



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

October 23, 2018

Weather Study

METEOROLOGY

WPR18FA276

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A. ACCIDENT

Location: Near Silver City, Idaho
Date: September 30, 2018
Time: 0837 mountain daylight time
1437 Coordinated Universal Time (UTC)
Aircraft: Cessna 210M, Registration: N732MV

B. METEOROLOGIST

Paul Suffern
Senior Meteorologist
Operational Factors Division (AS-30)
National Transportation Safety Board

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist did not travel for this investigation and gathered the weather data for this investigation from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Centers for Environmental Information (NCEI). All times are mountain daylight time (MDT) on September 30, 2018, and are based upon the 24-hour clock, where local time is -6 hours from UTC, and UTC=Z (unless otherwise noted). Directions are referenced to true north and distances in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The final wreckage location was latitude 43.0752° N, longitude 116.7711° W, at an approximate elevation of 6,647 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 Weather Prediction Center, 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 joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC 00-45H.¹

¹

https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1030

1.1 Surface Analysis Chart

The northwest section of the NWS Surface Analysis Chart for 0900 MDT is provided as figure 1 with the approximate location of the accident site marked within the red circle. The chart indicated a stationary frontal boundary located across central Washington stretching southeastward across central Idaho (northeast of the accident site), and into western Wyoming. A surface low pressure center was located across north central Idaho with a pressure of 1010-hectopascals (hPa). Another surface low pressure center was located in northern Utah with a pressure of 1004-hPa. A surface trough² stretched northwestward from the surface low pressure center in northern Utah, with the surface trough located just northeast of the accident site region.

The station models around the accident site depicted air temperatures in the upper 50's to low 60's degrees Fahrenheit (°F), dew point temperatures in the mid 30's to low 40's °F with temperature-dew point spreads of 17° F or more, a southwest to west wind of 10 knots, and mostly clear skies.

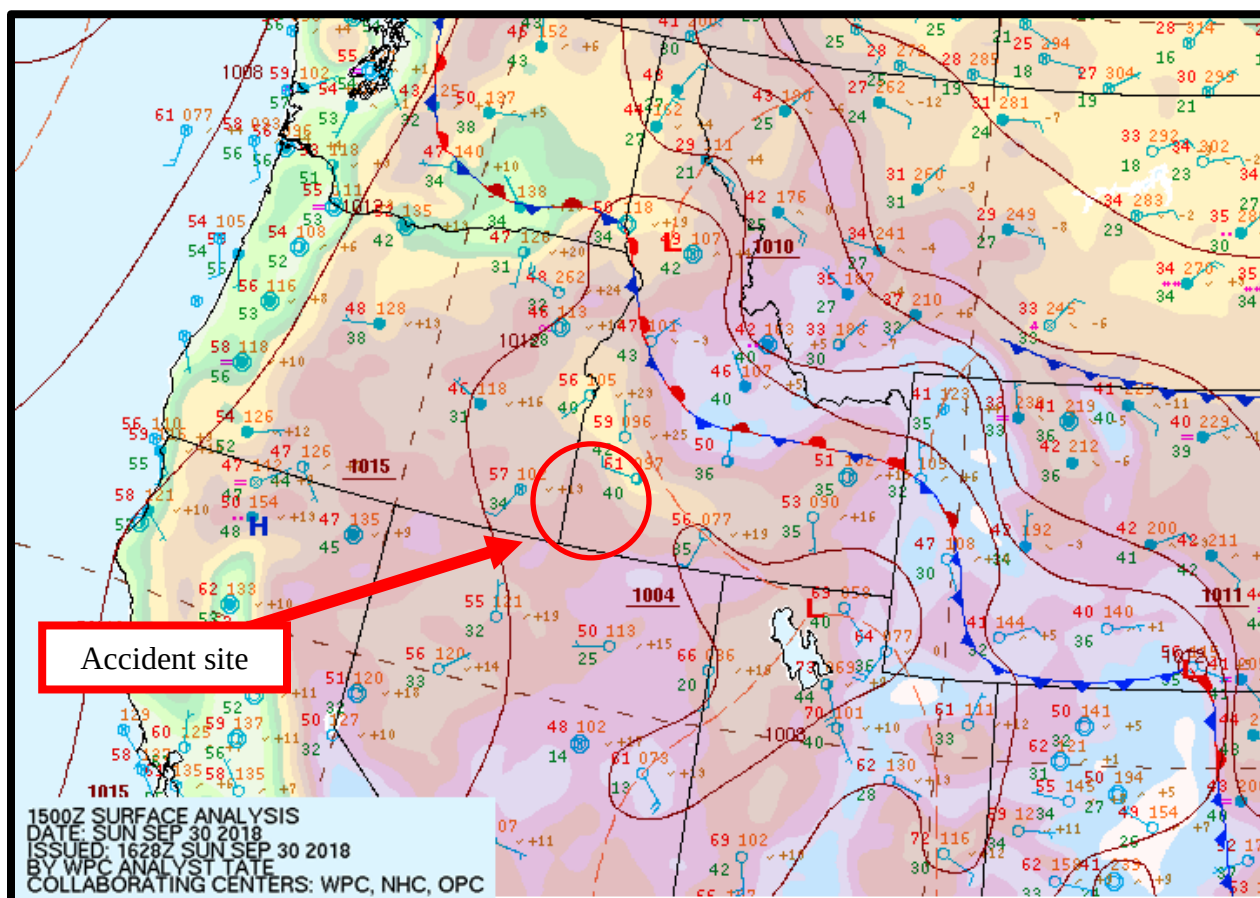


Figure 1 – NWS Surface Analysis Chart for 0900 MDT

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² Trough – An elongated area of relatively low atmospheric pressure or heights.

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 0600 MDT at 850-, 700-, 500-, and 300-hPa are presented in figures 2 through 5. There were mid-level troughs located on either side of the accident site at 700-hPa (figure 3) and a mid-level trough located west of the accident site over the coastal region of Washington and Oregon at 500-hPa (figure 4). An upper level trough was located just west of the accident site over central Washington and Oregon (figure 5). Troughs can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present. The wind was from the west at 15 knots 850-hPa with the wind becoming southwesterly at 50 knots by 500-hPa (figure 4). At 300-hPa, the wind was from the southwest at 50 knots (figure 5).

