



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

October 8, 2020

Factual Report

METEOROLOGY

ERA20LA262

Table Of Contents

A.	ACCIDENT	3
B.	METEOROLOGIST	3
C.	DETAILS OF THE INVESTIGATION	3
D.	WEATHER INFORMATION	3
1.0	Synoptic Situation	3
1.1	Surface Analysis Chart	4
1.2	Upper Air Charts	4
2.0	SPC Products	9
3.0	Surface Observations	10
4.0	Upper Air Data	14
5.0	Satellite Data	15
6.0	Regional Radar Imagery Information	17
7.0	Radar Imagery Information	19
7.1	Volume Scan Strategy	19
7.2	Beam Height Calculation	20
7.3	Reflectivity	20
7.4	Base Reflectivity and Lightning Data	22
8.0	Pilot Reports	24
9.0	Convective SIGMETs	24
10.0	CWSU Advisories	26
11.0	AIRMETs	26
12.0	Graphical Forecasts for Aviation	27
13.0	Terminal Aerodrome Forecast	27
14.0	NWS Area Forecast Discussion	28
15.0	Winds and Temperature Aloft Forecast	30
16.0	Pilot Weather Briefing and Witness Information	31
17.0	Astronomical Data	32
18.0	Thunderstorm Training Information	32
E.	LIST OF ATTACHMENTS	34

A. ACCIDENT

Location: Malbis, Alabama
Date: July 28, 2020
Time: 1901 central daylight time
0001 Coordinated Universal Time (UTC) on July 29, 2020
Aircraft: Beech F33; Registration: N3156W

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 official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Centers for Environmental Information (NCEI). All times are central daylight time (CDT) on July 28, 2020, and are based upon the 24-hour clock, where local time is -5 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. NWS airport and station identifiers use the standard International Civil Aviation Organization 4-letter station identifiers versus the International Air Transport Association 3-letter identifiers, which deletes the initial country code designator "K" for U.S. airports.

The accident site location used was at latitude 30.7133° N, longitude 87.7050° W, with an approximate elevation of 105 feet (ft).

D. WEATHER 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

https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1030

1.1 Surface Analysis Chart

The southeastern section of the NWS Surface Analysis Chart for 1900 CDT is provided as figure 1 with the approximate location of the accident site marked within the red circle. The chart identified no frontal systems located near the accident site at the accident time. High pressure systems were located over eastern Texas and southeastern Oklahoma with pressures of 1014- and 1013-hectopascals (hPa), respectively. A low pressure system was located over southeastern Oklahoma as well at 1011-hPa.

The station models around the accident site depicted air temperatures in the low 70's to low 80's degrees Fahrenheit (°F), dew point temperatures in the 70's °F with temperature-dew point spreads of 3°F or less, a southwest wind at 10 knots, cloudy sky cover, and moderate rain.

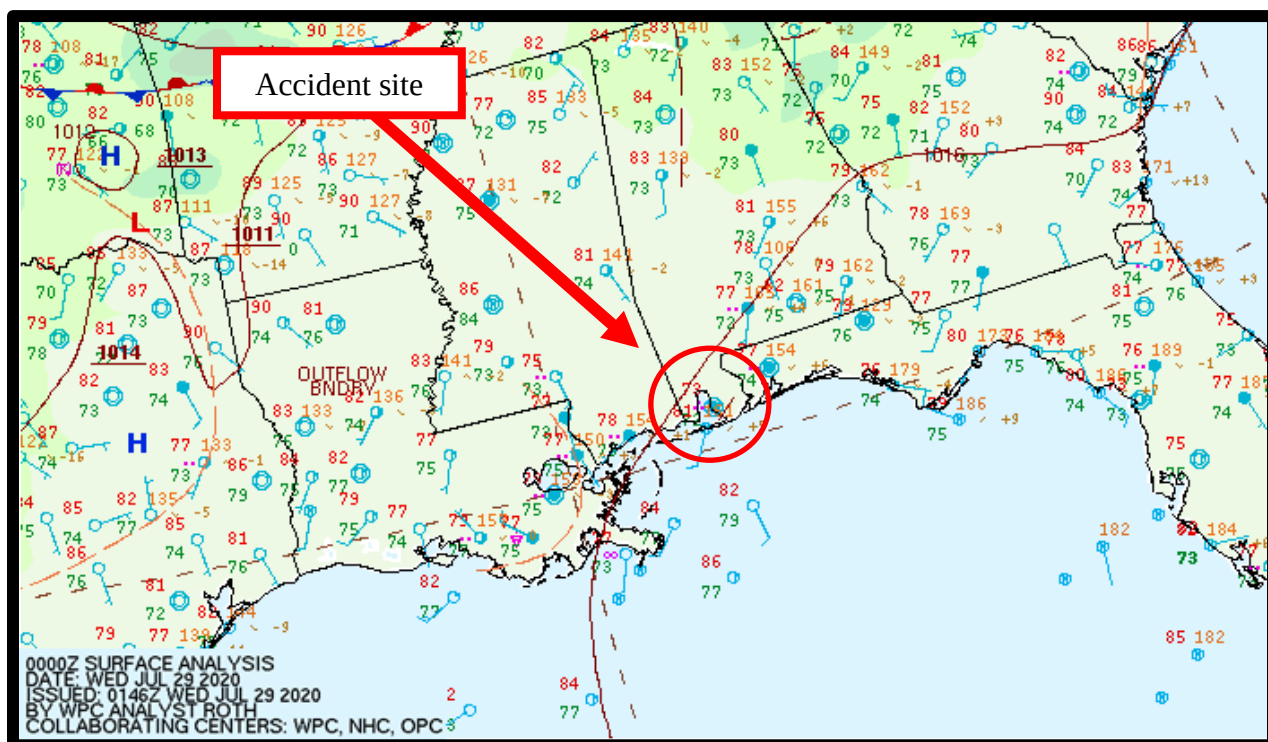


Figure 1 – NWS Surface Analysis Chart for 1900 CDT

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 1900 CDT at 925-, 850-, 700-, 500-, and 300-hPa are presented in figures 2 through 6. There was a low- and mid-level trough² located just to the west and above the accident site from 925- through 700-hPa. Troughs can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present. There was a west wind between 20 to 25 knots at 925-hPa above the accident site with the wind remaining westerly through 700-hPa (figure 4). The wind speed became variable under 10 knots by 500- and 300-hPa.

[235](#)

