



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

November 24, 2020

Specialist's Factual Report

METEOROLOGY

WPR20LA304

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A. ACCIDENT

Location: Seeley Lake, Montana
Date: September 12, 2020
Time: 2200 mountain daylight time
0400 Coordinated Universal Time (UTC) September 13, 2020
Airplane: Cessna 172; Registration: N3720R

B. SENIOR METEOROLOGIST

Paul Suffern
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 12, 2020, 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. 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.

The accident site location used was at latitude 47.1972° N, longitude 113.4456° W, with an approximate elevation of 4,325 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/1030235

1.1 Surface Analysis Chart

A northern section of the NWS Surface Analysis Chart for 2100 MDT is provided as figure 1 with the approximate location of the accident site marked within the red circle. The chart depicted a low-pressure system at 1011-hectopascals (hPa) over eastern Montana with a cold front extending west and northwest into northern Montana, and into southwestern Canada. Another low-pressure system was located over Washington at 1012-hPa with a trough² extending north and south of the low. The accident site was located on the warm air side of the cold front in area of a weak pressure gradient.

The station models around the accident site depicted air temperatures in the upper 60's degrees Fahrenheit (°F), dew point temperatures in the upper 30's to low 40's °F with temperature-dew point spreads of 20°F or more, variable winds at or under 5 knots, and generally clear skies with haze reported across northwestern Montana and northern Idaho.

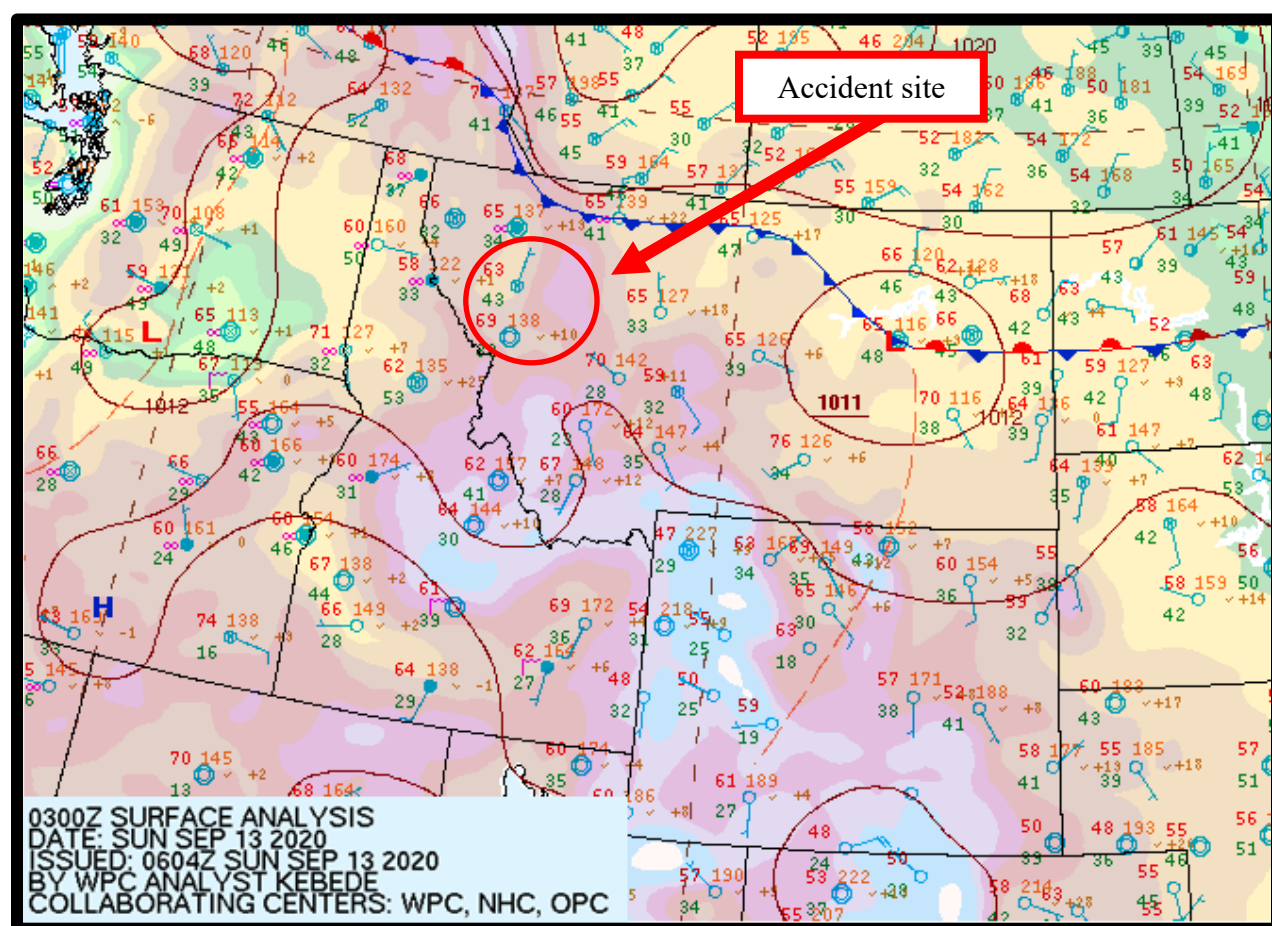
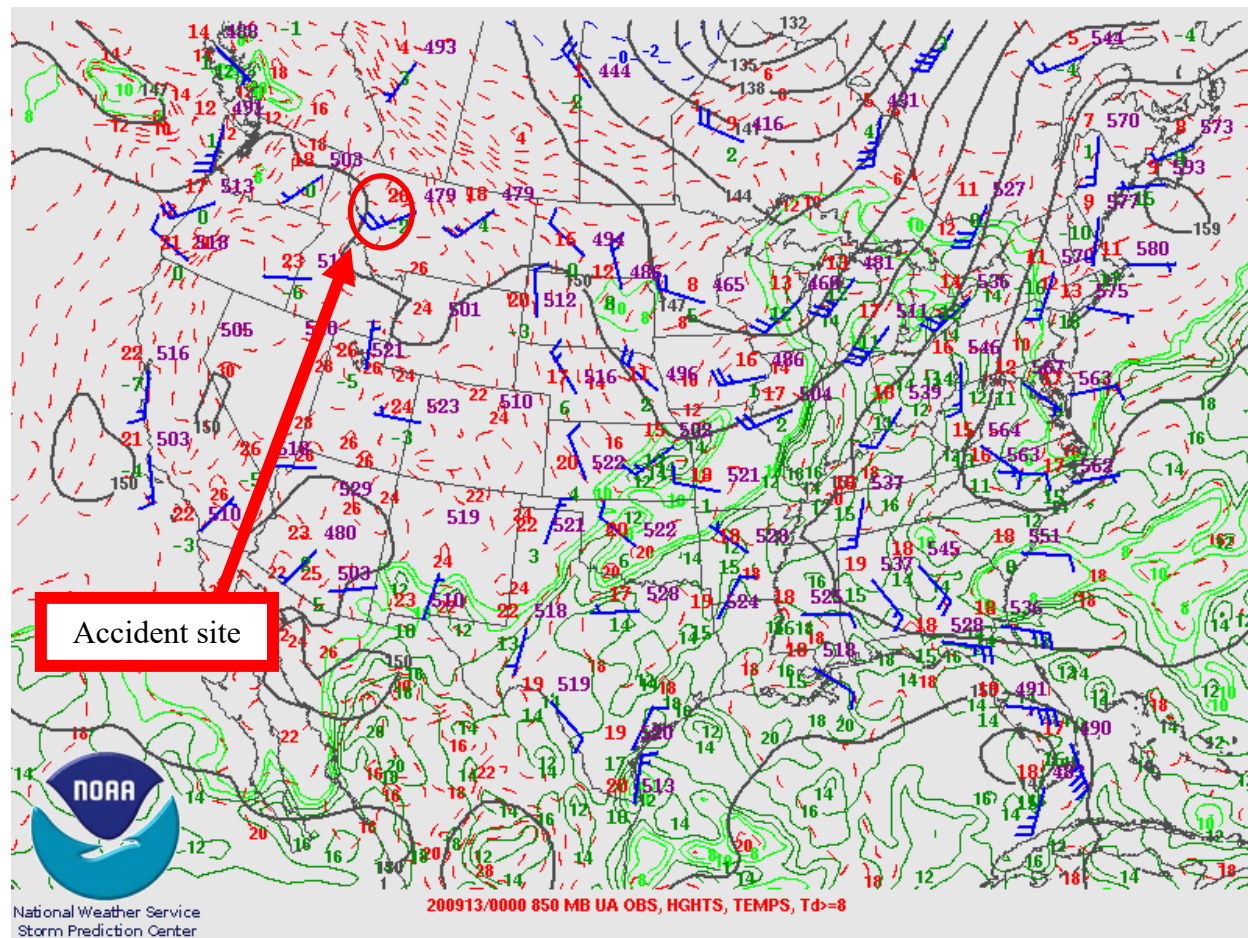


