DEPARTMENT OF NATURAL RESOURCES

Climate Summary for Watersheds

Root River

June, 2019

DEPARTMENT OF NATURAL RESOURCES

The Climate Summary for Watersheds is supported by the Watershed Health Assessment Framework (WHAF) team; River Ecology Unit, Division of Ecological and Water Resources.

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Visit the Watershed Health Assessment Framework online at *mndnr.gov/whaf*

Funding for this project comes from the Clean Water Fund, which receives 33 percent of the sales tax revenue from the Clean Water, Land and Legacy Amendment, approved by voters in November 2008. The Clean Water Fund's purpose is to protect, enhance and restore water quality in lakes, rivers, streams and groundwater. At least 5 percent of the money is targeted for the protection of drinking water sources. The Legislature allocates funds for water quality work and drinking water protection based on recommendations from the Clean Water Council.

CLEAN WATER LAND & LEGACY AMENDMENT

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Climate Summary for Watersheds:
Root River

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This report provides an overview of climate conditions based on data collected from 1895 through 2018. The focus is on reporting trends in seasonal and annual temperature and precipitation.

This report summarizes climate data using 30-year averages, and compares the most recent thirty year average (1989-2018) to the entire climate record average (1895-2018). This approach generates values for the amount of change (deviation) seen in the most recent 30 years when compared to the entire 120-year period of record. Results are presented in both maps and charts.

Why is climate important to understand for managing the health of major watersheds?

Climate is a foundational ecological condition. Other natural processes evolve in response to local, regional and global climate conditions.

Why is it important to view climate change for major watersheds?

Climate measurements are showing a shift in foundational climate conditions. Other ecological processes are changing in response. Communities and individuals making decisions about managing land and water resources for infrastructure, flood protection, habitat protection, water supply, and other needs must be aware of this shift and informed about its potential impacts.

What is included in this summary?

Observed Climate Change

- Temperature: Minimum, Mean and Maximum
  - Maps: Recent Average Temperature, Deviation from Record
  - Charts: Annual Average Temperature, Deviation from Record by Month
- Precipitation: Mean
  - Maps: Recent Average Precipitation, Deviation from Record
  - Charts: Annual Average Precipitation, Deviation from Record by Month

Data sources

National Centers for Environmental Information (NOAA-NCEI). (2019). Global Historical Climatology Network Daily nClimGrid. Retrieved from *https://www.ncdc.noaa.gov/land-based-station-data/global-historical-climatology-network-ghcn*

Vose, R.S., Applequist, S., Durre, I., Menne, M.J., Williams, C.N., Fenimore, C., Gleason, K., & Arndt, D. (2014). Improved Historical Temperature and Precipitation Time Series For U.S. Climate Divisions. Journal of Applied Meteorology and Climatology, 53(May), 1232–1251. DOI: 10.1175/JAMC-D-13-0248.1

Information about the source data

The maps and figures contained in this document are produced from the Global Historical Climatology Network Daily (GHCN-D) nClimGrid data. The foundational dataset of GHCN-D is a database of daily climate summaries from climate monitoring stations around the world. The GHCN-D staff interpolate observations from climate stations to create a continuous coverage of climate values, this derived product is called nClimGrid. Vose et. al. (2014) assess the accuracy of nClimGrid for calculating average climate values for each of the 344 U.S. climate divisions; according to their estimates, errors are "likely less than 0.5°C for temperature and 20mm for precipitation at the start of the record, falling rapidly thereafter".

While the quality of the input data is high, this Climate Summary is designed for exploration of climate trends at the statewide and major watershed scales. The GHCN-D Source Data is available for further analysis if users need measured observations for a specific climate monitoring station.

Limitations to using this data

- The maps and figures represent observed data only. These maps and charts should not be used to predict future climate conditions.
- The maps are created from 30 year averages and reflect the climate from that period. Patterns will not be constant when compared to a different 30-year period.
- The development of nClimGrid involves anomaly detection and spatial interpolation. Individual climate station data may be smoothed during this analysis, which can result in values that are slightly different than the original observations.
- Contour lines were developed to help illustrate and interpret climate patterns on the landscape. Contours creation involves the use of interpolation and smoothing.
- Given the above two points, some of the map's precise details may reflect the mapping and display techniques, rather than true climatic variations.

For further information and guidance

The content of this document was developed by the Watershed Health Assessment Framework (WHAF) program staff, with guidance and feedback from the Minnesota Climatology Working Group.

For questions and guidance on managing for watershed health, or for information on the methods used to develop this document, contact the WHAF staff.

