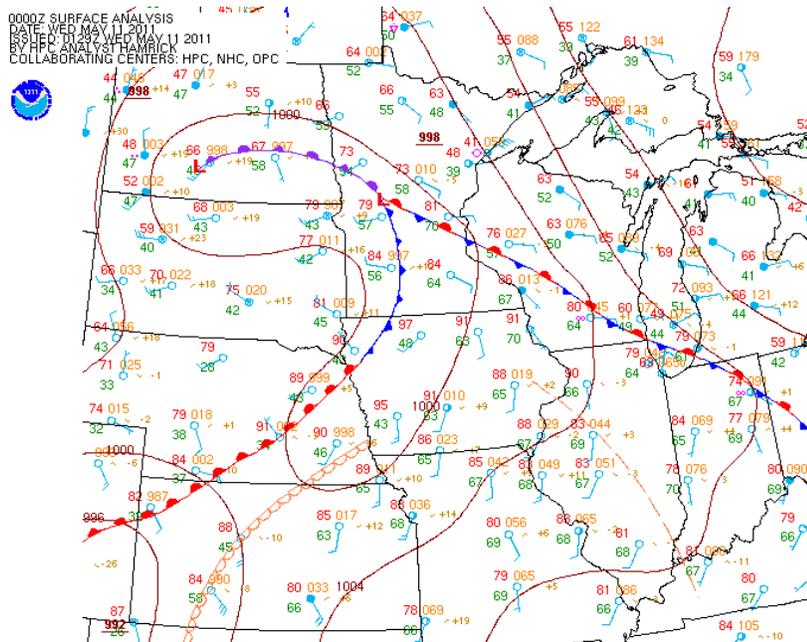


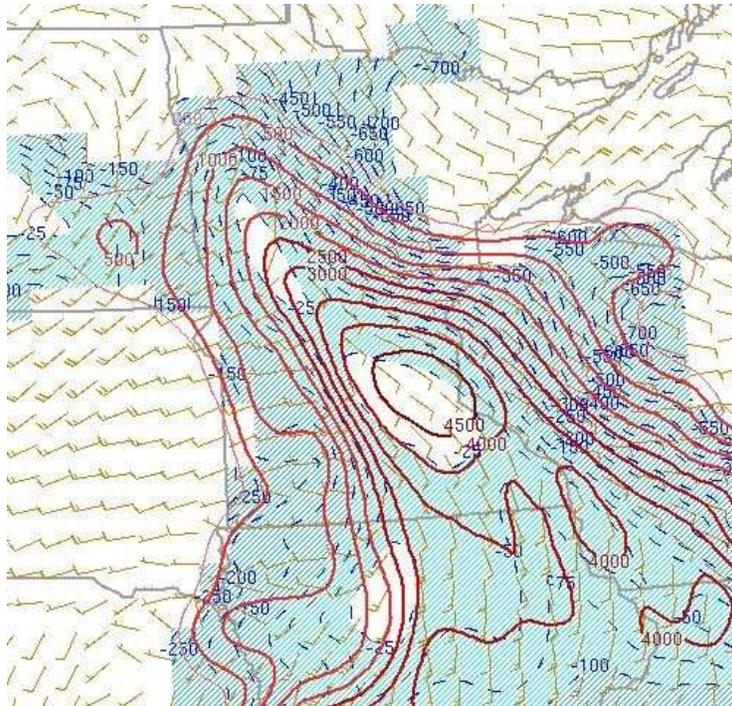
May 10, 2011: Very Large Hail and St. Michael Area Tornado

