NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

October 1, 2019

Weather Study

METEOROLOGY

CEN19LA039

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A. ACCIDENT

Location: Fargo, North Dakota
Date: November 30, 2018
Time: about 1353 central standard time (1953 UTC)[1]
Airplane: Cessna 550; N941JM

B. METEOROLOGIST

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Senior Meteorologist
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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 standard time (CST) for November 30, 2018 (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).

The accident occurred at Hector International Airport (FAR)[2] in Fargo, North Dakota, which was located at: 46.9206389° north latitude, 96.8157500° west longitude, at an elevation of 901 feet.

D. WEATHER INFORMATION

1.0 Surface Observations

An Automated Surface Observing System was located at FAR and its human-augmented reports from the times surrounding the accident time are presented here.

[1229 CST] SPECI KFAR 301829Z 13008KT 6SM BR OVC005 M01/M01 A2990 RMK AO2 T10061011=

[1242 CST] SPECI KFAR 301842Z 15007KT 6SM BR OVC004 M01/M01 A2990 RMK AO2 T10111011=

[1] UTC – abbreviation for Coordinated Universal Time

[2] The National Weather Service (NWS) 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.

[1253 CST] METAR KFAR 301853Z 16008KT 6SM BR OVC004 M01/M01 A2990 RMK AO2 SLP137 T10061011=

[1353 CST] METAR KFAR 301953Z 20010KT 5SM BR OVC004 M01/M01 A2991 RMK AO2 SLP142 T10111011=

[1409 CST] SPECI KFAR 302009Z 17008KT 4SM BR OVC003 M01/M01 A2992 RMK AO2 T10111011=

At 1353 CST, FAR reported a wind at from 200° at 10 knots, visibility of 5 statute miles, mist, ceiling overcast at 400 feet above ground level, temperature of -1° Celsius (C) and a dew point temperature of -1°C, altimeter setting of 29.91 inches of mercury; remarks: station with a precipitation discriminator, sea level pressure of 1014.2 hectopascals (hPa), temperature of -1.1°C and a dew point temperature of -1.1°C.

2.0 Pilot Reports

Publicly disseminated pilot reports[3] (PIREPs) made between 1100 and 1700 CST within 150 statute miles of the accident location at or below 15,000 feet are presented here. About 30 minutes after the accident, a Citation Excel aircraft at 3,000 feet at FAR reported overcast skies, a temperature of -2°C and moderate rime icing.

BJI UA /OV BJI/TM 1701/FL035/TP BE65/SK OVC019-TOP035/TA M03/IC LGT RIME 035-019/RM DURD

GFK UA /OV GFK/TM 1826/FLDURD/TP CRJ2/SK OVC011-TOP030/TA M07/IC LGT RIME/RM ON APPROACH TO GFK

ABR UA /OV ABR/TM 1831/FL000/TP CRJ2/SK OVC003-TOPUNKN/RM DURD

FAR UA /OV KFAR/TM 2021/FL030/TP C56X/SK OVC/TA M02/IC MOD RIME

GFK UA /OV GFK/TM 2035/FLDURGD/TP CRJ2/SK OVC012-TOP031/IC MOD RIME/RM ON FINAL RWY 35L GFK/ BRAG

3.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR) model[4] sounding (figure 1) for the accident site at 1400 CST was retrieved from the National Oceanic and Atmospheric Administration's Air Resources Laboratory. Near the surface, the wind was from the south at about 5 knots and veered to a west-southwest wind of about 15 knots at about 6,000 feet. A temperature inversion was noted between about 2,800 and 3,400 feet. The entire atmosphere below 700 hPa was below freezing except for

[3] These do not include pilot reports only broadcast via radio.

[4] 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.

a layer between about 3,700 feet and 5,800 feet and a layer about 100 feet thick immediately above the surface. The relative humidity was 99 percent or greater between about 1,250 and 3,150 feet.

Calculations made by the Rawinsonde OBservation Program (RAOB) indicated the potential for icing conditions between about 1,100 feet and 3,400 feet, which included light rime and moderate clear icing severities. RAOB identified clouds between about 1,400 and 3,600 feet.

