NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

August 31, 2016

Group Chairman's Weather Study Report

METEOROLOGY

WPR15FA072

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A. ACCIDENT

Location: 7 miles west of Benson, Arizona
Date: December 31, 2014
Time: approximately 1710 mountain standard time (0010 UTC[1] on January 1st, 2015)
Aircraft: Bell 206, registration: N57AW

B. METEOROLOGY GROUP

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C. SUMMARY

On December 31, 2014, at 1710 mountain standard time, a Bell 206 L4, N57AW, collided with terrain 7 miles west of Benson, Arizona. The commercial pilot and pilot rated mechanic were fatally injured, and the helicopter was destroyed. The helicopter was registered to N57AW LLC, and operated by Airwest Helicopters as 14 Code of Federal Regulations Part 91 positioning flight. Visual meteorological conditions prevailed for the flight, which operated on a company visual flight rules flight plan. The flight originated form Glendale, Arizona, at 1550, and was destined for Sierra Vista, Arizona.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist did not travel for this investigation and gathered the weather data for this investigation from the NTSB's Washington D.C. office and from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Climatic Data Center (NCDC). All times are mountain standard time (MST) on December 31, 2014, and are based upon the 24-hour clock, where local time is -7 hours from UTC, and UTC=Z (unless otherwise noted). Directions are referenced to true north and distances in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The accident location was located at latitude 31.96° N, longitude 110.41° W, at an approximate elevation 4,280 feet.

[1] UTC – is an abbreviation for Coordinated Universal Time.

E. 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 (NCEP) and the Weather Prediction Center (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 joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC-0045G CHG 1.

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart for 1700 MST is provided as figure 1, with the approximate location of the accident site marked. The chart depicted a cold front stretched from just south of the accident site southwest across northern Mexico and into the eastern Pacific Ocean. A stationary front stretched from just south of the accident site southeastward into northern and central Mexico. A surface low pressure center with a pressure of 1006-hectopascals (hPa) was located in southeastern Arizona just south of the accident site (figure 1). Two other surface low pressure centers were located in central and eastern Arizona with pressures of 1008-hPa. The station models around the accident site depicted temperatures in the low 40's to upper 50's Fahrenheit (F), with temperature-dew point spreads of 15° F or more south and east of the accident site and temperature-dew point spreads of 5° F or less west of the accident site, a variable wind between 5 and 20 knots, mostly cloudy skies, and moderate rain west of the accident site. Areas near and ahead of fronts and surface low pressure centers are typically areas where enhanced lift, clouds, and precipitation can occur. The cloudy skies and rainy conditions would have been expected to move from west to east across Arizona with the mid- and upper-level wind pattern (section 1.2). The NWS Surface Analysis Chart from 1400 MST indicated that the surface low pressure center was west of the accident site, but east of the departure location at 1400 MST (figure 2). The station models around the accident site from the 1400 MST NWS Surface Analysis Chart depicted temperatures in the mid 40's to low 60's Fahrenheit (F), with temperature-dew point spreads of 30° F or more south and east of the accident site and temperature-dew point spreads of 10° F or less west of the accident site, a clockwise wind between 10 and 30 knots around the area of low pressure, and mostly cloudy skies. Both the 1400 and 1700 MST NWS Surface Analysis Chart indicated the accident site and southeastern Arizona were in an area favored for clouds and precipitation development, due to the proximity of the surface frontal boundaries and area of surface low pressure in southeastern Arizona.

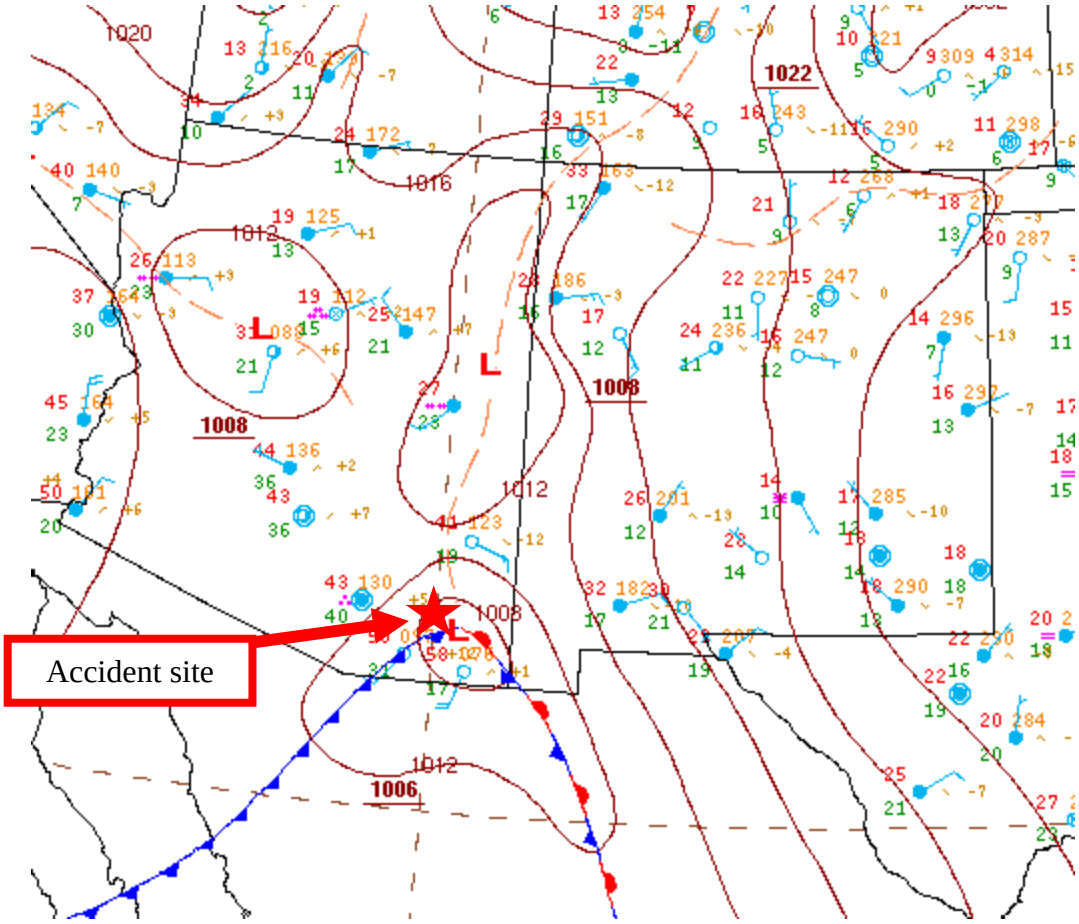

Figure 1 – NWS Surface Analysis Chart for 1700 MST

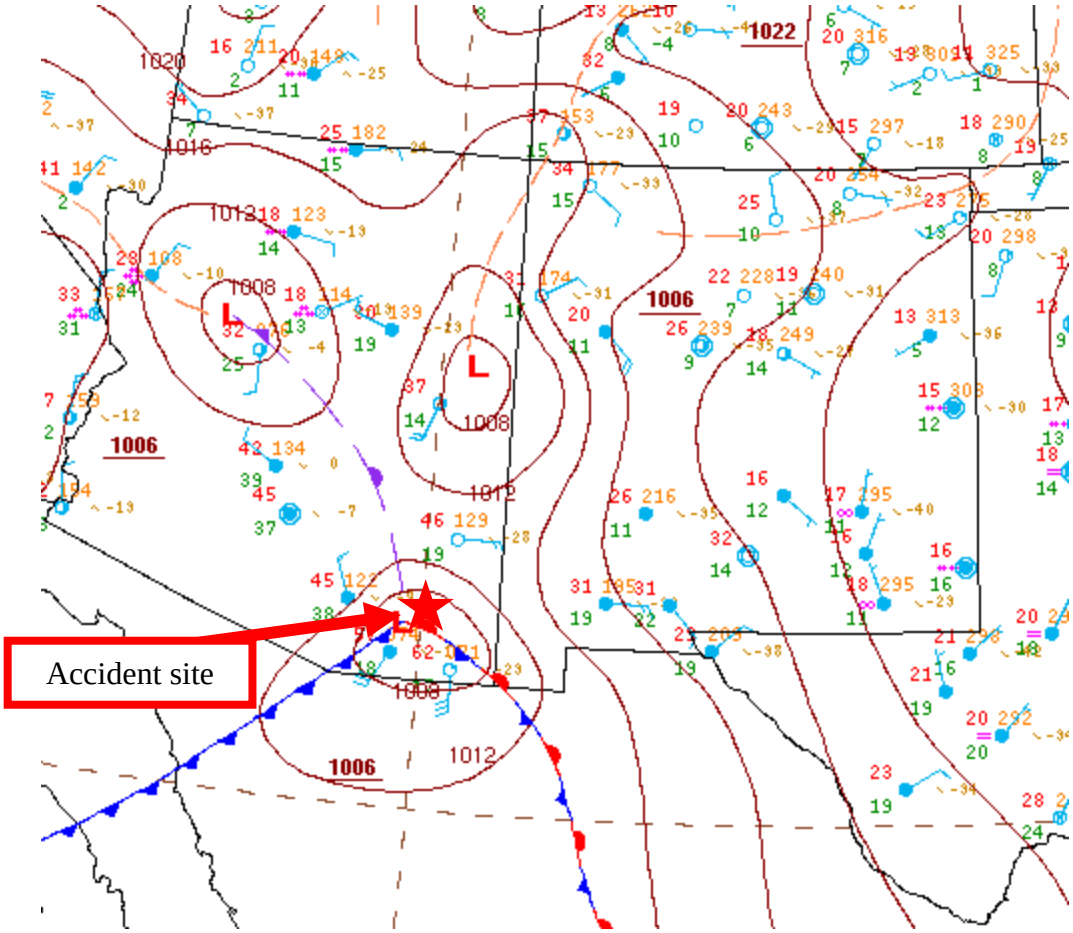

Figure 2 – NWS Surface Analysis Chart for 1400 MST

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 1700 MST at 925-, 850-, 700-, 500-, and 300-hPa are presented in figures 3 through 7. The 700- and 500-hPa charts depicted a mid-level trough[2] and associated mid-level low pressure area just west of the accident site at 1700 MST with a southwesterly wind above 50 knots. Areas near and ahead of troughs are typically areas where enhanced lift, clouds, and precipitation can occur. The strong southwesterly wind at 700- and 500-hPa would have helped move any clouds or precipitation across southern Arizona from southwest to northeast. The wind remained out of the southwest at 300-hPa with the wind speed around 100 knots.

[2] Trough – An elongated area of relatively low atmospheric pressure or heights.

