



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

September 17, 2019

Weather Study

METEOROLOGY

ERA19FA181

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A. ACCIDENT

Location: Auburn Township, Ohio
Date: May 28, 2019
Time: 2355 eastern daylight time
0355 Universal Coordinated Time (UTC) on May 29, 2019
Airplane: Piper PA-28R-180; Registration: N3933T

B. METEOROLOGIST

Don Eick
Meteorologist Specialist
Operational Factors Division (AS-30)
National Transportation Safety Board

C. SUMMARY

On May 28, 2019, at 2355 eastern daylight time, a Piper PA-28R-180, N3933T, was destroyed when it collided with trees and terrain near Auburn Township, Ohio. The private pilot was fatally injured. The airplane was registered to and operated by the pilot as a Title 14 *Code of Federal Regulations* Part 91 personal flight. Night instrument meteorological conditions prevailed in the area at the time the accident occurred. A visual flight rules flight plan was filed for the flight that departed Cincinnati-Lunken Airport (LUK), Cincinnati, Ohio, about 2209 and destined for the Geauga County Airport (7G8), Middlefield, Ohio.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's Senior Meteorologist was not on scene for this investigation and conducted the meteorology phase of the investigation from the Washington D.C. office, collecting data from official National Weather Service (NWS) sources including the Weather Prediction Center (WPC) and the National Center for Environmental Information (NCEI). All times are eastern daylight time (EDT) based upon the 24-hour clock, local time is -4 hours from UTC, and UTC=Z. NWS airport and station identifiers use the standard International Civil Aviation Organization 4-letter station identifiers versus the International Air Transport Association 3-letter identifiers, which deletes the initial country code designator "K" for U.S. airports. Directions are referenced to true north and distances in nautical miles. Heights are in feet (ft) 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 41.375278° N and longitude 81.193056° W, at an elevation of approximately 1,123 ft.

E. WEATHER INFORMATION

1.0 Synoptic Conditions

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 (NCEP) located in College Park, Maryland. These are the base products used in describing weather features and in the creation of forecasts and warnings. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular “Aviation Weather Services”, AC 00-45H change 1.

1.1 Surface Analysis Chart

The northeast section of the NWS Surface Analysis Chart for 2300 EDT on May 28, 2019 is included as figure 1 with the approximate accident site marked by a red star. The chart depicted a west-to-east orientated stationary front extending across northern Ohio into northern Pennsylvania, with low pressure systems located to the east over Long Island, New York, at 1004-hPa and another low to the west-southwest over Kansas at 999-hPa. A high pressure system at 1010-hPa was located over Lake Michigan to the northwest and another high-pressure system over the Gulf of Mexico at 1015-hPa to the south (off the regional view). The accident site was located in the vicinity of the stationary front in a region of a weak pressure gradient. The location along the front and between the two high and low-pressure areas is also referred to as a COL¹.

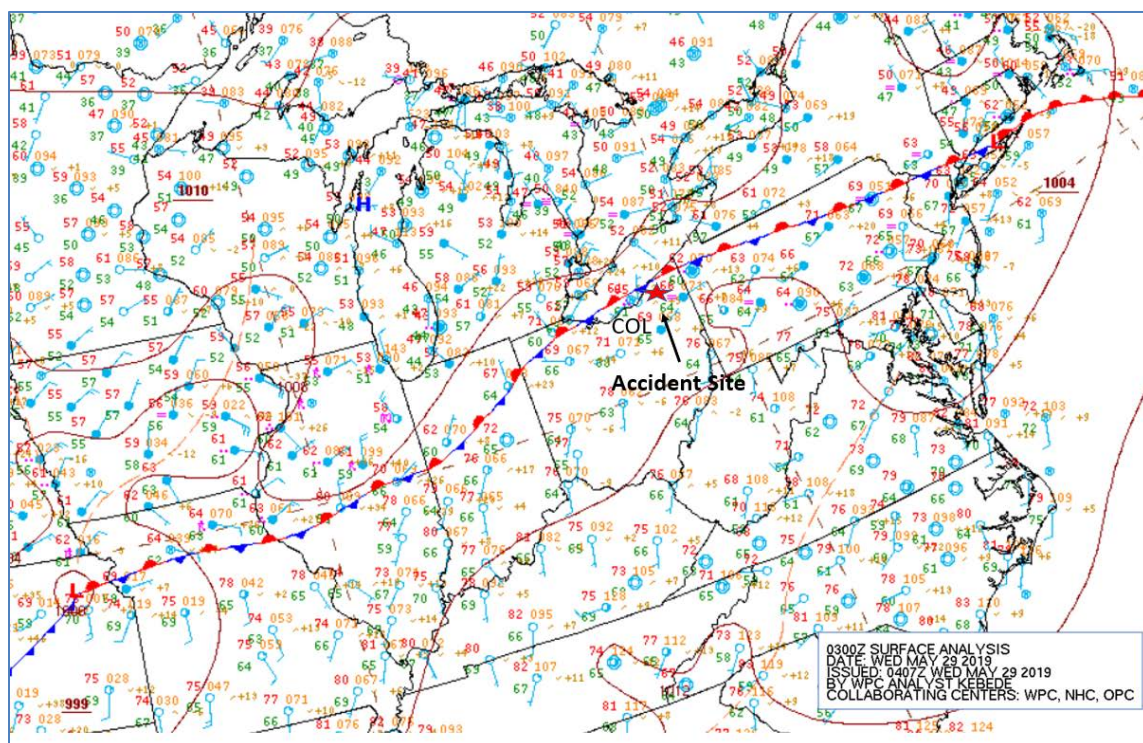


Figure 1 - Northeast section of the NWS Surface Analysis Chart for 2300 EDT

¹ A COL is also called a saddle point or neutral point in the pressure field.

The station models in the immediate vicinity of the accident site depicted light easterly winds of 5 knots, visibility restricted in mist, overcast clouds, temperatures in the mid to upper 60's degrees Fahrenheit (F), with dew point temperature in the mid 60's or temperature-dew point spreads of 4° F or less.

1.2 National Composite Radar Mosaic

A regional view of the NWS National Composite Weather Radar Mosaic for 2355 EDT centered over the accident site is included as figure 2, with the accident site marked by a red star and the closest airport with weather reporting capability noted. The radar mosaic depicted a west-to-east band of moderate to strong echoes extending approximately 20 miles south of the accident site, with a small area of very light intensity echoes near 20 dBZ located approximately 6 miles southeast of the accident site.

