



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

September 29, 2022

Specialist's Factual Report

METEOROLOGY

WPR22FA345

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A. ACCIDENT

Location: Seligman, Arizona
Date: September 13, 2022
Time: about 1101 mountain standard time (1801 UTC)¹
Aircraft: Type – Piper PA-46-310P; Registration – N43605

B. METEOROLOGIST

Mike Richards
Senior Meteorologist
Operational Factors Division (AS-30)
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C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board’s meteorological specialist did not travel in support of this accident investigation and gathered all weather data remotely. Unless otherwise noted, all times are in mountain standard time for September 13, 2022 (based upon the 24-hour clock), directions are referenced to true north, distances are in nautical miles and heights are above mean sea level (msl) unless otherwise noted. The accident site was located at about: 35.4839° north latitude; 112.72019° west longitude at an elevation of about 6,120 feet.

This report provides information on the weather conditions and forecasts applicable to the accident time and location.

D. WEATHER INFORMATION

1.0 Weather Radar

WSR-88D² Level-II base reflectivity weather radar imagery from the Flagstaff, Arizona, site (KFSX) is presented in Figures 1-5. KFSX was located approximately 92 miles northeast of the accident location at an elevation of about 7,515 feet. Assuming standard refraction and considering the 0.95° beam width³ for the WSR-88D radar beam, the KFSX -0.174° and 0.484° tilts would have “seen” altitudes above the accident location of between about 6,800 and 16,100 feet and between about 13,200 and 22,500 feet, respectively. Figures 1-4 show the evolution of

¹ UTC – abbreviation for Coordinated Universal Time

² Weather Surveillance Radar 88 Doppler (WSR-88D)

³ Here we define the angular width of the radar beam as the region of transmitted energy that is bounded by one-half the maximum power. The maximum power lies along the beam centerline and decreases outward from the radar antenna.

the weather radar picture during the final portion of the accident aircraft's flight path. The end of the accident aircraft's flight path is coincident with a "cell" of heavy to extreme reflectivity (Figure 4). A vertical cross-section of the Level-II base reflectivity weather radar imagery through this cell is presented in Figure 5.

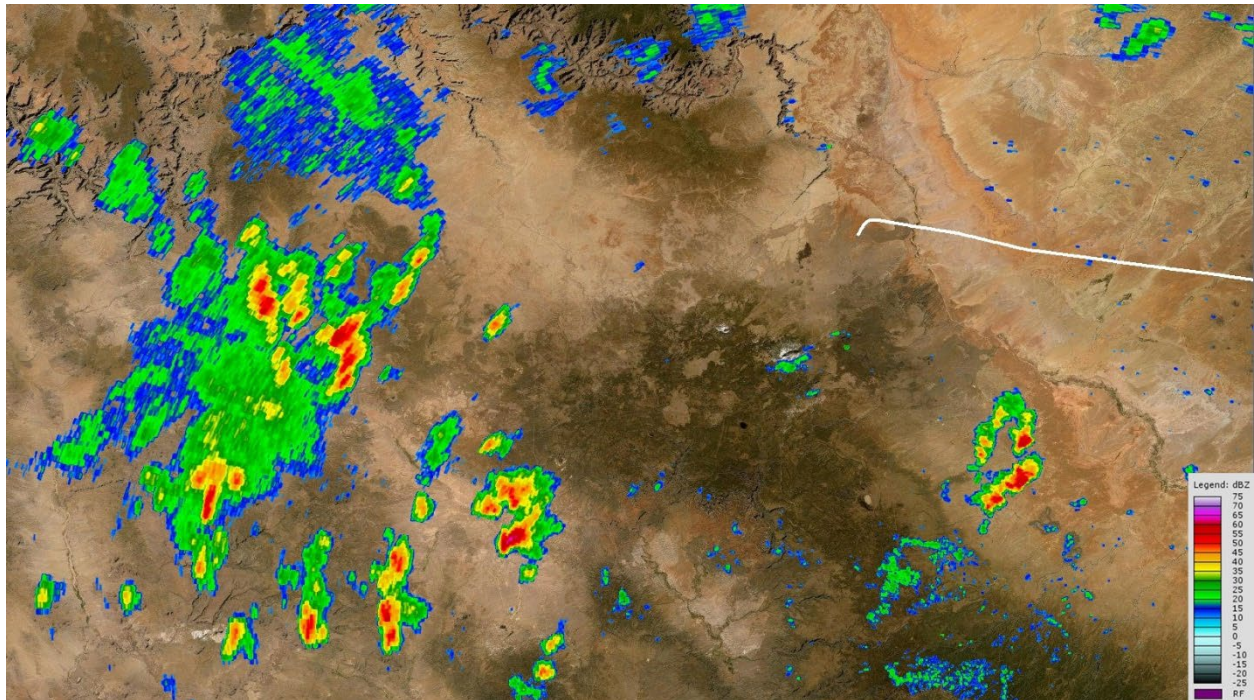


Figure 1 – KFSX -0.174° Level-II base reflectivity product from a sweep initiated at 1031:40. Accident aircraft's flight path through 1031:40 depicted by the white line. Reflectivity has been "smoothed" and reflectivity values less than 10 dBZ have been masked out.

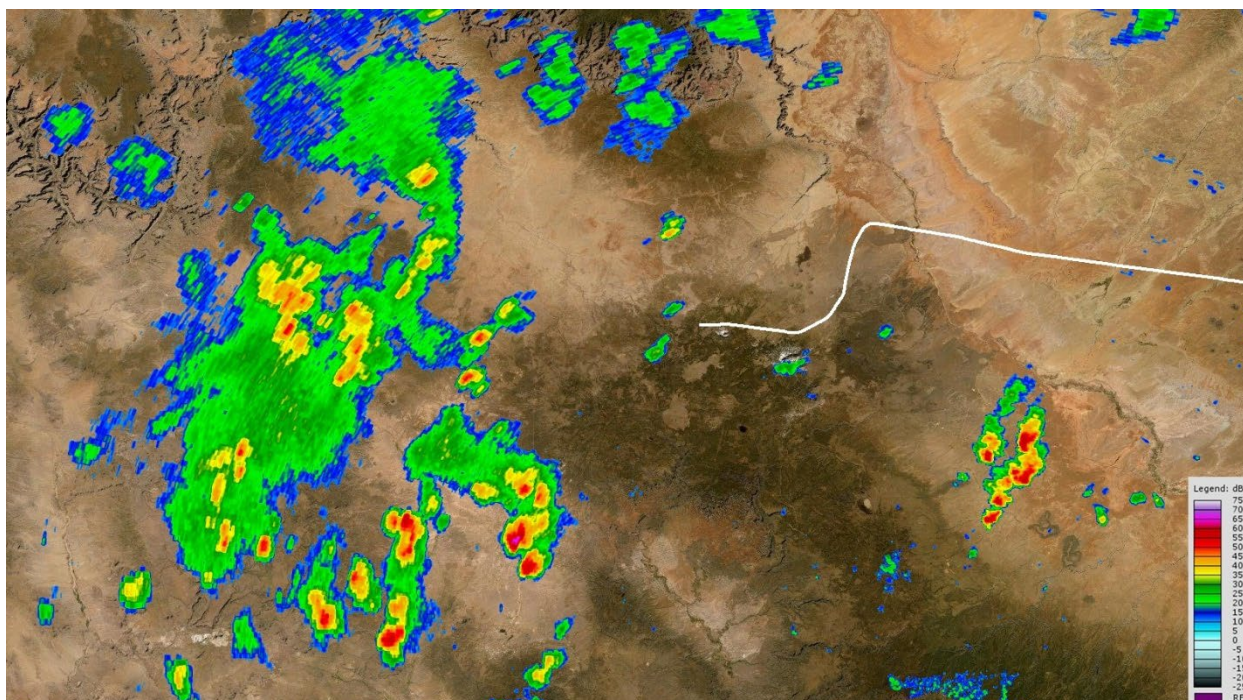


Figure 2 – KFSX 0.484° Level-II base reflectivity product from a sweep initiated at 1042:47. Accident aircraft's flight path through 1042:47 depicted by the white line. Reflectivity has been “smoothed” and reflectivity values less than 10 dBZ have been masked out.

