



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

May 29, 2019

Weather Study

METEOROLOGY

CEN19FA139

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A. ACCIDENT

Location: Moose Lake, Minnesota
Date: May 8, 2019
Time: about 1630 central daylight time (2130 UTC)¹
Airplane: M20J; N111JP

B. METEOROLOGIST

Mike Richards
Senior Meteorologist
Operational Factors Division (AS-30)
National Transportation Safety Board

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 daylight time (CDT) for May 8, 2019 (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: 46.423333° north latitude, 92.805556° west longitude, at an elevation of about 1,050 feet.

D. WEATHER INFORMATION

1.0 Synoptic Conditions

The north-central portion of the National Weather Service (NWS) Surface Analysis Chart for 1600 CDT is presented in figure 1. The surface analysis chart showed a warm front extending southward from Canada to the accident location. A cold front, which was advancing southeastward, stretched from western Ontario into North Dakota. A low-pressure system with a minimum pressure of 1000 hectopascals (hPa) was located over Iowa. Station models in the accident region generally depicted overcast skies and average winds from the northeast at 10-25 knots. Light and moderate rain were depicted south of the accident location.

¹ UTC – abbreviation for Coordinated Universal Time

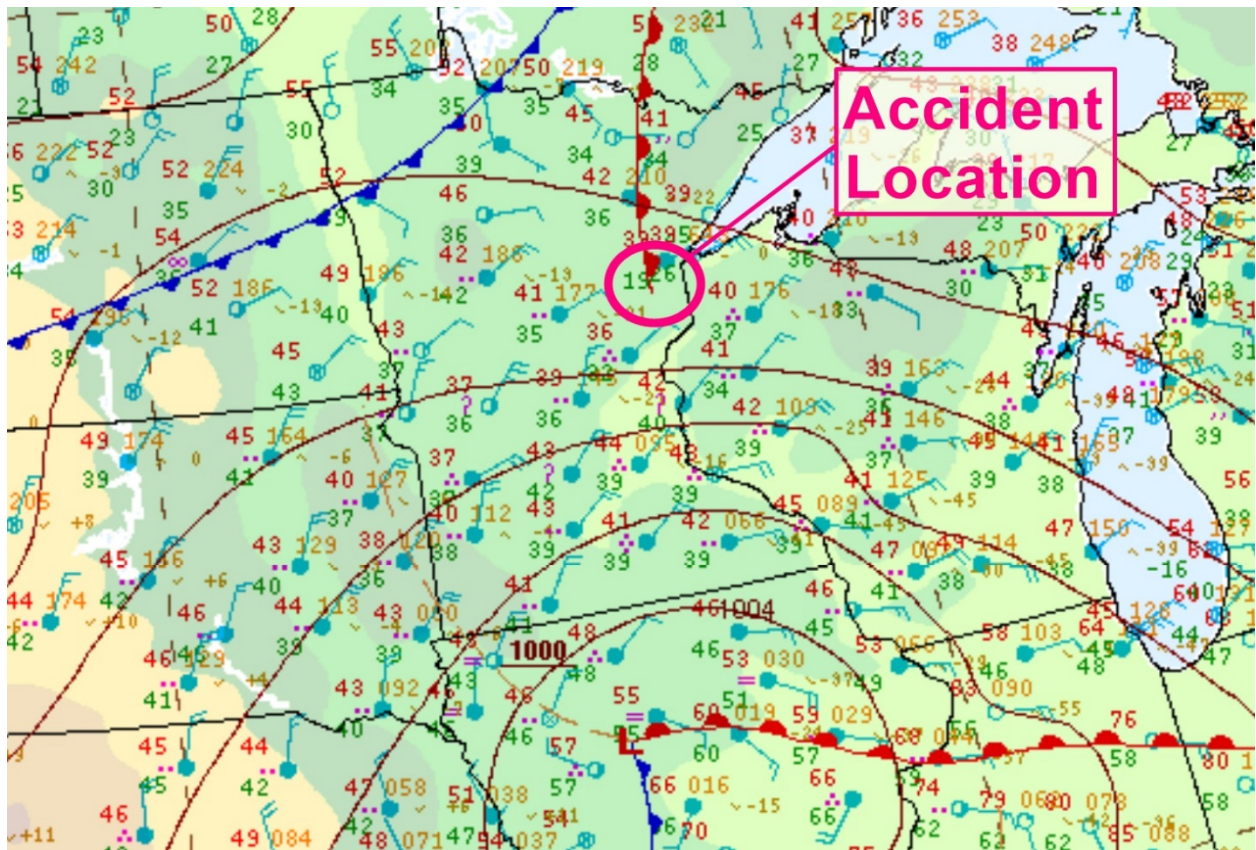


Figure 1 - NWS Surface Analysis Chart for 1600 CDT.

2.0 Surface Observations

An Automated Weather Observing System was located at Moose Lake Carlton County Airport (MZH)² in Moose Lake, Minnesota, and was located within one-half mile of the accident location at an elevation of 1,075 feet. Automated reports from KMZH during the times surrounding the accident time are presented here.

