National Transportation Safety Board

Office of Aviation Safety

Washington, D.C. 20594-2000

April 26, 2011

WEATHER STUDY

WPR11GA115

A. ACCIDENT

Location: Marana, Arizona
Date: January 31, 2011
Time: About 1115 mountain standard time (1815 UTC[1])
Aircraft: McDonnell-Douglas 369FF helicopter; registration N530RL

B. METEOROLOGICAL SPECIALIST

Donald Eick
Senior Meteorologist
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Operational Factors Division, AS-30
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C. SUMMARY

On January 31, 2011, about 1115 mountain standard time, a McDonnell-Douglas 369FF helicopter, N530RL, was substantially damaged during an attempted pinnacle landing on Waterman Peak near Marana, Arizona. The pilot received fatal injuries, two passengers received serious injuries, and one passenger received minor injuries. The public-use flight was operated by the Pima County Sheriff's Department (PCSD) in support of the Pima County Wireless Integrated Network (PCWIN) communications development project. Visual meteorological conditions prevailed, and no flight plan was filed for the flight.

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

D. DETAILS OF INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist was not on scene for this investigation and gathered all the weather data for this investigation from the Washington D.C. office from official National Weather Service (NWS) sources including the National Climatic Data Center (NCDC). All times are mountain standard time (MST) based upon the 24 hour clock, local time is +7 hours to UTC, and UTC=Z. 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 site was located at latitude 32° 21.08' North and longitude 111° 28.34' West at an elevation of approximately 3,600 feet and north of the peak of Mount Waterman.

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) located in Camp Springs, 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 00-45.

1.0.1 Surface Analysis Chart

The NWS Surface Analysis Chart for 1100 MST (1800Z) on January 31, 2011 is provided as figure 1, with the approximate location of the accident site marked. The chart depicted a low pressure system at 1006-hectopascals (hPa) over northeast New Mexico with a station front extending north and south from the low. A second low pressure system was located over southwestern New Mexico at 1007-hPa with a trough of low pressure extending northward towards the other low pressure system. A cold core high pressure system at 1014-hPa was located near the four corners area between Colorado and the New Mexico border in an area of light to moderate snow. Another high pressure system was located over central California at 1027-hPa. No defined surface boundaries were identified in the vicinity of the accident site.

The station models surrounding the accident site indicated a general westerly wind at approximately 10 knots with winds varying from the west-southwest to the west-northwest, scattered clouds, temperature in the low 50's (degrees Fahrenheit (F)), with dewpoint temperatures in the mid 30's to low 40's.

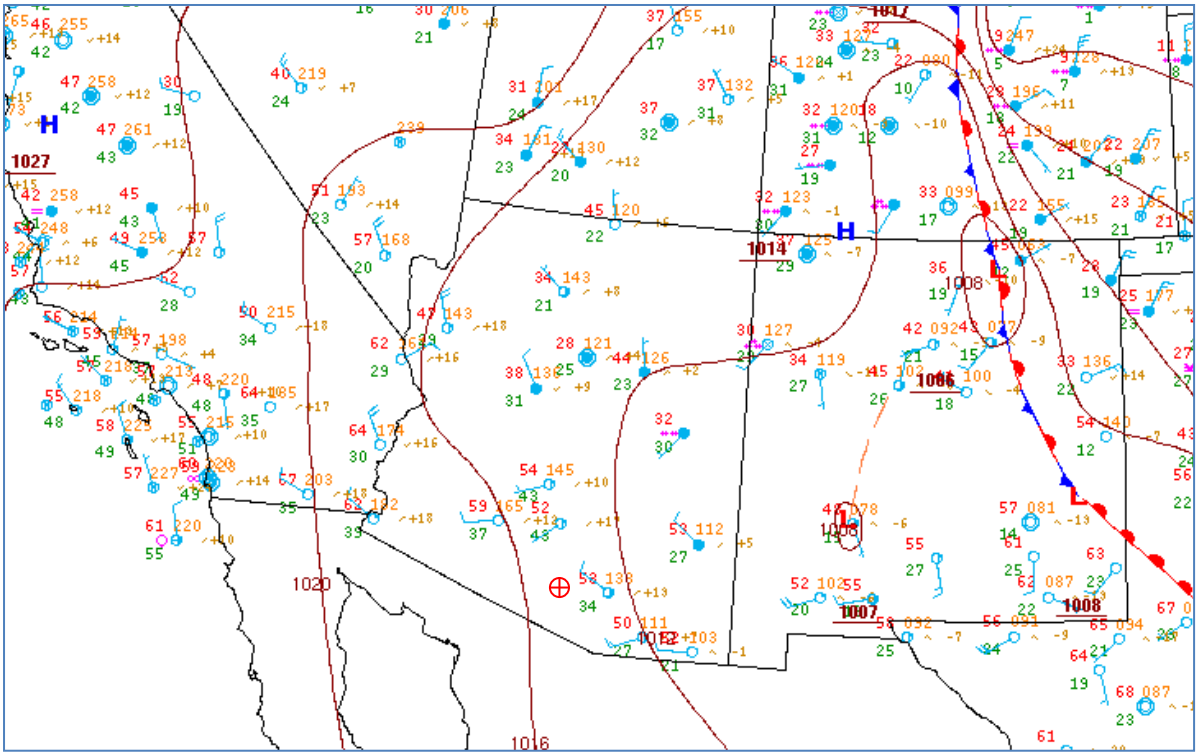


Figure 1 – NWS Surface Analysis Chart for 1100 MST

1.0.2 Constant Pressure Charts

The southwest section of the NWS 500-hPa Constant Pressure Chart for 0500 MDT (1200Z) on January 31, 2011 is included as figure 2. The chart depicted a long wave trough of low pressure extending southwestward from Utah through Arizona and southern California, which supported rising motion, clouds and moisture advection into eastern Arizona and western New Mexico.

The station model for Tucson indicated west-southwesterly wind of 55 knots at approximately 18,000 feet suggesting jet stream strength winds, a temperature of -55 Celsius (C), with a 100 meter height fall within the last 12-hours.

