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

WPR23FA137

METEOROLOGY

Specialist's Factual Report

July 17, 2023

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A. ACCIDENT

Location: Alcova, Wyoming
Date: March 21, 2023
Time: 1601 mountain daylight time
2201 coordinated universal time (UTC)
Airplane: Cessna 182S; Registration: N314FR

B. METEOROLOGY SPECIALIST

Paul Suffern
National Transportation Safety Board
Washington, DC

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's Senior Meteorologist did not travel for this investigation but gathered all data remotely. Data for this investigation were collected 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 Specialist's Factual Report contains the meteorological factors pertinent to the weather surrounding the accident time. All times are mountain daylight time (MDT) and are based upon the 24-hour clock, where local time is -6 hours from UTC. Directions are referenced to true north and distances are in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles. 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.

The accident site was located at approximate latitude 42.457831° N, longitude 106.64491° W, and elevation of 6,990 feet (ft).

D. FACTUAL INFORMATION

1.0 Synoptic Situation

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 and the WPC, located in College Park, Maryland. These are the base products used in describing synoptic weather features and in the creation of forecasts and warnings for the NWS. Reference to these charts can be found in the Federal Aviation Administration (FAA) "Aviation Weather Handbook", FAA-H-8083-28.[1]

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart centered over the northcentral United States for 1500 MDT is provided as figure 1 with the location of the accident site within the black circle. The chart depicted a series of low-pressure systems and frontal boundaries from Montana to Wyoming then eastward through Minnesota and another series of frontal boundaries southeastward into Oklahoma. There was a low-pressure system at 1003-hectopascals (hPa) in southeastern Wyoming along the frontal boundary with another low-pressure system in northwestern Wyoming at 1007-hPa. The accident site was located north of the cold front on the cool side of the front. Fronts can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present.

The station model closest to the accident site depicted an air temperature of 47 degrees Fahrenheit (°F), dew point temperature of 10°F, partly cloudy skies, and a west wind at 25 knots.

[1] FAA-H-8083-28

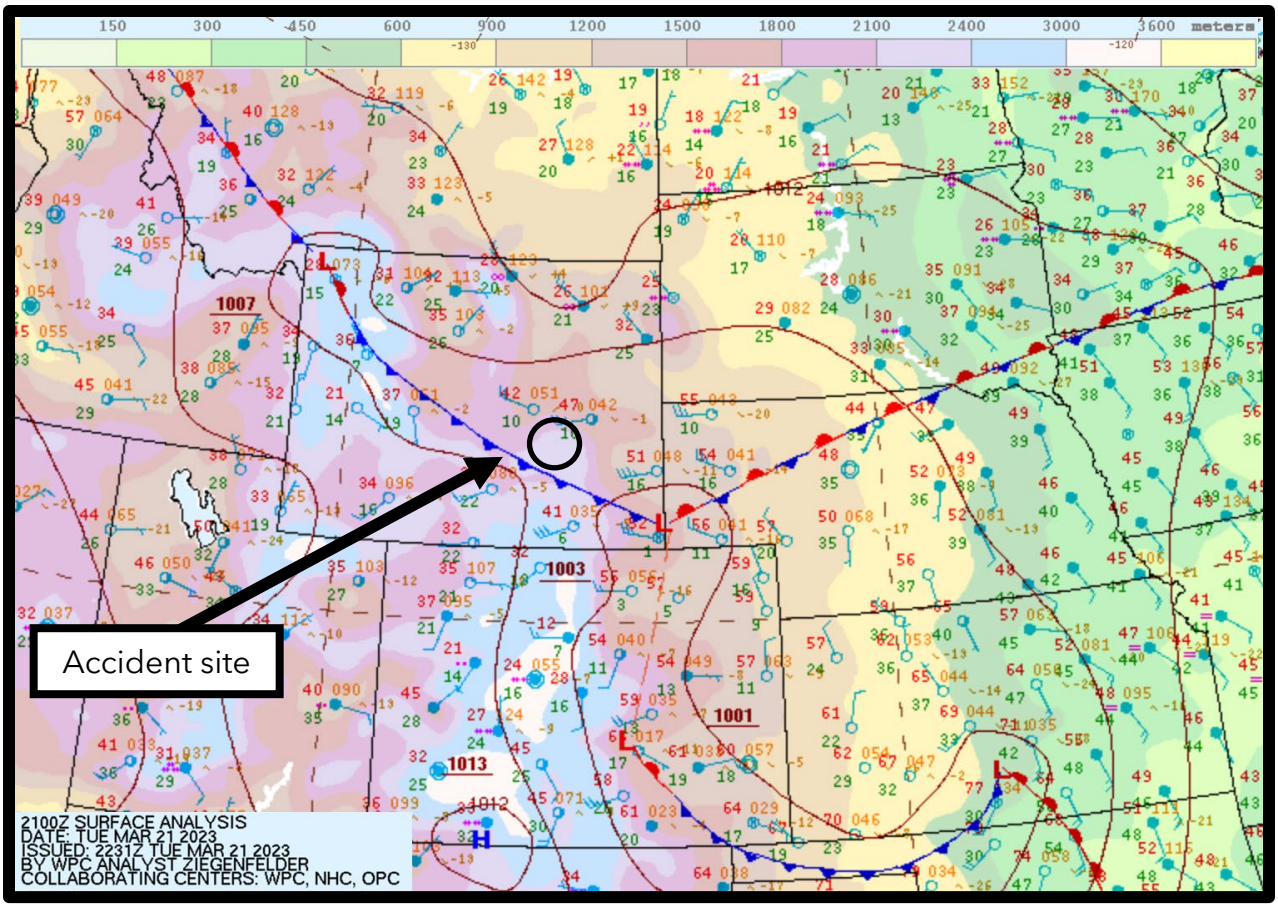

Figure 1. NWS Surface Analysis Chart for 1500 MDT.

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 1800 MDT at 700- and 500-hPa are presented in figures 2 and 3. The charts indicated a ridge[2] just west of the accident site at 700- and 500-hPa. The 700-hPa constant pressure chart depicted a northwest wind around 10 knots with a 20 knot west wind by 500-hPa above the accident site (figure 3).

[2] Ridge – An elongated area of relatively high atmospheric pressure or heights.

