National Transportation Safety Board

Office of Aviation Safety

Washington, D.C. 20594-2000

March 23, 2012

METEOROLOGICAL FACTUAL REPORT

ERA12MA122

A. Accident

Location: Green Cove Springs, Florida
Date: December 26, 2011
Time: approximately 0554 eastern standard time (1054 UTC[1])
Aircraft: Bell 206B, registration: N5016M

B. Meteorological Specialist

Paul Suffern
Senior Meteorologist
National Transportation Safety Board
Operational Factors Division, AS-30
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C. Summary

On December 26, 2011, at 0554 eastern standard time, a Bell 206B, N5016M, operated by SK Logistics, d.b.a. SK Jets, collided with terrain while maneuvering near Green Cove Springs, Florida. The certificated airline transport pilot and 2 passengers (a doctor and a medical technician) were fatally injured. The on-demand air taxi flight was conducted under the provisions of 14 Code of Federal Regulations Part 135. Night instrument meteorological conditions prevailed along the route and no flight plan was filed for the planned flight to Shands Cair Heliport (63FL), Gainesville, Florida. The flight originated from Mayo Clinic Heliport (6FL1), Jacksonville, Florida, about 0537.

[1] UTC – is an abbreviation for Coordinated Universal Time.

D. Details of Investigation

The National Transportation Safety Board's (NTSB) Meteorologist was not on scene for this investigation and gathered all 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 Climatic Data Center (NCDC). All times are eastern standard time (EST) on December 26, 2011, and are based upon the 24-hour clock, where local time is -5 hours from UTC, and UTC=Z. 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 29.88° N, longitude 81.76° W, elevation: 118 feet.

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 (NCEP) and the Ocean Prediction Center (OPC) located in Camp Springs, 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-0045G CHG 1.

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart for 0700 EST is provided as figure 1, with the approximate location of the accident site marked. The chart depicted a stationary front to the south of the accident site, stretching from central Florida westward into the northern Gulf of Mexico. A cold front stretched from eastern Florida northeastward into the western Atlantic Ocean. The station models surrounding the accident site depicted temperatures from the low 50's to low 60's Fahrenheit (F), with temperature-dew point spreads of 3° F or less, a north wind between 5 and 20 knots, and mostly cloudy skies. Station models along and south of the stationary and cold fronts had temperatures from the low to mid 60's F, with temperature-dew point spreads of 1° F or less, a north to northeast wind of 5 to 10 knots, cloudy skies, and fog.

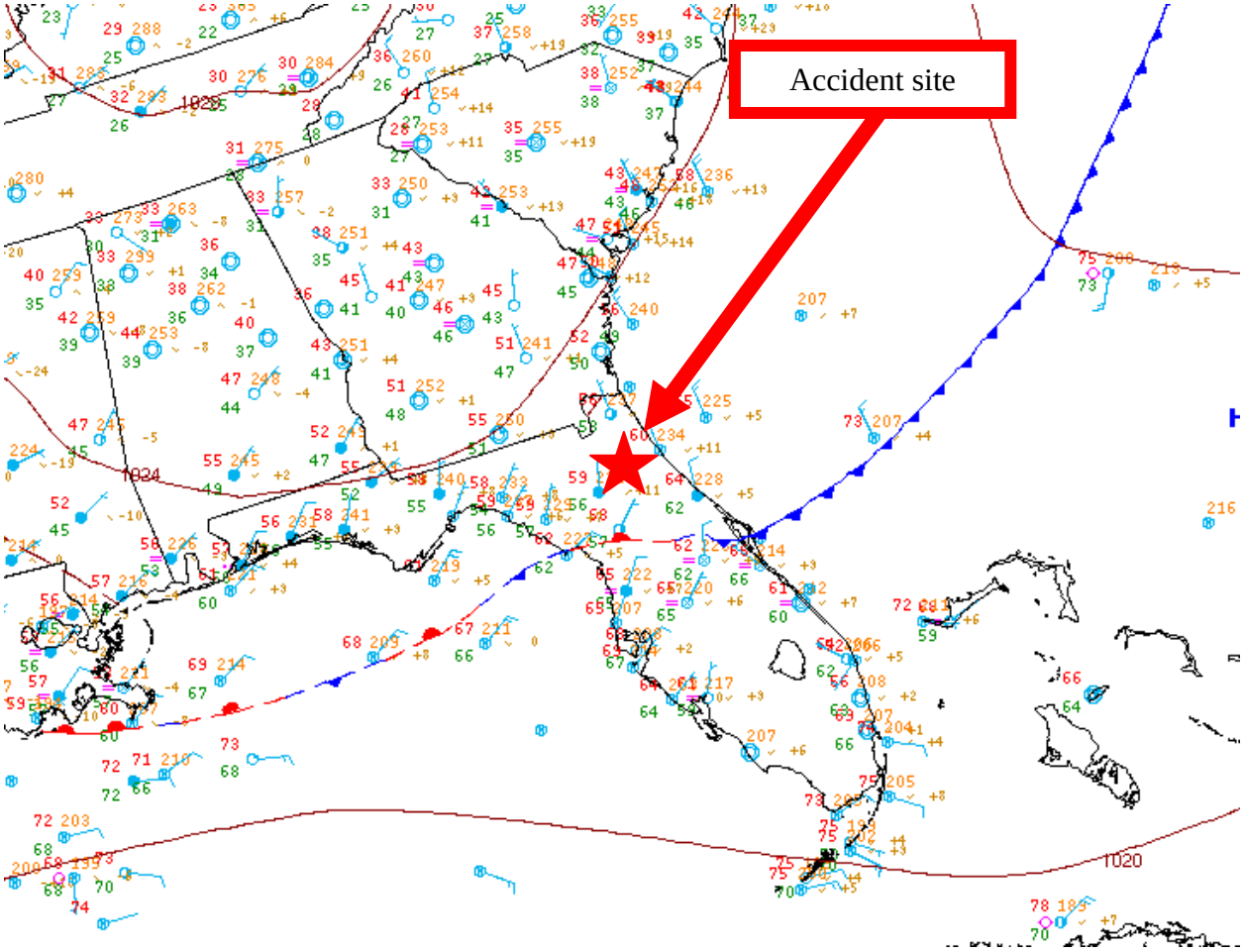


Figure 1 – NWS Surface Analysis Chart for 0700 EST

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 0700 EST are presented for 925-, 850-, 700-, 500-, and 300-hectopascals (hPa) in figures 2 through 6. The 850-, 700-, and 500-hPa charts depicted a mid-level ridge[2], typically associated with calm weather and light surface winds, located west of the accident site stretched from the northeastern Gulf of Mexico northwestward into the Upper Midwest. The wind near the accident site was from the north at 5 knots at 925-hPa (figure 2) becoming westerly near 55 knots at 300-hPa (figure 6).

[2] Ridge – An elongated area of relatively high atmospheric pressure or heights.

