National Transportation Safety Board
Office of Aviation Safety
Washington, DC 20594

ERA23FA001

# METEOROLOGY

Specialist's Factual Report

October 20, 2022

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## A. ACCIDENT

| | |
|---|---|
| Location: | Hermantown, Minnesota |
| Date: | October 1, 2022 |
| Time: | 2317 central daylight time (CDT)<br>0417 universal coordinated time (UTC) |
| Airplane: | Cessna 172S; Registration: N262TA |

## B. METEOROLOGY SPECIALIST

| | |
|---|---|
| Specialist | Donald Eick<br>National Transportation Safety Board<br>Washington, D.C. |

## C. 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 documents the pertinent meteorological parameters to the accident. All times are reported as central daylight time (CDT) based upon the 24-hour clock, local time is -5 hours from UTC, and UTC=Z. Airport and 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. 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 46.841679° N and longitude 92.222941° W, at an elevation of about 1,410 ft.

## D. FACTUAL INFORMATION

### 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 joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC 00-45H change 2[1].

### 1.1 Surface Analysis Chart

The NWS northcentral section of the NWS Surface Analysis Chart for 2200 CDT is included as figure 1 with the approximate accident site marked by the red star. The chart depicted a high pressure system at 1034-hectopascals (hPa)[2] over northern Ontario, Canada (just off the chart) with a ridge of high pressure extending southwestward into Minnesota. A low-pressure system at 1014-hPa was located over South Dakota associated with a frontal wave with a stationary front extending eastward into southern Minnesota, and a cold front southwestward into Nebraska. The accident site was located between the high and low pressure systems on the cold air side of the front. The station models surrounding the accident site depicted light easterly winds of 10 knots or less, overcast clouds, temperature of 48° Fahrenheit (F), and a dew point of 46° F. No precipitation or restrictions to visibility were depicted over the area.

[1] https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1030235

[2] Hectopascals (hPa) is the standard for reporting sea-level pressure and is interchangeable with the former term millibar (mb) with the same units. The international Standard Atmosphere (ISA) is based on a sea-level pressure of 1013.25-hPa at sea-level at a temperature of 15° Celsius (C) or 59° Fahrenheit (F).

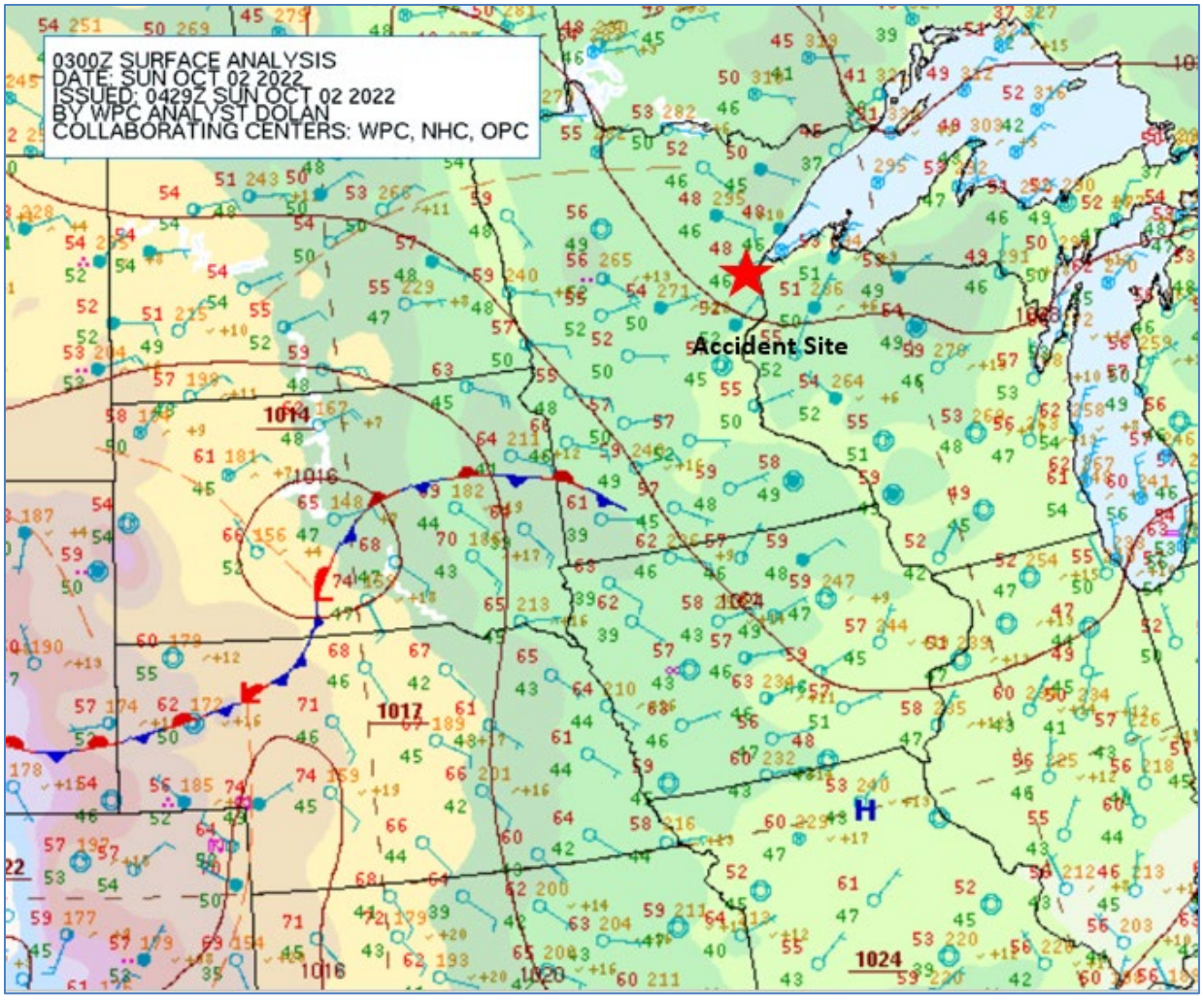


**Figure 1 - NWS Surface Analysis Chart for 2200 CDT with the accident site marked by the red star.**

## 1.2 Regional Composite Radar Mosaic

The NWS National Composite Radar Mosaic was reviewed to determine if there were any significant areas of precipitation in the vicinity at the time of the accident. Figure 2 is the regional composite radar image for 2315 CDT which depicted a band of echoes extending from Grand Forks southeastward to Minneapolis, with no significant meteorological echoes within 60 miles of the accident site.