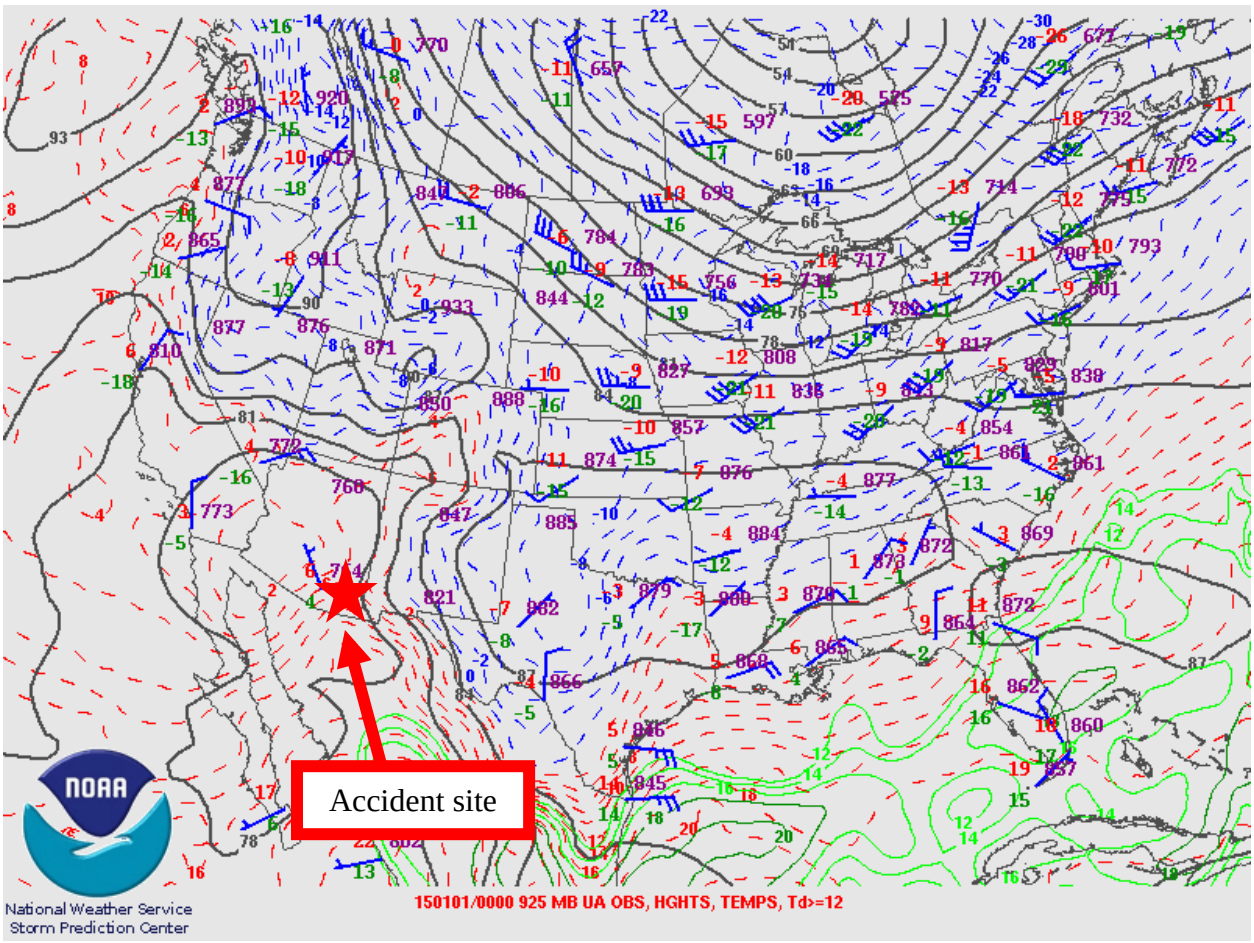

Figure 3 – 925-hPa Constant Pressure Chart for 1700 MST

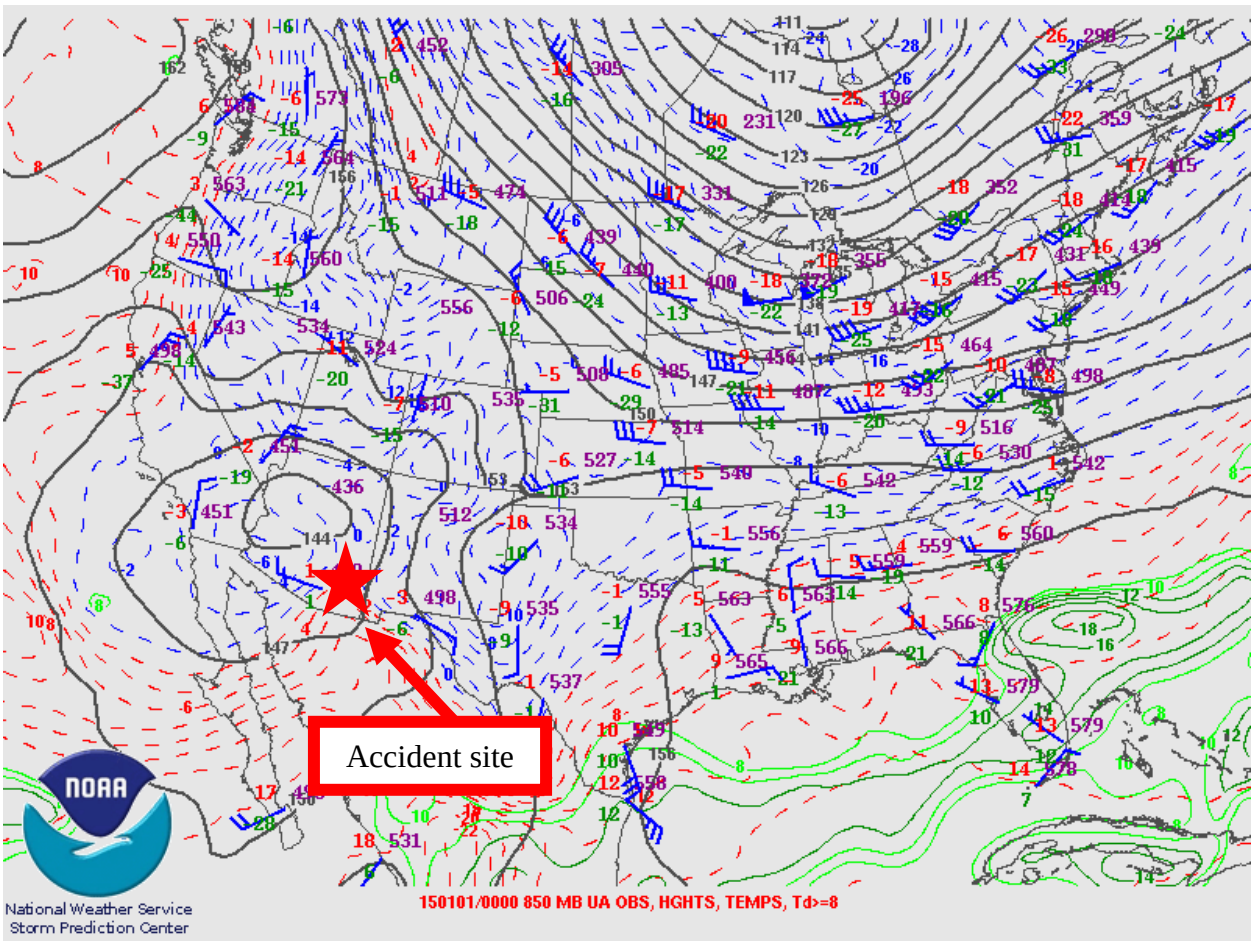

Figure 4 – 850-hPa Constant Pressure Chart for 1700 MST

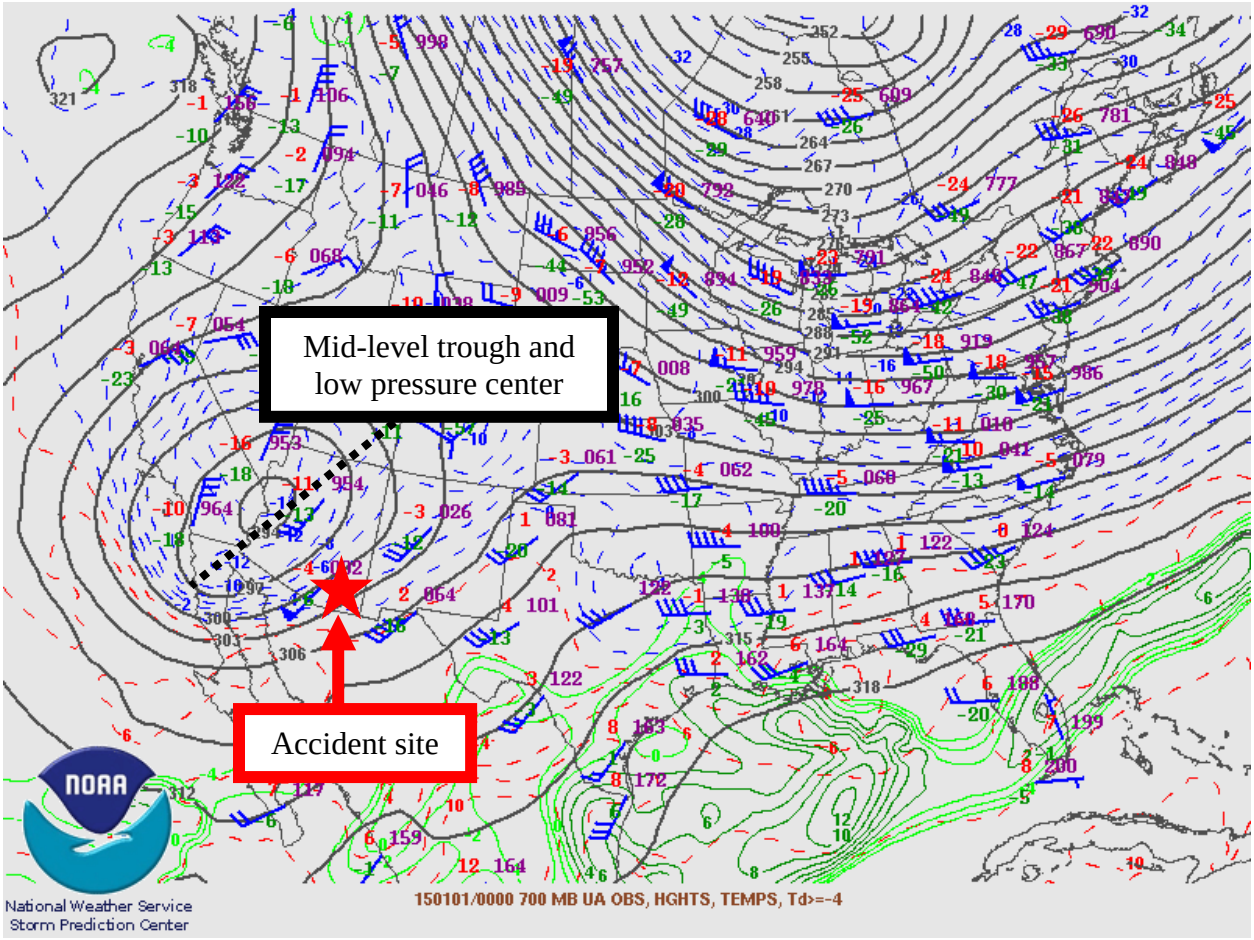

Figure 5 – 700-hPa Constant Pressure Chart for 1700 MST

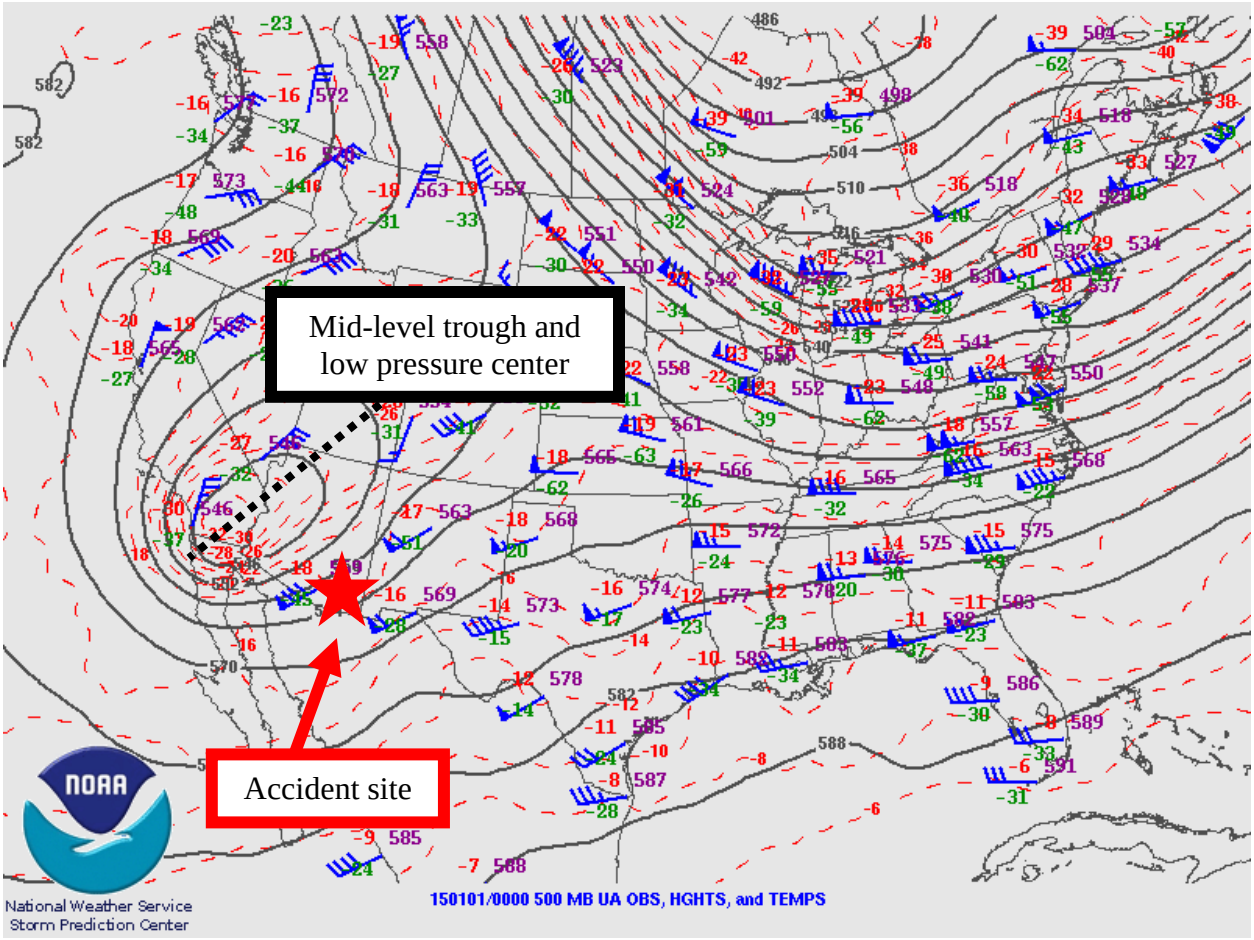

Figure 6 – 500-hPa Constant Pressure Chart for 1700 MST

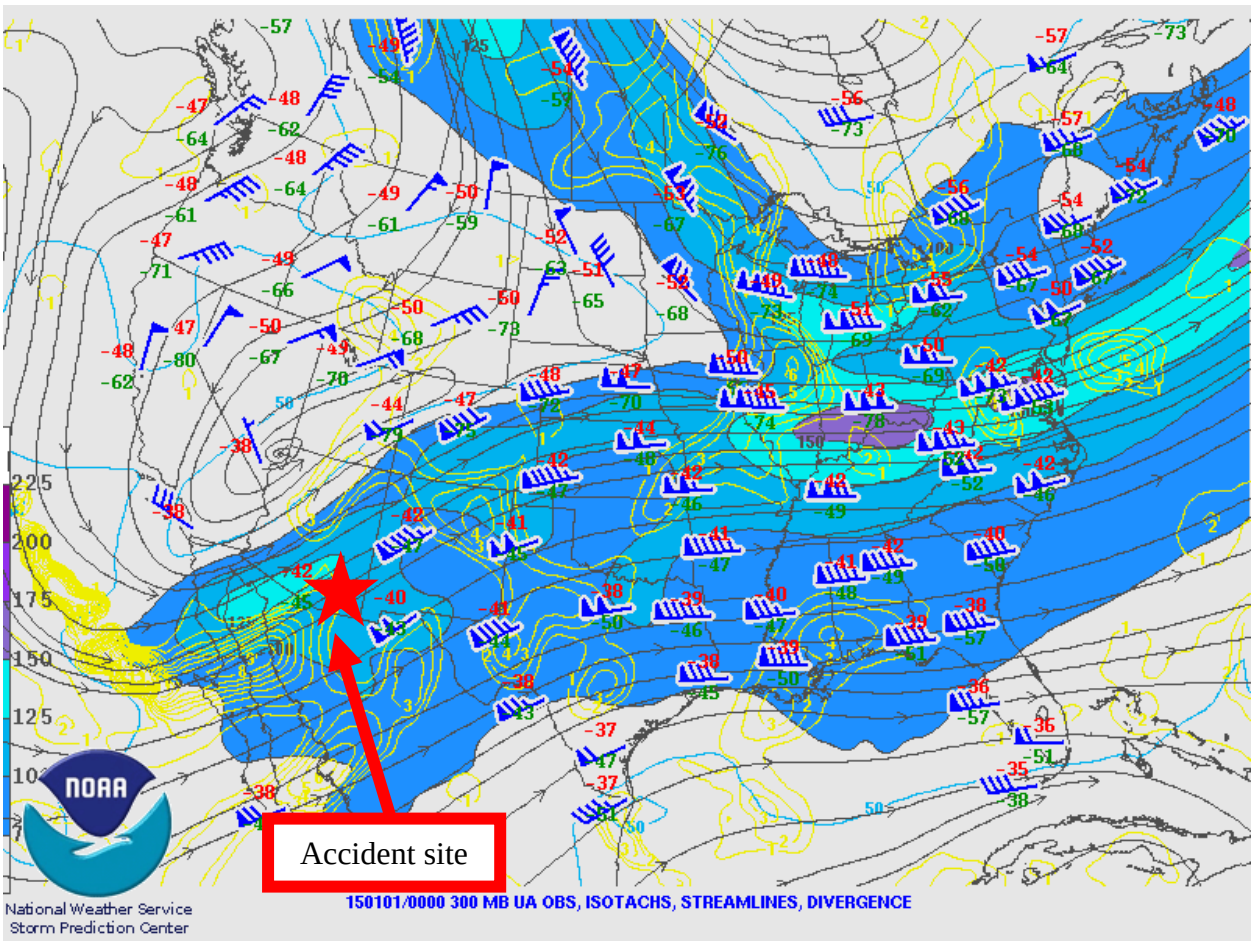

Figure 7 – 300-hPa Constant Pressure Chart for 1700 MST

2.0 Storm Prediction Center Products

There was no convective weather forecast by SPC for the accident site at the accident time.

3.0 Surface Observations

The area surrounding the accident site was documented utilizing official NWS Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language.

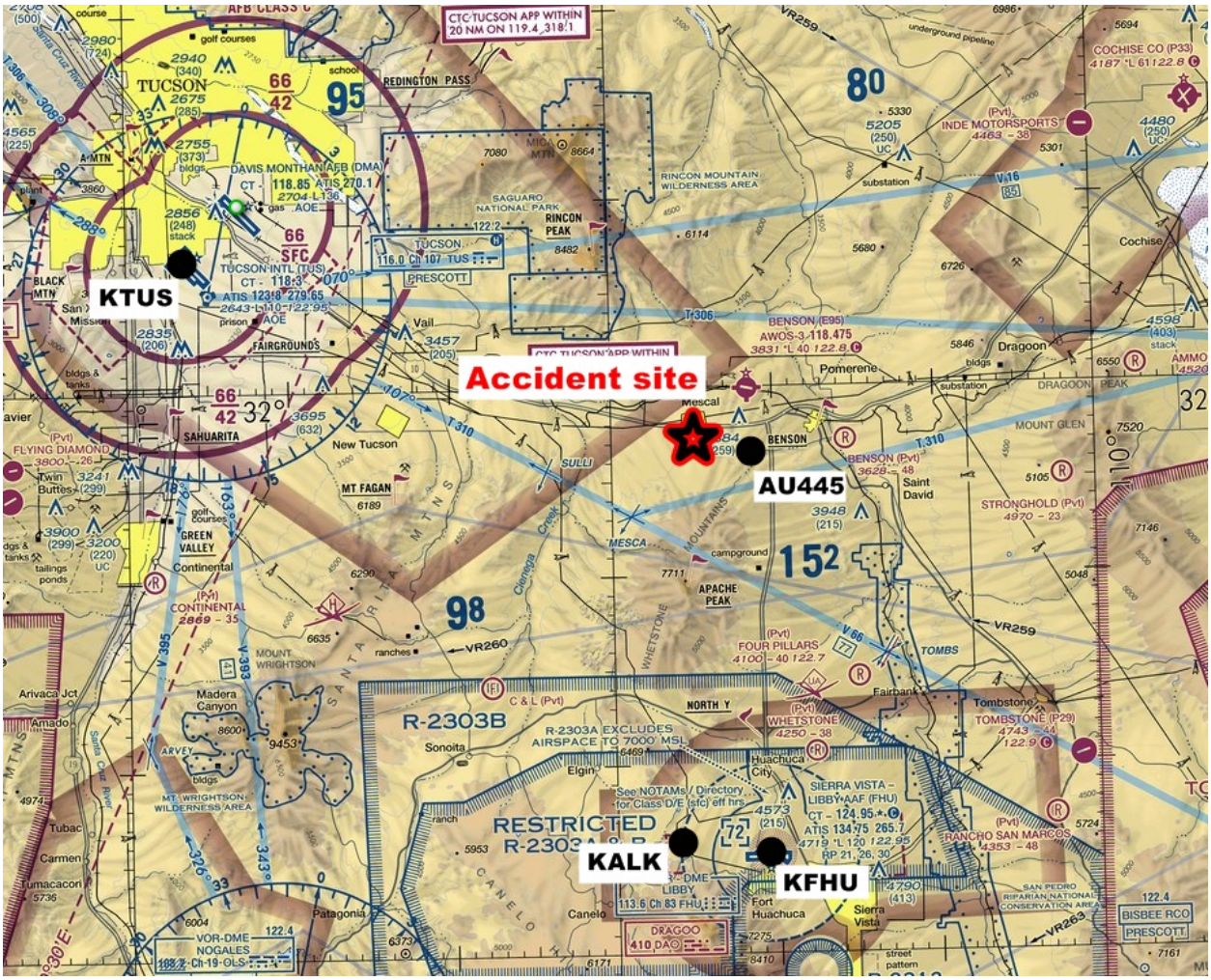

Figure 8 – Map of Arizona with the location of the accident site, surface observation sites, and upper air sounding site

AA1OV-2 Benson observation site (AU445) was the closest weather station to the accident site located 3 miles east-southeast of the accident site (figure 8), at an elevation of 4,250 feet, and its reports were not supplemented. The following observations were taken and disseminated during the times surrounding the accident[3] (figure 9):

[3] The bold sections in this NWS product and the rest of products in the weather factual report are to highlight the individual sections that directly reference the weather conditions that are or will affect the accident location around the accident time.

ID = AU445	TMP ° F	RELH %	SKNT mph	GUST mph	DRCT °	QFLG	ALTI in	P24I in	DWP °F
12-31-2014 23:03 MST	32	89	22	32	235	OK	29.85	0.06	29.2
12-31-2014 22:52 MST	35	92	5	17	242	OK	29.86	0.06	32.9
12-31-2014 22:43 MST	35	92	10	14	222	OK	29.86	0.05	32.9
12-31-2014 22:32 MST	36	91	6	13	215	OK	29.86	0.04	33.7
12-31-2014 22:22 MST	36	91	10	14	252	OK	29.86	0.02	33.7
12-31-2014 22:12 MST	35	93	1	4	239	OK	29.86	0.01	33.2
12-31-2014 22:03 MST	36	93	3	6	276	OK	29.86	0	34.2
12-31-2014 21:52 MST	36	93	4	8	252	OK	29.86	0	34.2
12-31-2014 21:42 MST	36	93	6	8	269	OK	29.86	0	34.2
12-31-2014 21:32 MST	36	92	5	9	260	OK	29.86	0	33.9
12-31-2014 21:23 MST	37	92	4	8	263	OK	29.86	0	34.9
12-31-2014 21:13 MST	36	93	3	8	238	OK	29.86	0	34.2
12-31-2014 21:03 MST	36	94	5	8	255	OK	29.86	0	34.5
12-31-2014 20:52 MST	36	94	2	11	236	OK	29.86	0	34.5
12-31-2014 20:42 MST	36	94	7	14	287	OK	29.85	0	34.5
12-31-2014 20:32 MST	36	94	11	15	248	OK	29.85	0	34.5
12-31-2014 20:22 MST	36	94	10	16	264	OK	29.85	0	34.5
12-31-2014 20:12 MST	35	94	11	17	293	OK	29.86	0	33.5
12-31-2014 20:02 MST	36	93	11	17	253	OK	29.86	0	34.2
12-31-2014 19:53 MST	36	92	8	15	248	OK	29.86	0	33.9
12-31-2014 19:43 MST	36	92	8	19	255	OK	29.86	0	33.9
12-31-2014 19:32 MST	36	92	11	19	248	OK	29.86	0	33.9
12-31-2014 19:23 MST	36	92	11	17	232	OK	29.86	0	33.9
12-31-2014 19:12 MST	37	91	12	21	240	OK	29.85	0	34.6
12-31-2014 19:02 MST	37	91	11	18	238	OK	29.86	0	34.6
12-31-2014 18:52 MST	37	92	12	21	224	OK	29.86	0	34.9
12-31-2014 18:42 MST	37	92	12	18	246	OK	29.86	0	34.9
12-31-2014 18:32 MST	37	92	15	20	232	OK	29.85	0	34.9
12-31-2014 18:22 MST	37	93	14	20	253	OK	29.85	0	35.2
12-31-2014 18:13 MST	37	94	12	20	225	OK	29.85	0	35.5
