NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

October 4, 2017

Group Chairman's Factual Report

METEOROLOGY

CEN17FA168

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A. ACCIDENT

Location: Amarillo, Texas
Date: April 28, 2017
Time: about 2348 central daylight time (0448 UTC[1] on April 29, 2017)
Airplane: PC12 air ambulance; N933DC

B. METEOROLOGY GROUP

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C. SUMMARY

On April 28, 2017, about 2348 central daylight time (CDT), a Pilatus PC-12 airplane, N933DC, impacted terrain near Rick Husband Amarillo International Airport (AMA), in Amarillo, Texas. The airline transport pilot and two flight crew were fatally injured. The airplane was destroyed. The airplane was registered to and operated by Rico Aviation LLC, under the provisions of 14 *Code of Federal Regulations* Part 135 as an air ambulance flight. The flight was operated on an instrument flight rules flight plan. The flight was originating at the time of the accident and was enroute to Clovis Municipal Airport in Clovis, New Mexico.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) meteorological specialist travelled to Amarillo, Texas, in support of this accident investigation. Unless otherwise noted, all times are in CDT for April 28, 2017 (based upon the 24-hour clock), directions are referenced to true north, distances are in nautical miles and heights are above mean sea level (msl).

Coordinates used for the accident location are: 35.196389° north latitude, 101.704722° west longitude, at an elevation of about 3,600 feet.

[1] UTC – abbreviation for Coordinated Universal Time

E. WEATHER INFORMATION

1.0 Synoptic Conditions

The National Weather Service (NWS) Surface Analysis Chart for 0100 CDT on April 29, 2017, is presented in figure 1. The surface analysis chart showed a low pressure center southeast of the accident location along the Texas-Oklahoma border. Minimum pressure was identified as 997 hectopascals (hPa). A cold front extended southwest from the low pressure center into southwest Texas, and a stationary front extended northeast from the low pressure center through Oklahoma and into northern Arkansas. Station models behind the cold front and in the panhandle of Texas identified surface winds from the north and northeast, with magnitudes between 15 and 25 knots, overcast skies, and some light rain. A WSR-88D regional radar composite reflectivity mosaic obtained from the National Centers for Environmental Information (NCEI) for 2350 CDT (figure 2) identified light to moderate values of reflectivity across a substantial portion of the Texas Panhandle, including near the accident location.

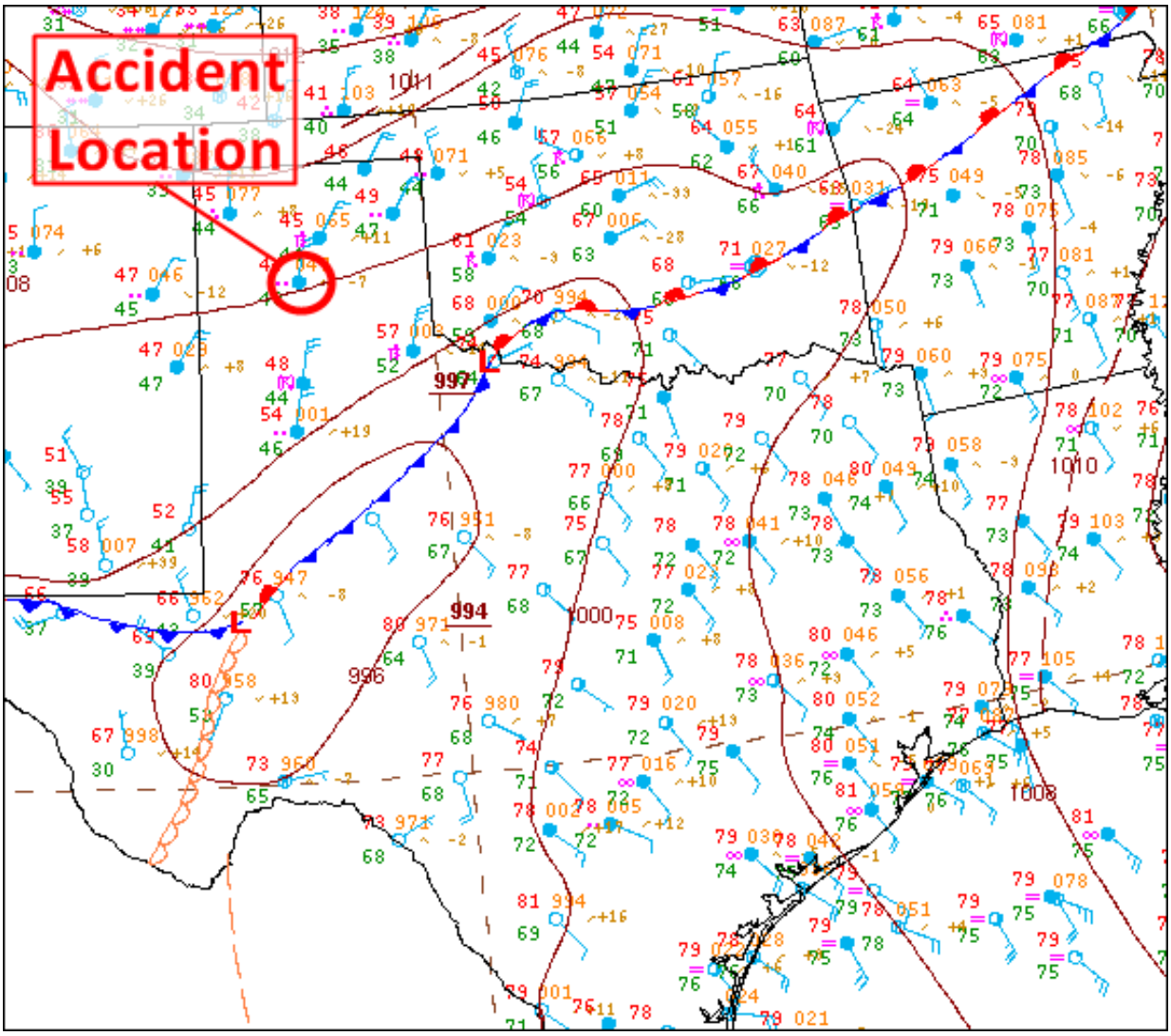

Figure 1 - NWS Surface Analysis Chart for 0100 CDT on April 29, 2017.

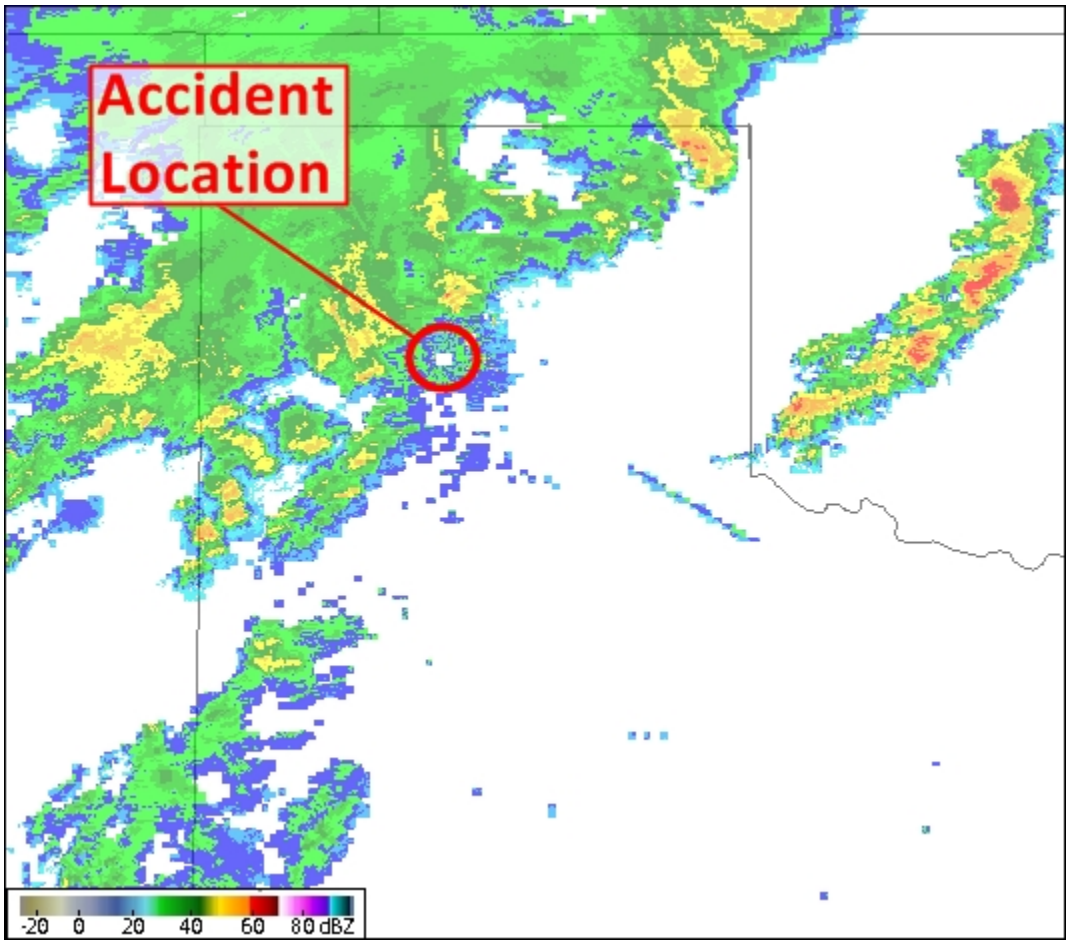

Figure 2 – NCEI WSR-88D mosaic from 2350 CDT.

2.0 Surface Observations

An Automated Surface Observing System (ASOS) was located at AMA[2], which was located about one mile north of the accident location at an elevation of about 3,600 feet. Reports from AMA during the times surrounding the accident time, which were issued while a certified weather observer was logged into the ASOS' augmentation system through the 2253 CDT observation, and were automated beginning with the 2353 CDT observation, are presented here:

[2210 CDT] SPECI KAMA 290310Z 36015KT 10SM -RA BKN010 BKN016 OVC047 08/07 A2980 RMK AO2 RAB00 PRESRR P0000 T00830072=

[2] The National Weather Service (NWS) uses the 4-digit International Civil Aviation Organization (ICAO) format for station identifiers (as seen in the body of some formatted weather observations). This report uses the 3-digit International Air Transport Association format for station identification, which does not use the geographic designating digit ("K" for stations in the continental U.S. and "P" for U.S. stations in Alaska and the Pacific region) as found in the ICAO format.

[2230 CDT] SPECI KAMA 290330Z 01019KT 10SM -RA BKN008 BKN012 OVC018 08/07 A2978 RMK AO2 RAB00 P0001 T00780072=

[2253 CDT] METAR KAMA 290353Z 01020G27KT 10SM BKN006 OVC037 08/07 A2977 RMK AO2 PK WND 01027/0347 LTG DSNT SW RAB00E31 CIG 004V013 SLP056 P0001 T00780072=

[2353 CDT] METAR KAMA 290453Z AUTO 36021G28KT 10SM BKN007 OVC012 07/07 A2978 RMK AO2 PK WND 36032/0426 LTG DSNT W RAB14E25 CIG 005V009 SLP057 P0000 T00720067=

[0042 CDT] [3] SPECI KAMA 290542Z AUTO 36016G28KT 6SM -RA BR BKN008 OVC014 07/06 A2978 RMK AO2 PK WND 02034/0532 WSHFT 0522 LTG DSNT N RAB18 P0004 T00670061=

At 2353 CDT, AMA reported a wind from 360° at 21 knots with gusts to 28 knots, visibility of ten statute miles or greater, ceiling broken at 700 feet above ground level (agl), overcast cloud base at 1,200 feet agl, temperature of 7° Celsius (C) and a dew point temperature of 7°C, altimeter setting of 29.78 inches of mercury; remarks: station with a precipitation discriminator, peak wind of 32 knots from 360° occurred at 2326 CDT, lightning more than 10 miles away to the west, rain began at 2314 CDT and ended at 2325 CDT, ceiling variable between 500 feet agl and 900 feet agl, sea-level pressure of 1005.7 hPa, trace amount of precipitation since 2253 CDT, temperature of 7.2°C and dew point temperature of 6.7°C.

