NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

May 7, 2019

Weather Study

METEOROLOGY

CEN19FA100

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A. ACCIDENT

Location: Plain City, Ohio
Date: March 17, 2019
Time: about 1745 eastern daylight time (2145 UTC)[1]
Aircraft: C421; N424TW

B. METEOROLOGIST

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C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's meteorological specialist did not travel in support of this accident investigation and gathered all weather data remotely. Unless otherwise noted, all times are in eastern daylight time (EDT) for March 17, 2019 (based upon the 24-hour clock), directions are referenced to true north, distances are in nautical miles and heights are above mean sea level (msl).

Coordinates used for the accident location: 40.19640278° north latitude, 83.19726111° west longitude, at an elevation of about 970 feet.

D. WEATHER INFORMATION

1.0 Surface Observations

An Automated Weather Observing System (AWOS) was located at Delaware Municipal Airport/Jim Moore Field (DLZ) [2] in Delaware, Ohio, which was located about 6 miles northeast of the accident location at an elevation of about 945 feet. Automated reports from DLZ during the times surrounding the accident time are presented here.

[1716 EDT] METAR KDLZ 172116Z AUTO 00000KT 1 1/2SM -SN SCT007 OVC016 01/00 A3020 RMK AO2=

[1] UTC – abbreviation for Coordinated Universal Time
[2] The National Weather Service (NWS) uses the 4-digit International Civil Aviation Organization (ICAO) format for station identifiers (as seen in the body of some formatted weather observations). This report uses the 3-digit International Air Transport Association format for station identification, which does not use the geographic designating digit ("K" for stations in the continental U.S. and "P" for U.S. stations in Alaska and the Pacific region) as found in the ICAO format.

[1735 EDT] METAR KDLZ 172135Z AUTO 08003KT 3SM -SN SCT004 OVC016 01/00 A3020 RMK AO2=

[1755 EDT] METAR KDLZ 172155Z AUTO 11005KT 3SM -SN BKN006 OVC011 00/00 A3019 RMK AO2=

[1815 EDT] METAR KDLZ 172215Z AUTO 00000KT 1 1/4SM -SN BKN006 OVC009 00/00 A3020 RMK AO2=

At 1735 EDT, DLZ reported a wind from 080° at 3 knots, visibility of 3 statute miles, light snow, scattered clouds at 400 feet above ground level (agl), ceiling overcast at 1,600 feet agl, temperature of 1° Celsius (C) and a dew point temperature of 0°C, altimeter setting of 30.20 inches of mercury; remarks: automated station with a precipitation discriminator.

At 1755 EDT, DLZ reported a wind from 110° at 5 knots, visibility of 3 statute miles, light snow, ceiling broken at 600 feet agl, ceiling overcast 1,100 feet agl, temperature of 0°C and a dew point temperature of 0°C, altimeter setting of 30.19 inches of mercury; remarks: automated station with a precipitation discriminator.

An AWOS was located at Union County Airport (MRT) in Marysville, Ohio, which was located about 7 miles west-northwest of the accident location at an elevation of about 1,020 feet. Automated reports from MRT during the times surrounding the accident time are presented here.

[1715 EDT] METAR KMRT 172115Z AUTO 00000KT 5SM BKN004 OVC008 01/00 A3020 RMK AO2 T00110003=

[1735 EDT] METAR KMRT 172135Z AUTO 00000KT 3SM BKN004 OVC012 01/00 A3019 RMK AO2 T00100001=

[1755 EDT] METAR KMRT 172155Z AUTO 00000KT 1SM OVC004 01/00 A3019 RMK AO2 T00050000=

[1815 EDT] METAR KMRT 172215Z AUTO 00000KT 1/2SM OVC006 00/00 A3019 RMK AO2 T00020000=

At 1735 EDT, MRT reported a calm wind, visibility of 3 statute miles, ceiling broken at 400 feet agl, overcast clouds at 1,200 feet agl, temperature of 1°C and a dew point temperature of 0°C, altimeter setting of 30.19 inches of mercury; remarks: automated station with a precipitation discriminator, temperature of 1.0°C and dew point temperature of 0.0°C.

At 1755 EDT, MRT reported a calm wind, visibility of 1 statute mile, ceiling overcast at 400 feet agl, temperature of 1°C and a dew point temperature of 0°C, altimeter setting of 30.19 inches of mercury; remarks: automated station with a precipitation discriminator, temperature of 0.5°C and dew point temperature of 0.0°C.

