

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



ERA24FA088

METEOROLOGY

Specialist's Factual Report

April 19, 2024

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A. ACCIDENT

Location: Leyden, Massachusetts
Date: January 14, 2024
Time: 1125 eastern standard time
1625 coordinated universal time (UTC)
Airplane: Beechcraft 95-B-55; Registration: N7345R

B. METEOROLOGY SPECIALIST

Paul Suffern
Senior Meteorologist
National Transportation Safety Board
Washington, DC

C. DETAILS OF THE INVESTIGATION

The NTSB's Senior Meteorologist did not travel for this investigation but gathered all data remotely. Data for this investigation were 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 standard time (EST) and are based upon the 24-hour clock, where local time is -5 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 42.657361° N, longitude 72.600333° W, at an elevation of 590 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 Federal Aviation Administration (FAA) "Aviation Weather Handbook", FAA-H-8083-28.¹

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart centered over the northeastern United States for 1300 EST is provided as figure 1 with the location of the accident site within the black circle. The chart depicted a dissipating occluded front extending from Montreal, Canada southward across Vermont and Massachusetts, and became a cold front further southward across Connecticut and turning southwestward across New Jersey, Delaware, Maryland and into North Carolina.

The station models closest to the accident site depicted air temperatures of 34 to 37 degrees Fahrenheit (°F), dew point temperatures of 15 to 20°F, overcast sky cover, with winds from the south at 5 to 15 knots. Light snow was reported at several stations west of the front across New York state.

¹ [FAA-H-8083-28](#)

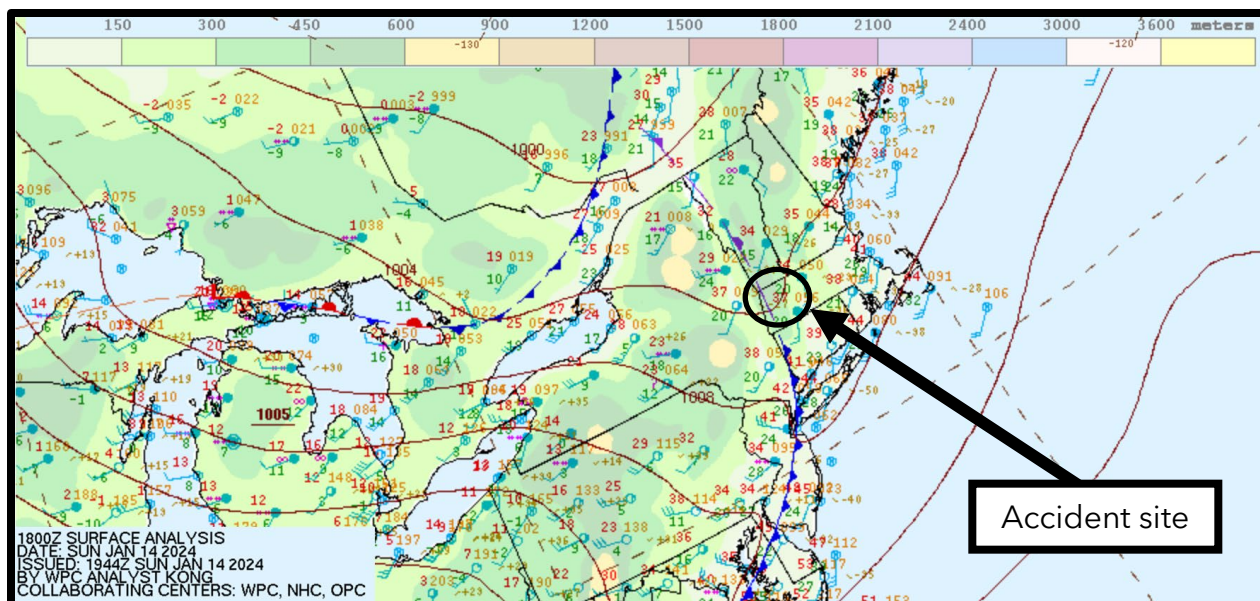


Figure 1. NWS Surface Analysis Chart for 1300 EST.

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 0700 EST at 925-, 850-, and 700-hectopascals (hPa) are presented in figures 2 through 4. The charts indicated a low- and mid-level trough² at 925- through 700-hPa (figures 2 through 4) over the Great Lakes region. 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-southwest wind around 30 knots (figure 2) becoming a southwest 40 knot wind by 850-hPa (figure 3). By 700-hPa, the wind remained from the southwest, but increased to 60 knots (figure 4).

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

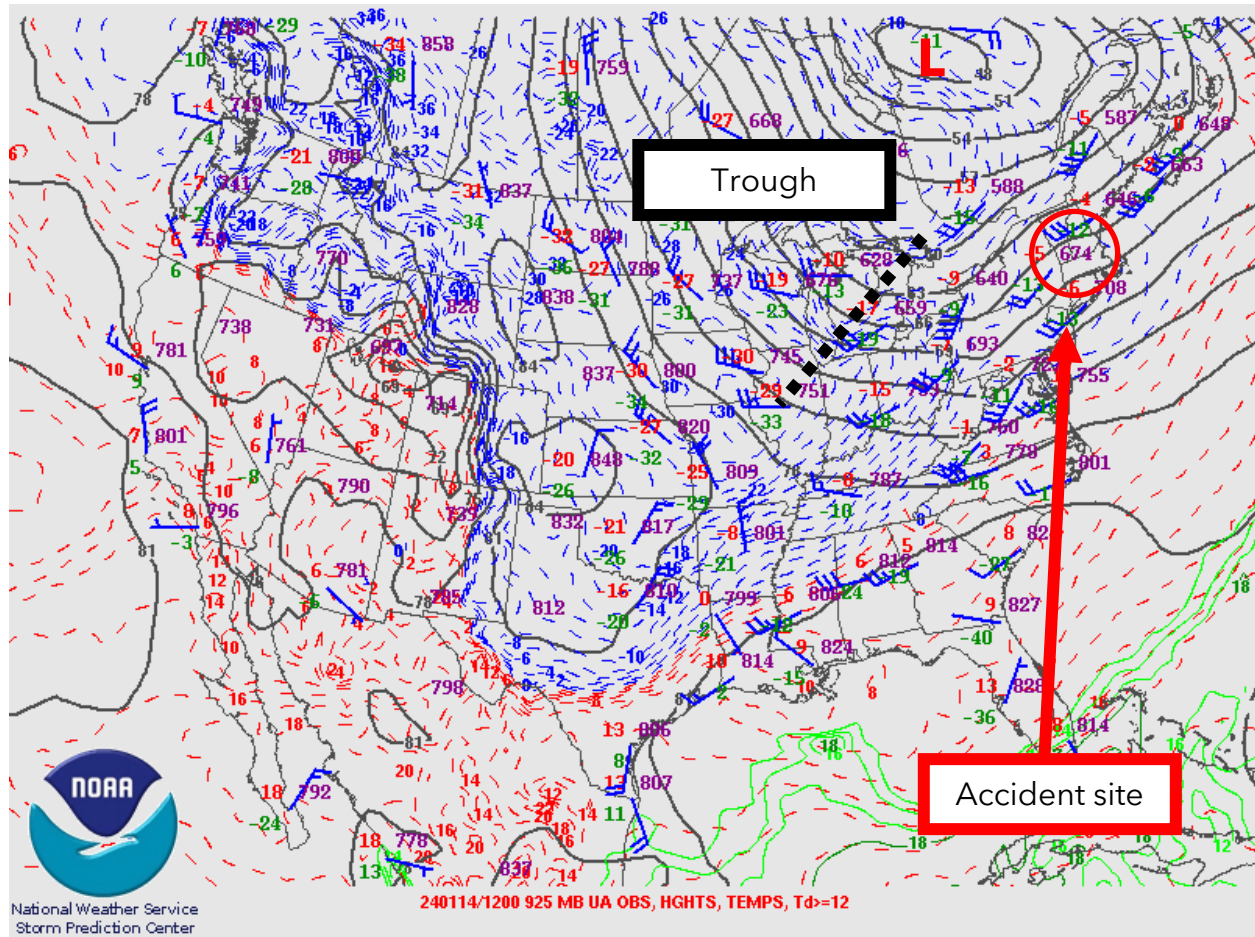


Figure 2. 925-hPa Constant Pressure Chart for 0700 EST.

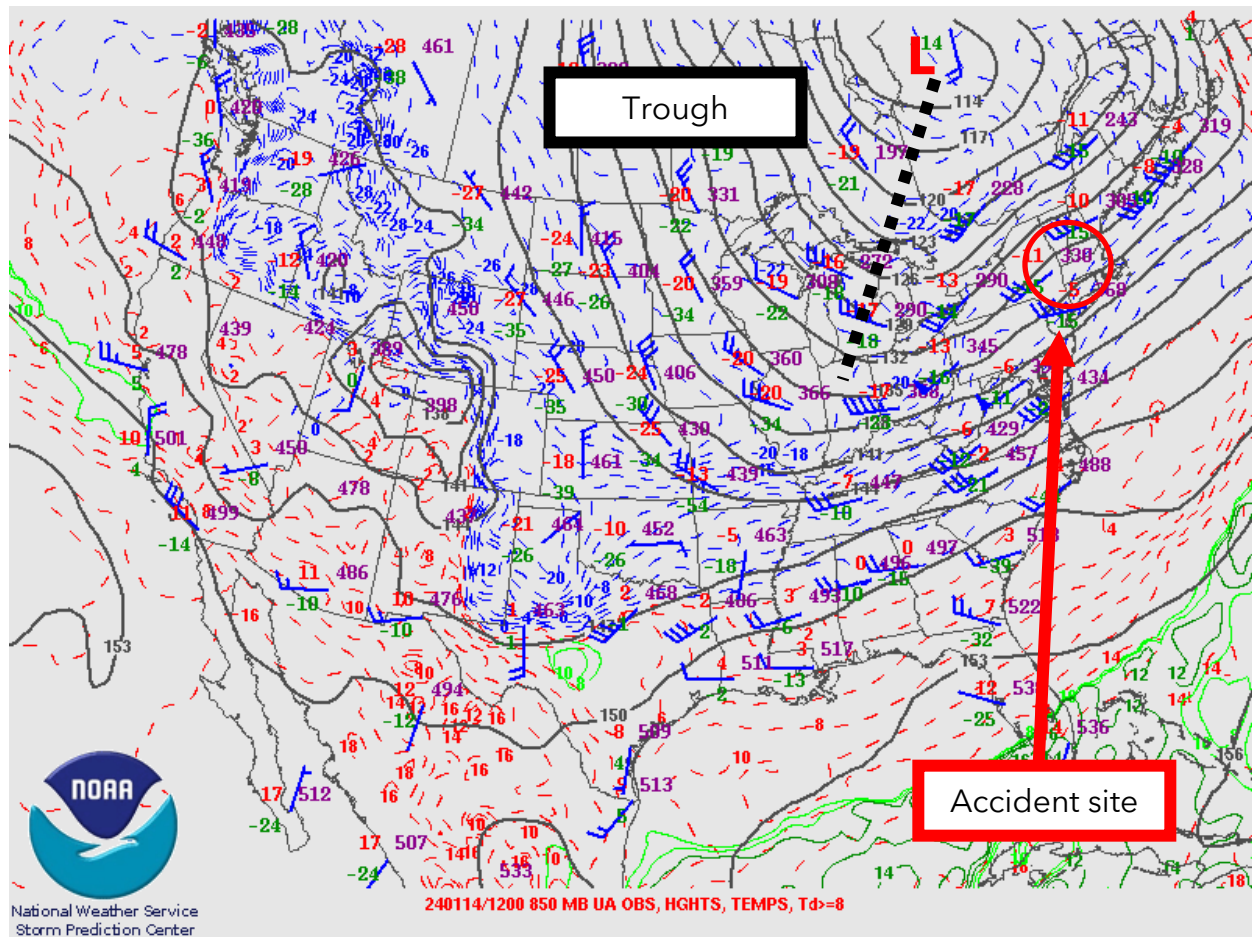


Figure 3. 850-hPa Constant Pressure Chart for 0700 EST.

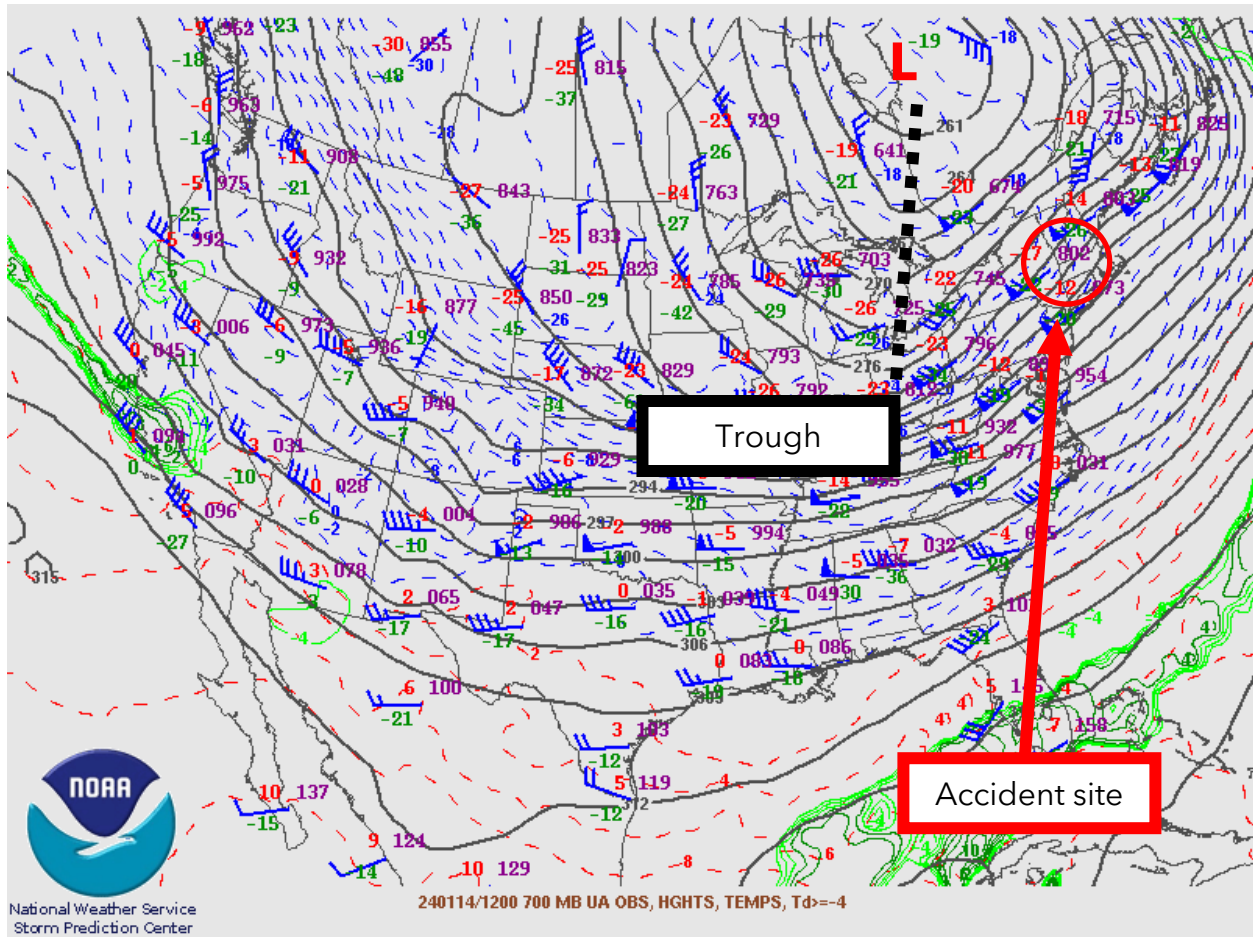


Figure 4. 700-hPa Constant Pressure Chart for 0700 EST.

2.0 Storm Prediction Center Convective Outlook

SPC issued a Day 1 Convective Outlook at 0743 EST (figure 5) with the accident site located in an area where a chance of thunderstorms was predicted. The SPC defines the “TSTM” area as an area where a 10% or higher probability of thunderstorms is forecast during the valid period. The text of the SPC Day 1 Convective Outlook follows figure 5.