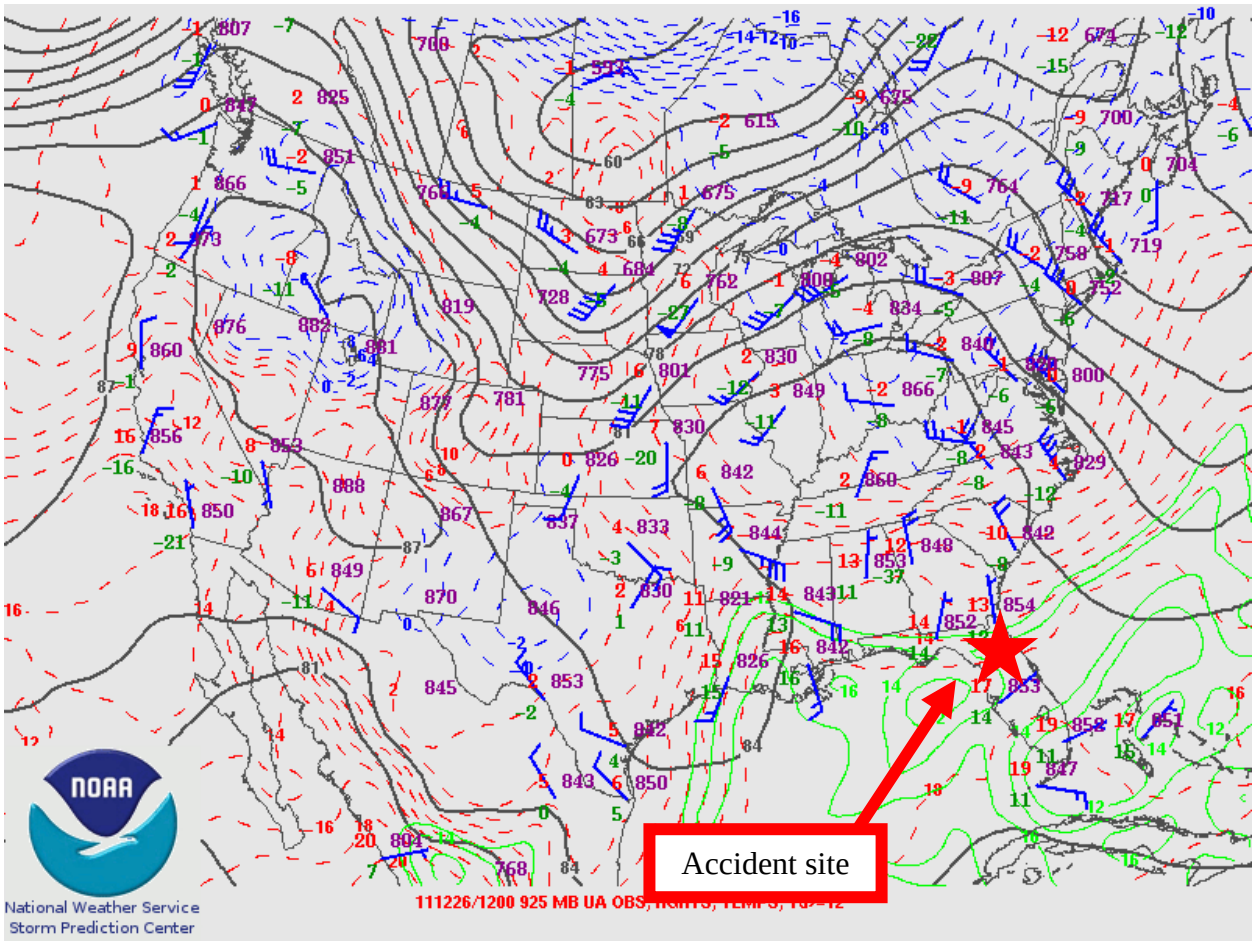


Figure 2 – 925-hPa Constant Pressure Chart for 0700 EST

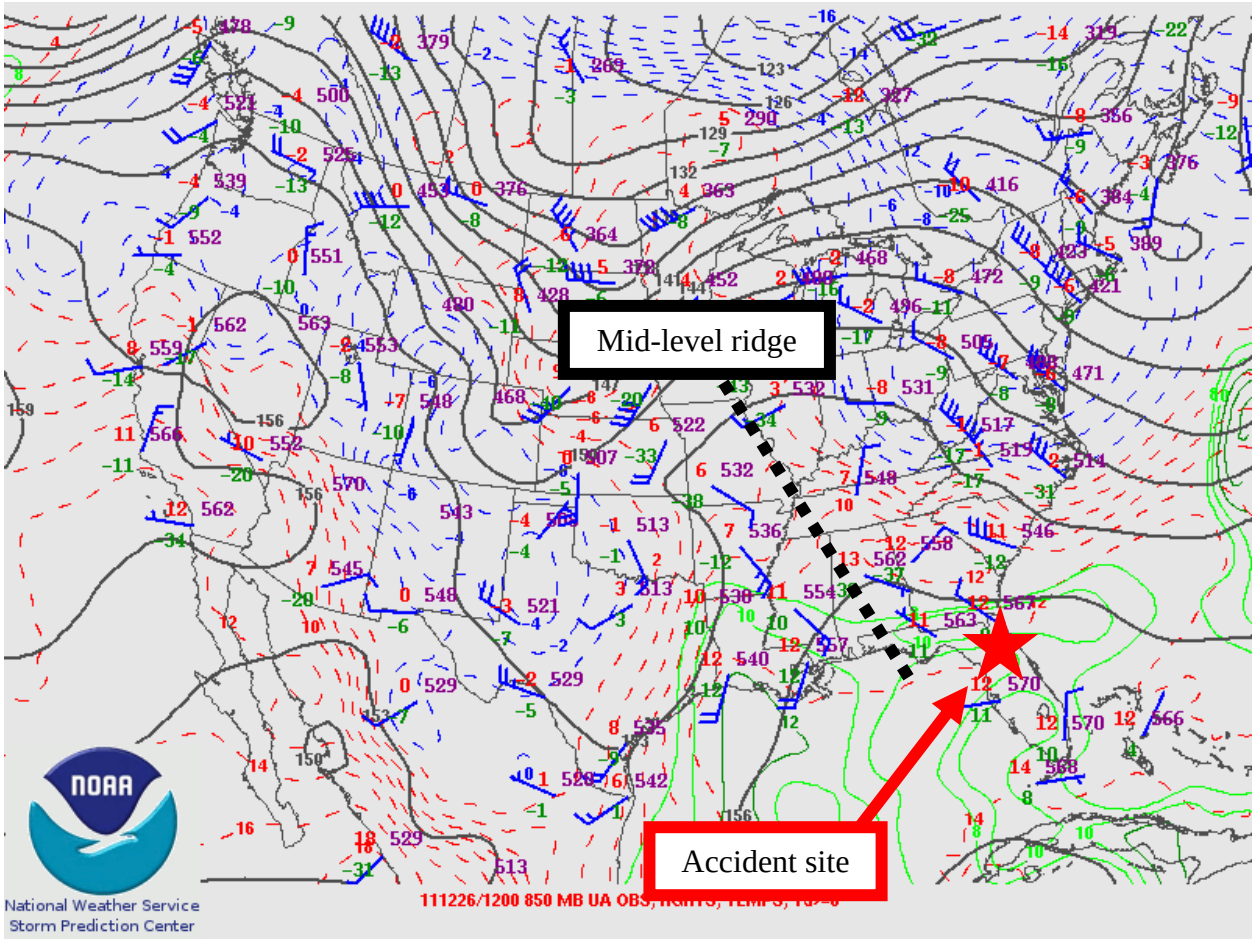


Figure 3 – 850-hPa Constant Pressure Chart for 0700 EST

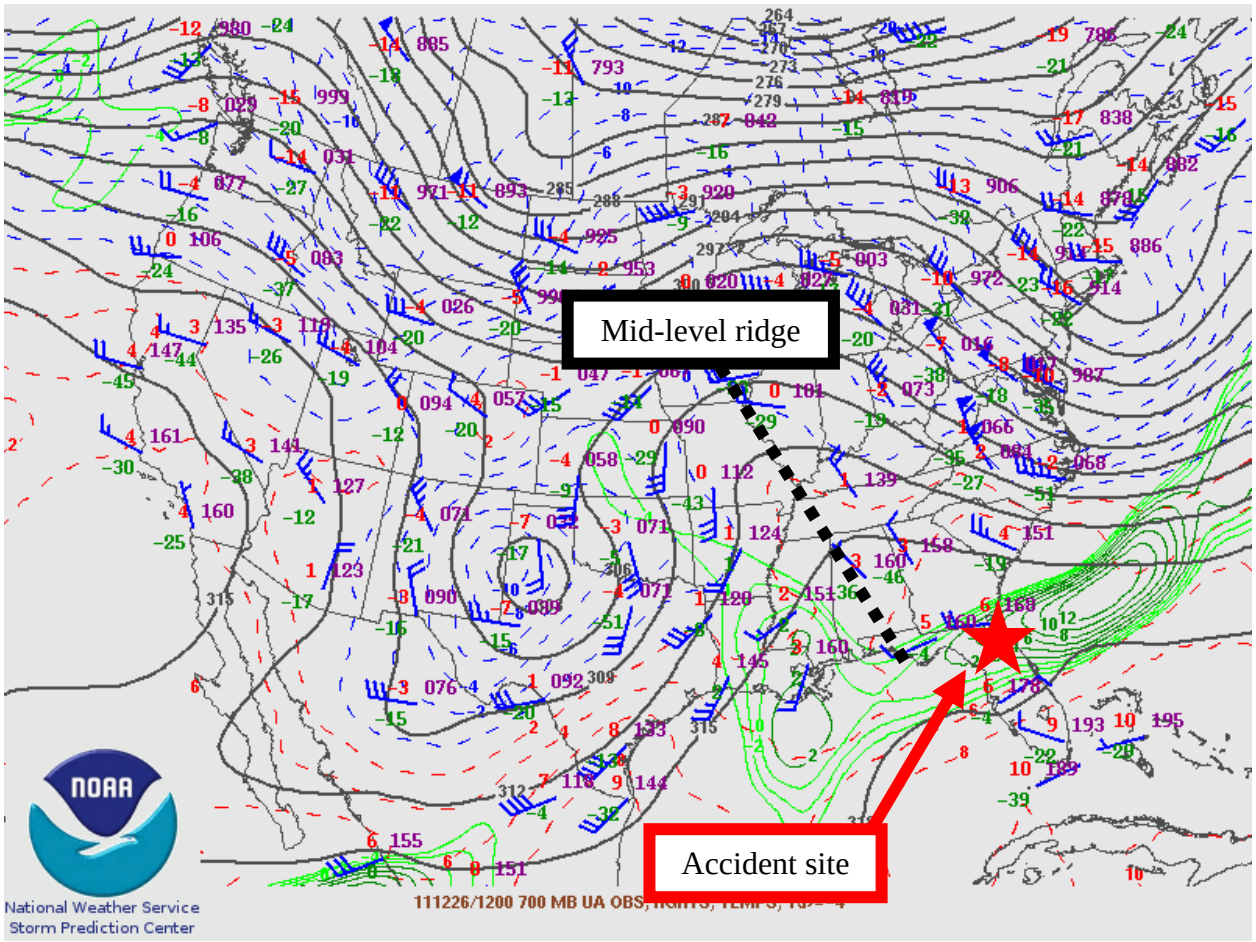


Figure 4 – 700-hPa Constant Pressure Chart for 0700 EST

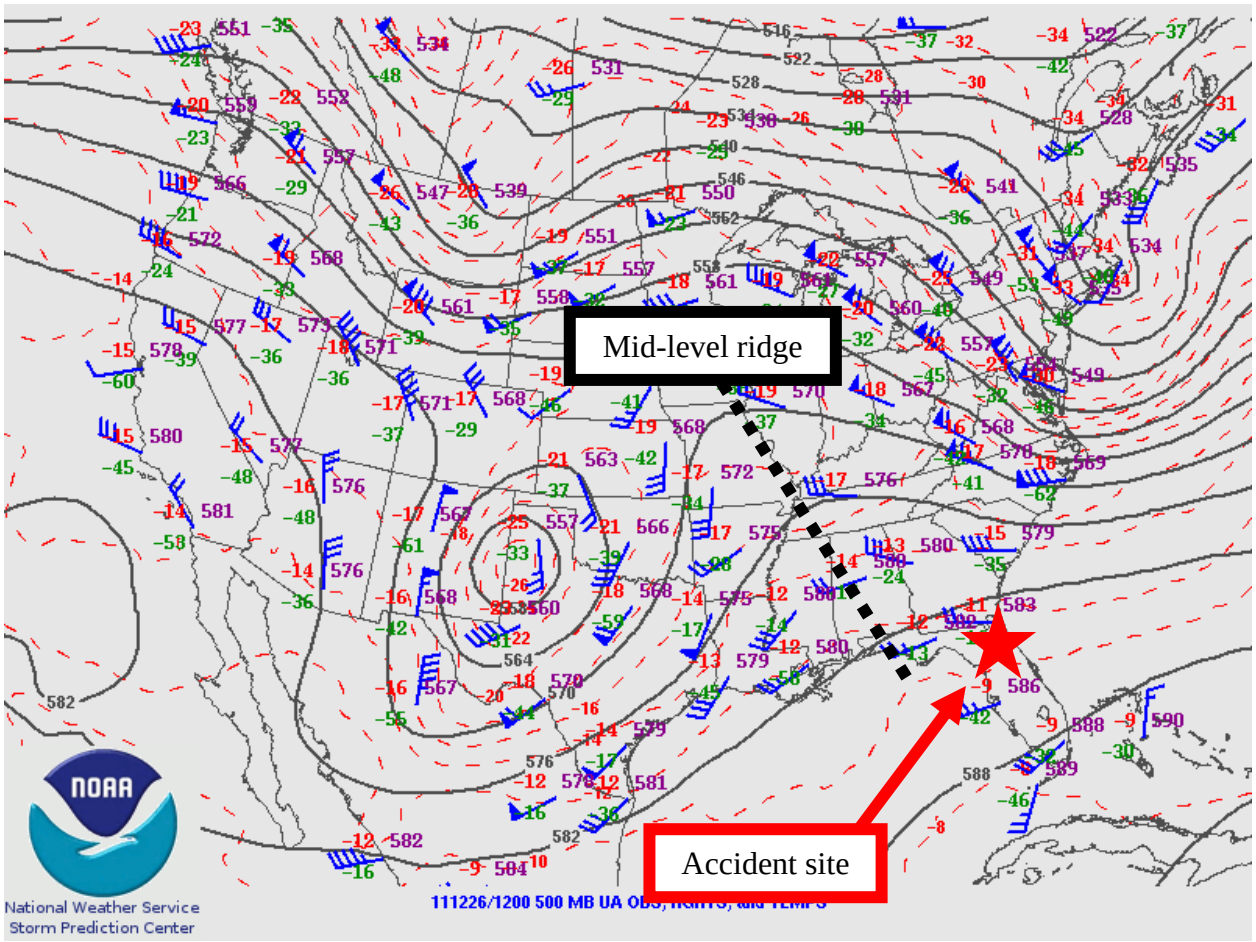


Figure 5 – 500-hPa Constant Pressure Chart for 0700 EST

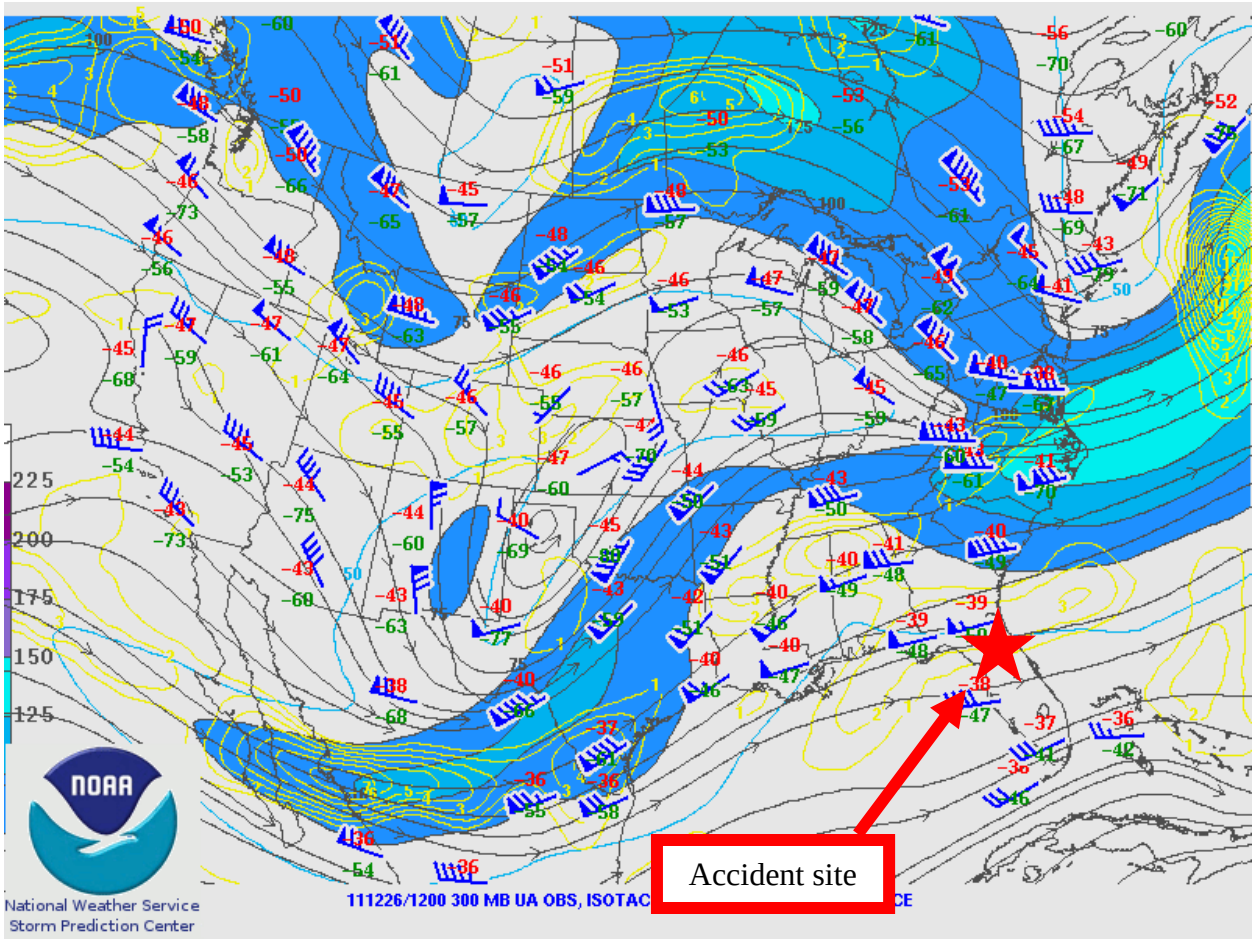


Figure 6 – 300-hPa Constant Pressure Chart for 0700 EST

2.0 Surface Observations

The area surrounding the accident site was documented utilizing official NWS Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language.

