

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



WPR21LA141

METEOROLOGY

Specialist's Factual Report

December 12, 2022

TABLE OF CONTENTS

A. ACCIDENT.....	3
B. METEOROLOGY INVESTIGATOR	3
C. SUMMARY	3
D. DETAILS OF THE INVESTIGATION	3
E. FACTUAL INFORMATION.....	4
1.0 SYNOPTIC CONDITIONS	4
1.1 Surface Analysis Chart.....	4
1.2 Upper Air Charts	5
1.3 National Radar Composite	8
1.4 12-hour Short Term Prognostic Chart.....	9
2.0 OBSERVATIONS.....	10
2.1 Lordsburg, New Mexico.....	10
2.2 Silver City, New Mexico.....	11
2.3 Deming, New Mexico	12
3.0 PILOT REPORTS	13
4.0 ATMOSPHERIC SOUNDING.....	14
5.0 SATELLITE IMAGERY	17
6.0 WEATHER RADAR IMAGERY	18
7.0 NWS FORECASTS	21
7.1 Terminal Aerodrome Forecast.....	21
7.2 Area Forecast Discussion.....	22
7.3 Graphic Forecast for Aviation.....	23
7.4 Winds and Temperature Aloft Forecast.....	25
7.5 Inflight Weather Advisories	26
8.0 ASTRONOMICAL CONDITIONS	27

A. ACCIDENT

Location: Animas, New Mexico
Date: March 24, 2021
Time: about 0021 mountain daylight time (MDT)
0621 coordinated universal time (UTC)
Airplane: Mooney M20B; Registration: N74786

B. METEOROLOGY INVESTIGATOR

Donald Eick
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Office of Aviation Safety
Operational Factors Division
National Transportation Safety Board
Washington, DC

C. SUMMARY

On March 24, 2021, at 0021 mountain daylight time, a Mooney M20B, N74786, was substantially damaged when it was involved in an accident near Animas, New Mexico. The pilot and passenger were seriously injured. The airplane was operated as a Title 14 Code of Federal Regulations Part 91 cross country personal flight.

The pilot had filed an Instrument Flight Rules (IFR) flight plan for a flight from Fort Stockton-Pecos County Airport (FST), Fort Stockton, Texas, to Tucson International Airport (TUS), Tucson, Arizona. During the flight, the pilot reported a loss of engine power and that they were experiencing light rime ice. The airplane became the subject of an Alert Notice (ALNOT) when Albuquerque Center lost communication with the pilot and the airplane dropped off radar.

According to responding Law Enforcement, the airplane came to rest in mountainous terrain at an elevation of about 5,010 ft above mean sea level (MSL) about a mile northwest of Pinkey Wright Mountains.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Senior Meteorologist was not on scene for this investigation and conducted the meteorology phase of the investigation remotely, collecting data 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 report documents the general weather products and forecasts over the region during the period and documents the pertinent meteorological parameters to the accident. All times are reported as MDT based upon the 24-hour clock, local time is -6 hours from UTC, and UTC=Z. Airport and 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. Directions are referenced to true north and distances in nautical miles. Heights are in feet (ft) msl unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The accident site was located at latitude 32.077911° North and longitude 108.727873° West based on the NTSB form 6120.1, at an elevation of about 5,010 ft.

E. FACTUAL INFORMATION

1.0 Synoptic Conditions

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 (NCEP) and the WPC located in College Park, Maryland. These are the base products used in describing weather features and in the creation of forecasts and warnings. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC 00-45H change 2¹.

1.1 Surface Analysis Chart

The southwest section of the NWS Surface Analysis Chart for 0000 MDT on March 24, 2021, is included as figure 1 with the approximate accident site marked by the red star. The chart depicted a low pressure system at 1000-hectopascals (hPa) over eastern New Mexico associated with a frontal wave with a cold front extending southwestward and a stationary front to the southeast of the low. Another low-pressure system was located over northern Arizona at 1006-hPa with several secondary troughs extending east, southwest and west from the low. Another trough was located east of the accident site in New Mexico and extended south-southeast into Mexico.

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

The closest station model on the chart over southwestern New Mexico to the north-northeast of the accident site depicted a northwest wind of 5 knots, light continuous rain, overcast clouds, with a temperature of 35° Fahrenheit (F) and a dew point temperature of 33° F. Other stations in southwestern Arizona also indicated overcast clouds and rain with winds from the northwest to west-southwest at 10 knots or less.

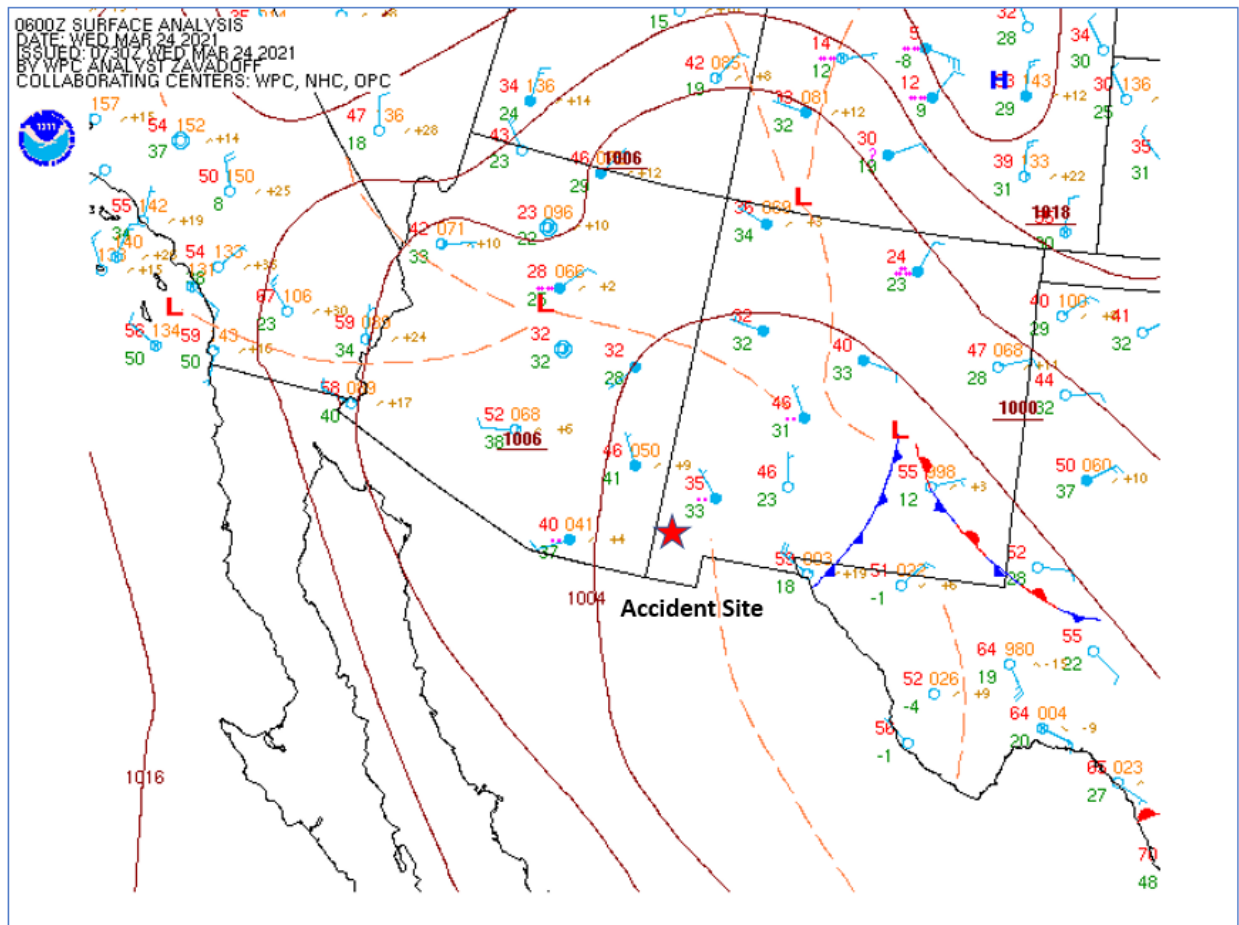


Figure 1 - The southwest section of the NWS Surface Analysis Chart for 0000 MDT with the accident site marked by the red star depicting the surface features over the area.

1.2 Upper Air Charts

The 850-, 700-, 500- and 300-hPa constant pressure charts for 1800 MDT on March 23, 2021, were obtained from the University of Wyoming upper air archives² and are included as figures 2-5 respectively with the approximate accident marked by a red star. The charts depict the pressure surfaces by height contours (blue lines), temperature by the isotherms (green dashed lines), isotachs on the 300-hPa chart

² <http://weather.uwyo.edu/upperair/>

(alternat light blue, gray, white shades), and the wind, temperature, and moisture conditions by the station models at approximately 5,000 ft, 10,000 ft, 18,000 ft, and 30,000 ft. The data for the charts were obtained from the NWS rawinsondes launched during the period. The associated low and high pressure systems have been annotated for reference. The charts depicted a vertically stacked cut-off low pressure system over central Arizona with a long wave trough extending southwest. The accident site was located to the southeast of the upper level low and upper level trough and in an area favorable for rising vertical motion and cloud and precipitation formation. The station models over the area between southern Arizona and southwestern Texas depicted generally west-southwest winds at 25 to 35 knots at 10,000 ft and increased in speed to 50 to 60 knots at 18,000 ft, and 110 knots at 30,000 ft.

