



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

August 10, 2021

Specialist's Factual Report

METEOROLOGY

ERA21FA189

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A. ACCIDENT

Location: Brownsville, Tennessee
Date: April 20, 2021
Time: 2052 central daylight time
0152 Coordinated Universal Time (UTC) on April 21
Airplane: Piper PA-28RT-201T; Registration: N4303G

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 and also from the National Centers for Environmental Information (NCEI). This Specialist Factual Report contains the meteorological factors pertinent to the weather surrounding the accident time. All times are central daylight time (CDT), and are based upon the 24-hour clock, where local time is -5 hours from UTC. 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 station identifiers use the standard International Civil Aviation Organization 4-letter station identifiers versus the International Air Transport Association 3-letter identifiers, which deletes the initial country code designator "K" for U.S. airports.

The accident site was located at latitude 35.5541° N, Longitude 89.3918° W, with an approximate elevation of 295 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

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart centered over the Tennessee Valley for 2200 CDT is provided as figure 1 with the location of the accident site within the red circle. The chart depicted a low-pressure center with a pressure of 1008-hectopascals (hPa) over northeastern Kentucky, with a cold front extending southwestward from the low across Kentucky, central Tennessee, into Mississippi. The accident site was located west of the frontal boundary on the cold air side of the front.

The station models around the accident site depicted air temperatures in the mid to upper 30’s degrees Fahrenheit (°F), dew point temperatures in the mid 30’s °F with temperature-dew point spreads of 6°F or less, a north to northwest wind at 10 knots, with mostly cloudy skies and light rain.

¹

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

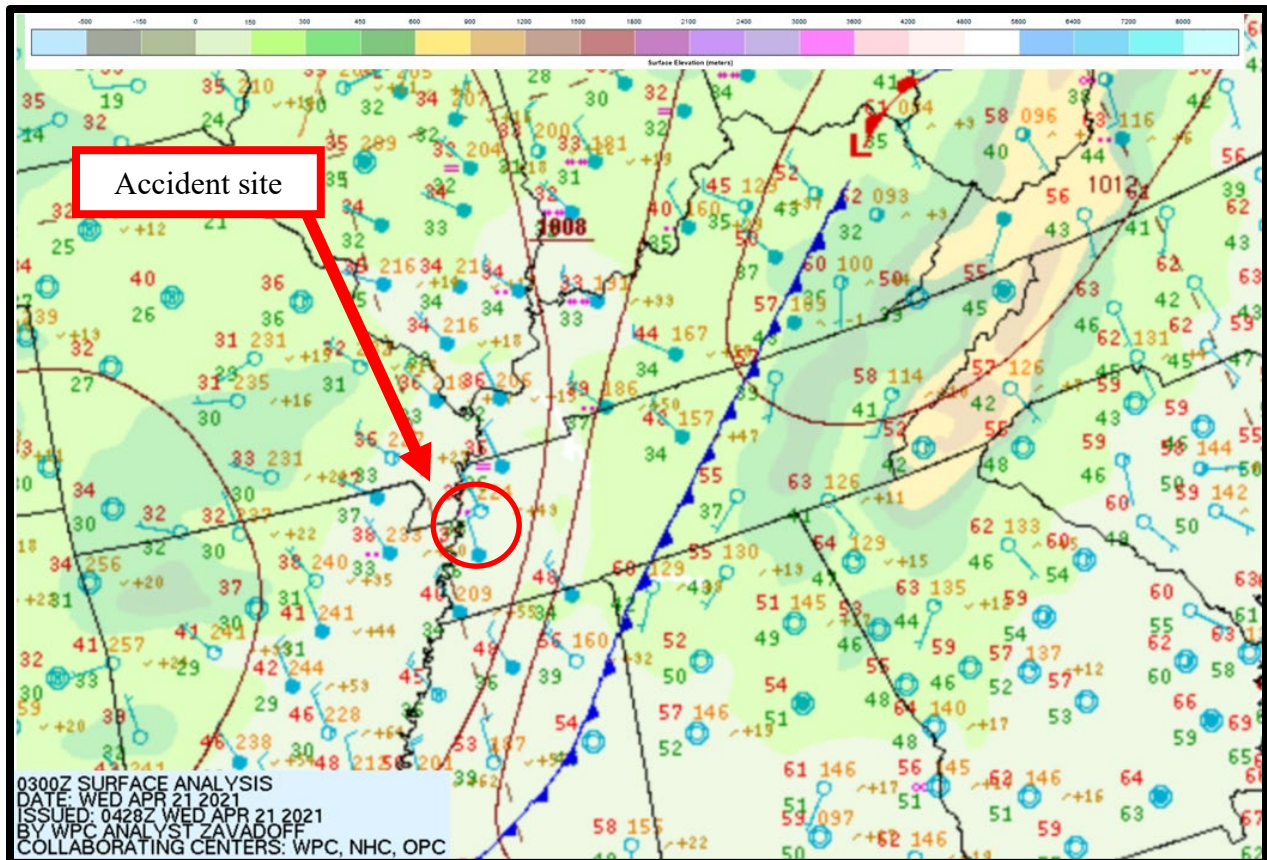


Figure 1 – NWS Surface Analysis Chart for 2200 CDT.

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 1900 CDT at 925-, 850- and 700-hPa are presented in figures 2 through 4. A low- and mid-level trough² was located above of the accident site at 925-, 850-, and 700-hPa (figures 2, 3, and 4). Troughs are a reflection of the frontal systems aloft and typically slope westward towards the cold air. These troughs can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present. There was a southwest wind at 15 knots at 925-hPa with the wind remaining southwesterly at 20 knots by 700-hPa.