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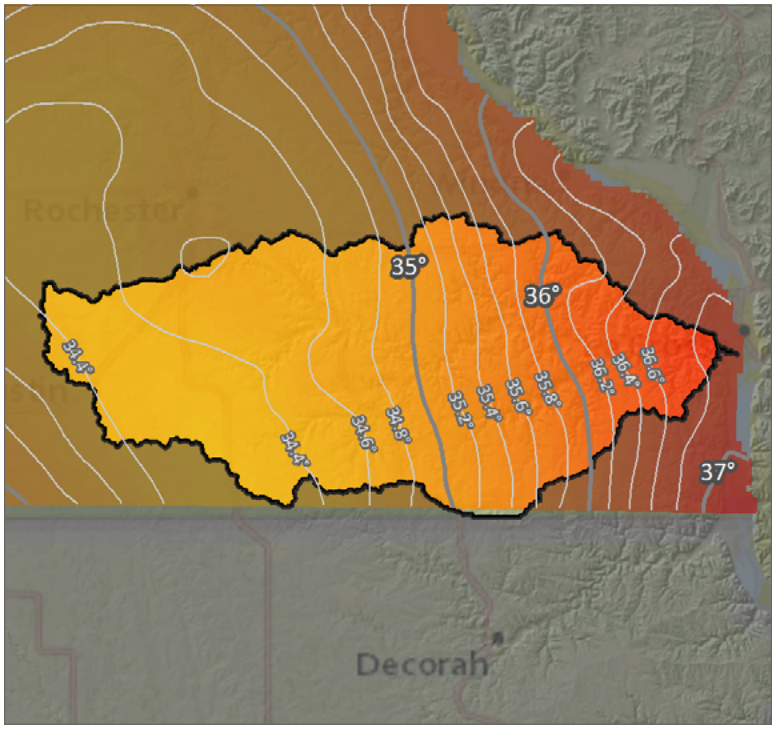
For questions and guidance on climatology data and its appropriate use, contact the Minnesota Climatology Working Group.

climate@umn.edu

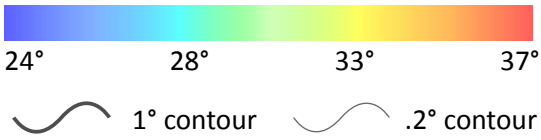
Observed Climate Change

Minimum Temperature

What do the most recent observations tell us? This map shows the average minimum temperature for the 1989 to 2018 period. Averages are calculated from daily measurements and interpolated to create a continuous temperature model. Contour lines help illustrate the pattern on the landscape. The summary table provides averages across all points within the watershed, as an annual value and by season.



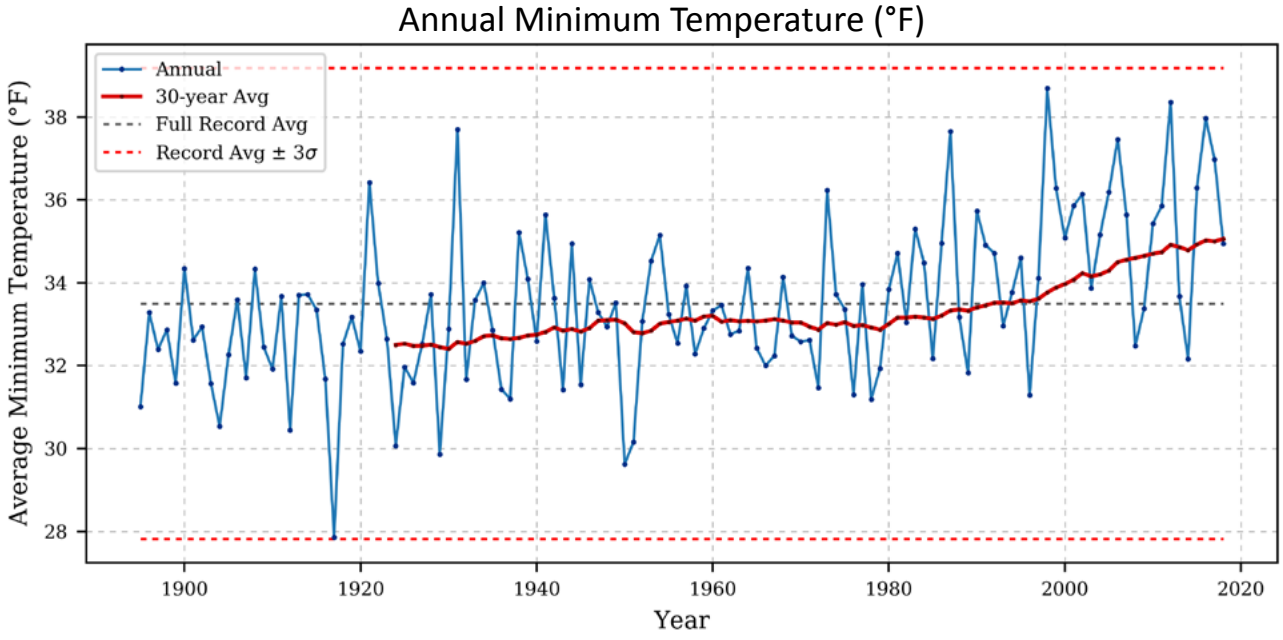
Average Minimum Temperature (°F), 1989-2018



