National Transportation Safety Board
Office of Aviation Safety
Washington, DC 20594

ERA23FA024

METEOROLOGY

Specialist's Factual Report

January 6, 2023

TABLE OF CONTENTS

A. ACCIDENT

Location: Marietta, Ohio
Date: October 18, 2022
Time: 0709 eastern daylight time
1109 coordinated universal time (UTC)
Airplane: Beech E-90; Registration: N515GK

B. METEOROLOGY SPECIALIST

Specialist Paul Suffern
National Transportation Safety Board
Washington, DC

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's Senior Meteorologist did not travel for this investigation, but gathered all data remotely. Data for this investigation was collected 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 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 accident site was located at approximate latitude 39.4009° N, longitude 81.4104° W, at an elevation of 612 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 WPC, 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 northeastern United States for 0800 EDT is provided as figure 1 with the location of the accident site within the black circle. The chart depicted two low-pressure system over southern Ontario at pressures 995- and 997-hectopascal (hPa), respectively with a cold front extending southward from the low-pressure centers into New York, Pennsylvania, western Maryland, and then southwestward across Virginia, and then westward through Kentucky into southern Illinois. The accident site was located west and behind the cold front on the cold air side of the front.

The station model closest to the accident site depicted an air temperature of 38 degrees Fahrenheit (°F), dew point temperature of 33°F, overcast skies, and a calm wind.

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

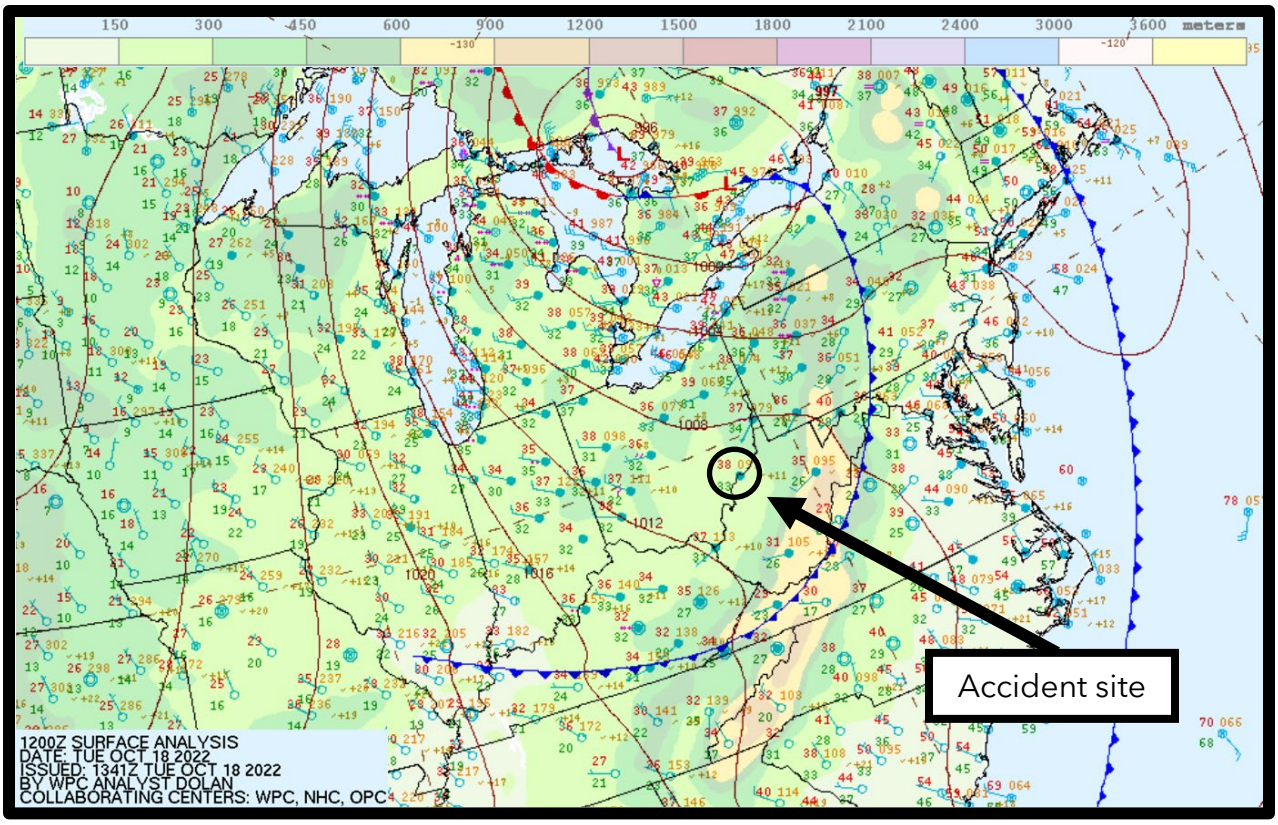

Figure 1. NWS Surface Analysis Chart for 0800 EDT.

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 0800 EDT at 925-, 850-, 700-, and 500-hPa are presented in figures 2, 3, 4 and 5. The charts indicated a vertically stacked low-pressure center in southern Ontario with a low- and mid-level trough[2] over and east of the accident site. Troughs and fronts can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present. The 925-hPa constant pressure chart depicted a west wind of 20 knots near the accident site (figure 2) with the wind remaining westerly through 500-hPa (figure 5).

[2] Trough – An elongated area of relatively low atmospheric pressure or heights.

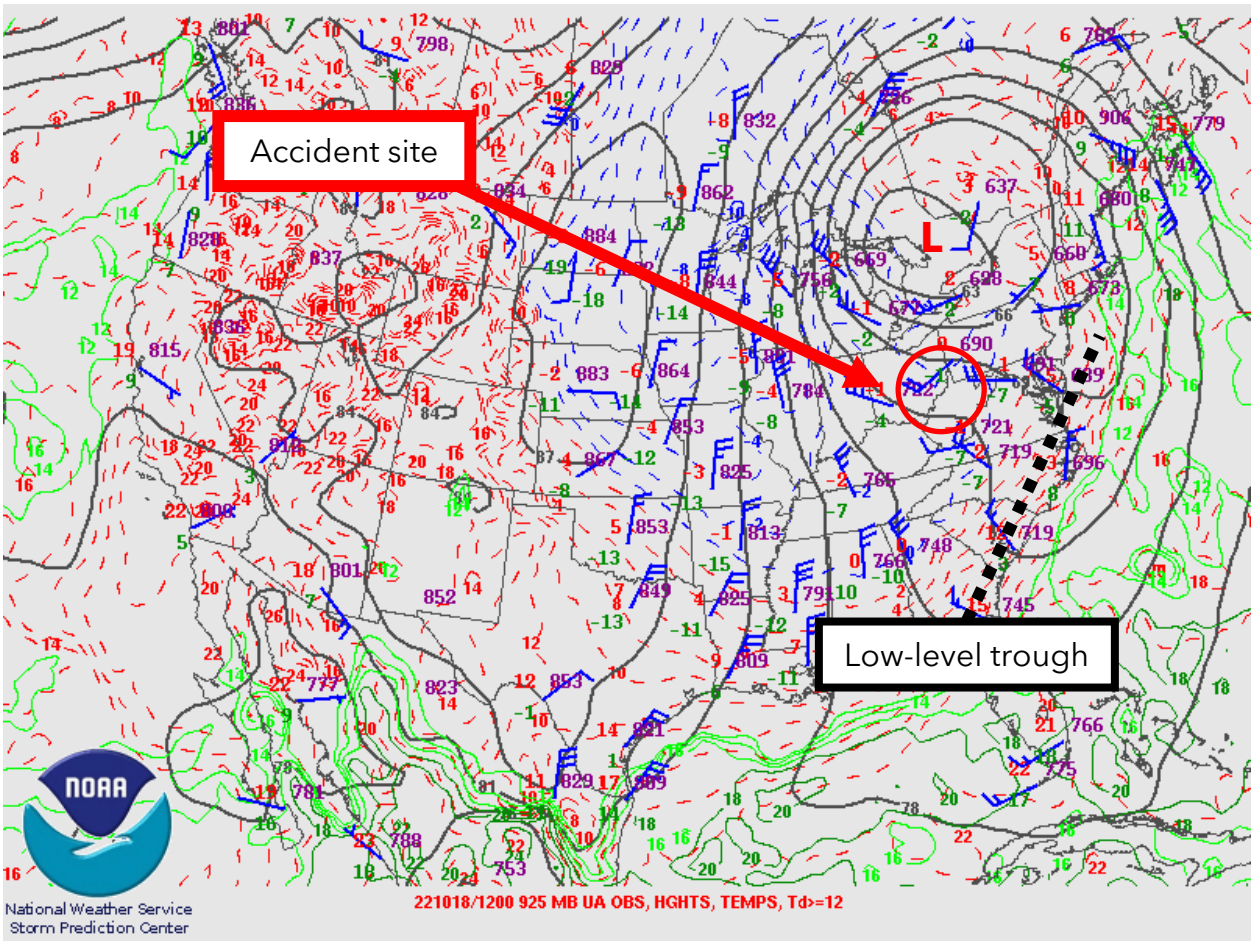

Figure 2. 925-hPa Constant Pressure Chart for 0800 EDT.