12-31-2014 18:02 MST	37	94	12	18	228	OK	29.86	0	35.5
12-31-2014 17:53 MST	37	94	12	18	249	OK	29.86	0	35.5
12-31-2014 17:42 MST	37	94	13	19	236	OK	29.86	0	35.5
12-31-2014 17:32 MST	37	93	12	18	266	OK	29.86	0	35.2
12-31-2014 17:22 MST	38	92	10	20	260	OK	29.86	0	35.9
12-31-2014 17:12 MST	38	91	10	16	263	OK	29.86	0	35.6
12-31-2014 17:02 MST	38	90	9	15	243	OK	29.86	0	35.4
12-31-2014 16:52 MST	39	88	9	13	250	OK	29.86	0	35.8
12-31-2014 16:42 MST	40	86	8	11	273	OK	29.86	0	36.2
12-31-2014 16:32 MST	40	84	7	13	240	OK	29.86	0	35.6
12-31-2014 16:22 MST	42	79	8	12	271	OK	29.86	0	36
12-31-2014 16:12 MST	45	68	7	9	229	Caution	29.86	0	35.1
12-31-2014 16:02 MST	48	61	7	11	267	Caution	29.85	0	35.2
12-31-2014 15:53 MST	52	50	10	15	232	Caution	29.85	0	34
12-31-2014 15:43 MST	52	49	6	12	266	Caution	29.84	0	33.5
12-31-2014 15:33 MST	52	49	10	19	238	Caution	29.84	0	33.5
12-31-2014 15:22 MST	52	49	10	22	278	Caution	29.83	0	33.5

Figure 9 – Surface observations from AU445 between 1522 MST and 2303 MST

AU445 weather at 1652 MST was reported as wind from 250° at 8 knots with gusts to 11 knots, temperature of 4° Celsius (C), dew point temperature of 2° C, a relative humidity of 88 percent, and an altimeter setting of 29.86 inches of mercury.

AU445 weather at 1702 MST was reported as wind from 243° at 8 knots with gusts to 13 knots, temperature of 3° C, dew point temperature of 2° C, a relative humidity of 90 percent, and an altimeter setting of 29.86 inches of mercury.

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AU445 weather at 1712 MST was reported as wind from 263° at 9 knots with gusts to 14 knots, temperature of 3° C, dew point temperature of 2° C, a relative humidity of 91 percent, and an altimeter setting of 29.86 inches of mercury.

AU445 weather at 1722 MST was reported as wind from 260° at 9 knots with gusts to 17 knots, temperature of 3° C, dew point temperature of 2° C, a relative humidity of 92 percent, and an altimeter setting of 29.86 inches of mercury.

Pioneer Airfield (KALK) was the closest official weather station to the accident site and had an Automated Weather Observing System (AWOS[4]) whose reports were not supplemented. KALK was located 21 miles south of the accident site at an elevation of 4,767 feet (figure 8). The following observations were taken and disseminated during the times surrounding the accident:

[1256 MST] KALK 311956Z AUTO 20025G37KT 10SM CLR 12/M08 A2989
RMK AO2 PK WND 21042/1900 SLP060 T01221083 TSNO=

[1356 MST] KALK 312056Z AUTO 20024G31KT 10SM CLR 12/M06 A2988
RMK AO2 PK WND 21040/2038 SLP059 T01221061 56014 TSNO=

[1456 MST] KALK 312156Z AUTO 23024G30KT 10SM CLR 12/M02 A2988
RMK AO2 PK WND 22036/2126 SLP060 T01171022 TSNO=

[1556 MST] KALK 312256Z AUTO 22021G31KT 10SM CLR 10/M01 A2988 RMK AO2 PK WND 23033/2227 SLP062 T01001011 TSNO=

[1656 MST] KALK 312356Z AUTO 21014KT 10SM SCT042 BKN050 09/01 A2990 RMK AO2 PK WND 22031/2322 SLP069 T00890006 10128 20089 53005 TSNO=

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[4] AWOS – Automated Weather Observing System is equipped with meteorological instruments to observe and report temperature, dewpoint, wind speed and direction, visibility, cloud coverage and ceiling up to twelve thousand feet, and altimeter setting.

