



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

January 6, 2021

Specialist's Factual Report

METEOROLOGY

CEN21LA030

Table Of Contents

A. ACCIDENT	3
B. METEOROLOGIST	3
C. DETAILS OF THE INVESTIGATION	3
D. FACTUAL INFORMATION	4
1.0 Synoptic Situation	4
1.1 Surface Analysis Chart	4
1.2 Upper Air Charts	5
2.0 SPC Products	8
3.0 Surface Observations	10
4.0 Upper Air Data	13
5.0 Satellite Data	15
6.0 Regional Radar Imagery Information	16
7.0 Radar Imagery Information	17
7.1 Volume Scan Strategy	17
7.2 Beam Height Calculation	19
7.3 Reflectivity	19
7.4 Base Reflectivity and Lightning Data	20
8.0 Pilot Reports	21
9.0 SIGMET	21
10.0 CWSU Advisories	21
11.0 AIRMETs	22
12.0 Graphical Forecasts for Aviation	25
13.0 Terminal Aerodrome Forecast	25
14.0 NWS Area Forecast Discussion	26
15.0 Winds and Temperature Aloft Forecast	28
16.0 Pilot Weather Briefing	29
17.0 CWSU ZFW Weather Briefing Information	29
18.0 Icing Potential	29
19.0 Accident Scene Imagery	37
20.0 Astronomical Data	41
E. LIST OF ATTACHMENTS	41

A. ACCIDENT

Location: Lubbock, Texas
Date: October 26, 2020
Time: 1558 central daylight time
2058 Coordinated Universal Time (UTC)
Airplane: Cessna 210; Registration: N9622T

B. METEOROLOGIST

Paul Suffern
Senior Meteorologist
Operational Factors Division (AS-30)
National Transportation Safety Board

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist did not travel for this investigation and gathered the weather data for this investigation from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Centers for Environmental Information (NCEI). All times are central daylight time (CDT) on October 26, 2020, and are based upon the 24-hour clock, where local time is -5 hours from UTC, and UTC=Z (unless otherwise noted). Directions are referenced to true north and distances in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles. NWS airport and station identifiers use the standard International Civil Aviation Organization 4-letter station identifiers versus the International Air Transport Association 3-letter identifiers, which deletes the initial country code designator "K" for U.S. airports.

The accident site was located at latitude 33.5606° N, Longitude 101.8348° W, with an approximate elevation of 3,195 feet (ft).

D. 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 and the Weather Prediction Center, located in College Park, Maryland. These are the base products used in describing synoptic weather features and in the creation of forecasts and warnings for the NWS. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular “Aviation Weather Services”, AC 00-45H.¹

1.1 Surface Analysis Chart

A southcentral section of the NWS Surface Analysis Chart for 1600 CDT is provided as figure 1 with the approximate location of the accident site marked by the red circle. The chart identified a low pressure system over southern New Mexico with a pressure of 1001-hectopascals (hPa) and another low pressure system over southeastern Texas with a pressure 1012-hPa. A high pressure system was located over eastern Colorado with a pressure of 1032-hPa. A cold frontal boundary stretched from southern New Mexico eastward across northern Mexico and into eastern Texas. The accident site was located north of the cold front on the cool side of the boundary.

The station models around the accident site depicted air temperatures in the mid 20’s degrees Fahrenheit (°F), dew point temperatures in the low 20’s °F with temperature-dew point spreads of 2°F or less, a northeast wind of 10 to 25 knots, overcast sky cover, and freezing rain and mist.

¹

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

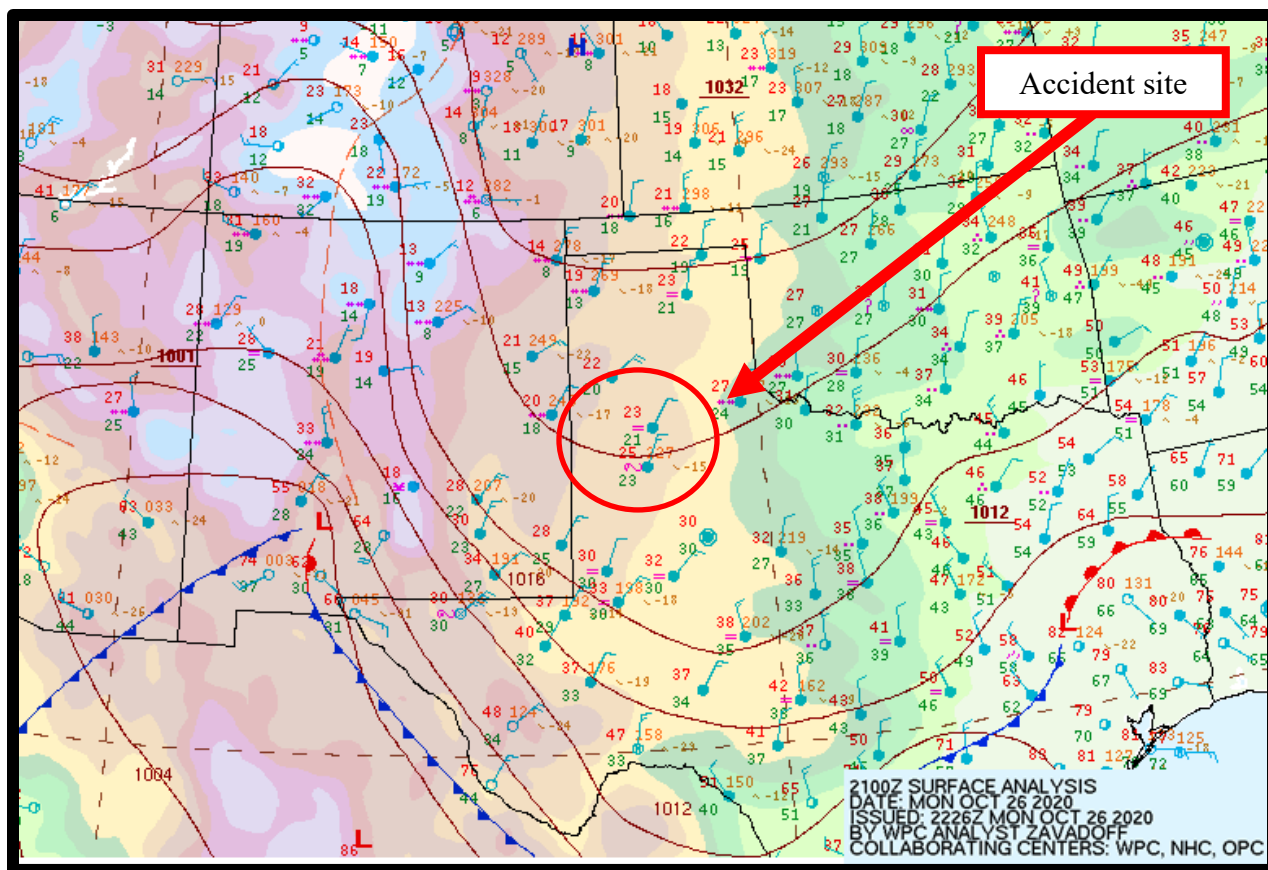


Figure 1 – NWS Surface Analysis Chart for 1600 CDT

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 1900 CDT at 850-, 700-, 500-hPa are presented in figures 2 through 4. A trough² was located west of the accident site over the desert Southwest at 700- and 500-hPa (figures 3 and 4, respectively). Troughs can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present. There was a northeast wind at 20 knots at 850-hPa with below-freezing temperatures above the accident location (figure 2) while at 700-hPa the wind was from the southwest at 30 knots with above freezing temperatures (figure 3) above the accident location. By 500-hPa the wind was southwesterly at 50 knots (figure 4) above the accident location.

