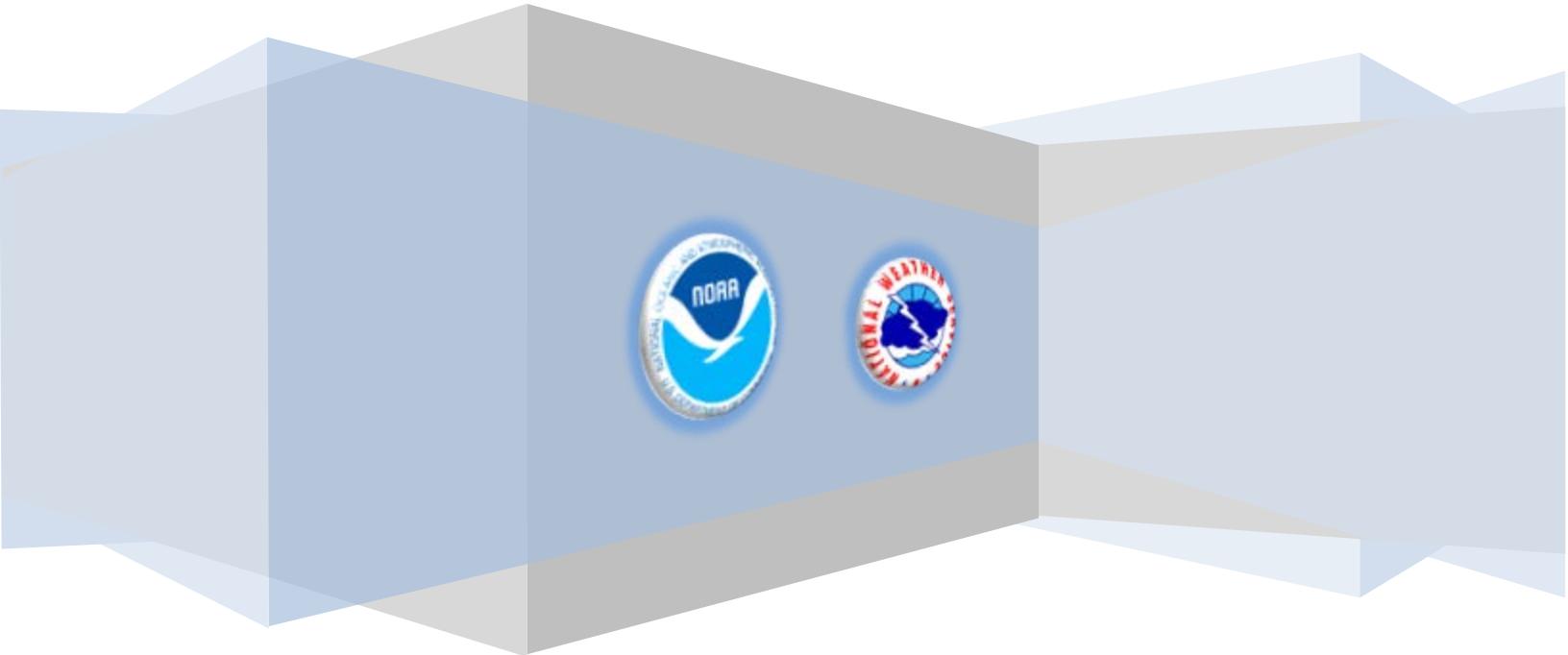


Natural Hazards

Assessment

Vernon County, WI

Prepared by: NOAA / National Weather Service La Crosse, WI



Natural Hazards Assessment

for

Vernon County, WI

Prepared by NOAA / National Weather Service – La Crosse
Last Update: October 2016

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Natural Hazards Assessment

Vernon County, WI

Prepared by National Weather Service – La Crosse

Overview

Vernon County is in the Upper Mississippi River Valley of the Midwest with relatively hilly terrain and bluffs. It is bordered by the Mississippi River to the west.

The area experiences a temperate climate with both warm and cold season extremes.