[1756 MST] KALK 010056Z AUTO 20015G23KT 10SM OVC047 08/00 A2988 RMK AO2 PK WND 19028/0041 SLP067 T00830000 TSNO=

[1856 MST] KALK 010156Z AUTO 22015G25KT 10SM BKN045 OVC055 08/01 A2989 RMK AO2 SLP070 T00830006 TSNO=

[1956 MST] KALK 010256Z AUTO 25012G19KT 10SM -RA BKN035 OVC046 03/01 A2990 RMK AO2 RAB20 SLP083 P0000 60000 T00280006 53002 TSNO=

[2035 MST] KALK 010335Z AUTO 24011KT 7SM RA SCT014 BKN020 OVC040 02/01 A2992 RMK AO2 P0002 TSNO=

KALK weather at 1556 MST was reported as wind from 220° at 21 knots with gusts to 31 knots, 10 miles visibility, clear skies below 12,000 feet above ground level (agl), temperature of 10° C, dew point temperature of -1° C, and an altimeter setting of 29.88 inches of mercury. Remarks: automated station with a precipitation discriminator, peak wind from 230° at 33 knots at 1527 MST, sea level pressure 1006.2 hPa, temperature 10.0° C, dew point temperature -1.1° C, lightning detection system with the sensor not operating.

KALK weather at 1656 MST was reported as wind from 210° at 14 knots, 10 miles visibility, scattered clouds at 4,200 feet agl, a broken ceiling at 5,000 feet agl, temperature of 9° C, dew point temperature of 1° C, and an altimeter setting of 29.90 inches of mercury. Remarks: automated station with a precipitation discriminator, peak wind from 220° at 31 knots at 1622 MST, sea level pressure 1006.9 hPa, temperature 8.9° C, dew point temperature 0.6° C, 6-hourly maximum temperature of 12.8° C, 6-hourly minimum temperature of 8.9° C, 3-hourly pressure increase of 0.5 hPa, lightning detection system with the sensor not operating.

KALK weather at 1756 MST was reported as wind from 200° at 15 knots with gusts to 23 knots, 10 miles visibility, an overcast ceiling at 4,700 feet agl, temperature of 8° C, dew point temperature of 0° C, and an altimeter setting of 29.88 inches of mercury. Remarks: automated station with a precipitation discriminator, peak wind from 190° at 28 knots at 1741 MST, sea level pressure 1006.7 hPa, temperature 8.3° C, dew point temperature 0.0° C, lightning detection system with the sensor not operating.

KALK weather at 1856 MST was reported as wind from 220° at 15 knots with gusts to 25 knots, 10 miles visibility, a broken ceiling at 4,500 feet agl, overcast skies at 5,500 feet agl, temperature of 8° C, dew point temperature of 1° C, and an altimeter setting of 29.89 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1007.0 hPa, temperature 8.3° C, dew point temperature 0.6° C, lightning detection system with the sensor not operating.

Sierra Vista Municipal Airport-Libby Army Airfield (KFHU) was located 3 miles north of Fort Huachuca Sierra Vista, Arizona, and had an Automated Surface Observing System (ASOS[5]) whose reports were by an official human observer. KFHU was the closest official observation to the accident flight's destination, and was located 22 miles south-southeast of the accident site, at an elevation of 4,719 feet, and had a 10° easterly magnetic variation[6] (figure 8). The following observations were taken and disseminated during the times surrounding the accident:

[1155 MST] KFHU 311855Z 20034G44KT 10SM FEW040 SCT160 BKN200 14/M11 A2987 RMK SLP084=

[1255 MST] KFHU 311955Z 21030G41KT 10SM FEW040 FEW160 OVC200 13/M09 A2985 RMK PK WND 20045/1859 SLP081=

[1355 MST] KFHU 312055Z 21028G36KT 10SM FEW036 BKN200 OVC330 14/M08 A2983 RMK PK WND 20044/37 SLP074 57019=

[1455 MST] KFHU 312155Z 20029G35KT 10SM FEW036 BKN200 OVC330 13/M04 A2984 RMK PK WND 20048/10 SLP079=

[1556 MST] KFHU 312256Z AUTO 22022G29KT 10SM CLR 11/M02 A2985 RMK AO2 PK WND 22034/2226 SLP087 T01111022 $=

[1656 MST] KFHU 312356Z AUTO 22017G24KT 10SM CLR 10/M01 A2987 RMK AO2 PK WND 22028/2300 SLP097 T01001006 10139 20100 53012 $=

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[1756 MST] KFHU 010056Z AUTO 19022G30KT 10SM CLR 09/M01 A2986 RMK AO2 PK WND 19030/0053 SLP089 T00941006 $=

[1856 MST] KFHU 010156Z AUTO 20018G25KT 10SM FEW042 09/00 A2986 RMK AO2 PK WND 20038/0058 SLP090 T00890000 $=

[1956 MST] KFHU 010256Z AUTO 25009G22KT 10SM FEW040 SCT049 BKN060 06/01 A2987 RMK AO2 PK WND 19029/0226 CIG 050 WEST SLP096 T00610006 53001 $=

[2056 MST] KFHU 010356Z AUTO 24012G16KT 9SM -RA BKN039 BKN048 OVC060 04/02 A2986 RMK AO2 RAB28 SLP095 P0000 T00440022 $=

[5] ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, ceiling, temperature, dewpoint, altimeter, and barometric pressure.
[6] Magnetic variation – The angle (at a particular location) between magnetic north and true north.

KFHU weather at 1556 MST was reported as wind from 220° at 22 knots with gusts to 29 knots, 10 miles visibility, clear skies below 12,000 feet agl, temperature of 11° C, dew point temperature of -2° C, and an altimeter setting of 29.85 inches of mercury. Remarks: automated station with a precipitation discriminator, peak wind from 220° at 34 knots at 1526 MST, sea level pressure 1008.7 hPa, temperature 11.1° C, dew point temperature -2.2° C, maintenance needed on system.

KFHU weather at 1656 MST was reported as wind from 220° at 17 knots with gusts to 24 knots, 10 miles visibility, clear skies below 12,000 feet agl, temperature of 10° C, dew point temperature of -1° C, and an altimeter setting of 29.87 inches of mercury. Remarks: automated station with a precipitation discriminator, peak wind from 220° at 28 knots at 1600 MST, sea level pressure 1009.7 hPa, temperature 10.1° C, dew point temperature -0.6° C, 6-hourly maximum temperature of 13.9° C, 6-hourly minimum temperature of 10.0° C, 3-hourly pressure increase of 1.2 hPa, maintenance needed on system.

KFHU weather at 1756 MST was reported as wind from 190° at 22 knots with gusts to 30 knots, 10 miles visibility, clear skies below 12,000 feet agl, temperature of 9° C, dew point temperature of -1° C, and an altimeter setting of 29.86 inches of mercury. Remarks: automated station with a precipitation discriminator, peak wind from 190° at 30 knots at 1753 MST, sea level pressure 1008.9 hPa, temperature 9.4° C, dew point temperature -0.6° C, maintenance needed on system.

KFHU weather at 1856 MST was reported as wind from 200° at 18 knots with gusts to 25 knots, 10 miles visibility, few clouds at 4,200 feet agl, temperature of 9° C, dew point temperature of 0° C, and an altimeter setting of 29.86 inches of mercury. Remarks: automated station with a precipitation discriminator, peak wind from 200° at 38 knots at 1758 MST, sea level pressure 1009.0 hPa, temperature 8.9° C, dew point temperature 0.0° C, maintenance needed on system.

Tucson International Airport (KTUS) was located 6 miles south of Tucson, Arizona, and had an ASOS whose reports were supplemented by air traffic control. KTUS was located 29 miles west-northwest of the accident site, at an elevation of 2,643 feet, and had a 12° easterly magnetic variation (figure 8). The following observations were taken and disseminated during the times surrounding the accident:

[1429 MST] KTUS 312129Z 33009KT 6SM -RA BR FEW006 BKN019 OVC050 07/05 A2993 RMK AO2 RAB09 P0000 T00670050=

[1432 MST] KTUS 312132Z 33009KT 5SM -RA BR BKN006 BKN012 OVC050 07/05 A2993 RMK AO2 RAB09 P0001 T00670050=

[1453 MST] KTUS 312153Z 34009KT 8SM -RA BKN006 BKN012 OVC050 07/05 A2993 RMK AO2 RAB09 SLP124 P0002 T00670050=

[1500 MST] KTUS 312200Z 32008KT 7SM -RA SCT006 OVC012 07/05 A2993 RMK AO2 P0000 T00670050=

[1511 MST] KTUS 312211Z 34007KT 6SM -RA BR FEW004 OVC009 07/05 A2993 RMK AO2 P0001 T00670050=

[1553 MST] KTUS 312253Z 34007KT 10SM -RA OVC012 06/05 A2993 RMK AO2 SLP125 P0004 T00610050=

[1626 MST] KTUS 312326Z 36005KT 4SM -RA BR BKN006 OVC011 06/05 A2995 RMK AO2 CIG 004V009 P0005 T00610050=

[1635 MST] KTUS 312335Z 01003KT 4SM RA BR SCT006 OVC011 06/04 A2995 RMK AO2 P0006 T00610044=

[1648 MST] KTUS 312348Z 01004KT 4SM -RA BR BKN006 OVC011 06/04 A2995 RMK AO2 P0008=

[1653 MST] KTUS 312353Z 00000KT 3SM RA BR BKN006 OVC011 06/04 A2995 RMK AO2 SLP130 P0008 60014 T00610044 10156 20061 51005=

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[1750 MST] KTUS 010050Z 30004KT 4SM RA BR SCT007 BKN012 OVC018 06/04 A2994 RMK AO2 P0011=

[1753 MST] KTUS 010053Z 33004KT 4SM RA BR FEW007 SCT012 OVC018 06/04 A2994 RMK AO2 SLP130 P0011 T00560039=

[1853 MST] KTUS 010153Z 34004KT 6SM RA BR FEW006 BKN015 OVC023 06/03 A2994 RMK AO2 SLP129 P0008 T00560033=

[1953 MST] KTUS 010253Z 00000KT 8SM -RA OVC021 06/03 A2994 RMK AO2 SLP129 P0005 60024 T00560033 58000=

KTUS weather at 1648 MST was reported as wind from 010° at 4 knots, 4 miles visibility, light rain, mist, broken ceiling at 600 feet agl, overcast skies at 1,100 feet agl, temperature of 6° C, dew point temperature of 4° C, and an altimeter setting of 29.95 inches of mercury. Remarks: automated station with a precipitation discriminator, one-hourly precipitation of 0.08 inches.

KTUS weather at 1653 MST was reported as wind calm, 3 miles visibility, moderate rain, mist, a broken ceiling at 600 feet agl, overcast skies at 1,100 feet agl, temperature of 6° C, dew point temperature of 4° C, and an altimeter setting of 29.95 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1013.0 hPa, one-hourly precipitation of 0.08 inches, 6-hourly precipitation of 0.14 inches, temperature 6.1° C, dew point temperature 4.4° C, 6-hourly maximum temperature of 15.6° C, 6-hourly minimum temperature of 6.1° C, 3-hourly pressure increase of 0.5 hPa.

KTUS weather at 1750 MST was reported as wind from 300° at 4 knots, 4 miles visibility, moderate rain, mist, scattered clouds at 700 feet agl, a broken ceiling at 1,200 feet agl, overcast skies at 1,800 feet agl, temperature of 6° C, dew point temperature of 4° C, and an altimeter setting of 29.94 inches of mercury. Remarks: automated station with a precipitation discriminator, one-hourly precipitation of 0.11 inches.

KTUS weather at 1753 MST was reported as wind from 330° at 4 knots, 4 miles visibility, moderate rain, mist, few clouds at 700 feet agl, scattered clouds at 1,200 feet agl, an overcast ceiling at 1,800 feet agl, temperature of 6° C, dew point temperature of 4° C, and an altimeter setting of 29.94 inches of mercury. Remarks: automated station with a precipitation discriminator, sea level pressure 1013.0 hPa, one-hourly precipitation of 0.11 inches, temperature 5.6° C, dew point temperature 3.9° C.

The observations from AU445 indicated both LIFR[7] ceilings and visibilities were likely at the time of the accident near the accident site. AU445 relative humidities rapidly increased to 79 percent by 1622 MST and the relative humidities increased above 90 percent by 1702 MST which would likely be indicative of cloud cover and mist at or near the surface or 4,250 feet msl. KTUS experienced similar conditions to AU445 though conditions at KTUS were only IFR[8] with the ceilings below 1,000 feet. Breezy to windy conditions were present ahead of the lowering visibility and ceiling conditions as seen in the KALK and KFHU observations, with ceilings lowering at both of those locations as the rain moved eastward across southern Arizona after the accident time. The gusty winds ahead of the lowering ceilings and visibilities would have likely created low-level wind shear (LLWS) and will be further discussed in section 4.0 (figure 10).

[7] Low Instrument Flight Rules – Refers to the general weather conditions pilots can expect at the surface. LIFR criteria means a ceiling below 500 feet agl and/or less than 1 miles visibility.
[8] Instrument Flight Rules – Refers to the general weather conditions pilots can expect at the surface. IFR criteria means a ceiling below 1,000 feet agl and/or less than 3 miles visibility.