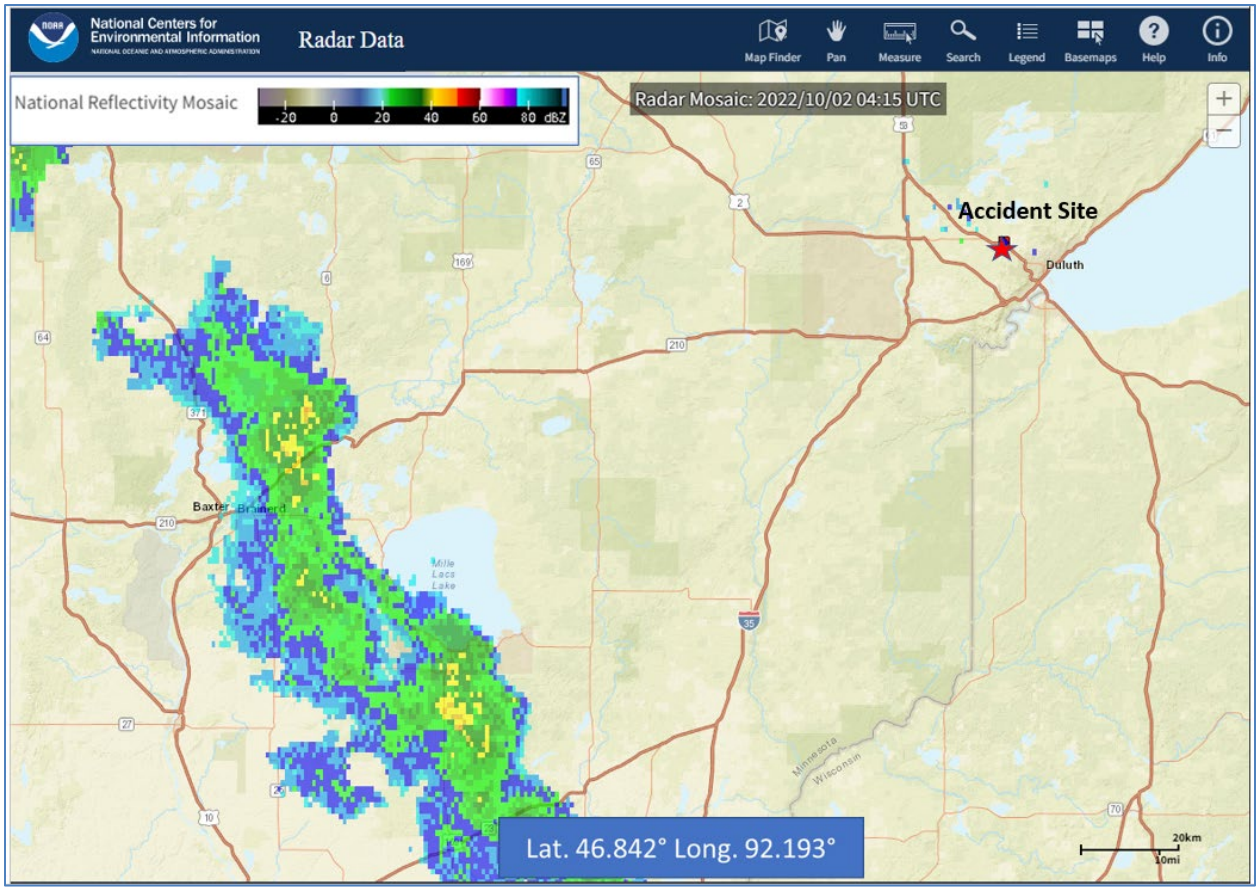


**Figure 2 - Regional Composite radar Mosaic for 2315 CDT with accident site.**

## 2.0 Observations

The area was documented using official Aviation Routine Weather Reports (METAR[3]) 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 1° west based on the latest sectional chart for the area.

## 2.1 Duluth, Minnesota

The closest weather reporting station was from the departure airport of Duluth International Airport (KDLH), Duluth, Minnesota, located less than 2 miles north of the accident site at an elevation of 1,428 ft. The airport had an Automated Surface Observation System (ASOS) and was augmented by air traffic controllers during normal operating hours between 0500 and 2400 CDT. Surrounding the time of the accident the following conditions were being reported:

[3] Abbreviation for METeorological Aerodrome Report.

*Weather observation for KDLH at 2255 CDT, wind from 080° at 10 knots gusting to 19 knots, visibility 5 miles, mist, ceiling overcast at 200 ft agl, temperature 9° C, dew point temperature 8° C, altimeter 30.38 inches of mercury (inHg). Remarks: automated station with a precipitation discriminator, sea-level pressure 1029.6-hPa, temperature 9.4° C, dew point temperature 8.3° C.*

*Weather observation for KDLH at 2355 CDT, wind from 080° at 12 knots, visibility 4 miles, mist, ceiling overcast at 200 ft agl, temperature 9° C, dew point temperature 8° C, altimeter 30.38 inHg. Remarks: automated station with a precipitation discriminator, sea-level pressure 1029.6-hPa, temperature 8.9° C, dew point temperature 7.8° C.*

The general flight categories[4] and raw observation for KDLH surrounding the period from 1855 through 0155 CDT were as follows:

IFR *METAR KDLH 012355Z 08011G20KT 10SM BKN007 BKN023 10/08 A3036 RMK AO2 SLP292 T01000078 10144 20100 51012=*

IFR *METAR KDLH 020055Z 09013KT 10SM OVC005 09/08 A3036 RMK AO2 SLP291 T00940078=*

LIFR *SPECI KDLH 020127Z 09013G24KT 10SM OVC004 09/08 A3036 RMK AO2 T00940078=*

IFR *METAR KDLH 020155Z 09012G22KT 10SM OVC005 09/08 A3037 RMK AO2 SLP294 T00940078=*

LIFR *SPECI KDLH 020214Z 08015G22KT 10SM OVC004 09/08 A3037 RMK AO2 T00940083=*

LIFR *METAR KDLH 020255Z 09015G24KT 10SM OVC003 09/08 A3037 RMK AO2 SLP293 T00940083 53002=*

***LIFR METAR KDLH 020355Z 08010G19KT 5SM BR OVC002 09/08 A3038 RMK AO2 SLP296 T00940083=***

***Accident 0417Z***

***LIFR METAR KDLH 020455Z 08012KT 4SM BR OVC002 09/08 A3038 RMK AO2 SLP296 T00890078=***

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[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 or the lowest layer of clouds reported as broken or overcast, or the vertical visibility into a surface based obscuration 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.

