

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



CEN23FA095

METEOROLOGY

Specialist's Factual Report

March 20, 2023

TABLE OF CONTENTS

A. ACCIDENT.....	3
B. METEOROLOGY INVESTIGATOR	3
C. DETAILS OF THE INVESTIGATION	3
D. WEATHER INFORMATION.....	3
1.0 SURFACE OBSERVATIONS	3
2.0 PILOT REPORTS	5
3.0 WEATHER RADAR.....	6
4.0 HRRR MODEL SOUNDING.....	7
5.0 SATELLITE IMAGERY	10
6.0 CURRENT ICING POTENTIAL	12
7.0 TERMINAL AERODROME FORECASTS.....	12
8.0 G-AIRMETS FOR ICING BELOW 18,000 FEET	13
9.0 SIGMETs FOR ICING	13
10.0 CWSU PRODUCTS FOR ICING	13
11.0 GRAPHICAL FORECASTS FOR AVIATION.....	13

A. ACCIDENT

Location: Hooker, Oklahoma

Date: 28 January 2023

Time: 1902 central standard time (0102 UTC¹ on 29 January 2023)

Aircraft: Type - Cessna 172; Registration - N6482B

B. METEOROLOGY INVESTIGATOR

Mike Richards

Senior Meteorologist

Office of Aviation Safety

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 standard time for 28 January 2023 (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 site was located at about: 36.97122° north latitude; 101.29074° west longitude at an elevation of about 3,100 feet.

This report provides information on icing conditions applicable to the final portion of the accident flight.

D. WEATHER INFORMATION

1.0 Surface Observations

An Automated Weather Observing Station (AWOS) was located at Hugoton Municipal Airport (HQG²), which was located about 11 miles north-northwest of the accident site

¹ UTC - abbreviation for Coordinated Universal Time

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.

at an elevation of about 3,135 feet. It had a magnetic variation of about 6° east. Automated longline³ reports from the HQG AWOS during the times surrounding the accident time are presented here, and the observation closest in time to the accident time is highlighted by bold text.

[1815] METAR KHQG 290015Z AUTO 04015G22KT 10SM OVC005 M01/M03
A2991 RMK AO2 T10131030=

[1835] METAR KHQG 290035Z AUTO 05014KT 10SM OVC005 M01/M03 A2991
RMK AO2 T10151030=

**[1855] METAR KHQG 290055Z AUTO 04014G19KT 10SM OVC005
M02/M03 A2993 RMK AO2 T10181031=**

[1915] METAR KHQG 290115Z AUTO 05017G20KT 10SM OVC005 M02/M03
A2994 RMK AO2 T10171032=

[1935] METAR KHQG 290135Z AUTO 05015G19KT 5SM BR OVC005 M02/M03
A2996 RMK AO2 T10211034=

At 1855, the HQG AWOS reported a wind from 040° at 14 knots with gusts to 19 knots, visibility 10 statute miles or greater, ceiling overcast at 500 feet above ground level (agl), temperature of -2° Celsius (C) and dew point temperature of -3°C, altimeter setting of 29.93 inches of mercury; Remarks included: automated station with a precipitation discriminator, temperature of -1.8°C and dew point temperature of -3.1°C.

An AWOS was located at Liberal Mid-America Regional Airport (LBL), which was located about 16 miles east-northeast of the accident site at an elevation of about 2,885 feet. LBL had a magnetic variation of about 5°30' east. Automated longline reports from the LBL AWOS during the times surrounding the accident time are presented here, and the observation closest in time to the accident time is highlighted by bold text.

[1756] METAR KLBL 282356Z AUTO 03019KT 10SM OVC007 M01/M02 A2991
RMK AO2 SLP148 T10061022 10111 21006 53030 FZRANO=

[1837] SPECI KLBL 290037Z AUTO 04019KT 10SM OVC005 M01/M02 A2992
RMK AO2 PK WND 02026/0002 FZRANO=

³ "Longline" refers to the dissemination of weather observations with the intent that they are available in near-real time to national databases (effectively, the whole world) and accessible to the general global public from a large number of vendors. This does not include public accessibility to observations from a reporting station's Very High Frequency (VHF; line-of-site) or telephone broadcast, where applicable. Longline-dissemination of weather observations is the primary vehicle through which the general global public has access to surface weather observations, particularly outside of the aviation community.

**[1856] METAR KLBL 290056Z AUTO 04019G22KT 10SM OVC005
M02/M03 A2993 RMK AO2 PK WND 02026/0002 SLP159
T10171028 FZRANO=**

[1941] SPECI KLBL 290141Z AUTO 02021KT 4SM BR OVC003 M02/M03 A2996
RMK AO2 FZRANO=

[1954] SPECI KLBL 290154Z AUTO 03015KT 2 1/2SM -SN BR OVC003 M03/M04
A2998 RMK AO2 SNB47 P0000 FZRANO=

At 1856, the LBL AWOS reported a wind from 040° at 19 knots with gusts to 22 knots, visibility 10 statute miles or greater, ceiling overcast at 500 feet agl, temperature of -2°C and dew point temperature of -3°C, altimeter setting of 29.93 inches of mercury; Remarks included: automated station with a precipitation discriminator, peak wind of 26 knots from 020° at 1852, sea level pressure of 1015.9 hectopascals (hPa), temperature of -1.7°C and dew point temperature of -2.8°C.

