

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



ERA23FA235

METEOROLOGY

Specialist's Factual Report

June 26, 2023

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A. ACCIDENT

Location: Summerville, South Carolina
Date: May 18, 2023
Time: 0024 eastern daylight time (EDT)
0424 coordinated universal time (UTC)
Airplane: Honda Aircraft HA-420; Registration: N255HJ

B. METEOROLOGY SPECIALIST

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National Transportation Safety Board
Washington, D.C.

C. SUMMARY

On May 18, 2023, about 0018 eastern daylight time, a Honda Aircraft Company HA-420 APMG, N225HJ, was destroyed when it was involved in an accident at the Summerville Airport (DYB), Summerville, South Carolina. The commercial pilot, and the five passengers were not injured. The airplane was being operated as a Title 14 Code of Federal Regulations Part 91 personal flight.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's Senior Meteorologist was not on scene for this investigation and conducted the meteorology phase of the investigation remotely, collecting data 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 report documents the general weather products and forecasts over the region during the period and the pertinent meteorological parameters related to the accident. All times are reported as EDT based upon the 24-hour clock, local time is -4 hours from UTC, and UTC=Z. NWS airport and weather 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. Directions are referenced to true north and distances in nautical miles. Heights are in feet (ft) above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The accident site was located at latitude 33.062278° N and longitude 80.280917° W, at an elevation of 56 ft.

1.0 Synoptic Conditions

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 (NCEP) and the WPC located in College Park, Maryland. These are the base products used in describing weather features and in the creation of forecasts and warnings. Reference to these charts can be found in the Federal Aviation Administration (FAA) "Aviation Weather Handbook", FAA-H-8083-28¹.

1.1 Surface Analysis Chart

The east-central portion of the NWS Surface Analysis Chart for 2300 EDT on May 17, 2023, depicting the conditions immediately prior to the accident is included as figure 1 with the approximate location of Summerville and the accident site marked by the red star. The chart depicted a low-pressure system at 1011-hectopascals (hPa)² over central South Carolina along a stationary front which extended east and west across the state. The accident site was located south of the frontal boundary in the warm air sector of the front. The station models surrounding the site depicted light winds, overcast clouds with a temperature of 70° Fahrenheit (F), and a dew point temperature of 70° F.

¹ <https://www.faa.gov/regulationspolicies/handbooksmanuals/aviation/faa-h-8083-28-aviation-weather-handbook>

² Hectopascals (hPa) is the standard unit for reporting pressure and is interchangeable with the former term millibar (mb) with the same units. The International Standard Atmosphere (ISA) which aircraft performance data is determined from are based at sea-level with a pressure of 1013.25-hPa at a temperature of 15° Celsius (C) or 59° Fahrenheit (F).

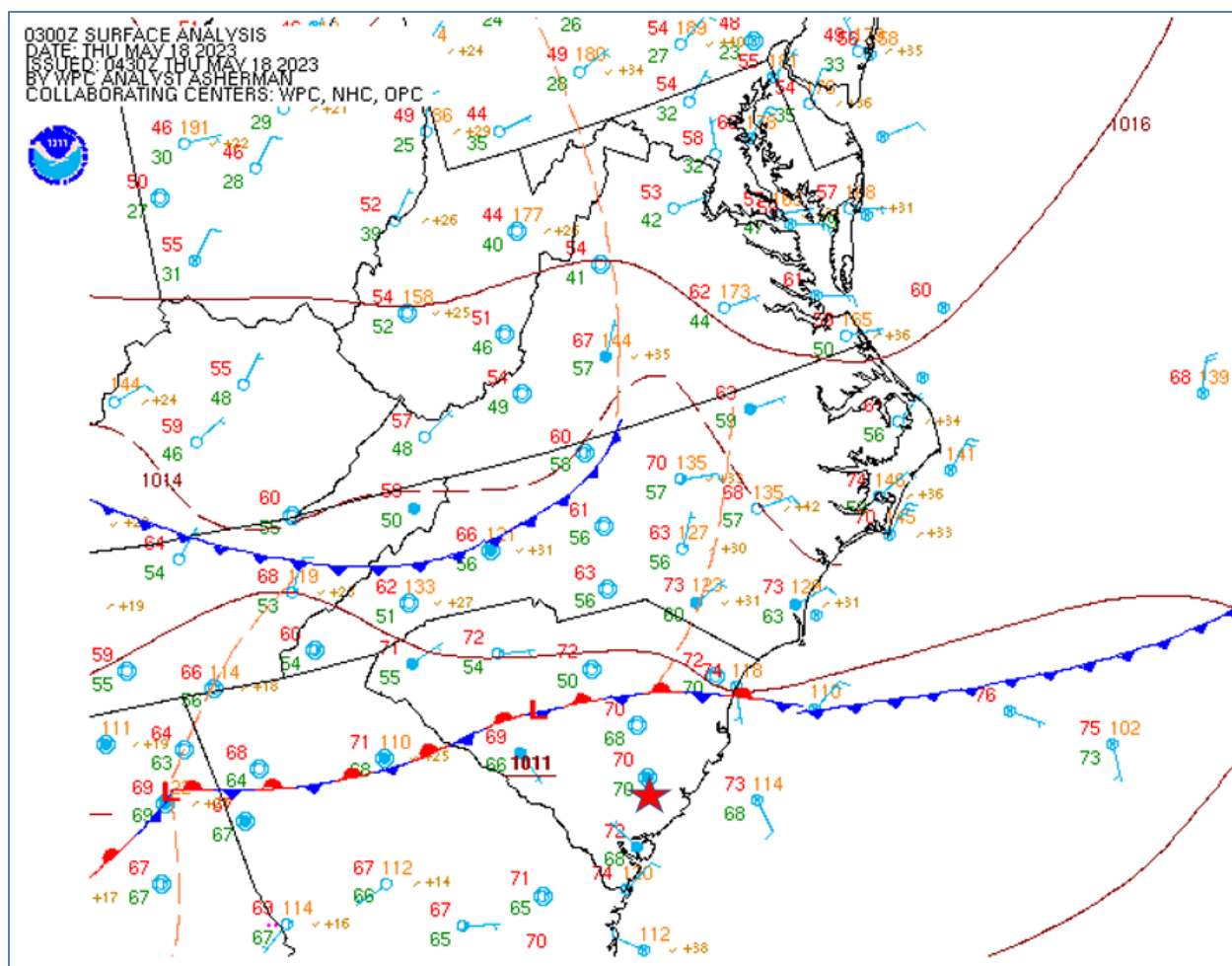


Figure 1 - NWS east-central section of the Surface Analysis Chart for 2300 EDT with the approximate accident site noted by the red star.

1.2 National Radar Composite Image

A review of the National Composite Radar Mosaic for 0025 EDT on May 18, 2023, is included as figure 2 with the accident site marked by the red star. The radar depicted several areas of precipitation over South Carolina, with the Summerville area under an area of echoes near 30 dBZ at 0025 EDT.