- [1536 CDT] METAR KMZH 082036Z AUTO 04007G15KT 5SM RA OVC014 02/00
A3005 RMK AO2=
- [1555 CDT] METAR KMZH 082055Z AUTO 05008G15KT 3SM -RA BKN010
OVC017 01/00 A3004 RMK AO2 P0001=
- [1615 CDT] METAR KMZH 082115Z AUTO 04011G16KT 2 1/2SM -SN OVC008
01/00 A3003 RMK AO2 P0002=

² This report uses the 3-digit International Air Transport Association format for airport identification, which does not use the geographic designating digit (e.g., “K” for stations in the continental U.S. and “P” for U.S. stations in Alaska and the Pacific region) as found in the 4-digit International Civil Aviation Organization (ICAO) identifier format. Weather observations from airports in this report are referenced by their reporting station’s identifier (using ICAO format that includes the geographic designating digit), not by the airport at which the reporting station is located.

[1635 CDT] METAR KMZH 082135Z AUTO 03011G18KT 1 1/4SM -SN OVC006 00/00 A3001 RMK AO2 P0002=

[1655 CDT] METAR KMZH 082155Z AUTO 04010G15KT 1SM -SN OVC006 00/00 A3000 RMK AO2 P0004=

At 1615 CDT, KMZH reported a wind from 040° at 11 knots with gusts to 16 knots, visibility of 2 and 1/2 statute miles, light snow, ceiling overcast at 800 feet above ground level (agl), temperature of 1° Celsius (C) and a dew point temperature of 0°C, altimeter setting of 30.03 inches of mercury; remarks: automated station with a precipitation discriminator, 0.02 inches of liquid equivalent precipitation since 1557 CDT.

At 1635 CDT, KMZH reported a wind at from 030° at 11 knots with gusts to 18 knots, visibility of 1 and 1/4 statute miles, light snow, ceiling overcast at 600 feet agl, temperature of 0°C and a dew point temperature of 0°C, altimeter setting of 30.01 inches of mercury; remarks: automated station with a precipitation discriminator, 0.02 inches of liquid equivalent precipitation since 1557 CDT.

One-minute observations retrieved from the MZH AWOS for the times surrounding the accident time are presented here. At 1630 CDT, the KMZH automated one-minute observation reported a wind at from 030° at 11 knots with gusts to 18 knots, visibility of 1 and 1/2 statute miles, light snow, ceiling overcast at 600 feet agl, temperature of 0°C and a dew point temperature of 0°C, altimeter setting of 30.02 inches of mercury; remarks: automated station with a precipitation discriminator, 0.02 inches of liquid equivalent precipitation since 1557 CDT.