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

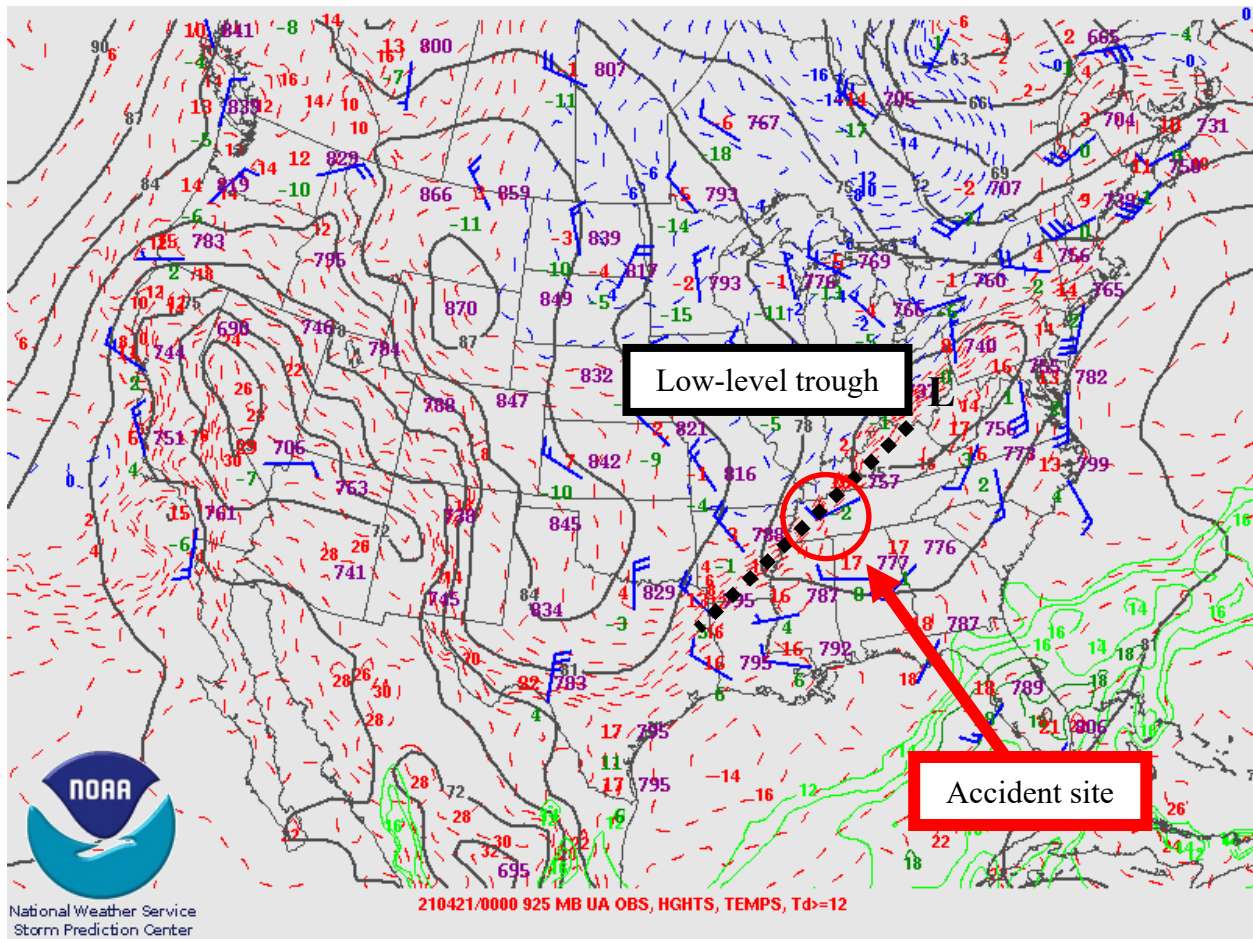


Figure 2 – 925-hPa Constant Pressure Chart for 1900 CDT.

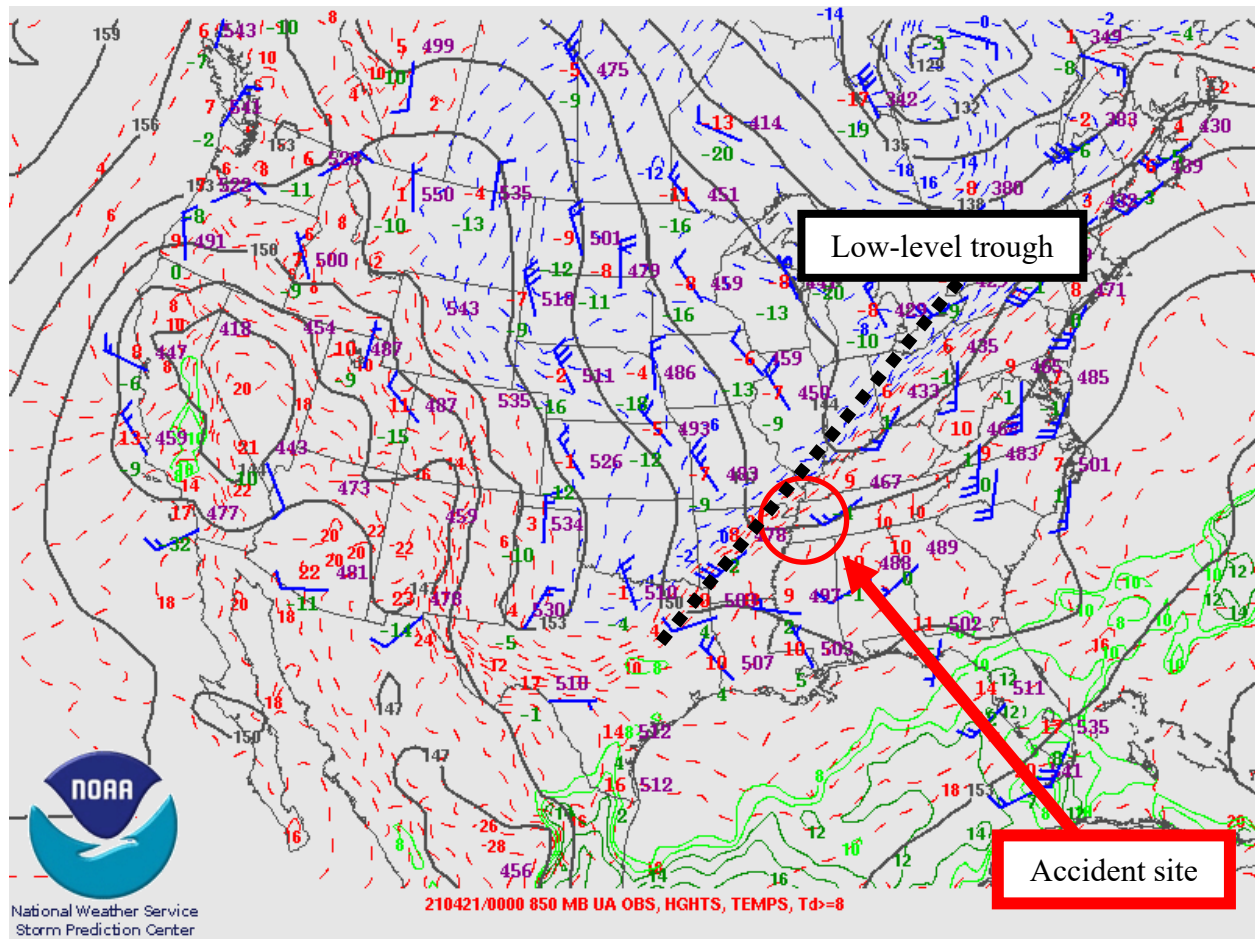


Figure 3 – 850-hPa Constant Pressure Chart for 1900 CDT.