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

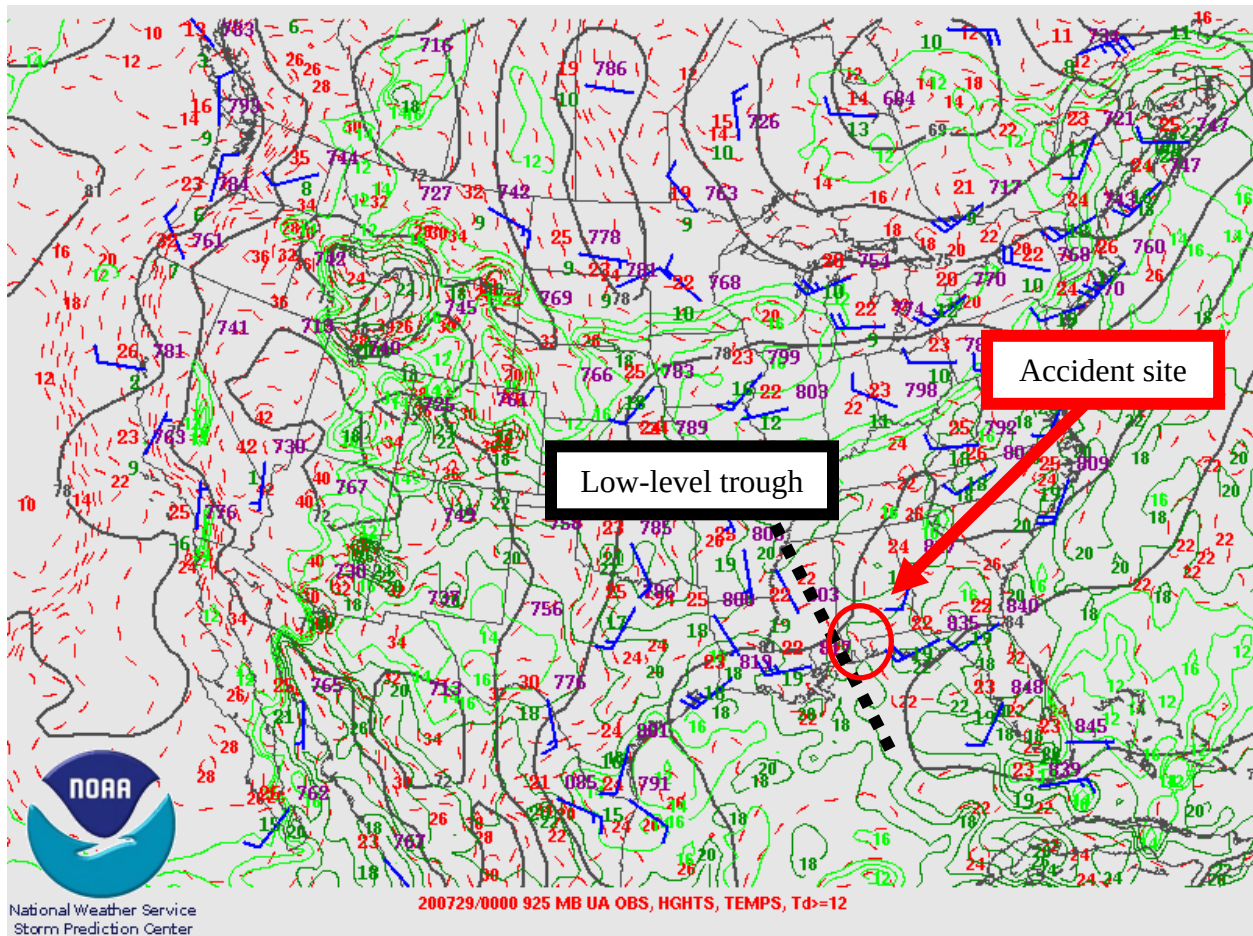


Figure 2 – 925-hPa Constant Pressure Chart for 1900 CDT

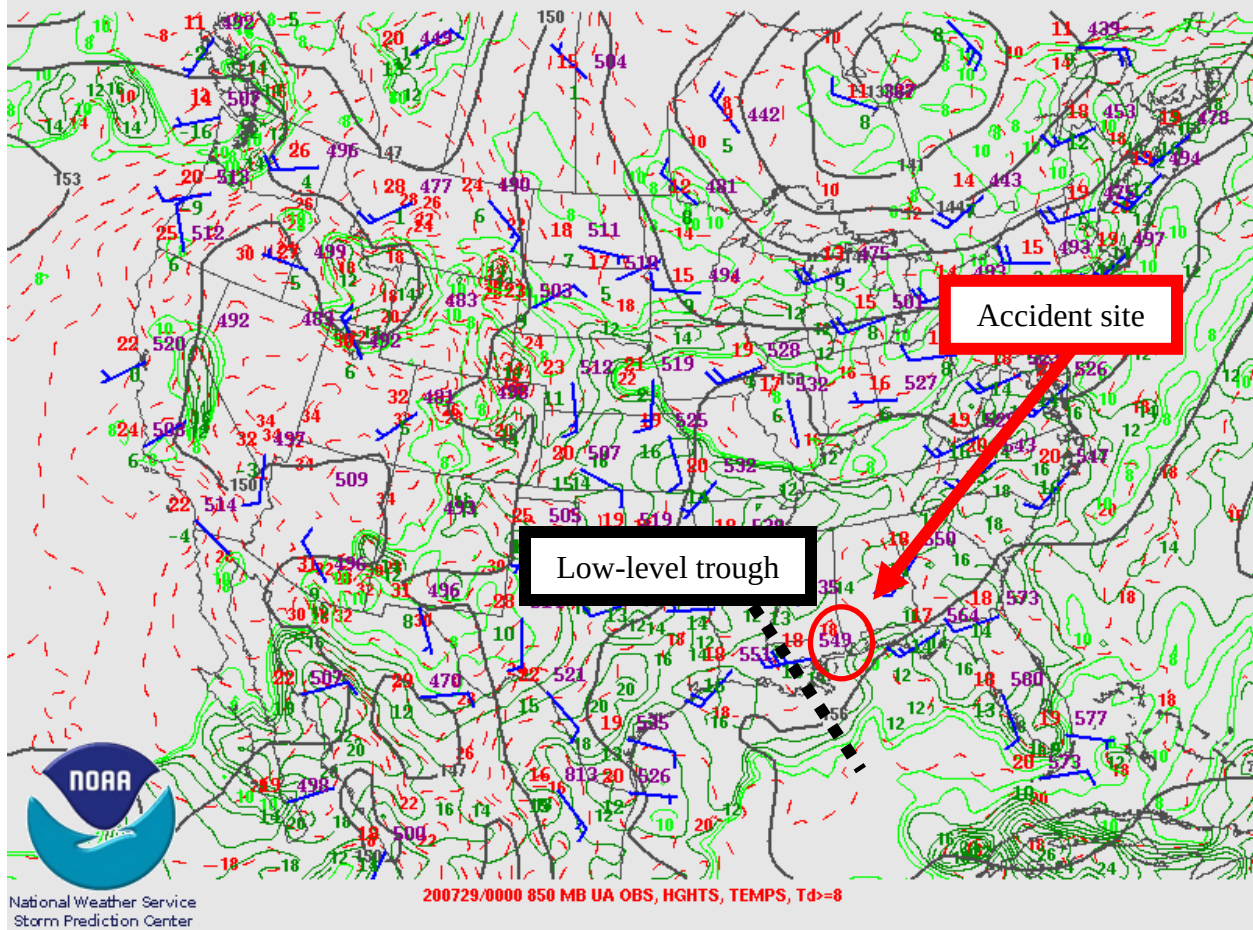


Figure 3 – 850-hPa Constant Pressure Chart for 1900 CDT

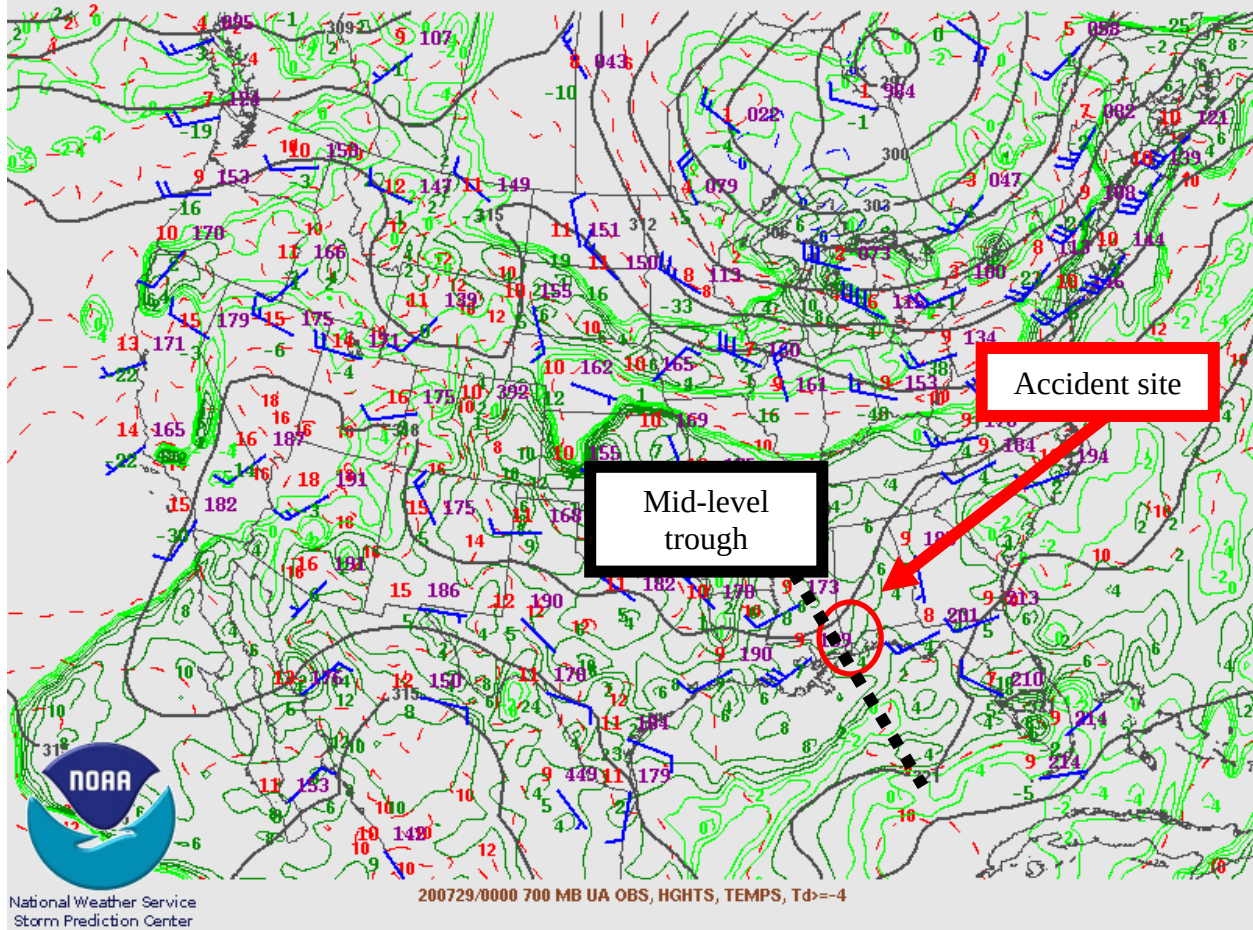


Figure 4 – 700-hPa Constant Pressure Chart for 1900 CDT

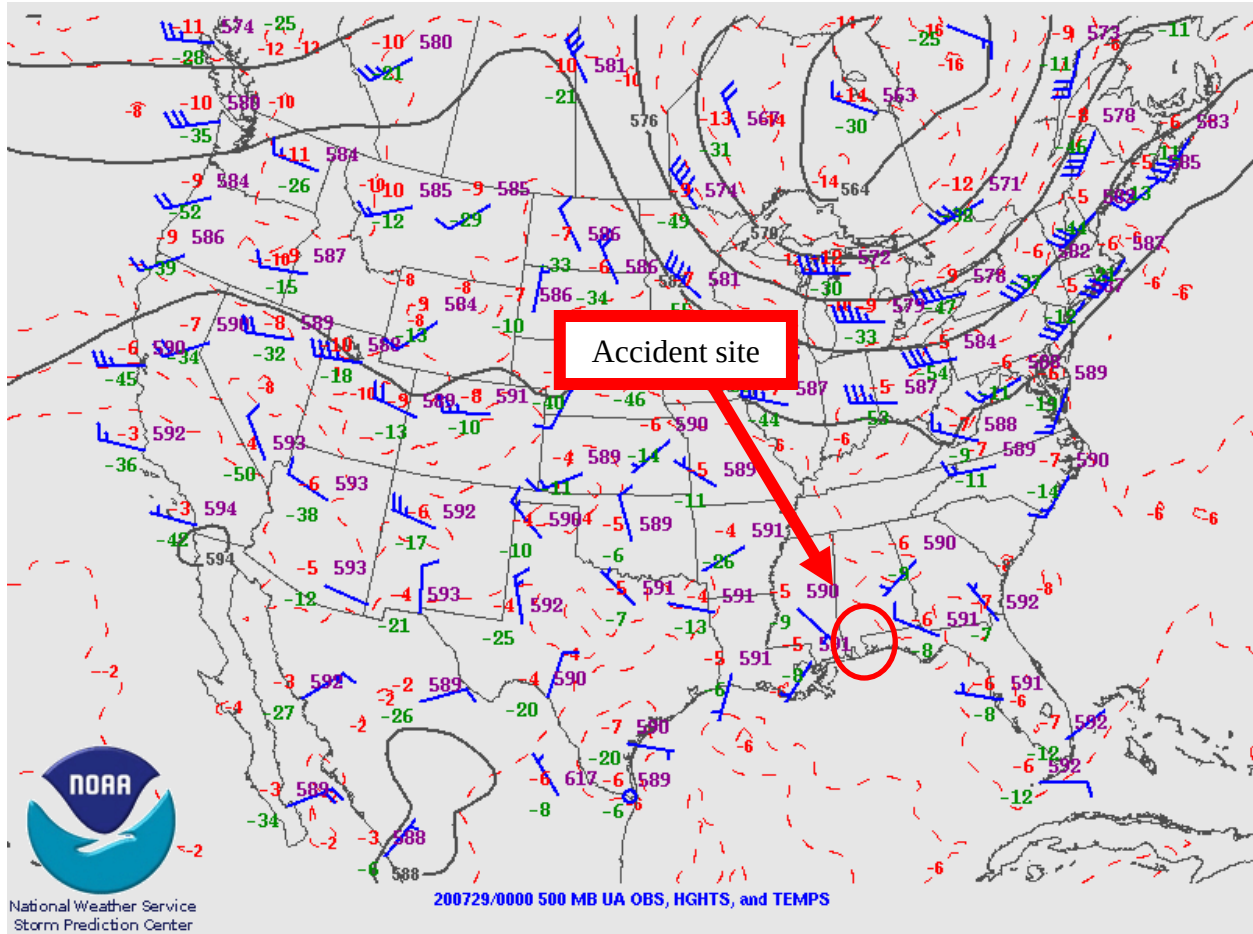


Figure 5 – 500-hPa Constant Pressure Chart for 1900 CDT

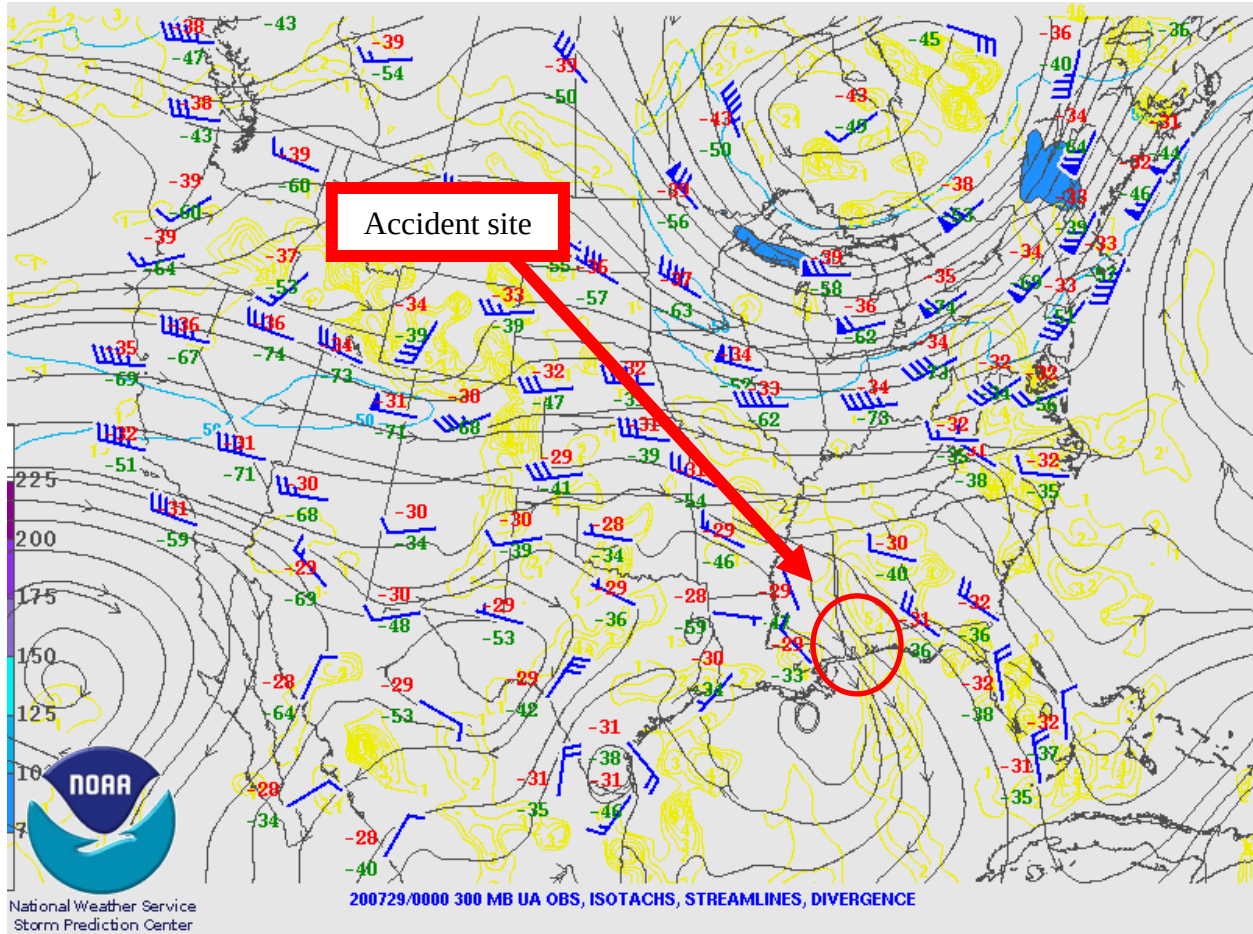


Figure 6 – 300-hPa Constant Pressure Chart for 1900 CDT

2.0 SPC Products

SPC issued the following Day 1 Convective Outlook at 1440 CDT (figure 7) with areas of general thunderstorms forecast for the accident site. SPC defines the “TSTM” area as an area that encloses where a 10% or higher probability of thunderstorms is forecast during the valid period.