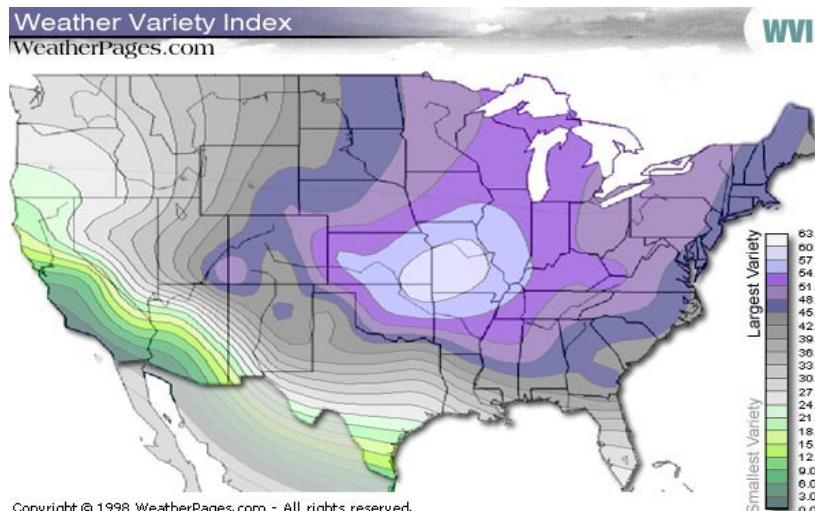
Winter months can bring occasional heavy snows, intermittent freezing precipitation or ice, and prolonged periods of cloudiness. While true blizzards are rare, winter storms impact the area on average about 3 to 4 times per season. Occasional arctic outbreaks bring extreme cold and dangerous wind chills.

Temperatures between river valleys and surrounding ridges can vary greatly. Typically high temperatures on ridges are 3° to 5°F colder than valleys. This can lead to slightly more average snowfall on ridge tops and occasionally a difference in winter precipitation types from ridge to valley.

Thunderstorms occur on average 30 to 50 times a year, mainly in the spring and summer months. The strongest storms can produce associated severe weather like tornadoes, large hail, or damaging wind. Both river flooding and flash flooding can occur, along with urban-related flood problems. The terrain can lead to mud slides and generally increases the flash flood threat. Heat and high humidity is occasionally observed in June, July, or August.

The autumn season usually has the quietest weather. Valley fog is most common in the late summer and early fall months. On calm nights, colder air settles into valleys leading to colder low temperatures compared to ridge top locations. High wind events can also occur occasionally, usually in the spring or fall.

The variability in weather can be seen in the following graphic, created by a private company (weatherpages.com) that rated each city on variations in temperature, precipitation, and other factors. La Crosse, WI ranked 27th highest and Madison, WI ranked 8th highest in variability out of 277 cities.

