

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



ERA23FA108

METEOROLOGY

Specialist's Factual Report

February 21, 2023

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A. ACCIDENT

Location: Dayton, Virginia
Date: January 11, 2023
Time: 1809 eastern standard time (EST)
2309 coordinated universal time (UTC)
Airplane: Piper PA-32R-301; Registration: N43156

B. METEOROLOGY INVESTIGATOR

Donald Eick
Senior Meteorologist
National Transportation Safety Board
Washington, DC

C. 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 remotely, collecting data from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the Weather Prediction Center (WPC) and the National Center for Environmental Information (NCEI). This report documents the general weather products and forecasts over the region during the period and the pertinent meteorological parameters related to the accident. All times are reported as eastern standard time (EST) based upon the 24-hour clock, local time is -5 hours from UTC, and UTC=Z. NWS airport and weather 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 38.52827° N and longitude 79.1325° W at an elevation of approximately 3,980 ft.

D. FACTUAL 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 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 Federal Aviation Administration (FAA) "Aviation Weather Handbook", FAA-H-8083-28¹.

1.1 Surface Analysis chart

The NWS east central section of the Surface Analysis Chart for 1900 EST (0000Z on January 12, 2023) is included as figure 1 with the approximate accident site marked by the red star. The chart depicted a low-pressure system at 1018-hectopascals (hPa)² along a stationary front over the North Carolina and South Carolina border to the south of the accident site. The stationary front extended east and then southeast of the low into South Carolina and into the Atlantic Ocean. To the west of the low, the front dipped³ southward into Georgia, then back north-northeast over eastern Tennessee into southern West Virginia, and then westward across Kentucky. A trough extended east-northeast of the low into North Carolina. A ridge of high-pressure extended southwest from New Jersey into central Virginia, to the east of the accident site.

The closest station model on the chart immediately east of the accident site depicted a calm wind, overcast clouds, a temperature of 37° Fahrenheit (F), and a dew point temperature of 34° F. Several stations west of the station reported light to moderate rain and mist.

¹ <https://www.faa.gov/regulationspolicies/handbooksmanuals/aviation/faa-h-8083-28-aviation-weather-handbook>

² Hectopascals (hPa) is the standard unit for reporting sea-level pressure and is interchangeable with the former term millibar (mb) with the same unit. The standard atmosphere is based on a sea-level pressure is 1013.25-hPa and a temperature of 15° Celsius (C), or 59° Fahrenheit (F).

³ The dip in the stationary front was due to cold air damming effects of the Appalachian Mountains, which restricted the movement of the front at low altitudes.

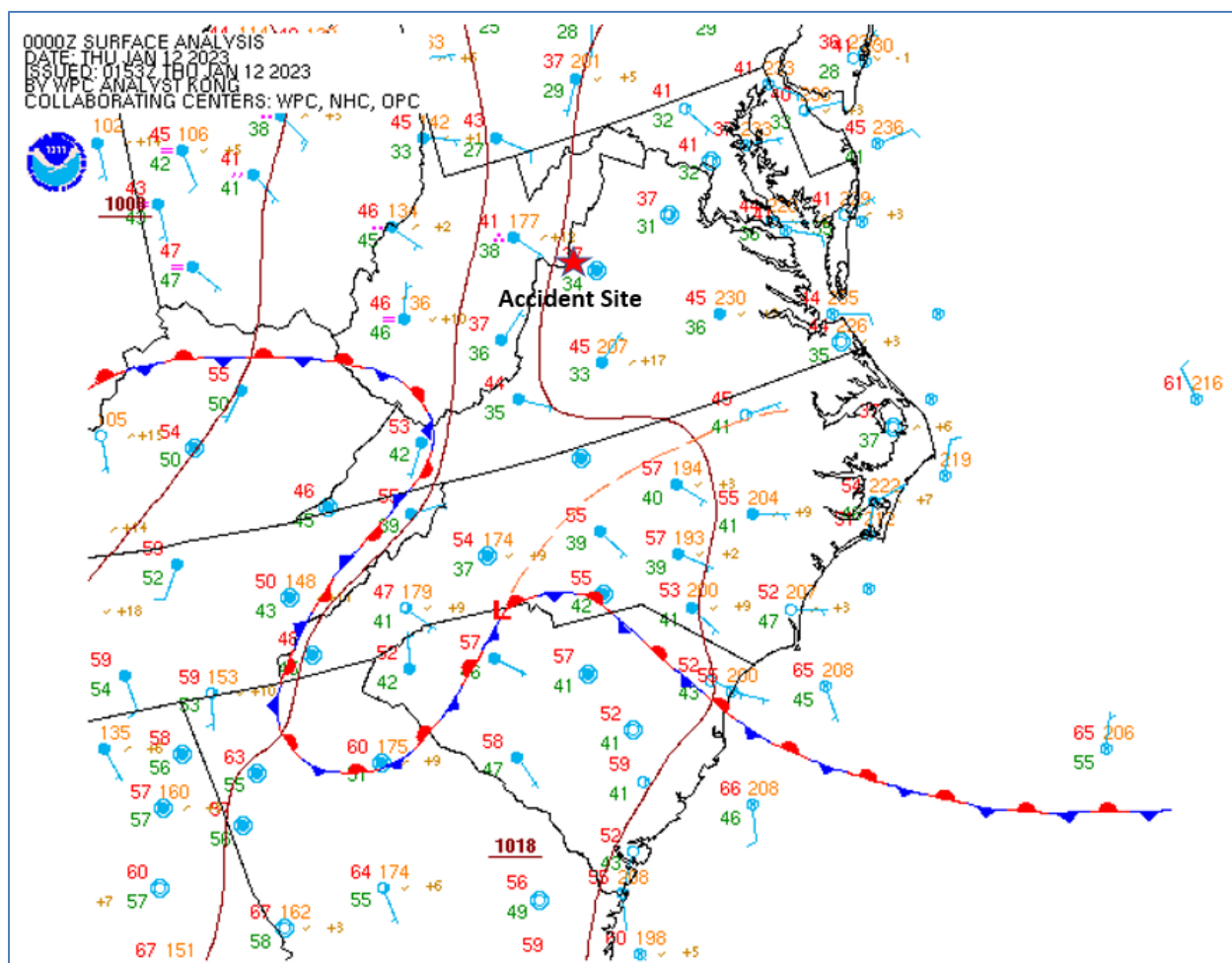


Figure 1 - East central section of the NWS Surface Analysis for 1900 EST with the approximate accident site marked by the red star.

2.0 Surface Observations

The area was documented using official Aviation Routine Weather Reports (METAR⁴) and Aviation Selected Special Weather Reports (SPECI) that were disseminated longline⁵ surrounding the period. 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.

⁴ METAR - an abbreviation for METeorological Aerodrome Report.

⁵ Longline - refers to the dissemination of weather observations with the intent that they are available in near real-time to the national database and available to users, and also achievable. This does not include observations which may have been broadcast locally by very high frequency (VHR) line-of-sight radio or by telephone from the station.

2.1 Bridgewater, Virginia

The closest official weather reporting location to the accident site was from Bridgewater Air Park (KVBW), Bridgewater, Virginia, located about 13 miles southeast of the accident site at an elevation of 1,165 ft. The airport had an Automated Weather Observation System (AWOS), which was not augmented by any human observer and issued observations every 20-minutes. At the approximate time of the accident the following conditions were reported.

KVBW weather observation at 1755 EST, automated, wind from 190° at 7 knots, visibility 7 miles, ceiling broken at 3,800 ft agl, overcast at 5,000 ft, temperature 4° Celsius (C), dew point temperature of 1° C, altimeter setting 30.11 inches of mercury (inHg). Remarks; automated station without a precipitation discriminator, temperature 3.9° C, dew point temperature 0.5° C.

The general flight categories⁶ and raw observations from KVBW from 1555 through 1835 EST were as follows.

