Docket No. SA-531

Exhibit No. 5-A

NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C.

Weather Group Chairman
Factual Report

(55 Pages)

National Transportation Safety Board

Office of Aviation Safety
Washington, D.C. 20594-2000
April 22, 2009

METEOROLOGICAL FACTUAL REPORT

DCA09MA027

A. ACCIDENT

Location: Clarence Center, New York
Date: February 12, 2009
Time: 2217 eastern standard time (0317 UTC[1] February 13, 2009)
Aircraft: Colgan Air operating as Continental Connection flight 3407, Bombardier Q400; Registration: N200WQ

B. METEOROLOGICAL GROUP

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C. SUMMARY

On February 12, 2009, about 2217 eastern standard time (EST), a Colgan Air Inc., Bombardier Dash 8-Q400, N200WQ, operating as Continental Connection flight 3407, crashed during an instrument approach to runway 23 at the Buffalo-Niagara International Airport (KBUF), Buffalo, New York. The crash site was approximately 5 nautical miles northeast of the airport in Clarence Center, New York, and mostly confined to one residential house. The four flight crew and 45 passengers were fatally injured and the aircraft was destroyed by impact forces and post crash fire. There was one ground fatality. Night visual meteorological conditions prevailed at the time of the accident. The flight was a Code of Federal Regulations (CFR) Part 121 scheduled passenger flight from Liberty International

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

Airport (KEWR), Newark, New Jersey to KBUF.

D. DETAILS OF INVESTIGATION

The National Transportation Safety Board's (NTSB) meteorologist specialist was launched on the go-team and arrived on scene in Buffalo at approximately 0700 local. Data for this investigation was gathered from the National Weather Service (NWS) Buffalo Weather Forecast Office (WSFO), the National Climatic Data Center (NCDC) archive sites, and through FAA/NWS weather circuits, and through the Safety Board's Man-computer Interactive Data System (McIDAS). All NWS products are issued based on Coordinated Universal Time (UTC) based upon the 24 hour clock, local time of eastern standard time (EST) is +5 hours to UTC, and UTC=Z. Directions are referenced to true north and distances in nautical miles. Heights are above mean sea level (MSL) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

Interviews were conducted with the NWS Buffalo WSFO staff and forecasters, the FAA contract ASOS Augmenter on duty during the accident, the Director of Operations of Noble Wind Energy, which operates an instrumented wind farm along the accident aircraft's flight path, and other first responders on scene during the period of the accident. Other data sources from scientists and research centers of the National Center for Atmospheric Research (NCAR), and the Massachusetts Institute of Technology Lincoln Laboratory (MIT/LL) provided meteorological data.

Accident coordinates were determined as latitude 43.011° North, longitude 78.638° West.

1.0 Synoptic Situation

The general 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 2200 EST (0300Z) is provided as figure 1. The chart depicted a 972-hectopascal (hPa) low pressure system over Nova Scotia associated with an occluded front. A strong pressure gradient was indicated over the northeast and New England, which was responsible for producing strong gusty surface winds during the day across the region. A secondary cold front extended behind the deep low off the northeast coast, with the front extending across extreme northern Maine, Vermont, and northern New York, Lake Ontario, Lake Huron, and into northern and upper Michigan.

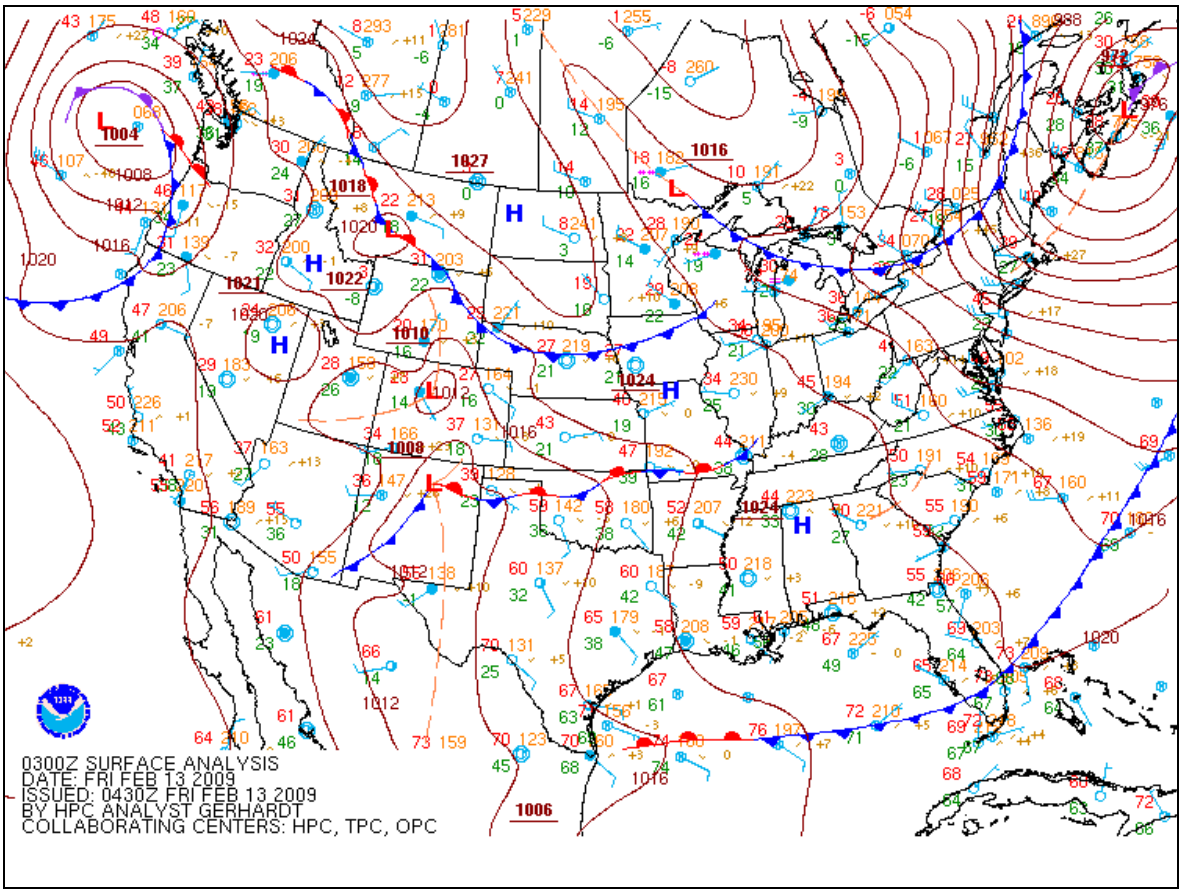


Figure 1 – National Surface Analysis Chart for 2200 EST

The northeast section of the NWS Surface Analysis Chart for 2200 EST (0300Z) is included as figure 2. The chart shows Buffalo and the accident site on the warm air side immediately south of the cold front. The station models on the chart indicated winds from the west at 15 to 20 knots, overcast skies, temperatures in the mid to low of 30's degrees Fahrenheit (F) along and south of the cold front, dew point temperatures below freezing with several stations reporting light continuous snow. The station model for Bradford (KBFD), Pennsylvania, south of the Buffalo area depicted light freezing rain. North of the front winds backed to the northwest at 10 to 20 knots, and temperatures dropped into the teens and 20's, and single digits further behind the front in central Canada.

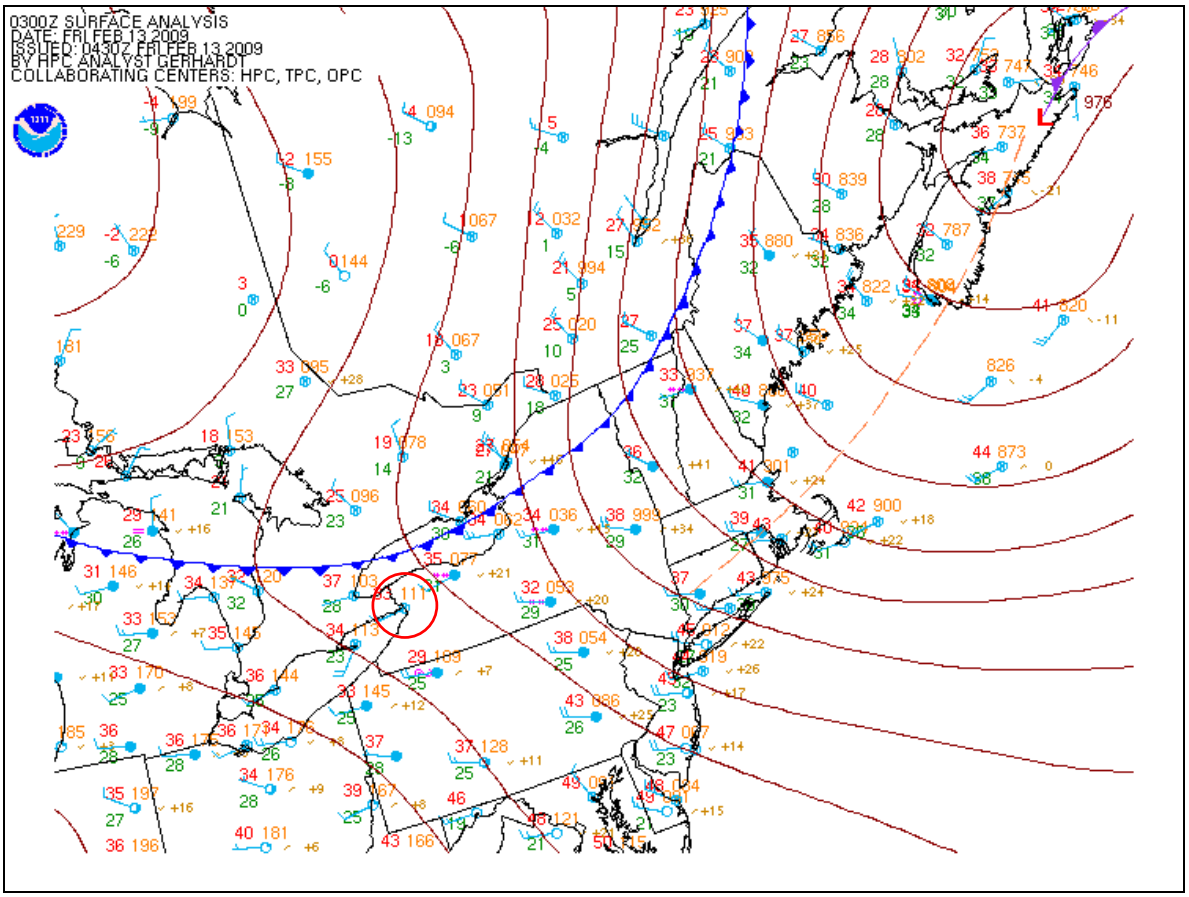


Figure 2 – Northeast regional Surface Analysis Chart for 2200 EST

1.0.2 Weather Depiction Chart

The NWS Weather Depiction Chart for 2000 EST (0100Z) is included as figure 3. The chart depicted an area of instrument flight rule (IFR) conditions[2] extending along the cold front across New York and northern Vermont and New Hampshire by a shaded contour line. Surrounding that area was an area of marginal visual flight rules (MVFR) conditions[3] indicated by an unshaded contour that covered most of New York State. The closest visual flight rule (VFR) conditions[4] without a contour line were depicted over central and southern Pennsylvania and New Jersey, and included the departure airport.

[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.

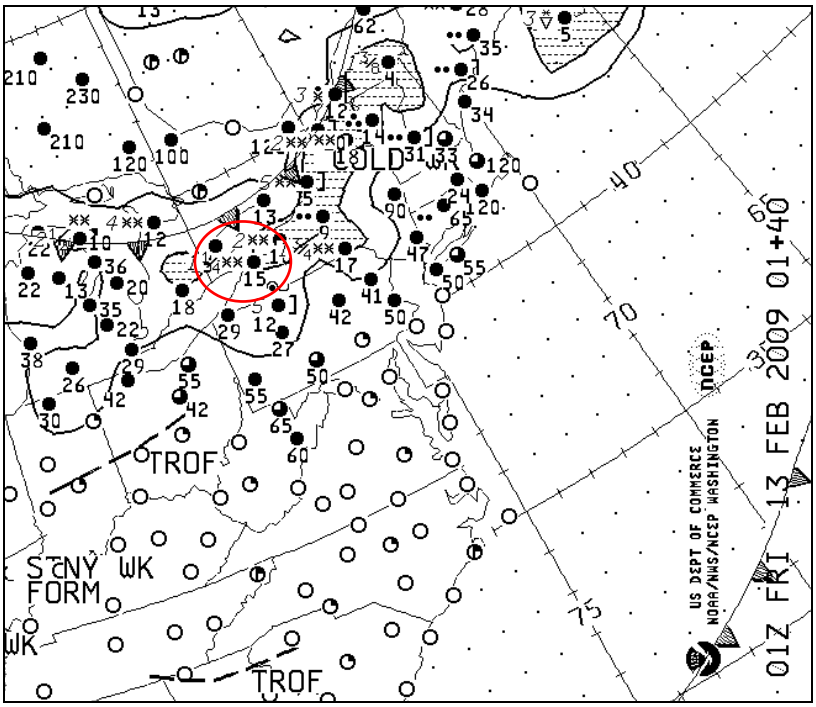


Figure 3 – NWS Weather Depiction Chart for 1900 EST

The station model for Buffalo depicted IFR conditions with a ceiling overcast at 1,500 feet agl and visibility 1 1/4 miles in light snow at 2000 EST. The surrounding station models reported light snow with a report of light freezing rain in northern Pennsylvania.

1.0.3 Radar Summary Chart

Weather Services International (WSI) is one of the major weather vendors distributing weather radar data to the airlines, the media such as the Weather Channel, and other weather users. One of the most common products that is produced during the winter months is a winter mosaic chart to help identify areas of convective or liquid precipitation, mixed freezing precipitation (shown in pink to red shades), and snow areas (blue tones). WSI mosaic's also utilizes a patented ground clutter-suppressing program to eliminate non-weather related echoes. Figure 4 is the WSI National Winter Mosaic Radar Summary Chart for 2215 EST (0315Z). The chart depicted a band of echoes under 30 dBZ extending over northern New York and New England in the form of mixed freezing precipitation and snow. Several first responders to the accident indicated that a mixture of snow and ice pellets or sleet was occurring when they arrived on site.

Section 5.0 of this report will document the NWS weather radar and flight track in further detail.

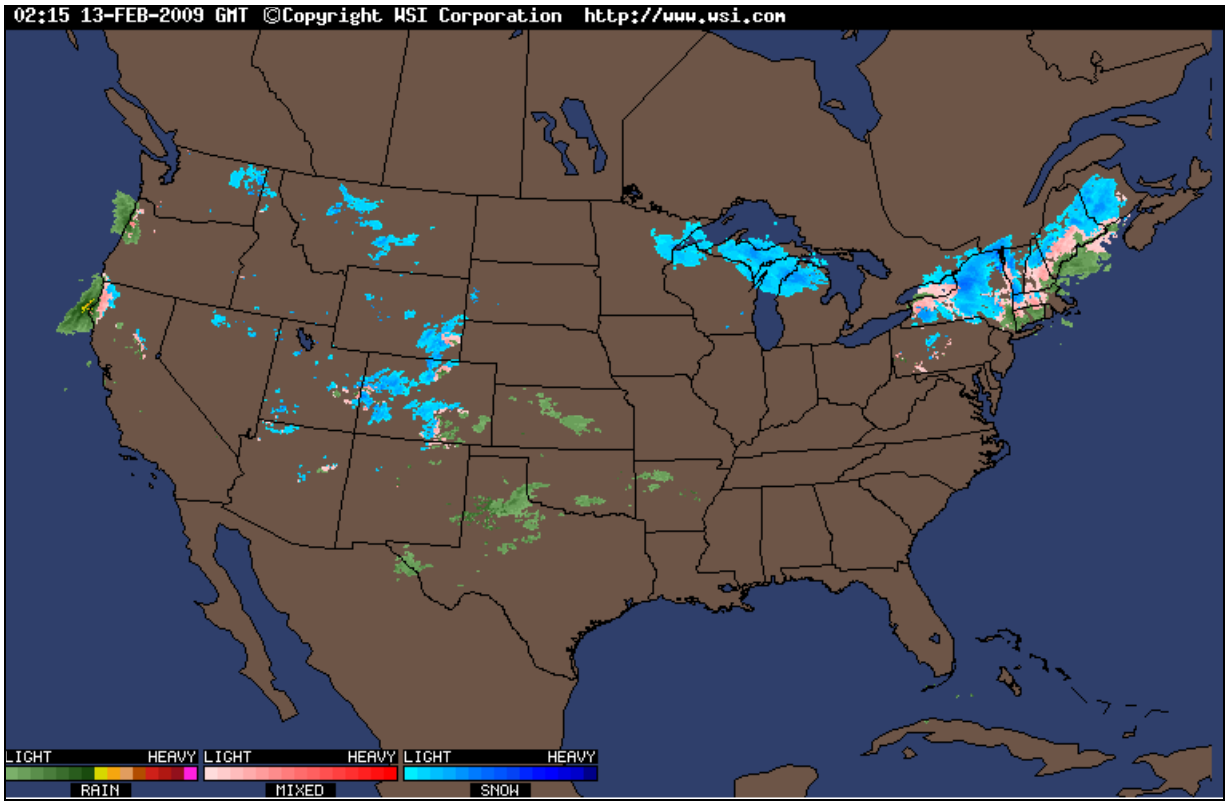


Figure 4 – WSI Winter Mosaic Radar Chart for 2215 EST

2.0 Observations

The area was documented utilizing Meteorological Aerodrome Reports (METAR) and special observations (SPECI) surrounding the area, and high-resolution 1- and 5-minute Automated Surface Observation System (ASOS) data.

2.0.1 Buffalo Niagara International Airport (KBUF), Buffalo, New York

The accident site was located approximately 5 miles northeast of Buffalo Niagara International Airport (KBUF), which is an elevation of 728 feet msl. The airport had an ASOS installed and was augmented by NWS certified weather observer located on the ground floor of the main passenger terminal at the airport. The following weather was reported prior to the accident, with cloud heights above ground level (agl):

The Buffalo observation at 2154 EST (0254Z) indicated winds from 240 degrees at 15 knots gusting to 22 knots, visibility 3 miles in light snow and mist, a few clouds at 1,100 feet agl, ceiling broken at 2,100 feet, overcast at 2,700 feet, temperature 1 degree C, dew point –1 degrees C, altimeter 29.79 inches of Mercury (Hg). Remarks: automated observation, sea level pressure 1009.7-hPa, hourly precipitation 0.01 inches, 6-hour precipitation 0.4 inches, temperature 0.6 degree C, dew point –0.6 degree C, 3-hour pressure tendency risen 1.5-hPa.

The following observations were issued surrounding the period:

SPECI KBUF 130111Z 23014KT 2SM -SN BR OVC017 01/M01 A2977 RMK AO2 P0001=

SPECI KBUF 130149Z 24015KT 3SM -SN BR FEW011 OVC021 01/M01 A2978 RMK AO2 P0001=

METAR KBUF 130154Z 24015G23KT 3SM -SN BR FEW011 OVC021 01/M01 A2978 RMK AO2 SLP092 P0001 T00061006=

METAR KBUF 130254Z 24015G22KT 3SM -SN BR FEW011 BKN021 OVC027 01/M01 A2979 RMK AO2 SLP097 P0001 60004 T00061006 51015=

METAR KBUF 130354Z 24011KT 3SM -SN BR SCT011 OVC021 01/M01 A2981 RMK AO2 SLP103 P0002 T00061006=

KBUF 130454Z 26014KT 3SM -SN BR SCT011 OVC021 01/00 A2983 RMK AO2 SLP109 P0004 T00060000 401060000=

SPECI KBUF 130458Z 25012KT 3SM -FZRA BR BKN008 OVC015 01/00 A2983 RMK AO2 FZRAB58SNE58 CIG 005V012 P0000=

KBUF 130505Z 25012KT 4SM BR BKN008 BKN015 OVC021 01/00 2983 RMK AO2 FZRAB0458E0459SNE0458 CIG 005V011 P0000=

COR KBUF 130505Z 25012KT 4SM -SN BR BKN008 BKN015 OVC021 01/00 A2983 RMK AO2 CIG 005V011 P0000=

SPECI KBUF 130505Z 25012KT 4SM BR BKN008 BKN015 OVC021 01/00 A2983 RMK AO2 FZRAB0458E0459SNE0458 CIG 005V011 P0000=

METAR KBUF 130552Z 31010KT 1SM R23/5000VP6000FT -SN BR BKN007 OVC013 00/M01 A2985 RMK AO2 CIG 003V010 P0000=

Snow ended at Buffalo at 0415 EST (0915Z) with 1-inch of snow accumulation reported on the ground.

