



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

February 12, 2018

Weather Study

METEOROLOGY

WPR18FA053

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A. ACCIDENT

Location: Thompson's Station, Tennessee
Date: December 21, 2017
Time: about 1307 central standard time (1907 UTC)¹
Airplane: Type: Zodiac 601XL; Registration: N929GB

B. METEOROLOGIST

Mike Richards
Senior Meteorologist
Operational Factors Division (AS-30)
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C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's meteorological specialist did not travel in support of this accident investigation and gathered all weather data remotely. Unless otherwise noted, all times are in central standard time (CST) for December 21, 2017 (based upon the 24-hour clock), directions are referenced to true north, distances are in nautical miles and heights are above mean sea level (msl).

Coordinates used for the accident location: 35.819171° north latitude, 87.046571° west longitude, at an elevation of about 1,005 feet.

D. WEATHER INFORMATION

1.0 Synoptic Conditions

The Southeastern portion of the continental United States National Weather Service (NWS) Surface Analysis Chart for 1200 CST is presented in figure 1. The surface analysis chart showed a west-to-east-oriented stationary front in northern Tennessee immediately to the north of the accident location. Station models throughout Tennessee and southern Kentucky identified overcast sky conditions, with (generally) southerly winds of 10 knots or less, with some station models identifying dew point depressions of 0° Fahrenheit. A WSR-88D regional radar composite reflectivity mosaic obtained from the National Centers for Environmental Information (NCEI) for 1305 CST (figure 2) did not identify any values of reflectivity across the region.

¹ UTC – abbreviation for Coordinated Universal Time

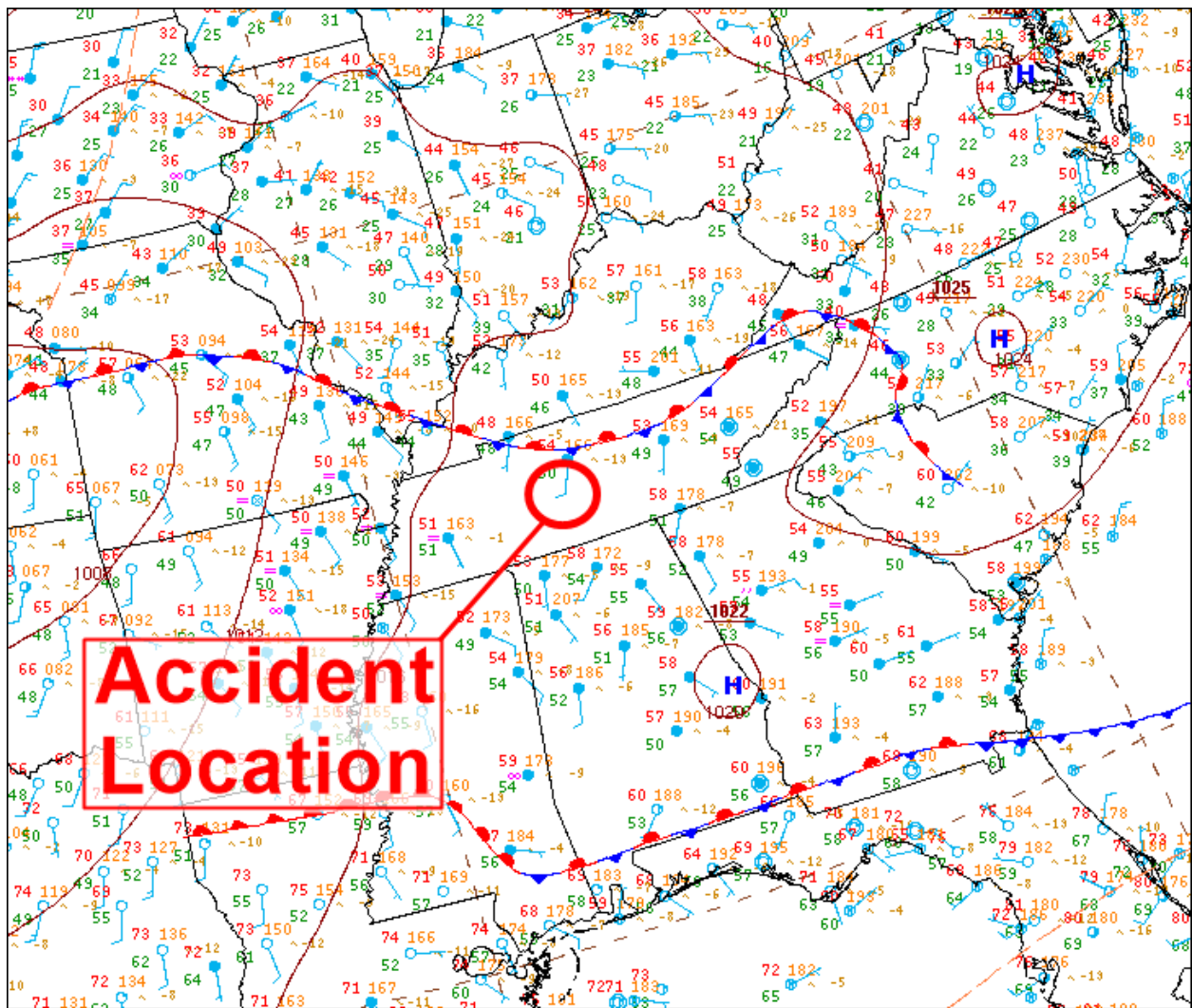


Figure 1 – Southeastern continental United States portion of the NWS Surface Analysis Chart for 1200 CST.