2.0 Pilot Reports

The following are the longline-disseminated pilot reports⁴ (PIREPs) reported between 1700 and 2100 below FL180⁵ within 100 miles of the accident location.

LBL UA /OV KLBL/TM 0053/FL076/TP BE9L/SK BASE 033 TOP 040 OVC/RM
ZKC FDC

DDC UA /OV DDC182001/TM 0216/FL054/TP BE9L/SK BASE 029 TOP 050/TA
M4/IC LGT MX/RM ZKC FDC

⁴ These do not include pilot reports only broadcast via radio.

⁵ 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 inches of mercury), the average sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above msl or agl.

3.0 Weather Radar

WSR-88D⁶ Level-II base reflectivity weather radar imagery from the Dodge City, Kansas, site (KDDC) is presented in Figure 1, and the KDDC Level-III hydrometeor classification product from that time is presented in Figure 2. KDDC was located approximately 78 miles northeast of the accident location with an antenna elevation of about 2,670 feet. Assuming standard refraction and considering the 0.95° beam width⁷ for the WSR-88D radar beam, the KDDC 0.527° tilt would have “seen” altitudes above the accident location of between about 7,100 and 15,000 feet.

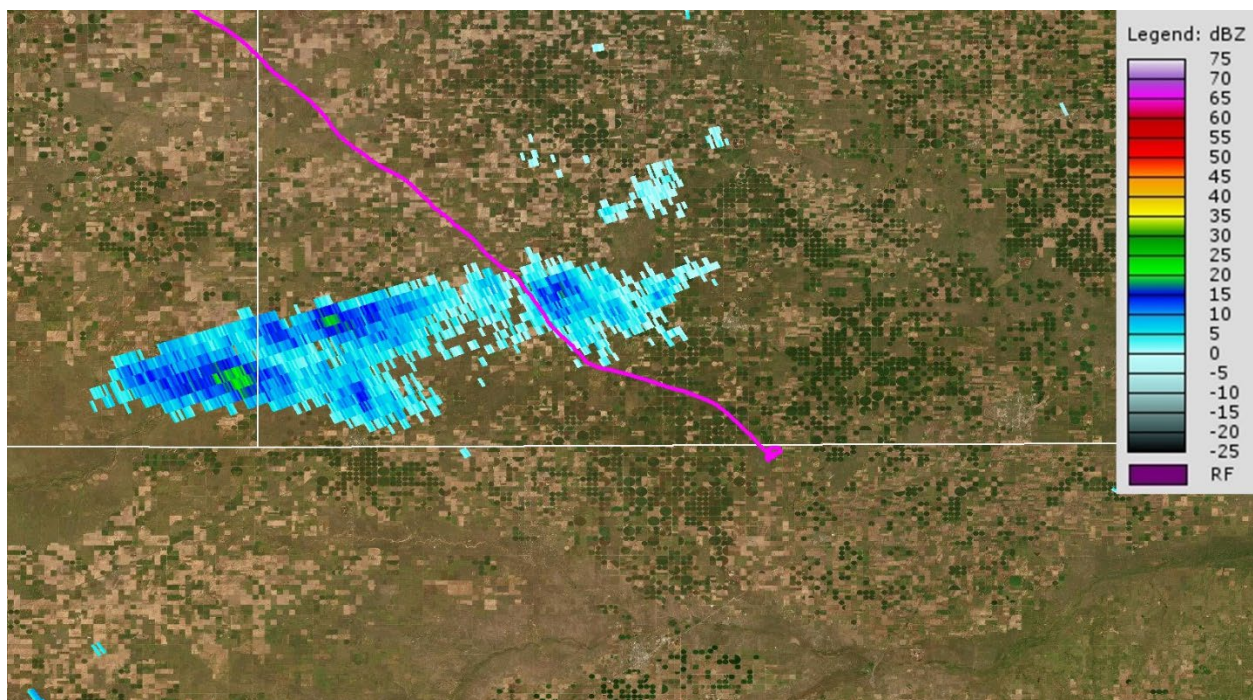


Figure 1 – KDDC 0.527° Level-II base reflectivity product from a sweep initiated at 1851:38. The final portion of the accident aircraft’s flight path is depicted by the purple line.

⁶ Weather Surveillance Radar 88 Doppler (WSR-88D)

⁷ 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 from the radar antenna.

