



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

February 27, 2019

Weather Study Report

METEOROLOGY

CEN19FA020

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A. ACCIDENT

Location: Near McDougal, Arkansas
Date: November 2, 2018
Time: 1320 central daylight time
1820 Coordinated Universal Time (UTC)
Aircraft: Hughes 369D, Registration: N5187S

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 November 2, 2018, 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.

The final wreckage location was located at latitude 36.4367° N, longitude 90.4525° W, at an approximate elevation of 291 feet (ft).

D. FACTUAL INFORMATION

1.0 Synoptic Situation

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

¹

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

1.1 Surface Analysis Chart

The central United States section of the NWS Surface Analysis Chart for 1300 CDT is provided as figure 1 with the approximate location of the accident site marked within a red circle. The chart indicated a warm front just south of the accident site. The warm front stretched from western Tennessee into southern Missouri. Another frontal boundary stretched from southern Iowa southward into northern Arkansas then westward into Oklahoma and Kansas. A low pressure center was located in southern Iowa with a pressure of 1009-hectopascals (hPa).

The station models around the accident site depicted air temperatures in the upper 40's to low 50's degrees Fahrenheit (°F), dew point temperatures in the mid 40's °F with temperature-dew point spreads of 9° F or less, a southwest wind of 10 knots, mostly cloudy skies and light rain.

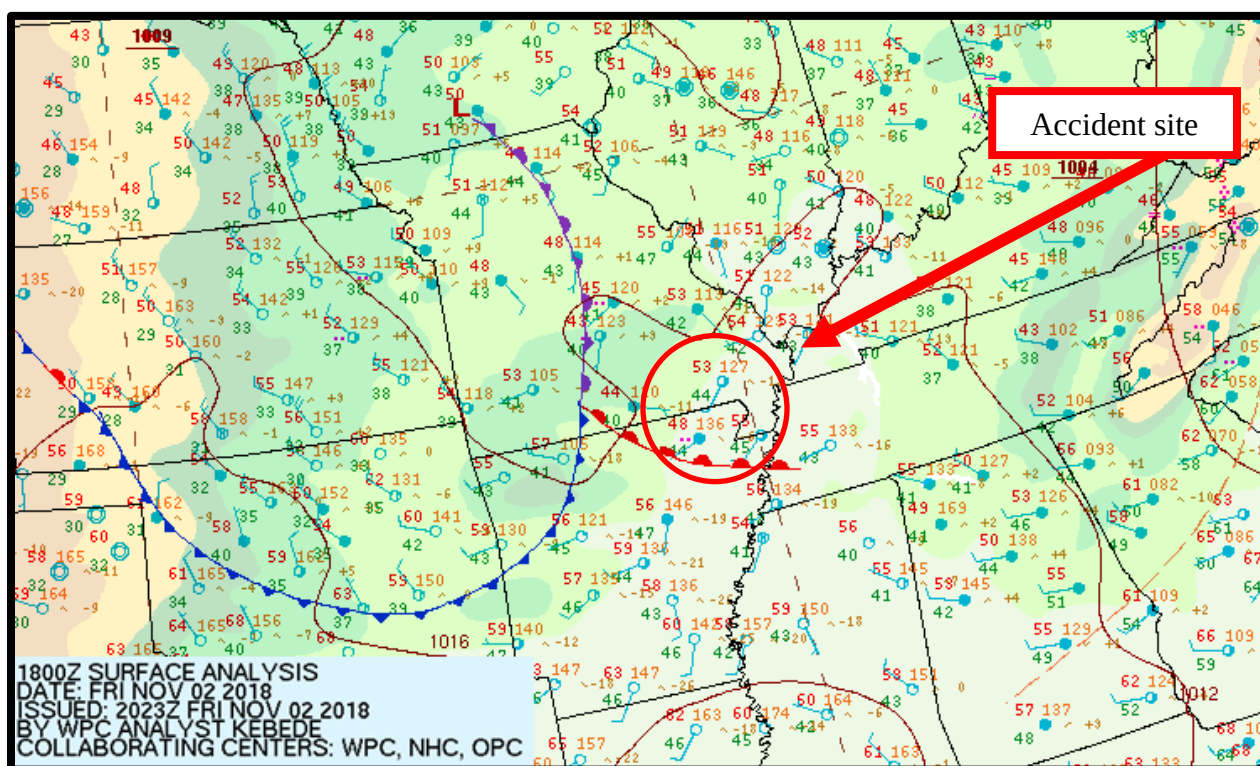


Figure 1 – NWS Surface Analysis Chart for 1300 CDT

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. At 925- through 300-hPa there were a low-, mid-, and upper-level troughs² located above the accident site. Troughs can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present. The wind was from the west at 20 knots at 925-hPa with the wind becoming northwesterly at 40 knots by 700-hPa (figure 4). At 300-hPa, the wind was from the northwest at 90 knots (figure 6).

