



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

May 18, 2020

Weather Study

METEOROLOGY

CEN20LA127

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A. ACCIDENT

Location: Pleasant Prairie, Ohio
Date: March 18, 2020
Time: 2247 eastern daylight time
0247 Universal Coordinated Time (UTC) on March 19, 2020
Aircraft: Piper PA-28; Registration: N3943T

B. METEOROLOGIST

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National Transportation Safety Board

C. SUMMARY

On March 18, 2020, about 2247 eastern daylight time, a Piper PA-28R-180 airplane, N3943T, was destroyed when it was involved in an accident in Pleasant Plain, Ohio. The pilot was fatally injured. The airplane was operated as a Title 14 *Code of Federal Regulations* (CFR) Part 91 personal flight. The flight originated in El Paso, Texas, with a destination of Clermont County Airport (KI69), Batavia, 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 39.294167° N and longitude 84.107778° W, at an elevation of 755 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) and the Weather Prediction Center (WPC) 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 2.

1.1 Surface Analysis Chart

The NWS high-resolution Surface Analysis Chart for 2300 EDT on March 18, 2020 (0300Z on March 19, 2020) centered over Ohio is included as figure 1 with the approximate accident site marked by a red star.

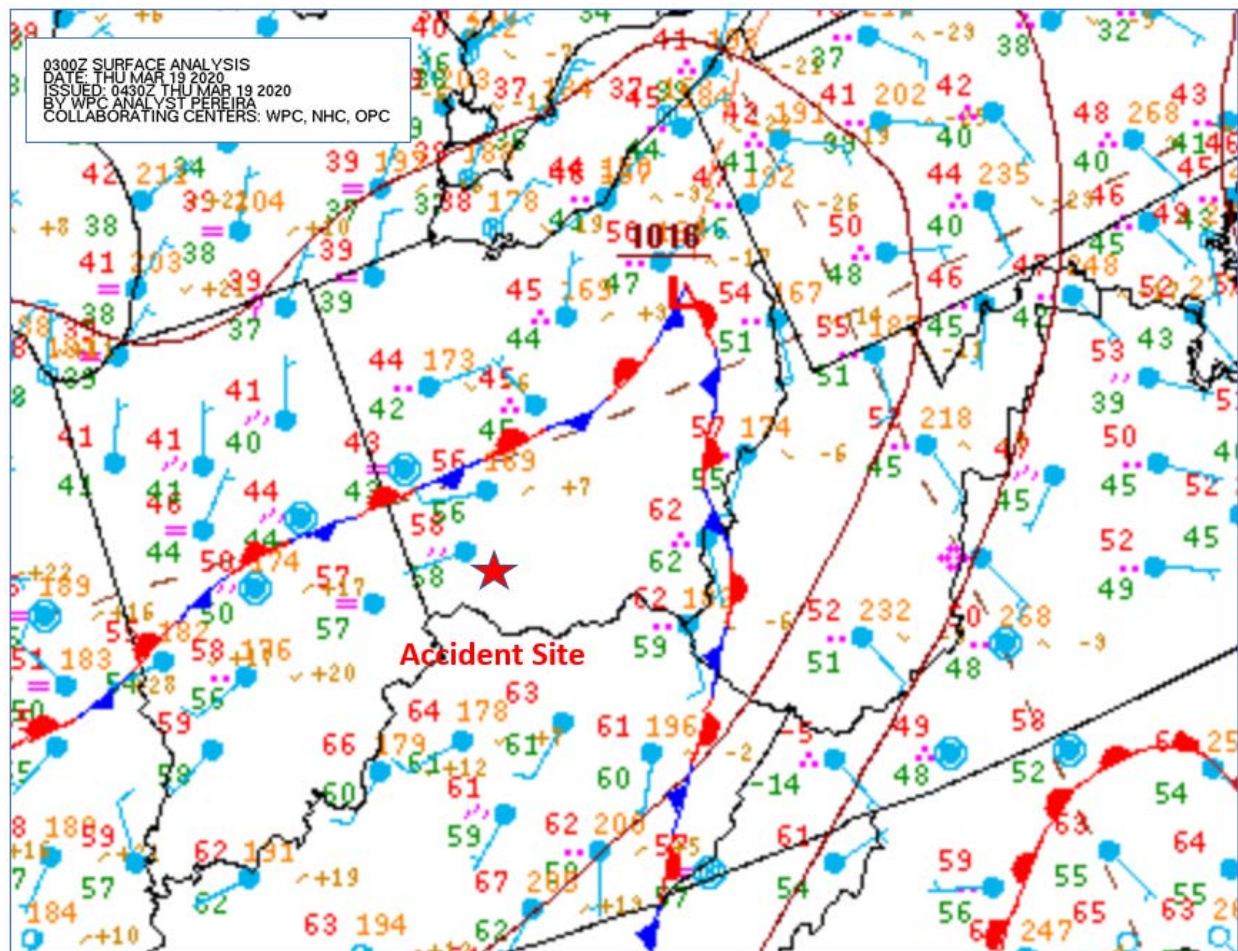


Figure 1 - NWS Surface Analysis Chart for 2300 EDT with the accident site marked by the red star

The Surface Analysis Chart for 2300 EDT depicted a low-pressure system over northeastern Ohio with a central pressure of 1016-hectopascals (hPa)¹ along a stationary front which extended westward across Ohio, Indiana, Illinois, Missouri, and Kansas. The stationary front was located to the north of the accident site and was generally parallel to the accident aircraft's route of flight. Another stationary front extended southward from the low across eastern Ohio, West Virginia, eastern Kentucky and Tennessee, and was located generally along the western slope of the Appalachian Mountain Range. The accident site was located in a wedge between these two stationary fronts.

The station model on the surface analysis chart in the general vicinity west of the accident site depicted westerly winds of about 5 knots, light drizzle, overcast cloud cover, with a temperature and dew point temperature of 58° F. Numerous stations surrounding the area depicted visibility restrictions in mist or precipitation from light drizzle to moderate rain and overcast sky conditions.

1.2 National Composite Radar Mosaic

The NCEI National Composite Reflectivity Radar Mosaic for 2245 EDT is included as figure 2 with the approximate accident site marked by the red star. The image depicted an extensive area of moderate to heavy echoes over eastern Ohio with a small band of scattered echoes extending from the Columbus to Cincinnati, Ohio, with the accident site located under this band with echoes ranging from 30 to 40 dBZ. The closest NWS weather surveillance radar will be documented in section 5.0 of this report.



Figure 2 - NWS National Composite Radar Mosaic for 2245 EDT over Ohio with the accident site marked

¹ Hectopascals is the new NWS reference for reporting sea level pressure and is interchangeable with the former term millibar (mb) with the same units. Standard sea-level pressure is 1013.25-hPa at 59° Fahrenheit (F) or 15° Celsius (C).

1.3 Convective Outlook

The NWS Storm Prediction Center (SPC) is tasked with providing timely and accurate forecasts and watches for severe thunderstorms and tornadoes over the contiguous United States. One of their primary products highlighting the expected areas of organized thunderstorms is the Convective Outlook (AC). The intent of the chart is to identify to users where the NWS SPC expects organized thunderstorms and severe thunderstorms² to form. The SPC Convective Outlook current at the time of the accident airplane's departure was issued at 1556 EDT and valid from 1600 through 0800 EDT on March 19, 2020 and is included as figure 3. The image includes the preliminary severe weather reports at the time. The text bulletin issued with the graphic is also included below.

The Convective Outlook indicated an enhanced risk of severe thunderstorms over northern Texas and Oklahoma, a marginal area over Tennessee and Kentucky, and a general risk of airmass type activity over Ohio. The preliminary severe weather reports indicated at least 16 reports of tornadoes, 17 reports of large hail, and high winds reported over Texas and Oklahoma, with no reports in the marginal area over Tennessee and Kentucky, or in Ohio during the period.

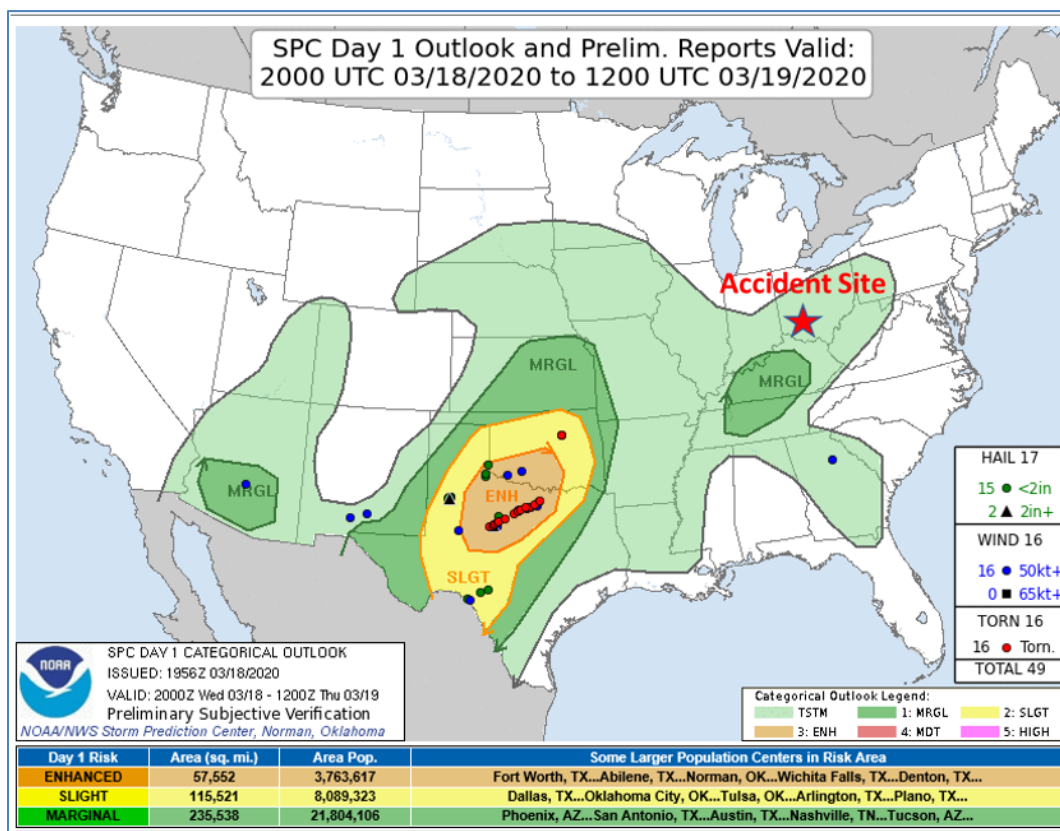


Figure 3 - Convective Outlook issued at 1556 EDT

SPC AC 181956

² A severe thunderstorm is one that produces a tornado, large hail over 1.0 inch in diameter, or outflow winds greater than 50 knots. While all thunderstorms imply the likelihood of severe turbulence, a severe thunderstorm implies a high likelihood of severe to extreme turbulence, wind shear, and a high probability of encountering hail.

Day 1 Convective Outlook
NWS Storm Prediction Center Norman OK
0256 PM CDT Wed Mar 18 2020

Valid 182000Z - 191200Z

...THERE IS AN ENHANCED RISK OF SEVERE THUNDERSTORMS FROM WEST-CENTRAL TEXAS INTO SOUTH-CENTRAL OKLAHOMA...

...SUMMARY...

Scattered severe thunderstorms are expected this afternoon through tonight across parts of the southern and central Plains. Severe wind gusts, large to very large hail, and tornadoes are possible.

...20z Update...

The outlook remains unchanged across the Plains with this update cycle. The ongoing forecast remains on track and in-line with latest guidance and surface observations. Reference MCD 193 for further details on the short-term risk across parts of Texas.

The only change to probabilities has been the removal of the 2% tornado area across southern AZ, where convection will likely remain higher-based and low level shear only marginally favorable. The main threat will continue to be isolated, marginally severe hail and gusty winds.

..Leitman.. 03/18/2020

..PREV DISCUSSION... /ISSUED 1207 PM CDT Wed Mar 18 2020/

...Southern Plains region...

Primary change to previous outlook has been to increase tornado probabilities across west central into northwest through north central TX area. An old outflow boundary will persist in this region, but should become more diffuse with time. Several CAM runs and especially the HRRR continue to initiate storms in warm sector by late afternoon initially along the dryline across west central TX. This initiation would be in advance of primary zone of forcing associated with the shortwave trough currently moving through northern Mexico. While 0-1 km shear will initially be weak/modest, an increase in the low-level jet during the early evening within an otherwise favorable deep-layer shear environment will support potential for supercells with low-level mesocyclones, tornadoes and very large hail as storms move northeast toward central through northwest and north central TX this evening. Otherwise additional storms will likely develop across west TX along retreating dryline during the evening and spread east through TX and OK during the overnight. The shear/instability parameter space will support organized storms with potential for linear/bowing segments as well as supercells capable of all severe hazards.

...Arizona...

A strong shortwave trough will rotate northeast through AZ this afternoon accompanied by steep lapse rates and strong vertical shear. Though weak instability will remain a limiting factor, a few storms could pose a threat for mainly locally strong wind gusts and marginally severe hail.

...Tennessee through Ohio Valley region...

Strong vertical shear accompanying a shortwave trough has spread across TN and KY, but widespread showers/rain continue to limit overall destabilization potential. Will maintain a marginal risk for this region for now, but threat appears very conditional.

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

1.4 12-hour Surface Prognostic Chart

The NWS WPC 12-hour Surface Prognostic Chart current for the period is included as figure 4 and depicted the forecast conditions for 0200 EDT on March 19, 2020. The chart depicted the main low-pressure system moving over Ohio with the trailing stationary front dropping into southern Ohio, Indiana, Illinois, and into central Missouri. The stationary front immediately east of the accident site that extended southward from the low in Ohio was depicted as a warm front that extended into West Virginia, then eastward into southern Virginia, North Carolina, and into the Atlantic. A separate stationary front was depicted in eastern Tennessee into Georgia and South Carolina. A large area of precipitation was depicted ahead of the low and along and south of the stationary front with another area of precipitation in the form of thunderstorms and rain showers extending over Texas into Arkansas, Tennessee, Kentucky and into Ohio. The forecast position of the front was in the vicinity of the destination or accident site and the potential for precipitation greater than 50% was expected over the area during the period.