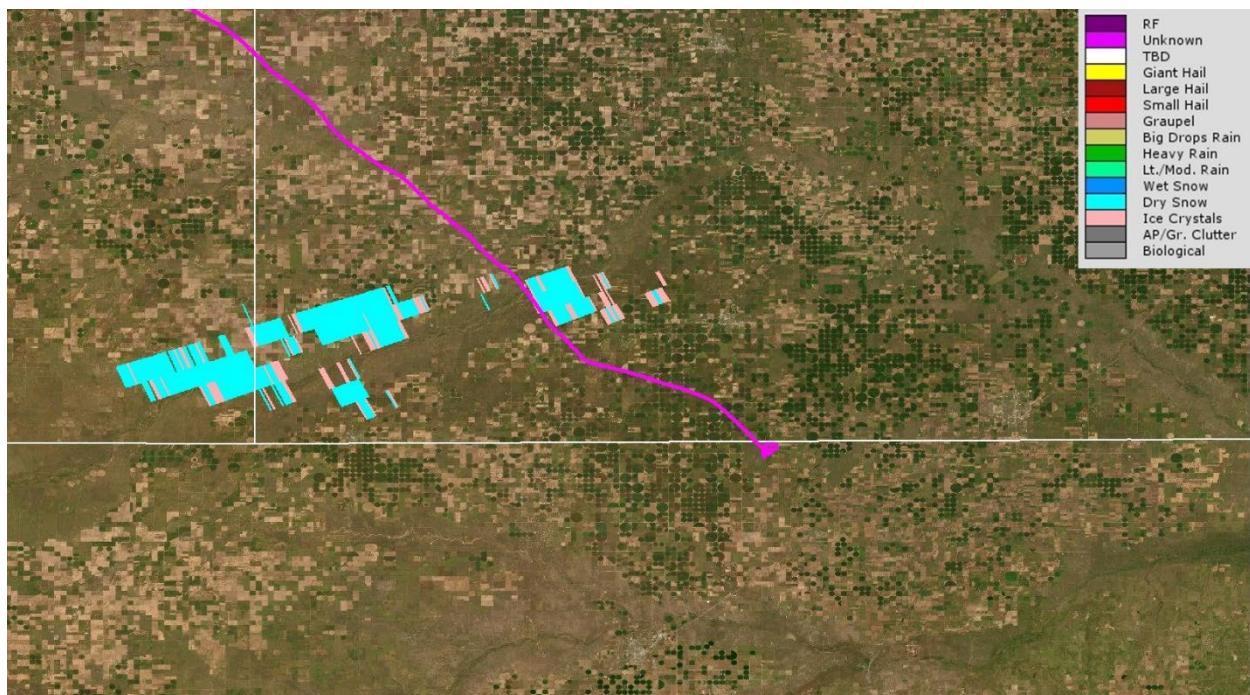


Figure 2 - KDDC 0.527° Level-III hydrometeor classification product from a sweep initiated at 1851:38. The final portion of the accident aircraft's flight path is depicted by the purple line.

4.0 HRRR Model Sounding

A High-Resolution Rapid Refresh (HRRR) model⁸ sounding (Figure 3) for near the accident site⁹ at 1900 using an elevation of 3,096 feet was retrieved from the National Oceanic and Atmospheric Administration's (NOAA) Air Resources Laboratory and analyzed by the RAOB program. Overcast clouds were identified by RAOB in the lower atmosphere from about 3,700 through 4,900 feet. Freezing levels were noted at about 6,100 and 5,500 feet, and RAOB identified the presence of icing below about 5,000 feet. RAOB identified the potential for turbulence between about 10,200 and 4,400 feet, including "extreme" turbulence around 5,000 feet. The near-surface wind was from the northeast at 15 knots, and the wind increased in magnitude to a northeast wind at about 25 knots at 4,500 feet. Above this level the wind veered to a southeast wind of about 5 knots at about 6,300 feet and continued to veer with height to a near-westerly wind of about 30 knots at 10,200 feet. A temperature inversion was noted between about 5,600 and 4,400 feet.

⁸ 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.

⁹ Coordinates used for the model were latitude: 36.97; longitude: -101.29.