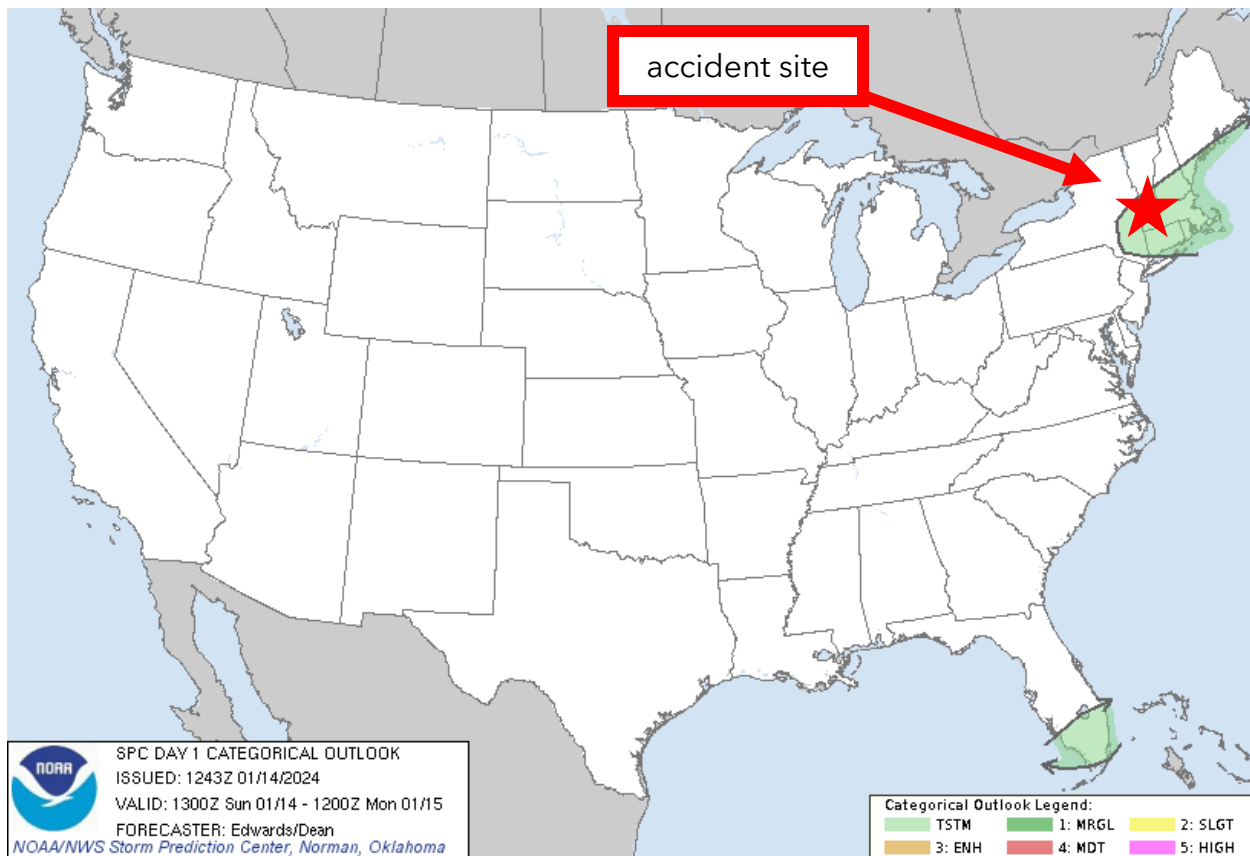


Figure 5. SPC day 1 Convective Outlook valid at the time of the accident.

SPC AC 141243

Day 1 Convective Outlook
 NWS Storm Prediction Center Norman OK
 0643 AM CST Sun Jan 14 2024

Valid 141300Z - 151200Z

...NO SEVERE THUNDERSTORM AREAS FORECAST...

...SUMMARY...

Isolated thunderstorms are possible over parts of south Florida, as well as from southeastern New York across parts of New England.

...Synopsis/Discussion...

A strong mid/upper-level low will meander across the James Bay region through the period, with an extensive fetch of cyclonic flow covering most of the CONUS. Most of the associated/embedded shortwave troughs will remain too removed from suitable low-level moisture/instability to influence thunder potential, with two exceptions:

1. A perturbation now located over parts of OH/IN, is forecast to move east-northeastward across the northern Mid-Atlantic and New England through 00Z. Associated strong large-scale scent/cooling

aloft today will help to offset cool near-surface temperatures across parts of southern New England, generating weak surface-based buoyancy anyway, with MLCAPE up to about 100 J/kg. This will support a fast-moving band of low-topped convection extending above the -20 deg C isotherm at times, with isolated embedded thunder. Downdrafts in a few embedded cells may produce strong gusts via downward momentum transfer. However, given the weak instability, organized severe potential appears too low and conditional to justify a categorical area at this time.

2. A southern-stream shortwave trough and vorticity banner are apparent in moisture-channel imagery over the northwestern Gulf. This positively tilted feature will move rapidly eastward today, crossing central FL around 00Z and south FL shortly thereafter. Associated large-scale lift, atop a residual low-level frontal zone (surface boundary over the Straits/Bahamas), will overlap enough moisture to support sporadic lightning with cells embedded in a precip plume. MUCAPE of 300-500 J/kg is possible, with the Mexican EML previously over the region having advected away. Still, midlevel lapse rates will be weak, with low CAPE density. Enough deep shear may remain to support some convective organization, but lack of greater instability and lift will keep severe potential meager at most.

..Edwards/Dean.. 01/14/2024

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NOTE: THE NEXT DAY 1 OUTLOOK IS SCHEDULED BY 1630Z

3.0 Surface Observations

The area surrounding the accident site was documented using official Aviation Routine Weather Reports (METARs) and Special Reports (SPECIs)³. 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 locations marked. A magnetic variation⁴ of 14° west was indicated over the area.

³ Latest criteria for SPECIs can be found in the Federal Meteorological Handbook: [Federal Meteorological Handbook Number 1, Surface Weather Observations and Reports \(icams-portal.gov\)](https://icams-portal.gov/fmh1/)

⁴ Magnetic variation - The angle (at a particular location) between magnetic north and true north. Latest measurement taken from <https://skyvector.com/>

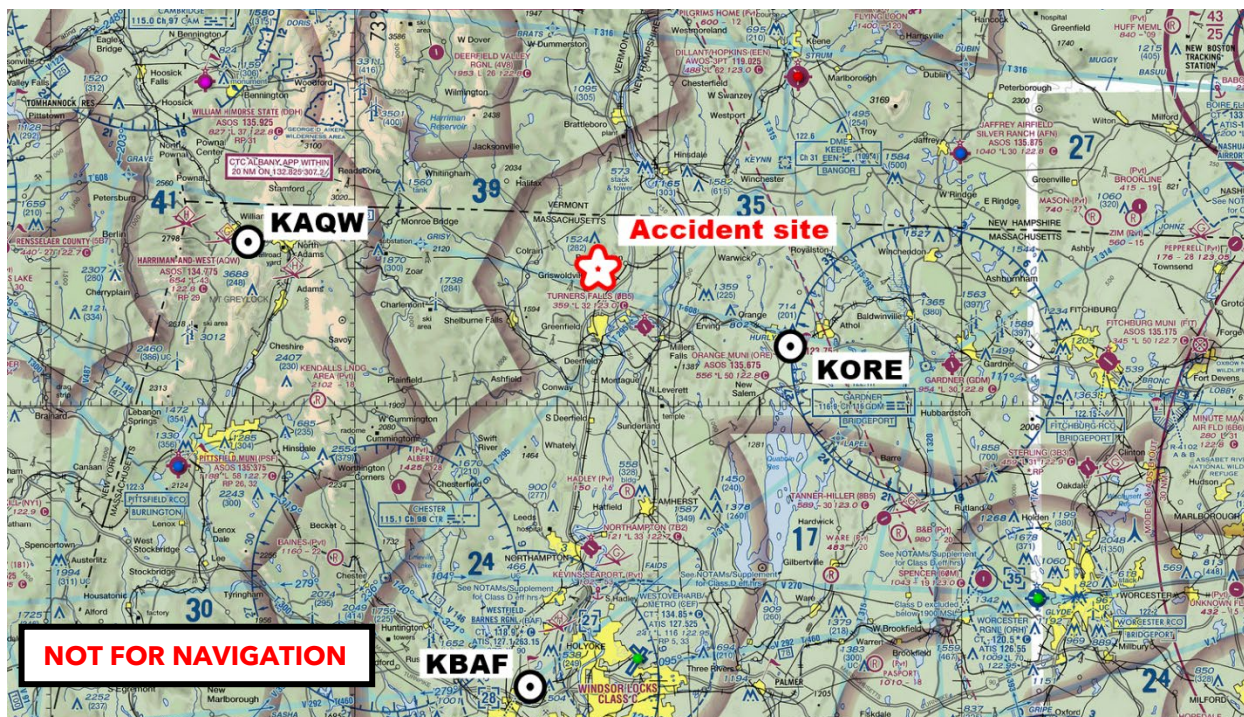


Figure 6. FAA sectional aeronautical chart of the accident area with the location of the accident site and surface observation sites noted.

Orange Municipal Airport (KORE) had the closest official weather station to the accident site. KORE had an Automated Surface Observing System (ASOS⁵) and its longline reports⁶ were not augmented. The KORE ASOS was located 15 miles east-southeast of the accident site (figure 6) at an elevation of 556 ft, and issued the following observations surrounding the accident time:⁷

[0652 EST] METAR KORE 141152Z AUTO 18004KT 10SM FEW055
M01/M08 A2973 RMK AO2 SLP073 70021 T10111083 10017 21011
53016

[0752 EST] METAR KORE 141252Z AUTO 20009KT 10SM CLR M01/M08
A2972 RMK AO2 SLP072 T10111083

⁵ 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.

⁶ "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.

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.

[0852 EST] METAR KORE 141352Z AUTO 20008KT 10SM CLR M01/M08
A2976 RMK AO2 SLP082 T10061083

[0952 EST] METAR KORE 141452Z AUTO 20018G28KT 10SM FEW120
00/M08 A2973 RMK AO2 PK WND 20031/1437 SLP074 T00001083
50001

**[1052 EST] METAR KORE 141552Z AUTO 22013G22KT 10SM
BKN045 01/M08 A2973 RMK AO2 PK WND 21030/1531 SLP073
T00061078**

ACCIDENT TIME 1125 EST

**[1152 EST] METAR KORE 141652Z AUTO 22011G23KT 10SM
BKN046 02/M07 A2968 RMK AO2 PK WND 19029/1555 SLP057
T00171072**

[1252 EST] METAR KORE 141752Z AUTO 20013G20KT 10SM BKN042
OVC055 01/M07 A2966 RMK AO2 PK WND 21026/1658 SLP050
T00111067 10017 21017 58023

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

KORE weather at 1052 EST, automated, wind from 220° at 13 knots with gusts to 22 knots, visibility 10 miles or greater, broken ceiling at 4,500 ft above ground level (agl), temperature of 1° Celsius (C), dew point temperature of -8°C, and an altimeter setting of 29.73 inches of mercury (inHg). Remarks, automated station with a precipitation discriminator, peak wind from 210° at 30 knots at 1031 EST, sea-level pressure 1007.3 hPa, temperature 0.6°C, dew point temperature -7.8°C.

KORE weather at 1152 EST, automated, wind from 220° at 11 knots with gusts to 23 knots, visibility 10 miles or greater, broken ceiling at 4,600 ft agl, temperature of 2°C, dew point temperature of -7°C, and an altimeter setting of 29.68 inHg. Remarks, automated station with a precipitation discriminator, peak wind from 190° at 29 knots at 1055 EST, sea-level pressure 1005.7 hPa, temperature 1.7°C, dew point temperature -7.2°C.

Westfield-Barnes Regional Airport (KBAF) was the departure airport. KBAF had an ASOS and its longline reports were augmented when the air traffic control (ATC) tower was in operation⁸. The KBAF ASOS was located 30 miles south-southwest of the accident site (figure 6), at an elevation of 270 ft, and issued the following observations surrounding the accident time:

[0753 EST] METAR KBAF 141253Z 17007KT 10SM CLR M01/M08 A2976
RMK AO2 SLP084 T10111083

[0853 EST] METAR KBAF 141353Z 19013KT 10SM CLR 00/M08 A2978
RMK AO2 SLP090 T00001083

[0953 EST] METAR KBAF 141453Z 21012KT 10SM BKN044 01/M08
A2978 RMK AO2 SLP092 T00111078 53007

**[1053 EST] METAR KBAF 141553Z 21014G25KT 10SM OVC049
02/M08 A2975 RMK AO2 PRESFR SLP080 T00171078**

DEPARTURE TIME 1105 EST

ACCIDENT TIME 1125 EST

**[1153 EST] METAR KBAF 141653Z 21017KT 10SM BKN048
OVC055 02/M07 A2971 RMK AO2 SLP065 T00221072**

[1253 EST] METAR KBAF 141753Z 21015G24KT 10SM SCT047 OVC060
03/M07 A2968 RMK AO2 PK WND 24028/1706 SLP056 T00281067
10028 21022 56036

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

KBAF weather at 1053 EST, wind from 210° at 14 knots with gusts to 25 knots, visibility 10 miles or greater, overcast ceiling at 4,900 ft agl, temperature of 2°C, dew point temperature of -8°C, and an altimeter setting of 29.75 inHg. Remarks, automated station with a precipitation discriminator, pressure falling rapidly, sea-level pressure 1008.0 hPa, temperature 1.7°C, dew point temperature -7.8°C.

⁸ ATC hours of operation 0700 to 2200 local time.

KBAF weather at 1153 EST, wind from 210° at 17 knots, visibility 10 miles or greater, broken ceiling at 4,800 ft agl, overcast skies at 5,500 ft agl, temperature of 2°C, dew point temperature of -7°C, and an altimeter setting of 29.71 inHg. Remarks, automated station with a precipitation discriminator, sea-level pressure 1006.5 hPa, temperature 2.2°C, dew point temperature -7.2°C.

Harriman-and-West Airport (KAQW) was the closest airport with official weather observations to the west of the accident site. KAQW had an ASOS and its longline reports were not augmented. The KAQW ASOS was located 25 miles west of the accident site (figure 6), at an elevation of 654 ft, and issued the following observations surrounding the accident time:

[0752 EST] METAR KAQW 141252Z AUTO 26003KT 10SM CLR 00/M09 A2969 RMK AO2 SLP061 T00001089

[0852 EST] METAR KAQW 141352Z AUTO 24009G15KT 10SM FEW120 01/M08 A2971 RMK AO2 SLP067 T00111083

[0952 EST] METAR KAQW 141452Z AUTO 24009G14KT 10SM BKN050 02/M08 A2972 RMK AO2 SLP069 T00171083 53006

[1052 EST] METAR KAQW 141552Z AUTO 22012G18KT 10SM BKN041 OVC055 02/M08 A2969 RMK AO2 SNB13E41 SLP060 P0000 T00171078

ACCIDENT TIME 1125 EST

[1152 EST] METAR KAQW 141652Z AUTO 21012G20KT 170V240 10SM BKN046 02/M08 A2966 RMK AO2 SLP051 T00221078

[1252 EST] METAR KAQW 141752Z AUTO 23019G29KT 10SM FEW048 BKN055 BKN070 03/M08 A2962 RMK AO2 PK WND 24029/1751 SLP036 60000 T00281078 10033 20000 58032

[1321 EST] SPECI KAQW 141821Z AUTO 24016G25KT 1 3/4SM -SN SCT028 BKN048 OVC055 02/M06 A2962 RMK AO2 SNB17 P0000 T00171061

[1329 EST] SPECI KAQW 141829Z AUTO 24008G25KT 1 1/4SM -SN BKN024 BKN033 OVC050 01/M04 A2962 RMK AO2 SNB17 P0000 T00111044

[1334 EST] SPECI KAQW 141834Z AUTO VRB06KT 2SM -SN BKN019 BKN033 OVC050 01/M04 A2962 RMK AO2 SNB17 P0000 T00111044

[1344 EST] SPECI KAQW 141844Z AUTO 27010G18KT 230V290 9SM
SCT019 BKN029 03/M04 A2962 RMK AO2 SNB17E44 P0000
T00281044

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

KAQW weather at 1052 EST, wind from 220° at 12 knots with gusts to 18 knots, visibility 10 miles or greater, broken ceiling at 4,100 ft agl, overcast skies at 5,500 ft agl, temperature of 2°C, dew point temperature of -8°C, and an altimeter setting of 29.69 inHg. Remarks, automated station with a precipitation discriminator, snow began at 1013 EST, snow ended at 1041 EST, sea-level pressure 1006.0 hPa, a trace of precipitation since 0952 EST, temperature 1.7°C, dew point temperature -7.8°C.

KAQW weather at 1152 EST, wind from 210° at 12 knots with gusts to 20 knots, wind direction varying between 170° and 240°, visibility 10 miles or greater, broken ceiling at 4,600 ft agl, temperature of 2°C, dew point temperature of -8°C, and an altimeter setting of 29.66 inHg. Remarks, automated station with a precipitation discriminator, sea-level pressure 1005.1 hPa, temperature 2.2°C, dew point temperature -7.8°C.

The observations from the KORE, KBAF, and KAQW reported VFR⁹ conditions prevailing at the time of the accident with winds gusting as high as 30 knots and cloud bases as low as 4,700 ft. After the accident, KAQL reported a period of light snow which restricted visibility to 1 ¼ miles with cloud bases as low as 1,900 ft agl.

