



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

November 28, 2017

Weather Study

METEOROLOGY

CEN17FA209

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A. AIRCRAFT ACCIDENT

Location: Dimmitt, Texas
Date: June 3, 2017
Time: 1437 central daylight time
1937 Coordinated Universal Time (UTC)
Airplane: Robinson R44 II; Registration: N7091F

B. METEOROLOGIST

Don Eick
Meteorologist Specialist
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National Transportation Safety Board

C. SUMMARY

On June 3, 2017, about 1437 central daylight time, a Robinson R44 II single-engine helicopter, N7091F, impacted terrain while maneuvering near Dimmitt, Texas. The private pilot, who was the sole occupant, sustained fatal injuries, and the helicopter sustained substantial damage. The helicopter was registered to Don Oppliger Trucking, Inc, Clovis, New Mexico, and operated by a private individual under Title 14 *Code of Federal Regulations* Part 91 as a business flight. Visual meteorological conditions prevailed at the time of the accident, and a flight plan was not filed for the local flight. The flight departed a private helipad near Farwell, Texas, about 1300.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Senior Meteorologist was not on scene for this investigation and conducted the meteorology phase of the investigation from the Washington D.C. office, collecting data from official National Weather Service (NWS) sources including the Weather Prediction Center (WPC) and the National Center for Environmental Information (NCEI). All times are central daylight time (CDT) based upon the 24 hour clock, local time is +5 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 34.420571° N and longitude 102.512262° W, at an elevation of about 3,867 feet (ft).

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 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 00-45H.

1.1 Surface Analysis Chart

The southcentral section of the NWS Surface Analysis Chart for 1300 CDT (1800Z) on June 3, 2017 is included as figure 1, with the approximate accident site marked by a red star. The chart depicted a stationary front extending across western Kansas where a frontal wave or low-pressure system at 1014-hectopascals (hPa) was located, with a cold front extending south-southwestward across the Oklahoma and Texas panhandles into eastern New Mexico. The accident site was located south of the cold front in the warm side of the front. To the east of the accident site, a dissipating stationary front was located over southern Oklahoma eastward through southern Arkansas, into Mississippi and Alabama. Several troughs of low pressure and an outflow boundary associated with thunderstorms were noted over eastern Texas. A weak pressure gradient was noted over northwestern Texas with generally light winds of 10 knots or less.

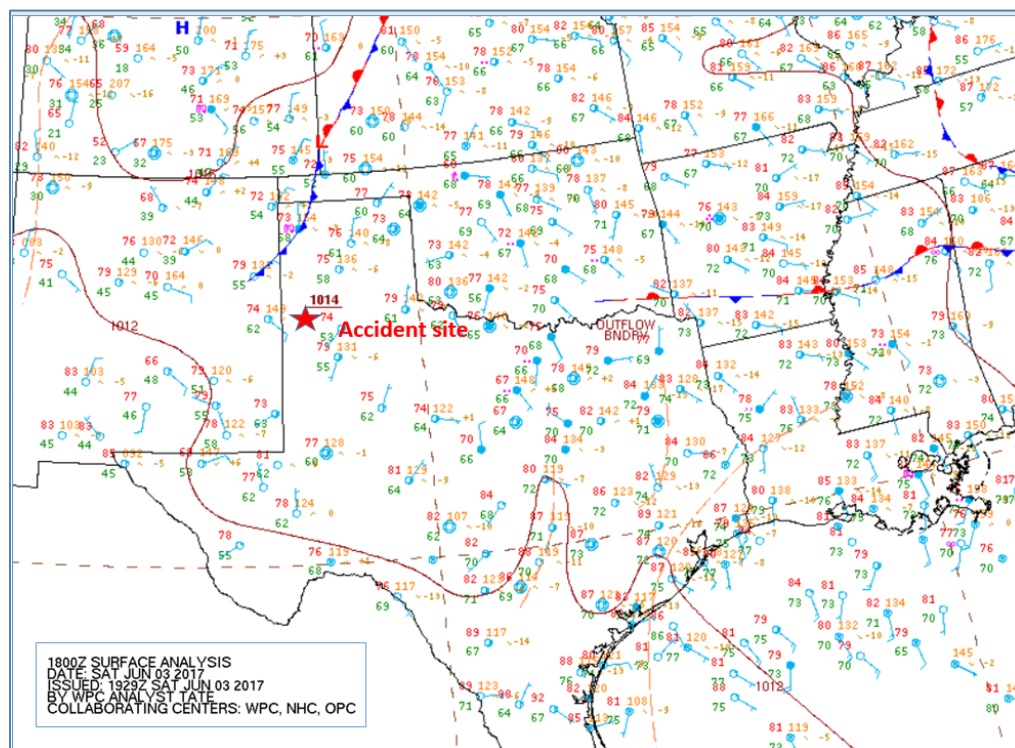


Figure 1 - Southcentral portion of the NWS Surface Analysis Chart for 1300 CDT

The station models in the immediate vicinity of the accident site on the 1300 CDT Surface Analysis Chart depicted southerly winds south of the accident site at 10 knots or less, scattered to broken sky conditions, with temperatures of 74° to 75° Fahrenheit (F), with dew point temperatures near 55° F. Further east, over the Texas and Oklahoma border the station models depicted a cyclonic or counter-clockwise wind flow pattern with numerous stations reporting rain and thunderstorms.

The next chart issued at 1600 CDT (2100Z) is included as figure 2 and continued to depict the low-pressure system over southwestern Kansas decreasing to 1012-hPa with the cold front extending southwestward into northern Texas and into New Mexico, to the north of the accident site. A trough of low pressure extended south-southwest from the cyclonic circulation center over the Texas and Oklahoma border. The station models immediately west and southeast of the accident site depicted east-southeast wind of 5 knots with stations to the north reporting north-northeasterly winds of 5 to 10 knots. Temperatures ranged from 78° to 80° F over Texas, with dew point temperatures from 54° to 59° F. To the west, thunderstorms and rain showers were reported near Clovis, New Mexico.

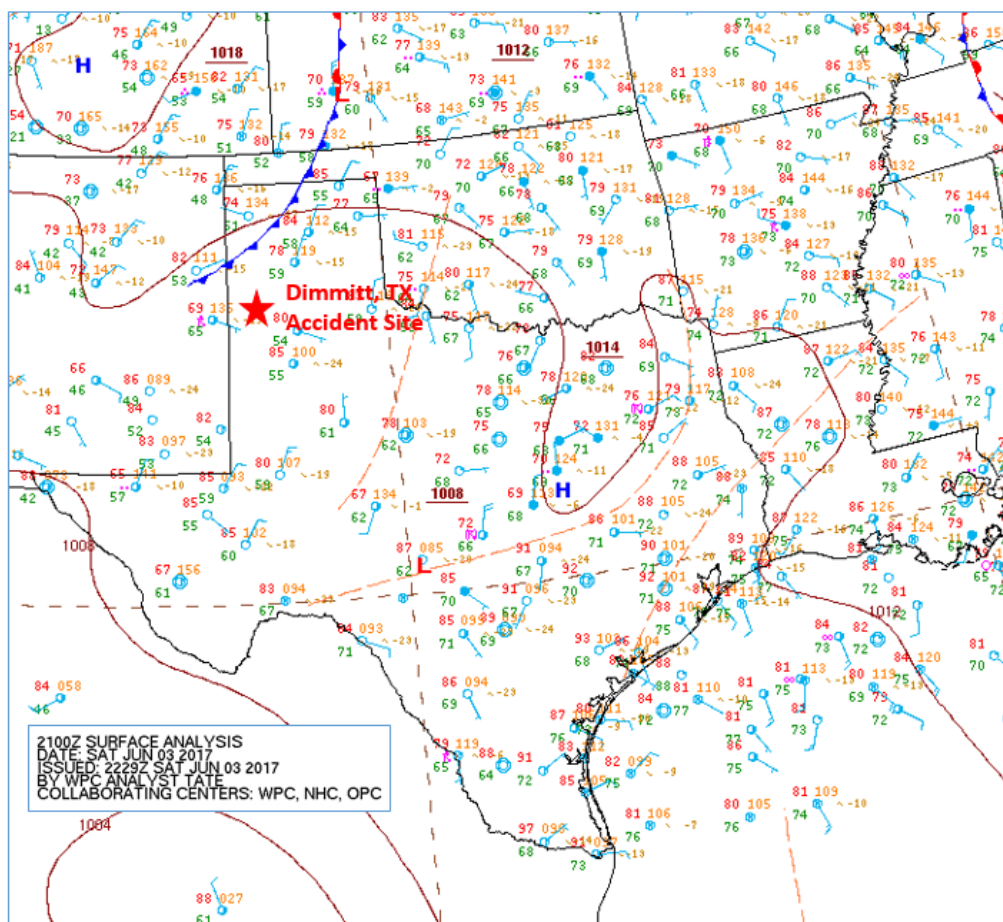


Figure 2 - Southcentral NWS Surface Analysis Chart for 1600 CDT

1.2 National Composite Radar Image

The NWS National Composite Radar Image at 1440 CDT (1940Z) on June 3, 2017 zoomed into the Dimmitt, Texas area is included as figure 3. The image depicted no significant echoes over the accident site, which is marked by a red star. A broken line of echoes associated with thunderstorms was located about 27 miles west of the accident site, moving eastward with time. Another area of echoes with intense radar reflectivity's was located about 25 miles east.

