



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

June 28, 2017

Weather Study

METEOROLOGY

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A. ACCIDENT

Location: Around 6 miles northwest of Austin, Pennsylvania
Date: October 16, 2016
Time: 1957 eastern daylight time
2357 Coordinated Universal Time (UTC)
Airplane: Piper PA-28-161, C-GYSN

B. METEOROLOGIST

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

C. SUMMARY

On October 16, 2016, about 1957 eastern daylight time, a Piper PA-28-161, Canadian registration C-GYSN, collided with trees near Austin, Pennsylvania. The commercial pilot, and two occupants were fatally injured, and the airplane was destroyed. The airplane was registered to and operated by St. Catharines Flying Club, under the provisions of 14 *Code of Federal Regulations* Part 91, as a personal flight. Instrument meteorological conditions prevailed and an instrument flight rules flight plan was filed. The flight originated from Richmond International Airport (RIC), Richmond, Virginia, about 1654, and was destined for St. Catharines/Niagara District Airport (CYSN), St. Catharines, Ontario, Canada.

D. 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 October 16, 2016, 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 accident site was located at latitude 41.700° N, longitude 78.181° W, at an approximate elevation of 1,995 feet.

E. WEATHER INFORMATION

1.0 Synoptic Situation

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

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart for 2000 EDT is provided as figure 1 with the approximate location of the accident site marked within the red circle. The chart depicted two frontal boundaries that stretched from southern Ontario westward across northern and central Michigan. Two surface high pressure centers were located in eastern North Carolina and the west-central Atlantic Ocean with a surface pressure of 1021-hectopascals (hPa). The accident site was not located in the vicinity of any surface low pressure centers or surface frontal boundaries. The station models around the accident site at 2000 EDT depicted air temperatures in the low to mid 60’s degrees Fahrenheit (°F), with temperature-dew point spreads of 13° F or less, a south to southwest wind under 10 knots, mostly cloudy skies, and light rain reported in southwestern New York.

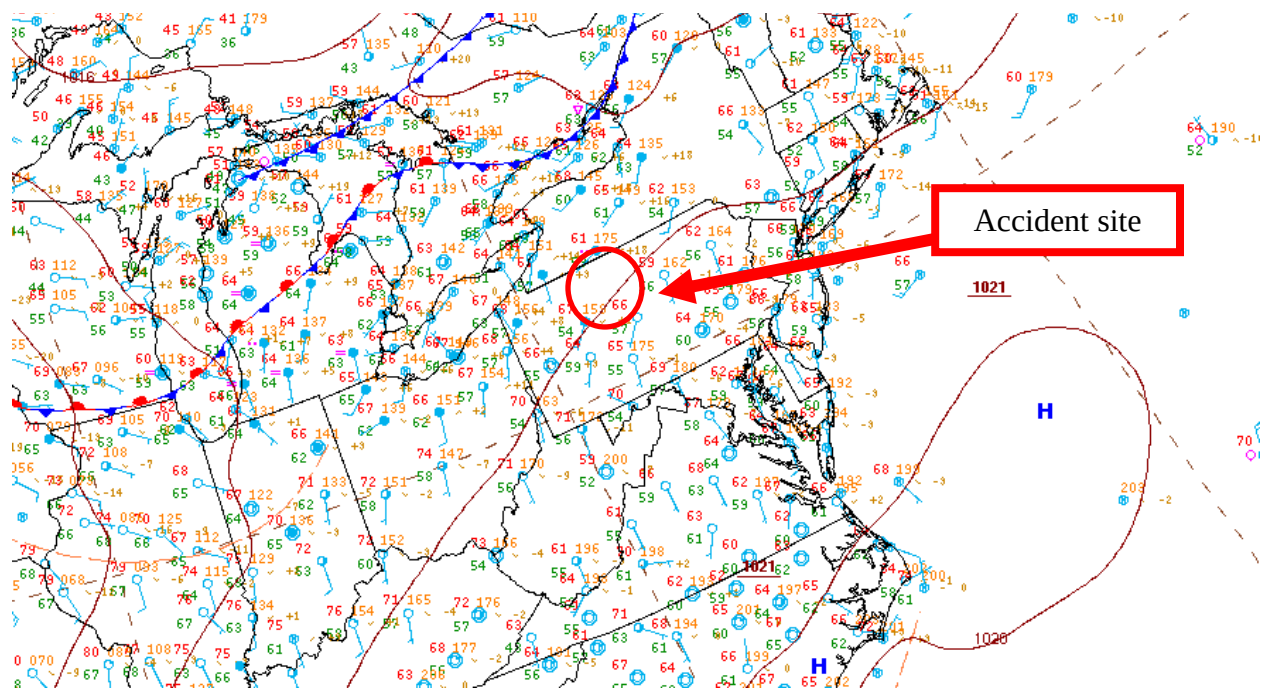


Figure 1 – NWS Surface Analysis Chart for 2000 EDT

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 2000 EDT at 925-, 850-, 700-, 500-, and 300-hPa are presented in figures 2 through 6. The 850-hPa chart depicted a low-level trough¹ just west of the accident site over central Ohio. The 700- and 500-hPa charts depicted a mid-level trough just west of the accident site located over western Pennsylvania. Troughs typically act as lifting mechanisms where enhanced lift, gusty winds, fronts, clouds, and precipitation can occur. There was a southwest wind of about 20 knots at 925-hPa (figure 2) with the wind becoming westerly by 700-hPa with a wind speed of 25 knots (figure 4). The 25-knot westerly wind at 700-hPa became a 45-knot west-northwest wind by 300-hPa (figure 6).