[1615 CDT] METAR KMZH 082115Z AUTO 04011G16KT 2 1/2SM -SN OVC008 01/00 A3003 RMK AO2 P0002

[1616 CDT] METAR KMZH 082116Z AUTO 04011G16KT 2 1/2SM -SN OVC008 01/00 A3003 RMK AO2 P0002

[1617 CDT] METAR KMZH 082117Z AUTO 04011G14KT 2 1/2SM -SN OVC008 01/00 A3003 RMK AO2 P0002

[1618 CDT] METAR KMZH 082118Z AUTO 04009G14KT 2 1/2SM -SN OVC008 01/00 A3003 RMK AO2 P0002

[1619 CDT] METAR KMZH 082119Z AUTO 04009G14KT 2SM -SN OVC008 01/00 A3003 RMK AO2 P0002

[1620 CDT] METAR KMZH 082120Z AUTO 04010G14KT 2SM -SN OVC008 01/00 A3003 RMK AO2 P0002

[1621 CDT] METAR KMZH 082121Z AUTO 04010G14KT 2SM -SN OVC008 01/00 A3003 RMK AO2 P0002

[1622 CDT] METAR KMZH 082122Z AUTO 04010G14KT 2SM -SN OVC008 00/00 A3003 RMK AO2 P0002

[1623 CDT] METAR KMZH 082123Z AUTO 04011G16KT 2SM -SN OVC008 00/00 A3003 RMK AO2 P0002

[1624 CDT] METAR KMZH 082124Z AUTO 04011G16KT 2SM -SN OVC006 00/00
A3002 RMK AO2 P0002

[1625 CDT] METAR KMZH 082125Z AUTO 04010G16KT 1 3/4SM -SN OVC006
00/00 A3002 RMK AO2 P0002

[1626 CDT] METAR KMZH 082126Z AUTO 04009G16KT 1 3/4SM -SN OVC006
00/00 A3002 RMK AO2 P0002

[1627 CDT] METAR KMZH 082127Z AUTO 04009G16KT 1 3/4SM -SN OVC006
00/00 A3002 RMK AO2 P0002

[1628 CDT] METAR KMZH 082128Z AUTO 04011G18KT 1 3/4SM -SN OVC006
00/00 A3002 RMK AO2 P0002

[1629 CDT] METAR KMZH 082129Z AUTO 04012G18KT 1 3/4SM -SN OVC006
00/00 A3002 RMK AO2 P0002

**[1630 CDT] METAR KMZH 082130Z AUTO 03011G18KT 1 1/2SM -SN OVC006
00/00 A3002 RMK AO2 P0002**

[1631 CDT] METAR KMZH 082131Z AUTO 04010G18KT 1 1/2SM -SN OVC006
00/00 A3002 RMK AO2 P0002

[1632 CDT] METAR KMZH 082132Z AUTO 04009G18KT 1 1/2SM -SN OVC006
00/00 A3002 RMK AO2 P0002

[1633 CDT] METAR KMZH 082133Z AUTO 04010G18KT 1 1/4SM -SN OVC006
00/00 A3002 RMK AO2 P0002

[1634 CDT] METAR KMZH 082134Z AUTO 04011G18KT 1 1/4SM -SN OVC006
00/00 A3001 RMK AO2 P0002

[1635 CDT] METAR KMZH 082135Z AUTO 03011G18KT 1 1/4SM -SN OVC006
00/00 A3001 RMK AO2 P0002

[1636 CDT] METAR KMZH 082136Z AUTO 03012G18KT 1 1/4SM -SN OVC006
00/00 A3001 RMK AO2 P0003

[1637 CDT] METAR KMZH 082137Z AUTO 03013G18KT 1 1/4SM -SN OVC006
00/00 A3001 RMK AO2 P0003

[1638 CDT] METAR KMZH 082138Z AUTO 04013G18KT 1SM -SN OVC006 00/00
A3001 RMK AO2 P0003

[1639 CDT] METAR KMZH 082139Z AUTO 04013KT 1SM -SN OVC004 00/00 A3001
RMK AO2 P0003

[1640 CDT] METAR KMZH 082140Z AUTO 03012KT 1SM -SN OVC006 00/00 A3001
RMK AO2 P0003

[1641 CDT] METAR KMZH 082141Z AUTO 04012KT 1SM -SN OVC006 00/00 A3001
RMK AO2 P0003

[1642 CDT] METAR KMZH 082142Z AUTO 04012KT 1SM -SN OVC006 00/00 A3001
RMK AO2 P0003

[1643 CDT] METAR KMZH 082143Z AUTO 04012KT 1SM -SN OVC004 00/00 A3001
RMK AO2 P0003

[1644 CDT] METAR KMZH 082144Z AUTO 03012G17KT 1SM -SN OVC006 00/00
A3001 RMK AO2 P0003

[1645 CDT] METAR KMZH 082145Z AUTO 03012G17KT 1SM -SN OVC004 00/00
A3001 RMK AO2 P0003

3.0 Weather Radar

WSR-88D³ Level-II and Level-III 0.483° weather radar data from Duluth, Minnesota (KDLH), are presented in figures 2-5. KDLH was located 35 miles northeast of the accident location at an elevation of about 1,450 feet. Around the time of the accident, these data depicted reflectivity values of 25-35 dBZ (figure 2), and radial velocity measurements of about 35 knots in a direction away from the radar (figure 3), over the accident location. The Hydrometeor Classification Algorithm (HCA; figure 4) identified dry snow above the accident location but also identified large areas of graupel south of the accident location. Assuming standard refraction and considering the 0.95° beam width⁴ for the WSR-88D radar beam, the KDLH 0.483° tilt would have “seen” altitudes above the accident location of between about 2,300 and 5,800 feet. Figure 5 presents a VAD wind profile⁵ for KDLH around the accident time. The VAD wind profile indicates that above KDLH at 1631 CDT, the wind between 2,000 and 4,000 feet was generally from the east-northeast at 30-35 knots with little variation in height.

³ Weather Surveillance Radar 88 Doppler (WSR-88D)

⁴ Here we define the angular width of the radar beam as the region of transmitted energy that is bounded by one-half the maximum power. The maximum power lies along the beam centerline and decreases outward.

⁵ VAD wind profile - A plot of horizontal winds as a function of height above a Doppler Radar. The display is plotted with height as the vertical axis and time as the horizontal axis (a so-called time-height display), which then depicts the change in wind with time at various heights.

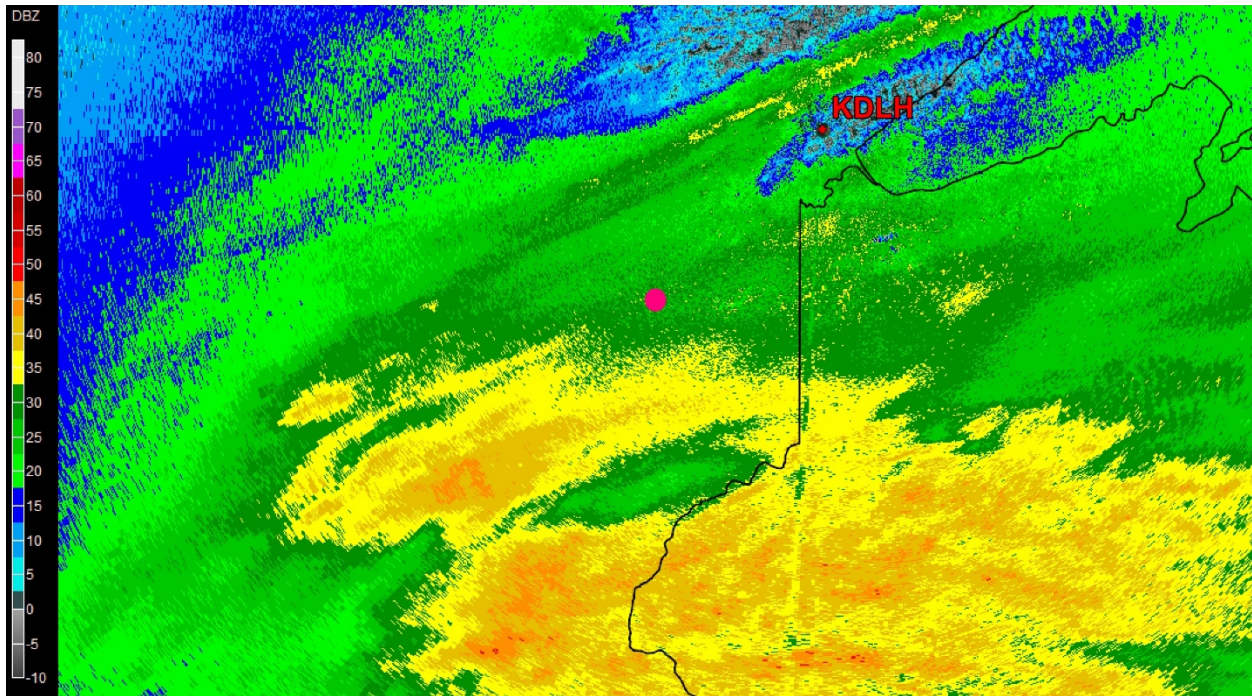


Figure 2 – KDLH 0.483° Level-II base reflectivity product from a sweep initiated at 1631 CDT. Pink dot denotes accident location.