*LIFR* *METAR KDLH 020555Z 08011KT 9SM OVC002 09/08 A3037 RMK AO2 SLP293 T00940083 10100 20089 401440089 50000=*

*LIFR* *METAR KDLH 020655Z 09009G17KT 10SM OVC004 09/08 A3037 RMK AO2 SLP293 T00940083=*

A review of the disseminated observations indicated LIFR to IFR conditions prevailing during the period, with ceilings reported overcast at 200 ft agl immediately surrounding the time of the accident with visibility restricted in mist.

## 2.2 KDLH 5-minute Observations

The 5-minute ASOS reports[5] from 2300 through 2330 CDT were obtained and are included below. These reports were potentially broadcasted but not disseminated longline. The report issued immediately prior to the accident is bold type below.

5-MIN KDLH 020400Z 09011G19KT 4SM BR OVC002 09/08 A3038 1010 93 600 090/11G19 RMK AO2 T00940083

5-MIN KDLH 020405Z 09011G19KT 3SM BR OVC002 09/08 A3037 1010 93 600 090/11G19 RMK AO2 T00940083

5-MIN KDLH 020410Z 09012G20KT 3SM BR OVC002 09/08 A3037 1010 96 600 090/12G20 RMK AO2 T00890083

**5-MIN KDLH 020415Z 09012G22KT 3SM BR OVC002 09/08 A3038 1010 96 600 090/12G22 RMK AO2 T00890083**

**Accident 0417Z**

5-MIN KDLH 020420Z 08011G22KT 5SM BR OVC002 09/08 A3038 1010 96 600 080/11G22 RMK AO2 T00890083

5-MIN KDLH 020425Z 09010KT 7SM OVC002 09/08 A3038 1010 93 600 090/10 RMK AO2 T00890078

5-MIN KDLH 020430Z 08011G17KT 7SM OVC002 09/08 A3038 1010 96 600 080/11G17 RMK AO2

[5] The 5-minute observations are an indication of the ASOS observations broadcasted locally and are available at the air traffic controllers tower position who augments the observations. The observations include after the altimeter setting the current pressure altitude, relative humidity, density altitude, and magnetic wind direction and wind speed before the remarks section. ATC controllers and ATIS broadcasts issue winds referenced to magnetic north to orientate to runway headings.

A review of the 5-minute ASOS observations also indicated LIFR conditions prevailing at the time of the accident and reported at 2315 CDT of winds from 090° true at 12 knots gusting to 22 knots, visibility 3 miles in mist, ceiling overcast at 200 ft agl, temperature 9° C, dew point temperature 8° C, and an altimeter of 30.38 inHg, with the relative humidity at 96%, a density altitude of 600 ft, and a magnetic wind from 090° true at 12 knots gusting to 22 knots.

## 2.3 METAR Display

A display of the METARs from the NWS Aviation Weather Center's webpage[6] at the approximate time of the accident is included as figure 3 with KDLH and the accident site within the red circle. The image depicted general LIFR to IFR conditions surrounding the accident site due to low ceilings with MVFR conditions to the northwest and east of the accident site.