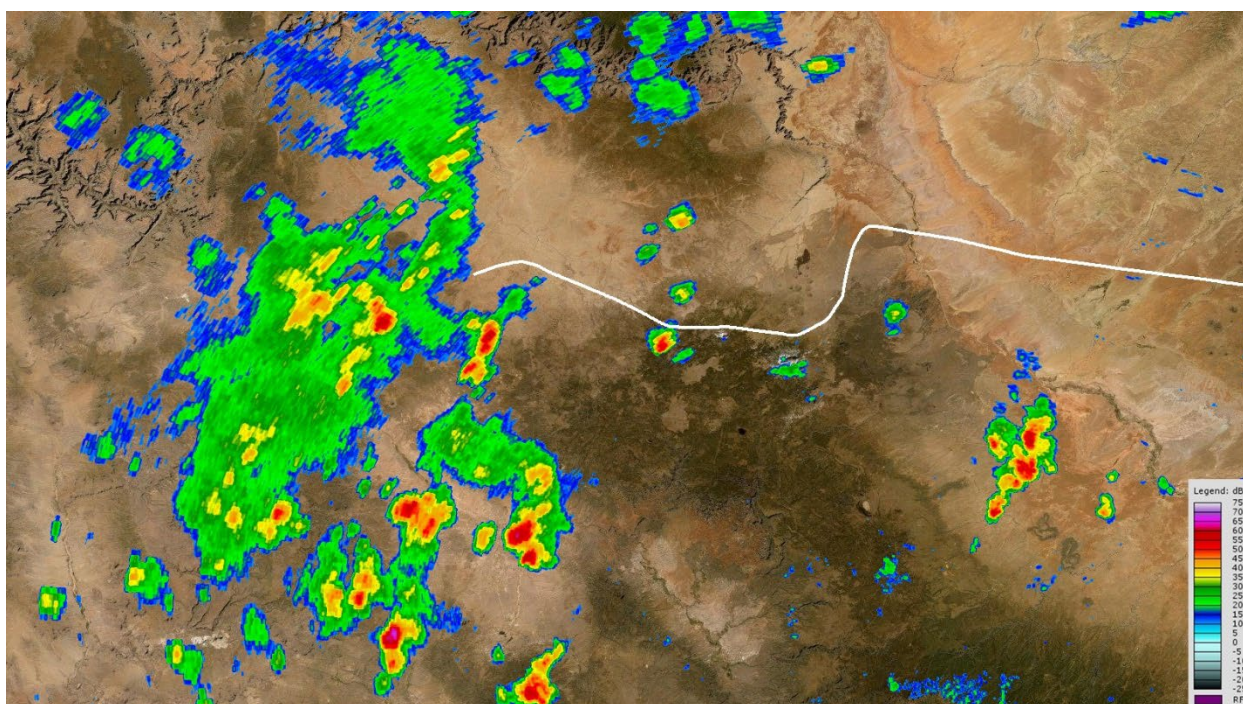


Figure 3 – KFSX 0.484° Level-II base reflectivity product from a sweep initiated at 1053:28. Accident aircraft's flight path through 1053:28 depicted by the white line. Reflectivity has been “smoothed” and reflectivity values less than 10 dBZ have been masked out.

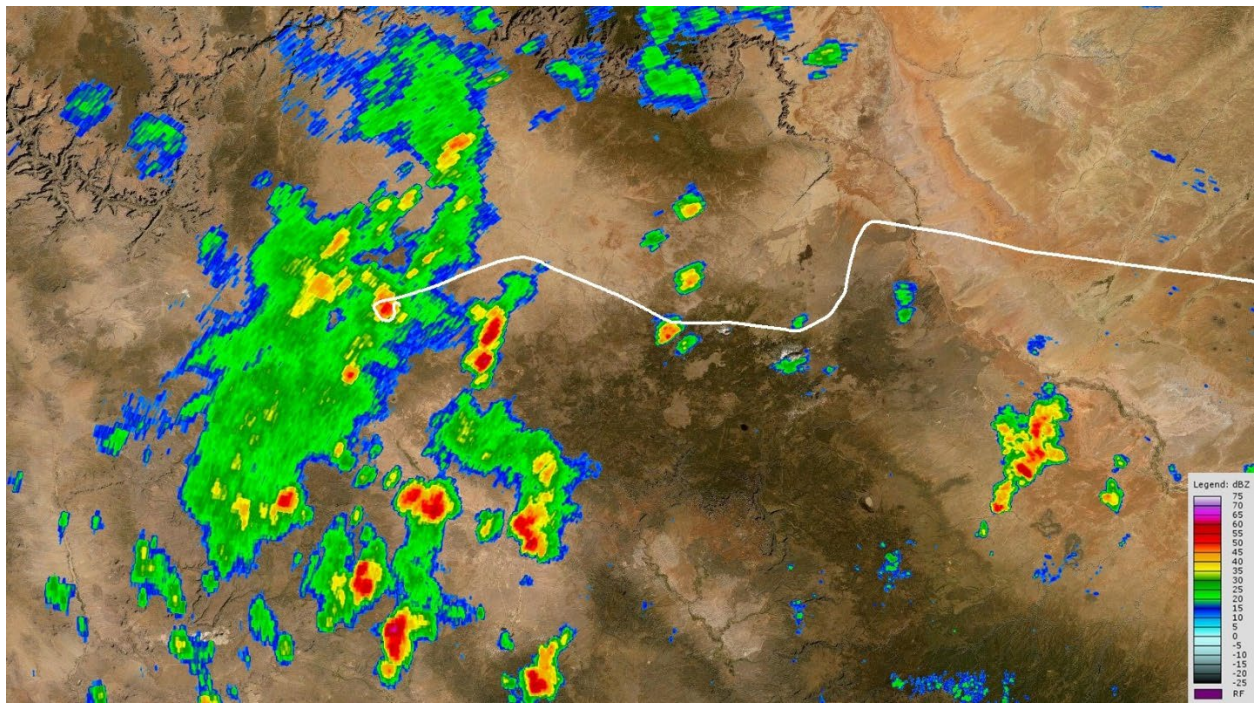


Figure 4 – KFSX 0.484° Level-II base reflectivity product from a sweep initiated at 1059:00. Accident aircraft's flight path through 1100:25 depicted by the white line. Reflectivity has been “smoothed” and reflectivity values less than 10 dBZ have been masked out.