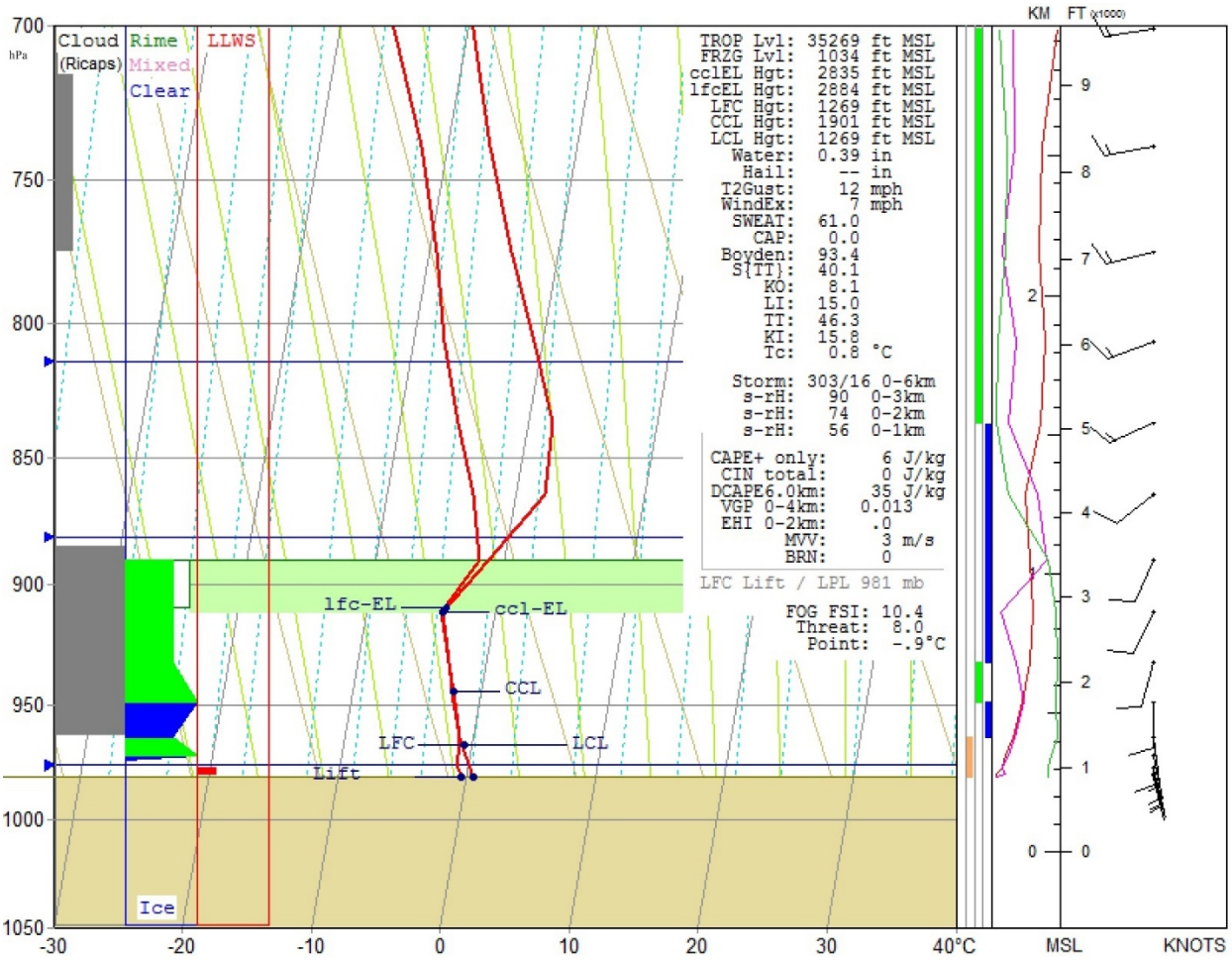

Figure 1 – HRRR model sounding data in SkewT/LogP format for 1400 CST at the accident site, surface to 700 hPa.

4.0 Satellite Imagery

Geostationary Operational Environmental Satellite (GOES)-16 infrared (10.3µm) data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison. Imagery from 1352 CST is presented in figure 2. Infrared cloud-top temperatures were about -6°C over the accident location at the accident time. Considering the HRRR sounding temperature and moisture profiles, this cloud top temperature likely corresponded most closely to cloud top heights of about 2,800 feet (which was the coldest height in the saturated layer).