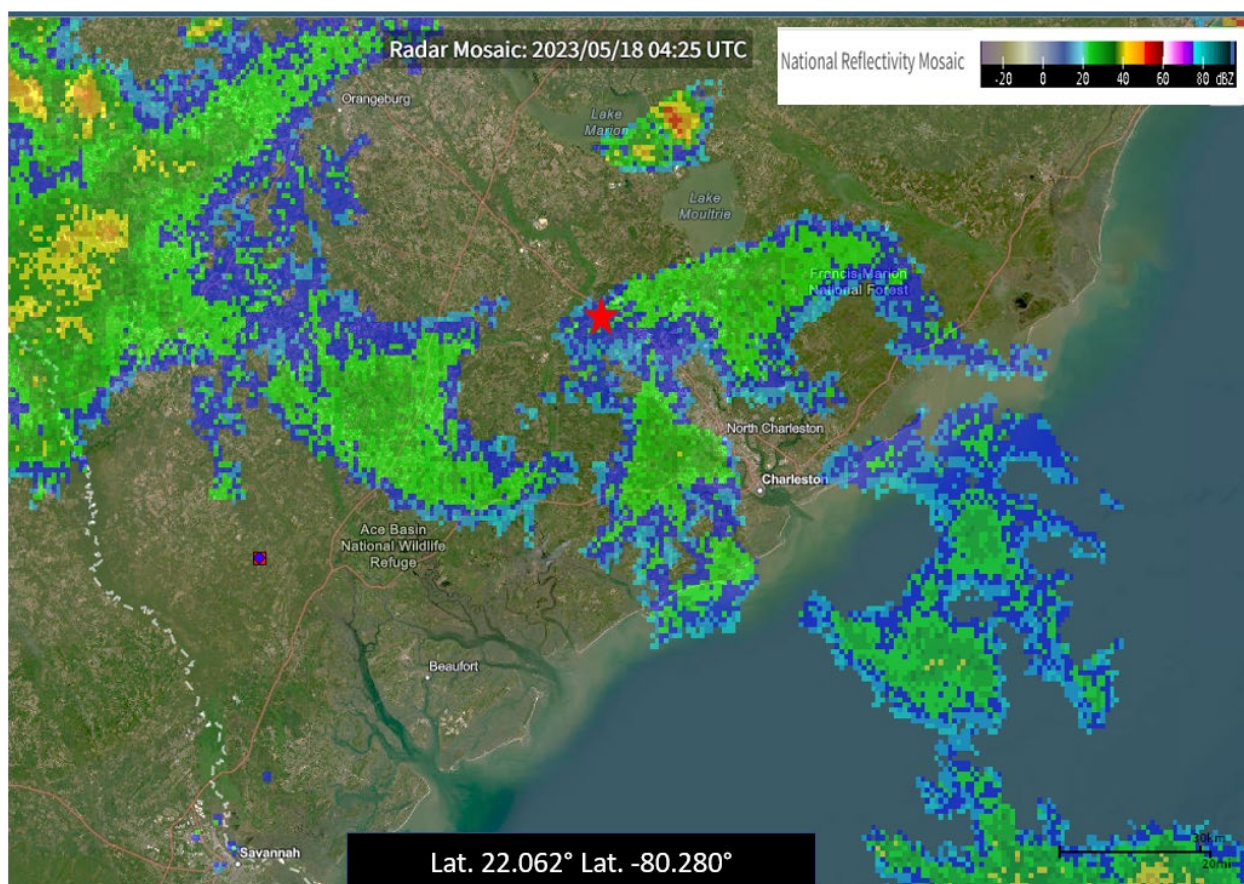


Figure 2 - Close up of the NWS National Composite Radar Mosaic for 0025 EDT over the area with the approximate accident site marked by the red star.

2.0 Surface Observations

The area surrounding the accident site was documented using official Aviation Routine Weather Reports (METAR) and Aviation Selected Special Weather Reports (SPECI). Cloud heights are reported above ground level (agl) in the following section, and the magnetic variation was estimated at 8° west based on the latest sectional chart for the area.

2.1 Summerville, South Carolina

The accident occurred while the aircraft was landing on runway 24 at Summerville Airport (KDYB), Summerville, South Carolina, which lists an elevation of 56 ft. The airport had an Automated Weather Observation System (AWOS), which was not augmented by any human observers and broadcasted weather locally on 119.575

VHF and disseminated longline³ on weather circuits every 20-minutes. Surrounding the time of the accident the following conditions were reported.

Weather observation for KDYB at 0015 EDT, automated, wind calm, visibility 6 miles in mist, a few clouds at 200 ft, ceiling broken at 3,200 ft, overcast at 10,000 ft, temperature 21° C, dew point temperature 21° C, altimeter setting 29.87 inches of mercury (inHg).

Accident 0024 EDT

Weather observation for KDYB at 0035 EDT, automated, wind calm, visibility 7 miles, ceiling broken at 400 ft, broken at 3,000 ft, overcast at 10,000 ft, temperature 21° C, dew point temperature 21° C, altimeter setting 29.86 inHg.

A review of the general flight categories⁴ and observations surrounding the period were as follows. The observations decoded above, and the time of the accident are in bold italic type for reference.

VFR METAR KDYB 172155Z AUTO 00000KT 9SM VCTS FEW075 SCT100 24/21 A2976 RMK AO2 LTG DSNT ALQDS
MVFR METAR KDYB 172215Z AUTO 00000KT 5SM VCTS RA BR FEW033 SCT047 BKN060 24/23 A2977 RMK AO2 LTG DSNT E-S
MVFR METAR KDYB 172235Z AUTO 00000KT 3SM -RA BR FEW033 SCT043 BKN049 23/23 A2978 RMK AO2 LTG DSNT E-SW
VFR METAR KDYB 172255Z AUTO 00000KT 7SM -RA FEW045 SCT065 BKN120 23/23 A2977 RMK AO2 LTG DSNT E AND SE P0003
VFR METAR KDYB 172315Z AUTO 00000KT 9SM CLR 23/23 A2977 RMK AO2 LTG DSNT E AND SE AND W
VFR METAR KDYB 172335Z AUTO 00000KT 9SM CLR 23/23 A2978 RMK AO2 LTG DSNT ALQDS
VFR METAR KDYB 172355Z AUTO VRB03KT 9SM CLR 22/22 A2979 RMK AO2 LTG DSNT ALQDS=
VFR METAR KDYB 180015Z AUTO 00000KT 9SM CLR 22/22 A2981 RMK AO2 LTG DSNT ALQDS=
VFR METAR KDYB 180035Z AUTO VRB03KT 9SM CLR 22/22 A2982 RMK AO2 LTG DSNT SE-SW=
VFR METAR KDYB 180055Z AUTO 00000KT 9SM CLR 22/21 A2982 RMK AO2 LTG DSNT SE-W=
VFR METAR KDYB 180115Z AUTO 00000KT 10SM CLR 21/21 A2983 RMK AO2 LTG DSNT SE-W=
VFR METAR KDYB 180135Z AUTO 00000KT 9SM CLR 21/21 A2984 RMK AO2 LTG DSNT SE AND S=
VFR METAR KDYB 180155Z AUTO 00000KT 9SM CLR 21/21 A2985 RMK AO2 LTG DSNT SE AND S=

³ Longline - refers to the dissemination of the data to the FAA and NWS using standard communication protocols in near real-time to users and are typically archived.

⁴ As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories:

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

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

VFR METAR KDYB 180215Z AUTO 00000KT 9SM CLR 21/21 A2986 RMK AO2=
VFR METAR KDYB 180235Z AUTO 19003KT 9SM FEW003 SCT070 21/21 A2988 RMK AO2 LTG DSNT
E AND SW=
VFR METAR KDYB 180255Z AUTO 00000KT 9SM OVC070 21/21 A2988 RMK AO2 LTG DSNT E=
IFR METAR KDYB 180335Z AUTO 00000KT 7SM -RA BKN005 OVC033 21/21 A2988 RMK AO2 LTG
DSNT E AND SE=
MVFR METAR KDYB 180355Z AUTO 00000KT 5SM BR SCT005 BKN035 OVC120 21/21 A2988 RMK
AO2 P0002=
**VFR METAR KDYB 180415Z AUTO 00000KT 6SM BR FEW002 BKN032 OVC100 21/21 A2987
RMK AO2=**
Accident 0424Z
**LIFR METAR KDYB 180435Z AUTO 00000KT 7SM BKN004 BKN030 OVC100 21/21 A2986 RMK
AO2=**
LIFR METAR KDYB 180455Z AUTO 00000KT 8SM BKN003 BKN007 OVC075 21/21 A2986 RMK AO2
P0001=
LIFR METAR KDYB 180515Z AUTO 00000KT 8SM BKN002 BKN044 OVC100 21/21 A2986 RMK AO2=

A review of the long-line observations noted thunderstorms and rain showers in the vicinity prior to the accident and ending at 2355 EDT with 0.05 inches of precipitation recorded during the 12-hour period prior to the accident. No lightning or thunderstorms were detected at the time of the accident within 30 miles of the station.

2.1.1 High Resolution AWOS data

The AWOS 1-minute data were obtained by the FAA technician servicing the system and provided the data to the NTSB investigator. The data surrounding the period from 0000 through 0045 EDT are included below, with time referenced to UTC. The table provides the wind direction and speed (kts), visibility (sm), day/night identifier, weather code, cloud cover, temperature (T° C), dew point temperature (Td° C), relative humidity (%), Density Altitude (DA ft), altimeter (inHg), and rain indicator. No remarks were reported during the period.

KSTA DDHHMM	WIND SPD	VIS	DAY WX	CLOUDS	T	Td	RH	DA	ALT	RAIN
KDYB 180400	240 2	5	N BR	SCT005 BKN029 OVC110	21	21	99	01100	2988	2
KDYB 180401	240 2	5	N BR	SCT005 BKN029 OVC110	21	21	99	01100	2988	0
KDYB 180402	230 2	5	N BR	FEW005 BKN030 OVC110	21	21	99	01100	2988	0
KDYB 180403	230 2	5	N BR	FEW005 BKN029 OVC110	21	21	99	01100	2988	0
KDYB 180404	240 2	6	N BR	FEW005 BKN029 OVC110	21	21	99	01100	2988	0
KDYB 180405	260 1	6	N BR	FEW005 BKN027 OVC110	21	21	99	01100	2988	0
KDYB 180406	280 1	6	N BR	FEW005 BKN029 OVC110	21	21	99	01100	2988	0
KDYB 180407	290 0	6	N BR	FEW005 BKN026 OVC110	21	21	99	01100	2988	1
KDYB 180408	300 1	6	N BR	FEW005 BKN026 OVC110	21	21	99	01100	2988	1
KDYB 180409	280 1	6	N BR	FEW004 BKN026 OVC110	21	21	99	01100	2988	1
KDYB 180410	270 1	6	N BR	FEW003 BKN026 OVC110	21	21	99	01100	2988	1
KDYB 180411	270 1	6	N BR	FEW003 BKN029 OVC110	21	21	99	01100	2987	1
KDYB 180412	280 0	6	N BR	FEW002 BKN029 OVC110	21	21	99	01100	2987	1
KDYB 180413	280 0	6	N BR	FEW002 BKN029 OVC110	21	21	99	01100	2987	1
KDYB 180414	280 0	6	N BR	FEW002 BKN029 OVC100	21	21	99	01100	2987	1
KDYB 180415	290 0	6	N BR	FEW002 BKN032 OVC100	21	21	99	01100	2987	1
KDYB 180416	290 0	6	N BR	FEW002 BKN031 OVC100	21	21	99	01100	2987	1
KDYB 180417	300 0	6	N BR	FEW003 BKN029 OVC100	21	21	99	01100	2987	1
KDYB 180418	310 0	6	N BR	FEW003 BKN029 OVC100	21	21	99	01100	2987	1