VFR METAR KVBW 112055Z AUTO 16007KT 10SM BKN120 07/M02 A3007 RMK AO1 T00651025
VFR METAR KVBW 112115Z AUTO 16006KT 10SM OVC110 06/M02 A3007 RMK AO1 T00611020
VFR METAR KVBW 112135Z AUTO 15005KT 10SM OVC110 06/M02 A3007 RMK AO1 T00611017
VFR METAR KVBW 112155Z AUTO 17004KT 10SM OVC110 06/M01 A3009 RMK AO1 T00571014
VFR METAR KVBW 112215Z AUTO 17005KT 10SM SCT050 BKN075 OVC100 06/M01 A3009 RMK
AO1 T00581014
VFR METAR KVBW 112235Z AUTO 18008KT 10SM BKN036 BKN043 OVC055 05/00 A3009 RMK
AO1 T00511003
VFR METAR KVBW 112255Z AUTO 19007KT 7SM BKN038 OVC050 04/01 A3011 RMK AO1 P0001
T00390005
Accident 2309Z
VFR METAR KVBW 112315Z AUTO 20005KT 5SM SCT036 BKN046 OVC050 03/02 A3011 RMK
AO1 P0003 T00320015
VFR METAR KVBW 112335Z AUTO 21004KT 10SM SCT034 OVC048 03/02 A3011 RMK AO1 P0004
T00280017

⁶ 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.

2.2 Harrisburg, Virginia

The next closest weather reporting location was located at Shenandoah Valley Regional Airport (KSHD), supporting the Staunton/Waynesboro/Harrisonburg area, in Virginia, and located 19 miles southeast of the accident site at an elevation of 1,201 ft. The airport had an AWOS that was also not augmented and disseminated observations every 20-minutes. At the time of the accident the following conditions were reported.

KSHD weather observation at 1755 EST, automated, wind from 200° at 5 knots, visibility 10 miles in light rain, ceiling overcast at 3,800 ft agl, temperature 3° C, dew point temperature of 1° C, altimeter setting 30.13 inHg. Remarks; automated station with a precipitation discriminator, hourly precipitation 0.02 inches, temperature 3.3° C, dew point temperature 1.0° C.

The general flight categories and raw observations for KSHD from 1555 through 1835 EST were as follows.

VFR METAR KSHD 112055Z AUTO 15005KT 10SM BKN120 06/M02 A3009 RMK AO2 T00631021
VFR METAR KSHD 112115Z AUTO 17005KT 10SM OVC120 06/M02 A3009 RMK AO2 T00601016
VFR METAR KSHD 112135Z AUTO 17004KT 10SM OVC110 06/M01 A3010 RMK AO2 T00571015
VFR METAR KSHD 112155Z AUTO 00000KT 10SM SCT090 OVC110 06/M01 A3011 RMK AO2 T00561012
VFR METAR KSHD 112215Z AUTO 19005KT 10SM SCT039 BKN060 OVC090 05/M01 A3012 RMK AO2
T00531014
VFR METAR KSHD 112235Z AUTO 18005KT 10SM RA SCT031 OVC038 04/00 A3013 RMK AO2 T00430000
VFR **METAR KSHD 112255Z AUTO 20005KT 10SM -RA OVC038 03/01 A3013 RMK AO2 P0002 T00330010**
Accident 2309Z
VFR METAR KSHD 112315Z AUTO 18003KT 10SM -RA BKN040 OVC050 03/01 A3013 RMK AO2 P0002
T00300011
VFR METAR KSHD 112335Z AUTO 19003KT 10SM -RA SCT040 OVC050 03/01 A3013 RMK AO2 P0002
T00270011

2.3 METAR Display

A depiction of the NWS Aviation Weather Center's METAR display⁷ of observations at 1815 EST with the regional radar mosaic overlaid and the approximate accident site marked by a red star is included as figure 2. The image depicted general VFR to MVFR conditions being reports at the stations surrounding the accident site, with temperatures from 38° to 44° F over the area, and with several stations reporting rain.

⁷ <https://www.aviationweather.gov/metar>

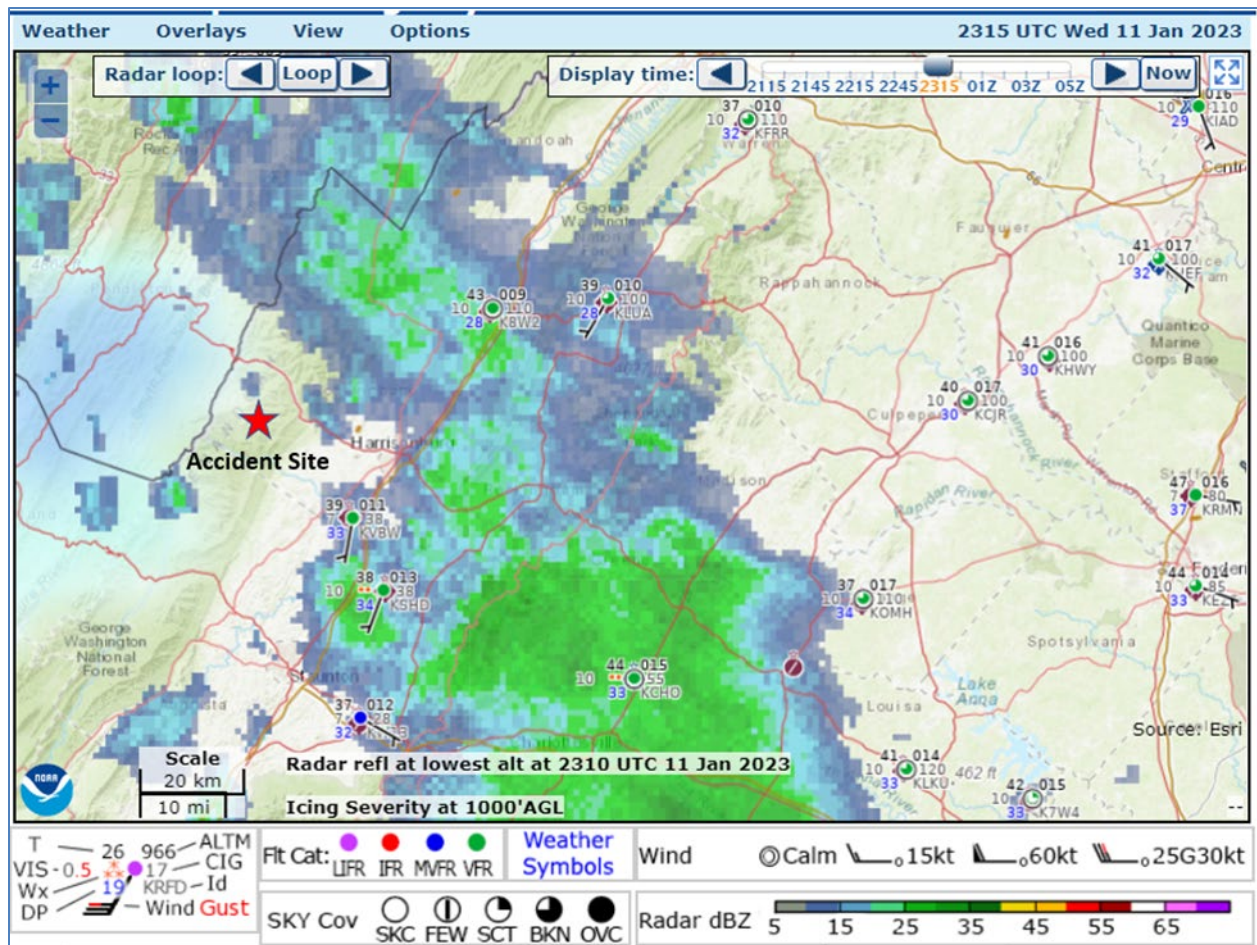


Figure 2 - NWS Aviation Weather center's METAR Display at 1815 EST with the approximate accident site noted by the red star.

