

# National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



DCA24LA097

## **METEOROLOGY**

Specialist's Factual Report

July 15, 2024

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## **A. ACCIDENT**

Location: Kelsey, New York  
Date: February 10, 2024  
Time: 1543 eastern standard time (EST)  
2043 coordinated universal time (UTC)  
Airplane: Boeing 777-222ER, N788UA

## **B. METEOROLOGY SPECIALIST**

Paul Suffern  
Senior Meteorologist  
National Transportation Safety Board  
Washington, DC

## **C. DETAILS OF THE INVESTIGATION**

The NTSB's Senior Meteorologist did travel for this investigation. On February 13, 2024, the decision was made to form an air traffic control (ATC) work group in support of this investigation. The ATC work group was formed and embedded with the group for the entire field investigation was a senior meteorologist investigator from the NTSB. On-site investigative work began on March 4, 2024 and concluded on March 8, 2024. The NTSB Operational Factors Group Chair and senior meteorologist investigator traveled to Chicago for interviews of United Airlines personnel on April 15 and 16, 2024. In addition, 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 42.073868° N, longitude 75.339386° W, at an altitude of 20,800 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.<sup>1</sup>

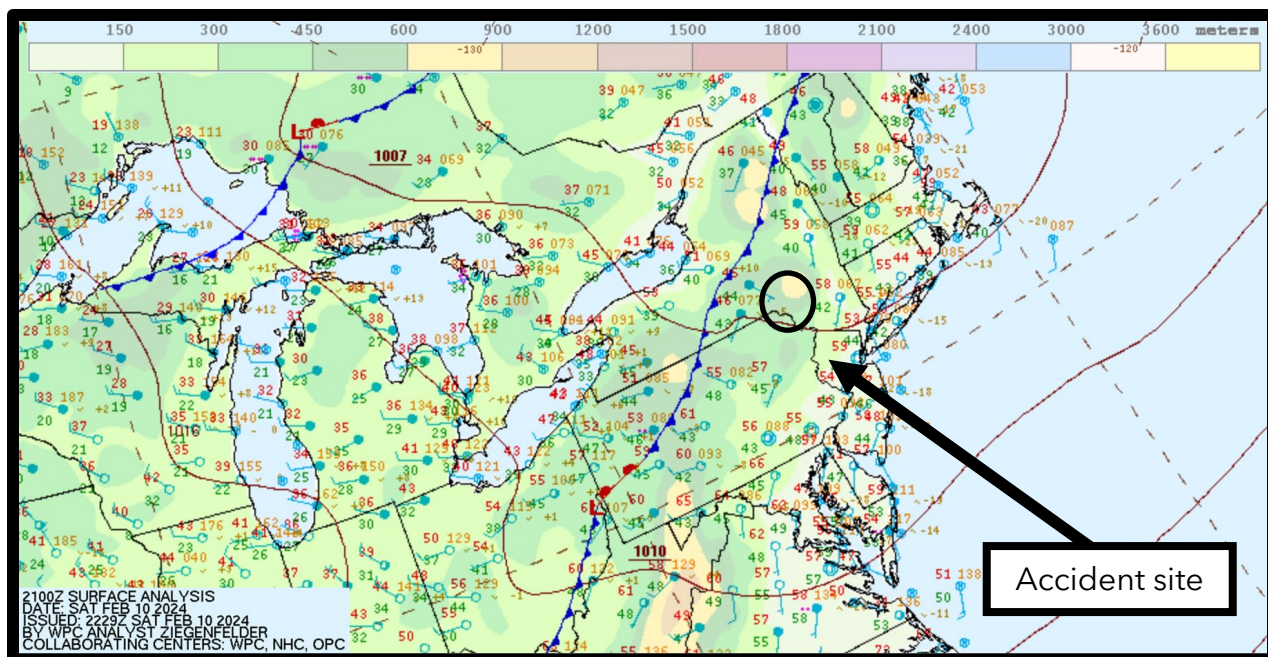
### **1.1 Surface Analysis Chart**

The NWS Surface Analysis Chart centered over the northeastern United States for 1600 EST is provided as figure 1 with the location of the accident site within the black circle. The chart depicted a low-pressure system at 1010-hectopascals (hPa) located in eastern Ohio along a frontal wave that stretched northeastward from the low across central New York and into southeastern Canada. The accident site was located east of the frontal boundary.

The station models closest to the accident site depicted air temperatures of the mid 40s degrees Fahrenheit (°F), dew point temperatures of the low 40s°F, overcast skies, and a surface wind light and variable at 5 knots.

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<sup>1</sup> [FAA-H-8083-28](#)

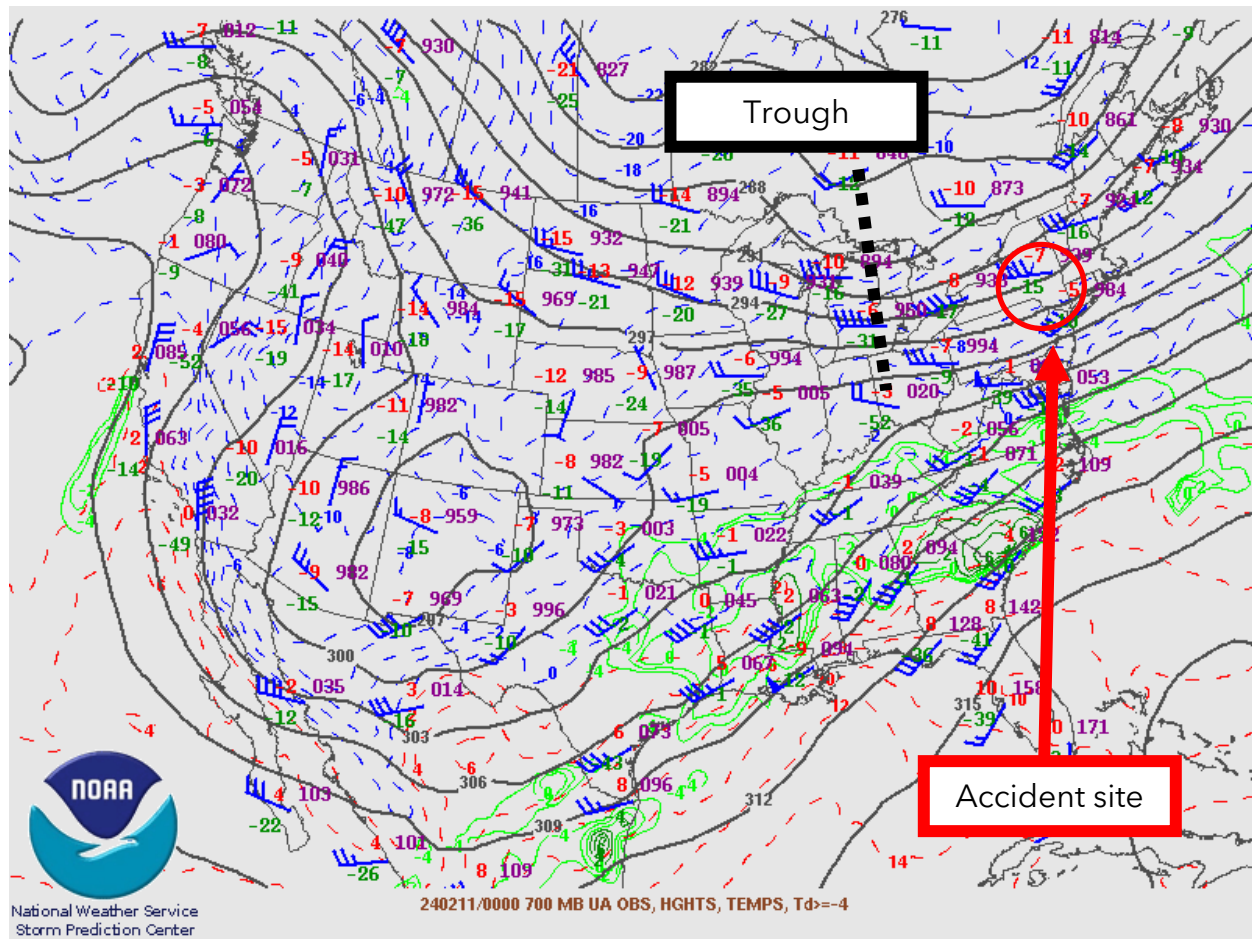


**Figure 1.** NWS Surface Analysis Chart for 1600 EST.

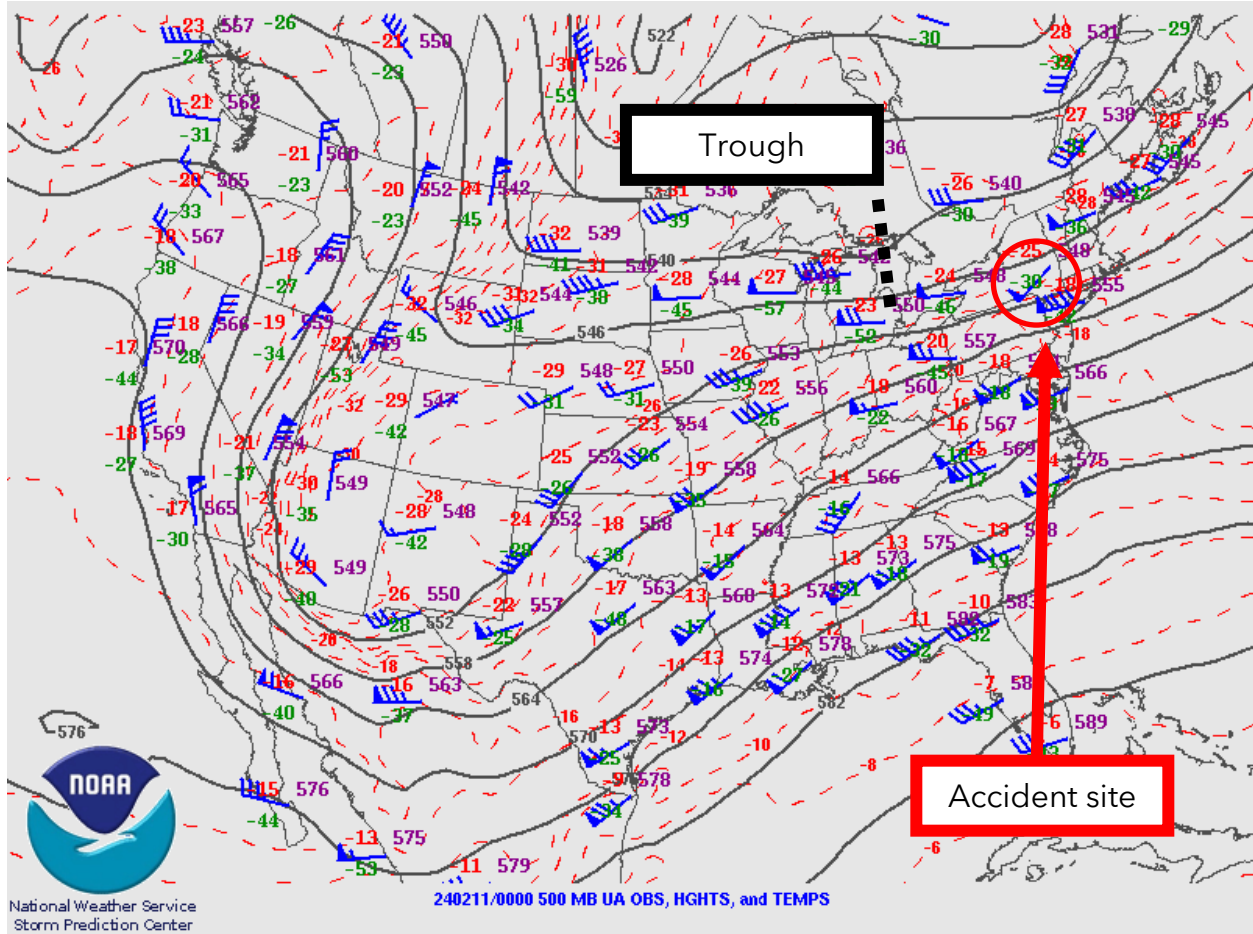
## 1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) issued Constant Pressure Charts for 1900 EST at 700-, 500-, and 300-hPa are presented in figures 2 through 4. The charts indicated a mid-level trough<sup>2</sup> at 700- and 500-hPa (figures 2 and 3) 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 700-hPa constant pressure chart depicted a west wind around 40 knots (figure 2) becoming a southwest 50 knot wind by 500-hPa (~18,000 ft, figure 3). The 300-hPa chart (figure 4) depicted the isotachs, or lines of equal wind speed, at approximately 30,000 ft which identified the jet stream maximum, which stretched from Michigan eastward into New York with winds of 150 knots and was located in the vicinity of the accident site.

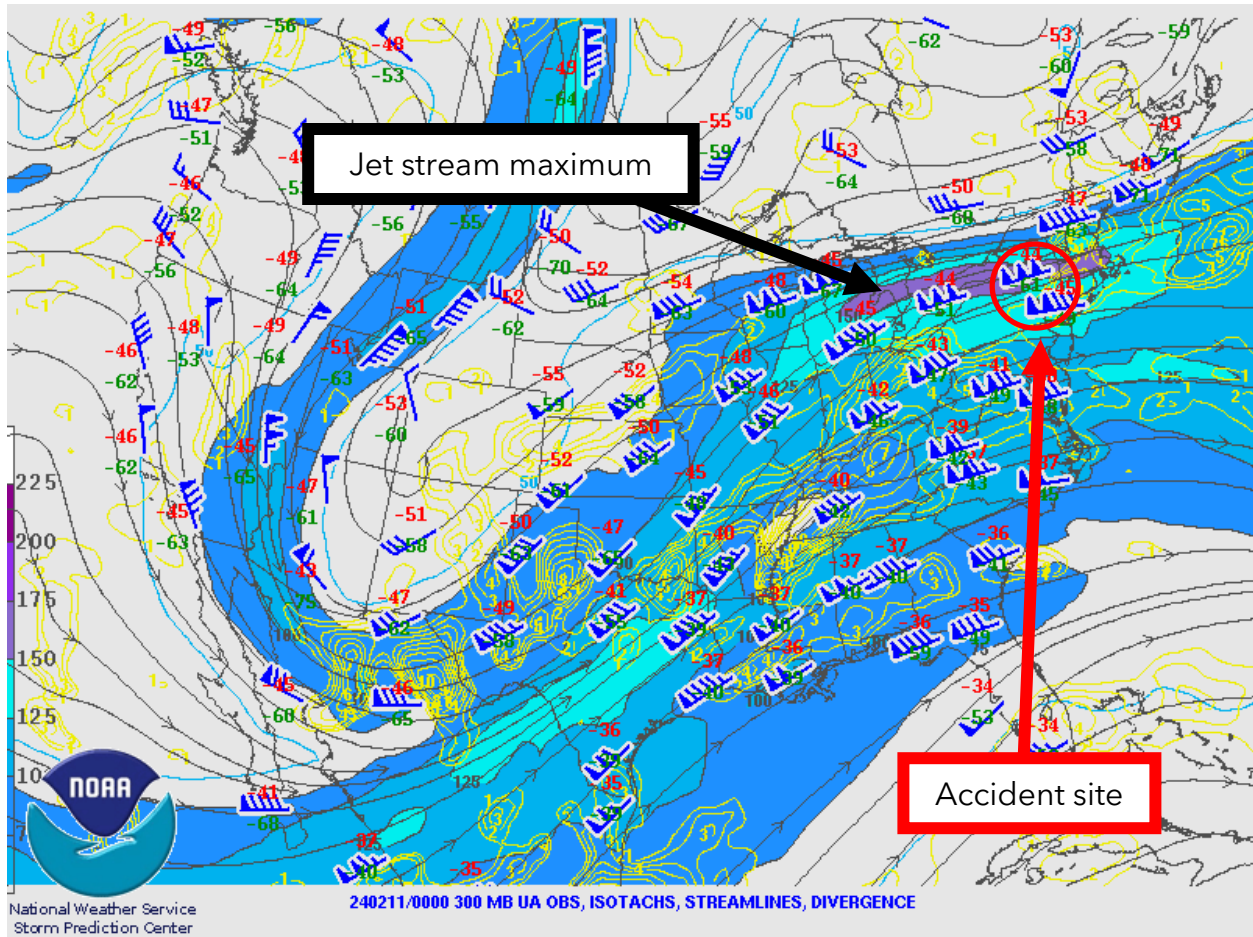
<sup>2</sup> Trough - An elongated area of relatively low atmospheric pressure or heights, and is associated with a wind shift and rising motion.