Selected parameters[4] from the AMA ASOS one-minute observations for 16 minutes surrounding the accident time are presented here:

Time	W_Dir	W_Mag	G_Dir	G_Mag	PW	Precip
2340	009°	20	009°	24	NP	0.00
2341	011°	19	007°	25	NP	0.00
2342	013°	20	017°	25	NP	0.00
2343	011°	21	008°	26	?0	0.00
2344	010°	22	011°	26	NP	0.00
2345	010°	21	011°	24	NP	0.00
2346	010°	22	011°	27	NP	0.00
2347	010°	22	011°	28	NP	0.00
2348	009°	22	013°	27	NP	0.00
2349	006°	21	006°	24	NP	0.00
2350	003°	21	003°	26	NP	0.00
2351	002°	21	008°	26	NP	0.00
2352	002°	20	360°	25	NP	0.00
2353	360°	21	352°	26	NP	0.00

[3] On April 29, 2017

[4] W_Dir = Direction of two-minute averaged wind (true); W_Mag = Magnitude of two-minute averaged wind (knots); G_Dir = Direction of five-second averaged wind (true); G_Mag = Magnitude of five-second averaged wind (knots); PW = present weather (NP = no present weather reported, meaning of "?0" is unknown; Precip = one-minute precipitation accumulation (inches).

2354	360°	20	356°	22	NP	0.00
2355	360°	18	006°	21	NP	0.00

3.0 Weather Radar

WSR-88D[5] Level-II and Level-III weather radar data from Amarillo, Texas (KAMA), are presented in figures 3-5. KAMA was located 2 miles north-northwest of the accident location. Around the time of the accident, 0.4° tilt base reflectivity imagery (figure 3) indicated light values of reflectivity in the area of the accident location. A 3.9° tilt radial velocity image (figure 4) from around the time of the accident identified *veering*[6] winds in the lowest 10,000 feet around the accident location. Figure 5 presents a VAD wind profile[7] for KAMA around the accident time. The VAD wind profile indicates that near the accident location the wind at 4,000 feet and 5,000 feet above msl was from the north-northeast at about 35 knots, the wind at 6,000 feet above msl was from the northeast at 30 knots, the wind at 7,000 feet above msl was from the east at 30 knots, the wind at 8,000 feet above msl was from the southeast at 35 knots, and the wind at 9,000 feet above msl was from the south-southeast at 45 knots.

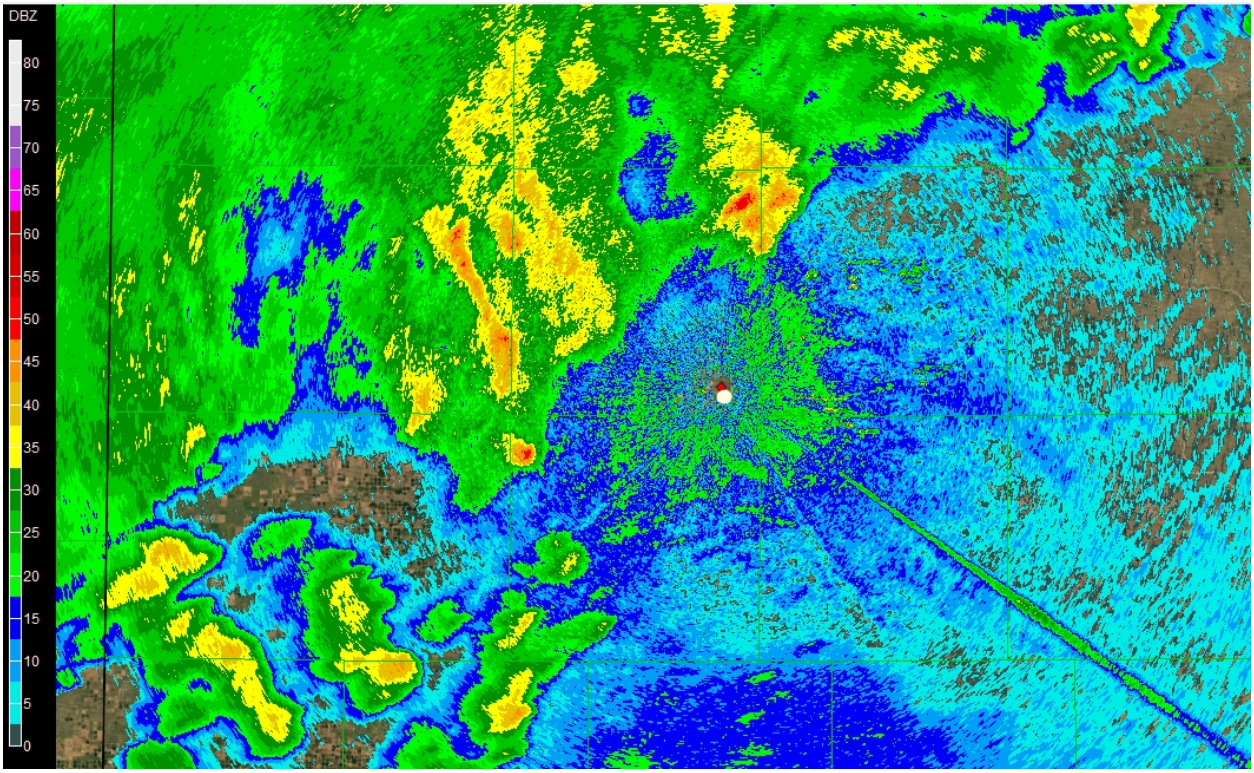

Figure 3 – KAMA 0.4° Level-II base reflectivity product from a sweep initiated at 2347 CDT. White dot denotes accident location.

[5] Weather Surveillance Radar 88 Doppler (WSR-88D)
[6] A veering wind is a wind (i.e., wind barbs) that turns clockwise with increasing height.
[7] VAD wind profile - A plot of horizontal winds as a function of height above a Doppler Radar. The display is plotted with height as the vertical axis and time as the horizontal axis (a so-called time-height display), which then depicts the change in wind with time at various heights.

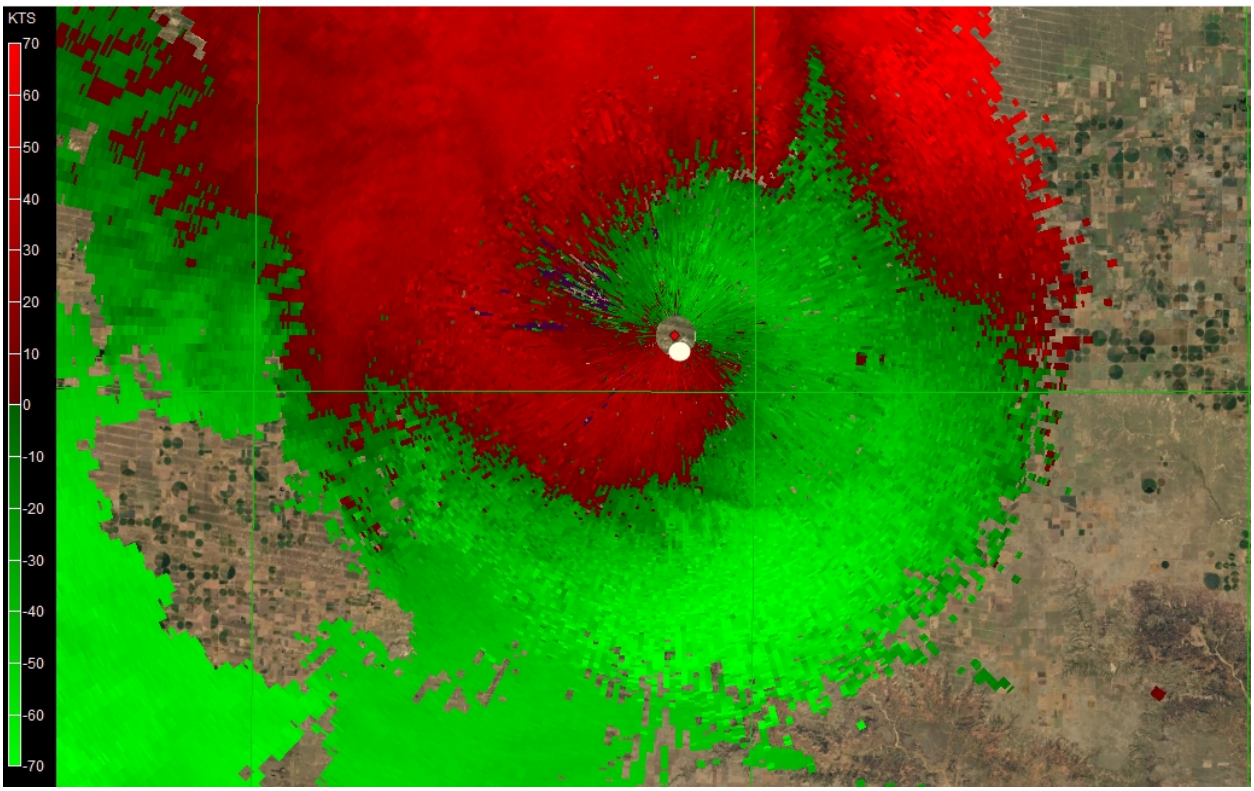

Figure 4 – KAMA 3.9° Level-II radial velocity product from a sweep initiated at 2347 CDT. White dot denotes accident location.

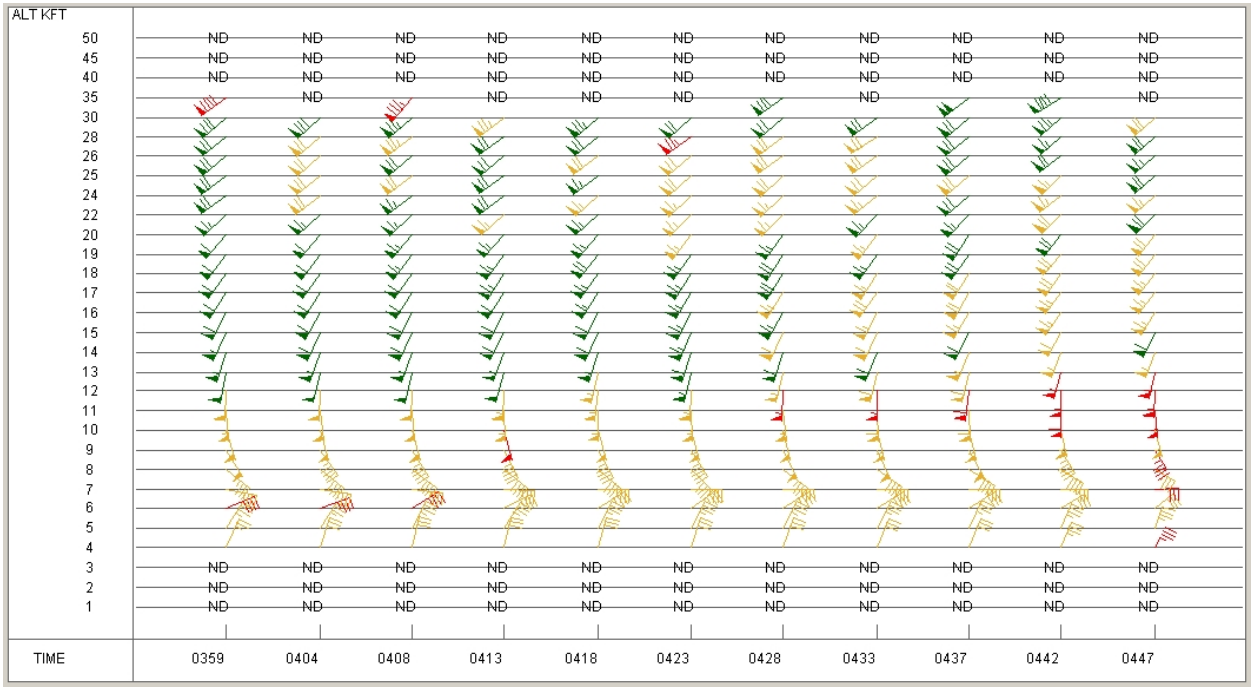

Figure 5 – KAMA VAD wind profile for the times leading up to the accident time. Time is in UTC on April 29, 2017, and height is in 1,000's of feet above msl.

Weather radar data obtained from the Standard Terminal Automation Replacement System (STARS) at the Amarillo Terminal Radar Approach Control (TRACON) were provided by the Federal Aviation Administration (FAA), and replayed by the NTSB using a separate playback program. Figure 6 depicts the STARS weather presentation at about 2348 CDT. Figure 7 describes how different radar levels are presented in the STARS display. Figure 6 presents a slightly different color shading (green/blue), however the solid color/dots are consistent.

Figure 6 – Amarillo TRACON STARS weather depiction from about 2348 CDT.