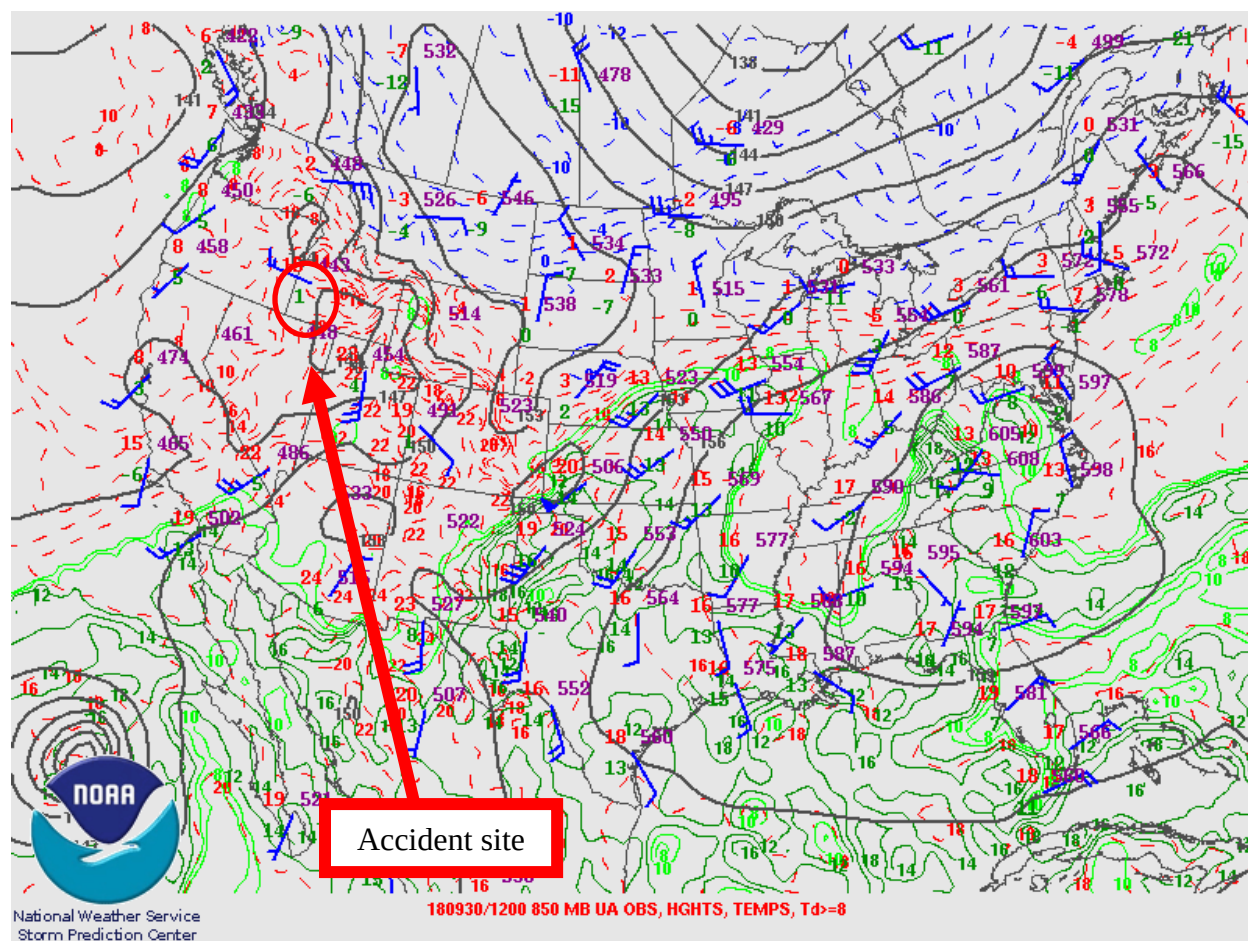


Figure 2 – 850-hPa Constant Pressure Chart for 0600 MDT

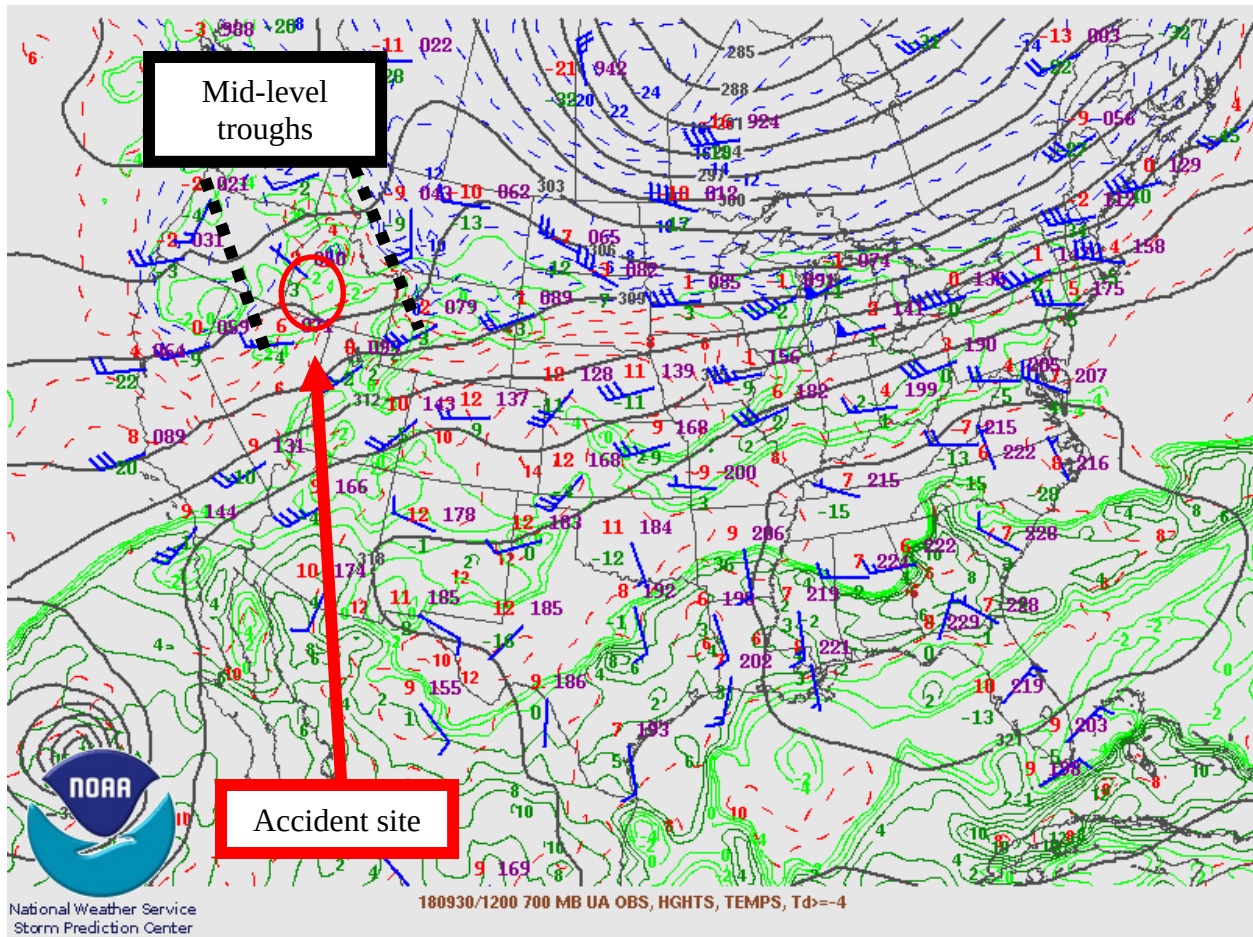


Figure 3 – 700-hPa Constant Pressure Chart for 0600 MDT

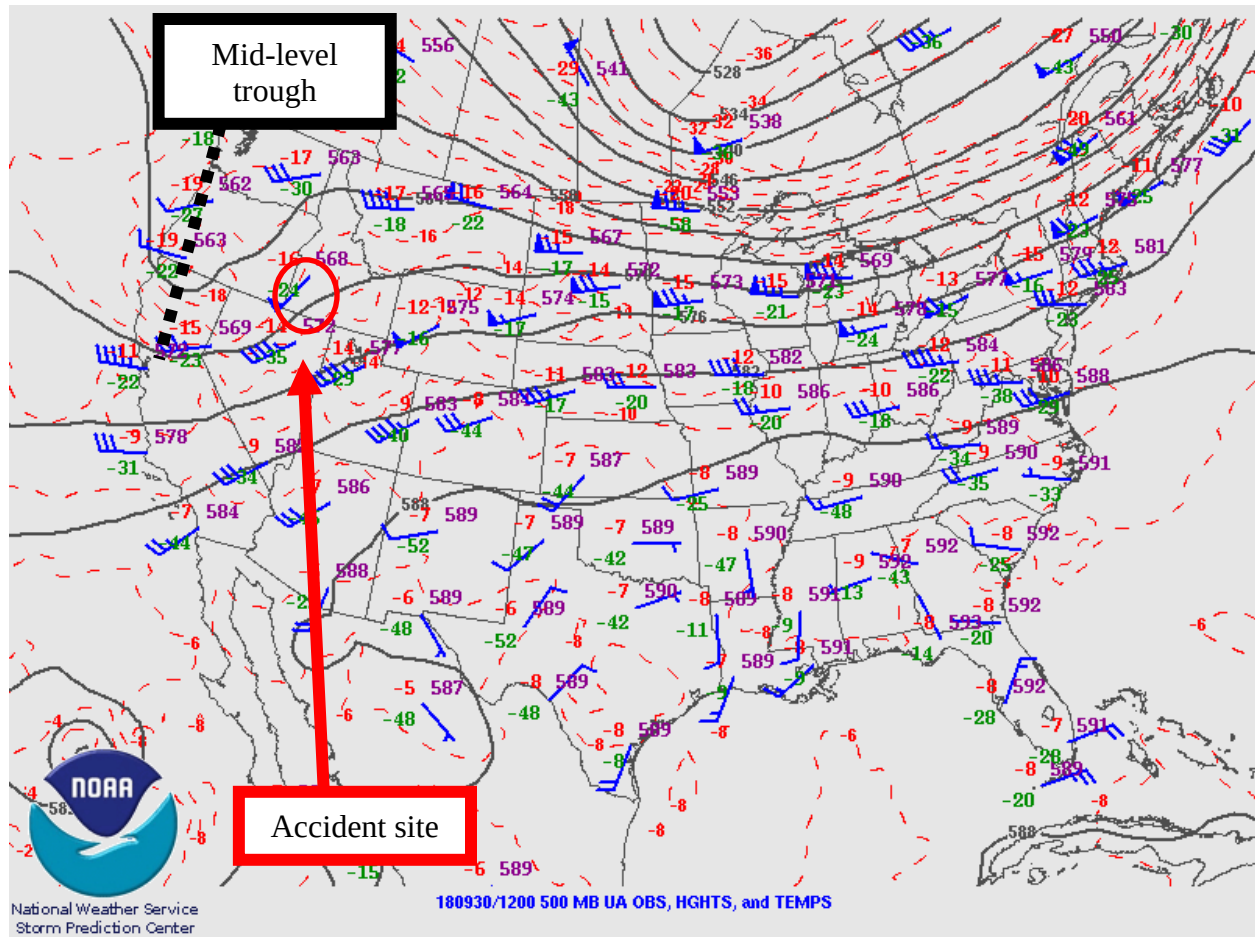


Figure 4 – 500-hPa Constant Pressure Chart for 0600 MDT

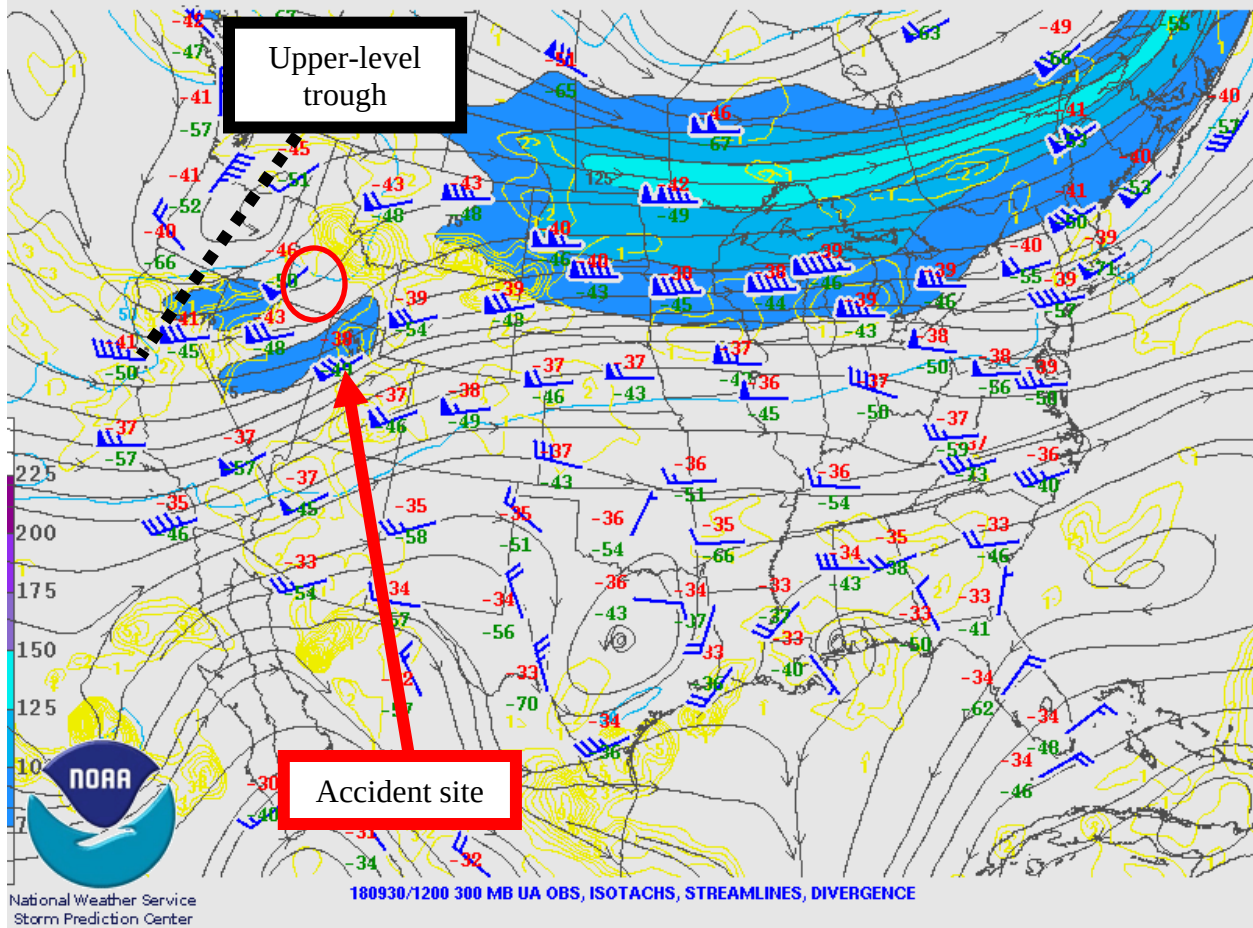


Figure 5 – 300-hPa Constant Pressure Chart for 0600 MDT

2.0 SPC Products

SPC issued the following Day 1 Convective Outlook at 0631 MDT (figure 6) with areas of general thunderstorms forecast for the accident site during the afternoon timeframe (after 1200 MDT). SPC defines the “TSTM” area as an area that encloses where a 10% or higher probability of thunderstorms is forecast during the valid period. This was the SPC Day 1 Convective Outlook valid at the accident time:

SPC AC 301231

Day 1 Convective Outlook
NWS Storm Prediction Center Norman OK
0731 AM CDT Sun Sep 30 2018

Valid 301300Z - 011200Z

...NO SEVERE THUNDERSTORM AREAS FORECAST...