An Automated Surface Observing System was located at Ohio State University Airport (OSU) in Columbus, Ohio, which was located about 9 miles southeast of the accident location at an elevation

of about 905 feet. Human-augmented reports from OSU during the times surrounding the accident time are presented here.

[1653 EDT] METAR KOSU 172053Z 00000KT 3SM -SN BR FEW012 BKN028 OVC034 02/00 A3020 RMK AO2 UPB35E44SNE35B44 SLP236 P0000 60000 T00220000 56013=

[1722 EDT] SPECI KOSU 172122Z 00000KT 3SM -SN BR FEW008 OVC016 02/00 A3020 RMK AO2 P0000 T00220000=

[1742 EDT] SPECI KOSU 172142Z 00000KT 2SM -SN BR FEW009 OVC013 02/00 A3019 RMK AO2 P0001 T00170000=

[1753 EDT] METAR KOSU 172153Z 00000KT 1 1/4SM -SN BR OVC013 01/00 A3019 RMK AO2 SLP233 P0001 T00110000=

[1814 EDT] SPECI KOSU 172214Z 00000KT 3/4SM -SN BR OVC010 01/00 A3019 RMK AO2 P0002 T00060000=

At 1722 EDT, OSU reported a calm wind, visibility of 3 statute miles, light snow, mist, few clouds at 800 feet agl, ceiling overcast at 1,600 feet agl, temperature of 2°C and a dew point temperature of 0°C, altimeter setting of 30.20 inches of mercury; remarks included: automated station with a precipitation discriminator, trace amount of liquid-equivalent precipitation since 1653 EDT, temperature of 2.2°C and dew point temperature of 0.0°C.

At 1742 EDT, OSU reported a calm wind, visibility of 2 statute miles, light snow, mist, few clouds at 900 feet agl, ceiling overcast at 1,300 feet agl, temperature of 2°C and a dew point temperature of 0°C, altimeter setting of 30.19 inches of mercury; remarks included: automated station with a precipitation discriminator, 0.01 inches of liquid-equivalent precipitation since 1653 EDT, temperature of 1.7°C and dew point temperature of 0.0°C.

At 1753 EDT, OSU reported a calm wind, visibility of 1 and 1/4 statute miles, light snow, mist, ceiling overcast at 1,300 feet agl, temperature of 1°C and a dew point temperature of 0°C, altimeter setting of 30.19 inches of mercury; remarks included: automated station with a precipitation discriminator, sea level pressure of 1023.3 hectopascals (hPa), 0.01 inches of liquid equivalent precipitation since 1653 EDT, temperature of 1.1°C and dew point temperature of 0.0°C.

2.0 Pilot Reports

Publicly disseminated pilot reports[3] (PIREP) made between 1600 and 1900 EDT in the central and southwest regions of Ohio are presented below.[4] Some PIREPs identified icing conditions below 15,000 feet.

OSU UA /OV DURGD/TM 2012/FL018/TP C56X/SK BASES 020 MSL RGD/WX BROKE OUT 2NM FINAL=

[3] These do not include pilot reports only broadcast via radio.
[4] Only pilot reports with the World Meteorological Organization header UBOH** were considered.