Figure 1 – NWS Surface Analysis Chart for 2100 MDT

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 1800 MDT at 850-, 700-, and 500-hPa are presented in figures 2 through 4. A ridge³ was located west of the accident site at 700- and 500-hPa (figures 3 and 4). There was a southwest wind of 25 knots at 850-hPa above the accident site with the wind becoming westerly by 700-hPa (figure 3). By 500-hPa the wind was westerly at 20 knots (figure 4).



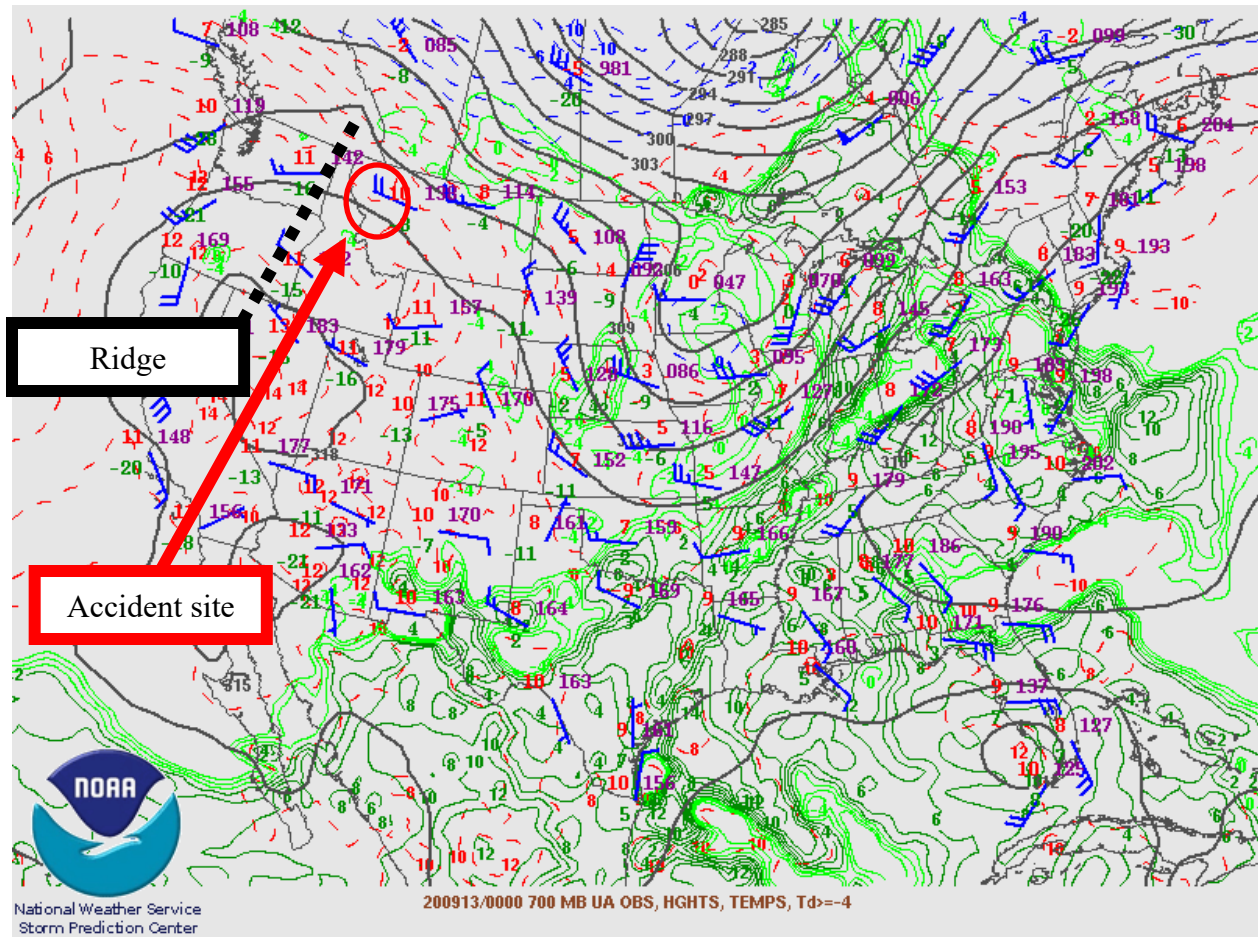


Figure 3 – 700-hPa Constant Pressure Chart for 1800 MDT

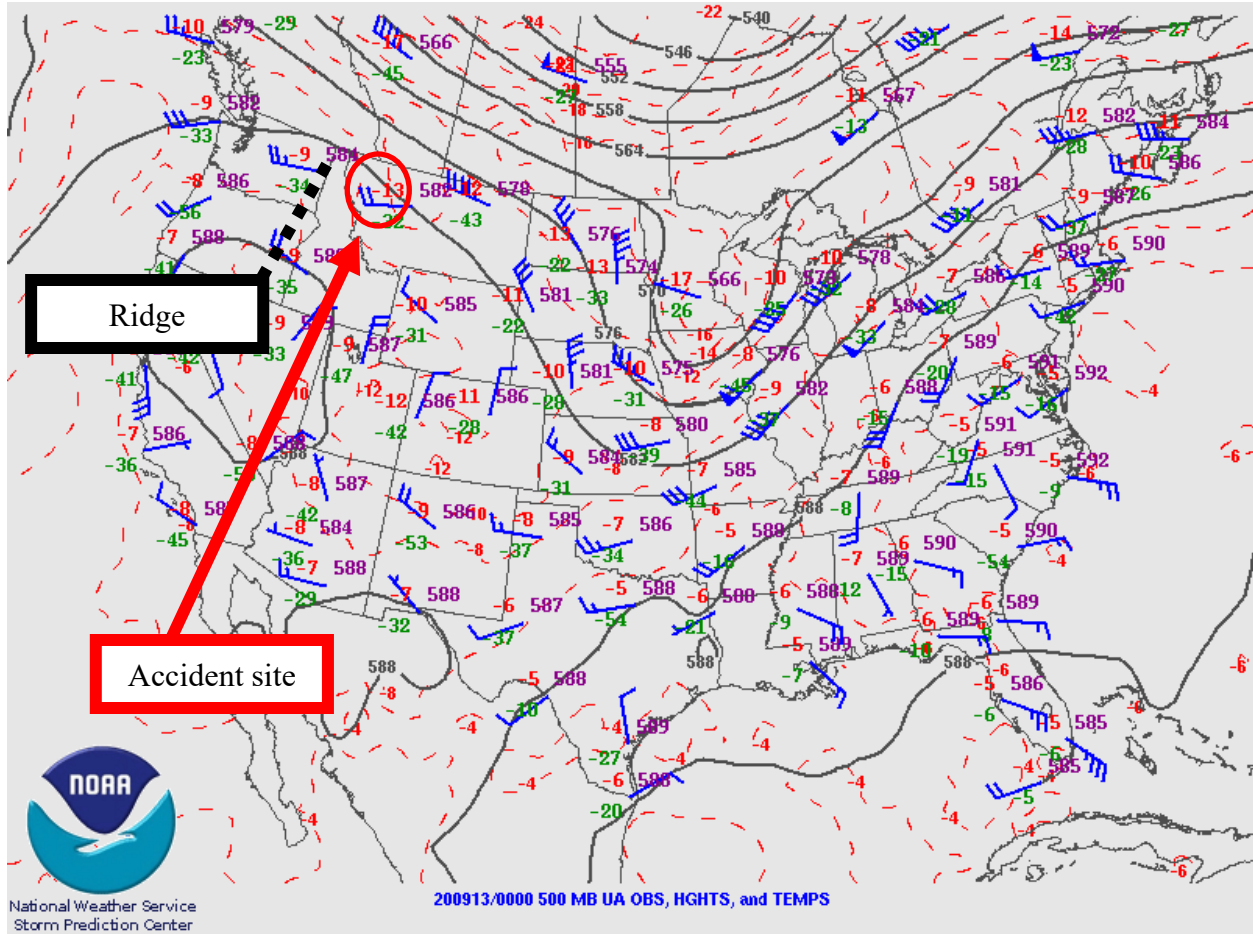


Figure 4 – 500-hPa Constant Pressure Chart for 1800 MDT

2.0 Surface Observations

The area surrounding the accident site was documented using official Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language. Figure 5 is a local sectional chart with the accident site and the closest weather reporting locations marked.



Figure 5 – Sectional map of the accident area with the location of the accident site and surface observation sites

Missoula International Airport (KMSO) had the closest official weather station to the accident site. KMSO had an Automated Surface Observing System (ASOS⁴) whose reports were supplemented by air traffic control (ATC) when the tower is in operation⁵. The KMSO ASOS site was located 31 miles southwest of the accident site (figure 5), at an elevation of 3,206 ft, and had a 13° easterly magnetic variation⁶. The following observations were taken and disseminated during the times surrounding the accident:⁷

[1753 MDT] METAR KMSO 122353Z 26005KT 10SM CLR 29/04 A2993 RMK AO2 SLP118 T02940039 10300 20200 56012 \$=

[1853 MDT] METAR KMSO 130053Z 29003KT 10SM CLR 27/07 A2994 RMK AO2 SLP123 T02720067 \$=

⁴ ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, weather, ceiling, temperature, dewpoint, altimeter, and barometric pressure.

⁵ ATC hours of operation are from 0600 to 2200 local.

⁶ Magnetic variation – The angle (at a particular location) between magnetic north and true north. Latest measurement taken from <https://skyvector.com/>

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

[1953 MDT] METAR KMSO 130153Z 32007KT 8SM CLR 23/05 A2995 RMK AO2 SLP132 T02280050 \$=

[2053 MDT] METAR KMSO 130253Z 00000KT 8SM CLR 21/03 A2997 RMK AO2 SLP138 T02060033 53010 \$=

[2153 MDT] METAR KMSO 130353Z AUTO 00000KT 6SM HZ CLR 16/03 A2999 RMK AO2 SLP146 T01610033 \$=

ACCIDENT TIME 2200 MDT

[2253 MDT] METAR KMSO 130453Z AUTO 16004KT 8SM CLR 18/03 A2999 RMK AO2 SLP143 T01780033 \$=

[2353 MDT] METAR KMSO 130553Z AUTO 35003KT 8SM OVC060 13/03 A3001 RMK AO2 SLP150 T01330033 10294 20133 51013 \$=

