



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

July 12, 2022

Specialist's Factual Report

METEOROLOGY

WPR22FA151

A. ACCIDENT

Location: Heyburn, Idaho
Date: April 13, 2022
Time: 0832 mountain daylight time
1432 Coordinated Universal Time (UTC)
Aircraft: Cessna 208B; Registration: N928JP

B. METEOROLOGY SPECIALIST

Specialist Paul Suffern
National Transportation Safety Board
Washington, DC

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist did a virtual launch for this investigation within the NTSB air traffic control (ATC) group. In addition information was gathered for this investigation from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources and also from the National Centers for Environmental Information (NCEI). This Specialist's Factual Report contains the meteorological data pertinent to the weather surrounding the accident time. All times are mountain daylight time (MDT) and are based upon the 24-hour clock, where local time is -6 hours from UTC. Directions are referenced to true north and distances are in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles. NWS station identifiers use the standard International Civil Aviation Organization 4-letter station identifiers versus the International Air Transport Association 3-letter identifiers, which deletes the initial country code designator "K" for U.S. airports.

The accident site was located at an approximate latitude 42.55143° N, Longitude 113.75969° W, and elevation of 4,165 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

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart centered over the western United States for 0900 MDT is provided as figure 1 with the location of the accident site within the black circle. The chart depicted a low-pressure system at 1014-hectopascals (hPa) over southern Idaho along a stationary front that extended west and then northwest across Idaho into Washington, and east-southeast over Wyoming and then southward into Colorado. A second low-pressure system at 1016-hPa was located over northern Utah with a trough² extending north and south of the low. Troughs and fronts can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present. The accident site was located below the surface trough and south of the stationary frontal boundary on the relatively warmer side of the front.

The station models around the accident site depicted air temperatures near freezing, dew point temperatures from the low 20's to near 12° Fahrenheit (°F), with temperature-dew point spreads of 9°F or less, clear skies (at Twin Falls, Idaho), and a southwest wind around 10 knots, to overcast clouds and northerly winds at 10 knots northeast of the accident site (at Pocatello, Idaho [KPIH]).

¹ https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1030235

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

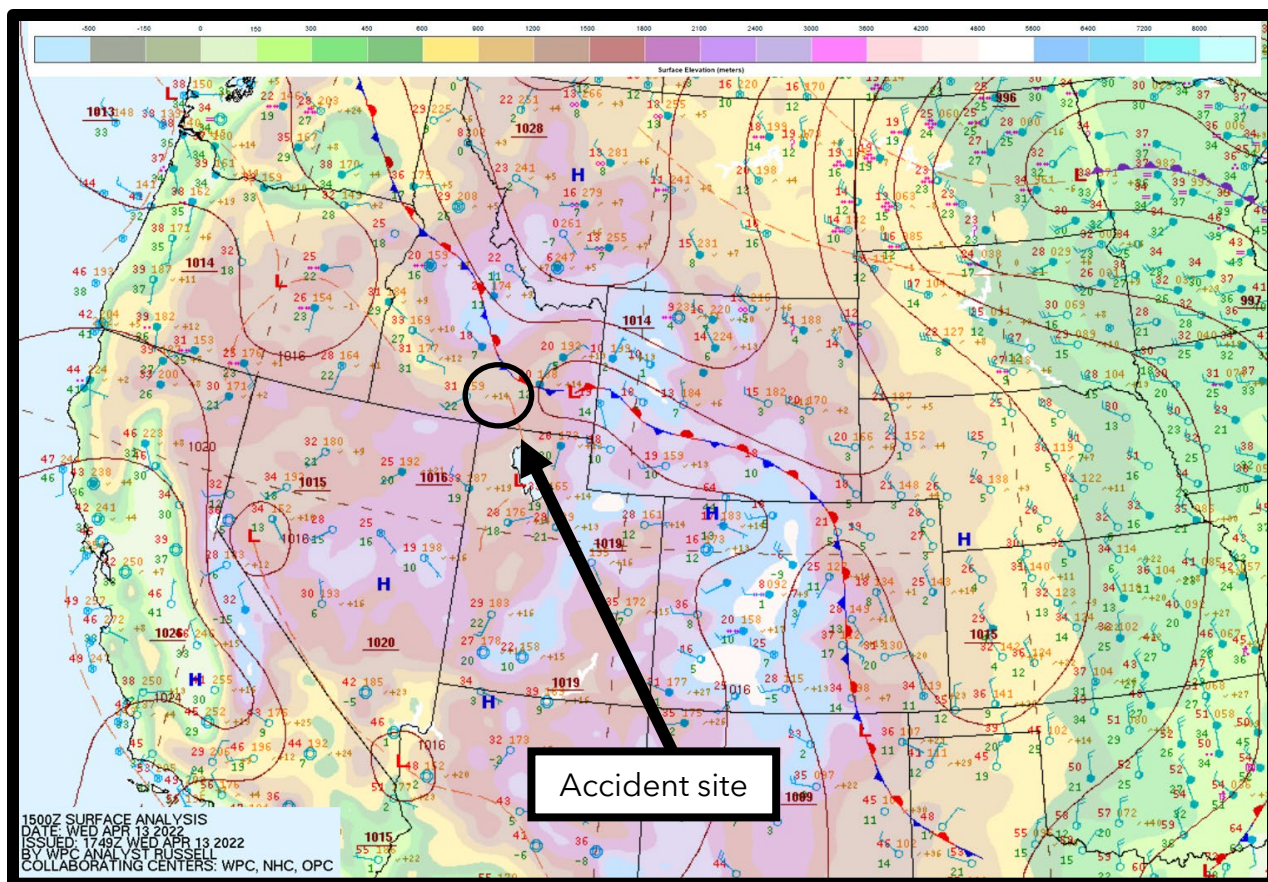


Figure 1. NWS Surface Analysis Chart for 0900 MDT.

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 0600 MDT at 700-, 500- and 300-hPa are presented in figures 2 through 4. The accident site was located ahead of a mid-level trough. The 700-hPa constant pressure chart depicted a west wind of 10 knots near the accident site with the wind increasing in speed to 30 knots by 500-hPa (figure 3). By 300-hPa, the wind was from the northwest around 60 knots (figure 4).

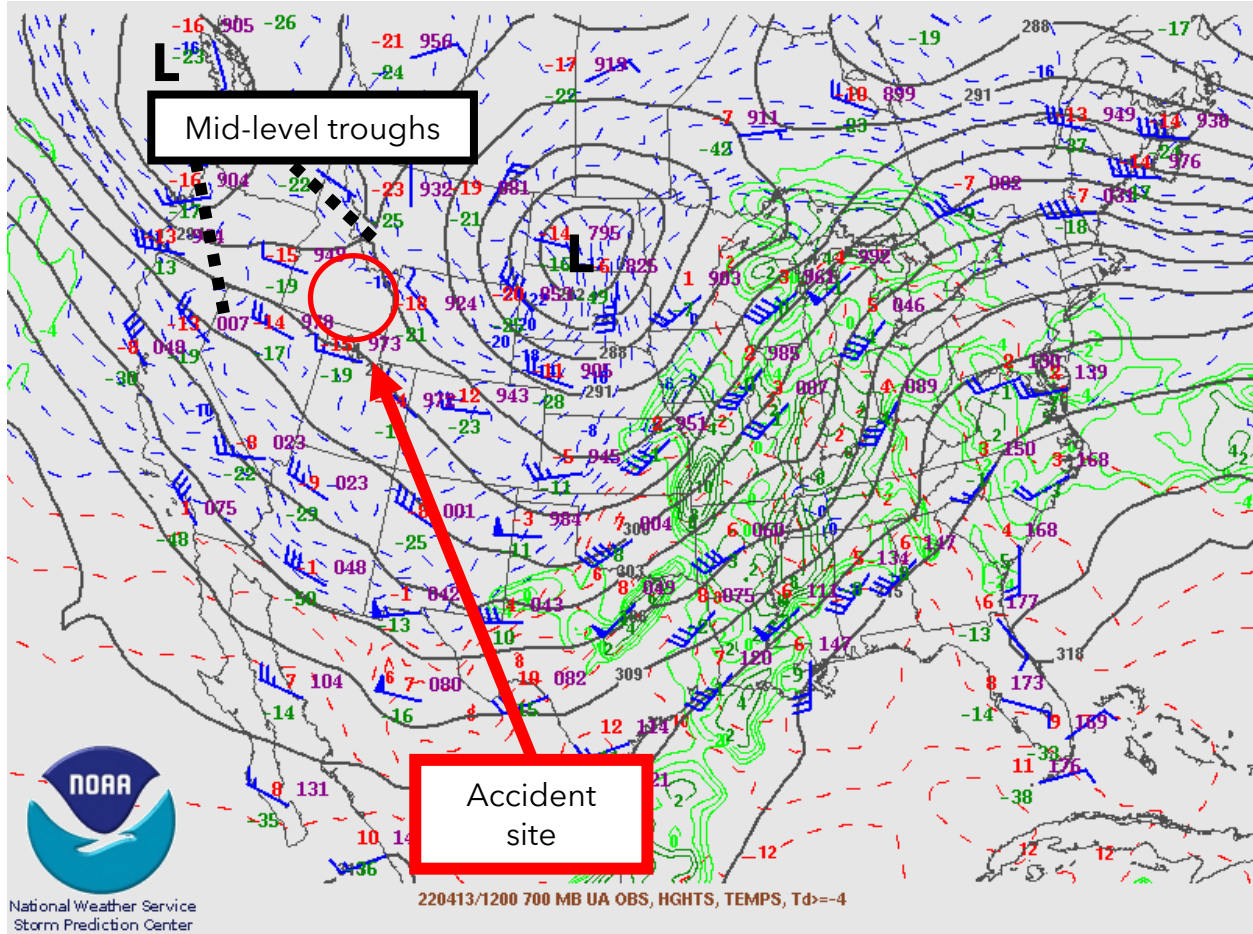


Figure 2. 700-hPa Constant Pressure Chart for 0600 MDT.

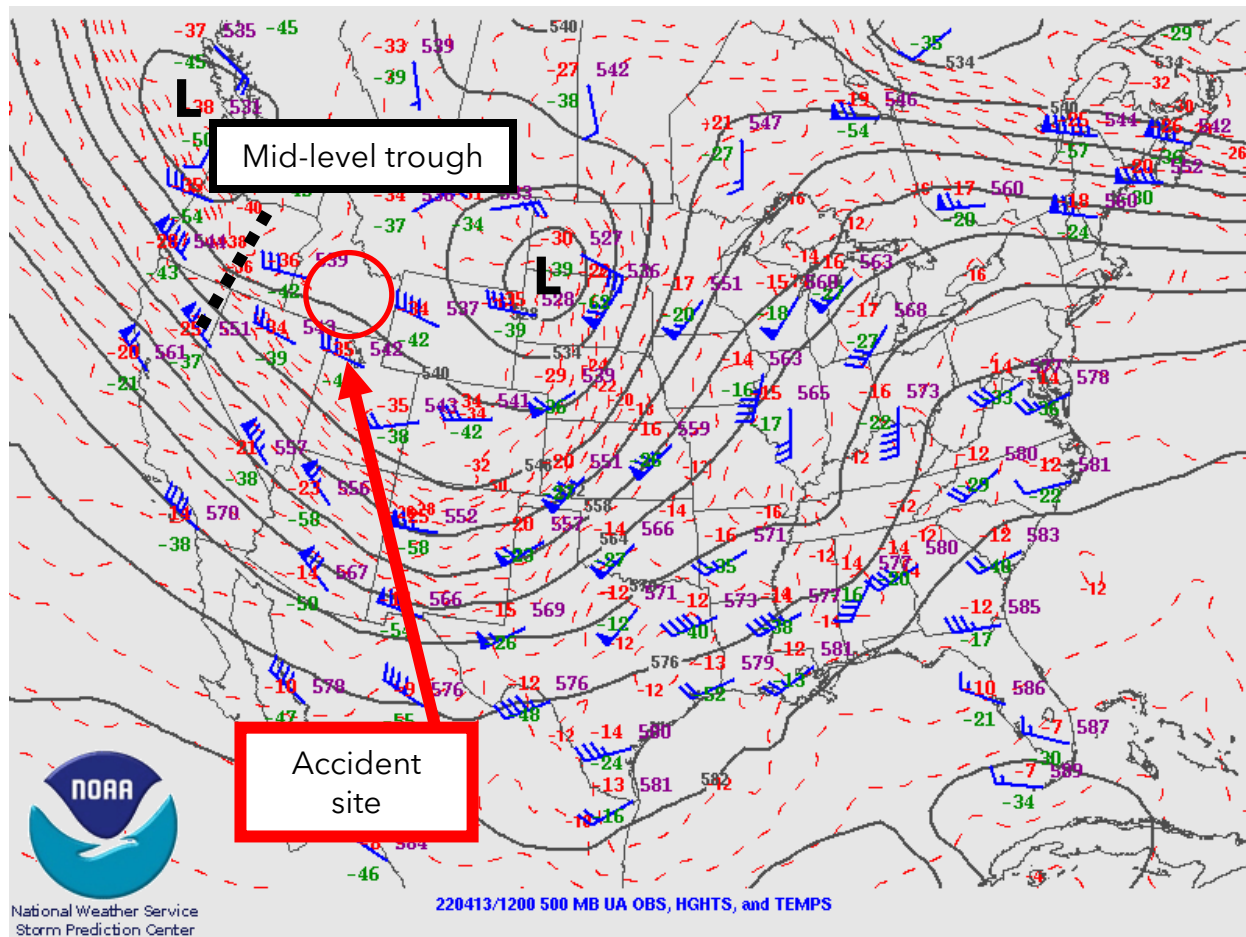


Figure 3. 500-hPa Constant Pressure Chart for 0600 MDT.

