



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

August 5, 2022

Specialist's Factual Report

METEOROLOGY

ERA22LA191

A. ACCIDENT

Location: Grantsville, Maryland
Date: April 16, 2022
Time: 1947 eastern daylight time
2347 Coordinated Universal Time (UTC)
Aircraft: Piper PA-32-260; Registration: N3618W

B. METEOROLOGY SPECIALIST

Specialist Paul Suffern
National Transportation Safety Board
Washington, DC

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist did not launch for this investigation, but information was gathered from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources and also from the National Centers for Environmental Information (NCEI). This Specialist's Factual Report contains the meteorological factors pertinent to the weather surrounding the accident time. All times are eastern daylight time (EDT) and are based upon the 24-hour clock, where local time is -4 hours from UTC. Directions are referenced to true north and distances are in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles. NWS 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.

The weather encounter location was at an approximate latitude 39.674227° N, Longitude 79.10285° W, and elevation of 11,000 feet (ft).

D. FACTUAL INFORMATION

1.0 Synoptic Situation

The synoptic or large-scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction and the Weather Prediction Center, located in College Park, Maryland. These are the base products used in describing synoptic weather features and in the creation of forecasts and warnings for the NWS. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC 00-45H.¹

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart centered over the eastern United States for 2000 EDT is provided as figure 1 with the location of the weather encounter within the black circle. The chart depicted a low-pressure system over Massachusetts at 1008-hectopascals (hPa) with a cold front stretching southwestward from Massachusetts across New Jersey through northern Virginia and into the Tennessee Valley. A surface trough² was depicted stretching northern Virginia southward across the central Carolinas and into eastern Georgia. Troughs can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present. The weather encounter was located west of the cold front on the cool side of the front.

The station models around the weather encounter location depicted air temperatures in the mid-40s to mid-50s Fahrenheit (°F), dew point temperatures in the mid-40s Fahrenheit (°F), with temperature-dew point spreads of 10°F or less, cloudy skies in northern West Virginia and southwestern Pennsylvania, mostly cloudy skies indicated in the western Maryland Panhandle, and a northwest wind around 5 knots.

¹ https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1030235

² Trough - An elongated area of relatively low atmospheric pressure or heights.

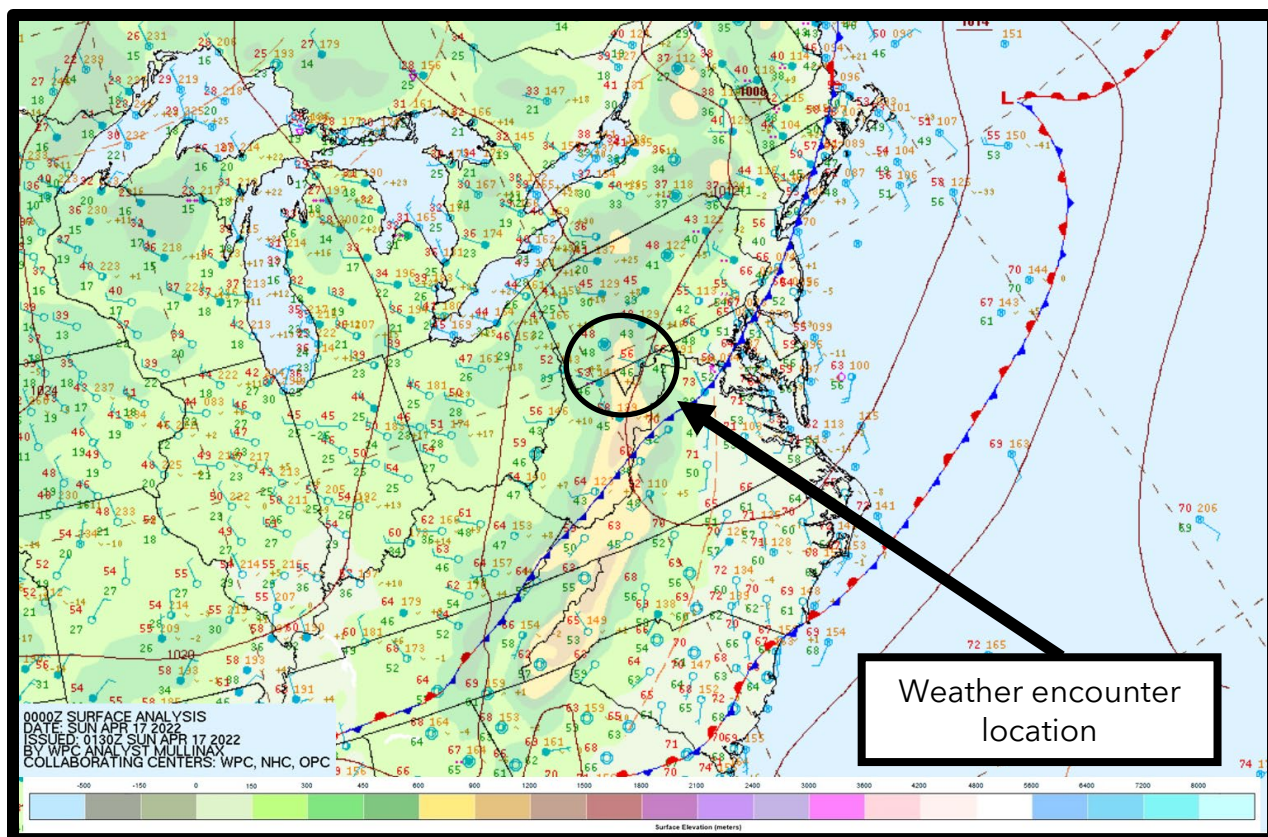


Figure 1. NWS Surface Analysis Chart for 2000 EDT.

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 2000 EDT at 850-, 700- and 500-hPa are presented in figures 2 through 4. The weather encounter location was located in between two mid-level troughs at 700-hPa. The 850-hPa constant pressure chart depicted a northwest wind of 15 knots winds near the weather encounter location with the wind increasing in speed to 75 knots by 500-hPa (figure 4).

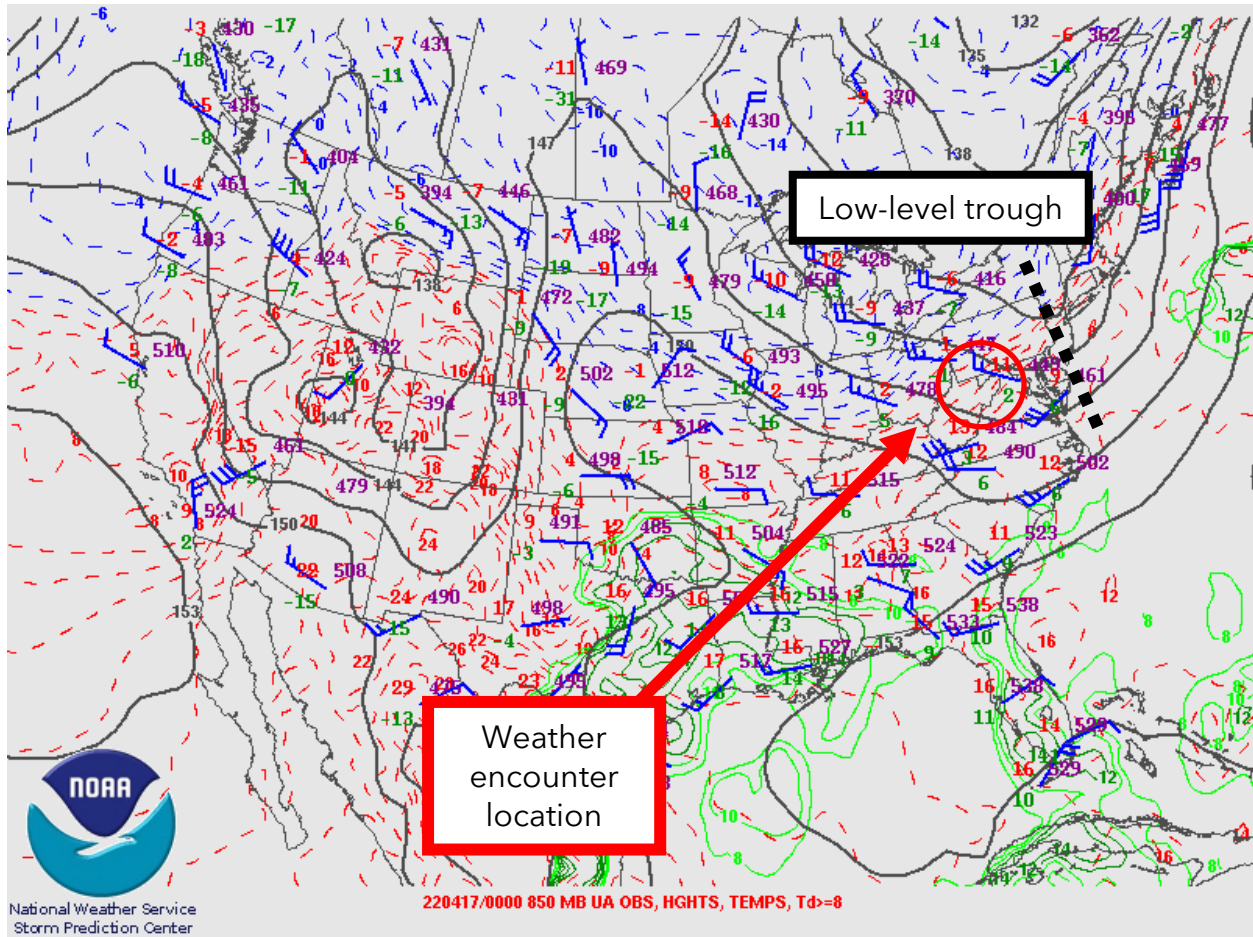


Figure 2. 850-hPa Constant Pressure Chart for 2000 EDT.

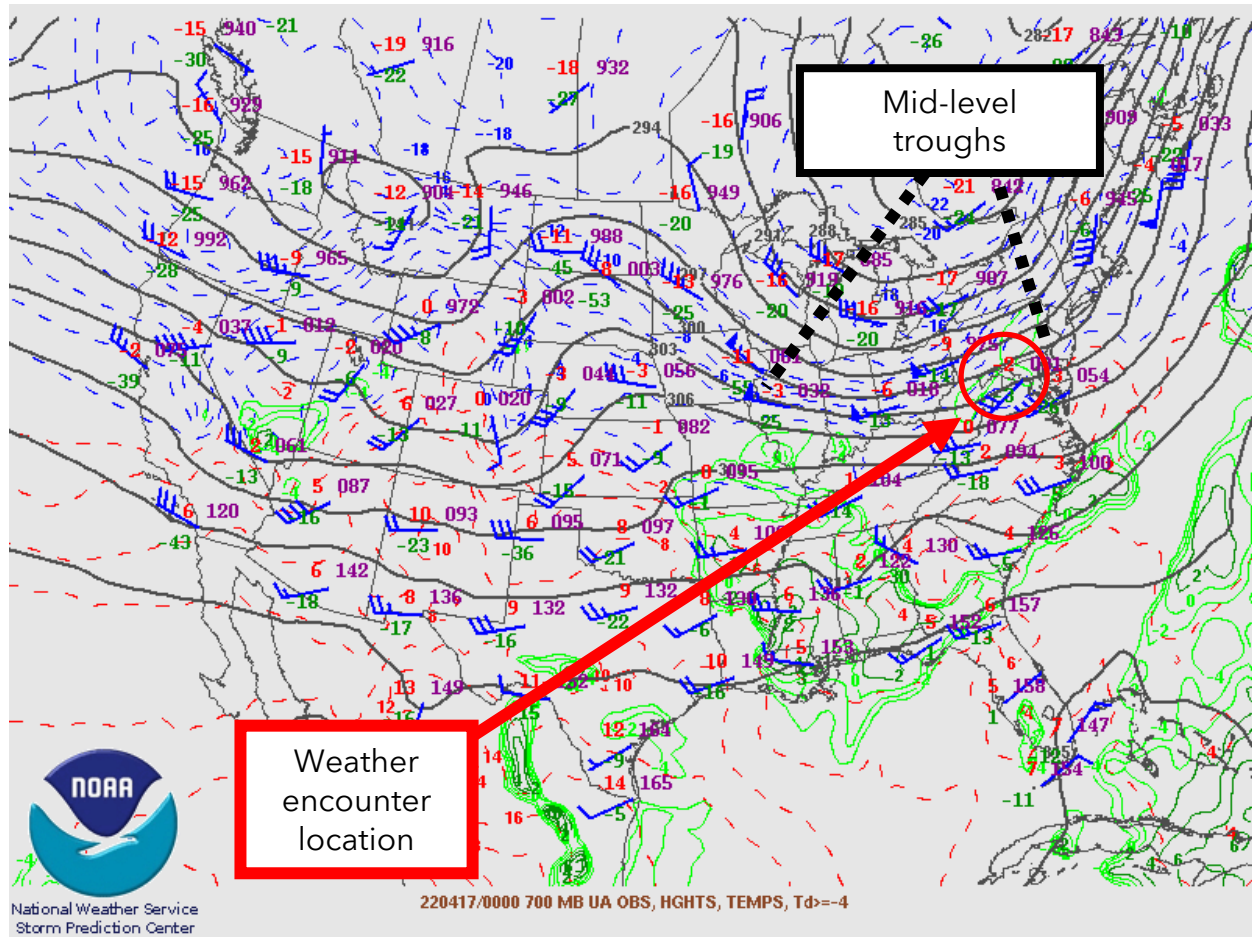


Figure 3. 700-hPa Constant Pressure Chart for 2000 EDT.

