NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

September 4, 2018

Weather Study

METEOROLOGY

CEN18FA217

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A. ACCIDENT

Location: Moose, Wyoming
Date: June 9, 2018
Time: 1115 mountain daylight time (MDT)
1715 coordinated universal time (UTC)
Airplane: LET L-23 Super Blanik glider; registration: N317BA

B. METEOROLOGIST

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C. SUMMARY

On June 9, 2018, about 1115 mountain daylight time, a retractable tandem-geared LET L-23 (Super Blaník) glider, N317BA, collided with remote mountainous terrain while en route about 7 miles northwest of Moose, Wyoming after departing from the Driggs-Reed Memorial Airport (DIJ), Driggs, Idaho. The commercial pilot and the passenger sustained fatal injuries. The glider was destroyed. The glider was registered to Teton AvJet, LLC, Driggs, and was operated by Teton Aviation Center, Driggs, under the provisions of Title 14 *Code of Federal Regulations (CFR)* Part 91 as a visual flight rules sightseeing tour flight. Visual meteorological conditions prevailed at the time of the accident, and no flight plan was filed. The flight originated from DIJ at 0950 and was released from the tow airplane at 1037.

D. 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 from the Washington D.C. office, collecting data from official National Weather Service (NWS) sources including the Weather Prediction Center and the National Center for Environmental Information. All times are mountain daylight time (MDT) based upon the 24-hour clock, local time is +6 hours to UTC, and UTC=Z. NWS airport and 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 43.731944° N and longitude 110.811944° W, at an elevation of approximately 12,000 ft on the west slope of Middle Teton Mountain, which is the third largest mountain in the 40 mile long Teton Mountain Range in Wyoming.

E. WEATHER 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) 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.

1.1 Surface Analysis Chart

The NWS regional display of the Surface Analysis Chart for 1200 MDT (1800Z) on June 9, 2018 is included as figure 1, with the accident site location within the red circle. The chart depicted a low-pressure system with a sea-level pressure of 999-hectopascals (hPa)[1] to the west of the accident location over Idaho along an associated cold front that extended south-southwestward and a stationary front to the north-northeast. A high-pressure system[2] at 1011-hPa was located immediately north-northeast of the accident site in northwestern Wyoming. A trough of low pressure was also depicted across central Montana stretching south-southeastward into central Wyoming, with another trough over Nevada. The resultant pressure gradient indicated south to southwesterly surface winds across the area.

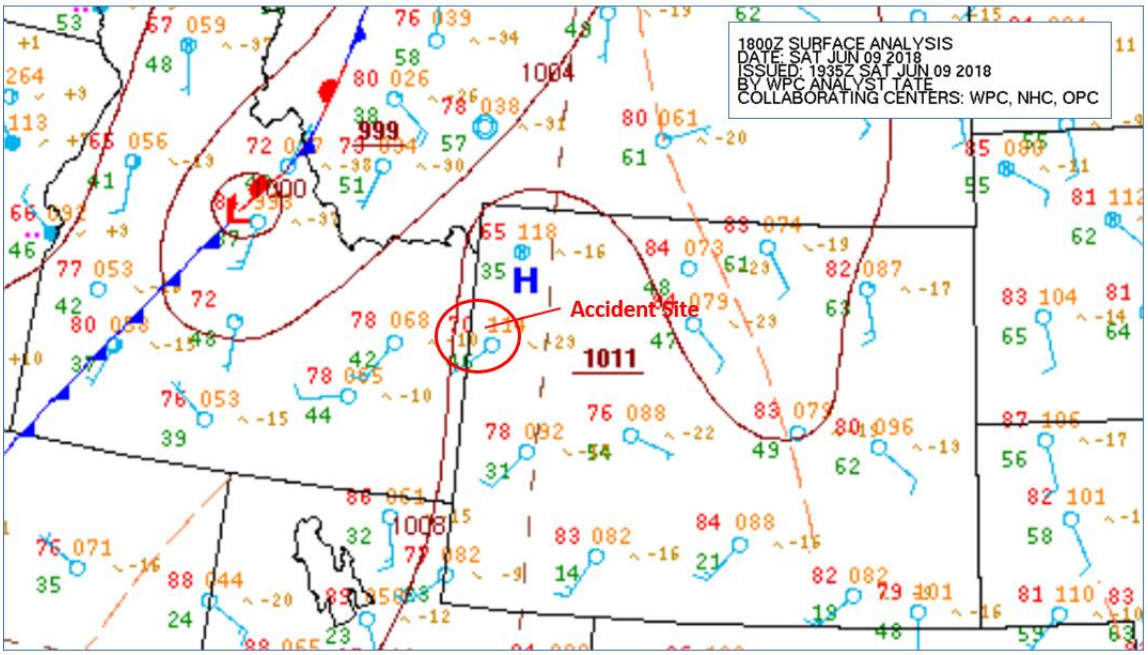

Figure 1 – Regional NWS Surface Analysis Chart for 1200 MDT

[1] Hectopascal is the standard term for reporting sea level pressure and is interchangeable with the term millibar (mb) with the same units. Standard sea level pressure is 1013.25-hPa.

[2] High pressure systems typically imply subsiding air, stable conditions, generally clear skies, with an anticyclonic or counter-clockwise outward wind flow from the high.

The surrounding station models depicted southwesterly winds of 10 knots, clear skies, with temperatures in the 70's degrees Fahrenheit (°F), with dew point temperatures in the 40's °F. The station models depicted no significant weather in the immediate vicinity during the period.

1.2 Regional Radar Mosaic

A regional view of the NWS national composite radar mosaic is included as figure 2 for 1115 MDT with the approximate accident site marked by a red star. The image depicted just a few very light intensity echoes over high terrain with no echoes in the vicinity of the accident site.

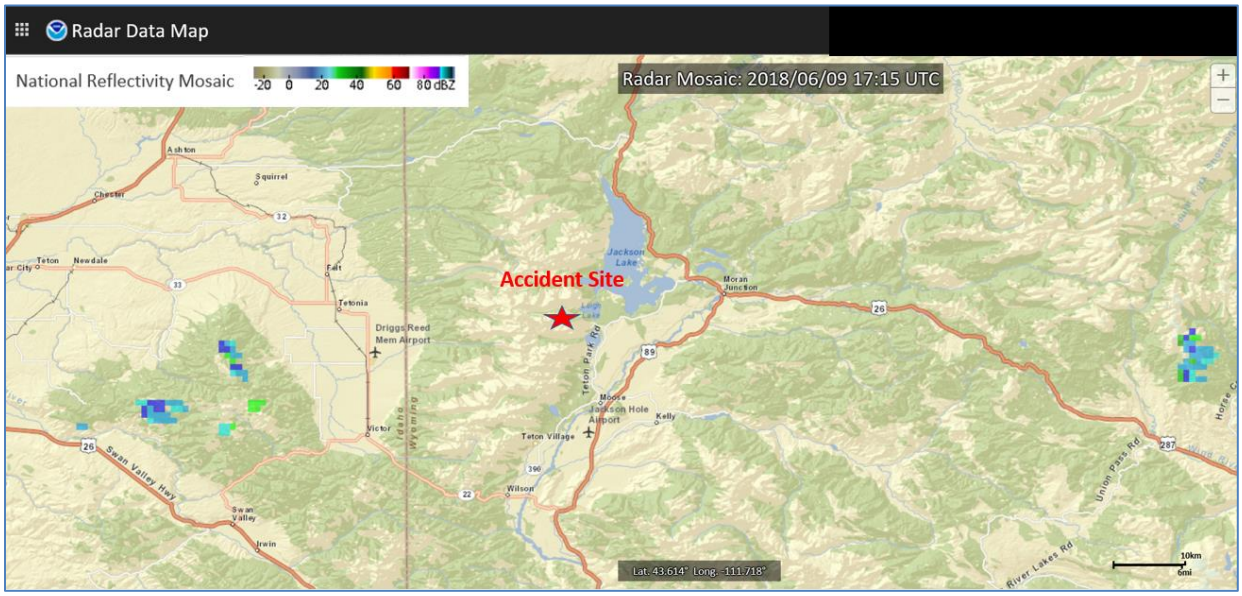

Figure 2 - Regional Composite Reflectivity image for 1115 MDT

1.3 Upper Level Charts

The NWS Storm Prediction Center's (SPC) forecast upper air constant pressure charts[3] for 700-, 500-, and 300-hPa for 0600 MDT on June 9, 2018 are included as figure 3 through 5, and represent the conditions at approximately 10,000 ft, 18,000 ft, and 30,000 ft. The upper level charts have been annotated with the location of upper level low's, high's, and troughs for clarity. The charts depict contour lines of equal height and provide an indication of wind direction, which is typically parallel to the contour lines. The 700- and 500-hPa charts also provide isotherms or lines of equal temperature (red dashed lines), and on the 700-hPa chart also depicts temperature-dew point spreads less than 4° C (green). On the 300-hPa chart isotachs or lines of equal wind speed are also provided, which help to depict the jet stream.