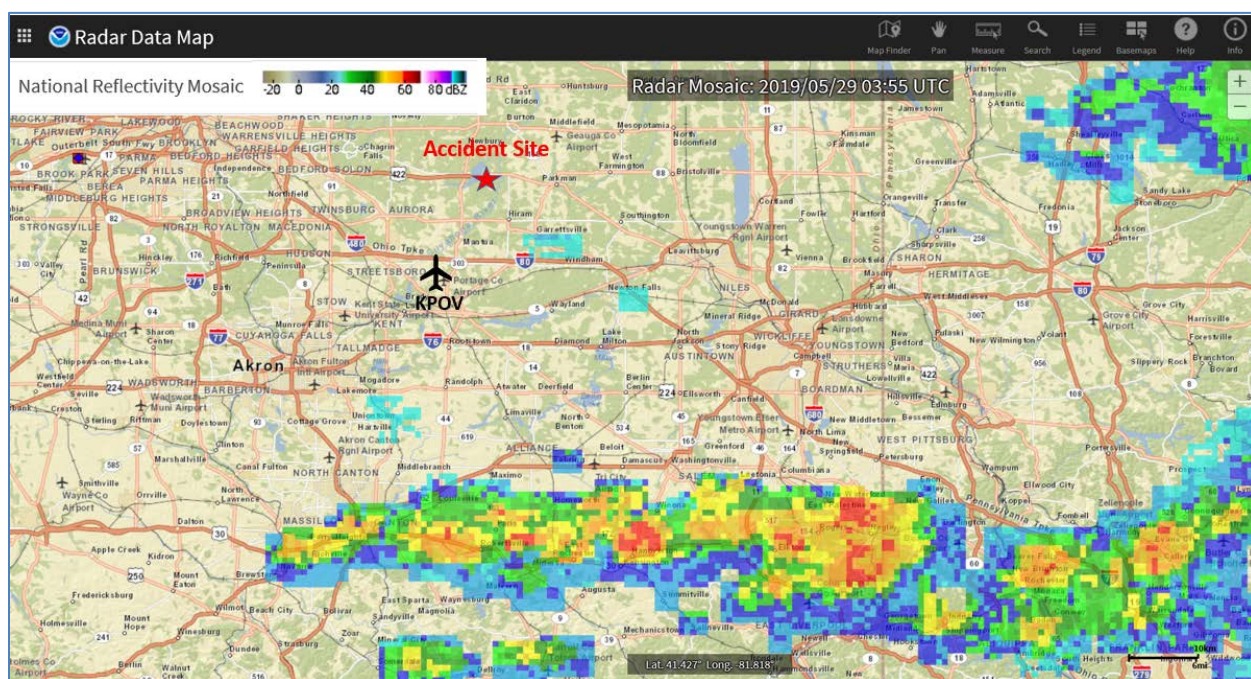


Figure 2 - National Composite Radar Mosaic for 2355 EDT

2.0 Observations

The official observations issued surrounding the accident site were documented using standard meteorological aerodrome reports (METARs)² and specials (SPECI). Cloud heights are reported above ground level (agl) in the following section, and the magnetic variation was estimated at 9° west based on the latest sectional chart for the area.

² METAR is also called Aviation Routine Weather Report.

2.1 Portage County Airport, Ravenna, Ohio

The closest weather reporting facility to the accident site was from Portage County Airport (KPOV), Ravenna, Ohio, located approximately 12 miles south of the accident site and 17 miles southwest of the planned destination airport, at an elevation of 1,198 ft. The airport had an Automated Weather Observation System (AWOS) which issued reports every 20-minutes. The following conditions were reported:

KPOV weather observation at 2355 EDT, wind calm, visibility 7 miles, scattered clouds at 5,000 ft agl, temperature 18° Celsius (C), dew point 17° C, altimeter 29.76 inches of mercury (Hg). Remarks: automated station with a precipitation discriminator, hourly precipitation 0.01 inches, temperature 18.2° C, dew point 17.2° C, present weather indicator not operative (PWINO).

KPOV weather observation at 0015 EDT, wind calm, visibility 1 1/4 miles, scattered clouds at 200 ft agl, scattered at 4,800 ft, temperature 18° C, dew point 17° C, altimeter 29.76 inches of Hg. Remarks: automated station with a precipitation discriminator, temperature 17.7° C, dew point 16.7° C, PWINO.

Based on the sky cover, the temperature and dew point spread, and the surrounding station, mist was likely occurring during the period but not reported due to the present weather sensor being inoperative.

The general flight categories³ and raw observations from approximately 2100 through 2400 EDT were as follows:

VFR METAR KPOV 290056Z AUTO 28005KT 10SM BKN120 19/17 A2974 RMK AO2 P0002 T01890167 PWINO=

VFR METAR KPOV 290115Z AUTO 00000KT 10SM SCT042 SCT120 19/17 A2974 RMK AO2 T01850166 PWINO=

VFR METAR KPOV 290135Z AUTO 30003KT 10SM SCT027 BKN040 BKN049 19/17 A2975 RMK AO2 P0001 T01850170 PWINO=

MVFR METAR KPOV 290156Z AUTO 00000KT 7SM OVC027 19/17 A2974 RMK AO2 P0001 T01850170 PWINO=

MVFR METAR KPOV 290215Z AUTO 00000KT 4SM OVC025 18/17 A2975 RMK AO2 T01810170 PWINO=

MVFR METAR KPOV 290235Z AUTO 00000KT 5SM OVC025 18/17 A2977 RMK AO2 P0001 T01820172 PWINO=

MVFR METAR KPOV 290255Z AUTO 00000KT 7SM OVC023 18/17 A2978 RMK AO2 P0001 T01830173 PWINO=

MVFR METAR KPOV 290315Z AUTO 00000KT 7SM BKN020 BKN027 BKN050 18/17 A2977 RMK AO2 T01810171 PWINO

³ As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories:

- Low Instrument Flight Rules (LIFR*) – ceiling below 500 ft above ground level (agl) and/or visibility less than 1 statute mile.
- Instrument Flight Rules (IFR) – ceiling between 500 to below 1,000 feet agl and/or visibility 1 to less than 3 miles.
- Marginal Visual Flight Rules (MVFR**) – ceiling from 1,000 to 3,000 ft agl and/or visibility 3 to 5 miles.
- Visual Flight Rules (VFR) – ceiling greater 3,000 ft agl and visibility greater than 5 miles.

* By definition, IFR is a ceiling less than 1,000 ft agl and/or visibility less than 3 miles while LIFR is a sub-category of IFR.

**By definition, VFR is a ceiling greater than or equal to 3,000 ft agl and visibility greater than 5 miles while MVFR is a sub-category of VFR.

VFR METAR KPOV 290335Z AUTO 00000KT 7SM BKN050 BKN055 18/17 A2977 RMK AO2 T01810171 PWINO=

VFR METAR KPOV 290355Z AUTO 00000KT 7SM SCT050 18/17 A2976 RMK AO2 P0001 T01820172 PWINO=

Accident 0355Z

IFR METAR KPOV 290415Z AUTO 00000KT 1 1/4SM SCT002 SCT048 18/17 A2976 RMK AO2 T01770167 PWINO=

IFR METAR KPOV 290435Z AUTO 00000KT 2SM SCT002 SCT041 18/17 A2977 RMK AO2 T01760166 PWINO=

MVFR METAR KPOV 290455Z AUTO 00000KT 3SM BKN027 BKN033 BKN041 18/17 A2978 RMK AO2 T01780170 PWINO

MVFR METAR KPOV 290515Z AUTO 00000KT 3SM SCT001 BKN025 18/17 A2978 RMK AO2 T01780170 PWINO=

2.2 Cuyahoga County Airport, Cleveland, Ohio

The next closest weather reporting station was from Cuyahoga County Airport (KCGF), Cleveland, Ohio, located approximately 20 miles northwest of the accident site at an elevation of 876 ft. The airport also had an AWOS and issued observations hourly with specials as required when the tower was in operation, and in the automated mode every 20-minutes when it was closed. At the time of the accident the following conditions were being reported.

KCGF weather observation at 2355 EDT, automated, wind from 090° at 4 knots, visibility 10 miles or more, ceiling overcast at 900 ft agl, temperature 17° C, dew point temperature 16° C, altimeter 29.77 inches of Hg. Remarks: automated station with a precipitation discriminator, freezing rain sensor inoperative, temperature 17.3° C, dew point 16.2° C.