The closest weather reporting to the accident site was from an Automated Weather Observing System (AWOS[3]) located at Palatka Municipal Airport (K28J), 2 miles northwest of Palatka, Florida. These observations were taken from automated equipment and were not supplemented by a human observer. K28J had an elevation of 48 feet, was located 14 miles southeast of the accident site, and had a 5° westerly magnetic variation[4]. The following observations were disseminated around the time of the accident:

[3] 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 feet, and altimeter setting.

[4] Magnetic variation – The angle (at a particular location) between magnetic north and true north.

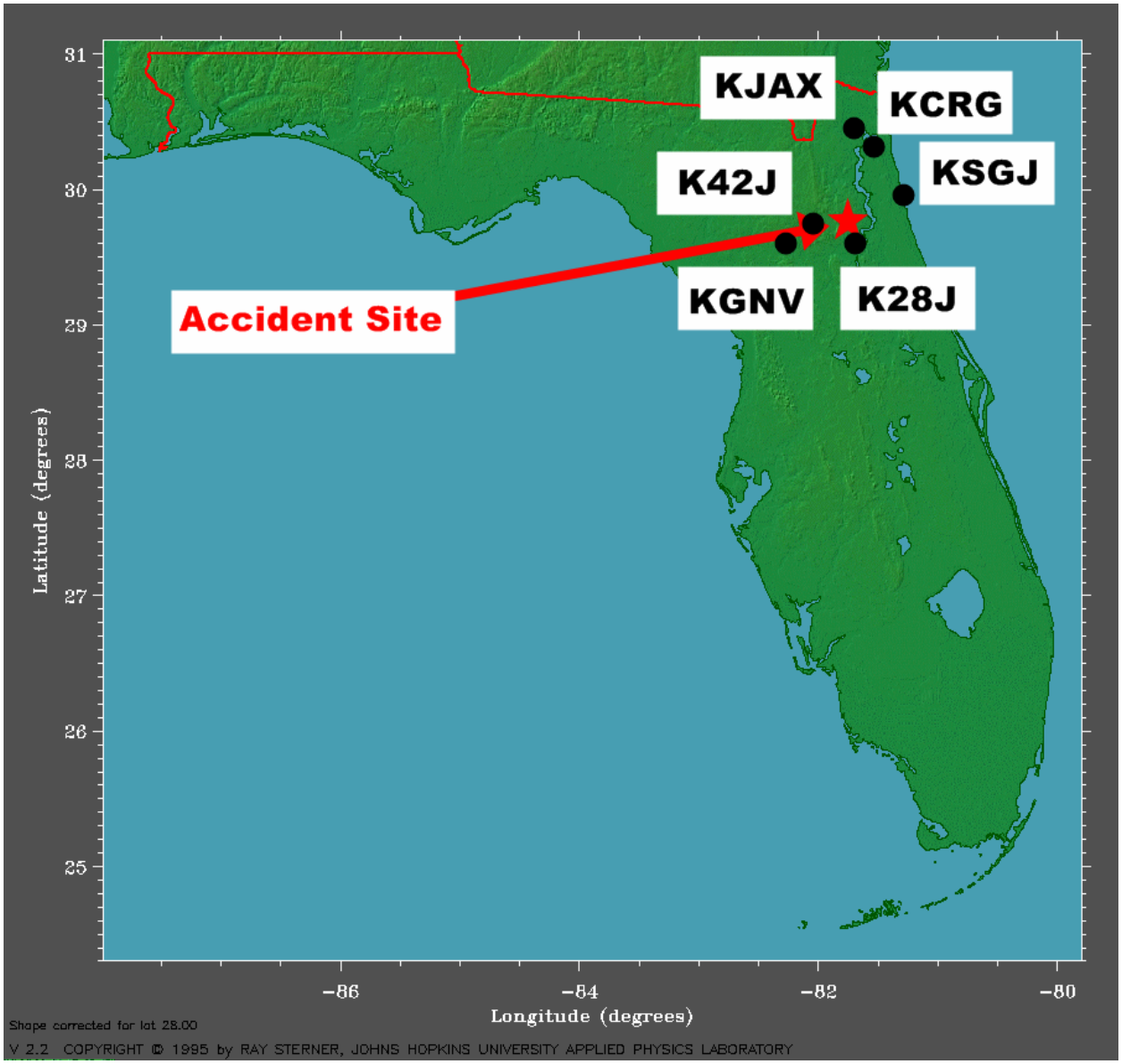


Figure 7 – Map of Florida with the location of METAR, radar, and upper-air sounding sites

[0549 EST] K28J 261049Z 00000KT 9SM FEW036 BKN070 15/14 A3021

[0550 EST] K28J 261050Z 00000KT 10SM FEW036 BKN070 15/14 A3021

[0551 EST] K28J 261051Z 02003KT 10SM FEW038 BKN070 15/14 A3021

[0552 EST] K28J 261052Z 02003KT 10SM FEW038 BKN070 15/14 A3021

[0553 EST] K28J 261053Z 00000KT 10SM FEW038 BKN070 15/14 A3021

[0554 EST] K28J 261054Z 01003KT 10SM FEW038 BKN070 15/14 A3021

ACCIDENT TIME 0554 EST

[0555 EST] K28J 261055Z 01003KT 9SM FEW038 SCT070 15/14 A3021

[0556 EST] K28J 261056Z 36003KT 9SM FEW038 SCT070 15/14 A3021

[0557 EST] K28J 261057Z 36003KT 9SM FEW038 SCT070 15/14 A3021

K28J weather at 0553 EST, wind calm, 10 miles visibility, few clouds at 3,800 feet above ground level (agl), a broken ceiling at 7,000 feet, temperature of 15° Celsius (C), dew point temperature of 14° C, altimeter setting of 30.21 inches of mercury.

K28J weather at 0554 EST, wind from 010° at 3 knots, 10 miles visibility, few clouds at 3,800 feet agl, a broken ceiling at 7,000 feet, temperature of 15° C, dew point temperature of 14° C, altimeter setting of 30.21 inches of mercury.

K28J weather at 0555 EST, wind from 010° at 3 knots, 9 miles visibility, few clouds at 3,800 feet agl, scattered clouds at 7,000 feet, temperature of 15° C, dew point temperature of 14° C, altimeter setting of 30.21 inches of mercury.

An AWOS located at Keystone Airpark (K42J), 3 miles north of Keystone Heights, Florida, was also disseminating observations around the time of the accident. These observations were taken from automated equipment and were not supplemented by a human observer. K42J had an elevation of 196 feet, was located 15 miles west of the accident site, and had a 5° westerly magnetic variation (figure 7). The following observations were disseminated around the time of the accident:

[0355 EST] METAR K42J 260855Z AUTO 00000KT 3SM SCT001 BKN016 15/15 A3020 RMK AO1

[0415 EST] METAR K42J 260915Z AUTO 00000KT 3SM SCT080 15/15 A3020 RMK AO1

[0435 EST] METAR K42J 260935Z AUTO 00000KT 2 1/2SM FEW070 SCT080 14/14 A3019 RMK AO1

[0455 EST] METAR K42J 260955Z AUTO 00000KT 2 1/2SM FEW070 15/15 A3019 RMK AO1

[0515 EST] METAR K42J 261015Z AUTO 00000KT 2SM SCT001 14/14 A3020 RMK AO1

[0535 EST] METAR K42J 261035Z AUTO 00000KT 2SM SCT001 14/14 A3020 RMK AO1

Departure from Mayo Clinic Heliport 0537 EST

ACCIDENT TIME 0554 EST

[0555 EST] METAR K42J 261055Z AUTO 02003KT 3SM BKN055 14/14 A3021 RMK AO1

[0615 EST] METAR K42J 261115Z AUTO 03003KT 8SM FEW009 SCT055 14/14 A3022 RMK AO1

[0635 EST] METAR K42J 261135Z AUTO 02005KT 9SM BKN007 14/14 A3022 RMK AO1

K42J weather at 0515 EST, wind calm, 2 miles visibility, scattered clouds at 100 feet agl, temperature of 14° C, dew point temperature of 14° C, altimeter setting of 30.20 inches of mercury.

K42J weather at 0535 EST, wind calm, 2 miles visibility, scattered clouds at 100 feet agl, temperature of 14° C, dew point temperature of 14° C, altimeter setting of 30.20 inches of mercury.

K42J weather at 0555 EST, wind from 020° at 3 knots, 3 miles visibility, a broken ceiling at 5,500 feet agl, temperature of 14° C, dew point temperature of 14° C, altimeter setting of 30.21 inches of mercury.

Gainesville Regional Airport (KGNV), located 3 miles northeast of Gainesville, Florida, had an Automated Surface Observing System (ASOS[5]) whose reports were augmented by the tower. KGNV is located 29 miles west-southwest of the accident site, at an elevation of 151 feet, and has a 4° westerly magnetic variation (figure 7). The following observations were taken and disseminated during the times surrounding the accident:

[0424 EST] KGNV 260924Z AUTO 00000KT 7SM BKN014 16/14 A3019 RMK AO2

[0436 EST] KGNV 260936Z AUTO 00000KT 7SM SCT014 16/14 A3019 RMK AO2

[0453 EST] KGNV 260953Z AUTO 00000KT 7SM SCT070 16/14 A3018 RMK AO2 SLP219 T01560144

Departure from Mayo Clinic Heliport 0537 EST

[0553 EST] KGNV 261053Z AUTO 02003KT 7SM CLR 16/14 A3021 RMK AO2 SLP228 T01560139

ACCIDENT TIME 0554 EST

[5] ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, ceiling, temperature, dewpoint, altimeter, and barometric pressure.

[0648 EST] KGNV 261148Z 04003KT 7SM FEW009 OVC060 15/13 A3021 RMK AO2

[0653 EST] KGNV 261153Z 02003KT 7SM SCT009 OVC060 15/13 A3022 RMK AO2 SLP231 T01500133 10183 20150 51011

[0701 EST] KGNV 261201Z 03004KT 7SM BKN007 OVC060 16/14 A3022 RMK AO2

[0753 EST] KGNV 261253Z 02007KT 10SM OVC007 15/13 A3024 RMK AO2 SLP240 T01500128

[0853 EST] KGNV 261353Z 04005KT 10SM SCT009 16/13 A3026 RMK AO2 SLP247 T01560128

KGNV weather at 0453 EST, wind calm, visibility 7 miles, scattered clouds at 7,000 feet agl, temperature of 16° C, dew point temperature of 14° C, and an altimeter setting of 30.18 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1021.9 hPa, temperature 15.6° C, dew point temperature 14.4° C.

KGNV weather at 0553 EST, wind from 020° at 3 knots, visibility 7 miles, clear skies below 12,000 feet agl, temperature of 16° C, dew point temperature of 14° C, and an altimeter setting of 30.21 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1022.8 hPa, temperature 15.6° C, dew point temperature 13.9° C.

KGNV weather at 0648 EST, wind from 040° at 3 knots, visibility 7 miles, few clouds at 900 feet agl, an overcast ceiling at 6,000 feet, temperature of 15° C, dew point temperature of 13° C, and an altimeter setting of 30.21 inches of mercury. Remarks: automated station with a precipitation discriminator.

