



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

June 30, 2017

Weather Study

METEOROLOGY

CEN17LA144

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A. ACCIDENT

Location: Near Fort Wayne, Indiana
Date: March 29, 2017
Time: 2156 Eastern Daylight Time
0156 Coordinated Universal Time (UTC) on March 30, 2017
Airplane: Cirrus SR-20, N580PU

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 March 29, 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 accident site was located at latitude 40.9783° N, longitude 85.1953° W, at an approximate elevation of 798 feet.

D. WEATHER INFORMATION

1.0 Synoptic Situation

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

1.1 Surface Analysis Chart

A section of the NWS Surface Analysis Chart for 2300 EDT is provided as figure 1 with the approximate location of the accident site marked within the red circle. The chart depicted two surface low pressure systems located well west-southwest of the accident site with the low pressure centers located in western Missouri and eastern Kansas with pressures of 1002- and 1001-hPa, respectively. The surface low pressure centers were associated with an occluded frontal system with the frontal boundaries stretching east-southeastward from eastern Kansas through southeastern Georgia. The station models around the accident site depicted air temperatures in the mid 40's degrees Fahrenheit (°F), dew point temperatures in the mid 30's °F, a northeast to east wind around 15 knots, and cloudy skies.

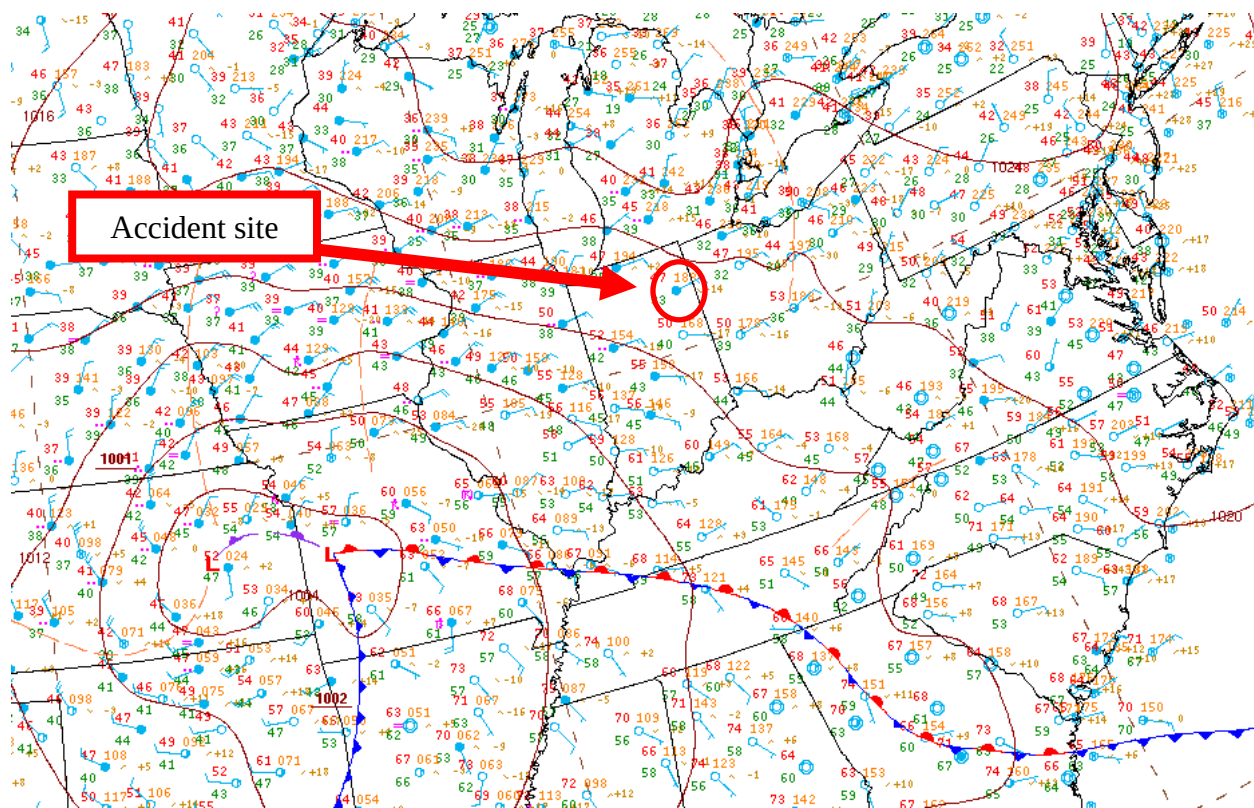


Figure 1 – Section of the NWS Surface Analysis Chart for 2300 EDT

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 accident site was located near a low-level trough¹ at 925- and 850-hPa (figures 2 and 3). At 700-hPa a mid-level trough was located above the accident site (figure 4). Areas near troughs are often favored locations for enhanced vertical motion, clouds, and precipitation. There was an east to northeast wind of 20 knots at 925-hPa (figure 2) with the wind becoming southwesterly by 700-hPa (figure 4). By 300-hPa, the wind was westerly at 50 knots (figure 6).