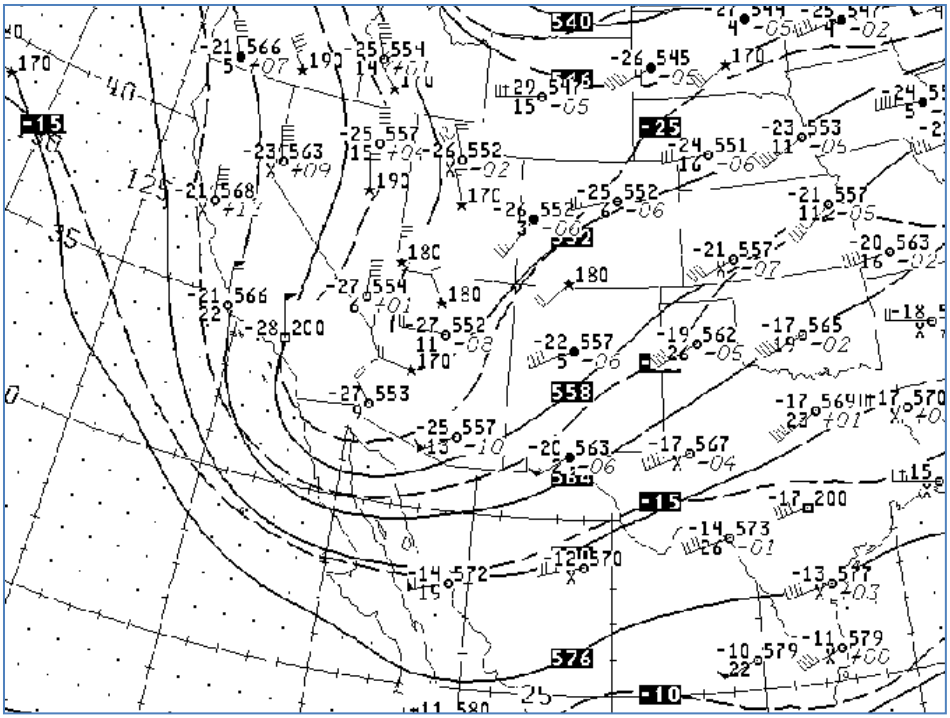


Figure 2 – 500-hPa Constant Pressure System for 0500 MST

1.0.3 Convective Outlook

The NWS Storm Prediction Center's Convective Outlook issued at 0916 MST is included as figure 3 depicting the expected location and intensity of organized convective activity for the next 24-hours over the United States. The chart depicted a risk of general air mass type thunderstorms over eastern Arizona and a large portion of New Mexico. The only potential for organized severe storms was over central Texas where a slight risk of severe thunderstorms was identified.

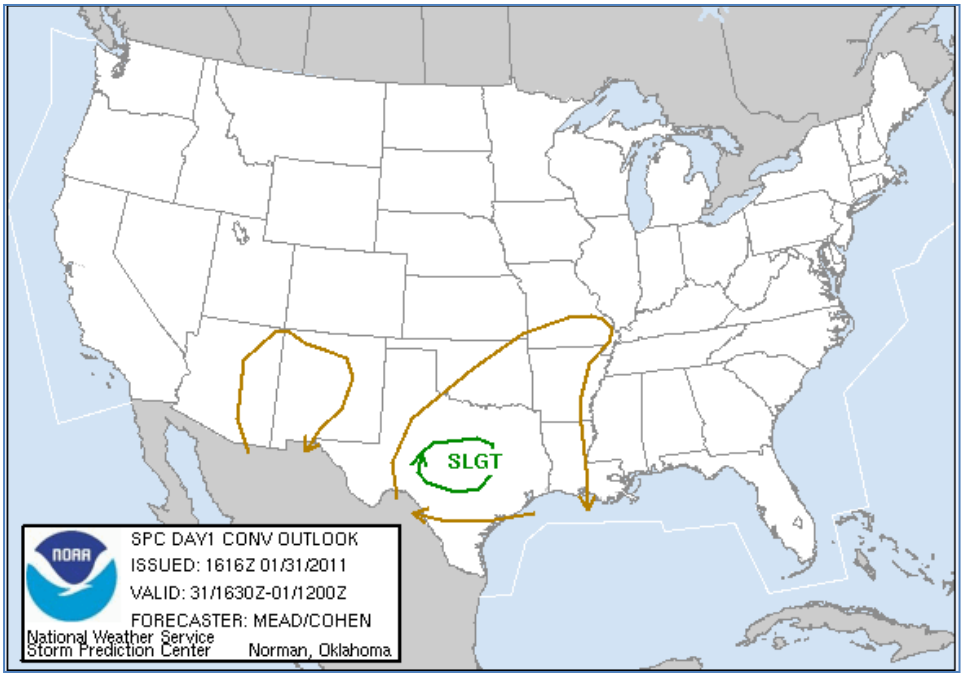


Figure 3 – Convective Outlook for 0916 MST

SPC AC 311616

DAY 1 CONVECTIVE OUTLOOK
NWS STORM PREDICTION CENTER NORMAN OK
1016 AM CST MON JAN 31 2011

VALID 311630Z - 011200Z

...THERE IS A SLGT RISK OF SVR TSTMS TONIGHT OVER CNTRL TX...

...TX...

INTENSE MIDLEVEL TROUGH/PV ANOMALY DIGGING SEWD THROUGH THE LOWER CO VALLEY INTO BAJA/GULF OF CA THIS MORNING WILL REACH ITS LOWEST LATITUDE OVER NWRN MEXICO TONIGHT PRIOR TO LIFTING ENEWD THROUGH WRN TX BY 01/12Z. AT THE SURFACE...A REINFORCING SURGE OF CP AIR OVER THE CNTRL PLAINS WILL PROGRESS SWD THROUGH THE SRN HIGH PLAINS...LIKELY SERVING AS THE FOCUS FOR STRONG TO SEVERE TSTM DEVELOPMENT TONIGHT INTO TUE MORNING.

12Z REGIONAL SOUNDINGS INDICATE THE PRESENCE OF A SHALLOW...MOIST BOUNDARY LAYER OVER S TX...CHARACTERIZED BY DEW POINTS IN THE LOWER/MID 60S AND LOWEST 100-MB MEAN MIXING RATIOS OF 10-12 G/KG. RELATIVELY WARM MIDLEVEL THERMAL PROFILES AND A RESULTING CAP ARE EXPECTED TO INHIBIT THE DEVELOPMENT OF DEEP...MOIST CONVECTION THROUGH THE DIURNAL HEATING CYCLE.

BY TONIGHT...LOW-LEVEL MASS RESPONSE TO THE APPROACH OF ABOVE-MENTIONED MIDLEVEL SYSTEM WILL RESULT IN THE NWWD ADVECTION OF THE MOIST BOUNDARY LAYER INTO CNTRL TX. THIS PROCESS WILL OCCUR BENEATH THE EWD ADVECTION OF A STEEP MIDLEVEL LAPSE RATE PLUME OFF THE MEXICO PLATEAU WITH ENVIRONMENT BECOMING MODERATELY UNSTABLE

/I.E. MUCAPE OF AROUND 1000 J PER KG/ FOR PARCELS BASED ABOVE A STABLE NEAR-SURFACE INVERSION. STRONG LOW-LEVEL CONVERGENCE ALONG THE INTENSIFYING COLD FRONT COUPLED WITH INCREASING DCVA SHOULD SUPPORT THE DEVELOPMENT OF MAINLY POST-FRONTAL...ELEVATED TSTMS OVER PORTIONS OF W-CNTRL TX BETWEEN 01/03-06Z WITH THE PRIMARY HAZARD BEING SEVERE HAIL. TSTMS MAY TEND TO ORGANIZE INTO A QLCS LATE TONIGHT ALONG OR PERHAPS IN IMMEDIATE WAKE OF COLD FRONT OVER CNTRL TX WITH A CONTINUED RISK FOR HAIL AND PERHAPS LOCALLY DAMAGING WIND GUSTS.

..MEAD/COHEN.. 01/31/2011

2.0 Surface Observations

The closest weather reporting stations surrounding the accident site were documented utilizing standard Meteorological Aerodrome Reports (METARs) and special reports (SPECIs). Cloud heights in the following section are reported above ground level (agl).

The closest station to the accident site was Ryan Field Airport (KRYN), located 19 miles southeast of the accident site and 10 miles southwest of the city of Tucson at an elevation of 2,417 feet. The airport had an Automated Weather Observation System (AWOS-3) and reported the following conditions surrounding the period:

METAR KRYN 311745Z 09011G16KT 10SM FEW075 SCT090 13/01 A3000

Accident 1815Z

METAR KRYN 311945Z 28009KT 10SM FEW055 SCT070 11/03 A2999=

METAR KRYN 312045Z 32011G18KT 10SM FEW080 12/03 A2996=

Surrounding the period of the accident, VFR conditions were reported with visibility unrestricted at 10 miles and a few clouds between 5,500 to 7,500 feet. At 1045 (1745Z) KRYN reported an easterly wind from 090° at 11 knots gusting to 16 knots with a shift in the wind by 1245 (1945Z) to the west or 280° at 9 knots and with a 2° Celsius (C) drop in temperature and an increase in dew point temperature. By 1345 MST (2045Z) wind veered 40° to the northwest or from 320° at 11 knots gusting to 18 knots.

