

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



WPR23FA141

METEOROLOGY

Specialist's Factual Report

August 15, 2023

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A. ACCIDENT

Location: Oxbow, Oregon
Date: April 2, 2023
Time: 0950 Pacific daylight time
1650 coordinated universal time (UTC)
Airplane: Cirrus SR22; Registration: N424SW

B. METEOROLOGY SPECIALIST

Paul Suffern
Senior Meteorologist
National Transportation Safety Board
Washington, DC

C. DETAILS OF THE INVESTIGATION

The NTSB's Senior Meteorologist did not travel for this investigation but gathered all data remotely. Data for this investigation were collected from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the Weather Prediction Center (WPC) and the National Center for Environmental Information (NCEI). This Specialist's Factual Report contains the meteorological factors pertinent to the weather surrounding the accident time. All times are Pacific daylight time (PDT) and are based upon the 24-hour clock, where local time is -7 hours from UTC. Directions are referenced to true north and distances are in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles. NWS station identifiers use the standard International Civil Aviation Organization 4-letter station identifiers versus the International Air Transport Association 3-letter identifiers, which deletes the initial country code designator "K" for U.S. airports.

The accident site was located at approximate latitude 44.960639° N, longitude 116.85855° W, and elevation of 2,375 feet (ft).

D. FACTUAL INFORMATION

1.0 Synoptic Situation

The synoptic or large-scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction and the WPC, located in College Park, Maryland. These are the base products used in describing synoptic weather features and in the creation of forecasts and warnings for the NWS. Reference to these charts can be found in the Federal Aviation Administration (FAA) "Aviation Weather Handbook", FAA-H-8083-28.¹

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart centered over the northwestern United States for 1100 PDT is provided as figure 1 with the location of the accident site within the black circle. The chart depicted a low-pressure system at 1011-hectopascals (hPa) located in central Oregon. A frontal boundary stretched from north to south from the Pacific northwest through central Oregon and into California. Fronts can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present.

The station model closest to the accident site depicted an air temperature of 25 degrees Fahrenheit (°F), dew point temperature of 21°F, cloudy skies, and a south wind at 10 knots.

¹ [FAA-H-8083-28](#)

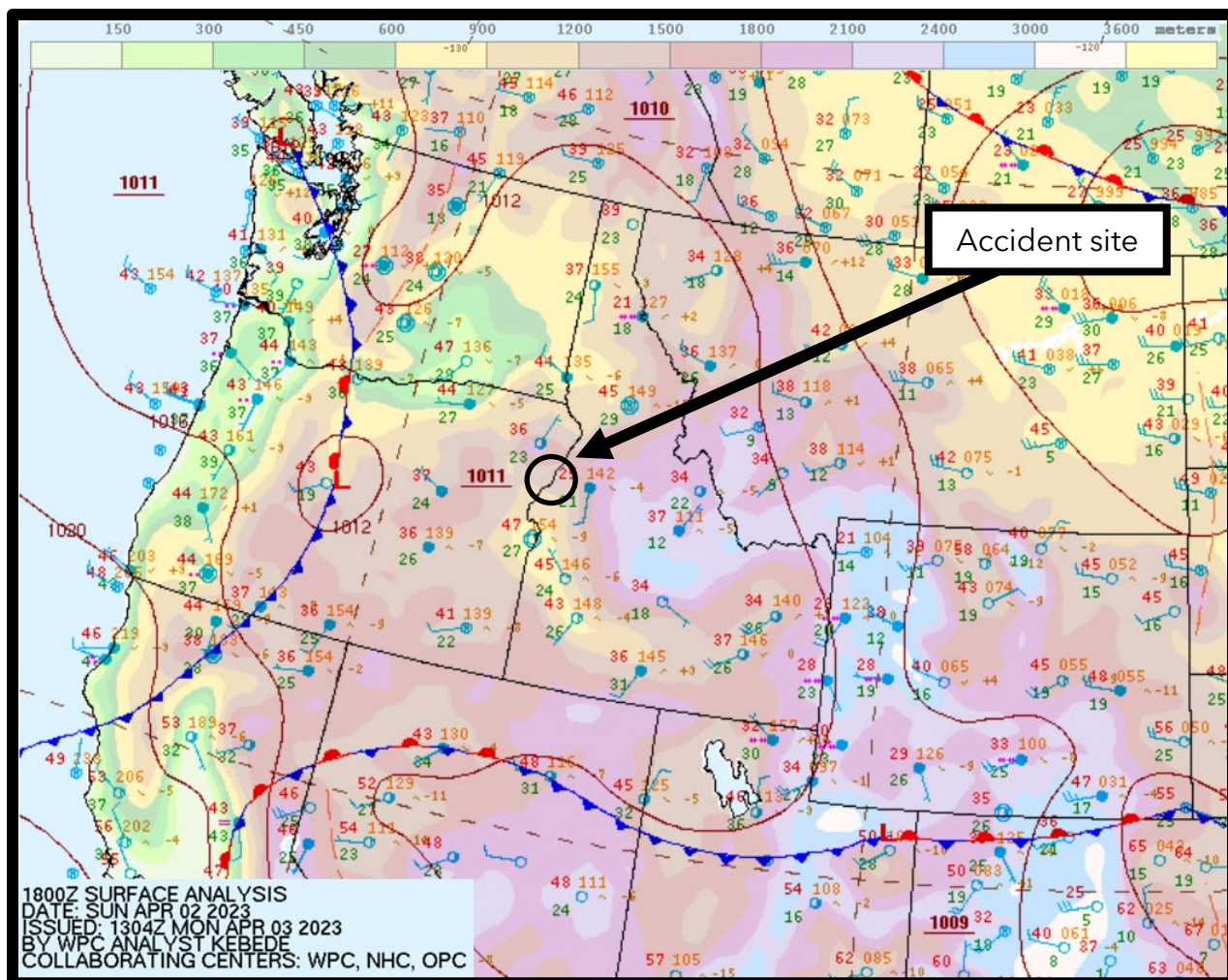


Figure 1. NWS Surface Analysis Chart for 1100 PDT.

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 0500 PDT at 850-, 700-, and 500-hPa are presented in figures 2 through 4. The charts depicted a trough² to the west of the accident site over the Pacific Northwest coast. The 850-hPa constant pressure chart depicted a northwest wind around 10 knots above the accident site (figure 2) with the wind becoming westerly at 30 knots by 700-hPa (figure 3), and westerly at 70 knots by 500-hPa (figure 4).