KMSO weather at 2153 MDT, automated, wind calm, visibility 6 miles, haze, clear skies below 12,000 ft above ground level (agl), temperature of 16°Celsius (C), dew point temperature of 3°C, and an altimeter setting of 29.99 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1014.6 hPa, temperature 16.1°C, dew point temperature 3.3°C, maintenance is needed on the system.

KMSO weather at 2253 MDT, automated, wind from 160° at 4 knots, visibility 8 miles, clear skies below 12,000 ft agl, temperature of 18°C, dew point temperature of 3°C, and an altimeter setting of 29.99 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1014.3 hPa, temperature 17.8°C, dew point temperature 3.3°C, maintenance is needed on the system.

Ronan Airport (K7S0) had the next closest official weather station to the accident site. K7S0 had an Automated Weather Observing System (AWOS⁸) whose reports were not supplemented. The K7S0 AWOS site was located 35 miles northwest of the accident site (figure 5) at an elevation of 3,086 ft. The following observations were taken and disseminated during the times surrounding the accident:

[2125 MDT] METAR K7S0 130325Z AUTO 05004KT 10SM 16/06 A2996 RMK A01 RONAN=

[2140 MDT] METAR K7S0 130340Z AUTO 07004KT 8SM 14/06 A2997 RMK A01 RONAN=

⁸ 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 12,000 feet, and altimeter setting.

***[2155 MDT] METAR K7S0 130355Z AUTO 36004KT 6SM HZ 14/06 A2997 RMK A01
RONAN=***

ACCIDENT TIME 2200 MDT

[2210 MDT] METAR K7S0 130410Z AUTO 02003KT 7SM 16/05 A2997 RMK A01 RONAN=

[2225 MDT] METAR K7S0 130425Z AUTO 01003KT 7SM 15/05 A2997 RMK A01 RONAN=

K7S0 weather at 2155 MDT, automated, wind from 360° at 4 knots, visibility 6 miles, haze, temperature of 14°C, dew point temperature of 6°C, and an altimeter setting of 29.97 inches of mercury. Remarks: automated station without a precipitation discriminator.

K7S0 weather at 2210 MDT, automated, wind from 020° at 3 knots, visibility 7 miles, temperature of 16°C, dew point temperature of 5°C, and an altimeter setting of 29.97 inches of mercury. Remarks: automated station without a precipitation discriminator.

The observations from KMSO and K7S0 surrounding the accident time indicated VFR⁹ conditions with restrictions to visibility due to haze.

Several unofficial surface observations sites were closer to the accident site than KMSO and K7S0 and locations are documented in figure 6. Both Seeley Lake (SEEM8)¹⁰ and Seeley Elementary School (A3632)¹¹ stations were located within 2 miles from the accident site. The data from SEEM8 and A3632 can be found in attachments 1 and 2.

⁹ As defined by 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.

¹⁰ https://mesowest.utah.edu/cgi-bin/droman/meso_base_dyn.cgi?stn=SEEM8&unit=0&timetype=LOCAL

¹¹ https://mesowest.utah.edu/cgi-bin/droman/meso_base_dyn.cgi?stn=A3632&unit=0&timetype=GMT