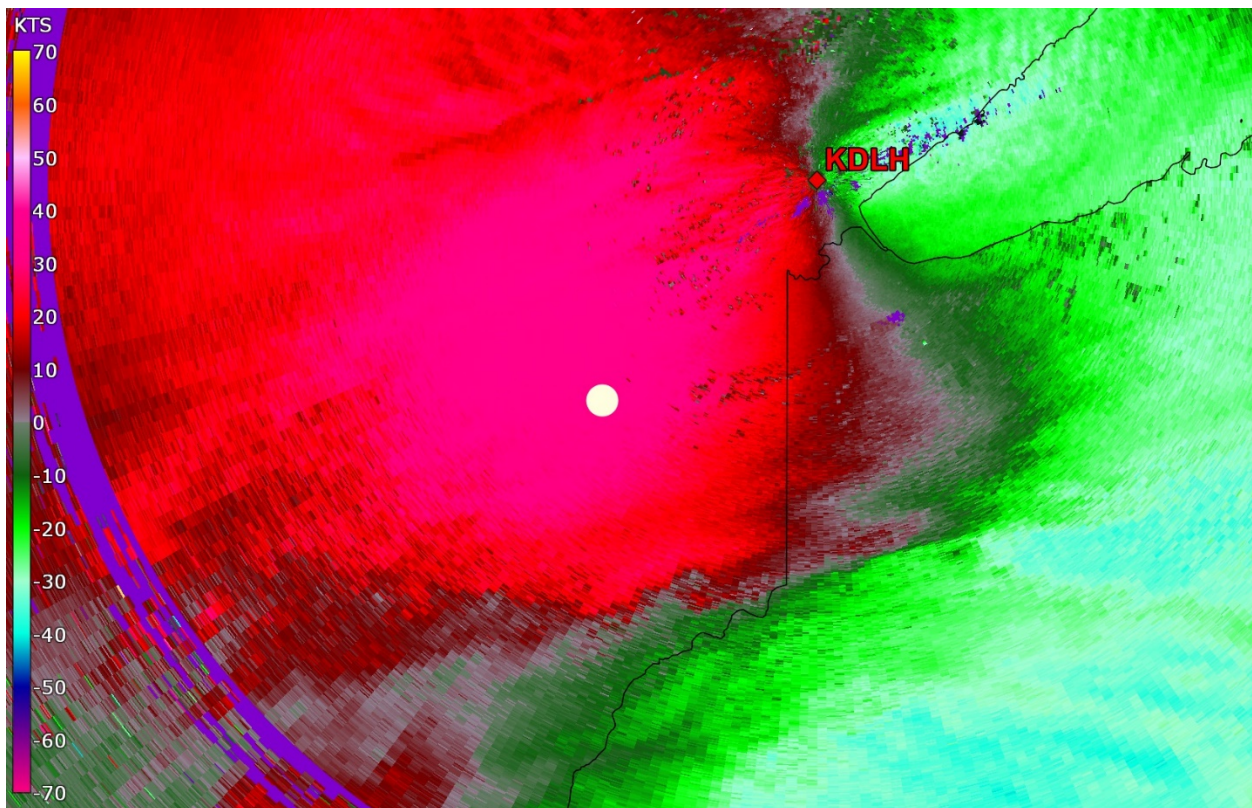


Figure 3 – KDLH 0.483° Level-III base velocity product from a sweep initiated at 1631 CDT. White dot denotes accident location.