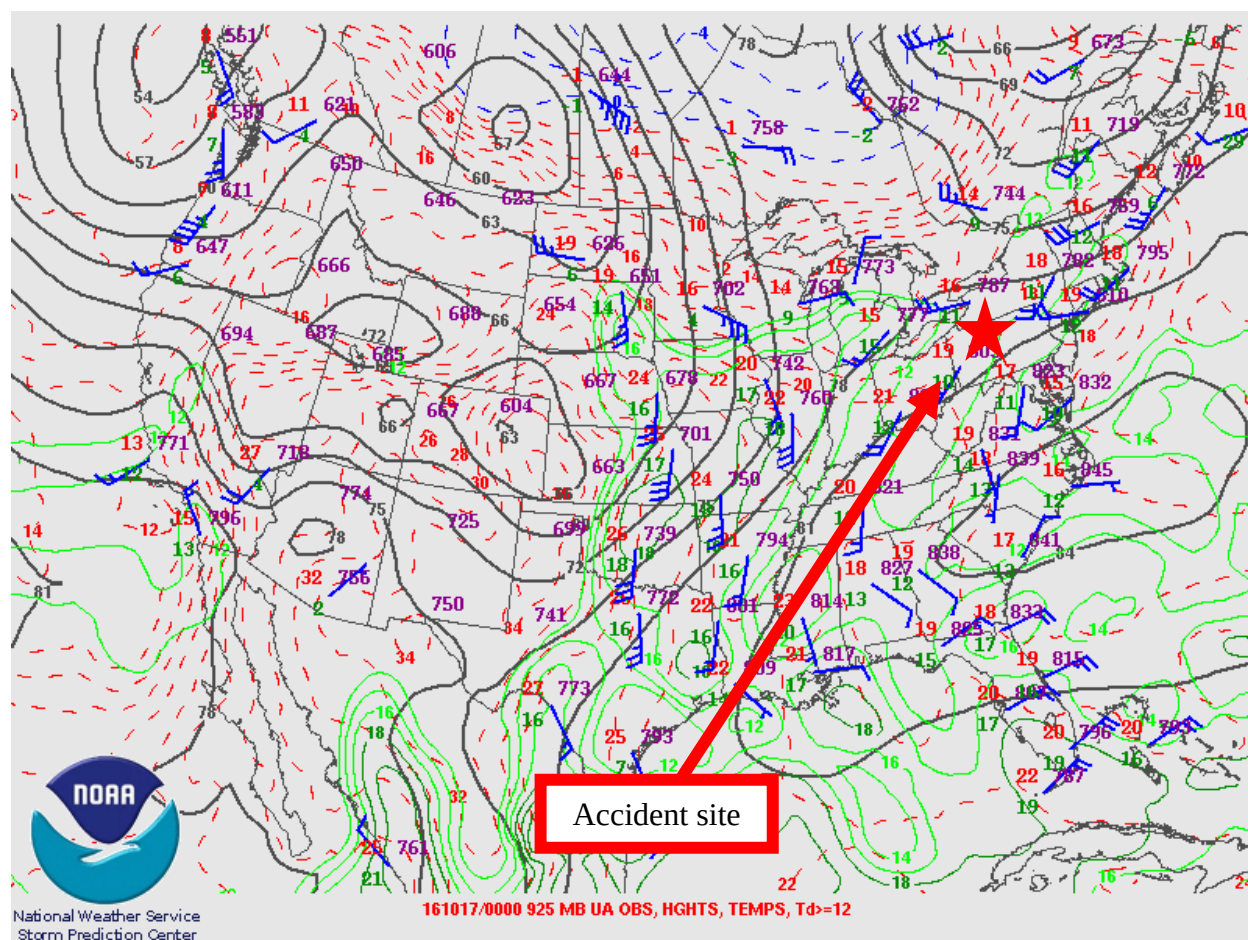


Figure 2 – 925-hPa Constant Pressure Chart for 2000 EDT

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

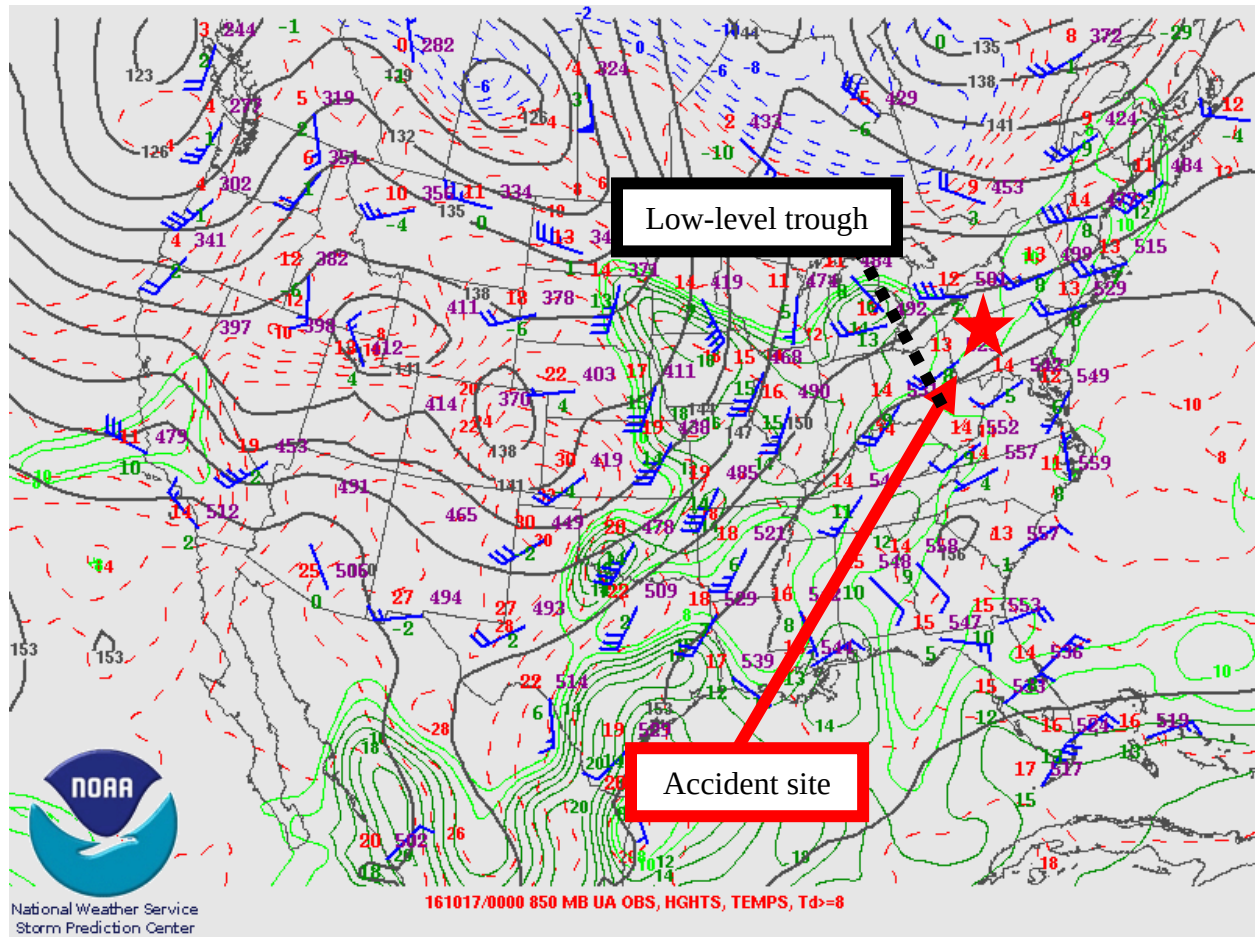


Figure 3 – 850-hPa Constant Pressure Chart for 2000 EDT

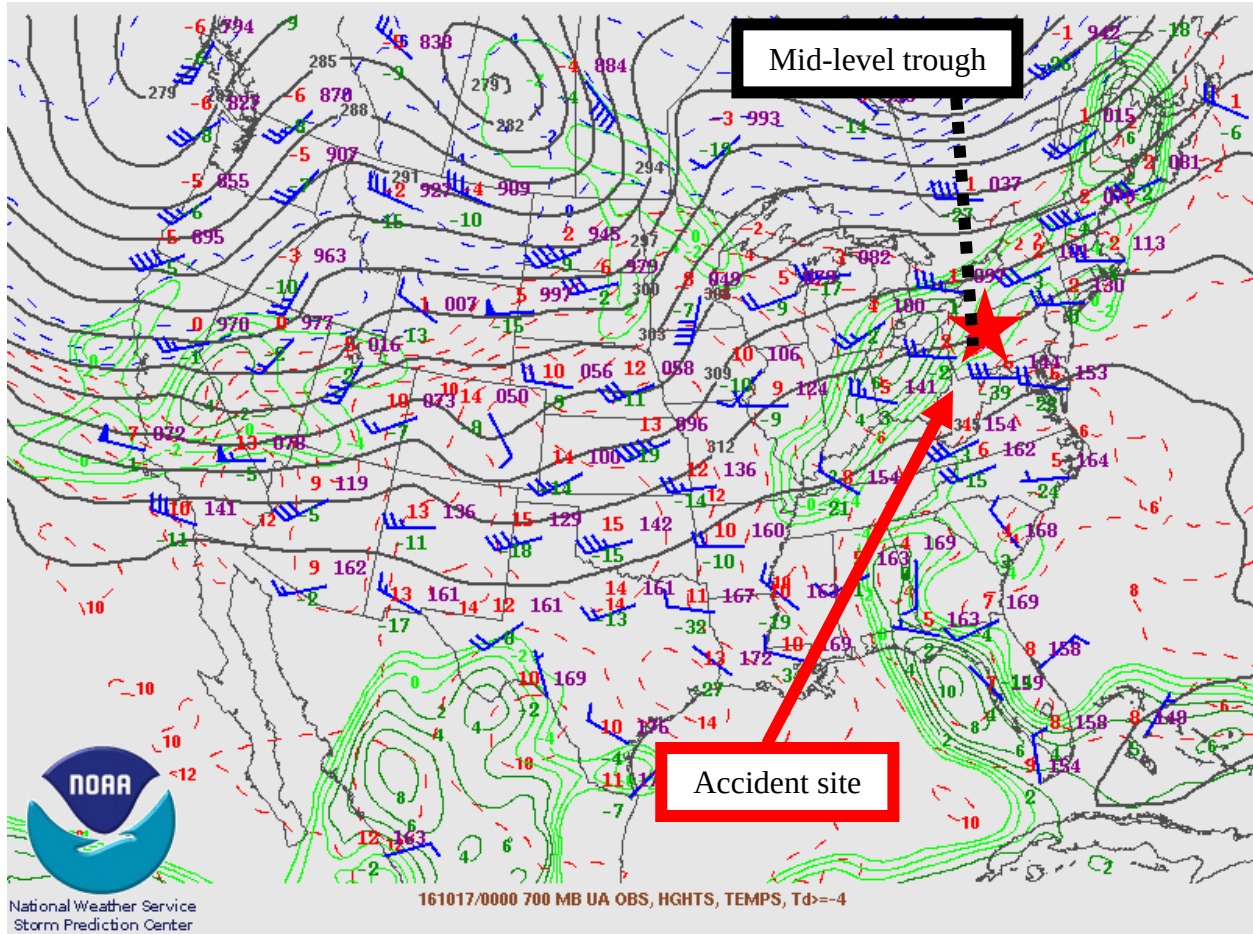


Figure 4 – 700-hPa Constant Pressure Chart for 2000 EDT

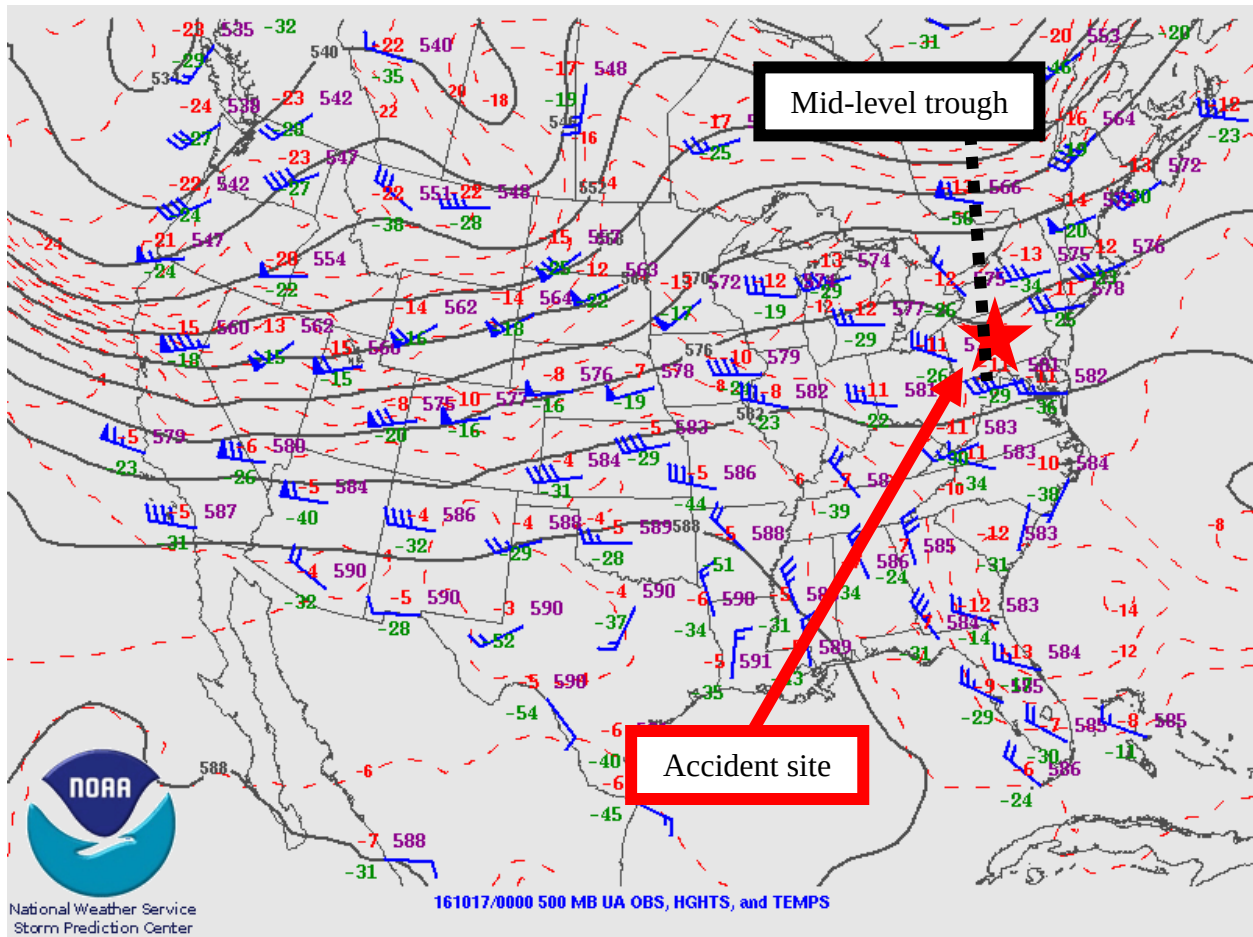


Figure 5 – 500-hPa Constant Pressure Chart for 2000 EDT

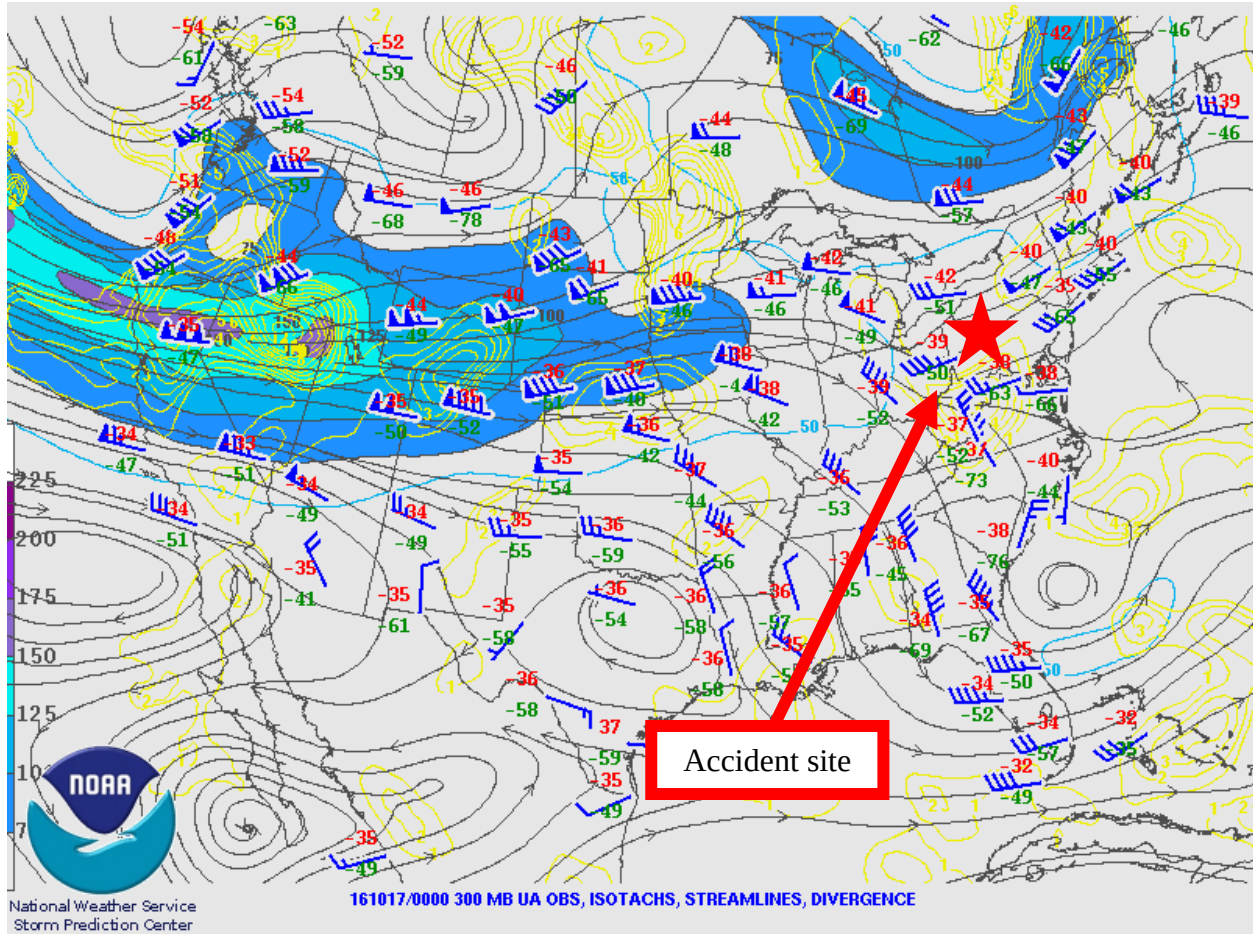


Figure 6 – 300-hPa Constant Pressure Chart for 2000 EDT

2.0 Storm Prediction Center Products

The NWS SPC issued the following Day 1 Convective Outlook at 1537 EDT (figure 7) with areas of general thunderstorms forecast for the accident site:

SPC AC 161937

DAY 1 CONVECTIVE OUTLOOK
NWS STORM PREDICTION CENTER NORMAN OK
0237 PM CDT SUN OCT 16 2016

VALID 162000Z - 171200Z

...THERE IS A MRGL RISK OF SVR TSTMS THIS EVENING AND TONIGHT OVER THE UPPER MS VALLEY...

...SUMMARY...

ISOLATED SEVERE HAIL IS POSSIBLE TONIGHT ACROSS PARTS OF THE UPPER MISSISSIPPI VALLEY EASTWARD TOWARD NORTHWESTERN LAKE MICHIGAN.

NO SIGNIFICANT CHANGES HAVE BEEN MADE TO THE ONGOING FORECAST.

WARM/CAPPED LOW-LEVEL ENVIRONMENT CONTINUES TO SUGGEST THAT THUNDERSTORMS TONIGHT WILL BE ISOLATED AND MAINLY ELEVATED...LIMITING THE RISK OF ORGANIZED SEVERE STORMS. PLEASE REFER TO THE PREVIOUS DISCUSSION FOR FURTHER DETAILS.

..HART.. 10/16/2016

.PREV DISCUSSION... /ISSUED 1113 AM CDT SUN OCT 16 2016/

...UPPER MS VALLEY TO UPPER GREAT LAKES...

12Z RAOB/SATELLITE DATA CLEARLY DEPICT A SHORT-WAVE TROUGH OVER THE NRN/CNTRL ROCKIES. THIS FEATURE WILL EJECT NEWD INTO THE ERN DAKOTAS BY EARLY EVENING BEFORE PROGRESSING INTO NWRN ONTARIO BY 17/12Z. LARGE-SCALE ASCENT IS EXPECTED TO SPREAD INTO THE UPPER MS VALLEY/UPPER GREAT LAKES REGION DURING THE LATTER HALF OF THE PERIOD AS HEIGHT FALLS INCREASE IN ADVANCE OF SHORT WAVE. VERY WARM LOWER TROPOSPHERIC TEMPERATURES WILL SUPPRESS WARM SECTOR CONVECTION ACROSS THE PLAINS/MID MS VALLEY...THUS PRIMARY FOCUS FOR TSTM ACTIVITY WILL BE ELEVATED IN NATURE AS WARM ADVECTION INCREASES ACROSS THE MRGL RISK AREA TONIGHT. FORECAST SOUNDINGS SUGGEST PARCELS LIFTED AOA 850MB SHOULD PROVE ADEQUATELY BUOYANT FOR ROBUST UPDRAFTS THAT COULD GENERATE HAIL. EARLIER THOUGHTS REGARDING THE RISK FOR HAIL CONTINUE FROM EXTREME EASTERN MN INTO NRN WI.

...PACIFIC COAST...

STRONG MID-LEVEL JET...IN EXCESS OF 100KT AT 500MB...WILL TRANSLATE INLAND ALONG THE CNTRL CA COAST LATER THIS EVENING. HEIGHT FALLS AND COOLING PROFILES ALOFT WILL ENHANCE LAPSE RATES AND CONVECTIVE POTENTIAL NORTH OF THE JET. THERMODYNAMIC PROFILES ARE MUCH MORE FAVORABLE FOR TSTMS TODAY THAN SATURDAY ALONG THE COAST AS INSTABILITY/LAPSE RATES SHOULD SUPPORT UPDRAFTS PENETRATING LEVELS NECESSARY FOR LIGHTNING PRODUCTION. SATELLITE/LIGHTNING DATA SUPPORT THIS WITH SCT TSTMS ONGOING BENEATH THE TROUGH OFF THE OREGON/NRN CA COAST.

CLICK TO GET WUUS01 PTSDY1 PRODUCT

NOTE: THE NEXT DAY 1 OUTLOOK IS SCHEDULED BY 0100Z

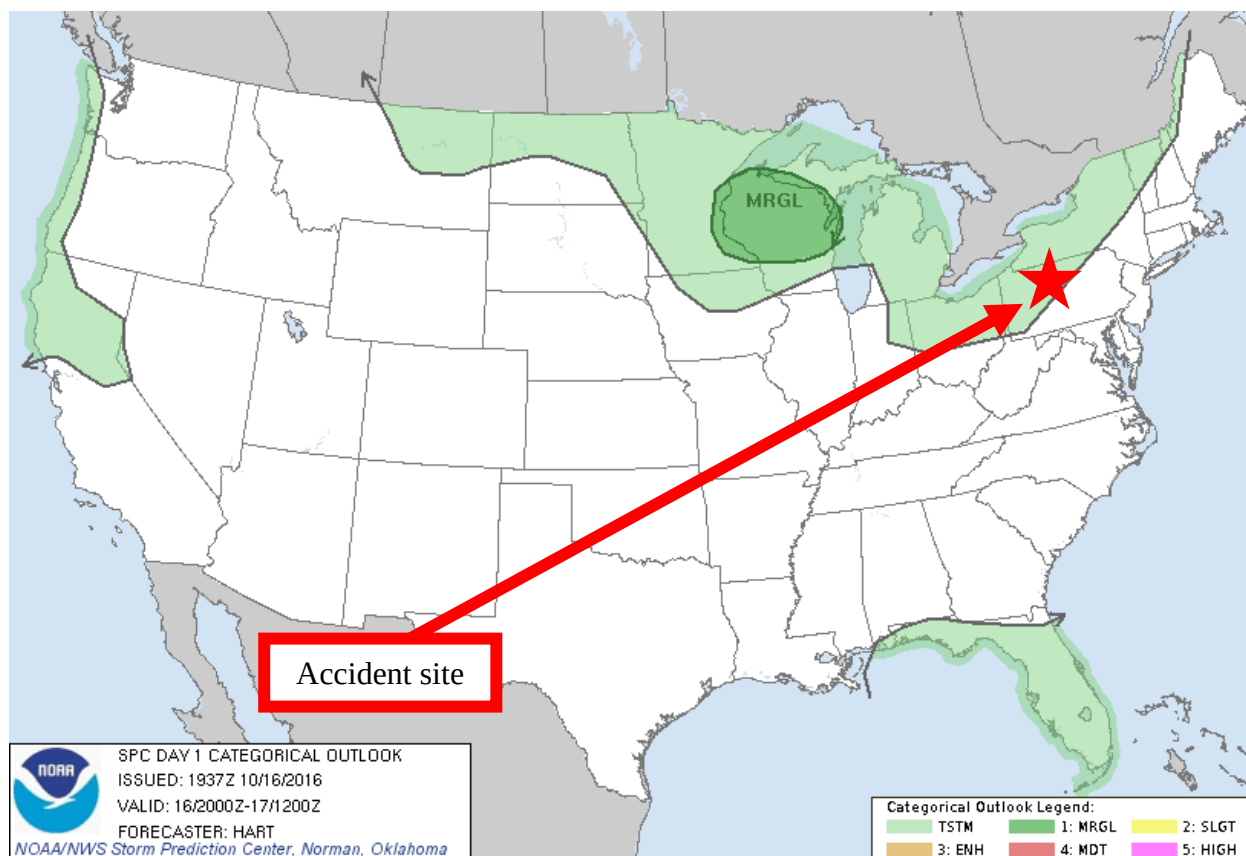


Figure 7 – SPC day 1 Convective Outlook valid at the time of the accident

3.0 Surface Observations

The area surrounding the accident site was documented using official NWS Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language with visibility reported in statute miles for this section. Figure 8 is a sectional map of the region with the accident site and the closest weather reporting location marked.

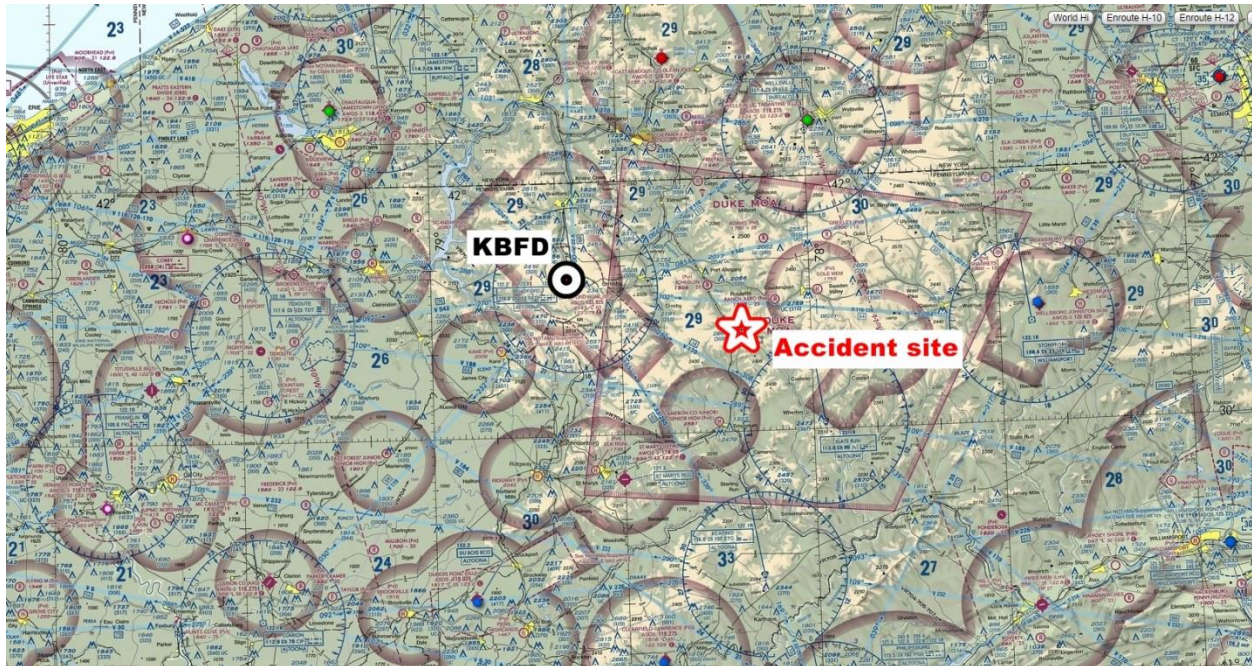


Figure 8 – Sectional Chart of northcentral Pennsylvania with the location of the accident site and surface observation site

Bradford Regional Airport (KBFD) had the closest official weather station to the accident site, located 10 miles south of Bradford, Pennsylvania. KBFD had an Automated Surface Observing System (ASOS²) whose reports were not supplemented. KBFD was located 21 miles west-northwest of the accident site, at an elevation of 2,143 feet, and had an 11° westerly magnetic variation³ (figure 8). The following observations were taken and disseminated during the times surrounding the accident:⁴

[1453 EDT] METAR KBFD 161853Z AUTO 26008G15KT 10SM FEW035 FEW048
SCT060 21/14 A3005 RMK AO2 SLP166 T02110139=

[1553 EDT] METAR KBFD 161953Z AUTO 22009G17KT 10SM FEW037 FEW045
SCT090 21/13 A3003 RMK AO2 SLP160 T02110133=

[1653 EDT] METAR KBFD 162053Z AUTO 21008KT 10SM FEW038 21/14 A3001 RMK
AO2 SLP153 T02060139 56019=

² ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, ceiling, temperature, dewpoint, altimeter, and barometric pressure.

³ Magnetic variation – The angle (at a particular location) between magnetic north and true north. 1985, latest measurement taken from <http://www.airnav.com/airport/KBFD>

⁴ The bold sections in this NWS product and the rest of products in this report are intended to highlight the sections that directly reference the weather conditions that effected the accident location around the accident time. The local times in section 3.0 next to the METARs are provided for quick reference between UTC and local times around the accident time.

[1753 EDT] METAR KBFD 162153Z AUTO VRB06KT 10SM FEW034 BKN050 OVC100
20/14 A3001 RMK AO2 SLP153 T02000144=

[1853 EDT] METAR KBFD 162253Z AUTO 31003KT 6SM RA FEW042 BKN075 OVC100
18/15 A3002 RMK AO2 RAB41 SLP159 P0001 T01830150=

[1904 EDT] SPECI KBFD 162304Z AUTO 29007KT 1 3/4SM +RA BR SCT032 BKN041
OVC080 17/16 A3004 RMK AO2 PRESRR P0012 T01670161=

**[1912 EDT] SPECI KBFD 162312Z AUTO 32007KT 3SM -RA BR FEW025 BKN037
OVC085 17/16 A3004 RMK AO2 P0013 T01670161=**

**[1953 EDT] METAR KBFD 162353Z AUTO 31004KT 5SM -RA BR FEW040 BKN048
OVC080 16/16 A3005 RMK AO2 SLP169 P0019 60020 T01610161 10217
20161 53013=**

ACCIDENT TIME 1957 EDT/2357 UTC

**[2018 EDT] SPECI KBFD 170018Z AUTO 31006KT 3SM RA BR FEW007 BKN042
OVC055 16/16 A3006 RMK AO2 P0006 T01610161=**

**[2026 EDT] SPECI KBFD 170026Z AUTO 33003KT 2SM RA BR FEW007 BKN041
OVC050 16/16 A3006 RMK AO2 P0011 T01610161=**

[2037 EDT] SPECI KBFD 170037Z AUTO 00000KT 5SM -RA BR SCT035 BKN050
OVC085 16/16 A3005 RMK AO2 P0012 T01610161=

[2053 EDT] METAR KBFD 170053Z AUTO 18003KT 3SM RA BR BKN038 BKN044
OVC070 16/16 A3005 RMK AO2 SLP169 P0016 T01610161=

KBFD weather at 1912 EDT, wind from 320° at 7 knots, 3 miles visibility, light rain, mist, a few clouds at 2,500 feet above ground level (agl), broken ceiling at 3,700 feet agl, overcast skies at 8,500 feet agl, temperature of 17° Celsius (C), dew point temperature of 16° C, and an altimeter setting of 30.04 inches of mercury. Remarks: automated station with a precipitation discriminator, precipitation of 0.13 inches since the last hourly observation, temperature 16.7° C, dew point temperature 16.1° C.

