Docket No. SA-533
Exhibit No. 5-A

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C.

METEOROLOGY GROUP CHAIRMAN'S FACTUAL REPORT

by

Donald Eick

31 Pages

National Transportation Safety Board

Office of Aviation Safety
Washington, D.C. 20594-2000
September 10, 2009

METEOROLOGICAL FACTUAL REPORT

CEN09MA142

A. ACCIDENT

Location: Lubbock, Texas
Date: January 27, 2009
Time: 0437 Central Standard Time (1037 UTC[1])
Aircraft: Empire Airlines flight 8284, ATR-42; registration: N902FX

B. METEOROLOGICAL SPECIALIST

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C. SUMMARY

On January 27, 2008, at approximately 0437 central standard time (CST), N902FX, an Aerospatiale Alenia ATR-42-320, operating as Empire flight 8284, sustained substantial damage when it collided with terrain short of the runway while executing the Instrument Landing System (ILS) RWY 17R approach at Lubbock Preston Smith International Airport (KLBB), Lubbock, Texas. The airplane was registered to Federal Express Corporation, Memphis, Tennessee, and operated by Empire Airlines, Hayden, Idaho. The airline transport pilot rated captain was seriously injured and the commercial rated first officer sustained minor injuries. An instrument flight rules flight plan was filed for the flight that departed Fort Worth Alliance Airport (KAFW), Fort Worth, Texas, at approximately 0319 CST. Instrument meteorological conditions prevailed for the supplemental cargo flight operated under 14 Code of Federal Regulations Part 121.

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

D. DETAILS OF INVESTIGATION

The National Transportation Safety Board's (NTSB) meteorologist specialist was not on scene for this investigation and gathered all the weather data for this investigation from the Washington D.C. office from official National Weather Service (NWS) sources including the National Climatic Data Center (NCDC). All NWS products are issued based on Coordinated Universal Time (UTC) based upon the 24 hour clock, local time of central standard time (CST) is +6 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.

1.0 Synoptic Situation

The synoptic or large scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction (NCEP) located in Camp Springs, Maryland. These are the base products used in describing weather features and in the creation of forecasts and warnings. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC 00-45.

1.0.1 Surface Analysis Chart

The NWS Surface Analysis Chart for 0600 CST (1200Z) is provided as figure 1, with the approximate location of the accident site encircled in red. The chart depicted a low pressure center at 1017-hectopascals (hPa) over eastern Texas with a warm front extending eastward into northern Louisiana and a stationary front extending southwestward across Texas. The accident site was located north of the stationary front. A trough of low pressure also extended north-northeast from the low from northeast Texas into Arkansas. An extensive area of overcast skies, precipitation, and mist was noted extending along and north of the front. Temperatures south of the front across Texas were in the mid to upper 60's (degrees Fahrenheit), and rapidly dropped north of the front into the teens across the extreme northern Texas panhandle into Oklahoma, Kansas, and Missouri.

The station model for Lubbock Texas indicated winds from the north-northeast at approximately 10 knots, freezing drizzle, overcast clouds, temperature 19 degrees Fahrenheit (F), dew point of 16 degrees C, sea level pressure of 1023.9-hPa.

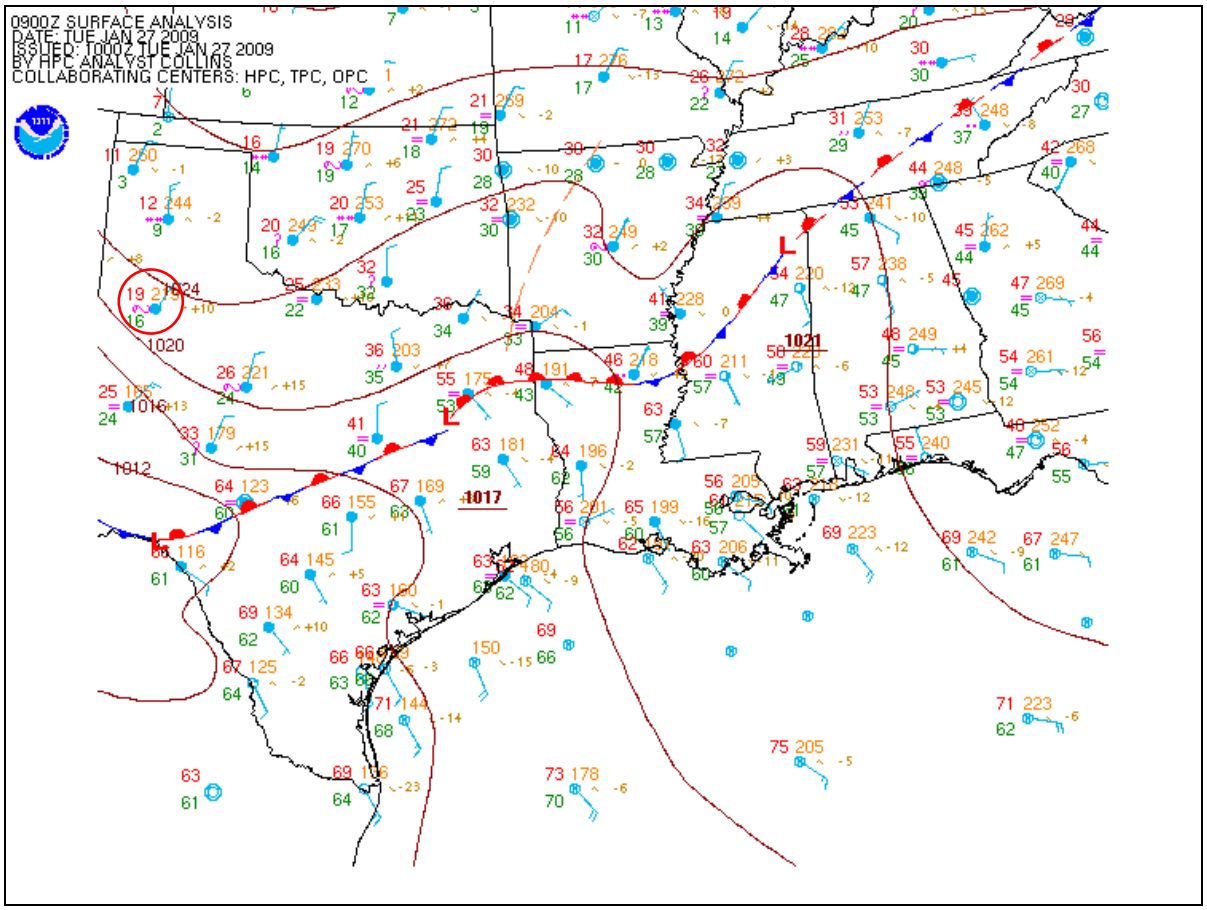


Figure 1 – NWS Surface Analysis for 0300 CST

Figure 2 is the NWS Surface Analysis and Satellite Composite Chart for 0600 CST (1200Z). The chart continued to depict the low over eastern Texas with the stationary front across Texas, and a cold core high pressure system at 1034-hPa over Nebraska. The pressure pattern and resultant wind pattern on the chart indicated cold air advection across Kansas, Oklahoma, into northern Texas, and warm moist air advecting northward from the Gulf of Mexico into eastern Texas and Louisiana, and producing an extensive area of overrunning clouds and precipitation north of the front.

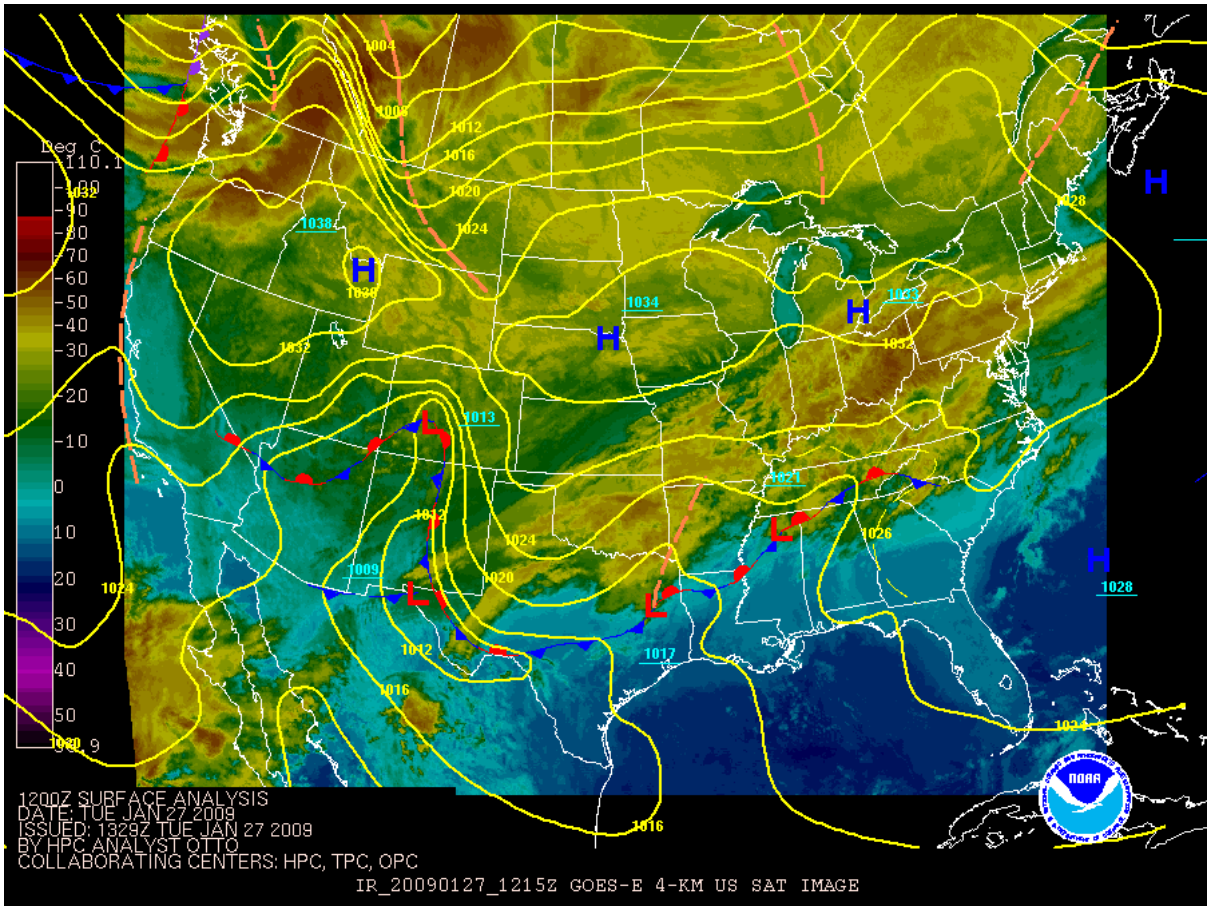


Figure 2 – NWS Surface Analysis Chart and Satellite composite for 0600 CST

1.0.2 Weather Depiction Chart

The NWS Weather Depiction Chart for 0400 CST (1000Z) is included as figure 3. The chart depicted an extensive area of instrument flight rule (IFR) conditions[2] extending along and north of the front over Texas, Oklahoma, and Arkansas by a shaded contour line, which extended over the accident site. Surrounding that area was an area of marginal visual flight rules (MVFR) conditions[3] indicated by an unshaded contour that covered the extreme part of the Texas and Oklahoma panhandles, and Kansas. The closest visual flight rule (VFR) conditions[4] without a contour line was depicted over western New Mexico and southern Colorado.

[2] IFR conditions – are defined as a ceiling or lowest layer of clouds reported as broken or overcast, or the vertical visibility into a surface based obscuration of less than 1,000 feet above ground level (agl) and/or visibility less than 3 statute miles.

[3] MVFR conditions – are defined as a ceiling between 1,000 and 3,000 feet agl inclusive and/or visibility 3 to 5 miles inclusive.

[4] VFR conditions – are defined as no ceiling or a ceiling greater than 3,000 feet agl and visibility greater than 5 miles.