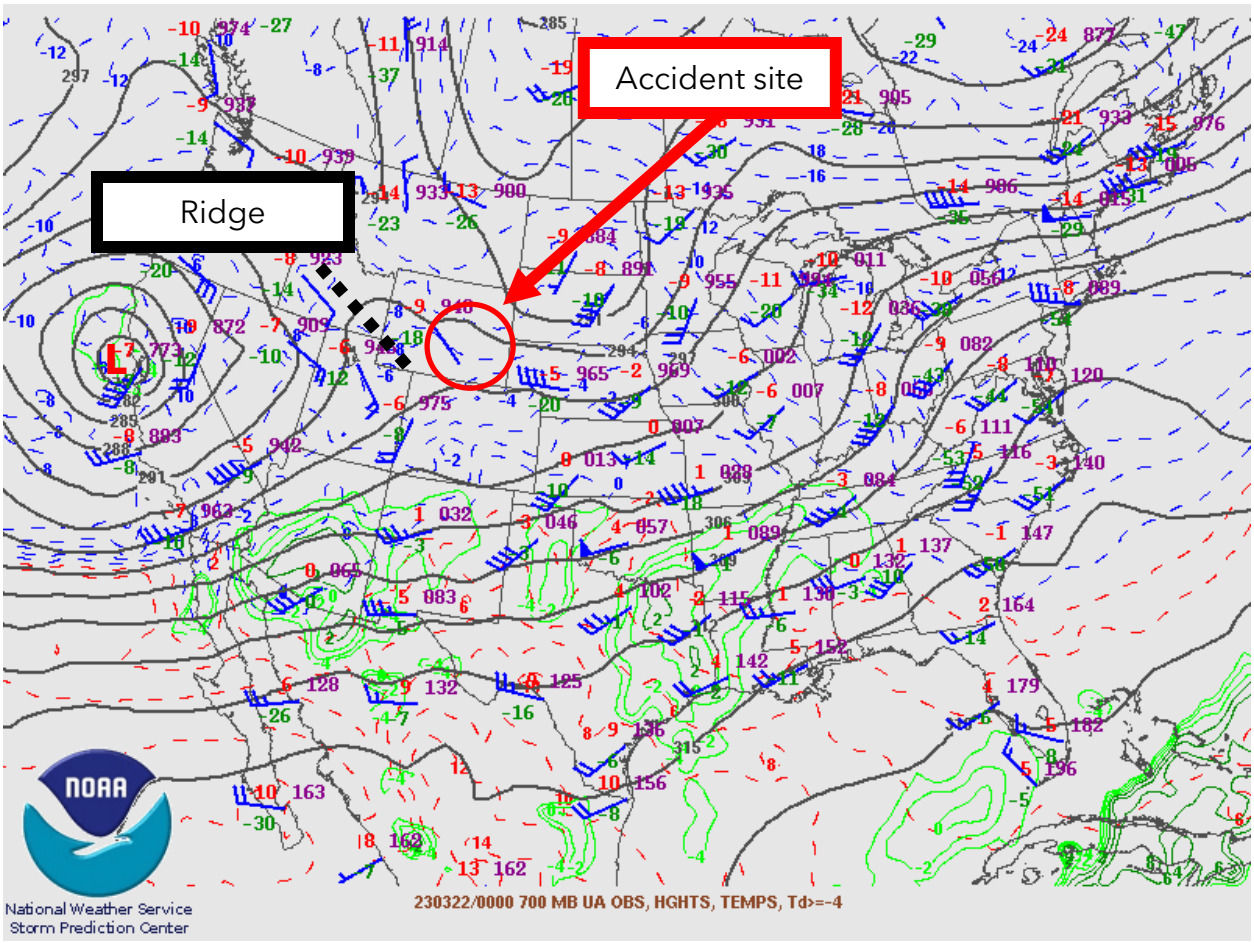

Figure 2. 700-hPa Constant Pressure Chart for 1800 MDT.

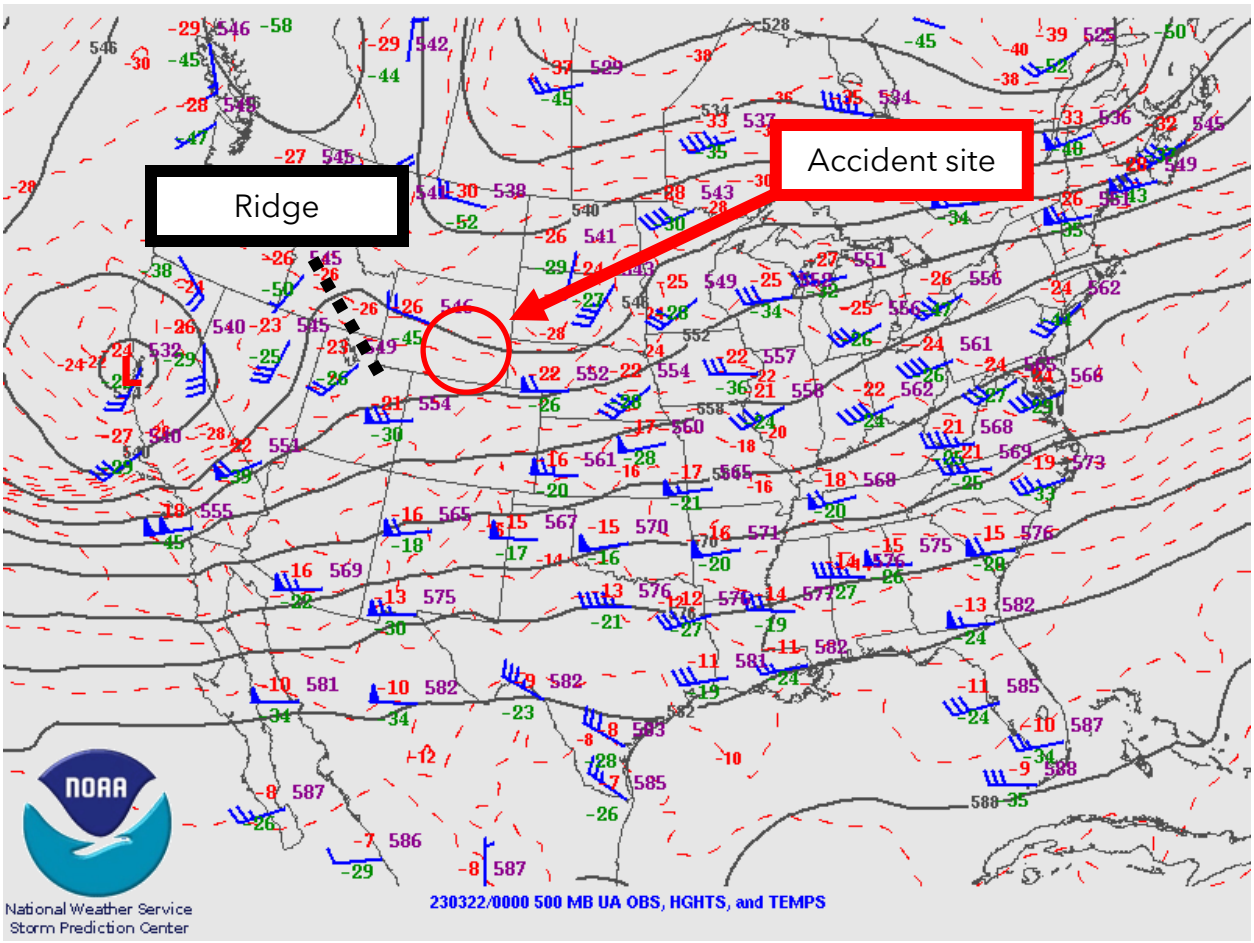

Figure 3. 500-hPa Constant Pressure Chart for 1800 MDT.

2.0 Surface Observations

The area surrounding the accident site was documented using official Aviation Routine Weather Reports (METARs) and Special Reports (SPECIs). The following observations were taken from standard code and are provided in plain language. Figure 4 is a local sectional chart with the accident site and the closest weather reporting location marked. A magnetic variation[3] of 9° east was indicated over the area.

