



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

January 9, 2018

Group Chairman's Factual Report

METEOROLOGY

ERA17FA313

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A. ACCIDENT

Location: Near Jacksonburg, West Virginia
Date: September 5, 2017
Time: 1148 eastern daylight time
1548 Coordinated Universal Time (UTC)
Airplane: Cirrus SR-20, Registration: N135CD

B. METEOROLOGIST

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

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist did not travel for this investigation and gathered the weather data for this investigation from the NTSB's Washington D.C. office and from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Centers for Environmental Information (NCEI). All times are eastern daylight time (EDT) on September 5, 2017, and are based upon the 24-hour clock, where local time is -4 hours from UTC, and UTC=Z (unless otherwise noted). Directions are referenced to true north and distances in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The wreckage location was at latitude 39.5410° N, longitude 80.5660° W, at an approximate elevation of 1,400 feet (ft).

D. FACTUAL INFORMATION

1.0 Synoptic Situation

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

1.1 Surface Analysis Chart

The mid-Atlantic section of the NWS Surface Analysis Chart for 1100 EDT is provided as figure 1 with the approximate location of the accident site marked within the red circle. The chart identified a cold front located just west of the accident site with the cold front stretching from central New York southwestward through southern Ohio and into central Tennessee. A surface trough¹ was located east of the accident site stretching north to south from central Maryland into central South Carolina. A surface low pressure center with a pressure of 1010-hectopascals (hPa) was located in western Ohio. The station models around the accident site depicted air temperatures in the mid 60's to low 70's degrees Fahrenheit (°F), dew point temperatures in the low to mid 60's °F with temperature-dew point spreads of 5° F or less, a south to southwest wind of 5 to 10 knots, and cloudy skies with areas of fog reported at the two closest station models north and west of the accident site.

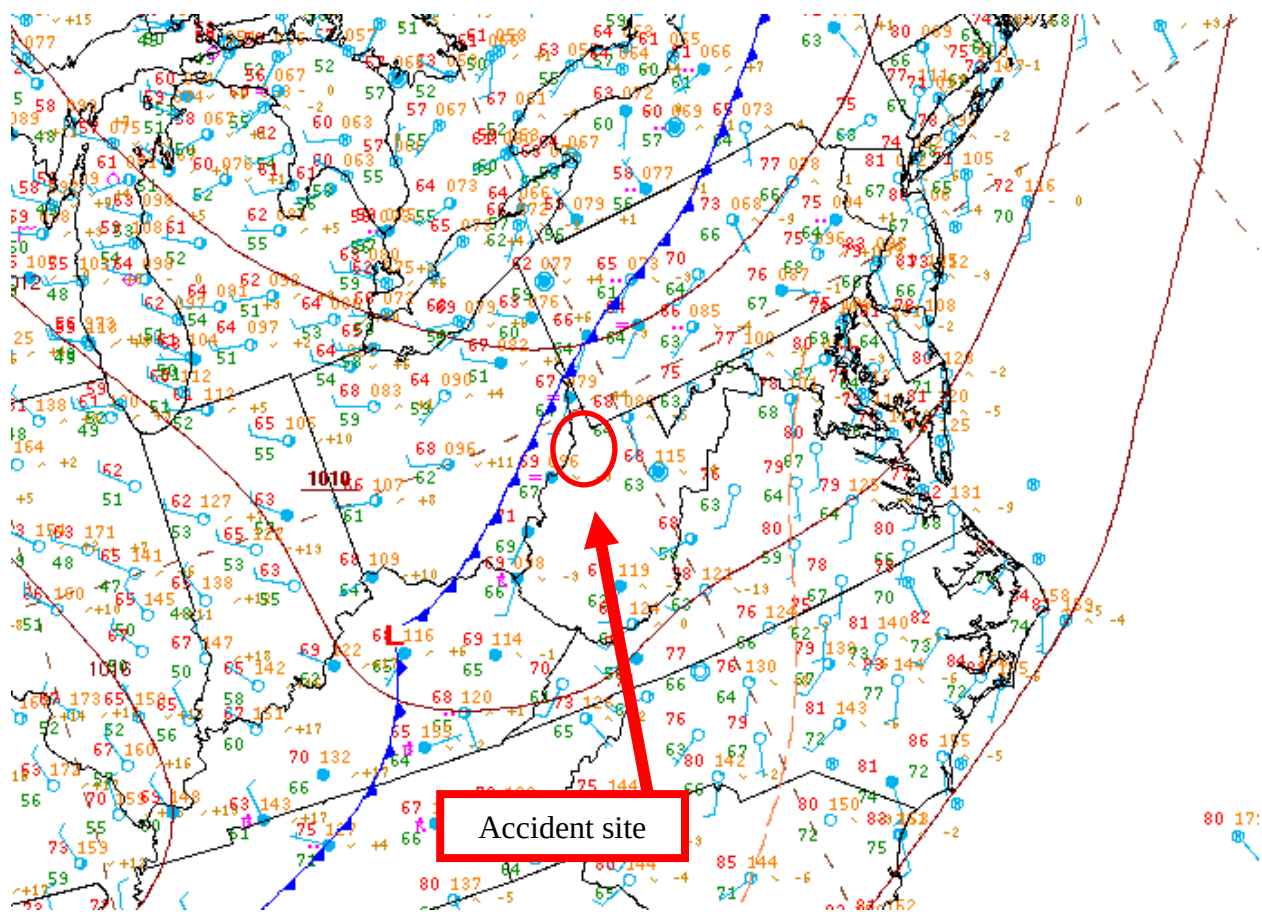


Figure 1 – NWS Surface Analysis Chart for 1100 EDT

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

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 0800 EDT at 925-, 850-, 700-, 500-, and 300-hPa are presented in figures 2 through 6. There was a low- and mid-level trough located west of the accident site (figures 2 to 5) at 925- through 500-hPa. Troughs can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present. There was a southwest wind of 30 knots at 925- and 850-hPa with the wind becoming westerly at 40 knots by 700-hPa. The wind became southwesterly again by 300-hPa at 50 knots (figure 6).