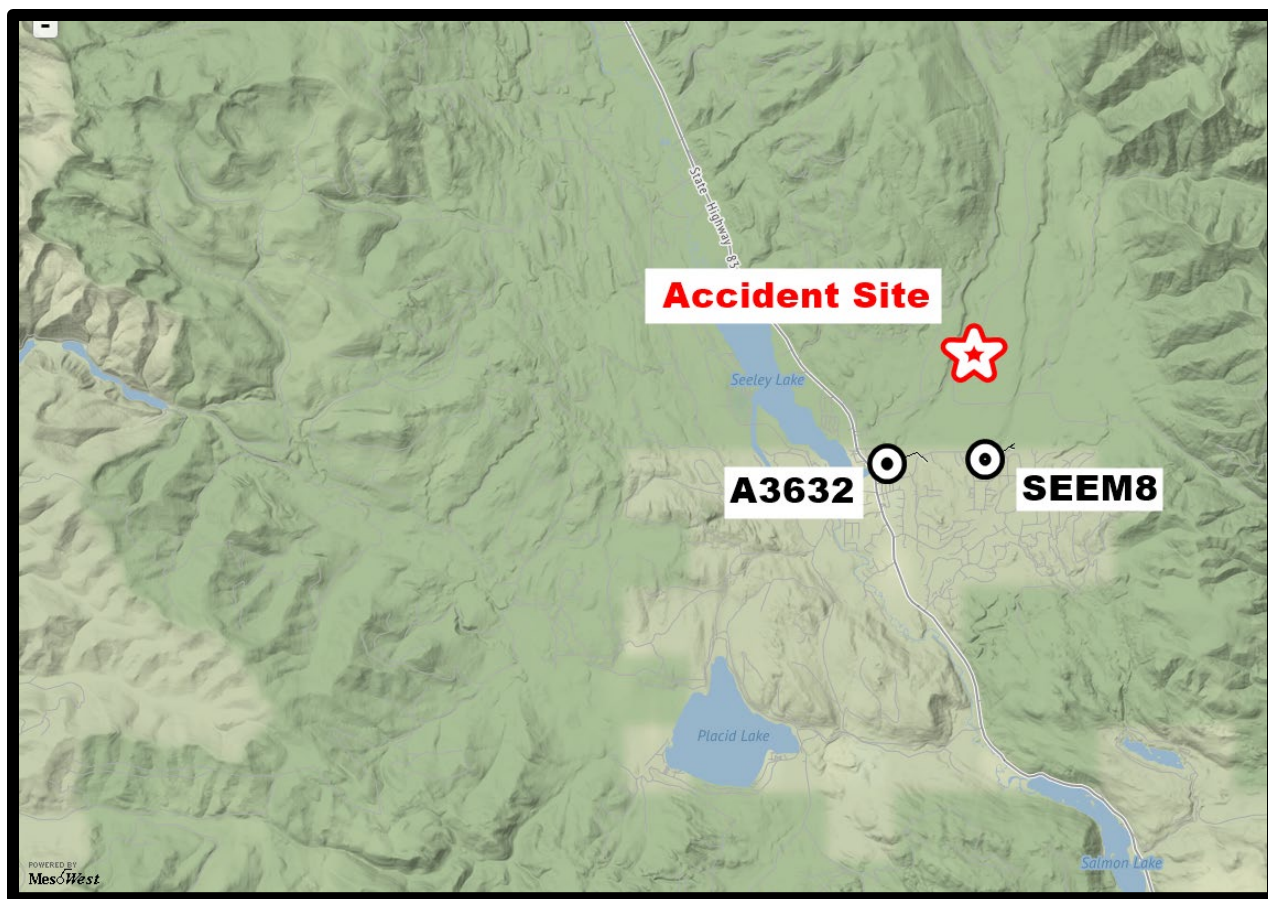


Figure 6 – Unofficial surface observation site locations

3.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR)¹² model sounding was created for the accident site for 2200 MDT with a station elevation of 4,393 ft.¹³ The 2200 MDT HRRR sounding was plotted on a standard Skew-T Log P diagram¹⁴ with the derived stability parameters included in figure 7 with data from the surface to 600-hPa (or approximately 14,000 ft above msl). These data were analyzed using the RAOB¹⁵ software package. The sounding depicted the lifted condensation level (LCL)¹⁶ at 10,274 ft msl and the convective condensation level (CCL)¹⁷ at 17,205 ft msl. The freezing level was located at 14,587 ft above msl. The precipitable water value was 0.38 inches.

¹² 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.

¹³ HRRR sounding was created using NOAA Air Resource Laboratory: <https://ready.arl.noaa.gov/READYamet.php>

¹⁴ 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.

¹⁵ RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.

¹⁶ LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

¹⁷ 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.

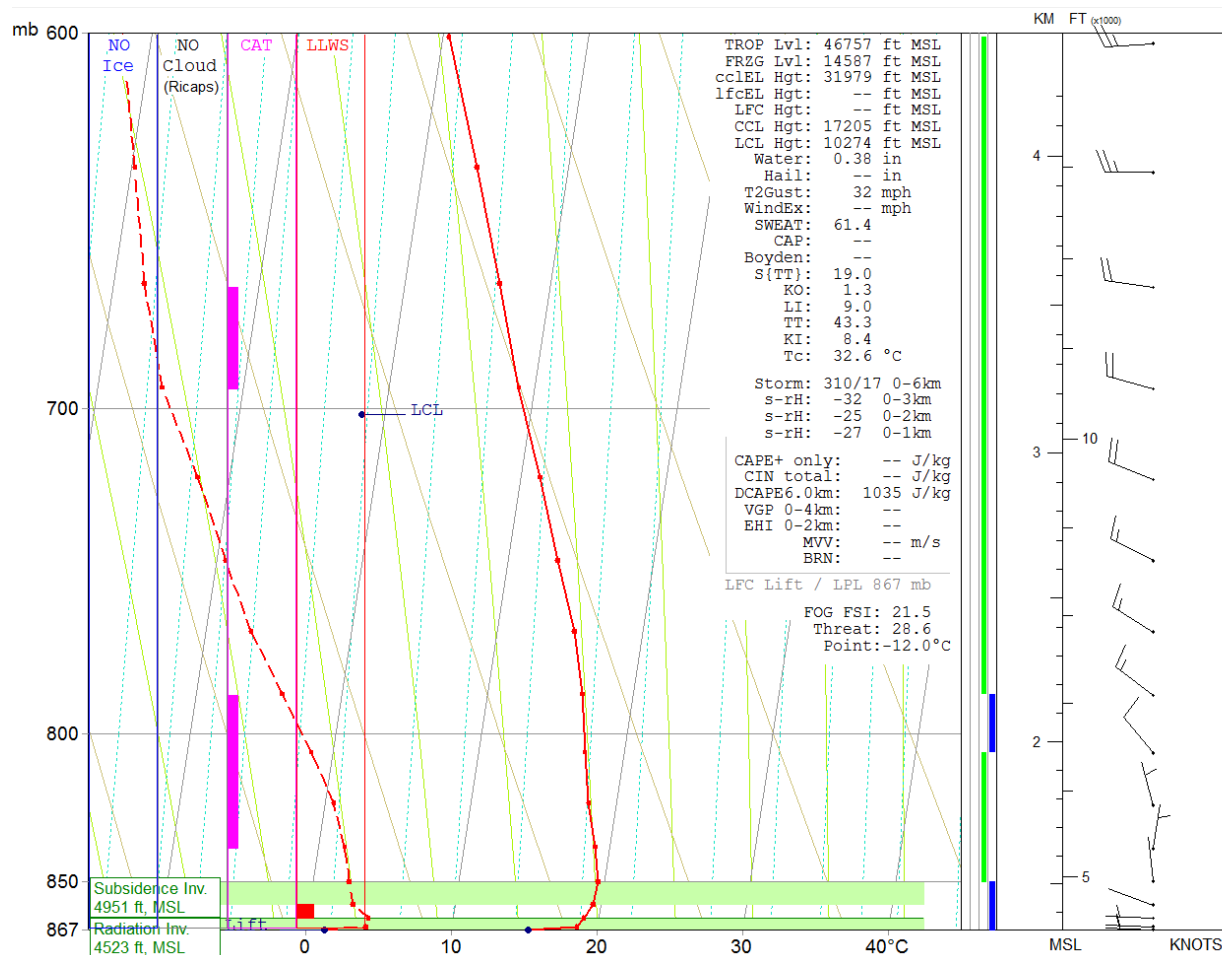


Figure 7 – 2200 MDT HRRR sounding

The 2200 MDT HRRR sounding for the accident site identified alternating layers of a conditionally stable and a conditionally unstable environment from the surface through 14,000 ft above msl. RAOB did not identify any areas of clouds below 14,000 ft above msl. A radiation inversion¹⁸ was located at 130 ft agl and a subsidence inversion was located at 558 ft agl.

The 2200 MDT HRRR sounding wind profile indicated a near surface wind from 272° at 4 knots with the wind remaining from the west below 5,000 ft above msl (~600 ft agl). The wind became northerly between 5,000 and 6,500 ft above msl, and then above 6,500 ft above msl the wind became westerly again. The wind remained at or below 10 knots through 7,000 ft above msl. The wind speed increased to between 15 and 25 knots between 7,000 and 14,000 ft above msl. RAOB did indicate the possibility of light low-level wind shear (LLWS) around 4,600 ft above msl (~200 ft agl). RAOB indicated that a slight chance of light clear-air turbulence existed in several layers between 5,500 ft and 12,000 ft above msl.