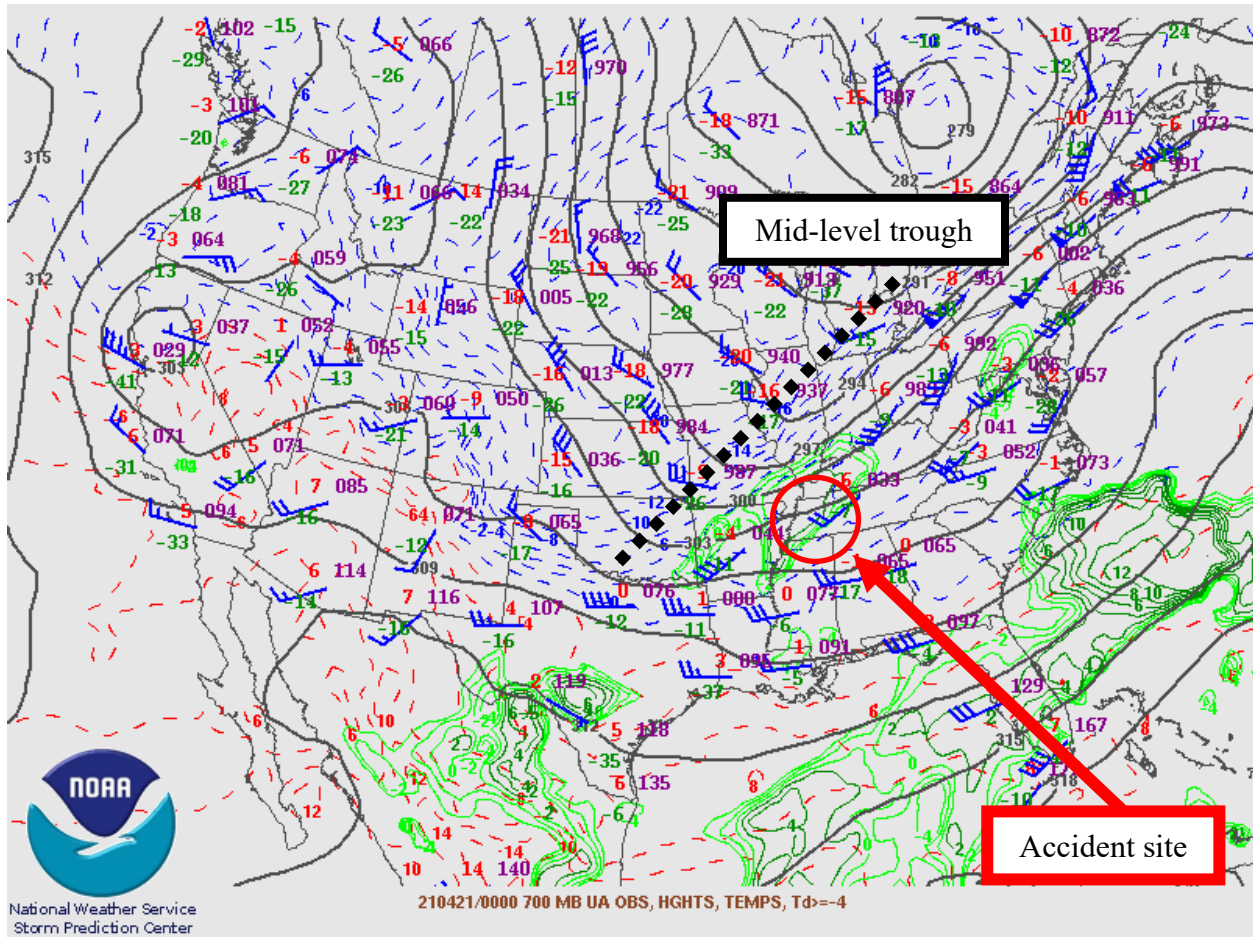


Figure 4 – 700-hPa Constant Pressure Chart for 1900 CDT.

2.0 Surface Observations

The area surrounding the accident site was documented using official Aviation Routine Weather Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language. Figure 5 is a local sectional chart with the accident site and the closest weather reporting locations marked.



Figure 5 – Sectional map of the accident area with the location of the accident site, surface observation site, and forecast site.

Covington Municipal Airport (KM04) had the closest official weather station to the accident site. KM04 had an Automated Weather Observing System (AWOS³) whose longline reports were not supplemented. The KM04 AWOS was located 10 miles west of the accident site, at an elevation of 280 ft, and had a 2° westerly magnetic variation⁴ (figure 5). The following automated longline observations were disseminated during the times surrounding the accident:⁵

[1915 CDT] METAR KM04 202320Z AUTO 35026G33KT 7SM SCT100 14/04 A2996 RMK A01=

[1935 CDT] METAR KM04 210035Z AUTO 34018G28KT 10SM BKN080 BKN095 07/03 A3006 RMK A01=

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. AWOS are maintained by the FAA.

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 text that directly reference the weather conditions that affected the accident location around the accident time. The local times in this section next to the METARs are provided for quick reference between UTC and local times around the accident time.

[1955 CDT] METAR KM04 210055Z AUTO 35017KT 10SM OVC075 06/03 A3007 RMK A01=

[2010 CDT] METAR KM04 210110Z AUTO 34018KT 8SM BKN019 BKN060 OVC080 06/03 A3009 RMK A01=

[2035 CDT] METAR KM04 210135Z AUTO 01017G24KT 6SM BR OVC015 05/04 A3010 RMK A01=

ACCIDENT TIME 2052 CDT

[2055 CDT] METAR KM04 210155Z AUTO 35018KT 5SM BR OVC012 05/04 A3011 RMK A01=

[2110 CDT] METAR KM04 210210Z AUTO 01016G21KT 10SM SCT011 OVC016 04/03 A3012 RMK A01=

The bold type observations surrounding the time of the accident in plain language were as follows:

KM04 weather at 2035 CDT, automated, wind from 010° at 17 knots with gusts to 24 knots, visibility 6 miles, mist, overcast ceiling 1,500 ft above ground level (agl), temperature of 5° Celsius (C), dew point temperature of 4°C, and an altimeter setting of 30.10 inches of mercury (inHg). Remarks: automated station without a precipitation discriminator.

KM04 weather at 2055 CDT, automated, wind from 350° at 18 knots, visibility 5 miles, mist, overcast ceiling 1,200 ft agl, temperature of 5° C, dew point temperature of 4°C, and an altimeter setting of 30.11 inHg. Remarks: automated station without a precipitation discriminator.

The observations from KM04 surrounding the accident time indicated MVFR⁶ conditions with reduced visibility in mist and a north wind at 17 knots gusting to 24 knots.

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.

3.0 Upper Air Sounding

A High-Resolution Rapid Refresh (HRRR)⁷ model sounding was created for the accident site for 2200 CDT which provided a surface elevation of 315 ft.⁸ The 2100 CDT HRRR sounding was plotted on a standard Skew-T Log P diagram⁹ with the derived stability parameters and is included in figure 6 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 and the level of free convection (LFC)¹² at 1,068 ft agl (1,383 ft msl), and the convective condensation level (CCL)¹³ at 1,287 ft agl (1,602 ft msl). The freezing level was located at 7,527 ft msl. The precipitable water value was 0.79 inches.

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 Eosonde Research Services, The Villages, Florida.

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

¹² 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.

¹³ 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.

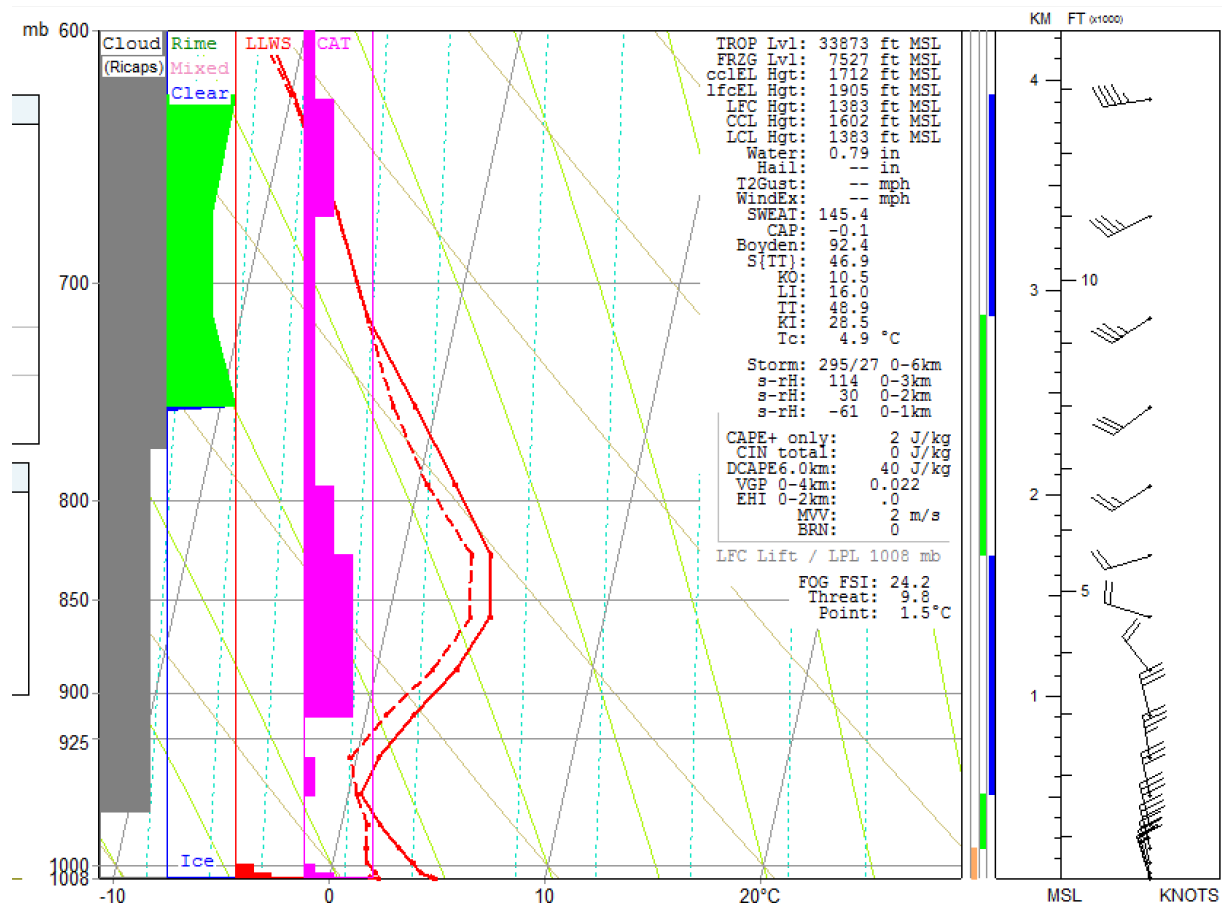


Figure 6 – 2100 CDT HRRR sounding.