⁹ The NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories:

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

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

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

4.0 Upper Air Sounding

A High-Resolution Rapid Refresh (HRRR)¹⁰ model sounding was created¹¹ for the approximate accident site coordinates for 1100 EST. The HRRR sounding was plotted on a standard Skew-T Log P diagram¹² from the surface to 600-hPa (or approximately 14,000 ft) using the RAOB¹³ software package and is included as figure 7. The sounding depicted an elevation of 682 ft over the grid point with a near surface temperature of 0.5°C, a dew point temperature of -6.4°C, and a relative humidity of 60%. The sounding depicted the lifted condensation level (LCL)¹⁴ and the level of free convection (LFC)¹⁵ at 2,795 ft agl (3,477 ft msl), and the convective condensation level (CCL)¹⁶ at 3,815 ft agl (4,497 ft msl). The freezing level was located at 763 ft. The precipitable water value was 0.20 inches.

¹⁰ 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.

¹¹ HRRR sounding was created using NOAA Air Resource Laboratory: [READY Archived Meteorology \(noaa.gov\)](https://ready.arl.noaa.gov/).

¹² 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.

¹³ RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Esonde Research Services, The Villages, Florida.

¹⁴ LCL – The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

¹⁵ 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.

¹⁶ 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.

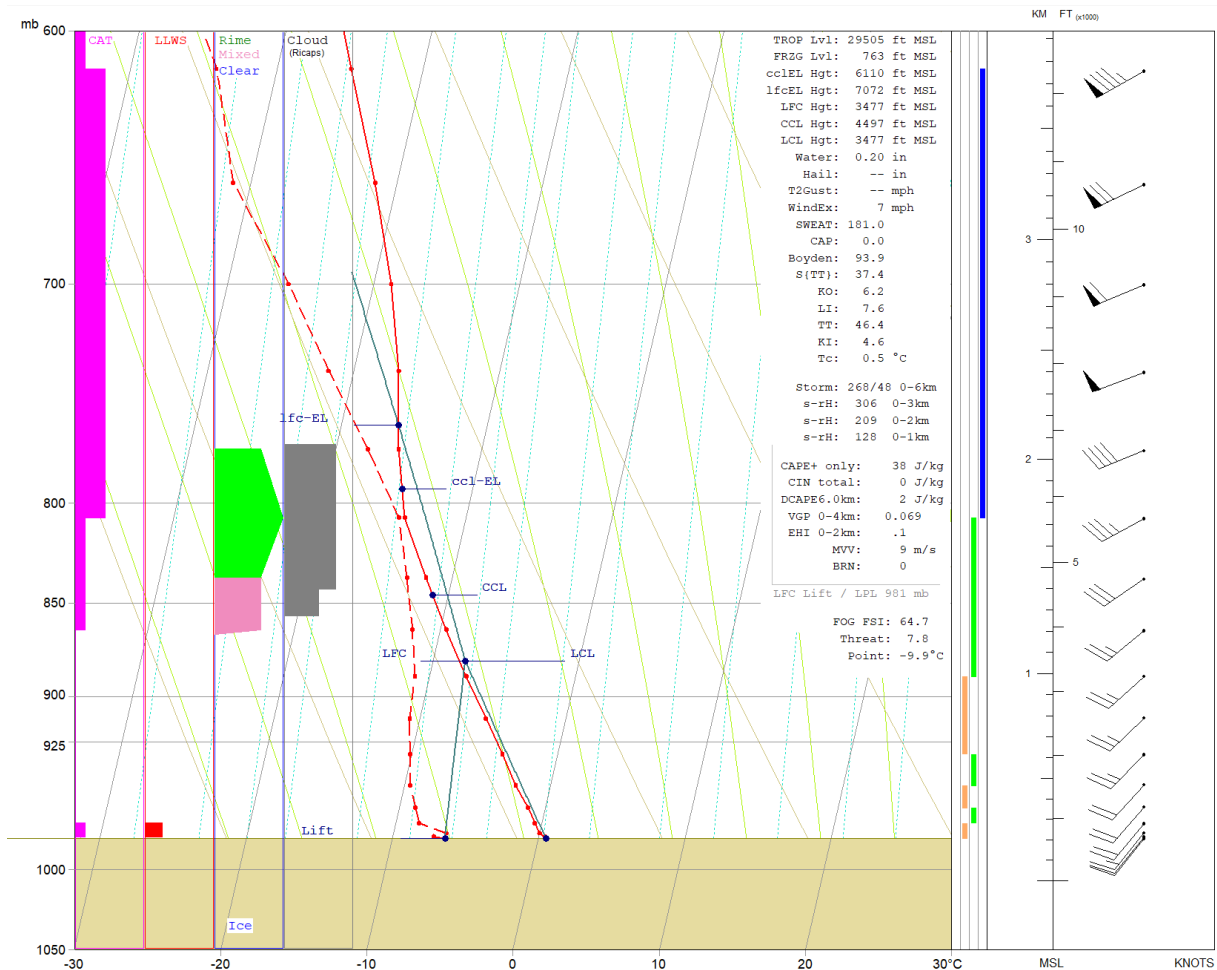


Figure 7. 1100 EST HRRR sounding.

The 1100 EST HRRR sounding identified both unstable and conditionally unstable environments from the surface through 5,500 ft, then a stable layer above 5,500 ft through 14,000 ft. RAOB indicated a cloud layer between 4,000 ft (~3,300 ft agl) and 7,000 ft (~6,300 ft agl). Moderate rime and mixed icing was indicated by RAOB between 4,000 and 7,000 ft.

The 1100 EST HRRR sounding wind profile indicated a near-surface wind from 215° at 12 knots with the wind remaining southwesterly through 6,000 ft. The wind speed increased to 20 knots by 1,100 ft and to 27 knots by 4,000 ft. Around 12,500 ft the wind was from the southwest at 83 knots. Light low-level wind shear (LLWS) was indicated by RAOB below 400 ft agl. RAOB indicated light to moderate clear air turbulence (CAT) below 400 ft agl and above 4,000 ft.

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, respectively) at wavelengths of 0.64 microns (μm) and 10.3 μm , respectively, were retrieved for the period from 0800 EST through 1600 EST and reviewed, and the closest images to the time of the accident were documented.

Figure 8 presents the GOES-16 visible image at 1126 EST at 3X magnification with the accident site highlighted with a red square. There were two layers of cloud cover indicated above the accident site with both layers of cloud cover moving from southwest to northeast (attachment 1). The visible imagery indicated a transverse banding¹⁷ in the lower cloud cover including above the accident site. Figures 9 and 10 present the GOES-16 infrared image at 1116 and 1126 EST at 6X magnification with the accident site highlighted with a red square. Cloud cover was indicated above the accident site with lower brightness temperatures (green colors; higher cloud tops) located over New York, west of the accident site. The brightness temperature above the accident site dropped by 10 Kelvin between 1116 and 1126 EST with a brightness temperature of 252 Kelvin¹⁸ above the accident site at the accident time. The brightness temperature of 252 Kelvin would have been near 10,000 ft based on the vertical temperature profile provided by the 1100 EST HRRR sounding. It should be noted these figures have not been corrected for any parallax error.

¹⁷

https://www.weather.gov/source/zhu/ZHU_Training_Page/Miscellaneous/gravity_wave/gravity_wave.html

¹⁸ around -21°C

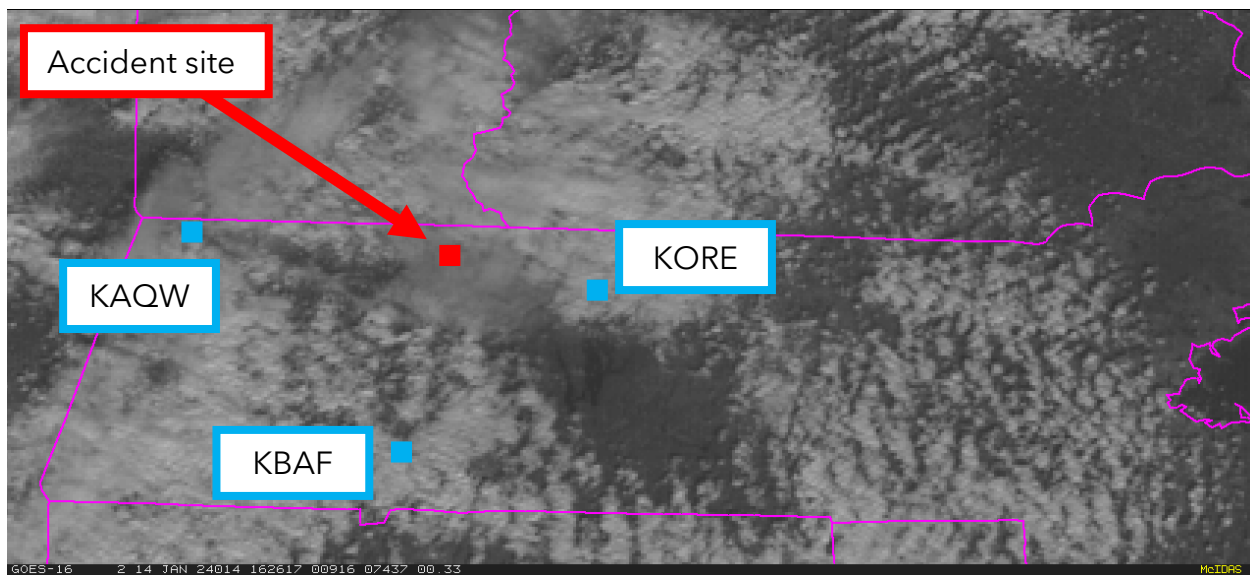


Figure 8. GOES-16 visible image at 1126 EST.

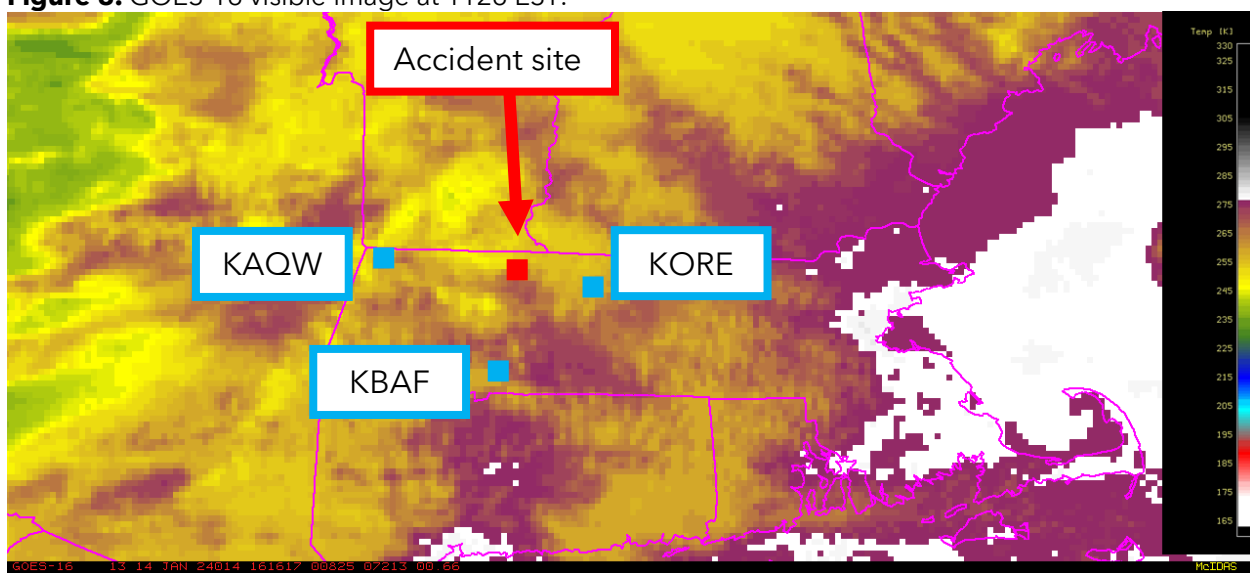


Figure 9. GOES-16 infrared image at 1116 EST.

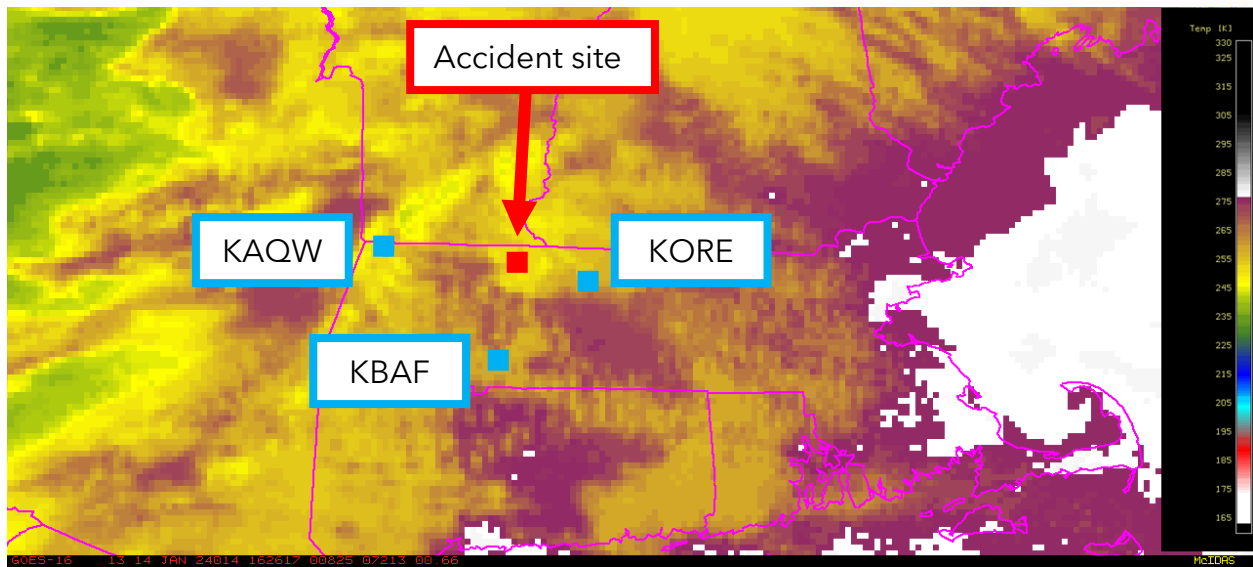


Figure 10. GOES-16 infrared image at 1126 EST.

6.0 National Radar Imagery

A regional view of the NWS National Reflectivity Mosaic is included as figure 11 for 1125 EST with the approximate location of the accident site marked by a red circle. The mosaic imagery depicted no echoes above the accident site.

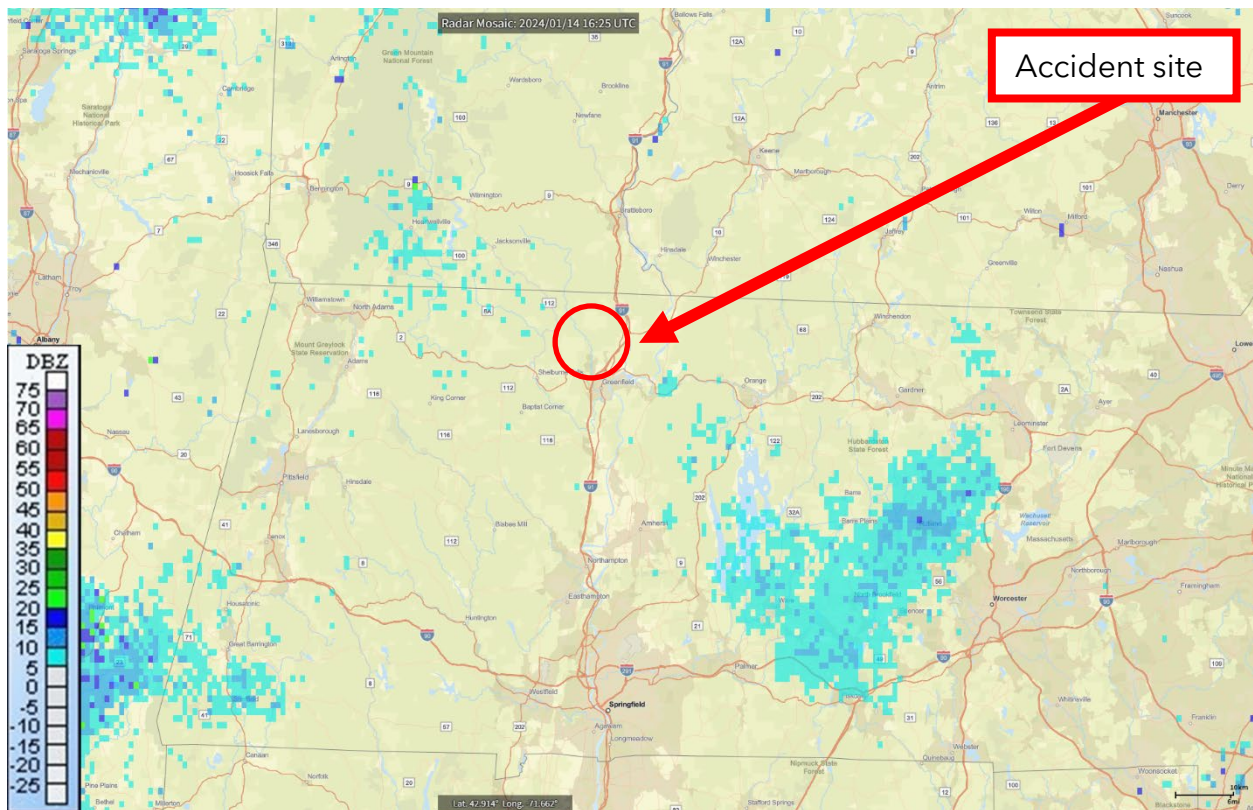


Figure 11. National Reflectivity Mosaic for 1125 EST.