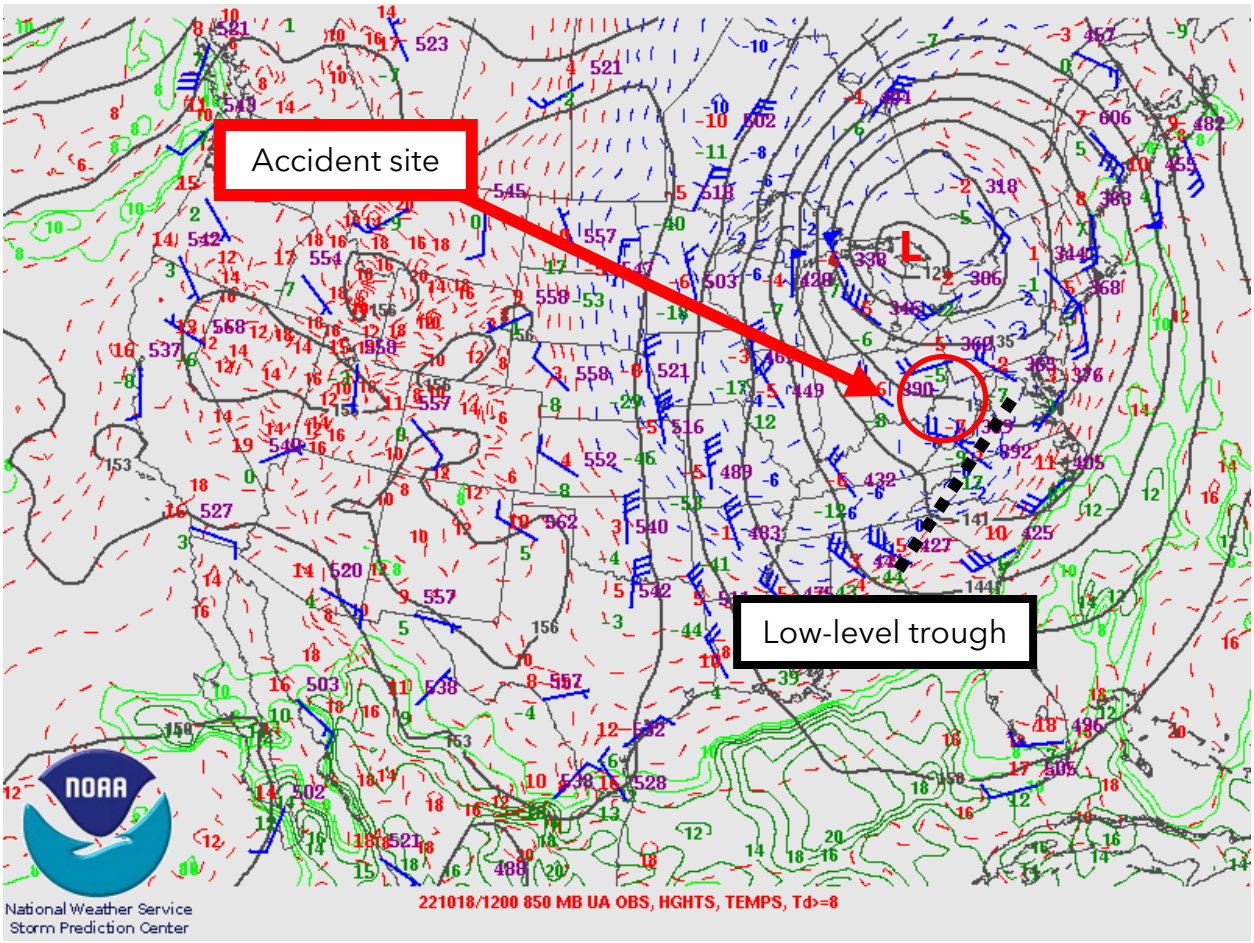

Figure 3. 850-hPa Constant Pressure Chart for 0800 EDT.

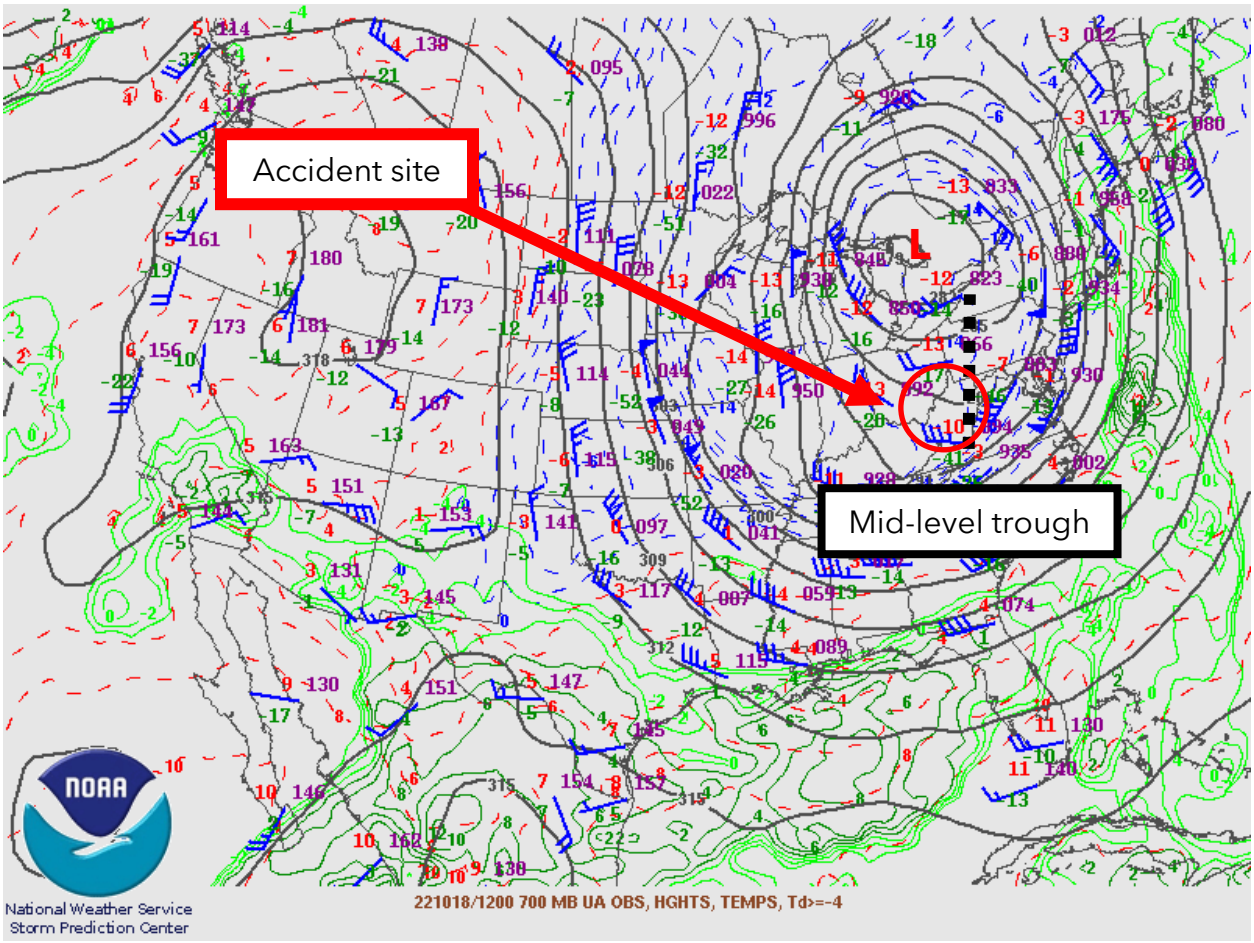

Figure 4. 700-hPa Constant Pressure Chart for 0800 EDT.

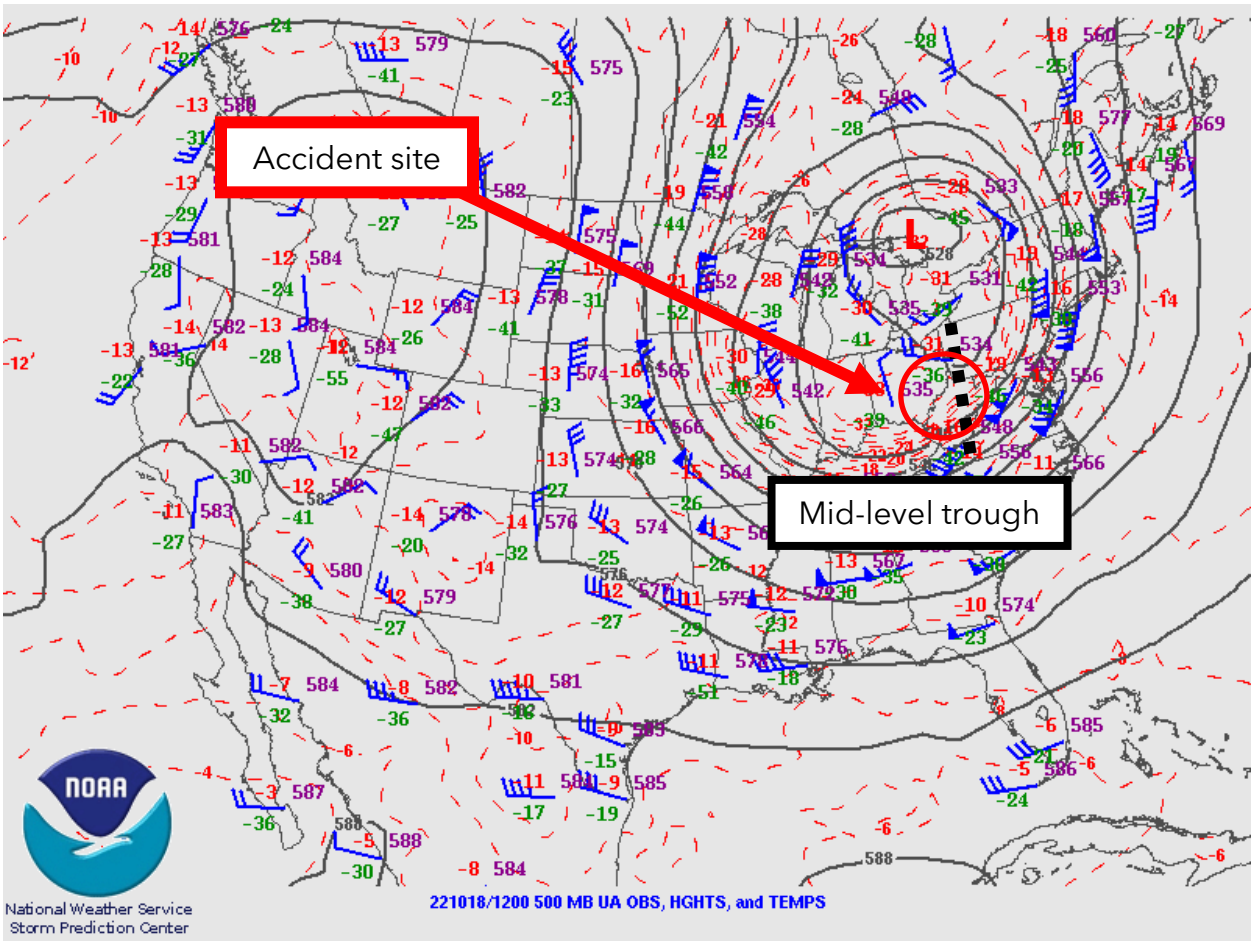

Figure 5. 500-hPa Constant Pressure Chart for 0800 EDT.