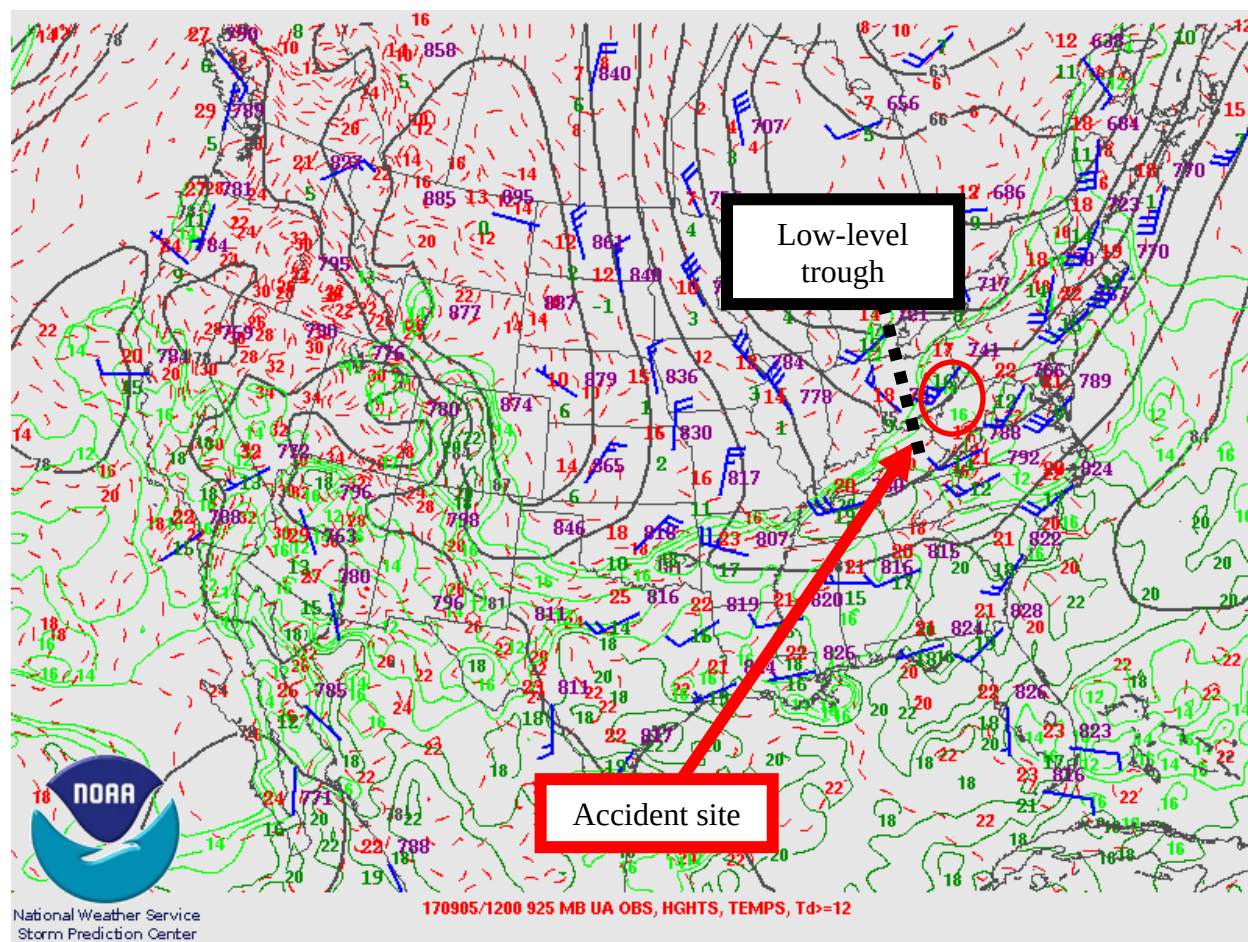


Figure 2 – 925-hPa Constant Pressure Chart for 0800 EDT

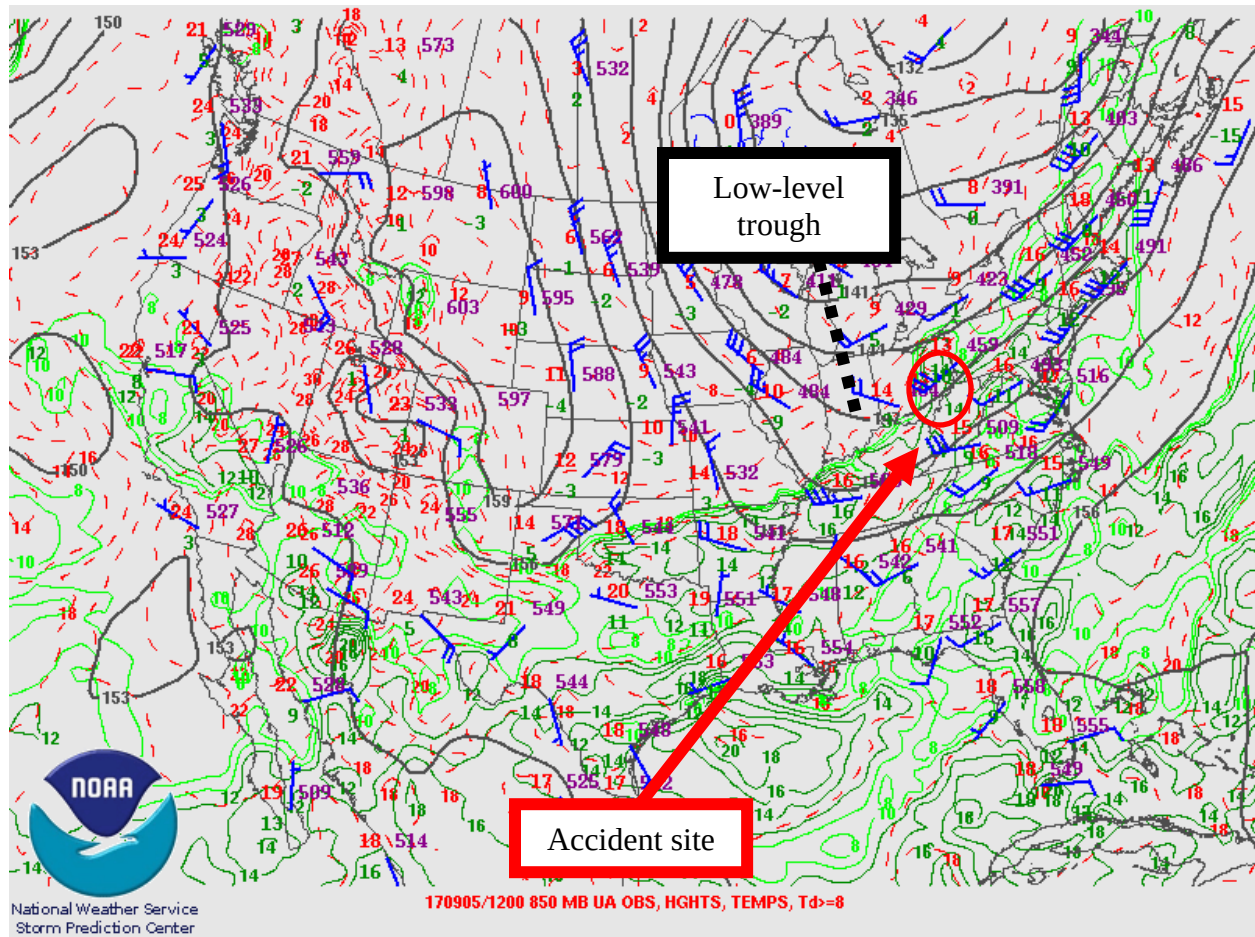


Figure 3 – 850-hPa Constant Pressure Chart for 0800 EDT

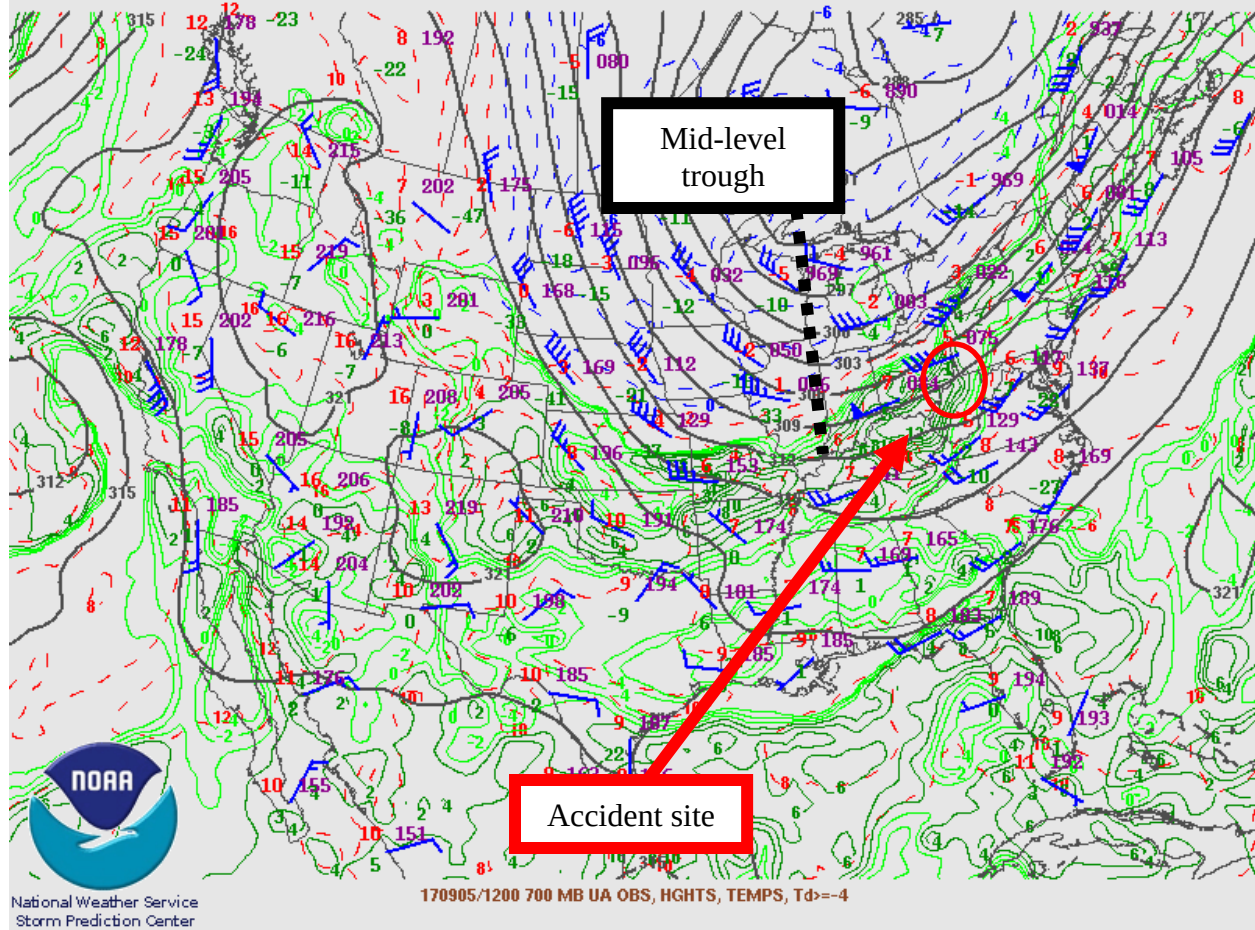


Figure 4 – 700-hPa Constant Pressure Chart for 0800 EDT

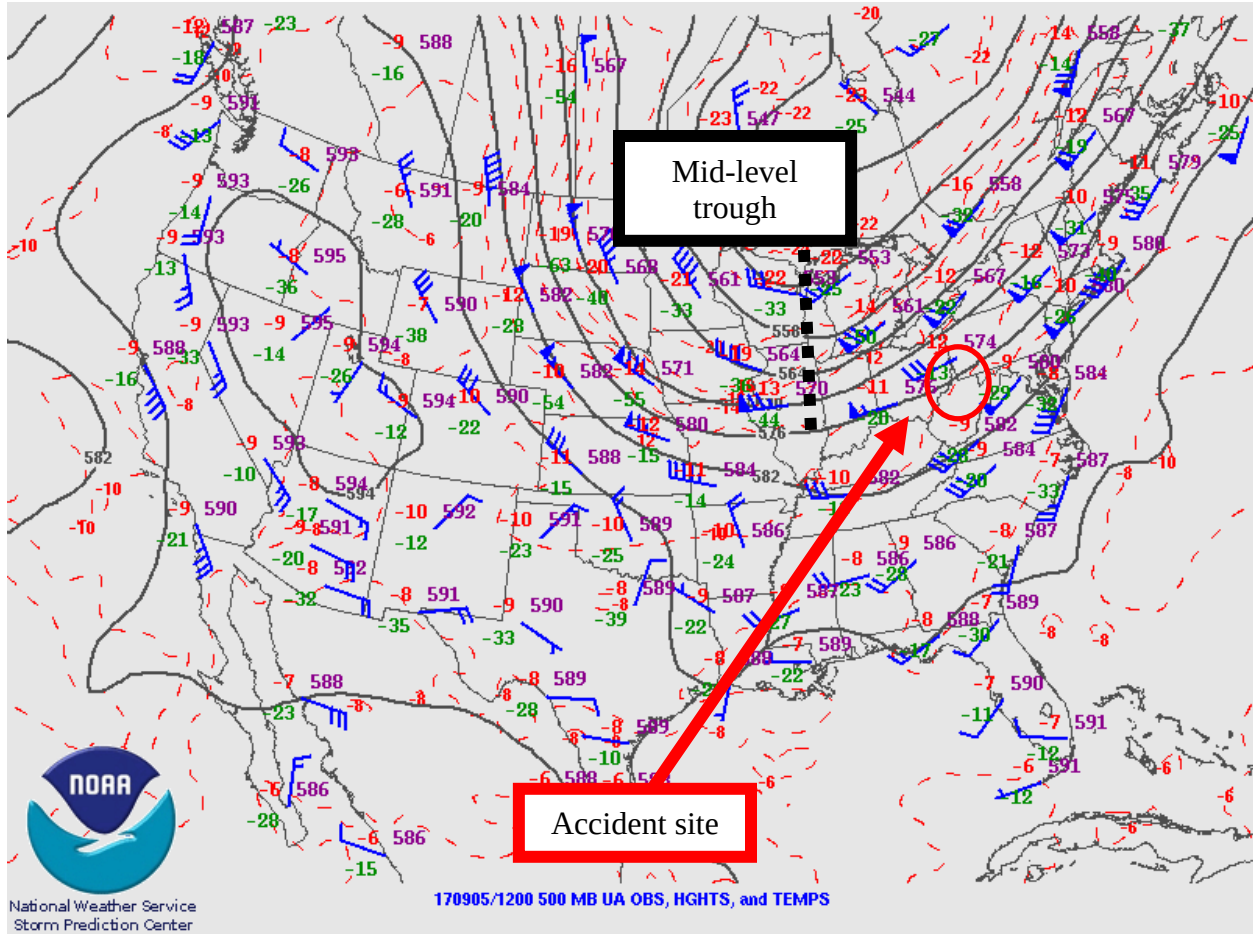


Figure 5 – 500-hPa Constant Pressure Chart for 0800 EDT

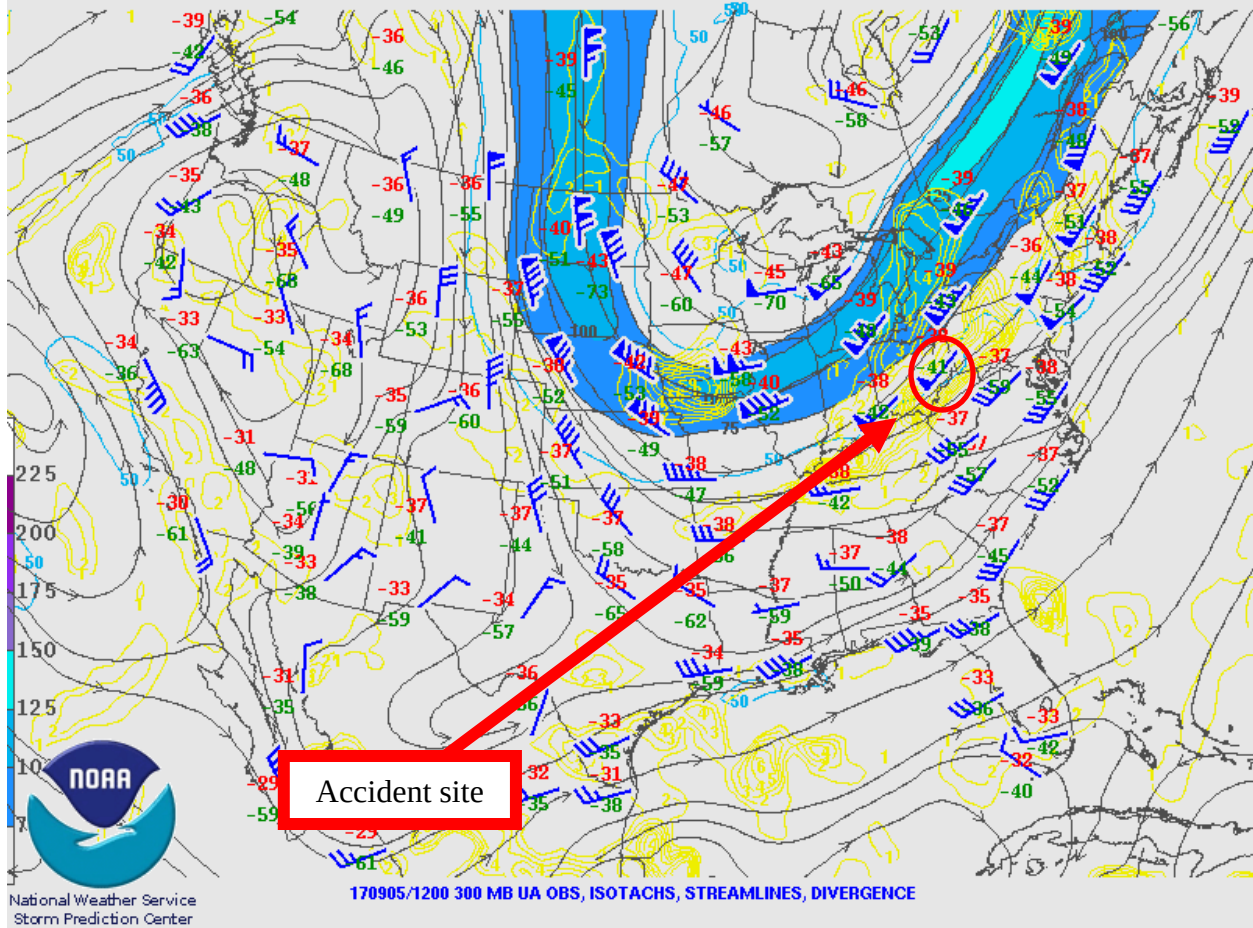


Figure 6 – 300-hPa Constant Pressure Chart for 0800 EDT

2.0 SPC Products

The SPC issued the following Day 1 Convective Outlook at 0854 EDT (figure 7) with areas of thunderstorms and a marginal risk for severe thunderstorm forecast for the accident site. The accident site was located in an area where the SPC forecasted a 5 percent chance of damaging thunderstorm winds or wind gusts 50 knots or greater within 25 miles of a point (figure 8) and a 5 percent chance of one-inch diameter hail or larger within 25 miles of a point (figure 9). Similar forecast and graphics were made for the Day 1 Convective Outlook valid at the time of the weather briefing²:

SPC AC 051254

Day 1 Convective Outlook
NWS Storm Prediction Center Norman OK
0754 AM CDT Tue Sep 05 2017

Valid 051300Z - 061200Z

² http://www.spc.noaa.gov/products/outlook/archive/2017/day1otlk_20170905_1200.html

...THERE IS A SLIGHT RISK OF SEVERE THUNDERSTORMS ACROSS THE MID-ATLANTIC/NORTHEAST STATES...

...THERE IS A MARGINAL RISK OF SEVERE THUNDERSTORMS FROM THE ARKLATEX/LOWER MS VALLEY TO NEW ENGLAND...

...SUMMARY...

Severe thunderstorms are possible especially this afternoon through early evening across portions of the Northeast and Mid-Atlantic States. Additional strong thunderstorms are possible ahead of a cold front extending to Texas and perhaps across portions of the Southwest and Great Basin.

...Northeast/Mid-Atlantic States to Southern Appalachians...

Considerable longwave trough amplification will continue to occur over the eastern half of the CONUS through the period, with upper heights gradually falling as far south as the Gulf Coast States and coastal Southeast. Gradual cooling aloft and a steady strengthening of mid/high-level cyclonic flow will occur roughly coincident with an east/southeastward-advancing front across the Northeast/Mid-Atlantic regions today, while the stronger winds aloft will tend to lag the front in areas farther to the south along with poorer mid-level lapse rates.

Although scattered convection and thicker cloud cover precedes the cold front in some areas near/west of the Appalachians spine early this morning, somewhat stronger heating/insolation is expected in the lee of the Appalachians into parts of New England this afternoon. This includes areas from eastern PA and NJ into southeast NY and much of interior New England. Convection should generally increase and intensify this afternoon initially near the mountains, with the aforementioned strengthening winds aloft contributing to well-organized/sustained convection including some initial supercells and evolving line segments. Damaging winds should be the most common severe hazard, although some hail will be possible especially with any supercells and a tornado cannot be ruled out. Storm intensity should gradually wane this evening, although some potential for strong/locally severe thunderstorms could linger into at least late evening across the coastal mid-Atlantic and/or parts of New England.

...Southern Appalachians to Lower MS Valley/ArkLaTex...

At least some potential for strong to locally severe thunderstorms are expected mainly this afternoon across the region as convection diurnally increases and intensifies near the south/southeastward-moving cold front.

...Southwest States...

Aided by a belt of moderately strong east/southeasterly mid-level winds, a few stronger storms with gusty winds could occur across parts of AZ and/or the Lower CO River Valley into interior southern CA this afternoon into evening. However, the potential for organized/sustained severe weather currently appears low, especially with a trend of a somewhat drier air mass across AZ.