4.0 Upper Air Data

The closest official upper air sounding site was at KTUS with a site number of 72274. The 1700 MST KTUS sounding was plotted on a standard Skew-T log P diagram[9] with the derived stability parameters included in figure 10 (with data from the surface to 600-hPa, or 14,000 feet msl.) This data was analyzed utilizing the RAOB[10] software package. The sounding depicted the Lifted Condensation Level (LCL)[11] at 3,174 feet msl, a Convective Condensation Level (CCL)[12] of 4,270 feet, and a Level of Free Convection (LFC)[13] at 3,200 feet. The freezing level was located at 7,362 feet. The precipitable water value was 0.53 inches.

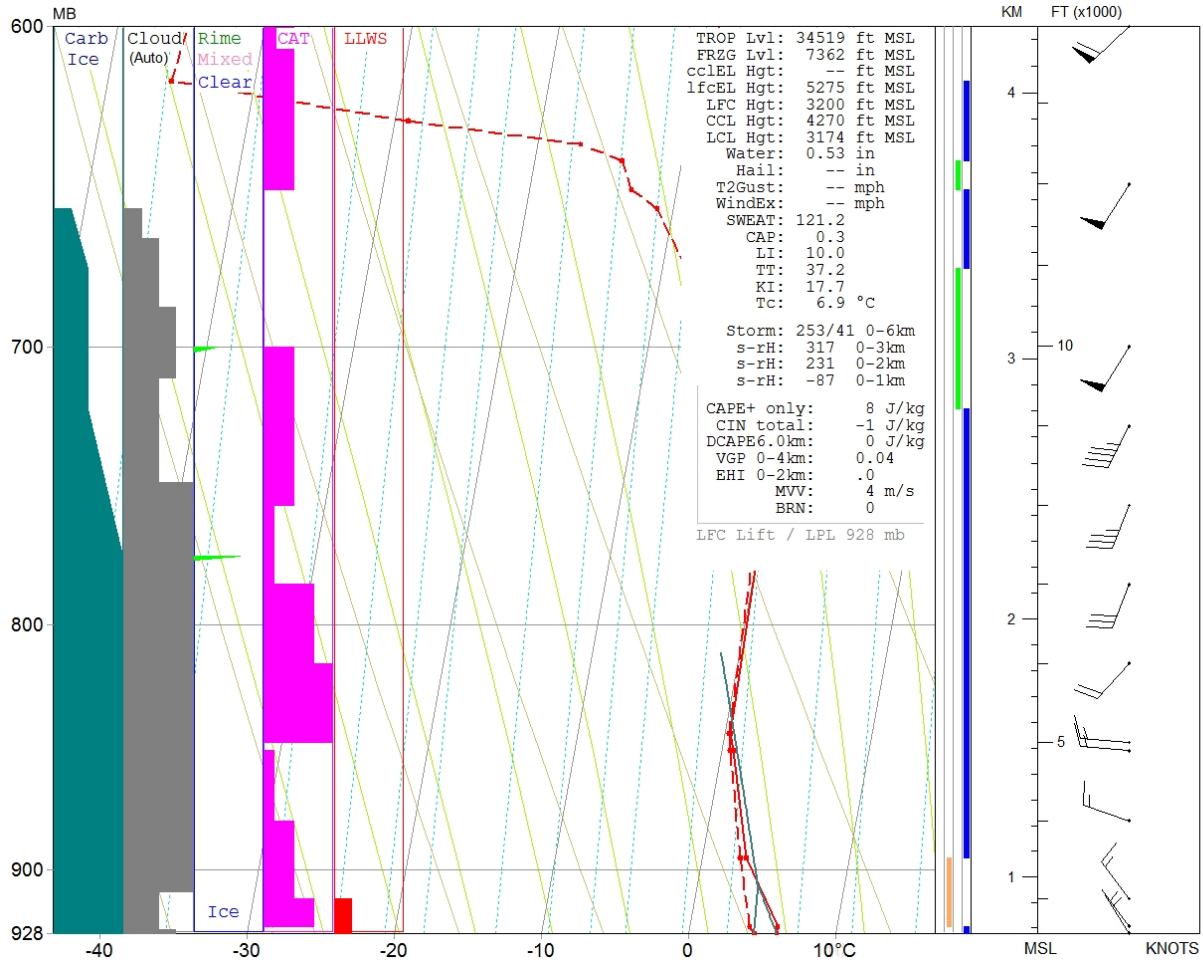


Figure 10 – 1700 MST KTUS sounding

[9] 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.

[10] RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamopras, Pennsylvania.

[11] Lifting Condensation Level (LCL) - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

[12] 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.

[13] Level of Free Convection (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.

The 1700 MST KTUS sounding indicated a relatively moist vertical environment from the surface through 12,000 feet msl. This environment would have been conducive of cloud formation as indicated by RAOB from the surface to 12,000 feet, especially with the mid-level trough and frontal boundaries in the area of the accident site (sections 1.1. and 1.2). Rime icing was indicated by RAOB between 7,000 and 8,000 feet.

The sounding wind profile indicated there was a surface wind from 330° at 3 knots and the wind became westerly by 5,000 feet with the wind speed near 20 knots. The wind then became southwesterly by 6,000 feet with an increase in speed to over 50 knots by 10,000 feet. LLWS indicated by RAOB below 3,000 feet with several layers of possible clear-air turbulence identified by RAOB from the surface through 14,000 feet. With the surface winds at KFHU, KALK, and AU445, it was likely there was LLWS near or at the accident site at the accident time along with the LIFR conditions.

5.0 Satellite Data

Visible and infrared data from the Geostationary Operational Environmental Satellite number 15 (GOES-15) was obtained from the NCDC and processed with the NTSB's Man-computer Interactive Data Access System (McIDAS) workstation. Visible and infrared imagery (GOES-15 bands 1 and 4) at a wavelength of 0.65 microns (μm) and 10.7 μm retrieved brightness temperatures for the scene. Satellite imagery surrounding the time of the accident, from 1300 MST through 1900 MST at approximately 15-minute intervals, were reviewed and the closest images to the time of the accident are documented here.

Figures 11 and 12 present the GOES-15 visible imagery from 1645 and 1700 MST at 2X magnification with the accident site highlighted with a red square. Inspection of the visible imagery indicated a general southwest to northeast movement of the clouds over the accident site at the accident time. There were several patterns of clouds near the accident site and this would likely be indicative of several different layers of clouds from the surface to the top of the clouds. Figure 13 presents the GOES-15 infrared imagery from 1700 MST at 4X magnification with the accident site highlighted with a red square. Inspection of the infrared imagery indicated more enhanced and higher clouds (greens, higher cloud tops) were above the accident site at the accident time. Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 1700 MST KTUS sounding, the approximate cloud-top heights over the accident site were 28,000 feet at 1700 MST.