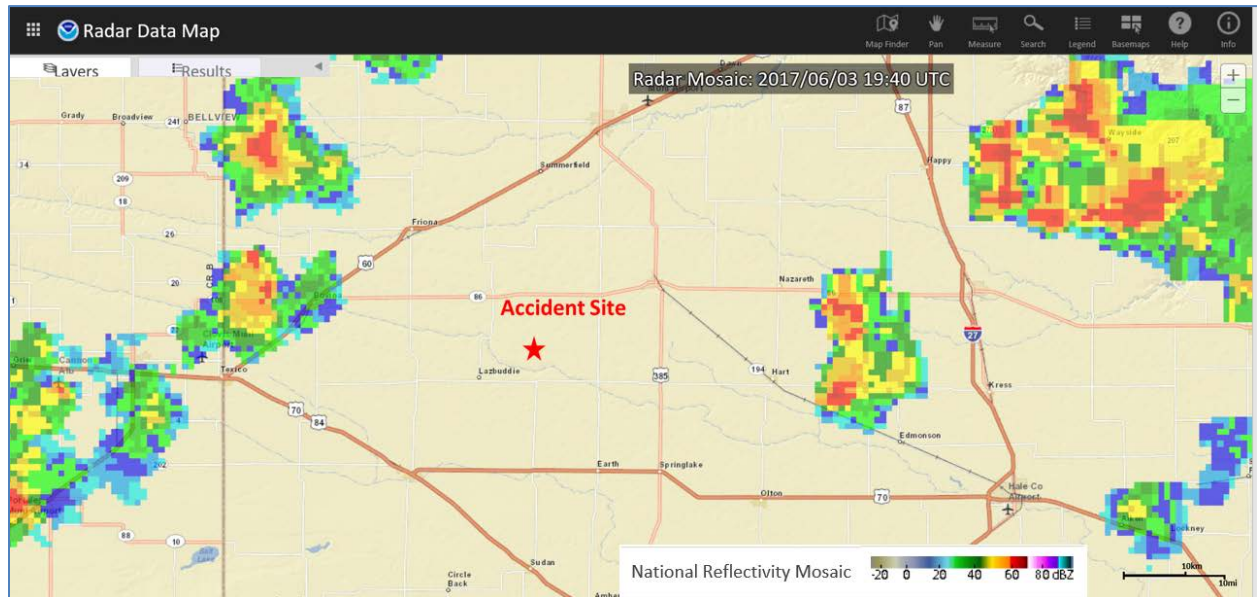


Figure 3 - National Composite Radar Reflectivity image at 1440 CDT

The closest NWS Weather Surveillance Radar will be further documented in section 5.0 of this report.

1.3 12-Hour Surface Prognostic Chart

The NWS 12-hour Surface Prognostic Chart valid at the time of the accident for 0100 CDT (0600Z) on June 4, 2017 is included as figure 4. The chart depicted a low-pressure system over northern Texas with a stationary front extending eastward across the southeast. A large area of rain showers and thunderstorms were expected over the southcentral United States shown by a red hatched area, with rain coverage less than 50% of the area by light green shading and over 50% coverage in dark green. Scattered rain showers and thunderstorms with less than 50% coverage was expected over eastern New Mexico and the Texas Panhandle during the period.

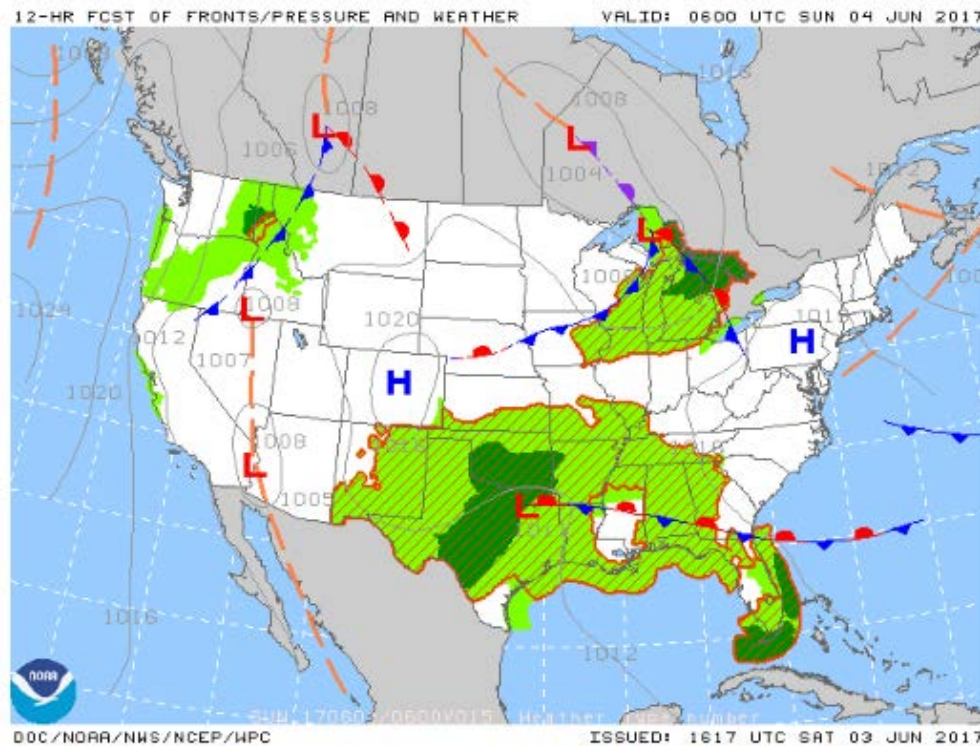


Figure 4 - NWS 12-hour Surface Prognostic Chart valid for 0100 CDT June 4, 2017

1.4 Convective Outlook

The NWS Storm Prediction Center's (SPC) Convective Outlook Chart issued at 1127 CDT and valid for the accident period is included as figure 5. The chart expected a general risk of thunderstorms over the region during the period.

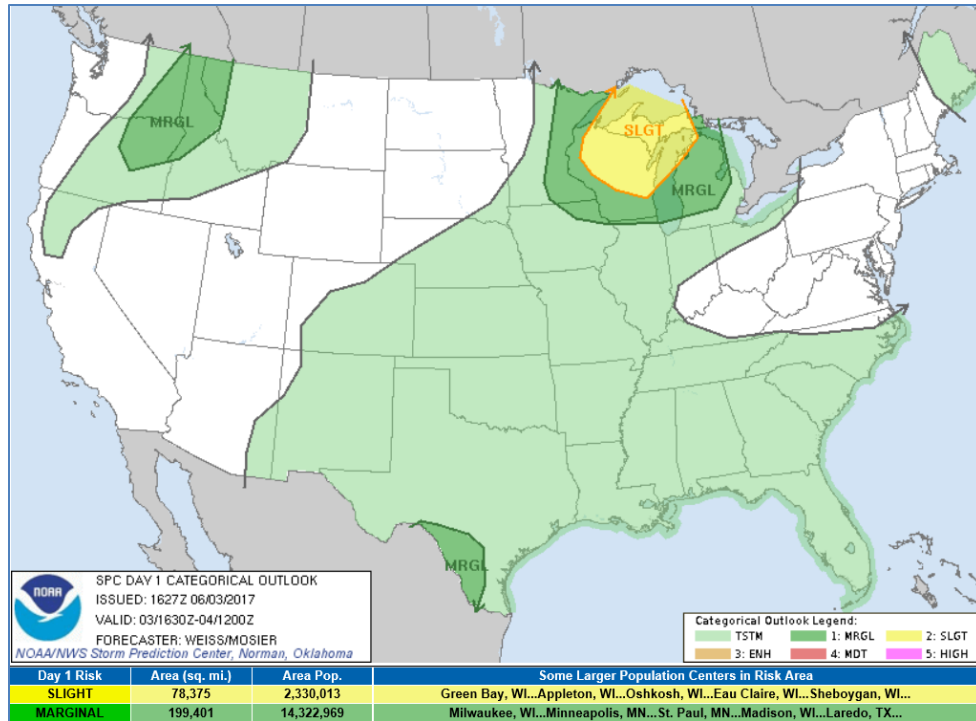


Figure 5 - Convective Outlook valid from 1130 CDT through 0700 CDT

SPC AC 031627
 Day 1 Convective Outlook
 NWS Storm Prediction Center Norman OK
 1127 AM CDT Sat Jun 03 2017

Valid 031630Z - 041200Z

...THERE IS A SLIGHT RISK OF SEVERE THUNDERSTORMS OVER THE UPPER GREAT LAKES REGION...

...THERE IS A MARGINAL RISK OF SEVERE THUNDERSTORMS FROM THE UPPER MISSISSIPPI VALLEY INTO THE GREAT LAKES...

...THERE IS A MARGINAL RISK OF SEVERE THUNDERSTORMS OVER PARTS OF SOUTH TEXAS...

...THERE IS A MARGINAL RISK OF SEVERE THUNDERSTORMS OVER THE NORTHERN INTERMOUNTAIN REGION...

...Parts of South Texas...

Water vapor imagery indicates a slow moving upper vorticity max over northern Mexico to the immediate south of ELP. Downstream from this system, strong convection has been occurring over higher terrain west of the Rio Grande. Strong heating over the lower valley where weak southeast low-level winds veer to modest westerly flow in the mid-levels may support a few storms spreading eastward across the border into parts of southern Texas. Isolated hail and strong wind gusts will be possible later this afternoon and evening.

2.0 Surface Observations

The surrounding area was documented using official Meteorological Aerodrome Reports (METARs) across the region. The magnetic variation over the area was estimated at 9° East based on the local sectional chart. Cloud heights are reported in ft above ground level (agl) in this section.

2.1 Hereford, Texas

The closest weather reporting location to the accident site was from Hereford Municipal Airport (KHRX), Hereford, TX, was located about 28 miles north-northeast at an elevation of 3,788 ft. The airport had an Automated Weather Observation System (AWOS), which issues an observation every 20-minutes. The following conditions were reported at the approximate time of the accident:

KHRX weather at 1435 CDT, automated, wind from 070° at 3 knots, visibility unrestricted at 10 miles or more, scattered clouds at 4,000 ft, temperature 26° Celsius (C), dew point temperature 14° C, altimeter 30.06 inches of mercury (Hg). Remarks: automated weather system with a precipitation discriminator, lightning distant¹ southwest, temperature 26.2° C, dew point 13.8° C.

A review of the observations surrounding the period indicated that between 0500 to 1000 CDT low instrument flight rule (LIFR) conditions were reported due to low ceilings and visibility in fog and mist. Conditions improved to visual flight rule (VFR) conditions with no significant clouds below 12,000 ft reported or clear skies and unrestricted visibility through the afternoon. At 1435 CDT through 1800 CDT distant lightning was reported at the station, with thunderstorms reported in the vicinity at 1535 and 1615 CDT, and at the airport at 1635 CDT when wind gusts of 36 knots were reported. The raw observations and general flight categories² during the period were as follows:

LIFR METAR KHRX 031215Z AUTO 00000KT M1/4SM FG OVC001 15/14 A3007 RMK AO2 T01450144
LIFR METAR KHRX 031235Z AUTO 17004KT 1/2SM FG OVC001 15/15 A3008 RMK AO2 T01470147
LIFR METAR KHRX 031255Z AUTO 00000KT 3/4SM BR OVC001 15/15 A3008 RMK AO2 T01510151
LIFR METAR KHRX 031315Z AUTO 15006KT 5SM BR OVC001 15/15 A3008 RMK AO2 T01520152
LIFR METAR KHRX 031335Z AUTO 15005KT 7SM OVC003 16/16 A3009 RMK AO2 T01550155

¹ Distant – with regards to lightning means beyond 10 miles but less than 30 miles from the airport location point.