..Guyer/Broyles.. 09/05/2017

CLICK TO GET WUUS01 PTSDY1 PRODUCT

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

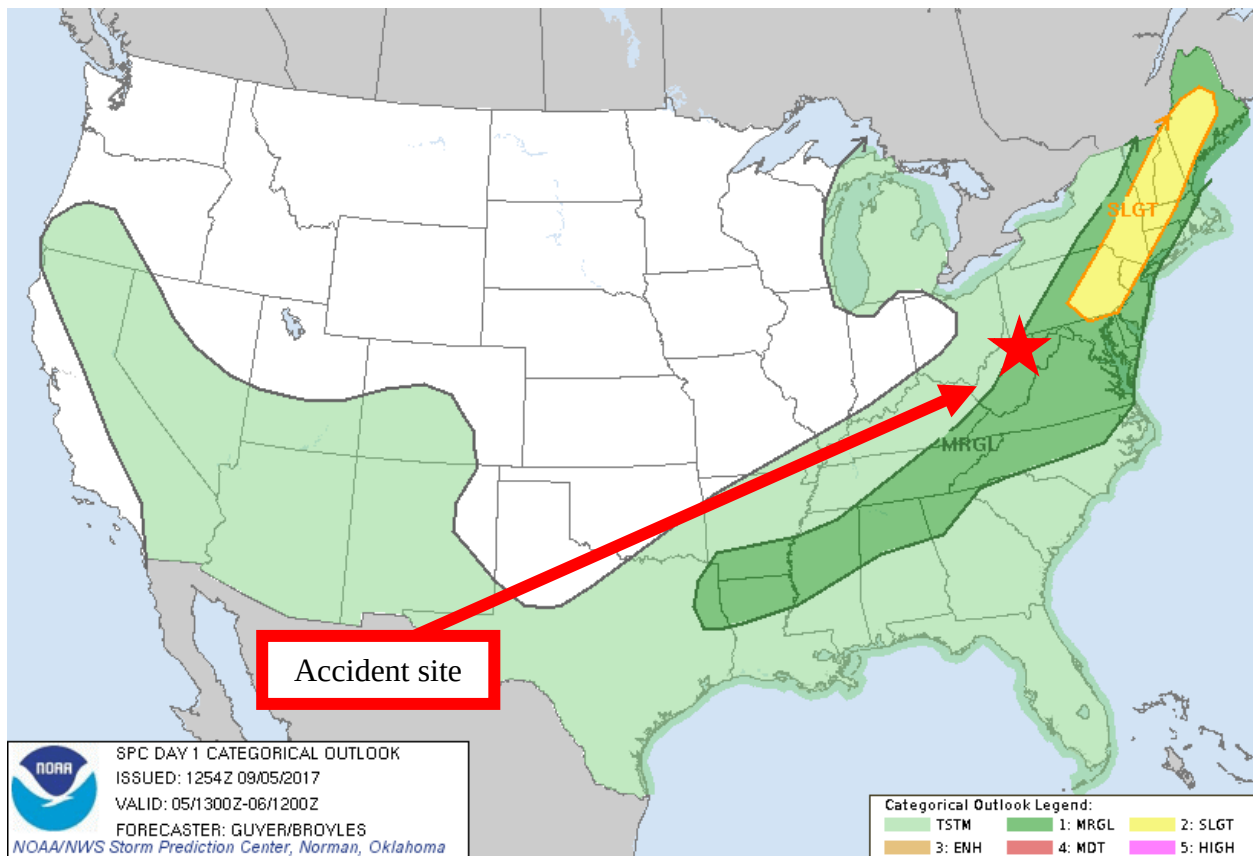


Figure 7 – SPC day 1 Convective Outlook valid at the time of the accident

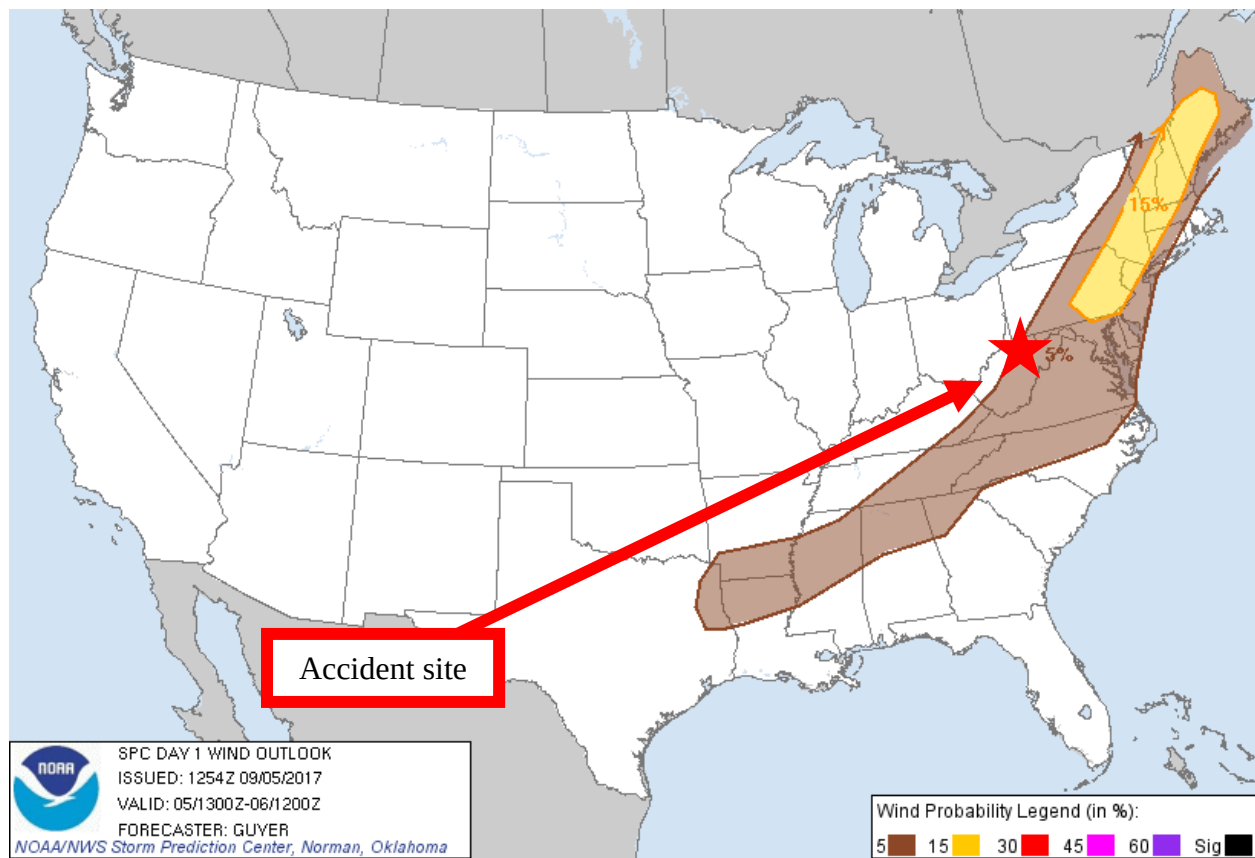


Figure 8 – SPC day 1 Wind Outlook valid at the time of the accident

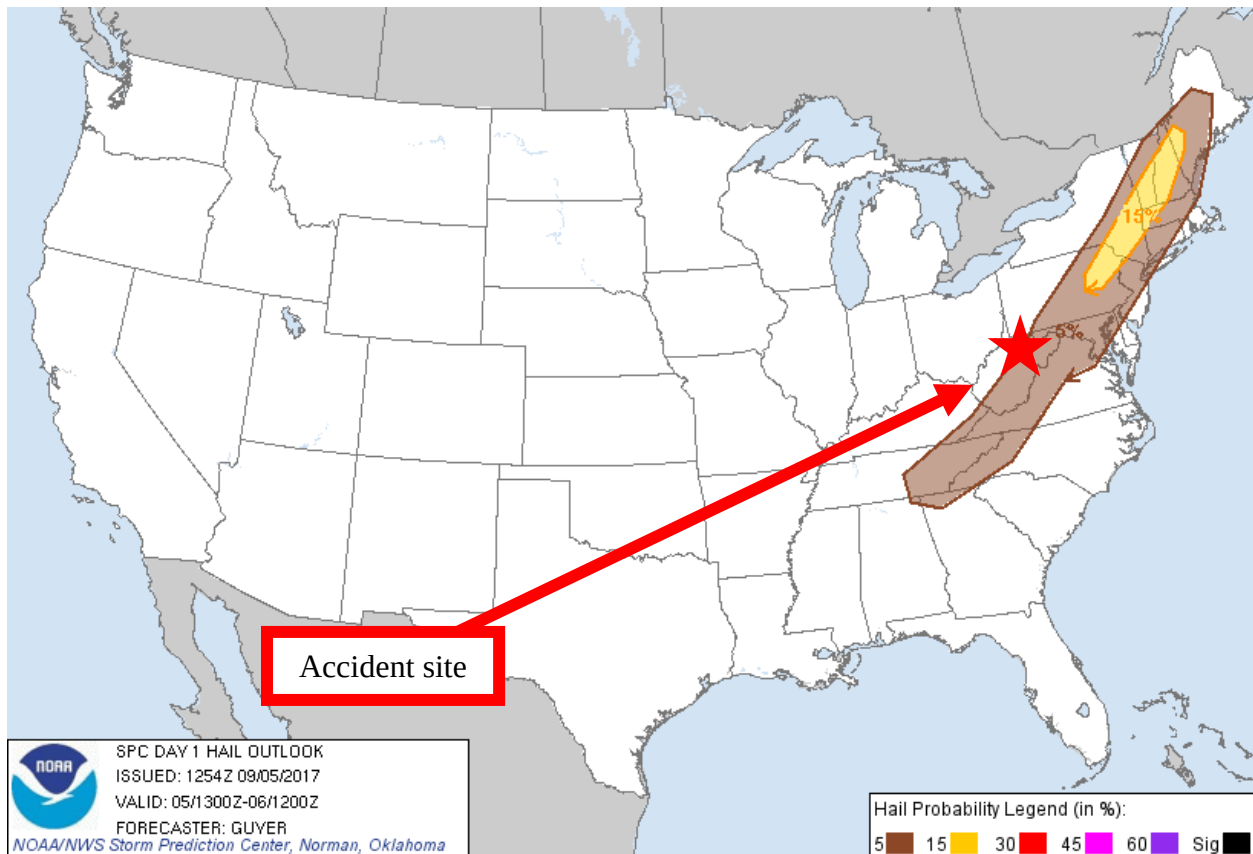


Figure 9 – SPC day 1 Hail Outlook valid at the time of the accident

3.0 Surface Observations

The area surrounding the accident site was documented using official Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). Figure 10 is a sectional chart with the accident site and the closest official weather reporting location to the accident site marked.

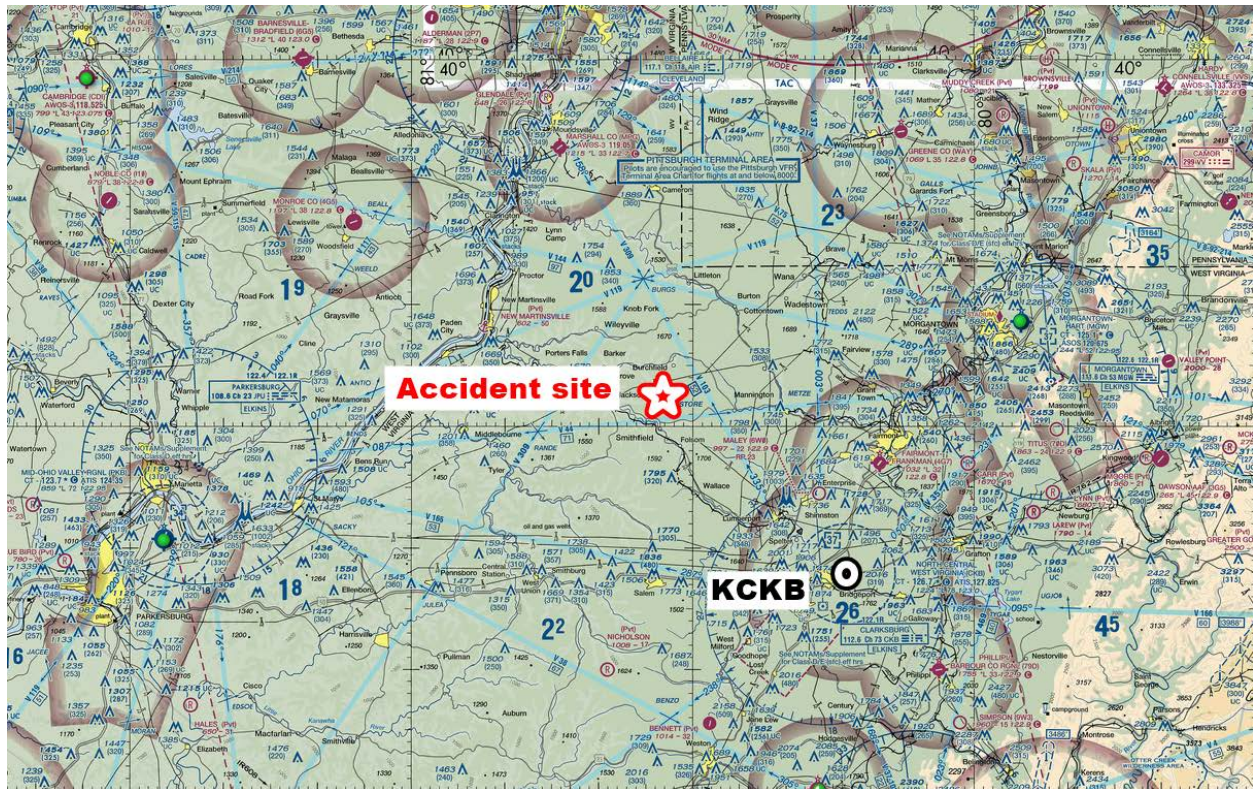


Figure 10 – Sectional chart of accident area with the location of the accident site and closest surface observation site

North Central West Virginia Airport (KCKB) had the closest official weather observation point to the accident site, and was located 1-mile northeast of Clarksburg, West Virginia. KCKB had an Automated Surface Observing System (ASOS)³ whose reports were supplemented by air traffic control. KCKB was located 21 miles southeast of the accident site, at an elevation of 1,224 ft, and had an 8° westerly magnetic variation⁴ (figure 10). The following observations were taken and disseminated during the times surrounding the accident:⁵

[0853 EDT] METAR KCKB 051253Z 0000KT 6SM VCTS BR FEW035 BKN090 OVC110
19/18 A2984 RMK AO2 LTG DSNT ALQDS RAB1156E43 SLP089
P0004 T01940178=

[0927 EDT] SPECI KCKB 051327Z 2000KT 2SM +TSRA BR FEW018 SCT031 OVC090
19/18 A2985 RMK AO2 LTG DSNT ALQDS RAB1257 TSB27
P0007 T01890178=

³ ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, ceiling, temperature, dewpoint, altimeter, and barometric pressure.

⁴ Magnetic variation – The angle (at a particular location) between magnetic north and true north. 1995, latest measurement taken from <http://airnav.com/airport/KCKB>

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

[0935 EDT] SPECI KCKB 051335Z VRB03KT 1SM +TSRA BR FEW018 BKN031 OVC090
19/18 A2984 RMK AO2 LTG DSNT ALQDS RAB1257 TSB27 P0013
T01890178 RVRNO=

[0946 EDT] SPECI KCKB 051346Z 17005KT 3SM -TSRA BR FEW018 BKN031 OVC090
19/18 A2983 RMK AO2 LTG DSNT ALQDS RAB1257 TSB27 P0017
T01940178=

[0953 EDT] METAR KCKB 051353Z 18005KT 7SM VCTS -RA FEW038 BKN065 OVC085
19/18 A2983 RMK AO2 LTG DSNT ALQDS RAB1257 TSB27E52 SLP089
P0017 T01940178=

**[1053 EDT] METAR KCKB 051453Z 19008KT 10SM BKN026 BKN032 OVC040 20/18
A2983 RMK AO2 LTG DSNT W-N RAE50 SLP086 P0000 60021
T02000178 50001=**

**[1101 EDT] SPECI KCKB 051501Z 19009KT 10SM SCT026 BKN034 OVC042 21/18
A2982 RMK AO2 LTG DSNT W-N P0001 T02060178=**

ACCIDENT TIME 1148 EDT

**[1153 EDT] METAR KCKB 051553Z 21012KT 10SM VCTS BKN018 BKN023 BKN095
22/18 A2982 RMK AO2 LTG DSNT W-NE SLP082 P0001 T02170183=**

**[1232 EDT] SPECI KCKB 051632Z 23007KT 2SM +TSRA OVC017 21/18 A2982 RMK
AO2 LTG DSNT ALQDS RAB27 TSB27 P0004 T02110183=**

[1253 EDT] METAR KCKB 051653Z 22008KT 2SM -TSRA BR FEW009 BKN017 OVC028
20/19 A2983 RMK AO2 LTG DSNT ALQDS RAB27 TSB27 SLP088 P0013
T02000189=

[1256 EDT] SPECI KCKB 051656Z 21006KT 2SM -TSRA BR BKN012 BKN027 OVC038
20/19 A2983 RMK AO2 LTG DSNT ALQDS P0000 T02000189=

KCKB weather at 1053 EDT, wind from 190° at 8 knots, 10 miles visibility or greater, a broken ceiling at 2,600 ft above ground level (agl), broken skies at 3,200 ft agl, overcast skies at 4,000 ft agl, temperature of 20° Celsius (C), dew point temperature of 18° C, and an altimeter setting of 29.83 inches of mercury. Remarks, station with a precipitation discriminator, lightning distant⁶ west through north, rain ended at 1050 EDT, sea level pressure 1008.6 hPa, a trace of precipitation since 0953 EDT, 6-hourly precipitation of 0.21 inches, temperature of 20.0° C, dew point temperature 17.8° C, 3-hourly pressure decrease of 0.1 hPa.

KCKB weather at 1101 EDT, wind from 190° at 9 knots, 10 miles visibility or greater, scattered clouds at 2,600 ft agl, a broken ceiling at 3,400 ft agl, overcast skies at 4,200 ft agl, temperature

⁶ Distant indicated that the lightning was beyond 10 miles but less than 30 miles from the center of the airport (or airport location point, ALP).

of 21° C, dew point temperature of 18° C, and an altimeter setting of 29.82 inches of mercury. Remarks, station with a precipitation discriminator, lightning distant west through north, 0.01 inches of precipitation since 1053 EDT, temperature of 20.6° C, dew point temperature 17.8° C.

KCKB weather at 1153 EDT, wind from 210° at 12 knots, 10 miles visibility or greater, vicinity⁷ thunderstorms, a broken ceiling at 1,800 ft agl, broken skies at 2,300 ft agl, broken skies at 9,500 ft agl, temperature of 22° C, dew point temperature of 18° C, and an altimeter setting of 29.82 inches of mercury. Remarks, station with a precipitation discriminator, lightning distant west through northeast, sea-level pressure 1008.2 hPa, 0.01 inches of precipitation since 1053 EDT, temperature of 21.7° C, dew point temperature 18.3° C.