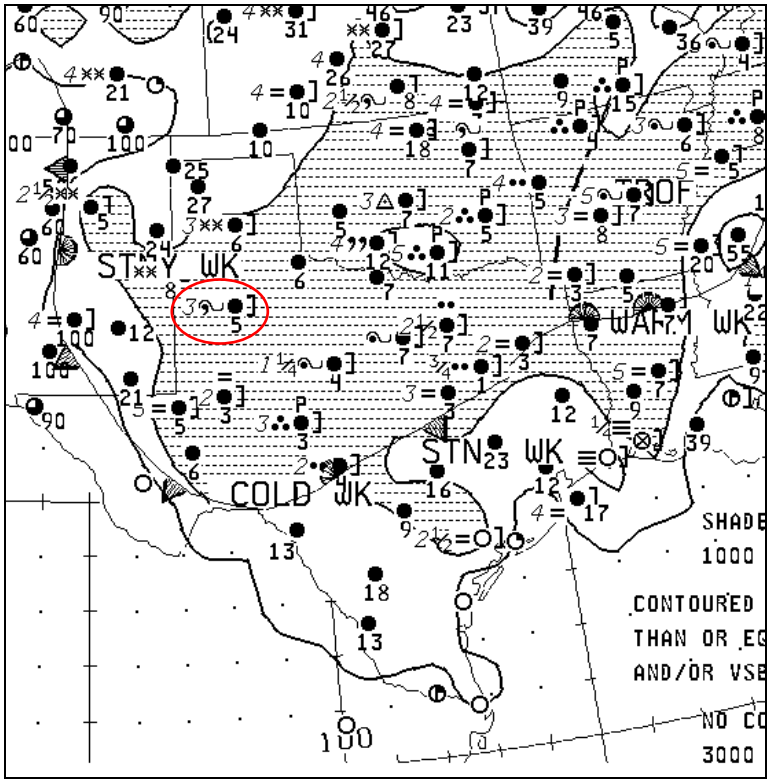
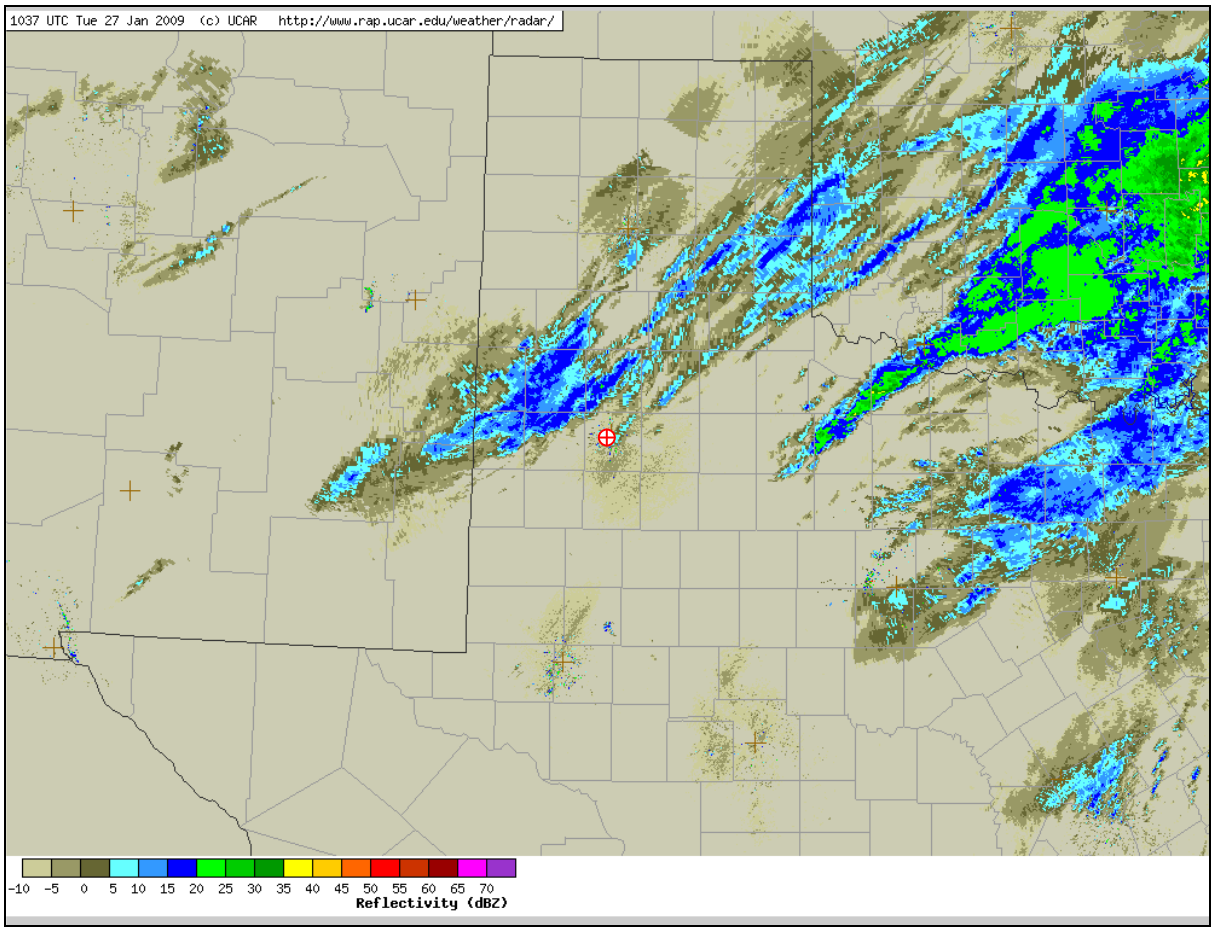


Figure 3 – NWS Weather Depiction Chart for 0400 CST

The station model for Lubbock depicted IFR conditions with a ceiling overcast at 500 feet agl and visibility 3 miles in light freezing drizzle.

1.0.3 Radar Summary Chart

The National Center for Atmospheric Research (NCAR) regional radar mosaic for 0437 CST (1037Z) is included as figure 4. The mosaic chart depicted several northeast to southwest bands of echoes over Texas, with Lubbock area on the southwest side of one of theses bands with reflectivities of 5 to 10 dBZ or very light intensity echoes.



Figures 4 - NWS Radar Summary Chart for

Based on the radar summary chart depicted the potential for echoes in the vicinity of the accident site, the closest weather surveillance radar was documented and is included in section 5.0 of this report.

2.0 Surface Observations

The surrounding area was documented utilizing official NWS Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). The following observations are taken from standard code provided in plain language, with cloud heights reported above ground level (agl).

2.0.1 Lubbock Preston Smith International Airport, Lubbock, Texas

Lubbock Preston Smith International Airport (KLBB) is located 4 miles north of the city of Lubbock, Texas, at an elevation of 3,282 feet msl. The airport was equipped with an Automated Surface Observation System (ASOS) and was augmented by a NWS certified

weather observer. The following conditions were reported surrounding the period of the accident:

KLBB weather observation at 0353 CST (0953Z), wind from 010 degrees at 14 knots, visibility 3 miles in light freezing drizzle[5] and mist, ceiling[6] overcast at 500 feet, temperature -8 degrees Celsius (C), dew point temperature -9 degrees C, altimeter setting 30.13 inches of Hg. Remarks; automated observation system, pressure rising rapidly, sea level pressure 1022.7-hPA, hourly precipitation less than 0.01 of an inch (trace), temperature –7.8 degrees C, dew point –9.4 degrees C.

KLBB special weather observation at 0408 CST (1008Z), wind from 020 degrees at 11 knots gusting to 19 knots, visibility 2 miles in light freezing drizzle and mist, ceiling overcast at 500 feet, temperature -8 degrees C, dew point temperature -9 degrees C, altimeter setting 30.12 inches of Hg. Remarks; automated observation system, hourly precipitation less than 0.01 of an inch (trace).

KLBB weather observation at 0453 CST (1053Z), wind from 020 degrees at 13 knots gusting to 18 knots, visibility 2 miles in light freezing drizzle and mist, ceiling overcast at 500 feet, temperature -8 degrees C, dew point temperature -9 degrees C, altimeter setting 30.13 inches of Hg. Remarks; automated observation system, ceiling 400 variable 900 feet, sea level pressure 1022.8-hPA, hourly precipitation less than 0.01 inch (trace), temperature –7.8 degrees C, dew point –9.4 degrees C.

Freezing precipitation began at approximately 2300 CST on January 26, 2009 with light freezing rain and ice pellets changing to light freezing drizzle, which continued until after the accident at the time of the accident with IFR conditions. The total liquid equivalent precipitation recorded during the period ending at 0553 CST was less than 0.01 inches or a trace of precipitation.

Freezing drizzle by definition is a form of supercooled large droplet (SLD), which is defined as liquid droplets with diameters greater than 0.05 mm at temperatures less than 0°C. The accretion rate of light freezing drizzle is less than or equal to 0.01 inches per hour (in/hr), with visibility greater than 1/2 mile as defined by the American Meteorological Society (AMS) Glossary, and the NWS Federal Meteorological Handbook (FMH-1). Moderate freezing drizzle is defined as visibility 1/2 mile or less, but greater to 1/4 mile, and an accretion rate between 0.01 and 0.02 in/hr. Heavy freezing drizzle is reported with visibility 1/4 mile or less, with an accretion rate greater than 0.02 in/hr.

[5] Freezing drizzle (FZDZ) – is defined as drizzle is precipitation at ground level or aloft in the form of liquid water drops which have diameters less than 0.5 mm and greater than 0.05 mm. Freezing drizzle is drizzle that exists at air temperatures less than 0°C (supercooled), remains in liquid form, and freezes upon contact with objects on the surface or airborne. Aeronautical Information Manual (AIM), section 7-1-7.

[6] Ceiling – is defined as the lowest layer of clouds reported as broken or overcast, or the vertical visibility into a surface based obscuration.

2.0.2 High Resolution 5-minute Observations

The ASOS 5-minute observation recorded during the period are included below with additional information on pressure altitude, relative humidity, density altitude, and magnetic winds follow after the altimeter setting and prior to the remarks section.

01/27/09 04:30:31 5-MIN KLBB 271030Z 01014G19KT 2SM -FZDZ BR OVC005 M08/M09 A3013 3090 88 1100 360/14G19 RMK AO2 CIG 004V009 P0000

01/27/09 04:35:31 5-MIN KLBB 271035Z 02012KT 2SM -FZDZ BR OVC005 M08/M09 A3013 3090 88 1100 010/12 RMK AO2 CIG 004V009 P0000

01/27/09 04:40:31 5-MIN KLBB 271040Z 01014KT 2SM -FZDZ BR OVC005 M08/M09 A3014 3080 88 1100 360/14 RMK AO2 CIG 004V009 P0000

01/27/09 04:45:31 5-MIN KLBB 271045Z 01013KT 2SM -FZDZ BR OVC005 M08/M09 A3013 3090 88 1100 360/13 RMK AO2 CIG 004V009 P0000

01/27/09 04:50:31 5-MIN KLBB 271050Z 02013KT 2SM -FZDZ BR OVC005 M08/M09 A3013 3090 88 1100 010/13 RMK AO2 CIG 004V009 SLP228 P0000 T10781094

01/27/09 04:55:31 5-MIN KLBB 271055Z 01011G18KT 2SM -FZDZ BR OVC005 M08/M09 A3014 3080 88 1100 360/11G18 RMK AO2 CIG 004V009 P0000

01/27/09 05:00:31 5-MIN KLBB 271100Z 02016G19KT 2 1/2SM -FZDZ BR OVC005 M08/M09 A3013 3090 88 1100 010/16G19 RMK AO2 CIG 004V009 P0000

The observation at 0435:31 CST for KLBB indicated wind from 020 degrees at 12 knots, visibility 2 miles in light freezing drizzle and mist, ceiling overcast at 500 feet agl, temperature –8 degrees C, dew point –9 degrees C, altimeter 30.13 inches of Hg, pressure altitude 3,090 feet, relative humidity 88 percent, density altitude 1,100 feet, magnetic wind from 010 degrees at 12 knots. Remarks; automated observation system, ceiling 400 feet variable 900 feet, hourly precipitation less than 0.01 inch.

3.0 Upper Air Data

The closest upper air sounding or rawinsonde observation (RAOB) was from the NWS Amarillo (KAMA), Texas, site number 72363, located approximately 93 miles north of the accident site at an elevation of 3,606 feet msl. The 1800 CST January 26, 2009 (0000Z on January 27, 2009) sounding from KAMA plotted on a standard Skew-T log P diagram[7] from the surface to 500-mb or 18,000 feet with the observed and derived stability parameters is included as figure 5. During the period of this sounding KAMA was reporting similar conditions as Lubbock surrounding the period of the accident with light freezing rain and

[7] 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.

freezing fog, a ceiling overcast at 300 feet agl, with a temperature of –7 degrees C. The sounding depicted a moist low-level environment with the lifted condensation level (LCL)[8] and level of free convection (LFC)[9] at 876-hPa or at 443 feet agl (4,049 feet msl), and a convective condensation level (CCL)[10] at 537-hPa or 13,171 feet agl (16,776 feet msl). Temperatures were below freezing at the surface at –7 degrees C with two defined temperature inversions below 10,000 feet. The first temperature inversion was identified associated with the front and extended from approximately 4,900 to 6,800 feet, with second inversion immediately above that to approximately 7,200 feet associated with subsidence. The temperature inversions resulted in a layer between 6,000 and 11,000 feet above freezing. The soundings moisture profile indicated a relative humidity of 75 percent or more from the surface to 6,600 feet, and had a precipitable water content of 0.21 inches. The sounding temperature and moisture profiles supported light freezing precipitation and ice pellet formation at the surface, and airframe icing conditions between the surface and 6,500 feet (4,000 feet agl).

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

[9] 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.