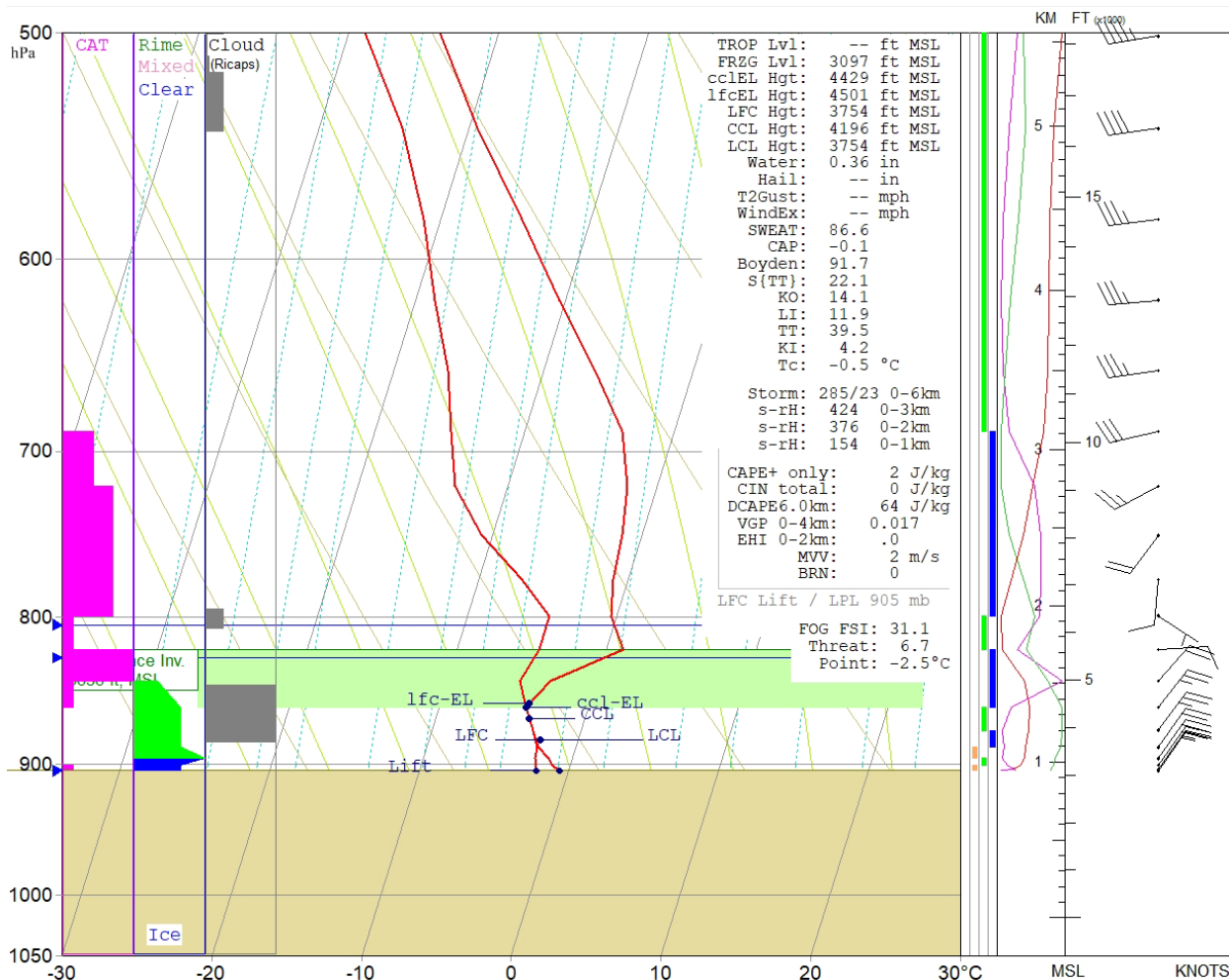


Figure 3 - HRRR model sounding data in SkewT/LogP format for 1900 near the accident site, surface to 500 hPa.

A HRRR model sounding (Figure 4) for a location (green dot)¹⁰ identified in Figure 5 at 1900 using an elevation of 3,312 feet was retrieved from the NOAA Air Resources Laboratory and analyzed by the RAOB program. Below 20,000 feet RAOB identified cloudy conditions between about 19,500 and 14,000 feet, and between about 5,600 and 3,800 feet.

¹⁰ Coordinates used for the model were latitude: 37.19; longitude: -101.69.