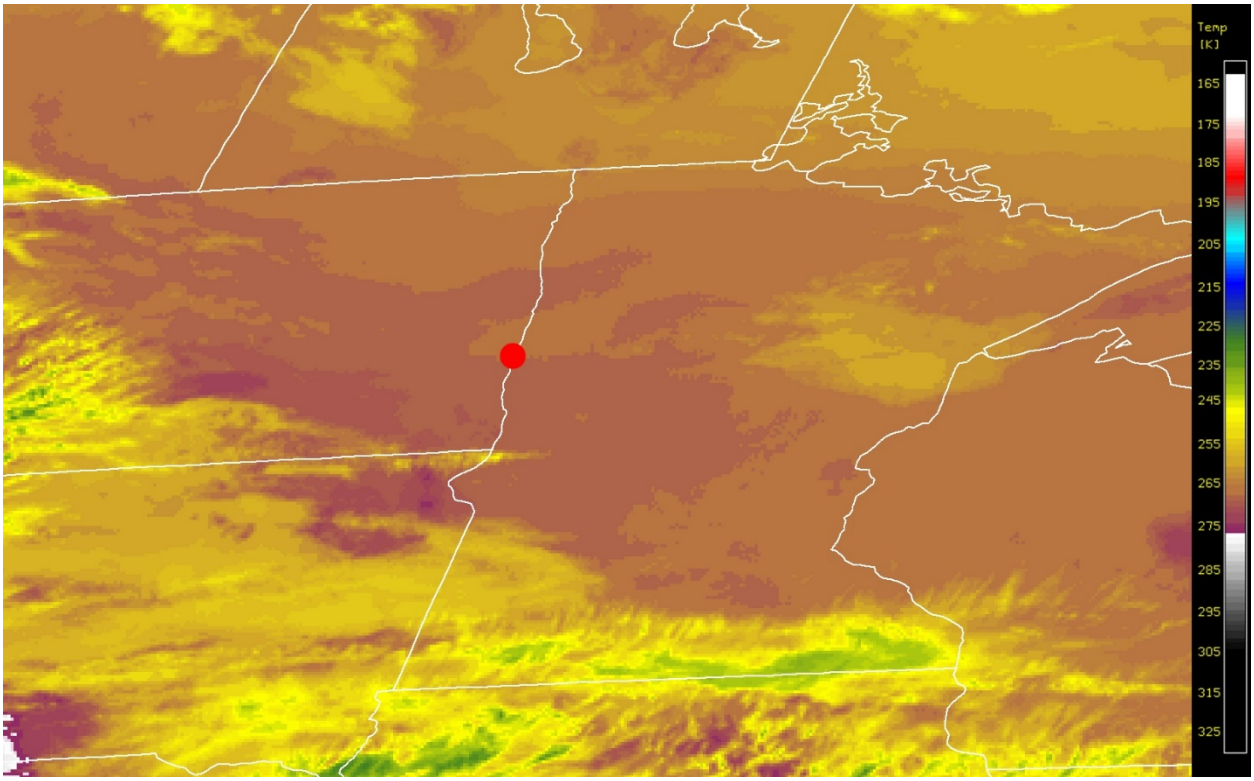

Figure 2 – GOES-16 infrared imagery (brightness temperature in degrees Kelvin) from 1352 CST. Accident location denoted by red dot. This image has not been corrected for any parallax error.

Figure 3 presents a satellite-based icing analysis by the National Aeronautics and Space Administration's (NASA) Langley Research Center (LaRC)[5] using GOES satellite data from about 1345 CST. This analysis identified areas of "high probability of light icing," "moderate or greater icing" and "heavy icing" near the accident area.

[5] https://cloudsway2.larc.nasa.gov/cgi-bin/site/showdoc?docid=22&lkdomain=Y&domain=ICNG_CONUS_GEW