**Figure 2.** 700-hPa Constant Pressure Chart for 1900 EST.



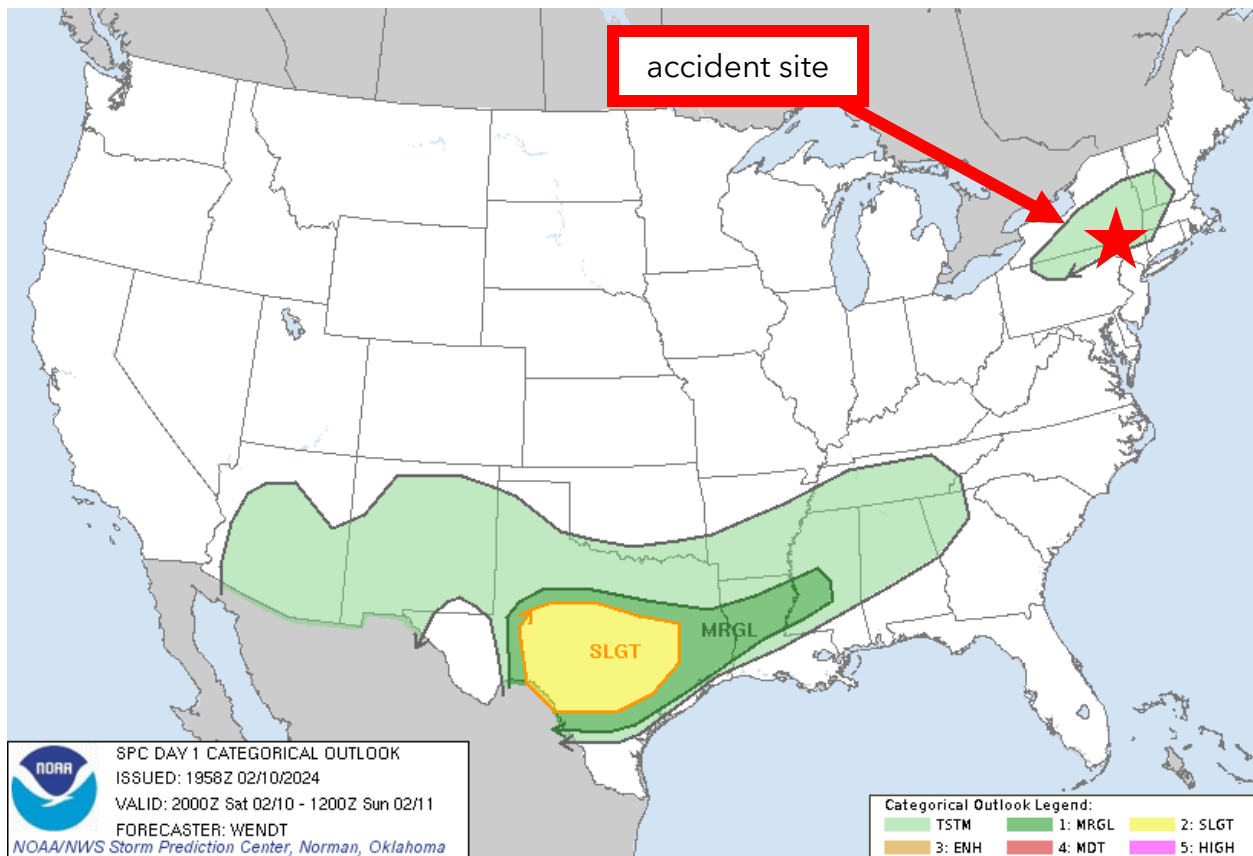
**Figure 3.** 500-hPa Constant Pressure Chart for 1900 EST.



**Figure 4.** 300-hPa Constant Pressure Chart for 1900 EST.

## 2.0 Storm Prediction Center Convective Outlook

SPC Day 1 Convective Outlook issued at 1458 EST (figure 5) with the accident site noted by the red star was located in an area where a chance of general 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. A similar SPC forecast for the accident site was also issued for the 1130 and 0800 EST Day 1 Convective Outlooks.



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

### 3.0 Surface Observations

The area surrounding the accident site was documented using official Aviation Routine Weather Reports (METARs) and Special Reports (SPECIs)<sup>3</sup>. The following observations were taken from standard code and are provided in plain language. A magnetic variation<sup>4</sup> of 12° west was indicated over the area.

<sup>3</sup> 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://www.federalmeteorologicalhandbook.com/)

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

Greater Binghamton Airport (KBGM) had the closest official weather station to the accident site. KBGM had an Automated Surface Observing System (ASOS<sup>5</sup>) and its longline<sup>6</sup> reports were augmented by ATC when the tower was in operation<sup>7</sup>. The KBGM ASOS was located 27 miles east-southeast of the accident site, at an elevation of 1,636 ft, and the following observations surrounding the accident time were issued:<sup>8</sup>

[1353 EST] METAR KBGM 101853Z 20007KT 150V240 10SM FEW028  
SCT050 BKN070 12/07 A2972 RMK AO2 RAB33E50 SLP067 P0000  
T01220067

[1423 EST] SPECI KBGM 101923Z 30010G31KT 2 1/2SM VCTS RA  
FEW026 BKN036 OVC075 08/03 A2976 RMK AO2 PK WND  
31031/1919 RAB14 PRESRR P0000 T00780033

[1426 EST] SPECI KBGM 101926Z 29008G31KT 1 3/4SM +TSRA  
FEW027 BKN043 OVC055 06/03 A2975 RMK AO2 PK WND  
31031/1919 RAB14 TSB25 P0006 T00610028

[1433 EST] SPECI KBGM 101933Z 27007KT 3SM TSRA FEW027 BKN039  
OVC049 06/03 A2975 RMK AO2 PK WND 31031/1919 LTG DSNT E  
RAB14 TSB25 P0017 T00610033

[1450 EST] SPECI KBGM 101950Z 28010KT 5SM RA OVC039 07/04  
A2974 RMK AO2 PK WND 31031/1919 LTG DSNT NE AND E RAB14  
TSB25E47 P0020

**[1453 EST] METAR KBGM 101953Z 28011KT 4SM RA BR OVC041  
07/05 A2974 RMK AO2 PK WND 31031/1919 LTG DSNT NE AND E  
RAB14 TSB25E47 SLP078 P0020 T00720050**

### **ACCIDENT TIME 1543 EST**

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<sup>5</sup> 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.

<sup>6</sup> "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.

<sup>7</sup> ATC hours of operation between 0600 and midnight local time.

<sup>8</sup> 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.

**[1553 EST] METAR KBGM 102053Z 23005KT 10SM BKN046  
OVC080 08/06 A2974 RMK AO2 RAE52 SLP077 P0005 60025  
T00780061 56005**

[1653 EST] METAR KBGM 102153Z 24007KT 10SM BKN045 OVC100  
08/07 A2975 RMK AO2 SLP079 T00830067

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

KBGM weather at 1453 EST, wind from 280° at 11 knots, visibility 4 statute miles, moderate rain, mist, overcast ceiling at 4,100 ft above ground level (agl), temperature of 7° Celsius (C), dew point temperature of 5°C, and an altimeter setting of 29.74 inches of mercury (inHg). Remarks, automated station with a precipitation discriminator, peak wind from 310° at 31 knots at 1419 EST, lightning distant<sup>9</sup> northeast and east, rain began at 1414 EST, thunderstorm began at 1425 and ended at 1447 EST, sea-level pressure 1007.8-hPa, 0.20 inches of precipitation since 1353 EST, temperature 7.2°C, dew point temperature 5.0°C.

KBGM weather at 1553 EST, wind from 230° at 5 knots, visibility 10 statute miles or greater, broken ceiling at 4,600 ft agl, overcast skies at 8,000 ft agl, temperature of 8°C, dew point temperature of 6°C, and an altimeter setting of 29.74 inHg. Remarks, automated station with a precipitation discriminator, rain ended at 1552 EST, sea-level pressure 1007.7-hPa, 0.05 inches of precipitation since 1453 EST, 6-hourly precipitation of 0.25 inches, temperature 7.8°C, dew point temperature 6.1°C, 3-hourly pressure tendency increase of 0.5 hPa.

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<sup>9</sup> Distant indicated that the lightning was beyond 10 miles but less than 30 miles from the center of the airport (or airport location point, [ALP]).

The observations from the KBGM ASOS around the accident time identified MVFR to VFR<sup>10</sup> conditions around the accident time with IFR conditions due to visibility restrictions when the thunderstorm activity went across KBGM between 1353 and 1453 EST. During the period from 1423 through 1453, KBGM reported lightning activity associated with the thunderstorms. In addition, winds gusted as high as 31 knots.

## 4.0 Upper Air Sounding

A High-Resolution Rapid Refresh (HRRR)<sup>11</sup> model sounding was created<sup>12</sup> for the approximate accident site coordinates for 1600 EST. The HRRR sounding was plotted on a standard Skew-T Log P diagram<sup>13</sup> from the surface to 300-hPa (or approximately 30,000 ft) using the RAOB<sup>14</sup> software package and is included as figure 6. The sounding depicted an elevation of 1,476 ft over the grid point with a near surface temperature of 8.9°C, a dew point temperature of 6.6°C, and a relative humidity of 85%. The sounding depicted the lifted condensation level (LCL)<sup>15</sup> at 2,430 ft, the level of free convection (LFC)<sup>16</sup> at 3,058 ft, and the convective condensation level (CCL)<sup>17</sup> at 3,697 ft. The freezing level was located at 5,744 ft. The precipitable water value was 0.66 inches. The tropopause was identified at 38,835 ft.

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<sup>10</sup> 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.

<sup>11</sup> 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.

<sup>12</sup> HRRR sounding was created using NOAA Air Resource Laboratory: [READY Archived Meteorology \(noaa.gov\)](https://ready.noaa.gov/).

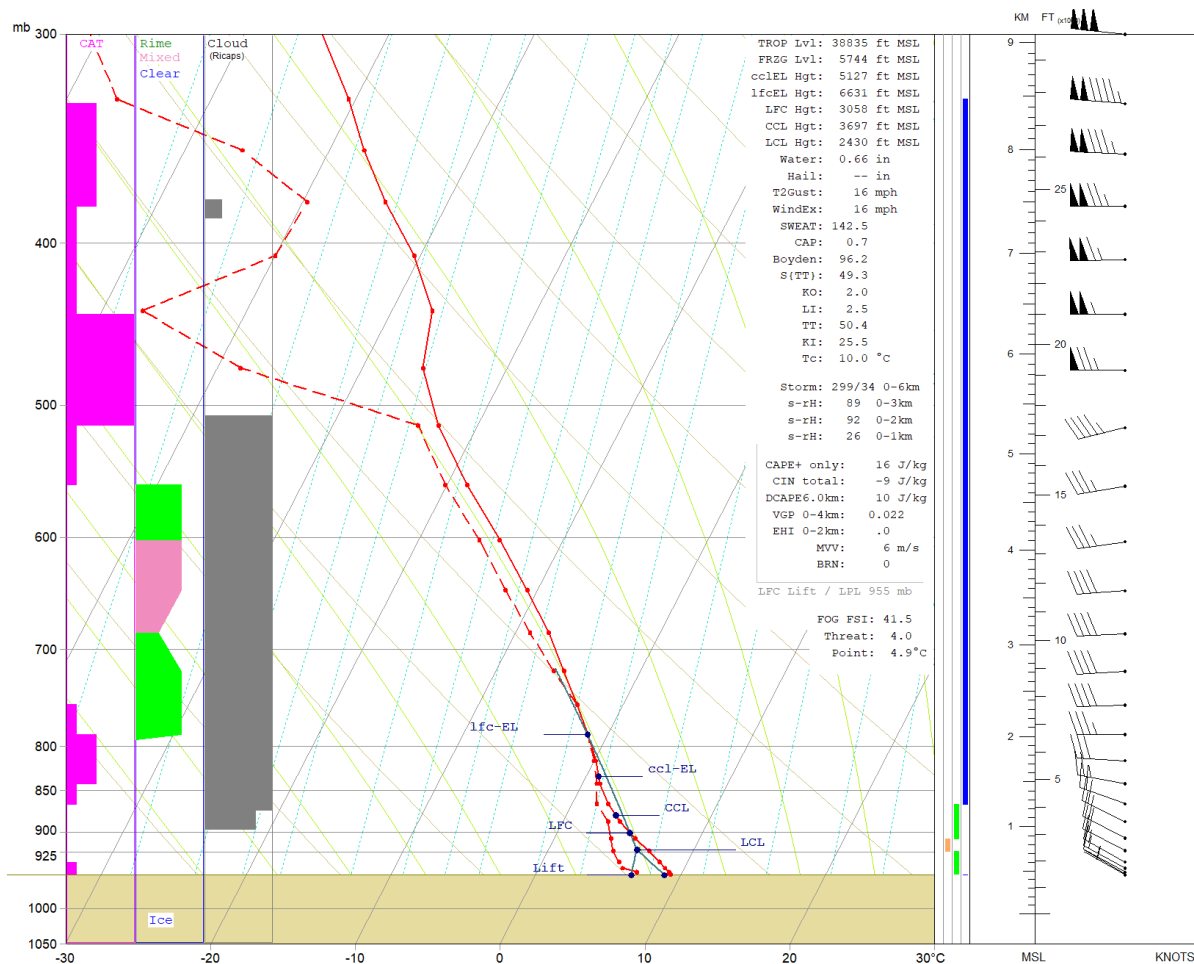
<sup>13</sup> Skew T log P diagram - is a standard meteorological plot using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

<sup>14</sup> RAOB - (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Esonde Research Services, The Villages, Florida.

<sup>15</sup> LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

<sup>16</sup> 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.

<sup>17</sup> 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 6.** 1600 EST HRRR sounding.

The 1600 EST HRRR sounding indicated a conditionally unstable atmosphere from the surface through 4,000 ft, then a stable atmosphere above 4,000 ft. There was a Convective Available Potential Energy (CAPE)<sup>18</sup> of 16 Joules/kilogram (J/kg), with the maximum vertical velocity (MVV) for this atmosphere was calculated as 6 meters/second (about 1,181 ft per minute).<sup>19</sup> Outside of cumulonimbus clouds, RAOB indicated cloud cover in two layers between 3,000 ft and 18,000 ft and a second cloud layer around 25,000 ft. Moderate rime and mixed icing was indicated by RAOB between 6,500 and 15,000 ft.

<sup>18</sup> Convective Available Potential Energy (CAPE) - CAPE is a measure of the amount of energy available for convection and is directly related to the maximum potential vertical speed within an updraft.

<sup>19</sup> MVV is not usually considered a realistic estimate for maximum vertical velocity in a storm. Anecdotes suggest considering a value of MVV/2, however it is not well understood when or where such a half-value should be applied.

The 1600 EST HRRR sounding wind profile indicated a near-surface wind from 301° at 7 knots with the wind becoming westerly by 10,000 ft. The wind speed increased to 40 knots by 10,000 ft and to 150 knots by 30,000 ft. The westerly wind increased from 45 knots near 17,000 ft to 75 knots by 19,000 ft, and to 105 knots by 21,000 ft. RAOB indicated moderate or greater clear air turbulence (CAT) between 18,000 ft and 21,000 ft. At the accident aircraft's altitude around the time of the accident<sup>20</sup> (~21,000 ft) the temperature was -27.2°C, the dew point temperature was -47.2°C, and the wind was from 270° at 110 knots.

## 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 1200 EST through 2000 EST and reviewed, and the closest images to the time of the accident were documented.

Figure 7 presents the GOES-16 visible image at 1546 EST at 3X magnification with the accident site highlighted with a red square. There was cloud cover indicated above the accident site with the cloud cover moving from west to east (attachment 1). The visible imagery indicated a transverse banding<sup>21</sup> in the cloud cover including above the accident site. Figure 8 presents the GOES-16 infrared image at 1546 EST at 8X 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 above and to the northeast through south of the accident site. The brightness temperature of 251 Kelvin<sup>22</sup> would have been near 17,000 ft based on the vertical temperature profile provided by the 1600 EST HRRR sounding. A lower brightness temperature of 245 Kelvin was noted in the higher altitude portions of the transverse banding near the accident site and would have corresponded to 23,000 ft based on the vertical temperature profile from the 1600 EST HRRR sounding. It should be noted these figures have not been corrected for any parallax error.

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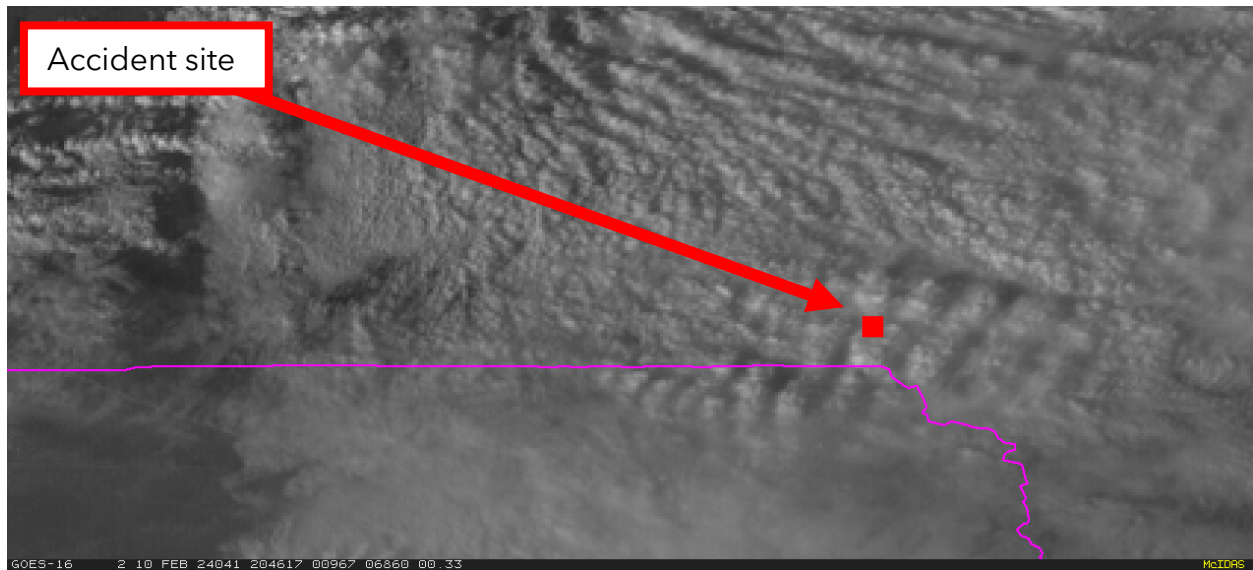
<sup>20</sup> See ATC and track data located in the docket of this investigation.