The general flight categories and raw observations reported surrounding the period were as follows:

MVFR METAR KCGF 282245Z 03003KT 5SM HZ BKN035 BKN050 21/18 A2968 RMK TSB41

MVFR METAR KCGF 282345Z 28006KT 3SM TSRA OVC025 20/19 A2976

IFR SPECI KCGF 290045Z 34006KT 1SM VCTS BR OVC005 19/18 A2974

IFR METAR KCGF 290145Z 08006KT 3SM BR OVC005 17/17 A2974

MVFR METAR KCGF 290245Z 00000KT 3SM BR BKN015 17/16 A2974

IFR SPECI KCGF 290315Z AUTO 02005KT 4SM BR BKN005 BKN050 17/17 A2976 RMK AO2 FZFRANO T01700166

IFR SPECI KCGF 290335Z AUTO 06005KT 7SM OVC007 17/16 A2977 RMK AO2 FZFRANO T01710163

Accident 0355Z

IFR METAR KCGF 290355Z AUTO 09004KT 10SM OVC009 17/16 A2977 RMK AO2 FZFRANO T01730162

MVFR METAR KCGF 290415Z AUTO 10SM OVC011 17/16 A2977 RMK AO2 LTG DSNT SE FZFRANO T01720162

MVFR METAR KCGF 290435Z AUTO 04003KT 7SM OVC011 17/17 A2978 RMK AO2 LTG DSNT SE AND W FZFRANO T01730165

MVFR METAR KCGF 290455Z AUTO 00000KT 7SM OVC011 17/16 A2978 RMK AO2 FZFRANO T01720163

MVFR METAR KCGF 290515Z AUTO 05004KT 7SM OVC011 17/16 A2977 RMK AO2 LTG DSNT SE FZFRANO T01710164

2.3 Youngstown-Warren Regional Airport, Youngstown/Warren, Ohio

The next closest weather reporting location to the accident site and the destination airport was from Youngstown-Warren Regional Airport (KYNG), Youngstown/Warren, Ohio, was located approximately 28 miles east of the accident site and 21 miles southeast of the destination airport at an elevation of 1,192 ft. The airport had an Automated Surface Observation System (ASOS) and was augmented by observers. The following conditions at the time of the accident.

KYNG weather observation at 2351 EDT, wind from 140° at 3 knots, visibility 1/4 mile in dense fog, vertical visibility 100 ft agl, temperate 19° C, dew point 18° C, altimeter setting 29.74 inches of Hg. Remarks: automated station with a precipitation discriminator, sea-level pressure 1006.4-hPa, temperature 18.9° C, dew point 17.8° C.

The general flight categories and raw observation issued surrounding the period were as follows.

VFR METAR KYNG 282151Z 25007KT 9SM -TSRA FEW025 BKN045CB BKN080 OVC130 22/20 A2971 RMK AO2 SLP052 OCNL LTGIC NE AND SE-SW TS NE AND SE-SW MOV E P0003 T02170200

VFR METAR KYNG 282251Z 22006KT 9SM -TSRA FEW012 BKN035CB BKN080 OVC200 22/19 A2971 RMK AO2 SLP054 FRQ LTGCAIC SE-SW TS SE-SW MOV E P0000 T02170194

MVFR SPECI KYNG 282334Z 21011G16KT 4SM TSRA BR FEW008 BKN028CB OVC080 21/19 A2971 RMK AO2 OCNL LTGIC OHD-SW TS OHD-SW MOV E P0004 T02060189

IFR SPECI KYNG 282344Z 22009G18KT 1SM +TSRA BR SCT007 OVC020CB 20/18 A2973 RMK AO2 OCNL LTGIC OHD-S TS OHD-S MOV E P0009 T02000183

IFR METAR KYNG 282351Z 22009KT 2SM +TSRA BR SCT007 BKN020CB OVC060 20/18 A2974 RMK AO2 SLP064 OCNL LTGIC OHD TS OHD MOV E P0024 60035 T02000183 10283 20200 53007

MVFR SPECI KYNG 290009Z 21008KT 4SM -TSRA BR FEW007 BKN022CB BKN060 OVC130 19/18 A2974 RMK AO2 OCNL LTGCAIC OHD-E TS OHD-E MOV E P0026 T01940183

MVFR METAR KYNG 290051Z 20005KT 3SM -TSRA BR FEW007 BKN024CB OVC070 19/18 A2974 RMK AO2 SLP063 VIS NW-NE 2 OCNL LTGCAIC N-E TS N-E MOV E P0034 T01940178

MVFR SPECI KYNG 290124Z 00000KT 6SM -RA BR FEW006 BKN018 OVC080 20/18 A2974 RMK AO2 TSE23 OCNL LTG DSNT SE P0003 T02000183

MVFR METAR KYNG 290151Z 03006KT 6SM -RA BR SCT006 BKN018 BKN050 OVC200 20/18 A2973 RMK AO2 TSE23 SLP061 OCNL LTG DSNT SE P0003 T02000183

MVFR METAR KYNG 290251Z 08005KT 3SM BR FEW005 BKN024 OVC040 19/18 A2976 RMK AO2 RAE02 SLP071 OCNL LTG DSNT NW-N P0000 60037 T01890178 53007

MVFR SPECI KYNG 290333Z 15003KT 4SM BR FEW005 SCT024 BKN050 OVC200 18/17 A2975 RMK AO2 T01830172

IFR SPECI KYNG 290342Z 15004KT 1SM BR BCFG FEW001 BKN050 OVC200 19/17 A2975 RMK AO2 OCNL LTG DSNT SW T01890172

LIFR METAR KYNG 290351Z 14003KT 1/4SM FG VV001 19/18 A2974 RMK AO2 SLP064 T01890178

Accident 0355Z

LIFR METAR KYNG 290451Z 30003KT 1/4SM FG VV001 19/18 A2976 RMK AO2 SLP069 T01890178 402830156

LIFR KYNG 290551Z 00000KT 1/4SM FG VV001 19/18 A2976 RMK AO2 SLP070 60037 T01890178 10200 20183 53000

2.4 METAR Display

A display of the METAR observation at 2400 EDT with the radar mosaic overlaid from the NWS Aviation Weather Center's website is included as figure 3, and with the approximate accident site marked by the red star and the approximate position of the planned destination airport Geauga County Airport (7G8), Middlefield, Ohio, included. The station models are color coded by flight category.