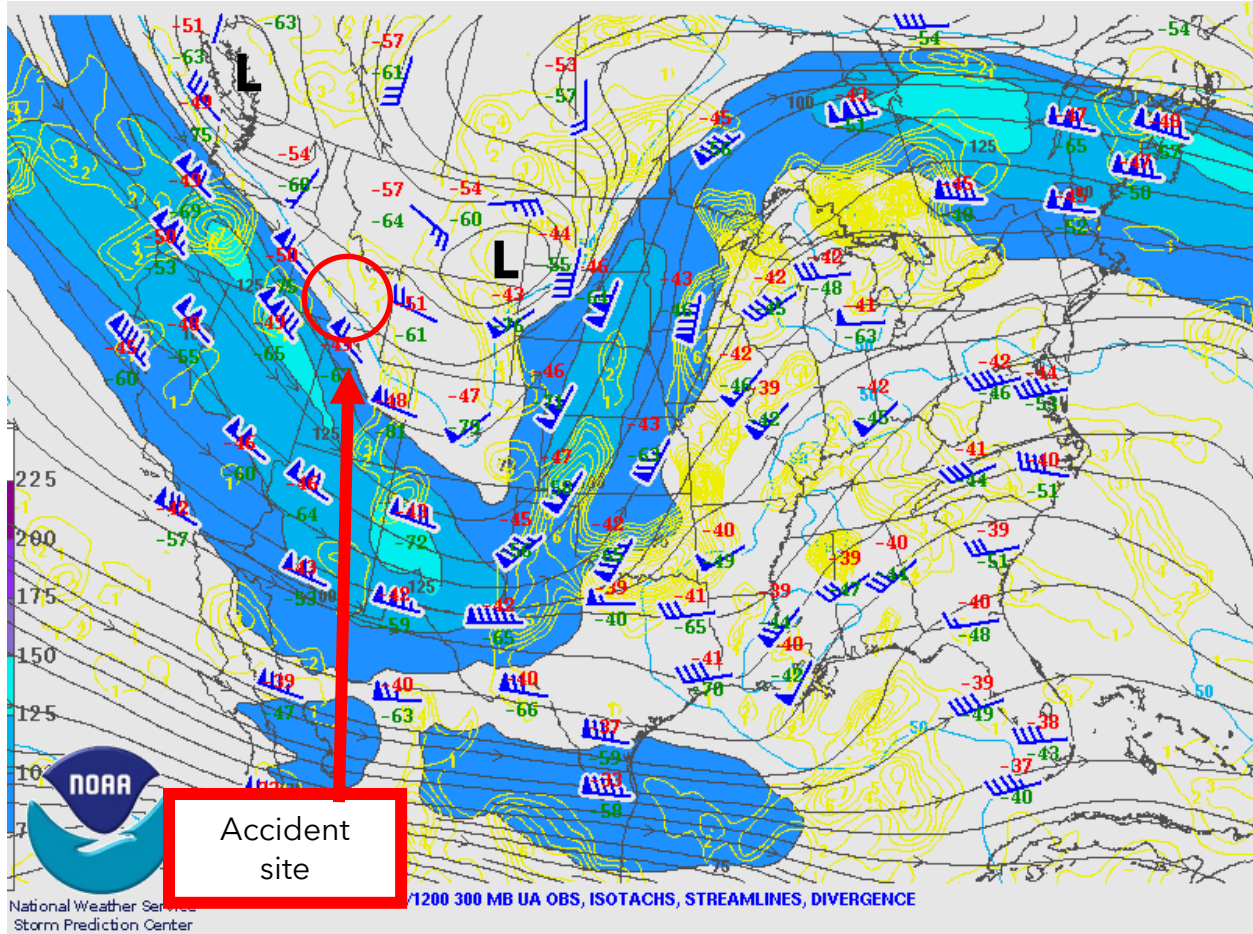


Figure 4. 300-hPa Constant Pressure Chart for 0600 MDT.

2.0 Storm Prediction Center Convective Outlook

SPC issued the following Day 1 Convective Outlook at 0658 MDT (figure 5) with areas of general thunderstorms forecast for the accident site. SPC defines the “TSTM” area as an area that encloses where a 10% or higher probability of thunderstorms is forecast during the valid period. The SPC Day 1 Convective Outlook text follows figure 5.

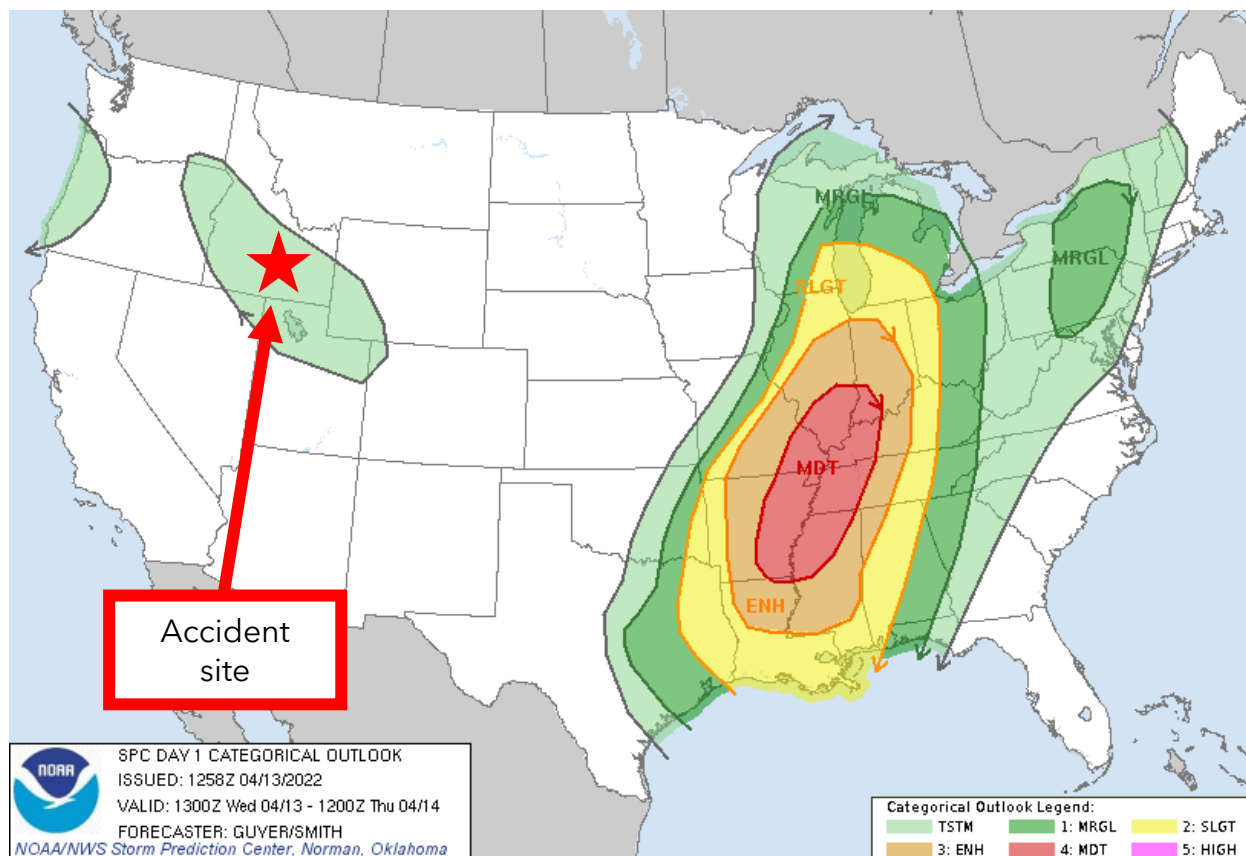


Figure 5. SPC day 1 Convective Outlook valid at the time of the accident.

SPC AC 131258

Day 1 Convective Outlook
NWS Storm Prediction Center Norman OK
0758 AM CDT Wed Apr 13 2022

Valid 131300Z - 141200Z

...THERE IS A MODERATE RISK OF SEVERE THUNDERSTORMS ACROSS PORTIONS OF AR/MS/TN/MO/IL/IN/KY...

...SUMMARY...

Numerous severe thunderstorms are expected today across the Mid-South and lower/middle Mississippi Valley and Midwest. Tornadoes, some of which will be strong, widespread and potentially significant damaging thunderstorm winds, and large hail are likely especially within the Moderate and Enhanced Risk areas.

A severe-storm outbreak is expected today into tonight. Widespread severe storms are likely across a very broad north-south region from the Lower Mississippi Valley and Mid-South into the Midwest, with

atmospheric ingredients favorable for all severe hazards, including potentially significant/intense severe storms.

...Mid-South/Lower to Middle Mississippi Valley/Midwest...

An upper trough, with its axis centered over the High Plains early today, will eject northeastward toward the Midwest/Ohio Valley, with a pronounced strengthening of mid/high-level jet stream winds (80-110 kt) particularly over the Ozarks/Midwest/Ohio Valley. These strong winds and related height falls/forcing for ascent will overspread a semi-moist boundary layer (low to middle 60s F surface dewpoints) across the Midwest ahead of an eastward-moving cold front, with more consequential moisture availability (upper 60s F) expected across the ArkLaTex/Mid-South/Lower Mississippi Valley, where severe/supercell-conducive wind profiles will exist even well south of the stronger portions of the polar jet.

Speaking to early morning airmass characteristics, pre-dawn surface analysis in conjunction with 00z and 06z (via PERiLS project) upper-air analysis/trends reflect some air mass impacts via a persistent MCS and resultant MCV across western Tennessee and nearby ArkLaMiss. Observed meso-high and MCS-aftermath dry air in vicinity of the ArkLaMiss are expected to decay relatively early today, although these factors cast some uncertainty for the spatial details of later-day availability of rich moisture. For these reasons, along with a considerable amount of upstream early day convection/cloud cover, an upward adjustment to the current Moderate Risk category does not appear prudent at this time /13z/. That said, regarding the early day MCV/lingering outflow, an ample moisture reservoir over east Texas (850 mb dewpoints 12+C) is expected to largely replenish the broad warm/moist sector into the afternoon (reference 12z Shreveport LA observed sounding etc.), which will be beneath a notable eastward-extending elevated mixed layer.

For short-term details across southeast Oklahoma and the ArkLaTex, see Mesoscale Discussion 471. Regarding central/southern Missouri and western Illinois in the short-term, see Mesoscale Discussion 472.

By midday/early afternoon, moderate to strong instability and steadily weakening CINH will be in place across Arkansas/Louisiana toward the Lower Mississippi Valley, where model forecasts have MLCAPE in the 2000 to 3000 J/kg range. Ample deep-layer/low-level shear will be favorable for supercells, initially capable of large hail and tornadoes. Discrete supercells ahead of the organizing squall line will have the potential for strong/intense tornadoes including some that are potentially long-track, particularly as the

low-level jet further strengthens across the region later this afternoon into early evening. This corridor of stronger/longer-duration tornado concern is focused across the Mid-South/ArkLaMiss vicinity. Otherwise, potentially widespread/locally significant damaging thunderstorm wind gusts will also evolve as the squall line organizes, intensifies, and moves eastward with embedded bowing segments, although QLCS-related tornadoes can also be expected.

The damaging wind/tornado risk may linger through the late-evening/overnight hours across portions of Mississippi/Alabama and southern Louisiana and the Florida Panhandle. This would be via a persistence of moist and strong/confluent low-level flow, although 850 mb winds are forecast to gradually weaken overnight.

For areas northward into/across Missouri, Illinois, and Indiana, it appears likely that storms will increase and intensify initially across southern Missouri, as early as this morning in vicinity of the outflow-enhanced effective cold front. These storms will pose a damaging wind and some severe hail risk especially into the afternoon as they organize and race east-northeastward. The potential for tornadoes will exist as well, in dual scenarios including any pre-squall line supercellular development and within an evolving QLCS itself, especially as storms encounter a dramatically strengthening south-southwesterly low-level jet (50-60 kt at 850 mb) across southeast Missouri and areas eastward across Illinois/Indiana/Kentucky. Tornadoes and potentially widespread/locally significant damaging winds are likely especially through the afternoon and early/mid-evening hours.

...Northeast States...

Low-level moistening will occur today in the wake of a northward-shifting warm front, with isolated thunderstorm development across the region this afternoon expected to be aided by a northeastward-moving shortwave trough aside from orographic lift. Weak to locally moderate destabilization across central New York into central/eastern Pennsylvania may support a few severe storms as lapse rates diurnally steepen. A few instances of wind damage and hail would be the primary hazards.

..Guyer/Smith.. 04/13/2022

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

3.0 Surface Observations

The area surrounding the accident site was documented using official Aviation Routine Weather Reports (METARs) and Specials Reports (SPECIs). The following observations were taken from standard code and are provided in plain language. Figure 6 is a local sectional chart with the accident site and the closest weather reporting locations marked. The chart depicted the magnetic variation³ of 12° east over the area.

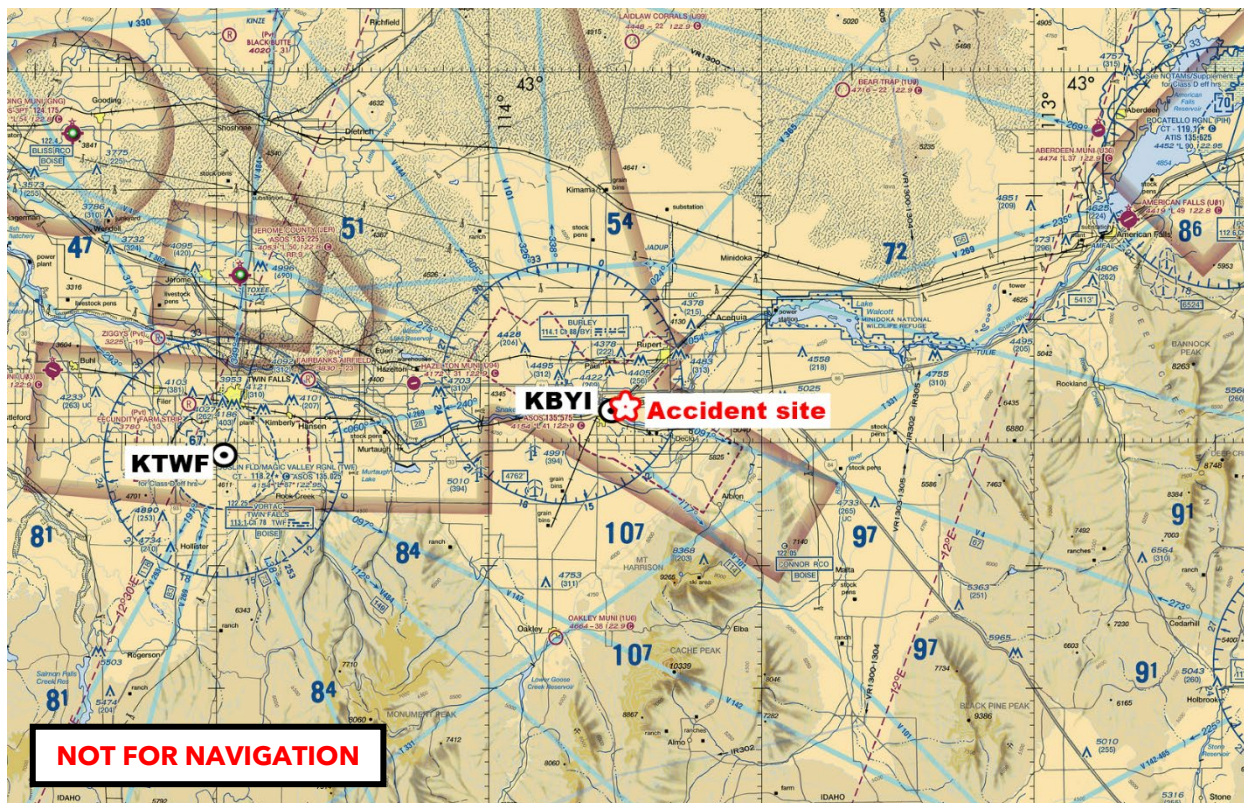


Figure 6. Sectional map of the accident area with the location of the accident site and surface observation sites.