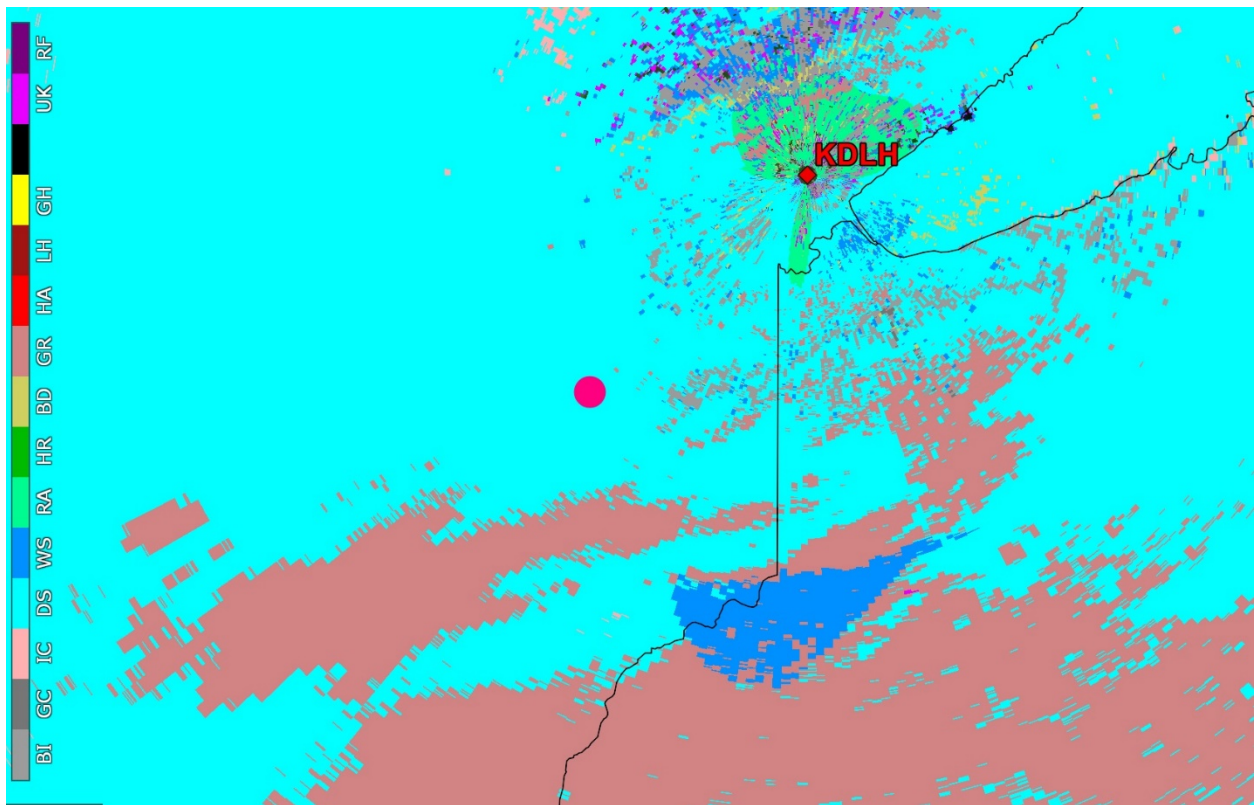


Figure 4 – KDLH 0.483° Level-III HCA product from a sweep initiated at 1631 CDT. Pink dot denotes accident location.

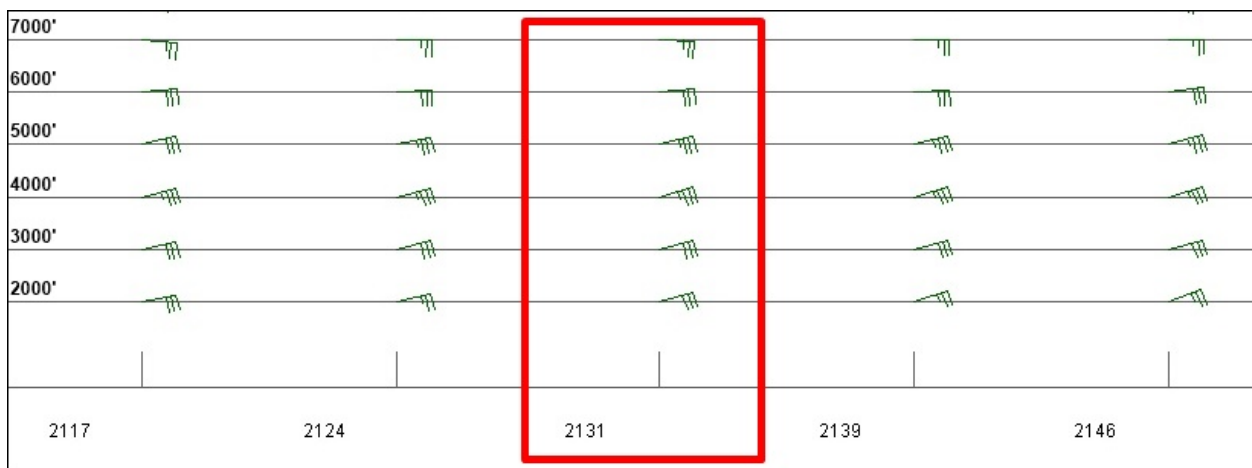


Figure 5 – KDLH VAD wind profile for the times surrounding the accident time. Time is in UTC.

4.0 Pilot Reports

Publicly disseminated pilot reports⁶ (PIREPs) made between about 1500 and 1800 CDT below 15,000 feet within 100 miles of the accident location are presented here. There were several reports applicable to very near the surface, which reported low level wind shear (LLWS) or light to moderate turbulence. However, these reports were located over 80 miles south of the accident location.

ANE UUA /OV DURD ANE/TM 2030/FL001/TP BE20/RM LLWS -10KT 001-SFC

ANE UA /OV DURD ANE/TM 2040/FL027/TP PA31/TB LGT-MOD TURB 027-SFC

ANE UUA /OV DURD ANE/TM 2250/FL001/TP BE20/RM LLWS + OR -10KT 001-SFC

MSP UA /OV MSP315030/TM 2055/FLDURGD/TP PA46/TA M02/TB MOD ABV 060/IC MOD CLR

DLH UA /OV DLH/TM 2209/FLDURGD/TP E35L/IC NEG

ANE UUA /OV DURD ANE/TM 2115/FL001/TP PA46/RM LLWS -10KT 001-SFC

DLH UA /OV DLH/TM 2115/FLDURGD/TP F16/SK B021

DLH UA /OV DLH225020/TM 2215/FL033/TP C208/RM BRAP

RNH UA /OV RNH/TM 2256/FL045/TP C208/TA M02/IC MOD MX 045-080/RM DURC

5.0 Satellite Imagery

Geostationary Operational Environmental Satellite (GOES)-16 visible (0.64 μ m) data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison. Imagery from 1626 CDT is presented in figure 6. The GOES-16 visible imagery depicted extensive overcast conditions across the region.