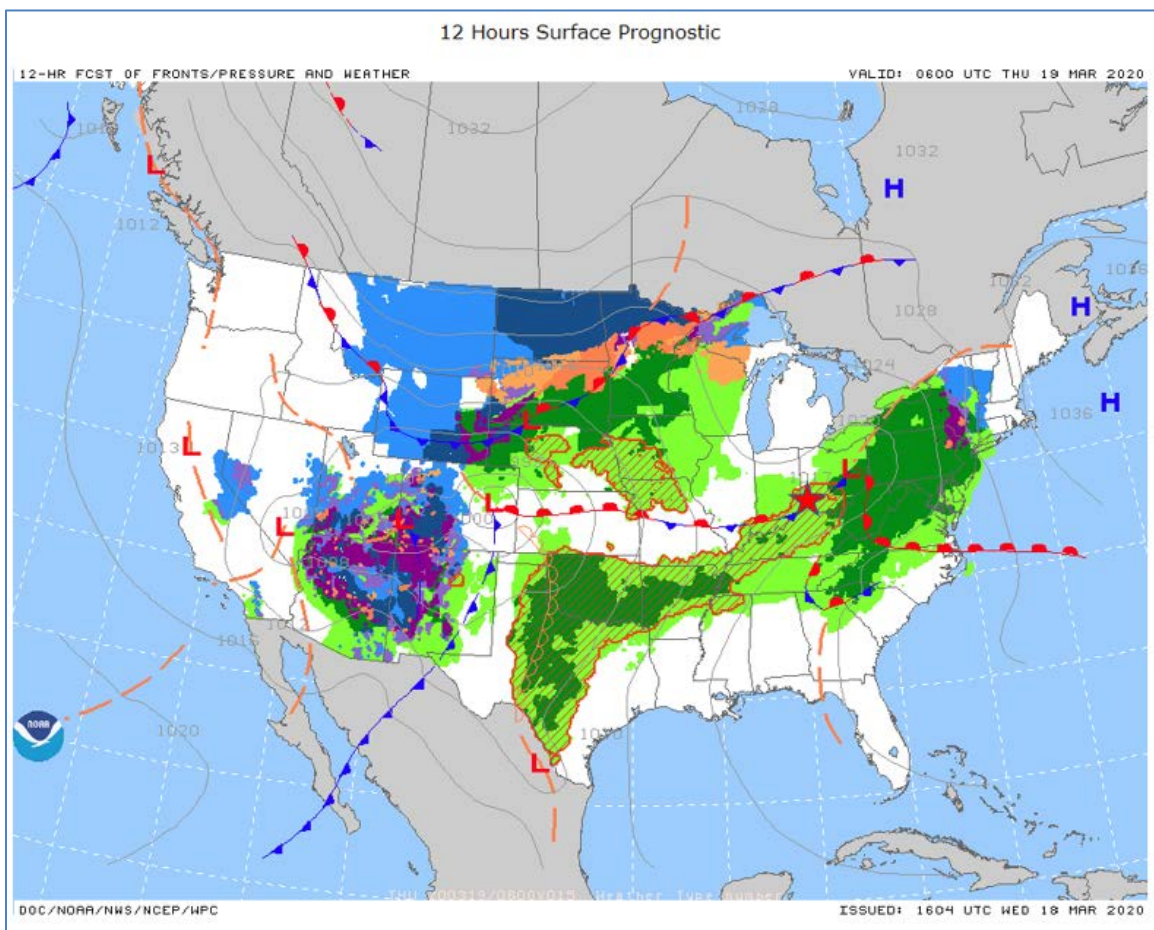


Figure 4 -12-hour Surface Prognostic Chart valid for 02 EDT on March 19, 2020

1.5 12-hour Low-Level Significant Weather Prognostic Chart

The 12-hour Low-Level Significant Weather Prognostic Chart valid for 0200 EDT on March 19, 2020, is included as figure 5. The chart depicted an extensive area of instrument flight rule (IFR) conditions by a red contour over most of the central and eastern United States and included Ohio. Outside the IFR area was an area of marginal visual flight rule (MVFR) conditions indicated by a blue scallop line that extended from Texas eastward through Georgia, with another area of IFR conditions along the Gulf coast. The chart also depicted the freezing level between 8,000 ft and 10,000 ft over Ohio by a thin light blue dashed line. An area of moderate turbulence from the surface through 10,000 ft was depicted over western Ohio and to 15,000 ft over eastern Ohio indicated by the brown dashed line.

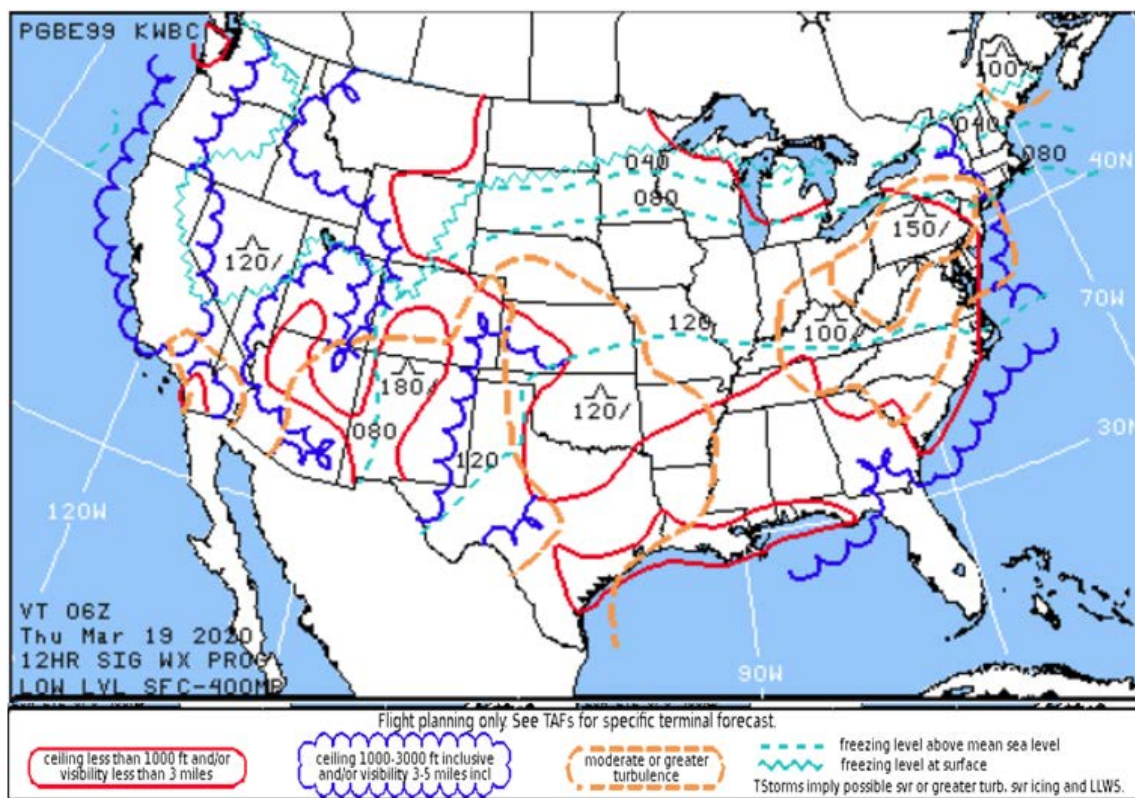


Figure 5 - 12-hour Low-Level Significant Weather Prognostic Chart valid for 0200 EDT on March 19, 2020

2.0 Surface Observations

The official observations issued surrounding the accident site were documented using standard meteorological aerodrome reports (METARs) and specials (SPECI). Cloud heights are reported above ground level (agl) in the following section, and the magnetic variation was estimated at 4° west based on the latest sectional chart for the area.

2.1 Batavia, Ohio

The closest weather reporting station to the accident site was Clermont County Airport (KIA6), Batavia, Ohio, located approximately 14 miles south of the accident site at an elevation of 843 ft. The airport had an Automated Weather Observation System (AWOS) and issued observations every 20-minutes. The following conditions were reported surrounding the time of the accident.

KI69 weather observation at 2236 EDT, automated, wind from 230° at 8 knots, visibility 7 miles in moderate drizzle, ceiling overcast at 600 ft agl, temperature and dew point 16° degrees Celsius (C), altimeter 30.03 inches of mercury (Hg). Remarks: automated station, hourly precipitation 0.01 inches, temperature 16.4° C, dew point 15.9° C.

KI69 weather observation at 2255 EDT, automated, wind from 220° at 8 knots, visibility 5 miles in heavy drizzle, ceiling overcast at 600 ft agl, temperature 17° C, dew point 16° C, altimeter 30.04 inches of Hg. Remarks: automated station with a precipitation discriminator, hourly precipitation (since 2155 EDT) 0.01 inches, 3-hour precipitation total 0.09 inches, temperature 16.5° C, dew point 16.0° C.

The general flight categories³ and raw observations from approximately 2035 through 2316 EDT were as follows:

IFR METAR KIA69 190035Z AUTO 22008G14KT 10SM RA BKN008 BKN029 OVC095 16/15 A3003 RMK AO2 P0001 T01560151=

VFR METAR KIA69 190036Z AUTO 21008KT 10SM RA SCT008 BKN050 OVC095 16/15 A3003 RMK AO2 P0001 T01560151=

VFR METAR KIA69 190055Z AUTO 22006KT 10SM -RA SCT017 BKN032 OVC095 16/15 A3003 RMK AO2 P0002 T01560152=

MVFR METAR KIA69 190056Z AUTO 22007KT 10SM -RA SCT017 BKN030 OVC095 16/15 A3003 RMK AO2 P0002 T01560152=

MVFR METAR KIA69 190115Z AUTO 21007KT 7SM RA SCT008 BKN013 OVC018 16/16 A3003 RMK AO2 P0004 T01590155=

IFR METAR KIA69 190135Z AUTO 21007KT 10SM RA BKN008 OVC012 16/16 A3003 RMK AO2 P0006 T01610157=

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

- 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.

IFR METAR KI69 190155Z AUTO 21009KT 14SM -DZ OVC008 16/16 A3003 RMK AO2 P0006
T01630160=

IFR METAR KI69 190215Z AUTO 22009KT 7SM RA OVC008 17/16 A3002 RMK AO2 T01650159=

IFR METAR KI69 190216Z AUTO 21008KT 7SM RA OVC008 17/16 A3003 RMK AO2 T01650160=

IFR METAR KI69 190235Z AUTO 23007KT 7SM DZ OVC006 17/16 A3003 RMK AO2 P0001 T01650160=

IFR METAR KI69 190236Z AUTO 23008KT 7SM DZ OVC006 16/16 A3003 RMK AO2 P0001 T01640159=

Accident 0247Z

IFR METAR KI69 190255Z AUTO 22008KT 5SM +DZ OVC006 17/16 A3004 RMK AO2 P0001 60009
T01650160=

IFR METAR KI69 190315Z AUTO 23009KT 4SM +RA BKN006 OVC013 16/16 A3004 RMK AO2 P0002
T01630160=

IFR METAR KI69 190316Z AUTO 23009KT 4SM +RA BKN006 OVC013 16/16 A3004 RMK AO2 P0002
T01630160=

2.2 Cincinnati, Ohio

The next closest weather reporting station was Cincinnati Municipal Airport - Lunken Field (KLUK), Cincinnati, Ohio, located 19 miles southwest of the accident site and had an Automated Surface Observation System (ASOS) which was augmented by air traffic control personnel during normal hours of operation and reported the following conditions.

KLUK special weather observation at 2237 EDT, wind from 210° at 8 knots, visibility 10 miles or more, ceiling overcast at 1,400 ft agl, temperature 17° C, dew point 16° C, altimeter 30.02 inches of Hg. Remarks: automated station with a precipitation discriminator, temperature 17.2° C, dew point 16.1° C.

The general flight categories and raw observations from 2100 through 2300 EST were as follow.

IFR SPECI KLUK 181805Z 00000KT 1 3/4SM R21L/6000VP6000FT +RA BR BKN012 BKN034 OVC060
11/09 A3013 RMK AO2 LTG DSNT SW P0004 T01060089

IFR SPECI KLUK 181809Z 00000KT 1 1/4SM R21L/6000VP6000FT +TSRA BR BKN012 BKN030 OVC060CB
11/09 A3013 RMK AO2 LTG DSNT NW TSB08 OCNL LTGCC S TS S MOV NE P0005 T01060089

IFR SPECI KLUK 181821Z 27004KT 2SM R21L/3000VP6000FT TSRA BR BKN012 BKN030 OVC060CB 10/09
A3013 RMK AO2 LTG DSNT NW TSB08 OCNL LTGCC E TS E MOV NE P0020 T01000094

IFR SPECI KLUK 181837Z 00000KT 2 1/2SM R21L/5000VP6000FT RA BR FEW010 BKN021 OVC036 10/10
A3011 RMK AO2 LTG DSNT E TSB08E36 TS MOV NE P0028 T01000100

MVFR METAR KLUK 181853Z 02003KT 5SM -RA BR SCT013 BKN020 OVC036 11/10 A3010 RMK AO2 LTG
DSNT NE AND E TSB08E36 SLP193 TS MOV NE P0029 T01060100

MVFR SPECI KLUK 181924Z 03003KT 4SM -RA BR SCT008 OVC026 11/11 A3008 RMK AO2 P0002
T01110106

IFR SPECI KLUK 181939Z 34004KT 2 1/2SM -RA BR BKN007 OVC026 11/11 A3008 RMK AO2 P0004

IFR SPECI KLUK 181950Z 00000KT 1 3/4SM R21L/5500VP6000FT RA BR BKN007 BKN015 OVC029 11/11
A3007 RMK AO2 P0008

IFR METAR KLUK 181953Z 00000KT 2SM R21L/6000VP6000FT RA BR BKN007 BKN015 OVC031 11/11
A3007 RMK AO2 SLP184 P0009 T01060106

IFR METAR KLUK 182053Z 35003KT 2 1/2SM -RA BR BKN008 OVC012 11/11 A3003 RMK AO2 SLP171
P0013 60051 T01110106 58022

IFR METAR KLUK 182153Z 00000KT 2 1/2SM R21L/5000VP6000FT RA BR SCT007 BKN011 OVC017 12/12
A2999 RMK AO2 SLP157 P0007 T01220117

IFR SPECI KLUK 182200Z 27005KT 1 1/4SM R21L/5000VP6000FT RA BR SCT007 BKN013 OVC021 12/12
A2999 RMK AO2 P0003 T01170117

IFR SPECI KLUK 182208Z 28008KT 1 1/4SM RA BR BKN007 OVC017 12/12 A3000 RMK AO2 P0005
T01170117

LIFR SPECI KLUK 182225Z 16005KT 1/2SM R21L/3500VP6000FT +RA FG BKN006 BKN022 OVC070 13/13
A3000 RMK AO2 P0024 T01330133

IFR SPECI KLUK 182231Z 31003KT 1 1/4SM R21L/4500VP6000FT RA BR SCT006 BKN027 OVC070 13/13
A2999 RMK AO2 P0026 T01280128

IFR SPECI KLUK 182241Z VRB04KT 1 1/2SM -RA BR FEW006 SCT037 OVC070 14/13 A2999 RMK AO2
P0027 T01390133

MVFR METAR KLUK 182253Z 22004KT 4SM -RA BR FEW035 BKN070 OVC090 15/14 A3000 RMK AO2
SLP159 P0030 T01500139

MVFR SPECI KLUK 190129Z 20009KT 10SM -RA BKN014 BKN028 OVC038 17/16 A3002 RMK AO2 P0003
T01670156=

MVFR SPECI KLUK 190150Z 21010KT 10SM BKN016 OVC021 17/16 A3002 RMK AO2 RAE34 P0003=

MVFR METAR KLUK 190153Z 21010KT 10SM BKN016 OVC021 17/16 A3002 RMK AO2 RAE34 SLP164 P0003
T01670156=

MVFR **SPECI KLUK 190237Z 21008KT 10SM OVC014 17/16 A3002 RMK AO2 T01720161=**

Accident 2247Z

MVFR METAR KLUK 190253Z 21009KT 10SM BKN013 OVC019 17/16 A3003 RMK AO2 SLP168 60004
T01670156 53004=

MVFR SPECI KLUK 190308Z AUTO 28008KT 4SM +RA BR SCT010 BKN015 OVC021 17/16 A3004 RMK AO2
RAB04 P0002 T01670161=

MVFR SPECI KLUK 190316Z AUTO 27011KT 6SM -RA BR FEW008 BKN013 OVC040 17/16 A3004 RMK AO2
RAB04 P0002 T01670156=

MVFR SPECI KLUK 190327Z AUTO 26010KT 9SM -RA FEW008 BKN024 OVC036 17/15 A3005 RMK AO2 RAB04 P0002 T01670150=

A further review of the METARs for the period prior to 2100 EDT indicated that thunderstorms and rain showers had moved through the area between 1400 through 2132 EST with approximately 0.95 inches of precipitation, before the second band moved through at 2304 EDT.