[6] https://www.aviationweather.gov/metar

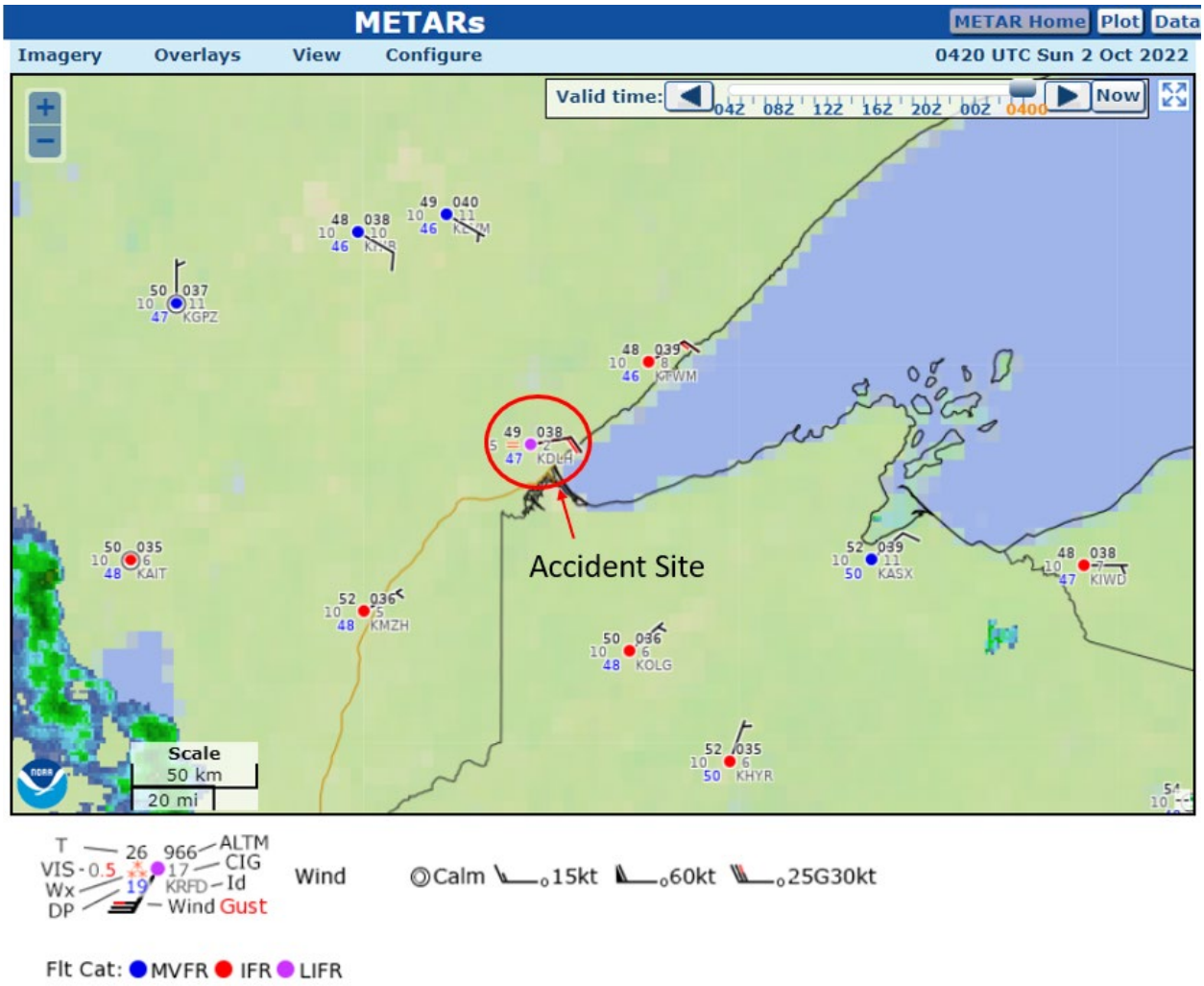


**Figure 3 - METAR display of the observation at 2320 CDT with accident site within the red circle.**

## 3.0 Model Sounding

A High-Resolution Rapid Refresh (HRRR)[7] numerical model data was obtained from the NOAA Air Resource Laboratory archive using the closest grid point[8] to the accident site coordinates. The HRRR model data was then plotted on a standard

[7] 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.
[8] Grid point coordinates were latitude 46.84° N and longitude 92.19° W.

skew T log P diagram[9] using the RAOB Analysis software[10] for 2300 CDT from the surface to 450-hPa (approximately 22,000 ft) and is included as figure 4.

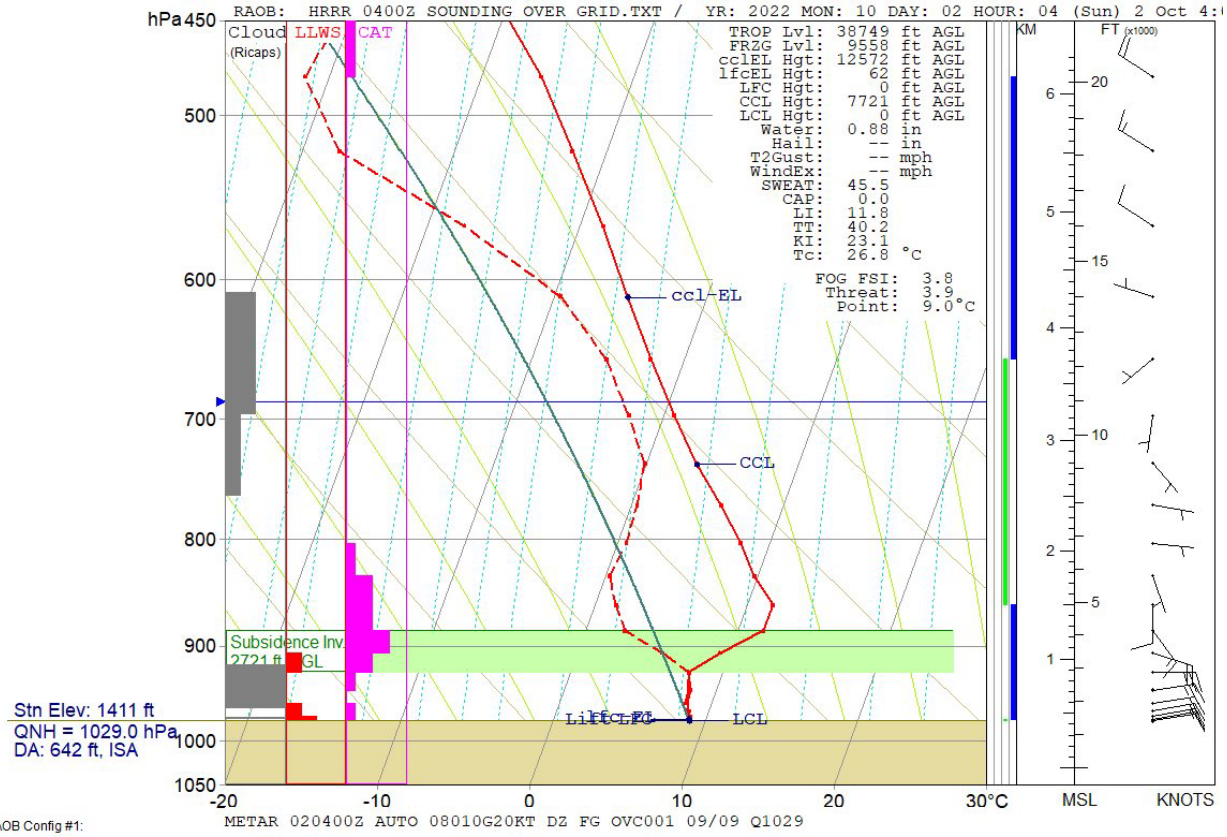


**Figure 4 - HRRR model sounding over the approximate accident site for 2300 CDT.**

The sounding indicated an elevation of 1,411 ft over the grid point with a near surface temperature and dew point temperature of 9° C (48° F), a relative humidity of 100%, with an approximate density altitude of 642 ft. The lifted condensation level (LCL)[11] and the level of free convection (LFC)[12] were at the surface, with the convective condensation level (CCL)[13] at 7,720 ft agl. An inversion was noted between about

[9] Skew T log P diagram is a standard meteorological plot or thermodynamic diagram 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.

[10] RAOB –The Universal RAwinsonde OBservation program is an interactive sounding analysis program developed by Eosonde Research Services (ERS) previously known as Environmental Research Services, The Villages, Florida.

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

[12] 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.

[13] Convective Condensation Level (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.

3,000 ft through 5,000 ft (green shaded area) where temperature increased with altitude. The sounding was characterized as stable based on the inversion and the Lifted Index[14] of 11.8. The freezing level was identified at about 11,000 ft. The RAOB Analysis program supported fog with an overcast layer of clouds from 100 ft agl with tops near 3,000 ft with another layer of broken clouds between 8,000 ft and 14,000 ft msl. The HRRR wind profile indicated a surface wind from 080° at 10 knots gusting to near 20 knots with a low-level wind maximum near the base of the inversion near 2,400 ft msl with winds from 090° at 23 knots, and decreasing to less than 10 knots between 5,000 and 16,000 ft. The mean 0 to 6 km (or 18,000 ft) wind was from 310° at 3 knots.