[3] Magnetic variation – The angle (at a particular location) between magnetic north and true north. Latest measurement taken from https://skyvector.com/

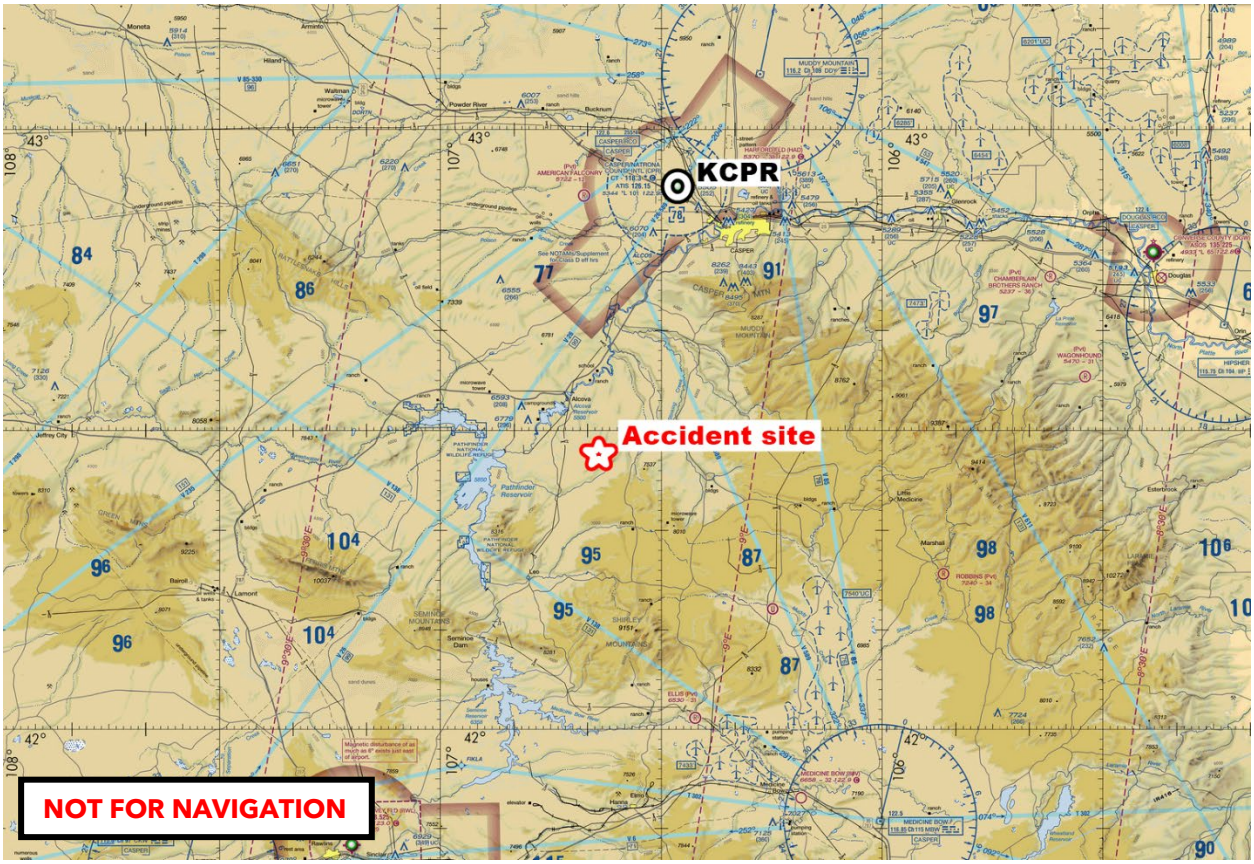

Figure 4. FAA sectional aeronautical chart of the accident area with the location of the accident site and surface observation site noted.

Casper/Natrona County International Airport (KCPR), Casper, Wyoming was the closest official weather station to the accident site. KCPR had an Automated Surface Observing System (ASOS[4]) and its longline[5] reports were augmented by air traffic control (ATC) when the tower was in operation[6]. The KCPR ASOS was located 28 miles north-northeast of the accident site (figure 4), at an elevation of 5,344 ft, and issued the following observations surrounding the period of the accident:[7]

[4] ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, weather phenomena, ceiling, temperature, dewpoint, altimeter, and barometric pressure. ASOS are maintained by the NWS.

[5] "Longline" refers to the dissemination of weather observations with the intent that they are available in near-real time into the national databases and accessible to users. This does not include 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 weather observations are distributed.

[6] ATC hours of operation 0500 to 2100 local.

[7] The bold sections of products in this report are intended to highlight the text that directly reference the weather conditions that affected the accident region around the accident time. The local times in this section next to the METARs are provided for quick reference between UTC and local times.

[1153 MDT] METAR KCPR 211753Z 26024G32KT 10SM CLR 04/M10 A2968 RMK AO2 PK WND 24037/1659 SLP053 60000 T00391100 10044 21033 50003 $

[1253 MDT] METAR KCPR 211853Z 25020G28KT 10SM CLR 05/M10 A2969 RMK AO2 PK WND 27031/1808 SLP054 T00501100 $

[1353 MDT] METAR KCPR 211953Z 25016G26KT 10SM FEW055 06/M09 A2968 RMK AO2 PK WND 26027/1938 SLP050 T00561094 $

[1453 MDT] METAR KCPR 212053Z 29020G31KT 10SM CLR 06/M12 A2969 RMK AO2 PK WND 29031/2045 SLP051 T00561122 51000 $

[1553 MDT] METAR KCPR 212153Z 30017G25KT 10SM CLR 06/M09 A2971 RMK AO2 PK WND 27027/2055 SLP058 T00561094 $

ACCIDENT TIME 1601 MDT

[1653 MDT] METAR KCPR 212253Z 31009G21KT 10SM SCT060 05/M11 A2973 RMK AO2 SLP069 T00501111 $

[1753 MDT] METAR KCPR 212353Z 36011KT 10SM SCT060 04/M09 A2974 RMK AO2 SLP081 T00391089 10061 20039 51017 /

The bold type observations decoded in plain language were as follows:

KCPR weather at 1553 MDT, wind from 300° at 17 knots with gusts to 25 knots, visibility 10 miles or greater, clear skies below 12,000 ft above ground level (agl), temperature of 6° Celsius (C), dew point temperature of -9°C, and an altimeter setting of 29.71 inches of mercury (inHg). Remarks, automated station with a precipitation discriminator, peak wind from 270° at 27 knots at 1455 MDT, sea level pressure 1005.8 hPa, temperature 5.6°C, dew point temperature -9.4°C, maintenance indicator on.

KCPR weather at 1653 MDT, wind from 310° at 9 knots with gusts to 21 knots, visibility 10 miles or greater, scattered clouds at 6,000 ft agl, temperature of 5°C, dew point temperature of -11°C, and an altimeter setting of 29.73 inHg. Remarks, automated station with a precipitation discriminator, sea level pressure 1006.9 hPa, temperature 5.0°C, dew point temperature -11.1°C, maintenance indicator on.

The observations from the KCPR ASOS around the accident time identified VFR[8] conditions with winds gusting as high as 31 knots at 1445 MDT.

3.0 Upper Air Sounding

A High-Resolution Rapid Refresh (HRRR)[9] model sounding was created[10] for the approximate accident site coordinates for 1600 MDT. The HRRR sounding was plotted on a standard Skew-T Log P diagram[11] from the surface to 500-hPa (or approximately 18,000 ft) using the RAOB[12] software package and is included as figure 5. The sounding depicted an elevation of 6,890 ft over the grid point with a near surface temperature of 1.0°C, a dew point temperature of -12.8°C, and a relative humidity of 35%. The sounding depicted the lifted condensation level (LCL)[13] and the level of free convection (LFC)[14] at 12,401 ft, and the convective condensation level (CCL)[15] at 12,672 ft. The freezing level was located at 6,934 ft. The precipitable water value at 0.13 inches.