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

Burley Municipal Airport (KBYI), the intended destination airport, had the closest official weather station to the accident site. KBYI had an Automated Surface Observing System (ASOS⁴) whose longline⁵ reports were not augmented. The KBYI ASOS was located within a mile southwest of the accident site, at an elevation of around 4,154 ft, and issued the following observations surrounding the period of the accident:⁶

[0706 MDT] SPECI KBYI 131306Z AUTO 20006KT 2SM -SN BR FEW006
SCT019 OVC027 M04/M05 A2995 RMK AO2 P0000 T10391050=

[0726 MDT] SPECI KBYI 131326Z AUTO 20006KT 6SM -SN BR FEW007
BKN018 OVC027 M04/M05 A2996 RMK AO2 P0000 T10391050=

[0753 MDT] METAR KBYI 131353Z AUTO 20006KT 7SM -SN FEW019
BKN024 OVC033 M03/M06 A2996 RMK AO2 SNE31B50 SLP164 P0000
T10331056=

[0801 MDT] SPECI KBYI 131401Z AUTO 20008KT 2 1/2SM -SN BR
BKN026 OVC033 M03/M05 A2996 RMK AO2 P0000 T10281050=

**[0810 MDT] SPECI KBYI 131410Z AUTO 19008KT 1SM -SN BR
BKN023 OVC028 M03/M05 A2996 RMK AO2 P0000 T10331050=**

MISSED APPROACH at KBYI 0812 MDT

ACCIDENT TIME 0832 MDT

**[0840 MDT] SPECI KBYI 131440Z AUTO 21008KT 2 1/2SM -SN
BKN030 OVC047 M03/M06 A2997 RMK AO2 P0000 T10281056=**

[0845 MDT] SPECI KBYI 131445Z AUTO 20008KT 4SM -SN BR BKN032
BKN040 OVC048 M03/M05 A2997 RMK AO2 P0000 T10281050=

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

⁵ "Longline" refers to the dissemination of weather observations with the intent that they are available in near-real time to national databases and accessible to the general global public from a large number of vendors. This does not include public accessibility to observations from a reporting station's Very High Frequency (VHF; line-of-site) or telephone broadcast, where applicable. Longline dissemination of weather observations is the primary vehicle through which the weather observations are distributed.

⁶ The bold sections in this NWS product and the rest of the products in this report are intended to highlight the text 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.

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

KBYI weather at 0810 MDT, automated, wind from 190° at 8 knots, visibility 1-mile, light snow, mist, broken ceiling at 2,300 ft above ground level (agl), overcast skies at 2,800 ft agl, temperature of -3° Celsius (C), dew point temperature -5°C, and an altimeter setting of 29.96 inches of mercury (inHg). Remarks: automated station with a precipitation discriminator, a trace of precipitation since 0753 MDT, temperature -3.3°C, dew point temperature -5.0°C.

KBYI weather at 0840 MDT, automated, wind from 210° at 8 knots, visibility 2.5 miles, light snow, broken ceiling at 3,000 ft agl, overcast skies at 4,700 ft agl, temperature of -3°C, dew point temperature -6°C, and an altimeter setting of 29.97 inHg. Remarks: automated station with a precipitation discriminator, a trace of precipitation since 0753 MDT, temperature -2.8°C, dew point temperature -5.6°C.

For additional KBYI METARs and SPECIs please see attachment 1.

The next closest official weather station to the accident site was Joslin Field/Magic Valley Regional Airport (KTWF), located 32 miles west of the accident site at an elevation of 4,154 ft. KTWF had an ASOS whose longline reports were augmented by ATC when the tower was in operation⁷. KTWF ASOS observations surrounding the accident time are shown below:

[0353 MDT] METAR KTWF 130953Z AUTO 24008KT 10SM FEW045
OVC050 M02/M06 A2992 RMK AO2 SLP141 T10221056=

[0453 MDT] METAR KTWF 131053Z AUTO 21007KT 10SM OVC060
M02/M06 A2993 RMK AO2 SLP140 T10221056=

[0553 MDT] METAR KTWF 131153Z 22007KT 10SM SCT041 OVC050
M02/M06 A2993 RMK AO2 SLP141 70001 T10221056 11022 21044
53003=

[0653 MDT] METAR KTWF 131253Z 25010KT 10SM FEW120 M03/M06
A2995 RMK AO2 SLP147 T10281061=

**[0753 MDT] METAR KTWF 131353Z 24008KT 10SM BKN060
BKN075 OVC095 M02/M06 A2997 RMK AO2 SLP158 T10221056=**

ACCIDENT TIME 0832 MDT

⁷ ATC operational hours 0600 to 2100 local time.

**[0853 MDT] METAR KTWf 131453Z 23010KT 10SM CLR M01/M06
A2998 RMK AO2 SLP159 T10061056 52014=**

[0953 MDT] METAR KTWf 131553Z 26012KT 10SM OVC033 00/M06
A2999 RMK AO2 SLP162 T00001056=

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

KTWF weather at 0753 MDT, wind from 240° at 8 knots, visibility 10 miles or greater, broken ceiling at 6,000 ft agl, broken skies at 7,500 ft agl, overcast skies at 9,500 ft agl, temperature of -2°C, dew point temperature -6°C, and an altimeter setting of 29.97 inHg. Remarks: automated station with a precipitation discriminator, sea level pressure 1015.8 hPa, temperature -2.2°C, dew point temperature -5.6°C.

KTWF weather at 0853 MDT, wind from 230° at 10 knots, visibility 10 miles or greater, clear skies, temperature of -1°C, dew point temperature -6°C, and an altimeter setting of 29.98 inHg. Remarks: automated station with a precipitation discriminator, sea level pressure 1015.9 hPa, temperature -0.6°C, dew point temperature -5.6°C, 3-hourly pressure increase of 1.4 hPa.

The observations from KBYI surrounding the accident time indicated IFR⁸ conditions due to visibility restrictions in the snow with VFR conditions present at KTWf.

⁸ 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.

4.0 Upper Air Sounding

A High-Resolution Rapid Refresh (HRRR)⁹ model sounding was created for the approximate accident site coordinates for 0900 MDT.¹⁰ The HRRR sounding was plotted on a standard Skew-T Log P diagram¹¹ from the surface to 600-hPa (or approximately 14,000 ft) using the RAOB¹² software package and is included as figure 7. The sounding depicted an elevation of 4,147 ft over the grid point with a near surface temperature of -1.3°C and a dew point temperature of -5.7°C. The sounding depicted the lifted condensation level (LCL)¹³ at 1,789 ft agl, the level of free convection (LFC)¹⁴ at 1,906 ft agl, and the convective condensation level (CCL)¹⁵ at 2,369 ft agl. The precipitable water value at 0.20 inches.

⁹ The HRRR is a NOAA real-time three-kilometer resolution, hourly-updated, cloud-resolving, convection-allowing atmospheric model, initialized by three-kilometer grids with three-kilometer radar assimilation. Radar data is assimilated in the HRRR every 15 minutes over a one-hour period.

¹⁰ HRRR sounding was created using NOAA Air Resource Laboratory:

<https://ready.arl.noaa.gov/READYamet.php>

¹¹ Skew T log P diagram – is a standard meteorological plot using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

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

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

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

¹⁵ CCL – The level in the atmosphere to which an air parcel, if heated from below, will rise dry adiabatically, without becoming colder than its environment just before the parcel becomes saturated.



The 0900 MDT HRRR sounding wind profile indicated a near surface wind from 220° at 7 knots with the wind remaining southwesterly at 10 knots below 6,000 ft. Above 6,000 ft, the wind became westerly between 10 and 20 knots through 14,000 ft. RAOB indicated the possibility of light low-level wind shear (LLWS) below 100 ft agl and light clear air turbulence above 10,000 ft.

5.0 Satellite Data

Geostationary Operational Environmental Satellite numbers 16 and 17 (GOES-16, -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. Visible and infrared imagery (GOES-16,-17 bands 2 and 13) at wavelengths of 0.64 microns (μm) and 10.3 μm , respectively, were retrieved for the period from 0600 MDT through 1200 MDT and reviewed, and the closest images to the time of the accident were documented.

Figure 8 is the GOES-17 visible imagery from 0830 MDT at 2X magnification with the accident site highlighted with a red square and cloud cover indicated above the accident site. The cloud cover was moving from west to east with cloud cover remaining over the accident site (attachment 2, GOES-16 imagery). Figure 9 presents the GOES-17 infrared imagery from 0830 MDT at 6X magnification with the accident site highlighted with a red square and cloud cover indicated above the accident site. The lower brightness temperatures (green colors; higher cloud tops) were located to the south of the accident site. The brightness temperature of 265 Kelvin above the accident site would have been near 7,000 ft based on the vertical temperature profile provided by the 0900 MDT HRRR sounding. It should be noted these figures have not been corrected for any parallax error.

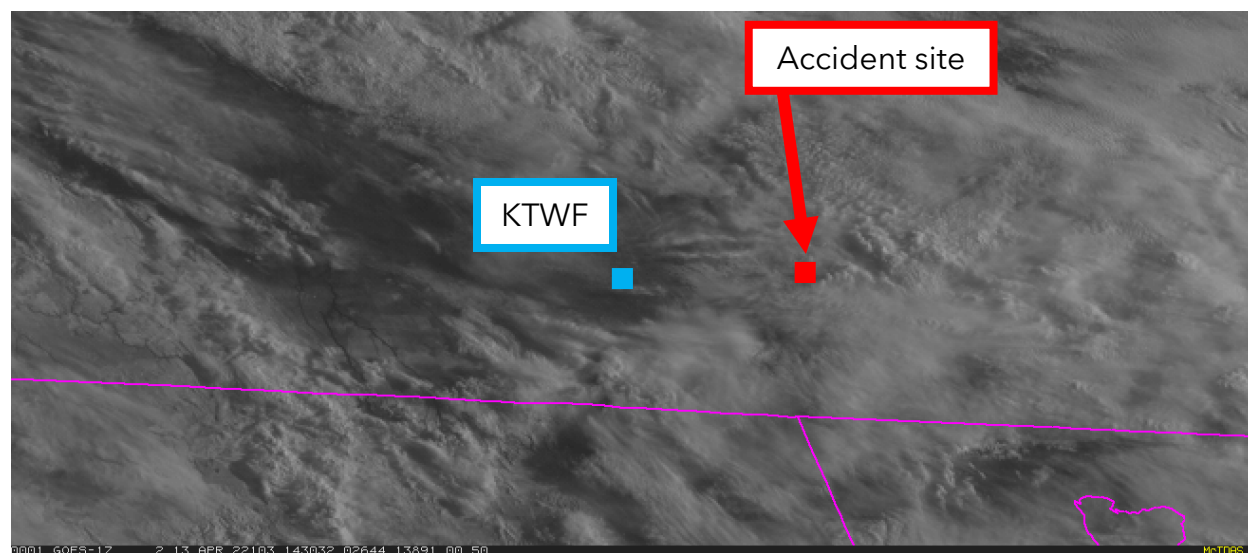


Figure 8. GOES-17 visible image at 0830 MDT.

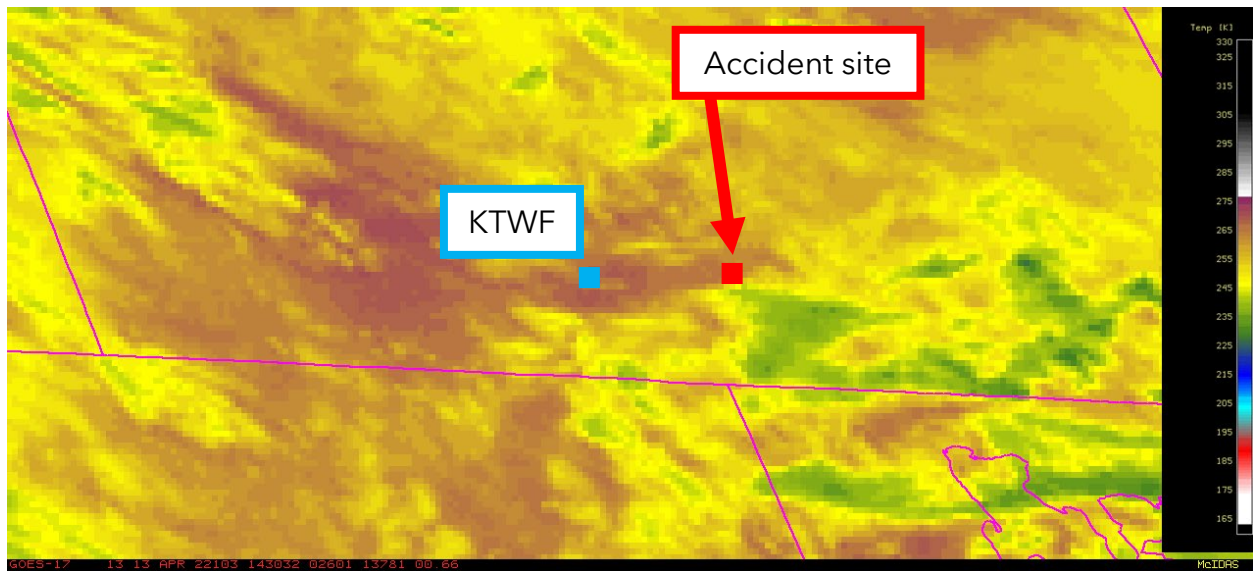


Figure 9. GOES-17 infrared image at 0830 MDT.

6.0 National Radar Imagery

A regional view of the NWS National Reflectivity Mosaic is included as figure 10 for 0830 MDT with the approximate location of the accident site marked by a red circle. The image depicted 10 to 20 dBZ¹⁶ echoes above the accident site.