A table of the HRRR parameters below 12,000 ft of height, pressure, temperature (T), dew point temperature (Td), relative humidity (RH), wind, potential Clear Air Turbulence (CAT) intensity, and Low-Level Wind Shear (LLWS) based on the vertical wind shear is included below.

| Height (ft-msl) | Pres (hPa) | T (°C) | Td (°C) | RH (%) | Wind (deg/kts) | CAT (FAA) | LLWS (FAA) |
|---|---|---|---|---|---|---|---|
| 1411 | 978 | 9.0 | 9.0 | 100 | 079/ 10 | | |
| 1467 | 976 | 8.9 | 8.9 | 100 | 079/ 9 | LGT | MODRT |
| 1551 | 973 | 8.9 | 8.9 | 100 | 079/ 14 | LGT | LIGHT |
| 1719 | 967 | 8.7 | 8.6 | 99 | 079/ 17 | LGT | LIGHT |
| 1945 | 959 | 8.4 | 8.3 | 99 | 080/ 21 | | |
| 2345 | 945 | 8.3 | 8.2 | 99 | 082/ 23 | LGT | |
| 2867 | 927 | 7.8 | 7.8 | 100 | 090/ 23 | MDT | LIGHT |
| 3460 | 907 | 9.4 | 5.6 | 77 | 110/ 18 | SVR | |
| 4132 | 885 | 11.7 | 2.6 | 54 | 146/ 13 | MDT | |
| 4919 | 860 | 11.7 | 1.4 | 49 | 181/ 10 | MDT | |
| 5792 | 833 | 9.8 | 0.3 | 52 | 163/ 4 | LGT | |
| 6789 | 803 | 8.1 | 0.6 | 59 | 097/ 5 | | |
| 7922 | 770 | 5.9 | 0.4 | 68 | 100/ 5 | | |
| 9167 | 735 | 3.3 | -0.1 | 78 | 142/ 4 | | |
| 10575 | 697 | 0.7 | -2.3 | 80 | 188/ 5 | | |

The RAOB Analysis program indicated a layer of potential moderate or greater turbulence between 2,500 ft through 5,700 ft msl associated with the stable layer of the inversion and strong vertical wind shears.

[14] 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. Negative values indicate instability - the more negative, the more unstable the air is, and the stronger the updrafts are likely to be with any developing thunderstorms.

## 4.0 Satellite Imagery

The NOAA Geostationary Operational Environmental Satellite number 16 (GOES-16) 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 imagery were reviewed surrounding the period, and the closest images to the accident time documented. The infrared long wave imagery (band 13) at a wavelength of 10.3 microns ( $\mu$ m) provided radiative cloud top temperatures with a nominal spatial resolution of 2 km. Due to the time of the accident the higher resolution visible imagery (band 2) was not available surrounding the time of the accident due to the low sun angle and nighttime conditions. The following satellite image have not been corrected for any parallax error.

Figure 5 is the GOES-16 infrared red image at 2316 CDT at 6X magnification with a standard MB temperature enhancement curve applied to highlight the higher and colder cloud tops. The image depicted a band of low overcast clouds over the area with a radiative cloud top temperature of 276 Kelvin or 2.8° C, which corresponded to cloud tops near 9,500 ft. Other higher clouds were noted over the area with higher cloud tops to the northwest through west of the accident site associated with more cumuliform clouds with vertical development and precipitation.

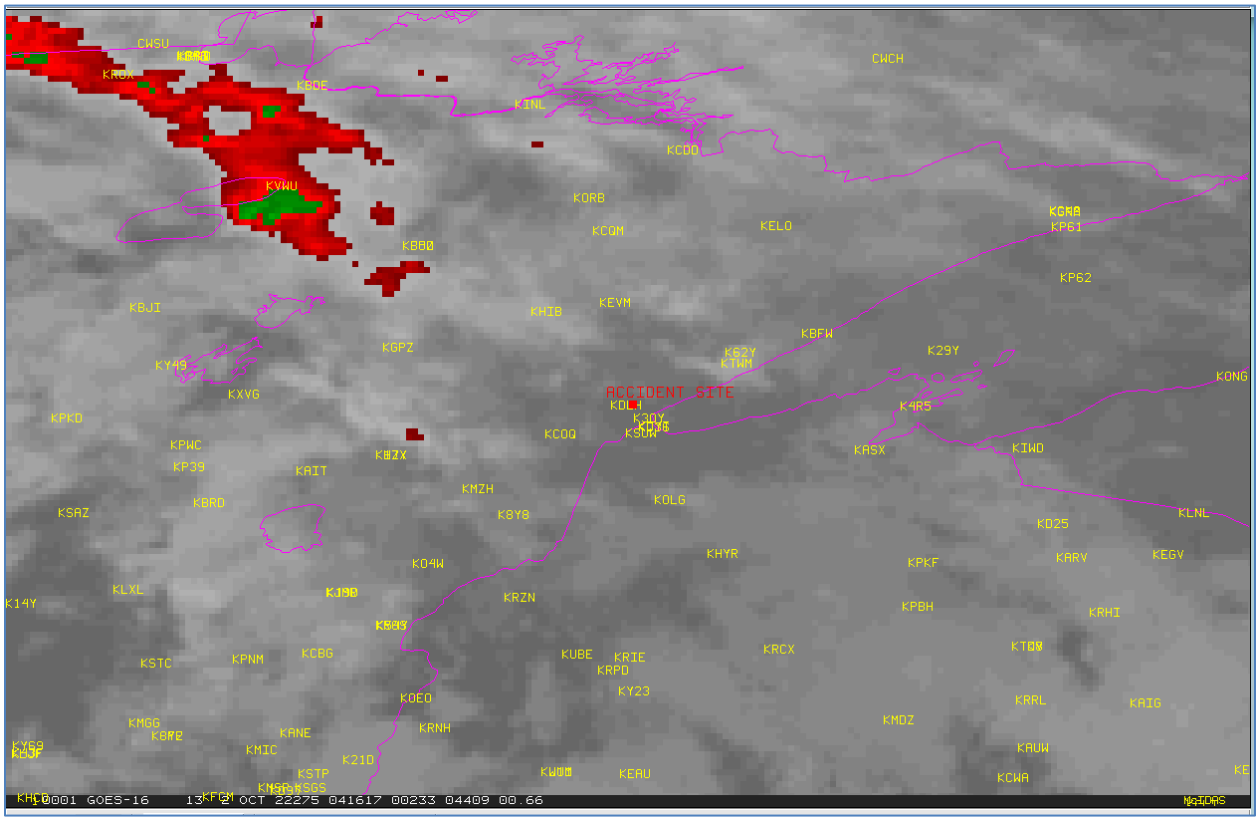


**Figure 5 - GOES-16 infrared image for 2316 CDT at 6X magnification with accident site.**

## 5.0 Pilot Reports

A search of the NWS database[15] for any pilot reports or PIREPs immediately surrounding the period from 1900 through 0300 CDT, within 120 miles and below 18,000 ft provided no reports.