The 2100 CDT HRRR sounding for the accident site indicated a conditionally unstable environment from 5,500 ft msl through 9,000 ft msl with the accident flight's altitude near 7,300 ft msl before descent¹⁴. A defined temperature inversion was noted from the LCL through about 6,000 ft, where temperature increased or remained constant with height. Clouds were indicated by RAOB from 1,500 ft msl through 14,000 ft msl, and moderate rime icing conditions were indicated above 7,500 ft msl.

The 2100 CDT HRRR sounding wind profile indicated a near surface wind from 345° at 16 knots with the wind backing¹⁵ to the west by 5,000 ft msl. The wind speed increased to 30 knots by 2,000 ft msl with the wind speed to 45 knots by 13,000 ft msl. RAOB indicated the possibility of moderate or greater clear-air turbulence in several layers between 2,000 ft and 14,000 ft msl. At the accident flight's altitude of approximately 7,300 ft msl before descent, the temperature was 0.5°C, dew point temperature -0.9°C, wind from 234° at 25 knots.

¹⁴ See air traffic control (ATC) data located in the docket for this accident.

¹⁵ A counterclockwise turning of the wind with height in the northern hemisphere.

4.0 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 1800 CDT through 2300 CDT and reviewed, and the closest images to the time of the accident were documented. Due to sun angle the visible imagery did not provide helpful data.

Figure 7 presents the GOES-16 infrared imagery from 2050 CDT at 6X magnification with the accident site highlighted with a red square. The lower brightness temperatures (yellow colors; higher cloud tops) were located above and to the southwest through northeast of the accident site. Based on the brightness temperatures (about 262 Kelvin) above the accident site and the vertical temperature profile provided by the 2100 CDT HRRR sounding, the approximate cloud-top heights over the accident site were 13,500 ft msl at 2050 CDT. It should be noted these figures have not been corrected for any parallax error.

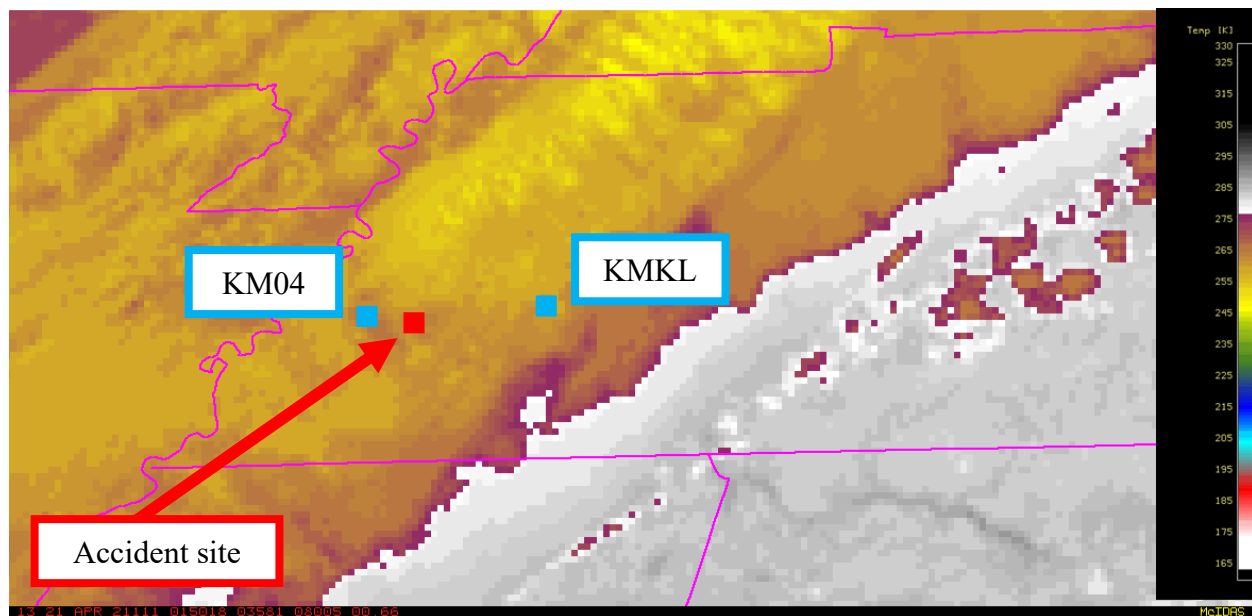


Figure 7 – GOES-16 infrared image at 2050 CDT.

5.0 Regional Radar Imagery Information

A regional view of the NWS National Composite Radar Mosaic from the + is included as figure 8 for 2055 CDT with the approximate location of the accident site marked within a red circle. The image depicted echoes from 20 to 35 decibels (dBZ¹⁶) above the accident site at 2055 CDT.

¹⁶ 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.

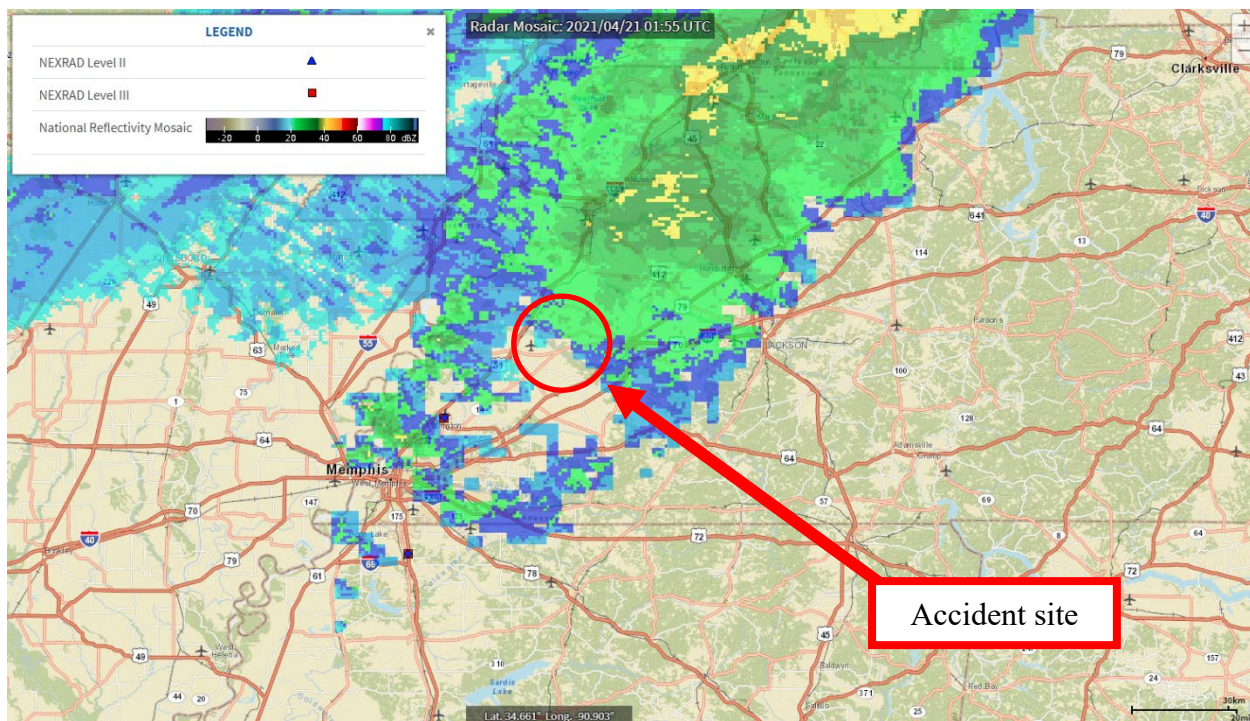


Figure 8 – Regional Composite Reflectivity image for 2055 CDT.