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

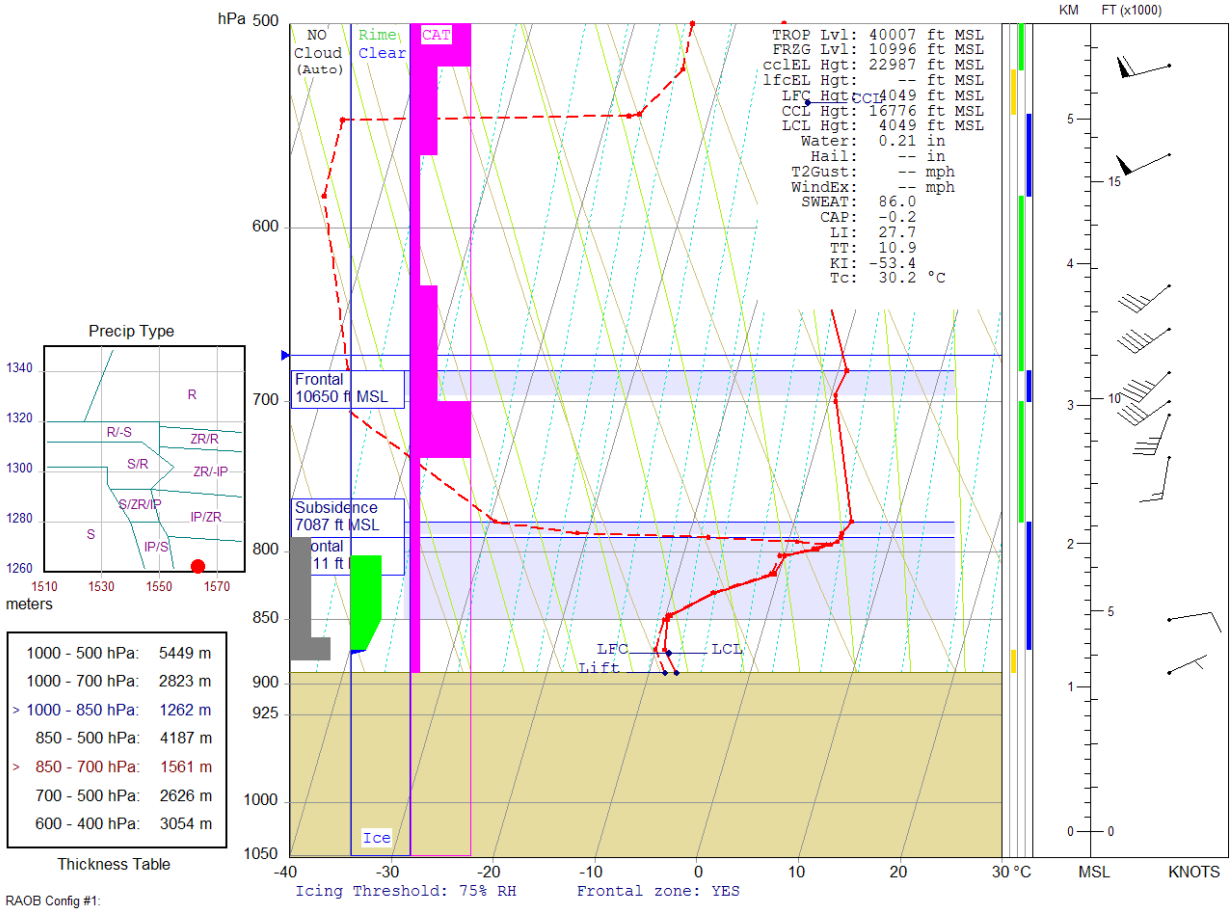


Figure 5 –KAMA sounding at 1800 CST

The temperature inversions resulted in a Lifted Index (LI)[11] of 27.7 and indicated an absolutely stable atmosphere and supported stratiform type clouds, including nimbostratus.

The sounding wind profile indicated surface wind from 065 degrees at 5 knots, with winds easterly below the inversions and then shifting to the south and then southwesterly above 8,000 feet with increasing wind speeds, and then westerly above 15,000 feet. At 10,600 feet there was a localized wind maximum from 225 degrees at 45 knots. The level of maximum wind was identified at 40,600 feet immediately above the tropopause with winds from 245 degrees at 132 knots.

[11] Lifted Index (LI) - A common measure of atmospheric instability. Its value is obtained by computing the temperature that air near the ground would have if it were lifted to some higher level (around 18,000 feet, usually) and comparing that temperature to the actual temperature at that level. Negative values indicate instability - the more negative, the more unstable the air is, and the stronger the updrafts are likely to be with any developing thunderstorms.

The sounding provided the following data:

HEIGHT (FT-MSL)	PRES (HPA)	T (ºC)	TD (ºC)	RH (%)	WIND (DEG/KTS)	LWC (G/M³)	CAT	ICING (INTENSITY-TYPE)
3,606	891.0	-7.3	-8.4	92	065/5KT			Base: 876
4,126	873.0	-9.1	-10.0	93		0.011	70% LGT	88% Trace Clear
4,804	850.0	-9.7	-10.0	98	080/11KT	0.112		90% LGT Rime
4,894	847.0	-9.5	-9.7	98		0.128		91% LGT Rime
5,412	830.0	-5.9	-6.0	99		0.262		99% LGT Rime
5,854	816.0	-0.5	-0.8	98		0.471		31% LGT Rime
6,276	803.0	0.0	-0.5	96		0.598		16% LGT Rime
6,441	798.0	3.0	2.7	98				
6,542	795.0	4.2	3.8	97				
6,609	793.0	4.8	0.8	75				
6,711	790.0	5.0	-8.0	38				
6,813	787.0	5.0	-21.0	13				
7,087	779.0	5.6	-29.4	6			LGT	
8,606	735.7				190/13KT		XTR	
9,606	708.5				200/33KT		XTR	
9,926	700.0	0.6	-48.4	1	235/40KT			
10,077	696.0	0.4	-48.6	1			98% MDT	

Notes: intensity codes are LGT – light, MDT – moderate, SVR – severe, XTR - extreme

The next KAMA sounding for 0600 CST (1200Z) is included as figure 6. During the period of this sounding light snow and mist were reported at the station. The sounding depicted a moist low-level environment with the LCL and LFC at 881-hPa or at 401 feet agl (4,007 feet msl), and a CCL at 546-hPa or 12,656 feet agl (16,262 feet msl). Surface temperature was –12 degrees C with two defined temperature inversions below 10,000 feet. The first temperature inversion was identified associated with the front and extended from approximately 5,000 to 7,161 feet. The second inversion was located between 7,600 and 8,952 feet associated with subsidence and resulted in temperatures above freezing from 7,707 to 10,600 feet. The soundings moisture profile indicated a relative humidity of 75 percent or more from the surface to 7,600 feet, and had a precipitable water content of 0.25 inches. The sounding moisture and temperature profiles supported icing conditions from the surface to 7,500 feet.

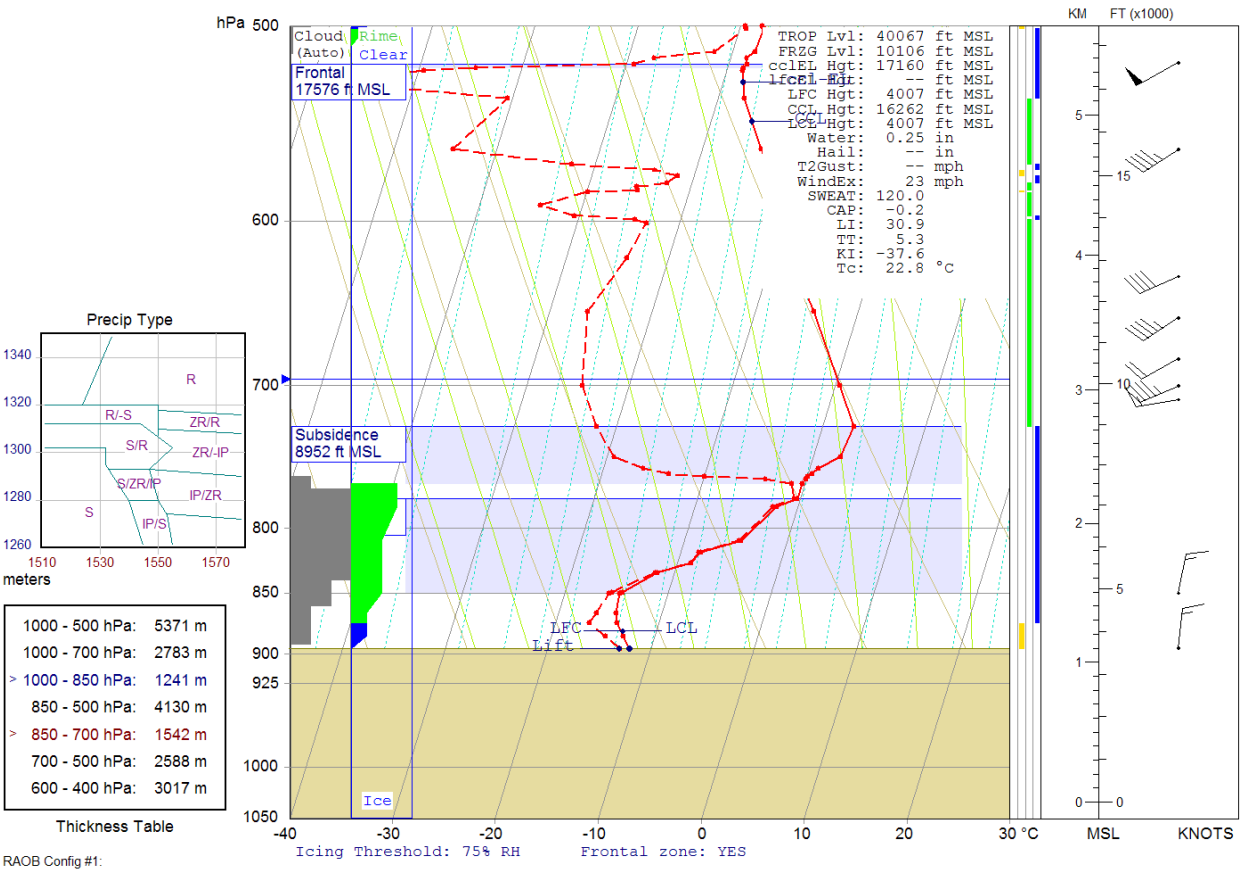


Figure 6 –KAMA sounding at 0600 CST

The sounding continued to depict a stable atmosphere with a Lifted Index (LI) of 30.9 and supported stratiform to nimbostratus type clouds.

The sounding wind profile indicated surface wind from 005 degrees at 13 knots, with light winds through 5,000 feet. Above the second inversion at approximately 9,000 feet, the wind abruptly shifted to the west and increased from 13 knots at 9,600 feet to 45 knots at approximately 10,000 feet, and resulted in a strong vertical wind shear and a high probability of severe or greater turbulence. The level of maximum wind was identified at 40,600 feet with winds from 260 degrees at 150 knots.

The sounding provided the following data:

HEIGHT (FT-MSL)	PRES (HPA)	T (ºC)	TD (ºC)	RH (%)	WIND (DEG/KTS)	LWC (G/M³)	CAT	ICING (INTENSITY-TYPE)
3,606	895.0	-12.1	-13.1	92	005/13KT			Base:895 hPa
3,888	885.0	-13.1	-14.8	87		0.030		53% Trace Clear
4,200	874.0	-14.1	-16.8	80		0.056		35% Trace Clear
4,429	866.0	-14.5	-16.4	85		0.080	0% LGT	42% Trace Rime
4,893	850.0	-14.7	-15.8	91	010/17	0.123		48% LGT Rime
4,922	849.0	-14.5	-15.5	92		0.138		51%LGT Rime
5,368	834.0	-11.7	-11.9	98		0.236		77% LGT Rime
5,612	826.0	-8.7	-8.7	100		0.329		95% LGT Rime
5,860	818.0	-8.1	-8.3	98		0.380		98% LGT Rime
6,144	809.0	-4.5	-4.7	99		0.532		94% LGT Rime
6,960	784.0	-2.1	-2.4	98		0.819		66% MDT Rime
7,161	778.0	-0.3	-0.6	98		0.963		25% MDT Rime
7,535	767.0	-0.3	-1.3	93		1.031		23% MDT Rime
7,638	764.0	-0.1	-4.0	75				
7,707	762.0	0.0	-10.0	47				
7,776	760.0	0.4	-13.6	34				
7,915	756.0	0.8	-16.2	27				
8,196	748.0	2.6	-19.4	18				
8,952	727.0	3.0	-22.0	14			97% LGT	
9,606	709.2				260/13KT		100% XTR	
9,952	700.0	0.4	-24.6	13	245/44KT		100% XTR	
10,606	682.7				240/22KT		100% XTR	
11,606	657.0				235/43KT		100% MDT	

Notes: intensity codes are LGT – light, MDT – moderate, SVR – severe, XTR - extreme

4.0 Satellite Data

The Geostationary Operations Environmental Satellite number 12 (GOES-12) data was obtained from the National Climatic Data Center (NCDC) and displayed on the National Transportation Safety Board's Man-computer Interactive Data Access System (McIDAS) workstation. The infrared imagery (band 4) at a long wavelength of 10.7 microns (μm) provided a 4-kilometer (km) resolution with radiative cloud top temperatures. The satellite imagery surrounding the time of the accident were reviewed and the applicable images documented below.

Figure 6 includes the GOES-12 infrared band 4 images at 0432 and 0445 CST respectively at 4X magnification. The image depicts an extensive area of low to mid-level stratus to nimbostratus type clouds extending over northern and central Texas, New Mexico, Oklahoma, and Arkansas, with high cirriform clouds above the low to mid level clouds. The radiative cloud top temperature over Lubbock ranged of 239.40 to 241.0 degrees Kelvin (K) or –33.76 to –32.16 degrees C, which according to the KAMA sounding indicated cloud tops in the range of 37,000 feet or high cirrostratus clouds.