2.0.2 High Resolution 5-minute Observations at KBUF

The ASOS 5-minute observation recorded during the period from 2200 to 2230 EST (0300Z to 0330Z) 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.

```
02/12/09 22:00:31  5-MIN KBUF 130300Z 25016G21KT 3SM -SN BR FEW011
   OVC021 01/M01 A2980 840 92 -600 260/16G21 RMK AO2 P0000

02/12/09 22:05:31  5-MIN KBUF 130305Z 25014G21KT 3SM -SN BR FEW011
   OVC021 01/M01 A2980 840 92 -600 260/14G21 RMK AO2 P0000

02/12/09 22:10:31  5-MIN KBUF 130310Z 25014KT 3SM -SN BR FEW011 OVC021
01/M01 A2980 840 92 -600 260/14 RMK AO2 P0001
```

02/12/09 22:15:31 5-MIN KBUF 130315Z 25014KT 3SM -SN BR FEW011 OVC021 01/M01 A2980 840 92 -600 260/14 RMK AO2 P0001

02/12/09 22:20:31 5-MIN KBUF 130320Z 25015KT 3SM -SN BR FEW011 OVC021 01/M01 A2980 840 92 -600 260/15 RMK AO2 P0001

02/12/09 22:25:31 5-MIN KBUF 130325Z 25016KT 3SM -SN BR FEW011 OVC021 01/M01 A2981 830 92 -600 260/16 RMK AO2 P0001

02/12/09 22:30:31 5-MIN KBUF 130330Z 24014KT 3SM -SN BR FEW011 OVC021 01/M01 A2981 830 92 -600 250/14 RMK AO2 P0001

The KBUF observation at 2215 EDT indicated wind from 250 degrees at 14 knots, visibility 3 miles in light snow and mist, a few clouds at 1,100 feet, ceiling overcast at 2,100 feet, temperature 1 degree C, dew point –1 degree C, altimeter 29.80 inches of Hg, pressure altitude 840 feet, relative humidity 92 percent, density altitude 600 feet below sea level, magnetic winds from 260 degrees at 14 knots. Remarks: automated observation system, hourly precipitation 0.01 inches.

The 1-minute data for KBUF at 2217 EST indicated an average 2-minute wind from 243 degrees at 13 knots with a peak wind from 248 degrees at 16 knots, with an RVR on runway 23 of more than 6,000 feet.

2.0.3 Observations – Niagara Falls International Airport (KIAG), Niagara Falls, NY

The next closest NWS weather reporting site was from Niagara Falls International Airport (KIAG) located 14 miles northwest of KBUF, at an elevation of 589 feet msl. The airport had an ASOS equipped with NWS certified weather observers to augment the system until approximately 2200 local. The following observations were available surrounding the period:

METAR KIAG 130253Z 26018KT 10SM -RA OVC022 02/M01 A2980 RMK AO2 RAE07B45 SLP101 8/5// P0000 60001 T00221006 53016

METAR KIAG 130353Z 26014G21KT 10SM -RA OVC021 02/M01 A2981 RMK AO2 SLP107 LAST P0000 T00221006

SPECI KIAG 130433Z AUTO[5] *31013KT 6SM -FZRA BR BKN012 OVC017 02/00 A2983 RMK AO2 RAE0354B24E27UPB13E24FZRAB27 P0000*

SPECI KIAG 130440Z AUTO 32010KT 5SM FZRA BR SCT008 OVC014 01/M01 A2983 RMK AO2 RAE0354B24E27UPB13E24FZRAB27 P0001

SPECI KIAG 130443Z AUTO 32011KT 5SM -FZRA BR SCT008 OVC015 01/M01 A2984 RMK AO2 RAE0354B24E27UPB13E24FZRAB27 P0001

SPECI KIAG 130449Z AUTO 32010KT 7SM -RA BKN010 BKN015 OVC026 01/M01 A2984

[5] AUTO – automatic mode, indicates no one is logged onto the system for augmentation.

METAR KIAG 130453Z AUTO 32011KT 7SM -SN BKN008 OVC013 00/M01 A2984 RMK AO2 RAE0354B24E27B49E51UPB13E24FZRAB27E53SNB53 CIG 005V010 SLP117 P0001 T00001011 400940000

SPECI KIAG 130519Z AUTO 32010KT 8SM -FZRA OVC010 M01/M02 A2985 RMK AO2 UPB06E18FZRAB18SNE06B09E15 CIG 006V013 P0001

SPECI KIAG 130527Z AUTO 31009KT 9SM -SN FEW006 OVC012 M01/M02 A2985 RMK AO2 UPB06E18FZRAB18E25SNE06B09E15B25 P0001

METAR KIAG 130553Z AUTO 33009KT 10SM OVC012 M01/M02 A2986 RMK AO2 UPB06E18B34E41FZRAB18E25SNE06B09E15B25E34 SLP126 P0001 60003 T10061022 10028 21006 53022

SPECI KIAG 130614Z AUTO 32010KT 9SM OVC015 M01/M03 A2987 RMK AO2 SNB00E10 P0000

The observation at Niagara Falls (KIAG) at 2153 EST indicated winds from 260 degrees at 18 knots, visibility 10 miles in light rain, ceiling overcast at 2,200 feet, temperature 2 degrees C, dew point –1 degree C, altimeter 29.80 inches of Hg. Remarks: automated observation system, rain ended at 2107 and began again at 2145 EST, sea level pressure 1010.1-hPa, stratocumulus clouds obscuring the sky, hourly precipitation less than 0.01 inches, 6-hour precipitation 0.01 inches, temperature 2.2 degrees C, dew point –0.6 degree C, 3-hour pressure tendency risen 1.6-hPa over the period.

After the NWS certified weather observer logged off the system for the evening, the ASOS reported at 2333 EST (0433Z) light freezing rain. A combination of light freezing rain, unknown freezing precipitation, and snow were reported and ended at 0034 EST on February 13, 2009.

3.0 Upper Air Sounding

The NWS KBUF upper air sounding or rawinsonde observation (RAOB), site number 72528, launched at approximately 1900 EST on February 12, 2009 (0000Z on February 13, 2009), was plotted on a standard Skew-T log P diagram[6] from the surface to 500-mb or 18,000 feet with the observed and derived stability parameters and is included as figure 5. During the period of this sounding KBUF depicted a moist low-level environment with the lifted condensation level (LCL)[7] at 975-hPa or at 163 feet agl (868 feet msl), and a

[6] 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.

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

convective condensation level (CCL)[8] at 917-hPa or 1,757 feet agl (2,462 feet msl). Surface temperature was 0.4 degrees C with the freezing level identified at 288 feet agl (933 feet msl). There were two frontal inversions identified at 5,703 feet msl and 10,460 feet msl with temperature remaining below freezing through the layers.

The soundings moisture profile indicated a relative humidity of 75 percent or more from the surface to 16,000 feet msl, and with relative humidity greater than 90 percent from the surface to 9,500 feet msl. The precipitable water content was 0.42 inches. The sounding temperature and moisture profiles supported precipitation in the form of snow at the surface, and supported airframe icing conditions between the surface and 16,000 feet. The icing analysis program indicated a probability greater than 60 percent below 9,500 feet with a maximum probability of 98 percent at 5,700 feet of encountering moderate rime type icing, with a liquid water content (LWC) of 0.918 grams per cubic meter (g/m³).

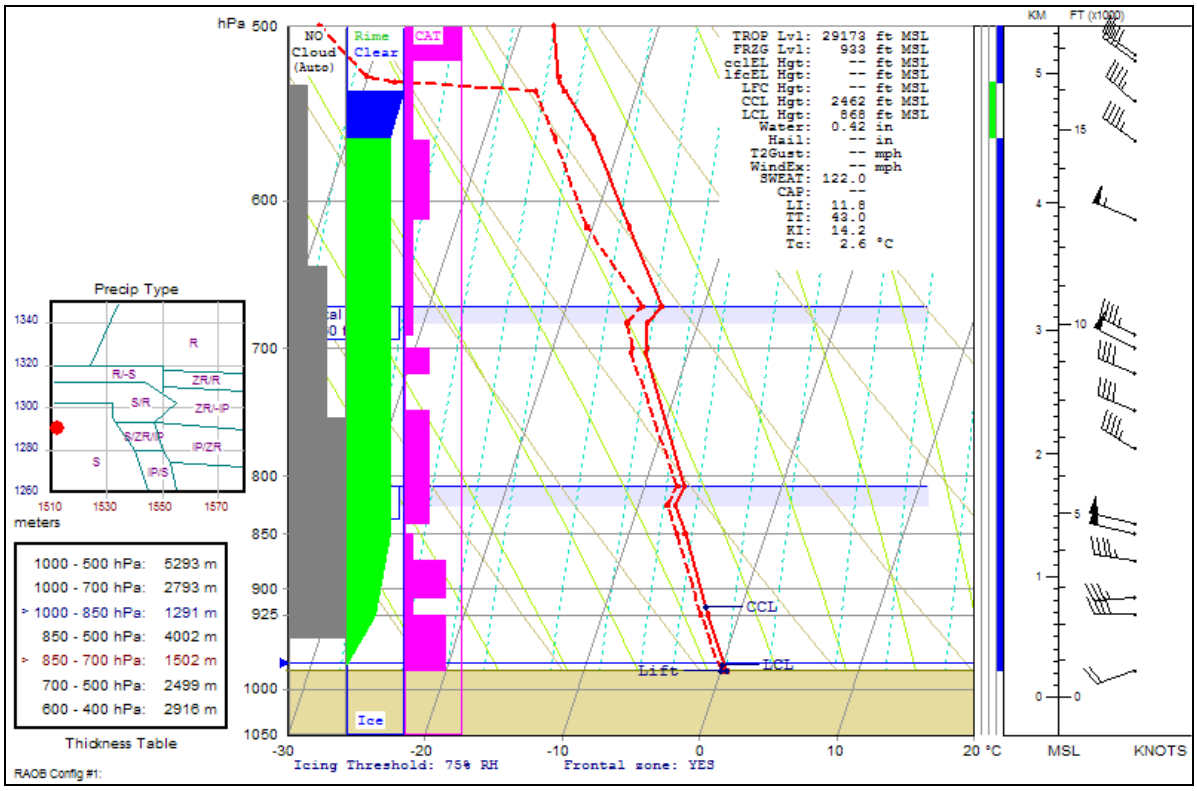


Figure 5 –KBUF sounding at 1900 EST

The temperature inversions resulted in a Lifted Index (LI)[9] of 11.8 and indicated a stable atmosphere that supported stratiform type clouds, including nimbostratus.

[8] 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.

[9] Lifted Index (LI) - A common measure of atmospheric instability. Its value is obtained by computing the temperature of a parcel near the surface lifted adiabatically to 18,000 feet, and comparing that temperature to the

The sounding wind profile indicated surface winds from 250 degrees at 20 knots gusting to 25 knots, with winds veering to the west-northwest with height through 10,000 feet. A low-level wind maximum was identified at 4,700 feet msl with winds from 297 degrees at 50 knots. The maximum wind was from 285 degrees at 73 knots at 38,700 feet, with the tropopause height at 29,172 feet. At 2,700 feet, the wind was identified from 265 degrees at 36 knots, with a temperature of –3 degrees C.

The sounding provided the following data:

Level	Height (ft-MSL)	Pres (hPa)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (FAA)	LLWS	Icing - Type (AF @ 75% RH)
1	705	981.0	0.4	0.0	97	250 / 20	SVR	LIGHT	Base:975 mb
2	2246	925.0	-2.3	-2.8	96	270 / 38	LGT		LGT Rime
3	2705	908.8				265 / 36	SVR		
4	3705	874.3				280 / 45	LGT		
5	4436	850.0	-5.9	-6.5	96	285 / 48			MDT Rime
6	4705	841.1				285 / 50			
7	5202	825.0	-7.3	-7.9	95				MDT Rime
8	5703	809.0	-7.1	-7.6	96		MDT		MDT Rime
9	6705	777.6				305 / 45	MDT		
10	7705	747.5				295 / 42			
11	8705	718.5				295 / 42			
12	9258	703.0	-13.1	-14.2	91		MDT		MDT Rime
13	9365	700.0	-13.1	-14.2	91	300 / 48			MDT Rime
14	9705	690.5				300 / 46			
15	10016	682.0	-13.7	-15.2	88				MDT Rime
16	10460	670.0	-13.1	-14.5	89				MDT Rime
17	12505	617.0	-17.3	-20.4	77		LGT		MDT Rime
18	12705	612.0				295 / 54	MDT		
19	14705	563.8				310 / 43			
20	14781	562.0	-22.1	-24.9	78		LGT		MDT Rime
21	15705	540.8				315 / 43			
22	15962	535.0	-25.3	-27.4	83				SVR Clear
23	16185	530.0	-25.9	-37.9	32				
24	16320	527.0	-26.1	-40.1	26		LGT		

Table – KBUF rawinsonde observation for 1900 EST

4.0 LAPS Sounding

The NWS Local Analysis and Prediction System (LAPS) sounding was obtained from the KBUF WSFO and documented the conditions at the approximate time of the accident over the grid point of the accident site. The LAPS combines numerous data sources into a set of analysis and forecast parameters on a 10-kilometer grid with high temporal resolution. The KBUF Weather Service Forecast Office (WSFO) provided a screen capture of the LAPS image for 2200 EST (0300Z) and is included as figure 6. The data is plotted on a standard

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.

skew-T log P chart, with the wind profile on the right side of the chart, and the stability parameters in a table below the charts. The image depicted saturated conditions to approximately 9,500 feet, with the freezing level at 1,097 feet msl.

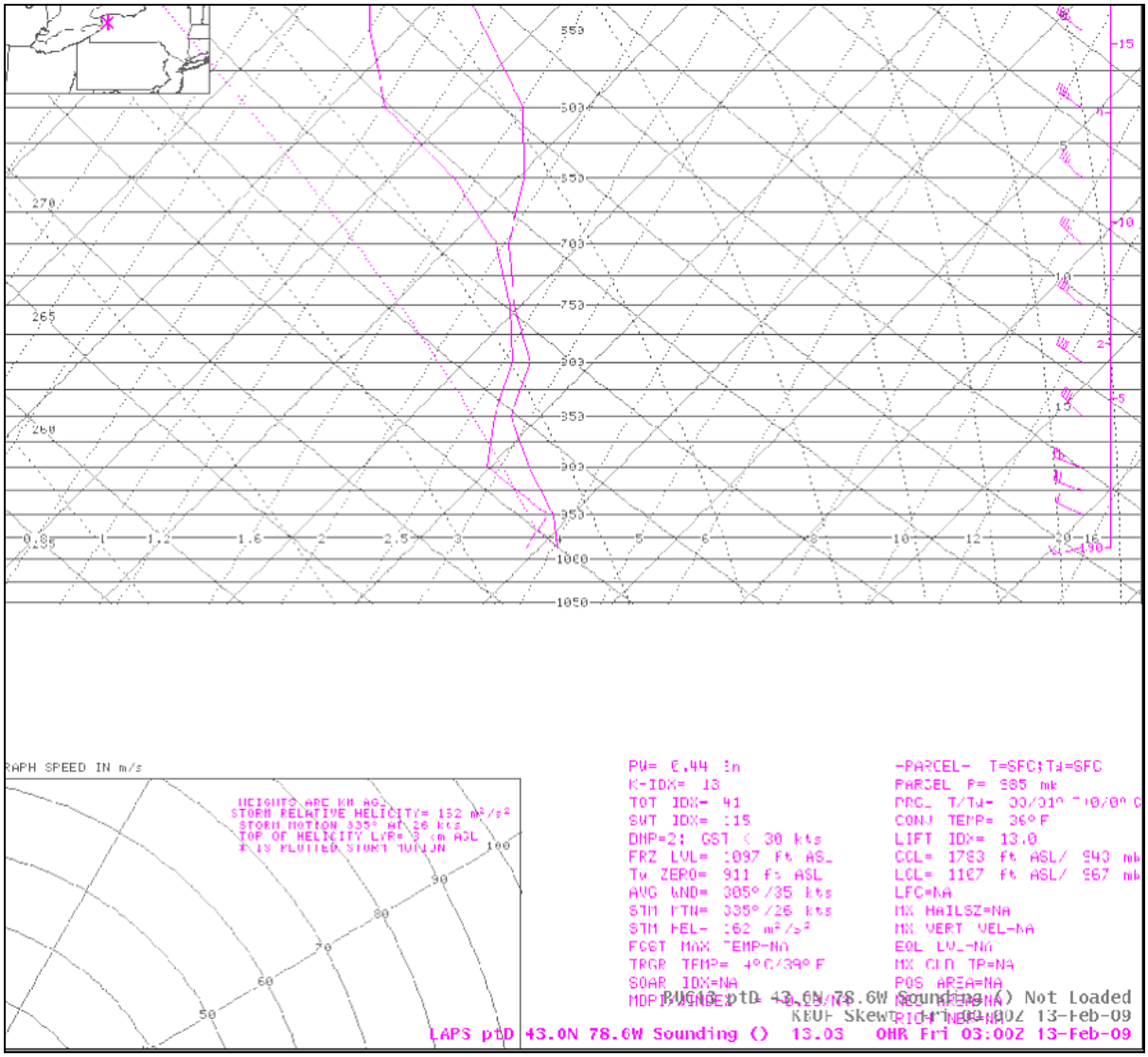


Figure 6 – LAPS sounding for 2200 EST

5.0 Satellite Data

The Geostationary Operations Environmental Satellite number 12 (GOES-12) data was reviewed at the KBUF WSFO, with note of the snow cover over the area generally south of the accident site. The GOES-12 image below was created on Safety Board's McIDAS software. 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 7 is the GOES-12 infrared band 4 image at 2215 EST (0315Z) at 6X magnification, with the accident site marked by a red square. The image depicts an extensive area of low to mid-level stratiform clouds over the accident site to eastern Pennsylvania. The radiative cloud top temperature over the accident site was 260.7 degrees Kelvin (K) or –12.4 degrees C, which according to the KBUF sounding indicated cloud tops near 8,000 feet.

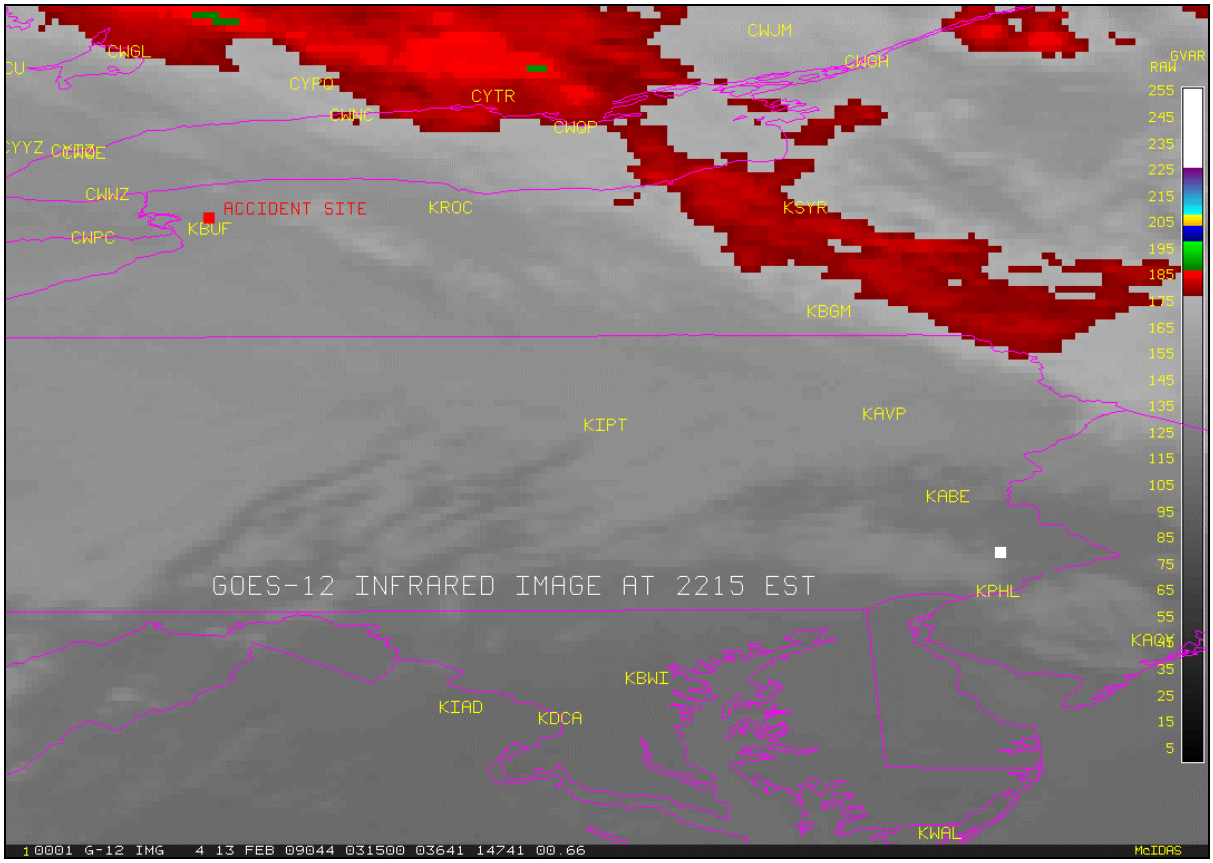


Figure 7 – GOES-12 infrared images at 2215 EST

Figure 8 is the GOES-12 infrared image at 2215 EST obtained from the National Center for Atmospheric Research (NCAR) web site with a different color enhancement curve applied with radiative cloud top temperatures in degrees C. The image depicts a band of clouds extending of the Buffalo area with radiative cloud top temperatures in the range of –15 to –20 degrees C. Cloud top temperatures colder than –20 degrees C tend to promote dendrite snow crystal formation and decrease the potential for significant airframe icing conditions.

