



# National Transportation Safety Board

Office of Aviation Safety  
Washington, D.C. 20594-2000  
October 9, 2008

## METEOROLOGICAL FACTUAL REPORT

DCA08MA085

### A. ACCIDENT

Location: Owatonna, Minnesota  
Date: July 31, 2008  
Time: 0945 central daylight time (1445 UTC<sup>1</sup>)  
Aircraft: East Coast Jet, BAE 125-800A; registration: N818MV

### B. METEOROLOGICAL SPECIALIST

Donald E. Eick  
Senior Meteorologist  
National Transportation Safety Board  
Operational Factors Division, AS-30  
Washington, D.C. 20594-2000

### C. SUMMARY

On July 31, 2008, about 0945 central daylight time, a Hawker Beechcraft BAE 125-800A, N818MV, operated by East Coast Jets, was destroyed when it impacted terrain during a go-around from runway 30 at the Owatonna Degner Regional Airport (KOWA), near Owatonna, Minnesota. The non-scheduled domestic passenger flight was operating under 14 CFR Part 135. Visual meteorological conditions prevailed at the time of the accident, and an instrument flight rules flight plan had been filed and activated for the flight, but had been cancelled before the landing. The pilot, co-pilot, and six passengers sustained fatal injuries. The flight originated from the Atlantic City International Airport, near Atlantic City, New Jersey the same day.

---

<sup>1</sup> UTC – is an abbreviation for Coordinated Universal Time.

## **D. DETAILS OF INVESTIGATION**

The National Transportation Safety Board's (NTSB) meteorology specialist was on site for this investigation although no formal weather group was formed. Weather data was obtained from the National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS), including the NWS Chanhassen, Minnesota, Weather Service Forecast Office (WSFO) responsible for the Owatonna area, the Minnesota Department of Transportation, witnesses, and from on-site surveys. Weather products are normally issued with reference to UTC based upon the 24 hour clock but amended to local time for this report. Local time of central daylight time (CDT) is +5 hours to UTC, and UTC=Z. Directions are referenced to true north and distances are in nautical miles. Heights are above mean sea level (MSL) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

### **1.0 Synoptic Situation**

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

#### **1.0.1 Surface Analysis Chart**

The NWS Surface Analysis Chart for 1000 CDT (1500Z) on July 31, 2008, depicted a low pressure system with a central pressure of 1003-hectopascals (hPa) immediately west of the intersections of the North and South Dakota, and Minnesota borders. A stationary front extended southeast from the low across southern Minnesota and Wisconsin, and was located in the immediate vicinity north of the accident site. A small scale or "mesoscale" high pressure system with a central pressure of 1013-hPa was located immediately south over the Minnesota and Iowa border with an outflow boundary across Iowa. To the north of the front another outflow boundary was identified across Minnesota. To the west, another stationary front extended south-southwest from the main low pressure system across South Dakota into Nebraska. A band of light to moderate rain was depicted extending over southern Minnesota and Iowa, and extended over the accident site.

The station model in the immediate vicinity of the accident site indicated winds from the south at approximately 10 knots, moderate rain, broken clouds, temperature 66 degrees Fahrenheit (F), and a dew point of 63 degrees F.



weather and typically have an intense leading edge squall line<sup>4</sup> with an extensive area of stratified rain and embedded thunderstorms trailing behind the system. The leading edge squall line in this case was further classified as a bow echo<sup>5</sup>, which typically is associated with severe weather in the form of strong straight line winds, microbursts, and tornadoes. The NWS had issued severe thunderstorm watches and warning with this area, which are documented in section 9.0 of this report. The approximate accident location has been marked on the images for reference.

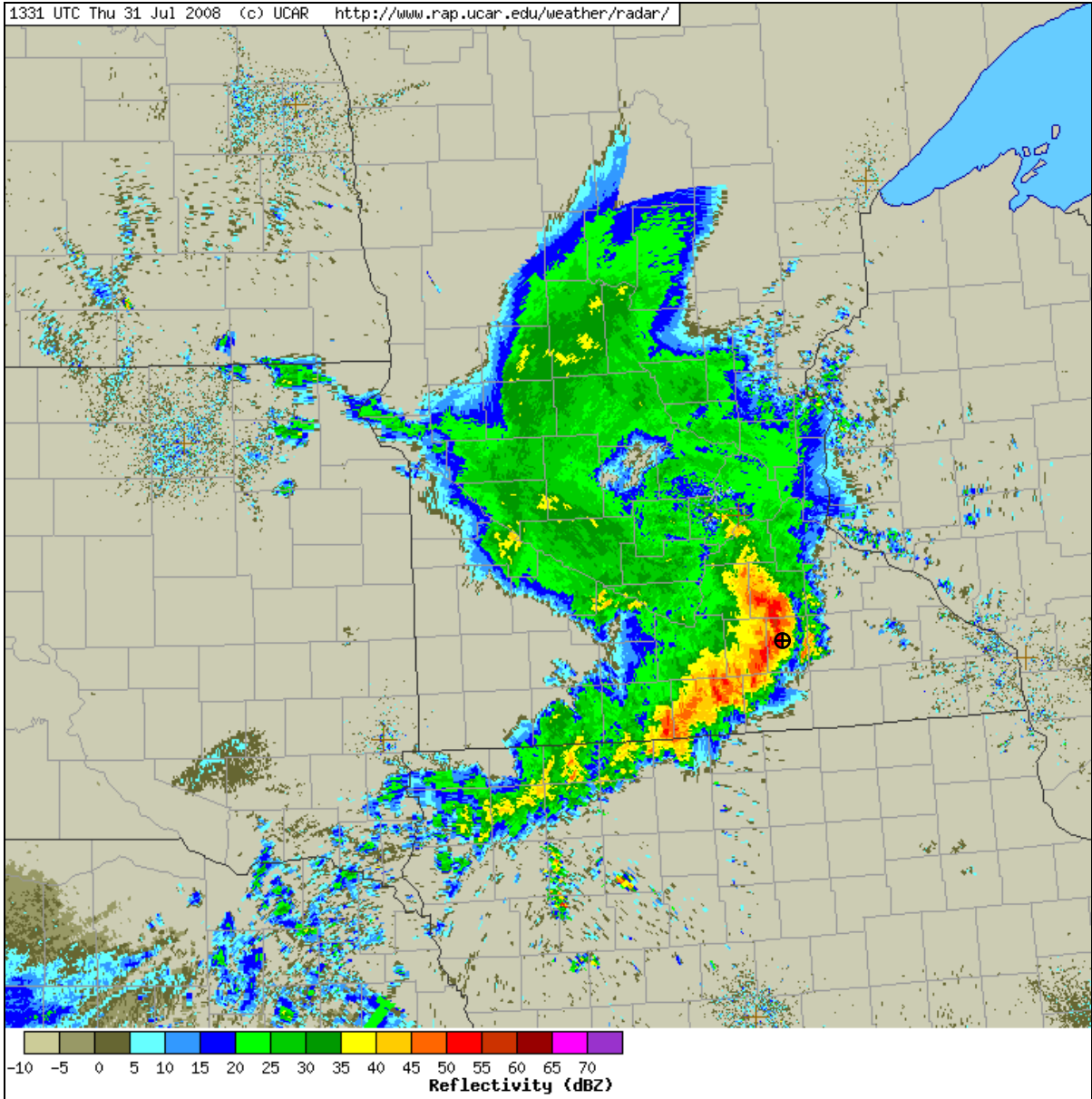
Figure 2 depicts the leading edge of the bow echo with radar echoes of 50 to 60 dBZ<sup>6</sup> of intense to extreme intensity, moving through the Owatonna area around 0830 CDT, with an extensive area of stratified echoes in the range of 30 to 40 dBZ behind the leading edge. The Owatonna Fire House located approximately 3 miles south of the airport at this time reported wind gusts as high as 83 miles per hour (mph) during this period, and the NWS and local 911 operators received numerous reports of trees and powerlines down across the region.

---

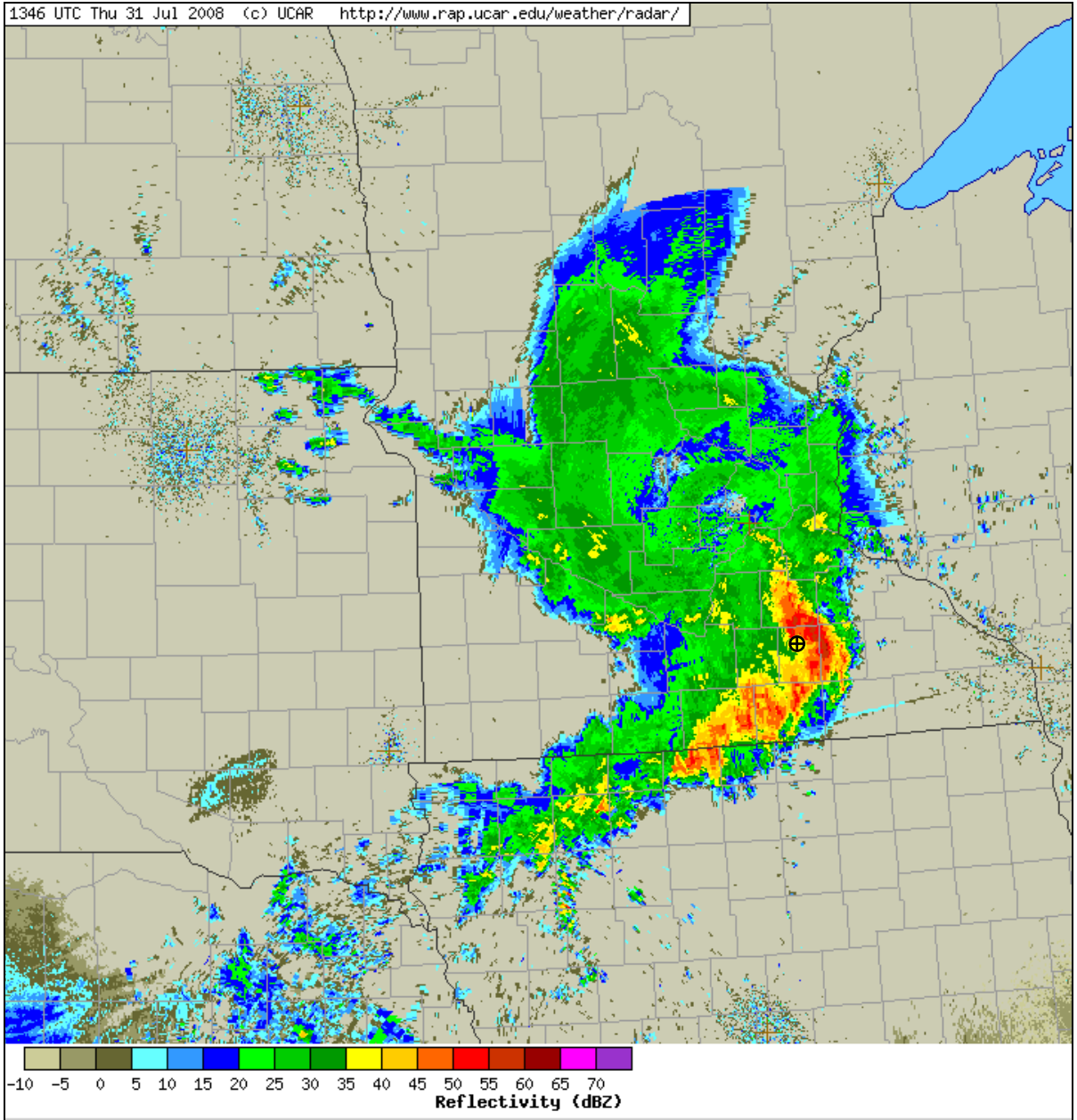
<sup>4</sup> Squall line – is a line of thunderstorms that have a common lifting mechanism. Lifting mechanisms tend to occur in bands. Examples of banded lifting mechanisms include fronts, large outflow boundaries, gravity waves, and isentropic lifting associated with CSI. The classic squall line will develop out ahead of and parallel to a cold front or dry line boundary. The storms first develop where there is the best combination of moisture, instability, and lift. The storms will continue to evolve and new cells will develop (commonly toward the south and east). The squall line will sustain itself by producing its own lift due to outflow boundaries. As long as instability and moisture remain present out ahead of the squall line, the squall line will continue to propagate.

<sup>5</sup> Bow echo – is a radar echo, which is linear but bent outward in a bow shape. Damaging straight-line winds often occur near the "crest" or center of a bow echo. A bow-shaped line of convective cells that is often associated with swaths of damaging straight-line winds, microbursts and small tornadoes. Key structural features include an intense rear-inflow jet impinging on the core of the bow, with bookend or line-end vortices on both sides of the rear-inflow jet, behind the ends of the bowed convective segment. Bow echoes have been observed with scales between 10 and 100 miles, and often have lifetimes between 3 and 6 hours. At early stages in their evolution, both cyclonic and anticyclonic bookend vortices tend to be of similar strength, but later in the evolution, the northern cyclonic vortex often dominates, giving the convective system a comma-shaped appearance. The northern bookend vortex can sometimes lead to tornado formation, where the circulation exhibits cyclonic rotation.

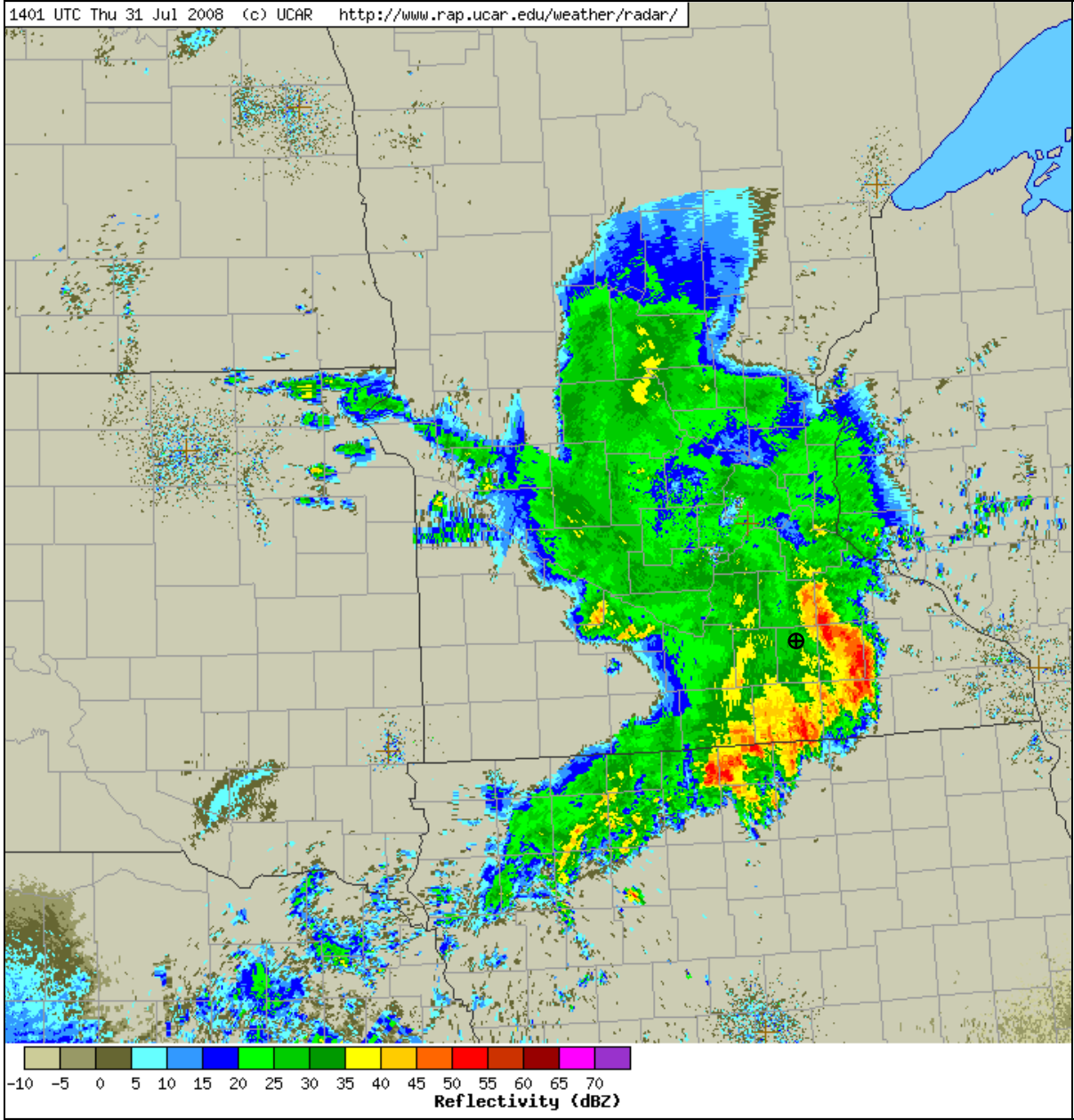
<sup>6</sup> Reflected intensities are measured in dBZ (decibels of Z). As the strength of the signal returned to the radar increases the dBZ values increases. The Doppler radar does not determine where rain is located, only areas of returned energy. The "dB" in the dBZ scale is logarithmic and has no numerical value, but is used only to express a ratio. The "z" is the ratio of the density of water drops (measured in millimeters, raised to the 6th power) in each cubic meter ( $\text{mm}^6/\text{m}^3$ ). Mathematically:  $\text{dBZ} = 10 * \log (z/z_0)$ . Where  $z$  = reflectivity factor and  $Z_0$  is defined to be  $1 \text{ mm}^6/\text{m}^3$



**Figure 2 – NCAR regional radar mosaic for 0831 CDT**



**Figure 3 – NCAR regional radar mosaic for 0846 CDT**



**Figure 4 – NCAR regional radar mosaic for 0901 CDT**

Figure 5 depicts the conditions prior to the accident with echoes of 20 to 40 dBZ over the Owatonna area, associated with light to moderate rain.

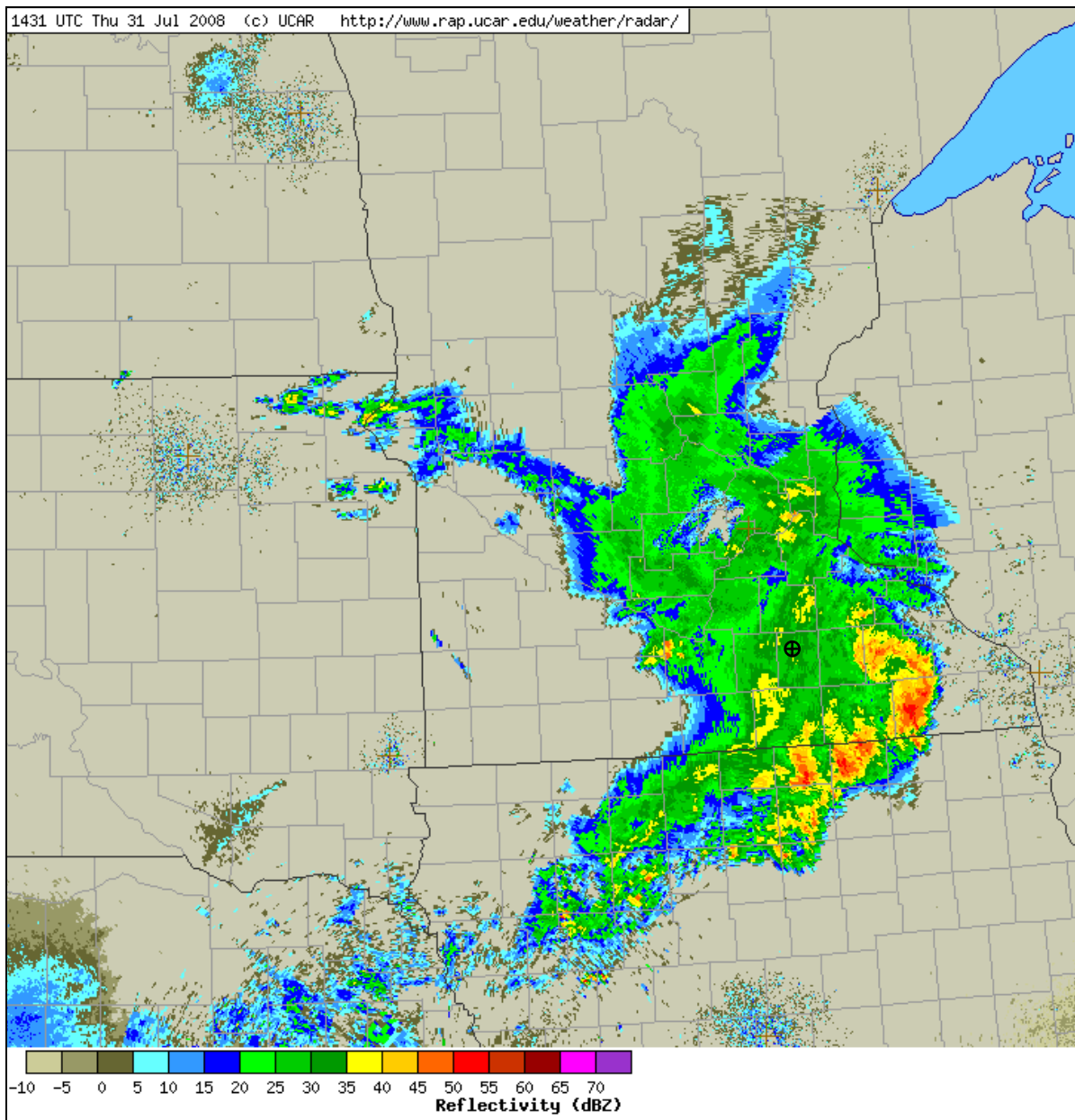
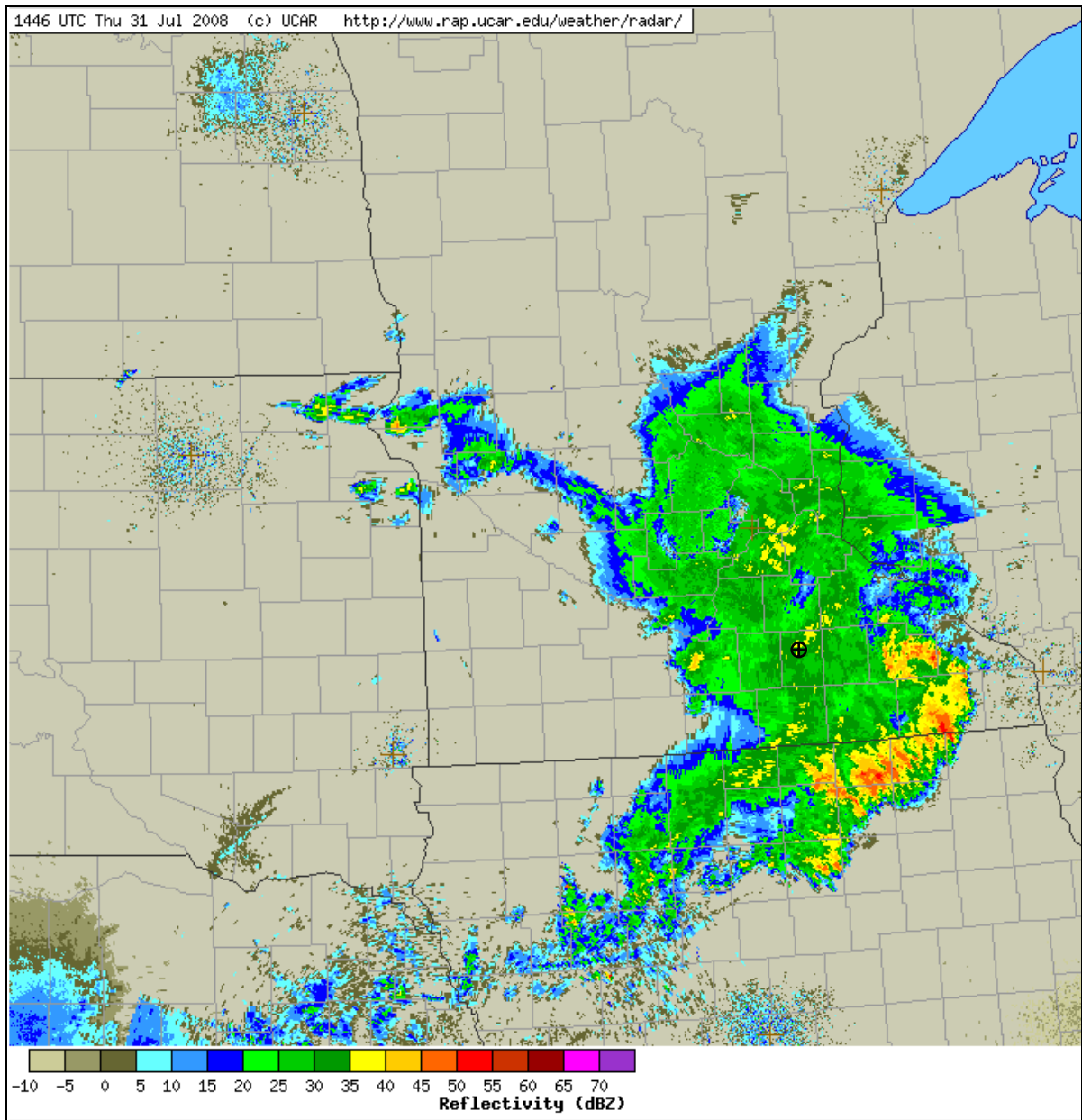