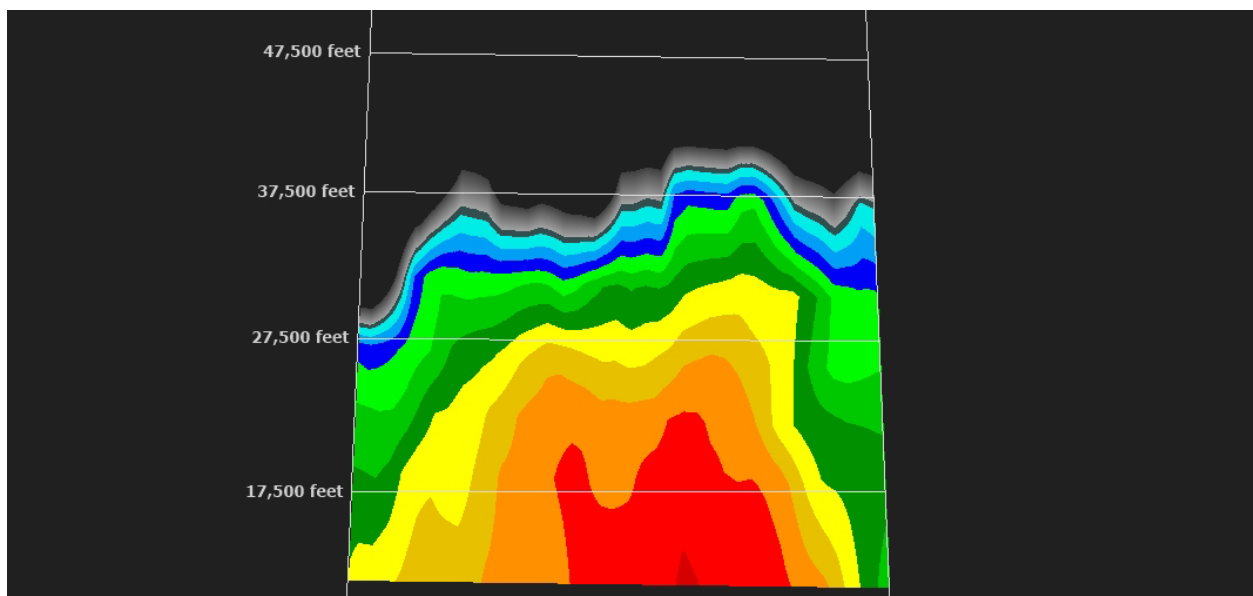


Figure 5 – Vertical cross-section of the KFSX Level-II base reflectivity weather radar imagery for the volume scan initiated at 1058:16. Color table is as presented in Figures 1-4. The left-hand-side surface coordinates are 35.526512° latitude, -112.799240° longitude; the right-hand-side surface coordinates are 35.441494° latitude, -112.743347° longitude. Height scale is approximate to within about 100 feet.

2.0 CIWS

Archive data from the FAA's Corridor Integrated Weather System (CIWS) for the accident region at 1100 are presented in Figure 6. This image presents convective growth and decay (orange and blue hatched areas, respectively) and echo top information. Maximum cloud tops around the accident location were at 38,000 feet.

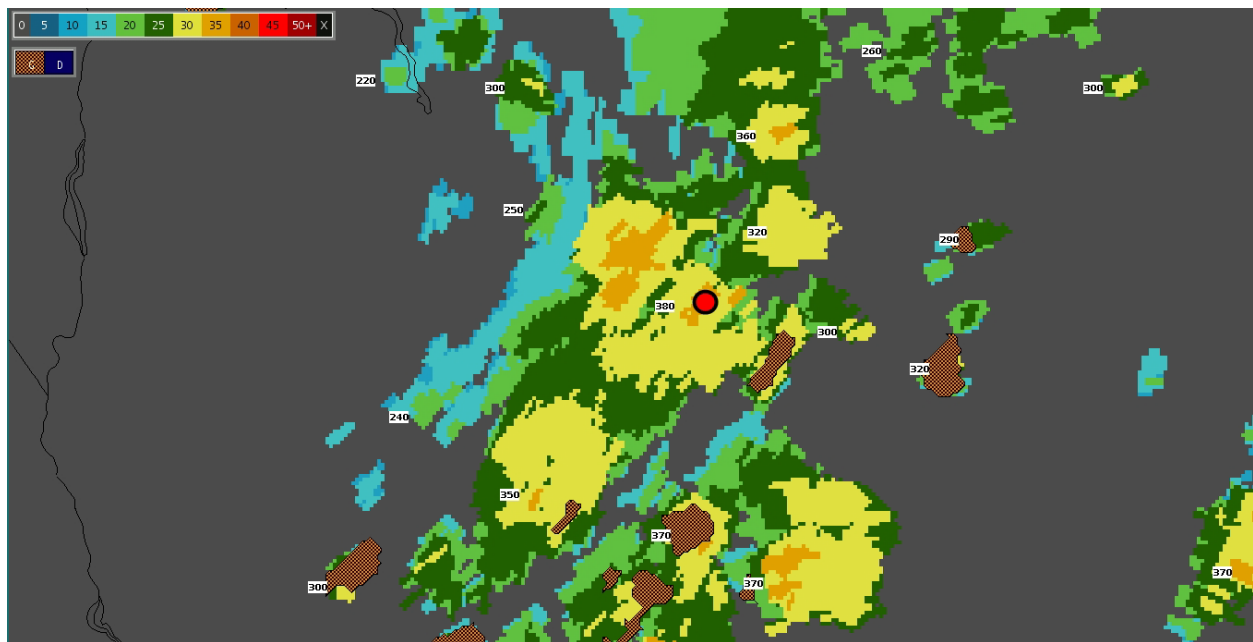


Figure 6 – Archive CIWS display from 1100. Areas of convective growth are identified by the orange hatched areas. Other colors define echo tops as defined by the colorbar in 1,000s of feet. The accident location is denoted by the red circle.

3.0 Lightning

A review of the Earth Networks Total Lightning Network (ENTLN) lightning database revealed numerous flash total lightning activity between 1045 and 1105 around the accident location.⁴ The entire dataset may be found in Attachment 1. Figure 7 presents the total lightning activity in the immediate vicinity of the final portion of the accident aircraft's flight path.

⁴ The ENTLN was queried for a geographic area bounded by latitudes 35.7955°N and 35.1424°N, and longitudes 113.3075°W and 112.1265°W.

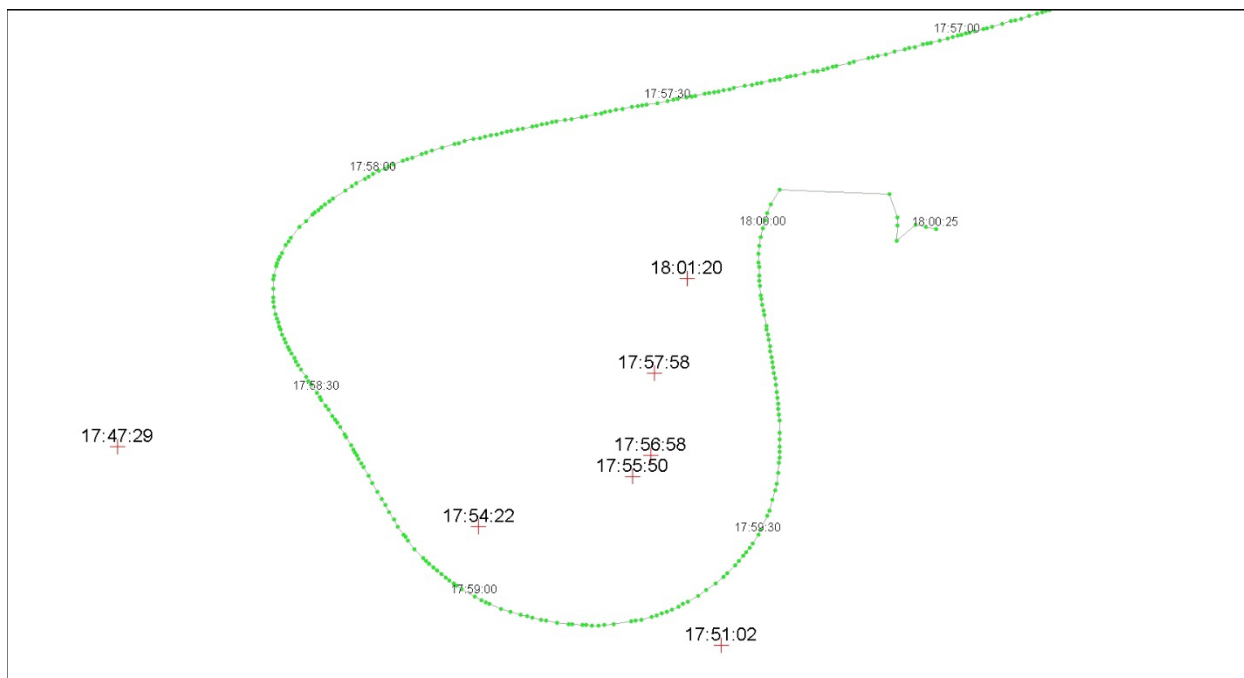


Figure 7 – ENTNLN flash total lighting points (red “+” symbol with larger bold UTC times) and the final portion of the accident aircraft’s flight path (green dots with non-bolded UTC times).