7.0 Weather Surveillance Radar Imagery

The closest NWS Weather Surveillance Radar-1988 Doppler (WSR-88D)¹⁹ to the accident site was from Albany (KENX), New York, located 65 miles west of the accident site. The 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.

¹⁹ 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.

7.1 Volume Scan Strategy

During the period surrounding the accident, the KENX WSR-88D radar was operating in the precipitation mode VCP-215²⁰ (figure 12). 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.

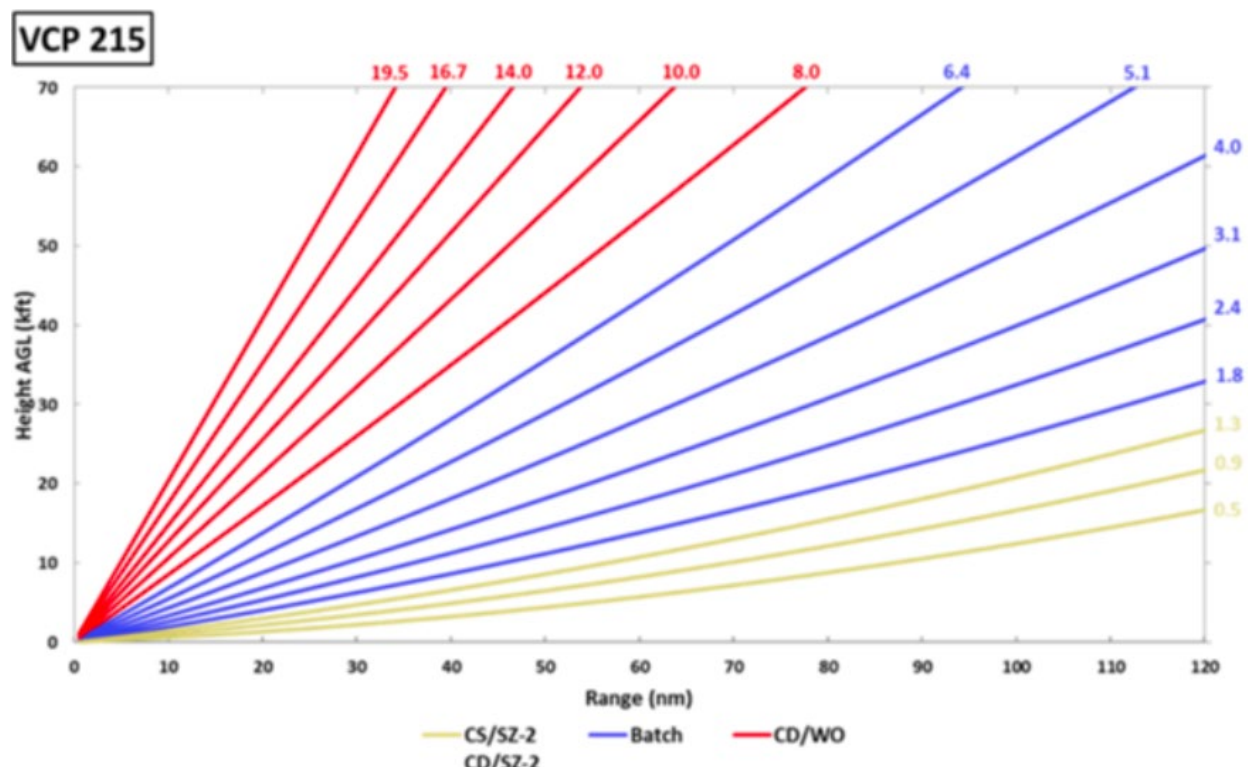


Figure 12. VCP-215 precipitation Mode Scan Strategy.

²⁰ 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 refraction²¹ of the KENX WSR-88D radar beam with the antenna elevation at 1,934 ft, and considering a beamwidth²² of 0.95°, the following table shows the approximate heights for the 0.53° radar beams' center, top and base for certain antenna elevations over the accident site. These heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
KENX 0.53°	8,390 ft	5,110 ft	11,660 ft

Based on the radar height calculations, the 0.53° elevation scan reviewed from KENX listed in the above table combined to depict conditions between 5,110 ft and 11,660 ft over the accident site.

7.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²³ 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 dBZ²⁴ and is a general measure of echo intensity. The FAA Aviation Weather Handbook 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 to 50 dBZ, inclusive. Finally, any dBZ values above 50 dBZ shall be described as "extreme."

²¹ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

²² Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

²³ 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.

²⁴ 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.

7.4 Base Reflectivity Data

Figures 13, 14, 15, and 16 present the KENX WSR-88D base reflectivity images for the 0.53° elevation scan initiated at 1112:47, 1117:24, 1122:01, and 1126:52 EST with resolutions of 0.5° X 250 m. These images depicted reflectivity values between -5 and 5 dBZ above the accident flight's location at 1113 and 1117 EST with no reflectivity values above the accident flight's location at 1122 and 1126 EST. The reflectivity targets were moving from southwest to northeast at the time of the accident (attachment 2).

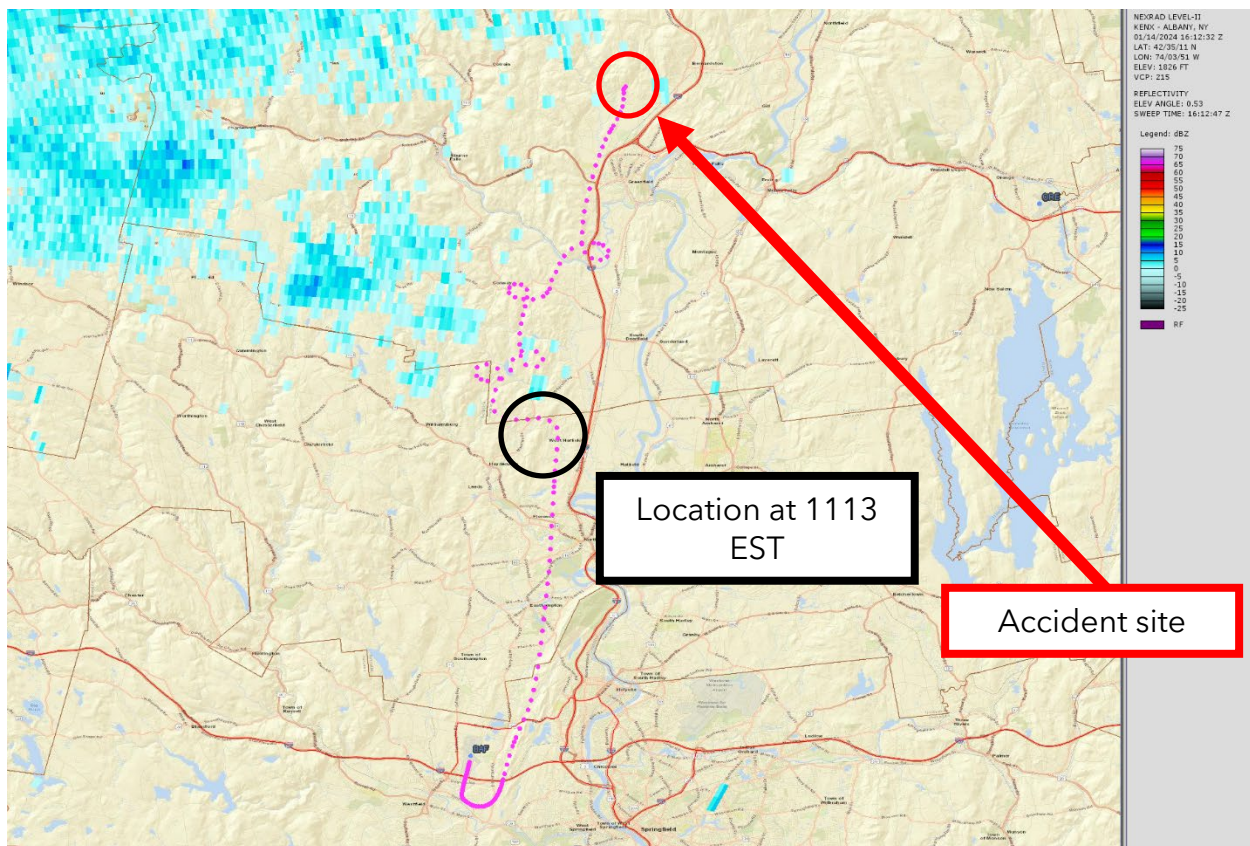


Figure 13. KENX WSR-88D reflectivity for the 0.53° elevation scan initiated at 1112:47 EST with the accident site marked with the red circle and the location of the accident aircraft in the black circle. The pink is the airplane flight track.

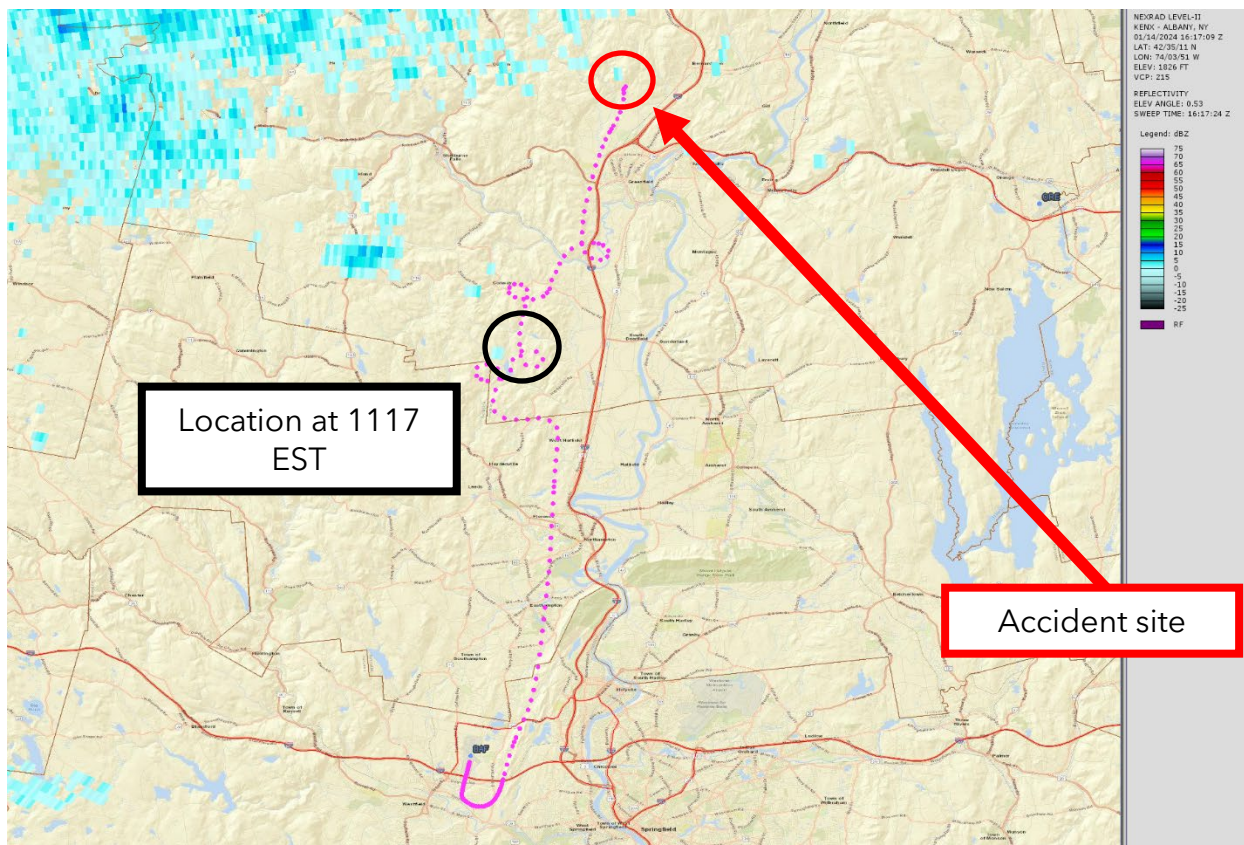


Figure 14. KENX WSR-88D reflectivity for the 0.53° elevation scan initiated at 1117:24 EST with the accident site marked with the red circle and the location of the accident aircraft in the black circle. The pink is the airplane flight track.

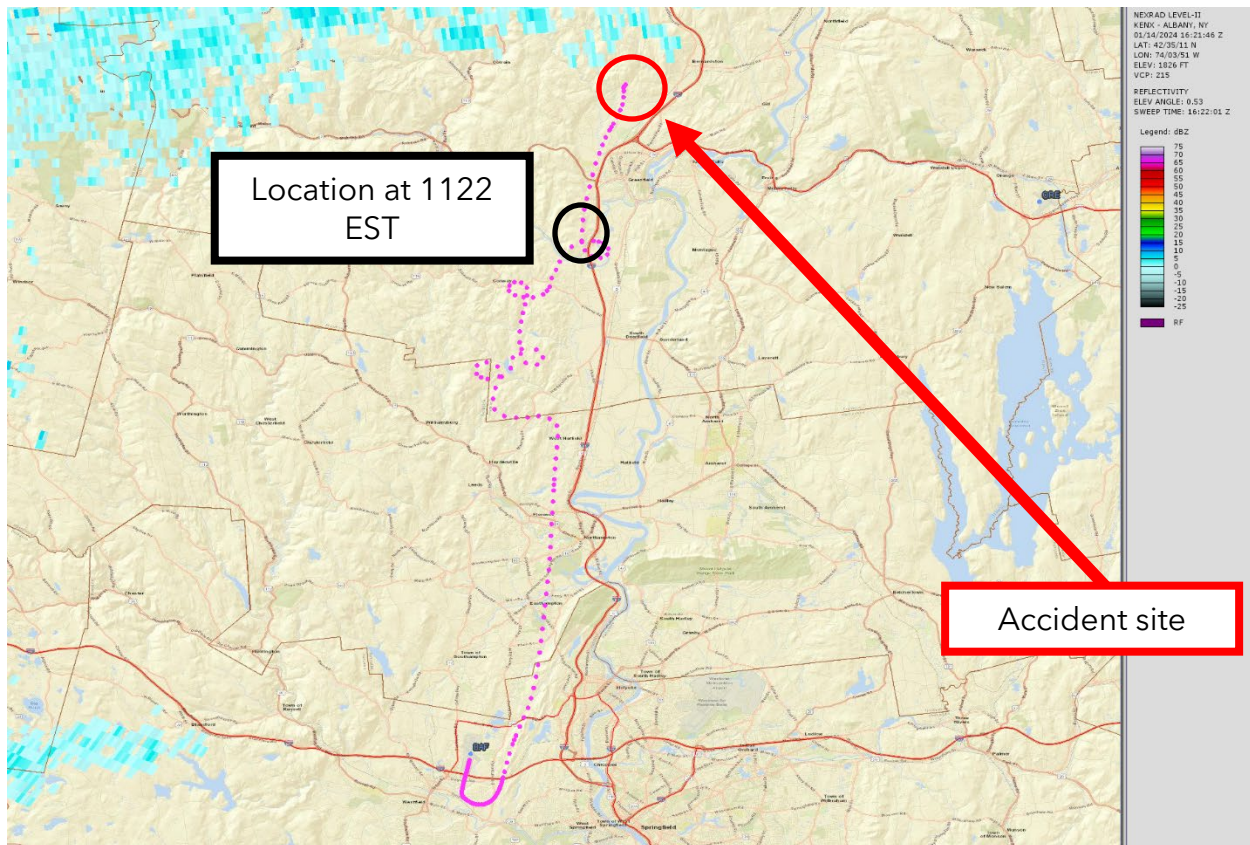


Figure 15. KENX WSR-88D reflectivity for the 0.53° elevation scan initiated at 1122:01 EST with the accident site marked with the red circle and the location of the accident aircraft in the black circle. The pink is the airplane flight track.