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

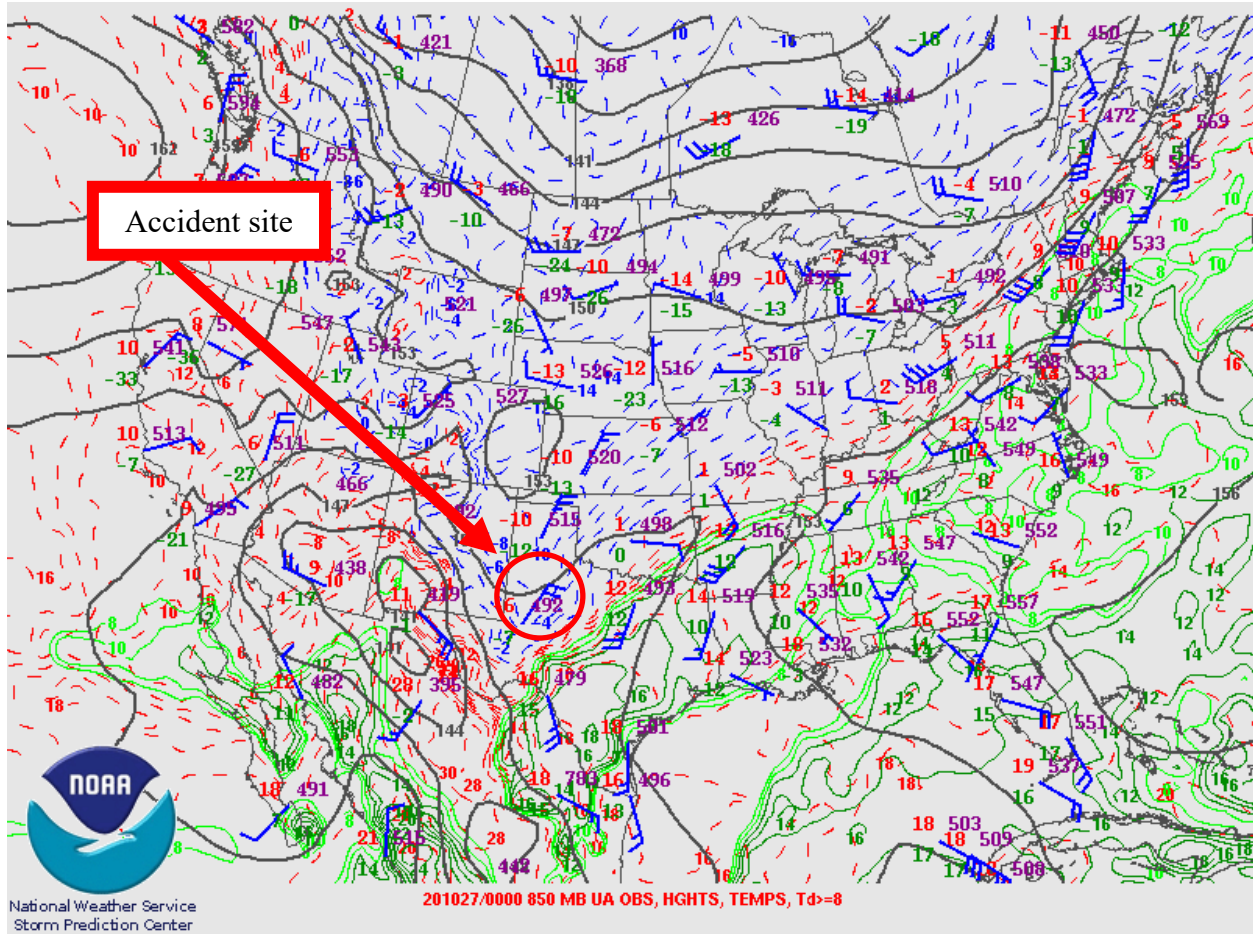


Figure 2 – 850-hPa Constant Pressure Chart for 1900 CDT

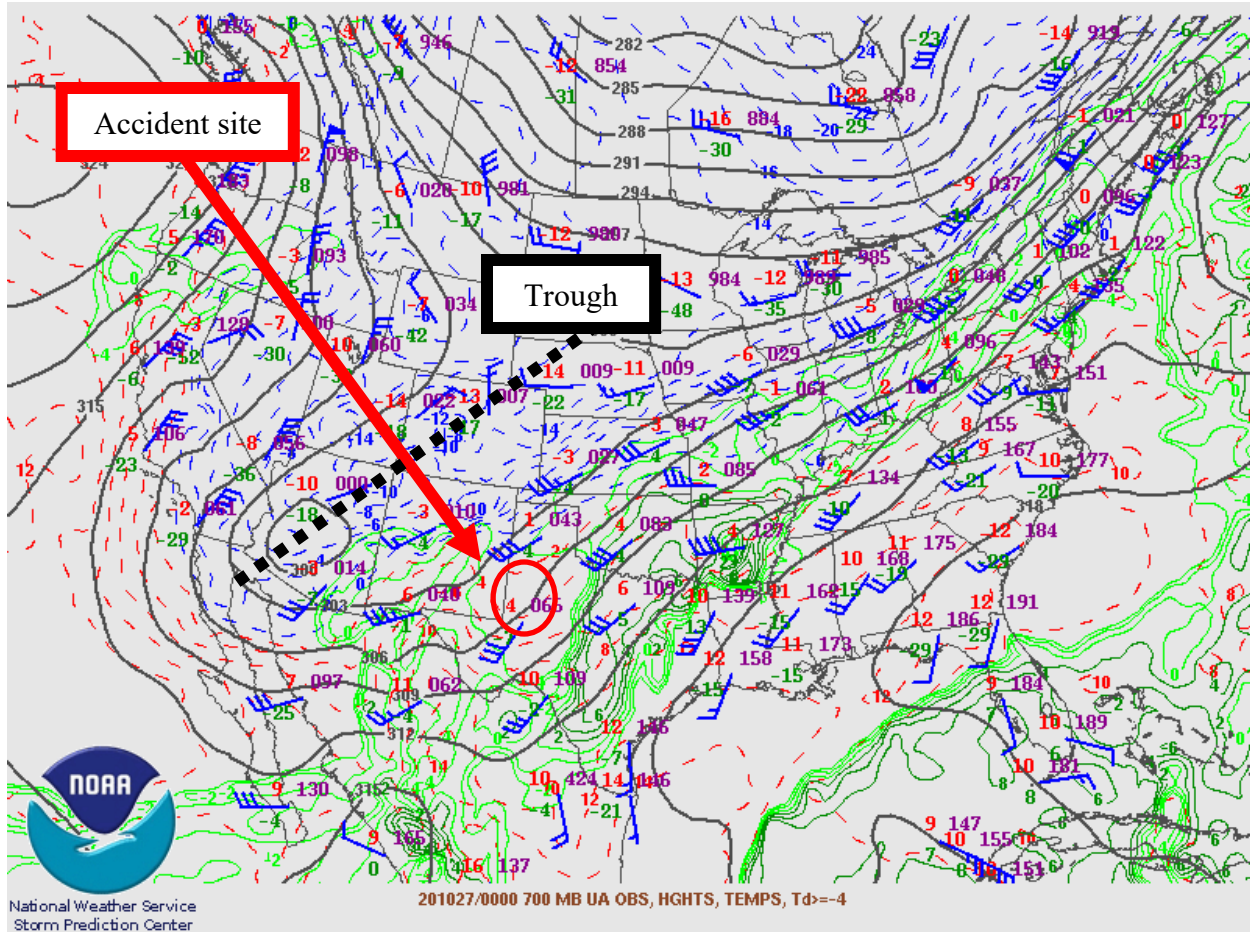


Figure 3 – 700-hPa Constant Pressure Chart for 1900 CDT

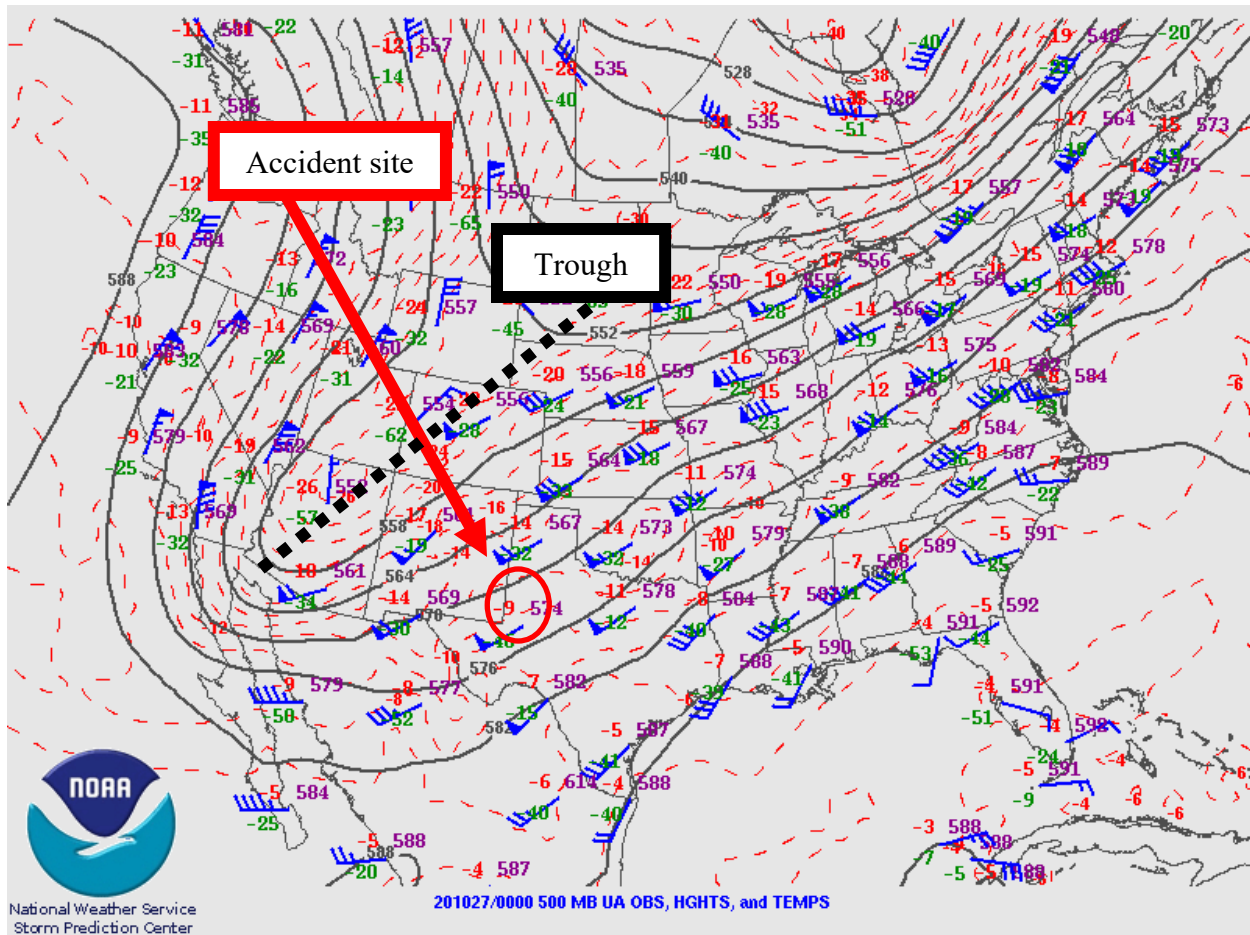


Figure 4 – 500-hPa Constant Pressure Chart for 1900 CDT

2.0 SPC Products

SPC issued the following Day 1 Convective Outlook at 1444 CDT (figure 5) with areas of general thunderstorms forecast for the accident site. SPC defines the “TSTM” area as an area that encloses where a 10% or higher probability of thunderstorms is forecast during the valid period. The SPC Day 1 Convective Outlook text follows figure 5.

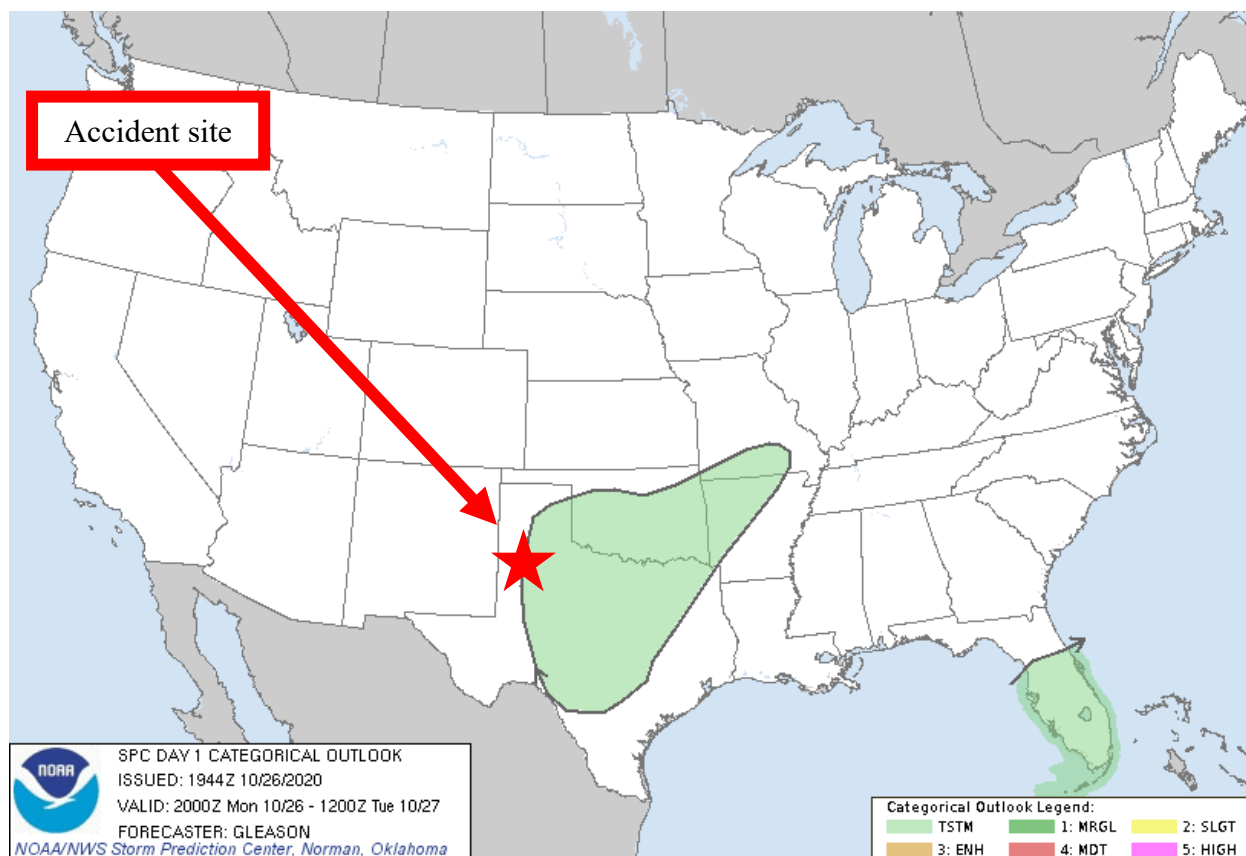


Figure 5 – SPC day 1 Convective Outlook valid at the time of the accident

SPC AC 261944

Day 1 Convective Outlook
NWS Storm Prediction Center Norman OK
0244 PM CDT Mon Oct 26 2020

Valid 262000Z - 271200Z

...NO SEVERE THUNDERSTORM AREAS FORECAST...

...SUMMARY...

Organized severe thunderstorms are not expected across the contiguous U.S. through tonight.

...20Z Update...

No major changes have been made to the ongoing forecast. Isolated to scattered elevated thunderstorms will remain possible across parts of the southern Plains into the Ozarks through tonight.

..Gleason.. 10/26/2020

..PREV DISCUSSION... /ISSUED 1108 AM CDT Mon Oct 26 2020/

...Southern Plains through Tuesday morning...

A shallow, cold air mass continues to move southward across central TX. Bands of elevated thunderstorms (some producing freezing rain

and sleet) are ongoing in association with warm advection and frontogenesis in the 850-700 mb layer atop the frontal surface. The larger buoyancy aloft and stronger forcing for ascent are expected to shift gradually southeast of the I-44 corridor in OK through this afternoon into this evening. Elevated convection should again increase over northwest TX and spread northeastward into OK in response to speed maxima ejecting northeastward in advance of the closed mid-upper low forming over AZ. Much of this convection after 06z will produce substantial sleet and freezing rain accumulations where boundary-layer temperatures will be below 32F (along and northwest of I-44).

...South FL this afternoon...

Daytime heating within a maritime tropical air mass will support scattered diurnal thunderstorm development along and south of a weak front across central FL. The convection will be a little more concentrated in the deeper moist profiles across southwest FL.

CLICK TO GET WUUS01 PTSDY1 PRODUCT

NOTE: THE NEXT DAY 1 OUTLOOK IS SCHEDULED BY 0100Z

3.0 Surface Observations

The area surrounding the accident site was documented using official Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language. Figure 6 is a local sectional chart with the accident site and the closest weather reporting location marked.



Figure 6 – Sectional map of the accident area with the location of the accident site and surface observation site

Lubbock Preston Smith International Airport (KLBB) had the closest official weather station to the accident site. KLBB had an Automated Surface Observing System (ASOS³) whose reports were supplemented by an official weather observer. KLBB was located 6 miles north of the accident site, at an elevation of 3,282 ft, and had a 6° easterly magnetic variation⁴. The following observations were taken and disseminated during the times surrounding the accident:⁵

[1253 CDT] METAR KLBB 261753Z 02015G21KT 2 1/2SM BR OVC008 M03/M04 A3021
RMK AO2 SFC VIS 3 CIG 005V012 SLP241 60000 I1001 I6004
T10281044 11017 21033 58006=

[1323 CDT] SPECI KLBB 261823Z 02015KT 5SM BR OVC008 M03/M05 A3021 RMK
AO2 CIG 006V012 T10331050=

[1353 CDT] METAR KLBB 261853Z 36015KT 5SM -FZDZ BR OVC008 M03/M05 A3019
RMK AO2 FZDZB53 CIG 006V013 SLP239 P0000 I1000 T10331050=

³ ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, ceiling, temperature, dewpoint, altimeter, and barometric pressure.

⁴ Magnetic variation – The angle (at a particular location) between magnetic north and true north. Latest measurement taken from <https://skyvector.com/>

⁵ The bold sections in this NWS product and the rest of the products in this report are intended to highlight the sections that directly reference the weather conditions that affected the accident location around the accident time. The local times in this section next to the METARs are provided for quick reference between UTC and local times around the accident time.

[1453 CDT] METAR KLBB 261953Z 02014KT 5SM -FZDZ BR OVC008 M03/M05 A3016
RMK AO2 SLP228 P0000 I1000 T10331050=

***[1553 CDT] METAR KLBB 262053Z 02015G21KT 4SM -FZDZ BR OVC007 M04/M05
A3016 RMK AO2 SLP227 P0000 60000 I1000 I3000 T10391050 56015=***

ACCIDENT TIME 1558 CDT

***[1632 CDT] SPECI KLBB 262132Z 03017KT 4SM -FZDZ BR OVC007 M04/M05 A3015
RMK AO2 P0000 I1006 T10391050=***

[1653 CDT] METAR KLBB 262153Z 04017G21KT 4SM -FZDZ BR OVC007 M04/M05
A3015 RMK AO2 SLP226 P0000 I1007 T10391050=

KLBB weather at 1553 CDT, wind from 020° at 15 knots with gusts to 21 knots, visibility 4 miles, light freezing drizzle, mist, overcast ceiling at 700 ft above ground level (agl), temperature of -4°Celsius (C), dew point temperature of -5°C, and an altimeter setting of 30.16 inches of mercury (inHg). Remarks: automated station with a precipitation discriminator, sea level pressure 1022.7 hPa, a trace of precipitation since 1453 CDT, 6-hourly precipitation of a trace, a trace of ice accumulation since 1453 CDT, 3-hourly ice accumulation of a trace, temperature -3.9°C, dew point temperature -5.0°C, 3-hourly pressure decrease of 1.5 hPa.

KLBB weather at 1632 CDT, wind from 030° at 17 knots, visibility 4 miles, light freezing drizzle, mist, overcast ceiling at 700 ft agl, temperature of -4°C, dew point temperature of -5°C, and an altimeter setting of 30.15 inHg. Remarks: automated station with a precipitation discriminator, a trace of precipitation since 1553 CDT, 0.06 inches of ice accumulation since 1553 CDT, temperature -3.9°C, dew point temperature -5.0°C.