An ASOS at Northeast Florida Regional Airport (KSGJ), located 4 miles north of St. Augustine, Florida, also disseminated weather conditions surrounding the time of the accident. KSGJ is located 22 miles east-northeast of the accident site, at an elevation of 10 feet, and has a 4° westerly magnetic variation (figure 7). These observations were taken from automated equipment and were not supplemented by a human observer. The following observations were taken and disseminated during the times surrounding the accident:

[0158 EST] KSGJ 260658Z AUTO 32005KT 10SM OVC011 17/15 A3021 RMK AO2 SLP229 T01670150

[0233 EST] KSGJ 260733Z AUTO 33006KT 10SM OVC015 16/15 A3021 RMK AO2

[0258 EST] KSGJ 260758Z AUTO 34006KT 10SM OVC015 16/15 A3021 RMK AO2 SLP230 T01610150

[0327 EST] KSGJ 260827Z AUTO 34004KT 10SM SCT017 BKN070 OVC090 16/15 A3020 RMK AO2

[0358 EST] KSGJ 260858Z AUTO 00000KT 10SM BKN065 OVC085 16/14 A3020 RMK AO2 SLP226 T01610144 58002

[0458 EST] KSGJ 260958Z AUTO 36009KT 10SM SCT009 BKN065 OVC080 16/15 A3020 RMK AO2 SLP227 T01610150

[0509 EST] KSGJ 261009Z AUTO 36010KT 10SM BKN009 OVC080 16/15 A3020 RMK AO2

Departure from Mayo Clinic Heliport 0537 EST

ACCIDENT TIME 0554 EST

[0558 EST] KSGJ 261058Z AUTO 36014KT 10SM OVC007 16/14 A3022 RMK AO2 SLP232 T01560144

[0632 EST] KSGJ 261132Z AUTO 01011KT 10SM OVC005 16/14 A3023 RMK AO2

[0647 EST] KSGJ 261147Z AUTO 01012KT 10SM SCT005 OVC012 16/13 A3023 RMK AO2

[0658 EST] KSGJ 261158Z 36014KT 10SM FEW007 OVC012 16/13 A3024 RMK AO2 SLP238 T01560133 10167 20156 53012

[0729 EST] KSGJ 261229Z 01010KT 10SM SCT012 OVC080 16/13 A3024 RMK AO2

KSGJ weather at 0458 EST, wind from 360° at 9 knots, visibility 10 miles, scattered clouds at 900 feet agl, a broken ceiling at 6,500 feet, overcast skies at 8,000 feet, temperature of 16° C, dew point temperature of 15° C, and an altimeter setting of 30.20 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1022.7 hPa, temperature 16.1° C, dew point temperature 15.0° C.

KSGJ weather at 0509 EST, wind from 360° at 10 knots, visibility 10 miles, a broken ceiling at 900 feet agl, overcast skies at 8,000 feet, temperature of 16° C, dew point temperature of 15° C, and an altimeter setting of 30.20 inches of mercury. Remarks: automated station with a precipitation discriminator.

KSGJ weather at 0558 EST, wind from 360° at 14 knots, visibility 10 miles, an overcast ceiling at 700 feet agl, temperature of 16° C, dew point temperature of 14° C, and an altimeter setting of 30.22 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1023.2 hPa, temperature 15.6° C, dew point temperature 14.4° C.

An ASOS at Craig Municipal Airport (KCRG), located 8 miles east of Jacksonville, Florida, disseminated weather conditions surrounding the time of the accident. KCRG is located 30 miles northeast of the accident site, at an elevation of 41 feet, and has a 4° westerly magnetic variation (figure 7). These observations were taken from automated equipment and were augmented by the tower. The following observations were taken and disseminated during the times surrounding the accident:

[0353 EST] KCRG 260853Z AUTO 35005KT 10SM BKN070 16/14 A3021 RMK AO2 SLP229 T01560139 55002

[0442 EST] KCRG 260942Z AUTO 36008KT 10SM SCT009 OVC070 15/13 A3021 RMK AO2

[0453 EST] KCRG 260953Z AUTO 01010KT 10SM BKN007 BKN011 OVC070 15/13 A3021 RMK AO2 SLP230 T01500128

Departure from Mayo Clinic Heliport 0537 EST

[0553 EST] KCRG 261053Z AUTO 01006KT 10SM OVC007 14/13 A3022 RMK AO2 CIG 006V010 SLP234 T01440128

ACCIDENT TIME 0554 EST

[0628 EST] KCRG 261128Z 02003KT 10SM SCT007 OVC085 14/12 A3023 RMK AO2

[0653 EST] KCRG 261153Z 02007KT 10SM OVC085 14/12 A3023 RMK AO2 SLP236 70010 T01440117 10161 20144 53006

[0753 EST] KCRG 261253Z 36004KT 10SM FEW080 14/11 A3024 RMK AO2 SLP240 T01390111

[0853 EST] KCRG 261353Z 01008KT 10SM CLR 15/11 A3027 RMK AO2 SLP248 T01500106

[0953 EST] KCRG 261453Z 03008KT 10SM CLR 16/11 A3028 RMK AO2 SLP254 T01560106 53018

KCRG weather at 0453 EST, wind from 010° at 10 knots, visibility 10 miles, a broken ceiling at 700 feet agl, broken skies at 1,100 feet, overcast skies at 7,000 feet, temperature of 15° C, dew point temperature of 13° C, and an altimeter setting of 30.21 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1023.0 hPa, temperature 15.0° C, dew point temperature 12.8° C.

KCRG weather at 0553 EST, wind from 010° at 6 knots, visibility 10 miles, an overcast ceiling at 700 feet agl, temperature of 14° C, dew point temperature of 13° C, and an altimeter setting of 30.22 inches of mercury. Remarks: automated station with a precipitation discriminator, ceiling variable between 600 and 1,000 feet agl, sea level pressure 1023.4 hPa, temperature 14.4° C, dew point temperature 12.8° C.

KCRG weather at 0628 EST, wind from 020° at 3 knots, visibility 10 miles, scattered clouds at 700 feet agl, an overcast ceiling at 8,500 feet, temperature of 14° C, dew point temperature of 12° C, and an altimeter setting of 30.23 inches of mercury. Remarks: automated station with a precipitation discriminator.

3.0 Upper Air Data

The closest upper air sounding to the accident site was from Jacksonville, Florida (KJAX), which was approximately 37 miles north of the accident site, with a site number 72206 and a station elevation of 29 feet (figure 7). The 0700 EST sounding from KJAX was plotted on a standard Skew-T log P diagram[6], which is presented along with the derived stability parameters in figure 8 (with data from the surface to 600-hPa, or approximately 14,000 feet msl). These data were analyzed utilizing the RAOB[7] software package. The sounding depicted a moist vertical environment with the Lifted Condensation Level (LCL)[8] at 485 feet and a Convective Condensation Level (CCL)[9] at 7,278 feet. The freezing level was located at 13,416 feet. The tropopause height was identified at 41,198 feet. The precipitable water value was 1.29 inches.

[6] 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.

[7] RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamopras, Pennsylvania.

[8] Lifting Condensation Level (LCL) - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

[9] Convective Condensation Level (CCL) – The level in the atmosphere to which an air parcel, if heated from below, will rise dry adiabatically, without becoming colder than its environment just before the parcel becomes saturated.

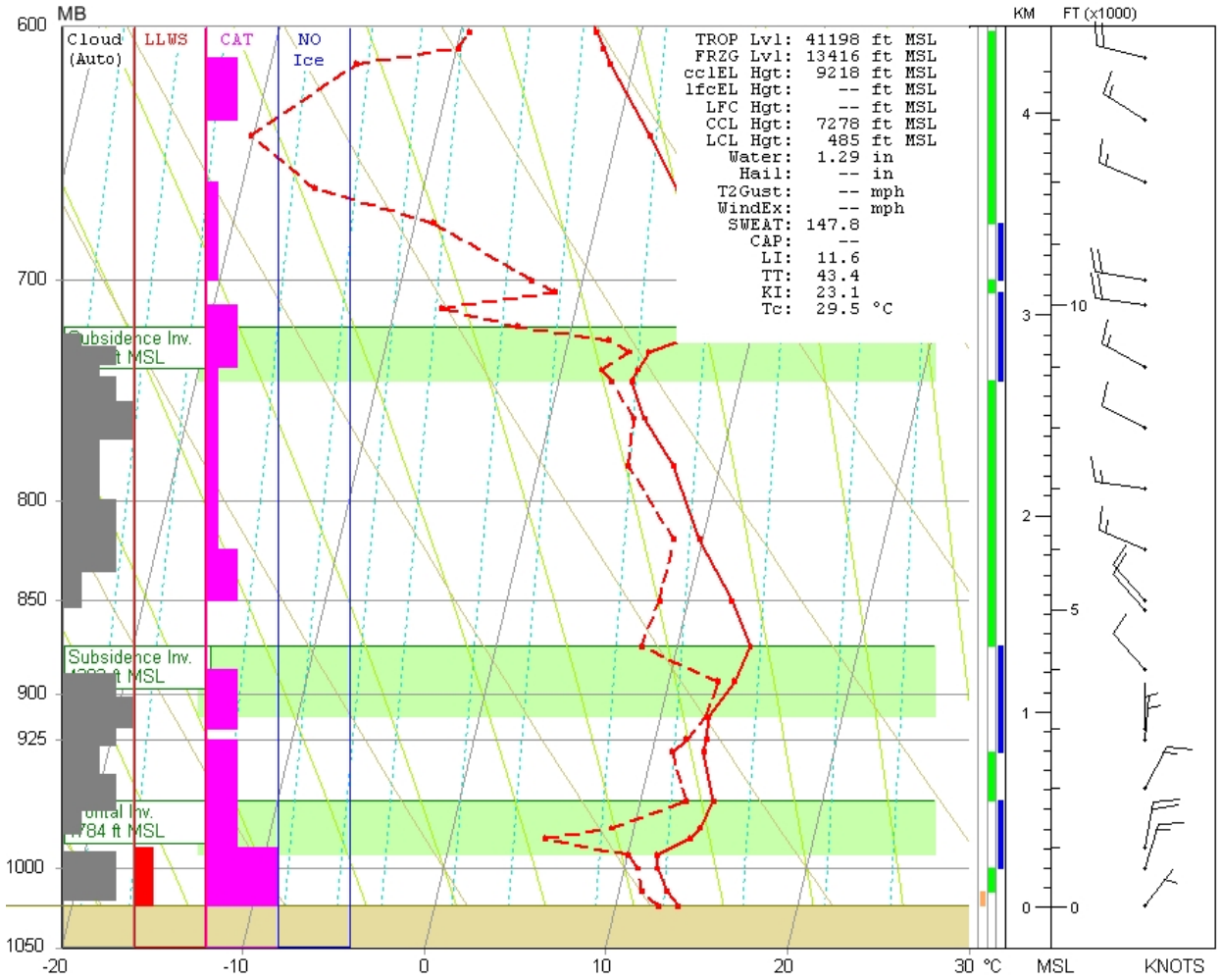


Figure 8 –KJAX 0700 EST sounding

The sounding parameters indicated a moist and stable environment from the surface to approximately 4,500 feet. Such conditions are considered supportive for vertical cloud formation and RAOB indicated the potential for the presence of clouds from 400 feet through 10,000 feet. No areas of icing were identified by RAOB below 14,000 feet. A frontal inversion was identified by RAOB at 1,784 feet.

The sounding wind profile indicated there was a surface wind from 035° at 3 knots and the wind remained out of the north through 2,000 feet while slowly increasing in speed to 15 knots. From 2,000 feet through 14,000 feet the wind backed[10] from the north to the west while increasing in speed to 21 knots. RAOB indicated areas of low level wind shear (LLWS) from the surface through 1,000 feet. Areas of clear air turbulence were also indicated in several layers from the surface through 14,000 feet.

[10] Backing wind – Wind which changes in a counter-clockwise direction with time at a given location, or which changes direction in a counter-clockwise sense with height.

4.0 Satellite Data

Infrared data from the Geostationary Operational Environmental Satellite number 13 (GOES-13) data was obtained from the National Climatic Data Center (NCDC) and processed with the NTSB's Man-computer Interactive Data Access System (McIDAS) workstation. The infrared imagery (GOES-13 band 2 and 4), at wavelengths of 3.9 microns (µm) and 10.7 µm retrieved brightness temperatures for the scene. A technique to detect and highlight low clouds and stratus was employed by subtracting the brightness temperatures of the 10.7 µm image from the 3.9 µm image. Using this technique, low clouds and stratus made of liquid water during the nighttime will appear much darker than higher clouds made of both liquid water and ice. Satellite imagery surrounding the time of the accident, from 0200 EST through 0800 EST at approximately 15-minute intervals, were reviewed and the closest images to the time of the accident are documented here.