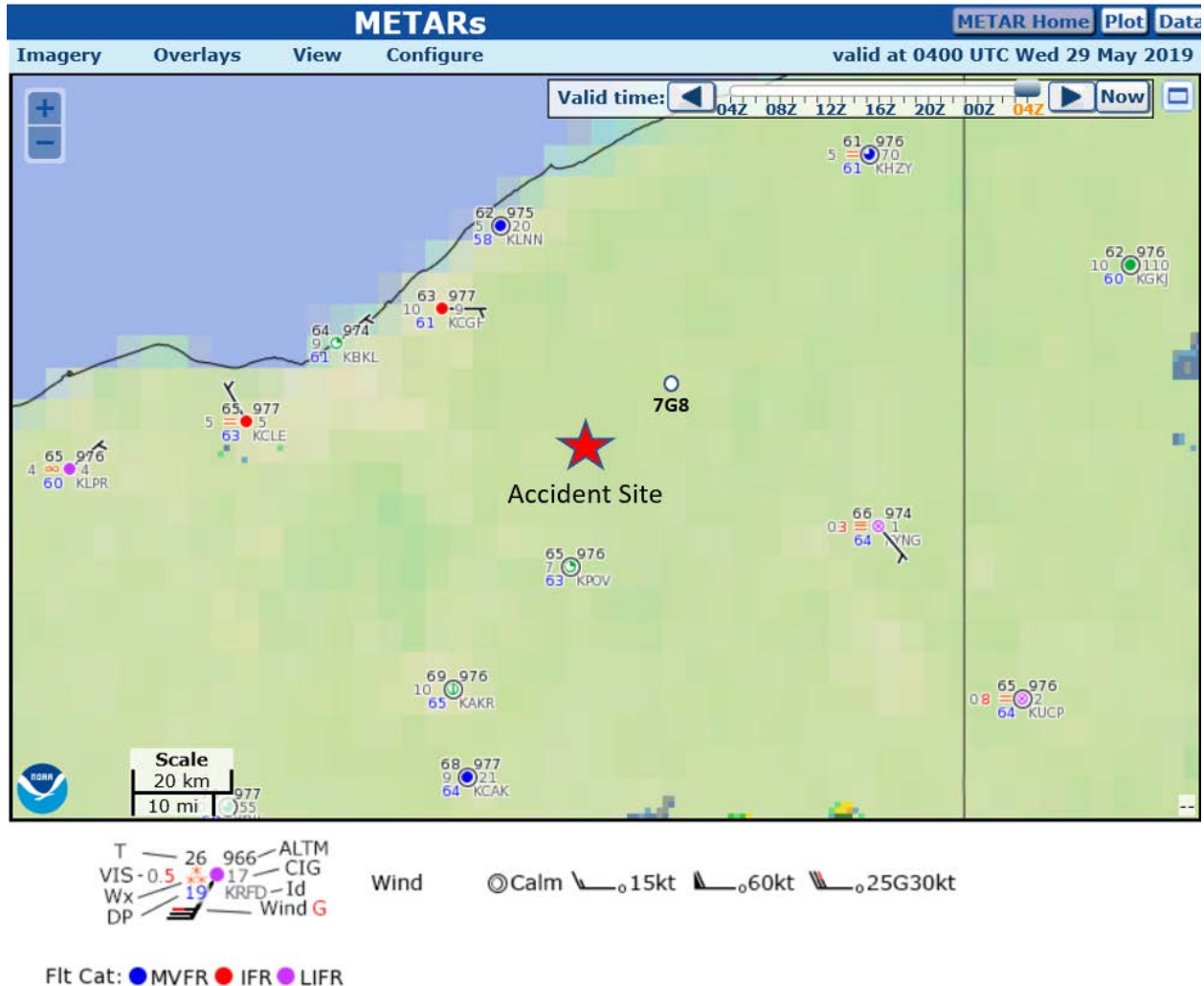


Figure 3 - METAR display for 2400 EDT

Several stations west, north, and east of the accident site were reporting IFR to LIFR conditions at the time of the accident, with several others northeast and south reporting MVFR conditions. A summary of the reported conditions at the airports by distance was as follows:

<u>FLT CAT</u>	<u>DISTANCE</u>	<u>STATION</u>
VFR	12NM S	KPOV (Portage County Airport, Ravenna, OH)
IFR	20NM NW	KCGF (Cuyahoga County Airport, Cleveland, OH)
MVFR	23NM NNW	KLNN (Willoughby Lost Nation Airport, Willoughby, OH)
VFR	27NM SW	KAKR (Akron Fulton International Airport, Akron, OH)
VFR	27NM NW	KBKL (Burke Lake Airport, Cleveland, OH)
LIFR	28NM E	KYNG (Youngstown-Warren Regional Airport, Youngstown/Warren, OH)
IFR	34NM W	KCLE (Cleveland-Hopkins International Airport, Cleveland, OH)
MVFR	34NM SSW	KCAK (Akron-Canton Regional Airport, Akron, OH)
MVFR	38NM NE	KHZY (Northeast Ohio Regional Airport, Ashtabula, OH)
LIFR	48NM ESE	KUCP (New Castle Municipal Airport, New Castle, PA)
LIFR	51NM W	KLPR (Lorain County Regional Airport, Lorain/Elyria, OH)
VFR	53NM ENE	KGKJ (Port Meadville Airport, Meadville, PA)

A review of the stations reporting VFR conditions at the time also showed variable ceilings and restricted visibility during the period with MVFR conditions prevailing during the period.

3.0 Sounding

To determine the vertical structure and state of the atmosphere a High-Resolution Rapid Refresh (HRRR)⁴ numerical model data was retrieved from the NOAA Air Resources Laboratory using the accident site coordinates and plotted on a standard Skew T log P diagram⁵ using the complete Rawinsonde Observation RAOB program software⁶. Figure 4 is the HRRR model sounding from the surface at an elevation of about 1,200 ft through 450-hPa or approximately 21,000 ft for 2400 EDT (0000Z on May 29, 2019). The HRRR sounding depicted a near-surface temperature of 19° C (66° F), a dew point temperature of 18° C (64° F), and a relative humidity of 95%. The sounding indicated a lifted condensation level (LCL) at 378 ft agl, a convective condensation level (CCL) at 3,400 ft agl, and a level of free convection at 7,600 ft agl, with a low-level frontal inversion from 500 ft agl through approximately 2,500 ft where temperature remained constant or increased with height. The sounding supported multiple layers of clouds from the LCL through 12,000 ft where the relative humidity exceeded 90%. The precipitable water content of the sounding was 1.66 inches. The freezing level was identified at 12,700 ft which was above the accident airplane's cruising level. The sounding was characterized as conditionally unstable with a Lifted Index (LI) of 1.0 and a Most Unstable LI of -2.0.

⁴ The HRRR is a National Oceanic and Atmospheric Administration (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 Skew T log P diagram – is a standard meteorological plot or thermodynamic diagram 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.

⁶ RAOB software – The complete RAWinsonde OBservation program is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania, for plotting and analyzing upper air data

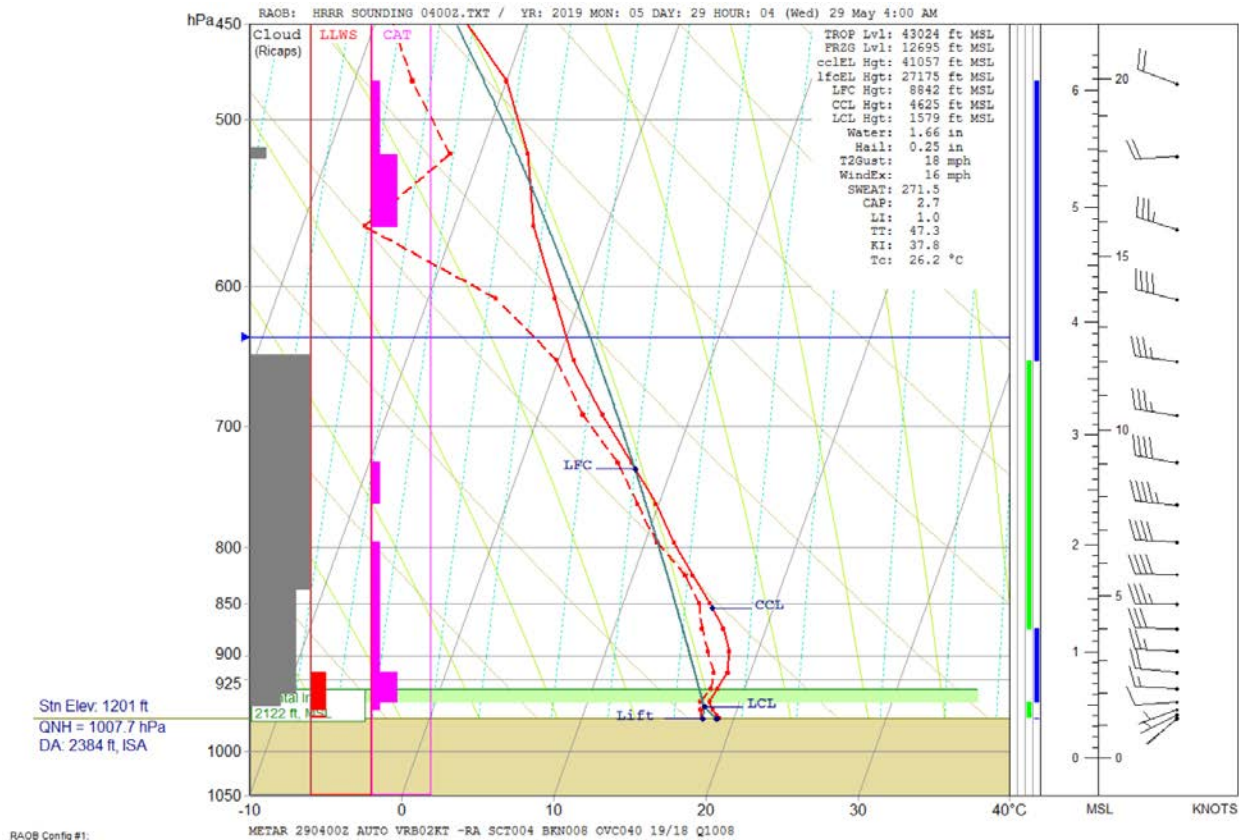


Figure 4 - HRRR model sounding for 2400 EDT over the accident site coordinates

The HRRR 2400 EDT wind profile indicated a calm near-surface wind with the winds from the west immediately this level. Wind speed increased to 15 knots above the frontal inversion. A low-level wind maximum was identified at 7,800 ft from 280° at 44 knots, with the mean 0 to 6 kilometer (~18,000 ft) wind was from 280° at 31 knots. The expected storm motion of any convective storms was from 310° at 24 knots.