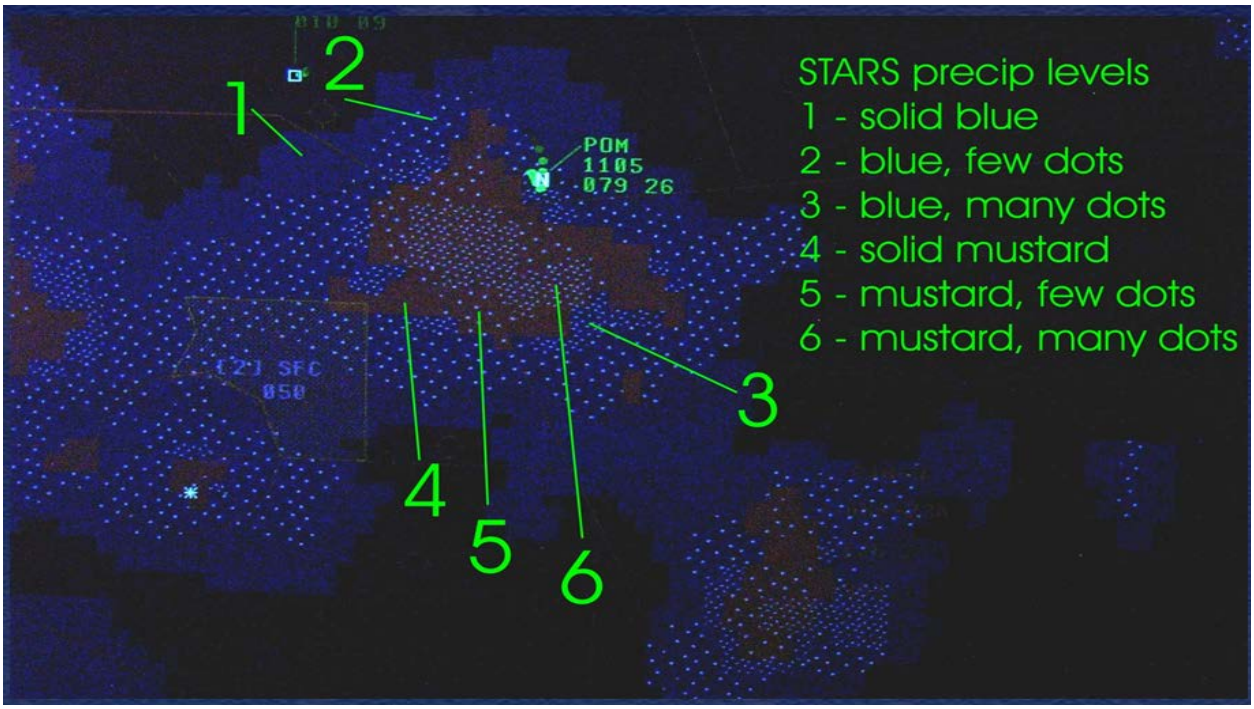

Figure 7 – Example of weather radar presentation in STARS.

According to the FAA the dBZ thresholds for the color scale (levels) presented in the STARS display are as follows:

Level 1: 18 < 30 dBZ
Level 2: 30 < 41 dBZ
Level 3: 41 < 46 dBZ
Level 4: 46 < 50 dBZ
Level 5: 50 < 57 dBZ
Level 6: 57+ dBZ

4.0 ITWS/WSP

AMA did not have an Integrated Terminal Weather System (ITWS) or Weather System Processor (WSP) capabilities.

5.0 GTG

The Graphical Turbulence Guidance (GTG) turbulence product is generated operationally at the National Centers for Environmental Prediction and published for public use on the Aviation Weather Center's (AWC) website.[8]

GTG version 3.0 (provided here) yields computer-generated four-dimensional forecasts of information related to the expected intensity of clear-air turbulence, mountain wave turbulence and turbulence from low-level terrain and thermally-induced sources. It is not intended to predict turbulence associated with convection and thunderstorm clouds, but may provide some guidance in areas of properly predicted thunderstorms when the convection is widespread.

Attachment 1 provides GTG imagery for clear air turbulence at altitudes of 3,000, 5,000, 7,000 and 9,000 feet, applicable to times surrounding the accident time, that were publicly available on the AWC website during times surrounding the accident. These images depict mainly light to moderate severities[9] of turbulence over AMA during the times surrounding the accident time.

6.0 Lightning

The Earth Networks Total Lightning Network (ENTLN) detected the following lightning activity[10] in the region around AMA between 2330 CDT on April 28, 2017, and 0000 CDT on April 29, 2017 (also see figure 8):

Time (CDT)	FlashType	Latitude	Longitude
2334:41	in cloud	34.9972	-102.21933
2345:40	cloud to ground	35.34369	-102.1378
2349:14	in cloud	35.3885	-102.14206
2352:48	cloud to ground	35.36721	-102.14654
2354:37	cloud to ground	35.3919	-102.07268
2355:14	in cloud	35.47329	-101.88055
2356:03	cloud to ground	35.45326	-102.07671
2356:42	cloud to ground	35.48594	-101.85758
2357:29	cloud to ground	35.42764	-102.07826
2357:29	cloud to ground	35.42653	-102.07633
2358:20	in cloud	35.52275	-101.86847
2358:37	cloud to ground	35.43222	-102.01345
2359:04	cloud to ground	35.34817	-102.06068
2359:54	in cloud	35.45781	-102.02822
2359:58	in cloud	34.79084	-101.96754

[8] https://www.aviationweather.gov/adds/
[9] Applicable to "light" aircraft.
[10] Additional lightning parameters were also available.

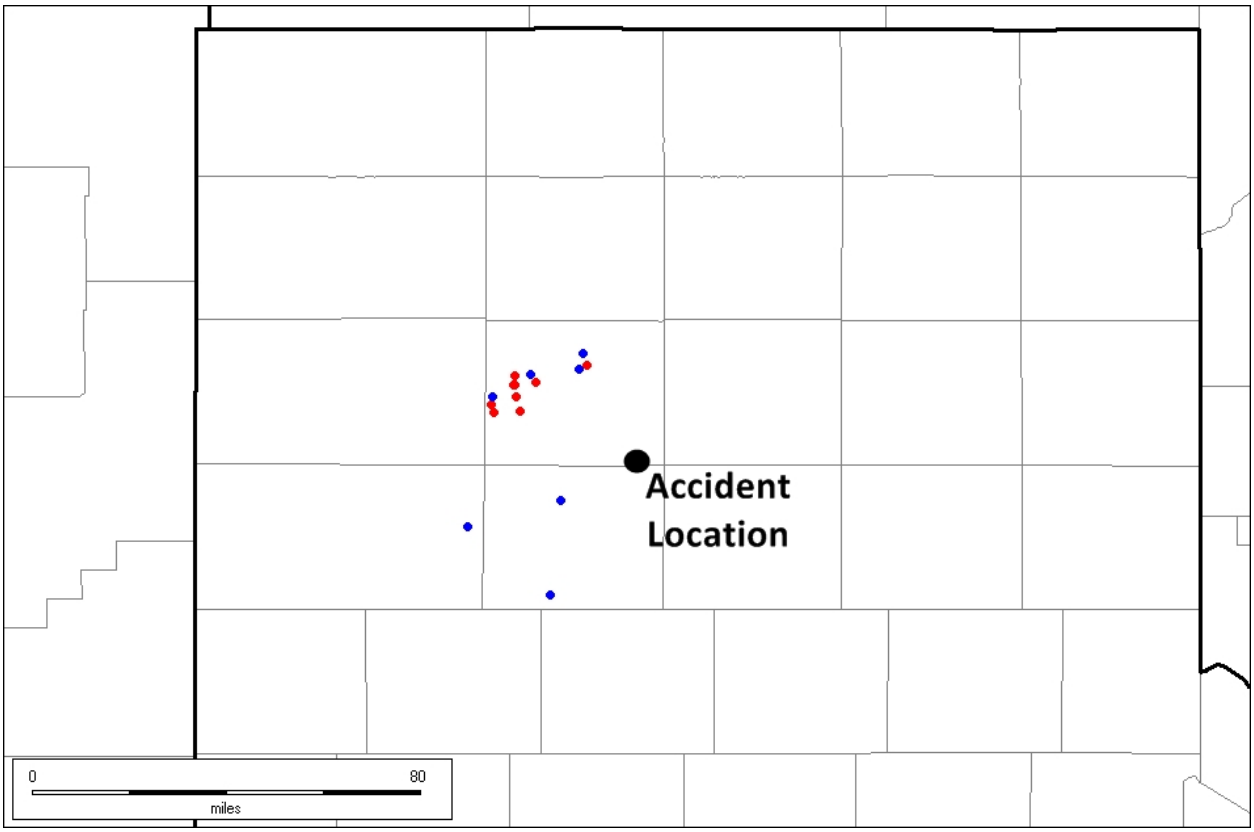

Figure 8 – ENTLN lightning activity for the region near the accident location, between 1030 and 1200 CDT. Red dots denote cloud-to-ground strokes and blue dots denote in-cloud strokes.

Archive data from the Federal Aviation Administration's Corridor Integrated Weather System (CIWS; figure 9), which presents cloud-to-ground lightning flash detections from the National Lightning Detection Network, identified lightning activity between 2344 and 2350 CDT.

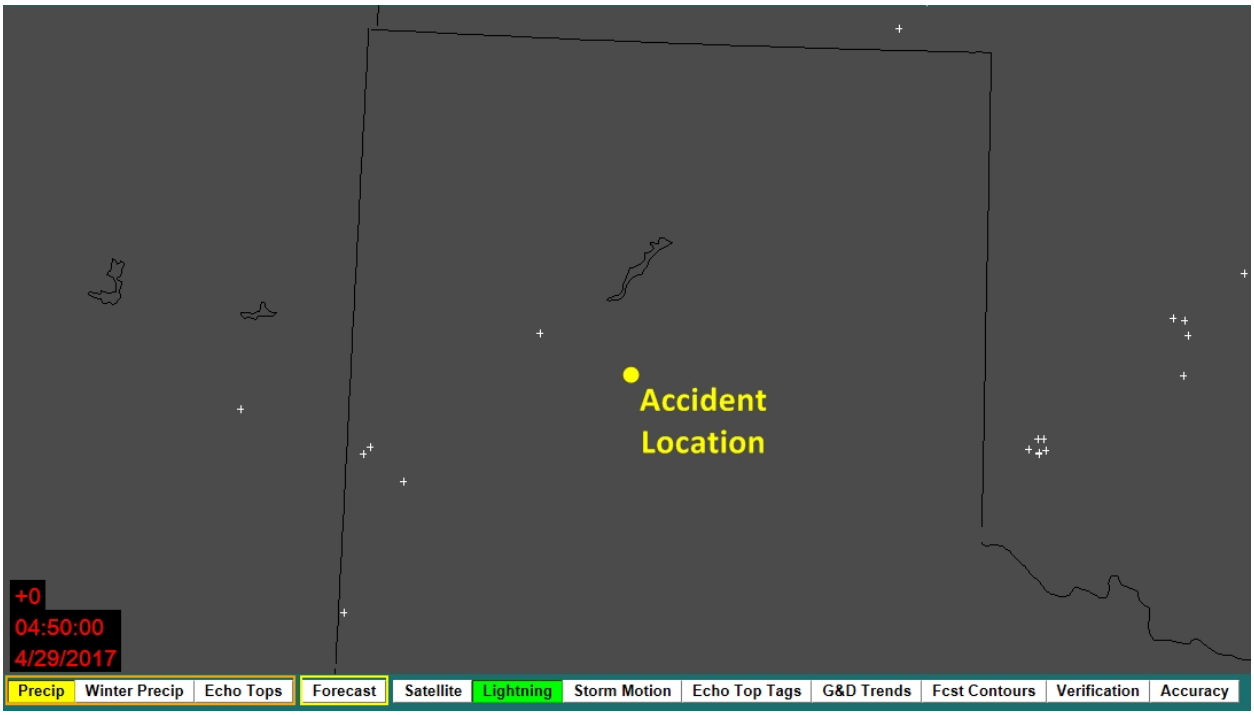

Figure 9 – Archive CIWS display from 2350 CDT. White "+" symbols denote lightning activity.

7.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR) model[11] sounding (figure 10) for the accident location at 0000 CDT on April 29, 2017, was retrieved from the National Oceanic and Atmospheric Administration's (NOAA) Air Resources Laboratory. The near-surface wind was from the north-northeast at a magnitude of about 20 knots. At about 5,500 feet, the wind was from the northeast with a magnitude of about 30 knots. Above this level the wind veered with height and increased in magnitude to a south wind at 45 knots at about 11,000 feet. A temperature inversion was noted between 6,200 feet and 7,800 feet. The freezing level was near 13,000 feet. Calculations made by the Rawinsonde OBservation Program identified a layer of significant turbulence between about 5,500 feet and 12,600 feet. Relative humidity was greater than 90 percent between near the surface and about 10,000 feet, as well as in a layer between about 16,000 feet and 18,000 feet.