DAY UA /OV DAY/TM 2027/FL018/TP GLF4/SK BKN018=

CMH UA /OV DAY/TM 2029/FLDURD/TP GLF4/SK BKN B018/IC NEG=

DAY UA /OV ROD2137/TM 2137/FL120/TP PA34/TA M20/IC LGT MX=

CVG UA /OV 8 E FLM/TM 2154/FLDURD/TP CRJ9/TA -02/WV CONT MOD 100-080/IC -MIXED=

CMH UA /OV CMH090005/TM 2203/FL025/TP CRJ2/TA M1/IC LGT MIXED=

DAY UA /OV DAY270005/TM 2211/FL070/TP CRJ7/SK BKN BASES 020 TOPS 065/TA 1/IC NEG=

DAY UA /OV DAY/TM 2241/FL082/TP CRJ2/SK OVC B005 T082/TA M9/IC LGT RIME IC=

3.0 Weather Radar

Terminal Doppler Weather Radar (TDWR) 1.0° reflectivity imagery from Columbus, Ohio (TCMH) and WSR-88D ("NEXRAD") 0.48° base reflectivity imagery from near Cincinnati, Ohio (KILN) are presented in figures 1 and 2, respectively. TCMH was located approximately 25 miles east-southeast of the accident location at an elevation of about 1,150 feet. KILN was located about 55 miles south-southwest of the accident location at an elevation of about 1,170 feet. Assuming standard refraction and considering the approximate beam widths of 0.55° (TCMH) and 0.95° (KILN), the TCMH 1.0° tilt would have "seen" altitudes above the accident location of between about 3,500 and 4,500 feet above msl, and the KILN 0.48 tilt would have "seen" altitudes above the accident location of between about 12,300 and 17,800 feet above msl. The radar imagery identified an area of relatively high reflectivity coincident with the accident aircraft's reversal of direction immediately prior to the accident.

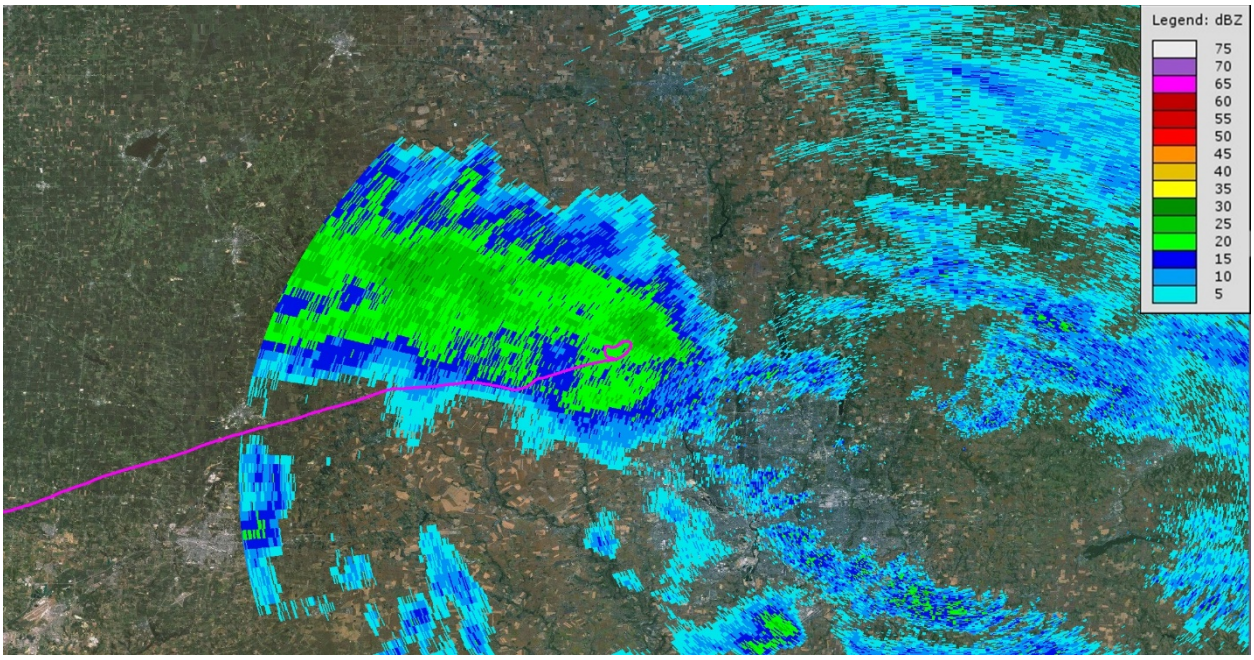

Figure 1 – TCMH 1.0° reflectivity product from about 1747 EDT. Final portion of accident aircraft's flight path denoted by purple line.