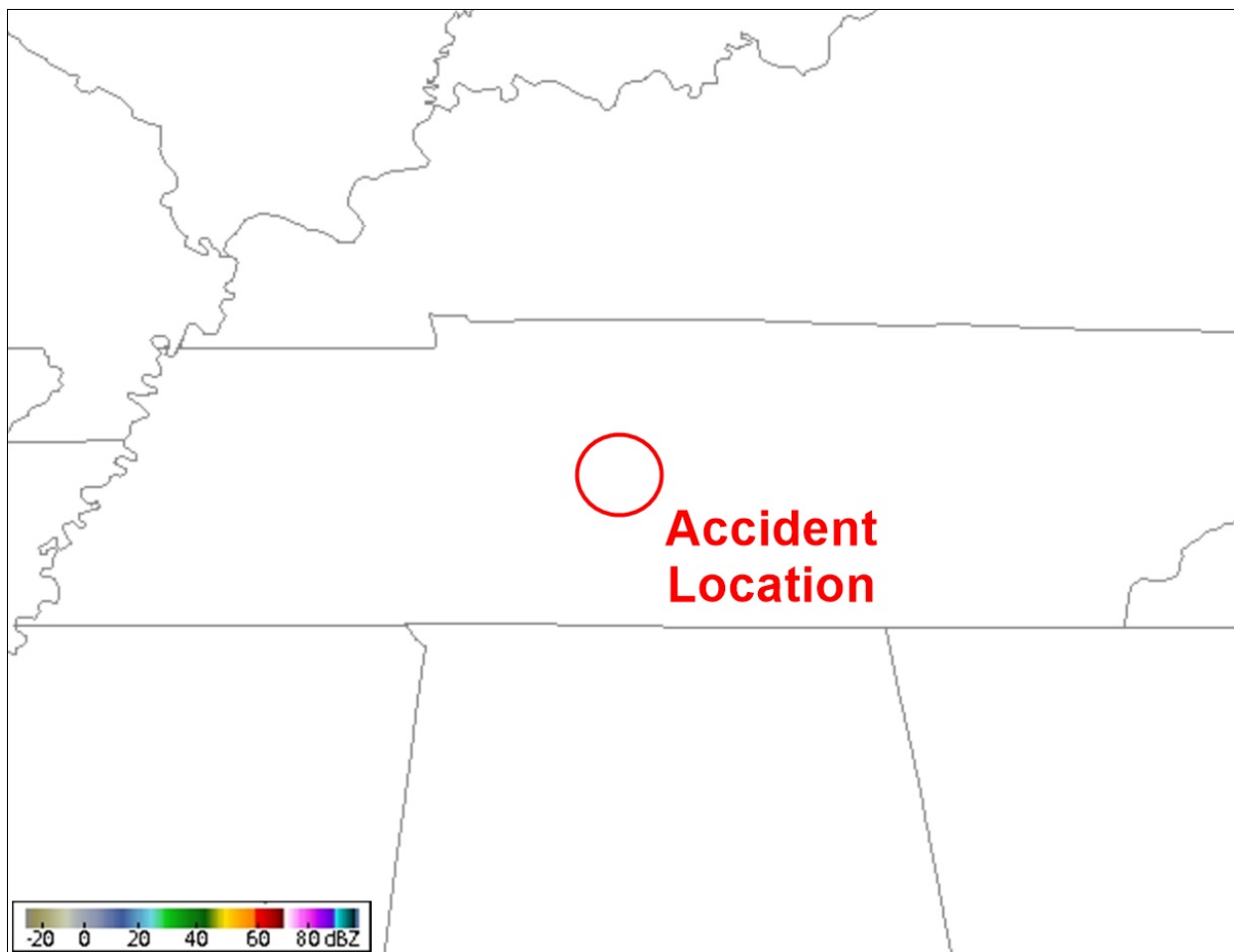


Figure 2 – NCEI WSR-88D mosaic from 1305 CST.

2.0 Surface Observations

An Automated Weather Observing System (AWOS) was located at Maury County Airport (MRC)² in Columbia, Tennessee, and was located about 17 miles south-southwest of the accident location at an elevation of 681 feet. Automated reports from MRC during the times surrounding the accident time are presented here. Observations throughout the period identified overcast ceilings between 400 and 600 feet above ground level (agl), visibilities from 7 statute miles to 10 statute miles or greater and dew point depressions of 0° Celsius (C).

² The National Weather Service uses the 4-digit International Civil Aviation Organization (ICAO) format for station identifiers (as seen in the body of some formatted weather observations). This report uses the 3-digit International Air Transport Association format for station identification, which does not use the geographic designating digit (“K” for stations in the continental U.S. and “P” for U.S. stations in Alaska and the Pacific region) as found in the ICAO format.

[1135 CST] METAR KMRC 211735Z AUTO 19008KT 10SM OVC004 11/11 A3001
RMK A01=

[1155 CST] METAR KMRC 211755Z AUTO 20008KT 10SM OVC005 11/11 A3001
RMK A01=

[1215 CST] METAR KMRC 211815Z AUTO 20007KT 10SM OVC005 11/11 A3002
RMK A01=

[1235 CST] METAR KMRC 211835Z AUTO 19009KT 10SM OVC006 11/11 A3002
RMK A01=

[1255 CST] METAR KMRC 211855Z AUTO 20009KT 7SM OVC005 11/11 A3001
RMK A01=

[1315 CST] METAR KMRC 211915Z AUTO 18007KT 10SM OVC006 11/11 A3001
RMK A01=

[1335 CST] METAR KMRC 211935Z AUTO 20010KT 9SM OVC006 11/11 A3001
RMK A01=

An AWOS was located at John C. Tune Airport (JWN) in Nashville, Tennessee, and was located about 23 miles north-northeast of the accident location at an elevation of 501 feet. Automated reports from JWN during the times surrounding the accident time are presented here. Observations throughout the period identified overcast ceilings between 600 and 800 feet agl, visibilities from 8 statute miles to 10 statute miles or greater and dew point depressions of 1° C and 2° C.

[1115 CST] METAR KJWN 211715Z AUTO 18008KT 9SM OVC007 11/10 A3001
RMK A01=

[1135 CST] METAR KJWN 211735Z AUTO 16007KT 9SM OVC007 11/10 A3001
RMK A01=

[1155 CST] METAR KJWN 211755Z AUTO 19010KT 8SM OVC008 11/10 A3000
RMK A01=

[1215 CST] METAR KJWN 211815Z AUTO 18007KT 10SM OVC007 11/10 A3000
RMK A01=

[1235 CST] METAR KJWN 211835Z AUTO 20006KT 10SM OVC007 11/10 A3001
RMK A01=

[1255 CST] METAR KJWN 211855Z AUTO 19010KT 10SM OVC007 11/10 A3001
RMK A01=

[1315 CST] METAR KJWN 211915Z AUTO 21008KT 10SM OVC007 11/10 A3000
RMK A01=

[1335 CST] METAR KJWN 211935Z AUTO 21007KT 10SM OVC006 12/10 A3000
RMK A01=

An Automated Surface Observing System was located at Nashville International Airport (BNA) in Nashville, Tennessee, and was located about 25 miles northeast of the accident location at an elevation of 599 feet. Reports from BNA during the times surrounding the accident time, which were augmented by a weather observer, are presented here. Observations throughout the period identified overcast ceilings between 900 and 1,100 feet agl, visibilities of 10 statute miles or greater and dew point depressions of 2° C and 3° C.

[1153 CST] METAR KBNA 211753Z 20008KT 10SM OVC009 12/10 A3002 RMK AO2
SLP166 60000 T01220100 10122 20083 58013=
[1253 CST] METAR KBNA 211853Z 21009KT 10SM OVC009 13/11 A3003 RMK AO2
SLP167 T01330106=
[1303 CST] SPECI KBNA 211903Z 21009KT 10SM OVC010 13/11 A3003 RMK AO2
T01330106=
[1353 CST] METAR KBNA 211953Z 21013KT 10SM OVC011 14/11 A3001 RMK AO2
SLP163 T01390106=

An AWOS was located at Smyrna Airport (MQY) in Smyrna, Tennessee, and was located about 28 miles east-northeast of the accident location at an elevation of 543 feet. Reports from MQY during the times surrounding the accident time, which were augmented by a weather observer, are presented here. Observations throughout the period identified overcast ceilings between 900 and 1,300 feet agl, visibilities of 10 statute miles or greater and dew point depressions of 2° C.

[1156 CST] METAR KMQY 211756Z 18009KT 10SM OVC009 13/11 A3003 RMK
AO2 SLP117 P0001 60005 T01280106 10128 20078 58016=
[1225 CST] SPECI KMQY 211825Z VRB04KT 10SM OVC011 13/11 A3003 RMK
AO2 P0001=
[1256 CST] METAR KMQY 211856Z 20005KT 10SM OVC011 14/12 A3003 RMK
AO2 SLP115 P0001 T01390117=
[1356 CST] METAR KMQY 211956Z 20008G15KT 10SM OVC013 14/12 A3002 RMK
AO2 SLP108 P0001 T01440117=

An AWOS was located at Bomar Field-Shelbyville Municipal Airport (SYI) in Shelbyville, Tennessee, and was located about 34 miles southeast of the accident location at an elevation of 800 feet. Automated reports from SYI during the times surrounding the accident time are presented here. Observations throughout the period identified overcast ceilings between 1,100 and 1,400 feet agl, visibilities of 10 statute miles or greater and dew point depressions of 2° C.

[1135 CST] METAR KSYI 211735Z AUTO 19011KT 10SM OVC011 14/12 A3002
RMK A01=
[1155 CST] METAR KSYI 211755Z AUTO 19012KT 10SM OVC011 14/12 A3002
RMK A01=

[1215 CST] METAR KSYI 211815Z AUTO 19011KT 10SM OVC011 14/12 A3002
RMK A01=

[1235 CST] METAR KSYI 211835Z AUTO 19012KT 10SM OVC012 14/12 A3002
RMK A01=

[1255 CST] METAR KSYI 211855Z AUTO 19011KT 10SM OVC014 14/12 A3002
RMK A01=

[1315 CST] METAR KSYI 211915Z AUTO 19011G18KT 10SM OVC014 14/12 A3002
RMK A01=

[1335 CST] METAR KSYI 211935Z AUTO 20013KT 10SM OVC013 14/12 A3002
RMK A01=

3.0 Pilot Reports

The following pilot reports were made in the accident region prior to the accident time.

