV/SGJ areas btwn 12-16z. KSSI will remain north of most of the activity today with just a few showers/storms in the Vicinity. Model trends showing shower/storm activity fading after 18z and will leave VFR conds with some VCSH through about 00z, then SW flow at the surface will bring low level moisture and low level MVFR CIGS in the 1000-1500 ft range out of the GOMEX and across TAF sites starting with GNV around 03z and pushing into the remainder of sites by 06z. CIGS may end up lower in the 500-1000 ft range but will just lowering trend for now.

&&

.MARINE...
Small Craft Advisories will remain for the offshore waters as

S/SW winds of 20 to 25 knots continue this morning with SCEC for the nearshore waters with S/SW winds at 15-20 knots with seas 3-5 ft nearshore and 5-7 ft offshore. For this afternoon through tonight expect a general S/SW flow around 15 knots with seas 3-6 ft. Then ahead of next storm system on Wednesday expect SW winds to increase to 25-30 knots by Wed Night with gusts to gale force possible and Gale Warnings may be required. Winds remain near gale force at 25-30 knots and veer to W and NW on Thu and Thu Night and possible Gale Warnings may continue. Small Craft Advisories continue in the offshore NW flow behind the front on Friday then begin to weaken on Saturday as High pressure builds into the region.

Rip Currents: Low Risk in the developing offshore flow both Today and Wednesday.

&&

.PRELIMINARY POINT TEMPS/POPS...
AMG 83 67 85 57 / 10 40 50 70
SSI 78 69 83 62 / 60 40 30 70
JAX 83 69 90 64 / 70 20 20 70
SGJ 81 69 90 66 / 50 10 10 50
GNV 83 68 90 63 / 80 10 10 70
OCF 83 67 91 65 / 60 0 10 60

&&

.JAX WATCHES/WARNINGS/ADVISORIES...
FL...None.
GA...None.
AM...Small Craft Advisory until 4 PM EDT this afternoon for Waters from Altamaha Sound GA to Fernandina Beach FL from 20 to 60 NM-Waters from Fernandina Beach to St. Augustine FL from 20 to 60 NM-Waters from St. Augustine to Flagler Beach FL from 20 to 60 NM.

Small Craft Advisory until 4 AM EDT early this morning for Coastal waters from Altamaha Sound to Fernandina Beach FL out 20 NM-Coastal waters from Fernandina Beach to St. Augustine FL out 20 NM-Coastal waters from St. Augustine to Flagler Beach FL out 20 NM.

&&

$$

13.0 NWS Warnings

The NWS Office in Jacksonville, Florida, issued the following Severe Thunderstorm Warning at 0900 EDT (valid through 0945 EDT) for the thunderstorm area encountered by the accident flight (section 6.5). In addition, a Tornado Warning was issued at 0910 EDT (valid through 0945 EDT) for the thunderstorm area encountered by the accident flight (section 6.5):

855
WUUS52 KJAX 041300
SVRJAX
FLC001-083-041345-
/O.NEW.KJAX.SV.W.0079.170404T1300Z-170404T1345Z/

BULLETIN - IMMEDIATE BROADCAST REQUESTED
Severe Thunderstorm Warning
National Weather Service Jacksonville FL
900 AM EDT TUE APR 4 2017

The National Weather Service in Jacksonville has issued a

* Severe Thunderstorm Warning for...
  Southern Alachua County in northern Florida...
  Northwestern Marion County in northern Florida...

* Until 945 AM EDT

* At 858 AM EDT, a severe thunderstorm was located near Archer, or 7
  miles north of Williston, moving east at 20 mph.

  HAZARD...60 mph wind gusts.

  SOURCE...Radar indicated.

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

* Locations impacted include...
  Archer, Cross Creek, Micanopy, Reddick, McIntosh, Flemington and
  Lowell.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

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

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

&&

LAT...LON 2934 8241 2948 8241 2948 8256 2958 8253
      2954 8215 2927 8220
TIME...MOT...LOC 1258Z 284DEG 17KT 2948 8247

TORNADO...POSSIBLE
HAIL...<.75IN
WIND...60MPH

$$

119
WFUS52 KJAX 041310
TORJAX
FLC083-041345-

/O.NEW.KJAX.TO.W.0039.170404T1310Z-170404T1345Z/

BULLETIN - EAS ACTIVATION REQUESTED
Tornado Warning
National Weather Service Jacksonville FL
910 AM EDT TUE APR 4 2017

The National Weather Service in Jacksonville has issued a

* Tornado Warning for...
  Northwestern Marion County in northern Florida...

* Until 945 AM EDT

* At 909 AM EDT, a severe thunderstorm capable of producing a tornado
  was located 7 miles northeast of Williston, moving southeast at 20
  mph.

  HAZARD...Tornado and quarter size hail.

  SOURCE...Radar indicated rotation.

  IMPACT...Flying debris will be dangerous to those caught without
        shelter. Mobile homes will be damaged or destroyed.
        Damage to roofs, windows, and vehicles will occur. Tree
        damage is likely.

* This tornadic thunderstorm will remain over mainly rural areas of
  northwestern Marion County, including the following locations:
  McIntosh, Reddick and Flemington.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

TAKE COVER NOW! Move to a basement or an interior room on the lowest
floor of a sturdy building. Avoid windows. If you are outdoors, in a
mobile home, or in a vehicle, move to the closest substantial shelter
and protect yourself from flying debris.

&&

LAT...LON 2939 8241 2944 8241 2949 8238 2949 8222
      2948 8221 2947 8221 2946 8219 2945 8219
      2946 8221 2946 8222 2943 8221 2942 8220
      2942 8216 2927 8222
TIME...MOT...LOC 1309Z 294DEG 19KT 2946 8238

TORNADO...RADAR INDICATED
HAIL...1.00IN

$$

14.0 NWS Hazardous Weather Outlook

The NWS Office in Jacksonville, Florida, issued the following Hazardous Weather Outlook (HWO) at 0401 EDT. The HWO stated that a band of strong thunderstorms was located along the Georgia/Florida border and would continue to move southward across northeastern Florida during the morning hours before the thunderstorms weakened during the afternoon:

087
FLUS42 KJAX 040801
HWOJAX

Hazardous Weather Outlook
National Weather Service Jacksonville FL
401 AM EDT Tue Apr 4 2017

AMZ450-452-454-470-472-474-FLZ020>025-030>033-035>038-040-124-125-
GAZ132>136-149>154-162>166-051000-
Coastal waters from Altamaha Sound to Fernandina Beach FL out
20 NM-
Coastal waters from Fernandina Beach to St. Augustine FL out
20 NM-
Coastal waters from St. Augustine to Flagler Beach FL out 20 NM-
Waters from Altamaha Sound GA to Fernandina Beach FL from 20 to
60 NM-
Waters from Fernandina Beach to St. Augustine FL from 20 to 60 NM-
Waters from St. Augustine to Flagler Beach FL from 20 to 60 NM-
Hamilton-Suwannee-Columbia-Baker-Inland Nassau-Inland Duval-Union-
Bradford-Clay-St. Johns-Gilchrist-Alachua-Putnam-Flagler-Marion-
Coastal Nassau-Coastal Duval-Coffee-Jeff Davis-Bacon-Appling-
Wayne-Atkinson-Ware-Pierce-Brantley-Inland Glynn-Coastal Glynn-
Echols-Clinch-Charlton-Inland Camden-Coastal Camden-
401 AM EDT Tue Apr 4 2017

...SMALL CRAFT ADVISORY FOR THE OFFSHORE WATERS...

...SEVERE THUNDERSTORMS POSSIBLE ON WEDNESDAY AND WEDNESDAY NIGHT...

This Hazardous Weather Outlook is for Northeast Florida,
Southeast Georgia and the Adjacent Coastal Waters.

.DAY ONE...Today and Tonight...