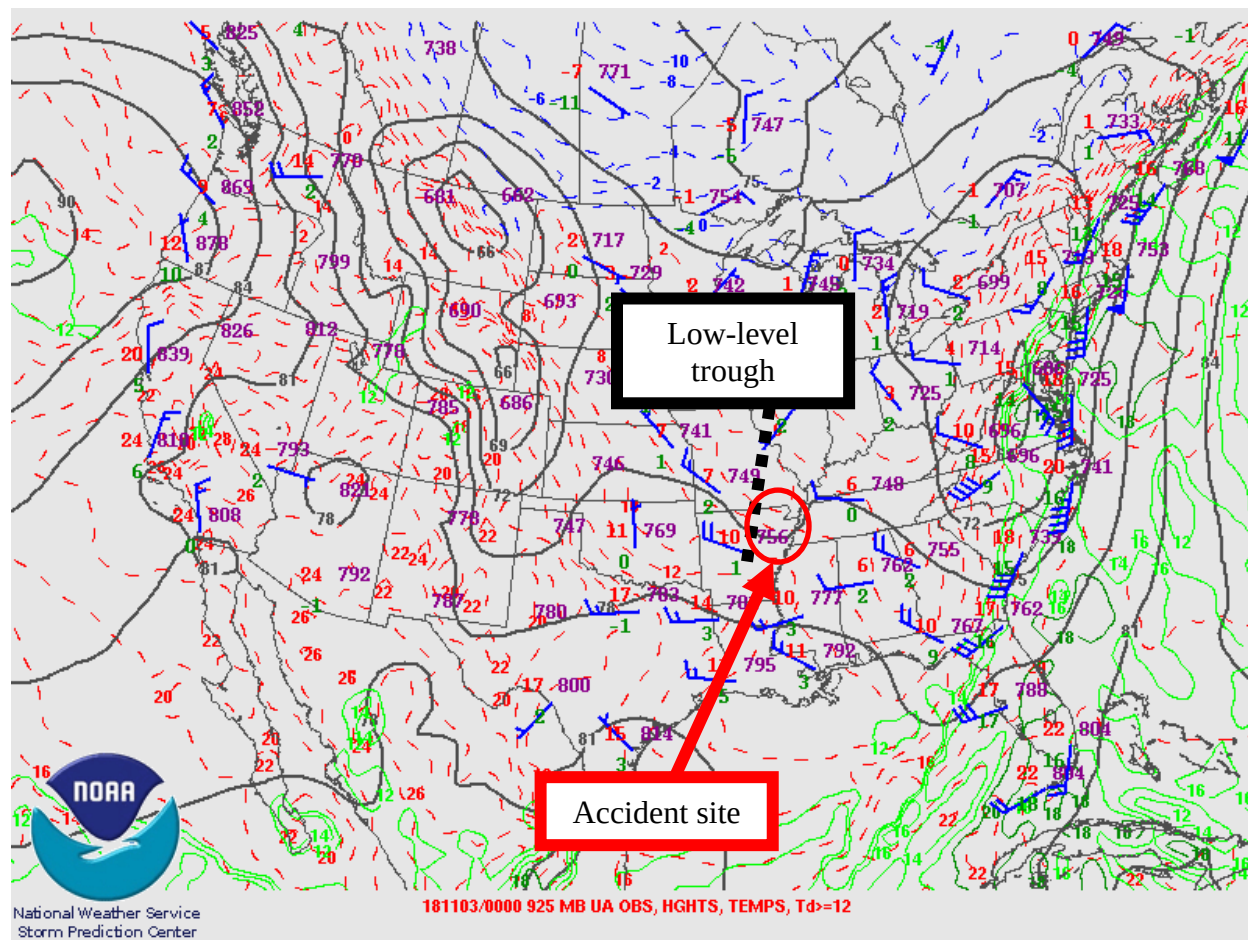


Figure 2 – 925-hPa Constant Pressure Chart for 1900 CDT

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

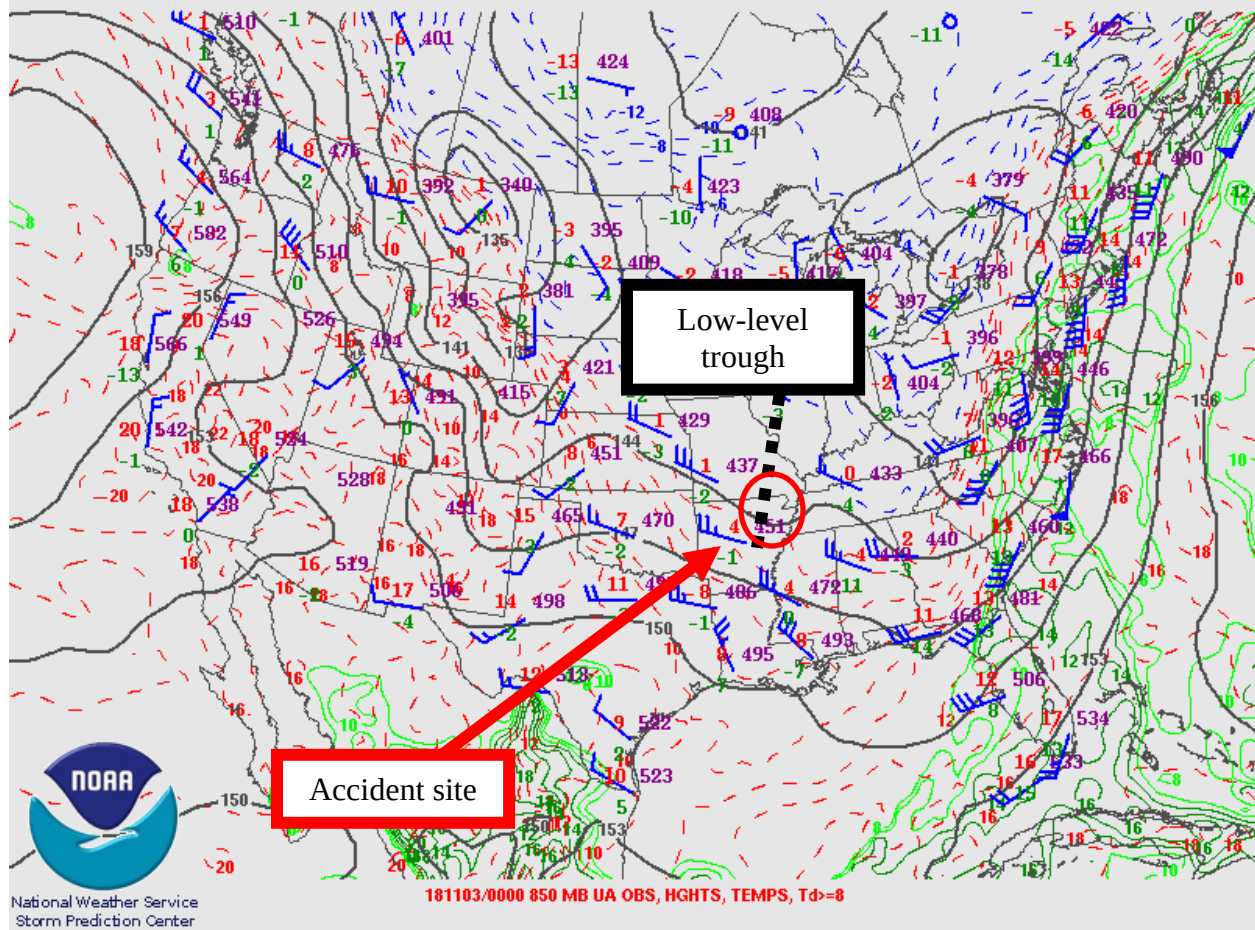


Figure 3 – 850-hPa Constant Pressure Chart for 1900 CDT

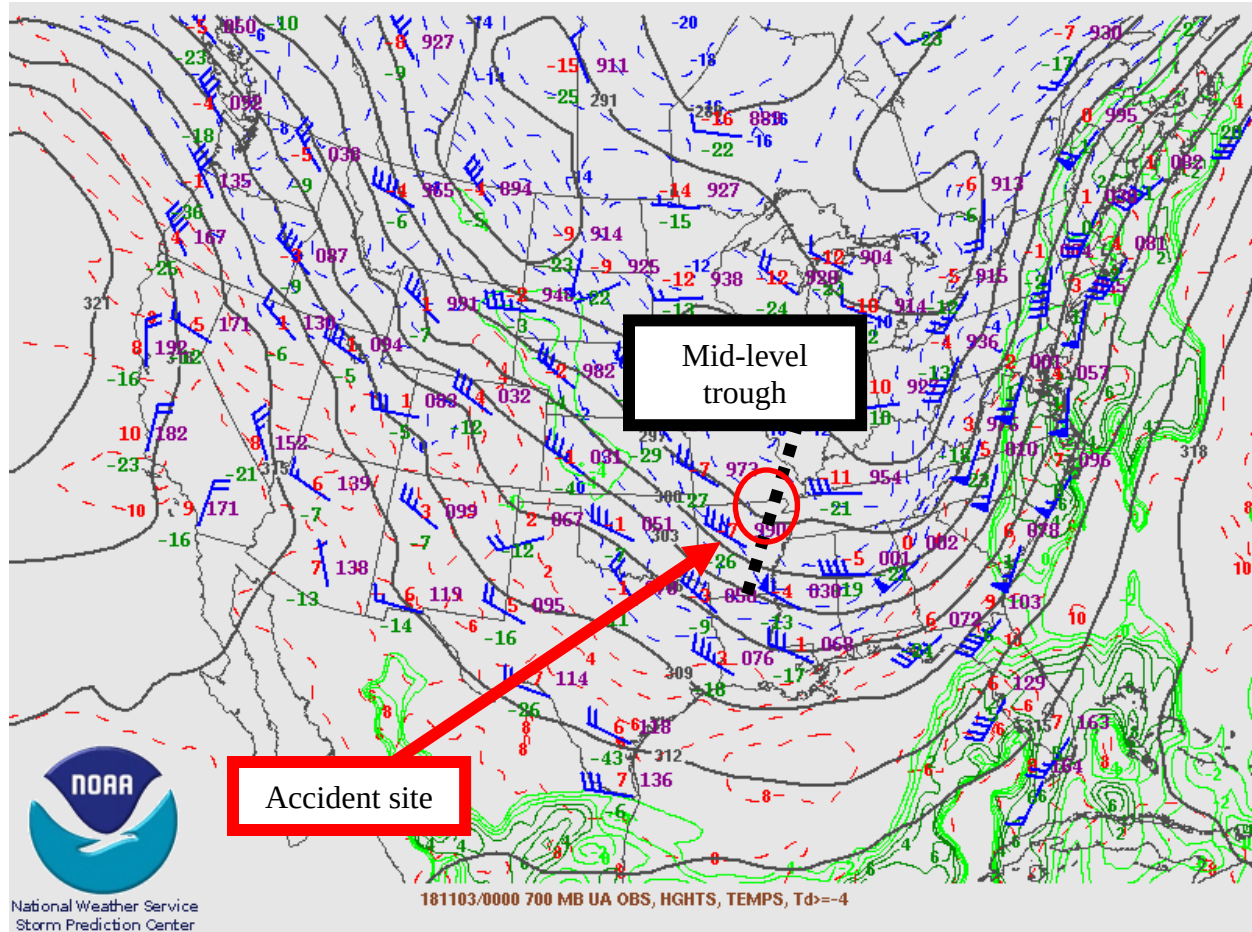


Figure 4 – 700-hPa Constant Pressure Chart for 1900 CDT

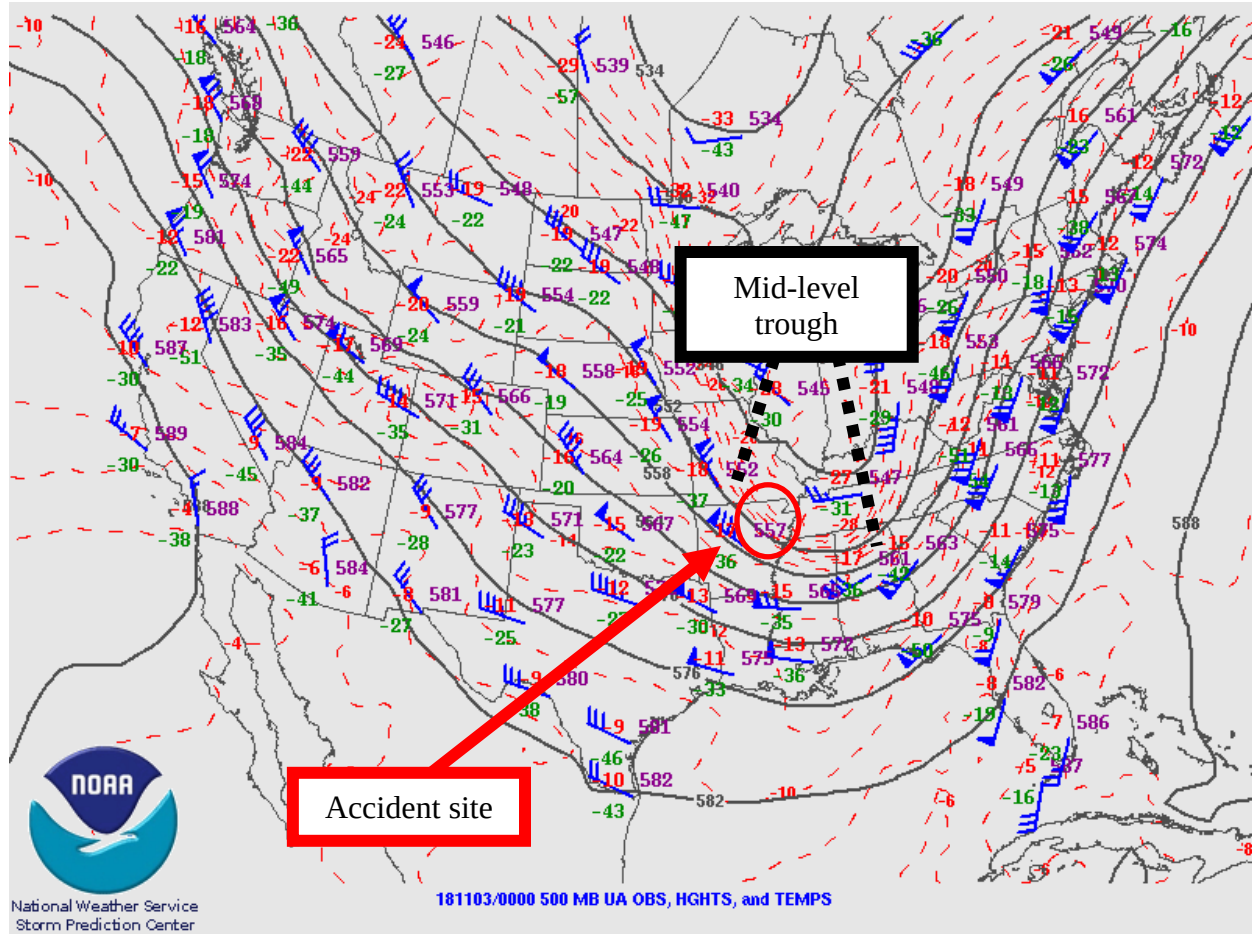


Figure 5 – 500-hPa Constant Pressure Chart for 1900 CDT

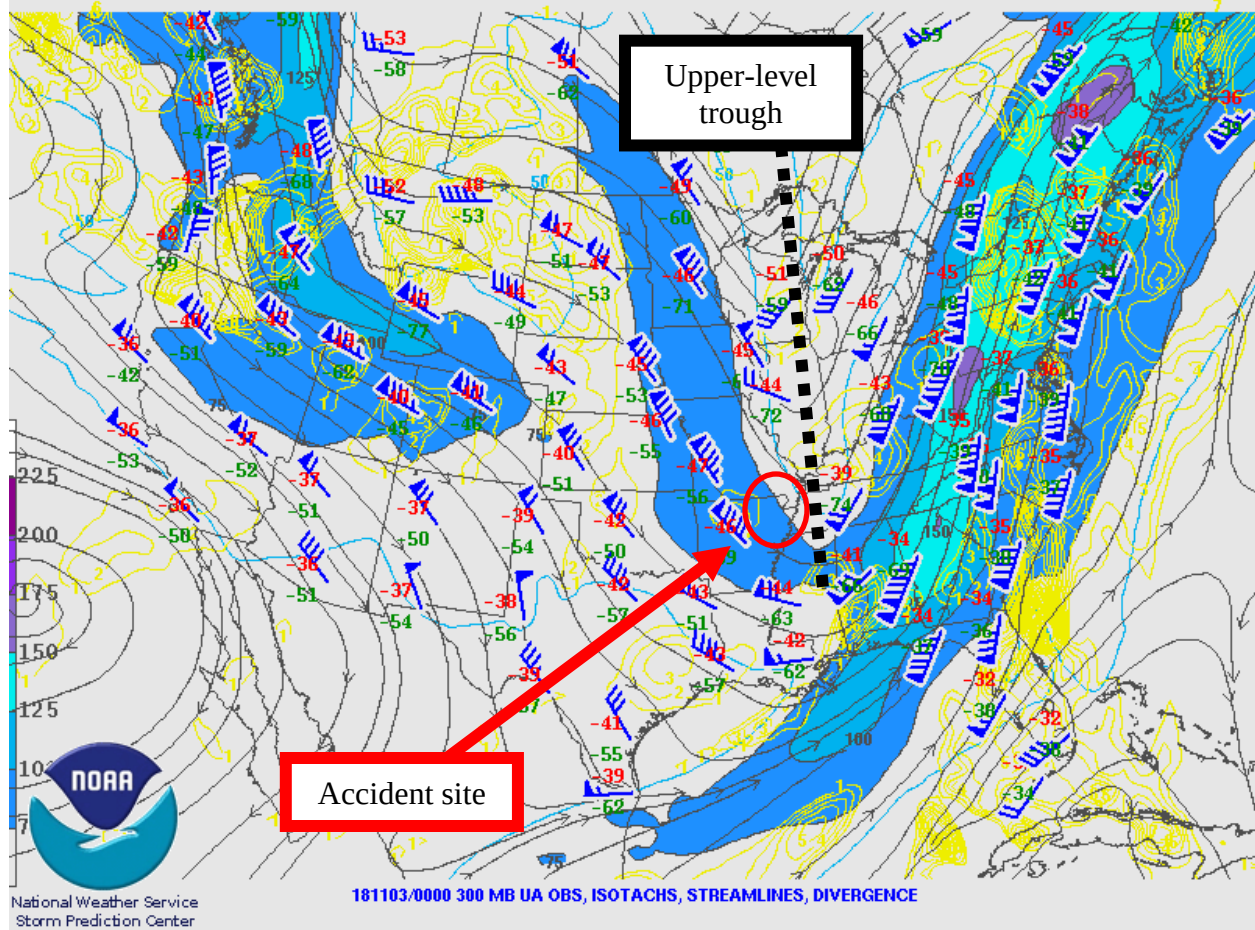


Figure 6 – 300-hPa Constant Pressure Chart for 1900 CDT

2.0 SPC Products

SPC issued the following Day 1 Convective Outlook at 1127 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. The SPC Day 1 Convective Outlook text follows figure 7:

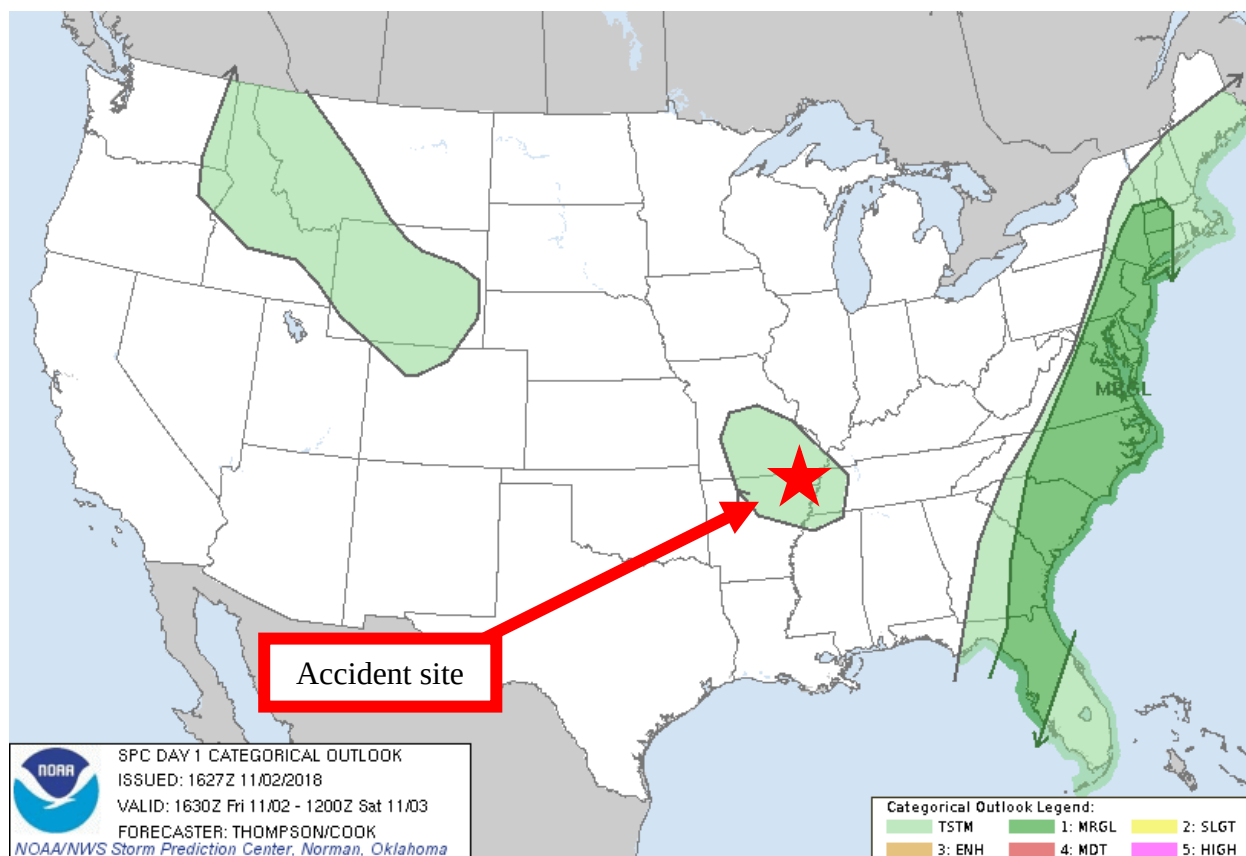


Figure 7 – SPC day 1 Convective Outlook valid at the time of the accident

SPC AC 021627

Day 1 Convective Outlook
 NWS Storm Prediction Center Norman OK
 1127 AM CDT Fri Nov 02 2018

Valid 021630Z - 031200Z

...THERE IS A MARGINAL RISK OF SEVERE THUNDERSTORMS THIS AFTERNOON INTO EARLY TONIGHT FROM THE SOUTHEAST ATLANTIC COAST INTO THE MID ATLANTIC REGION...

...SUMMARY...

Isolated damaging winds and a tornado or two will be possible this afternoon/evening, primarily from central North Carolina into parts of the Mid Atlantic region.

...Piedmont this afternoon/evening...

A lead shortwave trough over MS/AL this morning will eject quickly northeastward over the Appalachians, in advance of an amplifying midlevel trough (now over the MS Valley) that will reach the Mid Atlantic by tonight. Associated surface cyclogenesis is expected from the Piedmont this afternoon to southern New England overnight.

A moist low-level air mass is present east of the Appalachians (boundary-layer dewpoints in the 60s), though widespread clouds and

poor midlevel lapse rates will limit potential destabilization. Low-level mass response to the cyclogenesis will result in increasing low-level flow/shear by this evening near and just east of the path of the surface wave, across NC/VA/MD later this afternoon/evening. There will be some conditional tornado/damaging wind threat, though the depth/intensity of the convection is in question given the weak buoyancy/poor lapse rates. Will opt to maintain Marginal categorical risk for tornado/damaging winds, but will continue to monitor closely for later evidence of a small corridor of somewhat greater severe threat this afternoon along the path of the surface cyclone.

Farther south, some isolated stronger convective elements (within the larger precipitation areas) could pose a threat for strong wind gusts today from north FL into eastern SC.

..Thompson/Cook.. 11/02/2018

CLICK TO GET WUUS01 PTSDY1 PRODUCT

NOTE: THE NEXT DAY 1 OUTLOOK IS SCHEDULED BY 2000Z

3.0 Surface Observations

The area surrounding the accident site was documented using official Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). Figure 8 is a sectional chart with the accident site and the closest weather reporting locations to the accident site marked.

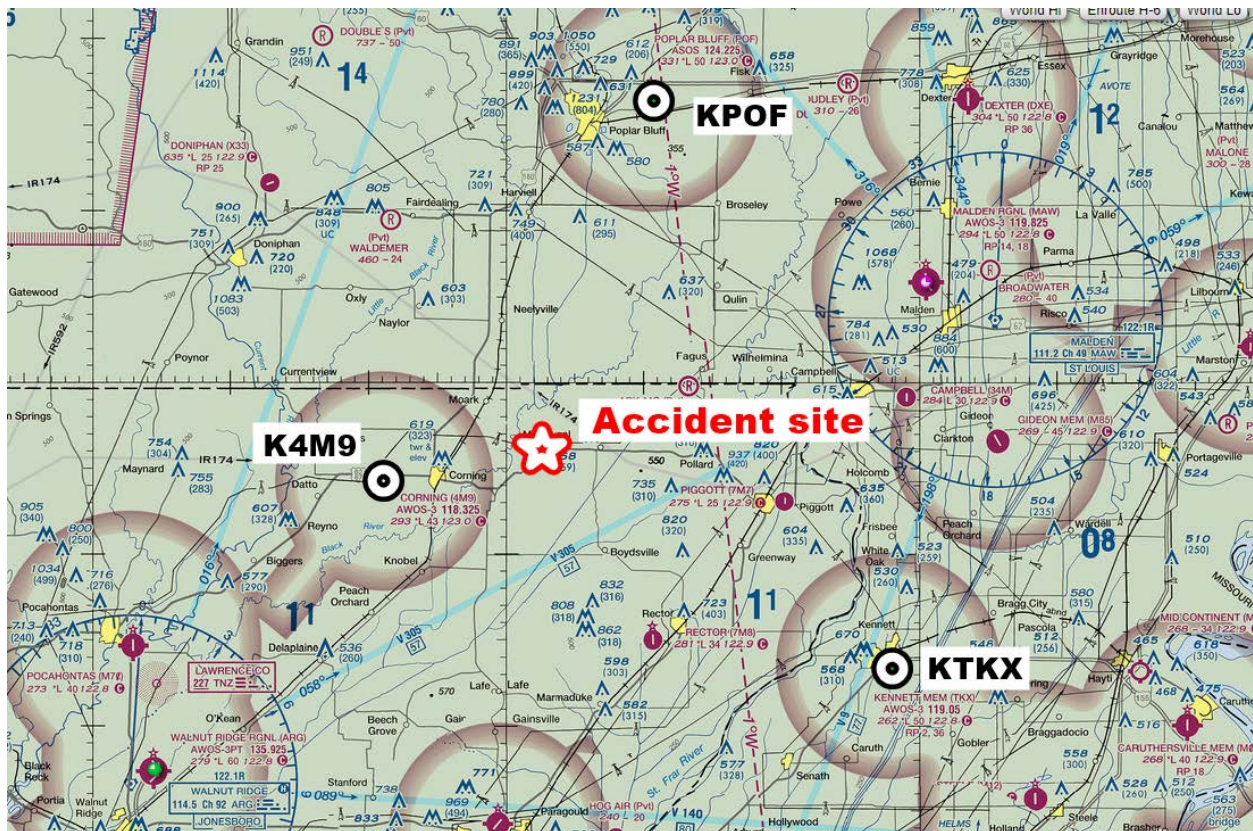


Figure 8 – Sectional chart of accident area with the location of the accident site and the closest surface observation sites

Corning Municipal Airport (K4M9) had the closest official weather observation point to the accident site, and was located 3 miles west of Corning, Arkansas. K4M9 had an Automated Weather Observing System (AWOS³) whose reports were not supplemented. K4M9 was located 10 miles west-southwest of the accident site, at an elevation of 293 ft, and had a 1° westerly magnetic variation⁴ (figure 8). The following observations were taken and disseminated during the times surrounding the accident:⁵

[1135 CDT] METAR K4M9 021635Z AUTO 23011KT 10SM CLR 12/08 A2994 RMK AO2 PWINO=

[1155 CDT] METAR K4M9 021655Z AUTO 21012KT 10SM CLR 11/08 A2993 RMK AO2 PWINO=

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. Latest measurement taken from <https://skyvector.com/>

⁵ Bolded sections in this report highlight information that directly reference the weather conditions that affected the accident location around the accident time.

[1215 CDT] METAR K4M9 021715Z AUTO 22010KT 10SM CLR 11/08 A2993 RMK
AO2 PWINO=
[1235 CDT] METAR K4M9 021735Z AUTO 24012KT 10SM CLR 11/08 A2992 RMK
AO2 PWINO=
**[1255 CDT] METAR K4M9 021755Z AUTO 24010KT 10SM FEW021 11/08 A2992 RMK
AO2 PWINO=**
**[1315 CDT] METAR K4M9 021815Z AUTO 25012KT 10SM FEW022 FEW027 10/08
A2992 RMK AO2 PWINO=**

ACCIDENT TIME 1320 CDT

**[1335 CDT] METAR K4M9 021835Z AUTO 24010G17KT 6SM BR CLR 09/08 A2992
RMK AO2 PWINO=**
**[1355 CDT] METAR K4M9 021855Z AUTO 26008KT 9SM CLR 09/09 A2991 RMK AO2
PWINO=**
[1415 CDT] METAR K4M9 021915Z AUTO 25008KT 10SM CLR 09/09 A2991 RMK
AO2 PWINO=

K4M9 weather at 1255 CDT, automated, wind from 240° at 10 knots, 10 miles visibility or greater, few clouds at 2,100 ft above ground level (agl), temperature of 11° Celsius (C), dew point temperature of 8° C, and an altimeter setting of 29.92 inches of mercury. Remarks: automated station with a precipitation discriminator, precipitation identifier sensor not available.