The observations from KLBB surrounding the accident time indicated IFR⁶ conditions with wind gusts reported to 21 knots from the north-northeast and 0.06 inches of ice accumulation between 1553 and 1632 CDT.

⁶ 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 below 500 ft above ground level (agl) and/or visibility less than 1 statute mile.
- Instrument Flight Rules (IFR) – ceiling between 500 to below 1,000 feet agl and/or visibility 1 to less than 3 miles.
- Marginal Visual Flight Rules (MVFR**) – ceiling from 1,000 to 3,000 ft agl and/or visibility 3 to 5 miles.
- Visual Flight Rules (VFR) – ceiling greater 3,000 ft agl and visibility greater than 5 miles.

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

**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.

4.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR)⁷ model sounding was created for the accident site for 1600 CDT with station elevation of 3,202 ft.⁸ The 1600 CDT HRRR sounding was plotted on a standard Skew-T Log P diagram⁹ with the derived stability parameters included in figure 7 with data from the surface to 600-hPa (or approximately 14,000 ft msl). This data was analyzed using the RAOB¹⁰ software package. The sounding depicted the lifted condensation level (LCL)¹¹ at 1,341 ft agl, the level of free convection (LFC)¹² at 1,341 ft agl, and the convective condensation level (CCL)¹³ at 1,445 ft agl. It was below freezing at the surface, but warmed above freezing by 7,500 ft above msl. The sounding went below freezing again around 12,500 ft above msl. The precipitable water value was 0.47 inches.

⁷ 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.

⁸ HRRR sounding was created using NOAA Air Resource Laboratory: <https://ready.arl.noaa.gov/READYamet.php>

⁹ Skew T log P diagram – is a standard meteorological plot using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

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

¹¹ LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

¹² 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.

¹³ CCL – The level in the atmosphere to which an air parcel, if heated from below, will rise dry adiabatically, without becoming colder than its environment just before the parcel becomes saturated.

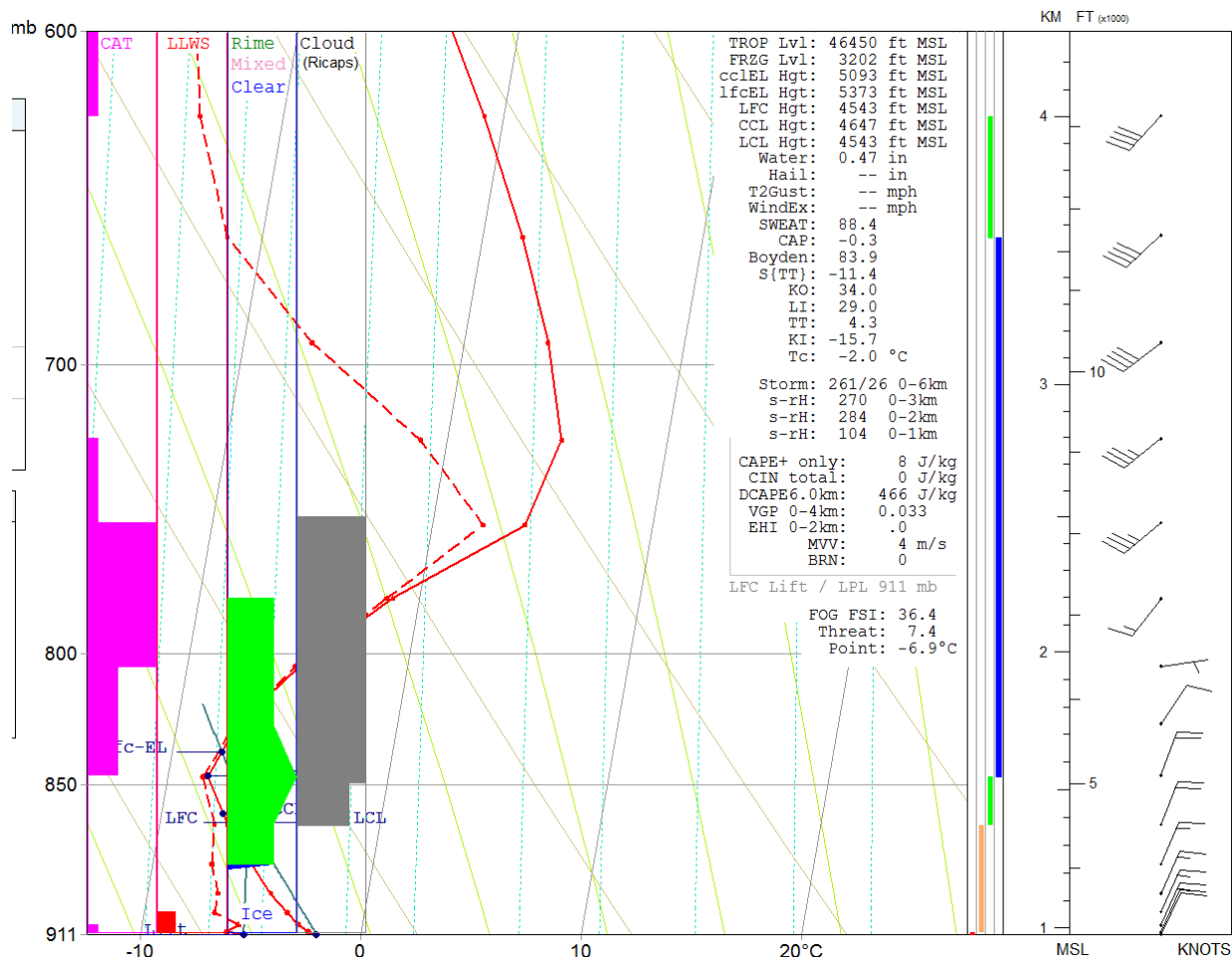


Figure 7 – 1600 CDT HRRR sounding

The 1600 CDT HRRR sounding for the accident site indicated an unstable and conditionally unstable environment from the surface through 5,000 ft above msl, then a stable environment from 5,000 ft above msl through 11,500 ft above msl. RAOB identified the possibility of clouds between 4,250 to 8,500 ft above msl (~1,000 to 5,250 ft agl). RAOB identified moderate rime icing between 4,000 and 7,250 ft above msl (~750 to 4,000 ft agl).

The 1600 CDT HRRR sounding wind profile indicated a near surface wind from 024° at 11 knots with the wind remaining northeasterly through 6,000 ft. The wind speed increased to 20 knots by 4,000 ft above msl. The wind veered¹⁴ to the southwest by 7,000 ft above msl and the wind increased in speed to 40 knots by 10,000 ft above msl. RAOB indicated the possibility of light low-level wind shear (LLWS) between the surface and 500 ft agl. RAOB indicated that a chance of moderate or greater clear-air turbulence existed between 5,000 and 9,000 ft above msl.

¹⁴ A clockwise turning of the wind with height in the northern hemisphere.

5.0 Satellite Data

Geostationary Operational Environmental Satellite number 16 (GOES-16) visible and infrared data were 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 software. Visible and infrared imagery (GOES-16 bands 2 and 13) at wavelengths of 0.64 microns (μm) and 10.3 μm , respectively, were retrieved for the period from 1000 CDT through 1300 CDT and reviewed, and the closest images to the time of the accident were documented.

Figures 8 and 9 present the GOES-16 visible imagery at 1550 and 1600 CDT at 2X magnification with the accident site highlighted with a red square. The visible imagery indicated an extensive layer of flat top clouds above the accident site. The cloud cover was moving from north to south across the accident site (attachment 1).

Figure 10 presents the GOES-16 infrared imagery from 1600 CDT at 6X magnification with the accident site highlighted with a red square. The lower brightness temperatures (yellow colors; higher cloud tops) were located to the northwest of the accident site. Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 1600 CDT HRRR sounding, the approximate cloud-top heights over the accident site were either¹⁵ 7,500 or 11,000 ft above msl at 1600 CDT (276 Kelvin). It should be noted these figures have not been corrected for any parallax error. The Daytime Microphysics Red, Green, Blue (RGB) imagery¹⁶ indicated the cloud cover above the accident site was thick or thin, small drop, low clouds (attachment 2).

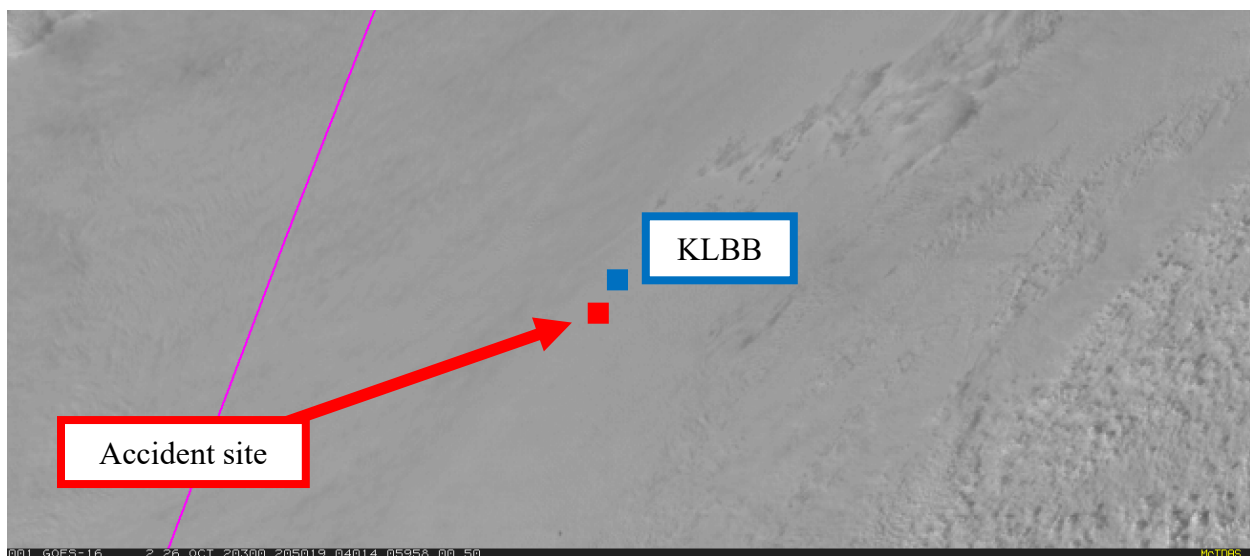


Figure 8 – GOES-16 visible image at 1550 CDT

¹⁵ The 1600 CDT HRRR sounding crossed the 276 Kelvin temperature twice and so the brightness temperature could be either of these altitudes (section 1.2).

¹⁶ https://weather.msfc.nasa.gov/sport/training/quickGuides/rgb/QuickGuide_DtMicroRGB_NASA_SPoRT.pdf

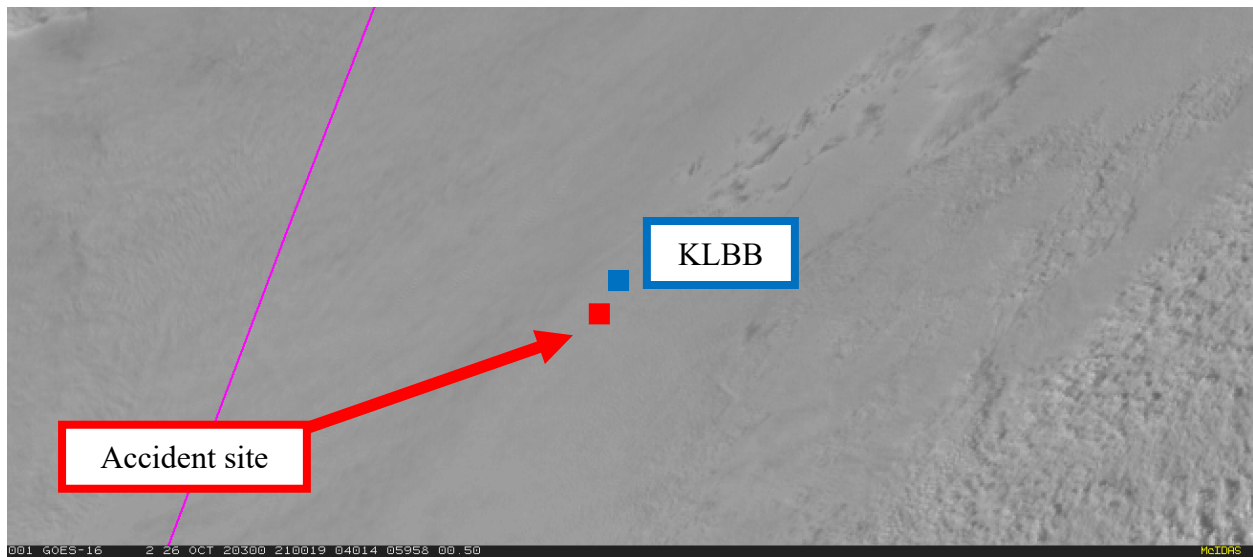


Figure 9 – GOES-16 visible image at 1600 CDT

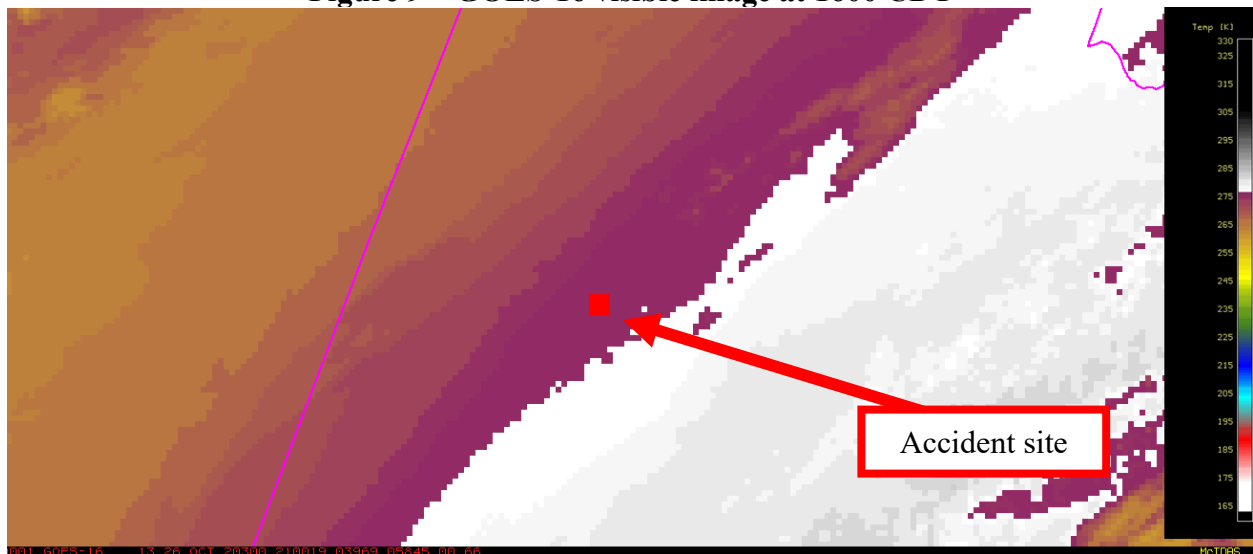


Figure 10 – GOES-16 infrared image at 1600 CDT

Additional GOES-16 data was provided by the National Aeronautics and Space Administration (NASA) Langley Research Center Climate Science Branch (LARC-E302). LARC-E302 imagery¹⁷ available before the accident time at 1540 CDT indicated a high probability of light icing, with cloud top temperatures between 270 and 280 Kelvin, and a supercooled liquid water (SLW) cloud top phase. For more information please see attachment 11.