## 6.0 NWS Forecasts

The forecasts issued by the local Duluth Weather Forecast Office (WFO) and the Aviation Weather Center in Kansas City, MO issued surrounding the period are documented below.

### 6.1 Terminal Aerodrome Forecast

The normally scheduled TAF for KDLH was issued at 1832 CDT and was amended twice during the period leading up to the accident.

*TAF KDLH 012332Z 0200/0224 08012G20KT P6SM BKN007 BKN025*
***FM020200 08011G17KT 3SM BR VCSH OVC005***
*FM020700 08010KT 1 1/2SM BR VCSH OVC003*
*FM021600 10008KT P6SM BKN013*
*FM021900 12008KT P6SM SCT020 BKN040=*

*AMD TAF KDLH 020059Z 0201/0224 08012G20KT P6SM OVC005*
***FM020300 08011G17KT 3SM BR VCSH OVC005***
*FM020700 08010KT 1 1/2SM BR VCSH OVC003*
*FM021600 10008KT P6SM BKN013*
*FM021900 12008KT P6SM SCT020 BKN040=*

***AMD TAF KDLH 020307Z 0203/0224 08013G23KT 6SM BR OVC003***
*FM020700 08010KT 1 1/2SM BR VCSH OVC003*
*FM021600 10008KT P6SM BKN013*
*FM021900 12008KT P6SM SCT020 BKN040=*

The KDLH TAFs expected IFR to LIFR conditions to prevail during the period due to low ceilings and visibility in fog/mist with rain showers in the vicinity, with easterly winds gusting from 17 to 23 knots. The IFR conditions were predicted from the time of issuance through 1100 CDT on October 2, 2022, when MVFR conditions were predicted.

[15] Includes PIREPs making into the NWS database and may not include "ride reports" or other reports made on radio frequency to air traffic control and not formally entered as a PIREP into the national database.

## 6.2 Area Forecast Discussion

The NWS Area Forecast Discussions (AFD) are issued by each WFO to describe the short-term weather conditions within their region with an aviation section that includes 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 short term, and aviation sections issued by KDLH at 1840 CDT was as follows.

*FXUS63 KDLH 012340*
*AFDDLH*

*Area Forecast Discussion*
*National Weather Service Duluth MN*
*640 PM CDT Sat Oct 1 2022*

*.DISCUSSION...(This evening through Friday)*
*Issued at 454 PM CDT Sat Oct 1 2022*

*Summary: Low chances for rain will continue into the new week before a stronger system moves through bringing much colder air to the region over the latter portion of the new week.*

*High pressure was located to our north over northwestern Ontario this afternoon with low pressure over central South Dakota. A warm front arced eastward into southern Minnesota from this low. Showers were ongoing along and to the north of this front along the I-94 corridor. A few spotty showers were seen on radar over the Northland, but most areas were dry under partly to mostly cloudy skies with a weak shortwave aloft diving to the southeast. The warm front will lift to the north overnight and shift the area of showers to the north as well. This will spread showers across the Brainerd Lakes area into the Iron Range through the night before dissipating Sunday morning. High pressure is expected to build to our east as well, impeding the eastward progression of the low over South Dakota.*

*An upper low will move out of the Northern Rockies Monday into Tuesday and send a few shortwaves our direction around the periphery of an upper ridge. This will keep low chances for showers in place for Monday into Tuesday. This upper low will finally work through the region for the middle portion of the week and bring better chances for rain for Wednesday into Thursday as*
*a secondary upper low drops out of Canada behind the first system. Unseasonably cold air will pour in with this low as well and may lead to some snowflakes mixing in with rain showers across*
*northern areas early Thursday morning and then again across northwest Wisconsin late Thursday. Cold high pressure then looks to build in for the end of the period, but lake-effect showers may*
*linger across northwest Wisconsin.*

*Highs will be above normal for Sunday through Wednesday with highs in the upper 60s and lower 70s for Monday. Temperatures will then be sharply colder for Thursday and Friday with highs only reaching the 40s.*

*.AVIATION...(For the 00Z TAFS through 00Z Sunday evening)*

*Issued at 640 PM CDT Sat Oct 1 2022*

*A wide range of conditions were occurring across the Northland early this evening with IFR conditions around Lake Superior to VFR well inland**.** A few light showers were occurring in spots too with a band of steadier showers from northern North Dakota southeast through southeast Minnesota. We expect the band of steadier showers to lift north and east tonight as an area of FGEN moves north. KBRD will have the best chance at seeing rain tonight. We may have to increase chances further north as well but confidence isn't all that high now for the other TAF sites.*

*We did lower the visibility further for the KDLH TAF as guidance is persistent that fog will form and given the lowering ceilings we're experiencing now. We drop them to IFR but some guidance is even lower to below a half mile at times. We don't have high enough confidence to include those low visibilities at this time.*

*There will be improvement to the ceilings from south to north during the day Sunday most areas rising to VFR.*

## 6.3 Graphic Forecast for Aviation

The NWS Graphical Forecasts 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 Data (NDFD) with the Graphic-Airmen's Meteorological Information (G-AIRMET)[16] 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. The 3-hour GFA forecasts issued at about 2000 CDT and valid for the period from 2200 through 0100 CDT on October 2, 2022, are included as figures 6-7. The GFA Aviation Surface Forecast (figure 6) depicted easterly winds at 10 to 15 knots, with a small area of visibility of 1 to 3 miles in the vicinity of the accident site, with a chance of rain showers to the south through northwest of the area. The chart depicted a G-AIRMET for IFR conditions over the area at the time. While the GFA Aviation Cloud Forecast (figure 7) depicted an area of overcast clouds with bases near 2,400 ft and tops near 4,000 ft msl with a G-AIRMET for icing over Minnesota, Wisconsin, northern Iowa, and the Dakotas to the south and west of the accident site.

[16] AIRman's METeorological Information (AIRMET) is a concise description of weather phenomena that are occurring or may occur (forecast) along an air route that may affect aircraft safety. Compared to SIGMETs, AIRMETs cover less severe weather: moderate turbulence and icing, sustained surface winds of 30 knots or more, low-level wind shear, or widespread restricted visibility.