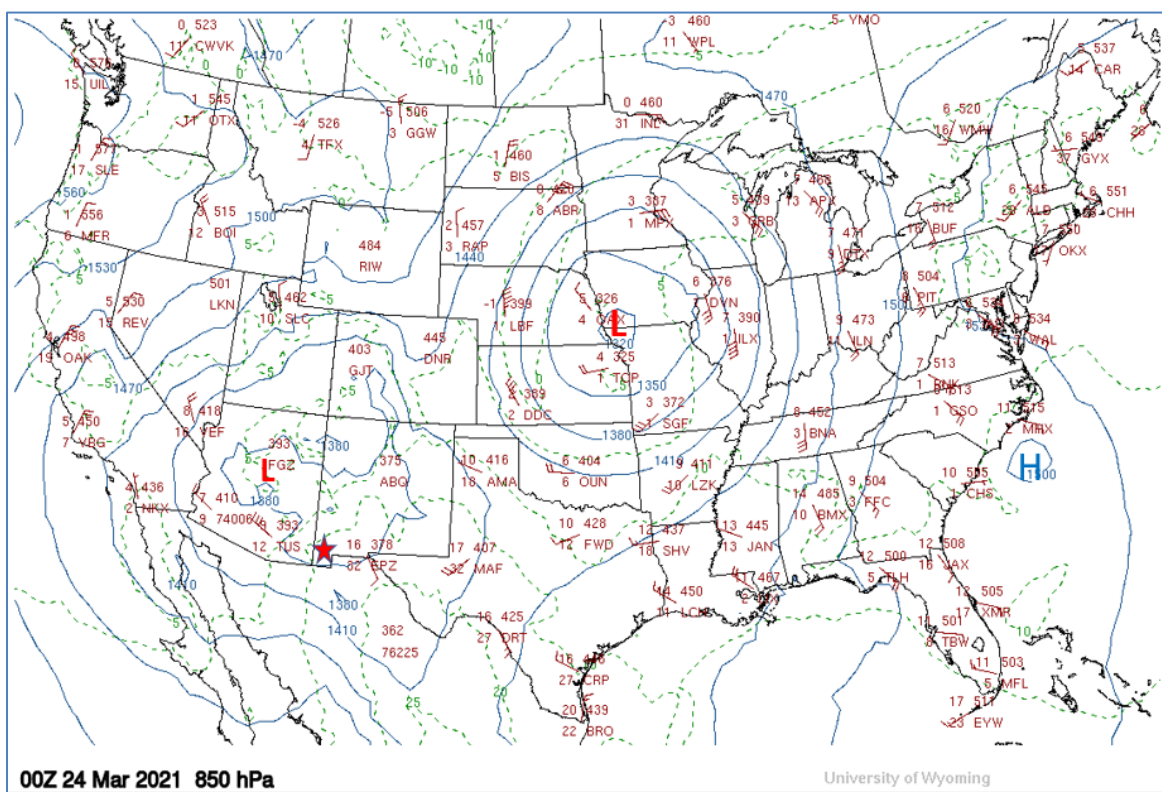


Figure 2 - 850-hPa chart for 1800 MDT March 23, 2021, depicting the conditions near 5,000 ft.

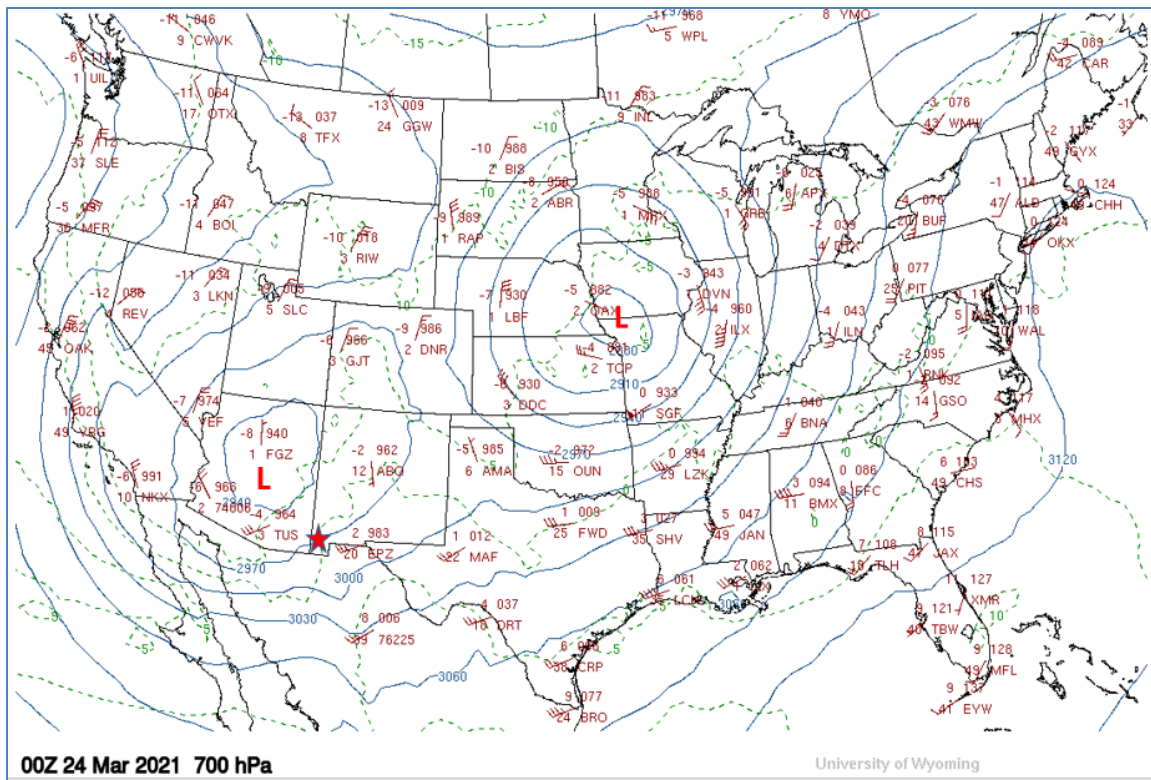


Figure 3 - 700-hPa chart for 1800 MDT March 23, 2021, depicting the conditions near 10,000 ft.

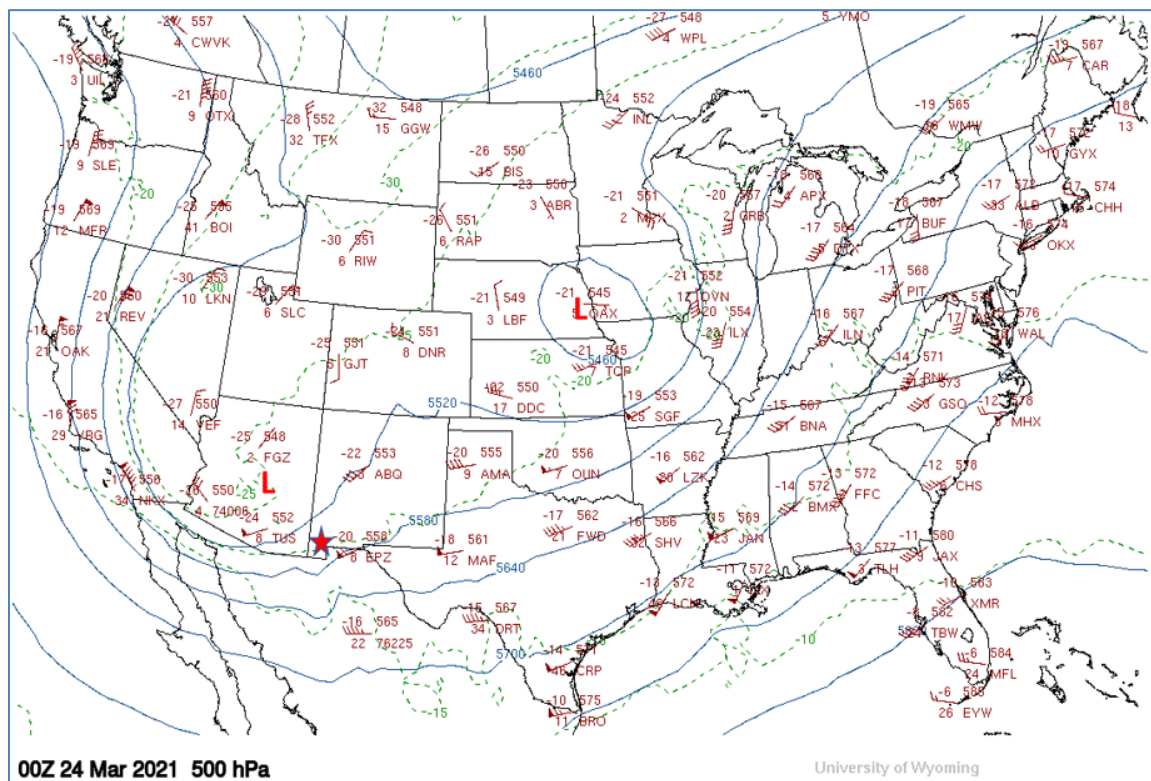


Figure 4 - 500-hPa chart for 1800 MDT March 23, 2021, depicting the conditions near 18,000 ft.

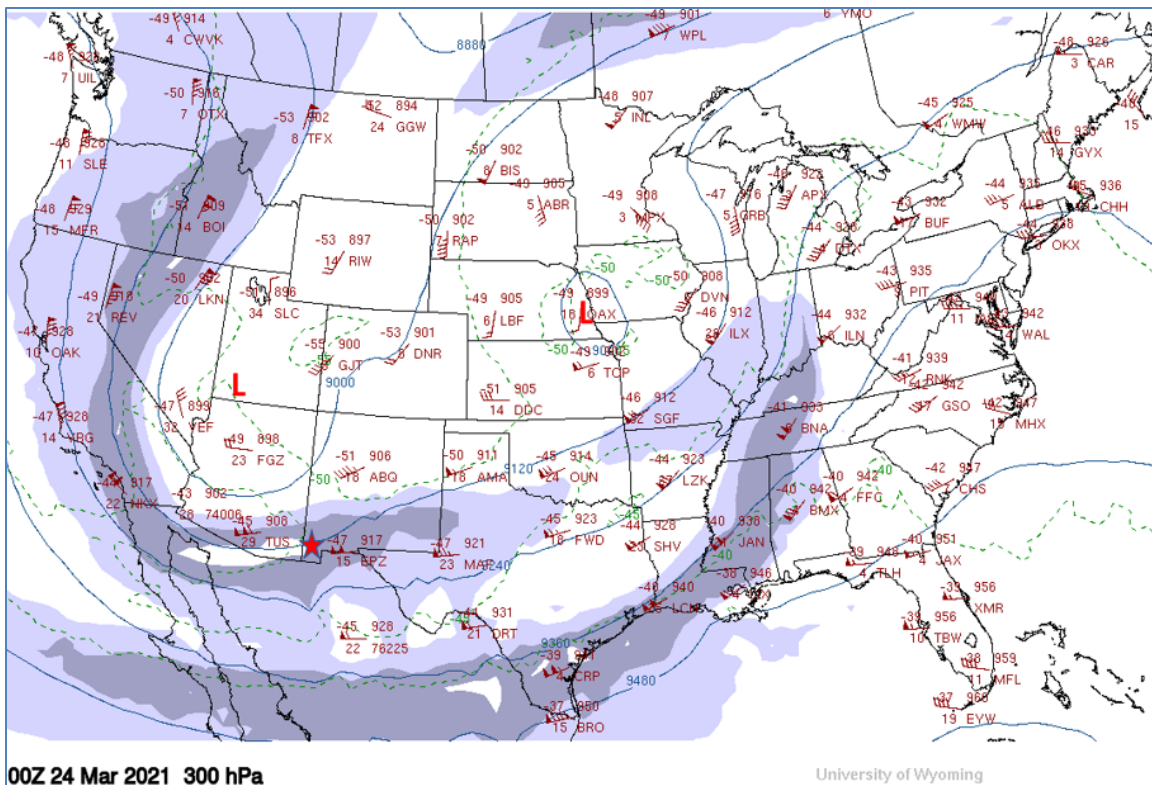


Figure 5 - 300-hPa chart for 1800 MDT on March 23, 2021, depicting the conditions at 30,000 ft.