⁶ These do not include pilot reports only broadcast via radio.

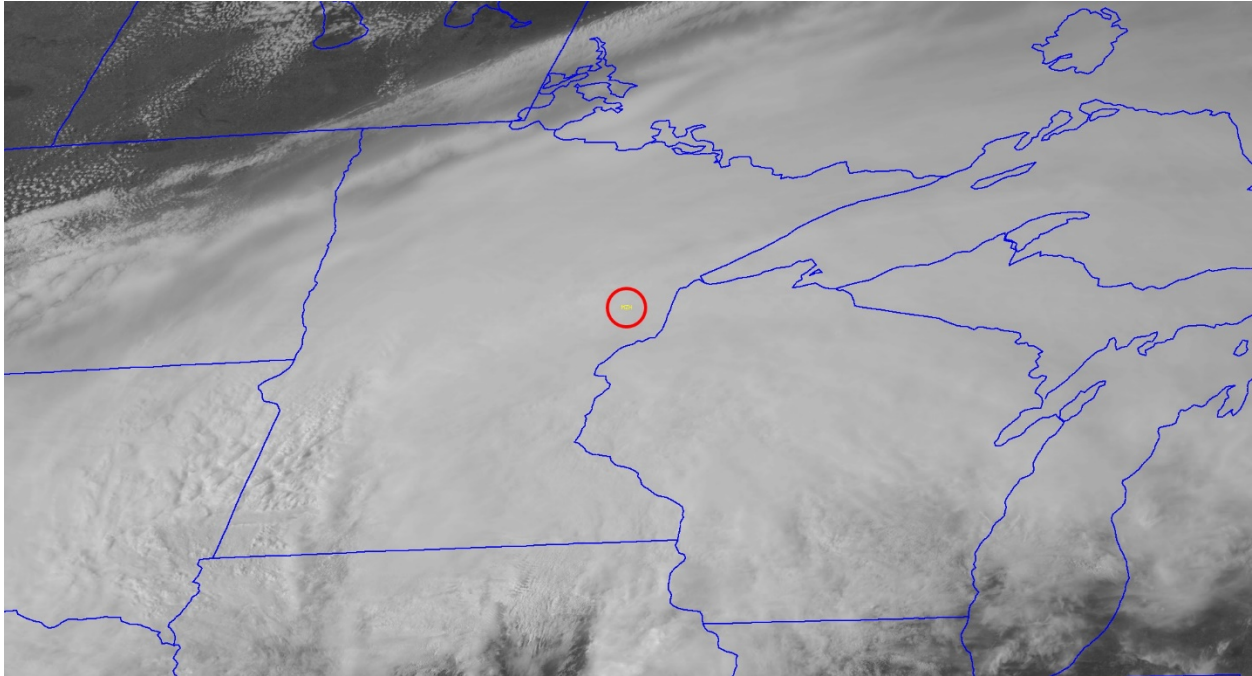


Figure 6 – GOES-16 visible imagery from 1626 CDT. Accident location denoted by red circle. This image has not been corrected for any parallax error.

6.0 Area Forecast Discussion

An Area Forecast Discussion (AFD) was issued at 1526 CDT by the NWS WFO in Duluth, Minnesota. This AFD contained an “Aviation” section that was originally issued in an AFD at 1303 CDT and is presented here. The Aviation section discussed a change from rain to snow conditions at Duluth as well as gusty winds and a lowering ceiling and visibility for the region.

*FXUS63 KDLH 082026
AFDDLH
Area Forecast Discussion
National Weather Service Duluth MN
326 PM CDT Wed May 8 2019*

*.AVIATION...(For the 18Z TAFS through 18Z Thursday afternoon)
Issued at 103 PM CDT Wed May 8 2019*

A low pressure system will move from southwest Iowa to near Green Bay, WI by 18Z Thursday. Precipitation will spread northward into the terminals this afternoon or this evening. I have the lowest confidence in precipitation occurring at INL, but seems likely everywhere else. Precipitation will likely change to all snow tonight at DLH but may remain a mix at BRD/HIB/HYR. Winds will be gusty later this afternoon and overnight as the pressure gradient tightens. Ceilings and visibilities will trend into the MVFR/IFR range overnight during the period when precipitation is most intense. The system will lift out of the terminals Thursday morning with conditions gradually improving.

7.0 AIRMETs

An AIRMET SIERRA for instrument flight rule (IFR) conditions was issued by the NWS' Aviation Weather Center (AWC) at 1545 CDT and was active for the accident site at the accident time.

*WAUS43 KKCI 082045
WA3S
-CHIS WA 082045
AIRMET SIERRA UPDT 5 FOR IFR VALID UNTIL 090300*

*.
AIRMET IFR...ND SD NE KS MN IA MO WI LM LS MI IL
FROM 30ESE INL TO YQT TO 40NW SSM TO 40NE TVC TO 40W TVC TO ORD TO
30ESE PWE TO 50SE GCK TO 40ESE LAA TO GLD TO BFF TO 70SW RAP TO 100SE
MLS TO 30S DIK TO 60NNW ABR TO 30E BJI TO 30ESE INL
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.*

At 1553 CDT, the AWC issued an amended AIRMET TANGO that included advisories for moderate turbulence below 10,000 feet and low level wind shear (LLWS) potential active for the accident location at the accident time.