¹⁶ dBZ - A non-dimensional "unit" of radar reflectivity which represents a logarithmic power ratio (in decibels or dB) with respect to radar reflectivity factor, Z.

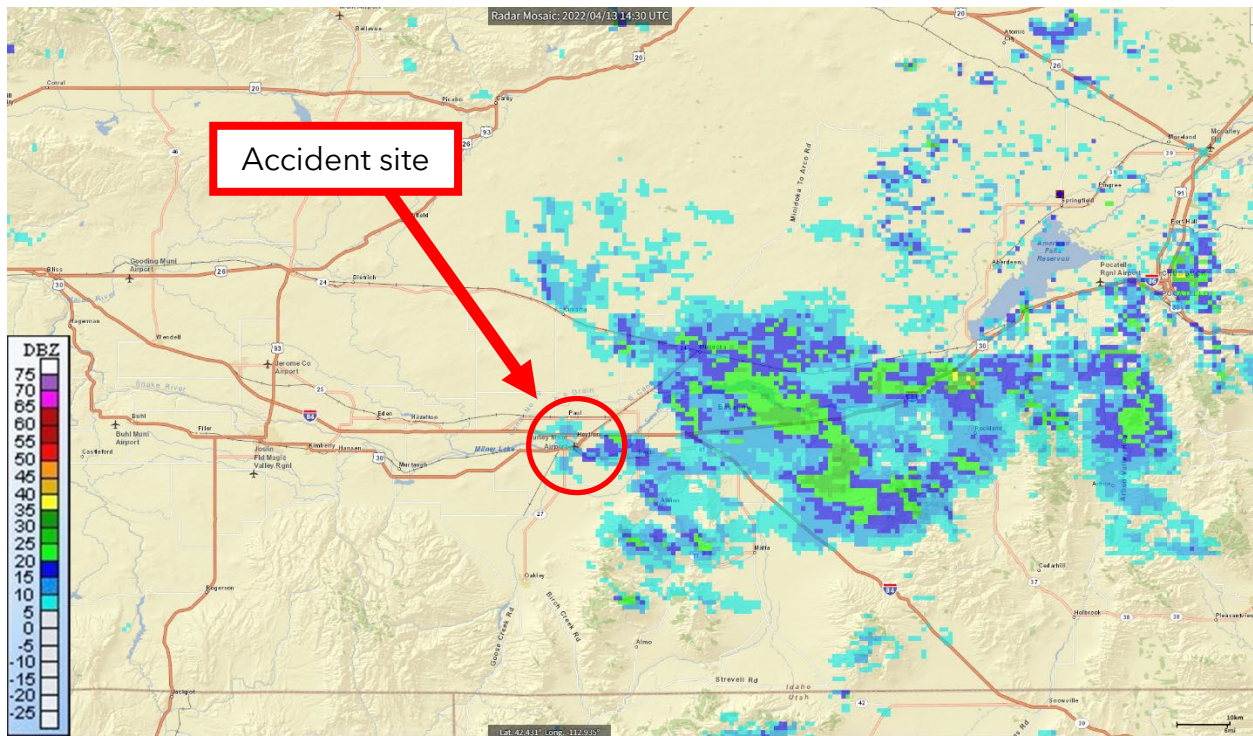


Figure 10. National Reflectivity Mosaic for 0830 MDT.

7.0 Weather Surveillance Radar Imagery

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)¹⁷ to the accident site was Pocatello, Idaho, (KSFY) located 58 miles northeast of the accident site. Level II archive radar data were obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

7.1 Volume Scan Strategy

The WSR-88D is a computer-controlled radar system, which automatically creates a complete series of specific scans in a specific sequence known as a volume scan. Individual elevation scans are immediately available. Products that require data from multiple elevation scans are not available until the end of the five-to-ten-minute volume scan.

¹⁷ 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.

The WSR-88D operates in two main scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan where the radar makes 15 elevation scans from 0.5° to 19.5° every six minutes or so. This particular scanning strategy is documented as volume coverage pattern 215 (VCP-215, figure 11). Mode B is the clear-air mode, where the radar makes 5 elevation scans during a ten-minute period. During the period surrounding the accident, the KSFY WSR-88D radar was operating in the precipitation mode VCP-215. The following figure provides an indication of the different elevation angles in this VCP, and the approximate height and width of the radar beam with distance from the radar site.

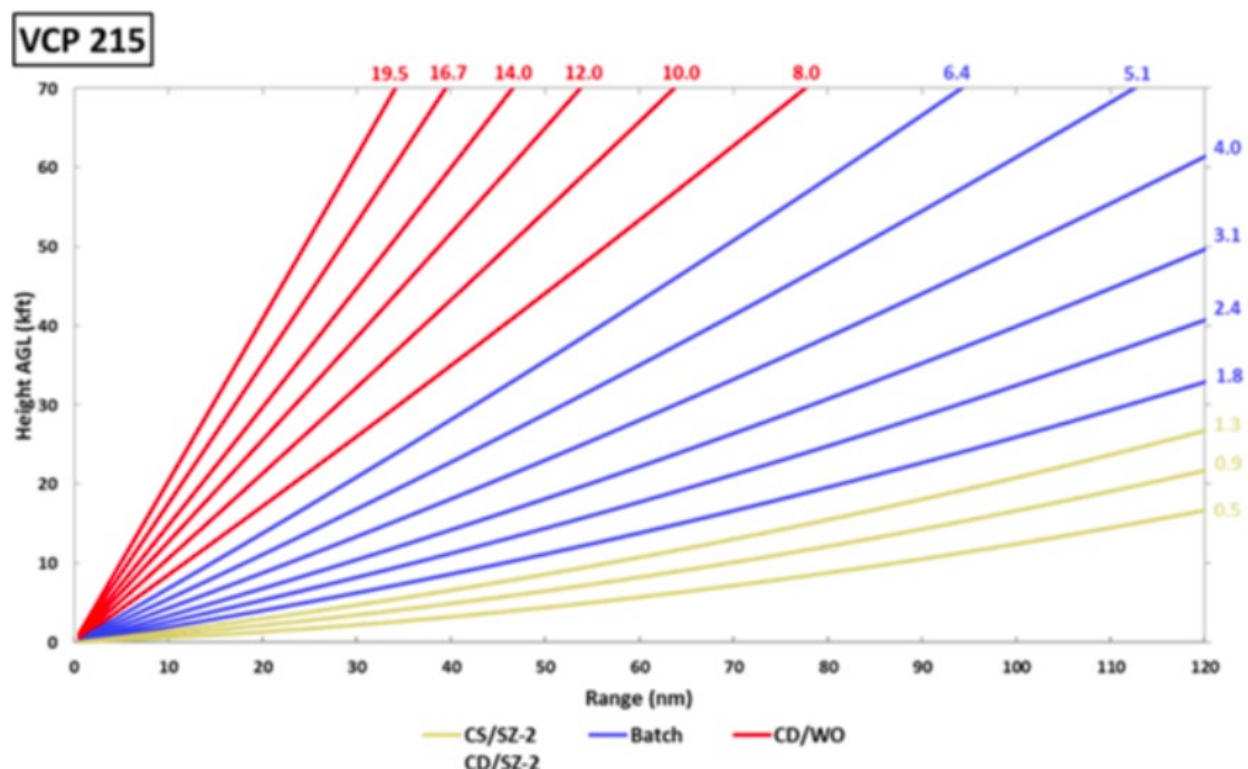


Figure 11. VCP-215 Precipitation Mode Scan Strategy¹⁸.

¹⁸ Contiguous Surveillance (CS)--The low Pulse Repetition Frequency (PRF) scan of the split cut. Gives a high R_{max} value to determine proper target location and intensity, but a low V_{max} value limits the velocities that can be measured. Contiguous Doppler (CD)--The high PRF scan of the split cut. Gives a low R_{max} value causing more range folded (multiple trip) echoes, but a high V_{max} value to get higher, more accurate velocity values. Batch Mode - Uses alternating low and high PRFs on each radial for one full rotation at each elevation angle. The two resulting data sets (low PRF and high PRF) are combined to resolve range ambiguity. Used in the middle elevation angles. W - With range unfolding (W) WO - Without range unfolding (WO)

7.2 Beam Height Calculation

Assuming standard refraction¹⁹ of the KSFx WSR-88D radar beam with an antenna height at 4,539 ft, and considering a beamwidth²⁰ of 0.95°, the following table shows the approximate heights for the radar beam center, base, and top for antenna elevations over the accident site. These heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
KSFx 0.5°	10,050 ft	7,190 ft	12,910 ft

Based on the radar height calculations, the elevation scans from KSFx listed in the above table depicted the conditions between 7,190 ft and 12,910 ft over the accident site and these scans "saw" the closest altitudes to the ground.

¹⁹ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

²⁰ Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

7.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²¹ it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in dBZ and is a general measure of echo intensity. FAA Advisory Circular AC 00-24C²², "Thunderstorms," dated February 19, 2013, defines the echo intensity levels and weather radar echo intensity terminology associated with those levels. For dBZ values less than 30 the weather radar echo intensity terminology should be "light." For dBZ values between 30 and 40, the terminology should be "moderate." "Heavy" terminology is used for dBZ values greater than 40 dBZ but less than 50 dBZ, inclusive. With any dBZ values above 50 dBZ shall be described as "extreme."

7.4 Base Reflectivity and Lightning Data

Figures 12 through 17 present the KSFY WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 0759:43, 0809:00, 0813:38, 0818:17, 0827:33, and 0832:10 MDT, respectively, with a resolution of 0.5° X 250 m. The flight track data²³ was added to figures 12 through 17 for context. Reflectivity values between 5 and 20 dBZ were located above the accident site and at or above the accident flight level and track for the majority of the time from 0759 MDT onward. The band of precipitation was moving from west to east with time (attachment 3).

There were no lightning flashes²⁴ reported within 50 miles of the accident site within 30 minutes prior to or following the accident time.²⁵

²¹ Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at the earth's surface; also, any water particles blown by the wind from the earth's surface. Hydrometeors are classified as; (a) Liquid or solid water particles suspended in the air: cloud, water droplets, mist, or fog. (b) Liquid precipitation: drizzle and rain. (c) Freezing precipitation: freezing drizzle and freezing rain. (d) Solid (frozen) precipitation: ice pellets, hail, snow, snow pellets, and ice crystals. (e) Falling particles that evaporate before reaching the ground: virga. (f) Liquid or solid water particles lifted by the wind from the earth's surface: drifting snow, blowing snow, blowing spray. (g) Liquid or solid deposits on exposed objects: dew, frost, rime, and glazed ice.

²²

https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1020774

²³ For more information please see the docket in this accident.

²⁴ Lightning Flash – This is one contiguous conducting channel and all the current strokes/pulses that flow through it. There are two types of flashes: ground flashes and cloud flashes.

²⁵ A review of Earth Networks Total Lightning network and GOES-16 Geostationary Lightning Mapper was done.

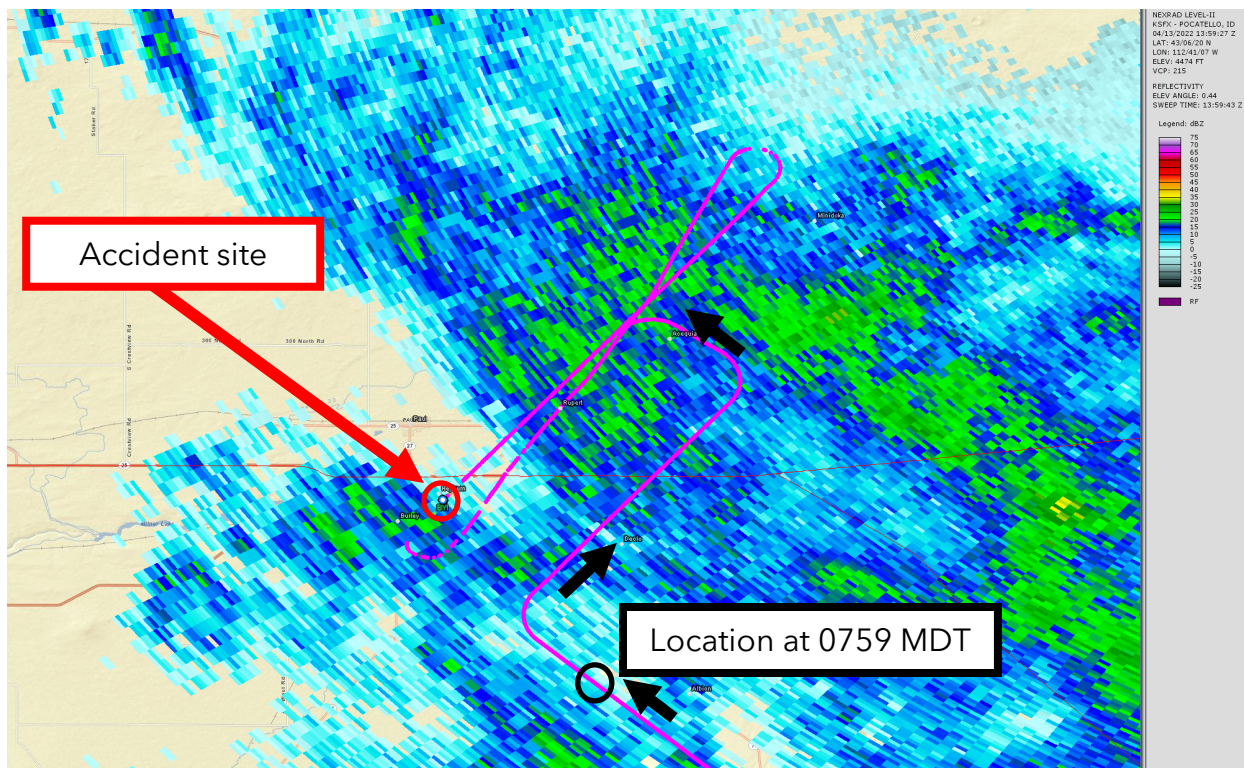


Figure 12. KSFx WSR-88D reflectivity for the 0.5° elevation scan initiated at 0759:43 MDT with the accident site marked with red circle. The flight track is in pink with arrows pointing in the direction of travel.