Watershed Average

Time period	Value
Annual	35.1°
Winter (Dec. - Feb.)	10.3°
Spring (March - May)	34.3°
Summer (June - Aug.)	58.0°
Fall (Sept. Nov.)	37.5°

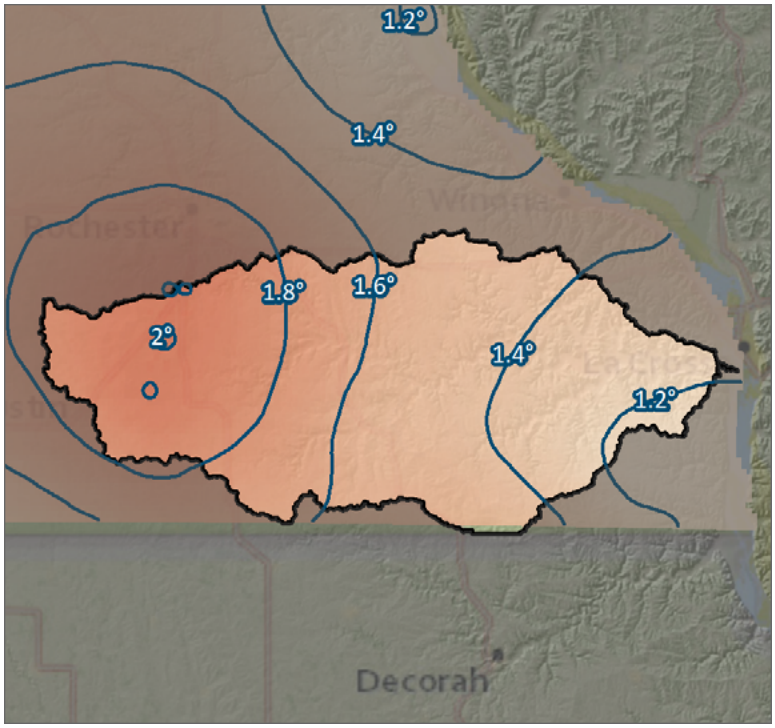
How have annual average and long-term averages changed over the climate record? This figure provides annual average values (solid blue line) alongside the 30-year running average (solid red line), and the overall record average (dashed blue line). The figure allows us to compare values across three time periods and observe how recent observations compare to long-term trends.



Observed Climate Change

Minimum Temperature

How do recent observations differ from the full climate record? This map shows the difference between the recent observations (1989-2018) and the entire climate record (1895-2018). The average of the entire climate record is subtracted from the recent 30-year average, to show where the most change has been observed. Positive contour values show areas that have recently been warmer than the historic average.



Minimum Temperature Departure from Historic Average (°F)