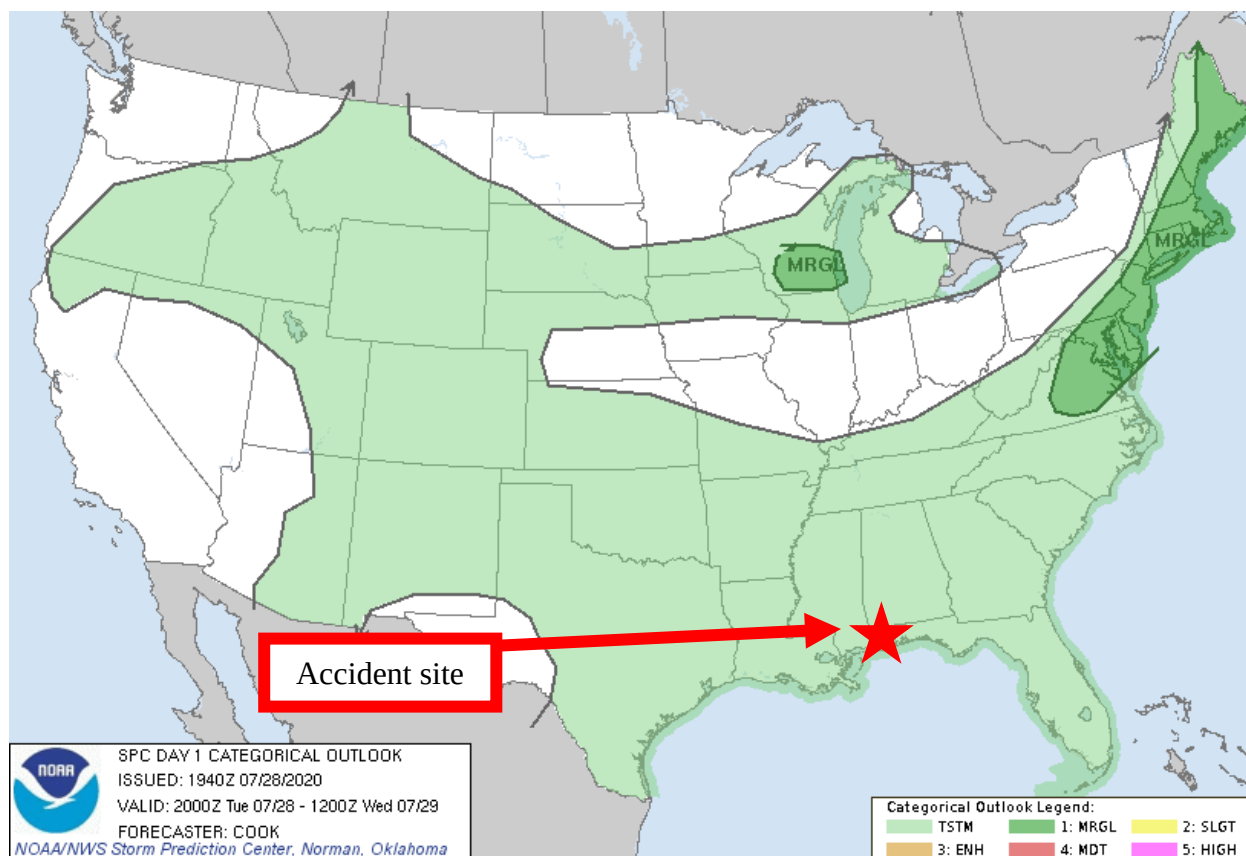


Figure 7 – SPC day 1 Convective Outlook valid at the time of the accident

3.0 Surface Observations

The area surrounding the accident site was documented using official Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language. Figure 8 is a local sectional chart with the accident site and the closest weather reporting locations marked.

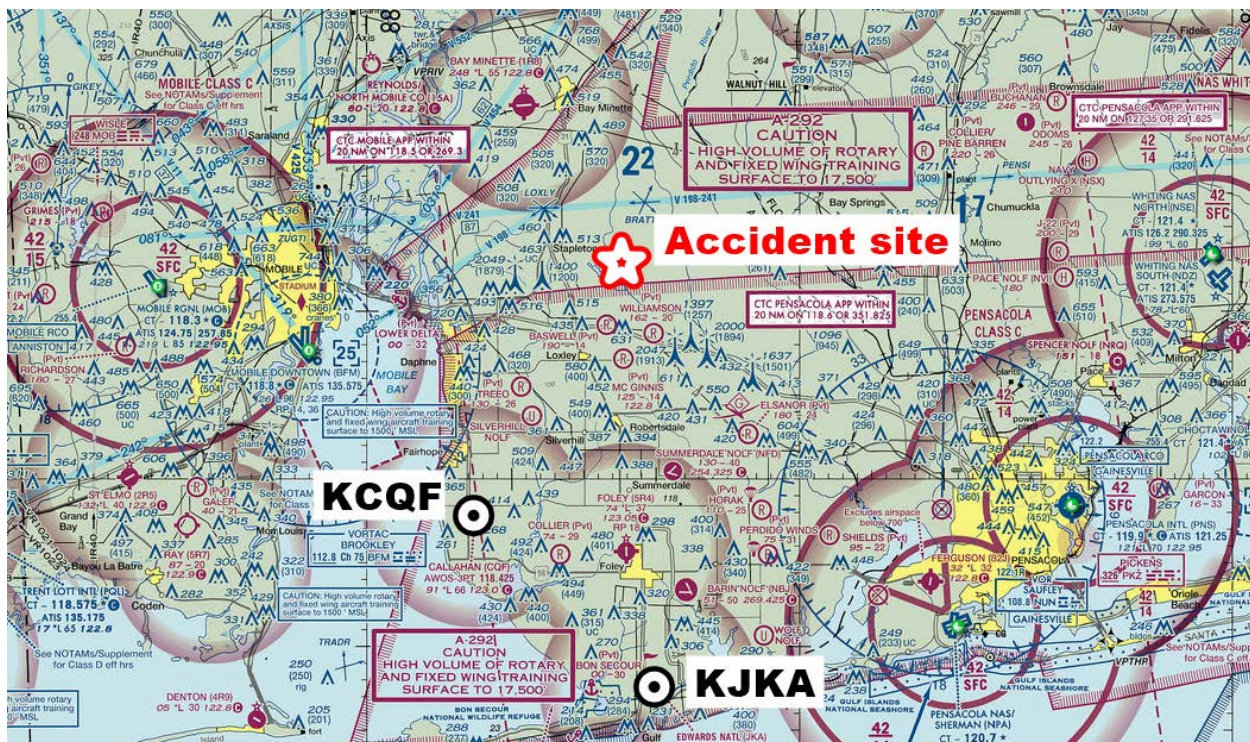


Figure 8 – Sectional map of the accident area with the location of the accident site and surface observation sites

H L Sonny Callahan Airport (KCQF) had the closest official weather station to the accident site. KCQF had an Automated Weather Observing System (AWOS³) whose reports were not supplemented. The KCQF AWOS was located 18 miles southwest of the accident site (figure 8), at an elevation of 91 ft. KCQF had a 3° westerly magnetic variation⁴. The following observations were taken and disseminated during the times surrounding the accident:⁵

[1735 CDT] METAR KCQF 282235Z AUTO 17018G25KT 10SM BKN013 BKN019 OVC025 26/23 A3000 RMK AO2=

[1755 CDT] METAR KCQF 282255Z AUTO 17012G18KT 10SM SCT011 BKN023 OVC070 25/23 A3001 RMK AO2=

[1815 CDT] METAR KCQF 282315Z AUTO 19007G14KT 10SM SCT009 BKN031 OVC070 25/23 A3001 RMK AO2=

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 12,000 feet, and altimeter setting.

⁴ Magnetic variation – The angle (at a particular location) between magnetic north and true north. Latest measurement taken from <https://skyvector.com/>

⁵ The bold sections in this NWS product and the rest of the products in this report are intended to highlight the sections that directly reference the weather conditions that affected the accident location around the accident time. The local times in this section next to the METARs are provided for quick reference between UTC and local times around the accident time.

[1835 CDT] METAR KCQF 282335Z AUTO 27010G15KT 220V310 10SM RA SCT011
BKN020 OVC060 25/23 A3004 RMK AO2=

**[1855 CDT] METAR KCQF 282355Z AUTO 00000KT 1/2SM +RA OVC012 23/22 A3003
RMK AO2 P0042=**

ACCIDENT TIME 1901 CDT

**[1915 CDT] METAR KCQF 290015Z AUTO 00000KT 2SM +RA SCT012 BKN035 OVC047
23/23 A3004 RMK AO2 VIS 1 1/4V3 P0009=**

[1935 CDT] METAR KCQF 290035Z AUTO 22003KT 1 3/4SM +RA SCT009 BKN020
OVC042 23/22 A3004 RMK AO2 P0042=

KCQF weather at 1855 CDT, automated, wind calm, a half mile visibility, heavy rain, an overcast ceiling at 1,200 ft above ground level (agl), temperature of 23°Celsius (C), dew point temperature of 22°C, and an altimeter setting of 30.03 inches of mercury. Remarks: automated station with a precipitation discriminator, 0.42 inches of precipitation since 1755 CDT.

KCQF weather at 1915 CDT, automated, wind calm, 2 miles visibility, heavy rain, scattered clouds at 1,200 ft agl, broken ceiling at 3,500 ft agl, overcast skies at 4,700 ft agl, temperature of 23°C, dew point temperature of 23°C, and an altimeter setting of 30.04 inches of mercury. Remarks: automated station with a precipitation discriminator, visibility varying between 1 and a quarter miles and 3 miles, 0.09 inches of precipitation since 1855 CDT.

Jack Edwards National Airport (KJKA) was the departure airport. KJKA had an AWOS whose reports were not supplemented. KJKA AWOS site was located 25 miles south of the accident site (figure 8), at an elevation of 17 ft, and had a 3° westerly magnetic variation. The following observations were taken and disseminated during the times surrounding the accident:

[1735 CDT] METAR KJKA 282235Z AUTO 23007G15KT 2SM +RA SCT021 BKN032
OVC041 A3003 RMK AO2 LTG DSNT NW P0018=

[1755 CDT] METAR KJKA 282255Z AUTO 25014G21KT 2 1/2SM +RA SCT010 BKN016
OVC032 25/24 A3003 RMK AO2 VIS 1 1/2V3 LTG DSNT N P0041 T02480235=

[1815 CDT] METAR KJKA 282315Z AUTO 21008G24KT 1 1/2SM +RA BKN012 BKN021
OVC038 24/23 A3002 RMK AO2 P0027 T02370226=

[1835 CDT] METAR KJKA 282335Z AUTO 22012KT 5SM RA SCT022 BKN075 OVC085
24/23 A3003 RMK AO2 LTG DSNT SW P0031 T02400228=

DEPARTURE TIME 1845 CDT

**[1855 CDT] METAR KJKA 282355Z AUTO 23009G22KT 5SM -RA SCT075 OVC095
24/23 A3002 RMK AO2 P0035 60078 T02400229 10309 20236=**

ACCIDENT TIME 1901 CDT

***[1915 CDT] METAR KJKA 290015Z AUTO 22005KT 7SM -RA SCT055 BKN070 OVC110
24/23 A3003 RMK AO2 P0002 T02420228=***

***[1935 CDT] METAR KJKA 290035Z AUTO 00000KT 10SM -DZ SCT050 BKN070 BKN110
24/23 A3003 RMK AO2 P0003 T02440230=***

KJKA weather at 1855 CDT, automated, wind from 230° at 9 knots with gusts to 22 knots, 5 miles visibility, light rain, scattered clouds at 7,500 ft agl, an overcast ceiling at 9,500 ft agl, temperature of 24°C, dew point temperature of 23°C, and an altimeter setting of 30.02 inches of mercury. Remarks: automated station with a precipitation discriminator, 0.35 inches of precipitation since 1755 CDT, 6-hourly precipitation of 0.78 inches, temperature 24.0°C, dew point temperature 22.9°C, 6-hourly maximum temperature of 30.9°C, 6-hourly minimum temperature of 23.6°C.

KJKA weather at 1915 CDT, automated, wind from 220° at 5 knots, 7 miles visibility, light rain, scattered clouds at 5,500 ft agl, a broken ceiling at 7,000 ft agl, overcast skies 11,000 ft agl, temperature of 24°C, dew point temperature of 23°C, and an altimeter setting of 30.03 inches of mercury. Remarks: automated station with a precipitation discriminator, 0.02 inches of precipitation since 1855 CDT, temperature 24.2°C, dew point temperature 22.8°C.