KBFD weather at 1953 EDT, wind from 310° at 4 knots, 5 miles visibility, light rain, mist, few clouds at 4,000 feet agl, a broken ceiling at 4,800 feet agl, overcast skies at 8,000 feet agl, temperature of 16° C, dew point temperature of 16° C, and altimeter setting of 30.05 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1016.9 hPa, precipitation of 0.19 inches since the last hourly observation, 6-hourly precipitation of 0.20 inches, temperature 16.1° C, dew point temperature 16.1° C, 6-hourly maximum temperature of 21.7° C, 6-hourly minimum temperature of 16.1° C, 3-hourly pressure increase of 1.3 hPa.

KBFD weather at 2018 EDT, wind from 310° at 6 knots, 3 miles visibility, moderate rain, mist, few clouds at 700 feet agl, a broken ceiling at 4,200 feet agl, overcast skies at 5,500 feet agl, temperature of 16° C, dew point temperature of 16° C, and altimeter setting of 30.06 inches of mercury. Remarks: automated station with a precipitation discriminator, on precipitation of 0.06 inches since the last hourly observation, temperature 16.1° C, dew point temperature 16.1° C.

KBFD weather at 2026 EDT, wind from 330° at 3 knots, 2 miles visibility, moderate rain, mist, few clouds at 700 feet agl, a broken ceiling at 4,100 feet agl, overcast skies at 5,000 feet agl, temperature of 16° C, dew point temperature of 16° C, and altimeter setting of 30.06 inches of mercury. Remarks: automated station with a precipitation discriminator, precipitation of 0.11 inches since the last hourly observation, temperature 16.1° C, dew point temperature 16.1° C.

The observations from KBFD surrounding the accident time indicated MVFR⁵ to IFR⁶ conditions due to visibilities with light to moderate rain. These surface conditions matched the weather radar imagery and the rain shower line that the accident flight likely encountered (sections 6.4 and 6.5).

4.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR)⁷ model sounding was created for the accident site for 2000 EDT. The 2000 EDT sounding was plotted on a standard Skew-T log P diagram⁸ with the derived stability parameters included in figure 9 (with data from the surface to 600-hPa, or 14,000 feet msl.) This data was analyzed utilizing the RAOB⁹ software package. The sounding depicted the lifted condensation level (LCL)¹⁰ at 3,796 feet, a convective condensation level (CCL)¹¹ of 6,137 feet, and a level of free convection (LFC)¹² at 6,240 feet. The freezing level was located at 11,963 feet. The precipitable water value was 1.23 inches.

⁵ 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 and/or 3 to 5 miles visibility.

⁶ Instrument Flight Rules – Refers to the general weather conditions pilots can expect at the surface. IFR criteria means a ceiling below 1,000 feet agl and/or less than 3 miles visibility.

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 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.

⁹ RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.

¹⁰ Lifting Condensation Level (LCL) - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

¹¹ Convective Condensation Level (CCL) – The level in the atmosphere to which an air parcel, if heated from below, will rise dry adiabatically, without becoming colder than its environment just before the parcel becomes saturated.

¹² Level of Free Convection (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.

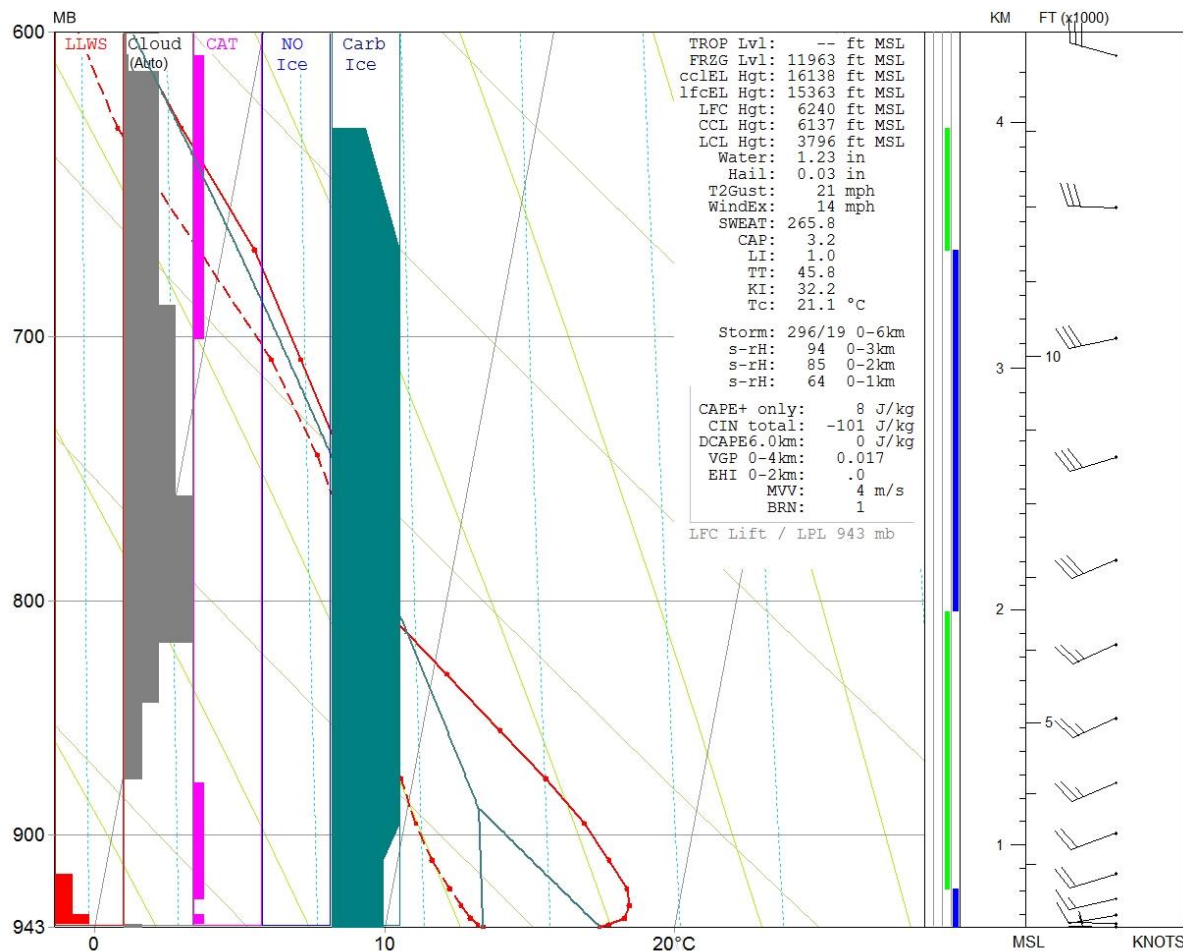


Figure 9 – 2000 EDT HRRR sounding for the accident site

The 2000 EDT HRRR sounding indicated two conditionally unstable layers between the surface and 14,000 feet with a stable layer between 6,500 and 11,500 feet. With the low- and mid-level troughs (section 1.2) in the area of the accident site around the accident time, this environment would have been supportive of cloud formation and rain shower activity. With only 8 J/kg of CAPE¹³, there was not enough instability to allow for the formation of thunderstorm activity at the accident time (section 6.5). RAOB identified the possibility of clouds from 4,500 feet through 14,000 feet. No areas of icing were indicated by RAOB for below 14,000 feet.

The 2000 EDT HRRR sounding wind profile indicated a surface wind from 271° at 5 knots with the wind remaining primarily west to northwesterly through 14,000 feet. The wind speed increased from 5 knots at the surface to 20 knots by 3,000 feet. The wind speed then remained between 20 and 30 knots through 14,000 feet. The possibility of low-level wind shear was indicated by RAOB between the surface and 3,000 feet, and several layers of possible light to moderate clear-air turbulence were identified between the surface and 14,000 feet.

¹³ 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.

5.0 Satellite Data

Visible and infrared data from the Geostationary Operational Environmental Satellite number 13 (GOES-13) 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 NTSB's Man-computer Interactive Data Access System software. Visible and infrared imagery (GOES-13 band 1 and 4) at wavelengths of 0.65 microns (μm) and 10.7 μm , respectively, were retrieved for the period. Satellite imagery surrounding the time of the accident, from 1600 EDT on October 16 through 0300 EDT on October 17 at approximately 15-minute intervals were reviewed, and the closest images to the time of the accident are documented here.

Figures 10 and 11 present the GOES-13 infrared imagery from 1945 and 2015 EDT at 4X magnification with the accident site highlighted with a red square. The infrared imagery indicated cooler brightness temperatures and cloud tops (green and blue colors) located to the east of the accident site and northeastward into central New York. The clouds were moving from west to east (attachment 1) with most of the higher clouds east of the accident site around the accident time. Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 2000 EDT HRRR sounding, the approximate cloud-top heights over the accident site were 28,000 feet at 1945 EDT. It should be noted these figures have not been corrected for any parallax error.

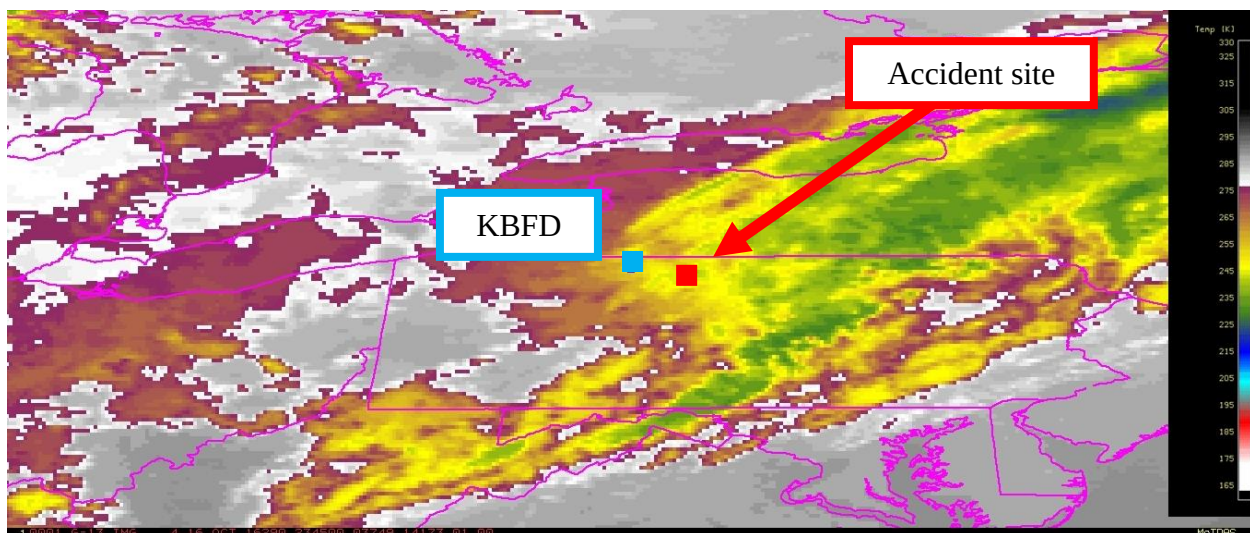


Figure 10 – GOES-13 infrared image at 1945 EDT

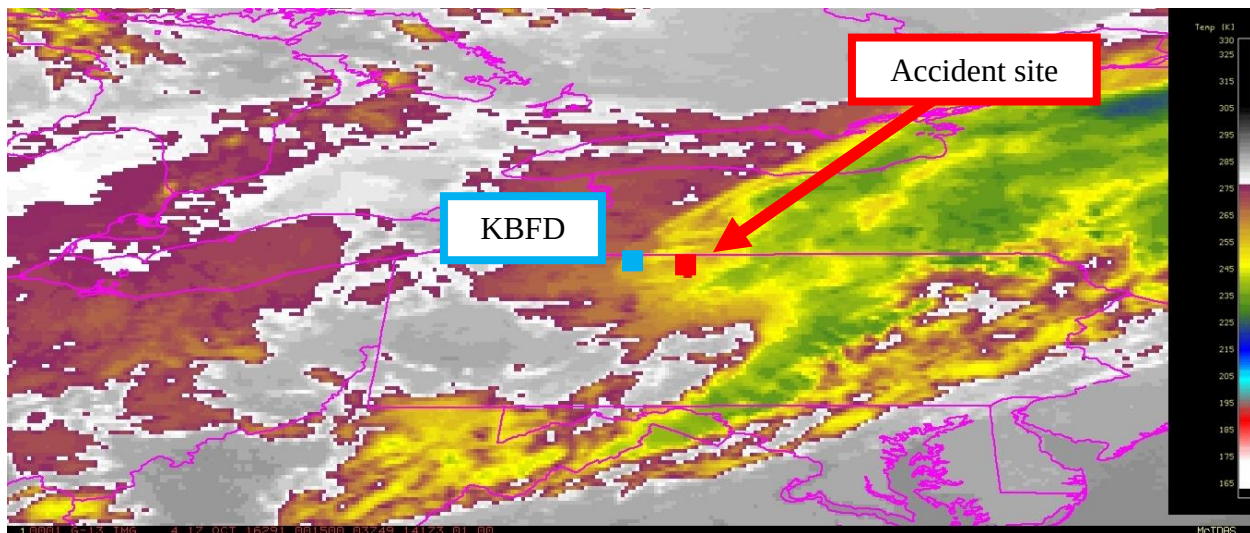


Figure 11 – GOES-13 infrared image at 2015 EDT

6.0 Radar Imagery Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)¹⁴ to the accident site was the State College, Pennsylvania, radar (KCCX), which was located 47 miles south-southeast of the accident site at an elevation of 2,405 feet. 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.

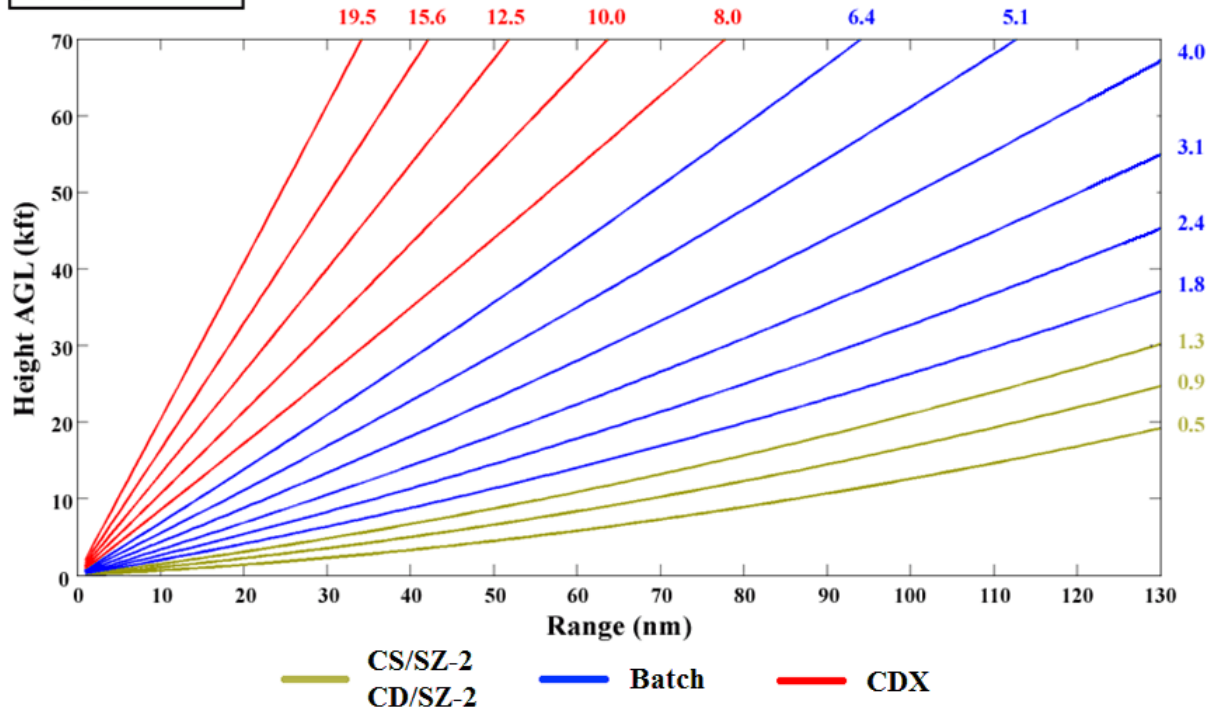
6.1 Volume Scan Strategy

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 212 (VCP-212). 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 KCCX WSR-88D radar was operating in the precipitation mode (Mode A, VCP-212). 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.

¹⁴ 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 212



VCP-212 Precipitation Mode Scan Strategy¹⁵

6.2 Beam Height Calculation

Assuming standard refraction¹⁶ of the WSR-88D 0.95° wide radar beam, the following table shows the approximate beam height and width¹⁷ information¹⁸ of the radar display over the site of the accident. The heights have been rounded to the nearest 10 feet.

¹⁵ 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)

¹⁶ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

¹⁷ Beam width – A measure of the angular width of a radar beam.

¹⁸ Beamwidth values are shown for legacy resolution products. Super resolution products would have an effective beamwidth that would be approximately half these values.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP	BEAM WIDTH
0.5°	6,500 feet	4,180 feet	8,820 feet	4,640 feet

Based on the radar height calculations, the 0.5° elevation scans depicted the conditions between 4,180 feet and 8,820 feet msl over the accident site and these are the closest altitudes to the accident flight level before the accident occurred.¹⁹

6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²⁰ 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 (dBZ²¹), 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:

¹⁹ For more information, please see the air traffic control (ATC) data located in the docket for this accident.

²⁰ 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.

²¹ 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.

- 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 12 provides a radar summary image from 1945 EDT with reflectivity values over the northeastern United States. The accident site was located in an area of 30 to 50 dBZ values at 1945 EDT. These reflectivity values indicated light to heavy echoes at the accident site around the accident time with turbulence, heavy rain, lightning, large hail, and organized surface wind gusts all likely.