KCKB weather at 1232 EDT, wind from 230° at 7 knots, 2 miles visibility, heavy rain and thunderstorms, an overcast ceiling at 1,700 ft agl, temperature of 21° C, dew point temperature of 18° C, and an altimeter setting of 29.82 inches of mercury. Remarks, station with a precipitation discriminator, lightning distant all quadrants, rain began at 1227 EDT, thunderstorm began at 1227 EDT, 0.04 inches of precipitation since 1153 EDT, temperature of 21.1° C, dew point temperature 18.3° C.

The observations from KCKB surrounding the accident time indicated mainly MVFR⁸ to VFR⁹ conditions with lightning distant west through north. After the accident time visibilities at KCKB decreased to IFR¹⁰ in thunderstorms and heavy rain.

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

⁸ Marginal Visual Flight Rules – Refers to the general weather conditions pilots can expect at the surface. MVFR criteria means a ceiling between 1,000 and 3,000 feet agl (inclusive) and/or 3 to 5 miles visibility.

⁹ 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 6 miles visibility.

¹⁰ Instrument Flight Rules – Refers to the general weather conditions pilots can expect at the surface. IFR criteria means a ceiling below 1,000 ft agl and/or less than 3 miles visibility.

4.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR)¹¹ model sounding was created for the accident site for 1200 EDT with a surface elevation of 935 ft. The 1200 EDT HRRR sounding was plotted on a standard Skew-T log P diagram¹² with the derived stability parameters included in figure 11 (with data from the surface to 600-hPa, or 14,000 ft msl.) This data was analyzed using the RAOB¹³ software package. The sounding depicted the lifted condensation level (LCL)¹⁴ at 1,943 ft msl, a convective condensation level (CCL)¹⁵ of 2,712 ft, and a level of free convection (LFC)¹⁶ at 1,943 ft. The freezing level was 13,272 ft. The precipitable water value was 1.74 inches.

¹¹ 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.

¹² 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.

¹³ RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.

¹⁴ LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

¹⁵ 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.

¹⁶ LFC – The level at which a parcel of saturated air becomes warmer than the surrounding air and begins to rise freely. This occurs most readily in a conditionally unstable atmosphere.

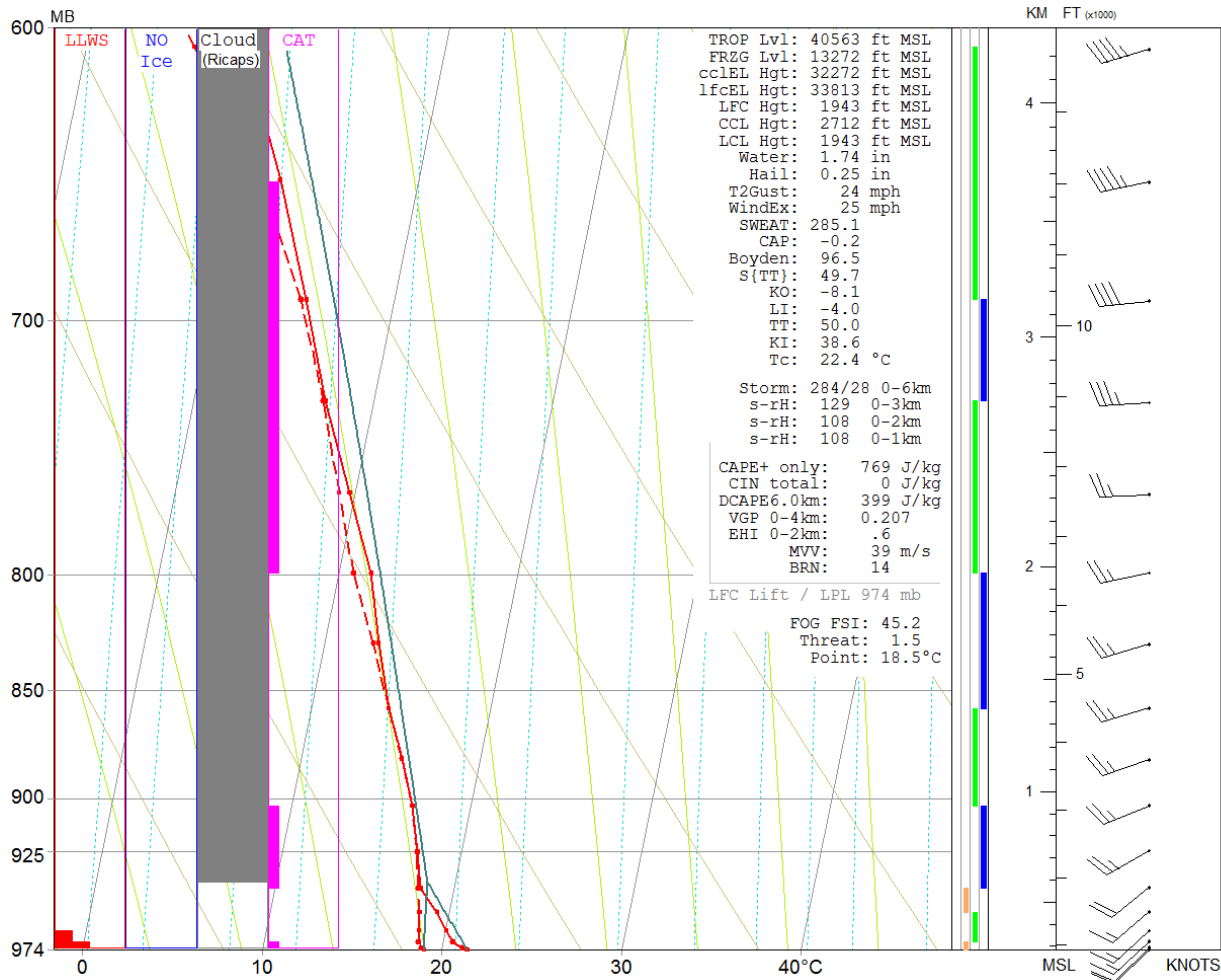


Figure 11 – 1200 EDT HRRR sounding for the accident site

The 1200 EDT HRRR sounding indicated an alternating stable and conditionally unstable environment from the surface through 14,000 ft with 769 Joules/kilogram (J/kg) of CAPE¹⁷. The Maximum vertical velocity (MVV) for this atmosphere was calculated as 39 meters/second (about 7,677 ft per minute).¹⁸ Downdraft CAPE (DCAPE; 6 kilometers agl)¹⁹ was measured at 399 J/kg. RAOB identified the possibility of clouds between 2,000 ft through 14,000 ft. No areas of icing were indicated by RAOB for below 14,000 ft.

The 1200 EDT HRRR sounding wind profile indicated a surface wind from 223° at 9 knots with the wind becoming westerly by 7,000 ft. The wind remained westerly from 7,000 ft through 14,000 ft and the wind speed was between 25 and 45 knots. RAOB indicated the possibility of low-level wind shear between the surface and 1,200 ft. RAOB indicated the possibility of clear-air turbulence in several layers between the surface and 12,000 ft.

¹⁷ 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.

¹⁸ 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.

¹⁹ 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.

5.0 Satellite Data

Visible and infrared 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 imagery (GOES-16 bands 2 and 13) at wavelengths of 0.64 microns (μm) and 10.3 μm , respectively, were retrieved for the period. Satellite imagery surrounding the time of the accident, from 1000 EDT through 1400 EDT at approximately 15-minute intervals were reviewed, and the closest images to the time of the accident are documented here.

Figures 12 and 13 present the GOES-16 visible imagery from 1147 and 1152 EDT at 2X magnification with the accident site highlighted with a red square. Inspection of the visible imagery indicated cloud cover over the accident site with that cloud cover moving from southwest to northeast. Figure 14 presents the GOES-16 infrared imagery from 1147 EDT at 4X 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 southwest and northeast of the accident site at the accident time. Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 1200 EDT HRRR sounding, the approximate cloud-top heights over the accident site were 34,000 ft at 1147 EDT. It should be noted these figures have not been corrected for any parallax error.

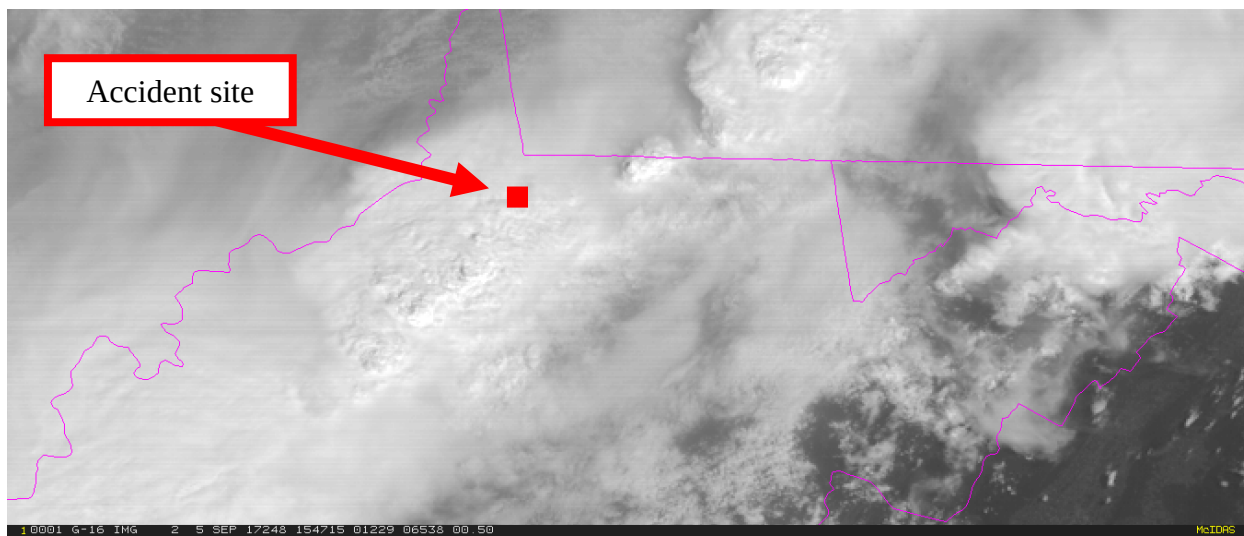


Figure 12 – GOES-16 visible image at 1147 EDT

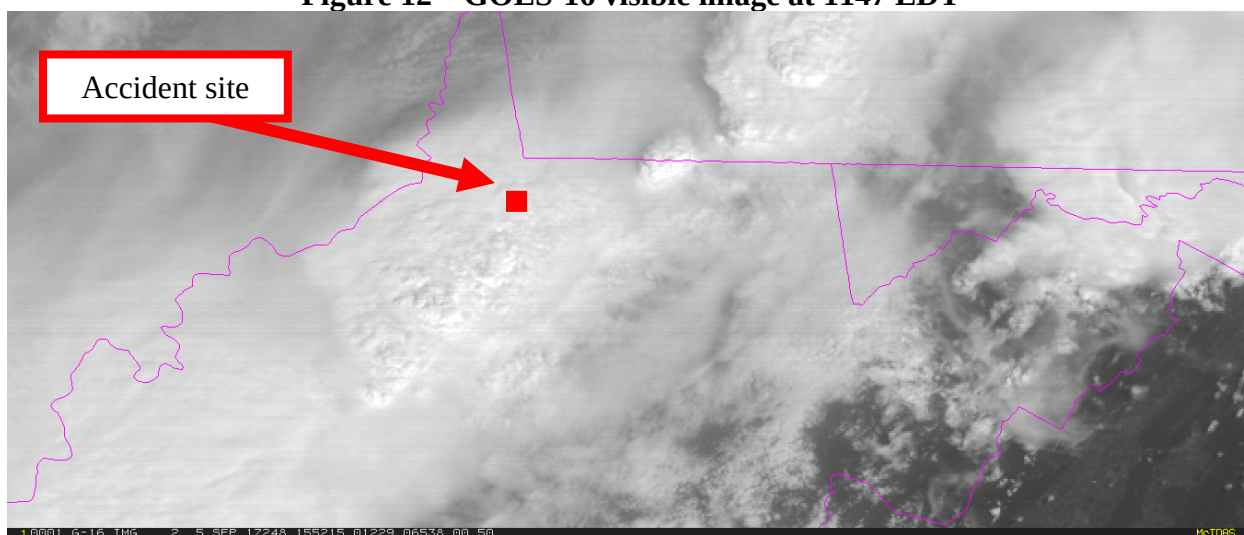


Figure 13 – GOES-16 visible image at 1152 EDT

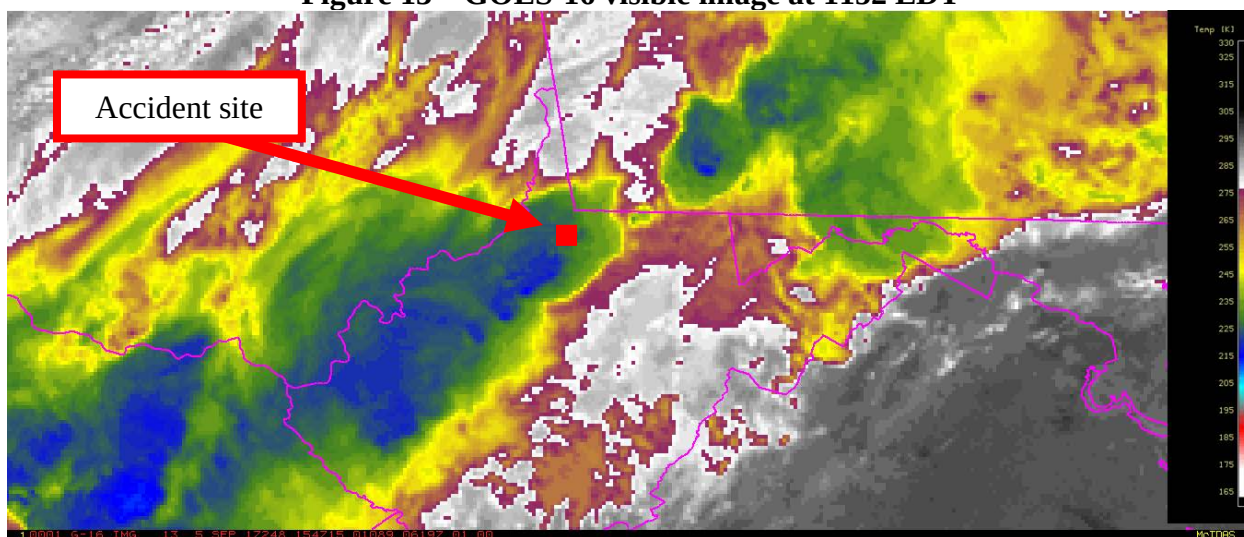


Figure 14 – GOES-16 infrared image at 1147 EDT

6.0 Radar Imagery Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)²⁰ to the accident site was the Pittsburgh, Pennsylvania, radar (KPBZ), which was located 62 miles north-northeast of the accident site at an elevation of 1,185 ft. Level II and III archive radar data were obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