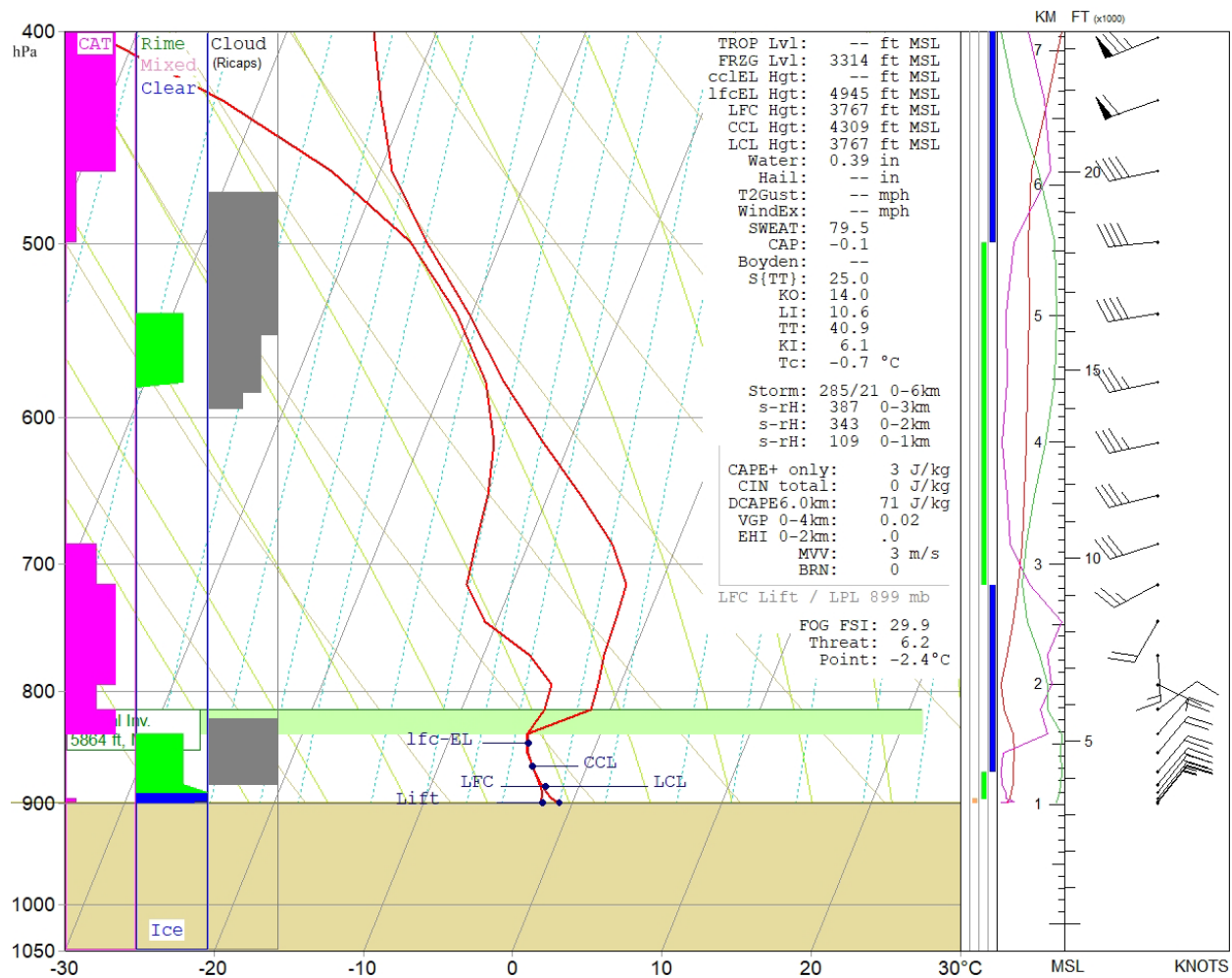


Figure 4 – HRRR model sounding data in SkewT/LogP format for 1900 for a location (green dot) identified in Figure 5, surface to 400 hPa.

5.0 Satellite Imagery

Geostationary Operational Environmental Satellite (GOES)-16 infrared (10.3 μ m) data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison. GOES-16 infrared “window” imagery from 1901 is presented in Figure 5. Infrared brightness temperatures over the accident site were about -6°C, which, when considering the 1900 HRRR sounding, generally corresponded to cloud top heights of both 5,000 and 11,200 feet. Thus, there is not certainty in determining cloud top heights above the accident site solely via this method.

Figure 6 presents a “nighttime microphysical RGB” GOES-16 band combination image for 1901. This imagery combines various pieces of infrared satellite data to help determine cloud phase and height. Figure 7 presents an interpretation of this image.