2.3 METAR Display

The METAR display from the NWS Aviation Weather Center's website for southwestern Ohio for 2208 and 2308 EDT with the radar image overlaid are included as figures 6-7 respectively. The charts depicted the general flight categories by the color coded station model, station identifier, and weather conditions at the time of the images, with the temperature and dew point temperatures provided in °F. The stations surrounding the accident site reported MVFR to LIFR conditions across the region with overcast cloud cover and visibilities restricted in mist, drizzle and rain. A narrow band of echoes is also noted moving eastward at 2208 EDT and extending over the accident site by 2308 EDT.

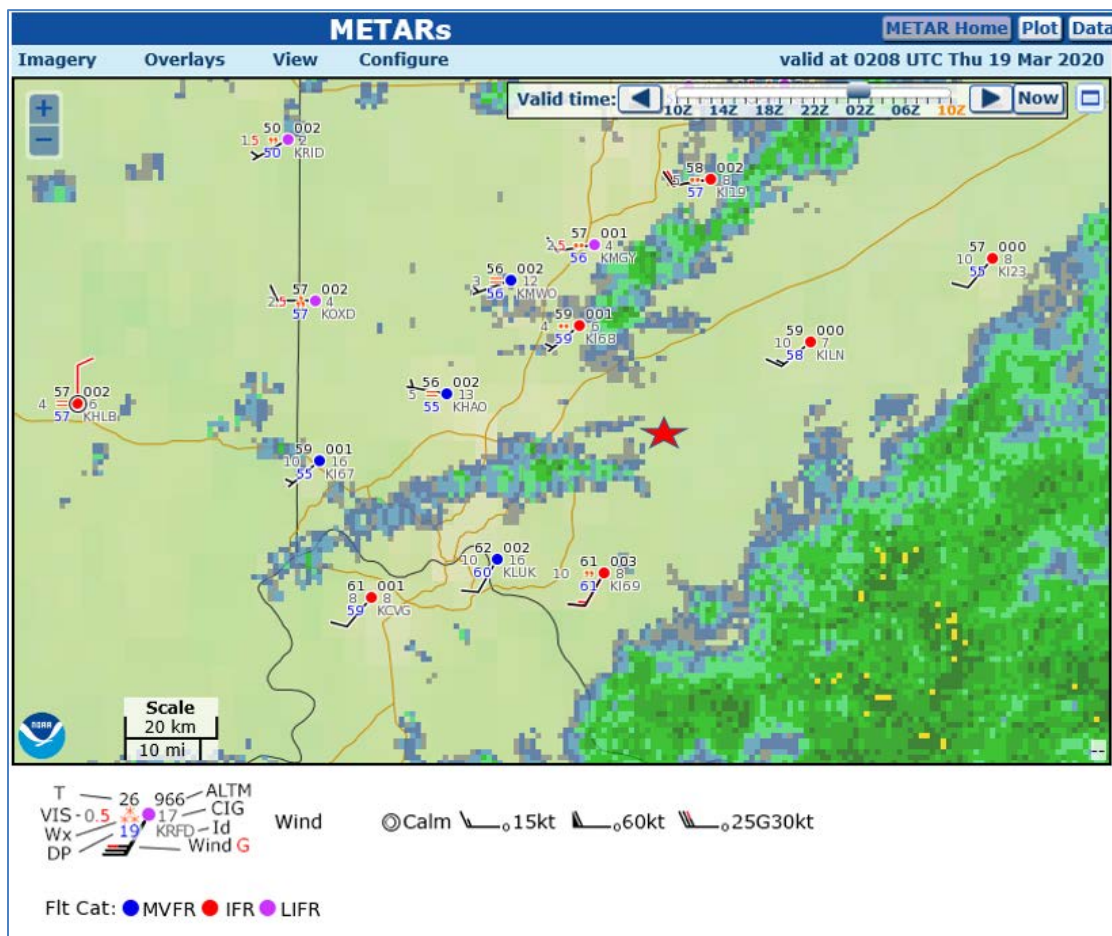


Figure 6 - NWS AWC METAR display at 2208 EDT with the radar and accident site overlaid

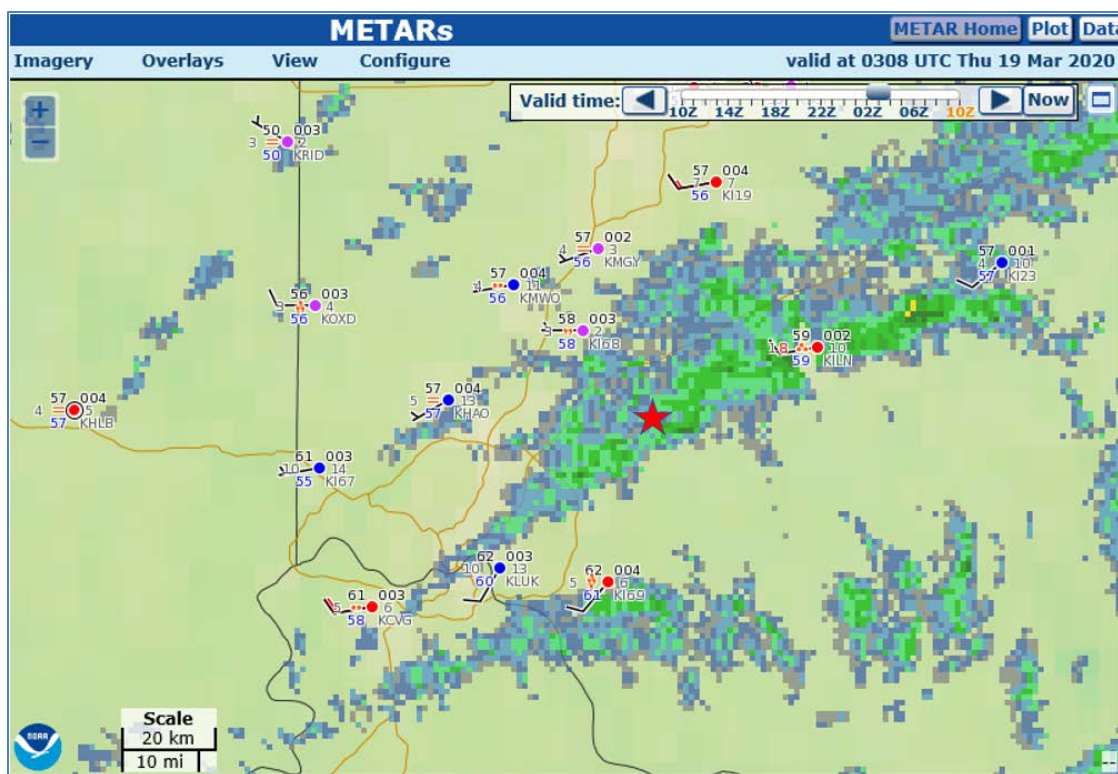


Figure 7 - NWS AWC METAR display at 2308 EDT with the accident site and radar overlaid

3.0 Sounding

To determine the vertical structure and state of the atmosphere over the accident site the closest NWS sounding from Wilmington (KILN), Ohio, 15 miles northeast of the accident site and High-Resolution Rapid Refresh (HRRR)⁴ numerical model data were retrieved from the NOAA Air Resources Laboratory and plotted on a standard Skew T log P diagram⁵ using the complete Rawinsonde Observation RAOB program software⁶.

3.1 NWS Wilmington Sounding

Figure 8 is the observed NWS KILN rawinsonde observation for 2000 EDT from the surface to 450-hPa or about 21,000 ft. The KILN sounding indicated a station elevation of 1,007 ft with a near surface temperature and dew point of 13° C with a relative humidity of 100%. The lifted condensation level (LCL)⁷ was identified immediately above the surface at about 700 ft agl (1,048

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

⁷ Lifted Condensation Level (LCL) - the level at which a lifted parcel becomes saturated. The LCL height corresponds

ft msl) and with a nearly isothermal layer where temperature remained nearly constant with increasing height to about 3,800 ft. The convective condensation level (CCL)⁸ was at 3,700 ft agl (4,746 ft) and was identified immediately above the isothermal or stable layer. The precipitable water⁹ content was 1.25 inches. The RAOB algorithm supported multiple layers of clouds with bases at approximate 1,700 ft agl with tops near 20,000 ft and supported light rain at the surface. The freezing level was identified at about 10,930 ft, and supported icing in clouds above this level. The atmosphere was characterized as conditionally unstable.

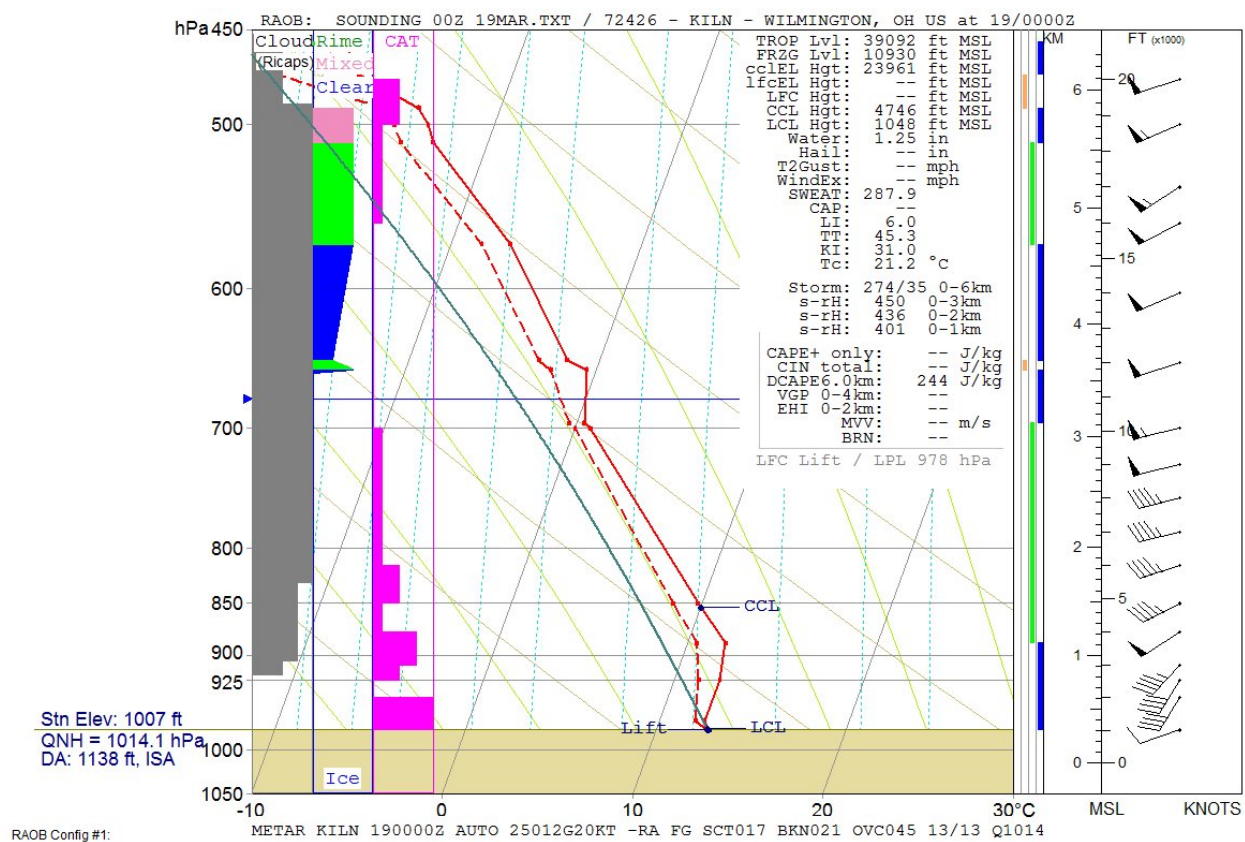


Figure 8 - Observed NWS KILN 2000 EDT sounding

The KILN observed 2200 EDT sounding wind profile indicated a surface wind from the west-southwest or from 250° at 12 knots, with winds backing¹⁰ to the south immediately above the surface with increasing wind speeds to 40 knots immediately above the surface at 2,000 ft and then veering¹¹ west-southwestward with height above the isothermal layer at 4,000 ft where a low-level wind maximum was also observed with the wind was from 240° at 50 knots. The mean 0 to 6 kilometer storm motion wind was from 275° at 35 knots. Winds were westerly at 50 knots or more

to cloud base height for forced ascent.

⁸ 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.

⁹ Precipitable Water (PW) is a measure of the depth of liquid water at the surface that would result after precipitating all of the water vapor in a vertical column over a given location, usually extending from the surface to 300 mb.

¹⁰ A backing wind is a wind that turns counter-clockwise with height. A backing wind is associated with cold air advection and dynamic sinking.

¹¹ Veering wind is a wind the turns clockwise with height, and is normally associated with warm air advection.

above 9,000 ft. The wind profile supported the potential for moderate turbulence below 5,000 ft due to strong vertical wind shears.