Figures 9 and 10 present the GOES-13 infrared imagery from 0545, 0602, 0615, and 0632 EST at 8X magnification. Higher clouds (red and yellows) are present just north of the accident site and these higher clouds are moving from west to east from 0545 through 0632 EST. The 10.7µm brightness temperature was retrieved over the accident site as 8° C (figure 10), which, when considering the KJAX upper air sounding indicated cloud top heights of approximately 7,000 feet msl (figure 8). Figures 11 and 12 present the GOES-13 infrared imagery from 0602, 0615, and 0632 EST at 8X magnification with a satellite infrared differencing technique to detect and highlight low clouds and stratus applied to the bottom of figure 11 and all of figure 12. The images depicted a layer of low clouds and stratus over the accident site at 0602 EST. This layer of low clouds and stratus moved southward from 0602 through 0632 EST covering K42J, and approaching KGNV and K28J (figure 12).

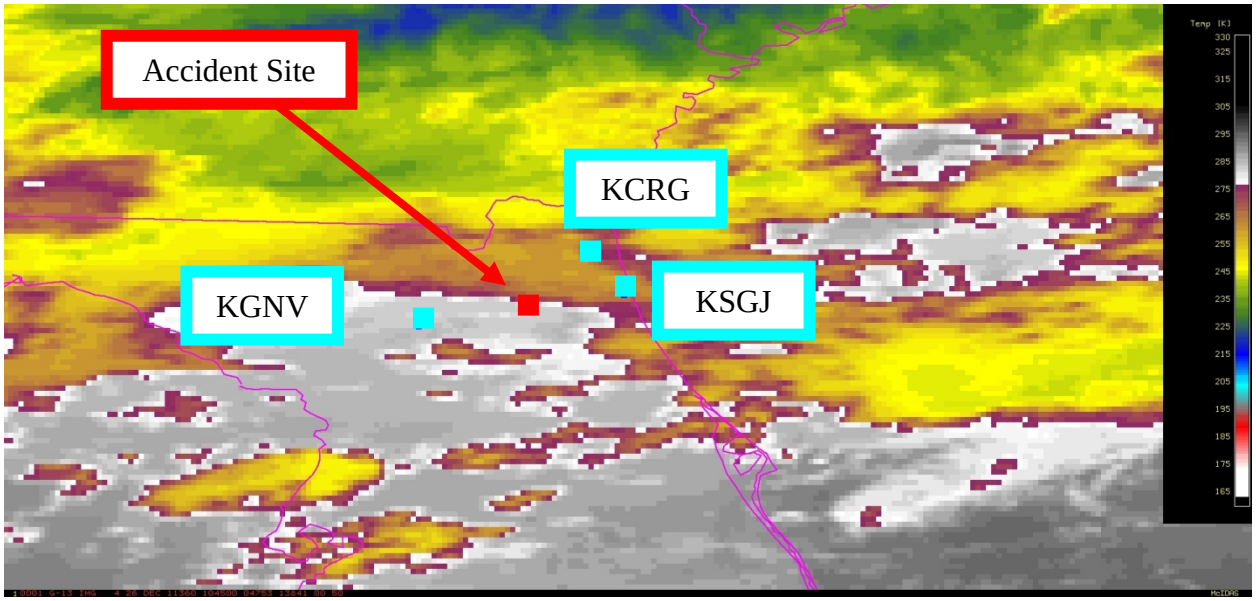


Figure 9 – GOES-13 infrared image at 0545 EST

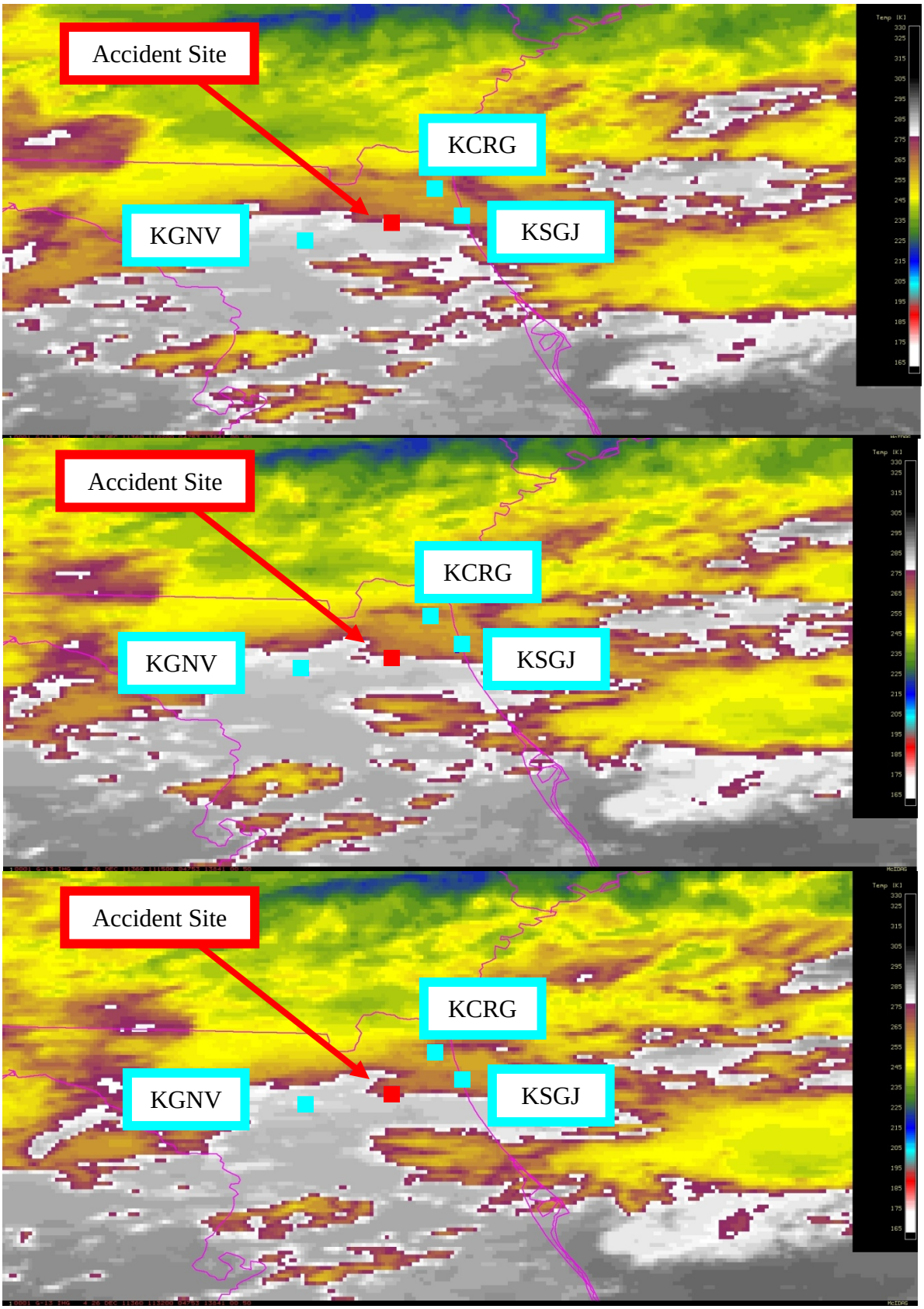


Figure 10 – GOES-13 infrared image at 0602, 0615, and 0632 EST

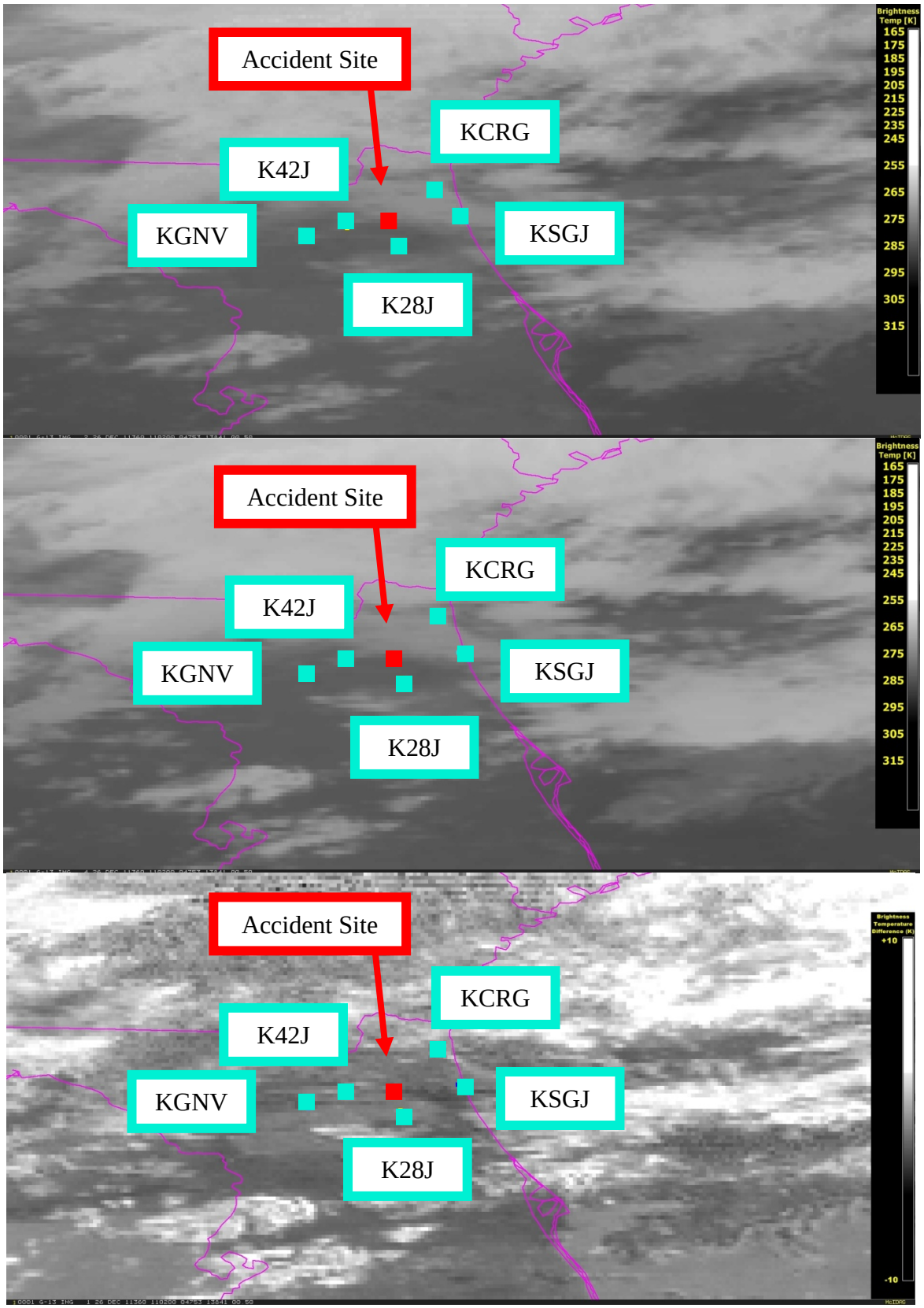


Figure 11 – GOES-13 infrared image (a) band 2 (b) band 4 (c) band 4 minus band 2 at 0602 EST