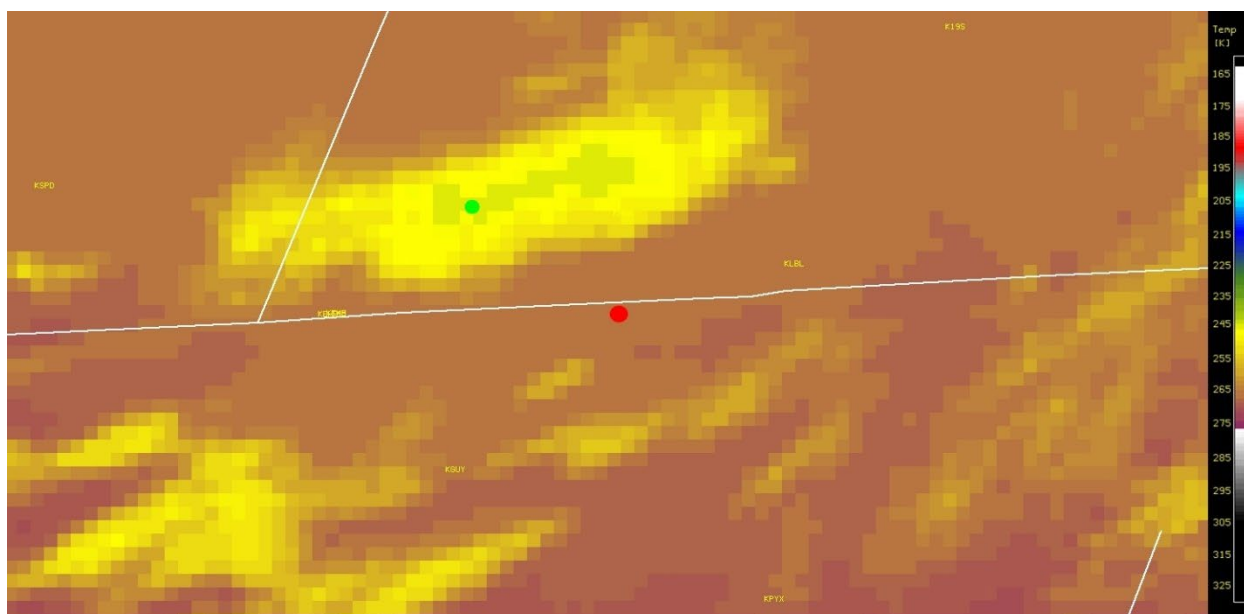


Figure 5 - GOES-16 infrared imagery from 1901. Accident location denoted by the red dot. HRRR model sounding location denoted by the green dot. Image is not corrected for parallax error.

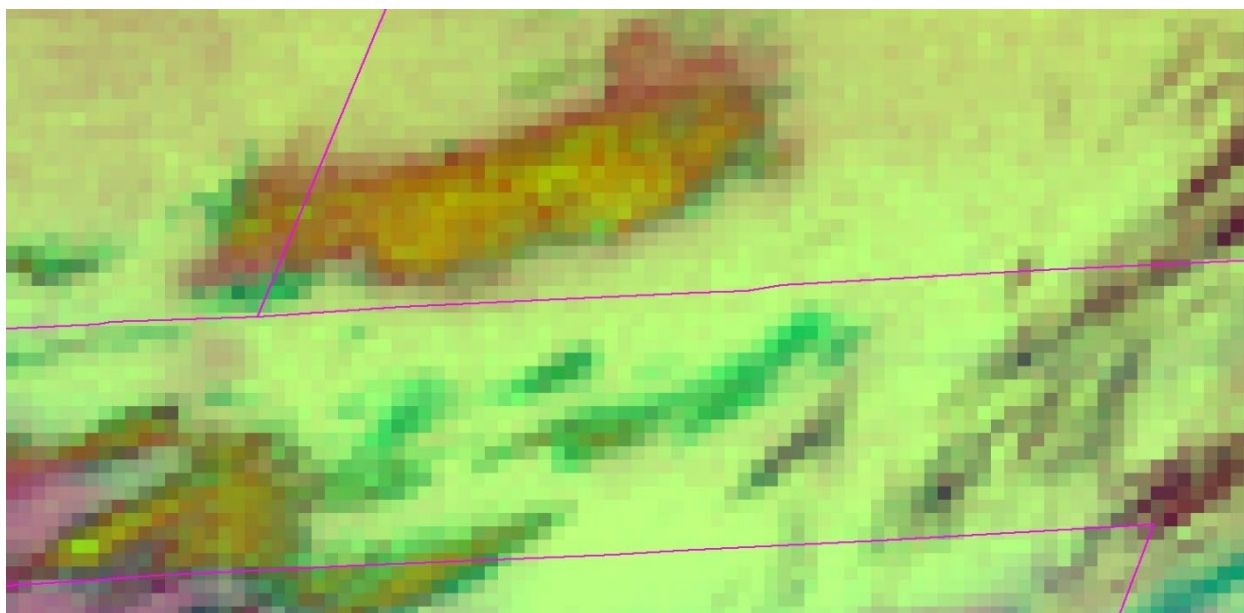


Figure 6 - GOES-16 nighttime microphysical RGB image from 1901. This image has not been corrected for any parallax error.