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

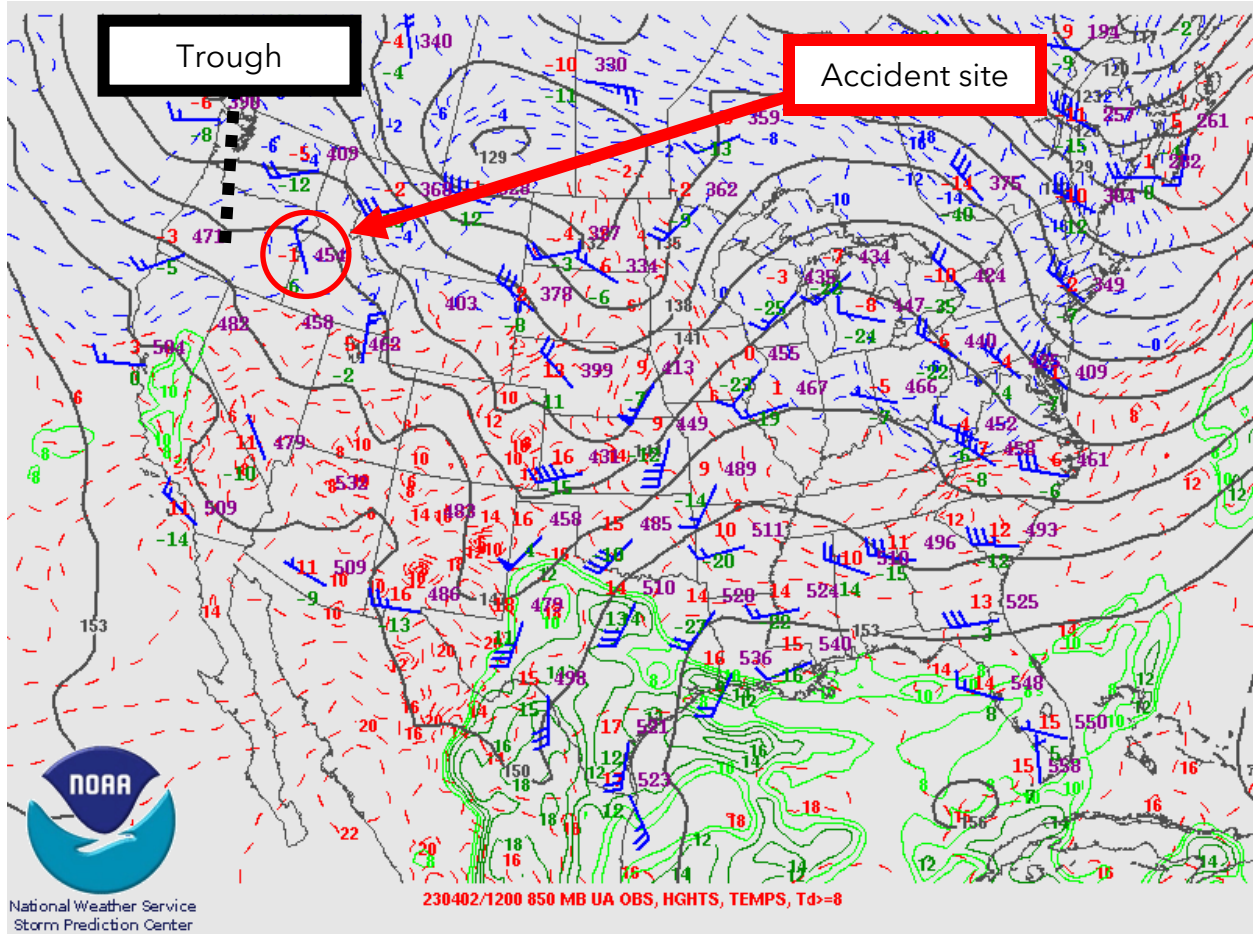


Figure 2. 850-hPa Constant Pressure Chart for 0500 PDT.

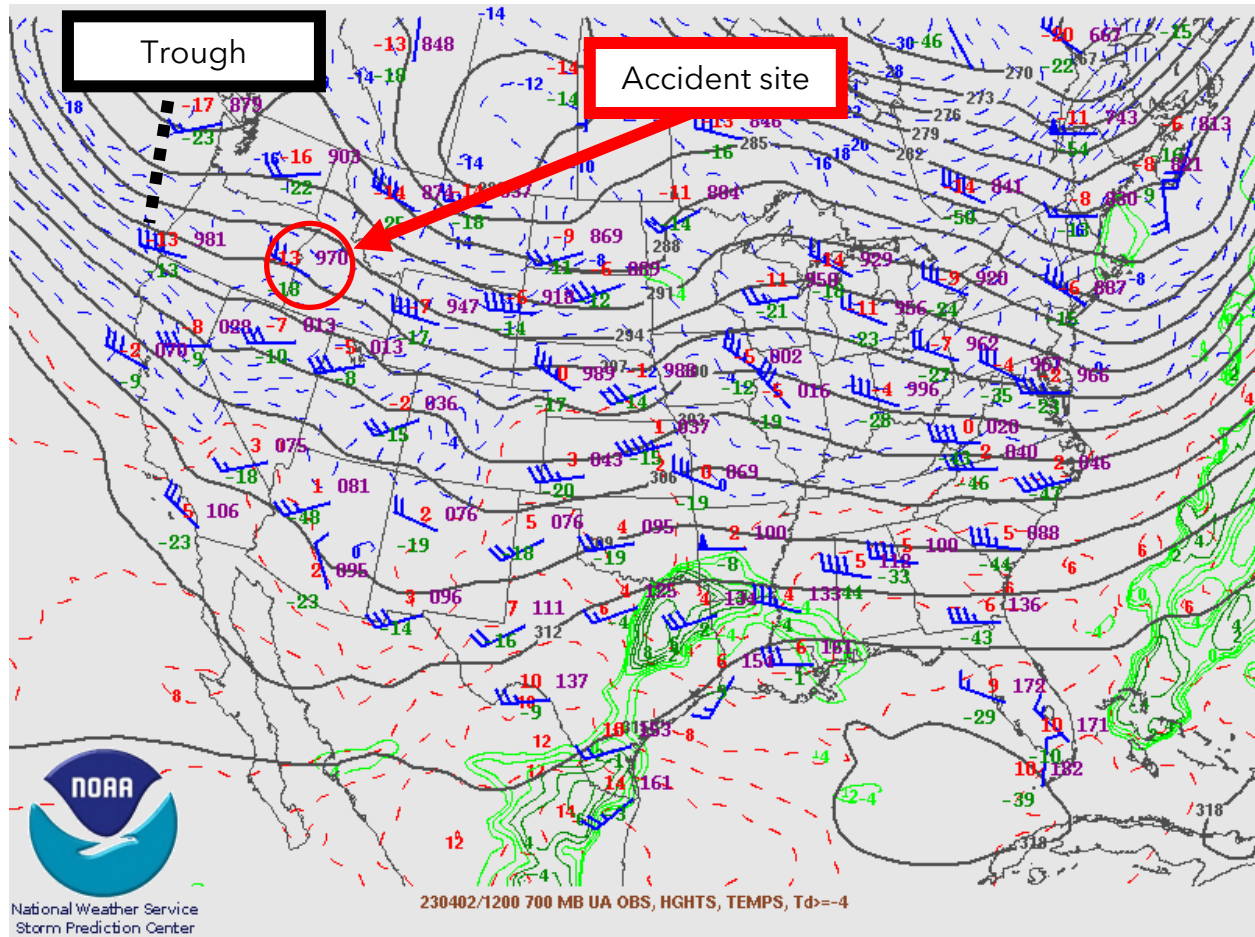


Figure 3. 700-hPa Constant Pressure Chart for 0500 PDT.

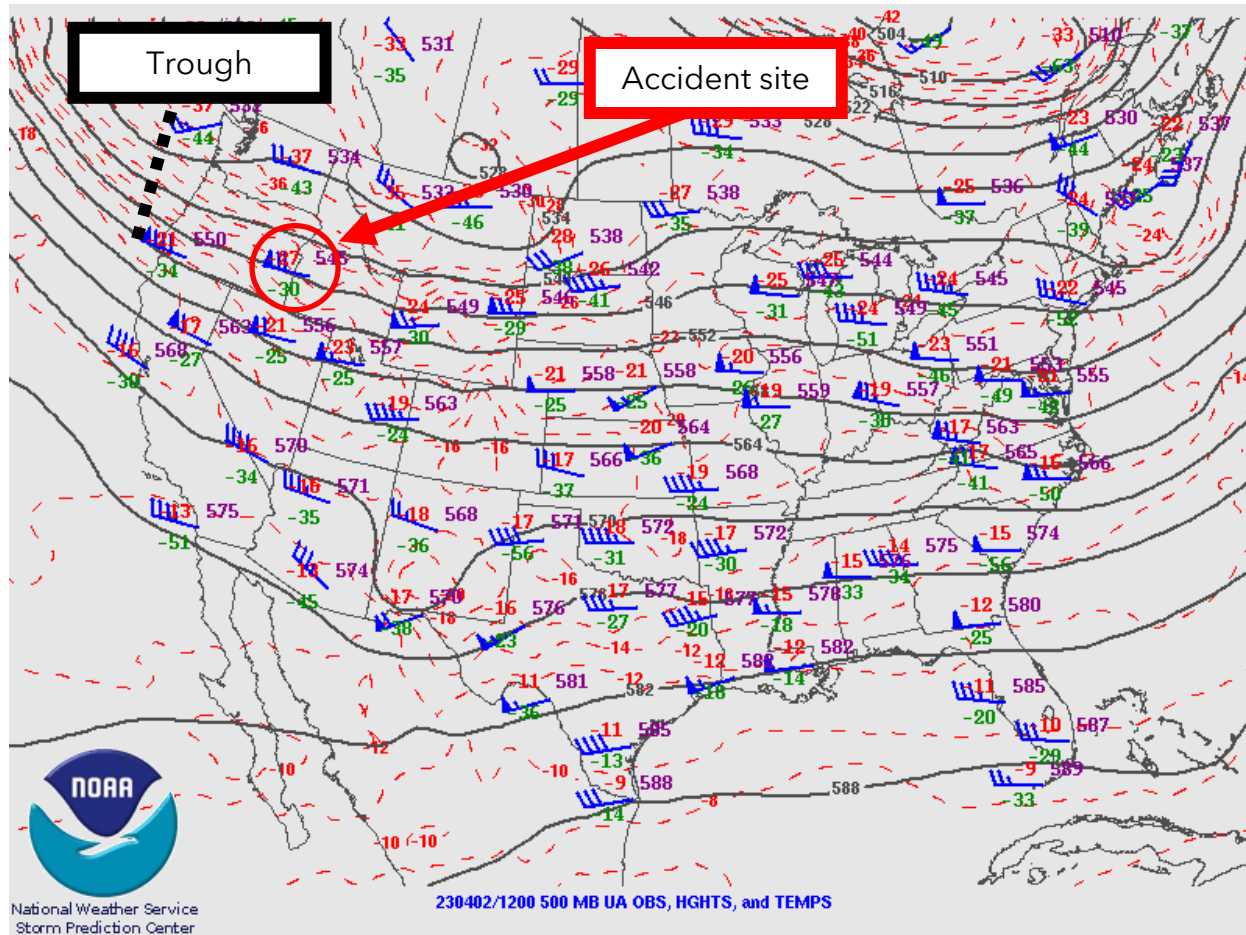


Figure 4. 500-hPa Constant Pressure Chart for 0500 PDT.