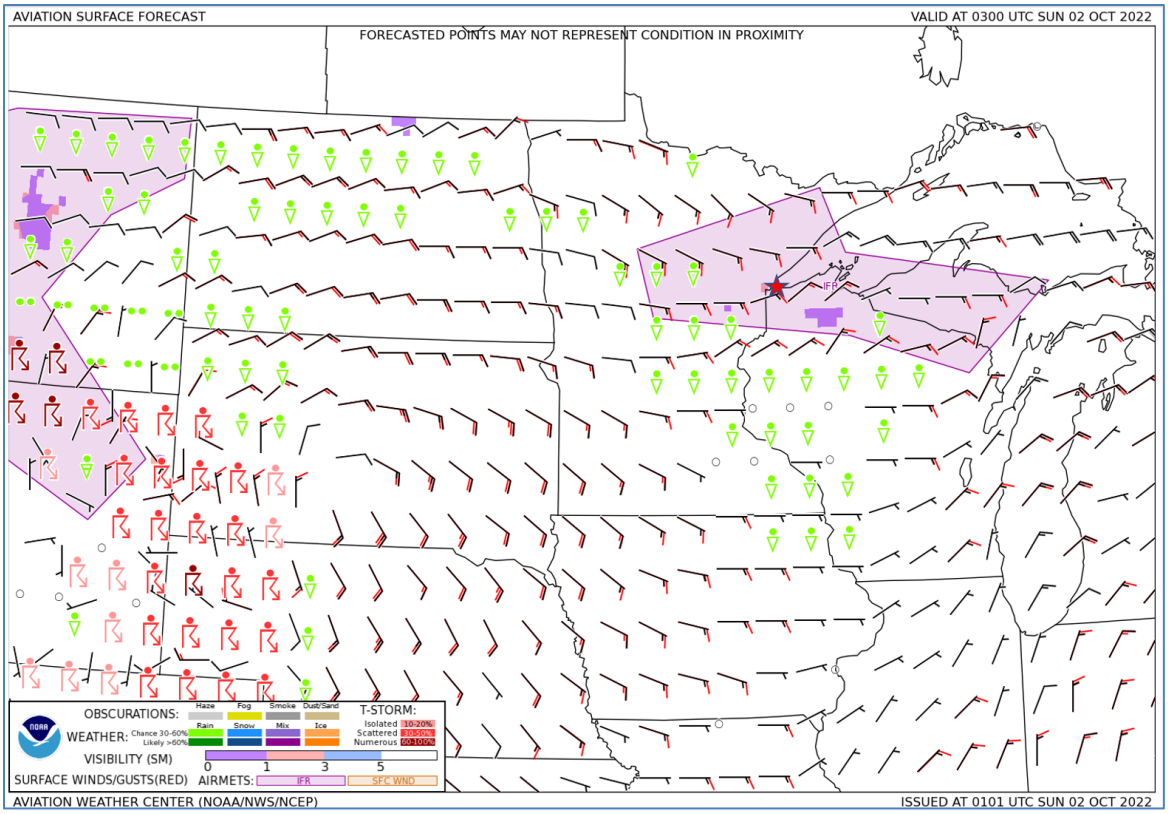


**Figure 6 - GFA 3-hour Surface Forecast valid for 2200 CDT.**

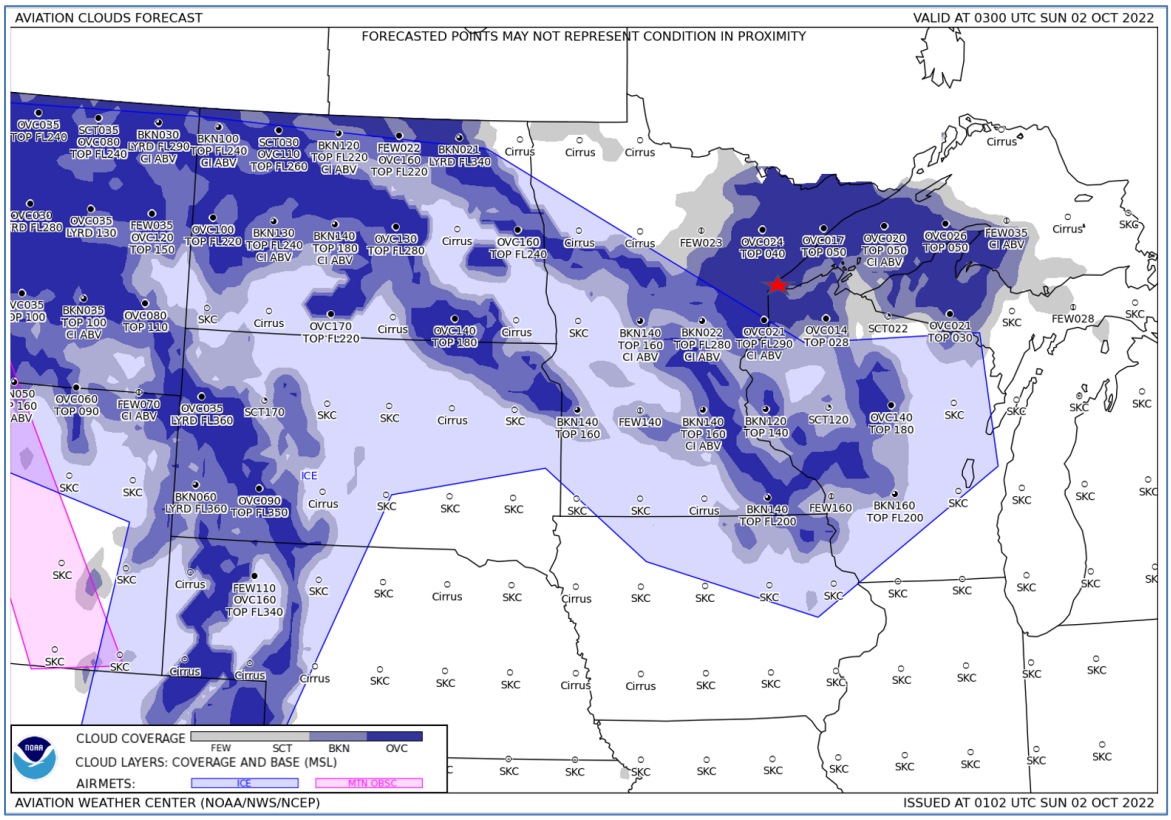


**Figure 7 - GFA 3-hour Cloud Forecast valid for 2200 CDT.**

## 6.4 Inflight Weather Advisories

Inflight Aviation Weather Advisories are forecasts to 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 FAA Air Route traffic Control Center's (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 which 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 controllers upon issuance and available on other inflight weather broadcasts.