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

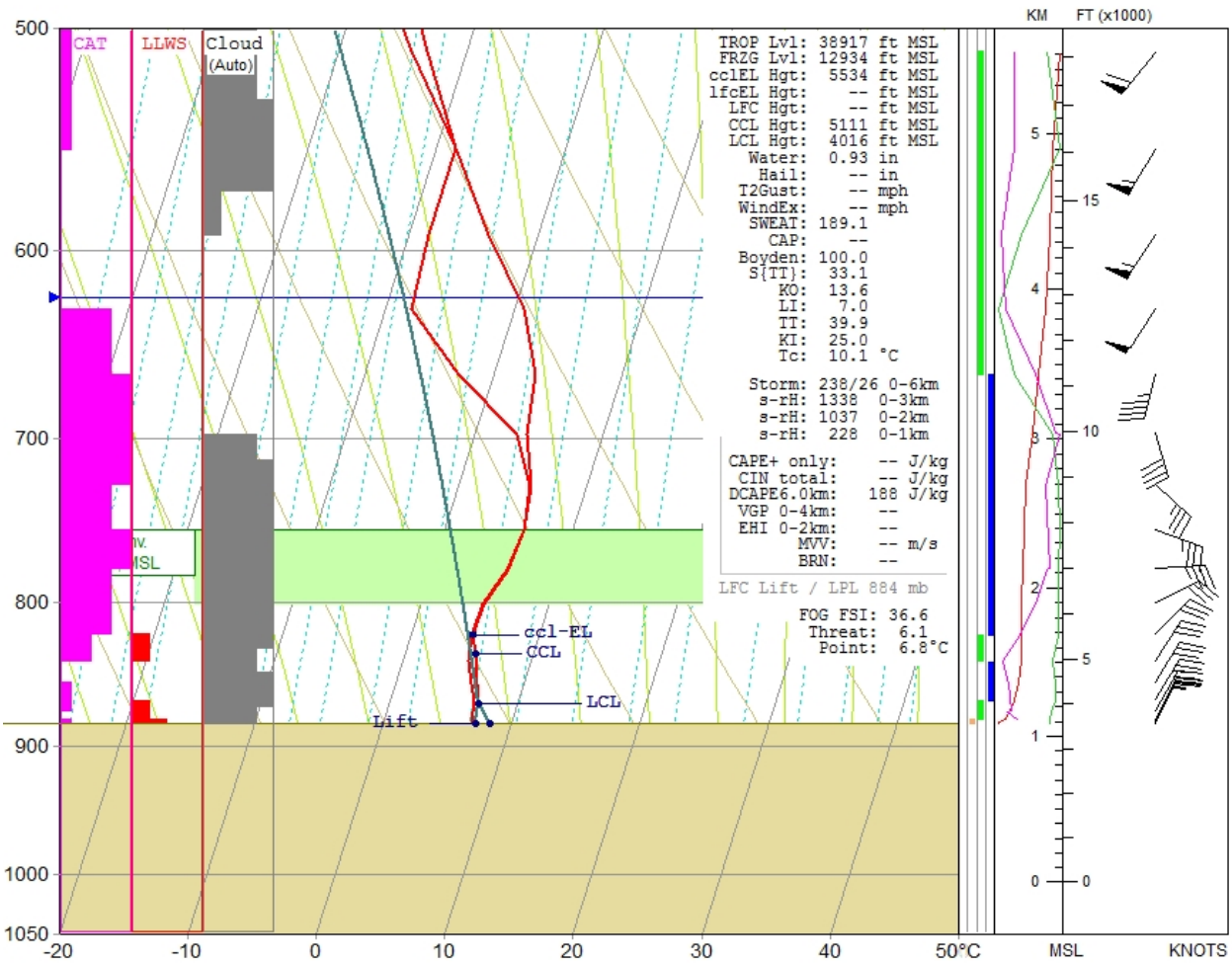

Figure 10 – HRRR model sounding data in SkewT/LogP format for 0000 CDT on April 29, 2017, for the accident location, surface to 500 hPa.

Meteorological data (including moisture information) from an AMDAR-reporting[12] aircraft on descent to AMA, which landed at AMA about 40 minutes prior to the accident time, are presented here. Altitude is pressure altitude in feet[13], pressure (Pres) is in hPa, wind direction (W-Dir) is referenced to true north, wind magnitude (W-Mag) is in knots, and temperature (Temp) and dew point temperature (D_Temp) are in °C.

Time	Latitude	Longitude	Altitude	Pres	W-Dir	W-Mag	Temp	D_Temp
0343	34.085	-99.846	38000	206	230°	73	-58.5	-60.4
0346	34.269	-100.179	36820	219	237°	63	-57.1	-64.9
0347	34.335	-100.296	35710	230	236°	64	-54.6	-57.3
0348	34.402	-100.414	32760	265	232°	69	-47.0	-52.2
0349	34.469	-100.532	30150	299	220°	66	-40.8	-44.9

[12] *AMDAR* has been a generally-accepted, worldwide term for automated weather reports from commercial aircraft.
[13] These altitudes are calculated from the aircraft's static pressure according to the International Standard Atmosphere regardless of altitude (1013.25 hPa is always surface pressure).

0350	34.535	-100.647	27880	331	218°	64	-35.1	-39.1
0351	34.585	-100.761	25650	365	226°	65	-29.5	-33.2
0352	34.652	-100.871	23460	402	220°	59	-24.1	-32.5
0353	34.702	-100.976	21370	440	233°	58	-18.8	-28.3
0354	34.752	-101.079	19350	478	236°	60	-13.5	-25.0
0355	34.802	-101.182	17390	519	223°	54	-10.0	-13.7
0356	34.835	-101.286	15410	562	217°	56	-5.5	-9.6
0357	34.885	-101.389	13040	618	204°	51	-0.8	-3.8
0358	34.919	-101.487	11340	661	201°	51	4.0	-2.0
0359	34.969	-101.581	9040	723	158°	39	7.5	3.7
0400	34.984	-101.681	7480	768	122°	34	8.0	8.0
0401	35.001	-101.772	6120	808	070°	35	8.5	6.4
0402	35.018	-101.837	5690	822	038°	41	4.5	4.1
0403	35.051	-101.862	5450	829	024°	36	4.0	4.0
0404	35.084	-101.851	5430	830	027°	39	4.8	4.8
0406	35.134	-101.804	5370	831	027°	36	4.8	4.8
0407	35.168	-101.774	4720	852	014°	30	5.5	5.5
0408	35.184	-101.742	4030	874	358°	22	7.0	7.0

The AMDAR data is presented in SkewT/LogP format in figure 11. Near the surface the wind was from the north at 22 knots. Above this level the wind veered with height and increased in magnitude to a maximum value (for the lowest 10,000 feet above msl) of 41 knots at about 5,700 feet. A strong temperature inversion was noted between about 5,700 and 6,100 feet. Calculations made by the RAOB yielded several layers of significant turbulence below 10,000 feet.

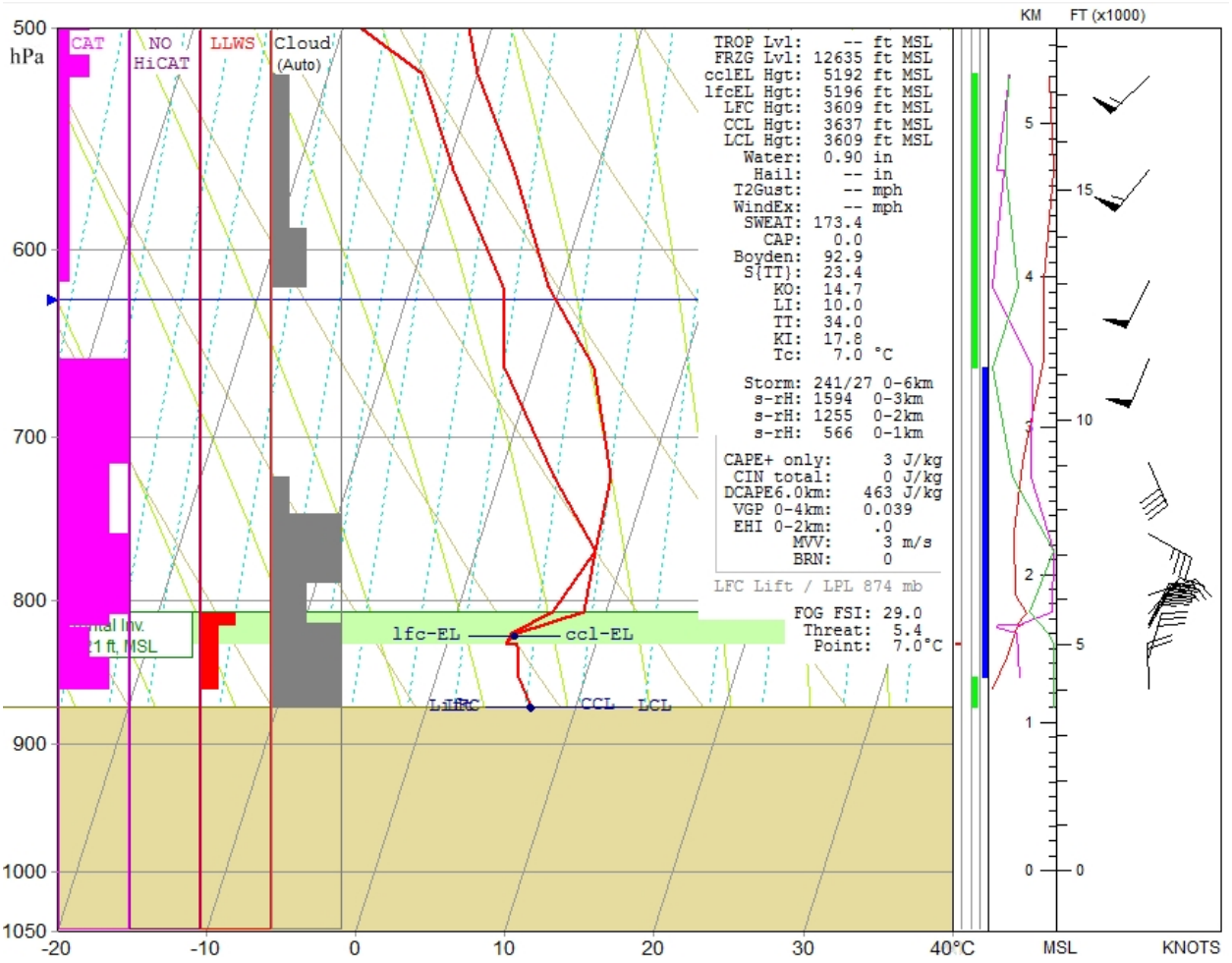

Figure 11 – AMDAR sounding data in SkewT/LogP format, surface to 500 hPa.

8.0 Pilot Reports

There were no publicly disseminated pilot reports[14] for AMA between 2100 CDT on April 28, 2017, and 0300 CDT on April 29, 2017, below 10,000 feet.

[14] Only pilot reports with the three-letter station identifier of AMA were considered.

9.0 Satellite Imagery

Geostationary Operational Environmental Satellite (GOES)-13 infrared (10.7µm) data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison. Imagery from 2345 CDT is presented in figure 12. The GOES-13 infrared cloud-top temperatures in the area of the accident location varied between about -14°C and -42°C, which, according to the HRRR model sounding, corresponded to cloud top heights of about 18,500 feet and 30,700 feet[15], respectively. It should be noted that figure 12 has not been corrected for any parallax error.