...SUMMARY...

Severe storms are not forecast through tonight.

...Discussion...

Scattered storms are expected across the Gulf Coast States into southern GA through this afternoon amid light and variable deep-layer winds. A swath of elevated convection should develop this evening into tonight across parts of the Corn Belt. Small hail may occur owing to adequate speed shear but weak buoyancy and cluster mode should limit potential for severe hail. Isolated storms should develop in association with a dampening shortwave trough that will eject east from OR to WY. Isolated storms should occur over AZ this afternoon through tonight as moisture increases downstream of TC Rosa. However, weak winds below 500 mb should mitigate potential for organized severe.

..Grams.. 09/30/2018

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NOTE: THE NEXT DAY 1 OUTLOOK IS SCHEDULED BY 1630Z

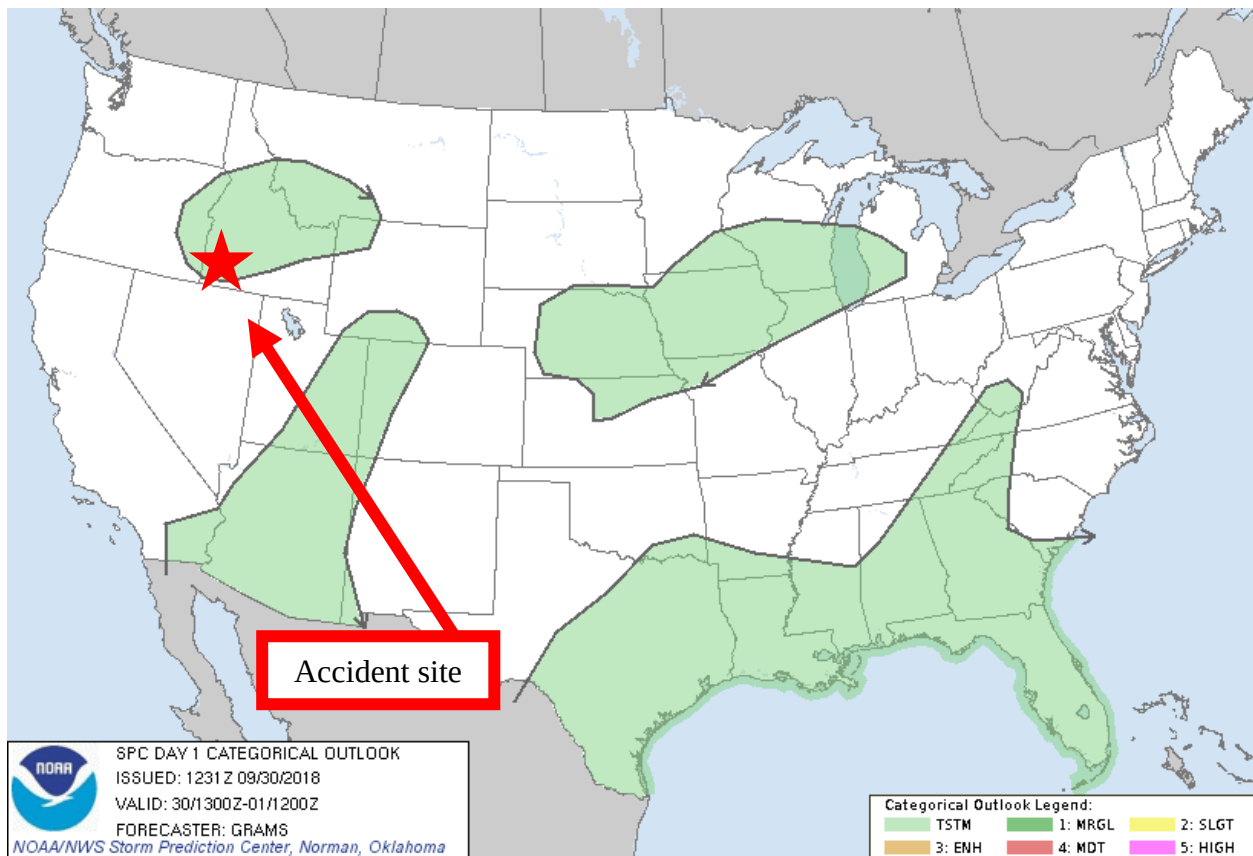


Figure 6 – SPC day 1 Convective Outlook valid at the time of the accident

3.0 Surface Observations

The area surrounding the accident site was documented using official Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). Figure 7 is a sectional chart with the accident site and the closest weather reporting locations to the accident site marked.

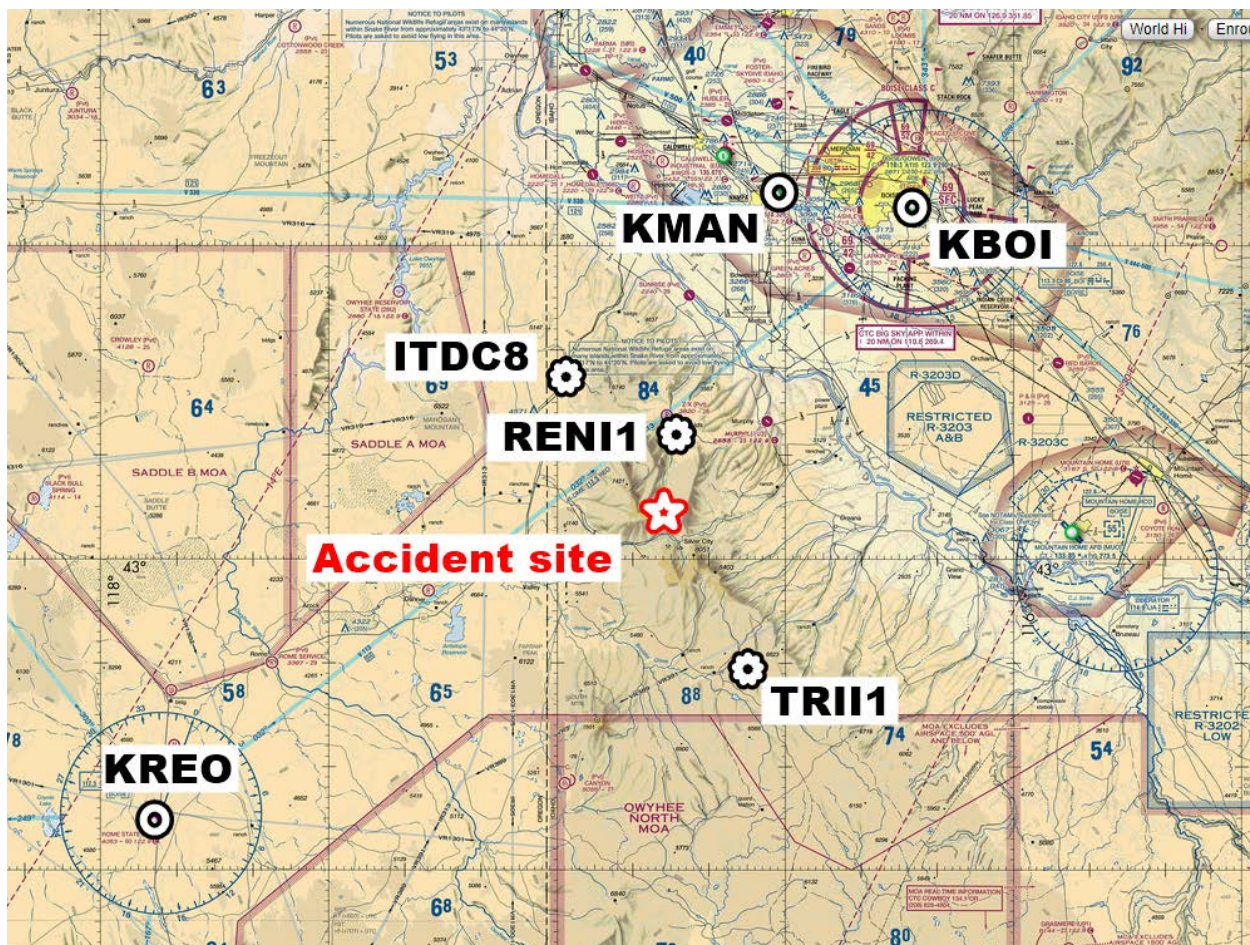


Figure 7 – Sectional chart of accident area with the location of the accident site and the closest surface observation sites

Nampa Municipal Airport (KMAN) had the closest official weather observation point to the accident site. KMAN had an Automated Weather Observing System (AWOS³) whose reports were not supplemented. KMAN was located 32 miles north-northeast of the accident site, at an elevation of 2,537 ft, and had a 16° easterly magnetic variation⁴ (figure 7). The following observations were taken and disseminated during the times surrounding the accident:⁵

[0655 MDT] METAR KMAN 301255Z AUTO 30006G12KT 10SM 18/04 A2978 RMK A01=

[0715 MDT] METAR KMAN 301315Z AUTO 25007KT 10SM 17/05 A2980 RMK A01=

[0735 MDT] METAR KMAN 301335Z AUTO 28007KT 10SM 15/07 A2981 RMK A01=

³ AWOS – Automated Weather Observing System is equipped with meteorological instruments to observe and report temperature, dewpoint, wind speed and direction, visibility, cloud coverage and ceiling up to twelve thousand feet, and altimeter setting.