The observations from KCQF and KJKA surrounding the accident time indicated LIFR⁶ to MVFR conditions, due to visibility with light to heavy rain. At the time of the accident flight's departure from KJKA the conditions were MVFR at KJKA with moderate rainfall reported.

⁶ As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories:

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

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

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

4.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR)⁷ model sounding was created for the accident site for 1900 CDT with station elevation of 148 ft.⁸ The 1900 CDT HRRR sounding was plotted on a standard Skew-T Log P diagram⁹ with the derived stability parameters included in figure 9 with data from the surface to 600-hPa (or approximately 14,000 ft msl). These data were analyzed using the RAOB¹⁰ software package. The sounding depicted the lifted condensation level (LCL)¹¹ at 382 ft agl, the convective condensation level (CCL)¹² at 1,212 ft agl, and the level of free convection (LFC)¹³ at 5,546 ft agl. The freezing level was located at 15,808 ft msl. The precipitable water value was 2.66 inches. The mean storm motion was from 269° at 13 knots.

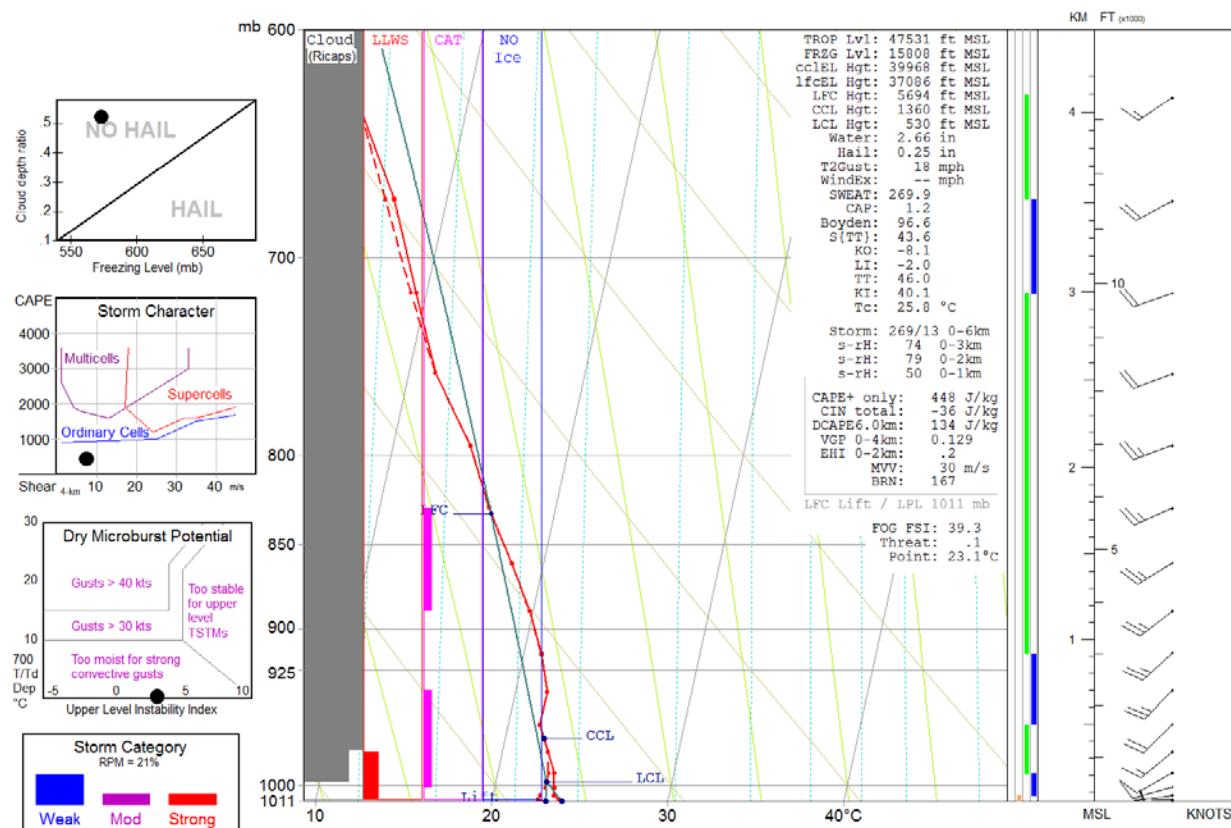


Figure 9 – 1900 CDT HRRR sounding

⁷ 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.

⁸ HRRR sounding was created using NOAA Air Resource Laboratory: <https://ready.arl.noaa.gov/READYamet.php>

⁹ 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.

¹⁰ RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.

¹¹ LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

¹² 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.

¹³ 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.

The 1900 CDT HRRR sounding for the accident site indicated alternating layers of a conditionally unstable environment and stable environment from the surface through 14,000 ft. RAOB identified the possibility of clouds outside of rain showers or thunderstorms from 1,500 ft msl through 14,000 ft msl. 448 Joules/kilogram (J/kg) of CAPE¹⁴ were indicated on the sounding and the maximum vertical velocity (MVV) for this atmosphere was calculated as 30 meters/second (about 5,906 ft per minute).¹⁵ Given the environment, RAOB indicated that ordinary rain shower or thunderstorm cell development was possible with no hail or severe thunderstorm activity (wind, tornadoes, hail, etc...). Downdraft CAPE (DCAPE; 6 kilometers agl)¹⁶ was measured at 134 J/kg. If rain showers or thunderstorms formed in this environment, the 1900 CDT HRRR sounding indicated that the strongest wind speeds possible at the surface (due to, for example, a microburst, outflow boundary, or gust front) would have been 18 mph (16 knots) according to the T2Gust parameters.

The 1900 CDT HRRR sounding wind profile indicated a surface wind from 270° at 4 knots with the wind remaining from the west to southwest through 14,000 ft. The wind speed increased to 20 knots by 1,500 ft msl. RAOB indicated the possibility of light low-level wind shear (LLWS) outside of a rain shower or thunderstorm activity between the surface and 1,500 ft msl. RAOB indicated that a chance of light clear-air turbulence existed in two layers between the surface and 6,000 ft. At the accident airplane's altitude before descent (and accident time)¹⁷ around 5,000 ft, the sounding indicated a southwest wind at 24 knots with a temperature of 18.2°C and a relative humidity of 100%.

5.0 Satellite Data

The Geostationary Operational Environmental Satellite number 16 (GOES-16) visible and infrared data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System software. Visible and infrared imagery (GOES-16 bands 2 and 13) at wavelengths of 0.64 microns (μm) and 10.3 μm, respectively, were retrieved for the period from 1600 CDT through 2200 CDT and reviewed, and the closest images to the time of the accident were documented.

Figures 10 and 11 present the GOES-16 visible imagery at 1850 and 1900 CDT at 2X magnification with the accident site highlighted with a red square. The visible imagery indicated an extensive layer of cloud cover with cumuliform cloud cover closest to the ground and cirriform cloud cover above the accident site. The cloud cover was moving from northwest to southeast (attachment 1) with the cumuliform cloud cover growing and expanding in areal extent through the accident time.

¹⁴ 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.

¹⁵ 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.

¹⁶ 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.

¹⁷ For more information please see the NTSB ATC information in the docket for this accident.

Figure 12 presents the GOES-16 infrared imagery from 1900 CDT at 6X magnification with the accident site highlighted with a red square. Inspection of the infrared imagery indicated cloud cover over the accident site. The lower brightness temperatures (blue and green colors; higher cloud tops) were located above and surrounded the accident site from north through southwest. Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 1900 CDT HRRR sounding, the approximate cloud-top heights over the accident site were 41,000 ft at 1900 CDT (219 Kelvin). It should be noted these figures have not been corrected for any parallax error.