K4M9 weather at 1315 CDT, automated, wind from 250° at 12 knots, 10 miles visibility or greater, few clouds at 2,200 ft agl, few clouds at 2,700 ft agl, temperature of 10° C, dew point temperature of 8° C, and an altimeter setting of 29.92 inches of mercury. Remarks: automated station with a precipitation discriminator, precipitation identifier sensor not available.

K4M9 weather at 1335 CDT, automated, wind from 240° at 10 knots with gusts to 17 knots, 6 miles visibility, mist, clear skies below 12,000 ft agl, temperature of 9° C, dew point temperature of 8° C, and an altimeter setting of 29.92 inches of mercury. Remarks: automated station with a precipitation discriminator, precipitation identifier sensor not available.

K4M9 weather at 1355 CDT, automated, wind from 260° at 8 knots, 9 miles visibility, clear skies below 12,000 ft agl, temperature of 9° C, dew point temperature of 9° C, and an altimeter setting of 29.91 inches of mercury. Remarks: automated station with a precipitation discriminator, precipitation identifier sensor not available.

Poplar Bluff Municipal Airport (KPOF) was the next closest official weather observation point to the accident site. KPOF had an Automated Surface Observing System (ASOS⁶) whose reports were not supplemented. KPOF was located 21 miles northwest of the accident site at an elevation of 331 ft (figure 8). The following observations were taken and disseminated during the times surrounding the accident:

[0826 CDT] SPECI KPOF 021326Z AUTO 23005KT 10SM SCT004 06/06 A2994 RMK
AO2 T00610061=

[0853 CDT] METAR KPOF 021353Z AUTO 23006KT 10SM FEW003 07/07 A2993 RMK
AO2 SLP138 T00720067=

[0953 CDT] METAR KPOF 021453Z AUTO 24005KT 10SM CLR 08/06 A2994 RMK
AO2 SLP139 T00780061 51008=

[1053 CDT] METAR KPOF 021553Z AUTO 23003KT 10SM CLR 10/07 A2993 RMK
AO2 SLP137 T01000067=

**[1153 CDT] METAR KPOF 021653Z AUTO 23008KT 10SM CLR 12/07 A2992 RMK
AO2 SLP134 T01170067=**

**[1253 CDT] METAR KPOF 021753Z AUTO 22011KT 10SM BKN110 12/07 A2990 RMK
AO2 SLP127 T01170067 10117 20039 58012=**

ACCIDENT TIME 1320 CDT

**[1353 CDT] METAR KPOF 021853Z AUTO 22014G19KT 10SM FEW028 SCT100 SCT110
11/06 A2988 RMK AO2 SLP122 T01110061=**

**[1453 CDT] METAR KPOF 021953Z AUTO 24011G19KT 10SM BKN070 OVC085 10/06
A2988 RMK AO2 SLP120 T01000061=**

[1553 CDT] METAR KPOF 022053Z AUTO 25005KT 10SM OVC060 09/06 A2989 RMK
AO2 SLP122 T00940056 55005=

[1653 CDT] METAR KPOF 022153Z AUTO 31003KT 10SM -RA OVC050 09/06 A2989
RMK AO2 RAB41 SLP124 P0000 T00890061=

KPOF weather at 1153 CDT, automated, wind from 230° at 8 knots, 10 miles or greater visibility, clear skies below 12,000 ft agl, temperature of 12° C, dew point temperature of 7° C, and an altimeter setting of 29.92 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1013.4 hPa, temperature 11.7° C, dew point temperature 6.7° C.

⁶ ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, ceiling, temperature, dewpoint, altimeter, and barometric pressure.

KPOF weather at 1253 CDT, automated, wind from 220° at 11 knots, 10 miles or greater visibility, broken ceiling at 11,000 ft agl, temperature of 12° C, dew point temperature of 7° C, and an altimeter setting of 29.90 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1012.7 hPa, temperature 11.7° C, dew point temperature 6.7° C, 6-hourly maximum temperature of 11.7° C, 6-hourly minimum temperature of 3.9° C, 3-hourly pressure decrease of 1.2 hPa.

KPOF weather at 1353 CDT, automated, wind from 220° at 14 knots with gusts to 19 knots, 10 miles or greater visibility, few clouds at 2,800 ft agl, scattered clouds at 10,000 ft agl, scattered clouds at 11,000 ft agl, temperature of 11° C, dew point temperature of 6° C, and an altimeter setting of 29.88 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1012.2 hPa, temperature 11.1° C, dew point temperature 6.1° C.

KPOF weather at 1453 CDT, automated, wind from 240° at 11 knots with gusts to 19 knots, 10 miles or greater visibility, broken ceiling at 7,000 ft agl, overcast skies at 8,500 ft agl, temperature of 10° C, dew point temperature of 6° C, and an altimeter setting of 29.88 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1012.0 hPa, temperature 10.0° C, dew point temperature 6.1° C.

The observations from K4M9 and KPOF surrounding the accident time indicated VFR⁷ conditions, however, the winds increased in magnitude with gusts to 19 knots out of the southwest.

⁷ Visual Flight Rules – Refers to the general weather conditions pilots can expect at the surface. VFR criteria means a ceiling greater than 3,000 feet agl and greater than 5 miles visibility.

4.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR)⁸ model sounding was created for the accident site for 1300 CDT with station elevation of 262 ft.⁹ The 1300 CDT HRRR sounding was plotted on a standard Skew-T Log P diagram¹⁰ with the derived stability parameters included in figure 9 (with data from the surface to 700-hPa (or approximately 10,000 ft msl). This data was analyzed using the RAOB¹¹ software package. The sounding depicted the lifted condensation level (LCL)¹² at 1,568 ft agl (1,830 ft msl), the level of free convection (LFC)¹³ at 1,568 ft agl (1,830 ft msl), and the convective condensation level (CCL)¹⁴ at 3,268 ft agl (3,530 ft msl). The sounding had a greater than 80% relative humidity from ~1,600 ft msl through 12,000 ft msl. The freezing level was located at 4,979 ft msl. Based on the accident aircraft's flight altitudes there were no icing issues in this accident. The precipitable water value was 0.59 inches.

⁸ 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.

⁹ HRRR sounding was created using NOAA Air Resource Laboratory: <https://ready.arl.noaa.gov/READYamet.php>

¹⁰ 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.

¹¹ RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.

¹² LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

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.

¹⁴ 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.

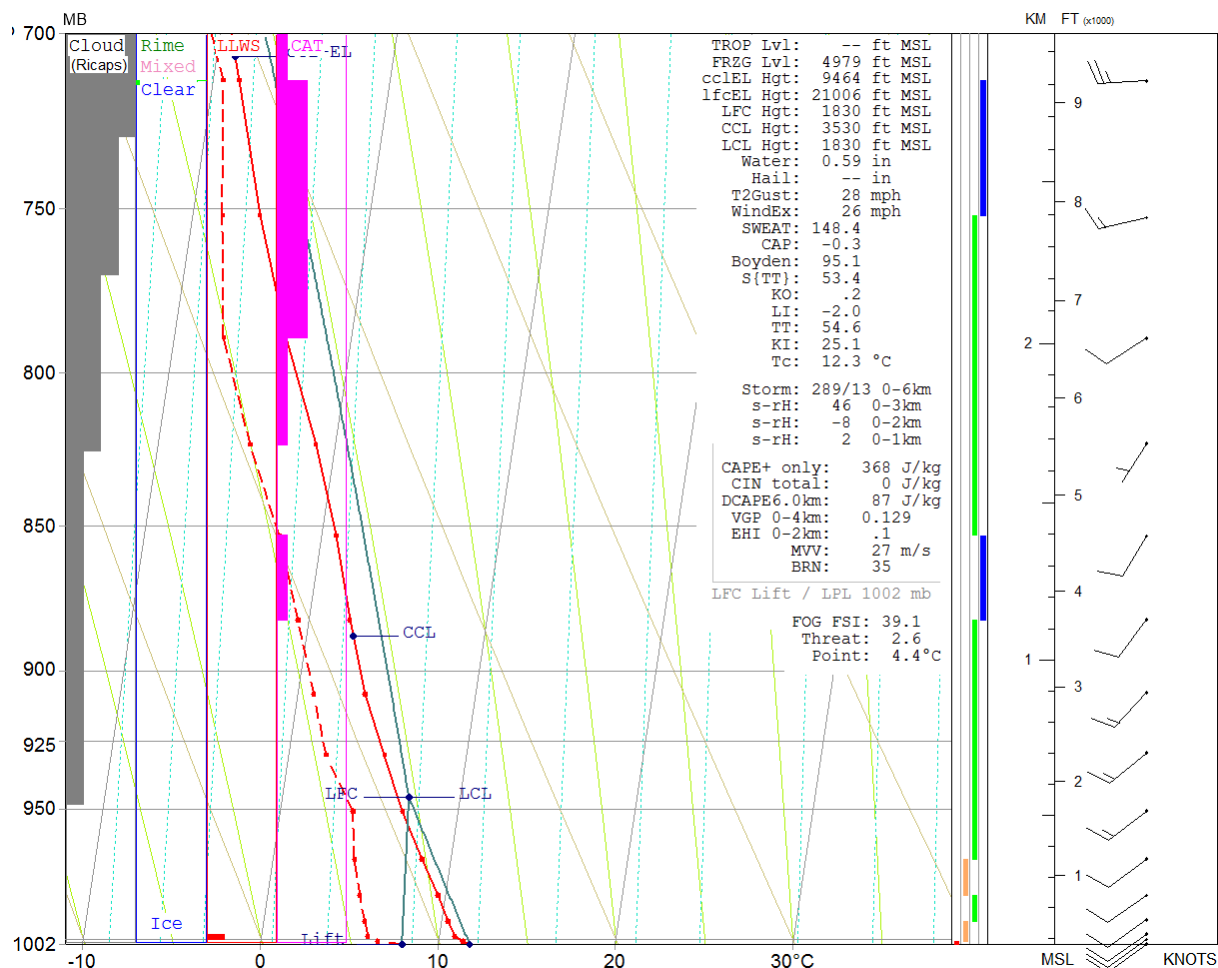


Figure 9 – 1300 CDT HRRR sounding for the accident site

The 1300 CDT HRRR sounding for the accident site indicated an unstable to conditionally unstable environment from the surface through 3,600 ft, with a stable layer above 3,600 ft through 4,500 ft. RAOB identified the possibility of clouds above 2,000 ft msl. 368 Joules/kilogram (J/kg) of CAPE¹⁵ were indicated on the sounding with the maximum vertical velocity (MVV) for this atmosphere was calculated as 27 meters/second (about 5,315 ft per minute).¹⁶ Downdraft CAPE (DCAPE; 6 kilometers agl)¹⁷ was measured at 87 J/kg. If rain showers or thunderstorms formed the 1300 CDT HRRR sounding indicated the strongest wind speeds possible with a microburst, outflow boundary, or gust front would have been 28 mph (24 knots) as indicated by the T2Gust parameter, or 26 mph (23 knots) as indicated by the WindEx parameter.¹⁸

¹⁵ 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.

¹⁶ 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.

¹⁷ 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.

