Historical Climatology: Detroit, Michigan

GLISA
A NOAA RISA TEAM

Overview

Detroit is a historical city surrounded by the Great Lakes, and it serves as one of the major centers for commercial, financial, and transportation within the region. Like most of the region, the City of Detroit experiences many climate impacts; however, factors such as land use, pre-existing infrastructure and socioeconomic capactiy will determine the city's responsiveness to climate change. Increases in extreme heat days and precipitation lead to more potential threats of heat waves and flooding for the city. Compared to recent years, Detroit has begun its steps to revitalize much of city's landscape and infrastructure to accomodate the changes in climate. Because of its close proximity to Downtown Detroit, all information is provided by the climate station for Windsor, ON.*

Summary of Observed Changes

More precipitation: Total precipitation increased 10.7% (3.6 inches), from 1951 through 2014. Fall increases over that time exceeded 30% (2.3 inches).

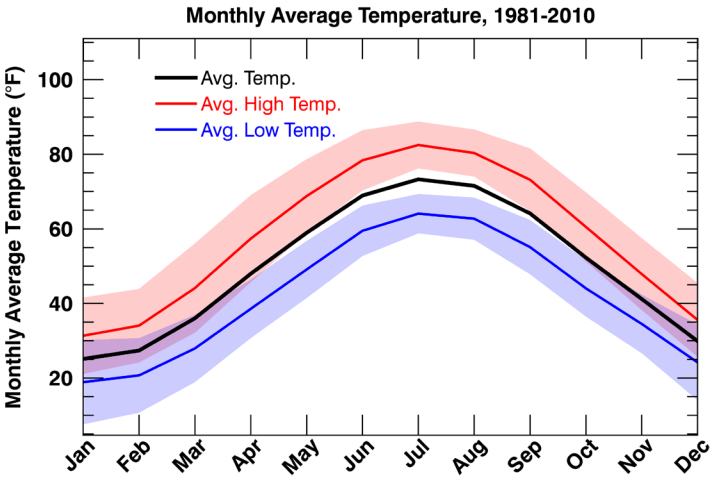
Less heavy precipitation: The number of very heavy precipitation events has decreased by 1.8% (comparing the 1951-1980 total to the 1981-2010 total).

Rising average temperatures: Annual average temperatures warmed by 2.7°F from 1951-2014. Average low temperatures have warmed at a greater rate than average high temperatures for the city.

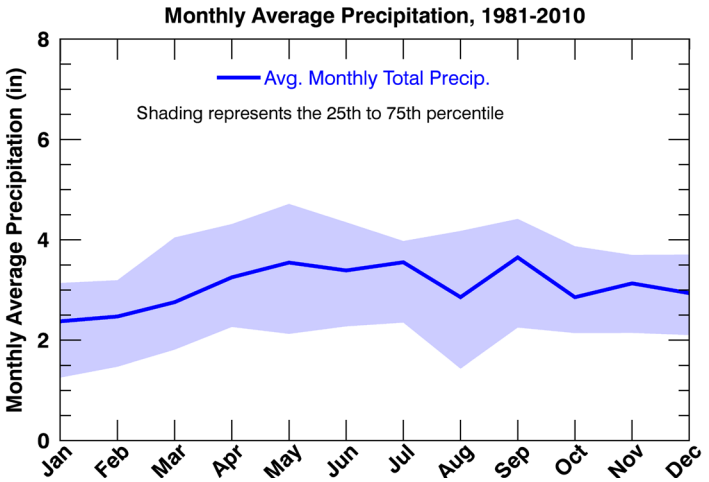
Longer freeze-free season: The freeze-free period of the year has lengtened drastically, by approximately 15 days, from 1951-2014.

Recent Climate Summary: 1981-2010 Temperature and Precipitation

Average Temperature	49.9°F
Average Low Temperature	41.8°F
Average High Temperature	58°F
Days/Year that exceed 90°F	8.9
Days/Year that fall below 32°F	114.5
Lowest Annual Average Temperature	48°F
Highest Annual Average Temperature	53.4°F
Average Precipitation Total	37.0 in
Lowest Annual Precipitation Total	25.5 in
Highest Annual Precipitation Total	48.3 in
Days/Year that exceed 1.25" of Precipitation	3.3