Based on the Safety Board's Air Traffic Control Specialist data the accident airplane was cruising at approximately 2,600 ft msl prior to the accident. The conditions at 2,600 ft based on the HRRR model indicated a wind from 275° at 16 knots, a temperature of 18° C, with a 0.9° C temperature-dew point spread. The RAOB algorithm also indicated a high probability of light to moderate turbulence due to a strong vertical wind shear near the frontal inversion and a vertical shear of 4 knots per 1,000 ft. There was also a moderate risk of induction or carburetor type icing.

Based on the HRRR model sounding the RAOB algorithms indicated the conditions at the accident site at 2400 EDT were wind calm, potential for light rain and mist, scattered clouds at 400 ft agl, ceiling broken at 800 ft agl, overcast at 4,000 ft, with a temperature of 19° C, a dew point temperature of 18° C.

4.0 Satellite Imagery

The Geostationary Operational Environmental Satellite number 16 (GOES-16) data was obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System (McIDAS) software. The infrared long wave imagery was obtained surrounding the time of the accident, with the images closest to the time of the accident documented below. The infrared long wave imagery (band 13) at a wavelength of 10.3 microns (μm) provided radiative cloud top temperatures with a nominal spatial resolution of 2 km.

Figure 5 is the GOES-16 infrared image for 2356 EDT at 4X magnification with a standard MB temperature enhancement curve applied to highlight the higher and colder cloud tops typically associated with deep convection. The estimated frontal position based on the NWS 2400 EDT (0000 on May 29, 2019) analysis is also overlaid for reference, with the accident site marked by a white square. The image depicted a broken to overcast layer of low and mid-level clouds over the area with the radiative cloud top temperature over the accident site was observed at -28°C , which corresponded to high cirriform cloud tops near 27,500 ft. Several enhanced areas of cumulonimbus clouds were identified over Pennsylvania moving eastward with time.

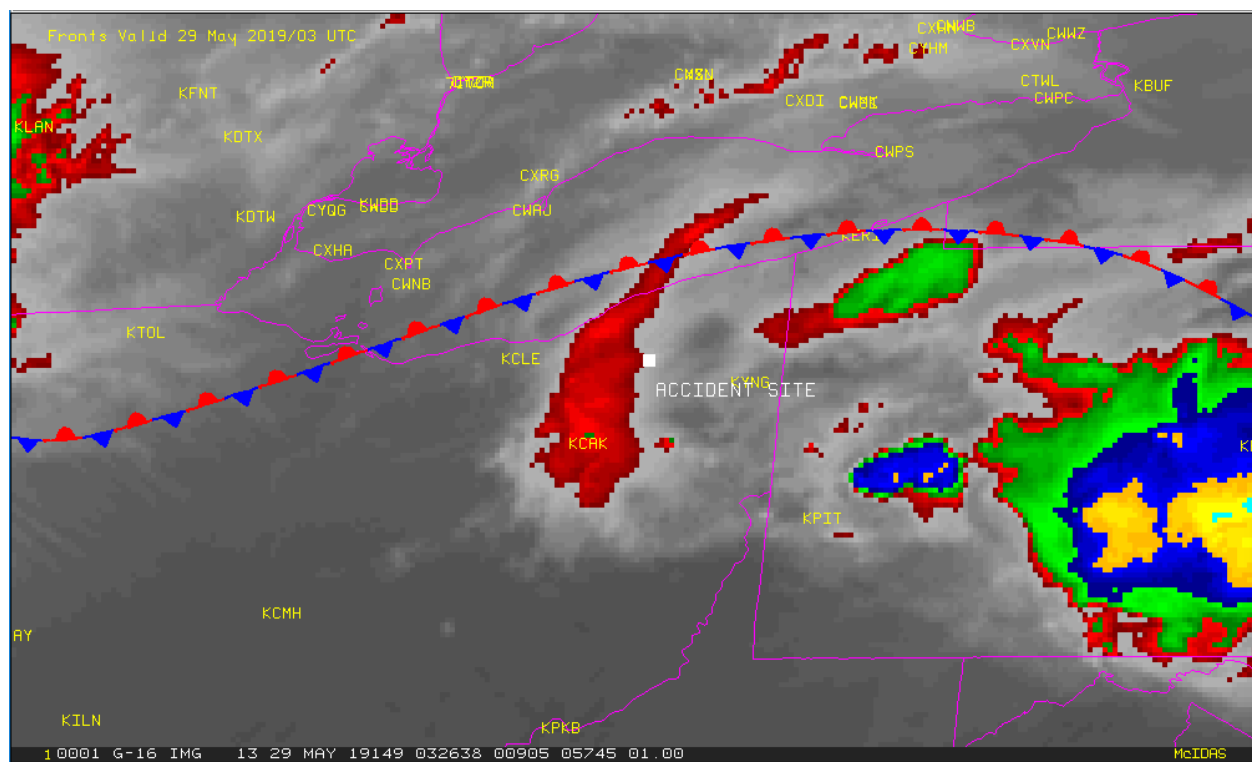


Figure 5 - GOES-16 infrared satellite image for 2356 EDT

5.0 Pilot Reports

The following pilot reports or PIREPs were recorded within 100 miles of the accident site during the period from 1800 EDT on May 28, 2019 through 0400 EDT on May 29, 2019. The original

report in standard code and abbreviations is provided, with a decoded plain language converted to local time following that report.

MFD UA /OV MFD315010/TM 2235/FL160/TP CRJ9/TB LGT-OCNL MDT TURB

Mansfield Lahm Regional Airport (MFD), Mansfield, Ohio, routine pilot report (UA); Over – 315 and 10 miles from MFD VORTAC or approximately 80 miles west-southwest of the accident site; Time – 1835 EDT; Altitude – 16,000 ft; Type aircraft – Canadair Regional air carrier Jet (CRJ); Turbulence – light to occasional moderate turbulence.

AGC UA /OV EWC160025/TM 2238/FL200/TP C560/TB MDT TURB/RM SOUTH OF STORM

Allegheny County Airport (AGC), Pittsburgh, Pennsylvania, routine pilot report (UA); Over – 160° radial and 25 miles from Ellwood City (EWC) VORTAC or approximately 80 miles southeast of the accident site; Time – 1838 EDT; Flight Level – 20,000 ft; Type aircraft – Cessna Citation corporate business jet; Turbulence – moderate turbulence; Remarks – south of storm system.

6.0 NWS Forecasts

6.1 Terminal Aerodrome Forecasts

A Terminal Aerodrome Forecast (TAF) is a concise statement of the expected meteorological conditions to aviation for a specific time period within 5 statute miles of the center of the airport's runway complex or terminal.

The NWS Cleveland, Ohio, Weather Forecast office (WFO) was responsible for the Auburn Township area. No TAFs are issued for the destination airport or for KPOV. The closest TAF to the destination and the accident site was issued for KYNG. The forecast current at the time prior to the accident airplane departing was issued at 1920 EDT and expected a period of thunderstorms and heavy rain, with possible hail up until 2300 EDT. From 2300 through 0400 EDT the forecast expected a wind from 300° at 4 knots, visibility 6 miles or more, with ceiling broken at 3,500 ft agl. The forecast was as follows.