4.0 HRRR Model Sounding

A High-Resolution Rapid Refresh (HRRR) model⁵ sounding (Figure 8) for near the accident location⁶ at 1100 using an elevation of 6,120 feet was retrieved from the National Oceanic and Atmospheric Administration’s Air Resources Laboratory and analyzed by the RAwinsonde OBservation (RAOB) program. Near 15,000 feet the wind was from the southwest at about 25 knots. Above this level the wind remained from the southwest and decreased in magnitude to a wind of about 15 knots near 20,000 feet. Clouds were indicated between about 15,000 and 27,000 feet. Calculations made by RAOB indicated that the most-unstable Convective Available Potential Energy (CAPE) parameter was 714 Joules/kilogram (from 814 hectopascals [hPa]). Maximum vertical velocity⁷ for the most-unstable atmosphere was calculated as 39 meters/second (about 7,675 feet per minute). Light rime icing potential was indicated between about 15,500 and 23,500 feet.

⁵ 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.

⁶ Coordinates used for the model were 35.48, -112.72.

⁷ MVV is not usually considered a realistic estimate for maximum vertical velocity in a storm. Anecdotes suggest considering a value of MVV/2, however it is not well understood when or where such a half-value should be applied.

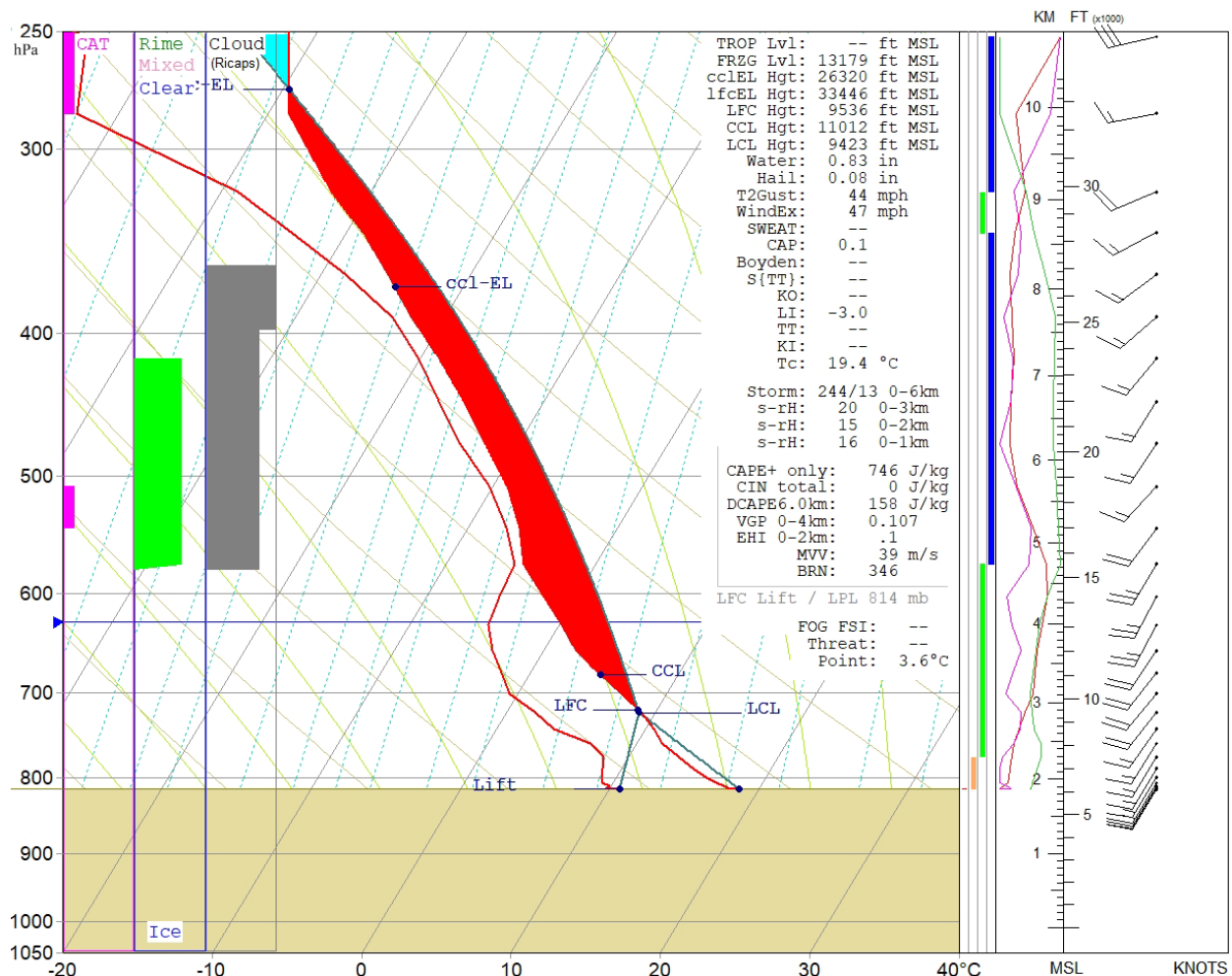


Figure 8 – HRRR model sounding data in SkewT/LogP format for 1100 near the accident site, surface to 250 hPa.

5.0 Satellite Imagery

Geostationary Operational Environmental Satellite (GOES)-17 visible (0.64 μ m) and infrared (10.3 μ m) data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison. Images from 1056 are presented in Figures 9 and 10. The GOES-17 visible imagery depicted cloudy conditions over the accident region. Infrared cloud-top temperatures over the accident site were about -40°C, which, when considering the 1100 HRRR sounding, corresponded to cloud top heights of about 33,600 feet.

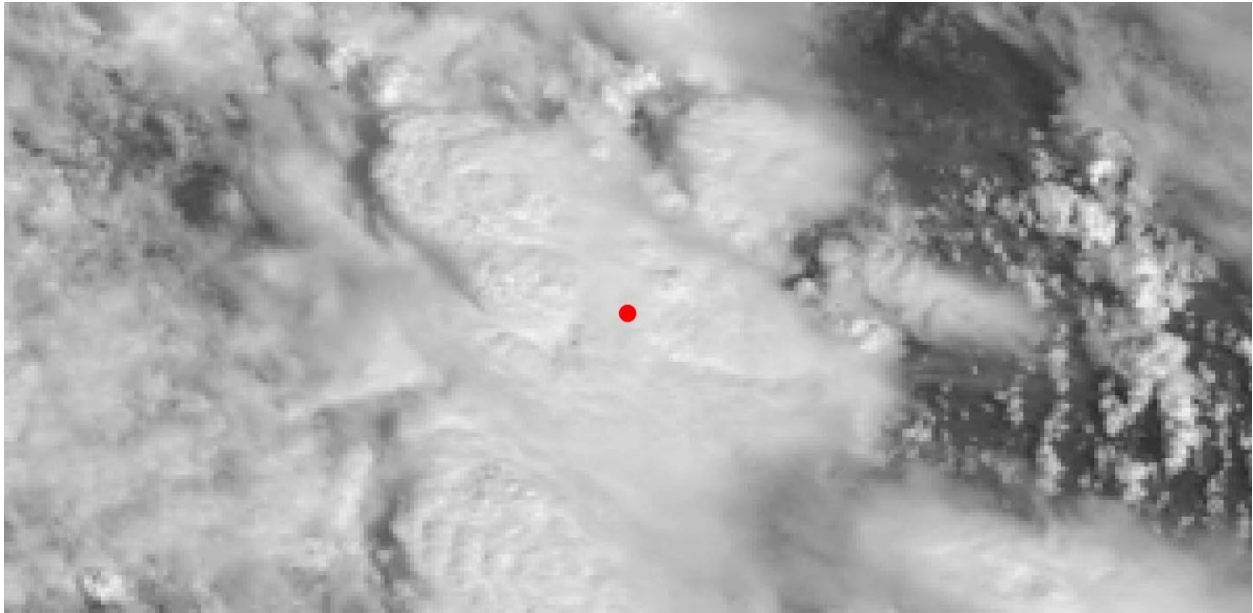


Figure 9 – GOES-17 visible imagery from 1056. Accident location denoted by the red dot. Image is not corrected for parallax error.