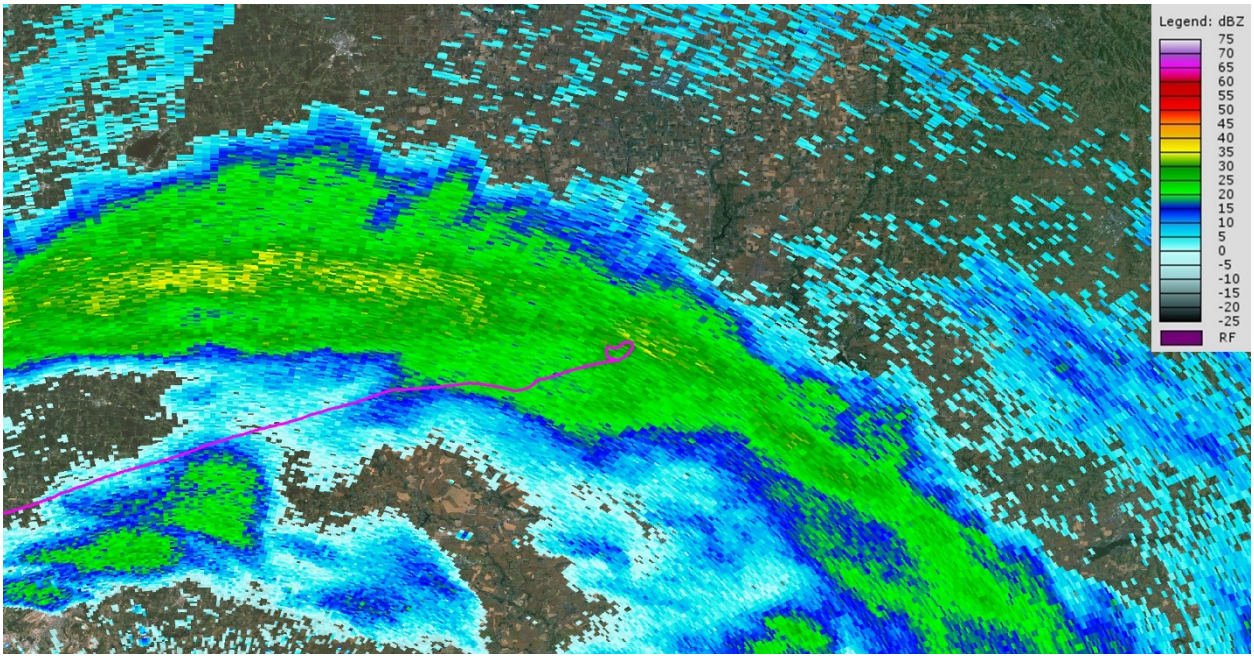

Figure 2 – KILN 0.48° Level-II base reflectivity product from 1747 EDT. Final portion of accident aircraft's flight path denoted by purple line.

4.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR) model[5] sounding (figure 3) for the accident site at 1800 EDT was retrieved from the National Oceanic and Atmospheric Administration's Air Resources Laboratory. The HRRR sounding indicated that the wind was light and variable below 3,000 feet. Above this level the wind was generally from the west and increased in magnitude to about 30 knots at about 7,000 feet. The freezing level was identified to be at about 1,400 feet. Below 5,000 feet, calculations made by the Rawinsonde OBservation Program indicated the potential for light rime icing down through about 2,500 feet, with the potential for moderate clear icing below that level to about 1,400 feet.