3.0 Sounding

To determine the vertical structure and state of the atmosphere over the accident site a High-Resolution Rapid Refresh (HRRR) numerical model⁸ sounding was obtained from archive data from the NOAA Air Resource Laboratory's website for the closest grid point⁹ to the accident site for 1800 EST. The sounding was then plotted on a standard skew-T log P diagram¹⁰ utilizing the RAOB Analysis software¹¹ from the surface to 400-hPa (approximately 22,000 ft) and is included as figure 3.

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

⁹ Grid point was at latitude 38.53° N and longitude 79.13° W.

¹⁰ 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.

¹¹ RAOB -The Complete RAOBwinsonde OBservation program is an interactive sounding analysis

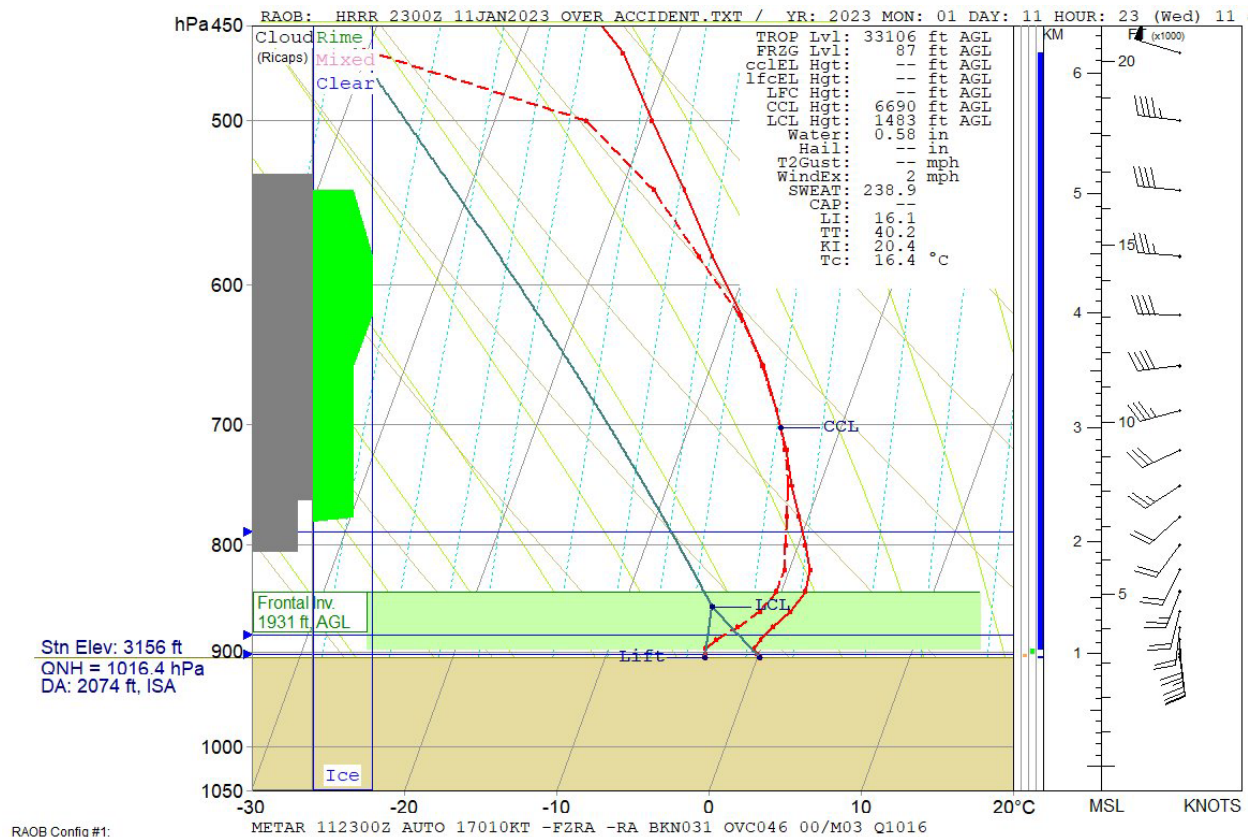


Figure 3 - HRRR numerical sounding for 1800 EST over the approximate accident site.

The HRRR sounding depicted an elevation of 3,156 ft over the grip point, with a near-surface temperature of 0.2° C (32.4° F), a dew point temperature of -3.4° C (25.9° F), a relative humidity of 77%, and a density altitude of 2,074 ft. The sounding depicted a frontal inversion from the surface through 1,913 ft agl (about 5,000 ft msl), where the temperatures increased with altitude and resulted in capping a shallow layer near the surface with near freezing temperatures and warmer air aloft. The lifted condensation level (LCL)¹² was identified at 1,483 ft agl and the convective condensation level (CCL)¹³ at 6,690 ft agl. The RAOB Analysis program supported a broken to overcast layer of nimbostratus type clouds from about 3,000 ft agl (6,200 ft msl) with tops near 17,000 ft and supported the development of rain with the precipitable water content of 0.58 inches. Multiple freezing levels were identified from just above the surface, with temperatures at -0.2 to -0.4 C below 1,000 ft above the surface, with temperatures above freezing above this layer. The second freezing level was identified at 6,800 ft with below freezing temperature above this level. The

program developed by Eosonde Research Services (ERS) previously known as Environmental Research Services, The Villages, Florida.

¹² Lifted Condensation Level (LCL) - the level at which a lifted parcel becomes saturated. The LCL height corresponds to cloud base height for forced ascent.

¹³ Convective Condensation Level (CCL) - the height at which a parcel of air, when heated sufficiently from below, rises and becomes saturated. It is where newly forming convective clouds should form bases.

atmosphere was characterized as stable with a Lifted Index (LI)¹⁴ of 16.1 with no significant Convective Available Potential Energy (CAPE) values.

The wind profile indicated southerly surface winds of 10 knots with winds veering to the west with height. A low-level wind maximum was identified at about 5,000 ft with a wind from 200° at 24 knots. At the accident airplanes initial cruising level of 6,500 ft the sounding indicated a wind from 215° at 22 knots with a temperature of 0.5° C, and a relative humidity near 92%. The mean 0 to 6 kilometer (18,000 ft) wind was from 270° at 33 knots.

A table of the HRRR sounding parameters of height, pressure, temperature, dew point temperature, relative humidity, wind direction and speed, derived Clear Air turbulence (CAT), Low-Level Wind Shear (LLWS), and icing potential from the surface to about 11,000 ft were as follows.

Height (ft-msl)	Pres (hPa)	T (°C)	Td (°C)	RH (%)	DD/FF (deg/kt)	CAT (FAA)	LLWS	ICING (FAA)
3156	906	0.2	-3.4	77	173/ 10			
3185	905	0.2	-3.5	76	173/ 10	LGT	MODRT	
3272	902	-0.1	-3.5	78	174/ 14		LIGHT	
3418	897	-0.4	-3.6	79	175/ 16			
3683	888	-0.2	-3.1	81	178/ 18	LGT		
4041	876	0.3	-2.0	85	186/ 20	LGT		
4497	861	1.1	-0.9	86	194/ 22			
5087	842	1.6	-0.3	87	199/ 24	LGT		
5723	822	1.4	-0.3	88	205/ 22	LGT		
6440	800	0.5	-0.8	91	215/ 21	LGT		
7275	775	-0.6	-1.4	94	225/ 22	LGT		LGT Rime
8169	749	-1.8	-2.0	99	235/ 24	LGT		LGT Rime
9199	720	-3.0	-3.1	99	244/ 28	MDT		LGT Rime
10341	689	-4.6	-4.6	100	254/ 34	LGT		LGT Rime

At the accident airplane's cruising altitude of 6,500 ft the sounding indicated a temperature of 0.5° C with the wind from 215° at 21 knots, and at 5,500 ft a wind from 200° at 23 knots with a temperature near 1.5° C. The RAOB analysis program did not indicated any structural icing potential below 6,500 ft.