Synopsis

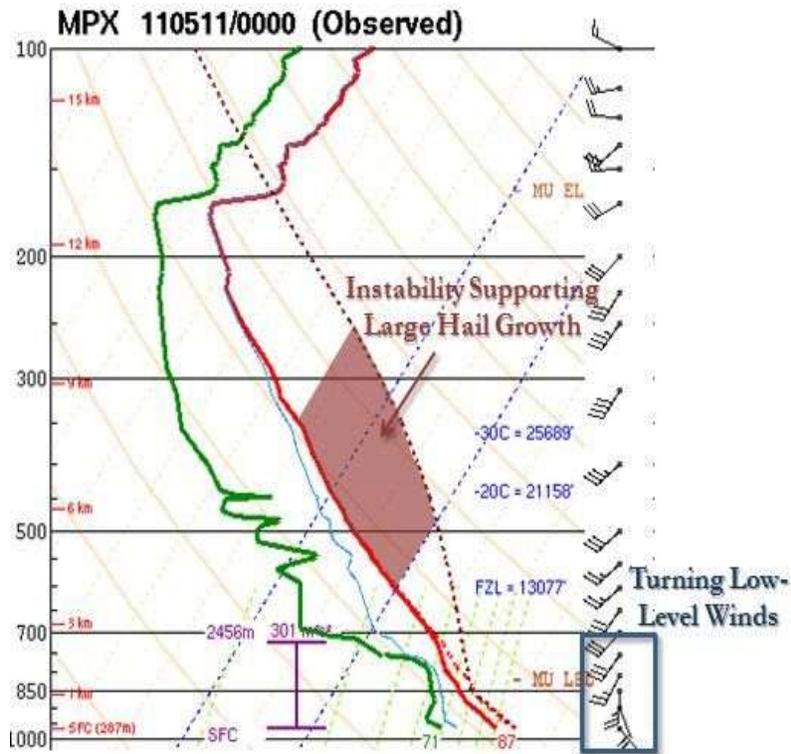
A severe weather event with primarily large hail unfolded across central and eastern Minnesota on Tuesday evening. Warmth and moisture to the highest levels observed so far in the Twin Cities during 2011, surged northward ahead of an approaching surface low pressure. Afternoon temperatures reached the upper 70s to lower to mid 90s across much of the area. Dew points accelerated into the mid 60s and lower 70s by late afternoon. Such high warmth and moisture created strong to extreme instability in the atmosphere. The values of the lowest 100 mb mixed-layer CAPE were a high 4,500 J/kg and were actually even larger in the hours prior. The lack of convective inhibition at this time allowed storms to further blossom from 6 to 8 pm, which is the period that the storms entered the Twin Cities metro area. The deep instability, including well above the freezing level in the atmosphere, led to much of the hail being golf ball size or larger. This was even the case at the NWS Forecast Office in Chanhassen (see below), where hail just over two inches in diameter occurred at the edge of a storm core. Atmospheric wind shear was supportive for supercells. Turning wind direction in the low-levels further offered tornado potential in some storms. This was realized within a corridor immediately ahead of the focusing feature: a cold front/dry-line. Indeed there were multiple storms that developed with rotating wall clouds and/or funnels along this boundary, with at least one of these likely having produced a tornado near St. Michael.