6.0 Regional Radar Imagery Information

A regional view of the NWS national composite radar mosaic is included as figure 11 for 1600 CDT with the approximate location of the accident site marked within a red circle. The image depicted scattered echoes from 0 to 20 decibels (dBZ¹⁸) above the accident site.

¹⁷ https://satcorps.larc.nasa.gov/cgi-bin/site/showdoc?docid=22&lkdomain=Y&domain=ICNG_CONUS_GEW

¹⁸ dBZ – A non-dimensional “unit” of radar reflectivity which represents a logarithmic power ratio (in decibels , or

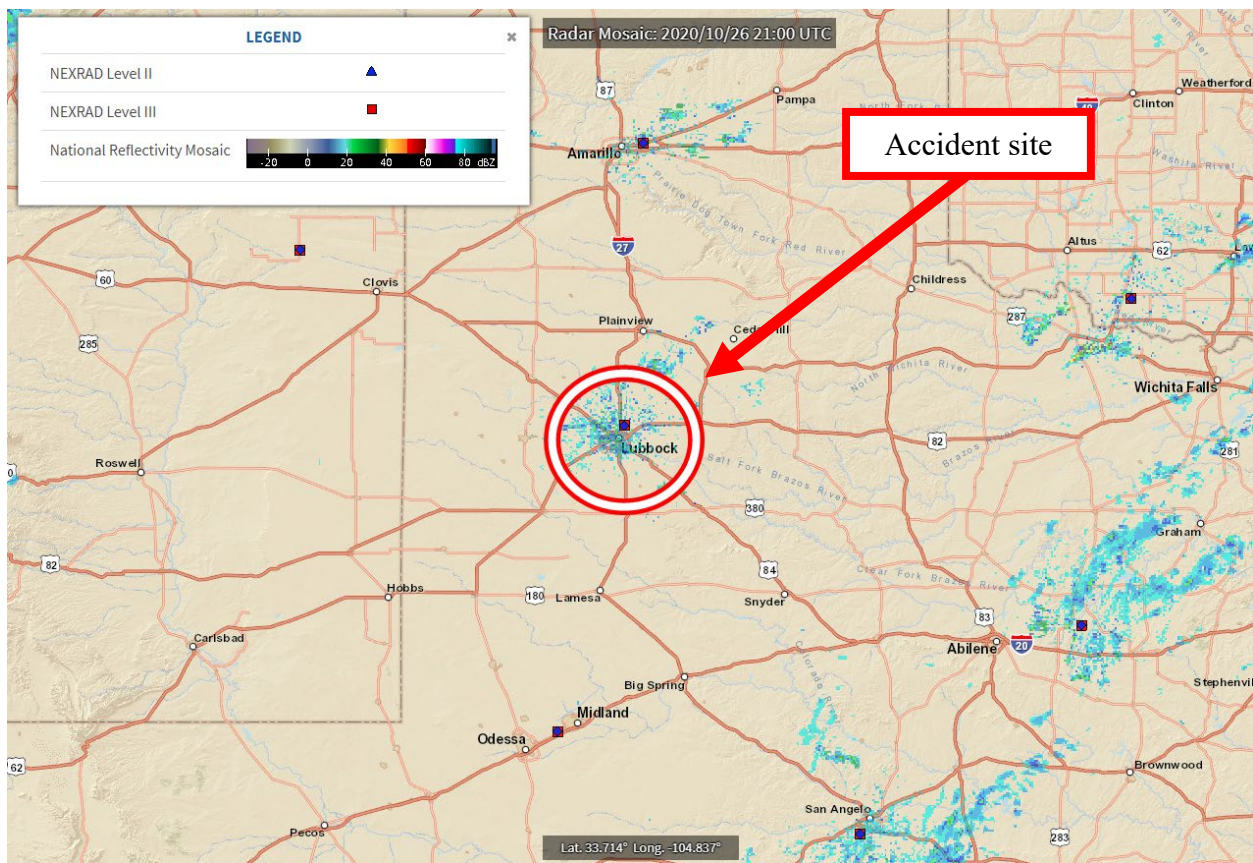


Figure 11 – Regional Composite Reflectivity image for 1600 CDT

7.0 Radar Imagery Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)¹⁹ to the accident site was Lubbock, Texas (KLBB) located 6 miles north of the accident site. Level II archive radar data was obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

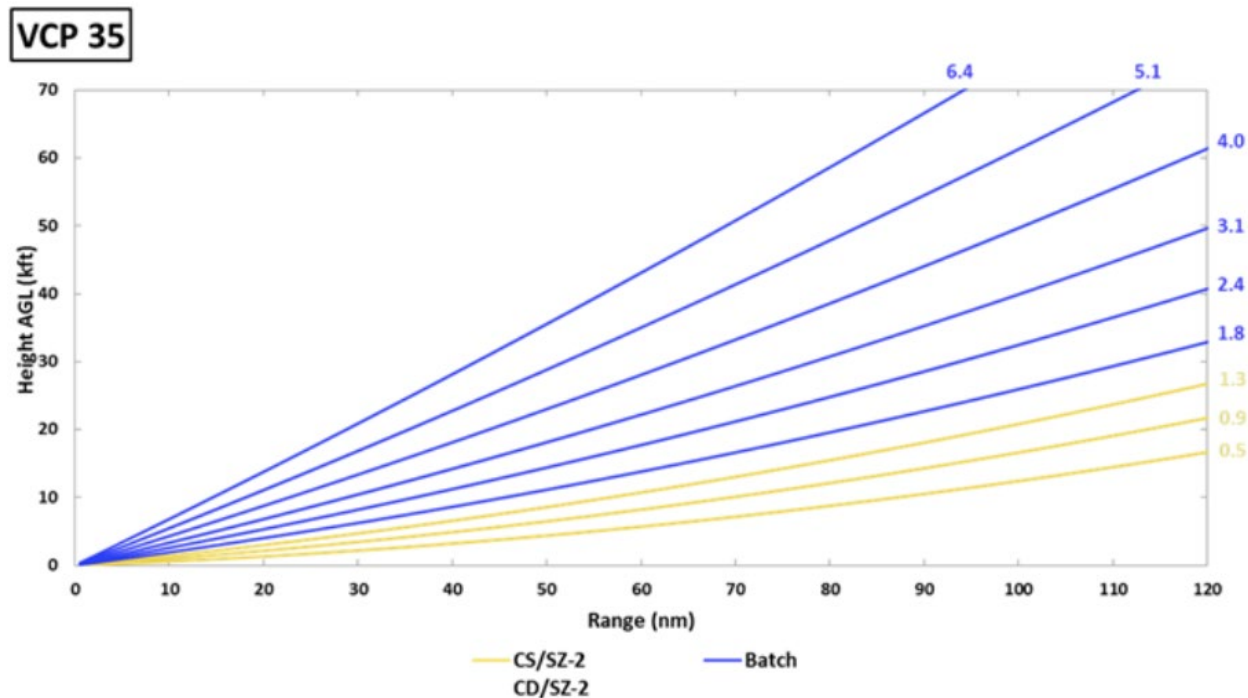
7.1 Volume Scan Strategy

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. Products that require data from multiple elevation scans are not available until the end of the five to ten minute volume scan.

dB) with respect to radar reflectivity factor, Z.

¹⁹ The WSR-88D is an S-band 10-centimeter wavelength radar with a power output of 750,000 watts, and with a 28-foot parabolic antenna that concentrates the energy between a 0.87° and 0.96° beam width. The radar produces three basic types of products: base reflectivity, base radial velocity, and base spectral width.

The WSR-88D operates in several different scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has three common scanning strategies. The most common is where the radar makes 14 elevation scans from 0.5° to 19.5° every four and a half minutes. This particular scanning strategy is documented as volume coverage pattern 212 (VCP-212). Mode B is the clear-air mode, where the radar makes 9 elevation scans during a ten-minute period. During the period surrounding the accident, the KLBB WSR-88D radar was operating in the clear-air mode VCP-35. 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.



VCP-35 Clear-air Mode Scan Strategy²⁰

²⁰ Contiguous Surveillance (CS)--The low Pulse Repetition Frequency (PRF) scan of the split cut. Gives a high R_{max} value to determine proper target location and intensity, but a low V_{max} value limits the velocities that can be measured. Contiguous Doppler (CD)--The high PRF scan of the split cut. Gives a low R_{max} value causing more range folded (multiple trip) echoes, but a high V_{max} value to get higher, more accurate velocity values.

Batch Mode – Uses alternating low and high PRFs on each radial for one full rotation at each elevation angle. The two resulting data sets (low PRF and high PRF) are combined to resolve range ambiguity. Used in the middle elevation angles.

W – With range unfolding (W)

WO – Without range unfolding (WO)

7.2 Beam Height Calculation

Assuming standard refraction²¹ of the KLBB WSR-88D radar beam with the antenna elevation at 3,378 ft, and considering a beamwidth²² of 0.95°, the following table shows the approximate heights for the radar beam center, base and top for antenna elevations over the accident site. These heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
KLBB 1.3°	4,230 ft	3,930 ft	4,530 ft

Based on the radar height calculations, the elevation scans from KLBB listed in the above table depicted the conditions between 3,930 ft and 4,530 ft above msl over the accident site and these scans “saw” the closest altitudes to the accident aircraft’s flight level before the descent in altitude.^{23,24}

7.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²⁵ it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in dBZ and is a general measure of echo intensity. FAA Advisory Circular AC 00-24C²⁶, “Thunderstorms,” dated February 19, 2013, also defines the echo intensity levels and weather radar echo intensity terminology associated with those levels. For dBZ values less than 30 the weather radar echo intensity terminology should be “light.” For dBZ values between 30 and 40, the terminology should be “moderate.” “Heavy” terminology is used for dBZ values greater than 40 dBZ but less than 50 dBZ, inclusive. Finally, any dBZ values above 50 dBZ shall be described as “extreme.” From the NWS, precipitation conditions at the surface can be inferred from VIP Levels described in the chart below:

²¹ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

²² Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

²³ Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of ft. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the standard sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

²⁴ For more information please see air traffic control (ATC) data located in the docket of this accident.

²⁵ Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at the earth’s surface; also, any water particles blown by the wind from the earth’s surface. Hydrometeors are classified as; (a) Liquid or solid water particles suspended in the air: cloud, water droplets, mist or fog. (b) Liquid precipitation: drizzle and rain. (c) Freezing precipitation: freezing drizzle and freezing rain. (d) Solid (frozen) precipitation: ice pellets, hail, snow, snow pellets, and ice crystals. (e) Falling particles that evaporate before reaching the ground: virga. (f) Liquid or solid water particles lifted by the wind from the earth’s surface: drifting snow, blowing snow, blowing spray. (g) Liquid or solid deposits on exposed objects: dew, frost, rime, and glazed ice.

²⁶

https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1020774

- VIP 1 (Level 1, 18-30 dBZ) - Light precipitation
- VIP 2 (Level 2, 30-38 dBZ) - Light to moderate rain
- VIP 3 (Level 3, 38-44 dBZ) - Moderate to heavy rain
- VIP 4 (Level 4, 44-50 dBZ) - Heavy rain
- VIP 5 (Level 5, 50-57 dBZ) - Very heavy rain; hail possible
- VIP 6 (Level 6, >57 dBZ) - Very heavy rain and hail; large hail possible

7.4 Base Reflectivity and Lightning Data

Figure 12 presents the KLBB WSR-88D base reflectivity images for the 1.3° elevation scans initiated at 1556:02 CDT, with a resolution of 0.5° X 250 m. Reflectivity values between 0 and 10 dBZ were located above the accident site at the accident time and indicative of very light precipitation (section 7.3). The band of precipitation was moving from west to east over the accident site at the accident time (attachment 4).