3.2 Numerical Model Sounding

Figure 9 is the HRRR numerical model sounding for 2300 EDT from the surface through 450-hPa or approximately 21,000 ft over the approximate accident site. The HRRR sounding indicated a station elevation of 748 ft with a near surface temperature and dew point of 16° C with a relative humidity of 100%. The LCL was at 1,000 ft, the CCL was at 2,444 ft, and the level of free convection (LFC)¹² at 4,483 ft. The model indicated a similar precipitable water content of 1.27 inches. The RAOB algorithm supported an overcast cloud layer with a base near 1,300 ft agl with tops near 10,000 ft, with another layer of scattered clouds above between 12,000 and 16,000 ft. The freezing level was identified at about 11,000 ft. The atmosphere was characterized as conditionally unstable with a Lifted Index¹³ of 0.0, and a Convective Available Potential Energy (CAPE) of 47 Joules/kilogram. The maximum vertical velocity (MVV) was 10 meters/second or 20 knots.

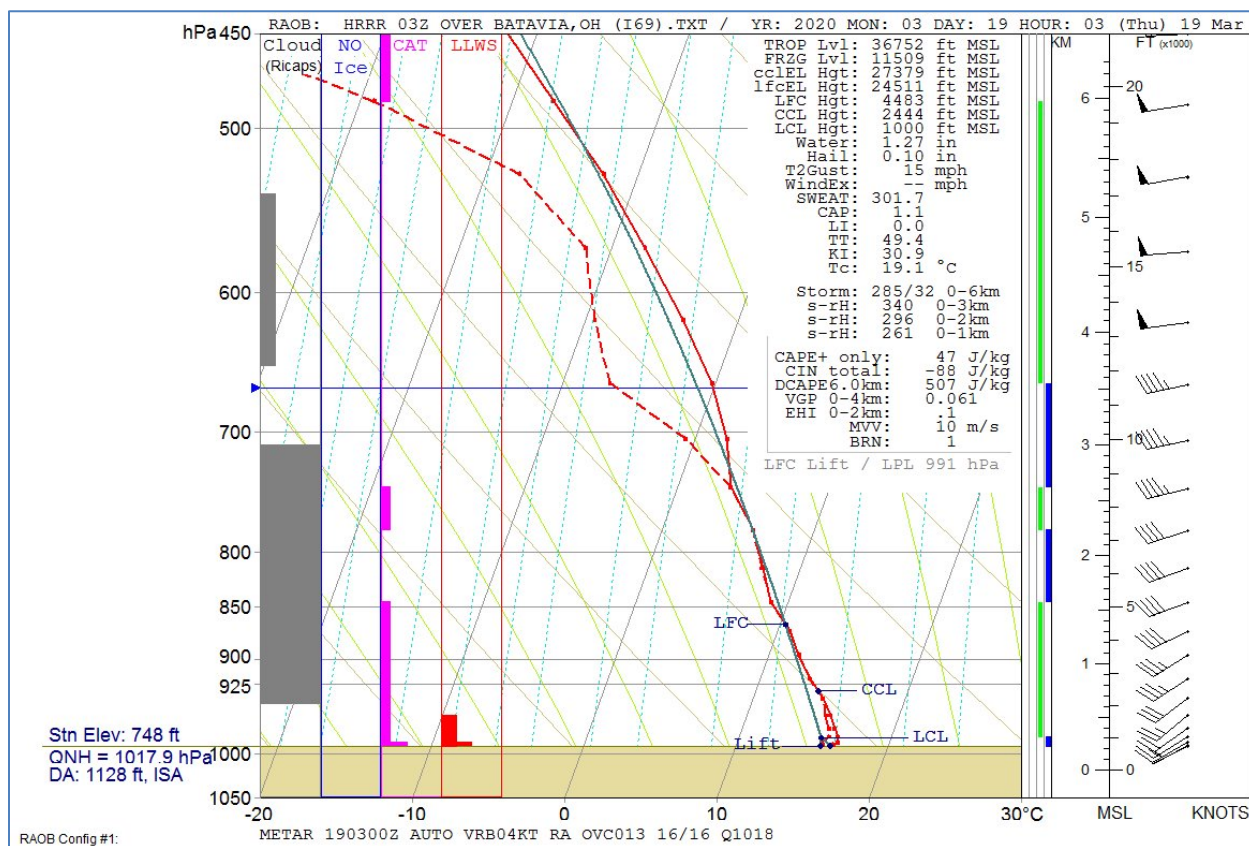


Figure 9 - HRRR sounding for 2300 EDT over the accident site

¹² Level of Free Convection (LFC) - the last level where a parcel becomes buoyant, or "warmer" than the environmental temperature at the same level. The LFC represents the bottom of the layer containing CAPE.

¹³ Lifted Index (LI) - the difference between the lifted parcel temperature at 500 hPa and the 500 hPa temperature in the sounding. Negative values denote parcels that are warmer than the background 500 hPa temperatures and are thus buoyant or "unstable".

The HRRR wind profile indicated surface wind from the southwest at 5 knots or less, with winds veering slowly to the west with height with increasing wind speeds immediately above the surface. At 3,000 ft the wind was from approximately 240° at 35 knots. The HRRR wind profile reduced the turbulence potential below 6,000 ft over the region.

Figure 10 is a comparison of the two soundings, with the KILN observed 2000 EDT sounding (color coded in blue) and the HRRR numerical model for 2300 EDT over the accident site (color coded in red). The HRRR model sounding did not capture the low layer isothermal layer or the low-level wind maximum, and generally smoothed the wind field. Both soundings however depicted a saturated layer supporting overcast clouds from about 1,200 ft through at least 10,000 ft.

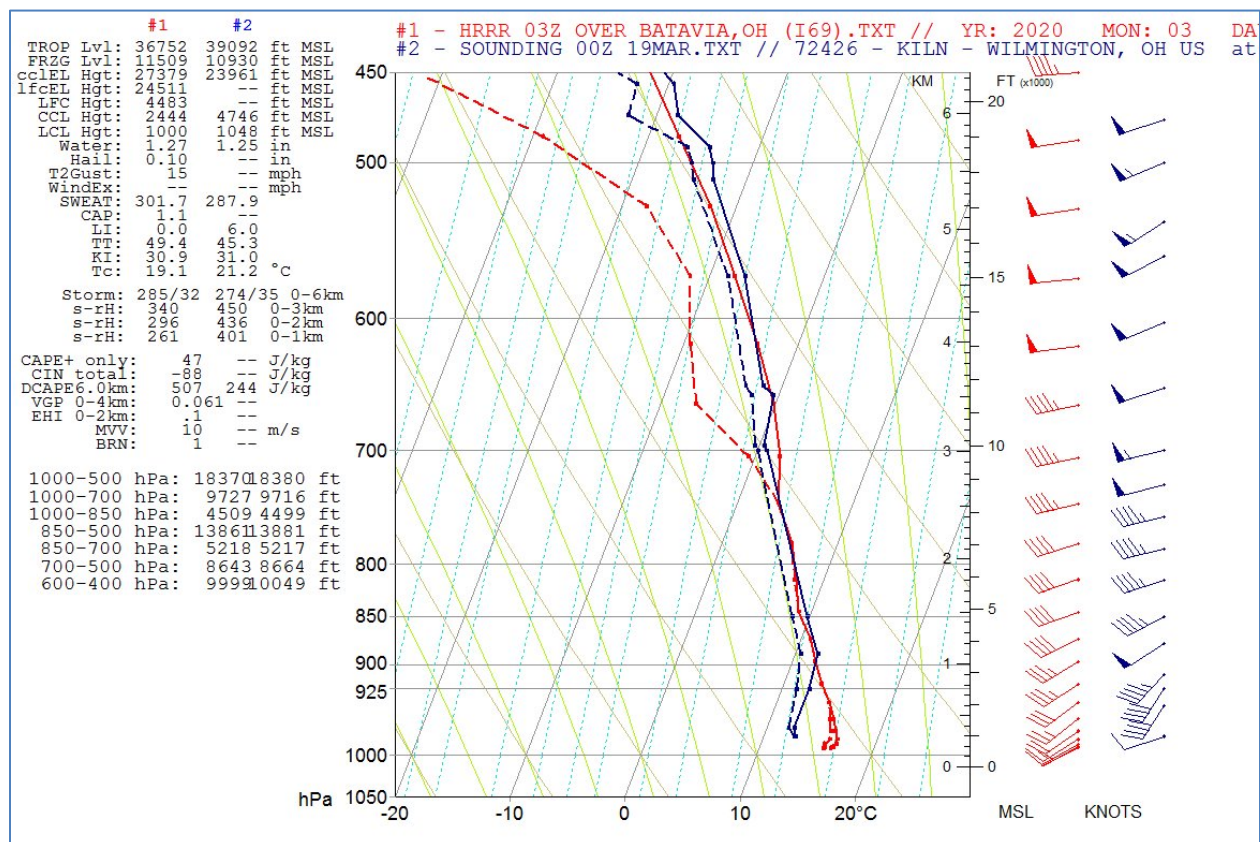


Figure 10 - KILN observed 2000 EDT (blue) and HRRR model sounding for 2300 EDT (red)

4.0 Satellite Imagery

The Geostationary Operational Environmental Satellite number 16 (GOES-16) imagery data were 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 for times 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.

The GOES-16 infrared image at 2X magnification for 2246 EDT with a standard MB temperature enhancement curve applied to highlight the higher and colder cloud tops associated with deep convection with the fronts from 2300 EDT overlaid is included as figure 11. The image depicted an extensive area of low stratiform clouds over the region and accident site. The radiative cloud top temperature over the accident site was 0.8° C, which corresponding to tops near 10,000 ft based on the soundings. The closest defined cumulonimbus type clouds were identified approximately 60 miles east of the accident site over south-central Ohio.

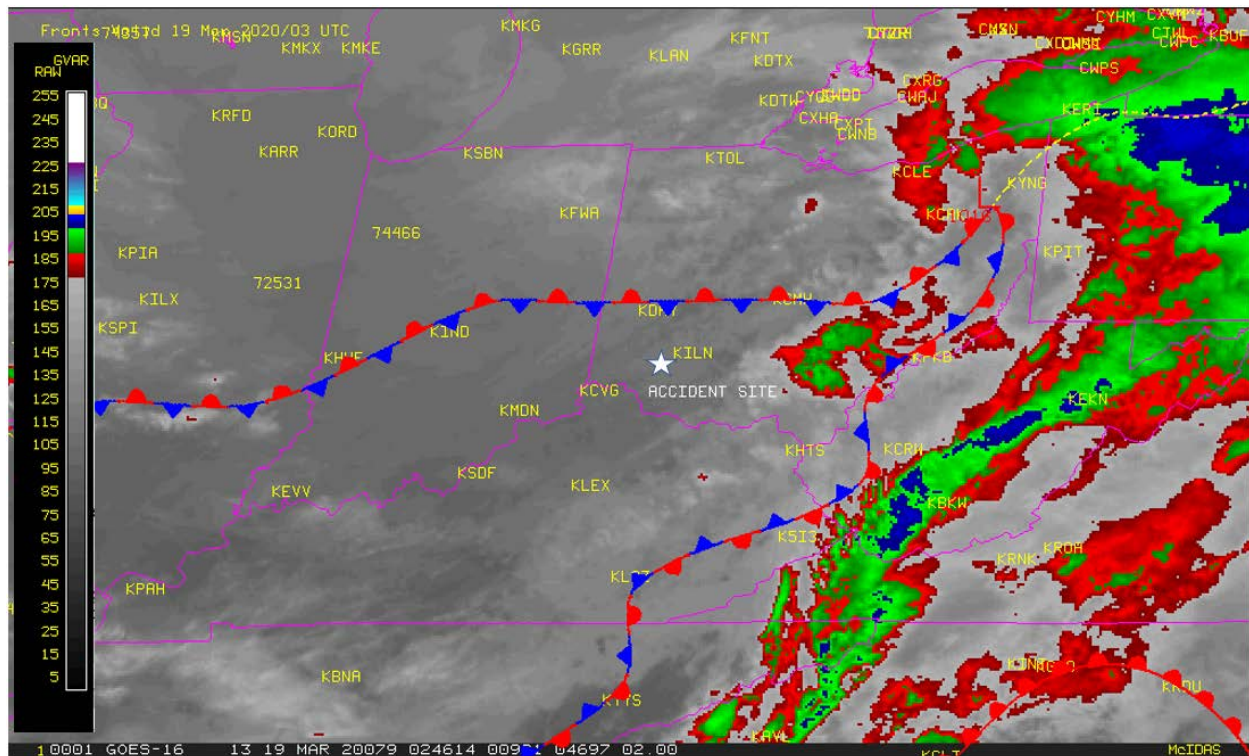


Figure 11 - GOES-16 infrared image at 2246 EDT at 2X magnification with a standard MB temperature enhancement curve applied and the frontal positions at 2300 EDT overlaid. The accident site is marked by the white star.

5.0 Weather Surveillance Radar Imagery

The closest NWS Weather Surveillance Radar 1988 Doppler (WSR-88D) was located approximately 15 miles northeast of the accident site at KILN¹⁴. The level II archive data was obtained from the NCEI using the Hierarchical Data Storage System and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software.

The WSR-88D is a S-band 10-centimeter wavelength radar with a power output of 750,000 watts, with a 28-foot parabolic antenna concentrating the energy into a 0.95° beam width. The radar produces three basic types of products reflectivity, radial velocity, and spectral width.

¹⁴ The WSR-88D Radar Data Acquisition (RDA) system location was in Wilmington, Ohio, and served the greater Cincinnati area with the NWS Weather Forecast Office.

5.1 Volume Scanning Strategies

During the period the KILN WSR-88D was operating in the precipitation mode volume scan pattern 12 (VCP-12), where the radar makes 14 different elevation scans in 4 minutes. This scanning strategy is often used during periods of convection and provides extra low elevation angles that increase the low-level vertical resolution of the potential storms. Figure 12 is a depiction of the VCP-12 scanning strategy with the beam height for the various elevation scans. Based on the chart the 0.5° and 0.9° elevation scans best covered the altitudes along the final minutes of the flight.