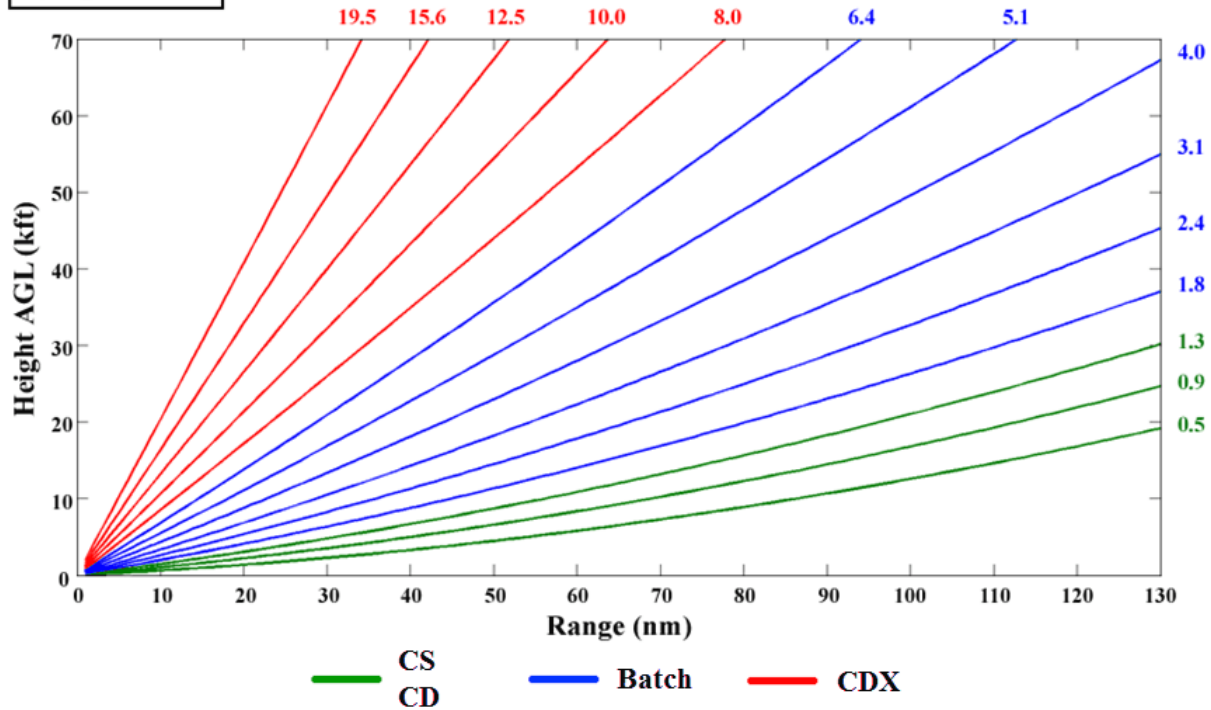
6.1 Volume Scan Strategy

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

The WSR-88D operates in several different scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has three common scanning strategies. The most common is where the radar makes 14 elevation scans from 0.5° to 19.5° every four and a half minutes. This particular scanning strategy is documented as volume coverage pattern 12 (VCP-12). 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 KPBZ WSR-88D radar was operating in the precipitation mode (Mode A, VCP-12). 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 12



VCP-12 Precipitation Mode Scan Strategy²¹

6.2 Beam Height Calculation

Assuming standard refraction²² of the WSR-88D 0.95° wide radar beam, the following table shows the approximate beam height and width²³ information²⁴ of the radar display over the site of the accident. The heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP	BEAM WIDTH
0.5°	7,260 ft	4,200 ft	10,320 ft	6,120 ft

²¹ Contiguous Surveillance (CS)--The low PRF scan of the split cut. Gives a high R_{max} value to determine proper target location and intensity, but a low V_{max} value limits the velocities that can be measured.

Contiguous Doppler (CD)--The high PRF scan of the split cut. Gives a low R_{max} value causing more range folded (multiple trip) echoes, but a high V_{max} value to get higher, more accurate velocity values.

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

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

²⁴ Beamwidth values are shown for legacy resolution products. Super resolution products would have an effective beamwidth that would be approximately half these values.

Based on the radar height calculations, the 0.5° elevation scan depicted the conditions between 4,200 ft and 10,320 ft msl over the accident site and these are the closest altitudes to the accident flight level before the accident occurred.²⁵

6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²⁶ it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in decibels (dBZ²⁷), and is a general measure of echo intensity. FAA Advisory Circular AC 00-24C, “Thunderstorms,” dated February 19, 2013, also defines the echo intensity levels and weather radar echo intensity terminology associated with those levels. For dBZ values less than 30 the weather radar echo intensity terminology should be “light.” For dBZ values between 30 and 40, the terminology should be “moderate.” “Heavy” terminology is used for dBZ values greater than 40 dBZ but less than 50 dBZ, inclusive. Finally, any dBZ values above 50 dBZ shall be described as “extreme.” From the NWS, precipitation conditions at the surface can be inferred from VIP Levels described in the chart below:

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

6.4 Regional Weather Radar Summary

Figure 15 provided a radar summary image from 1145 EDT with reflectivity values over the Mid-Atlantic United States. The accident site was located near an area of 30 to 50 dBZ values at 1145 EDT. These reflectivity values indicated moderate to extreme echoes at the accident site around the accident time with severe turbulence, lightning, large hail, extensive surface wind gusts, and turbulence all possible (section 6.3).

²⁵ For more information, please see the air traffic control (ATC) data located in the docket for this accident.

²⁶ 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.

²⁷ 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.

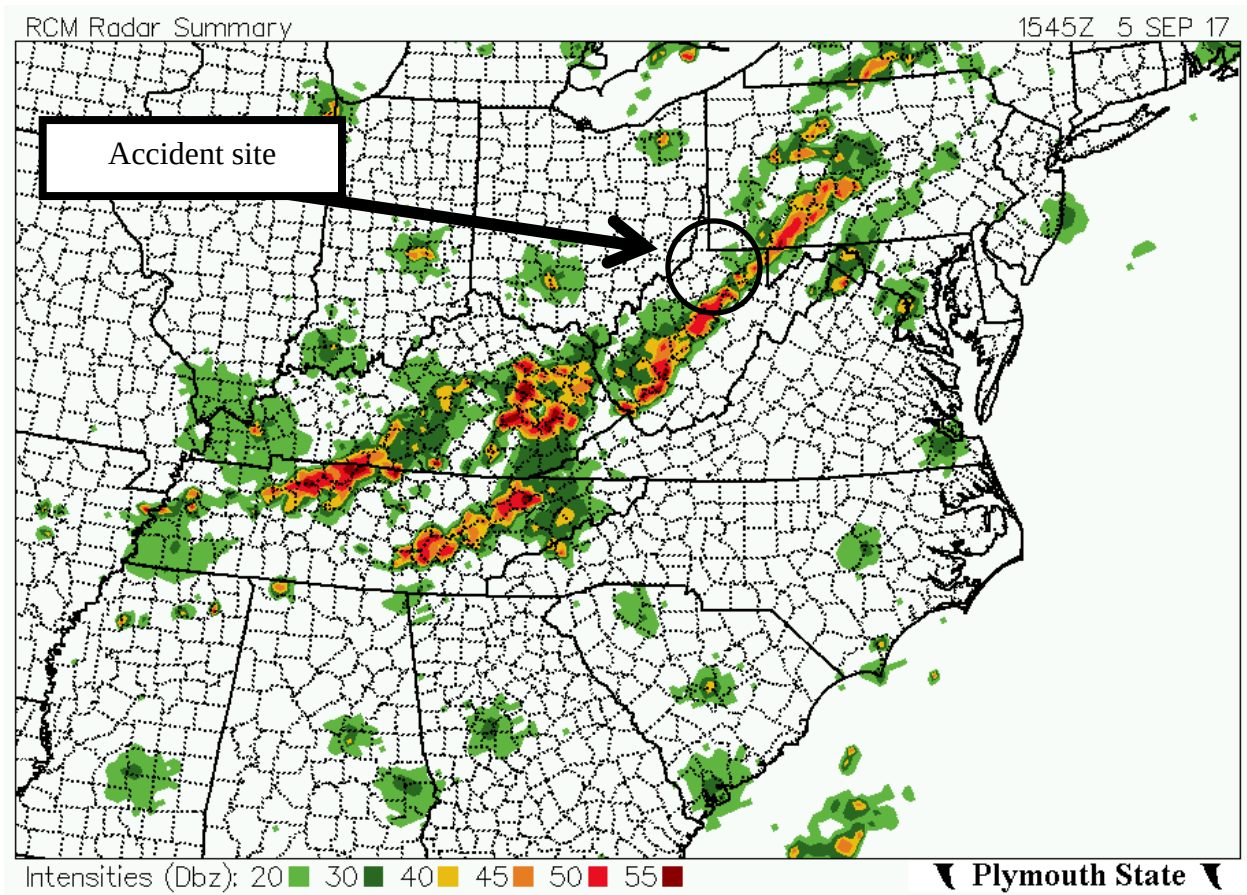


Figure 15 – Radar summary image for 1145 EDT with the accident site

6.5 Base Reflectivity and Lightning Data

Figures 16 through 19 present the KPBZ WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 1139, 1143, 1147, and 1151 EDT with a resolution of 0.5° X 250 meters. The ATC flight track is also included with the arrows pointing in the direction of travel.²⁸ The accident flight track depicted the flight located in an area of echoes of 30 to 45 dBZ between 1139 and 1147 EDT (figures 16, 17, and 18). The accident pilot described the weather conditions to ATC between 1140 and 1146 EDT, and the accident pilot told ATC they had exited the precipitation by 1145:41 EDT.²⁹ There were no echoes located above the accident site at 1147 EDT (figure 18). There were lightning flashes³⁰ and strikes located in central and northern West Virginia around the accident time with over 1,100 lightning flashes associated with the thunderstorms between 1100 and 1200 EDT (figure 19).³¹ However, there were no lightning flashes or strikes located within 10 miles of the accident flight between 1139 and 1151 EDT.

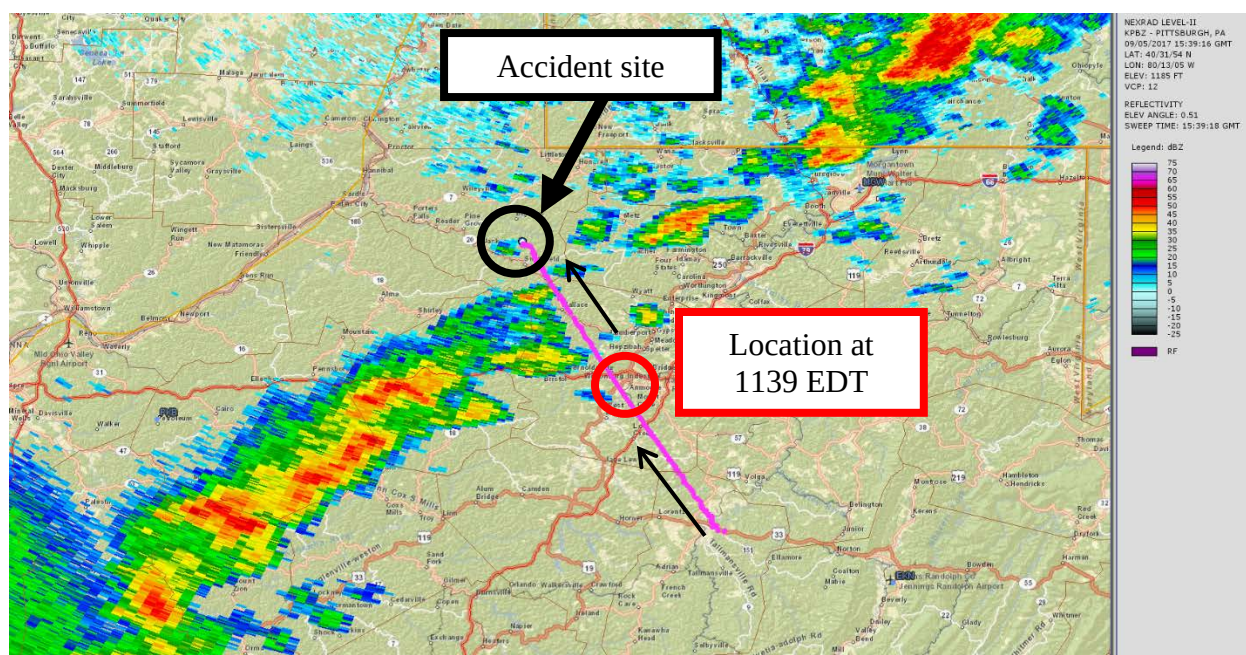


Figure 16 – KPBZ WSR-88D reflectivity for the 0.5° elevation scan initiated at 1139 EDT with the ATC flight track (pink line) and arrows pointing in direction of travel

²⁸ For more information, please see the ATC track data located in the docket for this accident.

²⁹ For more information, please see the ATC transcript located in the docket for this accident.

³⁰ 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.

³¹ A review of Earth Networks Total Lightning network was done.

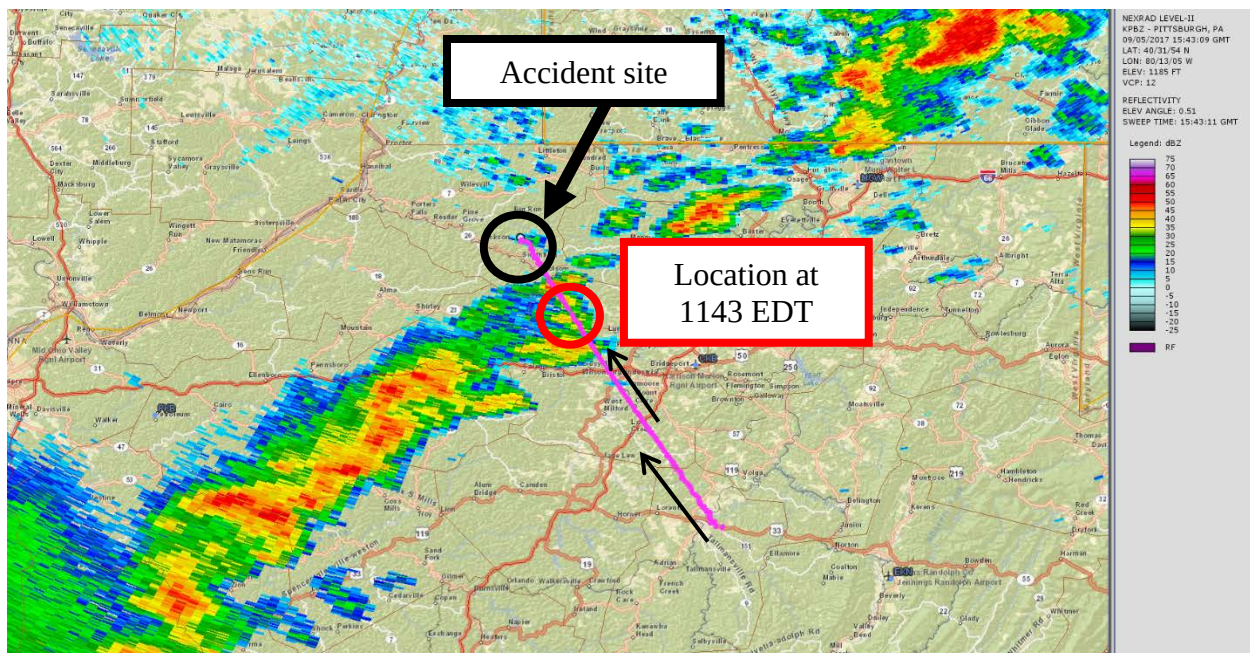


Figure 17 – KPBZ WSR-88D reflectivity for the 0.5° elevation scan initiated at 1143 EDT with the ATC flight track (pink line) and arrows pointing in direction of travel