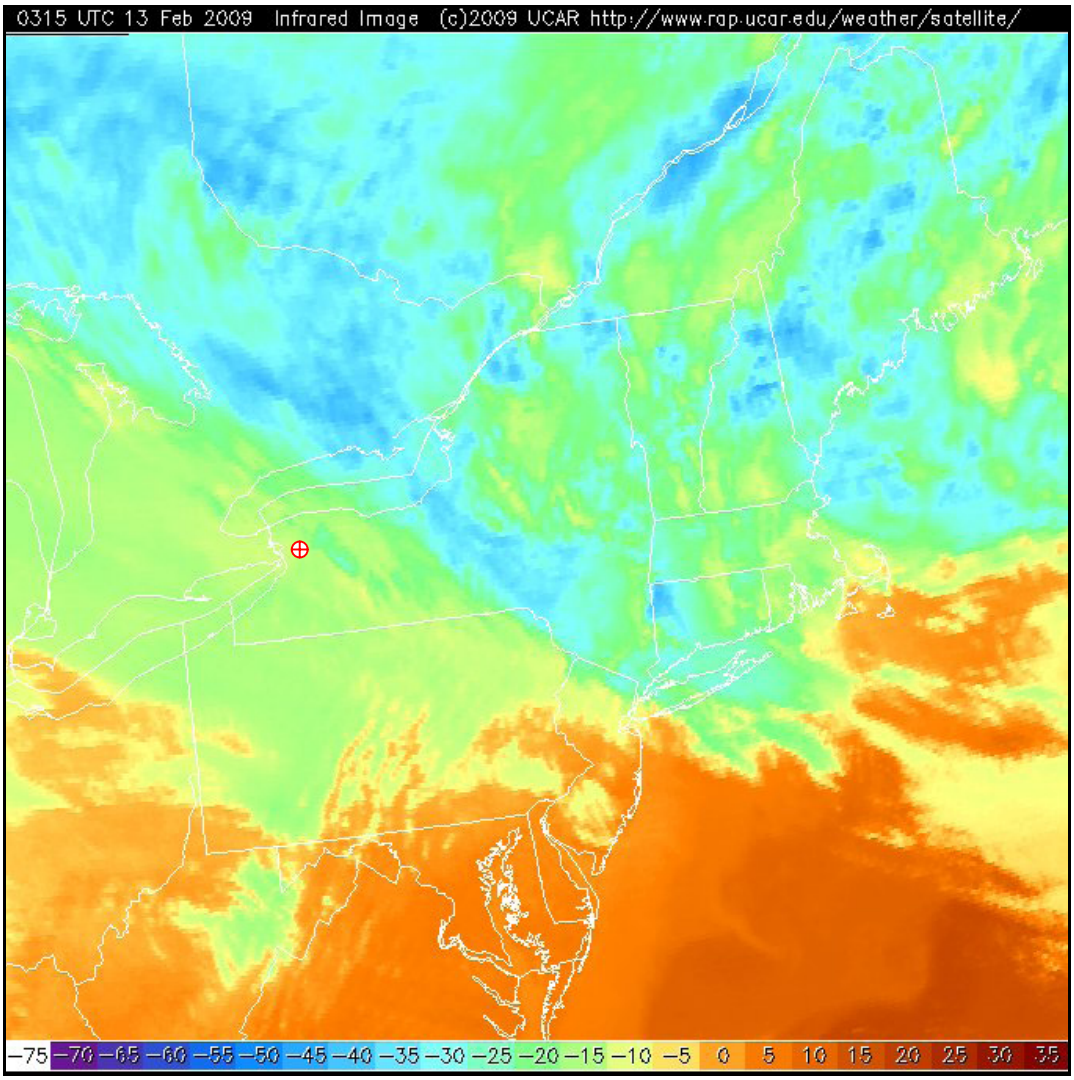


Figure 8 – GOES-12 infrared image at 2215 EST with cloud top temperatures

Figure 9 is the National Aeronautics and Space Administration (NASA) Moderate Resolution Imaging Spectroradiometer (MODIS) image from the Terra polar orbiting satellite image on February 9, 2009, showing the extent of the ice over Lake Erie and the regional snowfall on the surface prior to the accident. A red cross marks the approximate location of the accident site. The image depicts Lake Erie, the shallowest of the great lakes covered in ice, with western Lake Ontario ice free. The support for lake effect snow from westerly winds was therefore minimized from Lake Erie, but still possible with northerly winds from Lake Ontario.

Figure 9 – MODIS Ice coverage on February 9, 2009

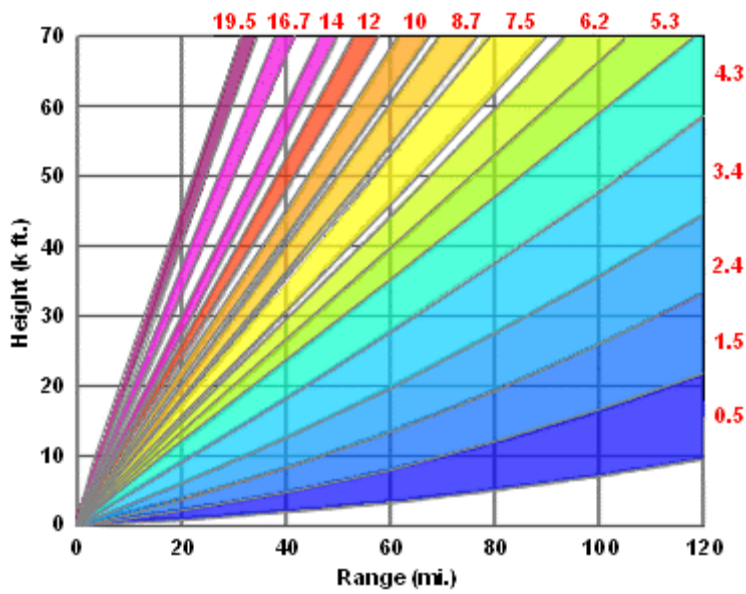
6.0 Weather Radar Information

The Buffalo NWS WSFO was also the site of the Weather Surveillance Radar-1988, Doppler (WSR-88D), located at approximately 6 miles south-southwest of the accident site. A review of the KBUF WSR-88D indicated several banding features oriented in a northwest to southeast direction, and moving southeast across the area during the evening of February 12, 2009. Radar images were reviewed surrounding the period from the KBUF WSFO, and are created in this report utilizing the level II archive radar data obtained from the National Climatic Data Center (NCDC) and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software.

6.0.1 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 Principal Users Processor (PUP). Products that require data from multiple elevation scans are not available until the end of the 6-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 6-minutes. This particular scanning strategy is documented as volume coverage pattern 21 (VCP-21). The quickest precipitation scan is VCP-11 where the radar makes the 14 elevation scans every 5-minutes. Mode B is the clear air mode, where the radar makes 5 elevation scans during a 10-minute period. During the period surrounding the accident the KBUF WSR-88D radar was operating in the normal precipitation mode (Mode A, VCP-11). 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-11 Precipitation Mode Scan Strategy

6.0.2 Beam Height Calculation

Assuming standard refraction[10] of the 0.95 degree radar beam from the KBUF WSR-88D, with an antenna height of 790 feet msl, the following table shows the approximate beam height and width information of the radar display over the site of the accident. The heights have been rounded to the nearest 10 feet.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP	BEAM WIDTH
0.5	1,130 feet	830 feet	1,430 Feet	600 feet
1.5	1,770 feet	1,470 feet	2,070 feet	600 feet
2.5	2,400 feet	2,100 feet	2,710 feet	600 feet
3.5	3,040 feet	2,740 feet	3,340 feet	600 feet

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

The 2.5 degree elevation scan covered the altitude between 2,100 and 2,710 feet and best represented conditions at the altitude of the flight upset.

6.0.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[11], 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[12]), and is a general measure of echo intensity. The chart below relates the NWS video integrator and processor (VIP) intensity levels versus the WSR-88D's display levels, precipitation mode reflectivity in decibels, and rainfall rates.

NWS VIP/DBZ CONVERSION TABLE

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

[11] 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, and blowing spray. (g) Liquid or solid deposits on exposed objects: dew, frost, rime, and glaze ice.

[12] dBZ - 10 log Ze

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

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

6.0.4 Base Reflectivity

Figure 10 is the KBUF WSR-88D base reflectivity image for the 0.5 degree elevation scan completed at 2219 EST (0319Z) with a resolution of 1° X 1 kilometers, with the accident airplanes flight track overlaid. The image depicts a broad area of light reflectivity over the accident site with values of 5 to 25 dBZ immediately along the flight path. An important note of the local area is that the small area of high reflectivity values south-southeast of the Buffalo and the accident site are false returns associated with Noble Wind Energy wind turbines.

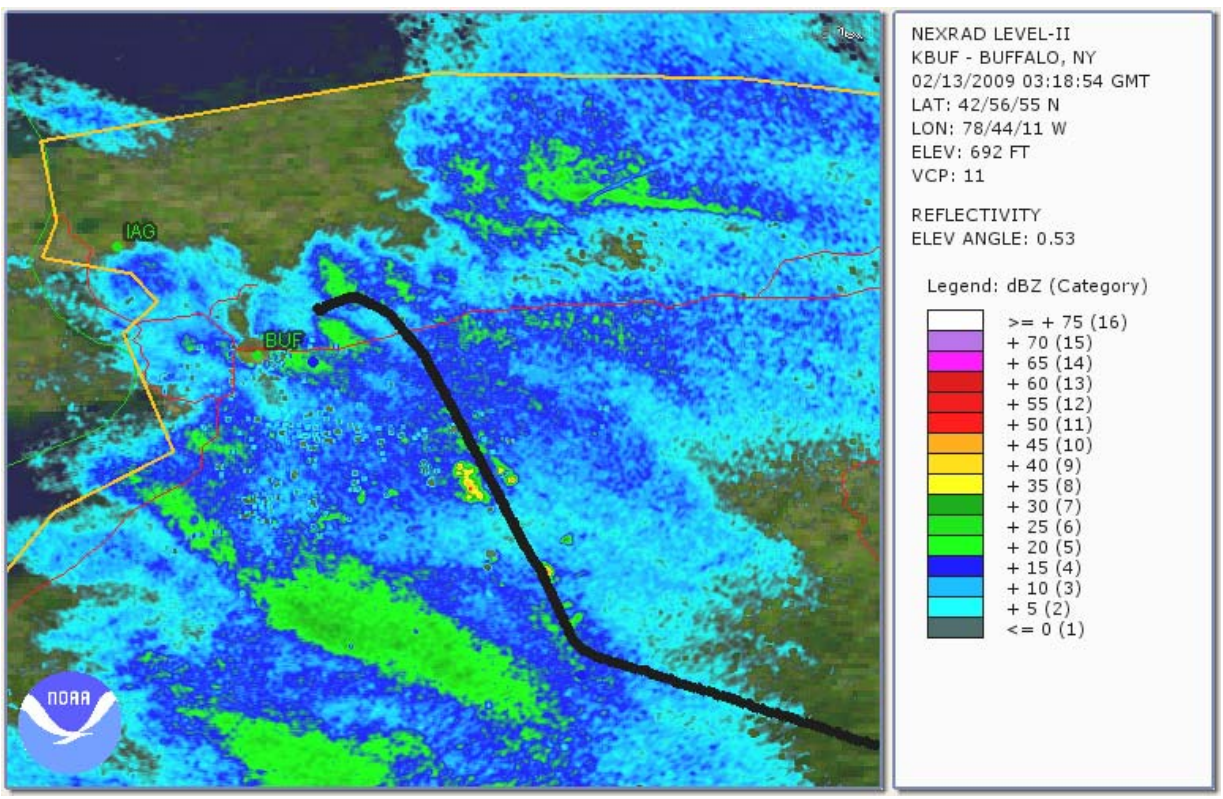


Figure 10 – KBUF WSR-88D 0.5 degree elevation scan for 2219 EST

Figures 11 and 12 are the 1.5 and 2.5 degree elevation scans for 2219 EST respectively. The accident site and track continue through echoes of 4 to 25 dBZ. The strongest echoes were encountered as the accident airplane turned southwestward inbound towards the airport.

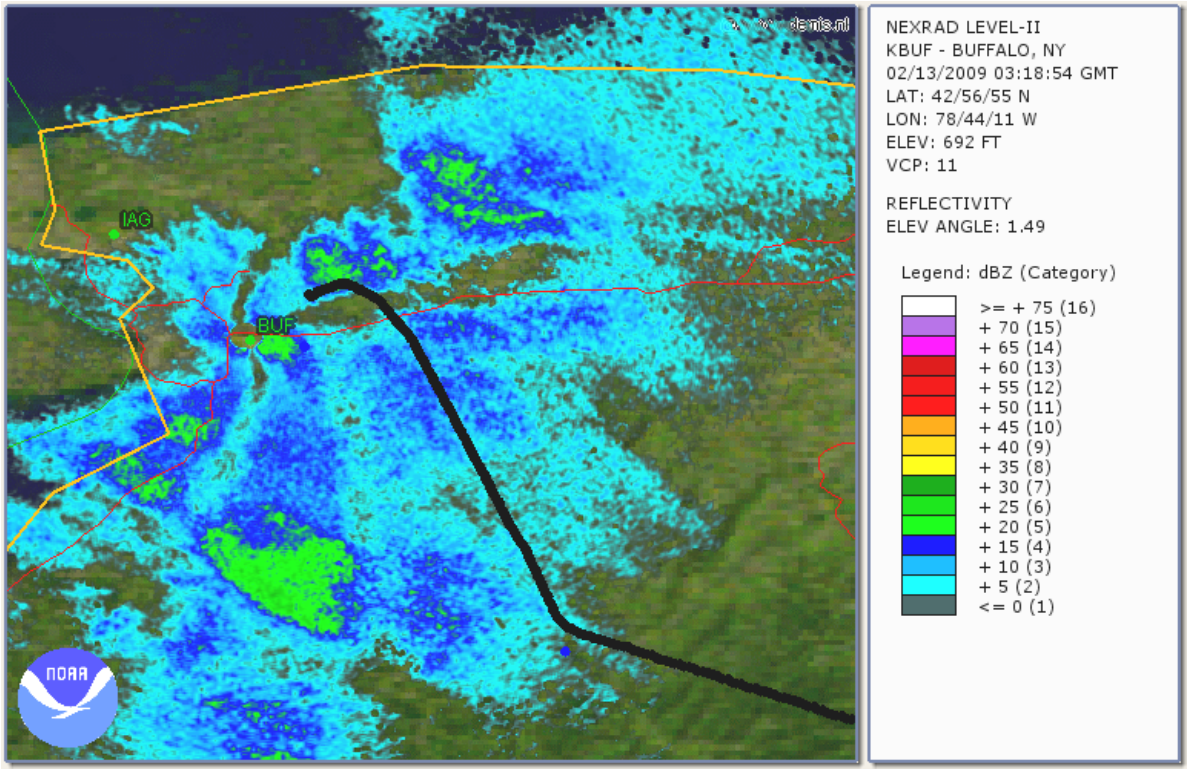


Figure 11 – KBUF WSR-88D at 1.5 degree elevation scan at 2219 EST

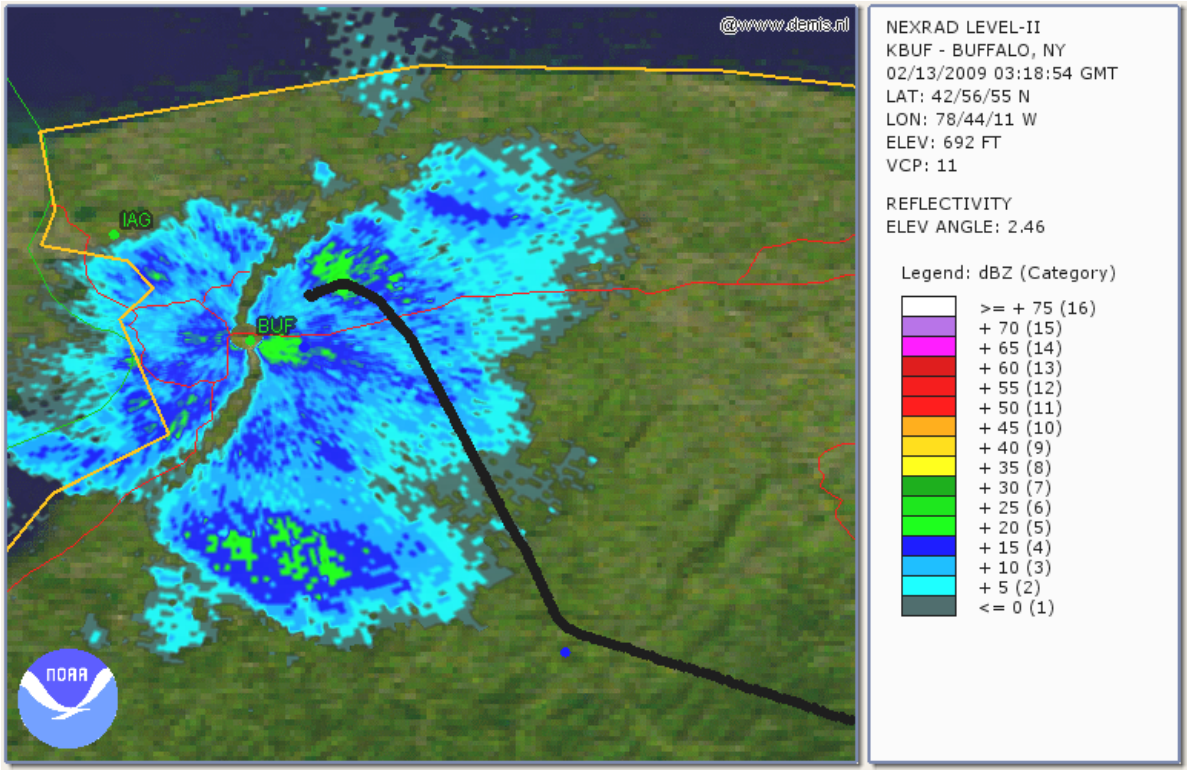


Figure 12 – KBUF WSR-88D at 2.5 degree elevation scan at 2219 EST

The KBUF WSR-88D radial velocity and spectrum width products indicated westerly winds near 50 knots across the region at 5,000 feet, with no significant change in wind speed in the vicinity of the accident site and therefore were not reproduced for the report.

7.0 NWS Weather Text Products

The NWS aviation weather text products were documented from the Safety Board's McIDAS system. These products are referenced in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC 00-45. These products are normally used for preflight briefing and flight dispatcher flight following, and flight crew preflight information, and were available to the air carrier.

7.0.1 Terminal Aerodrome Forecast (TAF)

The NWS WSFO issued the following Terminal Aerodrome Forecasts (TAFs) for KBUF surrounding the period:

TAF KBUF 122321Z 1300/1324 25014G24KT 5SM -SHSN BR OVC010
FM130600 30012G20KT P6SM BKN015 BKN060
FM130900 30012KT P6SM BKN025

FM131200 32010KT P6SM SCT025 BKN120
FM131800 32006KT P6SM SCT030=

TAF AMD KBUF 130020Z 1300/1324 24015KT 1 1/2SM -SHSN OVC015
FM130200 25014G24KT 5SM -SHSN BR OVC020
FM130600 30012G20KT P6SM BKN015 BKN060
FM130900 30012KT P6SM BKN025
FM131200 32010KT P6SM SCT025 BKN120
FM131800 32006KT P6SM SCT030=

The forecast valid at the time of the accident was the amended forecast issued at 1920 EST (0020Z). The forecast from 1900 EST expected winds from 240 degrees at 15 knots, visibility 1 1/2 miles in light snow showers, ceiling overcast at 1,500 feet agl. From 2100 through 0100 EST the forecast expected winds from 250 degrees at 14 knots gusting to 24 knots, visibility 5 miles in light snow showers and mist, ceiling overcast at 2,000 feet.

7.0.2 Pilot Reports

The following pilot reports (PIREPs) were recorded over New York and Pennsylvania surrounding the time of the accident. The reports are in standard format and code, provided in plain language. The reports are as follows:

Buffalo (BUF) routine pilot report (UA); Over – 7 miles south of BUF; Time – 1250 EST (1750Z); Flight level – unknown; Type aircraft – Embraer EMB-190 (E190) air carrier jet; Icing – light rime icing between 4,000 and 6,000 feet; Remarks – temperature unknown.

Buffalo (BUF) routine pilot report (UA); Over – 5 miles west of BUF; Time – 1329 EST (1829Z); Flight level – 4,500 feet; Type aircraft – Boeing B-737 (B737) air carrier jet; Temperature – minus 12 degrees C; Icing – light rime icing between 7,000 and 4,500 feet; Remarks – during descent.

Buffalo (BUF) routine pilot report (UA); Over – 10 miles southwest of BUF; Time – 1429 EST (1929Z); Flight level – unknown; Type aircraft – Falcon (GALX) business jet; Temperature – minus 16 degrees C; Icing – moderate rime icing between 10,000 and 12,000 feet.

Buffalo (BUF) routine pilot report (UA); Over – 10 miles southwest of BUF; Time – 1517 EST (2017Z); Flight level – 10,000 feet; Type aircraft – Boeing B-737 (B737) air carrier jet; Temperature – minus 7 degrees C; Icing – light-to-moderate rime icing between 3,000 and 13,000 feet.

Toronto (YZ) routine pilot report (UA); Over – BUF; Time – 1525 EST (2025Z); Flight level – during descent; Type aircraft – Embraer EMB-135 (E135) air carrier jet; Icing – moderate rime icing between 9,000 and 13,000 feet.

Buffalo (BUF) routine pilot report (UA); Over – route between BUF and 10 miles east of BUF; Time – 1614 EST (2114Z); Flight level – unknown; Type aircraft – Canadaire Regional Jet (CRJ1); Temperature – minus 7 degrees C; Icing – light-to-moderate rime icing between 9,000 and 14,000 feet.