The charts depicted a long wave trough over the western United States with southwesterly winds over Idaho and Wyoming with wind speeds increasing with height with little change in direction.

[3] The SPC upper air maps are produced by using the available 1200Z rawinsonde observations with a first guess from the 0600Z North American Mesoscale (NAM) numerical model 6-hour forecast of the objective analysis. Errors may result if NAM model data is not available, or if sounding data is late or erroneous.

The front side of an upper level trough also implies upper-level divergence and general rising motion of the area, and if adequate moisture is available the development of clouds and precipitation. Upper level troughs also support surface fronts.

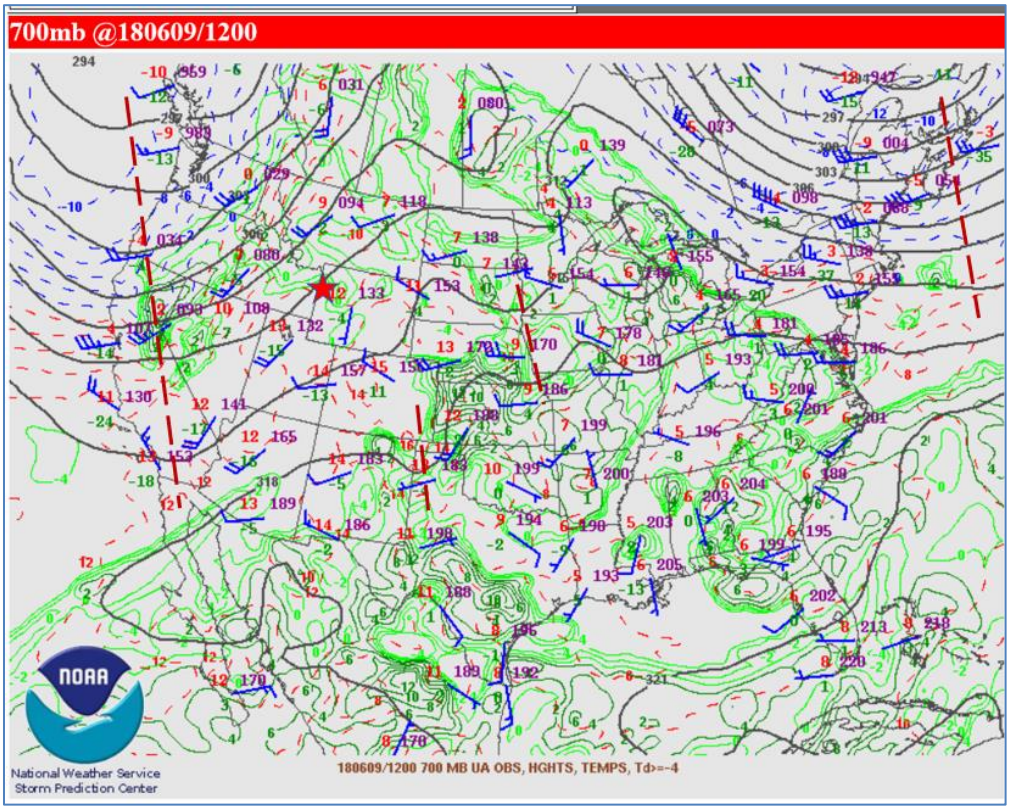

Figure 3 - 700-hPa Upper Air Chart for 0600 MDT representing conditions at 10,000 ft

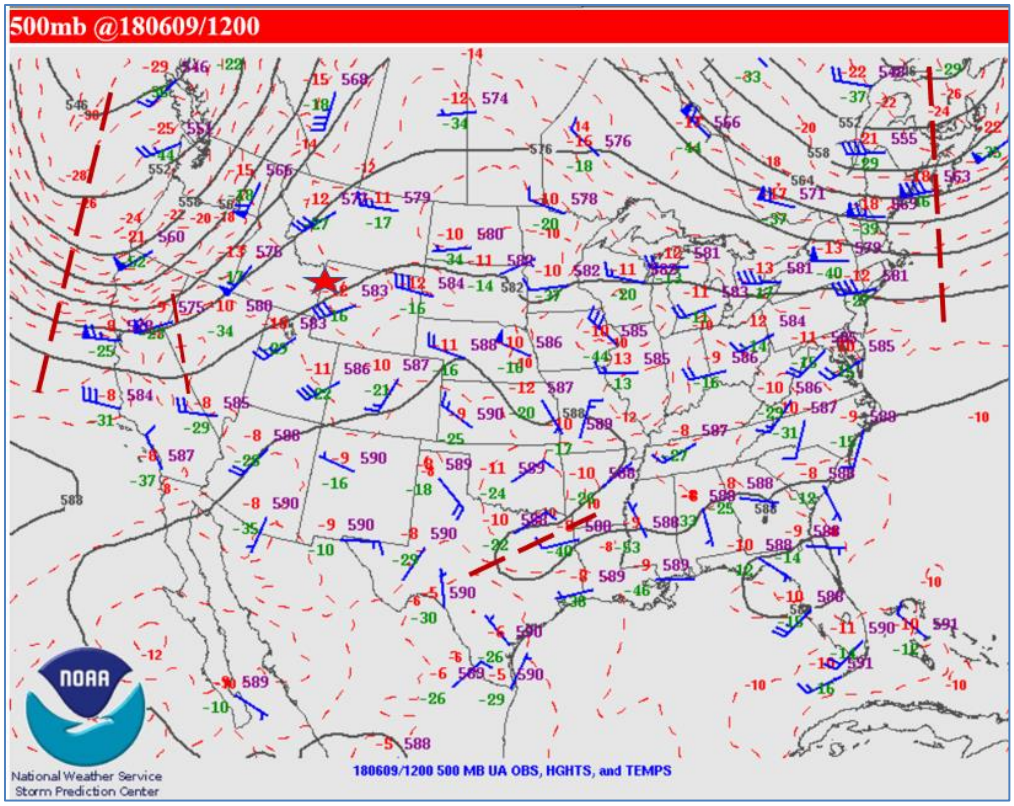

Figure 4 - 500-hPa Upper Air Chart for 0600 MDT representing conditions at 18,000 ft