¹⁸ Similar conditions were seen on the 1400 CDT HRRR sounding.

The 1300 CDT HRRR sounding wind profile indicated a surface wind from 232° at 9 knots with the wind remaining between 10 and 20 knots through 10,000 ft. The wind direction remained west-southwest to westerly through 10,000 ft. RAOB indicated a small chance of very light low-level wind shear (LLWS) between the surface and 240 ft agl (~500 ft msl). RAOB indicated a small chance of clear-air turbulence existed between 4,000 ft msl and 10,000 ft msl.

5.0 Satellite Data

Data from the Geostationary Operational Environmental Satellite number 16 (GOES-16) data was obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System software. Visible and infrared (bands 2 and 13) imagery at wavelengths of 0.64 microns (μm) and 10.3 μm were retrieved for the period. Satellite imagery surrounding the time of the accident, from 1100 CDT through 1600 CDT at approximately 5-minute intervals were reviewed, and the closest images to the time of the accident are documented here.

Figure 10 presents the GOES-16 visible imagery from 1330 CDT at 2X magnification with the accident site highlighted with a red square. Inspection of the visible imagery indicated cloud cover over the accident site at the accident time. The cloud cover was moving from west to east at the accident time (attachment 1). Figure 11 presents the GOES-16 infrared imagery from 1330 CDT 5X 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 (bright yellow and green colors; higher cloud tops) were located over the accident site at the accident time. Based on the brightness temperatures above the accident site (244° Kelvin) and the vertical temperature profile provided by the 1400 CDT HRRR sounding, the approximate cloud-top heights over the accident site were 18,500 ft at 1330 CDT. It should be noted these figures have not been corrected for any parallax error.

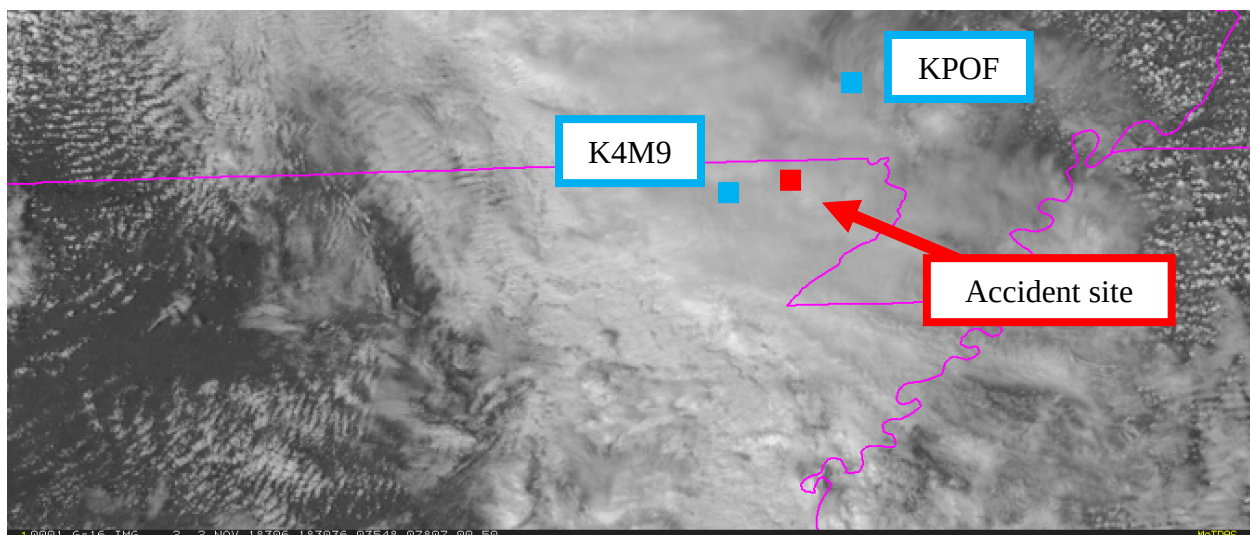


Figure 10 – GOES-16 visible image at 1330 CDT

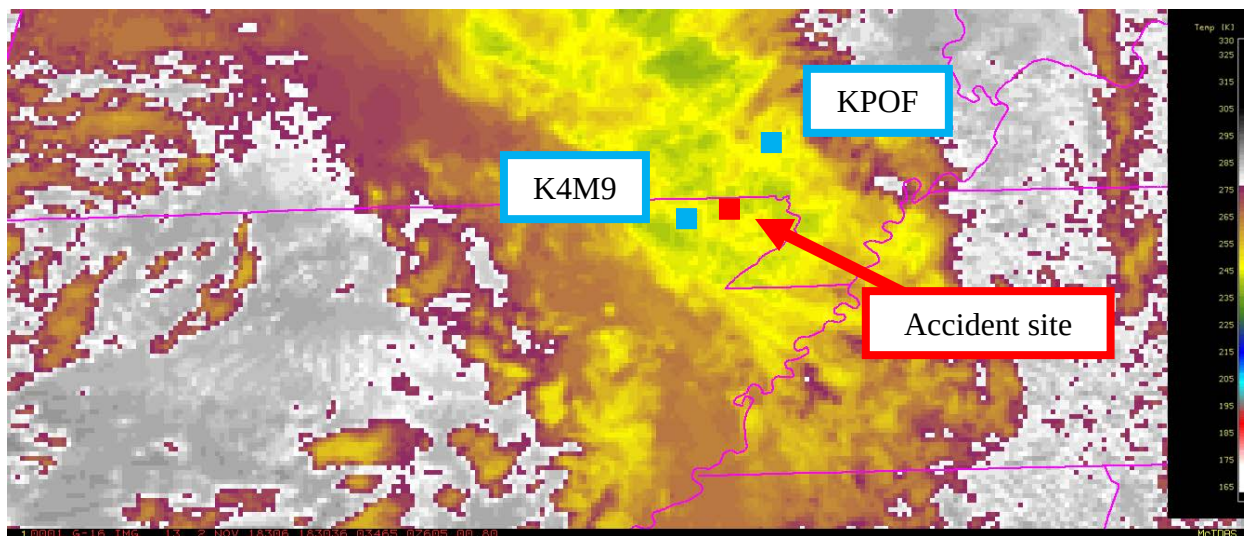


Figure 11 – GOES-16 infrared image at 1330 CDT

6.0 Regional Radar Imagery Information

A regional view of the NWS national composite radar mosaic is included as figure 12 for 1330 CDT with the approximate accident site marked by a red circle. The image depicted 20 to 30 decibels (dBZ¹⁹) echoes near the accident site.

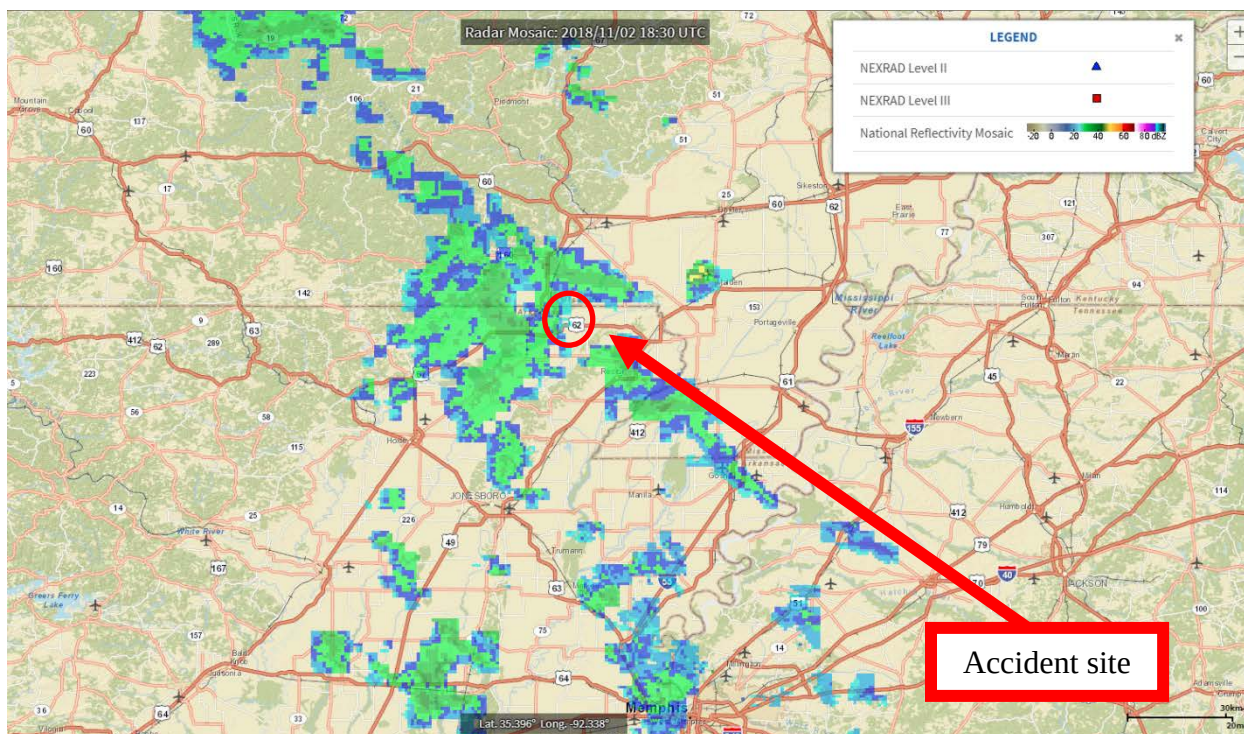


Figure 12 – Regional Composite Reflectivity image for 1330 CDT

¹⁹ 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.

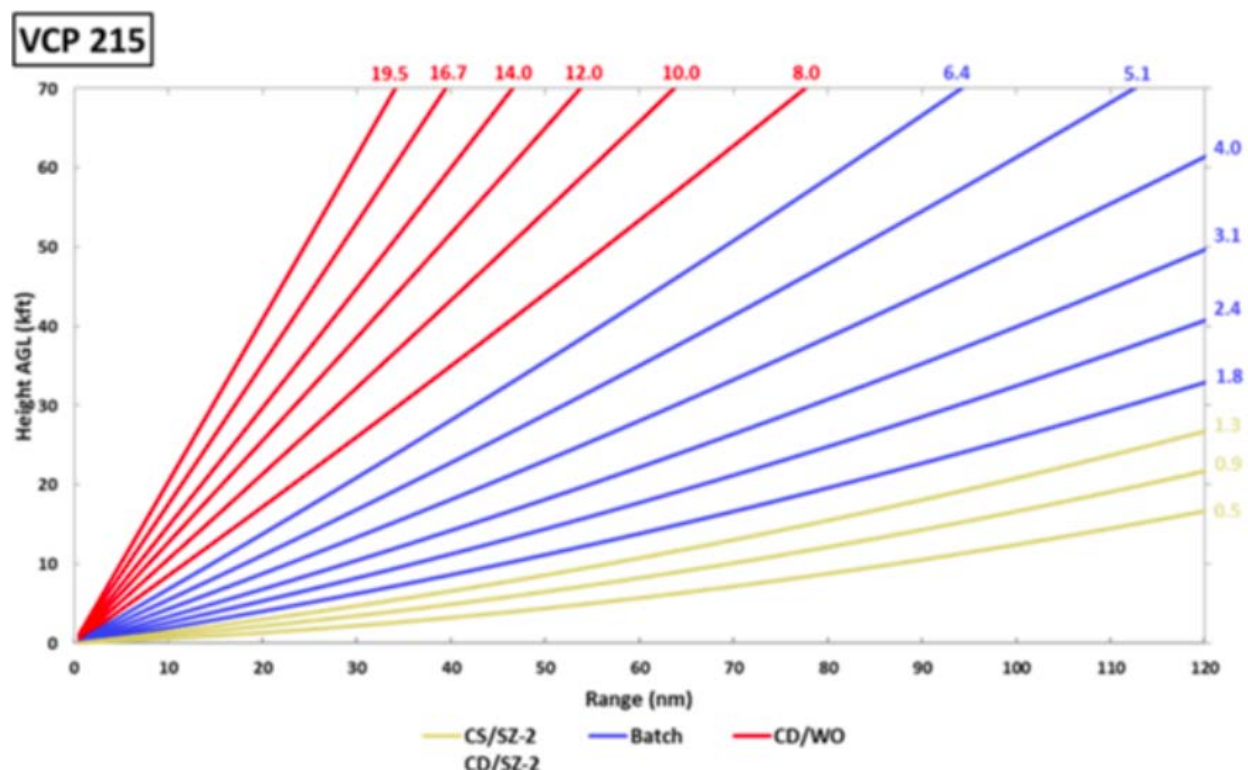
7.0 Radar Imagery Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)²⁰ to the accident site was Memphis, (KNQA), Tennessee, which was located 71 miles southeast of the accident site. Level II archive radar data was 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° around 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 KNQA 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.