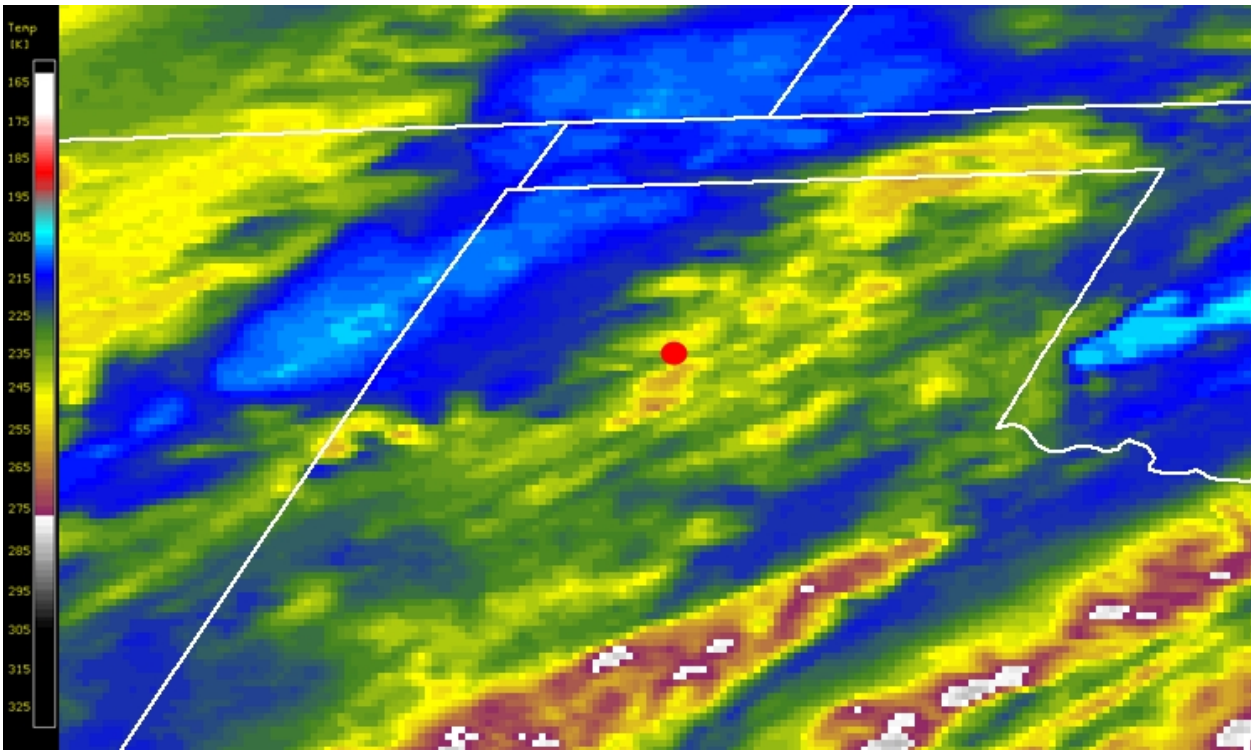

Figure 12 – GOES-13 infrared imagery from 2345 CDT. Accident location is denoted by the red dot.

[15] Higher tropospheric data output from the HRRR sounding is not presented in figure 10.

10.0 Terminal Aerodrome Forecasts

At 2036 CDT, a Terminal Aerodrome Forecast (TAF) was issued for AMA by the NWS Weather Forecast Office (WFO) in Amarillo, Texas, that forecasted for the accident time: wind from 020° at 17 knots with gusts to 25 knots, visibility greater than 6 statute miles, light rain showers, scattered clouds at 3,000 feet agl, ceiling overcast at 5,000 feet agl.

KAMA 290136Z 2902/2924 **02017G25KT P6SM -SHRA SCT030 OVC050**
TEMPO 2902/2904 BKN009 OVC070
FM290900 01012G31KT 4SM -RA OVC010
FM291500 35020G30KT 2SM -RA OVC005=

11.0 Area Forecast

An Area Forecast that included the state of northwest Texas panhandle was issued at 2045 CDT by the AWC in Kansas City, Missouri. Cloud heights are above msl. The portion of the Area Forecast directed toward the northwest Texas panhandle forecasted for the accident time: overcast clouds at 6,000 feet with clouds layered to FL270[16], widely scattered light rain showers, a northeasterly surface wind with gusts to 25 knots.

FAUS44 KKCI 290145
FA4W
DFWC FA 290145
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 292000
CLDS/WX VALID UNTIL 291400...OTLK VALID 291400-292000
OK TX AR TN LA MS AL
.
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...01Z LO PRESS W TX PNHDL. WRMFNT TX PNHDL-CNTRL OK-NRN AR-WRN KY. BY 20Z LO PRESS NERN OK. WRMFNT NERN OK-SWRN MO. CDFNT NERN OK-CNTRL TX-BIG BEND TX.
.
NWRN TX
PNHDL...OVC060 LYRD FL270. WDLY SCT -SHRA. WND NELY G25KT. 09Z OVC040. VIS 4SM -RA. WND NELY 20G30KT. OTLK...IFR CIG RA WND.
S PLAINS...BKN100 TOP FL250. WDLY SCT -SHRA/-TSRA. CB TOP FL390. 09Z OVC050. WND NELY G25KT. OTLK...MVFR CIG WND.

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

12.0 Aviation Section of the Area Forecast Discussion

An Area Forecast Discussion (AFD) was issued at 2255 CDT by the NWS WFO in Amarillo, Texas. The aviation portion of that AFD, which was originally disseminated with an AFD issued at 1842 CDT, is presented here.

FXUS64 KAMA 290355
AFDAMA
Area Forecast Discussion...UPDATED
National Weather Service Amarillo TX
1055 PM CDT Fri Apr 28 2017

.PREV DISCUSSION... /Issued 642 PM CDT Fri Apr 28 2017/
AVIATION...
A cold front continues to slide south across the Panhandles, winds have shifted out of the north and increased 15 to 25kts with slightly higher gusts. Ceilings will continue to lower behind the cold front but should remain VFR/MVFR until early Saturday morning. We expect to see a transition from liquid to frozen precip at KDHT and KGUY around 13Z Saturday. KAMA will lag behind the other terminals and possibly won't make the transition until after 18Z Saturday. Once the precip change occurs we will likely see ceilings continue to worsen into IFR or possible LIFR conditions. Confidence in timing is not high enough to add snow to the prevailing forecast, so will continue with rain until future TAF issuances.

13.0 AIRMETs

There was one Airmen's Meteorological Information (AIRMET) advisory active for the accident location at the accident time for altitudes below 10,000 feet:[17]

At 2145 CDT, an AIRMET SIERRA for instrument flight rule (IFR) conditions[18] and precipitation/mist was issued by the AWC:

WAUS44 KKCI 290245
WA4S
DFWS WA 290245
AIRMET SIERRA FOR IFR VALID UNTIL 290900
.
AIRMET IFR...OK TX AR NE KS IA MO WI LM MI IL IN
FROM 40SW BAE TO 40SE ORD TO 50WSW DXO TO FWA TO 30N CVG TO 50WSW PXV TO 50NNW LIT TO 30SE OKC TO 30SSW TXO TO 30ESE TBE TO 50W LBL TO GLD TO 20N BFF TO 50ESE LBF TO 40SW BAE
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 09Z THRU 15Z.

[17] AIRMETs for icing are not considered here because the freezing level was near 13,000 feet above msl, well above the accident aircraft's maximum flight altitude.
[18] IFR conditions - ceilings less than 1,000 feet agl and/or visibility less than three statute miles.

There were no AIRMETs active for turbulence or low level wind shear (LLWS) at the accident location at the accident time below 10,000 feet. The following AIRMETs that advised of turbulence below 10,000 feet and LLWS were active in the region. They are also depicted in figure 13.

At 2145 CDT, AIRMET TANGOs for moderate turbulence below FL180, moderate turbulence below 16,000 feet and LLWS potential were issued by the AWC:

WAUS45 KKCI 290245
WA5T
-SLCT WA 290245
AIRMET TANGO FOR TURB VALID UNTIL 290900
.
AIRMET TURB...NV CO AZ NM CA AND CSTL WTRS
FROM 50N FMG TO LAS TO 60WSW TBC TO 30ENE RSK TO GLD TO 50W LBL TO 30ESE TBE TO INK TO ELP TO 50S TUS TO BZA TO 20S MZB TO 220SW MZB TO 130WSW SNS TO 30W ENI TO 50N FMG
MOD TURB BLW FL180. CONDS CONTG BYD 09Z THRU 15Z.
.
AIRMET TURB...WY NV UT CO AZ NM
FROM 20N BFF TO GLD TO 20ENE RSK TO 60WSW TBC TO LAS TO 30SSE ILC TO 20W SLC TO 60W LAR TO 20N BFF
MOD TURB BLW 160. CONDS CONTG BYD 09Z THRU 15Z.

WAUS44 KKCI 290245
WA4T
-DFWT WA 290245
AIRMET TANGO FOR TURB AND LLWS VALID UNTIL 290900
.
LLWS POTENTIAL...OK TX AR TN LA MS AL MO IL IN KY
BOUNDED BY 20ENE CVG – HNN – HMV - 40E VXV - 30ESE MLU - 40NE TXK - 70WSW TTT-60SW SPS - 20W RZC - 70ESE RZC - 20ENE CVG
LLWS EXP. CONDS CONTG BYD 09Z ENDG 09-12Z

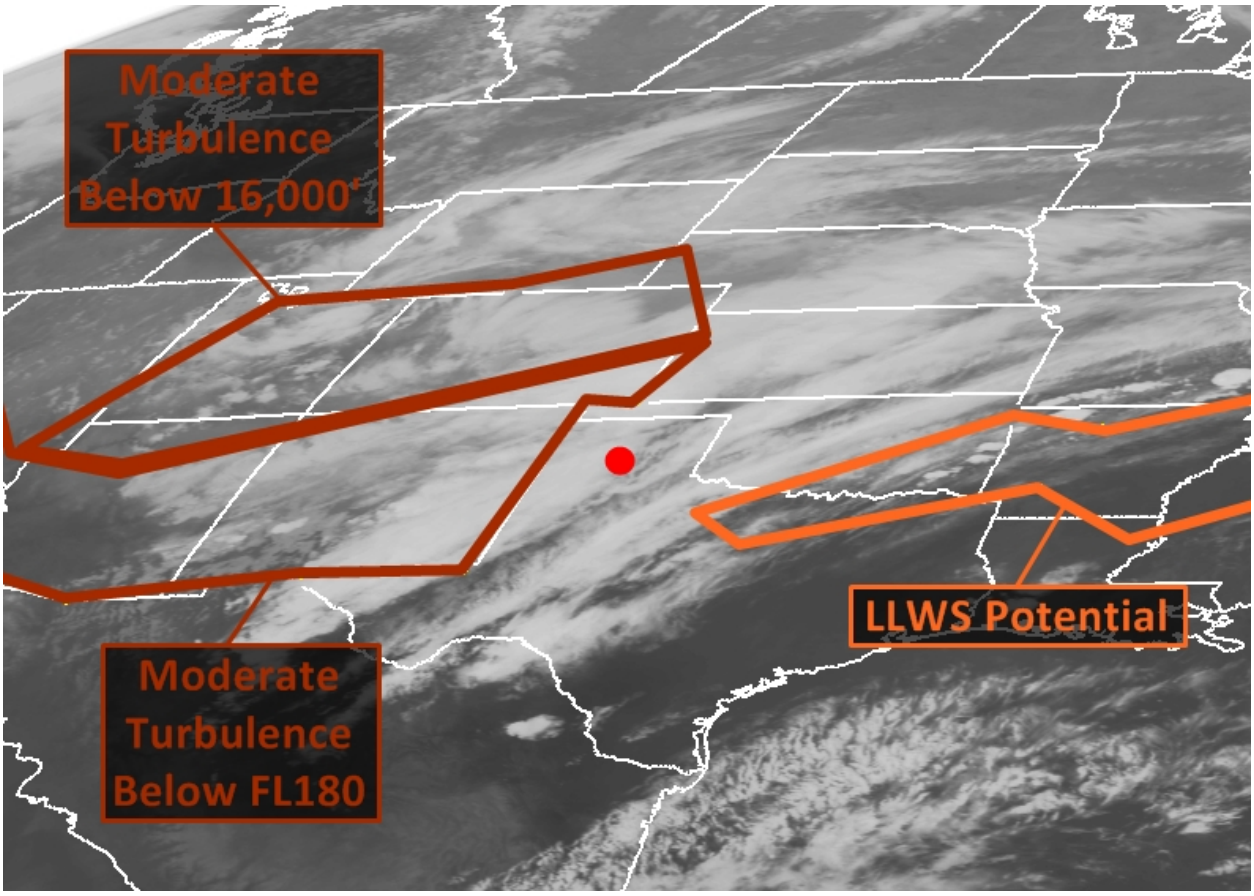

Figure 13 – Regional AIRMETs for turbulence below 10,000 feet and LLWS that were active at the accident time. Accident location denoted by the red dot. Overlaid onto GOES-13 infrared image from 2137 CDT.

There was an AIRMET active for turbulence below FL180 over the accident location, however this AIRMET's lower boundary was 10,000 feet. This AIRMET is depicted in figure 14.