Surface Weather Map: 7 pm

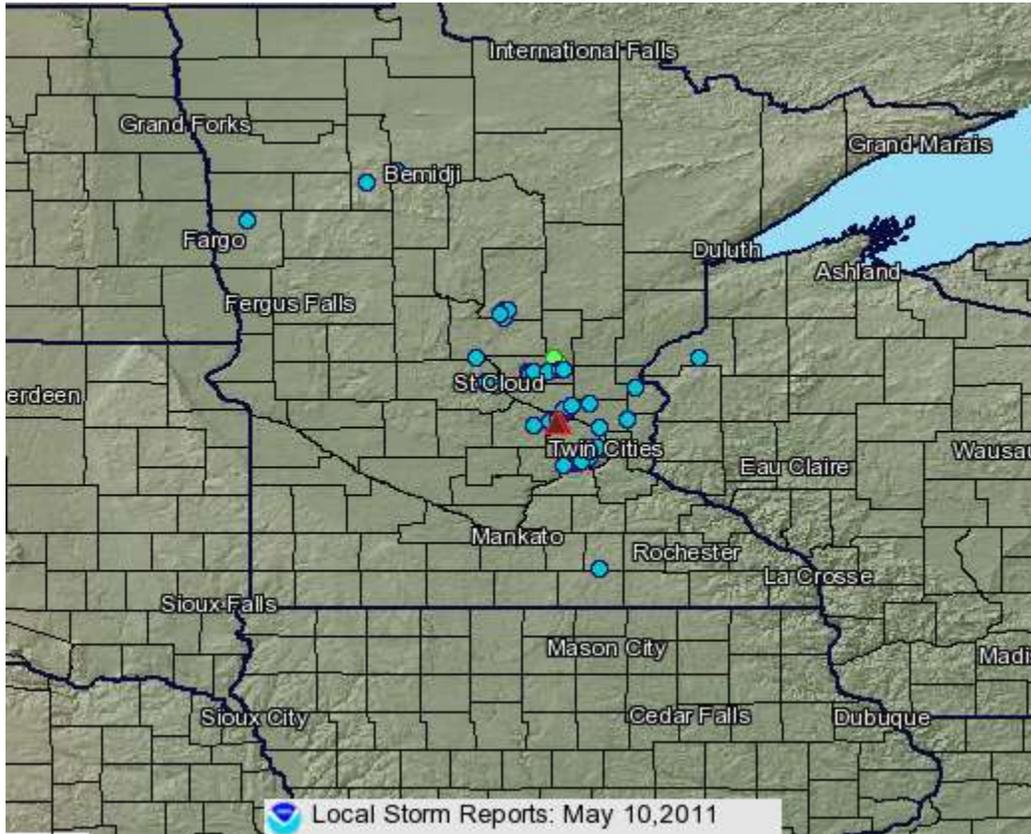


Mixed-Layer Instability Plot (J/kg)



NWS Chanhassen Weather Balloon Data from 7 pm

Storm Reports



..TIME...	...EVENT...	...CITY LOCATION...	...LAT.LON...
..DATE...MAG....	..COUNTY LOCATION..ST..	...SOURCE....
	..REMARKS..		
0627 PM	HAIL	BOWLUS	45.82N 94.41W
05/10/2011	M0.75 INCH	MORRISON MN	TRAINED SPOTTER
0630 PM	HAIL	1 ESE ST JOSEPH	45.56N 94.30W
05/10/2011	M1.00 INCH	STEARNS MN	TRAINED SPOTTER
0638 PM	HAIL	1 S BOWLUS	45.81N 94.41W
05/10/2011	M1.25 INCH	MORRISON MN	TRAINED SPOTTER
0643 PM	HAIL	1 N ST JOSEPH	45.58N 94.32W
05/10/2011	M1.75 INCH	STEARNS MN	TRAINED SPOTTER
0644 PM	HAIL	ST JOSEPH	45.57N 94.32W
05/10/2011	M1.25 INCH	STEARNS MN	TRAINED SPOTTER
0704 PM	HAIL	2 E CLEARWATER	45.41N 94.00W
05/10/2011	M0.75 INCH	SHERBURNE MN	TRAINED SPOTTER
0705 PM	HAIL	CLEAR LAKE	45.45N 94.00W
05/10/2011	M0.75 INCH	SHERBURNE MN	TRAINED SPOTTER