KDYB 180419	320	1	7	N	FEW004 SCT027 BKN040	21	21	99	01100	2987	1
KDYB 180420	340	1	7	N	FEW004 SCT027 BKN040	21	21	99	01100	2987	1
KDYB 180421	340	1	7	N	FEW004 SCT027 BKN040	21	21	99	01100	2987	1
KDYB 180422	350	1	7	N	FEW004 SCT027 BKN040	21	21	99	01100	2987	1
KDYB 180423	340	1	7	N	FEW004 SCT027 BKN040	21	21	99	01100	2987	1
KDYB 180424	340	1	8	N	FEW004 SCT027 BKN040	21	21	99	01100	2987	1
KDYB 180425	350	1	8	N	FEW004 SCT027 BKN040	21	21	99	01200	2987	1
KDYB 180426	360	1	8	N	SCT004 BKN040 OVC100	21	21	99	01200	2986	1
KDYB 180427	360	1	8	N	SCT004 BKN031 OVC100	21	21	99	01200	2986	1
KDYB 180428	360	1	7	N	SCT003 BKN037 OVC100	21	21	99	01200	2986	1
KDYB 180429	350	1	7	N	SCT003 BKN027 OVC100	21	21	99	01200	2986	1
KDYB 180430	350	1	7	N	SCT003 BKN026 OVC100	21	21	99	01200	2986	1
KDYB 180431	360	2	7	N	SCT003 BKN024 OVC110	21	21	99	01200	2986	1
KDYB 180432	010	2	7	N	SCT003 BKN024 OVC110	21	21	99	01200	2986	1
KDYB 180433	010	2	7	N	BKN003 BKN023 OVC100	21	21	99	01200	2986	1
KDYB 180434	010	2	7	N	BKN003 BKN029 OVC100	21	21	99	01200	2986	1
KDYB 180435	010	2	7	N	BKN004 BKN030 OVC100	21	21	99	01200	2986	1
KDYB 180436	010	2	7	N	BKN004 BKN030 OVC100	21	21	99	01200	2986	1
KDYB 180437	010	2	7	N	BKN004 BKN033 OVC110	21	21	99	01200	2986	1
KDYB 180438	020	2	7	N	BKN004 BKN035 OVC100	21	21	99	01100	2986	1
KDYB 180439	020	2	7	N	BKN005 BKN035 OVC100	21	21	99	01100	2986	1
KDYB 180440	030	2	7	N	BKN005 BKN035 OVC100	21	21	99	01100	2986	1
KDYB 180441	030	2	7	N	BKN005 BKN039 OVC100	21	21	99	01100	2986	1
KDYB 180442	030	2	7	N	BKN005 BKN034 OVC100	21	21	99	01100	2986	1
KDYB 180443	030	2	7	N	FEW003 BKN006 OVC110	21	21	99	01100	2986	1
KDYB 180444	030	2	7	N	BKN005 BKN085 OVC110	21	21	99	01100	2986	1
KDYB 180445	020	2	7	N	BKN005 BKN080 OVC110	21	21	99	01100	2986	1

At the time of the accident the KDYB AWOS 1-minute observation was reporting the following conditions.

KDYB weather at 0024 EDT, automated, wind from 340° magnetic at 1 knot, visibility 8 miles, night, a few clouds at 400 ft, scattered clouds at 2,700 ft, ceiling broken at 4,000 ft, temperature 21° C, dew point temperature 21° C, relative humidity 99%, density altitude 1,100 ft, altimeter 29.87 inHg, rain code 1.

The data indicated that the ceiling broken at 300 ft was first reported at 0033 EDT, or approximately 9 minutes after the accident.

2.2 Moncks Corner, South Carolina

The next closest weather reporting station was from Berkeley County Airport (KMKS), Moncks Corner, South Carolina, located about 14 miles northeast of the accident site at an elevation of 74 ft. The airport had an AWOS and issued observations longline every 20-minutes. The following are the conditions surrounding the period.

VFR METAR KMKS 172055Z AUTO 03011G17KT 10SM TS SCT046 SCT050 BKN065 24/17 A2975
RMK AO2 LTG DSNT E THRU W=
VFR METAR KMKS 172135Z AUTO 06007KT 10SM VCTS SCT047 BKN075 OVC090 24/18 A2975 RMK
AO2 LTG DSNT ALQDS=
VFR METAR KMKS 172155Z AUTO 07005KT 10SM SCT047 SCT060 SCT075 24/17 A2976 RMK AO2
LTG DSNT ALQDS=
VFR METAR KMKS 172215Z AUTO 00000KT 10SM VCTS SCT060 SCT070 SCT100 23/19 A2977 RMK

AO2 LTG DSNT SE AND NW=
VFR METAR KMKS 172255Z AUTO 20004KT 10SM -RA SCT065 OVC090 22/21 A2980 RMK AO2 LTG DSNT SE AND S P0001=
VFR METAR KMKS 172315Z AUTO 16003KT 10SM -RA SCT047 SCT060 BKN085 21/20 A2979 RMK AO2 LTG DSNT SE AND S P0001=
VFR METAR KMKS 172335Z AUTO 16004KT 10SM SCT050 SCT075 SCT100 21/20 A2979 RMK AO2 LTG DSNT E AND SE P0001=
VFR METAR KMKS 172355Z AUTO 19003KT 10SM SCT050 SCT065 BKN110 21/20 A2979 RMK AO2 LTG DSNT SE AND W P0001=
VFR METAR KMKS 180015Z AUTO 22004KT 10SM SCT060 SCT080 SCT095 21/20 A2982 RMK AO2 LTG DSNT SW=
VFR METAR KMKS 180035Z AUTO 19003KT 10SM SCT070 21/20 A2982 RMK AO2=
VFR METAR KMKS 180055Z AUTO 18003KT 10SM CLR 20/19 A2983 RMK AO2 LTG DSNT S=
VFR METAR KMKS 180115Z AUTO 00000KT 10SM CLR 20/19 A2984 RMK AO2 LTG DSNT S=
VFR METAR KMKS 180135Z AUTO 00000KT 10SM CLR 20/19 A2985 RMK AO2 LTG DSNT S=
VFR METAR KMKS 180155Z AUTO 00000KT 10SM CLR 20/19 A2985 RMK AO2 LTG DSNT S=
VFR METAR KMKS 180215Z AUTO 00000KT 10SM SCT110 20/19 A2987 RMK AO2=
VFR METAR KMKS 180235Z AUTO 00000KT 10SM SCT110 20/19 A2988 RMK AO2 LTG DSNT SE=
VFR METAR KMKS 180255Z AUTO 22004KT 10SM CLR 20/20 A2989 RMK AO2 LTG DSNT SE=
VFR METAR KMKS 180315Z AUTO 22004KT 10SM SCT075 20/20 A2989 RMK AO2=
VFR METAR KMKS 180335Z AUTO 23003KT 10SM BKN075 20/20 A2989 RMK AO2 LTG DSNT SE AND S=
VFR METAR KMKS 180355Z AUTO 00000KT 10SM -RA SCT075 BKN080 20/20 A2989 RMK AO2 LTG DSNT SE=
VFR METAR KMKS 180415Z AUTO 00000KT 7SM -RA SCT060 BKN070 BKN090 20/20 A2988 RMK AO2=
Accident 0424Z
VFR METAR KMKS 180435Z AUTO 00000KT 7SM -RA BKN060 BKN070 OVC090 20/20 A2988 RMK AO2 P0001=
VFR METAR KMKS 180455Z AUTO 00000KT 7SM -RA SCT004 SCT049 BKN060 20/20 A2988 RMK AO2 P0001=

At the approximate time of the accident KMKS reported the following conditions.

Weather observation for KMKS at 0015 EDT, automated, wind calm, visibility 7 miles in light rain, scattered clouds at 600 ft, ceiling broken at 7,000 ft, and broken clouds at 9,000 ft, temperature 20° C, dew point temperature 20° C, altimeter 29.88 inHg.