2.0 Storm Prediction Center Convective Outlook

The SPC issued a Day 1 Convective Outlook at 0915 PDT (figure 5) with areas of general thunderstorms forecast for the accident site. SPC defines the “TSTM” area as an area where a 10% or higher probability of thunderstorms is forecast during the valid period. Similar Day 1 Convective Outlooks were issued for the accident region at 0600 and 0500 PDT.

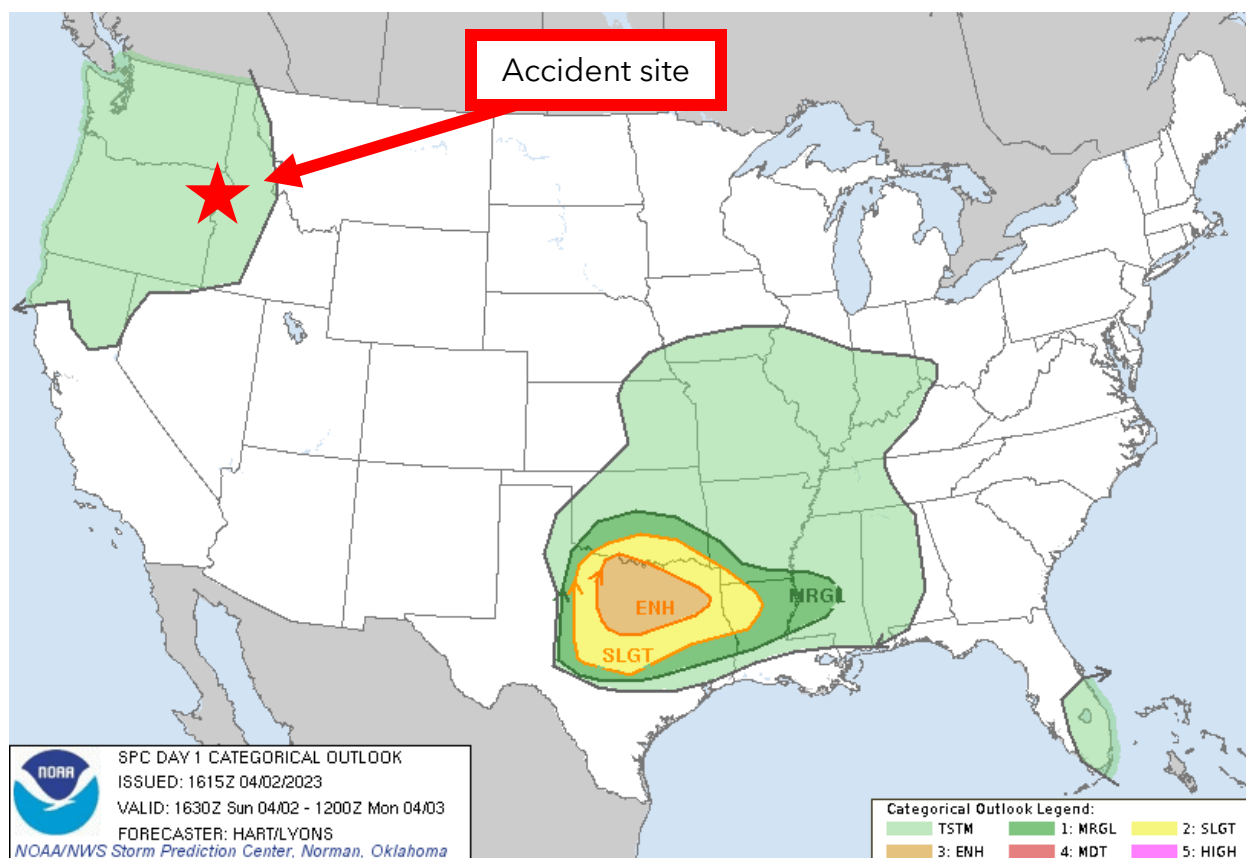


Figure 5. SPC day 1 Convective Outlook valid at the time of the accident.

3.0 Surface Observations

The area surrounding the accident site was documented using official Aviation Routine Weather Reports (METARs) and Special Reports (SPECIs)³. 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 location marked. A magnetic variation⁴ of 14° east was indicated over the area.

³ Latest criteria for SPECIs can be found in the Federal Meteorological Handbook: [Federal Meteorological Handbook Number 1, Surface Weather Observations and Reports \(icams-portal.gov\)](https://www.federalmeteorologicalhandbook.com/)

⁴ Magnetic variation - The angle (at a particular location) between magnetic north and true north. Latest measurement taken from <https://skyvector.com/>

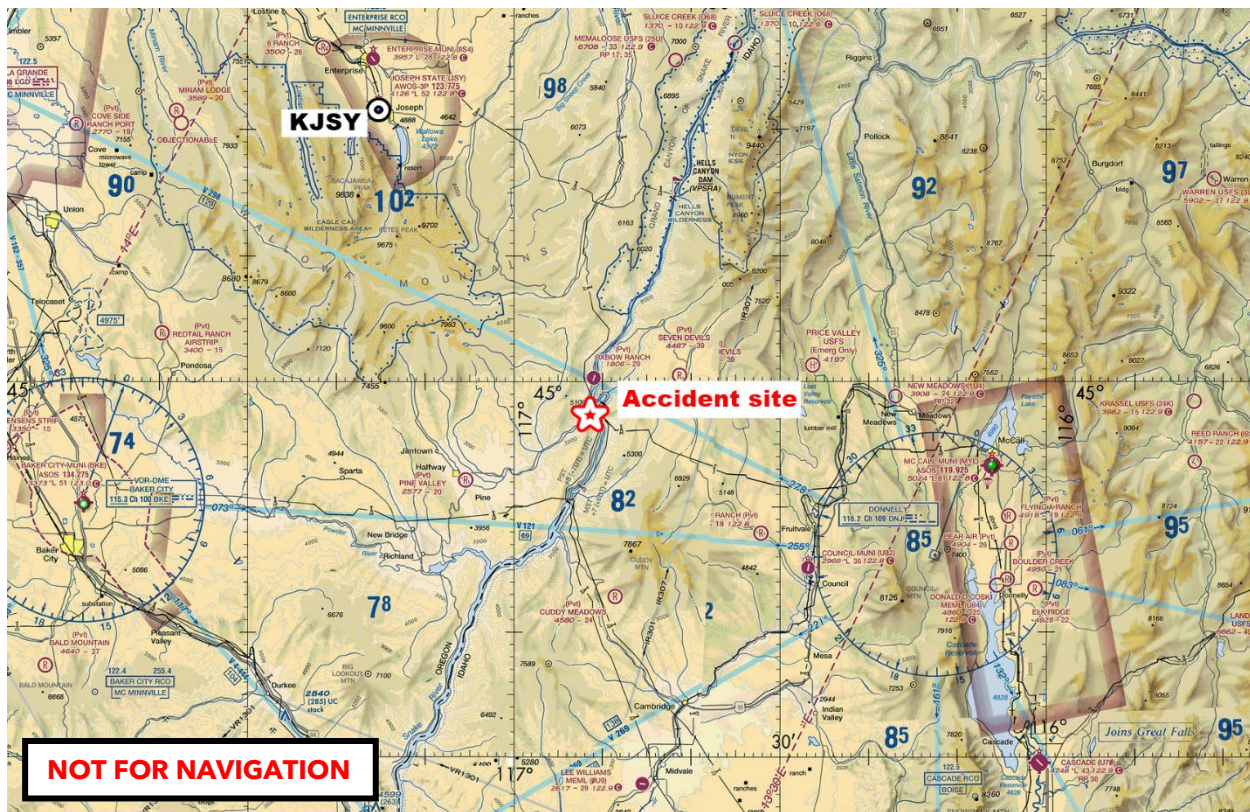


Figure 6. FAA sectional aeronautical chart of the accident area with the location of the accident site and surface observation site noted.

Joseph State Airport (KJSY) had the closest official weather station to the accident site. KJSY had an Automated Weather Observing System (AWOS⁵) and its longline⁶ reports were not augmented. The KJSY AWOS was located 29 miles northwest of the accident site (figure 6), at an elevation of 4,126 ft, and issued the following observations surrounding the period of the accident:⁷

⁵ AWOS - Automated Weather Observing System is equipped with meteorological instruments to typically observe and report temperature, dewpoint, wind speed and direction, visibility, cloud coverage and ceiling up to 12,000 feet, and altimeter setting. AWOS are maintained by the FAA. Certain AWOS may have different reporting or observational equipment.