During the period the NWS had no SIGMETs or Convective SIGMETs current over the region surrounding the period of the accident, and the NWS Minneapolis CWSU had issued no CWA's surrounding the period. The NWS AWC only had G-AIRMET Sierra current for IFR conditions and G-AIRMET Zulu for icing conditions between the freezing level and Flight level 240 (FL240)[17], which extended well above the accident airplane's altitude. Figure 8 is a depiction of G-AIRMET for IFR conditions due to ceilings below 1,000 ft agl and/or visibility below 3 miles in mist over the region at the time of the accident from the NWS AWC's website[18].

[17] A Flight Level (FL) is reference to altitudes generally above 18,000 ft, where aircraft altitudes are based on pressure altitudes when the altimeter is set to 29.92 inHg. Flight Levels are reported in hundreds of feet, where FL240 means approximately 24,000 ft msl.
[18] https://www.aviationweather.gov/gairmet

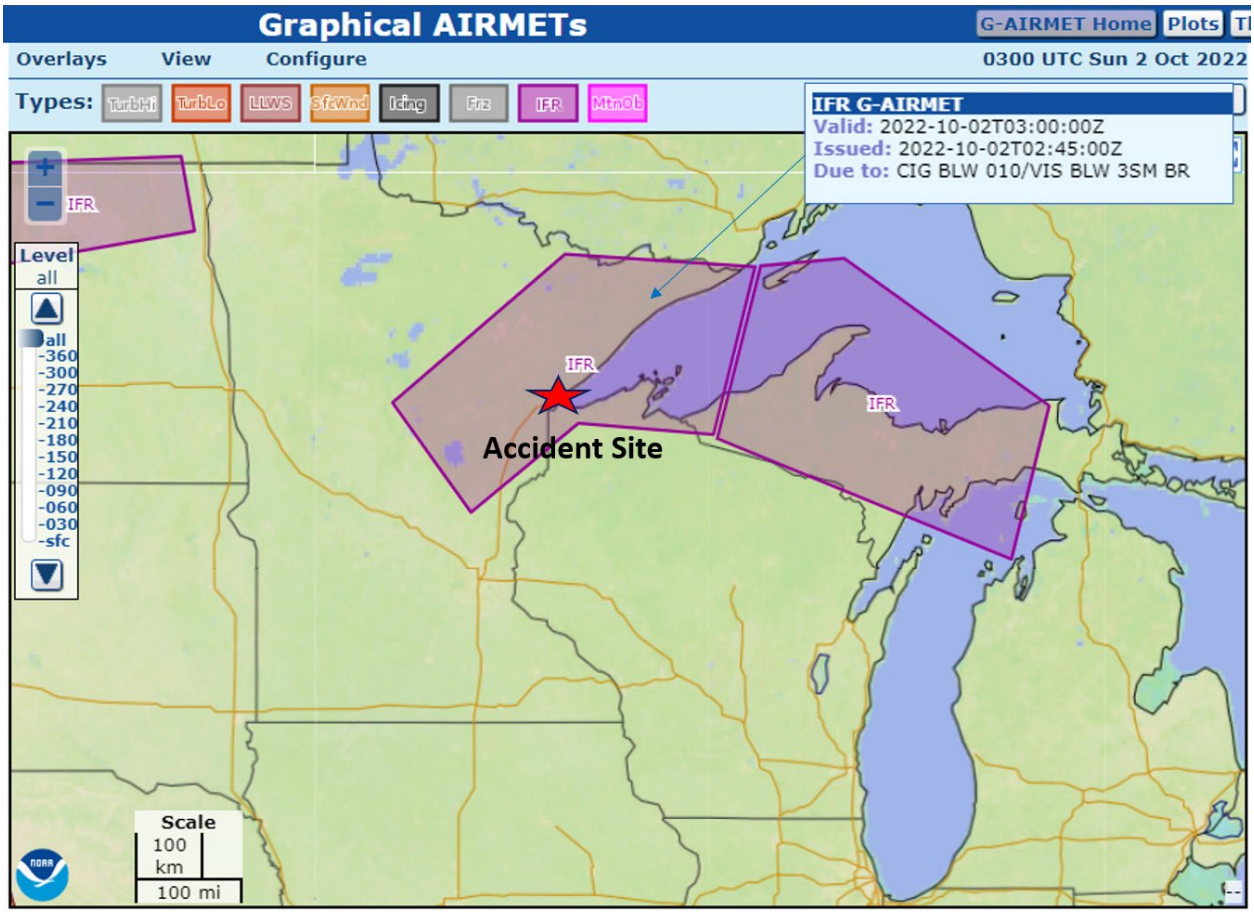


**Figure 8 - Depiction of G-AIRMET for IFR conditions at 2200 CDT with the accident site.**

## 7.0 Weather briefing Information

A search of the FAA's Automated Flight Service Station (AFSS) provider Leidos indicated that they or no other 3rd party vendors using the Lockheed Flight Service (LFS) system had any contact with N262TA on the day of the accident. A separate search of ForeFlight indicated that the accident pilot had filed an IFR flight plan from KDLH to KSGS at 2244 CDT, with a planned altitude of 6,000 ft and an expected time enroute of 1:15. No alternate airport was designated. A copy of the weather briefing generated with the flight plan is included as attachment 1. The pilot did not view any other weather imagery inside the app prior to the accident flight.

## 8.0 Astronomical Conditions

The Unites States Naval Observatory website[19] provided the following astronomical conditions over Duluth on October 1, 2022. The time of the accident has been added in bold italic type for reference.

| Sun | Time (CDT) |
|---|---|
| Begin Civil Twilight | 0637 |
| Sunrise | 0707 |
| Upper Transit | 1258 |
| Sunset | 1848 |
| End Civil Twilight | 1918 |
| ***Accident*** | ***2317*** |

| Moon | Time |
|---|---|
| Moon Rise | 1402 |
| Moon Culmination | 1803 |
| Moon Set | 2201 |
| ***Accident*** | ***2317*** |

At the time of the accident the sun was more than 15° below the horizon and the moon was about 11° below the horizon at an azimuth of 240°. The phase of the moon was a first quarter and was 40% illuminated when visible.

## E. ATTACHMENTS

Attachment 1 – ForeFlight Weather Briefing

Submitted by:

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NTSB Senior Meteorologist

[19] https://aa.usno.navy.mil/data/RS_OneDay