2.3 Charleston, South Carolina

The next closest weather reporting station was from Charleston International Airport (KCHS), Charleston, South Carolina was located about 16 miles southeast of KDYB at an elevation of 46 ft. The airport had an Automated Surface Observation System (ASOS), which was augmented by air traffic control personnel. The following flight conditions and observations were reported surrounding the period.

VFR SPECI KCHS 172101Z 34021G33KT 10SM TS SCT040CB BKN060 BKN075 30/18 A2972 RMK AO2 PK WND 32033/2100 TSB01 OCNL LTGICCC W-N-NE TS W-N-NE MOV E

T03000178=

MVFR SPECI KCHS 172117Z 36012G27KT 5SM TSRA BR BKN040CB BKN060 BKN075 24/19 A2975
RMK AO2 PK WND 32033/2100 WSHFT 2058 RAB10 TSB01 PRESRR OCNL LTGICCC W-
N-NE TS W-N-NE MOV E P0001 T02440194=

VFR METAR KCHS 172156Z 02006KT 10SM -TSRA BKN035CB BKN045 OVC065 23/19 A2976 RMK
AO2 PK WND 32033/2100 WSHFT 2058 RAB10 TSB01 SLP077 OCNL LTGICCC ALQDS
TS ALQDS MOV E P0004 T02280194=

VFR METAR KCHS 172256Z 04004KT 7SM TSRA SCT010CB BKN045 OVC095 22/20 A2979 RMK AO2
SLP088 OCNL LTGIC SE-S TS SE-S MOV E P0024 T02220200=

VFR SPECI KCHS 172302Z 06008KT 7SM RA SCT010 BKN055 OVC095 22/20 A2979 RMK AO2 TSE02
TS MOV E CB DSNT SE-S P0001 T02220200=

VFR METAR KCHS 172356Z 14005KT 10SM SCT030 SCT055 BKN095 22/19 A2980 RMK AO2 RAE37
TSE02 SLP092 CB DSNT SE P0007 60035 T02170194 10333 20217 51030=

VFR METAR KCHS 180056Z 09005KT 10SM FEW055 SCT110 BKN200 22/19 A2982 RMK AO2
SLP098 T02170189=

VFR METAR KCHS 180156Z 00000KT 10SM -RA FEW030 BKN120 OVC200 22/19 A2985 RMK AO2
RAB47 SLP108 CB DSNT S AND SW P0000 T02170194=

VFR METAR KCHS 180256Z 20004KT 10SM -RA SCT011 BKN070 OVC090 22/20 A2988 RMK AO2
SLP118 P0002 60002 T02170200 53026=

VFR METAR KCHS 180356Z 26003KT 10SM -RA SCT060 BKN095 OVC110 22/20 A2988 RMK AO2
SLP116 P0001 T02170200=

VFR **SPECI KCHS 180423Z 26003KT 10SM FEW003 SCT011 BKN110 22/21 A2988 RMK AO2
RAE19 P0000 T02170206=**

Accident 0424Z

VFR METAR KCHS 180456Z 00000KT 10SM -RA SCT004 BKN075 OVC100 22/20 A2985 RMK AO2
RAE19B37 SLP108 P0001 T02170200 403330211=

At the time of the accident the following conditions were reported at KCHS.

Special weather observation for KCHS at 0023 EDT, wind from 260° at 3 knots, visibility 10 miles or more, a few clouds at 300 ft, scattered clouds at 1,100 ft, ceiling broken at 11,000 ft, temperature 22° C, dew point temperature 21° C, and altimeter 29.88 inHg. Remarks: automated station with a precipitation discriminator, rain ended at 0019 EDT, hourly precipitation a trace, temperature 21.7° C, dew point 20.6° C.

A review of the KCHS observation indicated general VFR conditions reported during the period, with a thunderstorm, moderate rain and gusting winds between 1701 and 1902 EDT with approximately 0.28 inches of precipitation recorded. With light rain showers also reported between 2147 and 2319 EDT with an additional 0.04 inches of precipitation.

2.4 NWS Aviation Weather Center METAR depiction

A depiction of the conditions from the NWS Aviation Weather Center's METAR website for 0025 EDT is included as figure 3. KDYB is noted in the center of the image with the regional radar mosaic overlaid for the period.



A High-Resolution Rapid Refresh (HRRR) numerical model⁵ for 0000 EDT was obtained from the NOAA Air Resource laboratory for the closest grid point to the accident site. The data was then plotted on a standard Skew T log P diagram⁶ from the surface to 450-hPa using the RAOB Analysis software⁷ and is included as figure 4.

⁷ RAOB –The Universal RAWinsonde OBservation program is an interactive sounding analysis program developed by Eosonde Research Services (ERS) previously known as Environmental Research Services.

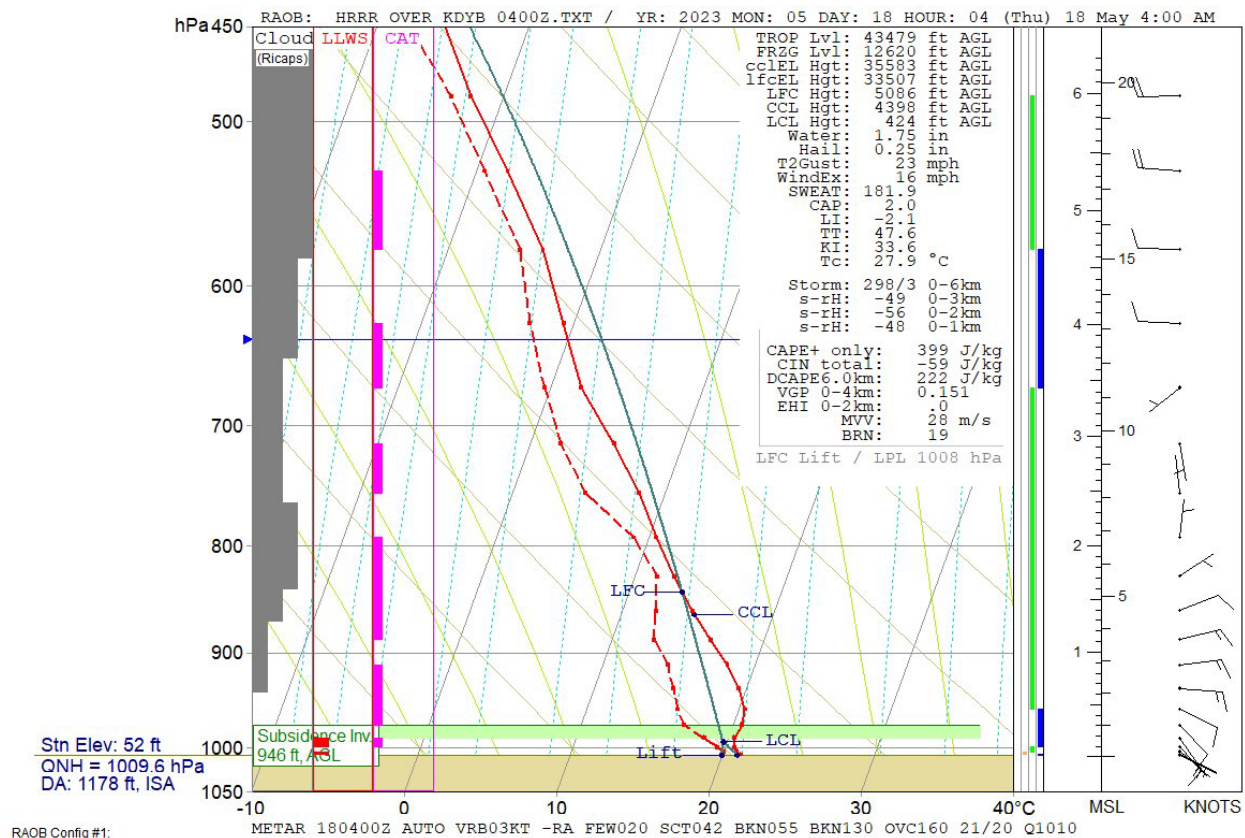


Figure 4 - High-Resolution Rapid Refresh (HRRR) numerical model sounding over the closes grid point to the accident site for 0000 EDT.

The HRRR 0000 EDT model depicted an elevation of 52 ft over the grid point with a near surface temperature of 21° C (70° F), a dew point temperature of 20° C (68° F), with a relative humidity of 94%, which resulted in a density altitude of 1,178 ft. The sounding depicted a lifted condensation level (LCL)⁸ at 424 ft agl, with a convective condensation level (CCL)⁹ at 4,398 ft, and the level of free convection (LFC)¹⁰ at 5,086 ft. An inversion was noted from the LCL to about 2,000 ft. The precipitable water content was 1.75 inches, the Lifted Index¹¹ was -2.1 and the convective available potential energy

The Villages, Florida.

⁸ Lifted Condensation Level (LCL) - the level at which a lifted parcel becomes saturated. The LCL height corresponds to cloud base height for forced ascent.