BNA UA /OV BNA240003/TM 1655/FLDURC/TP CRJ7/SK OVC013-TOP022=

At 1055 CST, an Bombardier CRJ-700 type aircraft located 3 miles on the 240° radial from BNA, reported overcast clouds at 1,300 feet with clouds tops at 2,200 during climb.

BNA UA /OV BNA020003/TM 1657/FLDURD/TP E170/SK OVC013-TOP022=

At 1057 CST, an Embraer 170 type aircraft located 3 miles on the 020° radial from BNA, reported overcast clouds at 1,300 feet with clouds tops at 2,200 during decent.

BNA UA /OV BNA020003/TM 1732/FLDURD/TP CRJ7/SK OVC013-TOP UNK=

At 1132 CST, an Bombardier CRJ-700 type aircraft located 3 miles on the 020° radial from BNA, reported overcast clouds at 1,300 feet with clouds tops unknown during decent.

BNA UA /OV BNA250005/TM 1745/FLDURC/TP LJ45/SK OVC013-TOP024=

At 1145 CST, an Learjet 45 type aircraft located 5 miles on the 250° radial from BNA, reported overcast clouds at 1,300 feet with clouds tops at 2,400 feet during climb.

BNA UA /OV BNA020004/TM 1855/FLDURD/TP B737/SK OVC015-TOP025=

At 1255 CST, an Boeing 737 type aircraft located 4 miles on the 020° radial from BNA, reported overcast clouds at 1,500 feet with clouds tops at 2,500 feet during decent.

4.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR) model³ sounding (figure 3) valid for the accident location at 1300 CST was retrieved from the NOAA Air Resources Laboratory. The wind near the surface was from the south-southwest at about 10 knots. Above this level, the wind veered slightly with height and increased in magnitude to a west wind of about 30 knots at about 10,000 feet. Below 3,000 feet the relative humidity was 93 percent or greater. The freezing level was at about 12,000 feet. Calculations made by the Rawinsonde OBServation Program did not identify any layers of potential significant turbulence.

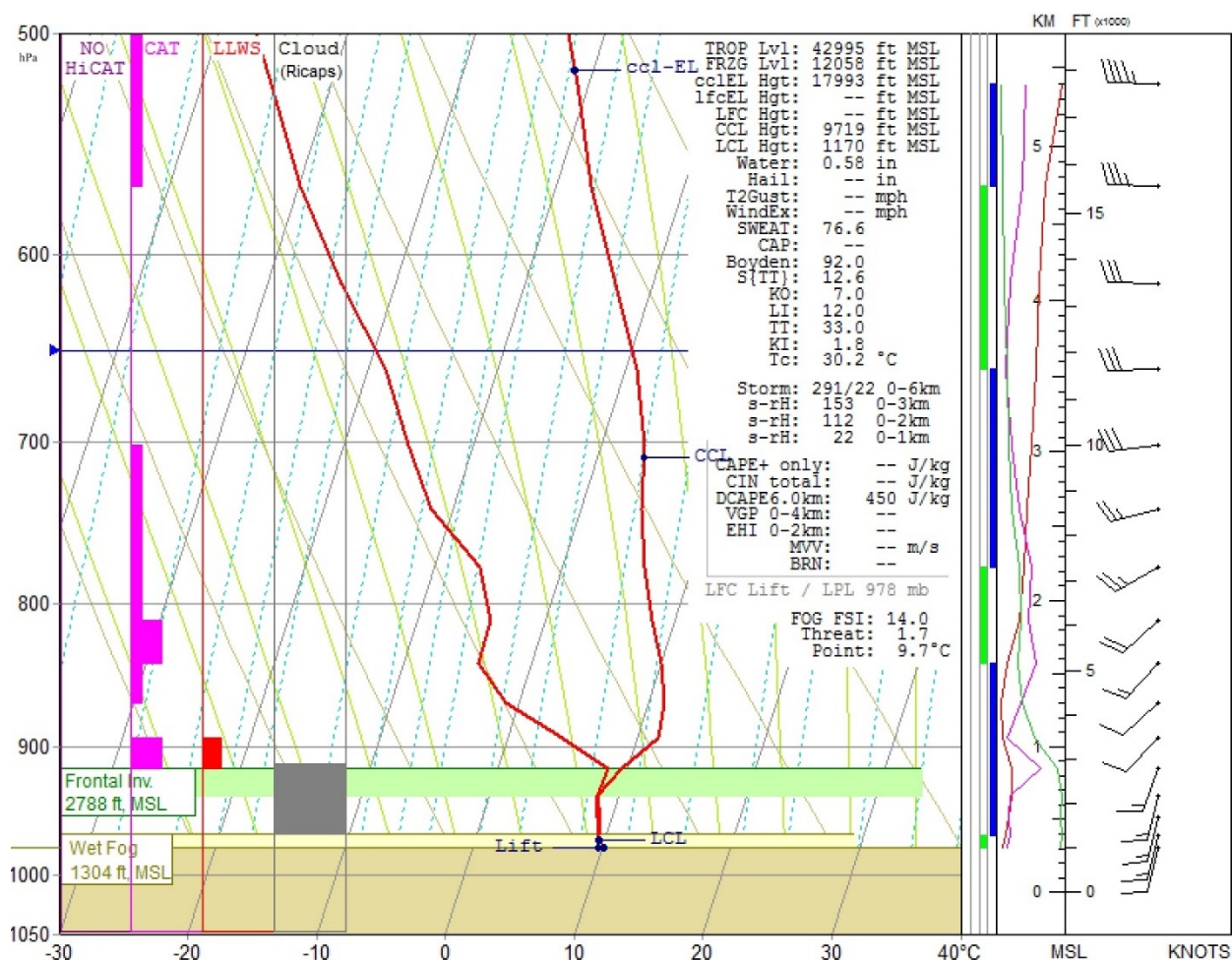


Figure 3 – HRRR model sounding data in SkewT/LogP format for 1300 CST at the accident site, surface to 500 hectopascals.

³ The HRRR is a National Oceanic and Atmospheric Administration (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.

5.0 Satellite Imagery

Geostationary Operational Environmental Satellite (GOES)-16 “visible” ($0.64\mu\text{m}$) and infrared ($10.3\mu\text{m}$) data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison. Imagery from 1307 CST are presented in figures 4 and 5. The GOES-16 visible data revealed extensive cloudy conditions over the accident region. Some of these clouds exhibited a wave-like pattern. Minimum infrared cloud-top temperatures over the accident location were 7°C , which, according to the HRRR model sounding, corresponded to cloud top heights of about 6,900 feet. However, because of a temperature inversion at lower levels, confidence in this cloud top height is not high, and the minimum brightness temperatures may correspond more to cloud top heights below 3,000 feet. It should be noted figures 4 and 5 have not been corrected for any parallax error.