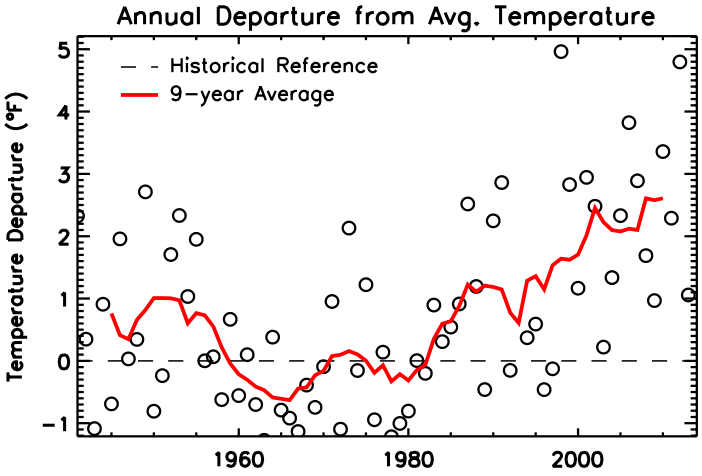
Average monthly temperatures during the 1981-2010 period. Shaded bands represent the standard deviation in the 30-year monthly average.



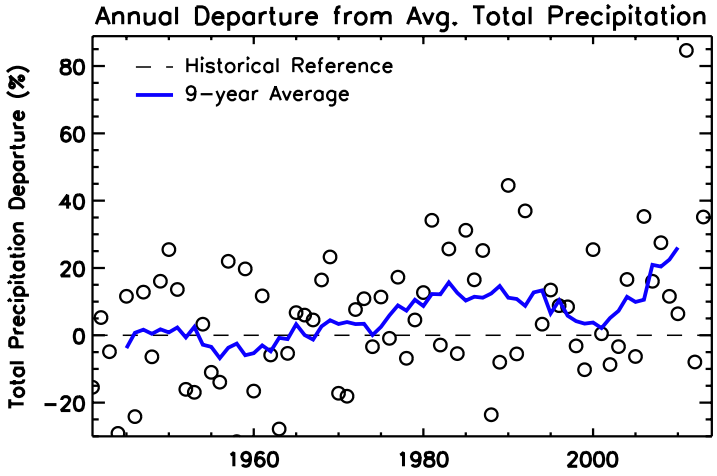
Average monthly total precipitation for the 1981-2010 period. The shaded band represents the 25th to 75th percentile.

GLISA is a collaboration of the University of Michigan Climate Center and Michigan State University.
*All data is provided by the GHCN station for Windsor, ON, Canada

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.



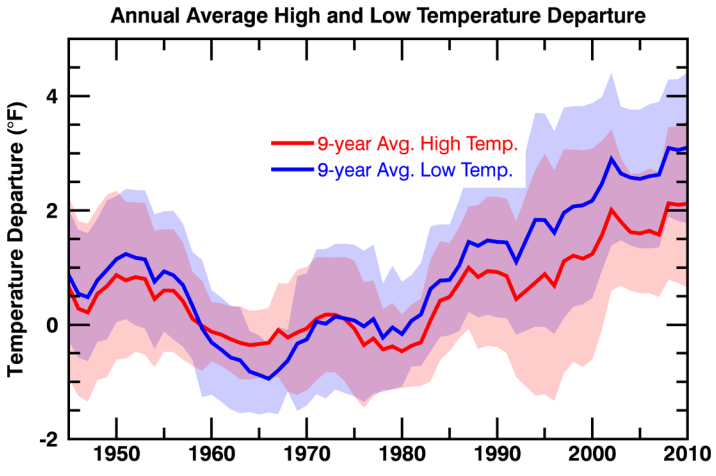
Annual departures from the 1951-1980 average of total annual precipitation. The solid blue line is the 9-year moving average. Open circles are departures from the 1951-1980 average for single years.

Changes in Average Temperature 1951-2014	°F	°C
Annual	2.7	1.5
Winter, December-February	2.2	1.2
Spring, March-May	3.1	1.7
Summer, June-August	2.5	1.4
Fall, September-November	1.9	1.0

Temperatures around the city have increased since the 1980s and have steadily increased to present day. Annual average temperatures have warmed by 2.7°F from the period of 1951-2014. The greatest increase in average temperatures occur in the spring with 3.1°F warming. The fall shows the lowest change in average temperature with values of 1.9°F warming.

Changes in Total Precipitation 1951-2014	inches	%
Annual	8.4	25.2
Winter, December-February	2.1	30.4
Spring, March-May	2.6	29
Summer, June-August	1.0	9.4
Fall, September-November	3.0	40

Precipitation in the area has been moderately increased with a 25.2% increase in annual total precipitation from 1951-2014. Most of the seasonal changes have seen increase in total precipitation, and the fall shows the most change of all the seasons with an increase of total precipitation being 40% from 1951-2014, and this is equivalent to 3.0 inches for the season.