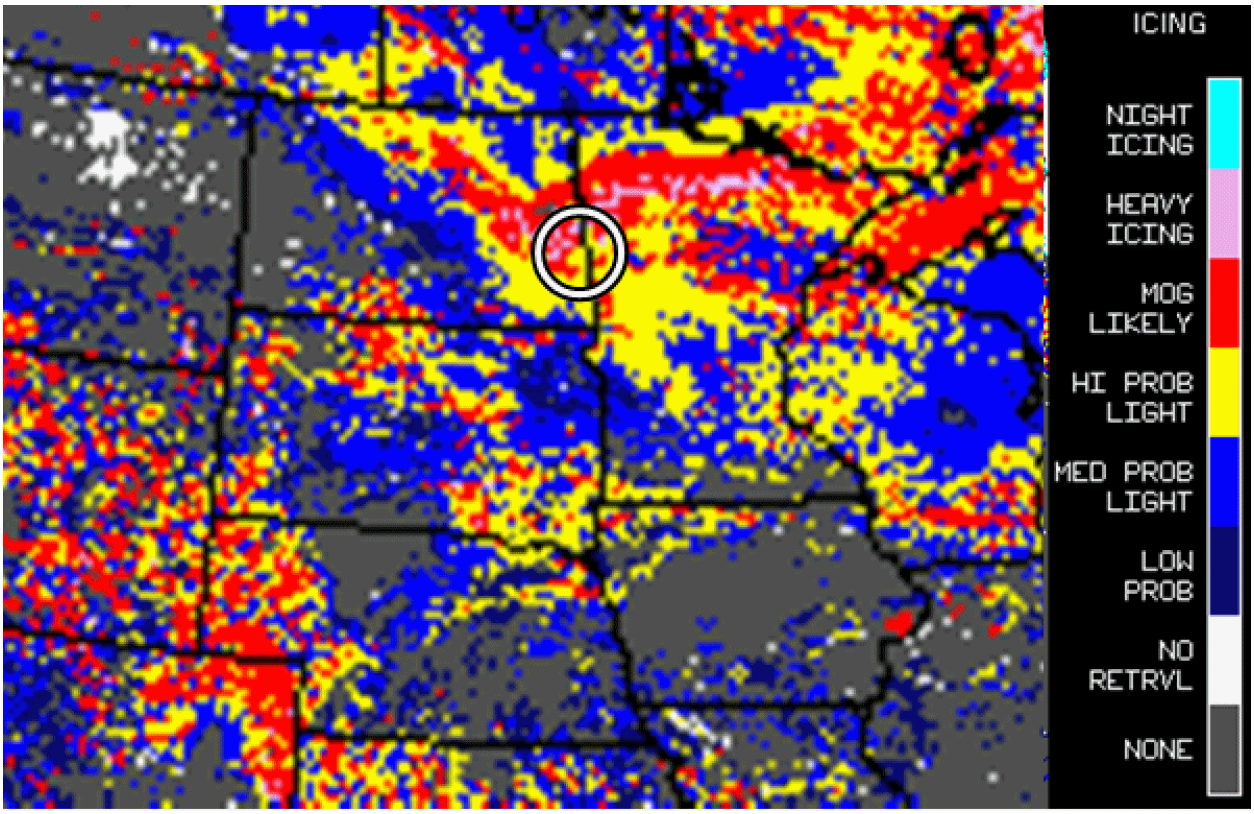

Figure 3 - Satellite-based icing analysis by NASA LaRC from 1345 CST. Accident location identified by the white circle.

5.0 Weather Radar

A review of weather radar imagery revealed no pertinent meteorological radar returns near the accident location at the accident time.

6.0 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 4-7) depict GFA forecast information on sky condition, icing, mountain obscuration, instrument flight rule (IFR)[6] condition and surface wind Airmen's

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

Meteorological Information (AIRMET) advisories, surface visibility, surface wind, precipitation, and other obscurations and hazards, valid for the times surrounding the accident.