0713 PM	HAIL	LITTLE ROCK	45.81N 94.06W
05/10/2011	M0.75 INCH	BENTON	MN TRAINED SPOTTER
0713 PM	HAIL	1 ENE ELLENDALE	43.88N 93.28W
05/10/2011	M1.00 INCH	STEELE	MN TRAINED SPOTTER
0720 PM	HAIL	BUFFALO	45.18N 93.87W
05/10/2011	M1.00 INCH	WRIGHT	MN TRAINED SPOTTER
0733 PM	HAIL	2 ESE CARVER	44.75N 93.59W
05/10/2011	M0.88 INCH	SCOTT	MN TRAINED SPOTTER
0736 PM	HAIL	3 W ST MICHAEL	45.21N 93.73W
05/10/2011	M0.75 INCH	WRIGHT	MN TRAINED SPOTTER
0737 PM	HAIL	1 WNW FOLEY	45.67N 93.93W
05/10/2011	M1.00 INCH	BENTON	MN TRAINED SPOTTER
0739 PM	HAIL	3 W ST MICHAEL	45.21N 93.73W
05/10/2011	M0.75 INCH	WRIGHT	MN TRAINED SPOTTER
0740 PM	HAIL	CHASKA	44.82N 93.61W
05/10/2011	M1.00 INCH	CARVER	MN TRAINED SPOTTER
0741 PM	HAIL	WAITE PARK	45.55N 94.22W
05/10/2011	M1.00 INCH	STEARNS	MN TRAINED SPOTTER
0743 PM	HAIL	CHASKA	44.82N 93.61W
05/10/2011	M1.75 INCH	CARVER	MN TRAINED SPOTTER
0743 PM	HAIL	FOLEY	45.66N 93.91W
05/10/2011	M1.00 INCH	BENTON	MN TRAINED SPOTTER
0743 PM	HAIL	3 W ST MICHAEL	45.21N 93.73W
05/10/2011	M1.75 INCH	WRIGHT	MN TRAINED SPOTTER
0743 PM	HAIL	1 SSW FOLEY	45.65N 93.91W
05/10/2011	M1.00 INCH	BENTON	MN TRAINED SPOTTER
0748 PM	HAIL	CHANHASSEN	44.86N 93.56W
05/10/2011	M2.00 INCH	CARVER	MN OFFICIAL NWS OBS

AT WEATHER OFFICE

0752 PM	HAIL	OAK PARK	45.17N 93.27W
05/10/2011	M0.75 INCH	ANOKA	MN TRAINED SPOTTER
0754 PM	TORNADO	2 WNW HANOVER	45.17N 93.70W
05/10/2011		WRIGHT	MN NWS STORM SURVEY

AN NWS STORM SURVEY ASSESSED AN EF-1 TORNADO WITH MAXIMUM WINDS NEAR 90 MPH TRACKED FOR APPROXIMATELY THREE MILES TO THE NORTHEAST ENDING ONE MILE WEST OF ST. MICHAEL. A GARAGE WAS HEAVILY DAMAGED AT A HOUSEHOLD NEAR THE END OF THE TRACK WHICH WAS DETERMINED TO BE THE MAXIMUM INTENSITY. MUCH OF THE OTHER DAMAGE WAS EF-0 IN

INTENSITY. TIME IS ESTIMATED.

0755 PM	HAIL	EDEN PRAIRIE	44.85N 93.46W
05/10/2011	M1.00 INCH	HENNEPIN MN	TRAINED SPOTTER
0756 PM	HAIL	3 ENE EDEN PRAIRIE	44.86N 93.39W
05/10/2011	M0.75 INCH	HENNEPIN MN	TRAINED SPOTTER
0758 PM	HAIL	ST MICHAEL	45.21N 93.66W
05/10/2011	M1.00 INCH	WRIGHT MN	TRAINED SPOTTER
0758 PM	HAIL	RONNEBY	45.68N 93.87W
05/10/2011	M2.00 INCH	BENTON MN	TRAINED SPOTTER
0758 PM	HAIL	5 WSW EDEN PRAIRIE	44.83N 93.55W
05/10/2011	M1.00 INCH	CARVER MN	TRAINED SPOTTER
0803 PM	HAIL	EDINA	44.89N 93.36W
05/10/2011	E1.25 INCH	HENNEPIN MN	TRAINED SPOTTER
0803 PM	HAIL	1 ENE EDEN PRAIRIE	44.86N 93.43W
05/10/2011	M1.75 INCH	HENNEPIN MN	TRAINED SPOTTER
0805 PM	HAIL	1 SSW EDEN PRAIRIE	44.84N 93.47W
05/10/2011	E1.25 INCH	HENNEPIN MN	TRAINED SPOTTER
0808 PM	HAIL	EDINA	44.89N 93.36W
05/10/2011	M1.00 INCH	HENNEPIN MN	TRAINED SPOTTER
0810 PM	HAIL	2 W ELK RIVER	45.33N 93.61W
05/10/2011	M1.00 INCH	SHERBURNE MN	TRAINED SPOTTER
0810 PM	HAIL	EDINA	44.89N 93.36W
05/10/2011	M1.00 INCH	HENNEPIN MN	TRAINED SPOTTER
0810 PM	HAIL	3 S MINNEAPOLIS	44.92N 93.28W
05/10/2011	M0.75 INCH	HENNEPIN MN	TRAINED SPOTTER
0813 PM	HAIL	OTSEGO	45.29N 93.61W
05/10/2011	M0.75 INCH	WRIGHT MN	TRAINED SPOTTER
0813 PM	HAIL	EDEN PRAIRIE	44.85N 93.46W
05/10/2011	M1.00 INCH	HENNEPIN MN	TRAINED SPOTTER
0815 PM	HAIL	ALBERTVILLE	45.24N 93.66W
05/10/2011	M2.00 INCH	WRIGHT MN	TRAINED SPOTTER
0815 PM	HAIL	EDINA	44.89N 93.36W
05/10/2011	M1.75 INCH	HENNEPIN MN	TRAINED SPOTTER
0815 PM	HAIL	3 NE EDEN PRAIRIE	44.89N 93.41W
05/10/2011	M2.00 INCH	HENNEPIN MN	TRAINED SPOTTER
0819 PM	HAIL	ALBERTVILLE	45.24N 93.66W
05/10/2011	M2.75 INCH	WRIGHT MN	TRAINED SPOTTER
0820 PM	HAIL	MINNEAPOLIS	44.96N 93.27W