2.0 Surface Observations

The area surrounding the accident site was documented using official Aviation Routine Weather Reports (METARs) and Special 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 accident site and the closest weather reporting location marked. A magnetic variation[3] of 8° west was indicated 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/

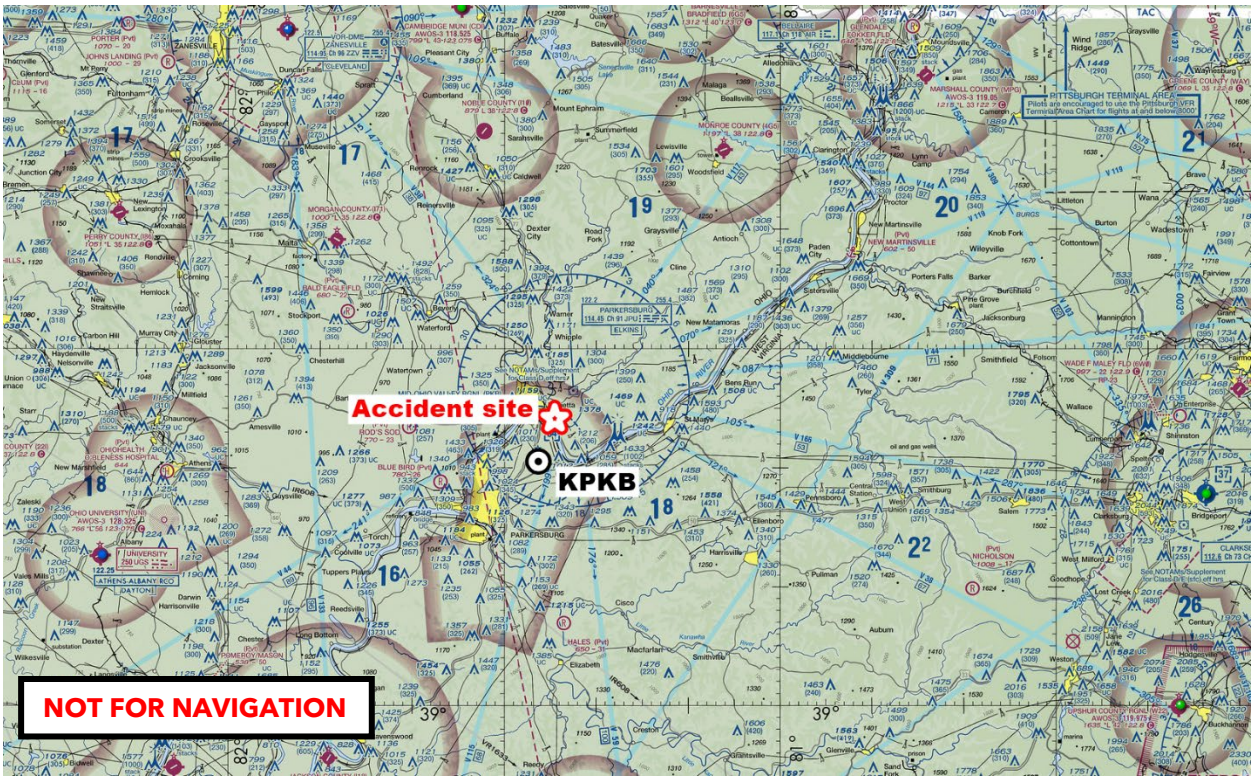

Figure 6. FAA sectional aeronautical chart of the accident area with the location of the accident site and surface observation site.

Mid-Ohio Valley Regional Airport (KPKB), Parkersburg, West Virginia, had the closest official weather station to the accident site, and was also the intended destination airport. KPKB had an Automated Surface Observing System (ASOS[4]) and longline[5] reports were augmented by air traffic control (ATC) when the tower was in operation[6]. The KPKB ASOS was located 4 miles south-southwest of the accident site, at an elevation of 808 ft, and issued the following observations surrounding the period of the accident:[7]

[0333 EDT] SPECI KPKB 180733Z AUTO VRB06KT 10SM OVC029 04/M02 A2976 RMK AO2 T00441017

[4] ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, weather phenomena, ceiling, temperature, dewpoint, altimeter, and barometric pressure. ASOS are maintained by the NWS.

[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] ATC hours of operation 0700 to 2300 local.

[7] The bold sections of products in this report are intended to highlight the text that directly reference the weather conditions that affected the accident region around the accident time. The local times in this section next to the METARs are provided for quick reference between UTC and local times.

[0353 EDT] METAR KPKB 180753Z AUTO 29006KT 10SM OVC027 04/M02 A2976 RMK AO2 SLP081 T00441017

[0453 EDT] METAR KPKB 180853Z AUTO VRB05KT 10SM OVC022 04/M01 A2977 RMK AO2 SLP084 T00391006 55001

[0553 EDT] METAR KPKB 180953Z AUTO 26008KT 10SM OVC016 03/00 A2979 RMK AO2 RAB20E30 SLP089 P0000 T00330000

[0653 EDT] METAR KPKB 181053Z 26003KT 10SM OVC014 03/01 A2980 RMK AO2 SLP094 T00330006

ACCIDENT TIME 0709 EDT

[0750 EDT] SPECI KPKB 181150Z 26006KT 10SM OVC013 03/01 A2981 RMK AO2

[0753 EDT] METAR KPKB 181153Z VRB03KT 10SM OVC013 03/01 A2981 RMK AO2 SLP097 60000 T00330006 10044 20033 51011

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

KPKB weather at 0653 EDT, wind from 260° at 3 knots, visibility 10 miles or greater, overcast ceiling at 1,400 ft above ground level (agl), temperature of 3° Celsius (C), dew point temperature 1°C, and an altimeter setting of 29.80 inches of mercury (inHg). Remarks, automated station with a precipitation discriminator, sea level pressure 1009.4 hPa, temperature 3.3°C, dew point temperature 0.6°C.

KPKB weather at 0750 EDT, wind from 260° at 6 knots, visibility 10 miles or greater, overcast ceiling at 1,300 ft agl, temperature of 3°C, dew point temperature 1°C, and an altimeter setting of 29.81 inHg. Remarks, automated station with a precipitation discriminator.

The observations from KPKB surrounding the accident time indicated MVFR[8] conditions prevailed due to ceilings.

[8] 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.

3.0 Upper Air Sounding

The closest NWS upper air observation was from Pittsburg (KPIT), Pennsylvania, station ID of 72520, with a surface elevation of 1,224 ft. The KPIT sounding was located 80 miles southwest of the accident site. The 0800 EDT KPIT sounding was plotted on a standard Skew-T Log P diagram[9] using the RAOB software[10] from the surface to 600-hPa (or approximately 14,000 ft) along with the derived stability parameters and is included as figure 7. The sounding depicted the lifted condensation level (LCL)[11] and the level of free convection (LFC)[12] at 1,353 ft agl (2,577 ft msl), and the convective condensation level (CCL)[13] at 1,789 ft agl (3,013 ft msl). The freezing level was located at 2,391 ft with the precipitable water value at 0.38 inches.

* 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.
[9] 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.
[10] RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Eosonde Research Services, The Villages, Florida.
[11] LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.
[12] 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.
[13] 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.

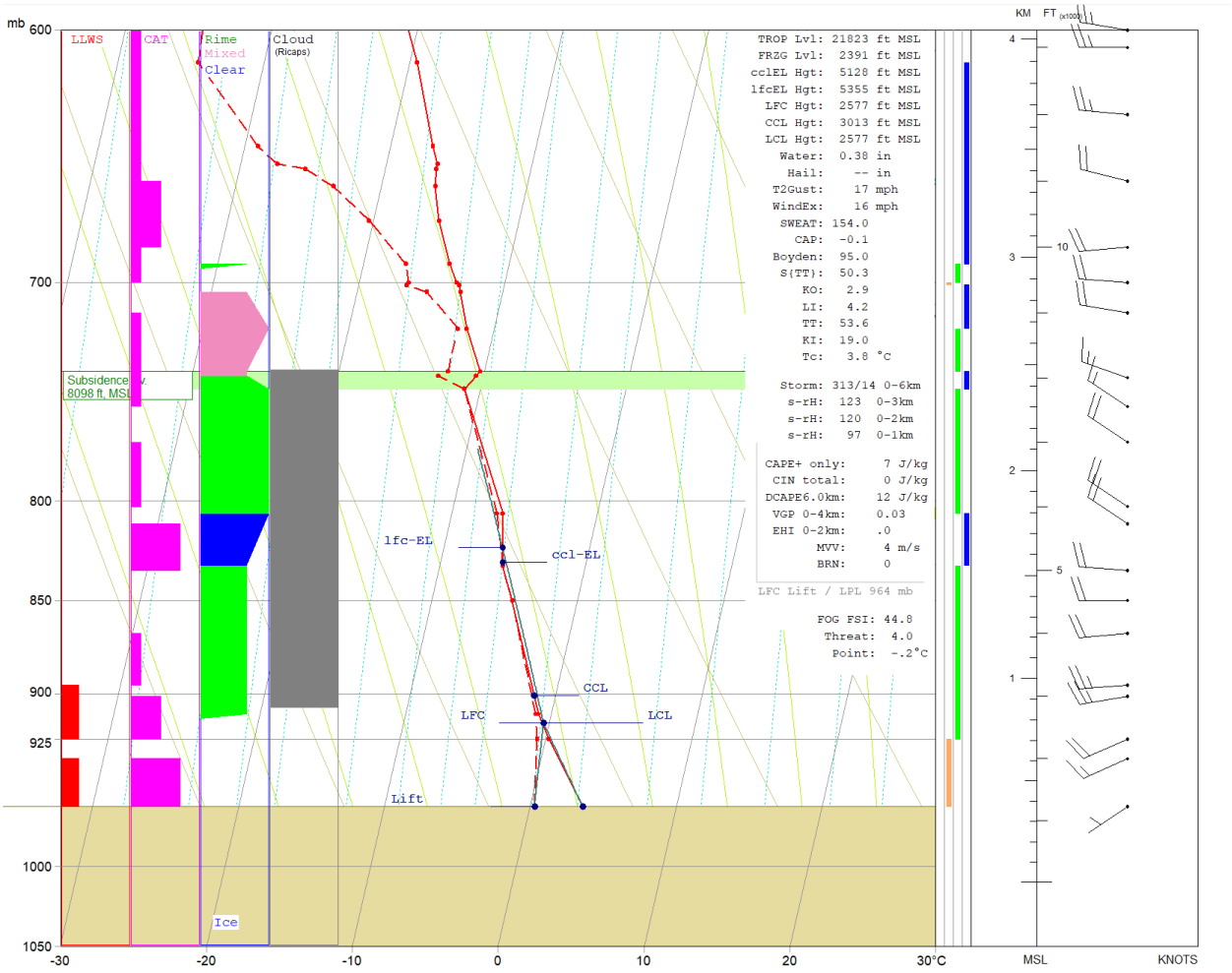

Figure 7. 0800 EDT KPIT sounding.

The 0800 EDT KPIT sounding indicated an unstable to conditionally environment from the surface through 5,000 ft, with alternating layers of stable and conditional unstable environment from 5,000 ft through 14,000 ft. Clouds were indicated by RAOB analysis program to be present from 2,600 ft through 8,000 ft. The top of a subsidence inversion[14] was noted at 8,098 ft. RAOB indicated moderate or greater icing potential (rime, clear, mixed) from 2,600 ft through 9,000 ft.

The 0800 EDT KPIT sounding wind profile indicated a near surface wind from 235° at 6 knots with the wind remaining westerly through 14,000 ft. The wind speed increased to 20 knots by 2,300 ft and 25 knots by 3,000 ft. The RAOB analysis program indicated the possibility of light low-level wind shear (LLWS) below 3,000 ft with several layers of light to moderate clear air turbulence (CAT) from the surface through 14,000 ft.

[14] Inversion – A departure from the usual decrease of the value of an atmospheric property with increasing altitude; also, the layer through which this departure occurs (the "inversion layer"), or the lowest altitude at which the departure is found (the "base of the inversion").