<sup>21</sup> Transverse Bands - Bands of clouds oriented perpendicular to the flow in which they are embedded. They often are seen best on satellite photographs. When observed at high levels (i.e., in cirrus formations), they may indicate severe or extreme turbulence.

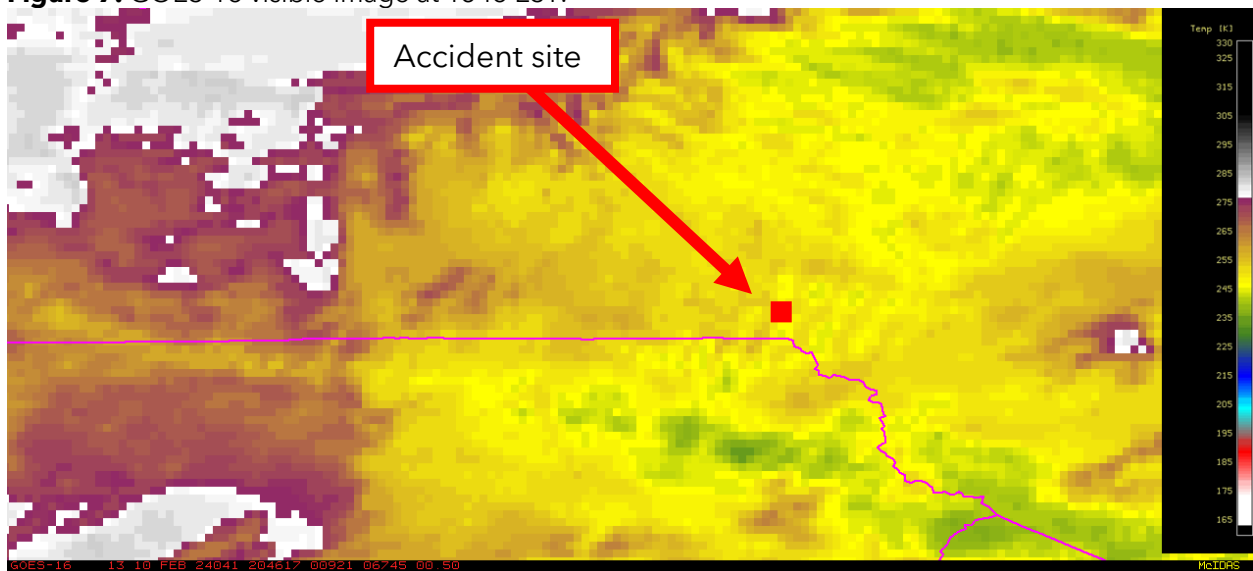
[https://www.weather.gov/source/zhu/ZHU\\_Training\\_Page/Miscellaneous/gravity\\_wave/gravity\\_wave.html](https://www.weather.gov/source/zhu/ZHU_Training_Page/Miscellaneous/gravity_wave/gravity_wave.html)

<sup>22</sup> around -22°C

A review of the GOES-16 satellite imagery with Geostationary Lightning Mapper indicated lightning activity in the vicinity of the band of convective clouds moving across New York during the period.



**Figure 7.** GOES-16 visible image at 1546 EST.

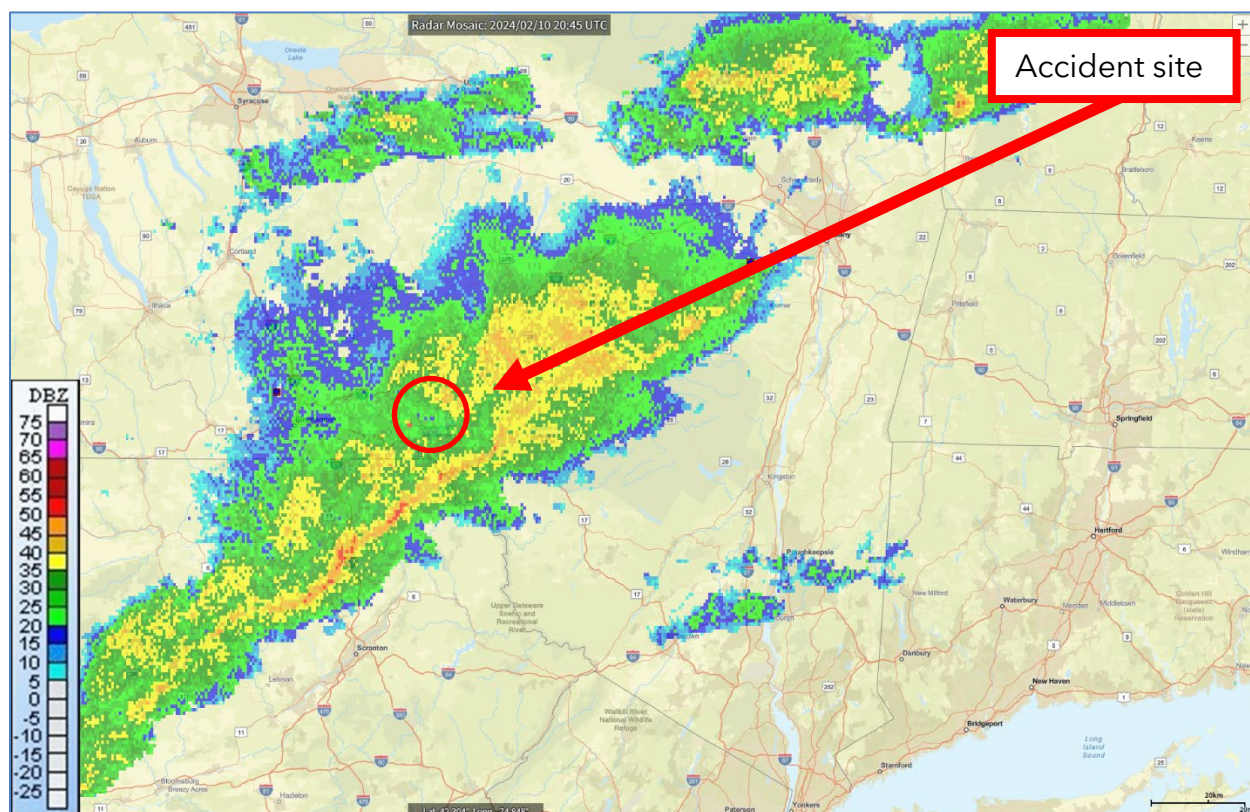


**Figure 8.** GOES-16 infrared image at 1546 EST.

## 6.0 National Radar Imagery

A regional view of the NWS National Reflectivity Mosaic is included as figure 9 for 1545 EST with the approximate location of the accident site marked by a red

circle. The mosaic imagery depicted echoes of 25 to 40 dBZ<sup>23</sup> above the accident site.



**Figure 9.** National Reflectivity Mosaic for 1545 EST.

## 7.0 Weather Surveillance Radar Imagery

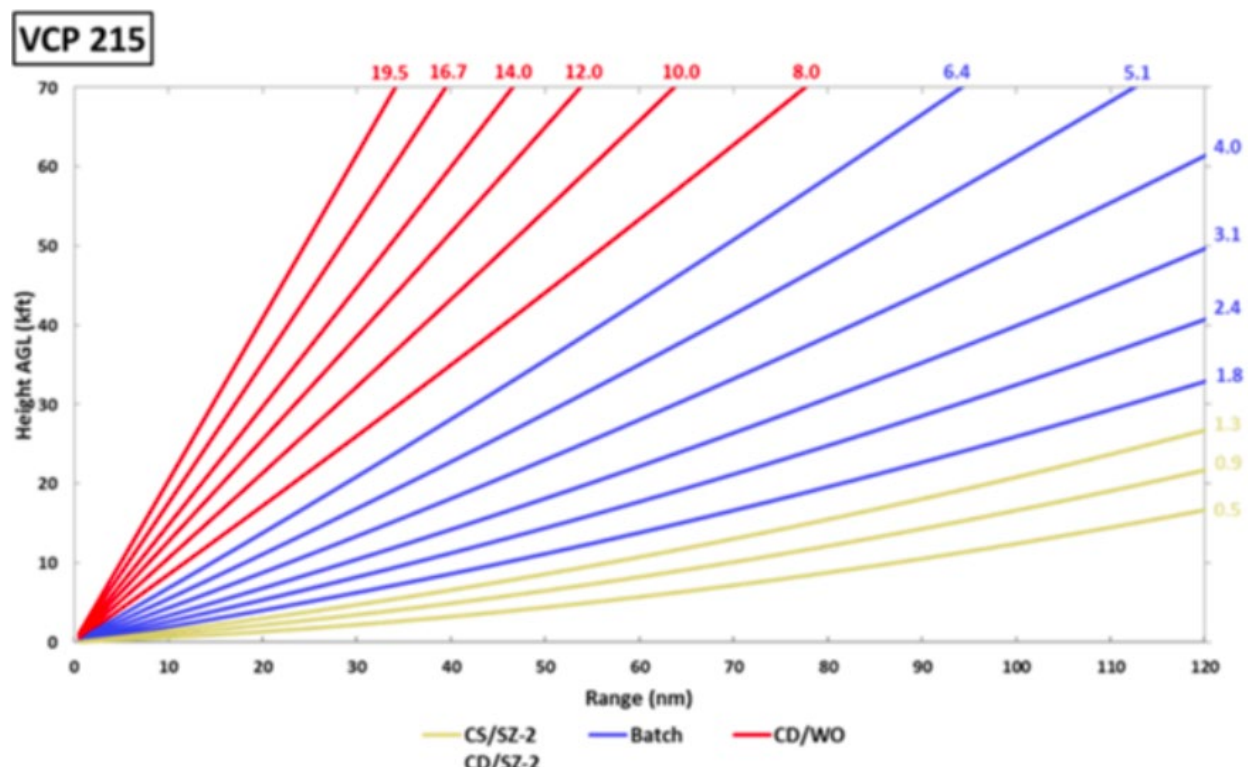
The closest NWS Weather Surveillance Radar-1988 Doppler (WSR-88D)<sup>24</sup> to the accident site was from Binghamton, (KBGM), New York, located 27 miles west of the accident site. The Level II archive radar data were obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

<sup>23</sup> 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.

<sup>24</sup> 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 KBGM WSR-88D radar was operating in the precipitation mode VCP-215<sup>25</sup> (figure 10). 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 10.** VCP-215 precipitation Mode Scan Strategy.

<sup>25</sup> 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 refraction<sup>26</sup> of the KBGM WSR-88D radar beam with the antenna elevation at 1,703 ft, and considering a beamwidth<sup>27</sup> of 0.95°, the following table shows the approximate heights for the 6.37° 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  |
|-------------------|-------------|-----------|-----------|
| KBGM 6.37°        | 20,380 ft   | 19,020 ft | 21,740 ft |

Based on the radar height calculations, the 6.37° elevation scan reviewed from KBGM listed in the above table combined to depict conditions between 19,020 ft and 21,740 ft over the accident site and these were the closest altitudes<sup>28</sup> to the accident aircraft's altitude at the accident time.

## 7.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors<sup>29</sup> 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 dBZ 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."

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<sup>26</sup> Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

<sup>27</sup> Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

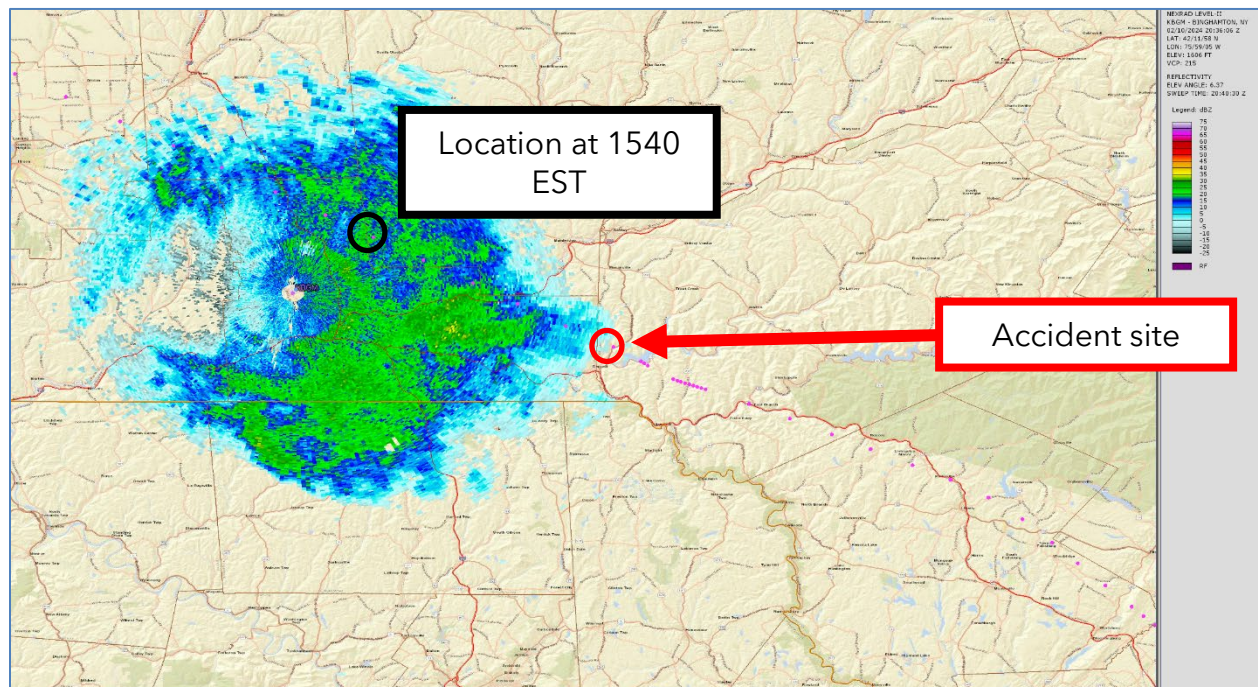
<sup>28</sup> See ATC and track data information contained in the docket for this accident.

<sup>29</sup> 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.

## 7.4 Base Reflectivity Data and Lightning Data

Figures 11 and 12 present the KBGM WSR-88D base reflectivity images for the 6.37° elevation scan initiated at 1540:30 and 1546:38 EST with resolutions of 0.5° X 250 m. These images depicted portions of reflectivity values between -10 and 0 dBZ over the accident site location. The reflectivity targets were moving from west to east at the time of the accident (attachment 2).

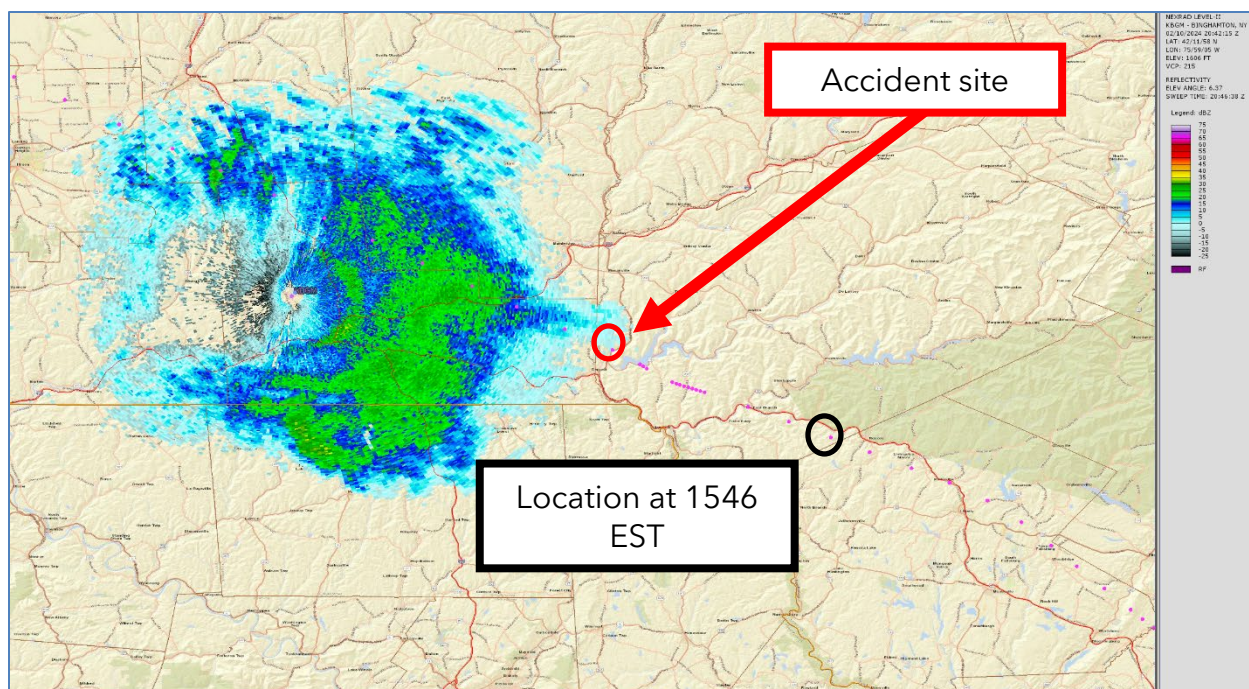
There were no lightning flashes<sup>30</sup> reported within 25 miles of the accident site within 10 minutes prior to and following the accident time.<sup>31</sup>



**Figure 11.** KBGM WSR-88D reflectivity for the 6.37° elevation scan initiated at 1540:30 EST with the accident site marked with the red circle and the location of the accident aircraft in the black circle. The pink dots are the airplane flight track points.

<sup>30</sup> Lightning Flash – This is one contiguous conducting channel and all the current strokes/pulses that flow through it. There are two types of flashes: ground flashes and cloud flashes.

<sup>31</sup> A review of Earth Networks Total Lightning network and GOES-16 Geostationary Lightning Mapper (GLM) was done.