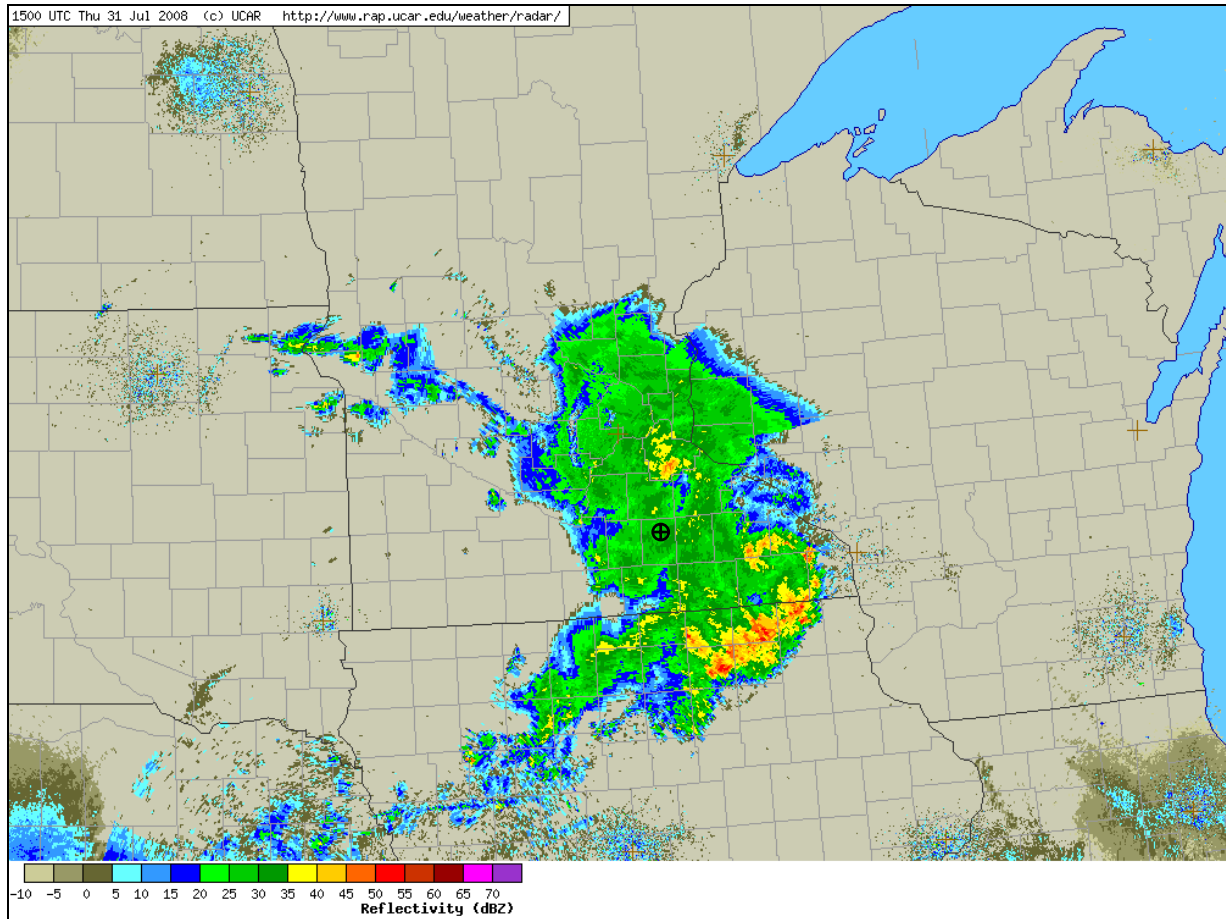
Figure 5 – NCAR regional radar mosaic for 0931 CDT

Figure 6 is the radar image at the time of the accident indicating echoes in the range of 20 to 40 dBZ continuing over the Owatonna area. The local weather radar will be detailed in section 4.0 of this report.



**Figure 6 – NCAR regional radar mosaic for 0946 CDT**

Figure 7 is the radar at 1000 CDT after the accident, echoes on the range of 20 to 35 dBZ continuing over the area, with the western edge of the system approaching the Owatonna area.

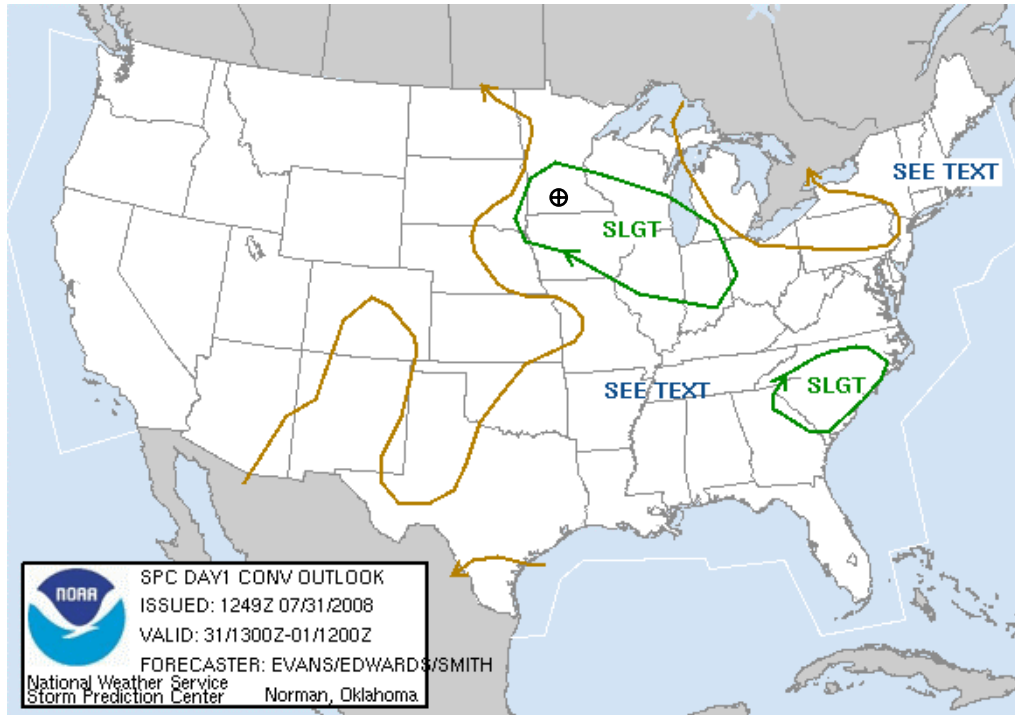


**Figure 7 – NCAR regional radar mosaic for 1000 CDT**

### 1.0.3 Convective Outlook

The NWS Storm Prediction Center (SPC) Convective Outlook (AC) graphic identified areas where strong to severe thunderstorms were expected for the following day. It was issued at 0739 CDT (1239Z) on July 31, 2008, and is included as figure 8 with the narrative following the image. The NWS SPC expected a slight chance of severe thunderstorms<sup>7</sup> over southern Minnesota and Wisconsin, Iowa, Illinois, and Indiana. The narrative indicated that at 0800 CDT (1300Z) a long-lived bow echo with a history of producing significant wind damage was moving across southern Minnesota along a well-defined frontal boundary.

<sup>7</sup> A severe thunderstorm is one that produces tornadoes, hail larger than 3/4 inch in diameter, and/or strong damaging winds of 50 knots or more. A severe thunderstorm implies severe to extreme turbulence, severe icing, and a high potential for microbursts.



**Figure 8 – NWS Convective Outlook issued at 0749 CDT**

*DAY 1 CONVECTIVE OUTLOOK  
NWS STORM PREDICTION CENTER NORMAN OK  
0749 AM CDT THU JUL 31 2008*

*VALID 311300Z - 011200Z*

*...THERE IS A SLGT RISK OF SVR TSTMS FROM THE NRN MS RIVER VALLEY  
ACROSS THE SRN GREAT LAKES REGION...*

*...THERE IS A SLGT RISK OF SVR TSTMS OVER MUCH OF THE CAROLINAS...*

*...UPPER MIDWEST...*

*LONG-LIVED BOW ECHO WITH HISTORY OF SIGNIFICANT DAMAGING WINDS EARLY THURSDAY MORNING CONTINUES ALONG WELL-DEFINED SURFACE FRONT EXTENDING FROM THE SRN GREAT LAKES INTO SERN MN AS OF 13Z. SOME QUESTION ABOUT WHETHER OR NOT SYSTEM WILL SURVIVE STRONG CAPPING THROUGH THE MID/LATE MORNING ACROSS THE UPPER MS RIVER VALLEY. HOWEVER...CLEAR SKIES AND STEEP LAPSE RATES AHEAD OF THE SYSTEM...ALONG WITH WELL-DEFINED MCV...SUGGEST SYSTEM MAY EITHER CONTINUE SEVERE OR WEAKEN BRIEFLY BEFORE RE-INTENSIFYING LATER THIS MORNING/EARLY THIS AFTERNOON DOWNSTREAM. IF SYSTEM DOES WEAKEN CONSIDERABLY THIS MORNING...RELATED OUTFLOW/DIFFERENTIAL HEATING ZONE WILL BLEND WITH SYNOPTIC WARM FRONT OVER NRN IA/SRN WI INTO NRN IL. THIS SHOULD SERVE AS PRIMARY FOCUS FOR AFTERNOON/EVENING SVR POTENTIAL INCLUDING SUPERCCELL RISK.*

*BY AFTERNOON...VERY STG INSTABILITY SHOULD DEVELOP WITHIN AND S OF WARM FRONTAL/DIFFERENTIAL HEATING ZONE...WITH STG SFC HEATING AND*

*FRONTAL CONVERGENCE TO YIELD WEAK CINH. SFC DEW POINTS IN THE UPPER 60S TO LOW 70S F WILL BE COMMON BY MID-LATE AFTERNOON BENEATH 7-8 DEG C/KM MIDLEVEL LAPSE RATES...CONTRIBUTING TO MLCAPES IN 3000-4000 J/KG RANGE. ALTHOUGH SFC WINDS ARE NOT FCST TO BE PARTICULARLY STG...DIRECTIONAL SHEAR IS. RELATIVELY BACKED FLOW INVOF BOUNDARY SHOULD YIELD LOOPED HODOGRAPHS...AS WELL AS ENHANCED STORM-RELATIVE INFLOW IN NARROW CORRIDOR. DISCRETE SUPERCELLS WOULD HAVE POTENTIAL FOR DAMAGING HAIL GIVEN THEIR INTERNAL FORCING AND LARGE AMBIENT BUOYANCY. INSTABILITY GRADIENT WILL BE FAVORED CORRIDOR FOR MOTION OF ANY SUBSEQUENT MCS...EXPANDED UPSCALE OR RE-INTENSIFIED FROM EARLIER ACTIVITY. ASSOCIATED WIND THREAT MAY EXTEND ACROSS MUCH OF THE SRN GREAT LAKES AND CENTRAL IND/IL GIVEN BROAD REGION OF MODERATE NWLY FLOW ALOFT.*

## **2.0 Surface Observations**

Owatonna Degner Regional Airport (KOWA), Owatonna, located in Steele County, Minnesota, at an elevation of 1,146 feet msl, had an Automated Weather Observation System (AWOS-3) installed with a lightning detection system. The system was a stand-alone system with no augmentation by any weather observers and was located approximately 500 feet from the approach end of runway 30, southwest of the runway. Mounted near the AWOS were the airport's orange windsock and precision approach path indicator (PAPI) light system. The AWOS system issued an observation every 20-minutes for dissemination long-line, but also had an update rate every minute for VHF broadcast for airborne aircraft and for the local weather display systems located in the fixed base operation (FBO) and main terminal.

### **2.0.1 METAR Observations**

The official Meteorological Aerodrome Reports (METARs) reported long-line surrounding the period of the accident were as follows, with cloud heights reported above ground level (agl):

KOWA weather at 0835 CDT (1335Z), automated, wind from 300 degrees at 36 knots gusting to 55 knots, visibility 2 miles in thunderstorm and heavy rain, scattered clouds at 200 feet agl, scattered clouds at 1,400 feet, ceiling broken at 2,200 feet, temperature 19 degrees Celsius (C), dew point 17 degrees C, altimeter 29.84 inches of Mercury (Hg). Remarks: automated observation system, visibility 1 mile variable 5 miles, 20-minute precipitation 0.22 inches, lightning distant all quadrants.

KOWA weather at 0855 CDT (1355Z), automated, wind from 320 degrees at 31 knots gusting to 42 knots, visibility missing, weather thunderstorm and moderate rain, clouds missing, temperature 18 degrees C, dew point 16 degrees C, altimeter 29.82 inches of Hg. Remarks: automated observation system, 20-minute precipitation 0.02 inches, lightning distant<sup>8</sup> all quadrants.

---

<sup>8</sup> Distant lightning – is defined as not at the aerodrome, but within 10 to 25 miles of the station.

KOWA weather at 0915 CDT (1415Z), automated, wind from 320 degrees at 8 knots, visibility 10 miles in thunderstorm and moderate rain, scattered clouds at 3,700 feet, ceiling broken at 4,500 feet, overcast at 5,000 feet, temperature 18 degrees C, dew point 16 degrees C, altimeter 29.88 inches of Hg. Remarks: automated observation system, 20-minute precipitation 0.03 inches, lightning distant all quadrants.

KOWA weather at 0935 CDT (1435Z), automated, wind from 180 degrees at 3 knots, visibility 10 miles with thunderstorms in the vicinity<sup>9</sup>, light rain, scattered clouds at 3,800 feet, scattered clouds at 4,900 feet, ceiling broken at 10,000 feet, temperature 18 degrees C, dew point 16 degrees C, altimeter 29.85 inches of Hg. Remarks: automated observation system, 20-minute precipitation 0.05 inches, lightning distant all quadrants.

KOWA weather at 0945 CDT (1445Z), automated, wind from 170 degrees at 6 knots, visibility 10 miles with moderate rain, scattered clouds at 1,800 feet, scattered clouds at 2,900 feet, ceiling broken at 3,700 feet, temperature 19 degrees C, dew point 17 degrees C, altimeter 29.83 inches of Hg. Remarks: automated observation system, 20-minute precipitation 0.09 inches, lightning distant east through south.

KOWA weather at 1015 CDT (1515Z), automated, wind from 220 degrees at 12 knots, visibility 10 miles with thunderstorms in the vicinity, moderate rain, scattered clouds at 2,100 feet, ceiling broken at 3,700 feet, broken at 5,000 feet, temperature 18 degrees C, dew point 16 degrees C, altimeter 29.85 inches of Hg. Remarks: automated observation system, 20-minute precipitation 0.05 inches, lightning distant all quadrants.

KOWA weather at 1035 CDT (1535Z), automated, wind from 160 degrees at 6 knots, visibility 10 miles with thunderstorms in the vicinity, light rain, scattered clouds at 2,500 feet, scattered at 5,000 feet, temperature 18 degrees C, dew point 16 degrees C, altimeter 29.77 inches of Hg. Remarks: automated observation system, 20-minute precipitation 0.03 inches, lightning distant southeast.

KOWA weather at 1055 CDT (1555Z), automated, wind from 240 degrees at 3 knots, visibility 10 miles in light rain, sky clear below 12,000 feet, temperature 19 degrees C, dew point 17 degrees C, altimeter 29.77 inches of Hg. Remarks: automated observation system, 20-minute precipitation 0.03 inches, lightning distant northeast and southeast.

## **2.0.2 Five-minute AWOS Observations**

Mr. Robert Milton, AWOS Program Manager, Minnesota Department of Transportation, was contacted and provided the 5-minute observations for KOWA on July 31, 2008. Mr. Milton indicated that at approximately 0840 CDT when heavy rain and winds of 55 knots (63 mph) were recorded, the system went off line due to a power outage<sup>10</sup>, but came back on line shortly

---

<sup>9</sup> Vicinity – is defined as not at the aerodrome, but within 5 to 10 miles of the station.

<sup>10</sup> An interview with the Owatonna Airport Manager indicated that at 0900 CDT the runway inspection noted that the Precision Approach Path Indicator (PAPI) glide slope indicator lights located in the vicinity of the AWOS system and

thereafter without any maintenance at 0921 CDT. The system was reported to be working normally with no maintenance problems noted at the time of the accident. The 5-minute AWOS observations are included as attachment 1 at the end of this report.

The KOWA AWOS updates weather conditions every 1-minute and makes those observation available to pilot's on VHF radio frequency. According to the cockpit voice recorder group chairmen's report, the pilots listened to the weather broadcast between 0923 and 0925 CDT. The closest observation to that time and the time of the accident are as follows:

KOWA automated observation at 0921 CDT (1421Z), winds from 020 degrees at 2 knots, visibility 10 miles in thunderstorm and moderate rain, scattered clouds at 3,500 feet agl, ceiling broken at 4,600 feet, overcast at 6,000 feet, temperature 18 degrees C, dew point 16 degrees C, altimeter 29.86 inches of Hg. Remarks: precipitation detected 0.03 inches in the last 5-minutes, runway sensor - wet, lightning at airport and distant all quadrants.

KOWA automated observation at 0946 CDT (1446Z), winds from 170 degrees at 6 knots, visibility 10 miles in moderate rain, scattered clouds at 1,900 feet agl, scattered at 3,500 feet, ceiling broken at 6,000 feet, temperature 18 degrees C, dew point 17 degrees C, altimeter 29.84 inches of Hg. Remarks: precipitation detected 0.01 inches in the last 5-minutes, runway sensor - wet, lightning distant all quadrants.

The observations also noted that 10-minutes prior to the accident winds shifted from the north to the south and south-southeast.

### **3.0 Satellite Imagery**

The Geostationary Operations Environmental Satellite number 12 (GOES-12) data was obtained from the National Climatic Data Center (NCDC) and was displayed on the National Transportation Safety Board's computers utilizing the Man-computer Interactive Data Access System (McIDAS) software. Both visible and infrared imagery were obtained surrounding the time of the accident. The infrared imagery (band 4) at a wavelength of 10.7 microns ( $\mu\text{m}$ ) provided a 4-kilometer (km) resolution with radiative cloud top temperatures. The visible imagery (band 1) at a wavelength of 0.65  $\mu\text{m}$  provided a resolution of 1 km. The satellite imagery surrounding the time of the accident at approximately every 15-minutes were reviewed and the closest images documented below.