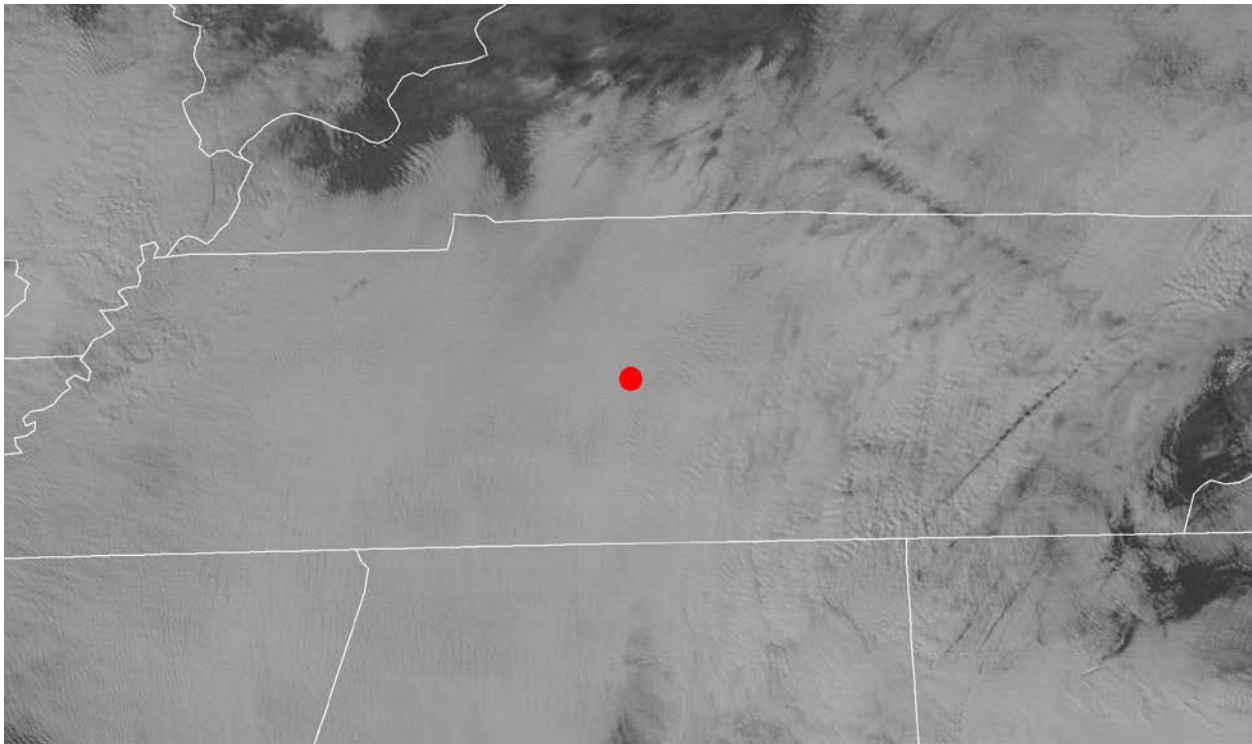


Figure 4 – GOES-16 visible imagery from 1307 CST. Accident location denoted by red circle.

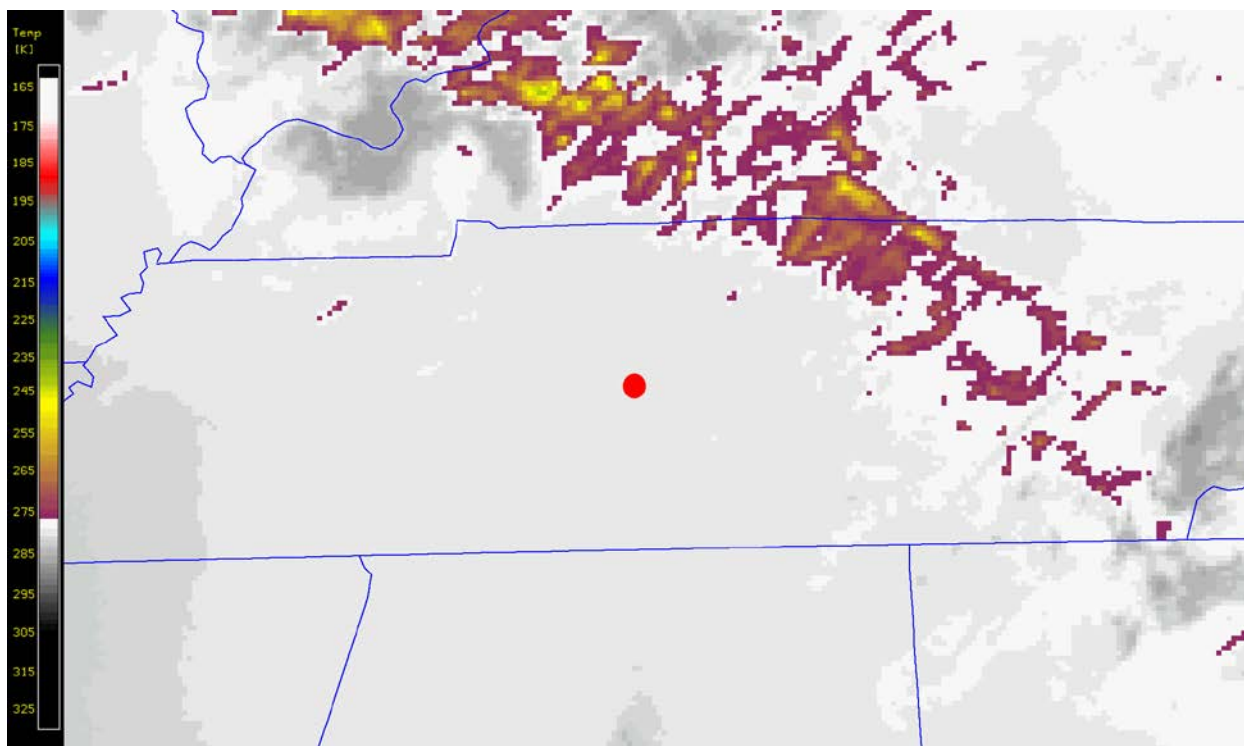


Figure 5 – GOES-16 infrared brightness temperature (degrees Kelvin) imagery from 1307 CST. Accident location denoted by red circle.

6.0 Terminal Aerodrome Forecasts

The departure and destination airports did not have Terminal Aerodrome Forecasts (TAF). There were no TAF sites close to the accident location. The following TAFs were issued for BNA and MQY prior to the accident time. Conditions forecasted in the TAF are only valid within 5 statute miles from the forecast site.

[1136 CST] KMQY 211736Z 2118/2218 **19005KT 4SM BR OVC009**
 FM212000 19008KT P6SM BKN012
 FM220300 20008KT P6SM BKN009
 FM220800 19012KT 6SM -DZ OVC008
 FM221500 19013KT 4SM -RA OVC007=

The 1136 CST MQY TAF forecasted for the accident time: wind from 190° at 5 knots, visibility of 4 statute miles, mist and ceiling overcast at 900 feet agl.

[1257 CST] KMQY 211857Z 2119/2218 **19008KT P6SM BKN012**
 FM220300 20008KT P6SM BKN009
 FM220800 19012KT 6SM -DZ OVC008
 FM221500 19013KT 4SM -RA OVC007=

The 1257 CST MQY TAF (amendment) forecasted for the accident time: wind from 190° at 8 knots, visibility greater than 6 statute miles and ceiling broken at 1,200 feet agl.

[1136 CST] KBNA 211736Z 2118/2218 **19005KT P6SM OVC009**

FM212100 18008KT P6SM BKN012

FM220300 17008KT P6SM BKN009

FM220800 18012KT 6SM -DZ OVC008

FM221500 18013KT 4SM -RA OVC007=

The 1136 CST BNA TAF forecasted for the accident time: wind from 190° at 5 knots, visibility greater than 6 statute miles and ceiling overcast at 900 feet agl.

7.0 Area Forecast Discussion

An Area Forecast Discussion (AFD) was issued at 1147 CST by the NWS Weather Forecast Office in Nashville, Tennessee. The Aviation section of that AFD is presented here.

FXUS64 KOHX 211747

AFDOHX

Area Forecast Discussion

National Weather Service Nashville TN

1147 AM CST Thu Dec 21 2017

.UPDATE...

FOR 18Z AVIATION DISCUSSION.

.AVIATION...

18Z TAF DISCUSSION.

Widespread IFR ceilings have been slow to lift and expected to generally remain this way, although some breaks into MVFR are likely later this afternoon, at least for a few hours. IFR expected to redevelop later this evening and overnight ahead of precipitation that will overspread the region early Friday. This activity will initially begin light, possibly as drizzle, then increase in intensity by late Friday morning and last through much of the day and evening. Prolonged IFR or LIFR is likely through this time.

8.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) are intended to provide the necessary aviation weather information to give users a complete picture of the weather that may impact flight in the continental United States. Hourly model data and forecasts, including information on clouds, flight category, precipitation, icing, turbulence, wind, and other output from the NWS are available, however only certain imagery are archived by the NWS.