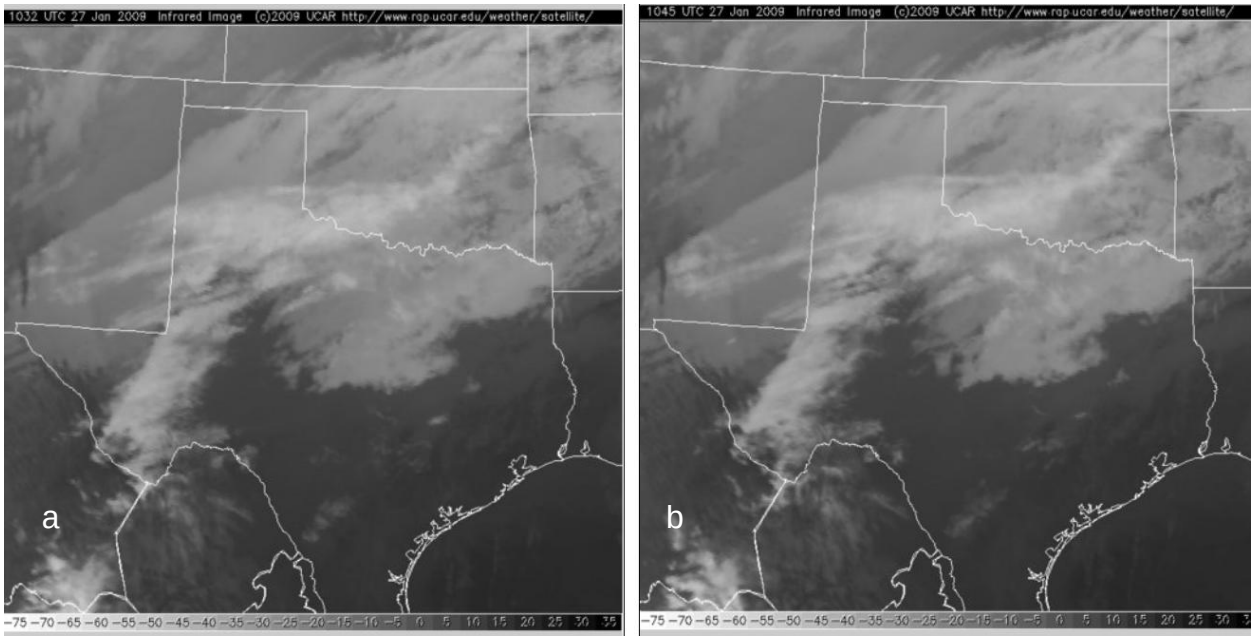


Figure 6 – GOES-12 infrared images at (a) 0432 and (b) 0445 CST respectively

5.0 Weather Radar Information

The NWS KLBB Weather Surveillance Radar-1988, Doppler (WSR-88D) was located on the field. The level II archive data was obtained from the National Climatic Data Center (NCDC) utilizing the Hierarchical Data Storage System (HDSS) and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software.

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

5.0.1 Volume Scan Strategy

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

The WSR-88D operates in several different scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has two common scanning strategies. The most common is where the radar makes 9 elevation scans from 0.50 degrees to 19.5 degrees every six minutes. This particular scanning strategy is documented as volume coverage pattern 21 (VCP-21). Mode B is the clear air mode, where the radar makes 5 elevation scans

during a ten minute period. During the period surrounding the accident the KLBB WSR-88D radar was operating in the clear air mode (Mode 3, VCP-32). 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.

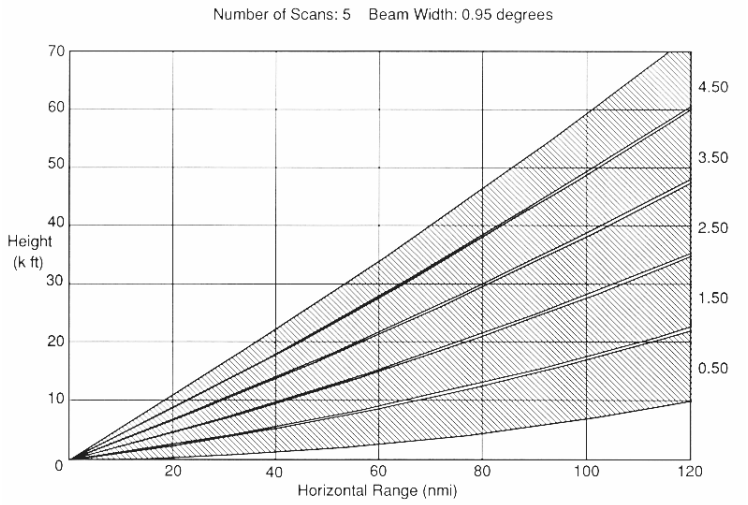


Figure 5-3
Clear Air Scan
Volume Coverage Patterns 31 and 32

VCP-32 Precipitation Mode Scan Strategy

5.0.2 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[12] it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in decibels (dBZ[13]), and is a general measure of echo intensity. The chart below relates the NWS video integrator and processor (VIP) intensity levels versus the WSR-88D's display levels, precipitation mode reflectivity in decibels, and rainfall rates.

[12] 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 glaze ice.

[13] dBZ - 10 log Ze

NWS VIP/DBZ CONVERSION TABLE

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

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

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

5.0.4 Base Reflectivity

Figure 7 is the KLBB WSR-88D base reflectivity image for the 0.5 degree elevation scan completed at 0434:35 CST (1034:35Z) with a resolution of 1° X 1 kilometers, with the flight track overlaid. The image depicts several northeast to southwest bands of echoes with reflectivity values of 12 to 24 dBZ. A large area of very light echoes extends over the Lubbock area, most of which was associated with ducting of the radar beam due to the inversion aloft and was characterized as a ground clutter. Freezing drizzle is not very reflective to radar energy and usually does not paint a significant radar return. Larger droplets and icing conditions were likely in the northeast to southwest bands located west, north, northeast, and east of the KLBB area.

The next closest WSR-88D was located approximately 100 miles south in Midland/Odesa (KMAF), Texas. Image 8 is the KMAR WSR-88D 0.5 degree base reflectivity image at 0436

CST (1036Z). The image shows one of the northeast to southwest band of echoes at 12 to 16 dBZ extend over the flight track and over KLBB.

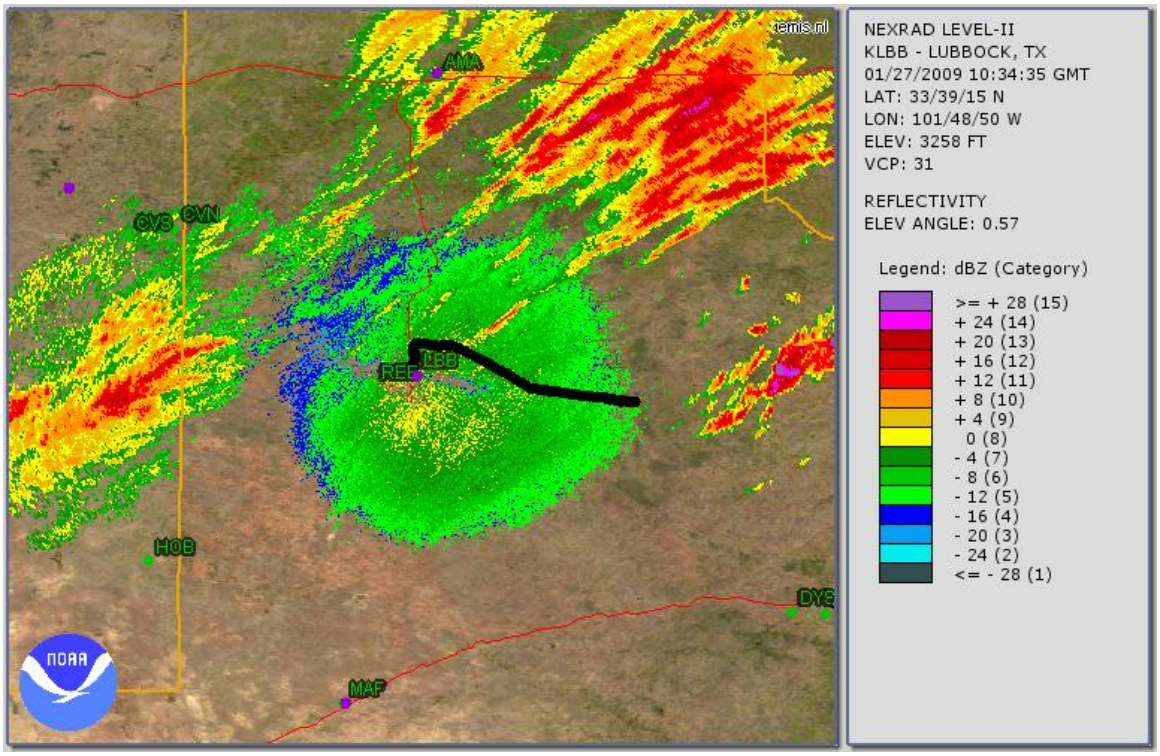


Figure 7 – KLBB WSR-88D 0.5 degree elevation scan for 0434 CST

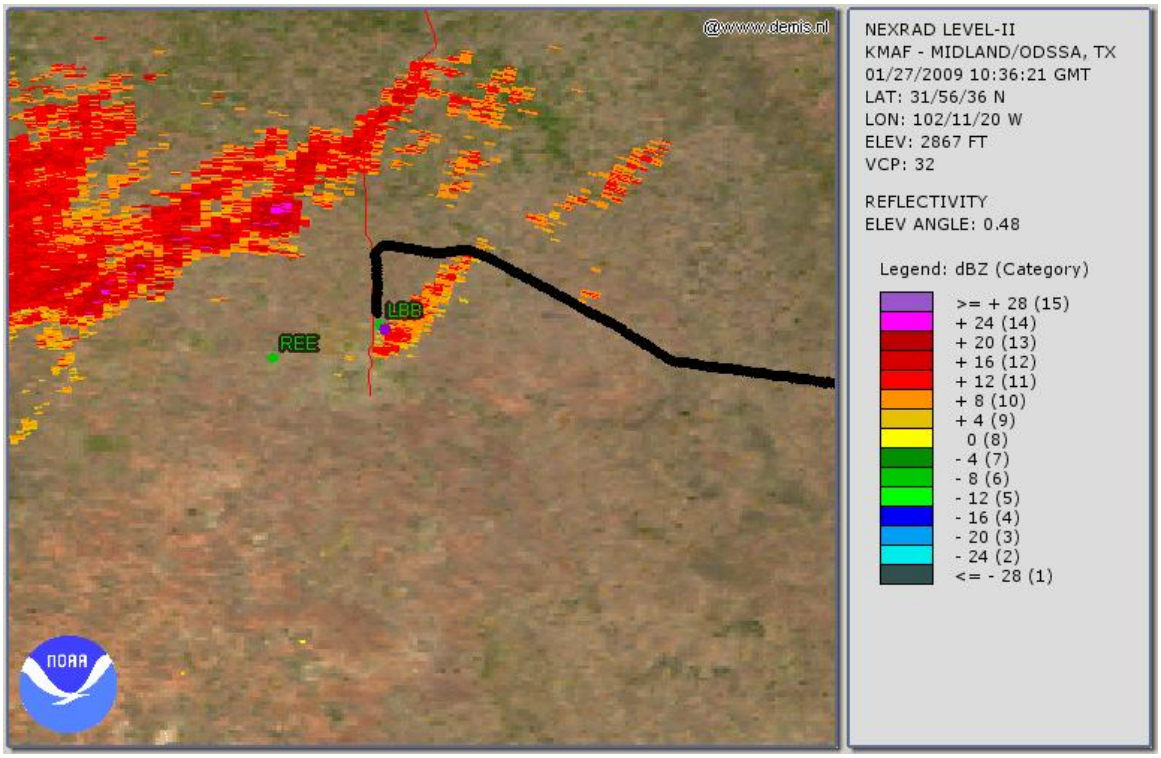


Figure 8 – KMAF WSR-88D 0.5 degree image at 0436 CST

6.0 Pilot Reports

The following pilot reports (PIREPs) were recorded over Texas surrounding the time of the accident. The reports are in standard format and code. The reports are as follows:

TYR UA /OV FZT/TM 0137/FL210/TP MD82/TA M14/IC LGT RIME/RM FL210-190 ZFW AWC-WEB:KZFW=

MAF UA /OV MAF/TM 0144/FL250/TP B737/TB CONT LGT CHOP/RM LGT-MOD TURB FL270-290 AWC-WEB:SWA=

DFW UA /OV DFW360010 /TM 0205 /FLUNKN /TP MD87 /SK OVC003-TOP100/SKC /TB MOD BLO 100=

LBB UA /OV LBB090005 /TM 0217 /FLUNKN /TP B733 /SK OVC001-TOP050 /TA 00 /IC LGT RIME /RM DURC=

Another pilot report was obtained from the Fort Worth (ZFW) Air Route Traffic Control Center (ARTCC), which was not disseminated in the FAA/NWS archive weather database. The report is also believed to be from the accident airplanes enroute report of icing conditions. The report was as follows:

DFW UA /OV ABI360055 /TM 1004 /FL180 /TP AT43 /TA –15 /IC MOD RIME

The pilot report indicated it was a routine pilot report, from Dallas Ft. Worth. The location was 55 miles north of Abilene (ABI) at 0404 CST (1004Z), at 18,000 feet a pilot operating an ATR-43 aircraft reported a temperature of –15 degrees C, and moderate rime icing conditions.[14]

7.0 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 (IFR) bulletin for the same area in order to get a complete picture of the weather. The area forecast together with the AIRMET Sierra bulletin are used to determine forecast enroute weather and to interpolate conditions at airports which do not have a terminal forecast (TAF) issued. The NWS Aviation Weather Center (AWC) located in Kansas City, Missouri, issues the FA at regular intervals and issues specials reports as necessary usually in the form of an AIRMET. The region that covers northwest Texas is under the Dallas-Ft. Worth (KDFW) regional forecast. The forecast valid for this accident was issued at 2045 CST on February 26, 2009 (0245Z on February 27, 2009), and was valid until 0900 CST (1500Z).