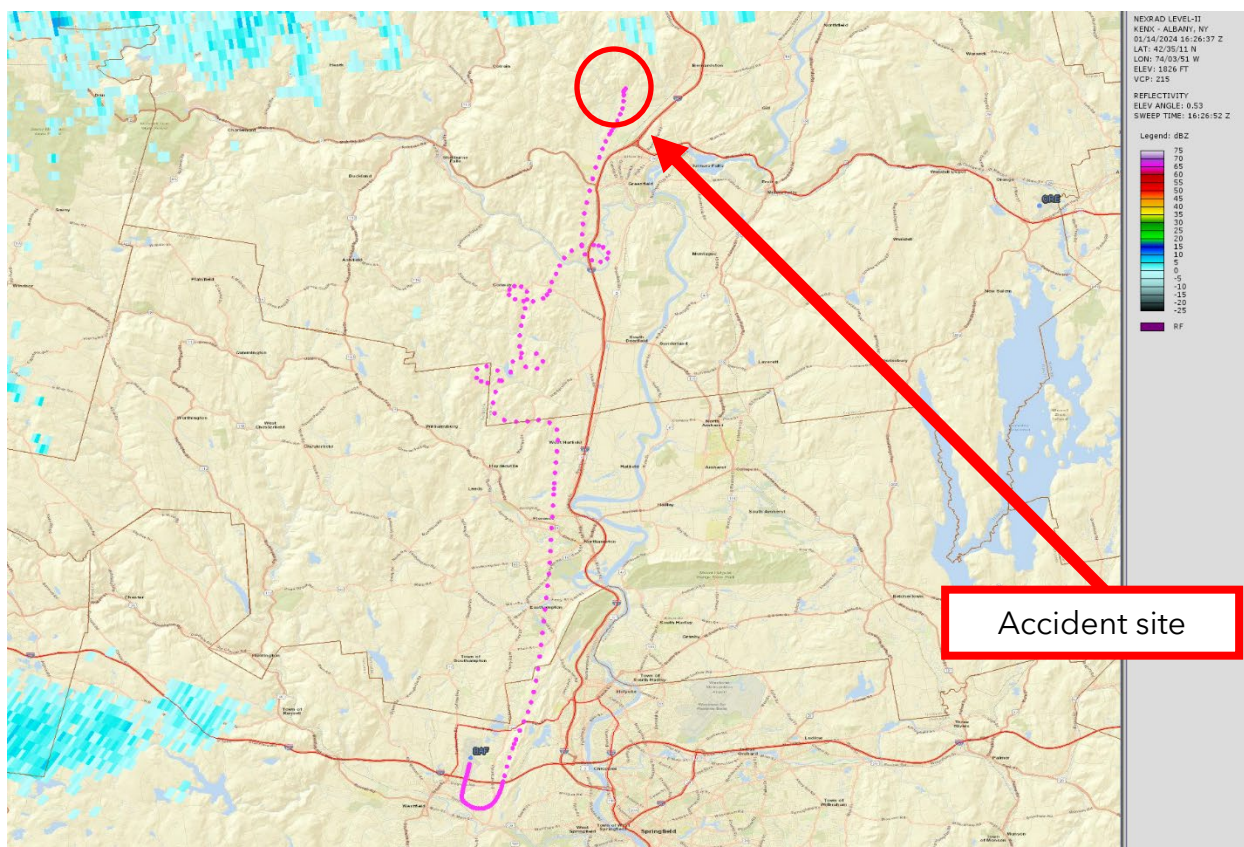


Figure 16. KENX WSR-88D reflectivity for the 0.53° elevation scan initiated at 1126:52 EST with the accident site marked with the red circle. The pink is the airplane flight track.

8.0 Pilot Reports

The longline-disseminated pilot reports²⁵ (PIREPs) distributed into the national airspace system (NAS) within 2 hours of the accident time and within 100 miles of the accident site at altitudes below 18,000 ft are shown here:

BOS UUA /OV BOS040003/TM 1428/FL010/TP C402/RM LLWS +/- 10KTS ON FINAL
BELOW 010

OWD UA /OV OWD/TM 1435/FL035/TP C172/TB LGT-MOD/RM LGT-MOD TURB BLO
035

RUT UA /OV RUT010015/TM 1452/FL090/TP C402/SK TOP070/TA M19/IC TRACE-LGT
CLR 090

BVY UA /OV BVY/TM 1458/FL005/TP P28R/TB MODERATE CHOP ON FINAL RWY 27

BOS UA /OV BOS150020/TM 1520/FL060/TP A320/TB NEG/IC NEG/RM SMOOTH

²⁵ Only PIREPs with the World Meteorological Organization headers UBNY**, UBCT**, UBRI**, UBVT**, UBNH**, and UBMA** were considered. These do not include pilot reports only broadcast via radio.

DURD ROBUC ARRIVAL RWY22L
BDL UA /OV BDL090025/TM 1522/FL160/TP E170/TB CONS LGT CHOP
BDL UA /OV BDL/TM 1527/FL050/TP E75L/TB MOD CHOP
BDL UA /OV BDL/TM 1528/FL060/TP E75L/TB MOD/RM DURC
POU UA /OV IGN090010/TM 1537/FL120/TP E170/TB INTMT LGT CHOP
SWF UA /OV 20 NM N SWF/TM 1558/FL050/TP C510/TA -9/IC MODERATE RIME
BOS UA /OV BOS180010/TM 1600/FL040/TP C402/TB LGT OCL MOD/RM OCNL
LIGHT TURB 050
ALB UA /OV ALB150010/TM 1601/FL050/TP CRJ7/SK BASES OVC050/RM DURD
BVY UUA /OV BVY/TM 1603/FL005/TP GLF6/WV MDT CHOP AT 500 MSL/TB +/- 10
KTS SHORT FINAL RWY 27
BOS UA /OV BOS130015/TM 1609/FL050/TP E170/TB MOD CHOP/IC NEG/RM MOD
CHOP DURC SFC-050/ SMOOTH ABOVE
BOS UA /OV BOS270016/TM 1618/FL050/TP PC12/TB LGT-MOD/RM LGT TO MOD
TURB SFC 070
MSV UA /OV DNY100040/TM 1635/FL140/TP DA62/TB LGT-MOD 140-130
BDR UA /OV BDR270004/TM 1637/FL050/TP B712/SK OVC050/TB LGT
BDL UA /OV BDL180020/TM 1638/FL083/TP A319/SK BASES 042 TOPS 083
BOS UA /OV BOS/TM 1647/FL075/TP E75S/TB LGT-MOD CHOP/RM LGT TO MOD
CHOP DURC SFC - 075/ TOPS 075
1P1 UA /OV RUT090057/TM 1700/FL100/TP C402/TA M18/TB LGT-MOD/IC NEG
MHT UUA /OV KMHT/TM 1700/FL020/TP E145/TB LT CHOP/RM +/-10 KTS 020 AND
BLO. DURD RWY 24
ALB UA /OV ALB210015/TM 1705/FL160/TP E75L/TB CONS MOD CHOP 160
CON UA /OV CON27020/TM 1705/FL100/TP C402/TB MOD-SEV
CON UUA /OV CON290030/TM 1705/FL100/TP C402/TB MOD-SEV 100
ALB UA /OV ALB240025/TM 1706/FL060/TP PA34/TB LGT-MOD CHOP
ALB UA /OV ALB210030/TM 1712/FL140/TP E175/TB CONS MOD
SFZ UA /OV PUT/TM 1713/FL140/TP E190/TB NEG CHOP/RM MOSTLY SMOOTH
BDL UA /OV BDL320005/TM 1713/FL050/TP E170/SK BASE 040/TB NEG
LEB UA /OV LEB/TM 1715/FL000/TP E55P/TB LGT CAT BLO 110
PVD UA /OV PVD/TM 1715/FL120/TP E190/TB LGT CHOP
ALB UA /OV ALB210025/TM 1718/FL120/TP CRJ7/SK CONS MOD CHOP 160-120
ALB UA /OV KALB/TM 1719/FLDURC/TP CRJ7/SK BASE BKN040
HVN UA /OV MAD/TM 1719/FL130/TP E145/TB LGT CHOP
BVY UUA /OV BVY/TM 1720/FL005/TP P28R/WV MODERATE CHOP 500 AGL/TB +/-

10 KTS SHORT FINAL RWY 27
 HFD UA /OV HFD/TM 1721/FL150/TP E545/TB MOD/RM POCKETS OF MODERATE
 BAF UA /OV CTR290010/TM 1723/FL130/TP B737/TB LGT 190-130
 BDL UA /OV BDL/TM 1730/FL010/TP B737/TB LGT CHOP 010/RM DURD RY24
 BDL UA /OV BDL255020/TM 1731/FL140/TP E190/TB CONS LGT-MOD
 JPX UA /OV HTO360015/TM 1736/FL090/TP PC12/TA M14/TB MOD/IC LGT RIME/RM
 DURD
 POU UUA /OV IGN280010/TM 1737/FL150/TP PC12/TB SEV CAT 150
 BDL UA /OV HFD340010/TM 1740/FL030/TP PA72/TB CONST LGT/RM DURD 050-030
 ALB UA /OV KALB/TM 1741/FLDURGD/TP CRJ9/SK TOP 120 BASE 020/IC NEG
 BDL UA /OV BDL180010/TM 1746/FL078/TP A320/SK TOP078/TB LGT 040-070/RM
 DURC
 POU UA /OV IGN300010/TM 1746/FL130/TP F900/TB MOD 130
 PWM UA /OV CDOGG/TM 1749/FL110/TP CRJ9/TB MOD 130-110/RM DURD CDOGG
 ARVL
 BDL UA /OV HFD180005/TM 1751/FL060/TP PC12 /TB LGT OCSNL MOD /IC NEG
 BOS UA /OV BOS135025/TM 1756/FL080/TP E75S/TB OCNL LGT CHOP 080-050
 DURD
 HPN UA /OV HPN020008/TM 1758/FL040/TP F900/TB MOD
 EEN UA /OV EEN/TM 1802/FL050/TP GLF4/TB LGT-MOD/RM DURD 080-060
 BDR UA /OV BDR270010/TM 1802/FL160/TP A319/TB MOD/RM DURC 130-160
 BDL UA /OV MAD/TM 1805/FL110/TP CRJ7/WX IMC/TB MOD
 BDL UA /OV ORH240010/TM 1807/FL050/TP CL60/TB MOD
 ALB UA /OV ALB/TM 1813/FL120/TP CL30/TA M38/TB MOD CHOP 120/IC LGT RIME
 120
 SFZ UA /OV PUT050020/TM 1816/FL160/TP E75S/TB LGT-MOD CHOP
 BED UUA /OV BED/TM 1825/FL010/TP B737/RM LLWS +-10 BELOW 010 LANDING
 RWY29

9.0 Significant Meteorological Information

There was no convective Significant Meteorological Information (SIGMET) advisory valid for the accident site at the accident time. There was a non-convective SIGMET valid for the accident site at the accident time (figure 17). SIGMET Uniform 2 was issued at 1026 EST and valid through 1426 EST for occasional severe turbulence between 3,000 ft and 16,000 ft due to strong low-level winds:

WSUS01 KPCI 141526
 BOSU WS 141526
 SIGMET UNIFORM 2 VALID UNTIL 141926
 SIGMET
 VT MA CT NY NJ PA WV MD DC DE VA AND CSTL WTRS
 FROM MSS TO 30ENE MPV TO SIE TO 40W CSN TO 30WSW SYR TO MSS
**OCNL SEV TURB BTN 030 AND 160. DUE TO STG LOW LVL WND. RPTD BY
 ACFT. CONDS CONTG BYD 1926Z.**

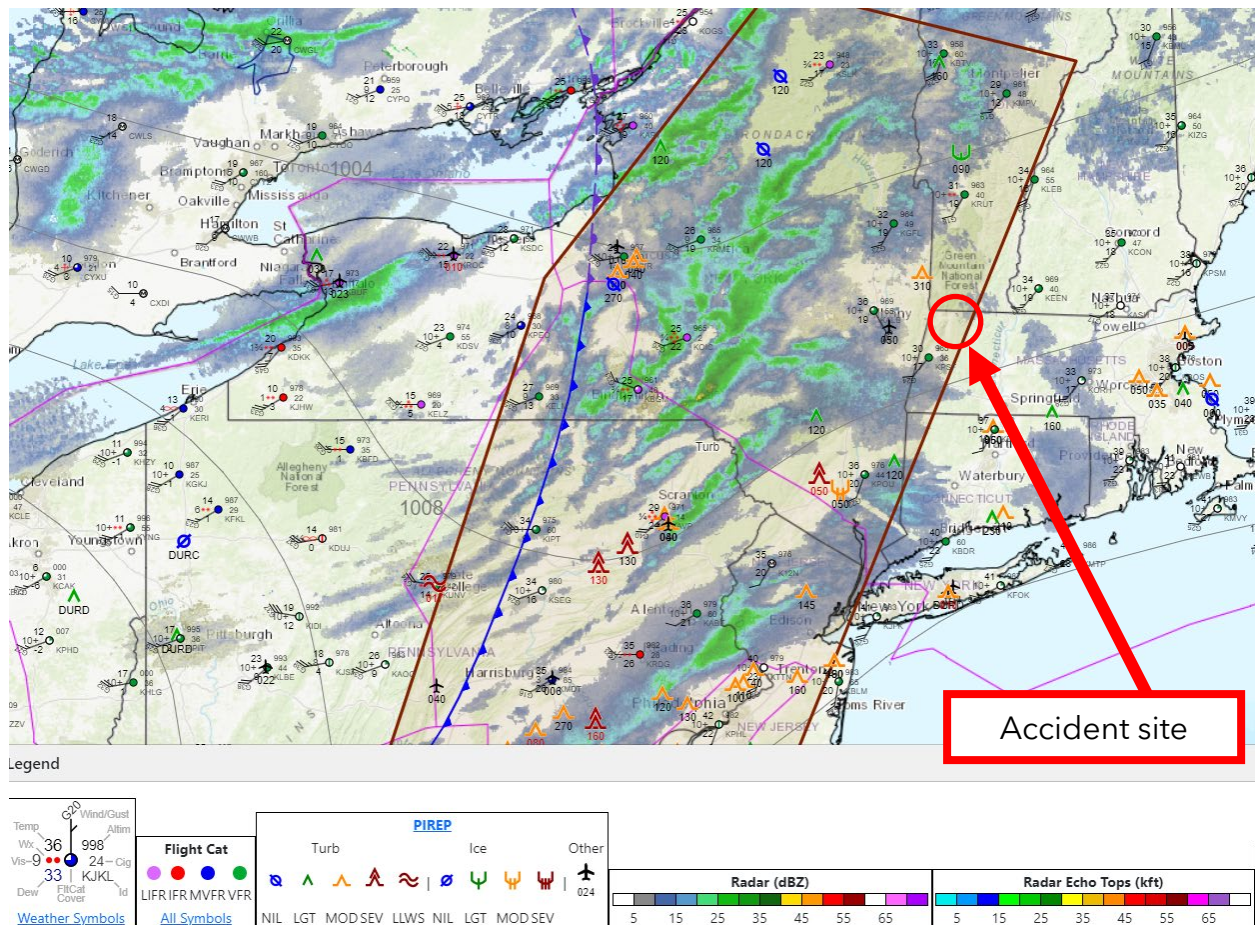


Figure 17. SIGMET Uniform 2 valid at the accident time with AWC observation page valid from 1130 EST.

10.0 Center Weather Service Advisories

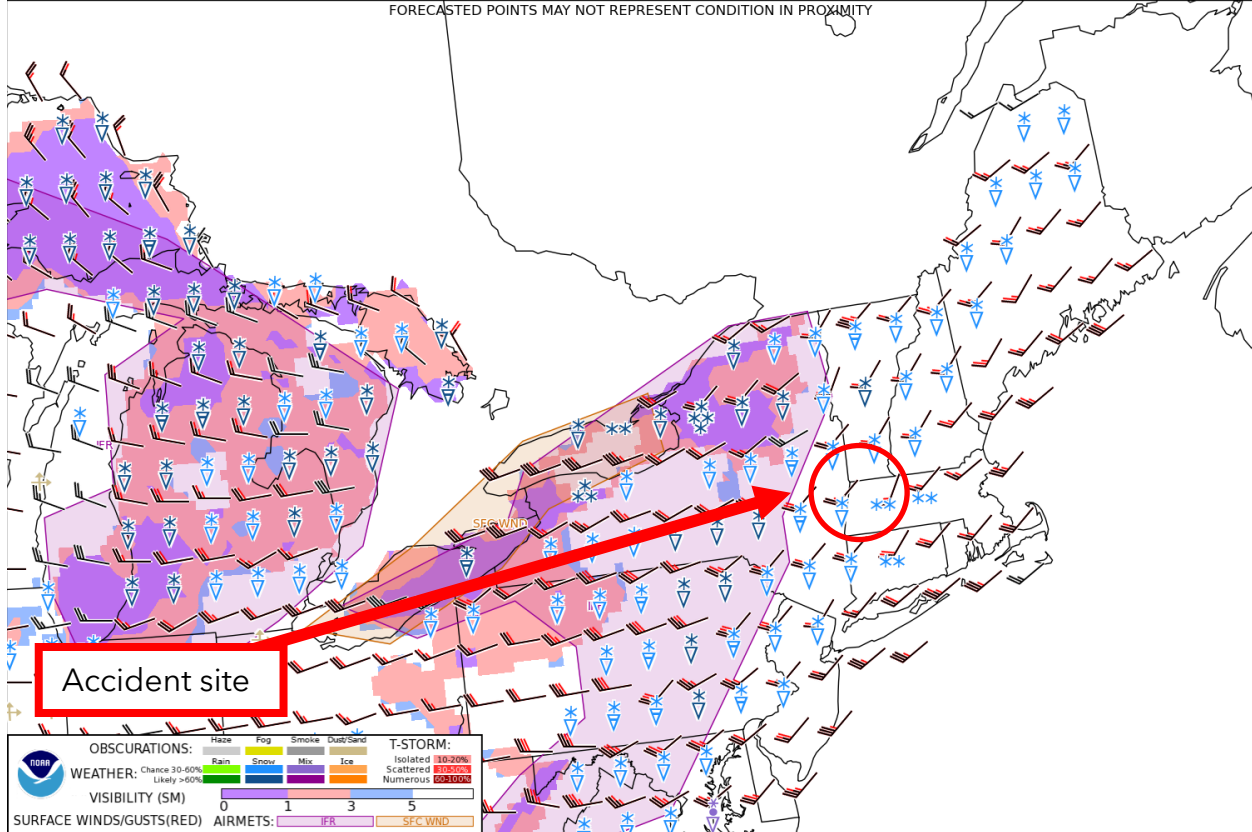
The Boston (ZBW) Air Route Traffic Control Center (ARTCC) Center Weather Service Unit (CWSU) was responsible for the accident region. There was no Center Weather Advisory (CWA) valid for the accident site at the accident time.