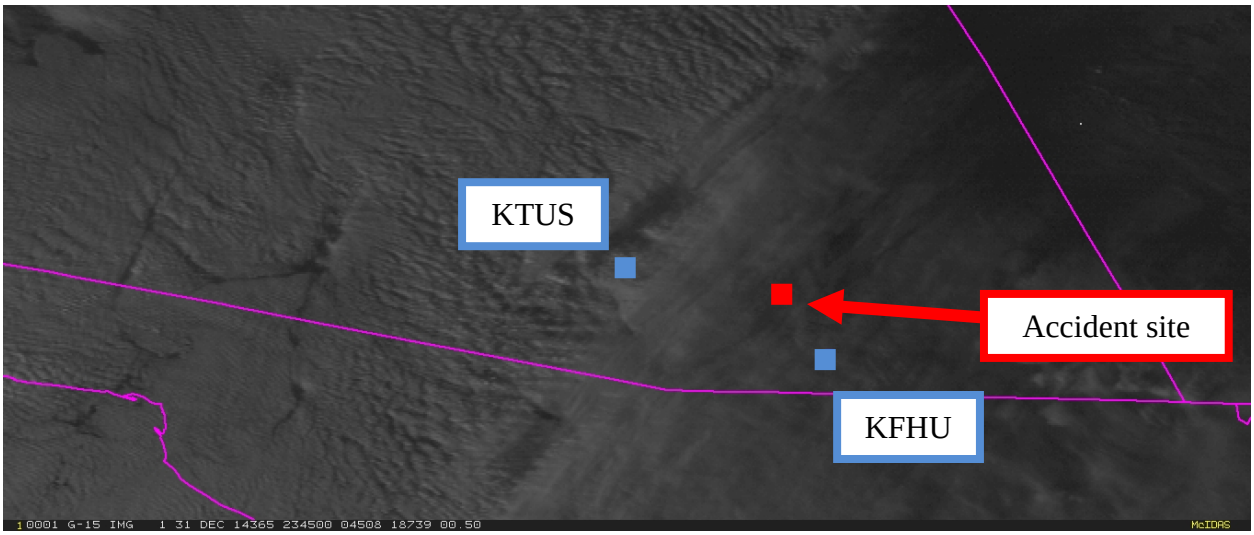


Figure 11 – GOES-15 visible image at 1645 MST

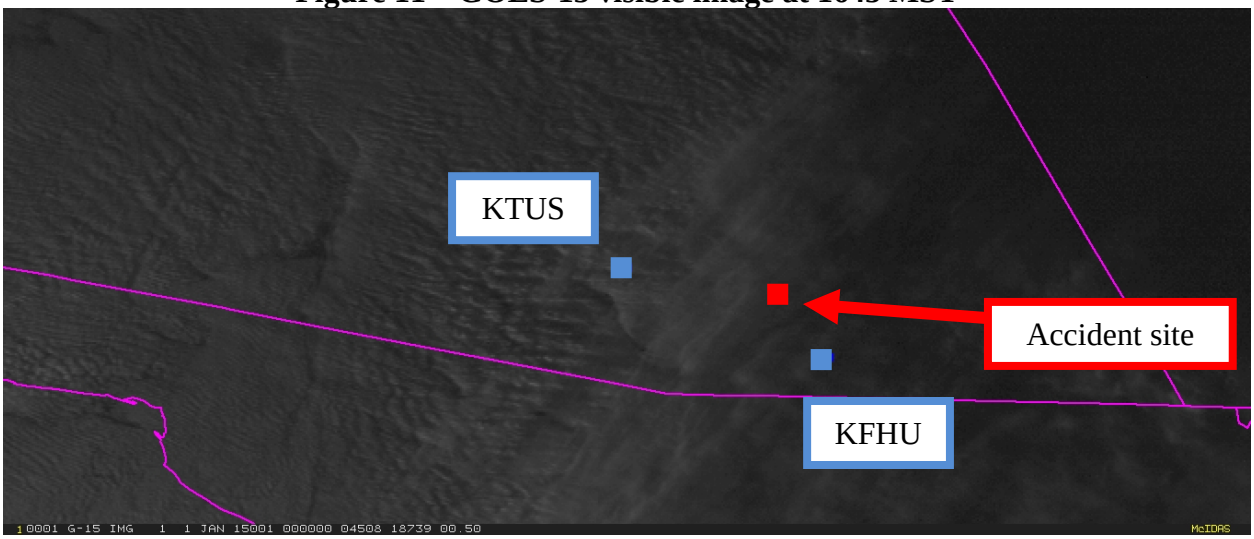


Figure 12 – GOES-15 visible image at 1700 MST

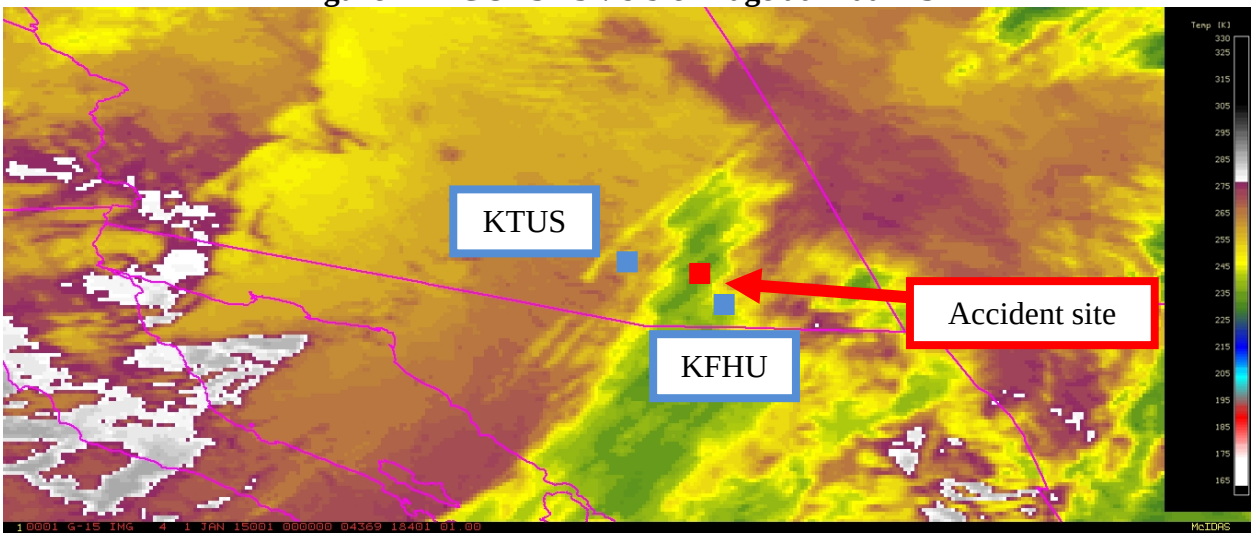


Figure 13 – GOES-15 infrared image at 1700 MST

6.0 Radar Imagery Information

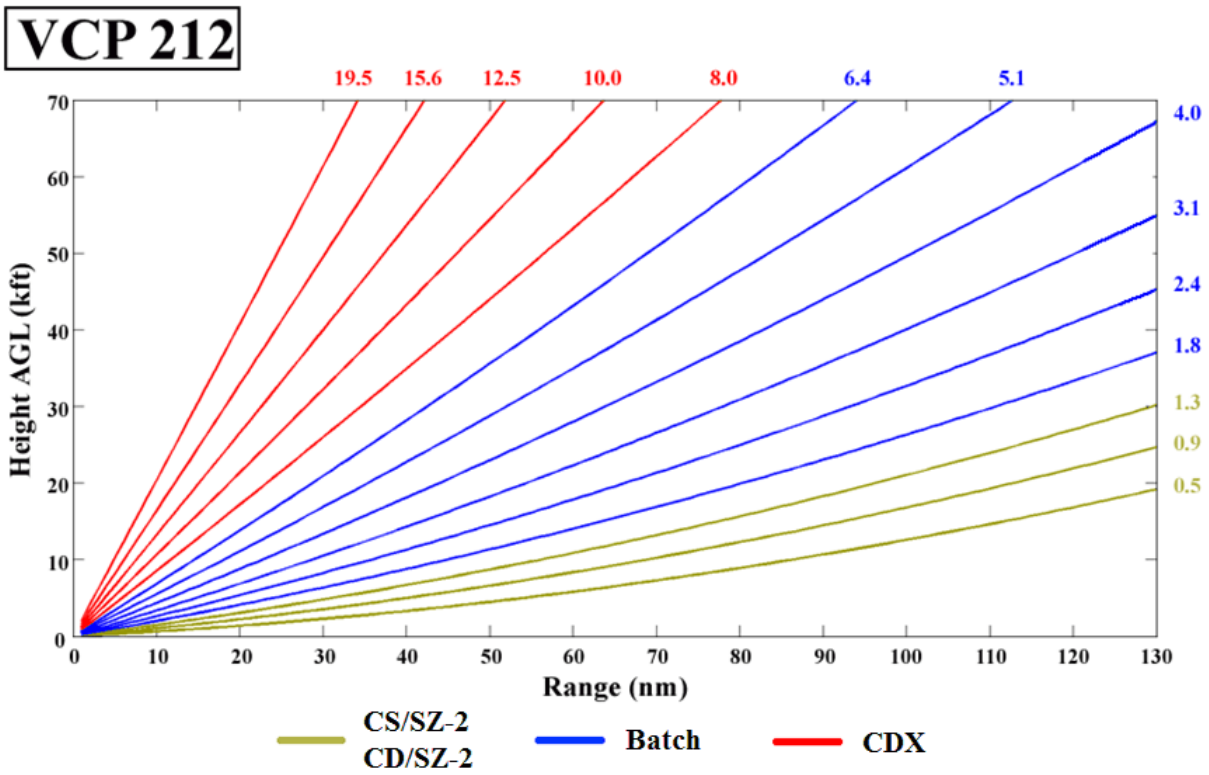
The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)[14] was from Tucson, Arizona, (KEMX), located 10 miles west-southwest of the accident site with an elevation of 5,202 feet. Level II and III archive radar data was obtained from the NCDC utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

6.1 Volume Scan Strategy

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

The WSR-88D operates in several different scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has three common scanning strategies. The most common is where the radar makes 14 elevation scans from 0.5° to 19.5° every four and a half minutes. This particular scanning strategy is documented as volume coverage pattern 212 (VCP-212). Mode B is the clear-air mode, where the radar makes 5 elevation scans during a ten minute period. During the period surrounding the accident, the KEMX WSR-88D radar was operating in the precipitation mode (Mode A) VCP-212. The following chart 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.

[14] 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.



VCP-212 Precipitation Mode Scan Strategy

6.2 Beam Height Calculation

Assuming standard refraction[15] of the WSR-88D 0.95° wide radar beam, the following table shows the approximate beam height and width[16] information[17] of the radar display over the site of the accident. The heights have been rounded to the nearest 10 feet.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP	BEAM WIDTH
0.5°	5,800 feet	5,310 feet	6,300 feet	990 feet

Based on the radar height calculations, the 0.5° elevation scan depicted the conditions between 5,310 feet and 6,300 feet msl over the accident site and these are the closest altitudes to the accident flight level before the accident occurred.[18]

[15] Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.
[16] Beam width – A measure of the angular width of a radar beam.
[17] Beamwidth values are shown for legacy resolution products. Super resolution products would an effective beamwidth that would be approximately half these values.
[18] For more information please see the ATC data.

6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[19] 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[20]), and is a general measure of echo intensity. The chart below relates the NWS video integrator and processor (VIP) intensity levels versus the WSR-88D's display levels, precipitation mode reflectivity in decibels, and rainfall rates.

NWS VIP/DBZ CONVERSION TABLE

NWS VIP	WSR-88D LEVEL	PREC MODE DBZ	RAINFALL
0	0 1 2	< 5 5 to 9 10 to 14	
1 Very Light	3 4 5	15 to 19 20 to 24 25 to 29	.01 in/hr .02 in/hr .04 in/hr
2 Light to Moderate	6 7	30 to 34 35 to 39	.09 in/hr .21 in/hr
3 Strong	8	40 to 44	.48 in/hr
4 Very Strong	9	45 to 49	1.10 in/hr
5 Intense	10	50 to 54	2.49 in/hr
6 Extreme	11 12 13 14 15	55 to 59 60 to 64 65 to 69 70 to 74 > 75	>5.67 in/hr

[19] 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.

[20] 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.

Federal Aviation Administration (FAA) Advisory Circular AC 00-24B, “Thunderstorms,” dated January 2, 1983, also defines the echo intensity levels and potential weather phenomena associated with those levels. If the maximum VIP Level is 1 “weak” and 2 “moderate”, then light to moderate turbulence is possible with lightning. VIP Level 3 is “strong” and severe turbulence is possible with lightning. VIP Level 4 is “very heavy” and severe turbulence is likely with lightning. VIP Level 5 is “intense” with severe turbulence, lightning, hail likely, and organized surface wind gusts. VIP Level 6 is “extreme” with severe turbulence, lightning, large hail, extensive surface wind gusts and turbulence.

6.4 Base Reflectivity and Lightning Data

Figure 14 presents the KEMX WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 1708 MST with a resolution of 0.5° X 250 m. There were no precipitation targets over the accident site at the accident time. There were no lightning strikes near the accident site at the accident time. These weather radar observations are consistent with the observations from AU445 with the accumulating precipitation not occurring until 2212 MST.

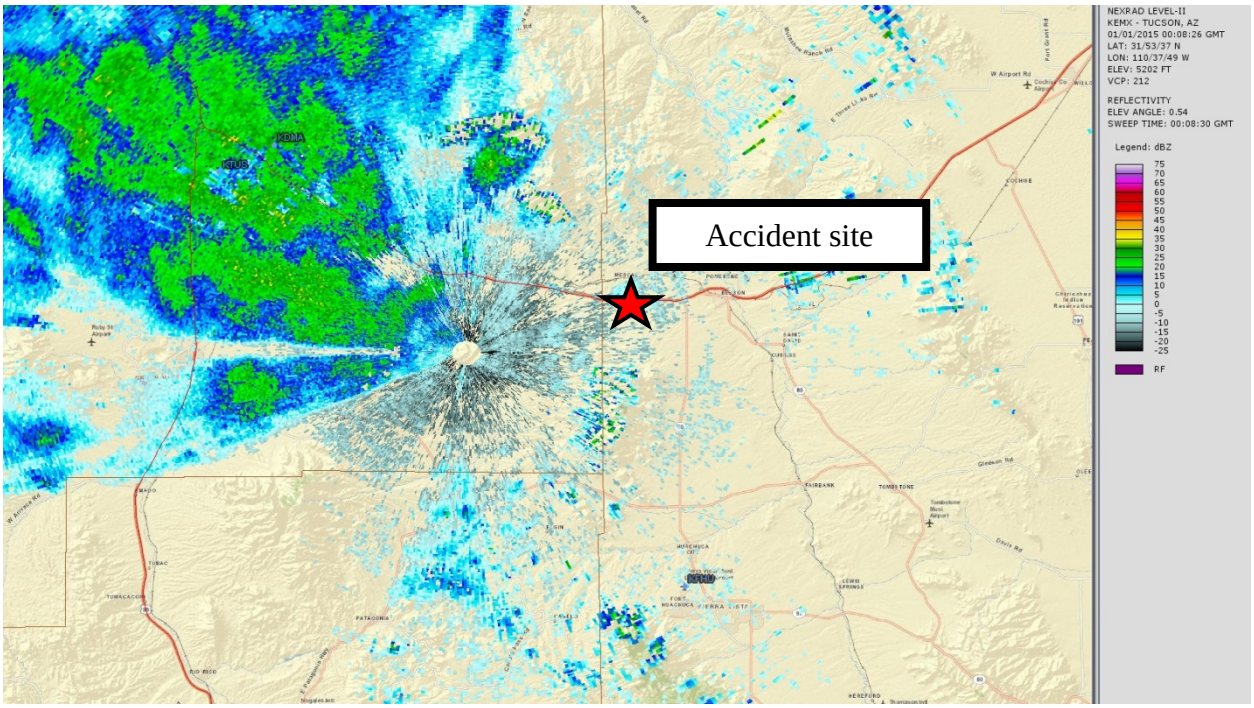


Figure 14 – KEMX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1708 MST

7.0 Pilot Reports

All pilot reports (PIREPs) were reviewed close to the accident site from around three hours prior to the accident time to around three hours after the accident time and the PIREPs displayed below:

TUS UA /OV TUS /TM 2148 /FL050 /TP CRJ7 /SK BKN-TOP045 /WV 32011KT /TB MOD /RM AIS 500FT=

TUS UA /OV TUS290065/TM 2350/FL110/TP BE59/TA -12/IC LIGHT-MOD RIME/RM /ZAB=

TUS UA /OV TUS /TM 0009 /FL125 /TP C550 /TA UNKN /IC LGT MOD RIME 125-115 /RM FAP RWY 29R=

TUS UA /OV TUS022047/TM 0040/FL130/TP C208/TA -10/IC MOD CLEAR/RM /ZAB=

TUS UUA /OV TUS/TM 0055/FL145/TP C208/TA -12/IC MOD TO SEVERE/RM ZAB TMU=

DMA UA /OV TUS090015 /TM 0133 /FL110 /TP AC90 /SK OVC040-TOPUNKN /TA M02 /IC LGT RIME 090 /RM IMC=

TUS UA /OV TUS075052/TM 0140/FL110/TP AC90/TA -5/IC LT MIX/RM ZAB TMU =

TUS UA /OV TUS300045/TM 0210/FL090/TP PA31/TA -4/IC LGT TO MOD RIME/RM ZAB TMU=

Routine pilot report (UA); Over Tucson, Arizona; Time – 1448 MST (2148Z); Altitude – 5,000 feet; Type aircraft – Canadair Regional Jet CRJ-700; Sky – Broken ceiling with tops at 4,500 feet; Wind – From 320° at 11 knots; Turbulence – Moderate; Remarks – Airport in sight at 500 feet agl.

Routine pilot report (UA); 65 miles from Tucson, Arizona, on the 290° radial; Time – 1650 MST (2350Z); Altitude – 11,000 feet; Type aircraft – Beechcraft Baron; Temperature – -12° C; Icing – Light to moderate rime.

Routine pilot report (UA); Over Tucson, Arizona; Time – 1709 MST (0009Z); Altitude – 12,500 feet; Type aircraft – Cessna Citation II; Temperature – Unknown; Icing – Light to moderate rime between 12,500 and 11,500 feet; Remarks – Final approach to runway 29R.

Routine pilot report (UA); 47 miles from Tucson, Arizona, on the 220° radial; Time – 1740 MST (0040Z); Altitude – 13,000 feet; Type aircraft – Cessna 208; Temperature – -10° C; Icing – Moderate clear.

Urgent pilot report (UUA); Over Tucson, Arizona; Time – 1755 MST (0055Z); Altitude – 14,500 feet; Type aircraft – Cessna 208; Temperature – -12° C; Icing – Moderate to severe.

Routine pilot report (UA); 15 miles from Tucson, Arizona, on the 090° radial; Time – 1833 MST (0133Z); Altitude – 11,000 feet; Type aircraft – Turbo Commander 690; Sky – Overcast skies at 4,000 feet with tops unknown; Temperature – -2° C; Icing – Light rime at 9,000 feet; Remarks – Instrument meteorological conditions.

Routine pilot report (UA); 52 miles from Tucson, Arizona, on the 075° radial; Time – 1840 MST (0140Z); Altitude – 11,000 feet; Type aircraft – Turbo Commander 690; Temperature – -5° C; Icing – Light mixed.

Routine pilot report (UA); 45 miles from Tucson, Arizona, on the 300° radial; Time – 1910 MST (0210Z); Altitude – 9,000 feet; Type aircraft – Piper PA-31 Navajo; Temperature – -4° C; Icing – Light to moderate rime.

8.0 SIGMET and CWSU Advisories

No SIGMET was valid for the accident site at the accident time for the accident flight.

No Center Weather Service Unit (CWSU) Advisory (CWA) was valid for the accident site at the accident time.

No Meteorological Impact Statements (MIS) were valid for the accident site at the accident time.