⁶ "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.

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

[0815 PDT] METAR KJSY 021515Z AUTO 00000KT 10SM SCT035
SCT042 BKN048 M04/M06 A2987 RMK AO2 T10361064 TSNO

[0835 PDT] METAR KJSY 021535Z AUTO 00000KT 10SM SCT042
SCT048 SCT060 M04/M08 A2987 RMK AO2 T10441078 TSNO

[0855 PDT] METAR KJSY 021555Z AUTO 00000KT 10SM SCT047
BKN050 M03/M07 A2987 RMK AO2 T10351071 TSNO

[0915 PDT] METAR KJSY 021615Z AUTO 00000KT 10SM SCT044
OVC050 M03/M07 A2986 RMK AO2 T10271066 TSNO

**[0935 PDT] METAR KJSY 021635Z AUTO 00000KT 10SM SCT042
OVC048 M01/M06 A2986 RMK AO2 T10081056 TSNO**

ACCIDENT TIME 0950 PDT

**[0955 PDT] METAR KJSY 021655Z AUTO 00000KT 10SM SCT037
OVC046 00/M05 A2986 RMK AO2 T00011051 TSNO**

[1015 PDT] METAR KJSY 021715Z AUTO 00000KT 10SM BKN046
01/M06 A2986 RMK AO2 T00061059 TSNO

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

KJSY weather at 0935 PDT, automated, wind calm, visibility 10 miles or greater, scattered clouds at 4,200 ft above ground level (agl), overcast ceiling at 4,800 ft agl, temperature of -1° Celsius (C), dew point temperature of -6°C, and an altimeter setting of 29.86 inches of mercury (inHg). Remarks, automated station with a precipitation discriminator, temperature -0.8°C, dew point temperature -5.6°C, lightning detection system sensor is not operating.

KJSY weather at 0955 PDT, automated, wind calm, visibility 10 miles or greater, scattered clouds at 3,700 ft agl, overcast ceiling at 4,600 ft agl, temperature of 0°C, dew point temperature of -5°C, and an altimeter setting of 29.86 inHg. Remarks, automated station with a precipitation discriminator, temperature 0.1°C, dew point temperature -5.1°C, lightning detection system sensor is not operating.

The observations from the KJSY AWOS around the accident time identified VFR⁸ conditions with a cloud ceiling around 8,700 to 8,900 ft.

⁸ The NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories:

- Low Instrument Flight Rules (LIFR*) - ceiling below 500 ft above ground level (agl) and/or visibility less than 1 statute mile.

4.0 Upper Air Sounding

A High-Resolution Rapid Refresh (HRRR)⁹ model sounding was created¹⁰ for the approximate accident site coordinates for 1000 PDT. The HRRR sounding was plotted on a standard Skew-T Log P diagram¹¹ from the surface to 500-hPa (or approximately 18,000 ft) using the RAOB¹² software package and is included as figure 7. The sounding depicted an elevation of 2,356 ft over the grid point with a near surface temperature of 3.8°C, a dew point temperature of -2.1°C, and a relative humidity of 65%. The sounding depicted the lifted condensation level (LCL)¹³, and the level of free convection (LFC)¹⁴ at 4,757 ft, and the convective condensation level (CCL)¹⁵ at 6,063 ft. The freezing level was located at 3,388 ft. The precipitable water value at 0.27 inches.

-
- Instrument Flight Rules (IFR) - ceiling between 500 to below 1,000 feet agl and/or visibility 1 to less than 3 miles.
 - Marginal Visual Flight Rules (MVFR**) - ceiling from 1,000 to 3,000 ft agl and/or visibility 3 to 5 miles.
 - Visual Flight Rules (VFR) - ceiling greater 3,000 ft agl and visibility greater than 5 miles.

* By definition, IFR is a ceiling less than 1,000 ft agl and/or visibility less than 3 miles while LIFR is a sub-category of IFR.

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

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

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

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

¹² RAOB - (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by 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.

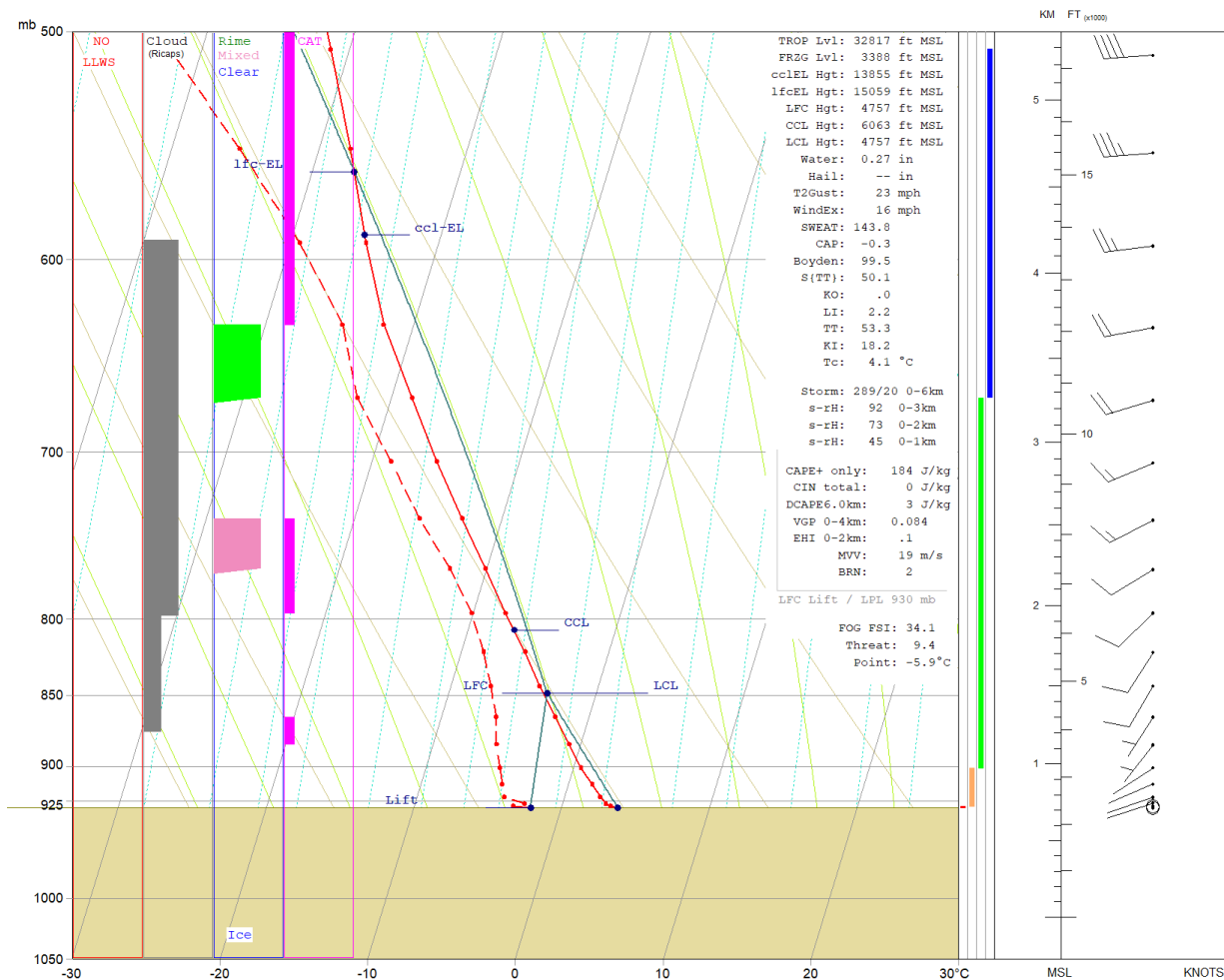


Figure 7. 1000 PDT HRRR sounding.

The 1000 PDT HRRR sounding indicated an unstable to conditionally unstable environment from the surface through 10,500 ft, then a stable environment from 10,500 ft through 18,000 ft. RAOB indicated a cloud layer from 4,000 ft through 13,800 ft. Light to moderate rime and mixed icing was indicated by RAOB in two layers between 7,000 ft and 12,500 ft.

The 1000 PDT HRRR sounding wind profile indicated a calm near surface wind with the wind becoming westerly through 18,000 ft. The wind speed increased to 15 knots by 10,000 ft and to 40 knots by 18,000 ft. RAOB did not indicate the possibility of low-level wind shear (LLWS), but RAOB did indicate light clear air turbulence (CAT) in several layers between the 4,000 ft and 18,000 ft. At the airplane's approximate altitude before descent¹⁶ (around 13,500 ft), the temperature was -24.9°C, the dew point temperature was -29.4°C, the relative humidity was 66%, and the wind was from 263° at 26 knots.

¹⁶ Please see track information located in the docket of this accident.