11.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products issued by the AWC around 0800 EST and valid at 1000 EST are shown in figures 18 and 19 (additional GFA forecast products produced after 0800 EST were not available due to AWC archiving constraints). The GFA surface forecasts applicable at 1000 EST for the accident site indicated VFR conditions with a chance (between 30 and 60 percent) of light snow showers and a southwest wind of 20 knots with gusts to 25 knots. The GFA cloud forecast applicable to the accident site for 1000 EST indicated overcast cloud cover at the accident site with cloud bases around 5,000 ft and cloud tops to 14,000 ft. Graphical AIRMET²⁶ (G-AIRMET) Zulu was valid for 1000 EST for the accident site (figure 19). The only human-generated information reflected in the two GFA products were the G-AIRMETs. G-AIRMET Zulu and Sierra were noted for the 1300 EST GFA surface and cloud forecasts with the snow shower activity forecast further east (figures 20 and 21). G-AIRMETs Sierra, Tango, and Zulu issued at 0945 EST and valid for 1000 and 1300 EST can be found in figures 22 through 26.

²⁶ 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.

FORECASTED POINTS MAY NOT REPRESENT CONDITION IN PROXIMITY



AVIATION WEATHER CENTER (NOAA/NWS/NCEP)

ISSUED AT 1301 UTC SUN 14 JAN 2024

Figure 18. GFA Surface Forecast valid at 1000 EST with forecast issued at 0801 EST.

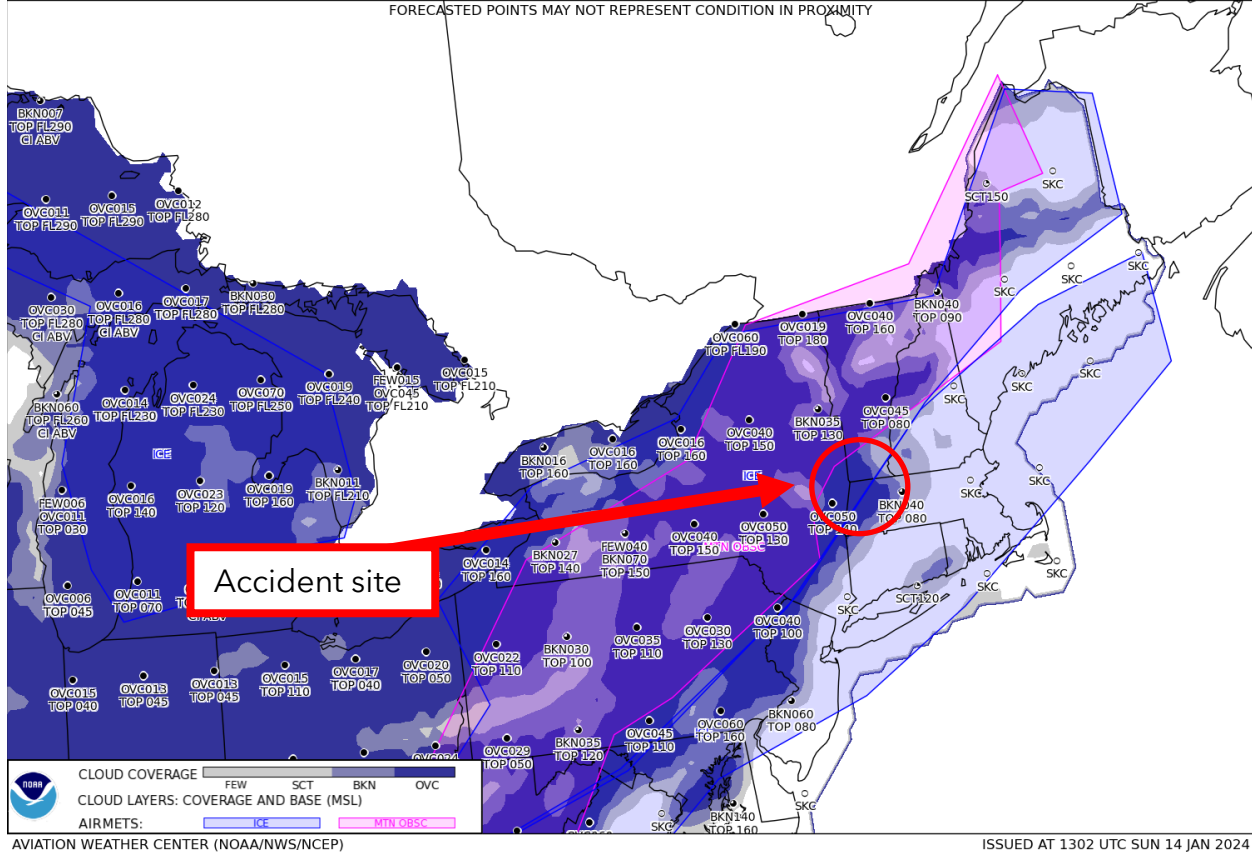
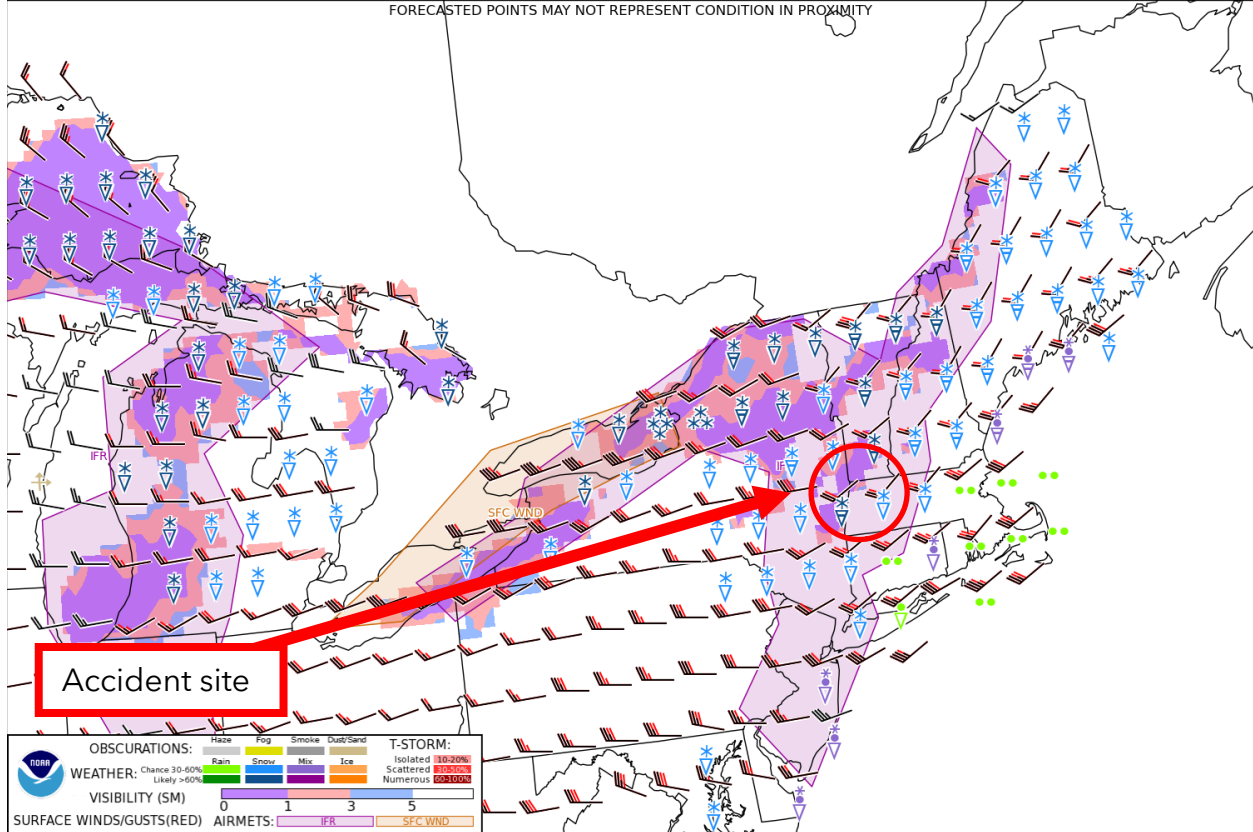


Figure 19. GFA Aviation Clouds Forecast valid at 1000 EST with forecast issued at 0802 EST.

FORECASTED POINTS MAY NOT REPRESENT CONDITION IN PROXIMITY



AVIATION WEATHER CENTER (NOAA/NWS/NCEP)

ISSUED AT 1301 UTC SUN 14 JAN 2024

Figure 20. GFA Surface Forecast valid at 1300 EST with forecast issued at 0801 EST.

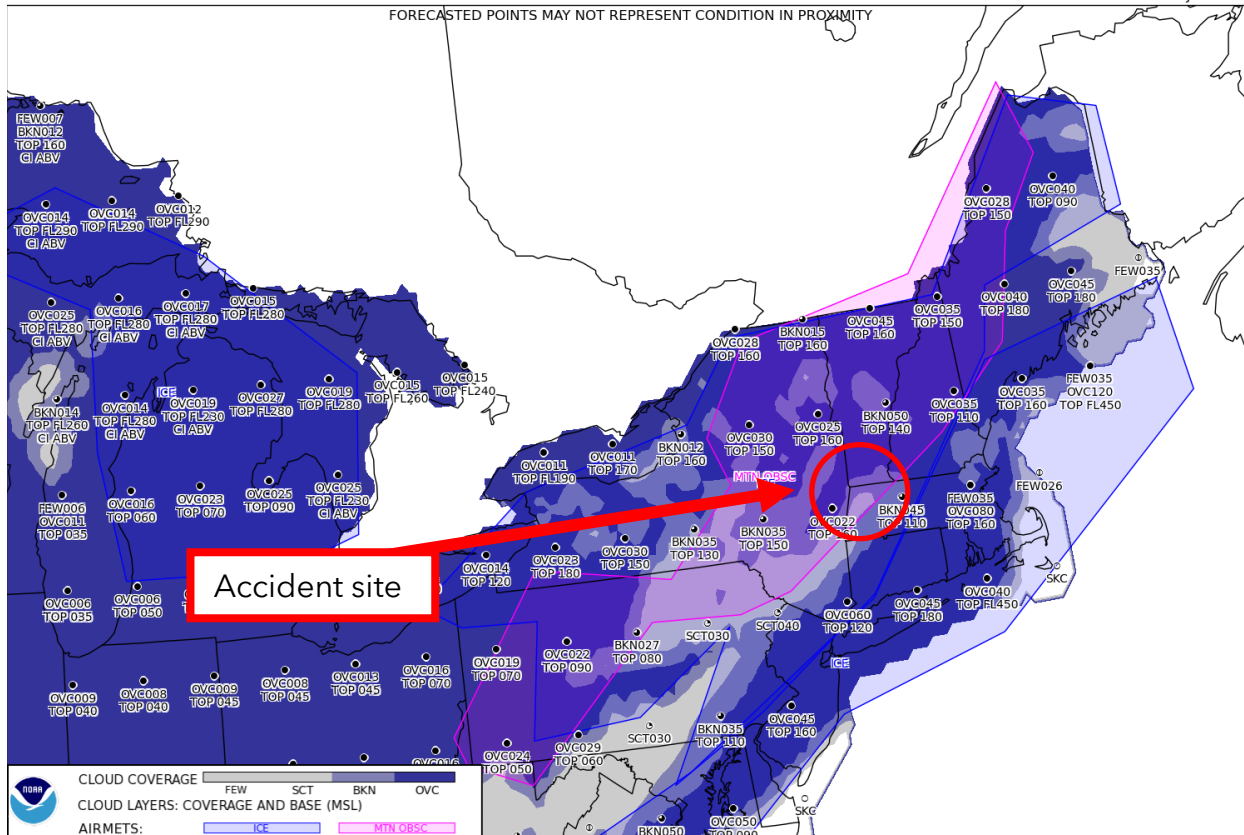


Figure 21. GFA Aviation Clouds Forecast valid at 1300 EST with forecast issued at 0802 EST.

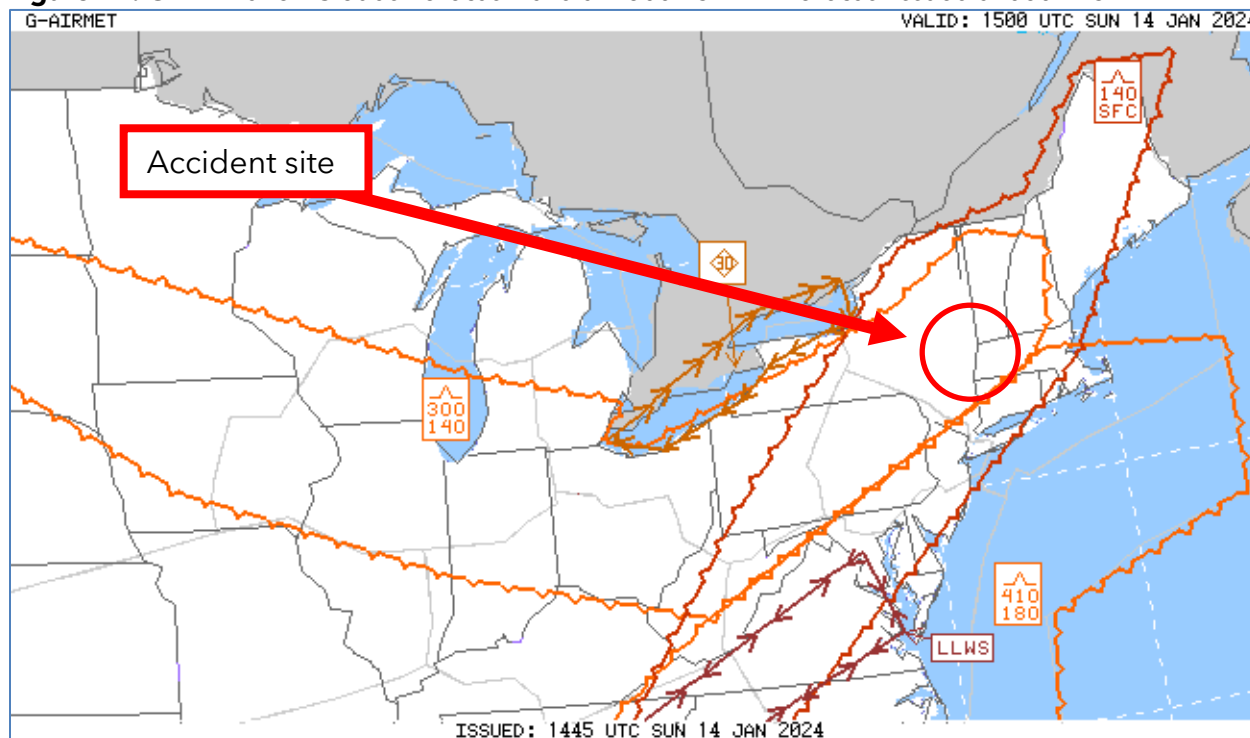


Figure 22. G-AIRMET Tango valid at 1000 EST with forecast issued at 0945 EST.