AVIATION CLOUDS FORECAST

VALID AT 1800 UTC THU 21 DEC 2017

FORECASTED POINTS MAY NOT REPRESENT CONDITION IN PROXIMITY

CLOUD COVERAGE: FEW SCT BKN OVC

CLOUD LAYERS: COVERAGE AND BASE (MSL)

AIRMETS: MKN OBSC

AVIATION WEATHER CENTER (NOAA/NWS/NCEP)

ISSUED AT 1602 UTC THU 21 DEC 2017

⁴ IFR conditions - Ceilings less than 1,000 feet agl and/or visibility less than three statute miles.

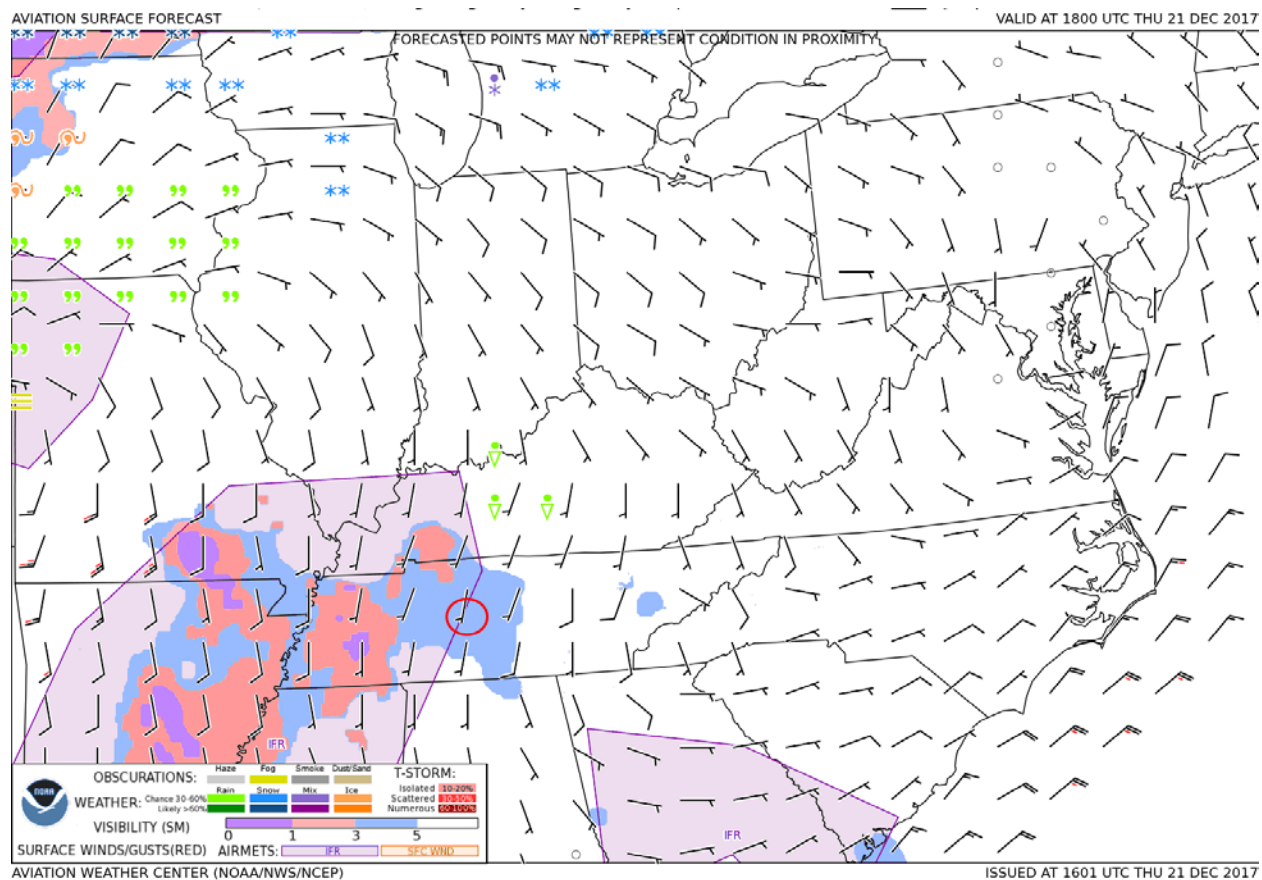


Figure 7 – GFA forecast imagery depicting IFR condition and surface wind AIRMETS, surface visibility, surface wind, precipitation, and other obscurations and hazards. Issued about 1000 CST and valid for 1200 CST. This GFA forecast imagery depicted a surface visibility of between 3 and 5 statute miles and a southerly surface wind of about 5 knots for the accident location. An IFR AIRMET was forecast to be close to the accident location. Accident location denoted by red circle in central Tennessee.

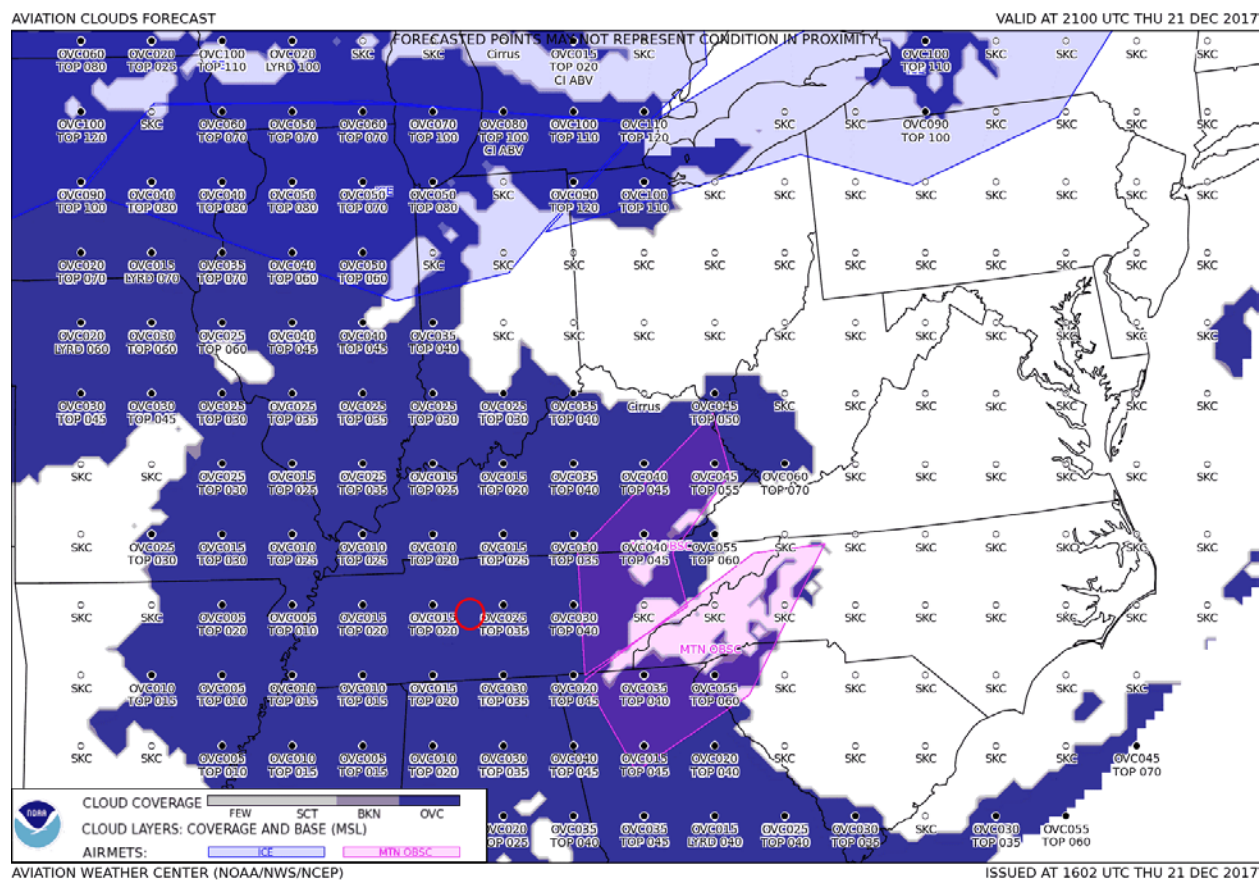


Figure 8 – GFA forecast imagery depicting sky condition and icing and mountain obscuration AIRMETS. Issued about 1000 CST and valid for 1500 CST. This GFA forecast imagery depicted overcast conditions with cloud bases between 1,500 and 2,500 feet above msl and cloud tops between 2,000 and 3,500 feet above msl in the area of the accident location. Accident location denoted by red circle in central Tennessee.