⁴ Magnetic variation – The angle (at a particular location) between magnetic north and true north. Latest measurement taken from <https://www.aimav.com/airport/KMAN>

⁵ Bolded sections in this report highlight information that directly reference the weather conditions that affected the accident location around the accident time.

[0755 MDT] METAR KMAN 301355Z AUTO 29005KT 10SM 14/07 A2982 RMK A01=

[0815 MDT] METAR KMAN 301415Z AUTO 28004KT 10SM CLR 14/07 A2983 RMK A01=

[0835 MDT] METAR KMAN 301435Z AUTO 09005KT 10SM CLR 13/09 A2985 RMK A01=

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[0855 MDT] METAR KMAN 301455Z AUTO VRB05KT 10SM CLR 16/05 A2985 RMK A01=

[0915 MDT] METAR KMAN 301515Z AUTO VRB04KT 10SM CLR 17/03 A2986 RMK A01=

[0935 MDT] METAR KMAN 301535Z AUTO 29009KT 10SM CLR 18/03 A2986 RMK A01=

[0955 MDT] METAR KMAN 301555Z AUTO 27008KT 10SM CLR 17/03 A2987 RMK A01=

KMAN weather at 0815 MDT, automated, wind from 280° at 4 knots, 10 statute miles or greater visibility, clear skies below 12,000 ft above ground level (agl), temperature of 14° Celsius (C), dew point temperature of 7° C, and an altimeter setting of 29.83 inches of mercury. Remarks: automated station without a precipitation discriminator.

KMAN weather at 0835 MDT, automated, wind from 090° at 5 knots, 10 statute miles or greater visibility, clear skies below 12,000 ft agl, temperature of 13° C, dew point temperature of 9° C, and an altimeter setting of 29.85 inches of mercury. Remarks: automated station without a precipitation discriminator.

KMAN weather at 0855 MDT, automated, wind variable at 5 knots, 10 statute miles or greater visibility, clear skies below 12,000 ft agl, temperature of 16° C, dew point temperature of 5° C, and an altimeter setting of 29.85 inches of mercury. Remarks: automated station without a precipitation discriminator.

KMAN weather at 0915 MDT, automated, wind variable at 4 knots, 10 statute miles or greater visibility, clear skies below 12,000 ft agl, temperature of 17° C, dew point temperature of 3° C, and an altimeter setting of 29.86 inches of mercury. Remarks: automated station without a precipitation discriminator.

Rome State Airport (KREO) had the closest official weather observation point to the south and west of the accident site. KREO had an AWOS whose reports were not supplemented. KREO was located 57 miles southwest of the accident site at an elevation of 4,053 ft (figure 7). The following observations were taken and disseminated during the times surrounding the accident:

[0252 MDT] METAR KREO 300852Z AUTO 23010KT 17/M01 A2984 RMK AO1 SLP063
T01721011 51020 \$=

[0352 MDT] METAR KREO 300952Z AUTO 23008KT 16/M01 A2986 RMK AO1 SLP072
T01611006 \$=

[0452 MDT] METAR KREO 301052Z AUTO 21010KT 15/M01 A2985 RMK AO1 SLP070
T01501006 \$=

[0552 MDT] METAR KREO 301152Z AUTO 23019G23KT 15/01 A2986 RMK AO1 SLP074
T01500006 10194 20144 51006 \$=

***[0652 MDT] METAR KREO 301252Z AUTO 21016G23KT 14/01 A2987 RMK AO1 SLP081
T01440011 \$=***

***[0752 MDT] METAR KREO 301352Z AUTO 20016G22KT 14/01 A2988 RMK AO1 SLP090
T01390006 \$=***

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***[0852 MDT] METAR KREO 301452Z AUTO 21010KT 14/01 A2990 RMK AO1 SLP102
T01390011 53013 \$=***

***[0952 MDT] METAR KREO 301552Z AUTO 22016G20KT 14/02 A2991 RMK AO1 SLP109
T01390022 \$=***

[1052 MDT] METAR KREO 301652Z AUTO 21015G22KT 17/03 A2994 RMK AO1 SLP110
T01670028 \$=

[1152 MDT] METAR KREO 301752Z AUTO 22015G23KT 18/02 A2994 RMK AO1 SLP110
T01780022 10183 20139 51011 \$=

KREO weather at 0652 MDT, automated, wind from 210° at 16 knots with gusts to 23 knots, temperature of 14° C, dew point temperature of 1° C, and an altimeter setting of 29.87 inches of mercury. Remarks: automated station without a precipitation discriminator, sea level pressure 1008.1 hPa, temperature 14.4° C, dew point temperature 1.1° C, maintenance is needed on the system.

KREO weather at 0752 MDT, automated, wind from 200° at 16 knots with gusts to 22 knots, temperature of 14° C, dew point temperature of 1° C, and an altimeter setting of 29.88 inches of mercury. Remarks: automated station without a precipitation discriminator, sea level pressure 1009.0 hPa, temperature 13.9° C, dew point temperature 0.6° C, maintenance is needed on the system.

KREO weather at 0852 MDT, automated, wind from 210° at 10 knots, temperature of 14° C, dew point temperature of 1° C, and an altimeter setting of 29.90 inches of mercury. Remarks: automated station without a precipitation discriminator, sea level pressure 1010.2 hPa, temperature 13.9° C, dew point temperature 1.1° C, 3-hourly pressure increase of 1.3 hPa, maintenance is needed on the system.

KREO weather at 0952 MDT, automated, wind from 220° at 16 knots with gusts to 20 knots, temperature of 14° C, dew point temperature of 2° C, and an altimeter setting of 29.91 inches of mercury. Remarks: automated station without a precipitation discriminator, sea level pressure 1010.9 hPa, temperature 13.9° C, dew point temperature 2.2° C, maintenance is needed on the system.

RENI1 was the closest non-official surface observation site to the accident site located 8 miles north of the accident site at an elevation of 4,000 ft (figure 7). Figure 8 contains the observations from RENI1 surrounding the accident time:

# STATION: REN11												
# STATION NAME: USCRN SITE AT WATERSHED RESEARCH CENTER NEAR MURPHY 10W												
# LATITUDE: 43.20444												
# LONGITUDE: -116.75056												
# ELEVATION [ft]: 4000												
# STATE: ID												
Station_ID	Date_Time	air_temp	relative_humidity_set_1	wind_speed_set_1	precip_accum_one_hour_set_1	wind_gust_set_1	precip_accum_five_minute_set_1	solar_radiation_set_1	soil_temp	precip_accum_set_1	soil_moist	dew_point_temperature_set_1d
		Fahrenheit	%	Miles/hour	Inches	Miles/hour	Inches	W/m**2	Fahrenheit	Inches	%	Fahrenheit
REN11	09/30/2018 06:00 MDT	55.67	41			0	12.3	0		0.04		32.16
REN11	09/30/2018 07:00 MDT	54.79	41			0	8.19	0		0.04		31.37
REN11	09/30/2018 08:00 MDT	53.2	45			0	9.51	0		0.04		32.24
REN11	09/30/2018 09:00 MDT	57.94	41			0	7.07	74		0.04		34.22
REN11	09/30/2018 10:00 MDT	59.31	38			0	9.86	139		0.04		33.54
REN11	09/30/2018 11:00 MDT	60.73	38			0	12.5	255		0.04		34.82
REN11	09/30/2018 12:00 MDT	62.56	35			0	11.95	471		0.04		34.38
REN11	09/30/2018 13:00 MDT	62.6	35			0	16.24	188		0.04		34.42
REN11	09/30/2018 15:00 MDT	66.07	28			0	14.38	306		0.04		31.9
REN11	09/30/2018 16:00 MDT	66.36	30			0	11.74	288		0.04		33.87

Figure 8 – List of observations from RENI1 surrounding the accident time

RENI1 weather at 0800 MDT was reported as, wind gust at 9.51 miles-per-hour (mph), temperature of 53.2° F, a dew point temperature of 32.24° F, and a relative humidity of 45 percent.

RENI1 weather at 0900 MDT was reported as, wind gust at 7.07 mph, temperature of 57.94° F, a dew point temperature of 34.22° F, and a relative humidity of 41 percent.

RENI1 weather at 1000 MDT was reported as, wind gust at 9.86 mph, temperature of 59.31° F, a dew point temperature of 33.54° F, and a relative humidity of 38 percent.

Ion Summit (ITDC8) was the next closest non-official surface observation site to the accident site located 16 miles northwest of the accident site at an elevation of 4,305 ft (figure 7). Figure 9 contains the observations from ITDC8 surrounding the accident time:

# STATION: ITDC8								
# STATION NAME: Ion Summit								
# LATITUDE: 43.29447								
# LONGITUDE: -116.98612								
# ELEVATION [ft]: 4305								
# STATE: ID								
Station_ID	Date_Time	air_temp_set_1	relative_humidity_set_1	wind_speed_set_1	wind_direction_set_1	wind_gust_set_1	road_tem	dew_point_temperature_set_1
		Fahrenheit	%	Miles/hour	Degrees	Miles/hour	Fahrenheit	Fahrenheit
ITDC8	09/30/2018 04:30 MDT	58.1	41	11.18	175	13.42	58.1	34.36
ITDC8	09/30/2018 04:45 MDT	58.28	40	12.75	175	16.11	59	33.9
ITDC8	09/30/2018 05:15 MDT	57.02	41	10.51	161	12.08	58.82	33.38
ITDC8	09/30/2018 05:30 MDT	53.42	52	6.49	298	8.95	55.58	36.08
ITDC8	09/30/2018 05:45 MDT	54.32	50	9.62	193	12.3	57.02	35.92
ITDC8	09/30/2018 06:15 MDT	53.42	51	2.46	234	4.92	55.22	35.59
ITDC8	09/30/2018 06:30 MDT	54.68	41	5.37	184	8.28	57.92	31.27
ITDC8	09/30/2018 06:45 MDT	55.22	40	3.36	158	4.7	56.12	31.14
ITDC8	09/30/2018 07:15 MDT	56.3	38	2.01	241	5.59	56.66	30.84
ITDC8	09/30/2018 07:30 MDT	55.22	41	7.16	157	8.5	55.94	31.75
ITDC8	09/30/2018 07:45 MDT	53.96	45	7.38	165	9.4	55.58	32.93
ITDC8	09/30/2018 08:15 MDT	53.6	45	3.36	192	4.92	55.4	32.6
ITDC8	09/30/2018 08:30 MDT	51.26	52	2.01	236	3.58	54.86	34.08
ITDC8	09/30/2018 08:45 MDT	51.08	54	5.14	182	8.05	55.94	34.86
ITDC8	09/30/2018 09:15 MDT	52.34	54	8.28	202	9.84	58.1	36.04
ITDC8	09/30/2018 09:30 MDT	53.96	47	11.63	189	13.42	59.54	34.02
ITDC8	09/30/2018 09:45 MDT	54.68	48	6.26	216	7.83	60.26	35.22
ITDC8	09/30/2018 10:15 MDT	56.3	43	12.75	202	15.66	63.32	33.93
ITDC8	09/30/2018 10:30 MDT	56.12	44	10.96	202	13.87	64.04	34.34
ITDC8	09/30/2018 10:45 MDT	56.84	44	8.95	222	11.86	64.58	35
ITDC8	09/30/2018 11:15 MDT	56.84	44	7.38	287	9.4	67.1	35
ITDC8	09/30/2018 11:30 MDT	57.02	47	9.17	289	12.08	69.44	36.84
ITDC8	09/30/2018 11:45 MDT	57.92	44	8.95	253	12.53	76.64	35.98

Figure 9 – List of observations from ITDC8 surrounding the accident time

ITDC8 weather at 0830 MDT was reported as, wind from 236° at 2.01 mph with gusts to 3.58 mph, temperature of 51.26° F, a dew point temperature of 34.08° F, and a relative humidity of 52 percent.