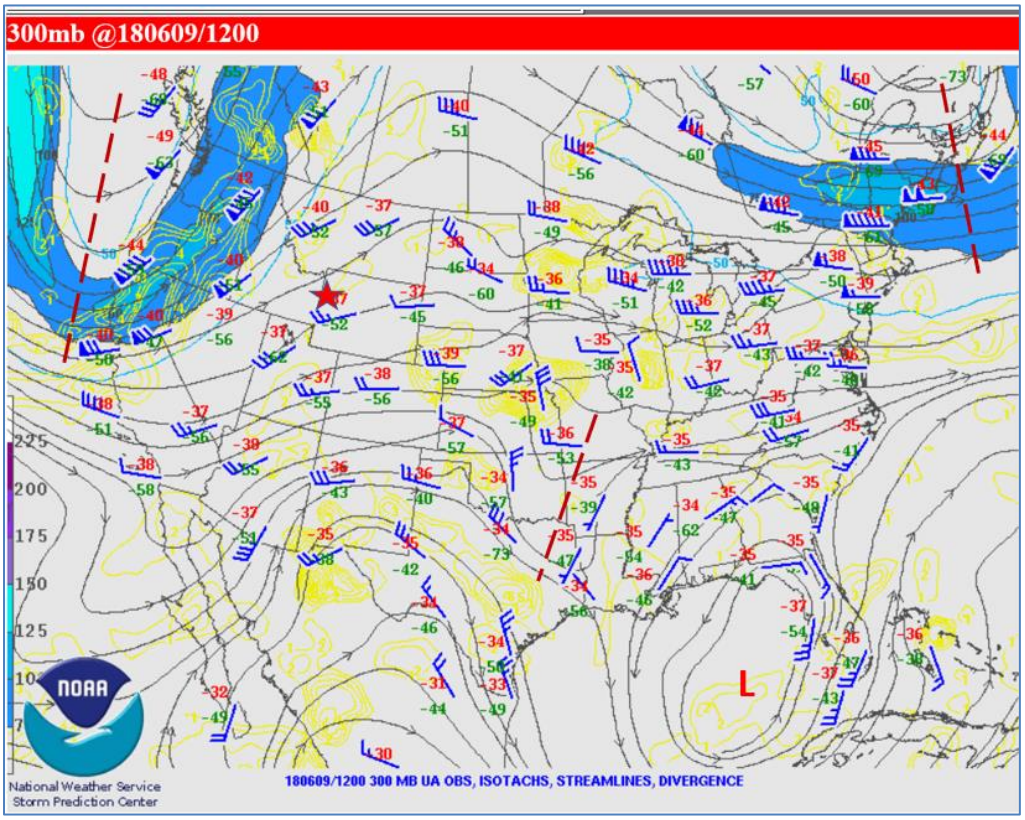

Figure 5 - 300-hPa Upper Air Chart for 0600 MDT representing conditions at 30,000 ft

2.0 Observations

The departure airport and other reporting locations in the immediate surrounding area were documented utilizing official NWS Meteorological Aerodrome Reports (METARs), which are included in plain language with time converted to local time. Cloud heights are reported in height above ground level (agl) in the following section.

2.1 Driggs, Idaho

The accident glider departed from Driggs-Reed Memorial Airport (KDIJ), Driggs, Idaho at approximately 1015 MDT, which was located approximately 12 ½ miles west of the accident site. The airport had an Automated Weather Observation System (AWOS) and listed an elevation of 6,231 ft, and a 12° east magnetic variation. At the approximate time of the accident the following conditions were being reported:

> *KDIJ weather observation at 1056 MDT (1656Z), automated[4], wind from 190° at 14 knots gusting to 20 knots, visibility 10 miles or more, sky clear below 12,000 ft agl, temperature 24° Celsius (C), dew point 2° C, altimeter setting 29.99 inches of mercury (Hg). Remarks: automated observation system with a precipitation discriminator, sea level pressure 1008.7-hPa, temperature 24.4° C, dew point 2.2° C, thunderstorm senor inoperative.*

The observation at 1056 MDT indicated a relative humidity of 23%, which resulted in a density altitude of approximately 8,740 ft. The raw observations from approximately 0800 through 1500 MDT were as follows:

METAR KDIJ 091356Z AUTO 00000KT 10SM CLR 17/06 A3004 RMK AO2 SLP105 T01670061=

METAR KDIJ 091456Z AUTO 00000KT 10SM CLR 20/07 A3002 RMK AO2 SLP106 T02000067 58010=

METAR KDIJ 091556Z AUTO 15010G14KT 10SM CLR 24/04 A3000 RMK AO2 SLP094 T02390039=

METAR KDIJ 091656Z AUTO 19014G20KT 10SM CLR 24/02 A2999 RMK AO2 SLP087 T02440022 TSNO

Accident 1715Z

METAR KDIJ 091756Z AUTO 18018G22KT 10SM CLR 26/02 A2998 RMK AO2 PK WND 17027/1740 SLP083 T02560022 10256 20083 56013=

METAR KDIJ 091856Z AUTO 20014G21KT 10SM CLR 27/02 A2995 RMK AO2 SLP077 T02670022=

METAR KDIJ 091956Z AUTO 20015G22KT 10SM CLR 27/02 A2992 RMK AO2 PK WND 21026/1919 SLP063 T02720022=

METAR KDIJ 092056Z AUTO 23017G25KT 10SM CLR 27/03 A2989 RMK AO2 SLP055 T02720028 56023=

[4] Automated – indicates that there was no human augmentation of the observation, or any additional supplementary information was not added to the observation.

2.2 Jackson Hole, Wyoming

The next closest weather reporting location to the accident site was Jackson Hole Airport (KJAC), Jackson, Wyoming, 8 miles south-southeast (157° azimuth) of the accident site at an elevation of 6,451 ft. The airport also had an AWOS and reported the following conditions:

> *KJAC weather observation at 1056 MDT (1656Z), wind calm, visibility 10 miles or more, sky clear below 12,000 ft agl, temperature 18° C, dew point 7° C, altimeter 30.04 inches of Hg. Remarks: automated observation system with a precipitation discriminator, sea level pressure 1012.7-hPa, temperature 18.3° C, dew point 6.7° C.*

The raw observations from approximately 0800 through 1600 MDT were as follows:

METAR KJAC 091356Z 00000KT 10SM CLR 10/04 A3012 RMK AO2 SLP151 T01000044=

METAR KJAC 091456Z 18003KT 10SM CLR 14/05 A3010 RMK AO2 SLP138 6//// T01390050 58009=

METAR KJAC 091556Z 19003KT 10SM CLR 16/06 A3007 RMK AO2 SLP137 T01610056=

METAR KJAC 091656Z 00000KT 10SM CLR 18/07 A3004 RMK AO2 SLP127 T01830067=

Accident 1715Z

METAR KJAC 091756Z 23004KT 10SM CLR 21/08 A3002 RMK AO2 SLP114 6//// T02110078 10217 20039 56023=

METAR KJAC 091856Z 15003KT 10SM CLR 24/06 A2998 RMK AO2 SLP099 T02390056=

METAR KJAC 091956Z VRB06KT 10SM CLR 25/06 A2994 RMK AO2 SLP084 T02500061=

METAR KJAC 092056Z 21019G22KT 10SM CLR 27/M01 A2990 RMK AO2 SLP066 T02671006 56032=

METAR KJAC 092156Z 21017G27KT 10SM CLR 27/M01 A2989 RMK AO2 PK WND 20030/2112 SLP065 T02671011=

2.3 Display of Observations

A display of the observations from the NWS Aviation Weather Center's (AWC) website for 1100 MDT is included as figure 6, with the approximate accident site marked by the red star. The station plots over the area indicated calm winds over Wyoming with clear skies west of the higher elevation, with southerly winds gusting to 15 to 20 knots over Idaho and southern Wyoming.