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

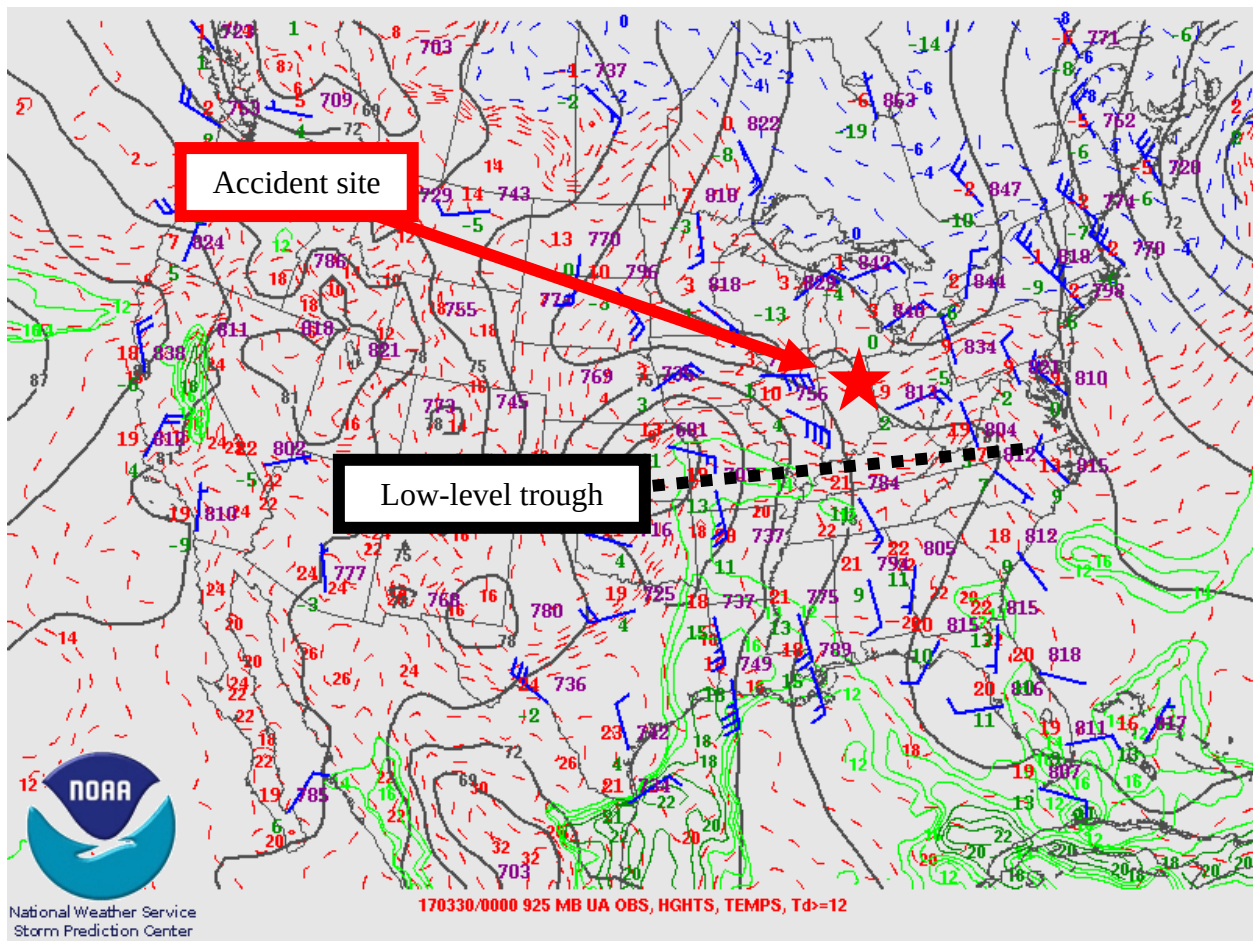


Figure 2 – 925-hPa Constant Pressure Chart for 2000 EDT

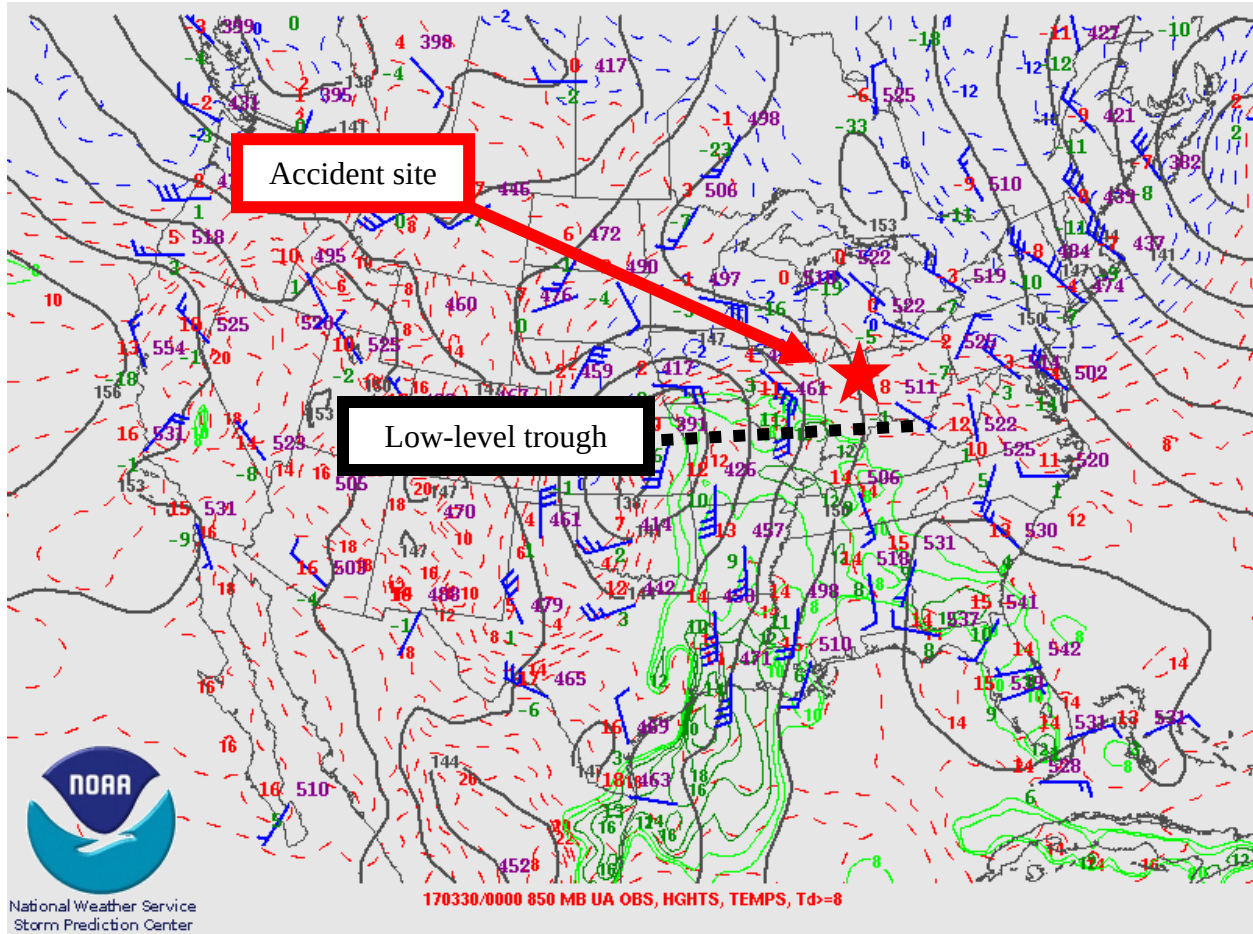


Figure 3 – 850-hPa Constant Pressure Chart for 2000 EDT

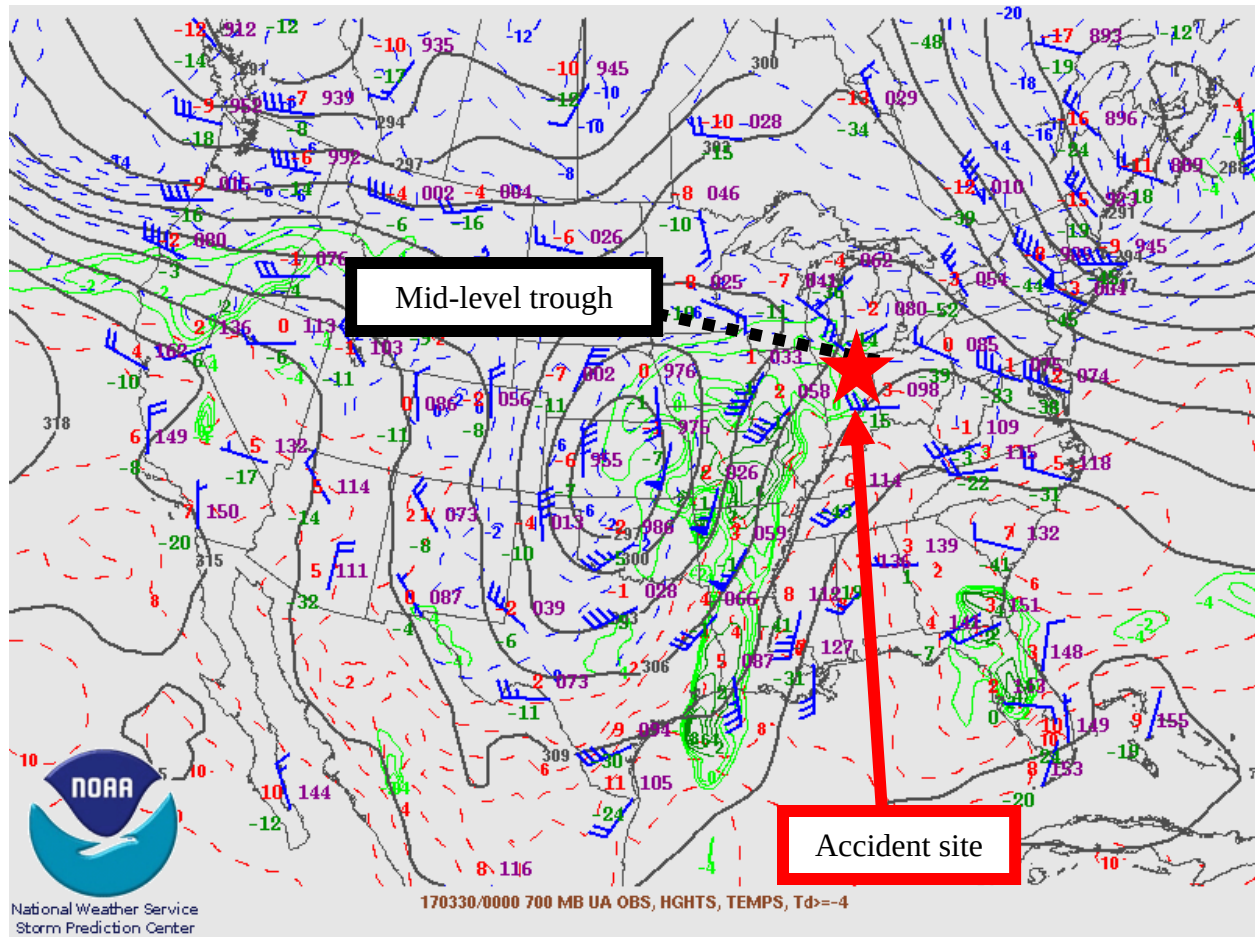


Figure 4 – 700-hPa Constant Pressure Chart for 2000 EDT

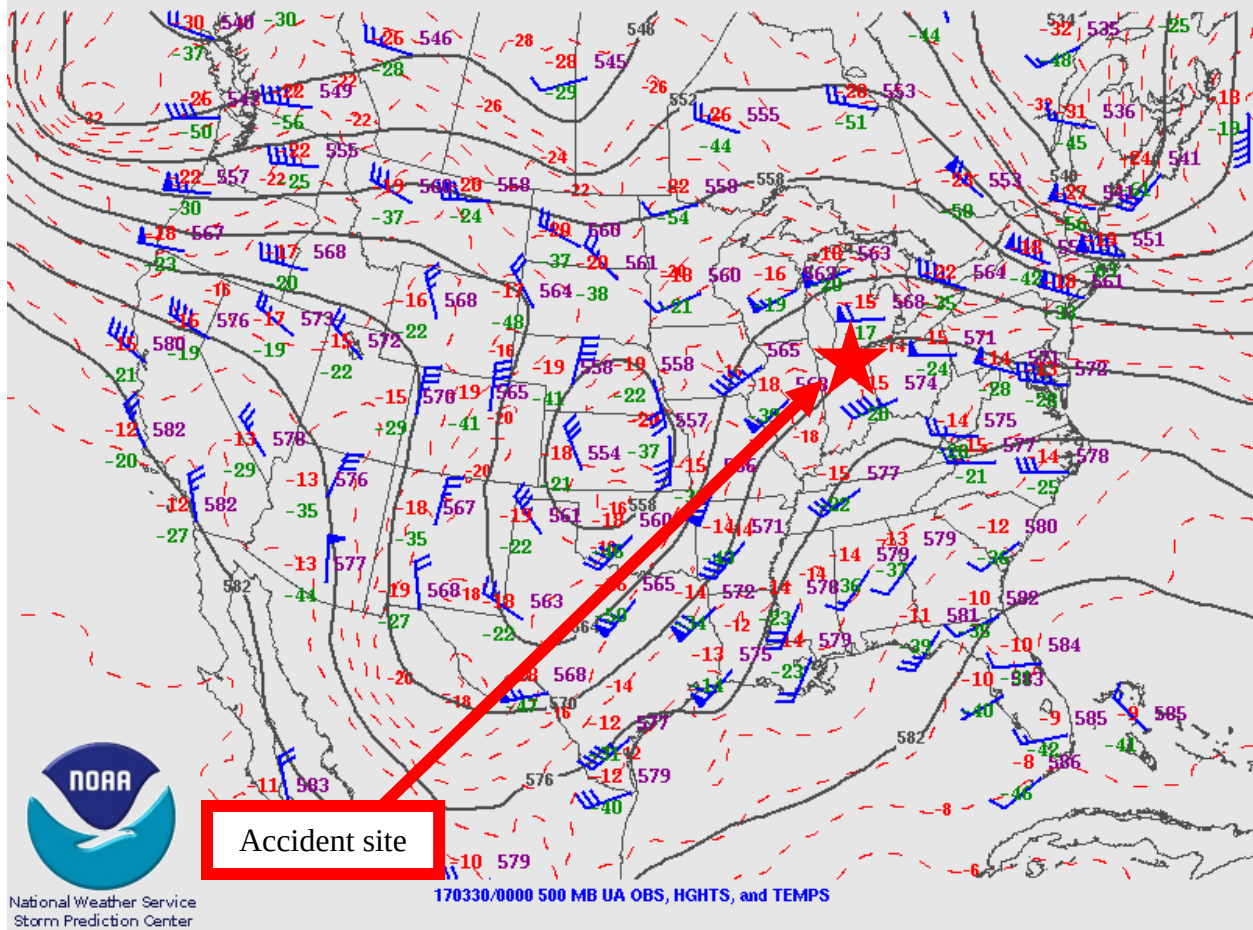


Figure 5 – 500-hPa Constant Pressure Chart for 2000 EDT

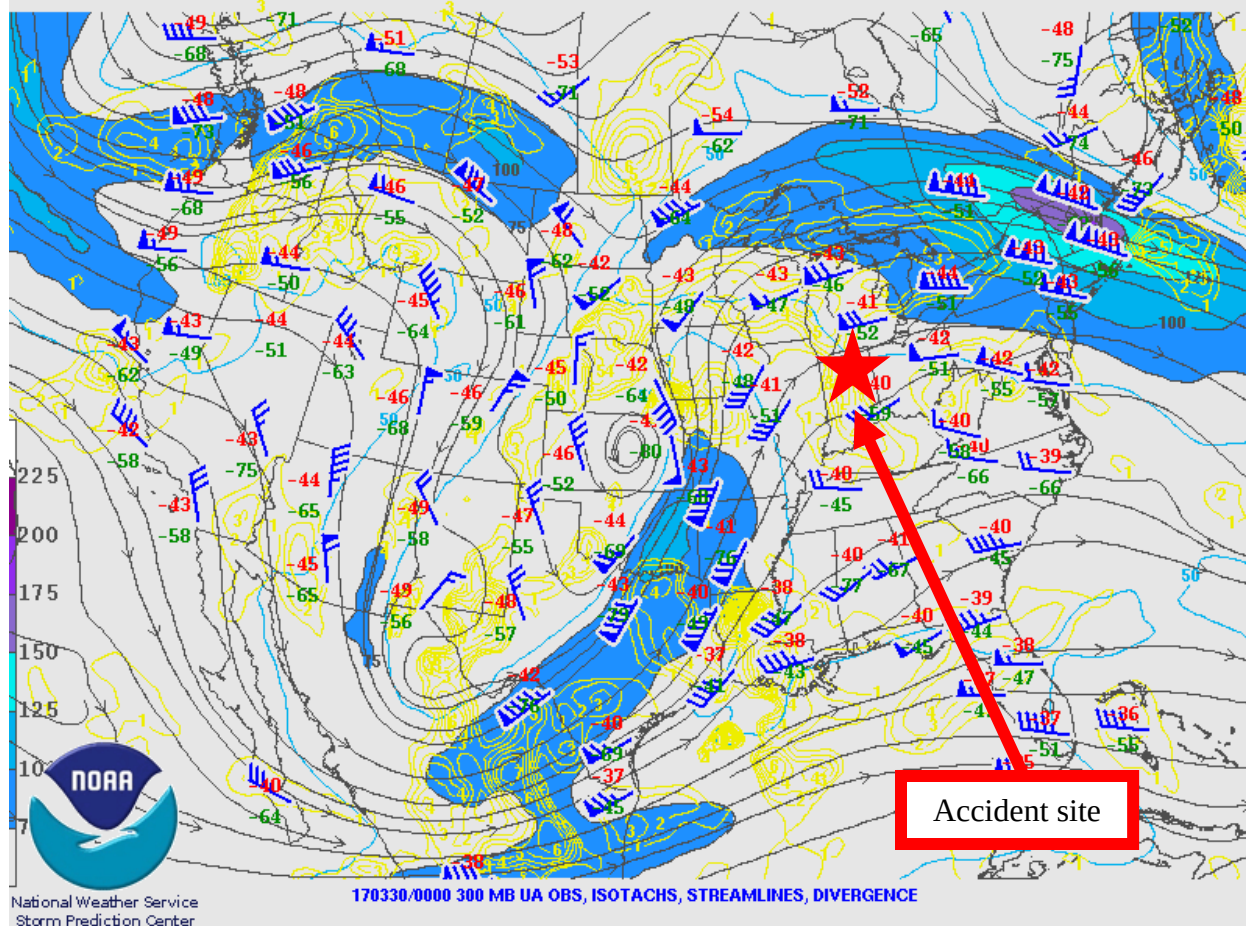


Figure 6 – 300-hPa Constant Pressure Chart for 2000 EDT

2.0 SPC Products

The SPC issued the following Day 1 Convective Outlook at 2050 EDT (figure 7) with areas of general thunderstorms forecast for Indiana during the overnight period. The 1600 EDT Day 1 Convective Outlook forecast similar timing and area for the thunderstorm activity across the Mississippi Valley and Midwest region:

SPC AC 300050

Day 1 Convective Outlook
NWS Storm Prediction Center Norman OK
0750 PM CDT Wed Mar 29 2017

Valid 300100Z - 301200Z

...THERE IS AN ENHANCED RISK OF SEVERE THUNDERSTORMS ACROSS PORTIONS OF THE OZARKS...

...THERE IS AN ENHANCED RISK OF SEVERE THUNDERSTORMS ROUGHLY ALONG THE LOWER MISSISSIPPI VALLEY AND EXTENDING INTO SOUTHWEST LOUISIANA...

...THERE IS A SLIGHT RISK OF SEVERE THUNDERSTORMS FROM THE MISSOURI VICINITY SOUTH TO THE LOUISIANA GULF COAST...

...THERE IS A MARGINAL RISK OF SEVERE THUNDERSTORMS SURROUNDING THE SLIGHT RISK AREA...

...SUMMARY...

Severe thunderstorms will continue tonight from parts of far East Texas, extreme eastern Oklahoma, and southeast Kansas eastward into the lower and middle Mississippi Valley. Large hail, damaging winds, and a few tornadoes are expected.