There were no lightning flashes²⁷ near the accident site at the accident time.²⁸

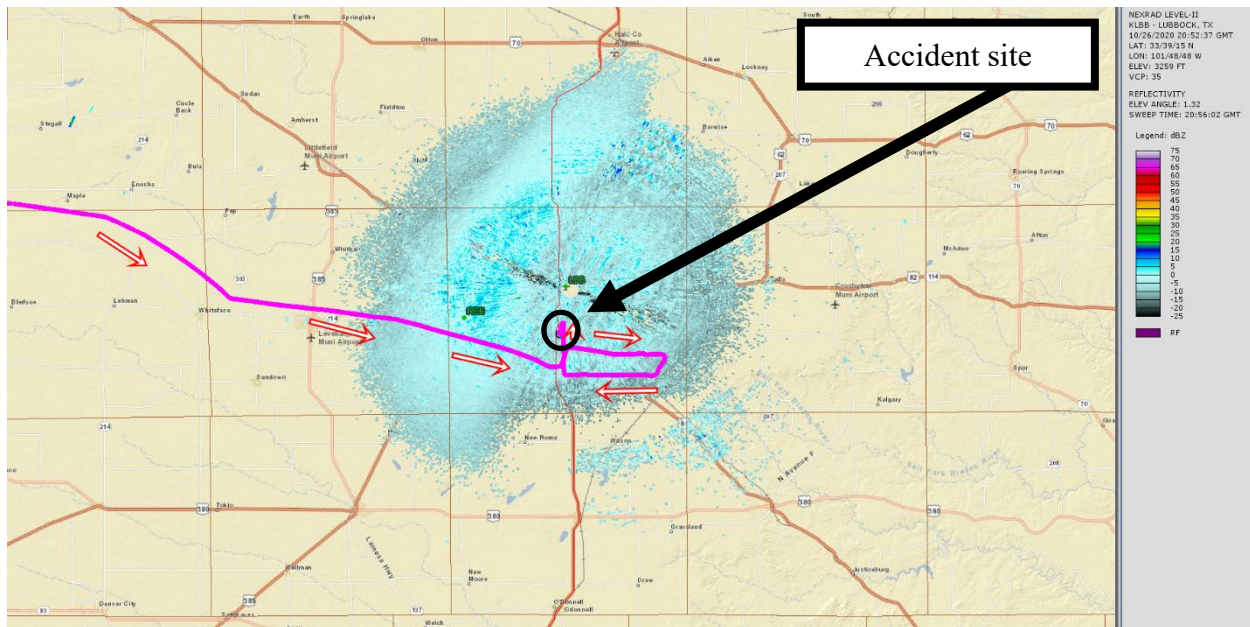


Figure 12 – KLBB WSR-88D reflectivity for the 0.5° elevation scan initiated at 1556:02 CDT with the accident site marked with black circle and the accident flight track in pink with arrows pointing in the direction of travel

²⁷ Lightning Flash – This is one contiguous conducting channel and all the current strokes/pulses that flow through it. There are two types of flashes: ground flashes and cloud flashes.

²⁸ A review of Earth Networks Total Lightning network was done.

8.0 Pilot Reports²⁹

The following are the publicly longline-disseminated pilot reports³⁰ (PIREPs) distributed into the national airspace within 110 miles of the accident site from about two hours prior to the accident time to two hours after the accident time for below 18,000 ft above msl. There were many reports of icing below 7,000 ft and a report of freezing rain at 1547 CDT.³¹

LBB UA /OV 2S/TM 1935/FL035/TP CRJ9/SK B039

MAF UA /OV MAF360025/TM 1941/FL060/TP C182/TA -2C/IC LGT RIME

MAF UA /OV MAF/TM 1943/FL036/TP C680/SK OVC/RM DURC TOPS078

MAF UA /OV MAF/TM 2019/FL045/TP C56X/SK OVC/TA M01/IC LGT RIME/RM DURD

LBB UA /OV LBB/TM 2034/FL087/TP C56X/SK T087

LBB UA /OV LBB/TM 2045/FL039/TP C56X/SK B039

LBB UA /OV LBB/TM 2047/FL070/TP CRJ9/IC FREEZIN RAIN BELOW 070 OAT-3

LBB UA /OV 5W/TM 2110/FL052/TP CRJ2/SK T 083 B 038/IC MOD RIME ICE

LBB UA /OV LBB/TM 2118/FL052/TP BE20/IC LGHT MIXED ICE OAT -6

MAF UA /OV MAF180002/TM 2141/FL035/TP BE20/SK OVC005/IC TRC CLR

MAF UA /OV MAF360005/TM 2222/FL033/TP CRJ2/SK OVC/RM DURC TOPS077

LBB UA /OV 10 NW OF LBB/TM 2230/FL080/TP B737/SK BASE 039 TOPS 080/IC LT RIME FROM 045 TO 060 OAT 0

LBB UA /OV LBB060007/TM 2250/FL082/TP CRJ2/SK T082/IC LGT MX 045-082

9.0 SIGMET

There were no convective or non-convective Significant Meteorological Information (SIGMET) advisories valid for the accident site at the accident time.

10.0 CWSU Advisories

The Fort Worth Center (ZFW) Air Route Traffic Control Center (ARTCC) Center Weather Service Unit (CWSU) was responsible for the accident region. The ZFW CWSU issued no Meteorological Impact Statements (MIS) for the area prior to the accident. ZFW CWSU issued Center Weather Advisory (CWA) 205 at 1450 CDT that was valid until 1650 CDT. CWA 205 warned of an area of occasional freezing rain, freezing drizzle and light snow with conditions continuing beyond 1650 CDT (figure 13):

²⁹ Only pilot reports with the World Meteorological Organization headers UBNM**, UBTX**, UBOK**, UBCO**, and UBKS** were considered.

³⁰ These do not include pilot reports only broadcast via radio.

³¹ For more information please see the ATC factual located in the docket for this accident.

FAUS22 KZFW 261950
 ZFW2 CWA 261950
 ZFW CWA 205 VALID UNTIL 262150
FROM 25NW LBB-CDS-35S MMB-35E OKC-SPS-40SW LBB-25NW LBB
AREA OCNL FZRA/FZDZ/-SN. CONDS CONTG BYD 2150Z.
 =

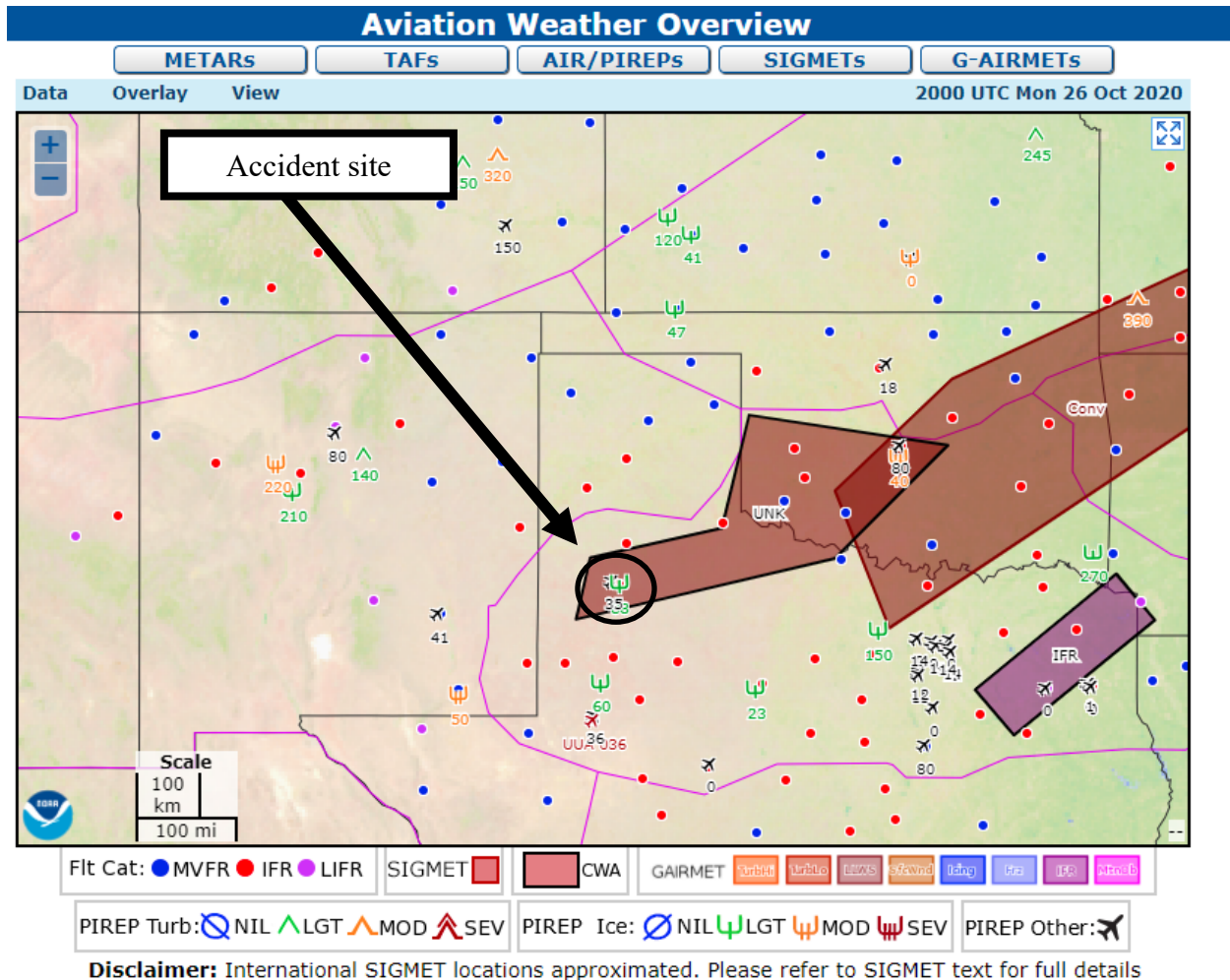


Figure 13 – AWC page with the CWAs, SIGMETs, and PIREPs valid at 1500 CDT

11.0 AIRMETs

Airmen's Meteorological Information (AIRMET) advisories Sierra and Zulu were valid for the accident site at the accident time. The AIRMETs warned of IFR conditions due to precipitation, mist, and fog, and moderate icing below 10,000 ft. AIRMETs Sierra and Zulu were also valid before the accident flight departed and the text is contained below:

WAUS44 KPCI 262045

WA4S

-DFWS WA 262045

AIRMET SIERRA UPDT 7 FOR IFR AND MTN OBSCN VALID UNTIL 270300

AIRMET IFR...OK TX AR LA

**FROM OSW TO RZC TO 20NNE ARG TO 60ESE LIT TO 60SE CWK TO 20SE
DLF TO 70SE MRF TO 70W INK TO INK TO 30ENE TCC TO 50SSE ICT TO
OSW**

CIG BLW 010/VIS BLW 3SM PCPN/BR/FG. CONDS CONTG BYD 03Z THRU 09Z.

AIRMET MTN OBSCN...TX

**FROM 50W INK TO FST TO 50NW DLF TO 90SE MRF TO 20WNW MRF TO 80SE
ELP TO ELP TO 50W INK**

MTNS OBSC BY CLDS/BR. CONDS CONTG BYD 03Z THRU 09Z.

AIRMET MTN OBSCN...TN

FROM 50WSW LOZ TO HNV TO GQO TO 50WSW LOZ

**MTNS OBSC BY CLDS/PCPN/BR. CONDS DVLPG 00-03Z. CONDS CONTG BYD
03Z THRU 09Z.**

OTLK VALID 0300-0900Z...IFR AL

BOUNDED BY LGC-50SW PZD-40S MGM-20NNW MGM-LGC

**CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS DVLPG AFT 06Z. CONDS
CONTG THRU 09Z.**

....

WAUS44 KPCI 261445

WA4S

-DFWS WA 261445

AIRMET SIERRA UPDT 5 FOR IFR AND MTN OBSCN VALID UNTIL 262100

AIRMET IFR...OK TX AR LA

**FROM OSW TO RZC TO 30NNW ARG TO 40NNW LIT TO 60SE LIT TO 30ESE
MLU TO 40W AEX TO 30ENE IAH TO 30SSW CWK TO 50W SAT TO 20SE MRF
TO 40E ELP TO INK TO 30ENE TCC TO LBL TO OSW**

CIG BLW 010/VIS BLW 3SM PCPN/BR/FG. CONDS CONTG BYD 21Z THRU 03Z.

AIRMET IFR...AR TN LA MS AL AND CSTL WTRS

**FROM 70S PXV TO 20SSE LOZ TO 60WSW GQO TO 50SSW CEW TO 30E LSU
TO 30SSW MHZ TO 50SE MLU TO 50NW SQS TO 40ESE ARG TO 70S PXV**

CIG BLW 010/VIS BLW 3SM BR/FG. CONDS ENDG 18-21Z.

AIRMET MTN OBSCN...TN

FROM 50WSW LOZ TO HNV TO GQO TO 50WSW LOZ

MTNS OBSC BY CLDS/BR/FG. CONDS ENDG BY 18Z.

AIRMET MTN OBSCN...TX

**FROM 50W INK TO FST TO 50WNW DLF TO 110WSW DLF TO 40E ELP TO 50W
INK**

MTNS OBSC BY CLDS/BR. CONDS CONTG BYD 21Z THRU 03Z.

....

WAUS44 KPCI 262045

WA4Z

-DFWZ WA 262045

AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 270300

.
AIRMET ICE...OK TX NE KS IA MO WI LM MI LH IL IN
FROM 60SW YVV TO 30S ECK TO DXO TO FWA TO 50ESE END TO 50S AMA TO
20ENE TCC TO 20ESE TBE TO 50W LBL TO GLD TO 40ENE AKO TO 30N DBQ
TO 30NE BAE TO 60SW YVV
MOD ICE BTN FRZLVL AND FL200. FRZLVL SFC-040. CONDS CONTG BYD 03Z
THRU 09Z.

.
AIRMET ICE...OK TX
FROM 50ESE END TO 20NNW ADM TO 70SE ABI TO 30SE FST TO 40N MRF TO
70ESE ELP TO INK TO 30S TXO TO 50S AMA TO 50ESE END
MOD ICE BLW 100. CONDS CONTG BYD 03Z THRU 09Z.

.
AIRMET ICE...OK TX AR KS MO IL IN KY
FROM FWA TO CVG TO 30W HNN TO 60SE FAM TO 40SW TTT TO 20NNW ADM
TO 50ESE END TO FWA
MOD ICE BTN FRZLVL AND FL250. FRZLVL 040-120. CONDS CONTG BYD 03Z
THRU 09Z.

.
OTLK VALID 0300-0900Z
AREA 1...ICE OK TX NE KS
BOUNDED BY 40SSE OBH-SLN-20NNE SPS-60E ABI-20E SJT-50SW SJT-30S
FST-80WSW INK-40WNW INK-INK-30ESE TBE-50W LBL-GLD-50SE SNY-40SSE
OBH
MOD ICE BLW FL220. CONDS DVLPG AFT 03Z. CONDS CONTG THRU 09Z.

.
AREA 2...ICE OK TX AR KS MO
BOUNDED BY 40W IRK-50SSW STL-20W MLC-60E ABI-SLN-40W IRK
MOD ICE BLW 100. CONDS CONTG THRU 09Z.