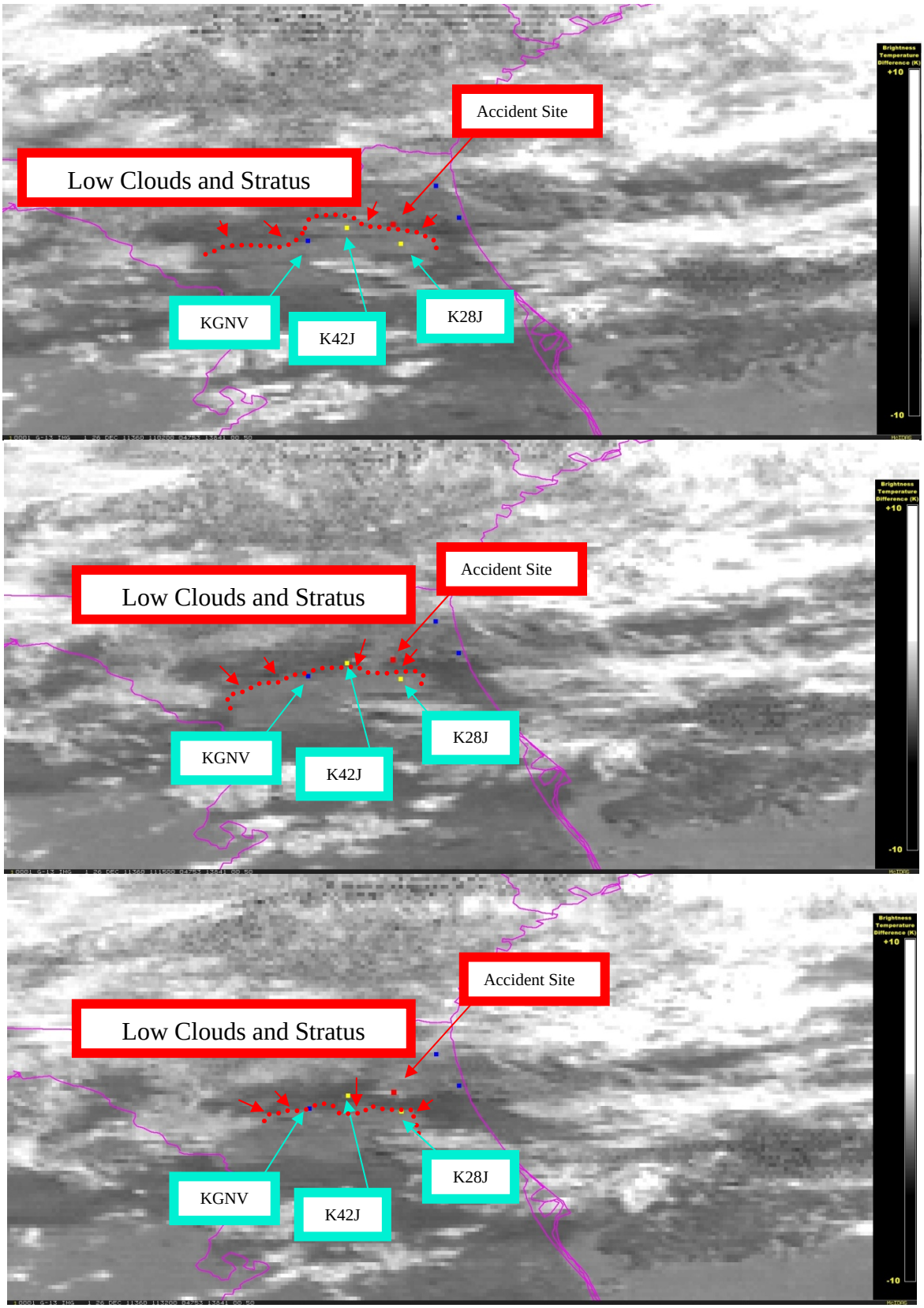


Figure 12 – GOES-13 infrared image band 4 minus band 2 at 0602, 0615, and 0632 EST

Infrared data from the National Oceanic and Atmospheric Administration (NOAA) Satellite number 15 (NOAA-15)'s Advanced Very High Resolution Radiometer (AVHRR) was obtained from the Comprehensive Large Array-Data Stewardship System (CLASS) and processed with the NTSB's McIDAS workstation. The infrared imagery (NOAA-15 band 3 and 4), at wavelengths of 3.7 µm and 10.8 µm retrieved brightness temperatures for the scene. A technique to detect and highlight low clouds and stratus was employed by subtracting the brightness temperatures of the 10.8 µm image from the 3.7 µm image. AVHRR imagery over the accident site was available at 0546 EST and is documented here.

Figure 13 presents the NOAA-15 infrared imagery at 0546 EST at 3X magnification with the satellite infrared differencing technique to detect and highlight low clouds and stratus applied to the bottom of figure 13. The image showed lower clouds and stratus (darker parts of the image) over the accident site northward to KSGJ and KCRG matching the observations from Section 2.0 and the GOES-13 imagery. The NOAA-15 AVHRR had a resolution of near 1 kilometer (km) by 1 km at nadir[11] and was therefore able to highlight the position of the low cloud cover and stratus with more detail than the GOES-13 imagery.

[11] Nadir – The point on the earth directly below the satellite at any given time during its orbit.

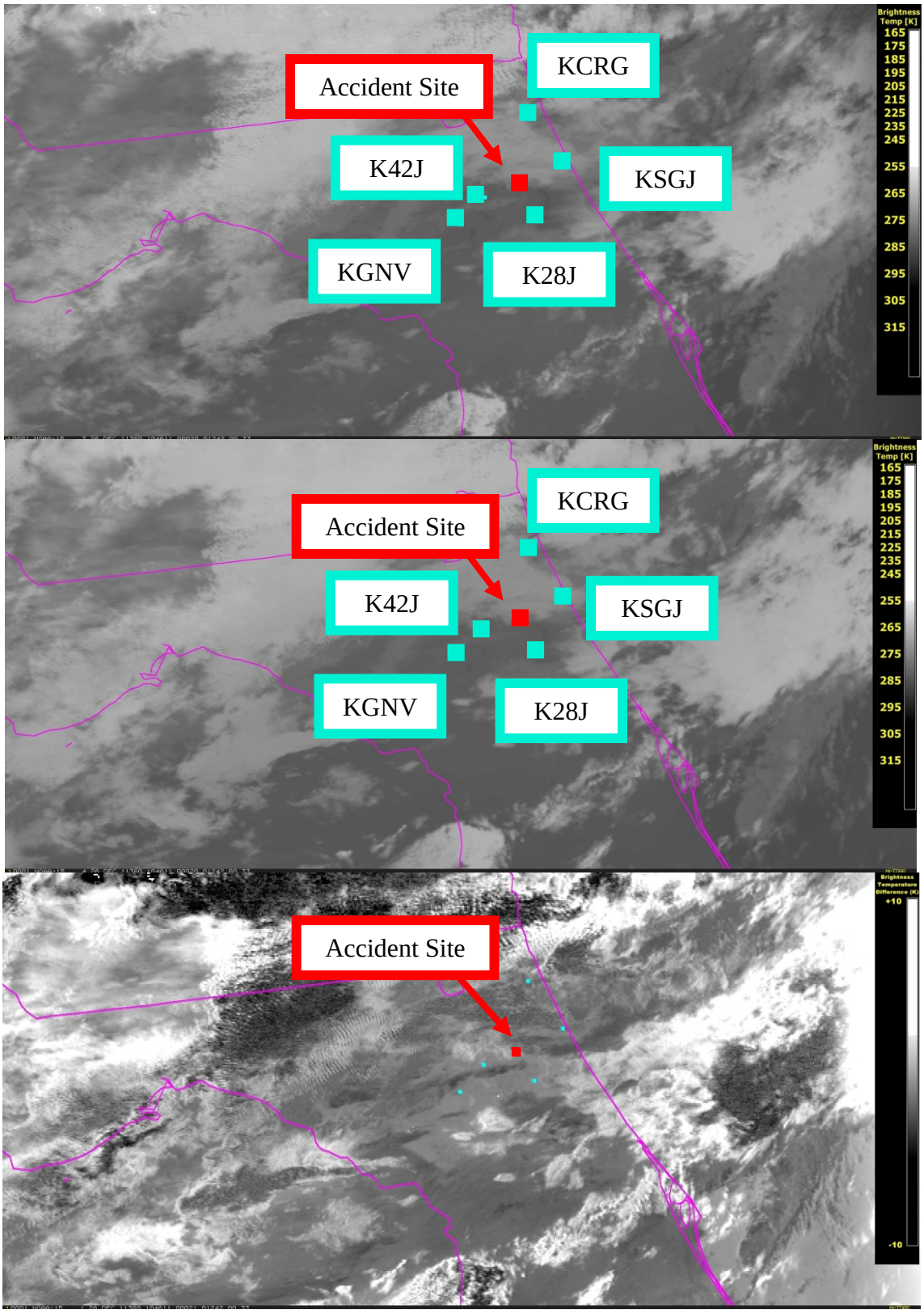


Figure 13 – AVHRR infrared image (a) band 3 (b) band 4 (c) band 4 minus band 3 at 0546 EST

5.0 Radar Imagery

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D) was at KJAX. Level II archive radar data was obtained from the NCDC utilizing the Hierarchical Data Storage System (HDSS) and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software.

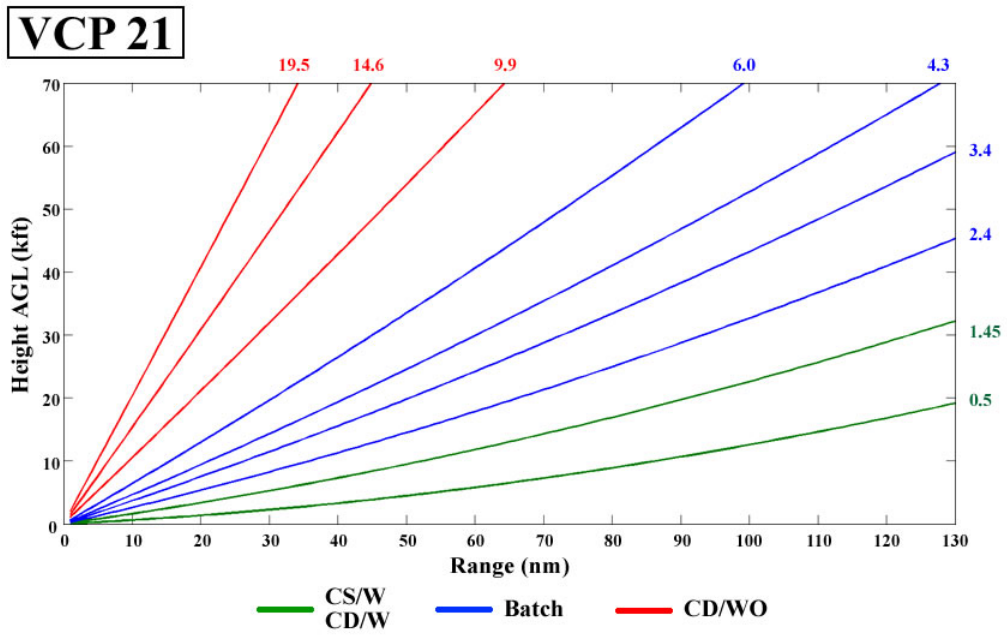
The WSR-88D is an S-band 10-centimeter wavelength radar with a power output of 750,000 watts, and with a 28-foot parabolic antenna that concentrates the energy into a 0.95° beam width[12]. The radar produces three basic types of products: base reflectivity, base radial velocity, and base spectral width.

5.1 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 two common scanning strategies. The most common is where the radar makes 9 elevation scans from 0.5° to 19.5° every six minutes. This particular scanning strategy is documented as volume coverage pattern 21 (VCP-21). 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 normal precipitation mode (Mode A, VCP-21). 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.

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



VCP-21 Precipitation Mode Scan Strategy

5.2 Beam Height Calculation

Assuming standard refraction[13] of the WSR-88D 0.95° wide radar beam, the following table shows the approximate beam height and width information of the radar display over the site of the accident. The heights have been rounded to the nearest 10 feet.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP	BEAM WIDTH
0.5°	2,980 feet	1,160 feet	4,800 feet	3,650 feet

Based on the radar height calculations, the 0.5° elevation scan depicted the conditions between 1,160 feet to 4,800 feet msl over the accident site.

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

5.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[14] 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[15]), and is a general measure of echo intensity. The chart below relates the NWS video integrator and processor (VIP) intensity levels versus the WSR-88D's display levels, precipitation mode reflectivity in decibels, and rainfall rates.

NWS VIP/DBZ CONVERSION TABLE

NWS VIP	WSR-88D LEVEL	PREC MODE DBZ	RAINFALL
0	0	< 5	
	1	5 to 9	
	2	10 to 14	
1	3	15 to 19	.01 in/hr
Very Light	4	20 to 24	.02 in/hr
	5	25 to 29	.04 in/hr
2	6	30 to 34	.09 in/hr
Light to Moderate	7	35 to 39	.21 in/hr
3	8	40 to 44	.48 in/hr
Strong			
4	9	45 to 49	1.10 in/hr
Very Strong			
5	10	50 to 54	2.49 in/hr
Intense			
6	11	55 to 59	>5.67 in/hr
Extreme	12	60 to 64	
	13	65 to 69	
	14	70 to 74	
	15	> 75	

5.4 Base Reflectivity

Figure 14 presents the KJAX WSR-88D base reflectivity image for the 0.5° elevation scan initiated at 0555 EST with a resolution of 0.5° X 250 meters. Figure 14 depicted no echoes over the accident site at the accident time.