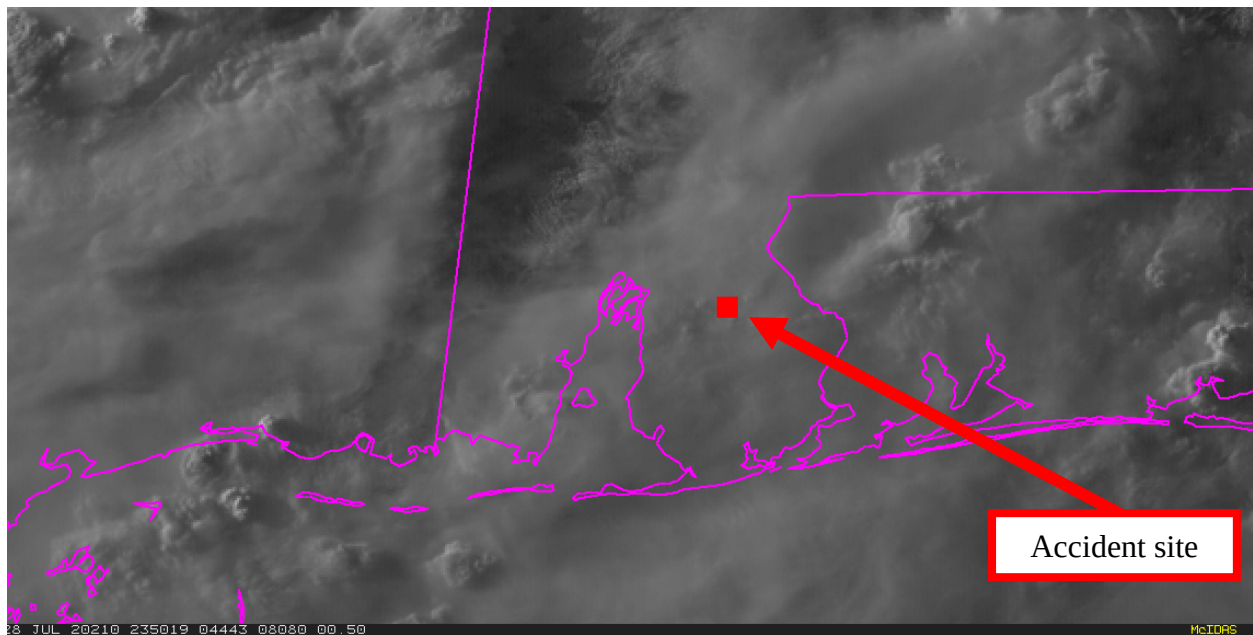


Figure 10 – GOES-16 visible image at 1850 CDT

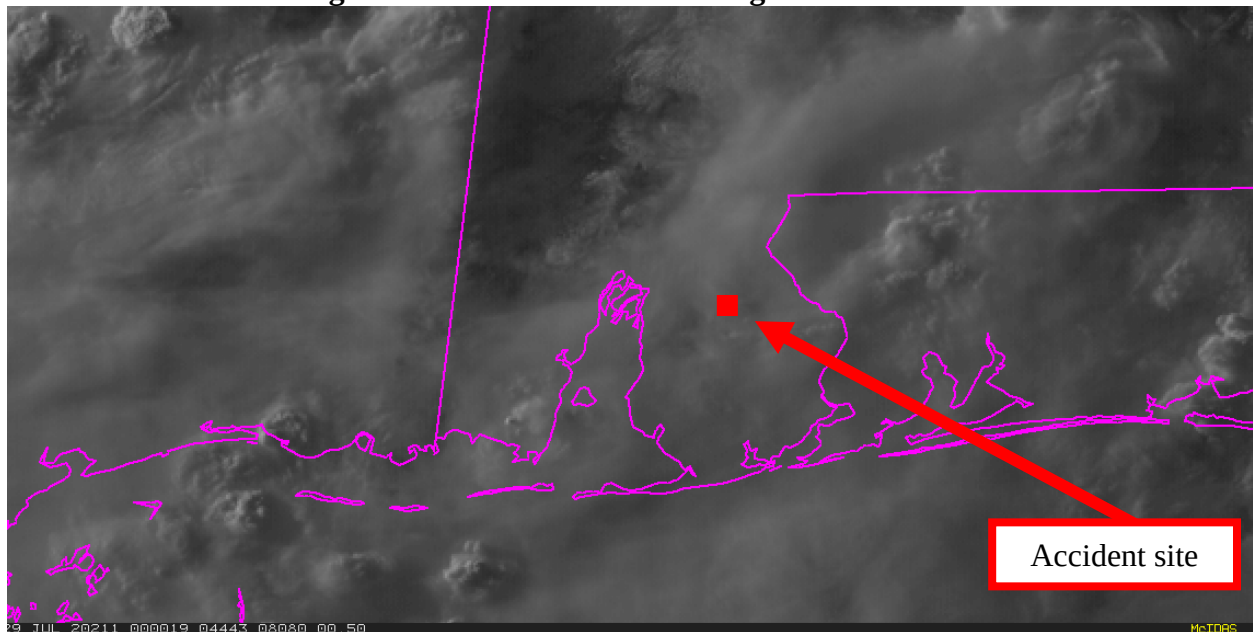


Figure 11 – GOES-16 visible image at 1900 CDT

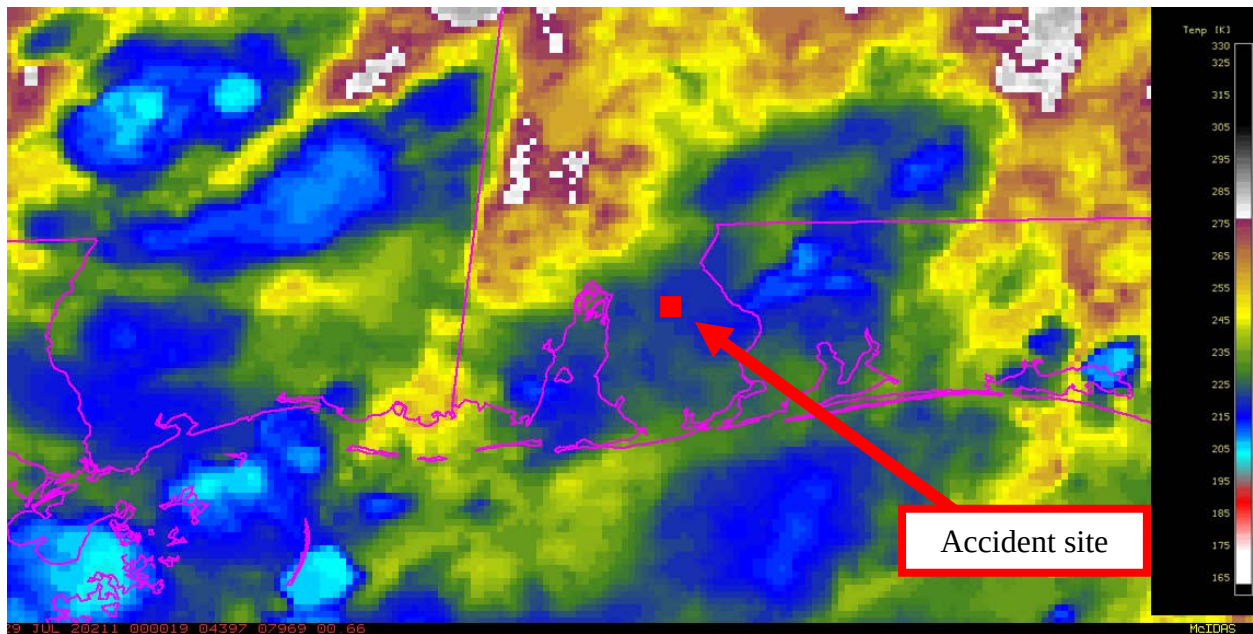


Figure 12 – GOES-16 infrared image at 1900 CDT

6.0 Regional Radar Imagery Information

A regional view of the NWS national composite radar mosaic is included as figure 13 for 1900 CDT with the approximate location of the accident site found within the white circle. The image depicted echoes from 40 to 50 decibels (dBZ¹⁸) above the accident site. In addition, the NWS national composite radar mosaic from 1615 CDT, the time of the Leidos weather briefing provided to the accident pilot (section 16.0), is provided in figure 14 with the departure location found within the red circle.

¹⁸ 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.

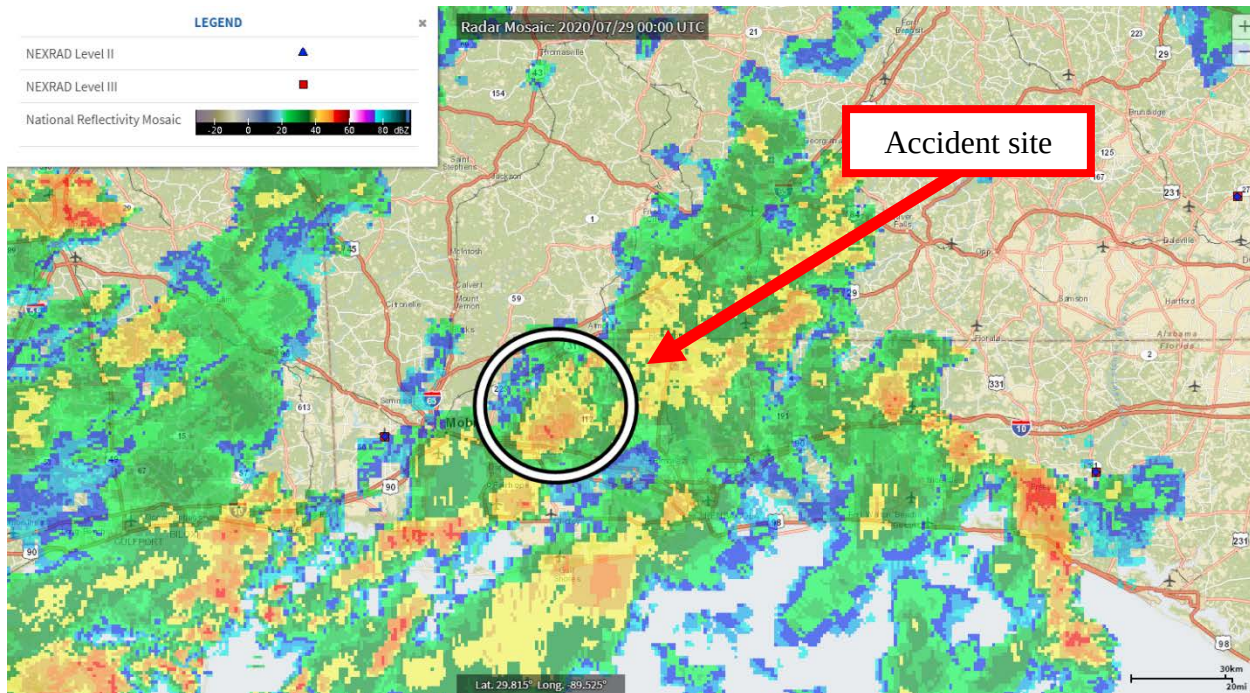


Figure 13 – Regional Composite Reflectivity image for 1900 CDT

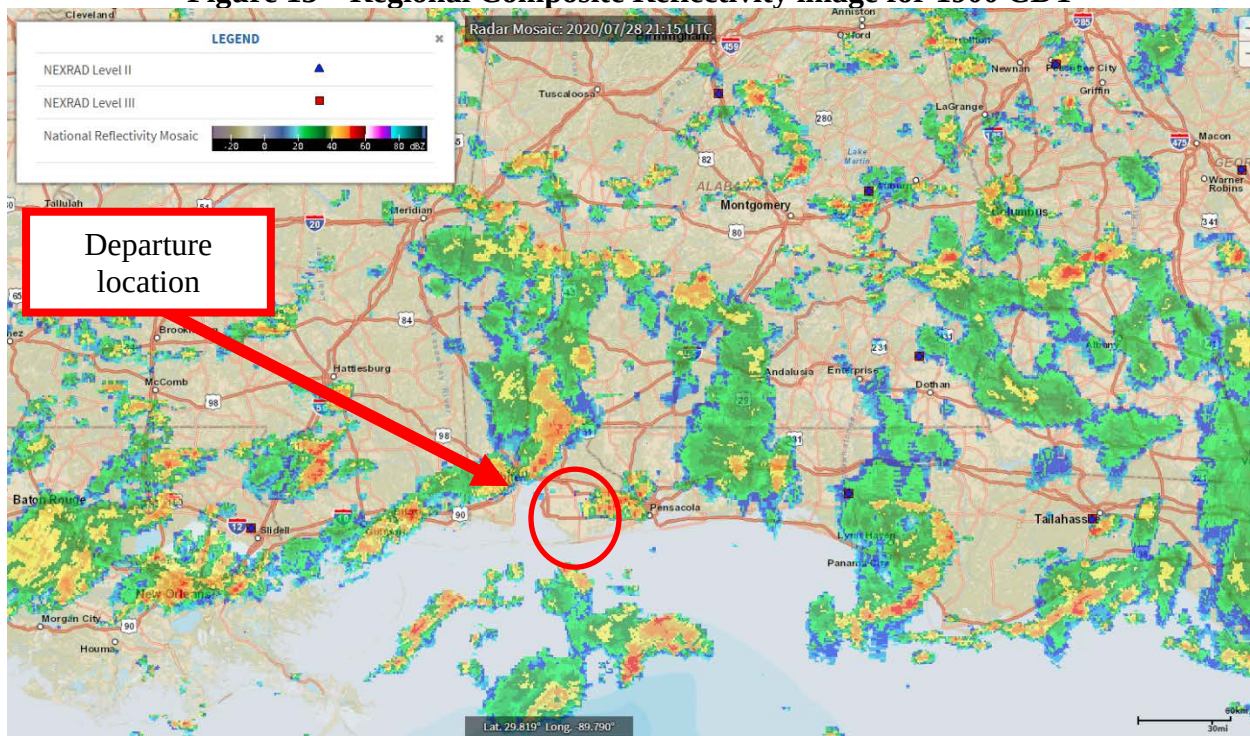


Figure 14 – Regional Composite Reflectivity image for 1615 CDT

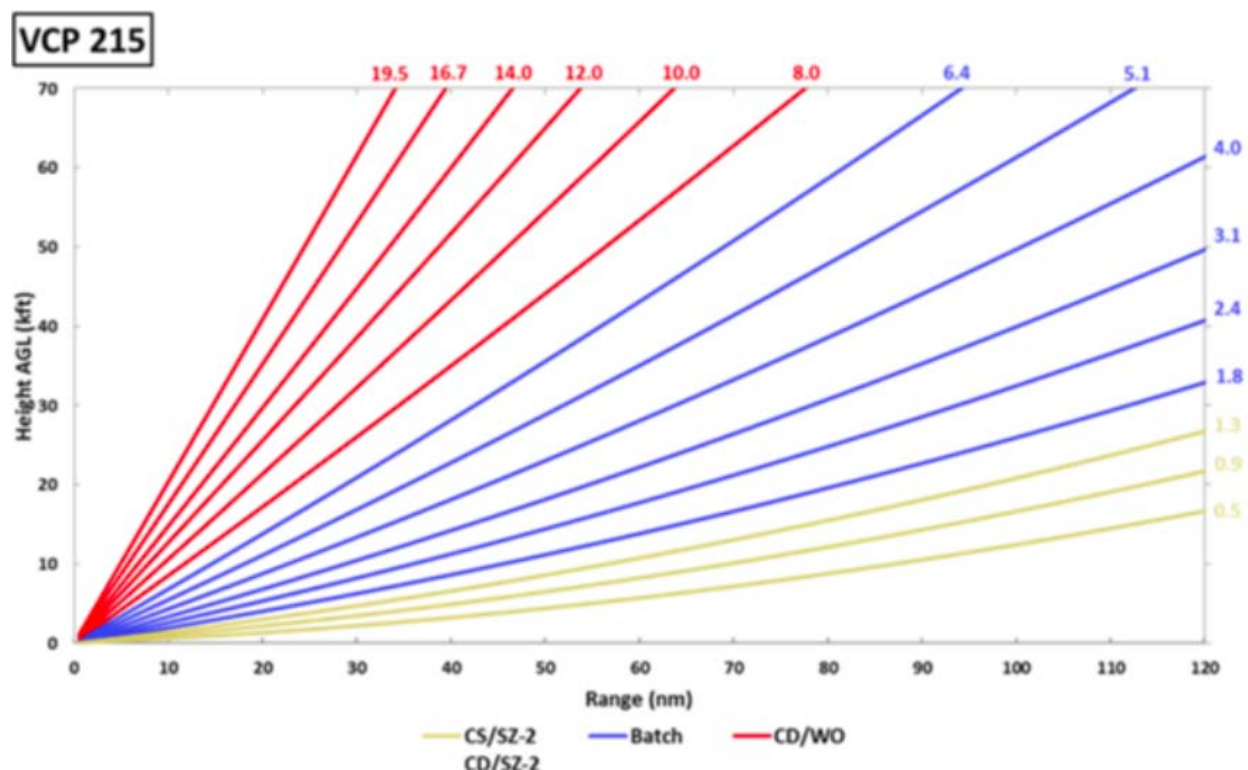
7.0 Radar Imagery Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)¹⁹ to the accident site was Mobile, Alabama, (KMOB) located 28 miles west of the accident site. Level II archive radar data were obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

7.1 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. 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 15 elevation scans from 0.5° to 19.5° every six minutes. This particular scanning strategy is documented as volume coverage pattern 215 (VCP-215). 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 KMOB WSR-88D radar was operating in the precipitation mode VCP-215. 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.



¹⁹ 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.