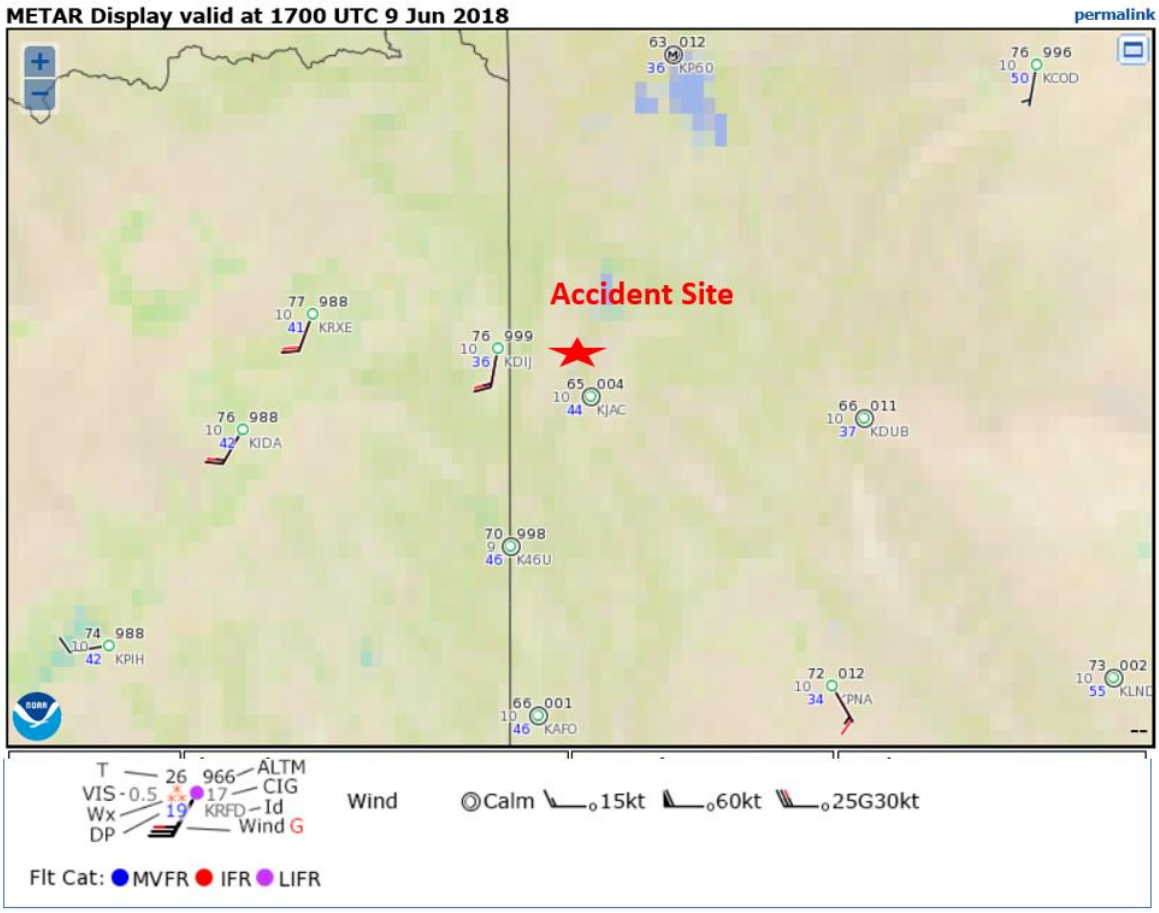

Figure 6 - METAR display at 1100 MDT

A similar plot of the topography with respect to the stations reporting was obtained from the University of Utah's MesoWest archive site for 1115 MDT and is included as figure 7. The map includes NWS observations (METARs) and Remote Automated Weather Stations (RAWS) from the land management agencies across the region. The temperatures and dew points are provided in degrees F, with wind speed in miles per hour (mph). The image depicted general light southerly winds across the region.

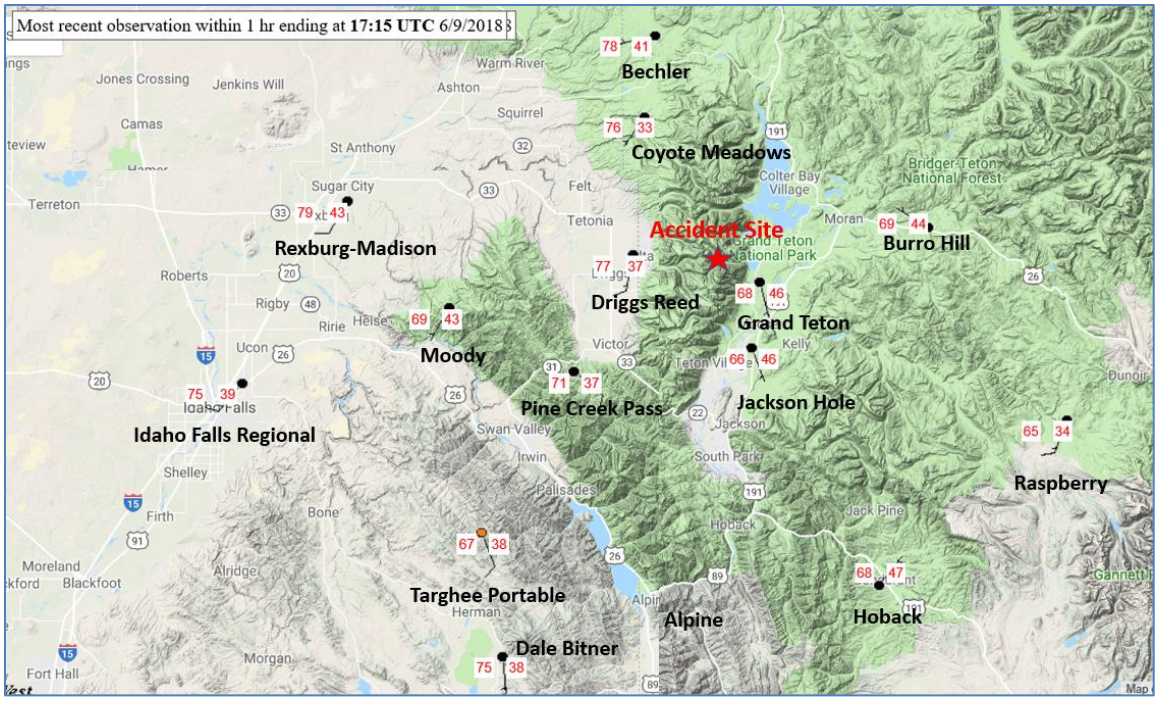

Figure 7 - MesoWest display of observations for 1100 MDT

3.0 Sounding

To determine the vertical structure and state of the atmosphere over the accident site a High-Resolution Rapid Refresh (HRRR)[5] numerical model data was retrieved from the NOAA Air Resources Laboratory and plotted on a standard Skew T log P diagram[6] using the complete Rawinsonde Observation (RAOB) program software[7] from the surface to 150-hPa (approximately 35,000 ft). Figure 5 is the HRRR numerical model sounding based on model run from 0600 MDT and valid for 1100 MDT.

[5] The HRRR is a National Oceanic and Atmospheric Administration (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.

[6] 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.

[7] RAOB software – The complete RAwinsonde OBservation program is an interactive sounding analysis program developed by Environmental Research Services, Matamopras, Pennsylvania, for plotting and analyzing upper air data.

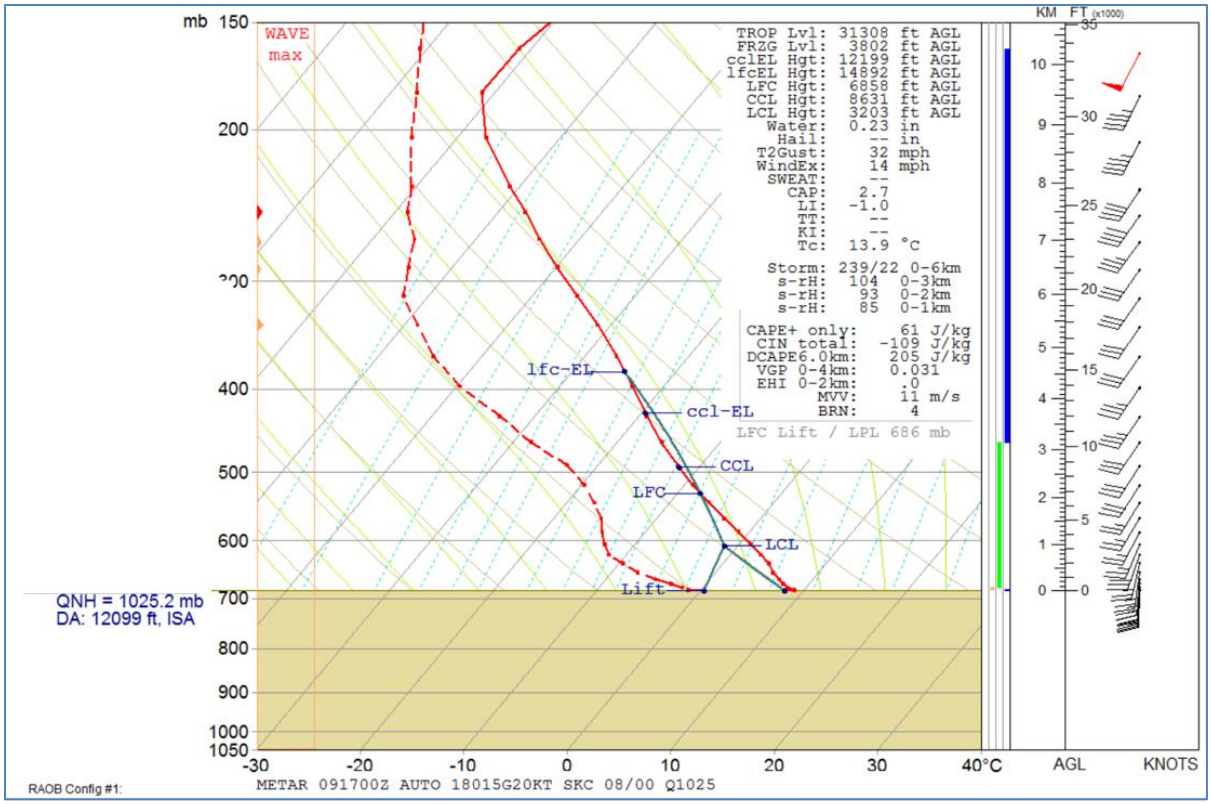

Figure 8 - HRRR numerical Model sounding for 1100 MDT over the accident site

The HRRR 1100 MDT sounding with a base elevation of 10,736 ft expected a surface temperature of 8.2° C (46.8° F), a dew point temperature of 0.4° C (32.7° F), with a relative humidity of 58%, and a convective temperature of 13.9° C. The lifted condensation level (LCL)[8] was at about 3,200 ft agl, the level of free convection (LFC)[9] at 6,860 ft agl, and the convective condensation level (CCL)[10] at 8,630 ft agl. The precipitable water content was 0.23 inches, with the freezing level identified at 14,540 ft. The relative humidity was not greater than 50% through the entire depth of the sounding, and thus did not support any cloud or precipitation formation. The sounding profile below 10,000 ft was characterized as conditional unstable (noted in green bar on right side of chart) with a Lifted Index[11] of -1. The sounding thermal structure did not support any strong thermal activity.