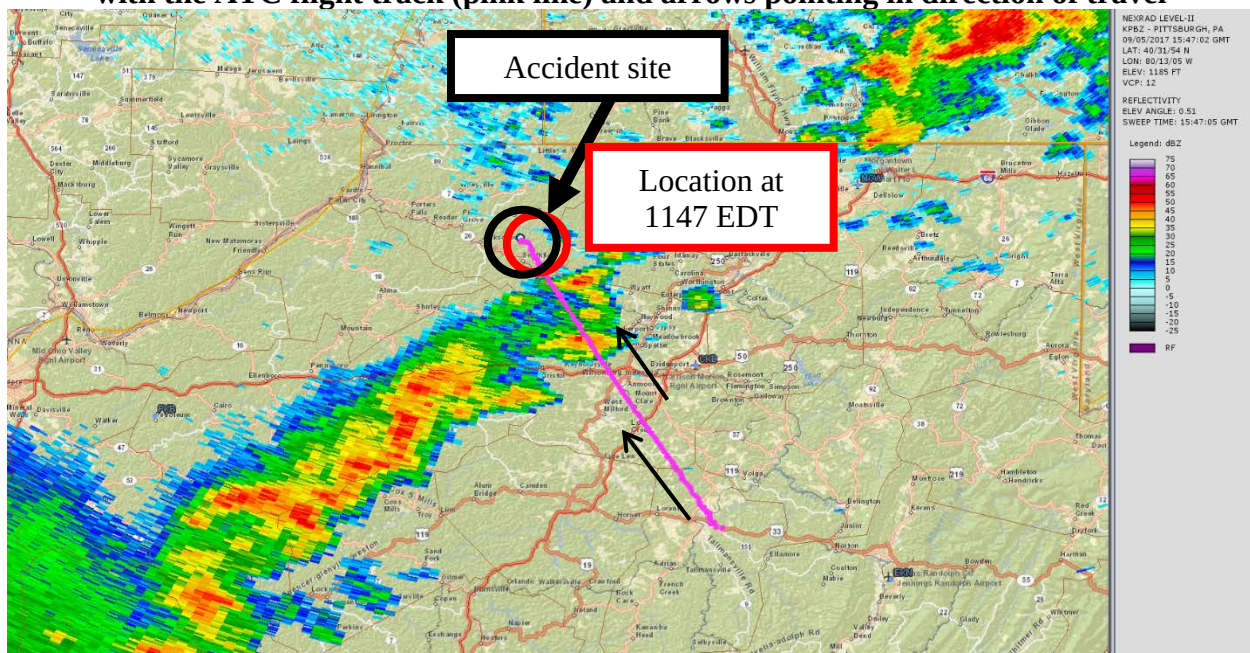


Figure 18 – KPBZ WSR-88D reflectivity for the 0.5° elevation scan initiated at 1147 EDT with the ATC flight track (pink line) and arrows pointing in direction of travel

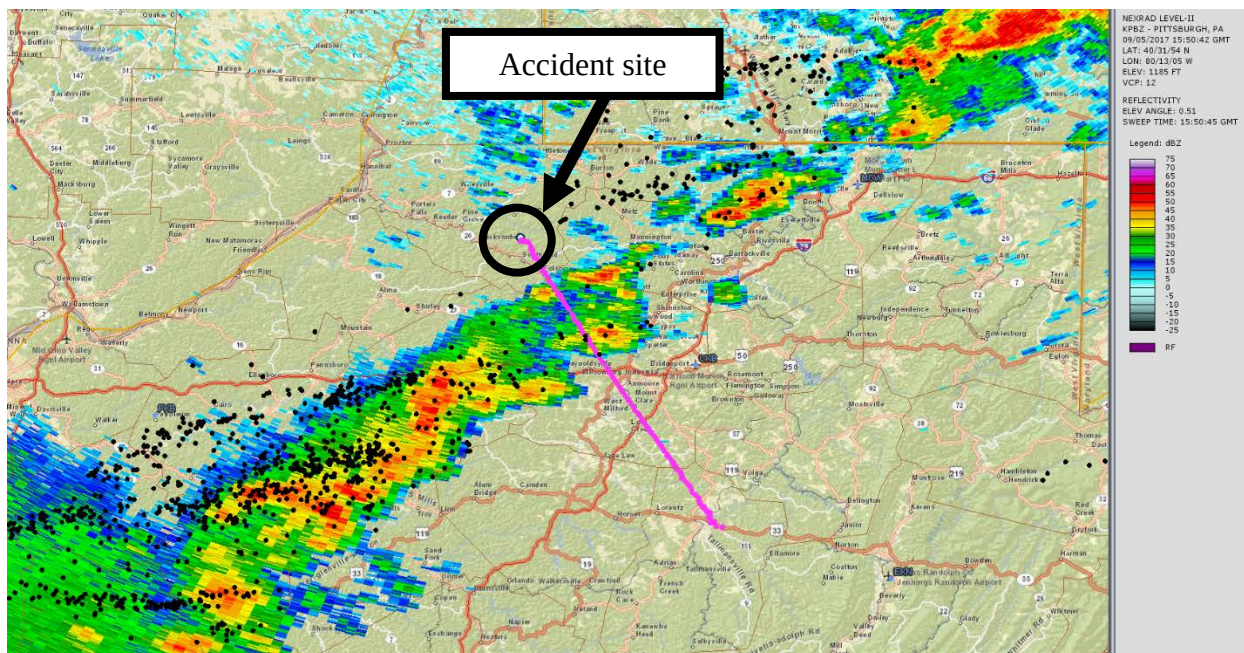


Figure 19 – KPBZ WSR-88D reflectivity for the 0.5° elevation scan initiated at 1151 EDT with the ATC flight track (pink line) and lightning flashes (black dots) from 1100 to 1200 EDT

7.0 Pilot Reports³²

All PIREPs within 150 miles of the accident site from about two hours prior to the accident time to about two hours after the accident time were reviewed. Only PIREPs for below FL180³³ are provided below:

JST UA /OV JST100015/TM 1355/FL160/TP MU2/TA M16/IC LGT RIME=

MFD UA /OV MFD/TM 1404/FL60/TP PA23/SK SCTUNKN-TOP025/WX FV08SM/TA 10/TB SMTH/RM OVC LAYER ABOVE UNKN=

PIT UA /OV 3 MILE FINAL RWY 28L AT PIT/TM 1415/FL024/TP E190/SK BKN024/WX BR=

PIT UA /OV 20 W PIT/TM 1542/FL100/TP B737/SK BASES 1200 TOPS 8000/RM BASES RAGGED=

LWB UA /OV LWB/TM 1615/FL3400/TP E145/RM BASE AT 3400=

LWB UA /OV LWB/TM 1637/FL042/TP BE9L/RM BASE-042=

PKB UA /OV JPU210030/TM 1714/FL160/TP C25A/TA M6/IC LGT RIME/RM 160-180=

PKB UA /OV JPU/TM 1725/FL200/TP PC12/TA M12/IC LGT RIME 200-110 =

³² Only pilot reports with the WMO header UBOH**, UBWV**, and UBPA** identifier were considered.

³³ 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); 15 miles from Johnstown, Pennsylvania, on the 100° radial; Time – 0955 EDT (1355Z); Altitude – 16,000 ft; Type aircraft – Mitsubishi MU-2; Temperature – -16° C; Icing – Light rime.

Routine pilot report (UA); Over Mansfield, Ohio; Time – 1004 EDT (1404Z); Altitude – 6,000 ft; Type aircraft – Piper PA-23; Sky – Scattered layer unknown bases with tops at 2,500 ft; Weather – 8 miles visibility; Temperature – 10° C; Turbulence – Smooth; Remarks – Overcast layer above unknown level.

Routine pilot report (UA); On 3-mile final into runway 28L into Pittsburg, Pennsylvania; Time – 1015 EDT (1415Z); Altitude – 2,400 ft; Type aircraft – Embraer ERJ-190; Sky – Broken skies at 2,400 ft; Weather – Mist.

Routine pilot report (UA); 20 miles west of Pittsburg, Pennsylvania; Time – 1142 EDT (1542Z); Altitude – 10,000 ft; Type aircraft – Boeing B737-700; Sky – Bases at 1,200 ft with tops at 8,000 ft; Remarks – Bases ragged.

Routine pilot report (UA); Over Lewisburg, West Virginia; Time – 1215 EDT (1615Z); Altitude – 3,400 ft; Type aircraft – Embraer ERJ-145; Remarks – Base at 3,400 ft.

Routine pilot report (UA); Over Lewisburg, West Virginia; Time – 1237 EDT (1637Z); Altitude – 4,200 ft; Type aircraft – Beechcraft King Air; Remarks – Base at 4,200 ft.

Routine pilot report (UA); 30 miles from Parkersburg, West Virginia, on the 210° radial; Time – 1314 EDT (1714Z); Altitude – 16,000 ft; Type aircraft – Cessna 525A; Temperature – -6° C; Icing – Light rime; Remarks – Between 16,000 and 18,000 ft.

Routine pilot report (UA); Over Johnstown, Pennsylvania; Time – 1325 EDT (1725Z); Altitude – 20,000 ft; Type aircraft – Pilatus PC-12; Temperature – -12° C; Icing – Light rime between 20,000 and 11,000 ft.

8.0 SIGMET and CWSU Advisories

There was a Significant Meteorological Information (SIGMET) advisory valid for the accident site at the accident time. SIGMET 29E was valid for the accident site at the accident time and warned of an area of thunderstorms with tops to FL450 (figure 20). The SIGMET was forecast to move from 270° at 45 knots. Two SIGMETs were valid along the proposed route of flight before departure and at the time the accident pilot received Leidos weather briefing (section 14.0):

WSUS31 KPCI 051455

SIGE

MKCE WST 051455

CONVECTIVE SIGMET 29E

VALID UNTIL 1655Z

PA MD WV OH

FROM 40NNW JST-60S JST-30ESE EKN-20NW HNN-40NNW JST

AREA TS MOV FROM 27045KT. TOPS TO FL450.

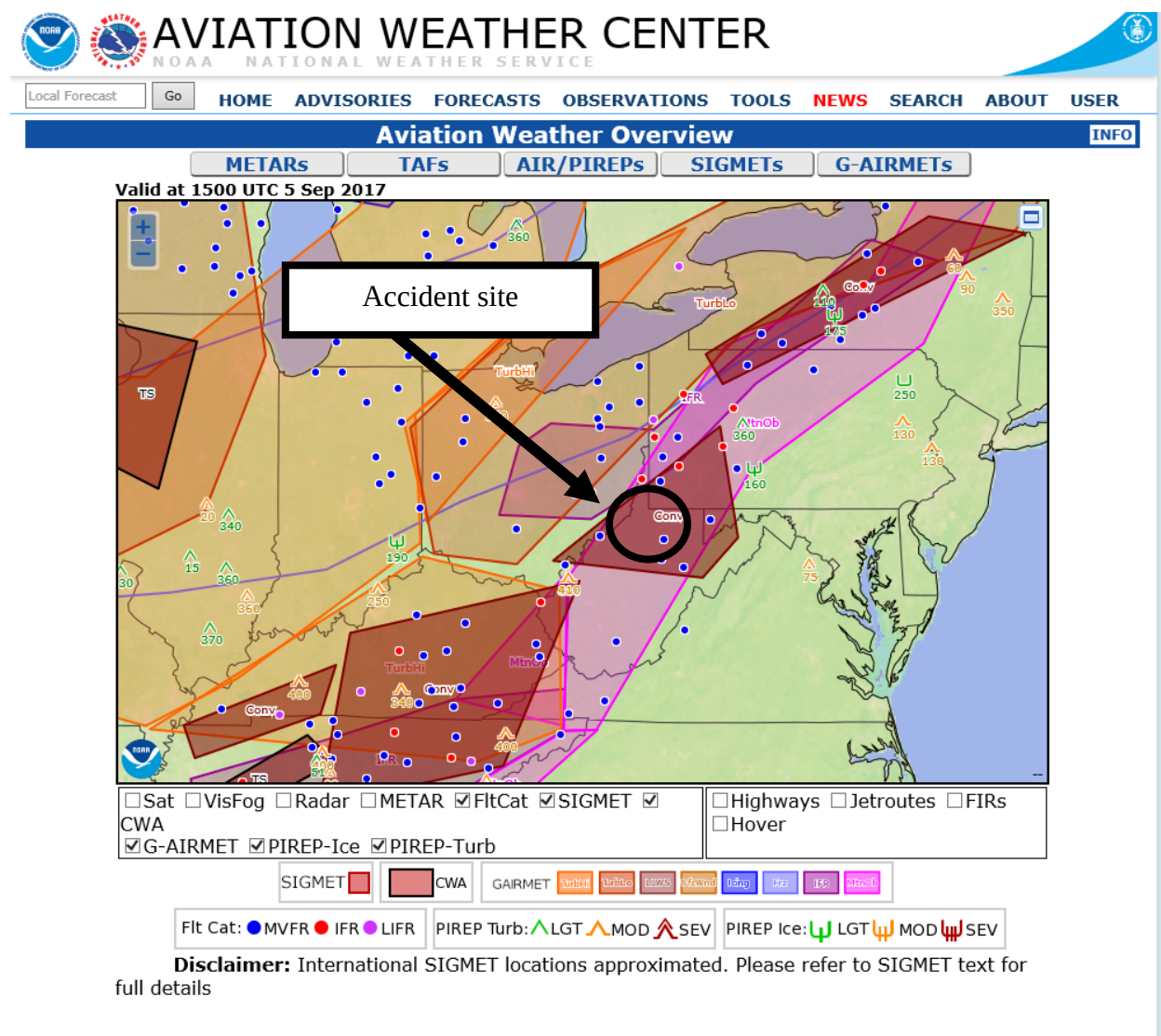


Figure 20 – AWC graphic with SIGMETs, CWAs, and AIRMETs valid at 1100 EDT

No Center Weather Service Unit (CWSU) Center Weather Advisories were valid for the accident site at the accident time. A Meteorological Impact Statement (MIS) issued by the CWSU in Cleveland Air Route Traffic Control Center (ARTCC) at 0645 EDT was valid for the accident site at the accident time and it discussed widely scattered thunderstorms decreasing in coverage through 1100 EDT then redeveloping after 1300 EDT and forming a broken line of thunderstorms. The thunderstorm movement was expected to be from the southwest at 40 to 45 knots with tops to FL250 to FL360. Patchy moderate turbulence below 12,000 ft was also expected. The CWSU at the Washington ARTCC also issued a MIS at 0645 EDT, which was valid at the time of the accident flight, that discussed isolated to widely scattered thunderstorms across the northwestern area of the airspace (including the area the accident flight flew through) with an increase in thunderstorms by the afternoon. Areas of moderate turbulence below 10,000 ft were also expected in Washington ARTCC's airspace:

FAUS20 KZOB 051045
 ZOB MIS 01 VALID 051045-051900
 ...FOR ATC PLANNING PURPOSES ONLY...
**SE 1/2 ZOB.. WDLY SCT TS DCRG THRU 15Z.. REDVLPG AFT 17Z AND FORMING
 BKN LINE. MOV FROM SW 40-45KT. TOPS FL250-360. PTCHY LGT-ISOL MOD
 ICE 100-FL220. PTCHY MOD TURB BLW 120. PTCHY IFR ENDG 14Z. ENTIRE
 ZOB.. PTCHY MOD TURB FL180-350.**
 =

FAUS20 KZDC 051045
 ZDC MIS 01 VALID 051045-051900
 ...FOR ATC PLANNING PURPOSES ONLY...
**ISOL-WDLY SCT EMBD TS NW ZDC THIS MORNING. SCT TS NW ZDC
 BY EARLY THIS AFTN WITH A FEW TS ALSO PSBL E NC AFT 17Z.
 TS TOPS FL350-450+. AREAS OF MOD TURB FL250-400 AND
 BLW 100 N & W ZDC. OCNL MOD ICE 140-FL270 NW ZDC.**

9.0 AIRMETs

There was an Airmen's Meteorological Information (AIRMET) Sierra that was valid for the accident site at the accident time (figure 20). This AIRMET Sierra warned of mountain obscuration conditions in clouds and precipitation:

554
 WAUS41 KPCI 051445
 WA1T
 -BOST WA 051445
 AIRMET TANGO UPDT 2 FOR TURB VALID UNTIL 052100
 .
 AIRMET TURB...NY LO PA OH LE
 FROM 60W YSC TO 40E SYR TO 20SW APE TO 40E CVG TO CVG TO FWA TO
 30SE ECK TO YOW TO 60W YSC
 MOD TURB BTN FL180 AND FL340. CONDS CONTG BYD 21Z THRU 03Z.
 .
 AIRMET TURB...VT NY LO PA OH LE
 FROM 20E YSC TO 60SW MPV TO 60ESE BUF TO 40WNW HNN TO CVG TO FWA
 TO 30SSE ECK TO YOW TO 50W YSC TO 20E YSC
 MOD TURB BTN 050 AND FL180. CONDS CONTG BYD 21Z THRU 03Z.
 .
 OTLK VALID 2100-0300Z...TURB ME NH VT NY LO PA OH LE WV MD
 BOUNDED BY YSC-50WNW BGR-50WSW BKW-HNN-CVG-FWA-30SE ECK-YOW-YSC
 MOD TURB BTN 100 AND FL180. CONDS CONTG THRU 03Z.