.
FRZLVL...RANGING FROM SFC-175 ACRS AREA
MULT FRZLVL BLW 140 BOUNDED BY 30SSE ORD-30SSW TUL-60WSW TTT-
20ESE FST-ELP-INK-50NE TCC-40ESE TBE-30SSE ORD
MULT FRZLVL 040-150 BOUNDED BY DXO-FWA-30NNW CVG-50S AXC-FAM-
20NNE TTT-30NNE SAT-DLF-50WSW DLF-70SSE MRF-ELP-20ESE FST-
60WSW TTT-30SSW TUL-20ESE JOT-40SE PMM-DXO
SFC ALG 60W INK-40S MAF-30W SJT-40S ABI-40ENE OKC-OSW
040 ALG 50W INK-50ESE FST-30ESE SJT-TUL-40SE OSW
080 ALG ELP-50SE MRF-50NW DLF-30ESE JCT-MLC-30E RZC
120 ALG 30SSE DLF-20N SAT-50NW TXK-40SE FSM-20NE ARG
160 ALG LRD-30W CRP-40WNW LCH-40SSW MHZ-LGC

....

WAUS44 KKCI 261445
WA4Z

-DFWZ WA 261445

AIRMET ZULU UPDT 2 FOR ICE AND FRZLVL VALID UNTIL 262100

.
AIRMET ICE...OK TX AR NE KS IA MO WI LM MI LH IL IN
FROM 20SE ECK TO 20NNW FWA TO 20ESE STL TO 20S ADM TO 30SSE SJT
TO 30SE INK TO 40N INK TO 30ESE TBE TO 50W LBL TO GLD TO 20SE ECK
MOD ICE BTN FRZLVL AND FL250. FRZLVL SFC-040. CONDS CONTG BYD 21Z
THRU 03Z.

.
AIRMET ICE...OK TX AR MO MI LH IL IN KY

FROM 20SE ECK TO 20E DXO TO FWA TO 20N CVG TO 30NE BWG TO 50N DYR
TO 20S ADM TO 20ESE STL TO 20NNW FWA TO 20SE ECK
MOD ICE BTN FRZLVL AND FL250. FRZLVL 040-120. CONDS CONTG BYD 21Z
THRU 03Z.

.
OTLK VALID 2100-0300Z...ICE OK TX NE KS IA MO WI LM MI LH IL
BOUNDED BY 60ESE SSM-60WNW YVV-40ENE ECK-20S ECK-70WSW MCI-20WNW
ADM-50ESE ABI-30N SJT-20WSW FST-INK-30ESE TBE-50W
LBL-GLD-SNY-50NNW OVR-20W BAE-30SE GRB-30SSW TVC-20NW ASP-60ESE
SSM
MOD ICE BTN FRZLVL AND FL200. FRZLVL SFC-040. CONDS CONTG THRU
03Z.

.
FRZLVL...RANGING FROM SFC-170 ACRS AREA
MULT FRZLVL 040-150 BOUNDED BY 30NW RZC-50S SGF-MLC-TTT-20SSW
ACT-30WNW CWK-30ENE DLF-40W MRF-ELP-INK-SJT-60E ABI-50ESE
OKC-30NW RZC
MULT FRZLVL BLW 140 BOUNDED BY OSW-30NW RZC-50ESE OKC-60E ABI-
SJT-INK-30SE TCC-60SSE TBE-50W LBL-OSW
SFC ALG 60N INK-70SE LBB-50WSW SPS-30WSW OSW-OSW
040 ALG 30N INK-20ENE INK-20W SJT-40SSE ABI-40SSW OKC-OSW
080 ALG 50E ELP-40W FST-60WSW JCT-60ENE JCT-ADM-20NW RZC
120 ALG 50WSW MRF-50W DLF-30E DLF-30W CWK-50S MLC-FSM-50WNW
ARG
160 ALG 50S LRD-60WSW LCH-40NNW CEW-40W PZD

....

12.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products made available before the accident flight and valid at 1600 CDT are shown in attachment 5. The GFA surface forecast products indicated MVFR to IFR surface visibilities, between a 30 and 60 percent chance of freezing rain, and a surface wind from the north at 15 knots with gusts to 25 knots. A graphical-AIRMET (G-AIRMET)³² was valid for IFR conditions. The GFA cloud forecast valid before departure for around the accident time indicated overcast skies at 4,000 to 5,000 ft above msl, with cloud tops to 10,000 ft above msl. A G-AIRMET was valid for icing conditions. For more information please see attachment 5.

13.0 Terminal Aerodrome Forecast

KLBB was the closest airport to the accident site with an NWS³³ Terminal Aerodrome Forecast (TAF). The KLBB TAF valid at the time of the accident was issued at 1248 CDT and was valid for a 24-hour period beginning at 1300 CDT. The TAF for KLBB was as follows:

TAF KLBB 261748Z 2618/2718 **03017KT 3SM -FZDZ BR OVC008**
FM270600 02016KT 3SM -FZRAPL OVC008
FM271500 02017KT 5SM -FZDZ OVC008=

³² <https://aviationweather.gov/gairmet>

³³ According to NWS Instruction 10-813: "A NWS TAF consists of the expected meteorological conditions significant to aviation at an airport for a specified time period. For the U.S., this is the area within five (5) statute miles (SM) of the center of an airport's runway complex." www.nws.noaa.gov/directives/sym/pd01008013curr.pdf

After 1300 CDT, the forecast expected a wind from 030° at 17 knots, 3 miles visibility, light freezing drizzle, mist, and an overcast ceiling at 800 ft agl.

14.0 NWS Area Forecast Discussion

The NWS office in Lubbock, Texas, (WFO LUB) issued the following Area Forecast Discussion (AFD) at 1258 CDT (closest AFD to the accident time with an aviation section). The aviation section of the AFD discussed IFR ceilings with wintry precipitation through the following day:

FXUS64 KLUB 261758
AFDLUB

Area Forecast Discussion
National Weather Service Lubbock TX
1258 PM CDT Mon Oct 26 2020

.AVIATION...

Low stratus will persist through the TAF cycle, mostly at IFR levels, though brief MVFR conditions are possible. In addition, wintry precipitation will continue to affect the terminals. During lulls, including this afternoon and evening, freezing fog/drizzle and even light snow will be possible. Better lift and more widespread heavier precipitation will likely affect the terminals after midnight into Tuesday morning. Freezing rain and sleet will be most likely during the heavier precipitation, and there could even be additional thunder mixed in.

&&

.PREV DISCUSSION... /issued 829 AM CDT Mon Oct 26 2020/

UPDATE...

Quick update, primarily to expand the Winter Weather Advisory to include our entire FA (adding the southern Rolling Plains) for the rest of today. We did also lower forecast highs today, as temperatures will not rise during the day, instead holding steady or slowly falling. Temperatures have already dipped to at or just below freezing over the southern Rolling Plains, where convectively enhanced showers/storms are currently in place. Overall impacts from this round of freezing rain (and sleet) should be fairly minimal given the marginal temperatures there, but still worthy of being in a Winter Weather Advisory. We do still expect a relative lull in activity this afternoon, though pockets of freezing drizzle/fog will be possible. The next round of heavier precipitation, in the form of a wintry mix, will arrive late this evening/tonight, when the Winter Storm Warning is in effect.

PREV DISCUSSION... /issued 333 AM CDT Mon Oct 26 2020/

SHORT TERM...

The upper low was diving south across Utah early this morning. An

area of large scale lift was seen in water vapor imagery and in the upper level PVA fields swinging across southern Arizona and southern New Mexico. Models pick up on this showing an increase in the upper level divergence and a small increase in the Q-vector convergence fields. This lift will provide a brief period of enhanced lift mostly off the caprock around the 12-15Z time period. Also a brief introduction of a frontogenetical layer between 700-600mb off the caprock will scoot east by late morning. This lift may also be enough to produce some convective elements which was already seen this morning over the central Texas Panhandle. A decrease in the isentropic lift will occur by late this morning lasting into the evening with lighter winds on the 290-300K surfaces. Lift will pick up again after 06Z tonight with an increase in the upper level jet winds and isentropic lift on the aforementioned theta surfaces. Models are not entirely clear on the isotherm packing and resulting possible frontogenetical forcing off the caprock for early Tuesday morning. But this frontogenetical forcing layer may exist providing additional convective and precipitation chances off the caprock.

The elephant in the room is the precipitation type but not much has changed in the thinking of the p-type from previous model runs. A very strong warm layer aloft will exist off the caprock on the order of +7C. This warm layer will persist off the caprock all for at least all of tonight and tomorrow morning. The surface temperature will be the determining factor for the p-type. Some areas may see temperatures hover around 33-35F this afternoon keeping p-type all liquid with some portions of the Rolling Plains and southeastern Texas Panhandle cold enough for freezing rain/drizzle. Shifting on the caprock, a shallow cold layer will exist for much of the day today supporting freezing drizzle. The cold layer will deepen tonight supporting more sleet mixing in by early Tuesday morning. A much deeper cold layer will exist in the southwestern Texas Panhandle supporting mostly sleet for today. Some snow could mix in if the warm layer cools enough but we will also temporarily lose the saturated layer above -10C. A remoistening is expected to occur tonight supporting a better chance of snow in this area. Generally very light ice accumulations can be expected on the caprock through early Tuesday morning. Accumulating ice will be more likely off the caprock early Tuesday morning. Also, accumulating snowfall will be more likely in the southwestern and south-central Texas Panhandle early Tuesday morning.

LONG TERM...

Tuesday will be a mess with precip mode being fairly dependent upon the high temp. Temperatures will not warm too much tomorrow, 10 degrees or less from tomorrow morning's lows. Precip will be ongoing with the warm conveyor fully active. Sounding profiles differ model to model, but in general the NAM and ECMWF are more in line with each other while the GFS is an outlier. The GFS keeps 850H temps above freezing for much of the FA tomorrow afternoon leading more to a heavy freezing rain event with snow/sleet possible along the Texas/New Mexico state line. The NAM and ECMWF keep above freezing 850H temps across the eastern Rolling Plains with freezing rain and/or rain most likely while leaving snow or a mixture of snow and sleet across much of the FA. As the NAM and ECMWF have handled this system better the forecast will reflect those two. Overall there is

still much uncertainty with precip mode.

The GFS continues to bring the upper low southward by mid to late Wednesday morning while warming surface temps. The ECMWF brings the upper low towards our western row of counties before pulling northeastward over the Texas Panhandle. An area of enhanced lift ahead of the upper low will only enhance precip coverage and intensity. Both models show the possibility for mixed precip as the low approaches the FA, however dynamic cooling will likely allow for precip to fall as mostly or all snow for areas on the Caprock with a mix across the Rolling Plains. The possibility exists for several inches of snowfall across portions of the South Plains. For this reason we have decided to upgrade our Winter Storm Watch to a Warning.

The last main question that remains for this system is the possibility for wrap around precip late Wednesday into early Thursday. This will depend on the path of the upper low. The track as shown by the ECMWF would keep most of the wrap around precip across the central and northern Texas Panhandle while the GFS track would affect the northern half of the FA. By Thursday afternoon the upper low should be well to our east. Northwesterly flow aloft will give way to slight upper ridging Friday. Flow will become more zonal Saturday before an upper ridge amplifies over the western US and a weak cold front pushes into the region. November looks to start off with highs in the mid to upper 60s.

&&

.LUB WATCHES/WARNINGS/ADVISORIES...

Winter Weather Advisory until 7 PM CDT this evening for TXZ021>044.

Winter Storm Warning from 7 PM this evening to 1 PM CDT Wednesday for TXZ021>044.

&&

\$\$

15.0 Winds and Temperature Aloft Forecast

The NWS 1455 CDT Winds and Temperature Aloft forecast valid for the closest point to the accident site is included below:

FBUS31 KWN0 261955

FD1US1

DATA BASED ON 261800Z

VALID 270000Z FOR USE 2000-0300Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
LBB		0814-05	2132+07	2235+00	2353-11	2366-24	239338	740446	732454

The accident site was located closest to the Lubbock, Texas, (LBB) forecast point. The 1455 CDT LBB forecast for use between 1500 CDT and 2200 CDT indicated a wind at 6,000 ft from 080° at 14 knots with a temperature of -5°C, a wind at 9,000 ft from 210° at 32 knots with a temperature of 7°C, and a wind at 12,000 ft from 220° at 35 knots with a temperature of 0°C

16.0 Pilot Weather Briefing

The accident pilot did not request a weather briefing from Flight Service Leidos.

A search of archived ForeFlight information indicated that the accident pilot did request weather information for a flight at 11,000 ft via ForeFlight (attachment 6) at 1246 CDT with a planned departure of 1255 CDT. The 1246 CDT weather briefing information contained weather information valid at 1246 CDT including AIRMETs, CWA, a surface analysis chart, current METARs valid along the route of flight, PIREPs, a GFA forecast, TAFs, turbulence cross section information, and the winds aloft information. The accident pilot accessed convective weather imagery at 0728 and 0758 CDT as well (attachment 6). There is no record of the accident pilot receiving or retrieving any other weather information before or during the accident flight.

17.0 CWSU ZFW Weather Briefing Information

CWSU ZFW provided a pre-duty weather briefing on the accident day for ATC working within ZFW airspace (which included ATC talking with the accident aircraft). The weather briefings contained weather information valid at the time the briefings were given (see attachments 7 and 8). In addition, the FAA tower chief at Lubbock airport is on the WFO LUB weather distribution list receiving weather briefings to partners within the WFO LUB region.

18.0 Icing Potential³⁴

Current Icing Potential (CIP) and Forecast Icing Potential (FIP) products are created by the NWS Aviation Weather Center (AWC) and are intended to be supplemental to other icing advisories (e.g. AIRMETs and SIGMETs). Figures 14 through 16 are the FIP icing probabilities and icing severity products and 1-hour forecast valid at 1600 CDT at 4,000, 5,000, and 6,000 ft above msl. The FIP images in figures 14 through 16 indicated above 80% probability of icing at 5,000 and 6,000 ft at 1600 CDT above the accident site. The FIP also indicated that the icing near the accident site would likely be in the light category. The FIP indicated a 10 to 40% probability of Supercooled Large Droplets (SLD) over the accident site at both 1500 and 1600 CDT (attachment 10).³⁵

³⁴ B.C. Bernstein, F. McDonough, M. K. Politovich, B. G. Brown, T. P. Ratvasky, D. R. Miller, C.A. Wolff, and G. Cuning, Current Icing Potential: Algorithm Description and Comparison with Aircraft Observations (Journal of Applied Meteorology, 2005), pp. 969-986.