ITDC8 weather at 0845 MDT was reported as, wind from 182° at 5.14 mph with gusts to 8.05 mph, temperature of 51.08° F, a dew point temperature of 34.86° F, and a relative humidity of 54 percent.

ITDC8 weather at 0915 MDT was reported as, wind from 202° at 8.28 mph with gusts to 9.84 mph, temperature of 52.34° F, a dew point temperature of 36.04° F, and a relative humidity of 54 percent.

Triangle (TRII1) was a Remote Automatic Weather Station (RAWS) and was the third closest non-official surface observation site to the accident site located 17 miles south-southeast of the accident site at an elevation of 5,270 ft (figure 7). Figure 10 contains the observations from TRII1 surrounding the accident time:

#STATION: TRII1											
#STATION NAME: TRIANGLE											
#LATITUDE: 42.828611											
#LONGITUDE: -116.588611											
#ELEVATION [ft]: 5270											
#STATE: ID											
Station_ID	Date_Time	air_temp_set_1 Fahrenheit	relative_humidity_set_1 %	wind_speed_set_1 Miles/hour	wind_direction_set_1 Degrees	wind_gust_set_1 Miles/hour	solar_radiation_set_1 W/m**2	precip_accum_set_1 inches	peak_wind_speed_set_1 Miles/hour	peak_wind_direction_set_1 Degrees	dew_point_temperature_set_1 Fahrenheit
TRII1	09/30/2018 02:55 MDT	55	47	8.01	262	14.99	0	9.29	14.99	252	34.98
TRII1	09/30/2018 03:55 MDT	51.01	58	8.99	262	21	0	9.29	21	270	36.61
TRII1	09/30/2018 04:55 MDT	46.99	65	5.99	207	12.01	0	9.29	12.01	259	35.71
TRII1	09/30/2018 05:55 MDT	43	69	4.99	221	7	0	9.29	7	211	33.41
TRII1	09/30/2018 06:55 MDT	48	58	7	273	10	0	9.29	10	278	33.78
TRII1	09/30/2018 07:55 MDT	50	47	8.01	276	14	1	9.29	14	265	30.38
TRII1	09/30/2018 08:55 MDT	50	48	4.99	264	12.01	32	9.29	12.01	279	30.91
TRII1	09/30/2018 09:55 MDT	54	43	13	270	18.99	177	9.29	18.99	272	31.83
TRII1	09/30/2018 10:55 MDT	55	43	11.01	264	21	222	9.29	21	269	32.74
TRII1	09/30/2018 11:55 MDT	55.99	39	11.01	275	18.01	294	9.29	18.01	269	31.21
TRII1	09/30/2018 12:55 MDT	60.01	34	14	259	22.01	579	9.29	22.01	250	31.4
TRII1	09/30/2018 13:55 MDT	64.99	29	14	266	32.99	850	9.29	32.99	267	31.88
TRII1	09/30/2018 14:55 MDT	62.01	33	8.01	301	22.01	455	9.29	22.01	304	32.45
TRII1	09/30/2018 15:55 MDT	61	31	8.99	266	16.99	253	9.29	16.99	279	29.99
TRII1	09/30/2018 16:55 MDT	63	32	10	272	16.99	367	9.29	16.99	289	32.55
TRII1	09/30/2018 17:55 MDT	61	33	5.99	289	17	311	9.29	17	284	31.58
TRII1	09/30/2018 18:55 MDT	60.01	31	7	290	14.99	60	0	14.99	274	29.12
TRII1	09/30/2018 19:55 MDT	52	40	3	259	8.01	25	0	8.01	281	28.25

Figure 10 – List of observations from TRII1 surrounding the accident time

TRII1 weather at 0755 MDT was reported as wind from 276° at 8.01 mph with gusts to 14 mph, temperature of 50° F, dew point temperature of 30.38° F, and a relative humidity of 47 percent.

TRII1 weather at 0855 MDT was reported as wind from 264° at 4.99 mph with gusts to 12.01 mph, temperature of 50° F, dew point temperature of 30.91° F, and a relative humidity of 48 percent.

TRII1 weather at 0955 MDT was reported as wind from 270° at 13 mph with gusts to 18.99 mph, temperature of 54° F, dew point temperature of 31.83° F, and a relative humidity of 43 percent.

The observations from KMAN and KREO surrounding the accident time indicated VFR⁶ conditions with gusty winds near the terrain and to the southwest of the accident site.

⁶ Visual Flight Rules – Refers to the general weather conditions pilots can expect at the surface. VFR criteria means a ceiling greater than 3,000 feet agl and greater than 6 miles visibility.

4.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR)⁷ model sounding was created for the accident site for 0900 MDT with an elevation of 5,509 ft.⁸ The 0900 MDT HRRR sounding was plotted on a standard Skew-T Log P diagram⁹ with the derived stability parameters included in figure 11 (with data from the surface to 600-hPa (or approximately 14,000 ft msl). This data was analyzed using the RAOB¹⁰ software package. The sounding depicted the lifted condensation level (LCL)¹¹ at 4,861 ft agl (10,370 ft msl) and the convective condensation level (CCL)¹² at 9,889 ft agl (15,398 ft msl). The freezing level was located at 11,537 ft msl with no icing concerns for this accident. The precipitable water value was 0.31 inches.

⁷ The HRRR is a NOAA real-time three-kilometer resolution, hourly-updated, cloud-resolving, convection-allowing atmospheric model, initialized by three-kilometer grids with three-kilometer radar assimilation. Radar data is assimilated in the HRRR every 15 minutes over a one hour period.

⁸ HRRR sounding was created using NOAA Air Resource Laboratory: <https://ready.arl.noaa.gov/READYamet.php>

⁹ 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.

¹⁰ RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.

¹¹ LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

¹² 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.

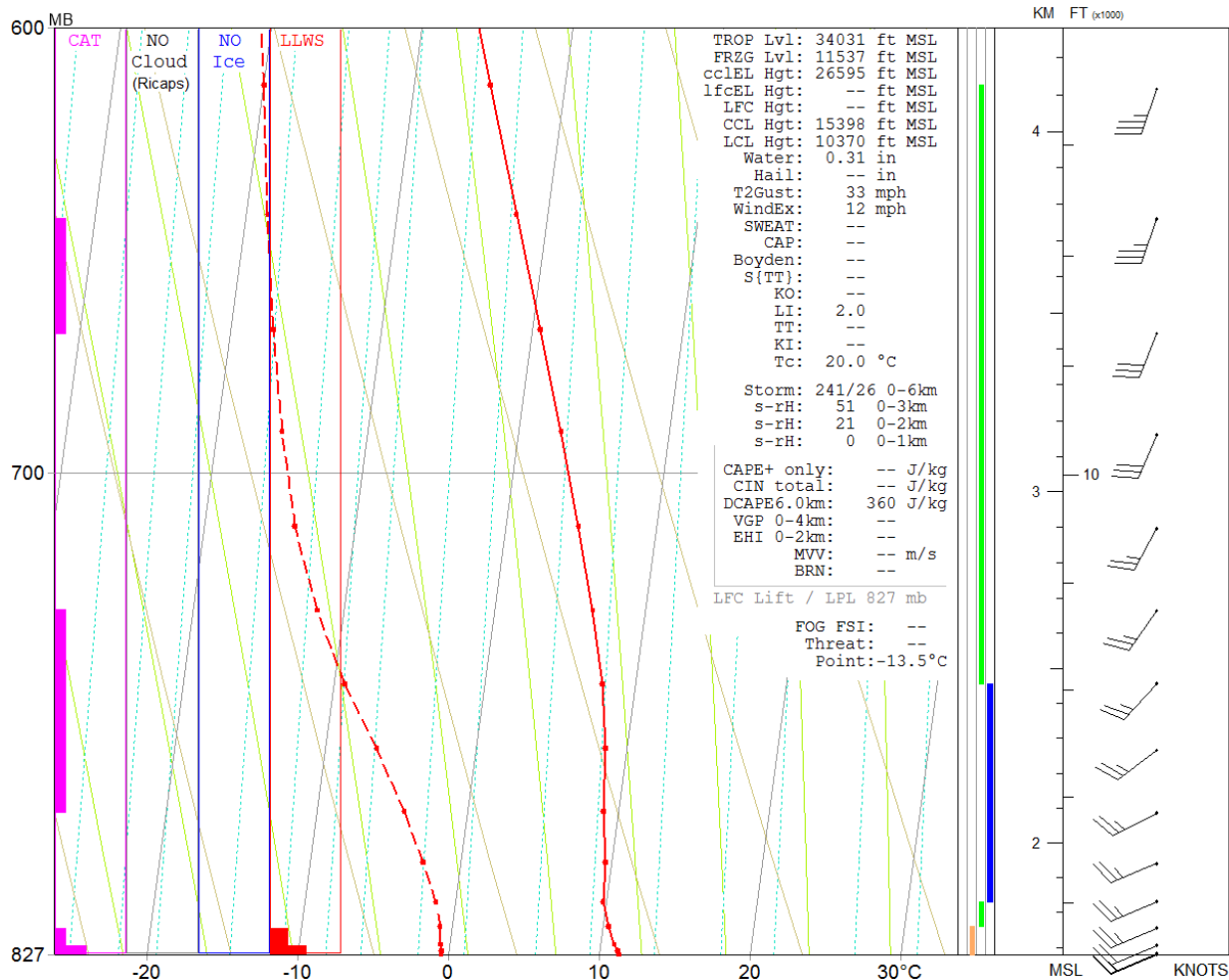


Figure 11 – 0900 MDT HRRR sounding

The 0900 MDT HRRR sounding indicated an unstable and conditionally unstable environment from the surface through 6,000 ft, then a layer of stable conditions from 6,000 ft through 8,000 ft, with a conditionally unstable environment above 8,000 ft. RAOB did not identify the possibility of clouds between the surface and 14,000 ft.