...Discussion...

Very slow eastward advance of an upper low over Kansas and an associated surface storm system is resulting in an increase in convective coverage/intensity this evening across parts of Missouri, western Arkansas, and into East Texas/western Louisiana. Afternoon destabilization -- which was aided by diurnal heating within a relatively cloud-free dry slot which expanded across western portions of Missouri and Arkansas -- is fueling the developing convection.

Updraft organization/severe risk is being aided by favorably strengthening/veering flow with height observed across the warm sector per area VWP's and evening RAOBs. While risk persists across the lower Mississippi Valley area, severe threat is increasing farther north. The greatest risk this evening is expected to evolve across the Ozarks vicinity over the next several hours -- east of a southeast Kansas surface low and in proximity to the west-to-east warm front where most favorable shear profiles are indicated.

Risk will likely continue into the overnight hours, crossing the middle and lower Mississippi Valley before diminishing gradually late in the period.

..Goss.. 03/30/2017

CLICK TO GET WUUS01 PTSDY1 PRODUCT

NOTE: THE NEXT DAY 1 OUTLOOK IS SCHEDULED BY 0600Z

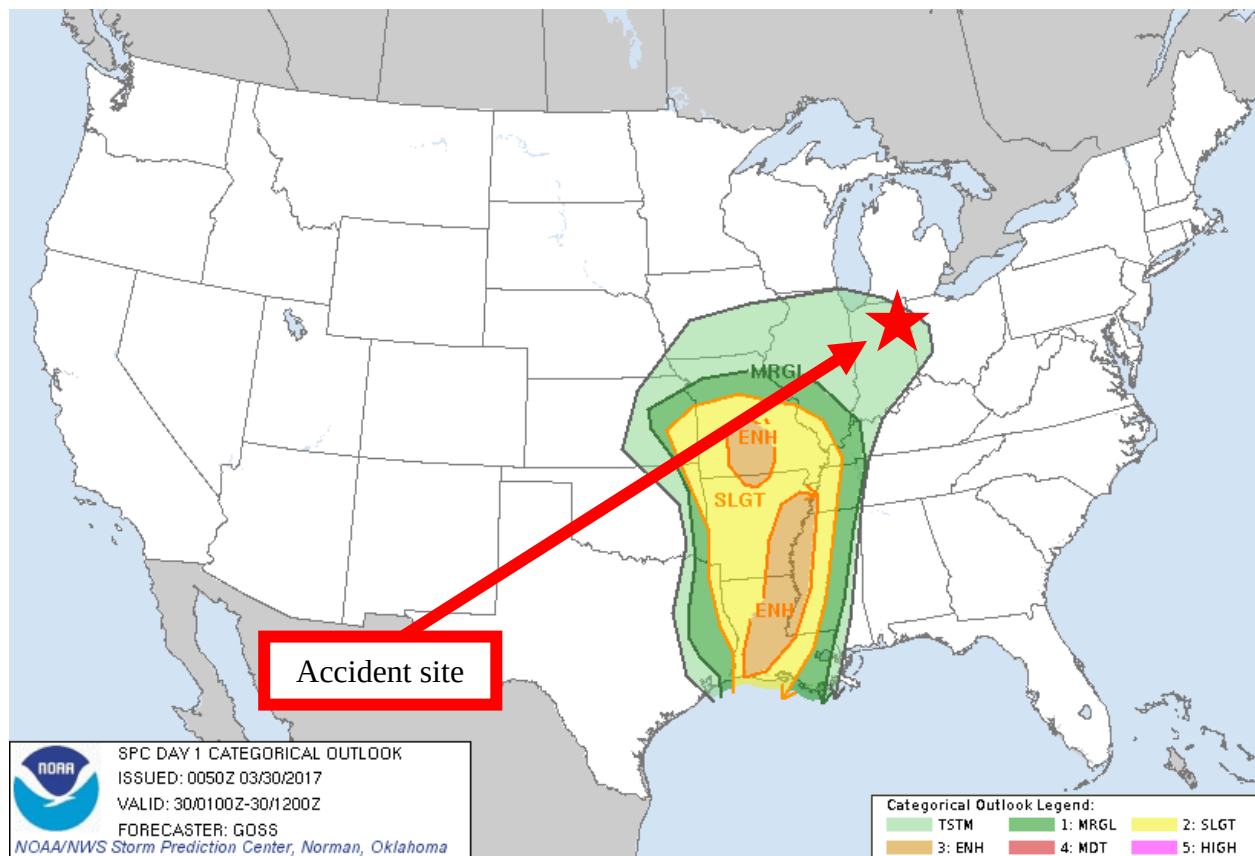


Figure 7 – SPC day 1 Convective Outlook valid at the time of the accident

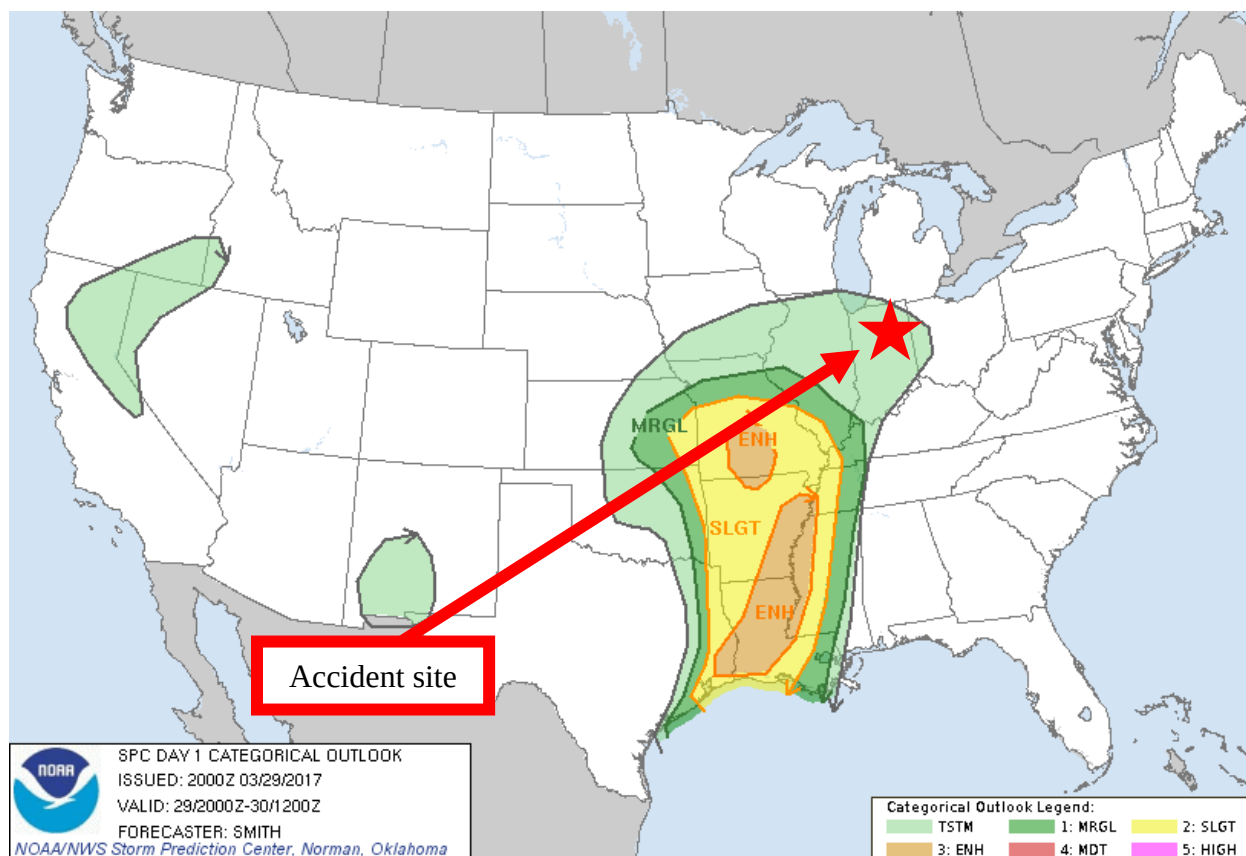


Figure 8 – SPC day 1 Convective Outlook valid at the time of the weather briefings

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 9 is a sectional chart with the accident site and the closest weather reporting locations marked.

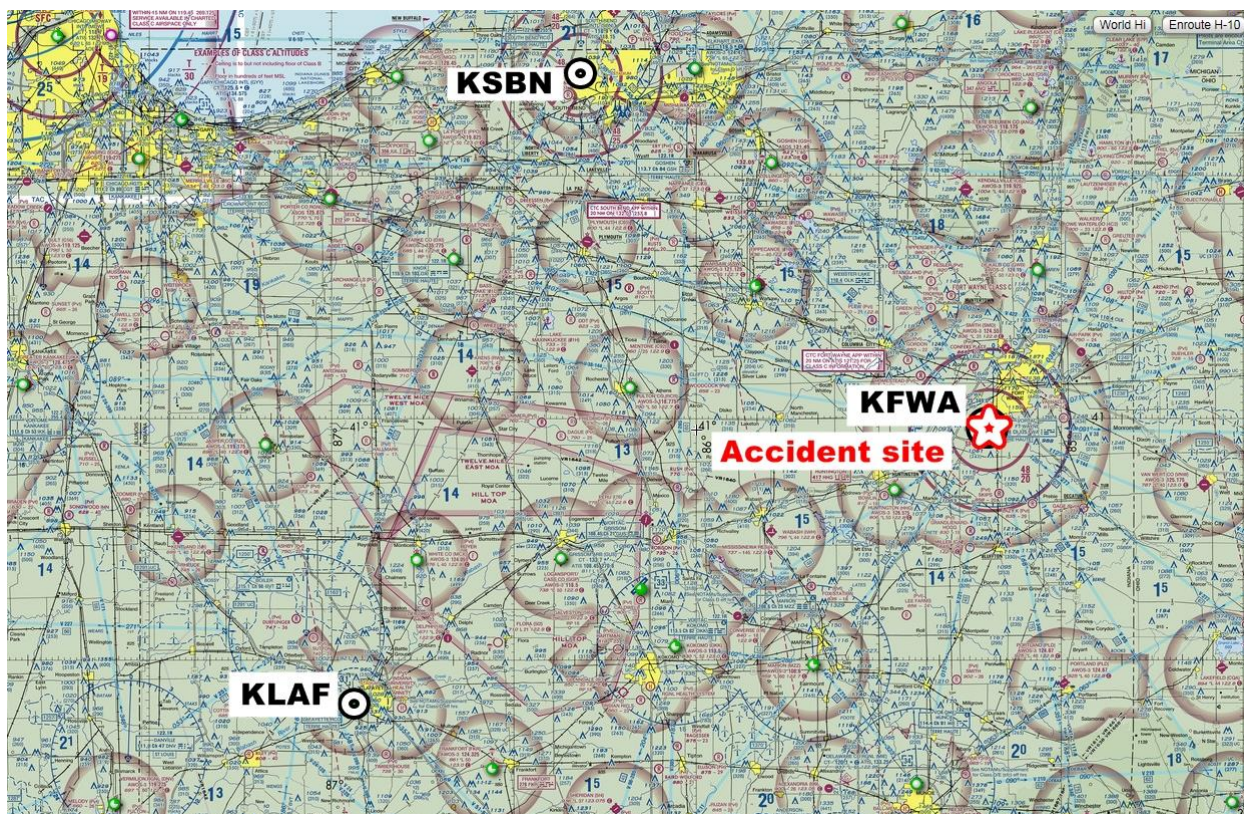


Figure 9 – Sectional chart of accident area with the location of the accident site and surface observation sites

Fort Wayne International Airport (KFWA) was the intended destination airport, located 7 miles southwest of Fort Wayne, Indiana. KFWA had an Automated Surface Observing System (ASOS²) whose reports were supplemented by an official human observer. The KFWA ASOS was located within a mile of the accident site at an elevation of 815 feet, and had a 3° westerly magnetic variation³ (figure 9). The following observations were taken and disseminated during the times surrounding the accident with the times after 0000 EDT being March 30:⁴

[1554 EDT] METAR KFWA 291954Z 07018G23KT 10SM FEW150 BKN250 14/03 A3019
RMK AO2 SLP225 T01390033 \$=

[1654 EDT] METAR KFWA 292054Z 08019G25KT 10SM SCT160 BKN250 13/03 A3017
RMK AO2 SLP219 T01330028 58017 \$=

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/KFWA>

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 affected 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.

