Historical Climatology: Marquette, Michigan

Overview

Winters in Marquette tend to be long, cold, and snowy. Lake Superior does, however, moderate temperatures in Marquette. Nearshore, temperatures are 3-4°F warmer than locations a few miles inland. The area typically experiences warm but cooler temperatures during the late spring and early summer, and warmer temperatures during the late fall and early winter. In the late winter, as ice builds up on Lake Superior, Marquette experiences larger temperature variations similar to those seen at inland locations. The lake effect also increases cloudiness and snowfall during the fall and winter. Through 2002, Marquette averaged 141 inches of snowfall per year, and was the fifth snowiest city in the United States large enough to be reported. Sudden, severe periods of lake-effect precipitation are relatively common.

Summary of Observed Changes

Rising average temperatures: Annual average temperatures warmed by 2.7°F from 1962-2014, faster than national and global rates.

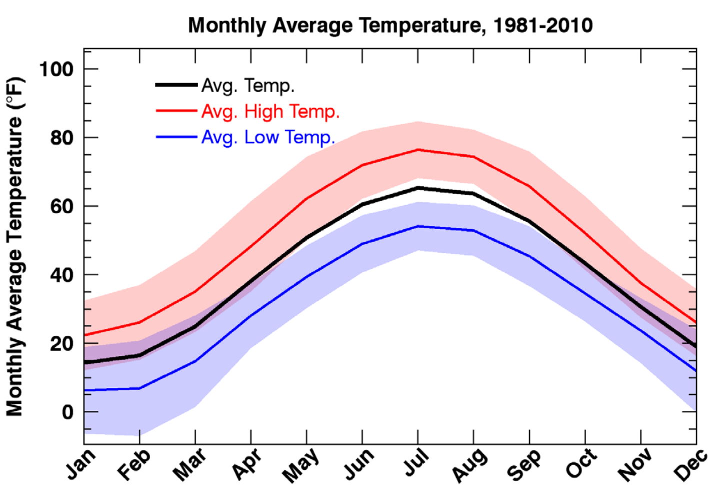
Longer freeze-free season: The length of the freeze-free season (growing season), increased 24 days from 1962-2014.

More precipitation: Precipitation increased by 9.5% from 1962-2014. Nearby locations have recorded declines in precipitation, however, and the western U.P. has seen a slight decline during the same time period, opposite the trend of the Great Lakes region.

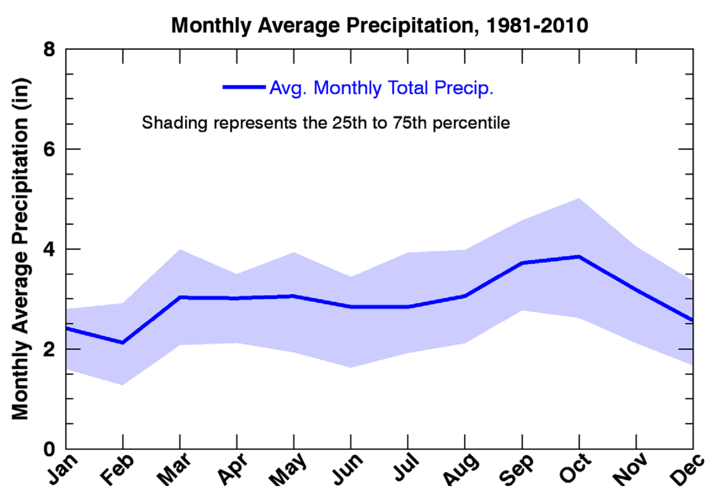
Fewer heavy precipitation events: The number of very heavy precipitation events (liquid water equivalent) has decreased by 19% (comparing the 1951-1980 total to the 1981-2010 total).