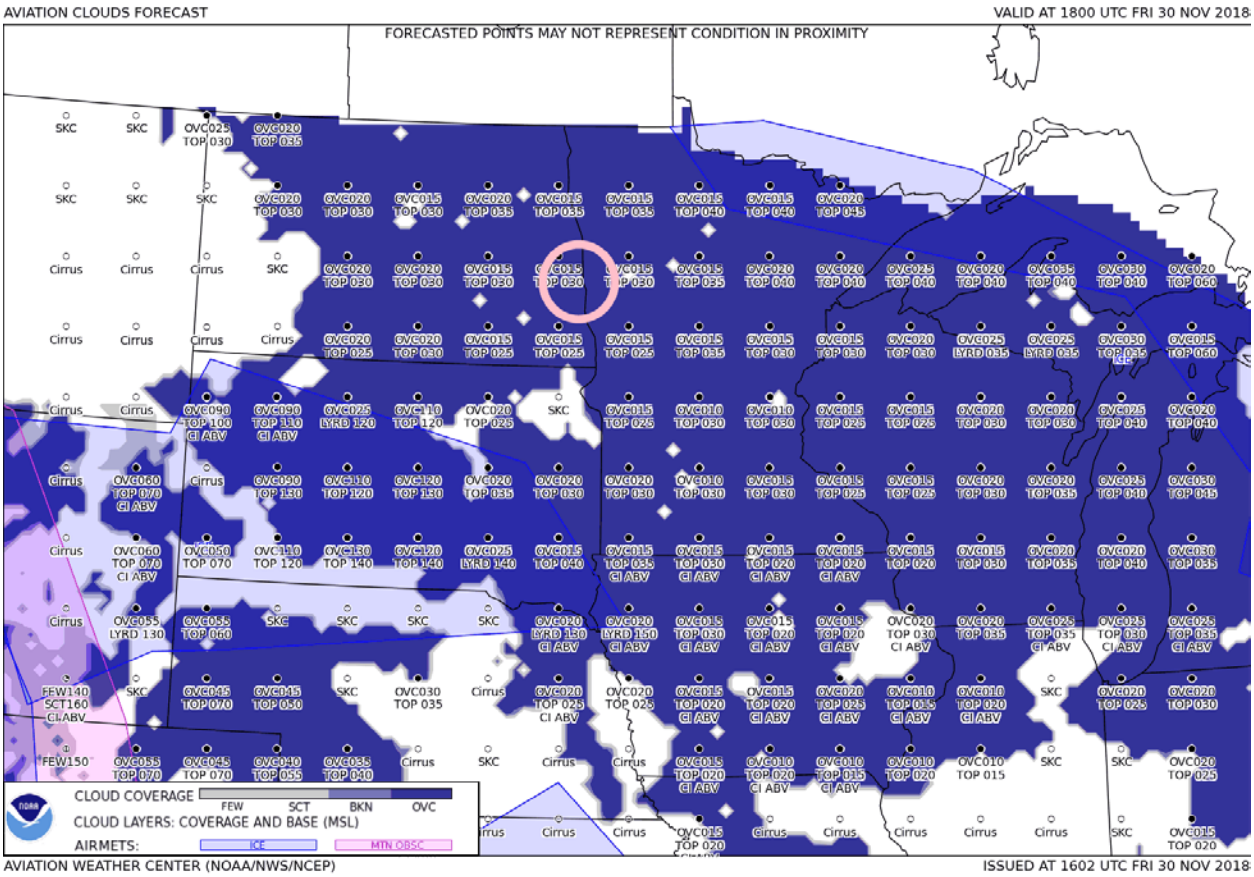

Figure 4 – GFA forecast imagery depicting sky condition and icing and mountain obscuration AIRMETs. Issued about 1000 CST and valid for 1200 CST. This GFA forecast imagery depicted overcast sky conditions over the accident region with cloud tops at 3,000 feet and cloud bases at 1,500 feet noted near the accident site. The accident location is located within the pink circle.