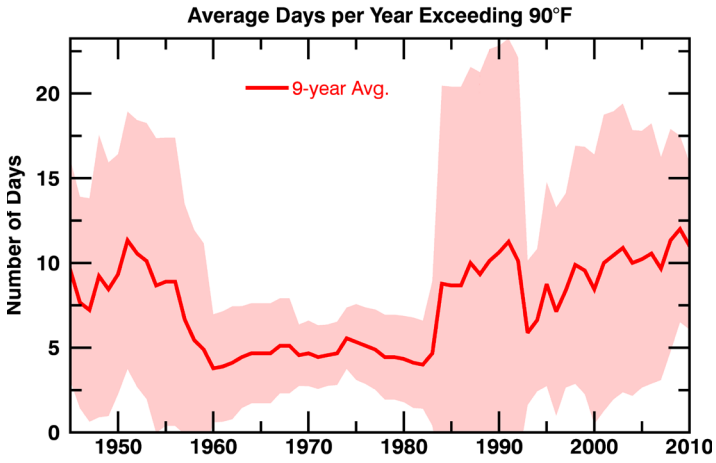
Changes in Average High and Low Temperatures from 1951 through 2014	°F	°C
Highs	2.0	1.1
Lows	3.4	1.9

The rate at which the nighttime lower temperatures have increased from 1951-2014 is greater than the daytime higher temperatures for the city. This is fairly expected with nightly temperatures not cooling down throughout the city.

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.

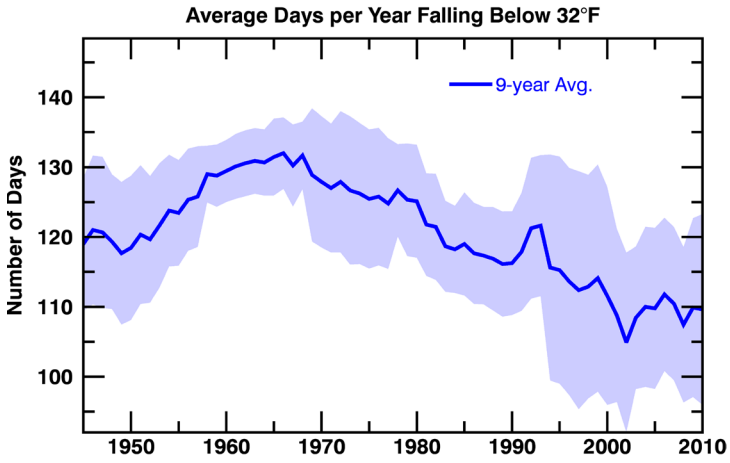
Data source: NCDC GHCN-Daily dataset.
*All data is provided by the GHCN station for Windsor, ON

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.

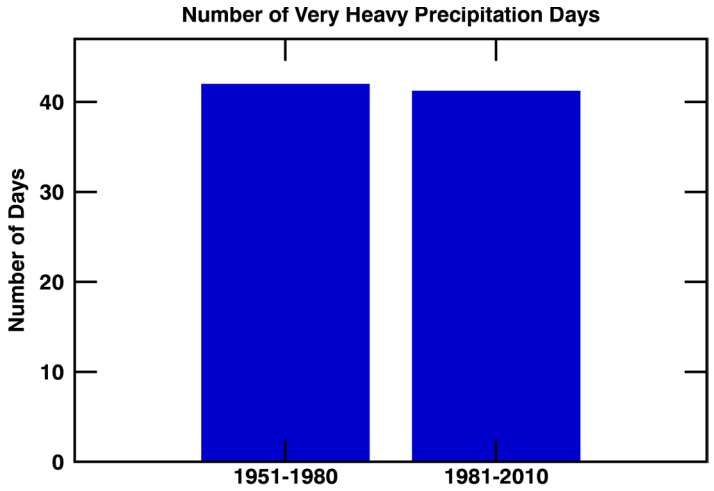
The change in days above 90°F has increased by approximately 3 days in an average year. This is peculiar compared to the rest of the region where this trend is relatively stable or flat. Local factors such as infrastructure and land-use changes can possibly contribute to Detroit experiencing an increase in the number of days.



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.

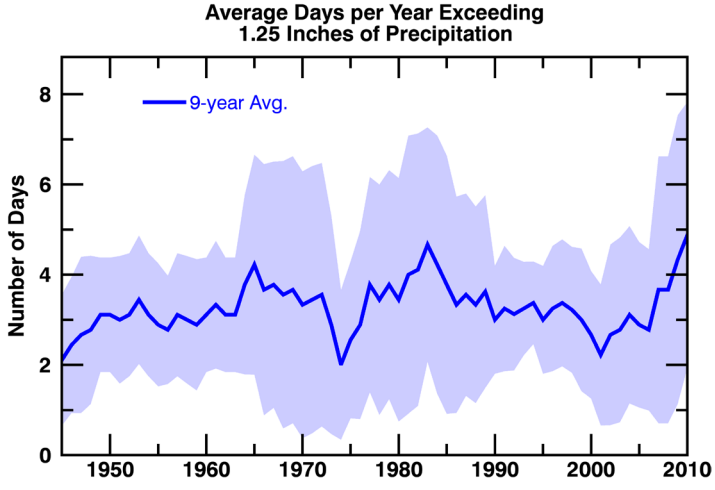
The number of days falling below 32°F per year dropped by 12.6 from 1951-2014, a drastic change compared to other locations in the region.