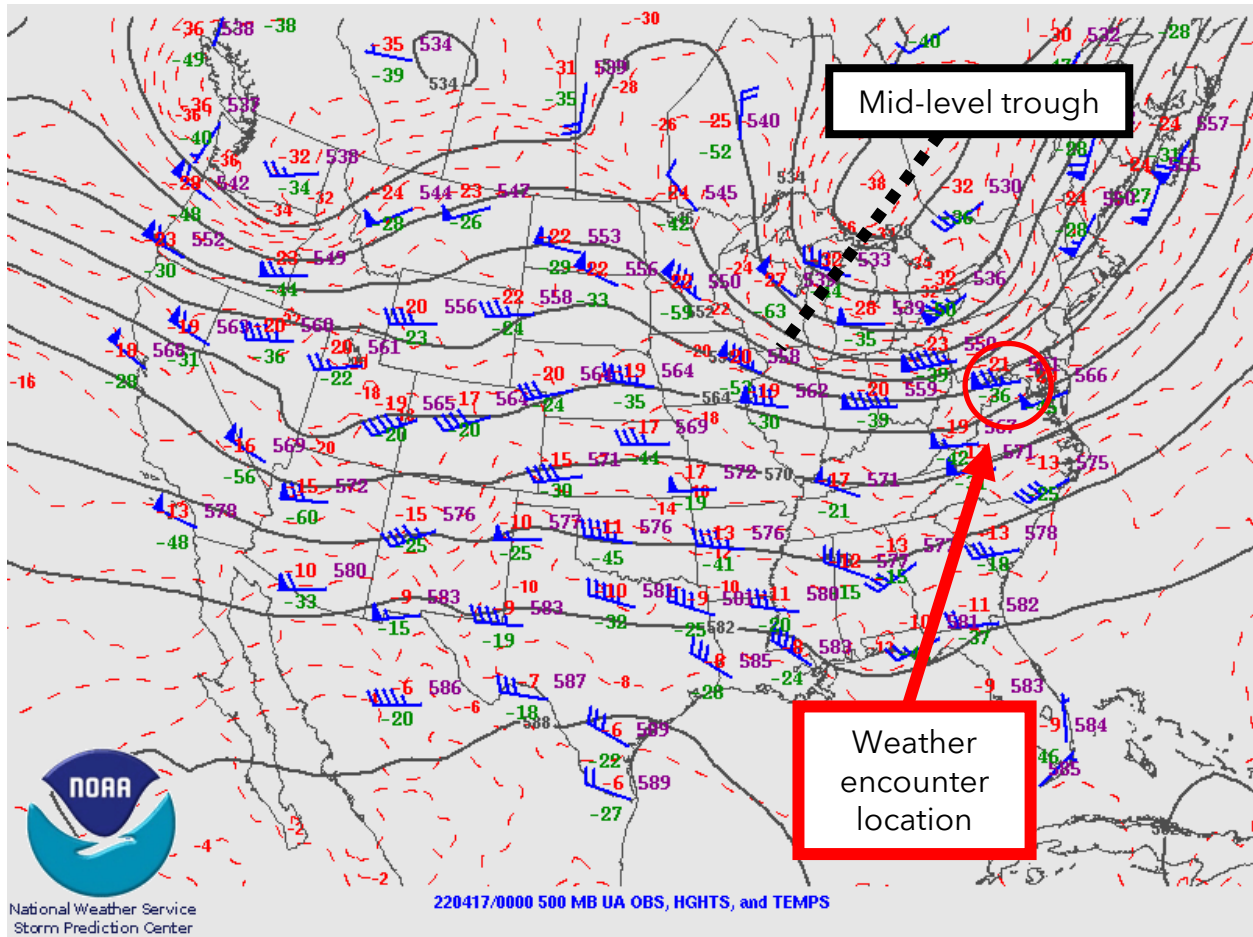


Figure 4. 500-hPa Constant Pressure Chart for 2000 EDT.

2.0 Storm Prediction Center Convective Outlook

SPC issued a Day 1 Convective Outlook at 1459 EDT (figure 5) with areas of general thunderstorms forecast for east of the weather encounter location. SPC defines the "TSTM" area as an area that encloses where a 10% or higher probability of thunderstorms is forecast during the valid period.

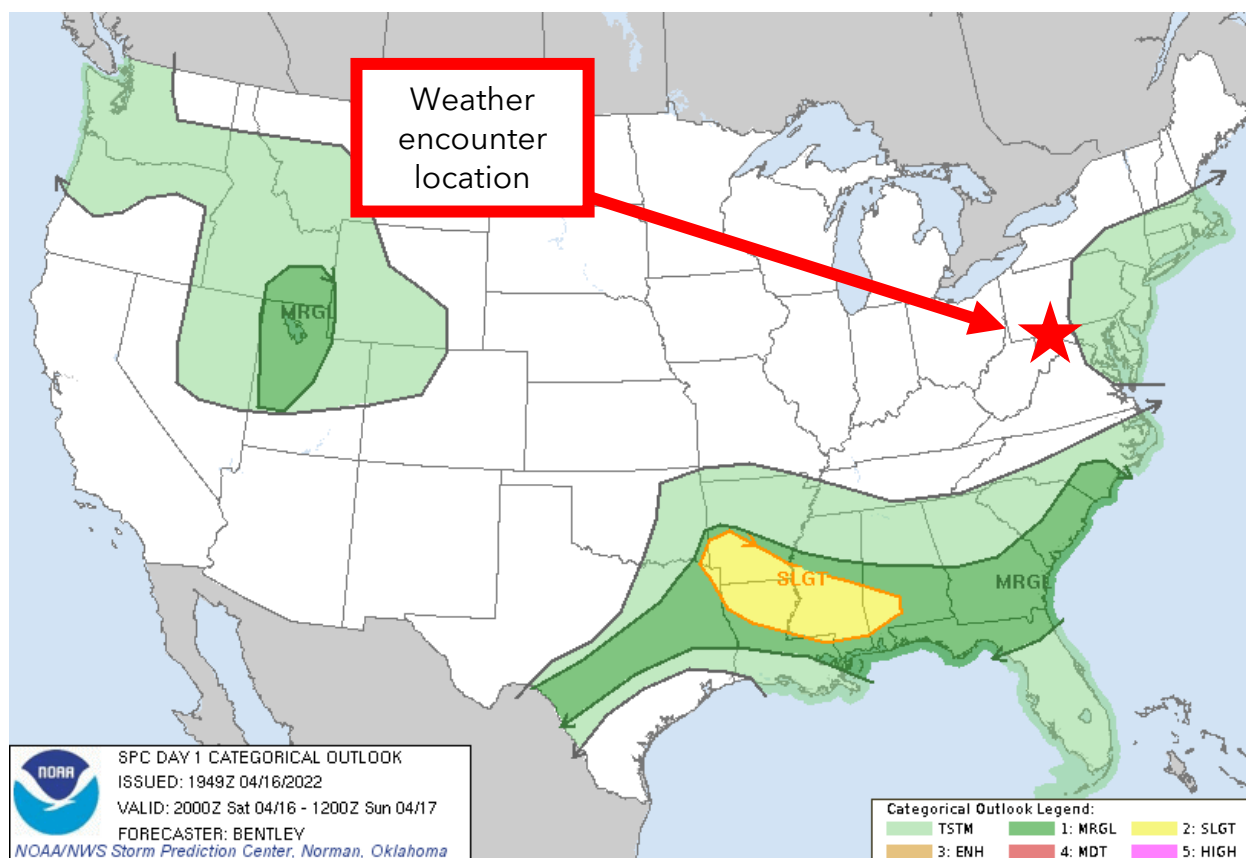


Figure 5. SPC day 1 Convective Outlook valid at the time of the accident.

3.0 Surface Observations

The area surrounding the weather encounter location was documented using official Aviation Routine Weather Reports (METARs) and Specials Reports (SPECIs). The following observations were taken from standard code and are provided in plain language. Figure 6 is a local sectional chart with the weather encounter location and the closest weather reporting location marked. The chart depicted the magnetic variation³ of 10° west over the area.

³ Magnetic variation - The angle (at a particular location) between magnetic north and true north. Latest measurement taken from <https://skyvector.com/>

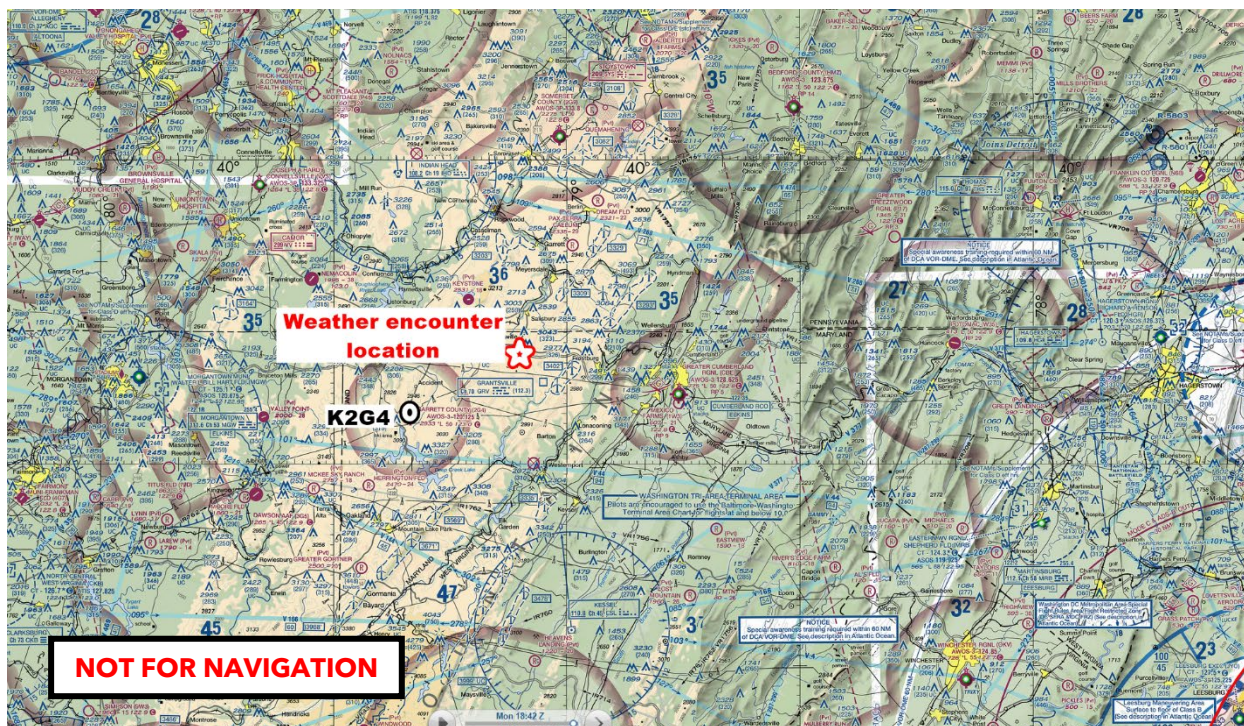


Figure 6. Sectional map of the accident area with the location of the weather encounter and surface observation site.

Garrett County Airport (K2G4) had the closest official weather station to the weather encounter location. K2G4 had an Automated Weather Observing System (AWOS⁴) whose longline⁵ reports were not augmented. The K2G4 AWOS was located 12 miles southwest of the weather encounter location, at an elevation of 2,933 ft, and issued the following observations surrounding the period of the accident:⁶

[1815 EDT] METAR K2G4 162215Z AUTO 28006KT 10SM SCT014
BKN022 OVC070 08/07 A2989 RMK AO1=

[1825 EDT] METAR K2G4 162225Z AUTO 30006KT 10SM BKN013

⁴ AWOS - Automated Weather Observing System is equipped with meteorological instruments to observe and report temperature, dewpoint, wind speed and direction, visibility, cloud coverage and ceiling up to 12,000 feet, and altimeter setting. AWOS are maintained by the FAA.

⁵ "Longline" refers to the dissemination of weather observations with the intent that they are available in near-real time to national databases and accessible to the general global public from a large number of vendors. This does not include public accessibility to observations from a reporting station's Very High Frequency (VHF; line-of-site) or telephone broadcast, where applicable. Longline dissemination of weather observations is the primary vehicle through which the weather observations are distributed.

⁶ The bold sections in this NWS product and the rest of the products in this report are intended to highlight the text that directly reference the weather conditions that affected the accident location around the accident time. The local times in this section next to the METARs are provided for quick reference between UTC and local times around the accident time.

OVC020 08/07 A2989 RMK AO1=

[1855 EDT] METAR K2G4 162255Z AUTO 28010G20KT 242V332 10SM
BKN004 OVC010 07/07 A2990 RMK AO1=

[1905 EDT] METAR K2G4 162305Z AUTO 27009G20KT 252V082 4SM
BKN004 OVC010 07/07 A2991 RMK AO1=

***[1935 EDT] METAR K2G4 162335Z AUTO 29008G16KT 7SM
OVC004 07/07 A2991 RMK AO1=***

WEATHER ENCOUNTER TIME 1947 EDT

***[1955 EDT] METAR K2G4 162355Z AUTO 29013G20KT 3SM
OVC003 06/06 A2992 RMK AO1=***

[2015 EDT] METAR K2G4 170015Z AUTO 29008G18KT 252V312 10SM
OVC005 06/06 A2992 RMK AO1=

The bold type observations decoded in plain language were as follows:

K2G4 weather at 1935 EDT, automated, wind from 290° at 8 knots with gusts to 16 knots, visibility 7 miles, overcast ceiling at 400 ft above ground level (agl), temperature of 7° Celsius (C), dew point temperature 7°C, and an altimeter setting of 29.91 inches of mercury (inHg). Remarks, automated station without a precipitation discriminator.

K2G4 weather at 1955 EDT, automated, wind from 290° at 13 knots with gusts to 20 knots, visibility 3 miles, overcast ceiling at 300 ft agl, temperature of 6°C, dew point temperature 6°C, and an altimeter setting of 29.92 inHg. Remarks, automated station without a precipitation discriminator.

The observations from K2G4 surrounding the weather encounter and accident time indicated LIFR⁷ conditions due to ceiling heights.

⁷ 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-

4.0 Upper Air Sounding

Pittsburgh, Pennsylvania, had an upper air sounding (KPIT) that had a station ID of 72520, with a surface elevation of 1,224 ft. KPIT was located 73 miles northwest of the weather encounter location. The 2000 EDT KPIT sounding was plotted on a standard Skew-T Log P diagram⁸ from the surface to 500-hPa (or approximately 18,000 ft) along with the derived stability parameters and is included as figure 7. These data were analyzed using the RAOB⁹ software package. The sounding depicted the lifted condensation level (LCL)¹⁰ at 2,832 ft, the level of free convection (LFC)¹¹ at 3,038 ft, and the convective condensation level (CCL)¹² at 4,812 ft. The freezing level was located at 5,100 ft with the precipitable water value at 0.52 inches.

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.

⁸ Skew T log P diagram - is a standard meteorological plot using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

⁹ RAOB - (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Esonde Research Services, The Villages, Florida.

¹⁰ LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

¹¹ LFC - The level at which a parcel of saturated air becomes warmer than the surrounding air and begins to rise freely. This occurs most readily in a conditionally unstable atmosphere.