⁹ Convective Condensation Level (CCL) - the height at which a parcel of air, when heated sufficiently from below, rises and becomes saturated. It is where newly forming convective clouds should form bases.

¹⁰ Level of Free Convection (LFC) - the level where a parcel becomes buoyant, or "warmer" than the environmental temperature at the same level. The LFC represents the bottom of the layer containing CAPE.

¹¹ Lifted Index (LI) - A common measure of atmospheric instability. Its value is obtained by computing the temperature that air near the ground would have if it were lifted to 500-hPa or approximately 18,000 feet and comparing that temperature to the actual temperature at that level. Positive values indicate a stable atmosphere, while negative numbers indicate instability.

(CAPE) was 399 Joules/kilogram, which according to the RAOB Analysis program both indicated a conditionally unstable atmosphere and supported thunderstorms and rain showers over the area.

A table of the HRRR parameters of height, pressure, temperature (T), dew point temperature (Td), relative humidity (RH%), wind, and derived Low-Level Wind Shear (LLWS) and Clear Air Turbulence (CAT) from the surface to 10,000 ft is included below. The wind has been rounded to the near 5°. No significant LLWS or turbulence outside of convection other than that of a light severity was indicated.

Height (ft-msl)	Pres (hPa)	T (°C)	Td (°C)	RH (%)	Wind (dir/kts)	LLWS (FAA)	CAT (FAA)
52	1008	21.0	20.0	94	120/ 3		
80	1007	21.2	19.9	92	120/ 3		LIGHT
165	1004	20.9	20.0	95	135/ 5		
307	999	20.6	19.5	93	140/ 6	LGT	LIGHT
593	989	20.4	18.4	88	150/ 9		
998	975	20.6	16.8	79	140/ 10	LGT	
1498	958	20.4	16.0	76	120/ 10	LGT	
2157	936	19.5	15.2	76	095/ 13	LGT	
2891	912	18.2	14.3	78	085/ 15		
3672	887	16.5	12.8	79	075/ 14	LGT	
4567	859	14.6	12.2	86	065/ 10	LGT	
5620	827	12.6	11.5	93	055/ 5	LGT	
6810	792	10.5	9.0	90	005/ 3		
8152	754	8.3	4.8	79	355/ 1	LGT	
9625	714	5.5	2.0	78	170/ 5		
11284	671	2.0	-0.4	84	230/ 4	LGT	

4.0 Satellite Imagery

The NOAA Geostationary Operational Environmental Satellite number 16 (GOES-16) infrared and visible imagery were obtained from an archive at the Space Science Engineering Center (SSEC) at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System (McIDAS) software. The infrared band 13 at a wavelength of 10.3 microns (μm) provided a resolution of 2 kilometers (km) with radiative cloud top temperatures, with the visible band at 0.64 μm with a resolution of 0.5 km. However, at the time of the accident the low sun angle made the visible imagery unusable.

Figure 5 is the GOES-16 infrared image for 0026 EDT at 4X magnification with a standard MB temperature enhancement curve applied to highlight the higher and often colder convective cloud tops and high cirriform type clouds. The image depicted an area of low and high-level enhanced clouds over the accident site and extending eastward with a radiative cloud top temperature of 236 Kelvin (-38.16°C) over the

GOES-16 infrared image for 0026 EDT at 4X magnification

10001 GOES-16 13 18 MAY 23138 033117 02069 05665 01.00

The GOES-16 GeoColor image for 0026 EDT is included as figure 6. The GeoColor imagery is a multispectral product composed of True Color (using a simulated green component) during daytime, and an infrared product that uses multiple bands at night. During the day, the imagery looks approximately as it would when viewed with the human eye from space. The GeoColor was developed by the Cooperative Institute for Research in the Atmosphere (CIRA) and the Regional and Mesoscale Meteorology Branch (RAMMBA) of NOAA's Center for Satellite Applications and research (STAR). The GOES-16 GeoColor image depicted an area of low and mid-level cloud cover over the region.

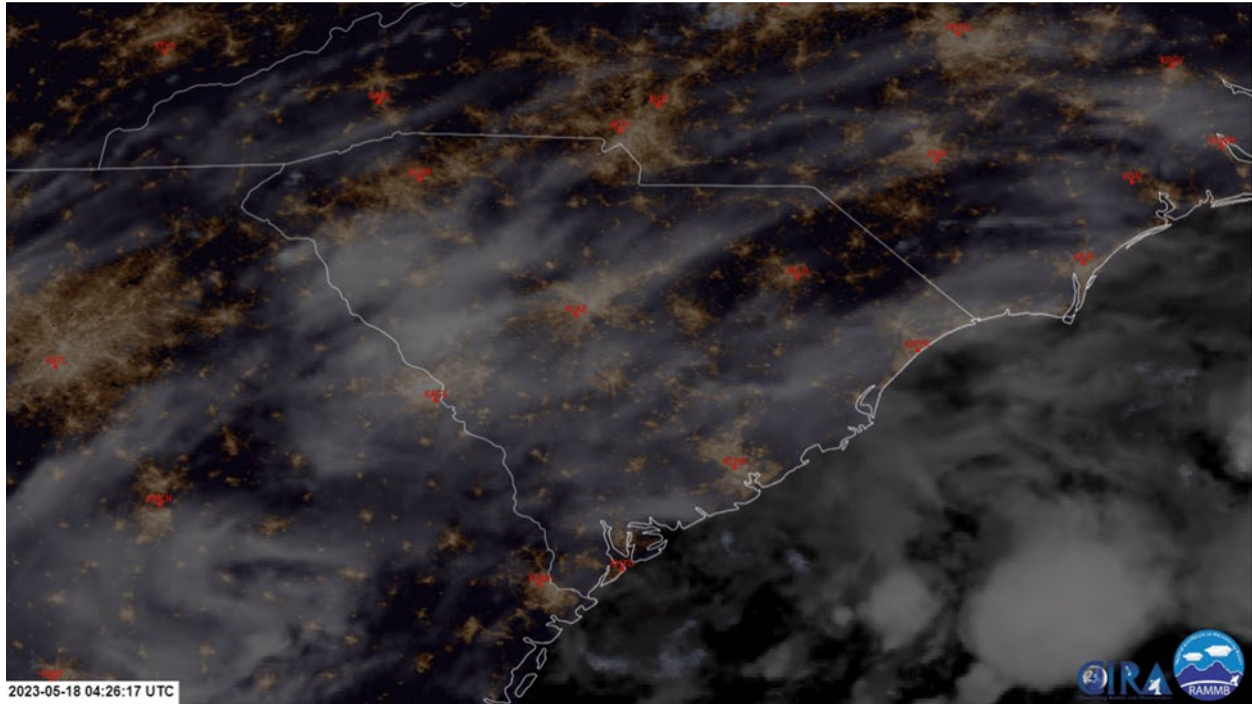


Figure 6 - GOES-16 GeoColor image for 0026 EDT depicting multiple layers of low to mid-level clouds over South Carolina during the period.

5.0 NWS Weather Radar Imagery

The closest NWS Weather Surveillance radar-1988 Doppler (WSR-88D)¹² was at Charleston (KCLX), South Carolina, located about 45 miles southeast of the accident site. The KCLX level II data were downloaded from the NWS NCEI and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software¹³. During the period surrounding the accident, the NWS KCLX WSR-88D was operating in the precipitation mode, volume scanning pattern VCP-212, where the radar makes 14 different elevation scans in about 4.5 minutes. This pattern is one of the standard VCPs used during period when strong convection is expected over the region. Based on the KCLX WSR-88D with an antenna height of 229 ft, at a distance of 45 miles the lowest 0.3° elevation scan was centered near 3,050 ft and scanning the altitudes between 780 ft through 5,320 ft over the accident site assuming standard refraction.

¹² The WSR-88D is a S-band 10-centimeter wavelength radar with a power output of 750,000 watts, with a 28-foot parabolic antenna concentrating the energy into a 0.95° beam width. The radar produces three basic types of products reflectivity, radial velocity, and spectral width.

¹³ <https://www.ncdc.noaa.gov/wct/>

5.1 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors¹⁴, 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 decibels of Z (dBZ)¹⁵ and is a general measure of echo intensity. The FAA Aviation Weather Handbook¹⁶ defines echoes less than 30 dBZ as "light" in intensity, "moderate" echoes 30-40 dBZ, "heavy" with echoes of >40-50 dBZ, and "extreme" intensity with echoes above >50 dBZ. These are the new standard radio phraseology terms used by air traffic controllers to describe weather conditions to pilots as shown in the following table in figure 7. Light rain is typically reported at the surface when reflectivities reach 20 dBZ, while air traffic control will not display information of echoes less than 26 dBZ or light intensity echoes on their weather displays or disseminate alerts of any such echoes.

Reflectivity (dBZ) Ranges	Weather Radar Echo Intensity Terminology
<30 dBZ	Light
30-40 dBZ	Moderate
>40-50 dBZ	Heavy
>50 dBZ	Extreme

Figure 7 - Reflectivity ranges and standard terminology on echo intensity.