Changes in Heavy Precipitation



The number of daily precipitation totals for the 1951-1980 and 1981-2010 periods that exceeded the size of the heaviest 1% of storms as defined by the 1951-1980 period.

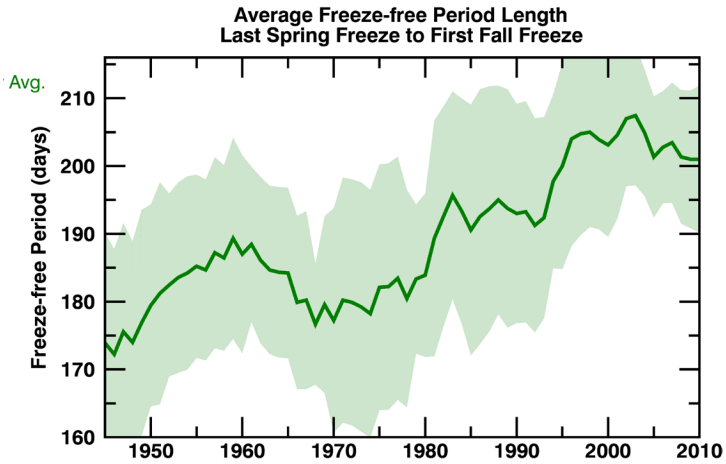
A "Very Heavy" Precipitation Day, as defined by the National Climate Assessment, is in the top 1% of daily precipitation totals. These precipitation events are typically disruptive and can cause infrastructure damage. Detroit has seen a miniscule decrease in these precipitation events (42 storms from 1951-1980 to 41 from 1981-2010).



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.

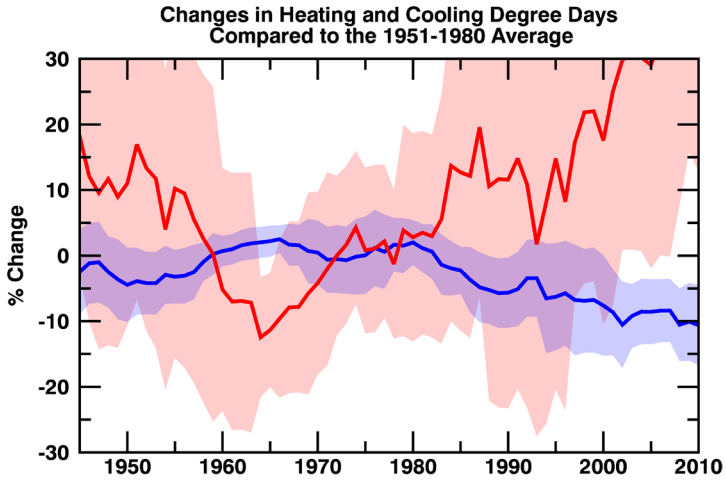
Daily precipitation totals that exceed 1.25" may lead to nuisance flooding and minor infrastructure impacts in some areas. Detroit sees 0.7 days more per year compare to the past, and this is equivalent to a 22% increase for the city.

Changes in Seasonality



The freeze-free season (growing season) for Detroit has increased by 15 days during the period of 1951-2014, which is consistent with the increase in the Great Lakes region. The growth seasons have seen drastic changes in 1980s and 1990s, but has slightly declined in the recent decade (2000-2010).

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. Detroit has seen more days that require cooling compared to days that require heating for residents.

From 1951-2014, there has been a drastic change in the amount of cooling degree days compared to heating degree days in the area. The increase for cooling degree days has increased by 40.1%, which coincides with the warming temperatures of the region. This trend outpaces the decrease in heating degree days, which has seen a decline by 11%.

Projected Future Climate of Detroit

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°F in the region through mid-century.
- **More high temperature days:** Despite little observed change in the number of days with high temperatures above 90°F, the number of hot days is expected to increase with rising average temperatures.
- **Freeze-free season:** Even though the growing season has lengthened in the past at this particular station, it is projected to lengthen by 1-2 months under high emissions scenarios for the region overall.
- **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.
- **More Heavy Precipitation:** Heavy precipitation events will likely continue to become more intense and more frequent as they have in the recent past.
- **Changing winter precipitation:** With warmer temperatures, rain may fall in place of snow, and mixed winter precipitation events, like freezing rain, may become more likely in some areas.

Data source: NCDC GHCN-Daily dataset.
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