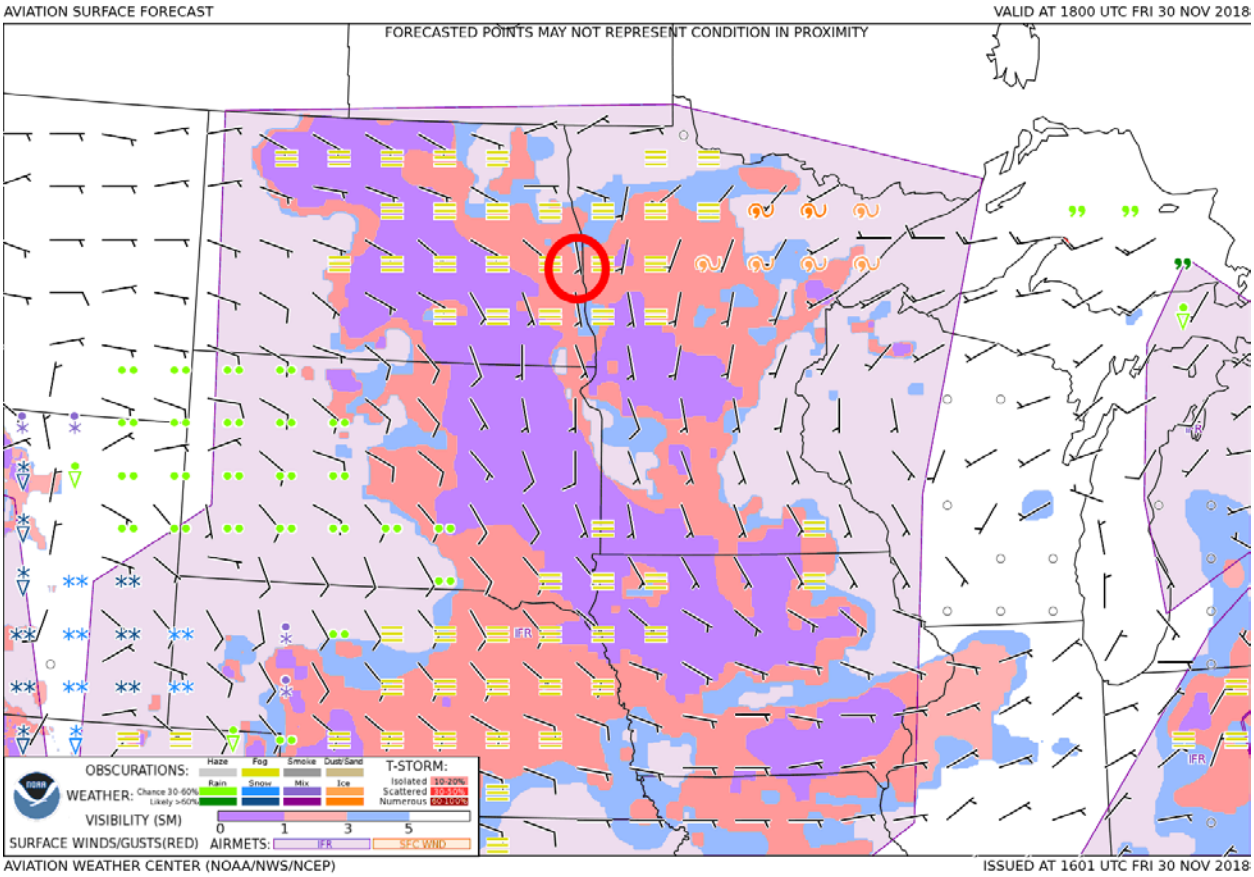

Figure 5 – GFA forecast imagery depicting IFR conditions and surface wind AIRMETs, surface visibility, surface wind, precipitation, and other obscurations and hazards. Issued about 1000 CST and valid for 1200 CST. This GFA forecast imagery depicted a surface visibility of between 1 to 3 statute miles at the accident location and a southerly surface wind of 5 knots and fog near the accident location. An AIRMET for IFR conditions was active over the accident region. The accident location is located within the red circle.

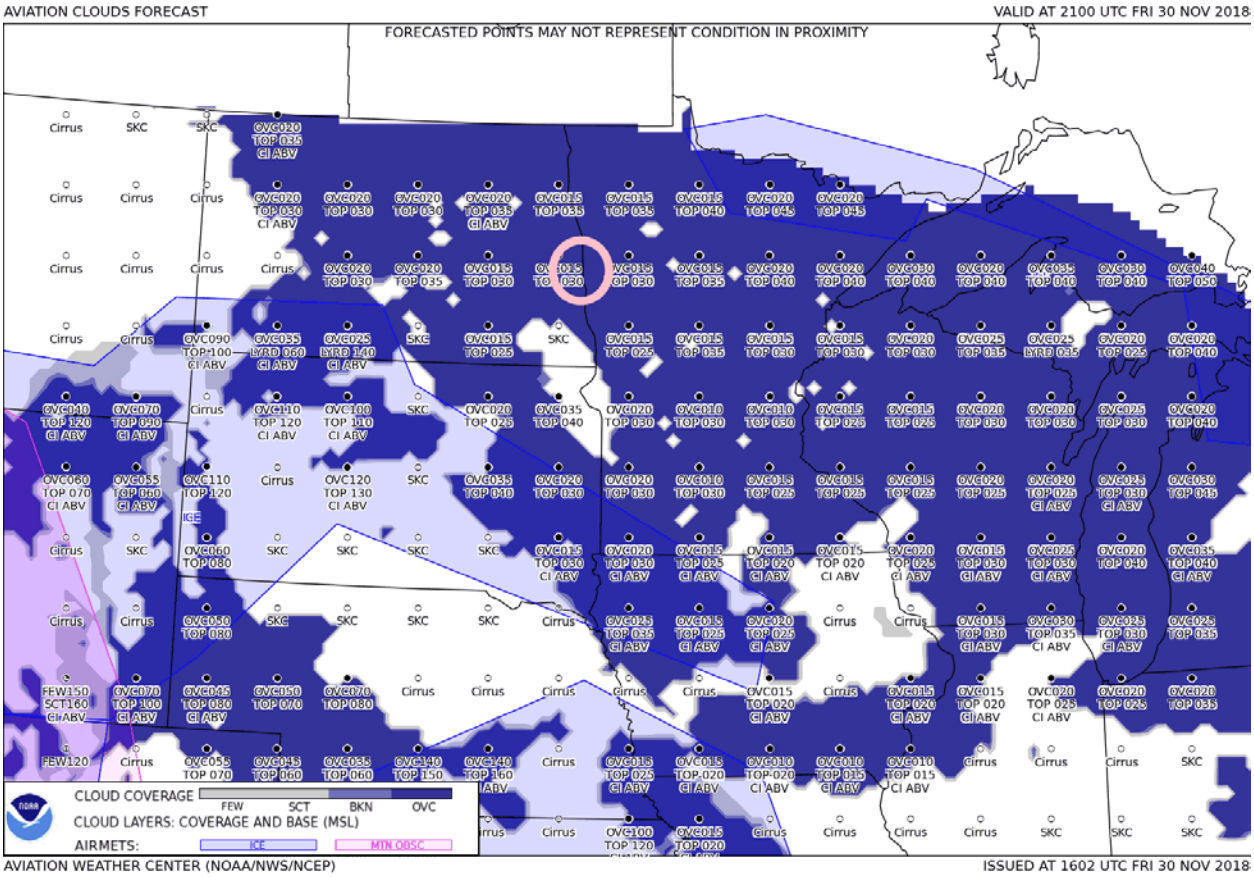

Figure 6 – GFA forecast imagery depicting sky condition and icing and mountain obscuration AIRMETs. Issued about 1000 CST and valid for 1500 CST. This GFA forecast imagery depicted overcast sky conditions over the accident region with cloud tops at 3,000 feet and cloud bases at 1,500 feet noted near the accident site. The accident location is located within the pink circle.