Recent Climate Summary: 1981-2010 Temperature and Precipitation

Average Temperature	40.3°F
Average Low Temperature	30.7°F
Average High Temperature	50°F
Days/Year that exceed 90°F	2.7
Days/Year that fall below 32°F	183
Lowest Annual Average Temperature	38.0°F
Highest Annual Average Temperature	43.4°F
Average Precipitation Total	35.6 in
Lowest Annual Precipitation Total	24.2 in
Highest Annual Precipitation Total	51.64 in
Days/Year exceeding 1.25" Precip. (LWE)	3.3

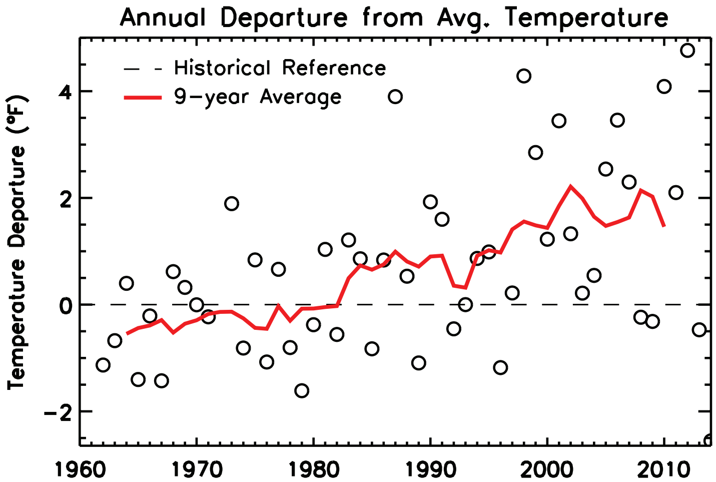


Average monthly temperatures during the 1981-2010 period. Shaded bands represent the standard deviation in the 30-year monthly average.

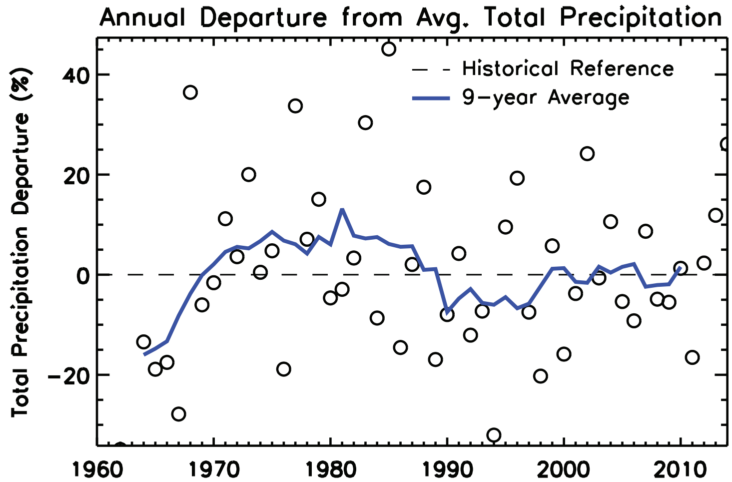


Average monthly total precipitation for the 1981-2010 period. The shaded band represents the 25th to 75th percentile.

Changes in Average Temperature and Precipitation



Annual departures from the 1951-1980 average annual temperature. The solid red line is the 9-year moving average. Open circles represent the departure from the 1951-1980 historical reference for a single year.



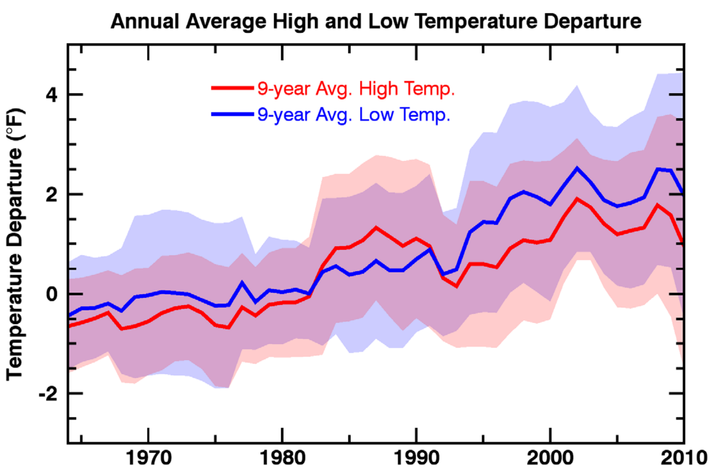
Annual departures from the 1951-1980 average of total annual precipitation. The solid blue line is the 9-year moving average. Open circles are departures from the 1951-1980 average for single years.