*TAF KYNG 282320Z 2900/2924 29008KT 6SM -TSRA OVC040CB
TEMPO 2900/2903 3SM +TSRAGS OVC012CB
FM290300 30004KT P6SM BKN035
FM290800 VRB03KT P6SM BKN015
TEMPO 2908/2912 BKN008
FM291400 VRB03KT P6SM BKN020
FM291800 22005KT 6SM -SHRA VCTS OVC025CB=*

The forecast was amended at 2218 EDT immediately after the flight departed and removed the thunderstorm and heavy rain and hail from the forecast, with MVFR conditions expected with visibility 6 miles in light rain showers and ceiling overcast at 1,500 ft until 2400 EDT.

***AMD TAF KYNG 290218Z 2902/2924 03006KT 6SM -SHRA OVC015**
FM290400 VRB03KT P6SM BKN035
FM290700 VRB03KT P6SM SCT008 BKN015
TEMPO 2908/2912 BKN008
FM291400 VRB03KT P6SM BKN025
FM291800 22005KT 6SM -SHRA VCTS OVC025CB=*

The forecast was amended immediately after the accident at 0002 EDT and expected a light and variable wind of 3 knots, visibility 4 miles in mist, with ceiling broken at 3,500 ft agl, with a temporary period between 0000 and 0400 EDT of visibility 1/4 mile in dense fog, vertical visibility 100 ft agl. The forecast was as follows.

AMD TAF KYNG 290402Z 2904/2924 VRB03KT 4SM BR BKN035
TEMPO 2904/2908 1/4SM FG VV001
FM291400 VRB03KT P6SM BKN025
FM291800 22005KT 6SM -SHRA VCTS OVC025CB=

6.2 Area Forecast Discussion

The NWS WFO issues an Area Forecast Discussion (AFD) at regular intervals and is intended to provide a well-reasoned discussion of the meteorological thinking which went into the preparation of the Zone Forecast Product. The forecaster will try to focus on the most particular challenges of the forecast. The text will be written in plain language or in proper contractions. At the end of the discussion, there will be a list of all advisories, non-convective watches, and non-convective warnings. The term non-convective refers to weather that is not caused by thunderstorms. An intermediate AFD will be issued when either significant forecast updates are being made or if interesting weather is expected to occur.

The NWS KCLE WFO issued the Area Forecast Discussion (AFD) discussing the synopsis, local short term forecast, and the reasoning behind the TAF issuance over the region. The forecast available prior to the accident airplanes departure was issued at 1518 EDT and was as follows, the long term forecast and marine discussions have not been reproduced here.

FXUS61 KCLE 281918
AFDCLE

Area Forecast Discussion
National Weather Service Cleveland OH
318 PM EDT Tue May 28 2019

.SYNOPSIS...

Low pressure over the region will drift northeast tonight driving a weak cold front south into the area this evening. The front will stall in the area tonight and Wednesday as waves of low pressure move east along the boundary. The front will finally drop south of the area behind low pressure Thursday. High pressure will build in for Friday.

.NEAR TERM /THROUGH WEDNESDAY NIGHT/...

Low pressure just north of Lake Erie will move east this evening and in its wake, a cold front will move south into the area. The front is currently in sern lwr MI into central Indiana. There is however, convergence set up across the inland counties from near the FDY area ene, enhanced across nern OH and nwrn PA by the lake breeze. Thunderstorms have developed along this convergence zone. Currently surface based CAPES are around 3500j/kg. Thermodynamics support large hail and strong downburst winds. Shear support steady state, rotating storms especially east half of the area. Expect strong to severe thunderstorms to continue to spread east across the area into early evening. Overnight convection should tend to drift sse and weaken through the late evening. After midnight the HRRR shows convection moving back toward the area from the west along the stalled out boundary. The HRRR takes most of this north more across the lake and possibly affecting some of the northwestern counties. Towards morning another wave will be moving east through

northern Indiana toward northwestern OH. Wednesday this stalled front will be across the area and models show another weak impulse moving east along the front during the day. Would expect redevelopment with the more favored area across the southern and eastern counties. Will need to keep chance pops going through Wednesday night. Towards morning Thursday however will increase pops back to likely in the west as another low approaches from the west. Highs Wednesday from north 70 north to near 80 far south.

.SHORT TERM /THURSDAY THROUGH FRIDAY NIGHT/...

Thursday will likely be another active weather day over the forecast area. A shortwave trough over the central CONUS will propagate east into the Great Lakes region and get absorbed into a larger trough over the eastern CONUS. At the surface a low will enter Ohio and move east across the forecast area. With good forcing expected over the region along with decent instability and moisture and some good jet dynamics, showers and thunderstorms are likely on Thursday and some severe storms may be possible. Have continued with the high likely PoPs, but have not gone to categorical as there are coverage concerns at this time. There are some timing issues still at this time, but Thursday will be yet another day to watch in what is an active weather week. High pressure will emerge over the eastern Great Lakes on Friday behind Thursday's low. Light northerly flow, some slight cold air advection, and sinking air entering the region will keep temperatures near to perhaps a couple degrees below normal.

.AVIATION /18Z Tuesday THROUGH Sunday/...

Showers and thunderstorms will continue to track across northern Ohio and nwrn PA into the evening along and ahead of a weak cold front dropping into the area from the north. Some storms may be severe with strong gusty winds and hail through early evening. Expect CIGS to be low VFR, mostly under 5kft, through the afternoon and evening with IFR/LIFR expected within thunderstorms. The favorable area of thunderstorm development will tend to drift south into the evening with a likely break mid/late evening. Guidance suggests more showers and storms approach from the west after 06z-08z with additional development to be expected into the morning Wednesday. CIGS overnight however should drop to MVFR with the front across the region and very moist air in place. No big change for Wednesday and a mix of VFR down to IFR in weather.

OUTLOOK...Non-VFR possible for periods of time through Thursday.

6.3 Graphic Forecast for Aviation

The Graphic Forecast for Aviation (GFA) replaced the Area Forecast for providing enroute weather conditions and cloud cover with bases and tops. The GFA static forecast for “Aviation Surface Forecast” issued by the AWC during the period for wind, visibility, and weather phenomena, with the Graphic AIRMET (G-AIRMET) Sierra⁷ for IFR conditions is included as figure 6 with the GFA “Aviation Cloud Forecast” provided cloud coverage, bases, layers, and tops with the G-AIRMET Sierra for mountain obscuration issued during the period is included as figure 7. The accident site and destination airport are located within the red circle. The GFA Surface Chart depicted light northwesterly winds of 5 knots, with visibility restricted between 3 to 5 miles, with potential thunderstorms over the area. G-AIRMET Sierra for IFR conditions extended over extreme northeast Ohio, western Pennsylvania, and New York, and included the accident site. The GFA Cloud Forecast expected overcast clouds with bases at 5,000 ft msl (~4,000 ft agl) with tops layered to 37,000 ft. G-AIRMET Sierra for mountain obscuration was current to the east over Pennsylvania, New York.

⁷ Airmen’s Meteorological Information (AIRMET) is a concise description of weather phenomena that are occurring or may occur (forecast) over an area having a significant impact on the safety of aircraft. AIRMET Sierra is for widespread restricted visibility below 3 statute miles and/or ceilings less than 1,000 ft agl or IFR conditions and mountain obscuration conditions.