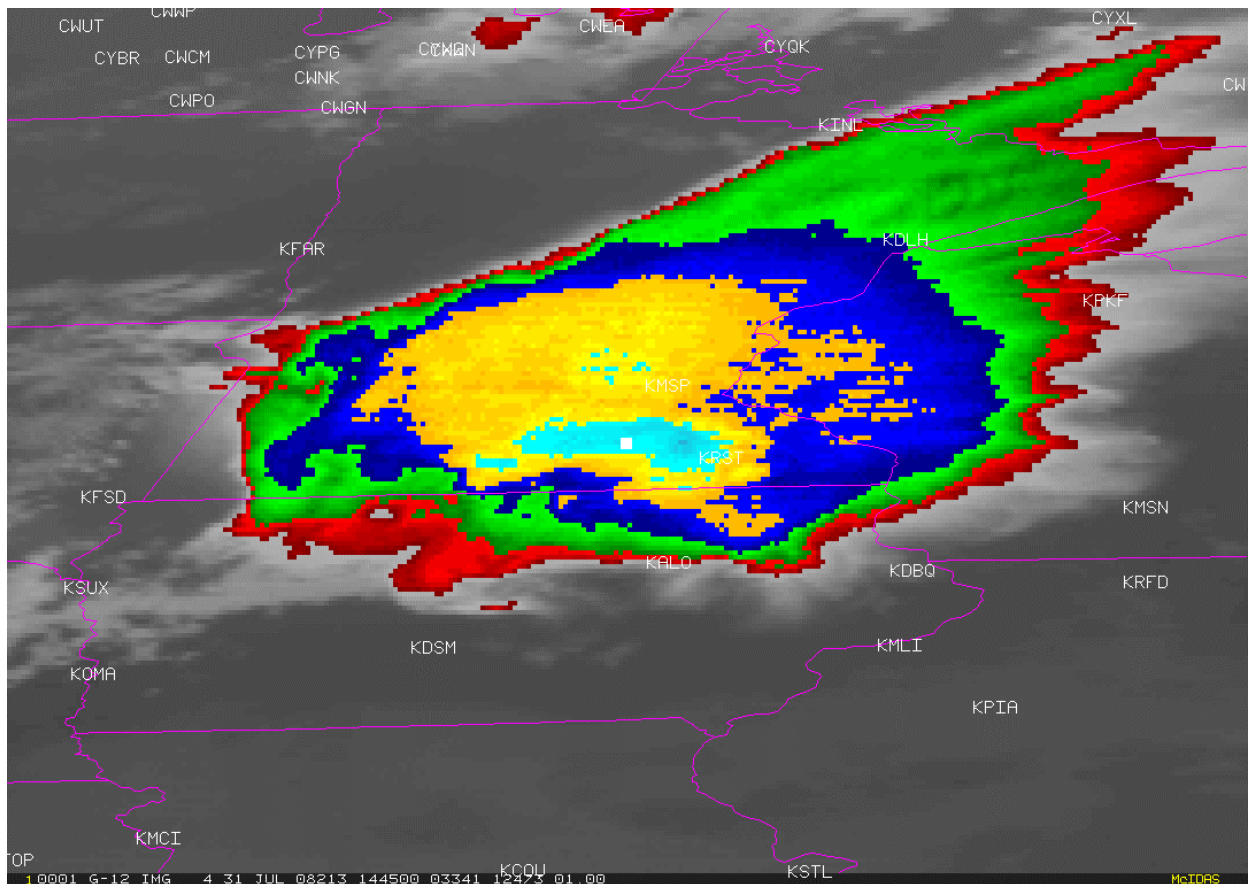
Figure 9 is the GOES-12 infrared image at 0945 CDT (1445Z) at 2X magnification with a standard MB temperature enhancement curve applied to highlight the higher and colder clouds tops associated with deep convection. The image depicted a large region of cumulonimbus clouds and cirrostratus clouds associated with the cumulonimbus anvil blow off with the MCS over southern Minnesota and northern Iowa, and extending over the accident site. The radiative

---

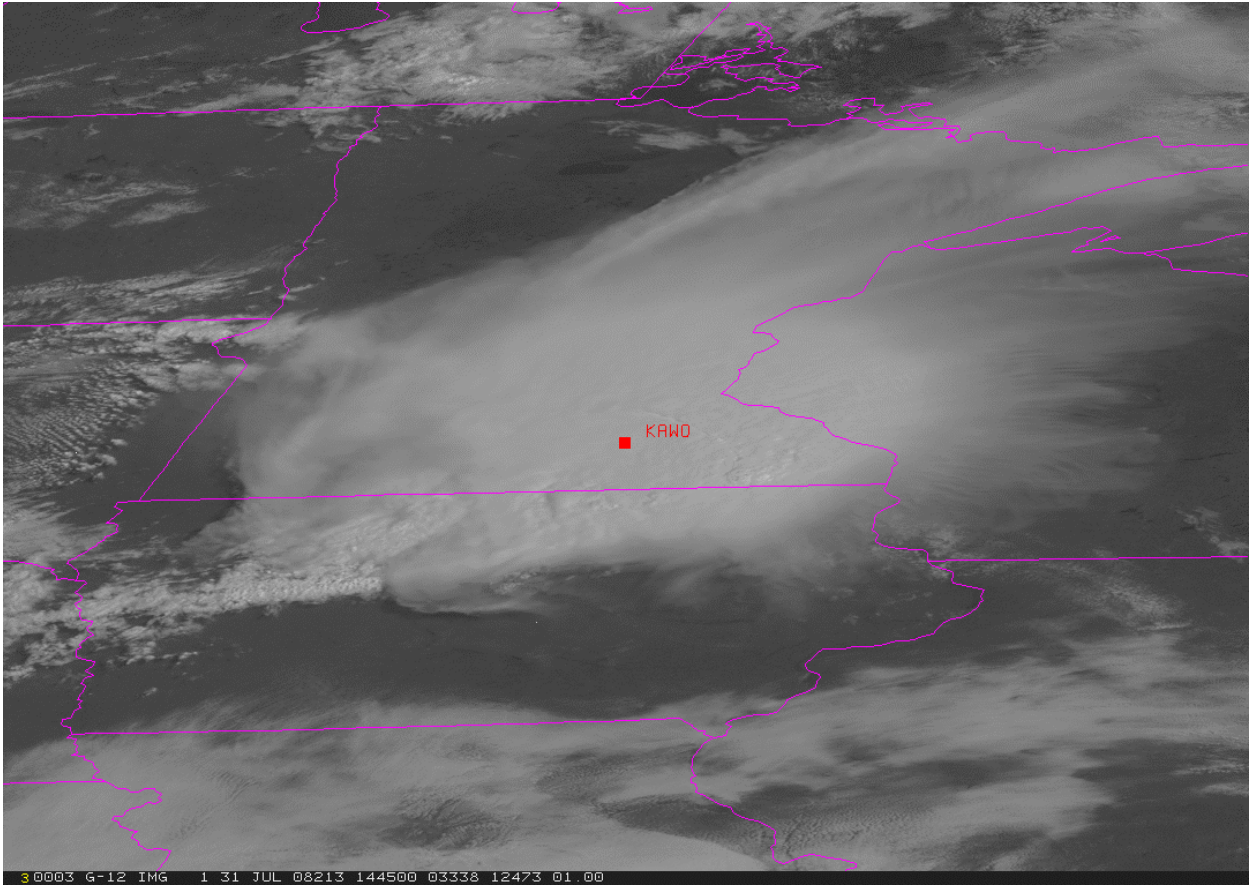
the Runway End Indicator Lights (REIL) were also out of service. The airport was in the progress of calling the FAA Flight Service Station (FSS) to issuing a notice to airmen, when the accident occurred. The PAPI and REIL were both working on the morning of August 1<sup>st</sup> without any maintenance or servicing. The cause of the outage was unknown.

cloud top temperature over KOWA was  $-61$  degrees C, which corresponded to cloud tops near 44,000 feet.

Figure 10 is the GOES-12 visible image at 0945 CDT, at 1 km resolution with KOWA marked. The image depicts KOWA under the anvil of a cumulonimbus cloud. The most intense portions of the cumulonimbus cloud with defined overshooting cloud tops can be identified over northern Iowa and southeastern Minnesota.



**Figure 9 – GOES-12 infrared image at 0945 CDT**



**Figure 10 – GOES-12 visible image at 0945 CDT**

#### **4.0 Weather Radar Information**

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D) was located at Chanhassen (KMPX), Minnesota, approximately 46 miles north of the accident site. The base reflectivity images were recreated from Level II archive data obtained from the National Climatic Data Center (NCDC) utilizing the Hierarchical Data Storage System (HDSS) and displayed using NEXRAD Interactive Viewer and Data Exporter software.

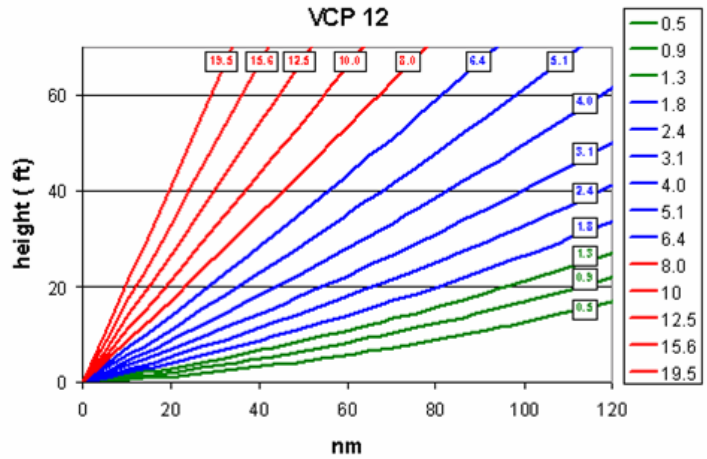
The WSR-88D is an S-band 10 centimeter wavelength radar with a power output of 750,000 watts, with a 28-foot parabolic antenna concentrating the energy into a 0.95-degree and 0.50-degree high resolution beam width. The radar produces three basic types of products reflectivity, radial velocity, and spectral width.

##### **4.0.1 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 is known as a volume scan. Individual elevation scans are immediately available on the WSR-88D's Principle Users Processor (PUP).

Products that require data from multiple elevation scans are not available until the end of the volume scan period.

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 to 19.5 degrees every 6 minutes. This particular scanning strategy is documented as volume coverage pattern 21 (VCP-21). VCP-21 is used primarily for "stratiform" precipitation or non-severe convective events where vertical features of rain clouds are not as important as during the convective, thunderstorm-type of rain. VCP-12 is used during period of potential severe convection, where the radar makes 14 tilts within 4 1/2-minutes with greater resolution at the lower elevation angles. 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 KMPX WSR-88D radar was operating in the severe convection precipitation mode (Mode A, VCP-12). 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-12 Precipitation Mode Scan Strategy**

#### 4.0.2 Beam Height Calculation

Assuming standard refraction<sup>11</sup> of the 0.95 degree radar beam of the WSR-88D, the following table shows the approximate beam height and width information of the KMPX WSR-88D radar display over the site of the accident, based on the antenna height of 1,101 feet msl. The heights have been rounded to the nearest 10 feet.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP	BEAM WIDTH
0.5	4,940 feet	2,630 feet	7,560 feet	4,630 feet
1.3	8,840 feet	6,530 feet	11,160 feet	4,630 feet

<sup>11</sup> Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

### 4.0.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors<sup>12</sup> 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<sup>13</sup>), 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	< 5	Trace
	1	5 to 9	
	2	10 to 14	
1 Very Light	3	15 to 19	.01 in/hr
	4	20 to 24	.02 in/hr
	5	25 to 29	.04 in/hr
2 Light to Moderate	6	30 to 34	.09 in/hr
	7	35 to 39	.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	55 to 59	>5.67 in/hr
	12	60 to 64	
	13	65 to 69	
	14	70 to 74	
	15	> 75	

<sup>12</sup> Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at the earth's surface; also, any water particles blown by the wind from the earth's surface. Hydrometeors are classified as; (a) Liquid or solid water particles suspended in the air: cloud, water droplets, mist or fog. (b) Liquid precipitation: drizzle and rain. (c) Freezing precipitation: freezing drizzle and freezing rain. (d) Solid (frozen) precipitation: ice pellets, hail, snow, snow pellets, and ice crystals. (e) Falling particles that evaporate before reaching the ground: virga. (f) Liquid or solid water particles lifted by the wind from the earth's surface: drifting snow, blowing snow, blowing spray. (g) Liquid or solid deposits on exposed objects: dew, frost, rime, and glaze ice.

<sup>13</sup> Reflected intensities are measured in dBZ (decibels of Z). As the strength of the signal returned to the radar increases the dBZ values increases. The Doppler radar does not determine where rain is located, only areas of returned energy. The "dB" in the dBZ scale is logarithmic and has no numerical value, but is used only to express a ratio. The "z" is the ratio of the density of water drops (measured in millimeters, raised to the 6th power) in each cubic meter (mm<sup>6</sup>/m<sup>3</sup>). Mathematically: dBZ= 10 \* log (z/z0). Where z = reflectivity factor and Z0 is defined to be 1 mm<sup>6</sup>/m<sup>3</sup>

The Federal Aviation Administration (FAA) Advisory Circular AC 00-24B titled “Thunderstorms” dated January 2, 1983, also defines the echo intensity levels and potential weather phenomena associated with those levels. If the maximum VIP Level is 1 “weak” and 2 “moderate”, then light to moderate turbulence is possible with lightning. VIP Level 3 is “strong” and severe turbulence is possible with lightning. VIP Level 4 is “very heavy” and severe turbulence is likely with lightning. VIP Level 5 is “intense” with severe turbulence, lightning, hail likely, and organized surface wind gusts. VIP Level 6 is “extreme” with severe turbulence, lightning, large hail, extensive surface wind gusts and turbulence.

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:

<u>Intensity Level</u>	<u>dBZ Levels</u>
"Light"	< 30 dBZ
"Moderate"	30 to 40 dBZ
"Heavy"	> 40 to 50 dBZ
"Extreme"	> 50 dBZ

#### **4.0.4 Base Reflectivity Data**

The flight track of the accident airplane designated as East Coast Jet flight 81 (ECJ81) obtained from the FAA National Track Analysis Program (NTAP) overlaid on the KMPX WSR-88D base reflectivity image for 0929 CDT (1429Z) is included as figure 11, with the aircraft’s location at that time marked. The image depicts the accident aircraft on a general direct route until entering Minnesota and then deviating north around the intense leading edge, entering the system and then turning southward, before turning northwestward into the Owatonna area. The flight was operating within the MCS in the stratified rain area with on descent and on approach into Owatonna area.

The KMPX WSR-88D base reflectivity image for 0946 CDT (1446Z) is included as figure 12, with the accident aircraft’s flight track overlaid. The image depicts the flight operating through echoes of 20 to 35 dBZ or “light to moderate” intensity echoes on descent into KOWA, with maximum intensity echoes of 40 dBZ in the immediate vicinity.

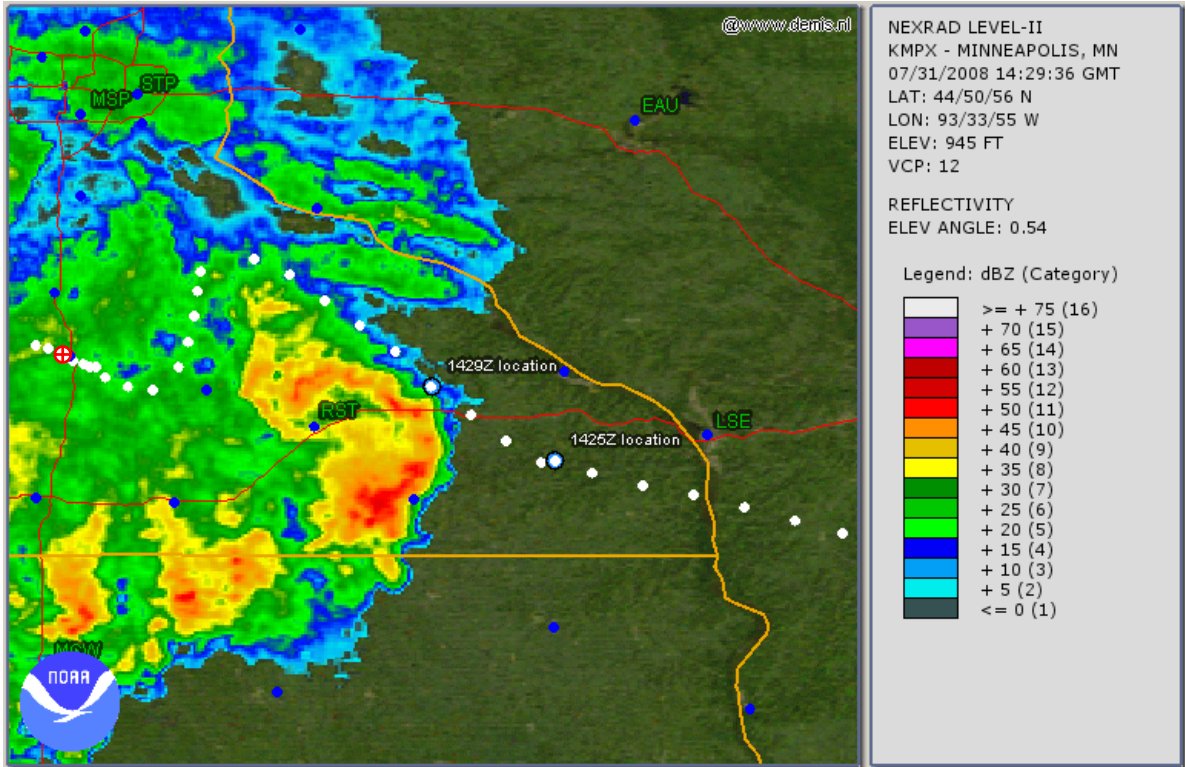


Figure 11 – Radar and Flight Aware track of ECJ81

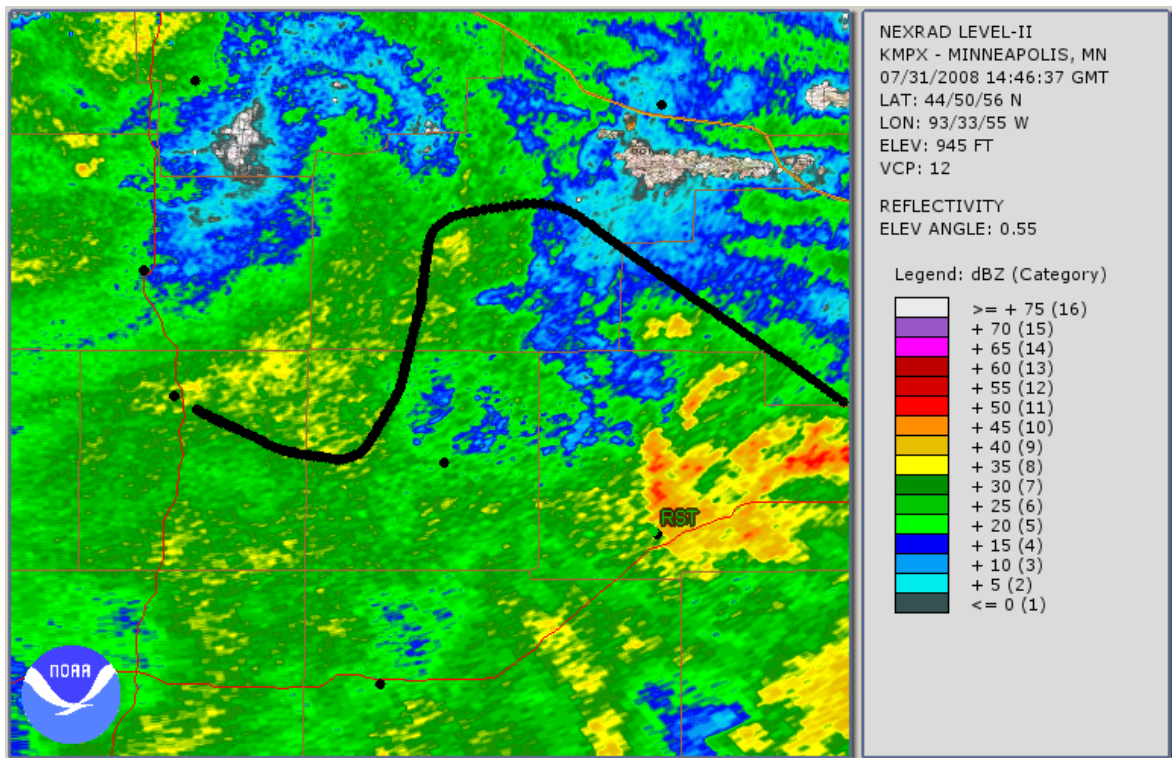


Figure 12 – KMPX WSR-88D base reflectivity image for 0946 CDT

#### 4.0.5 Base Velocity Data

Base velocity image depicts the radial velocity component of the wind (either towards or away from the radar), and helps to identify boundaries and regions of significant shear. Negative values are towards the radar and positive values away from the radar. Range folding (RF) occurs when the radar cannot distinguish whether the returned energy is from the most recently transmitted pulse or from a previous pulse that is returned from a more distant target or echo.

Figure 13 is the KMPX WSR-88D base radial velocity image at 0946 CDT, with a circle over KOWA for reference. The image depicted maximum winds of 64 knots near Rochester (KRST), east of the accident site. Inbound wind (or westerly) speeds of 20 knots were depicted over KOWA; however, at the time of the accident, the wind component was normal to the radar beam. Therefore, the NWS La Crosse (KARX) WSR-88D the radial velocity winds over the accident site were also documented.