Band of Strong Thunderstorms with locally heavy rainfall and gusty winds from the FL/GA border southward across Northeast Florida will continue this morning before fading this afternoon. A few storms may become strong to severe at times with damaging winds and large hail. Locally heavy rainfall is possible with temporary and minor flooding issues at times.

Small Craft Advisory will remain in effect through the afternoon
for the offshore waters.

.DAYS TWO THROUGH SEVEN...Wednesday through Monday...

Another strong frontal boundary will approach Wednesday and push

through the region Wednesday Night and early Thursday with another round of strong to severe thunderstorms expected. Stronger activity will be capable of producing damaging wind gusts, isolated tornadoes and locally heavy rainfall.

Windy conditions are expected Wednesday through Friday and Small Craft Advisories are expected over the coastal waters, with near Gale Force wind gusts possible. Wind Advisories may be required for the land areas on Wednesday.

.SPOTTER INFORMATION STATEMENT...

Spotter activation will not be needed.

For additional information, visit the National Weather Service in Jacksonville website on the internet at weather.gov/jax.

$$

15.0 Local Storm Reports

The NWS Office in Jacksonville, Florida, reported two storm reports of wind damage associated with the severe thunderstorm located near the accident site at the accident time (sections 6.5 and 13.0). The first wind damage storm report was from 0845 EDT and reported tree down across road blocking traffic at northwest 13th street and northwest 16th avenue in Gainesville, Florida. The second wind damage storm report was from 0900 EDT and reported trees down near highway 320 and county road 329 in Micanopy, Florida:

1245 UNK 1 SSW GAINESVILLE ALACHUA FL 2967 8234 TREE DOWN ACROSS ROAD BLOCKING TRAFFIC AT NW 13TH ST AND NW 16TH AVE IN GAINESVILLE. (JAX)

1300 UNK 4 NNW FLEMINGTON MARION FL 2946 8231 TREES DOWN NEAR HIGHWAY 320 AND COUNTY ROAD 329 IN MICANOPY. (JAX)

16.0 Winds and Temperature Aloft Forecast

The NWS 0401 EDT Winds and Temperature Aloft forecast valid for the closest point to the accident site is included below:

```
FBUS31 KWNO 040801
FD1US1
-DATA BASED ON 040600Z
VALID 041200Z   FOR USE 0800-1500Z. TEMPS NEG ABV 24000

FT  3000    6000    9000   12000   18000   24000  30000  34000  39000

-JAX 1830 2036+12 2142+06 2346+03 2655-09 2756-20 265637 265548 274659
```

The accident site was closest to the JAX (Jacksonville, Florida) forecast point. The 0401 EDT JAX forecast indicated a wind at 3,000 ft from 180° at 30 knots, a wind at 6,000 ft from 200° at 36 knots with a temperature of 12° C, a wind at 9,000 ft from 210° at 42 knots with a temperature of 6° C, and a wind at 12,000 ft from 230° at 46 knots with a temperature of 3° C.

17.0 Pilot Weather Briefing

A search of official weather briefing sources, such as Lockheed Martin Flight Service (LMFS), Leidos weather briefings, and Direct User Access Terminal Service (DUATS) was done. The accident pilot did receive official DUATS and Leidos weather briefings. The accident pilot received a text DUATS weather briefing at 1746 EDT on April 3 (attachment 4). The accident pilot selected the "Weather Outlook Route" for the DUATS weather briefing. The April 3 1746 EDT DUATS weather briefing contained the Area Forecast, the SPC Day 1 Convective Outlook, severe weather watches and warnings along the proposed route of flight, SIGMETs, CWAs, AIRMETs, METARs, PIREPs, TAFs, and the Winds Aloft Forecast all valid at 1746 EDT on April 3. The accident pilot then received another DUATS weather briefing at 1810 EDT on April 3 (attachment 4). The accident pilot selected the "Low Alt Weather Brief" at 1810 EDT on April 3. The April 3 1810 EDT DUATS weather briefing contained the Area Forecast, the SPC Day 1 Convective Outlook, severe weather watches and warnings along the proposed route of flight, SIGMETs, CWAs, AIRMETs, METARs, PIREPs, TAFs, and the Winds Aloft Forecast all valid at 1810 EDT on April 3. The accident pilot then received the same "Low Alt Weather Brief" at 1811 EDT on April 3 from DUATS (attachment 4).

The accident pilot then received several Leidos text weather briefings during the morning of the accident (and prior to departure) with the first Leidos text weather briefing requested by the accident pilot at 0612 EDT on April 4. The 0612 EDT Leidos text weather briefing contained Convective SIGMET 27E (section 8.0), the SPC Day 1 Convective Outlook, AIRMETs, CWAs, the Area Forecast, TAFs, and that no urgent PIREPs were current along the route of flight (attachment 5). The accident pilot then received the next Leidos weather briefing at 0715 EDT (still prior to departure). The 0715 EDT Leidos text weather briefing contained Convective SIGMET 28E (section 8.0), the SPC Day 1 Convective Outlook, AIRMETs, CWAs, NWS severe weather warnings along the route of flight, METARs, TAFs, the Winds Aloft Forecast, and that no urgent PIREPs were current along the route of flight (attachment 6). The accident pilot received the final Leidos weather briefing at 0730 EDT (and prior to departure). The 0730 EDT Leidos text weather briefing contained Convective SIGMET 28E (section 8.0), the SPC Day 1 Convective Outlook, AIRMETs, CWAs, NWS severe weather warnings along the route of flight, METARs, TAFs, the Winds Aloft Forecast, and that no urgent PIREPs were current along the route of flight (attachment 7). While attachments 5 through 7 only contain the text weather information, the accident pilot would have had access to weather products in a graphical format, but those Leidos graphics are not archived at this time (attachment 8).

In addition to the DUATS, Leidos, and LMFS weather information, the accident pilot was receiving updated text weather information via text message (SMS) format from LMFS (attachment 9). The SMS information sent at 0651 EDT contained Convective SIGMET 28E information (section 8.0). The SMS information sent at 0654 EDT contained information on a severe thunderstorm warning valid along the route of flight. The SMS information sent at 0702 EDT contained information on a severe thunderstorm warning valid along the route of flight. The SMS information sent at 0740 EDT contained information on a severe thunderstorm warning valid along the route of flight. The SMS information sent at 0748 EDT contained information on a severe thunderstorm warning valid along the route of flight. The SMS information sent at 0749 EDT contained Convective SIGMET 29E information (section 8.0). The SMS information sent at 0753 EDT contained information on a CWA valid along the route of flight. The SMS information sent at 0802 EDT contained information on a severe thunderstorm warning valid along the route of flight. The SMS information sent at 0814 EDT contained information on a severe thunderstorm warning valid along the route of flight. The SMS information sent at 0829 EDT contained information on an AIRMET valid along the route of flight. The SMS information sent at 0832 EDT contained information on an AIRMET valid along the route of flight. It is unknown if the accident pilot viewed the available SMS weather information.

A search of ForeFlight weather information revealed that the accident pilot did not request a weather briefing using ForeFlight Mobile prior to his flight. It is unknown if the accident pilot checked or received additional weather information before or during the accident flight.

18.0 FIS-B Regional NEXRAD with Flight Path

Figures 37 through 41 are the regional NEXRAD weather radar data available to the pilot in the cockpit from Flight Information Services–Broadcast (FIS-B), if the accident pilot had the regional NEXRAD weather radar screen selected (at this horizontal scale) on his electronic equipment.[36] The FIS-B regional NEXRAD weather radar data is updated once every 5 minutes and is based upon composite NEXRAD reflectivity data. The FIS-B data indicated that the accident aircraft would have passed through an area of purple on the regional NEXRAD plot (figures 40 and 41) between 0905 EDT and the accident time. For additional information regarding the regional NEXRAD weather radar data please see attachments 10 and 11. For the exact dBZ scales used in the FIS-B regional NEXRAD please see attachment 12.