[8] Lifting Condensation Level (LCL) - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

[9] Level of Free Convection (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.

[10] Convective Condensation Level (CCL) – The height where an air parcel becomes saturated when heated from below and lifted adiabatically due to buoyancy. It marks where the cloud base begins when air is heated from below to the convective temperature, without mechanical lift.

[11] Lifted Index (LI) – is 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 some higher level (around 18,000 feet, usually) 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.

The HRRR wind profile indicated a surface wind from 180° at 15 knots, with wind veering clockwise with height to the southwest below 10,000 ft with then a gradual increase in wind speeds with height. The mean 0 to 6-kilometer (km) or 18,000 ft wind was from 210° at 29 knots, and the level of maximum wind was identified at 44,100 ft from 210° at 48 knots and was located immediately above the tropopause at 42,000 ft. With respect to turbulence, a shallow layer was identified at 10,735 ft with a strong vertical shear and indicated potential moderate and/or greater turbulence. No other layers indicated any strong vertical wind shears for the production of any significant turbulence over the region. The wind profile did support the development of weak mountain wave activity to the north-northeast of the mountain range with the potential for light turbulence with the wave between 26,000 and 33,600 ft.

A table of the HRRR model heights, pressure, temperature (T), dew point (Td), relative humidity (RH%), and wind direction and speed, clear air turbulence (CAT), low-level wind shear (LLWS), icing, and mountain wave potential from the surface to 30,000 ft is included below in figure 9.

Height (ft-MSL)	Pres (mb)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (FAA)	LLWS	Icing - Type (AFGWC method)	Wave/x---W---Turb nm	fpm	max
10735	686	8.2	0.4	58	182 / 15	LGT	MODRT				
10814	684	9.0	-1.2	49	183 / 20						
10973	680	8.2	-2.0	49	183 / 21						
11253	673	7.5	-3.4	46	184 / 23						
11576	665	6.7	-5.2	42	185 / 25						
12066	653	5.6	-7.5	38	188 / 26						
12730	637	4.4	-9.7	35	192 / 27	LGT					
13322	623	3.0	-11.7	33	198 / 28						
14098	605	1.1	-13.0	34	202 / 27						
14937	586	-1.0	-14.2	36	206 / 27						
15888	565	-3.5	-15.4	39	209 / 26						
16961	542	-6.2	-17.3	41	210 / 27						
18167	517	-9.2	-19.7	42	211 / 28						
19521	490	-12.3	-23.0	40	211 / 29						
21041	461	-15.7	-28.3	33	212 / 31						
22752	430	-19.2	-33.4	27	212 / 33						
24686	397	-23.0	-39.7	20	213 / 33						
26625	366	-27.0	-44.7	17	213 / 31						
28412	339				212 / 30						
28561	337	-31.3	-48.7	16					5.74	228	LIGHT
30197	314				213 / 30						

Figure 9 - HRRR model data

The sounding profile indicated that along the gliders flight path and in the vicinity of the accident site, southerly winds from 185º at 25 to 27 knots were encountered, with a potential for light turbulence at 12,700 ft. With this wind direction, no significant orographic lift would be generated on the western slopes of the Teton Mountain Range.

4.0 Satellite Imagery

The Geostationary Operational Environmental Satellite number 16 (GOES-16) data was 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 (McIDAS) software. The infrared long wave, water vapor, and visible band imagery were obtained surrounding the time of the accident. The infrared long wave imagery (band 13) at a wavelength of 10.3 microns (µm) provided an image with a nominal spatial resolution of 2 km. The visible imagery (band 2) at a wavelength of 0.64 µm provided a nominal spatial resolution of 0.5 km.

The GOES-16 visible and infrared imagery were reviewed and depicted clear skies over the region and over the accident site. The water vapor imagery was also reviewed and did not depict any significant moisture channel darkening over the area, which often defines significant mountain wave activity and turbulence. Figure 10 is the GOES-16 visible image for 1117 MDT at 2X magnification. The visible image depicted the snowcapped mountains over the region with no observed clouds in the immediate vicinity of the accident site. Specifically, no observed lenticular or rotor clouds associated with mountain wave activity were observed over the region.

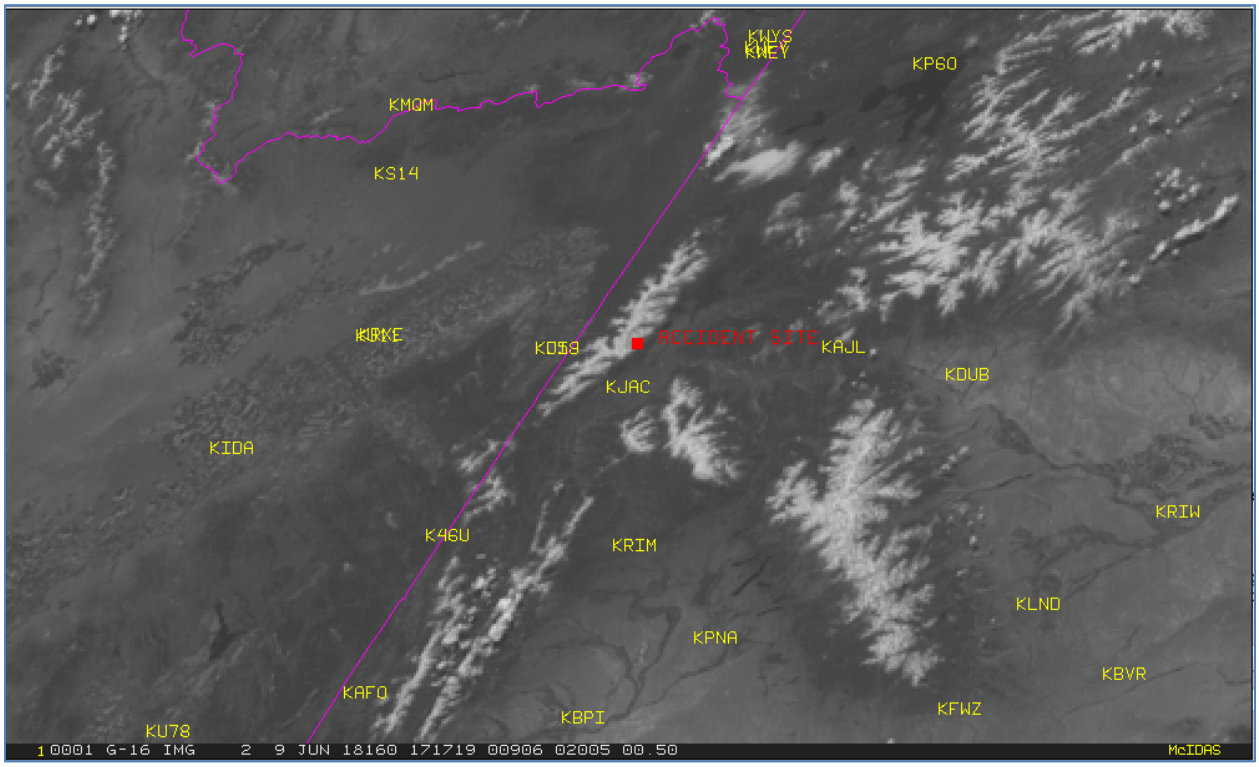

Figure 10 - GOES-16 visible image at 1117 MDT

5.0 Pilot Reports

A review of the pilot reports (PIREPs) issued over the region on June 9, 2018 provided the following reports below 18,000 ft over Wyoming, northern Utah, and southern Montana, from the period from 0800 through 2000 MDT. The reports are included below in plain language taken from standard code and abbreviations, with the time converted to local and were as follows:

Helena Regional Airport (KHLN), Helena, Montana routine pilot report; Over – 50 miles west-southwest of HLN (180 miles north-northwest of accident site); Time – 0815

MDT; Altitude 17,000 ft; Type aircraft -Cessna Citation business jet; Temperature – minus 4° C; Icing – moderate time icing between 17,000 and 20,000 ft.