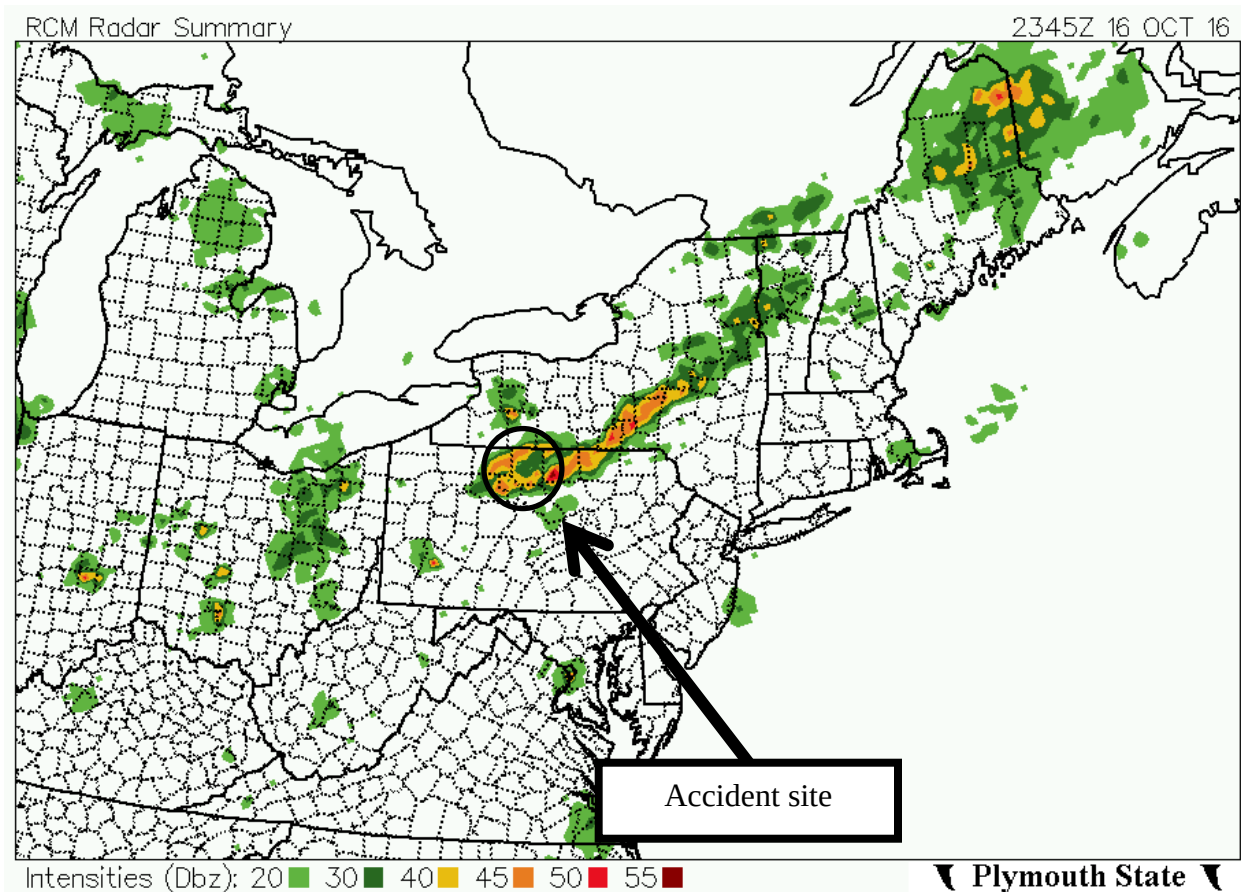


Figure 12 – Radar summary image for 1945 EDT with the accident site area circled

6.5 Base Reflectivity and Lightning Data

Figures 13 through 16 present the KCCX WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 1952, 1955, 1957, and 2000 EDT with a resolution of 0.5° X 250 m. The air traffic control (ATC) flight track is also included with the arrows pointing in the direction of travel. The accident flight track indicated that the accident flight entered the clouds or light precipitation around 1946 EDT (attachment 2), with the accident flight entering an area of 30 to 50 dBZ reflectivity values by 1954 EDT (figures 14, 15, 16, and attachment 2). The reflectivity values above the accident site at the accident time corresponded to light to heavy rain with severe turbulence, updrafts and downdrafts, small hail, and lightning likely (section 6.3). An archived lightning database was reviewed and there were no lightning strikes near the accident site at the accident time.²² However, the accident flight still likely encountered instrument meteorological conditions, with heavy rain, turbulence, and updrafts and downdrafts.

²² A review of Earth Networks Total Lightning network was done.

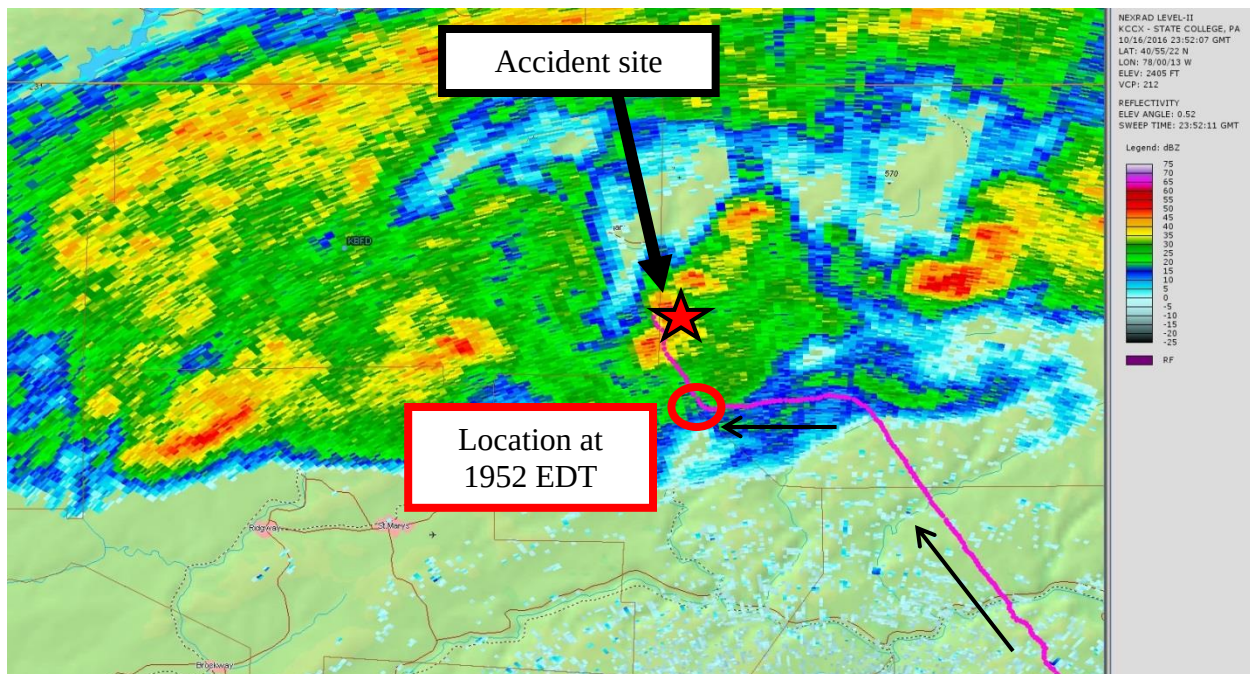


Figure 13 – KCCX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1952 EDT with the ATC flight track (pink dots) and arrows pointing in direction of travel

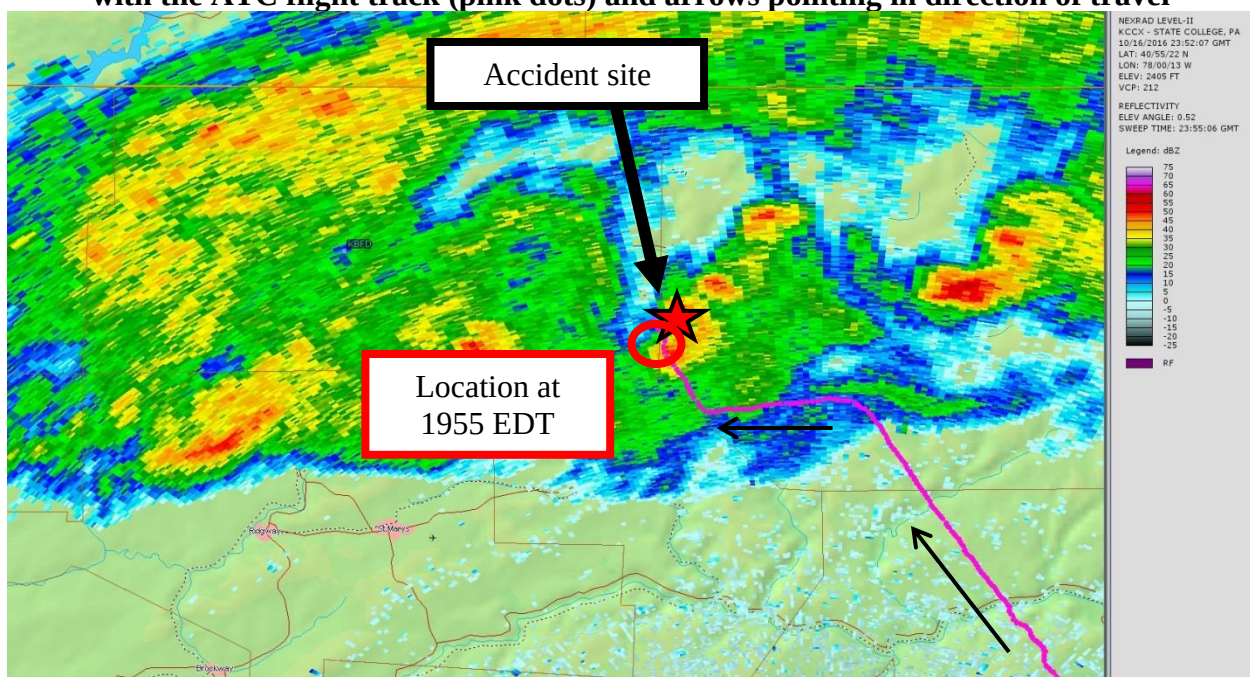


Figure 14 – KCCX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1955 EDT with the ATC flight track (pink dots) and arrows pointing in direction of travel

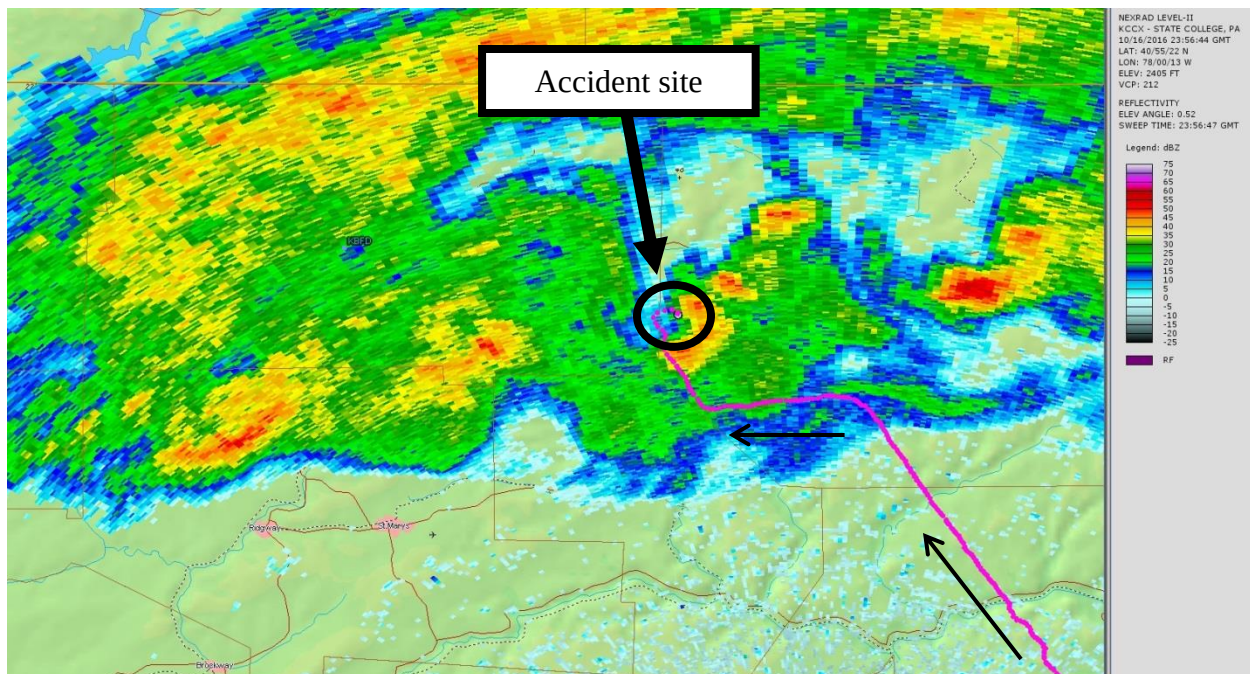


Figure 15 – KCCX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1957 EDT with the ATC flight track (pink dots) and arrows pointing in direction of travel

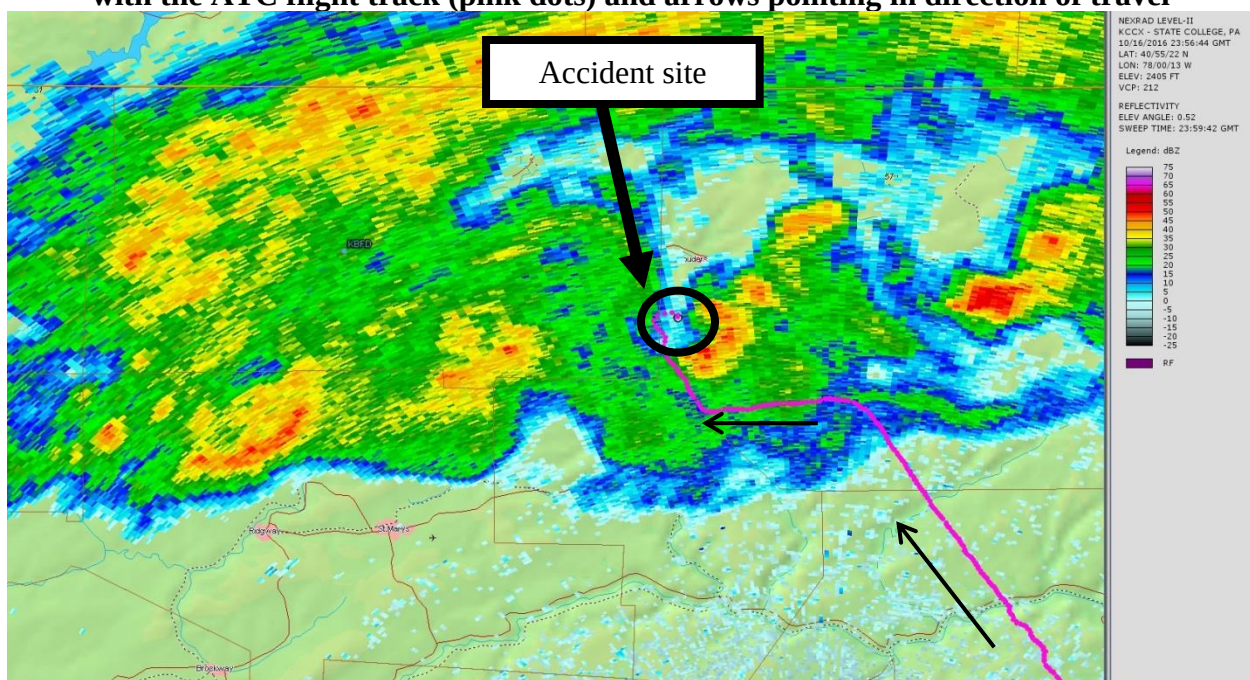


Figure 16 – KCCX WSR-88D reflectivity for the 0.5° elevation scan initiated at 2000 EDT with the ATC flight track (pink dots) and arrows pointing in direction of travel

6.6 Base Reflectivity Comparison C-GYSN and C-GNOP Flight Tracks²³

Figures 17 through 24 present the KCCX WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 1945, 1947, 1950, 1952, 1955, 1957, 2000 and 2006 EDT with a resolution of 0.5° X 250 m. The ATC flight track for both C-GYSN (accident flight) and C-GNOP (parallel track airplane flight track) are included with the arrows pointing in the direction of travel. Both aircraft were at similar altitudes around 6,000 feet msl. The ATC flight track data indicated that C-GYSN first encountered precipitation around 1946 EDT (figure 17), while C-GNOP first encountered precipitation around 1948 EDT (figures 18 and 19). While C-GYSN encountered dBZ values as high as 45 to 50 dBZ between 1952 and 1955 EDT (figures 20 and 21), C-GNOP flew through reflectivity targets indicated as high as 35 dBZ between 1952 and 2000 EDT (figures 20 through 23). A text message was sent by one of the occupants of C-GYSN at 1946 EDT, which read in part, “I’m stuck in freezing rain...”²⁴ and the text message was sent right when C-GYSN entered precipitation (figures 17 and 18). The freezing level was located above 11,000 feet (section 4.0).

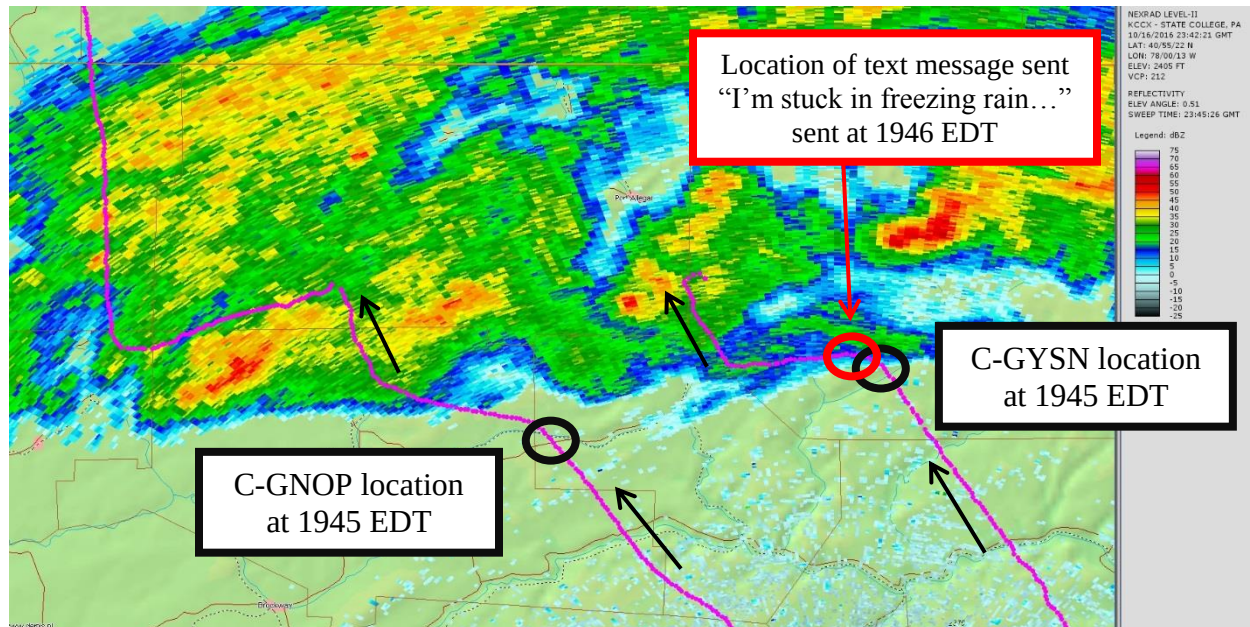


Figure 17 – KCCX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1945 EDT with the ATC flight track of C-GYSN (pink dots, right track) and ATC flight track of C-GNOP (pink dots, left track)

²³ For more information, please see the ATC data located in the NTSB public docket for this investigation.

²⁴ For more information concerning this text message, please see the NTSB public docket for this investigation.