The 0900 MDT HRRR sounding wind profile indicated a surface wind from 245° at 15 knots with the wind remaining southwesterly to southerly through 14,000 ft. The wind magnitude increased to 25 knots by 5,700 ft and the wind magnitude remained between 25 to 35 knots from 5,700 ft through 14,000 ft. RAOB indicated a chance of light to moderate low-level wind shear (LLWS) in between the surface and 6,000 ft. RAOB indicated a chance of light to moderate clear-air turbulence existed in several layers between the surface and 12,500 ft.

5.0 Satellite Data

Visible and infrared data from the Geostationary Operational Environmental Satellite number 15 (GOES-15) 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 software. Visible and infrared imagery (GOES-15 bands 1 and 4) at wavelengths of 0.65 microns (μm) and 10.7 μm , respectively, were retrieved. Satellite imagery surrounding the time of the accident from 0600 MDT through 1100 MDT, at approximately 15-minute intervals were reviewed, and the closest images to the time of the accident were documented.

Figures 12 and 13 present the GOES-16 visible imagery from 0830 and 0845 MDT 2X magnification with the accident site highlighted with a red square. Inspection of the visible imagery indicated cloud cover over the accident site with the cloud cover moving from southwest to northeast. Figure 14 presents the GOES-15 infrared imagery from 0845 MDT 6X magnification with the accident site highlighted with a red square. Inspection of the infrared imagery indicated the lower brightness temperatures (green and blue colors; higher cloud tops) were located over and to the northeast of the accident site. Based on the brightness temperatures above the accident site (247° Kelvin) and the vertical temperature profile provided by the 0900 MDT HRRR sounding, the approximate cloud-top heights over the accident site were 22,500 ft at 0845 MDT. It should be noted these figures have not been corrected for any parallax error. In addition, the GOES-16 visible and low-level water vapor imagery showed a signal of mountain wave activity likely over the terrain in southwestern Idaho at and around the accident time (attachments 1 and 2). For more discussion on mountain wave conditions please see section 17.0.

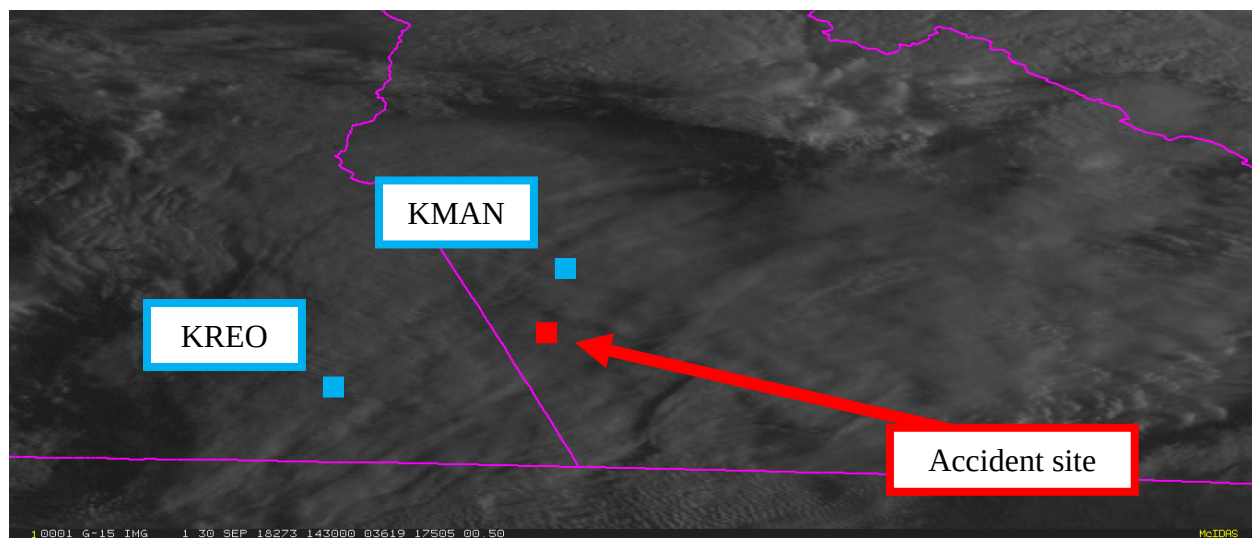


Figure 12 – GOES-15 visible image at 0830 MDT

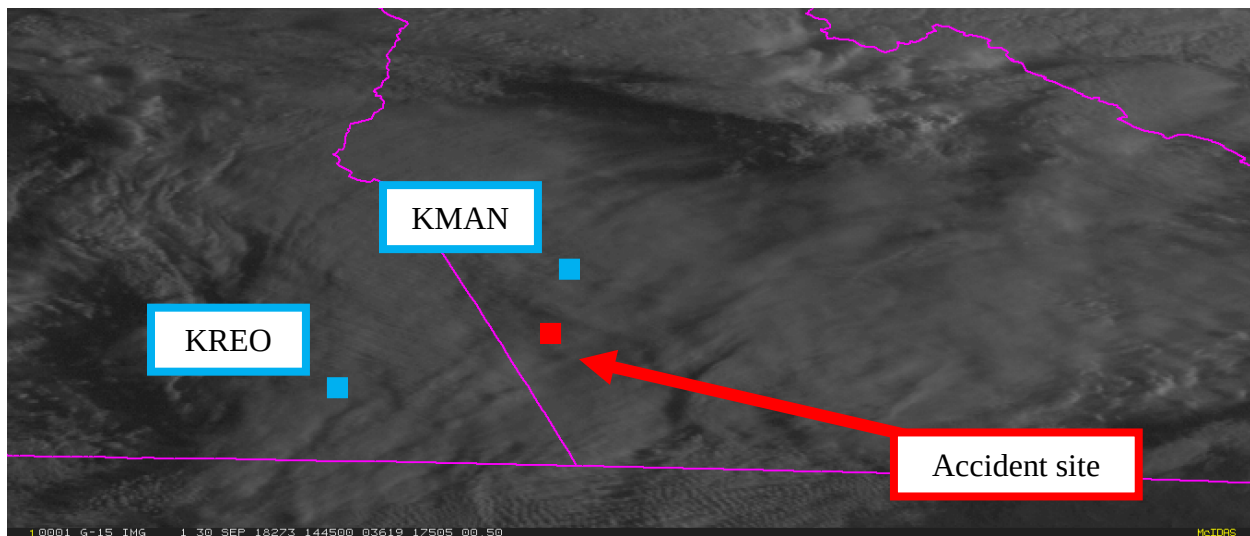


Figure 13 – GOES-15 visible image at 0845 MDT

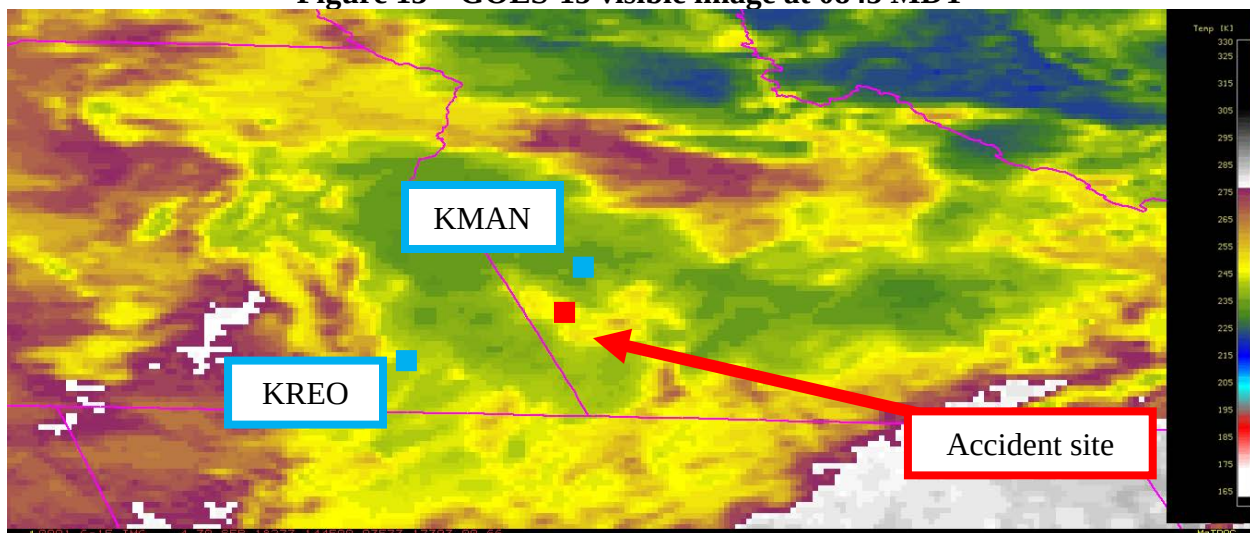


Figure 14 – GOES-15 infrared image at 0845 MDT

6.0 Radar Imagery Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)¹³ to the accident site was the Boise/Ada County, Idaho, radar (KCBX), which was located 34 miles northeast of the accident site. Level II archive radar data was obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software. No precipitation targets were noted above the accident site around the accident time.

¹³ The WSR-88D is an S-band 10-centimeter wavelength radar with a power output of 750,000 watts, and with a 28-foot parabolic antenna that concentrates the energy between a 0.87° and 0.96° beam width. The radar produces three basic types of products: base reflectivity, base radial velocity, and base spectral width.

7.0 Pilot Reports¹⁴

All PIREPs within 150 miles of the accident site from about three hour prior to the accident time to three hours after the accident time were reviewed, and of these, no PIREPs were issued into the national airspace system for below FL200¹⁵.