HLN routine pilot report (UA); Over – Yellowstone Airport (KWYS) to HLN (from 60 to 180 miles north-northwest of accident site); Time – 1026 MDT; Altitude – 10,500 ft; Type aircraft – Cessna 182 single engine airplane; Turbulence – negative; Remarks – smooth conditions with light turbulence in mountain pass.

Bozeman Yellowstone International Airport (KBZN), Bozeman, Montana routine pilot report (UA); Over – Whitehall VORTAC (HIA), Whitehall, Montana (about 180 miles north-northwest of accident site); Time – 1152 MDT; altitude 12,000 ft; Type aircraft – Piper Arapaho (PA40) multi-engine airplane; Turbulence – light.

Gillette-Campbell County Airport (KGCC), Wyoming routine pilot report (UA); Over – between Custer County Airport (KCUT), Custer, SD and 30 miles south of Gillette-Campbell County Airport (KGCC), Gillette, WY (about 230 to 310 miles east of the accident site); Time – 1152 MDT; Altitude – 8,500 ft; Type aircraft – Cessna 182 single engine airplane; Sky cover – scattered cumulus clouds bases unknown with tops to 8,000 ft; Turbulence – negative; Remarks – fair weather cumulus clouds and smooth conditions.

Salt Lake City International Airport (KSLC), Utah routine pilot report (UA); Over – 25 miles west of Bonneville, UT (BVL) VORTAC (about180 miles south-southwest of the accident site); Time – 1215 MDT; Altitude – 11,000 ft; Type aircraft – Canadair Regional Jet air carrier jet; Turbulence – moderate.

6.0 NWS Forecasts

A review of the standard NWS aviation weather forecasts and advisories were as follows.

6.1 Terminal Aerodrome Forecasts

The closest Terminal Aerodrome Forecast's (TAF) to the accident site were issued for the departure airport KDIJ and KJAC. While a TAF is only valid for a 5-mile radius of the airport center point, it provides a more time specific breakdown of wind, visibility, and cloud coverage expected over the region than other NWS forecasts. The forecasts current at the time of the accident for KDIJ was issued by the NWS Pocatello-Idaho Falls (KPIH), Idaho, Weather Forecast Office (WFO), while the KJAC was issued by the NWS Riverton (KRIV), Wyoming, WFO. Both forecasts were issued at the normal period at 0520 MDT and valid for a 24-hour period beginning at 0600 MDT. The forecasts were as follows:

<u>Driggs-Reed Memorial Airport (KDIJ), Driggs, Idaho</u>

TAF KDIJ 091120Z 0912/1012 11006KT P6SM SKC
FM091700 20015G25KT P6SM FEW120
FM100300 16010G20KT P6SM FEW060 BKN120=

The forecast from 1100 through 2100 MDT expected a wind from 200° at 15 knots gusting to 25 knots, with visibility 6 miles or more, with a few clouds at 12,000 ft agl.

Jackson Hole Airport (KJAC), Jackson, Wyoming

TAF KJAC 091120Z 0912/1012 VRB04KT P6SM SKC
FM091700 19011KT P6SM SKC
FM091900 20018G26KT P6SM SKC
FM100200 21012KT P6SM SKC
FM101000 24011KT P6SM SCT100=

The forecast from 1100 through 1300 MDT expected a wind from 190° at 11 knots, visibility 6 miles or more, with sky clear below 12,000 ft agl. After 1300 MDT the winds were expected from 200 at 18 knots with gusts to 26 knots.

6.2 Area Forecast Discussion

The NWS Area Forecast Discussions (AFD) issued by the WFO for the morning forecast period are presented below. Although not a primary aviation product, the AFD is intended to provide a well-reasoned discussion of the meteorological thinking which went into the preparation of the Zone Forecast Product and TAFs. The forecaster will try to focus on the most particular challenges of the forecast. The text will be written in plain language or in proper contractions. At the end of the discussion, there will be a list of all local advisories, non-convective watches, and non-convective warnings. The term "non-convective" refers to weather that is not caused by thunderstorms. An intermediate Area Forecast Discussion will be issued when either significant forecast updates are being made or if interesting weather is expected to occur. The long-term section of the discussions were not included in the discussions below.

FXUS65 KPIH 090910
AFDPIH

Area Forecast Discussion
National Weather Service Pocatello ID
310 AM MDT Sat Jun 9 2018

.SHORT TERM...Today and Sunday. Some big changes are afoot over the next couple of days, with ***the biggest impacts coming in the form of wind and much colder temperatures****. We are seeing things slowing down a bit, meaning it's likely that any showers and thunderstorm development across the central mountains southward really won't come to late afternoon. Many of these storms will be "garden variety" but some could produce small hail and gusty winds. Stronger, even severe storms, are not likely at the moment.* ***Overall winds are still expected to crank up, looking at 15-30mph over most locations. Higher elevations of the mountains especially across the Lost River/Lemhi Ranges and along the Divide will see winds of 25-40mph with higher gusts way up there.*** *Current trends also continue to push the strongest winds for the Snake Plain and adjacent locales off until toward sunrise into Sunday afternoon. This coincides with the front finally pushing across the rest of the state.* ***Behind that front, the colder air will make a quick push into eastern Idaho.*** *Snow levels by sunrise will be around 6500-7500ft in most places, but remaining closer to 8000-9000ft along the Divide south along the Wyoming border. Light precipitation (though we can't locally heavy bursts) should be mostly still focused across the central mountains and east toward Island Park. The higher resolution models are still producing a few showers (maybe even a thunderstorm overnight) father south along the front. Since it's a small chance, we did include that in the forecast. For Sunday, showers a maybe a stray thunderstorm will be focused across the central mountains*

east to Island Park. The big impact will be winds continue to be quite breezy and colder temperatures. How cold? How about 20-30 DEGREES COLDER vs today. The wind? Look for 15-30mph winds except across the Snake Plain where 25-35mph are forecast with higher gusts. At the moment, we are holding onto low-end advisory winds across the Snake Plain from just before sunrise through Sunday afternoon. If this holds up as forecast, don't be surprised to see us issue a Wind Advisory at some point. Keyes

.AVIATION...VFR conditions expected today and Sunday. Frontal system coming through this afternoon and evening will bring a few showers and thunderstorms to the KSUN area. ***Southwest to west winds increase to 20 to 25 mph with gusts up to 40 mph in the Snake Plain late this afternoon****, possibly remaining breezy overnight and Sunday. RS*

FXUS65 KRIW 090746
AFDRIW

Area Forecast Discussion
National Weather Service Riverton WY
146 AM MDT Sat Jun 9 2018

.SHORT TERM...Today through Monday night

Today looks like the day when we should finally turn off the thunderstorm machine with drier air over much of the area. The GFS still shows isolated thunderstorms near the Big Horns, but both the NAM and European keep the area completely dry so we went with a dry forecast. We still can't completely rule out a stray "little green
blob" with strong wind gusts across the north, but I'm not plastering a whole area with POPS for one or two showers. ***The main story today will be the temperatures as this could turn out to be the warmest day so far this year. With a southwesterly breeze providing some warming downsloping flow, many lower elevations will see highs in the low and even mid 90s. This could bring enhanced fire behavior however as relative humidity will be quite low. Tonight, a strong cold front will approach the west*** *but will not pass through the area until Sunday.*

This afore mentioned cold front will pass through the area on Sunday. At this point, it looks to have little moisture to work with, the best forcing remaining to the north. It does have a bit of a punch in the form of wind though. ***The models show 700 millibar winds increasing to 40 to 45 knots ahead of the frontal passage*** *so places like Casper and Rock Springs will become quite blustery. Even places like Riverton could get quite windy, especially when flow turns northwest with the cold advection behind it. At this point, it does not look high wind worthy but I could some wind gusts to 40 to 50 mph at times. As for the chance of thunderstorms, the only places would be the far northwest and around Johnson County with a bit of shortwave energy enhancing lift. The GFS even shows some showers possibly dropping southward into Casper. The other models are not as bullish though so we kept them dry for now. Temperatures may be tricky as well as a lot depends on the timing of the frontal passage, especially further east. it could even get cold enough for patchy frost later Sunday night in the more protected areas West of the Divide.*

.AVIATION...12Z Issuance

VFR conditions to prevail at the terminal sites through 12Z Sunday. A gusty wind will develop at most of the terminal sites between 18Z and 20Z from the south to southwest. The wind will gradually subside after 02Z. *Very isolated showers will occur over the far north after 21Z through 01Z. A cold front moves into far west WY after 09Z Sunday with a gusty wind in places by 12Z Sunday.*

Both the NWS Pocatello, Idaho, and Riverton, Wyoming, forecast offices indicated no specific aviation hazards, but mentioned the potential for strong downslope flow given the southwesterly wind flow over the area. The approaching cold front was the focus of potential weather and increasing winds in the following days.