4.0 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 0500 EDT through 1100 EDT and reviewed, and the closest images to the time of the accident were documented. Given the sun angle, the visible imagery (band 2) did not provide useful information.

Figure 8 presents the GOES-16 infrared image at 0711 EDT at 6X magnification with the accident site highlighted with a red square. The image depicted cloud cover over the accident site. The lower brightness temperatures (orange and yellow colors; higher cloud tops) were located southeast of the accident site at the accident time. The brightness temperature of 262 Kelvin above the accident site would have been near 8,500 ft based on the vertical temperature profile provided by the 0800 EDT KPIT sounding. It should be noted these figures have not been corrected for any parallax error. The Nighttime Microphysics Red, Green, Blue (RGB) imagery[15] indicated the cloud cover was moving from northwest to southeast with the aqua colored lower clouds in place across Ohio and West (attachment 1).

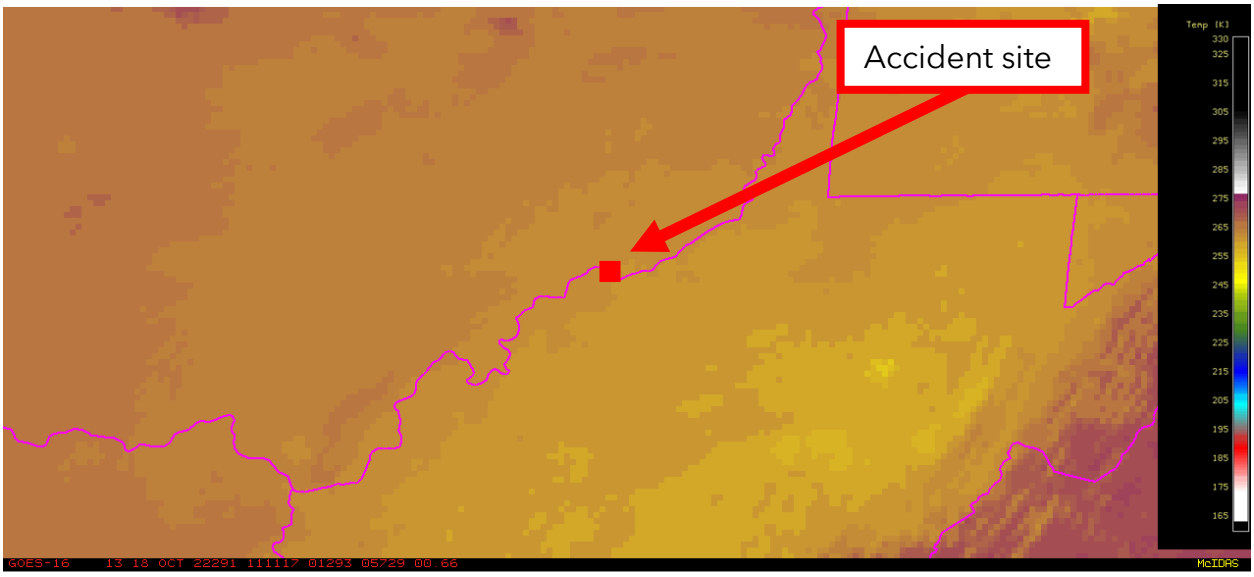

Figure 8. GOES-16 infrared image at 0711 EDT.

[15] RGB Nighttime Microphysics Reference Guide.pdf (nasa.gov)

5.0 National Radar Imagery

A regional view of the NWS National Reflectivity Mosaic is included as figure 9 for 0710 EDT with the approximate location of the accident site marked by a red circle. The image depicted no precipitation echoes above the accident site.

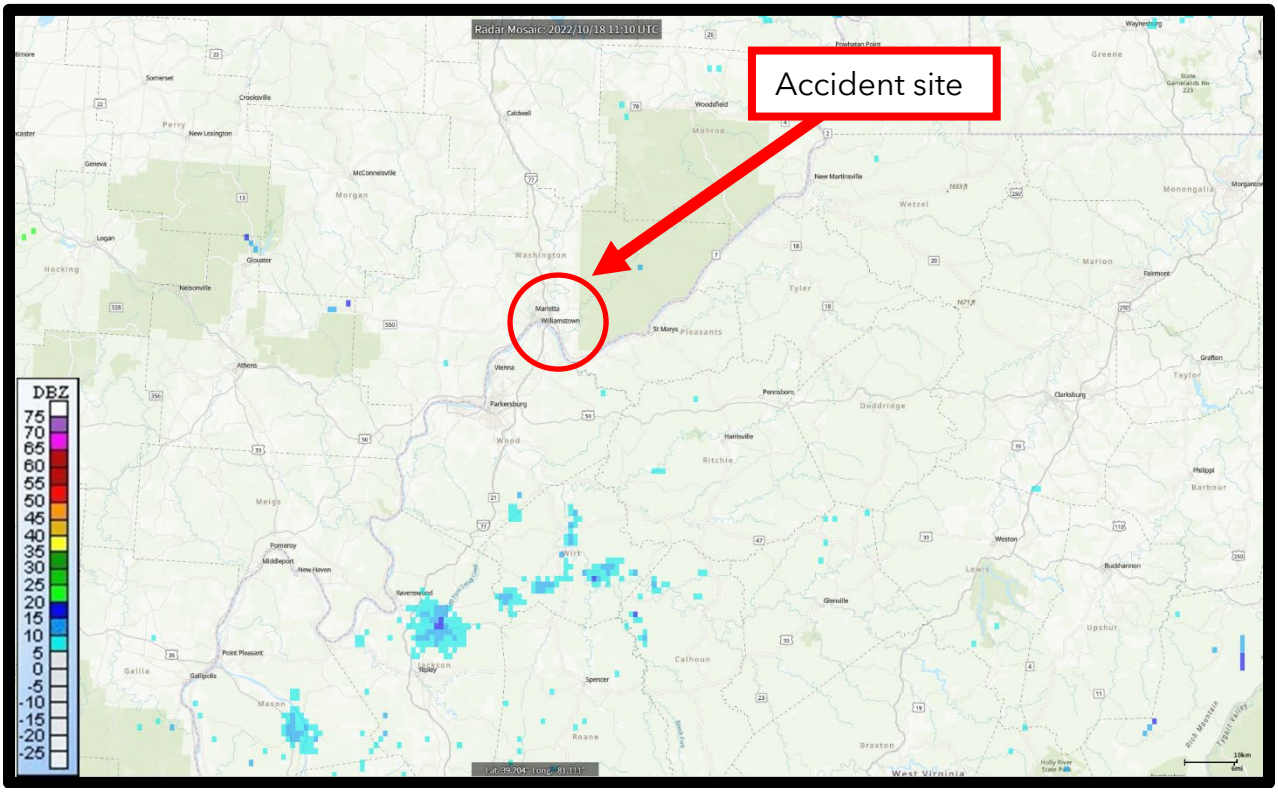

Figure 9. National Reflectivity Mosaic for 0710 EDT.

6.0 Pilot Reports

The longline-disseminated pilot reports[16] (PIREPs) distributed into the national airspace system (NAS) were reviewed two hours either side of the accident time and the PIREPs issued into the NAS within 100 miles of the accident site for below 19,000 ft are shown below:

CMH UA /OV CMH360015/TM 0938/FLDURGD/TP C25C/SK T066 OVC B049 SCT / 45/TA M08/IC MOD RIM 66-49

ZZV UA /OV ZZV188027/TM 0948/FL060/TP C208/SK TOP070/TA M06/IC LGT RIME 060-070

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

CMH UA /OV CMH/TM 1000/FL150/TP A321/TB NEG/RM ON DEPT

CRW UA /OV CRW100012/TM 1005/FL085/TP CRJ7/SK OVC034-TOP085/TA M02/IC LGT RIME/RM DURC

CRW UA /OV CRW/TM 1009/FL049/TP PC12/SK 032-049 OVC

CRW UA /OV GLAZE300011/TM 1017/FL078/TP S22T/TA M10/IC MOD RIME 078-066/RM DURD

CMH UA /OV CMH/TM 1026/FLDURGD/TP B737/SK B024 OVC T030 B045 OVC T057/IC LT RIME IN CLOUDS

PIT UA /OV PIT/TM 1028/FL030/TP E75S/SK BKN030/TA M05/RM ICE AT 050 PILOT UNABLE TO IDENTIFY THE TYPE OR INTENSITY

HTS UA /OV HTS/TM 1045/FLUNKN/TP B752/SK OVC028-TOP053 OVC063-TOP070/TA 03/RM DURC

CRW UA /OV CRW/TM 1046/FL080/TP PC12/TA NEGATIVE 8/IC TRACE MX/RM DURC CRW RWY 23

CRW UA /OV CRW/TM 1052/FL070/TP SR22/TA NEGATIVE 10/WV 311/23/IC MOD RIME/RM DURC CRW RWY23 SOUTHBOUND

PIT UA /OV PIT/TM 1104/FL080/TP E75L/TA M06/IC TRACE/RM TRACE AT 80 20NM E OF PIT DURD RWY 38C

PKB UA /OV 4I3/TM 1108/FL140/TP C340/SK SKC/TB NEG/IC NEG

CMH UA /OV CMH/TM 1108/FLDURGC/TP CRJ2/SK B032 T055/IC LGT RIME

PIT UA /OV PIT/TM 1115/FL070/TP C208/TA M07/IC TRACE/RM TRACE 20 NE OF PIT

CRW UA /OV CRW/TM 1115/FL030/TP CRJ2/SK BASES 030 TOPS 085 OVC/TA NEAGATIVE 11/IC LGT MX/RM DURC CRW RWY 23

PKB UA /OV PKB180010/TM 1119/FLDURGC/TP E145/SK BASE 025/WX TOP075/TA M09/TB TRACE RIME 055

PIT UA /OV PIT/TM 1125/FL070/TP B737/TA M07/IC MOD RIME/RM 7 N OF PIT

CMH UA /OV CMH/TM 1133/FLDURGD/TP C25C/SK B024

PKB UA /OV 10G/TM 1139/FL040/TP C208/IC TRACE RIME 040-047

PIT UA /OV PIT/TM 1145/FL035/TP A320/TA M06/IC LT RIME/RM 5 E OF PIT 60-35 DURD RWY 28C

PKB UA /OV PKB320015/TM 1205/FL055/TP C208/TA M08/IC LGT RIME/RM IMC TOPS 067

VTA UA /OV VTA/TM 1208/FLDURGD/TP E55P/SK T060 B045 SCT/ 040/IC LT RIME IN CLOUDS

ZZV UA /OV ZZV/TM 1217/FL100/TP C525/TA 00/IC TRACE RIME 030

PKB UA /OV PKB270010/TM 1219/FL060/TP C208/SK OVC021-TOP034/OVC057/TA M06/IC LGT RIME

DAY UA /OV UNI360015/TM 1230/FL060/TP C208/TA M08/IC LGT RIME

CAK UA /OV CAK225010/TM 1230/FLDURGC/TP F900/SK 045OVC056

PIT UA /OV PIT180010/TM 1250/FLDURGD/TP C525/SK BKN030/TA 00/IC LGT RIME/RM BETWEEN LAYERS AT 040/ LT RIME AT 060

CKB UA /OV OBIED/TM 1300/FL050/TP F2TH/SK IMC/TA -6/IC LIGHT MIXED

PKB UA /OV JPU030005/TM 1306/FL150/TP PC12/TB NEG/RM VMC

CMH UA /OV CMH/TM 1306/FLDURD/TP B737/SK B040 T058/IC NEG

CMH UA /OV CMH/TM 1308/FLDURD/TP B737/SK B040 T052

7.0 Significant Meteorological Information

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

8.0 Center Weather Service Advisories

The Indianapolis (ZID) 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 ZID CWSU at the accident time.