5.0 Satellite Data

Geostationary Operational Environmental Satellite number 18 (GOES-18) 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-18 bands 2 and 13) at wavelengths of 0.64 microns (μm) and 10.3 μm , respectively, were retrieved for the period from 0700 PDT through 1200 PDT and reviewed, and the closest images to the time of the accident were documented.

Figure 8 presents the GOES-18 visible image at 0951 PDT at 2X magnification with the accident site highlighted with a red square. The visible imagery indicated cloud cover above the accident site at the accident time with the cloud cover moving from west to east (attachment 1). Figure 9 presents the GOES-18 infrared image at 0951 PDT at 7X magnification with the accident site highlighted with a red square. The lower brightness temperatures (green colors; higher cloud tops) were located in areas surrounding the accident site at the accident time. The brightness temperature of 250 Kelvin above the accident site would have been near 13,200 ft based on the vertical temperature profile provided by the 1000 PDT HRRR sounding. It should be noted these figures have not been corrected for any parallax error.

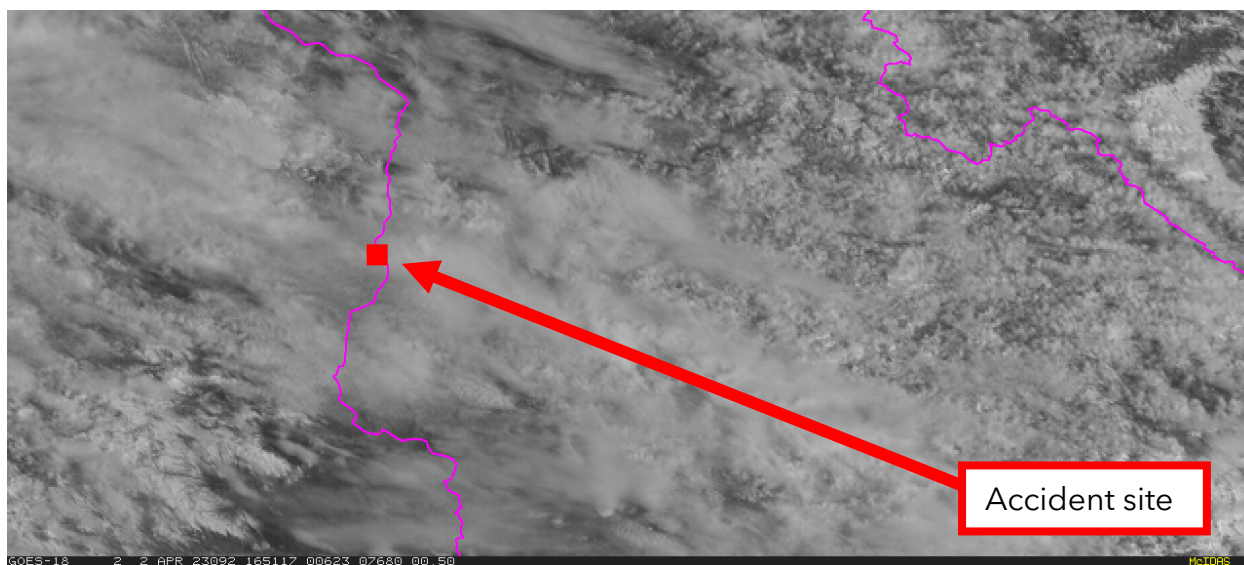


Figure 8. GOES-18 visible image at 0951 PDT.

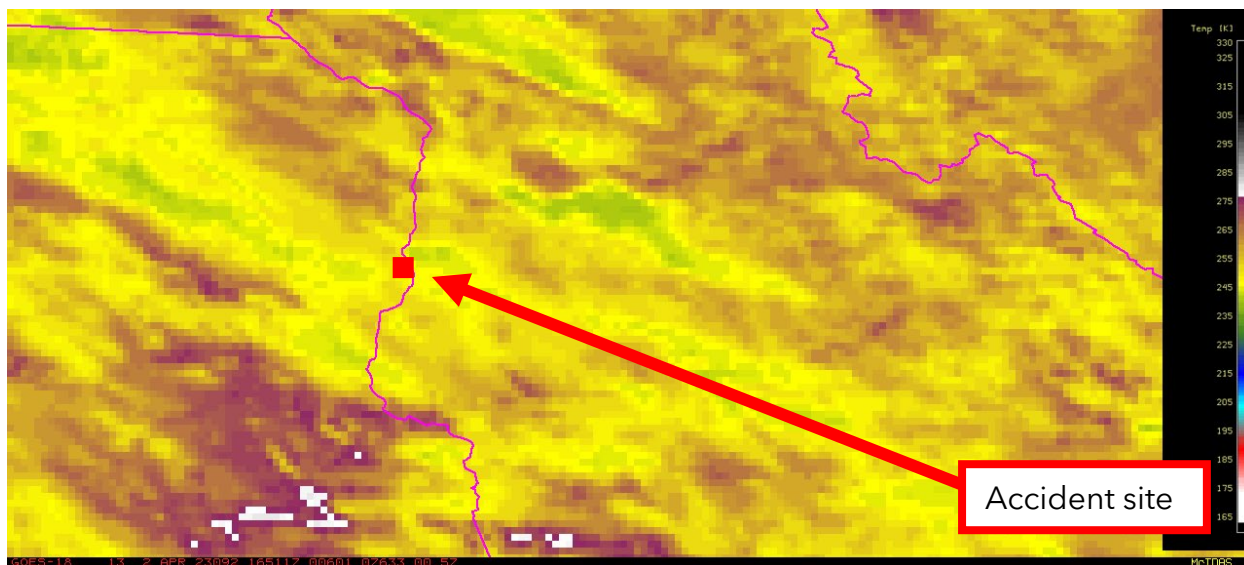


Figure 9. GOES-18 infrared image at 0951 PDT.

6.0 National Radar Imagery

A regional view of the NWS National Reflectivity Mosaic is included as figure 10 for 0950 PDT with the approximate location of the accident site marked by a red circle. The image depicted 5 to 20 dBZ¹⁷ echoes above the accident site.

¹⁷ 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.

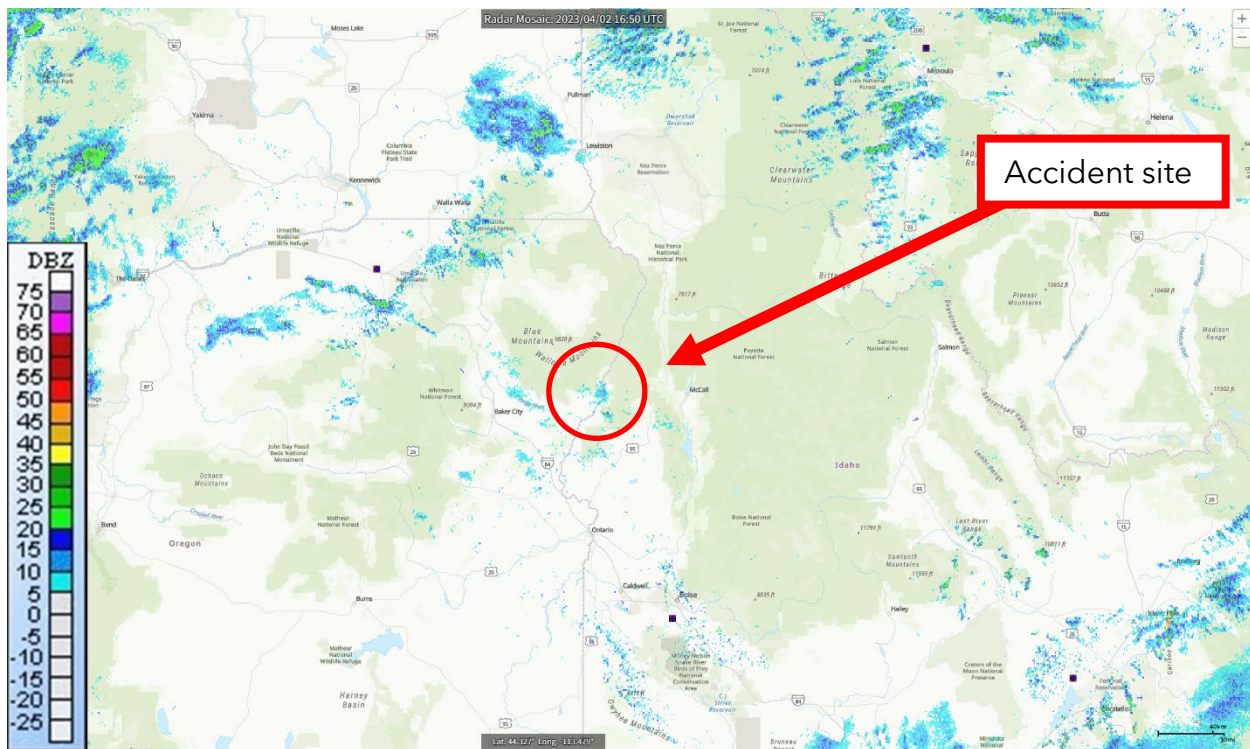


Figure 10. National Reflectivity Mosaic for 0950 PDT.