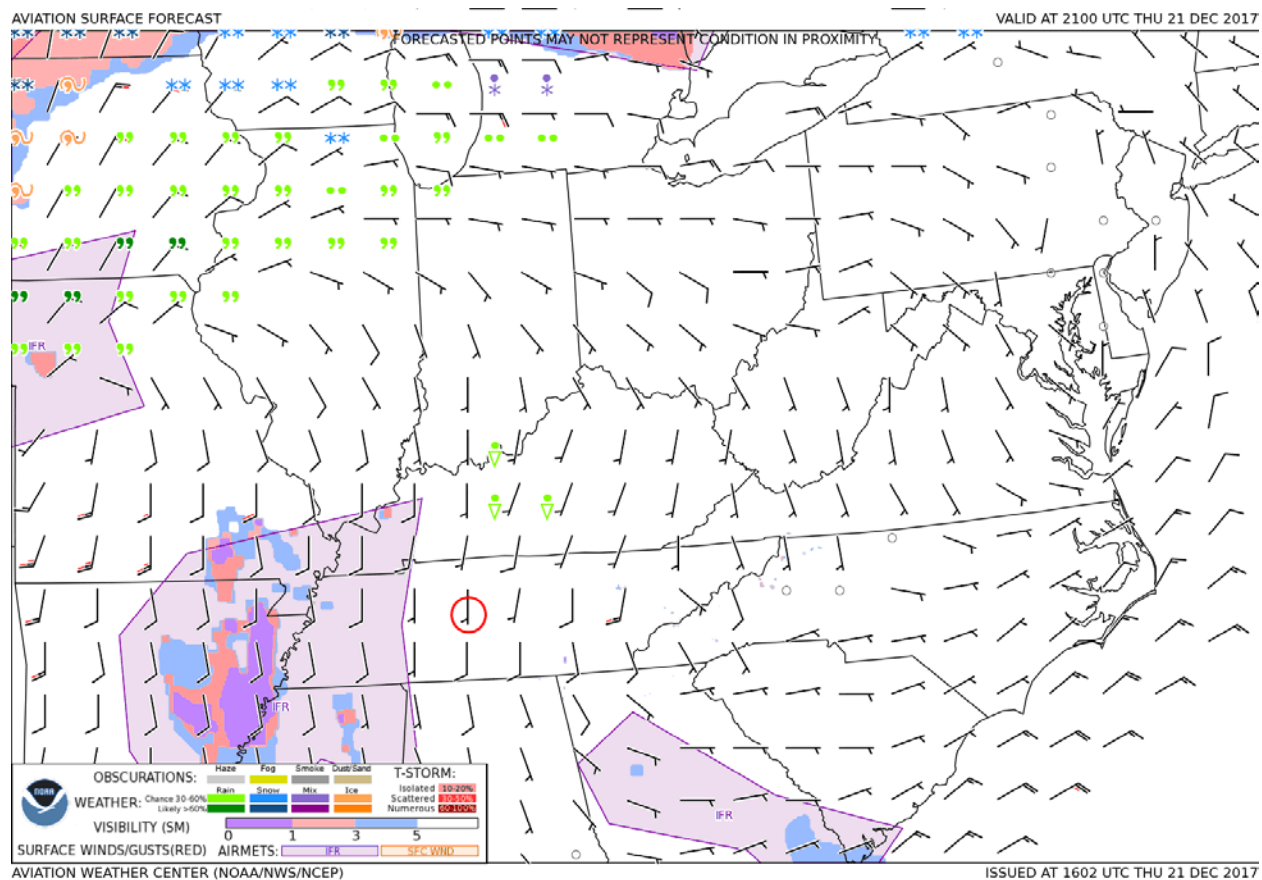


Figure 9 – GFA forecast imagery depicting IFR condition and surface wind AIRMETS, surface visibility, surface wind, precipitation, and other obscurations and hazards. Issued about 1000 CST and valid for 1500 CST. This GFA forecast imagery depicted a surface visibility greater than 5 statute miles and a southerly surface wind of 5-10 knots for the accident location. Accident location denoted by red circle in central Tennessee.

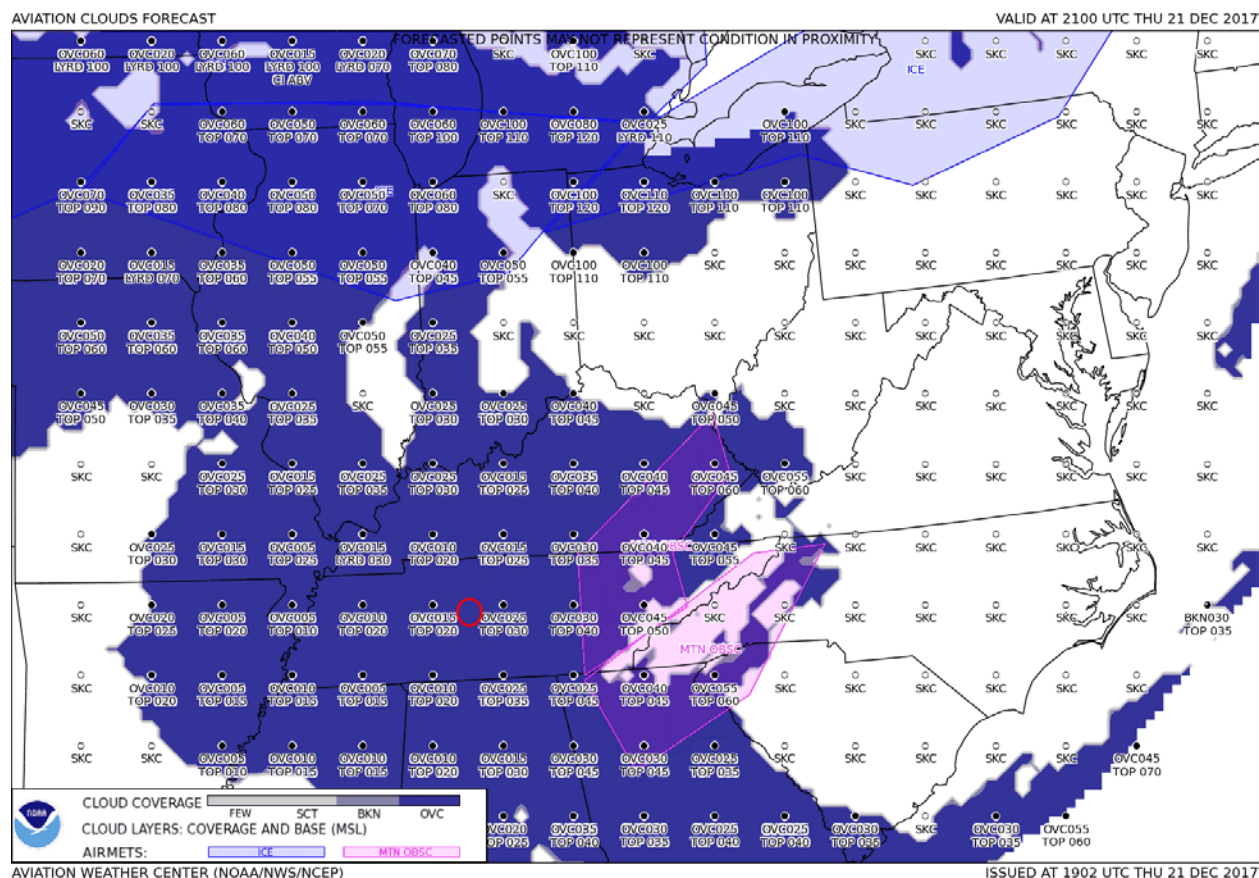


Figure 10 – GFA forecast imagery depicting sky condition and icing and mountain obscuration AIRMETS. Issued about 1300 CST and valid for 1500 CST. This GFA forecast imagery depicted overcast conditions with cloud bases between 1,500 and 2,500 feet above msl and cloud tops between 2,000 and 3,000 feet above msl in the area of the accident location. Accident location denoted by red circle in central Tennessee.