**Figure 12.** KBGM WSR-88D reflectivity for the 6.37° elevation scan initiated at 1546:38 EST with the accident site marked with the red circle and the location of the accident aircraft in the black circle. The pink dots are the airplane flight track points.

## 8.0 Pilot Reports

The longline-disseminated pilot reports<sup>32</sup> (PIREPs) distributed into the national airspace system (NAS) within 2 hours of the accident time and within 150 miles of the accident site for above 10,000 ft are shown below. The bolded PIREPs were from in and around Binghamton (BGM):

SMQ UA /OV SBJ/TM 1844/FL140/TP CRJ7/TB MOD CONS

PSB UA /OV PSB170015/TM 1856/FL410/TP GLF5/TB CONS MOD CHOP 395-417

ISP UA /OV DPK180040/TM 1858/FL430/TP C25B/TB MOD CHOP

ISP UA /OV DPK220050/TM 1901/FL250/TP B737/TB LGT-MOD CHOP

**BGM UA /OV RKA/TM 1904/FL220/TP B737/TB MOD 230-220/RM CAT**

AVP UA /OV LVZ/TM 1908/FL170/TP EA50/TA M12/TB MOD/IC MOD MIX/RM 120-170

ROC UA /OV ROC140015/TM 1909/FLDURGD/TP CRJ9/SK BKN036-TOP050/TB LGT-OCNL  
MOD TURB 025-100

**BGM UA /OV CFB/TM 1910/FL220/TP E190/TB MOD**

<sup>32</sup> Only PIREPs with the World Meteorological Organization headers UBNY\*\*, UBCT\*\*, UBPA\*\*, UBNJ\*\*, and UBMA\*\* were considered. These do not include pilot reports only broadcast via radio.

PHL UA /OV ARD237011/TM 1911/FL110/TP B739/TB MOD  
SYR UA /OV 30 SW SYR/TM 1917/FL055/TP B737/TB MOD CHOP 055-230  
SMQ UA /OV BWZ/TM 1920/FL170/TP B737/TB LGT-MOD  
BLM UA /OV COL/TM 1924/FL100/TP B38M/TB CONS MOD CHOP  
BLM UA /OV COL/TM 1926/FL170/TP A320/TB CONS MOD CHOP  
AVP UA /OV LVZ/TM 1927/FL120/TP E145/TA M07/TB MOD/IC LGT RIME  
ISP UA /OV DPK180030/TM 1941/FL390/TP B739/TB LGT-MOD CHOP  
MGJ UA /OV HUO200010/TM 1945/FL200/TP E75L/TB CONS LGT CAT  
ISP UA /OV DPK180020/TM 1945/FL400/TP A333/TB MOD  
JFK UA /OV JFK300020/TM 1951/FL390/TP A333/TB LGT CHOP

**BGM UA /OV CFB/TM 1957/FL220/TP B38M/TB LGT-MOD CHOP 200-220**

SYR UA /OV SYR300047/TM 2015/FL350/TP A21N/TB LGT CHOP  
MMU UA /OV MMU270010/TM 2018/FL160/TP E75S/TB MOD

**BGM UA /OV HNK/TM 2022/FL220/TP B789/TB MOD CHOP 220-190**

POU UA /OV IGN/TM 2030/FL380/TP B789/TB OCNL LGT CHOP  
POU UA /OV IGN/TM 2030/FL350/TP B738/TB OCNL LGT CHOP  
ALB UA /OV ALB200020/TM 2031/FL400/TP A332/TB LGT

**BGM UA /OV DNY140005/TM 2038/FL200/TP C68A/TB MOD 200-190**

**UCA UUA /OV UCA/TM 2043/FL240/TP TBM8/TB MOD-SEV 240/RM +/- 600FT**

**ALTITUDE LOSS**

**BGM UUA /OV HNK/TM 2052/FL210/TP B737/TB MOD-SEV CAT 200-210**

**BGM UA /OV BGM180040/TM 2054/FL170/TP E145/TB MOD**

**BGM UA /OV CFB360005/TM 2059/FL150/TP E145/TA M17/IC LGT RIME**

**BGM UUA /OV RKA250030/TM 2109/FL210/TP CRJ7/TB MOD-SEV CAT/RM 180-210**

JFK UA /OV JFK130025/TM 2112/FL130/TP E75L/TB LGT-MOD CHOP 120-130  
ALB UA /OV ALB180030/TM 2113/FL380/TP B737/TB CONS LGT 380

**BGM UA /OV CFB040015/TM 2114/FL170/TP E170/TA -02/TB MOD/IC MX**

ALB UA /OV CAM/TM 2119/FL260/TP B764/TB MOD/RM DURD  
POU UA /OV PWL/TM 2119/FL185/TP B739/TB LGT CHOP/RM 185-220 DURC  
ALB UA /OV ALB180020/TM 2120/FL190/TP E75S/TB OCNL MOD

**BGM UA /OV HNK/TM 2120/FL170/TP B772/TB MOD/RM WIND SHEAR WITH MINOR  
SPEED CHANGES**

POU UA /OV PWL230015/TM 2124/FL110/TP A21N/TA M06/IC LGT RIME  
AVP UA /OV LVZ330008/TM 2127/FL120/TP E145/TA M10/IC LGT RIME  
ARP UAL716 4253N 07709W 2130 F240 275/160 TB OCNL MOD TURB IC

**BGM UA /OV RKA128050/TM 2132/FL240/TP E75L/RM LGT TURB 230-150 ON LGRA**

## **ARRIVAL**

ALB UA /OV ALB/TM 2137/FL260/TP CRJ9/TB MOD 230-260

AVP UA /OV LVZ020015/TM 2147/FL120/TP A319/TA M08/IC LGT-MOD RIME

### **BGM UA /OV CFB/TM 2149/FL150/TP CRJ7/TB LGT CHOP**

ALB UA /OV ALB170030/TM 2155/FL220/TP C750/TB MOD/RM DURC

JFK UA /OV JFK200020/TM 2200/FL095/TP E75S/TA M05/IC LGT RIME 105-095

UCA UA /OV UCA100025/TM 2201/FL210/TP A319/TB CONS LGT 110-200/RM

POU UA /OV PWL/TM 2206/FL160/TP CL35/TA 02/TB LGT CHOP/IC MOD MX 160

SEG UA /OV MIP120020/TM 2213/FL170/TP A321/TB MOD CHOP 130-170/IC NEG

GFL UA /OV GFL/TM 2217/FL370/TP A333/TB NEG 370

SYR UA /OV SYR180015/TM 2218/FL380/TP B737/TB LGT-MOD CHOP

JFK UA /OV JFK/TM 2219/FL300/TP B738/TB LGT CHOP

POU UA /OV IGN020030/TM 2219/FL230/TP A320/TB CONS LGT 200 OCNL MOD 210-230

ALB UA /OV ALB240025/TM 2220/FL205/TP B737/SK TOP210/RM DURD

POU UA /OV IGN020030/TM 2220/FL240/TP A320/TB NEG 240

POU UA /OV PWL070020/TM 2221/FL140/TP C56X/TA 01/TB LGT CHOP/IC LGT RIME

RIC UA /OV CSN008135/TM 2222/FL180/TP B737/TA M21/IC MOD RIME/RM DURC 180-210

ALB UA /OV ALB130030/TM 2224/FL220/TP E170/SK TOP220/TB MOD 220

FIG UA /OV ETG/TM 2224/FL320/TP BCS3/TB LGT-MOD CHOP

UCA UA /OV UCA/TM 2228/FL250/TP DH8D/TB NEG 250

POU UA /OV IGN/TM 2228/FL140/TP C56X/TA M01/IC MOD RIME

### **BGM UA /OV HNK/TM 2229/FL190/TP CRJ7/TB LGT CHOP 190**

ARP UAL2635 4130N 07758W 2230 F330 M49 286/145 TB LIGHT SK CLEAR IC NONE

### **BGM UA /OV CFB270050/TM 2234/FL380/TP B737/TB LGT-MOD**

BUF UA /OV BUF/TM 2234/FL350/TP E75S/TB MOD

ARP UAL638 4129N 07532W 2241 F302 M45 273/138 TB LGT

BTV UA /OV BTV210045/TM 2241/FL140/TP BCS3/TB LGT CHOP 140

A System Service Review (SSR) team conducted a review of the ATC audio between 1454 and 1623 EST for the ATC sector involved in the accident. During that period, 46 aircraft traversed the sector, 27 aircraft required a depicted weather call, and 16 aircraft were issued one correctly. Thirty six of the 46 aircraft required a PIREP to be issued and 26 aircraft received a PIREP as required. Seventeen PIREPs were received at the ATC sector during the timeframe and 8 of those were input and distributed correctly.

## 9.0 Significant Meteorological Information

There were no non-convective Significant Meteorological Information (SIGMET) advisories valid for the accident site at the accident time. There was a Convective SIGMET<sup>33</sup> valid for the accident site at the accident time. SIGMET 29E issued at 1455 EST forecast an area of embedded thunderstorms (figure 13) with tops to FL280<sup>34</sup> with the SIGMET box area moving from 250° at 40 knots:

WSUS31 KKCI 101955  
SIGE  
-MKCE WST 101955  
CONVECTIVE SIGMET 29E  
VALID UNTIL 2155Z  
ME NH VT NY PA  
FROM 60WNW BGR-50WSW BGR-30NNE HAR-10NW EWC-60WNW BGR  
**AREA EMBD TS MOV FROM 25040KT. TOPS TO FL280.**

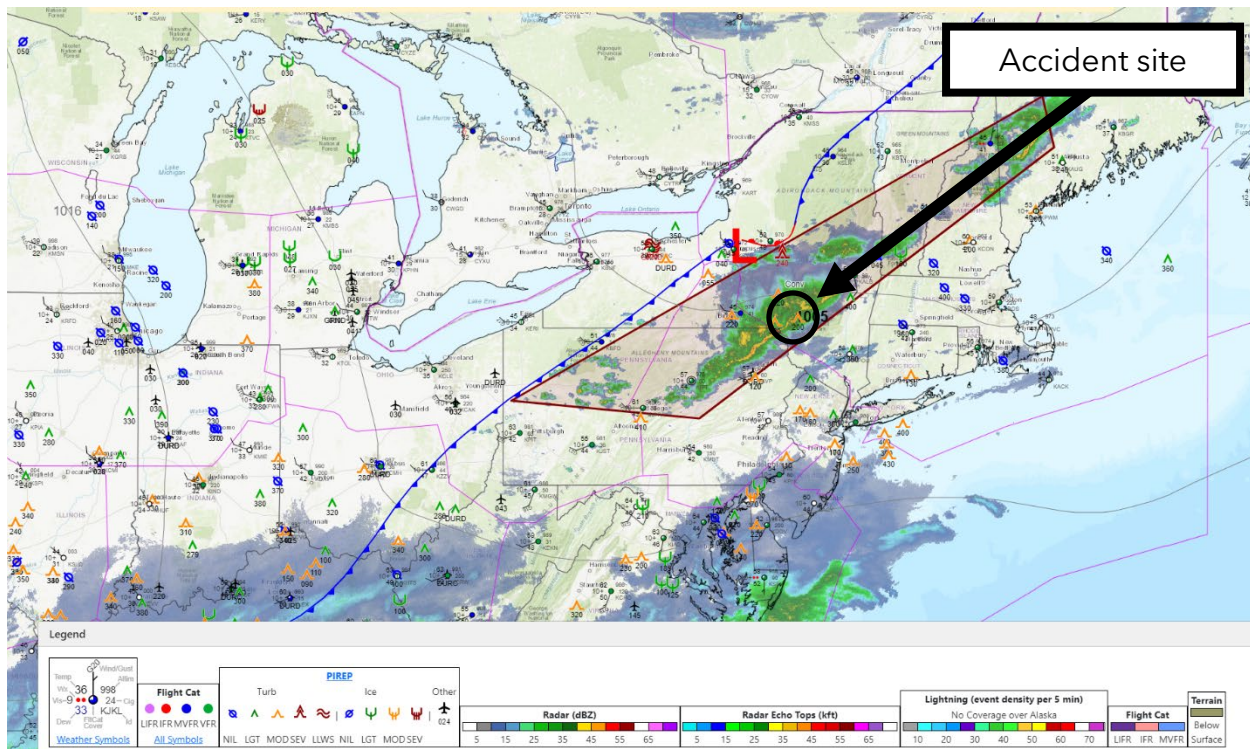
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<sup>33</sup> US Convective SIGMETs - Convective SIGMETs are issued in the conterminous U.S. if these conditions are occurring or expected to occur:

- Line of thunderstorms at least 60 miles long with thunderstorms affecting 40% of its length
- Area of thunderstorms covering at least 40% of the area concerned and exhibiting a very strong radar reflectivity or a significant satellite or lightning signature
- Embedded or severe thunderstorms expected to occur for more than 30 minutes

Special issuance criteria occur with tornado, hail greater than 3/4 inch in diameter, and wind gusts greater than or equal to 50 knots. Any convective SIGMET implies severe or greater turbulence, severe icing, and low level wind shear. A convective SIGMET may be issued for any convective situation which the forecaster feels is hazardous to all categories of aircraft. Bulletins are issued hourly at Hour+55. The text of the bulletin consists of either an observation and a forecast or just a forecast. The forecast is valid for up to 2 hours.

<sup>34</sup> Flight Level - A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of ft. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the standard sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.



**Figure 13.** Aviation Weather Center observation page valid at 1545 EST with fronts, PIREPs, and the area of Convective SIGMET 29E highlighted. The location of the accident site is marked by the black circle.

## 10.0 Center Weather Service Advisories and Information

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. The ZBW CWSU did complete several Pre-Duty Weather Briefings (PDWB) on the day of the accident one of which was completed at 1235 EST. For more information please see attachment 3. The ZBW CWSU station log information was also provided for the day of the accident and is found in attachment 4.

## 11.0 Text Airmen's Meteorological Information

The NWS Aviation Weather Center (AWC) had text Airmen's Meteorological Information (AIRMET) advisory Tango and Zulu valid for the accident site at the accident time for above 15,000 ft. The text AIRMET Tango was issued at 1200 EST and forecast moderate turbulence between FL240 and FL420 until 1600 EST. The text AIRMET Zulu was issued at 1024 EST and forecast moderate icing between the freezing level<sup>35</sup> and 17,000 ft until 1600 EST:

<sup>35</sup> Freezing level between 2,000 and 7,000 ft.

WAUS41 KPCI 101700 AAA

WA1T

-BOST WA 101700 AMD

AIRMET TANGO UPDT 5 FOR TURB AND LLWS VALID UNTIL 102100

**AIRMET TURB...ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DC DE VA  
AND CSTL WTRS  
FROM 70S YQB TO 60W MLT TO 60SW YSJ TO 200SE ACK TO 160SE SIE TO  
20NE ECG TO 30ENE LYH TO 20ESE BKW TO 50WSW BKW TO HNN TO CVG TO  
FWA TO 30SE ECK TO YOW TO 70S YQB  
MOD TURB BTN FL240 AND FL420. CONDS CONTG BYD 21Z THRU 03Z.**

AIRMET TURB...CT NY NJ PA MD DC DE VA AND CSTL WTRS...UPDT  
FROM 20NNW SAX TO 30WSW HTO TO 40SSE HTO TO 100ESE SBY TO 80E  
ORF TO 20ENE ORF TO RIC TO 20NNW CSN TO 20W EMI TO 30WSW ETX TO  
20NNW SAX  
MOD TURB BTN 100 AND FL190. CONDS ENDG 18-21Z.  
...NEW AIRMET...

LLWS POTENTIAL...PA WV MD VA NC SC  
BOUNDED BY 30SSW JST-40W EMI-20S DCA-20NNE RIC-20WSW LYH-GSO-  
20ENE ODF-20S VXV-HMV-HNN-50SW EKN-30SSW JST  
LLWS EXP. CONDS CONTG BYD 21Z THRU 03Z.

LLWS POTENTIAL...ME NH VT MA NY AND CSTL WTRS  
BOUNDED BY 70NW PQI-40NNE PQI-40WSW YSJ-30SE ENE-30NNE BDL-30S  
SYR-20SE YOW-70NE MPV-70NW PQI  
LLWS EXP. CONDS CONTG BYD 21Z THRU 03Z.

OTLK VALID 2100-0300Z...TURB ME NH VT MA RI CT NY LO NJ PA OH LE  
WV MD DC DE VA NC AND CSTL WTRS  
BOUNDED BY 70S YQB-70W MLT-60SW YSJ-200SE ACK-160SE SIE-220ESE  
ECG-170ESE ECG-20NE ECG-20WSW BKW-HNN-CVG-FWA-30SE ECK-YOW-70S  
YQB  
MOD TURB BTN FL240 AND FL420. CONDS CONTG THRU 03Z.

....

952

WAUS41 KPCI 101524 AAA

WA1Z

-BOSZ WA 101524 AMD

AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 102100

**AIRMET ICE...ME NH VT MA CT NY LO NJ PA OH LE WV AND CSTL WTRS  
FROM 70NW PQI TO 40NE PQI TO 110SE BGR TO 20N BOS TO 40ENE SAX TO  
30NNE APE TO 40NNW CLE TO 20NE YOW TO 70NNE MPV TO 70NW PQI  
MOD ICE BTN FRZLVL AND 170. FRZLVL 020-070. CONDS CONTG BYD 21Z  
THRU 03Z.**

AIRMET ICE...MA RI CT NY NJ PA OH WV MD DC DE VA NC SC GA AND  
CSTL WTRS...UPDT

FROM 20SSE PVD TO 20ESE ACK TO 80SSE ACK TO 140S ACK TO 200SE SIE  
TO 190ESE ECG TO 110SE ECG TO 70S ILM TO 40NNW SAV TO 30WNW PZD  
TO GQO TO HNV TO HNN TO CVG TO 50S FWA TO 20SSE PVD  
MOD ICE BTN FRZLVL AND FL250. FRZLVL 070-130. CONDS CONTG BYD 21Z  
THRU 03Z.