² As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories:

- Low Instrument Flight Rules (LIFR*) – ceiling or lowest layer of clouds reported as broken, overcast or the vertical visibility into a surface based obscuration below 500 ft agl and/or visibility less than 1 statute mile.
- Instrument Flight Rules (IFR) – ceiling between 500 to below 1,000 feet agl and/or visibility 1 to less than 3 miles.
- Marginal Visual Flight Rules (MVFR**) – ceiling from 1,000 to 3,000 ft agl and/or visibility 3 to 5 miles.
- Visual Flight Rules (VFR) – ceiling greater 3,000 ft agl and visibility greater than 5 miles.

* By definition, IFR is a ceiling less than 1,000 ft agl and/or visibility less than 3 miles while LIFR is a sub-category of IFR.

**By definition, VFR is a ceiling greater than or equal to 3,000 ft agl and visibility greater than 5 miles while MVFR is a sub-category of VFR.

LIFR METAR KHRX 031355Z AUTO 17004KT 10SM OVC003 16/16 A3009 RMK AO2 T01590159
 LIFR METAR KHRX 031415Z AUTO 14004KT 10SM OVC003 17/17 A3010 RMK AO2 T01650165
 VFR METAR KHRX 031435Z AUTO 17004KT 10SM SCT003 BKN080 17/17 A3010 RMK AO2 T01650165
 VFR METAR KHRX 031455Z AUTO 20004KT 10SM SCT003 SCT080 17/17 A3010 RMK AO2 T01700169
 VFR METAR KHRX 031515Z AUTO 18003KT 10SM SCT090 18/16 A3010 RMK AO2 T01830164
 VFR METAR KHRX 031535Z AUTO 00000KT 10SM CLR 19/16 A3010 RMK AO2 T01900159
 VFR METAR KHRX 031555Z AUTO 00000KT 10SM CLR 20/16 A3010 RMK AO2 T02020157
 VFR METAR KHRX 031615Z AUTO 33003KT 10SM CLR 21/15 A3010 RMK AO2 T02080153
 VFR METAR KHRX 031635Z AUTO 00000KT 10SM CLR 21/15 A3009 RMK AO2 T02100154
 VFR METAR KHRX 031655Z AUTO 00000KT 10SM CLR 22/15 A3009 RMK AO2 T02230153
 VFR METAR KHRX 031715Z AUTO 00000KT 10SM CLR 23/15 A3009 RMK AO2 T02280152
 VFR METAR KHRX 031735Z AUTO 00000KT 10SM CLR 24/15 A3009 RMK AO2 T02440154
 VFR METAR KHRX 031755Z AUTO 09004KT 10SM CLR 25/15 A3009 RMK AO2 T02490147 10250 20142=
 VFR METAR KHRX 031815Z AUTO 02008KT 10SM SCT032 24/15 A3009 RMK AO2 T02430150=
 VFR METAR KHRX 031835Z AUTO 08008KT 10SM CLR 24/15 A3009 RMK AO2 T02440145=
 VFR METAR KHRX 031855Z AUTO 06004KT 10SM CLR 26/14 A3008 RMK AO2 T02560143=
 VFR METAR KHRX 031915Z AUTO 02008KT 10SM SCT040 26/14 A3008 RMK AO2 T02580141=
 VFR **METAR KHRX 031935Z AUTO 07003KT 10SM SCT040 26/14 A3006 RMK AO2 LTG DSNT SW T02620138=**
Accident 1937Z
 VFR METAR KHRX 031955Z AUTO 03005KT 10SM SCT040 27/14 A3005 RMK AO2 LTG DSNT E AND NW T02690144=
 VFR METAR KHRX 032015Z AUTO 03008KT 10SM CLR 28/14 A3004 RMK AO2 LTG DSNT E AND NW T02790141=
 VFR METAR KHRX 032035Z AUTO 02008KT 360V060 10SM VCTS CLR 28/13 A3004 RMK AO2 LTG DSNT N
 T02820129=
 VFR METAR KHRX 032055Z AUTO 02004KT 10SM CLR 27/13 A3003 RMK AO2 LTG DSNT ALQS T02730127=
 VFR METAR KHRX 032115Z AUTO 36012KT 10SM VCTS SCT065 SCT070 SCT095 28/13 A3003 RMK AO2 LTG DSNT N
 AND E T02760126=
 VFR METAR KHRX 032135Z AUTO 34021G36KT 10SM TS SCT060 SCT095 22/10 A3004 RMK AO2 LTG DSNT ALQS
 T02150099=
 VFR METAR KHRX 032155Z AUTO 03008KT 7SM -RA SCT026 SCT036 BKN085 18/15 A3004 RMK AO2 LTG DSNT
 ALQS T01800153=
 VFR METAR KHRX 032235Z AUTO 04004KT 10SM CLR 19/16 A3004 RMK AO2 LTG DSNT NE AND E T01930159=
 VFR METAR KHRX 032255Z AUTO 03005KT 10SM SCT110 20/17 A3004 RMK AO2 LTG DSNT NE THRU S T02020168

2.2 Clovis, New Mexico

The next closest official weather reporting location to the accident site was from Clovis Municipal Airport (KCVN), Clovis, NM, 28 miles west of the accident site at an elevation of 4,216 ft. The airport had an AWOS installed and reported the following conditions at about the time of the accident:

KCVN weather at 1435 CDT, winds from 080° at 5 knots, visibility 10 miles with thunderstorms in the vicinity, ceiling broken at 6,000 ft, temperature 26° C, dew point 12° C, and an altimeter setting of 30.07 inches of Hg. Remarks: automated weather station without a precipitation discriminator, lightning distant southwest, thunderstorm began at 1425 CDT.

A review of the observations surrounding the period did not indicate any morning fog issues such as reported with KHRX and reported lightning in the distance surrounding the station between 1335 through 1815 CDT with a thunderstorm reported at the airport at 1515 CDT. The raw observations and flight categories reported surrounding the period were as follows:

VFR METAR KCVN 031755Z AUTO 12006KT 10SM CLR 23/12 A3010 RMK AO1 10230 20130 54000
 VFR METAR KCVN 031815Z AUTO 12005KT 10SM CLR 24/12 A3009 RMK AO1
 VFR METAR KCVN 031835Z AUTO 11008KT 10SM CLR 26/12 A3009 RMK AO1 LTG DSNT W
 VFR METAR KCVN 031855Z AUTO 14005KT 10SM CLR 24/12 A3008 RMK AO1 LTG DSNT SW=
 VFR METAR KCVN 031915Z AUTO 10003KT 10SM SCT060 26/12 A3007 RMK AO1 LTG DSNT NE=
 VFR **METAR KCVN 031935Z AUTO 08005KT 10SM VCTS BKN060 26/12 A3007 RMK AO1 LTG DSNT SW TSB24=**

Accident 1937Z

VFR METAR KCVN 031955Z AUTO 10008KT 9SM VCTS OVC060 25/11 A3006 RMK AO1 LTG DSNT SW TSB24=
MVFR METAR KCVN 032015Z AUTO 08007KT 5SM TS FEW025 SCT034 BKN060 19/14 A3006 RMK AO1 LTG DSNT N=
VFR METAR KCVN 032035Z AUTO 07004KT 10SM VCTS FEW025 SCT044 BKN075 21/14 A3006 RMK AO1 LTG DSNT
N=
VFR METAR KCVN 032055Z AUTO 00000KT 10SM VCTS FEW065 BKN075 22/13 A3005 RMK AO1 LTG DSNT ALQDS
TSE39B46 57017=
VFR METAR KCVN 032115Z AUTO 32006KT 10SM VCTS FEW065 SCT090 22/15 A3005 RMK AO1 LTG DSNT ALQDS=
VFR METAR KCVN 032135Z AUTO 31004KT 10SM VCTS FEW090 SCT110 21/14 A3005 RMK AO1 LTG DSNT ALQDS
TSE18B31=
VFR METAR KCVN 032155Z AUTO 32006KT 10SM BKN110 21/14 A3005 RMK AO1 LTG DSNT ALQDS TSE18B31E46=
VFR METAR KCVN 032235Z AUTO 02007KT 10SM FEW100 SCT120 22/14 A3004 RMK AO1 LTG DSNT E
VFR METAR KCVN 032255Z AUTO 01008KT 10SM FEW120 22/13 A3004 RMK AO1 LTG DSNT E
VFR METAR KCVN 032315Z AUTO 02009KT 10SM CLR 22/14 A3004 RMK AO1 LTG DSNT E
VFR METAR KCVN 032355Z AUTO 05010KT 10SM CLR 22/13 A3004 RMK AO1 10270 20190 402700130 57003

2.3 Plainview, Texas

The next closest reporting site was from Hale County Airport (KPVW), Plainview, TX, located 42 miles south-southeast of the accident site at an elevation of 3,374 ft. The airport had an AWOS and reported the following conditions at the time of the accident:

KPVW weather observation at 1435 CDT, automated, wind from 260° at 3 knots, visibility unrestricted at 10 miles or more, scattered clouds at 5,000 ft, ceiling broken at 6,500 ft, overcast at 7,500 ft, temperature 24° C, dew point 12° C, altimeter 30.01 inches of Hg. Remarks: automated weather system with a precipitation discriminator, temperature 24.4° C, dew point 11.9° C.