6.0 Radar Imagery Information

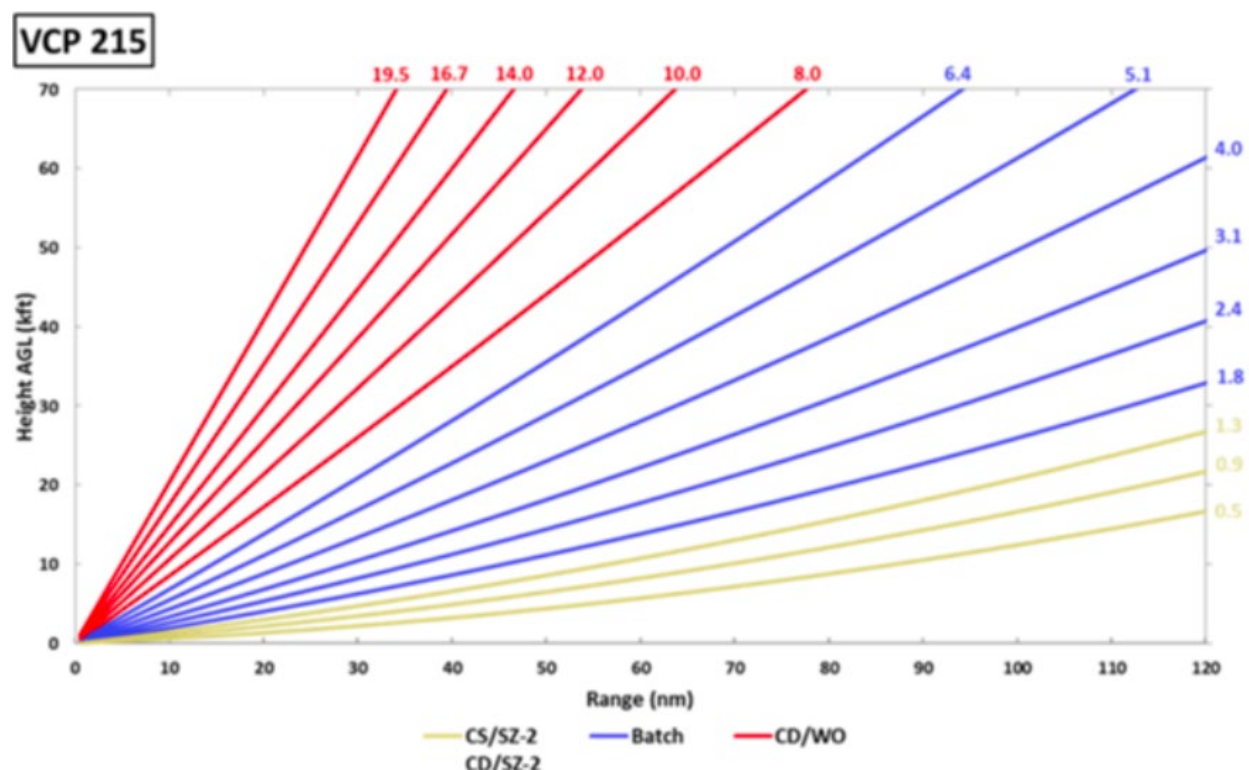
The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)¹⁷ to the accident site was Memphis, Tennessee, (KNQA) located 27 miles west-southwest of the accident site. Level II archive radar data were obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA’s Weather and Climate Toolkit software.

6.1 Volume Scan Strategy

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

¹⁷ 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.

The WSR-88D operates in two main scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has three common scanning strategies¹⁸. The most common is where the radar makes 15 elevation scans from 0.5° to 19.5° every six minutes. This scanning strategy is documented as volume coverage pattern 215 (VCP-215). Mode B is the clear-air mode, where the radar makes 9 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.



VCP-215 Precipitation Mode Scan Strategy.

¹⁸ 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)

6.2 Beam Height Calculation

Assuming standard refraction¹⁹ of the KNQA WSR-88D radar beam with the antenna elevation at 435 ft, and considering a beamwidth²⁰ of 0.95°, the following table shows the approximate heights for the radar beam center, base, and top for an antenna elevation over the accident site. These heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
KNQA 1.8°	6,110 ft	4,780 ft	7,440 ft

Based on the radar height calculations, the elevation scan from KNQA listed in the above table depicted the conditions between 4,780 ft and 7,440 ft above msl over the accident site and these scans “saw” the closest altitudes to the aircraft’s altitude before descent²¹.

6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²² 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 00-24C²³, “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.”

¹⁹ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

²⁰ Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

²¹ For more information please see ATC data located in the docket.

²² 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.

²³

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

6.4 Base Reflectivity and Lightning Data

Figures 9 through 11 present the KNQA WSR-88D base reflectivity images for the 1.8° elevation scans initiated at 2039:55, 2046:46, and 2053:47 CDT, with a resolution of 0.5° X 250 m. Reflectivity values between 10 and 25 dBZ were located along the flight track and over the accident site at the accident time. The precipitation was moving from southwest to northeast over the accident site at the accident time (attachment 1).

There were no lightning flashes²⁴ near the accident site at the accident time.²⁵

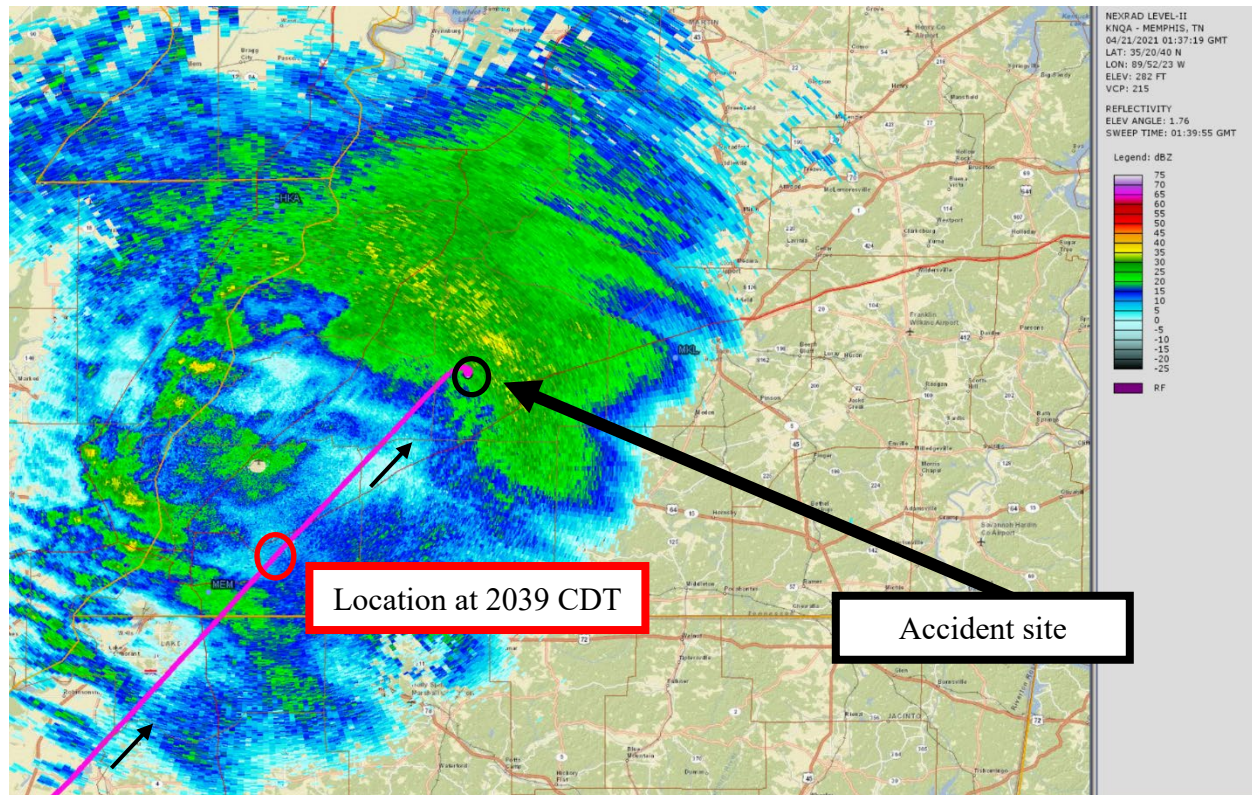


Figure 9 – KNQA WSR-88D reflectivity for the 1.8° elevation scan initiated at 2039:55 CDT with the accident site marked with a black circle and the accident flight track in pink with arrows pointing in the direction of travel.