7.0 Weather Surveillance Radar Imagery

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)¹⁸ to the accident site was in Boise, Idaho, (KCBX) located 92 miles south-southeast of the accident site. The 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.

¹⁸ 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.

7.1 Volume Scan Strategy

During the period surrounding the accident, the KCBX WSR-88D radar was operating in the clear-air mode VCP-35¹⁹ (figure 11). 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.

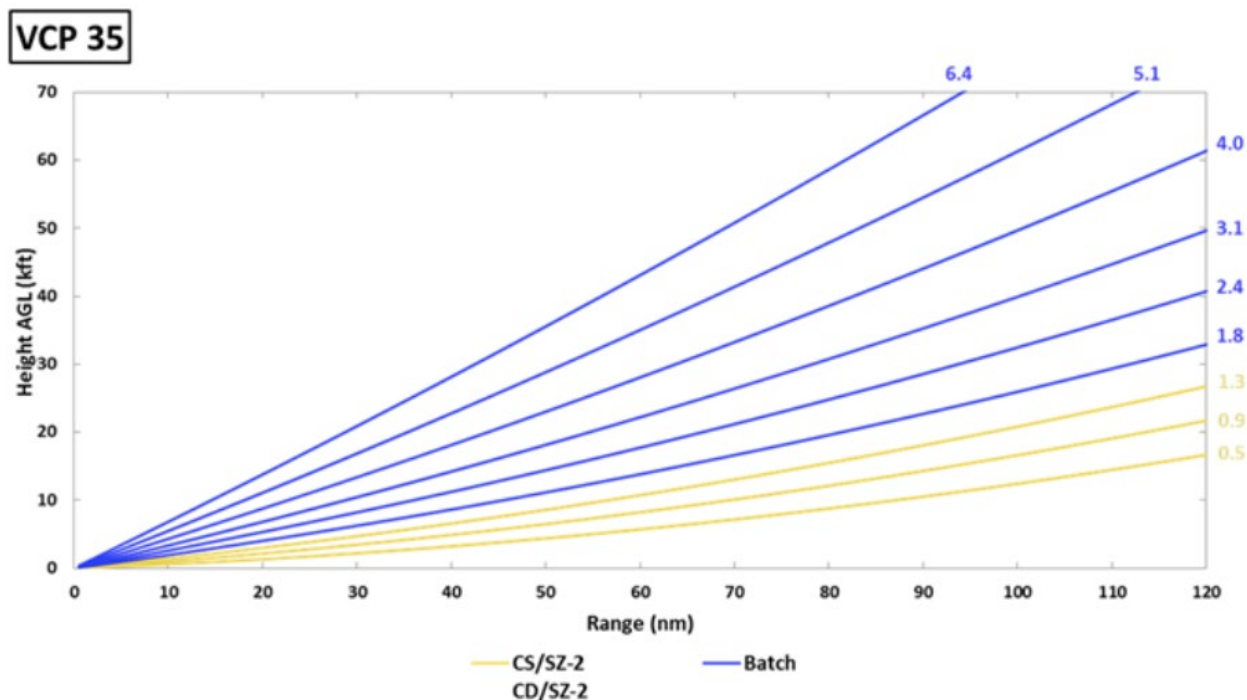


Figure 11. VCP-35 Clear-air Mode Scan Strategy.

¹⁹ 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 refraction²⁰ of the KCBX WSR-88D radar beam with the antenna elevation at 3,171 ft, and considering a beamwidth²¹ of 0.95°, the following table shows the approximate heights for the radar beams' centers, tops and bases for certain antenna elevations over the accident site. These heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
KCBX 0.48°	13,460 ft	8,830 ft	18,100 ft

Based on the radar height calculations, the elevation scans reviewed from KCBX listed in the above table combined to depict conditions between 8,830 ft and 18,100 ft over the accident site.

7.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²² 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. The FAA Aviation Weather Handbook also 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 to 50 dBZ, inclusive. Finally, any dBZ values above 50 dBZ shall be described as "extreme."

²⁰ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

²¹ Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

²² 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.

7.4 Base Reflectivity and Lightning Data

Figures 12 and 13 present the KCBX WSR-88D base reflectivity images for the 0.48° elevation scans initiated at 0946:10 and 0953:13 PDT with resolutions of 0.5° X 250 m. These images depicted reflectivity values between 5 and 15 dBZ moving from west to east over the accident site at the time of the accident (attachment 4).

There were no lightning flashes²³ reported within 25 miles of the accident site within 30 minutes before and after the accident time.²⁴

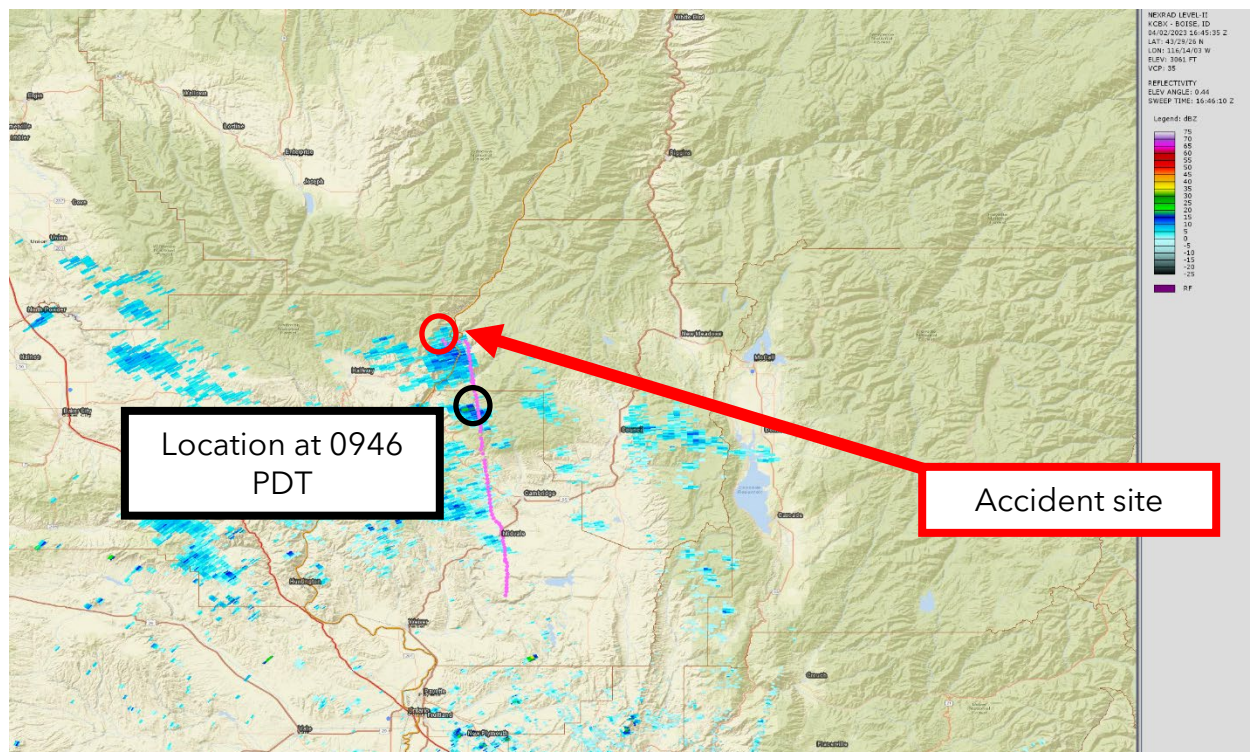


Figure 12. KCBX WSR-88D reflectivity for the 0.44° elevation scan initiated at 0946:10 PDT with the accident site marked with the red circle and the location of the accident aircraft in the black circle.

²³ 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.

²⁴ A review of Earth Networks Total Lightning network and GOES-17 Geostationary Lightning Mapper was done.