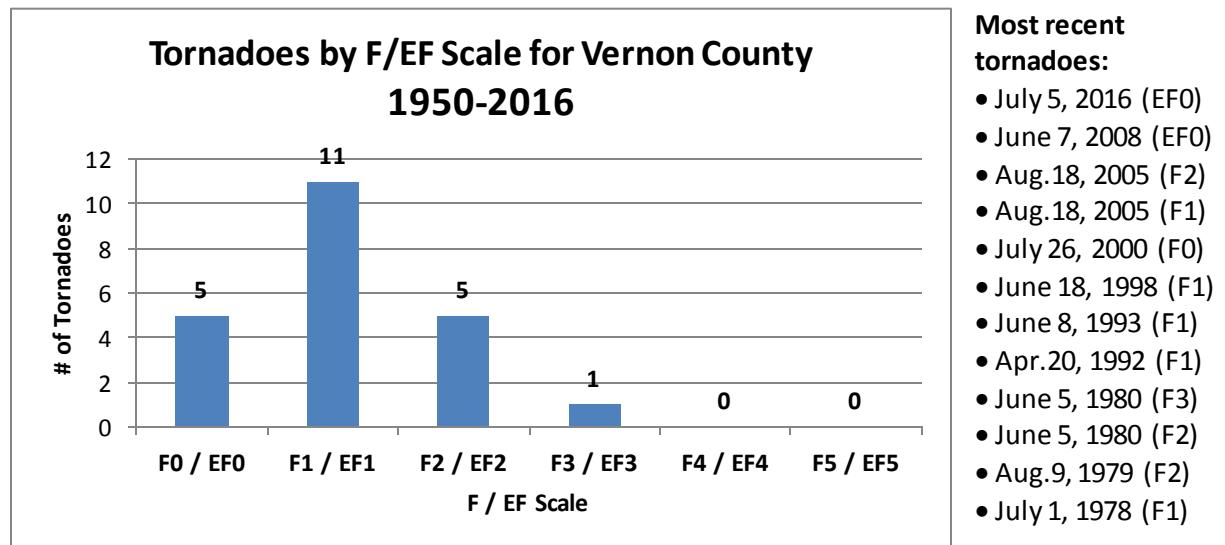


Since 1998, Vernon County has been included in a FEMA Federal Disaster Declaration 8 times:

- 1998 – Severe storms
- 2000 – Severe storms / flooding
- 2001 – Flooding
- 2004 – Severe storms / flooding
- 2007 – Severe storms / flooding
- 2008 – Severe storms / flooding
- 2013 – Severe storms / flooding
- 2016 – Severe storms / flooding

Tornadoes

Even though Wisconsin averages about 23 tornadoes per year, Vernon County has only had 21 tornadoes since 1950, averaging about one tornado every 3 years. Most tornadoes are short-lived and small. May and June are the peak months and most occur between 3 and 9 p.m., but they can occur nearly any time of year and at all times of the day.



The more notable tornadoes to hit Vernon County include the “Great Tornado of 1865” that destroyed much of Viroqua and killed at least 20 people. Hundreds of buildings were damaged or destroyed. In 1980 a strong tornado (F3) tracked from near Stoddard, WI to the Readstown, WI area damaging 8 homes, 30 barns, and 200 other rural structures. The Viola, WI area was hit by an F2 as recent as August 18, 2005, one of 27 tornadoes in Wisconsin that day. That tornado caused over a million dollars in damage and injured three. The terrain may limit some tornadoes from forming but brief touchdowns and tracks are still possible even through the bluffs and valleys.

Strongest tornadoes: (1850-2016)

- June 28, 1865 (F?) – 100 inj, 22 dead
- June 6, 1906 (F4) – 26 inj, 4 dead
- June 7, 1908 (F3) – 3 inj, 2 dead
- June 5, 1980 (F3) – 1 inj, 0 dead
- Aug.18, 2005 (F2) – 3 inj, 0 dead

Vernon County Tornado Facts:

- No F5 or EF5 tornadoes
- Only one F4 tornado and two F3s
- 29 deaths and 152 injuries since 1850
- Tornadoes have occurred March – October
- Most have occurred in June (11)

Tornado Watches	Tornado Warnings
Year	Year
2016	0
2015	1
2014	1
2013	3
2012	1
2011	4
2010	6
2009	2
2008	9
2007	7

Enhanced Fujita (EF) Scale	
EF0	65-85 mph
EF1	86-110 mph
EF2	111-135 mph
EF3	136-165 mph
EF4	166-200 mph
EF5	>200 mph