1.3 National Radar Composite

The National Composite Radar Mosaic for 0020 MDT is included as figure 6 and depicted an area of echoes with reflectivity values between 15 and 35 dBZ or light to moderate intensity echoes extending over southwest New Mexico and over the general route of flight of the accident airplane over southern New Mexico, with a band of echoes immediately west of the accident site. Data from the closest NWS weather surveillance radars are documented in section 6.0 of this report.

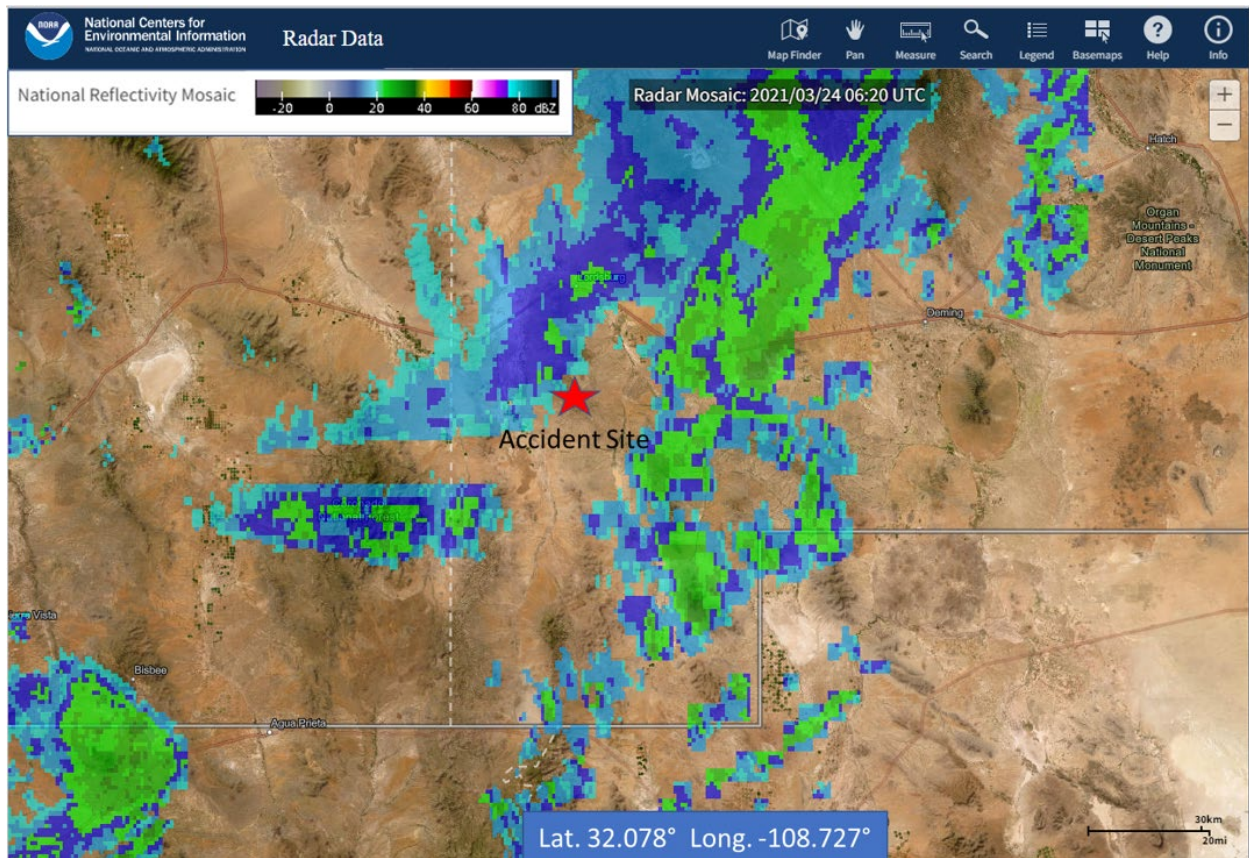


Figure 6 - National Composite Radar Mosaic for 0020 MDT with the accident site marked by the red star depicting the echoes over the region.

1.4 12-hour Short Term Prognostic Chart

The NWS 12-hour Surface Prognostic Chart issued at 2152 MDT and valid for 1200 MDT is included as figure 7. The chart depicted a large area of mixed freezing precipitation and rain showers expected over Texas, New Mexico, Arizona, and Colorado during the period. The accident site was located with a chance of rain over the area, which was defined as a chance of measurable rain of 0.01 inches or more at the valid time, and rain likely over eastern Arizona.

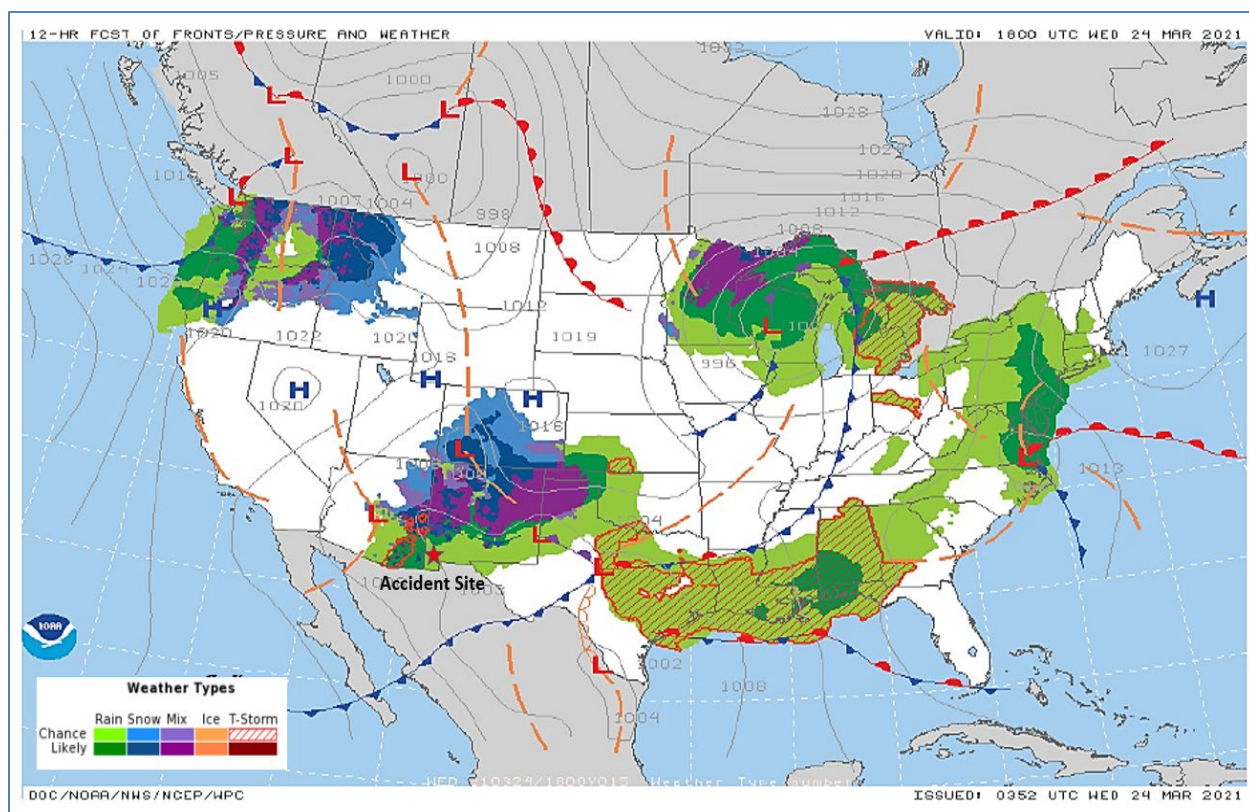


Figure 7 - NWS 12-hour Surface Prognostic Chart valid for 1200 MDT depicting the primary surface features and precipitation expected during the period.

2.0 Observations

The area was documented using official Aviation Routine Weather Reports (METAR) and Aviation Selected Special Weather Reports (SPECI). Cloud heights are reported above ground level (agl) in the following section, and the magnetic variation was estimated at 9° east based on the latest sectional chart for the area.

2.1 Lordsburg, New Mexico

The closest weather reporting location to the accident site was from Lordsburg Municipal Airport (KLSB), Lordsburg, New Mexico, located about 15 miles north at an elevation of 4,289 ft. The airport had a nonfederal Automated Weather Observation System (AWOS) which was not augmented by any human observers. The AWOS reports from KLSB were not disseminated into the national database and were only broadcasted locally on VHF radio³ for the airport and were not available in any archive for documentation.

³ KLSB broadcasts on 118.1 VHF (very high frequency) and is also available by telephone.

2.2 Silver City, New Mexico

The next closest weather reporting facility was from Grant County Airport (KSVC), Silver City, New Mexico, located about 44 miles northeast of the accident site at an elevation of 5,446 ft. The airport had an AWOS that issued observations every 20-minutes and was not augmented by any human observer during the period. The following conditions were reported at the approximate time of the accident.

KSVC weather observation at 0015 MDT, automated, wind from 300° at 9 knots, visibility 10 miles or more in light rain, ceiling⁴ broken at 1,300 ft agl, overcast at 2,200 ft, temperature 2° Celsius (35° F), dew point temperature 1°C (33°F), altimeter 29.79 inches of mercury (inHg). Remarks: automated station with a precipitation disseminator, temperature 1.7° C, dew point temperature 0.7° C.