²⁴ 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.

²⁵ A review of Earth Networks Total Lightning network was done.

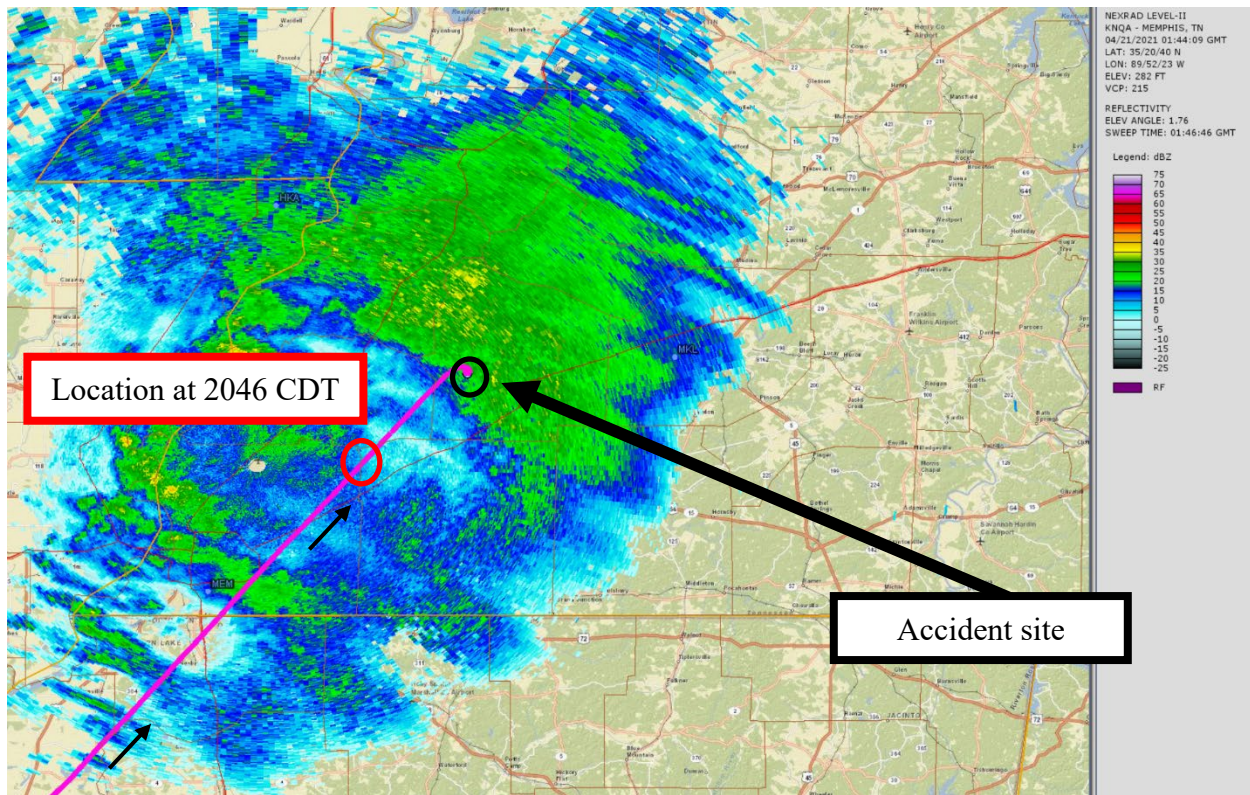


Figure 10 – KNQA WSR-88D reflectivity for the 1.8° elevation scan initiated at 2046:46 CDT with the accident site marked with a black circle and the accident flight track in pink with arrows pointing in the direction of travel.

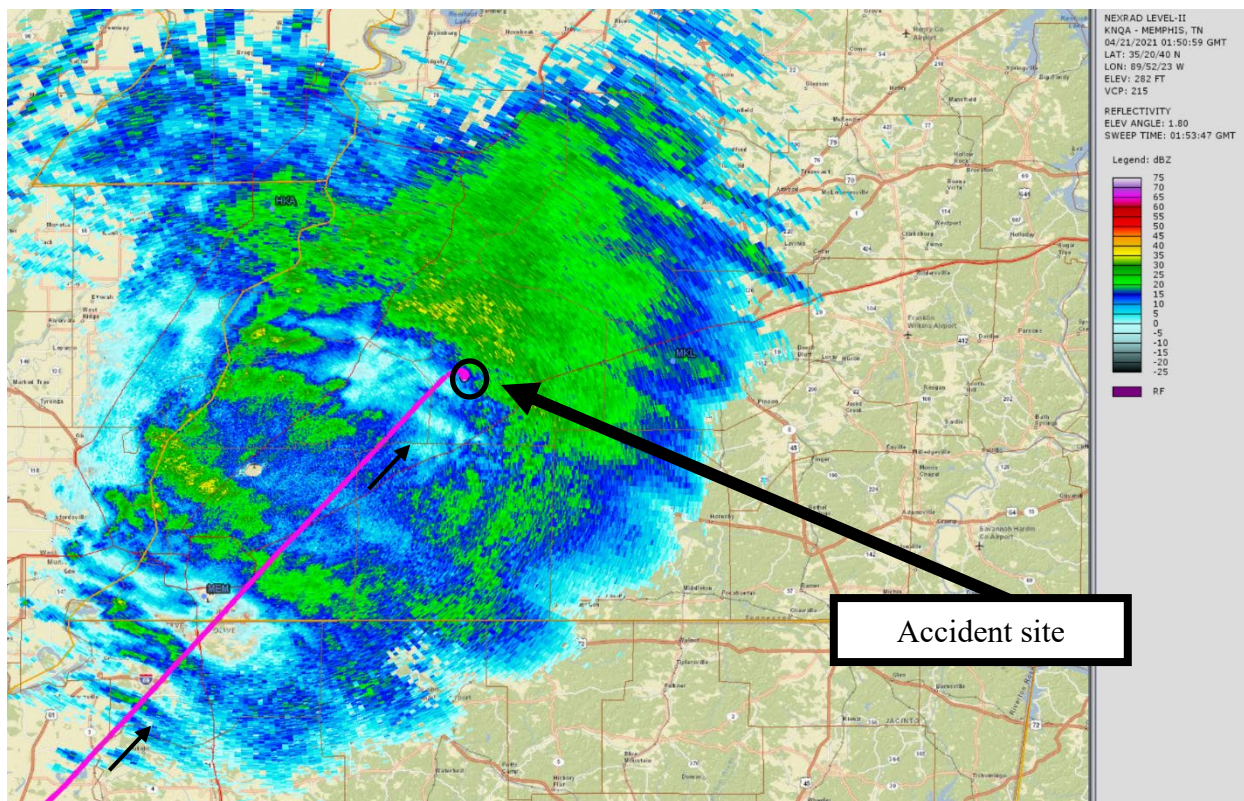


Figure 11 – KNQA WSR-88D reflectivity for the 1.8° elevation scan initiated at 2053:47 CDT with the accident site marked with a black circle and the accident flight track in pink with arrows pointing in the direction of travel.