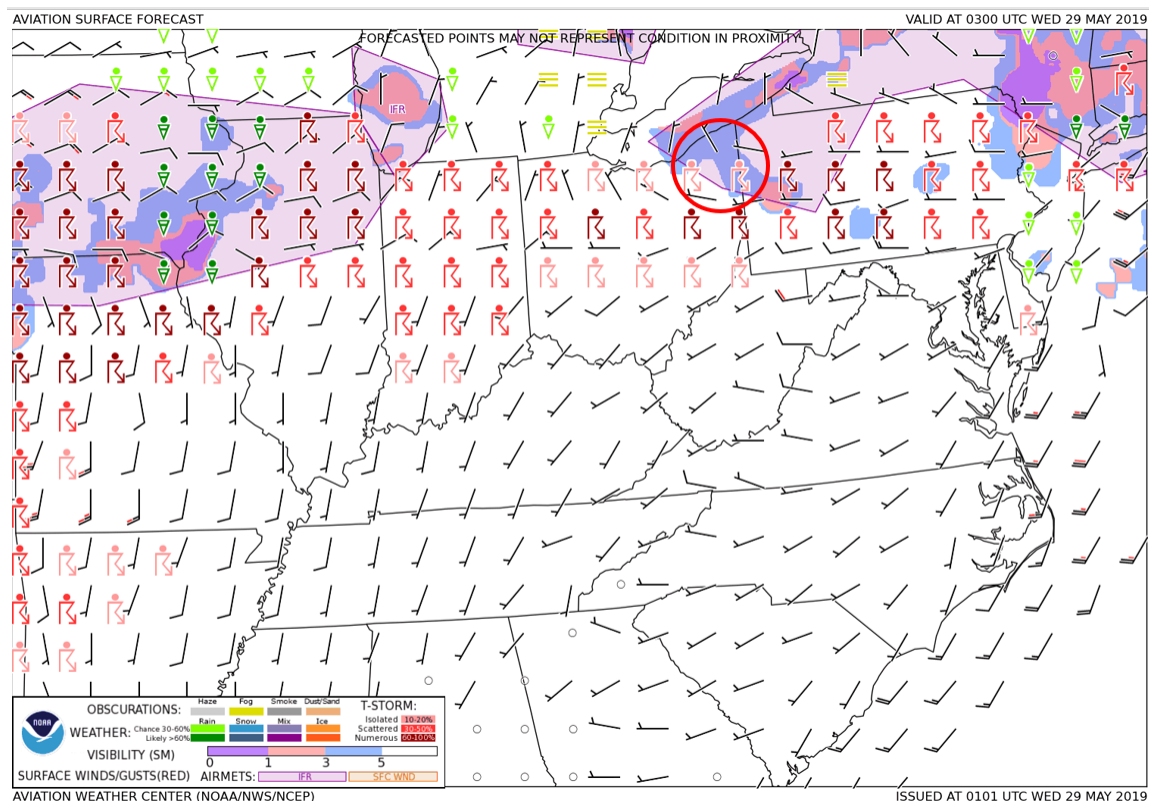


Figure 6 - Graphic Forecast for Aviation Surface Forecast valid for 2300 EDT

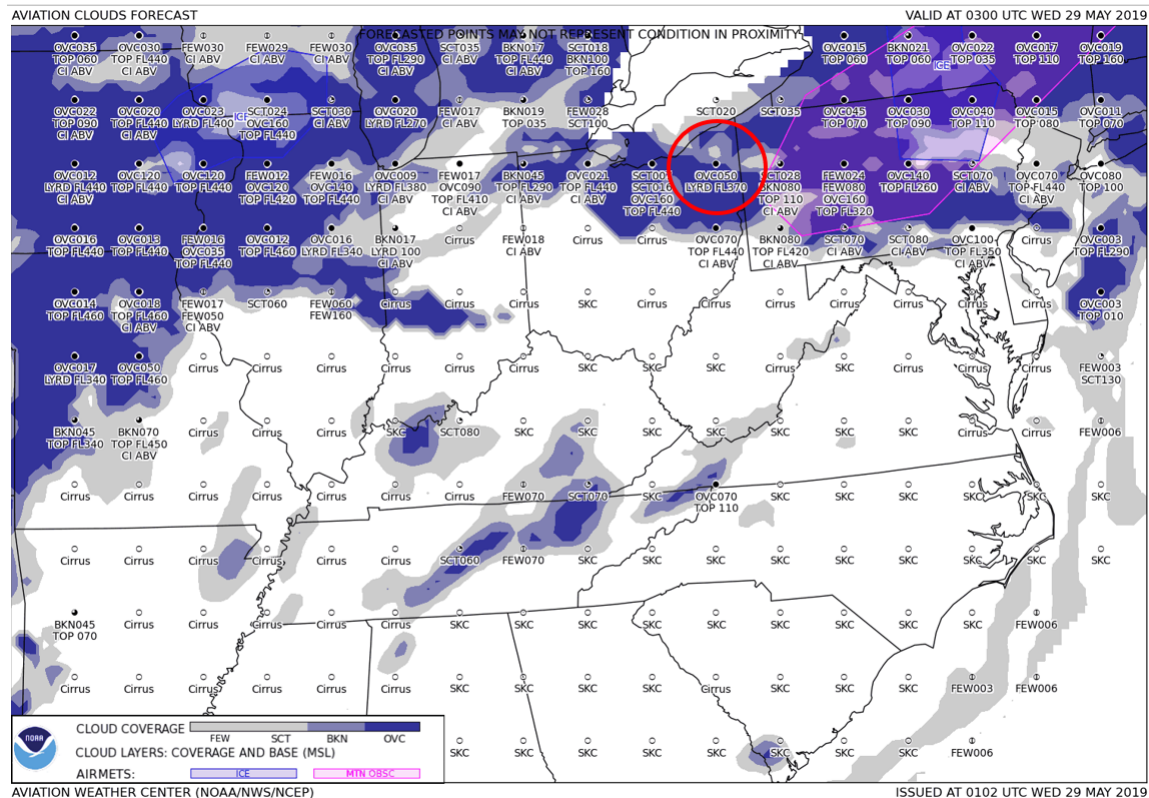


Figure 7 - Graphic Forecast for Aviation Cloud Forecast valid for 2300 EDT

6.4 Winds and Temperature Aloft Forecast

The NWS Winds and Temperature Aloft Forecast for the approximate route of flight current during the period was valid for 0200 EDT on May 29, 2019, and for use between 2200 and 0500 EDT surrounding the period of the accident.

*WINDS ALOFT FORECASTS
DATA BASED ON 290000Z
VALID 290600Z FOR USE 0200-0900Z. TEMPS NEG ABV 24000*

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
CVG	2429	2635+15	2629+12	2627+06	2729-12	2541-20	285137	285647	273858
CMH	2628	2631+14	2620+08	2729+04	2828-10	2744-20	275037	275147	274858
CLE	2617	2734+13	2832+08	2838+03	2740-09	2743-22	275837	275947	275859
AGC	2617	2733+13	2733+08	2834+03	2837-09	2841-21	264737	265247	265459

The wind forecast for CLE for 3,000 ft expected a wind from 260° at 17 knots, with winds at 6,000 ft from 270° at 34 knots with a temperature of 13° C.

7.0 NWS Inflight Weather Advisories

Inflight Aviation Weather Advisories are forecasts to advise en route aircraft of the development of potentially hazardous weather. Inflight aviation weather advisories in the conterminous U.S. are issued by the NWS AWC, as well as from the Center Weather Service Units (CWSU) associated with FAA ARTCCs. There are four basic types of inflight aviation weather advisories: the Significant Meteorological Information (SIGMET), the Convective SIGMET, the AIRMET, and the Center Weather Advisory (CWA). Inflight advisories serve to notify en route pilots of the possibility of encountering hazardous flying conditions which may not have been forecast at the time of the preflight briefing. Whether or not the condition described is potentially hazardous to a particular flight is for the pilot to evaluate on the basis of experience and the operational limits of the aircraft. The following advisories were current during the period.