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[8] 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.

**By definition, VFR is a ceiling greater than or equal to 3,000 ft agl and visibility greater than 5 miles while MVFR is a sub-category of VFR.

[9] 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.

[10] HRRR sounding was created using NOAA Air Resource Laboratory: READY Archived Meteorology (noaa.gov).

[11] Skew T log P diagram – is a standard meteorological plot 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.

[12] RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Eosonde Research Services, The Villages, Florida.

[13] LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

[14] LFC – The level at which a parcel of saturated air becomes warmer than the surrounding air and begins to rise freely. This occurs most readily in a conditionally unstable atmosphere.

[15] 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.

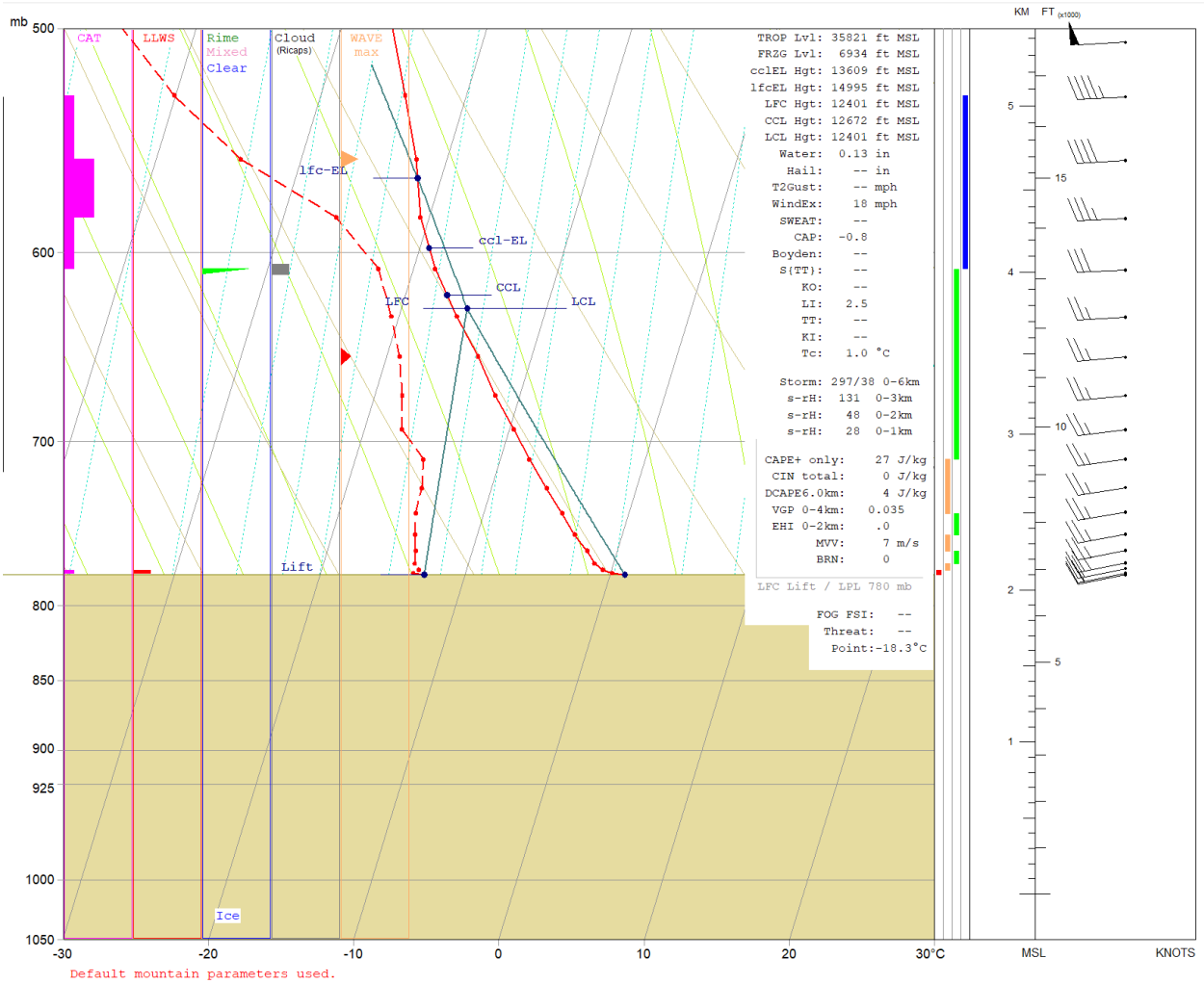

Figure 5. 1600 MDT HRRR sounding.

The 1600 MDT HRRR sounding indicated a conditionally unstable environments from the surface through 13,000 ft, with a stable atmosphere above. RAOB indicated the potential for clouds within a shallow layer with the cloud base around 13,000 ft (~6,000 ft agl) with light rime icing in that 500 ft thick cloud layer.

The 1600 MDT HRRR sounding wind profile indicated a near surface wind from 258° at 20 knots with the wind remaining westerly through 18,000 ft. The wind speed increased to 25 knots by 1,000 ft agl and to 50 knots by 18,000 ft. RAOB indicated the possibility of light low-level wind shear (LLWS) and light clear air turbulence (CAT) between the surface and 500 ft agl. Using the default mountain parameters in RAOB no mountain wave activity was indicated by 11,000 ft.

4.0 Satellite Data

Geostationary Operational Environmental Satellite number 16 (GOES-16) visible and infrared data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System software. Visible and infrared imagery (GOES-16 bands 2 and 13) at wavelengths of 0.64 microns (μm) and 10.3 μm, respectively, were retrieved for the period from 1200 MDT through 1800 MDT and reviewed, and the closest images to the time of the accident were documented.

Figure 6 presents the GOES-16 visible image at 1600 MDT at 2X magnification with the accident site highlighted with a red square. The image depicted no cloud cover over the accident site with a west-east oriented cumulus cloud band in between the accident site and KCPR. The cloud band was moving from west to east (attachment 1). Snow was present across most of the terrain surrounding the accident area and areas of snow would be regions of white below the moving cloud cover found in attachment 1. No GOES-16 band 13 imagery is shown given that the GOES-16 visible imagery depicted no cloud cover over the accident site. It should be noted these figures have not been corrected for any parallax error.