[36] For more information on the electronic equipment located on the accident aircraft please see the docket information for this accident.

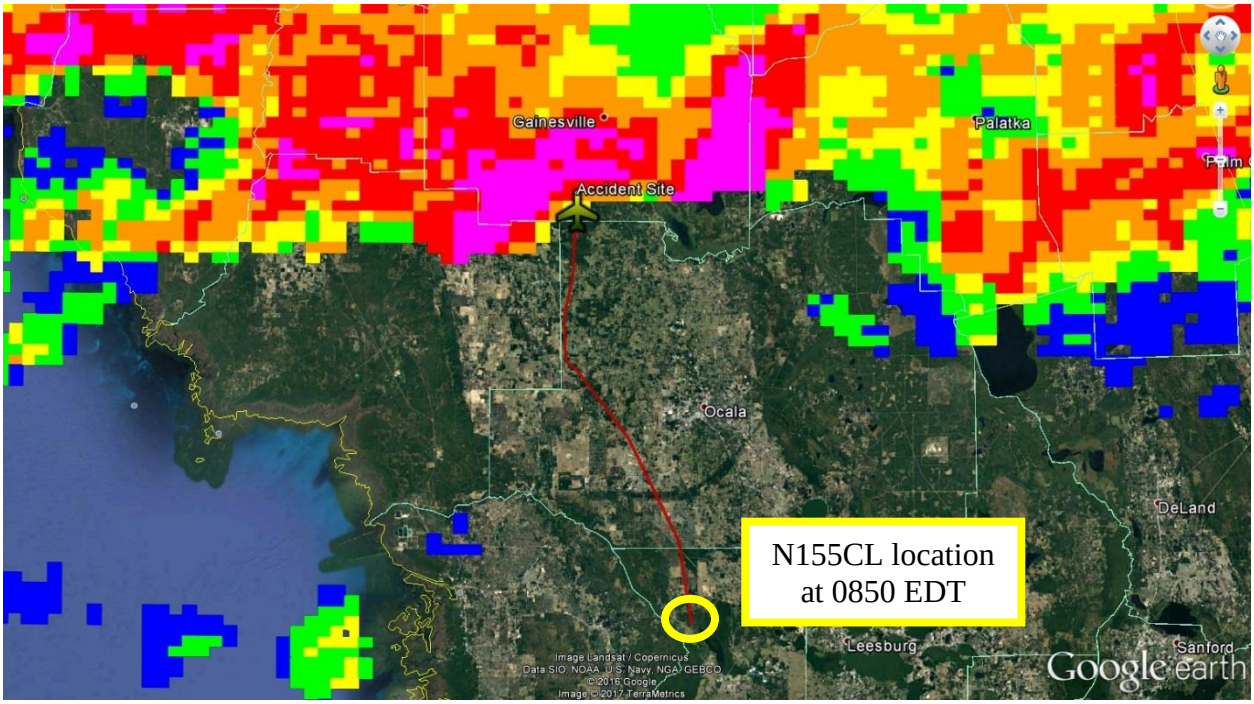


Figure 37 –FIS-B regional NEXRAD plot valid at 0850 EDT with ATC radar track from 0850 to 0908 EDT

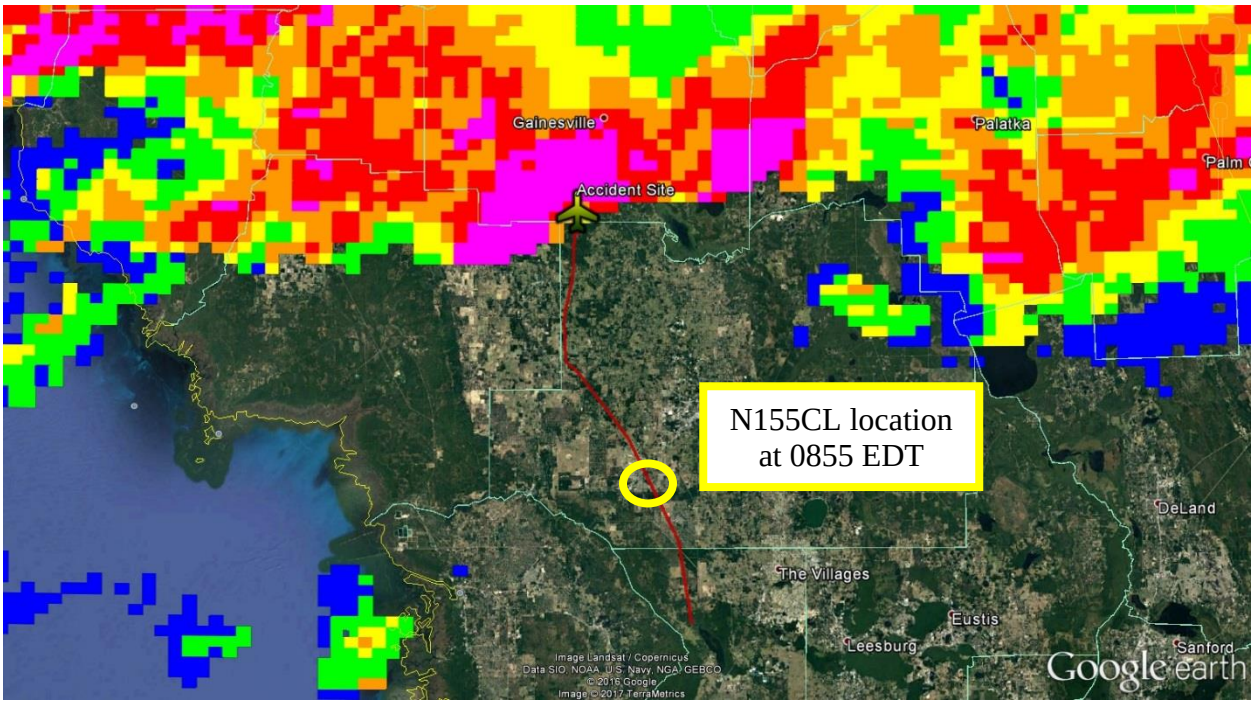


Figure 38 – FIS-B regional NEXRAD plot valid at 0855 EDT with ATC radar track from 0850 to 0908 EDT