The NWS AWC issued Convective SIGMETs 8E at 2255 EDT and Convective SIGMET 10E at 2355 EDT for an area of severe thunderstorms over extreme eastern Ohio, West Virginia, and Pennsylvania, which were moving eastward at 40 knots, with tops to 45,000 ft. These advisories extended immediately east of the direct route of flight and the accident site.

*WSUS31 KNCI 290255
SIGE
-MKCE WST 290255
CONVECTIVE SIGMET 8E
VALID UNTIL 0455Z
PA WV OH
FROM 40ENE CLE-50SW HNK-40WSW HAR-20NE AIR-40ENE CLE
AREA SEV TS MOV FROM 27040KT. TOPS TO FL450.
HAIL TO 1.0 IN...WIND GUSTS TO 50KT POSS.*

*WSUS31 KNCI 290355
SIGE
-MKCE WST 290355*

CONVECTIVE SIGMET 10E
 VALID UNTIL 0555Z
 PA WV OH
 FROM 40S JHW-40NNE ETX-20N EMI-40SSE CLE-40S JHW
 AREA SEV TS MOV FROM 27040KT. TOPS TO FL450.
 HAIL TO 1.0 IN...WIND GUSTS TO 50KT POSS.

The NWS AWC also issued AIRMETs Sierra for IFR conditions and mountain obscuration conditions and they are depicted in figure 8. The image depicts the AIRMET Sierra for IFR conditions extending over northeast Ohio and included the accident site. The text versions of the advisories follow the graphic image.

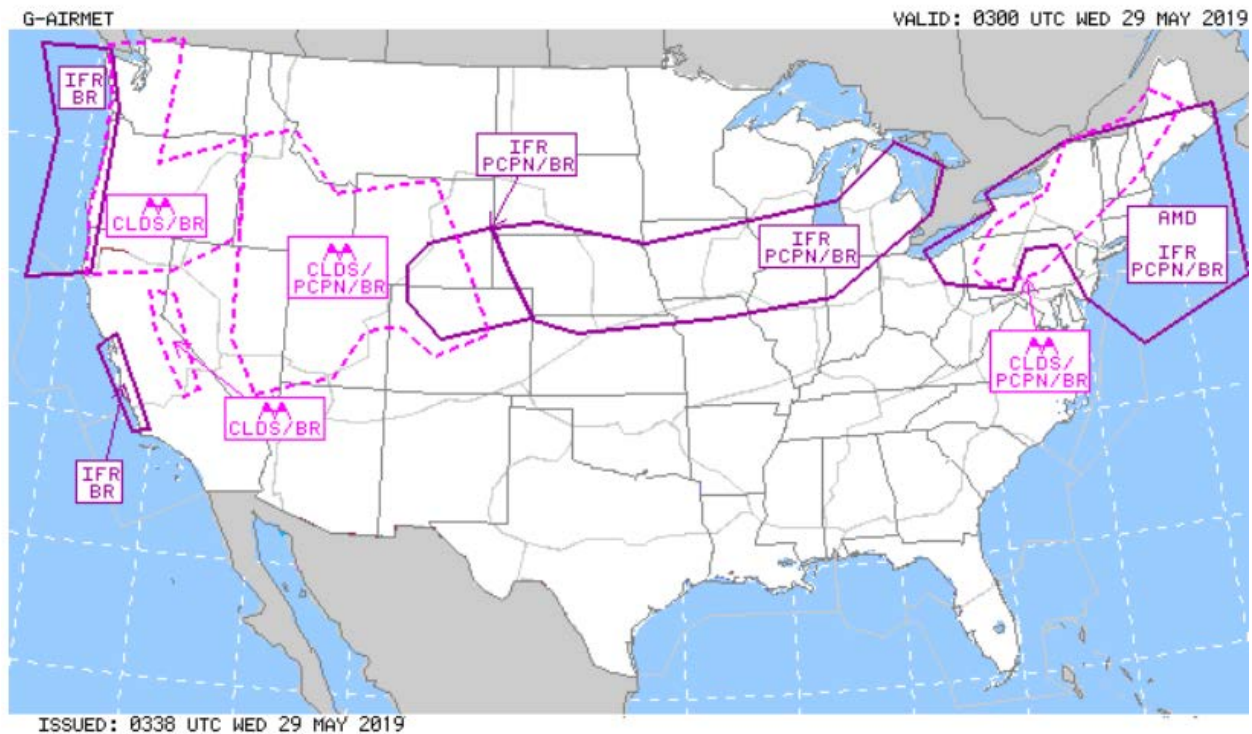


Figure 8 - AIRMET Sierra for IFR and mountain obscuration conditions

WAUS41 KPCI 290245
 WA1S
 BOSS WA 290245
 AIRMET SIERRA FOR IFR AND MTN OBSCN VALID UNTIL 290900

AIRMET IFR...ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DE AND CSTL WTRS
 FROM 20ESE PQI TO 50WSW YSJ TO 200SE ACK TO 160SE SIE TO 20NNW SIE TO 20SSE AIR TO
 20W FWA TO 30SE ECK TO 90SW YOW TO MSS TO YSC TO 60ESE YQB TO 20ESE PQI
 CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 09Z THRU 15Z.

WAUS41 KPCI 290338 AAA
 WA1S
 BOSS WA 290338 AMD
 AIRMET SIERRA UPDT 1 FOR IFR AND MTN OBSCN VALID UNTIL 290900

AIRMET IFR...ME NH VT MA RI CT NY LO NJ PA OH LE WV MD AND CSTL WTRS...UPDT

*FROM 20SE PQI TO 40WSW YSJ TO 200SE ACK TO 180SE SIE TO SIE TO 20SE AIR TO 20W FWA TO 30SSE ECK TO 90ENE YYZ TO 30NE MSS TO YSC TO 50ESE YQB TO 20SE PQI
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 09Z THRU 15Z.*

The NWS AWC also had AIRMET Tango current for moderate turbulence below 15,000 ft over the region which included the accident site. The text of the advisory is included below.

WAUS41 KPCI 290245

WA1T

-BOST WA 290245

AIRMET TANGO FOR TURB AND LLWS VALID UNTIL 290900

*.
AIRMET TURB...ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DC DE VA AND CSTL WTRS
FROM 60SW YSJ TO 200SE ACK TO 160SE SIE TO HNV TO HNN TO CVG TO FWA TO 20SW DXO
TO 40SE DXO TO 20WSW BUF TO 20ESE YYZ TO 50S BGR TO 60SW YSJ
MOD TURB BLW 150. CONDS CONTG BYD 09Z THRU 15Z.*

8.0 Preflight Weather Briefing

A search of the Federal Aviation Administration's contract Automated Flight Service Station (AFSS) provider Leidos indicated that they recorded that the accident pilot filed a VFR flight plan utilizing Garmin Pilot App for the flight departing at 1830 EDT flying direct at 4,500 ft to the destination with an estimated time of arrival at 1955 EDT. However, the pilot did not request any weather or route briefings during the period. A similar search of ForeFlight also indicated that they had no contact with the pilot on the day of the accident. It is therefore unknown what weather information the pilot may have used to brief himself prior to departing on the flight.

9.0 Astronomical Data

The United States Naval Observatory's website provided the following astronomical conditions for Ravenna, Portage County, Ohio for May 28th. The time of the accident has been included in bold italic print for reference.

Sun

Beginning of civil twilight	0524 EDT
Sunrise	0557 EDT
Sun transit	1322 EDT
Sunset	2048 EDT
End of civil twilight	2124 EDT
<i>Accident</i>	<i>2355 EDT</i>

Moon

Moonrise	0313 EDT
Moonset	1453 EDT

At the time of the accident both the Sun and the Moon were more than 15° below the horizon and provided no illumination. The Moon phase was a waning crescent.

Submitted by:

Don Eick
Senior Meteorologist