²⁰ 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 Strategy²¹

7.2 Beam Height Calculation

Assuming standard refraction²² of the KNQA WSR-88D radar beam, at an elevation of 435 ft and considering a beamwidth²³ of 0.95°, the following table shows the approximate heights for the radar beam center, top and base for the 0.5° antenna elevation over the accident site. These heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
0.5°	7,860 ft	4,360 ft	11,360 ft

Based on the radar height calculations, the 0.5° elevation scan depicted the conditions between 4,360 ft and 11,360 ft msl over the accident site and these scans are the closest altitudes to the surface and the accident aircraft's altitude before the accident occurred.

7.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²⁴ 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 00-24C²⁵, "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

²¹ 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)

²² Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

²³ Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

²⁴ 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.

²⁵

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

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.

7.4 Base Reflectivity and Lightning Data

Figures 13, 14, and 15 present the KNQA WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 1323:38, 1330:18, and 1337:12 CDT with a resolution of 0.5° X 250 m. Reflectivity values between 20 and 34 dBZ moved from west to east above the accident site at the accident time. These reflectivity values would correspond to light to moderate precipitation and occurred at the same time as the wind gusts increased to 17 knots at K4M9 at 1335 CDT (section 3.0).

There were no lightning flashes²⁶ around the accident site at the accident time.²⁷

²⁶ 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.

²⁷ A review of Earth Networks Total Lightning network was done.

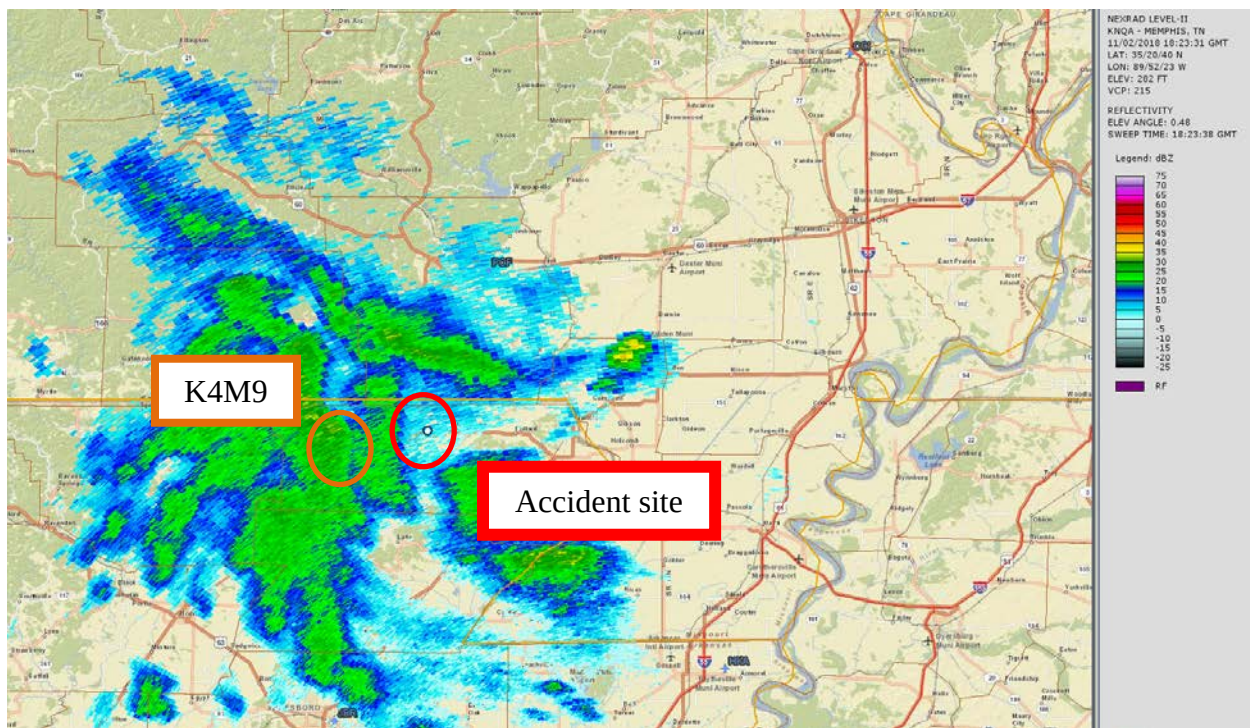


Figure 13 – KNQA WSR-88D reflectivity for the 0.5° elevation scan initiated at 1323:38 CDT

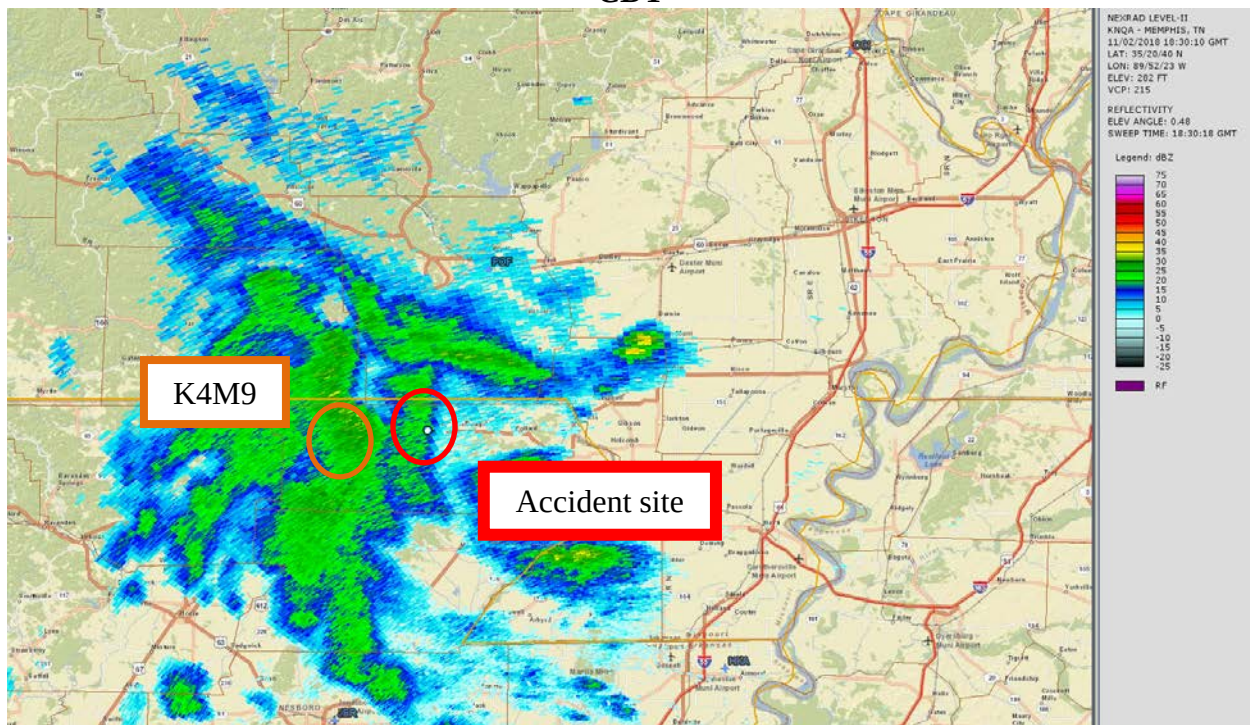


Figure 14 – KNQA WSR-88D reflectivity for the 0.5° elevation scan initiated at 1330:18 CDT

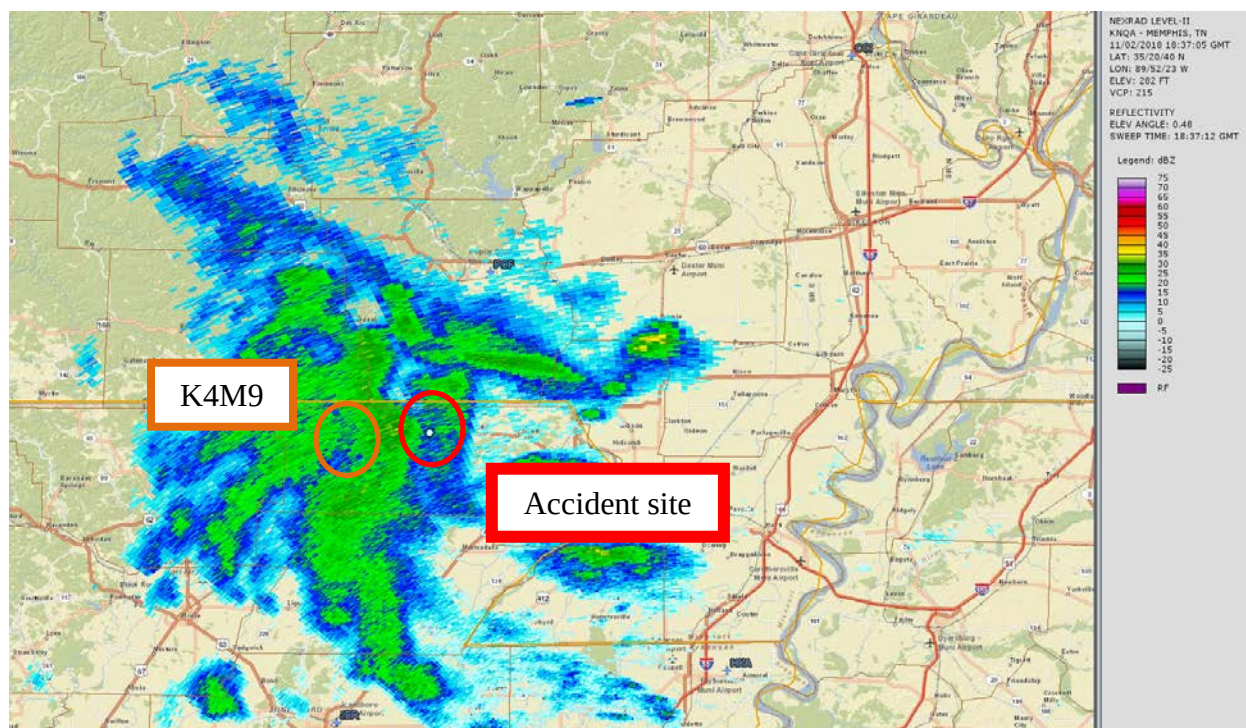


Figure 14 – KNQA WSR-88D reflectivity for the 0.5° elevation scan initiated at 1337:12 CDT

8.0 Pilot Reports²⁸

All PIREPs within 100 miles of the accident site from about one hour prior to the accident time to about one hour after the accident time were reviewed. Only PIREPs for below FL200²⁹ are provided below:

LIT UA /OV ARG300030/TM 1735/FL040/TP C206/IC TRACE RIME/RM ZME

BNA UA /OV MKL/TM 1753/FL060/TP M20P/IC LGT MX/RM ZME

JBR UA /OV ARG/TM 1820/FL040/TP BE36/TA 02/IC LGT RIME 040-060/RM ZME

The decoded PIREPs in plain language from standard code and abbreviation were as follows:

Routine pilot report (UA), Little Rock, Arkansas (LIT); Over – 30 miles from Walnut Ridge, Arkansas, (ARG) on the 300° radial; Time – 1235 CDT (1735Z); Altitude – 4,000 ft; Type aircraft – Cessna 206; Icing – Trace rime; Remarks – Memphis Air Route Traffic Control Center (ZME).