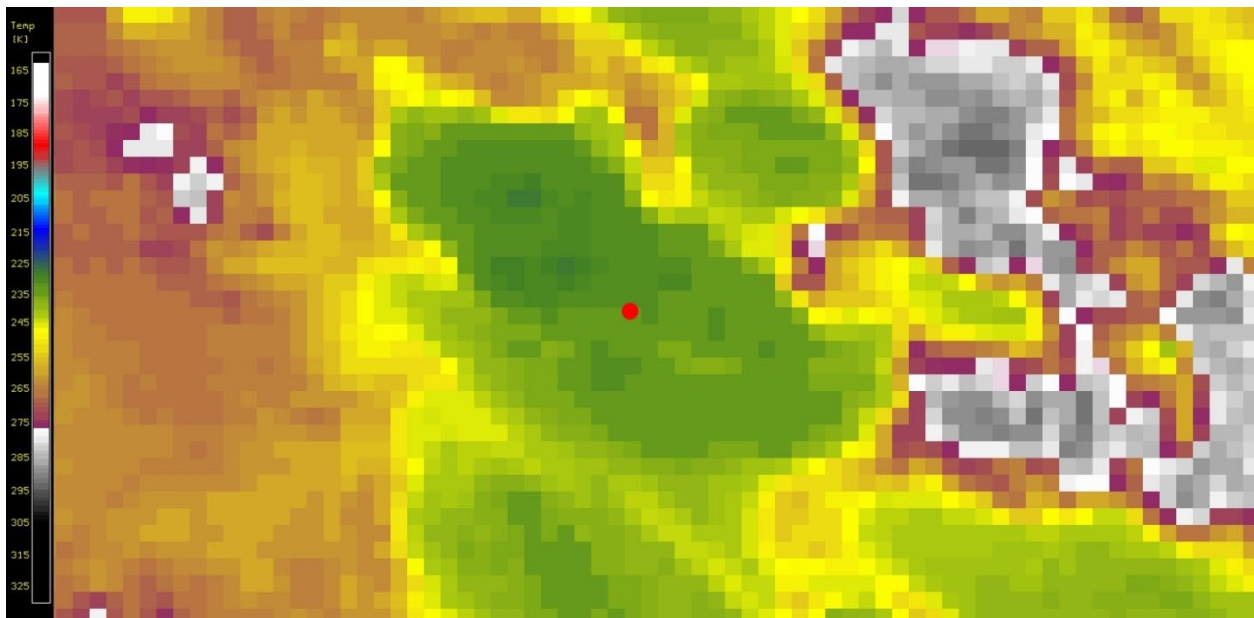


Figure 10 – GOES-17 infrared brightness temperature imagery from 1056. Accident location is denoted by the red dot. This image has not been corrected for any parallax error.

6.0 Pilot Reports

The following longline-disseminated pilot reports⁸ (PIREPs) were applicable within 75 miles of the accident location between 0900 and 1200.

PRC UA /OV DRK025012 /TM 1610 /FL090 /TP C172 /SK SKT040 /RM OV KPRC BASES 070-080 MASL N OF KPRC BASES 090 MSL AND LOWERING AWC-WEB

PRC UA /OV DRK260045/TM 1615/FL370/TP B737/SK TOP390/RM S - ZAB/FDCS

GCN UA /OV GCN360015 /TM 1640 /FL250 /TP BE30 /TA M13 /IC LGT RIME /RM DURD FL260-FL240 AWC-WEB

GCN UA /OV GCN360015/TM 1640/FL250/TP BE30/TA M13/IC LGT RIME 260-240/RM DURD. COR ICE. ZLA CWSU

GCN UA /OV GCN280040 /TM 1651 /FL180 /TP B350 /TA M02 /IC LGT RIME/RM AWC-WEB

IGM UA /OV PGS080010/TM 1801/FL220/TP B737/TB MOD CAT/RM ZLA CWSU

7.0 Surface Observations

An Automated Weather Observing System (AWOS) was located at H. A. Clark Memorial Field Airport (CMR⁹) which was in Williams, Arizona, about 28 miles east-southeast of the accident location at an elevation of about 6,690 feet and had a magnetic variation of about 10°30' east. Automated longline¹⁰ reports from the CMR AWOS during the times surrounding the accident time are presented here, and the observation closest in time to the accident time is highlighted by bold text.

[0935] METAR KCMR 131635Z AUTO 19008G14KT 10SM SCT032 SCT043 SCT049 19/11 A3019 RMK AO2=

[0955] METAR KCMR 131655Z AUTO 21009KT 10SM FEW032 FEW048 18/10 A3019 RMK AO2=

⁸ These do not include pilot reports only broadcast via radio.

⁹ This report uses the 3-digit International Air Transport Association format for airport identification, which does not use the geographic designating digit (e.g., “K” for stations in the continental U.S. and “P” for U.S. stations in Alaska and the Pacific region) as found in the 4-digit International Civil Aviation Organization (ICAO) identifier format. Weather observations from airports in this report are referenced by their reporting station’s identifier (using ICAO format that includes the geographic designating digit), not by the airport at which the reporting station is located.

¹⁰ “Longline” refers to the dissemination of weather observations with the intent that they are available in near-real time to national databases (effectively, the whole world) 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 general global public has access to surface weather observations, particularly outside of the aviation community.

[1015] METAR KCMR 131715Z AUTO 20012KT 10SM CLR 18/10 A3019 RMK AO2=
 [1035] METAR KCMR 131735Z AUTO 21012KT 10SM FEW048 FEW100 19/11 A3019 RMK AO2=
[1055] METAR KCMR 131755Z AUTO 20010G18KT 170V230 10SM CLR 20/10 A3019 RMK AO2=
 [1115] METAR KCMR 131815Z AUTO 20008G15KT 10SM FEW100 19/11 A3018 RMK AO2=
 [1135] METAR KCMR 131835Z AUTO 21016G22KT 10SM FEW041 FEW055 BKN090 20/11 A3019 RMK AO2=

At 1055, the CMR AWOS reported a wind from 200° at 10 knots with gusts to 18 knots, wind variable between 170° and 230°, visibility 10 statute miles or greater, sky clear, temperature of 20° Celsius (C) and dew point temperature of 10°C, altimeter setting of 30.19 inches of mercury; Remarks: automated station with a precipitation discriminator.

An Automated Surface Observing System (ASOS) was located at Grand Canyon National Park Airport (GCN) which was in Grand Canyon, Arizona, about 39 miles northeast of the accident location at an elevation of about 6,600 feet and had a magnetic variation of about 10°30' east. Augmented longline reports from the GCN ASOS during the times surrounding the accident time are presented here, and the observation closest in time to the accident time is highlighted by bold text.