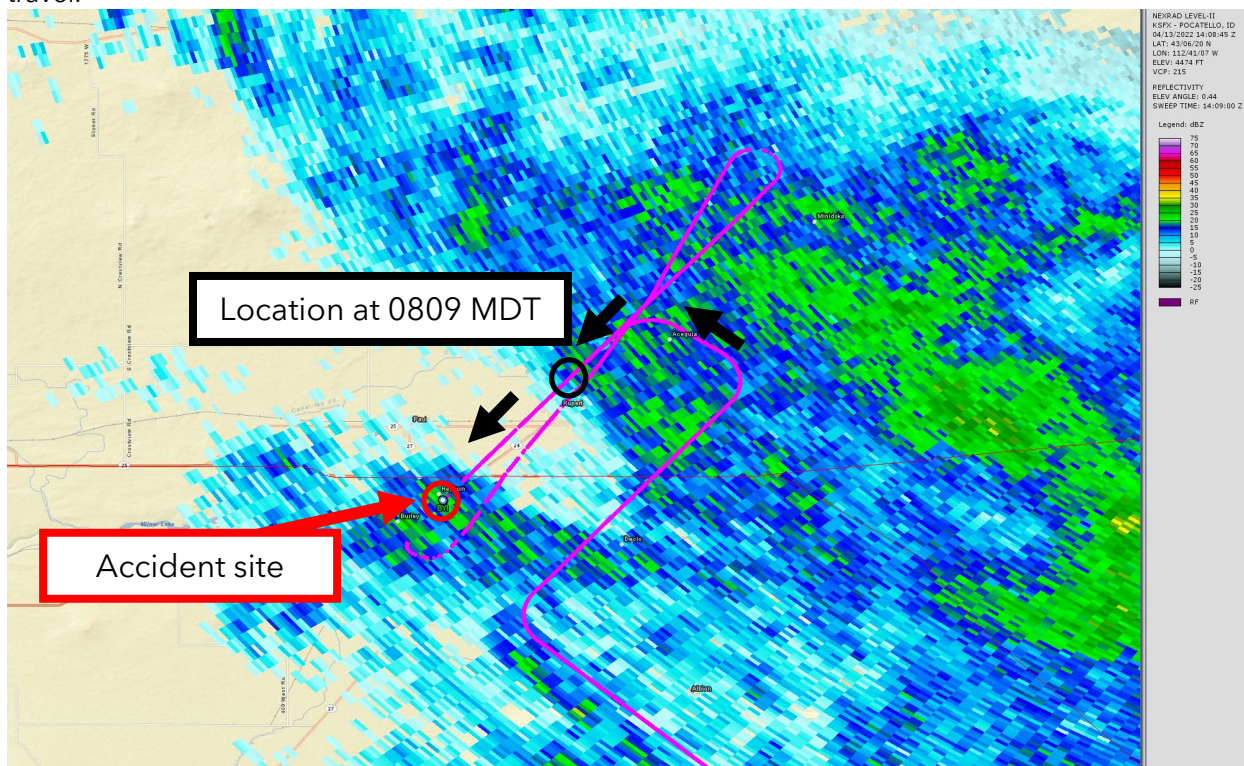


Figure 13. KSFx WSR-88D reflectivity for the 0.5° elevation scan initiated at 0809:00 MDT with the accident site marked with red circle. The flight track is in pink with arrows pointing in the direction of travel.

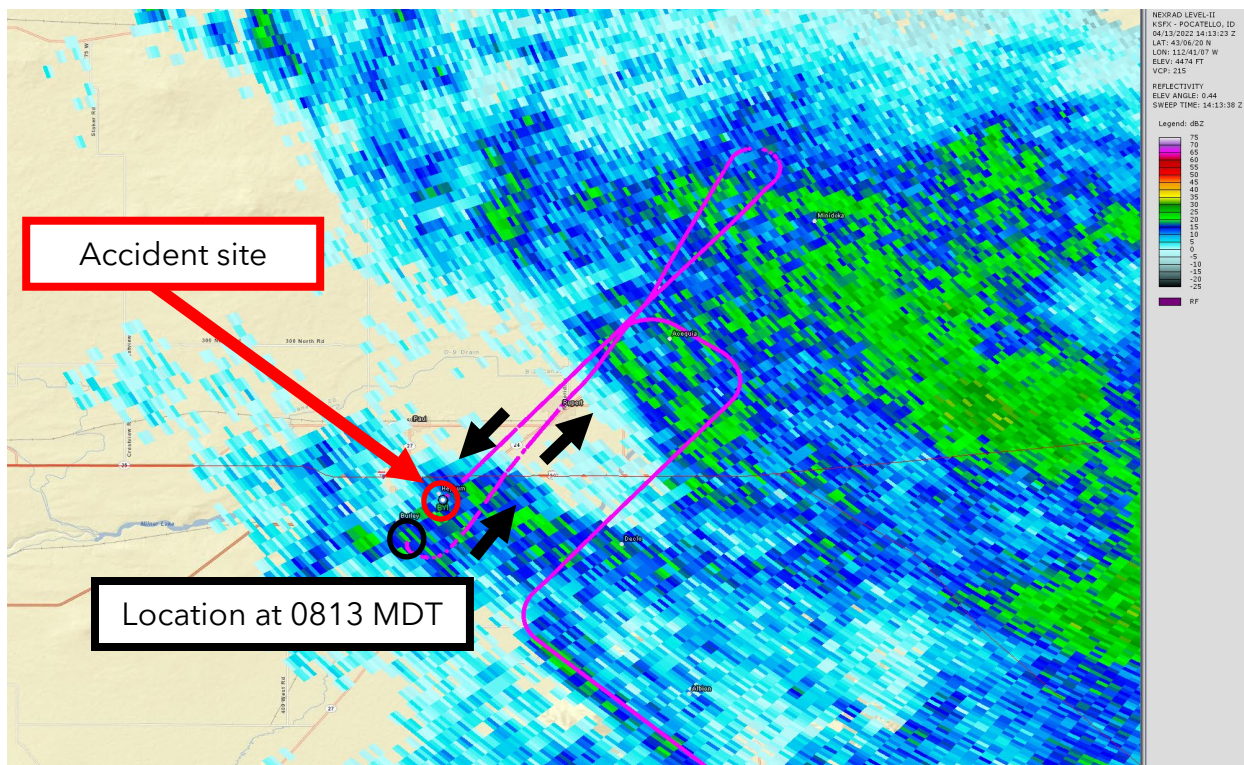


Figure 14. KSFx WSR-88D reflectivity for the 0.5° elevation scan initiated at 0813:38 MDT with the accident site marked with red circle. The flight track is in pink with arrows pointing in the direction of travel.

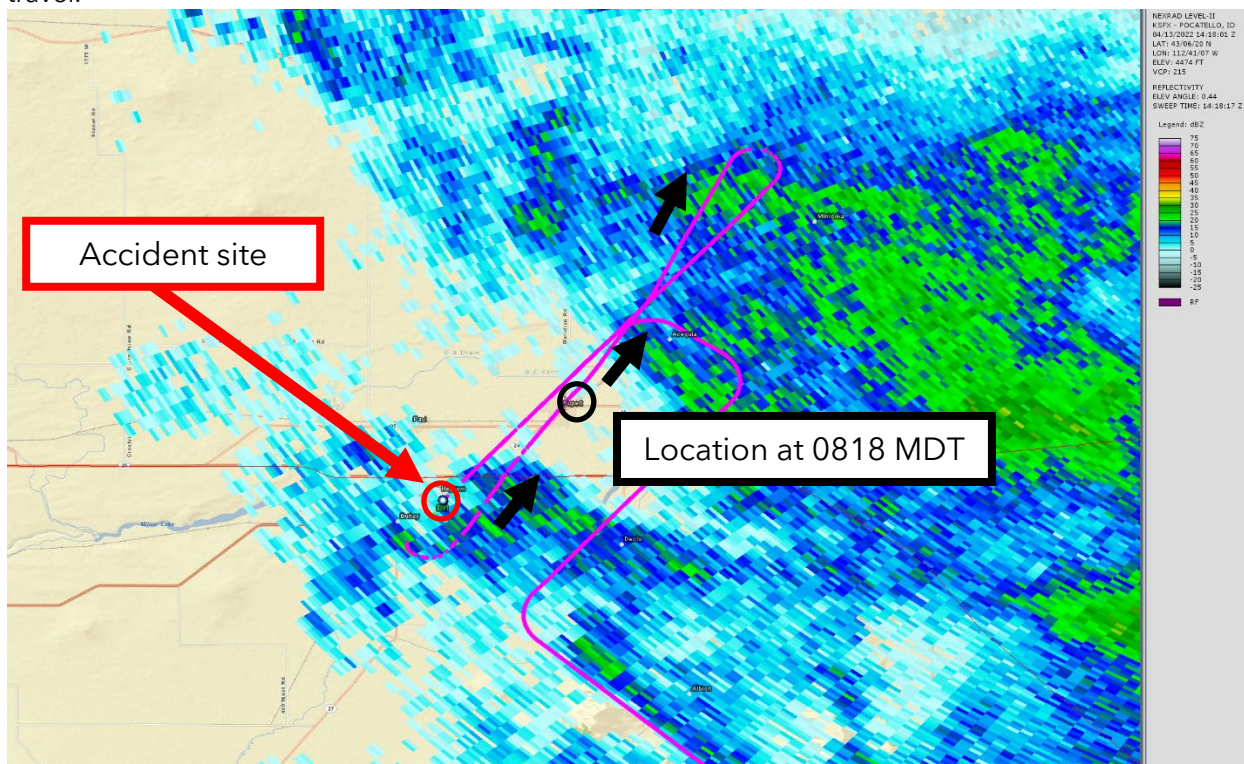


Figure 15. KSFx WSR-88D reflectivity for the 0.5° elevation scan initiated at 0818:17 MDT with the accident site marked with red circle. The flight track is in pink with arrows pointing in the direction of travel.

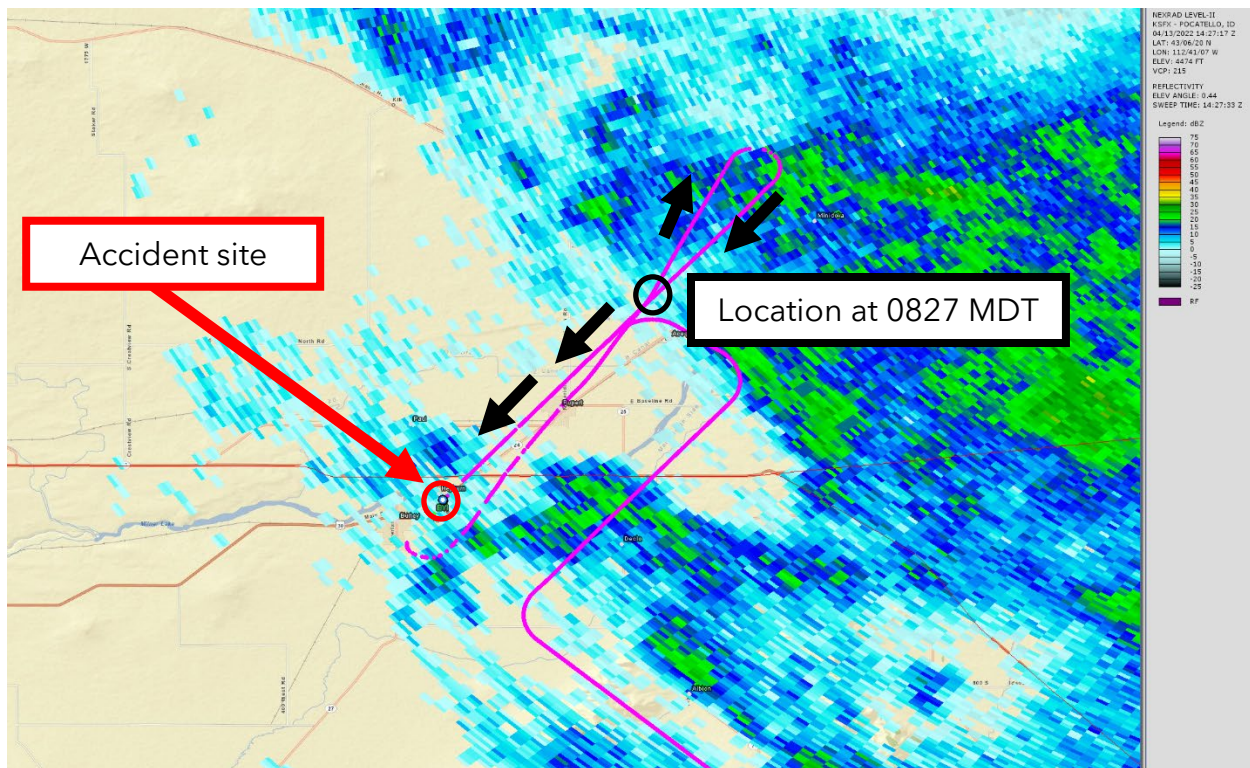


Figure 16. KSFx WSR-88D reflectivity for the 0.5° elevation scan initiated at 0827:33 MDT with the accident site marked with red circle. The flight track is in pink with arrows pointing in the direction of travel.

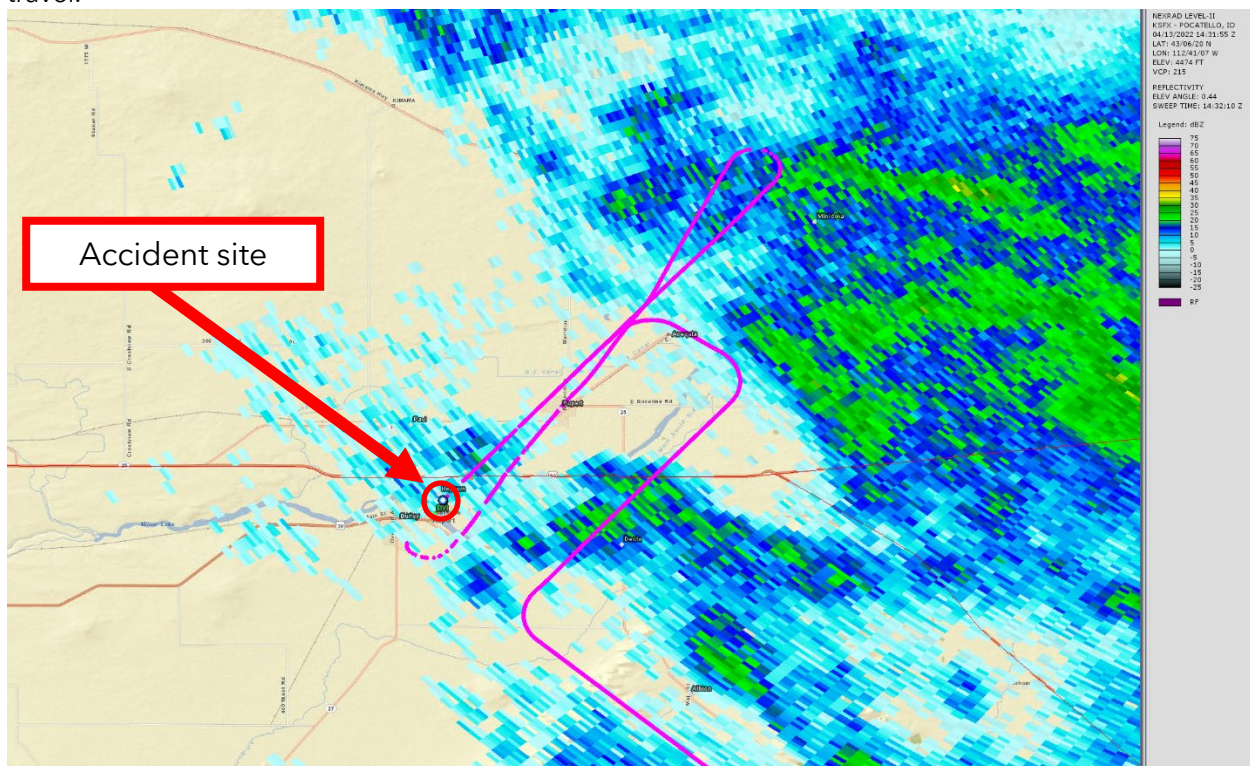


Figure 17. KSFx WSR-88D reflectivity for the 0.5° elevation scan initiated at 0832:10 MDT with the accident site marked with red circle. The flight track is in pink.