A review of the observations indicated that IFR conditions were reported at the station between 0715 through 1015 CDT due to low ceilings and visibility in fog and mist. VFR conditions were reported after 1015 through 1635 CDT, when rain showers and thunderstorms were reported with gusts to 29 knots, and temporary heavy rain and high based storms at 6,000 ft agl. The raw observations and flight categories during the period were as follows:

LIFR METAR KPVW 031215Z AUTO 04003KT 3/4SM BR OVC003 15/15 A3004 RMK AO2 T01510150
LIFR METAR KPVW 031235Z AUTO 00000KT 1SM BR OVC003 15/15 A3005 RMK AO2 T01500147
LIFR METAR KPVW 031255Z AUTO 01003KT 1 1/2SM BR OVC003 15/15 A3006 RMK AO2 T01530150
LIFR METAR KPVW 031315Z AUTO 00000KT 5SM BR OVC003 15/15 A3006 RMK AO2 T01540149
LIFR METAR KPVW 031335Z AUTO 00000KT 5SM BR OVC003 16/15 A3006 RMK AO2 T01580150
LIFR METAR KPVW 031355Z AUTO 13003KT 5SM BR OVC003 16/15 A3006 RMK AO2 T01590152
LIFR METAR KPVW 031415Z AUTO 00000KT 3SM BR OVC003 16/15 A3007 RMK AO2 T01590154
LIFR METAR KPVW 031435Z AUTO 00000KT 7SM OVC003 16/15 A3007 RMK AO2 T01640154
IFR METAR KPVW 031455Z AUTO 00000KT 10SM OVC005 17/16 A3007 RMK AO2 T01700155
IFR METAR KPVW 031515Z AUTO 00000KT 10SM BKN005 17/15 A3006 RMK AO2 T01730154
VFR METAR KPVW 031535Z AUTO 00000KT 10SM SCT005 18/16 A3005 RMK AO2 T01790157
VFR METAR KPVW 031555Z AUTO 00000KT 10SM CLR 19/16 A3005 RMK AO2 T01890157
VFR METAR KPVW 031615Z AUTO 00000KT 10SM CLR 20/15 A3005 RMK AO2 T02040147
VFR METAR KPVW 031635Z AUTO 22003KT 10SM CLR 22/13 A3005 RMK AO2 T02160129
VFR METAR KPVW 031655Z AUTO 00000KT 10SM CLR 22/13 A3005 RMK AO2 T02210131
VFR METAR KPVW 031715Z AUTO 24003KT 10SM SCT040 SCT046 22/13 A3005 RMK AO2 T02210125
VFR METAR KPVW 031735Z AUTO 24006KT 10SM SCT040 BKN046 24/13 A3005 RMK AO2 T02350129
VFR METAR KPVW 031755Z AUTO 22004KT 10SM BKN045 23/12 A3005 RMK AO2 T02320119 10238 20150
VFR METAR KPVW 031815Z AUTO 15003KT 10SM BKN045 24/13 A3004 RMK AO2 T02370125
VFR METAR KPVW 031835Z AUTO 27004KT 10SM BKN047 BKN060 25/13 A3004 RMK AO2 T02450128
VFR METAR KPVW 031855Z AUTO 18005KT 10SM BKN047 BKN065 24/13 A3003 RMK AO2 T02420125
VFR METAR KPVW 031915Z AUTO 19004KT 10SM BKN050 BKN065 25/12 A3002 RMK AO2 LTG DSNT E T02520122

VFR **METAR KPVW 031935Z AUTO 26003KT 10SM SCT050 BKN065 OVC075 24/12 A3001 RMK AO2 T02440119 Accident 1937Z**

VFR METAR KPVW 031955Z AUTO 00000KT 10SM SCT065 26/12 A2999 RMK AO2 LTG DSNT N T02580120

VFR METAR KPVW 032015Z AUTO 00000KT 10SM SCT060 SCT070 26/12 A2998 RMK AO2 T02630119 TSNO

VFR METAR KPVW 032035Z AUTO 00000KT 10SM BKN060 BKN080 25/12 A2998 RMK AO2 LTG DSNT NW THRU NE T02520116

VFR METAR KPVW 032055Z AUTO 11003KT 10SM SCT060 BKN075 BKN085 26/12 A2997 RMK AO2 LTG DSNT NW THRU NE T02640121

VFR METAR KPVW 032115Z AUTO 03023G29KT 10SM BKN060 BKN070 BKN080 27/12 A2999 RMK AO2 LTG DSNT N AND NE T02660120

MVFR METAR KPVW 032135Z AUTO 02017G29KT 3SM +RA SCT045 BKN050 OVC080 19/14 A3002 RMK AO2 LTG DSNT ALQS P0006 T01910138

VFR METAR KPVW 032155Z AUTO 08008KT 10SM -RA SCT021 BKN060 OVC110 15/14 A3001 RMK AO2 LTG DSNT ALQS P0019 T01450138

VFR METAR KPVW 032215Z AUTO 05009KT 10SM BKN120 16/15 A2999 RMK AO2 LTG DSNT NE THRU S T01560150

3.0 Sounding

The closest sounding to the accident site was from Amarillo (KAMA), TX, site number 72363, located 82 miles northeast from the accident site, at an elevation of 3,606 ft. The 1900 CDT sounding (0000Z on June 4, 2017) was plotted on a Skew-T log P diagram³ from the surface to 500-hPa or 18,000 ft utilizing RAOB software⁴, and is included as figure 6.

The KAMA sounding depicted a surface temperature of 21.8° C, a dewpoint of 16.8° C, with a relative humidity of 73%. The sounding had a lifted condensation level (LCL)⁵ at 2,091 ft agl, a level of free convection (LFC)⁶ at 3,513 ft agl, and convective condensation level (CCL)⁷ at 4,829 ft agl. The layer between the CCL and 13,000 ft had a relative humidity greater than 80% and indicated a nearly saturated conditions supporting cumulus cloud development, which was indicated by the gray shading on the left side of the diagram. The estimated tops of convective or cumulonimbus type clouds based on the equilibrium level (EL)⁸ was 41,000 ft, with the tropopause located 50,900 ft. The freezing level was identified at about 13,000 ft.

³ Skew T log P diagram – is a standard meteorological plot or thermodynamic diagram using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

⁴ RAOB software – The complete Rawinsonde Observation program is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.

⁵ Lifting Condensation Level (LCL) - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

⁶ 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.

⁷ 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 cumuliiform clouds, which are normally produced from surface heating and thermal convection.

⁸ Equilibrium Level (EL) - On a sounding, the level above the level of free convection (LFC) at which the temperature of a rising air parcel again equals the temperature of the environment. The height of the EL is the height at which thunderstorm updrafts no longer accelerate upward. Thus, to a close approximation, it represents the height of expected (or ongoing) thunderstorm tops. However, strong updrafts will continue to rise past the EL before

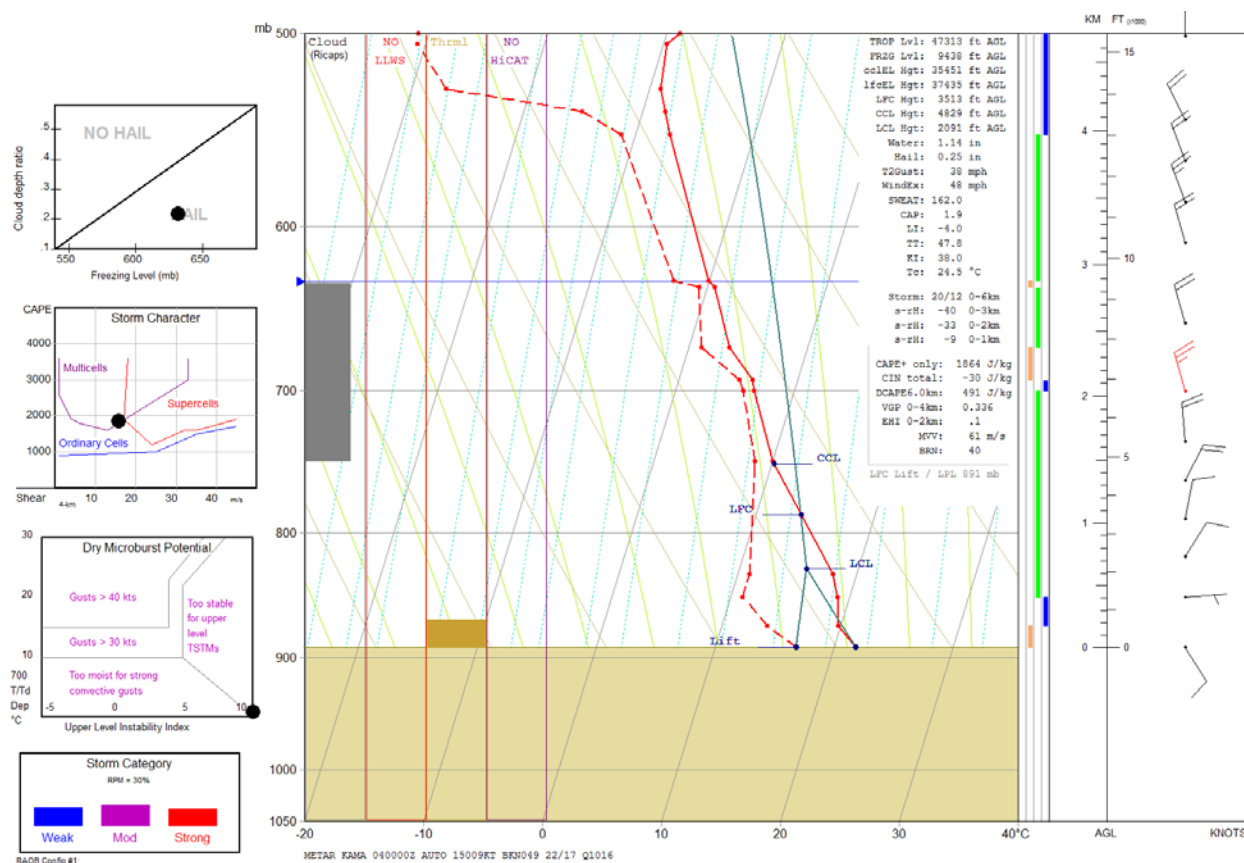


Figure 6 - KAMA sounding at 1900 CDT

The atmosphere was characterized as conditionally unstable with a Lifted Index of -4.0, a Convective Available Potential Energy (CAPE)⁹ value of 1,864 Joules per kilogram (J/kg), and a K-Index of 38.0, which indicated an approximately 85% probability of air-mass-type thunderstorm formation. The precipitable water content was 1.14 inches. The maximum vertical velocity (MVV) of the potential updrafts was 61 meters per second (m/s) and the Downdraft CAPE¹⁰ was 491 J/kg. The sounding profile supported a moderate risk of strong ordinary cells to multicellular type thunderstorms with potential outflow wind gusts (T2 Gusts) and microburst potential (WINDEX) of up to 42 knots.

stopping, resulting in storm tops that are higher than the EL. This process sometimes can be seen visually as an overshooting tops or anvil dome. The EL typically is higher than the tropopause, and is a more accurate reference for storm tops.

⁹ Convective Available Potential Energy (CAPE) – is a measure of the amount of energy available for convection. CAPE is directly related to the maximum potential vertical speed within an updraft; thus, higher values indicate greater potential for severe weather.

¹⁰ DCAPE – Downdraft CAPE can be used to estimate the potential strength of rain-cooled downdrafts within thunderstorm convection, and is similar to CAPE. Larger DCAPE values are associated with stronger downdrafts and DCAPE values over 1,000 J/kg have been associated with strong thunderstorm downdrafts and damaging outflow winds.