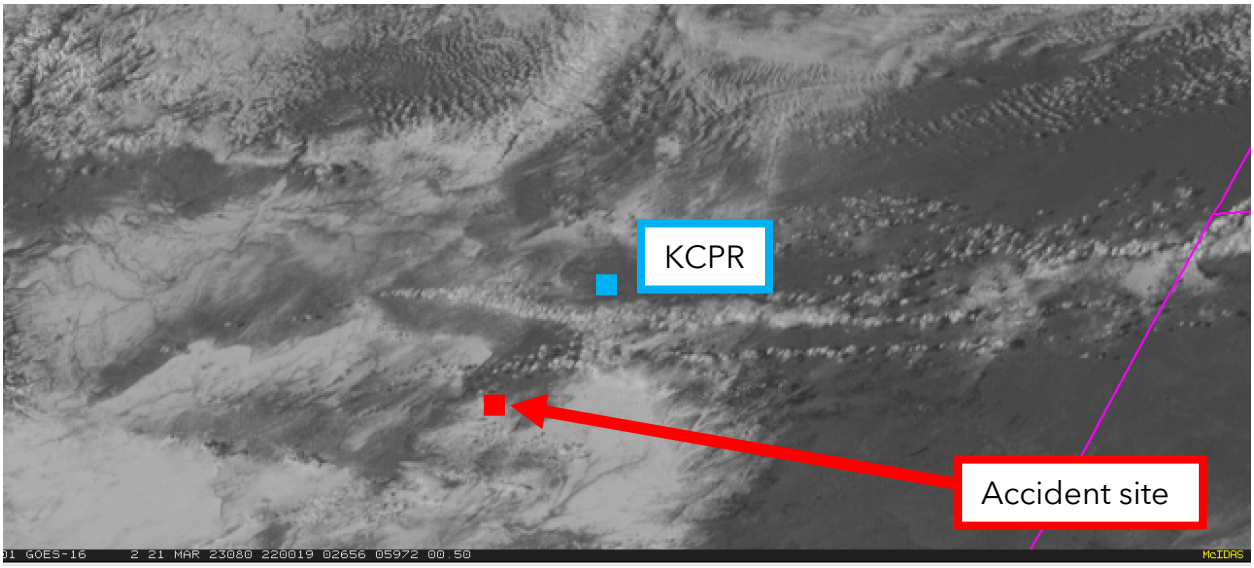

Figure 6. GOES-16 visible image at 1600 MDT.

5.0 Pilot Reports

The longline-disseminated pilot reports[16] (PIREPs) distributed into the national airspace system (NAS) within three hours before and after the accident time and within 100 miles of the accident site at altitudes below 18,000 ft are shown here:

CPR UA /OV CPR080010/TM 1913/FL080/TP SR22/TB LGT-MOD/RM CONT TURB TO SFC

CPR UA /OV CPR350015/TM 2138/FL140/TP SR22/SK SKC125-TOP140/TB LGT TB/IC NEG

6.0 Significant Meteorological Information

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

7.0 Center Weather Service Advisories

The Denver (ZDV) Air Route Traffic Control Center (ARTCC) Center Weather Service Unit (CWSU) was responsible for the accident region. There was no Center Weather Advisory (CWA) valid for the accident site at the accident time.

8.0 Airmen's Meteorological Information

The NWS Aviation Weather Center had text Airmen's Meteorological Information (AIRMET) advisory Tango valid for the accident site at the accident time. The text AIRMET Tango was issued at 1445 MDT and forecast moderate turbulence below 16,000 ft:

WAUS45 KKCI 212045
WA5T
-SLCT WA 212045
AIRMET TANGO UPDT 6 FOR TURB STG WNDS AND LLWS VALID UNTIL 220300
.
AIRMET TURB...WY CO NM
FROM BFF TO GLD TO 50W LBL TO 30ESE TBE TO 40NNE INK TO 50W INK
TO 20W ELP TO 60WNW LAR TO BFF
MOD TURB BTN FL240 AND FL410. CONDS CONTG BYD 03Z ENDG BY 06Z.
.
AIRMET TURB...ID MT WY NV UT OR CA AND CSTL WTRS

[16] Only PIREPs with the World Meteorological Organization headers UBWY**, UBMT**, UBCO**, and UBUT** were considered. These do not include pilot reports only broadcast via radio.

FROM 80SW DIK TO 70SW RAP TO BFF TO 70W BVL TO 20ESE CZQ TO 70SSE SNS TO 140SW SNS TO 130WSW ENI TO 70WSW PYE TO 40NNE RBL TO 50WSW REO TO 60SSE BKE TO 80SW DIK
MOD TURB BTN FL220 AND FL360. CONDS CONTG BYD 03Z ENDG BY 06Z.
.
AIRMET TURB...WY NV UT CO AZ NM CA AND CSTL WTRS
FROM 60WNW LAR TO 20WSW ELP TO 50S TUS TO BZA TO 20S MZB TO 220SW MZB TO 140SW SNS TO 70SSE SNS TO 20SE CZQ TO 70W BVL TO 60WNW LAR
MOD TURB BTN FL180 AND FL410. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET TURB...WY CO NM
FROM 20WNW CZI TO 50ENE DDY TO 30NE PUB TO 30ESE TBE TO 20WSW INK TO ELP TO 40NE JNC TO 30E CHE TO 40W DDY TO 20WNW CZI
MOD TURB BLW 160. CONDS CONTG BYD 03Z ENDG 03-06Z.
.
AIRMET TURB...WY NV UT CO AZ NM CA AND CSTL WTRS
FROM 80WSW TWF TO 40SE MLD TO 40NE JNC TO ELP TO 50S TUS TO BZA TO 20S MZB TO 220SW MZB TO 140SW SNS TO SNS TO 60NNE CZQ TO 80WSW TWF
MOD TURB BLW FL180. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET TURB...NV OR CA AND CSTL WTRS
FROM 30SE LKV TO 80WSW TWF TO 60NNE CZQ TO SNS TO 140SW SNS TO 150WSW FOT TO 130WNW FOT TO 30SW OED TO 70SE OED TO 30SE LKV
MOD TURB BLW 120. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET STG SFC WNDS...CO NM
FROM HBU TO 30NNE CIM TO 40W CIM TO 40NNE RSK TO HBU
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS DVLPG 21-00Z. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET STG SFC WNDS...NM
FROM 50N CME TO 40W INK TO 60E ELP TO 60ENE TCS TO 50N CME
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS ENDG 00-03Z.
.
AIRMET STG SFC WNDS...AZ NM
FROM 40SW PHX TO 20N SSO TO 70SSE SSO TO 50S TUS TO 70ESE BZA TO 40SW PHX
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET STG SFC WNDS...NV UT AZ CA AND CSTL WTRS
FROM 30NE ELY TO 50NW BCE TO 20SW PGS TO 40ENE TRM TO 30WSW BZA TO 40ESE MZB TO 50E LAX TO 20N RZS TO 30ENE EHF TO 60ENE MOD TO 50NW OAL TO 20ESE OAL TO 40W ELY TO 30NE ELY
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS CONTG BYD 03Z THRU 09Z.
.
LLWS POTENTIAL...ID WY NV UT CO AZ
BOUNDED BY 70ESE REO-60ESE MLD-40E CHE-EED-50SSE OAL-70E FMG-60WNW BAM-70ESE REO
LLWS EXP. CONDS CONTG BYD 03Z THRU 09Z.