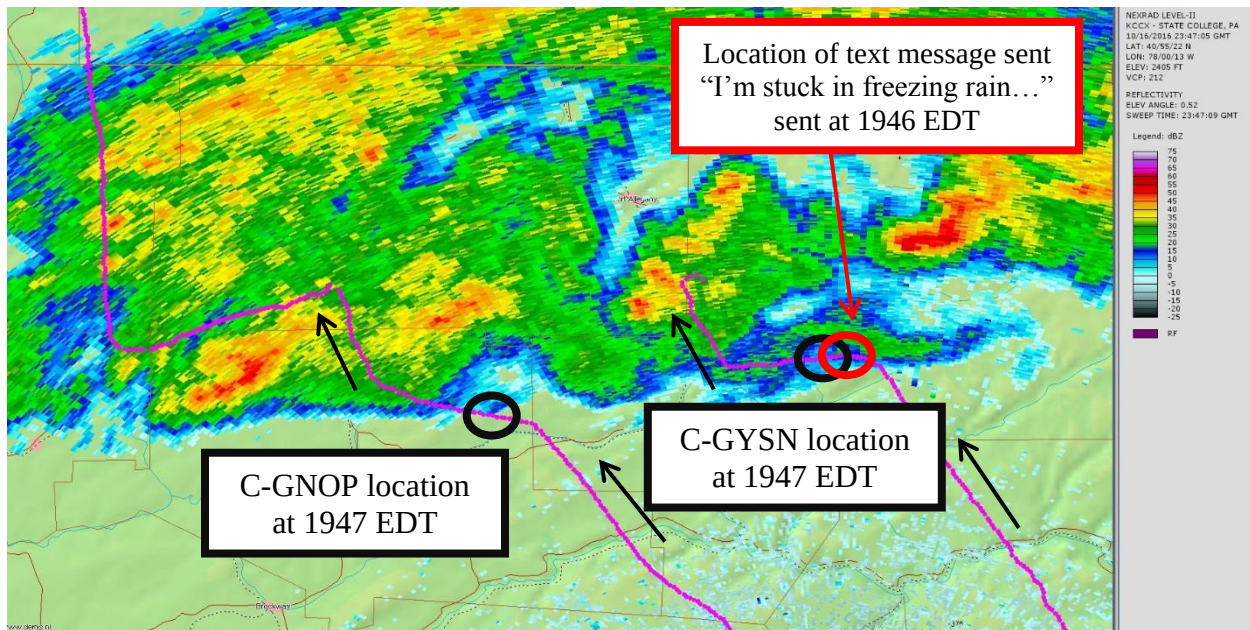


Figure 18 – KCCX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1947 EDT with the ATC flight track of C-GYSN (pink dots, right track) and ATC flight track of C-GNOP (pink dots, left track)

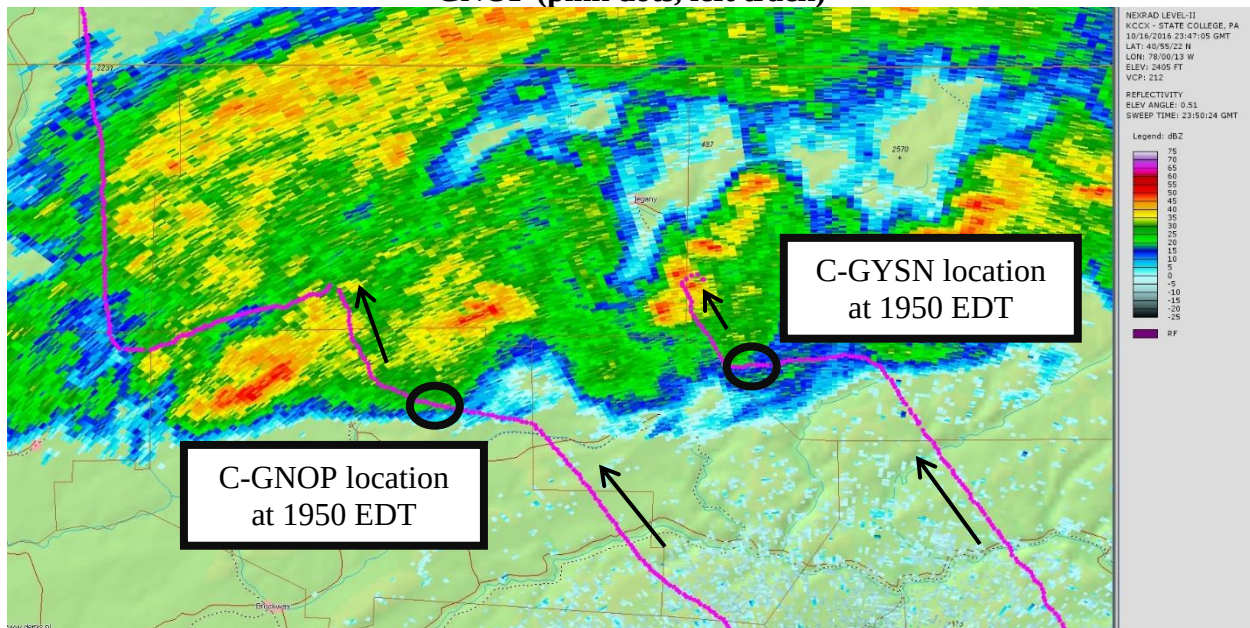


Figure 19 – KCCX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1950 EDT with the ATC flight track of C-GYSN (pink dots, right track) and ATC flight track of C-GNOP (pink dots, left track)

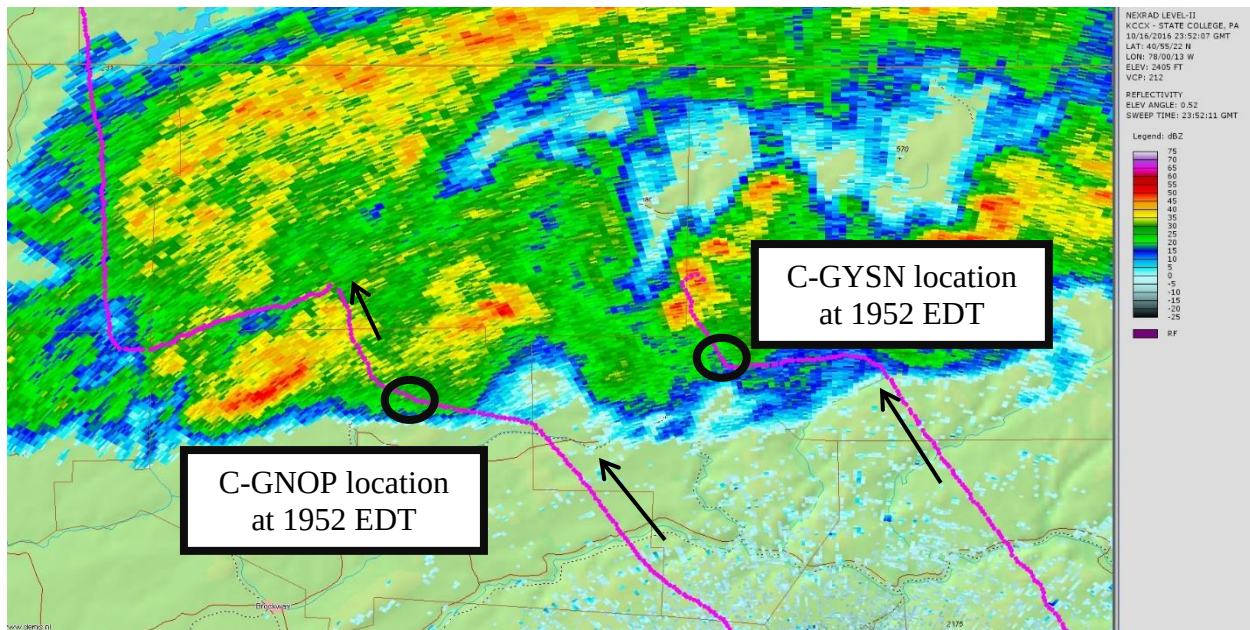


Figure 20 – KCCX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1952 EDT with the ATC flight track of C-GYSN (pink dots, right track) and ATC flight track of C-GNOP (pink dots, left track)

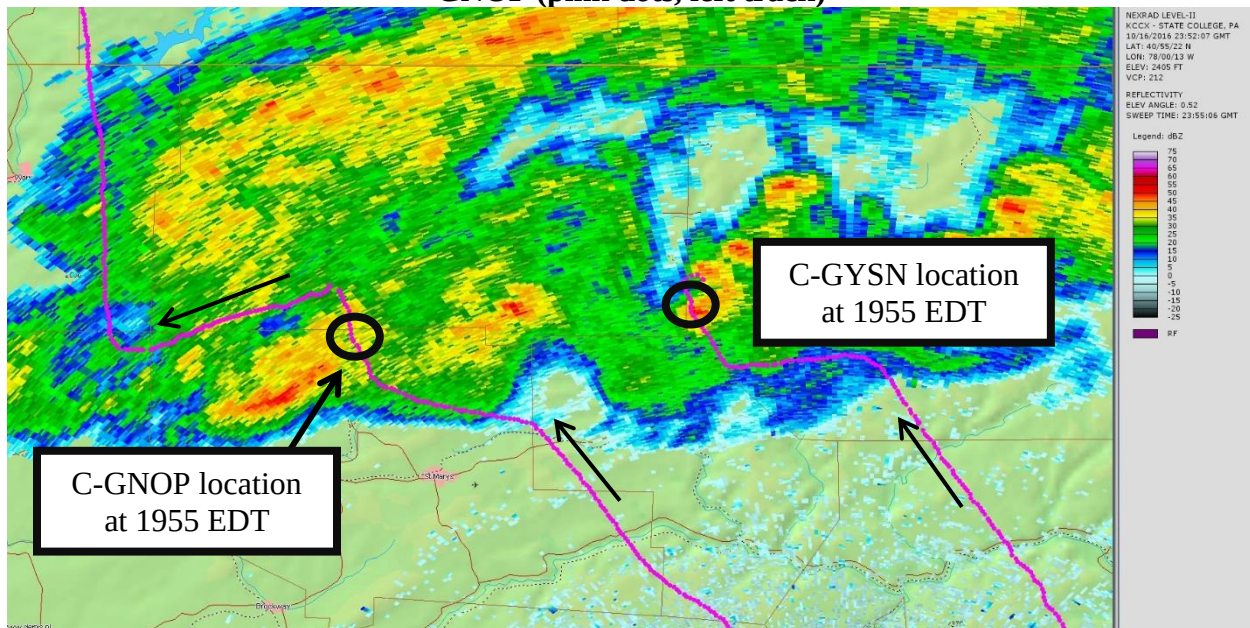


Figure 21 – KCCX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1955 EDT with the ATC flight track of C-GYSN (pink dots, right track) and ATC flight track of C-GNOP (pink dots, left track)

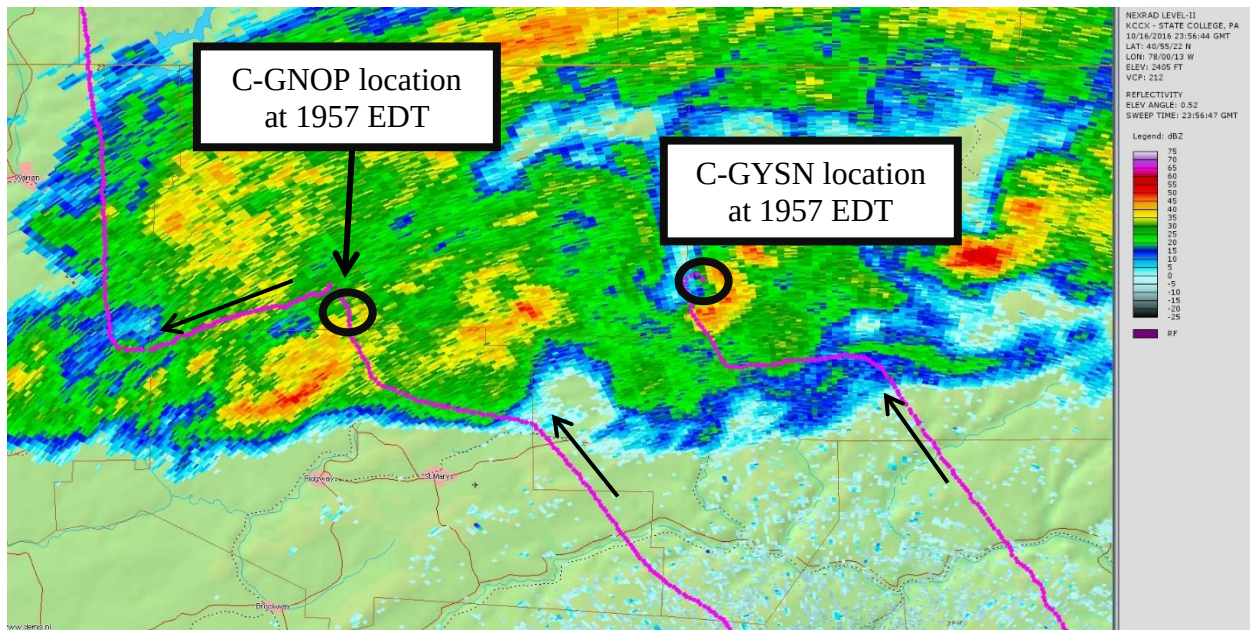


Figure 22 – KCCX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1957 EDT with the ATC flight track of C-GYSN (pink dots, right track) and ATC flight track of C-GNOP (pink dots, left track)

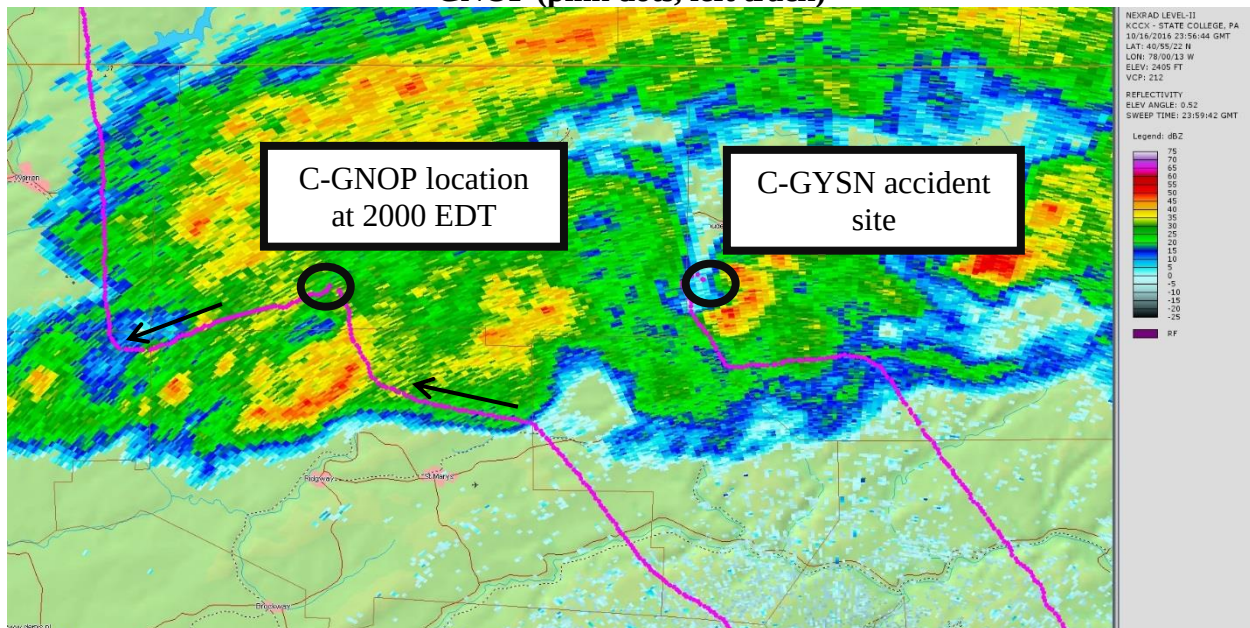


Figure 23 – KCCX WSR-88D reflectivity for the 0.5° elevation scan initiated at 2000 EDT with the ATC flight track of C-GYSN (pink dots, right track) and accident site location circled, and the ATC flight track of C-GNOP (pink dots, left track)

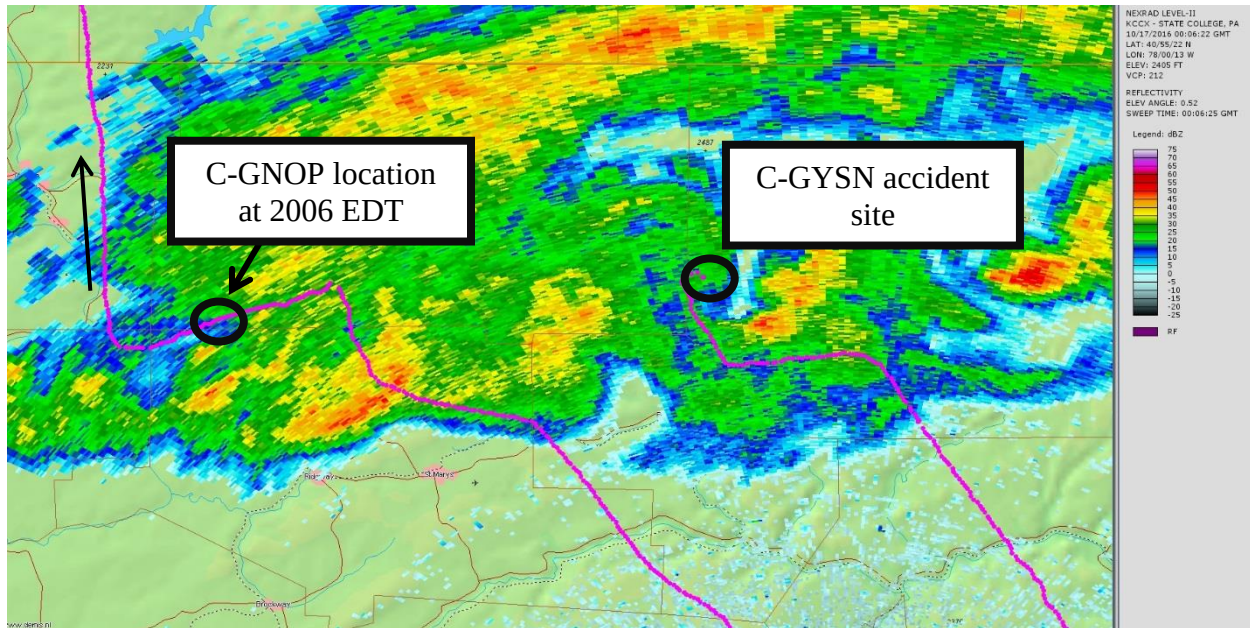


Figure 24 – KCCX WSR-88D reflectivity for the 0.5° elevation scan initiated at 2006 EDT with the ATC flight track of C-GYSN (pink dots, right track) and accident site location circled, and ATC flight track of C-GNOP (pink dots, left track)

6.7 3-Dimensional Radar Reflectivity Data

Figures 25, 26, 27, 28, and 29 present a 3-dimensional view of the KCCX WSR-88D base reflectivity for the elevation scans initiated at 1947, 1952, and 1957 EDT. The accident aircraft's flight track obtained from ATC²⁵ was also plotted on the Google Earth image for a time comparison with the base reflectivity images. Figure 25 indicated that the accident flight flew into an area of greater than 10 to 20 dBZ reflectivity values around 1947 EDT (figure 25), with the accident flight likely in instrument meteorological conditions (IMC) and precipitation. By 1952 to 1957 EDT the accident flight flew through greater than 40 dBZ values (figures 26 and 27). After 1957 EDT the accident flight was still located in greater than 20 dBZ values (figures 28 and 29), with IMC likely along with turbulence, wind shear, and updrafts and downdrafts associated with the rain shower activity.

²⁵ For more information see the ATC data contained in the docket for this accident.