337
 WAUS41 KPCI 051445
 WA1Z
 -BOSZ WA 051445
 AIRMET ZULU UPDT 2 FOR ICE AND FRZLVL VALID UNTIL 052100
 .
 NO SGFNT ICE EXP OUTSIDE OF CNVTV ACT.

.
FRZLVL...RANGING FROM 085-160 ACRS AREA
120 ALG 40W HNN-20ESE AIR-60SSE MSS-PQI-60NE PQI
....

791
WAUS41 KPCI 051445
WA1S
-BOSS WA 051445
AIRMET SIERRA UPDT 3 FOR IFR AND MTN OBSCN VALID UNTIL 052100
.

AIRMET IFR...ME NH MA AND CSTL WTRS
FROM 50SE HUL TO 110SSW YSJ TO 80E BOS TO 50ENE ENE TO 20S BGR
TO 50SE HUL
CIG BLW 010/VIS BLW 3SM BR. CONDS DVLPG 18-21Z. CONDS CONTG BYD
21Z THRU 03Z.

.
AIRMET IFR...ME NH VT NY LO PA OH WV
FROM 60ENE YSC TO 50SW BGR TO 30ESE SLT TO 50SE APE TO 50SW APE
TO 30NE ROD TO 30SW CLE TO 20NNW EWC TO 40ESE BUF TO 50SE MSS TO
60ENE YSC
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 21Z ENDG 00-03Z.

.
AIRMET MTN OBSCN...ME NH VT NY PA WV MD VA
FROM 40SE YQB TO 20WNW BGR TO 40S MPV TO 40SW HAR TO 40SSE PSK
TO HNV TO HNN TO 20SW JHW TO SYR TO 30ESE YOW TO YSC TO 40SE YQB
MTNS OBSC BY CLDS/PCPN. CONDS CONTG BYD 21Z THRU 03Z.

.
OTLK VALID 2100-0300Z
AREA 1...IFR ME NH MA AND CSTL WTRS
BOUNDED BY 50ESE PQI-150ENE ACK-50NE ACK-30NE ENE-30SW BGR-20S
MLT-50ESE PQI
CIG BLW 010/VIS BLW 3SM BR. CONDS CONTG THRU 03Z.

.
AREA 2...MTN OBSCN ME NH VT MA NY PA WV MD VA
BOUNDED BY 40SSE YQB-HUL-40SW CON-40WSW HAR-50WSW CSN-30NNE GSO-
HNV-20S HNN-30ESE AIR-30W JST-40SE BUF-SYR-MSS-YSC-40SSE YQB
MTNS OBSC BY CLDS/PCPN. CONDS CONTG THRU 03Z.
....

10.0 Area Forecast

The Area Forecast issued at 0445 EDT, valid at the accident time for the accident location, forecast a broken ceiling at 4,000 to 5,000 ft with broken skies at 10,000 ft and cloud tops at FL180. Scattered light rain showers and widely scattered thunderstorms with light rain with tops to FL400 were also forecast:

756
FAUS41 KPCI 050845
FA1W
-BOSC FA 050845
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 060300
CLDS/WX VALID UNTIL 052100...OTLK VALID 052100-060300

ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DC DE VA AND CSTL WTRS

.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG.

.
SYNOPSIS...LRG SCALE UPR TROF EXTDS FM ONT THRU THE UPR MS VLY
AND GRTLKS RGN. TROF WL GRDLY SHFT EWD. CDFNT EXTDS FM SE
QUE-CNTRL NY-SE OH-WRN TN. CDFNT WL SLOLY MOV EWD TO EXTD FM NERN
ME-SERN NY-WRN VA-NRN GA BY 00Z.

.
ME NH VT
NRN SXNS...BKN030-040 OVC100 TOPS FL180. OCNL VIS 3-5SM -SHRA BR.
ISOL -TSRA. CB TOPS FL360. OTLK...MVFR CIG SHRA.
SRN SXNS...SCT-BKN100 TOPS 140. BECMG 1821 SCT-BKN040 BKN100 TOPS
160. WDLY SCT -SHRA/-TSRA. CB TOPS FL400. OTLK...MVFR CIG SHRA
TSRA.

.
MA RI CT
WRN MA/CT...SCT100. 18Z SCT045 SCT100. BECMG 1921 SCT-BKN050
BKN100 TOPS 150. WDLY SCT -SHRA/-TSRA. CB TOPS FL400. OTLK...VFR
SHRA TSRA.
ERN MA/RI...SKC. 17Z OCNL SCT050. OTLK...VFR.

.
NY LO
NERN NY...BKN040-050 OVC100 TOPS FL180. OCNL VIS 3-5SM -SHRA BR.
BECMG 1518 BKN040-050 TOPS 080. OTLK...MVFR CIG..02Z VFR.
SERN NY...
INLAND SXNS...SCT-BKN120 TOPS 150. BECMG 1821 SCT-BKN050 BKN100
TOPS FL180. WDLY SCT -TSRA. CB TOPS FL400. OTLK...VFR SHRA
TSRA..01Z MVFR CIG SHRA.
CSTL SXNS INCL LONG ISLAND...SKC. 17Z SCT050 SCT-BKN CI.
OTLK...VFR.
WRN NY/LO...
WRN SXNS...BKN030-040 TOPS 080 BKN CI. ISOL -SHRA. 17Z SCT040-050
SCT CI. OTLK...VFR.
ERN SXNS...BKN020-030 OVC100 TOPS FL180. OCNL VIS 3-5SM -SHRA BR.
ISOL -TSRA. CB TOPS FL360. 17Z BKN025-030 TOPS 070. OTLK...MVFR
CIG..01Z VFR.

.
PA NJ
WRN PA...BKN030-040 OVC100 TOPS FL180. OCNL VIS 3-5SM -SHRA BR.
ISOL -TSRA. CB TOPS FL360. BECMG 1518 BKN025-030 TOPS 080. 21Z
BKN-SCT040-050. OTLK...VFR.
ERN PA...SCT100 SCT CI. 15Z SCT040-050 SCT100. BECMG 1821
BKN040-050 BKN100 TOPS FL180. SCT -SHRA/-TSRA. CB TOPS FL420.
OTLK...VFR SHRA TSRA..01Z MVFR CIG NERN PA.
NJ...SKC. 15Z SCT050. OTLK...VFR..00Z VFR TSRA.

.
OH LE
NWRN OH/WRN LE...SCT040 BKN CI. OCNL VIS 3-5SM BR. 15Z SCT040.
18Z SCT-BKN040 TOPS 070. OTLK...VFR.
NERN OH/ERN LE...BKN015-025 TOPS 070. TIL 13Z OCNL VIS 3-5SM BR.
17Z SCT-BKN040 TOPS 070. OTLK...VFR.
SWRN OH...BKN020-030 TOPS 060 BKN CI. OCNL VIS 3-5SM BR. 14Z
BKN040. 18Z BKN-SCT040-050. OTLK...VFR.

SERN OH...BKN030-040 OVC100 TOPS FL200. OCNL VIS 3-5SM -SHRA. SCT
-TSRA. CB TOPS FL420. 15Z BKN030-040 TOPS 080. 18Z
BKN-SCT040-050. OTLK...VFR.

.

WV

WRN HLF...BKN100 TOPS 160 BKN CI. BECMG 1215 BKN040-050 BKN100
TOPS FL180. SCT -SHRA/WDLY SCT -TSRA. CB TOPS FL400. 18Z
BKN030-040 TOPS 070. OTLK...VFR.

ERN HLF...SCT060 SCT-BKN CI. BECMG 1518 BKN050 BKN100 TOPS FL180.
SCT -SHRA/-TSRA. CB TOPS FL400. OTLK...VFR TSRA..00ZMVFR CIG.

.

MD DC DE VA

WRN MD/WRN VA...SCT CI. 15Z SCT-BKN CI. 17Z SCT060 BKN CI. BECMG
1821 SCT-BKN060 BKN120 TOPS FL180. SCT -SHRA/WDLY SCT -TSRA. CB
TOPS FL400. OTLK...VFR SHRA TSRA.

ERN MD/ERN VA/DC/DE...SKC. 18Z SCT050 SCT CI. OTLK...VFR SHRA
TSRA.

.

CSTL WTRS

SKC. 18Z WND SSWLY G25-30KT. OTLK...VFR WND.

....

11.0 Terminal Aerodrome Forecast

KCKB was the closest site to the accident site with an NWS Terminal Aerodrome Forecast (TAF). The TAF valid at the accident time was issued at 1057 EDT and was valid for a 21-hour period beginning at 1100 EDT. The 1057 EDT TAF for KCKB was as follows:

KCKB 051457Z 0515/0612 **21004KT P6SM OVC035**
FM051600 22008KT P6SM VCTS OVC025CB
FM051800 24008KT 4SM TSRA OVC015CB
FM052100 26005KT P6SM BKN015
FM060200 26004KT P6SM BKN030
FM060300 26003KT P6SM BKN035=

The TAF expected a wind from 210° at 4 knots, greater than 6 miles visibility, and an overcast ceiling at 3,500 ft agl.

12.0 NWS Area Forecast Discussion

The NWS Office in Pittsburgh, Pennsylvania, issued the following Area Forecast Discussion (AFD) at 1021 EDT (closest AFD to the accident time with an aviation section). The aviation section of the AFD discussed areas of MVFR to IFR associated with the rain shower and thunderstorms activity:

FXUS61 KPBZ 051421
AFDPBZ

Area Forecast Discussion
National Weather Service Pittsburgh PA
1021 AM EDT Tue Sep 5 2017

.SYNOPSIS...

Showery weather and well below normal temperatures can be expected through the week until high pressure returns this weekend.

&&

.NEAR TERM /THROUGH TONIGHT/...

Showers and isolated storms will associated with a crossing front will continue to push east today. Activity will be primarily east of Pittsburgh.

Aloft, the associated upper trough will continue to deepen over the northeast and shortwaves within the flow will provide lift for additional scattered rain showers over southern and eastern counties into tonight.

&&

.SHORT TERM /WEDNESDAY THROUGH FRIDAY/...

Cold temperature and shower chances will plague the region into Friday as the Eastern CONUS trough entrenches and as shortwaves within flow dig off the Lakes and into its base. Expect temperature about 10 to 15 degrees below average for the short term period.

&&

.LONG TERM /FRIDAY NIGHT THROUGH MONDAY/...

The Eastern CONUS trough is expected to linger into the weekend although gradual filling is indicated. Moderating temperature and suppressed precipitation are thus forecast into early next week. The remnant of hurricane Irma is expected to degrade weather for midweek as per the latest deterministic model and ensemble trends.

&&

.AVIATION /14Z TUESDAY THROUGH SATURDAY/...

Areas of MVFR/local IFR conditions are expected through early afternoon with showers/sct thunderstorms advancing across the region ahead of an approaching cold front. Widespread MVFR/local IFR cigs are also expected to develop this morning with low level moisture pooling near the front. Improvement to VFR is expected from mid to late afternoon after FROPA.

.Outlook...

Periodic restrictions are possible through Fri under an upper trough.

&&

.PBZ WATCHES/WARNINGS/ADVISORIES...

MD...None.

OH...None.

PA...None.

WV...None.

&&

\$\$

13.0 Winds and Temperature Aloft Forecast

The NWS 1001 EDT Winds and Temperature Aloft forecast valid for the closest point to the accident site is included below:

```
FBUS31 KWN0 051401
FD1US1
- DATA BASED ON 051200Z
VALID 051800Z FOR USE 1400-2100Z. TEMPS NEG ABV 24000

FT 3000    6000    9000    12000    18000    24000    30000    34000    39000
EKN      2531+12 2434+07 2435+01 2538-10 2540-21 244337 235648 236956
```

The accident site was closest to the Elkins, West Virginia, (EKN) forecast point. The 1001 EDT EKN forecast indicated a wind at 6,000 ft from 250° at 31 knots with a temperature of 12° C and a wind at 9,000 ft from 240° at 34 knots with a temperature of 7° C.

14.0 Pilot Weather Briefing

A search of official weather briefings from Leidos weather briefings and Direct User Access Terminal Service (DUATS) was done. The accident pilot received an official Leidos weather briefing at 0825 EDT (Attachments 1 and 2). The Leidos briefing contained the standard information including the latest SIGMETs (including SIGMET 14E and SIGMET 18C valid along the proposed route of flight), METARs, TAFs, Graphical Forecast for Aviation (GFA, Attachment 3), PIREPs, AIRMETs, and Winds Aloft Forecast all valid along the proposed route of flight. While the GFA information was available to the pilot in graphical format (Attachments 3 and 4), the Leidos weather briefer also described the GFA images as part of the weather briefing to the accident pilot (Attachment 2).

A search of archived data from ForeFlight was done and the accident pilot did not request nor receive weather briefing information from ForeFlight.

15.0 FIS-B Regional NEXRAD with Flight Path

Figures 21 through 25 are the regional NEXRAD weather radar data available to the pilot in the cockpit from Flight Information Services–Broadcast (FIS-B), if the accident pilot had the regional NEXRAD weather radar screen selected (at this horizontal scale) on his electronic equipment.³⁴ The FIS-B regional NEXRAD weather radar data is updated once every 5 minutes and is based upon composite NEXRAD reflectivity data. The FIS-B data indicated that there were no precipitation targets or echoes along the flight track until 1150 EDT (figures 21 through 25). For additional information regarding the regional NEXRAD weather radar data please see attachments 5 and 6. For the exact dBZ scales used in the FIS-B regional NEXRAD please see attachment 7. In addition, the FAA has done some research on general aviation pilot's ability to detect important weather events, plan a response, and avoid hazardous conditions, and this research is available through the Weather Information Latency Demonstrator (WILD) and the Partnership to Enhance General Aviation Safety, Accessibility, and Sustainability (PEGASAS).

³⁴ For more information on the electronic equipment located on the accident aircraft please see the docket information from this accident.