*WAUS43 KKCI 082053 AAA
WA3T
-CHIT WA 082053 AMD
AIRMET TANGO UPDT 6 FOR TURB AND LLWS VALID UNTIL 090300*

*.
AIRMET TURB...ND SD NE KS MN IA MO WI LS OK TX
FROM 60ENE BIS TO 50ENE DLH TO 60E ONL TO 40N IRK TO 40WSW IRK TO
30ENE END TO 40ESE LBB TO 20WNW TXO TO 60SE TBE TO 50W LBL TO GLD TO
20NE SNY TO 70SSE RAP TO 60ENE BIS
MOD TURB BLW 100. CONDS CONTG BYD 03Z THRU 09Z.*

*.
LLWS POTENTIAL...MN IA WI LM LS MI LH IL IN
BOUNDED BY 50NW DLH-70S YQT-50W SSM-40NNW ASP-30SE ECK-60SW DXO-
20WNW BVT-50W DSM-50SE RWF-70SSE FAR-50NW DLH
LLWS EXP. CONDS CONTG BYD 03Z THRU 09Z.*

At 1545 CDT, the AWC also issued an AIRMET ZULU for moderate icing between the freezing level and FL220⁷ that was active for the accident location at the accident time.

⁷ Flight Level (FL) - a standard nominal altitude of an aircraft, in hundreds of feet. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 in Hg), the average sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above msl or agl.

WAUS43 KPCI 082045

WA3Z

-CHIZ WA 082045

AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 090300

AIRMET ICE...ND SD NE KS MN IA MO WI LM LS MI LH

FROM 50ENE INL TO YVV TO 50SE ECK TO 70SE FSD TO 40ESE MCI TO 50W LBL

TO GLD TO BFF TO 70SW RAP TO 100SE MLS TO 50ENE INL

MOD ICE BTN FRZLVL AND FL220. FRZLVL 040-100. CONDS CONTG BYD 03Z

THRU 09Z.

8.0 SIGMETs

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

9.0 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 might 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.

The following images (figures 7 and 8) depict GFA forecast information on sky condition, icing, mountain obscuration, instrument flight rule (IFR)⁸ condition and surface wind AIRMETs, surface visibility, surface wind, precipitation, and other obscurations and hazards, valid for the times surrounding the accident.

⁸ IFR conditions - Ceilings less than 1,000 feet agl and/or visibility less than three statute miles.