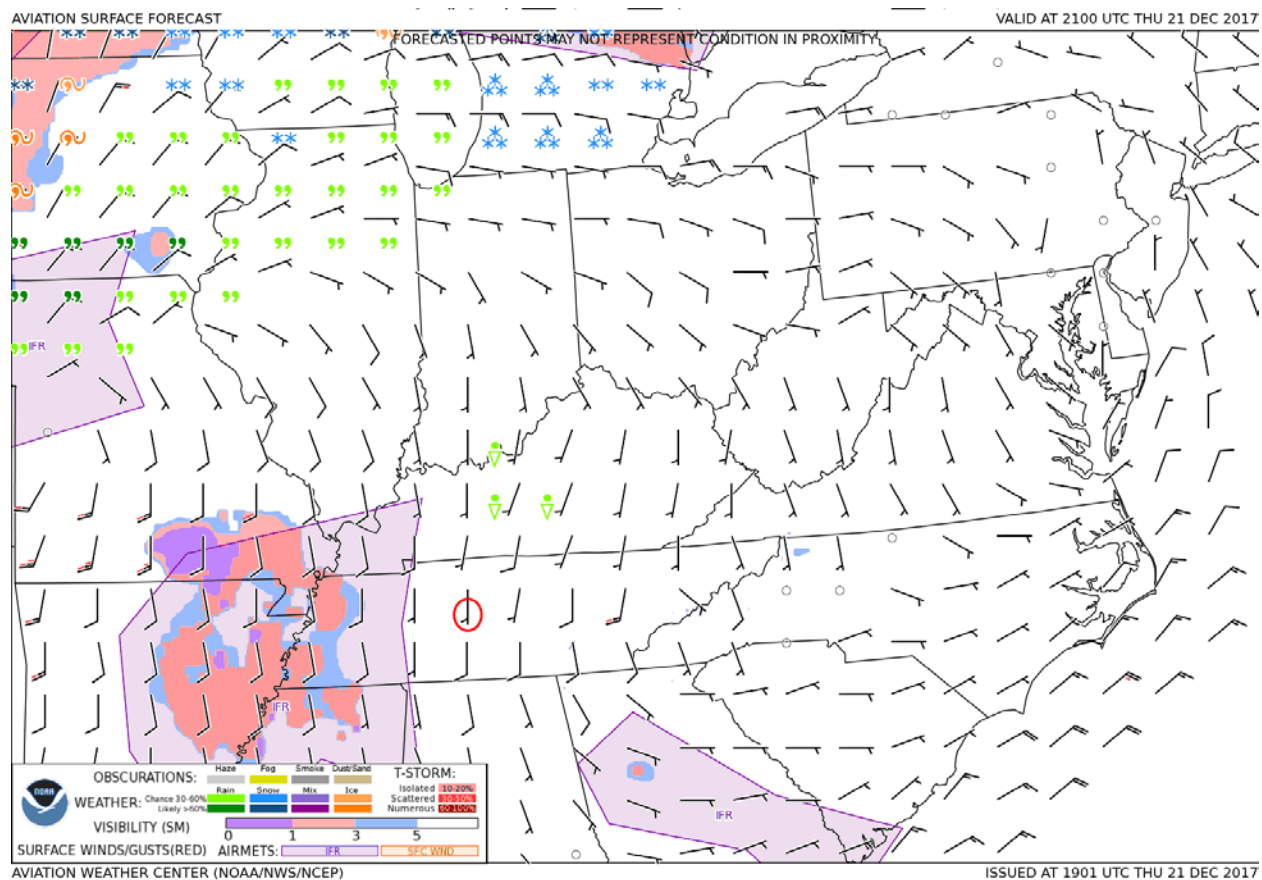


Figure 11 – GFA forecast imagery depicting IFR condition and surface wind AIRMETS, surface visibility, surface wind, precipitation, and other obscurations and hazards. Issued about 1300 CST and valid for 1500 CST. This GFA forecast imagery depicted a surface visibility greater than 5 statute miles and a southerly surface wind of 5-10 knots for the accident location. Accident location denoted by red circle in central Tennessee.

9.0 AIRMETs

There were no AIRMET advisories for icing or for turbulence below FL270 over the accident region. The following AIRMET for IFR conditions was active for the accident location at the accident time and advised of ceilings below 1,000 feet and visibilities below 3 statute miles with mist and fog.

WAUS44 KKCI 211445
WA4S
-DFWS WA 211445
AIRMET SIERRA UPDT 3 FOR IFR AND MTN OBSCN VALID UNTIL 212100
.
AIRMET IFR...OK TX AR TN LA MS AL MO IL IN KY
FROM BUM TO 40SSW COU TO 30WNW FAM TO 40E PXV TO 40E LOZ TO
20WSW HMV TO GQO TO 50SW PZD TO 40W CEW TO 60SE SJI TO 30N HRV
TO 30SSE MLU TO 20S EIC TO MLC TO 20SW RZC TO BUM
CIG BLW 010/VIS BLW 3SM BR/FG. CONDS CONTG BYD 21Z THRU 03Z.

10.0 SIGMETs

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

11.0 Center Weather Advisories

At 1148 CST, the Center Weather Service Unit at the Memphis Air Route Traffic Control Center issued the following Center Weather Advisory that was active for the accident location at the accident time and advised of an area of low instrument flight rule (LIFR)⁵ conditions with ceilings from 200 to 400 feet agl.

FAUS22 KZME 211748
ZME2 CWA 211750
ZME CWA 204 VALID UNTIL 211950
FROM 30WNW BWG-35S BNA-30ESE IGB-40W SQS-65NNE DYR-30WNW
BWG
**AREA LIFR CONDS. CIG 002 TO 004 IN. EXP CONDS TO CONT THRU 20Z
WITH SOME IMPROVEMENT.**

⁵ LIFR conditions – A subcategory of IFR conditions. Ceiling less than 500 feet agl and/or visibility less than one statute mile

12.0 Weather Depiction Charts

A Weather Depiction Chart details surface conditions as derived from METAR and other surface observations. It typically displays major fronts or areas of high and low pressure. The Weather Depiction Chart also provides a graphic display of IFR, visual flight rule (VFR)⁶, and marginal visual flight rule (MVFR)⁷ conditions. Areas of IFR conditions are shown by a hatched area outlined by a smooth line. MVFR regions are shown by a non-hatched area outlined by a smooth line. Areas of VFR are not outlined.

Figure 12 present the Weather Depiction Chart that was valid at 1300 CST.