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[14] 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.

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

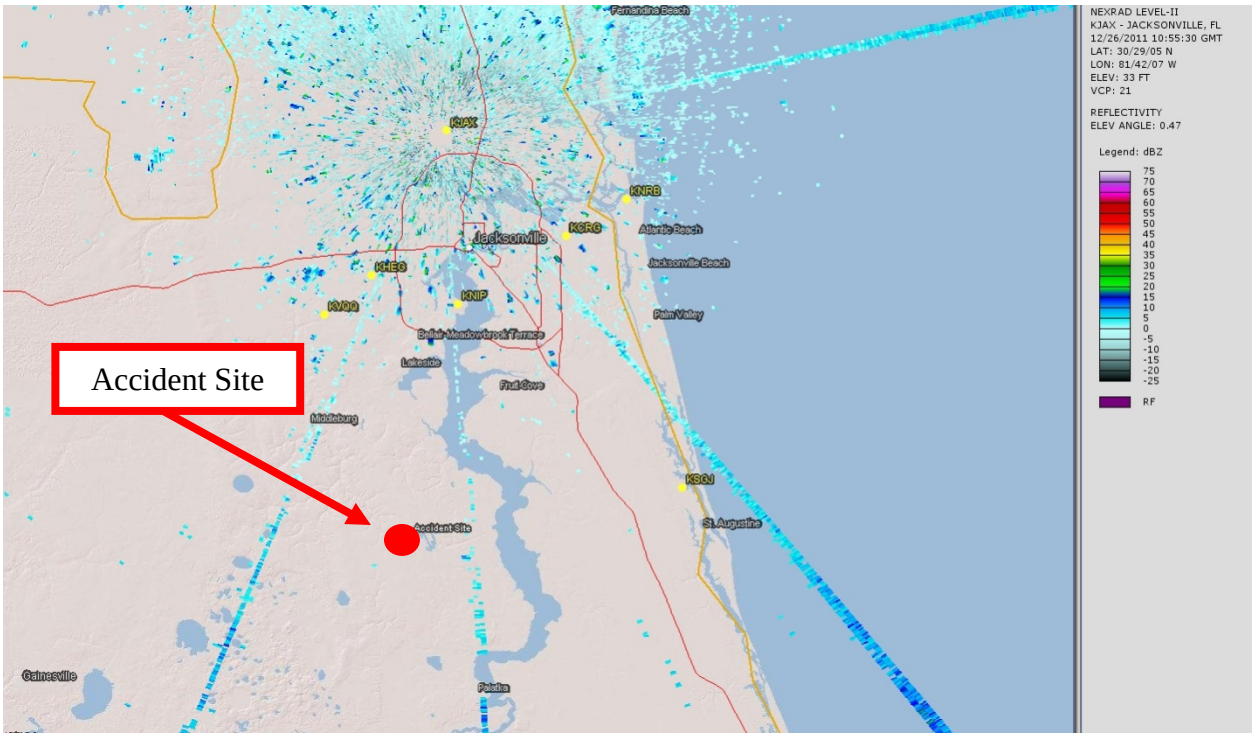

Figure 14 – KJAX WSR-88D 0.5° elevation scan for 0555 EST

5.5 Lightning

No lightning was detected near the accident site at the accident time.

6.0 Pilot Reports

Pilot reports (PIREPs) were reviewed from two hours prior to the accident time to two hours after the accident time below 20,000 feet and these PIREPs were disseminated:

PNS UA /OV PNS090005 /TM 1205 /FLUNKN /TP B712 /SK OVC005-TOP050
/WX -RA /RM DURC SCT LYR ABV=

SFB UA /OV SFB /TM 1209 /FLUNKN /TP MD88 /SK OVC-TOP012 /RM DURC
RWY 9L=

SFB UA /OV SFB /TM 1227 /FLUNKN /TP MD88 /SK OVC002-TOP014 /RM
DURC RWY 9L=

LAL UA /OV LAL /TM 1250 /FLUNKN /TP UNKN /SK OVC-TOP008=

Routine pilot report (UA); 5 miles from Pensacola, Florida, on the 090° radial; Time – 0705 EST (1205Z); Altitude – unknown; Type aircraft – Boeing 717-200; Sky – Overcast at 500 feet agl with tops at 5,000 feet; Weather – Light rain; Remarks – During climb scattered layers above.

Routine pilot report (UA); Over Orlando, Florida; Time – 0709 EST (1209Z); Altitude – Unknown; Type aircraft – McDonnell Douglas MD-88; Sky – Overcast with tops to 1,200 feet agl; Remarks – During climb from runway 9L.

Routine pilot report (UA); Over Orlando, Florida; Time – 0727EST (1227Z); Altitude – Unknown; Type aircraft – McDonnell Douglas MD-88; Sky – Overcast at 200 feet agl with tops to 1,400 feet; Remarks – During climb from runway 9L.

Routine pilot report (UA); Over Lakeland, Florida; Time – 0750 EST (1250Z); Altitude – Unknown; Type aircraft – Unknown; Sky – Overcast with tops to 800 feet agl.

7.0 SIGMET and CWSU Advisories

No SIGMET or Center Weather Advisory (CWA) was active for the accident site at the accident time.

A Meteorological Impact Statement (MIS) was issued by the Center Weather Service Unit in Jacksonville, Florida, at 2034 EST on December 25th valid through 0600 EST on December 26th and the accident time. Scattered rain showers and isolated thunderstorms moving from 250° at 15 knots with tops forecasted to FL350[16], moderate rime and mixed icing in clouds and precipitation from 9,000 feet msl to FL240, and patchy LIFR[17] ceilings at or about 500 feet msl, and visibility at or below 2 miles in light rain and fog were forecasted for the southeastern United States, including the accident site:

FAUS20 KZJX 260134
ZJX MIS 01 VALID 260230-261100
...FOR ATC PLANNING PURPOSES ONLY...
OVR GA/FL/ADJ GULF/ATLC WATERS SCT SHRA/ISOLD TS
MOV FM 25015KT. MAX TOPS FL350. MOD RIME/MXD ICGICIP
090-FL240. PATCHY LIFR CIGS AOB 005 AND VIS AOB 2SM
IN -RA/FG. ...PR...
=

8.0 AIRMETs

AIRMET SIERRA was valid for the accident site at the accident time, and it forecasted IFR[18] flight conditions with mist and fog (figure 15):

WAUS42
WAUS42 KKCI 260845
WA2S

[16] Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of feet. 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.
[17] Low Instrument Flight Rules (LIFR) – Refers to the general weather conditions pilots can expect at the surface. LIFR criteria are ceilings less than 500 feet agl and/or visibilities less than 1 mile.
[18] Instrument Flight Rules – Refers to the general weather conditions pilots can expect at the surface. IFR criteria means a ceiling below 1,000 feet agl and/or less than 3 miles visibility.

_MIAS WA 260845
AIRMET SIERRA UPDT 3 FOR IFR VALID UNTIL 261500
.
AIRMET IFR...NC SC GA AND CSTL WTRS
FROM RDU TO 30S ILM TO 40W CHS TO 20SSE MCN TO 20SSE LGC TO GQO
TO 30SSE VXV TO RDU
CIG BLW 010/VIS BLW 3SM BR/FG. CONDS ENDG 12-15Z.
.
AIRMET IFR...GA FL AND CSTL WTRS
FROM 20SSE SAV TO 20ENE CRG TO 60SW TLH TO 60SE SJI TO 40W CEW
TO 50SW PZD TO 30WNW PZD TO 20SSE SAV
CIG BLW 010/VIS BLW 3SM BR/FG. CONDS CONTG BYD 15Z ENDG 18-21Z.
.
AIRMET IFR...GA FL AND CSTL WTRS
FROM 20ENE CRG TO 20SE VRB TO 20SSW RSW TO 20ENE PIE TO 40NNE
CTY TO 20ENE CRG
CIG BLW 010/VIS BLW 3SM BR/FG. CONDS ENDG 12-15Z.
....

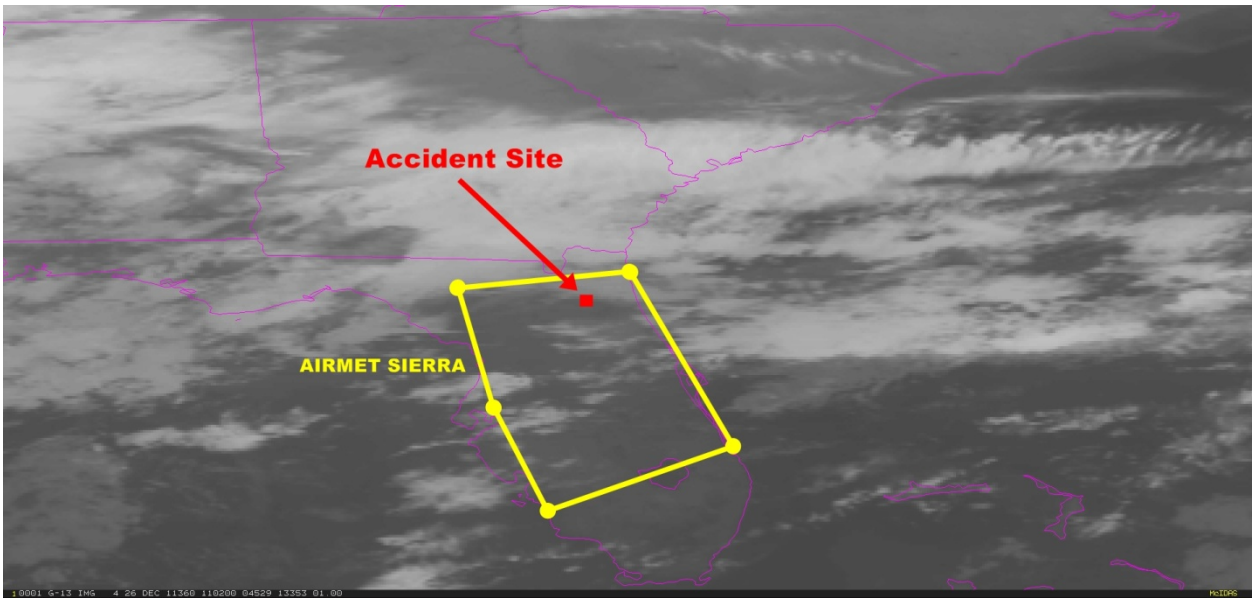

Figure 15 – AIRMET SIERRA valid at the accident time

9.0 Terminal Aerodrome Forecast

KGNV (figure 7) was the closest site with a NWS Terminal Aerodrome Forecast (TAF[19]). The TAF valid at the time of the accident was issued at 0507 EST and was valid for a 20-hour period beginning at 0500 EST. The TAF forecast for KGNV was as follows:

KGNV 261007Z 2610/2706 **03006KT P6SM SCT020 BKN040**
TEMPO 2610/2614 BKN015
FM261400 05010KT P6SM BKN015 BKN025
FM261800 07010G15KT P6SM SCT020 BKN040
FM270000 07006KT P6SM BKN020 OVC040=

[19] Terminal Aerodrome Forecast (TAF) – These forecasts apply to a five statute mile radius from the center of the airport runway complex where the TAF is valid.

The forecast expected wind from 030° at 6 knots, greater than 6 miles visibility, scattered clouds at 2,000 feet agl, and a broken ceiling at 4,000 feet. Temporary conditions of a broken ceiling at 1,500 feet agl were expected between 0500 and 0900 EST.

Another TAF was issued at 0621 EST but it was valid after the accident time for a 24-hour period beginning at 0700 EST:

KGNV 261121Z 2612/2712 02006KT P6SM SCT010 BKN035
TEMPO 2612/2615 BKN008
FM261500 06009G14KT P6SM SCT020 BKN040
TEMPO 2615/2618 BKN020
FM270000 07006KT P6SM BKN020 OVC040
FM270600 14006KT P6SM VCSH BKN010 OVC020 WS020/14035KT=

The forecast expected wind from 020° at 6 knots, greater than 6 miles visibility, scattered clouds at 1,000 feet agl, and a broken ceiling at 3,500 feet agl. Temporary conditions of a broken ceiling at 800 feet agl were expected between 0700 and 1000 EST.