The general flight categories⁵ and raw observations issued surrounding the period from 2215 through 0315 MDT in raw format were as follows. The observation decoded above is in bold type and the time of the accident added for reference.

VFR METAR KSVC 240415Z AUTO 26013G19KT 10SM SCT035 BKN045 OVC060 06/M01 A2977 RMK AO2 T00551015=

VFR METAR KSVC 240435Z AUTO 26012G16KT 10SM BKN042 OVC050 04/00 A2978 RMK AO2 T00391005=

MVFR METAR KSVC 240455Z AUTO 27013KT 10SM -RA SCT022 BKN028 OVC042 04/00 A2979 RMK AO2 T00361001=

MVFR METAR KSVC 240515Z AUTO 33013G16KT 4SM -RA BKN013 BKN017 OVC023 02/00 A2978 RMK AO2 P0001 T00160002=

MVFR METAR KSVC 240535Z AUTO 32009KT 7SM -SN BKN013 BKN020 OVC031 01/01 A2979 RMK AO2 P0003 T00140006=

MVFR METAR KSVC 240555Z AUTO 32007KT 10SM -RA SCT016 BKN023 OVC030 02/01 A2979 RMK AO2 P0003 60003 T00160007 10132 20010=

⁴ Ceiling is defined as the lowest height of the clouds reported as broken, overcast, or the vertical visibility into a surface based observation.

⁵ 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*) - of a 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.

**MVFR METAR K SVC 240615Z AUTO 30009KT 10SM -RA BKN013 OVC022 02/01 A2979 RMK
AO2 T00170007=**

Accident 0621Z

MVFR METAR K SVC 240635Z AUTO 32004KT 10SM -RA SCT011 BKN018 OVC050 01/00 A2979 RMK
AO2 P0001 T00130003=

VFR METAR K SVC 240655Z AUTO 00000KT 10SM SCT018 BKN042 OVC050 01/00 A2979 RMK AO2
P0001 T00130004 401641055=

VFR METAR K SVC 240715Z AUTO 36003KT 10SM -RA SCT008 SCT026 OVC039 02/00 A2977
RMK AO2 T00150003=

VFR METAR K SVC 240735Z AUTO 00000KT 10SM SCT026 BKN080 OVC090 02/00 A2976 RMK AO2
T00150000=

VFR METAR K SVC 240755Z AUTO 00000KT 10SM OVC090 02/00 A2976 RMK AO2 T00150000=

VFR METAR K SVC 240815Z AUTO 00000KT 10SM SCT090 OVC110 02/00 A2977 RMK AO2
T00160003=

VFR METAR K SVC 240835Z AUTO 21003KT 10SM OVC110 02/00 A2976 RMK AO2 T00150004=

IFR METAR K SVC 240855Z AUTO 00000KT 10SM BKN006 OVC110 02/01 A2975 RMK AO2 60001
T00150007=

VFR METAR K SVC 240915Z AUTO 22004KT 10SM SCT006 BKN080 OVC100 02/01 A2976 RMK AO2
T00150006=

Surrounding the period of the accident K SVC reported MVFR conditions prevailing with overcast clouds with rain and snow reported during the period, with temperatures just above freezing at the surface.

2.3 Deming, New Mexico

The next closest weather reporting facility to the accident site was from Deming Municipal Airport (KDMN), Deming, New Mexico, located approximately 52 miles east-northeast of the accident site at an elevation of 4,314 ft. The airport had an Automated Surface Observation System (ASOS) which was not augmented by any human observers during the period. The conditions reported at the approximate time of the accident were as follows.

KDMN special weather observation at 2353 MDT, automated, wind from 310° at 17 knots gusts to 27 knots, visibility 10 miles or more in light rain, scattered clouds at 5,500 ft agl, ceiling broken at 7,000 ft, overcast at 9,000 ft, temperature

6° C (43° F), dew point temperature 3° C (37° F), altimeter 29.74 inHg. Remarks: automated station with a precipitation disseminator, peak wind from 280° at 32 knots occurred at 2300 MDT, rain began at 2344 MDT, sea level pressure 1003.6-hPa, hourly precipitation less than 0.01 of an inch or a trace, sea-level pressure 1003.6-hPa, 6-hour precipitation less than 0.01 of an inch, temperature 6.1° C, dew point temperature 2.8° C, 6-hour maximum temperature 18.9° C, 6-hour minimum temperature 6.1° C, 3-hour pressure tendency risen 2.7-hPa.

The general flight categories and raw observations issued surrounding the period from 2153 through 0230 MDT in raw format were as follows.

VFR METAR KDMN 240353Z AUTO 29019G31KT 10SM OVC095 12/M04 A2970 RMK AO2 PK WND 30034/0338 T01221044=

VFR METAR KDMN 240453Z AUTO 28023G35KT 10SM SCT100 BKN110 09/M01 A2975 RMK AO2 PK WND 28035/0449 SLP036 T00891006 TSNO=

VFR METAR KDMN 240553Z AUTO 31017G27KT 10SM -RA SCT055 BKN070 OVC090 06/03 A2974 RMK AO2 PK WND 28032/0500 RAB44 SLP036 P0000 60000 T00610028 10189 20061 50027=

Accident 0621Z

VFR METAR KDMN 240653Z AUTO 29013G26KT 10SM -RA FEW016 BKN041 OVC070 05/03 A2979 RMK AO2 PK WND 29029/0636 RAE0555B38 SLP052 P0000 T00500028 402061017=

MVFR SPECI KDMN 240729Z AUTO 28013G20KT 9SM -RA FEW015 OVC027 04/02 A2980 RMK AO2 P0001 T00390022=

MVFR METAR KDMN 240753Z AUTO 25009KT 7SM RA SCT013 OVC021 03/02 A2981 RMK AO2 SLP058 P0006 T00330022=

VFR SPECI KDMN 240828Z AUTO 22006KT 10SM SCT031 BKN075 OVC100 03/02 A2977 RMK AO2 RAE23 P0002 T00280022=

A review of the observations for KDMN indicated general VFR conditions prevailing at the time of the accident with a period of MVFR conditions about an hour after the accident with light rain.

3.0 Pilot Weather Reports

The following pilot weather reports (PIREPs) were reported⁶ over the region below 18,000 ft. The reports are provided in raw code with abbreviation as received followed by a plain language decoded report.

⁶ Includes PIREPs making into the NWS/FAA database and may not include "ride reports" or other

DMN UA /OV DMN260040/TM 0442/FL110/TP C208/TA M08/IC LT RIME ICING/RM ZAB FDCCS

Deming, NM (DMN) routine pilot report; Over - 260° azimuth and 40 miles from DMN VORTAC⁷; Time - 2242 MDT; Altitude - 11,000 ft; Type aircraft - Cessna 208 Caravan single-engine turboprop; Temperature - minus 8°C; Icing - light rime type icing; Remarks - entered from Albuquerque Center (ZAB) Flight Data Center Specialist (FDCCS).

TUS UA /OV TUS360020/TM 0534/FL110/TP BE9L/TA M07/IC LGT RIME/RM ZAB/FDCCS

Tucson, AZ (TUS) routine pilot report; Over - 360° and 20 miles from TUS VORTAC; Time - 2334 MDT; Altitude - 11,000 ft; Type aircraft - Beechcraft King Air multi-engine turboprop; Temperature - minus 7°C; Icing - light rime type icing; Remarks - entered by ZAB FDCCS.

4.0 Atmospheric Sounding

A High-Resolution Rapid Refresh (HRRR)⁸ numerical model for 0000 MDT was obtained from the NOAA Air Resource Laboratory database using the closest grid point⁹ to the accident site. The HRRR sounding was then plotted on a standard Skew T log P diagram¹⁰ utilizing the RAOB software program¹¹ and is included as figure 8. The HRRR sounding depicted an elevation of 4,993 ft at the grid point with a near-surface temperature of 3.5° C (38° F), a dew point temperature of 3.0° C (37° F), a relative humidity of 97%, and a density altitude of 5,044 ft. The sounding depicted the lifted condensation level (LCL)¹² and level of free convection (LFC)¹³ at 209 ft agl, with the convective condensation level (CCL)¹⁴ at 1,722 ft agl. The sounding supported an

reports made on radio frequency to air traffic control and not formally entered as a PIREP into the national database.

⁷ VORTAC - is a ground based navigation system which consists of a very high frequency omnidirectional radio range (VOR) and a TACAN or tactical air navigation system for distance measuring. Unless otherwise noted it is collocated with the city identifier's name.

⁸ 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.

⁹ Nearest grid point was to the accident site was at latitude 32.08° N and longitude -108.73° W.

¹⁰ Skew T log P diagram is a standard meteorological plot or thermodynamic diagram 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.

¹¹ RAOB -The Universal RAwinsonde OBservation program is an interactive sounding analysis program developed by Eosonde Research Services (ERS) previously known as Environmental Research Services, The Villages, Florida.

¹² Lifted Condensation Level (LCL) - the level at which a lifted parcel becomes saturated. The LCL height corresponds to cloud base height for forced ascent.

¹³ Level of Free Convection (LFC) - the level where a parcel becomes buoyant, or "warmer" than the environmental temperature at the same level. The LFC represents the bottom of the layer containing CAPE.

¹⁴ Convective Condensation Level (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.

overcast layer of clouds with bases near 200 ft agl with tops to 16,000 ft based on the RAOB Analysis program (clouds depicted in gray on left side axis of sounding), and supported rain showers, given the general thickness of the clouds and a precipitable water¹⁵ content of 0.43 inches. The freezing level was identified at about 1,400 ft agl or 6,400 ft msl (blue horizontal line across sounding). The sounding was characterized as conditionally unstable with a Lifted Index¹⁶ of 0.0, and a Convective Available Potential Energy (CAPE)¹⁷ of 276 Joules/kilogram.