At 2145 CDT, an AIRMET TANGO for moderate turbulence between 10,000 feet and FL180, was issued by the AWC:

WAUS44 KKCI 290245
WA4T
-DFWT WA 290245
AIRMET TANGO FOR TURB AND LLWS VALID UNTIL 290900
.
AIRMET TURB...OK TX AR SD NE KS MN IA MO WI IL IN
FROM 50S DLH TO 60ESE EAU TO 50SSE DLL TO 20NNW TTH TO 40W FAM TO 40SW SPS TO 50N INK TO 30ESE TBE TO 50W LBL TO GLD TO BFF TO 70SW RAP TO 20NNE PIR TO 30E ABR TO 50S DLH
MOD TURB BTN 100 AND FL180. CONDS CONTG BYD 09Z THRU 15Z

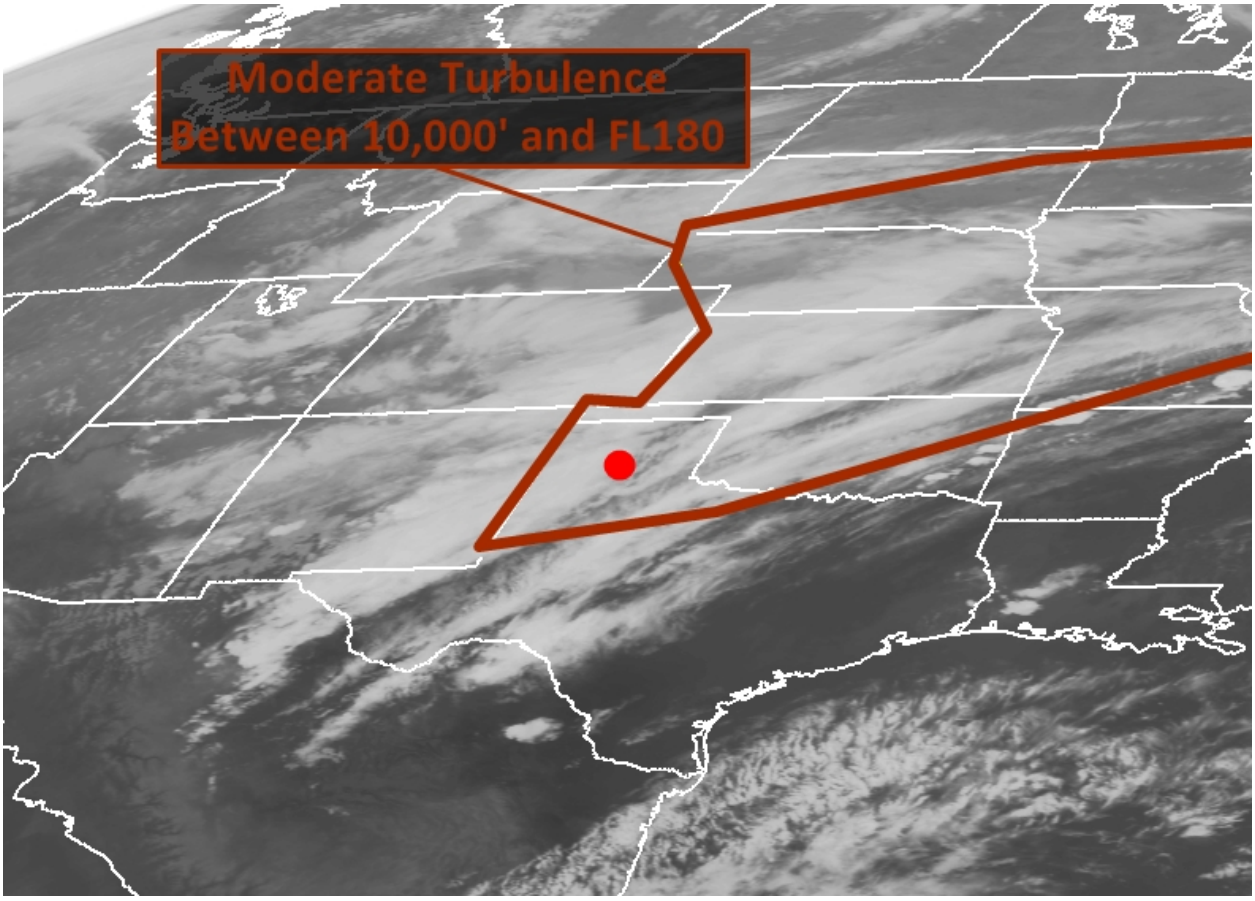

Figure 14 – Regional AIRMET for turbulence between 10,000 feet and FL180 that was active at the accident time. Accident location denoted by the red dot. Overlaid onto GOES-13 infrared image from 2137 CDT.

14.0 SIGMETs

There were no Convective or non-Convective Significant Meteorological Information (SIGMET) advisories active at the accident time that included the accident location within its published boundaries. However, the following Convective SIGMET issued at 2255 CDT was very close to the accident location (see Figure 15).

WSUS32 KKCI 290355
SIGC
MKCC WST 290355

CONVECTIVE SIGMET 10C
VALID UNTIL 0555Z
TX NM
FROM 60S LBL-30WSW CME-10ENE TCS-40N TCC-60S LBL
AREA TS MOV FROM 24020KT. TOPS TO FL390.
OUTLOOK VALID 290555-290955
FROM BVT-BNA-TXK-TCS-30NNE DBL-MCI-BVT

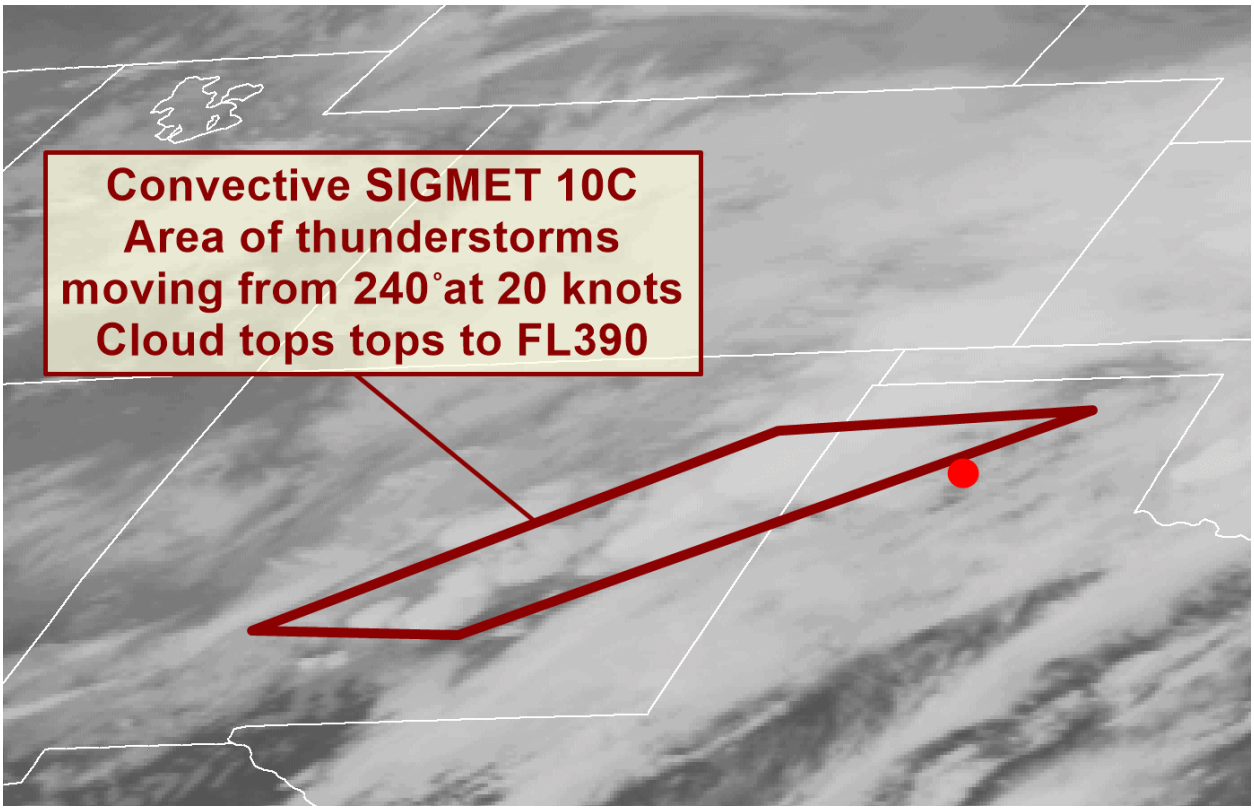

Figure 15 – Convective SIGMET 10C issued at 2255 CDT. Accident location denoted by the red dot. Overlaid onto GOES-13 infrared image from 2355 CDT.

According to the AWC[19], "Any Convective SIGMET implies severe or greater turbulence, severe icing, and low level wind shear."[20] Further, according to discussion with AWC staff, Convective SIGMETs are not geographically-static for their valid period, rather they should move with any movement vector included in that Convective SIGMET. National Weather Service Instruction 10-811 and FAA AC 00-45H both address the "movement" field (e.g., "MOV FROM 24045KT") in the text of a Convective SIGMET. The FAA AC 00-45H provides the following translation for the portion of the Convective SIGMET containing the movement field: "An intensifying area of severe thunderstorms moving from 240 degrees at 45 knots (to the northeast)." According to the Domestic Operations Branch Chief at the AWC (see Attachment 2), "On occasion when the thunderstorm cells contained in the [Convective SIGMET] are moving in vastly different direction than the [Convective SIGMET], we add a comment at the bottom of the [Convective SIGMET] something like "CELL MOV FROM 22040KT". Of course, we don't include all comment options in the NWS Directives, so most people don't know this."

[19] See Attachment 10, as well as: https://www.aviationweather.gov/sigmet/help
[20] Both the FAA's Aeronautical Information Manual (AIM) and the FAA's Advisory Circular (AC) 00-45H, Aviation Weather Services, provide this information as well.

15.0 CWSU Products

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

16.0 Prog Charts

According to the AWC, "The low-level graphics product is a forecast of aviation weather hazards, primarily intended to be used as a guidance product for briefing the VFR pilot. The forecast domain covers the 48 contiguous states, southern Canada and the coastal waters for altitudes below 24,000 ft. Low altitude Significant Weather ["Prog"] charts are issued four times daily and are valid at fixed times: 0000, 0600, 1200, and 1800 UTC. Each chart is divided on the left and right into 12 and 24 hour forecast intervals (based on the current NAM model available). The two panels depict freezing levels, turbulence, and low cloud ceilings and/or restrictions to visibility (shown as contoured areas of MVFR and IFR conditions)."

Figures 16-19 present low level prog charts valid for the times surrounding the accident time.

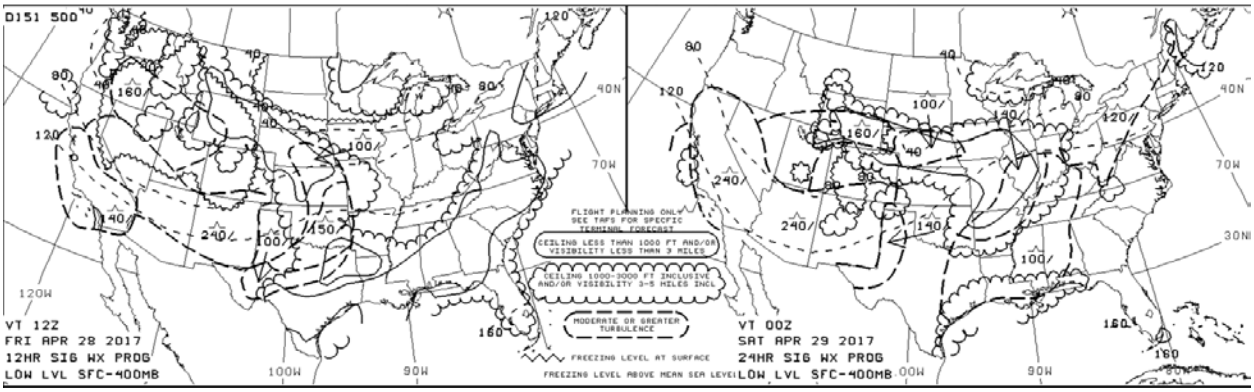

Figure 16 – Low level Prog chart issued at 1900 CDT on April 27, 2017, with the right-side panel, valid for 1900 CDT on the day of the accident, forecasting moderate or greater turbulence at or below 14,000 feet for a region that included Amarillo.