5.2 Base Reflectivity Imagery

Figure 8 is the WSR-88D KCLX WSR-88D 0.3° base reflectivity image for 0024 EDT, which depicted echoes of 10 to 15 dBZ (very light intensity echoes) over KDYB, with an isolated cell near 45 dBZ about 40 miles north of the accident site. No stronger reflectivity echoes were identified at the higher elevation scans over KDYB during the period.

¹⁴ Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at 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.

¹⁵ dBZ - Nondimensional "unit" of radar reflectivity which represents a logarithmic power ratio (in decibels, or dB) with respect to radar reflectivity factor, Z.

¹⁶ FAA Aviation Weather Handbook - WSR-88D Radar Precipitation Intensity Terminology (Table 24-8).

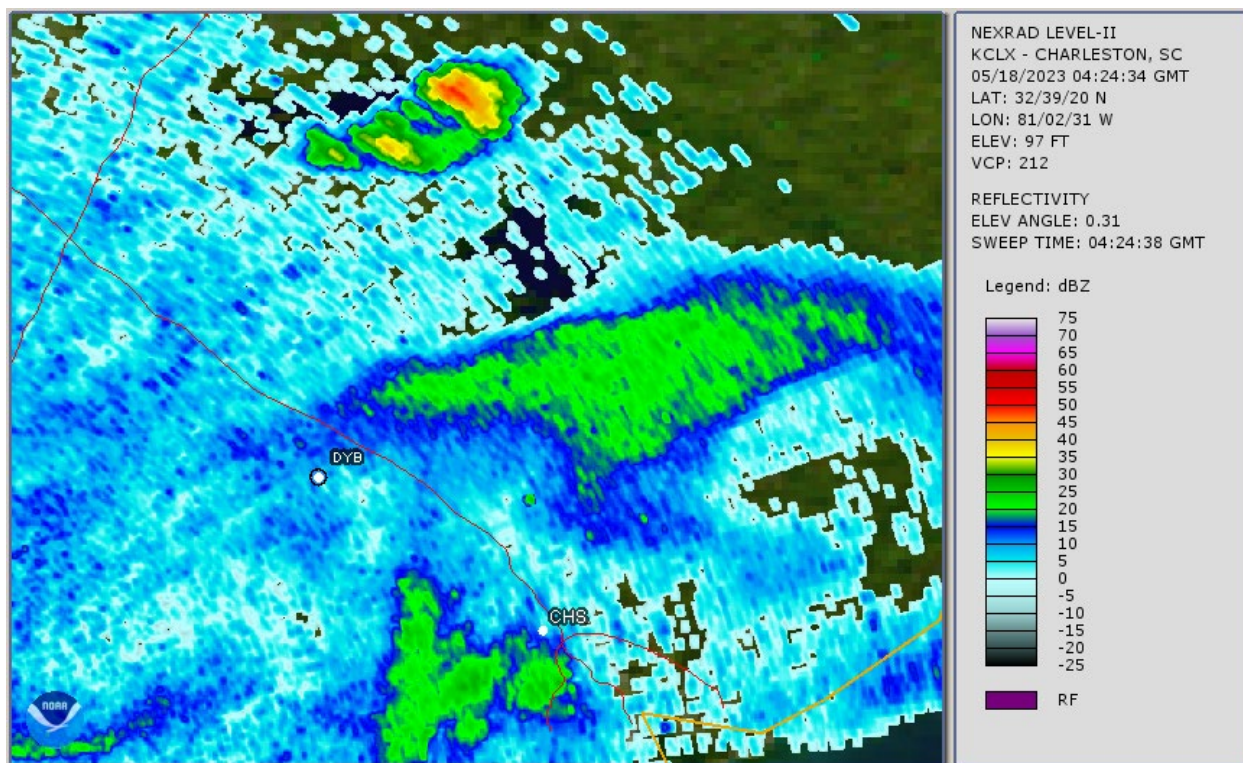


Figure 8 - NWS KCLX WSR-88D 0.3° base reflectivity image for 0024 EDT with DWB identified.

6.0 Pilot Reports

The following pilot reports (PIREPs) were disseminated longline¹⁷ within 60 miles of the accident site between 1700 and 2200 EDT, and below 18,000 ft.

CHS UA /OV CHS330010/TM 2145/FL050/TP E190/TB LIGHT

CHS UA /OV CHS020020/TM 2215/FL040/TP B738/WX -RA/TB OCCASIONAL LIGHT

CHS UA /OV CHS030005/TM 2247/FL030/TP E75L/WX -RA/TB SMOOTH

SAV UA /OV HXD/TM 2249/FL020/TP DA42/WX NEG RA/RM BASES 045-050

CHS UA /OV CHS210007/TM 2315/FL006/TP C17/SK BASES 006/TB SMOOTH

CHS UA /OV CHS150010/TM 0015/FL030/TP E195/RM FIELD IN SIGHT AT 030

There were no reports of low-level wind shear or any significant turbulence other than that of light intensity over the area during the period, while several reports of light rain were reported.

¹⁷ Includes only the reports official recorded and disseminated as a PIREP and may not include "ride reports" broadcasted or other conditions solicited by air traffic controllers and not entered in the formal PIREP format coding. These reports are available to users in near real-time.

7.0 NWS Forecasts and Advisories

The NWS Charleston (KCHS), South Carolina, Weather Forecast Office (WFO) was responsible for the local forecast and weather warnings for the area, while the NWS AWC located in Kansas City, Missouri, were responsible for the aviation enroute and inflight weather advisories.

7.1 Terminal Aerodrome Forecast

The NWS Terminal Aerodrome Forecast (TAF) is a concise statement of the expected meteorological conditions significant to aviation for a specified time period, usually 24-hours and within 5 statute miles of the center of the airport's runway complex (terminal). The NWS KCHS WFO does not routinely issue a TAF for KDYB. The closest TAF to KDYB is issued for Charleston International Airport (KCHS), located about 16 miles southeast of the accident site at an elevation of 46 ft. The TAF issued at 1938 EDT for KCHS was as follows.

*TAF KCHS 172338Z 1800/1824 06006KT P6SM -SHRA BKN050 OVC100
FM180900 05008KT P6SM SHRA BKN007 OVC012
FM181500 06012G21KT 5SM SHRA BR OVC009=*

7.2 Aviation Forecast Discussion

The NWS Aviation Forecast Discussions (AFD) are issued by each WFO to describe the short-term weather conditions within their region with an aviation section that included the general conditions as they relate to the creation of the TAF. These are useful for additional aviation-related issues that cannot be encoded into the TAF and provide some reasoning behind the forecast. These are generated roughly every 6 hours and correspond to the release of the latest TAFs for that office. The AFD issued at 2003 EDT was as follows.

*.AVIATION /00Z THURSDAY THROUGH MONDAY/...
18/00z TAF discussion:*

KSAV: Thunderstorms will be rolling through the SAV terminal site over the next few hours with gusty winds and potential for a window of MVFR conditions. Convection should wane by later this evening. Meanwhile, backdoor cold front will be sliding down through the region overnight. Lower (MVFR and possible IFR) cloud cover is looking to develop overnight and likely persist through the day Thursday. Showers and reduced visibilities are possible on Thursday as well.

KCHS/KJZI: Convection is probably done with for tonight. Backdoor cold front will be sliding down through the region overnight. Lower (MVFR and possible IFR) cloud cover is looking to develop overnight and likely persist through the day Thursday. Showers and reduced visibilities are possible on Thursday as well.

Extended Aviation Outlook: Flight restrictions are likely at all terminals Thursday due to reduced vsbys and cigs associated with showers and thunderstorms as well as a wedge entrenched across the local area. Gusty winds (25-30 kt) are also possible Thursday, mainly at KCHS and KJZI where a tight pressure gradient. Additional, rounds of showers/tstms are possible this weekend into early next week and could bring brief flight restrictions during the afternoon and evening hours.

7.3 Graphic Forecast for Aviation

The NWS Graphic Forecast for Aviation (GFA) is a graphical depiction of surface wind, thunderstorms, precipitation, color coded general flight categories, and cloud cover bases and tops, from graphical output from the NWS's National Digital Forecast Database (NDFD) with the Graphic-Airmen's Meteorological Information (G-AIRMET) for IFR conditions, mountain obscuration, icing conditions, and strong surface wind overlaid. The GFA provides a forecast for the enroute phase of flight and for locations without a TAF. The GFA is available at the NWS AWC website and through other weather briefing services. Figures 9 and 10 are the 3-hour GFA images issued about 2100 EDT on May 17, 2023, and valid for 2300 EDT. The images depicted light easterly winds with a chance of scattered thunderstorms and rain showers over the area. The cloud forecast depicted overcast clouds with tops to 39,000 ft.

Figures 11 and 12 are the GFA 6-hour forecasts valid for 0200 EDT on May 18, 2023, which continued to depict light north to northeasterly winds of 5 knots with a chance of thunderstorms and rain showers, with overcast clouds with tops layered to 39,000 ft.