.  
OTLK VALID 2100-0300Z

AREA 1...ICE ME NH VT MA RI CT NY LO NJ PA AND CSTL WTRS  
BOUNDED BY 70NW PQI-40NE PQI-60SW YSJ-150ENE ACK-50ESE ACK-20SSE  
PVD-20SW SAX-40NE EWC-50ENE BUF-50NE MSS-70NNE MPV-70NW PQI  
MOD ICE BTN FRZLVL AND 170. FRZLVL 020-070. CONDS CONTG THRU 03Z.

.  
AREA 2...ICE MA RI CT NY NJ PA OH WV MD DC DE VA NC SC GA AND  
CSTL WTRS  
BOUNDED BY 20SSE PVD-20ESE ACK-80ESE ACK-130E ACK-200SE ACK-160SE  
SIE-190ESE ECG-120SE ECG-50ESE ILM-40NNW SAV-MCN-40SSE  
LGC-GQO-HNV-HNN-CVG-50SW ROD-50SSW APE-40WSW JST-30SW SAX-20SSE  
PVD  
MOD ICE BTN FRZLVL AND FL250. FRZLVL 070-130. CONDS CONTG THRU  
03Z.

.  
FRZLVL...RANGING FROM 010-105 ACRS AREA  
MULT FRZLVL 010-070 BOUNDED BY 30SE ECK-30WNW CLE-20NNE ROD-  
50S FWA-FWA-30SE ECK  
040 ALG FWA-50W ERI-40NE BUF-80S YQB-30NW BGR-50SE HUL  
080 ALG 20E CVG-50SSW JST-40W EMI-40SSW ACK-150ESE ACK  
....

## 12.0 Terminal Aerodrome Forecast

There were no airports within 15 miles of the accident site with an NWS Terminal Aerodrome Forecast<sup>36</sup> (TAF).

## 13.0 National Weather Service Area Forecast Discussion

The NWS weather forecast office in Binghamton, New York, (WFO BGM) was responsible for the public surface forecast in the region of the accident site. WFO BGM issued the following Area Forecast Discussion (AFD) at 1538 EST, the AFD issued closest to the accident time with an aviation section:

---

<sup>36</sup> 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](http://www.nws.noaa.gov/directives/sym/pd01008013curr.pdf)

FXUS61 KBGM 102038  
AFDBGM

Area Forecast Discussion  
National Weather Service Binghamton NY  
338 PM EST Sat Feb 10 2024

.SYNOPSIS...

Rain showers and embedded thunderstorms will end early this evening as a cold front finishes moving through the area. Following the frontal passage, light lake effect rain and snow showers will develop for portions of north-central New York tonight into Sunday. A storm system will likely bring an accumulating snowfall to the region Monday night into Tuesday, especially for Northeast Pennsylvania and the southern Catskills.

&&

.NEAR TERM /THROUGH SUNDAY NIGHT/...  
335 PM Update:

A cold front continues to work its way through the region this afternoon. Along this front, a line of rain showers is present, along with a few embedded thunderstorms. With a cold pool of air aloft, some of these thunderstorms have produced small hail (mainly pea sized). This included here at the NWS Binghamton office earlier this afternoon.

The cold front will quickly move east of the area this evening, with colder air filtering into the region with 850mb temperatures falling to around -8C. This will trigger a weak lake response, although with minimal difference in the lake temperatures and the air temperatures, any organized lake effect precipitation will be hard to come by. In any event, some light lake effect rain and snow showers will be possible tonight into Sunday morning for areas north of the NY Thruway corridor, but little to no accumulation is expected. Low temperatures are expected to be in the lower to mid 30s.

High pressure moves into the area on Sunday, which will bring dry weather after any lingering light lake effect rain/snow showers end in the morning. Skies will remain mostly cloudy in the morning (especially across Central NY), but partial clearing is expected during the afternoon. Temperatures will be much cooler, but still above normal for this time of the year with highs in the mid 30s to mid 40s.

Dry conditions are expected to continue Sunday night, along with partly cloudy skies (except for areas along and north of the NY Thruway corridor which will likely be mostly cloudy). Lows are expected to be in the mid 20s to near 30.

&&

.SHORT TERM /MONDAY THROUGH TUESDAY NIGHT/...  
410 AM Update

The short term starts off quiet with zonal flow aloft and high pressure at the surface. Through the day Monday, a shortwave ejecting out of the high plains helps dig a trough in the central US. This helps build an upper level ridge initially but the ridge axis moves east with strong SW flow moving in. The shortwave trough moves up the Ohio River Valley Monday night with a coupled jet ahead of it resulting in a deepening surface low moving up the spine of the Appalachian Mountains. Trends in the overnight model runs have been slightly slower so backed off on chances of precipitation during the day on Monday and have a gradual increase through Monday night. There is not really deep antecedent cold air but enough to keep the forecasted vertical temperature profile below freezing for most of the area. Some models to warm above freezing in NEPA if the low does trend northward at all. Given that the snow does not begin until Monday night, decided to not be too aggressive with the forecast yet.

Looking at the dynamics as the low deepens, deterministic models all have good 700-500 mb frontogenesis with a saturated dendritic growth zone so there are good odds that a narrow mesoscale snow band will form with high snowfall rates likely exceeding an inch per hour or more. The placement of the band is still very uncertain. In order to reduce snowfall amounts, some of the NBM10th percentile was used to lower the ratios down and then some of the Canadian and NAM were slightly blended into the WPC QPF as those two models have a more southerly solution and it reduced the QPF some over the Southern Tier into NEPA. Warning criteria snow is looking likely wherever this band eventually sets up.

Without much high latitude blocking in the north Atlantic this storm is progressive and will propagate well into the Atlantic by late Tuesday with precipitation ending from west to east through the day. Some lake effect is possible in CNY and Finger Lakes late Tuesday as cold air advection strengthens behind the departing low.

&&

.LONG TERM /WEDNESDAY THROUGH SATURDAY/...  
410 AM Update

The long term is looking cooler as zonal flow sets up with an active subtropical jet. A few shortwaves are possible from mid week into the weekend but timing of those are uncertain and with the subtropical jet being strong, any meaningful precipitation will likely be staying to our south. Even though temperatures

fall back to climatology, even a few days forecasted being a couple degrees above climo, it will be almost 30 degrees colder than it is now so relatively it will feel like a cold pattern.

The pattern that sets up mid to late week looks to stick around for a bit. The zonal flow with NW flow in the northern plains is typically a drier pattern for much of the northeast despite it being cooler pattern. Chances of any coastal lows are minimal into mid to late February.

&&

**.AVIATION /20Z SATURDAY THROUGH THURSDAY/...**

**Conditions will fluctuate between VFR and MVFR at the NY terminals this afternoon as rain showers and a few isolated thunderstorms move through. Confidence in thunder was not high enough to include in the TAF for most terminals, except for KSYR. If expectations change, amendments to add thunder may be needed at other terminals.**

**Once the showers move through, conditions will likely return to VFR, before ceilings drop back down to MVFR this evening and overnight tonight. MVFR conditions are then expected to continue through most of the rest of the TAF period (at least through 18Z Sunday). KAVP likely remains VFR through most of the TAF period.**

Outlook...

Sunday afternoon through Sunday night...Lingering lake effect clouds and restrictions at the Central NY terminals, otherwise mainly VFR.

Monday...Mainly VFR

Monday night through Tuesday...Possible restrictions from snow, especially at KAVP, KBGM, and KELM.

Wednesday...Some lingering snow showers across Central NY and associated occasional restrictions; Mainly VFR at KAVP.

Thursday...Occasional restrictions possible in rain and snow showers.

&&

**.BGM WATCHES/WARNINGS/ADVISORIES...**

PA...Winter Storm Watch from Monday evening through Tuesday afternoon for PAZ038>040-043-044-047-048-072.

NY...Winter Storm Watch from Monday evening through Tuesday afternoon for NYZ057-062.

&&

## 14.0 Graphical Turbulence Guidance Data

The Graphical Turbulence Guidance Nowcast (GTGN) data<sup>37</sup> for 1545 EST along with National Center for Atmospheric Research (NCAR)<sup>38</sup> in situ eddy dissipation rate (EDR) algorithm data from the accident aircraft was provided and its data can be found in attachment 5. A peak EDR value of 0.431 was noted on the accident aircraft at 1543 EST corresponding to moderate to severe turbulence for a "heavy" class<sup>39</sup> of aircraft.

## 15.0 Consolidated Storm Prediction for Aviation Data

The Consolidated Storm Prediction for Aviation (CoSPA)<sup>40</sup> images were retrieved for 1530, 1535, 1540, and 1545 EST and provided in figures 14 through 17 with the accident site marked. Along with depicting Vertical Integrated Liquid (VIL) levels similar to those used in weather radar, lightning data, weather satellite, and storm motion, the CoSPA imagery provides forecasts of areas of convective growth (orange hatched areas) and areas of convective decay (blue hatched areas). The weather activity was moving from west to east with time.

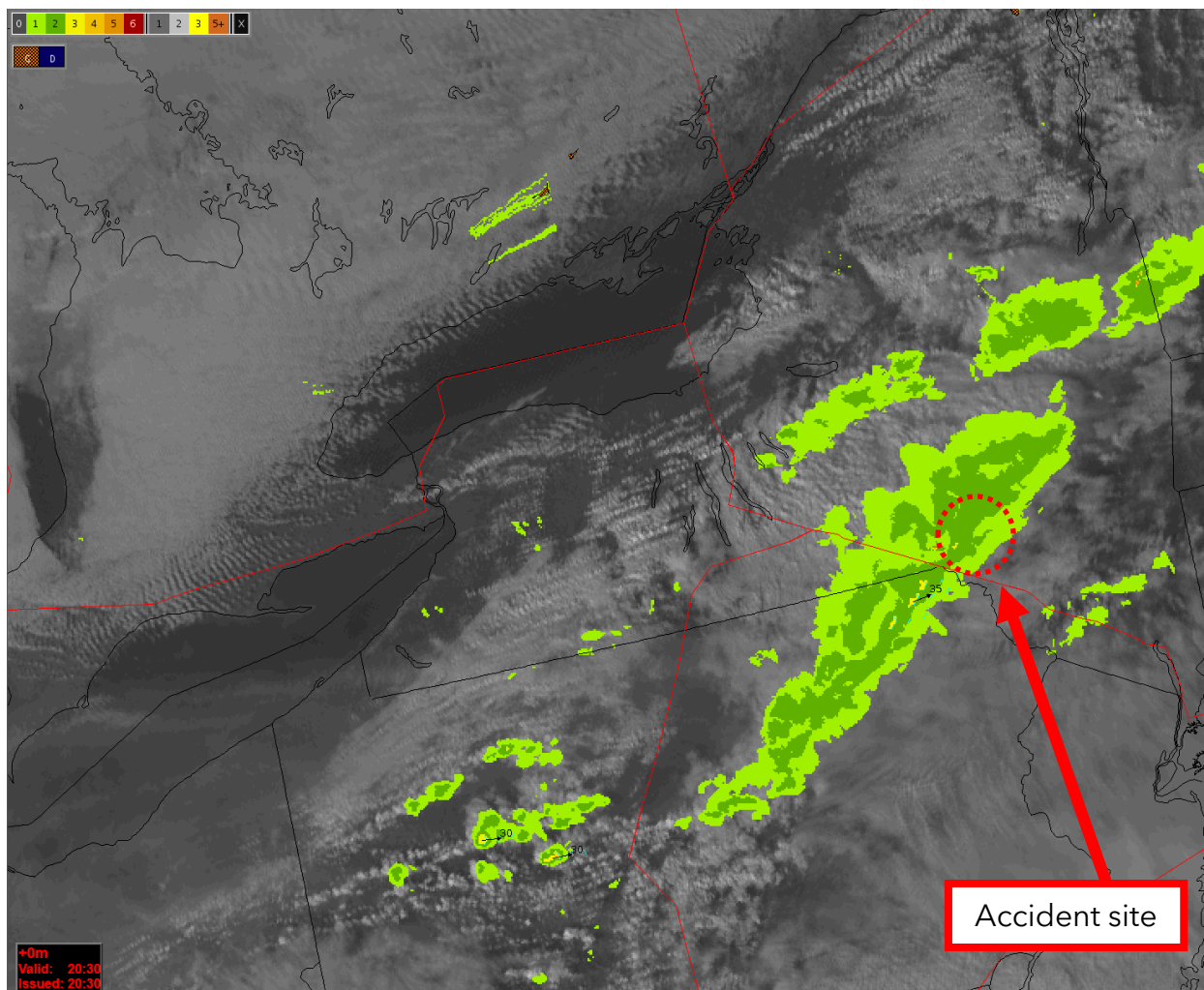
---

<sup>37</sup> [Graphical Turbulence Guidance Nowcast \(GTGN™\) | Research Applications Laboratory \(ucar.edu\)](#)

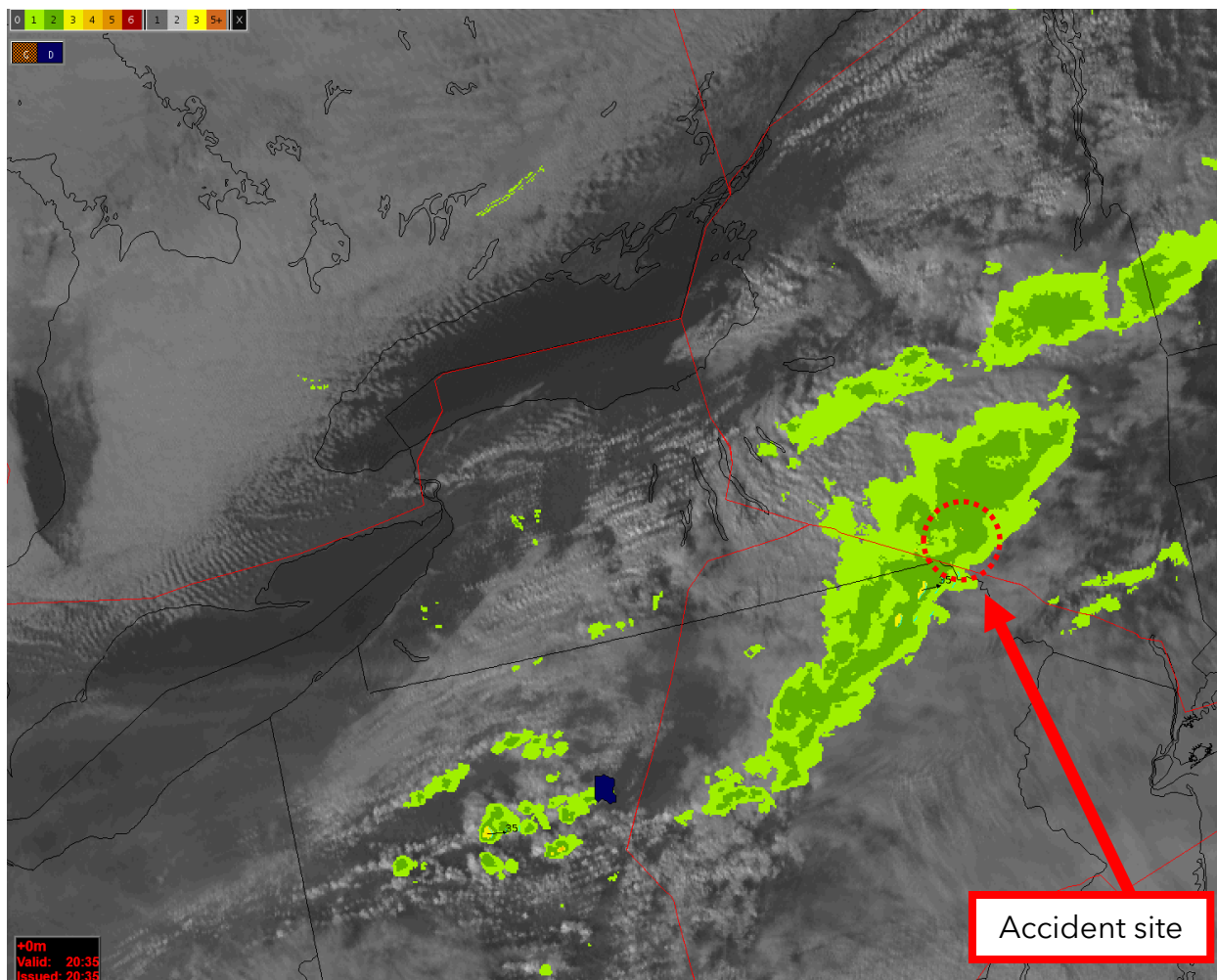
<sup>38</sup> [NSF National Center for Atmospheric Research | National Center for Atmospheric Research \(ucar.edu\)](#)

<sup>39</sup> [GFA Help \(aviationweather.gov\)](#)