The next closest station was from Tucson International Airport (KTUS) located approximately 30 miles southeast of the accident site at an elevation of 2,643 feet. The airport had an Automated Surface Observation System (ASOS) and reported the following conditions surrounding the period:

METAR KTUS 311653Z 31006KT 10SM SCT060 BKN070 BKN090 11/02 A3000 RMK AO2 SLP137 T01060017

METAR KTUS 311753Z 30009G16KT 10SM BKN070 12/01 A3000 RMK AO2 SLP138 T01170011 10122 20089 51013

Accident 1815Z

METAR KTUS 311853Z 31018G24KT 10SM SCT042 SCT065 BKN080 12/02 A2999 RMK AO2 LTG DSNT S SLP136 T01170017

METAR KTUS 311953Z 34008KT 10SM FEW060 SCT080 BKN095 11/03 A2998 RMK AO2 LTG DSNT S SLP133 T01060028

METAR KTUS 312053Z 29014G19KT 10SM CLR 13/01 A2996 RMK AO2 SLP125 T01280006 58013

METAR KTUS 312153Z 27015KT 10SM FEW047 BKN080 OVC100 13/01 A2995 RMK AO2 SLP121 T01330006

At 1053 MST Tucson reported wind from 300° at 9 knots gusting to 16 knots, visibility 10 miles, ceiling broken at 7,000 feet, temperature 12° C, dew point 1° C, altimeter 30.00 inches of mercury (Hg). The next scheduled observation at 1153 MST reported wind gusting to 24 knots with lightning in the distant south.

Davis Monthan Air Force Base (KDMA) located 4 miles northeast of KTUS and 32 miles southeast of the accident site at 2,704 feet reported the following conditions:

METAR KDMA 311655Z AUTO 27008KT 10SM SCT065 BKN085 10/02 A2997 RMK AO2 RAB1630E1640 SLP140 P0000 T01010020 $

METAR KDMA 311755Z AUTO 29010KT 260V330 10SM SCT060 OVC085 12/01 A2998 RMK AO2 CIG 060 RWY12 SLP143 60000 T01170013 10117 20081 51014 $

SPECI KDMA 311807Z AUTO 30011G14KT 10SM -DZ BKN060 OVC080 11/01 A2999 RMK AO2 DZB1807 SLP144 $

SPECI KDMA 311815Z AUTO 30009KT 10SM FEW041 BKN060 OVC080 11/01 A2998 RMK AO2 DZB1807E1815 SLP139 $

SPECI KDMA 311827Z AUTO 31010KT 9SM -RA SCT039 BKN055 OVC070 11/01 A2998 RMK AO2 RAB1827DZB1807E1815 SLP139 $

SPECI KDMA 311842Z AUTO 32009KT 10SM FEW029 SCT039 BKN050 BKN060 OVC075 10/03 A2998 RMK AO2 LTG DSNT SW RAB1827E1842DZB1807E1815 CIG 042 RWY12 SLP140 $

METAR KDMA 311855Z AUTO 34014KT 10SM FEW029 BKN038 BKN048 OVC060 11/03 A2997 RMK AO2 RAB1827E1842DZB1807E1815 SLP135 P0000 T01110031 $

SPECI KDMA 311906Z AUTO 32020G29KT 10SM -RA FEW027 OVC037 10/03 A2998 RMK AO2 PK WND 32029/1905 LTG DSNT S AND SW RAB1906 SLP142 $

SPECI KDMA 311943Z AUTO 34011KT 10SM FEW011 SCT040 BKN090 08/05 A2997 RMK AO2 PK WND 32029/1905 RAB1906E1943 SLP140 $

METAR KDMA 311955Z AUTO 34010KT 10SM FEW011 SCT080 BKN095 09/04 A2996 RMK AO2 PK WND 32029/1905 RAB1906E1943 SLP139 P0000 T00870038 $

METAR KDMA 312055Z AUTO 32006KT 10SM SCT041 12/01 A2994 RMK AO2 SLP128 60000 T01200012 58015 $

SPECI KDMA 312139Z AUTO 32014G26KT 10SM -DZ BKN047 BKN060 BKN075 12/01 A2993 RMK AO2 PK WND 30026/2131 DZB2139 SLP124 $

At the time of the accident at 1115 MST, Davis Monthan Air Force Base reported wind from 300 at 9 knots, visibility 10 miles, a few clouds at 4,100 feet, ceiling broken at 6,000 feet, overcast at 8,000 feet, temperature 11 C, dew point 1 C, with an altimeter 29.98 inches of Hg. Remarks: automated observation system, drizzle began at 1107 and ended at 1115 MST, sea level pressure 1013.9-hPa, maintenance indicator.

Lightning was also reported in the distant south and southwest after the accident with peak wind gusts to 29 knots, and light rain showers.

No other remote weather stations were identified in the area of the accident.

3.0 Upper Air Data

The NWS Tucson (KTUS) upper air sounding or rawinsonde observation (RAOB), site number 72274 closest to the time of the accident was documented. The 0500 MST sounding on January 31, 2011 from KTUS was plotted on a standard Skew-T log P diagram[2] utilizing RAOB[3] software from the surface to 18,000 feet and is included as figure 4. The sounding depicted a dry low-level environment with the lifted condensation level (LCL)[4] at 5,313 feet agl and a convective condensation level (CCL)[5] at 10,717 feet agl. The freezing level was identified at 4,866 feet agl (7,422 feet msl). The sounding had a relative humidity of 75 percent or more between 11,000 and 17,000 feet. The sounding had a precipitable water value of 0.36 inches.

[2] 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.

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

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

[5] Convective Condensation Level (CCL) - The height to which a parcel of air, if heated sufficiently from below, will rise adiabatically until condensation starts. This is typically used to identify the base of cumuliform clouds, which are normally produced from surface heating and thermal convection.