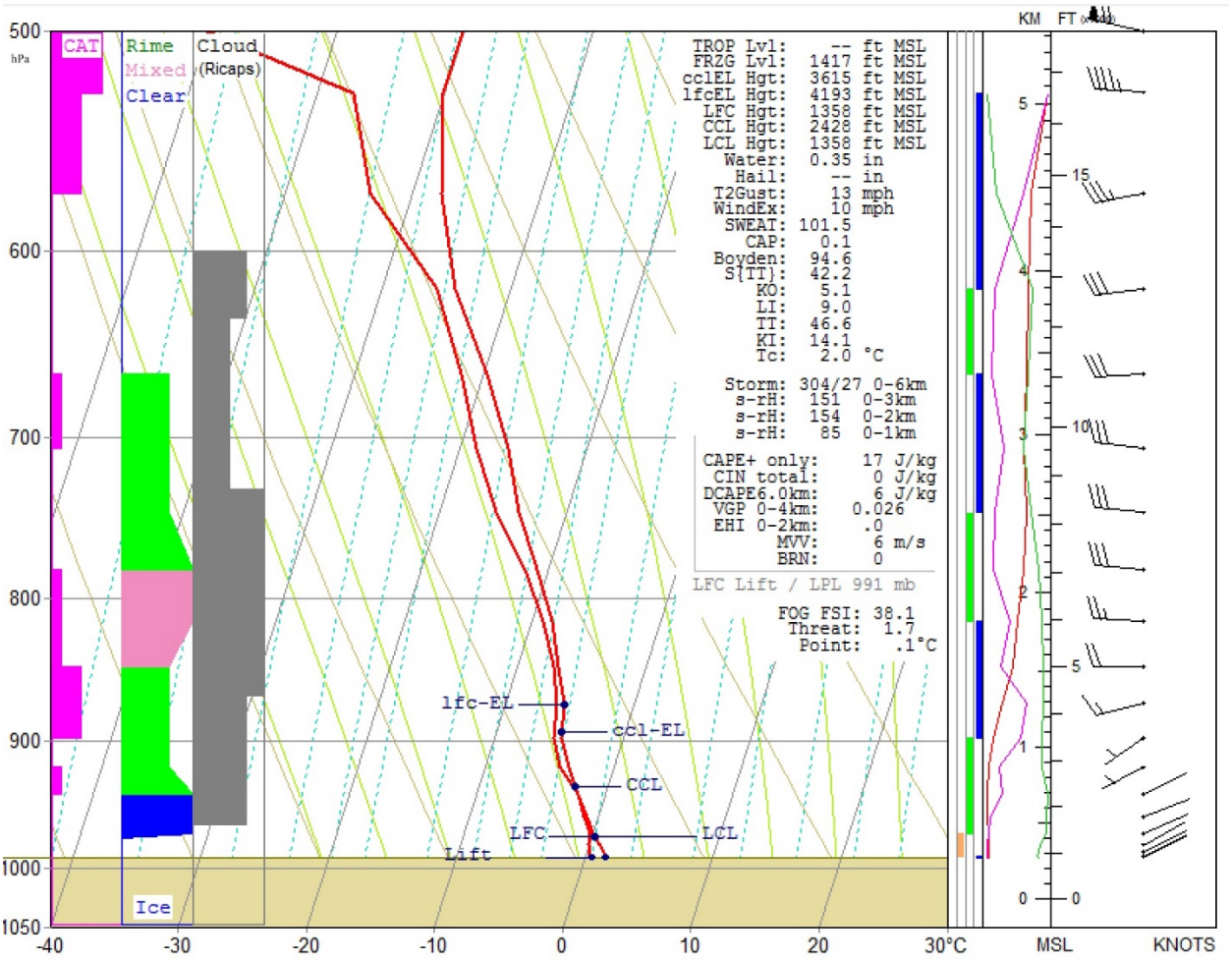

Figure 3 – HRRR model sounding data in SkewT/LogP format for 1800 EDT at the accident site, surface to 500 hPa.

[5] 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.

5.0 Satellite Imagery

Geostationary Operational Environmental Satellite (GOES)-16 visible (0.64µm) and infrared (10.3µm) data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison. Imagery from 1742 EDT are presented in figures 4 and 5. The GOES-16 visible imagery depicted cloudy conditions across the region. Infrared cloud-top temperatures in the immediate area of the accident location ranged from -20°C to -25°C, which, considering the HRRR sounding temperature profile, corresponded to cloud top heights of about 11,100 feet and 13,200 feet, respectively.