The wind profile indicated a surface wind from the southeast, or from 150° at 9 knots, with wind direction backing to the east and the north-northwest through 18,000 ft. A low-level wind maximum was identified at 6,700 ft agl with the wind from 345° at 25 knots. The mean 0 to 6 kilometer or 18,000 ft wind was from 350° at 16 knots, with the expected storm or cumulonimbus clouds movement from 020° at 15 knots.

A table of the observed height, pressure, temperature, dew point temperature, relative humidity, wind direction and speed, and derived clear air turbulence (CAT), low-level wind shear (LLWS), and icing potential based on the RAOB algorithms is included below as figure 7. The sounding indicated that the variable winds and strong vertical shears in the lowest 5,000 ft indicated a high probability of moderate and greater turbulence. While no threat from structural icing was indicated below 10,000 ft, the temperature and humidity profile supported a moderate to severe potential for carburetor-type icing.

Height (ft-MSL)	Pres (mb)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (FAA)	LLWS	Icing - Type (AFGW/C method)
3606	891	21.8	16.8	73	150 / 9			
4187	873	19.8	13.8	68		MDT		
4942	850	19.0	11.0	60	85 / 7			
5545	832	18.0	11.0	64		MDT		
6000	818				30 / 8	LGT		
7000	790				10 / 11	MDT		
8000	762				25 / 18			
8499	748	10.0	8.5	90		SVR		
9000	734				355 / 22	LGT		
10302	700	6.6	5.7	94	345 / 25			

Figure 7 - KAMA sounding data and derived turbulence, low-level wind shear, and icing

A High Resolution Rapid Refresh (HRRR) numerical model sounding was also run utilizing data from the NOAA Air Resource Laboratory archive data. Figure 8 is the HRRR numerical model sounding over the accident site at 1500 CDT. The model sounding provided slightly warmer surface temperatures and cloud heights, with clouds bases near 5,500 ft and at 19,000 ft. The stability indices were also similar and supported afternoon convective activity with similar potential outflow winds. The model wind profile provided a slightly smoother wind profile with light and variable surface winds backing to the south immediately above the surface, and to the east at 3,000 ft and the north by 7,000 ft. No strong vertical shears or turbulence were noted below 8,000 ft.

Figure 9 is the height, pressure, temperature, dew point, relative humidity, wind, and derived turbulence, LLWS, and icing for the HRRR model at 1500 CDT. While no structural icing was expected, the thermal and moisture fields supported a moderate and greater risk of carburetor-type icing to 10,000 ft.

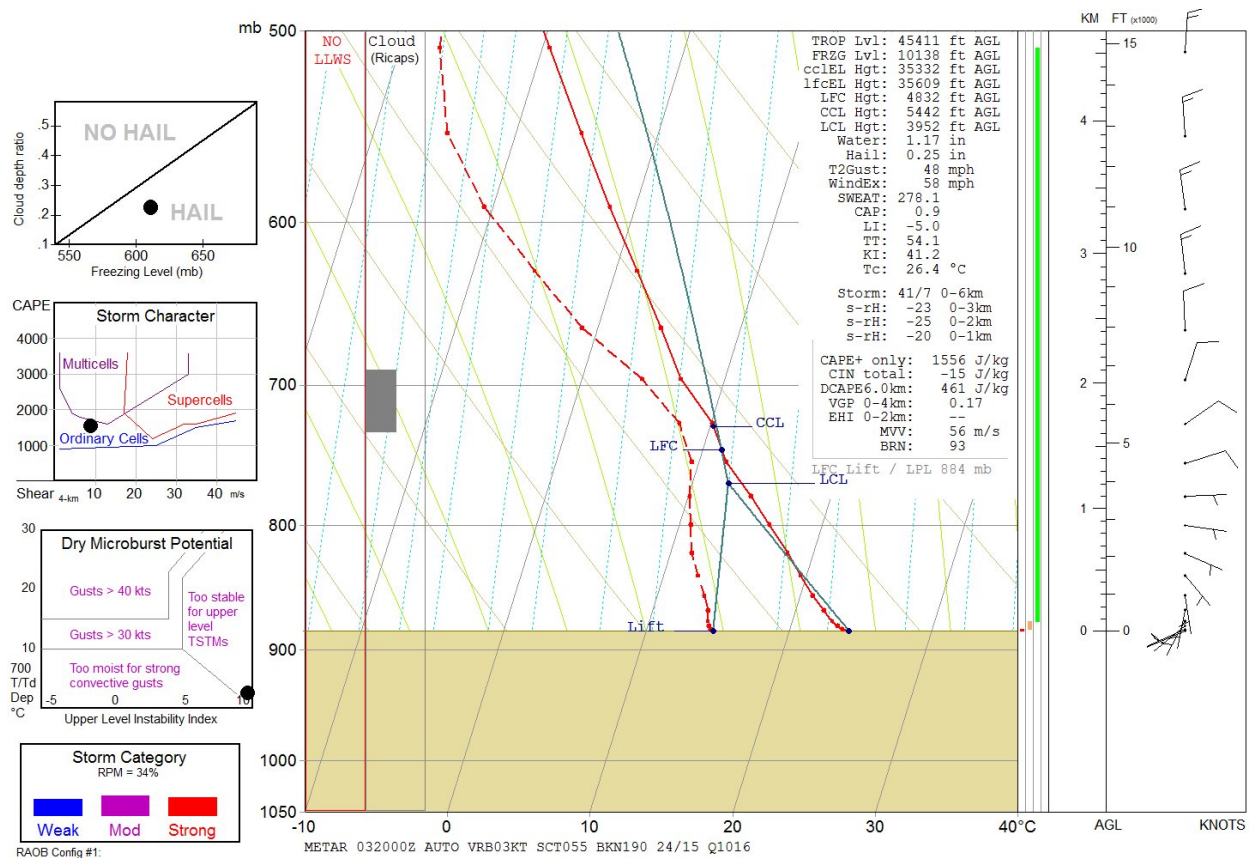


Figure 8 - HRRR numerical model sounding for 1500 CDT over the accident site

Height (ft-MSL)	Pres (mb)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (FAA)	LLWS	Icing - Type (AFGWC method)
3819	884	24.2	14.7	55	245 / 3			
3852	883	23.7	14.5	56	245 / 3			
3950	880	23.3	14.3	57	229 / 3			
4081	876	22.8	14.1	58	207 / 3			
4376	867	22.0	13.9	60	190 / 3			
4773	855	20.9	13.3	62	172 / 3			
5309	839	19.6	12.4	63	142 / 3			
5922	821	18.2	11.5	65	115 / 4			
6685	799	16.3	10.8	70	98 / 6			
7428	778	14.4	10.1	75	87 / 7			
8332	753	11.9	9.5	85	72 / 8			
9335	726	10.1	7.8	86	53 / 8	LGT		
10483	696	6.9	4.2	83	16 / 8	LGT		

Figure 9 - HRRR model data below 10,000 ft for 1500 CDT

4.0 Satellite Imagery

The Geostationary Operational Environmental Satellite number 13 (GOES-13) data was obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System (McIDAS) software. Both the infrared long wave, and visible band imagery were obtained surrounding the time of the accident. The infrared long wave imagery (band 4) at a wavelength of 10.7 microns (μm) provided standard satellite image with radiative cloud top

temperatures with a resolution of 4 km. The visible imagery (band 1) at a wavelength of 0.65 μm provided a resolution of 1 km.

Figures 10 and 11 are the GOES-13 visible imagery at 1430 and 1445 CDT at 2X magnification immediately surrounding the time of the accident. The images depicted a broken line of cumulus congestus to cumulonimbus clouds extending along the Texas and New Mexico border west of the accident site, with a band of altocumulus type clouds extending over the accident site and KHRX, and casting a shadow on the ground under the clouds. Well defined cumulonimbus clouds are also identified immediately south of KAMA with towering cumulus to cumulus congestus type clouds to the southwest of the large cell between the accident site and northwest of KPVW. The cumulus type clouds were observed to get more vertically defined with time, and the mid cloud band over the accident site slowly moved eastward with time.

The GOES-13 infrared image detected radiative cloud top temperatures from 262° to 266° Kelvin (K) or -7° to -11° C over the accident site, which corresponded to clouds tops between 16,600 to 20,000 ft based on the KAMA sounding. The cloud tops associated with the cumulonimbus clouds south of KAMA had radiative cloud top temperatures as low as 223° K or -50° C, which corresponded to cloud tops near 36,500 ft during the period.