VCP-215 Precipitation Mode Scan Strategy²⁰

7.2 Beam Height Calculation

Assuming standard refraction²¹ of the KMOB WSR-88D radar beam with the antenna elevation at 289 ft, and considering a beamwidth²² of 0.95°, the following table shows the approximate heights for the radar beam center, top and base for antenna elevations over the accident site. These heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
KMOB 1.3°	4,710 ft	3,330 ft	6,090 ft

Based on the radar height calculations, the elevation scans from KMOB listed in the above table depicted the conditions between 3,330 ft and 6,090 ft msl over the accident site and these scans “saw” the closest altitudes to the accident aircraft’s flight level before the descent in altitude.^{23,24}

7.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²⁵ it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in dBZ and is a general measure of echo intensity. FAA Advisory Circular AC 00-24C²⁶,

²⁰ Contiguous Surveillance (CS)--The low Pulse Repetition Frequency (PRF) scan of the split cut. Gives a high $R_{\max}$ value to determine proper target location and intensity, but a low $V_{\max}$ value limits the velocities that can be measured. Contiguous Doppler (CD)--The high PRF scan of the split cut. Gives a low $R_{\max}$ value causing more range folded (multiple trip) echoes, but a high $V_{\max}$ value to get higher, more accurate velocity values.

Batch Mode – Uses alternating low and high PRFs on each radial for one full rotation at each elevation angle. The two resulting data sets (low PRF and high PRF) are combined to resolve range ambiguity. Used in the middle elevation angles.

W – With range unfolding (W)

WO – Without range unfolding (WO)

²¹ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

²² Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

²³ Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of ft. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the standard sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

²⁴ For more information please see air traffic control (ATC) data located in the docket of this accident.

²⁵ 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.

²⁶

“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:

- 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

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

7.4 Base Reflectivity and Lightning Data

Figures 15 through 18 present the KMOB WSR-88D base reflectivity images for the 1.3° elevation scans initiated at 1845:51, 1851:54, 1857:54, and 1903:52 CDT, respectively, with a resolution of 0.5° X 250 m. Reflectivity values between 40 and 55 dBZ were located above the accident site at the accident time and indicative of moderate to very heavy rainfall (section 7.3). The areas of thunderstorms and rain showers were moving eastward with time (attachment 1).

There were 5 lightning flashes²⁷ near the accident site between 1845 and 1851 CDT as indicated by the pink dots on the following figures.²⁸

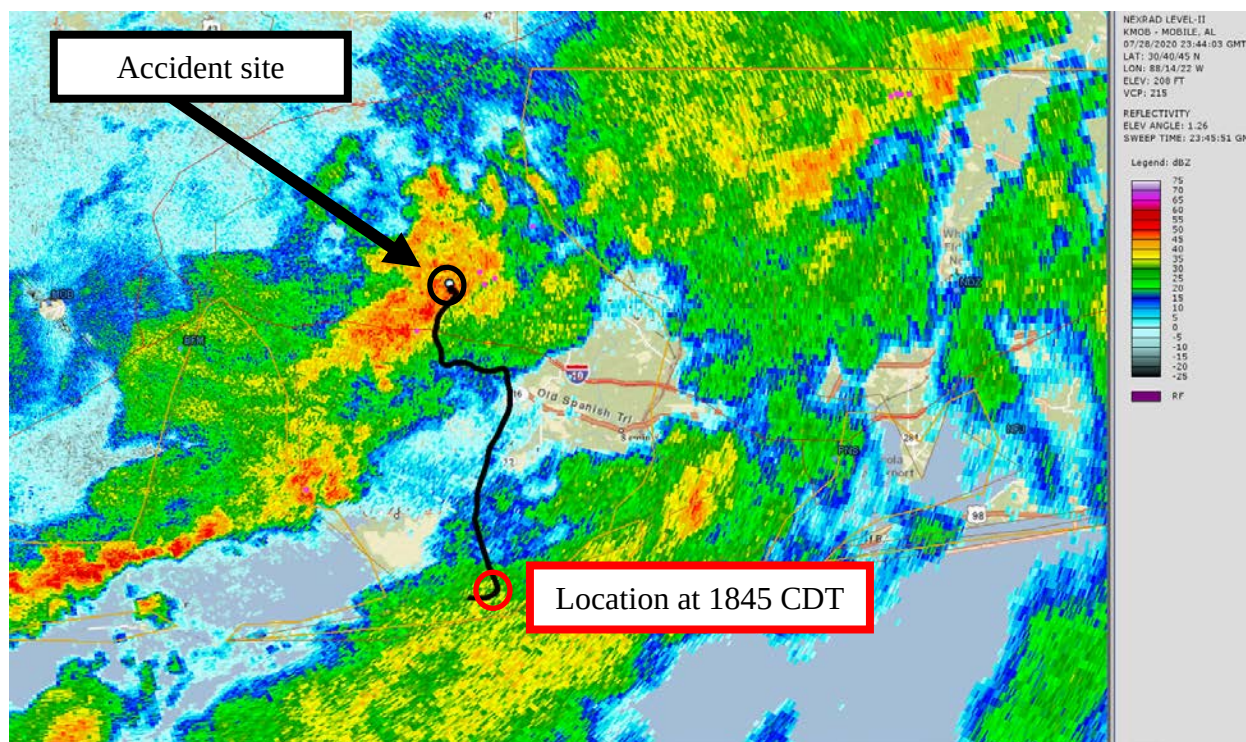


Figure 15 – KMOB WSR-88D reflectivity for the 1.3° elevation scan initiated at 1845:51 CDT with the accident site marked with the black circle and the accident flight track as the black line

²⁷ 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.

²⁸ A review of Earth Networks Total Lightning network was done.

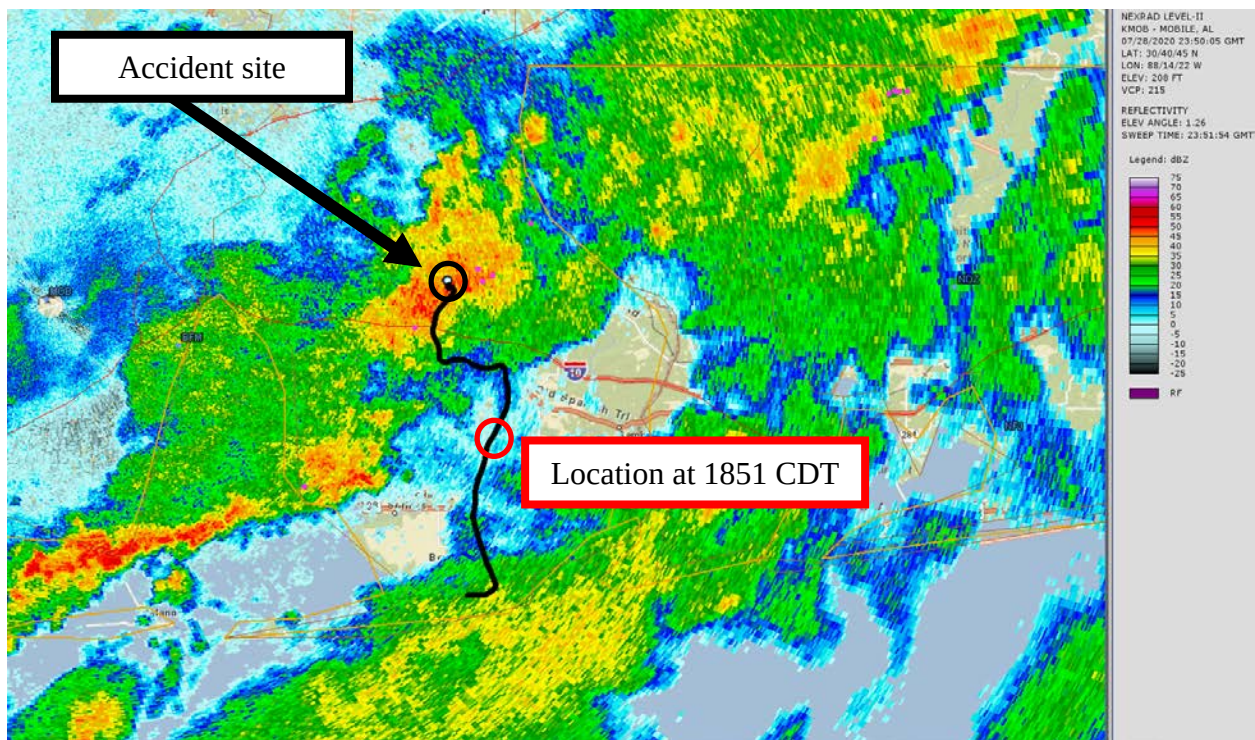


Figure 16 – KMOB WSR-88D reflectivity for the 1.3° elevation scan initiated at 1851:54 CDT with the accident site marked with the black circle and the accident flight track as the black line

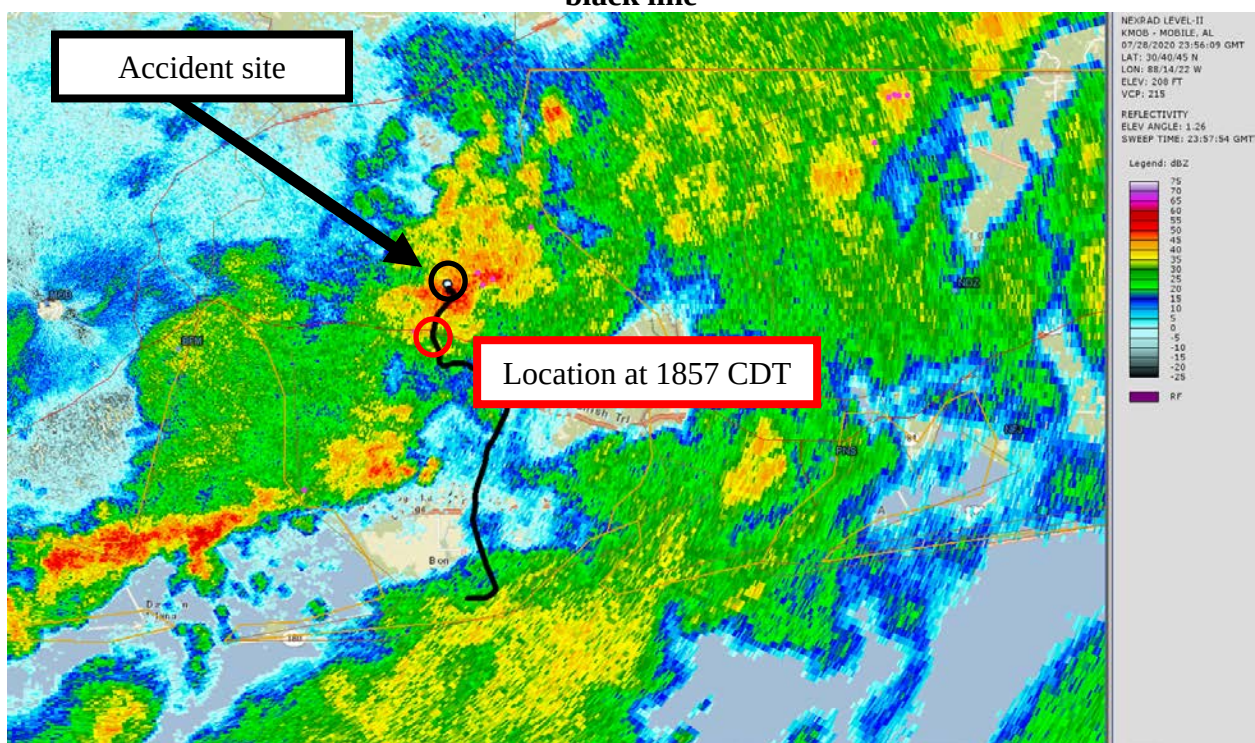


Figure 17 – KMOB WSR-88D reflectivity for the 1.3° elevation scan initiated at 1857:54 CDT with the accident site marked with the black circle and the accident flight track as the black line