[0915] SPECI KGCN 131615Z 24003KT 7SM -RA FEW019 BKN065 OVC085 12/11 A3020 RMK AO2 RAB1557 P0010 T01220106=
 [0954] METAR KGCN 131654Z 00000KT 7SM FEW080 SCT095 BKN120 15/12 A3019 RMK AO2 LTG DSNT NE RAB1557E44 SLP145 P0010 T01500117=
[1054] METAR KGCN 131754Z 00000KT 10SM FEW048 BKN110 16/13 A3019 RMK AO2 LTG DSNT SW AND W RAB10E27 SLP148 P0001 60012 T01560128 10156 20122 51003=
 [1154] METAR KGCN 131854Z 21010KT 10SM TS FEW027 FEW037 SCT100 19/12 A3017 RMK AO2 LTG DSNT ALQDS TSB54 SLP128 T01890122

At 1054, the GCN ASOS reported a calm wind, visibility of 10 statute miles or greater, few clouds at 4,800 feet above ground level (agl), ceiling broken at 11,000 feet agl, temperature of 16°C and dew point temperature of 13°C, altimeter setting of 30.19 inches of mercury; Remarks included: automated station with a precipitation discriminator, lightning more than 10 miles away to the southwest and west, rain began at 1010 and ended at 1027, sea level pressure of 1014.8 hPa, 0.01 inches of liquid equivalent precipitation since 0954, 0.12 inches of liquid equivalent precipitation fell over the past six hours, temperature of 15.6°C and dewpoint temperature of 12.8°C, six hour maximum temperature of 15.6°C, six hour minimum temperature of 12.2°C, a pressure increase of 0.3 hPa over the past three hours.

8.0 Area Forecast Discussion

The National Weather Service (NWS) Flagstaff, Arizona, Weather Forecast Office issued the following "Synopsis," "Update" and "Aviation" sections of an Area Forecast Discussion at 0919.

FXUS65 KFGZ 131619

AFDFGZ

Area Forecast Discussion

National Weather Service Flagstaff AZ

919 AM MST Tue Sep 13 2022

.SYNOPSIS...Isolated to scattered thunderstorm activity will continue into the morning hours then become more numerous this afternoon. For Wednesday, storm coverage is expected to decrease and become focused mainly from the Mogollon Rim northward. On Thursday and over the coming weekend drier air will arrive, mostly putting an end to the thunderstorm threat. Look for a gradual warming trend through the period.

.UPDATE...Only minor updates this morning to account for current trends and latest CAMs, as the going forecast is on track. Expect an active day across the CWA similar to yesterday, but with less shear. Storms most numerous around and NW of the Flagstaff area, and over the White Mountains. In addition to our typical thunderstorm threats (hail, strong winds), training storms will have the potential for locally heavy rainfall.

.AVIATION...For the 18Z TAF package...Mainly VFR conditions persist for the next 24 hours with SCT to BKN cloud cover. Expect scattered SHRA/TSRA developing after 20Z with greatest coverage across northwest Coconino County and along/northeast of the Mogollon Rim. Anticipate activity to decrease after 05Z Wed with storms continuing across northwest Coconino County and northeast Arizona overnight. Gusty winds, minor turbulence, and brief MVFR/IFR conditions, resulting in mountain obscuration at times, will be possible in and around any storms. South/southwest winds 10-15 kts are otherwise expected in the afternoon. Aviation discussion not updated for TAF amendments.

9.0 G-AIRMETs

A Graphical Airmen's Meteorological Information (G-AIRMET) is a graphical advisory of weather that may be hazardous to aircraft but are less severe than SIGMETs. They are only valid at specific time "snapshots". G-AIRMETs include forecasts for discrete times that are three hours apart for a period of up to 12 hours into the future (i.e., when G-AIRMETs are issued, they include 00-, 03-, 06-, 09- and 12-hour forecasts). This suite of forecasts is issued at 0300 UTC, 0900 UTC, 1500 UTC and 2100 UTC (the G-AIRMET issuance times), with updates issued as necessary.

There were no G-AIRMETs active for the accident location at 0800 or 1100.

10.0 SIGMETs

There were no non-convective Significant Meteorological Information (SIGMET) advisories active for the accident location at the accident time.

A Convective SIGMET advisory was issued by the NWS Aviation Weather Center at 0955 for an area that included the accident location. This Convective SIGMET advised of an area of thunderstorms with cloud tops to FL390¹¹. The Convective SIGMET polygon was indicated to be moving from 210° at 20 knots.

*WSUS33 KKCI 131655
SIGW
-MKCW WST 131655
CONVECTIVE SIGMET 44W
VALID UNTIL 1855Z
AZ UT NV
FROM 50SW DTA-30WSW HVE-10S DRK-30SE EED-60NNE LAS-50SW DTA
AREA TS MOV FROM 21020KT. TOPS TO FL390.*

The Convective SIGMET that was issued at 0955 was superseded by another Convective SIGMET issued at 1055 for an area that included the accident location and was valid at the accident time (Figure 11). This Convective SIGMET advised of an area of severe thunderstorms with cloud tops to FL390, hail to one inch and wind gusts to 50 knots possible. The Convective SIGMET polygon was indicated to be moving from 210° at 20 knots.

*WSUS33 KKCI 131755
SIGW
-MKCW WST 131755
CONVECTIVE SIGMET 47W
VALID UNTIL 1955Z
AZ UT NV
FROM 10NW BVL-30SSW HVE-30WSW SJN-60SE EED-10WSW ILC-10NW BVL
AREA SEV TS MOV FROM 21020KT. TOPS TO FL390.
HAIL TO 1 IN...WIND GUSTS TO 50KT POSS.*

¹¹ Flight Level (FL) - a standard nominal altitude of an aircraft, in hundreds of feet. This altitude is calculated from the international standard pressure datum of 1013.25 hPa (29.92 inches of mercury), the average sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above msl or agl.

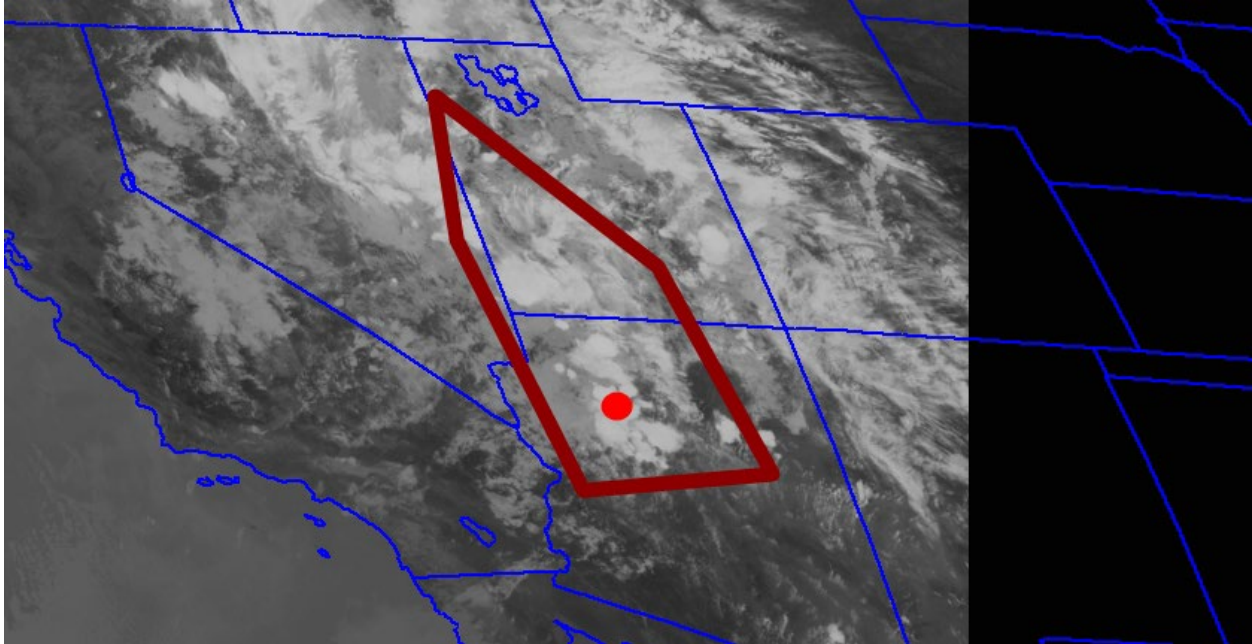


Figure 11 – Convective SIGMET issued at 1055 (dark red polygon), overlaid on GOES-17 infrared imagery from 1056. Accident location denoted by the red dot.