¹⁸ Inversion – A departure from the usual decrease of the value of an atmospheric property with increasing altitude; also, the layer through which this departure occurs (the "inversion layer"), or the lowest altitude at which the departure is found (the "base of the inversion").

4.0 Satellite Data

The Geostationary Operational Environmental Satellite number 17 (GOES-17) 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. The visible and infrared imagery (GOES-17 bands 2 and 13) at wavelengths of 0.64 microns (μm) and 10.3 μm , respectively, were retrieved for the period from 1800 MDT through 2300 MDT and reviewed, and the closest images to the time of the accident were documented. Given the sun angle and time of day the visible imagery (band 2) did not provide useful information.

Figure 8 presents the GOES-16 infrared imagery from 2200 MDT at 4X magnification with the accident site highlighted with a red square. The lower brightness temperatures (yellow and green colors; higher cloud tops) were located to the east, north, and south of the accident site. Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 2200 MDT HRRR sounding, the approximate cloud-top heights over the accident site were 14,000 ft msl at 2200 MDT (275 Kelvin). It should be noted these figures have not been corrected for any parallax error.

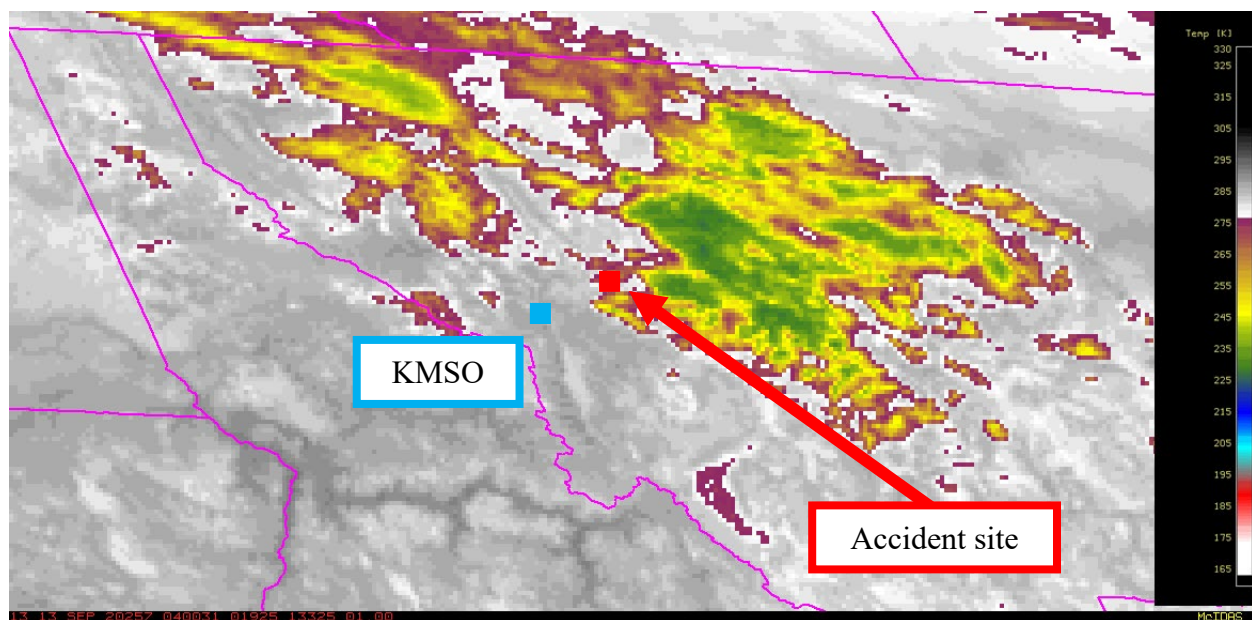


Figure 8 – GOES-16 infrared image at 2200 MDT

5.0 Regional Radar Imagery Information

A regional view of the NWS national composite radar mosaic is included as figure 9 for 2200 MDT with the approximate location of the accident site marked by the red circle. The image depicted no precipitation echoes above the accident site at the accident time.

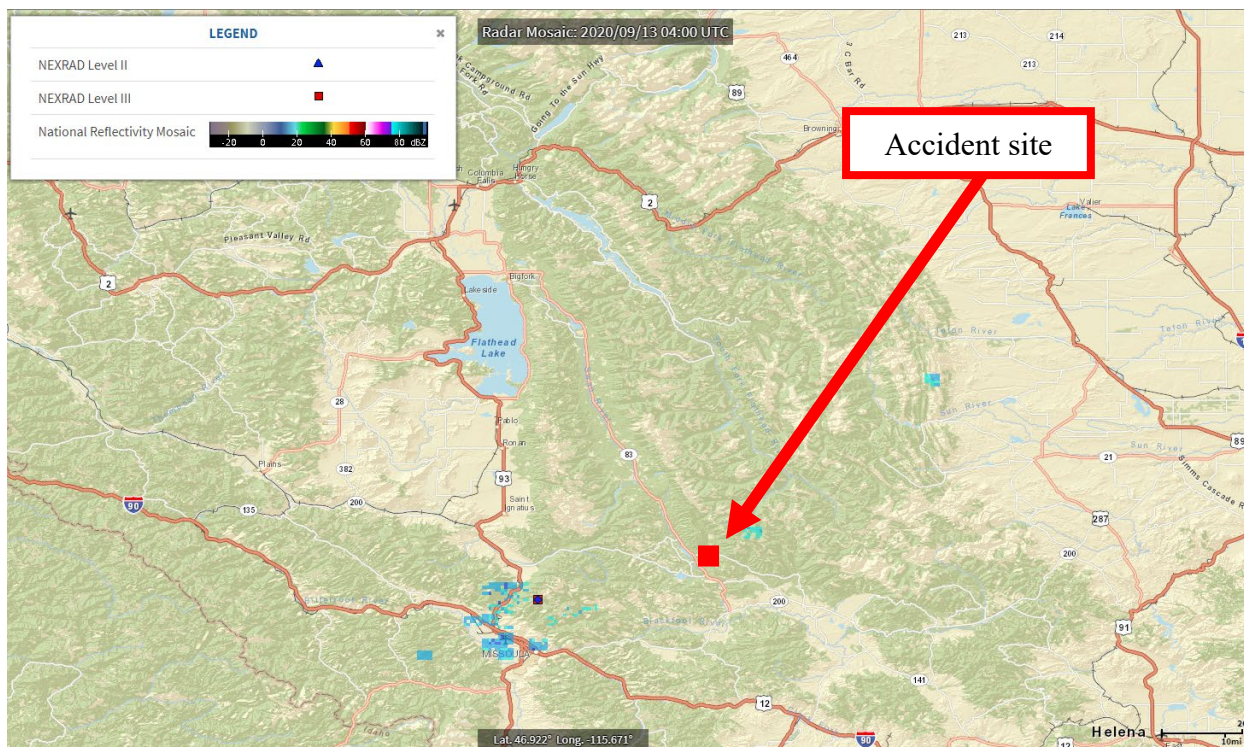


Figure 9 – Regional Composite Reflectivity image for 2200 MDT

6.0 Pilot Reports¹⁹

There were no publicly longline-disseminated pilot reports²⁰ (PIREPs) made below 15,000 ft msl within 75 miles of the accident site from about two hours prior to the accident time to two hours after the accident time.

7.0 SIGMETs

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

8.0 CWSU Advisories

There were no Center Weather Service Unit (CWSU) Meteorological Impact Statements (MIS) or Center Weather Advisories (CWA) valid for the accident site at the accident time.

¹⁹ Only pilot reports with the World Meteorological Organization headers UBMT**, UBID**, and UBWY** were considered.

²⁰ These do not include pilot reports only broadcast via radio.