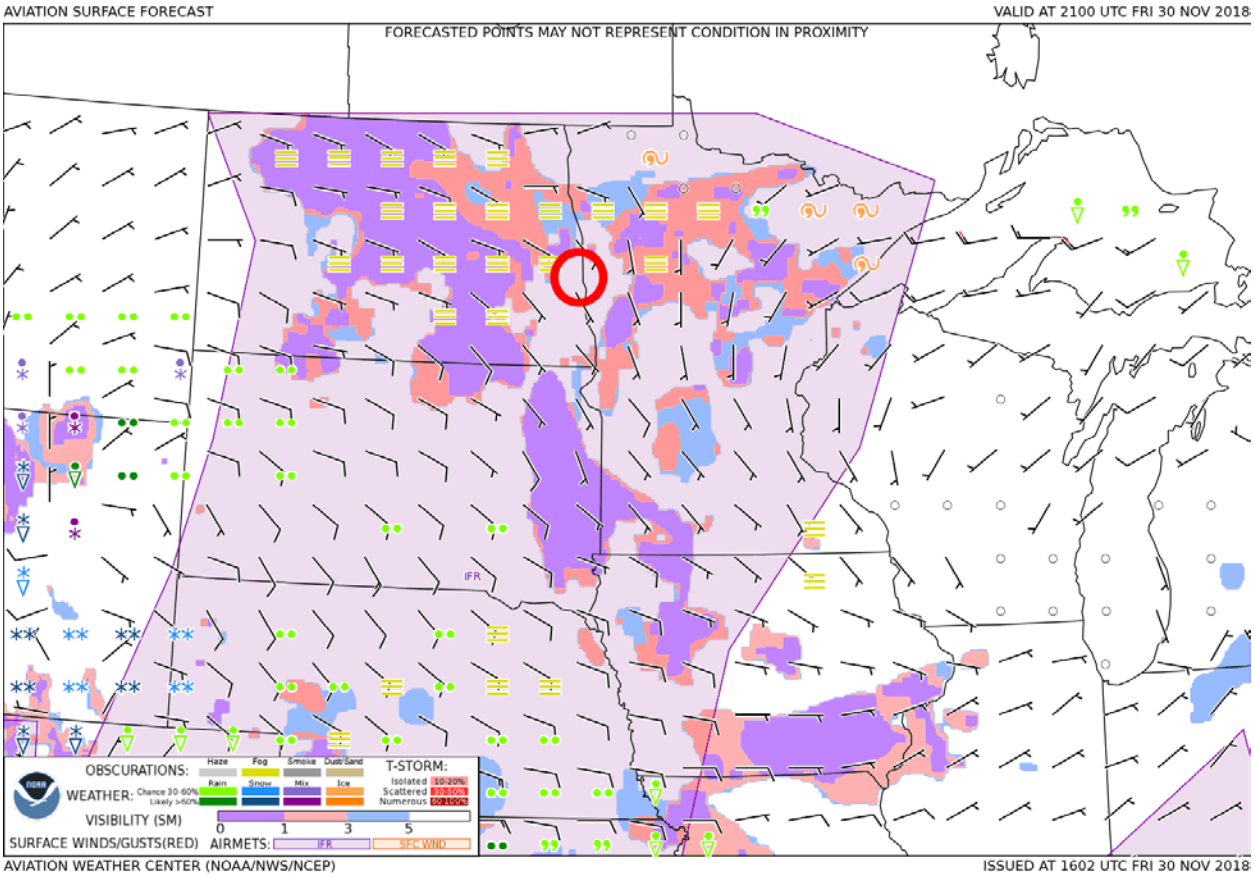

Figure 7 – GFA forecast imagery depicting IFR conditions and surface wind AIRMETs, surface visibility, surface wind, precipitation, and other obscurations and hazards. Issued about 1000 CST and valid for 1500 CST. This GFA forecast imagery depicted a surface visibility of greater than 5 statute miles at the accident location and a southeasterly surface wind of about 5 knots and fog near the accident location. An AIRMET for IFR conditions was active over the accident region. The accident location is located within the red circle.