Changes in Average Temperature 1951-2014	°F	°C
Annual	2.7	1.5
Winter, December-February	4.4	2.4
Spring, March-May	2.3	1.3
Summer, June-August	2.6	1.4
Fall, September-November	1.5	0.8

Changes in Total Precipitation 1951-2014	inches	%
Annual	3.4	-9.5
Winter, December-February	1.4	21.6
Spring, March-May	2.2	25.97
Summer, June-August	-1.5	-15.3
Fall, September-November	1.4	12.8

Typical for the Midwest, temperatures in Marquette have risen steadily since the 1960s. Annual average temperatures warmed by 2.7°F from 1962-2014, faster than observed national and global rates of warming. All seasons have warmed with winter warming much faster.

Annual precipitation increased at this inland Marquette location by 9.5% from 1962-2014, but precipitation trends have been highly variable place-to-place in the U.P., and overall, the Western U.P. has seen a slight decrease in precipitation over the same period.



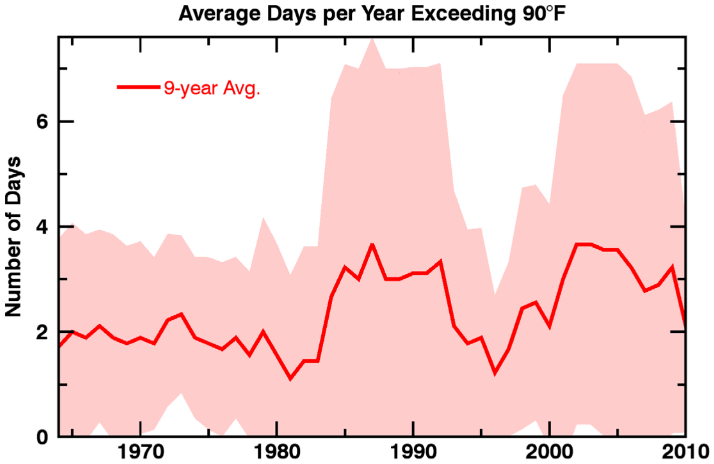
Changes in Average High and Low Temperatures from 1951 through 2014	°F	°C
Highs	+2.2	1.2
Lows	+3.2	1.8

Overnight low temperatures warmed significantly faster than mid-day high temperatures from 1962 through 2014, consistent with the general trend for the Great Lakes region. This means that temperatures have cooled less overnight than they have warmed during mid-day.

Left: Departures from the 1951-1980 average high and low temperatures. The red and blue lines are the 9-year moving averages. The shaded bands represent the standard deviations.

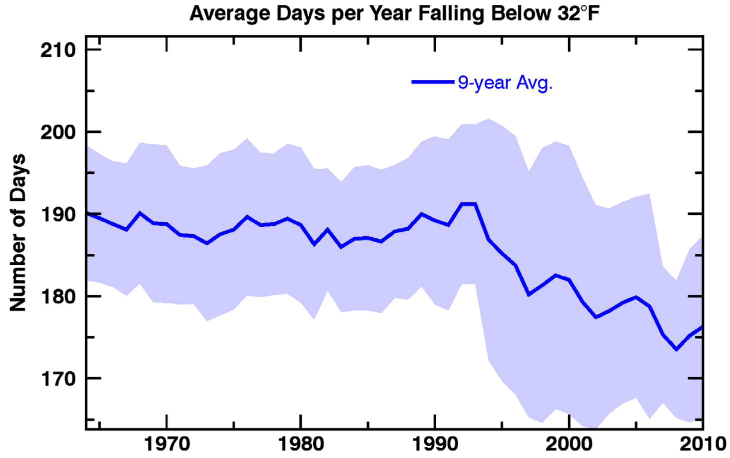
Data source: NCDC GHCN-Daily dataset.

Changes in Hot and Cold Days



The red line represents the 9-year moving average of the number of days per year exceeding 90°F. The shaded band represents the standard deviation.