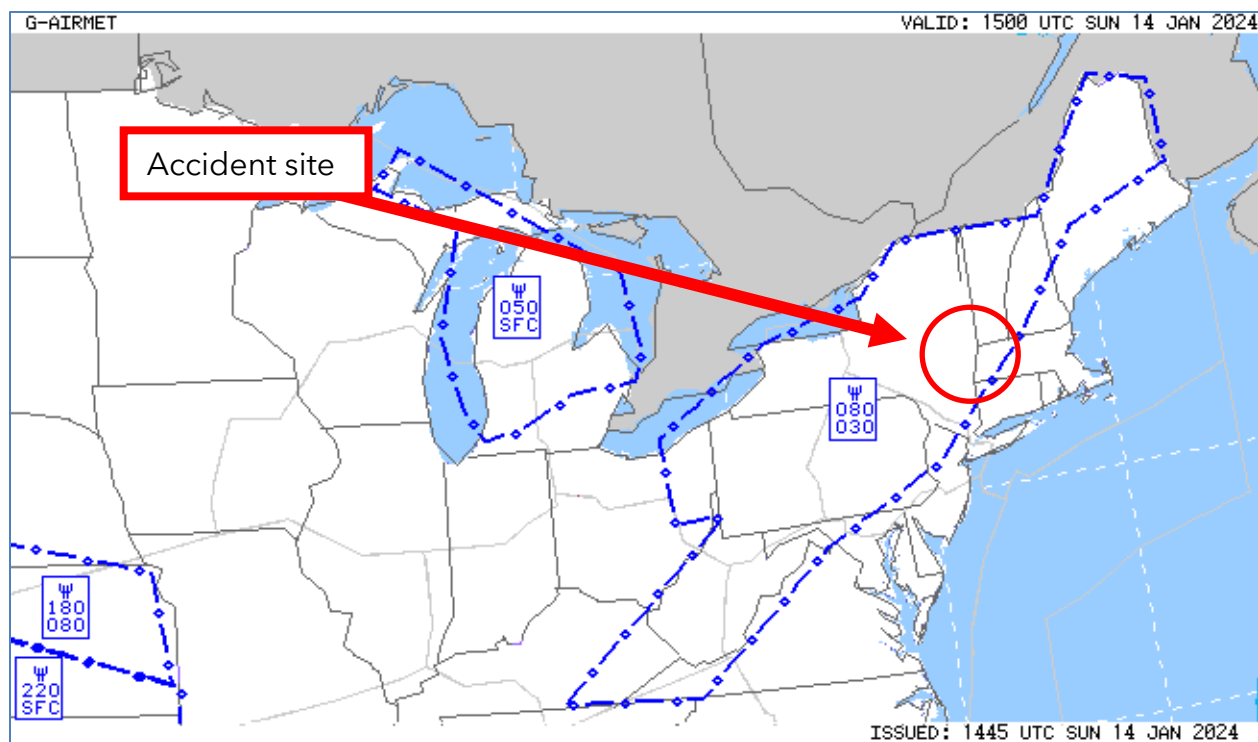


Figure 23. G-AIRMET Zulu valid at 1000 EST with forecast issued at 0945 EST.

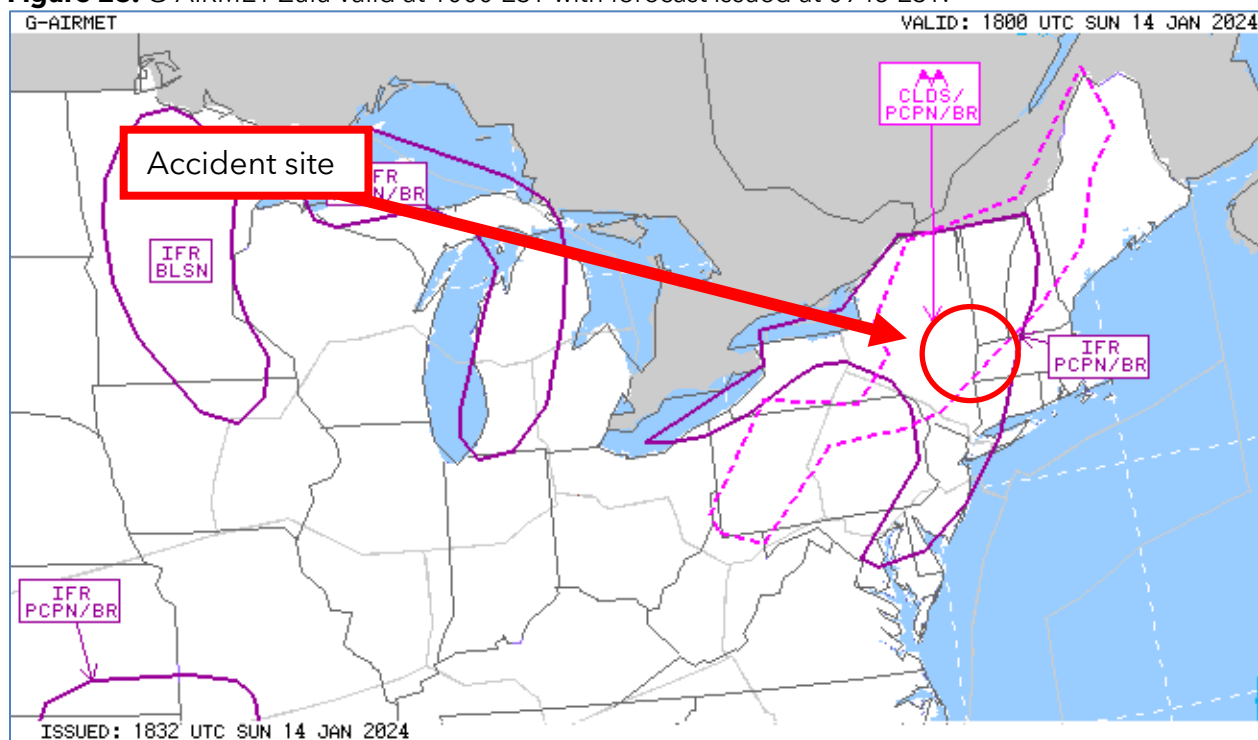


Figure 24. G-AIRMET Sierra valid at 1300 EST with forecast issued at 1332 EST.

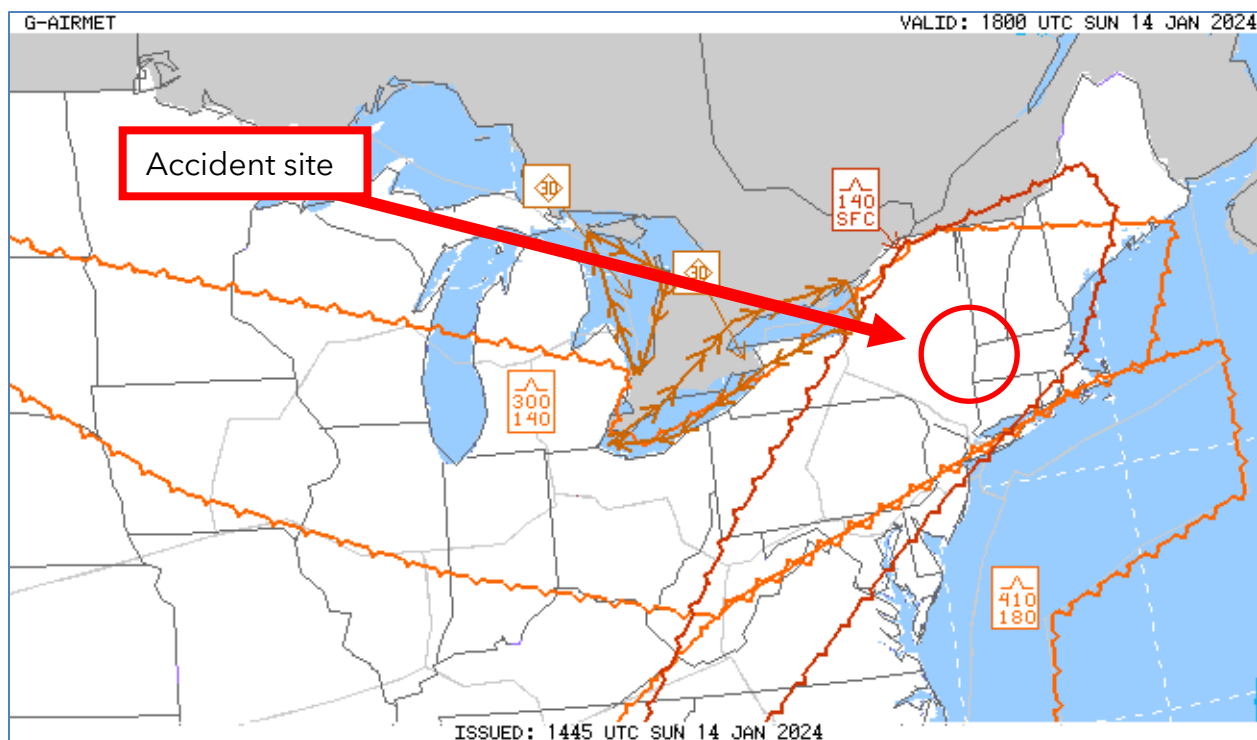


Figure 25. G-AIRMET Tango valid at 1300 EST with forecast issued at 0945 EST.

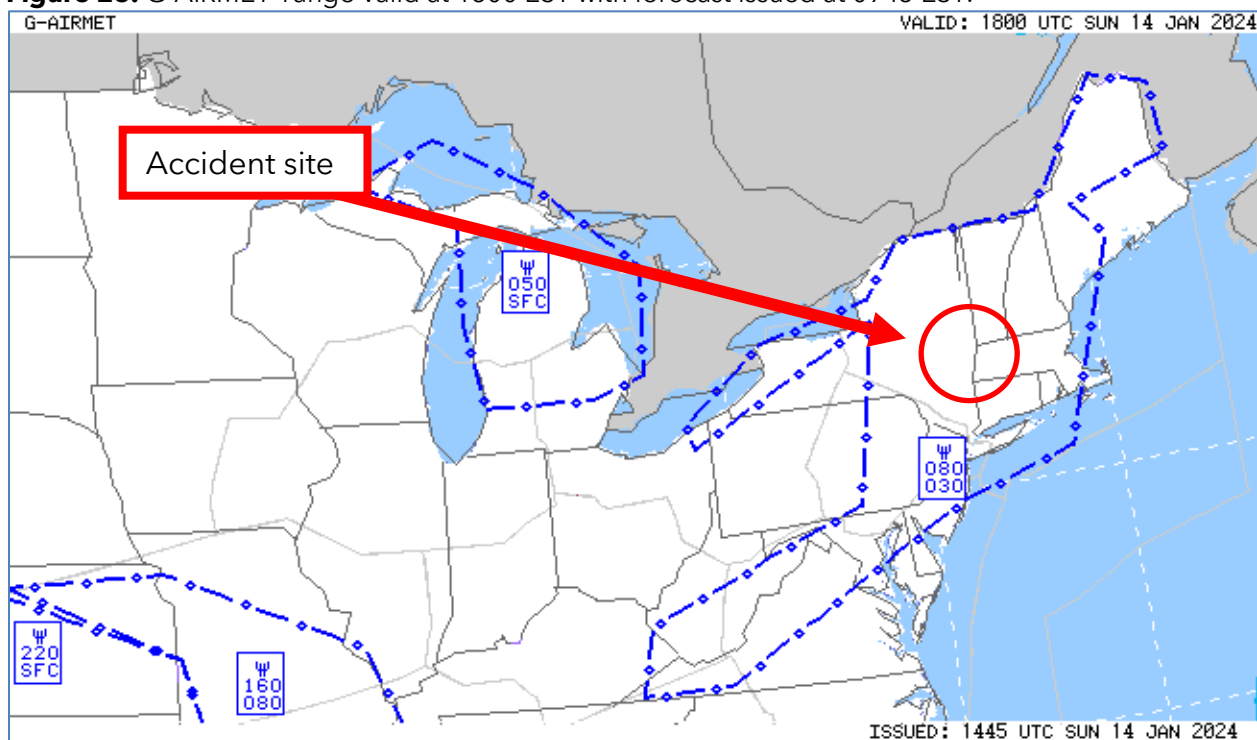


Figure 26. G-AIRMET Zulu valid at 1300 EST with forecast issued at 0945 EST.

12.0 Text Airmen's Meteorological Information

The NWS Aviation Weather Center (AWC) had text Airmen's Meteorological Information (AIRMET) advisory Sierra, Tango, and Zulu valid for the accident site at the accident time. The text AIRMETs were issued between 0945 and 1052 EST and forecast IFR and mountain obscuration conditions due to clouds, precipitation, and mist, moderate turbulence below 14,000 ft, and moderate icing between 3,000 and 8,000 ft:

WAUS41 KPCI 141552 AAA

WA1S

-BOSS WA 141552 AMD

AIRMET SIERRA UPDT 3 FOR IFR AND MTN OBSCN VALID UNTIL 142100

.

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

**FROM 70NW PQI TO 20NNW PQI TO 50ESE BOS TO 70S HTO TO 30ESE BKW
TO 50S HNN TO 20SSE JST TO 30W PSB TO 20NW CLE TO 20ENE YOW TO
70NNE MPV TO 70NW PQI**

CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 21Z THRU 03Z.

.

AIRMET MTN OBSCN...ME NH VT MA NY

**FROM 70NW PQI TO MLT TO CON TO 60S ALB TO SYR TO MSS TO 80S YQB
TO 70NW PQI**

MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 21Z THRU 03Z.

.

AIRMET MTN OBSCN...NY PA WV MD VA

FROM SYR TO 60S ALB TO HAR TO 20SSW PSK TO HNV TO 20SSW HNN TO
JHW TO SYR

MTNS OBSC BY CLDS/PCPN/BR. CONDS ENDG BY 21Z.

.

OTLK VALID 2100-0300Z...IFR ME NH VT MA RI CT NY LO NJ PA OH LE

AND CSTL WTRS...UPDT

BOUNDED BY 70NW PQI-40NNE PQI-20SSE HUL-30SE BGR-50ESE BOS-60S

HTO-30NE ALB-20SSW ERI-30N CLE-20ENE YOW-70NNE MPV-70NW PQI

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

....

WAUS41 KPCI 141526 AAA

WA1T

-BOST WA 141526 AMD

AIRMET TANGO UPDT 3 FOR TURB STG WNDG AND LLWS VALID UNTIL 142100

.

...SEE SIGMET UNIFORM SERIES...UPDT

.

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

**FROM 20ENE HUL TO 150ENE ACK TO 80ESE CYN TO 20NE BKW TO 40S HNN
TO HNN TO CVG TO FWA TO 30SE ECK TO YOW TO 70NNE MPV TO 20ENE HUL
MOD TURB BTN 140 AND FL300. CONDS CONTG BYD 21Z THRU 03Z.**

.

AIRMET TURB...NH MA RI CT NY NJ PA OH WV MD DC DE VA AND CSTL WTRS
FROM 140ENE ACK TO 200SE ACK TO 160SE SIE TO 20NE ECG TO HMV TO 60WSW BKW TO 20NE BKW TO 90ESE CYN TO 140ENE ACK
MOD TURB BTN FL180 AND FL410. CONDS CONTG BYD 21Z THRU 03Z.

AIRMET TURB...ME NH VT MA RI CT NY LO NJ PA WV MD DC DE VA NC SC GA AND CSTL WTRS
FROM 100NE PQI TO 30ESE ENE TO 40E BOS TO 30S BOS TO 20N SBY TO 20WNW CAE TO 40SE GQO TO 20S VXV TO HMV TO 40S HNN TO 20ESE AIR TO 20WSW MSS TO 60NNW MPV TO 90SSW YQB TO 70NW PQI TO 100NE PQI MOD TURB BLW 140. CONDS CONTG BYD 21Z THRU 03Z.

AIRMET STG SFC WND...NY LO PA OH LE
FROM 50SW YOW TO 30NNE SYR TO 20W JHW TO CLE TO 30S DXO TO 70WSW YYZ TO 20NNW YYZ TO 50SW YOW
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS CONTG BYD 21Z THRU 03Z.

AIRMET STG SFC WND...ME NH MA RI CT NY NJ MD DE AND CSTL WTRS
FROM 60S BGR TO 100SSW YSJ TO 140ENE ACK TO 90SSE ACK TO 180ESE SIE TO 90ESE SBY TO 20SE CYN TO 20WSW JFK TO 60S BGR
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS DVLPG 18-21Z. CONDS CONTG BYD 21Z THRU 03Z.

LLWS POTENTIAL...WV MD DC VA NC SC
BOUNDED BY DCA-20N ORF-SPA-GQO-20NNW HMV-DCA
LLWS EXP. CONDS ENDG 15-18Z.

OTLK VALID 2100-0300Z...STG SFC WND...ME NH MA RI CT NY NJ MD DE VA AND CSTL WTRS
BOUNDED BY 50WSW YSJ-200SE ACK-160SE SIE-90ESE SBY-20SE CYN-20WSW JFK-20SSW ENE-50WSW YSJ
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS CONTG THRU 03Z.
....

WAUS41 KPCI 141445
WA1Z
-BOSZ WA 141445
AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 142100

AIRMET ICE...ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DC DE VA AND CSTL WTRS
FROM 70NW PQI TO 40NE PQI TO 60WSW YSJ TO 60SE HTO TO 20ESE CYN TO 30NW SBY TO 20SE PSK TO 40SW PSK TO HMV TO HNN TO 20E AIR TO 40ESE APE TO 20NNW CLE TO 20WSW MSS TO 80NE MPV TO 70NW PQI MOD ICE BTN 030 AND 080. CONDS CONTG BYD 21Z THRU 03Z.