¹² CCL - The level in the atmosphere to which an air parcel, if heated from below, will rise dry adiabatically, without becoming colder than its environment just before the parcel becomes saturated.

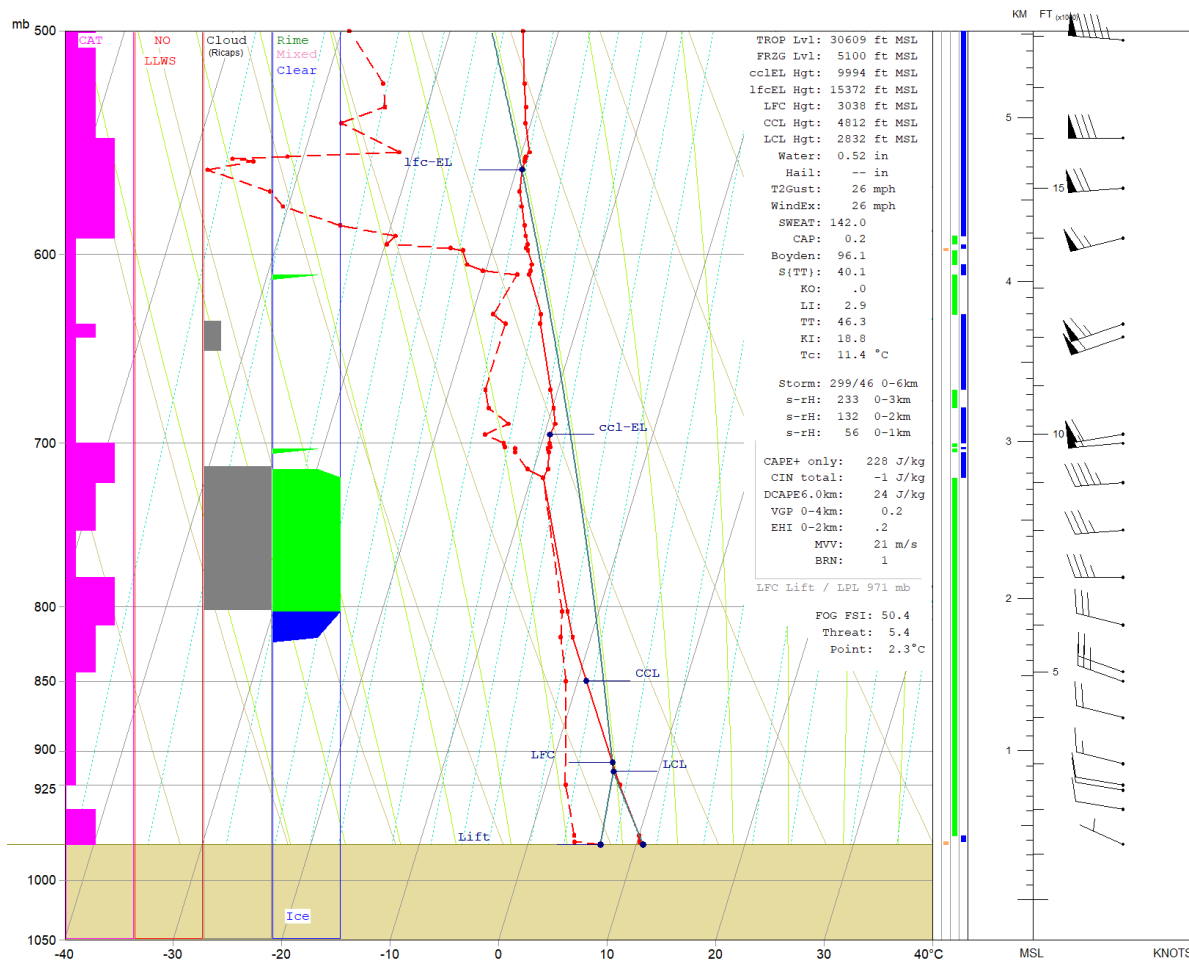


Figure 7. 2000 EDT KPIT sounding.

The 2000 EDT KPIT sounding for the weather encounter location indicated a conditionally unstable environment from the surface through 9,000 ft with a mainly stable layer above 9,000 ft. Clouds were indicated by RAOB between 6,200 and 9,500 ft, and in a small layer near 12,500 ft. Moderate or greater icing potential was indicated by RAOB between 6,200 and 9,500 ft, and in two layers near 10,000 and 13,000 ft.

The 2000 EDT KPIT sounding wind profile indicated a near surface wind from 295° at 3 knots with the wind remaining westerly through 18,000 ft. The wind speed increased above 20 knots by 5,000 ft and above 60 knots by 10,000 ft. RAOB did not indicate the possibility of low-level wind shear (LLWS), but did indicate the possibility of moderate clear air turbulence in several layers from the surface through 18,000 ft. Based on the KPIT sounding, at the accident aircraft's altitude before descent¹³, near 11,000 ft, the temperature was -10.7°C, the relative humidity was 61 percent, and the wind was from 250° at 61 knots.

¹³ Please see the docket of this accident for more information.

5.0 Satellite Data

Geostationary Operational Environmental Satellite number 16 (GOES-16) visible and infrared 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 software. Visible and infrared imagery (GOES-16 bands 2 and 13) at wavelengths of 0.64 microns (μm) and 10.3 μm , respectively, were retrieved for the period from 1600 EDT through 2200 EDT and reviewed, and the closest images to the time of the accident were documented.

Figure 8 presents the GOES-16 visible imagery from 1940 EDT at 2X magnification with the weather encounter location highlighted with a red square and cloud cover indicated above the weather encounter location. Figures 9 and 10 present the GOES-16 infrared imagery from 1940 and 1950 EDT at 6X magnification with the weather encounter location highlighted with a red square and cloud cover indicated above the weather encounter location. The lower brightness temperatures (yellow colors; higher cloud tops) were located above the weather encounter location at the encounter time. The cloud cover was moving from west to east. The brightness temperature of 258 Kelvin above the weather encounter location would have been near 13,000 ft based on the vertical temperature profile provided by the 2000 EDT KPIT sounding. It should be noted these figures have not been corrected for any parallax error.

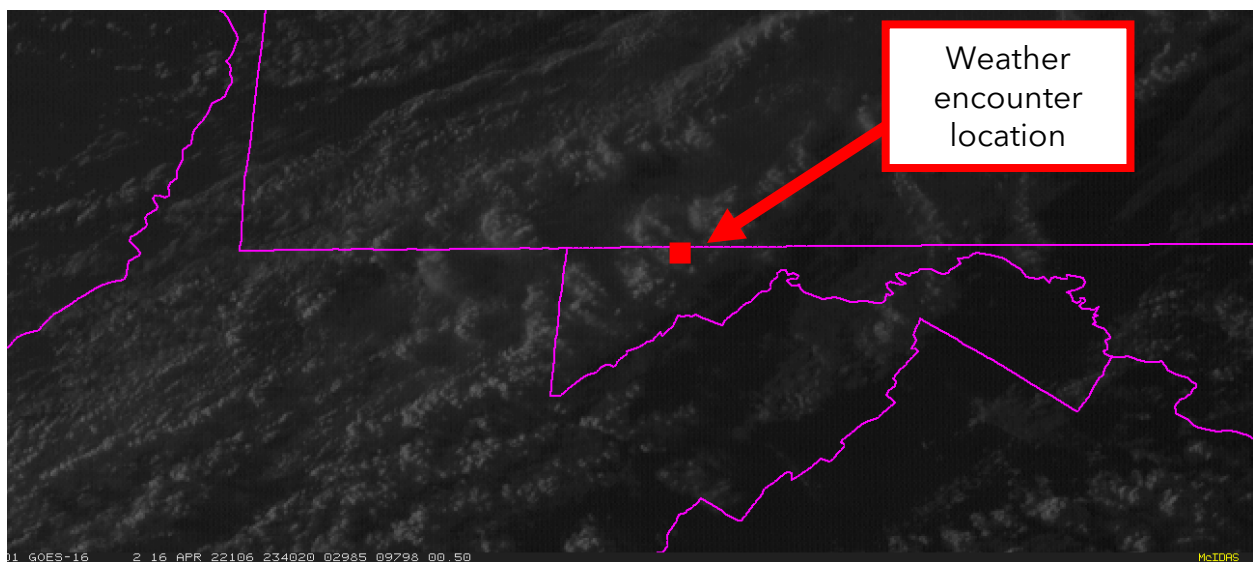


Figure 8. GOES-16 visible image at 1940 EDT.

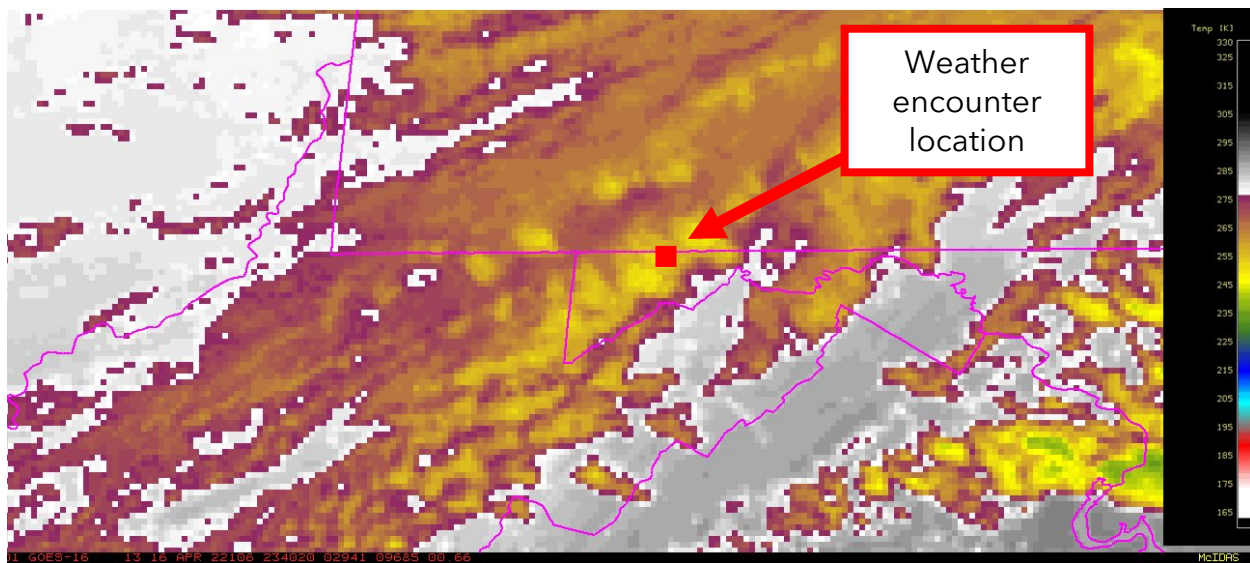


Figure 9. GOES-16 infrared image at 1940 EDT.

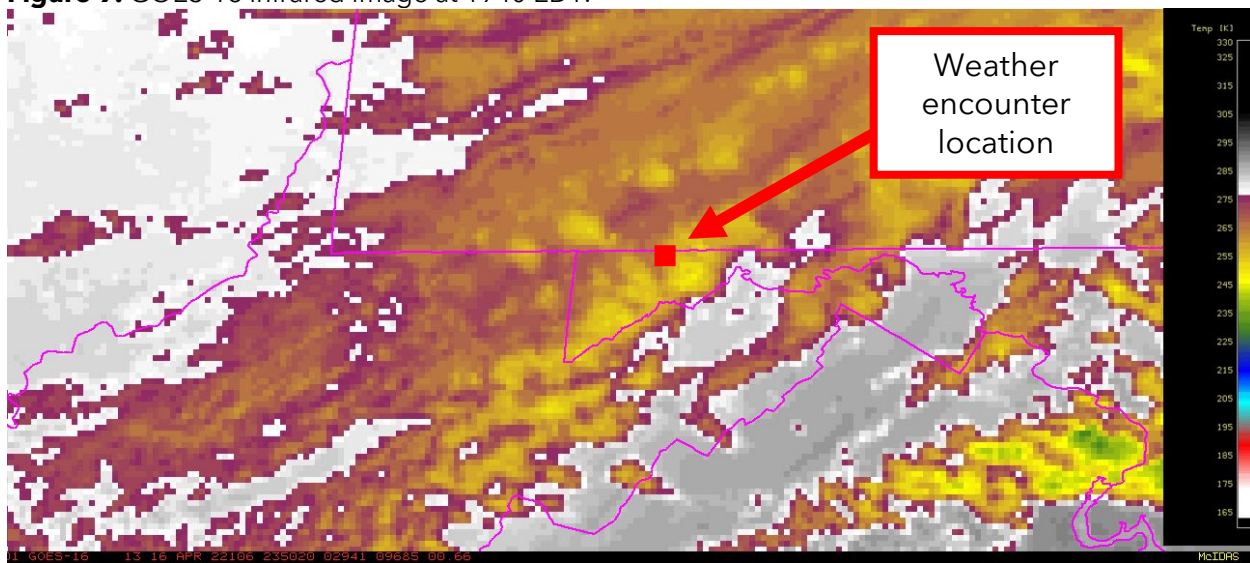


Figure 10. GOES-16 infrared image at 1950 EDT.

6.0 National Radar Imagery

A regional view of the NWS National Reflectivity Mosaic is included as figure 11 for 1945 EDT with the approximate location of the weather encounter marked by a red circle. The image depicted 10 to 30 dBZ¹⁴ echoes at the weather encounter location.

¹⁴ dBZ - A non-dimensional "unit" of radar reflectivity which represents a logarithmic power ratio (in decibels or dB) with respect to radar reflectivity factor, Z.