8.0 Pilot Reports

The longline-disseminated pilot reports²⁶ (PIREPs) distributed into the national airspace (NAS) were reviewed for about two hours either side of the accident time and the PIREPs issued into the NAS within 100 miles of the accident site for below 18,000 ft are shown below:

IDA UA /OV IDA/TM 1413/FL090/TP B190/SK OVC082-TOP090/TB NEG/IC NEG/RM DURD RY21

PIH UA /OV KPIH/TM 1420/FL070/TP C208/SK OVC070-TOP085/TA M18/TB NEG/IC LGT RIME 120-100/RM DURD RY3 PIH

BOI UA /OV BOI090030/TM 1501/FL100/TP C25B/SK VMC/WX UNLIMITED/TB NEG/IC NEG/RM SMOOTH

PIH UA /OV KPIH/TM 1546/FL110/TP C208/SK OVC-TOP110/TB NEG/IC NEG/RM DURD RY3 PIH

IDA UA /OV IDA/TM 1550/FL090/TP AT72/SK OVC084-TOP090/TB NEG/IC NEG/RM DURD RY03

9.0 Significant Meteorological Information

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

10.0 Center Weather Service Advisories

The Salt Lake City (ZLC) Air Route Traffic Control Center (ARTCC) Center Weather Service Unit (CWSU) was responsible for the accident region. There were no Center Weather Advisories (CWA)s valid from ZLC CWSU at the accident time. The pre-duty weather briefing produced by ZLC CWSU valid at the accident time is located in attachment 4. In addition, ZLC CWSU had weather website for Twin Falls, Idaho, (TWF) ATC with specific TWF area weather information²⁷.

²⁶ Only pilot reports with the World Meteorological Organization headers UBNV**, UBUT**, UBID**, UBWY**, UBMT**, and UBOR** were considered. These do not include pilot reports only broadcast via radio.

²⁷ [PDWB TWF \(weather.gov\)](https://www.weather.gov/pdwb/twf)

11.0 Airmen's Meteorological Information

There were text Airmen's Meteorological Information (AIRMET) advisories Sierra and Zulu valid for the accident site at the accident time. The Graphical AIRMETs²⁸ (G-AIRMET) valid at the accident time are contained in attachment 5 (section 12.0). Text AIRMETs Sierra and Zulu issued at 0410 and 0245 MDT, respectively, forecast mountain obscuration conditions due to clouds, precipitation and mist, and moderate icing between the freezing level²⁹ and 16,000 ft:

WAUS45 KPCI 131010 AAA
WA5S
-SLCS WA 131010 AMD
AIRMET SIERRA UPDT 2 FOR IFR AND MTN OBSCN VALID UNTIL 131500
.
AIRMET IFR...MT WY
FROM 30SSE YXC TO 40NW HVR TO 50NNW ISN TO 50SW RAP TO 30SW BIL
TO 80E DLN TO 30SSE YXC
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 15Z THRU 21Z.
.
AIRMET IFR...ID NV WA OR CA AND CSTL WTRS...UPDT
FROM 40S YDC TO 20ENE BOI TO 80WNW BAM TO 30NE RBL TO 20ENE ENI
TO 30WNW FOT TO 30S HQM TO 40S YDC
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 15Z THRU 21Z.
.
AIRMET MTN OBSCN...ID WY NV UT CO
FROM 40SE LKV TO 50SE REO TO 40NE LAR TO 50WSW PUB TO 30NNE RSK
TO 40W CHE TO 30W HVE TO 40SSW FMG TO 40SE LKV
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 15Z THRU 21Z.
.
AIRMET MTN OBSCN...ID MT WY
FROM 40SSW YQL TO GTF TO HVR TO 40NE LAR TO 50SE REO TO 70NNW
DNJ TO 70W HLN TO 40SSE YXC TO 40SSW YQL
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 15Z THRU 21Z.
.
OTLK VALID 1500-2100Z
AREA 1...IFR ID MT WY UT CO
BOUNDED BY 40SSE YXC-60ENE HVR-50NNW ISN-40SSW RAP-60SSW BOY-
40SE OCS-50ESE DTA-20NW SLC-30E PIH-40N JAC-40SSE YXC
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG THRU 21Z.
.
AREA 2...IFR ID MT NV WA OR CA AND CSTL WTRS
BOUNDED BY 70SSW YDC-70ENE PDT-50N LKT-20W DBS-60NW BAM-20E ENI-
40W FOT-30S HQM-70SSW YDC
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG THRU 21Z.
....

WAUS45 KPCI 130845
WA5Z

²⁸ <https://aviationweather.gov/gairmet>

²⁹ Freezing level between the surface and 4,000 ft.

-SLCZ WA 130845
AIRMET ZULU UPDT 1 FOR ICE AND FRZLVL VALID UNTIL 131500

.
AIRMET ICE...ID MT WY NV UT CO
FROM 80WSW YXC TO 40SSW YXC TO 50SSW HLN TO 30SSE CZI TO 30SW CYS
TO 30E HBU TO 50SE JNC TO 20NW MTU TO 20E DTA TO 30SE BVL TO 60SW
ELY TO 60SSW FMG TO 40SE LKV TO 50SE REO TO 80WSW YXC
MOD ICE BTN FRZLVL AND 160. FRZLVL SFC-040. CONDS CONTG BYD 15Z
THRU 21Z.

.
AIRMET ICE...MT
FROM 60NNE GGW TO 50NNW ISN TO 80SW DIK TO 50WNW MLS TO 40W GGW
TO 60NNE GGW
MOD ICE BLW 150. CONDS CONTG BYD 15Z THRU 21Z.

.
OTLK VALID 1500-2100Z...ICE ID MT WY NV UT CO WA OR CA AND CSTL
WTRS
BOUNDED BY 40SE YDC-50SE MLP-30SSE DBS-20NNE LAR-50E HBU-50SE
JNC-20NE MTU-40WNW HVE-70SE FMG-70SE SNS-130SW SNS-140WSW
FOT-140W TOU-40SE YDC
MOD ICE BTN FRZLVL AND FL180. FRZLVL SFC-080. CONDS CONTG THRU
21Z.

.
FRZLVL...RANGING FROM SFC-110 ACRS AREA
SFC ALG EED-40ENE PHX-20NNE SSO-40NW DMN-40NE TCS-LAA-50S GLD
080 ALG 40N BZA-20SSW SSO-50SE TCS-40W CME-40E CME-60SSW TXO

....

12.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products issued before the accident flight and valid at 0900 MDT are shown in attachment 5. The GFA surface forecast applicable to the accident region that was valid before the accident flight's departure for times surrounding the accident time indicated VFR surface visibilities with a chance (between 30 to 60 percent) of snow showers and a southwest surface wind at 5 knots. The GFA cloud forecast applicable to the accident region that was valid before departure for times surrounding the accident time indicated cloud bases between 5,000 and 6,000 ft and cloud tops 14,000 and FL210³⁰ with cirrus clouds above. The G-AIRMETs Sierra and Zulu were overlaid on the GFA cloud forecast imagery. The only human-generated information reflected in the two GFA products were the G-AIRMETs. For more information, please see attachment 5.

³⁰ 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 standard 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.

13.0 Terminal Aerodrome Forecast

KBYI was the closest site with an NWS Terminal Aerodrome Forecast³¹ (TAF) current at the time of the accident. The KBYI TAF was issued 0520 MDT and was valid for a 24-hour period beginning at 0600 MDT. The 0520 MDT TAF for KBYI was as follows:

TAF KBYI 131120Z 1312/1412 **24007KT P6SM VCSH BKN050 OVC080**
FM131700 27012G20KT P6SM VCSH SCT025 BKN050
FM132000 27014G24KT 6SM -SN SCT020 BKN035
FM140200 22009KT P6SM VCSH SCT030 BKN060
FM140800 22006KT P6SM BKN060=

Between 0600 and 1100 MDT the forecast expected a wind from 240° at 7 knots, greater than 6 miles visibility, vicinity³² showers, a broken ceiling at 5,000 ft agl, and overcast skies at 8,000 ft agl.

14.0 National Weather Service Area Forecast Discussion

The NWS Weather Forecast Office in Pocatello, Idaho, (WFO PIH) was responsible for the public forecast in the region of the accident site. WFO PIH issued the following Area Forecast Discussion (AFD) at 0327 MDT, the closest AFD to the accident time with an aviation section, that identified MVFR to IFR conditions within the precipitation:

FXUS65 KPIH 130927
AFDPIH

Area Forecast Discussion
National Weather Service Pocatello ID
327 AM MDT Wed Apr 13 2022

.SHORT TERM...Today through Thursday night.
Pattern of very cold conditions with periods of snow and rain will continue through Thursday night. Expect a narrow band of heavy snow near Blackfoot to dissipate this morning and will let winter weather advisory expire at 4 am. The next batch of snow and rain will come mainly this afternoon then dissipating overnight. Yet another wave will bring rain and snow Thursday as well. High elevations could see an inch or snow additional snow today. Could see 1 to 3 inches in the mountains Thursday. Incredibly cold

³¹ According to NWS Instruction 10-813: "An NWS TAF consists of the expected meteorological conditions significant to aviation at an airport for a specified time period. For the U.S., this is the area within five (5) statute miles (SM) of the center of an airport's runway complex."

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

³² In the vicinity of the airport is defined as a weather phenomenon within 5-10 statute miles of the airfield.

temperatures will continue today with most high temperatures in the 30s even at low elevations but some locations in low elevations may see lower 40s. Many low elevations will be in the mid to upper 40s on Thursday. Expect some difficult travel in the mountains the next two days mainly with the periods of snow continuing.

GK

.LONG TERM...Friday through Wednesday. General pattern remains very unsettled through the extended range, with passage of a system generally every other day into early next week. Driest days appear to be Friday and Sunday, with a trend toward drier and warmer beginning Tuesday. Saturday and Monday should be the wettest days, with a slow warm up with each system. Models are trending toward a more unstable airmass for Saturday, with an increasing potential for thunder during the day and ahead of the frontal passage overnight. In general, snow levels show a slow increase, with increasing chances of a valley rain/mountain snow event as compared to the colder short term period. Ensemble clusters are in general agreement with the trend toward a slow increase in daytime temperatures, and in general with timing of the major systems Saturday and Monday. Only change above the Blend was to nudge daytime winds upwards slightly toward 90th percentile speeds, in line with increased wind guidance. DMH

&&

.AVIATION...Persistent band of light snow continues through the Snake Plain, though it is lined up between KIDA and KPIH terminals. Outside of the snow band, ceilings remain MVFR to VFR early this morning. Next round of showers shifts through East Idaho this afternoon and evening. Temperatures remain cold enough to support snow or a rain/snow mix to valley floors, and isolated thunder might be possible as well. Confidence for precipitation with second band later today is highest for all but KIDA, and the best chance for TS would fall at KBYI/KPIH 18Z-03Z. Expect ceilings to remain MVFR or better except MVFR/IFR during precipitation. DMH

&&

.PIH WATCHES/WARNINGS/ADVISORIES...
None.

&&

\$\$

15.0 Winds and Temperature Aloft Forecast

The NWS Winds and Temperature Aloft forecast issued at 0759 MDT and valid for the closest point to the accident site is included below:

FBUS31 KWNO 131359
FD1US1
DATA BASED ON 131200Z
VALID 131800Z FOR USE 1400-2100Z. TEMPS NEG ABV 24000

FT 3000 6000 9000 12000 18000 24000 30000 34000 39000
PIH 2705 2719-13 2723-20 2823-36 2941-46 297350 296551 286551

The closest forecast point to the accident site was Pocatello, Idaho, (PIH). The 0759 MDT PIH forecast for use between 0800 MDT and 1500 MDT indicated a wind at 6,000 ft from 270° at 5 knots, a wind at 9,000 ft from 270° at 19 knots with a temperature of -13°C, and a wind at 12,000 ft from 270° at 23 knots with a temperature of -20°C.

16.0 Icing Potential

The NWS Current Icing Product (CIP) and Forecast Icing Product (FIP³³) are created by the NWS AWC and are intended to supplement other icing advisories (e.g., AIRMETs and SIGMETs)³⁴. Figures 18 through 20 are the FIP icing probabilities and icing severity products and 1-hour forecast valid at 0900 MDT at 5,000, 6,000, and 7,000 ft, and indicated a 20 to 70% probability of icing at 5,000 to 7,000 ft over the area. The FIP also indicated that the icing intensity near the accident site would range from “trace” to “moderate” intensity categories.³⁵

The CIP product indicated a 20 to 80% probability of icing at 5,000, 6,000 and 7,000 ft msl at 0900 MDT above the accident site (figures 21, 22, and 23). The CIP also indicated that the icing near the accident site would be in the “trace to moderate” category above 5,000 ft. In addition, the CIP indicated an unknown probability of Supercooled Large Droplets (SLD)³⁶ above the accident site at 0900 MDT (attachment 6). For more FIP and CIP data please see attachment 6. For

³³ B.C. Bernstein, F. McDonough, M. K. Politovich, B. G. Brown, T. P. Ratvasky, D. R. Miller, C.A. Wolff, and G. Cuning, Current Icing Potential: Algorithm Description and Comparison with Aircraft Observations (Journal of Applied Meteorology, 2005), pp. 969-986.