Severe Thunderstorms / Lightning

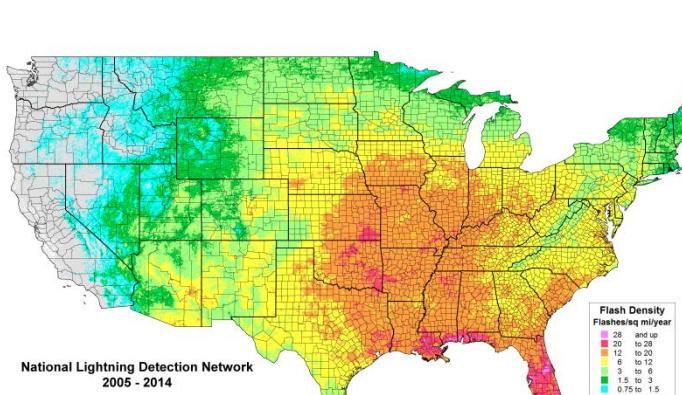
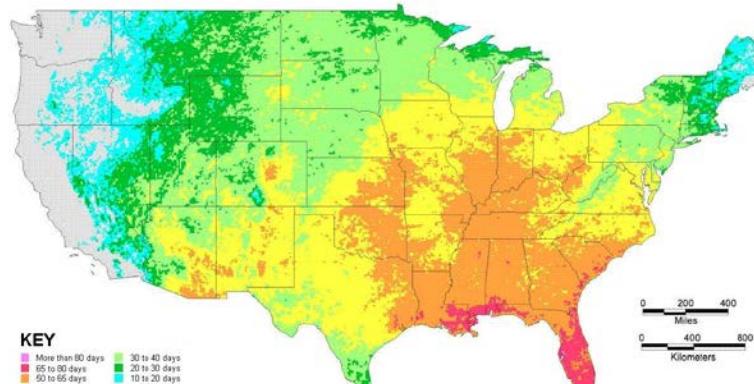
Vernon County averages 40 thunderstorm days per year. The National Weather Service (NWS) considers a thunderstorm severe when it produces wind gusts of 58 mph (50 knots) or higher, 1 inch diameter hail or larger, or a tornado.

Downdraft winds from a severe thunderstorm can produce local or widespread damage, even tornado-like damage if strong enough. Most severe thunderstorm winds occur in June or July and between the hours of 4 and 8 p.m., but can occur at other times. Most damage involves blown down trees, powerlines, and damage to weaker structures (i.e. barns, outbuildings, garages) with occasional related injuries. In 1998, a large squall line moved through the region with wind gusts in excess of 100 mph knocking down hundreds of trees and damaging buildings. Power was also out in many communities. There have been 83 damaging wind reports since 2000 in the county.

Large hail can also occur in a severe thunderstorm. June is the peak month with the most common time between 1 and 9 p.m., but it can occur in other warm season months and at any time of day. Hail is typically a crop damaging hazard but can damage roofs, windows, and vehicles if large enough ($>1"$). Expenses can be high. Injuries or fatalities are rare for hail. In August 2006, a series of storms dropped golf ball size hail in the far eastern parts of the county for over an hour. In September 1984, baseball size hail fell in Readstown, WI damaging numerous vehicles and roofs. There have been 81 large hail ($\geq 3/4"$) reports in the county since 2000.

Non-severe thunderstorms still pose a lightning risk. According to the Vaisala Group, an average of just under 300,000 cloud-to-ground strikes hit Wisconsin each year based on data from 2006 to 2015. Nationally, Wisconsin ranks 11th in lightning related fatalities with 8 deaths reported between 2006 and 2015. There were lightning fatalities in Wisconsin in 2008, 2011, and 2016 but no fatalities or injuries reported in Vernon County from lightning since 1982.

Average Number of Thunderstorm Days per Year



VAISALA

Severe Thunderstorm Watches	Severe Thunderstorm Warnings
Year	Year
2016	8
2015	12
2014	3
2013	15
2012	11
2011	11
2010	8
2009	12
2008	3
2007	13
	13
	8

Flooding and Hydrologic Concerns

Vernon County has an extensive flood history. On occasion intense, heavy rain producing thunderstorms or consecutive thunderstorms (“training”) can bring excessive rainfall leading to flash flooding. The hilly terrain promotes rapid run-off and enhances the threat. Mud and landslides can occur in extreme cases, especially along the Mississippi River.

June is the most common month for flash floods, but they can occur from May through September. They are most common in the evening hours, between 8-10 p.m., but can occur at other times and typically last from 3-6 hours. Since 1982, there have been 11 deaths from flooding in Wisconsin, including 2 in Vernon Co. in 2016.

In August 2007, seven to thirteen inches of rain fell in one evening across the county leading to widespread flash flooding and property damage. Numerous roads were damaged and closed, people were evacuated, hundreds of homes had flooded basements, and landslides were common. The county was declared

a federal disaster area with an estimated 35 million dollars in damage. Over 1,100 people applied for FEMA assistance including 33 businesses.