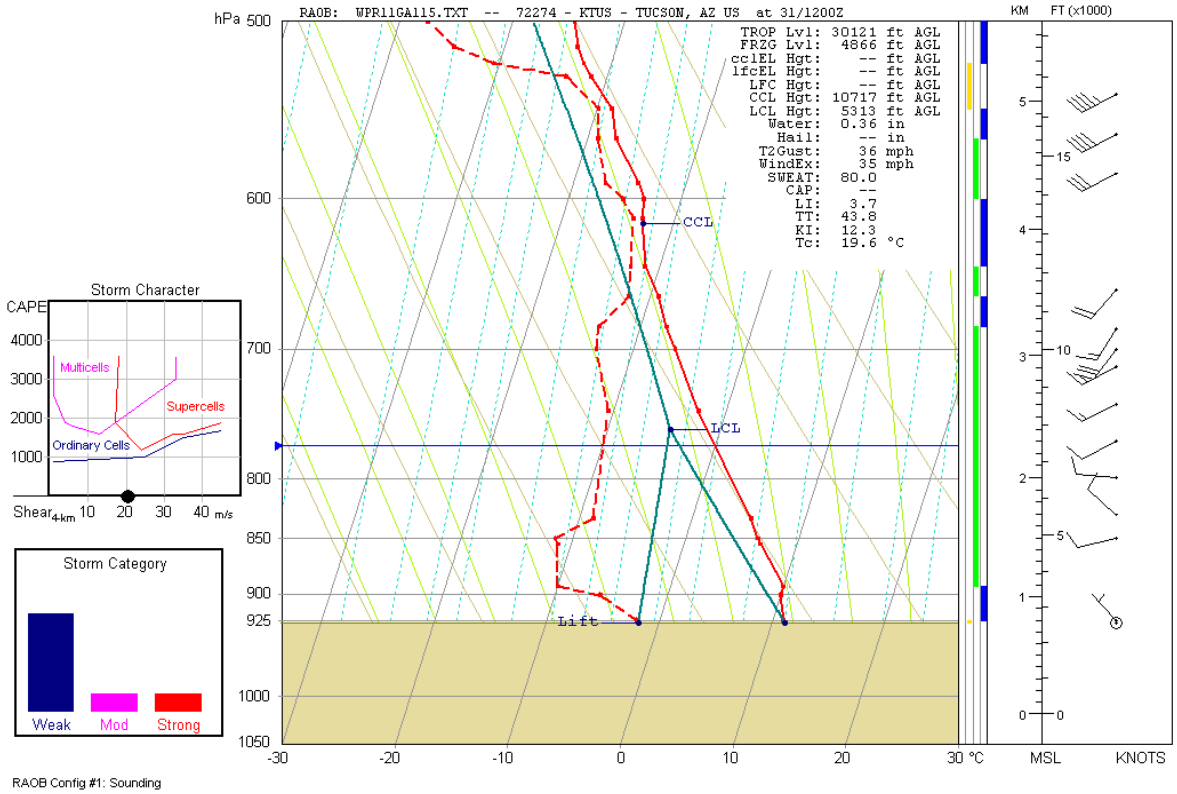


Figure 4 –KTUS 0500 MST sounding

The sounding depicted a conditionally unstable atmosphere below 15,000 feet indicated by a green bar on the right side of the chart with the Lifted Index (LI)[6] of 3.7 indicating a more conditionally stable atmosphere supporting a weak support for thunderstorms. The sounding indicated a potential for microburst and strong outflow winds from any potential convection by the Windex values of 30 knots (35 mph) and T2 Gust value of 31 knots (36 mph). This was verified by a peak wind of 29 knots at KDMA after the accident and while precipitation was reported and lightning activity.

The sounding wind profile indicated calm surface wind with wind direct from the west and southwest with height. The mean cloud layer wind flow was from 242° at 46 knots, and the mean 0 to 6 kilometer wind was from 239° at 30 knots. The following table is the observed elements from the sounding.

[6] 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 some higher level (around 18,000 feet, usually) 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.

Height (ft-MSL)	Pres (hPa)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (FAA)	LLWS	Icing - Type (AF @ 75% RH)
2556	927.0	11.2	-1.8	40	0 / 0	MDT		
2615	925.0	11.0	-2.0	40	320 / 6			
3333	901.0	10.0	-6.0	32				
3576	893.0	10.0	-10.0	23				
4754	855.0	6.8	-11.2	26		LGT		
4912	850.0	6.4	-11.6	26	255 / 12			
5454	833.0	5.2	-8.8	36		SVR		
5556	829.8				315 / 10	MDT		
6556	799.0				275 / 12	MDT		
7556	769.3				240 / 12			
8368	746.0	-2.5	-10.5	54				
8556	740.6				240 / 14			
9556	712.5				240 / 15	XTR		
10014	700.0	-6.3	-13.3	58	215 / 29	SVR		
10556	685.3				210 / 17			
10606	684.0	-7.7	-13.7	62				Base:670 mb
11400	663.0	-9.3	-11.9	81		LGT		TRC Rime

Table 1 – sounding parameters

The North American Mesoscale (NAM) Model for 1100 MST (1800Z) plotted on similar Skew-T log P diagram is included as figure 5 for KTUS. The model conditioned to depict the LCL near 5,052 feet agl. The sounding had a Lifted Index of -0.7 and indicated a more unstable atmosphere and supported strong outflow winds.

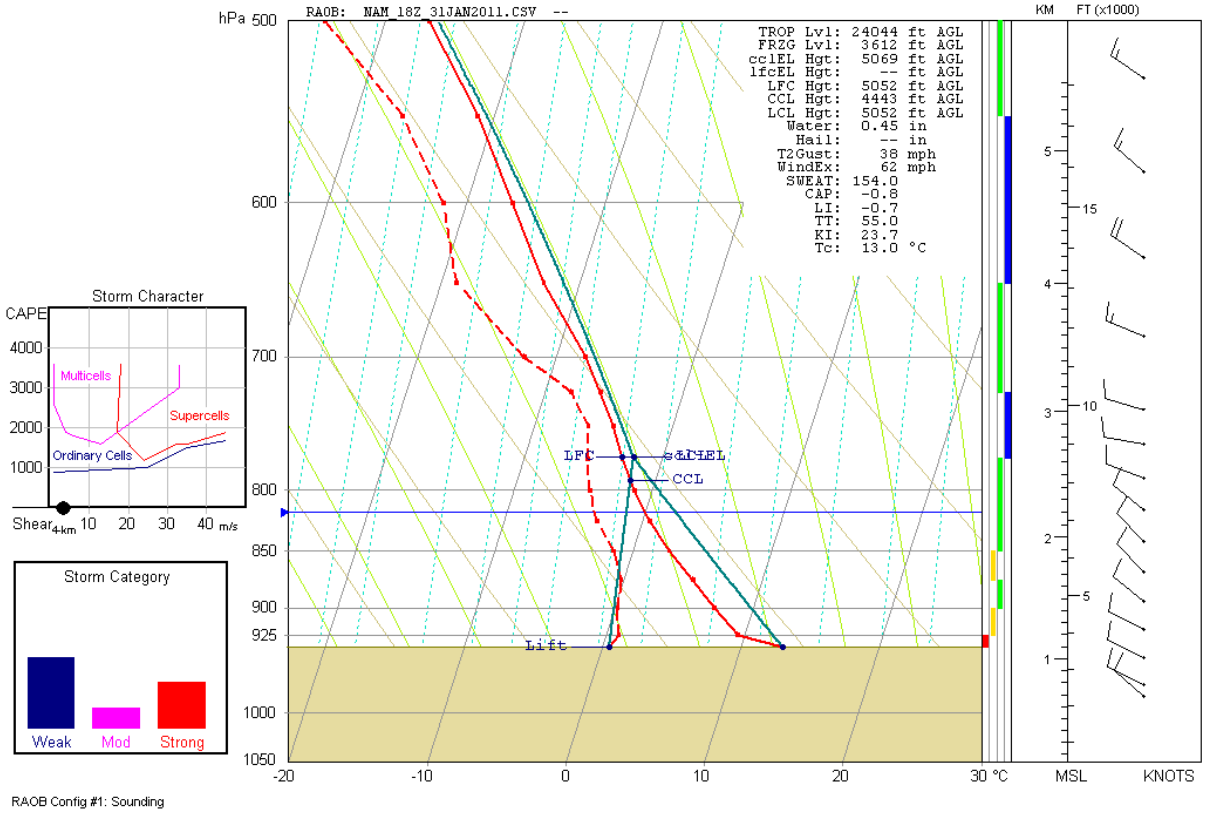


Figure 5 – KTUS NAM model sounding for 1100 MST

4.0 Satellite Data

The Geostationary Operational Environmental Satellite number 11 (GOES-11) data was obtained and displayed from the National Transportation Safety Board's Man-computer Interactive Data Access System (McIDAS) workstation. Both visible and infrared imagery was obtained surrounding the time of the accident. The infrared imagery (band 4) at a wavelength of 10.7 microns (μm) provided a 4-kilometer (km) resolution with radiative cloud top temperatures. The visible imagery (band 1) at a wavelength of 0.65 μm provided a resolution of 1 km.