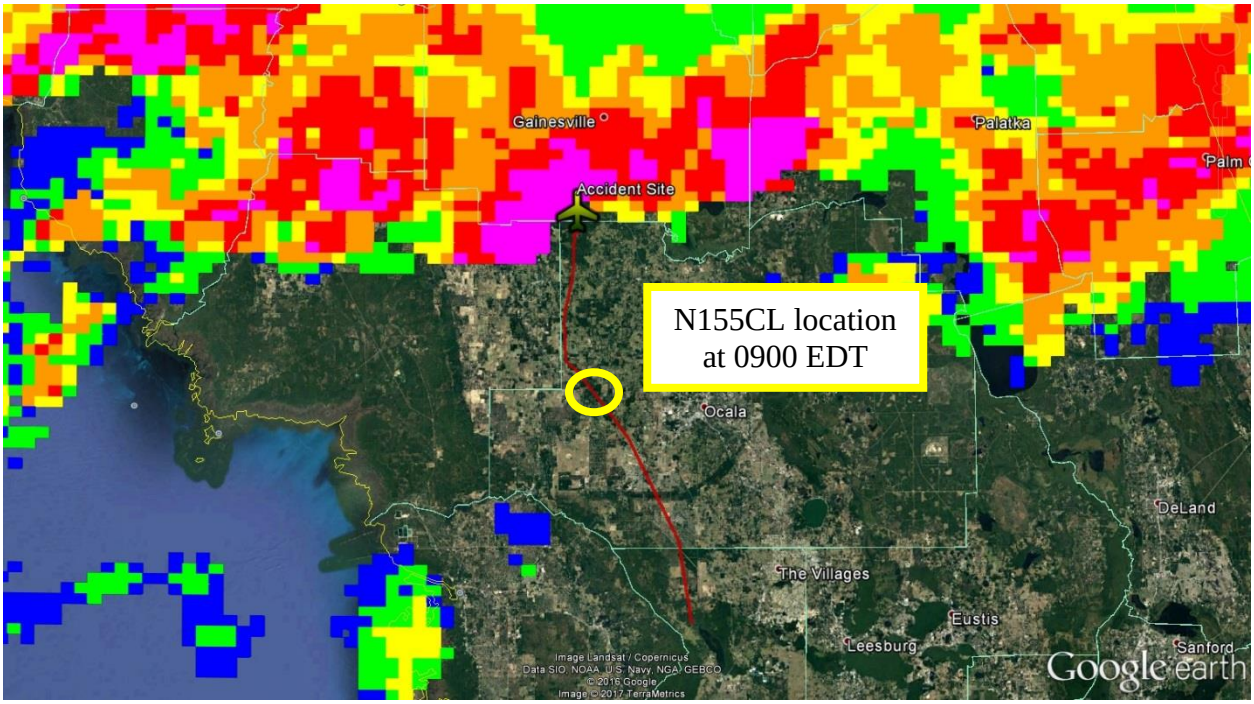


Figure 39 – FIS-B regional NEXRAD plot valid at 0900 EDT with ATC radar track from 0850 to 0908 EDT

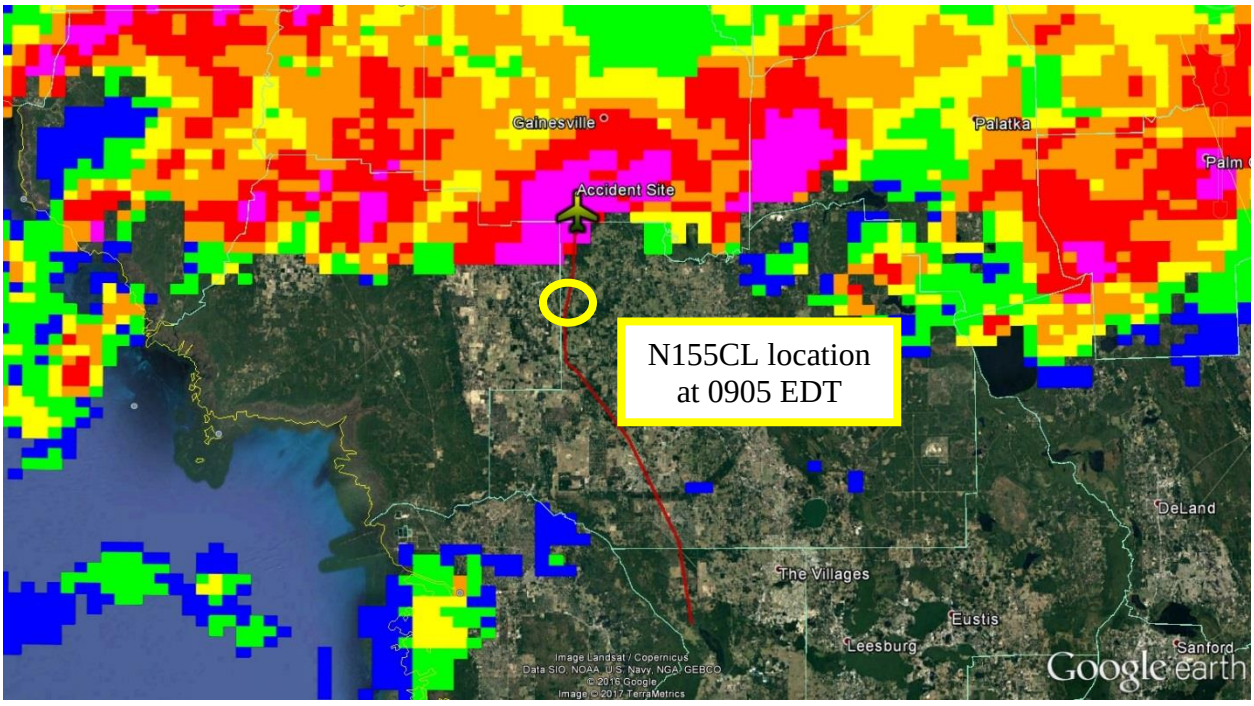


Figure 40 – FIS-B regional NEXRAD plot valid at 0905 EDT with ATC radar track from 0850 to 0908 EDT

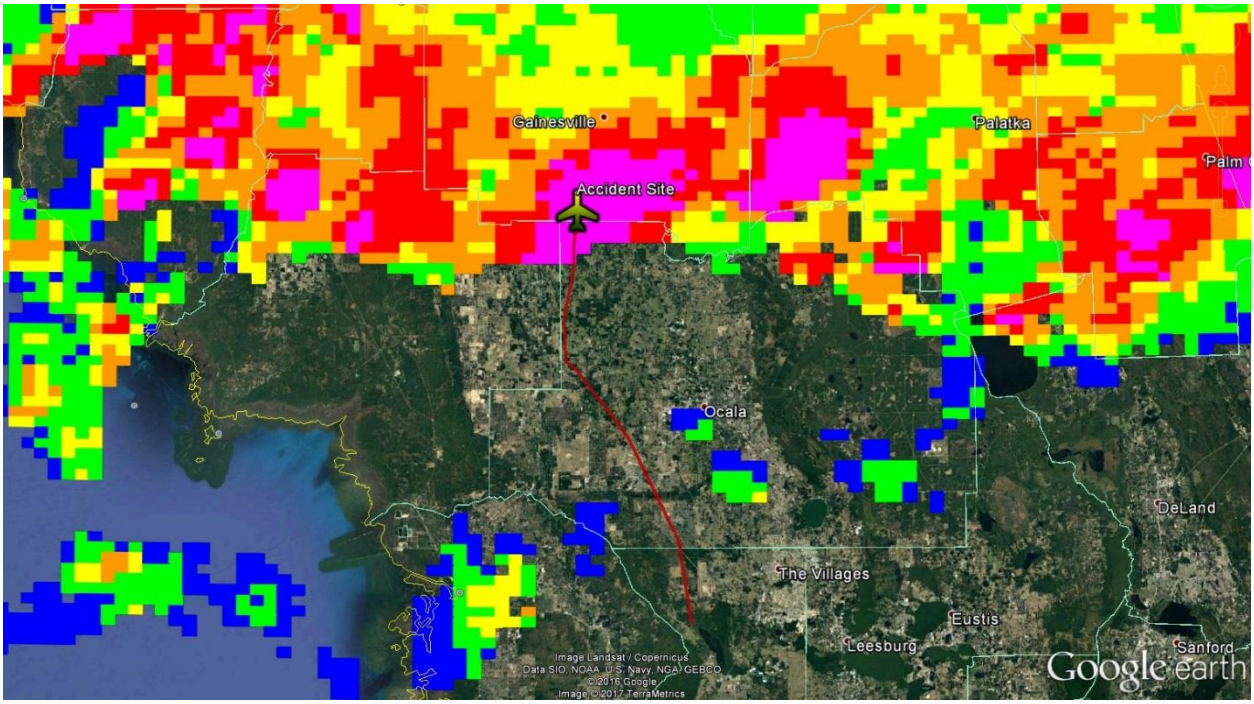


Figure 41 – FIS-B regional NEXRAD plot valid at 0910 EDT with ATC radar track from 0850 to 0908 EDT

19.0 XM Weather Data

The airplane was equipped with a Garmin[37], which could be optionally fitted to be able to display XM Weather information with a subscription. If the accident pilot had been viewing XM Weather composite radar information he would have had a chance to view something similar to figures 42 through 46, which was XM Weather composite radar information available around and before the accident time. The scale used in the XM Weather composite radar information is located in figure 47. The XM Weather composite radar images from 0850 through 0910 EDT displayed 20 dBZ values above the accident site at 0850 EDT with 50 dBZ values and greater above the accident site from 0900 EDT onward (figures 42 through 46). For additional information regarding the XM Weather composite radar data please see attachment 13.