C.A. Wolff, F. McDonough, M. K. Politovich, B.C. Bernstein, and G. Cuning, FIP Severity Technical Document (Prepared for the Aviation Weather Technology Transfer Technical Review Board), pp. 1-44.

<https://arc.aiaa.org/doi/abs/10.2514/6.2009-3531>

³⁵ <https://www.aviationweather.gov/icing/fip>

The CIP product indicated above 80% probability of icing at 4,000 to 6,000 ft at 1600 CDT above the accident site (figures 17, 18, and 19). The CIP also indicated that the icing near the accident site would be in the light to moderate category above 4,000 ft above msl. The CIP also indicated a 90 to 100% probability of SLD at the accident site at 1500 and 1600 CDT (attachment 10). For more FIP and CIP data please see attachment 10.

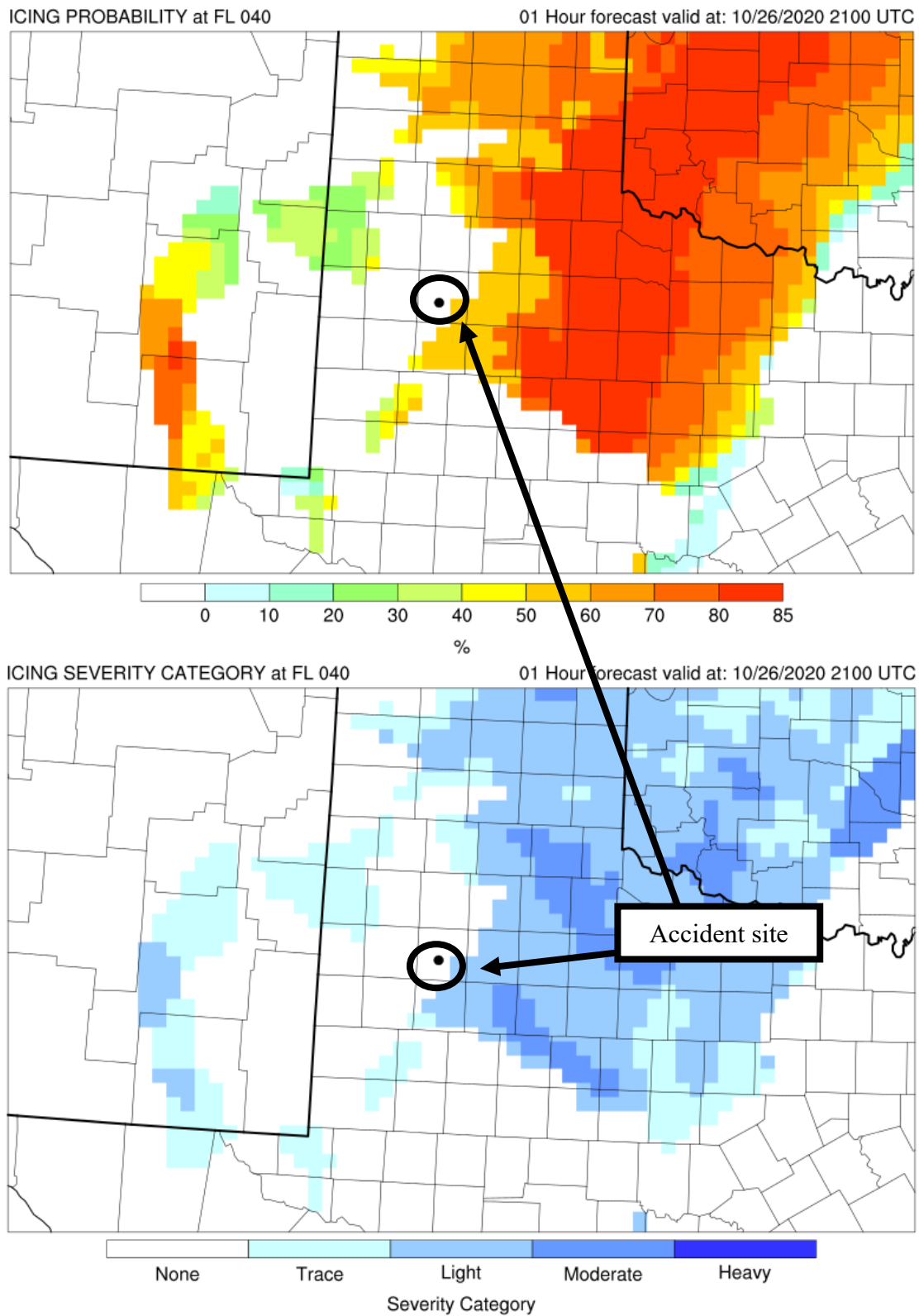


Figure 14 – (top) FIP probability of icing at 4,000 ft above msl and (bottom) FIP severity of icing at 4,000 ft above msl. 1-hour forecast valid for 1600 CDT

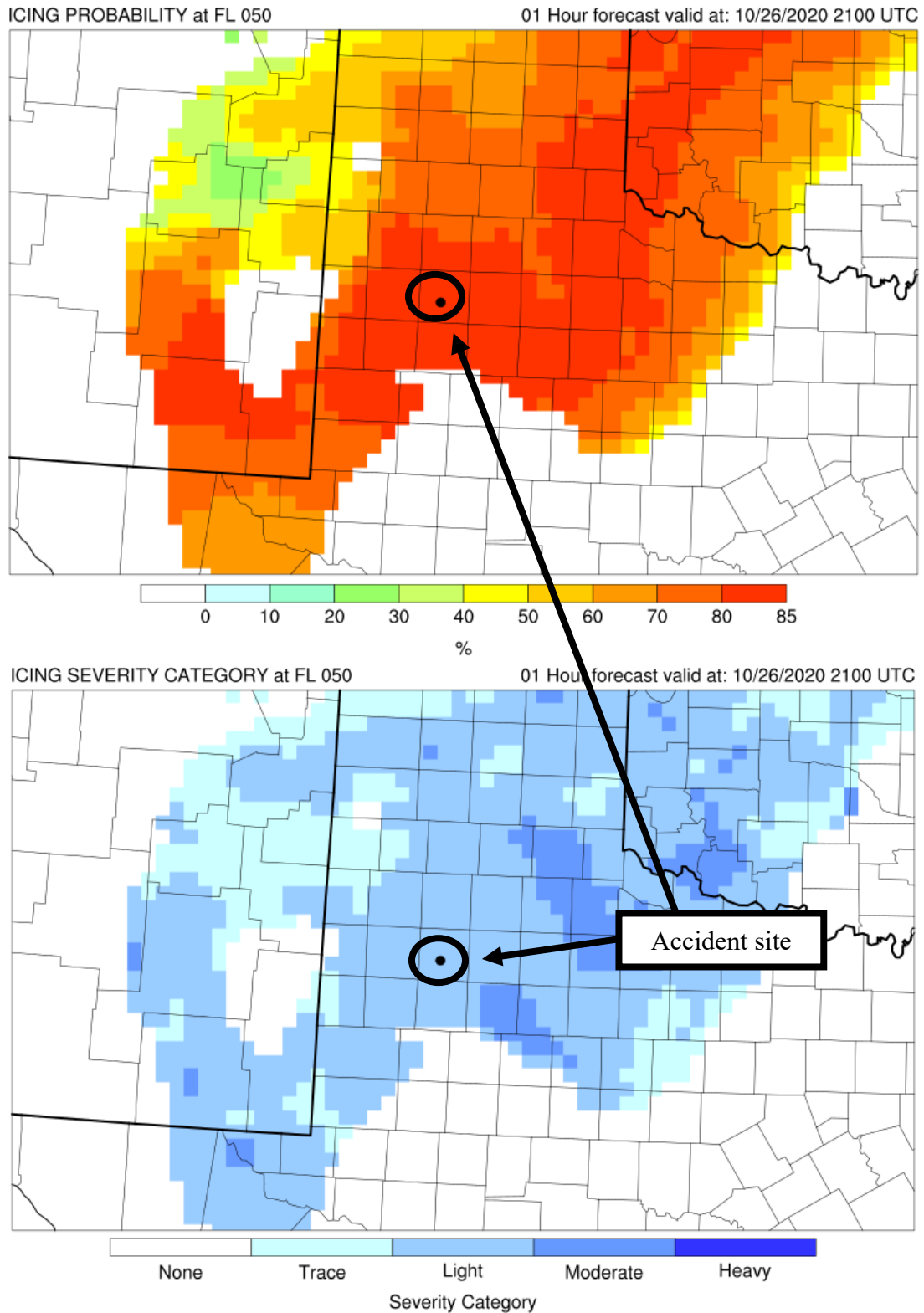


Figure 15 – (top) FIP probability of icing at 5,000 ft above msl and (bottom) FIP severity of icing at 5,000 ft above msl. 1-hour forecast valid for 1600 CDT

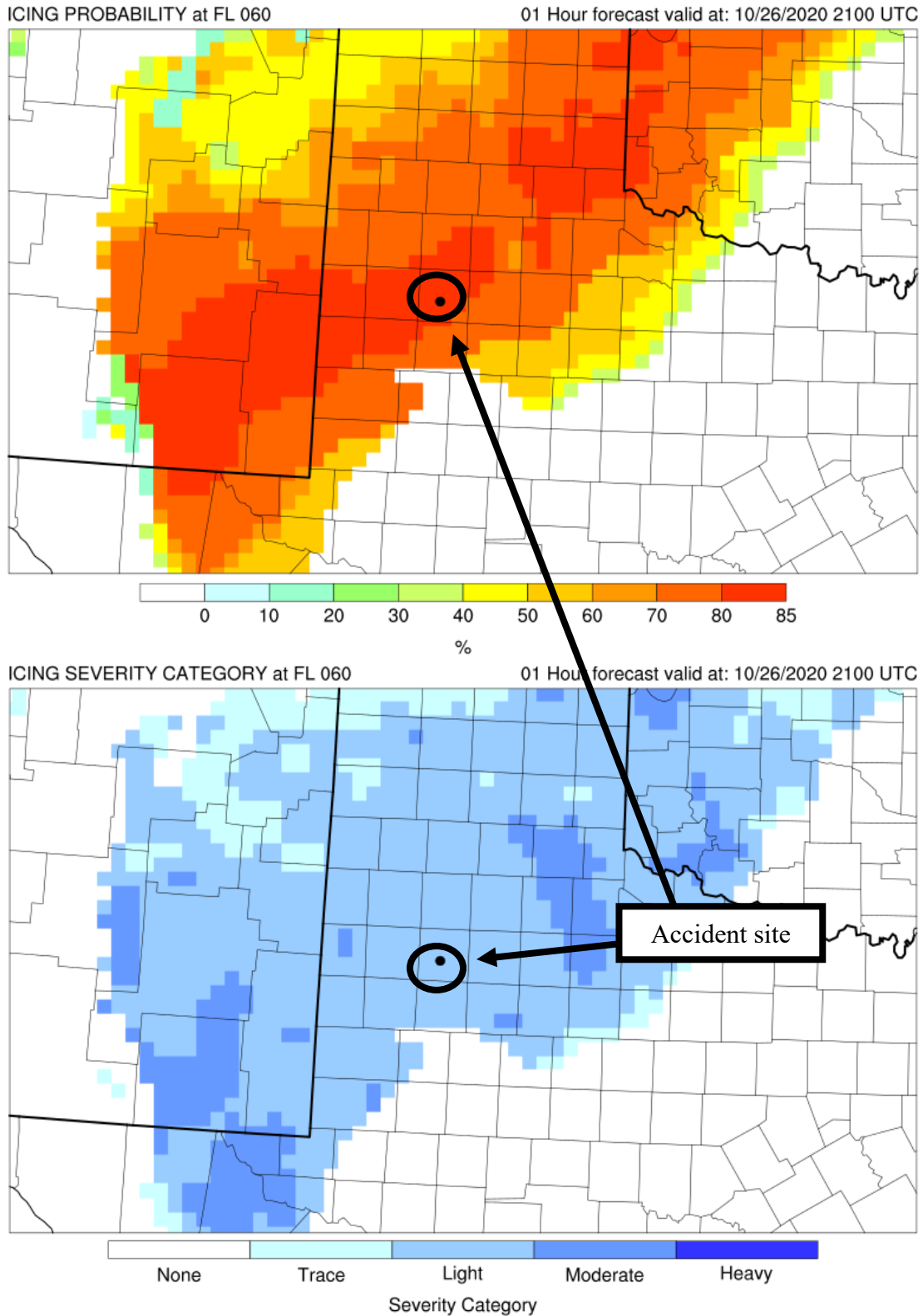
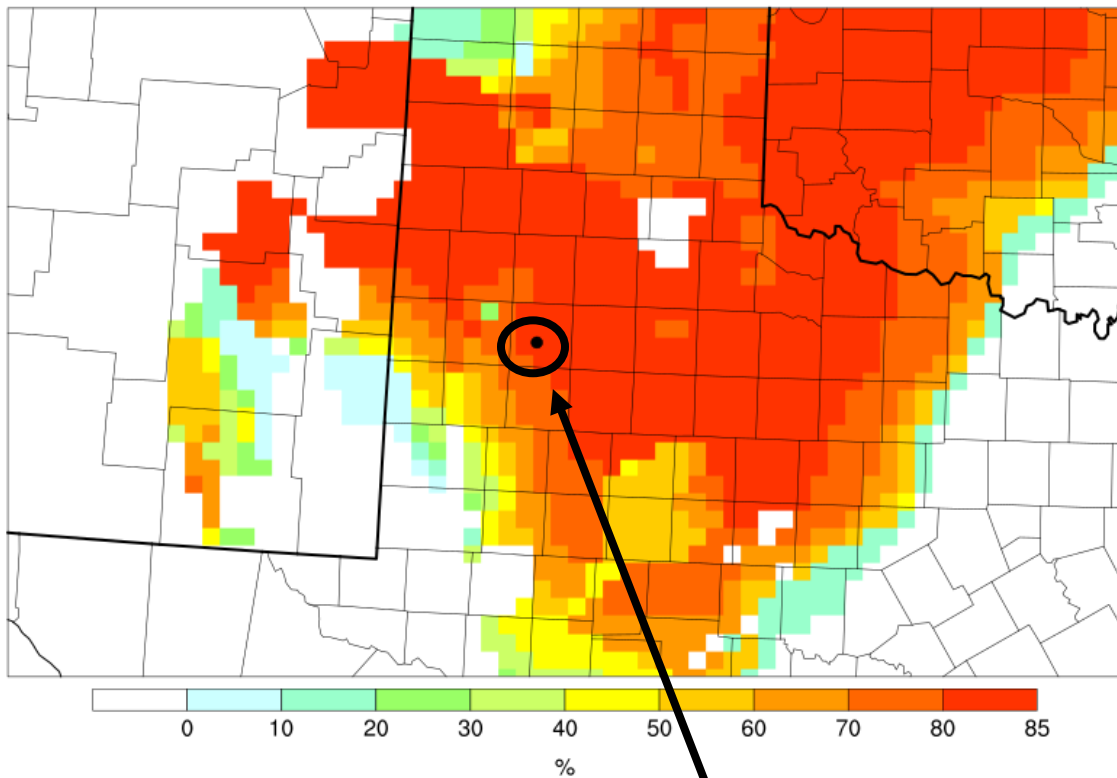