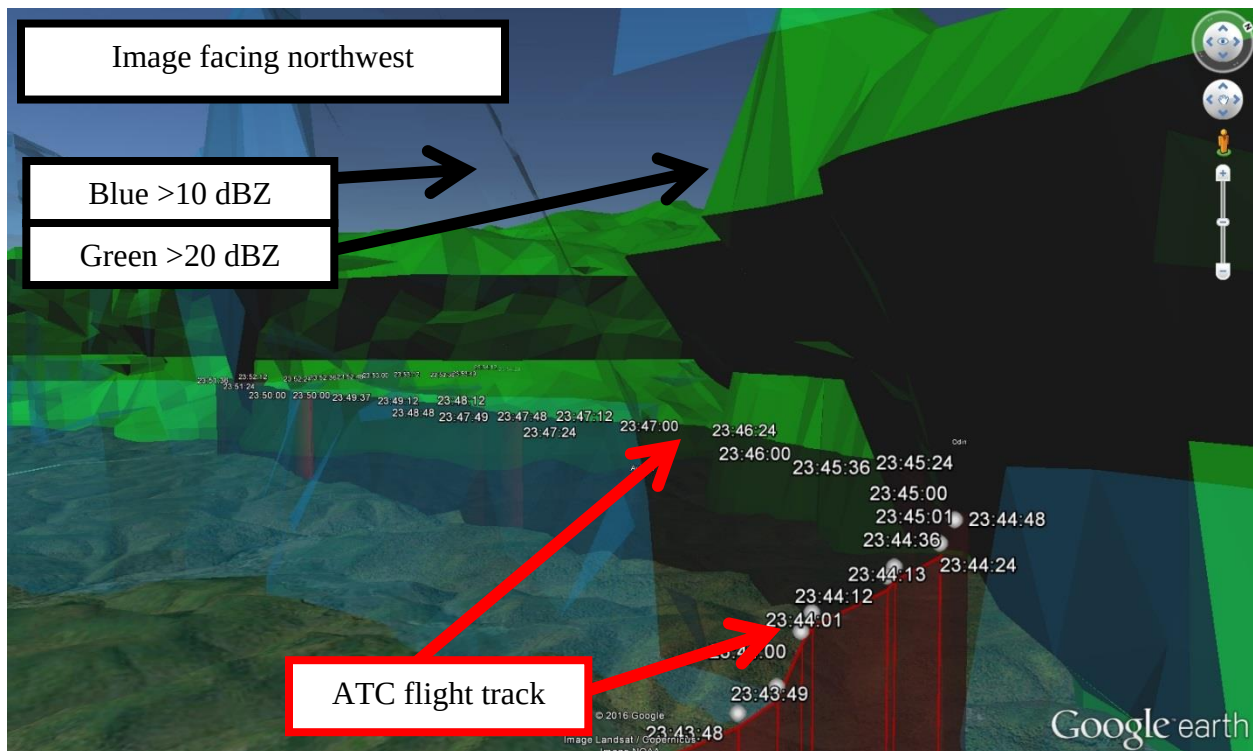


Figure 25 – 3-dimensional KCCX WSR-88D base reflectivity from the scan initiated at 1947 EDT and the ATC Flight Track (gray dots) with the image facing northwest

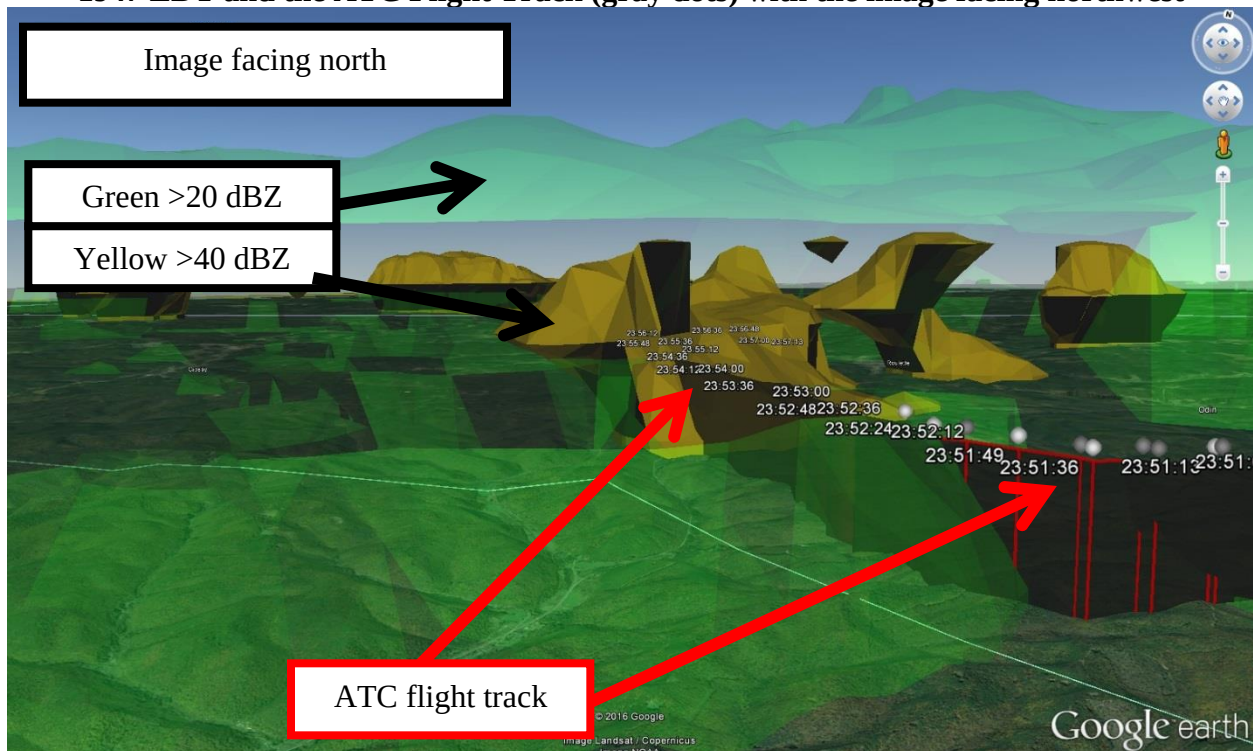


Figure 26 – 3-dimensional KCCX WSR-88D base reflectivity from the scan initiated at 1952 EDT and the ATC Flight Track (gray dots) with the image facing north

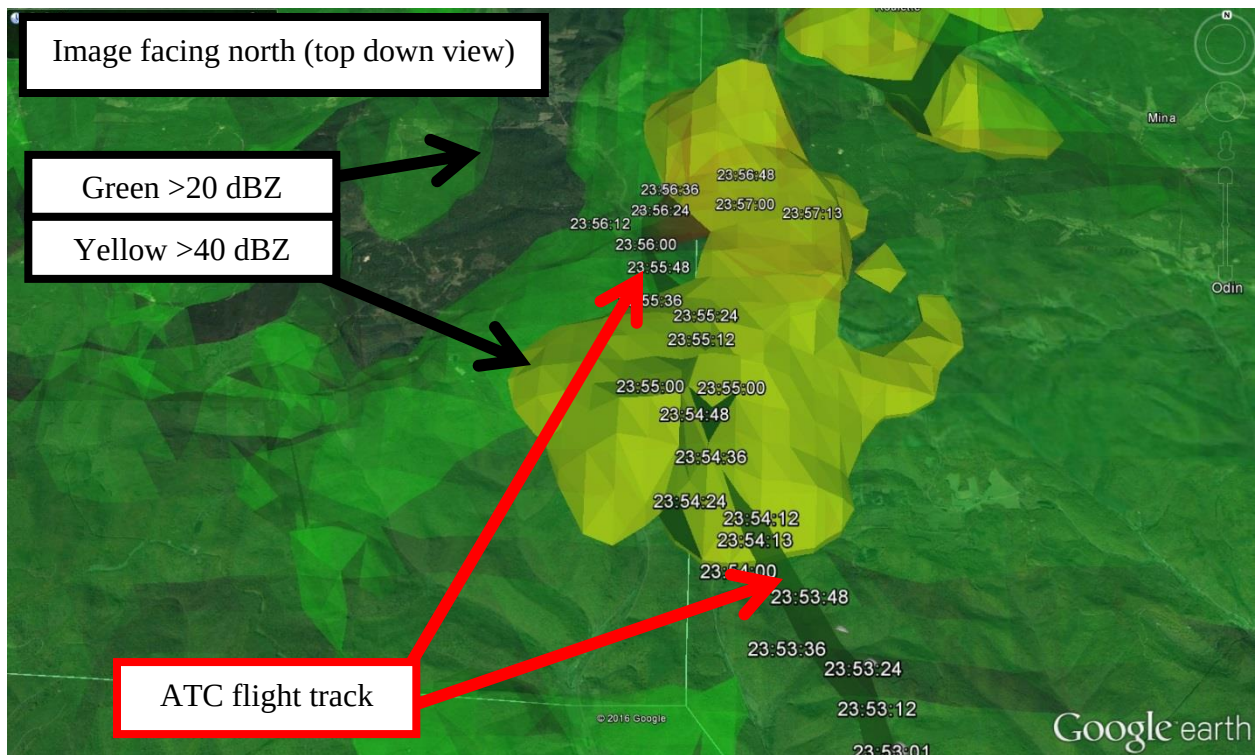


Figure 27 – 3-dimensional KCCX WSR-88D base reflectivity from the scan initiated at 1952 EDT and the ATC Flight Track (gray dots) with the image facing north (top down view)



Figure 28 – 3-dimensional KCCX WSR-88D base reflectivity from the scan initiated at 1957 EDT and the ATC Flight Track (gray dots) with the image facing northeast

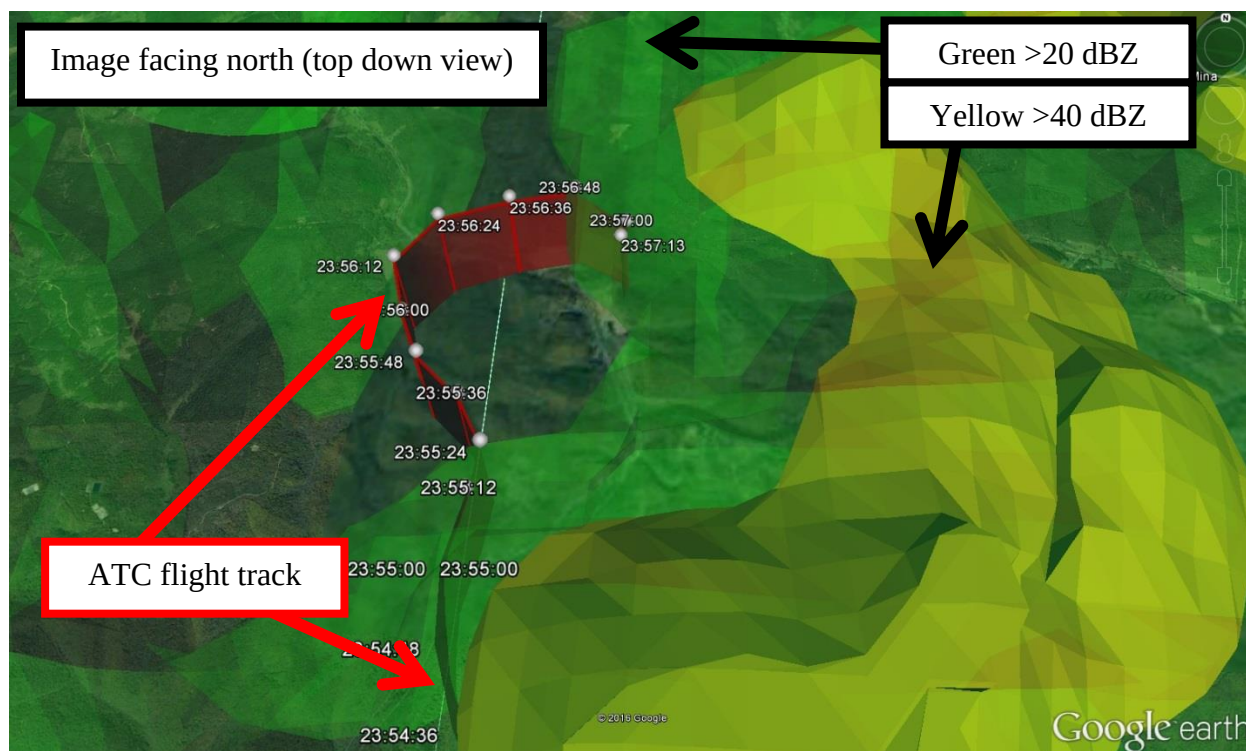


Figure 29 – 3-dimensional KCCX WSR-88D base reflectivity from the scan initiated at 1957 EDT and the ATC Flight Track (gray dots) with the image facing north (top down view)

7.0 Pilot Reports

All pilot reports (PIREPs) close to the accident site from about three hours prior to the accident time to about two hours after the accident time for below FL250²⁶ are provided below:

DKK UA /OV DKK-JHW/TM 2148/FL150/TP A319/TA M4/IC LGT CLR=

DKK UA /OV JHW300020/TM 2229/FL200/TP B737/TA UNKNOWN/IC LIGHT RIME ICE/RM DURGC FL200-240=

PEO UA /OV ITH310030/TM 2256/FL160/TP B190/TA M03/IC LIGHT RIME ICE=

BFD UA /OV BFD130020/TM 2332/FL170/TP SW4/TA M04/IC MOD MIXED ICING/RM DURGD 170-140=

ELZ UA /OV BFD055020/TM 2350/FL220/TP LJ31/TA M22/IC MOD RIME ICE/RM DURGC 220-240=

Routine pilot report (UA); Between Dunkirk and Jamestown, New York; Time – 1748 EDT (2148Z); Altitude – 15,000 feet msl; Type aircraft – Airbus A319; Temperature – -4° C; Icing – Light clear.

²⁶ Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of feet. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the average sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

Routine pilot report (UA); 20 miles from Jamestown, New York, on the 300° radial; Time – 1829 EDT (2229Z); Altitude – FL200; Type aircraft – Boeing 737; Temperature – Unknown; Icing – Light rime ice; Remarks – During climb FL200 to FL240.

Routine pilot report (UA); 30 miles from Ithaca, New York, on the 310° radial; Time – 1856 EDT (2256Z); Altitude – 16,000 feet msl; Type aircraft – Beechcraft 1900; Temperature – -3° C; Icing – Light rime ice.

Routine pilot report (UA); 20 miles from Bradford, Pennsylvania, on the 130° radial; Time – 1932 EDT (2332Z); Altitude – 17,000 feet msl; Type aircraft – Fairchild Swearingen Metroliner; Temperature – -4° C; Icing – Moderate mixed icing; Remarks – During descent between 17,000 and 14,000 feet msl.

Routine pilot report (UA); 20 miles from Bradford, Pennsylvania, on the 055° radial; Time – 1950 EDT (2350Z); Altitude – FL220; Type aircraft – Learjet 31; Temperature – -22° C; Icing – Moderate mixed ice; Remarks – During climb between FL220 and FL240.

8.0 SIGMET and CWSU Advisories

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

The Center Weather Service Unit (CWSU) in Cleveland (ZOB) issued a Meteorological Impact Statement (MIS) that was valid for the accident site at the accident time. No CWSU Center Weather Advisories (CWA)s were valid for the accident site at the accident time. The MIS issued by ZOB was issued at 1324 EDT and valid through 2130 EDT. The MIS discussed isolated moderate turbulence possible from FL280 to FL400 throughout the ZOB airspace. MVFR conditions with isolated IFR conditions were discussed in rain showers and mist with that area moving from northwest to southeast with time and ceilings below 5,000 feet msl spreading southeastward:

FAUS20 KZOB 161724

ZOB MIS 02 VALID 161724-170130

...FOR ATC PLANNING PURPOSES ONLY...

THRUT...ISOL MOD TURB POSS FROM FL280-400...SPRDG W-E. SW-NE 1/3 ZOB

PTCHY LGT-MOD ICE 105-FL260...MOV NW-SE. NW 1/4 AREAS IFR CIG MVFR

VIS. NW 3/4 MOSTLY MVFR ISOL IFR IN SHRA/BR...MOV NW-SE. CIG BLW

050...SPRDG SE.

=

9.0 AIRMETS

Airmen's Meteorological Information (AIRMET) advisories Tango, Zulu, and Sierra were issued at 1645 EDT and valid at the accident time for the accident site (figures 30 through 35). The AIRMETS valid at the accident flight's altitude were AIRMETS Tango and Sierra forecasting moderate turbulence below 10,000 feet and mountain obscuration conditions due to clouds, precipitation, and mist. Only AIRMET Tango for moderate turbulence below 10,000 feet was in effect before the accident flight departed (figures 30 and 31):

WAUS41 KPCI 162045

WA1Z

_BOSZ WA 162045

AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 170300

.
AIRMET ICE...ME NH VT MA CT NY PA AND CSTL WTRS
FROM 70NW PQI TO 50NE PQI TO 60WSW YSJ TO 60SE ENE TO 40WSW BDL
TO 20E PSB TO 30ESE JHW TO 40NE SYR TO 30SSE YOW TO YSC TO 70NW
PQI
MOD ICE BTN 100 AND FL220. CONDS CONTG BYD 03Z ENDG 06-09Z.

.
OTLK VALID 0300-0900Z...ICE ME NH VT MA RI CT NY NJ PA AND CSTL
WTRS
BOUNDED BY 40NNE PQI-40ENE HUL-100SSW YSJ-80ESE ENE-20S BDL-20NNE
SAX-30E PSB-60SW SYR-50W ALB-50E MPV-40ENE YSC-40NNE PQI
MOD ICE BTN 100 AND FL220. CONDS ENDG 06-09Z.

.
FRZLVL...RANGING FROM 090-140 ACRS AREA
120 ALG 40ESE ECK-30SE CLE-30SSE JST-150ESE ACK

....

WAUS41 KPCI 162045

WA1T

_BOST WA 162045

AIRMET TANGO UPDT 3 FOR TURB VALID UNTIL 170300

.
AIRMET TURB...ME NH VT MA NY LO PA OH LE WV MD
FROM 70NW PQI TO 60NE PQI TO 20ESE HUL TO 30E ALB TO 20NNW SAX
TO 30WSW HNK TO 20W HAR TO 20E EKN TO 20NW APE TO 40S ECK TO
30SE YOW TO YSC TO 70NW PQI
MOD TURB BTN FL250 AND FL380. CONDS CONTG BYD 03Z ENDG 06-09Z.

.
AIRMET TURB...NY PA OH WV MD VA
FROM 40ENE SYR TO HNK TO 20WSW EMI TO 50E BKW TO 40N HNV TO HNN
TO ERI TO 40ENE SYR
MOD TURB BLW 100. CONDS ENDG 21-00Z.

.
OTLK VALID 0300-0900Z
AREA 1...TURB NY LO PA LE WV MD VA
BOUNDED BY 60NE YYZ-50ESE SLT-30SSE CSN-60SSE EKN-20SSE EWC-40W
YYZ-60NE YYZ
MOD TURB BTN FL240 AND FL390. CONDS DVLPG 06-09Z. CONDS CONTG
THRU 09Z.

.
AREA 2...TURB ME NH VT MA RI CT NY LO NJ AND CSTL WTRS
BOUNDED BY 90NE PQI-20ENE HUL-60SE ENE-40S BDL-SAX-20WSW HNK-
50NE SLT-50NW SYR-30ESE YOW-30W YSC-70NW PQI-90NE PQI

MOD TURB BTN FL250 AND FL380. CONDS ENDG 06-09Z.

....

WAUS41 KPCI 162045

WA1S

_BOSS WA 162045

AIRMET SIERRA UPDT 6 FOR IFR AND MTN OBSCN VALID UNTIL 170300

.

AIRMET IFR...ME

FROM 70NW PQI TO 60NE PQI TO 30S HUL TO 20ESE YSC TO 70NW PQI

CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS DVLPG 00-03Z. CONDS CONTG

BYD 03Z THRU 09Z.