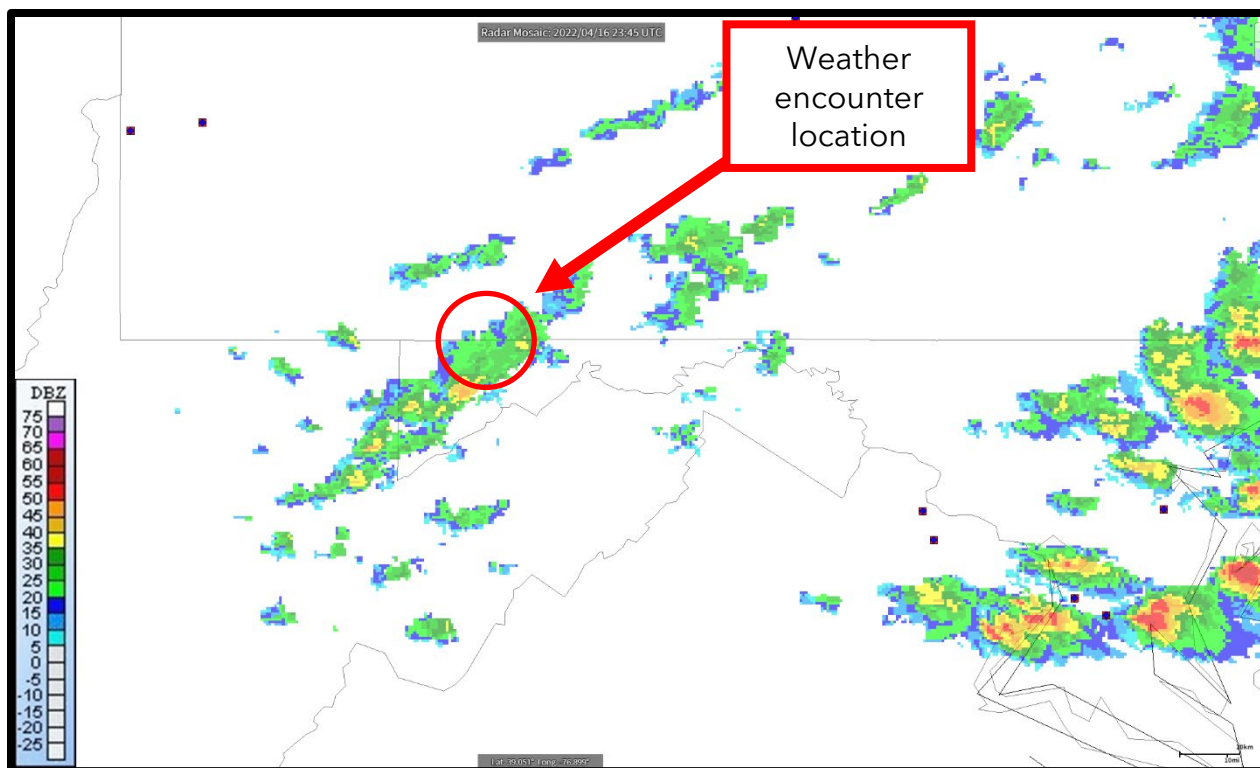


Figure 11. National Reflectivity Mosaic for 1945 EDT.

7.0 Weather Surveillance Radar Imagery

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)¹⁵ to the weather encounter location was Pittsburgh, Pennsylvania, (KPBZ) located 73 miles northwest of the weather encounter location. Level II archive radar data were obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

7.1 Volume Scan Strategy

The WSR-88D is a computer-controlled radar system, which automatically creates a complete series of specific scans in a specific sequence known as a volume scan. Individual elevation scans are immediately available. Products that require data from multiple elevation scans are not available until the end of the five-to-ten-minute volume scan.

¹⁵ The WSR-88D is an S-band 10-centimeter wavelength radar with a power output of 750,000 watts, and with a 28-foot parabolic antenna that concentrates the energy between a 0.87° and 0.96° beam width. The radar produces three basic types of products: base reflectivity, base radial velocity, and base spectral width.

The WSR-88D operates in two main scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan where the radar makes 15 elevation scans from 0.5° to 19.5° every six minutes or so. This particular scanning strategy is documented as volume coverage pattern 215 (VCP-215, figure 12). Mode B is the clear-air mode, where the radar makes 5 elevation scans during a ten-minute period. During the period surrounding the accident, the KPBZ WSR-88D radar was operating in the precipitation mode VCP-215. The following figure provides an indication of the different elevation angles in this VCP, and the approximate height and width of the radar beam with distance from the radar site.

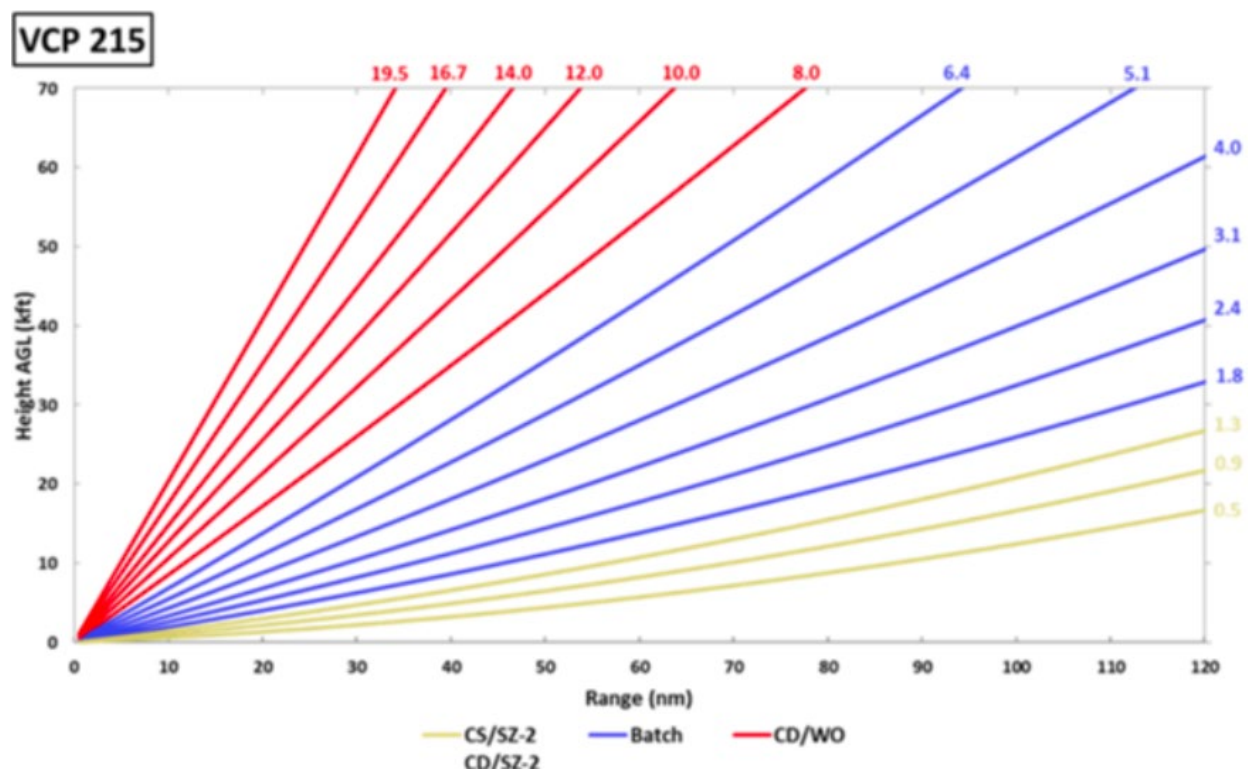


Figure 12. VCP-215 Precipitation Mode Scan Strategy¹⁶.

¹⁶ Contiguous Surveillance (CS)--The low Pulse Repetition Frequency (PRF) scan of the split cut. Gives a high R_{max} value to determine proper target location and intensity, but a low V_{max} value limits the velocities that can be measured. Contiguous Doppler (CD)--The high PRF scan of the split cut. Gives a low R_{max} value causing more range folded (multiple trip) echoes, but a high V_{max} value to get higher, more accurate velocity values. Batch Mode - Uses alternating low and high PRFs on each radial for one full rotation at each elevation angle. The two resulting data sets (low PRF and high PRF) are combined to resolve range ambiguity. Used in the middle elevation angles. W - With range unfolding (W) WO - Without range unfolding (WO)

7.2 Beam Height Calculation

Assuming standard refraction¹⁷ of the KPBZ WSR-88D radar beam with the antenna elevation at 1,266 ft, and considering a beamwidth¹⁸ of 0.95°, the following table shows the approximate heights for the radar beam center, top and base for antenna elevations over the weather encounter location. These heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
KPBZ 0.5°	9,000 ft	5,400 ft	12,600 ft

Based on the radar height calculations, the elevation scans from KPBZ listed in the above table depicted the conditions between 5,400 ft and 12,600 ft over the weather encounter location and these scans “saw” the closest altitudes to the ground.

¹⁷ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

¹⁸ Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

7.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors¹⁹ 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 dBZ²⁰ and is a general measure of echo intensity. FAA Advisory Circular AC 00-24C²¹, "Thunderstorms," dated February 19, 2013, also defines the echo intensity levels and weather radar echo intensity terminology associated with those levels. For dBZ values less than 30 the weather radar echo intensity terminology should be "light." For dBZ values between 30 and 40, the terminology should be "moderate." "Heavy" terminology is used for dBZ values greater than 40 dBZ but less than 50 dBZ, inclusive. Finally, any dBZ values above 50 dBZ shall be described as "extreme."

7.4 Base Reflectivity and Lightning Data

Figures 13 through 16 present the KPBZ WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 1935:50, 1940:09, 1944:28, and 1948:46 EDT, respectively, with a resolution of 0.5° X 250 m. The flight track data²² were added to figures 13 through 16 for context. Reflectivity values between 5 and 15 dBZ were present near the aircraft's location at 1935 EDT, with the accident aircraft located within reflectivity values between 5 and 30 dBZ starting at 1944 EDT. The band of precipitation was moving from west to east with time (attachment 1).

There were no lightning flashes²³ reported within 50 miles of the weather encounter location within 30 minutes prior to or following the encounter time.²⁴

¹⁹ Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at the earth's surface; also, any water particles blown by the wind from the earth's surface. Hydrometeors are classified as; (a) Liquid or solid water particles suspended in the air: cloud, water droplets, mist, or fog. (b) Liquid precipitation: drizzle and rain. (c) Freezing precipitation: freezing drizzle and freezing rain. (d) Solid (frozen) precipitation: ice pellets, hail, snow, snow pellets, and ice crystals. (e) Falling particles that evaporate before reaching the ground: virga. (f) Liquid or solid water particles lifted by the wind from the earth's surface: drifting snow, blowing snow, blowing spray. (g) Liquid or solid deposits on exposed objects: dew, frost, rime, and glazed ice.

²⁰ dBZ – A non-dimensional "unit" of radar reflectivity which represents a logarithmic power ratio (in decibels or dB) with respect to radar reflectivity factor, Z.

²¹

https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1020774

²² For more information please see the docket in this accident.

²³ Lightning Flash – This is one contiguous conducting channel and all the current strokes/pulses that flow through it. There are two types of flashes: ground flashes and cloud flashes.

²⁴ A review of Earth Networks Total Lightning network and GOES-16 Geostationary Lightning Mapper was done.

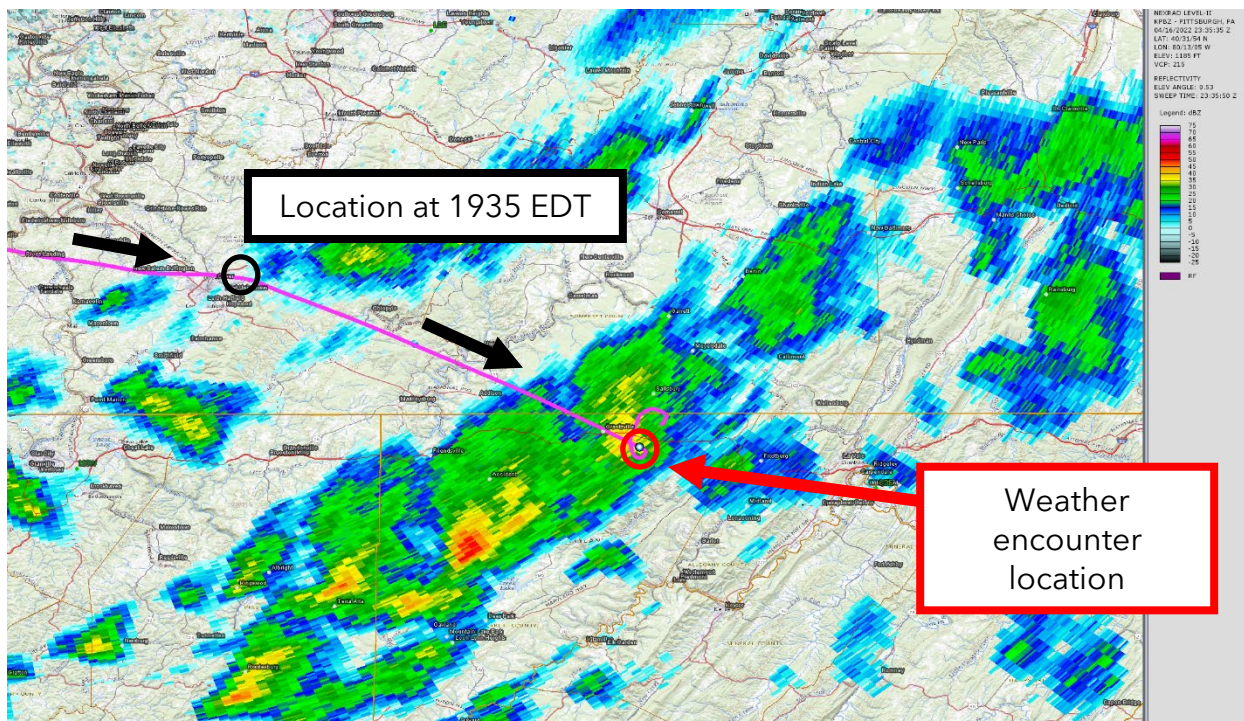


Figure 13. KPBZ WSR-88D reflectivity for the 0.5° elevation scan initiated at 1935:50 EDT with the weather encounter location marked with the red circle. The flight track is in pink with arrows pointing in the direction of travel.