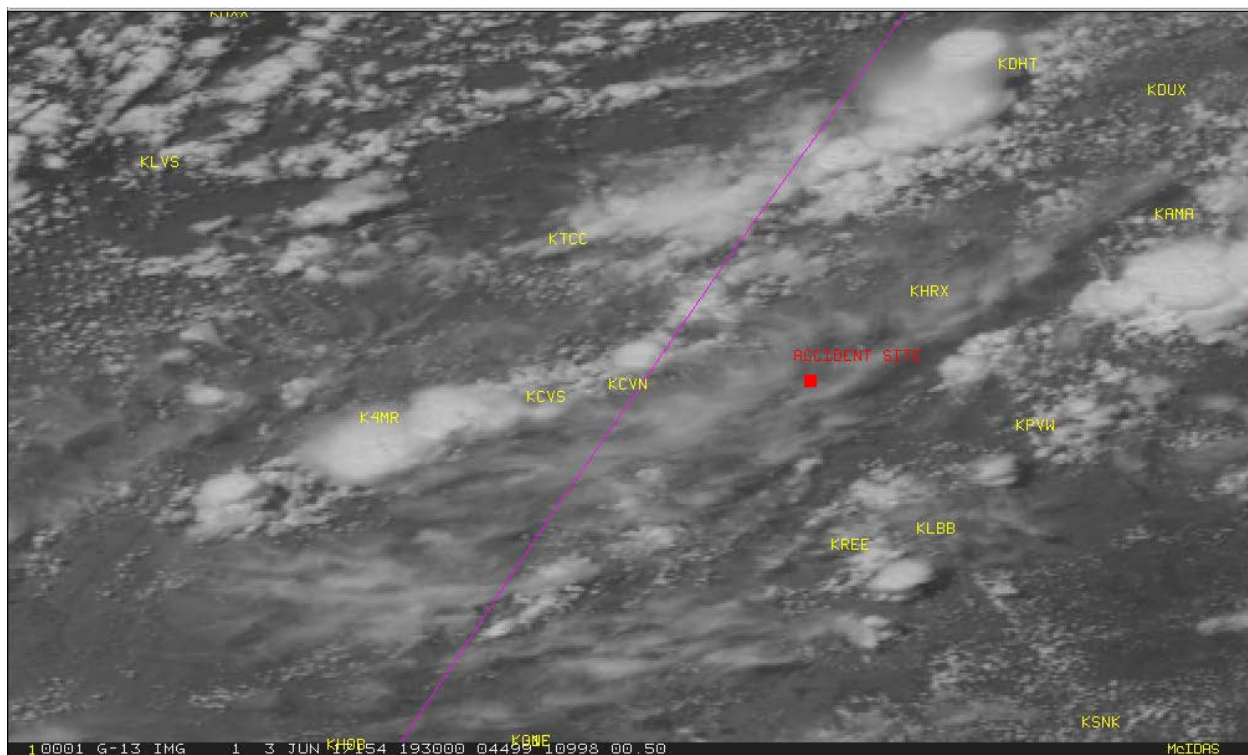


Figure 10 - GOES-13 visible image at 1430 CDT

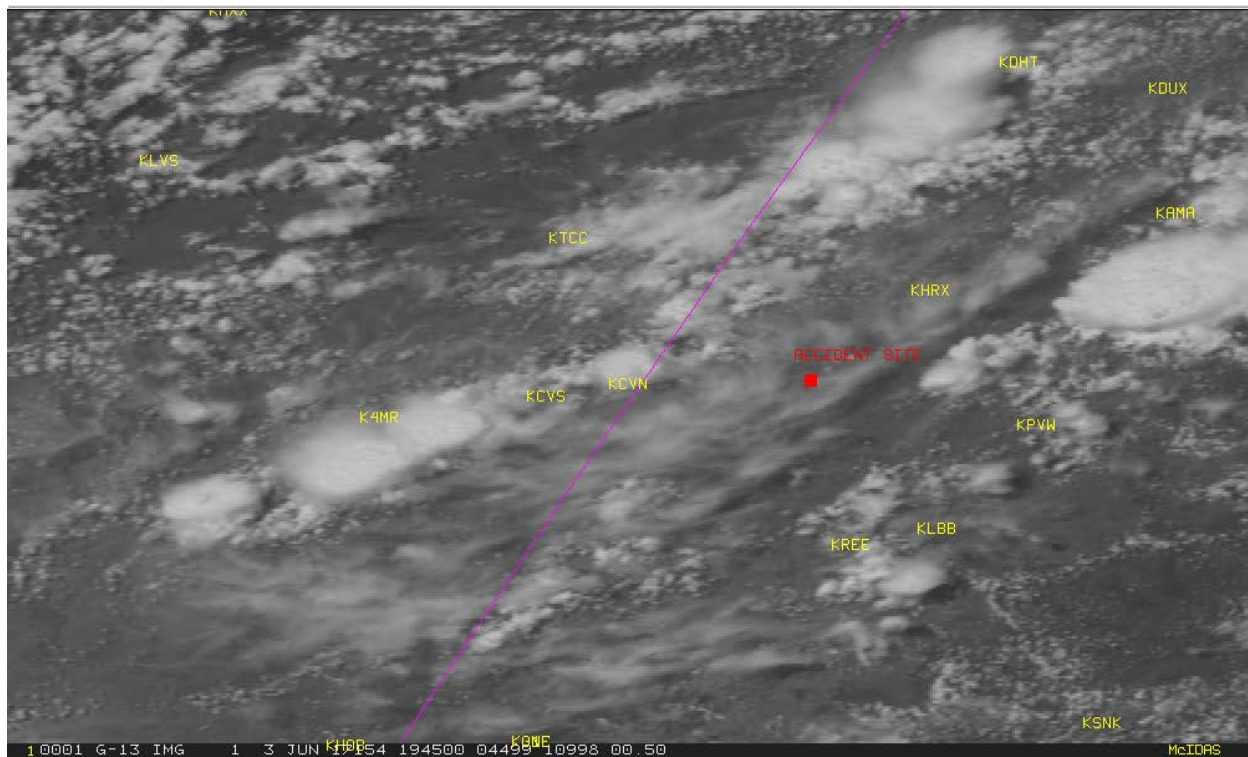


Figure 11 - GOES-13 visible image at 1445 CDT

5.0 Weather Surveillance Radar Imagery

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D) was located at Lubbock, TX, 55 miles south-southeast of the accident site. The level II and III archive data was obtained from the NCEI using the Hierarchical Data Storage System and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software. The KLBB WSR-88D 0.5° base reflectivity image at 1438 CDT (1938Z) is included as figure 12, with the flight track overlaid in black. No significant echoes associated with any organized areas of precipitation were noted along the flight track. Only echoes of 5 dBZ¹¹ or less were noted, which were associated with false echoes or other non-meteorological echoes such as birds and bugs. No defined outflow boundaries were noted in the base reflectivity or radial velocity imagery at the time.

¹¹ Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy, and is a function of the drop size distribution, number of droplets per unit volume, physical state, shape, and aspect. Reflectivity is normally displayed in decibels, or more specifically 10 log Ze, and is a general measure of echo intensity.

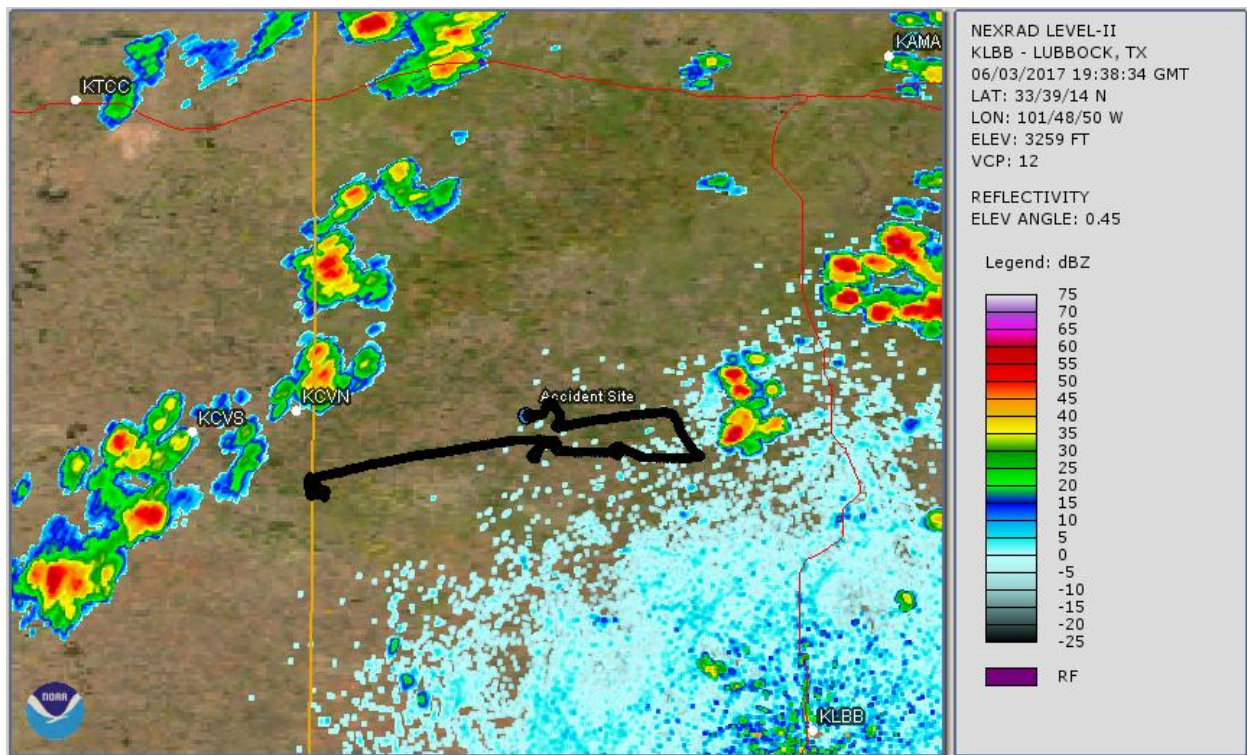


Figure 12 - KLBB WSR-88D 0.5° base reflectivity image at 1438 CDT with flight track overlaid

The KLBB WSR-88D Vertical Azimuth Display (VAD) Wind Profile was plotted to document the localized winds associated with the echoes, and is included as figure 13. The VAD Wind Profile between 1357 through 1446 CDT indicated light easterly winds near 5 knots at 4,000 ft, veering to the west at 10 knots at 6,000 ft, and veering to the north with height with wind speeds increasing to 15 knots above 12,000 ft. The KLBB VAD Wind Profile indicated that an easterly wind component was noted, which would have produced a tailwind component of 10 knots over the flight path at the time of the accident.

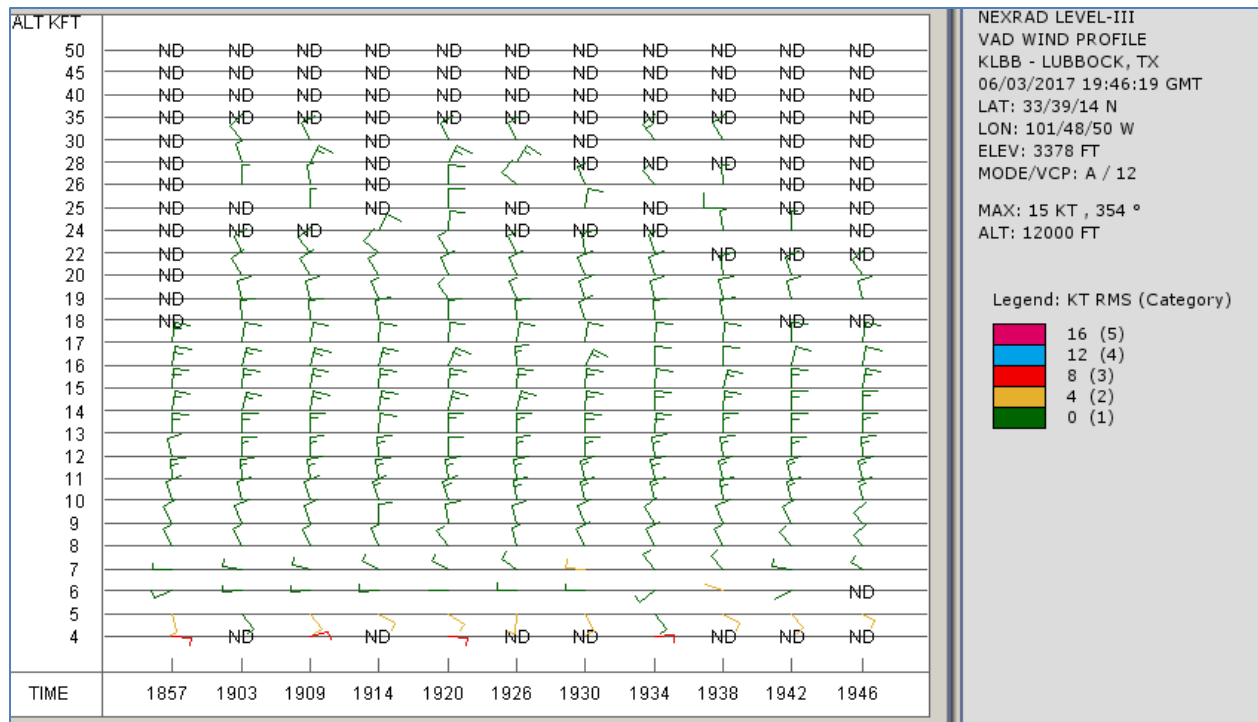


Figure 13 - KLBB WSR-88D VAD Wind Profile from 1357 through 1446 CDT

6.0 Pilot Reports

The following pilot reports (PIREPs) were recorded over northwestern Texas surrounding the accident period from 1230 through 1800 CDT. The reports are in standard code and abbreviations, with time in UTC, and are as follows:

AMA UA /OV 10 SE PNH/TM 1757/FLDURC/TP E170/SK OVC B065=

AMA UA /OV 26 E PNH/TM 1817/FL060/TP M20P/RM CONT LGT CHOP=

LBB UA /OV PVW325022 /TM 1959 /FL370 /TP B738 /SK TOPS FL370-380 /RM FM KZFW AWC-WEB=

LBB UA /OV LBB185025 /TM 2207 /FL360 /TP E145 /TB LGT CHOP /RM FM KZFW AWC-WEB=

MAF UA /OV BGS360035 /TM 2207 /FL400 /TP CL60 /TB NEG /RM MOSTLY SMOOTH. FM KZFW AWC-WEB=

LBB UA /OV LBB200035 /TM 2208 /FL360 /TP E145 /SK TOPS FL380-390 /RM WX TOPS EST. FM KZFW AWC-WEB=

LBB UA /OV LBB /TM 2220 /FL380 /TP B738 /SK TOPS FL380-400 /RM WX TOPS EST. FM KZFW AWC-WEB=

CVS UA /OV TXO /TM 2221 /FL410 /TP WW24 /SK TOPS FL450 /RM WX TOPS EST. FM KZFW AWC-WEB=

TCC UA /OV TCC/TM 2252/FL330/TP B737/RM LGT TURBULENCE=

LBB UA /OV LBB185010 /TM 2307 /FL430 /TP C56X /SK TOPS FL440-450/RM WX TOPS. TOPS FL410 TO THE SOUTH.
FM KZFW AWC-WEB=

The two low-level reports during the period indicated cloud bases near 6,500 ft and reported continuous light chop or turbulence near 6,000 feet. The other reports were from pilots operating at higher altitudes and reported cumulonimbus clouds tops near the time of the accident in the

37,000 to 38,000 ft range, and later upwards to 45,000 ft, with a couple reporting light turbulence.

7.0 Terminal Aerodrome Forecasts

The closest Terminal Aerodrome Forecast (TAF) to the accident site was for Hale County Airport (KPVW), Plainview, TX, and was issued by the NWS Lubbock Weather Forecast Office. The forecast current at the time of the accident and valid for a 5-miles radius of KPVW was as follows:

*TAF KPVW 031740Z 0318/0418 VRB06KT P6SM SCT040 BKN250
FM032000 VRB06KT P6SM VCSH SCT030 BKN080
FM040100 VRB06KT P6SM SCT040 BKN150
FM040800 VRB06KT 3SM BR SCT015 BKN040 BKN200*

The forecast expected light and variable surface winds, visibility better than 6 miles, with scattered clouds at 4,000 ft agl, and ceiling broken at 25,000 ft. After 1500 CDT, rain showers were expected in the vicinity of the airport through 2000 CDT.

8.0 Area Forecast

The Area Forecast (FA) is a forecast of 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 bulletin for the same area for any IFR conditions 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 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 forecast current at the time of the accident was issued at 1345 CDT and was valid through 0200 CDT, and was as follows:

*DFWC FA 031845
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 041300
CLDS/WX VALID UNTIL 040700...OTLK VALID 040700-041300
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...QSTNRY FNT OVR WRN TN-NERN AL MOVG SLOLY NEWD AND WKNG
BY 06Z. CDFNT OVR SWRN KS-XTRM NWRN OK/TX PNHDL BY 13Z OVR SERN
KS BECMG QSTNRY FNT OVR N CNTRL OK-W CNTRL TX-SWRN TX.
.
NWRN TX
PNHDL...BKN080 LYRD FL250. OCNL VIS 3SM SCT -TSRA. CB TOP FL450. BECMG 0305 SCT060
BKN100 TOP FL180. OTLK...09Z E PTN IFR CIG BR.
SOUTH PLAINS...*

W HLF..BKN090 LYRD FL250. WDLY SCT -TSRA. CB TOP FL450. 03Z BKN100 TOP FL220. ISOL - TSRA. OTLK...VFR.

E HLF..BKN-SCT060 BKN120 TOP FL250. WDLY SCT -TSRA. CB TOP FL450. 03Z SCT060 BKN120 TOP FL220. OTLK...VFR 11Z MVFR CIG TSRA BR.

.
SWRN TX

MTNS WWD...SCT-BKN120 TOP FL250. WDLY SCT -TSRA. CB TOP FL450. 03Z SCT120 SCT-BKN CI.

OTLK...VFR 11Z SERN QTR MVFR CIG TSRA.

RMNDR...

W HLF..SCT-BKN080 TOP FL250. WDLY SCT -TSRA. CB TOP FL450. BECMG 0305 BKN140. OTLK...VFR.

E HLF..BKN060 TOP FL240. WDLY SCT -TSRA. CB TOP FL450. BECMG 0305 BKN-SCT080 TOP 140.

OTLK...VFR 09Z MVFR CIG TSRA 11Z IFR CIG TSRA BR.

The forecast for New Mexico was issued under the Salt Lake City regional header and was issued at 1445 CDT and was as follows:

FAUS45 KKCI 031945

FA5W

SLCC FA 031945

SYNOPSIS AND VFR CLDS/WX

SYNOPSIS VALID UNTIL 041400

CLDS/WX VALID UNTIL 040800...OTLK VALID 040800-041400

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...20Z TROF SW AB-LWT-NCNTRL WY. HI PRES CNTRD OVR CNTRL CO. CDFNT FM LOW PRES NR GLD-SE CO-NERN NM-ABQ. HI PRES RMNDR. 03Z TROF SRN AB-SW MT. THERMAL TROF NRN ID-NCNTRL NV-THERMAL LOW PRES 40S EED-SW AZ. HI PRES CNTRD OVR DEN. 14Z CDFNT SE AB-SW MT-SE OR-NERN CA. WRMFNT SE AB-NERN MT-SCNTRL ND. HI PRES CNTRD OVR CNTRL CO. THERMAL TROF SW ID-SRN NV-SE CA-SW AZ.

.
NM

NW...SKC. OTLK...VFR.

SW-CNTRL...SCT130. WDLY SCT -TSRA. CB TOP FL400. 02Z SCT-BKN CI. OTLK...VFR.

NERN PLAINS...BKN110 TOP FL200. WDLY SCT -TSRA. CB TOP FL400. 01Z SCT -SHRA/ISOL -TSRA. 04Z BKN CI. OTLK...VFR 12Z MVFR CIG BR.

SE PLAINS...SCT110 BKN150 TOP FL220. ISOL -SHRA/-TSRA. CB TOP FL400. 03Z SCT120 BKN CI. OTLK...VFR.

....

9.0 Inflight Weather Advisories

Inflight Aviation Weather Advisories are forecasts to advise en route aircraft of development of potentially hazardous weather. Inflight aviation weather advisories in the conterminous U.S. are issued by the NWS AWC, as well as from the Center Weather Service Units (CWSU) associated with FAA Air Route Traffic Control Center's (ARTCCs).

There are four basic types of inflight aviation weather advisories: the Significant Meteorological Advisory (SIGMET), the Convective SIGMET, the Airmen's Meteorological

Information (AIRMET), and the Center Weather Advisory (CWA). These advisories use the same location identifiers (either VORs, airports, or well-known geographic areas) to describe the hazardous weather areas. The Severe Weather Watch Bulletins (WWs), with the associated Alert Messages (AWW) supplements these advisories.

On June 3rd prior to the accident, the NWS had multiple Convective SIGMETs and AIRMETs Sierra advisories issued. No CWA's were issued by the Dallas (KZFW) or Albuquerque (KZAB) CWSU prior to the accident, and no weather watches or alert messages (WW/AWW) were current for the region.

9.1 Convective SIGMETs

Figure 14 is a graphic depiction of the Convective SIGMETs (red polygons) issued at 1355 CDT, with five separate advisories issued for various regions of Texas. One advisory, Convective SIGMET 88C issued for the Amarillo area bordered the area to the north of the accident site, but did not extend over the site. Convective SIGMETs are issued hourly and are valid for 2 hours, but are subsequently updated each hour. No advisories were issued at 1255 CDT for the Texas panhandle or northwest Texas.