[37] For more information on the electronic equipment located on the accident aircraft please see the docket information for this accident.

XM COMPOSITE 7:50AM CDT / 8:50 EDT

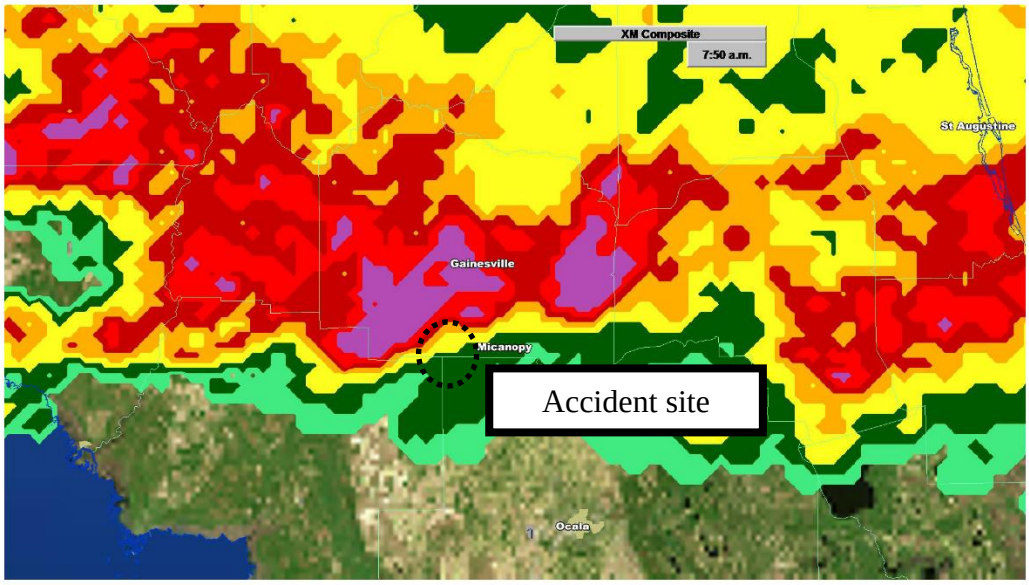


Figure 42 –XM Weather Radar from 0850 EDT

XM COMPOSITE 7:55AM CDT / 8:55 EDT

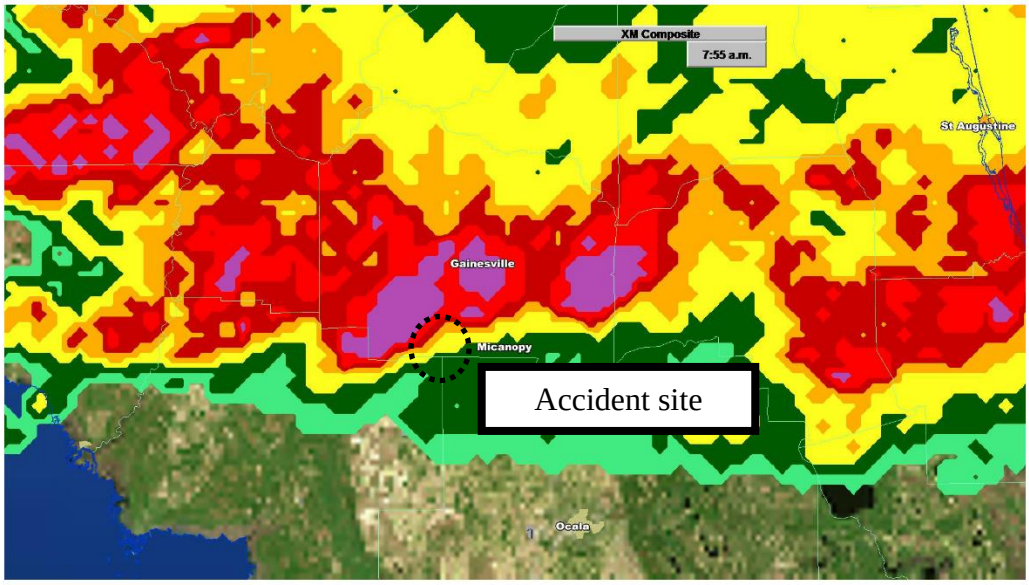


Figure 43 – XM Weather Radar from 0855 EDT

XM COMPOSITE 8:00AM CDT / 9:00 EDT

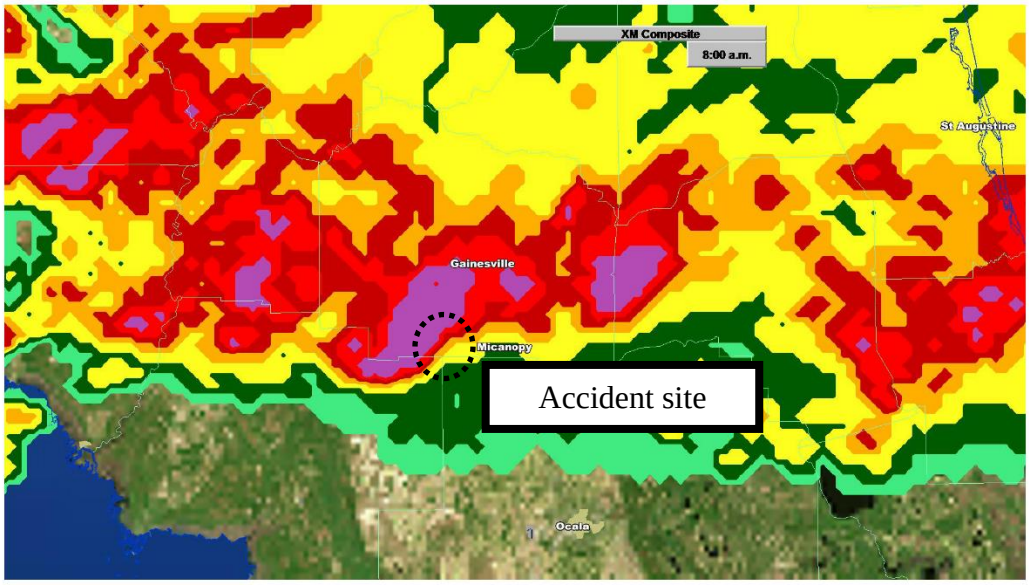


Figure 44 – XM Weather Radar from 0900 EDT

XM COMPOSITE 8:05AM CDT / 9:05 EDT

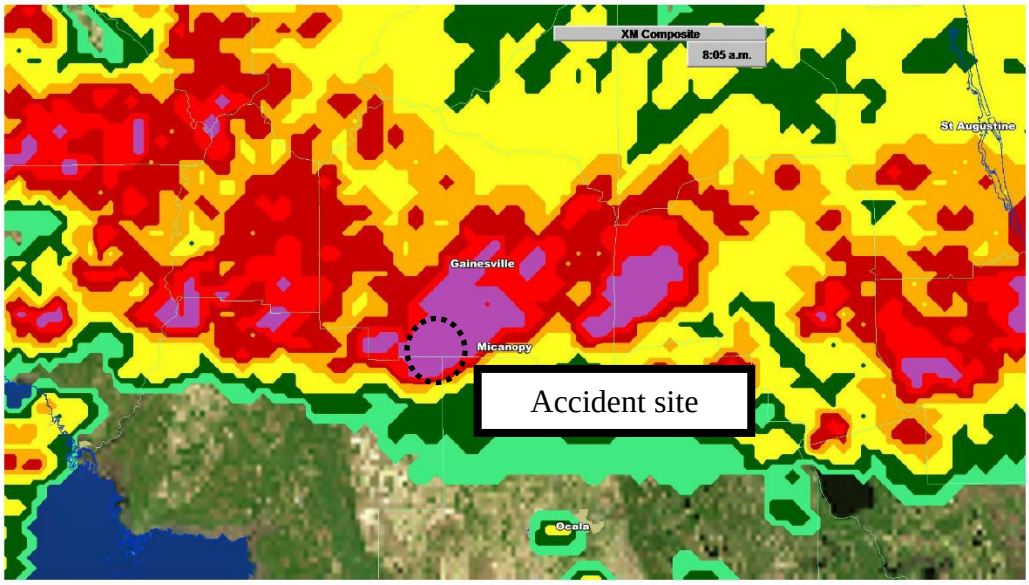


Figure 45 – XM Weather Radar from 0905 EDT

XM COMPOSITE 8:10AM CDT / 9:10 EDT

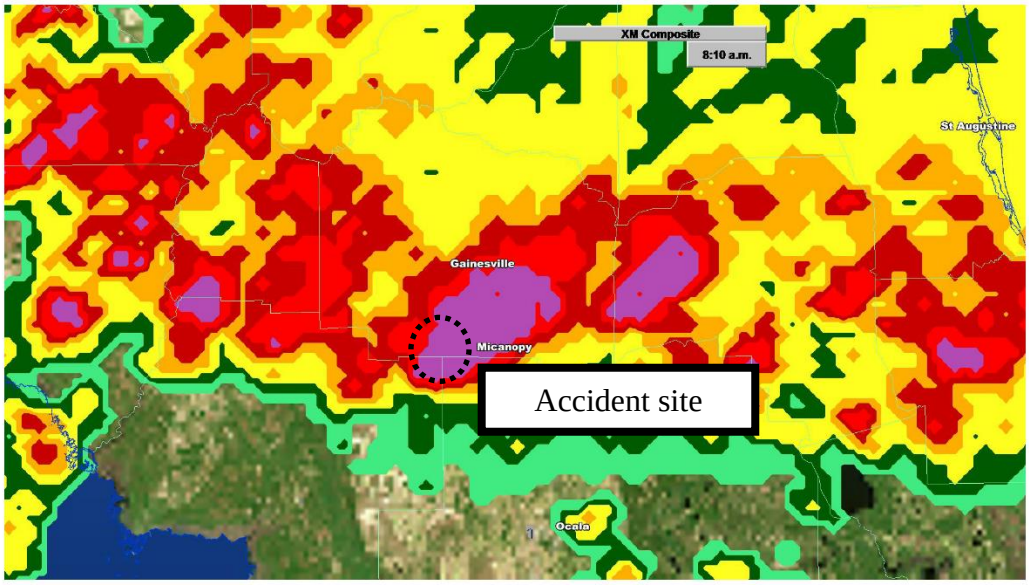


Figure 46 – XM Weather Radar from 0910 EDT

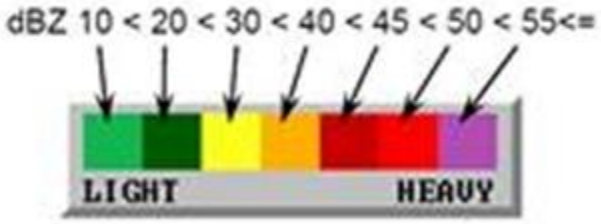


Figure 47 – XM Weather Radar scale for figures 42 through 46

20.0 Consolidated Storm Prediction for Aviation Data

The Consolidated Storm Prediction for Aviation (CoSPA) images were retrieved for 0850, 0855, 0900, 0905, and 0910 EDT and provided in figures 48 through 52 with the accident site marked. The CoSPA, along with depicting NWS weather radar VIP levels, lightning data, weather satellite, and storm motion, forecast areas of likely rain shower or thunderstorm growth (orange hatched areas) and areas of likely rain shower or thunderstorm dissipation (blue hatched areas). The thunderstorm activity across northcentral Florida moved from west to east between 0850 and 0910 EDT. VIP levels increased in intensity and coverage above the accident site between 0850 and 0910 EDT. CoSPA indicated a likely area of updraft growth above the accident site as early as 0855 EDT (figure 49).