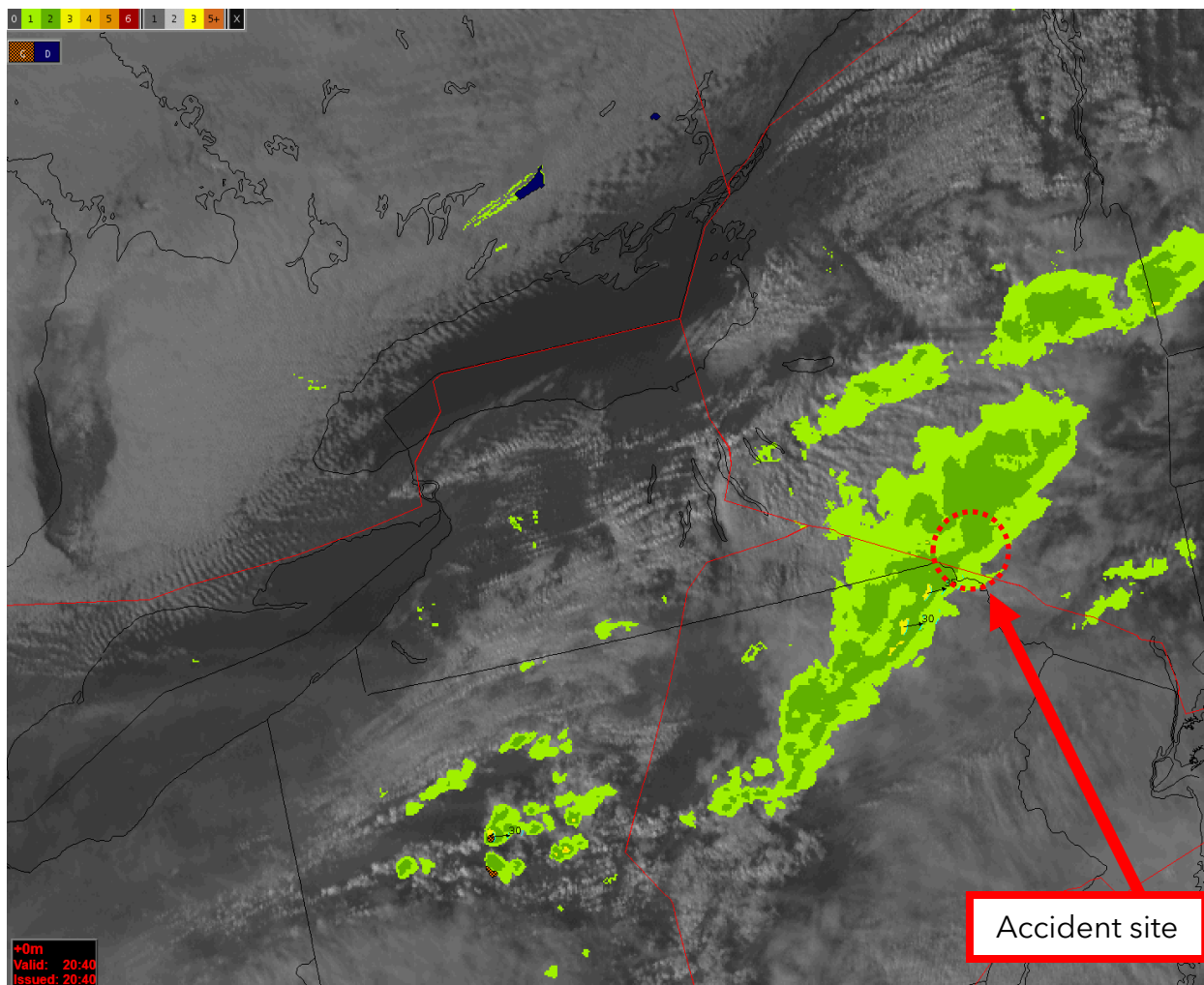
<sup>40</sup> <https://cospa.wx.ll.mit.edu/>  
<https://ral.ucar.edu/projects/CoSPA/index.php>  
<https://ral.ucar.edu/solutions/products/consolidated-storm-prediction-aviation-cospa>



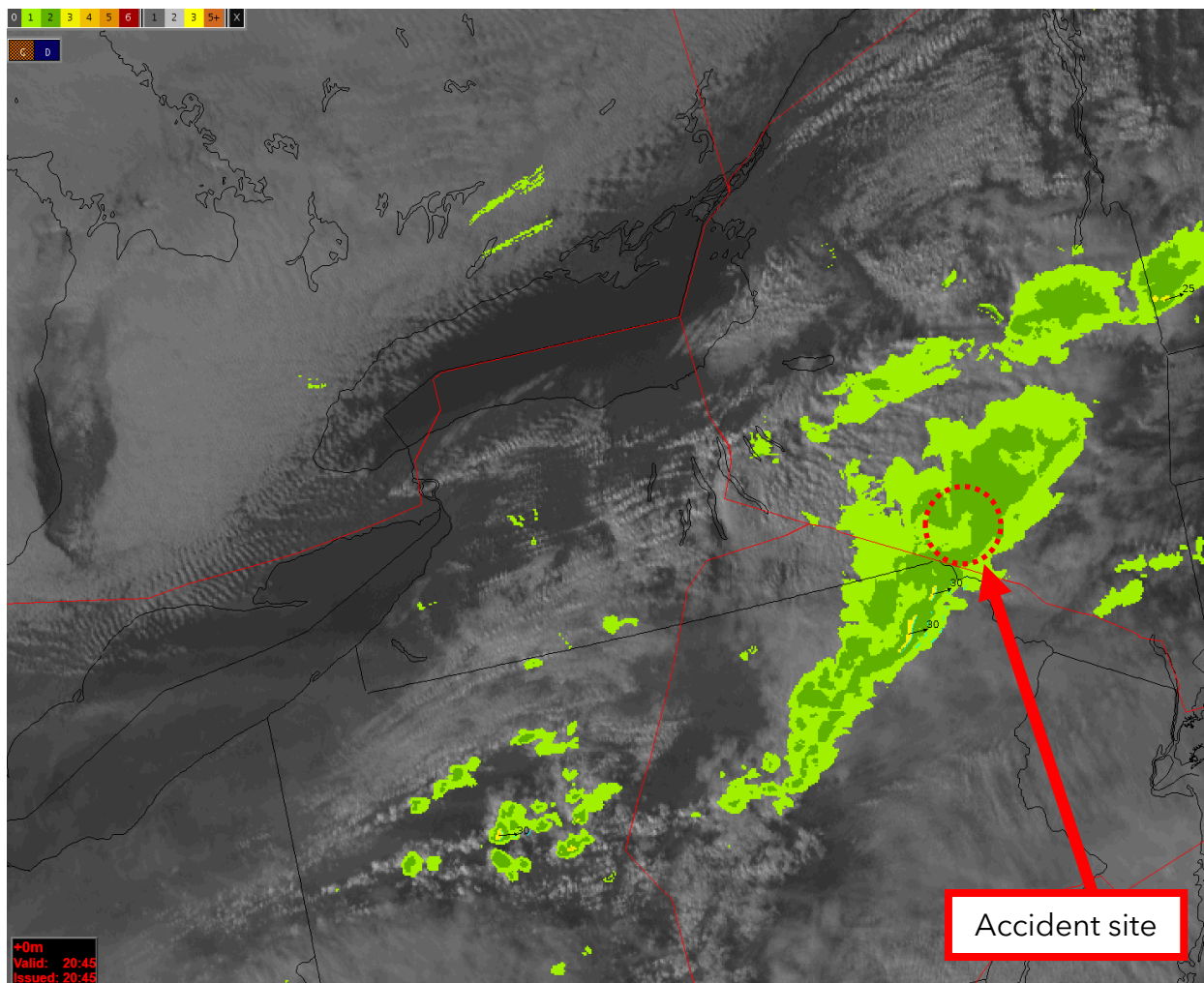
**Figure 14.** CoSPA image from 1530 EST with the accident site marked.



**Figure 15.** CoSPA image from 1535 EST with the accident site marked.



**Figure 16.** CoSPA image from 1540 EST with the accident site marked.

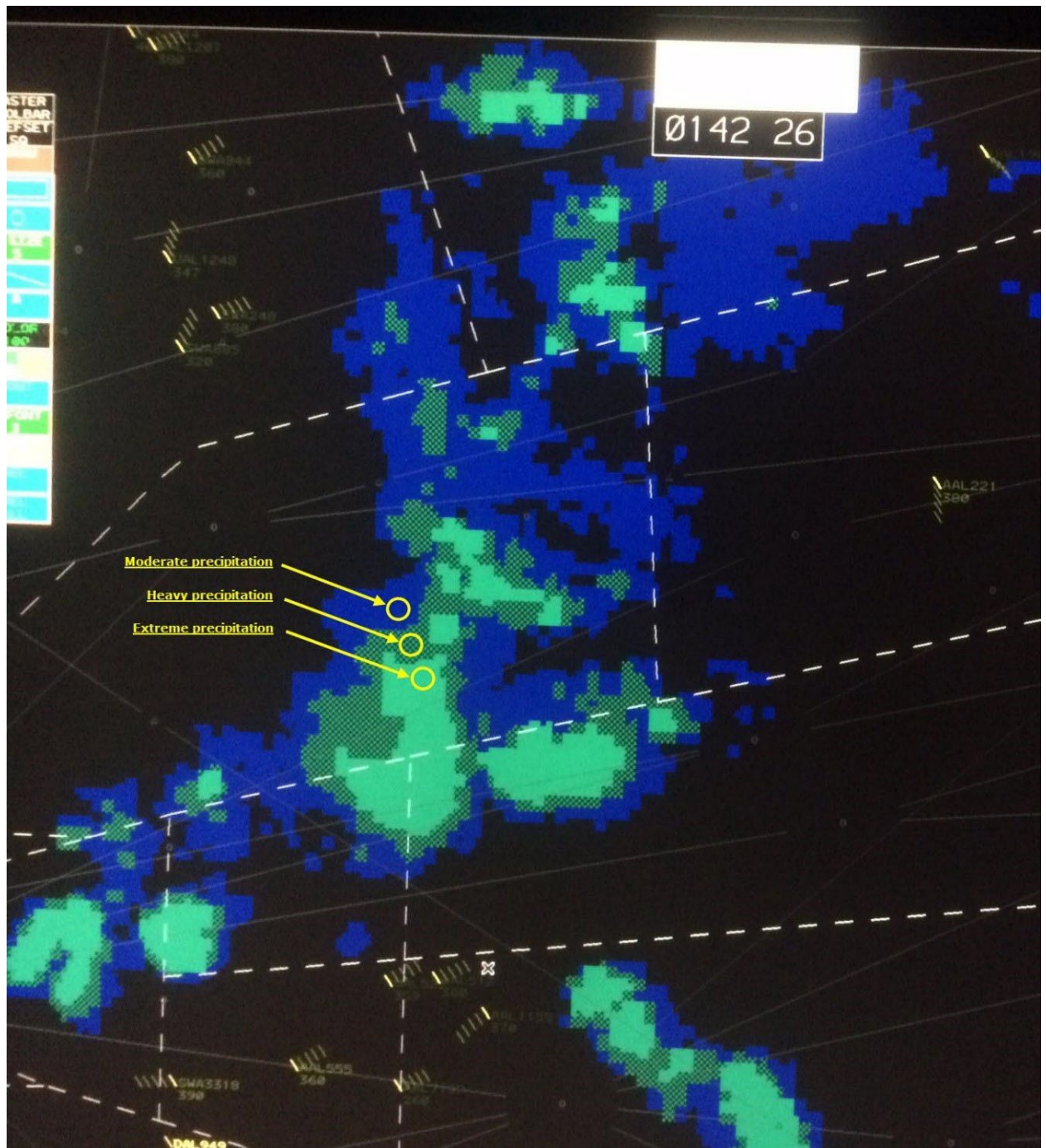


**Figure 17.** CoSPA image from 1545 EST with the accident site marked.

## 16.0 Display of sector 13 ERAM Imagery

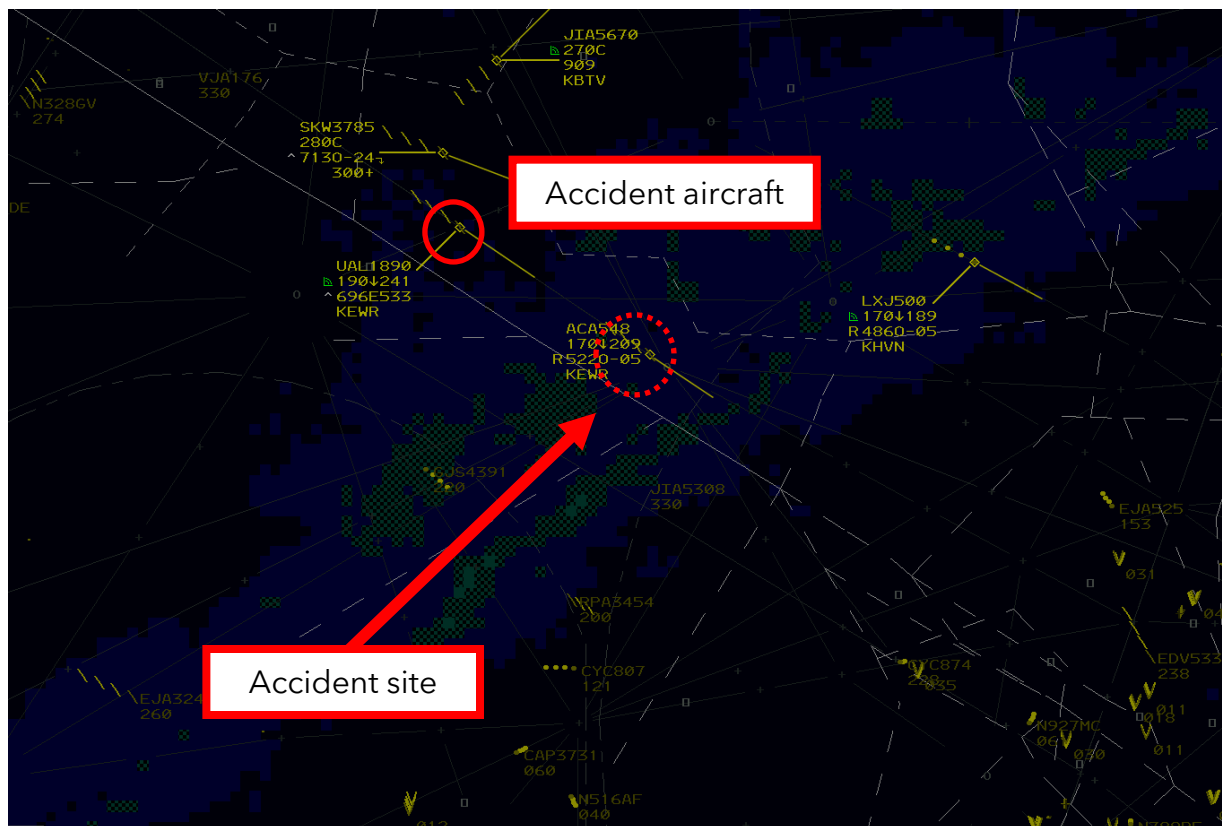
The ATC workgroup conducted a review of facility documents and an En Route Automation Modernization (ERAM) replay of the accident controller's display. The ERAM system processes flight and surveillance data, provides communications, and generates display data to air traffic controllers. ERAM has increased flexibility in routing around congestion, bad weather and other airspace restrictions. After the accident, the FAA secured the sector 24 ERAM replay showing the sector 24 controller preference settings and intensities.

Figure 18 provides an exemplar display of ERAM displayed precipitation. Figures 19 through 24 show the sector 24 ERAM displayed precipitation at 1541, 1542, 1543, 1543:30, 1544, and 1545 EST. The accident aircraft was in a displayed area of moderate to heavy precipitation between 1543 and 1546 EST. For more ERAM<sup>41</sup> imagery please see attachment 6.