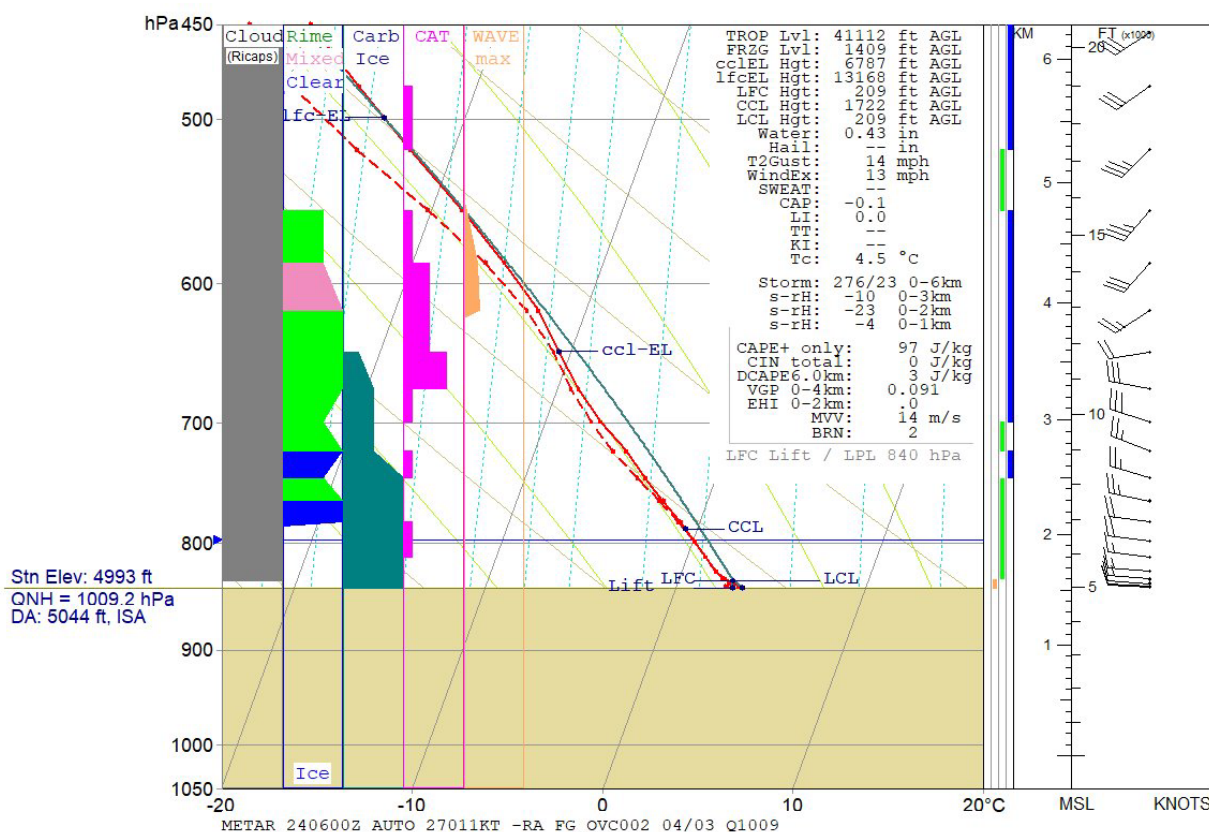


Figure 8 - A High-Resolution Rapid Refresh (HRRR) numerical model sounding for 0000 MDT over the closest grid point to the accident site depicting the vertical structure of temperature, moisture, winds, and other significant levels.

The HRRR wind profile indicated a surface wind from the west or from 270° at 11 knots with little variation in direction with height through 12,000 ft with wind speeds

¹⁵ Precipitable Water (PW) - The total amount of (condensed) water available within the lowest 400-hPa of the sounding.

¹⁶ Lifted Index (LI) - A common measure of atmospheric instability. Its value is obtained by computing the temperature that air near the ground would have if it were lifted to 500-hPa or approximately 18,000 feet and comparing that temperature to the actual temperature at that level. Negative values indicate instability - the more negative, the more unstable the air is, and the stronger the updrafts are likely to be with any developing thunderstorms.

¹⁷ Convective Available Potential Energy (CAPE) - is a measure of the amount of energy available for convection. CAPE is directly related to the maximum potential vertical speed within an updraft; thus, higher values indicate greater potential for severe weather.

increasing with height. The mean 0 to 6 kilometer (km) (or 18,000 ft) wind was from 250° at 30 knots. The accident airplane's cruising altitude varied from 10,000 ft up to 14,700 ft during the last 20-minutes of flight, with winds from 290° at 29 knots with a temperature of -8° C at 10,000 ft and winds from 220° at 32 knots with a temperature of -17° C at 15,000 ft.

A table of the HRRR sounding parameters of height, pressure, temperature, dew point temperature, relative humidity, wind direction and speed, derived Clear Air turbulence (CAT), icing potential, and mountain wave potential from the surface to about 18,000 ft were as follows.

Height (ft-msl)	Pres (hPa)	T (°C)	Td (°C)	RH (%)	DD/FF (deg/kt)	CAT (FAA)	ICING (FAA)	Wave nm fpm max		
4993	840	3.5	3.0	97	273/ 11					
5025	839	3.3	2.6	95	273/ 11					
5120	836	3.0	2.7	98	274/ 12					
5248	832	2.4	2.3	99	276/ 13					
5472	825	1.8	1.8	100	276/ 14					
5892	812	1.0	1.0	100	278/ 16	LGT				
6351	798	0.1	0.1	100	278/ 19	LGT				
6917	781	-1.0	-1.1	99	279/ 22		MDT Clear			
7527	763	-2.3	-2.5	99	282/ 24		MDT Clear			
8183	744	-3.7	-4.1	97	288/ 25	LGT	LGT Rime			
8960	722	-5.2	-5.9	95	293/ 27		MDT Clear			
9792	699	-7.1	-7.6	96	290/ 29	LGT	LGT Rime			
10722	674	-8.9	-9.3	97	282/ 28	SVR	MDT Rime			
11759	647	-10.6	-10.9	98	260/ 22	MDT	MDT Rime			
12913	618	-12.5	-13.1	95	234/ 23	MDT	MDT Rime	3.60	511	LIGHT
14239	586	-15.2	-16.2	92	219/ 28	LGT	LGT Mixed	5.14	513	LIGHT
15668	553	-18.4	-20.2	86	219/ 35		LGT Rime	7.06	120	LIGHT
17304	517	-22.3	-25.1	78	223/ 35	LGT				
18981	482	-26.2	-29.7	72	232/ 31					

The sounding supported the potential for light to moderate turbulence between 5,800 and 17,000 ft, which is displayed in magenta on the left side axis of the sounding. Light rime to clear type icing was identified in the clouds between 6,400 and 16,000 ft, which is displayed on left axis (blue for clear, green for rime, and pink for mixed type icing conditions). The sounding also indicated the potential for light mountain wave activity around 12,900 ft and 18,000 ft based on the RAOB program worst case conditions. The sounding also supported a severe risk for serious carburetor type icing¹⁸ below 8,000 ft (indicated by dark green on left axis) at cruise or power off conditions.

¹⁸ Based on the Fuels and Lubricants Laboratory of the National Research Council of Canada study on carburetor icing in aircraft engines. Serious icing at cruise and climb power.

5.0 Satellite Imagery

The NOAA Geostationary Operational Environmental Satellite number 17 (GOES-17) imagery were obtained from an archive at the Space Science Engineering Center (SSEC) at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System (McIDAS) software. The infrared band 13 at a wavelength of 10.3 μm provided a resolution of 2 kilometers with radiative cloud top temperatures. Figure 9 is the GOES-17 infrared image for 0021 MDT at 4X magnification with a standard MB temperature enhancement curve applied, and the accident site marked by the white square. The image depicted an overcast layer of clouds over the accident site with a radiative cloud top temperature of 249 Kelvin or -24°C , which corresponds to cloud tops near 18,000 ft based on the HRRR sounding. Enhanced cloud cover was depicted extending southwest through west and northeast of the accident site associated with higher and colder clouds tops.

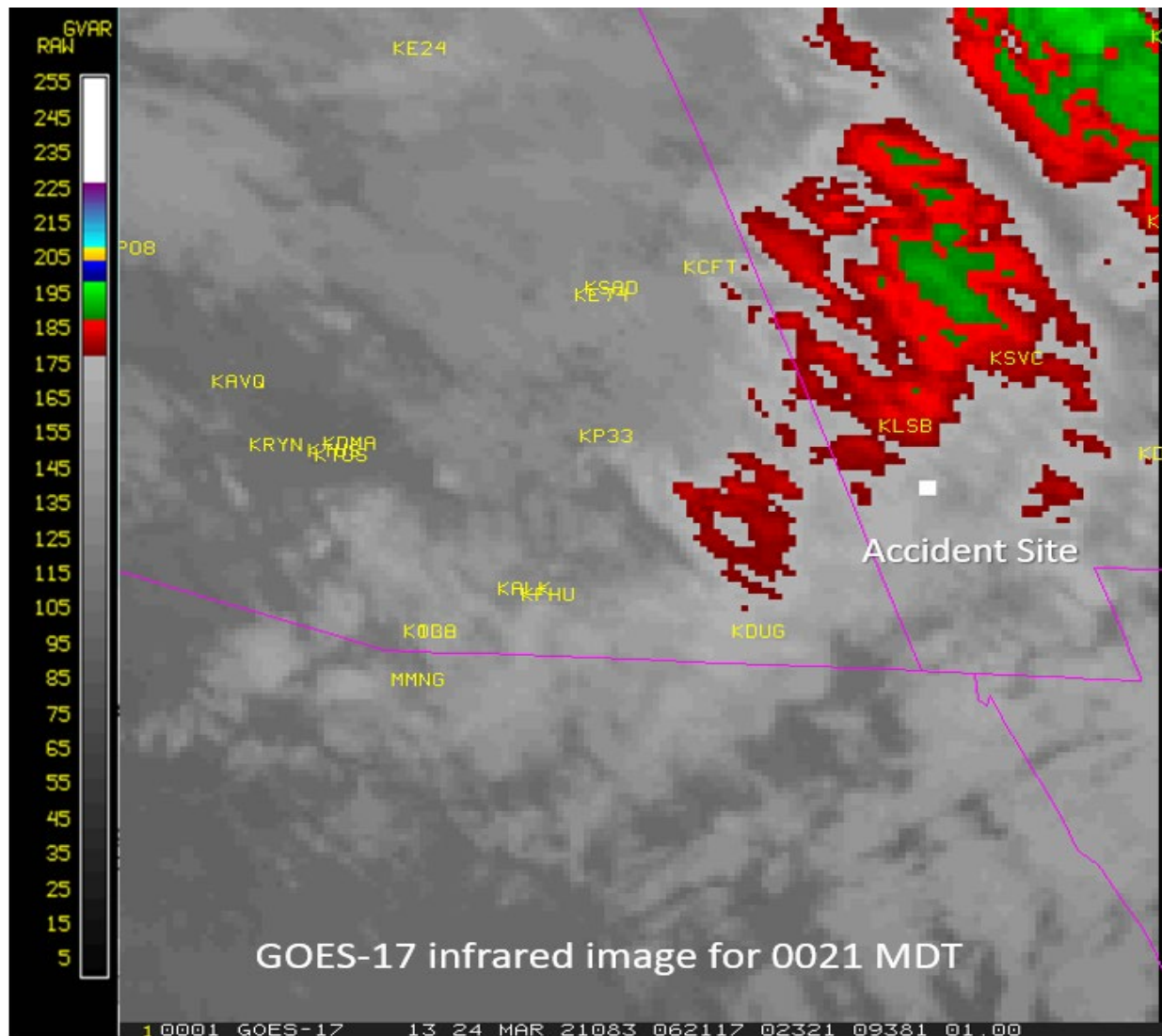


Figure 9 - GOES-17 infrared image at 0021 MDT at 4X magnification and a standard MB temperature enhancement curve applied with accident marked by the white square.