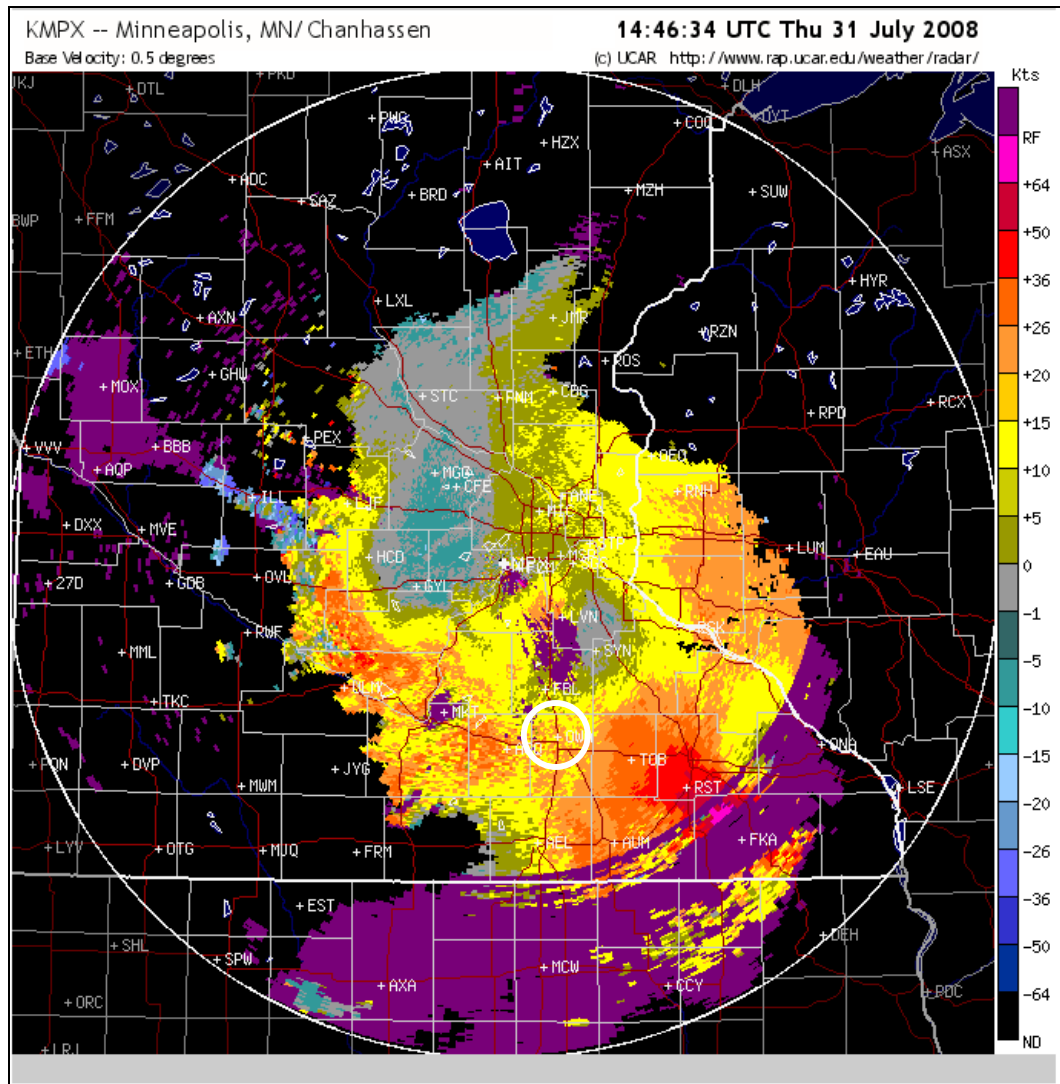


Figure 13 – KMPX WSR-88D radial velocity image for 0946 CDT

Figure 14 is the NWS KAPX WSR-88D base radial velocity image at 0946 CDT (1446Z). KARX radar was located 91 miles southeast of KOWA, and depicted inbound winds (westerly winds) of 40 to 50 knots over KOWA at the 0.5 degree beams altitude at approximately 10,360 feet. Closer to the radar site, near Rochester (KRST) and Preston (KFKA), inbound or westerly winds in excess of 50 knots are depicted. At this time, KRST reported surface wind gusts of 53 knots.

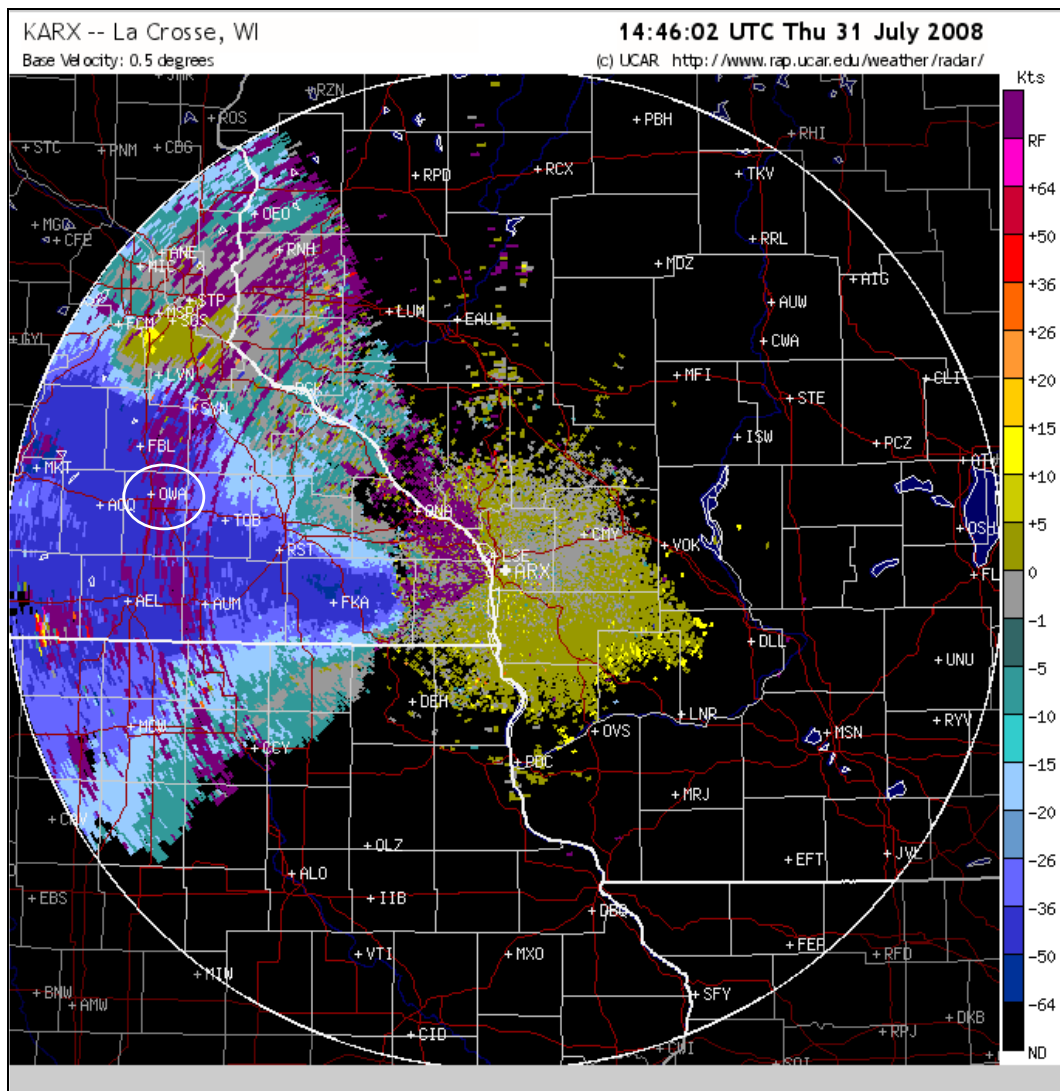


Figure 14 – KARX WSR-88D radial velocity image at 0946 CDT

## 5.0 Lightning Data

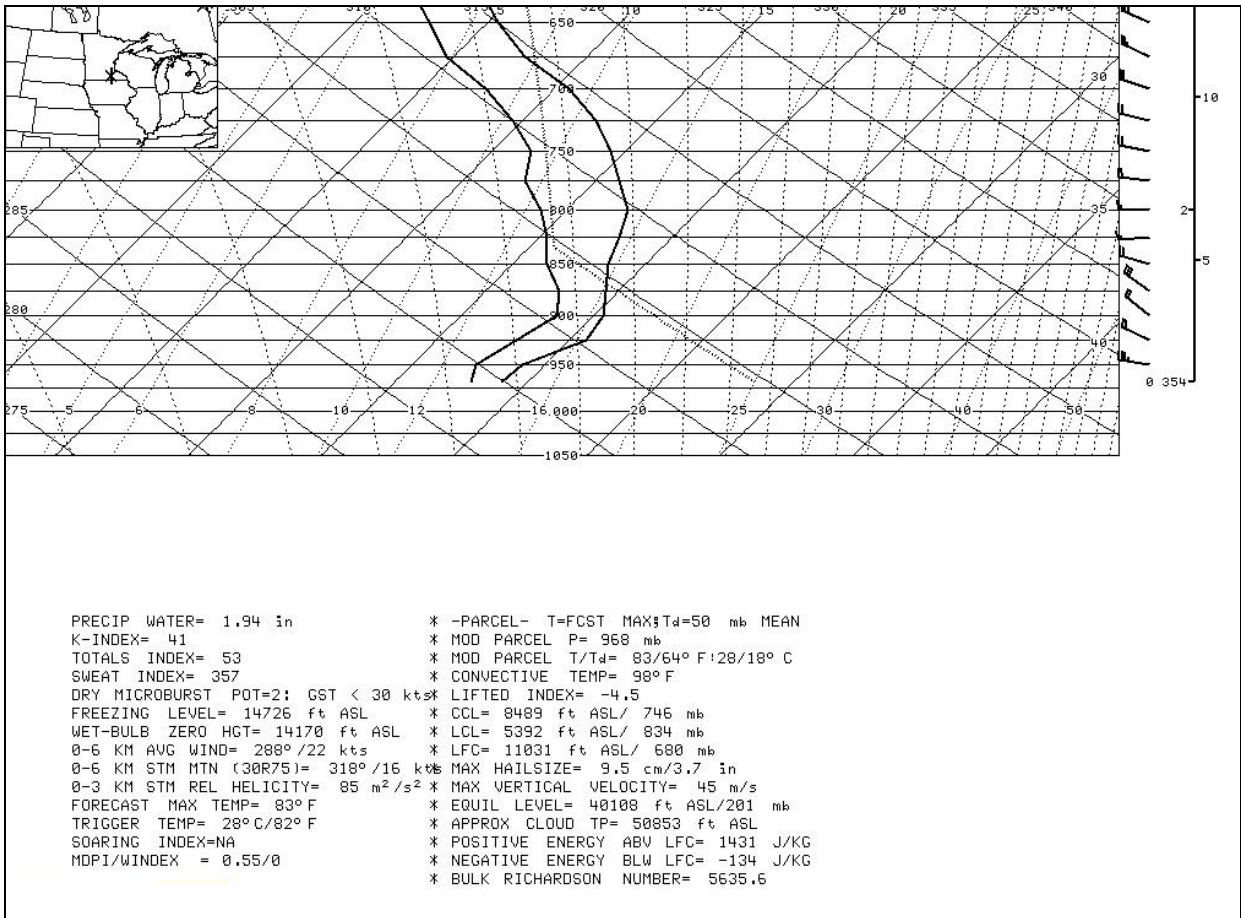
The National Lightning Detection Network (NLDN) operated by Vaisala's was reviewed for cloud-to-ground lightning strikes within 15 miles of the accident location. The NLDN network did not detect any lightning activity within 15 miles between 1436 and 1451 CDT on July 31, 2008, but did detect lightning outside of that distance.

## 6.0 Sounding Data

The most representative upper air sounding data during the period was obtained from the NWS Local Analysis and Prediction System (LAPS). A screen capture of the LAPS 0930 CDT (1430Z) and 1000Z (1500Z) soundings was obtained and are included as figures 15 and 16 respectively. The data is plotted on a standard 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.

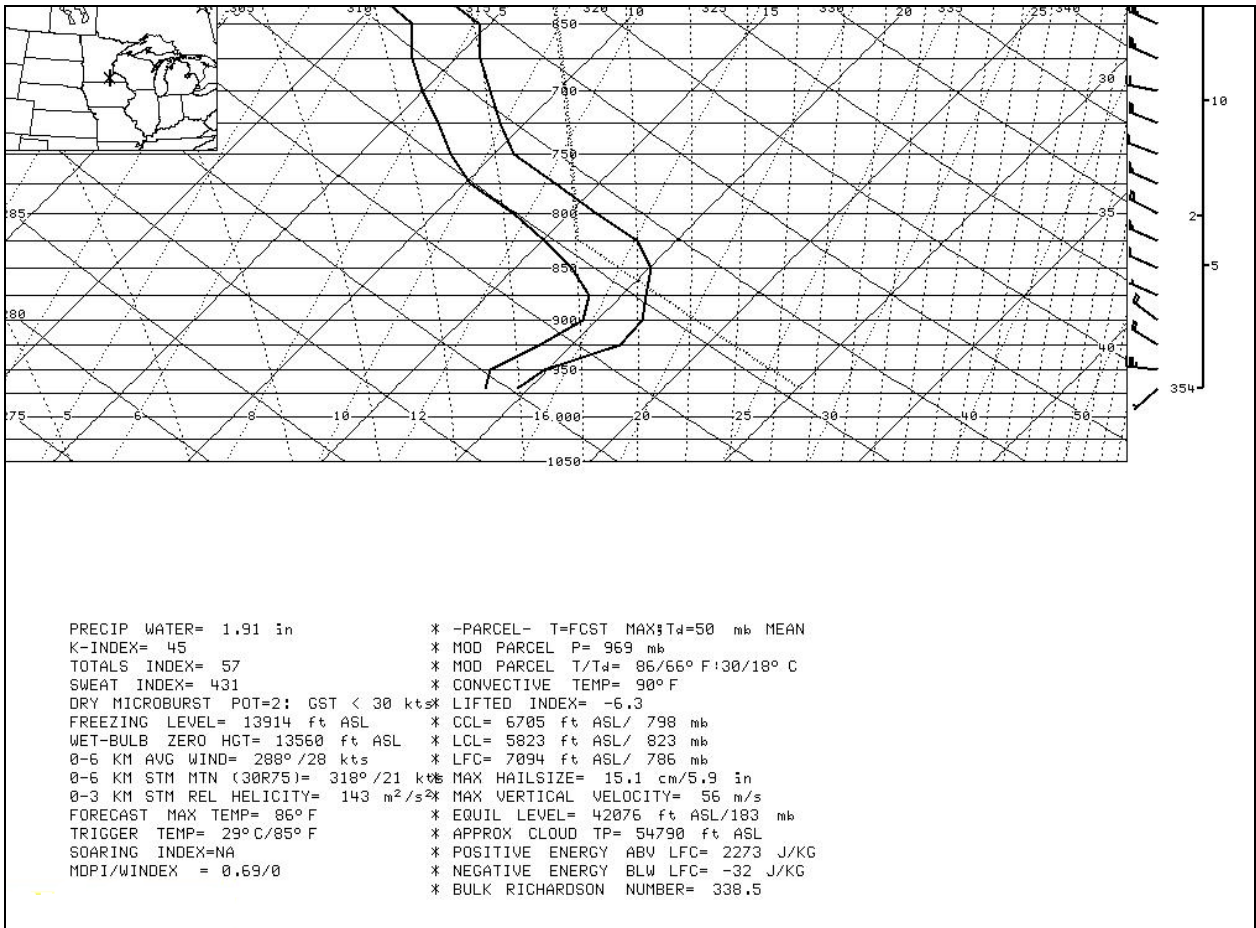
The LAPS sounding at 0930 CDT indicated a moist low-level environment from the surface through 15,000 feet, with temperature-dew point spreads 5 degrees C or less. The lifted condensation level (LCL) was identified at 834-hPa or 5,392 feet, the convective condensation level (CCL) at 746-hPa or 8,489 feet, and the level of free convection (LFC) at 680-hPa or 11,031 feet. The equilibrium level (EL) was at 201-hPa or 40,108 feet, with the expected cloud tops at 50,853 feet. The freezing level was 14,726 feet and support light to moderate icing in clouds above that level. The sounding was unstable with a lifted index of  $-4.5$ , with the K-index of 41, and all other parameters favorable for severe thunderstorms, which had moved through the area earlier that morning.

The right hand section of the LAPS provided the vertical wind profile, and indicated a calm surface wind, with winds at approximately 120 feet agl or 1,665 feet msl from 278 degrees at 33 knots. Similar conditions were observed at approximately 620 feet agl or 1,774 feet msl, with the winds from 279 degrees at 34 knots. The sounding indicated a potential low-level wind shear condition over KOWA.



**Figure 15 – LAPS KOWA sounding for 0930 CDT**

The LAPS for 1000 CDT is included as figure 16, and depicted similar conditions with surface wind from 230 degrees at 4 knots, and at 1,829 feet msl from 278 degrees at 33 knots, and wind above 50 knots between 12,000 to 15,000 feet.



**Figure 16 – LAPS KOWA sounding for 1000 CDT**

## 7.0 NWS Weather Service Forecast Office (WSFO) Interviews

On August 1, 2008, the Meteorology Chairmen Specialist met with Mr. Todd D. Kraise, the Warning Coordination Meteorologist In-Charge (MIC); Mr. Ross Carlyon, the Hydrological Meteorological Technician (HMT); and Mr. Rick Hiltbrand, the Lead Forecaster.

### 7.0.1 Warning Coordination Meteorologist In-Charge (MIC)

Mr. Todd D. Kraise was responsible for the operation and administration of the WSFO at the regional office located in Chanhassen, Minnesota. Mr. Kraise provided details relating to local reporting locations, a summary of the weather conditions across the area on the day of the accident, identified key personnel on duty during the period, and provided the public forecasts and warnings issued during the period (log included as attachment 2 at bottom of this report), storm spotter reports, and storm reports (included in section 9.0).

### **7.0.2 Hydrological Meteorological Technician (HMT)**

Mr. Ross Carlyon, the Hydrological Meteorological Technician (HMT) on duty from 0800 to 1800 CDT on July 31, 2008, identified his duties as included collecting, disseminating reports of severe weather to the media for warning purposes, and reviewing post warning data for verification purposes. He then reviewed the log of severe weather reports that he had entered. Mr. Carlyon stated the reports indicated an extensive band of damaging winds, small hail, and reports of funnel clouds across the region as the system moved southeastward across southern Minnesota. He stated that one high wind report of interest was from Redwood Falls (KRFD), west of Owatonna, which reported a peak wind gust of 51 knots (59 mph) at 0818 CDT. This was located behind the main band of convection, and not classified as thunderstorm related. The weather warning had been cancelled at the time of the report as the main convective section of the system had passed the station at the time.

### **7.0.3 Lead Forecast on Duty**

Meteorologist Mr. Rick Hiltbrand was the Lead Forecaster on duty the day of the accident. He was working a short turn shift from 0700 to 1500 CDT, and was on his first day of the work week. He indicated that when he arrived, the severe weather had already started across Minnesota in their warning area. He described the system as a large MCS, with a well-defined bow echo that moved from South Dakota, southern Minnesota, into Iowa and Wisconsin. Upon seeing the severe weather, they requested and received authorization to hold the three midnight shift meteorologists over to help. He then issued an Aviation Weather Warning (AWW) to the Minneapolis-St. Paul International Airport (KMSP), which is the only airport in the region that specific airport warnings are issued for, warning of the potential storm moving across the area. The aviation forecasting duties were then transferred to the NWS Duluth WSFO, so they forecasters could concentrate on their weather warnings, which continued through the morning hours.

Mr. Hiltbrand played the NWS Advanced Weather Interactive Processing System (AWIPS) reconstruction disk of the event and described the system utilizing the WSR-88D, satellite imagery, LAPS sounding, and other data. He identified the MCS and bow echo that depicted well-defined circulation features with several mesocyclones, tornado vortex signatures (TVS), and mesoscale vorticity center (MVC). The MCS was characterized as a classic intense leading edge bow echo with a rear inflow jet that brought high level drier air and winds downward to the surface and accelerating the system southeastward. The MXP WSR-88D base radial velocity data had depicted inbound or westerly winds of 114 knots at 7,000 feet associated with the rear inflow jet. The reconstruction of the event showed that the MCS and related bow echo had moved southeastward at 55 even faster than the initially weather advisories had issued. The crest of the bow echo moved through the Owatonna area at 0830 CDT with a mesocyclone and TVS immediately north of the airport associated with the northern bookend vortice when the high gusting winds were recorded. A tornado warning had been issued due to these signatures on radar; however, other than straight-line wind damage no specific tornado was confirmed by spotters. Similar signatures were also observed from the NWS La Crosse radar located approximately 90 miles southeast of KOWA.

At the time of the accident, Mr. Hiltbrand indicated that the KMXR WSR-88D base reflectivity image depicted echoes of 20 to 30 dBZ over KOWA associated with light to moderate rain. Some embedded convective activity was still occurring behind the main convective line and did depict some decreasing lightning activity. The base radial velocity images depicted inbound winds of 80 knots at 4,100 feet immediately east of KOWA at 0854 CDT related to the rear inflow jet. At the time of the accident, the band of winds were normal to the radar beam and could not provide accurate information of wind directly overhead of KOWA, the maximum winds observed over southern Minnesota were over 64 knots near KRST. The KAPX base radial velocity image at 0946 CDT depicted inbound (westerly) winds of 40 to 50 knots over KOWA at approximately 10,000 feet.

The lightning data showed that at 0700 CDT, the MCS and associated bow echo had an excess of 700 cloud-to-ground lightning strikes, with the lightning activity decreasing as it moved southeastward through the area and the rear inflow jet mixed drier more stable air into the system. No significant lightning strikes were observed at 0945 CDT in the vicinity of KOWA.

The LAPS sounding was reviewed and the stability indices favored severe weather, and depicted the influence of the rear inflow jet across the KOWA area, and indicated strong westerly low-level winds immediately above the surface.

At 1000 CDT, the worst of the weather had moved out of their warning region responsibility and they released the midnight shift and regained their aviation forecast responsibilities.

With regards to aviation support, the NWS indicated that they do not issue a Terminal Aerodrome Forecast (TAF) for KOWA. At the time of the accident, a Convective SIGMET, severe thunderstorm warning was current for the area.

## **8.0 Aviation Text Products**

The standard NWS aviation weather products issued surrounding the period of the accident were also documented.

### **8.0.1 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 AIMET 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 FA is a 12-hour forecast of VFR clouds and weather significant to flight operations plus a 6-hour outlook. The forecast includes a synopsis section, which is a brief summary of the location and movement of fronts, pressure system, and circulation patterns. FAs are issued 3 times a day from Kansas City Aviation Weather Center (AWC). The region that

covers the KAWO area is under the Chicago (KCHI) regional forecast. The forecast current at the time prior to the flight's departure was issued at 0445 CDT (0945Z) on July 31, 2008, and was valid until 1700 CDT (2200Z). The forecast for Minnesota was as follows:

*CHIC FA 310945  
SYNOPSIS AND VFR CLDS/WX  
SYNOPSIS VALID UNTIL 010400  
CLDS/WX VALID UNTIL 312200...OTLK VALID 312200-010400  
ND SD NE KS MN IA MO WI LM LS MI LH IL IN KY*

*.  
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...10Z LO PRES NWRN SD. WRMFNT EXTDG EWD FROM LO PRES ACRS NERN SD-FAR SRN MN-FAR SRN WI-FAR SRN MI. CDFNT MOVG INTO WRN PTNS SD EARLY IN FCST PD. BY 010400 LO PRES SERN SD. STNR FNT EXTDG SEWD FROM LO INTO NRN IN AND CDFNT CURVING SWWD FROM LO ACRS ERN AND SRN NE. WK LO PRES SERN MO MOVG SLOLY EWD THRUT PD AND WKNG.*

*MN SWRN...BKN050 BKN120 TOP FL180. WDLY SCT TSRA POSS SEV. CB TOP FL450. 17Z SCT050 SCT100. OTLK...VFR TSRA.  
NWRN...BKN150 TOP FL240. VIS 5SM BR. OCNL -RA SRN PTNS. 15Z SCT050. 19Z WDLY SCT -TSRA. CB TOP FL340. OTLK...VFR TSRA/23Z VFR.  
NERN...AGL SCT010 BKN CI. VIS 3SM BR. SCT050 SCT-BKN CI. 21Z WDLY SCT -TSRA. CB TOP FL340. OTLK...VFR TSRA.  
SERN...AGL SCT050 SCT CI. OCNL VIS 3-5SM BR. 17Z WDLY SCT TSRA POSS SEV. CB TOP FL450. OTLK...VFR TSRA.*

The forecast indicated that a warm front extended from a low pressure system across northeastern South Dakota through southern Minnesota, Wisconsin, and Michigan. The forecast for southwestern Minnesota expected widely scattered thunderstorms and rain showers, and possible severe thunderstorms, with cumulonimbus cloud tops to 45,000 feet until 1200 CDT. Southeastern Minnesota expected occasional visibility 3 to 5 miles in mist, with widely scattered thunderstorms and rain showers after 1200 CDT, with possible severe thunderstorms, with tops to 45,000 feet.