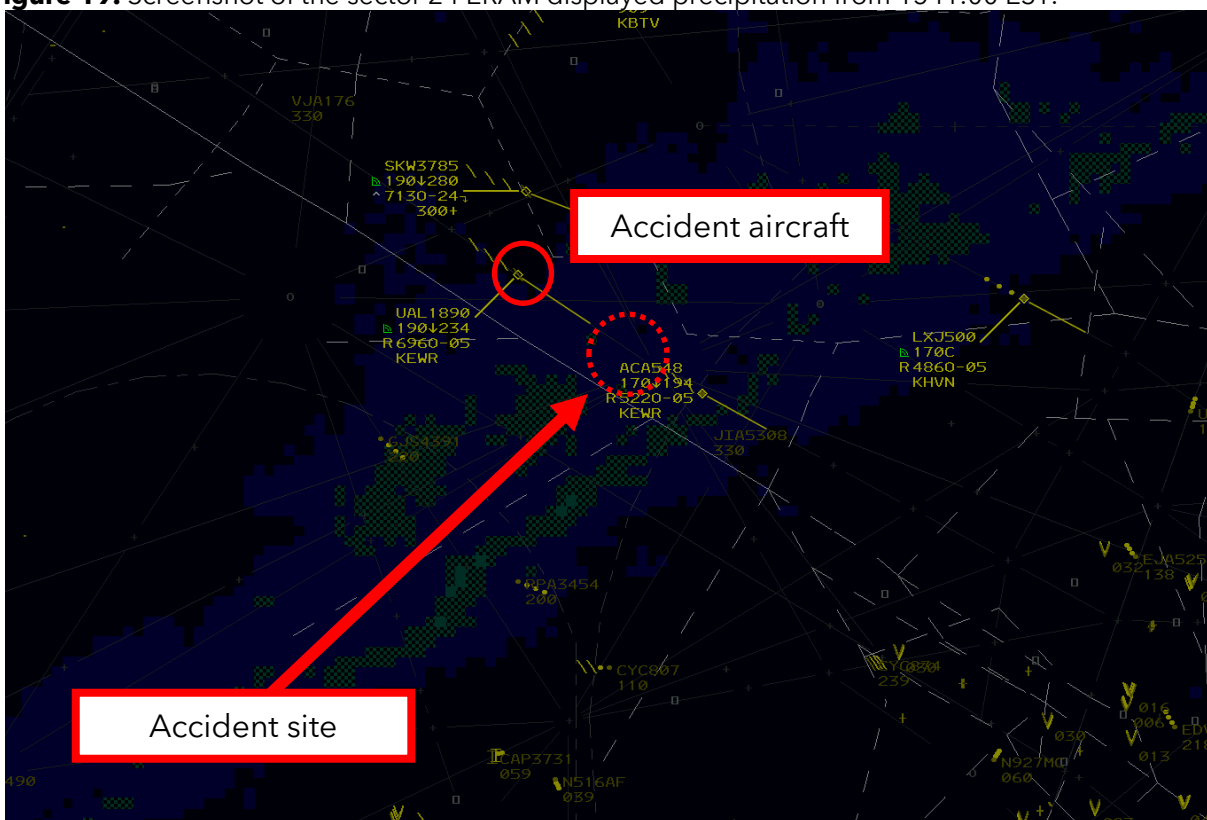


**Figure 18.** Exemplar display of ERAM derived precipitation levels.

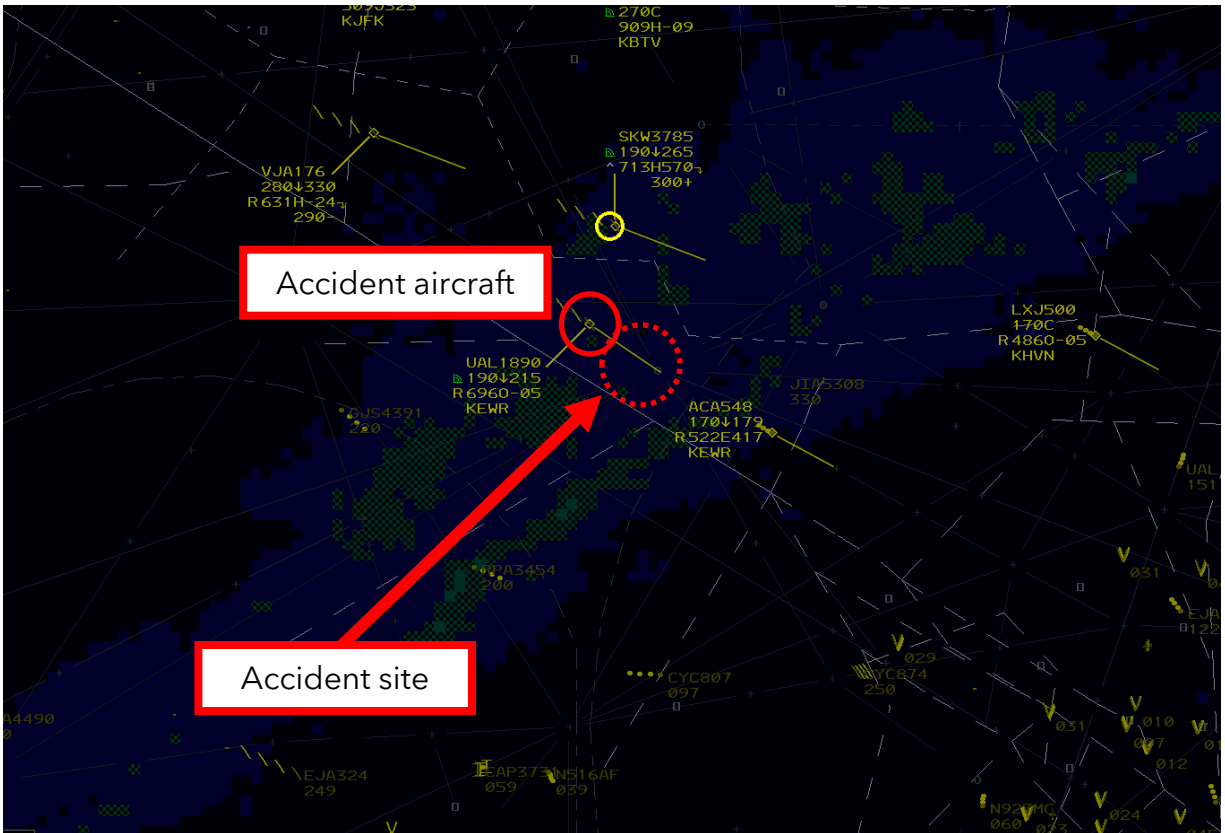
<sup>41</sup> Additional ATC information can be found in the docket for this accident.



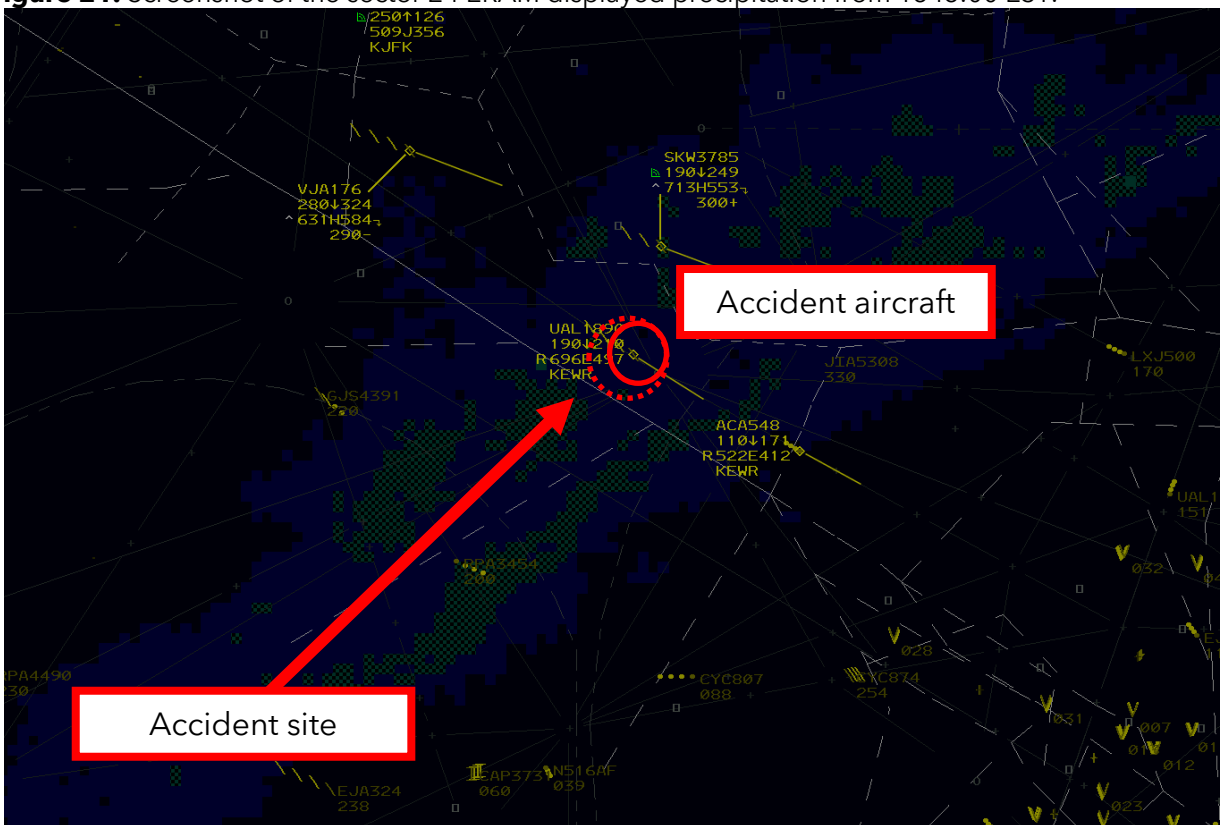
**Figure 19.** Screenshot of the sector 24 ERAM displayed precipitation from 1541:00 EST.



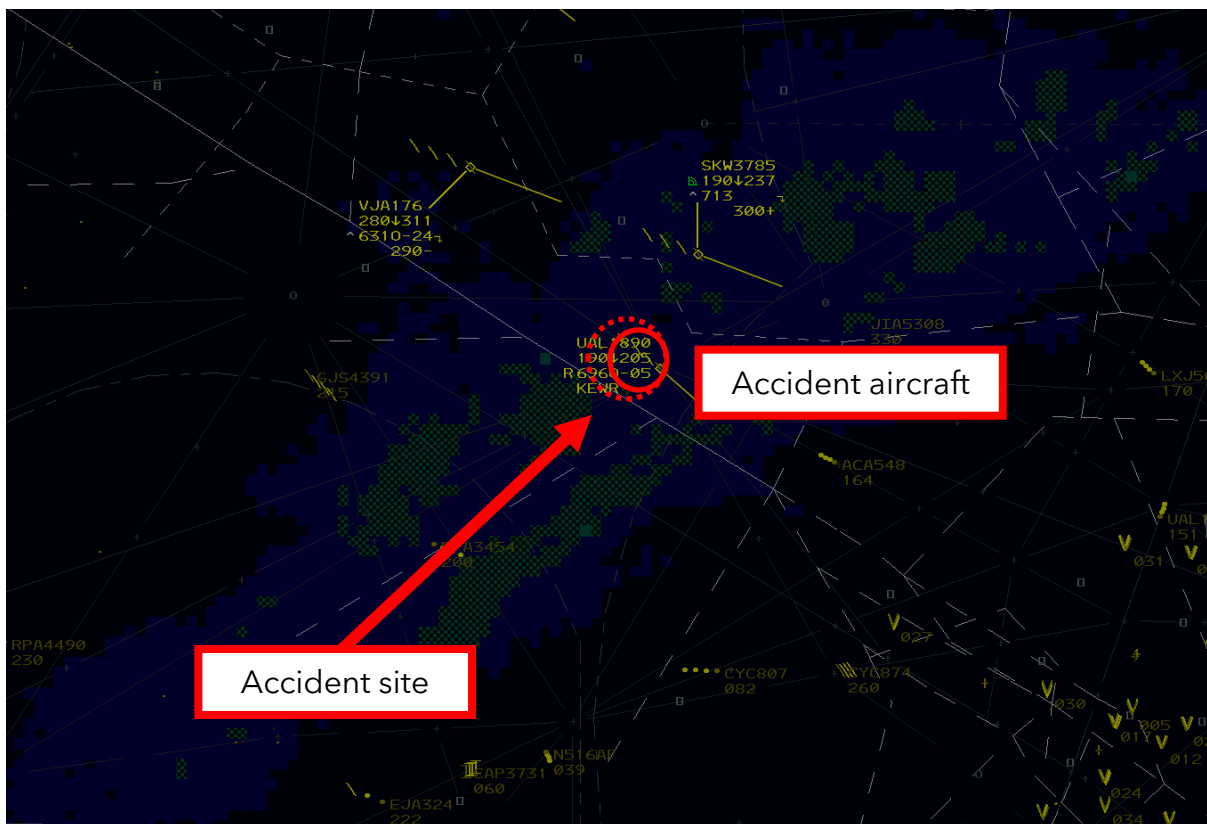
**Figure 20.** Screenshot of the sector 24 ERAM displayed precipitation from 1542:00 EST.



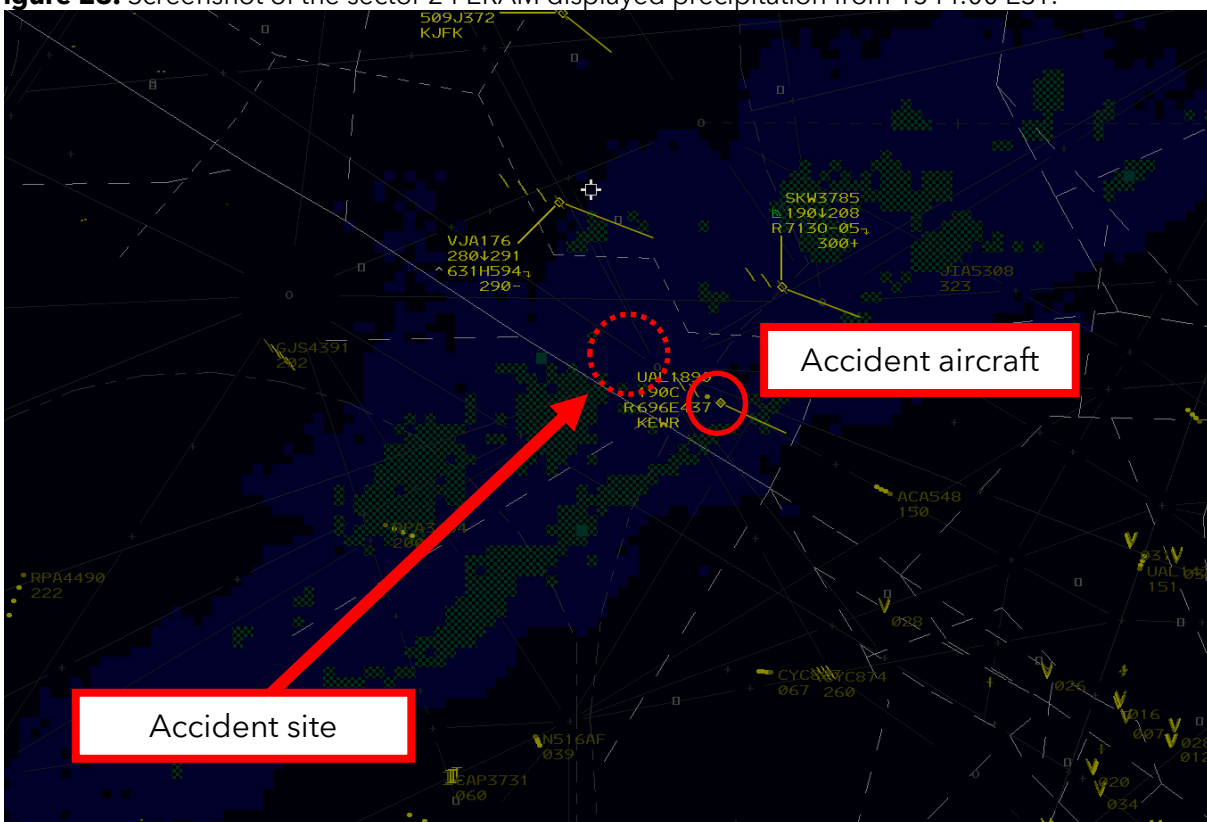
**Figure 21.** Screenshot of the sector 24 ERAM displayed precipitation from 1543:00 EST.



**Figure 22.** Screenshot of the sector 24 ERAM displayed precipitation from 1543:30 EST.



**Figure 23.** Screenshot of the sector 24 ERAM displayed precipitation from 1544:00 EST.



**Figure 24.** Screenshot of the sector 24 ERAM displayed precipitation from 1545:00 EST.

## 17.0 Astronomical Data

The astronomical data obtained for the accident site on February 10, 2024, indicated the following:

### **SUN**

|                      |                              |
|----------------------|------------------------------|
| Begin civil twilight | 0636 EST                     |
| Sunrise              | 0704 EST                     |
| Sun transit          | 1216 EST                     |
| <b>Accident time</b> | <b>1543 EST<sup>42</sup></b> |
| Sunset               | 1728 EST                     |
| End civil twilight   | 1756 EST                     |

At the time of the accident the Sun was at an altitude of 16.25° and azimuth of 232.47°.

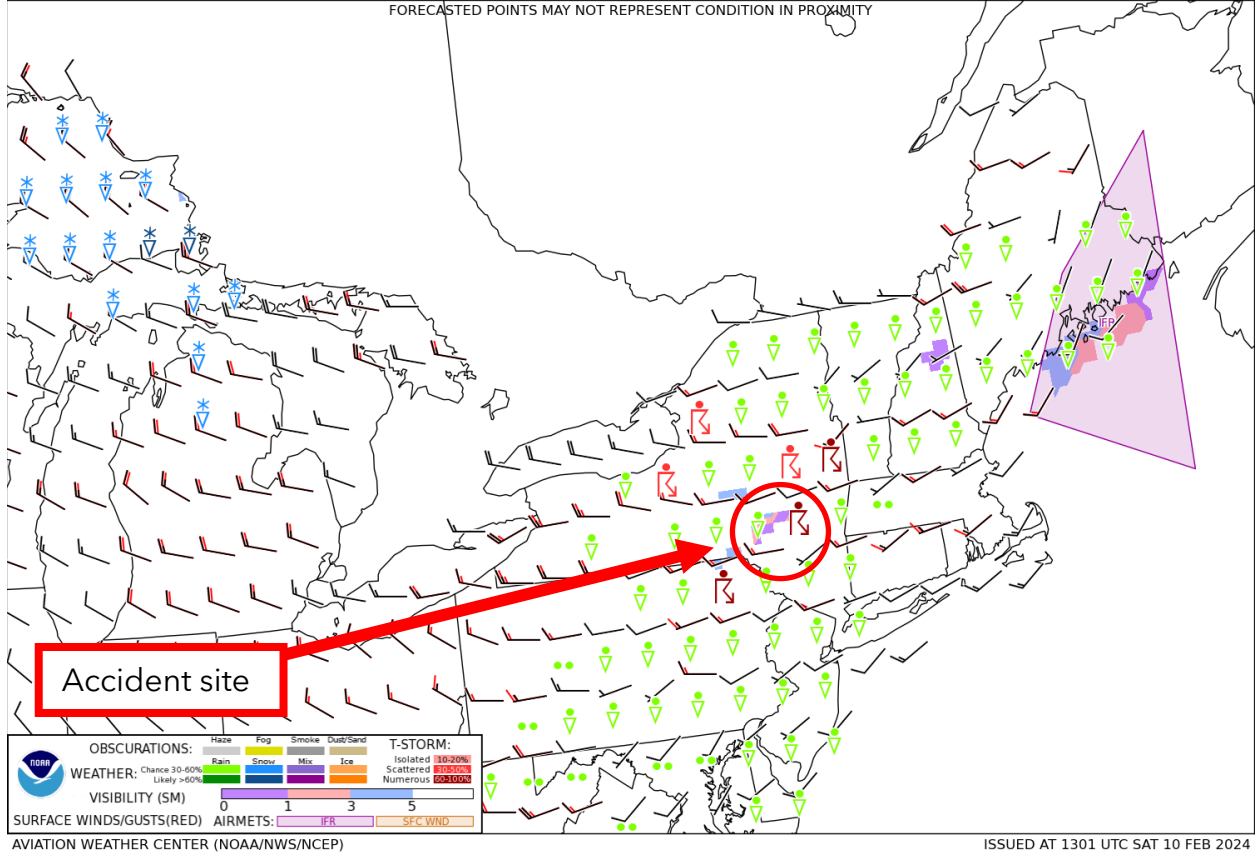
## 18.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products issued by the AWC before the accident flight and valid at 1600 EST and issued around 0800 EST are shown in figures 25 and 26 (additional GFA forecast products produced after 0800 EST are not available due to AWC archiving constraints). The GFA surface forecasts applicable at 1600 EST for the accident site indicated VFR to LIFR conditions with a west wind of 10 knots and gusts to 15 knots. Numerous (between 60 and 100 percent) thunderstorms were forecast for the accident area along with a chance (between 30 and 60 percent) of rain showers. The GFA cloud forecast applicable to the accident site for 1600 EST indicated overcast cloud cover at the accident site with few clouds at 5,000 ft, overcast ceiling at 5,000 ft with clouds tops at FL210 and cirrus clouds above. The Graphical AIRMETs<sup>43</sup> (G-AIRMET) Sierra and Zulu valid at the 1600 EST timeframe are located on figure 26. The only human-generated information reflected in the two GFA products were the G-AIRMETs. The G-AIRMET Zulu for moderate icing conditions valid at 1600 EST applicable to the accident site is found on figure 27. G-AIRMET Tango valid for the accident site at 1600 EST is found in figure 28.