.
LLWS POTENTIAL...UT CO AZ NM
BOUNDED BY 40E CHE-40NE PUB-50S GLD-50W LBL-30ESE TBE-50NE TCC-30SSE FTI-40SSW CME-70NW SSO-60WSW TUS-60ESE BZA-70SW DRK-EED-40E CHE
LLWS EXP. CONDS CONTG BYD 03Z THRU 09Z.
.
OTLK VALID 0300-0900Z
AREA 1...TURB ID MT WY NV UT CO OR CA AND CSTL WTRS
BOUNDED BY 100SE MLS-70SW RAP-BFF-50S OCS-50S LAX-220SSW RZS-120WSW PYE-40SW RBL-80S LKV-30SE REO-100SE MLS
MOD TURB BTN FL200 AND FL330. CONDS DVLPG 03-06Z. CONDS CONTG THRU 09Z.
.
AREA 2...TURB ID WY NV UT CO AZ NM CA AND CSTL WTRS
BOUNDED BY 20ENE BPI-20N CYS-20NNE LAA-60SSE LAA-30ESE TBE-INK-ELP-50S TUS-BZA-20S MZB-220SW MZB-140WSW RZS-30W BTY-70ESE REO-TWF-20ENE BPI
MOD TURB BLW FL180. CONDS CONTG THRU 09Z.
.
AREA 3...STG SFC WNDS NV UT AZ CA
BOUNDED BY 40NE ELY-20WNW HVE-70S HVE-70ENE TBC-30SW SJN-60ENE PHX-DRK-20W EED-40SW TRM-50E LAX-20NE RZS-50SSW BTY-40E OAL-30W ELY-40NE ELY
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS CONTG THRU 09Z.
....

9.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products issued by the Aviation Weather Center (AWC) before the accident flight and valid from 1500 until 1800 MDT are shown in attachment 2. The GFA surface forecasts applicable to the accident site that were valid before the accident flight's departure from 1500 until 1800 MDT indicated VFR conditions with a west wind of 10 to 15 knots and gusts to 25 knots. The GFA cloud forecast applicable to the accident site that was valid from 1500 until 1800 MDT indicated mainly cirrus clouds with an area of few to scattered cloud coverage east of the accident site with bases at 10,000 ft. The Graphical AIRMET[17] (G-AIRMET) Tango valid for the accident site from 1500 MDT until 1800 MDT is located in figure 7. The only human-generated information reflected in the two GFA products were the G-AIRMETs.

[17] Graphical AIRMETs (G-AIRMETs), found on the Aviation Weather Center webpage at http://aviationweather.gov, are graphical forecasts of en-route weather hazards valid at discrete times no more than 3 hours apart for a period of up to 12 hours into the future (for example, 00, 03, 06, 09, and 12 hours). G-AIRMETs are snap shots at discrete time intervals as defined above. The text AIRMET is the result of the production of the G-AIRMET but provided in a time smear for a 6hr valid period.

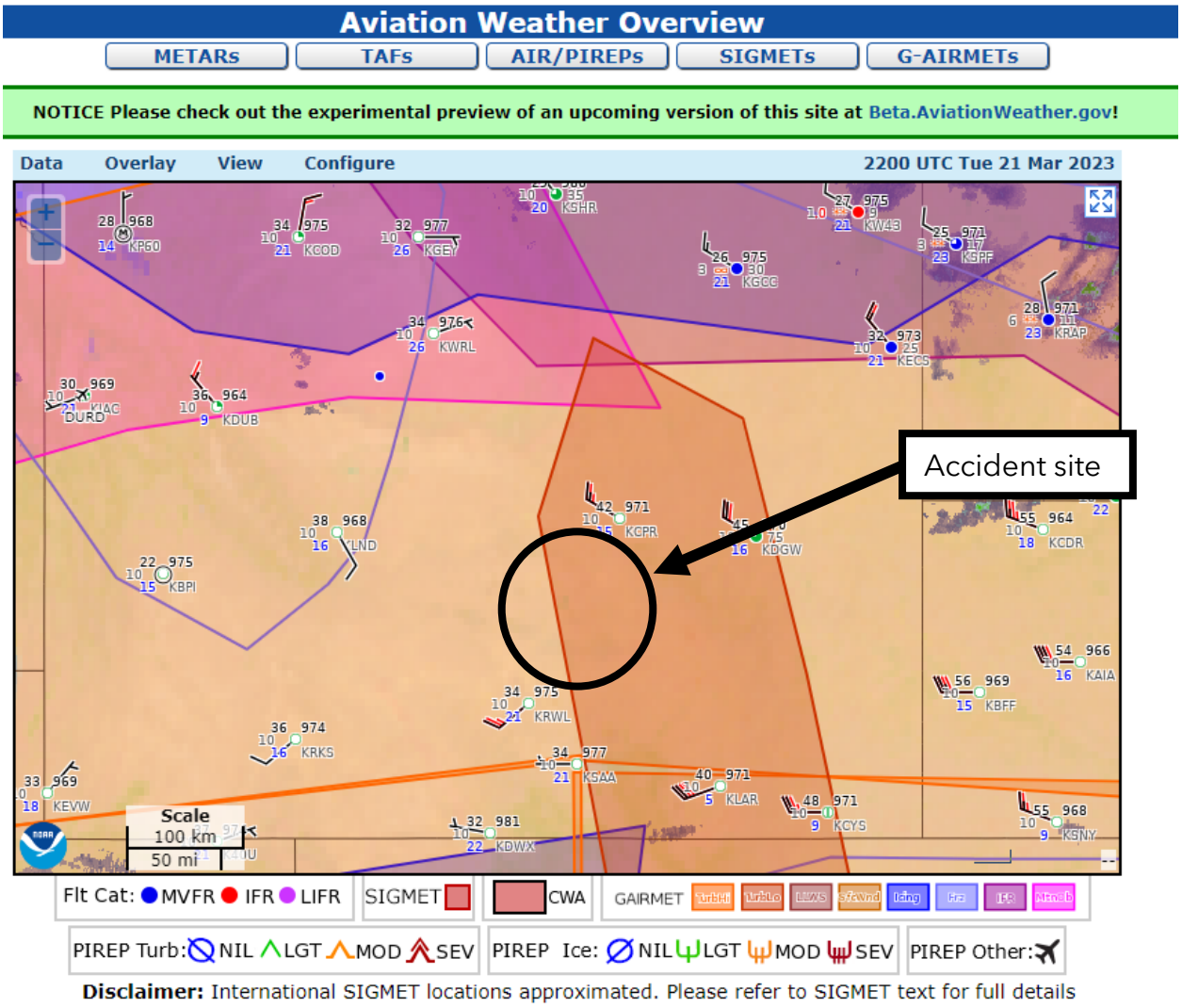

Figure 7. AWC graphic from 1600 MDT with G-AIRMETs overlaid.

10.0 Terminal Aerodrome Forecast

KCPR was the closest site with an NWS Terminal Aerodrome Forecast[18] (TAF) current at the time of the accident. The KCPR TAF valid at the accident time was issued at 1127 MDT and was valid for a 24-hour period beginning at 1200 MDT. The 1127 MDT TAF for KCPR was as follows:

FTUS45 KRIW 211727
TAFCPR
TAF
KCPR 211727Z 2118/2218 23015G25KT P6SM FEW035
FM212000 26020G30KT P6SM SKC
FM220000 29011KT P6SM FEW200
FM220300 04006KT P6SM VCSH BKN050 OVC100
FM220600 03008KT 5SM -SN BKN025 OVC050=

Between 1400 and 1800 MDT the KCPR forecast expected a wind from 260° at 20 knots with gusts to 30 knots, 6 miles visibility or greater, and clear skies.