The forecast was amended at 0645 CDT (1145Z) and expected the following:

*CHIC FA 311145 AMD  
SYNOPSIS AND VFR CLDS/WX  
SYNOPSIS VALID UNTIL 010400  
CLDS/WX VALID UNTIL 312200...OTLK VALID 312200-010400  
ND SD NE KS MN IA MO WI LM LS MI LH IL IN KY*

*.  
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...10Z LO PRES NWRN SD. WRMFNT EXTDG EWD FROM LO PRES ACRS NERN SD-FAR SRN MN-FAR SRN WI-FAR SRN MI. CDFNT MOVG INTOWNRN PTNS SD EARLY IN FCST PD. BY 010400 LO*

*PRES SERN SD. STNR FNT EXTDG SEWD FROM LO INTO NRN IN AND CDFNT CURVING SWWD FROM LO ACRS ERN AND SRN NE. WK LO PRES SERN MO MOVG SLOLY EWD THRUT PD AND WKNG.*

*MN...UPDT*

*SWRN...BKN050 BKN120 TOP FL180. WDLY SCT TSRA POSS SEV. CB TOP FL450. 17Z SCT050 SCT100. OTLK...VFR TSRA.*

*NWRN...BKN150 TOP FL240. VIS 5SM BR. OCNL -RA SRN PTNS. 15Z SCT050. 19Z WDLY SCT -TSRA. CB TOP FL340. OTLK...VFR TSRA/23Z VFR.*

*NERN...AGL SCT010 BKN CI. VIS 3SM BR. SCT050 SCT-BKN CI. 21Z WDLY SCT -TSRA. CB TOP FL340. OTLK...VFR TSRA.*

*SERN...AGL SCT050 SCT CI. OCNL VIS 3-5SM BR. 13Z WDLY SCT TSRA POSS SEV. CB TOP FL450. OTLK...VFR TSRA.*

The amended forecast for southeastern Minnesota expected scattered clouds at 5,000 feet with scattered cirrus clouds above, with visibility 3 to 5 miles in mist. From 0600 CDT (1300Z) widely scattered thunderstorms and rain showers, and possible severe thunderstorms, with cumulonimbus cloud tops to 45,000 feet. The outlook from 1500 to 2100 CDT (2200Z to 0400Z) expected VFR conditions to prevail with thunderstorms and rain showers.

## **8.0.2 In-Flight Weather Advisories**

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

### **Convective SIGMETs**

*MKCC WST 311355*

*CONVECTIVE SIGMET 36C*

*VALID UNTIL 1555Z*

*WI MN IA NE SD ND*

*FROM 20E BRD-20SW ODI-80SSE FSD-40NNE ABR-20E BRD*

*AREA SEV TS MOV FROM 29045KT. TOPS ABV FL450.*

*HAIL TO 2 IN...WIND GUSTS TO 70KT POSS.*

*OUTLOOK VALID 311555-311955*

*AREA 1...FROM 80NE MOT-60WNW INL-INL-70ESE DLH-40NNW BDF-30NE*

*OBH-40W ABR-80NE MOT*

*WST ISSUANCES EXPD. REFER TO MOST RECENT ACUS01 KWNS FROM STORM*

*PREDICTION CENTER FOR SYNOPSIS AND METEOROLOGICAL DETAILS.*

Convective SIGMET 36C was current at the time of the accident and warned of an area of severe thunderstorms moving from 290 degrees at 45 knots, with tops above 45,000 feet. Hail to 2-inches and wind gusts to 70 knots were possible with these storms. Severe to extreme turbulence, severe icing, low-level wind shear, and localized IFR conditions were implied with the issuance of the bulletin. The outlook section referred the users to see the latest Convective

Outlook (AC) bulletin (included in section 1.0.3 of this report) for a further synopsis and meteorological details on the severe thunderstorms.

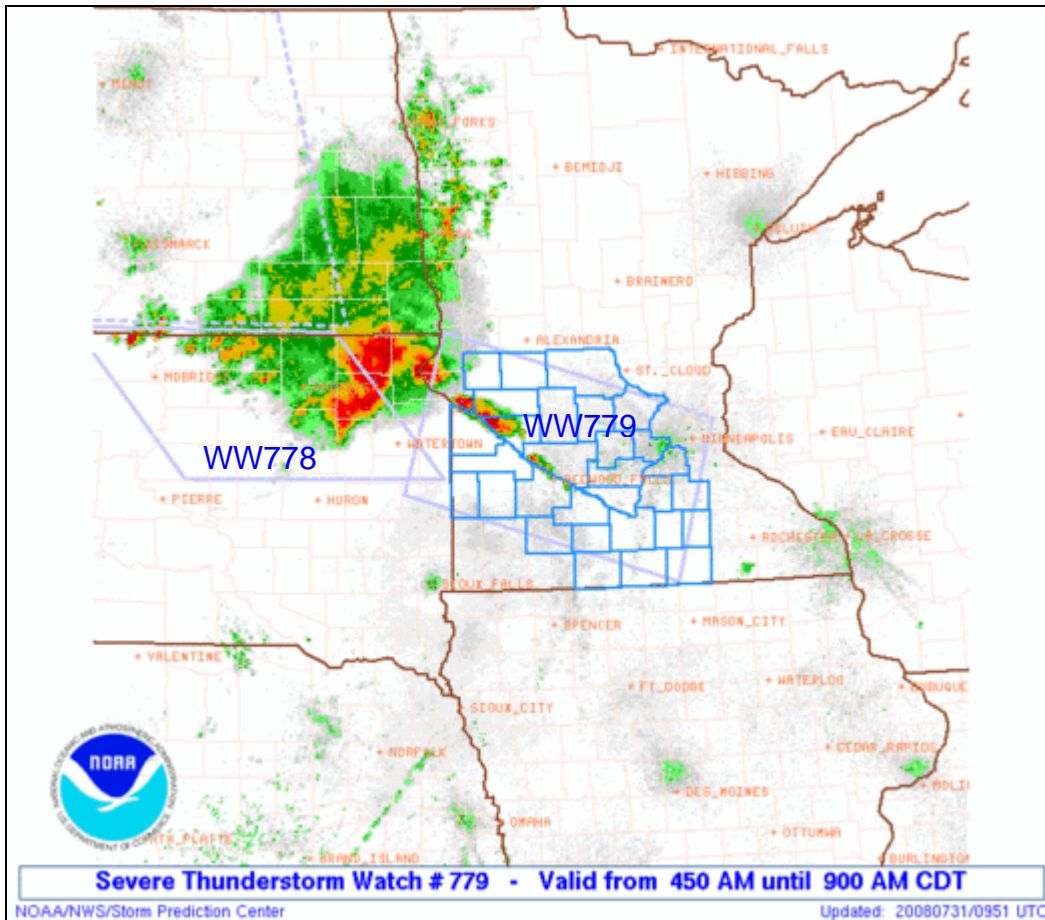
### **Severe Weather Forecast Alerts**

The NWS Storm Prediction Center (SPC) issued several severe weather watches prior to the accident airplane's departure from Atlantic City. Weather watch number 779 was issued at 0450 CDT and was valid until 0900 CDT for southern Minnesota for a line of severe thunderstorms moving east-southeast at 40 knots. The line was identified as a bowing mesoscale convective system and potential derecho<sup>14</sup> event with damaging winds that was running along the warm front, which was stalled over the area. Figure 17 is a depiction of weather watches 778 and 779 over the weather radar mosaic at the time of issuance.

Weather watch number 780 was issued at 0710 CDT and extended over the accident site. The advisory however, was issued with a "test" message heading and was replaced by weather watch number 781 at 0720 CDT and valid until 1200 CDT. Figure 18 is a depiction of weather watches 779 and 781 that extended over southern Minnesota and the radar mosaic at the time of the issuance of the advisory.

---

<sup>14</sup> Derecho - a widespread and usually fast-moving windstorm associated with convection. Derechos include any family of downburst clusters produced by an extratropical MCS, and can produce damaging straight-line winds over areas hundreds of miles long and more than 100 miles across.



**Figure 17 – Weather Watches 778 and 779**

WW 779 SEVERE TSTM MN 310950Z - 311400Z  
 AXIS..55 STATUTE MILES EITHER SIDE OF LINE..  
 20WSW VVV/ORTONVILLE MN/ - 40S MSP/MINNEAPOLIS MN/  
 ..AVIATION COORDS.. 50NM EITHER SIDE /68E ABR - 35S MSP/  
 HAIL SURFACE AND ALOFT..2 INCHES. WIND GUSTS..60 KNOTS.  
 MAX TOPS TO 500. MEAN STORM MOTION VECTOR 29040.

Public full version of the advisory:

*URGENT - IMMEDIATE BROADCAST REQUESTED  
 SEVERE THUNDERSTORM WATCH NUMBER 779  
 NWS STORM PREDICTION CENTER NORMAN OK  
 450 AM CDT THU JUL 31 2008*

*THE NWS STORM PREDICTION CENTER HAS ISSUED A  
 SEVERE THUNDERSTORM WATCH FOR PORTIONS OF*

*SOUTHWEST AND CENTRAL MINNESOTA*

*EFFECTIVE THIS THURSDAY MORNING FROM 450 AM UNTIL 900 AM CDT.*

*HAIL TO 2 INCHES IN DIAMETER...THUNDERSTORM WIND GUSTS TO 70  
 MPH...AND DANGEROUS LIGHTNING ARE POSSIBLE IN THESE AREAS.*

*THE SEVERE THUNDERSTORM WATCH AREA IS APPROXIMATELY ALONG AND 55 STATUTE MILES EITHER SIDE OF A LINE FROM 20 MILES WEST SOUTHWEST OF ORTONVILLE MINNESOTA TO 40 MILES SOUTH OF MINNEAPOLIS MINNESOTA. FOR A COMPLETE DEPICTION OF THE WATCH SEE THE ASSOCIATED WATCH OUTLINE UPDATE (WOUS64 KWNS WOU9).*

*REMEMBER...A SEVERE THUNDERSTORM WATCH MEANS CONDITIONS ARE FAVORABLE FOR SEVERE THUNDERSTORMS IN AND CLOSE TO THE WATCH AREA. PERSONS IN THESE AREAS SHOULD BE ON THE LOOKOUT FOR THREATENING WEATHER CONDITIONS AND LISTEN FOR LATER STATEMENTS AND POSSIBLE WARNINGS. SEVERE THUNDERSTORMS CAN AND OCCASIONALLY DO PRODUCE TORNADOES.*

*OTHER WATCH INFORMATION...CONTINUE..WW 777.. WW778...*

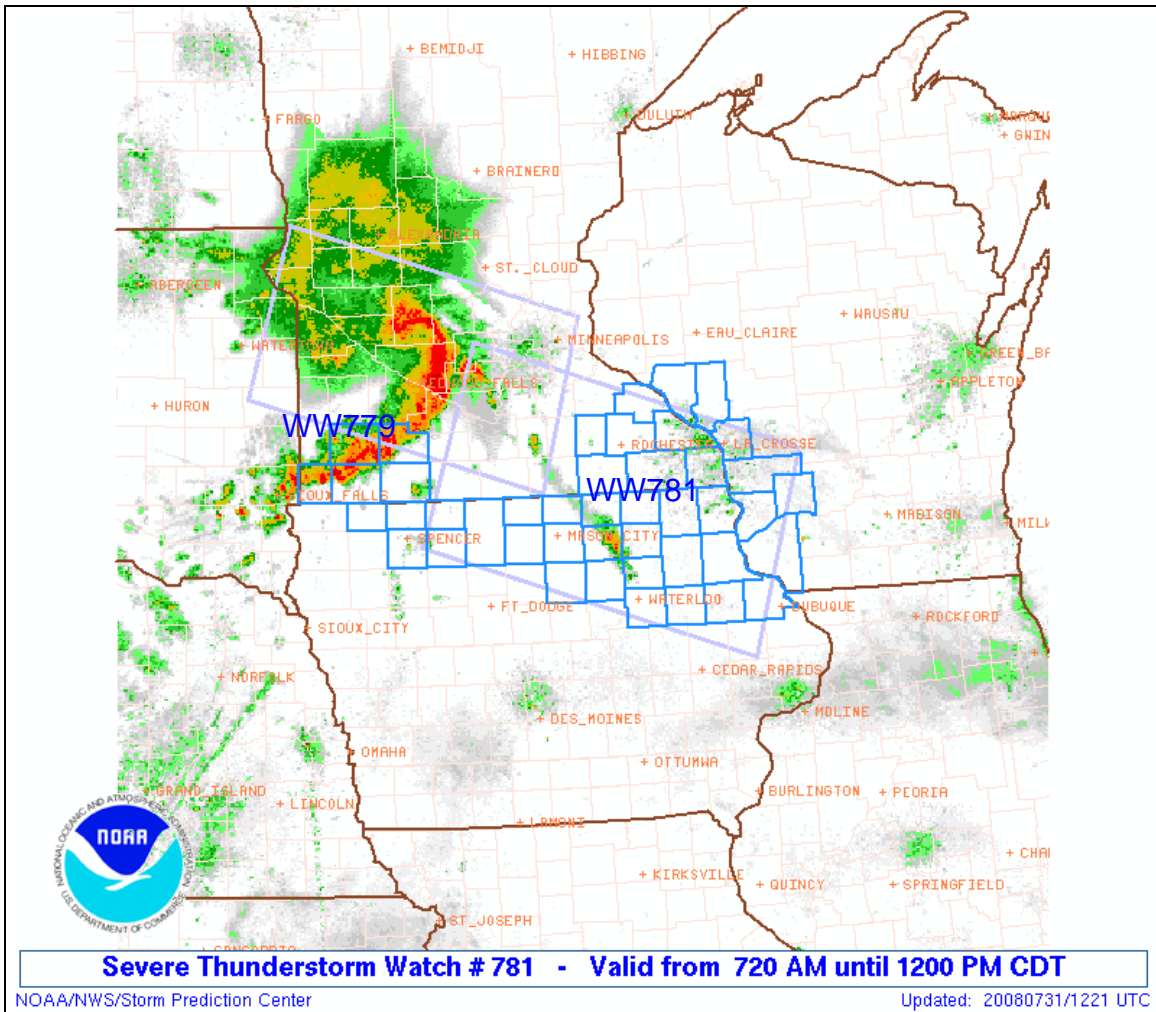
*DISCUSSION...BOWING MCS/POTENTIAL DERECHO IS EXPECTED TO CONTINUE RACING ESEWD ACROSS WW EARLY THIS MORNING INVOF STALLED SURFACE FRONT AND ASSOCIATED INSTABILITY GRADIENT. WIND DAMAGE WILL LIKELY BE QUITE INTENSE/WIDESPREAD WITH THESE STORMS. STRENGTHENING SWLY LLJ WILL ALSO SUPPORT ELEVATED STORMS AHEAD OF THE LINE WITHIN DEVELOPING WAA-WING...AND IN WAKE OF SYSTEM ATOP STRONG SURFACE COLD POOL...WITH THREATS OF LARGE HAIL.*

*AVIATION...A FEW SEVERE THUNDERSTORMS WITH HAIL SURFACE AND ALOFT TO 2 INCHES. EXTREME TURBULENCE AND SURFACE WIND GUSTS TO 60 KNOTS. A FEW CUMULONIMBI WITH MAXIMUM TOPS TO 500. MEAN STORM MOTION VECTOR 29040.  
...EVANS*

*STATUS REPORT #1 ON WW 779  
VALID 311100Z - 311240Z  
THE SEVERE WEATHER THREAT CONTINUES ACROSS THE ENTIRE WATCH AREA.  
FOR ADDITIONAL INFORMATION SEE MESOSCALE DISCUSSION 1972  
..GUYER..07/31/08  
ATTN...WFO...MPX...FSD...*

*STATUS REPORT #2 ON WW 779  
VALID 311230Z - 311340Z  
SEVERE WEATHER THREAT CONTINUES RIGHT OF A LINE FROM 15 WNW BKX TO 25 SE AXN.  
FOR ADDITIONAL INFORMATION SEE MESOSCALE DISCUSSION 1973  
..GUYER..07/31/08  
ATTN...WFO...MPX...FSD...*

*WW 780 TEST SEVERE TSTM IA MN WI 311210Z - 311700Z  
AXIS..65 STATUTE MILES EITHER SIDE OF LINE..  
25NNW FRM/FAIRMONT MN/ - 75SSE LSE/LA CROSSE WI/  
..AVIATION COORDS.. 55NM EITHER SIDE /37SE RWF - 29N DBQ/  
HAIL SURFACE AND ALOFT..2 INCHES. WIND GUSTS..70 KNOTS.  
MAX TOPS TO 500. MEAN STORM MOTION VECTOR 30040.*



**Figure 18 – Weather Watches 779 and 781**

*WW 781 SEVERE TSTM IA MN WI 311220Z - 311700Z  
 AXIS..65 STATUTE MILES EITHER SIDE OF LINE..  
 25NNW FRM/FAIRMONT MN/ - 75SSE LSE/LA CROSSE WI/  
 ..AVIATION COORDS.. 55NM EITHER SIDE /37SE RWF - 29N DBQ/  
 HAIL SURFACE AND ALOFT..2 INCHES. WIND GUSTS..70 KNOTS.  
 MAX TOPS TO 500. MEAN STORM MOTION VECTOR 30040.*

Public plain language issuance:

*URGENT - IMMEDIATE BROADCAST REQUESTED  
 SEVERE THUNDERSTORM WATCH NUMBER 781  
 NWS STORM PREDICTION CENTER NORMAN OK  
 720 AM CDT THU JUL 31 2008*

*THE NWS STORM PREDICTION CENTER HAS ISSUED A  
 SEVERE THUNDERSTORM WATCH FOR PORTIONS OF*

*NORTHERN IOWA  
 SOUTHERN MN MINNESOTA*

*SOUTHWEST WI WISCONSIN*

*EFFECTIVE THIS THURSDAY MORNING FROM 720 AM UNTIL NOON CDT.*

*HAIL TO 2 INCHES IN DIAMETER...THUNDERSTORM WIND GUSTS TO 80 MPH...AND DANGEROUS LIGHTNING ARE POSSIBLE IN THESE AREAS.*

*THE SEVERE THUNDERSTORM WATCH AREA IS APPROXIMATELY ALONG AND 65 STATUTE MILES EITHER SIDE OF A LINE FROM 25 MILES NORTH NORTHWEST OF FAIRMONT MINNESOTA TO 75 MILES SOUTH SOUTHEAST OF LA CROSSE WISCONSIN. FOR A COMPLETE DEPICTION OF THE WATCH SEE THE ASSOCIATED WATCH OUTLINE UPDATE (WOUS64 KWNS WOU1).*

*REMEMBER...A SEVERE THUNDERSTORM WATCH MEANS CONDITIONS ARE FAVORABLE FOR SEVERE THUNDERSTORMS IN AND CLOSE TO THE WATCH AREA. PERSONS IN THESE AREAS SHOULD BE ON THE LOOKOUT FOR THREATENING WEATHER CONDITIONS AND LISTEN FOR LATER STATEMENTS AND POSSIBLE WARNINGS. SEVERE THUNDERSTORMS CAN AND OCCASIONALLY DO PRODUCE TORNADOES.*

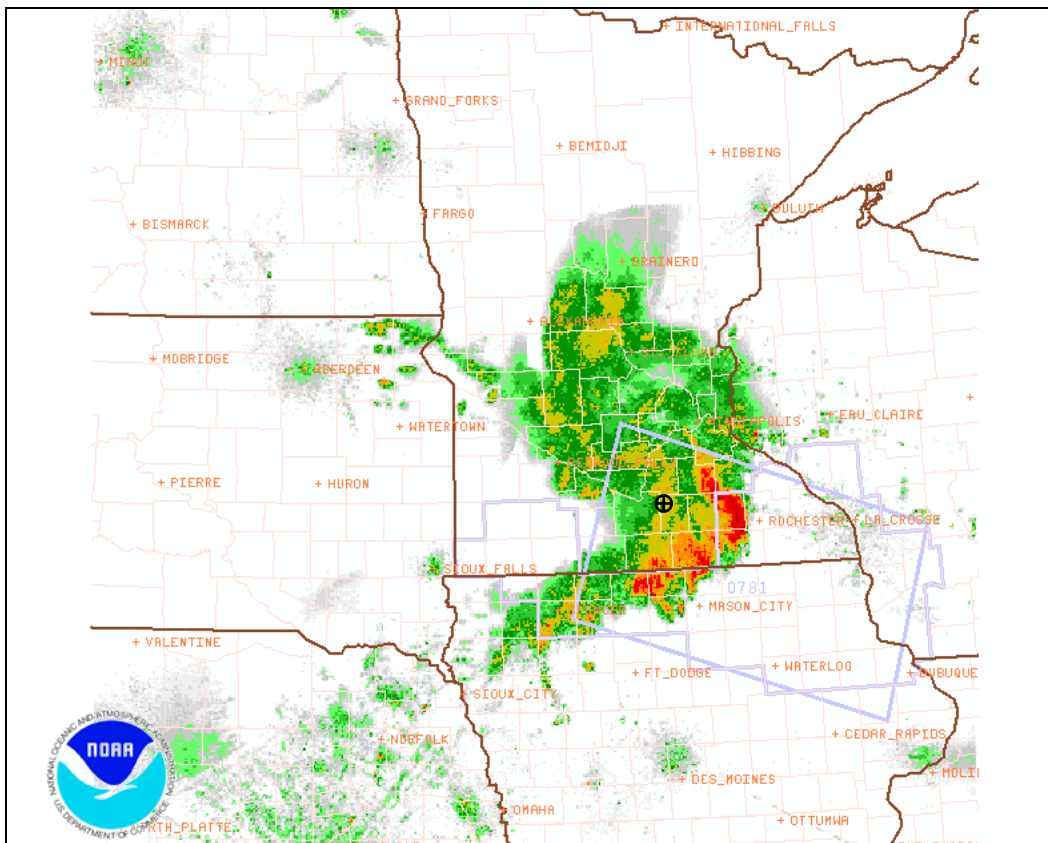
*OTHER WATCH INFORMATION...THIS SEVERE THUNDERSTORM WATCH REPLACES SEVERE THUNDERSTORM WATCH NUMBER 780. WATCH NUMBER 780 WILL NOT BE IN EFFECT AFTER 720 AM CDT. CONTINUE..WW 779....*

*DISCUSSION...SEVERE MCS/BOW ECHO WITH HISTORY OF WIND DAMAGE WILL CONTINUE TO QUICKLY SPREAD SOUTHEASTWARD THROUGH THE MORNING ACROSS SOUTHERN MN INTO SOUTHWEST WI...WITH ADDITIONAL DEVELOPMENT LIKELY INTO NORTHERN IA. POTENTIAL WILL EXIST FOR WIDESPREAD DAMAGING WINDS AND SEVERE HAIL THROUGH THE MORNING.*

*AVIATION...A FEW SEVERE THUNDERSTORMS WITH HAIL SURFACE AND ALOFT TO 2 INCHES. EXTREME TURBULENCE AND SURFACE WIND GUSTS TO 70 KNOTS. A FEW CUMULONIMBI WITH MAXIMUM TOPS TO 500. MEAN STORM MOTION VECTOR 30040.  
...EVANS/GUYER*

Severe thunderstorm watch number 781 was issued at 0720 CDT and was current at the time of the accident for southeastern Minnesota, northern Iowa, and southwestern Wisconsin. The advisory warned of a line of severe thunderstorms, with hail to 2 inches and wind gusts to 70 knots. Cumulonimbus cloud tops above 50,000 feet, with the mean storm vector from the northwest at 40 knots. The discussion further identified a severe mesoscale convective system with a bow echo with a history of producing damaging winds.