.

AIRMET IFR...OH LE

FROM 20ENE DXO TO 20WNW CLE TO 40NE ROD TO 30NE FWA TO 20ENE DXO

CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS DVLPG 00-03Z. CONDS CONTG

BYD 03Z THRU 09Z.

.

AIRMET MTN OBSCN...ME NH VT NY PA

**FROM 70NW PQI TO MLT TO 40NW ENE TO ALB TO SLT TO JHW TO SYR TO
MSS TO YSC TO 70NW PQI**

MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.

.

OTLK VALID 0300-0900Z

AREA 1...IFR NY LO PA OH LE

BOUNDED BY 50N SYR-40NE SLT-20WSW PSB-20NNE APE-FWA-DXO-40E YYZ-
50N SYR

CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG THRU 09Z.

.

AREA 2...IFR ME NH VT MA NY LO

BOUNDED BY 70NW PQI-50NE PQI-40SSE HUL-50ESE YSC-20SE ALB-40NE

SLT-40N SYR-30SE YOW-YSC-70NW PQI

CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG THRU 09Z.

.

AREA 3...MTN OBSCN ME NH VT MA NY PA

BOUNDED BY 70NW PQI-MLT-CON-30ESE PSB-EWC-JHW-SYR-MSS-YSC-70NW
PQI

MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG THRU 09Z.

....

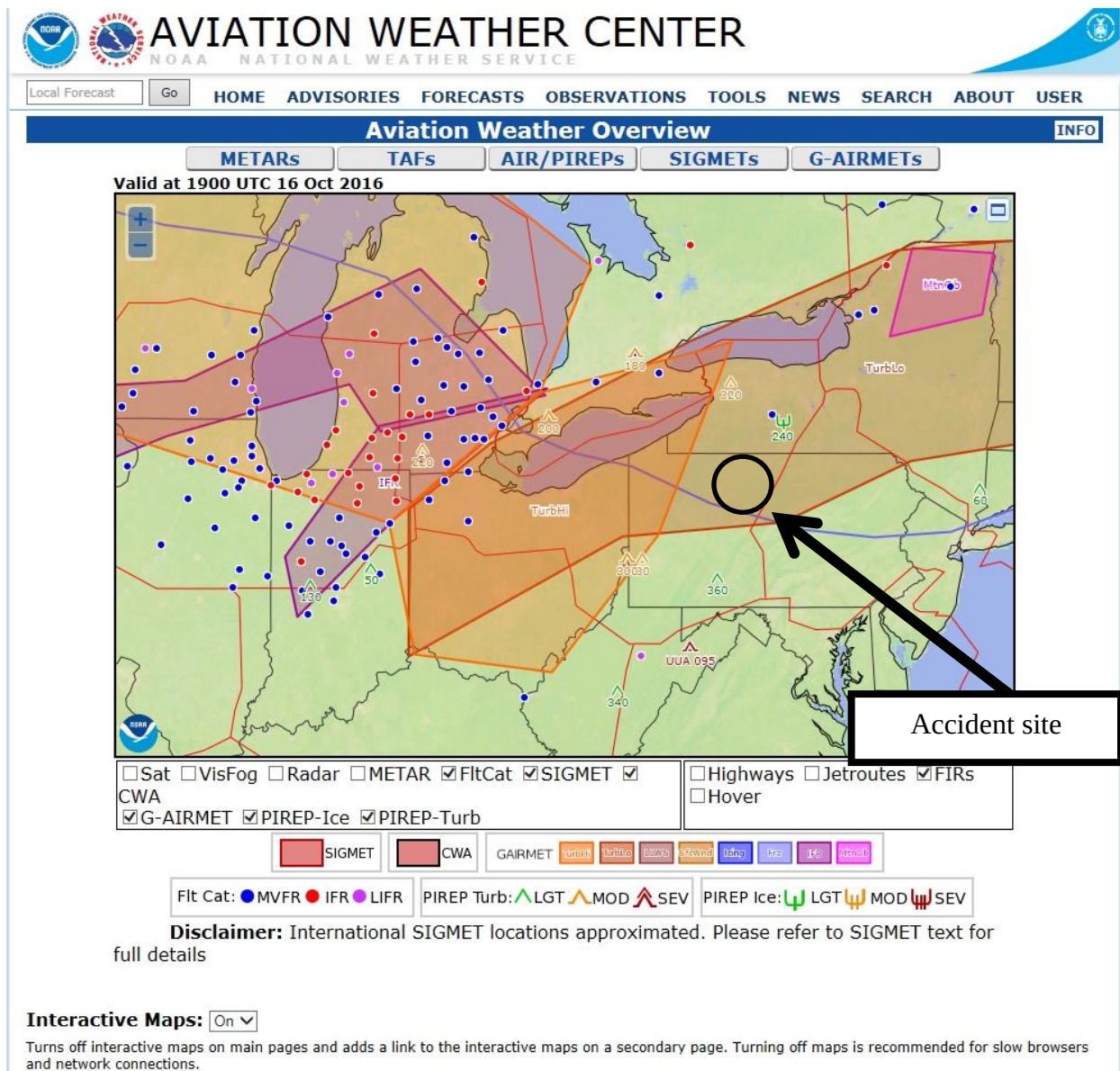


Figure 30 – AWC SIGMET, CWA, and AIRMET graphic valid for 1500 EDT



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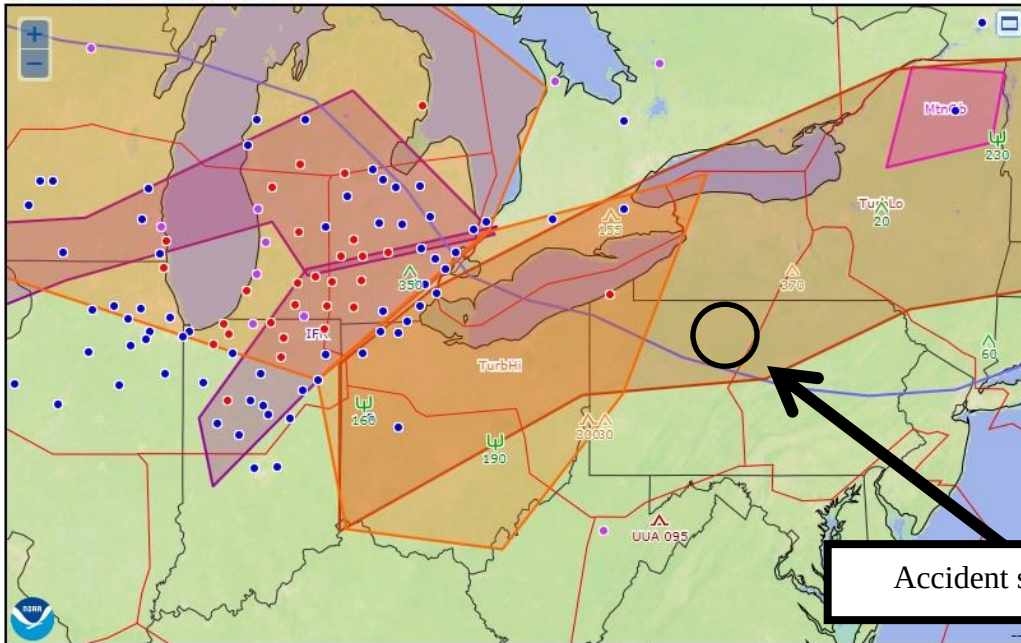
TAFs

AIR/PIREPs

SIGMETs

G-AIRMETs

Valid at 2000 UTC 16 Oct 2016



☐ Sat ☐ VisFog ☐ Radar ☐ METAR ☒ FltCat ☒ SIGMET ☒
CWA
☒ G-AIRMET ☒ PIREP-Ice ☒ PIREP-Turb

☐ Highways ☐ Jetroutes ☒ FIRs
☐ Hover

SIGMET

CWA

GAIRMET

PIREP-Ice

PIREP-Turb

PIREP-Ice

PIREP-Turb

Flt Cat: ● MVFR ● IFR ● LIFR

PIREP Turb: ▲ LGT ▲ MOD ▲ SEV

PIREP Ice: ▲ LGT ▲ MOD ▲ SEV

Disclaimer: International SIGMET locations approximated. Please refer to SIGMET text for full details

Interactive Maps:

Turn off interactive maps on main pages and add a link to the interactive maps as a secondary page. Turning off maps is recommended for slow browsers.

Figure 31 – AWC SIGMET, CWA, and AIRMET graphic valid for 1600 EDT



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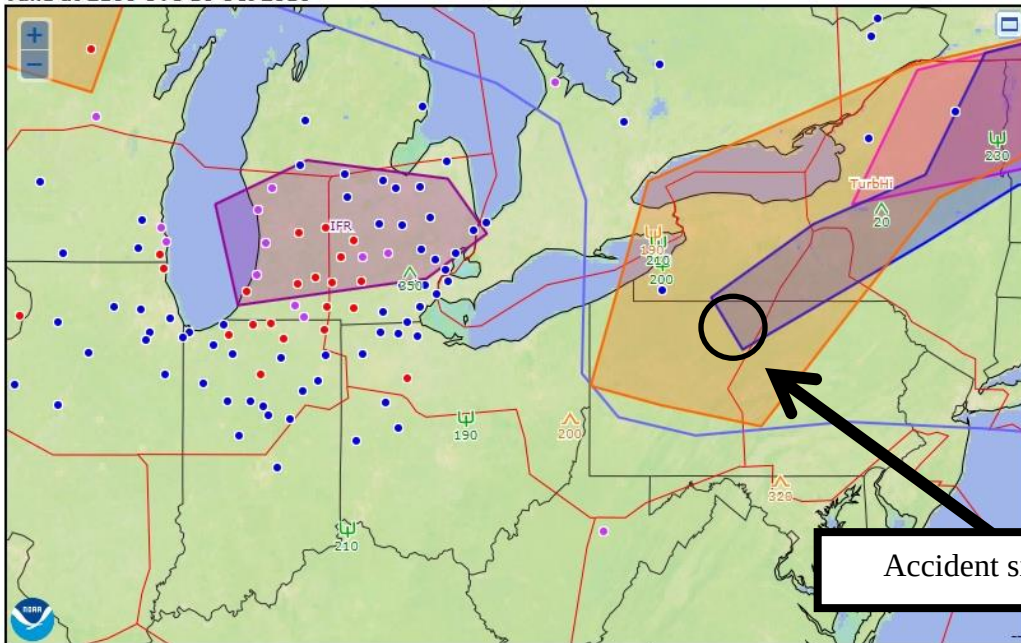
TAFs

AIR/PIREPs

SIGMETs

G-AIRMETs

Valid at 2100 UTC 16 Oct 2016



☐ Sat ☐ VisFog ☐ Radar ☐ METAR ☒ FltCat ☒ SIGMET ☒
CWA
☒ G-AIRMET ☒ PIREP-Ice ☒ PIREP-Turb

☐ Highways ☐ Jetroutes ☒ FIRs
☐ Hover

SIGMET

CWA

GAIRMET

IFR

IFR

IFR

IFR

IFR

IFR

Flt Cat: ● MVFR ● IFR ● LIFR

PIREP Turb: ▲ LGT ▲ MOD ▲ SEV

PIREP Ice: ▲ LGT ▲ MOD ▲ SEV

Disclaimer: International SIGMET locations approximated. Please refer to SIGMET text for full details

Interactive Maps:

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Figure 32 – AWC SIGMET, CWA, and AIRMET graphic valid for 1700 EDT



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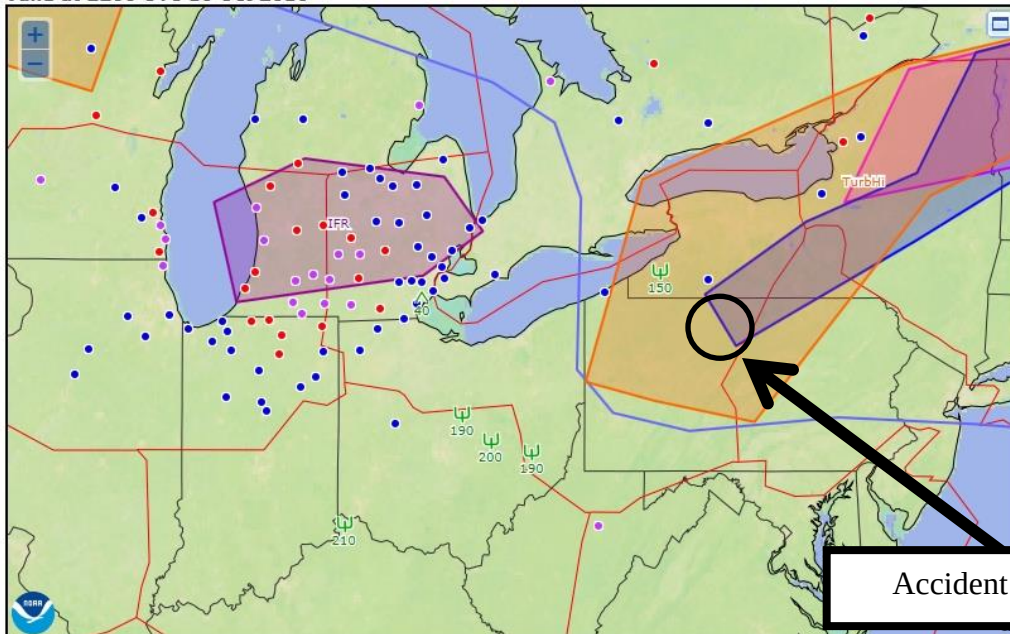
TAFs

AIR/PIREPs

SIGMETs

G-AIRMETs

Valid at 2200 UTC 16 Oct 2016



☐ Sat ☐ VisFog ☐ Radar ☐ METAR ☒ FltCat ☒ SIGMET ☒
CWA
☒ G-AIRMET ☒ PIREP-Ice ☒ PIREP-Turb

☐ Highways ☐ Jetroutes ☒ FIRs
☐ Hover

SIGMET CWA G-AIRMET

Flt Cat: ● MVFR ● IFR ● LIFR PIREP Turb: ▲ LGT ▲ MOD ▲ SEV PIREP Ice: ▲ LGT ▲ MOD ▲ SEV

Disclaimer: International SIGMET locations approximated. Please refer to SIGMET text for full details

Interactive Maps:

Turns off interactive maps on main pages and adds a link to the interactive maps on a secondary page. Turning off maps is recommended for slow browsers

Figure 33 – AWC SIGMET, CWA, and AIRMET graphic valid for 1800 EDT

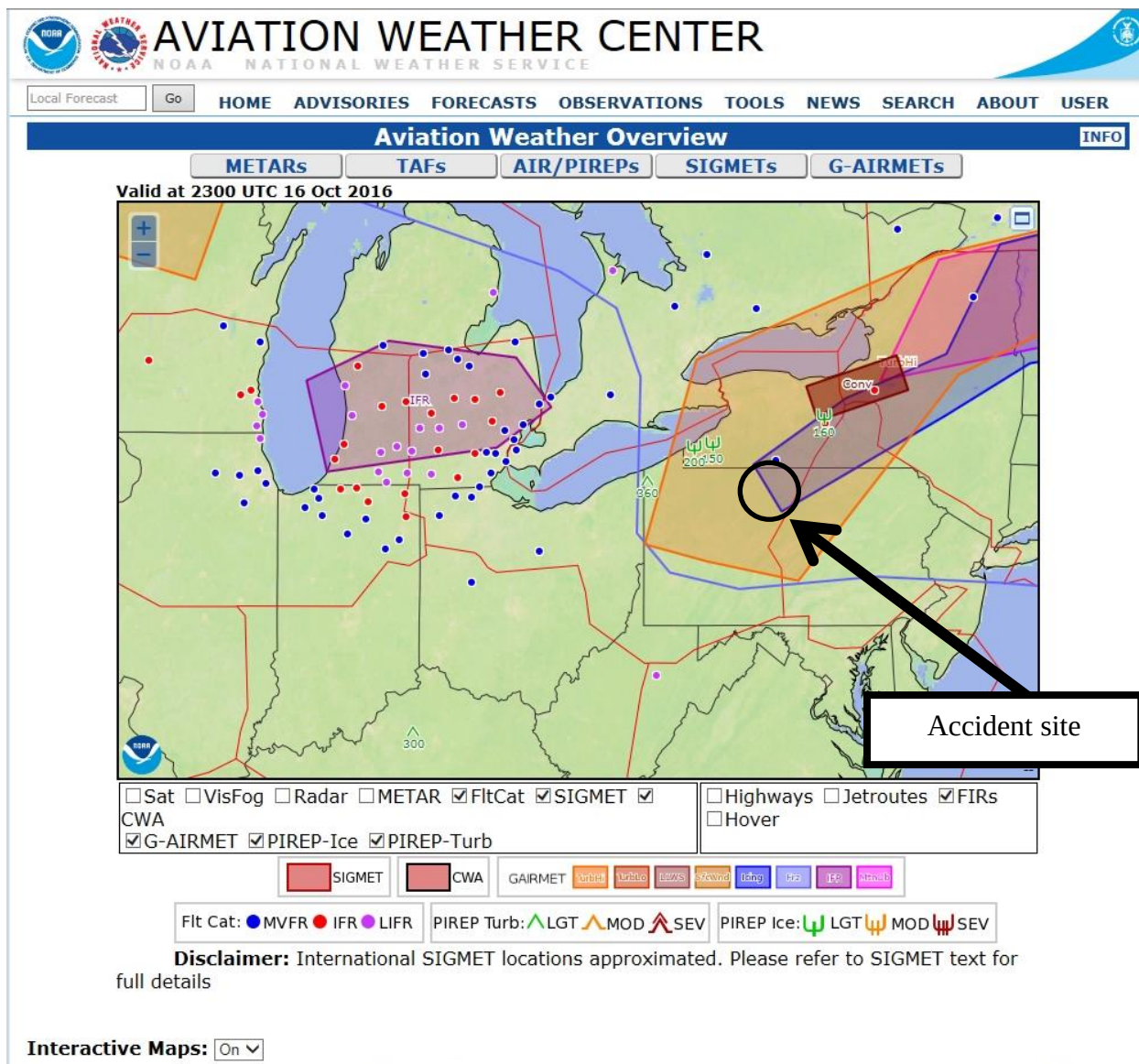
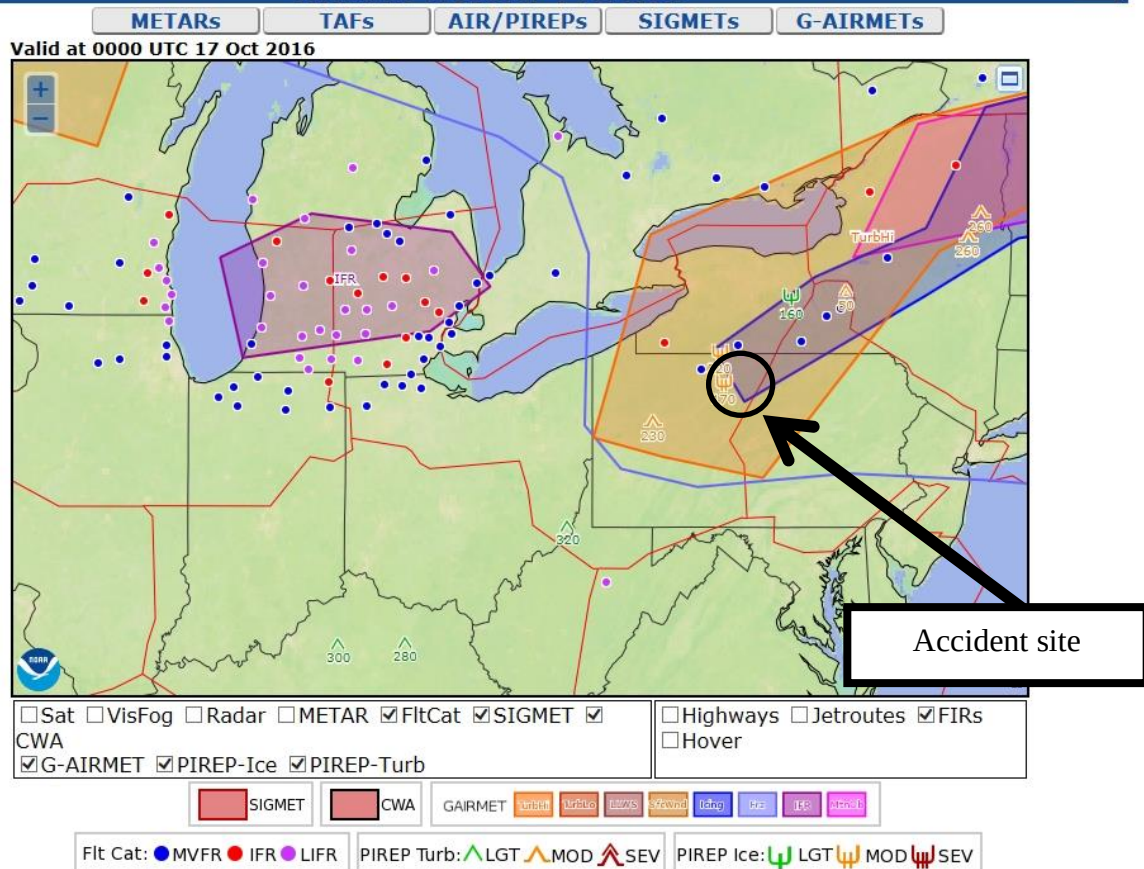


Figure 34 – AWC SIGMET, CWA, and AIRMET graphic valid for 1900 EDT

Aviation Weather Overview [INFO](#)



Disclaimer: International SIGMET locations approximated. Please refer to SIGMET text for full details

Interactive Maps:

Turns off interactive maps on main pages and adds a link to the interactive maps on a secondary page. Turning off maps is recommended for slow browsers.