11.0 National Weather Service Area Forecast Discussion

The NWS weather forecast office in Riverton, Wyoming, (WFO RIW) was responsible for the public forecast in the region of the accident site. WFO RIW issued the following Area Forecast Discussion (AFD) at 1545 MDT, the closest AFD to the accident time with an aviation section:

FXUS65 KRIW 212145
AFDRIW

Area Forecast Discussion
National Weather Service Riverton WY
345 PM MDT Tue Mar 21 2023

.DISCUSSION...(This evening through Tuesday)
Issued at 122 PM MDT Tue Mar 21 2023

The upper-level low center for the current storm system if over
Johnson County and moving eastward. Snow showers will continue over
northern WY through the afternoon with northerly flow increasing in
the Bighorn Basin and Johnson County. The Bighorn Mountains should
pick up another 1-2 inches by sunset, with less than an inch in the
lower elevations to the west and east of the mountains. With
temperatures in the mid to upper 20s, area roadways are likely slick

[18] According to NWS Instruction 10-813: "An 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." www.nws.noaa.gov/directives/sym/pd01008013curr.pdf

and visibilities would be reduced in areas of heavier showers. As mentioned, these showers should diminish around 6 pm this evening. Snow showers also continue this afternoon over northwest WY, particularly the mountain areas of YNP, the Absarokas, and the northern Tetons. The northern parts of Jackson Hole as well as the eastern foothills of the Absarokas should also see some snow showers, with up to an inch accumulation before decreasing around sunset. **To the south across parts of central WY, gusty west winds have already developed and will increase somewhat during the afternoon hours before decreasing before sunset. There could be some areas of blowing snow, particularly on north-south oriented roadways, but warming temperatures are modifying the snowpack to decrease those chances.**

As activity across northern WY wanes this evening, clouds will increase from the south over southwest WY as moisture from the deep CA low surges northeastward. Models are showing precipitation starting around midnight across far SW WY, including southern Lincoln County, then quickly spreading north and northeast. As the upper-level low center moves from CA into Nevada Wednesday morning, moisture will increase and the mid- and upper-level flow will strengthen as well. Diffluent flow on the northern edge of the moisture will combine with favorable jet dynamics to produce dynamically driven snow from southern into central WY during the day. Favorable orographic flow across western WY will keep snow going over that area during the day and into the night as well. The low however is expected to weaken as the shortwave trough quickly moves from Utah through Wyoming and into South Dakota Wednesday night. Thus, expecting widespread advisory snow amounts across much of the forecast area From early Wednesday morning through Thursday morning. Generally, 6 to 8 inches in mountain areas, and 3 to 5 inches in the lower elevations. Some lower elevation areas may only see 1 to 3 inches, but also be combined with gusty southwest wind to make conditions briefly hazardous. While southwest into south-central WY will see quite gusty southwest wind Wednesday afternoon, east of the divide will see breezy north-northeast flow through about midnight Wednesday night. As with the current system, light to moderate snow showers are expected to continue across western WY due to weakly diffluent flow and moderate orographic flow.

Thursday midday will see a brief lull in precipitation across much of the area, although the surface pressure gradient and mid-level flow of 20-30 knots will help gusty west wind to increase over the southern two-thirds of the forecast area. A shortwave trough in the westerly flow will then increase moisture once again into western WY starting late Thursday as mid-level flow increases to around 30 knots. The trough then pushes into western WY Friday morning accompanied with a tighter surface and mid-level gradient to increase surface winds and favorable orographic flow. Parts of western WY should see moderate to heavy snowfall during the day Friday. As the trough moves through northern-central WY Friday afternoon, strong west winds will push through central and southern WY, and light to moderate snow will also develop across northern WY

as a cold front with northwest flow move over that area.

A broad trough is expected to remain over the western US from Saturday into Sunday, continuing moist WSW flow into the area and keeping light to moderate snow over the western mountains and parts of northern WY. Temperatures will certainly be below normal during the weekend after warming somewhat Thursday and Friday. Lows Saturday and Sunday morning will again drop to around zero across western and SW WY, especially in the Upper Green River Basin. Weak high pressure is expected to build over the area Monday and Tuesday as yet another storm system along the west coast keeps up the trend of California moisture finding its way into the Intermountain West. A slight chance of snow will continue for the western mountains and parts of southwest WY.

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.AVIATION...(For the 00Z TAFS through 00Z Wednesday evening)
Issued at 338 PM MDT Tue Mar 21 2023

KJAC will see VCSH the next couple hours as a convective band continues to meander along the Tetons and Jackson Hole. As this band is being pushed by the approaching system, any impacts at KJAC the next couple hours will be minimal and brief, but Mountain obscuration will continue. The next winter storm still expected tonight, and timing of the next round of snow remain on track, with KRKS around 03Z, KJAC to KRIW to KCPR around 06Z, and KCOD to KWRL to KBYG between 09Z and 12Z. Once snow starts, expect dominant MVFR conditions will lower vis and cigs for snow to continue through at least 06Z Thursday. Brief periods of heavier are possible all sites on Wednesday, but are too brief to mention with TEMPO lowerings yet.

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.FIRE WEATHER...
Issued at 122 PM MDT Tue Mar 21 2023

One storm system is over north-central WY moving eastward today, with lingering snow showers over NW and north-central WY, which should diminish by sunset. Gusty west winds will also continue over parts of central and south-central WY this afternoon, decreasing around sunset. Clouds will then increase from the southwest as the next storm system advances, bringing snow showers to SW WY around midnight, and quickly spreading NE early Wednesday morning. Moderate to heavy snow is possible from eastern Sweetwater County into central WY and over the western mountains during the day. Gusty southwest winds will increase Wednesday afternoon from SW into central WY. Breezy north wind will develop east of the divide. Expecting some snow across almost all of western and central WY through Thursday morning as a result, with 1 to 4 inches in the lower elevations, and 4 to 8 inches of snow in the mountains. Temperatures will remain below normal for the next few days. Another

storm will push through the area late Thursday into Friday, bringing
cooler temps for the weekend.

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.RIW WATCHES/WARNINGS/ADVISORIES...
Winter Weather Advisory from 6 AM Wednesday to midnight MDT
Wednesday night for WYZ007-016>018.

Winter Weather Advisory from 9 AM Wednesday to midnight MDT
Wednesday night for WYZ009>011.

Winter Weather Advisory from 3 AM Wednesday to 6 AM MDT Thursday
for WYZ012>015-023>026.

Winter Weather Advisory from 3 AM Wednesday to midnight MDT
Wednesday night for WYZ019-020-022-028-030.

Winter Weather Advisory from midnight tonight to 6 AM MDT
Thursday for WYZ027.

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12.0 Winds and Temperature Aloft Forecast

The NWS 1359 MDT Winds and Temperature Aloft forecast valid for the closest point to the accident site is included below:

FBUS31 KWNO 211959
FD1US1
DATA BASED ON 211800Z
VALID 220000Z FOR USE 2000-0300Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
MBW			**2722**	**2730-13**	2754-23	2563-34	259446	760852	258557

The closest forecast point to the accident site was the Medicine Bow, Wyoming (MBW). The 1359 MDT forecast was for use between 1400 MDT and 2100 MDT.