[1754 EDT] METAR KFWA 292154Z 08018G21KT 10SM BKN140 BKN250 13/01 A3017
RMK AO2 PK WND 07027/2100 SLP219 T01280006 \$=

[1854 EDT] METAR KFWA 292254Z 07020G24KT 10SM BKN120 BKN250 12/01 A3015
RMK AO2 SLP212 T01170006 \$=

[1954 EDT] METAR KFWA 292354Z 08018G25KT 10SM BKN110 BKN250 10/00 A3012
RMK AO2 PK WND 07030/2302 SLP204 T01000000 10144 20100 58017 \$=

**[2054 EDT] METAR KFWA 300054Z 09019G26KT 10SM SCT100 BKN230 09/M01 A3010
RMK AO2 PK WND 09030/0028 SLP195 T00891006 \$=**

**[2154 EDT] METAR KFWA 300154Z 10020G26KT 10SM BKN100 OVC120 09/M01 A3009
RMK AO2 PK WND 10027/0108 SLP192 T00891006 \$=**

ACCIDENT TIME 2156 EDT

**[2231 EDT] SPECI KFWA 300231Z 08018KT 10SM OVC085 08/01 A3008 RMK AO2
PK WND 09026/0204 T00830006 \$=**

**[2254 EDT] METAR KFWA 300254Z 08015G26KT 10SM OVC085 08/01 A3007 RMK
AO2 PK WND 08026/0246 SLP188 T00830006 56014 \$=**

[2354 EDT] METAR KFWA 300354Z 04010KT 10SM BKN085 OVC100 08/01 A3012
RMK AO2 PRESRR SLP203 T00830011 \$=

[0054 EDT] METAR KFWA 300454Z 07014G21KT 10SM BKN075 OVC100 07/02 A3006
RMK AO2 PK WND 07026/0439 RAB0359E37 SLP182 P0005 T00670022
401440017 \$=

KFWA weather at 2054 EDT, wind from 090° at 19 knots with gusts to 26 knots, 10 miles visibility, scattered clouds at 10,000 feet above ground level (agl), broken ceiling at 23,000 feet agl, temperature of 9° Celsius (C), dew point temperature of -1° C, and an altimeter setting of 30.10 inches of mercury. Remarks, station with a precipitation discriminator, peak wind from 090° at 30 knots at 2028 EDT, sea level pressure 1019.5 hPa, temperature 8.9° C, dew point temperature -0.6° C, maintenance is needed on the system.

KFWA weather at 2154 EDT, wind from 100° at 20 knots with gusts to 26 knots, 10 miles visibility, broken ceiling at 10,000 feet agl, overcast skies at 12,000 feet agl, temperature of 9° C, dew point temperature of -1° C, and an altimeter setting of 30.09 inches of mercury. Remarks, station with a precipitation discriminator, peak wind from 100° at 27 knots at 2108 EDT, sea level pressure 1019.2 hPa, temperature 8.9° C, dew point temperature -0.6° C, maintenance is needed on the system.

KFWA weather at 2231 EDT, wind from 080° at 18 knots, 10 miles visibility, overcast ceiling at 8,500 feet agl, temperature of 8° C, dew point temperature of 1° C, and an altimeter setting of 30.08 inches of mercury. Remarks, station with a precipitation discriminator, peak wind from 090° at 26 knots at 2204 EDT, temperature 8.3° C, dew point temperature 0.6° C, maintenance is needed on the system.

KFWA weather at 2254 EDT, wind from 080° at 15 knots with gusts to 26 knots, 10 miles visibility, overcast ceiling at 8,500 feet agl, temperature of 8° C, dew point temperature of 1° C, and an altimeter setting of 30.07 inches of mercury. Remarks, station with a precipitation discriminator, peak wind from 080° at 26 knots at 2246 EDT, sea level pressure 1018.8 hPa, temperature 8.3° C, dew point temperature 0.6° C, 3-hourly pressure drop of 1.4 hPa, maintenance is needed on the system.

Purdue University Airport (KLAF) was the departure airport, located 2 miles southwest of Lafayette, Indiana. KLAF had an ASOS whose reports were supplemented by air traffic control. KLAF was located 86 miles west-southwest of the accident site, at an elevation of 606 feet, and had a 1° westerly magnetic variation⁵ (figure 9). The following observations were taken and disseminated during the times surrounding the accident with the times after 0000 EDT being March 30:

[1554 EDT] METAR KLAF 291954Z 09016KT 10SM SCT120 14/05 A3011 RMK AO2
SLP195 T01440050=

[1654 EDT] METAR KLAF 292054Z 10012KT 10SM OVC110 13/05 A3013 RMK AO2
SLP206 T01280050 55007=

[1754 EDT] METAR KLAF 292154Z 08020G27KT 10SM OVC090 13/05 A3003 RMK
AO2 PK WND 07027/2151 RAB20E37 SLP171 P0000 T01280050=

[1854 EDT] METAR KLAF 292254Z 10020G23KT 10SM BKN090 OVC110 13/06 A3002
RMK AO2 PK WND 10029/2201 SLP167 T01280056=

[1954 EDT] METAR KLAF 292354Z 10019G26KT 10SM BKN075 OVC110 13/05 A3002
RMK AO2 PK WND 09027/2324 SLP166 60000 T01280050 10144 20128 56039=

**[2054 EDT] METAR KLAF 300054Z AUTO 09017G28KT 10SM OVC060 12/05 A2998
RMK AO2 PK WND 10029/0019 SLP154 T01220050=**

**[2154 EDT] METAR KLAF 300154Z AUTO 09020G25KT 10SM -RA BKN055 OVC070
12/05 A2998 RMK AO2 PK WND 10027/0101 RAB54 SLP154
P0000 T01170050=**

ACCIDENT TIME 2156 EDT

⁵ Magnetic variation – The angle (at a particular location) between magnetic north and true north. 1985, latest measurement taken from <http://www.aimav.com/airport/Klaf>

**[2254 EDT] METAR KLAF 300254Z AUTO 09016G21KT 10SM -RA OVC050 11/06
A2998 RMK AO2 RAE15B45 SLP154 P0000 60000 T01110056 56012=**

**[2354 EDT] METAR KLAF 300354Z AUTO 08010KT 9SM -RA SCT055 BKN070 OVC100
10/07 A2998 RMK AO2 SLP154 P0001 T01000067=**

**[0054 EDT] METAR KLAF 300454Z AUTO 08013G20KT 10SM FEW080 BKN100 09/06
A2992 RMK AO2 RAE12 PRESFR SLP132 P0001 T00890061 401440067=**

**[0154 EDT] METAR KLAF 300554Z AUTO 08017KT 10SM -RA FEW055 OVC080 08/06
A2989 RMK AO2 RAB40 SLP122 P0003 60005 T00830056 10128 20083 58031=**

KLAF weather at 2054 EDT, automated, wind from 090° at 17 knots with gusts to 28 knots, 10 miles visibility, overcast ceiling at 6,000 feet agl, temperature of 12° C, dew point temperature of 5° C, and an altimeter setting of 29.98 inches of mercury. Remarks, station with a precipitation discriminator, peak wind from 100° at 29 knots at 2019 EDT, sea level pressure 1015.4 hPa, temperature 12.2° C, dew point temperature 5.0° C.

KLAF weather at 2154 EDT, automated, wind from 090° at 20 knots with gusts to 25 knots, 10 miles visibility, light rain, broken ceiling at 5,500 feet agl, overcast skies at 7,000 feet agl, temperature of 12° C, dew point temperature of 5° C, and an altimeter setting of 29.98 inches of mercury. Remarks, station with a precipitation discriminator, peak wind from 100° at 27 knots at 2101 EDT, rain began at 2154 EDT, sea level pressure 1015.4 hPa, one-hourly precipitation of a trace, temperature 11.7° C, dew point temperature 5.0° C.

KLAF weather at 2254 EDT, automated, wind from 090° at 16 knots with gusts to 21 knots, 10 miles visibility, light rain, overcast ceiling at 5,000 feet agl, temperature of 11° C, dew point temperature of 6° C, and an altimeter setting of 29.98 inches of mercury. Remarks, station with a precipitation discriminator, rain ended at 2215 EDT, rain began at 2245 EDT, sea level pressure 1015.4 hPa, one-hourly precipitation of a trace, 6-hourly precipitation of a trace, temperature 11.1° C, dew point temperature 5.6° C, 3-hourly pressure decrease of 1.2 hPa.

KLAF weather at 2354 EDT, automated, wind from 080° at 10 knots, 9 miles visibility, light rain, scattered clouds at 5,500 feet agl, broken ceiling at 7,000 feet agl, overcast skies at 10,000 feet agl, temperature of 10° C, dew point temperature of 7° C, and an altimeter setting of 29.98 inches of mercury. Remarks, station with a precipitation discriminator, sea level pressure 1015.4 hPa, one-hourly precipitation of 0.01 inches, temperature 10.0° C, dew point temperature 6.7° C.

South Bend International Airport (KSBN) was the destination airport for the second leg of the intended route on the accident day. KSBN was located 3 miles northwest of South Bend, Indiana. KSBN had an ASOS whose reports were supplemented by air traffic control. KSBN was located 67 miles northwest of the accident site, at an elevation of 798 feet, and had a 3° westerly magnetic variation⁶ (figure 9). The following observations were taken and disseminated during the times surrounding the accident with the times after 0000 EDT being March 30:

⁶ Magnetic variation – The angle (at a particular location) between magnetic north and true north. 1985, latest measurement taken from <http://www.aimav.com/airport/KSBN>

[1554 EDT] METAR KSBN 291954Z 11008G17KT 10SM CLR 13/01 A3020 RMK AO2 SLP231 T01280006=

[1654 EDT] METAR KSBN 292054Z 08008KT 10SM FEW120 12/00 A3017 RMK AO2 SLP220 T01220000 58024=

[1754 EDT] METAR KSBN 292154Z 10011KT 10SM BKN070 OVC095 12/00 A3019 RMK AO2 SLP229 T01170000=

[1854 EDT] METAR KSBN 292254Z 09013G21KT 10SM BKN100 12/M01 A3009 RMK AO2 SLP193 T01171006=

[1954 EDT] METAR KSBN 292354Z 10016G26KT 10SM SCT075 OVC090 11/00 A3009 RMK AO2 PK WND 10028/2327 SLP192 T01060000 10139 20106 58028=

[2054 EDT] METAR KSBN 300054Z 11014KT 10SM -RA FEW048 FEW060 OVC090 09/01 A3011 RMK AO2 PK WND 11026/0002 RAB04 SLP201 P0000 T00940011=

[2154 EDT] METAR KSBN 300154Z 05006KT 10SM OVC085 08/03 A3012 RMK AO2 RAE35 SLP203 P0002 T00830028=

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[2254 EDT] METAR KSBN 300254Z 09008KT 10SM -RA OVC085 08/02 A3009 RMK AO2 RAB41 SLP194 P0000 60002 T00830017 50002=

[2354 EDT] METAR KSBN 300354Z 08009G18KT 10SM OVC075 08/01 A3009 RMK AO2 RAE43 SLP193 P0000 T00830011=

[0054 EDT] METAR KSBN 300454Z AUTO 09010KT 10SM OVC075 08/02 A3006 RMK AO2 RAB16E29 SLP183 P0000 T00780017 401391006=

[0154 EDT] METAR KSBN 300554Z AUTO 09012KT 10SM BKN065 BKN080 OVC120 08/02 A3000 RMK AO2 SLP162 60002 T00780017 10106 20078 58029=

KSBN weather at 2054 EDT, wind from 110° at 14 knots, 10 miles visibility, light rain, few clouds at 4,800 feet agl, few clouds at 6,000 feet agl, overcast ceiling at 9,000 feet agl, temperature of 9° C, dew point temperature of 1° C, and an altimeter setting of 30.11 inches of mercury. Remarks, station with a precipitation discriminator, peak wind from 110° at 26 knots at 2002 EDT, rain began at 2004 EDT, sea level pressure 1020.1 hPa, one-hourly precipitation of a trace, temperature 9.4° C, dew point temperature 1.1° C.

KSBN weather at 2154 EDT, wind from 050° at 6 knots, 10 miles visibility, overcast ceiling at 8,500 feet agl, temperature of 8° C, dew point temperature of 3° C, and an altimeter setting of 30.12 inches of mercury. Remarks, station with a precipitation discriminator, rain ended at 2135 EDT, sea level pressure 1020.3 hPa, one-hourly precipitation of 0.02 inches, temperature 8.3° C, dew point temperature 2.8° C.

KSBN weather at 2254 EDT, wind from 090° at 8 knots, 10 miles visibility, light rain, overcast ceiling at 8,500 feet agl, temperature of 8° C, dew point temperature of 2° C, and an altimeter setting of 30.09 inches of mercury. Remarks, station with a precipitation discriminator, rain began at 2241 EDT, sea level pressure 1019.4 hPa, one-hourly precipitation of a trace, 6-hourly precipitation of 0.02 inches, temperature 8.3° C, dew point temperature 1.7° C, 3-hourly pressure increase of 0.2 hPa.