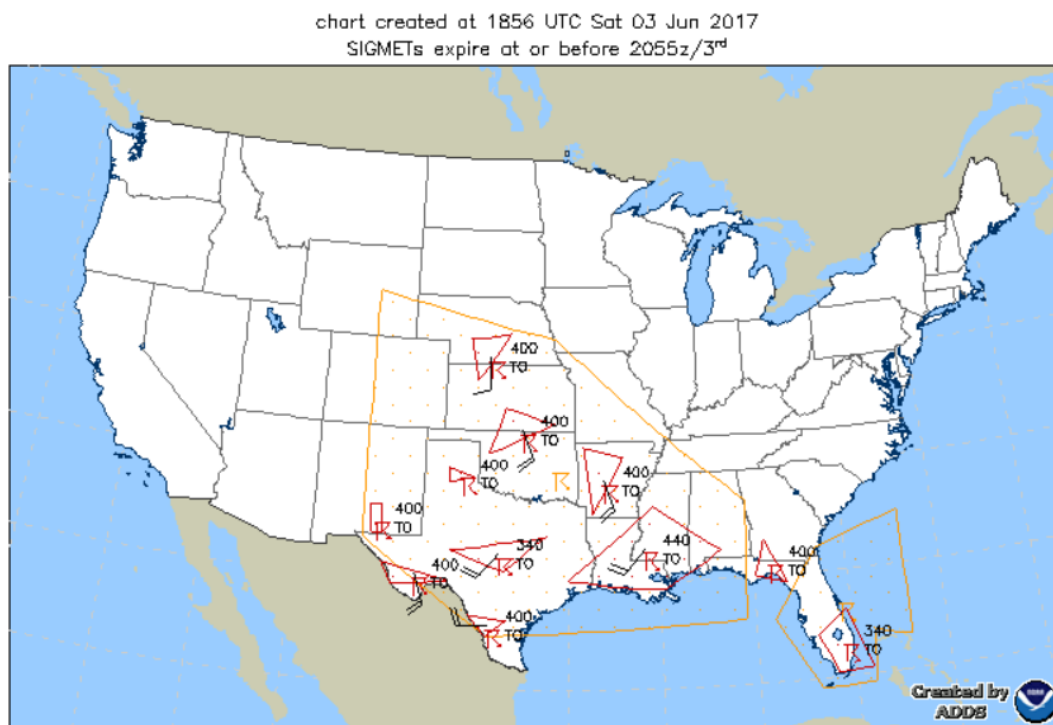


Figure 14 - Convective SIGMETs issued at 1355 CDT and valid for the time of the accident

WSUS32 KPCI 031855
SIGC
-MKCC WST 031855
CONVECTIVE SIGMET 81C
VALID UNTIL 2055Z
TX

FROM 60SE TTT-50N SAT-50SE MAF-60SE TTT
AREA EMBD TS MOV FROM 22020KT. TOPS TO FL340.

CONVECTIVE SIGMET 82C
VALID UNTIL 2055Z
FL AL MS LA TX AND MS LA CSTL WTRS
FROM SQS-30N CEW-20SE HRV-20ENE IAH-SQS
AREA EMBD TS MOV FROM 22020KT. TOPS TO FL440.

CONVECTIVE SIGMET 83C
VALID UNTIL 2055Z
OK KS
FROM 50WNW ICT-30WNW OSW-30SE MMB-50WNW ICT
AREA TS MOV FROM 16020KT. TOPS TO FL400.

CONVECTIVE SIGMET 84C
VALID UNTIL 2055Z
AR
FROM RZC-50WSW ARG-30SE TXK-RZC
AREA TS MOV FROM 16020KT. TOPS TO FL400.

CONVECTIVE SIGMET 85C
VALID UNTIL 2055Z
TX
FROM 70WNW MRF-60NW DLF-50SW MRF-70WNW MRF
AREA TS MOV FROM 16020KT. TOPS TO FL400.

CONVECTIVE SIGMET 86C
VALID UNTIL 2055Z
KS CO
VCNTY GLD
ISOL SEV TS D30 MOV LTL. TOPS TO FL400.
TORNADOES...HAIL TO 1 IN...WIND GUSTS TO 50KT POSS.

CONVECTIVE SIGMET 87C
VALID UNTIL 2055Z
KS NE
FROM OBH-HLC-LBF-OBH
AREA TS MOV FROM 18010KT. TOPS TO FL400.

CONVECTIVE SIGMET 88C
VALID UNTIL 2055Z
TX
FROM AMA-30N CDS-40S AMA-AMA
AREA TS MOV LTL. TOPS TO FL400.

CONVECTIVE SIGMET 89C
VALID UNTIL 2055Z
NM
FROM 50W CME-40ENE ELP
LINE TS 30 NM WIDE MOV LTL. TOPS TO FL400.

CONVECTIVE SIGMET 90C
VALID UNTIL 2055Z
TX
FROM 60SSE DLF-50WNW CRP-LRD-60SSE DLF

AREA TS MOV FROM 27020KT. TOPS TO FL400.

OUTLOOK VALID 032055-040055

FROM DDY-OVR-30N LGC-160SSW TLH-LRD-ELP-DDY

WST ISSUANCES EXPD. REFER TO MOST RECENT ACUS01 KWNS FROM STORM
PREDICTION CENTER FOR SYNOPSIS AND METEOROLOGICAL DETAILS.

9.2 AIRMETs

The NWS AWC issued AIRMET Sierra update 2 at 0945 CDT for an extensive area of IFR conditions over northwest Texas and included the accident site and is shown in figure 15. The advisory ended at 1300 CDT and was not extended. Figure 16 is the current advisories valid at 1300 CDT or the time of the accident.

SIERRA 2017-06-03 15:00:00

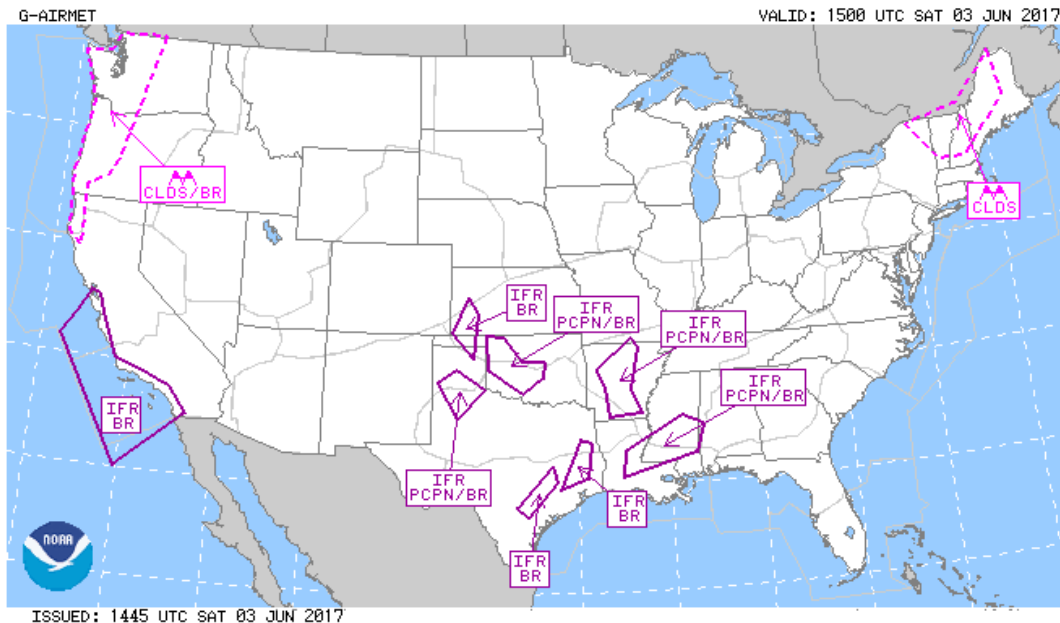


Figure 15 - AIRMET Sierra valid at 1000 CDT

WAUS44 KKCI 031445

WA4S

-DFWS WA 031445

AIRMET SIERRA UPDT 2 FOR IFR VALID UNTIL 032100

AIRMET IFR...OK TX KS

FROM 40SE GLD TO 20E GCK TO 50WSW MMB TO 50W LBL TO 40SE GLD
CIG BLW 010/VIS BLW 3SM BR. CONDS ENDG 15-18Z.

AIRMET IFR...TX

FROM 20NW AMA TO CDS TO 40SSE LBB TO 20N TXO TO 20NW AMA
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS ENDG 15-18Z.

AIRMET IFR...OK TX

FROM 50E LBL TO 60NE MMB TO 30S END TO 40WSW TUL TO 50ESE OKC TO

30ENE SPS TO 50NNE CDS TO 50E LBL
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS ENDG 15-18Z.

SIERRA 2017-06-03 18:00:00

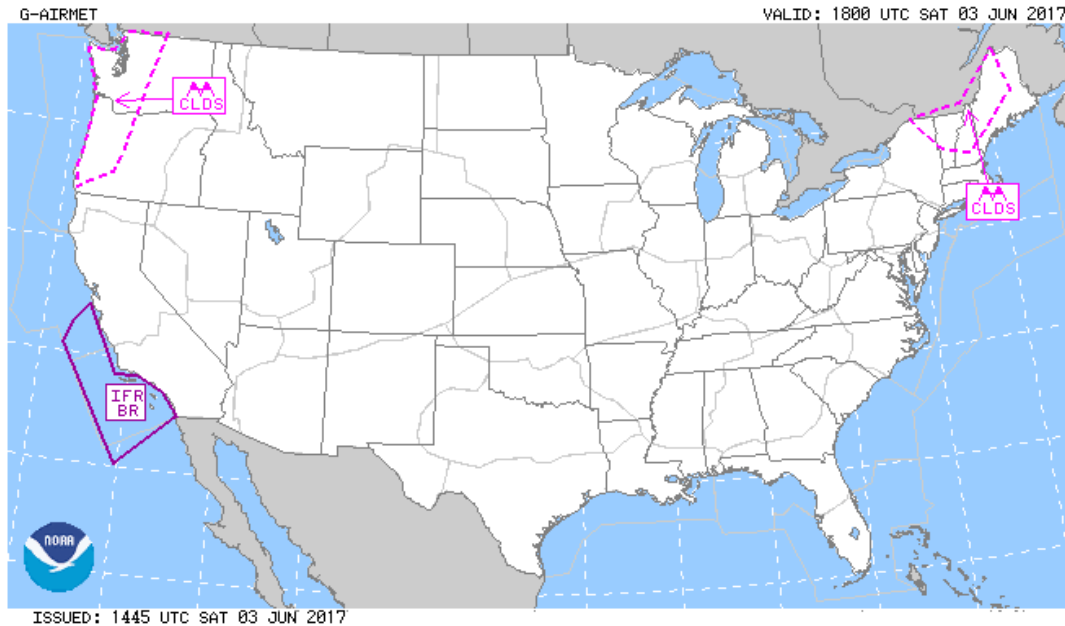


Figure 16 - AIRMET Sierra valid at 1300 CDT

10.0 Winds and Temperature Aloft

The winds and temperature aloft forecast current at the time of the accident is included below, and was valid at 1300 CDT and for use between 0900 through 1600 CDT.

WINDS ALOFT FORECASTS
DATA BASED ON 031200Z
VALID 031800Z FOR USE 1400-2100Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
LBB		9900+16	3510+09	3412+03	3508-11	3005-21	990037	141248	181555
AMA		0208	3517+08	3415+03	0108-10	3505-21	990036	100748	161055
TCC		0106	9900+10	3406+03	3613-10	0117-21	011937	031747	061457

The forecast for Lubbock (LBB) for 6,000 ft (depicted as 9900+16) was for wind light and variable at 5 knots or less, with a temperature of 16° C. At 9,000 ft the wind was from the north or 350° at 10 knots with little variation in direction or speed with height through 30,000 ft.

Submitted by:

Don Eick
Senior Meteorologist