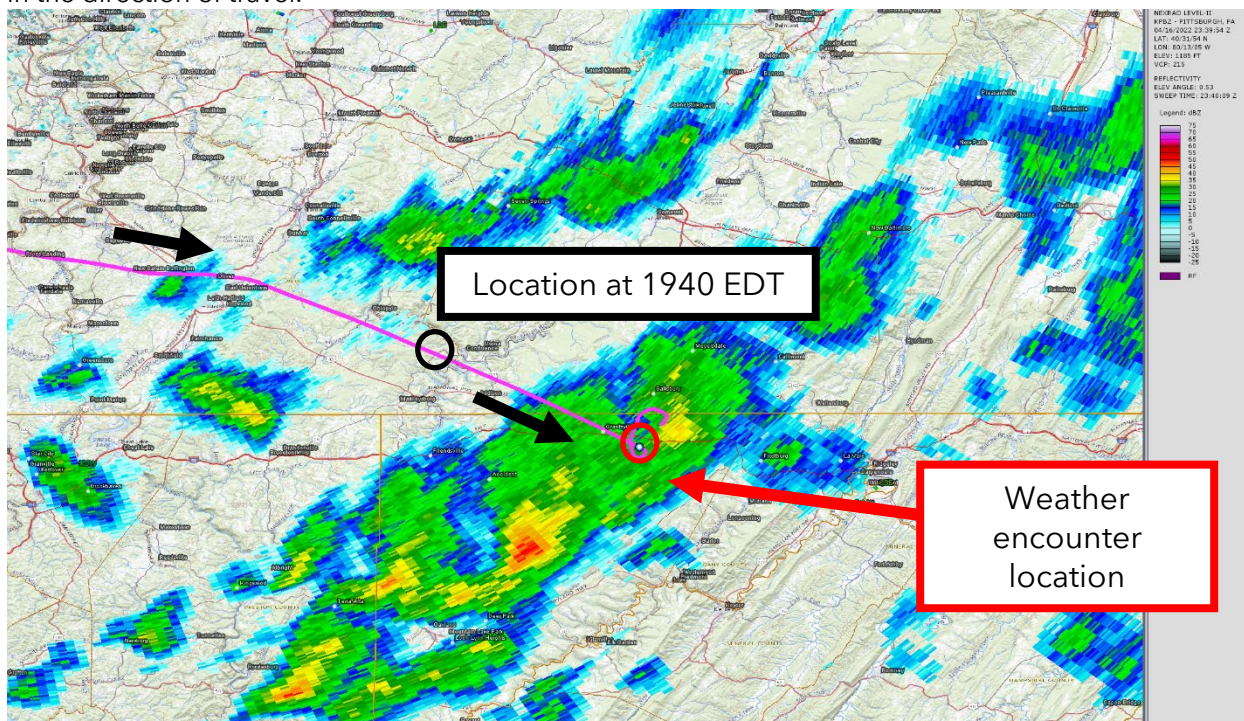


Figure 14. KPBZ WSR-88D reflectivity for the 0.5° elevation scan initiated at 1940:09 EDT with the weather encounter location marked with the red circle. The flight track is in pink with arrows pointing in the direction of travel.

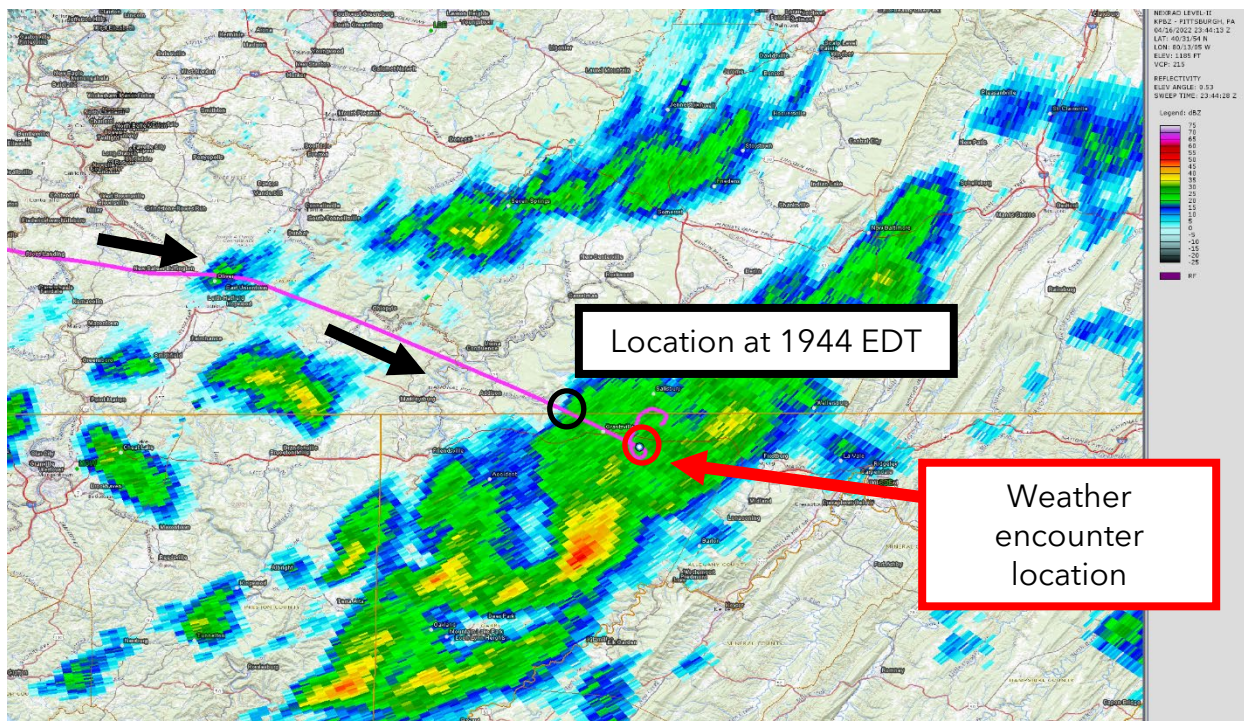


Figure 15. KPBZ WSR-88D reflectivity for the 0.5° elevation scan initiated at 1944:28 EDT with the weather encounter location marked with the red circle. The flight track is in pink with arrows pointing in the direction of travel.

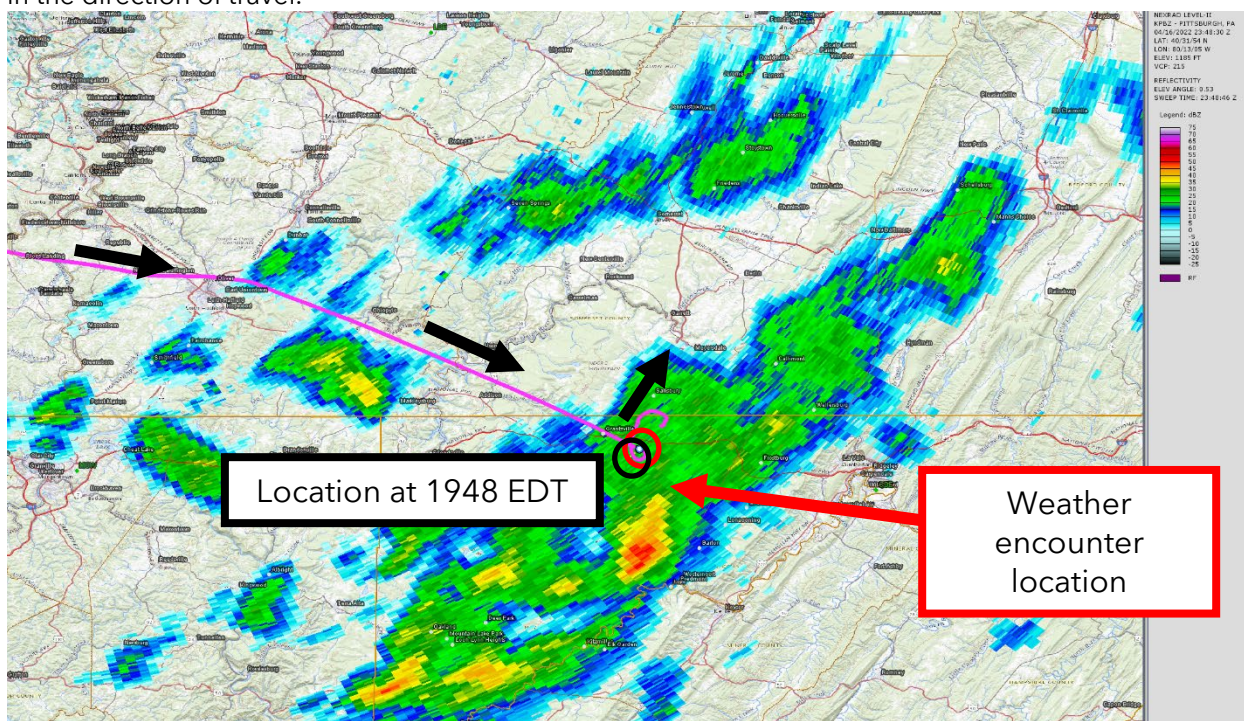


Figure 16. KPBZ WSR-88D reflectivity for the 0.5° elevation scan initiated at 1948:46 EDT with the weather encounter location marked with the red circle. The flight track is in pink with arrows pointing in the direction of travel.

8.0 Pilot Reports

The longline-disseminated pilot reports²⁵ (PIREPs) distributed into the national airspace (NAS) were reviewed for about two hours on either side of the accident time and the PIREPs issued into the NAS within 100 miles of the weather encounter location for below 19,000 ft are shown below:

DUJ UA /OV CIP180010/TM 2134/FL070/TP C208/TA M04/TB LGT-MOD CHOP/IC MIXED=

PIT UA /OV PIT/TM 2206/FL060/TP B350/SK BKN060-TOPUNKN/RM KW/WS=

CKB UA /OV 2G4225015/TM 2254/FL050/TP C172/TB LIGHT=

MRB UA /OV MRB090015/TM 2302/FL190/TP A319/TA M25/TB MOD-SEV/IC MOD RIME=

MRB UUA /OV MRB090015/TM 2303/FL190/TP B737/TA M25/TB MOD-SEV/IC MOD RIME=

HLG UA /OV AIR080030/TM 0024/FL140/TP B38M/TB LGT CHOP 140-180=

MRB UA /OV MRB270015/TM 0056/FL190/TP B738/TB MOD=

JST UA /OV IHD220015/TM 0120/FL110/TP A320/TB CONT LIGHT TURB DURD BELOW 110/IC NEG=

JST UUA /OV LBE/TM 0138/FL070/TP P28R/TA -1/TB MOD TURB/IC MOD RIME/RM 6 NE LBE=

9.0 Significant Meteorological Information

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

10.0 Center Weather Service Advisories

The Cleveland (ZOB) Air Route Traffic Control Center (ARTCC) Center Weather Service Unit (CWSU) was responsible for the accident region. There was no Center Weather Advisory (CWA) valid from ZOB CWSU at the accident time.

²⁵ Only pilot reports with the World Meteorological Organization headers UBWV**, UBPA**, UBMD**, and UBVA** were considered. These do not include pilot reports only broadcast via radio.

11.0 Airmen's Meteorological Information

There were text Airmen's Meteorological Information (AIRMET) advisories Sierra, Tango, and Zulu valid for the weather encounter location at the accident time. The text AIRMETs Sierra, Tango, and Zulu were issued at 1645 EDT and forecast mountain obscuration conditions due to clouds, precipitation and mist, IFR conditions, moderate turbulence below 10,000 ft, and moderate icing between the freezing level²⁶ and 17,000 ft:

WAUS41 KPCI 162045

WA1S

-BOSS WA 162045

AIRMET SIERRA UPDT 6 FOR IFR AND MTN OBSCN VALID UNTIL 170300

AIRMET IFR...NY PA OH LE WV MD VA

**FROM 40WSW BUF TO 50ESE BUF TO 50E PSB TO 50S JST TO 50SSE EKN
TO 50ESE HNN TO 20W ERI TO 40WSW BUF**

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

AIRMET IFR...ME NH VT MA RI CT NY LO PA AND CSTL WTRS

FROM 30ENE PQI TO 50SW YSJ TO ACK TO 40SSE HNK TO 50E BUF TO

50SSE MSS TO 20S YSC TO 50ENE YSC TO 70ESE YQB TO 30ENE PQI

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

AIRMET MTN OBSCN...ME NH VT MA NY PA WV MD VA

**FROM 60E YQB TO 30SSW HUL TO 40SW BGR TO 20SW ENE TO SAX TO 40E
PSB TO 50S JST TO 50ESE EKN TO 20SSE BKW TO 30SSE AIR TO 20SW
JHW TO 50WSW SYR TO 60E MSS TO 20W YSC TO 60SE YQB TO 60E YQB
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.**

OTLK VALID 0300-0900Z

AREA 1...IFR NY PA OH LE

BOUNDED BY 40S YYZ-50ESE BUF-40E SLT-30SSW PSB-50WNW ERI-40S YYZ

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

AREA 2...IFR ME NH VT MA RI CT NY LO NJ AND CSTL WTRS

BOUNDED BY 50ENE PQI-110SSW YSJ-130ENE ACK-140S ACK-80S HTO-

20SSW PVD-30SW BDL-20E SAX-30NW SYR-60SSW YOW-20SE YOW-50E MSS-

50S YSC-30ESE YQB-60W PQI-50ENE PQI

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

AREA 3...MTN OBSCN ME NH VT MA NY PA WV MD VA

BOUNDED BY 70NW PQI-20SW HUL-20SSW ENE-20W SAX-20ENE PSB-50ESE

EKN-40SSW EKN-40ESE AIR-40SE ERI-20WNW JHW-30ESE YOW-70W YSC-YSC-

70NW PQI

MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG THRU 09Z.

....

WAUS41 KPCI 162045

²⁶ Freezing level between the 3,000 and 8,000 ft.

WA1T

-BOST WA 162045

AIRMET TANGO UPDT 3 FOR TURB AND LLWS VALID UNTIL 170300

.
AIRMET TURB...ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DC DE VA
AND CSTL WTRS

FROM 70WNW PQI TO 30NE PQI TO 60SW YSJ TO 200SE ACK TO 130ESE
SIE TO 30SSE EKN TO 20ENE CVG TO FWA TO 20NE DXO TO 30WNW CLE TO
30SE YOW TO 30SSE YSC TO 70WNW PQI
MOD TURB BTN FL180 AND FL360. CONDS CONTG BYD 03Z THRU 09Z.

.
**AIRMET TURB...NH VT MA CT NY NJ PA OH WV MD DC DE VA
FROM 20NNW CON TO 30W BOS TO 20NW SIE TO 30N RIC TO 60SSW HNN TO
60E CVG TO 30E APE TO 20SW SLT TO 40NNE ALB TO 20NNW CON
MOD TURB BLW 100. CONDS DVLPG 00-03Z. CONDS CONTG BYD 03Z THRU
09Z.**

.
AIRMET TURB...ME NH MA RI CT NY NJ AND CSTL WTRS
FROM 50SSE HUL TO 150ENE ACK TO 130SSE HTO TO 90ESE CYN TO 50SE
JFK TO 40S BDL TO 20SW BGR TO 50SSE HUL
MOD TURB BLW 120. CONDS CONTG BYD 03Z ENDG 03-06Z.