9.0 Airmen's Meteorological Information

The NWS Aviation Weather Center had Airmen's Meteorological Information (AIRMET) advisories Sierra and Zulu valid for the accident site at the accident time for below 10,000 ft. The text AIRMETs Sierra and Zulu were issued at 0445 EDT and forecast mountain obscuration conditions due to clouds, precipitation, and mist and moderate icing between the freezing level[17] and 12,000 ft:

WAUS41 KKCI 180845
WA1S
-BOSS WA 180845
AIRMET SIERRA UPDT 2 FOR IFR AND MTN OBSCN VALID UNTIL 181500
.
AIRMET IFR...ME NH VT MA RI CT NY NJ MD DE AND CSTL WTRS
FROM 70NW PQI TO 60NE PQI TO 140ESE ACK TO 90SSE ACK TO 120S ACK
TO 120SE SIE TO 20SSE HTO TO 30WSW BDL TO 40SSE MSS TO 40E MSS
TO 70NE MPV TO 60SE YQB TO 70NW PQI
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 15Z THRU 21Z.
.
AIRMET IFR...NY PA OH LE WV MD VA
FROM 50ENE BUF TO 20ENE SLT TO 20E JST TO 40ENE EKN TO 40E BKW
TO 50SW BKW TO 20SE HNN TO AIR TO 30WNW CLE TO 40WNW ERI TO
30NNE ERI TO 50ENE BUF
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 15Z ENDG 15-18Z.
.
AIRMET IFR...OH

[17] Freezing level ranged from the surface to 3,000 ft.

FROM 40SW DXO TO 40SSW CLE TO 20ESE APE TO CVG TO FWA TO 40SW DXO
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 15Z ENDG 15-18Z.
.
AIRMET MTN OBSCN...NY PA WV MD VA
FROM SYR TO 30WNW HNK TO 30NNE HAR TO 50SE JST TO 50E BKW TO PSK
TO HMV TO HNN TO JHW TO SYR
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 15Z THRU 21Z.
.
AIRMET MTN OBSCN...ME NH VT MA NY
FROM 70NW PQI TO MLT TO CON TO 50S ALB TO 50ESE SYR TO MSS TO
50NE MPV TO 80SSE YQB TO 70NW PQI
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 15Z THRU 21Z.
.
OTLK VALID 1500-2100Z...IFR ME NH VT MA RI CT NY NJ MD DE AND
CSTL WTRS
BOUNDED BY 70NW PQI-60NE PQI-200SE ACK-160SE SIE-100SSE HTO-
30SSE PVD-30ENE BDL-20ESE MPV-80SSE YQB-70NW PQI
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG THRU 21Z.
....

WAUS41 KKCI 180845
WA1Z
-BOSZ WA 180845
AIRMET ZULU UPDT 1 FOR ICE AND FRZLVL VALID UNTIL 181500
.
AIRMET ICE...NY LO PA OH LE WV MD
FROM 60SW MSS TO 30NE HNK TO 30ESE HAR TO 40SW HAR TO 60S JST TO
40SE ROD TO 50ESE CVG TO CVG TO FWA TO 20S DXO TO 20WNW JHW TO
20SE YYZ TO 60SW MSS
MOD ICE BTN FRZLVL AND 150. FRZLVL SFC-030. CONDS CONTG BYD 15Z
THRU 21Z.
.
AIRMET ICE...OH WV MD VA
FROM 40SE ROD TO 60S JST TO 30SSW HAR TO 40NE PSK TO 40SW PSK TO
HMV TO HNN TO 50ESE CVG TO 40SE ROD
MOD ICE BTN FRZLVL AND 120. FRZLVL SFC-030. CONDS CONTG BYD 15Z
THRU 21Z.
.
AIRMET ICE...NH VT MA CT NY NJ PA MD DC DE VA AND CSTL WTRS
FROM 80NE MPV TO 30WNW ENE TO 30E BDL TO 40S BDL TO 20NE CYN TO
40SW SBY TO 30SSE CSN TO 40SW ETX TO 20NE HNK TO 30SE YOW TO
60NNW MPV TO 80NE MPV
MOD ICE BTN FRZLVL AND FL200. FRZLVL 040-080. CONDS CONTG BYD 15Z
ENDG 18-21Z.
.
AIRMET ICE...ME NH MA RI CT NY NJ AND CSTL WTRS
FROM 70NW PQI TO 20NE PQI TO 60WSW YSJ TO 140E ACK TO 30S ACK TO
60SE HTO TO 20NE CYN TO 30ESE BDL TO 30WNW ENE TO 80NE MPV TO
70NW PQI
MOD ICE BTN FRZLVL AND FL200. FRZLVL 080-100. CONDS CONTG BYD 15Z
THRU 21Z.
.
OTLK VALID 1500-2100Z

AREA 1...ICE NY LO NJ PA OH LE WV
BOUNDED BY 60NNW MPV-20ESE SAX-SLT-HNN-CVG-FWA-20SSE DXO-30W
JHW-30E YYZ-50NNW SYR-30ESE YOW-60NNW MPV
MOD ICE BTN FRZLVL AND 150. FRZLVL SFC-030. CONDS CONTG THRU 21Z.
.
AREA 2...ICE NJ PA WV MD DC DE VA NC GA
BOUNDED BY SLT-20SE SAX-30NE RIC-50SSE LYH-40WNW CSN-HMV-HNN-SLT
MOD ICE BTN FRZLVL AND 120. FRZLVL SFC-030. CONDS CONTG THRU 21Z.
.
FRZLVL...RANGING FROM 015-110 ACRS AREA
  040 ALG 50S LYH-40ESE DCA-50S ETX-50NW ALB-20E YOW
  080 ALG 20SSW ORF-60ESE SIE-CON-60SSE YQB-70NW PQI
....

10.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products issued before the accident flight and valid at 0800 EDT are shown in attachment 2. The GFA surface forecast applicable to the accident site that was valid before the accident flight's departure for times surrounding the accident time indicated VFR surface visibilities and a west-southwest wind of 5 knots with gusts to 15 knots. The GFA cloud forecast applicable to the accident site that was valid before departure for times surrounding the accident time indicated overcast cloud coverage at 2,400 ft with clouds top between 7,000 and 10,000 ft. The Graphical AIRMETs[18] (G-AIRMETs) Sierra and Zulu valid for the accident site at the accident time is located on the GFA cloud forecast graphic. The only human-generated information reflected in the two GFA products were the G-AIRMETs.

11.0 Terminal Aerodrome Forecast

KPKB was the closest site with an NWS Terminal Aerodrome Forecast[19] (TAF) current at the time of the accident. The KPKB TAF valid before departure was issued at 0507 EDT and was valid for a 21-hour period beginning at 0500 EDT. The 0507 EDT TAF for KPKB was as follows:

[18] Graphical AIRMETs (G-AIRMETs), found on the Aviation Weather Center webpage at http://aviationweather.gov, are graphical forecasts of en-route weather hazards valid at discrete times no more than 3 hours apart for a period of up to 12 hours into the future (for example, 00, 03, 06, 09, and 12 hours). G-AIRMETs are snap shots at discrete time intervals as defined above. The text AIRMET is the result of the production of the G-AIRMET but provided in a time smear for a 6hr valid period.

[19] 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

FTUS41 KRLX 180907 AAA
TAFPKB
TAF AMD
KPKB 180907Z 1809/1906 **25006KT P6SM OVC018**
FM181400 27012G20KT P6SM BKN024
FM181800 26014G21KT P6SM OVC035
FM190000 25007G14KT P6SM OVC027=

Between 0500 and 1000 EDT the KPKB forecast expected a wind from 250° at 6 knots, greater than 6 miles visibility, and an overcast ceiling at 1,800 ft agl.

12.0 National Weather Service Area Forecast Discussion

The NWS weather forecast office in Charleston, West Virginia, (WFO RLX) was responsible for the public forecast in the region of the accident site. WFO RLX issued the following Area Forecast Discussion (AFD) at 0624 EDT, the closest AFD to the accident time with an aviation section:

FXUS61 KRLX 181024
AFDRLX

AREA FORECAST DISCUSSION
National Weather Service Charleston WV
624 AM EDT Tue Oct 18 2022

.SYNOPSIS...
Clouds and colder air work back into the area today, with
periods of mountain snow and lowland rain/snow showers.
Unseasonably cold air will linger most of the week.

&&

.NEAR TERM /THROUGH TONIGHT/...
As of 220 AM Tuesday...

Overall forecast thinking remains similar to previous shifts.
Upper trough continues to sag south across the area, with
widespread lower cloud cover slowly taking hold. Temperatures at
may locations are struggling to hit freezing, particularly
across the north where the cloud cover has helped to limit a
drop somewhat, and thinking we will probably not have enough of
a drop in temperatures tonight to warrant canceling the growing
season...rats, nor does a freeze watch or warning look
warranted for Tuesday night at this point, but will allow the
day shift to reevaluate that.

Otherwise, shortwaves rotating around the upper low into the
area, combined with moisture off the lakes will create periods
of rain and snow showers, particularly across northern zones.
Still looking at some light accumulations, particularly across

the mountains where 1 to 3 inches cannot be completely ruled out in spots of the highest terrain, mainly later tonight.

With the cloud cover and upper trough in place, not expecting much of a rise in temperatures across the area today, and this with continued gusty winds, will make for a rather blustery day.

Cloud cover and light snow shower activity will continue overnight as additional shortwaves rotate through the area, with greater chance for precipitation across the north and east.

&&

.SHORT TERM /WEDNESDAY THROUGH FRIDAY/...
As of 600 AM Tuesday...

A large mid/upper level low over the lower Great Lakes Wednesday morning lifts northeast through the eastern Great Lakes and eastern Canada while opening up into a trough this period. A short wave trough rotating around the larger low swings across the forecast area Wednesday morning, enhancing rain and snow showers across northern portions of the area. A resurrected lake effect band off Lake Michigan will farther enhance showers across the north, especially upon impingement into the western slopes of the mountains.