9.0 AIRMETs

Airmen's Meteorological Information (AIRMET) advisory Sierra was valid for the accident site at the accident time. The AIRMET Sierra warned of IFR conditions and mountain obscuration due to haze and smoke:

```
WAUS45 KPCI 130245
WA5S
-SLCS WA 130245
AIRMET SIERRA FOR IFR AND MTN OBSCN VALID UNTIL 130900
.
AIRMET IFR...ID MT NV WA OR CA AND CSTL WTRS
FROM 40SSE YQL TO 30SE LKT TO 80WSW TWF TO 60NNE FMG TO 60ESE
CZQ TO 70SSW CZQ TO 20S ENI TO 50WSW OED TO 50SW SEA TO 30NNW
TOU TO 40SSE YQL
CIG BLW 010/VIS BLW 3SM HZ/FU. CONDS CONTG BYD 09Z THRU 15Z.
.
AIRMET MTN OBSCN...ID MT NV UT WA OR CA
FROM 20E HUH TO 50SSE YQL TO 20ESE BVL TO 50WSW BVL TO 50ENE OAL
TO 30SW BTY TO 50NNW HEC TO 60W HEC TO 40W EHF TO 20WSW SAC TO
OED TO 40SSE SEA TO 20E HUH
MTNS OBSC BY FU/HZ. CONDS CONTG BYD 09Z THRU 15Z.
....
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10.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products made available before the accident flight and valid at 2100 MDT are shown in attachment 3. These GFA surface forecast products indicated surface visibilities of 5 statute miles or greater with haze and smoke, and a surface wind variable at 5 knots. In addition, the accident site was covered by a graphical-AIRMET (G-AIRMET)²¹ for IFR conditions. The GFA cloud forecast valid before departure for around the accident time indicated clear skies and then cirrus clouds over the accident site with a G-AIRMET valid for mountain obscuration conditions. For more information please see attachment 3.

11.0 Terminal Aerodrome Forecast

KMSO was the closest airport to the accident site with an NWS Terminal Aerodrome Forecast (TAF). The KMSO TAF valid at the time departure was issued at 1720 MDT and was valid for a 24-hour period beginning at 1800 MDT. The TAF for KMSO was as follows:

```
TAF KMSO 122320Z 1300/1324 VRB04KT 6SM HZ SKC
FM130300 29004KT 6SM FU SKC
FM131500 VRB02KT 4SM FU SKC=
```

After 2100 MDT, the forecast expected a wind from 290° at 4 knots, visibility 6 miles, smoke, and clear skies.

²¹ <https://aviationweather.gov/gairmet/help>

12.0 NWS Area Forecast Discussion

The NWS office in Missoula, Montana, issued the following Area Forecast Discussion (AFD) at 1408 MDT (closest AFD to the accident time). The aviation section of the AFD discussed reducing visibilities due to the wildfire smoke during the accident day and into the following day:

FXUS65 KMSO 122008
AFDMSO

Area Forecast Discussion
National Weather Service Missoula MT
208 PM MDT Sat Sep 12 2020

...AIR QUALITY AND VISIBILITY EXPECTED TO STEADILY DEGRADE DUE TO INCREASING WILDFIRE SMOKE...

.DISCUSSION...Current satellite imagery shows the progression of wildfire smoke has begun to infiltrate northwest Montana and north central Idaho as of this afternoon. Smoke will continue pushing eastward, dropping visibility and degrading air quality as it fully engulfs the rest of the Northern Rockies by Sunday. Weather observations and webcam images across eastern Washington and eastern Oregon show visibility has lowered to less than one mile, and the same should be expected for north central Idaho and western Montana.

For the latest air quality information for Montana, please visit:
<http://svc.mt.gov/deq/todaysair>

For the latest air quality information for Idaho, please visit:
<http://airquality.deq.idaho.gov>

Such prominent smoke will also affect full heating potential during the daytime hours. As a result, we have limited forecast high temperatures Sunday and Monday, keeping them several degrees cooler than what forecast models have suggested.

Not much in the way of relief is expected going into the middle of next week. A brief, mostly dry disturbance is still likely Monday into Tuesday, but will produce an increase in winds across southwest Montana. Once again, depending on how much and how dense the smoke is in valleys, wind may not have much of an effect at all, save for southwest Montana. A Fire Weather Watch has been issued for SW MT for the combination of very low humidity and the threat for winds.

Major discrepancies still exist between forecast models after Wednesday on whether the region stays smoky and under the continued influence of high pressure...or if we get a break in the form of cooler and wetter conditions. Until more confidence can be gained, uncertainty remains in the long term.

&&

.AVIATION...Satellite loops this afternoon show smoke moving into the Northern Rockies. Surface observations in Washington, Oregon, and northern Idaho show low visibility with 1/2 to 1SM common. This low visibility smoke is forecast to overtake central Idaho tonight and western Montana during Sunday morning. Widespread visibility reductions are expected during Sunday which may remain for many days. Westerly terrain winds may increase on Sunday but smoke could keep most of the region stable.

&&

.MSO WATCHES/WARNINGS/ADVISORIES...

MT...Fire Weather Watch from Monday afternoon through Monday evening
Deerlodge/West Beaverhead...East Beaverhead.

ID...None.

&&

\$\$

13.0 Winds and Temperature Aloft Forecast

The NWS 1955 MDT Winds and Temperature Aloft forecast valid for the closest point to the accident site is included below:

```
FBUS31 KWNO 130155
FD1US1
DATA BASED ON 130000Z
VALID 130600Z    FOR USE 0200-0900Z. TEMPS NEG ABV 24000

FT  3000    6000    9000    12000    18000    24000    30000    34000    39000
GPI      2608+18 2512+10 2716+05 2727-10 2842-23 294739 294949 295657
```

The accident site was located closest to the Kalispell, Montana (Glacier Park International Airport), (GPI) forecast point. The 1955 MDT GPI forecast for use between 2000 MDT and 0300²² MDT indicated a wind at 6,000 ft from 260° at 8 knots with a temperature of 18°C and a wind at 9,000 ft from 250° at 12 knots with a temperature of 10°C.

14.0 Pilot Weather Briefing

A search of the FAA contract Automated Flight Service Station (AFSS) provider Leidos and third party vendor ForeFlight, indicated that the accident pilot did not make contact with them for any flight plan, weather briefing, or inflight contact. There was no record of the accident pilot receiving or retrieving any other weather information before or during the accident flight.

²² September 13

15.0 HRRR-Smoke Data

HRRR-Smoke²³ model data surrounding the accident time was retrieved. The HRRR-Smoke was initialized at 1800 MDT and produced smoke information for 2200 MDT which is included in figures 10, 11, 12, and 13. The imagery indicated between 20 and 100 $\mu\text{g}/\text{m}^3$ concentration of fine particulate matter (fire smoke) near the surface of the accident site through 6,000 ft agl. For more information on HRRR-Smoke please see attachment 4.

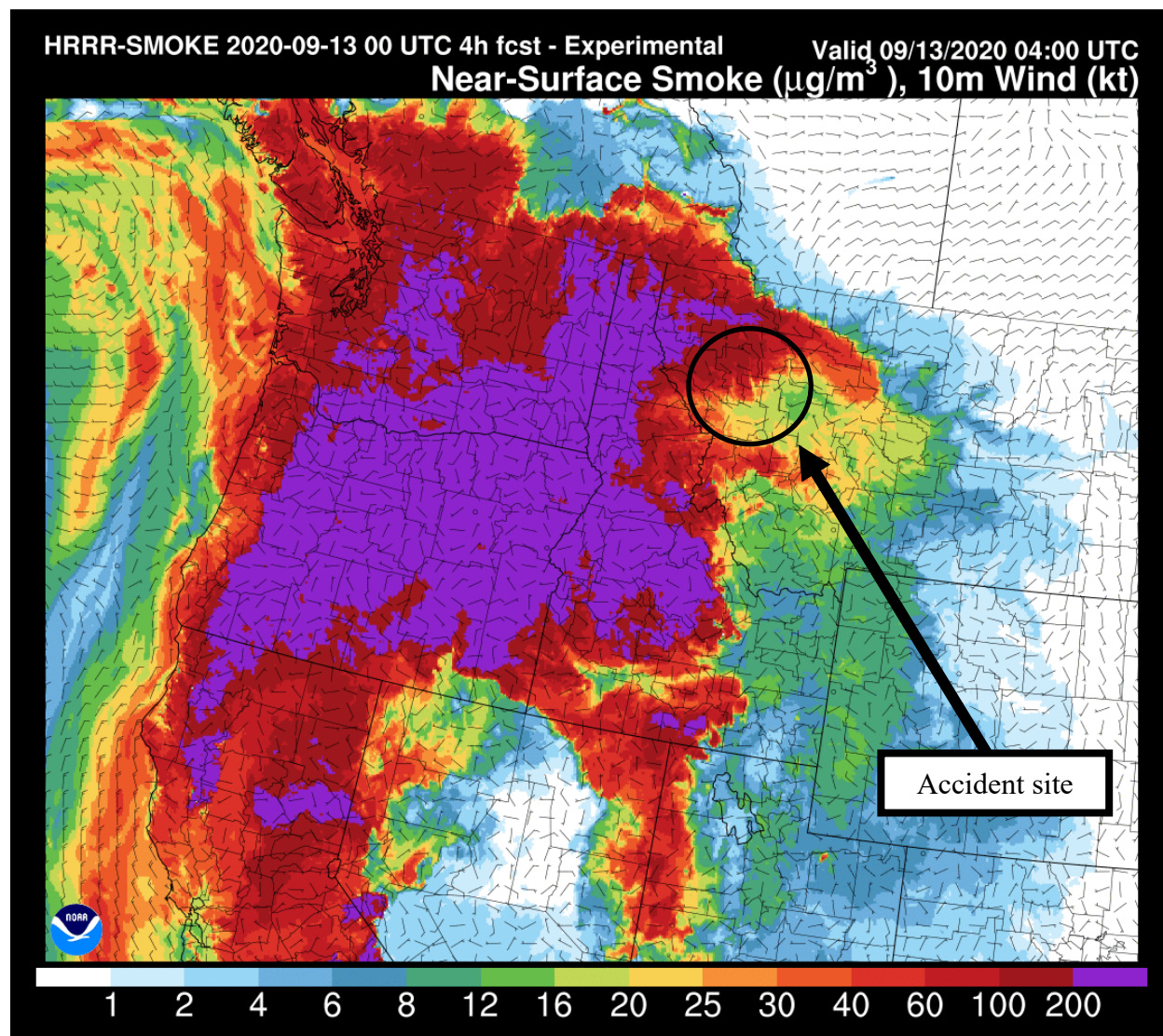