[14] The accident pilot in an interview with the Operations Group described the icing conditions enroute at the time as moderate icing bordering on severe. That information was not disseminated to air traffic control, which would have noted the report as an urgent pilot report (UUA) and would have reported moderate-to-severe (MOD-SVR) icing conditions.

FAUS44 KKCI 270245
-DFWC FA 270245
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 272100
CLDS/WX VALID UNTIL 271500...OTLK VALID 271500-272100
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...03Z LOW PRES NRN NM WITH STNR FNT TO NR ABI-NW LA. STG SWLY FLOW ALF WITH ABUNDANT OVERRUNNING PCPN. MXD PCPN OVR OK AR AND SRN MO. 12Z LOW PRES NR INK. CDFNT INK-50NW CWK-LOW PRES EXTRM SERN OK THEN WRMFNT TO SERN TN-SERN NC. MXD PCPN WRN TN-AR-OK-NCNTRL TX. 21Z LOW PRES NERN NM WITH STNR FNT TO INK THEN CDFNT TO DLF-IAH-LOW PRES ECNTRL AR THEN WRMFNT TO BNA-NERN NC.

NWRN TX
CIG BKN010-015 TOP 120 OVC CI. VIS 3SM -FZRASN BR. 12Z VIS 3SM BR THRUT. OCNL -FZDZ SRN HLF TIL 14Z. OTLK...IFR CIG BR BECMG VFR 21Z.

N CNTRL TX
WRN...OVC025-030 LYRD FL250. VIS 3SM BR. OCNL -FZDZ. OTLK...IFR CIG FZDZ BR.
NERN...OVC015 LYRD FL250. VIS 3SM BR. OCNL -RA/-DZ. 10Z VIS 3SM -FZRA BR. OTLK...IFR CIG FZRA BR.

The forecast for northwestern Texas was for ceilings broken between 1,000 to 1,500 feet agl with tops to 12,000 feet with overcast cirrus clouds above, visibility 3 miles in light freezing rain, snow, and mist. After 0600 CST the forecast was visibility 3 miles in mist with occasional light freezing drizzle over the southern half of the area until 0800 CST.

8.0 In-Flight Weather Advisories

The NWS issues in-flight weather advisories designated as Severe Weather Forecast Alerts (AWW's), Convective SIGMET's (WST's), SIGMET's (WS's), Center Weather Advisories (CWA's), and AIRMET's (WA's). In-flight advisories serve to notify en route pilots of the possibility of encountering hazardous flying conditions, which may not have been forecast at the time of the preflight briefing. Whether or not the condition described is potentially hazardous to a particular flight is for the pilot and/or dispatcher in a Part 121 operation to evaluate on the basis of experience and the operational limits of the aircraft.

No SIGMETs were current for any severe criteria; however, a full set of AIRMETs[15] were current over the region at the time of the accident and are included below with AIRMETs

[15] Airman's Meteorological Information - AIRMET (WA) are advisories of significant weather phenomena but describe conditions at intensities lower than those which require the issuance of SIGMETs. AIRMETs are intended for dissemination to all pilots in the preflight and en route phase of flight to enhance safety. AIRMET Bulletins are issued on a scheduled basis every 6 hours beginning at 0145Z during Central Daylight Time and at 0245Z during Central Standard Time. Unscheduled updates and corrections are issued as necessary.

Tango and Zulu plotted in figure 9 (AIRMET Sierra are issued for IFR and mountain obscuration conditions and were not considered to be operational significant to this case, operating on an instrument flight plan).

WAUS44 KKCI 270845
-DFWS WA 270845
AIRMET SIERRA UPDT 1 FOR IFR AND MTN OBSCN VALID UNTIL 271500
.
AIRMET IFR...OK TX AR TN LA MS AL
FROM OSW TO RZC TO HMV TO GQO TO 30SE IGB TO 50SW JAN TO 50ENE
LFK TO 40SW LFK TO 30S FST TO 70W INK TO INK TO 30ESE TBE TO OSW
CIG BLW 010/VIS BLW 3SM PCPN/BR/FG. CONDS CONTG BYD 15Z THRU 21Z.
.
AIRMET IFR...TX AR TN LA MS AL AND CSTL WTRS
FROM GQO TO 50SW PZD TO 40W CEW TO 50SW CEW TO 20SE HRV TO 50SSE
IAH TO 30SW CRP TO 60S LRD TO DLF TO 50WSW DLF TO 30S FST TO
40SW LFK TO 50WNW AEX TO 40SW JAN TO 30SE IGB TO GQO
CIG BLW 010/VIS BLW 3SM BR/FG. CONDS CONTG BYD 15Z ENDG 15-18Z.
.
AIRMET IFR...OK AR TN NE KS IA MO IL IN KY
FROM FOD TO 30NE UIN TO 20W BVT TO 30S FWA TO CVG TO HNN TO HMV
TO RZC TO OSW TO 50W LBL TO 20SE HLC TO 40NNE SLN TO FOD
CIG BLW 010/VIS BLW 3SM PCPN/BR/FG. CONDS CONTG BYD 15Z THRU 21Z.
.
AIRMET MTN OBSCN...TX
FROM 50W INK TO 70WNW DLF TO 90SSE MRF TO 40E ELP TO 50W INK
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 15Z ENDG 18-21Z.

WAUS44 KKCI 270845
-DFWT WA 270845
AIRMET TANGO UPDT 1 FOR TURB AND LLWS VALID UNTIL 271500
.
AIRMET TURB...TX AR TN LA MS AL AND CSTL WTRS
FROM HMV TO GQO TO 20S LGC TO 30S SJI TO 20NW LEV TO 60SW LCH TO RZC TO HMV
MOD TURB BLW 160. CONDS CONTG BYD 15Z THRU 21Z.
.
AIRMET TURB...OK TX AR AND CSTL WTRS
FROM 40SE ICT TO OSW TO RZC TO 60SW LCH TO 40SSW PSX TO 20ENE
BRO TO 90W BRO TO 20SW DLF TO INK TO 70WSW LBB TO 40SE ICT
MOD TURB BLW 160. CONDS CONTG BYD 15Z THRU 21Z.
.
AIRMET TURB...OK TX AR TN LA MS
FROM OSW TO RZC TO HMV TO MEM TO 40E LFK TO 20SSE CWK TO 30W LRD TO DLF TO 100SSE MRF TO 60SSW MRF TO ELP TO INK TO 30ESE TBE TO 50W LBL TO OSW
MOD TURB BTN FL200 AND FL390. CONDS CONTG BYD 15Z THRU 21Z.
.
LLWS POTENTIAL...OK TX AR TN LA MS AL MO IL IN KY
BOUNDED BY 30ENE PXV-50SE IIU-50W VXV-50W GQO-60W SQS-60SE ACT-50WNW CWK-60SSE ABI-60S SPS-20N MLC-40WSW FAM-30ENE PXV
LLWS EXP. CONDS ENDG 12-15Z.

WAUS44 KKCI 270845
-DFWZ WA 270845

AIRMET ZULU UPDT 1 FOR ICE AND FRZLVL VALID UNTIL 271500

.

AIRMET ICE...OK TX AR TN MS KS MO IL IN KY
FROM CVG TO HNN TO HMV TO 20SW BNA TO 50SSE DYR TO 50SW MEM TO 70SE ABI TO 40W SJT TO INK TO 50NNE TCC TO 30N GAG TO 50ENE BUM TO 70ESE STL TO CVG
MOD ICE BTN FRZLVL AND FL220. FRZLVL SFC-120. CONDS CONTG BYD 15Z THRU 21Z.

.

AIRMET ICE...OK TX NE KS MN IA MO WI LM MI IL IN KY
FROM 40NNE MCW TO 30WNW GIJ TO DXO TO FWA TO CVG TO 70ESE STL TO 50ENE BUM TO 20ESE ICT TO 50NNE TCC TO 30ESE TBE TO 50W LBL TO GLD TO 20W SNY TO 60NW OVR TO 40NNE MCW
MOD ICE BLW FL220. CONDS CONTG BYD 15Z THRU 21Z.

.

FRZLVL...RANGING FROM SFC-150 ACRS AREA
MULT FRZLVL BLW 130 BOUNDED BY 30WSW CVG-HNN-HMV-20NE MEM-50ENE ACT-40SE JCT-60SE FST-70E ELP-INK-20ENE TCC-30E LBL-20N ICT-30WSW CVG
SFC ALG 30W INK-50E FST-50NE JCT-50NW TXK-30WNW BNA
040 ALG 30SSE INK-60WSW SJT-20NNW JCT-70WSW ACT-40WSW TXK-30SE DYR-30SSE BWG
080 ALG 40SSE ELP-80SE FST-40NNW SAT-40WNW MSL-20S VXV
120 ALG 60SSW MRF-20SSE DLF-30SSW SAT-60SSE EIC-40SW IGB-20NNE LGC

Figure 9 shows AIRMET Tango for occasional moderate turbulence below 16,000 feet and AIRMET Zulu for occasional moderate icing conditions below 22,000 feet.

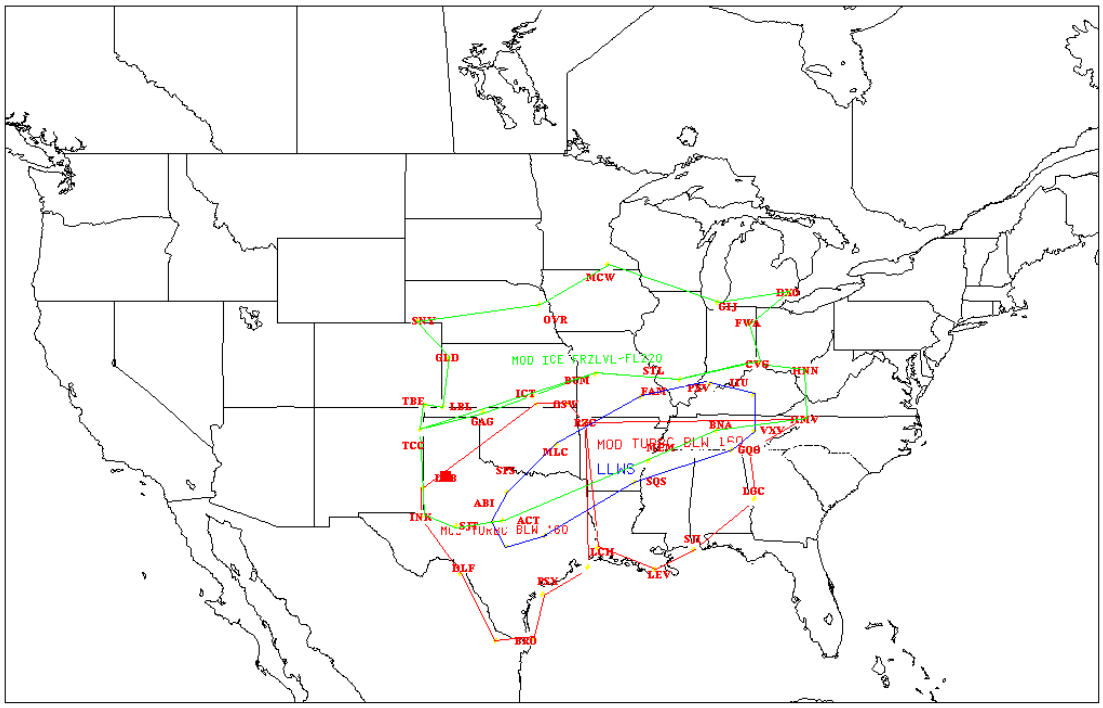


Figure 9 – In-flight Weather Advisories current at 0245 CST

9.0 Terminal Aerodrome Forecast (TAF)

The KLBB Terminal Aerodrome Forecast (TAF) current at the time of the accident was issued at 2327 CST on January 26, 2009 (0527Z January 27, 2009) and was as follows:

KLBB 270527Z 2706/2806 03012KT 1 1/2SM -FZDZ BR OVC001
TEMPO 2708/2712 1/2SM –FZDZ FZFG
FM271400 01012KT 2SM BR OVC005
FM271600 36008KT P6SM BKN008 OVC020
FM271800 34008KT P6SM SCT035 BKN120
FM280100 VRB05KT P6SM SKC=

The TAF current for KLBB at the time of the accident expected winds from 030 degrees at 12 knots, visibility 1 1/2 miles in light freezing drizzle and mist, ceiling overcast at 100 feet agl, with temporary conditions between 0200 and 0600 CST of visibility 1/2 mile in light freezing drizzle and freezing fog. The freezing precipitation was expected to end after 0800 CST.