05/10/2011	M0.88 INCH	HENNEPIN	MN	TRAINED SPOTTER
NEAR TARGET FIELD				
0821 PM	HAIL	OAK PARK		45.17N 93.27W
05/10/2011	M2.00 INCH	ANOKA	MN	TRAINED SPOTTER
0824 PM	HAIL	ELK RIVER		45.33N 93.57W
05/10/2011	M1.75 INCH	SHERBURNE	MN	TRAINED SPOTTER
0825 PM	HAIL	ELK RIVER		45.33N 93.57W
05/10/2011	M1.00 INCH	SHERBURNE	MN	TRAINED SPOTTER
0825 PM	HAIL	MINNEAPOLIS		44.96N 93.27W
05/10/2011	M0.88 INCH	HENNEPIN	MN	TRAINED SPOTTER
IN UPTOWN				
0828 PM	HAIL	GOLDEN VALLEY		44.99N 93.36W
05/10/2011	M2.50 INCH	HENNEPIN	MN	PUBLIC
AT INTERSECTION OF 394 AND LOUISIANA AVE.				
0828 PM	HAIL	5 WSW MINNEAPOLIS		44.95N 93.36W
05/10/2011	M1.75 INCH	HENNEPIN	MN	TRAINED SPOTTER
0829 PM	HAIL	MINNEAPOLIS		44.96N 93.27W
05/10/2011	M1.75 INCH	HENNEPIN	MN	TRAINED SPOTTER
REPORTED AT CORNER OF FRANKLIN AND LYNDAL.				
0830 PM	FUNNEL CLOUD	HOPKINS		44.93N 93.41W
05/10/2011		HENNEPIN	MN	AMATEUR RADIO
HIGHWAY 169 AND EXCELSIOR LOOKING NORTH MOVING NORTHEAST				
0830 PM	HAIL	ST LOUIS PARK		44.95N 93.36W
05/10/2011	M2.50 INCH	HENNEPIN	MN	TRAINED SPOTTER
0833 PM	HAIL	MINNEAPOLIS		44.96N 93.27W
05/10/2011	M1.75 INCH	HENNEPIN	MN	TRAINED SPOTTER
BROADWAY AND INTERSTATE 94				
0834 PM	HAIL	4 SSW FORESTON		45.68N 93.75W
05/10/2011	M2.00 INCH	MILLE LACS	MN	TRAINED SPOTTER
0835 PM	HAIL	2 N ST LOUIS PARK		44.98N 93.36W
05/10/2011	M1.75 INCH	HENNEPIN	MN	TRAINED SPOTTER
0835 PM	HAIL	GOLDEN VALLEY		44.99N 93.36W
05/10/2011	M0.75 INCH	HENNEPIN	MN	TRAINED SPOTTER
0835 PM	HAIL	3 SSW FOREST LAKE		45.24N 93.01W
05/10/2011	M2.00 INCH	WASHINGTON	MN	TRAINED SPOTTER
0835 PM	HAIL	MINNEAPOLIS		44.96N 93.27W