²⁸ Only pilot reports with the World Meteorological Organization (WMO) header UBAR**, UBMO**, UBIL**, UBKY**, UBTN**, and UBMS** identifier were considered.

²⁹ Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of ft. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the average sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

Routine pilot report (UA), Nashville, Tennessee (BNA); Over – Jackson, Tennessee (MKL); Time – 1253 CDT (1753Z); Altitude – 6,000 ft; Type aircraft – Mooney M20; Icing – Light mixed; Remarks – ZME.

Routine pilot report (UA), Jonesboro, Arkansas (JBR); Over – ARG; Time – 1320 CDT (1820Z); Altitude – 4,000 ft; Type aircraft – Beechcraft Bonanza; Temperature – 2° C; Icing – Light rime between 4,000 and 6,000 ft; Remarks – ZME.

9.0 SIGMET

There were no convective or non-convective Significant Meteorological Information (SIGMET) advisories valid for the accident site at the accident time.

10.0 CWSU Advisories

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

11.0 AIRMETs

There was Airmen's Meteorological Information (AIRMET) advisory Zulu that was valid for the accident site at the accident time. The 0945 CDT AIRMET warned of moderate icing conditions between the freezing level³⁰ and FL180. The 1201 CDT AIRMET Zulu, which amended the 0945 CDT AIRMET, warned of the same moderate icing conditions:

WAUS43 KPCI 021445

WA3Z

-CHIZ WA 021445

AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 022100

.

...SEE SIGMET WHISKEY SERIES...

.

AIRMET ICE...ND SD NE

FROM 50NNW ISN TO 50NE ISN TO 20SSW BIS TO 40ENE AKO TO BFF TO 70SW RAP TO 50NNW ISN

MOD ICE BTN FRZLVL AND FL200. FRZLVL SFC-060. CONDS DVLPG AFT 15Z. CONDS CONTG BYD 21Z THRU 03Z.

.

AIRMET ICE...SD KS MN IA MO WI IL IN KY AR TN MS AL

FROM 40SW BRD TO 20WNW DLL TO PXV TO MSL TO 20NW IGB TO 30NE TXK TO 40S FSM TO 30E OVR TO 30N FSD TO 40SW BRD

MOD ICE BTN FRZLVL AND FL180. FRZLVL 030-070. CONDS CONTG BYD 21Z THRU 03Z.

.

AIRMET ICE...MN MO WI LM LS MI LH IL IN KY TN

FROM YQT TO SSM TO YVV TO 30SE ECK TO FWA TO CVG TO 30W HNN TO 50WNW VXV TO 30ESE BNA TO 20N MSL TO 20NNW PXV TO 50SSW JOT TO 30NE BAE TO YQT

MOD ICE BTN 030 AND 120. CONDS CONTG BYD 21Z THRU 03Z.

³⁰ Freezing level between 3,000 and 7,000 ft.

.
AIRMET ICE...ND SD MN WI LS
FROM 40NNE INL TO 30NNW DLH TO 40NNE EAU TO 20WNW DLL TO 40SW BRD
TO 40N FSD TO 20NE ABR TO 70NE MOT TO 40NNE INL
MOD ICE BTN FRZLVL AND 150. FRZLVL 010-030. CONDS CONTG BYD 21Z
THRU 03Z.

.
OTLK VALID 2100-0300Z
AREA 1...ICE SD NE KS
BOUNDED BY 80SW DIK-40S PIR-30WNW OVR-70ESE SLN-20NNE ICT-20S
HLC-40ENE LAA-GLD-BFF-70SW RAP-80SW DIK
MOD ICE BTN FRZLVL AND FL220. FRZLVL 020-100. CONDS CONTG THRU
03Z.

.
AREA 2...ICE MI LH IL IN KY TN
BOUNDED BY 70NW YVV-YVV-30SE ECK-FWA-CVG-HNN-HMV-50SSW VXV-20ESE
BNA-40SW TTH-40WSW FWA-70NW YVV
MOD ICE BTN 040 AND 120. CONDS CONTG THRU 03Z.

.
AREA 3...ICE IA MO WI IL IN KY AR TN MS AL
BOUNDED BY 60SW BAE-40SE BDF-30ENE AXC-30ESE BNA-GQO-40W
VUZ-60ESE LIT-30WNW IRK-40SW FOD-30SW DBQ-60SW BAE
MOD ICE BTN FRZLVL AND FL180. FRZLVL 030-070. CONDS CONTG THRU
03Z.

.
AREA 4...ICE ND SD MN IA WI LS IL
BOUNDED BY 70SW YWG-30N INL-80WNW YQT-40N DLH-50SSE DLH-50SW
RHI-60SW BAE-30SW DBQ-40SW FOD-70SW YWG
MOD ICE BTN FRZLVL AND 150. FRZLVL 010-040. CONDS CONTG THRU 03Z.

.
AREA 5...ICE ND SD NE
BOUNDED BY 60NNW MOT-50NNE MOT-60E MOT-40SE ABR-30E ONL-80SW
DIK-50NNW ISN-60NNW MOT
MOD ICE BTN FRZLVL AND FL200. FRZLVL SFC-060. CONDS CONTG THRU
03Z.

.
FRZLVL...RANGING FROM 010-100 ACRS AREA
MULT FRZLVL 040-090 BOUNDED BY 70SSW ISN-60ESE LBF-20SSW MCK-
20NW GLD-BFF-70SW RAP-70SSW ISN
MULT FRZLVL 040-090 BOUNDED BY CVG-HNN-50WSW BKW-30SW VXV-
30SE BNA-CVG
MULT FRZLVL 050-100 BOUNDED BY GQO-LGC-MGM-30SW LCH-30NNE IAH-
30SW IGB-20NE MSL-GQO
040 ALG 80SW DIK-50S ANW-20NW OBH-20W FSD-50SE RWF-40E PXV-
60E CVG
080 ALG 40E LAA-20W GCK-30E LBL

....

WAUS43 KPCI 021701 AAA
WA3Z
-CHIZ WA 021701 AMD
AIRMET ZULU UPDT 4 FOR ICE AND FRZLVL VALID UNTIL 022100

.
AIRMET ICE...ND SD NE
FROM 50NNW ISN TO 50NE ISN TO 20SSW BIS TO 40ENE AKO TO BFF TO
70SW RAP TO 50NNW ISN

MOD ICE BTN FRZLVL AND FL200. FRZLVL SFC-060. CONDS DVLPG AFT 15Z. CONDS CONTG BYD 21Z THRU 03Z.

.
AIRMET ICE...SD KS MN IA MO WI IL IN KY AR TN MS AL
FROM 40SW BRD TO 20WNW DLL TO PXV TO MSL TO 20NW IGB TO 30NE TXK
TO 40S FSM TO 30E OVR TO 30N FSD TO 40SW BRD
MOD ICE BTN FRZLVL AND FL180. FRZLVL 030-070. CONDS CONTG BYD 21Z
THRU 03Z.

.
AIRMET ICE...MN MO WI LM LS MI LH IL IN KY TN
FROM YQT TO SSM TO YVV TO 30SE ECK TO FWA TO CVG TO 30W HNN TO
50WNW VXV TO 30ESE BNA TO 20N MSL TO 20NNW PXV TO 50SSW JOT TO
30NE BAE TO YQT
MOD ICE BTN 030 AND 120. CONDS CONTG BYD 21Z THRU 03Z.

.
AIRMET ICE...ND SD MN WI LS
FROM 40NNE INL TO 30NNW DLH TO 40NNE EAU TO 20WNW DLL TO 40SW BRD
TO 40N FSD TO 20NE ABR TO 70NE MOT TO 40NNE INL
MOD ICE BTN FRZLVL AND 150. FRZLVL 010-030. CONDS CONTG BYD 21Z
THRU 03Z.

.
OTLK VALID 2100-0300Z
AREA 1...ICE SD NE KS
BOUNDED BY 80SW DIK-40S PIR-30WNW OVR-70ESE SLN-20NNE ICT-20S
HLC-40ENE LAA-GLD-BFF-70SW RAP-80SW DIK
MOD ICE BTN FRZLVL AND FL220. FRZLVL 020-100. CONDS CONTG THRU
03Z.

.
AREA 2...ICE MI LH IL IN KY TN
BOUNDED BY 70NW YVV-YVV-30SE ECK-FWA-CVG-HNN-HMV-50SSW VXV-20ESE
BNA-40SW TTH-40WSW FWA-70NW YVV
MOD ICE BTN 040 AND 120. CONDS CONTG THRU 03Z.

.
AREA 3...ICE IA MO WI IL IN KY AR TN MS AL
BOUNDED BY 60SW BAE-40SE BDF-30ENE AXC-30ESE BNA-GQO-40W
VUZ-60ESE LIT-30WNW IRK-40SW FOD-30SW DBQ-60SW BAE
MOD ICE BTN FRZLVL AND FL180. FRZLVL 030-070. CONDS CONTG THRU
03Z.

.
AREA 4...ICE ND SD MN IA WI LS IL
BOUNDED BY 70SW YWG-30N INL-80WNW YQT-40N DLH-50SSE DLH-50SW
RHI-60SW BAE-30SW DBQ-40SW FOD-70SW YWG
MOD ICE BTN FRZLVL AND 150. FRZLVL 010-040. CONDS CONTG THRU 03Z.

.
AREA 5...ICE ND SD NE
BOUNDED BY 60NNW MOT-50NNE MOT-60E MOT-40SE ABR-30E ONL-80SW
DIK-50NNW ISN-60NNW MOT
MOD ICE BTN FRZLVL AND FL200. FRZLVL SFC-060. CONDS CONTG THRU
03Z.

.
FRZLVL...RANGING FROM 010-100 ACRS AREA
MULT FRZLVL 040-090 BOUNDED BY 70SSW ISN-60ESE LBF-20SSW MCK-
20NW GLD-BFF-70SW RAP-70SSW ISN
MULT FRZLVL 040-090 BOUNDED BY CVG-HNN-50WSW BKW-30SW VXV-
30SE BNA-CVG
MULT FRZLVL 050-100 BOUNDED BY GQO-LGC-MGM-30SW LCH-30NNE IAH-

30SW IGB-20NE MSL-GQO
040 ALG 80SW DIK-50S ANW-20NW OBH-20W FSD-50SE RWF-40E PXV-
60E CVG
080 ALG 40E LAA-20W GCK-30E LBL
....

12.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products made available before the accident flight are shown in attachment 2. The GFA surface forecast products indicated a mix of IFR³¹ and MVFR³² visibilities as the band of rain showers moved from west to east across the accident region (section 7.4) with a chance (between 30 and 60 percent) of rain showers. The surface wind was indicated to be between 5 and 10 knots. However, the 0802 CDT GFA cloud forecast products indicated clear skies over the accident site at 1300 CDT, with the 1102 CDT GFA cloud forecast products indicated a cloud ceiling at 3,000 ft msl with the cloud tops at 4,000 ft msl. For more information please see attachment 2.