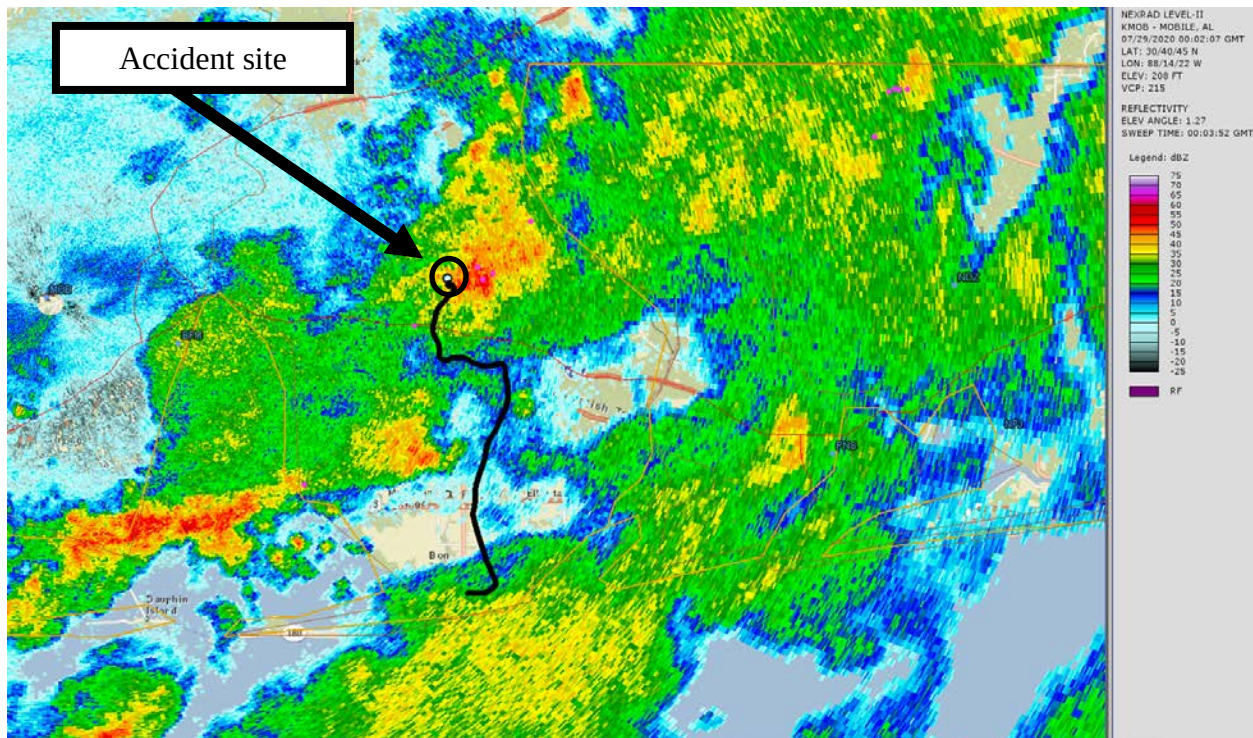


Figure 18 – KMOB WSR-88D reflectivity for the 1.3° elevation scan initiated at 1903:52 CDT with the accident site marked with the black circle and the accident flight track as the black line

8.0 Pilot Reports²⁹

There was one pilot report (PIREP) distributed into the national airspace within 100 miles of the accident site from about two hours prior to the accident time to two hours after the accident time and it is reported below:

PNS UA /OV PNS35014/TM 2220/FL50/TP B717/WX +RA/TB LIGHT

9.0 Convective SIGMETs

Convective Significant Meteorological Information (SIGMET) advisories 11C and 21C were valid for the accident site around the accident time. SIGMET 11C was issued at 1755 CDT and valid through 1955 CDT and it warned of a line of thunderstorms 40 miles wide with the forecast box moving from 250° at 20 knots with thunderstorm tops above FL450 (figure 19). SIGMET 21C replaced SIGMET 11C and was valid at the accident time being issued at 1855 CDT valid through 2055 CDT. SIGMET 21C warned of an area of thunderstorms with the forecast box moving from 250° at 15 knots with thunderstorm tops above FL450 (figure 20):

²⁹ Only pilot reports with the World Meteorological Organization headers UBAL**, UBMS**, UBFL**, UBLA**, and UBGA** were considered.

WSUS32 KPCI 282255
SIGC
MKCC WST 282255

CONVECTIVE SIGMET 11C
VALID UNTIL 0055Z
FL AL MS LA AND AL MS LA CSTL WTRS
FROM 20N CEW-50E HRV
LINE TS 40 NM WIDE MOV FROM 25020KT. TOPS ABV FL450.

WSUS32 KPCI 282355
SIGC
MKCC WST 282355

CONVECTIVE SIGMET 21C
VALID UNTIL 0155Z
FL AL MS LA AND CSTL WTRS
FROM 30S MHZ-40N CEW-20ESE CEW-60SSE LEV-80WSW LEV-30S MHZ
AREA TS MOV FROM 25015KT. TOPS ABV FL450.

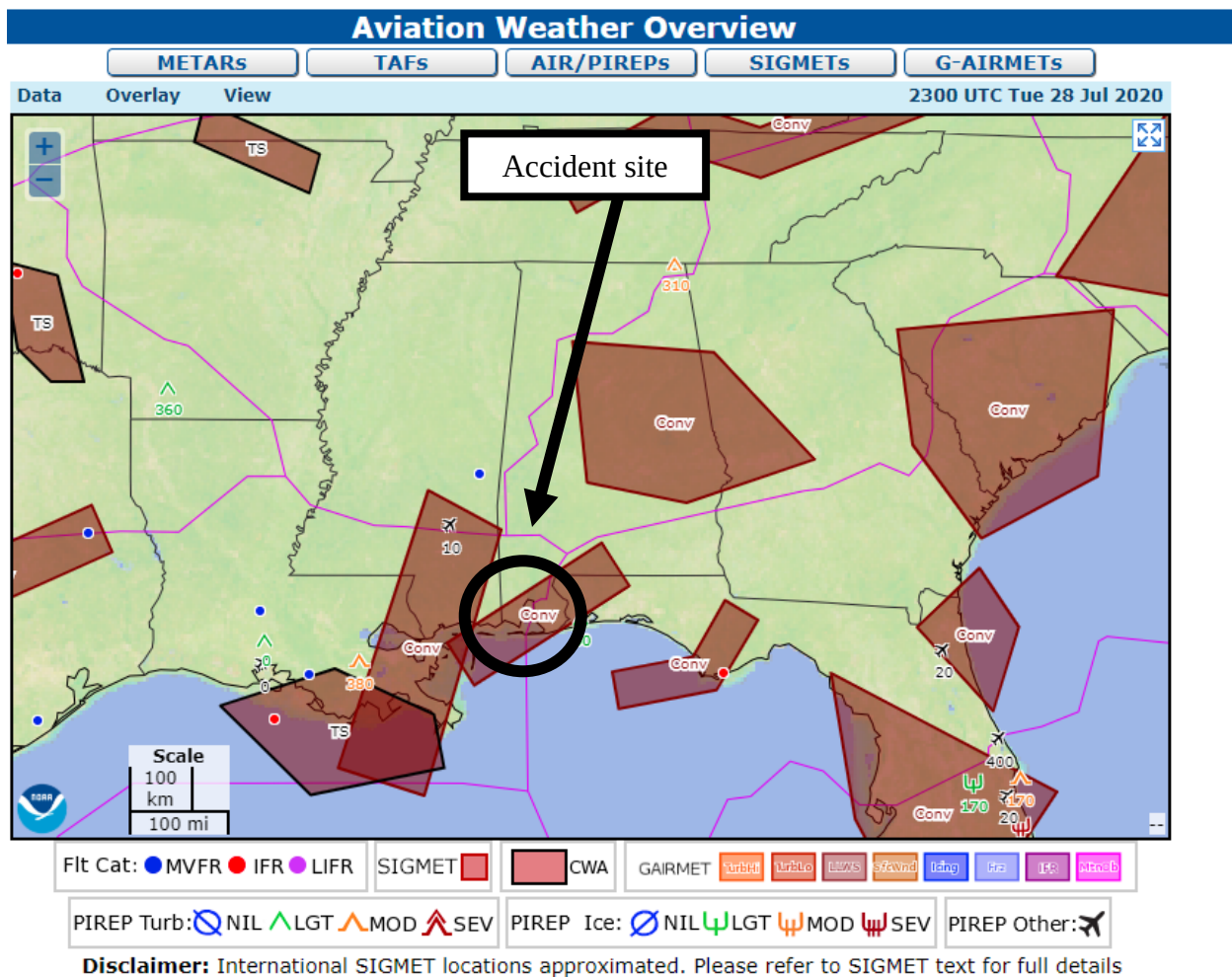


Figure 19 – SIGMETs, PIREPs, and CWAs valid at 1800 CDT

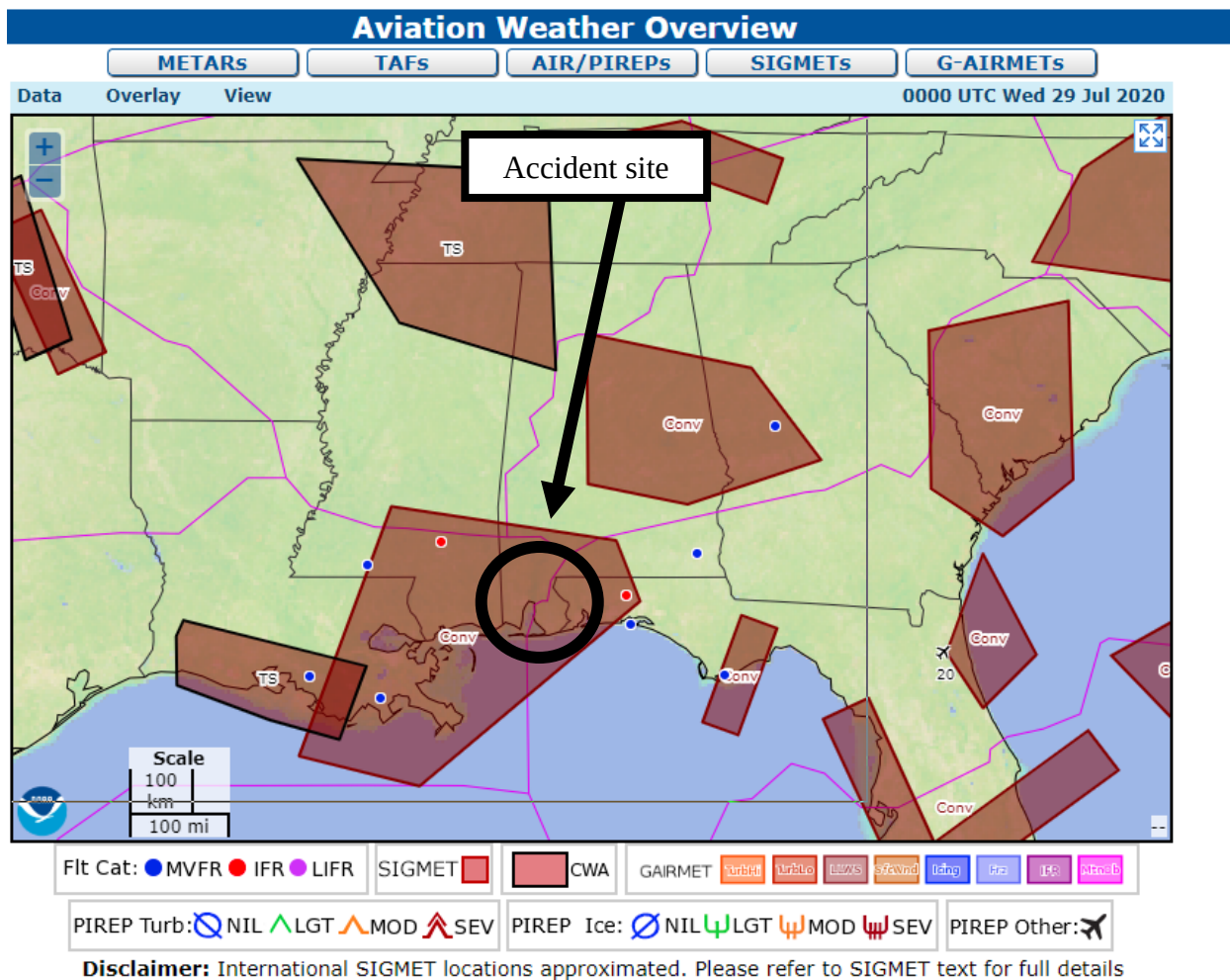


Figure 20 – SIGMETs, PIREPs, and CWAs valid at 1900 CDT

10.0 CWSU Advisories

There were no Center Weather Service Unit (CWSU) Meteorological Impact Statements (MIS) or Center Weather Advisories (CWA) valid for the accident site at the accident time.

11.0 AIRMETs

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

12.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products made available before the accident flight and valid at 1900 CDT are shown in attachment 3. The GFA surface forecast products indicated VFR surface visibilities with between a 30 and 60 percent chance of rain shower activity and a surface wind from the south at 5 knots with gusts to 15 knots for the accident site. Scattered thunderstorm activity (between a 30 and 50 percent chance of thunderstorm activity) was forecast for the majority of the intended route of flight. The GFA cloud forecast valid before departure for 1900 CDT indicated broken to overcast ceilings at 1,000 to 3,000 ft msl, with cloud tops between FL330 and FL450. For more information please see attachment 3.