6.0 Weather Radar Imagery

The accident occurred between two NWS Weather Surveillance Radar - 1988 Doppler (WSR-88D)¹⁹ systems, Tucson (KEMX), AZ, located 98 miles west of the accident site and El Paso (KEPZ), TX, 104 miles to the east. Both radars provided useful information on the weather echoes over the area during the period, but due to range limitation could not capture all the low-level echoes along the flight path surrounding the period. The level II archive data were obtained from the NCEI using the Hierarchical Data Storage System and displayed using the NWS NEXRAD Interactive

¹⁹ The WSR-88D is a S-band 10-centimeter wavelength radar with a power output of 750,000 watts, with a 28-foot parabolic antenna concentrating the energy into a 0.95° beam width. The radar produces three basic types of products reflectivity, radial velocity, and spectral width.

Viewer and Data Exporter software. During the period, the KEPZ WSR-88D was operating in the standard clear air mode identified as volume scanning pattern 32 (VCP-32) where the radar makes 5 different elevation scans during the 10 minute scan. The NWS KEMX WSR-88D was operating in the precipitation mode VCP-212 where the radar makes 17 elevation scans in 4 ½ minutes and is the fastest scanning strategy used to examine distant precipitation echoes.

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²⁰, 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 decibels (dBZ)²¹ and is a general measure of echo intensity. The FAA Advisory Circular AC 00-24C - "Thunderstorm" defines echoes less than 30 dBZ as "light" in intensity, "moderate" echoes 30-40 dBZ, "heavy" with echoes of >40-50 dBZ, and "extreme" intensity with echoes above >50 dBZ. These are the new standard radio phraseology terms used by air traffic controllers to describe weather conditions to pilots as shown in the following table. Light rain is typically reported at the surface when reflectivities reach 20 dBZ²², while air traffic control will not display echoes less than 30 dBZ or light intensity echoes on their weather displays.

Reflectivity (dBZ) Ranges	Weather Radar Echo Intensity Terminology
< 30 dBZ	Light
30 – 40 dBZ	Moderate
>40 – 50 dBZ	Heavy
>50 dBZ	Extreme

The NWS KEMX WSR-88D 0.48° base reflectivity image for 0023 MDT is included as figure 10 and depicted a band of echoes immediately west through north of the accident site. The image depicted the last minutes of the accident airplane's descent free of any echoes along the aircraft's flight path. The KEMX radar's 0.48°

²⁰ Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at 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.

²¹ dBZ - Nondimensional "unit" of radar reflectivity which represents a logarithmic power ratio (in decibels, or dB) with respect to radar reflectivity factor, Z.

²² Typical cloud droplets range from 1 to 40 microns (µm) and usually are not detected by the WSR-88D radars. As droplet size increase and the number of drops, radar detection increases. Drizzle droplets range from 40 to 200 µm and may show up as very light reflectivity returns. Rain droplets typically have a diameter greater than 200 µm. Water droplets larger than 50 µm encountered at below freezing temperatures are defined as Supercooled large Droplets (SLD) and pose a serious risk of structural icing conditions to aircraft.

elevation beam was centered near 16,670 ft over the accident site and was sampling the altitudes between 11,730 ft through 21,610 ft assuming standard refraction of the radar beam. KLSB was located immediately north of the accident site and was under light reflectivity echoes.

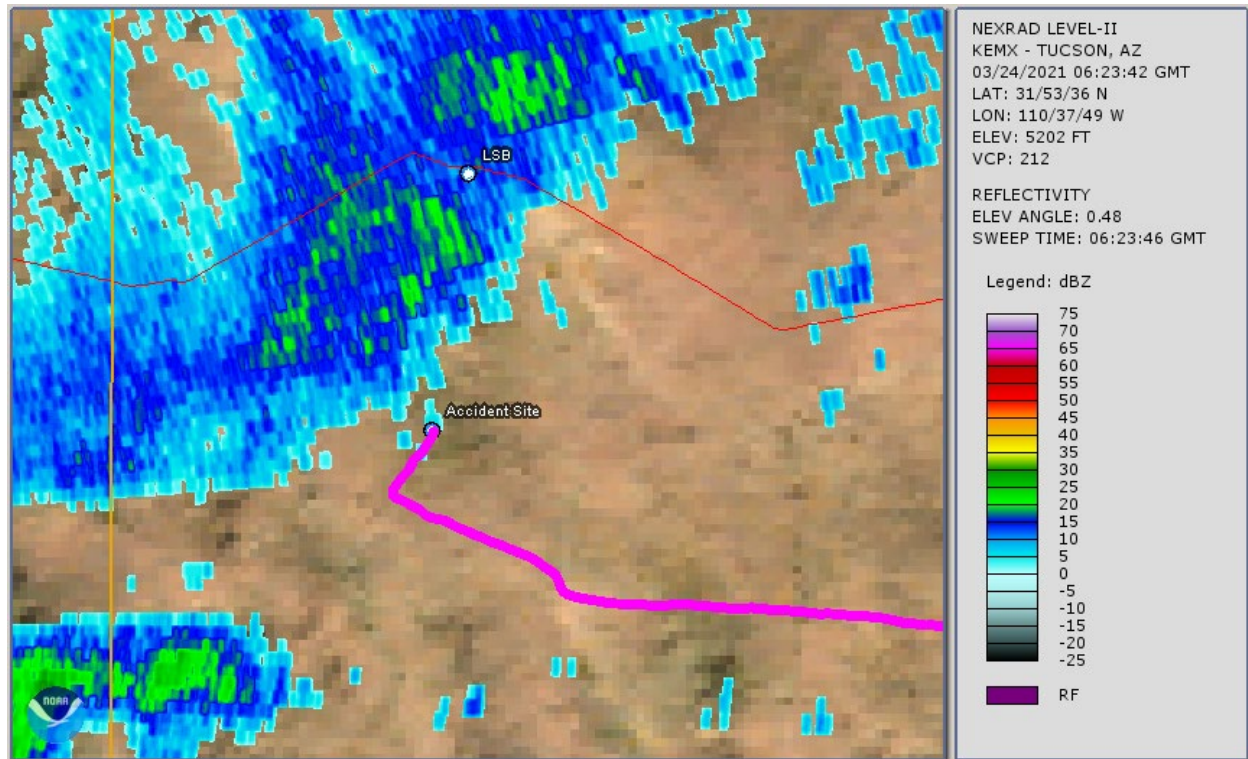


Figure 10 - NWS KEMX WSR-88D 0.48° base reflectivity image for 0023 MDT with the accident airplanes flight track overlaid.

The NWS KEPZ WSR-88D 0.44° base reflectivity image for 0015 MDT with the flight track of N74786 overlaid in magenta is included as figure 11. The center of the KEPZ's 0.44° beam was near 16,240 ft and sampled the altitudes between approximately 11,000 ft and 21,480 ft over the accident site. The imagery showed between about 0002 through 0011 MDT echoes of 20 to 30 dBZ were depicted over the flight track. During this period, the accident airplane was in cruise at 12,300 ft and began to climb to a maximum height of 14,200 ft at 0007 MDT and then shortly after began to descend as it exited the precipitation.

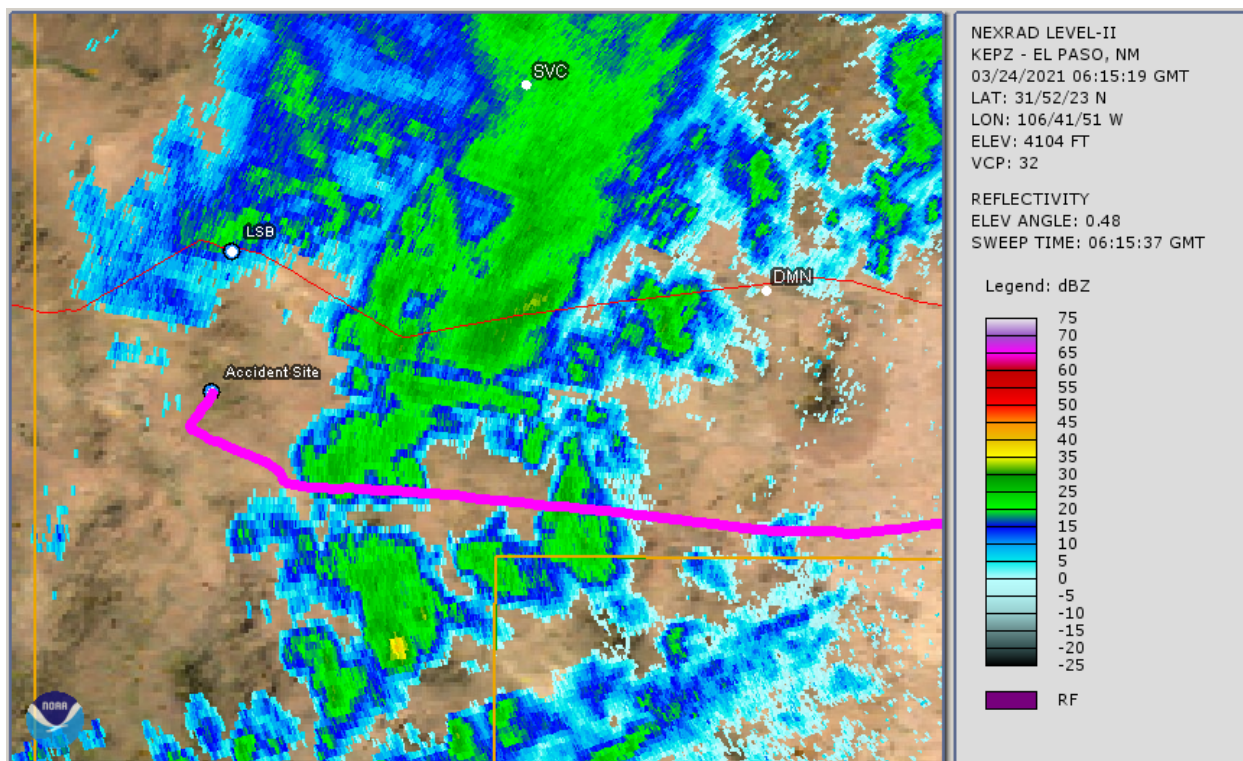


Figure 11 - NWS KEPZ WSR-88D 0.44° base reflectivity image for 0015 MDT with the flight track overlaid.