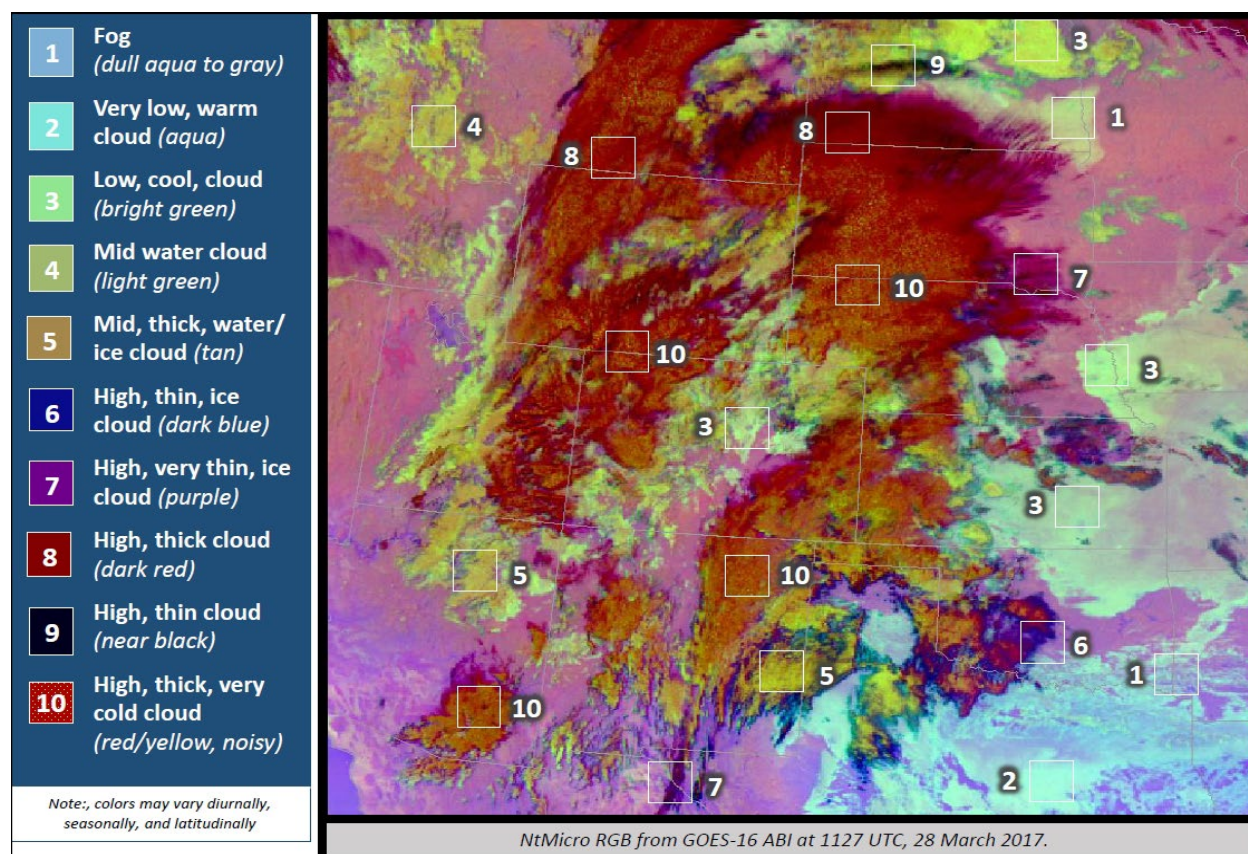


Figure 7 - Interpretation aid for the GOES-16 nighttime microphysical RGB image found in Figure 6.¹¹

¹¹ https://www.star.nesdis.noaa.gov/goes/documents/QuickGuide_GOESR_NtMicroRGB_final.pdf

6.0 Current Icing Potential

Images presenting output from the Current Icing Potential (CIP) valid for 1908 for altitudes at and below 10,000 feet for the accident region were provided by the National Center for Atmospheric Research (NCAR)¹² and are presented in Attachment 1.

The CIP imagery provides information on expected icing severity as five categories: none, trace, light, moderate, and heavy. The severity estimates 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; severe = less than 5 minutes.¹³

The images presented in this report show data from NCAR's prototype CIP algorithms and were generated using NCAR's visualization software. These algorithms differ in various ways from the operational CIP that provided data used to generate the publicly available images accessible through the NWS Aviation Weather Center on the accident day. NCAR's prototype CIP represent the latest research and development conducted by their team of in-flight icing scientists and have passed internal validation exercises using voice PIREPs of icing conditions and scientific airborne research observations of in-flight icing (when available).

7.0 Terminal Aerodrome Forecasts

At 1731 a Terminal Aerodrome Forecasts (TAF) was issued for LBL that forecasted for the accident time: a wind from 030° at 15 knots with gusts to 24 knots, visibility of 5 statute miles, mist, ceiling broken at 800 feet agl. The LBL TAF was not applicable to the accident location. According to National Weather Service (NWS) Instruction 10-813: "A NWS TAF consists of the expected meteorological conditions significant to aviation at an airport for a specified time period. For the U.S., this is the area within five (5) statute miles (SM) of the center of an airport's runway complex."¹⁴

*TAF KLBL 282331Z 2900/2924 **03015G24KT 5SM BR BKN008**
FM290600 02014G24KT P6SM BKN011
FM291400 02013G18KT P6SM OVC018
FM292100 07009KT P6SM BKN020=*

¹² Courtesy of Mr. Daniel Adriaansen and Ms. Allyson Rugg, NCAR.

¹³ These are general values. Users should always consider the icing susceptibility of their airframe and availability of icing protection provided by their aircraft. Different aircraft and different flight configurations (airspeed, angle of attack, etc.) will experience variations in accretion rate.

¹⁴ www.nws.noaa.gov/directives/sym/pd01008013curr.pdf

8.0 G-AIRMETs for Icing Below 18,000 Feet

A Graphical-Airmen's Meteorological Information (G-AIRMET) is a graphical advisory of weather that may be hazardous to aircraft but are less severe than SIGMETs. They are only valid at specific time "snapshots". G-AIRMETs are issued at 0300 UTC, 0900 UTC, 1500 UTC and 2100 UTC (with updates issued as necessary) and are valid at discrete times three hours apart for a period of up to 12 hours into the future (i.e., 00-, 03-, 06-, 09- and 12-hour forecasts from the issuance time).