Buffalo (BUF) routine pilot report (UA); Over – 10 miles southeast of BUF; Time – 1815 EST (2315Z); Flight level – 5,000 feet; Type aircraft – Airbus A-319 (A319) air carrier jet; Temperature – minus 7 degrees C; Icing – light-to-moderate rime icing.

Dunkirk (DKK) urgent pilot report (UUA); Over – DKK (approximately 45 miles southwest of accident site); Time – 1815 EST (2315Z); Flight level – 8,000 feet; Type aircraft – Cessna 421 Golden Eagle (C421) multiengine airplane; Icing – severe icing; Temperature – unknown.

Erie (ERI) routine pilot report (UA); over – 20 miles southeast of ERI; Time – 1924 EST (0024Z); Flight level – 6,000 feet; Type aircraft – Piper Navajo (PA31) multiengine airplane; Temperature – minus 4 degrees C; Icing – moderate rime icing.

Erie (ERI) routine pilot report (UA); over – 10 miles southeast of ERI; Time – 1945 EST (0045Z); Flight level – 8,000 feet; Type aircraft – Cessna Caravan (C208) turbine engine airplane; Sky cover – overcast bases 3,500 feet with tops at 8,000 feet; Temperature – minus 9 degrees C; Icing – moderate mixed icing.

Dunkirk (DKK) routine pilot report (UA); Over – 15 miles north of Jamestown (JHW); Time – 2017 EST (0117Z); Flight level – 19,500 feet; Type aircraft – Boeing B-737 (B737) air carrier jet; Turbulence – continuous light chop.

Toronto (YZ) urgent pilot report (UA); Over – Hamilton (CYHM), Ontario; Time – 2054 EST (0154Z); Flight level – 1,800 feet; Type aircraft – Israel Astra Westwind (ASTR) business jet; Remarks – 10 knot wind shear on final approach for runway 30.

Phillipsburg (PSB) routine pilot report (UA); Over – Tyrone (TON), Pennsylvania; Time – 2105 EST (0205Z); Flight level – 8,000 feet; Type aircraft – Cessna Caravan (C208) single engine turboprop; Temperature – minus 8 degrees C; icing – light mixed icing.

Toronto (YZ) routine pilot report (UA); Over – 20 miles northwest of London (CYXU), Ontario; Time –2128 EST (0228Z); Flight level – during climb; Type aircraft – Boeing B-737 air carrier jet; Icing – moderate rime type icing between 4,000 to 10,000 feet.

Toronto (YZ) routine pilot report (UA); Over – 35 miles east of Hamilton (CYHM); Time – 2234 EST (0334Z); Flight level – during descent; Type aircraft – Cessna Caravan (C208) single engine turboprop; Icing – light to moderate rime type icing between 3,000 to 6,000 feet; Remarks – temperature at 3,000 feet minus 4 degrees C, at 6,000 feet temperature minus 10 degrees C.

Figure 13 is a plot of the pilot reports between 2000 through 0800 EST from the NWS Aviation Weather Center's website.

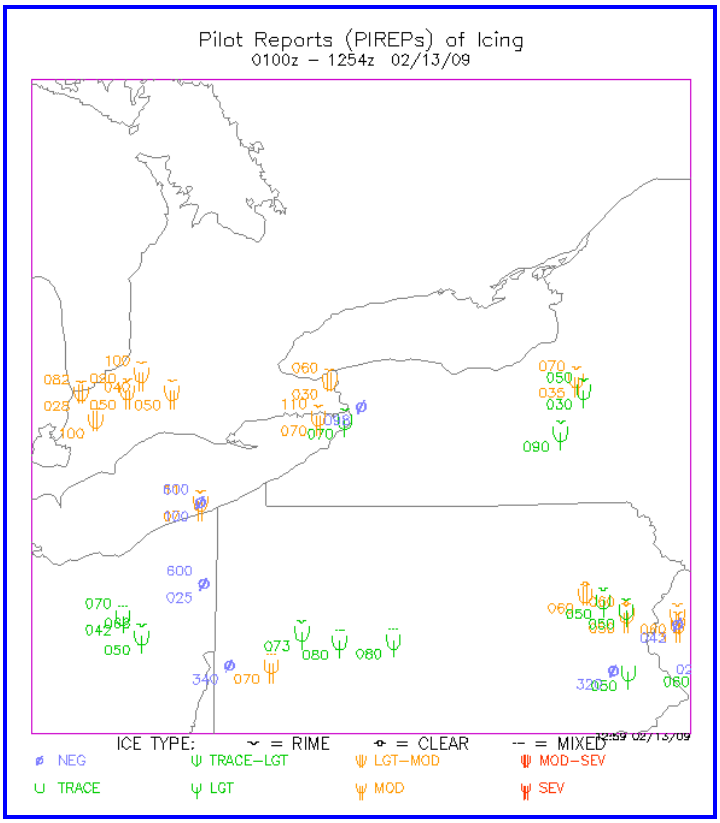


Figure 13 – Pilot Reports

7.0.3 Area Forecast

The Area Forecast (FA) is a forecast of Visual Flight Rules (VFR) clouds and weather conditions over an area as large as the size of several states. It must be used in conjunction with the AIRMET Sierra (IFR) bulletin for the same area in order to get a complete picture of the weather. The area forecast together with the AIRMET Sierra bulletin are used to determine forecast enroute weather and to interpolate conditions at airports which do not have a terminal forecast (TAF) issued. The NWS Aviation Weather Center (AWC) located in Kansas City, Missouri, issues the FA at regular intervals and issues specials reports as necessary usually in the form of an AIRMET. The region that covers New York is under the Boston (KBOS) regional forecast. The forecast valid for this accident was issued at 2045 EST on February 12, 2009 (0145Z on February 13, 2009) and was valid until 0900 EST February 13, 2009 (1400Z). The full text version of the FA was as follows:

FAUS41 KKCI 130145
FA1W
-BOSC FA 130145
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 132000

CLDS/WX VALID UNTIL 131400...OTLK VALID 131400-132000
ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DC DE VA AND CSTL WTRS
.
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...02Z LOW PRES E OF ME. CDFNT FM WRN NY EWD TO E CNTRL ME MOVING SWD. 06Z CDFNT FM WRN NY EWD TO SERN ME. 12Z CDFNT FM WRN NY EWD TO SERN MA AND INTO ATLANTIC. 20Z CDFNT FM NWRN PA SEWD TO ERN VA AND INTO ATLANTIC.
.
NY LO
WRN NY/LO...OVC030 TOP 160. VIS 3-5SM -SN BR. WND W 20G30KT. 03Z OVC025. VIS 3SM -SN BR. WND W 20G30KT. 06Z BKN030 BKN070 TOP 120. 12Z SCT040 BKN120 TOP 150. OTLK...VFR.
S CNTRL NY...OVC025 TOP 140. VIS 3-5SM -SHSN BR. WND NW 20G30KT. 06Z OVC035 TOP 130. OCNL -SHSN. WND NW 15G25KT. 12Z BKN040 TOP 070. OTLK...VFR.
N CNTRL NY...OVC020 LYRD FL280. VIS 3-5SM -SN BR. WND NW 15G30KT. 06Z SCT030 OVC120 TOP FL290. 12Z BKN120 TOP FL250. OTLK...VFR.
NERN NY...OVC030 LYRD FL280. VIS 3-5SM -SN BR. BECMG 0304 OVC040 TOP 070. VIS 3-5SM -SN BR. 06Z SCT035 BKN055 TOP 130. 12Z SCT045 SCT CI. OTLK...VFR.
SERN NY...BKN045 OVC130 TOP FL240. WND NW 25G35KT. 06Z SCT040 BKN CI. 12Z SCT050 SCT CI. OTLK...VFR.
LONG ISLAND...BKN050 TOP 160. WND W 25G35KT. 12Z SCT050. WND NW 20G30KT. OTLK...VFR.

The forecast for western New York and Lake Ontario expected overcast clouds at 3,000 feet with tops to 16,000 feet, visibility 3 to 5 miles in light snow and mist, winds westerly at 20 knots gusting to 30 knots. From 2200 to 0100 EST (0300Z to 0600Z) overcast clouds at 2,500 feet, visibility 3 miles in light snow and mist, winds westerly at 20 knots gusting to 30 knots.

7.0.4 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)[13]. 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 aircraft dispatcher to evaluate on the basis of experience and the operational limits of the aircraft.

Figure 14 is a plot of all the advisories current at 2200 EST with the accident site marked.

[13] Airman's Meteorological Information - AIRMET (WAs) 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.

The NWS Aviation Weather Center (AWC) had a full series of AIRMET current for the region for IFR, turbulence, and icing conditions. The bulletins were as follows:

WAUS41 KKCI 130245
-BOSS WA 130245
AIRMET SIERRA FOR IFR AND MTN OBSCN VALID UNTIL 130900
.
AIRMET IFR...ME NH VT MA NY LO PA LE AND CSTL WTRS
FROM 70NW PQI - 60NE PQI - 50SSW BGR - 40SSE ALB - 20WNW PSB – ERI – 30SE ECK – YYZ – YOW –YSC – 70NW PQI
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 09Z ENDG 09-12Z.
.
AIRMET MTN OBSCN...ME NH VT MA NY PA
FROM 70NW PQI - HUL – CON – HNK - EWC - JHW - SYR - MSS - YSC - 70NW PQI
MTNS OCNL OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 09Z ENDG 12-15Z.
....
WAUS41 KKCI 130245
-BOST WA 130245
AIRMET TANGO FOR TURB AND STG SFC WNDS VALID UNTIL 130900
.
...SEE SIGMET VICTOR SERIES...
.
AIRMET TURB...ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DC DE VA AND CSTL WTRS
FROM YOW - 40WSW YSJ - 200SE ACK - 190S ACK - DCA - FWA - 30SE ECK - YOW
MOD TURB BTN FL200 AND FL380. CONDS CONTG BYD 09Z THRU 15Z.
.
AIRMET TURB...ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DC DE VA AND CSTL WTRS
FROM 70NW PQI - 60NE PQI - 200SE ACK - 160SE SIE - 20NE ECG - HMV - HNN - CVG - FWA - 30SE ECK - YOW - YSC - 70NW PQI
MOD TURB BLW 080. CONDS CONTG BYD 09Z THRU 15Z.
.
AIRMET STG SFC WNDS...ME NH MA RI NY NJ MD DE VA AND CSTL WTRS
FROM 140S YSJ - 200SE ACK - 160SE SIE - 60SSE SIE - 20SSE JFK - ACK - 140S YSJ -
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS CONTG BYD 09Z THRU 15Z.
....
WAUS41 KKCI 130245
-BOSZ WA 130245
AIRMET ZULU FOR ICE AND FRZLVL VALID UNTIL 130900
.
AIRMET ICE...ME NH VT MA RI CT NY LO NJ PA AND CSTL WTRS
FROM 70NW PQI - 60NE PQI - 200SE ACK - 20S JFK - 30N SAX – BUF - YYZ - 40SW MSS – YSC - 70NW PQI
MOD ICE BLW FL180. CONDS CONTG BYD 09Z ENDG 12-15Z.
.
AIRMET ICE...MA CT NY LO NJ PA OH LE WV MD DE VA AND CSTL WTRS
FROM YYZ - BUF - 30N SAX - 20S JFK - CYN - 50NW CSN - 20S EKN – HNN - FWA - 30SE ECK - YYZ
MOD ICE BTN 030 AND 080. CONDS CONTG BYD 09Z THRU 15Z.
.
OTLK VALID 0900-1500Z
AREA 1...ICE NY LO NJ PA OH LE WV MD VA
BOUNDED BY YYZ-30W ALB-SAX-EMI-20S EKN-FWA-30SE ECK-YYZ
MOD ICE BTN 030 AND 080. CONDS CONTG THRU 15Z.
.
AREA 2...ICE ME NH MA RI CT NY NJ AND CSTL WTRS

BOUNDED BY 40SE HUL-200SE ACK-70SSE HTO-JFK-40SE HUL
MOD ICE BLW 160. CONDS ENDG 12-15Z.
.
FRZLVL...RANGING FROM SFC-100 ACRS AREA
MULT FRZLVL 040-100 BOUNDED BY 50N LYH-20NE ECG-180E ECG-190ESE ECG-60ENE ILM-GSO-20WSW PSK-50N LYH
SFC ALG 20E CVG-40W EKN-20NNW HAR-30SSW BOS-110SE BGR
040 ALG 50WSW BKW-20E LYH-30ESE ORF-30ENE ECG

AIRMET Sierra for IFR conditions extended over the accident site for ceilings less than 1,000 feet agl and/or visibility below 3 miles in precipitation and mist. AIRMET Tango for occasional moderate turbulence below 8,000 feet, and AIRMET Zulu for occasional moderate icing below 18,000 feet.

The following SIGMETs were issued surrounding the period, with SIGMET Victor 7 being issued at 2130 EST (0230Z) updating and replacing Victor 6, which was issued at 1830 EST (2230Z):

WSUS01 KKCI 122230
SIGMET VICTOR 6 VALID UNTIL 130230
NY PA MA CT NHVT RI NJ WV VA MD DC DE NC AND CSTL WTRS
FROM CON TO 100NE ACK TO 50E ECG TO GSO TO PSK TO BUF TO CON
OCNL SEV TURB BLW 080 DUE TO STG WLY LOW LVL WNDS. COND CONTG BYD 0230Z.

WSUS01 KKCI 130230
-BOSV WS 130230
SIGMET VICTOR 7 VALID UNTIL 130630
NY PA MA CT NH VT RI NJ WV VA MD DC DE NC AND CSTL WTRS
FROM 110SSE BGR TO ACK TO 20NE ECG TO CLT TO BUF TO 110SSE BGR
OCNL SEV TURB BLW 080 DUE TO STG WLY LOW LVL WNDS. CONDS CONTG
BYD 0630Z.

SIGMET Victor extended over the route of flight and the Buffalo area for occasional severe turbulence below 8,000 feet due to strong westerly low-level winds. The conditions were expected to continue beyond the estimated time of arrival.

No Convective SIGMETs were current for the eastern United States for thunderstorm activity.

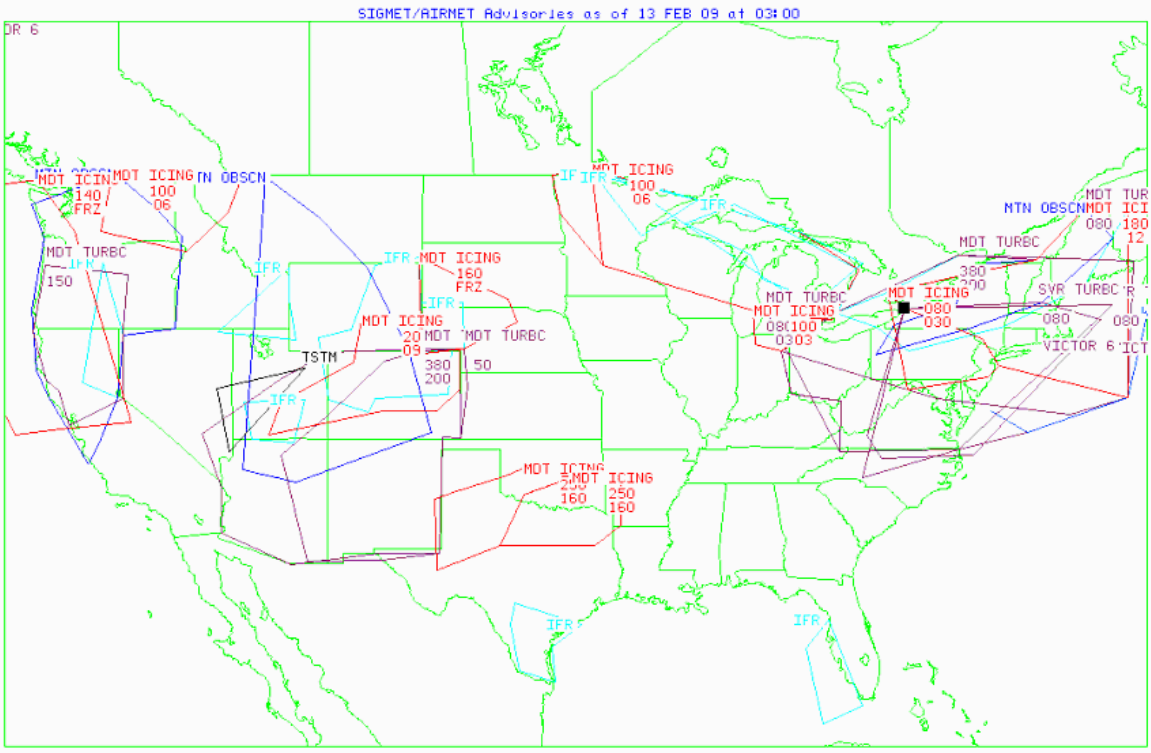


Figure 14 – In-flight Weather Advisories current at 2200 EST

7.0.5 Center Weather Service Unit Products

The Buffalo area is under the Cleveland (ZOB) Air Route Traffic Control Center (ARTCC), and the majority of the route was through the New York Center's airspace (ZNY). The ZOB and ZNY Center Weather Service Units (CWSU) are staffed for 16-hours of operation and operate between 0600 and 2200 local, both offices were closed at the time of the accident. The following Meteorological Impact Statements (MIS) and Center Weather Advisory (CWA) were issued prior to their closures:

<u>Cleveland (ZOB)</u>

FAUS20 KZOB 121833
ZOB MIS 02 VALID 121835-130500
...FOR ATC PLANNING PURPOSES ONLY...
INTENSE LOW CENTERED OVER NRN NY AND MOV NE. JET CORE OVER OH VALLEY. W WIND 80-120KT AT FL260-320.
HAZARD WITHIN ZOB AIRSPACE THRU 12 HRS...
TS IMPLY SEV...SEV ICING...LLWS AND IFR COND.
1. TS...NONE.
2. ICING...PATCHY LGT-MOD RIME 030-070 NRN 1/2.
3. TURB...OCNL LGT-MOD ISOL SEV BLW 080 ERN 1/2 TIL 00Z. ISOL MOD FL270-370.
4. STG LOW LEVEL WINDS...LLWS POTENTIAL AND SIGNIFICANT HUB AIRPORT

CROSSWINDS...SFC WIND W 20G35KT
5. IFR COND...AREAS WRN NY IN SHSN
ZOB AIRSPACE OUTLOOK 12 TO 24 HRS OUT...NO SGFNT HAZARDS.

The Cleveland MIS issued at 1333 EST indicated an intense low pressure system centered over northern New York was moving northeast, with a jet stream core over the Ohio Valley with westerly winds at 80 to 120 knot at 26,000 through 32,000 feet. The hazards affecting the airspace included patchy light-to-moderate rime icing between 3,000 and 7,000 feet over the northern half of the area. Occasional light-to-moderate, to isolated severe turbulence below 8,000 feet over the eastern half of the area till 1900 EST, with isolated moderate turbulence between 27,000 and 37,000 feet. The advisory was warned of strong low-level winds and low-level wind shear (LLWS) and cross winds with westerly surface winds of 20 knots gusting to 35 knots.

New York (ZNY)

ZNY1 CWA 121620 COR
ZNY CWA 103 VALID UNTIL 121820
FM 35SW SYR - HNK - 10N JFK - JFK - 35SW CYN - EMI - 55S PSB – PSB - 35SW SYR
LLWS CONDS XPCT TO CONT ACROSS ZNY. FCST WINDS 55-60KT 020-030.
SEE VICTOR SIGMETS FOR OCNL SEV TURB BLW 080

New York Center Weather Advisory (CWA) number 103 issued at 1120 EST and current until 1320 EDT was issued for southeast New York and New Jersey for low-level wind shear conditions associated with winds of 55 to 60 knots at 2,000 to 3,000 feet.

FAUS20 KZNY 122147
ZNY MIS 03 VALID 122150-130600
...FOR ATC PLANNING PURPOSES ONLY...
HI PRESS LOCATED OVER THE NORTHEAST WILL MOV EWD THRU THE PERIOD AS
TWO LO PRESS SYSTEMS DVLP AND MOV INTO THE AREA. ON LO WILL DVLP IN
TN/KY AND MOV INTO THE NRN OH VALLEY REGION THRU LATE TODAY AND
TONIGHT. THE SECOND LO WILL DVLP OFF THE COAST OF VA AND BEG TO MOV
NEWD OVERNIGHT.
.
ICING/TURB- MOD ICING IS EXPECTED IN ALL DOMESTIC ZNY FM FZLVL TO
FL180...ICING WILL LAST BYD THE END OF THE PERIOD. OCNL MOD TURB IS
POSS BETWEEN FL280 AND FL370...TURB IS MORE LIKELY IN SRN ZNY.
.
TRACON AREA FORECAST- SNOW SHOWERS WILL CONT THRU THE AREA WITH CONDS
CONT IFR WITH CIGS OVC 008-012 WITH VIS 2-4SM...VIS MAY BEC AS LO AS
3/4SM IN HEAVIER SNOW SHOWERS...BETWEEN 00-04Z SNOW WILL BEGIN TO
CHANGE OVER TO RAIN WITH SLEET/FREEZIN RAIN POSS AS WELL...AFT
03-05Z ALL PRECIP IN THE AREA WILL FALL AS RAIN. WINDS WILL BE
LGT/VRB BEC 090-110 10-12KT BY 20Z.
.
ZNY OCEANIC AIRSPACE- NO SIG WX.
.
THUNDERSTORMS- NIL.
.
OUTLOOK 06-18Z...SHRA AND BR WITH IFR CONDS AND POSS ISOL LIFR. RAIN
MAY BE HEAVY AT TIMES AND WILL LAST THRU THE PERIOD.