.
LLWS POTENTIAL...ME NH MA RI NY AND CSTL WTRS
BOUNDED BY 50WSW YSJ-110SSW YSJ-70S ACK-70SSE HTO-20ESE HTO-
40SSW BGR-50WSW YSJ
LLWS EXP. CONDS DVLPG 21-00Z. CONDS CONTG BYD 03Z ENDG 03-06Z.

.
OTLK VALID 0300-0900Z...TURB ME NH VT MA RI CT NY NJ PA OH WV MD
DC DE VA AND CSTL WTRS
BOUNDED BY 110SE BGR-150ENE ACK-90SE ACK-150S ACK-110SE SIE-30N
ORF-80SSW HNN-50E CVG-30E APE-20SW SLT-50SSW MPV-110SE BGR
MOD TURB BLW 100. CONDS CONTG THRU 09Z.

....

WAUS41 KPCI 162045

WA1Z

-BOSZ WA 162045

AIRMET ZULU UPDT 4 FOR ICE AND FRZLVL VALID UNTIL 170300

.
AIRMET ICE...NH MA RI NY NJ MD DE VA NC CSTL WTRS
FROM 130ENE ACK TO 190SE ACK TO 160SE SIE TO 180E ECG TO 110SE
ECG TO 80E ECG TO 80ESE CYN TO 130ENE ACK
MOD ICE BTN FRZLVL AND FL200. FRZLVL 080-100. CONDS ENDG 00-03Z.

.
**AIRMET ICE...ME NH VT MA RI CT NY NJ PA WV MD DE VA AND CSTL WTRS
FROM 70NW PQI TO 30ENE PQI TO 40ESE HUL TO 110SSW YSJ TO 20SSW
ACK TO 50SSE HTO TO 50SE JFK TO 20N SBY TO 30SE AIR TO 20SSW EWC
TO 50NNW ALB TO 50ENE MSS TO 30ESE YSC TO 70NW PQI
MOD ICE BTN FRZLVL AND 170. FRZLVL 030-080. CONDS CONTG BYD 03Z
THRU 09Z.**

.
AIRMET ICE...NY LO PA OH LE
FROM 60ENE MSS TO 50NNW ALB TO 20SSW EWC TO 20SW CLE TO 30NNW CLE

TO YYZ TO 40NW SYR TO 30SSE YOW TO 60ENE MSS
MOD ICE BTN 020 AND 100. CONDS DVLPG 00-03Z. CONDS CONTG BYD 03Z
THRU 09Z.

.
OTLK VALID 0300-0900Z
AREA 1...ICE ME NH VT MA RI CT NY NJ PA MD DE AND CSTL WTRS
BOUNDED BY 70NW PQI-50NE PQI-50SE HUL-150ESE ACK-130SSE HTO-20NNW
SBY-20WNW EMI-20NNE HAR-40SW BDL-20S YSC-70NW PQI
MOD ICE BTN FRZLVL AND 150. FRZLVL SFC-080. CONDS CONTG THRU 09Z.

.
AREA 2...ICE VT MA CT NY LO NJ PA OH LE WV
BOUNDED BY 20NNW MSS-20S YSC-40SW BDL-30NNE HAR-20NNW AIR-30SSW
CLE-30NNW CLE-YYZ-60NW SYR-20NNW MSS
MOD ICE BTN 020 AND 100. CONDS CONTG THRU 09Z.

.
FRZLVL...RANGING FROM 005-115 ACRS AREA
040 ALG 40WSW ROD-20W AIR-50ESE SLT-30WNW CON-30ENE HUL
080 ALG 40S HNN-30WSW CSN-50S HTO-20SE ACK-130ESE ENE-150ENE
ACK

....

12.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products issued before the accident flight and valid at 2000 EDT are shown in attachment 2. The GFA surface forecast applicable to the weather encounter location that was valid before the accident flight's departure for times surrounding the accident time indicated VFR to IFR surface visibilities with a chance (between 30 to 60 percent) of rain showers or scattered thunderstorms (between 30 to 50 percent) and a northwest surface wind at 5 knots with gusts to 15 knots. The GFA cloud forecast applicable to the weather encounter location that was valid before departure for times surrounding the accident time indicated overcast cloud bases at 2,600 ft and cloud tops at 16,000²⁷. The Graphical AIRMETs²⁸ (G-AIRMET) Sierra and Zulu were overlaid on the GFA surface and cloud forecast imagery. The only human-generated information reflected in the two GFA products were the G-AIRMETs. For more information, please see attachment 2.

²⁷ Flight Level - A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of ft. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the standard sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

²⁸ <https://aviationweather.gov/gairmet>

13.0 Terminal Aerodrome Forecast

There were no NWS Terminal Aerodrome Forecast²⁹ (TAF) sites located within 30 miles of the weather encounter location.

14.0 National Weather Service Area Forecast Discussion

The NWS weather forecast office in Baltimore, Maryland/Washington, DC, (WFO LWX) was responsible for the public forecast in the region of the weather encounter location. WFO LWX issued the following Area Forecast Discussion (AFD) at 1516 EDT, the closest AFD to the accident time with an aviation section:

FXUS61 KLWX 161916
AFDLWX

Area Forecast Discussion
National Weather Service Baltimore MD/Washington DC
316 PM EDT Sat Apr 16 2022

.SYNOPSIS...

A cold front will push through the area this evening. High pressure will build in for Sunday. A coastal low pressure will then impact the region Monday. High pressure will return again for the middle of next week ahead of another cold front which arrives by Thursday.

&&

.NEAR TERM /THROUGH SUNDAY NIGHT/...

Cold front remains across western PA and the Ohio Valley, but should start to make more progress southeastward over the next few hours. Meanwhile, shortwave over the Tennessee Valley will head toward us over the next few hours as well. This combination should result in scattered showers developing, now that there is a somewhat warmer and more moist air mass available to work with, though CAPE remains relatively meager. Some isolated thunder is possible but confidence is quite low. However, with plenty of wind to work with aloft, any shower, or the front itself, could mix down a few gusts of 30-40, possibly up to 50 mph, briefly. This is sub-severe, but an isolated tree branch may come down.

Dry and colder air mass blows in behind the front after midnight thru Sunday. High pressure will keep skies mostly clear, but temps will be in the 40s to low 50s all day long, and the gusty

²⁹ According to NWS Instruction 10-813: "An NWS TAF consists of the expected meteorological conditions significant to aviation at an airport for a specified time period. For the U.S., this is the area within five (5) statute miles (SM) of the center of an airport's runway complex."
www.nws.noaa.gov/directives/sym/pd01008013curr.pdf

breeze will keep wind chills lower.

High pressure nearby Sunday night will allow for a quick temp drop early in the evening thanks to dry air and winds going calm. However, then low pressure approaching from the southwest will start spreading clouds northeastward across the area. Have issued freeze watch across I-81 corridor and northern MD for potential for temps to reach 32, but admittedly this will be decided by the race between the radiational cooling and the approaching clouds, which will put an end to the temp drop. Thus, confidence is not great. That said, lows should easily be in the 30s for most, and 20s in the coldest spots (where the growing season has yet to start).

&&

.SHORT TERM /MONDAY THROUGH TUESDAY NIGHT/...

Coastal low pressure will move northeast across the region on Monday ahead of another approaching cold front. While the air mass it is moving into is chilly, for most it should still be warm enough for rain, albeit a chilly one with temps in the 30s or 40s much of the day. However, higher terrain will likely see some snow, with an inch or two possible especially above 2000 feet. Elsewhere, a general half inch of rain can be expected.

Rain moves out Monday night as the low pulls away and the cold front moves through. However, winds should keep temps mostly on the plus side of freezing for locations in the growing season.

Low pressure over New England will interact with high pressure over the Ohio Valley to produce a gusty breeze Tuesday and Tuesday evening. Some upslope rain and snow showers expected in the western mountains and perhaps along the Mason Dixon region to the I-81 corridor. Closer to I-81 may be more rain showers. Cooler than average temperatures with highs in the middle 50s. Freezing temps will again be possible behind the front Tuesday night with lows in the 20s and 30s.

&&

.LONG TERM /WEDNESDAY THROUGH SATURDAY/...

High pressure will move across the region Wednesday before making its way to the East Coast. A return flow will usher more seasonable air into the region. Some rain showers or mountain rain and snow showers may occur Wednesday night with an approaching cold front. Highs in the lower to middle 60s.

Warmer and more moist air on the way later on Thursday after a cold front pushes southeast of the region. Highs middle 60s to near 70.

An area of high pressure builds across the eastern Great Lakes and down the eastern slopes of the mountains Friday. There could

be some rain showers in the western zones Friday night.

&&

.AVIATION /19Z SATURDAY THROUGH THURSDAY/...

VFR conditions thru Sunday night. Main concern is a brief gusty shower or t-storm ahead of or with the approaching cold front this evening. Gusts could pass 40 knots briefly, but should not be widespread. NW flow with gusts 20-30 knots likely continues Sunday before dwindling Sunday night. Sub-VFR likely Monday as coastal low pressure brings rain and low cigs/vsby. VFR returns behind the system Monday night.

VFR conditions through Tuesday-Wednesday. Perhaps a brief period of MVFR Tuesday with a rain or snow shower near MRB terminal. Winds northwest 15 to 20 knots gusts up to 30 knots Tuesday, then northwest 10 knots Tuesday night. Winds becoming southwest 5 to 10 knots Wednesday, then southeast Wednesday night.

&&

.MARINE...

Southerly flow ahead of an approaching cold front will continue to produce SCA gusts. We may briefly see gale gusts associated with showers or an isolated thunderstorm ahead of or along the approaching front this evening, or a brief gale gust with the actual front itself. After that, SCA gusts likely persist more or less thru Sunday before tapering off Sunday night as coastal low pressure moves toward the region.

Small Craft Advisories likely Tuesday and Tuesday evening; otherwise, no marine hazards expected. Winds northwest 15 to 20 knots gusts up to 30 knots Tuesday, then northwest 10 knots Tuesday night. Winds becoming southwest 5 to 10 knots Wednesday, then southeast Wednesday night.

&&

.TIDES/COASTAL FLOODING...

Anomalies remain high presently. Northwest flow behind the approaching front will push them down a bit, but coastal low on Monday will likely help drive them back up. After that, northwest flow should push them down for a few days at least. All that having been said, no flooding is currently expected, just action stage, but this will be watched closely.

&&

.LWX WATCHES/WARNINGS/ADVISORIES...

DC...None.

MD...Freeze Watch from late Sunday night through Monday morning for MDZ003>006-008-503-505-507-508.

VA...Freeze Watch from late Sunday night through Monday morning for
VAZ025>031-501-505-507-508.

WV...Freeze Watch from late Sunday night through Monday morning for
WVZ051>053.

MARINE...Small Craft Advisory until 6 PM EDT Sunday for ANZ530>543.

&&

\$\$

15.0 Winds and Temperature Aloft Forecast

The NWS 1559 EDT Winds and Temperature Aloft forecast valid for the closest point to the weather encounter location is included below:

FBUS31 KWNO 161959

FD1US1

DATA BASED ON 161800Z

VALID 170000Z FOR USE 2000-0300Z. TEMPS NEG ABV 24000

FT 3000 6000 9000 12000 18000 24000 30000 34000 39000

EKN 2728+03 2649-01 2657-08 2890-20 7802-33 782145 782554 780054

The closest forecast point to the weather encounter location was Elkins, West Virginia, (EKN). The 1559 EDT EKN forecast for use between 1600 EDT and 2300 EDT indicated a wind at 6,000 ft from 270° at 28 knots with a temperature of +3°C, a wind at 9,000 ft from 260° at 49 knots with a temperature of -1°C, and a wind at 12,000 ft from 260° at 57 knots with a temperature of -8°C.

16.0 Icing Potential

The NWS Current Icing Product (CIP) and Forecast Icing Product (FIP³⁰) products are created by the NWS AWC and are intended to supplement other icing advisories (e.g., AIRMETs and SIGMETs)³¹. Figures 17 through 19 are the FIP icing probabilities and icing severity products and 1-hour forecast valid at 2000 EDT at 9,000, 10,000, and 11,000 ft, and indicated a 40 to 85% probability of icing at 9,000 to 11,000 ft over the area. The FIP also indicated that the icing intensity near the weather encounter location would range from "light" to "heavy."³²

The CIP product indicated a 30 to 85% probability of icing at 9,000, 10,000 and 11,000 ft msl at 2000 EDT at the weather encounter location (figures 20, 21, and 22). The CIP also indicated that the icing near the weather encounter location would be in the "light" to "heavy" categories above 9,000 ft. In addition, the CIP indicated a 50 to 80% probability of Supercooled Large Droplets (SLD)³³ at the weather encounter location at 2000 EDT (attachment 3). For more FIP and CIP data please see attachment 3. For additional icing information please see FAA Advisory Circular "Pilot Guide: Flight in Icing Conditions", AC 91-74B.³⁴

³⁰ B.C. Bernstein, F. McDonough, M. K. Politovich, B. G. Brown, T. P. Ratvasky, D. R. Miller, C.A. Wolff, and G. Cuning, Current Icing Potential: Algorithm Description and Comparison with Aircraft Observations (Journal of Applied Meteorology, 2005), pp. 969-986.

C.A. Wolff, F. McDonough, M. K. Politovich, B.C. Bernstein, and G. Cuning, FIP Severity Technical Document (Prepared for the Aviation Weather Technology Transfer Technical Review Board), pp. 1-44.

<https://arc.aiaa.org/doi/abs/10.2514/6.2009-3531>

Wolff, C. A., D. R. Adriaansen, and M. K. Politovich, 2014: Diagnosing and Forecasting In-Flight Icing Conditions in Alaska. Preprints, 6th AIAA Atmospheric and Space Environments Conference, Atlanta, GA, Amer. Inst. Aero. Astro., 2014-2070, available at: <http://arc.aiaa.org/doi/abs/10.2514/6.2014-2070>.

[Icing Product Alaska \(IPA\) - Experimental | NCAR Research Applications Laboratory | RAL \(ucar.edu\)](http://www.icingproductalaska.org/)

³¹ NCAR re-ran the CIP and FIP algorithms to produce the data highlighted in this report.