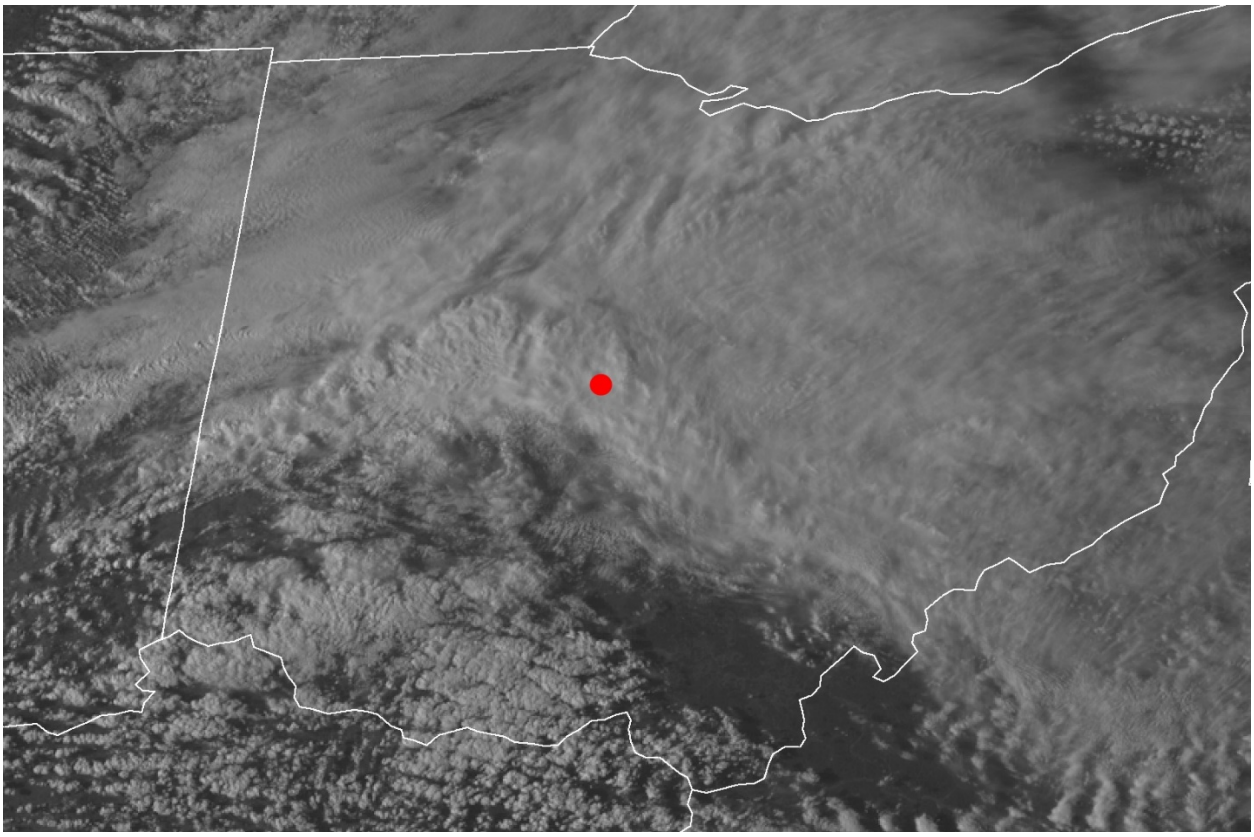

Figure 4 – GOES-16 visible imagery from 1742 EDT. Accident location denoted by red dot. This image has not been corrected for any parallax error.