C.A. Wolff, F. McDonough, M. K. Politovich, B.C. Bernstein, and G. Cuning, FIP Severity Technical Document (Prepared for the Aviation Weather Technology Transfer Technical Review Board), pp. 1-44.

<https://arc.aiaa.org/doi/abs/10.2514/6.2009-3531>

Wolff, C. A., D. R. Adriaansen, and M. K. Politovich, 2014: Diagnosing and Forecasting In-Flight Icing Conditions in Alaska. Preprints, 6th AIAA Atmospheric and Space Environments Conference, Atlanta, GA, Amer. Inst. Aero. Astro., 2014-2070, available at: <http://arc.aiaa.org/doi/abs/10.2514/6.2014-2070>.

[Icing Product Alaska \(IPA\) - Experimental | NCAR Research Applications Laboratory | RAL \(ucar.edu\)](#)

³⁴ NCAR re-ran the CIP and FIP algorithms to produce the data highlighted in this report.

³⁵ <https://www.aviationweather.gov/icing/fip>

The 5,000 ft modeled surface was below or close to the terrain on FIP and CIP at the accident site.

³⁶ [AWC - Icing \(aviationweather.gov\)](#)

additional icing information please see FAA Advisory Circular "Pilot Guide: Flight in Icing Conditions", AC 91-74B.³⁷

³⁷ [AC 91-74B - Pilot Guide: Flight In Icing Conditions – Document Information \(faa.gov\)](#)

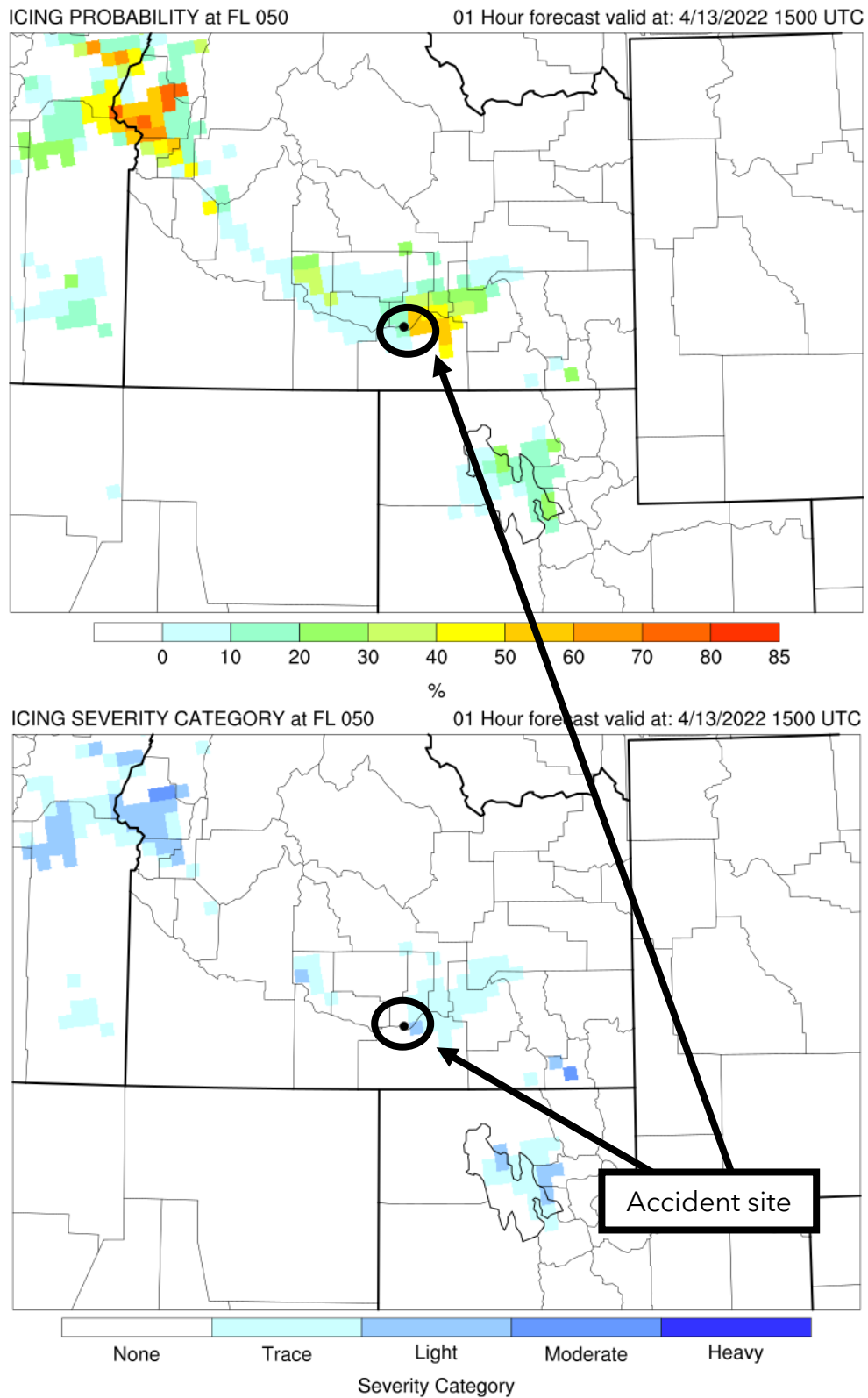


Figure 18. (top) FIP probability of icing at 5,000 ft and (bottom) FIP severity of icing at 5,000 ft 1-hour forecast valid at 0900 MDT.

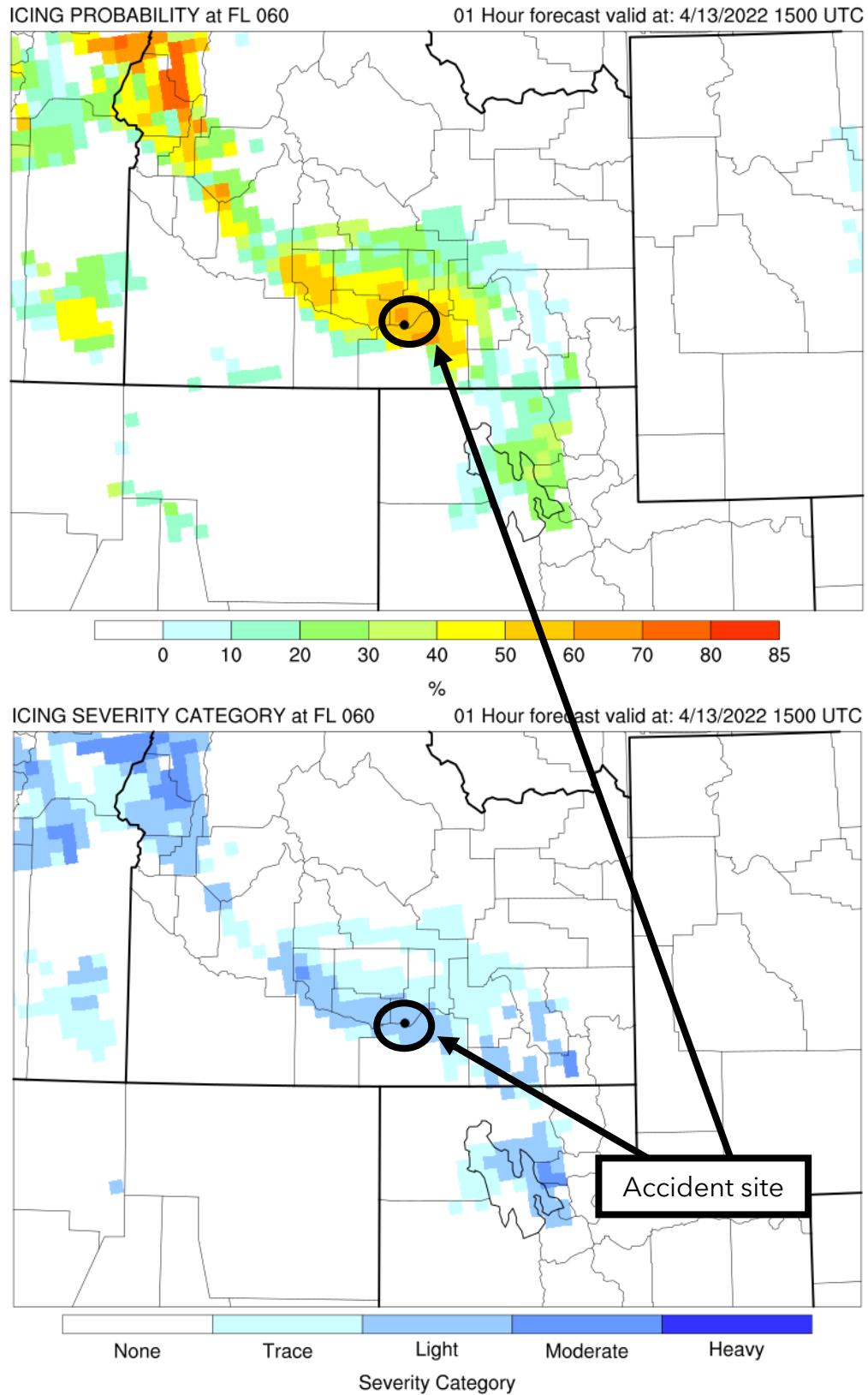


Figure 19. (top) FIP probability of icing at 6,000 ft and (bottom) FIP severity of icing at 6,000 ft 1-hour forecast valid at 0900 MDT.

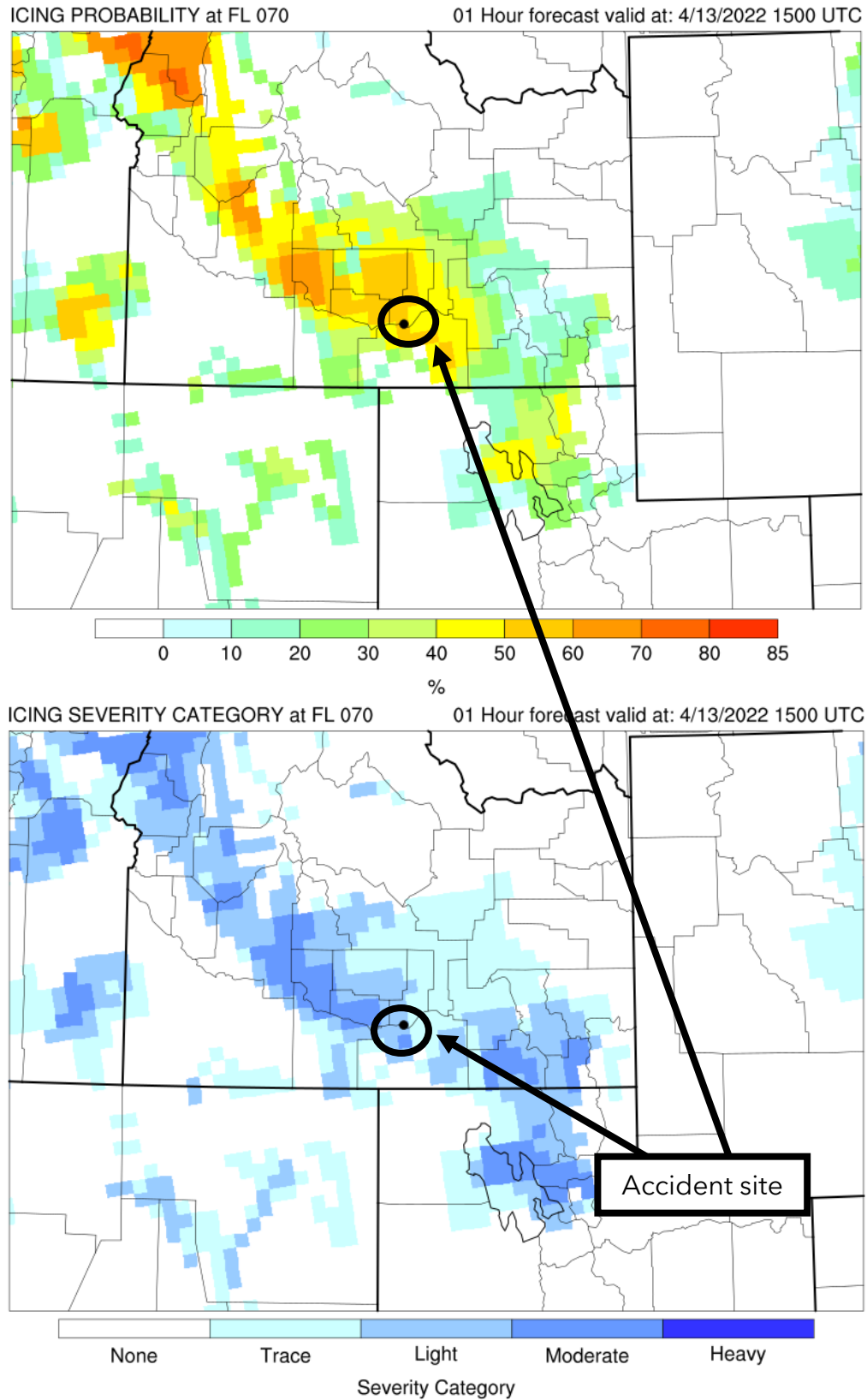


Figure 20. (top) FIP probability of icing at 7,000 ft and (bottom) FIP severity of icing at 7,000 ft 1-hour forecast valid at 0900 MDT.