KSBN weather at 2354 EDT, wind from 080° at 9 knots with gusts to 18 knots, 10 miles visibility, overcast ceiling at 7,500 feet agl, temperature of 8° C, dew point temperature of 1° C, and an altimeter setting of 30.09 inches of mercury. Remarks, station with a precipitation discriminator, rain ended at 2343 EDT, sea level pressure 1019.3 hPa, one-hourly precipitation of a trace, temperature 8.3° C, dew point temperature 1.1° C.

The observations from KFWA, KLAF and KSBN surrounding the accident time indicated VFR⁷ conditions around the accident site with light rain reported at KLAF and KSBN. The areas of light rain will be further examined in section 6.4. Gusty surface winds were reported at both KLAF and KFWA at and around the accident time with gusts as high as 30 knots at KFWA around 2028 EDT. The 1 minute ASOS data from KFWA was missing from March 24 at 0900 EDT through March 30 at 0130 EDT (attachment 1).

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

4.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR)⁸ model sounding was created for the accident site for 2200 EDT. The 2200 EDT sounding was plotted on a standard Skew-T log P diagram⁹ with the derived stability parameters included in figure 10 (with data from the surface to 600-hPa, or 14,000 feet msl.) This data was analyzed utilizing the RAOB¹⁰ software package. The sounding depicted the lifted condensation level (LCL)¹¹ at 3,271 feet and a convective condensation level (CCL)¹² of 15,899 feet. The freezing level was located at 10,393 feet. The precipitable water value was 0.66 inches.

⁸ The HRRR is a NOAA real-time three-kilometer resolution, hourly-updated, cloud-resolving, convection-allowing atmospheric model, initialized by three kilometer grids with three kilometer radar assimilation. Radar data is assimilated in the HRRR every 15 minutes over a one hour period.

⁹ Skew T log P diagram – is a standard meteorological plot using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

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

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

¹² 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.

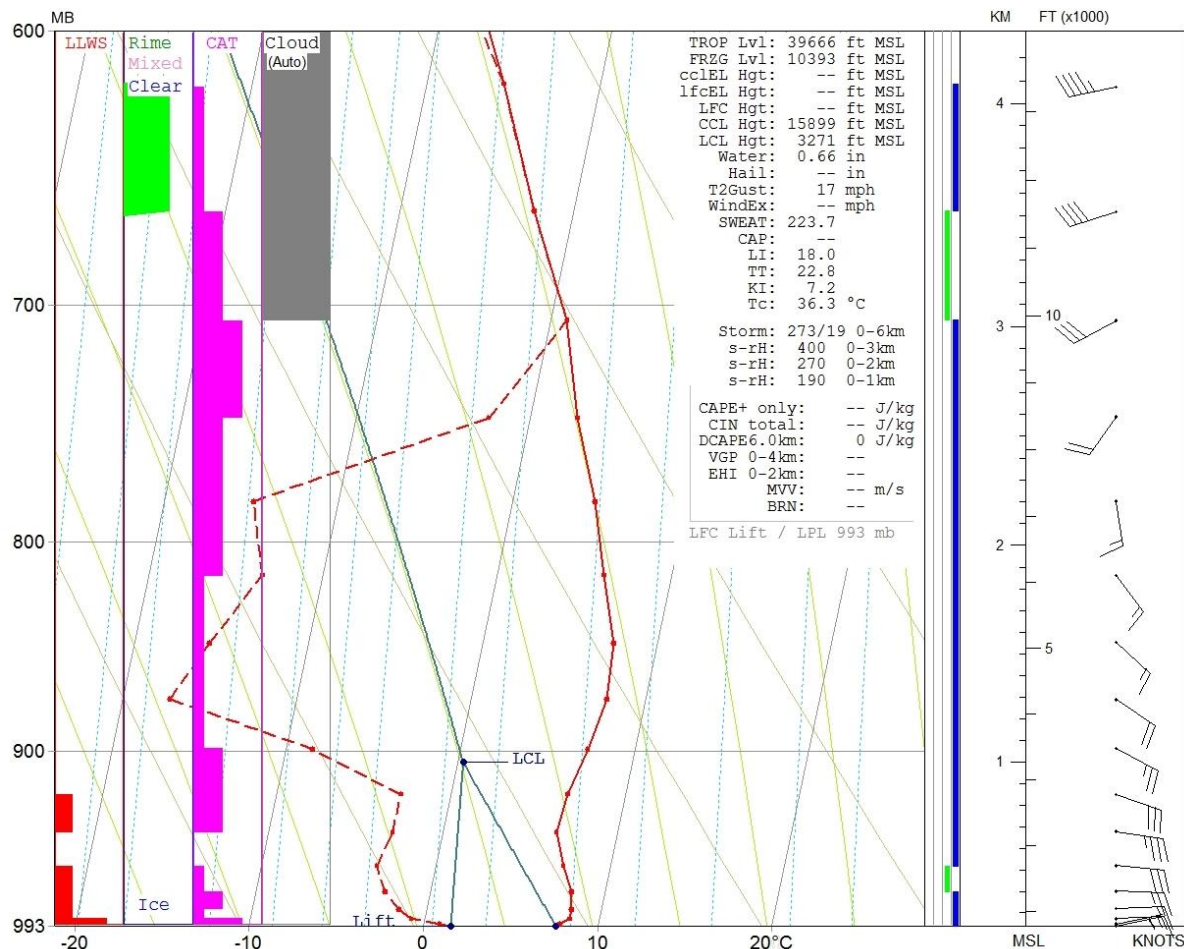


Figure 10 – 2200 EDT HRRR sounding for the accident site

The 2200 EDT HRRR sounding indicated a stable atmosphere below 10,000 feet. With the relatively dry atmosphere between the surface and 10,000 feet, RAOB indicated that clouds were likely above 10,000 feet. Rime icing was indicated by RAOB above 11,000 feet.

The 2200 EDT HRRR sounding wind profile indicated a surface wind from 078° at 7 knots with the wind increasing to 17 knots by 100 feet agl. The wind increased to 30 knots by 600 feet agl while remaining easterly. The wind veered (turned in a clockwise direction with height) between 2,000 feet msl and 14,000 feet. The wind speed remained between 15 and 45 knots between 2,000 feet and 14,000 feet. RAOB indicated the possibility of strong low-level wind shear (LLWS) between the surface and 2,500 feet, with clear-air turbulence possible between the surface and 11,500 feet.

5.0 Satellite Data

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 Man-computer Interactive Data Access System software. Infrared imagery (GOES-13 band 4) at wavelength of 10.7 microns was retrieved for the period. Satellite imagery surrounding the time of the accident, from 1900 EDT through 2300 EDT at approximately 15-minute intervals were reviewed, and the closest images to the time of the accident are documented here.

Figures 11 and 12 present the GOES-13 infrared imagery from 2145 and 2200 EDT at 4X magnification with the accident site highlighted with a red square. Inspection of the infrared imagery indicated cloud cover moving from southwest to northeast across the Ohio River Valley and the accident site. The lower brightness temperatures (green and blue colors, higher cloud tops) were located over Illinois, Wisconsin and western Indiana. Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 2200 EDT HRRR sounding, the approximate cloud-top heights over the accident site were estimated at 18,000 feet at 2200 EDT (figure 12). It should be noted these figures have not been corrected for any parallax error.

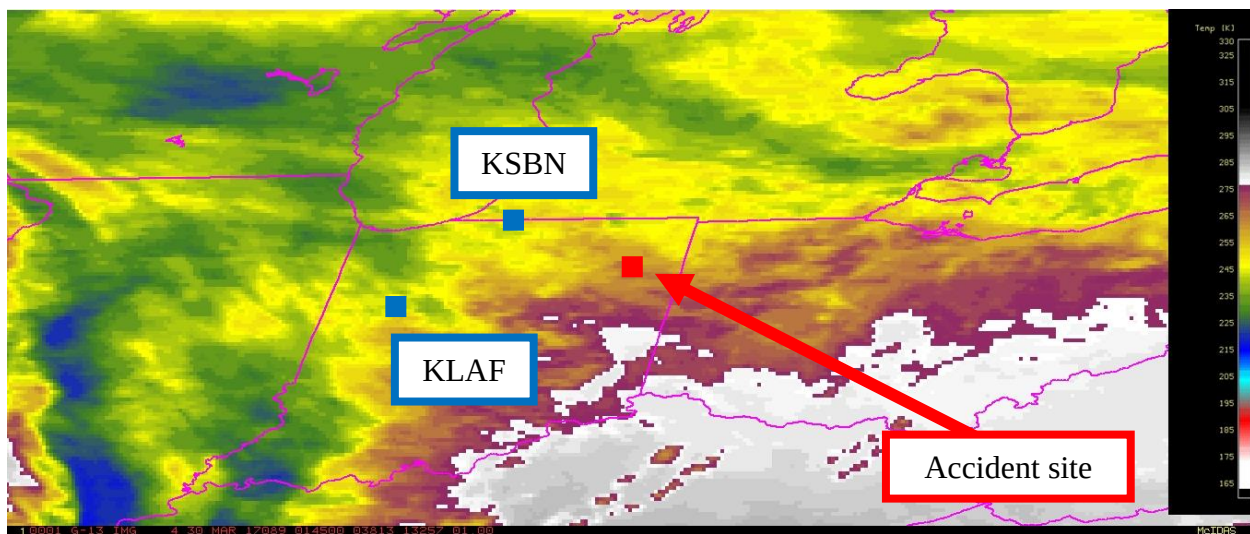


Figure 11 – GOES-13 infrared image at 2145 EDT

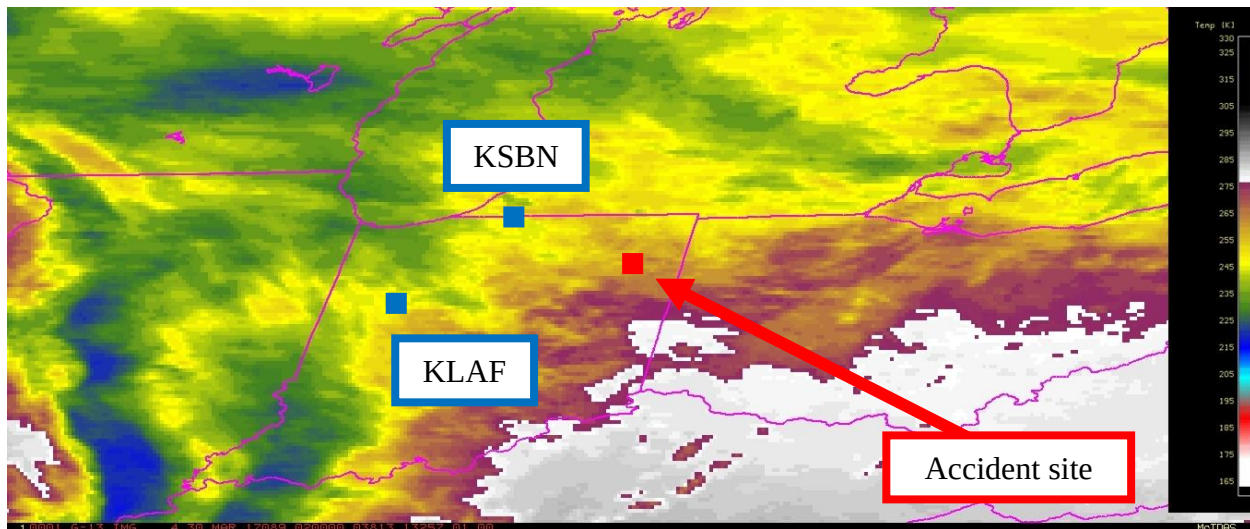


Figure 12 – GOES-13 infrared image at 2200 EDT

6.0 Radar Imagery Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)¹³ to the accident site was the Fort Wayne, Indiana, (KIWX) WSR-88D located 32 miles northwest of the accident site at 960 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.