The reason for the differences between the GFA surface forecast and the GFA cloud forecast is the two are computed automatically by two different weather models. The Rapid Refresh (RAP) weather model is used for the cloud forecast and the Localized Aviation MOS³³ Program (LAMP) weather model is used for the surface forecast charts, and both forecasts are issued with no human intervention. The only human-generated information reflected in the two GFA products are the AIRMETs and the GFA is “human-over-the-loop.”

13.0 Terminal Aerodrome Forecast

Kennett Memorial Airport (KTKX) was the closest site with a NWS Terminal Aerodrome Forecast (TAF). KTKX was located 24 miles southeast of the accident (figure 8). The KTKX TAF valid at the accident time was issued at 1241 CDT and was valid for a 24-hour period beginning at 1300 CDT. The 1241 CDT TAF for KTKX was as follows:

TAF KTKX 021741Z 0218/0318 **26012G18KT P6SM SCT100**
FM030000 VRB03KT P6SM SCT250
FM031500 18008KT P6SM FEW050=

Between 1300 and 1900 CDT, the TAF expected a wind from 260° at 12 knots with gusts to 18 knots, greater than 6 miles visibility, and scattered clouds at 10,000 ft agl. The 0620 CDT KTKX TAF forecast similar conditions for between 1300 CDT and 1900 CDT only changing the 10,000 ft agl scattered clouds to broken ceiling conditions.

³¹ Instrument Flight Rules (IFR) – Refers to the general weather conditions pilots can expect at the surface. IFR criteria means a ceiling below 1,000 ft agl and/or less than 3 miles visibility.

³² Marginal Visual Flight Rules – Refers to the general weather conditions pilots can expect at the surface. MVFR criteria means a ceiling 1,000 to 3,000 ft agl and/or 3 to 5 miles visibility.

³³ Model Output Statistics: https://www.weather.gov/mdl/mos_home

14.0 NWS Area Forecast Discussion

The NWS Office in Memphis, Tennessee, issued the following Area Forecast Discussions (AFD) at 1236 and 1006 CDT (closest AFDs to the accident time with an aviation section). The aviation section of the AFDs discussed that VFR conditions were expected to continue, and a west wind of 7 to 10 knots was mentioned in the 1006 CDT AFD:

FXUS64 KMEG 021736

AFDMEG

Area Forecast Discussion

National Weather Service Memphis TN

1236 PM CDT Fri Nov 2 2018

.UPDATE...

Updated to include 18z aviation discussion.

&&

.PREV DISCUSSION... /issued 1006 AM CDT Fri Nov 2 2018/

DISCUSSION...

Skies are partly cloudy across the forecast area this morning with temperatures ranging from the mid 40s to mid 50s. An area of showers is moving out of central Arkansas and into east Arkansas. This activity will continue to move east into the forecast area this afternoon. Will update forecast to remove morning wording.

ARS

PREV DISCUSSION... /issued 308 AM CDT Fri Nov 2 2018/

DISCUSSION...

Cool and mostly cloudy skies were the general rule early this morning...with wrap around moisture from yesterday's passing storm system slowly exiting the area. Temperatures were in the 40's with a few locations across north Mississippi still in the low 50s. Northwest winds had slacken since the evening hours with most stations reporting around 5 mph.

For today and tonight...a reinforcing shot of cold midlevel air of -26C at 500mb will drop into the base of the upper trough as it swings through the mid Mississippi Valley. Associated cloud cover already seen in eastern Kansas and western Missouri will sweep over the region late this morning through the evening hours. As temperatures warm into the mid and upper 50s instability showers are projected to develop. The colder air aloft may produce 100-200 j/kg of CAPE and LI's near zero during the afternoon hours for a few cracks of thunder to be heard as well. Rainfall amounts will be light overall. The passing shortwave will clear things out nicely later tonight allowing for low temperatures to fall into the upper 30's over the northern and

eastern Midsouth counties. Patchy frost formation is possible.

Saturday...weak high pressure will briefly dominate the weather as the upper flow remains northwesterly. Dry conditions will allow for temperatures to quickly warm into the upper 50s/low 60s by midday. High level cloud cover will increase during the afternoon and evening hours providing for warmer lows Saturday night. The next shortwave trough will move into the Plains after midnight...with models showing a plume of precipitation advancing east out ahead over the Ozarks. A few of these showers may make their way into the western Midsouth counties by sunrise.

Sunday through Tuesday...GFS and ECMWF both indicating a large upper trough becoming carved out over the central U.S. from passing shortwaves rotating through. Thus scattered showers will be the rule for Sunday with perhaps a lull in coverage Sunday night into most of the day Monday. A stronger shortwave will deepen a surface low Monday night over Missouri tracking into the Great Lakes on Tuesday. Currently the GFS is showing a more robust push of gulf air up the Mississippi Valley with CAPE amounts approaching 1000 j/kg into the Midsouth Delta counties by midnight. The ECMWF portrays a more conservative 200 j/kg approach. Both models do show a very high shear environment setting up with 40 degrees of directional turning in the lowest 2km generating helicity values exceeding $400 \text{ m}^2/\text{s}^2$. In addition midlevel lapse rates of $7\text{C}+$ will spread over the warm sector. From this have added wording in this morning's HWO for a few strong to severe storms. All severe hazards may stem from these values if model consistency is maintained. An associated cold front will pass through the area Tuesday...but due to the upper flow orientation staying westerly temperatures will only cool slightly.

Wednesday and Thursday...long range models start the period off dry as upper heights increase slightly. By Wednesday night into Thursday midlevel moisture will stream eastward in the zonal flow to trigger a few light showers. Seasonal temperatures this period.

JAB

&&

.AVIATION...
18z TAF Cycle

An upper level wave is bringing showers and lower ceilings to the terminals this afternoon. VFR conditions should persist despite this. Winds will become lighter overnight as skies become scattered again. VFR conditions persist through the end of the period, with winds turning to the south ahead of an approaching surface cyclone on Saturday afternoon.

ZDM

&&

.MEG WATCHES/WARNINGS/ADVISORIES...

AR...None.
MO...None.
MS...None.
TN...None.
&&

\$\$

FXUS64 KMEG 021506
AFDMEG

Area Forecast Discussion
National Weather Service Memphis TN
1006 AM CDT Fri Nov 2 2018

.DISCUSSION...

Skies are partly cloudy across the forecast area this morning with temperatures ranging from the mid 40s to mid 50s. An area of showers is moving out of central Arkansas and into east Arkansas. This activity will continue to move east into the forecast area this afternoon. Will update forecast to remove morning wording.

ARS

&&

.PREV DISCUSSION... /issued 308 AM CDT Fri Nov 2 2018/

DISCUSSION...

Cool and mostly cloudy skies were the general rule early this morning...with wrap around moisture from yesterday's passing storm system slowly exiting the area. Temperatures were in the 40's with a few locations across north Mississippi still in the low 50s. Northwest winds had slacken since the evening hours with most stations reporting around 5 mph.

For today and tonight...a reinforcing shot of cold midlevel air of -26C at 500mb will drop into the base of the upper trough as it swings through the mid Mississippi Valley. Associated cloud cover already seen in eastern Kansas and western Missouri will sweep over the region late this morning through the evening hours. As temperatures warm into the mid and upper 50s instability showers are projected to develop. The colder air aloft may produce 100-200 j/kg of CAPE and LI's near zero during the afternoon hours for a few cracks of thunder to be heard as well. Rainfall amounts will be light overall. The passing shortwave will clear things out nicely later tonight allowing for low temperatures to fall into the upper 30's over the northern and eastern Midsouth counties. Patchy frost formation is possible.

Saturday...weak high pressure will briefly dominate the weather as the upper flow remains northwesterly. Dry conditions will allow for temperatures to quickly warm into the upper 50s/low 60s by midday. High level cloud cover will increase during the afternoon

and evening hours providing for warmer lows Saturday night. The next shortwave trough will move into the Plains after midnight...with models showing a plume of precipitation advancing east out ahead over the Ozarks. A few of these showers may make their way into the western Midsouth counties by sunrise.

Sunday through Tuesday...GFS and ECMWF both indicating a large upper trough becoming carved out over the central U.S. from passing shortwaves rotating through. Thus scattered showers will be the rule for Sunday with perhaps a lull in coverage Sunday night into most of the day Monday. A stronger shortwave will deepen a surface low Monday night over Missouri tracking into the Great Lakes on Tuesday. Currently the GFS is showing a more robust push of gulf air up the Mississippi Valley with CAPE amounts approaching 1000 j/kg into the Midsouth Delta counties by midnight. The ECMWF portrays a more conservative 200 j/kg approach. Both models do show a very high shear environment setting up with 40 degrees of directional turning in the lowest 2km generating helicity values exceeding 400 m²/s². In addition midlevel lapse rates of 7C+ will spread over the warm sector. From this have added wording in this morning's HWO for a few strong to severe storms. All severe hazards may stem from these values if model consistency is maintained. An associated cold front will pass through the area Tuesday...but due to the upper flow orientation staying westerly temperatures will only cool slightly.

Wednesday and Thursday...long range models start the period off dry as upper heights increase slightly. By Wednesday night into Thursday midlevel moisture will stream eastward in the zonal flow to trigger a few light showers. Seasonal temperatures this period.

JAB

&&

.AVIATION...
12Z TAFs

VFR conditions expected for much of the period. Another shortwave trough will bring a chance of VCSH to the area this afternoon with gradual clearing expected by this evening. Light winds will become west winds between 7-10 kts, then light and variable towards this evening.

CJC

&&

.MEG WATCHES/WARNINGS/ADVISORIES...
AR...None.
MO...None.
MS...None.
TN...None.
&&

15.0 Winds and Temperature Aloft Forecast

The NWS 0857 CDT Winds and Temperature Aloft forecast valid for the closest point to the accident site is included below:

```
FBUS31 KWN0 021357
FD1US1
DATA BASED ON 021200Z
VALID 021800Z   FOR USE 1400-2100Z. TEMPS NEG ABV 24000

FT  3000    6000    9000   12000   18000   24000   30000   34000   39000
CGI 2608 3011-02 3014-10 2819-15 2518-27 2239-36 224742 234845 244747
```

The accident site was closest to the Cape Girardeau, Missouri, (CGI) forecast point. The 0857 CDT CGI forecast for use between 0900 and 1600 CDT indicated a wind from 260° at 8 knots at 3,000 ft, a wind from 300° at 11 knots at 6,000 ft with a temperature of -2° C, and a wind at 9,000 ft from 300° at 14 knots with a temperature of -10° C.

16.0 Pilot Weather Briefing

The accident pilot did not request a weather briefing through Leidos.

A search of archived ForeFlight information indicated that the accident pilot did not review or request any weather information from ForeFlight. Based on information from one of the linemen, the accident pilot checked the weather conditions prior to flight, but it is unknown which weather products the pilot checked (attachment 3). It is unknown if the accident pilot checked or received additional weather information during the accident flight.

17.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for the accident site on November 2, 2018, indicated the following:

SUN	
Begin civil twilight	0659 CDT
Sunrise	0726 CDT
Sun transit	1245 CDT
Accident	1330 CDT³⁴
Sunset	1804 CDT
End civil twilight	1831 CDT

³⁴ Inserted accident time for reference and context.

E. LIST OF ATTACHMENTS

Attachment 1 – GOES-16 visible imagery animation from 1132 to 1432 CDT

Attachment 2 – GFA products available before the accident flight for around the accident time

Attachment 3 – Witness information

Submitted by:

Paul Suffern
Senior Meteorologist

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