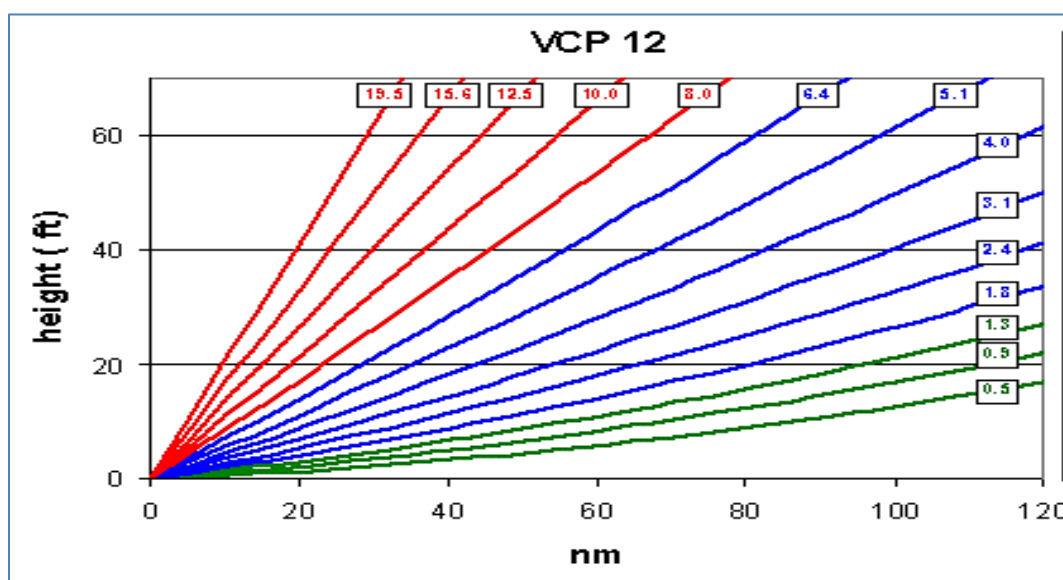


Figure 12 – VCP-12 scanning strategy depiction

5.2 Beam Height Calculations

Assuming a standard refraction¹⁵ of the WSR-88D 0.95° radar beam with the KILN antenna elevation at 1,170 ft and at 26 miles or as the accident airplane position at 2236 EDT at 3,800 ft, the 0.9° elevation scan best captured the flight conditions and was centered at 4,040 ft with the base at 2,730 ft and the top of the beam at 5,350 ft. Over the accident site at 15 miles from the radar, the 0.5° elevation scan was centered near 3,000 ft with the base of the beam at 1,690 ft and top of the beam near 4,310 ft and best captured the conditions at the accident airplanes last reported altitude of 2,800 ft.

5.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors¹⁶, it is a function of the drop size distribution, number of particles per

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

¹⁶ Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at the earth's surface. Hydrometeors are classified as; (a) Liquid or solid water particles suspended

unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in decibels (dBZ¹⁷) and is a general measure of echo intensity. Figure 13 relates the NWS former video integrator and processor (VIP) intensity levels (1-6) versus the WSR-88D's display levels (0-15), precipitation mode reflectivity in decibels (DBZ), and rainfall rates.

NWS VIP/DBZ CONVERSION TABLE			
NWS VIP	WSR-88D LEVEL	PREC MODE DBZ	RAINFALL
0	0	< 5	
	1	5 to 9	
	2	10 to 14	
1 Very Light	3	15 to 19	.01 in/hr
	4	20 to 24	.02 in/hr
	5	25 to 29	.04 in/hr
2 Light to Moderate	6	30 to 34	.09 in/hr
	7	35 to 39	.21 in/hr
3 Strong	8	40 to 44	.48 in/hr
4 Very Strong	9	45 to 49	1.10 in/hr
5 Intense	10	50 to 54	2.49 in/hr
6 Extreme	11	55 to 59	>5.67 in/hr
	12	60 to 64	
	13	65 to 69	
	14	70 to 74	
	15	> 75	

Figure 13 - NWS VIP levels, WSR-88D levels, reflectivity in dBZ and rainfall rates

The FAA has taken the NWS previous VIP levels 1 to 6 intensity levels and has redefined the intensity levels for pilots in Advisory Circular AC 00-24C - "Thunderstorm". That AC further defines echoes less than 30 dBZ as "light" in intensity, "moderate" echoes 30-40 dBZ, "heavy" with echoes of >40-50 dBZ, and "extreme" intensity with echoes above >50 dBZ. These are the new standard radio phraseology terms used by air traffic controllers to describe weather conditions to pilots as shown in figure 14.

Reflectivity (dBZ) Ranges	Weather Radar Echo Intensity Terminology
< 30 dBZ	Light
30 – 40 dBZ	Moderate
>40 – 50 dBZ	Heavy
>50 dBZ	Extreme

Figure 14 - Reflectivity values and echo intensity terminology

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 glaze ice.

¹⁷ dBZ - 10 log Ze

5.4 Composite Reflectivity Imagery

Composite reflectivity images utilize all elevation scans during each volume scan to create the image. It is composed of the greatest echo intensity (reflectivity) from any elevation angle seen from the radar. It is used to reveal the highest reflectivity value in the column. Composite reflectivity image is one of the last radar image views, necessitated by the need for all elevation scans to be completed before this image can be produced. Figures 15-17 are the KILN WSR-88D composite reflectivity images at approximately 2236, 2240, and 2245 EDT with the flight track overlaid. The images show the accident airplane enter into a band of light to moderate intensity echoes and then turn southward into moderate to heavy intensity echoes near 40 dBZ¹⁸, when the aircraft is observed beginning a spiral left descent into the ground.

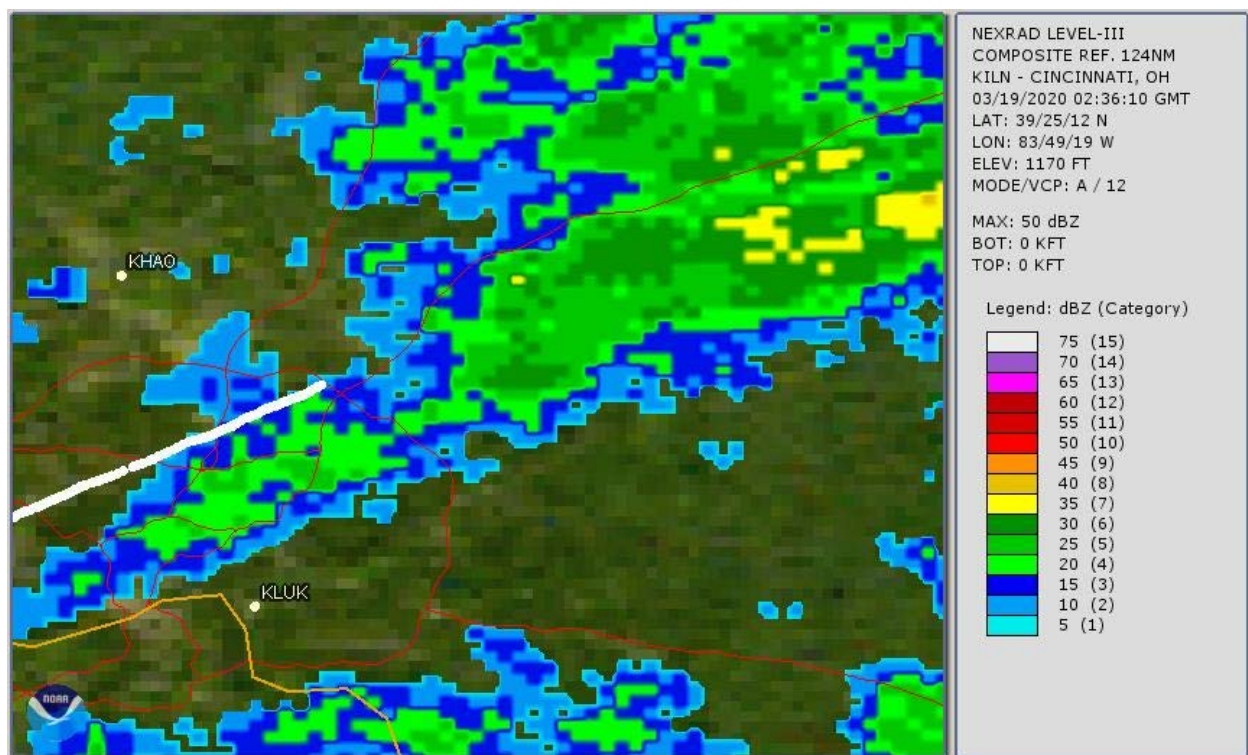


Figure 15 - KILN WSR-88D composite radar image for 2236 EDT with the flight track overlaid

¹⁸ According to the NTSB Air Traffic Control Specialist Report as N314VR turned southbound the accident pilot reported they were experiencing “heavy turbulence” and then stated they were experiencing a “heavy downdraft”.

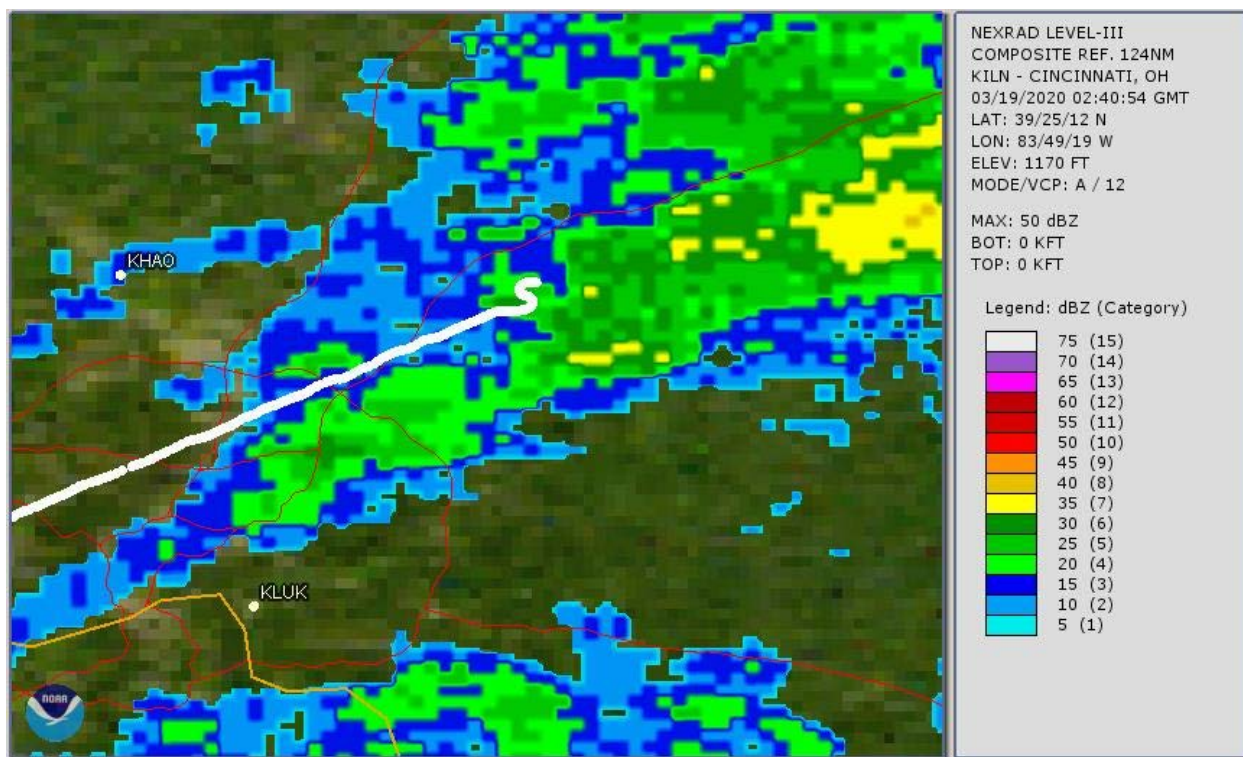


Figure 16 - KILN WSR-88D composite radar image for 2240 EDT with the flight track overlaid

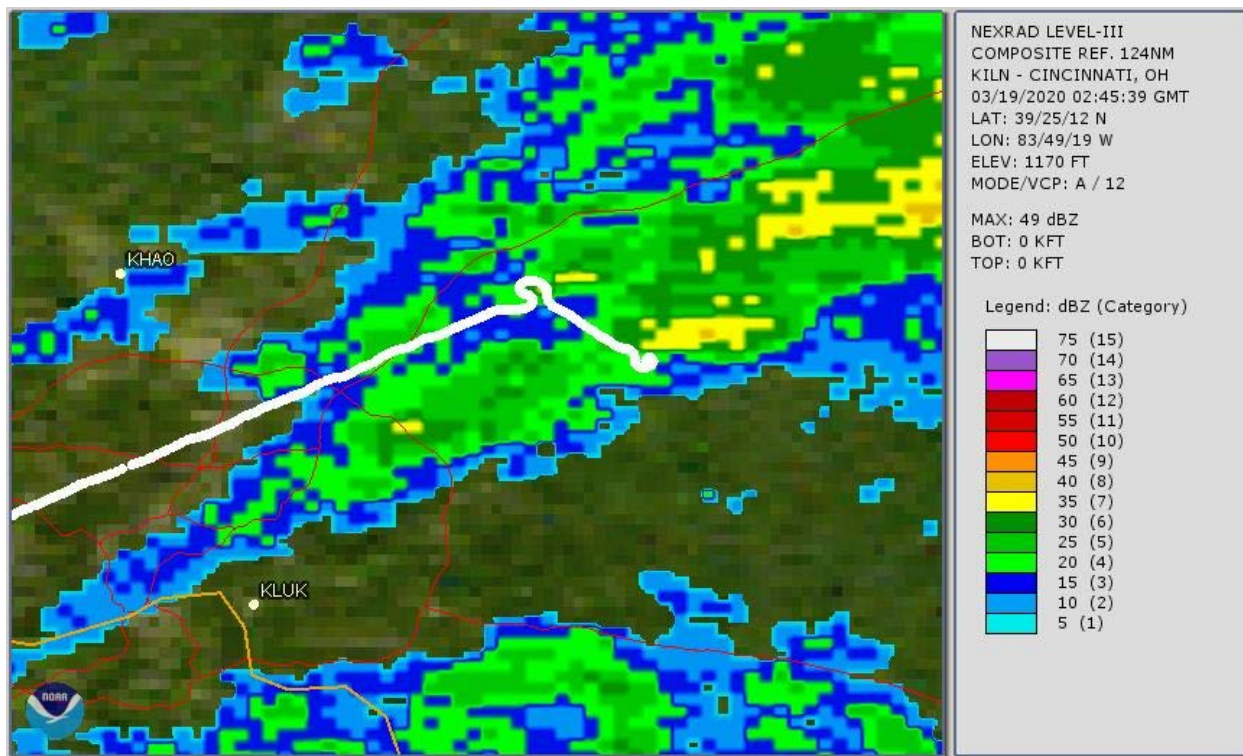


Figure 17 - KILN WSR-88D composite radar image for 2245 EDT with the flight track overlaid

5.5 Base Reflectivity Imagery

The NWS WSR-88D base reflectivity images are the individual elevation scan images for the VCP being operated. The lowest 0.5° base reflectivity elevation scan is often the one radar product distributed by vendors and also available on NWS sites, unless the user has the analysis software to open and view all the VCP scanning strategy for storm structure and to identify other features.

Figures 18-20 are the KILN WSR-88D 0.88° base reflectivity image for 2036 EDT, and the 0.5° base reflectivity images at 2040 and 2045 EDT with the flight track overlaid. The images continue to show the accident airplane encounter a band of echoes from 20 to 42 dBZ or moderate to heavy intensity echoes¹⁹.