³² <https://www.aviationweather.gov/icing/fip>

³³ [AWC - Icing \(aviationweather.gov\)](http://www.aviationweather.gov/icing/fip)

³⁴ [AC 91-74B - Pilot Guide: Flight In Icing Conditions - Document Information \(faa.gov\)](http://www.faa.gov/aircraft/air_certification/design_testing/airworthiness/AC91-74B/)

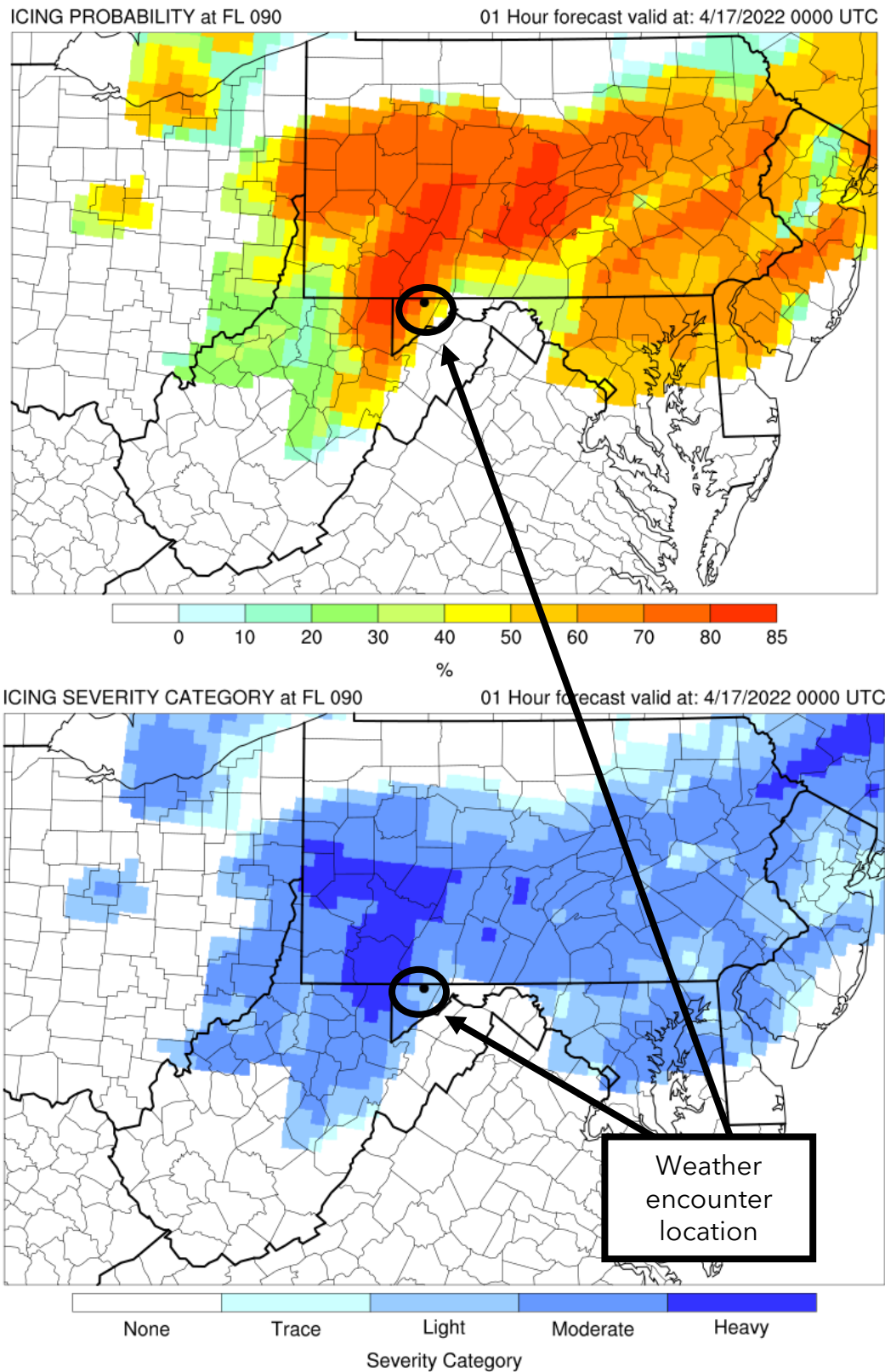


Figure 17. (top) FIP probability of icing at 9,000 ft and (bottom) FIP severity of icing at 9,000 ft 1-hour forecast valid at 2000 EDT.

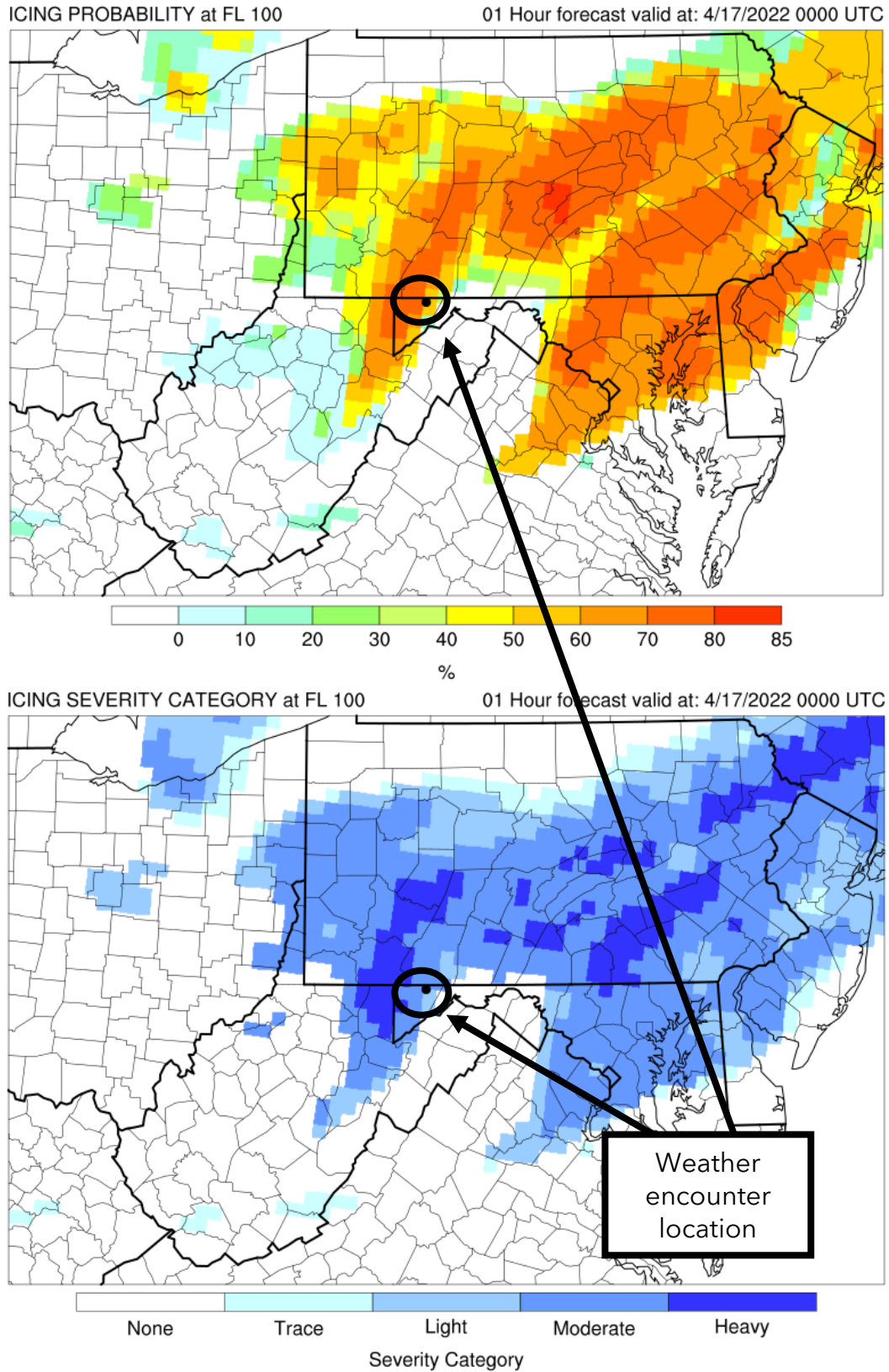


Figure 18. (top) FIP probability of icing at 10,000 ft and (bottom) FIP severity of icing at 10,000 ft 1-hour forecast valid at 2000 EDT.

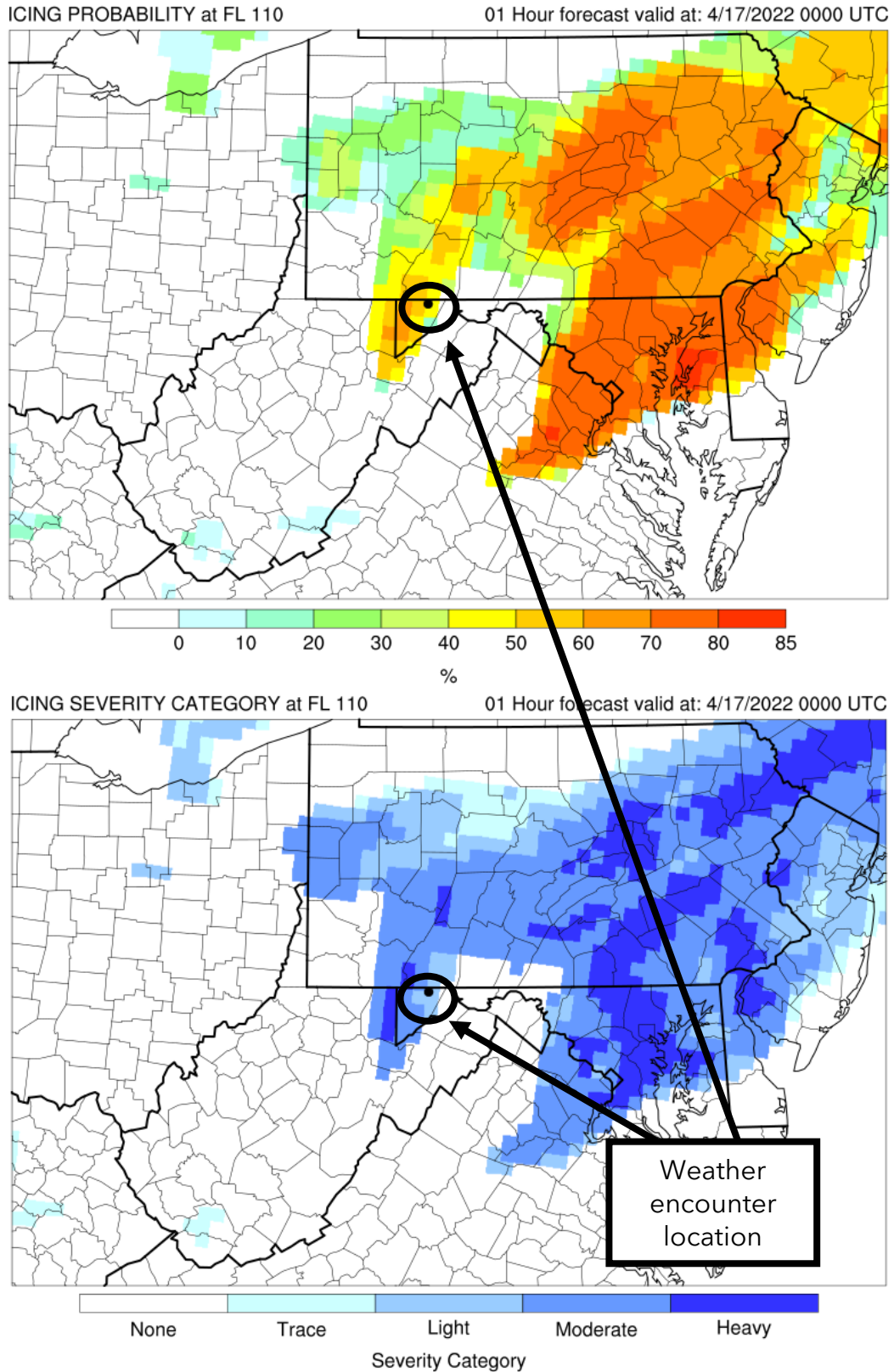


Figure 19. (top) FIP probability of icing at 11,000 ft and (bottom) FIP severity of icing at 11,000 ft 1-hour forecast valid at 2000 EDT.