In May 2004, southwest parts of Vernon County were hit with 5 inches of rain leading to significant flash

flooding and mudslides. A swollen creek near the Bad Axe River led to the death of a 64-year old woman who tried to drive through a low-water crossing during the late evening hours. Her body was found days later near the Mississippi River. (Picture right: Vehicle swept away in May 2004 flash flood – Courtesy of Vernon County Emergency Management)



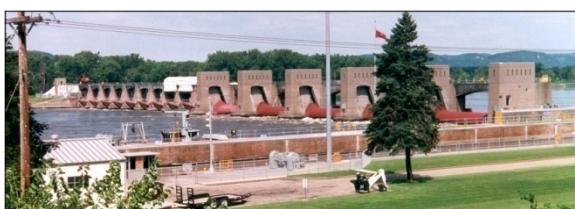
Five main watersheds can impact Vernon County—the Mississippi River, the Kickapoo River, The Bad Axe River, the South Branch of the Baraboo River, and Coon Creek. The Mississippi River is often highest in the spring associated with the seasonal snowmelt, but on rare occasions can reach flood stage during the summer or fall from heavy rain patterns. The combination of up-river snowmelt and area rain brought major flooding along the Mississippi River in April 2001, setting the 2nd highest crest levels in many locations. The record crest year remains 1965.

Mississippi River @ Genoa
Top 5 Crests (FS: 631 feet)

Year	Crest
1965	638.40'
1997	636.45'
2001	636.21'
1969	635.24'
1952	634.52'

Flooding along the Kickapoo and Bad Axe Rivers can be a bit more frequent, usually stemming from heavy rain patterns or snowmelt. In June 2008, 6 to 10 inches of rain across southwest Wisconsin led to record flooding and crests along the Kickapoo River. Communities along the river had extensive damage leading to another federal disaster declaration and causing close to \$12 million in damages.

The US Army Corps of Engineers maintains a Lock and Dam (#8) at Genoa, WI that is used to manage navigational water levels, not for flood control. In addition, there are 22 earthen dams owned by Vernon County and regulated by the state.



Winter Storms and Extreme Cold

Hazardous winter weather can bring a variety of conditions to Vernon County. Since 1982, an average of 3-4 winter storms impact the area each season. The terrain in the county does limit the number of true blizzards (only 3 since 1982) but heavy snow, blowing snow, ice, and sleet all occur. There have been a total of 6 documented deaths and 51 injuries as a direct result from winter storms in Wisconsin since 1982.

The 30-year average seasonal snowfall at Viroqua is 47.8 inches. There are occasions where milder daytime temperatures in valleys produce rain when a wintry mix or snow is falling on ridges. Blowing snow is more common on ridge tops as well. The all-time record one-day snowfall in Viroqua was 17.0 inches set on March 13, 1997. The bulk of snow falls between December and March. The largest winter storms tend to form over the central or southern Plains, then move northeast towards the western Great Lakes.

On February 23-25, 2007, a major winter storm impacted Vernon County. Heavy snow, including lightning, brought nearly a foot of snow the first night. Winds later increased and created major blowing and drifting. Some sleet and freezing rain fell next, followed by another round of heavy snow and blizzard conditions the next night. When the storm finally moved out, at least 20 inches of snow had fallen in parts of the county (Ontario and Coon Valley, WI), ranking as the largest multi-day snow storm on record. Another major storm hit less than a week later, leading to one of the snowiest weeks on record (25" in a 7-day period, ending 3/3/07 at Ontario, WI).

Top 5 Seasonal Snowfalls in Viroqua	
Years	Snowfall
2007-08	77.0"
1996-97	74.5"
1958-59	74.0"
1942-43	73.8"
1950-51	73.0"

On December 8-9, 2009, a blizzard brought 14.5" of snow to the Westby area along with nearly a foot to Viroqua, WI. In December 2010 a blizzard brought a foot of snow to Stoddard and Ontario with 14" reported in Viola, WI.

March can often be a snowy month. Even though snowfall may be less frequent, heavy wet snow can form from large spring storms. In 1997, a large winter storm dropped 20 inches of wet snow in Vernon County on March 13-14th.