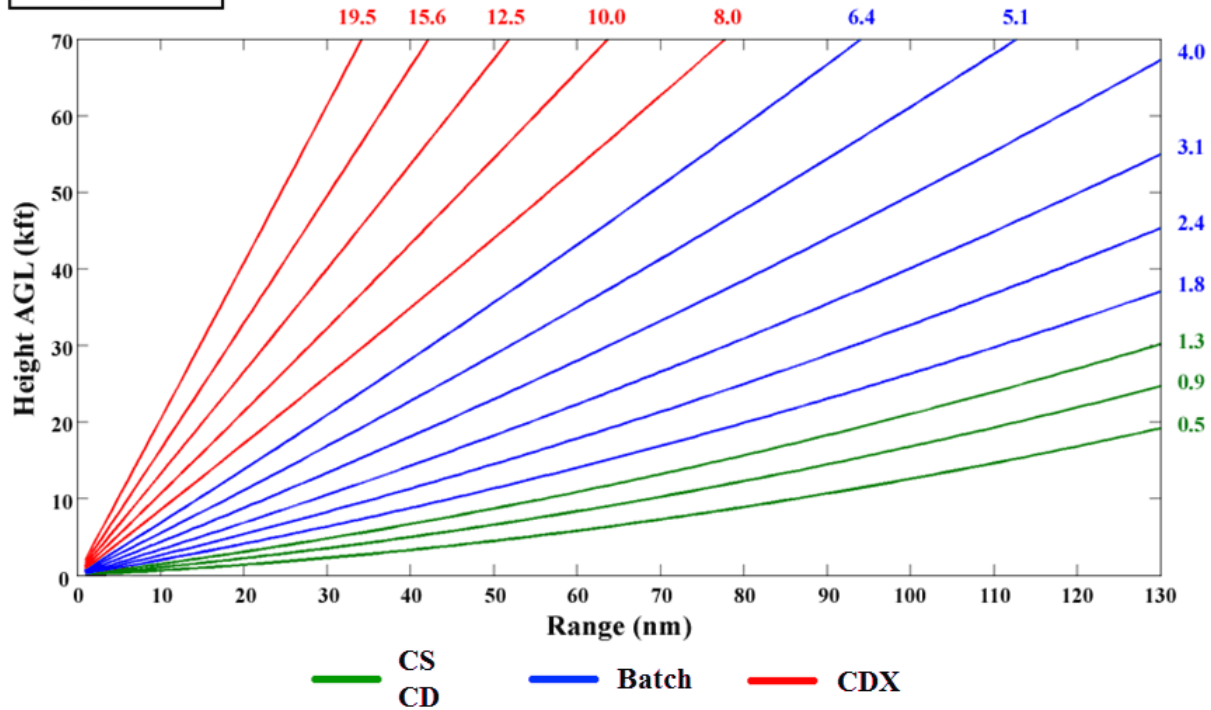
6.1 Volume Scan Strategy

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 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 KIWX 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.

¹³ 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 Strategy¹⁴

6.2 Beam Height Calculation

Assuming standard refraction¹⁵ of the WSR-88D 0.95° wide radar beam, the following table shows the approximate beam height and width¹⁶ information¹⁷ of the radar display over the site of the accident. The heights have been rounded to the nearest 10 feet.

¹⁴ 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)

¹⁵ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

¹⁶ Beam width – A measure of the angular width of a radar beam.

¹⁷ 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°	3,400 feet	1,820 feet	4,980 feet	3,160 feet

Based on the radar height calculations, the 0.5° elevation scan depicted the conditions between 1,820 feet and 4,980 feet msl over the accident site and these scans are the closest altitudes to the ground and accident site before the accident occurred.

6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors¹⁸ 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 (dBZ¹⁹), 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.

¹⁸ 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.

¹⁹ dBZ – A non-dimensional “unit” of radar reflectivity which represents a logarithmic power ratio (in decibels , or dB) with respect to radar reflectivity factor, Z.

6.4 Base Reflectivity and Lightning Data

Figures 13 and 14 present the KIWX WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 2155 and 2158 EDT with a resolution of 0.5° X 250 m. Base reflectivity values between -5 to 5 dBZ were located above the accident site around the accident time. These were likely non-precipitation targets above the accident site and KFWA, and likely associated with ground clutter given the low-level stable environment. The accident flight likely did not encounter any precipitation when flying from KLAF up to KFWA as the precipitation did not reach KLAF until around 2150 EDT (attachment 2 and section 3.0). There were no lightning strikes around the accident site at the accident time.²⁰

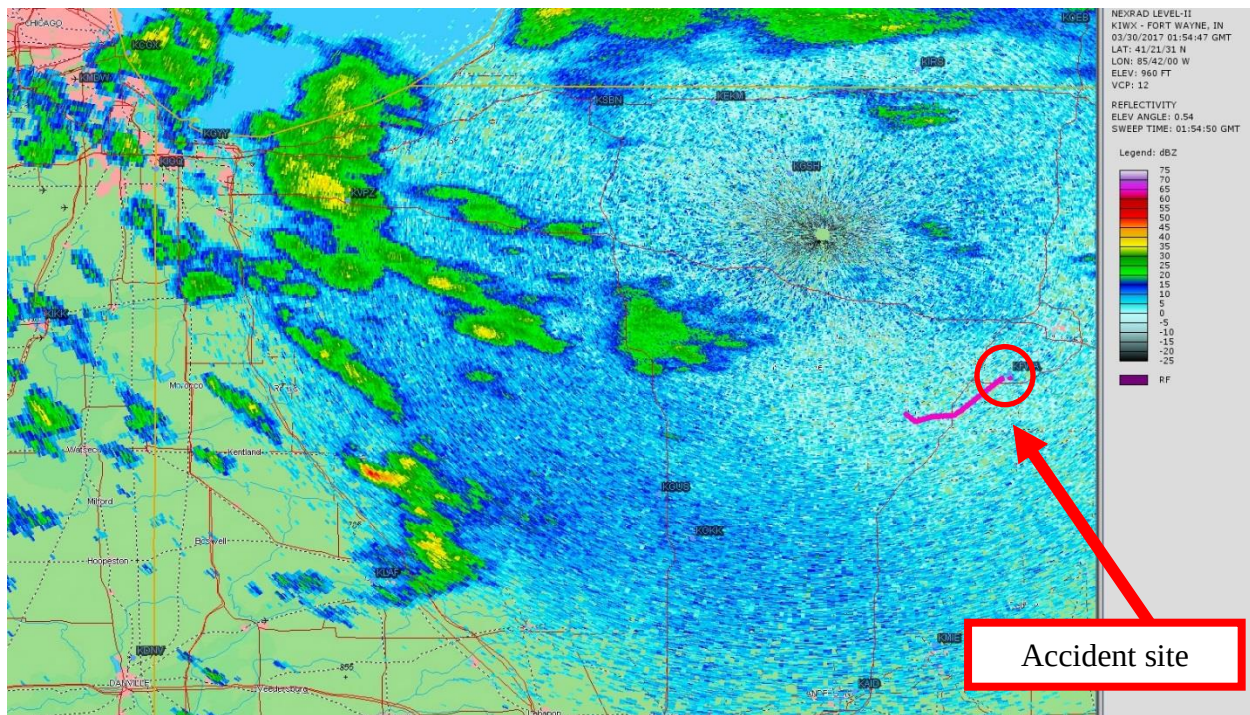


Figure 13 – KIWX WSR-88D reflectivity for the 0.5° elevation scan initiated at 2155 EDT with the accident site marked with red circle and the last 10 minutes of the ATC flight track as a pink line

²⁰ A review of Earth Networks Total Lightning network was done.

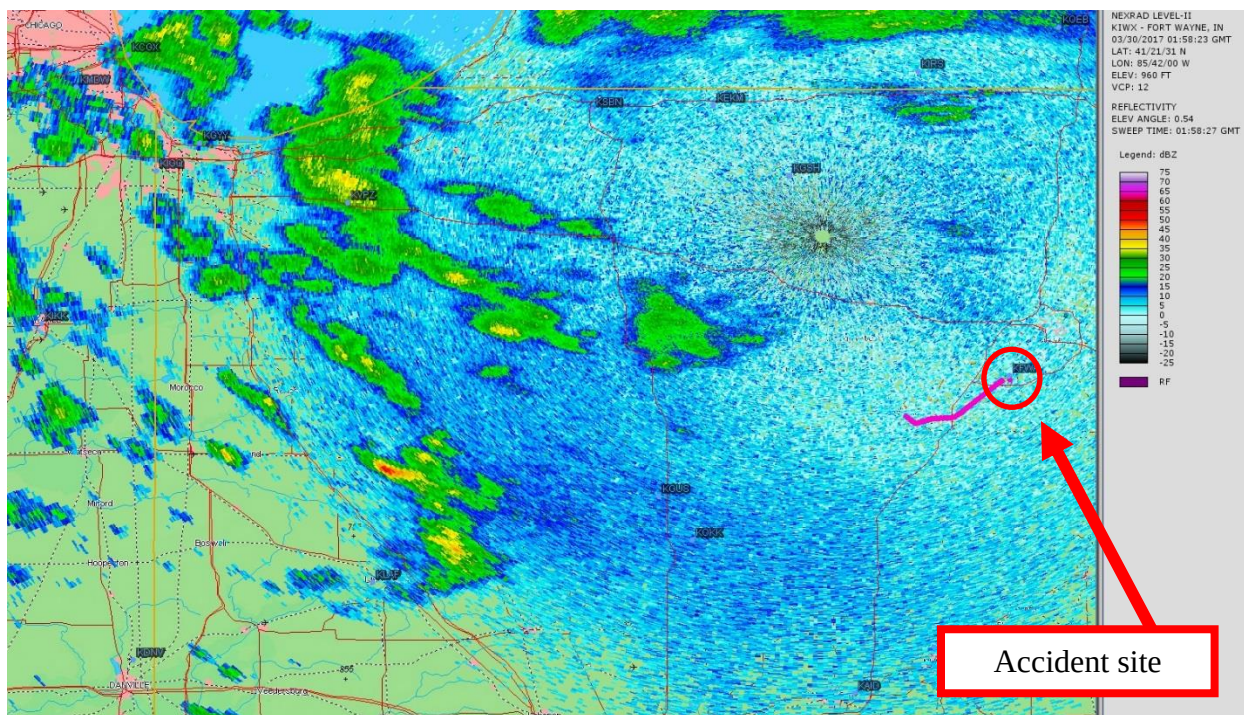


Figure 14 – KIWX WSR-88D reflectivity for the 0.5° elevation scan initiated at 2158 EDT with the accident site marked with red circle and the last 10 minutes of the ATC flight track as a pink line

7.0 Pilot Reports²¹

All pilot reports (PIREPs) close to the accident site from three hours prior to the accident time to three hours after the accident time were reviewed. Only PIREPs for below FL180²² are provided below:

IND UA /OV VHP360020/TM 2341/FL130/TP BE20/TA M05/IC LGT RIME 130-150=

GRR UA /OV PMM270025/TM 0018/FL140/TP E50P/TA M5/IC TRACE MX=

GRR UA /OV GRR /TM 0106 /FL030 /TP P28A /TB LGT CHOP BLO 030 /RM DURD=

GRR UA /OV MOP-GRR /TM 0226 /FL045 /TP C172 /SK OVC065 /TB NEG 055-045 /RM SMOOTH RIDE=

TEW UA /OV 49G135009 /TM 0241 /FL030 /TP P28A /WX -RA /TA 05 /IC NEG=

Routine pilot report (UA); 20 miles from Indianapolis, Indiana, on the 360° radial; Time – 1941 EDT (2341Z); Altitude – 13,000 feet; Type aircraft – Beech King Air 200; Temperature – -5° C; Icing – Light rime between 13,000 and 15,000 feet.

²¹ Only pilot reports with the WMO header UBMI**, UBIN**, and UBOH** identifier were considered.

²² 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); 25 miles from Pullman, Michigan, on the 270° radial; Time – 2018 EDT (0018Z on March 30); Altitude – 14,000 feet; Type aircraft – Embraer Phenom 100; Temperature – -5° C; Icing – Trace mixed.

Routine pilot report (UA); Over Grand Rapids, Michigan; Time – 2106 EDT (0106Z on March 30); Altitude – 3,000 feet; Type aircraft – Piper PA-28 Cherokee; Turbulence – Light chop below 3,000 feet; Remarks – During descent.

Routine pilot report (UA); Between Mount Pleasant and Grand Rapids, Michigan; Time – 2226 EDT (0226Z on March 30); Altitude – 4,500 feet; Type aircraft – Cessna 172; Sky – Overcast skies at 6,500 feet; Turbulence – Negative between 5,500 and 4,500; Remarks – Smooth ride.

Routine pilot report (UA); 9 miles from Charlotte, Michigan, on the 135° radial; Time – 2241 EDT (0241Z on March 30); Altitude – 3,000 feet; Type aircraft – Piper PA-28 Cherokee; Weather – Light rain; Temperature – 5° C; Icing – Negative.

8.0 SIGMET and CWSU Advisory

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

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

9.0 AIRMETs

No Airmen's Meteorological Information (AIRMET) advisories were valid for the accident site at the accident time for below 5,000 feet.

10.0 Area Forecast

The Area Forecast issued at 2145 EDT, valid at the accident time, forecast a broken ceiling between 8,000 and 10,000 feet with tops at 16,000 feet and broken cirrus above. Scattered light rain showers were not forecast for Indiana until 0500 EDT on March 30. The Area Forecast issued at 1445 EDT on March 29 forecast a broken ceiling at 9,000 feet with layered clouds through FL250 after 2100 EDT:

IN

SW...SCT035 BKN CI. 23Z BKN060 LYRD FL250. OTLK...VFR 10Z MVFR
CIG TSRA.