Figure 16 – (top) FIP probability of icing at 6,000 ft above msl and (bottom) FIP severity of icing at 6,000 ft above msl. 1-hour forecast valid for 1600 CDT

ICING PROBABILITY at FL 040

10/26/2020 2108 UTC



ICING SEVERITY at FL 040

10/26/2020 2108 UTC

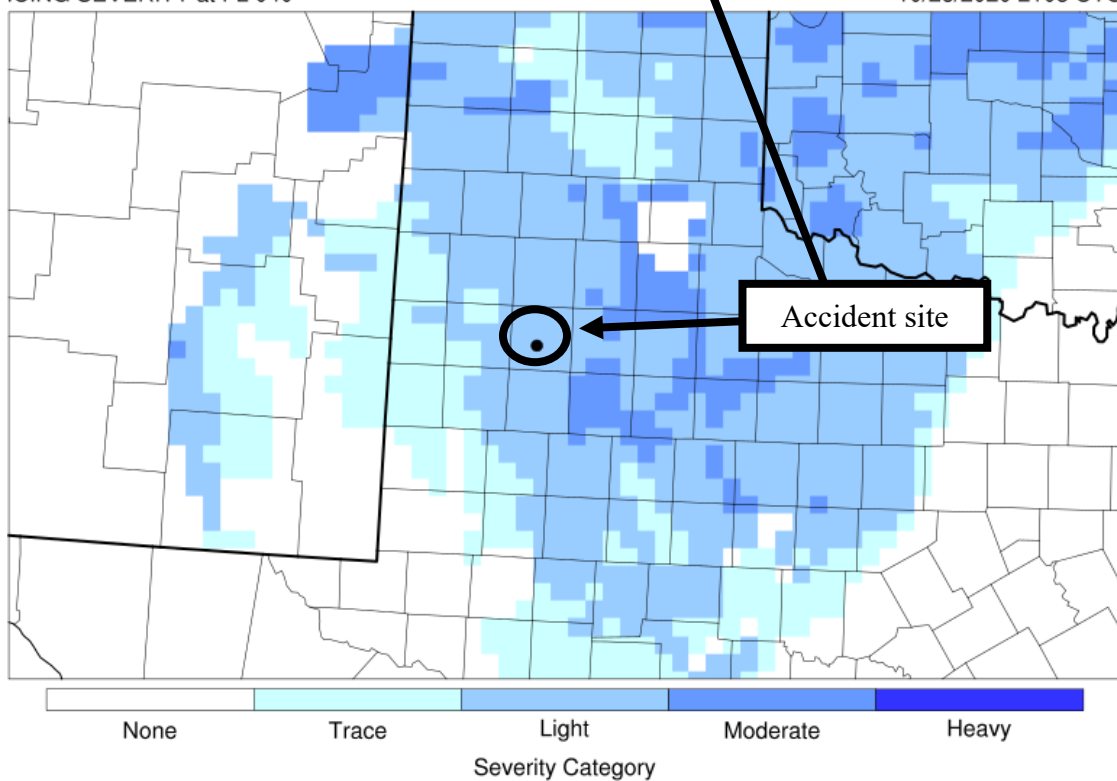


Figure 17 – (top) CIP probability of icing at 4,000 ft above msl and (bottom) CIP severity of icing at 4,000 ft above msl. valid for 1600 CDT

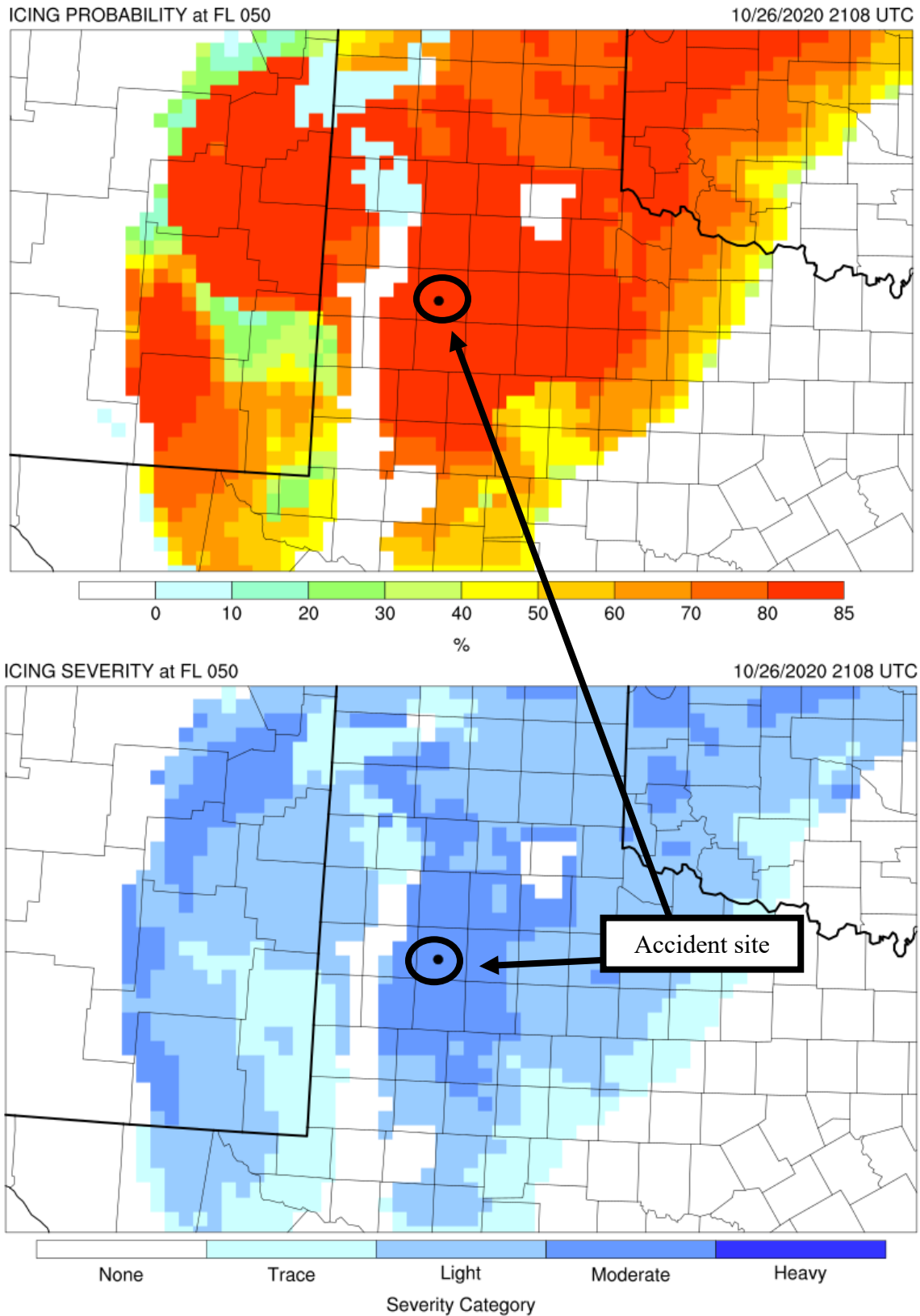


Figure 18 – (top) CIP probability of icing at 5,000 ft above msl and (bottom) CIP severity of icing at 5,000 ft above msl. valid for 1600 CDT

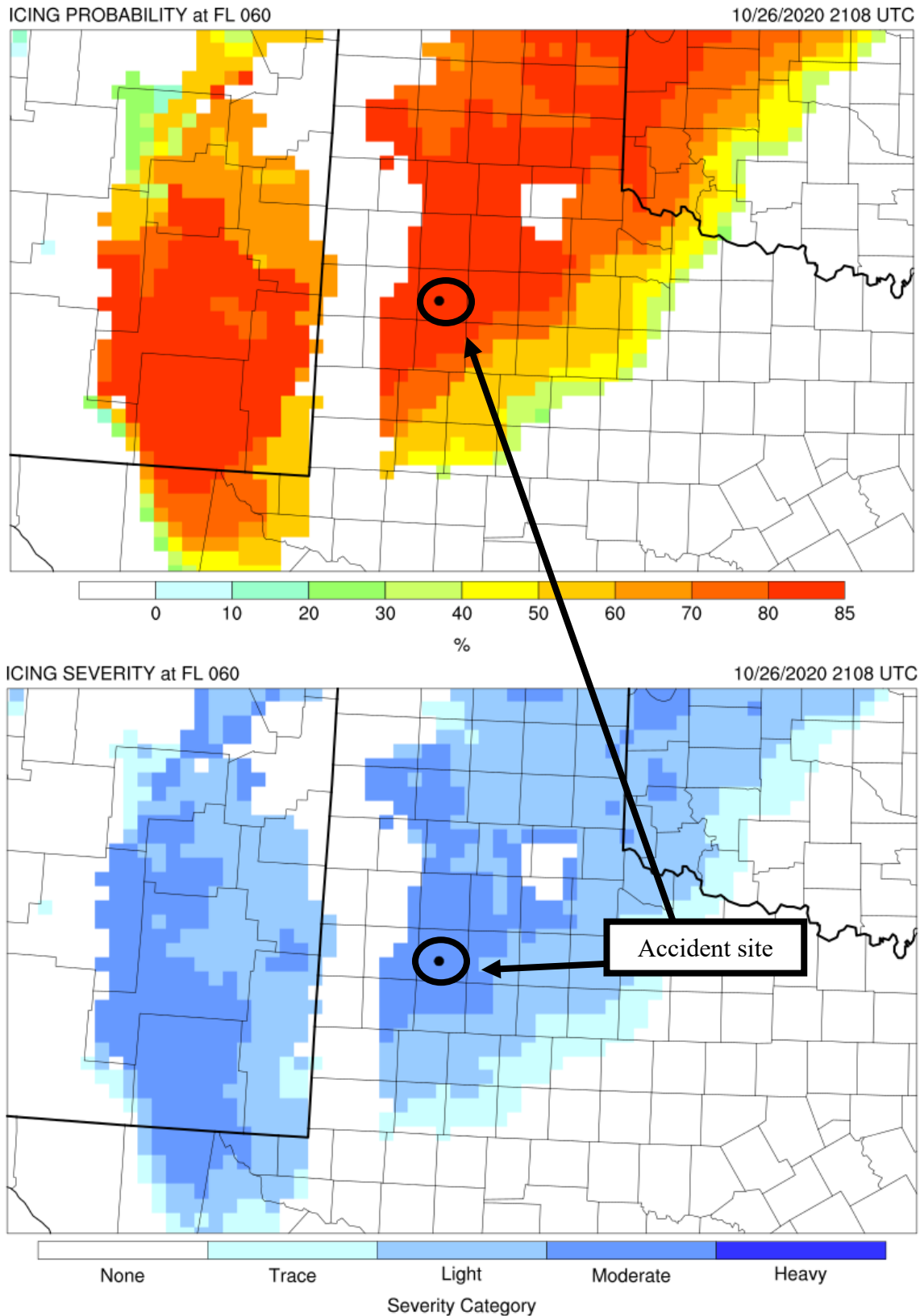


Figure 19 – (top) CIP probability of icing at 6,000 ft above msl and (bottom) CIP severity of icing at 6,000 ft above msl. valid for 1600 CDT

19.0 Accident Scene Imagery³⁶

Several accident scene pictures were taken by an FAA inspector the afternoon of the accident. These images show chunks of ice that were found on the ground located near the final accident site location (figures 20 through 23).

³⁶ For more information please see the docket of this investigation.



Figure 20 – Ice found near the accident aircraft



Figure 21 – Ice found near the accident aircraft



Figure 22 – Ice found near the accident aircraft



Figure 23 – Ice found near the accident aircraft

20.0 Astronomical Data

The astronomical data obtained for the accident site on October 26, 2020, indicated the following:

SUN	
Begin civil twilight	0736 CDT
Sunrise	0801 CDT
Sun transit	1331 CDT
Accident time	1558 CDT³⁷
Sunset	1901 CDT
End civil twilight	1926 CDT

E. LIST OF ATTACHMENTS

Attachment 1 – GOES-16 Visible animation from 1501 to 1706 CDT

³⁷ Inserted accident time for reference and context.

Attachment 2 – GOES-16 Daytime Microphysics RGB imagery from 1501 to 1706 CDT

Attachment 3 – NASA SPoRT quick guide for Daytime Microphysics RGB

Attachment 4 – KLBB base reflectivity animation from 1531 to 1613 CDT

Attachment 5 – GFA products valid for the accident flight

Attachment 6 – ForeFlight correspondence

Attachment 7 – ZFW CWSU pre-duty weather briefing from the morning of the accident

Attachment 8 – ZFW CWSU pre-duty weather briefing from the afternoon of the accident

Attachment 9 – NWS correspondence

Attachment 10 – FIP and CIP information valid for the accident flight

Attachment 11 – LARC-E302 imagery around the accident time

Submitted by:

Paul Suffern
Senior Meteorologist