Figure 35 – AWC SIGMET, CWA, and AIRMET graphic valid for 2000 EDT

10.0 Area Forecast

The Area Forecast issued at 1345 EDT, valid at the accident time (and departure time), forecasted scattered to broken clouds at 10,000 feet msl with tops at FL250. Between 1600 and 1800 EDT the ceiling was forecast to decrease to 6,000 feet msl with scattered light rain showers and isolated light rain and thunderstorms with cumulonimbus tops to FL350:

FAUS41 KPCI 161745

FA1W

_BOSC FA 161745

SYNOPSIS AND VFR CLDS/WX

SYNOPSIS VALID UNTIL 171200

CLDS/WX VALID UNTIL 170600...OTLK VALID 170600-171200

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...18Z CDFNT CNTRL QUE-SE ONT-CNTRL LH-W CNTRL LWR MI.
RDG FM MID ATLC CSTL WTRS TO S TX WITH HIGHS OVR S CNTRL NC AND
180SE SIE. 12Z CDFNT NRN NOVA SCOTIA-ME CSTL WTRS-S NH-CNTRL
NY-40SW YYZ LN CONTG WNWWD AS WRMFNT. RDG FM INTL WTRS OFF VA/NC
CST ACRS THE TN VLY TO S TX WITH HIGHS OVR NRN NC CSTL WTRS AND
NERN GA. HIGH SW QUE.

.
ME NH VT
NW ME/N NH/N VT...SCT060 BKN080 TOP FL250. ISOL -SHRA/-TSRA. CB
TOP FL350. 22Z OVC040. SCT -SHRA/ISOL -TSRA. 03Z OVC030 TOP 100.
ISOL -SHRA. OTLK...IFR CIG.
NERN ME...BKN060 TOP FL250. ISOL -SHRA. 22Z OVC020. ISOL -SHRA.
00Z OVC015. OTLK...IFR CIG.
SW ME/S NH/S VT...BKN060 TOP FL250. AFT 22Z WDLY SCT -SHRA.
OTLK...VFR BECMG 0709 MVFR CIG BR.
SE ME...BKN050 TOP 120. 21Z BKN060 TOP FL250. AFT 23Z WDLY SCT
-SHRA. OTLK...VFR BECMG 0709 MVFR CIG BR.

.
MA RI CT
WRN-CNTRL MA/CT...SCT-BKN060 BKN120 TOP FL180. ISOL -SHRA
WRN-CNTRL MA PTN. 03Z BKN060 TOP FL250. ISOL -SHRA THRUT.
OTLK...VFR SHRA.
ERN MA/RI...SCT040 WITH BKN CI ABV. 23Z BKN080 TOP FL180. 05Z
BKN060 TOP FL250. OTLK...VFR.

.
NY LO
N 1/2 WRN NY/LO...BKN060 TOP FL250. WDLY SCT -SHRA. 21Z OVC060.
SCT -SHRA/ISOL -TSRA. CB TOP FL350. 04Z OVC030. WDLY SCT -SHRA.
OTLK...MVFR CIG SHRA.
S 1/2 WRN NY-S CNTRL NY...BKN120 TOP FL180. BECMG 2022 BKN060 TOP
FL220. SCT -SHRA/ISOL -TSRA. CB TOP FL350. 03Z OVC040. SCT -SHRA.
OTLK...IFR CIG SHRA.
N CNTRL-NERN NY...OVC040 TOP FL250. SCT -SHRA/ISOL -TSRA. CB TOP
FL350. 04Z OVC030-040. ISOL -SHRA. OTLK...IFR CIG SHRA BR.
CSTL PLAIN...SCT060 BKN120 TOP FL180. OTLK...VFR.
RMNDR SE NY...SCT060 BKN120 TOP FL180. BECMG 0406 BKN060 TOP
FL250. ISOL -SHRA. OTLK...VFR SHRA.

.
PA NJ
NW-N CNTRL PA...SCT-BKN100 TOP FL250. BECMG 2022 BKN060. SCT
-SHRA/ISOL -TSRA. CB TOP FL350. 03Z OVC050. ISOL -SHRA.
OTLK...VFR SHRA BECMG 0709 MVFR CIG SHRA.
SW PA...SCT-BKN100 TOP FL180. BECMG 2200 BKN080. ISOL
-SHRA/-TSRA. CB TOP FL350. OTLK...VFR SHRA.
S CNTRL-SE PA...SCT080 BKN120 TOP FL180. OTLK...VFR BECMG 0709
MVFR CIG S CNTRL PA...VFR SE PA.
NERN PA/N NJ...SCT060 BKN120 TOP FL180. BECMG 0406 BKN060 TOP
FL250. ISOL -SHRA. OTLK...VFR SHRA.
S NJ...SCT060. 19Z SCT060 BKN120 TOP FL180. OTLK...VFR.

.
OH LE

NW 1/4 OH/W 1/4 LE...OVC060 LYRD FL280. SCT -SHRA/ISOL -TSRA. CB TOP FL350. 23Z BKN030 OVC060. WDLY SCT -SHRA. 04Z OVC020. VIS 3-5SM BR. ISOL -SHRA. OTLK...IFR CIG SHRA BR.

NERN 1/4 OH/E 3/4 LE...SCT060 BKN120 TOP FL280. ISOL -SHRA. 20Z OVC060. WDLY SCT -SHRA/ISOL -TSRA. CB TOP FL350. 01Z BKN030 OVC060. ISOL -SHRA. OTLK...MVFR CIG SHRA.

SW 1/4 OH...SCT060 WITH SCT CI ABV. 20Z BKN060 TOP FL250. WDLY SCT -SHRA/-TSRA. CB TOP FL350. 04Z SCT040 BKN100. OTLK...VFR.

SE 1/4 OH...SCT060 WITH SCT CI ABV. 00Z BKN120 TOP FL180. 03Z BKN060. ISOL -SHRA. OTLK...VFR SHRA.

.

WV MD DC DE VA

W WV PNHDL...BKN120 TOP FL180. 01Z BKN090. ISOL -SHRA. OTLK...VFR SHRA.

RMNDR W OF THE APLCNS...SCT050 WITH SCT CI ABV. BECMG 0103 BKN120 TOP FL180. OTLK...VFR.

N 1/3 APLCNS...SCT060 WITH SCT CI ABV. 03Z BKN120 TOP FL180. OTLK...VFR.

S 2/3 APLCNS...SCT060 WITH SCT CI ABV. OTLK...VFR.

SE MD/SE VA...SCT CI. 04Z SKC OR SCT CI. OTLK...VFR BECMG 0810 MVFR BR.

RMNDR MD/DC/DE/RMNDR N VA...SKC. OCNL SCT080. BECMG 0406 BKN120 TOP FL180. OTLK...VFR.

RMNDR S VA...SKC. OTLK...VFR BECMG 0709 MVFR BR.

.

CSTL WTRS

N OF ACK-150ENE ACK LN...BKN020 TOP 050. WND SW G25KT. BECMG 2123 BKN060 TOP FL180. AFT 03Z ISOL -SHRA. OTLK...MVFR CIG SHRA.

S OF SIE-150ESE ACK LN...SCT030. OTLK...VFR.

RMNDR...SCT030 WITH SCT CI ABV. BECMG 0104 SCT060 BKN120 TOP FL180. OTLK...VFR.

....

11.0 Terminal Aerodrome Forecast

KBFD was the closest site to the accident site with a NWS Terminal Aerodrome Forecast (TAF). The TAF valid at the time of the accident was issued at 1658 EDT and was valid for a 21-hour period beginning at 1700 EDT. The TAF for KBFD was as follows:

KBFD 162058Z 1621/1718 **21008KT P6SM FEW040**
 FM170000 24006KT P6SM VCSH OVC030
 FM170600 28003KT 4SM -SHRA BR OVC009
 FM171200 22003KT 4SM BR OVC003
 FM171600 22005KT P6SM OVC015=

The forecast expected a wind from 210° at 8 knots, greater than 6 statute miles visibility, and few clouds at 4,000 feet agl. Precipitation was not forecast in the vicinity of KBFD until 2000 EDT. The KBFD TAF did not match the observed surface conditions with the rain moving southeastward across the area (sections 3.0, 6.4, and 6.5) at the accident time, and the KBFD TAF was not consistent with the Area Forecast issued by the Aviation Weather Center (AWC).

The latest KBFD TAF valid before the accident flight departed was issued at 1328 EDT and was valid for a 24-hour period beginning at 1400 EDT. The 1328 EDT TAF for KBFD was as follows:

TAF KBFD 161728Z 1618/1718 **24010G18KT P6SM BKN045**
FM170000 24006KT P6SM VCSH OVC030
FM170600 28003KT 4SM -SHRA BR OVC009
FM171200 22003KT 4SM BR OVC003
FM171600 22005KT P6SM OVC015=

The forecast expected a wind from 240° at 10 knots with gusts to 18 knots, greater than 6 statute miles visibility, and a broken ceiling at 4,500 feet agl. The 1658 EDT KBFD TAF was consistent with the 1328 EDT KBFD TAF.

12.0 NWS Area Forecast Discussion

The NWS Office in State College, Pennsylvania, issued the following Area Forecast Discussion (AFD) at 1917 EDT (closest AFD to the accident time). The aviation section of the AFD discussed that VFR²⁷ conditions would likely prevail until a weak cold front moved close enough to the area to bring likely ceiling restrictions and scattered showers to the area including KBFD, late in the day and that night:

FXUS61 KCTP 162317

AFDCTP

Area Forecast Discussion

National Weather Service State College PA

717 PM EDT Sun Oct 16 2016

.SYNOPSIS...

A weak cold front will move to near the New York - Pennsylvania border tonight and Monday, before retreating back to the north as a warm front later Monday and Tuesday. Southwest flow aloft will bring much above normal daytime and nighttime temperatures to the region right into Wednesday. A weak cold front will push through the Commonwealth on Wednesday, followed by a slight cooling trend for Thursday through Saturday.

&&

.NEAR TERM /UNTIL 7 AM MONDAY MORNING/...

Convection surprisingly strong but very short at this hour.

Despite sunset and only meager warmth to work with there are a few mini bow echoes and associated bookend vortices rolling through the northern tier. KELZ had a G33KT, and similar gusts are likely occurring north of Route 6. The activity seems to be weakening slightly as expected - and is also not making progress all that far to the south. Forecast rolling along and tweaks made were only slight at best.

Prev...

Active long line of showers north through west of CWA will inch closer to area later this afternoon and tonight. Ahead of this area HRRR consistent in showing showers breaking out...and radar

²⁷ 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.

has shown this north of border in NYS. So will keep pops in the forecast through tonight with highest chances furthest north. With warm moist air and cloud cover in place...overnight lows will be well above average.

&&

.SHORT TERM /7 AM MONDAY MORNING THROUGH MONDAY NIGHT/...

Frontal system never really makes it through the area and begins to retreat with ridging and higher heights building in from south. Will have pops in forecast until front clears area and there could be enough instability for a few thunderstorms to form on Monday. Another warm day with temperatures well above average. Quiet night on Monday night though fog and low clouds likely to form late with the ample low level moisture and longer nights.

&&

.LONG TERM /TUESDAY THROUGH SUNDAY/...

A strong southwest flow of air will keep warmer than normal temperatures across the region into at least Thursday. Trend is for the cold front not to drop as far south by Tue.

Did up temperatures some, especially on Thursday. Adjusted temperatures on Thursday by about 5 degrees. Fits in better with others and model solutions.

Still looks like some rain and cooler temperatures for late in the week. Would not be surprise if by the time the colder air moves in, it is less than what the models show.

For now, enjoy the nice weather. 850 mb temperatures support temperatures at least in the lower 80s by Tuesday. Given the west to southwest flow, if we get much mixing, most likely it would be warmer than the lower 80s.

&&

.AVIATION /23Z SUNDAY THROUGH FRIDAY/...

VFR conditions will prevail areawide with winds picking up from the SW (and becoming gusty over the west).

A weak cold front get close enough to bring likely cig restrictions and scattered showers to the NW mountains (including KBFD) late day and esp tonight. Central areas should remain VFR, but a low cloud deck will again likely develop in the lower Susq early Mon morning.

Outlook...

Mon...Showers cig reductions possible, mainly north.

Tue...Improving conditions.

Wed...Chance showers and poss reductions NW half.

Thu...Chance of showers.

Fri...Chance of showers.

&&

.CTP WATCHES/WARNINGS/ADVISORIES...

None.

&&

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13.0 Winds and Temperature Aloft Forecast

The NWS 1600 EDT and 0959 EDT Winds and Temperature Aloft forecasts valid for the accident flight are included below. The 0959 EDT forecast would have been available and valid before the time of takeoff:

```

FBUS31 KWN0 162000
FD1US1
 DATA BASED ON 161800Z
VALID 170000Z   FOR USE 2000-0300Z. TEMPS NEG ABV 24000
FT  3000    6000    9000    12000    18000    24000    30000    34000    39000

PSB          2621+10 2826+04 2826-01 2737-12 2836-23 253939 274447 284852

FBUS31 KWN0 161359
FD1US1
 DATA BASED ON 161200Z
VALID 161800Z   FOR USE 1400-2100Z. TEMPS NEG ABV 24000
FT  3000    6000    9000    12000    18000    24000    30000    34000    39000

PSB          2728+10 2529+04 2532-01 2729-11 2729-22 253838 254548 304054

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The closest forecast point was Philipsburg, Pennsylvania, (PSB). The 0959 EDT PSB forecast indicated a wind at 6,000 feet from 270° at 28 knots with a temperature of 10° C and a wind at 9,000 feet from 250° at 29 knots with a temperature of 4° C. The 1600 EDT PSB forecast indicated a wind at 6,000 feet from 260° at 21 knots with a temperature of 10° C and a wind at 9,000 feet from 280° at 26 knots with a temperature of 4° C.

14.0 Pilot Weather Briefing and Information

A search of official weather briefing sources, such as LMFS and Direct User Access Terminal Service (DUATS), revealed that the accident pilot did not contact LMFS. In addition, the accident pilot did not review any information on ForeFlight before or during the accident flight.

Another airplane (C-GQXP) also bound for St. Catherines (CYSN) and travelling with, and just ahead of the accident flight, also encountered weather while passing through northern and northwestern Pennsylvania. The flight instructor (FI) of C-GQXP checked the weather the day before with the accident pilot present using his laptop, and also checked the weather the day of the accident but did not discuss the weather that day with the accident pilot. The FI of C-GQXP accessed aviationweather.gov and from the homepage accessed “Tools” and then “Flight Path Tool.” The FI of C-GQXP looked at the Prog charts and noted the location of the cold front. The FI of C-GQXP and the accident pilot discussed the weather and noted the freezing level was at 14,000 feet. The FI of C-GQXP indicated he did not save any of the graphical or text data from the weather search.

During the flight to CYSN, the FI of C-GQXP indicated he initially was flying at 7,000 feet, but when near Bradford descended to 5,000 ft. He indicated that ATC vectored him to the west to avoid precipitation that was ahead, and said at 5,000 feet the outside air temperature was between 10° and 12° C. He indicated that he was in the clouds about 5 minutes, and encountered light rain and turbulence.²⁸

²⁸ For more information concerning the NTSB interview of this pilot, please see the NTSB public docket for this investigation.

C-GNOP also bound for CYSN and travelling with, and just ahead of the accident flight, also encountered weather. The pilot-in-command reported that while flying at 6,000 feet msl, the outside air temperature (OAT) was between 9 and 10° C, and when at 7,000 feet msl, the OAT was 7° C. He reported flying in and out of clouds, and there was no sign of freezing rain. He made a PIREP to Federal Aviation Administration air traffic control that he was in light rain and encountering a smooth ride. His flight path paralleled the flight path of the accident airplane but he was flying west of the accident airplane. The PIREP, by the pilot-in-command of C-GNOP indicated above, was not distributed into the national airspace system.²⁹ The 2000 EDT HRRR sounding data (section 4.0) matched the OAT provided by C-GNOP and C-GQXP.

15.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for the accident site on October 16, 2016, indicated the following:

SUN

Begin civil twilight	0659 EDT
Sunrise	0727 EDT
Sun transit	1258 EDT
Sunset	1829 EDT
End civil twilight	1857 EDT

MOON

Moonrise	1834 on preceding day
Moon transit	0105 EDT
Moonset	0745 EDT
Moonrise	1913 EDT

The Phase of the Moon was full at 0023 EDT on October 16, 2016. The high and mid-level cloud cover along with the rain shower activity likely did not allow for the Moon to be visible around the accident time.

²⁹ For more information concerning the NTSB interview of this pilot, please see the NTSB public docket for this investigation.

F. LIST OF ATTACHMENTS

Attachment 1 – GOES-13 infrared satellite animation from 1845 to 2100 EDT

Attachment 2 – KCCX WSR-88D reflectivity for the 0.5° elevation scan animation from 1942 EDT to 2005 EDT with the ATC flight track (pink dots)

Submitted by:

Paul Suffern
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