7.0 NWS Forecasts

The NWS El Paso, Texas Weather Forecast Office (WFO) was responsible for the local weather products and public weather warnings for the county where the accident occurred, while the NWS Aviation Weather Center (AWC) located in Kansas City, Missouri, was responsible for the general aviation forecasts and advisories current around the period of the accident.

7.1 Terminal Aerodrome Forecast

The Terminal Aerodrome Forecast (TAF) is a concise statement of the expected meteorological conditions significant to aviation for a specified time period and within 5 statute miles of the center of the airport's runway complex (terminal). The TAFs issued by the El Paso WFO for KDMN, the closest station to the accident site and along the general route of flight, that were available for preflight and the latest forecast current at the time of the accident, are documented below. The bold type reflects the forecast period applicable to the time of the accident. The forecast available prior to departure was issued at 1723 MDT and expected general VFR conditions to prevail with rain showers and was as follows.

TAF KDMN 232323Z 2400/2424 24018G28KT P6SM SCT110
FM240500 24015G22KT P6SM -SHRA SCT050 BKN100
FM241200 25012KT P6SM BKN060
FM242000 26016G25KT P6SM VCSH SCT080 OVC110=

The next scheduled TAF was issued by the El Paso WFO at 2320 MDT and continued to expected VFR conditions to prevail with a chance of temporary rain showers and was as follows.

TAF KDMN 240520Z 2406/2506 24016G24KT P6SM VCSH SCT070 OVC100
TEMPO 2406/2410 6SM -SHRA BKN050
FM241200 26011KT P6SM BKN080
FM241900 28018G25KT P6SM VCSH SCT080 OVC110
FM250200 29009KT P6SM BKN120

The TAF current for KDMN at the time of the accident expected from 0000 MDT winds from 240° at 16 knots gusting to 24 knots, visibility 6 miles or more with rain showers in the vicinity, scattered clouds at 7,000 ft agl, ceiling overcast at 10,000 ft. With a temporary period between 1800 through of 0400 MDT of visibility 6 miles in light rain showers and a broken ceiling at 5,000 ft agl.

7.2 Area Forecast Discussion

The NWS Area Forecast Discussions (AFD) are issued by each WFO to describe the short-term weather conditions within their region with an aviation section that includes the general conditions as they relate to the creation of the TAF. These are useful for additional aviation-related issues that cannot be encoded into the TAF and provide some reasoning behind the forecast. These are generated roughly every 6 hours and correspond to the release of the latest TAFs for that office. The NWS El Paso WFO issued the following AFD at 2243 MDT on March 23, 2021.

*FXUS64 KEPZ 240443
AFDEPZ*

*Area Forecast Discussion
National Weather Service El Paso TX/Santa Teresa NM
1043 PM MDT Tue Mar 23 2021*

...UPDATED AVIATION...

*.AVIATION...06Z TAF CYCLE
Storm system will move into the area tonight through Wednesday night. CIGs will continue to lower at all terminals, becoming SCT060-080 OVC100 overnight across western areas and by 12Z most everywhere else. The first round of lowland -SHRA and mountain -SN will start from TCS to DMN and west between now and 11Z, then try to spread to LRU-ALM-ELP after 09Z though confidence is lower east of the Rio Grande. The*

Gila and Sacramento Mountains will see -SN linger off and on through most of the period. The second round of lowland precip looks to move in from west to east after 18Z. Activity will be more scattered, but all terminals have a chance of seeing -SHRA. There will even be a chance for a lightning strike or two during the afternoon. SW winds tonight will remain gusty in a few spots until morning, then become 260-29015-20G25KT after 18Z. CIGs will gradually rise at the end of the period as precip exits.

.PREV DISCUSSION... 133 PM MDT Tue Mar 23 2021...

.SYNOPSIS...

Breezy to windy conditions are expected to continue each day. Lowland rain and snow chances are possible tonight through early Thursday morning though best chances for precipitation will be for the mountains. For the weekend onwards, temperatures will be near or above normal for temperatures.

.DISCUSSION...

.SHORT TERM... Tonight and Wednesday...

Early afternoon satellite imagery continues to show a fairly vigorous upper low continuing to dig across southern Nevada into southern California. This trend is right in line with most operational models who show the upper low crossing Arizona tonight and New Mexico Wednesday. We are still seeing a healthy 100+ knot jet rounding the base of the low, which will help add to the systems overall dynamics as it passes through the Borderland tonight and tomorrow. Thus the idea of generating at least some precipitation across the CWA later this evening and into Wednesday remains intact. However, it does seem that the better precip chances and associated QPF values will favor the northern half of the region.

Speaking of precipitation, current dewpoints are extremely low across the area, but will likely increase significantly overnight thanks to top down moistening. While the precip currently is located closer to the upper low, as the nose of a 75 knot 500MB jet approaches this evening, much of the Gila could start to see some light precipitation develop. Snow levels near 7500' initially will quickly drop to around 5500' after midnight as wet bulbing effects take over. This could even mean a couple of inches of snow by morning at Silver City with 4 to 6 inches at higher elevations. The same goes for the Sacramento mountains later tonight and tomorrow morning as a similar scenario develops there with the advance of the upper low. Therefore will keep the current winter highlights in place for this forecast package.

The final piece of the puzzle is what to do about winds and dust for the Borderland. Winds are responding well to afternoon mixing and increasing pressure gradients, especially across southwestern New Mexico. While winds will come down some overnight, it should stay breezy for most areas with the core of the upper jet lingering just south of the international border. But so far, the usual dust initiation sources in northern Chihuahua have not shown much of a response. It may be just a tad too stable to loft large quantities of dust. None the less, localized areas of blowing dust will remain a concern, especially through sunset this evening.

7.3 Graphic Forecast for Aviation

The NWS Graphic Forecast for Aviation (GFA) is a graphical depiction of surface wind, thunderstorms, precipitation, color coded general flight categories, and cloud

cover bases and tops in msl heights, from graphical output from the NWS's National Digital Forecast Data (NDFD) with the Graphic-Airmen's Meteorological Information (G-AIRMET)²³ for IFR conditions, mountain obscuration, icing conditions, and strong surface wind overlaid. The GFA provides a forecast for the enroute phase of flight and for locations without a TAF. The GFA is available at the NWS AWC website and through other weather briefing services. The southwest 3-hour GFA forecasts issued about 2200 MDT on March 23, 2021, are included as figures 12 and 13.

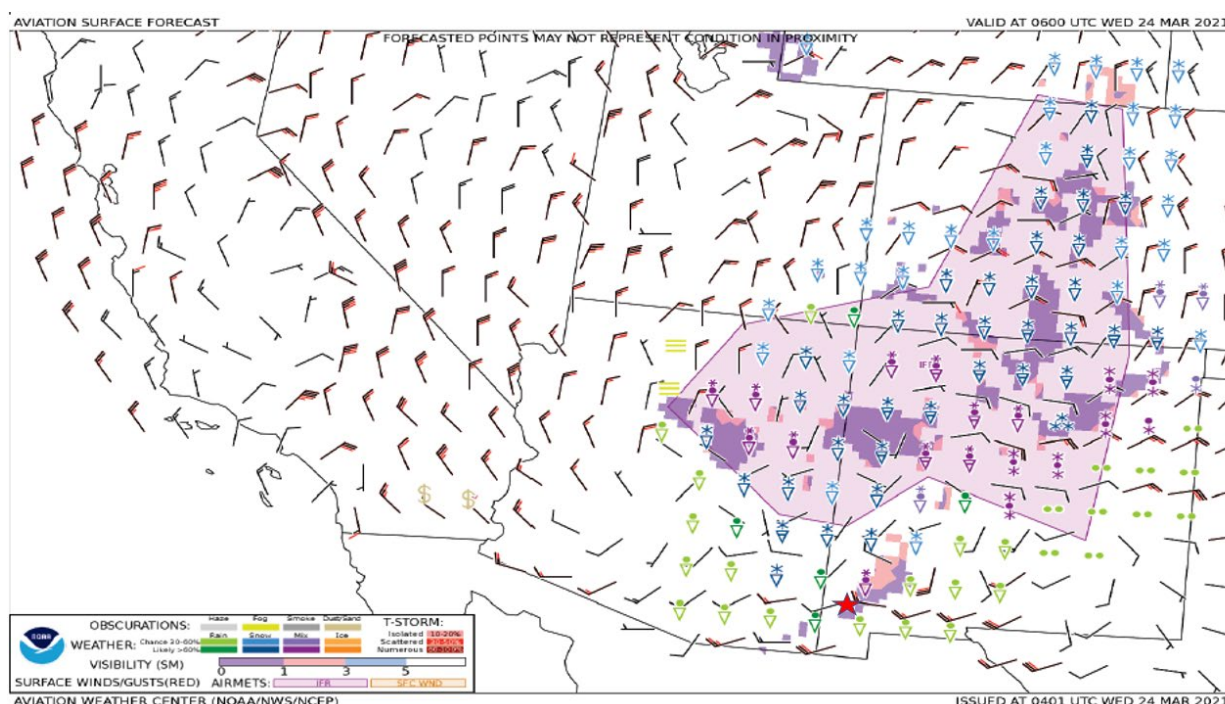


Figure 12 - NWS 3-hour Graphic Forecast for Aviation (GFA) Surface Forecast with the G-AIRMET for IFR conditions overlaid valid for 0000 MDT March 24, 2021.