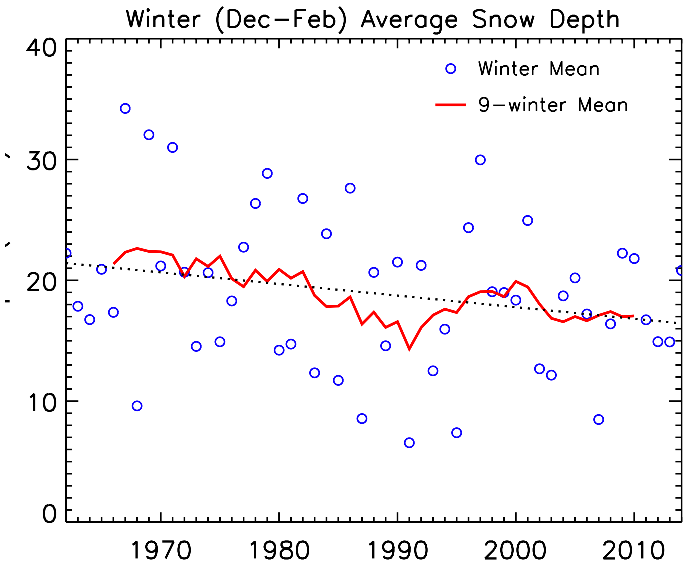
Despite rapidly rising average temperatures, the number of days per year that exceed 90°F has remained relatively stable, partially because the area so rarely sees such warm days. Regionally, a lack of increase in hot days may be due to other local factors and large-scale changes in land-use near observing sites.



The blue line represents the 9-year moving average of the number of days per year falling below 32°F. The shaded band is the standard deviation.

The number of days falling below 32°F per year dropped by 14.8 from 1962-2014. Much of the change has been due to a relatively rapid decrease since the mid-90s, a trend observed widely across the northern Midwest.

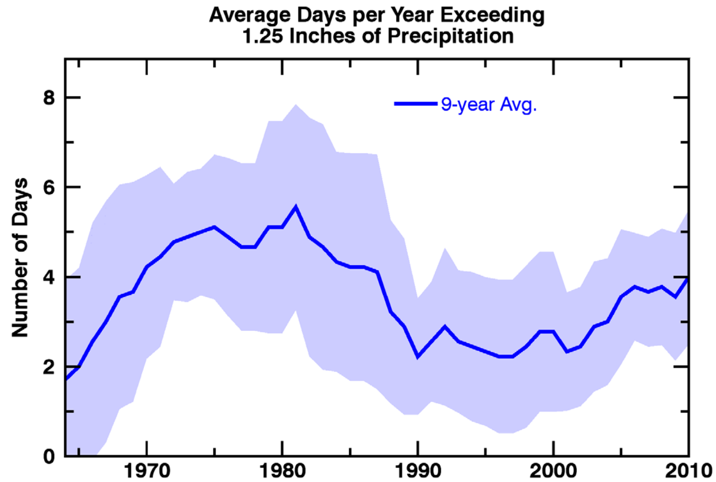
Changes in Snow Depth



December-February (winter) snow depth. The blue circles are individual average snow depths for each winter. The red line is the 9-year moving average. The dotted line is the linear best fit calculated from 1962-2014.

December-February snow depth has declined 5% eith warmer temperatures since 1962, even as snowfall and lake-effect snowfall have increased in many nearby locations.

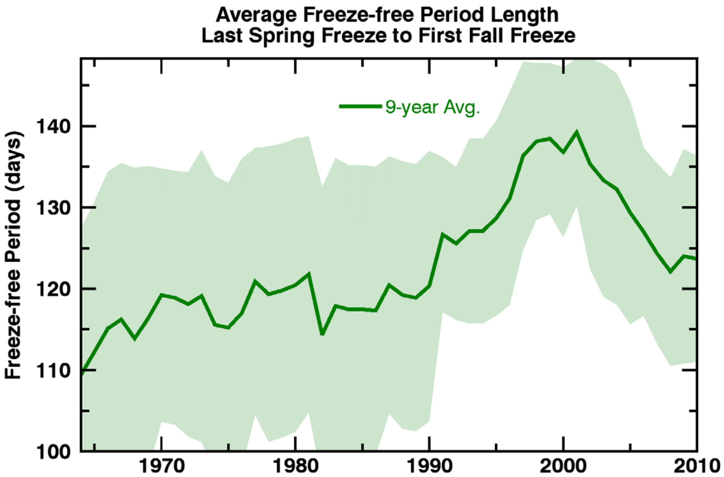
Changes in Heavy Precipitation



The blue line represents the 9-year moving average of the number of days per exceeding a daily total of 1.25 inches of precipitation. The shaded band represents the standard deviation.