10.0 Center Weather Service Unit

The ZFW ARTCC Center Weather Service Unit (CWSU) normal hours of operation is from 0600 to 2200 local. At 2117 CST on January 26, 2009 (0317Z on January 27, 2009), the KZFW CWSU issued Center Weather Advisory (CWA) number 207, which was valid until 2320 CST (0520Z). The advisory was as follows:

FAUS22 KZFW 270317
ZFW2 CWA 270320
ZFW CWA 207 VALID UNTIL 270520
FROM 35S GAG TO 50N MLC TO 30NW TXK TO 20N ADM TO 30SW LBB TO 35S GAG
AREAS OF FZRA/FZDZ WITH OCNL MOD MXD ICGICIP BLW 050.
BO

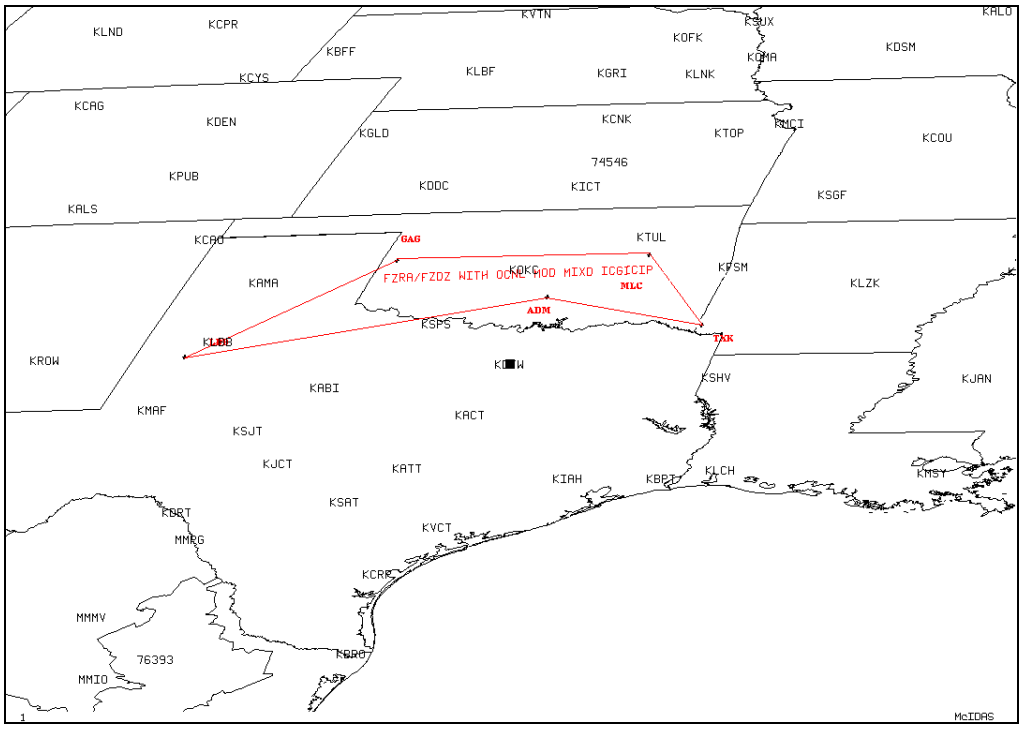


Figure 10 – ZFW CWA valid earlier in the evening for icing

The advisory expired at 2320 CST, and had warned of areas of moderate freezing rain and freezing drizzle with occasional moderate mixed icing in-clouds and in-precipitation below 5,000 feet across the ZFW airspace. AIRMET Zulu updated the advisory.

11.0 Icing Potential

The NWS Current Icing Potential (CIP) and Supercooled Large Droplet (SLD) Icing Diagnostic Charts were obtained from the NOAA Operational Model Archive and Distribution System (MODIS) for 0400 CST (1000Z) and 0500 CST (1100Z) on January 27, 2009. The CIP charts for 6,000 feet, 4,000 feet, and 2,000 feet and SLD for 4,000 feet, and 2,000 feet are included as figures 11 through 20. The charts depict a greater than 80 percent probability of encountering icing and SLD conditions from 6,000 feet to the surface.

Supercooled large droplet is a cloud droplet that has a mean volume diameter (MVD) larger than 50 microns (μm), which is approximately one-half the size of a human hair. SLD conditions often create the most severe icing environment due to droplet runback and aircraft that have been certified for flight into known icing conditions under Part 25 Appendix C, have not been tested in SLD conditions.