¹⁴ Lifted Index (LI) - A common measure of atmospheric instability. Its value is obtained by computing the temperature that air near the ground would have if it were lifted to 500-hPa or approximately 18,000 feet and comparing that temperature to the actual temperature at that level. Negative values indicate instability - the more negative, the more unstable the air is, and the stronger the updrafts are likely to be with any developing thunderstorms.

4.0 Satellite Imagery

The NOAA Geostationary Operational Environmental Satellite number 16 (GOES-16) infrared imagery were obtained from an archive at the Space Science Engineering Center (SSEC) at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System (McIDAS) software. The infrared band 13 at a wavelength of 10.3 microns (μm) provided a resolution of 2 kilometers (km) or 1.08 miles. Due to the low Sun angle the visible imagery was not applicable at the time of the accident. Figure 4 is the GOES-16 infrared image for 1811 EST at 4X magnification with the accident site indicated by the white square. An area of enhanced clouds was depicted over the accident site with radiative cloud top temperature of 239 Kelvin or -34°C , which corresponded to cloud tops near 34,000 ft based on the HRRR sounding.

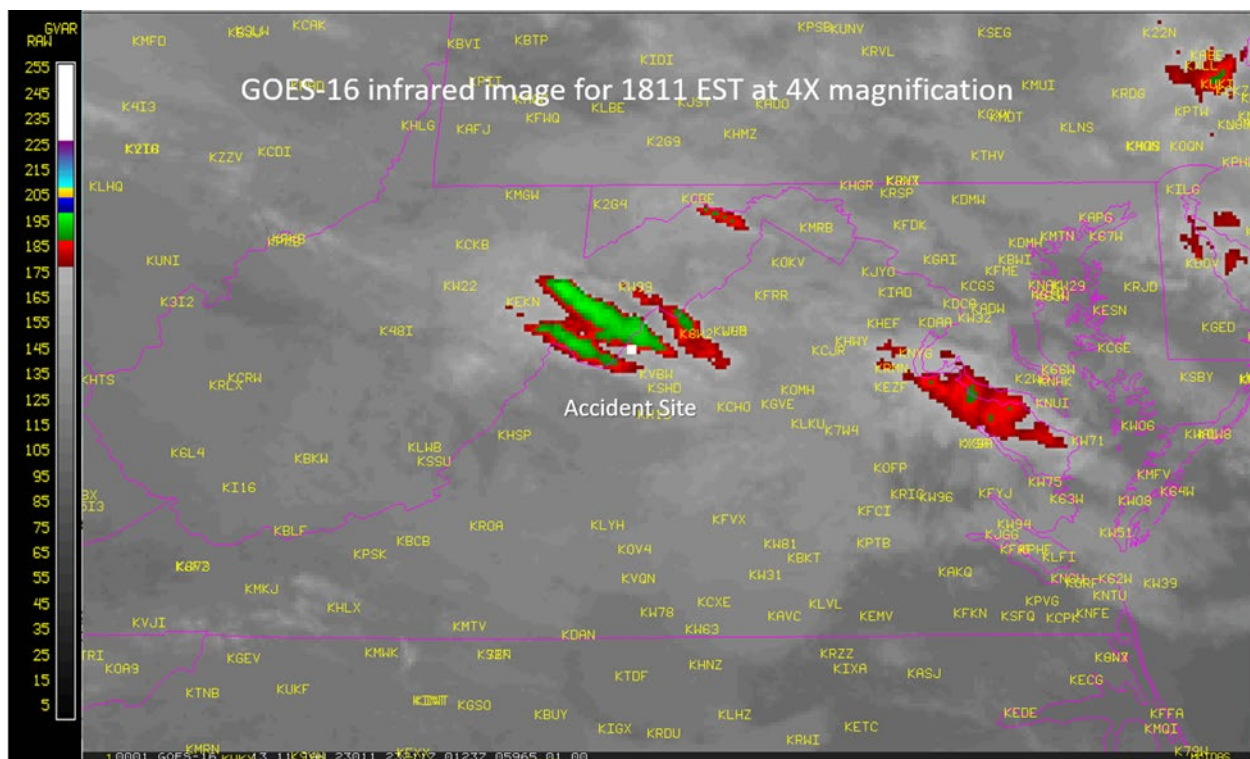


Figure 4 - GOES-16 infrared image for 1811 EST at 4X magnification with the accident site marked by the white square.

5.0 Weather Radar Imagery

The closest NWS Weather Surveillance Radar 1988 Doppler (WSR-88D)¹⁵ was located at Sterling (KLWX), Virginia, located about 82 miles northeast of the accident

¹⁵ 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.

site. The level II archive data were obtained from the NCEI using the Hierarchical Data Storage System and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software. During the period, the KLWX WSR-88D was operating in the standard precipitation mode identified as volume scanning pattern 215 (VCP-215) where the radar makes 15 different elevation scans during the 6 minute scan.

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 unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in dBZ¹⁷ and is a general measure of echo intensity. The FAA Aviation Weather Handbook, table 24-8 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. Light rain is typically reported at the surface when reflectivities reach 20 dBZ, while air traffic control will not display information of echoes less than 26 dBZ or light intensity echoes on their weather displays or disseminate alerts of any such echoes. These are the new standard radio phraseology terms used by air traffic controllers to describe weather conditions to pilots as shown in the table below.

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

Assuming a standard refraction of the KLWX WSR-88D's lowest 0.44° base reflectivity beam, an antenna height of 404 ft and at 82 miles from the antenna, the center of the beam would have been near approximately 8,690 ft over the accident site and sampling the airspace between 4,560 ft through 12,820 ft.

Figure 5 is the KLWX WSR-88D 0.44° base reflectivity image for 1808 EST with the flight track overlaid. The image depicted echoes of less than 30 dBZ (light intensity) over the route of flight where the pilot advised Air Traffic Control of his intention to descend from 6,500 ft to 5,500 ft. No echoes were detected over the accident site.

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 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.

¹⁷ dBZ stands for decibel relative to Z. It is a logarithmic dimensionless technical unit used in radar, mostly in weather radar, to compare the equivalent reflectivity factor (Z) of a remote object (in mm⁶ per m³) to the return of a droplet of rain with a diameter of 1 mm (1 mm⁶ per m³).