The GOES-11 visible image at 1100 MST (1800Z) is included as figure 6 at 2X magnification. The image depicts the accident site under the western portion of a band of clouds, which show several embedded cumulus congestus type clouds in the larger stratocumulus cloud layer. The cloud layer is also casting a shadow on the surface below and west of the accident site. The infrared image for the same period depicted a radiative cloud top temperature of 251° kelvin (k), which corresponded to cloud tops of 17,500 feet over the accident site with higher tops to 24,000 feet to the east.

Figure 7 is the next available GOES-11 visible image at 1130 MST (1830Z), which shows the band of clouds having moved eastward with several well defined cumulus congestus to cumulonimbus cloud tops immediately downwind or east of the accident site. Several single cell cumulonimbus clouds are identified half way between the accident site and the Tucson, and north and south of the area. In the vicinity of the accident site there was an abrupt clearing of the clouds with a small band of arch or roll clouds south of the accident site running west-to-east, suggesting an outflow of wind at low-levels from the north immediately above the surface.

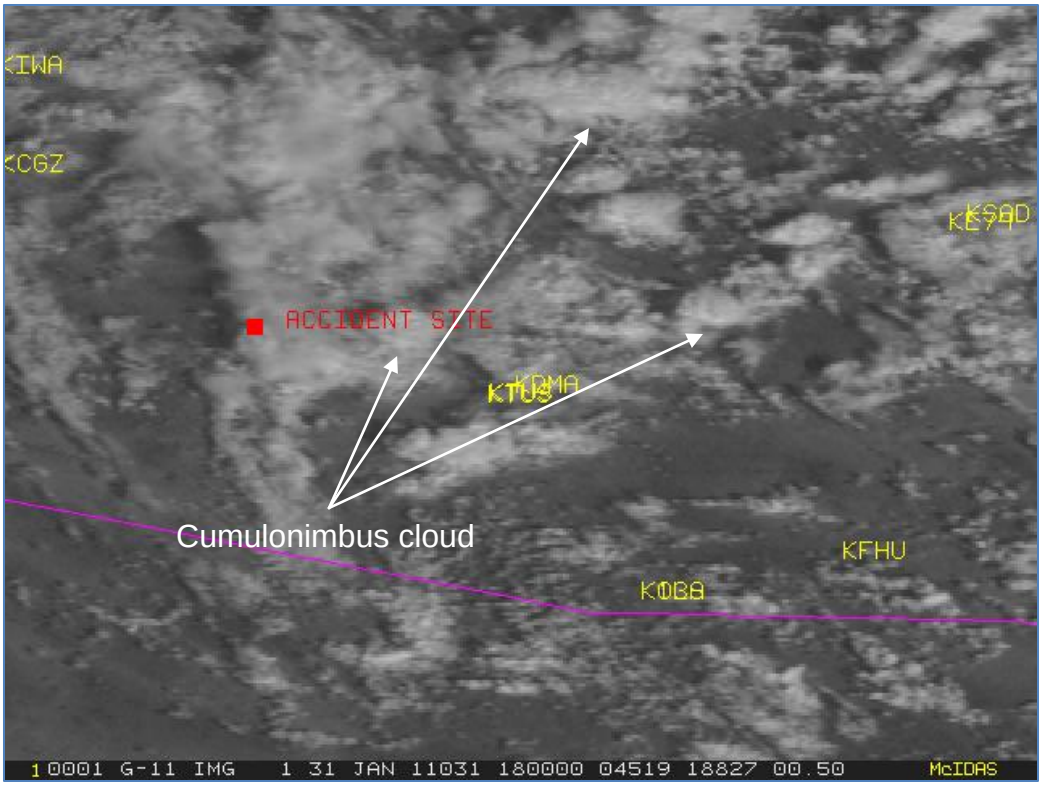


Figure 6 – GOES-11 visible image at 1100 MST

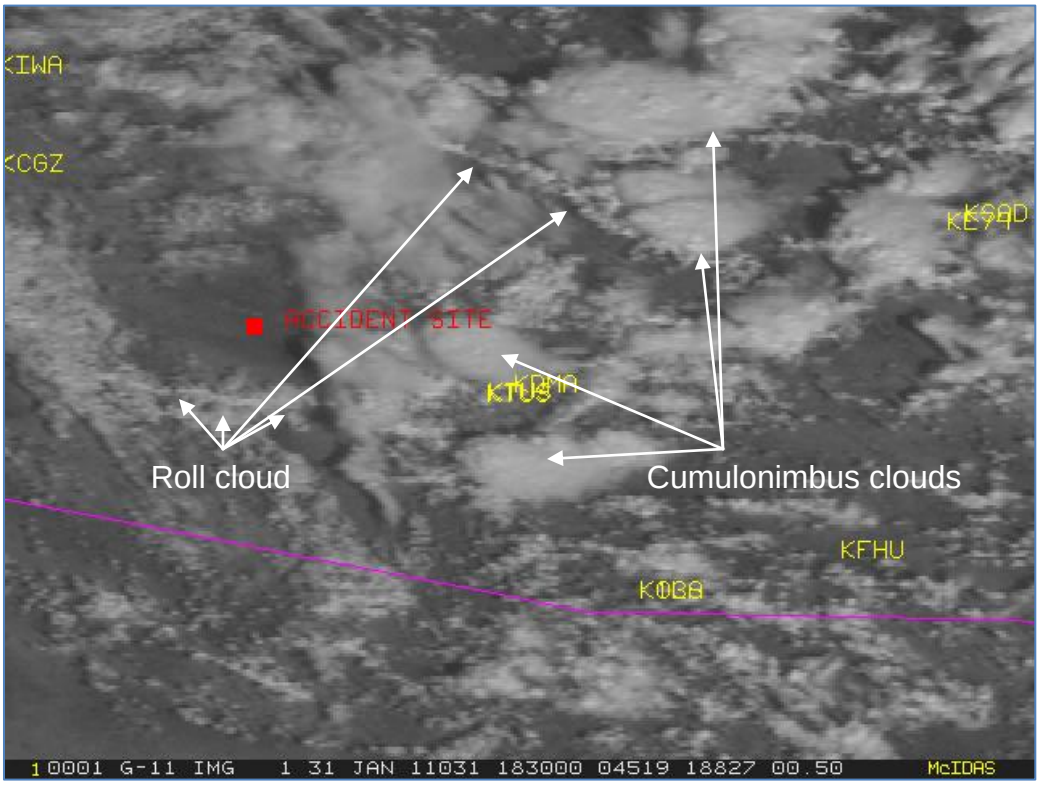


Figure 7 – GOES-11 visible image at 1130 MST

5.0 Weather Radar Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D) to the accident was the Tucson (KEMX[7]), Arizona radar which was located approximately 51 miles southeast of the accident site. The level II archive data was obtained from the National Climatic Data Center (NCDC) utilizing the Hierarchical Data Storage System (HDSS) and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software.