11.0 CWSU Products

There were no Center Weather Advisories or Meteorological Impact Statements issued by the NWS Center Weather Service Unit (CWSU) at the Los Angeles Air Route Traffic Control Center (ZLA) that were active for the accident location at the accident time.

12.0 Convective Outlook

At 0930, the NWS Storm Prediction Center issued a Convective Outlook that identified a general “thunderstorm” risk for the accident site (figure 12). Figure 13 provides a description of the different categories found in the Convective Outlook.

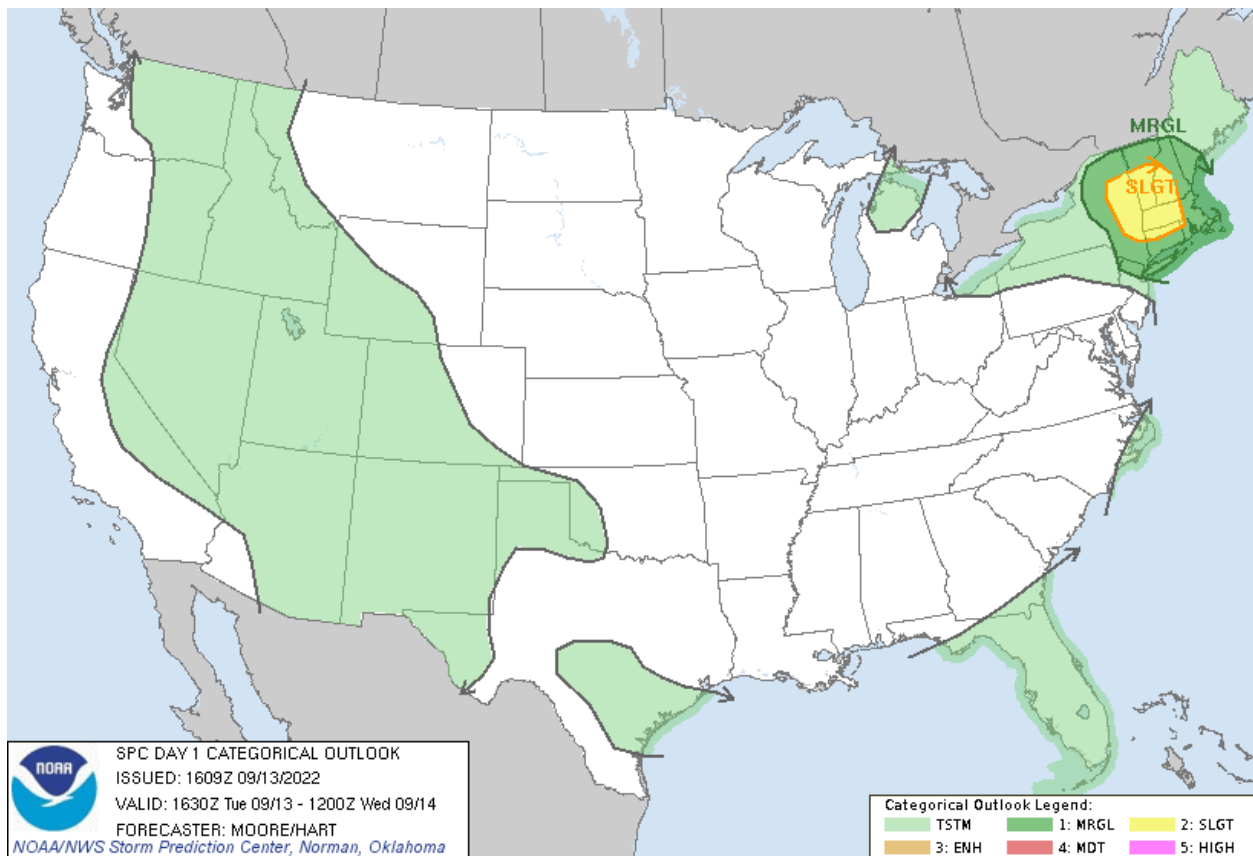


Figure 12 – SPC Convective Outlook issued at 0930.

Understanding Severe Thunderstorm Risk Categories					
THUNDERSTORMS (no label)	1 - MARGINAL (MRGL)	2 - SLIGHT (SLGT)	3 - ENHANCED (ENH)	4 - MODERATE (MDT)	5 - HIGH (HIGH)
No severe* thunderstorms expected	Isolated severe thunderstorms possible	Scattered severe storms possible	Numerous severe storms possible	Widespread severe storms likely	Widespread severe storms expected
Lightning/flooding threats exist with <u>all</u> thunderstorms	Limited in duration and/or coverage and/or intensity	Short-lived and/or not widespread, isolated intense storms possible	More persistent and/or widespread, a few intense	Long-lived, widespread and intense	Long-lived, very widespread and particularly intense
					
• Winds to 40 mph • Small hail	• Winds 40-60 mph • Hail up to 1" • Low tornado risk	• One or two tornadoes • Reports of strong winds/wind damage • Hail ~1", isolated 2"	• A few tornadoes • Several reports of wind damage • Damaging hail, 1 - 2"	• Strong tornadoes • Widespread wind damage • Destructive hail, 2" +	• Tornado outbreak • Derecho
* NWS defines a severe thunderstorm as measured wind gusts to at least 58 mph, and/or hail to at least one inch in diameter, and/or a tornado. All thunderstorm categories imply lightning and the potential for flooding. Categories are also tied to the probability of a severe weather event within 25 miles of your location.					

Figure 13 – Convective Outlook categories.

13.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) are intended to provide the necessary aviation weather information to give users a complete picture of the weather that might impact flight in the continental United States. Hourly model data and forecasts, including information on clouds, flight category, precipitation, icing, turbulence, wind, and other output from the NWS are available, however only certain imagery are archived by the NWS.

The following images (Figures 14 and 15) depict GFA forecast information on sky condition, icing, mountain obscuration, instrument flight rule (IFR)¹² condition and surface wind G-AIRMET advisories, surface visibility, surface wind, precipitation, and other obscurations and hazards, valid for a time near the accident time. The GFA forecast imagery depicted broken and overcast sky conditions in the accident region with a point to the northwest of the accident site identifying broken clouds at clouds at 15,000 feet with tops to FL220 (Figure 14). The GFA surface forecast also depicted a southerly surface wind of 5 knots near the accident location with scattered to numerous thunderstorms with rain across the region (Figure 15).

¹² IFR conditions - Ceilings less than 1,000 feet agl and/or visibility less than three statute miles.