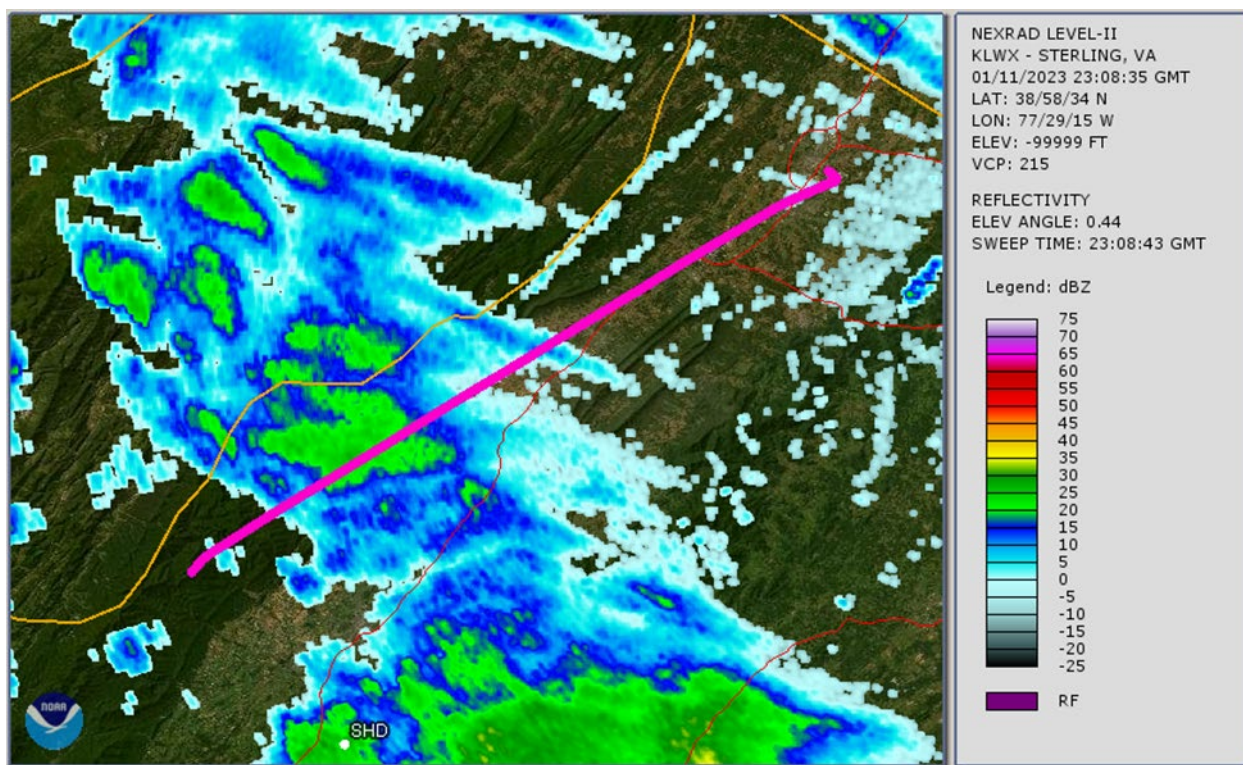


Figure 5 - KLWX WSR-88D 0.44° base reflectivity image for 1808 EST with the flight track of N43156 overlaid.

6.0 Pilot Weather Reports

A search of pilot weather reports (PIREPs) in the national database¹⁸ within 60 miles of the accident site between 1500 through 2100 EST below 18,000 ft provided the following reports. The two PIREPs in blue are discussed below.

CKB UA /OV EKN/TM 2118/FL070/TP DA42/WX -RA/TA 0/TB LGT CHOP

CHO UA /OV 10 SW CHO/TM 2149/FL160/TP AC95/TA MINUS 8/IC LIGHT RIME

SHD UA /OV SHD224013/TM 2222/FL060/TP SR22/TA -2/IC LIGHT RIME

CHO UA /OV 20 NM NE CHO/TM 2226/FL090/TP PA24/TB MODERATE

FCI UA /OV GVE230010/TM 2236/FL140/TP PC12/TA M6/IC LGT CLR

¹⁸ Includes only the reports official recorded and disseminated as a PIREP and may not include "ride reports" broadcasted or other conditions solicited by air traffic controllers and not entered in the formal PIREP format coding. These reports are disseminated in real-time into a database similar to METARs.

EKN UA /OV ESL090021/TM 2249/FL160/TP PC12/TA M16/IC LGT RIME

MRB UA /OV ESL360010/TM 2309/FL110/TP BE60/TA M04/IC LGT RIME

In reviewing the PIREPs it was noted that they all reported their altitude consistent with that of being on an IFR flight altitude versus a VFR hemispheric cruising altitude. There were two PIREPs relevant to the accident. The first was from a pilot operating a Diamond DA42 Twin Star multiengine airplane over Elkins (EKN), West Virginia, approximately 40 miles west-northwest of the accident site at 1618 EST at 7,000 ft. That pilot reported encountering light rain and light chop with a temperature of 0° C. The second report was from a pilot operating a Cirrus SR22 at 1722 EST located about 24 miles south of the accident site at 6,000 ft that reported the outside air temperature of -2° C, with light rime type icing. This report was below the noted freezing level as indicated in the HRRR sounding. All the other reports of icing (4) were above 11,000 ft and above the accident airplane's cruising level and were consistent with the RAOB analysis data.

7.0 NWS Forecasts and Advisories

The NWS Baltimore/Washington, DC, (KLWX) Weather Forecast office (WFO) located in Sterling, Virginia, was responsible for the local area where the accident occurred, while the NWS AWC was responsible for the aviation products.

7.1 Terminal Aerodrome Forecast

The Terminal Aerodrome Forecast (TAF) is a concise statement of the expected meteorological conditions significant to aviation for a specified time period and within 5 statute miles of the center of the airport's runway complex (terminal). The closest TAF to the accident site was issued for Charlottesville-Albemarle Airport (KCHO), Charlottesville, Virginia, located about 40 miles southeast of the accident site at an elevation of 640 ft. While not valid for the accident site, it provided a spot forecast for general conditions along the proposed route of flight. The forecast issued by KLWX at 1704 EST was an amended forecast and as follows.

AMD TAF KCHO 112204Z 1122/1218 27003KT P6SM OVC250

TEMPO 1122/1123 17004KT 6SM -RA BKN110

FM120000 14002KT P6SM OVC050

FM120400 07003KT P6SM -DZ OVC015

FM120800 17002KT P6SM OVC025

FM121200 16002KT 4SM BR OVC008

FM121500 19003KT P6SM OVC015=

The forecast for KCHO current for the period expected wind from 270° at 3 knots, visibility better than 6 miles, ceilings overcast at 25,000 ft agl, with temporary conditions between 1700 and 1800 EST of wind from 170° at 4 knots, visibility 6 miles in light rain, ceiling broken at 11,000 ft.

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 they relate to the creation of the TAF. These are useful for additional aviation-related issues that cannot be encoded into the TAF and provide some reasoning behind the forecast. These are generated roughly every 6 hours and correspond to the release of the latest TAFs for that office. The KLWX AFD issued at 1500 EST was as follows.

*FXUS61 KLWX 112000
AFDLWX*

*Area Forecast Discussion
National Weather Service Baltimore MD/Washington DC
300 PM EST Wed Jan 11 2023*

.SYNOPSIS...

Surface ridging will gradually buckle today as a warm front approaches from the central Appalachians later this evening into the overnight hours. A strong cold front and resultant low pressure system over the Ohio River Valley will push through the region late Thursday into Friday morning. Gusty northwest winds will kick in behind the front along with mountain snow showers Friday into Saturday. High pressure will gradually build in over the weekend, and is expected to be centered over the eastern states early next week.

.NEAR TERM /UNTIL 6 AM THURSDAY MORNING/...

Surface high pressure/ridging loses it's grip over the area this afternoon as a warm front lifts north from the central Appalachians. Mid-high level clouds will steadily increase in advance of the front with a weak 850-700mb wave low pressure passing through later this evening into tonight. Models continue to show decent isentropic lift along this boundary with the highest precipitation chances confined along and west of the Blue Ridge. Shower chances will encroach upon the I-64/US-250 corridor from Staunton to Charlottesville early this evening before spreading north toward western/central Maryland later tonight. A few wet snowflakes or even a brief 3-6 hour period of freezing rain cannot be ruled out over the Allegheny Highlands this evening as the onset of precipitation moves in. Uncertainty remains in regards to temperature profile and the extent of wet bulb cooling with little to no accumulation expected. Highest confidence for any freezing rain appears to be along the WV/VA border near Spruce Knob and at elevations above 3000 feet where trace amounts of ice can be expected.

With the extra cloud cover in place expect highs similar to Tuesday with mid to upper 40s for most outside the mountains. Lows tonight will hold fairly steady in the mid to upper 30s with sheltered valleys/exposed ridges closer to 32 degrees.

.AVIATION /20Z WEDNESDAY THROUGH MONDAY/...