10.0 Area Forecast

The Area Forecast for northern Florida, including the accident site, was issued at 0445 EST and it forecasted a broken ceiling at 1,000 feet msl, with an overcast layer at 8,000 feet, and tops at 15,000 feet. The visibility was forecast to be between 3 and 5 miles with mist:

FAUS42 KKCI 260945
FA2W
_MIAC FA 260945
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 270400
CLDS/WX VALID UNTIL 262200...OTLK VALID 262200-270400
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...10Z CDFNT 210E OMN-ORL-100W PIE-LOW PRES NW PTNS
GLFMEX. HI PRES RDG SCNTRL OH-NRN GA. 18Z HI PRES RDG CNTRL WV-SE
GA. CDFNT 190E VRB-VRB-SRQ-60W SRQ. 00Z HI PRES NERN NC-NERN FL.
CDFNT NRN BAHAMAS-RSW-ERN GLFMEX THEN STNR TO SE LA. UPR LVL
DISTURBANCE ERN TN. 04Z UPR LVL DISTURBANCE ERN KY. INVERTED TROF
FM LOW PRES NERN MS-SW WV. OCFNT NERN MS-SW AL. WRMFNT SW AL-FL
PNHDL-CTY-VRB-NRN BAHAMAS. CDFNT SW AL-20E SJI-CNTRL GLFMEX.
.
NC
NRN HLF...SKC. OTLK...VFR.
SRN MTNS...SKC. TIL 12Z OCNL VIS 3-5SM BR. OTLK...VFR.
SRN PIEDMONT...OVC015-020 TOP 025. VIS 3SM BR. 12Z SKC.
OTLK...VFR.
SRN CSTL PLAIN...OVC010 TOP 020. VIS 3SM BR. 12Z SKC. OTLK...VFR.
.

SC
MTNS...OVC020-025 TOP 030. VIS 3SM BR. 12Z SCT CI. OTLK...VFR.
PIEDMONT...OVC015 TOP 025. VIS 3SM BR. 11Z SKC. OTLK...VFR.
NRN CSTL PLAIN...OVC010 TOP 020. VIS 3SM BR. 12Z SKC. OTLK...VFR.
SRN CSTL PLAIN...BKN080 TOP 110. 13Z SKC. OTLK...VFR.
.
GA
NW...OVC020 TOP 035. VIS 3-5SM BR. 13Z SCT CI. OTLK...VFR.
NERN...SKC. OCNL VIS 3-5SM BR. 13Z SCT CI. OTLK...VFR.
SW...OVC010-020 TOP 070. VIS 3SM BR. 14Z SCT025 SCT080.
OTLK...VFR 00Z MVFR CIG SHRA TSRA BR.
SERN...BKN010 BKN060 TOP 080. VIS 3-5SM BR. 14Z SCT025 SCT050.
OTLK...VFR.
.
FL
WRN PNHDL...OVC010 LYRD 080. VIS 3-5SM BR. TIL 13Z ISOL -SHRA.
17Z OVC010 LYRD 150. OCNL VIS 5SM BR. OTLK...MVFR CIG SHRA 03Z
TSRA WND.
ERN PNHDL...OVC010 LYRD 080. VIS 3-5SM BR. 13Z BKN015. 16Z
BKN050. OTLK...VFR 03Z MVFR CIG SHRA TSRA.
NRN PEN...BKN010 OVC080 TOP 150. VIS 3-5SM BR. 14Z BKN040 TOP
080. OTLK...VFR 01Z MVFR CIG.
CNTRL PEN...SCT010. OCNL VIS 3-5SM BR. 14Z SCT025 SCT CI. 17Z
SCT040 SCT CI. OTLK...VFR.
SW PEN...SKC. OCNL VIS 3-5SM BR. 13Z SCT035 SCT CI. OTLK...VFR.
SE PEN...SCT025. 17Z SCT025 SCT-BKN060 TOP 080. OTLK...VFR.
KEYS...SCT025 SCT080. OTLK...VFR.
.
CSTL WTRS
ATLC WTRS
NC SC...SKC OR SCT CI. NC WTRS TIL 18Z WND NW 30-35KT.
OTLK...VFR.
GA/FL N OF 40E ORL...SCT015 BKN040 OVC080 TOP 140. ISOL -SHRA.
OTLK...VFR SHRA.
FL S OF 40E ORL...SCT025 SCT CI. OTLK...VFR.
GULF WTRS E OF 85W
N OF PIE-60W PIE...SCT025 SCT-BKN060 TOP 080. 15Z SCT020 BKN120
TOP FL200. OTLK...VFR 01Z MVFR CIG SHRA TSRA.
S OF PIE-60W PIE...SCT025 SCT080 BKN CI. OTLK...VFR.
....

11.0 National Weather Service Area Forecast Discussion

The National Weather Service Office in Jacksonville, Florida, issued the following Area Forecast Discussion at 0345 EST which discussed the highly variable flight conditions with LIFR conditions near KGNV and a northeast wind increasing to between 10 and 15 knots in the afternoon:

FXUS62 KJAX 260834
AFDJAX
AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE JACKSONVILLE FL
345 AM EST MON DEC 26 2011
...THUNDERSTORMS POSSIBLE TUESDAY...

.SHORT TERM...A FRONT WILL LINGER ACROSS N-CENTRAL FL TODAY AS HIGH PRESSURE BUILDS NORTH AND EAST OF THE AREA. LIGHT SHOWERS AND PATCHY DRIZZLE WILL SHIFT SOUTH ACROSS NORTHEAST FLORIDA THIS MORNING... THEN ACTIVITY IS EXPECTED TO BECOME DIFFUSE ACROSS OUR SOUTHERN ZONES THIS AFTERNOON. SKIES WILL GRADUALLY BECOME PARTLY CLOUDY TO MOSTLY SUNNY ACROSS SOUTHEAST GA...WHILE MOSTLY CLOUDY TO PARTLY CLOUDY CONDITIONS WILL PREVAIL ACROSS NE FL. BREEZY ONSHORE FLOW WILL NEAR 15-20 MPH WITH TEMPS HELD IN THE LOW/MID 60S COAST TO NEAR 70 WELL INLAND TOWARD THE INTERSTATE I-75.
TONIGHT THE FRONT TO THE SOUTH LIFTS NORTHWARD AS A WARM FRONT IN ADVANCE OF AN APPROACHING LOW PRESSURE SYSTEM. SHOWER ACTIVITY IS EXPECTED TO INCREASE ACROSS OUR CWA FROM THE WEST AS THE WARM FRONT POSITIONS ACROSS GA BY MORNING. AREAS OF FOG WILL ALSO BE POSSIBLE.
BY TUESDAY MORNING...OUR CWA WILL BE IN THE WARM SECTOR OF THE APPROACHING FRONTAL SYSTEM. MODELS ARE IN AGREEMENT WITH ENOUGH INSTABILITY AND DYNAMICS TO FAVOR THUNDERSTORMS ALONG THE APPROACHING COLD FRONT...WITH THE BEST CHANCE OF TSRA ACROSS OUR WESTERN GA ZONES BETWEEN 09Z-12Z...THEN CHANCES CONTINUING ESE EXITING THE FLAGLER COUNTY COAST TUE EVENING. STRONG STORMS WILL BE POSSIBLE GIVEN STRONG SHEAR PROFILES AND 850MB WINDS OF 45-50KT BETWEEN 12Z-21Z ACROSS OUR SUWANNEE RIVER VALLEY ZONES AND SE GA IN THE MORNING...THEN NEAR OUR ATLANTIC COAST BY AFTERNOON. A LAKE WIND ADVISORY MAY BE NEEDED FOR COASTAL AREAS IN THE AFTERNOON.
THE FRONT CLEARS THE AREA TUE EVENING AS SURFACE HIGH PRESSURE BUILDS IN FROM THE GULF COAST REGION. SFC FLOW VEER NW AS DRY AND COLD AIR ADVECTION FILTERS IN FROM THE NW. TEMPS WILL COOL INTO THE 40S BY WED MORNING...WITH HIGHS IN THE LOW 60S WED UNDER MOSTLY SUNNY SKIES. WED NIGHT A PASSING UPPER LEVEL SHORT WAVE TROUGH WILL INCREASE CIRRUS ACROSS THE AREA AS LOW LEVEL FLOW DECOUPLES AND MINS FALL INTO THE MID/UPPER 40S. THU TEMPS IN THE LOW 60S WITH LOWS IN THE UPPER 30S INLAND TO LOW 40S COAST UNDER CLEAR SKIES WITH PATCHY TO AREAS OF FROST POSSIBLE.
.LONG TERM...FRI THROUGH MON SURFACE HIGH PRESSURE BUILDS W-E ACROSS THE CWA AS TEMPS MODERATE TO NEAR CLIMO VALUES WITH HIGHS IN THE MID 60S TO NEAR 70 AND MINS IN THE LOW TO MID 40S. THE GFS ENSEMBLE INDICATES A WEAK AND POSSIBLY DRY COLD FRONTAL PASSAGE SUNDAY TRAILED AGAIN BY A GULF COAST SURFACE HIGH...WITH HIGHS NEXT MONDAY COOLING BACK INTO THE 60S ACROSS THE CWA.
&&
.**AVIATION...**
A WIDE MIXTURE OF CONDITIONS EARLY THIS MORNING FROM VFR SKIES AT THE JAX METRO TAFS WHILE GNV/SSI HAVE FALLEN INTO THE LIFR CATEGORY. CONDITIONS WILL GENERALLY IMPROVE AREA-WIDE TODAY WITH MAINLY VFR CONDS WITH POSSIBLE TEMPO MVFR CIGS AT TIMES. NE WINDS WILL INCREASE TO 10-15 KNOTS WITH GUSTS TO 15-20 KNOTS AT TIMES THIS AFTERNOON.
AS WARM FRONT LIFTS BACK NORTH TONIGHT...EXPECT MAINLY MVFR CIGS AND WILL HAVE TO RE-INTRODUCE SHOWERS BACK INTO THE TAF'S IN THE 06Z-12Z TIME FRAME.
&&
.MARINE...
STRONG SURGE OF NE WINDS TO ARRIVE TODAY AS HIGH BUILDS TO THE NORTH OVER THE CAROLINAS WITH WINDS VEERING AROUND THE CLOCK TO SE TONIGHT AND SW TUESDAY AND NW TUE NIGHT BEHIND THE NEXT FRONTAL PASSAGE. FOR NOW HAVE POSTED THE SMALL CRAFT ADVISORY FOR THE OFFSHORE WATERS THROUGH TUE NIGHT...BUT MAY NEED TO ADD THE NEARSHORE WATERS IN LATER FORECASTS FOR TUE AND TUE NIGHT. WINDS WILL INCREASE TO 20 TO

25 KNOTS WITH SEAS UP TO 6-8 FT AT TIMES OVER THE OFFSHORE WATERS.
HIGH PRESSURE BUILDS IN FROM WED-FRI WITH WINDS/SEAS RAPIDLY
DECREASING AND MUCH BETTER BOATING CONDITIONS EXPECTED.
RIP CURRENTS: MODERATE RISK OF RIPS AS NORTHEAST FLOW INCREASES WITH
BREAKERS BUILDING INTO THE 3-5 FT RANGE.
&&
.PRELIMINARY POINT TEMPS/POPS...
AMG 63 52 64 38 / 10 80 80 10
SSI 60 60 68 44 / 10 50 80 20
JAX 65 59 72 43 / 10 50 80 20
SGJ 66 65 73 47 / 10 40 80 20
GNV 69 59 72 42 / 20 40 80 20
OCF 71 60 74 45 / 20 30 80 20
&&
.JAX WATCHES/WARNINGS/ADVISORIES...
FL...NONE.
GA...NONE.
AM...SMALL CRAFT ADVISORY UNTIL 8 AM EST WEDNESDAY FOR ALTAMAHA SOUND
GA TO FERNANDINA BEACH FL 20 NM TO 60 NM OFFSHORE-
FERNANDINA BEACH TO ST AUGUSTINE FL 20 NM TO 60 NM OFFSHORE-
ST AUGUSTINE TO FLAGLER BEACH FL 20 NM TO 60 NM OFFSHORE.
&&
$$

12.0 Weather Watches

No weather watches were active for Florida at the time of the accident.

13.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for the accident site on December 26, 2011, indicated the following:

SUN	
Begin civil twilight	0654 EST
Sunrise	0721 EST
Sun transit	1228 EST
Sunset	1734 EST
End civil twilight	1801 EST
MOON	
Moonset	1849 EST on preceding day
Moonrise	0847 EST
Moon transit	1417 EST
Moonset	1952 EST
Moonrise	0927 EST on following day

Paul Suffern
NTSB Meteorologist