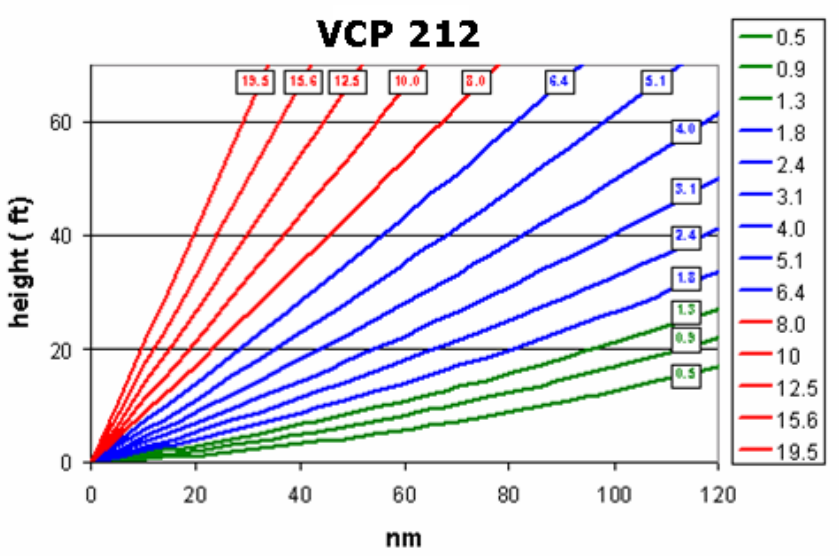
The WSR-88D is an S-band 10 centimeter wavelength radar with a power output of 750,000 watts, with a 28-foot parabolic antenna concentrating the energy into a 0.95-degree beam width. The radar produces three basic types of products reflectivity, radial velocity, and spectral width.

5.0.1 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 six 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 two common scanning strategies. The most common is where the radar makes 9 elevation scans from 0.50° to 19.5° every six minutes. This particular scanning strategy is documented as volume coverage pattern 21 (VCP-21). 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 severe weather precipitation mode (Mode A, VCP-212), where the radar made 14 elevation scans in 4 1/2 minutes. 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.

[7] The NWS Tucson's weather radar antenna site is identified as KEMX and is not co-located with the Tucson airport (KTUS).



VCP-212 Severe Precipitation Mode Scan Strategy

5.0.2 Beam Height Calculation

Assuming standard refraction[8] of the 0.95° radar beam of the KEMX WSR-88D with an antenna height of 5,317 feet and a distance of 51 miles, the following table shows the approximate beam height and width information 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°	9,740 feet	7,180 feet	12,320 feet	5,140 feet

Based on the radar height calculations, the 0.5° elevation scan depicts the conditions encompassing the altitude from 7,180 to 12,320 feet above the accident site. As a result radial velocity wind data would be of limited value over the accident site.

5.0.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[9] it is a function of the drop size distribution, number of particles per

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

[9] 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

unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in decibels (dBZ[10]), 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	< 5	
	1	5 to 9	
	2	10 to 14	
1	3	15 to 19	.01 in/hr
Very Light	4	20 to 24	.02 in/hr
	5	25 to 29	.04 in/hr
2	6	30 to 34	.09 in/hr
Light to	7	35 to 39	.21 in/hr
Moderate			
3	8	40 to 44	.48 in/hr
Strong			
4	9	45 to 49	1.10 in/hr
Very Strong			
5	10	50 to 54	2.49 in/hr
Intense			
6	11	55 to 59	>5.67 in/hr
Extreme	12	60 to 64	
	13	65 to 69	
	14	70 to 74	
	15	> 75	

The Federal Aviation Administration (FAA) Advisory Circular AC 00-24B titled "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.

Air traffic control (ATC) weather display systems also use radar weather processors with the ability to determine precipitation intensity, with controllers instructed to describe the intensity to pilots based on the following scale:

(a) "Light" (< 30 dBZ)
(b) "Moderate" (30 to 40 dBZ)
(c) "Heavy" (> 40 to 50 dBZ)
(d) "Extreme" (> 50 dBZ)

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glaze ice.

[10] dBZ - 10 log Ze

5.0.4 Base Reflectivity

Figure 8 is the KEMX WSR-88D base reflectivity image for the 0.5° degree elevation scan completed at 1113 MST provided at magnification and with a resolution of 1° X 1 kilometers. The image depicts a north to south band of light intensity echoes moving over the landing site where the accident will occur with several scattered defined very strong to intense echoes associated with convective activity east and south. The echoes likely associated with high based convection with little or no precipitation reaching the ground due to evaporation in the relatively dry low-level environment. The band of echoes moved eastward and dissipated significantly before reaching the Tucson area around 1230 MST. The peak wind of 29 knots reported at KMDA at 1209 corresponded to when the remains of one of the echoes passes near the station. The north to south band of echoes had dissipated and became scattered in nature with no defined organization.

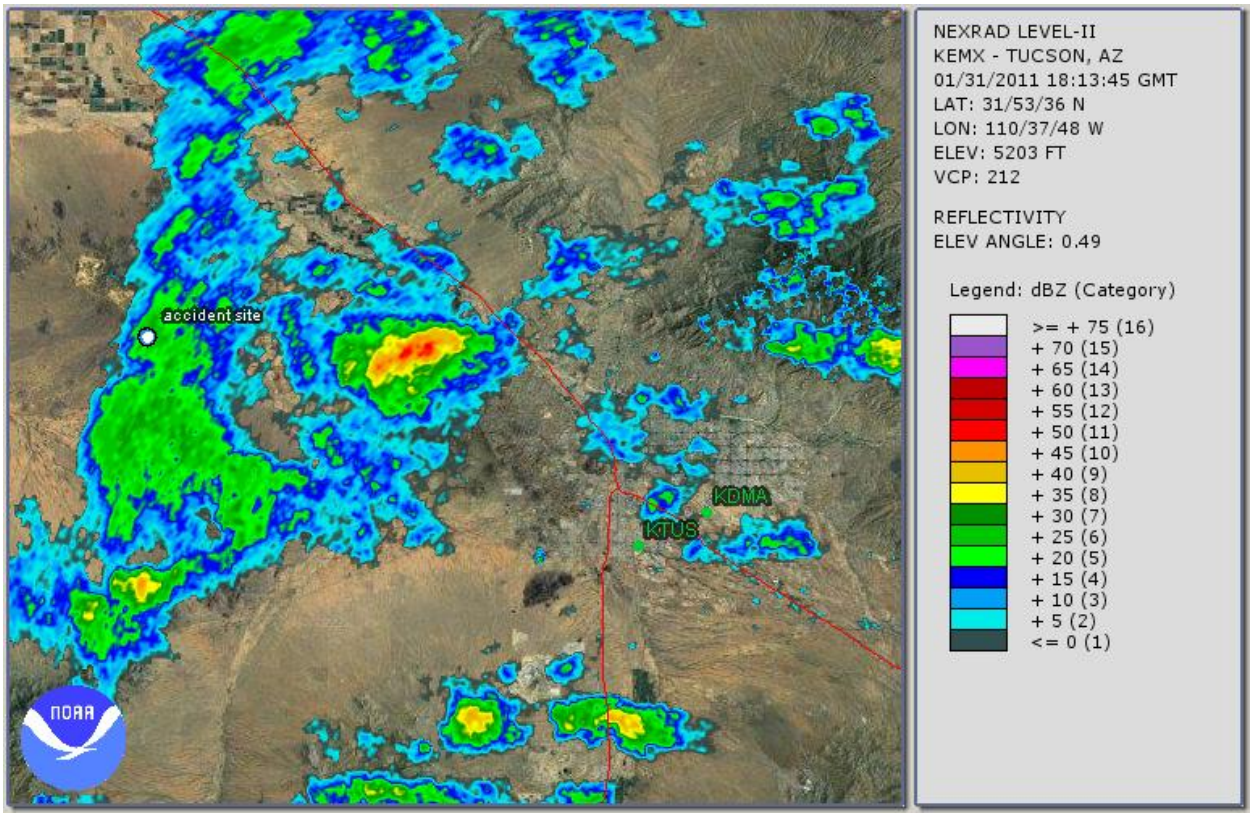

Figure 8 – KEMX WSR-88D 0.5° elevation scan base reflectivity image for 1113 MST

A review of lightning data indicated that the area of stronger reflectivity's located between the accident site and the Tucson area produced cloud-to-ground lightning strikes, but no cloud-to-ground or cloud-to-cloud strikes were identified within 5 miles of the accident site surrounding the period of the accident.