Figure 19 is a depiction of weather watch number 781 and the radar mosaic at approximately 0930 CDT, immediately prior to the accident.



**Figure 19 - Severe Thunderstorm Watch 781 and weather radar mosaic at 0930 CDT**

**AIRMETS**

*CHIS WA 31120 AMD  
 AIRMET SIERRA UPDT 2 FOR IFR AND MTN OBSCN VALID UNTIL 311500*

*AIRMET IFR...MN WI LS MI  
 FROM INL TO 30SW YQT TO SSM TO 50S SSM TO GRB TO 30ESE MSP TO BRD TO INL  
 CIG BLW 010/VIS BLW 3SM BR. CONDS ENDG BY 14Z.*

*AIRMET IFR...SD NE KS IA MO WI LM MI IL IN KY OK...UPDT  
 FROM 30ESE MSP TO ORD TO DXO TO FWA TO CVG TO FAM TO RZC TO OKC  
 TO 70E GCK TO 70S FSD TO 30ESE MSP  
 CIG BLW 010/VIS BLW 3SM BR/FG. CONDS ENDG 14-15Z.*

*CHIT WA 310845  
 AIRMET TANGO UPDT 1 FOR TURB VALID UNTIL 311500*

*AIRMET TURB...SD NE  
 FROM 80SW DIK TO 60SSW BIS TO PIR TO 50NNE ONL TO OBH TO MCK TO  
 BFF TO 80SW DIK  
 MOD TURB BLW 120. CONDS ENDG 14-15Z.*

*CHIZ WA 310845*

*AIRMET ZULU UPDT 1 FOR ICE AND FRZLVL VALID UNTIL 311500*

*.  
NO SGFNT ICE EXP OUTSIDE OF CNVTV ACT.*

*.  
FRZLVL...RANGING FROM 115-ABV 160 ACRS AREA  
120 ALG 20WNW ISN-70NE MOT  
160 ALG 40NNW BFF-50SSW ANW-60ENE HLC-20WNW SLN-20N BUM-40NNE  
SGF-40E SGF-50E RZC*

### **AIRMET UPDATES**

*WAUS43 KKCI 311445  
-CHIS WA 311445  
AIRMET SIERRA UPDT 3 FOR IFR AND MTN OBSCN VALID UNTIL 312100*

*.  
AIRMET IFR...MN WI LM LS MI LH  
FROM 20SW YQT TO SSM TO 60NNE ASP TO 70SSE SAW TO 60N RHI TO  
20SW YQT  
CIG BLW 010/VIS BLW 3SM BR/FG. CONDS ENDG 16-18Z.*

*CHIT WA 311445  
AIRMET TANGO UPDT 2 FOR TURB VALID UNTIL 312100*

*.  
NO SGFNT TURB EXP OUTSIDE OF CNVTV ACT.*

*CHIZ WA 311445  
AIRMET ZULU UPDT 2 FOR ICE AND FRZLVL VALID UNTIL 312100*

*.  
NO SGFNT ICE EXP OUTSIDE OF CNVTV ACT.*

*.  
FRZLVL...RANGING FROM 110-ABV 160 ACRS AREA  
120 ALG 30NW ISN-30NNE INL  
160 ALG 40NNW BFF-40N LBF-40ESE LBF-30SSE HLC-50WNW ICT-50WNW  
OSW-60ESE SGF-30WNW ARG*

### **8.0.3 Terminal Aerodrome Forecast (TAF)**

No TAFs are issued for KOWA. The nearest TAF to the accident site was for Rochester International Airport (KRST), Rochester, Minnesota, located 35 miles east of KOWA at an elevation of 1,317 feet msl. The forecasts issued surrounding the period were issued by the NWS La Crosse, Wisconsin, WSFO and are as follows:

*KRST 311133Z 311212 16006KT P6SM SCT100 BKN250  
FM1400 21003KT P6SM VCTS SCT035CB BKN090  
TEMPO 1416 32020G35KT 1SM +TSRA BR SCT003 OVC020CB  
FM1700 12012KT P6SM VCSH BKN030CB  
FM2100 22008KT P6SM BKN040  
FM0000 26008KT P6SM VCTS BKN035CB  
FM0300 33006KT P6SM SCT250  
TEMPO 0812 4SM BR=*

*TAF AMD KRST 311249Z 311312 19005KT 3SM BR BKN001*

OVC025 FM1400 33012KT 4SM -SHRA SCT006 BKN025CB  
TEMPO 1415 32020G35KT 3/4SM +TSRA BR SCT001 OVC010CB  
FM1700 12012KT P6SM VCSH BKN030CB  
FM2100 22008KT P6SM BKN040  
FM0000 26008KT P6SM VCTS BKN035CB  
FM0300 33006KT P6SM SCT250  
TEMPO 0812 4SM BR=

TAF AMD KRST 311341Z 311412 30012KT 4SM -SHRA SCT005 BKN025CB  
TEMPO 1415 32035G50KT 3/4SM +TSRA BR SCT001 OVC010CB  
FM1700 12012KT P6SM VCSH BKN030CB  
FM2100 22008KT P6SM BKN040  
FM0000 26008KT P6SM VCTS BKN035CB  
FM0300 33006KT P6SM SCT250  
TEMPO 0812 4SM BR=

#### 8.0.4 Center Weather Service Support

The Minneapolis KZMP Center Weather Service Unit (CWSU) issued the following Meteorological Impact Statement (MIS) bulletin at 0717 CDT to support air traffic control operations.

FAUS20 KZMP 311217  
ZMP MIS 01 VALID 311130-312100  
...FOR ATC PLANNING PURPOSES ONLY...  
ZMP AREA WITHIN A LN FM 25NE DSM-30SE ONL-50N ABR-FAR-35E ODI...SCT  
TO BKN TS/SHRA TOPS FL500-550 MOV FM 30045KT...WKNG THRU FCST  
PERIOD. ZMP AREA N OF A LN FM 55NNE ISN-35ENE EAU-40N SAW...MOD TURB  
FL300-420.

The advisory indicated scattered to broken area of thunderstorms and rain showers with tops between 50,000 to 55,000 feet, moving from 300 degrees at 45 knots. The activity was expected to weaken through the forecast period. Moderate turbulence was expected between 30,000 and 42,000 feet.

#### 8.0.5 Pilot Reports

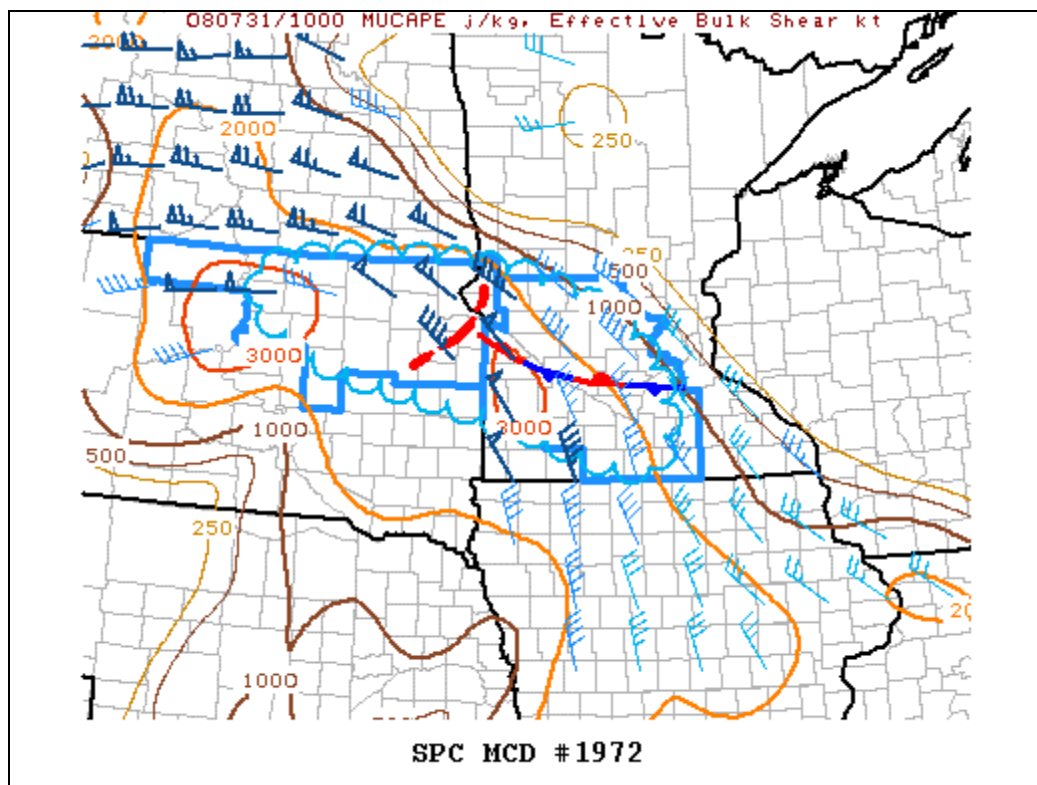
The following pilot reports were reported surrounding the period over Minnesota:

OTG UA /OV OTG/TM 1100/FL370/TP A320/TB CONT LGT OCNL MOD/RM "ROUGHER THAN A  
STUCCO BATHTUB=  
GPZ UA /OV GPZ/TM 1350/FL370/TP A320/TB CONT LGT CHOP OCNL MOD CHOP=  
MKT UA /OV MKT180015/TM 1400/FL200/TP MD82/TA M26/IC LGT RIME/RMFL200-290=  
BRD UA /OV BRD/TM 1450/FL370/TP B747/TB MOD=  
MSP UA /OV GEP090040/TM 1608/FL360 /TP CRJ/TB OCNL LGT-MOD=  
TVF UA /OV KCKN035008/TM 1624/FL370/TP B737/SK CLR/TA M52/WV 283103KT/TB NEG

The pilots of air carrier aircraft reported moderate turbulence and icing conditions above 20,000 feet.

## 8.0.6 Mesoscale Analysis

The following Mesoscale Discussions were issued by the NWS SPC during the period describing the meteorological reasons behind the issuance of the weather watches. The advisories provide some of the history of the MCS and bow echo across the region.



**Figure 20 - Mesoscale Discussion issued at 0528 CDT**

*MESOSCALE DISCUSSION 1972  
NWS STORM PREDICTION CENTER NORMAN OK  
0528 AM CDT THU JUL 31 2008*

*AREAS AFFECTED...EASTERN SD/SOUTHERN MN*

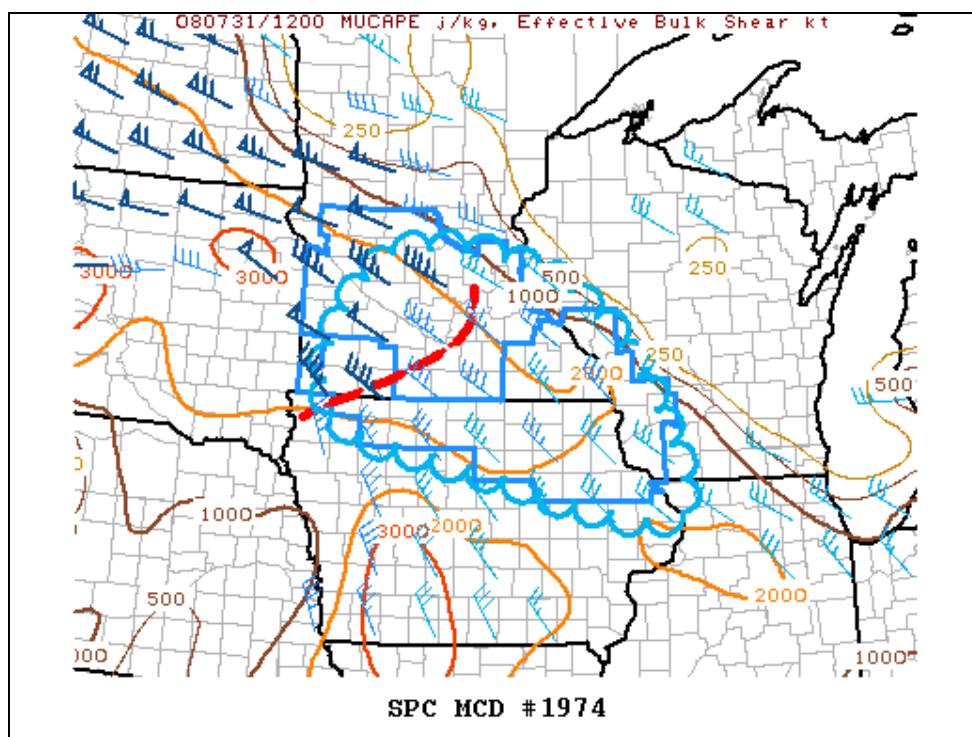
*CONCERNING...SEVERE THUNDERSTORM WATCH.. 778..779...  
VALID 311028Z - 311200Z*

*THE SEVERE WEATHER THREAT FOR SEVERE THUNDERSTORM WATCH 778...779...CONTINUES.*

*SEVERE TSTM WATCHES 778/779 CONTINUE UNTIL 12Z/14Z RESPECTIVELY. A  
CONSIDERABLE/WIDESPREAD DAMAGING WIND THREAT WILL CONTINUE TO INCREASE FROM  
FAR NORTHEAST SD INTO SOUTHWEST/SOUTH CENTRAL MN THROUGH THE EARLY MORNING  
HOURS...WITH SEVERE HAIL POSSIBLE AS WELL.*

*HIGHLY-ORGANIZED QUASI-LINEAR MCS CONTINUES TO ACCELERATE IN ITS FORWARD*

PROPAGATION WITH A 50-55 KT MOVING BOW ECHO ACROSS FAR NORTHEAST SD...NEARING THE I-29 CORRIDOR AS OF 10Z. THIS SEVERE MCS HAS A HISTORY OF WIND DAMAGE...WITH A 66 KT MEASURED GUST AT ABERDEEN AT AROUND 09Z...AND A MORE RECENT 54 KT GUST AT WATERTOWN SD /1016Z/. THE MCS CONTINUES TO EXHIBIT INCREASING ORGANIZATION OWING TO A SEEMINGLY WELL-BALANCED COLD POOL AMIDST 25-30 KT 0-3 KM SHEAR...A DEVELOPING PRESSURE RISE-FALL COUPLET...AND A LINE-EMBEDDED BROAD CIRCULATION/POTENTIAL MCV. AS A RESULT...WIND DAMAGE WILL REMAIN HIGHLY LIKELY THROUGH THE EARLY MORNING HOURS AS THE MCS/BOW ECHO CONTINUES TO FAVOR A HIGHLY SHEARED AND MOIST/UNSTABLE WNW-ESE FRONTAL CORRIDOR FROM FAR NORTHEAST SD INTO SOUTHERN MN /ROUGHLY ALONG AND NORTH OF THE MINNESOTA RIVER/. ASIDE FROM THE POTENTIAL FOR WIDESPREAD DAMAGING WINDS...SEVERE HAIL WILL REMAIN POSSIBLE...BOTH ATOP THE POST- MCS COLD POOL AS WELL AS IMMEDIATELY AHEAD OF THE SURGING MCS PRIOR TO BEING ENGULFED.  
 ..GUYER.. 07/31/2008



**Figure 21 – Mesoscale Discussion issued at 0803 CDT**

MESOSCALE DISCUSSION 1974  
 NWS STORM PREDICTION CENTER NORMAN OK  
 0803 AM CDT THU JUL 31 2008

AREAS AFFECTED...SOUTHERN MN/NORTHERN IA/SOUTHWEST WI  
 CONCERNING...SEVERE THUNDERSTORM WATCH.. 779...781...  
 VALID 311303Z - 311430Z

THE SEVERE WEATHER THREAT FOR SEVERE THUNDERSTORM WATCH  
 779...781...CONTINUES.

SEVERE TSTM WATCHES 779/781 CONTINUE UNTIL 14Z/17Z  
RESPECTIVELY...WITH CONTINUED POTENTIAL FOR WIDESPREAD DAMAGING WINDS AND  
SEVERE HAIL THIS MORNING ACROSS SOUTHERN MN/NORTHERN IA INTO SOUTHWEST WI.

VERY ORGANIZED SEVERE BOW ECHO/APPARENT DERECHO...NOW ASYMMETRIC IN NATURE  
WITH A NORTHERN PERIPHERY ROTATING COMMA HEAD AND EXTENSIVE COLD POOL...WILL  
CONTINUE TO RACE SOUTHEASTWARD ACROSS SOUTHERN MN/FAR NORTHERN IA INTO \\  
SOUTHWEST WI THIS MORNING. MEASURED SEVERE GUSTS/WIND DAMAGE HAVE BEEN  
PREVALENT OVERNIGHT/EARLY THIS MORNING WITH THIS SYSTEM ACROSS EASTERN  
SD/SOUTHWEST MN...WITH THE MOST RECENT STRONG/SEVERE GUSTS INCLUDING 51 KT AT  
NEW ULM AND 44 KT AT REDWOOD FALLS /1154Z/. THIS SEVERE MCS WILL CONTINUE TO  
FAVOR A WNW-ESE LOW LEVEL FRONTAL ZONE THAT EXTENDS ACROSS SOUTHERN MN INTO  
NORTHEAST IA/SOUTHWEST WI...WITH 12Z DAVENPORT RAOB REFLECTING THE MODERATE  
INSTABILITY/STEEP LAPSE RATES ACROSS THE REGION. EVEN IF THE SEVERE MCS/BOW  
ECHO DIURNALLY WEAKENS TO A DEGREE THIS MORNING...THE EXISTING MCV AND A  
MOIST/UNSTABLE AND RELATIVELY CLOUD-FREE ENVIRONMENT DOWNSTREAM WILL  
LIKELY FAVOR A RENEWED UPSWING LATER TODAY.