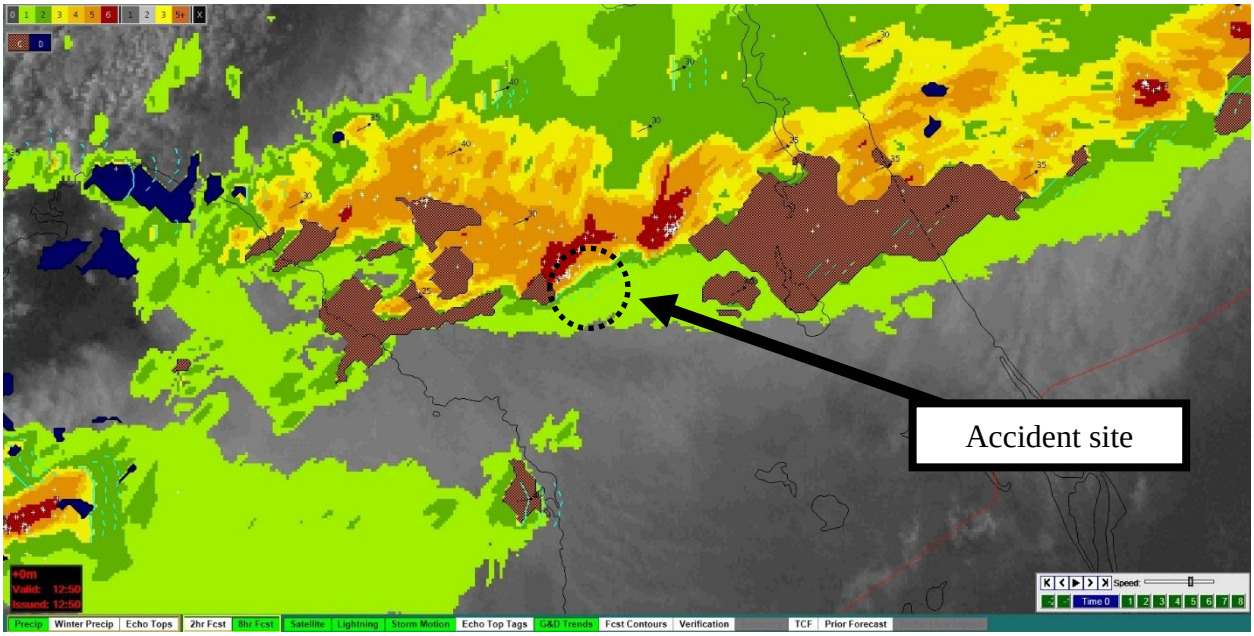


Figure 48 – CoSPA image from 0850 EDT with the accident site marked

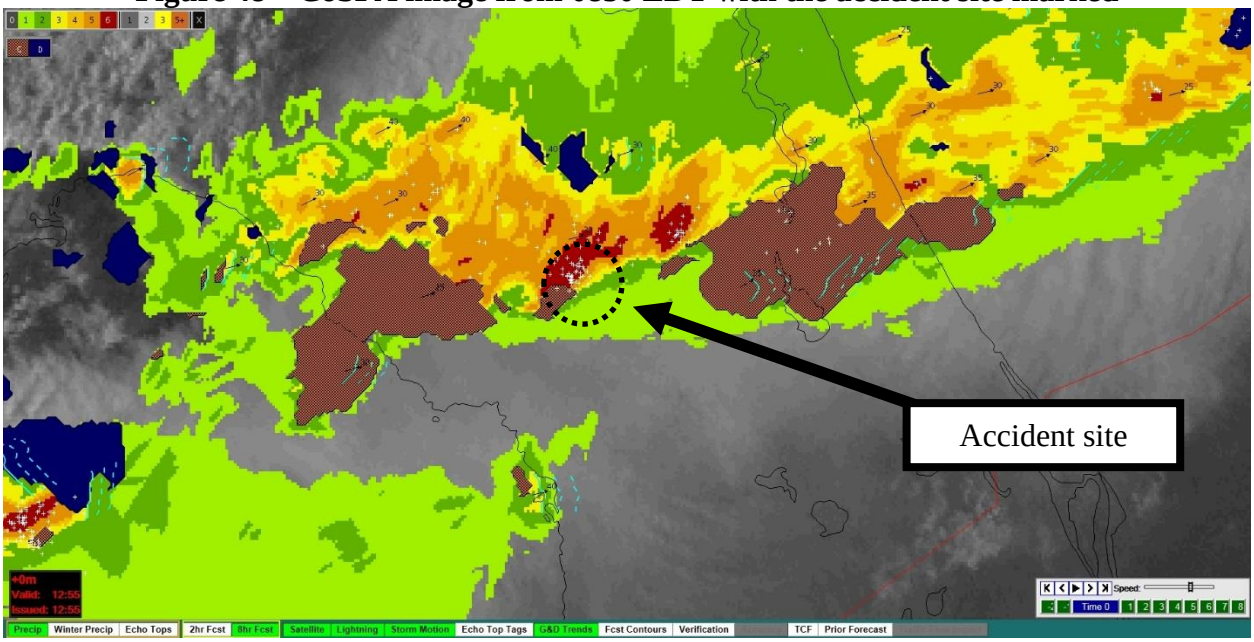


Figure 49 – CoSPA image from 0855 EDT with the accident site marked

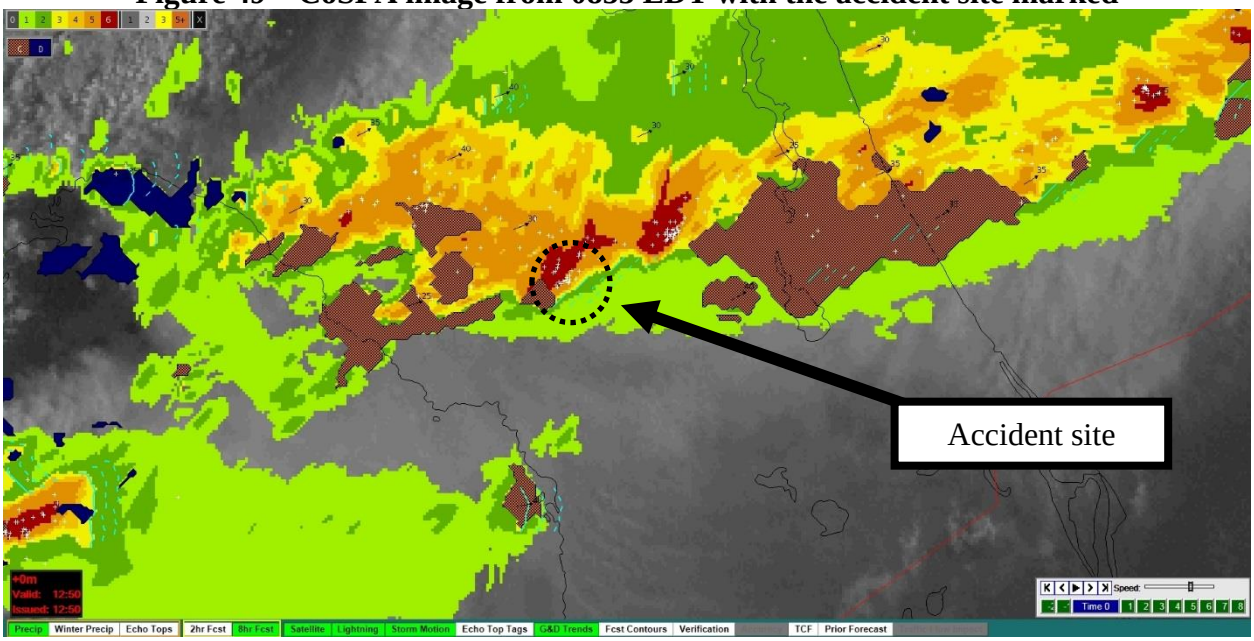


Figure 50 – CoSPA image from 0900 EDT with the accident site marked

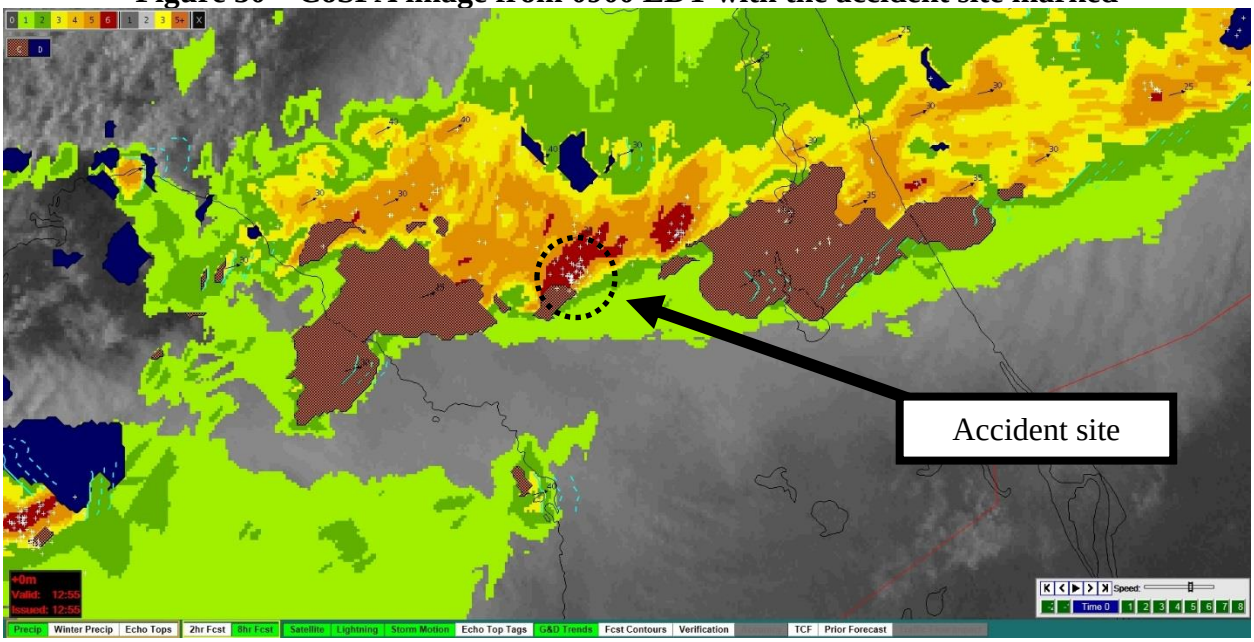


Figure 51 – CoSPA image from 0905 EDT with the accident site marked

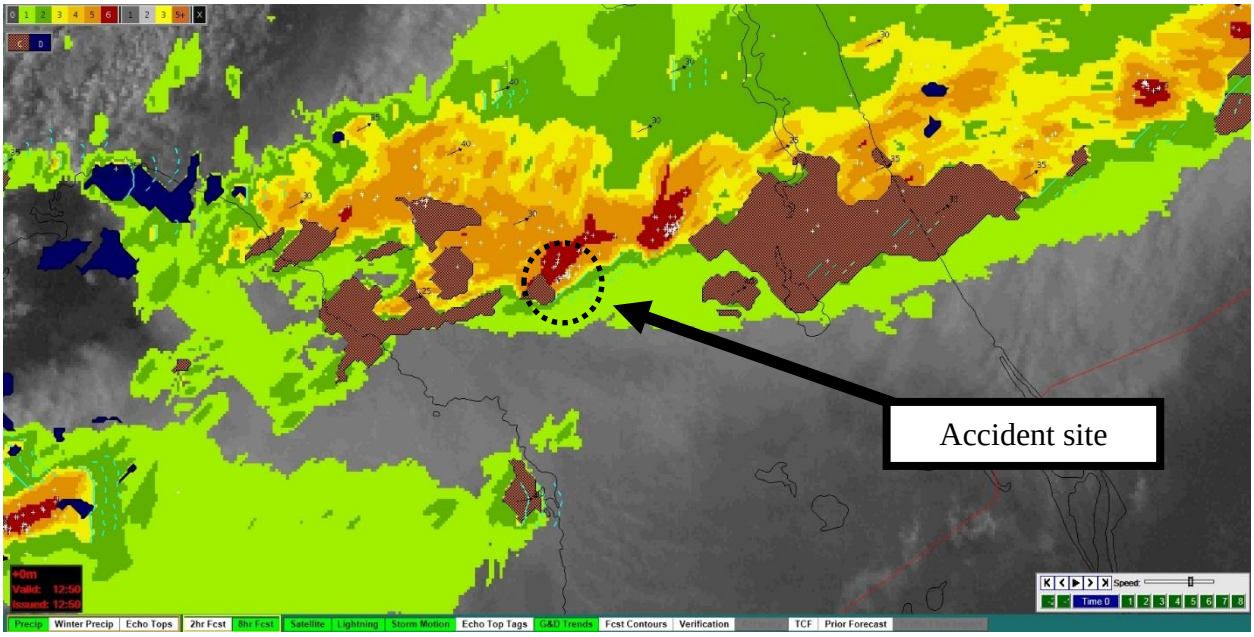


Figure 52 – CoSPA image from 0910 EDT with the accident site marked

21.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for the accident site on April 4, 2017, indicated the following:

SUN	
Begin civil twilight	0651 EDT
Sunrise	0715 EDT
Sun transit	1332 EDT
Sunset	1750 EDT
End civil twilight	1814 EDT

22.0 Thunderstorm Training Information

The Federal Aviation Administration's (FAA) Advisory Circular AC 00-24C titled "Thunderstorms" issued in February 2013 is a basic training guide on thunderstorm hazards used for flight training guidance. As a result of the hazardous nature of thunderstorms the FAA has published several common practices or do's and don'ts on thunderstorm flying, which are published in AC 00-24C and the Aeronautical Information Manual (AIM) under Chapter 7 Safety of Flight, section 7-1-29. The following avoidance rules are published:

DOS AND DON'TS OF THUNDERSTORM AVOIDANCE.

a. Thunderstorm Avoidance. Never regard any thunderstorm lightly, even when radar observers report the echoes are of light intensity. Avoiding thunderstorms is the best policy. Following are some dos and don'ts of thunderstorm avoidance:

(1) Don't land or takeoff in the face of an approaching thunderstorm. A sudden gust front of low-level turbulence could cause loss of control.

(2) Don't attempt to fly under a thunderstorm even if you can see through to the other side. Turbulence and wind shear under the storm could be hazardous.

(3) Don't attempt to fly under the anvil of a thunderstorm. There is a potential for severe and extreme clear air turbulence.

(4) Don't fly without airborne radar into a cloud mass containing scattered embedded thunderstorms. Scattered thunderstorms not embedded usually can be visually circumnavigated.

(5) Don't trust the visual appearance to be a reliable indicator of the turbulence inside a thunderstorm.

(6) Don't assume that ATC will offer radar navigation guidance or deviations around thunderstorms.

(7) Don't use data-linked weather next generation weather radar (NEXRAD) mosaic imagery as the sole means for negotiating a path through a thunderstorm area (tactical maneuvering).

(8) Do remember that the data-linked NEXRAD mosaic imagery shows where the weather *was*, not where the weather *is*. The weather conditions may be 15 to 20 minutes older than the age indicated on the display.

(9) Do listen to chatter on the ATC frequency for Pilot Weather Reports (PIREP) and other aircraft requesting to deviate or divert.

(10) Do ask ATC for radar navigation guidance or to approve deviations around thunderstorms, if needed.

(11) .Do use data-linked weather NEXRAD mosaic imagery (e.g., Flight Information Service-Broadcast (FIS-B)) for route selection to avoid thunderstorms entirely (strategic maneuvering).

(12) Do advise ATC, when switched to another controller, that you are deviating for thunderstorms before accepting to rejoin the original route.

(13) Do ensure that after an authorized weather deviation, before accepting to rejoin the original route, that the route of flight is clear of thunderstorms.