13.0 Terminal Aerodrome Forecast

Mobile Downtown Airport (KBFM), Mobile, Alabama, was the closest airport to the accident site with an NWS Terminal Aerodrome Forecast (TAF). The KBFM TAF valid at the time departure was issued at 1233 CDT and was valid for a 24-hour period beginning at 1300 CDT. The TAF for KBFM was as follows:

TAF KBFM 281733Z 2818/2918 26003KT P6SM VCSH SCT021 BKN035 BKN070
TEMPO 2818/2821 6SM -TSRA BKN030CB
FM282100 18009KT P6SM VCTS SCT035CB BKN070
TEMPO 2821/2824 6SM TSRA BKN035CB
FM290000 18006KT P6SM VCSH BKN040 BKN100
PROB30 2909/2915 4SM SHRA BKN025
FM291500 21007KT P6SM VCSH SCT025 BKN035
TEMPO 2915/2918 4SM TSRA BKN025CB=

After 1900 CDT, the forecast expected a wind from 180° at 6 knots, greater than 6 miles visibility, vicinity³⁰ showers, broken ceiling at 4,000 ft agl, broken skies at 10,000 ft agl.

The KBFM TAF valid at the time of the accident was issued at 1830 CDT and was valid for a 24-hour period beginning at 1900 CDT. The 1830 CDT TAF for KBFM was as follows:

TAF KBFM 282330Z 2900/2924 **VRB06KT P6SM -RA FEW020 BKN045 BKN110**
TEMPO 2900/2903 4SM SHRA BKN040
FM290900 18004KT P6SM SCT040 BKN070
PROB30 2909/2912 4SM SHRA BKN040
FM291200 19004KT 6SM SHRA SCT035 BKN080
PROB30 2912/2918 4SM TSRA BKN035CB
FM291800 20008KT 6SM SHRA VCTS SCT030CB BKN060=

After 1900 CDT, the forecast expected a variable wind at 6 knots, greater than 6 miles visibility, light rain, few clouds at 2,000 ft agl, broken ceiling at 4,500 ft agl, and broken skies at 11,000 ft agl. Temporary conditions³¹ of 4 miles visibility, moderate rain showers, and a broken ceiling at 4,000 ft agl were forecast between 1900 and 2200 CDT.

³⁰ In the vicinity of the airport is defined as a weather phenomenon within 5-10 statute miles of the airfield.

³¹ The TEMPO group is used for any conditions in wind, visibility, weather, or sky condition which are expected to last for generally less than an hour at a time (occasional), and are expected to occur during less than half the time period.

14.0 NWS Area Forecast Discussion

The NWS office in Mobile, Alabama, issued the following Area Forecast Discussion (AFD) at 1838 CDT (closest AFD to the accident time). The aviation section of the AFD discussed a high coverage of rain shower activity throughout the area with embedded thunderstorm activity, but the rain shower and thunderstorm activity was expected to lessen in coverage through the evening period but remain in the coastal regions:

FXUS64 KMOB 282338 AAA
AFDMOB

Area Forecast Discussion...UPDATED
National Weather Service Mobile AL
638 PM CDT Tue Jul 28 2020

.AVIATION...

00Z issuance...High coverage of showers with some embedded storms will gradually lessen in coverage through mid evening, but remain mainly along the coastal areas through the overnight hours. Redevelopment of showers and some storms are expected late tonight into the early Wednesday morning hours mainly near the coast which then develop quickly inland through noon. MVFR conditions will accompany the stronger showers and storms and MVFR/IFR ceilings are possible late tonight through Wednesday afternoon, otherwise VFR conditions will prevail. South to Southwest winds 5 to 10 knots diminish tonight then a southwest flow of 5 to 10 knots returns on Wednesday. /22

&&

.PREV DISCUSSION... /issued 407 PM CDT Tue Jul 28 2020/

NEAR TERM UPDATE /Now Through Wednesday/...A large and broad upper trof over the interior eastern states is weakly connected with a modest upper trof which extends across Mississippi/Alabama/Louisiana into the far western Gulf. This tenuous connection breaks down as the weak upper trof continues slowly westward into Texas tonight allowing for an upper ridge over the eastern Gulf and part of the extreme southeast states to expand into the central Gulf. The upper ridge continues to slowly expand a bit further west into the northwestern Gulf on Wednesday while a broad upper trof remains over the interior eastern states. A surface ridge remains in place from the east central Gulf to the western Gulf, and this pattern overall maintains a moist deep layer southwest flow over the forecast area with precipitable water values of 2.1-2.3 inches. MLCAPE values will be generally around 1000 J/kg today with similar values on Wednesday while shear remains very low. As a series of weak shortwaves move across the area within this rather moist environment, expect high coverage of showers and embedded storms to develop each day, first near the coast then spreading/developing further inland through the day. Some nuisance type flooding issues will be possible given the slow movement of the convection and efficient rain production. Have

updated for the rest of today to raise afternoon highs by around 2 degrees in several locations with other minor adjustments. Lows tonight range from the lower 70s inland to the mid/upper 70s at the coast. Highs on Wednesday will be in the mid to upper 80s. A moderate risk of rip currents continues through Wednesday. /29

SHORT TERM /Wednesday night Through Friday night/...The short term features a much needed, yet short lasting, break from the unsettled weather. An upper level ridge builds westward from the Atlantic into the Gulf of Mexico and spills into much of the Southeast through the remainder of the work week. While the ridge will control our weather locally, a shortwave trough aloft darts south through the Central Plains during this timeframe and will be the focus of some the weather in the extended time frame. Nevertheless, as the ridge builds south of the local area, winds aloft turn mostly zonal through Friday night. Down near the surface, the western Atlantic ridge continues to spill into the eastern Gulf on Thursday and eventually pushes deeper into the Gulf by Friday. As such, surface winds begin to take on more of a westerly component as we head into Friday. The deep plume of moisture across the area will slowly begin to exit the region on Thursday, although PWATs around 2 inches are slow to exit the areas east of I-65 on Thursday. By Friday, PWATs nose dive into the 1.2-1.5 inch range across much of the area, especially across southeast Mississippi. The POPs were trimmed back from the blends given the drier air filtering into the area. Expect thunderstorm coverage to be scattered across south central Alabama and northwest Florida on Thursday afternoon with only isolated coverage across south central Alabama on Friday afternoon. POPs were capped at around 15% across southeast Mississippi both afternoons.

Temperatures will be on the increase on Thursday and Friday as the cloud cover and rain coverage becomes less of an issue. Daytime highs soar into the low 90s on Thursday with a few mid 90s sprinkled into the forecast by Friday afternoon. Overnight temperatures will bottom out in the low 70s inland with upper 70s to near 80° at the beaches.

MODERATE risk of rip currents will persist through the short term.
07/mb

EXTENDED TERM /Saturday Through Tuesday/...As we roll into the weekend, the upper level ridge has less of an influence on the local forecast as the aforementioned shortwave trough slides into the Mid South and Midwest. This feature eventually joins up with a broader trough aloft that ends up encompassing much of the eastern half of the CONUS late this weekend into early next week. This leaves the area in another prolonged period of southwesterly flow aloft. Meanwhile, a surface low quickly develops in response to the shortwave this weekend over the Mid South and races off to the northeast with weak high pressure generally prevailing across the Gulf waters. A cold front associated with this low will slowly attempt to progress to the southeast over the weekend, but high pressure over the Gulf will likely stall or wash out the front well to the north of our local area.

Dry air will linger across the eastern portion on Saturday afternoon with PWATs increasing to nearly 2 inches again on Sunday. Trimmed back the POPs on Saturday afternoon for areas south and east of I-65. Outside of that POP adjustment, generally expecting scattered showers and storms Sunday through early next week. Could see a few strong to possibly severe storms on Saturday afternoon and Sunday afternoon, but not anticipating widespread severe weather. Looking further to the south, all eyes remain on the tropics during this same time frame. The National Hurricane Center is now issuing advisories on Potential Tropical Cyclone #9 as it heads west-northwest over the next several days. PTC #9 may approach the Florida peninsula late in the weekend. NOTE: Since the system is still in the formative stage today, there is a greater than average uncertainty that exists regarding both the track and intensity forecasts.

Temperatures will rise into the mid to low 90s each day in the extended. Overnight lows change very little, as is typical this time of year, with mid to low 70s expected for inland communities and upper 70s to near 80° along the immediate coast. 07/mb

MARINE...No marine impacts expected other than locally higher winds and waves/seas near the stronger storms that develop. /29

&&

.MOB WATCHES/WARNINGS/ADVISORIES...

AL...None.

FL...None.

MS...None.

GM...None.

&&

\$\$

15.0 Winds and Temperature Aloft Forecast

The NWS 1455 CDT Winds and Temperature Aloft forecast valid for the closest point to the accident site is included below:

FBUS31 KWN0 281955

FD1US1

DATA BASED ON 281800Z

VALID 290000Z FOR USE 2000-0300Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
MOB	2224	2424+16	2421+11	2517+06	2908-04	3110-14	322130	331940	021353

The accident site was located closest to the Mobile, Alabama, (MOB) forecast point. The 1455 CDT MOB forecast for use between 1500 CDT and 2200 CDT indicated a wind at 3,000 ft from 220° at 24 knots, a wind at 6,000 ft from 240° at 24 knots with a temperature of 16°C, and a wind at 9,000 ft from 240° at 21 knots with a temperature of 11°C.

16.0 Pilot Weather Briefing and Witness Information

At 1615 CDT the accident pilot called Leidos flight service for a weather briefing. A review of that recorded briefing revealed that the accident pilot inquired about the weather for his route of flight from KJKA to Northwest Alabama Regional Airport (KMSL), for both the afternoon of July 28 and the following day July 29th, with his preference for the following day at 1200 CDT. The briefer responded "it doesn't look good" for the following day (July 29), with thunderstorms, rain showers, low ceilings and reduced visibility expected, and that VFR flight was not recommended. The accident pilot then inquired about the weather for a flight that afternoon around 1800 CDT (July 28). The briefer responded "That's not looking so good right now" and advised that there were thunderstorms and rain showers over the area, and a convective SIGMET for the southern portion of his route, which noted an area of thunderstorms moving eastward. For the northern portion of the route, a CWA was in effect for developing thunderstorms, and "weather" was currently building along and on both sides of the route and around the destination. The briefer advised that VFR flight was not recommended. The accident pilot responded "It looks like my best shot is, I'm gonna probably go this afternoon because its going to be worse tomorrow...what I'm seeing... reported... online anyway is that everything is VFR as we speak ... are you seeing anything... between here and Muscle Shoals that's not VFR?" The briefer responded "I have some clouds that are between 1,200 and 2,000 feet and...then some higher clouds...multiple layers of clouds, I don't see anybody that's reporting [instrument meteorological conditions, IMC] either visibility or ceilings but there are clouds that are you know getting down pretty close to it even though they're scattered. You get into the areas where the precipitation is, and it could be IFR." The accident pilot responded "Well, I feel confident that if I go during the daylight that I can, unless I got a solid line of thunderstorms, that I can go around a lot of precipitation." The accident pilot added "If I'm going VFR I'm going this afternoon, unless I got clouds that are getting low enough that I can't fly... and I haven't heard anything to tell me that." The briefer then offered a recent weather observation from Mobile, Alabama (about 25 miles west of the intended route of flight) which indicated a visibility of 1.5 miles in heavy rain and mist, and advised that areas along the route of flight that may be experiencing rain showers or thunderstorms and may have the visibility or ceilings reduced to IMC, as it did in Mobile. The accident pilot and briefer then discussed where the precipitation was occurring, and the location covered by the convective SIGMETs in the area before concluding the call. For more information please see attachments 4 through 8.

According to a customer service representative at a fixed based operator (FBO) at KJKA, the accident pilot and his wife spent about 1 hour in the FBO, and the accident pilot kept checking the weather in the flight planning room, and on a monitor in the lobby which displayed weather radar from Flight Aware.

A search of archived ForeFlight information indicated that the accident pilot did not request weather information via ForeFlight. There is no record of the accident pilot receiving or retrieving any other weather information before or during the accident flight.

17.0 Astronomical Data

The astronomical data obtained for the accident site on July 28, 2020, indicated the following:

SUN

Begin civil twilight	0540 CDT
Sunrise	0606 CDT
Sun transit	1257 CDT
Accident time	1901 CDT³²
Sunset	1948 CDT
End civil twilight	2014 CDT

18.0 Thunderstorm Training Information

The Federal Aviation Administration's (FAA) Advisory Circular AC 00-24C "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).

³² Inserted accident time for reference and context.

- (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 -15°C.
- (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-16 Visible animation from 1806 to 2006 CDT

Attachment 2 – KMOB WSR-88D level 2 base reflectivity animation for the 1.3° elevation scans from 1820 to 1914 CDT

Attachment 3 – GFA products valid for the accident flight

Attachment 4 – Leidos preflight briefing log

Attachment 5 – Leidos standard weather briefing package from 1610 CDT

Attachment 6 – Leidos standard weather briefing package from 1615 CDT

Attachment 7 – Leidos weather briefing

Attachment 8 – GFA products available to accident pilot for weather briefing package

Submitted by:

Paul Suffern
Senior Meteorologist

THIS PAGE INTENTIONALLY BLANK