..GUYER.. 07/31/2008

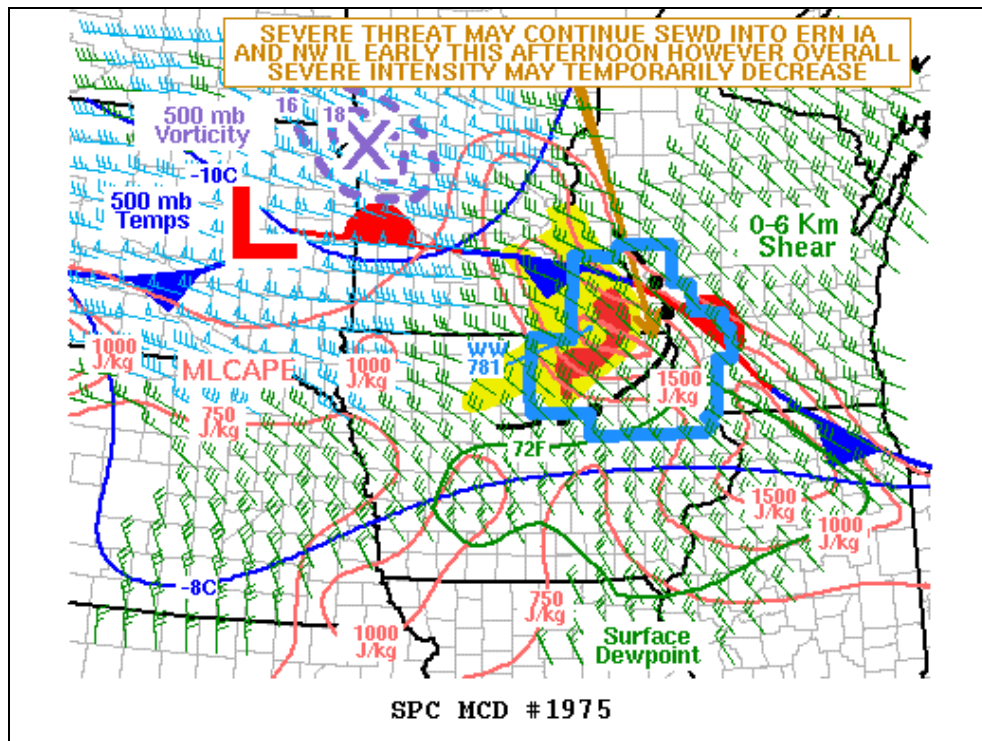


Figure 22 – Mesoscale Discussion issued at 1028 CDT

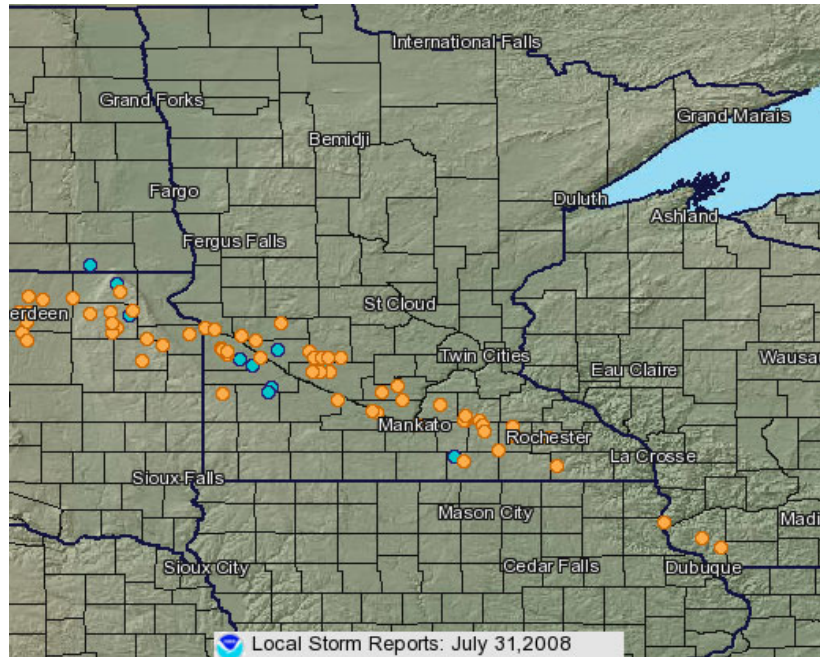
MESOSCALE DISCUSSION 1975  
NWS STORM PREDICTION CENTER NORMAN OK  
1028 AM CDT THU JUL 31 2008  
AREAS AFFECTED...SERN MN...NE IA...SW WI  
CONCERNING...SEVERE THUNDERSTORM WATCH 781...  
VALID 311528Z - 311700Z

*THE SEVERE WEATHER THREAT FOR SEVERE THUNDERSTORM WATCH 781 CONTINUES.*

*THE WIND DAMAGE AND HAIL THREAT WITH A BOWING LINE-SEGMENT CURRENTLY OVER NE IA AND SERN MN SHOULD CONTINUE SEWD ACROSS ERN IA...FAR SW WI INTO NW IL BY EARLY AFTERNOON. HOWEVER...INTENSITY WITH THE LINE HAS DECREASED OVER THE LAST 1 TO 2 HOURS. A WW MAY BECOME NECESSARY SOUTHEAST OF WW 781 IN CASE STRENGTHENING OCCURS WITH INCREASING INSTABILITY INTO EARLY AFTERNOON. 15Z SFC ANALYSIS SHOWS A 1004 MB LOW OVER NE SD WITH A QUASI-STATIONARY FRONT EXTENDING EWD ACROSS SRN MN INTO SW WI. A BOW ECHO/DERECHO IS LOCATED ALONG AND JUST SOUTH OF THE BOUNDARY MOVING SEWD AT ABOUT 40 TO 45 KT. AHEAD OF THE BOWING MCS...RUC ANALYSIS INDICATES MLCAPE VALUES RANGE FROM 1000 TO 2000 J/KG. THIS COMBINED WITH LARGE-SCALE ASCENT AHEAD OF A CNTRL MN SHORTWAVE TROUGH SUGGESTS THE MCS SHOULD PERSIST SEWD REACHING NW IL BY EARLY AFTERNOON. THE MCS IS LOCATED ON THE NOSE OF A 40 TO 50 KT MID-LEVEL JET WHICH IS CREATING STRONG VERTICAL SHEAR PROFILES SUPPORTIVE OF ORGANIZED FORWARD-PROPAGATING MULTICELL LINE SEGMENTS. ABUNDANT LOW-LEVEL MOISTURE /SFC DEWPOINTS IN THE LOWER 70S F/ AND STEEPENING LOW-LEVEL LAPSE RATES LATE THIS MORNING SHOULD CONTINUE A WIND DAMAGE POTENTIAL FOR SEVERAL MORE HOURS AS THE MCS RIDES SEWD DOWN THE INSTABILITY AXIS.  
..BROYLES.. 07/31/2008*

## 9.0 Storm Damage Reports

The NWS Chanhassen WSFO documented the damage from the MCS on July 31, 2008 and produced the following graphic in figure 23 based on the following storm damage reports received.



**Figure 23 – NWS Local Storm Reports**

PRELIMINARY LOCAL STORM REPORT  
NATIONAL WEATHER SERVICE TWIN CITIES/CHANHASSEN MN  
1012 AM CDT THU JUL 31 2008

DATE	TIME	EVENT	MAGNITUDE	CITY LOCATION	COUNTY	LAT/LONG	SOURCE
07/31/2008	0520 AM	HAIL	M1.75 INCH	8 NE MONTEVIDEO	CHIPPEWA, MN	45.03N 95.60W	LAW ENFORCEMENT
07/31/2008	0550 AM	TSTM WND GST TREE DAMAGE 60-70 MPH WIND GUSTS.	E70 MPH	4 NW MADISON, MN	LAC QUI PARLE	45.04N 96.25W	TRAINED SPOTTER
07/31/2008	0555 AM	HAIL	M0.75 INCH	5 NW MADISON, MN	LAC QUI PARLE	45.06N 96.26W	TRAINED SPOTTER
07/31/2008	0600 AM	TSTM WND DMG TOPS BROKEN OFF TREES.		5 NW MADISON, MN	LAC QUI PARLE	45.06N 96.26W	TRAINED SPOTTER
07/31/2008	0602 AM	HAIL	E0.75	DAWSON, MN	LAC QUI PARLE	44.93N 96.05W	TRAINED SPOTTER
07/31/2008	0610 AM	HAIL ESTIMATED 50 TO 60 MPH WIND GUST.	M0.75	S BOYD, MN	LAC QUI PARLE	44.85N 95.90W	TRAINED SPOTTER
07/31/2008	0610 AM	TSTM WND DMG WIND GUSTS ESTIMATED AT 80 MPH. MANY LARGE TREES DOWN AND A SEMI TRUCK BLOWN OVER.		APPLETON, MN	SWIFT	45.20N 96.02W	TRAINED SPOTTER
07/31/2008	0610 AM	HAIL	M1.75	4 W MONTEVIDEO	LAC QUI PARLE	44.95N 95.80W	TRAINED SPOTTER
07/31/2008	0613 AM	TSTM WND GST	M86.00 MPH	2 SSE MADISON	LAC QUI PARLE	44.99N 96.18W	AWOS
07/31/2008	0615 AM	TSTM WND DMG TREES DOWN IN TOWN.		APPLETON	SWIFT	45.20N 96.02W	BROADCAST MEDIA
07/31/2008	0615 AM	TSTM WND DMG WOOD FENCE SNAPPED AND TIN ROOF DAMAGED AT RADIO STATION. NUMEROUS TREES DOWN AROUND TOWN...MANY ROADS BLOCKED. FLAG POLE DOWN. POWER LINES DOWN. ROAD SIGNS DOWN.		MADISON, MN	LAC QUI PARLE	45.01N 96.19W	BROADCAST MEDIA
07/31/2008	0615 AM	TSTM WND GST WINDOWS BREAKING.	E70.00 MPH	ESE APPLETON, MN	SWIFT	45.20N 96.02W	TRAINED SPOTTER
07/31/2008	0615 AM	TSTM WND DMG TOP OF 18 INCH DIAMETER TREE		2 WSW BIG BEND CITY	CHIPPEWA	45.14N 95.86W	NWS EMPLOYEE
07/31/2008	0615 AM	HAIL	M1.00 INCH	5 N DANUBE	RENVILLE	44.86N 95.10W	CO-OP OBSERVER
07/31/2008	0616 AM	TSTM WND DMG 10 INCH TREE DOWN.		LAC QUI PARLE	MADISON	45.01N 96.19W	AMATEUR RADIO
07/31/2008	0620 AM	HAIL	M1.00 INCH	1 N DANUBE	RENVILLE	44.81N 95.10W	TRAINED SPOTTER
07/31/2008	0650 AM	TSTM WND DMG WIND SPEED ESTIMATED AT 60-70 MPH WITH TREES DOWN AND QUARTER SIZE HAIL.		4 W MONTEVIDEO	LAC QUI PARLE	44.95N 95.80W	TRAINED SPOTTER
07/31/2008	0650 AM	TSTM WND DMG LARGE TREES DOWN BOTH NORTH AND SOUTH SIDE OF TOWN.		OLIVIA	RENVILLE	44.78N 95.00W	TRAINED SPOTTER
07/31/2008	0654 AM	TSTM WND GST	M51.00 MPH	WABASSO	REDWOOD	44.40N 95.25W	TRAINED SPOTTER
07/31/2008	0700 AM	TSTM WND DMG 130 THOUSAND SQUARE FOOT BUILDING UNDER CONSTRUCTION, DESTROYED.		12 NW MURDOCK	SWIFT	45.35N 95.57W	TRAINED SPOTTER
07/31/2008	0703 AM	TSTM WND DMG TREES AND POWER LINES DOWN.		RAYMOND	KANDIYOHI	45.02N 95.24W	LAW ENFORCEMENT
07/31/2008	0710 AM	TSTM WND DMG TURKEY BARN ROOF BLOWN OFF.		3 N MORGAN	REDWOOD	44.46N 94.92W	TRAINED SPOTTER
07/31/2008	0711 AM	TSTM WND DMG TREES AND POWER LINES DOWN.		PRINSBURG	KANDIYOHI	44.94N 95.19W	LAW ENFORCEMENT
07/31/2008	0713 AM	TSTM WND DMG TREES AND POWER LINES DOWN.		4 E PRINSBURG	KANDIYOHI	44.94N 95.10W	LAW ENFORCEMENT
07/31/2008	0716 AM	TSTM WND DMG MANY TREES DOWN OR BROAKEN OFF		5 SSE CLARA CITY	CHIPPEWA	44.89N 95.31W	TRAINED SPOTTER
07/31/2008	0716 AM	TSTM WND DMG TREES AND POWER LINES DOWN.		BLOMKEST	KANDIYOHI	44.94N 95.02W	LAW ENFORCEMENT
07/31/2008	0720 AM	TSTM WND GST	E60.00 MPH	RAYMOND	KANDIYOHI	45.02N 95.24W	TRAINED SPOTTER
07/31/2008	0720 AM	TSTM WND DMG TREES AND POWER LINES DOWN.		LAKE LILLIAN	KANDIYOHI	44.95N 94.88W	LAW ENFORCEMENT
07/31/2008	0723 AM	TSTM WND GST WEST HIGH SCHOOL.	M75.00 MPH	1 SSE RENVILLE	RENVILLE	44.78N 95.20W	MESONET
07/31/2008	0727 AM	FUNNEL CLOUD FUNNEL DROPPED BRIEFLY THEN WENT BACK UP.		3 W LITCHFIELD	MEEKER	45.12N 94.59W	TRAINED SPOTTER
07/31/2008	0730 AM	TSTM WND DMG ONE FOOT DIAMETER TREES DOWN.		5 W OLIVIA	RENVILLE	44.79N 95.11W	TRAINED SPOTTER
07/31/2008	0734 AM	TSTM WND GST AIRPORT.	M68.00 MPH	3 W NEW ULM	BROWN	44.32N 94.52W	AWOS
07/31/2008	0736 AM	TSTM WND GST MNDOT.	M60.00 MPH	2 W WINTHROP	SIBLEY	44.54N 94.41W	MESONET
07/31/2008	0742 AM	TSTM WND GST	M67.00 MPH	4 N GAYLORD	SIBLEY	44.61N 94.22W	STORM CHASER
07/31/2008	0750 AM	TSTM WND DMG ARM SIZE BRANCHES BROKEN OFF.		3 ESE NEW SWEDEN	NICOLLET	44.45N 94.16W	TRAINED SPOTTER
07/31/2008	0754 AM	TSTM WND DMG TREES BLOWN DOWN.		NEW ULM	BROWN	44.31N 94.46W	LAW ENFORCEMENT

07/31/2008	0804 AM	TSTM WND GST ELYSIAN WEATHER STATION.	M65.00 MPH	4 NNW GREENLAND	LE SUEUR	44.26N 93.75W	TRAINED SPOTTER
07/31/2008	0807 AM	TSTM WND DMG 4 INCH BRANCHES, 6 TO 10 INCH TREES BLOWN DOWN.		MANKATO	BLUE EARTH	44.17N 93.99W	AMATEUR RADIO
07/31/2008	0807 AM	TSTM WND GST LE CENTER HIGH SCHOOL.	M84.00 MPH	NNE LE CENTER	LE SUEUR	44.39N 93.73W	MESONET
07/31/2008	0814 AM	TSTM WND DMG TREES REPORTED DOWN AROUND MANKATO.		MANKATO	BLUE EARTH	44.17N 93.99W	LAW ENFORCEMENT
07/31/2008	0816 AM	TSTM WND GST TREES DOWN NEAR HWY 60.	M58.00 MPH	4 W MORRISTOWN	RICE	44.22N 93.53W	TRAINED SPOTTER
07/31/2008	0820 AM	FUNNEL CLOUD CITIZEN REPORT...NOT CONFIRMED.		HOWARD LAKE MN	WRIGHT	45.06N 94.07W	PUBLIC
07/31/2008	0823 AM	TSTM WND DMG LARGE HAY BALES BLOWN ACROSS ROAD. 18 INCH DIAMETER TREE BLOWN DOWN.		1 S MORRISTOWN	RICE	44.21N 93.44W	AMATEUR RADIO
07/31/2008	0824 AM	NON-TSTM WND GST	M59.00 MPH	REDWOOD FALLS	REDWOOD	44.54N 95.11W	ASOS
07/31/2008	0830 AM	HAIL ESTIMATED 50 MPH WIND GUST.	M0.75 INCH	2 N FREEBORN	FREEBORN	43.80N 93.56W	TRAINED SPOTTER
07/31/2008	0830 AM	TSTM WND DMG LARGE TREES DOWN IN CENTRAL PARK. MINOR STREET FLOODING. PORT-O-POTTY BLOWN 20 FEET. SMALL TO MEDIUM LIMBS ON GROUND...DEBRIS EVERYWHERE.		OWATONNA MN	STEELE	44.09N 93.22W	TRAINED SPOTTER
07/31/2008	0833 AM	TSTM WND GST	M58.00 MPH	4 N MORRISTOWN	RICE	44.28N 93.44W	TRAINED SPOTTER
07/31/2008	0835 AM	TSTM WND GST AIRPORT.	M72.00 MPH	OWATONNA	STEELE	44.09N 93.22W	AWOS
07/31/2008	0836 AM	TSTM WND DMG MN VIKINGS TRAINING CAMP TENTS AND CROWD CONTROL FENCES ALL BLOWN DOWN. 8 INCH DIAMETER LIMB OFF TREE...ON MSMU CAMPUS. SEVERAL OTHER 2 TO 4 INCH DIAMETER BRANCHES. POWER OUT IN SOME AREAS...NEAR CAMPUS.		MANKATO	BLUE EARTH	44.17N 93.99W	TRAINED SPOTTER
07/31/2008	0836 AM	TSTM WND DMG SEMI TRUCK BLOWN OVER ON I-35.		5 S FARIBAULT	RICE	44.22N 93.27W	TRAINED SPOTTER
07/31/2008	0838 AM	TSTM WND GST	M68.00 MPH	4 N MORRISTOWN	RICE	44.28N 93.44W	TRAINED SPOTTER
07/31/2008	0838 AM	TSTM WND GST 30 FOOT PINE TREE UPROOTED. 18 INCH DIAMETER TREE DOWN.	M61.00 MPH	1 W MORRISTOWN	RICE	44.22N 93.46W	TRAINED SPOTTER
07/31/2008	0840 AM	TSTM WND DMG MULTIPLE TREES UP TO 24 INCH DIAMETER BLOWN DOWN IN TOWN ROADS BLOCKED. HARDWOODS SNAPPED OFF AT 6 FEET OFF GROUND...PINES ARE UPROOTED.		MEDFORD	STEELE	44.17N 93.24W	AMATEUR RADIO
07/31/2008	0840 AM	TSTM WND DMG 8 INCH DIAMETER BRANCH DOWN.		1 N MANCHESTER	FREEBORN	43.74N 93.45W	AMATEUR RADIO
07/31/2008	0840 AM	TSTM WND DMG SMALL TREE DOWN...MANY BRANCHES AND OTHER DEBRIS ON LAWNS.		BLOOMING PRAIRIE	STEELE	43.87N 93.05W	TRAINED SPOTTER
07/31/2008	0840 AM	TSTM WND DMG ONE 6 INCH DIAMETER TREE DOWN. ONE 12 TO 18 INCH DIAMETER TREE DOWN.		OWATONNA	STEELE	44.09N 93.22W	AMATEUR RADIO

## 10.0 Security Video

Cabela's Sporting Goods store was located on the northern side of the Owatonna airport boundary. The parking lot security camera videos were retrieved for July 31, 2008, and saved on a disk. A still shot looking north towards the access road to the accident site at the approximate time of the accident is included as figure 24. The image displays rain, standing water on the pavement, and an indication of southerly winds.



**Figure 24 – Cabela’s Sporting Goods parking lot at 0946 CDT**

## **11.0 Weather Briefing**

The pilot’s of N818MV utilized an Internet weather and flight plan provider “www.FltPlan.com” for their weather-briefing source. The weather document printed out and found at the accident site was issued at 0513 CDT (1013Z) on July 31, 2008, and consisted of 9 pages of weather text for the planned 4 legs of flight: Allentown (KABE) to Atlantic City (KACY), KACY to KOWA, KOWA to Crossville, TN (KCSV), and KCSV to KACY. The weather briefing data consisted generally of METARs, TAFs, and NOTAMs for the departure, destination, alternate airports and surrounding stations. There was no synopsis of weather features impacting the route, no in-flight weather advisories (Severe Weather Forecast Alerts, Convective SIGMET, AIRMETs, or Center Weather Advisories), enroute forecast, or convective outlook included in the briefing material. The web page did include links to the NWS Aviation Digital Data System (ADDS), and to the National weather radar mosaic, radar summary chart, and high level significant weather chart sites, but there was no record of the pilots reviewing these links or any additional weather information printed from these sources.

The flight departed KACY for KOWA at 0815 CDT (1315Z), or approximately 3 hours after the briefing data was printed out. The relevant briefing data for the KACY to KOWA route provided the following details:

**KOWA - ARRIVAL AIRPORT METARs**

KOWA 310955Z AUTO 00000KT 10SM CLR 18/17 A2975 RMK AO2=  
KOWA 310935Z AUTO 00000KT 10SM CLR 18/16 A2976 RMK AO2=  
KOWA 310915Z AUTO 00000KT 10SM CLR 18/16 A2976 RMK AO2=  
KOWA 310855Z AUTO 00000KT 10SM CLR 18/16 A2975 RMK AO2=  
KOWA 310835Z AUTO 00000KT 10SM CLR 19/17 A2976 RMK AO2=  
KOWA 310815Z AUTO 00000KT 10SM CLR 19/17 A2976 RMK AO2=  
KOWA 310755Z AUTO 00000KT 10SM CLR 19/17 A2976 RMK AO2=

**KOWA – ARRIVAL AIRPORT FORECAST – Planned Arrival Time 1414Z**

*Forecast for KOWA not found*

**Using KRST as Forecast Location**

KRST TAF 310525Z 310606 VRB03KT P6SM SCT200  
FM1000 VRB03KT 5SM BR SKC  
FM1300 21003KT P6SM SCT140  
FM1600 22006KT P6SM SCT035  
FM2200 23006KT P6SM VCTS BKN040CB

**KMKT – ALTERNATE AIRPORT FORECAST**

*Forecast for alternate airport NOT found*

**NEARBY ARRIVAL AIRPORT WEATHER**

KTOB 310955Z AUTO 00000KT 10SM CLR 17/16 A2977 RMK A02  
KAEL 310953Z AUTO 00000KT 4SM BR CLR 22/22 A2977 RMK A02  
KMKT 310955Z AUTO 15003KT 7SM CLR 20/19 A2974 RMK A01  
KAUM 310955Z AUTO 18003KT M1/4SM FG OVC001 19/19 A2976 RMK A02  
KRST 310954Z 00000KT 10SM CLR 17/16 A2977 RMK A02 SLP075 T01720156  
KRGK 310955Z 00000KT 10SM CLR 16/13 A2975 RMK A02

KAEL = ALBERTA LEE MUNI, ALBERTA LEE, MN

KAUM = AUSTIN MUNI, AUSTIN, MN

KTOB = DODGE CENTER, DODGE CENTER, MN

KMKT = MANKATO RGNL, MANKATO, MN

KRGK = RED WING RGNL, RED WING, MN

KRST = AUSTIN MUNI, AUSTIN, MN

**Not included were the current in-flight weather advisories:**

MKCC WST 310955

CONVECTIVE SIGMET 26C

VALID UNTIL 1155Z

MN SD ND

FROM 40N FAR-RWF-40S ABR-60NNE DPR-40N FAR

AREA SEV TS MOV FROM 26020KT. TOPS TO FL440.

HAIL TO 2 IN...WIND GUSTS TO 60KT POSS.

OUTLOOK VALID 311155-311555

AREA 1...FROM 30NNE TTH-160S CEW-120SSW LCH-ACT-ADM-30NNE TTH

WST ISSUANCES EXPD. REFER TO MOST RECENT ACUS01 KWNS FROM STORM

PREDICTION CENTER FOR SYNOPSIS AND METEOROLOGICAL DETAILS.

AREA 2...FROM 50NNE ISN-60WNW INL-RWF-ANW-50NNE ISN

REF WW 778.

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

WW 778 SEVERE TSTM SD 310625Z - 311200Z  
AXIS..85 STATUTE MILES EAST AND WEST OF LINE..  
45NE MBG/MOBRIDGE SD/ - 60WSW ATY/WATERTOWN SD/  
..AVIATION COORDS.. 75NM E/W /60SE BIS - 50S ABR/  
HAIL SURFACE AND ALOFT..2.5 INCHES. WIND GUSTS..60 KNOTS.  
MAX TOPS TO 500. MEAN STORM MOTION VECTOR 31035.