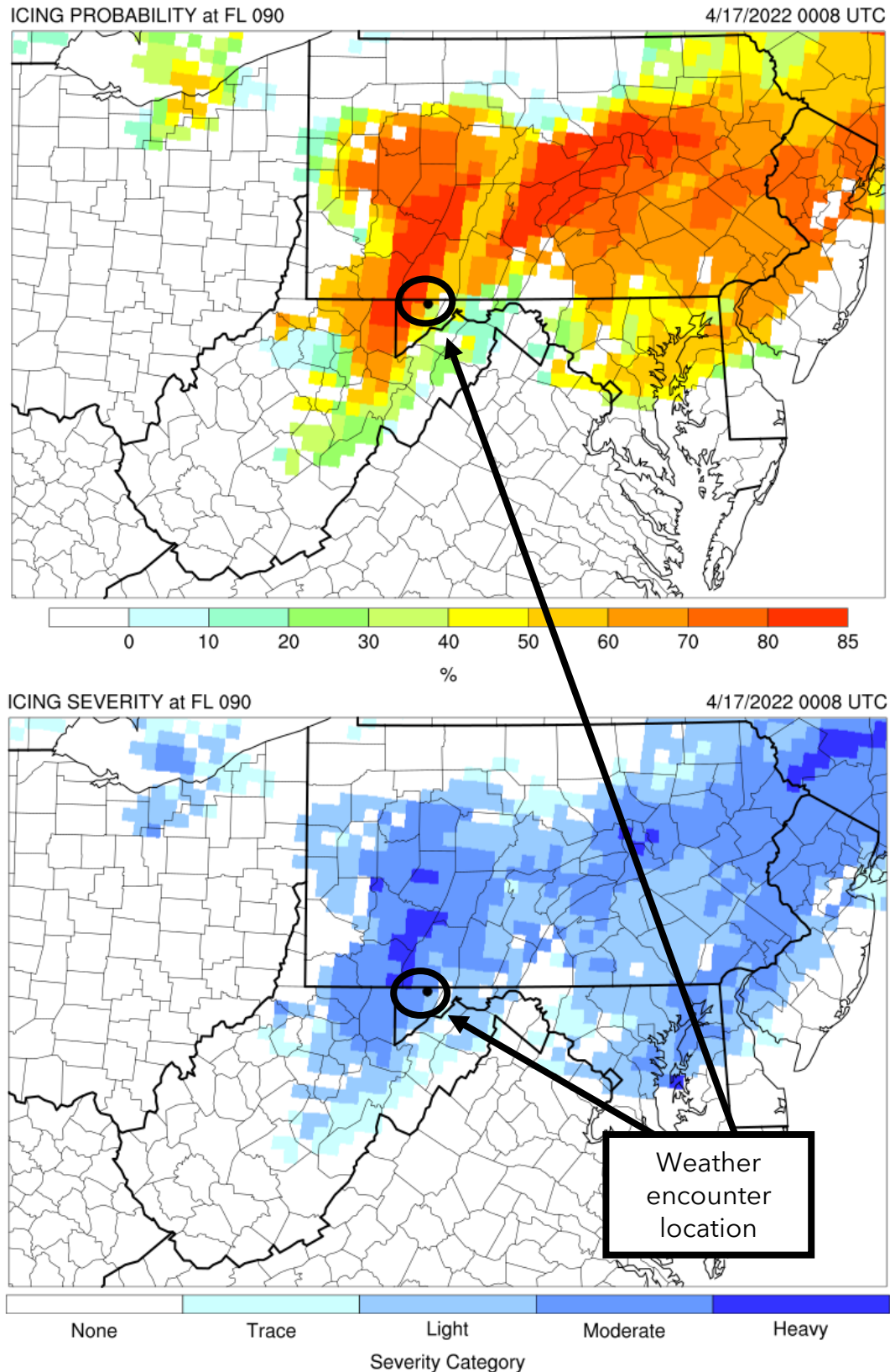
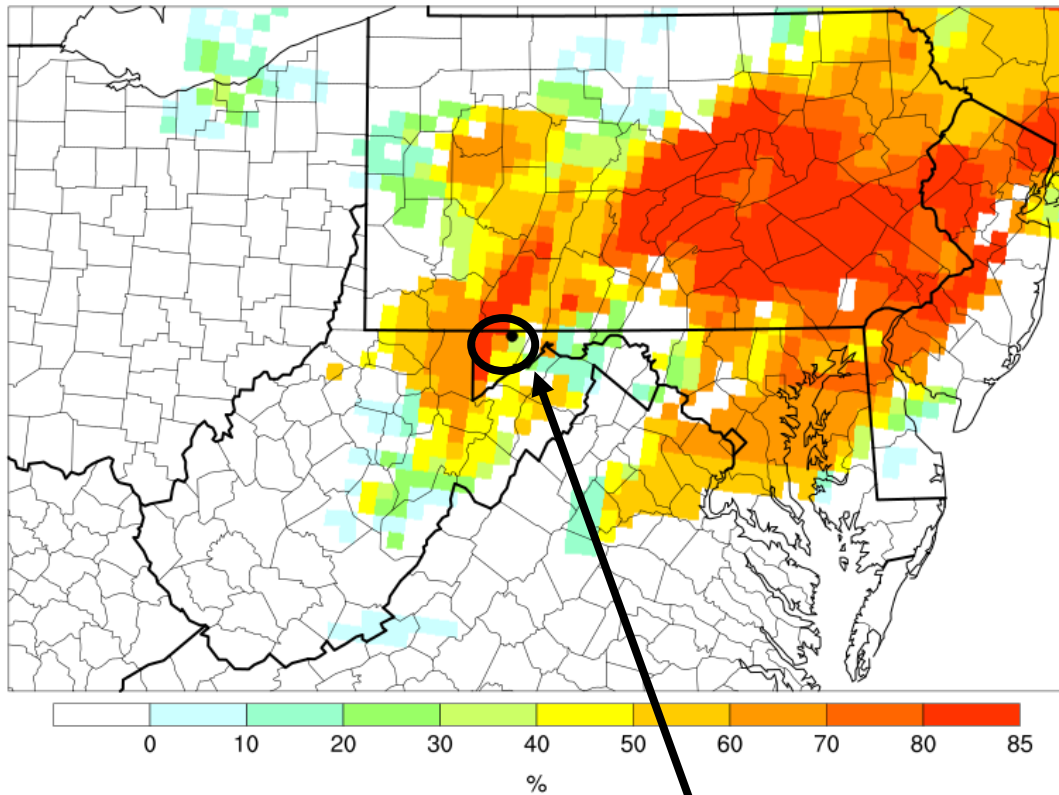


Figure 20. (top) CIP probability of icing at 9,000 ft and (bottom) CIP severity of icing at 9,000 ft valid around 2000 EDT.

ICING PROBABILITY at FL 100

4/17/2022 0008 UTC



ICING SEVERITY at FL 100

4/17/2022 0008 UTC

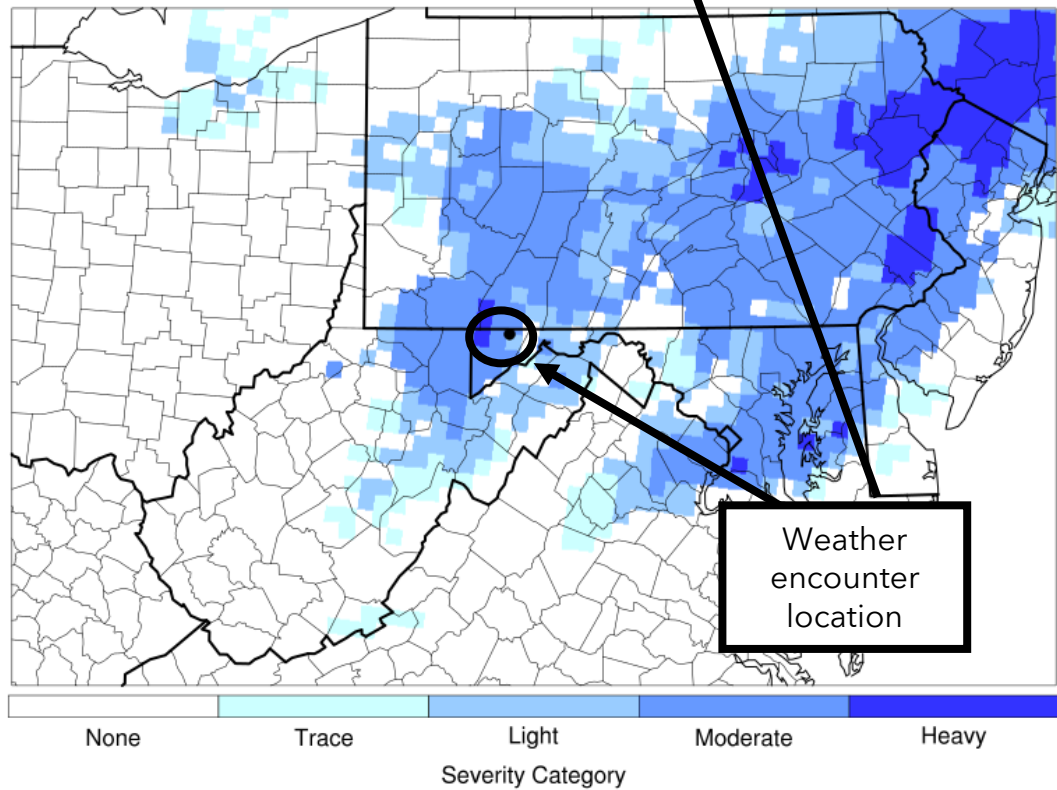
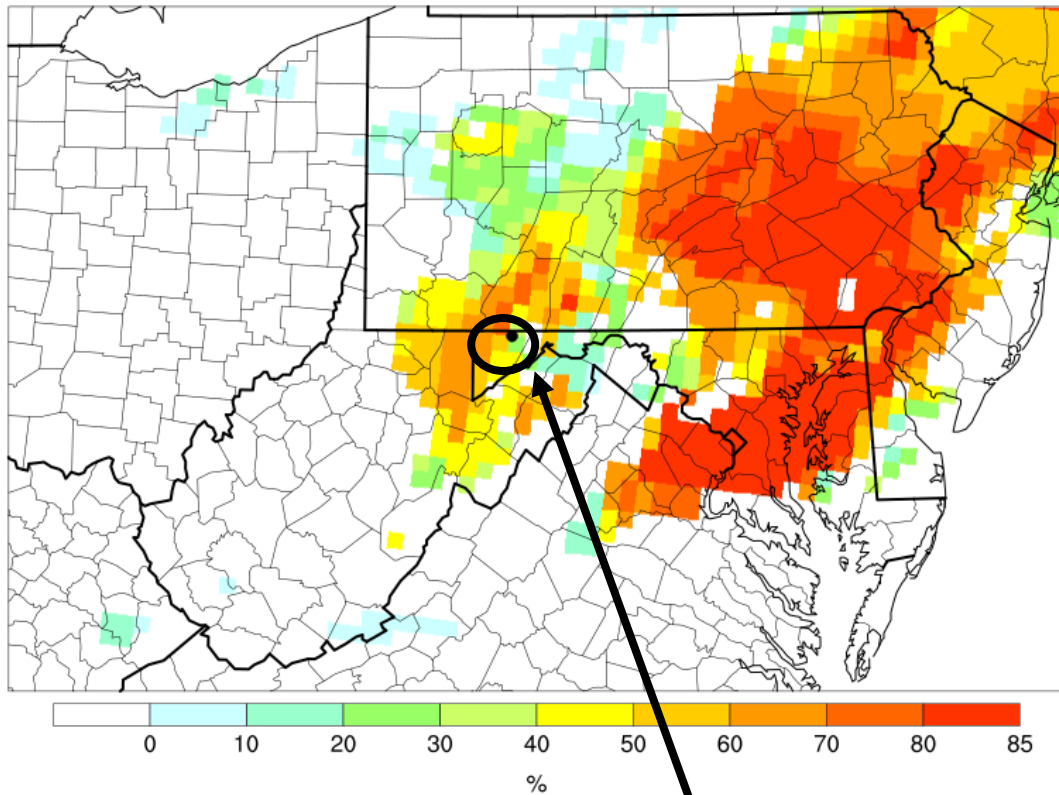


Figure 21. (top) CIP probability of icing at 10,000 ft and (bottom) CIP severity of icing at 10,000 ft valid around 2000 EDT.

ICING PROBABILITY at FL 110

4/17/2022 0008 UTC



ICING SEVERITY at FL 110

4/17/2022 0008 UTC

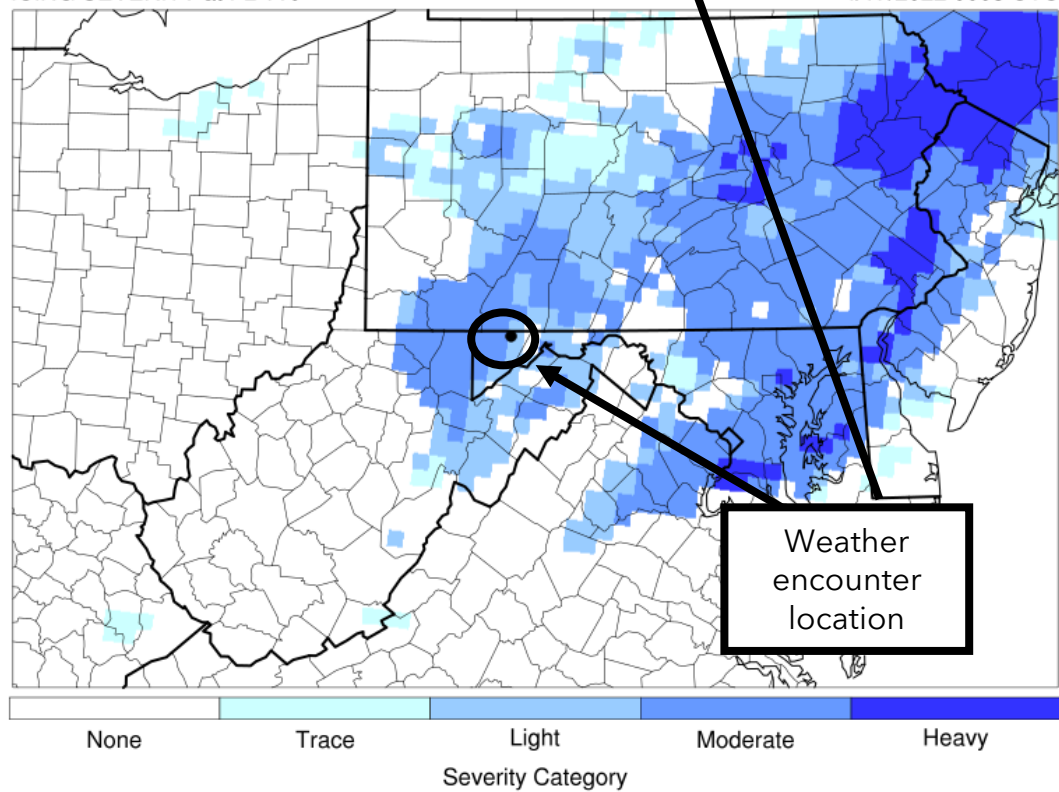


Figure 22. (top) CIP probability of icing at 11,000 ft and (bottom) CIP severity of icing at 11,000 ft valid around 2000 EDT.

17.0 Pilot Weather Briefing

The accident pilot did not request weather information³⁵ from Leidos Flight Service.

A search of archived ForeFlight information indicated that the accident pilot did have a ForeFlight account. The accident pilot did request and receive a ForeFlight weather briefing at 1713 EDT with a proposed departure time of 1725 EDT (attachment 4). In addition to the weather briefing request at 1713 EDT, the accident pilot requested and reviewed additional weather imagery between 1115 EDT on April 16 back to 1627 EDT on April 15 (attachment 4). With no cell phone internet access while in flight, ForeFlight is still able to access weather information directly from the FAA, but leaving no remote record of such access. For more information please see attachment 4.

18.0 Astronomical Data

The astronomical data obtained for the weather encounter location on April 16, 2022, indicated the following:

SUN

Begin civil twilight	0609 EDT
Sunrise	0637 EDT
Sun transit	1316 EDT
Accident time	1947 EDT³⁶
Sunset	1956 EDT
End civil twilight	2024 EDT

At the time of the accident the Sun was located at an altitude of 1.15° and azimuth of 282.90°.

³⁵ https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_91-92.pdf

³⁶ Inserted accident time for reference and context.

E. LIST OF ATTACHMENTS

Attachment 1 - KPBZ weather radar imagery animation from 1922 to 1957 EDT

Attachment 2 - GFA information valid at the accident time

Attachment 3 - Additional FIP and CIP information

Attachment 4 - ForeFlight correspondence

Submitted by:

Paul Suffern
Senior Meteorologist