While the precipitation will take the form of light snow to light rain showers in the morning tapering off in the afternoon across the lowlands, upslope enhancement over higher terrain is likely to result in further snow accumulation coming out of the near term, with another inch or two over the most favored higher windward terrain Wednesday morning into Wednesday afternoon, before tapering off. Low level flow backs to southwest with warm advection Wednesday, and the last of the precipitation lifts north of the forecast area early Wednesday evening, with the short wave gone and the larger mid/upper circulation lifting out.

Surface high pressure nosing in from the south in concert with building mid/upper level heights will bring about a dry close to the work week, although another short wave trough and low/mid level warm advection will bring some cloudiness overnight Thursday night into Friday. Despite some moisture advection, precipitation is not likely to be squeezed out, though could not rule out a slight change in this perspective as the time gets closer.

Central guidance reflects another chilly day Wednesday and cold Wednesday night and Thursday morning, before a warming trend ensues. Kept lows in the 20s in the valleys Thursday morning where decoupling is likely. This will warrant freeze headlines anywhere the growing season is not nixed by then. Lows may flirt with freezing again Friday morning, but thr warm advection

southwest flow may either kick temperatures back up before dawn or even warrant some upward adjustment as the time gets closer, particularly with the clouds associated with the short wave crossing then. Further, the freeze program is likely to be over by then.

&&

.LONG TERM /FRIDAY NIGHT THROUGH MONDAY/...
As of 600 AM Tuesday...

Surface high pressure and mid/upper level ridging, albeit with a weak short wave trough drifting through it, spells a dry, mild weekend. an amplified trough slowly approaches from the west early next week. Central guidance reflects above normal temperatures in a comfortable range for late October.

&&

.AVIATION /10Z TUESDAY THROUGH SATURDAY/...
As of 620 AM Tuesday...

Widespread MVFR cigs have taken hold across the area. In addition, westerly winds will increase again after 15Z Tuesday, with occasional gusts in the teens to 20 kt range area wide. Some decrease in gusts noted after 23Z. In addition, some improvement this afternoon to VFR, generally between 18-23Z Tuesday, but MVFR expected to redevelop after 23Z Tuesday, although areas across southern WV, southwest VA and northeast KY may remain VFR overnight.

In addition, occasional light rain and snow shower activity can be expected, mainly across the north and east, with brief IFR conditions possible at times, particularly at sites KCKB, and KEKN, but have not included in this TAF package as confidence in coverage and intensity, and associated restrictions is low.

FORECAST CONFIDENCE AND ALTERNATE SCENARIOS THROUGH 12Z WEDNESDAY...

FORECAST CONFIDENCE: Medium to high.

ALTERNATE SCENARIOS: Areas of IFR may be possible across the north and east, particularly Tuesday night in snow showers. Improvement at may sites to VFR this afternoon may vary from forecast.

EXPERIMENTAL TABLE OF FLIGHT CATEGORY OBJECTIVELY SHOWS CONSISTENCY OF WFO FORECAST TO AVAILABLE MODEL INFORMATION:
H = HIGH: TAF CONSISTENT WITH ALL MODELS OR ALL BUT ONE MODEL.
M = MEDIUM: TAF HAS VARYING LEVEL OF CONSISTENCY WITH MODELS.
L = LOW: TAF INCONSISTENT WITH ALL MODELS OR ALL BUT ONE MODEL.

UTC 1HRLY 10 11 12 13 14 15 16 17 18 19 20 21
EDT 1HRLY 06 07 08 09 10 11 12 13 14 15 16 17
CRW CONSISTENCY H H H H H H H H H H H M
HTS CONSISTENCY H H H H H H H H L H H H
BKW CONSISTENCY H H M M H H H H H H H H
EKN CONSISTENCY H H M H H H H H M M M H
PKB CONSISTENCY H H H H H H H H H H M L
CKB CONSISTENCY H H H H H H H M M M M M

AFTER 12Z WEDNESDAY...
IFR possible in snow showers in the higher mountainous terrain
through early afternoon Wednesday.

&&

.RLX WATCHES/WARNINGS/ADVISORIES...
WV...Freeze Warning until 10 AM EDT this morning for WVZ005>011-
013>020-024>031-033-034.
OH...Freeze Warning until 10 AM EDT this morning for OHZ066-067-075-
076-083>087.
KY...Freeze Warning until 10 AM EDT this morning for KYZ101>103-105.
VA...Freeze Warning until 10 AM EDT this morning for VAZ003-004.

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13.0 Winds and Temperature Aloft Forecast

The NWS 0359 EDT Winds and Temperature Aloft forecast valid for the closest points to the accident site are included below:

FBUS31 KWNO 180759
FD1US1
DATA BASED ON 180600Z
VALID 181200Z FOR USE 0800-1500Z. TEMPS NEG ABV 24000

FT 3000 6000 9000 12000 18000 24000 30000 34000 39000
AGC 2725 2916-08 2816-12 2822-18 3119-32 2434-40 246340 246441 255544
CMH 3125 3220-08 3125-11 3118-18 3410-33 3209-43 275140 275241 274743
CRW 3017 3016-08 3119-12 3120-19 2647-28 2594-31 761340 269544 267847

The closest forecast points to the accident site were Pittsburg, Pennsylvania, (AGC), Columbus, Ohio, (CMH), and Charleston, West Virginia, (CRW). The 0359 EDT forecasts were for use between 0400 EDT and 1100 EDT.

14.0 Icing Potential

The NWS Current Icing Product (CIP) and Forecast Icing Product (FIP[20]) products are created by the NWS AWC and are intended to supplement other icing advisories (e.g., AIRMETs and SIGMETs)[21]. Figures 10 through 12 are the FIP icing probabilities and icing severity products and 1-hour forecast valid at 0700 EDT at 3,000, 4,000, and 5,000 ft, and indicated a 60 to 85% probability of icing at 3,000 to 5,000 ft over the area. The FIP also indicated that the icing intensity near the accident site would range from "light" to "heavy."[22] FIP indicated a 20 to 80% probability of Supercooled Large Droplets (SLD)[23] at the accident site at 0700 EDT (attachment 3).

The CIP product indicated a 60 to 85% probability of icing at 3,000, 4,000 and 5,000 ft at 0700 EDT at the accident site (figures 13, 14, and 15). The CIP also indicated that the icing near the accident site would be in the "light" to "moderate" categories above 3,000 ft. In addition, the CIP indicated a 30 to 40% probability of SLD at the accident site at 0700 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.[24]

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[20] B.C. Bernstein, F. McDonough, M. K. Politovich, B. G. Brown, T. P. Ratvasky, D. R. Miller, C.A. Wolff, and G. Cunning, 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. Cunning, 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)

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

[22] https://www.aviationweather.gov/icing/fip

[23] AWC - Icing (aviationweather.gov)

[24] AC 91-74B - Pilot Guide: Flight In Icing Conditions – Document Information (faa.gov)

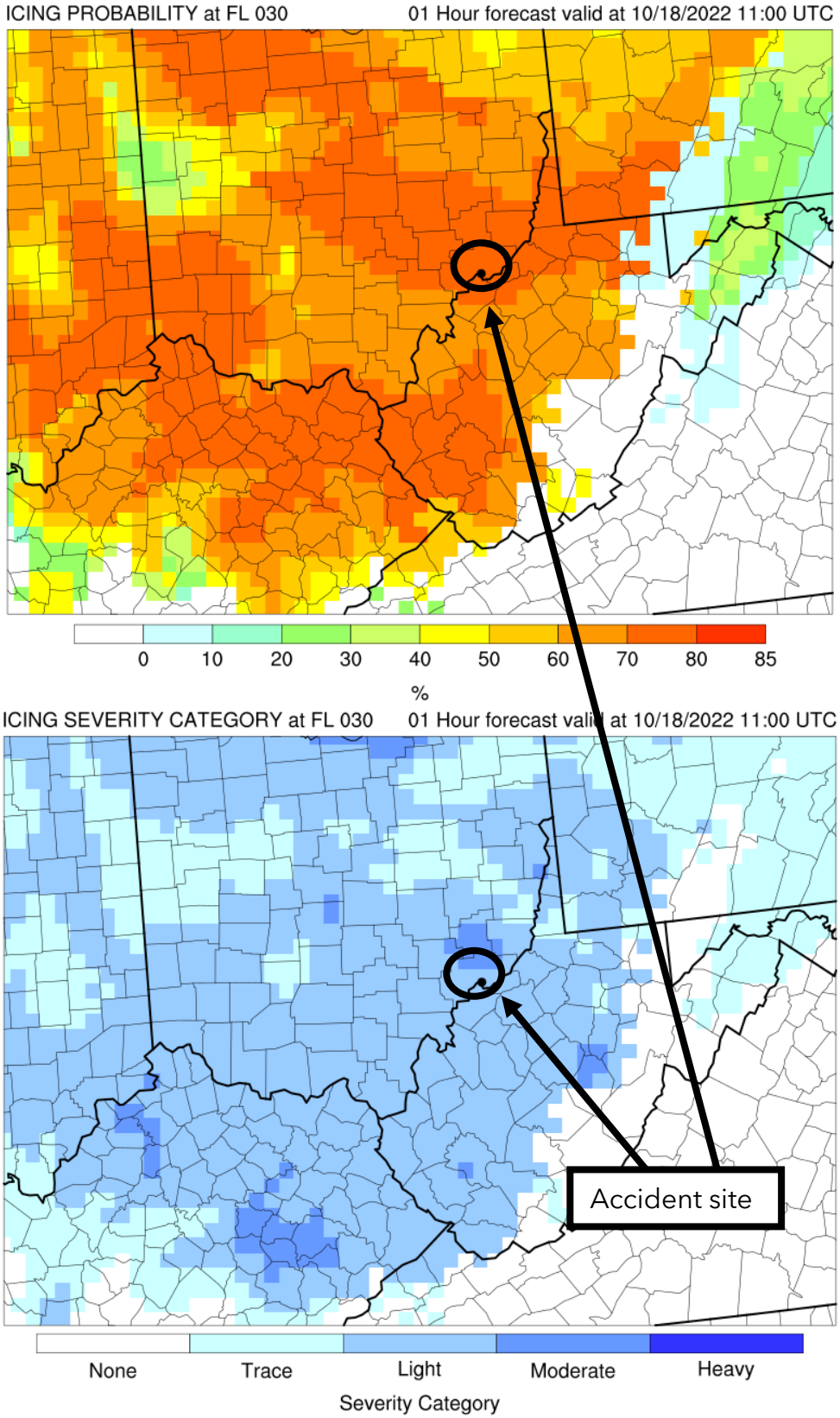

Figure 10. (top) FIP probability of icing at 3,000 ft and (bottom) FIP severity of icing at 3,000 ft 1-hour forecast valid at 0700 EDT.