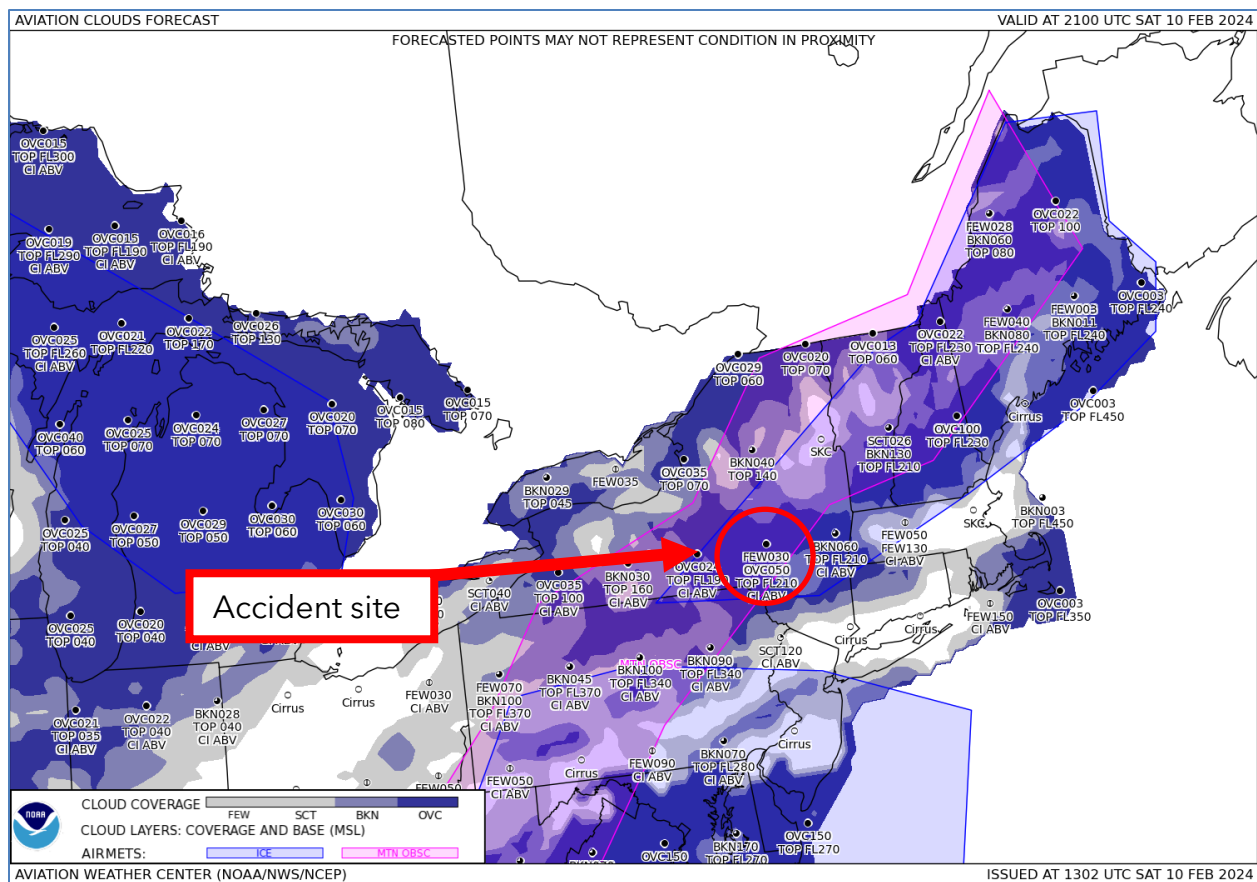
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<sup>42</sup> Inserted accident time for reference and context.

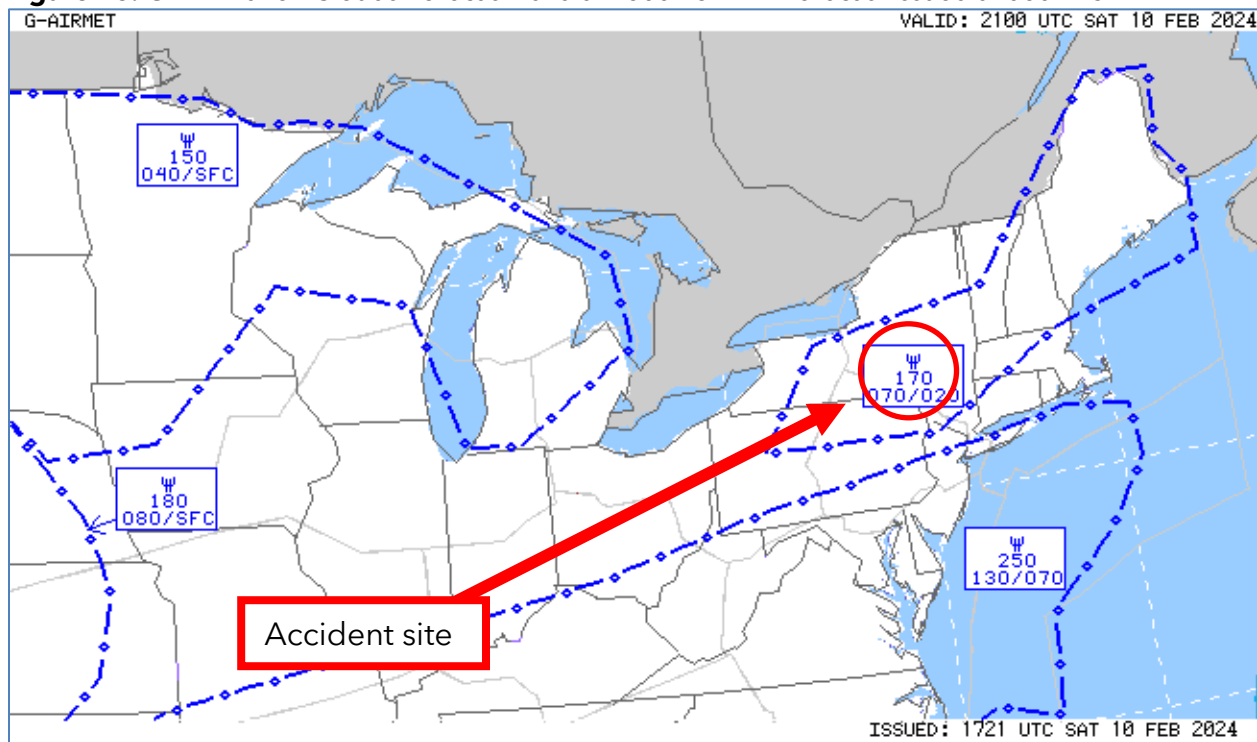
<sup>43</sup> Graphical AIRMETs (G-AIRMETs), found on the Aviation Weather Center webpage at <http://aviationweather.gov>, are graphical forecasts of en-route weather hazards valid at discrete times no more than 3 hours apart for a period of up to 12 hours into the future (for example, 00, 03, 06, 09, 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.



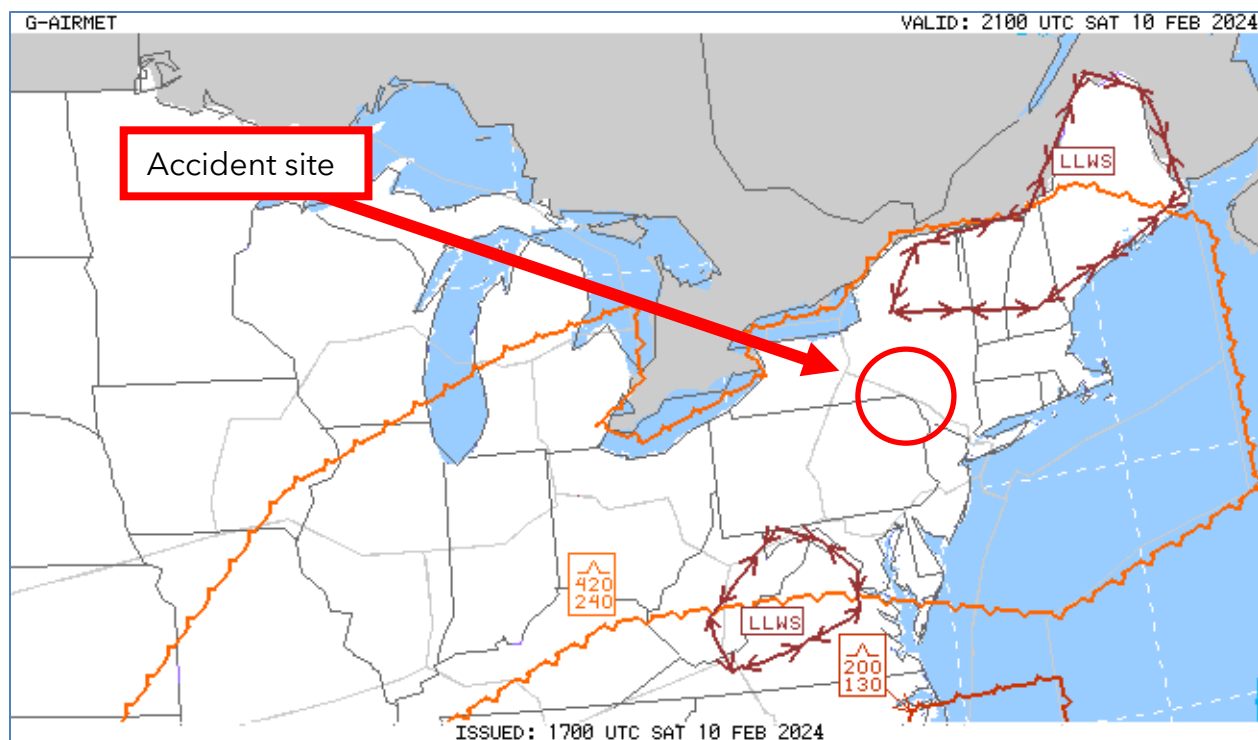
**Figure 25.** GFA Surface Forecast valid at 1600 EST with forecast issued at 0801 EST.



**Figure 26.** GFA Aviation Clouds Forecast valid at 1600 EST with forecast issued at 0802 EST.



**Figure 27.** G-AIRMET Zulu valid at 1600 EST with forecast issued at 1221 EST.



**Figure 28.** G-AIRMET Tango valid at 1600 EST with forecast issued at 1200 EST.

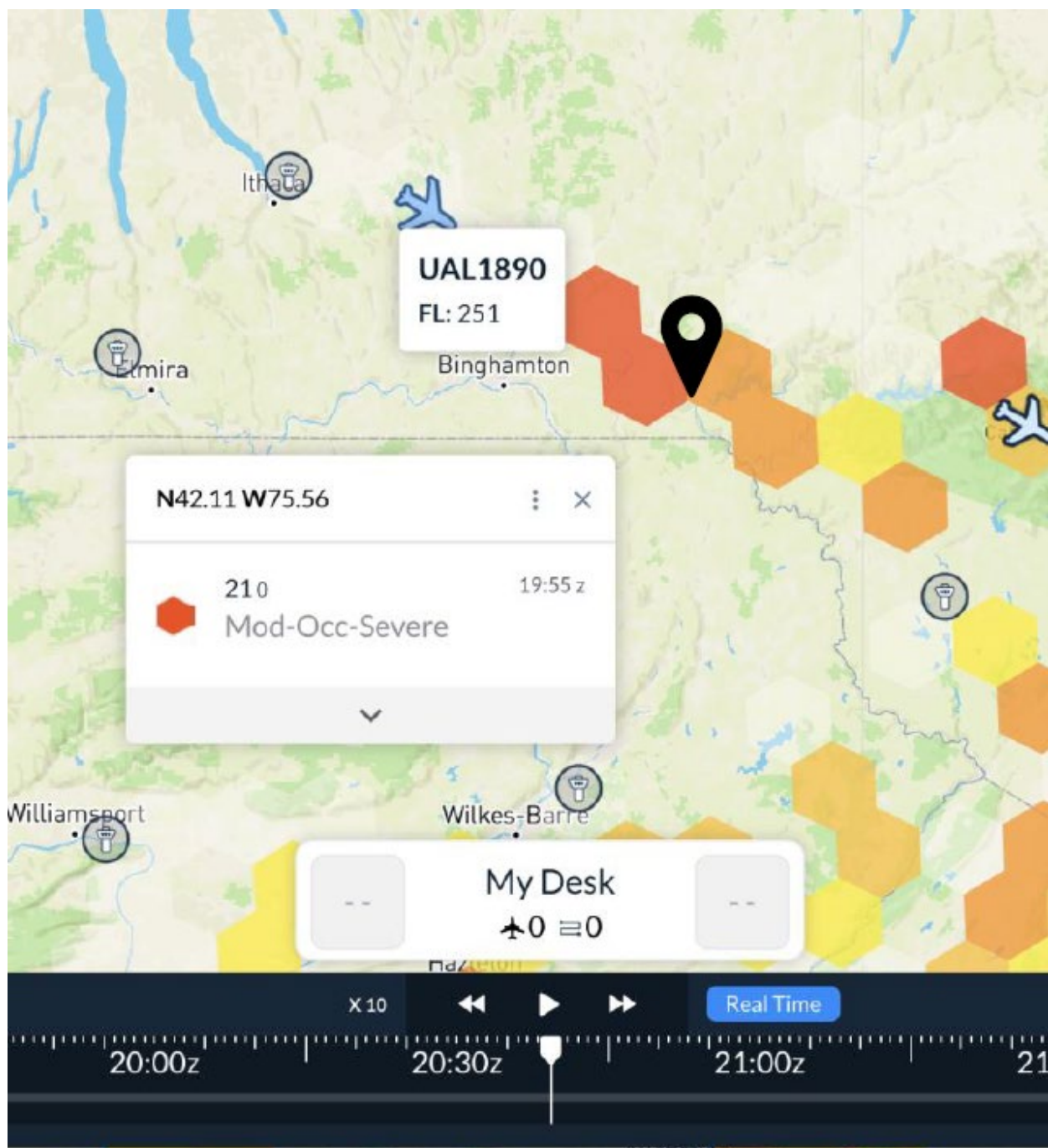
## 19.0 Pilot Weather Information

For more information regarding the pilots please see the Operational Factors factual report for this accident.

## 20.0 SkyPath Information

SkyPath<sup>44</sup> information was being reviewed and used by the accident pilots on the accident flight as supplemental turbulence information. The SkyPath information is available to pilots via a graphical tablet user interface similar to the exemplar image in figure 29. While the graphical information was not able to be retained around the accident time, the archived text data valid for the accident flight and in the region of the accident site can be found in attachments 8 through 10. For more information regarding the SkyPath application please see the Operational Factors factual report for this accident.

<sup>44</sup> [SkyPath - Your Ride Quality Partner](#)



**Figure 29.** SkyPath exemplar image around the accident flight.

## 21.0 United Weather Information

For this accident United requested their weather provider for a synopsis of the weather conditions surrounding the accident. That synopsis and weather review can be found in attachment 7.

**E. LIST OF ATTACHMENTS**

Attachment 1 - GOES-16 visible satellite imagery animation from 1406 to 1606 EST with GLM flash display

Attachment 2 - KBGM WSR-88D base reflectivity animation from 1513 to 1559 EST

Attachment 3 - ZBW CWSU PDWB valid on the day of the accident

Attachment 4 - ZBW CWSU shift log

Attachment 5 - GTGN dataset for the accident time

Attachment 6 - Sector 24 ERAM animation from 1530 to 1546 EST

Attachment 7 - United accident weather review

Attachment 8 - SkyPath archive information

Attachment 9 - SkyPath database information 1

Attachment 10 - SkyPath database information 2

Submitted by:

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