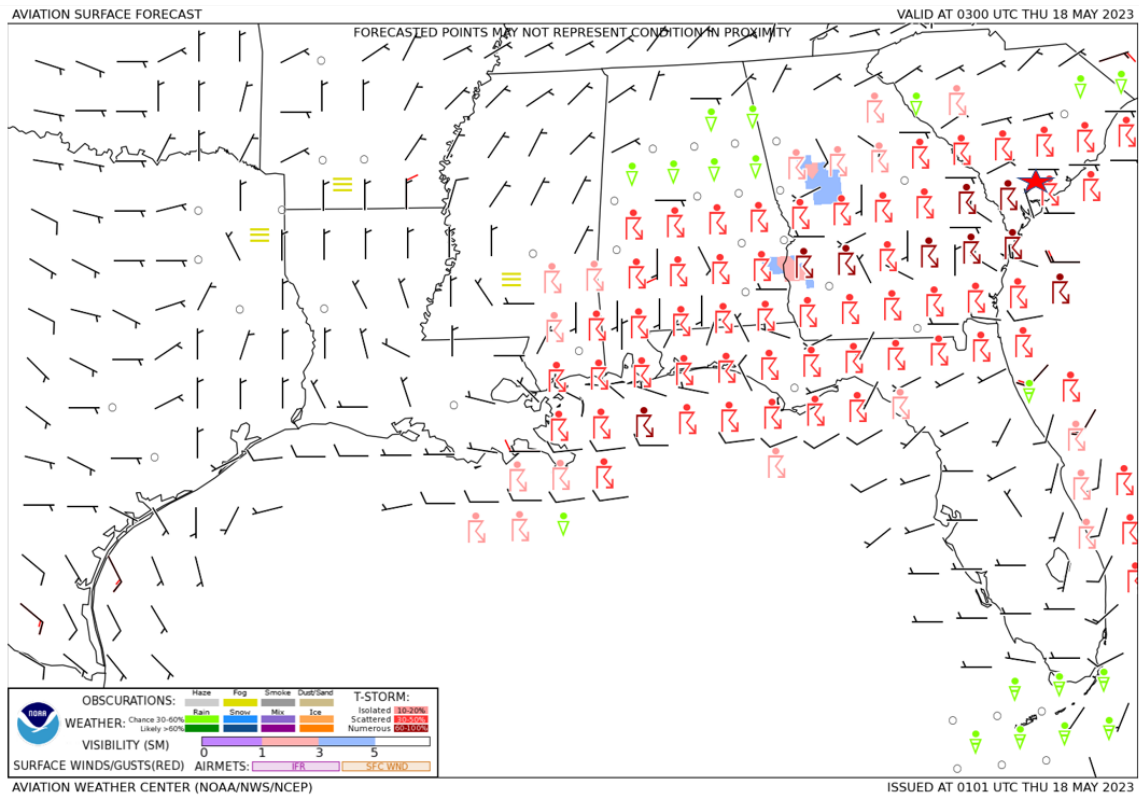


Figure 9 - Graphic Forecast for Aviation (GFA) 3-hour surface forecast valid for 2300 EDT.

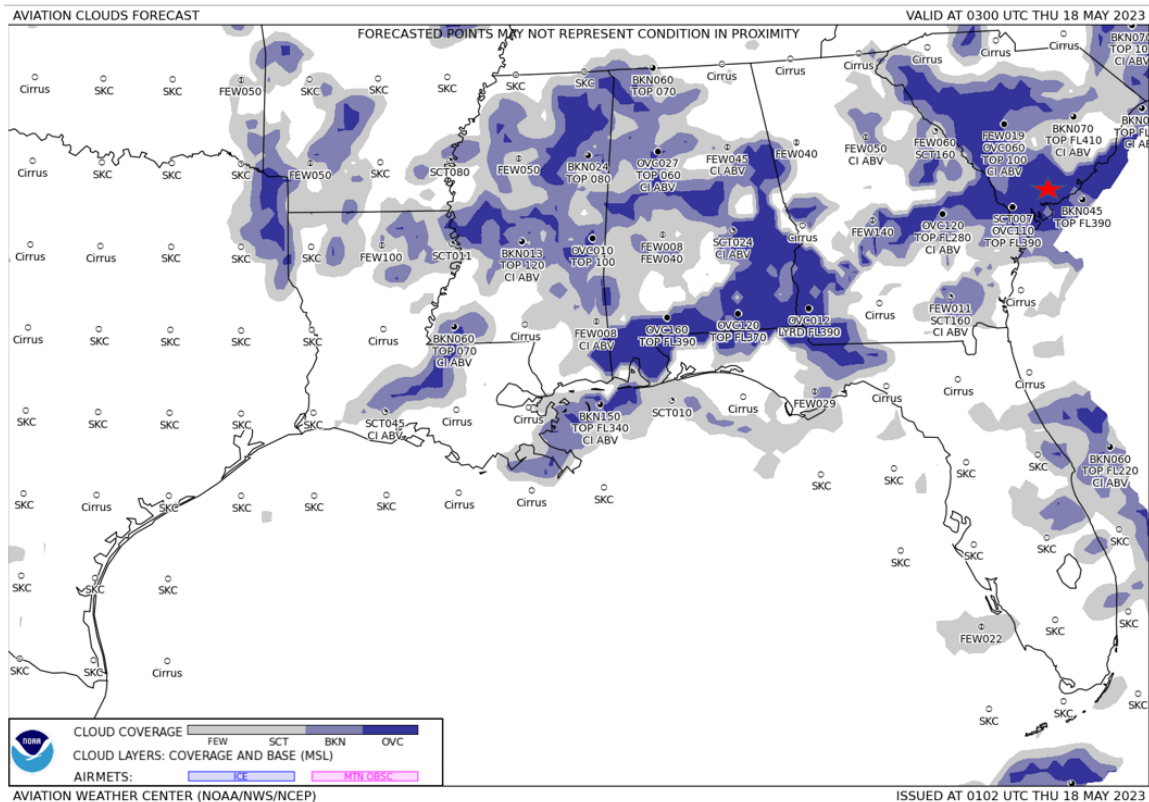


Figure 10 - GFA 3-hour cloud forecast valid for 2300 EDT.

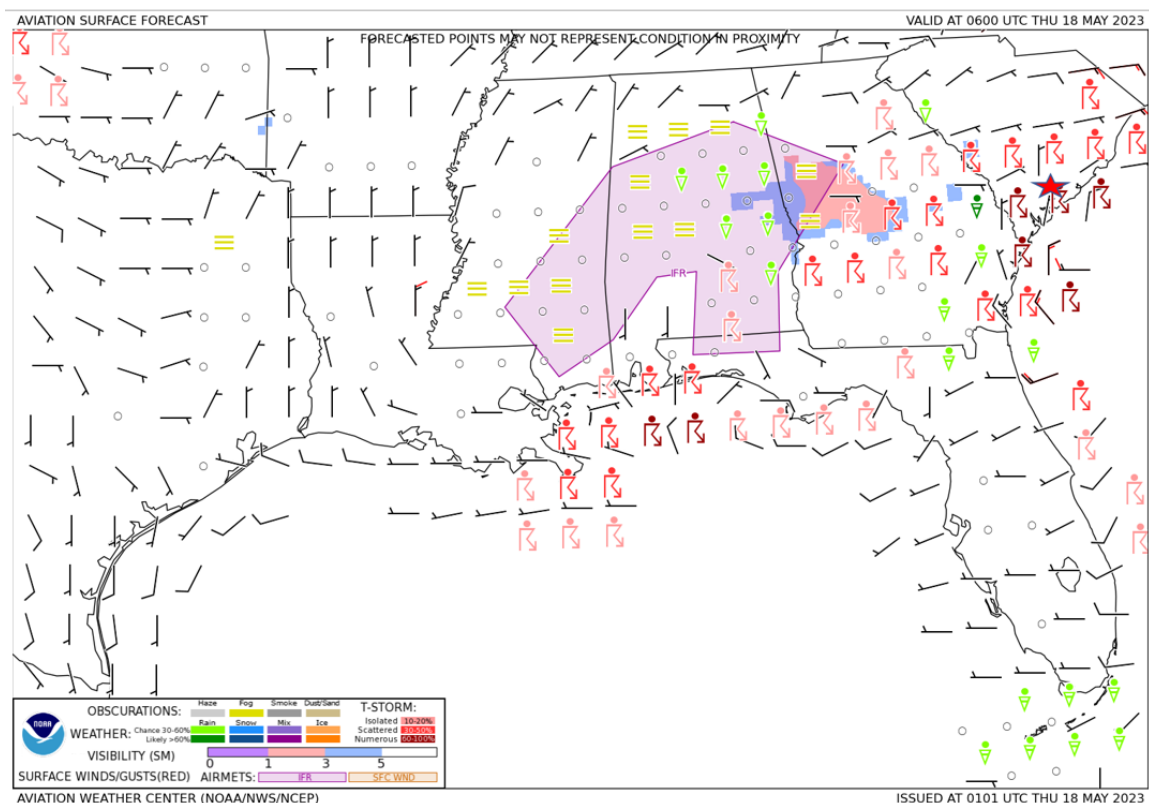


Figure 11 - GFA 6-hour surface forecast valid for 0200 EDT May 18, 2023.