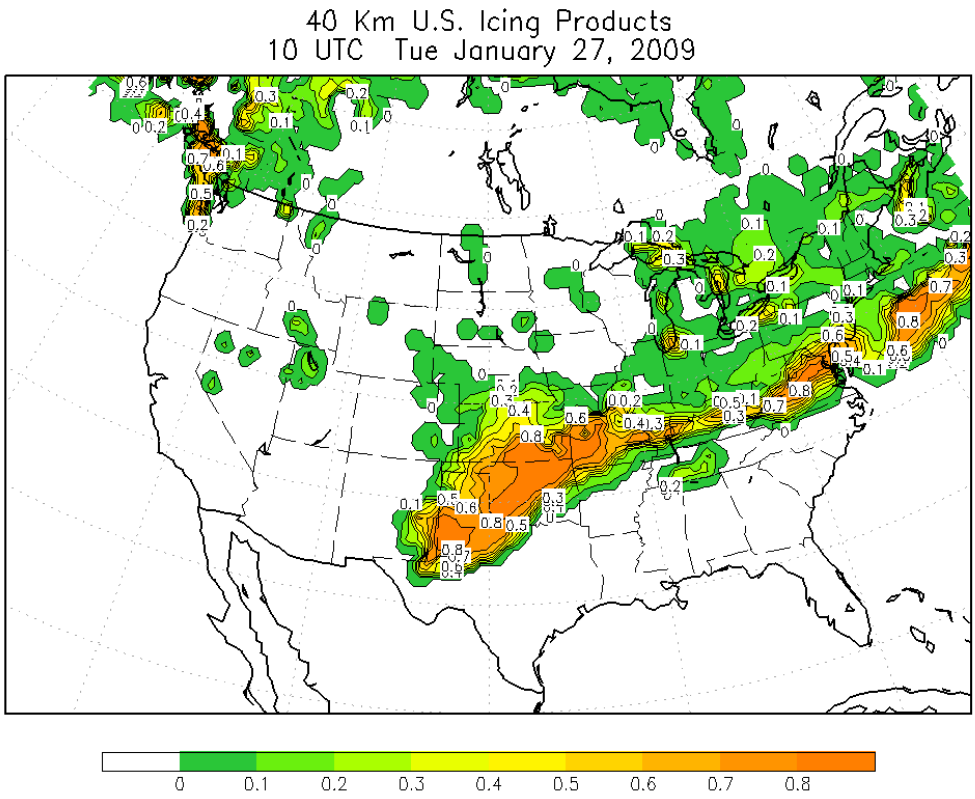


Figure 11 – CIP for 6,000 feet

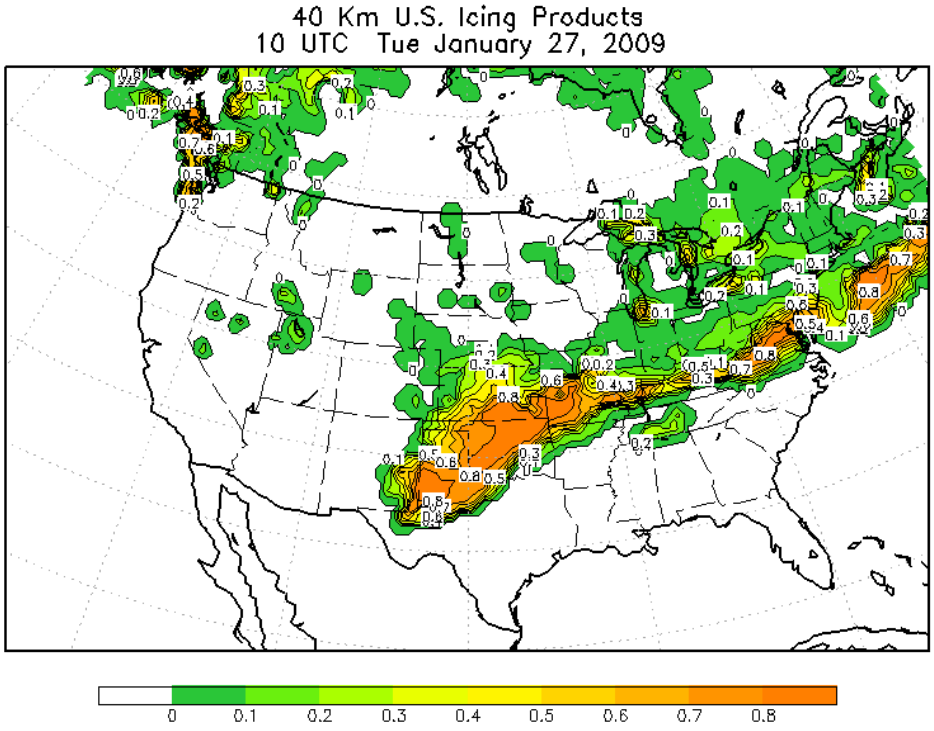


Figure 12 – CIP for 4,000 feet

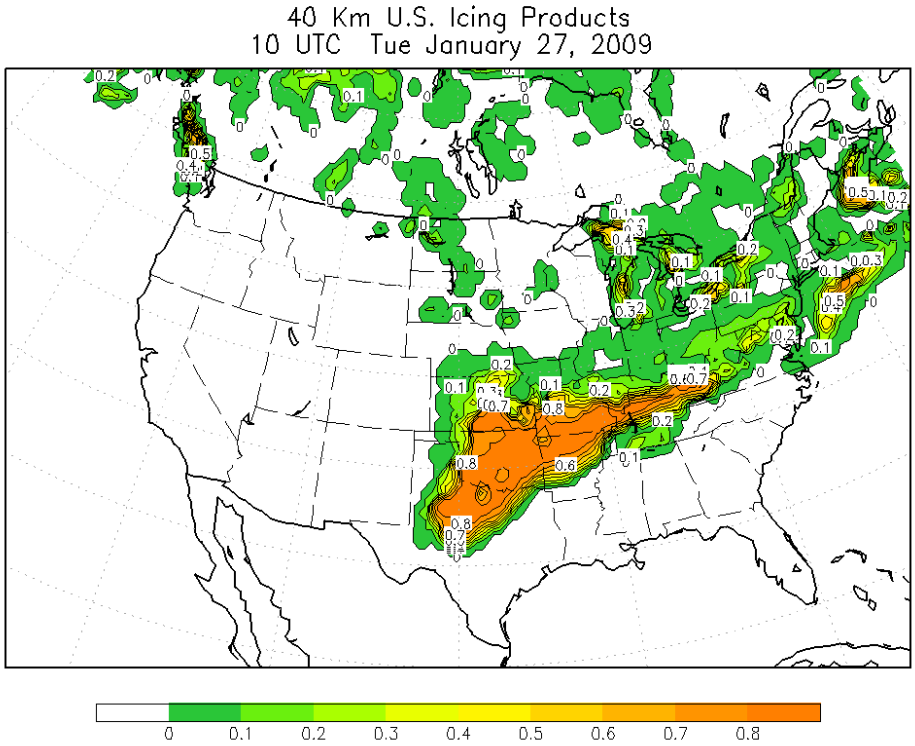


Figure 13 – CIP for 2,000 feet

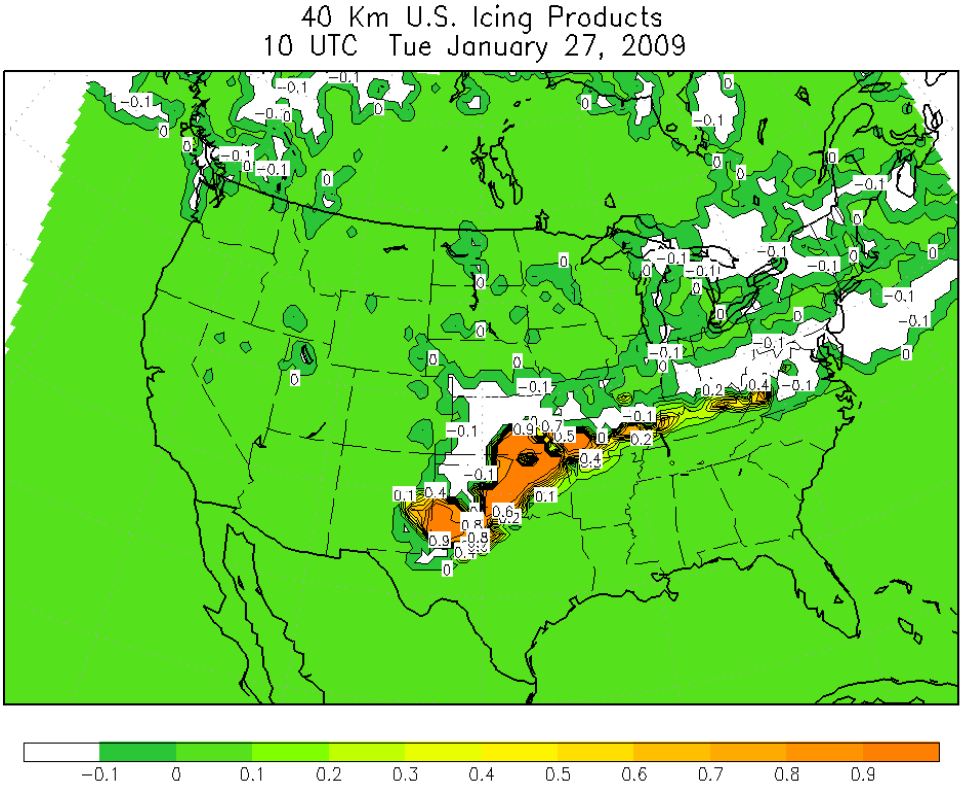


Figure 14 – SLD Potential for 4,000 feet

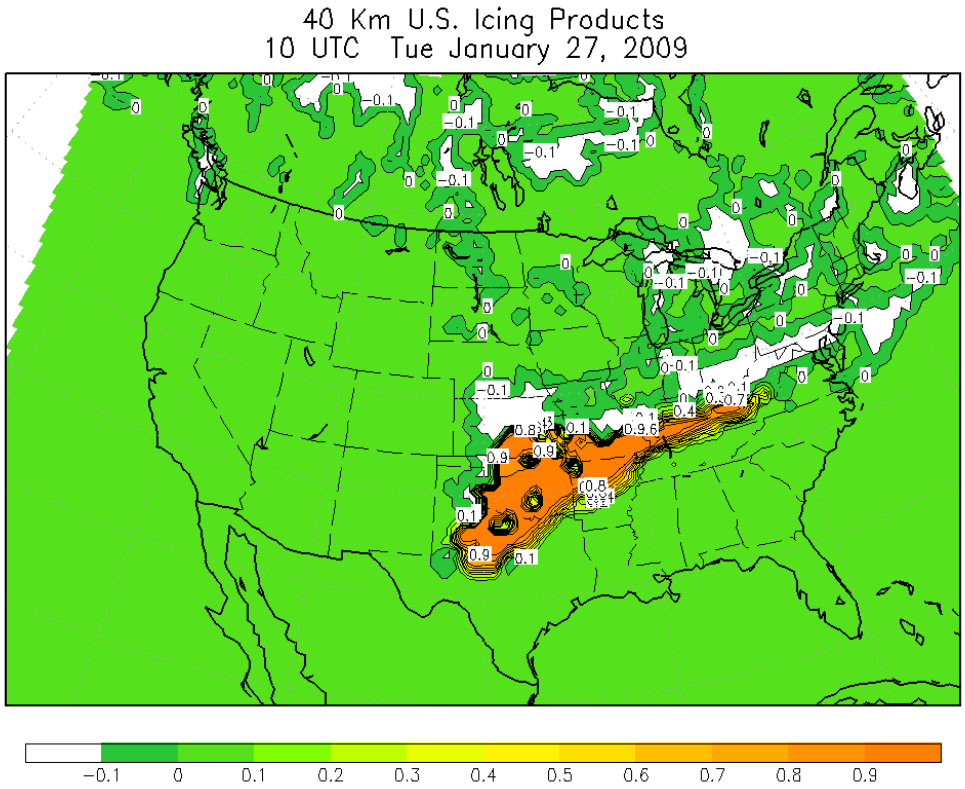


Figure 15 – SLD Potential for 2,000 feet

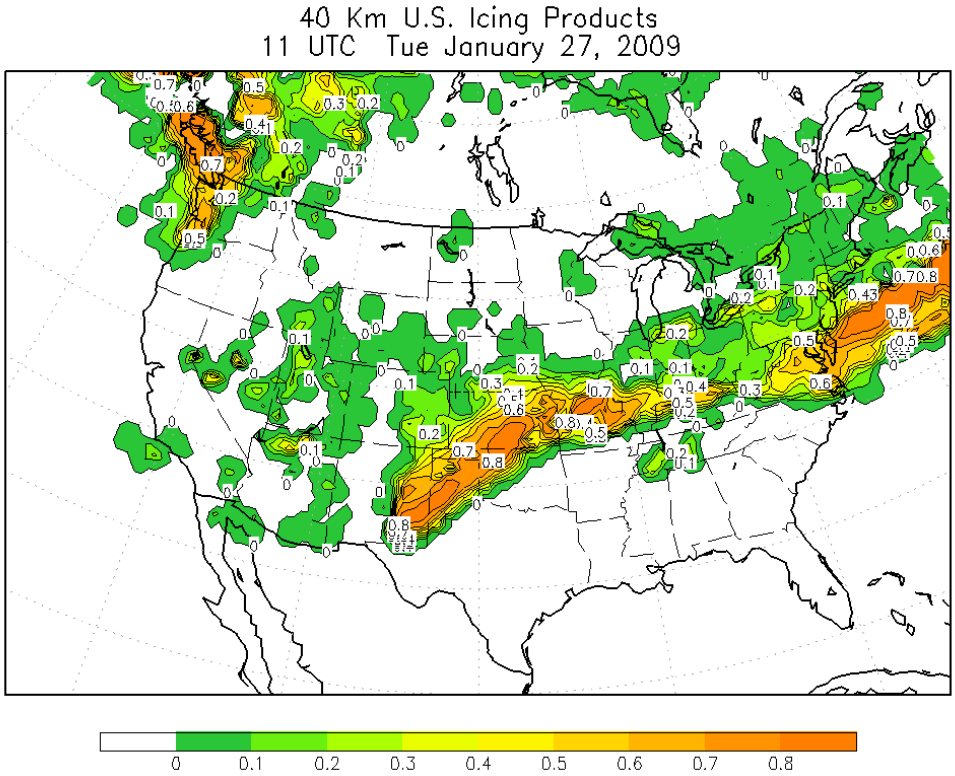


Figure 16 – CIP for 6,000 feet

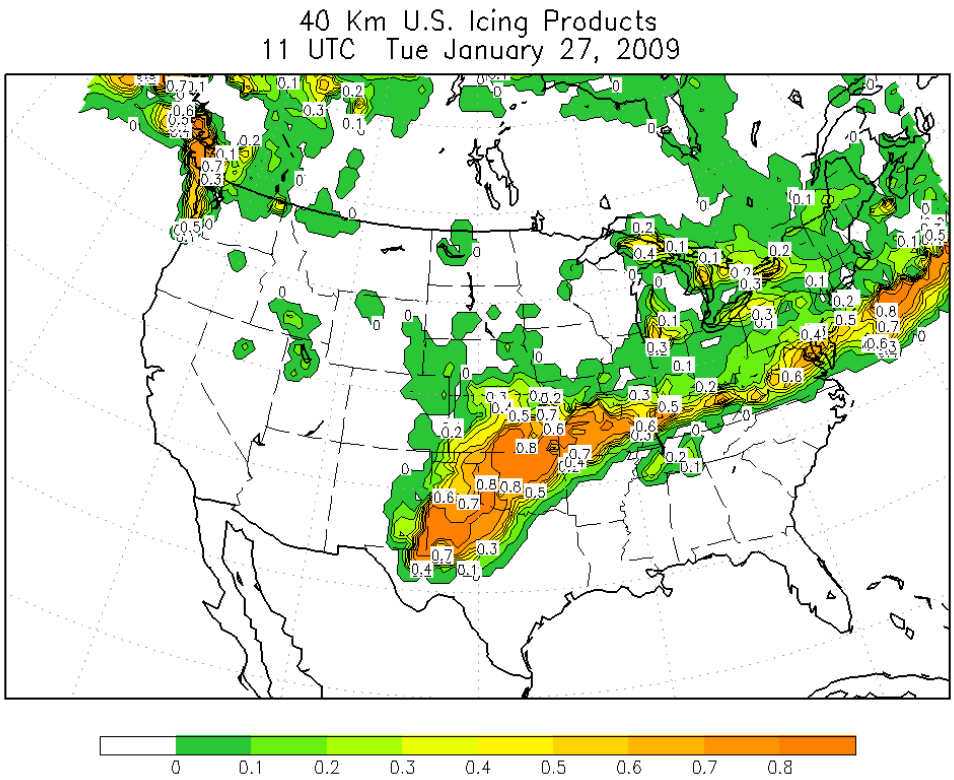


Figure 17 – CIP for 4,000 feet

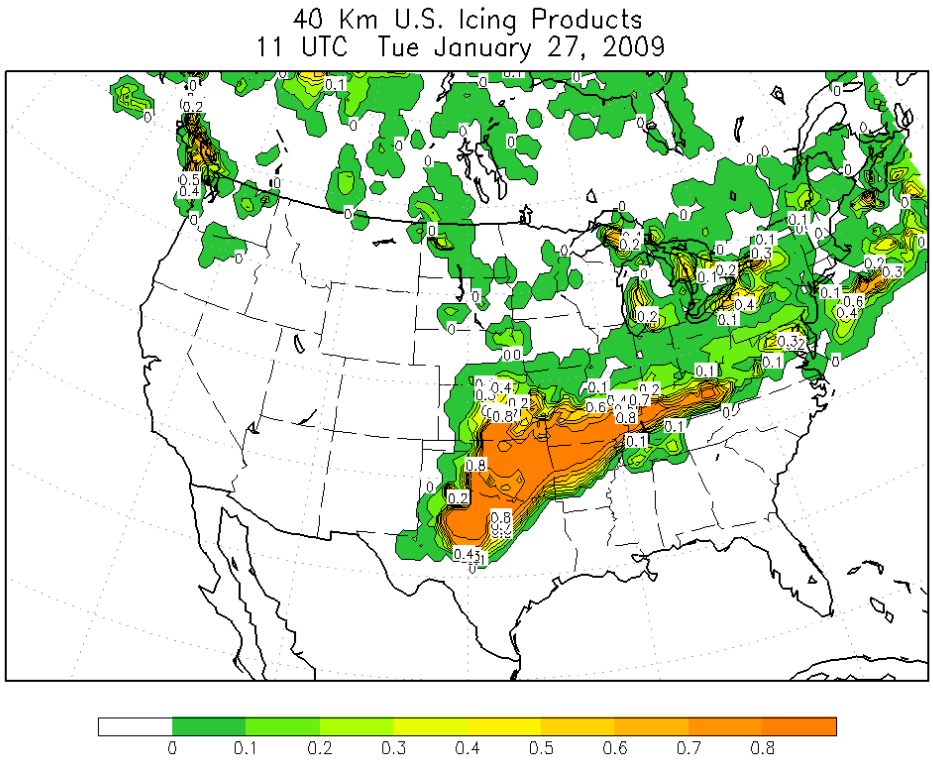


Figure 18 – CIP for 2,000 feet

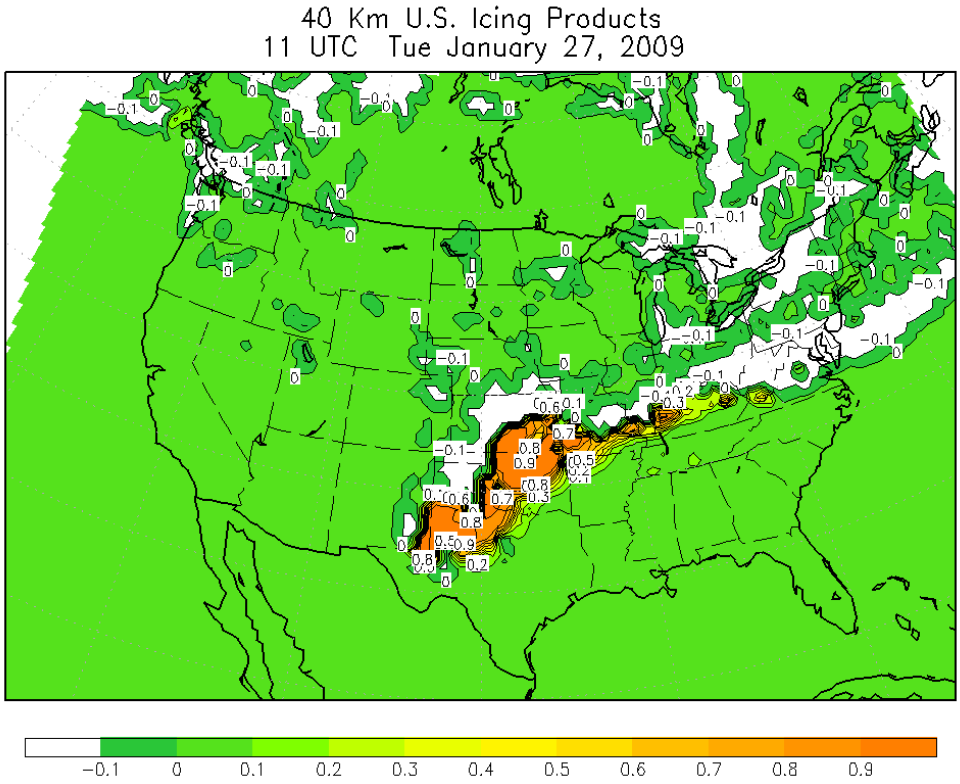


Figure 19 – SLD for 4,000 feet

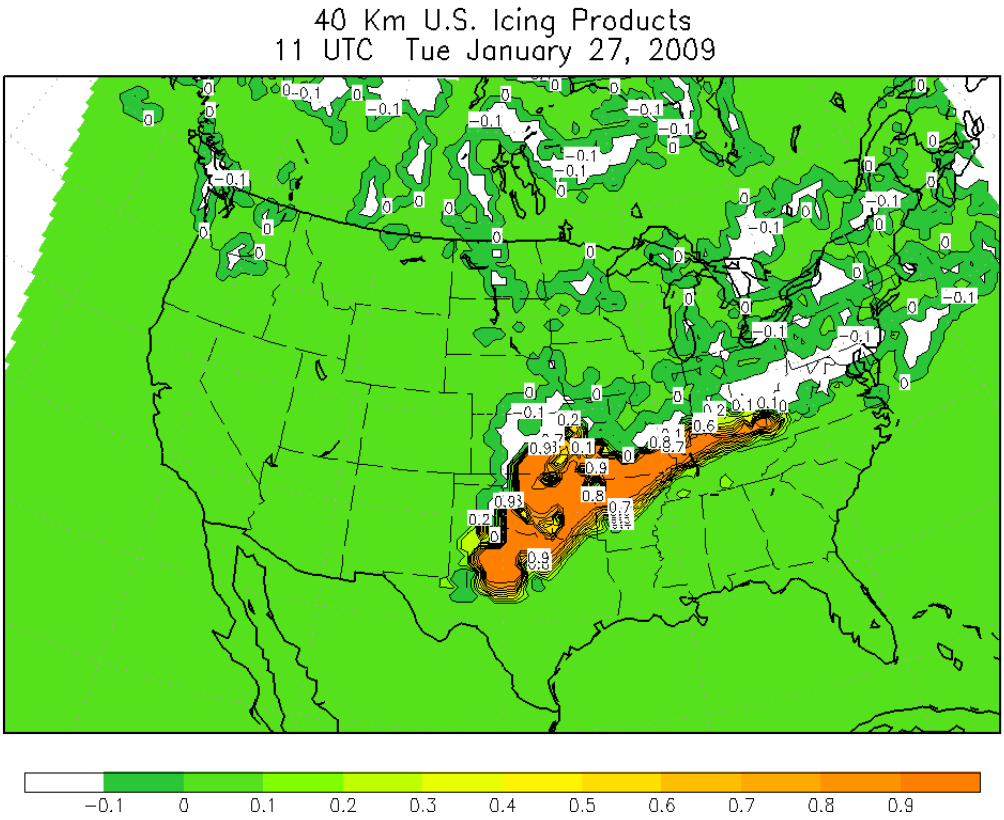


Figure 20 – SLD for 2,000 feet

The National Center for Atmospheric Rearch (NCAR) Research Applications Laboratory provided a cross section of the potential icing environment for 0400 CST (1000Z) between KAFW and KLBB, and is included as figure 21. This type of product is available at the NWS ADDS Flight Path Tool for icing. The chart includes icing severity[16], icing probability, SLD potential, Supercooled Liquid Water (SLW), and visible moisture or relative humidity (RH). The chart depicts a high probability of the aircraft encountering icing conditions after departure from KAFW, enroute at 18,000 feet, and on descent into the KLBB area below 6,000 feet.

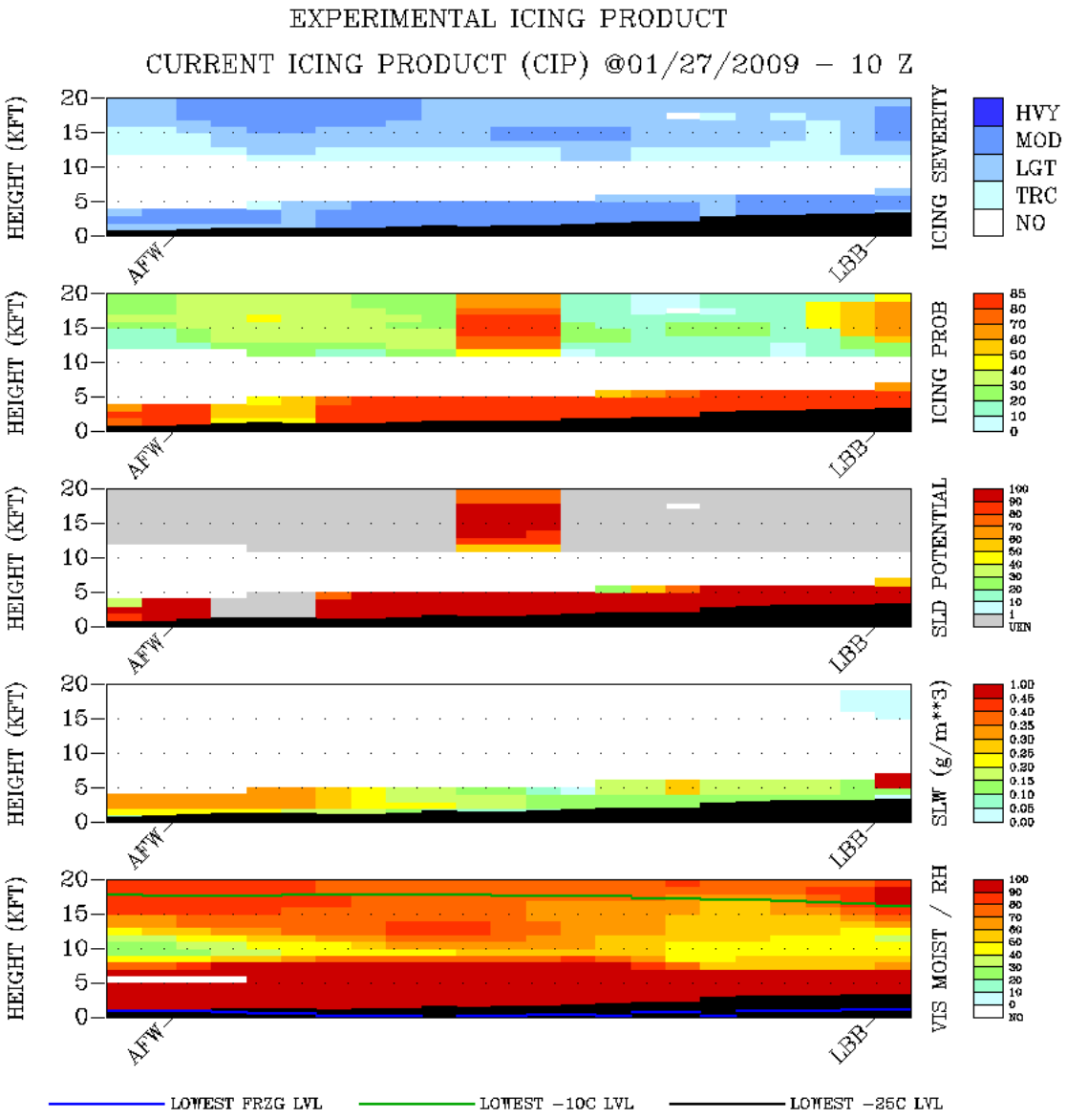


Figure 21 – NCAR CIP cross section from KAFW to KLBB for 0400 CST

[16] The CIP icing severity is intended to characterize the rate of ice accumulation. Data sources include model estimates of vertical motion, liquid water content, temperature, pilot reports, and CIP icing potential.

12.0 Flight Release and Weather Document

The Operations Group obtained and provided the flight release and weather document issued to the flight in their field notes. Empire Airlines operated under the Code of Federal Regulations (CFR) part 121 under a Supplemental Air Carrier, which does not require a Flight Dispatcher to authorize the release, provide the necessary preflight weather products and to flight follow the flight to the destination, but rather a flight follower. A flight follower does not have to meet the certification requirements of part 65, and does not carry the legal responsibility of sharing the responsibility of the safe operation of the flight as a dispatch, that responsibility falls on the director of operations of the air carrier. While Empire Airlines Flight Followers all are licensed dispatchers, except for a new hire, their specific duties are defined differently and do not required initial and recurrent training that a dispatcher requires.

The flight release was issued at 0211 CST (0811Z) with Roswell International Air Center Airport (KROW) located approximately 137 miles west of Lubbock as the alternate airport.

A review of the weather document indicated that it consisted of 14 pages of data, and is included as attachment 1. The destination weather for KLBB indicated the METARs were reporting IFR conditions with light freezing drizzle and mist, and the TAF expected the IFR conditions and light freezing drizzle to continue beyond the estimated time of arrival to after 0800 CST. Several observations surrounding KLBB also reported mixed freezing precipitation across the area, and indicated it was not an isolated event. The document also included the full series of AIRMETs current over the area, including AIRMET Zulu for occasional moderate icing conditions below 22,000 feet.

13.0 Astronomical Data

The following astronomical data was obtained from the United States Naval Observatory for Lubbock, Lubbock County, Texas for January 27, 2009.

SUN	
Begin civil twilight	0720 CST
Sunrise	0747 CST
Sun transit	1300 CST
Sunset	1814 CST
End civil twilight	1841 CST

MOON	
Moonrise	0831 CST
Moon transit	1405 CST
Moonset	1946 CST

At the time of the accident both the Moon and Sun were more than 15 degrees below the horizon, and provided no illumination over the area. The phase of the Moon was a waxing

crescent with only 2 percent of the Moon's visible disk illuminated. A new Moon occurred on January 26, 2009 at 0155 CST.

14.0 Icing Intensity