There was a G-AIRMET ZULU advisory issued at 1500 for moderate icing between the surface and FL190 that was active for the accident aircraft's flight track at 1800.

9.0 SIGMETs for Icing

There were no non-convective Significant Meteorological Information (SIGMET) advisories active for icing for the accident aircraft's flight path at applicable times.

10.0 CWSU Products for Icing

There were no products for icing issued by the Center Weather Service Units (CWSU) at the Denver and Kansas City Air Route Traffic Control Centers (ARTCC) that were active for icing for the accident aircraft's flight path at applicable times.

11.0 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.

Figure 8 depicts GFA forecast information on sky condition and icing and mountain obscuration Graphical Airmen's Meteorological Information (G-AIRMET) advisories valid for 1800. It depicted clear sky conditions over the accident site with a large area of cloud cover at various heights immediately to the west through northeast. G-AIRMETs for mountain obscuration and icing were located to the northwest or north.

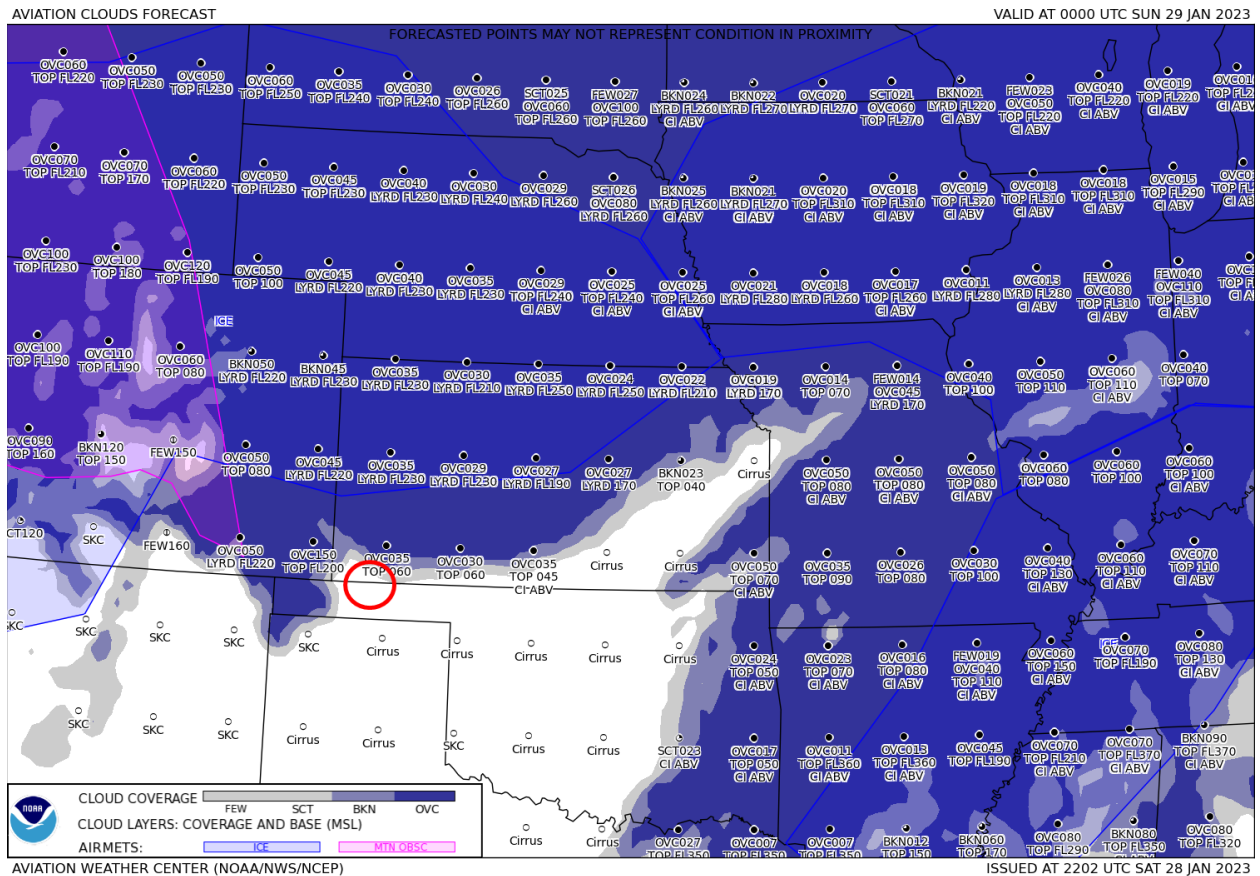


Figure 8 - GFA forecast imagery depicting sky condition and icing and mountain obscuration G-AIRMETS issued about 1600 and valid for 1800. The accident location is located within the red circle.

E. LIST OF ATTACHMENTS

Attachment 1 - Images presenting output from the CIP valid for 1908 for altitudes at and below 10,000 feet for the accident region.

Submitted by:

Mike Richards
Senior Meteorologist