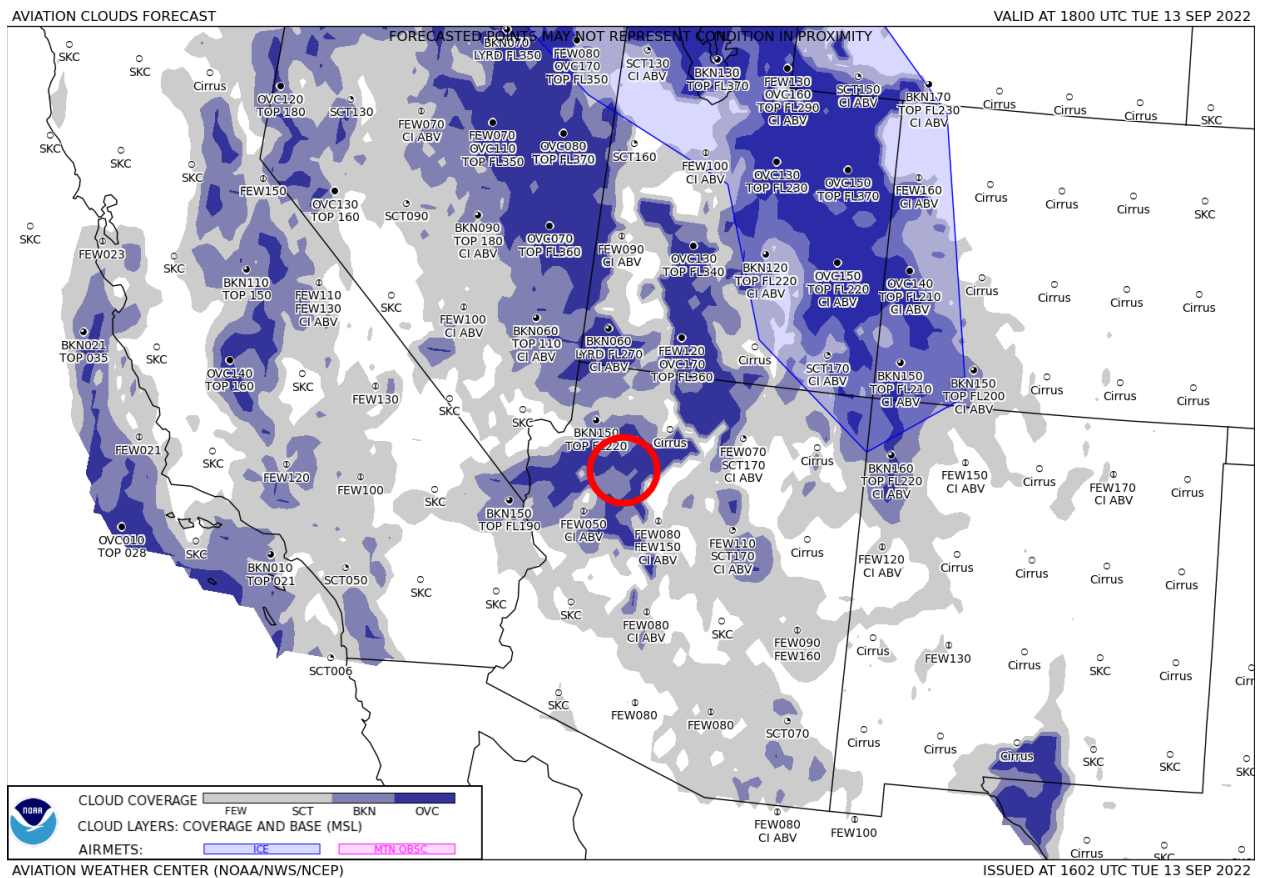


Figure 14 – GFA forecast imagery depicting sky condition and icing and mountain obscuration G-AIRMETs issued about 0900 and valid for 1100. The accident location is located within the red circle.

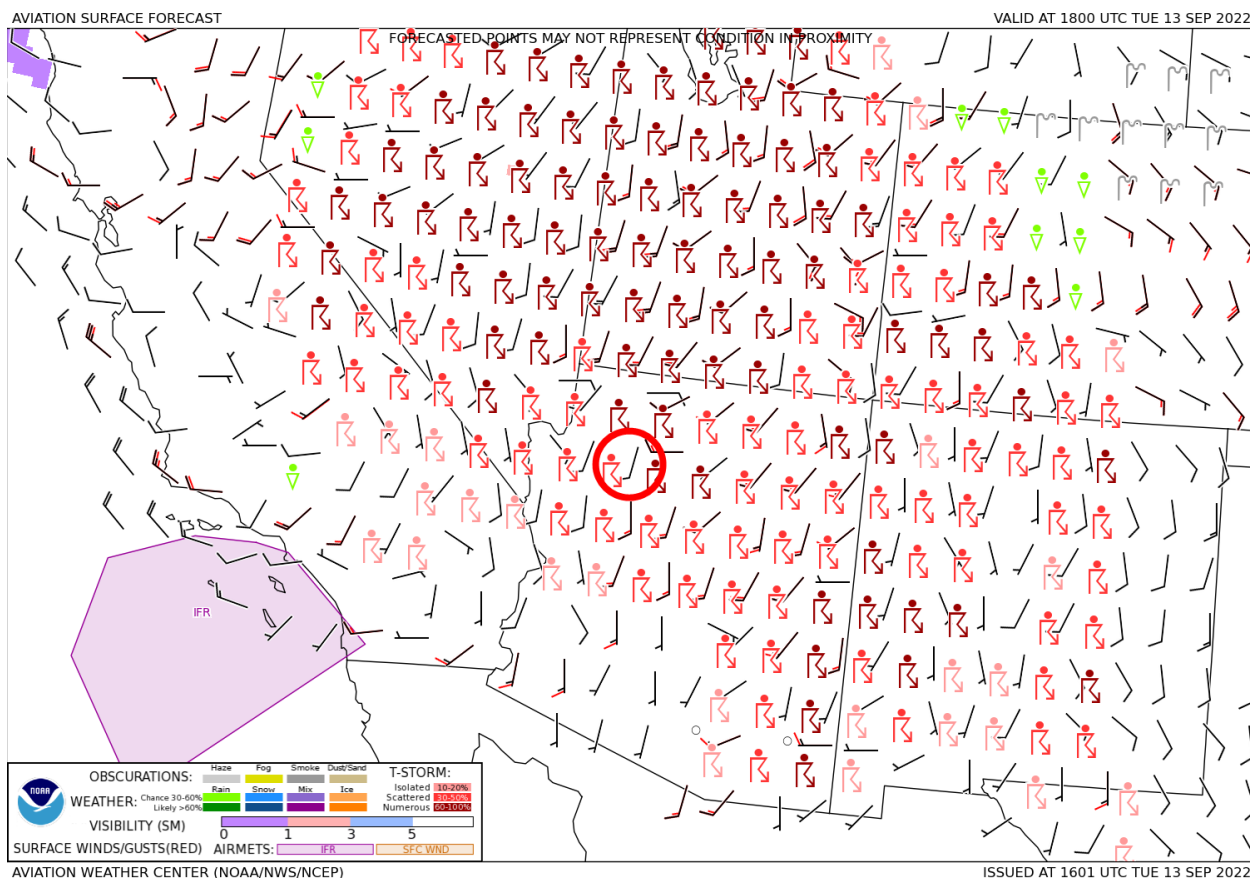


Figure 15 – GFA forecast imagery depicting IFR conditions and surface wind G-AIRMETs, surface visibility, surface wind, precipitation, and other obscurations and hazards. Issued about 0900 and valid for 1100. The accident location is located within the red circle.

14.0 Pre-Duty Weather Briefing

The Pre-Duty Weather Briefing issued by the ZLA CWSU about 0600 on the day of the accident can be found in the NTSB's docket for this accident investigation.

E. LIST OF ATTACHMENTS

Attachment 1 – Earth Networks Total Lightning Network lightning flash total lightning activity between 1045 and 1105 MST around the accident location.

Submitted by:

Mike Richards
Senior Meteorologist