²³ AIRman's METeorological Information (AIRMET) is a concise description of weather phenomena that are occurring or may occur (forecast) along an air route that may affect aircraft safety. Compared to SIGMETs, AIRMETs cover less severe weather: moderate turbulence and icing, sustained surface winds of 30 knots or more, low-level wind shear, or widespread restricted visibility.

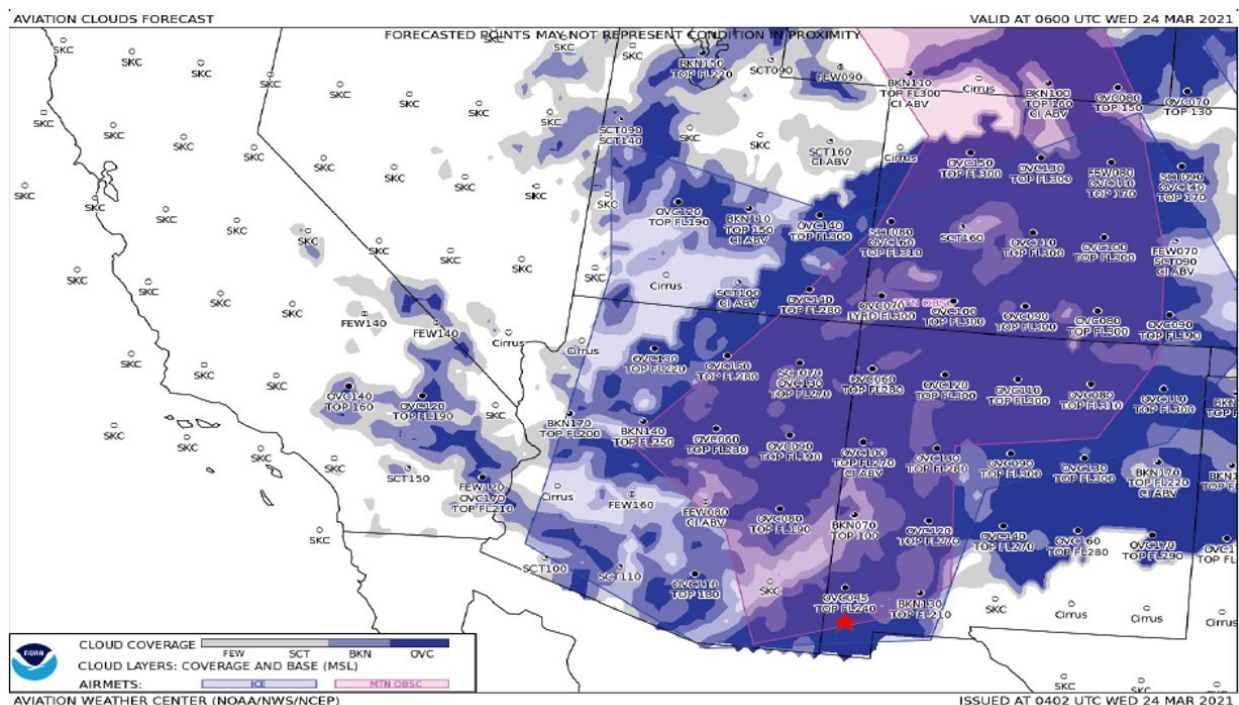


Figure 13 - NWS southwest 3-hour GFA Cloud Forecast valid for 0000 MDT March 24, 2021, with G-AIRMET for icing conditions in light blue and mountain obscuration conditions in pink.

The 3-hour GFA Surface Forecast (figure 12) depicted an area of restricted visibilities below 3 miles in southwestern New Mexico with westerly winds of 10 knots, with snow and rain showers over the general area and along the route of flight. The G-AIRMET for IFR conditions extended over northern Arizona and New Mexico and did not extend over the accident airplane's route of flight. The GFA Cloud Forecast (figure 13) expected overcast clouds with bases at 4,500 ft and tops to 24,000 ft²⁴. G-AIRMETs for icing conditions and mountain obscuration conditions extended over a large section of Arizona and New Mexico and extended over the accident site.

7.4 Winds and Temperature Aloft Forecast

The NWS Winds and Temperature Aloft Forecast current during the period for the general route of flight issued at 0756 MDT on March 23, 2021, and current at the time of departure was as follows.

FBUS33 KWN0 231356
FD3US3
-DATA BASED ON 231200Z
VALID 240000Z FOR USE 2100-0600Z. TEMPS NEG ABV 24000

²⁴ The cloud tops were presented in Flight Levels (FL) with altitude in hundreds of feet and reflect that above 18,000 ft aircraft fly constant pressure surfaces with their altimeters set to 29.92 inHg or 1013.25-hPa. The chart depicts FL240 or 24,000 ft.

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
-INK		2319+13	2320+04	2530-04	2651-18	2663-31	278047	268754	266457
-MRF			2218+06	2424-02	2647-16	2755-29	276945	267753	278159
-ELP	2322		2325+05	2331-04	2555-19	2676-30	259147	760154	277555
-TUS		2627+05	2530-03	2436-10	2551-23	2579-33	760843	760450	289053
-PHX 9900		2620+01	2625-05	2521-11	2614-24	2820-35	264644	275646	276450

7.5 Inflight Weather Advisories

Inflight Aviation Weather Advisories are forecasts to advise en route aircraft of the development of potentially hazardous weather. Inflight aviation weather advisories in the conterminous U.S. are issued by the NWS AWC, as well as from the CWSU at the various Air Route Traffic Control Centers (ARTCCs). There are four basic types of inflight aviation weather advisories: the Significant Meteorological Information (SIGMET), the Convective SIGMET, the AIRMET, and the Center Weather Advisory (CWA). Inflight advisories serve to notify en-route pilots of the possibility of encountering hazardous flying conditions that may not have been forecast at the time of the preflight briefing. Whether or not the condition described is potentially hazardous to a particular flight is for the pilot to evaluate based on experience and the operational limits of the aircraft. Once issued they are broadcast by FAA controller upon issuance and available on inflight weather broadcasts.

Surrounding the period of the accident the NWS had no SIGMETs, Convective SIGMETs, or CWAs current for the general route of flight. The NWS had several AIRMETs current for mountain obscuration conditions, moderate turbulence below 16,000 ft, and moderate icing between the freezing level and 20,000 ft current over the route and accident site during the period. The advisories were as follows.

AIRMET Sierra

WAUS45 KKCI 240315 AAA

WA5S

-SLCS WA 240315 AMD

AIRMET SIERRA UPDT 1 FOR IFR AND MTN OBSCN VALID UNTIL 240900

...NEW AIRMET...

AIRMET IFR...WY UT CO AZ NM...UPDT

FROM 30N CYS TO 20W SNY TO 30SSE CYS TO 30WSW TBE TO CME TO
50NNE ELP TO 50WNW TCS TO 70NNE TUS TO 40E DRK TO 20WNW DRK TO
60W TBC TO DVC TO 40W LAR TO 30N CYS
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 09Z THRU 15Z.

AIRMET MTN OBSCN...ID MT WY NV UT CO AZ NM

**FROM GTF TO LWT TO SHR TO CYS TO TBE TO 20WNW TCC TO ELP TO 60SE TUS
TO 30ENE EED TO 20N PGS TO 60NE TBC TO 50N JNC TO 30W TWF TO GTF
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 09Z THRU 15Z.**

AIRMET Tango

WAUS45 KPCI 240245

WA5T

-SLCT WA 240245

AIRMET TANGO FOR TURB VALID UNTIL 240900

.

AIRMET TURB...AZ NM

FROM 40SSE ALS TO 60SSE TBE TO INK TO ELP TO 50SSW SSO TO 60W

TCS TO 60SSE ABQ TO 40NNE ABQ TO 40SSE ALS

MOD TURB BLW 160. CONDS CONTG BYD 09Z THRU 15Z.

AIRMET Zulu

WAUS45 KPCI 240245

WA5Z

-SLCZ WA 240245

AIRMET ZULU FOR ICE AND FRZLVL VALID UNTIL 240900

.

AIRMET ICE...WY NV UT CO AZ NM

FROM 100SE MLS TO 70SW RAP TO 30NW GLD TO 50W LBL TO 30ESE TBE TO

30ESE TCC TO 50NW CME TO ELP TO 50S TUS TO BZA TO EED TO 40WSW

EED TO 30NNW PGS TO 40ENE ELY TO 40SW BOY TO 100SE MLS

MOD ICE BTN FRZLVL AND FL200. FRZLVL 040-100. CONDS CONTG BYD 09Z THRU 15Z.

.

FRZLVL...RANGING FROM SFC-100 ACRS AREA

MULT FRZLVL BLW 070 BOUNDED BY 60S YXH-40NE HVR-30ENE GTF-20NW GTF-
50SSE YQL-60S YXH

SFC ALG 30WNW BTY-20NNW TBC-40NE TBC-30WNW SJN-30SE SJN-20SE CIM-SNY

080 ALG ELP-40WNW CME-70SW TCC-20NW TXO

....

8.0 Astronomical Conditions

The United States Naval Observatory's website²⁵ provided the following astronomical conditions on March 23-24, 2021. The time of the accident has been added in bold italic type for reference.

<u>Sun</u>	<u>Date/Time (MDT)</u>
Begin civil twilight	0650 March 23, 2021
Sunrise	0714
Upper transit	1321
Sunset	1929
End civil twilight	1953
<i>Accident</i>	<i>0021 March 24, 2021</i>
Begin civil twilight	0649
Sunrise	0713

²⁵ <https://aa.usno.navy.mil/data/index>

<u>Moon</u>	<u>Date/Time (MDT)</u>
Moonrise	1513 March 23, 2021
Accident	0021 March 24, 2021
Moonset	0448 March 24, 2021

Nighttime prevailed at the time of the accident as the sun was more than 15° below the horizon. The moon was 52° above the horizon at an azimuth of 256°. The phase of the moon was a waxing gibbous with 75% of the disk illuminated.

Submitted by:

Donald Eick
NTSB Senior Meteorologist