RMNDR...SCT150 BKN CI. 01Z BKN090 LYRD FL250. OTLK...VFR SHRA.

FAUS43 KNCI 300145

FA3W

-CHIC FA 300145

SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 302000
CLDS/WX VALID UNTIL 301400...OTLK VALID 301400-302000
ND SD NE KS MN IA MO WI LM LS MI LH IL IN KY

.
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...02Z LOW 30N OSW WITH CDFNT ALG A 30N OSW-RZC-GGG LN.
WRMFNT ALG A 30N OSW-STL-BNA-GQO LN. 20Z LOW INVOF COU WITH CDFNT
ALG A COU-DEC-30E DYR LN. WRMFNT ALG A DEC-BVT-40W HNN-40NW ODF
LN.

.
ND
W QTR...SCT130 BKN CI. 11Z SCT-BKN110 TOPS 150. OTLK...VFR.
CNTRL HLF...BKN-SCT080 TOPS 120. 06Z SCT070 SCT100. OTLK...VFR.
E QTR...SCT CI. 11Z SCT-BKN090 TOPS 120. OTLK...VFR.

.
SD
W THIRD...SCT090. 09Z SCT050 SCT CI. OCNL VIS 3SM BR. OTLK...VFR.
CNTRL THIRD...SCT080. OTLK...VFR.
NERN...BKN-SCT060 TOPS 080 BKN CI. BECMG 0710 BKN025. OCNL VIS
4SM BR. OTLK...VFR WRN SXNS...IFR CIG BECMG AFT 18Z MVFR CIG ERN
SXNS.
SERN...BKN025 TOPS 120 OVC CI. TIL 05Z WDLY SCT -SHRA EXTRM SERN.
OTLK...VFR.

.
NE
PNHDL...SCT080. OTLK...VFR.
RMNDR W HLF...BKN050 TOPS 080 BKN CI. BECMG 0710 SCT050 BKN CI.
OCNL VIS 5SM BR. OTLK...VFR.
E HLF...OVC025 TOPS 150. OCNL VIS 5SM -RA. OTLK...IFR CIG SHRA
18Z MVFR CIG.

.
KS
W QTR...BKN060 TOPS 100. 08Z VIS 4SM BR. OTLK...IFR CIG BR 17Z
VFR.
RMNDR W HLF...OVC030 LYRD FL200. OCNL VIS 5SM -RA BR. WND NLY
20G35KT. BECMG 0609 OVC030 TOPS 140. OTLK...MVFR CIG WND.
E QTR...SCT020 BKN050-060 TOPS 090. WDLY SCT -TSRA. CB TOPS
FL400. BECMG 0407 BKN025. WDLY SCT -TSRA. OTLK...IFR CIG SHRA BR.
RMNDR E HLF...OVC025 TOPS 150. VIS 4SM IN SCT -SHRA BR. ISOL
-TSRA. CB TOPS FL400. OTLK...IFR CIG SHRA.

.
MN
NW QTR...SCT-BKN CI. OTLK...VFR.
NERN QTR...SCT-BKN120 TOPS 150 OVC CI. 10Z OCNL VIS 5SM BR. BECMG
0811 SCT020 SCT100. OCNL VIS 5SM BR. OTLK...VFR.
SW QTR...BKN025 OVC060 TOPS 120. OCNL -RA SRN SXNS. OTLK...MVFR
CIG THRUT...TIL 18Z RA SRN SXNS.
SE QTR...SCT020 OVC035 LYRD FL180. OCNL VIS 4SM -RA MAINLY SRN
SXNS. OTLK...MVFR CIG THRUT EXC IFR CIG SHRA SRN SXNS.

.
IA
N HLF...OVC020 TOPS 150. VIS 4SM -RA. OTLK...IFR CIG THRUT...RA

ERN SXNS.

S HLF...BKN020 TOPS 150. OCNL VIS 3SM IN SCT -SHRA. ISOL -TSRA.
CB TOPS FL400. OTLK...IFR CIG SHRA.

.

MO

N HLF...BKN030 TOPS 130. SCT -TSRA. TS POSS SEV SRN SXNS. CB TOPS
FL450. 07Z OVC020. SCT -SHRA. WDLY SCT -TSRA. OTLK...IFR CIG TSRA
NRN SXNS...MVFR CIG TSRA SRN SXNS.

S HLF...BKN-SCT060 LYRD FL220. WDLY SCT -TSRA...POSS SEV. CB TOPS
FL450. BECMG 0710 BKN030 TOPS 080. OCNL VIS 4SM BR. WDLY SCT
-TSRA ERN SXNS. OTLK...MVFR CIG RA WRN SXNS...MVFR CIG TSRA WND
ERN SXNS.

.

WI

N THIRD...OVC100 LYRD FL350. BECMG 0609 SCT-BKN070 BKN110. OCNL
-SN. OTLK...VFR.

CNTRL THIRD...BKN040 BKN070 LYRD FL200 BKN CI. OCNL VIS 4SM
-RASN. OTLK...MVFR CIG RASN THRUT EXC IFR CIG RASN ERN SXNS.

S THIRD...SCT035 OVC050 LYRD FL200 OVC CI. OCNL -RA. BECMG 0710
OVC020. VIS 3SM RA BR. WND E G25KT ERN SXNS. OTLK...MVFR CIG WRN
SXNS...IFR CIG RA BR WND ERN SXNS.

.

LS UPR MI

SCT-BKN150 TOPS FL200 BKN CI. OTLK...VFR.

.

LM LWR MI LH

N HLF...OVC120 LYRD FL270. BECMG 0710 SCT035 SCT-BKN050. OCNL VIS
5SM -RASN. OTLK...MVFR CIG RASN WRN SXNS...VFR SHRASN ERN SXNS.
SW QTR...BKN100 LYRD FL270. BECMG 0508 OVC050. OCNL VIS 4SM -RA
BR. 10Z OVC020. VIS 3SM RA BR. OTLK...IFR CIG RA BR WND.

SE QTR...BKN080 LYRD FL270. 11Z SCT030 OVC050. OCNL -RASN.
OTLK...MVFR CIG RASN.

.

IL

SCT025 BKN045 TOPS 170. WDLY SCT -SHRA NRN SXNS. BECMG 0609
BKN030. SCT -SHRA/-TSRA. CB TOPS FL400.OTLK...IFR CIG SHRA NRN
SXNS... MVFR CIG TSRA SRN SXNS.

.

IN

**BKN080-100 TOPS 160 BKN CI. 09Z BKN030 OVC050. SCT -SHRA. WDLY
SCT -TSRA. CB TOPS FL400. OTLK...MVFR CIG TSRA.**

.

KY

WRN...SCT-BKN050 BKN100 TOPS 130 BKN CI. 09Z BKN035. SCT -TSRA.
CB TOPS FL400. OTLK...VFR TSRA.

CNTRL...SCT-BKN100 TOPS 130. 06Z SCT-BKN050 BKN100. OTLK...VFR
TSRA.

ERN...SCT CI. 09Z BKN-SCT100 TOPS 130. OTLK...VFR 18Z TSRA.

....

FAUS43 KPCI 291845

FA3W

-CHIC FA 291845

SYNOPSIS AND VFR CLDS/WX

SYNOPSIS VALID UNTIL 301300

CLDS/WX VALID UNTIL 300700...OTLK VALID 300700-301300

ND SD NE KS MN IA MO WI LM LS MI LH IL IN KY

.
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...LOW PRES SYS NERN OK. HIGH PRES THRUT GRTLKS FCST TO
PERSIST THRU PD. 13Z LOW PRES SYS CNTRL MO WITH TROF CNTRL MO-SW
MN. CDFNT CNTRL MO-S CNTRL MO. WRMFNT CNTRL MO-CNTRL IL-SW
IN-SERN KY.

.
ND
W 2/3...BKN050 TOP 080. BKN CI. 20Z SCT060 BKN CI. OTLK...VFR.
E 1/3...SCT060 BKN CI. 20Z SCT-BKN100 LYRD FL250. BKN CI.
OTLK...VFR.

.
SD
W 1/3...BKN080 TOP 150. BKN CI. 23Z SCT150 BKN CI. OTLK...VFR.
RMNDR...
N HLF...BKN CI. OTLK...MVFR CIG.
S HLF...BKN050 LYRD FL250. TIL 00Z SCT -SHRA. 03Z BKN030.
OTLK...MVFR CIG 10Z IFR CIG BR.

.
NE
PNHDL...BKN040-050 TOP FL200. WND NE G25KT. 01Z SCT-BKN CI.
OTLK...VFR.
N CNTRL-NW...BKN035 LYRD FL250. 22Z BKN110. BECMG 0305 SCT150 BKN
CI. OTLK...VFR 10Z IFR BR.
RMNDR...CIG OVC010-015 TOP FL250. VIS 3SM SCT/NMRS -SHRA. WND NE
G25KT. OTLK...SWRN PTNS MVFR CIG ELSW IFR CIG BR SHRA.

.
KS
W HLF...OVC050 TOP FL250. WND N 25G35KT. VIS 3SM NMRS -SHRA. 06Z
BKN065. WND N G25KT. OTLK...VFR 09Z MVFR BR.
NERN...OVC020-025 TOP FL250. SCT -SHRA. AFT 21Z WDLY SCT -TSRA.
CB TOP FL440. OTLK...IFR CIG SHRA BR.
SE...BKN040 LYRD FL250. WDLY SCT -TSRA/-SHRA. CB TOP FL450. TS
POSS SEV. 02Z OVC060-070. VIS 3-5SM NMRS -SHRA. AFT 06Z OVC030.
OTLK...IFR CIG SHRA BR.

.
MN
N HLF...BKN CI. OTLK...VFR ERN PTNS 09Z MVFR CIG BR.
SW...SCT050 BKN080 LYRD FL250. WDLY SCT -SHRA. BECMG 0103 OVC030.
VIS 3SM SCT/NMRS -SHRA. OTLK...IFR CIG RA BR.
SE...BKN100 LYRD FL250. WDLY SCT -SHRA. 23Z OVC045. VIS 3-5SM -RA
BR. OTLK...MVFR CIG SHRA 10Z IFR CIG BR RA.

.
IA
NERN...SCT040 BKN060 LYRD FL250. VIS 3SM SCT -SHRA. 20Z OVC035.
VIS 3SM -RA BR. WND E G25KT. 05Z OVC020. OTLK...IFR CIG RA BR.
XTRM NW...BKN045-055 LYRD FL250. TIL 00Z SCT -SHRA. 03Z BKN030.
OTLK...MVFR CIG 10Z IFR CIG BR.
RMNDR...CIG OVC010-015 TOP FL250. WDSPRD VIS 3SM -RA BR. TIL 00Z
WND E G25KT. AFT 23Z WDLY SCT EMBD -TSRA POSS. CB TOP FL300.
OTLK...IFR CIG RA BR.

MO

N HLF...OVC025-035 TOP FL250. WDLY SCT -SHRA. AFT 22Z SCT-TSRA.
CB TOP FL440. TS MAY BE SVR. OTLK...MVFR CIG TSRA SHRA BR.
SW...SCT030 BKN090 LYRD FL250. AFT 20Z WDLY SCT/SCT -TSRA/-SHRA.
CB TOP ABV FL450. TS POSS SEV. OTLK...MVFR CIG TSRA 10Z IFR CIG
SHRA BR.
SE...BKN040 LYRD FL250. WDLY SCT -SHRA. 20Z BKN050. WDLY SCT/SCT
-TSRA/-SHRA. CB TOP ABV FL450. TS POSS SEV. OTLK...MVFR CIG TSRA
SHRA.

.

WI

N HLF...BKN CI. 22Z BKN100 LYRD FL250. 00Z SCT060-080 BKN120 LYRD
FL250. 03Z OVC060. SCT VIS 3-5SM -SHRA. OTLK...MVFR CIG RA BR.
S HLF...SCT060 OVC120 TOP FL250. WDLY SCT -SHRA. AFT 20Z
OVC060-080. BECMG 0204 OVC040. VIS 3-5SM -RA BR. OTLK...MVFR CIG
RA BR 11Z IFR CIG RA BR.

.

LS UPR MI

SCT-BKN150 LYRD FL250. BKN CI. OTLK...VFR.

.

LM LWR MI LH

E HLF...SCT040 SCT-BKN150 LYRD FL250. BKN CI. 01Z OVC120.
OTLK...VFR.
NW...SCT050 SCT-BKN120 LYRD FL250. BKN CI. 02Z BKN110.
OTLK...VFR.
SW...BKN120 LYRD FL250. BKN CI. 00Z OVC060. 06Z OVC030. VIS 3-5SM
-RA BR. OTLK...MVFR CIG RASN BR.