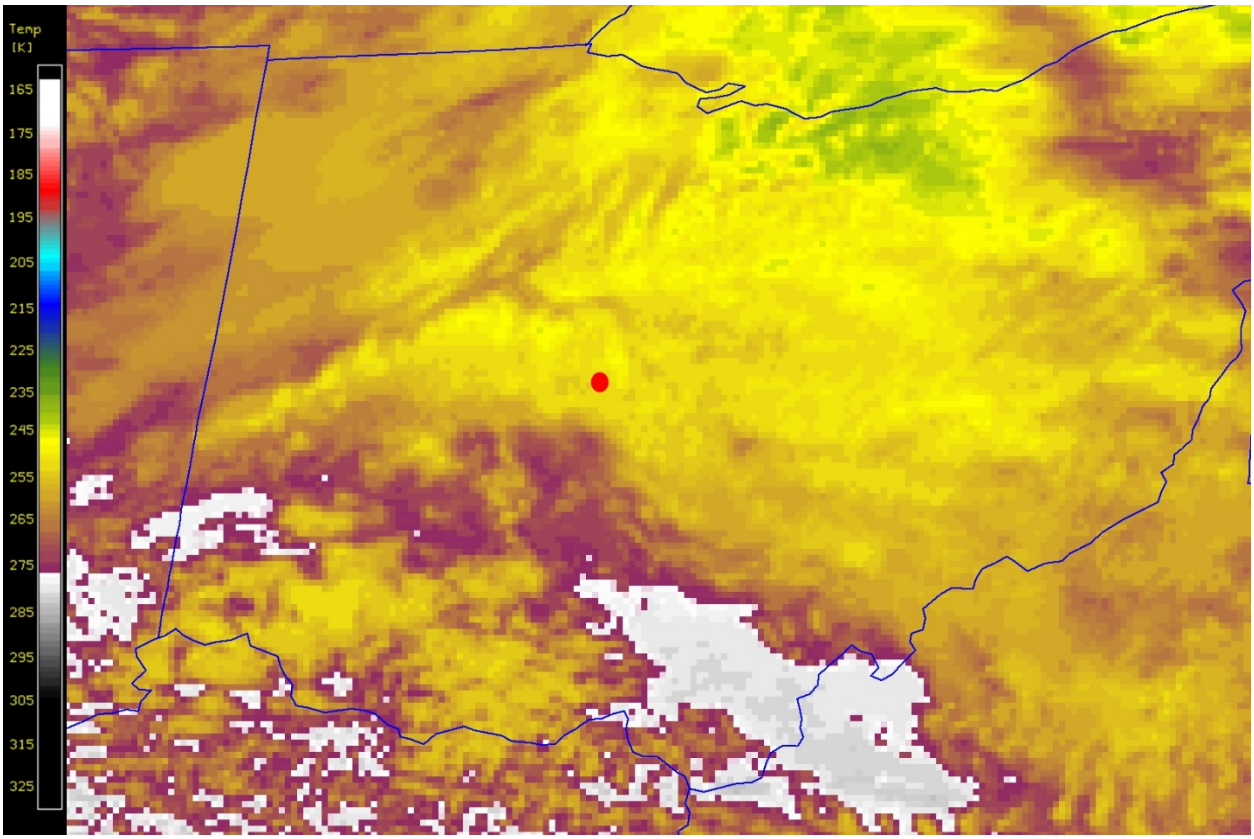

Figure 5 – GOES-16 infrared imagery (brightness temperature in degrees Kelvin) from 1742 EDT. Accident location denoted by red dot. This image has not been corrected for any parallax error.

6.0 Area Forecast Discussion

An Area Forecast Discussion (AFD) was issued at 1530 EDT by the NWS Weather Forecast Office in Wilmington, Ohio. The "Aviation" section of that AFD is presented here:

FXUS61 KILN 171930
AFDILN
AREA FORECAST DISCUSSION
National Weather Service Wilmington OH
330 PM EDT Sun Mar 17 2019

.AVIATION /19Z SUNDAY THROUGH FRIDAY/...
Surface low moving into West Central Indiana to track east across Southern Ohio this afternoon into early evening. Warm advection band of mainly snow showers ahead of this low to to pivot northeast - affecting all but KCVG/KLUK early this aftn. Expect MVFR ceilings with IFR vsbys in snow at times.

Models trying to start or change pcpn to rain too quick. Based on dry air and wet bulb effect have slowed this warming.

MVFR conditions will linger at KDAY/KCMH/KLCK longer. As the low passes and winds back from ne to nw...snow showers and MVFR conditions will likely linger later into the evening over KCMH/KLCK.

Surface high pressure will begin to nose into the area with VFR conditions expected late tonight into Monday.

OUTLOOK...MVFR ceilings possible Wednesday.

7.0 Terminal Aerodrome Forecasts

A Terminal Aerodrome Forecast (TAF) was issued at 1609 EDT for John Glenn Columbus International Airport (CMH) in Columbus, Ohio, which was located about 19 miles to the southeast of the accident site at an elevation of about 815 feet. Conditions forecasted in the TAF are only valid for 5 statute miles from the aerodrome. The 1609 EDT CMH TAF forecasted for the accident time: wind from 240° at 6 knots, visibility of 3 statute miles, light snow, mist, scattered clouds at 800 feet agl, ceiling overcast at 1,500 feet agl; temporary conditions[6]: visibility of 1 statute mile, light snow, mist, ceiling overcast at 800 feet agl.

KCMH 172009Z 1720/1818 **24006KT 3SM -SN BR SCT008 OVC015**
TEMPO 1720/1722 1SM -SN BR OVC008
FM172200 24006KT 3SM -SHSN BR SCT008 OVC015
FM180000 35006KT 3SM -SHSN BR SCT008 OVC015
FM180200 34007KT P6SM VCSH OVC025
FM180500 32005KT P6SM BKN035
FM180700 31005KT P6SM SCT035
FM181400 32009KT P6SM SCT250=

8.0 AIRMETs

There were two AIRMETs active below 10,000 feet over the accident location at the time of the accident. At 1645 EDT, an AIRMET SIERRA for instrument flight rule (IFR) conditions[7] in precipitation and mist was issued by the NWS Aviation Weather Center (AWC).