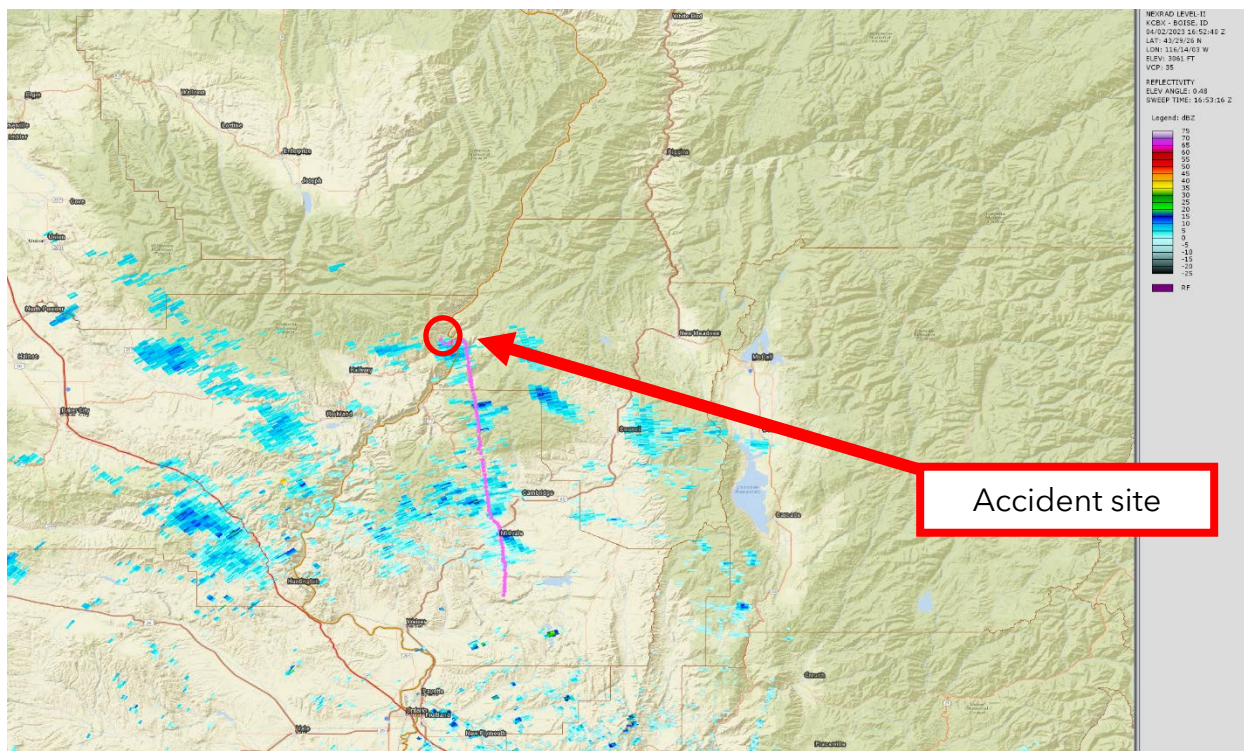


Figure 13. KCBX WSR-88D reflectivity for the 0.48° elevation scan initiated at 0953:16 PDT with the accident site marked with the red circle.

8.0 Pilot Reports

There were no longline-disseminated pilot reports²⁵ (PIREPs) distributed into the national airspace system (NAS) within two hours before and after the accident time and within 100 miles of the accident site at altitudes below 18,000 ft.

9.0 Significant Meteorological Information

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

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 was no Center Weather Advisory (CWA) valid for the accident site at the accident time.

²⁵ Only PIREPs with the World Meteorological Organization headers UBOR**, UBWA**, UBID**, and UBMT** were considered. These do not include pilot reports only broadcast via radio.

11.0 Airmen's Meteorological Information

The NWS Aviation Weather Center (AWC) had text Airmen's Meteorological Information (AIRMET) advisories Sierra and Zulu valid for the accident site at the accident time. The text AIRMETs Sierra and Zulu were issued at 0745 PDT and forecast (1) IFR conditions due to precipitation, mist, and fog, (2) mountain obscuration due to clouds, precipitation, and mist, and (3) moderate icing between the freezing level²⁶ and 14,000 ft:

WAUS45 KPCI 021445

WA5S

-SLCS WA 021445

AIRMET SIERRA UPDT 2 FOR IFR AND MTN OBSCN VALID UNTIL 022100

AIRMET IFR...ID MT

FROM 70S YXC TO 50NW LKT TO 50ENE BOI TO 20WSW BOI TO 30WNW DNJ TO 70SSW MLP TO 20WNW GEG TO 70S YXC

CIG BLW 010/VIS BLW 3SM PCPN/BR/FG. CONDS DVLPG 18-21Z. CONDS CONTG BYD 21Z THRU 03Z.

AIRMET IFR...ID MT WY NV UT CO

FROM 60S YXC TO 70SE FCA TO 20NNW DLN TO 80SW BIL TO 30WNW LAR TO 60SSE SLC TO 20NNE BAM TO 60SSE REO TO 70E BOI TO 60NW LKT TO 60S YXC

CIG BLW 010/VIS BLW 3SM PCPN/BR/FG. CONDS CONTG BYD 21Z THRU 03Z.

AIRMET MTN OBSCN...ID MT WY NV UT CO WA OR

FROM 40SSW YQL TO GTF TO 30SSE HLN TO 60SSW BIL TO 30S BOY TO 40N LAR TO 60SSW LAR TO 50ENE DTA TO 70NNE OAL TO 40S REO TO 40SSW BOI TO 50SSE EPH TO 80ESE YDC TO 50SW YXC TO 40SSW YQL MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 21Z THRU 03Z.

AIRMET MTN OBSCN...NV WA OR CA

FROM 20WNW HUH TO 40SE YDC TO EPH TO 30SSW BOI TO 40S REO TO 20W BAM TO 20NE FMG TO 50SW OAL TO 40SE EHF TO 60S TRM TO MZB TO LAX TO 50W RZS TO 30NNW FOT TO HQM TO 20WNW TOU TO 20WNW HUH MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 21Z THRU 03Z.

OTLK VALID 2100-0300Z...IFR MT

BOUNDED BY 30SSW YQL-50NE HVR-50NNW ISN-70SSW ISN-30S HVR-30SSW YQL

CIG BLW 010/VIS BLW 3SM PCPN/BR/FG. CONDS DVLPG AFT 21Z. CONDS CONTG THRU 03Z.

....

WAUS45 KPCI 021445

WA5Z

-SLCZ WA 021445

AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 022100

²⁶ Freezing level between the surface and 4,000 ft.

.
AIRMET ICE...ID WY NV UT CO OR CA
FROM 30NNW JAC TO 50SW BOY TO 30SE CZI TO 70SW RAP TO BFF TO 60SE
SNY TO 30E DBL TO 40S MTU TO 30SE BAM TO 50WSW FMG TO 50E RBL TO
20SSE LKV TO 70S BKE TO 20ESE BOI TO 30NNW JAC
MOD ICE BTN FRZLVL AND FL190. FRZLVL SFC-080. CONDS CONTG BYD 21Z
THRU 03Z.

.
AIRMET ICE...ID MT WA OR CA AND CSTL WTRS
FROM HUH TO 60SW YQL TO 60ESE FCA TO 40NW DLN TO 40SSE DNJ TO
60SW BKE TO 20SE FOT TO 70NW FOT TO 120WNW ONP TO 140W TOU TO
HUH
MOD ICE BTN FRZLVL AND 140. FRZLVL SFC-040. CONDS CONTG BYD 21Z
THRU 03Z.

.
AIRMET ICE...MT
FROM 50NNW ISN TO 60W DIK TO 50S GGW TO 50SE HVR TO 60WNW HVR TO
50NNW ISN
MOD ICE BLW 140. CONDS CONTG BYD 21Z THRU 03Z.

.
FRZLVL...RANGING FROM SFC-130 ACRS AREA
SFC ALG 100SSE LKV-30NW BVL-20S CHE-30NE CZI-70E LWT-20SSW
GGW-20WSW ISN
040 ALG 20ENE SHR-100SE MLS
080 ALG 40WSW OAL-60ENE OAL-60SW CHE-30ESE CYS-SNY
120 ALG 20S EED-30E PHX-40SSW DMN
....

12.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products issued by the AWC before the accident flight and valid from 0800 until 1400 PDT are shown in attachment 2. The GFA surface forecasts applicable to the accident site that were valid before the accident flight's departure from 0800 until 1400 PDT indicated VFR conditions with a southwest wind of 5 to 10 knots. In addition, a chance (between 30 and 60 percent) of light snow or light snow showers was expected by 0800 PDT with light snow showers to heavy snow likely (greater than 60 percent) by 1100 PDT. The GFA cloud forecast applicable to the accident site that was valid from 0800 until 1400 PDT indicated overcast clouds at the accident site with bases between 7,000 and 9,000 ft and tops between 17,000 ft and 18,000 ft. The Graphical AIRMETs²⁷ (G-AIRMETs) Sierra and Zulu were overlaid on the GFA cloud forecast products. The only human-generated information reflected in the two GFA products were the G-AIRMETs.

²⁷ Graphical AIRMETs (G-AIRMETs), found on the Aviation Weather Center webpage at <http://aviationweather.gov>, are graphical forecasts of en-route weather hazards valid at discrete times no more than 3 hours apart for a period of up to 12 hours into the future (for example, 00, 03, 06, 09, and 12 hours). G-AIRMETs are snap shots at discrete time intervals as defined above. The text AIRMET is the result of the production of the G-AIRMET but provided in a time smear for a 6hr valid period.