6.3 Inflight Weather Advisories

A review of the NWS inflight weather advisories indicated that there were no Significant Meteorological Information (SIGMET) advisories, Convective SIGMETs for thunderstorm activity, or Center Weather Advisories (CWA) issued for any hazardous weather conditions over the region during the period. The NWS AWC had a single Airmen Meteorological Information (AIRMET) advisory Tango current for moderate turbulence below 16,000 ft over a large portion of the central and southwestern United States and is included below and depicted in figure 11 over the GOES-15 visible satellite image for 0845 MDT (the time of the advisory issuance). The accident site was located within the boundary of the AIRMET advisory.

WAUS45 KKCI 091445
WA5T
-SLCT WA 091445
AIRMET TANGO UPDT 2 FOR TURB AND LLWS VALID UNTIL 092100
.
AIRMET TURB...ID MT WY NV UT CO AZ NM OR CA AND CSTL WTRS
FROM 40SSW YQL TO 30NW HVR TO CZI TO 20SE LAR TO ALS TO 50WNW
ABQ TO PHX TO BZA TO 20S MZB TO 30SW RZS TO 60SSE SNS TO 40WNW
BTY TO DLN TO 40SSW YQL
MOD TURB BLW 160. CONDS CONTG BYD 21Z THRU 03Z.

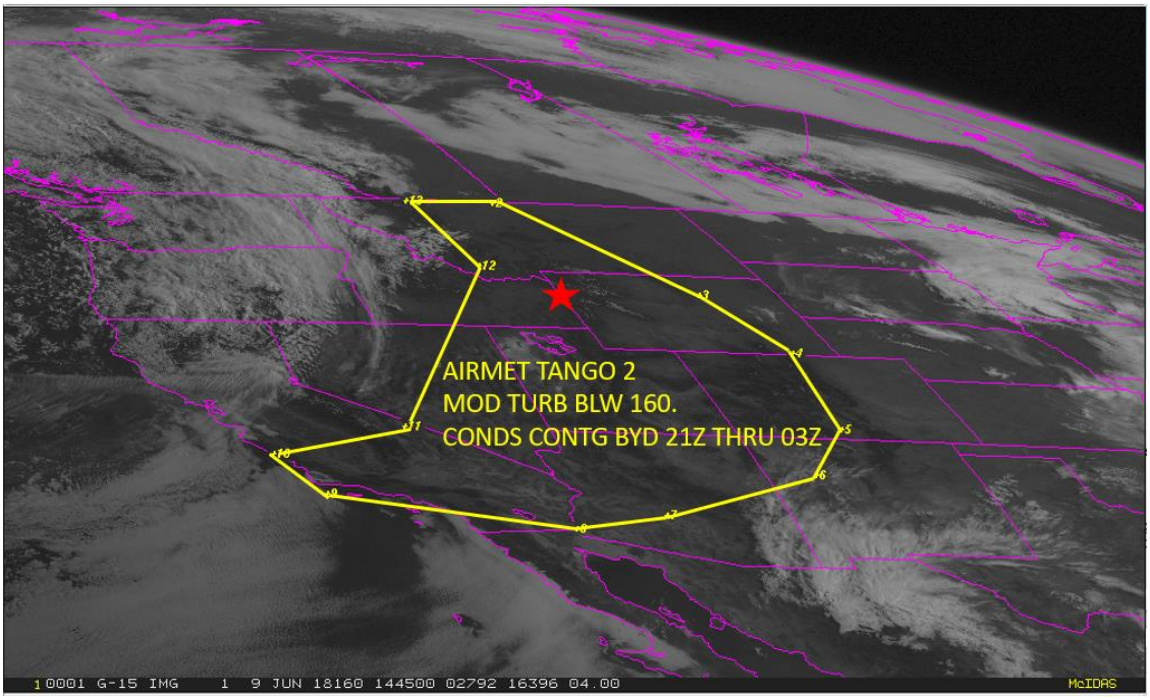

Figure 11 - GOES-15 visible image and AIRMET Tango for turbulence

6.4 Winds and Temperature Aloft Forecast

The following Winds and Temperature Aloft Forecast was current over the region at the time. The 3 stations surrounding the accident site were Dillon (DLN), Montana, Pocatello (KPIH),

Idaho, and Lander (LND), Wyoming. The wind forecast was valid for 1200 MDT and for use between 0800 and 1500 MDT, and were as follows:

WINDS ALOFT FORECASTS
DATA BASED ON 091200Z
VALID 091800Z FOR USE 1400-2100Z. TEMPS NEG ABV 24000

FT	*3000*	*6000*	*9000*	*12000*	*18000*	*24000*	*30000*	*34000*	*39000*
DLN			*1830+13*	*1938+07*	*2048-12*	*2144-23*	*204939*	*205849*	*206658*
PIH		*2014*	*1929+14*	*1930+07*	*2133-10*	*2236-22*	*224439*	*215048*	*215658*
LND			*1915+17*	*2018+08*	*2230-11*	*2223-22*	*223237*	*223447*	*223158*

The forecast for Pocatello (PIH), Idaho, immediately west of the accident site indicated at 6,000 ft the wind from 200º at 14 knots, at 9,000 ft wind from 190º at 29 knots with a temperature of 14º C, and at 12,000 ft wind from 190º at 30 knots with a temperature of 7º C. The forecast for Dillion (DLN), Montana, to the northwest expected at 9,000 ft a wind from 180º at 30 knots with a temperature of 13º C, at 12,000 ft wind from 190º at 38 knots with a temperature of 7º C. The forecast for Lander (LND), Wyoming, east-northeast for 9,000 ft indicated a wind from 190º at 15 knots with a temperature of 17º C, and at 12,000 ft from 200º at 18 knots with a temperature of 8º C.

6.5 Graphic Turbulence Guidance

The NWS AWC 2-hour western United State Graphic Turbulence Guidance (GTG) Clear Air Turbulence (CAT) forecast available during the period for a light category aircraft issued at 0900 MDT and valid at 1100 MDT from 7,000 ft through 14,000 ft was retrieved from the NWS website and document below in figure 12 and 13. The images depicted eddy dissipation rates (EDR) values in the range of 10 to 30, or light to moderate intensity turbulence below 12,000 ft. No high values were identified in the GTG model for anything other than moderate turbulence over the region.