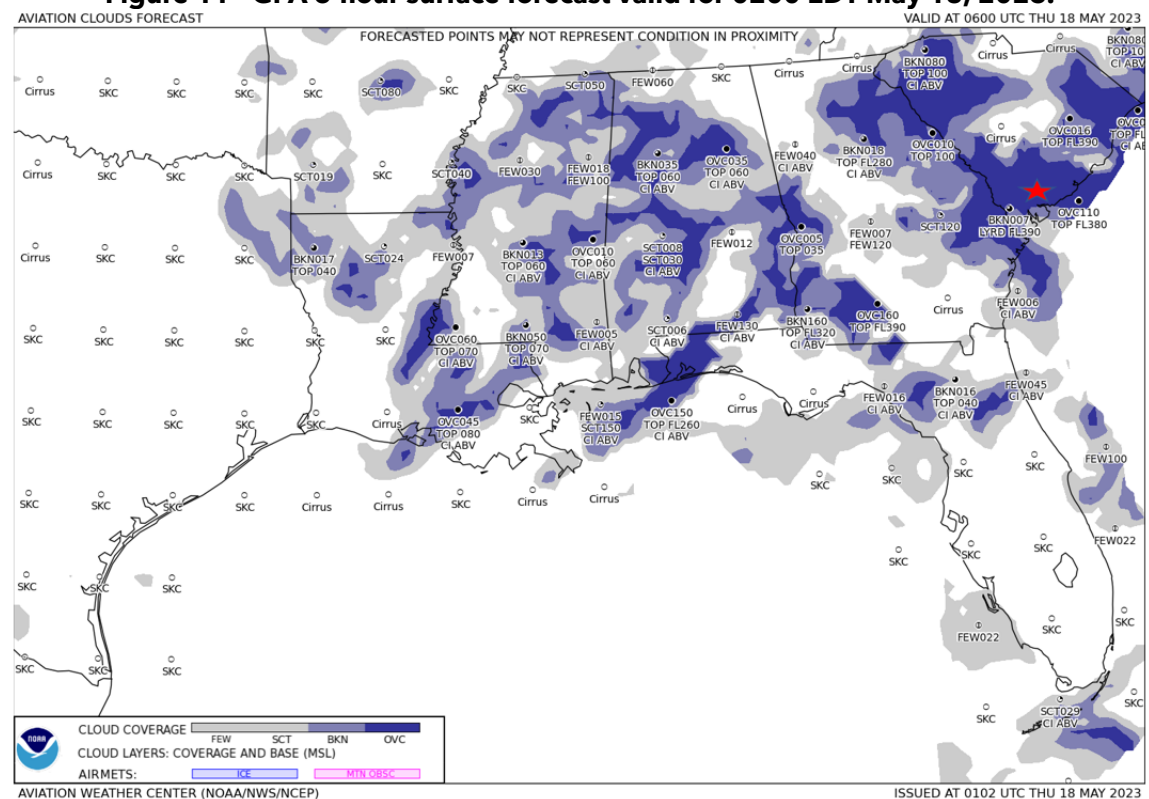


Figure 12 - GFA 6-hour cloud forecast valid for 0200 EDT on May 18, 2023.

7.4 NWS Inflight Weather Advisories

In-flight Aviation Weather Advisories are forecasts that advise en route aircraft of the development of potentially hazardous weather. Inflight aviation weather advisories in the conterminous U.S. are issued by the NWS AWC, as well as from the Center Weather Service Units (CWSU) at the various Air Route Traffic Control Centers (ARTCCs). There are four basic types of inflight aviation weather advisories: the Significant Meteorological Information (SIGMET), the Convective SIGMET, the G-AIRMET, and the Center Weather Advisory (CWA). Inflight advisories serve to notify en-route pilots of the possibility of encountering hazardous flying conditions that may not have been forecast at the time of the preflight briefing. Whether or not the condition described is potentially hazardous to a particular flight is for the pilot to evaluate based on experience and the operational limits of the aircraft. Once issued they are broadcast by FAA air traffic controllers upon issuance and available on inflight weather broadcasts.

At the time of the accident the NWS AWC had Convective SIGMET 9E current over the region, which included the accident site for an area of thunderstorms. The advisory is depicted as figure 13. There were no other advisories current for the accident site immediately surrounding the time of the accident.

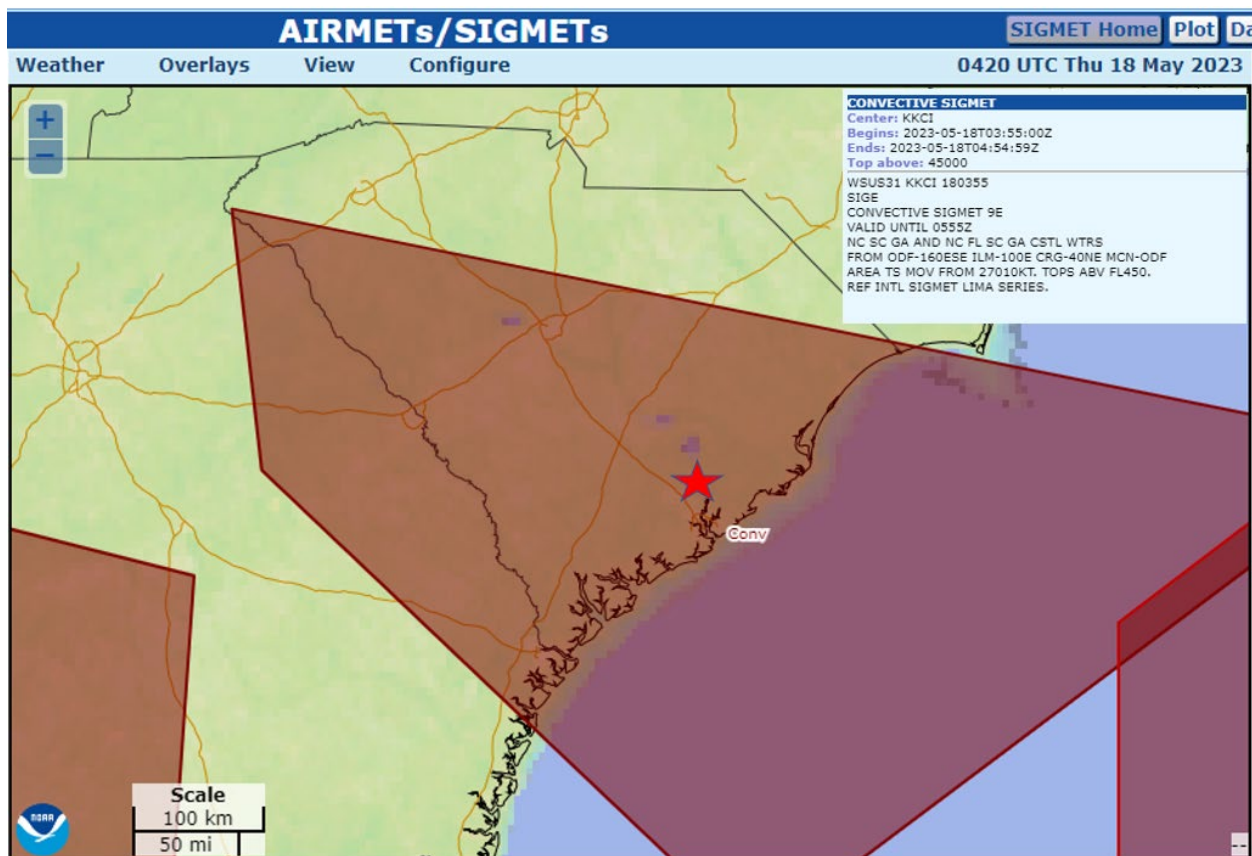


Figure 13 - Depiction of NWS AWC Convective SIGMETs current at the time of the accident.

8.0 Astronomical Conditions

The United States Naval Observatory website¹⁸ provided the following astronomical conditions for the period over Sommerville, South Carolina.

<u>Sun</u>	<u>Time (EDT)</u>
Sunset	2015 May 17th
End civil twilight	2042
Accident	0024 May 18th
Begin civil twilight	0552
Sunrise	0620
<u>Moon</u>	<u>Time (EDT)</u>
Moonset	1828 May 17th
Accident	0024 May 18th
Moonrise	0532

At the time of the accident the sun and moon were more than 13° below the horizon and provided no illumination. The phase of the moon was a waning crescent with only 4% of the moon's visible disk illuminated when above the horizon.

Submitted by:

Donald E. Eick
NTSB Senior Meteorologist

¹⁸ <https://aa.usno.navy.mil/data/index>