DISCUSSION...SMALL BOWING MCS/HP-SUPERCELL OVER S-CENTRAL ND EARLY THIS MORNING IS EXPECTED TO CONTINUE SEWD ALONG PERIPHERY OF STRONG CAPPING INVOF SURFACE FRONT OVERNIGHT INTO NRN/NERN SD. VERY STRONG WINDS AND ISOLATED LARGE HAIL CAN BE EXPECTED WITH THIS ACTIVITY. AS LLJ INCREASES AND BECOMES MORE SWLY NIGHT...ELEVATED STORMS WITH THREAT OF LARGE HAIL MAY ALSO PERSIST ATOP SURFACE COLD POOL IN WAKE OF LEADING STORMS THROUGH DAY BREAK.

AVIATION...A FEW SEVERE THUNDERSTORMS WITH HAIL SURFACE AND ALOFT TO 2.5 INCHES. EXTREME TURBULENCE AND SURFACE WIND GUSTS TO 60 KNOTS. A FEW CUMULONIMBI WITH MAXIMUM TOPS TO 500. MEAN STORM MOTION VECTOR 31035.

## 12.0 Astronomical Data

Data from the United States Naval Observatory located in Washington, DC, for Owatonna, Steele County, Minnesota on July 31, 2008, indicated the following astronomical data:

### SUN

Beginning of civil twilight	0529 CDT
Sunrise	0602 CDT
Sunset	2037 CDT
End of civil twilight	2110 CDT
Elevation of Sun at 0945	38.4 degrees above the horizon
Azimuth of Sun at 0945	120.5 degrees

## 13.0 Training Material

Current regulations under 91.1065, 91.1101, 135.293, and 121.419 state initial, transition, upgrade, and recurrent pilot testing requirements require a pilot receive enough meteorology training and procedures for recognizing and avoiding severe weather situations. FAA Advisory Circular (AC) 00-24B "Thunderstorms" was published in 1983 and discusses the hazards of thunderstorms and identified squall lines, but does not mention any of the currently identified severe thunderstorm types or some of their related signatures. Terms such as mesoscale convective complex or systems, line echo wave pattern (LEWP), bow echo, derecho, supercells, pulse storms, bookend vortices, rear inflow notch or mesocyclone, or tornadic vortex signature (TVS) are known severe weather producers and are not referenced in the aeronautical

information manual or any other FAA pilot reference material. The convective SIGMET and weather watches referred aviation users to see the latest convective outlook and mesoscale discussions that used these terms to describe the severe weather event.

Donald E. Eick  
NTSB Senior Meteorologist

**Attachment 1 – Owatonna (KOWA) Raw 5-minute AWOS-3 Data**

<u>YYMMDDTTT</u>	<u>CLOUDS</u>	<u>VIS</u>	<u>WX</u>	<u>T</u>	<u>TD</u>	<u>WIND</u>	<u>ALT</u>	<u>DENALT</u>	<u>PRECIP</u>	<u>REMARKS</u>
0000	0807311821 CLR BLO 120	10		025	018	19 006	2971	2800	00D	
0001	0807311801 CLR BLO 120	10		024	019	24 001	2973	2700	00D	

0002	0807311741	CLR BLO 120	10	023 018 15 001	2973 2600	00D		
0003	0807311721	CLR BLO 120	10	022 019 06 000	2972 2500	00D		
0004	0807311701	CLR BLO 120	10	021 017 28 001	2972 2300	00D		
0005	0807311641	CLR BLO 120	10	020 018 18 005	2972 2300	00D	WET	
0006	0807311638	CLR BLO 120	10	020 018 19 005	2970 2300	00D	WET	
0007	0807311623	SCT023	10	-RA 019 017 17 009	2970 2200	00D	WET LTG DSNT SE	
0008	0807311621	SCT023	10	RA 019 017 16 007	2971 2200	01D	WET	
0009	0807311614	CLR BLO 120	10	-RA 019 017 16 005	2973	00D	WET	
0010	0807311611	CLR BLO 120	10	-RA 019 017 20 002	2975	00D	WET LTG DSNT NE	
0011	0807311601	CLR BLO 120	10	019 017 22 001	2977	00D	WET LTG DSNT NE AND SE	
0012	0807311543	SCT100	10	-RA 018 017 29 001	2979	00D	WET LTG DSNT NE AND SE	
0013	0807311541	SCT027 SCT050 SCT100	10	-RA 018 017 25 000	2978	00D	WET LTG DSNT SE	
0014	0807311538	SCT050	10	-RA 018 016 18 003	2978	00D	WET LTG DSNT SE	
0015	0807311534	SCT025 SCT037 SCT050	10	-RA 018 016 17 006	2977	00D	WET LTG VCNTY AND DSNT SE	
0016	0807311529	SCT025 SCT037 SCT110	10	-RA 018 016 18 007	2979	01D	WET LTG VCNTY AND DSNT SE AND S	
0017	0807311524	SCT023 SCT037 BKN110	10	-RA 018 016 19 009	2982	00D	WET LTG VCNTY AND DSNT E THRU S	
0018	0807311521	SCT023 SCT037 BKN110	10	-RA 018 016 19 010	2983	01D	WET LTG VCNTY AND DSNT E THRU SW	
0019	0807311509	SCT018 SCT029 BKN110	10	RA 019 017 21 010	2986	00D	WET LTG VCNTY AND DSNT E THRU SW	
0020	0807311503	SCT018 SCT038 BKN110	10	-RA 019 017 22 008	2986	00D	WET LTG VCNTY AND DSNT SE	
0021	0807311502	SCT018 SCT033 BKN042	10	RA 019 017 21 007	2986	00D	WET LTG VCNTY AND DSNT E AND SE	
0022	0807311501	SCT018 SCT029 BKN039	10	RA 019 017 20 007	2985	01D	WET LTG DSNT E AND SE	
0023	0807311454	SCT018 SCT029 BKN037	10	RA 019 017 17 007	2983	01D	WET LTG DSNT E THRU S	
0024	0807311449	SCT018 SCT030 BKN041	10	RA 019 017 17 008	2983	01D	WET LTG DSNT E THRU W	
<b>0025</b>	<b>0807311446</b>	<b>SCT019 SCT035 BKN060</b>	<b>10</b>	<b>RA 018 017 17 006</b>	<b>2984</b>	<b>01D</b>	<b>WET LTG DSNT ALQDS</b>	
0026	0807311441	SCT022 SCT035 BKN100	10	RA 018 016 15 005	2984	01N	WET LTG VCNTY AND DSNT ALQDS	
0027	0807311435	SCT038 SCT049 BKN100	10	-RA 018 016 18 003	2985	01N	WET LTG VCNTY AND DSNT ALQDS	
0028	0807311421	SCT035 BKN046 OVC060	10	RA 018 016 02 002	2986	03N	WET LTG AT ARPT AND DSNT ALQDS	
0029	0807311401	MM	10	RA 018 016 32 019040	2984	02N	WET LTG AT ARPT AND DSNT ALQDS	
0030	0807311349	MM		MM MM MM MM	31 042 2981	MM	01N	WET LTG AT ARPT AND DSNT ALQDS
0031	0807311341	SCT002 BKN009 BKN017	2	+RA 018 016 29 028055	2981	29N	WET 1 1/4V 5 LTG AT ARPT AND DSNT ALQDS	
0032	0807311326	SCT022	5	-RA 022 020 26 004	2979 2400	00N	WET LTG AT ARPT AND DSNT ALQDS	
0033	0807311325	SCT022	5	-RA 022 020 26 002	2978 2400	00N	WET LTG AT ARPT AND DSNT SW THRU N	
0034	0807311321	SCT022	5	-RA 022 020 12 000	2976 2500	00D	WET LTG VCNTY AND DSNT SW THRU N	
0035	0807311320	SCT022	5	-RA 022 020 11 001	2976 2500	00D	WET LTG VCNTY AND DSNT SW THRU N	
0036	0807311319	SCT022	5	-RA 022 020 13 001	2976 2500	00D	LTG VCNTY AND DSNT SW THRU NW	

0037 0807311313 SCT022	5 BR	022 020 17 002	2975 2500	00D	LTG VCNTY AND DSNT W AND NW
0038 0807311301 SCT020	5 BR	022 020 06 002	2975 2500	00D	LTG AT ARPT AND DSNT W AND NW
0039 0807311258 SCT020	5 BR	022 020 11 002	2974 2500	00D	LTG AT ARPT AND DSNT W AND NW
0040 0807311248 SCT020 SCT036	5 BR	022 020 13 004	2974 2500	00D	LTG VCNTY AND DSNT W AND NW
0041 0807311241 SCT020 SCT036	5 BR	022 020 13 004	2974 2500	00D	LTG DSNT W AND NW
0042 0807311237 SCT020 SCT036	5 BR	022 020 15 004	2975 2500	00D	LTG DSNT W AND NW
0043 0807311235 SCT020 SCT036	5 BR	022 020 15 004	2975 2500	00D	LTG DSNT NW
0044 0807311221 SCT020 SCT036	4 BR	022 020 17 006	2976 2500	00D	LTG DSNT W AND NW
0045 0807311217 SCT036	4 BR	022 020 17 006	2976 2500	00D	LTG DSNT W AND NW
0046 0807311213 SCT034	4 BR	022 020 17 007	2975 2500	00D	LTG DSNT W
0047 0807311209 SCT034	4 BR	022 019 18 005	2975 2400	00D	LTG DSNT W AND NW
0048 0807311208 SCT034	4 BR	022 019 17 005	2975 2400	00D	LTG DSNT NW
0049 0807311206 SCT034	5 BR	021 019 17 004	2975 2400	00D	LTG DSNT W AND NW
0050 0807311201 CLR BLO 120	7	020 018 15 002	2975 2200	00D	LTG DSNT S THRU NW
0051 0807311200 CLR BLO 120	7	020 018 15 002	2975 2200	00D	LTG DSNT S THRU NW
0052 0807311151 CLR BLO 120	5 BR	019 017 15 003	2975 2200	00D	LTG VCNTY AND DSNT S THRU NW
0053 0807311149 CLR BLO 120	5 BR	019 017 16 002	2975 2200	00D	LTG VCNTY AND DSNT S AND NW
0054 0807311145 CLR BLO 120	5 BR	019 017 16 001	2974 2200	00D	LTG VCNTY AND DSNT S THRU NW
0055 0807311141 CLR BLO 120	4 BR	019 017 12 003	2974	00D	LTG DSNT S THRU NW
0056 0807311134 CLR BLO 120	5 BR	019 017 10 004	2973	00D	LTG DSNT S THRU NW
0057 0807311131 CLR BLO 120	5 BR	018 017 10 004	2973	00D	LTG DSNT S AND NW
0058 0807311124 CLR BLO 120	4 BR	018 016 10 003	2974	00D	LTG DSNT NW
0059 0807311121 CLR BLO 120	2 1/2 BR	018 016 10 003	2974	00D	1 1/4V 5
0060 0807311116 CLR BLO 120	3 BR	018 016 11 002	2975	00D	
0061 0807311101 CLR BLO 120	7	018 016 07 001	2976	00D	LTG DSNT NW
0062 0807311041 CLR BLO 120	10	018 016 12 003	2975	00N	
0063 0807311021 CLR BLO 120	10	018 016 13 003	2975	00N	
0064 0807311001 CLR BLO 120	10	018 016 11 002	2975	00N	
0065 0807310941 CLR BLO 120	10	018 016 09 000	2976	00N	
0066 0807310921 CLR BLO 120	10	018 016 05 001	2976	00N	
0067 0807310901 CLR BLO 120	10	018 016 13 001	2976	00N	
0068 0807310841 CLR BLO 120	10	019 017 19 000	2976	00N	
0069 0807310821 CLR BLO 120	10	019 017 16 002	2976	00N	
0070 0807310801 CLR BLO 120	10	019 017 11 003	2976	00N	
0071 0807310741 CLR BLO 120	10	018 016 14 001	2976	00N	
0072 0807310721 CLR BLO 120	10	019 017 12 002	2976 2200	00N	
0073 0807310701 CLR BLO 120	10	019 017 13 002	2976 2200	00N	
0074 0807310641 CLR BLO 120	10	020 017 16 003	2976 2200	00N	
0075 0807310621 CLR BLO 120	10	020 018 18 006	2976 2200	00N	
0076 0807310601 CLR BLO 120	10	019 017 11 001	2976	00N	
0077 0807310541 CLR BLO 120	10	019 017 08 002	2976	00N	
0078 0807310521 CLR BLO 120	10	018 017 12 002	2976	00N	
0079 0807310501 CLR BLO 120	10	019 017 13 001	2977	00N	
0080 0807310441 CLR BLO 120	10	019 017 12 001	2976 2200	00N	
0081 0807310421 CLR BLO 120	10	019 017 11 002	2976 2200	00N	
0082 0807310401 CLR BLO 120	10	019 017 13 000	2977	00N	
0083 0807310341 CLR BLO 120	10	021 018 18 000	2978 2300	00N	
0084 0807310321 CLR BLO 120	10	022 018 18 000	2977 2400	00N	

0085	0807310301	CLR BLO 120	10	022 018 20 000	2977 2400	00N
0086	0807310241	CLR BLO 120	10	021 018 22 003	2976 2300	00N
0087	0807310221	CLR BLO 120	10	022 018 21 002	2975 2400	00N
0088	0807310201	CLR BLO 120	10	022 019 23 002	2975 2500	00N
0089	0807310141	CLR BLO 120	10	023 019 22 002	2975 2600	00D
0090	0807310121	CLR BLO 120	10	024 019 23 002	2975 2700	00D
0091	0807310101	CLR BLO 120	10	026 021 24 002	2974 2900	00D
0092	0807310041	CLR BLO 120	10	027 021 25 002	2974 3000	00D
0093	0807310021	CLR BLO 120	10	027 019 25 002	2974 3100	00D
0094	0807310001	CLR BLO 120	7	028 018 26 002	2974 3100	00D
0095	0807302341	CLR BLO 120	10	028 018 25 004	2974 3200	00D
0096	0807302321	CLR BLO 120	10	029 017 26 006	2975 3200	00D
0097	0807302301	CLR BLO 120	10	029 017 25 004	2975 3200	00D
0098	0807302241	CLR BLO 120	10	029 017 24 005	2975 3200	00D
0099	0807302221	CLR BLO 120	10	029 016 25 006	2975 3200	00D
0100	0807302201	CLR BLO 120	10	029 016 27 005	2975 3300	00D
0101	0807302141	CLR BLO 120	10	029 016 26 007	2975 3300	00D*

Note – \*D for daytime and N for nighttime designators used for visibility sensor.

## Attachment 2 – NWS WSFO Issued Alerts

<b>Time</b>	<b>Station</b>	<b>Alert Details</b>
0450 CDT	KWNS	issuance of weather watch number 779 for severe thunderstorms. Remarks indicated a bowing MCS/potential derecho racing east-southeast across southwest and central Minnesota. Includes Steele County and the city of Owatonna.

- 0450 CDT KMPX immediate broadcast of weather watch 779 until 0900 CDT.
- 0503 CDT KWNS severe thunderstorm watch 779 outline and counties included.
- 0512 CDT KMPX emergency alert system activation – severe thunderstorms warning for Swift, Lac Qui Parle, Chippewa counties. Radar indicated a severe thunderstorm capable of producing large hail and damaging winds.
- 0520 CDT KMPX emergency alert system activation – severe thunderstorm warning for Lac Qui Parle and Yellow Medicine counties. Radar indicated a severe thunderstorm capable of producing large hail and damaging winds.
- 0535 CDT KMPX issues special weather statement – strong thunderstorms moving into southwest Minnesota with damaging winds in excess of 70 mph along with nickel size hail, spreading east at 25 mph.
- 0547 CDT KMPX emergency alert system activation – severe thunderstorm warning for Kandiyohi, Meeker, Chippewa, and Renville counties. Radar indicated a severe thunderstorm capable of producing large hail.
- 0554 CDT KMPX emergency alert system activation – severe thunderstorm warning for Swift, Lac Qui Parle, Chippewa, Yellow Medicine and Renville counties. Radar indicated a severe thunderstorm capable of producing large hail and damaging winds in excess of 65 mph.
- 0559 CDT KMPX special weather statement – severe thunderstorm warnings remain in effect for Yellow Medicine and Lac Qui Parle counties. Radar indicated a severe thunderstorm capable of producing nickel size hail and damaging winds in excess of 65 mph. Activity moving southeast at 65 mph.
- 0601 CDT KMPX special weather statement – threat of damaging winds and large hail associated with a line of strong thunderstorms moving southeast at 40 to 50 mph.
- 0603 CDT KWNS severe thunderstorm watch 779 outline and counties included.
- 0609 CDT KMPX emergency alert system activation – severe thunderstorm warning for Swift, Kandiyohi, Meeker, Chippewa, Renville, and Redwood counties. Radar indicated a line of severe thunderstorm capable of producing large hail and damaging winds in excess of 65 mph.
- 0617 CDT KMPX emergency alert system activation – severe thunderstorm warning for Yellow Medicine and Lac Qui Parle counties. Radar indicated a severe thunderstorm capable of producing large hail and damaging winds in excess of 65 mph.

- 0630 CDT KMPX emergency alert system activation – severe thunderstorm warning for McLeod, Renville, Sibley and Nicollet counties. Radar indicated a severe thunderstorm capable of producing large hail and damaging winds in excess of 60 mph.
- 0636 CDT KWNS severe weather statement – severe thunderstorm warnings for Kandiyohi, Swift, Meeker, Chippewa, Renville, Redwood counties. Radar indicated a line of severe thunderstorms capable of producing nickel size hail and destructive winds in excess of 75 mph.
- 0640 CDT KWNS severe thunderstorm watch 779 outline and counties included.
- 0648 CDT KMPX emergency alert system activation - tornado warning for Swift and Chippewa counties. Radar indicated possible tornadic thunderstorm.
- 0655 CDT KMPX emergency alert system activation – severe thunderstorm warning for Swift and Chippewa counties. Radar indicated a severe thunderstorm capable of producing large hail and destructive winds in excess of 70 mph.
- 0656 CDT KMPX emergency alert system activation – severe thunderstorm warning for Renville, Sibley, redwood, Le Sueur, Brown, and Nicollett counties. Radar indicated a line of severe thunderstorms capable of producing large hail and damaging winds in excess of 70 mph. Reports of hail the size of quarters and trees down.
- 0700 CDT KMPX special weather statement – tornado warning for Kandiyohi, Chippewa, and Swift counties. Radar indicated a severe thunderstorm capable of producing a tornado.
- 0703 CDT KWNS severe thunderstorm watch 779 outline and counties included.
- 0706 CDT KMPX emergency alert system activation – severe thunderstorm warning for Wright, Meeker, McLeod counties. Radar indicated a severe thunderstorm capable of producing large hail and damaging winds in excess of 70 mph.
- 0715 CDT KMPX emergency alert system activation – severe thunderstorm warning for Kandiyohi, Renville, and Redwood counties. Radar indicated a line of severe thunderstorms capable of producing large hail and destructive winds in excess of 70 mph.
- 0723 CDT KWNS severe thunderstorm watch 779 outline and counties included.
- 0725 CDT KMPX severe weather statement – tornado warning expected to cancel at 0730 CDT, radar indicated storm has weakened. Severe thunderstorm with damaging wind and large hail remains in effect for much of the area.

- 0727 CDT KMPX emergency alert system activation – severe thunderstorm warning for Watonwan county. Radar indicated a severe thunderstorm capable of producing large hail and destructive winds in excess of 70 mph.
- 0730 CDT KMPX Airport Weather Warning for KMSP. Severe thunderstorm warning with winds to 60 mph, large hail expected near 0830 CDT.
- 0732 CDT KMPX emergency alert system activation – severe thunderstorm warning for McLeod,  
line Carver, Renville, Scott, Sibley, Le Sueur, and Nicollet counties. Radar indicated a line of severe thunderstorms capable of producing large hail and damaging winds in excess of 65 mph.
- 0736 CDT KMPX emergency alert system activation - tornado warning for Kandiyohi, Meeker, McLeod counties. Spotters reported funnel cloud and radar indicated another possible tornadic thunderstorm.
- 0739 CDT KMPX emergency alert system activation – severe thunderstorm warning for Le Sueur, Nicollet, Blue Earth, and Waseca counties. Radar indicated a line of severe thunderstorms capable of producing large hail and damaging winds in excess of 65 mph.
- 0740 CDT KWNS severe thunderstorm watch 779 outline and counties included.
- 0746 CDT KWNS severe thunderstorm watch 779 outline and counties included.
- 0741 CDT KMPX extends weather watch 779 until 0900 CDT for Steele County.
- 0759 CDT KMPX emergency alert system activation – severe thunderstorm warning for Faribault  
and Martin counties. Radar indicated a severe thunderstorm capable of producing large hail and damaging winds in excess of 60 mph.
- 0801 CDT KMPX severe weather statement – warning for Redwood, Renville, and Kandiyohi cancelled. Radar indicated severe thunderstorm had weakened and moved out of the area.
- 0803 CDT KWNS severe thunderstorm watch 779 outline and counties included.
- 0810 CDT KMPX emergency alert system activation – severe thunderstorm warning for Hennepin, Dakota, Scott, Le Sueur, Rice, Waseca, and Steele counties. Spotters reported a severe thunderstorm with large hail and destructive winds in excess of 70 mph, moving eastward at 45 mph.

- 0821 CDT KMPX emergency alert system activation – severe thunderstorm warning for Freeborn county. Radar indicated a line of severe thunderstorms capable of producing large hail and damaging winds in excess of 60 mph, moving east at 56 mph.
- 0834 CDT KMPX emergency alert system activation – severe thunderstorm warning for Dakota and Goodhue counties. Radar indicated a severe thunderstorm with large hail and destructive winds in excess of 70 mph.
- 0847 CDT KMPX emergency alert system activation - tornado warning for Goodhue, Rice, and Steele counties. Radar indicated possible tornadic thunderstorm.
- 0903 CDT KWNS severe thunderstorm watch 779 - cancellation.
- 0905 CDT KMPX severe weather statement – tornado warning for Steele, Rice, Goodhue countines canceled.
- 0928 CDT KMPX severe weather statement – severe thunderstorm warning for Goodhue and Dakota counties will expire at 0930 CDT as storm move out of the area.