13.0 Pilot Weather Information

Title 14 CFR 91.103 states that "Each pilot in command shall, before beginning a flight, become familiar with all available information concerning that flight." FAA AC 91-92 "Pilot's Guide to a Preflight Planning" (dated March 15, 2021) provided pilot guidance on preflight self-briefings, including planning, weather interpretation, and risk identification/mitigation skills. The AC further stated in part:

> Pilots adopting these guidelines will be better prepared to interpret and utilize real-time weather information before departure and en route, in the cockpit, via technology like Automatic Dependent Surveillance-Broadcast (ADS-B) and via third-party providers. [19]

A search of archived information indicated that the accident pilot did not request weather information from Leidos Flight Service. A search of the ForeFlight database did not indicate any flights plans or weather briefings on the accident day or that the accident pilot had a ForeFlight account. It is unknown what weather information, if any, the accident pilot checked or received before departure and through the time of the accident.

14.0 Graphical Turbulence Guidance

Graphical Turbulence Guidance (GTG) data was retrieved from the Aviation Weather Center (AWC) Beta page[20] for 1600 MDT with GTG data from 500 ft agl (figure 8) and 1,000 ft agl (figure 9) displayed. For more information regarding GTG please see the Federal Aviation Administration (FAA) "Aviation Weather Handbook". The GTG graphical scale is embedded in figure 8 for reference.

[19] https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_91-92.pdf. The AC also listed multiple online FAA resources for aviation flight planning services for adverse weather.
[20] https://beta.aviationweather.gov/

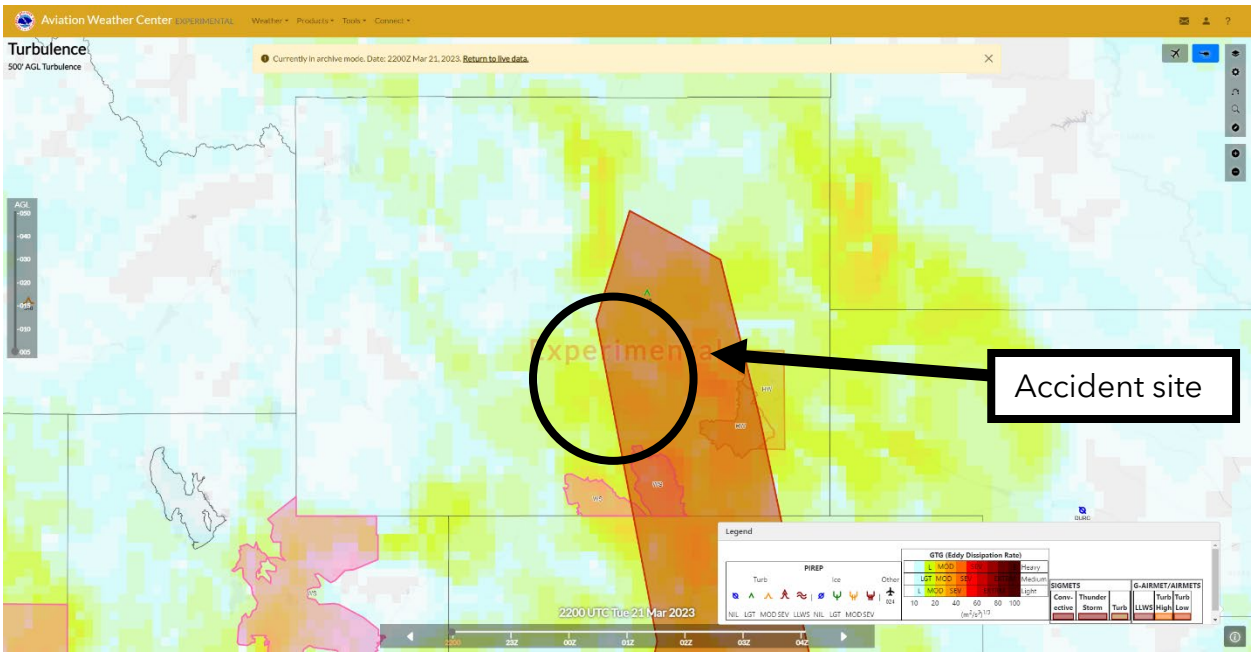

Figure 8. GTG information from 1600 MDT for 500 ft agl with NWS warnings and turbulence G-AIRMETs overlaid.

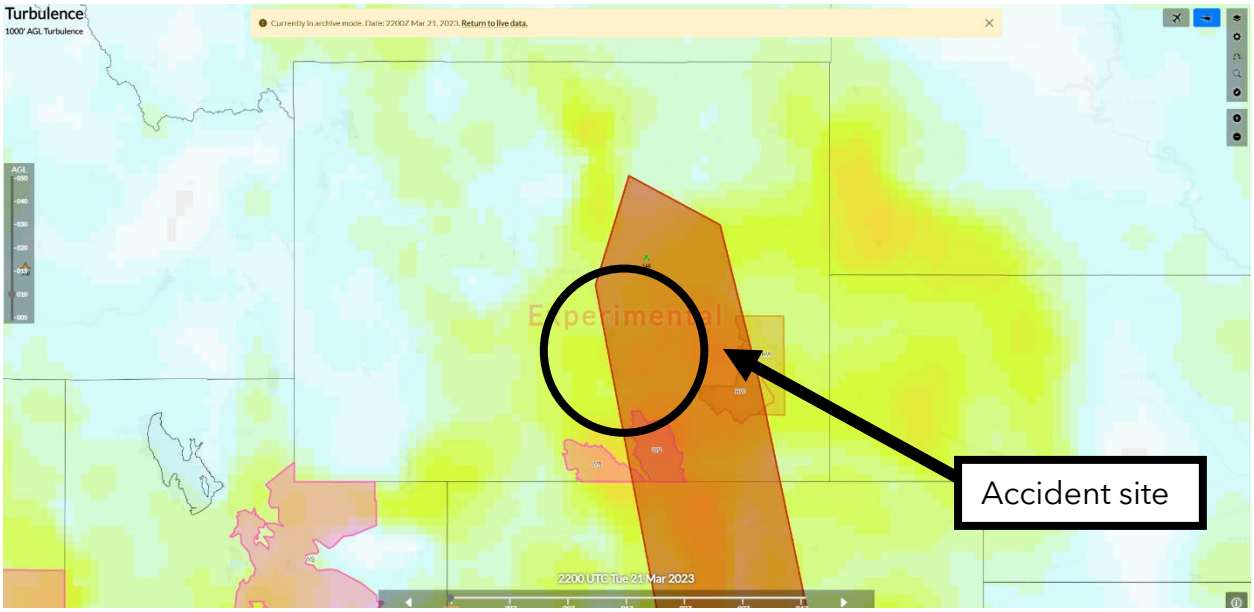

Figure 9. GTG information from 1600 MDT for 1,000 ft agl with NWS warnings and turbulence G-AIRMETs overlaid.

15.0 Astronomical Data

The astronomical data obtained for the accident site on March 21, 2023, indicated the following:

SUN	
Begin civil twilight	0640 MDT
Sunrise	0708 MDT
Sun transit	1314 MDT
Accident time	**1601 MDT**[21]
Sunset	1920 MDT
End civil twilight	1948 MDT

At the time of the accident the Sun was located at an altitude of 33.85° and azimuth of 233.02°.

E. LIST OF ATTACHMENTS

Attachment 1 – GOES-16 visible imagery animation from 1506 to 1706 MDT

Attachment 2 – GFA information valid at the accident time

Submitted by:

Paul Suffern
Senior Meteorologist

[21] Inserted accident time for reference and context.