.
ZDC WILL PROVIDE SERVICE BACKUP FOR ZNY AFT 122300Z. NO UPDATES AVAILABLE AFTER 130200Z.
.
KS

FAUS20 KZNY 130219
ZNY MIS 03 VALID 130200-131400
...FOR ATC PLANNING PURPOSES ONLY...
STRONG LOW PRESSURE OVER NOVA SCOTIA WILL CONT TO MOVE NE THRU THE OVERNIGHT. STRONG GUSTY WINDS WILL CONT OVERNIGHT FROM THE WEST WITH SPEEDS 25 GUSTING BTN 30 AND 40KT.
.
ICE...THRUT ZNY...MOD ICE BTN 030 AND 080.
.
TURB...SEE DOMESTIC SIGMET VICTOR SERIES FOR UPDATES ON SEV TURB BLW 080 THRUT ZNY. MOD TURB BLW 100. FREQUENT LLWS. MOD TURB BTN FL220 AND FL370. THE JET STREAM FLOWS FM W TO E OVR NRN ZDC WITH SPEEDS BTN 120 AND 130KT.
.
TRACON AREA FORECAST FOR THE NY METRO AIRPORTS OF JFK...LGA AND EWR AND PHL AIRPORT...VFR. SCT-BKN050. WNDS W 25GUSTS 30-40KT. 0400Z...WNDS W 20-25G30-35KT. 1000Z...SCT-BKN040-050. W-WNW 15-20G25-30KT.
.
OCEANIC SIGMETS...NO OCEANIC SIGMETS WERE IN EFFECT AT TIME OF THIS ISSUANCE. HOWEVER...THE CONVECTIVE SIGMET AREA WILL ALSO HAVE HI LVL TURB IN THE VCNTY OF THE JTST BTN FL220 AND FL370 AND MOD TURB BLW 100.
.
OUTLOOK 131400Z TO 140200Z...VFR. WNDS WNW TO NW 15-20 GUSTS NEAR 30KT. WNDS DIMINISH 140000Z...NW 12-16KT.
.
LAST...FM

The New York MIS bulletins indicated that strong gusting westerly winds were expected across the region. The advisory indicated that SIGMET Victor was current for severe turbulence below 8,000 feet, moderate turbulence below 10,000 feet, and between 22,000 to 37,000 feet, and occasional moderate icing between 3,000 and 8,000 feet.

8.0 TAMDAR Data

Two TAMDAR (Tropospheric Aircraft Meteorological Data Reports) equipped aircraft where operating in the Buffalo area surrounding the period and provided sounding profiles. TAMDAR data is automatically transmitted from the participating aircraft via the Aeronautical Radio Incorporated (ARINC) Aircraft Communications Addressing and Reporting System (ACARS) to the NWS. TAMDAR measures humidity, pressure, temperature, winds, icing and turbulence with the help of location, time and altitude provided by built-in Global Positioning System (GPS) technology. Figure 15 is an example of a

TAMDAR sensor that is installed into regional air carrier aircraft. The TAMDAR ice detector utilizes an optical beam to sense ice accumulation on the probe, once 0.02 inches of ice builds on the sensor a heater is activated to melts the ice. While no direct numerical accretion rate is directly measured, the system confirms icing layers and can provide an estimate of accretion rate by looking at the frequency of the heating cycle.

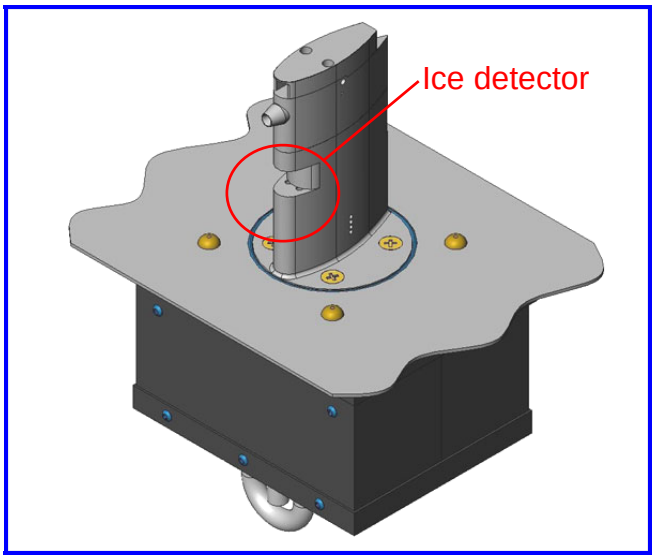


Figure 15 - TAMDAR Sensor

Figure 16 is the flight track of two Embraer ERJ-145 TAMDAR equipped aircraft identified as #9392 departing KBUF at 2139 EST (0239Z) to Washington Dulles International Airport (KIAD), and #9374 arriving at 2326 EST (0426Z) from KIAD. The segments in red indicate when the TAMDAR sensor detected icing and the heater activation. The other blue track is another TAMDAR aircraft that is over flying the Buffalo area above 16,000 feet, which is not reporting icing.

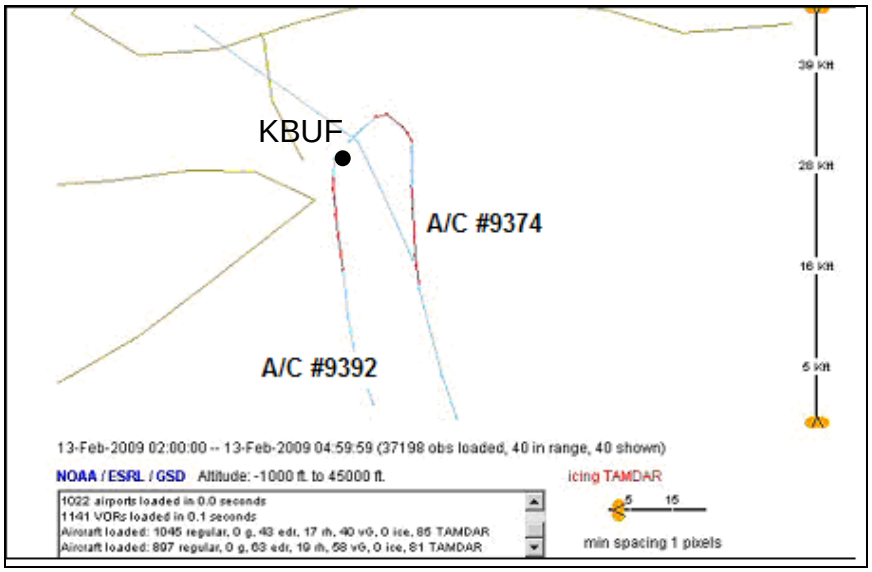


Figure 16 – TAMDAR aircraft plan view

Figure 17 shows the raw data obtained from aircraft #9392 during its ascent from KBUF. Shortly after departure at 2139 EST (0239Z), the aircraft encountered icing above 5,040 feet with an accretion rate greater than 0.02 inches at 6,000 feet and the heater remaining activated through 11,940 feet. The winds at the top of the icing layer at 11,940 feet, was from 309 degrees at 40 knots.

AC#9392 info

```
S (source): 0=ACARS, 1=MDCRS, 2=ACARS&MDCRS, 3=AMDAR, 4=TAMDAR, 5=Canadian
F (quality):    0 = good data, 1 = bad temp., 2 = bad wind, 3 = both bad
  (baro press): 4 = good data, 5 = bad temp., 6 = bad wind, 7 = both bad

AC#9392 BUF->IAD starting at 13-Feb-2009 02:37:51 with 28 obs
       ascent sounding starting at 13-Feb-2009 02:37:51
       descent sounding ending at 13-Feb-2009 03:27:55
S F HHMM     lat/lon          Alt   wd/ws      t   / td          edr    ice
4 0 0237 42.9120/-78.7580   2530 268°/037   -2.4/-4.40±0.5 ----/---- 0
4 2 0238 42.8970/-78.7710   3410 ---°/---   -3.9/-5.80±0.5 0.05/0.05 0
4 2 0239 42.8440/-78.7780   5050 ---°/---   -7.4/-8.10±0.4 0.05/0.15 0
4 0 0239 42.8090/-78.7750   6000 304°/038   -8.5/-8.90±0.4 ----/---- 4
4 3 0239 42.7820/-78.7720   6760 ---°/---   ----/-----±INF ----/---- 4
4 3 0240 42.7340/-78.7670   8430 ---°/---   ----/-----±INF ----/---- 4
4 3 0241 42.6740/-78.7570  10200 ---°/---   ----/-----±INF ----/---- 4
4 1 0242 42.5710/-78.7390  11940 309°/040   ----/-----±INF 0.15/0.25 4
4 0 0243 42.4390/-78.7170  14010 312°/044  -18.3/-24.4±0.9 0.15/0.15 0
4 2 0245 42.3160/-78.6900  16140 ---°/---  -22.8/-29.5±1.2 0.05/0.15 0
4 0 0246 42.1830/-78.6200  18540 305°/045  -27.8/-38.5±1.7 0.05/0.15 0
4 0 0249 41.8710/-78.4600  21000 305°/054  -31.3/-47.0±4.9 0.05/0.15 0
4 0 0256 41.0340/-78.0450  20960 305°/072  -30.8/-44.5±3.5 0.05/0.05 0
4 2 0257 40.8690/-77.9400  21000 ---°/---  -30.0/-45.6±3.3 0.05/0.05 0
4 0 0302 40.4340/-77.6150  18370 305°/067  -24.8/-38.2±3.3 0.05/0.05 0
4 0 0304 40.1490/-77.4670  15980 301°/065  -20.0/-36.2±3.7 0.05/0.05 0
4 0 0306 39.9690/-77.3740  13750 305°/066  -16.0/-33.5±3.6 0.05/0.05 0
4 2 0308 39.7570/-77.2660  12040 ---°/---  -12.9/-30.8±2.1 0.15/0.25 0
4 0 0310 39.6040/-77.3330  10100 305°/048   -8.9/-26.9±2.0 0.15/0.25 0
4 0 0311 39.5040/-77.3510   8270 304°/055   -7.4/-24.4±1.9 0.15/0.25 0
4 0 0313 39.3810/-77.3610   6560 291°/049   -9.5/-12.2±0.5 0.15/0.25 0
4 0 0314 39.2680/-77.3590   4950 297°/044   -4.4/-8.50±0.5 0.15/0.25 0
4 0 0317 39.0450/-77.3560   4100 298°/050   -1.9/-9.40±0.7 0.15/0.25 0
4 0 0320 38.8600/-77.3560   3900 298°/058   -1.4/-8.70±0.7 0.15/0.25 0
4 2 0321 38.8170/-77.3560   3180 ---°/---    1.0/-7.50±0.7 0.15/0.25 0
4 0 0324 38.8170/-77.4490   2790 299°/051    2.0/-8.40±0.8 0.25/0.35 0
4 2 0326 38.8740/-77.4590   1710 ---°/---    4.7/-7.00±0.6 0.15/0.95 0
4 0 0327 38.9420/-77.4570    330 293°/012    8.7/-5.10±0.7 0.25/0.65 0
```

Figure 17 – Aircraft #9392 Ascent Sounding from KBUF

Figure 18 is the Skew-T log-P soundings plot from aircraft #9332 depicting temperature, dew point temperature, and wind profile into KBUF. The diagram shows a relative humidity in excess of 85% from the surface through 6,000 feet indicating a saturated atmosphere.

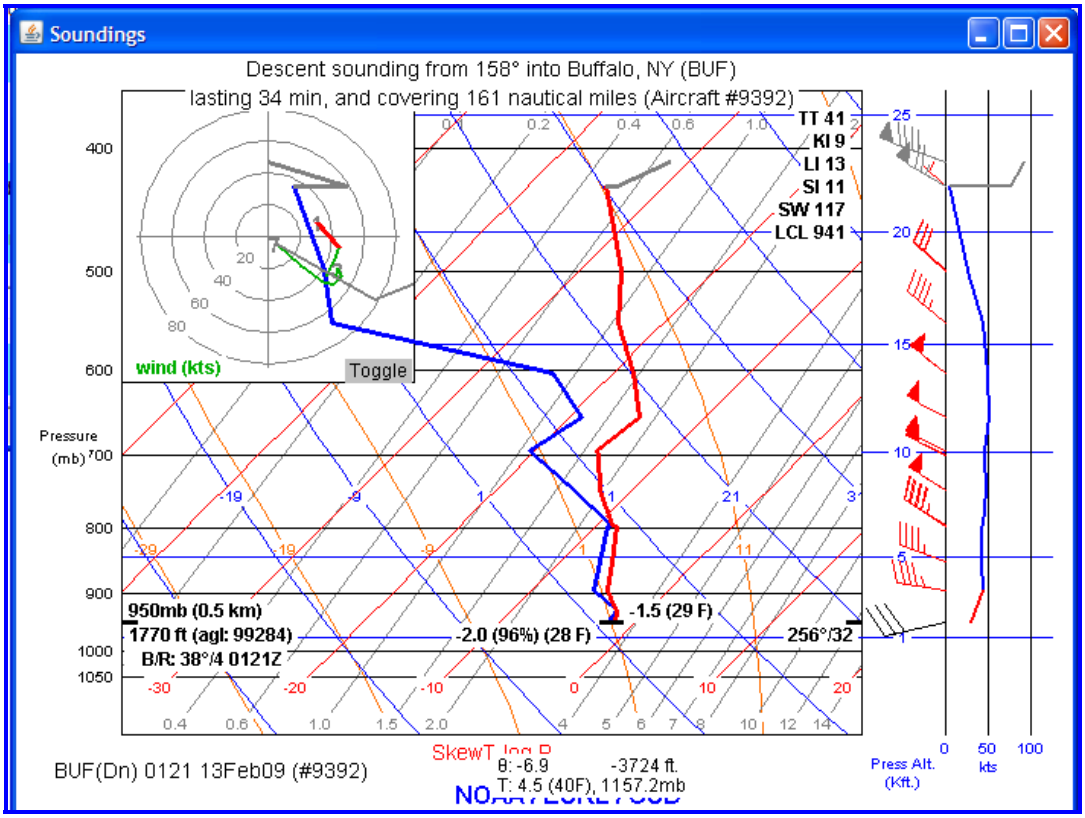


Figure 18 – Aircraft #9392 Ascent Sounding from KBUF

Figure 19 shows the raw data obtained from aircraft #9374 during its flight from KIAD to KBUF with an arrival time of approximately 2325 EST (0425Z). At 2313 EST (0413Z) descending through 10,000 feet, the aircraft encountered icing conditions continuing with the heater activated indicating a rate of 0.02 inches through 4,600 feet. The rate decreasing below 0.02 inches and then increasing again between 3,120 feet to 2,000 feet. The rate of icing remains below 0.02 inches to the surface with below freezing temperatures. The AirDat, LLC, program manager indicated this profile was indicative of a typical moderate icing event.

AC#9374 info

```
S (source): 0=ACARS, 1=MDCRS, 2=ACARS&MDCRS, 3=AMDAR, 4=TAMDAR, 5=Canadian
F (quality):    0 = good data, 1 = bad temp., 2 = bad wind, 3 = both bad
  (baro press): 4 = good data, 5 = bad temp., 6 = bad wind, 7 = both bad

AC#9374 IAD->BUF starting at 13-Feb-2009 03:33:12 with 46 obs
       ascent sounding starting at 13-Feb-2009 03:33:12
       descent sounding ending at 13-Feb-2009 04:25:53
S F HHMM     lat/lon          Alt   wd/ws     t   / td         edr    ice
4 0 0408 42.1420/-78.3030  13580 308°/046  -17.5/-24.6±1.4 0.05/0.05 0
4 0 0410 42.2670/-78.3600  11550 302°/039  -14.9/-18.9±1.0 0.05/0.05 0
4 0 0413 42.5220/-78.4470  10240 305°/038  -15.0/-20.0±0.7 0.05/0.25 0
4 0 0413 42.5340/-78.4490  10010 306°/037  -14.5/-19.5±0.7 0.15/0.25 0
4 0 0413 42.5870/-78.4560   8830 304°/037  -13.4/-14.8±0.5 ----/---- 4
4 3 0414 42.6190/-78.4590   8200 ---°/---   ----/-----±INF ----/---- 4
4 3 0416 42.7540/-78.4720   6200 ---°/---   ----/-----±INF ----/---- 4
4 1 0417 42.8190/-78.4740   4590 289°/042   ----/-----±INF 0.15/0.15 4
4 0 0418 42.8620/-78.4760   4070 283°/040   -5.4/-7.80±0.5 0.15/0.15 0
4 0 0419 42.9170/-78.4760   3810 288°/040   -5.4/-6.20±0.4 0.15/0.15 0
4 0 0419 42.9300/-78.4760   3480 288°/038   -4.9/-5.00±0.4 0.15/0.15 0
4 0 0420 42.9480/-78.4760   3180 284°/038   -4.0/-4.00±0.4 0.15/0.15 0
4 0 0420 42.9530/-78.4760   3120 285°/037   -4.0/-4.00±0.4 ----/---- 4
4 3 0420 42.9750/-78.4890   2820 ---°/---   ----/-----±INF ----/---- 4
4 3 0421 42.9900/-78.5110   2490 ---°/---   ----/-----±INF ----/---- 4
4 3 0422 43.0300/-78.5710   2360 ---°/---   ----/-----±INF 0.05/0.05 4
4 3 0423 43.0220/-78.6140   2360 ---°/---   ----/-----±INF 0.15/0.25 4
4 2 0424 42.9840/-78.6710   2000 ---°/---   -1.5/-2.40±0.3 0.15/0.25 0
4 2 0424 42.9740/-78.6840   1710 ---°/---   -1.9/-2.50±0.3 0.15/0.25 0
4 0 0425 42.9640/-78.6970   1410 265°/024   -1.0/-1.20±0.3 0.15/0.25 0
4 0 0425 42.9510/-78.7150   1050 254°/018   -0.4/-0.40±0.3 0.15/0.25 0
```

Figure 19 – Aircraft #9374 Descent Sounding Raw Data into KBUF

Figure 20 is a Skew T-log P sounding of aircraft #9374's descent into KBUF.

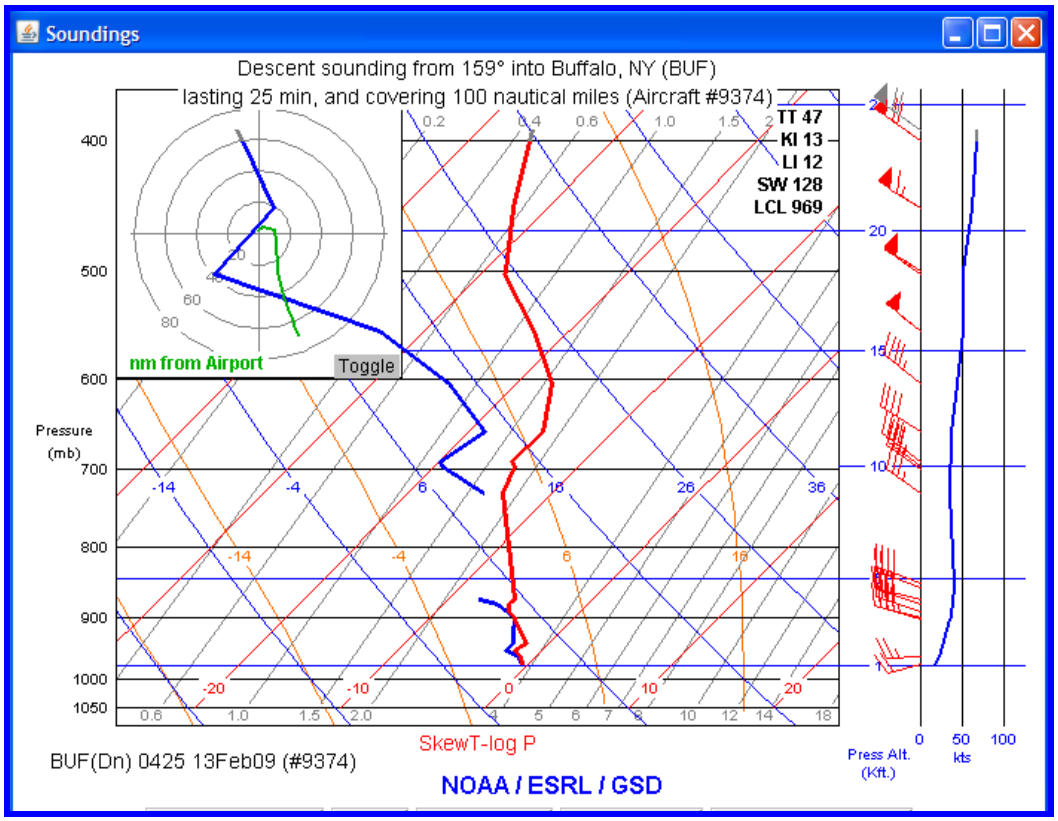


Figure 20 – Aircraft #9374 Descent Sounding Skew-T log-P into KBUF

9.0 Current Icing Product (CIP)

The Current Icing Product (CIP) is a supplementary weather product that provides a graphical view of the current icing environment. Input from weather sensors is provided to software models to produce this automatically generated graphical weather product. The CIP is updated hourly, and provides current information via icing severity graphics and icing probability graphics. CIP products are not forecasts, but presentations of current conditions at the time of the analysis.