7.0 Pilot Reports

The longline-disseminated pilot reports²⁶ (PIREPs) distributed into the national airspace (NAS) were reviewed from about two hours prior to the accident time to two hours after the accident time and the PIREPs within 100 miles of the accident site below 18,000 ft msl are shown below:

PAH UA /OV CNG180025/TM 2358/FL030/TP PC12/TA M07/IC LGT RIME 120-030/RM ZME

MEM UA /OV MEM/TM 0133/FLDURGD/TP H/C17/SK BKN019

MEM UA /OV MEM045030/TM 0140/FL100/TP C560/TB CONTINUOUS LGT TO MOD CHOP 105-165

MEM UA /OV 5 NORTH OF MEM/TM 0155/FL030/TP DC10/SK BASES AT 020

MEM UA /OV MEM060033/TM 0231/FL050/TP PC12/RM ZME SMOOTH, NO PRECIP, IN BETWEEN LAYERS

MEM UA /OV KMEM/TM 0242/FL010/TP A321

MEM UA /OV 1 S MEM/TM 0251/FLDURD/TP A306/SK B010

²⁶ Only pilot reports with the World Meteorological Organization headers UBTN**, UBMS**, UBAR**, UBMO**, UBIL**, UBAL**, and UBKY** were considered. These do not include pilot reports only broadcast via radio.

8.0 Significant Meteorological Information

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

9.0 Center Weather Service Advisories

The Memphis (ZME) Air Route Traffic Control Center (ARTCC) Center Weather Service Unit (CWSU) was responsible for the accident region. There were no Meteorological Impact Statements (MIS) or Center Weather Advisories (CWA) valid at the accident time.

10.0 Airmen's Meteorological Information

The NWS Aviation Weather Center had Airmen's Meteorological Information (AIRMET) advisories Tango and Zulu were valid for the area at the accident time (issued around 1545 CDT). The AIRMETs warned of moderate turbulence between 8,000 and 16,000 ft msl and moderate icing between the freezing level²⁷ and 18,000 ft msl.

WAUS43 KPCI 202045

WA3T

-CHIT WA 202045

AIRMET TANGO UPDT 4 FOR TURB VALID UNTIL 210300

.
AIRMET TURB...MN IA MO WI LM LS MI LH IL IN
FROM 80NNE SAW TO 50NW YVV TO 40NE ECK TO 30W DXO TO 40SE TTH TO
30WNW PXV TO 30SW STL TO 40WNW IRK TO 60SSE MSP TO 60NW SAW TO
80NNE SAW
MOD TURB BTN FL180 AND FL310. CONDS CONTG BYD 03Z THRU 09Z.

.
AIRMET TURB...KY
FROM 50W HNN TO HNN TO HNV TO 40S VXV TO 50NE LOZ TO 50W HNN
MOD TURB BLW 120. CONDS ENDG BY 03Z.

.
AIRMET TURB...MO IL IN KY TN
FROM CVG TO 50ESE CVG TO 20S BWG TO 60SE DYR TO 30SSW DYR TO
40NNW DYR TO CVG
MOD TURB BTN 080 AND 160. CONDS DVLPG 00-03Z. CONDS CONTG BYD
03Z THRU 09Z.

.
AIRMET TURB...MO MI IL IN KY OK TX AR TN
FROM 20NE DXO TO FWA TO CVG TO 40NNW DYR TO 60SE TTT TO 20WSW
SJT TO 60SW LBB TO 20NNE TXO TO 50NE CDS TO 40SSW TUL TO 50WNW
FAM TO 20NE DXO
MOD TURB BTN 030 AND 100. CONDS ENDG 00-03Z.

.
OTLK VALID 0300-0900Z
AREA 1...TURB KY

²⁷ The AIRMET indicated that the freezing level ranged between 1,000 and 7,000 ft msl over the area covered by the advisory.

BOUNDED BY 50S HNN-HMV-40SSW HMV-50ESE LOZ-50S HNN
MOD TURB BLW 060. CONDS DVLPG AFT 06Z. CONDS CONTG THRU 09Z.

.
AREA 2...TURB MO IL IN KY TN
BOUNDED BY 50WSW ROD-CVG-HNN-50S HNN-50ESE LOZ-40SSW LOZ-40SE
BWG-60SE DYR-30SSW DYR-40NNW DYR-50WSW ROD
MOD TURB BTN 080 AND FL180. CONDS CONTG THRU 09Z.

....

WAUS43 KKCI 202049 CCA
WA3Z
-CHIZ WA 202049 COR
AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 210300

.
**AIRMET ICE...KS IA MO WI LM MI LH IL IN KY OK AR TN MS...UPDT
FROM 20NE ASP TO 50SW YVV TO 30ESE ECK TO FWA TO CVG TO 30W HNN
TO 20S BNA TO 20ESE LIT TO 40SSE MLC TO 50ESE END TO 30WNW MCI TO
50E DBQ TO 20N MBS TO 20NE ASP
MOD ICE BTN FRZLVL AND FL180. FRZLVL 010-070. CONDS CONTG BYD 03Z
THRU 09Z.
...CORRECTED AIRMET...**

.
AIRMET ICE...ND SD NE KS MN IA MO WI LM LS MI IL IN...UPDT
FROM 60SE YWG TO 50WNW INL TO 50WSW YQT TO 50WNW TVC TO 20WNW MKG
TO 50E DBQ TO 30WNW MCI TO 70W BUM TO 50WSW SLN TO 30ENE AKO TO
BFF TO 70SW RAP TO 40N ISN TO 70NW MOT TO 60SE YWG
MOD ICE BTN FRZLVL AND 120. FRZLVL SFC-060. CONDS CONTG BYD 03Z
THRU 09Z.
...CORRECTED AIRMET...

.
OTLK VALID 0300-0900Z
AREA 1...ICE MO MI LH IL IN KY AR TN MS AL
BOUNDED BY ASP-60SSW YVV-30SE ECK-FWA-CVG-HNN-20N HMV-30WSW
VXV-MSL-40SSW MEM-20SSE LIT-40WSW FAM-ASP
MOD ICE BTN FRZLVL AND 160. FRZLVL SFC-050. CONDS CONTG THRU 09Z.

.
AREA 2...ICE ND SD NE KS MN IA MO WI LM LS MI IL IN KY
BOUNDED BY 70NNW MOT-50WSW YQT-20SW GRR-30WSW FAM-30NNW DBQ-40W
MSP-30SW COU-20N OSW-60SE LAA-GLD-BFF-70SW RAP-40SW ISN-70NNW MOT
MOD ICE BTN FRZLVL AND 120. FRZLVL SFC-040. CONDS CONTG THRU 09Z.

.
FRZLVL...RANGING FROM SFC-120 ACRS AREA
MULT FRZLVL 040-120 BOUNDED BY 30S FWA-40SSE CVG-40E MEM-
40SSE ABI-20NE INK-40NE TCC-20WNW SPS-60NW ARG-30S FWA
SFC ALG GLD-30SSW MCK-50SSW ABR-20ESE ABR-20NNE DLH-30ESE TVC-
40NW YVV
040 ALG GLD-20E HLC-50W SLN-50SW ICT
040 ALG 60ENE DYR-20E CVG

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11.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products issued before the accident flight and valid at 2200 CDT are shown in attachment 2. The GFA surface forecast products indicated VFR surface visibilities with a chance (between 30 to 60 percent) of rain showers, and a surface wind from the northwest at 15 knots and gusts to 25 knots. The GFA cloud forecast valid before departure for around the accident time indicated overcast ceilings at 2,400 ft msl with cloud tops at FL190²⁸. The Graphical AIRMET²⁹ (G-AIRMET) Zulu for icing valid for the accident site were overlaid on the GFA cloud forecast graphics. The only human-generated information reflected in the two GFA products are the G-AIRMETs and the GFA is “human-over-the-loop.” For more information, please see attachment 2.

12.0 Terminal Aerodrome Forecast

Mc Kellar-Sipes Regional Airport (KMKL) located 23 mile east of the accident site (figure 5) was the closest airport to the accident site with an NWS³⁰ Terminal Aerodrome Forecast (TAF). The KMKL TAF valid at the time of the accident was issued at 1838 CDT and was valid for a 24-hour period beginning at 1900 CDT. The 1838 CDT TAF for KMKL was as follows:

TAF KMKL 202338Z 2100/2124 34015G27KT P6SM BKN090
FM210100 34017G28KT P6SM VCSH BKN025 OVC080
TEMPO 2102/2105 -RASN OVC018
FM210600 34012KT P6SM VCSH SCT020 BKN050
FM211000 33010KT P6SM SKC
FM211600 34011G17KT P6SM SCT100=

After 1900 CDT, the forecast expected a wind from 340° at 17 knots with gusts to 28 knots, greater than 6 miles visibility, vicinity³¹ showers, broken ceiling at 2,500 ft agl, and overcast skies at 8,000 ft agl.