VFR conditions look to prevail at all TAF terminals through this afternoon as mid to high level clouds continue to thicken over the region. A warm front will approach the region from the central Appalachians yielding MVFR cigs lowering to 5-12 kft before 00-02z/7-9pm. Cigs will continue to lower below 5kft beyond 02z/7pm and into Thursday morning as the front lifts through. Some light rain and patchy drizzle may effect MRB and CHO around 03-08z/10pm-3am with lower confidence on precipitation chances further east toward the main corridor. Cigs will likely fluctuate between MVFR and IFR during this time with due in part to the influx in low level moisture late tonight into Thursday morning.

MVFR cigs will gradually lift to low end VFR late Thursday morning into Thursday midday as the cold front approaches the region. The front will bring a return to sub-VFR igs/vsbys Thursday afternoon and evening. Gusty SSE winds Thu afternoon will gradually shift to SSW, then W to NW by 13-16Z/8am-11am Fri. Rain ends shortly after 06Z/1am Friday with winds gusting up to 30 kt Friday and Saturday.

.LWX WATCHES/WARNINGS/ADVISORIES...

DC...None.

MD...None.

VA...None.

WV...None.

MARINE...Small Craft Advisory from noon to 6 PM EST Thursday for ANZ532>534-537-540-541-543.

7.3 Graphic Forecast for Aviation

The NWS Graphic Forecast for Aviation (GFA) is a graphical depiction of surface wind, thunderstorms, precipitation, color coded general flight categories, and cloud cover bases and tops, from graphical output from the NWS's National Digital Forecast Data (NDFD) with the Graphic-Airmen's Meteorological Information (G-AIRMET)¹⁹ for IFR conditions, mountain obscuration, icing conditions, and strong surface wind overlaid. The GFA provides a forecast for the enroute phase of flight and for locations without a TAF. The GFA is available at the NWS AWC website and through other weather briefing services. The GFA forecasts available prior to the accident flight's departure are documented below.

The GFA 3-hour Surface and Cloud Forecasts issued at about 1400 and valid for 1600 EST are included as figures 6 and 7 respectively, with the approximate accident site marked by the red star. The 6-hour forecasts valid for 1900 EST are included as figure 8 and 9. The GFA 3-hour Surface Forecast depicted southerly

¹⁹ AIRman's METeorological Information (AIRMET) is a concise description of weather phenomena that are occurring or may occur (forecast) along an air route that may affect aircraft safety. Compared to SIGMETs, AIRMETs cover less severe weather: moderate turbulence and icing, sustained surface winds of 30 knots or more, low-level wind shear, or widespread restricted visibility.

winds of 5 knots, with a 30-60% chance of light rain, with no significant visibility restrictions. Over West Virginia an area of visibility restrictions less than 3 miles and an area of greater than 60% chance of rain showers were depicted. A G-AIRMET for IFR conditions was depicted over central Kentucky, into eastern Tennessee, and western North Carolina, and into extreme northeastern Georgia. The GFA 3-hour Cloud Forecast depicted broken clouds with bases between 11,000 ft and 16,000 ft with tops near 25,000 ft. A G-AIRMET for moderate icing conditions above the freezing level was depicted over the accident site. A G-AIRMET for mountain obscuration was depicted over southern West Virginia into eastern Kentucky, Tennessee, extreme western Virginia and North Carolina, and South Carolina, and into Georgia.

The 6-hour GFA forecasts also issued about 1400 and valid for 1900 EST are included as figures 8 and 9. The GFA 6-hour Surface Forecast (figure 8) depicted an area of restricted visibility over the accident site with a greater than 60% of rain with southerly winds of 10 to 15 knots. The GFA 6-hour Cloud Forecast (figure 9) depicted overcast clouds with bases at 2,800 ft with tops to 23,000 ft. Based on the accident site elevation this implied mountain obscuration conditions over the area.

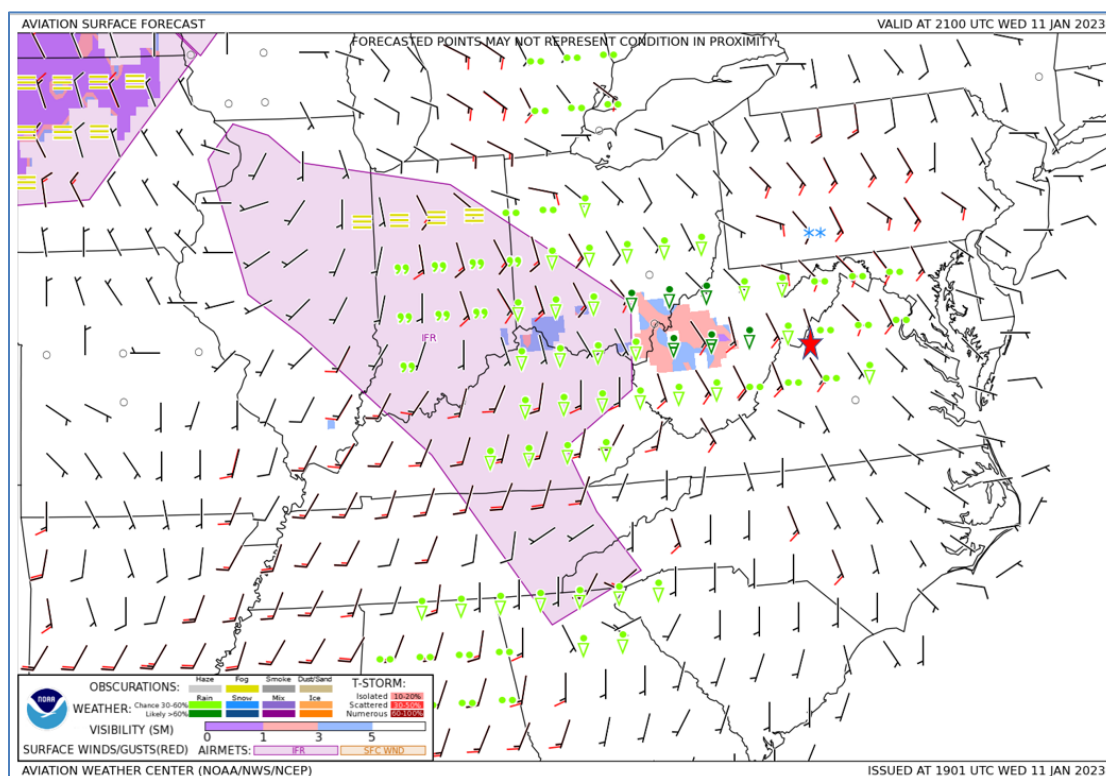


Figure 6 - Graphic Forecast for Aviation 3-hour Surface Forecast valid for 1600 EST.