Figure 21 shows the CIP valid at 2200 EST (0300Z) for 3,000 feet msl. The chart indicates a greater than 80 percent chance of encountering icing at 3000 feet over much of western New York State. Figure 22 shows the CIP for the same period at 5,000 feet msl. This chart indicates a 70 to 80 percent chance of encountering icing at 5000 feet over the Buffalo area. Figure 23 shows the CIP for 7,000 feet msl. This chart indicates a 60 to 80 percent chance of encountering icing at 7,000 feet msl over the Buffalo area.

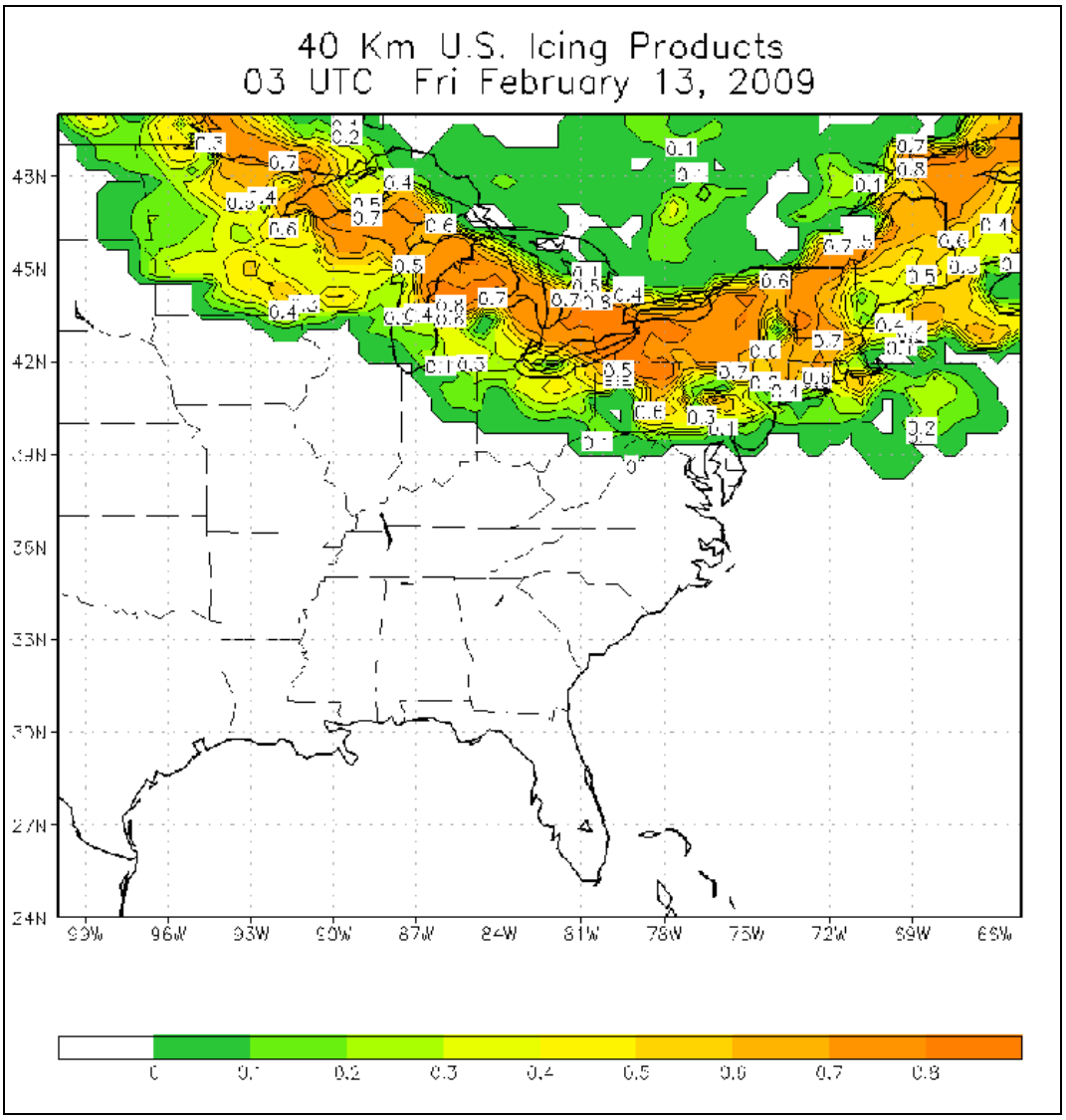


Figure 21 – CIP for 3,000 feet at 2200 EST

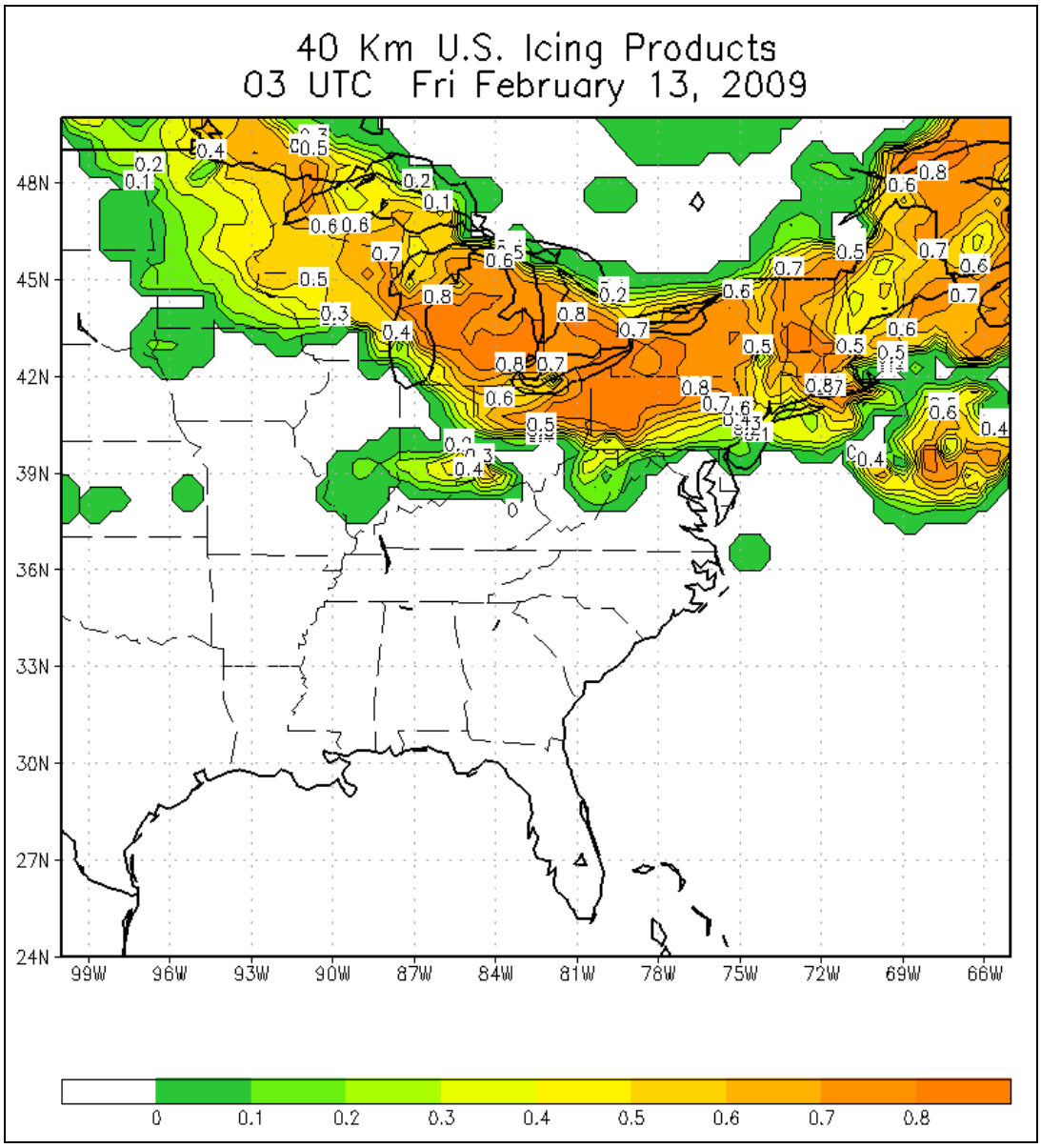


Figure 22 – CIP for 5,000 feet for 2200 EST

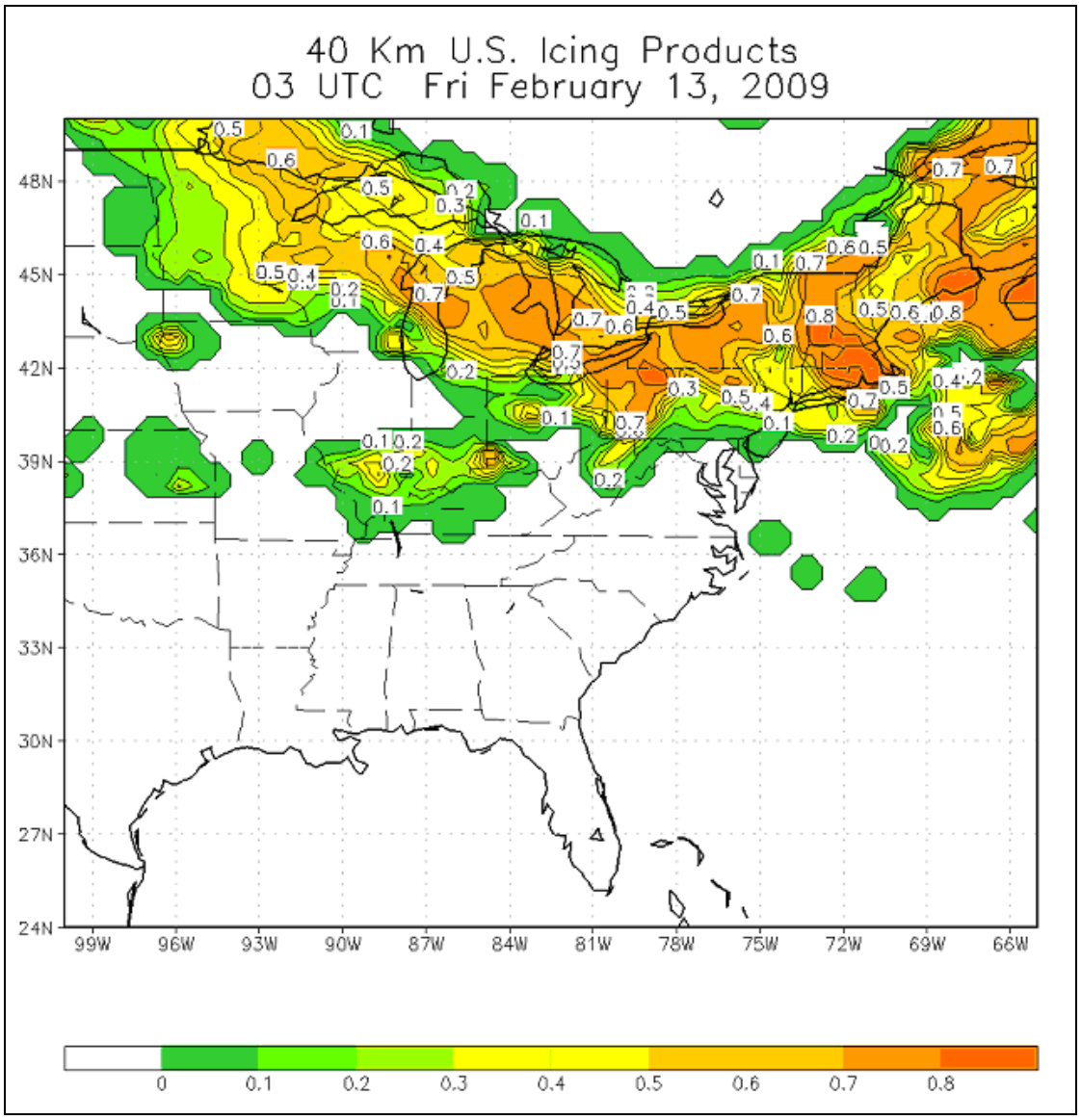


Figure 23 – CIP for 7,000 feet at 2200 EST

Figure 24 shows the supercooled large droplet (SLD) icing potential at 2200 EST (0300Z) at 3,000 feet msl. The chart shows the highest potential for SLD icing encounters at greater than 60 percent south of the accident location along the descent flight path of the accident aircraft.

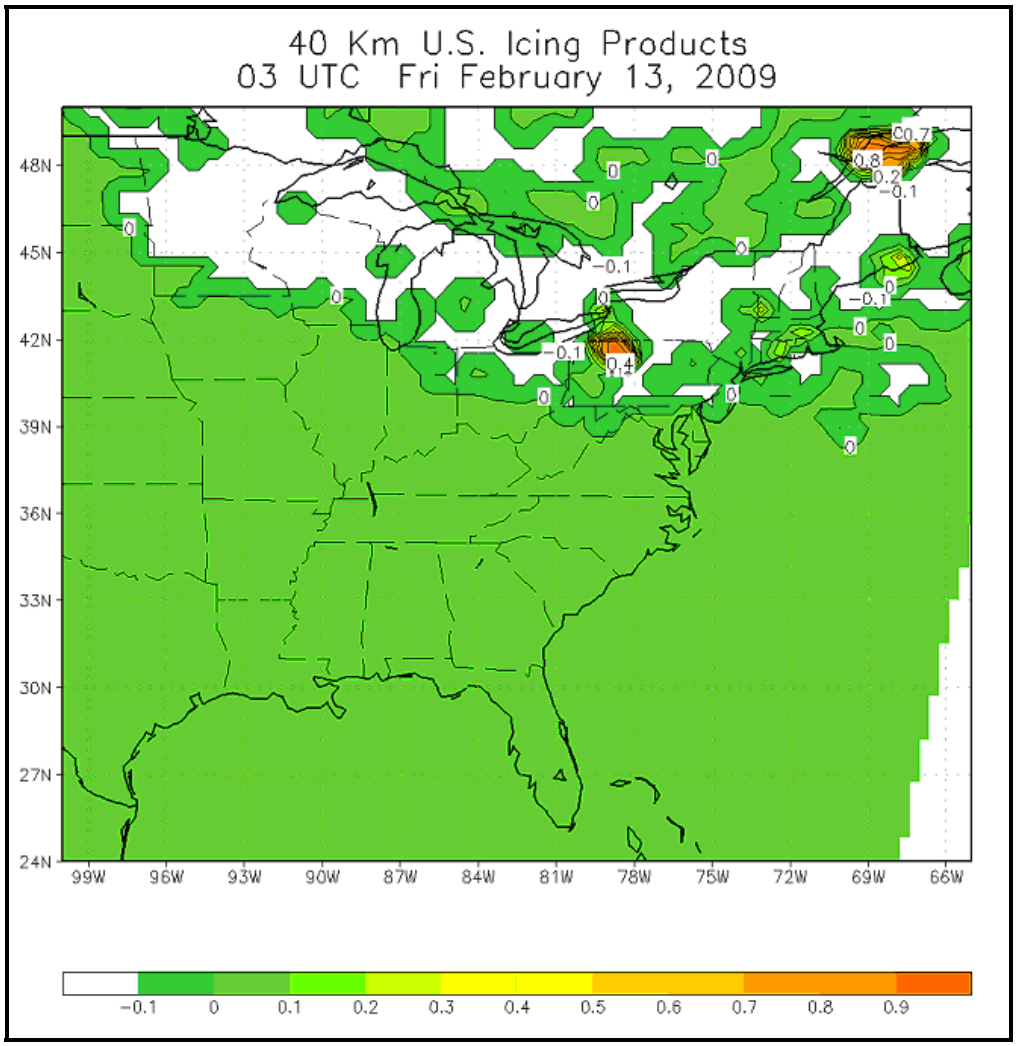


Figure 24 - SLD Icing Potential at 3,000 feet at 2200 EST

Figure 25 shows the supercooled large droplet (SLD) icing potential at 2200 EST (0300Z) at 5,000 feet msl. The chart shows the highest potential for SLD icing encounters at greater than 50 percent just south of the accident location along the descent flight path of the accident aircraft.

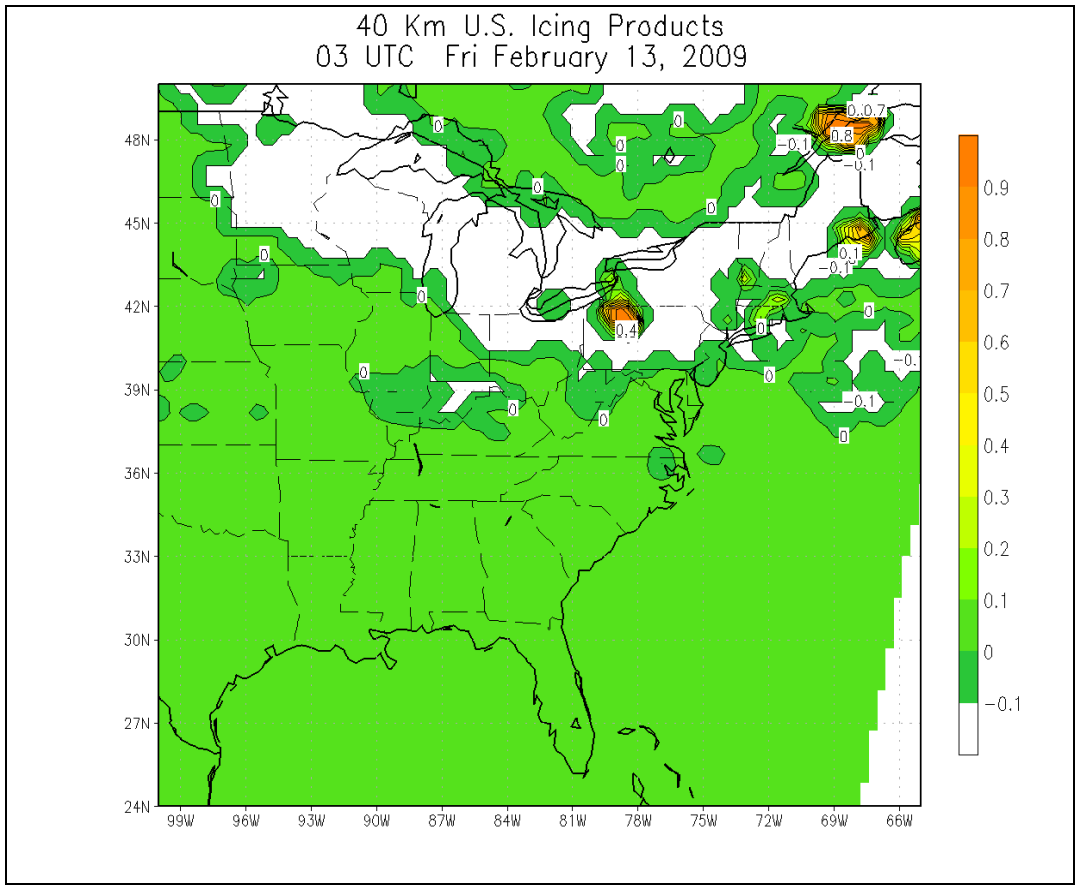


Figure 25 – SLD Icing Potential at 5,000 feet at 2200 EST

Figure 26 is a cross sectional plot from Newark (KEWR) to Buffalo (KBUF) for 2300 EST (0300Z) of the icing severity, icing probability, SLD potential, supercooled liquid water (SLW) content, and visible moisture/relative humidity (RH%) recreated by the National Center for Atmospheric Research (NCAR) Research Applications Laboratory for the accident. This type of product is available at the NWS ADDS Flight Path Tool for icing.

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, TAMDAR, and CIP icing potential.

The cross section generally depicted a threat of light to moderate icing below 12,000 feet along the route of flight from KEWR to KBUF, and up to 14,000 feet in the vicinity of Elmira (KELM), New York, and a small area of heavy or severe icing from 5,000 to 3,000 feet over the KBUF area. The icing probability in the KBUF area was greater than 80 percent below 7,000 feet, with a 40 percent of SLD conditions in that layer. The maximum SLW was in the vicinity of KELM and decreased to 0.20 to .25 g/m³ in the vicinity of KBUF. Visible moisture was greater than 90 percent below 10,000 feet over KBUF and extended down to 5,000 feet over KEWR, indicating overcast clouds over the entire route.