05/10/2011 M1.75 INCH HENNEPIN MN TRAINED SPOTTER

TARGET FIELD

0835 PM HAIL MINNEAPOLIS 44.96N 93.27W
05/10/2011 M2.00 INCH HENNEPIN MN TRAINED SPOTTER

BROADWAY AND INTERSTATE 94

0837 PM HAIL 1 E PEASE 45.70N 93.63W
05/10/2011 M1.75 INCH MILLE LACS MN EMERGENCY MNGR

AT INTERSECTION OF 100TH ST AND 125TH AVE.

0839 PM HAIL 1 NW MINNEAPOLIS 44.98N 93.29W
05/10/2011 M2.00 INCH HENNEPIN MN TRAINED SPOTTER

0840 PM HAIL ST LOUIS PARK 44.95N 93.36W
05/10/2011 M1.75 INCH HENNEPIN MN TRAINED SPOTTER

0858 PM HAIL MILACA 45.76N 93.65W
05/10/2011 M0.88 INCH MILLE LACS MN TRAINED SPOTTER

0900 PM HAIL ST FRANCIS 45.38N 93.36W
05/10/2011 M1.75 INCH ANOKA MN TRAINED SPOTTER

0904 PM HAIL 3 NE ELK RIVER 45.36N 93.52W
05/10/2011 M1.00 INCH SHERBURNE MN TRAINED SPOTTER

0915 PM FLASH FLOOD MILACA 45.76N 93.65W
05/10/2011 MILLE LACS MN LAW ENFORCEMENT

STANDING WATER ON ROADS CAUSING VEHICLES TO HYDRO PLANE.

0915 PM HAIL 2 E PEASE 45.70N 93.61W
05/10/2011 M2.00 INCH MILLE LACS MN TRAINED SPOTTER

0915 PM FLASH FLOOD 4 NNW MILACA 45.81N 93.69W
05/10/2011 MILLE LACS MN TRAINED SPOTTER

CULVERTS OVER FLOWING AND WATER BACKING UP ON ROADS.