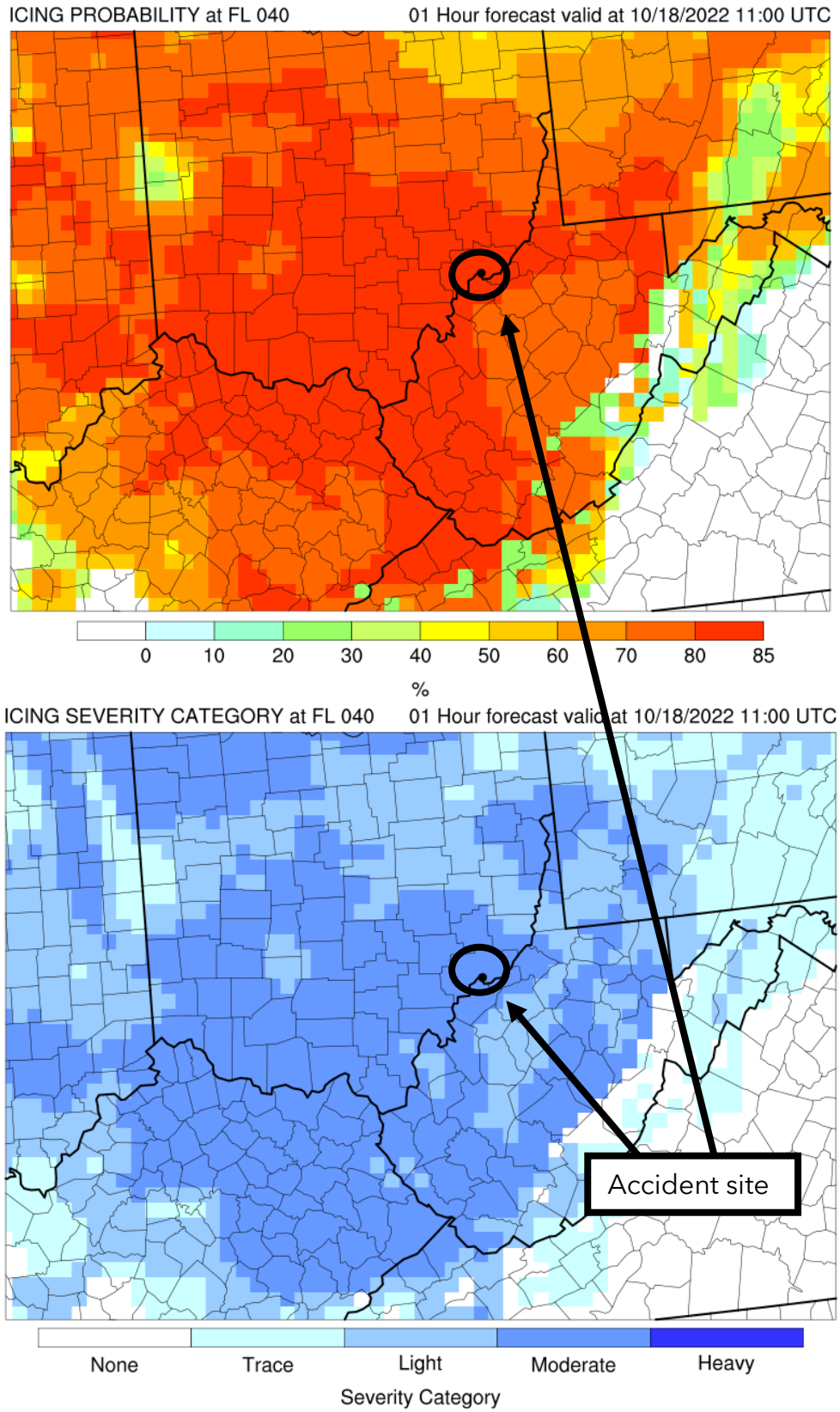

Figure 11. (top) FIP probability of icing at 4,000 ft and (bottom) FIP severity of icing at 4,000 ft 1-hour forecast valid at 0700 EDT.

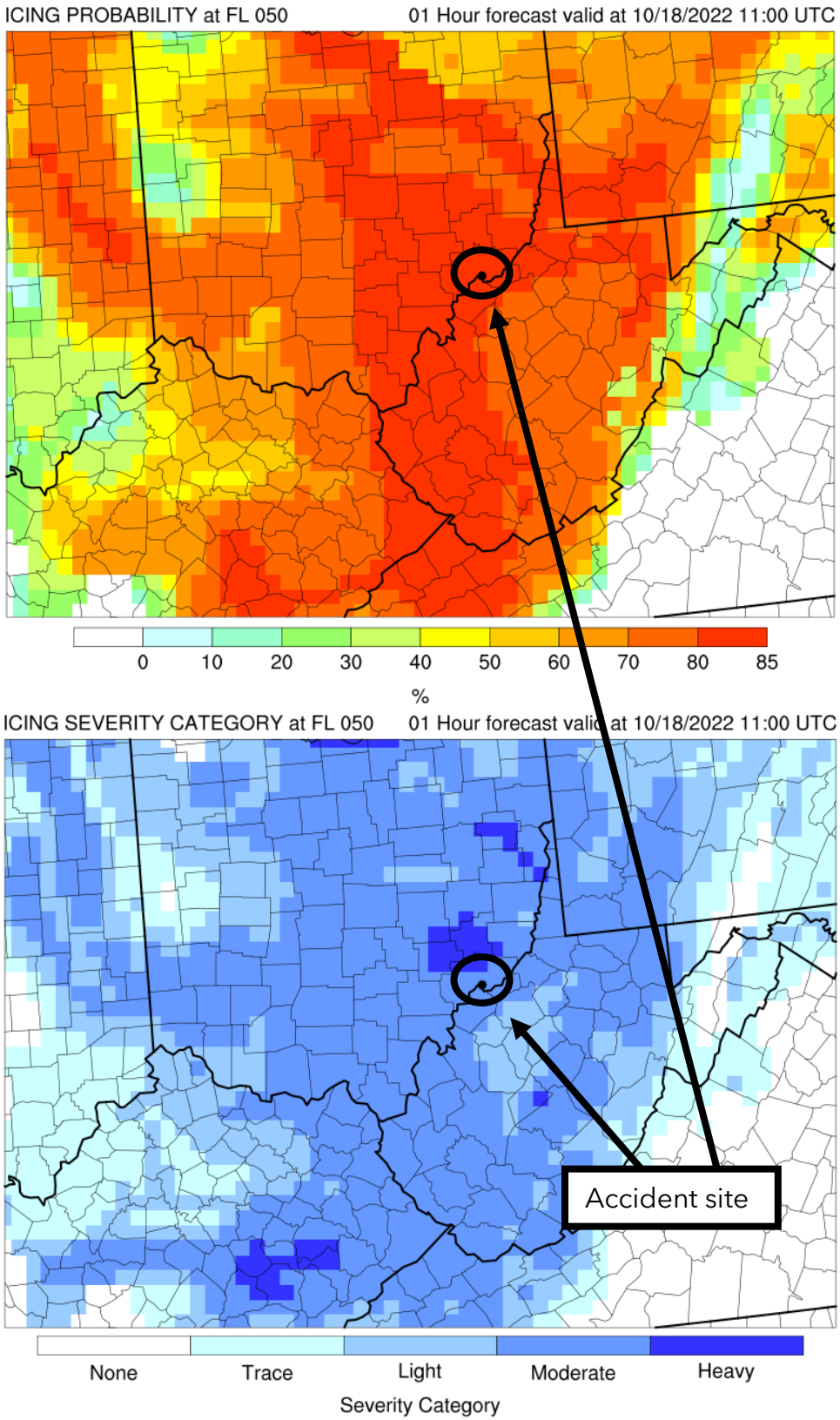

Figure 12. (top) FIP probability of icing at 5,000 ft and (bottom) FIP severity of icing at 5,000 ft 1-hour forecast valid at 0700 EDT.

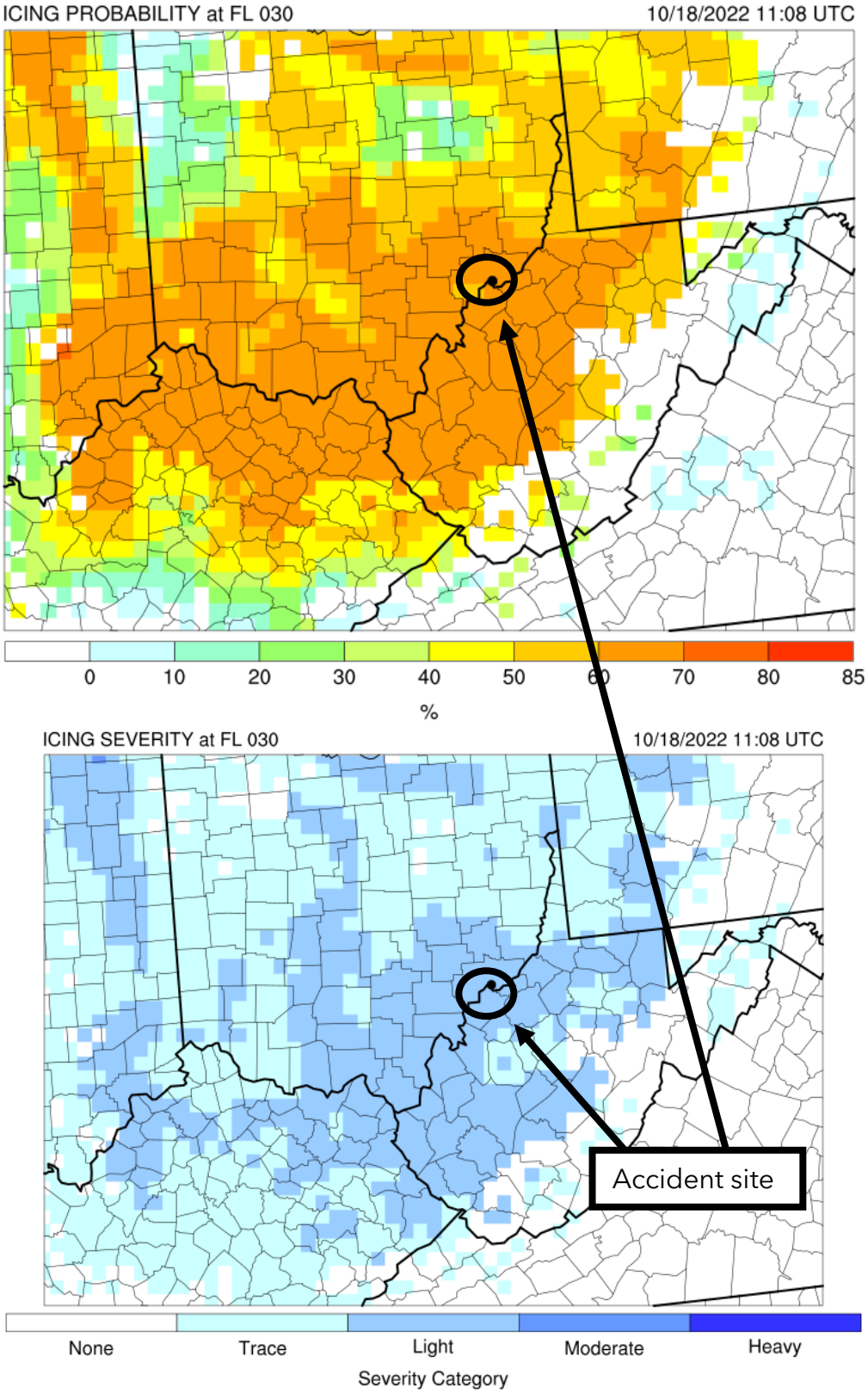

Figure 13. (top) CIP probability of icing at 3,000 ft and (bottom) CIP severity of icing at 3,000 ft valid around 0700 EDT.