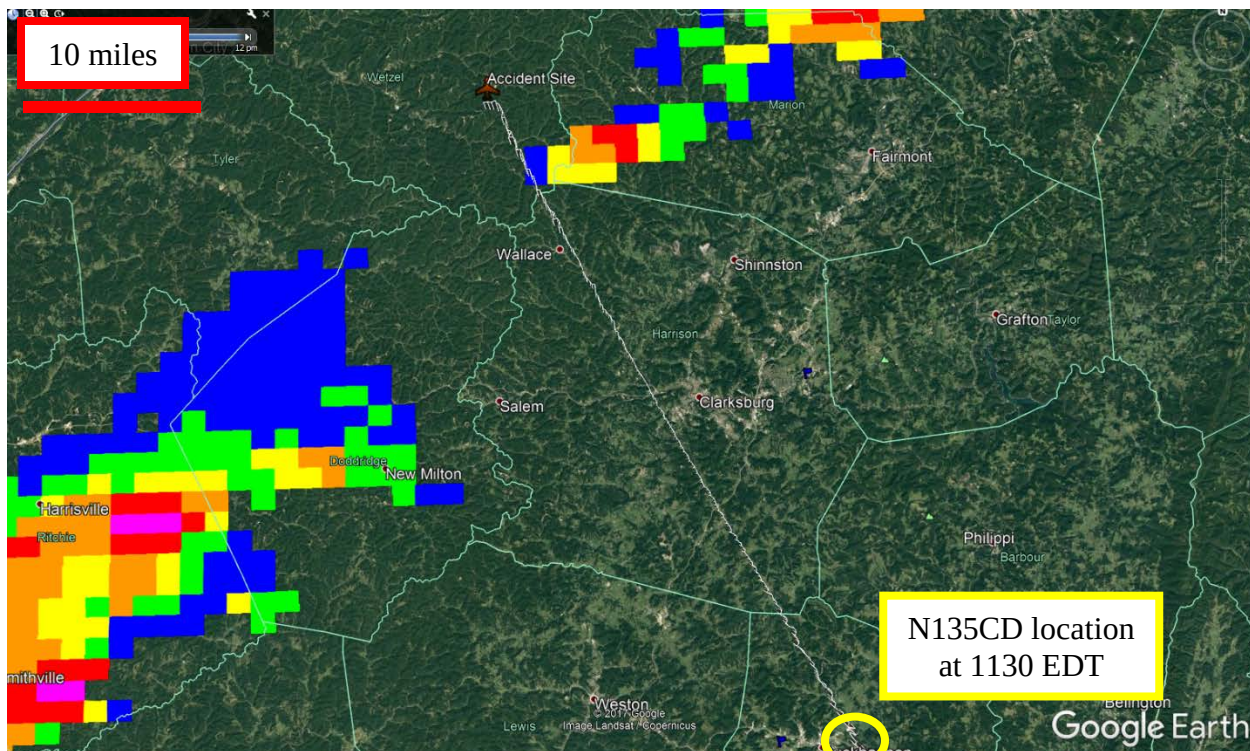


Figure 21 – FIS-B regional NEXRAD plot valid at 1130 EDT with ATC radar track from 1130 to 1148 EDT

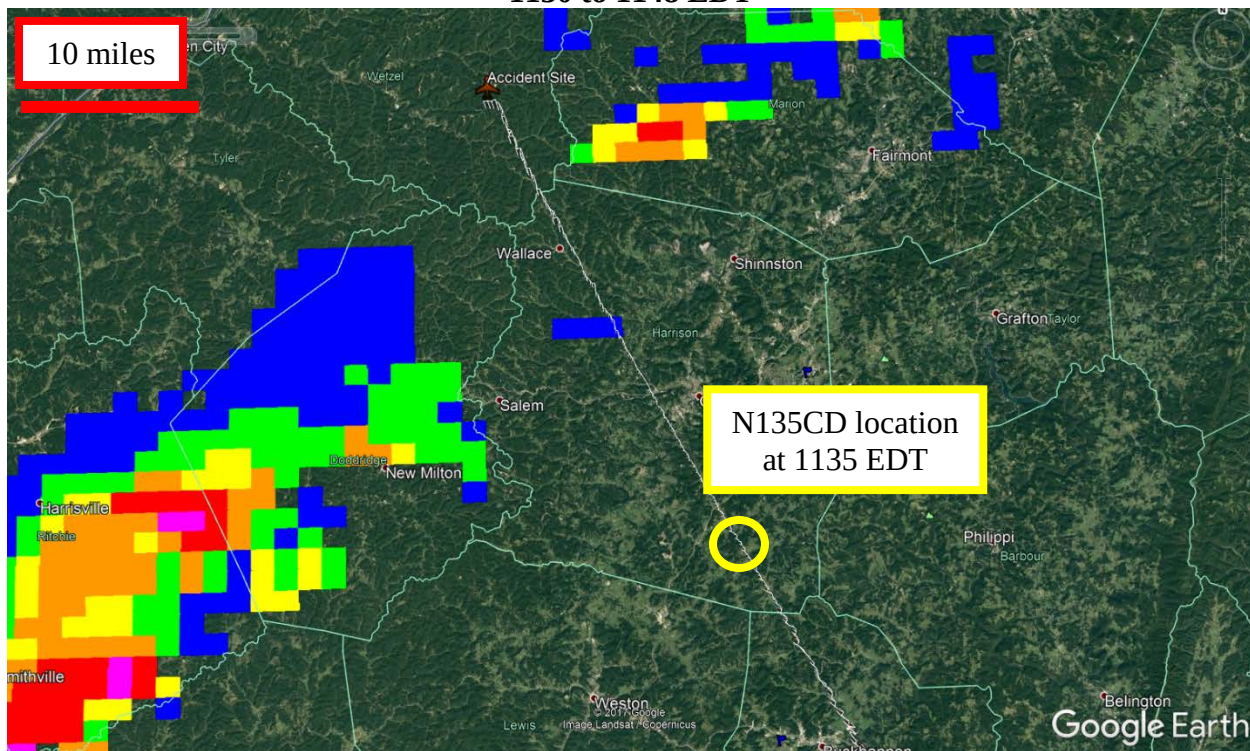


Figure 22 – FIS-B regional NEXRAD plot valid at 1135 EDT with ATC radar track from 1130 to 1148 EDT

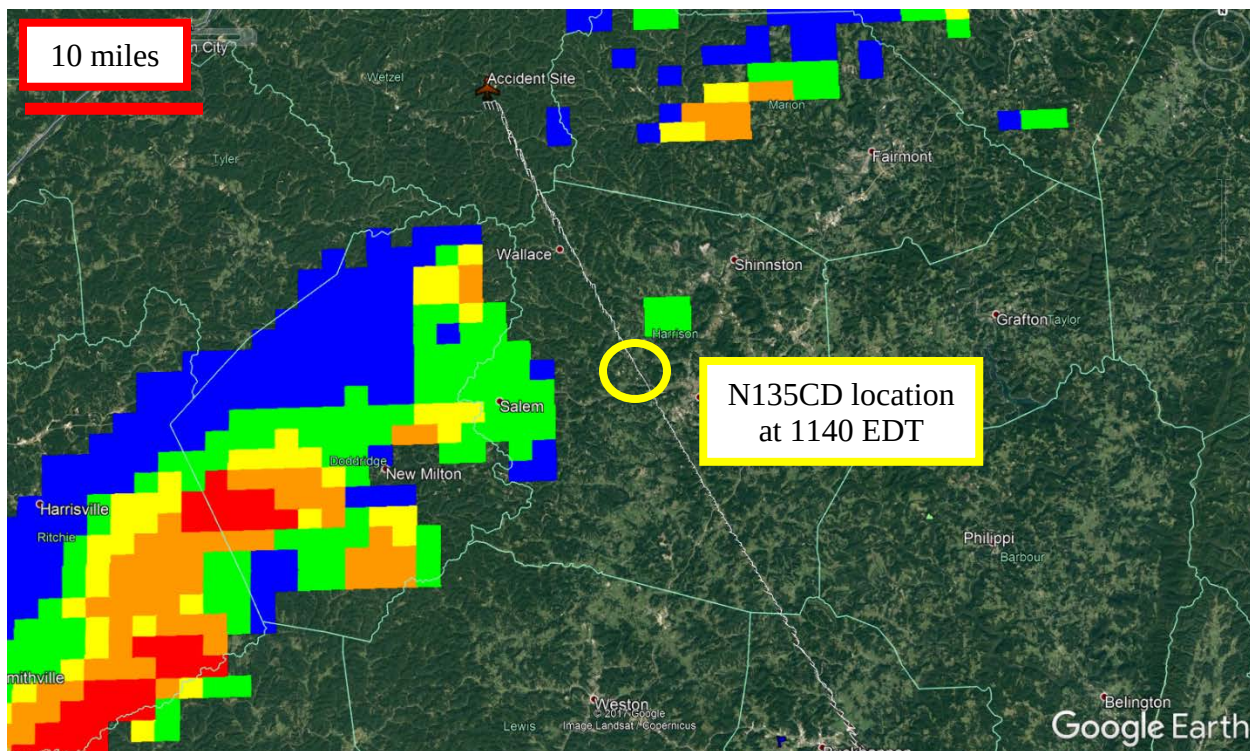


Figure 23 – FIS-B regional NEXRAD plot valid at 1140 EDT with ATC radar track from 1130 to 1148 EDT

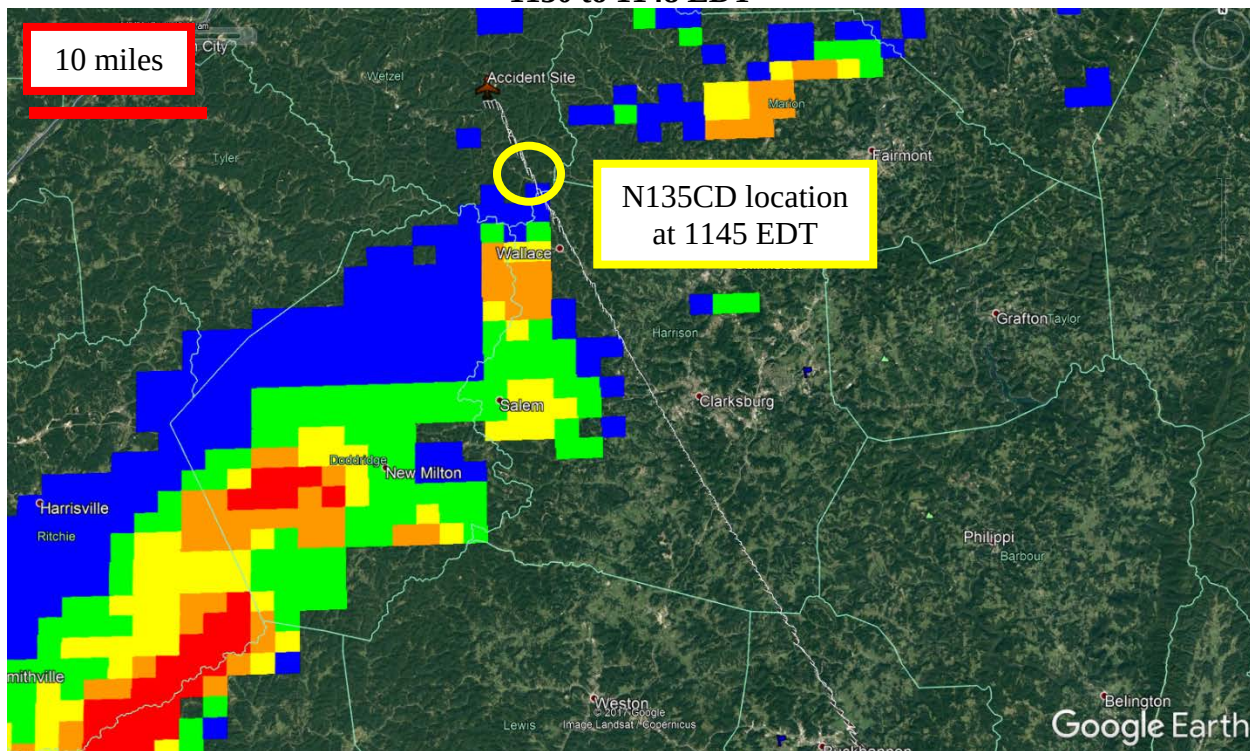


Figure 24 – FIS-B regional NEXRAD plot valid at 1145 EDT with ATC radar track from 1130 to 1148 EDT

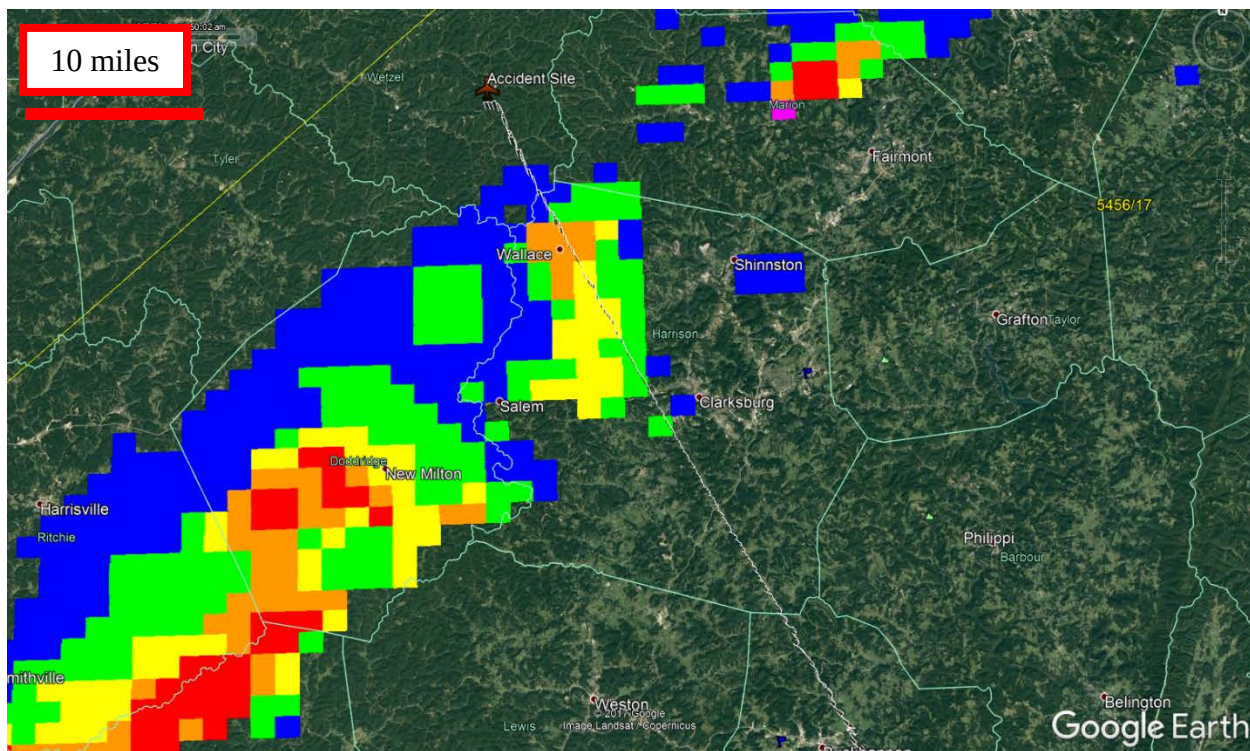


Figure 25 – FIS-B regional NEXRAD plot valid at 1150 EDT with ATC radar track from 1130 to 1148 EDT

16.0 XM Weather Data

The airplane was equipped with a Garmin³⁵, which could be fitted to display XM Weather information with a subscription. It is unknown if the pilot had a subscription to view XM Weather information. If the accident pilot had been viewing XM Weather composite radar information he would have had a chance to view something similar to figures 26 through 30, which was XM Weather composite radar information available from 1130 to 1150 EDT. The scale used in the XM Weather composite radar information is located in figure 31. The XM Weather composite radar images from at both 1135 and 1145 EDT displayed dBZ values less than 20 dBZ above the accident site (figures 27 and 29). For additional information regarding the XM Weather composite radar data please see attachment 8.

³⁵ For more information on the electronic equipment located on the accident aircraft please see the docket information from this accident.



Figure 26 –XM Weather Radar from 1130 EDT



Figure 27 – XM Weather Radar from 1135 EDT



Figure 28 – XM Weather Radar from 1140 EDT



Figure 29 – XM Weather Radar from 1145 EDT



Figure 30 – XM Weather Radar from 1150 EDT



Figure 31 – XM Weather Radar scale for figures 26 through 30

17.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for the accident site on September 5, 2017, indicated the following:

SUN

Begin civil twilight	0627 EDT
Sunrise	0654 EDT
Sun transit	1321 EDT
Sunset	1946 EDT
End civil twilight	2014 EDT

E. LIST OF ATTACHMENTS

Attachment 1 – Leidos weather briefing document from 0825 EDT

Attachment 2 – Leidos weather briefing audio from 0825 EDT

Attachment 3 – GFA products provided to the accident pilot during the Leidos weather briefing from 0825 EDT

Attachment 4 – Correspondence with Leidos regarding GFA products

Attachment 5 – FAA response to NTSB request 17-267 document

Attachment 6 – FAA response to NTSB request 17-267 data

Attachment 7 – FIS-B radar scale

Attachment 8 – XM composite weather radar data

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