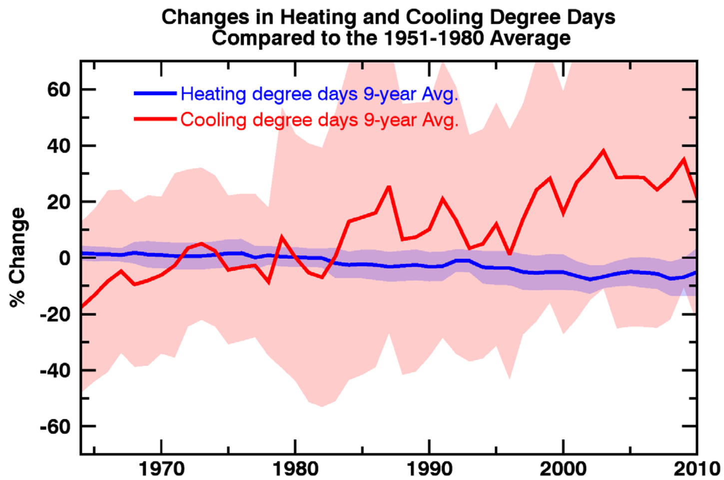
Daily precipitation totals that exceed 1.25” may lead to nuisance flooding and minor infrastructure impacts in some areas. While many locations to the south have seen large changes, Marquette has not seen a significant trend since the 1960s due to high multi-decadal variability. Year-to-year variation has been large.

Changes in Seasonality



The freeze-free season (growing season), lengthened by 24 days from 1962-2014. Most of this change has been due to an earlier end date of the freezing season (an earlier spring thaw). Through the late-90s and early-2000s, this location saw a period of shorter freeze periods, possibly due to local changes in land use or wind patterns. Omitting this period, the observed change would be approximately 12-18 days, still significant and in line with other locations in the northern Midwest.

Left: The green line represents the 9-year moving average of length of the time between the last freeze of spring and the first freeze of fall, the freeze-free period. The shaded band represents the standard deviation.



The percent change in heating and cooling degree day units from the 1951-1980 average. The red and blue solid lines represent the 9-year moving average. The shaded bands show the standard deviation.

Heating and cooling degree days are indexed units, not actual days, that roughly describe the demand to heat or cool a building. Cooling degree days accumulate on days warmer than 65°F when cooling is required. Heating degree days accumulate on days colder than 65°F when heating is required. Extremely hot days accumulate heating degree day units faster than a mildly warm day, and similarly, bitterly cold days accumulate cooling degree day units much faster than a mildly chilly day. Marquette sees far more days that require heating than it does days that require cooling, and so it accumulates far more heating degree days than cooling degree days in a given year.

From 1962 through 2014, total annual cooling degree days have increased by 46% while heating degree days have fallen by 9%, consistent with warming temperatures. Due to its cold climate, however, Marquette sees far more heating degree days than cooling degree days. The actual decline of 890 heating degree day units has outpaced the increase of 96 cooling degree day units.

Projected Future Climate of Marquette

Many of the observed trends in temperature and precipitation are expected to continue or accelerate in the future.

- **Average Temperature:** Models project average temperatures will continue to rise by 3.5-6°F in the region through mid-century. Temperatures are generally projected to warm faster in northern parts of the Great Lakes region.
- **Freeze-free season:** The freeze-free period is projected to continue to lengthen by an additional 1-2 months under high emissions scenarios.
- **Total Precipitation:** Most models project precipitation will increase overall, though the magnitude of projections vary widely. Many models project that summer precipitation will remain stable or decline.
- **Declining snow depth:** Snow depth will likely continue to decline as winter temperatures warm. Less snowpack and less snow cover during the spring and fall could have implications for local summer water supply and winter insulation against freeze damage.