A separate review of the KILN WSR-88D echo tops product depicted the maximum height of echoes of 18.5 dBZ to approximately 10,000 ft over the flight track and accident site, with maximum echo tops to about 25,000 ft located approximately 60 miles east to southeast of the radar site (refer to figure 3 National Composite Radar image).



Figure 18 - KILN WSR-88D 0.88° base reflectivity image at 2236 EDT with flight track overlaid

¹⁹ According to the NTSB Air Traffic Control Specialists Report after the accident aircraft turned southbound the pilot advised they were experiencing “heavy turbulence” and then stated they were experiencing a “heavy downdraft” immediately prior to entering a rapid left turn.

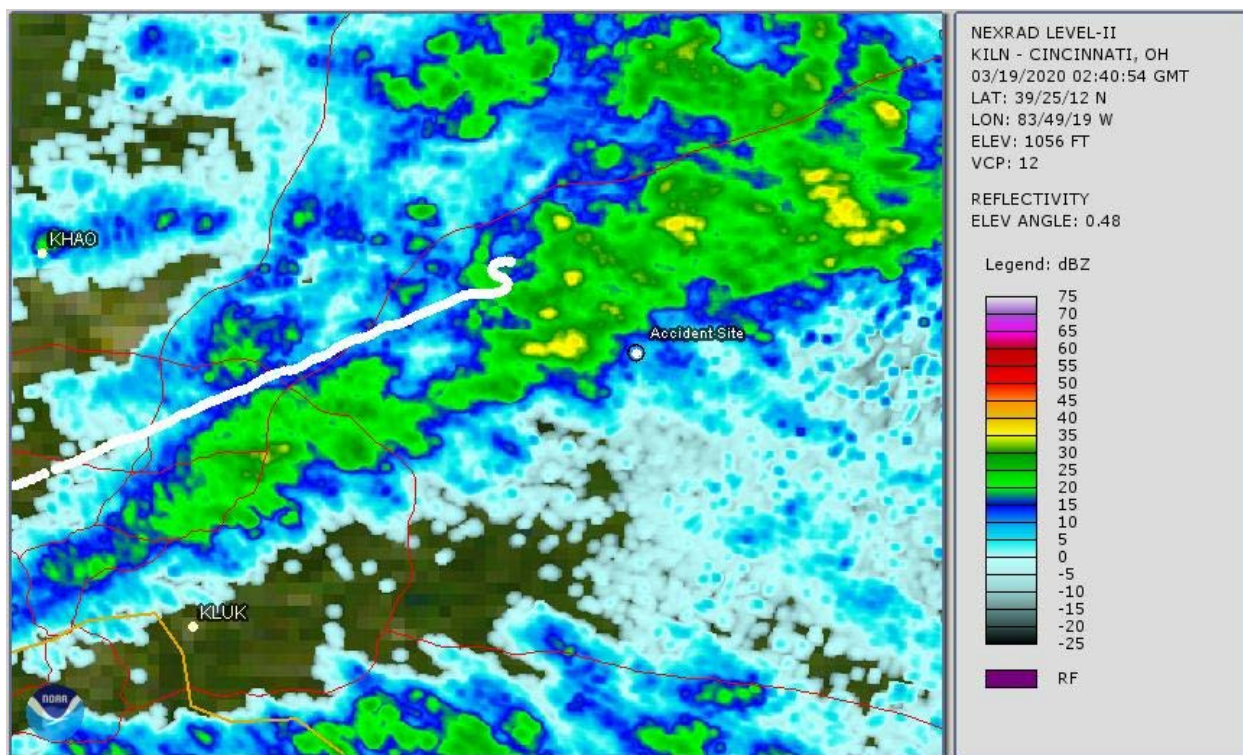


Figure 19 - KILN WSR-88D 0.5° base reflectivity image for 2240 EDT with flight track overlaid

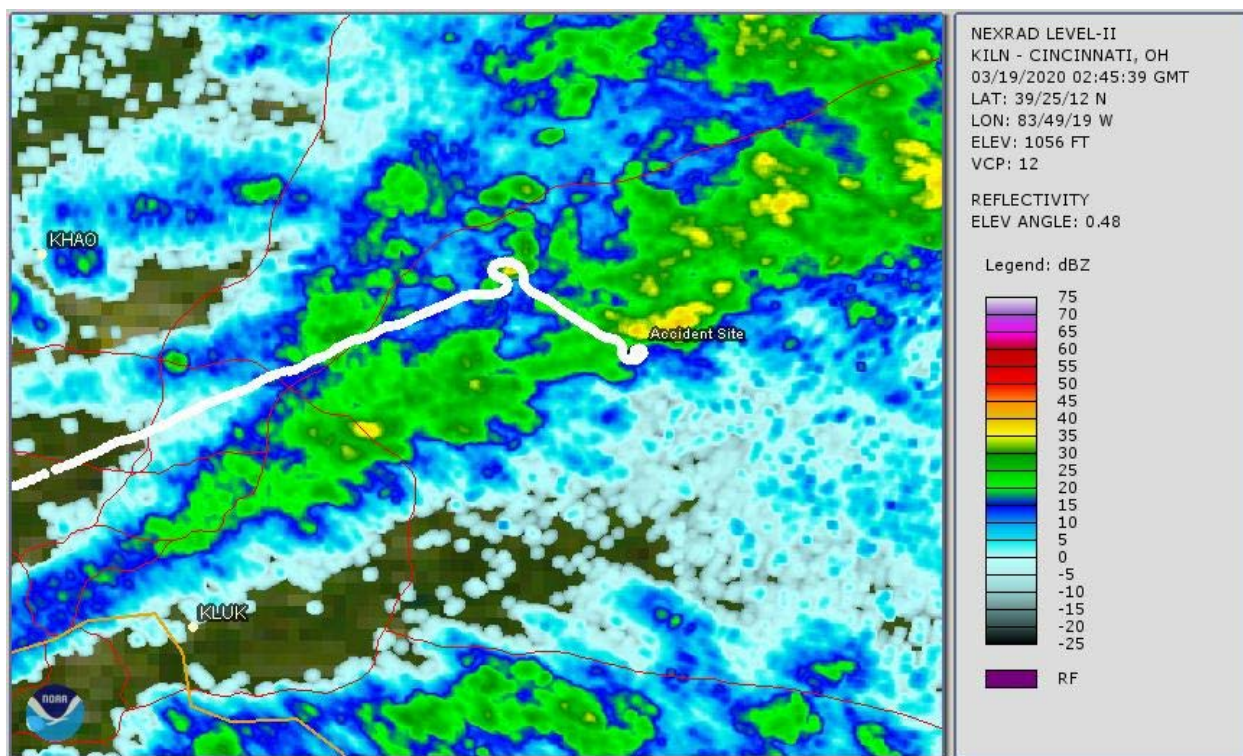


Figure 20 - KILN WSR-88D 0.5 base reflectivity image for 2045 EDT with the flight track overlaid

6.0 Pilot Reports

The following pilot reports (PIREPs) were reported within 100 miles and below 18,000 ft surrounding the period from 1830 through 0230 EDT. The reports are in raw code with abbreviations and time in UTC and are followed by a decoded report with time converted to local.

CVG UA /OV CVG090030/TM 2259/FLDURGC/TP B738/SK B 034 OVC T 076 LYRS ABV/TB OCNL LGT CHOP

Cincinnati/Northern Kentucky International Airport (CVG), Covington, Kentucky, routine pilot report; Over – 090° azimuth and 30 miles from the Cincinnati (CVG) VORTAC²⁰; Time – 1859 EDT; Altitude – during descent; Type aircraft – Boeing 737-800; Sky cover – bases at 3,400 ft overcast with tops to 7,600 ft with additional layers above; Turbulence – occasional light chop.

CVG UA /OV CVG225010/TM 2355/FLDURGC/TP B738/SK B 014 BKN T 022

CVG routine pilot report; Over – 225° azimuth and 10 miles from the CVG VORTAC; Time – 1955 EDT; Altitude – during climb; Type aircraft – Boeing 737-800; Sky cover – bases at 1,400 ft broken with tops to 2,200 ft.

CVG UA /OV CVG180010/TM 0018/FLDURGC/TP CRJ9/SK B 006 OVC T 034/TB NEG

CVG routine pilot report; Over – 180° azimuth and 10 miles from the CVG VORTAC; Time – 2018 EDT; Altitude – during climb; Type aircraft – Canadair CRJ-900; Sky cover – bases at 600 ft overcast with tops to 3,400 ft.

DAY UA /OV DAY/TM 0027/FL190/TP E170/TB MOD

James M. Cox Dayton International Airport (DAY), Dayton, Ohio routine pilot report; Over – DAY VORTAC; Time – 2027 EDT; Flight Level – 190; Type aircraft – Embraer EMB-170; Turbulence – moderate.

CVG UA /OV CVG270005/TM 0047/FLDURGC/TP CRJ7/SK B 022 BKN T 060/TB SMOOTH

CVG routine pilot report; Over – 270° azimuth and 5 miles from the CVG VORTAC; Time – 2018 EDT; Altitude – during climb; Type aircraft – Canadair CRJ-700; Sky cover – bases at 2,200 ft broken clouds with tops at 6,000 ft; Turbulence – smooth.

DAY UA /OV DAY/TM 0156/FLDURGD/TP CRJ9/SK B012

DAY routine pilot report; Over – DAY VORTAC; Time-2156 EDT; Altitude – during descent; Type aircraft - Canadair CRJ-900; Sky cover – bases of clouds at 1,200 ft.

SDF UA /OV IIU360036/TM 0207/FL110/TP P28R/TB NEG/IC NEG/RM VMC

Louisville Muhammad Ali International Airport (SDF), Louisville, Kentucky routine pilot report; Over – 360° azimuth and 36 miles from Louisville (IIU) VORTAC; Time – 2207 EDT; Altitude – 11,000ft; Type aircraft – Piper Cherokee Arrow PA-28R; Turbulence – negative; Icing – negative; Remarks – visual meteorological conditions (VMC).

LEX UA /OV FLM090045/TM 0231/FLDURD/TP UNKN/SK IMC/WX -RA/TB LGT 200-100

Blue Grass Airport (LEX), Lexington, Kentucky routine pilot report; Over – 090° azimuth and 1 miles from Falmouth (FLM) VORTAC; Time -2231 EDT; Altitude – during descent; Type aircraft – unknown; Sky cover – in instrument meteorological conditions; Weather – light rain; Turbulence – light between 20,000 and 10,000 ft.

²⁰ A VORTAC is a radio-based navigational aid for aircraft pilots consisting of a co-located VHF omnidirectional range (VOR) beacon for azimuth data and a tactical air navigation system (TACAN) beacon for distance.

CVG UA /OV CVG090001/TM 0412/FL016/TP CRJ9/SK OVC016-TOPUNKN/RM DURD

CVG routine pilot report; Over – 090° azimuth and 1 mile from CVG VORTAC; Time – 0012 EDT; Altitude – 1,600 ft; Type aircraft – Canadair CRJ-900; Sky cover – overcast with bases at 1,600 ft with tops unknown; Remarks – during descent.

CVG UA /OV CVG/TM 0516/FLDURGD/TP B727/SK TUNKN OVC B016

CVG routine pilot report; Over – CVG VORTAC; Time – 0116 EDT; Altitude – during descent; Type aircraft – Boeing 727; Sky cover – tops unknown, overcast with bases at 1,600 ft.

CVG UA /OV CVG090010/TM 0610/FLDURGD/TP B734/SK T110 BKN B035

CVG routine pilot report; Over – 090° azimuth and 10 miles from CVG VORTAC; Time – 0210 EDT; Altitude – during descent; Type aircraft – Boeing 737-400; Sky cover – tops 11,000 ft broken with bases at 3,500 ft.

During the period there were no urgent PIREPs recorded over the area. Of the 11 PIREPs recorded surrounding the period there were only 3 reports of turbulence, with 2 reporting light intensity turbulence and 1 that report moderate turbulence at 19,000 ft. None of the turbulence reports noted if they were in precipitation or convection at the time. There were also no reports of any significant icing, low-level wind shear, or other hazards over the area during the period. The majority of the PIREPs reported the variable sky cover over the area during the period.

7.0 NWS Forecasts

7.1 Terminal Aerodrome Forecasts

The NWS does not issue a Terminal Aerodrome Forecast (TAF) for KI69. The closest forecast to the planned destination airport was for KLUF located 10 miles west. While a TAF is only valid for a 5 mile radius from the airport's center point, weather providers/briefers and pilot's will often refer to the closest TAF to get a more concise statement of the expected meteorological conditions in the area for planning purposes. The forecast for KLUF issued surrounding the period relevant to the preflight planning and the time of the accident were as follows.

TAF KLUK 182331Z 1900/1924 VRB04KT 1 1/2SM -RA BR FEW006 SCT035 OVC070 WS020/23040KT
FM190100 22008KT 4SM BR VCSH OVC015
FM190500 27005KT 2SM BR VCSH BKN008
FM190900 31003KT 5SM BR VCSH OVC015
FM191800 15007KT 5SM SHRA OVC008
FM192200 19010G20KT 5SM SHRA OVC015=

1 AMD TAF KLUK 190005Z 1900/1924 21008KT P6SM -RA FEW012 BKN025 OVC060 WS020/23040KT
FM190200 22008KT 4SM BR VCSH OVC015
FM190500 27005KT 2SM BR VCSH BKN008
FM190900 31003KT 5SM BR VCSH OVC015
FM191800 15007KT 5SM SHRA OVC008
FM192200 19010G20KT 5SM SHRA OVC015=

2 AMD TAF KLUK 190101Z 1901/1924 20009KT P6SM -RA FEW016 BKN035 OVC100 WS020/23040KT
FM190200 22008KT 4SM BR VCSH OVC015
FM190500 27005KT 2SM BR VCSH BKN008

FM190900 31003KT 5SM BR VCSH OVC015
FM191800 15007KT 5SM SHRA OVC008
FM192200 19010G20KT 5SM SHRA OVC015=

3 AMD TAF KLUK 190200Z 1902/1924 21010KT P6SM VCSH BKN016 OVC021

FM190500 27005KT 2SM BR VCSH BKN008
FM190900 31003KT 5SM BR VCSH OVC015
FM191800 15007KT 5SM SHRA OVC008
FM192200 19010G20KT 5SM SHRA OVC015=

The initial TAF issued at 1931 EDT expected IFR to MVFR conditions to prevail during the period, with light rain and mist, and multiple layers of clouds, and with the potential of low-level wind shear at 2,000 ft with winds from 230° at 40 knots until 2100 EDT, with MVFR conditions continuing through 2200 EDT. The forecast was amended 3 times at 2005, 2101, and at 2200 EDT raising the general flight category from IFR to MVFR then VFR conditions through 0100 EDT on March 19, 2020. The forecast current at the time of the accident expected a wind from 210° at 10 knots, visibility 6 miles or more with rain showers in the vicinity, ceiling broken at 1,600 ft agl, and overcast at 2,100 ft. The wind shear conditions were removed and the IFR conditions were not expected until after 0100 through 0500 EDT on March 19, 2020.