Figure 10 – 2200 MDT Near-Surface Smoke image from HRRR-Smoke

²³ <https://rapidrefresh.noaa.gov/hrrr/HRRRsmoke/>

HRRR-SMOKE 2020-09-13 00 UTC 4h fcst - Experimental

Valid 09/13/2020 04:00 UTC

1000 ft AGL Smoke ($\mu\text{g}/\text{m}^3$), Wind (kt)

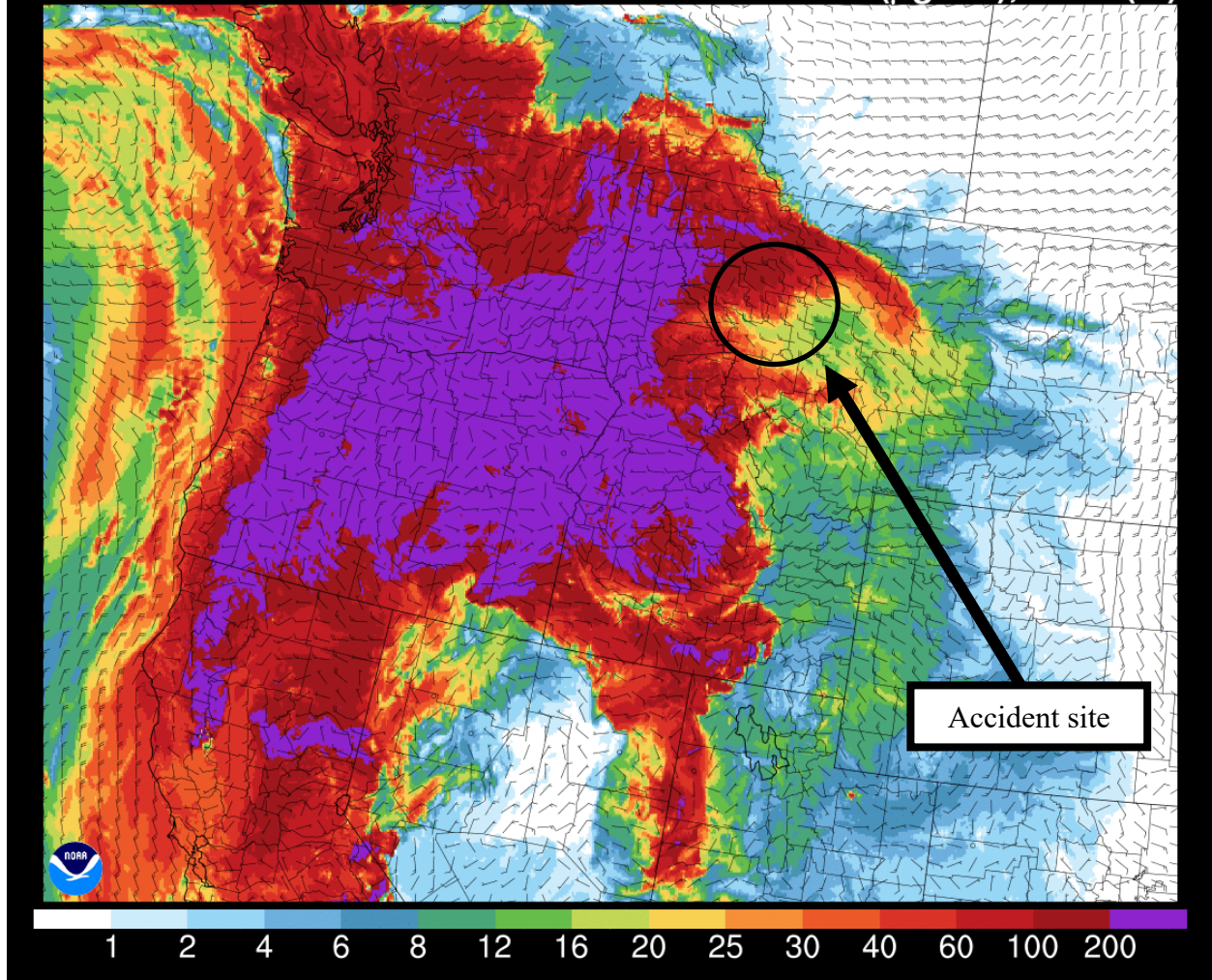


Figure 11 – 2200 MDT 1,000 ft agl Smoke image from HRRR-Smoke

HRRR-SMOKE 2020-09-13 00 UTC 4h fcst - Experimental

Valid 09/13/2020 04:00 UTC

6000 ft AGL Smoke ($\mu\text{g}/\text{m}^3$), Wind (kt)

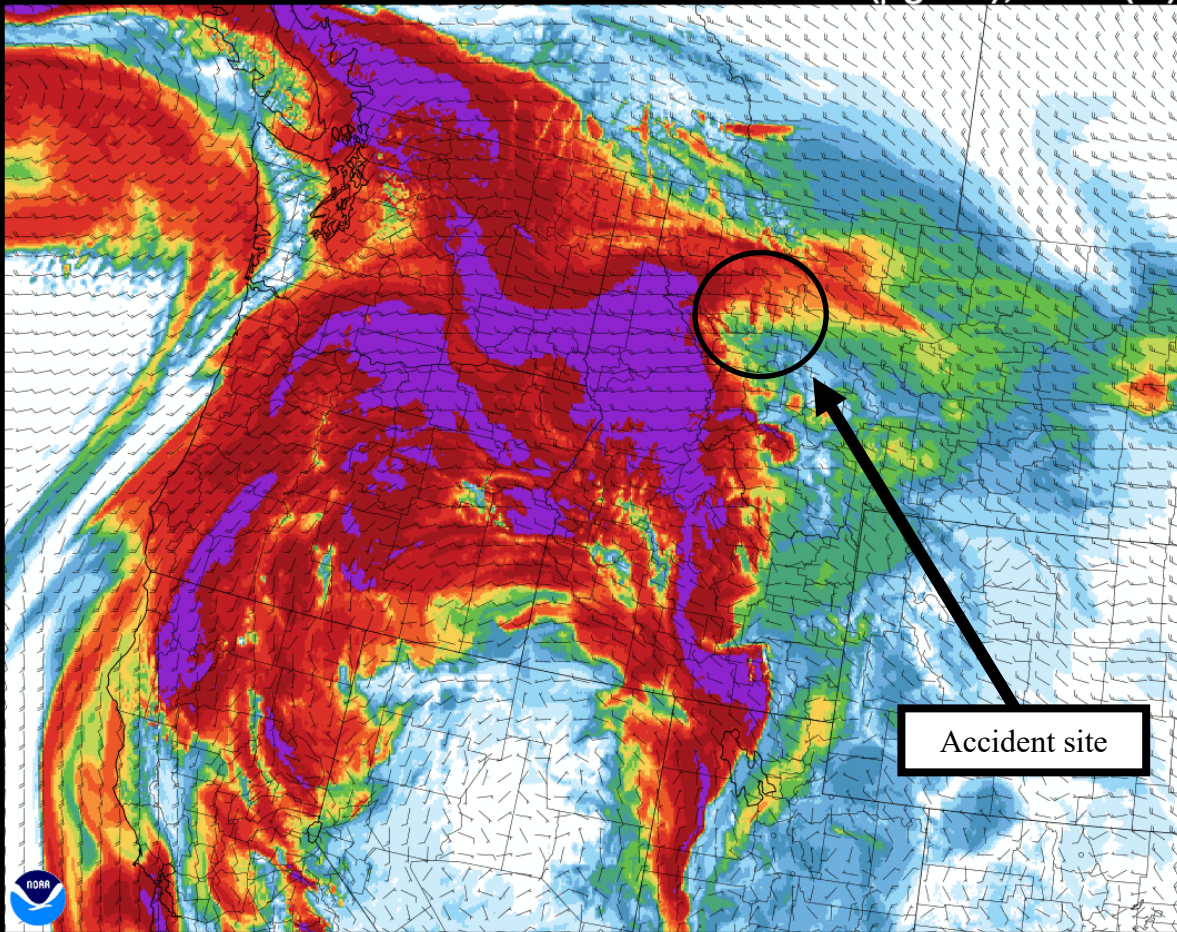


Figure 12 – 2200 MDT 6,000 ft agl Smoke image from HRRR-Smoke

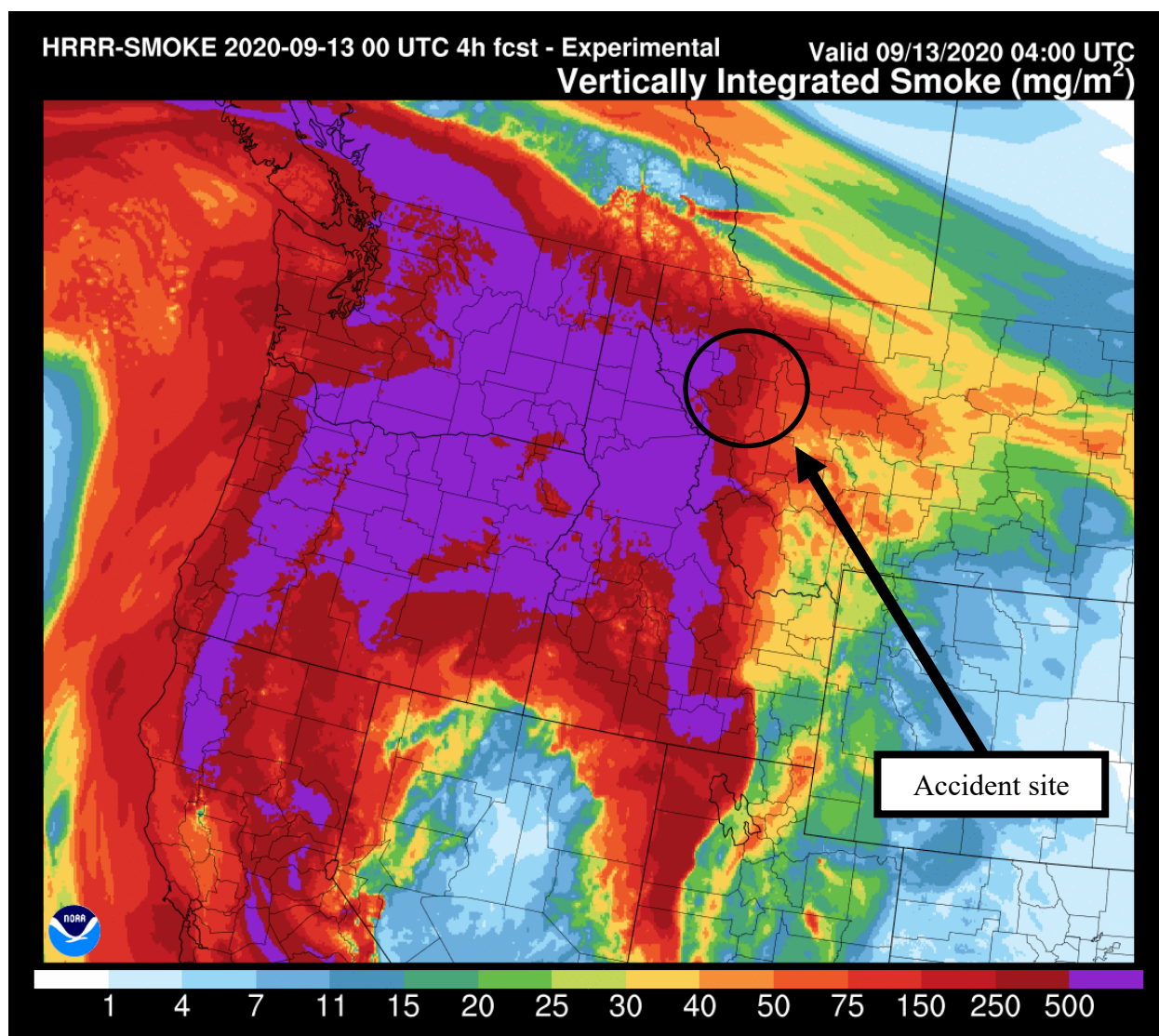


Figure 13 – 2200 MDT Vertically Integrated Smoke image from HRRR-Smoke

16.0 Astronomical Data

The astronomical data obtained for the accident site on September 12, 2020, indicated the following:

SUN	
Begin civil twilight	0639 MDT
Sunrise	0709 MDT
Sun transit	1329 MDT
Sunset	1949 MDT
End civil twilight	2019 MDT
Accident time	2200 MDT²⁴

²⁴ Inserted accident time for reference and context.

MOON

Moonrise	0103 MDT
Moon transit	0918 MDT
Moonset	1731 MDT
Accident time	2200 MDT²⁵

The Moon was Waning Crescent with 23.1% illumination.

E. LIST OF ATTACHMENTS

Attachment 1 – Weather observations from SEEM8 around the accident time

Attachment 2 – Weather observations from A3632 around the accident time

Attachment 3 – GFA products valid for the accident flight

Attachment 4 – HRRR-Smoke Information

Submitted by:

Paul Suffern
Senior Meteorologist

²⁵ Inserted accident time for reference and context.