(14) Do avoid by at least 20 miles any thunderstorm identified as severe or giving an intense radar echo. This is especially true under the anvil of a large cumulonimbus.

(15) Do circumnavigate the entire area if the area has 6/10 thunderstorm coverage.

(16) Do remember that vivid and frequent lightning indicates the probability of a severe thunderstorm.

(17) Do regard as extremely hazardous any thunderstorm with tops 35,000 ft or higher whether the top is visually sighted or determined by radar.

(18) Do give a PIREP for the flight conditions.

(19) Do divert and wait out the thunderstorms on the ground if unable to navigate around an area of thunderstorms.

b. Dos Before Entering a Storm. If unable to avoid penetrating a thunderstorm, the following are some dos *before* entering the storm:

(1) Tighten the safety belt, put on the shoulder harness (if installed), and secure all loose objects.

(2) Plan and hold the course to take the aircraft through the storm in a minimum time.

(3) To avoid the most critical icing, establish a penetration altitude below the freezing level or above the level of -15ºC.

(4) Verify that pitot heat is on and turn on carburetor heat or jet engine anti-ice. Icing can be rapid at any altitude and cause almost instantaneous power failure and/or loss of airspeed indication.

(5) Establish power settings for turbulence penetration airspeed recommended in the aircraft manual.

(6) Turn up cockpit lights to highest intensity to lessen temporary blindness from lightning.

(7) If using automatic pilot, disengage Altitude Hold Mode and Speed Hold Mode. The automatic altitude and speed controls will increase maneuvers of the aircraft thus increasing structural stress.

(8) If using airborne radar, tilt the antenna up and down occasionally. This will permit the detection of other thunderstorm activity at altitudes other than the one being flown.

c. Dos and Don'ts for Thunderstorm Penetration. Following are some dos and don'ts during the thunderstorm penetration:

(1) Do keep your eyes on the flight instruments. Looking outside the cockpit can increase danger of temporary blindness from lightning.

(2) Don't change power settings; maintain settings for the recommended turbulence penetration airspeed.

(3) Do maintain constant attitude. Allow the altitude and airspeed to fluctuate.

(4) Don't turn back once in the thunderstorm. A straight course through the storm most likely will get the aircraft out of the hazards most quickly. In addition, turning maneuvers increase stress on the aircraft.

E. LIST OF ATTACHMENTS

Attachment 1 – GOES-13 visible satellite imagery from 0815 to 1015 EDT

Attachment 2 – GOES-13 infrared satellite imagery from 0815 to 1015 EDT

Attachment 3 – Latitude and longitude lightning flashes and strikes surrounding the accident site between 0855 and 0915 EDT

Attachment 4 – DUATS standard weather briefing package from 1746, 1810, and 1811 EDT on April 3, 2017

Attachment 5 – Leidos standard weather briefing package from 0612 EDT

Attachment 6 – Leidos standard weather briefing package from 0715 EDT

Attachment 7 – Leidos standard weather briefing package from 0730 EDT

Attachment 8 – Correspondence with Leidos

Attachment 9 – LMFS contact history with N155CL

Attachment 10 – FAA response to NTSB request 17-137 document

Attachment 11 – FAA response to NTSB request 17-137 data

Attachment 12 – FAA response to NTSB request 17-137 data part 2

Attachment 13 – XM composite weather radar data

Submitted by:

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Paul Suffern
Senior Meteorologist

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