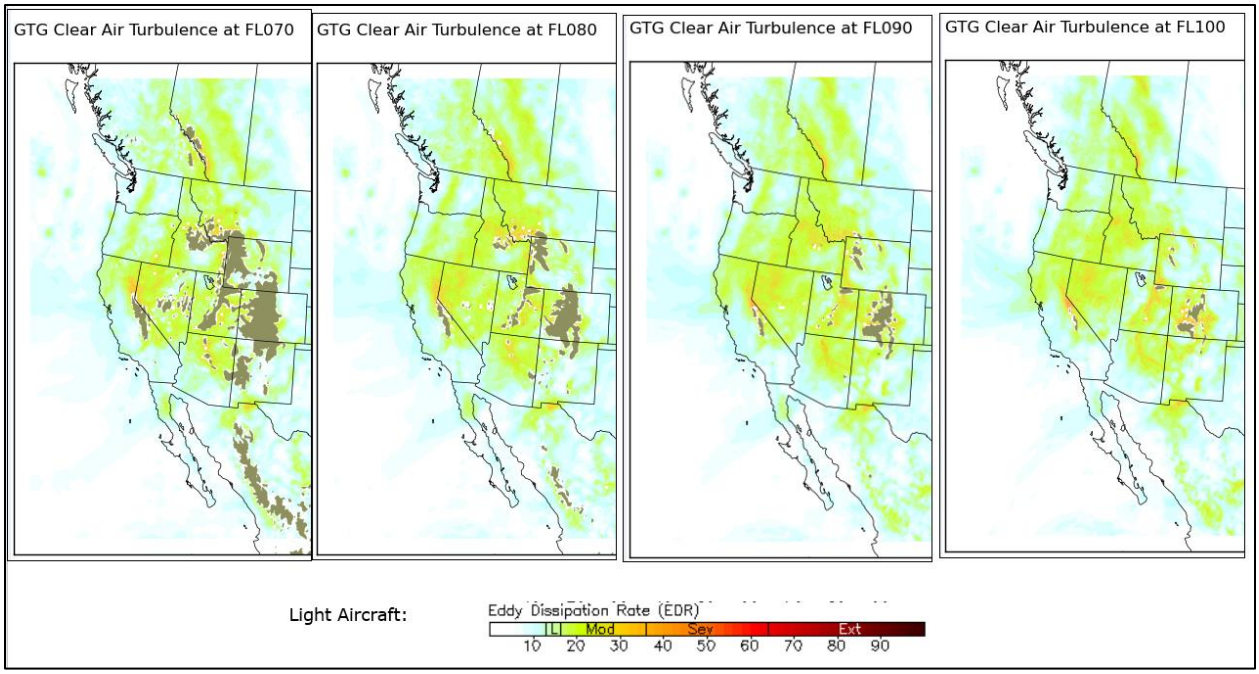

Figure 12 - Graphic Turbulence Guidance valid at 1100 MDT from 7,000 thru 10,000 ft

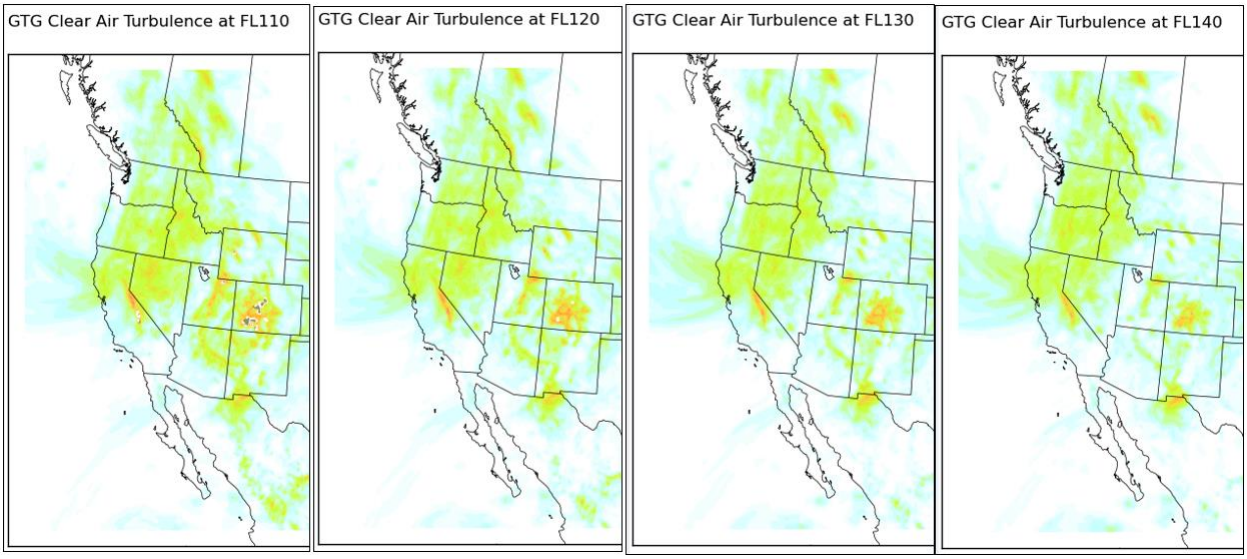

Figure 13 - Graphic Turbulence Guidance valid at 1100 MDT from 11,000 thru 14,000 ft

7.0 Weather Briefing Information

There was no record of the pilot having obtained a weather briefing from the FAA contract Automated Flight Service Station (AFSS) provider Leidos or from FltPlan.com (one of the largest private weather provider). It is therefore unknown what the pilot reviewed prior to departure concerning the weather reports and forecasts during the period.

8.0 Astronomical Data

The following astronomical data was obtained from the United States Naval Observatory website for the departure and planned destination in Driggs, Teton County, Idaho. The data was as follows:

Sun	
Beginning civil twilight	0509 MDT
Sunrise	0545 MDT
Sun transit	1323 MDT
Sunset	2101 MDT
End civil twilight	2136 MDT

At the approximate time of the accident the Sun was 56° above the horizon and at an azimuth of 118° from true north.

9.0 Witness Statements

Two pilots operating in the accident area were identified and provided statements regarding the weather conditions and their general observations of the conditions surrounding the time of the accident. The first pilot was the Tow Pilot who had launched the accident glider and was in general communication with the pilot during the period. The second was from a pilot on a local flight who heard the accident pilot on Unicom frequency and provided a statement on the weather conditions that he had encountered on his departure and return into KDIJ. Both statements are included as attachment 1 and 2 respectively.

9.1 Knowles - Tow Pilot Statement

The Tow Pilot, Sonny Knowles, indicated that he checked the weather and winds aloft data on Foreflight on his iPad and noted the southerly winds with speeds below 30 knots. He and the accident glider departed from runway 22 about 0950 MDT. He indicated that on climb out they found very little lift through 11,500 ft as they turned towards Darby Canyon, and found some limited lift off the various ridgelines. Upon reaching a point about 3 miles west of the South Teton at an altitude of 13,800 ft the accident glider was released at about 1037 MDT. He looked in his rear-view mirror to assure proper glider release and dove left for separation, and then returned to the airport and landed at approximately 1045 MDT. He indicated he communicated with the glider pilot via the radio throughout the flight, as they worked together to find lift for the glider to gain sufficient altitude for the release.

Regarding any turbulence encounter, Mr. Knowles indicated that he encountered no significant turbulence that seemed out of the ordinary, and that the flight seemed smoother than average.

9.2 Markowitz Statement

Another pilot of a Cessna Citation light business jet who departed from KDIJ at 1000 MDT immediately after the glider departed, on a local personal flight, flew up to the Yellowstone National Park area and then returned. He indicated that he climbed to 20,000 ft and was monitoring the UNICOM/CTAF[12] frequency during the flight. He indicated the weather was clear with no clouds, with calm winds on departure, and no turbulence was encountered on the climb out to the north. On his return to the airport and landing on runway 22, he reported encountering moderate turbulence over the mountainous terrain between 10,000 ft down to 500 ft agl on his approach into the airport.

Mr. Markowitz also indicated that he was familiar with the local operating area and that he recognized the glider pilot voice on the UNICOM/CTAF frequency and heard a total of 3 radio transmissions from the glider when he was out flying. The first was between 1035 to 1040 MDT when he heard the pilot conversing about getting ready to release the glider for the flight. The second time when he was returning and entering the traffic pattern at 1045 MDT, when he heard the glide pilot state on the radio, "break right, break left". He surmised the glider pilot may have accidentally pressed the radio push-to-talk switch in the glider. A few minutes later immediately before 1050 MDT, while on short final for runway 22, he heard the glider pilot yelling on the radio, "break right, break right". He indicated that he had the impression that the glider pilot sounded like she was under extreme stress when making the last transmission.

F. Attachments

1. Witness Statement from the tow pilot – Mr. Sonny Knowle

2. Witness Statement from Mr. Whit Markowitz

Submitted by:

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Don Eick
Senior Meteorologist

[12] UNICOM/CTAF – stands for Universal Communication and Common Traffic Advisory Frequency (CTAF) is a air-to-ground communication facility utilized at typically non-air traffic control airports to provide various non-flight related services such as to request fuel, or provide position reports such as entering the traffic pattern for a specific runway for common flight awareness.