The FAA Aeronautical Information Manual (AIM), chapter 7 Safety of Flight – Meteorology, section 7-1-21 advises pilots how to make pilot reports relating to airframe icing. The AIM advises:

> *a. The effects of ice on aircraft are cumulative-thrust is reduced, drag increases, lift lessens, and weight increases. The results are an increase in stall speed and a deterioration of aircraft performance. In extreme cases, 2 to 3 inches of ice can form on the leading edge of the airfoil in less than 5 minutes. It takes but 1/2 inch of ice to reduce the lifting power of some aircraft by 50 percent and increases the frictional drag by an equal percentage.*
>
> *b. A pilot can expect icing when flying in visible precipitation, such as rain or cloud droplets, and the temperature is between +02 and -10 degrees Celsius. When icing is detected, a pilot should do one of two things, particularly if the aircraft is not equipped with deicing equipment; get out of the area of precipitation; or go to an altitude where the temperature is above freezing. This "warmer" altitude may not always be a lower altitude. Proper preflight action includes obtaining information on the freezing level and the above freezing levels in precipitation areas. Report icing to ATC, and if operating IFR, request new routing or altitude if icing will be a hazard. Be sure to give the type of aircraft to ATC when reporting icing. The following describes how to report icing conditions.*
>
> *1. **Trace** - Ice becomes perceptible. Rate of accumulation slightly greater than sublimation. Deicing/anti-icing equipment is not utilized unless encountered for an extended period of time (over 1 hour).*
>
> *2. **Light** - The rate of accumulation may create a problem if flight is prolonged in this environment (over 1 hour). Occasional use of deicing/anti-icing equipment removes/prevents accumulation. It does not present a problem if the deicing/anti-icing equipment is used.*
>
> *3. **Moderate** - The rate of accumulation is such that even short encounters become potentially hazardous and use of deicing/anti-icing equipment or flight diversion is necessary.*
>
> *4. **Severe** - The rate of accumulation is such that deicing/anti-icing equipment fails to reduce or control the hazard. Immediate flight diversion is necessary.*

Advisory Circular AC 91-74A "Pilot Guide: Flight in Icing Conditions" published in December 2007 provides additional information on icing intensity and provides an estimate of icing accretion rate. The advisory provides the following definitions:

> *Trace – Ice becomes noticeable. The rate of accumulation is slightly greater than the rate of sublimation. A representative accretion rate for reference purposes is less than 1/4 inch (6 mm) per hour on the outer wing. The pilot should consider exiting the icing conditions before they become worse. Pilots should be aware that any ice, even in trace amounts, could be potentially hazardous.*

Light - The rate of ice accumulation requires occasional cycling of manual deicing systems to minimize ice accretions on the airframe. A representative accretion rate for reference purposes is 1/4 inch to one inch (0.6 to 2.5 cm) per hour on the outer wing. The pilot should consider exiting the condition.

Moderate icing – The rate of ice accumulation requires frequent cycling of manual deicing systems to minimize ice accretions on the airframe. A representative accretion rate for reference purposes is 1 to 3 inches (2.5 to 7.5 cm) per hour on the outer wing. The pilot should consider exiting the condition as soon as possible.

Heavy Icing - The rate of ice accumulation requires maximum use of the ice protection systems to minimize ice accretions on the airframe. A representative accretion rate for reference purposes is more than 3 inches (7.5 cm) per hour on the outer wing. Consider immediate exit from the conditions.

Severe icing - The rate of ice accumulation is such that ice protection systems fail to remove the accumulation of ice and ice accumulates in locations not normally prone to icing, such as areas aft of protected surfaces and any other areas identified by the manufacturer. Immediate exit from the condition is necessary.

Donald E. Eick
NTSB Senior Meteorologist