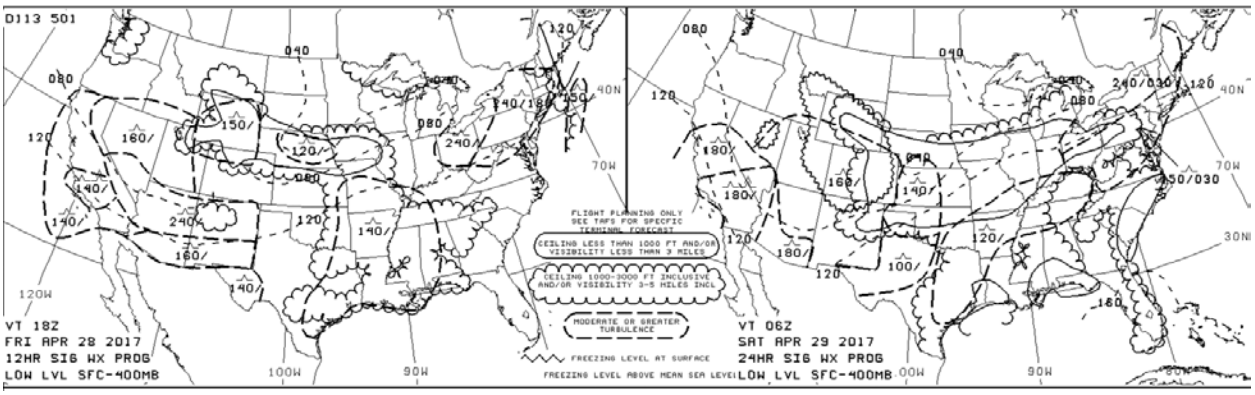

Figure 17 – Low level Prog chart issued at 0100 CDT on the day of the accident, with the right-side panel, valid for 0100 CDT on April 29, 2017, forecasting moderate or greater turbulence at or below 14,000 feet for a region that included Amarillo.

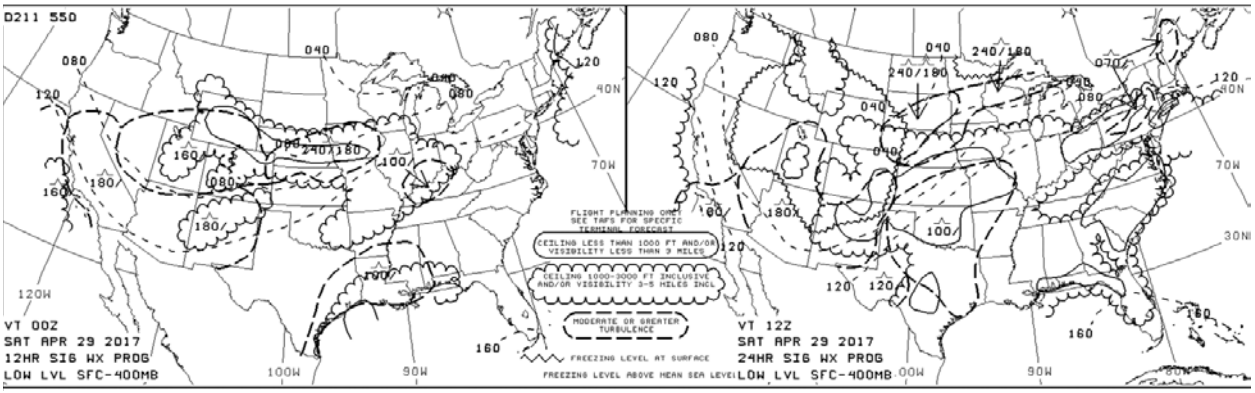

Figure 18 – Low level Prog chart issued at 0700 CDT on the day of the accident, with the left-side panel, valid for 1900 CDT on the day of the accident, not forecasting any turbulence for the Amarillo region.

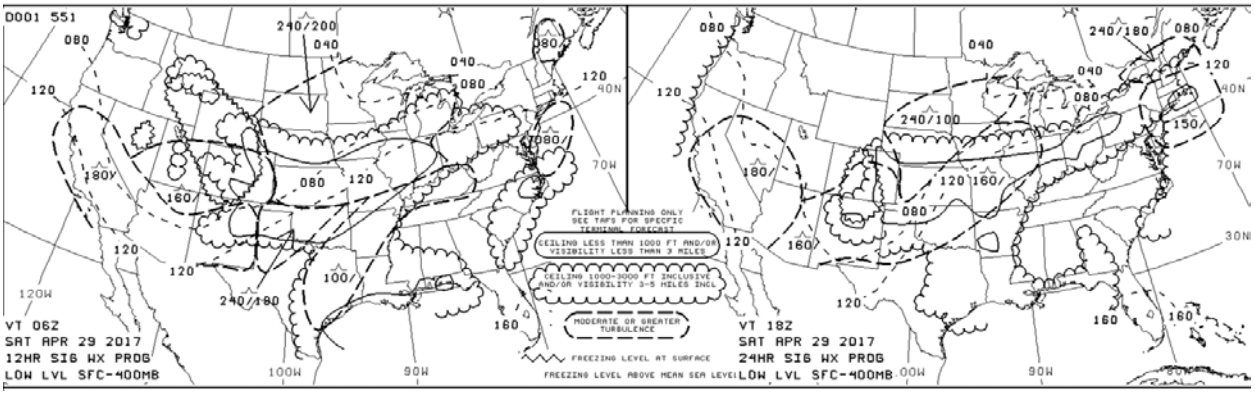

Figure 19 – Low level Prog chart issued at 1300 CDT on the day of the accident, with the left-side panel, valid for 0100 CDT on April 29, 2017, not forecasting any turbulence below FL180 for the Amarillo region.

17.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for 35° 12' north latitude and 101° 42' west longitude, for the accident location, indicated the following:

SUN	
Sunset	2030 CDT
End Civil Twilight	2057 CDT
MOON	
Moonset	2314 CDT

18.0 Preflight Weather Briefing

According to ForeFlight, the accident pilot retrieved a weather briefing for the accident flight (using tail number LN933DC) at 2303 CDT. The contents of the weather briefing are presented in Attachment 3.

According to ForeFlight:

> *The briefing was generated on 2017-04-29 at 0403z in conjunction with the flight plan being filed. We do not log whether it was read. However it would have displayed inside the app on the "File & Brief" page immediately after filing the plan. Inside the app they can view this "ForeFlight Briefing" format, or the "Legacy" briefing, whichever they prefer. The briefing is made available to any device that the pilot has signed-in to their ForeFlight account, either immediately or as soon as the device connects to the Internet. There were two iPads and one iPhone signed-in to their account.*
>
> *At the time that the briefing is generated in conjunction with filing a flight plan, we also email a copy of the briefing to the pilot's email address. They can then view the briefing the same way you did on any computer by clicking the link.*
>
> *The pilot also viewed multiple pieces of Weather Imagery prior to the flight. We do not archive the actual Weather Imagery that was viewed, but here is the list of which Imagery they retrieved at each time:*
>
> *4/28/2017 4:12 UTC: Latest Surface Analysis*
> *(from http://www.wpc.ncep.noaa.gov/#page=sfc, showing Fronts Only)*
>
> *4/28/2017 4:12 UTC: Today's Forecast*
> *(from http://www.wpc.ncep.noaa.gov/national_forecast/natfcst.php)*
>
> *4/28/2017 4:12 UTC: Day 3 Ending at 12Z Probability of Precipitation (PoP)*
> *(from http://www.wpc.ncep.noaa.gov/medr/pop_12hr.shtml)*
>
> *4/28/2017 4:17 UTC: MAV MOS Ceiling (6 HR)*

(from http://www.nws.noaa.gov/mdl/forecast/graphics/MAV/)

4/29/2017 1:16 UTC: Lowest Freezing Level (1 HR)
(from http://www.aviationweather.gov/icing/frzlvl)

4/29/2017 1:16 UTC: Lowest Freezing Level (2 HR)
(from http://www.aviationweather.gov/icing/frzlvl)

4/29/2017 1:16 UTC: Lowest Freezing Level (3 HR)
(from http://www.aviationweather.gov/icing/frzlvl)

4/29/2017 1:17 UTC: Lowest Freezing Level (5 HR)
(from http://www.aviationweather.gov/icing/frzlvl)

4/29/2017 1:17 UTC: Lowest Freezing Level (4 HR)
(from http://www.aviationweather.gov/icing/frzlvl)

19.0 Other Flight Crew Reports

Flight crew for several different aircraft that arrived/departed AMA within about one hour of the accident time were contacted regarding turbulence and/or weather conditions on the approach to/departure from AMA.

The first officer of an Embraer 170 that landed at AMA about 40 minutes prior to the accident time reported that there was nothing significant.

An Embraer 145 landed at AMA about 25 minutes prior to the accident time. About two weeks after the accident, the Director of Safety for that aircraft's operator provided information to the NTSB via email (see Attachment 4) that described the Embraer 145 flight crew's recollection of conditions encountered during its approach to AMA.

A Boeing 737 departed AMA about one hour after the accident time. On May 23, 2017, the FAA conducted a phone interview with the 737's flight crew regarding the weather conditions they experienced on departure from AMA, and provided a summary of that interview to the NTSB via email (see Attachment 5).

Following the initial phone interview, the FAA had phone conversations with the 737 flight crew where additional questions regarding weather were posed. The FAA provided summaries of those conversations to the NTSB via email (see Attachment 6).

Flight Data Recorder (FDR) data from the Boeing 737 was provided by the aircraft's operator. Plots of wind information recorded on the FDR data are included in Figure 20 (left and center panels; "FMC" and "IR-3" plots). The right panel in Figure 20 provides an NTSB derivation of the environmental temperature profile based on total air temperature and aircraft speed, which were retrieved from the FDR. The static air temperature information found in the FDR data was invalid. Please see the NTSB Performance Study for this accident for further information on the FDR dataset and descriptions of parameters plotted in Figure 20.

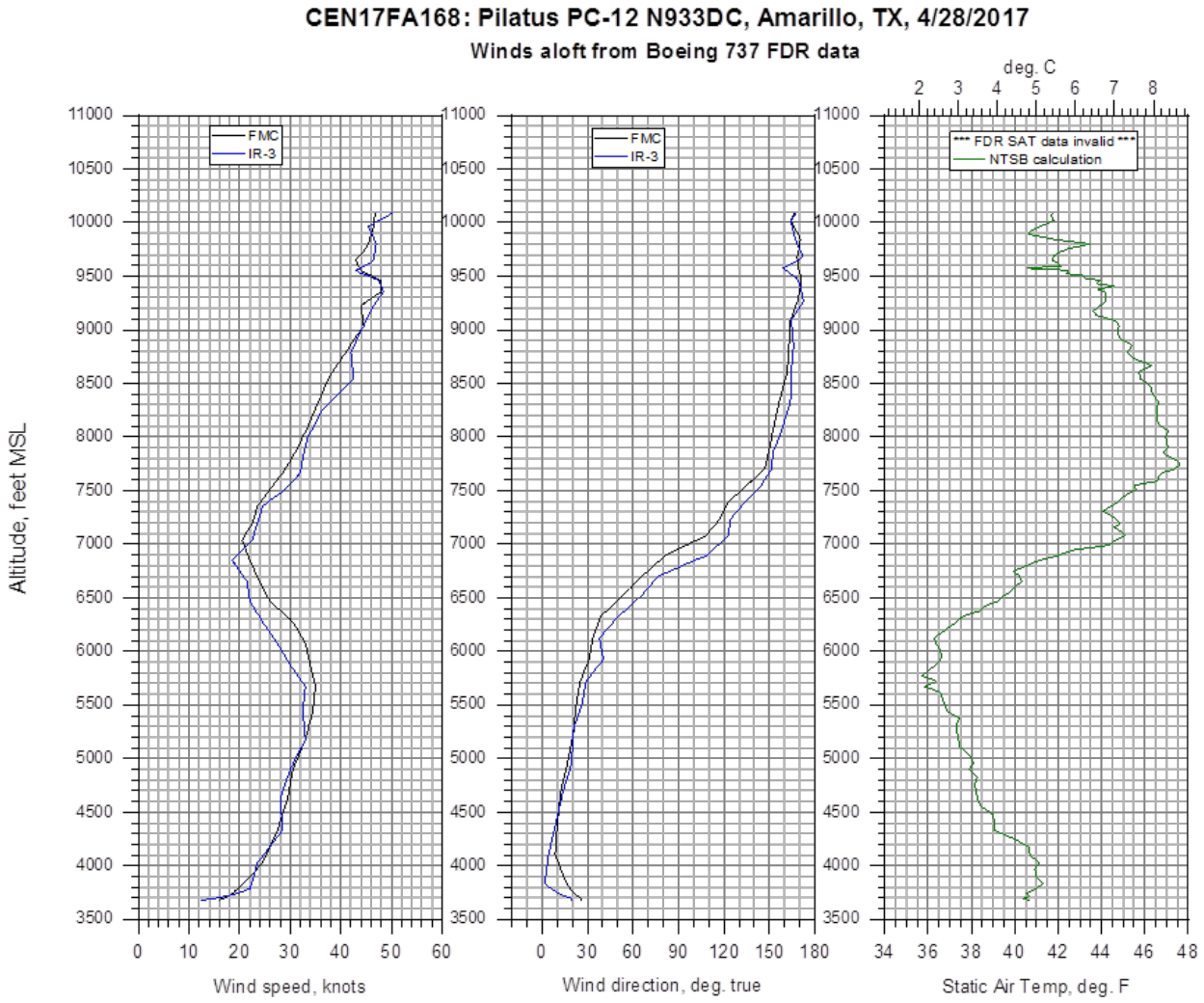

Figure 20 – Wind and environmental temperature profiles recorded on and derived from the FDR.