13.0 NWS Area Forecast Discussion

The NWS office in Memphis, Tennessee, (WFO MEG) issued an Area Forecast Discussion (AFD) at 1857 CDT. The aviation section of the AFD discussed gusting wind conditions the largest concern with MVFR conditions and precipitation moving across the region:

FXUS64 KMEG 202357 AAA
AFDMEG

Area Forecast Discussion...UPDATED
National Weather Service Memphis TN

²⁸ 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.

²⁹ <https://aviationweather.gov/gairmet>

³⁰ According to NWS Instruction 10-813: “A NWS TAF consists of the expected meteorological conditions significant to aviation at an airport for a specified time period. For the U.S., this is the area within five (5) statute miles (SM) of the center of an airport's runway complex.” www.nws.noaa.gov/directives/sym/pd01008013curr.pdf

³¹ In the vicinity of the airport is defined as a weather phenomenon within 5-10 statute miles of the airfield.

657 PM CDT Tue Apr 20 2021

.UPDATE...

Updated for 00Z Aviation Forecast Discussion below.

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.PREV DISCUSSION... /issued 250 PM CDT Tue Apr 20 2021/

DISCUSSION...

Much of the CONUS will remain under the influence of a longwave trough over the next several days. This trough will bring near record cold and a potential frost/freeze to portions of the Mid-South late tonight and possibly again Wednesday night. A sharp cold front currently extends from west-central AR, across southeast AR, and along the OH River. Temperatures behind this front are in the 40s and 50s, while areas in the warm sector are currently in the 70s.

This front will sweep across the Mid-South overnight. Gusty northwest winds are expected in the wake of this boundary with gusts of 25-30 mph for a few hours. Strong cold advection will usher in much colder air, with temperatures falling into the 30s across most of the CWA by sunrise. A light freeze is expected across northeast AR into far northwest TN, but it does look to be confined to a brief period around 12z. Surface winds of 5-10 mph may result in sufficient mixing to limit significant damage to vegetation, but protective actions are recommended. This freeze is marginal and all areas in the warning may not reach 32F, but I prefer to err on the side of caution given the given the state of the vegetation and the date.

Scattered showers are likely ahead of this front from late this afternoon into the overnight hours. mPing reports upstream over the higher terrain of the Ozarks are either all snow or a mix of rain/snow. Point soundings along the northern tier of counties in the Mid-South are supportive of a mix of rain/snow overnight. That said, warm ground and low QPF will result in no accumulation. This activity will end from west to east overnight, with nil PoPs by Wednesday.

Transient shortwave ridging behind the departing trough will lead to dry weather on Wednesday and Thursday but temperatures will remain well below climatology. Highs on Wednesday are expected to remain in the 50s with many areas warming back into the low/mid 60s for Thursday. A frost is possible for some areas across the Mid-South early Thursday morning. A 1028 mb anticyclone will build over the Mid-South, resulting in light winds and dry air. However, increasing mid/upper-level cloud cover could preclude a full decoupling of the boundary layer and may keep temperatures just warm enough to limit this frost potential. The main area of concern will west TN and northeast MS where cloud cover would arrive later. MOS continues to indicate minimum temperatures of 32-36F while the blends favor a warmer solution. Given the track record of model guidance in radiational cooling scenarios, I'm trending in the cooler direction (at least for the areas that

remain mostly clear). No headline will be issued at this time for Thursday morning, but one may be necessary eventually.

The trough that is forecast to affect the Mid-South late week looks to weaken as it moves across the area before eventually phasing with the northern stream over the Mid-Atlantic region. Showers, and a few thunderstorms, are expected Friday into Saturday, but the severe weather threat will likely be confined to the Gulf coast. Rainfall amounts exceeding 1" are most likely across north MS. The air mass associated with this wave will be of Pacific origin and should actually be warmer than what it is replacing. Thus, expect pleasant weather Sunday into Monday with temperatures climbing back above climatology by the latter.

A deep trough is poised to affect the area midweek. The 12z deterministic global models (as well as their ensemble means) build a ridge up the east coast ahead of this trough. This causes the trough to slow and lift more northeast as it moves out of the Plains. We're looking at an increasing potential for showers and thunderstorms to round out the forecast period, but the severe weather threat will be significantly influenced by the strength of the East Coast ridge. We've got plenty of time to assess this potential.

MJ

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.AVIATION...
00Z TAFs

Primary concern is winds this evening. Following frontal passage, observed gusts have been in line with guidance. KNQA VAD wind profiler showed winds 34030KT between FL020-030. This should represent the maximum gust potential through 03Z or so. Thereafter, low level pressure gradient and pressure advection will ease up, likely limiting MEM gust potential by 08Z.

A narrow band of MVFR ceilings may be accompanied by -SHRA at MEM, and perhaps a brief -SHRA/SN mix at MKL late this evening.

PWB

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.MEG WATCHES/WARNINGS/ADVISORIES...

AR...Freeze Warning from 3 AM to 9 AM CDT Wednesday for Clay-Craighead-Greene-Mississippi-Poinsett.

MO...Freeze Warning from 3 AM to 9 AM CDT Wednesday for Dunklin-Pemiscot.

MS...None.

TN...Freeze Warning from 3 AM to 9 AM CDT Wednesday for Dyer-Lake-Lauderdale-Obion-Weakley.

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14.0 Winds and Temperature Aloft Forecast

The NWS 1457 CDT Winds and Temperature Aloft forecast valid for the closest point to the accident site is included below:

```
FBUS31 KWN0 201957
FD1US1
DATA BASED ON 201800Z
VALID 210000Z    FOR USE 2000-0300Z. TEMPS NEG ABV 24000

FT  3000    6000    9000   12000   18000   24000   30000   34000   39000
MEM 3518 2318+04 2423-01 2635-07 2650-21 2759-30 267345 268851 760048
```

The closest forecast point to the accident site was Memphis, Tennessee, (MEM). The 1457 CDT MEM forecast for use between 1500 CDT and 2200 CDT indicated a wind at 3,000 ft from 350° at 18 knots, a wind at 6,000 ft from 230° at 18 knots with a temperature of 4°C, and a wind at 9,000 ft from 240° at 23 knots with a temperature of -1°C.

15.0 Pilot Weather Briefing

The accident pilot did not request weather information³² from Leidos Flight Service.

A search of archived ForeFlight information indicated that the accident pilot did not request weather information from ForeFlight, however, the accident pilot did use ForeFlight to enter several different flight routes on April 20. For more information see attachment 3. There is no record of the accident pilot receiving or retrieving any other weather information before or during the accident flight.

³² https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_91-92.pdf

16.0 Astronomical Data

The astronomical data obtained for the accident site on April 20, 2021, indicated the following:

SUN

Begin civil twilight	0552 CDT
Sunrise	0618 CDT
Sun transit	1256 CDT
Sunset	1935 CDT
End civil twilight	2002 CDT
Accident time	2052 CDT³³

MOON

Moonrise	1230 CDT
Moon transit	1955 CDT
Accident time	2052 CDT³⁴
Moonset	0232 CDT on April 21

At the time of the accident the Moon was located at an altitude of 71.53° and azimuth of 224.93° with 58.2% of the Moon visible disk illuminated.

E. LIST OF ATTACHMENTS

Attachment 1 – KNQA base reflectivity animation from 2030 to 2105 CDT

Attachment 2 – GFA valid for the accident site at accident time

Attachment 3 – ForeFlight information

Submitted by:

Paul Suffern
Senior Meteorologist

³³ Inserted accident time for reference and context.

³⁴ Inserted accident time for reference and context.