7.0 Terminal Aerodrome Forecasts

The Terminal Aerodrome Forecast (TAF) issued at 1133 CST for FAR forecasted for the accident time: a variable wind at 6 knots, visibility of 5 statute miles, ceiling overcast at 300 feet agl.

TAF KFAR 301733Z 3018/0118 **VRB06KT 5SM BR OVC003**
FM011500 05009KT P6SM OVC008=

8.0 AIRMETs

Several AIRMET advisories were issued by the NWS' Aviation Weather Center and active for the accident location at the accident time.

At 0845 CST, an AIRMET ZULU was issued for moderate icing below 10,000 feet.

WAUS43 KKCI 301445
WA3Z
-CHIZ WA 301445
AIRMET ZULU UPDT 2 FOR ICE AND FRZLVL VALID UNTIL 302100

AIRMET ICE...ND SD MN IA WI LM LS MI LH IL IN
FROM 30N INL TO YQT TO SSM TO YVV TO 30SE ECK TO 20ESE FWA TO 30ESE ORD TO 40SSE BAE TO 40SSW DLL TO MCW TO 70SSE BIS TO 40W BIS TO 40NNE ISN TO 30N INL
MOD ICE BLW 100. CONDS CONTG BYD 21Z ENDG BY 03Z.

At 0845 CST, an AIRMET ZULU was issued for moderate icing below 10,000 feet.

WAUS43 KKCI 301445
WA3S
-CHIS WA 301445
AIRMET SIERRA UPDT 2 FOR IFR AND MTN OBSCN VALID UNTIL 302100

AIRMET IFR...ND SD NE KS MN IA MO WI LM LS MI IL
FROM 30N INL TO YQT TO 70NNE SAW TO 50WSW TVC TO STL TO 60WNW ARG TO RZC TO OSW TO 40E LBL TO 30ENE LAA TO GLD TO BFF TO 70SW RAP TO 40W RAP TO 50N ISN TO 30N INL
CIG BLW 010/VIS BLW 3SM BR/FG. CONDS CONTG BYD 21Z THRU 03Z.

9.0 SIGMETs

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

10.0 Current Icing Potential/Forecast Icing Potential

Images presenting the Current Icing Potential (CIP) products valid for 1300 and 1400 CST and 1- and 2-hour Forecast Icing Potential (FIP) products valid for 1400 CST for between 500 and 4,000 feet for the accident region were provided by the National Center for Atmospheric Research (NCAR).[7] These images are presented in Attachment 1.

The CIP and FIP imagery provide information on expected icing severity as five categories: none, trace, light, moderate, and heavy. The severity estimations are roughly based on the accretion rate of ice on an airplane, and the levels are determined by the time it would take for an airfoil to accrete 1/4 of an inch of ice: trace = 1 hour; light = 15 minutes to 1 hour; moderate = 5 to 15 minutes;

[7] Courtesy of Mr. Daniel Adriaansen and Ms. Allyson Rugg, NCAR.

severe = less than 5 minutes. The rates are estimated from the amount of supercooled liquid water expected with a nominal drop diameter of 15 microns, and are further tuned by nearby pilot reports of encountered severity. These are relative values and the use of which should take into account the airframe and the level of icing protection provided by the aircraft. Different aircraft and different flight configurations (airspeed, angle of attack, etc.) will experience variations in accretion rate, and these rates have been simulated for a range of aircraft and are a "broad brush" approach to severity prediction.

The images presented in this report were generated using NCAR's graphics software and were not the publicly available images of the same fields accessible through the AWC on the accident day. For the FIP imagery, the NCAR graphics should present the same data as the FIP graphics that were publicly available via the AWC. For the CIP imagery, according to NCAR, "…there are small differences that can exist between observational data sources, and dataset availability. What's run at AWC is realtime- when CIP runs it uses the data available at that instant. If some data come in late, or a satellite image is slightly behind then CIP won't use it. When we run it [at NCAR] by hand after the fact, it's in "research mode" so there's no possibility of late data. The datastreams also differ slightly at the AWC vs. what we use here but it's by and large the same data…I am more confident our [CIP and FIP] answers would be indistinguishable when plotted using the same software, with perhaps minor differences on occasion with CIP due to the dataset issue."

11.0 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.

E. Attachments

Attachment 1. Images presenting output from the Current Icing Potential products valid for 1300 and 1400 CST and 1- and 2-hour Forecast Icing Potential forecasts valid for 1400 CST for between 500 and 4,000 feet for the accident region.

Submitted by:

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Mike Richards
Senior Meteorologist

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