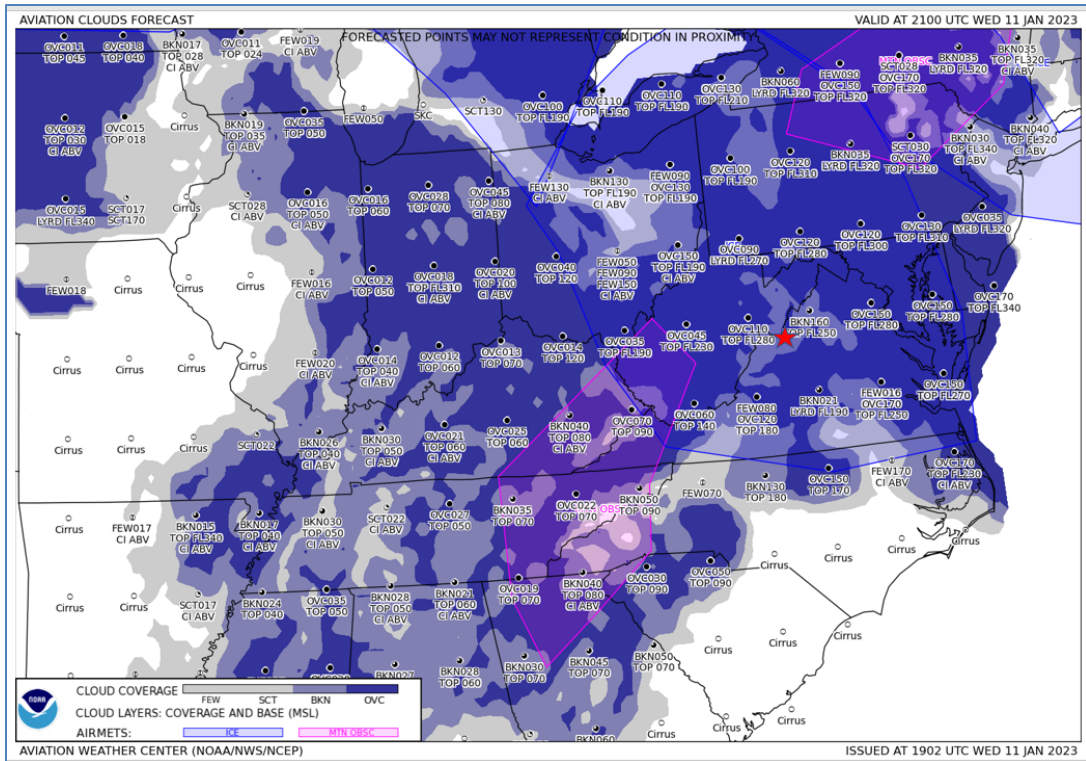


Figure 7 - Graphic Forecast for Aviation 3-hour Cloud Forecast valid for 1600 EST.

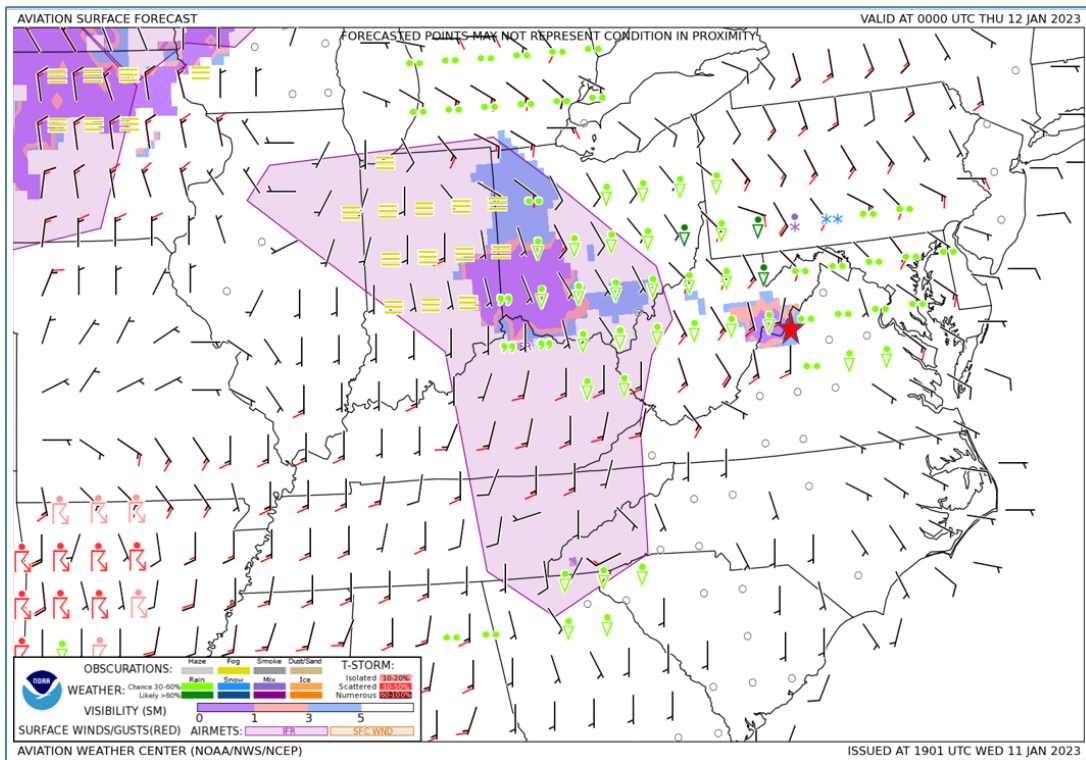


Figure 8 - Graphic Forecast for Aviation 6-hour Surface Forecast valid for 1900 EST.

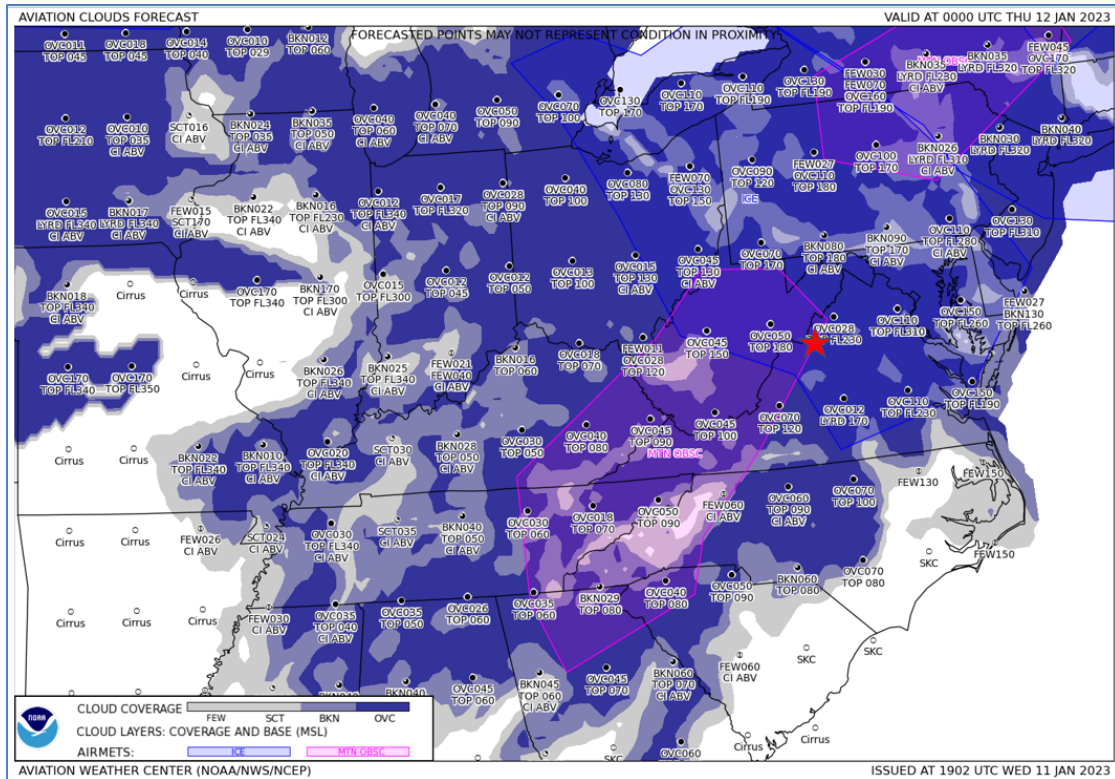


Figure 9 - Graphic Forecast for Aviation 6-hour Cloud Forecast valid for 1900 EST.

7.4 Winds and Temperatures Aloft Forecast

The NWS Winds and Temperatures Aloft Forecast based on the FBUS bulletin valid for the period was issued at 1459 EST and valid between 1500 and 2200 EST was as follows.