WAUS41 KKCI 172045
WA1S
-BOSS WA 172045
AIRMET SIERRA UPDT 7 FOR IFR AND MTN OBSCN VALID UNTIL 180300
.
AIRMET IFR...OH LE
FROM 50SW FNT TO DXO TO 40S DXO TO 20NW AIR TO 20W HNN TO 40ESE CVG TO 20NNW CVG TO 30NE IND TO 20SSE GIJ TO 50SW FNT

[6] Temporary conditions - fluctuations to forecast conditions which are expected to last less than one hour in each instance and, in the aggregate, to cover less than half of the indicated period.
[7] IFR conditions - Ceilings less than 1,000 feet agl and/or visibility less than three statute miles.

CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.

At 1645 EDT, an AIRMET ZULU for moderate ice between 5,000 and 14,000 feet was issued by the NWS Aviation Weather Center (AWC).

WAUS41 KKCI 172045
WA1Z
-BOSZ WA 172045
AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 180300
.
AIRMET ICE...PA OH LE WV MD VA
FROM 30SE ERI TO 30SSE EWC TO 30S DCA TO 50ESE LYH TO 40SW LYH TO 30NE HMV TO HNN TO CVG TO 20SSE FWA TO 50SSW DXO TO 20W CLE TO 30SE ERI
MOD ICE BTN 050 AND 140. CONDS CONTG BYD 03Z THRU 09Z.

9.0 SIGMETs

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

10.0 Current Icing Potential/Forecast Icing Potential

Images presenting output from the Current Icing Potential (CIP) and Forecast Icing Potential (FIP) products valid for 1700 and 1800 EDT for between 1,000 and 5,000 feet for the accident region were provided by the National Center for Atmospheric Research (NCAR).[8] These images are presented in Attachment 1 and depict a 50 percent or greater probability icing (mostly trace to light severities) between 3,000 and 5,000 feet at 1700 EDT, with moderate icing and supercooled large droplets in the region. Icing probabilities and severities were slightly less at 1800 EDT.

The CIP and FIP imagery provide information on expected icing severity as five categories: none, trace, light, moderate, and heavy. The severity estimations are roughly based on the accretion rate of ice on an airplane, and the levels are determined by the time it would take for an airfoil to accrete 1/4 of an inch of ice: trace = 1 hour; light = 15 minutes to 1 hour; moderate = 5 to 15 minutes; severe = less than 5 minutes. The rates are estimated from the amount of supercooled liquid water expected with a nominal drop diameter of 15 microns, and are further tuned by nearby pilot reports of encountered severity. These are relative values and the use of which should take into account the airframe and the level of icing protection provided by the aircraft. Different aircraft and different flight configurations (airspeed, angle of attack, etc.) will experience variations in accretion rate, and these rates have been simulated for a range of aircraft and are a "broad brush" approach to severity prediction.

[8] Courtesy of Mr. Daniel Adriaansen and Ms. Allyson Rugg, NCAR.

The images presented in this report were generated using NCAR's graphics software and were not the publicly available images of the same fields accessible through the AWC on the accident day. For the FIP imagery, the NCAR graphics should present the same data as the FIP graphics that were publicly available via the AWC. For the CIP imagery, according to NCAR, "…there are small differences that can exist between observational data sources, and dataset availability. What's run at AWC is realtime- when CIP runs it uses the data available at that instant. If some data come in late, or a satellite image is slightly behind then CIP won't use it. When we run it [at NCAR] by hand after the fact, it's in "research mode" so there's no possibility of late data. The datastreams also differ slightly at the AWC vs. what we use here but it's by and large the same data…I am more confident our [CIP and FIP] answers would be indistinguishable when plotted using the same software, with perhaps minor differences on occasion with CIP due to the dataset issue."

11.0 CWSU

There were no Center Weather Advisories or Meteorological Impact Statements issued by the Center Weather Service Unit (CWSU) at the Indianapolis Air Route Traffic Control Center that were active for the accident location at the accident time.

12.0 Astronomical Data

Astronomical data obtained from the United States Naval Observatory for 40° 12' north latitude and 83° 12' west longitude indicated that sunset occurred at 1942 EDT.

E. Attachments

Attachment 1. Images presenting output from the Current Icing Potential and Forecast Icing Potential products valid for 1700 and 1800 EDT for between 1,000 and 5,000 feet for the accident region.

Submitted by:

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Mike Richards
Senior Meteorologist

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