Ice storms (1/4" of ice or more) can occur but are relatively rare with only 5 occurrences since 1982.



Arctic cold outbreaks can occur in the upper Midwest as well. Snow depth can modify these cold temperatures leading to sub-zero readings on average 27 times a winter. Occasionally strong northwest winds will combine with arctic outbreaks to create dangerous wind chill conditions as well. The coldest temperatures are usually in January and February with average lows in the single digits and record lows colder than -25°F most days. The all-time record low at Hillsboro, WI is -44°F (1963) and at Genoa, WI -43°F (1951).

In 1996, the Viroqua area went 6 consecutive days with temperatures below zero degrees (F) following a blizzard about a week earlier. Low temperatures of -26°F, -33°F, -24°F, -33°F, -37°F, and -33°F were set in a row from late January into early February. Since 1982 there have been 38 fatalities in Wisconsin from cold weather and 54 direct injuries.

Coldest Lows at Viroqua, WI	
Low	Date
-42°F	1/15/1963
-37°F	2/3/1996
-36°F	12/19/1983
-35°F	3/1/1962
-34°F	1/19/1994

Heat, Drought, and Wildfires

On occasion the weather pattern across the upper Midwest favors prolonged heat and humidity, leading to heat waves. June through August are the warmest months with average high temperatures in the 80s and record highs above 100°F most days. The warmest temperature on record in the county was at Genoa, WI (lock and dam) of 109°F set in July 1995.

Since 1982, there have been 125 fatalities directly related to heat waves and another 95 indirectly, in Wisconsin. In Vernon County, there has been 15 heat waves since 1982 and one heat related death in 2012.

One of the longest heat waves on record occurred in July 1936 when the Viroqua area hit 90°F or higher for 15 consecutive days, including 9 days at or above 100°F and an all-time record of high of 108°F as noted right. In more recent years, heat waves have hit in 1995, 1999, 2001, 2011, 2012, and 2013. In July 2011 the heat index hit 108 (July 17th) and 109 (July 18th) which led to 6 deaths in the state.



Prolonged dry spells can also lead to drought causing extreme damage to crops. Droughts vary in length and intensity but abnormally dry to moderate drought conditions can occur quite frequently. Severe to extreme droughts occur far less frequently. A Secretarial Drought Designation was given to all of southern Wisconsin in 2012 for extreme drought.

Dry weather can also lead to a wildfire threat, especially in the spring before foliage has emerged (i.e. before green up) or in the fall after vegetation has started to die off. Warm, dry (i.e. lower relative humidities), and windy conditions all favor higher fire danger and can lead to sporadic grass fires in Vernon County. Thick, wooded areas also pose a threat for wildfires under extremely dry conditions but occur far less frequently.

Warmest Highs at Viroqua, WI	
High	Date
108°F	7/14/1936
108°F	7/13/1936
106°F	7/12/1936
106°F	5/31/1934
105°F	7/15/1936



Local Climatology

Here are some basic climatology figures for the Vernon County area. Data is valid for Viroqua, WI based on normals from a 30-year period (1981-2010).

Month	Normal Maximum Temperature	Normal Minimum Temperature	Average Temperature	Precipitation	Snowfall
JAN	24.6	6.5	15.5	0.93"	11.7"
FEB	29.7	10.9	20.3	0.79"	8.7"
MAR	41.8	22.4	32.1	1.49"	6.7"
APR	56.7	33.8	45.2	3.61"	2.5"
MAY	67.4	44.5	56.0	4.09"	0.0"
JUN	76.4	54.2	65.3	4.51"	0.0"
JUL	80.5	58.6	69.5	4.73"	0.0"
AUG	78.3	56.8	67.6	4.74"	0.0"
SEP	70.1	48.0	59.0	3.36"	0.0"
OCT	57.9	36.3	47.1	2.42"	0.5"
NOV	42.0	24.7	33.4	1.98"	4.9"
DEC	27.9	11.2	19.5	1.53"	11.9"
Year	54.3	33.9	44.1	34.69"	47.8"