FBUS31 KWN0 111959

FD1US1

-DATA BASED ON 111800Z

VALID 120000Z FOR USE 2000-0300Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
-EKN	2533+04	2732-01	2635-07	2847-20	2867-32	288349	298958	289559	
-CRW	2232	2528+03	2633+00	2738-05	2848-19	2864-32	287948	288757	780459
-RIC	2019	2422+00	2529-02	2642-07	2948-19	2966-31	297949	288556	307756
-ROA	1718	2532+04	2736+00	2838-06	2853-18	2865-31	287249	288457	780659
-TRI		2536+05	2737+03	2841-04	2858-17	2859-31	287248	288355	770460

The closest forecast point to the accident site was Elkins (EKN), West Virginia, about 40 miles west of the accident site. The EKN forecast for 6,000 ft expected a wind from 250° at 33 knots with a temperature of 4° C, and at 9,000 ft wind from 270° at 32 knots with a temperature of -1° C.

7.5 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 CWSU at the various Air Route Traffic Control Centers (ARTCCs). There are four basic types of inflight aviation weather advisories: the Significant Meteorological Information (SIGMET), the Convective SIGMET, the G-AIRMET, and the Center Weather Advisory (CWA). Inflight advisories serve to notify en-route pilots of the possibility of encountering hazardous flying conditions that 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 based on experience and the operational limits of the aircraft. Once issued they are broadcast by FAA controller upon issuance and available on inflight weather broadcasts.

A review of the inflight weather advisories indicated that no SIGMETs, Convective SIGMETs, or Center Weather Advisories (CWA) were current surrounding the period. The NWS had two G-AIRMETs issued at 1545 EST and current over the route and the accident site for mountain obscuration and icing conditions. The G-AIRMETs advisories depicted at the time of the accident is depicted in figure 10.

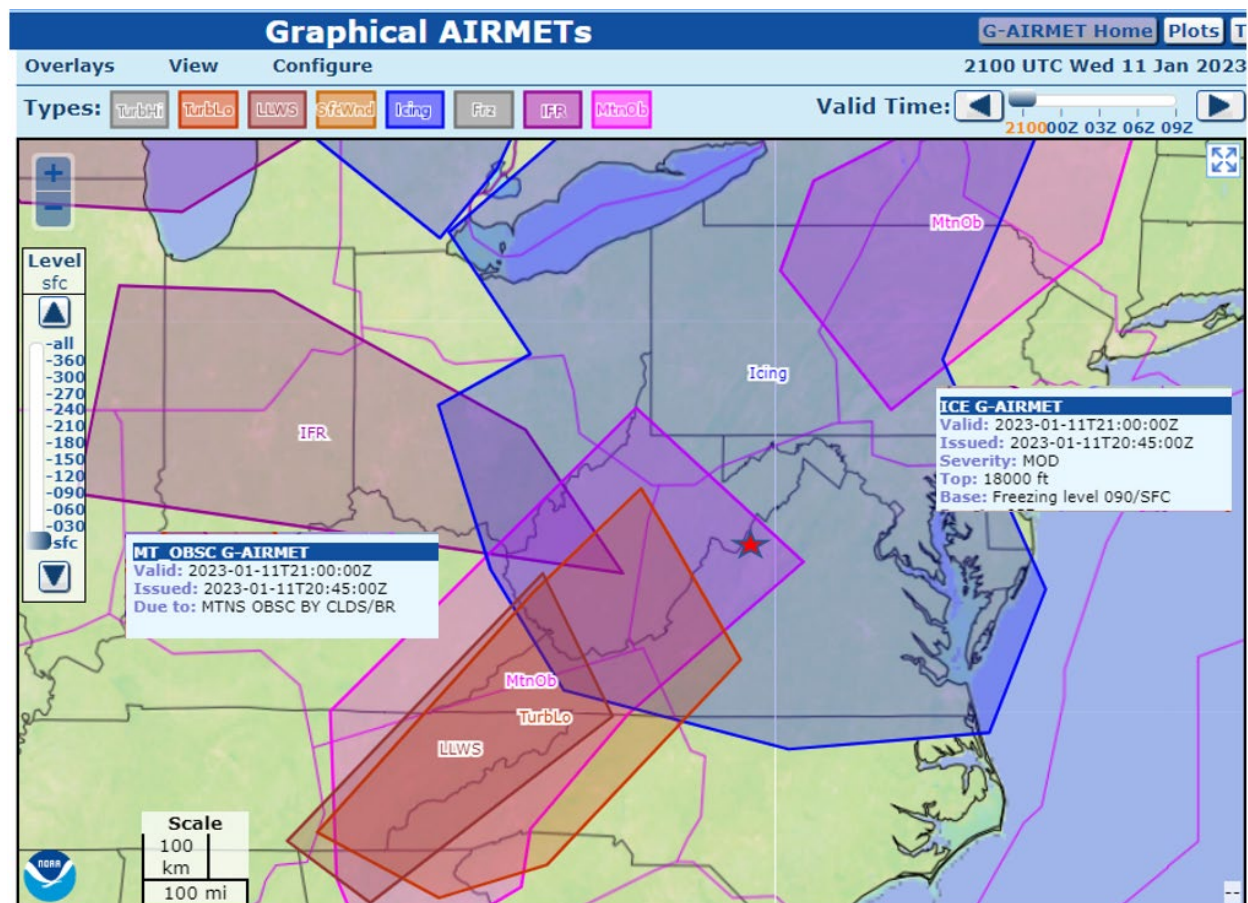


Figure 10 - G-AIRMETs current at the time of the accident, which is marked by the red star, G-AIRMET for mountain obscuration depicted in pink and moderate icing conditions in blue.

8.0 Astronomical Conditions

The United States Naval Observatory provided the following astronomical conditions for Harrisburg, Virginia, on January 11, 2023. The time of the accident is included for reference in bolt italic type.

<u>SUN</u>	<u>Time (EST)</u>
Begin civil twilight	0705
Sunrise	0734
Upper transit	1224
Sunset	1715
End civil twilight	1745
<i>Accident</i>	<i>1809</i>

<u>Moon</u>	<u>Time (EST)</u>
Moonset	1029
<i>Accident</i>	<i>1809</i>

At the time of the accident both the Sun and the Moon were more than 15° below the horizon.

9.0 Preflight Weather Briefing

A search of the FAA contract Automated Flight Service Station provider Leidos indicated that they and no other 3rd party weather vendor utilizing their flight planning system had any contact with the accident site for any weather briefings or flight plans prior to departure. A search of ForeFlight indicated that the pilot did have account with the pilot, but the pilot had not filed a flight plan or create a "Flight" which would have generated a weather briefing for the flight. The pilot had created several route strings during the period and view the airport data pages for KEET, KOKV, and KHQU, which does include the latest METAR/TAF and NOTAMs for that airport.

Date/Time (UTC)	Updated Route String
1/11/2023 22:16:57	KOKV KEET N43156 6500FT 20230111T22:30:00Z
1/11/2023 22:16:31	KOKV KEET N43156 7500FT 20230111T22:30:00Z
1/11/2023 21:49:37	KOKV KEET N43156 7500FT 20230111T22:00:00Z
1/11/2023 21:49:30	KOKV KEET
1/11/2023 16:57:07	KEET KOKV N43156 7500FT 20230111T17:00:00Z
1/11/2023 15:28:26	KEET KOKV N43156 7500FT 20230111T17:10:00Z
1/11/2023 15:28:12	KEET KOKV N43156 5500FT 20230111T17:10:00Z
1/11/2023 15:28:07	KEET KOKV N43156 5500FT 20230111T17:30:00Z
1/11/2023 15:27:45	KEET KOKV
1/11/2023 15:27:35	KEAR KEET N43156 5500FT
1/11/2023 5:44:23	KEET KOKV N43156 5500FT 20230111T17:00:00Z
1/11/2023 5:44:21	KEET KOKV N43156 5500FT 20230112T05:00:00Z
1/11/2023 5:44:18	KEET KOKV N43156 5500FT 20230112T05:25:00Z
1/11/2023 5:44:13	KEET KOKV N43156 5500FT 20230112T05:45:00Z

Figure 11 - ForeFlight Route Strings generated during the period.

Submitted by:

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