9.0 AIRMETs

AIRMETs Sierra, Tango, Zulu were issued at 1345 MST, and valid at the accident time for the accident site. They forecasted mountains obscured by clouds, precipitation, and mist, moderate turbulence below FL180[21], LLWS potential, and moderate icing below 17,000 feet. An update was done to AIRMET Tango at 1658 MST, but the accident site remained in the moderate turbulence forecast area along with areas of LLWS:

WAUS45 KKCI 312358 AAA
WA5T
_SLCT WA 312358 AMD
AIRMET TANGO UPDT 10 FOR TURB AND LLWS VALID UNTIL 010300
.
AIRMET TURB...NV UT CO AZ NM CA AND CSTL WTRS
FROM 80NNW FOT TO 40SSE LKV TO 80N FMG TO 40S BAM TO 20SSW LAS
TO 50W TBC TO 50WSW RSK TO ALS TO 50NNE TCC TO INK TO ELP TO 50S
TUS TO BZA TO 20S MZB TO 220SW MZB TO 130SW PYE TO 80NNW FOT
MOD TURB BLW FL180. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET TURB...ID WY NV UT CO AZ NM OR CA AND CSTL WTRS
FROM 100SE MLS TO 70SW RAP TO BFF TO GLD TO 50W LBL TO 30ESE TBE
TO INK TO 20ESE ELP TO 50S TUS TO BZA TO 20S MZB TO 220SW MZB TO
140WSW FOT TO 40W BOI TO 100SE MLS
MOD TURB BTN FL180 AND FL410. CONDS CONTG BYD 03Z THRU 09Z.
.
LLWS POTENTIAL...NM
BOUNDED BY 50ENE SJN-50SE ABQ-20SSW CME-40ENE ELP-20E TCS-50SE
SJN-50ENE SJN
LLWS EXP. CONDS DVLPG 00-03Z. CONDS CONTG BYD 03Z THRU 09Z.
....
WAUS45 KKCI 312045
WA5Z
_SLCZ WA 312045
AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 010300
.
AIRMET ICE...NM
FROM 30E TCC TO INK TO 70E ELP TO 60NNW CME TO 30E TCC
MOD ICE BLW 070. CONDS ENDG 00-03Z.
.
AIRMET ICE...NV UT CO AZ NM CA
FROM 20NE DVC TO 50WNW ABQ TO 50W TCS TO 50SSE SSO TO 50S TUS TO
BZA TO 60SSE TRM TO 40SE LAS TO 40SSE BCE TO 20NE DVC
MOD ICE BLW 170. CONDS CONTG BYD 03Z THRU 09Z.
.
OTLK VALID 0300-0900Z...ICE UT CO AZ NM
BOUNDED BY 50WSW HBU-30W ALS-30ENE ABQ-20ESE DMN-60SE SSO-50S
TUS-70WSW TUS-20SSW INW-60NNE TBC-40WNW DVC-50WSW HBU
MOD ICE BLW 170. CONDS CONTG THRU 09Z.
.
FRZLVL...RANGING FROM SFC-120 ACRS AREA

[21] Flight Level – A Flight Level (FL) is 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 inHg), the average sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

MULT FRZLVL BLW 070 BOUNDED BY 30SSE YQL-70NE GGW-50W DIK-
40SW MLS-20W BIL-30SSE YQL
MULT FRZLVL BLW 120 BOUNDED BY 60SSE TBE-INK-ELP-50SSE SSO-
50N SSO-50W TCS-20N DMN-60SSE TBE
SFC ALG EED-50ENE PHX-30W DMN-20W ELP
040 ALG 90SSW PHX-60S PHX-30NE PHX
....
WAUS45 KKCI 312045
WA5S
_SLCS WA 312045
AIRMET SIERRA UPDT 4 FOR IFR AND MTN OBSCN VALID UNTIL 010300
.
AIRMET IFR...UT AZ NM
FROM 40ESE ILC TO 30ENE BCE TO 70SW DVC TO 70SSW RSK TO 40ESE
SJN TO 40NNW SSO TO 20W PHX TO EED TO 40SSE LAS TO 60N PGS TO
40ESE ILC
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET IFR...NM
FROM 30ESE TCC TO INK TO 20E ELP TO 60W CME TO 70S FTI TO 30ESE
TCC
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET MTN OBSCN...NV UT AZ NM
FROM 50NNW HVE TO 30W DVC TO 60NNE SJN TO 70SSE SJN TO 60SSW SSO
TO 50S TUS TO 60SW TUS TO 20NW TUS TO 50W PHX TO 30SW LAS TO
50NNW HVE
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET MTN OBSCN...NM
FROM 60SE RSK TO 20SW FTI TO 60SE ABQ TO 70W INK TO ELP TO 50SSE
SSO TO 30WNW TCS TO 60W ABQ TO 60SE RSK
MTNS OBSC BY CLDS/BR. CONDS CONTG BYD 03Z THRU 09Z.
.
OTLK VALID 0300-0900Z
AREA 1...IFR UT CO AZ NM
BOUNDED BY 50SSE DTA-40NNE RSK-40S FTI-50N ELP-50SSE SSO-TUS-40E
PHX-50ESE EED-80SSE ILC-40ESE ILC-50SSE DTA
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG THRU 09Z.
.
AREA 2...MTN OBSCN CO NM
BOUNDED BY 40SSW JNC-30SE HBU-20WSW FTI-70SE ABQ-70W INK-ELP-
60SE SSO-40NW TCS-RSK-40SSW JNC
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG THRU 09Z.
....
WAUS45 KKCI 312045
WA5T
_SLCT WA 312045
AIRMET TANGO UPDT 9 FOR TURB AND LLWS VALID UNTIL 010300
.
...SEE SIGMET QUEBEC SERIES...
.
AIRMET TURB...NV UT CO AZ NM CA AND CSTL WTRS
FROM 80NNW FOT TO 40SSE LKV TO 80N FMG TO 40S BAM TO 20SSW LAS
TO 50W TBC TO 50WSW RSK TO ALS TO 50NNE TCC TO INK TO ELP TO 50S
TUS TO BZA TO 20S MZB TO 220SW MZB TO 130SW PYE TO 80NNW FOT

MOD TURB BLW FL180. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET TURB...ID WY NV UT CO AZ NM OR CA AND CSTL WTRS
FROM 100SE MLS TO 70SW RAP TO BFF TO GLD TO 50W LBL TO 30ESE TBE
TO INK TO 20ESE ELP TO 50S TUS TO BZA TO 20S MZB TO 220SW MZB TO
140WSW FOT TO 40W BOI TO 100SE MLS
MOD TURB BTN FL180 AND FL410. CONDS CONTG BYD 03Z THRU 09Z.
.
LLWS POTENTIAL...NM
BOUNDED BY 50ENE SJN-50SE ABQ-20SSW CME-40ENE ELP-20E TCS-50SE
SJN-50ENE SJN
LLWS EXP. CONDS DVLPG 00-03Z. CONDS CONTG BYD 03Z THRU 09Z.
....

10.0 Area Forecast

The Area Forecast issued at 1345 MST valid at the accident time forecasted a broken ceiling at 6,000 feet msl with tops to 10,000 feet, scattered light rain showers, and west wind with gusts to 25 knots:

FAUS45 KKCI 312045
FA5W
_SLCC FA 312045
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 011500
CLDS/WX VALID UNTIL 010900...OTLK VALID 010900-011500
ID MT WY NV UT CO AZ NM
.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG.
.
SYNOPSIS...ALF..STG UPR LOW OVR SRN CA/WRN AZ/SRN NV SHIFTING EWD
DURG PD. BY 15Z LOW CNTRD OVR N CNTRL AZ. FLOW MOD VRB AROUND THE
LOW.
SFC..LOW PRES S CNTRL AZ. CDFNT SWD INTO NRN GULF CA. BY 15Z LOW
MOVG NEWD TO XTRM NW NM. STNR FNT SWD THRU WRN NM INTO N CNTRL
OLD MEXICO. HI PRES OVR RMNDR AREA THRU PD.
.
ID
NRN...SCT050 SCT CI. 05Z BKN CI. OTLK...VFR.
CNTRL MTNS
XTRM S...BKN120 TOP 140. 00Z SCT140. OTLK...VFR.
RMNDR...SCT140. 02Z WRN SXNS BKN060 TOP 080. OTLK..VFR.
SWRN...BKN055 TOP 070. 23Z SCT050 BKN CI. 06Z BKN050 TOP 070.
OTLK...MVFR CIG.
S CNTRL...SCT060 BKN140 TOP 160. 02Z SCT120. 07Z BKN055 TOP 070.
OTLK...MVFR CIG.
SERN...BKN140 TOP 160. 23Z SCT120. OTLK...VFR.
.
MT
CONTDVD WWD
FLATHEAD VLY...BKN050 TOP 070. 22Z SCT050. 03Z BKN050 TOP 070.
OTLK..MVFR CIG.
RMNDR...SCT120. OTLK...VFR.

SWRN MTNS
SERN...BKN120 TOP 150. 23Z SCT120 BKN CI. OTLK...VFR.
RMNDR...SCT140. 23Z BKN CI. OTLK...VFR.
ERN SLOPES OF CONTDVD...SCT120 SCT CI. 23Z SCT140 BKN CI.
OTLK...VFR.
CNTRL
E OF CONTDVD...BKN120 TOP 150. 01Z SCT100. 06Z BKN120 TOP 150.
OTLK...VFR.
RMNDR...BKN120 TOP 150. OTLK...VFR.
ERN
N HLF...BKN070 TOP 150. 01Z SCT030 SCT CI. 06Z BKN120 TOP 150.
OTLK...VFR.
S HLF...BKN100 TOP 150. 02Z SCT100. OTLK...VFR.
.
WY
PLAINS
NRN...BKN110 TOP 150. 00Z SCT CI. OTLK...VFR.
SRN...SKC. OTLK...VFR.
MTNS E OF CONTDVD
NRN...SCT120. OTLK...VFR.
SRN...SKC. OTLK...VFR.
MTNS W OF CONTDVD
NRN...SCT CI. 23Z SKC. OTLK...VFR.
SRN...SCT CI. OTLK...VFR.
.
NV
NWRN
NRN THIRD...BKN120 TOP 150. 01Z SKC. OTLK...VFR.
SRN 2/3RDS...SCT120 SCT CI. SRN SXNS WND N 25G35KT.
OTLK...VFR...WND SRN SXNS.
NERN
NRN THIRD...SCT120. OCNL BKN120 TOP 150. 23Z SKC. OTLK...VFR.
SRN 2/3RDS...SKC. TIL 04Z WND N 20G30KT. OTLK..VFR.
SRN...BKN070 TOP 150. OCNL -SN. 03Z SCT080. OTLK...VFR.
.
UT
NRN HLF
WASATCH WWD...SCT120 XTRM NW OTRW SKC. 00Z SKC THRUT. OTLK...VFR.
ERN...BKN140 TOP 160. 02Z SCT150. OTLK...VFR.
SRN HLF
GRT BASIN...SCT080. BECMG 2200 BKN070 TOP FL180. VIS 3SM -SN.
OTLK...MVFR CIG SN...10Z VFR.
S CNTRL MTNS...BKN085 TOP FL200. VIS 3SM -SN. OTLK...IFR SN...10Z
MVFR CIG SN.
ERN...BKN080 TOP FL200. ISOL -SHSN. OTLK...MVFR CIG SN.
.
CO
PLAINS
NRN...SCT CI. OTLK...VFR.
SRN...SCT120 BKN CI. 22Z SCT120 SCT CI. OTLK...VFR.
FOOTHILLS...SKC OR SCT CI. OTLK...VFR.
MTNS
N HLF...SCT080. 02Z BKN140 TOP FL200. ISOL -SHSN. OTLK...VFR.
S HLF
SAN LUIS VLY...SCT140. BECMG 0306 BKN100 TOP FL200. VIS 3SM-SN.
OTLK...MVFR CIG SN.

RMNDR...BKN150 TOP FL200. BECMG 0709 BKN100. ISOL -SHSN.
OTLK..VFR...12Z MVFR CIG SN.
.
AZ
NRN HLF...BKN070-080 TOP FL220. VIS 3SM -SN BLSN. WND NE G25KT.
OTLK...IFR CIG SN.
SWRN...BKN040 TOP 120. SCT -SHRA. 22Z BKN080. OTLK...VFR.
SERN...BKN060 TOP 100. SCT -SHRA. WND W G25KT. BECMG 0305 TOP 140. VIS 3SM SCT -SHRA. OTLK...VFR.
.
NM
PLAINS
NRN...BKN060 TOP 080. OTLK...MVFR CIG...13Z IFR CIG SN.
SRN...OVC050 TOP 080. VIS 3SM -SN. 04Z TOP 100. VIS 3SM -FZDZ.
OTLK...IFR FZDZ BR.
MTNS E OF CONTDVD...BKN070-080 TOP 120. BECMG 0609 OVC070 TOP 160. VIS 5SM -SN. OTLK...IFR SN.
MTNS W OF CONTDVD
N HLF...BKN110 TOP 150. BECMG 2200 BKN080. VIS 3SM -SN. 05Z OVC075 TOP FL200. VIS 3SM -SN. OTLK...IFR CIG SN FZFG.
S HLF...BKN070 TOP 100. 06Z TOP 160. OTLK...MVFR CIG SHSNPL.
....