13.0 Terminal Aerodrome Forecast

There were no NWS Terminal Aerodrome Forecast²⁸ (TAF) locations within 30 miles of the accident site.

14.0 National Weather Service Area Forecast Discussion

The NWS Weather Forecast Office in Boise, Idaho, (WFO BOI) was responsible for the public forecast in the region of the accident site. WFO BOI issued the following Area Forecast Discussion (AFD) at 0909 PDT, which was the AFD issue closest to the accident time with an aviation section:

FXUS65 KBOI 021609
AFDBOI

Area Forecast Discussion
National Weather Service Boise ID
1009 AM MDT Sun Apr 2 2023

.DISCUSSION...Areas near the NV border will continue to see periods of light snow today. Accumulations will limited to colder surfaces at sites below 5000 feet with no accumulation expected below 4000 feet. Cold air aloft will lead to scattered afternoon showers. Marginal instability and daytime heating could be enough to support a thunderstorm or two across far eastern Oregon zones and portions of SW Idaho. For late this afternoon/evening forcing along the leading edge of the upper low could bring a more organized line of showers and possibly an embedded thunderstorm through the area. With colder air in place aloft, showers today are more likely to bring graupel and snow to valley floors. Accumulation at lower elevations would be minor and likely limited to colder surfaces. Have updated forecast to include mention of thunderstorms.

&&

.AVIATION...Areas of MVFR and local IFR/LIFR in rain and snow showers. Isolated thunder possible after 18z. Snow levels at valley floors this morning, rising to around 3000 ft this afternoon. Surface winds: W-NW 10-25 kt with gusts 25-35kt. Winds aloft at 10k ft MSL: W 20-35 kt.

&&

²⁸ 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

.PREV DISCUSSION...

SHORT TERM...Today through Tuesday night...Active weather will continue in the short-term as a sharp upper level trough dives southward across the western US. Moist westerly flow aloft will maintain shower activity across the region today mainly over higher terrain. Snow levels will hover near 3000 ft MSL with additional light snow accumulations ahead of an advancing cold front later this afternoon. The cold front will usher in more widespread snow showers, with stronger showers along the cold front producing brief bursts of snow with graupel at lower elevations. Lower valleys will see snow accumulations of up to an inch through tonight, with roughly 2 to 6 inches over the mountains. As the storm system continues southeastward, daytime instability will maintain scattered snow showers over the region through Monday evening. Post-frontal northwest winds will pick up Monday afternoon with gusts nearing 45 mph south and east of Boise across the Snake Plain. A secondary low will drop across the region on Tuesday, generating more snow showers mainly over the mountains as breezy winds continue along the I-84 corridor of south-central Idaho. Temperatures will stay 10-15 degrees below normal, with the coldest day of the period on Monday.

LONG TERM...Wednesday through Sunday...Northwest flow aloft will be in place Wednesday morning, bringing showers mainly to the mountains and maintaining well-below-normal temperatures. Brief weak ridging will arrive Thursday into Thursday night in advance of a shortwave trough just moving onto the coast. This shortwave will move through the ridge and over the area Friday. Each day will bring isolated to scattered showers, with the best chance coming Thursday night. These showers will be in the form of snow for all elevations through Thursday morning, then transition to rain at lower elevations and continued snow above around 3500 ft Thursday and 4500 ft Friday. Models indicate another weak shortwave trough will try to break through the weak ridge Saturday, keeping a slight chance for showers in the forecast. Snow accumulations in the mountains will be minor with these weak shortwave troughs. Saturday night and Sunday should be dry. Throughout the long term period we will see a warming trend. Temperatures will still be around 10 degrees below normal Wednesday, warm to about 5 degrees below normal Thursday and Friday, rise to near or just above normal Saturday, and then rise to 5-10 degrees above normal Sunday. At this time, it appears the streak of days below 60 degrees will end Saturday for folks in the Treasure Valley, and Sunday for folks in the Baker and western Magic Valleys.

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.BOI WATCHES/WARNINGS/ADVISORIES...

ID...None.

OR...None.

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15.0 Winds and Temperature Aloft Forecast

The NWS 0658 PDT, Winds and Temperature Aloft forecast valid for the closest points to the accident site are included below:

```
FBUS31 KWNO 021358
FD1US1
DATA BASED ON 021200Z
VALID 021800Z FOR USE 1400-2100Z. TEMPS NEG ABV 24000

FT 3000 6000 9000 12000 18000 24000 30000 34000 39000
BOI      2610-05 2825-12 2631-19 2659-29 7601-35 772048 760655 277955
IMB      2630-13 2527-20 2639-34 2676-40 269648 268450 266051
LWS 9900 2311-07 2417-15 2519-22 2627-36 2643-44 266649 266249 265248
```

The closest forecast points to the accident site were the Boise, Idaho, (BOI), Kimberly, Oregon, (IMB), and Lewiston, Idaho (LWS). The 0658 PDT forecast was for use between 0700 and 1400 PDT.

16.0 Icing Potential

The Current Icing Product (CIP) and Forecast Icing Product (FIP²⁹) imagery provided information on expected icing severity as five categories: none, trace, light, moderate, and heavy. The severity estimates are roughly based on the accretion rate of ice on an airplane, and the levels are determined by the time it would take for an airfoil to accrete 1/4 of an inch of ice: trace = 1 hour; light = 15 minutes to 1 hour; moderate = 5 to 15 minutes; severe = less than 5 minutes. Note that these are general values. Users should always consider the icing susceptibility of their airframe and availability of icing protection provided by their aircraft. Different aircraft and different flight configurations (airspeed, angle of attack, etc.) will experience variations in accretion rate.

²⁹ 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 \(ucar.edu\)](http://arc.aiaa.org/doi/abs/10.2514/6.2014-2070)

The images presented in this report show data from National Center for Atmospheric Research (NCAR)'s prototype CIP and FIP algorithms, generated using NCAR's visualization software. These algorithms differ in various ways from the operational CIP and FIP³⁰ that provided data used to generate the publicly available images accessible through the AWC on the accident day. NCAR's prototype CIP and FIP represent the latest research and development conducted by their team of in-flight icing scientists, and have passed internal validation exercises using voice pilot reports (PIREPs) of icing conditions and scientific airborne research observations of in-flight icing (when available). Through coordination with the FAA and NOAA, NCAR provides the prototype CIP and FIP for an independent validation exercise to determine their suitability for operational use. Pending the outcome of that validation, the operational versions are replaced with the prototype versions. The frequency with which the operational versions are updated is dependent upon the research and development advancements in the prototype versions and available resources to support the operational upgrade.

The FIP icing probabilities and icing severity products for the 1-hour forecast valid at 1000 PDT at 10,000 through 14,000 ft indicated a 10 to 30% probability of trace to moderate icing above the accident site (attachment 3). The CIP products indicated a 0 to 40% probability of trace to moderate icing from 10,000 ft through 14,000 ft at 1000 PDT above the accident site (attachment 3). For more FIP and CIP data and imagery please see attachment 3.

17.0 Pilot Weather Information

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

Pilots adopting these guidelines will be better prepared to interpret and utilize real-time weather information before departure and en route, in the cockpit, via technology like Automatic Dependent Surveillance-Broadcast (ADS-B) and via third-party providers.³¹

³⁰ <https://www.aviationweather.gov/icing/fip>

³¹ https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_91-92.pdf. The AC also listed multiple online FAA resources for aviation flight planning services for adverse weather.

A search of archived information indicated that the accident pilot did not request weather information from Leidos Flight Service. The accident pilot did not file a flight plan through ForeFlight, however, the accident pilot did create a "flight" (attachment 5) which did allow for a weather briefing to be generated (attachment 6). The weather briefing package was generated around 0800 PDT and contained all the standard weather information and products. For more information please see attachments 5 and 6. Prior to the flight the accident pilot had not viewed any weather imagery information on the ForeFlight App. It is unknown what additional weather information, if any, the accident pilot checked or received during the accident flight.

18.0 Astronomical Data

The astronomical data obtained for the accident site on April 2, 2023, indicated the following:

SUN

Begin civil twilight	0657 PDT
Sunrise	0726 PDT
Accident time	0950 PDT³²
Sun transit	1351 PDT
Sunset	2017 PDT
End civil twilight	2046 PDT

At the time of the accident the Sun was at an altitude of 24.32° and an azimuth of 108.39°.

³² Inserted accident time for reference and context.

E. LIST OF ATTACHMENTS

Attachment 1 - GOES-18 Visible imagery animation from 0801 to 1001 PDT

Attachment 2 - GFA information valid at the accident time

Attachment 3 - CIP and FIP imagery

Attachment 4 - Animation of KCBX imagery between 0931 and 0959 PDT

Attachment 5 - ForeFlight information

Attachment 6 - ForeFlight weather information

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