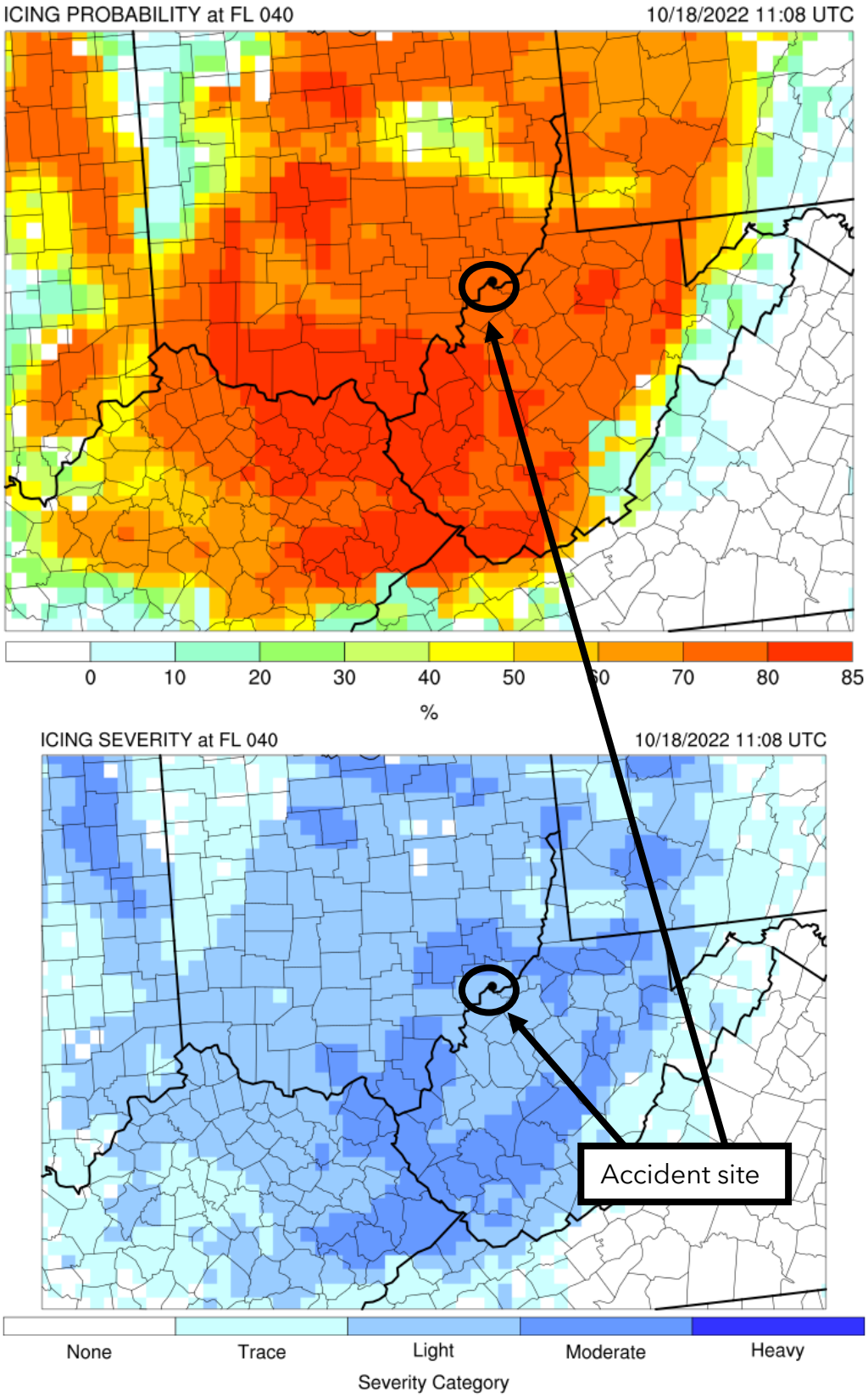

Figure 14. (top) CIP probability of icing at 4,000 ft and (bottom) CIP severity of icing at 4,000 ft valid around 0700 EDT.

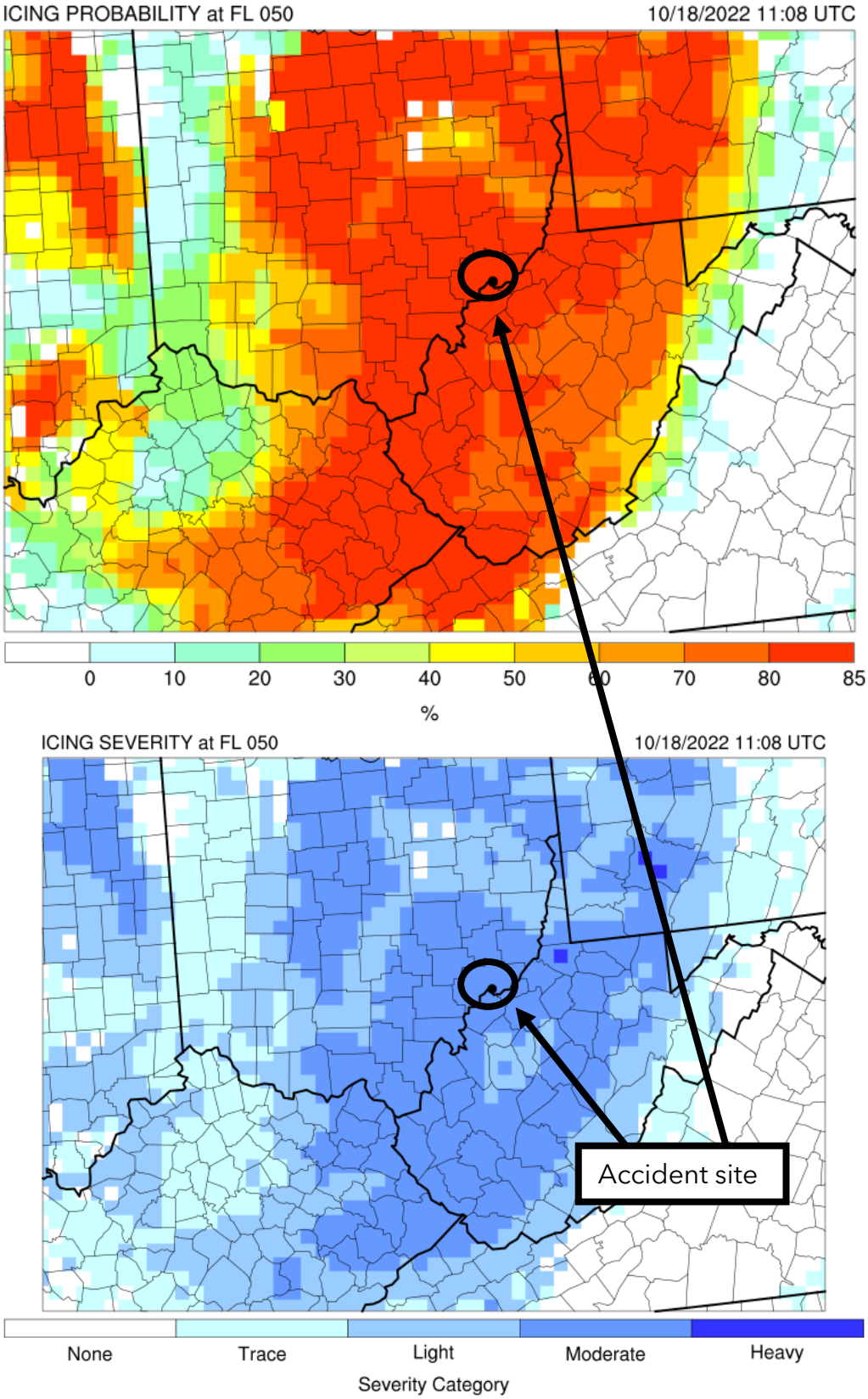

Figure 15. (top) CIP probability of icing at 5,000 ft and (bottom) CIP severity of icing at 5,000 ft valid around 0700 EDT.

15.0 Pilot Weather Information

Title 14 CFR 91.103 states that "Each pilot in command shall, before beginning a flight, become familiar with all available information concerning that flight." FAA AC 91-92 "Pilot's Guide to a Preflight Planning" (dated March 15, 2021) provided pilot guidance on preflight self-briefings, including planning, weather interpretation, and risk identification/mitigation skills. The AC further stated in part:

> Pilots adopting these guidelines will be better prepared to interpret and utilize real-time weather information before departure and en route, in the cockpit, via technology like Automatic Dependent Surveillance-Broadcast (ADS-B) and via third-party providers. [25]

A search of archived information indicated that the accident pilot did not request weather information from Leidos Flight Service. The accident pilot did use their ForeFlight account gather and receive a weather briefing through ForeFlight at 2008 EDT on October 17 (attachment 4). The ForeFlight weather briefing from 2008 EDT on October 17 contained all the standard weather forecast information valid then through the proposed departure and flight time starting at 0630 EDT on October 18. While the text AIRMETs (Sierra and Zulu) were highlighted for the accident flight route, the G-AIRMETs were not forecast for the region after 0500 EDT due to it being beyond the G-AIRMET forecast issuance timeframe (greater than 12 hours). No weather imagery was viewed in the ForeFlight App prior to the flight. For more information please see attachment 4.

16.0 Astronomical Data

The astronomical data obtained for the accident site on October 18, 2022, indicated the following:

SUN	
Accident time	**0709 EDT**[26]
Begin civil twilight	0712 EDT
Sunrise	0738 EDT
Sun transit	1311 EDT
Sunset	1843 EDT
End civil twilight	1909 EDT

At the time of the accident the Sun was located at an altitude of -6.56° and azimuth of 97.24°.

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[25] https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_91-92.pdf. The AC also listed multiple online FAA resources for aviation flight planning services for adverse weather.
[26] Inserted accident time for reference and context.

E. LIST OF ATTACHMENTS

Attachment 1 – GOES-16 Nighttime microphysics RGB satellite animation from 0606 to 0736 EDT

Attachment 2 – GFA information valid at the accident time

Attachment 3 – Additional FIP and CIP information around the accident time

Attachment 4 – ForeFlight Information

Submitted by:

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