0918 PM HAIL 2 E BOCK 45.78N 93.51W
05/10/2011 M0.88 INCH KANABEC MN TRAINED SPOTTER

1017 PM HAIL 1 SSE BRAHAM 45.71N 93.17W
05/10/2011 E0.75 INCH ISANTI MN TRAINED SPOTTER

1050 PM HAIL 2 NE NORTH BRANCH 45.53N 92.95W
05/10/2011 M1.50 INCH CHISAGO MN TRAINED SPOTTER

1114 PM HAIL NORTH BRANCH 45.51N 92.98W
05/10/2011 M0.75 INCH CHISAGO MN PUBLIC

St. Michael Area Tornado

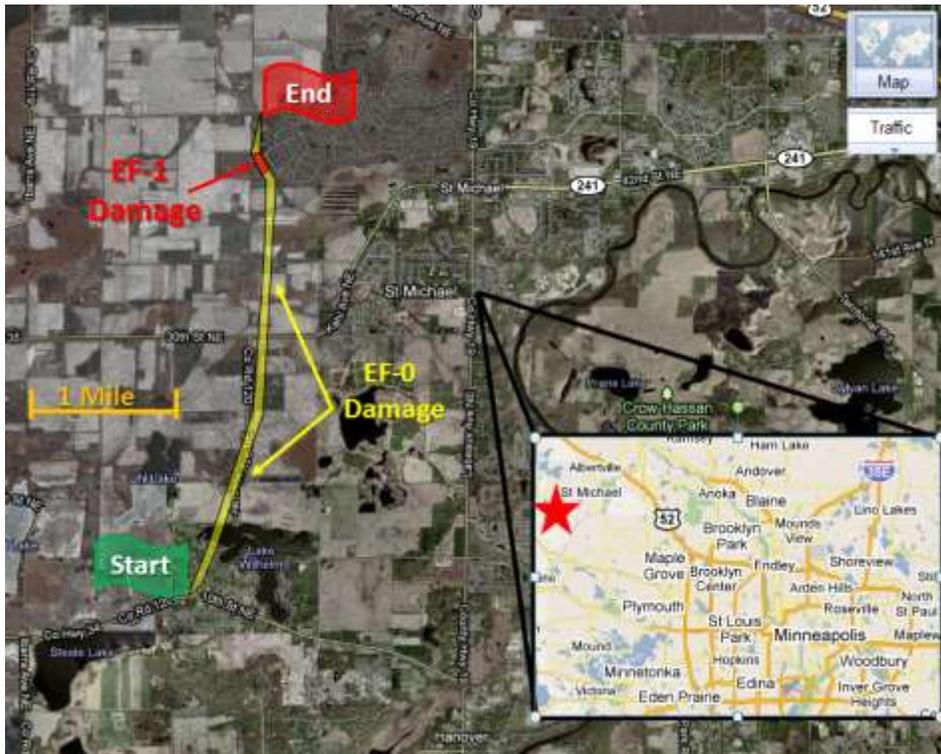
Magnitude: EF-1

Maximum Wind Speeds: Near 90 mph

Path Length: Approximately 3 miles

The tornado touched down just east of the intersection of County Roads 34 and 120 and tracked north-northeast for 3.1 miles. The only time it deviated from this track was toward the end of its existence, when it made a slight turn toward the north-northwest and intensified. After hitting the house, it turned back toward the north-northeast and quickly dissipated. The tornado was narrow, only 75 feet wide at most, and it was often narrower than 75 feet.

Most eyewitnesses did not realize there was a tornado, because they did not see the debris swirling at ground level and the funnel did not extend all the way to the ground. It turns out that the condensation funnel only extended downward for some distance, then it appeared like there was nothing, then the debris at the surface. However, the violently rotating wind made it all the way to the ground but there was not enough humidity in the few thousand feet above the ground to condense and create the cloud that makes the tornado visible.



St. Michael Area Tornado Damage Photos



Start of tornado damage. This is the backyard of a house that had two windows blown out, a TV antenna knocked over, and two doors inside the house ripped off their hinges. The backyard play area had toys strewn all over.



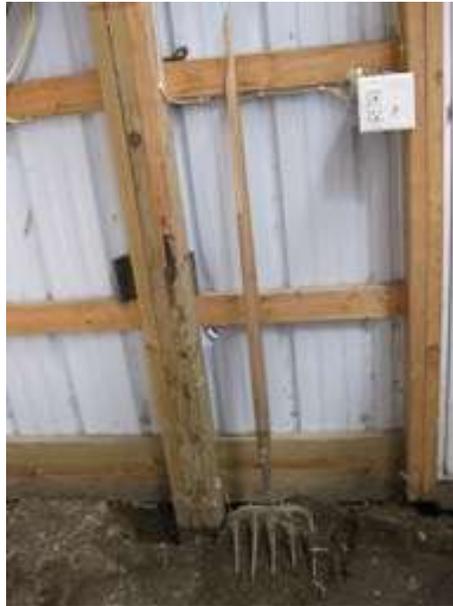
About 1/3 mile later, this house had some shingles blown off. About a dozen trees across the street were knocked over. Fences were blown down.



This shed is part of a farm about 1.3 miles north of the start. The wind got inside the shed from an opening at the other end. The shed was then lifted up by about three feet before it fell back to the ground



This beam was pulled out of the ground as the shed was lifted up.



Upper half of this pitchfork was punched through the wall as shed was lifted up.



This farm had some tin ripped off a shed and grain bin, about 1/2 mile before dissipation.



This house sustained the worst damage. The tornado made a jog to the left, intensified, and hit the house head on. The roof came off the garage and part of the house. The material was blown over the house and came to rest in and near a pond.