6.0 Area Forecast

The Area Forecast (FA) is a forecast of Visual Flight Rules (VFR) clouds and weather conditions over an area as large as the size of several states. It must be used in conjunction with the AIRMET Sierra (IFR) bulletin for the same area in order to get a complete picture of the weather. The area forecast together with the AIRMET Sierra bulletin are used to determine forecast enroute weather and to interpolate conditions at airports which do not have a terminal forecast (TAF) issued. The NWS Aviation Weather Center (AWC) located in Kansas City, Missouri, issues the FA at regular intervals and issues specials reports as necessary usually in the form of an AIRMET. The region that covers Arizona is under the Salt Lake City (KSLC) regional forecast. The forecast valid for this accident was issued at 0445 MST on January 31, 2011, and was valid until 1700 MST. The forecast was as follows:

FAUS45 KKCI 311145
FA5W
-SLCC FA 311145
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 010600
CLDS/WX VALID UNTIL 010000...OTLK VALID 010000-010600
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...12Z HI PRES NCNTRL MT. STNR FNT NERN OR-LOW PRES WCNTRL WY-LOW PRES NCNTRL CO-LOW PRES WRN OK PNHDL. TROF CNTRL MT-WCNTRL WY. TROF SW WY-LOW PRES NW AZ-SCNTRL AZ. LOW PRES CNTRL NM WITH TROF SWWD TO SW NM. UPR LVL TROF NERN MT-NW WY. UPR LVL TROF NERN UT-SW AZ. 06Z STNR FNT NRN ID-SW WY-NERN UT-LOW PRES CNTRL CO-NCNTRL NM THEN CDFNT TO LOW PRES SE NM-ABI. TROF ERN NV-NW AZ-LOW PRES NR TUS. HI PRES NERN MT.
.
AZ
NW...BKN080 TOP 150. 16Z SCT080. OTLK...VFR.
NCNTRL...SCT090 OVC130 TOP FL180. OCNL -SN. 18Z OVC070-080. VIS 3-5SM -SN BR. 21Z WDLY SCT -SHSN. OTLK...MVFR CIG SHSN BECMG 02Z VFR.
NERN...BKN110 TOP FL250. WDLY SCT -SHSN. 18Z BKN120. OTLK...VFR.
SWRN...BKN120 TOP 160. 17Z BKN080. OCNL -RA. WND W G25KT. OTLK...VFR.
SCNTRL...SCT120 SCT CI. 16Z BKN120. ISOL -SHRA. 22Z BKN120. OTLK...VFR.
SERN...BKN120 TOP FL180. 18Z BKN090. WND W G25-30KT. OTLK...VFR WND.
.
NM
NWRN...BKN100 TOP FL180. 15Z OCNL -RASN BECMG OCNL -SN 16Z. OTLK...VFR SHRA SHSN.
SWRN...BKN CI. 18Z BKN150. WND W G25KT. OTLK...VFR WND BECMG 02Z VFR SHRA WND.
NERN...BKN150 TOP FL250. 15Z WDLY SCT -SHSN. OTLK...IFR CIG SHRA SHSN.
SERN...SKC. 18Z BKN CI. 22Z WND S G25KT. OTLK....VFR WND BECMG SHSN.
.

The forecast for south central Arizona expected broken clouds at 12,000 feet with isolated light rain shower until 1500 MST.

7.0 In-Flight Weather Advisories

The NWS issues in-flight weather advisories designated as Severe Weather Forecast Alerts (AWW's), Convective SIGMET's (WST's), SIGMET's (WS's), Center Weather Advisories (CWA's), and AIRMET's (WA's). In-flight advisories serve to notify en route pilots of the possibility of encountering hazardous flying conditions, which 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 on the basis of experience and the operational limits of the aircraft. The following advisories were issued surrounding the period:

Convective SIGMETs

WSUS33 KKCI 311655
SIGW
-MKCW WST 311655
CONVECTIVE SIGMET...NONE
OUTLOOK VALID 311855-312255
FROM 50ENE RSK-40W ELP-40SW DMN-60SSW DMN-50SSW TUS-60WSW
TUS-50NNW TBC-50ENE RSK
WST ISSUANCES POSS. REFER TO MOST RECENT ACUS01 KWNS FROM STORM
PREDICTION CENTER FOR SYNOPSIS AND METEOROLOGICAL DETAILS.

WSUS33 KKCI 311755
SIGW
-MKCW WST 311755
CONVECTIVE SIGMET...NONE
OUTLOOK VALID 311955-312355
FROM 50ENE RSK-40W ELP-40SW DMN-60SSW DMN-50SSW TUS-60WSW
TUS-50NNW TBC-50ENE RSK
WST ISSUANCES POSS. REFER TO MOST RECENT ACUS01 KWNS FROM STORM
PREDICTION CENTER FOR SYNOPSIS AND METEOROLOGICAL DETAILS.

WSUS33 KKCI 311855
SIGW
-MKCW WST 311855
CONVECTIVE SIGMET...NONE
OUTLOOK VALID 312055-010055
FROM 50ENE RSK-40W ELP-40SW DMN-60SSW DMN-50SSW TUS-60WSW
TUS-50NNW TBC-50ENE RSK
WST ISSUANCES POSS. REFER TO MOST RECENT ACUS01 KWNS FROM STORM
PREDICTION CENTER FOR SYNOPSIS AND METEOROLOGICAL DETAILS.

WSUS33 KKCI 311908
SIGW
-MKCW WST 311908
CONVECTIVE SIGMET 1W
VALID UNTIL 2055Z
NM AZ
FROM 40SSE SJN-30WSW SSO-30SSW TUS-30WSW TUS-70SW SJN-40SSE SJN
DVLPG AREA TS MOV FROM 30020KT. TOPS TO FL250.
...SPECIAL...
OUTLOOK VALID 312055-010055

FROM 50ENE RSK-40W ELP-40SW DMN-60SSW DMN-50SSW TUS-60WSW
TUS-50NNW TBC-50ENE RSK
WST ISSUANCES POSS. REFER TO MOST RECENT ACUS01 KWNS FROM STORM
PREDICTION CENTER FOR SYNOPSIS AND METEOROLOGICAL DETAILS.

No Convective SIGMETs were current during the period; however, the outlook section highlighted eastern Arizona through central New Mexico for the potential development of thunderstorms during the period. After the accident at 1208 MST, an advisory was issued over the region for an area of developing thunderstorms moving east-southeast at 20 knots with tops to 25,000 feet.