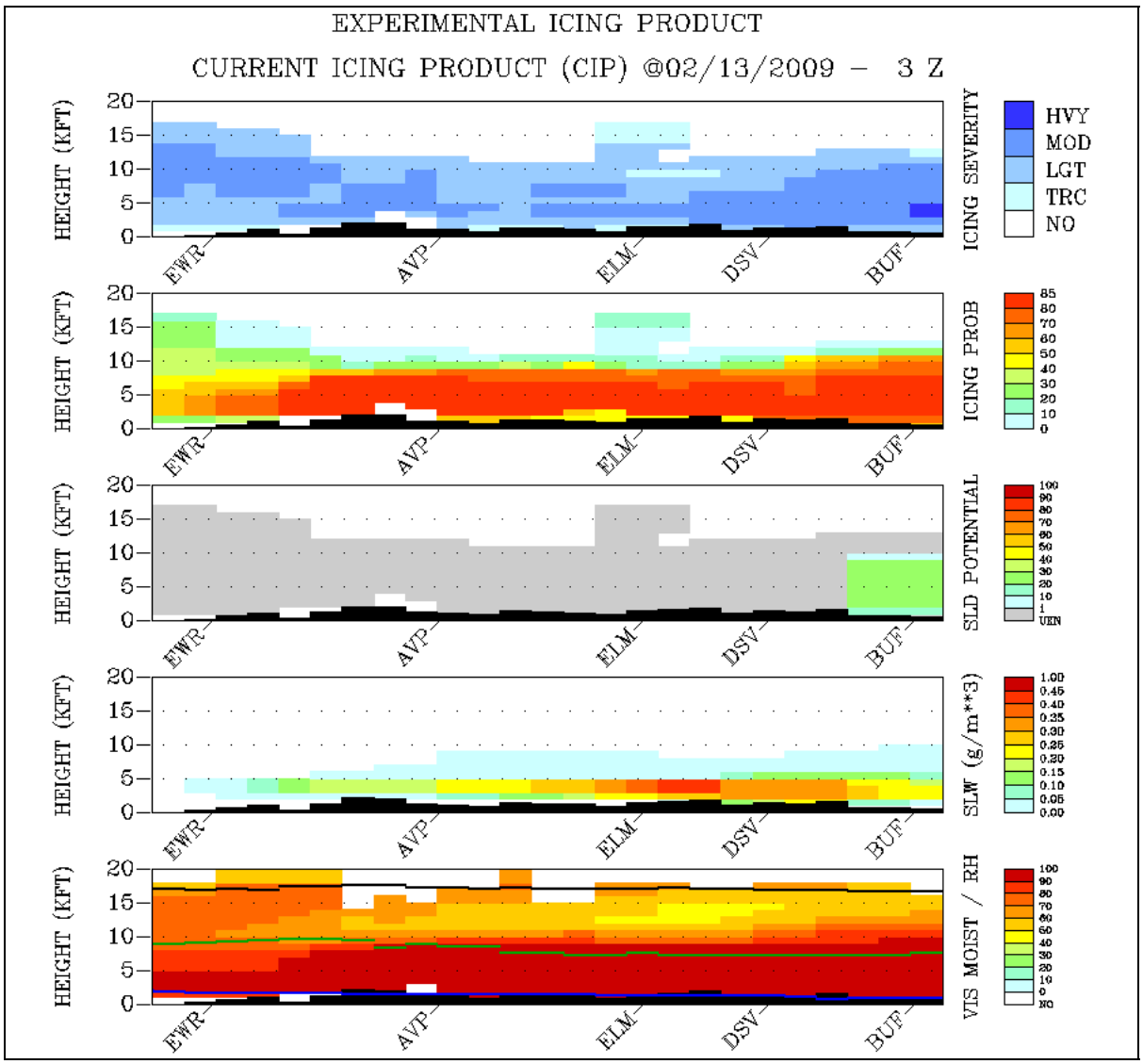


Figure 26 – NCAR CIP for 2300 EST

Figure 27 is the CIP Icing Severity image for 2200 EST (0300Z) from the NWS ADDS Flight Path Tool. The image depicts a light to moderate icing threat approaching the Buffalo area with a few embedded heavy or severe icing areas near Lake Ontario and western New York to the southwest through west of the accident site. The accident site was located within the area of moderate icing intensity at 6,000 feet.

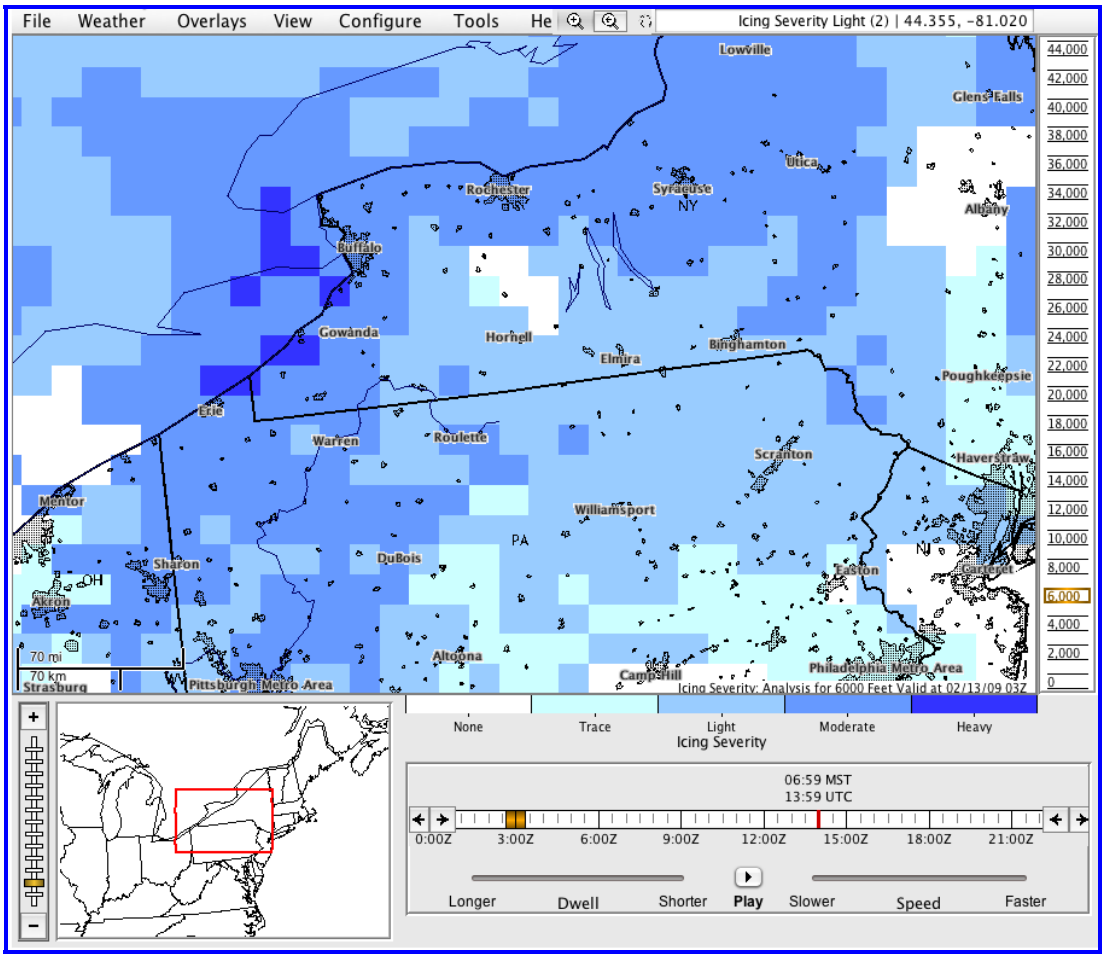


Figure 27 – CIP Icing Severity for 6,000 feet for 2200 EST

10.0 Icing Intensity References

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.*

The FAA has published a new training and reference guide for icing in Advisory Circular AC 91-74A "Pilot Guide: Flight in Icing Conditions" published in December 2007. That guide provides an icing accretion rate with intensity to help provide pilot's evaluation the icing environment. The advisory circular 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.*

The following table classifies icing type according to it description.

Icing Type	Contraction	Description
RIME	RM	Rough, milky, opaque ice formed by the instantaneous freezing of small super-cooled water droplets.
CLEAR	CL	A glossy, clear or translucent ice formed by the relatively slow freezing of large super-cooled water droplets.
MIXED	MX	A combination of both rime and clear.

11.0 Icing Questionnaire

A formal icing questionnaire was developed and was sent to flight crews who were operating in the KBUF area surrounding the period of the accident. The summaries basically summarized the weather as encountering stratiform or more correctly nimbostratus type clouds with tops near 8,000 feet and bases near 1,200 feet, with some variations in tops and bases reported. All the summaries reported the flights encountering snow. Many of the pilots reported seeing light radar returns on descent, while many did not use radar in the terminal area. While all reported some degree of icing, none issued a pilot report and indicated that they did not deem it as significant. No splattering of large liquid droplets were reported which would indicate SLD, and there were no reports of runback icing on the side windows. Only one pilot indicated observing ice on the top section of the wing beyond the protected surfaces. The following icing encounters were described by the pilots operating in the following aircraft from the questionnaires:

- American Eagle Embraer 145 arriving KBUF at approximately 2030 EST, pilot reported light rime icing in-clouds with accumulation of 1/4 inch observed in-flight with less than 1/2 inch of residual ice observed on the nose of the aircraft on the ground.

- Embraer 145 arriving KBUF around 2100 EST, pilot reported light mixed icing in-clouds with 1/8 inch of ice accumulation on the windshield. Reported less than 1/4 inch of mixed ice on airplane on the ground. Pilot's comment "not a bad night at all".

- Deadheading pilot on US Airways A-321 arriving at 2140 EST. Indicated solid IMC conditions until approximately 1,000 feet with snow. He observed no ice accumulation on the wing during the approach. Pilot was located in passenger cabin.

- Southwest B-737 arriving KBUF at approximately 2140 EST, pilot reported light to possible moderate mixed icing in-clouds, with several pockets of heavy icing during the encounter. Observed banding like structure in the echoes, with stratiform to stratocumulus type clouds. Observed icing on wiper nut and on windshield, and also noted some ice forming on the top chamber of the wing beyond the protected area. First officer described the encounter as light to moderate rime type icing, with a quick accumulation of 1/4 inch of ice. Bases of the clouds were ragged and not smooth with light turbulence. On departing the aircraft reported wet snow and ice pellet mixed precipitation.

- Southwest B-737 arriving KBUF at approximately 2150 EST, pilot reported the encounter as light to possible moderate rime icing, with not enough ice to be concerned with, and described the precipitation as wet snow.

- AirNow Embraer EMB-110 turboprop arriving KBUF at approximately 2200 EST, pilot reported clouds between 5,000 to 2,000 feet and encountering moderate rime type ice. He indicated that the boots were set to fast during the descent, which cleared the ice. The flight was in icing conditions between 8 to 10 minutes. After landing he observed 2 to 3 inches of ice on the spinner and some ice on unprotected surfaces, but commented "just another night in the northeast in the winter".

- American Eagle ERJ 145 arriving at KBUF at approximately 2210 EST, pilot reported cloud tops 9,000 feet with bases near 500 feet agl. Icing detector alerted between 7,000 and 500 feet, and observed only a trace of rime ice. The time in icing conditions was estimated at 10 minutes in the clouds.

- Southwest B-737 arriving at KBUF at approximately 2210 EST, pilot reported overcast layer of clouds between 5,000 and 500 feet with wet snow with "postal stamp size flakes" and light icing. Indicated he did not see any ice accumulating on airplane, other than slush on the landing gear trucks.

- United Airlines Airbus A-320 arriving at KBUF at approximately 2215 EST, pilots reported clouds between 10,000 feet to 2,300 feet, approached from the west and encountered light clear ice. Pilot stated that as snow hit the windshield it melted or splattered as it turned to water. No ice accumulated on airplane.

- Colgan Q400 arriving at KBUF at approximately 2230 EST. Pilot indicated that the ice detector illuminated at 5,000 feet, and they turned the ice protection system "all on", with 20-seconds the windshield frosted up, they were descending at 1,000 fpm and at 3,000 feet the ice melted off the windshield. The pilot described the icing as light to moderate rime ice between 5,000 and 3,000 feet.

- Express Jet Embraer EMB 145 arriving at KBUF at approximately 2245 EST, pilot reported cloud tops near 8,000 feet with bases near 2,000 feet with snow, with light rime ice encountered. Snow and snow pellets falling when they disembarked.

12.0 Interviews Conducted

During the on scene stage of the investigation several interviews were conducted in gathering the weather data. The following summaries are from those interviews and related follow-up activity.

12.0.1 Interview with First Responders

While on the initial walk around of the accident scene the weather chairmen talked to several fire fighters who responded to the accident. One of the responders lived within blocks of the accident site and was on scene before his pager even went off. When asked about weather conditions at the time, he described wet snow with some ice pellets mixed in. Others described large snow flakes. They indicated the temperature was at or just above freezing at the time, with temperatures falling through the night. They also confirmed that strong gusty winds had occurred earlier in the day and were responsible for limbs and branches down in the neighborhood.

The park cars and foliage in the area were covered with a mixture of ice and snow, which was not easily removed. A section of wreckage identified as a gear door from the accident airplane was also noted to be covered with ice and snow, and was located undisturbed in the back yard away from the fire damage and spray from the fire trucks. The ice did not appear to have occurred in flight, but rather after the accident.

12.0.2 NWS KBUF Forecast Office Interviews

The Weather Group Chairmen met with Mr. Thomas A. Niziol, the Manager in Charge (MIC) of the Buffalo NWS Office on the afternoon of February 13, 2009. Mr. Niziol provided a weather package prepared by his office which included the NWS Accident Incident Report, ASOS 5-minute observations, ASOS 1-minute data, KBUF sounding data, short term public forecast and Winter Weather Advisory, and other products issued surrounding the period and provided a description of the responsible of the Buffalo WSFO office. The KBUF office is responsible for taking rawinsonde upper air observations, and is the site of the WSR-88D, and for issuing aviation terminal forecasts, public short-term forecasts, and issuing weather advisories and warnings to the general public for the northwest section of New York.

Mr. Niziol reviewed the weather products and observations in the northwestern New York in their region of responsibility, including the KBUF and KIAG observations documented in section 2.0 of this report, the augmentation at the airport, the local mesoscale network, and a general weather reconstruction of events surrounding the period of the accident. Several forecasters and science operations officers were interviewed and asked to review several of the products available to the meteorologist surrounding the period including the sounding, LAPS, satellite imagery, WSR-88D, and observations, which have been documented in this report.

The NWS KBUF WSFO had issued a winter weather message at 1354 EST (1854Z) that summarized the conditions on February 12, 2009. The winter weather message is as follows:

WWUS41 KBUF 121854
WSWBUF
URGENT - WINTER WEATHER MESSAGE

NATIONAL WEATHER SERVICE BUFFALO NY
154 PM EST THU FEB 12 2009
...WINTER WEATHER RETURNS...
.A STRONG WESTERLY FLOW OF COLD AIR IN THE WAKE OF A DEEP STORM SYSTEM WILL CONTINUE TO PRODUCE ACCUMULATING SNOWS ACROSS PARTS OF WESTERN AND NORTH CENTRAL NEW YORK THIS AFTERNOON THROUGH EARLY TONIGHT. THE COMBINATION OF SNOW AND WESTERLY WINDS GUSTING UP TO 50 MPH WILL CREATE VERY POOR VISIBILITY AND DETERIORATING DRIVING CONDITIONS AS THE AFTERNOON WEARS ON.

NYZ001-002-010-011-013-122000-/O.CAN.KBUF.WW.Y.0008.000000T0000Z-090212T2300Z/
NIAGARA-ORLEANS-NORTHERN ERIE-GENESEE-LIVINGSTON-
INCLUDING THE CITIES OF...NIAGARA FALLS...MEDINA...BUFFALO...BATAVIA...GENESEO
154 PM EST THU FEB 12 2009
...WINTER WEATHER ADVISORY IS CANCELLED...
THE NATIONAL WEATHER SERVICE IN BUFFALO HAS CANCELLED THE WINTER WEATHER ADVISORY. A MIX OF RAIN AND SLUSHY SNOW HAS RESULTED IN LITTLE IF ANY ACCUMULATION. AN INCH OF LESS OF SNOW IS EXPECTED THIS EVENING AND EARLY TONIGHT.

WYOMING-CHAUTAUQUA-CATTARAUGUS-ALLEGANY-SOUTHERN ERIE-
INCLUDING THE CITIES OF...WARSAW...JAMESTOWN...OLEAN...WELLSVILLE...ORCHARD PARK...SPRINGVILLE
154 PM EST THU FEB 12 2009
...WINTER WEATHER ADVISORY NOW IN EFFECT UNTIL MIDNIGHT EST TONIGHT...
THE WINTER WEATHER ADVISORY IS NOW IN EFFECT UNTIL MIDNIGHT EST TONIGHT.
WIDESPREAD WET SNOW WILL CONTINUE THIS AFTERNOON...ESPECIALLY FROM LIVINGSTON...WYOMING AND SOUTHERN ERIE COUNTIES NORTHWARDS TO LAKE ONTARIO.
SLUSHY ACCUMULATIONS OF 1 TO 3 INCHES CAN BE EXPECTED OVER THESE AREAS TODAY...WITH UP TO 6 INCHES POSSIBLE OVER THE HIGHER TERRAIN OF WYOMING AND SOUTHERN ERIE COUNTIES. THE LEAST AMOUNT OF SNOW THIS AFTERNOON SHOULD BE FOUND OVER CHAUTAUQUA... CATTARAUGUS AND SOUTHERN ALLEGANY COUNTIES.
STRONG WINDS WILL ADD TO THE PROBLEMS AND GENERATE VERY POOR VISIBILITY AT TIMES AND MAKE IT DIFFICULT TO KEEP ROADWAYS CLEAR. OCCASIONAL SNOW IS THEN EXPECTED FOR MUCH OF THE REGION THIS EVENING AND EARLY TONIGHT WHEN ANOTHER 2 TO 3 INCHES OF ACCUMULATION WILL BE POSSIBLE...ESPECIALLY ALONG THE CHAUTAUQUA RIDGE TO SOUTHERN WYOMING COUNTY.
.
A WINTER WEATHER ADVISORY IS NORMALLY ISSUED FOR A VARIETY OF WINTER WEATHER CONDITIONS SUCH AS LIGHT SNOW... BLOWING SNOW...SLEET... FREEZING RAIN AND WIND CHILLS. WHILE THE WEATHER WILL BE SIGNIFICANT... THE WORD ADVISORY IMPLIES THAT SEVERE WINTER WEATHER IS NOT ANTICIPATED. STAY TUNED TO NOAA WEATHER RADIO OR YOUR FAVORITE SOURCE OF WEATHER INFORMATION FOR THE LATEST UPDATES. ADDITIONAL DETAILS CAN ALSO BE FOUND AT THE NWS BUFFALO WEBSITE.

The bulletin was updated at 2217 EST (0317Z) at the approximate time of the accident and was as follows:

WWUS41 KBUF 130317
WSWBUF
URGENT - WINTER WEATHER MESSAGE
NATIONAL WEATHER SERVICE BUFFALO NY
1017 PM EST THU FEB 12 2009
...WINTER WEATHER RETURNS...
.THE STORM THAT BROUGHT WARMTH AND STRONG WINDS TO THE REGION IS

CONTINUING TO WITHDRAW NORTHEASTWARD FROM THE CANADIAN MARITIMES. COLD AIR ON THE BACK SIDE OF THIS SYSTEM WILL CONTINUE TO PRODUCE ACCUMULATING SNOWS OVER HIGHER ELEVATIONS SOUTH AND SOUTHEAST OF BUFFALO AND SOUTHEAST OF LAKE ONTARIO...MAINLY ACROSS THE TUG HILL PLATEAU. BRISK WINDS COUPLED WITH THE SNOW WILL CONTINUE TO PRODUCE POOR DRIVING CONDITIONS.

Mr. Niziol and some of the staff identified several local remote weather reporting sites which were part of the Meteorological Assimilation Data Ingest System (MADIS) network, Williamsville (DW1806) located 6 miles west at an elevation of 594 feet msl, Williamsville (D0580) located 6 miles southwest at an elevation of 722 feet msl, and Iroquois (ABMN6), NY located 12 miles northeast of the accident site at an elevation of 620 feet msl. An additional site was identified located within a mile of the accident site at Clarence Center High School. These stations reported temperature, dew point, relative humidity, and wind data, but did not have precipitation type sensors. The following data was provided for these stations surrounding the period:

Station/Time (EST)	T (ºF)	Td (ºF)	RH (%)	Wind
Clarence Center High School				
2114	34	34	100	248º 05KT[14]
2214	34	34	100	248º 05KT
2329	34	34	100	269º 04KT
Williamsville (DW1806)				
2132	34	32.5	94	296º 05KT
2202	33	31.7	95	281º 05KT
2317	33	32	96	303º 05KT
2332	33	32	96	281º 05KT
Williamsville (D0580)				
2128	33	31.5	94	279º 05KT
2213	33	31.5	94	256º 04KT
2258	33	31.7	95	287º 04KT
Iroquois (ABMN6)				
2125	33	31.5	94	243º 08G14KT
2225	33	32.2	97	248º 06G12KT
2325	33	30.7	91	276º 05G15KT

One of the forecasters indicated that he lived approximately 12 miles due south of the accident site and was outside near the time of the accident and reported the weather conditions as snow with large snow flakes with riming occurring, making it a sleet type mixture. At the end of the storm he recorded approximately 2 1/2 inches of new snow during the period, and indicated his location was in area of higher elevation and was slightly colder than the Clarence Center area where the accident occurred.

[14] Clarence Center High School had an error in the wind sensor field and was reporting the reciprocal wind direction (off 180 degrees), and has been corrected in this report.

Mr. Niziol also indicated he became aware of the accident from local news broadcasts and indicated that at the office the NWS Northeast Region has provided the office several large screen televisions which provide a national and regional weather situational awareness and had a major news network, the Weather Channel, and local news broadcasted in the office.