8.0 SIGMET

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

9.0 CWSU Advisories

No Center Weather Service Unit (CWSU) Center Weather Advisory (CWA) or Meteorological Impact Statement (MIS) were valid for the accident site at the accident time.

10.0 AIRMETs

There was an Airmen's Meteorological Information (AIRMET) advisory Tango that was valid for the accident site at the accident time. The AIRMET warned of moderate turbulence conditions expected for below FL180:

WAUS45 KKCI 300845

WA5T

-SLCT WA 300845

AIRMET TANGO UPDT 1 FOR TURB AND LLWS VALID UNTIL 301500

.

AIRMET TURB...NV CA

FROM 60S TWF TO 40SE LAS TO 40ENE TRM TO 30SW TRM TO SAC TO

80SSW REO TO 60S TWF

MOD TURB BTN FL260 AND FL400. CONDS CONTG BYD 15Z THRU 21Z.

.

AIRMET TURB...ID MT WY NV UT WA OR CA AND CSTL WTRS

FROM HUH TO 50NNW ISN TO 70SW DIK TO 70W RAP TO 60S TWF TO 80SSW

REO TO SAC TO 140SW FOT TO 140WSW FOT TO 140W TOU TO HUH

MOD TURB BTN FL180 AND FL360. CONDS CONTG BYD 15Z THRU 21Z.

.

AIRMET TURB...ID MT WY NV UT CO AZ NM WA OR CA

FROM HLN TO SHR TO CYS TO TBE TO CME TO 70WNW CME TO RSK TO TBC

TO 40S EED TO BZA TO 40ESE MZB TO RBL TO PDT TO HLN

MOD TURB BLW FL180. CONDS CONTG BYD 15Z THRU 21Z.

.

AIRMET TURB...ID MT WA OR

FROM 30SSE YQL TO HLN TO PDT TO 70S YKM TO BTG TO HUH TO 30SSE

YQL

MOD TURB BLW 150. CONDS ENDG 12-15Z.

¹⁴ Only pilot reports with the WMO header UBID**, UBWA**, UBOR**, and UBNV** identifier were considered.

¹⁵ Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of ft. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the average sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

.
LLWS POTENTIAL...ID MT WY NV UT CO
BOUNDED BY 70E DLN-50SW BIL-BOY-50E DDY-30ESE CYS-DEN-JNC-80W
ILC-70E DLN
LLWS EXP. CONDS CONTG BYD 15Z ENDG 18-21Z.
....

11.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products made available before the accident flight indicated southwest to west surface winds around 10 knots with no precipitation forecast. The aviation cloud forecast indicated no cloud cover forecast west of the mountainous terrain and accident site, with clouds forecast along and east of the terrain with cloud ceilings at 14,000 to 15,000 ft msl and cirrus clouds above valid for 0900 MDT. For more information and imagery please see attachment 3.

12.0 Terminal Aerodrome Forecast

Boise Air Terminal/Gowen Field (KBOI) was the closest site with a NWS Terminal Aerodrome Forecast (TAF) to the accident location with KBOI located 38 miles northeast of the accident site (figure 7). The KBOI TAF valid at the accident time was an amended TAF issued at 0815 MDT and was valid for a 22-hour period beginning at 0800 MDT. The 0815 MDT TAF for KBOI was as follows:

KBOI 301415Z 3014/0112 **28007KT P6SM BKN100 OVC150**
FM302000 31011G18KT P6SM SCT100 BKN200
FM010000 30008KT P6SM VCSH BKN100
FM010300 VRB06KT P6SM SKC=

Between 0800 and 1400 MDT, the TAF expected a wind from 280° at 7 knots, greater than 6 statute miles visibility, a broken ceiling at 10,000 ft agl, and overcast skies at 15,000 ft agl.

13.0 NWS Area Forecast Discussion

The NWS Office in Boise, Idaho, issued the following Area Forecast Discussion (AFD) at 0311 MDT (closest AFD to the accident time with an aviation section). The aviation section of the AFD discussed the VFR conditions with isolated rain showers east and northeast of the accident site. Winds were expected to be west at 15 to 20 knots near 10,000 ft msl:

FXUS65 KBOI 300911
AFDBOI

Area Forecast Discussion
National Weather Service Boise ID
311 AM MDT Sun Sep 30 2018

.SHORT TERM...Today through Monday...An upper level trough continues to move into and through the forecast area this morning. Additional shower activity is anticipated through the overnight hours. Cooler temperatures will be found across the forecast

area in response to this trough. The axis of the trough should mostly be in Idaho by the mid-afternoon hours, with shower activity concentrated along the West Central Mountains and the higher terrain of Baker county. Models continue to show some afternoon instability with thunderstorms possible across the West Central Mountains of Idaho. As the trough axis drifts eastward, a transitory ridge will move over the area. Expect drier conditions for Monday with slightly warmer temperatures.

.LONG TERM...Monday night through Saturday...Gradual cooling and moistening as the upper air pattern carves out a long wave trough over the western US by the end of the week. The first significant upper trough comes south from western Canada into northern Idaho Tuesday with a chance of rain showers in northern zones. Meanwhile, a Pacific upper low will make landfall in California Tuesday and bring a chance of rain showers near our southern border with Nevada. Remnants of tropical storm Rosa will slide by in Utah and Colorado a little too far south and east to affect our area. The next upper trough in the northern stream will come in from the Gulf of Alaska Thursday. That trough looks strong enough for a chance of rain showers in all areas Thursday. Another trough from the Gulf of Alaska will bring more showers Friday, and by then it will be cold enough for snow above 6500 feet MSL in our northern mountains.

&&

.AVIATION...VFR. Isolated rain showers. Isolated afternoon thunderstorms northeast of a line from KBKE-KBOI-KSUN. Surface winds variable up to 10kt through 18Z, then west or northwest 10-20kt through 01/00Z. Gusts to 30kt near thunderstorms. Winds aloft near 10K feet MSL west 15-20kt.

&&

.BOI WATCHES/WARNINGS/ADVISORIES...
ID...None.
OR...None.

&&

\$\$

14.0 Winds and Temperature Aloft Forecast

The NWS 0757 MDT Winds and Temperature Aloft forecast valid for the closest point to the accident site is included below:

FBUS31 KWN0 301357
FD1US1
DATA BASED ON 301200Z
VALID 301800Z FOR USE 1400-2100Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
BOI		2612+09	2319+02	2226-04	2339-18	2247-31	237342	236346	245050

The accident site was closest to the Boise, Idaho, (BOI) forecast point. The 0757 MDT BOI forecast for use between 0800 and 1500 MDT indicated a wind at 6,000 ft from 260° at 12 knots with a temperature of 9° C, a wind at 9,000 ft from 230° at 19 knots with a temperature of 2° C, and a wind at 12,000 ft from 220° at 26 knots with a temperature of -4° C.

15.0 CWSU Graphics

The CWSU located at the Salt Lake City Air Route Traffic Control Center (ZLC), issued several graphical products on their website and via social media (Twitter and Facebook) warning of potential mountain wave conditions and other aviation hazards valid throughout the ZLC airspace on and before the accident day. For more information and timing please see attachments 4 and 5.

16.0 Pilot Weather Briefing and Witness Information

The accident pilot did not request a weather briefing through Leidos.

A search of archived ForeFlight information revealed that ForeFlight did not have any record of the accident pilot requesting a weather briefing before or during the accident flight. It is unknown if the accident pilot checked or received additional weather information before or during the accident flight.

After the accident occurred, two airplanes searched for the accident airplane. One of these airplanes was located at 6,500 ft msl and one mile east of the accident site after the accident time and recorded a wind from the southwest at 38 knots. For more information please see attachment 6.

17.0 Weather Research and Forecasting Model Simulation

A Weather Research and Forecasting Model (WRF) simulation was run to simulate the weather conditions surrounding the accident site at the accident time. WRF ARW (Advanced Research WRF core) version 3.2.1.5 was run with 3 domains with horizontal grid spacing of 8 km, 1.6 km, and 320 m over the accident site. Other WRF simulation parameters included: 55 vertical levels, the Kain-Fritsch cumulus parameterization scheme used on the outer domain, a Lin et al. microphysics scheme, a Yonsei University boundary layer scheme, Noah land surface physics, and the Dudhia scheme used for the long and short wave radiation. The terrain (in ft) used in domain 2 is shown in figure 15 along with the location of the cross sections used figures 16 and 17 (along with attachments 7 through 10) with the location of the accident site marked. Figures 16 and 17 depict the potential temperature¹⁶ in degrees Kelvin (solid lines) and the vertical velocity in ft per minute (color fill) at 0830 and 0845 MDT along a west-to-east cross-section. The vertical velocity data indicated that at the flight level¹⁷ the accident flight was travelling at before the encounter with terrain the accident flight was in an area of downdrafts with a magnitude between 200 and 600 ft per minute (figures 16 and 17 and attachments 7 and 8) with increasing downdraft magnitude near the higher terrain and east of that terrain (attachments 7 and 8). Attachments 9 and 10 indicated that the WRF simulation was consistent with the reported increase in wind magnitude over terrain at and after the accident time (section 16.0).

¹⁶ Potential temperature of a parcel of fluid at pressure P is the temperature that the parcel would acquire if adiabatically brought to a standard reference pressure P_0 , usually 1000 hPa.

¹⁷ For more information please see the ATC data contained in the docket of this accident.