AIRMETs

WAUS45 KKCI 311445 *2011031 1454*
WA5S
-SLCS WA 311445
AIRMET SIERRA UPDT 3 FOR IFR AND MTN OBSCN VALID UNTIL 312100
.
AIRMET IFR...ID UT
FROM DBS TO 20W JAC TO 40SE SLC TO 40ESE BVL TO 20WSW MLD TO
20SW TWF TO 50N TWF TO DBS
CIG BLW 010/VIS BLW 3SM BR/FG. CONDS ENDG 18-21Z.
.
AIRMET IFR...WY CO NM
FROM 40N BOY TO 70SW RAP TO BFF TO GLD TO 50W LBL TO 30ESE TBE
TO 30ENE TCC TO ABQ TO 60N SJN TO 20SSW OCS TO 30E BPI TO 40N BOY
CIG BLW 010/VIS BLW 3SM PCPN/BR/FG. CONDS CONTG BYD 21Z THRU 03Z.
.
AIRMET MTN OBSCN...ID MT WY UT CO AZ NM
FROM HLN TO 20NNW BIL TO 20WNW SHR TO CYS TO TBE TO 50WSW TCC TO
50S SSO TO 50S TUS TO PGS TO 20WSW MTU TO PIH TO 20WSW DLN TO HLN
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 21Z THRU 03Z.
....
WAUS45 KKCI 311445 *2011031 1449*
WA5Z
-SLCZ WA 311445
AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 312100
.
AIRMET ICE...WY NV UT CO AZ NM
FROM BFF TO GLD TO 50W LBL TO 30ESE TBE TO 50NNE TCC TO TCC TO
60SSE SSO TO 50S TUS TO 80SW PHX TO EED TO 80SSE ILC TO OCS TO BFF
MOD ICE BTN FRZLVL AND FL180. FRZLVL SFC-080. CONDS CONTG BYD 21Z THRU 03Z.
.
FRZLVL...RANGING FROM SFC-095 ACRS AREA
MULT FRZLVL BLW 090 BOUNDED BY 30ESE TBE-20NNW TXO-40SSE CIM-
30NNE CIM-30ESE TBE
SFC ALG 30SSE BTY-50N LAS-40SE TBC-20WNW SJN-50ESE SJN-30E FTI-30NE TCC
080 ALG 30W ELP-50WNW CME-40N CME-50SSW TXO
....
WAUS45 KKCI 311445 *2011031 1448*
WA5T
-SLCT WA 311445
AIRMET TANGO UPDT 2 FOR TURB VALID UNTIL 312100
.

AIRMET TURB...ID MT NV WA OR CA AND CSTL WTRS
FROM YXC TO TWF TO EED TO BZA TO 20S MZB TO 220SW MZB TO 150SW
SNS TO ENI TO 140W TOU TO YDC TO YXC
MOD TURB BTN FL210 AND FL390. CONDS CONTG BYD 21Z THRU 03Z.
.
AIRMET TURB...AZ NM
FROM 30ESE TBE TO 70SSE TBE TO INK TO 20WSW ELP TO 50S TUS TO
BZA TO EED TO 70N SJN TO 30ESE TBE
MOD TURB BTN FL180 AND FL410. CONDS CONTG BYD 21Z THRU 03Z.
.
AIRMET TURB...NV UT AZ NM CA AND CSTL WTRS
FROM 70NNE OAL TO BCE TO 60S HVE TO 40ESE TBE TO TXO TO INK TO
ELP TO 50S TUS TO BZA TO 30SSW MZB TO 30WNW RZS TO CZQ TO 70NNE OAL
MOD TURB BLW 150. CONDS CONTG BYD 21Z THRU 03Z.
.
OTLK VALID 2100-0300Z...TURB ID MT NV UT AZ WA OR CA AND CSTL WTRS
BOUNDED BY YDC-50WSW YQL-PGS-BZA-20S MZB-90SW MZB-RBL-100W TOU-YDC
MOD TURB BTN FL210 AND FL390. CONDS CONTG THRU 03Z.

WAUS45 KKCI 311531 AAA
WA5Z
-SLCZ WA 311531 AMD
AIRMET ZULU UPDT 4 FOR ICE AND FRZLVL VALID UNTIL 312100
.
AIRMET ICE...ID WY NV UT CO AZ NM...UPDT
FROM 30WSW PIH TO 40NE OCS TO BFF TO GLD TO 50W LBL TO 30ESE TBE
TO 60NE TCC TO TCC TO DMN TO 60SE SSO TO 50S TUS TO 60WSW TUS TO
80SW PHX TO 20WSW EED TO 70SSE ILC TO 30WSW PIH
MOD ICE BTN FRZLVL AND FL180. FRZLVL SFC-080. CONDS CONTG BYD 21Z THRU 03Z.
.
OTLK VALID 2100-0300Z...ICE WY UT CO AZ NM...UPDT
BOUNDED BY BFF-GLD-50W LBL-30ESE TBE-INK-20WNW ELP-60SSW TUS-20SW
PHX-SLC-70WNW LAR-BFF
MOD ICE BTN FRZLVL AND FL180. FRZLVL SFC-080. CONDS CONTG THRU 03Z.
.
FRZLVL...RANGING FROM SFC-095 ACRS AREA
MULT FRZLVL BLW 090 BOUNDED BY 30ESE TBE-20NNW TXO-40SSE CIM-
30NNE CIM-30ESE TBE
SFC ALG 30SSE BTY-50N LAS-40SE TBC-20WNW SJN-50ESE SJN-30E FTI-30NE TCC
080 ALG 30W ELP-50WNW CME-40N CME-50SSW TXO
....

The NWS had AIRMETs Tango current for moderate turbulence below 15,000 feet and AIRMET Zulu for moderate icing between the freezing level and 18,000 feet over the region.

8.0 Terminal Aerodrome Forecast (TAF)

The closest Terminal Aerodrome Forecast (TAF) to the accident site was from Tucson (KTUS) and the following forecasts were issued surrounding the period:

KTUS 311123Z 3112/0112 31006KT P6SM FEW080 OVC100

FM311800 29014G22KT P6SM VCSH SCT050 BKN080
TEMPO 3118/3122 P6SM -RA BKN040 OVC070
FM010300 22005KT P6SM SCT080 BKN120=

KTUS 311720Z 3118/0118 30008KT P6SM SCT050 SCT080
FM311900 29014G22KT P6SM SCT050 BKN080
TEMPO 3119/3122 P6SM -RA BKN040 OVC070
FM010400 20005KT P6SM SCT080 BKN120
FM011200 17004KT P6SM SCT080 SCT120=

TAF AMD
KTUS 311812Z 3118/0118 30008KT P6SM VCSH SCT050 SCT080
FM311900 29014G22KT P6SM SCT050 BKN080
TEMPO 3119/3122 P6SM -RA BKN040 OVC070
FM010400 20005KT P6SM SCT080 BKN120
FM011200 17004KT P6SM SCT080 SCT120=

The forecast that was issued at 0500 MST and available to the pilot during the period of his preflight planning indicated westerly wind at 14 knots gusting to 22 knots, with rain showers in the vicinity of the station between 1100 and 1500 MST, with a few clouds at 8,000 feet and overcast at 10,000 feet, with a temporary condition of light rain and a ceiling broken at 4,000 feet and overcast at 7,000 feet.

Donald Eick
NTSB Senior Meteorologist