7.2 Area Forecast Discussion

The NWS Area Forecast Discussions (AFD) are issued by each WFO to describe the short term weather conditions within their region with an aviation section that includes the general conditions as it relates to the creation of the TAF. These are useful for additional aviation-related issues that cannot be encoded into the TAF. The discussion also gives some reasoning behind the forecast. These are generated roughly every 6 hours and corresponds to the release of the latest TAFs for that office. The long term discussion section has been excluded below from the original AFD. The forecast discussion issued at 1938 EDT was as follows.

*FXUS61 KILN 182338
AFDILN*

*AREA FORECAST DISCUSSION
National Weather Service Wilmington OH
738 PM EDT Wed Mar 18 2020*

.SYNOPSIS..

Low pressure traversing the region will bring much above normal temperatures and ample precipitation through the end of the work week, along with gusty winds. Cool high pressure returns for the weekend before a weak disturbance brings additional rain chances early next week.

.NEAR TERM /THROUGH THURSDAY/...

With a shortwave pushing through the region, showers with embedded thunderstorms in an area of elevated instability will allow for moderate to briefly heavy rainfall through the region. While PW values approaching 1.5" which is in the 90th-99th percentile, overall movement of shortwave is pretty progressive with this initial shot of rain, so nothing outside of nuisance minor ponding of water is expected. The only possible concern is that, as the shortwave passes through, the surface frontal boundary lingers close to the Ohio river, setting up convergent area which may serve as a focus for possible training storms. Confidence low in this, but will have to monitor through the evening hours.

This mid-level shortwave pushes through the region pretty quickly overnight, bringing an end to the precipitation in the northern forecast area, left low chances elsewhere, with higher chances along the Ohio River and south.

.SHORT TERM /THURSDAY NIGHT/...

More vigorous shortwave trough and its associated deeper low pressure system will help to lift the stalled frontal boundary north as a warm front early on Thursday. Some timing differences between the available CAMs, but expect additional rounds of moderate to occasionally heavy embedded storms beginning in the late morning and continuing into Thursday evening before the region becomes warm sector. Temperatures well above normal, with highs in the mid 60s to lower 70s.

*As the shortwave ejects eastward late Thursday into Thursday night, ample cloud cover will inhibit instability somewhat, **but increasing low level southwesterly flow will bring the potential for severe storms through much of the SW forecast area, with an increase in low level wind shear ahead of the approaching cold frontal boundary especially Thursday evening and overnight. Enhanced LLJ above 50kts and efficient moisture transport will also bring potential for widespread moderate to occasionally heavy rain shifting slightly north in the forecast area along the warm frontal boundary. Some potential for both supercells in SE Indiana and bowing line segments through SW Ohio and northern KY ahead of the deepening low and intensifying cold frontal boundary.***

.AVIATION /00Z THURSDAY THROUGH MONDAY/...

*Aviation will adversely affected by rain, low ceilings and visibilities, wind shear, and gusty surface winds. **Though widespread showers will move out tonight, low level moisture will linger and produce IFR to LIFR conditions.** Showers are forecast to return Thursday, while ceilings and visibilities may improve somewhat. **Two periods of wind shear are predicted. Associated with a strong 925 mb wind flow, expected a brief period of wind shear near the start of the forecast, with another round possible near the end. Surface winds may gust over 20 knots toward the end of the forecast.***

OUTLOOK...MVFR conditions likely into Friday, with gusty winds possible in thunderstorms.

.ILN WATCHES/WARNINGS/ADVISORIES...

OH...None.

KY...None.

IN...None.

7.3 Graphic Forecast for Aviation

The NWS Graphic Forecast for Aviation (GFA) product replaced the Area Forecast and provides a graphical depiction of surface wind, weather, color coded general flight categories, and cloud cover bases and tops, with the Graphic-Airmen's Meteorological Information (G-AIRMET) for IFR conditions, mountain obscuration, icing conditions, and strong surface wind overlaid. The GFA is available at the NWS AWC website and through other weather briefing services. The GFA charts available prior to departure and valid during the period of the accident are included below.

Figures 21 and 22 are the sections of the GFA Aviation Surface Forecast issued at about 1800 EDT and valid for 2000 and 2300 EDT, respectively. The charts depicted the expected surface wind, visibility, flight category, precipitation and weather from data output from the NWS Localized Aviation MOS²¹ Product (LAMP), with any G-AIRMETs for IFR conditions expected

²¹ Model Output Statistics (MOS) guidance.

for the period. The GFA Surface Forecast charts depicted southwesterly winds of 10 knots, visibilities between 1 and 3 miles in rain showers with a greater than 50% probability of precipitation and a G-AIRMET for IFR conditions over the area during the periods.

Figures 23 and 24 are the GFA Aviation Clouds Forecast issued at about 1800 EDT and valid for 2000 and 2300 EDT respectively. The primary data are derived from the NWS Rapid Refresh (RAP) continental-scale NOAA hourly-updated assimilation modeling system run operational at NCEP to produce cloud layers, bases and tops. The GFA Cloud Forecasts indicated an overcast layer of clouds with bases at 1,300 ft and tops to 24,000 ft at 2000 EDT, with at 2300 EDT overcast with bases near 1,200 ft with tops near 12,000 ft.

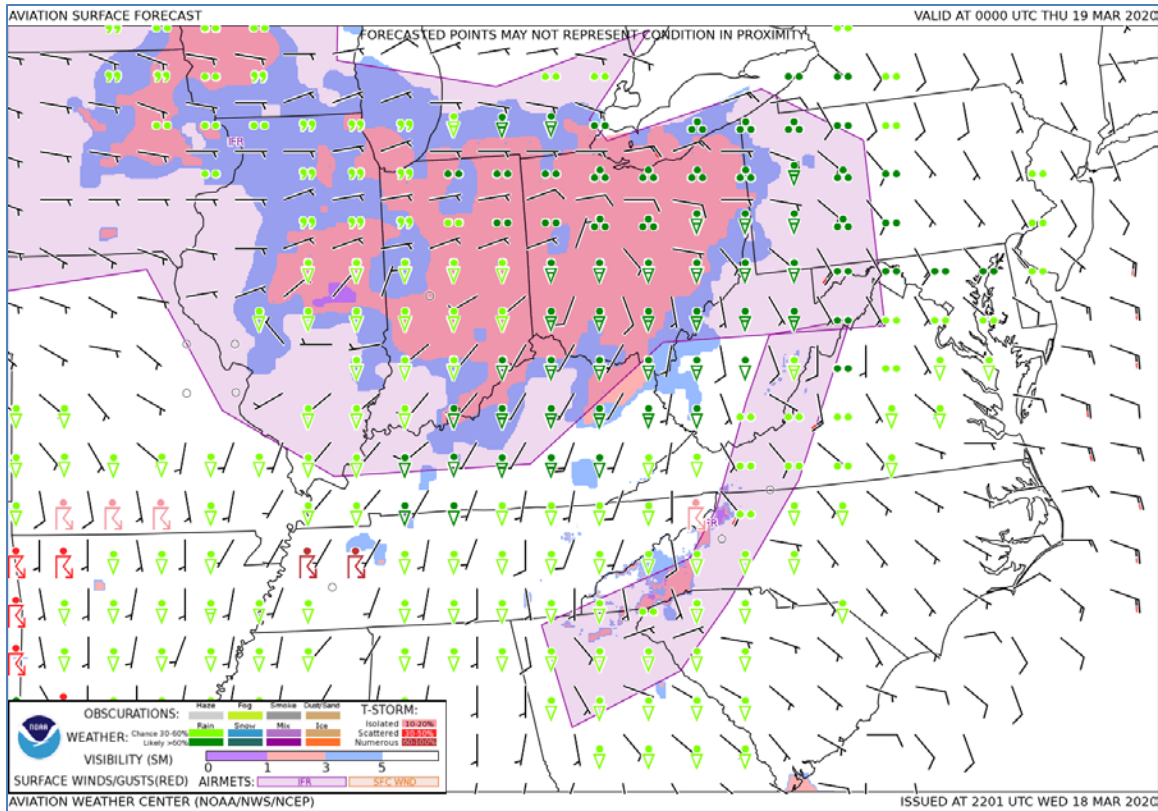


Figure 21 - Graphic Forecast for Aviation Surface Forecast issued about 1800 EDT and valid for 2000 EDT

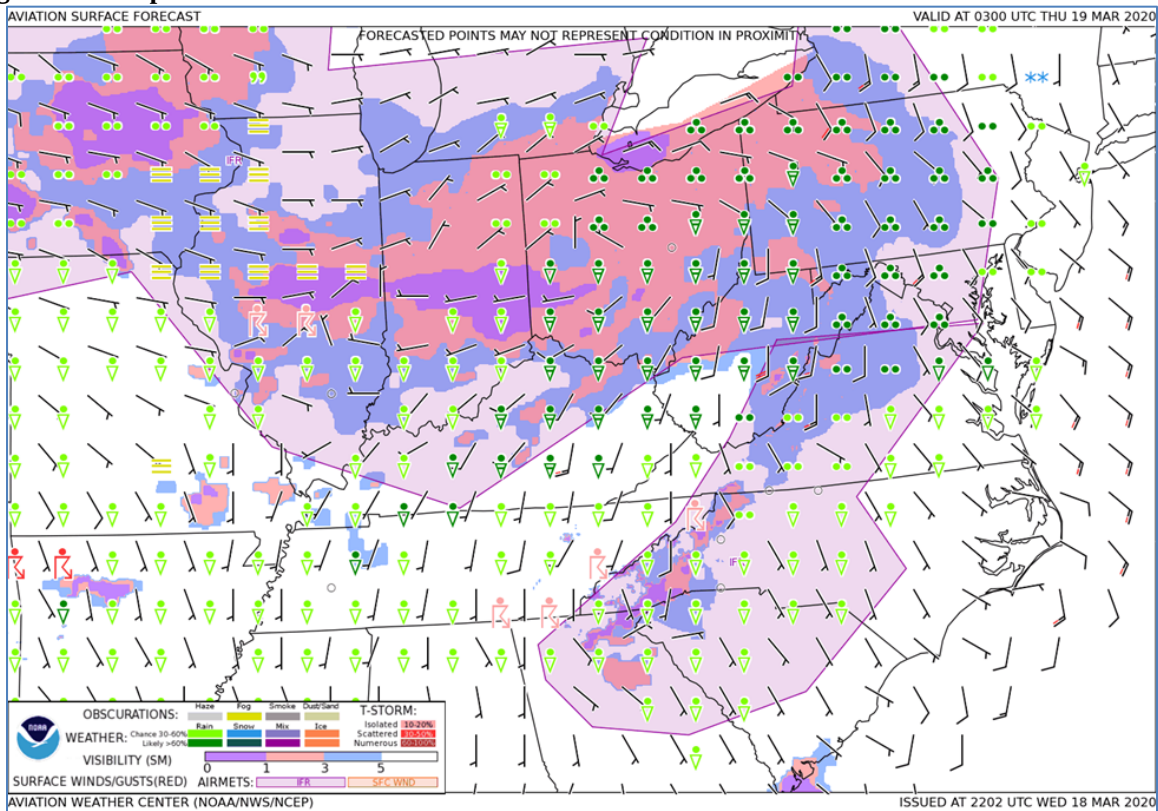


Figure 22 - Graphic Forecast for Aviation Surface Forecast issued about 1800 EDT and valid for 2300 EDT

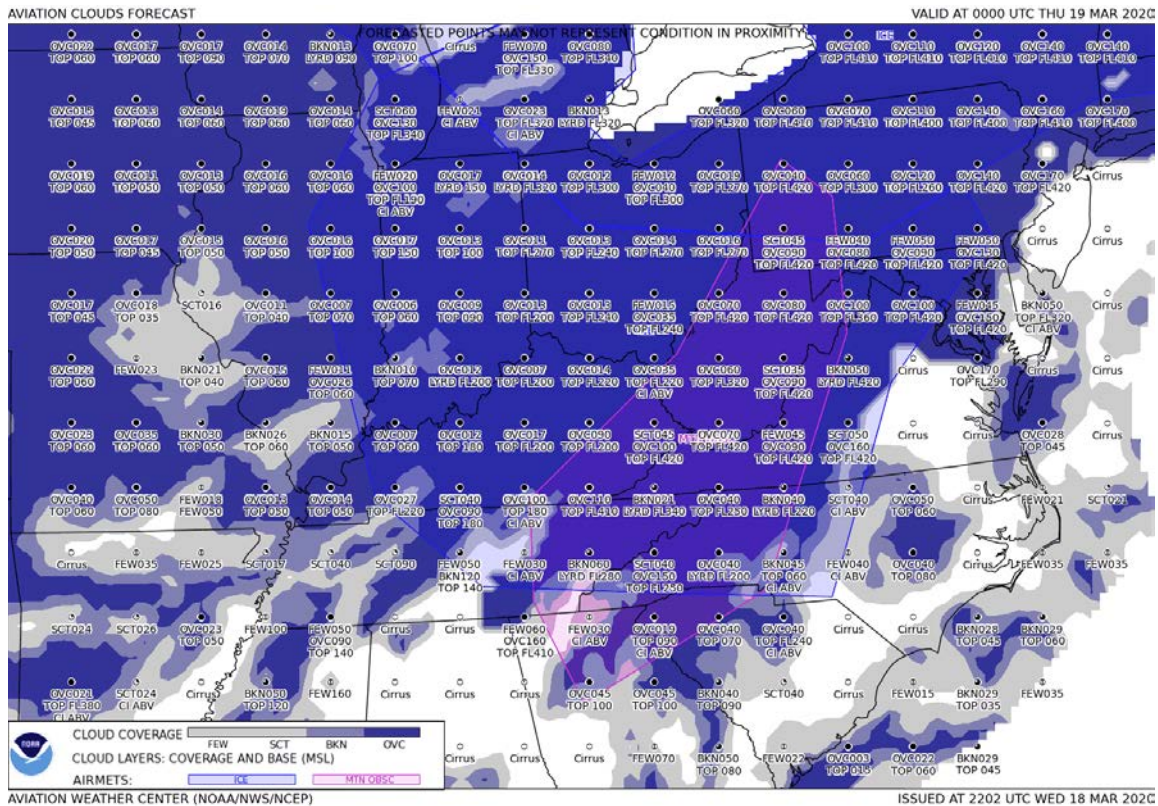


Figure 23 - Graphic Forecast for Aviation Cloud Forecast issued about 1800 EDT and valid for 2000 EDT