Meteorologist David Zaff reviewed the weather conditions on the Advanced Weather Interactive Processing System (AWIPS) workstation. The reconstruction of the weather showed a deep low pressure system and associated occluded front moving across the region in the morning hours with a strong pressure gradient that caused strong gusting winds across the area during the morning hours that reached 47 knots (54 mph) with rain, with rain mixing with snow during the day and changed to snow during the evening hours with falling temperatures from a morning high near 8 degrees C (46 degrees F) to 1 degree C (34 degrees F) at the time of the accident. The strongest winds were correlated with the maximum fetch over Lake Ontario from 220 to 240 degrees. The second surge of cold air into the area was associated with the back door cold front, which was documented as moving through KBUF at 0048 EST on February 13, 2009, or approximately 1 1/2 hour after the accident and was noted by a defined wind shift in the METARs.

Mr. Zaff reviewed the satellite and radar imagery, sounding data, and showed the vertical motion or Omega, and potential temperature analysis with time through the use of the offices BUFKIT[15]. Mr. Zaff indicated they had seen several Omega values moving through the area during the period, one at the approximate time of the accident, which appeared to enhance the clouds and precipitation during the period. Figure 28 is the BUFKIT cross section of vertical motion or omega values from 1900 EST (0000Z) Thursday on the right with time increasing to the left and ending at 0700 EST (1200Z) Sunday February 15, 2009. The model data is from the 1900 EST (0000Z) North American Model (NAM) showing omega as the white line on the skew T chart. Precipitation type, freezing level, estimated cloud tops, are also inferred from the chart. At approximately 2200 EST (0300Z) the image depicts relative humidity greater than 90 percent from the surface to 9,000 feet, with omega or upward vertical velocities of 10 meters per second (m/s) or 20 knots to 6,000 feet. Nearly all the lifting was below the –10 degrees C contour, which could implicate in the absence of snow, supercooled droplets, lacking condensation nuclei, would have a hard time reaching favorable colder temperatures to begin turning into ice crystals, as this process is more common at temperatures colder than –10 degrees C. Since there was snow being reported, and hence something for droplets to adhere to, the likelihood of pure freezing rain situation would be mitigated. He summarized by indicating that the sounding wasn't all that uncommon in a post cold front scenario for the Buffalo area.

Mr. Zaff also indicated that the weak cap or isothermal layer, which was not well defined in the forecast sounding, but was evident in the 1900 EST (0000Z) sounding, just below the -10 degrees C isotherm. This was significant as to act to prevent any further lift, and keep droplets that didn't ice over as supercooled droplets.

[15] BUFKIT is a forecast visualization and analysis tool kit developed by the NWS Buffalo WSFO staff and the Warning and Decision Training Branch (WDTB) in Norman, Oklahoma, and is used by over 75 NWS forecast offices, the Department of Defense, University, and Environment Canada.

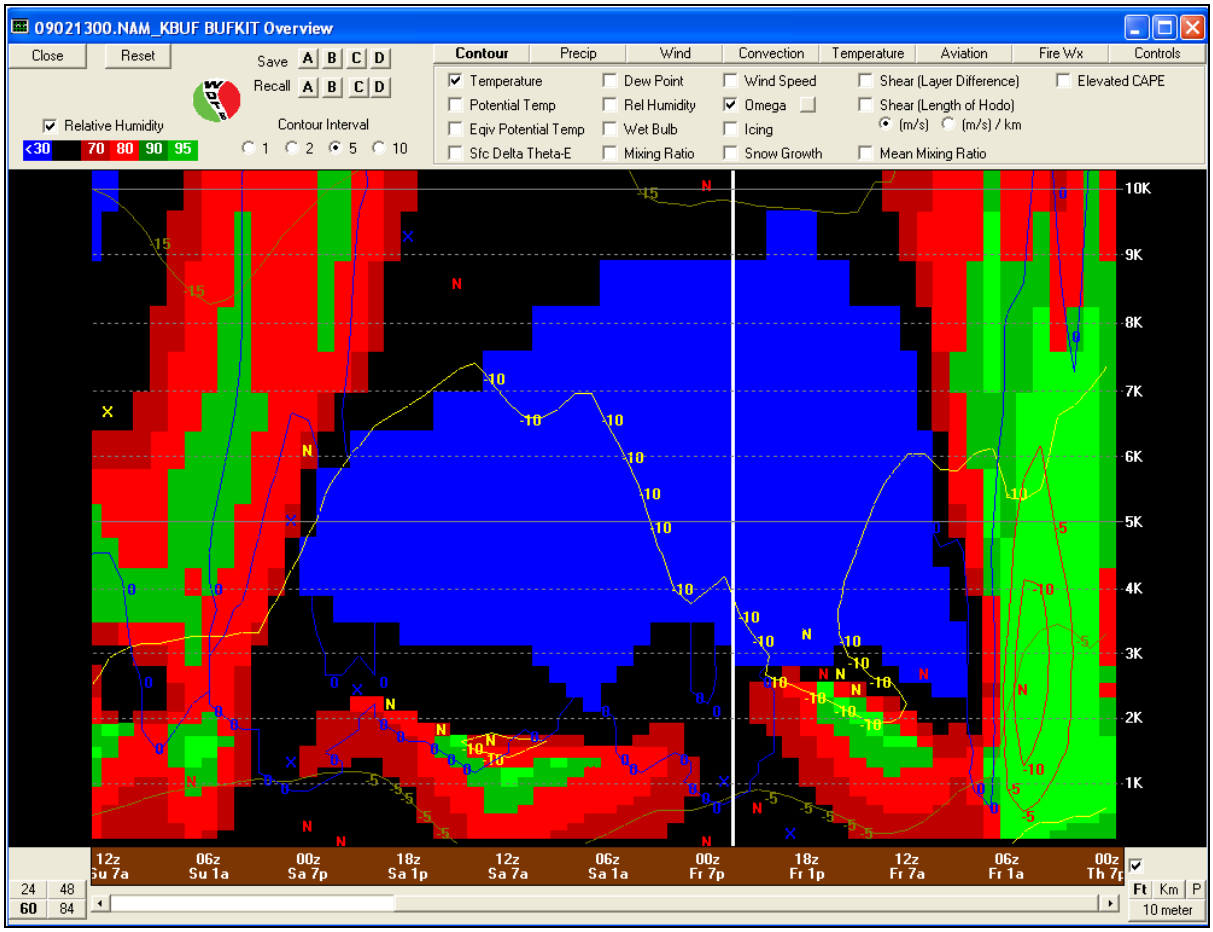


Figure 28 – BUFKIT meteogram of vertical motions

At the conclusion of the meeting with the NWS WSFO staff, Mr. Niziol provided me the contact numbers for the KBUF airport contract weather observer Mr. Rick Davis and Mr. Tim McNeil, Director of Operations for Noble Wind Energy for additional weather information.

12.0.3 KBUF NWS Certified Weather Observer

Buffalo Niagara International Airport is a level B augmentation[16] airport with 8 certified weather observers and was manned 24-hours a day. The augmenter's office is located in an office on the ground floor of the terminal building. On the evening of February 13, the Weather Group Chairman interviewed Mr. Rick Davis, the NWS Certified Weather Observer who worked the evening shift on the night of the accident and monitored him making several observations, and reviewing the weather observation logs on the night of the accident. Mr. Davis's shift is from 1600 to 2400 daily Monday through Friday. His experience includes 8 years in the United States Air Force, with years as a weather observer and 6 years as a

[16] See AIM section 7-1-12 Weather Observing Programs for a description of all the service levels.

forecaster. He was born and raised in the Buffalo area, and has been an observer at KBUF for the past 8 years.

On the night of the accident Mr. Davis indicated that the present weather was light snow, which consisted of large wet snow flakes. He indicated that at 2114 EST the ASOS system visibility sensor wanted to report 2 1/2 miles in light snow, but he could see the visibility markers at 3 miles and edited the system accordingly. He also edited the sky condition report at 2154 and 2249 EST based on his observation of the cloud coverage. The most significant event was at 0012 EST as he was briefing his relief and the ASOS issued a report of light freezing rain, Mr. Davis was not able to stop the issuance of the report and issued a correction immediately afterwards. Mr. Davis indicated that the large wet snow was still occurring and temperatures at the surface were above freezing, and that he observed no mixed precipitation or icing was observed. Mr. Davis indicated the same scenario was also noted at Niagara Falls Airport (KIAG), when the manual augmentation ended, the system reporting light freezing rain. He believed the problem was associated with the software logic of the ASOS system. I viewed the observation logs and in fact a correction was noted, but it is not reflected in the observations in sections 2.0.1 and 2.0.2 of this report. The sensor issue will be addressed to NWS Headquarters. Mr. Davis also indicated the ASOS cannot detect freezing drizzle or ice pellets, and other mixed freezing precipitation in automated mode.

The following edit log entries were made surrounding the time of the accident:

02/12/09 21:12:22 AUTO SPCL OBS CANCELLED SPECI KBUF 130211Z 24014KT 3SM –SN BR FEW009 BKN021 OVC027 01/M01 A2978 RM A02 P0000

02/12/09 21:14:56 EDITED SFC VIS AUTO 2 1/2 EDIT 3SM

02/12/09 21:15:22 AUTO SPCL OBS CANCELLED SPECI KBUF 130214Z 24014KT 2 1/2SM –SN BR FEW011 BKN021 OVC027 01/M01 A2978 RMK A02 POOO1

02/12/09 21:54:38 EDITED SKY AUTO SCT011 OVC021 EDIT FEW011 OVC021

02/12/09 21:54:38 EDITED SFC VIS AUTO 2 1/2SM EDIT 3SM

02/12/09 22:49:04 EDITED SKY PREV FEW011 OVC021 AUTO BKN009 OVC017 NEW SCT011 OVC021

02/12/09 00:11:29 EDITED SKY AUTO SCT008 BKN014 OVC019 EDIT BKN008 BKN01 OVC019

02/12/09 00:12:22 AUTO SPCL OBS CANCELLED SPECI KBUF 130511Z 26013KT 4SM BR SCT008 BKN014 OVC019 01/00 A2983 RMK A02 FZRAB0456E0459SNE0458 P0000

02/12/09 00:22:29 AUTO REM FOR PREWX TURNED OFF

During the period of the interview the NWS was also checking and calibrating the ASOS, and it was reported to be working normally.

The office does not monitor the tower or approach control radio frequencies, and he added that due to the level B nature of the station, flight schedule does not affect the observations or

that he is trying to support individual arriving or departing flights, and is constantly in the augmentation mode.

Mr. Davis indicated that several times during the winter season he receives calls from the tower indicating that the airlines are complaining about the type of precipitation being reported such as ice pellets and request to change the observation removing the more restrictive weather type, which the observers refuse to do. He was not aware of the specific restriction of air carriers from operating in ice pellets, moderate or greater freezing rain, mixed freezing precipitation or heavy snow, but was aware of the general hazards of freezing rain and icing from his aviation experience in the U.S. Air Force.

Mr. Davis was not notified of the accident and did not issue a special observation for the aircraft mishap. He learned of the accident after his shift from his wife, who was watching the local news. The next day his supervisor inquired about why he had been notified of the event and a special weather observation taken as required by the NWS Federal Meteorological Handbook procedures. He advised his supervisor he was not contacted. He then added that his supervisor reportedly called the tower and they advised him that they tried to contact the augmentation office with no one answering the phone and then tried contacting the supervisor himself without any luck. As reported by Mr. Davis, his supervisor later reviewed his incoming calls and indicated that no such call was made. Mr. Davis believed the tower likely called the NWS WSFO, located approximately a mile away, thinking it was there office.

12.0.4 ASOS Program manager

With several reports of freezing rain from KBUF and KIAG surrounding the period of the accident with temperatures at or above freezing, the NWS Headquarters was contacted and requested to review the weather conditions surrounding the period for any specific ASOS sensor problems and to verify the accuracy of the reports.

Ms. Laura Cook, the NWS ASOS Program Manager reviewed the data and advised that at temperatures near freezing, snow can become attached to the precipitation indicator (PI)[17] probe firmly enough to cause a frequency shift that could be misinterpreted as freezing rain. This problem of differentiating snow from freezing precipitation is overcome by checking the output of the PI sensor to determine if it is raining or snowing when the freezing rain sensor has a frequency shift. If the PI sensor indicates rain, then the report will be freezing rain. If the PI sensor indicates snow, then snow will be reported in the body of the report. This is identified in the ASOS User's Guide (www.nws.noaa.gov/asos/pdfs/aum-toc.pdf), on pages 36-38.

Mr. Rick Parry who works with the ASOS algorithms also reviewed the data and indicated that he knows of no problems with the LEDWI or PI and freezing rain sensors with

[17] Precipitation Identification (PI) sensor or better known as the Light Emitting Diode Weather identifier (LEDWI), that differentiates between rain from snow and determines the intensity of the precipitation.

snow or mixed freezing precipitation near freezing temperatures that would have caused the problem of falsely reporting freezing rain. He indicated that the upper limit in reporting freezing rain is an ambient temperature of less than 37 degrees F. He indicated that there were a few reasons for this, one being the error allowances in the temperature sensor. Another is to help bridge the events where the temperatures are near freezing, then dips below freezing, and then rises above freezing. If the temperature is truly 36 degrees F, the freezing rain sensor should not see a decrease in frequency since there should not be any ice accretion.

Based on their comments the reports of freezing rain at KBUF and KIAG were likely valid and light freezing precipitation was occurring across the region mixed with the wet snow documented by the METARs.

12.0.5 Interview with Director of Operations for Noble Wind Energy

On February 14, the meteorology working group interviewed Tim McNeil, Director of Operations for Noble Wind Energy which operates two wind turbine farms containing approximately 150 wind turbines oriented in a north-south axis 14 miles southeast of the accident site. The accident aircraft's initial approach path to KBUF took it over a portion of the wind turbine farm. During a previous interview with NWS personnel in Buffalo, they indicated they observe the wind turbine farm on their WSR-88D 0.5-degree scan as the maximum height of the of the turbine blades is approximately 350 feet agl. NWS personnel also indicated they were aware icing conditions had a negative effect on wind turbine operations and suggested contacting Noble Wind Energy as the sites are some weather instrumentation capability.

During the interview, McNeil stated the turbines are susceptible to degraded performance during icing conditions. Engineers on site compare power output generated by each turbine with wind speed measured by an anemometer on the turbine. As ice forms on the turbine blades, power output is reduced. McNeil stated the greatest turbine performance degradation occurs with precipitation present with temperatures at or slightly below 0 degrees C. Snow at temperatures of –10 degrees C or less does not affect turbine performance. He indicated that freezing rain and wet snow are the two atmospheric phenomena that negatively affect wind turbine performance. When Noble Wind Energy observes icing conditions at its wind turbine farm, they have concerns regarding ice shedding as large sections of ice can be flung significant distances from the turbines. Noble takes steps to mitigate this risk by expanding a safe zone around the turbine farm and notifying the public of reduced power output. Documented cases of ice shedding up to 1,750 feet have been recorded at other sites.

McNeil stated Noble's preliminary information from the evening of February 12 shows degraded wind turbine performance and reduced power output due to ice accretion on the wind turbine blades. He stated they maintain a data archive of approximately 500 parameters on a 10-minute average. He indicated that Noble Wind Energy would review the data and provide a more detail report of their findings, that report is included as attachment 1.

13.0 Dispatcher Statement

The aircraft dispatcher responsible for the flight planning, release, and flight following of Colgan Air flight 3407 was Mr. Stefan Pitter. Mr. Pitter provided a written statement of his actions regarding the flight and was interviewed on April 16, 2009 at the Colgan hangar in Manassas, Virginia.

Mr. Pitter's background included attended Dowling College on Long Island, where he earned 87 credits towards a Bachelor of Science degree in Aeronautics and Management, with a minor in flight. Prior to being hired by Colgan, he worked as a ramp agent for Hudson General Aviation between 1998 and 1999, a customer service agent for Frontier Airlines between 1999 and 2002, and a cargo agent for North American Aviation between 2002 and 2004. He then obtained his dispatch certificate from Flight Safety International in 2004 and was hired by Colgan Air in April 2005 as a dispatcher.

On February 12, 2009, he had been schedule on the evening shift from 1345 to 0145 EST, and had been responsible for dispatching 28 flights. He described his workload as light to moderate due to the reduced flight schedule caused by the air traffic control ground delay programs at Newark (KEWR) due to the weather and high winds, which had caused delays ranging from 1 1/2 to 3 hours. He had release flight 3407 at 1800 EST with no minimum equipment limitations (MEL) or maintenance issues, with an alternate airport of Rochester (KROC), plus reserve fuel.

He indicated that his weather support equipment included the Meteorologix[18] Sentry system to display analysis and prognostic charts, current AIRMETs and SIGMETs, the NWS ADDS website for icing products, and Flight Explorer aircraft situation display (ASD) to monitor the flights progress along the route, and the FAA website for notices to airmen. The weather document is provided through the Saber system through Meteorologix. Other than issuing the flight release and inquiring about their expected departure time, he had no communication with the flight crew. His normal communication method was through ACARS messaging, the station company radio relay, or through phone patches with Aeronautical Radio Incorporated (ARINC).

He indicated he was notified at approximately 2025 EST from the Continental Airlines Operations Director that they had just received a call from air traffic control informing them that flight 3407 might have gone down. He then looked at the Flight Explorer system and observed a Colgan flight inbound to KBUF and immediately attempted to send a message to the flight through ACARS, but got no response. He then noticed that the flight was the next scheduled flight and not the accident flight. He was then contact by Colgan Air's Director of Operations checking in on the operation and apprised him of the situation developing. He attempted to contact KBUF tower and the operations office at the airport, and got no response. The emergency response procedures were then initiated.

[18] Meteorologix was formerly called Kavouras Inc. and is a private weather contractor used by many air carriers and corporate flight departments for weather support, and is approved by the FAA as a weather provider.

When questioned about AIRMETs Mr. Pitter indicated they are not normally issued to the flights, only SIGMETs, which would have a major restriction on operations. He was aware of the AIRMET, but it was within operational limits to operate in moderate icing.

With regards to canceling flights for weather, Mr. Pitter indicated that he has no problems with canceling flights due to weather and is rarely challenged if it is required. He indicated that there was no management pressure to operate if he did not believe it was unsafe to operate.

14.0 Review of Dispatch Release and Weather Document

A copy of the dispatch release and weather document issued to Colgan Air 3407 is included as attachment 2. The dispatcher issued the release at 1800 EST (2300Z) for an estimated departure time at 1910 EST (0010Z). The flight was planned at a cruising altitude of flight level 160 for a total flight time of 53 minutes. Rochester International Airport (KROC) was listed as an alternate. The flight had the FAA required 45-minutes of reserve fuel (1,950 pounds (lbs)) and was planned to carry an additional 2,439 lbs. of contingency fuel for approximately 50 minutes extra duration.

The weather document consisted of 27 pages of weather data and notices to airmen (NOTAMs). The departure weather included 3-hours of METARs, two amended TAF's[19], and 3 pilot reports indicating light to moderate turbulence, and light rime icing conditions. The weather section took 1/2 page, with the following six pages of NOTAMs with over 68 FAA Flight Data Center (FDC) NOTAMs and airspace restriction changes.

The arrival weather section for KBUF contained 3-hours of METAR and SPECIs or 12 reports, and 3 amended TAFs. The TAFs all expected IFR to MVFR conditions during the period with conditions at the estimated time of arrival of winds from 270 degrees at 14 knots gusting to 24 knots with visibility 5 miles in light snow and mist, and an overcast ceiling at 1,000 feet agl. There were 2 PIREPs from turbojet air carrier aircraft reporting light to moderate rime icing in the Buffalo area between 3,000 and 14,000 feet. The NOTAMs for KBUF indicated all runways had patchy wet snow and ice on runways, and all ramps and taxiways were covered with thin wet snow. The document also included 12 military special airspace changes and 79 FDC NOTAM approach and departure procedure changes.

The alternate weather section for KROC contained 3-hours of METAR and SPECI observations and the current TAF. The forecast at the planned arrival time in the event of a divert was winds from 270 degrees at 20 knots gusting to 30 knots with visibility 6 miles in light rain and snow, ceiling broken at 1,500 feet agl, overcast at 2,500 feet, with visibility 4 miles in light snow and mist, ceiling overcast at 1,000 feet by 2200 EST. Over 120 FDC NOTAMs were included for the alternate airport.

[19] Only one TAF forecast is current at a given time. An amended TAF cancels the previous one.

The weather document included an outdated wind and temperature aloft forecast for JFK, SYR, and BUF that was valid at 1300 EST (1800Z) and for use between 1200 EST (1700Z) and 1600 EST (2100Z). The temperature data for all three stations showed temperatures below zero at all levels.

The enroute weather section consisted of the KBOS Area Forecast issued at 1345 EST (1845Z) with the VFR clouds and weather forecast information valid until 0200 EST (0700Z) on February 13, 2009, the latest Convective SIGMET and KBOS SIGMET Victor 6 issued at 1730 EST (2230Z) valid through 2130 EST (0230Z), and three Center Weather Advisories (CWA) which were no longer valid. No AIRMETs were included in the weather document.

15.0 Astronomical Data

The following information is provided for Buffalo, Erie County, New York (longitude W78.8, latitude N42.9) for February 12, 2009:

SUN

Begin civil twilight	0647
Sunrise	0717
Sun transit	1230
Sunset	1743
End civil twilight	1812

MOON

Moonrise	2145
Moonset	0851 on following day

The phase of the moon on 12 February was waning gibbous with 88% of the Moon's visible disk illuminated. At 2215 EST, the moon was 4.5 degrees above the horizon, at an azimuth of 106.7 degrees, and was 85% illuminated. A full moon had occurred on February 9, 2009 at 0950 EST.

Donald E. Eick
NTSB Senior Meteorologist

Matt Duke
ALPA Meteorological Representative