20.0 Additional Information

According to the NWS, NWSChat is an Instant Messaging program utilized by NWS operational personnel to share critical warning decision expertise and other types of significant weather information essential to the NWS's mission of saving lives and property. Logs of AWC NWSChat activity between 1300 CDT on April 28, 2017, and 0100 CDT on April 29, 2017, are presented in Attachment 7.

Statements were requested of three AWC forecasters on duty the night of the accident. These statements are presented in Attachment 8. Further, upon request from the NTSB, the AWC provided screenshots of meteorological guidance for turbulence on the night of the accident and pertinent to the accident region available to AWC forecasters prior to the issuance of the 2145 CDT AIRMETs. These screenshots are presented in Attachment 9.

A discussion with another AWC forecaster was recorded and a summary is presented in Attachment 10.

A copy of the "standard accident weather package" compiled by the ZAB CWSU and provided to the FAA at ZAB is presented in Attachment 11.

On May 8, 2017, the Warning Coordination Meteorologist for the NWS WFO in Amarillo, Texas, emailed (in part) the following text and imagery (figures 21-23) to an FAA inspector from the Lubbock Flight Standards District Office: *"Here are three images showing the wind shear zone at around 2500-3500 feet around 455Z as see from Amarillo radar. I used this time instead of 449Z as we don't have some higher slices of the radar at 455Z. Red shows wind away from the radar and green wind toward the radar. That spiral gray line indicates changing wind direction as the beam increases elevation with distance. You can see northerly wind near the surface and 40-60 southerly winds above 4000 ft. This is easiest to see in the 3D views. The box is defined by a rectangle in the plain view."*

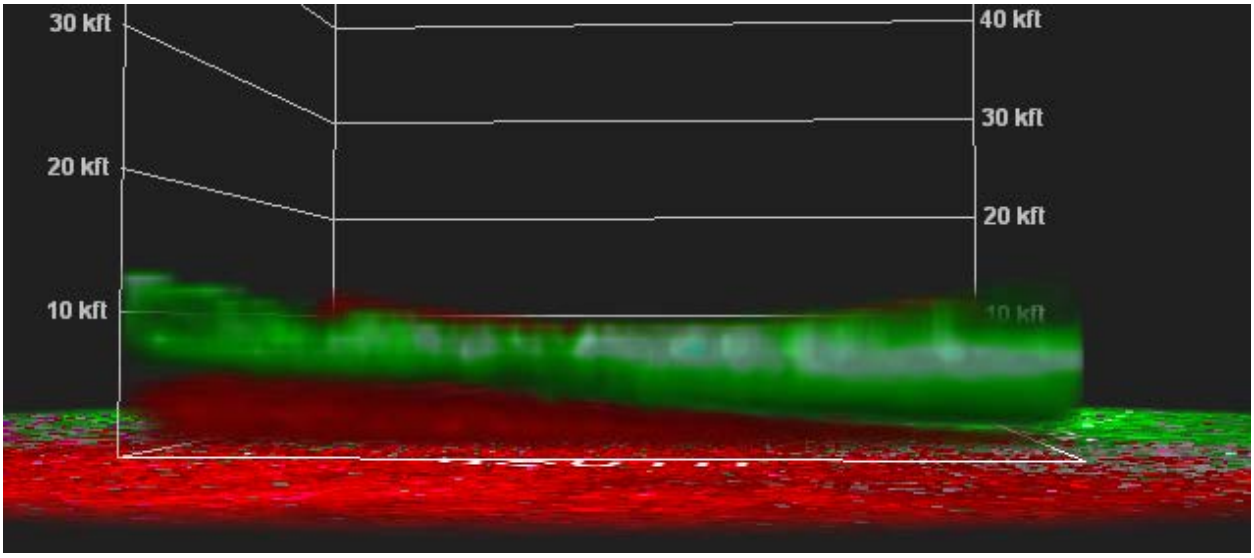

Figure 21 – One of three images included in the NWS Amarillo WFO Warning Coordination Meteorologist's email to an FAA inspector on May 8, 2017.

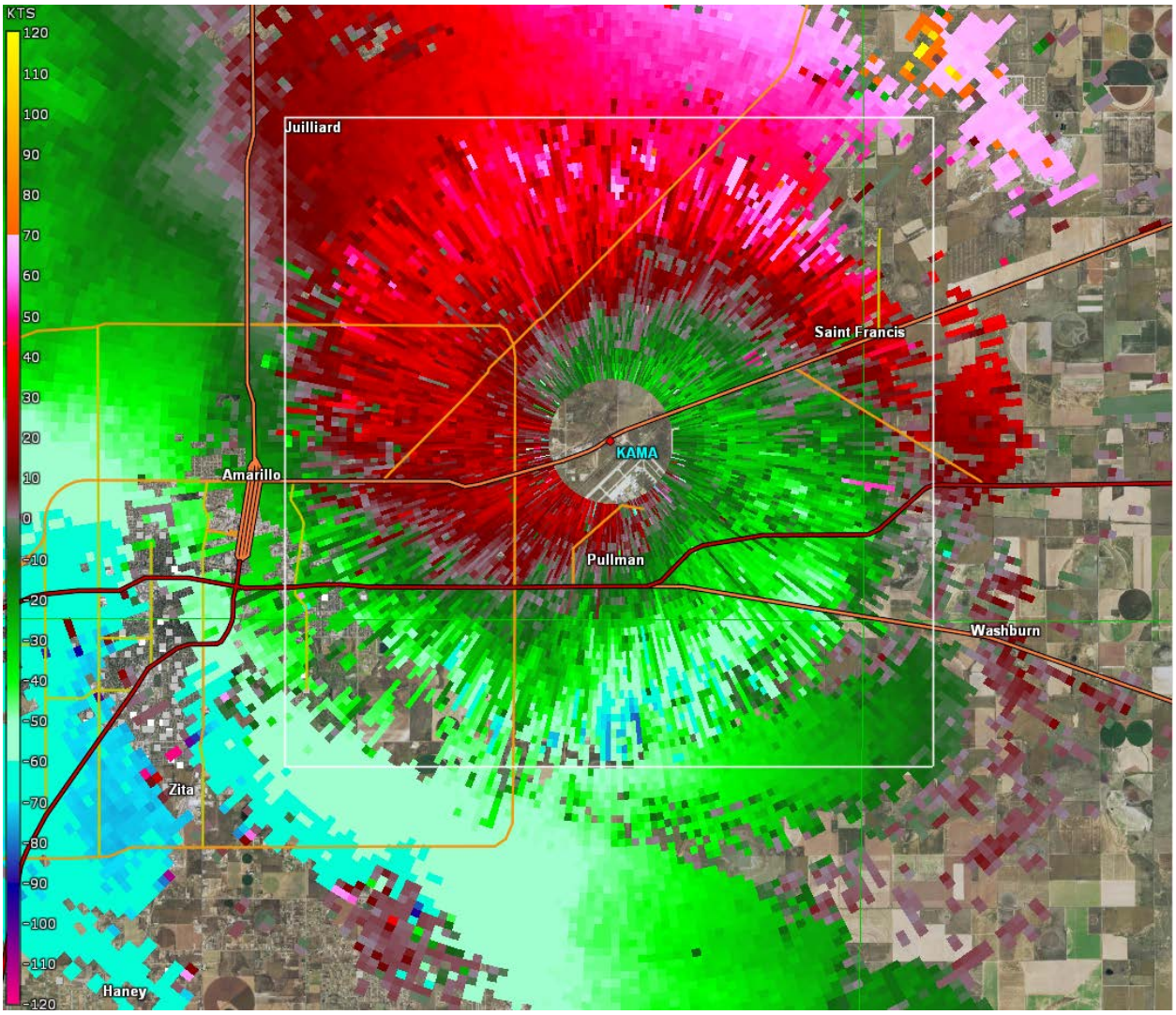

Figure 22 – One of three images included in the NWS Amarillo WFO Warning Coordination Meteorologist's email to an FAA inspector on May 8, 2017.

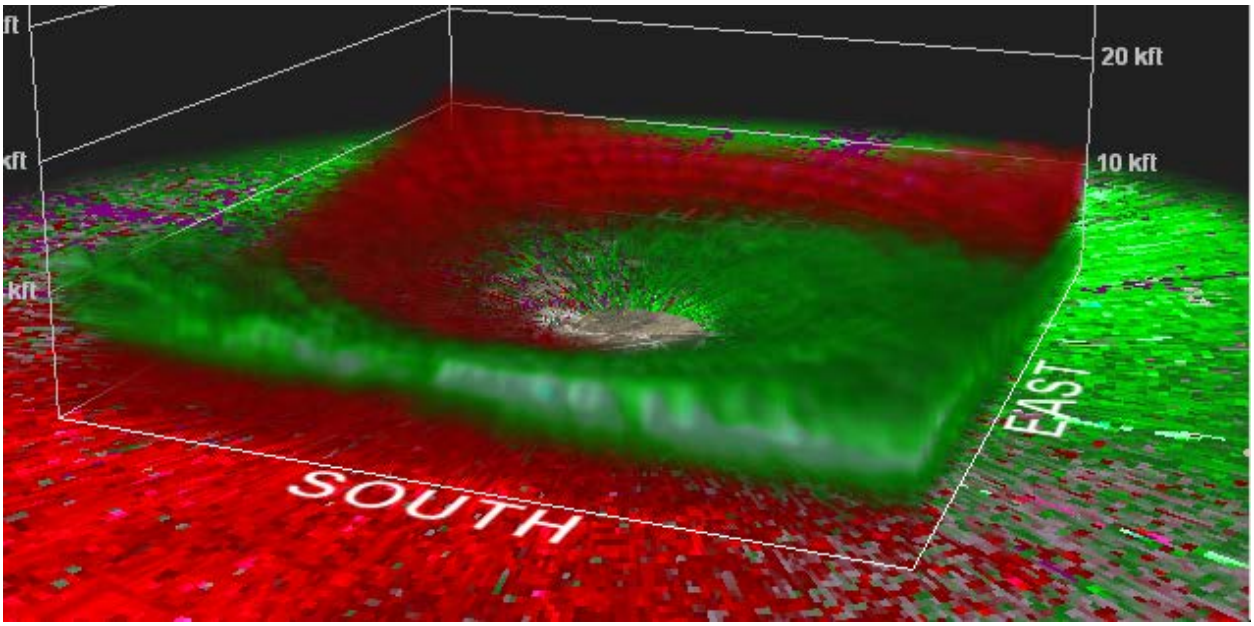

Figure 23 – One of three images included in the NWS Amarillo WFO Warning Coordination Meteorologist's email to an FAA inspector on May 8, 2017.

F. LIST OF ATTACHMENTS

Attachment 1 - GTG imagery for clear air turbulence at altitudes of 3,000, 5,000, 7,000 and 9,000 feet, applicable to times surrounding the accident time, that were publicly on the ADDS website during times surrounding the accident.

Attachment 2 - Email from the Domestic Operations Branch Chief at the Aviation Weather Center.

Attachment 3 - Contents of ForeFlight weather briefing generated at 2303 CDT. The "Legacy Briefing" portion of the briefing has been removed.

Attachment 4 - Email summarizing an Embraer 145 flight crew's description of encountered weather near AMA on the night of the accident.

Attachment 5 - Initial email summarizing a Boeing 737's flight crew's description of encountered weather near AMA on the night of the accident.

Attachment 6 - Additional emails summarizing a Boeing 737's flight crew's description of encountered weather near AMA on the night of the accident.

Attachment 7 - Logs of AWC NWSChat activity between 1300 CDT on April 28, 2017, and 0100 CDT on April 29, 2017.

Attachment 8 - Statements from three AWC forecasters on duty the night of the accident.

Attachment 9 - Screenshots of meteorological guidance for turbulence on the night of the accident and pertinent to the accident region available to AWC forecasters prior to the issuance of the 2145 CDT AIRMETs.

Attachment 10 - Record of conversation with an AWC forecaster.

Attachment 11 - A copy of the “standard accident weather package” compiled by the ZAB CWSU and provided to the FAA at ZAB

Submitted by:

_____

Mike Richards
Senior Meteorologist

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