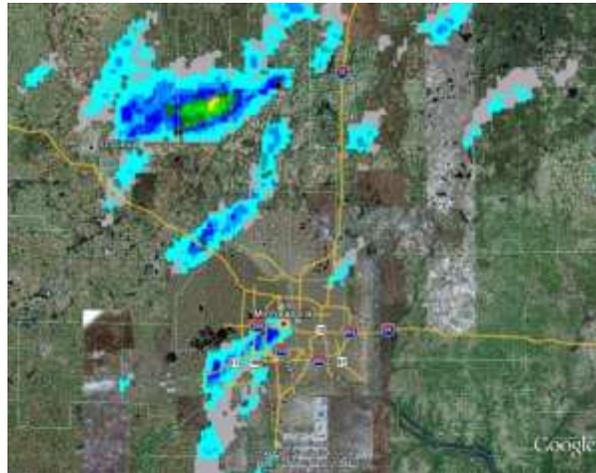


Another view of the house.



Looking north at the end of the tornado path.

Large Hail



Regional view of Doppler Radar Estimated Hail

NWS Doppler Radar has many algorithms that can calculate various storm-based parameters to assist NWS warning forecasters in storm interrogation as well as for understanding what occurred after an event. One of those is shown above from throughout Tuesday evening. Looking at this parameter over space and time, such as above, can often give a reasonable idea of where large hail occurred.

Large Hail Photos from the NWS Office in Chanhassen

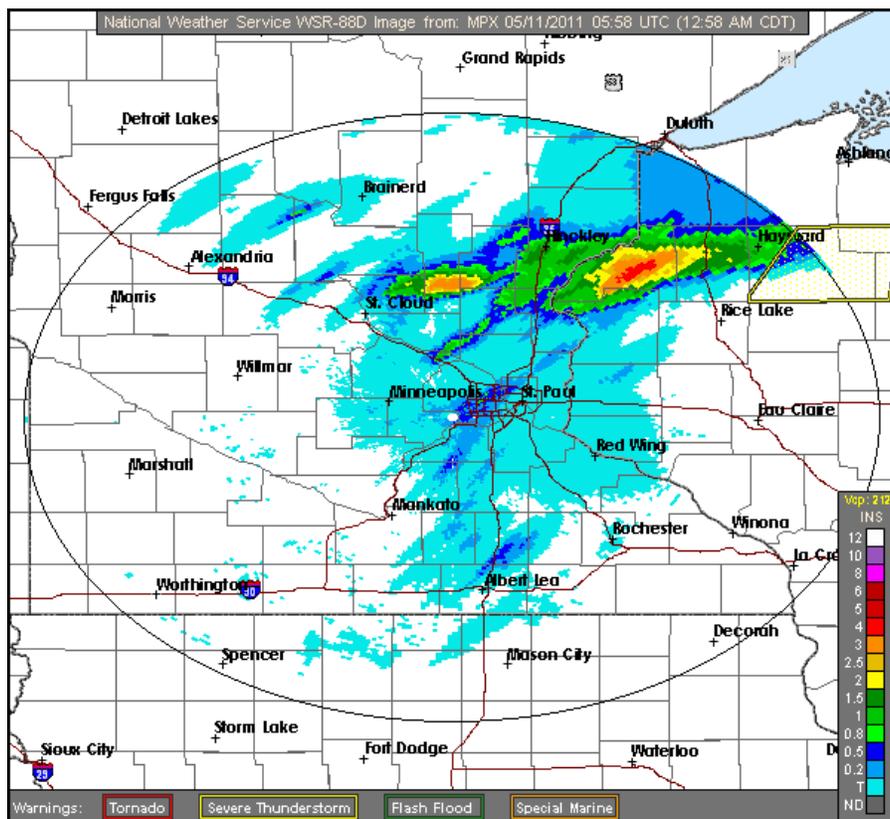


This hail fell at the office during the early evening. The hail in this photo is placed next to commonly compared objects. The different sized marbles reflect how it is challenging to use marbles as a comparison to report hail size.



1.75" to 2.2" diameter hail.

Rainfall



Radar Estimated Storm Total Precipitation: Some of the radar estimates will be high because of hail contamination on Tuesday evening.