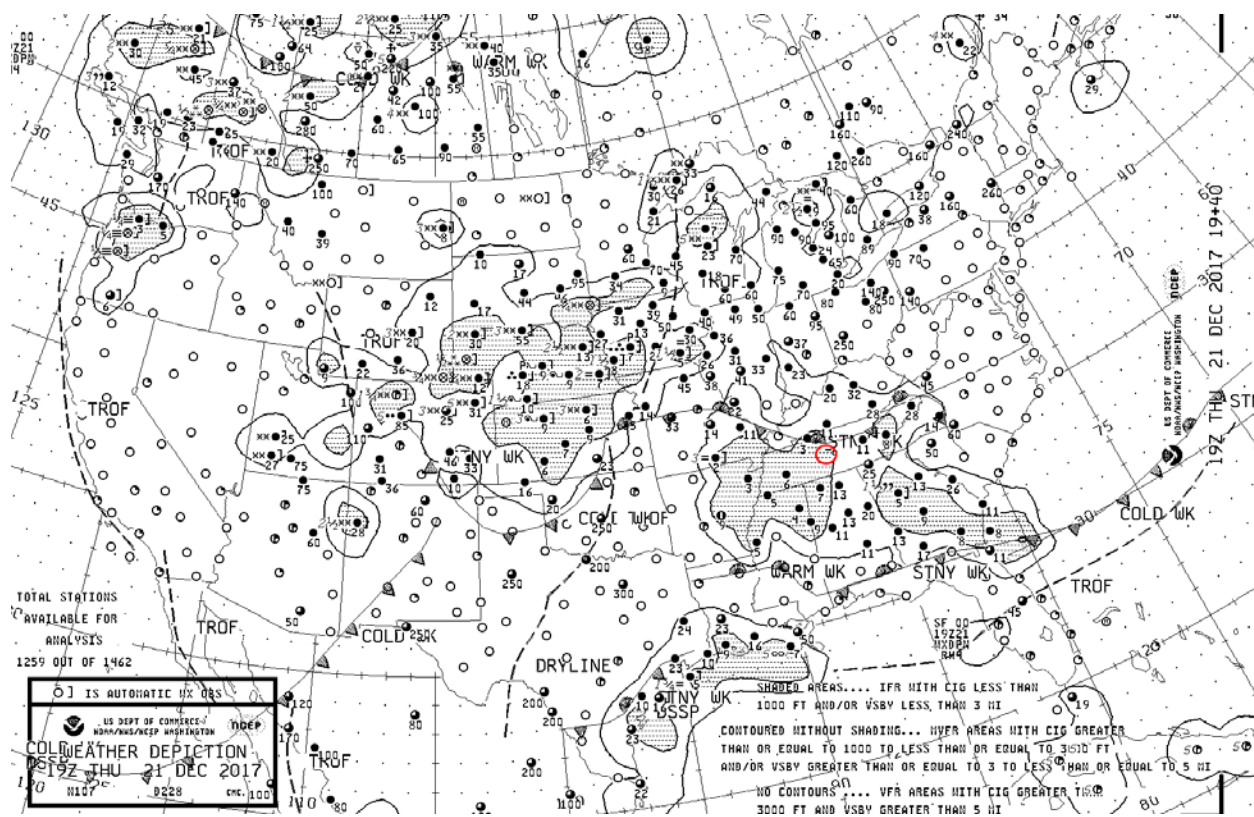


Figure 12 – Weather Depiction chart valid at 1300 CST depicted an area of IFR conditions at the accident location. The accident location is identified by the red circle over central Tennessee.

⁶ VFR conditions - Ceiling greater than 3,000 feet agl (or no ceiling) and visibility greater than five statute miles.

⁷ MVFR conditions - Ceilings between 1,000 and 3,000 feet agl (inclusive) and/or visibility between three and five statute miles (inclusive)

13.0 Prog Charts

The low-level Significant Weather (“prog”) chart graphic product is a forecast of aviation weather hazards, primarily intended to be used as a guidance product for briefing the VFR pilot. The forecast domain covers the 48 contiguous states, southern Canada and the coastal waters for altitudes below 24,000 ft. Low altitude prog charts are issued four times daily and are valid at fixed times: 0000, 0600, 1200, and 1800 UTC. Each chart is divided on the left and right into 12 and 24-hour forecast intervals (based on currently available model data). The two panels depict freezing levels, turbulence, and low cloud ceilings and/or restrictions to visibility (shown as contoured areas of MVFR and IFR conditions).

Figures 13 and 14 present low-level prog charts valid for the times surrounding the accident time. Because an official archive of this product was not available, these charts were retrieved from a non-government source.

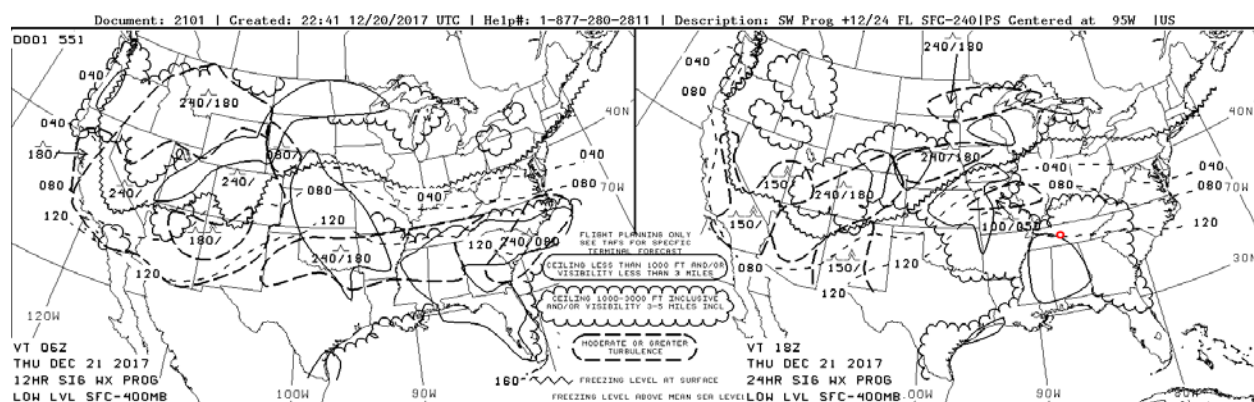


Figure 13 – Low level Prog chart created about 1640 CST on December 20, 2017, with the right-side panel valid for 1200 CST. The accident site (denoted by the red circle) was under a forecast for MVFR conditions and very close to an area of forecasted IFR conditions.

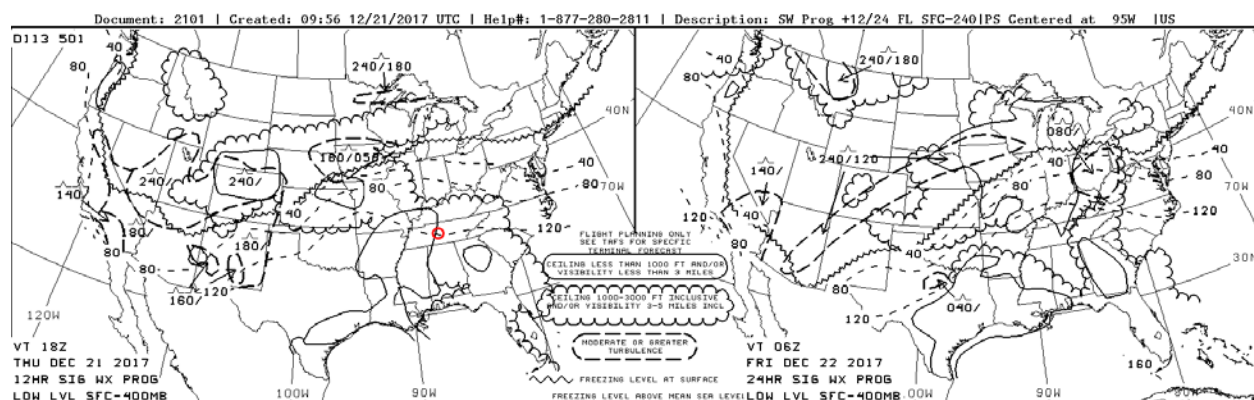


Figure 14 – Low level Prog chart created about 0400 CST, with the left-side panel valid for 1200 CST. The accident site (denoted by the red circle) was under a forecast for MVFR conditions and very close to an area of forecasted IFR conditions.

14.0 Astronomical

The astronomical data obtained from the United States Naval Observatory for 35° 49' north latitude and 87° 03' west longitude, for the accident location, indicated the following:

	SUN	
Sunrise		0655 CST
Sunset		1638 CST

Submitted by:

Mike Richards
Senior Meteorologist

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