11.0 Terminal Aerodrome Forecast

KFHU was the closest site with a Terminal Aerodrome Forecast (TAF). The TAF valid at the time of the accident was issued at 1556 MST and was valid for a 20-hour period beginning at 1500 MST. The TAF forecasted:

TAF AMD KFHU 3122/0201 **20020G35KT 9000 -RA OVC030 520009 620303 QNH2984INS**
TEMPO 3122/0101 21035G50KT 530009 530909
BECMG 0101/0102 27010G15KT 8000 -SN BKN015 620153 QNH2991INS
BECMG 0108/0109 22009KT 9999 NSW BKN015 QNH2998INS
BECMG 0117/0118 25012G18KT 9999 BKN220 QNH2994INS
TX13/3122Z TN00/0122Z AMD 312237 LAST NO AMDS AFT 3123 NEXT=

The KFHU forecast expected wind from 200° at 20 knots with gusts to 35 knots, 7 miles visibility, light rain, an overcast ceiling at 3,000 feet agl, occasional moderate turbulence in clear air from the surface to 9,000 feet, light rime icing in cloud from 3,000 to 6,000 feet, and minimum altimeter setting of 29.84 inHg. Temporary conditions between 1500 and 1800 MST of wind from 210° at 35 knots with gusts to 50 knots, frequent moderate turbulence in clear air from the surface to 9,000 feet, and frequent moderate turbulence in clear air from 9,000 feet to 18,000 feet was forecast.

The KFHU TAF issued at 1206 MST was the valid TAF before the approximate 1540 to 1550 MST takeoff time:

TAF KFHU 3119/0201 20025G35KT 9999 SCT030 BKN150 530009 QNH2987INS
TEMPO 3119/3123 21035G50KT 530009 530909
BECMG 3123/3124 30015G25KT 9000 -RA BKN020 520009 620303 QNH2992INS
BECMG 0102/0103 27010G15KT 8000 -SN BKN015 620153 QNH2995INS
BECMG 0108/0109 22009KT 9999 NSW BKN015 QNH2999INS
BECMG 0117/0118 25012G18KT 9999 BKN220 QNH2994INS
TX13/3122Z TNM01/0113Z LAST NO AMDS AFT 3123=

The 1206 MST KFHU TAF expected wind from 300° at 15 knots with gusts to 25 knots, 7 miles visibility, light rain, a broken ceiling at 2,000 feet agl, occasional light to moderate turbulence in clear air from the surface to 9,000 feet, light rime icing in cloud from 3,000 to 6,000 feet, and minimum altimeter setting of 29.92 inHg starting around 1600 MST and valid through 1900 MST.

KTUS was the closest official NWS site with a Terminal Aerodrome Forecast (TAF). The TAF valid at the time of the accident was issued at 1633 MST and was valid for a 24-hour period beginning at 1700 MST. The TAF forecasted:

TAF AMD KTUS 312333Z 0100/0124 **33006KT P6SM -RA SCT006 OVC012**
TEMPO 0100/0103 4SM -RA BR BKN006
FM010300 26006KT P6SM -RA SCT006 OVC015
FM010800 17006KT P6SM SCT015 BKN040
FM011600 VRB03KT P6SM SCT025 BKN050=

The KTUS forecast expected wind from 330° at 6 knots, greater than 6 miles visibility, light rain, scattered clouds at 600 feet agl, and an overcast ceiling at 1,200 feet agl. Temporary conditions between 1700 and 2000 MST of 4 miles visibility, light rain, mist, and a broken ceiling at 600 feet agl was forecast.

The KTUS TAF issued at 1513 MST was the valid TAF before the approximate 1540 to 1550 MST takeoff time:

TAF AMD KTUS 312213Z 3122/0118 **32008KT P6SM -RA SCT006 OVC015**
TEMPO 3122/0102 5SM -RA BR BKN006
FM010200 26008KT P6SM -SHRA SCT008 OVC020
FM010800 17006KT P6SM SCT020 BKN040
FM011600 VRB03KT P6SM SCT025 BKN050=

The 1513 MST KTUS TAF expected wind from 320° at 8 knots, greater than 6 miles visibility, light rain, scattered clouds at 600 feet agl, and an overcast ceiling at 1,500 feet agl. Temporary conditions between 1500 and 1900 MST of 5 miles visibility, light rain, mist, and a broken ceiling at 600 feet agl was forecast.

12.0 National Weather Service Area Forecast Discussion

The National Weather Service Office in Tucson, Arizona, issued an Area Forecast Discussion (AFD) at 1423 MST. The aviation section of the AFD mentioned IFR conditions developing due to lowering ceilings and precipitation from KTUS eastward starting around 1800 MST. The aviation section of the AFD also mentioned the gusty southwest wind ahead of the front with gusts to 35 knots:

FXUS65 KTWC 312123
AFDTWC
AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE TUCSON AZ
223 PM MST WED DEC 31 2014
.SYNOPSIS...GUSTY WINDS HAVE DEVELOPED TODAY AHEAD OF A STRONG WINTER STORM. RAIN AND SNOW WILL SPREAD IN FROM THE WEST THROUGH THURSDAY MORNING. SNOW LEVELS WILL FALL TO NEAR VALLEY FLOORS IN SOME LOCATIONS TONIGHT. ELEVATIONS ABOVE 4000 FEET CAN EXPECT ACCUMULATING SNOW BY THURSDAY MORNING WITH SIGNIFICANT SNOW IN THE MOUNTAINS. EXPECT PARTIAL CLEARING THURSDAY BEFORE A SECONDARY DISTURBANCE RESULTS IN A FEW SNOW SHOWERS THURSDAY NIGHT INTO FRIDAY MORNING. ANOTHER HARD FREEZE APPEARS INCREASINGLY LIKELY FOR THE TUCSON METRO AREA THURSDAY NIGHT AND FRIDAY NIGHT. COLD AND DRY TO START THE WEEKEND WITH A WARMING TREND BY EARLY NEXT WEEK.
&&
.DISCUSSION...WATER VAPOR IMAGERY SHOWS THE UPPER LOW SPINNING OVER SOUTHERN CALIFORNIA AND WESTERN ARIZONA AT THIS TIME. IR IMAGERY SHOWS EXTENSIVE CLOUDINESS ASSOCIATED WITH THIS SYSTEM COVERING MUCH OF THE SOUTHWESTERN STATES...AS WELL AS NORTHERN MEXICO. CLOUDS HAVE BEEN THICKENING AND LOWERING DURING THE PAST COUPLE OF HOURS AND WILL CONTINUE TO DETERIORATE THROUGHOUT THE EVENING AND OVERNIGHT. RADAR MOSAIC FROM AROUND THE REGION IS SHOWING A BAND OF SHOWERS THAT EXTENDS FROM THE EASTERN PORTIONS OF THE PHOENIX METRO AND INTO CENTRAL PINAL COUNTY AND JUST TO THE WEST OF THE TUCSON METRO AREA. THESE SHOWERS THEN EXTEND TO SOUTHWEST OF GREEN VALLEY. ALL OF THIS ACTIVITY WILL MOVE EAST THROUGH THE REMAINDER OF THE AFTERNOON AND INTO THE EVENING HOURS...WITH ACTIVITY GRADUALLY TAPERING OFF DURING THE OVERNIGHT HOURS AND EARLY IN THE DAY ON THURSDAY FROM WEST TO EAST.
THE LATEST SATELLITE DERIVED BLENDED TOTAL PRECIPITABLE WATER IMAGERY SHOWS PW VALUES OF AROUND 0.50 - 0.60 INCHES JUST SOUTH OF THE BORDER AT THIS TIME. LATEST OBSERVATIONS SHOW THE WINDS HAVE KICKED UP ACROSS MUCH OF THE FORECAST AREA...WITH SUSTAINED WINDS OF 20 TO 30 MPH WITH GUSTS OF AROUND 30 TO 40+ MPH. AS THESE WINDS CONTINUE... FROM THE SURFACE AND ALOFT...THE MOISTURE TO OUR SOUTH WILL BE CONTINUE TO BE TRANSPORTED NORTHWARD WITH SATURATION OCCURRING LATER THIS AFTERNOON AND INTO THE EVENING.
SNOW LEVELS ACROSS MY FORECAST AREA WILL CONTINUE TO FALL AS THE CENTER OF THE LOW PRESSURE SYSTEM PASSES BY TO OUR NORTH THROUGH EARLY THURSDAY...WITH SNOW LEVELS FALLING TO AROUND 3500 FEET BY LATE THIS EVENING AND AROUND 3000 FEET BY EARLY THURSDAY MORNING. INHERITED WINTER WEATHER WARNINGS AND ADVISORIES CONTINUE TO LOOK GOOD...SO NO CHANGES PLANNED AT THIS TIME.
THE NEXT AREA OF CONCERN WILL BE SUB-FREEZING LOW TEMPS FRIDAY AND SATURDAY MORNINGS...WHEN LOW TEMPS ARE EXPECTED TO BE IN THE MID 20S TO NEAR 30 FOR MUCH OF THE TUCSON METRO AND INTO CENTRAL PIMA COUNTY AND SOUTHEAST PINAL COUNTY. AFTER INSPECTION OF 12Z MOS LOW TEMP NUMBERS FOR FRIDAY AND SATURDAY MORNINGS...DECIDED TO GO WITH A HARD FREEZE WATCH FOR SOUTHEAST PINAL COUNTY...CENTRAL AND EASTERN PORTIONS OF PIMA COUNTY FRIDAY MORNING...THEN JUST FOR EASTERN PORTIONS OF PIMA COUNTY AND EASTERN PINAL COUNTY FOR SATURDAY MORNING SINCE THE LOWS WILL BE SLIGHTLY WARMER SATURDAY MORNING COMPARED TO FRIDAY...AND AREAL COVERAGE OF TEMPS AT OR BELOW 27 DEGS F WILL BE SMALLER.

AS THE LOW BEGINS TO EJECT TO THE EAST LATE THURSDAY INTO FRIDAY...
LINGERING MOISTURE AND COLD AIR WILL JUSTIFY KEEPING A WINTER
WEATHER ADVISORY FOR THE MOUNTAINS OF GRAHAM AND GREENLEE COUNTIES
AND FOR THE SANTA CATALINA AND RINCON MOUNTAINS OF EASTERN PIMA
COUNTY THROUGH LATE THURSDAY AFTERNOON. THE LOW WILL BE FAR ENOUGH
TO OUR EAST BY LATE FRIDAY/EARLY SATURDAY TO RESULT IN A RETURN TO
DRY CONDITIONS THROUGH THE REMAINDER OF THE FORECAST PERIOD WITH A
WARMING TREND BEGINNING EARLY NEXT WEEK.
&&
.AVIATION...VALID THRU 01/12Z.
MVFR WITH POSSIBLE IFR CONDITIONS DEVELOPING DUE TO LOWERING CEILINGS AND SHOWERS...FIRST AT KTUS/KOLS TERMINALS AND THEN AT KDUG AROUND 01/01Z. THE HIGHER TERRAIN WILL SEE SIGNIFICANT REDUCTIONS IN VISIBILITY DUE TO RAIN AND SNOW SHOWERS. SOME PARTIAL CLEARING IS
THEN EXPECTED FROM WEST TO EAST TOMORROW MORNING.
WINDS AHEAD OF THE FRONTAL BOUNDARY WILL GENERALLY BE OUT OF THE SOUTHWEST AT 15 TO 25 KTS WITH GUSTS NEAR 35 KTS WITH THE HIGHEST WIND SPEEDS IN AND AROUND THE KOLS/KDUG TERMINALS. WINDS WILL THEN SHIFT TO A MORE WESTERLY DIRECTION BEHIND THE COLD FRONT. WIND SPEEDS WILL REMAIN ELEVATED OVERNIGHT AT KDUG WHILE RELAXING TO 10 TO 15 KTS AT KTUS/KOLS AFTER 01/07Z. AVIATION DISCUSSION NOT
UPDATED FOR TAF AMENDMENTS.
&&
.FIRE WEATHER...A WINTER STORM WILL SPREAD SHOWERS ACROSS THE AREA
THIS AFTERNOON AND EVENING WITH BREEZY CONDITIONS THROUGH AT LEAST
THIS EVENING. SNOW LEVELS AT THE START OF THE PRECIPITATION WILL BE
NEAR 6000 FT THEN DROP TO 3-4000 FT BY THURSDAY MORNING AS THE
PRECIPITATION IS TAPERING OFF. THURSDAY THROUGH EARLY FRIDAY WILL
BE MUCH COLDER THAN NORMAL WITH A FEW SCATTERED SHOWERS AROUND...IN
THE FORM OF SNOW ABOVE ABOUT 3000 FT. THEREAFTER...THE WEEKEND WILL
BE DRY AND COLDER THAN NORMAL BUT WITH TEMPERATURES SLOWLY
MODERATING THROUGH MONDAY.
&&
.TWC WATCHES/WARNINGS/ADVISORIES...
WINTER STORM WARNING UNTIL 11 AM MST THURSDAY FOR AZZ510-511-514.
WINTER STORM WARNING FROM 5 PM TODAY TO 11 AM MST THURSDAY FOR AZZ506-509 ABOVE 4000 FEET.
WINTER WEATHER ADVISORY FROM 5 PM TODAY TO 11 AM MST THURSDAY FOR AZZ512-513.
WINTER WEATHER ADVISORY FROM LATE THURSDAY MORNING THROUGH THURSDAY AFTERNOON FOR AZZ510-511-514.
HARD FREEZE WATCH FROM LATE THURSDAY NIGHT THROUGH FRIDAY MORNING FOR AZZ502-504>506.
HARD FREEZE WATCH FROM LATE FRIDAY NIGHT THROUGH SATURDAY MORNING FOR AZZ504-506.
&&
$$

13.0 Pilot Weather Briefing

The accident pilot did not receive an official weather briefing from Lockheed Martin Flight Service (LMFS) or any other official source. There is no knowledge of any additional weather briefing information the accident pilot received.

14.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for the accident site on December 31, 2014, indicated the following:

SUN	
Begin civil twilight	0655 MST
Sunrise	0722 MST
Sun transit	1225 MST
Sunset	1728 MST
End civil twilight	1755 MST

F. LIST OF ATTACHMENTS

None.

Paul Suffern
NTSB, AS-30