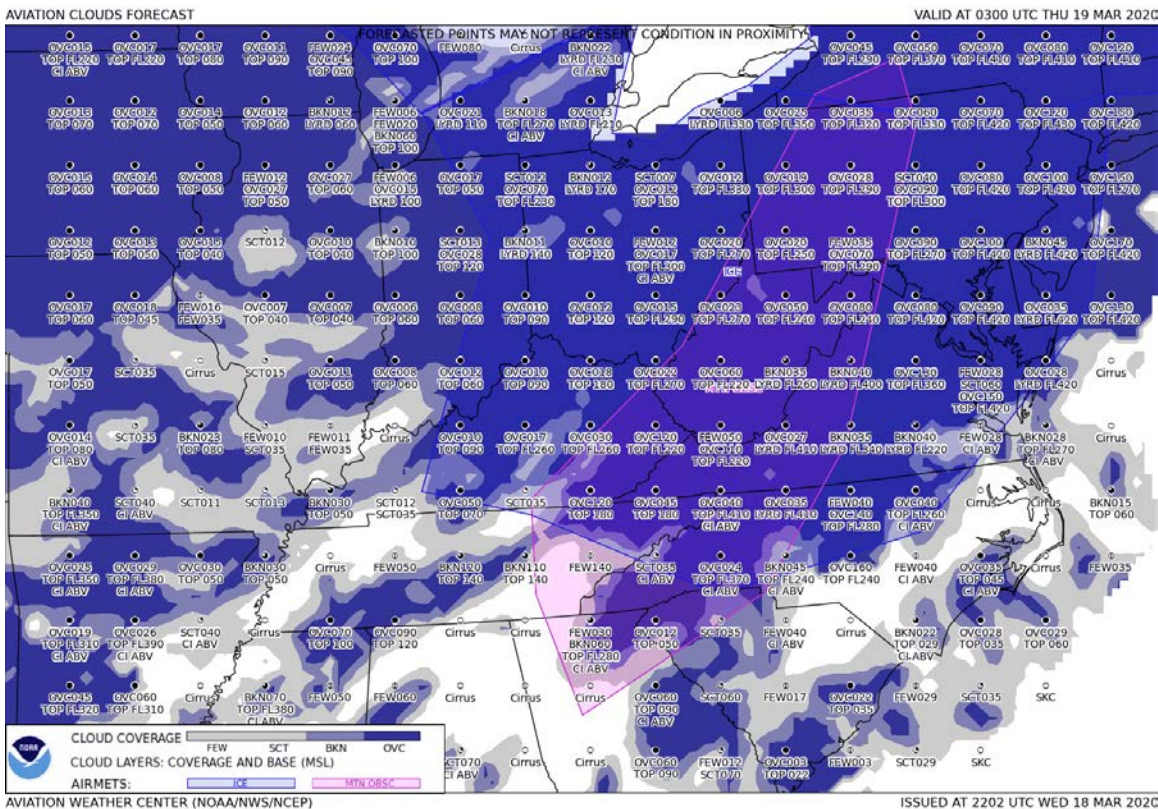


Figure 24 - Graphic Forecast for Aviation Cloud Forecast issued about 1800 EDT and valid for 2300 EDT

7.4 Winds and Temperature Aloft Forecast

The Winds and Temperature Aloft Forecast²² (FB) current for the route of flight was valid for 0100 EDT and for use between 2200 and 0500 EDT were as follows. The forecasts data for 45,000 ft and 53,000 ft have been excluded.

WINDS ALOFT FORECASTS

DATA BASED ON 190000Z

VALID 190600Z FOR USE 0200-0900Z. TEMPS NEG ABV 24000

<i>FT</i>	<i>3000</i>	<i>6000</i>	<i>9000</i>	<i>12000</i>	<i>18000</i>	<i>24000</i>	<i>30000</i>	<i>34000</i>	<i>39000</i>
<i>TUL</i>	1939	1935+12	2026+06	2237+00	2139-13	2452-24	247340	257651	258961
<i>FSM</i>	1932	2024+11	2128+06	2342+00	2343-12	2348-23	255440	255751	258457
<i>SGF</i>	2133	2125+12	2323+06	2326+00	2130-15	2447-25	246641	248152	258163
<i>CGI</i>	2222	2317+11	2525+06	2525+00	2636-12	2441-25	266441	267852	269160
<i>STL</i>	2020	2420+10	2421+05	2525-01	2643-13	2545-26	266942	267953	269363
<i>EVV</i>	2422	2620+10	2625+05	2728-02	2750-11	2743-25	267242	277652	279162
<i>LOU</i>	2632	2533+09	2733+05	2733-01	2851-12	2856-25	277541	278352	279062
<i>IND</i>	2623	2825+09	2939+05	2835-02	2849-16	2963-25	278442	278853	278465
<i>CVG</i>	2726	2541+07	2742+05	2740-01	2847-15	2969-25	288842	289153	279362
<i>CMH</i>	2827	2539+07	2545+02	2647-02	2751-16	2761-27	287942	288052	279359

While the flight was planned at 11,000 ft for the enroute portion of the flight. The accident airplane had descended below 8,000 ft within 50 miles of the accident site. The wind forecast for CVG the closest forecast station to the accident site, for 3,000 ft expected wind from 270° at 26 knots, at 6,000 ft the wind was from 250° at 41 knots with a temperature of 7° C.

8.0 NWS Inflight Weather Advisories

Inflight Aviation Weather Advisories are forecasts to advise en route aircraft of 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 Airmen's Meteorological Information (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.

During the period surrounding the time of the accident the NWS AWC issued no SIGMETs or Convective SIGMETs over Ohio²³ current; however, a series of AIRMETs were current for the area. The Indianapolis CWSU was closed and had no CWA's or Meteorological Impact Statements (MIS) that were current at the time of the accident.

²² Derived from FBUS31 KWNO winds aloft bulletin.

²³ The NWS AWC issued a series of Convective SIGMETs for embedded thunderstorms over Ohio between 1355 through 1755 EDT which were moving northeastward at 40 knots, with tops to about 30,000 ft. At the time of the accident, no advisory was in effect.

8.1 AIRMETs

The NWS AWC issued a full series of Graphic (G)-AIRMETs at 2044 EDT for IFR conditions, low-level moderate turbulence, low-level wind shear, and moderate icing above the freezing level. Figures 25-27 are the G-AIRMETs Sierra, Tango, and Zulu valid for the period between 2000 and 2300 EDT.

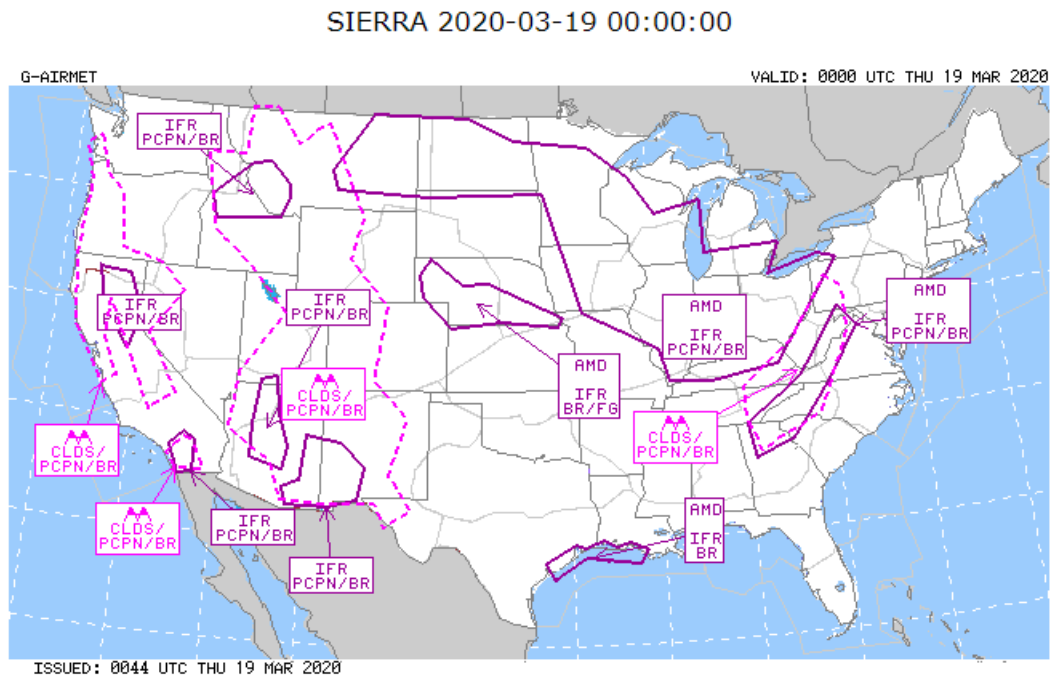


Figure 25 - G-AIRMET Sierra for IFR and mountain obscuration conditions from 2000 through 2300 EDT

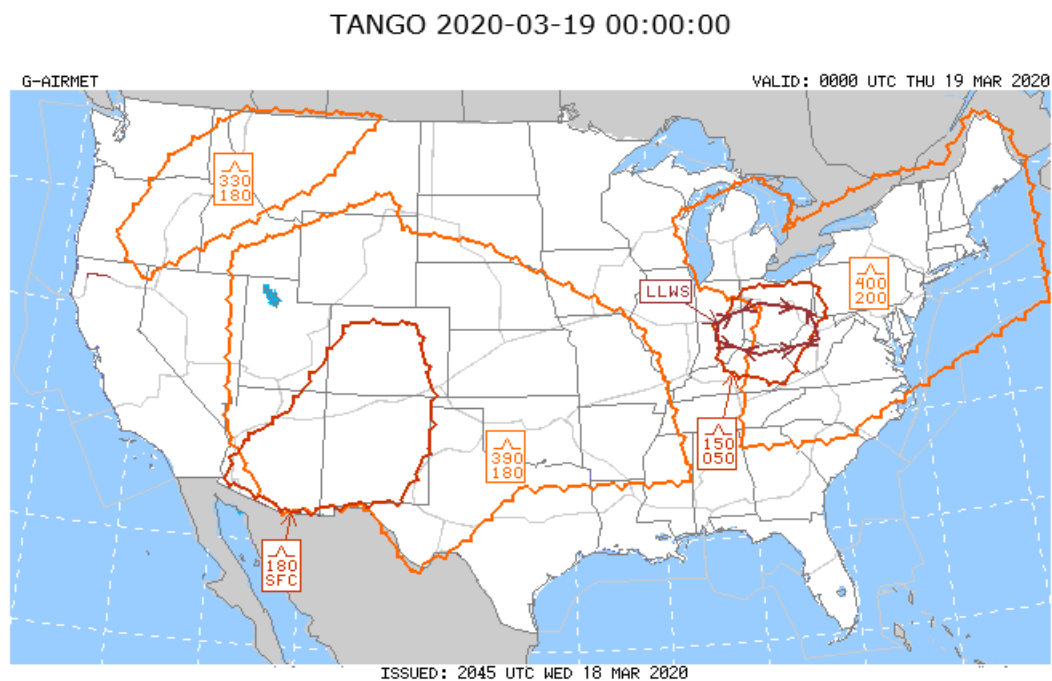


Figure 26 - G-AIRMET Tango for turbulence and low-level wind shear from 2000 through 2300 EDT

ZULU 2020-03-19 00:00:00

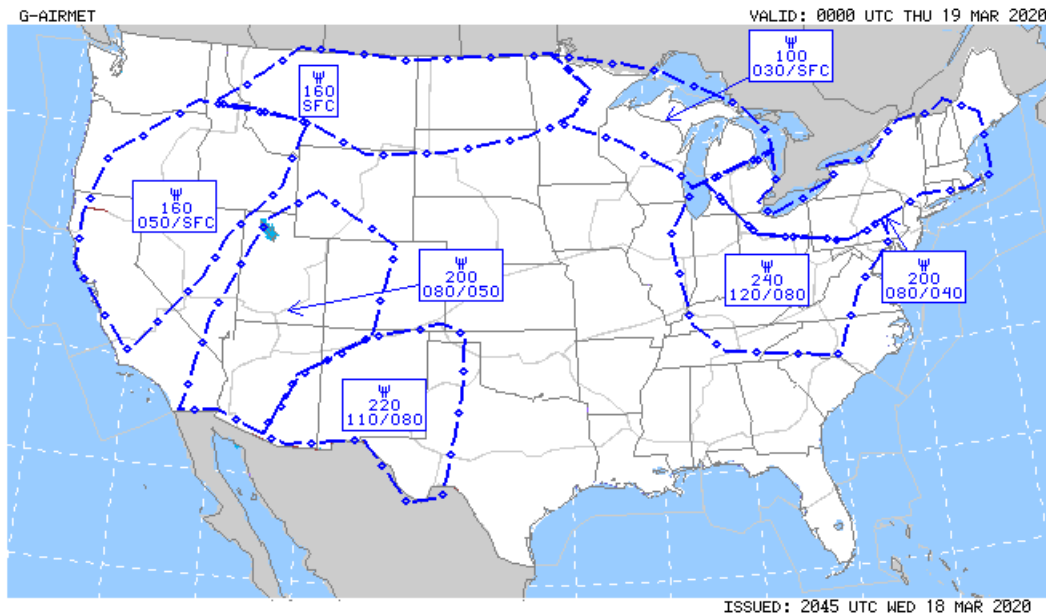


Figure 27 – G-AIRMET Zulu for icing conditions from 2000 through 2300 EDT

9.0 Preflight Weather Briefing

A search of the FAA contract Automated Flight Service Station (AFSS) provider Leidos indicated that they had no contact from the pilot regarding any weather briefings or other contacts inflight, while they did have the IFR flight plan on file through their web service. A separate search of ForeFlight also found no record of any weather briefings or requests for data. It is therefore unknown what weather information the pilot reviewed for familiarization and planning the flight.

There were two IFR flight plans filed for N314VR. The first one was filed at 1244 EDT (1644Z) from KERP with an estimated time of departure of 1300 EDT, requested cruising altitude of 11,000 ft with the destination of KMKO. The estimated time enroute was 5:00 hours, with no alternate airport listed, 7:00 hours of fuel on board, with one passenger on board. The second flight plan was filed at 1450 EDT (1850Z) departing from KMKO at approximately 1830 EDT, with a filed requested altitude of 11,000 ft. The estimated time enroute was 4:30 hours with the route as direct and the planned destination of K169 with no alternate airport specified. The total fuel on board was 7:30 hours.

10.0 Astronomical Conditions

The astronomical conditions were obtained from the United States Naval Observatory's Multiyear Interactive Computer Almanac (MICA) software for Batavia, Ohio, on March 18, 2020. The time of the accident has been added for reference in *italic bold type*.

Sun

Begin civil twilight 0716 EDT

Sunrise 0743 EDT

Transition 1345 EDT

Sunset 1947 EDT

End civil twilight 2014 EDT

Accident 2247 EDT

Moon

Moonrise 0447 EDT

Transition 0935 EDT

Moonset 1425 EDT

Accident 2247 EDT

At the time of the accident the Sun and Moon were both more than 15° below the horizon and provided no illumination. Official nighttime began at 2013 EDT.

Submitted by:

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