.

IL

N 1/3...OVC075 LYRD FL250. SCT -SHRA. ISOL/WDLY SCT -TSRA. CB TOP
FL290. BECMG 0406 OVC030. VIS 3SM SCT/NMRS -SHRA. WND E G25KT.
OTLK...IFR CIG SHRA TSRA WND.
RMNDR...BKN030 LYRD FL250. WDLY SCT -SHRA. ISOL -TSRA. CB TOP
FL290. 01Z OVC025. VIS 3-5SM SCT/NMRS -SHRA. WDLY SCT -TSRA. CB
TOP FL440. TS POSS SEV ESPY SRN PTNS. OTLK...IFR CIG TSRA SHRA
BR.

.

IN

SW...SCT035 BKN CI. 23Z BKN060 LYRD FL250. OTLK...VFR 10Z MVFR
CIG TSRA.
RMNDR...SCT150 BKN CI. 01Z BKN090 LYRD FL250. OTLK...VFR SHRA.

.

KY

W 1/3...SCT-BKN050 TOP 080 BKN CI. 23Z BKN050-060 LYRD FL250.
OTLK...VFR TSRA.
RMNDR...BKN035 TOP 080. 20Z SCT030 BKN CI. 04Z BKN150 LYRD FL250.
OTLK...VFR.

....

11.0 Terminal Aerodrome Forecast

KFWA 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 1927 EDT, and was valid for a 24-hour period beginning at 2000 EDT. The TAF for KFWA was as follows:

TAF KFWA 292327Z 3000/3024 **07016KT P6SM BKN120 OVC200**
FM301000 09013KT P6SM -SHRA OVC050
FM301200 09014KT 6SM -SHRA OVC025
FM301500 10014KT 4SM SHRA VCTS OVC015CB
FM302200 16012KT P6SM -SHRA VCTS OVC035CB=

The forecast expected a wind from 070° at 16 knots, greater than 6 miles visibility, broken ceiling at 12,000 feet agl, and overcast skies at 20,000 feet agl.

The 1330 EDT KFWA TAF was valid for a 24-hour period beginning at 1400 EDT. The 1330 EDT TAF for KFWA was as follows:

TAF KFWA 291730Z 2918/3018 **09013KT P6SM FEW150 SCT200**
FM300300 08013KT P6SM BKN110
FM300900 09013G22KT P6SM VCSH OVC070
FM301200 09012G23KT 6SM SHRA BR OVC045
FM301400 10012G22KT 5SM SHRA BR OVC015=

The forecast expected a wind from 090° at 13 knots, greater than 6 miles visibility, few clouds at 15,000 feet agl, and scattered clouds at 20,000 feet agl.

KLAF was the departure airport and had a TAF valid at the time of the accident that was issued at 1920 EDT, and was valid for a 24-hour period beginning at 2000 EDT. The TAF for KLAF was as follows:

TAF KLAF 292320Z 3000/3024 **09016KT P6SM OVC100**
FM300700 09012KT P6SM VCTS OVC060CB
FM301100 11013KT 6SM -SHRA VCTS OVC035CB
FM301200 11012KT 5SM -SHRA VCTS OVC030CB
FM301500 11011KT 3SM -SHRA VCTS OVC015CB
FM301800 13010KT 4SM SHRA VCTS OVC010CB
FM302000 14009KT P6SM SHRA VCTS OVC040CB=

The forecast expected a wind from 090° at 16 knots, greater than 6 miles visibility, an overcast ceiling at 10,000 feet agl. No rain or thunderstorm activity was forecast near KLAF until 0300 EDT on March 30.

The 1322 EDT KLAF TAF was valid for a 24-hour period beginning at 1400 EDT. The 1322 EDT TAF for KLAF was as follows:

TAF KLAF 291722Z 2918/3018 09014G21KT P6SM SCT080 BKN250
FM292300 08013KT P6SM BKN090
FM301000 09011KT P6SM VCSH OVC050
FM301200 10010KT P6SM OVC030
FM301400 10011KT 4SM -SHRA OVC020=

The forecast expected a wind from 080° at 13 knots, greater than 6 miles visibility, and a broken ceiling at 9,000 feet agl. No rain or thunderstorm activity was forecast near KLAF until 0600 EDT on March 30.

12.0 NWS Area Forecast Discussion

The NWS office in Northern Indiana issued the following Area Forecast Discussion (AFD) at 1933 EDT (closest AFD to the accident time with an aviation section). The aviation section of the AFD discussed VFR conditions persisting through the early morning hours, with lower ceilings and precipitation expected during the morning hours of March 30:

913
FXUS63 KIWX 292333
AFDIWX

Area Forecast Discussion
National Weather Service Northern Indiana
733 PM EDT Wed Mar 29 2017

.SYNOPSIS...
Issued at 330 PM EDT Wed Mar 29 2017

Rain will return to the area late tonight and persist through Thursday evening. Rainfall amounts will be around an inch for most locations. This may cause some minor flooding in low lying areas. Thunderstorms are also possible tomorrow...primarily from late afternoon through the evening. There is a low chance for severe storms south of highway 30 during this time. Rain showers continue on Friday but dry conditions expected over the weekend. Highs on Thursday will range from the 40s across Michigan to the low 60s across central Indiana. Highs Friday into the weekend will generally be in the 50s.

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.SHORT TERM...(This Evening through Tonight)
Issued at 330 PM EDT Wed Mar 29 2017

Quiet weather will continue through the evening as ridge axis downstream of potent upper low folds over our area. Decaying convection presently over Illinois will struggle to reach our CWA given persistent E/SE flow until after 06Z tonight and very dry air aloft noted in 12Z KDTX and KILN soundings. Radar mosaic looks decent but ceilings are 6-10 kft. A stray sprinkle may survive into our NW third this evening but best chances for rain will hold off until after 09Z when nose of southwesterly LLJ and associated theta-e surge arrive. Clouds will obviously be on the increase overnight but late arrival of veering winds and good warm/moist air advection should still allow overnight lows to drop into the upper 30s to low 40s. No concern for mixed precip, even in far NE counties where lows may touch mid 30s.

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.LONG TERM...(Thursday Night through Wednesday)
Issued at 330 PM EDT Wed Mar 29 2017

Rain and severe weather chances tomorrow are primary story for this forecast package. Another very moist airmass is being drawn north by this high amplitude southern stream wave. 850mb dewpoints hover around 10C with PW values around 1.25 inches. Meanwhile, plenty of dynamical support for UVM with coupled upper jet streaks (for a time), diffluence aloft, and ample midlevel CVA/height falls. 295K isentropic fields are correspondingly impressive in the AM WAA wing with 40kts of sharp cross-isobar flow and mixing ratios climbing above 6 g/kg. Rain virtually assured...though likely won't be steady through the whole day. Suspect a brief break in heavier rain in the early afternoon...between morning WAA/theta-e surge and evening arrival of CVA bullseye and associated surface low/convergent boundary. Storm total QPF anticipated to be around an inch for many locations. Some minor/nuisance flooding may be possible in typical low-lying areas given recent wet conditions but ground should be able to absorb this rain without significant impacts. Latest river forecasts holding in action stage at worst.

Severe weather threat appears low. As is typically the case in these events, low to midlevel wind/shear values are more than adequate with 40kt LLJ but destabilization remains highly questionable. Latest guidance continues to hold surface warm front over our southern CWA with ample clouds/precip earlier in the day to limit surface-based destabilization. If there is a sufficient break after midday precip, our far southern counties may destabilize enough to support a few strong storms in the 21-03Z period. However, amplified/cutoff nature of parent trough suggests a slightly later arrival of WAA precip (possibly mid-afternoon in eastern zones) that will leave a very narrow window for sufficient diurnal heating. Hail would be the main threat although isolated wind and tornadoes cannot be entirely ruled out if instability axis creeps far enough north. Certainly worth watching for our southern counties but threat does appear low at this point.

Sporadic rain showers will continue through Friday as vort lobe and deformation axis move overhead. Rainfall amounts during this period will be much lighter and more scattered. Weekend looks much more pleasant as ridge builds over the region. Not much CAA to speak of, so high temps will hold generally in the 50s Fri-Sun, near average for this time of year.

Wet pattern looks to continue into next week with one chance of rain on Monday and another Wed/Thu. Still plenty of details to iron out but looks favorable for several chances of decent rainfall. Temps may be a touch warmer but no significant deviations from climo expected at this time.

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**.AVIATION...(For the 00Z TAFS through 00Z Thursday Evening)
Issued at 728 PM EDT Wed Mar 29 2017**

VFR conditions look to persist through the evening and most of the overnight hours but conditions expected to begin deteriorating toward daybreak. Latest Hires model guidance showing several waves of pcpn with best chance for restrictions coming toward daybreak

into mid day Thursday with IFR expected. NAM 3km and RAP models want to bring warm front north a bit faster than spectral and other hires guidance with boundary to near the US30 corridor by 21z. This would bring warm sector and more mixed conditions into KFWA late in the period with wind shift to south and strong tsra chances. Trended winds a bit more southerly but holding onto more of a model mean at this point. Morning rain and strong easterly low level flow north of warm front could reinforce cold air and retard northward movement.

&&

.IWX WATCHES/WARNINGS/ADVISORIES...

IN...NONE.

MI...NONE.

OH...NONE.

LM...Small Craft Advisory from 4 AM to 4 PM EDT Thursday for LMZ043-046.

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13.0 Winds and Temperature Aloft Forecast

The NWS 1602 EDT Winds and Temperature Aloft forecast (for use between 1600 and 2300 EDT) valid for the accident flight are included below:

924

FBUS31 KWN0 292002

FD1US1

-DATA BASED ON 291800Z

VALID 300000Z FOR USE 2000-0300Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
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FWA	0931	1313+05	2308+02	2536-02	2560-15	2542-26	264441	274251	265561
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The accident site was closest to the FWA/KFWA forecast point. The 1602 EDT FWA forecast indicated a wind at 3,000 feet from 090° at 31 knots and a wind at 6,000 feet from 130° at 13 knots with a temperature of 5° C.

14.0 Pilot Weather Briefing

A search of official weather briefing sources, such as Lockheed Martin Flight Service (LMFS), Leidos weather briefings, and Direct User Access Terminal Service (DUATS) was done. The accident pilot and passenger, who was a certified flight instructor (CFI), received several official weather briefings prior to the accident flight. The FAA's PilotWeb service provided the first weather briefing information at 1506 EDT with the standard weather forecast information valid at 1506 EDT (attachment 3). The 1506 EDT weather briefing did not contain any type METAR or TAF information from KFWA or KSBN. Another weather briefing was received via Garmin at 1818 EDT, which included all the standard weather forecast information valid at 1818 EDT (attachment 4). The 1818 EDT weather briefing did contain the METAR and TAF information from KFWA and KSBN valid for 1818 EDT. The third weather briefing was request by just the accident pilot at 1934 EDT from DUATS and the DUATS weather briefing contained all the standard weather information including the METARs and TAFs from KSBN and KFWA (attachment 5). Along with the text information provided in attachments 2, 3, and 4, graphical weather information would have also been available to the pilot, but that graphical information is not archived at this time (attachment 6). When the accident pilot opened his flight plan at 2105 EDT (attachment 7), he received the latest AIRMET (described as "mid-level icing").

A search of ForeFlight weather information revealed that the accident pilot did not request a weather briefing using ForeFlight Mobile prior to the flight. It is unknown if the accident pilot checked or received any other weather information before or during the accident flight.

15.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for the accident site on March 29, 2017, indicated the following:

SUN

Begin civil twilight	0701 EDT
Sunrise	0728 EDT
Sun transit	1345 EDT
Sunset	2003 EDT
End civil twilight	2030 EDT

MOON

Moonrise	0840 EDT
Moon transit	1517 EDT
Moonset	2204 EDT

The phase of the Moon was Waxing Crescent with 3% of the Moon's visible disk illuminated. With the extensive cloud cover above the accident site at the accident time, the Moon would not likely have been visible.

E. LIST OF ATTACHMENTS

Attachment 1 – 1 minute ASOS data from KFWA missing around the accident time

Attachment 2 – KIWX WSR-88D reflectivity for the 0.5° elevation scan animation from 2057 EDT to 2202 EDT with the ATC flight track (pink dots)

Attachment 3 – PilotWeb text weather briefing information from 1506 EDT

Attachment 4 – Garmin text weather briefing information from 1818 EDT

Attachment 5 – DUATS weather briefing information from 1934 EDT

Attachment 6 – Email containing weather briefing information

Attachment 7 – Audio of opening flight plan and weather information provided at 2105 EDT

Submitted by:

Paul Suffern
Senior Meteorologist

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