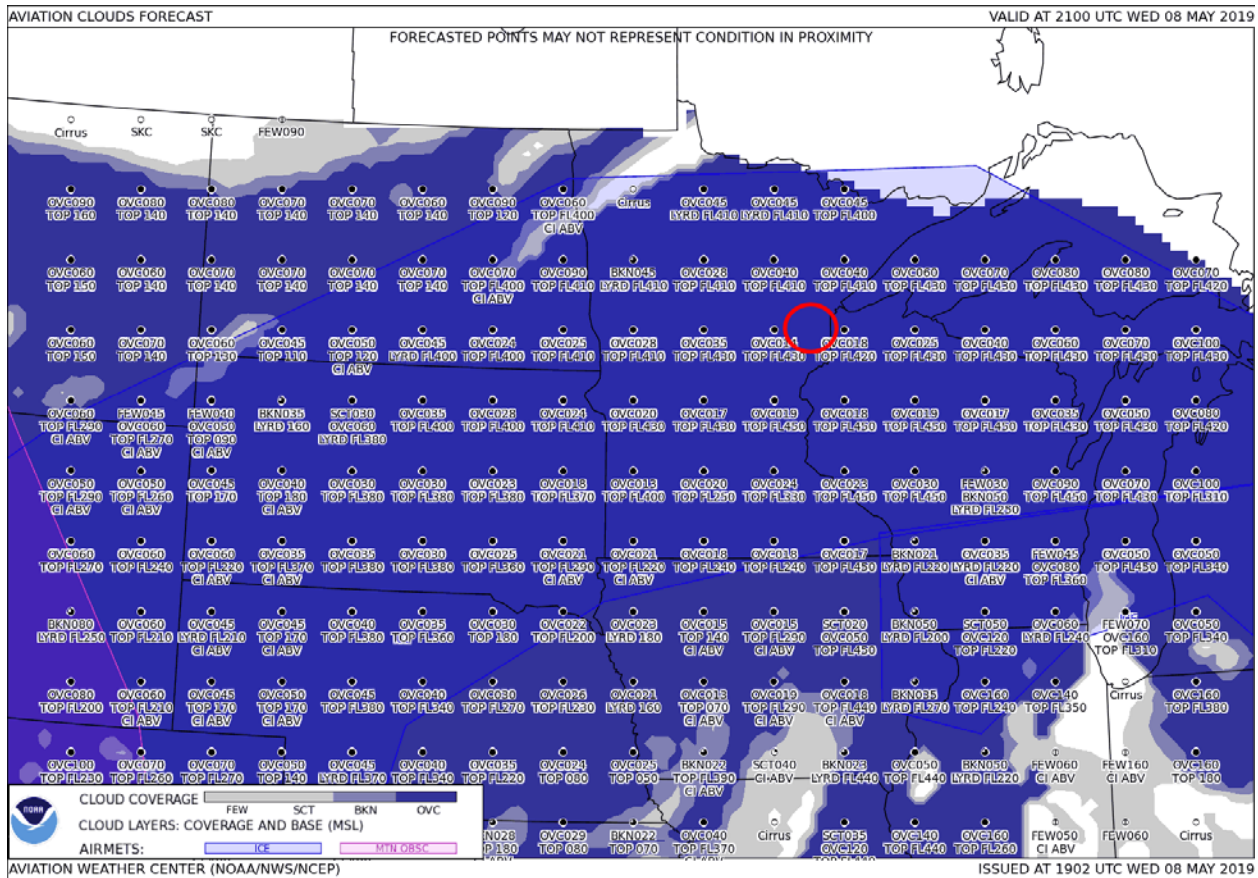


Figure 7 – GFA forecast imagery depicting sky condition and icing and mountain obscuration AIRMETs. Issued about 1400 CDT and valid for 1600 CDT. This GFA forecast imagery depicted overcast sky conditions over the accident region with cloud tops above 40,000 feet and cloud bases of 1,400 and 1,800 feet noted near the accident site. An AIRMET for icing was identified over the accident site. The accident location was within the red circle.

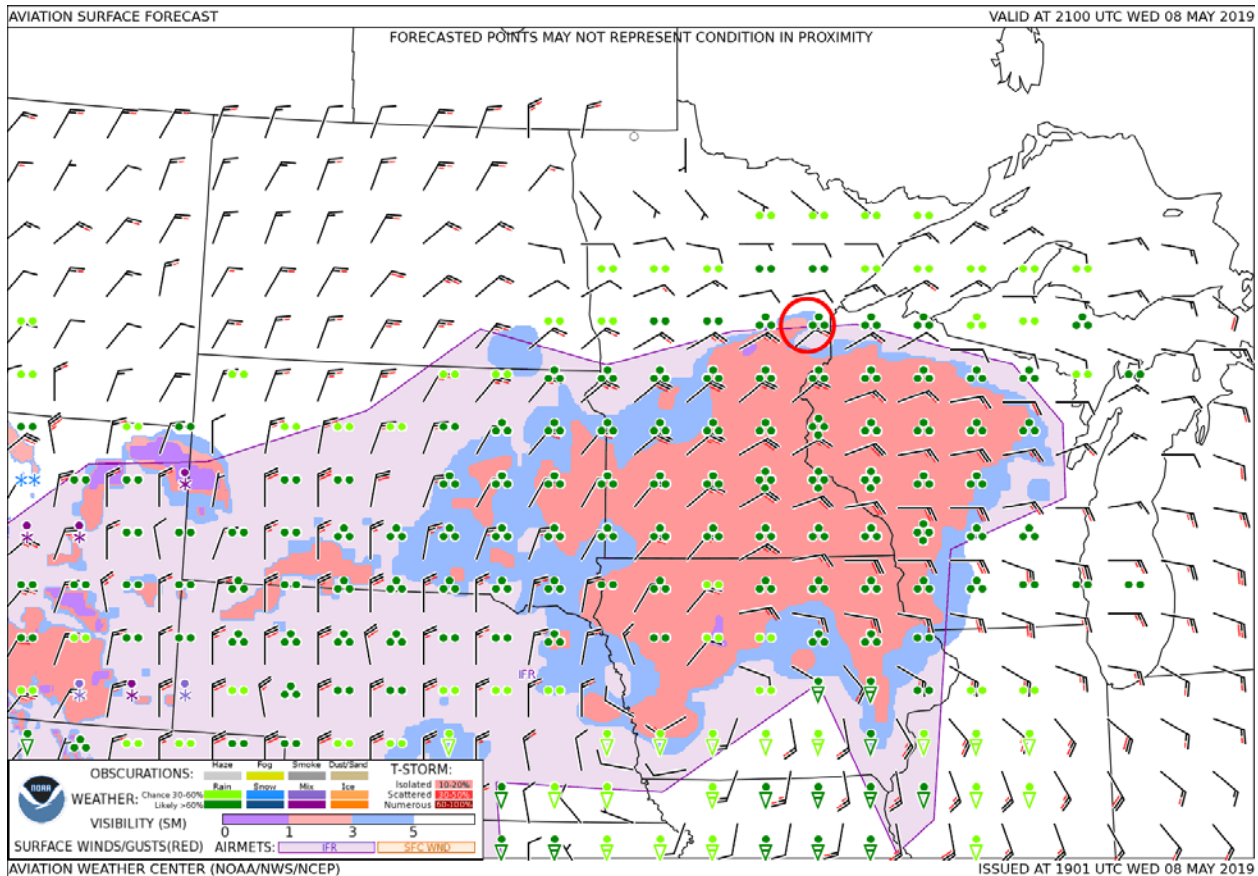


Figure 8 – GFA forecast imagery depicting IFR conditions and surface wind AIRMETs, surface visibility, surface wind, precipitation, and other obscurations and hazards. Issued about 1400 CDT and valid for 1600 CDT. This GFA forecast imagery depicted a surface visibility of 1 to 3 statute miles, a surface visibility of 3 to 5 statute miles, an AIRMET for IFR conditions and moderate rain around the accident location. South of the accident location, an average northeast wind of 15 knots with gusts to 20 knots was depicted. The accident location was within the red circle.

10.0 CWSU

There were no Center Weather Advisories or Meteorological Impact Statements issued by the Center Weather Service Unit (CWSU) at the Minneapolis Air Route Traffic Control Center that were active for the accident location at the accident time.

11.0 Weather Briefing

The transcript for a preflight weather briefing provided to the accident pilot by Leidos Flight Services prior to the accident flight can be found in the NTSB’s public docket for this accident.

Submitted by:

Mike Richards
Senior Meteorologist

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