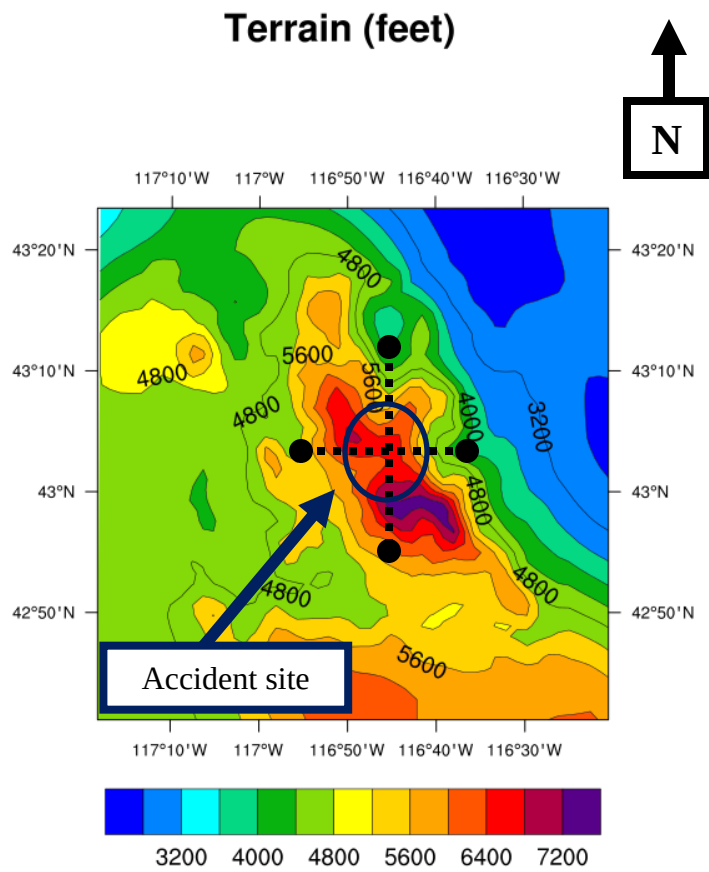


Figure 15 – WRF simulation terrain in ft with the accident site marked and the locations of the cross sections in the following figures (black dashed lines)

W

Vertical Velocity 2018-09-30_14:30:00

E

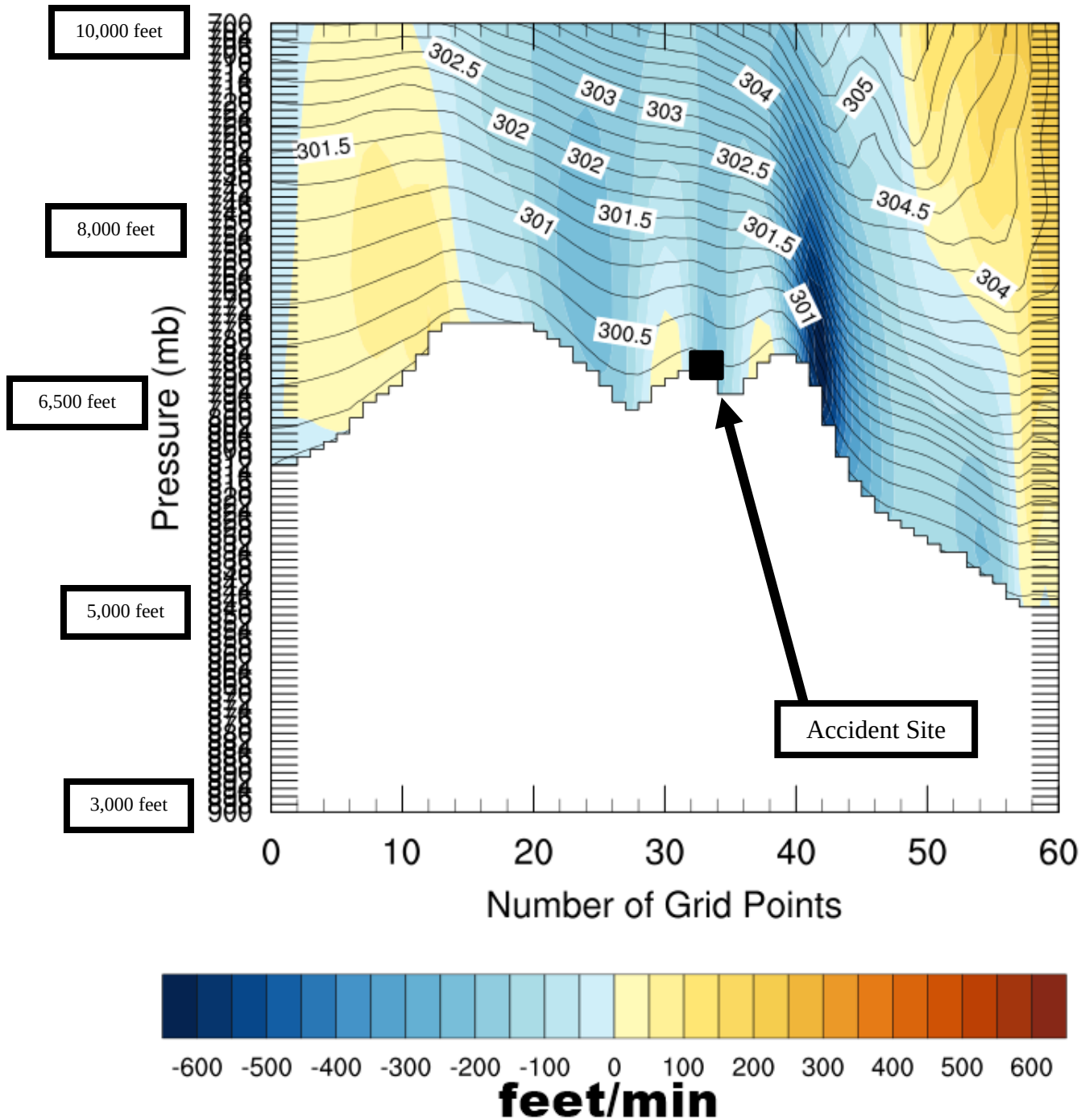


Figure 16 – WRF cross section from 0830 MDT of vertical velocity in ft per minute (color fill) and potential temperature in kelvin (black lines) from west to east across the terrain with the approximate accident site marked

W Vertical Velocity 2018-09-30_14:40:00 E

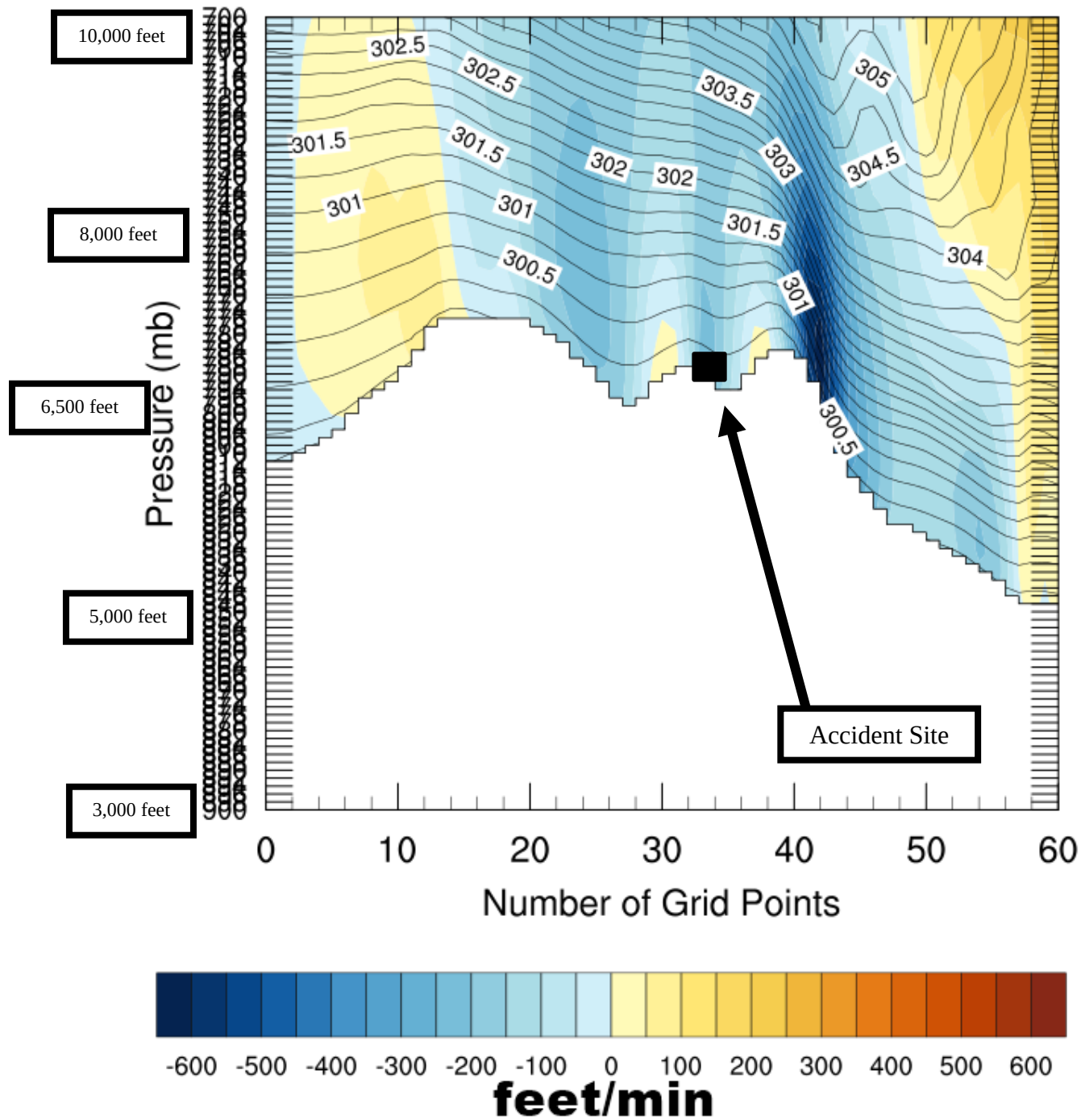


Figure 17 – WRF cross section from 0840 MDT of vertical velocity in ft per minute (color fill) and potential temperature in kelvin (black lines) from west to east across the terrain with the approximate accident site marked

18.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for the accident site on September 30, 2018, indicated the following:

SUN	
Begin civil twilight	0715 MDT
Sunrise	0743 MDT
Accident	0837 MDT¹⁸
Sun transit	1337 MDT
Sunset	1930 MDT
End civil twilight	1958 MDT

E. LIST OF ATTACHMENTS

Attachment 1 – GOES-16 Visible imagery from 0732 to 1037 MDT

Attachment 2 – GOES-16 Low-level water vapor imagery from 0652 to 1052 MDT

Attachment 3 – GFA products available before the accident flight for around the accident time

Attachment 4 – CWSU ZLC graphical products valid before and during accident time

Attachment 5 – Correspondence with NWS regarding graphical product valid times from CWSU ZLC

Attachment 6 – Correspondence with NTSB regarding wind information from post-accident flights

Attachment 7 – Animation of a west to east WRF cross section of vertical velocity and potential temperature from 0730 to 0930 MDT

Attachment 8 – Animation of a north to south WRF cross section of vertical velocity and potential temperature from 0730 to 0930 MDT

Attachment 9 – Animation of a west to east WRF cross section of wind magnitude and potential temperature from 0700 to 1000 MDT

Attachment 10 – Animation of a north to south WRF cross section of wind magnitude and potential temperature from 0700 to 1000 MDT

¹⁸ Inserted accident time for reference and context.

Submitted by:

Paul Suffern
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