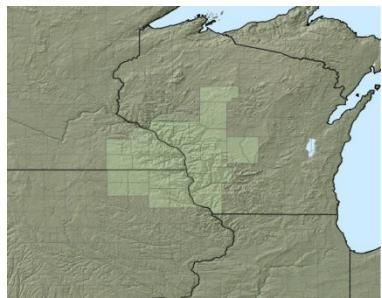
Miscellaneous facts:

- Warmest year on record – 1931 (50.8°F)
- Warmest month on record – July 1936 (79.1°F)
- Warmest day on record – July 13, 1936 and July 14, 1936 (108°F)
- Greatest number of days with 90°F or warmer – 1934 (41 times)
- Coldest year on record – 1917 (40.8°F)
- Coldest month on record – January 1912 (-0.7°F)
- Coldest day on record – January 15, 1963 (-42°F)
- Greatest number of days at 0°F or colder – 1978 (54 times)
- Wettest year on record – 2007 (53.09")
- Wettest month on record – August 2007 (21.74")
- Wettest day on record – August 19, 2007 (9.23")
- Driest year on record – 1939 (19.23")
- Driest month on record – February 1995 and March 1910 (Trace)
- Highest seasonal snowfall on record – 2007/08 (77.0")
- Highest monthly snowfall on record – December 1985 (35.0")
- Highest one-day snowfall on record – March 13, 1997 (17.0")
- Least seasonal snowfall on record – 1967/68 (12.0")



NOAA/National Weather Service Support and Weather Monitoring

NOAA's National Weather Service (NWS) forecast office at La Crosse, WI serves Vernon County with weather information and support on a continuous basis. Operating 24 hours a day, a staff of 23 issues routine and non-routine informational products for the area, including all watches, warnings, and advisories related to natural hazards. Doppler radar (WSR-88D) is co-located with the La Crosse NWS office and covers the region.



NWS La Crosse has a web site at: www.weather.gov/lacrosse

Normal communication during hazardous weather scenarios is via telephone, National Warning System (NAWAS), and amateur radio.

NOAA Weather Radio coverage in Vernon County includes three stations:

- WXJ86 (La Crosse) on 162.550 MHz
- WWG89 (Richland Center) on 162.475 MHz
- WWG86 (Prairie du Chien) on 162.500 MHz
- KE2XKP (Tomah/Ridgeville) on 162.525 MHz

Storm spotter groups consist of fire department personnel, amateur radio operators, and the general public, with some involvement from law enforcement. Spotter training is held annually with an average attendance in the past 5 years of 68.

There are a variety of weather monitoring sources in Vernon County, including:

Automated weather station(s):

- Viroqua (Y51)

River Gauge(s):

- Mississippi River Lock & Dam #8 @ Genoa
- Mississippi River @ Brownsville, MN
- Kickapoo River @ Ontario
- Kickapoo River @ La Farge
- Kickapoo River @ Viola
- Kickapoo River @ Readstown
- S.Branch Baraboo River @ Hillsboro



Cooperative Observers

- | | |
|-----------------------|-------------|
| • Genoa Lock & Dam #8 | • Hillsboro |
| • La Farge | • Ontario |
| • Readstown | • Viroqua |
| • Westby 3ENE | |

In addition, numerous volunteer reports from around the county are received at the La Crosse NWS office including rainfall, snowfall, and temperatures, on a routine basis.

Resources

National Weather Service – La Crosse	www.weather.gov/lacrosse
NWS La Crosse Tornado Database	www.weather.gov/ark/tornadomain
NWS La Crosse River Monitoring	http://www.crh.noaa.gov/ahps2/index.php?wfo=ark
NWS La Crosse Climate	www.weather.gov/climate/index.php?wfo=ark
NWS La Crosse Drought information	www.weather.gov/ark/drought
NWS La Crosse Storm Summaries	www.weather.gov/ark/events
NWS La Crosse NOAA Weather Radio page	www.weather.gov/ark/nwr
NWS Storm Prediction Center	http://www.spc.noaa.gov/
SPC Online Severe Weather Climatology	http://www.spc.nssl.noaa.gov/climo/online/grids/ http://www.spc.noaa.gov/climo/online/rda/ARX.html

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