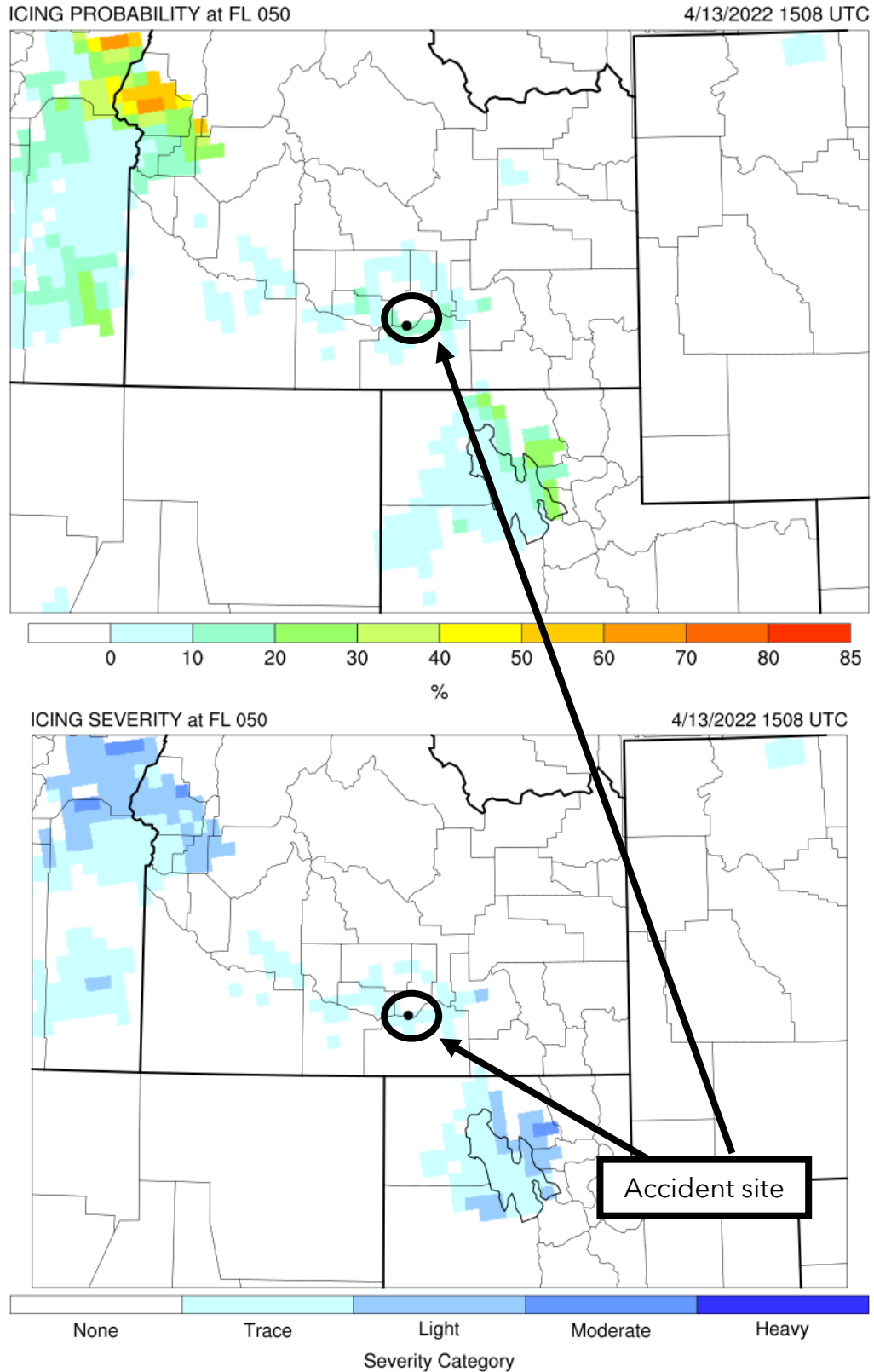


Figure 21. (top) CIP probability of icing at 5,000 ft and (bottom) CIP severity of icing at 5,000 ft valid around 0900 MDT.

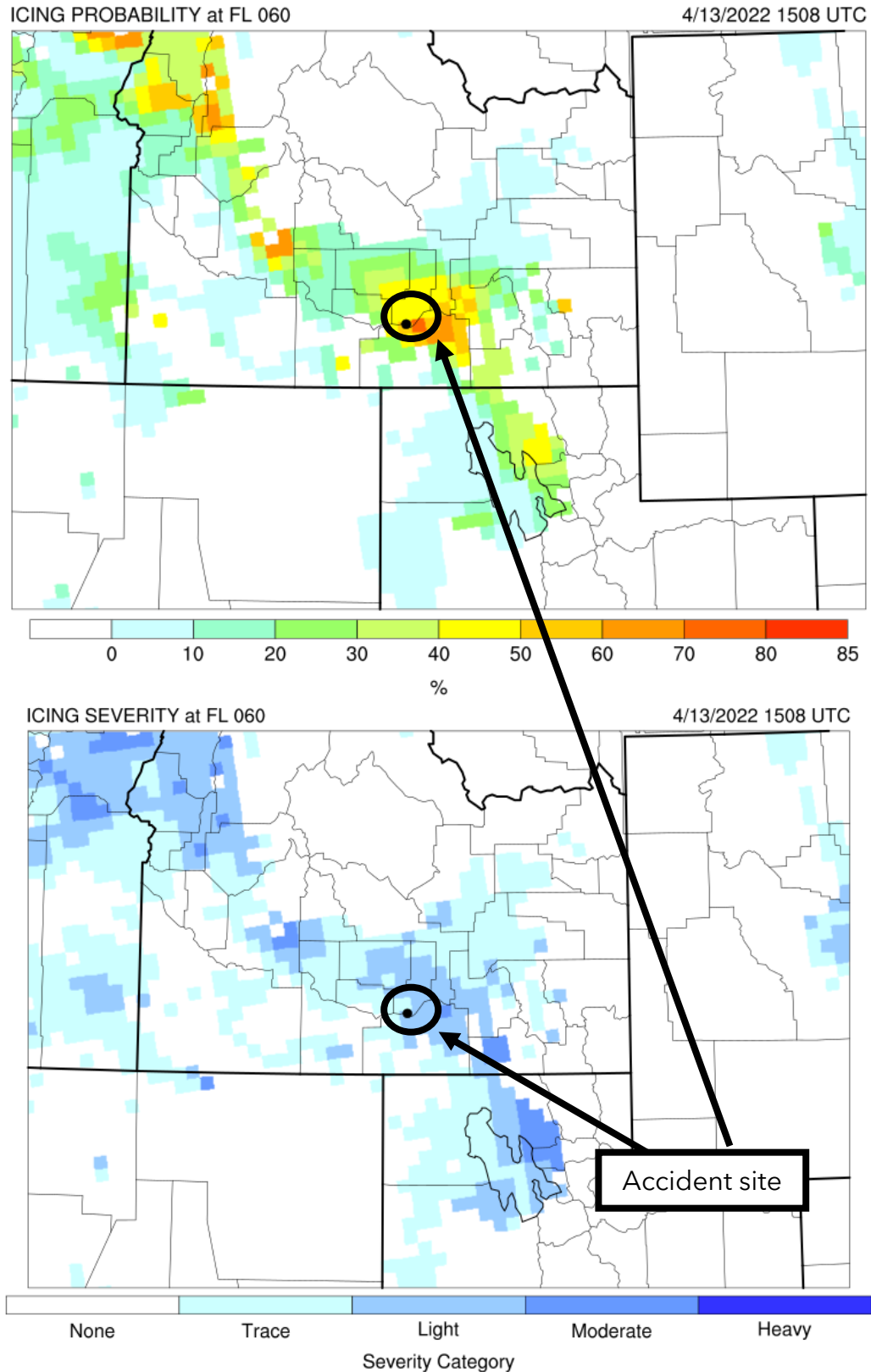
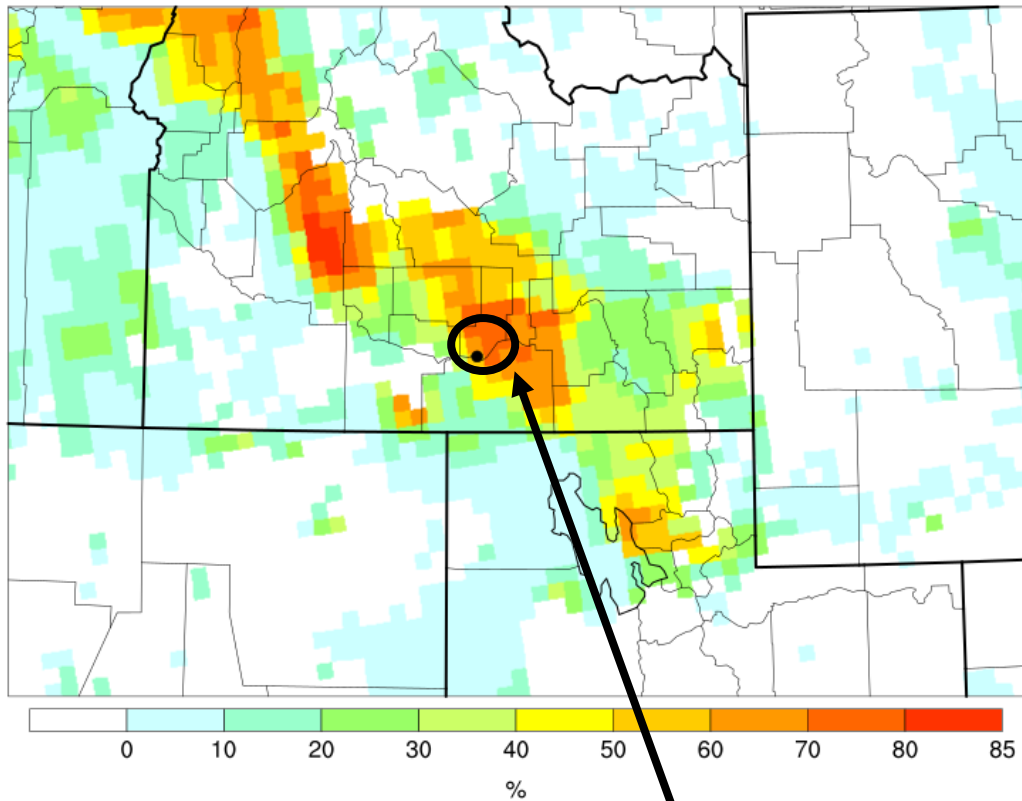


Figure 22. (top) CIP probability of icing at 6,000 ft and (bottom) CIP severity of icing at 6,000 ft valid around 0900 MDT.

ICING PROBABILITY at FL 070

4/13/2022 1508 UTC



ICING SEVERITY at FL 070

4/13/2022 1508 UTC

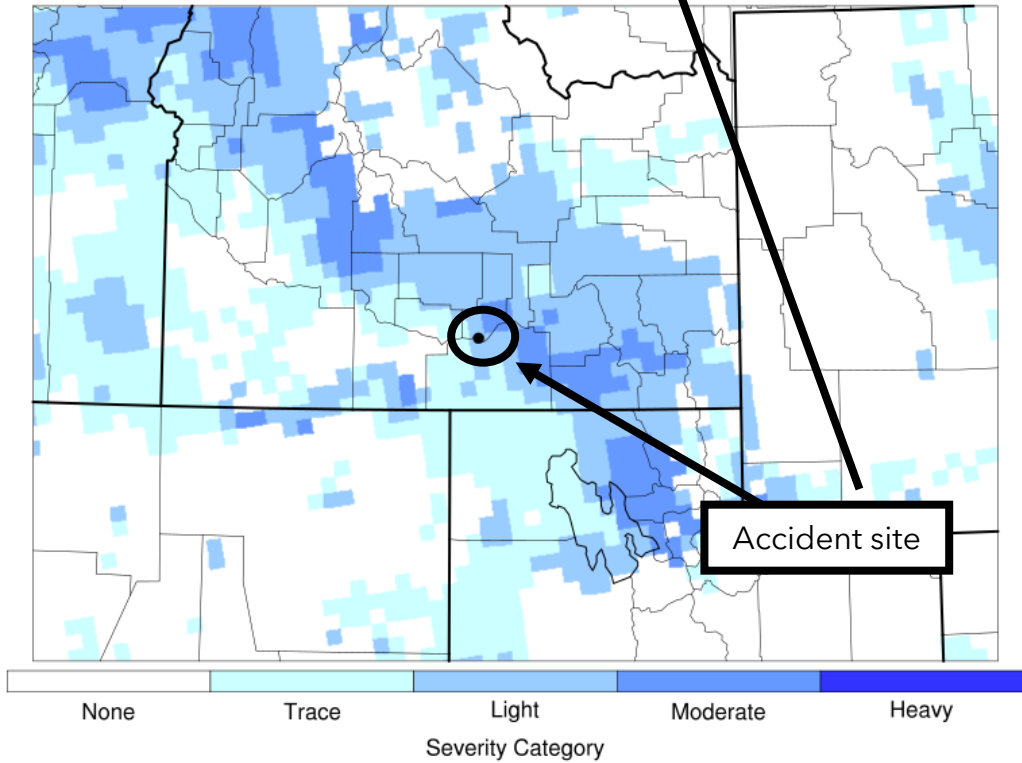


Figure 23. (top) CIP probability of icing at 7,000 ft and (bottom) CIP severity of icing at 7,000 ft valid around 0900 MDT.

17.0 Pilot Weather Briefing

The accident pilot did not request weather information³⁸ from Leidos Flight Service.

A search of archived ForeFlight information indicated that the accident pilot did have a ForeFlight account. The accident pilot did request a ForeFlight weather briefing at 0553 MDT with a proposed departure time of 0700 MDT (attachment 7). In addition to the weather briefing request at 0553 MDT, the accident pilot requested and reviewed the KBYI – RNAV GPS RWY 20 (FAA) chart at 0750 MDT and updated their route string at 0749 MDT. With no internet access while in flight, ForeFlight is still able to access weather information directly from the FAA, but leaving no remote record of such access. For more information please see attachment 7.

18.0 Witness Information

A witness to the accident stated that ten minutes before the accident the weather was a lot clearer. Within those ten minutes the snow went from little, tiny flakes to real big flakes, and the visibility had gotten considerably worse, but from the cloud line to the ground was still decent. The witness saw the accident airplane descend out of the clouds and go into the steam-cloud from the processing plant before the crash³⁹. Airframe icing was noted on the accident airplane after the accident (figure 24).

³⁸ https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_91-92.pdf

³⁹ For more information please see the witness statements located in the docket for this accident.



Figure 24. Icing on the airframe after the accident time.

19.0 Astronomical Data

The astronomical data obtained for the accident site on April 13, 2022, indicated the following:

SUN

Begin civil twilight	0628 MDT
Sunrise	0657 MDT
Accident time	0832 MDT⁴⁰
Sun transit	1335 MDT
Sunset	2015 MDT
End civil twilight	2044 MDT

At the time of the accident the Sun was located at an altitude of 16.63° and azimuth of 92.71°.

E. LIST OF ATTACHMENTS

Attachment 1 - Additional KBYI METARs and SPECIs surrounding the accident time

Attachment 2 - GOES-16 visible imagery animation from 0701 to 0906 MDT

Attachment 3 - KSFX weather radar imagery animation from 0759 to 0845 MDT

Attachment 4 - Pre-duty weather briefing produced by ZLC CWSU valid at the accident time

Attachment 5 - GFA information valid at the accident time

Attachment 6 - Additional FIP and CIP information

Attachment 7 - ForeFlight correspondence

Submitted by:

Paul Suffern
Senior Meteorologist

⁴⁰ Inserted accident time for reference and context.