AIRMET ICE...ME NH MA RI CT NY NJ MD DE VA AND CSTL WTRS
FROM 60WSW YSJ TO 110SSW YSJ TO 70SE ACK TO 60SE SBY TO 40SSE DCA TO 20S CYN TO 60SE HTO TO 60WSW YSJ
MOD ICE BTN 040 AND 140. CONDS DVLPG 18-21Z. CONDS CONTG BYD 21Z ENDG 00-03Z.

.
 OTLK VALID 2100-0300Z
 AREA 1...ICE ME NH MA RI CT NY NJ MD DE VA AND CSTL WTRS
 BOUNDED BY 40W YSJ-160E ACK-170SSE HTO-40SE SBY-30NW SBY-20E
 JFK-20NE BOS-ENE-40W YSJ
 MOD ICE BTN 040 AND 140. CONDS ENDG 00-03Z.

.
 AREA 2...ICE OH WV VA
 BOUNDED BY 40NNW CVG-20NW HNN-50SSE EKN-40ESE BKW-20NNE
 HNV-HNN-CVG-40NNW CVG
 MOD ICE BTN 050 AND FL200. CONDS DVLPG AFT 00Z. CONDS CONTG THRU
 03Z.

.
 FRZLVL...RANGING FROM SFC-055 ACRS AREA
 MULT FRZLVL 020-050 BOUNDED BY 70ESE ACK-130ESE ACK-190SE ACK-
 160S ACK-150ESE SIE-70ESE ACK
 SFC ALG 20N HNV-20ESE EMI-40SSE MLT-50SE HUL
 040 ALG 60SSW RIC-100ESE SBY-150SSE HTO-180SE ACK

13.0 Terminal Aerodrome Forecast

There were no NWS Terminal Aerodrome Forecast²⁷ (TAF)s within 25 miles of the accident site.

14.0 National Weather Service Area Forecast Discussion

The NWS weather forecast office in Boston/Norton, Massachusetts, (WFO BOX) was responsible for the public forecast in the region of the accident site. WFO BOX issued the following Area Forecast Discussion (AFD) at 1005 EST. This was the AFD issued closest to the accident time with an aviation section:

FXUS61 KBOX 141505
 AFDBOX

Area Forecast Discussion
 National Weather Service Boston/Norton MA
 1005 AM EST Sun Jan 14 2024

.SYNOPSIS...
 Arctic cold front brings scattered snow showers and a few
 heavier snow squalls this afternoon, clearing and becoming cold
 overnight. Quiet and colder on Monday. Colder weather is on tap

²⁷ 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

for much of next week. There is a chance of snow Tuesday as a storm passes to the south, and possibly again next Friday into Saturday.

&&

.NEAR TERM /UNTIL 7 PM THIS EVENING/...
10 AM update...

The main concern for this afternoon is for snow showers and a few heavy snow squalls resulting in hazardous travel. Rather potent mid level shortwave and cold front moves through this afternoon. Strong cooling aloft will result in rather steep 0-3km lapse rates on the order of 8-9 C/km and sufficient forcing for ascent along the boundary along with weak instability to support locally heavy snow squalls. In fact, some of the CAMs are indicating an organized linear band tied to the strongly forced front. Whether this occurs or we have less organized multiple small bands, at the very least we still expect localized brief heavy snow with near zero visibility and the potential for a quick inch or 2 of snow in the heaviest squalls with hazardous travel. The best chance will be in the interior where temps will be colder and precip starting as snow. Also could have some sort of flash freeze as temps start out above freezing before falling below leading to quick icing. Along and east of I-95, temps will reach low 40s before the showers move in so likely starting as rain showers here then changing to snow as intensity increases, but likely less impact here as roads may just remain wet.

Already, heavier bands of snow showers are moving through central NY and central/E PA where snow squall parameter is 2-4, maxed out near 5 in PA. This environment is forecast to advect over SNE this afternoon. Timing of potential squalls is 1-3 pm in western New Eng and 3-6 pm in the eastern New Eng.

In addition, winds will increase this afternoon and will likely see brief gusts to 40-50 mph along and just behind the cold front.

Previous discussion...

- * Snow showers and a few snow squalls are possible this afternoon with the approach of an Arctic cold front, this could lead to a quick 1-2 inches of snow over a short period of time, leading to difficult travel conditions.

- * Winds with and behind the front gust 35 to 45 mph.

Period of sunshine this morning, but this afternoon features adverse conditions. As mentioned, we will be monitoring the potential for snow squalls this afternoon, with the approach of an Arctic cold front. This is associated with a robust mid-level

shortwave. Have issued an SPS for portions of southern New England, this highlights the potential of snow squalls and strong post frontal wind gusts.

CIPS continues to highlight our region with their snow squall parameter with a 4/5 out of 5 on their scale. With the highest value across western Massachusetts and northwest Connecticut. Do feel that the area with the greatest chance of getting a snow squall will be areas west of I-495 in Massachusetts and generally north of the Mass Pike. What is supporting this dynamic frontal boundary, are a robust mid-level shortwave and surface cold front. Out ahead of the front there are steep lapse rates, the surface to 700mb lapse rates are in the neighborhood of 8-9C/km, along with a few hundred units of SBCAPE... which is highlighted this morning by SPC. A few rumbles of thunder are not out of the question. While not everyone will experience snow, it is possible to have some rain on the warmer side of the front. The problem here, if there is any light rain, behind the front temperatures are going to quickly fall and could lead to icy roadways/surfaces. Nevertheless, areas that receive a quick hitting snow squall are likely to have reduced visibilities, strong wind gusts, and snow accumulations of 1-2 are possible. Given that this all occurs in a matter of 20 to 40 minutes, if the conditions are right this afternoon, we are likely to issue snow squall warnings. This will give those on the roadways a heads and road conditions would quickly become poor and driving would become difficult. 00z CAMs continue to highlight this afternoon 18z-00z for the timing of the front.

Today will remain fairly breezy and then turn gusty as the front passes. Wind Advisory continues for Block Island, Martha's Vineyard, and Nantucket for those persistent gusts. Else where, while we do anticipate strong winds to mix down with the front, we feel that the snow squall warning will cover those enhanced gusts of 40 to 45 mph. Once again, these strong wind gusts will be highlighted in the SPS. If confidence were to increase with the morning update, there could be a short-fused wind advisory.

Highs this afternoon are largely near 40 at the coast, while the coastal plain are in the middle to upper 30s, and elevated terrain in the low 30s. Temperatures will quickly fall late this afternoon behind the front.

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.SHORT TERM /7 PM THIS EVENING THROUGH 6 PM MONDAY/...
Update: 320AM

Tonight:

The front clears the eastern coast and surface high pressure noses in from the southwest. Winds remain breezy overnight, but far less than those gusts earlier this afternoon. WSW wind gust

early in the night 20 to 30 mph, but diminish to less than 15 mph by nights end. It will be a pretty cold night given how mild it has been, so far this winter, but you might be surprised to know our average low for this time of year are the upper teens and low 20s. That is our forecast for lows tonight/Monday morning.

Monday:

Surface high pressure allows for a much needed quiet day along with lighter SW wind less than 10 mph. Looking for mainly clear skies and highs in the upper 20s and low 30s, slightly warmer at the coast in the low/mid 30s.

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.LONG TERM /MONDAY NIGHT THROUGH SATURDAY/...
Key Points...

- * Below normal temperatures expected most of next week
- * Some snow/mix possible Tue-early Wed, but may still miss our region to the south
- * Another storm system may bring more snow around Friday/Saturday

14/00Z guidance suite still has overall agreement on the mid level synoptic pattern this week. That does not mean that agreement is perfect. Still some spread in the timing and amplitude of the longwave trough axis as it moves east in the Monday Night into Wednesday time frame. Subtle differences could have a larger impact on our forecast than it might seem at first glance.

The operational Canadian model not only brought a low pressure closer to the coast than the GFS, but also was at least 6 hours faster moving this low pressure north. Meanwhile, the 13/12Z ECMWF was between these two models for track, but also at least 6 hours slower. These variations also appear in the GEFS ensemble output, with the majority of members having a farther offshore track, and about a 50/50 split with respect to the timing, some slower and some faster than the ensemble mean. The 13/18Z EPS had a similar track, but was considerably slower than most of the 14/00Z guidance. In short, there remains a fair amount of uncertainty with the details which will take more time to resolve.

That said, gaining confidence in a glancing blow from this low pressure Tuesday into Tuesday night. While light snow is more likely with a track well offshore, still a risk for some mixing or just plain rain across portions of SE MA. Water temperatures are still in the lower to mid 40s. Combine that with weaker lift and some daylight hours, and cannot dismiss the possibility of

that mixing.

Weak high pressure should then build into southern New England for Wednesday, and linger into Thursday. There continue to be signals for another low pressure to possibly impact our region sometime Friday into Saturday. Given the time range, it is best to keep an eye on the possibilities, with less focus on the details for the moment. The spread in possible outcomes is just too broad, ranging between a plowable snowfall to a complete miss.

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.AVIATION /15Z SUNDAY THROUGH THURSDAY/...

Forecast Confidence Levels:

Low - less than 30 percent.

Moderate - 30 to 60 percent.

High - greater than 60 percent.

Today... High confidence.

Mainly VFR, ceilings around 4 to 6 thousand feet developing by midday. Scattered snow showers and a few heavier snow squalls this afternoon may bring brief lower conditions to IFR. SW-WSW wind gusts 30-45 kts developing, strongest over the Islands.

Tonight... High confidence.

VFR. Diminishing wind, WSW gust 15-25 kts.

Monday... High confidence.

VFR. SW wind 5-15 kts.

KBOS TAF...High confidence in trends.

VFR. BKN ceilings around 5-6 thousand feet develop by midday with the possibility of a few snow showers or snow squall with brief IFR conditions. SW gusts 25 to 35 kts today, but diminish late this evening into the overnight hours.

KBDL TAF...High confidence in trends.

VFR. BKN ceilings around 5-6 thousand feet develop by midday with the possibility of a few snow showers or snow squall with brief IFR conditions and gust to 40 kts. Otherwise, SW gusts 20 to 30 kts today, diminish late this evening into the overnight hours.

Outlook /Monday Night through Thursday/...

Monday Night: VFR. Slight chance SN.

Tuesday: MVFR/IFR conditions possible. Chance SN, chance FZRA.

Tuesday Night: VFR. Breezy. Chance SN, chance FZRA.

Wednesday: VFR. Breezy.

Wednesday Night: VFR. Windy with local gusts up to 30 kt.

Thursday: VFR. Breezy.

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.MARINE...

Forecaster Confidence Levels:

Low - less than 30 percent.

Medium - 30 to 60 percent.

High - greater than 60 percent.

Through Monday... High confidence.

A Gale Warning remains in effect for much of today with gusty WSW wind 35 to 45 knots, strongest wind gusts over the south coastal waters. A quick moving cold front could produce a brief period of rain/snow showers mid to late afternoon and briefly reduce visibility. Gale force winds ending overnight, but strong enough with combined falling temperatures bring a chance of freezing sea spray to near short waters, with the highest confidence along northeast Massachusetts. High pressure settles in for Monday with lowering seas and lighter SW winds.

Outlook /Monday Night through Thursday/...

Monday Night: Winds less than 25 kt. Seas locally approaching 5 ft. Chance of rain, slight chance of snow.

Tuesday: Winds less than 25 kt. Rain, snow likely, chance of freezing rain. Areas of visibility 1 to 3 nm.

Tuesday Night: Moderate risk for Small Craft Advisory winds with gusts up to 25 kt. Seas locally approaching 5 ft. Chance of rain, chance of snow, chance of freezing rain. Local visibility 1 to 3 nm.

Wednesday: Low risk for Small Craft Advisory winds with gusts up to 25 kt. Areas of seas approaching 5 ft.

Wednesday Night: Moderate risk for Small Craft Advisory winds with gusts up to 30 kt. Seas up to 5 ft.

Thursday: Moderate risk for Small Craft Advisory winds with gusts up to 30 kt. Areas of seas approaching 5 ft.

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.BOX WATCHES/WARNINGS/ADVISORIES...

CT...None.

MA...Wind Advisory until 7 PM EST this evening for MAZ023-024.

RI...Wind Advisory until 7 PM EST this evening for RIZ008.

MARINE...Gale Warning until 7 PM EST this evening for ANZ230-236.

Gale Warning until 1 AM EST Monday for ANZ231>235-237-250-251-
254>256.

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15.0 Winds and Temperature Aloft Forecast

The NWS 0856 EST Winds and Temperature Aloft forecast, which was intended for use between 0900 and 1600 EST and was valid for the closest points to the accident site, are included below:

FBUS31 KWNO 141356

FD1US1

DATA BASED ON 141200Z

VALID 141800Z FOR USE 1400-2100Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
ALB	2327	2438-15	2550-23	2548-32	2476-38	7401-40	741243	741545	751646
BDL	2335	2452-14	2573-21	2496-25	7517-34	7538-38	744546	743146	741345
BOS	2336	2547-13	2476-16	2388-22	7404-33	7431-38	744846	742445	740446

16.0 Icing Potential

The Current Icing Product (CIP) and Forecast Icing Product (FIP²⁸) imagery provided information on expected icing severity as five categories: none, trace, light, moderate, and heavy. The severity estimates are roughly based on the accretion rate of ice on an airplane, and the levels are determined by the time it would take for an airfoil to accrete 1/4 of an inch of ice: trace = 1 hour; light = 15 minutes to 1 hour; moderate = 5 to 15 minutes; severe = less than 5 minutes. Note that these are general values. Users should always consider the icing susceptibility of their airframe and availability of icing protection provided by their aircraft. Different aircraft and different flight configurations (airspeed, angle of attack, etc.) will experience variations in accretion rate.

The images presented in this report show data from National Center for Atmospheric Research (NCAR)'s prototype CIP and FIP algorithms, generated using NCAR's visualization software. These algorithms differ in various ways from the operational CIP and FIP²⁹ that provided data used to generate the publicly available images accessible through the AWC on the accident day. NCAR's prototype CIP and FIP represent the latest research and development conducted by their team of in-flight icing scientists, and have passed internal validation exercises using voice pilot reports (PIREPs) of icing conditions and scientific airborne research observations of in-flight icing (when available). Through coordination with the FAA and NOAA, NCAR provides the prototype CIP and FIP for an independent validation exercise to determine their suitability for operational use. Pending the outcome of that validation, the operational versions are replaced with the prototype versions. The frequency with which the operational versions are updated is dependent upon the research and development advancements in the prototype versions and available resources to support the operational upgrade.

The FIP icing probabilities and icing severity products for the 1-hour forecast valid at 1100 and 1200 EST at 2,000 through 4,000 ft indicated a 10% to 50% probability of trace to light icing above the accident site (attachment 3). The highest probabilities and intensity rates were at 4,000 ft. The CIP products indicated a 10 to

²⁸ 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://arc.aiaa.org/doi/abs/10.2514/6.2014-2070)

²⁹ <https://www.aviationweather.gov/icing/fip>

40% probability of trace to light icing from 2,000 ft through 4,000 ft at 1100 and 1200 EST above the accident site (attachment 3). The CIP indicated an unknown potential probability of Supercooled Large Droplets (SLD)³⁰ above the accident site at 2,000 through 4,000 ft at 1100 and 1200 EST. For more FIP and CIP data and imagery please see attachment 3.

The first responders to the accident site took a picture of the accident airplane wing when they first arrived on scene around 1400 EST (figure 27) and clear icing was visible on the left wing of the accident airframe.



Figure 27. Zoomed in photograph taken by the first responders around 1400 EST of the left wing of the aircraft.

³⁰ [AWC - Icing \(aviationweather.gov\)](http://AWC-icing.aviationweather.gov)

17.0 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.³¹

A search of archived information indicated that the accident pilot did not request weather information from Leidos Flight Service. The accident pilot did have an account with ForeFlight and did enter a route on their ForeFlight account before the accident flight (attachment 4). Neither the flight instructor or the pilot rated passenger viewed weather imagery or requested a weather briefing before the accident flight (attachment 4). It is unknown what weather information, if any, was viewed before or during the accident flight.

18.0 Astronomical Data

The astronomical data obtained³² for the accident site on January 14, 2024, indicated the following:

SUN

Begin civil twilight 0647 EST

Sunrise 0718 EST

Accident time 1125 EST³³

Sun transit 1159 EST

Sunset 1641 EST

End civil twilight 1812 EST

At the time of the accident the Sun was 25.58° above the horizon at an azimuth of 171.13°.

³¹ 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.

³² <https://www.suncalc.org/> and <https://www.mooncalc.org/>

³³ Inserted accident time for reference and context.

E. LIST OF ATTACHMENTS

Attachment 1 - GOES-16 visible imagery animation from 1036 to 1236 EST

Attachment 2 - KENX WSR-88D base reflectivity animation from 1058 to 1142 EST

Attachment 3 - FIP and CIP information valid for the accident site

Attachment 4 - ForeFlight Information

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