1.0° 1.85° 2.7°

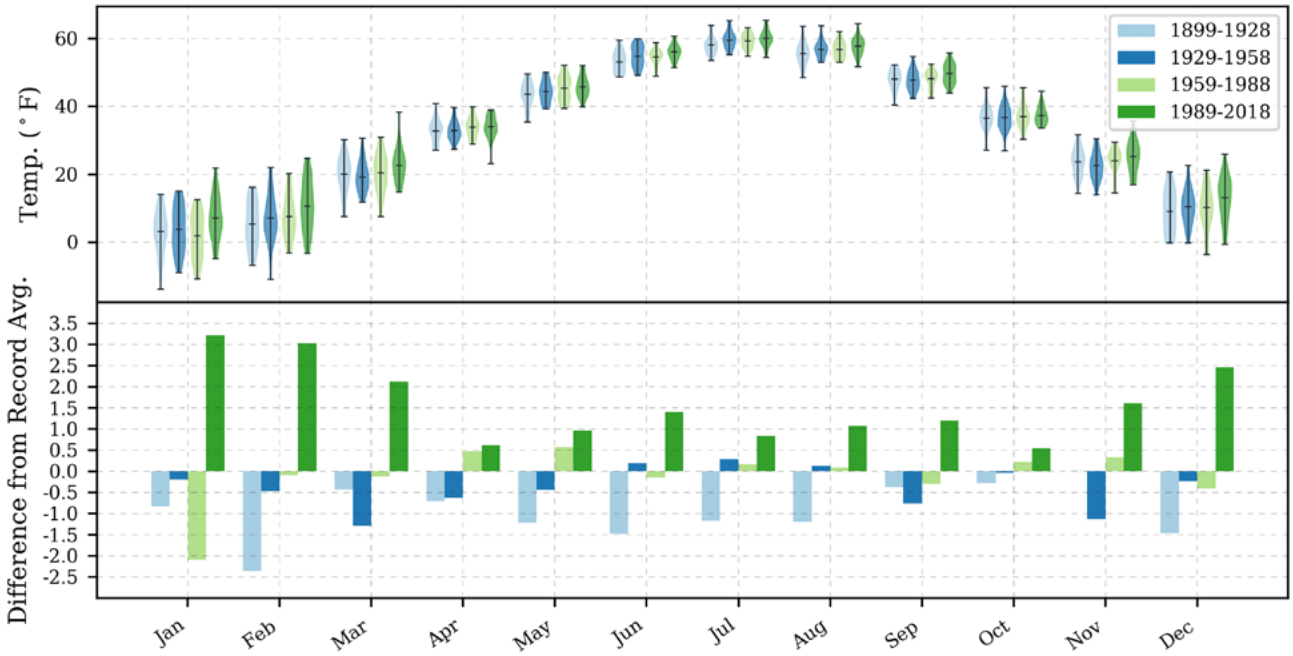
.2° contour

Watershed Average Departure

Time period	Value
Annual	1.6°
Winter (Dec. - Feb.)	2.8°
Spring (March - May)	1.2°
Summer (June - Aug.)	1.1°
Fall (Sept. Nov.)	1.1°

What is the range of values for each month, and how do they compare to the record average?
These figures display the distribution of minimum temperature values for four adjacent 30-year periods. From this figure we see the range of values that are observed in each month. The deviation charts show us which months have experienced the greatest average change when compared to the entire record average (1895-2018).

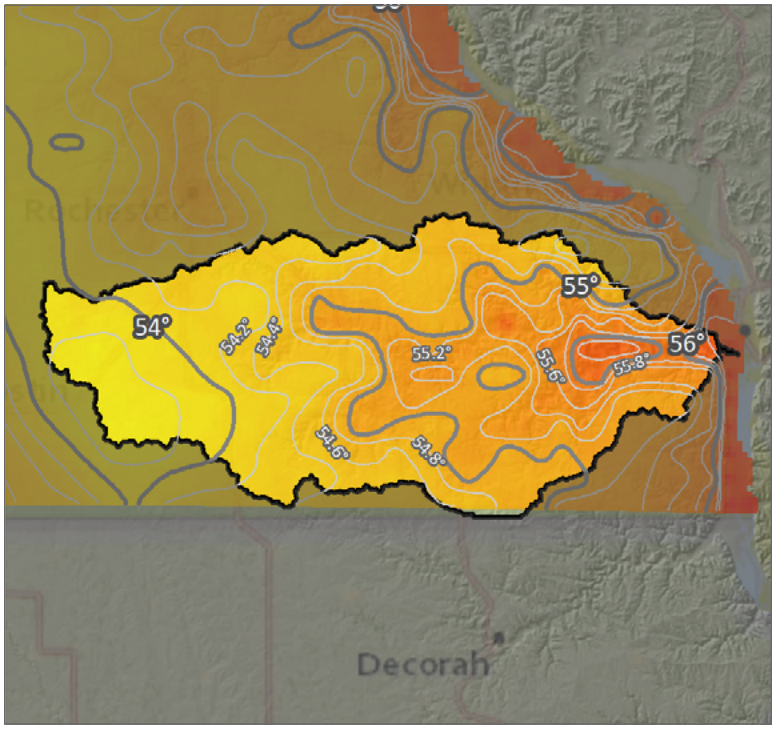
Monthly Minimum Temperature Distribution and Departure from Record Mean (°F)



Observed Climate Change

Maximum Temperature

What do the most recent observations tell us? This map shows the average maximum temperature for the 1989 to 2018 period. Averages are calculated from daily measurements and interpolated to create a continuous temperature model. Contour lines help illustrate the pattern on the landscape. The summary table provides averages across all points within the watershed, as an annual value and by season.



Average Maximum Temperature (°F), 1989-2018

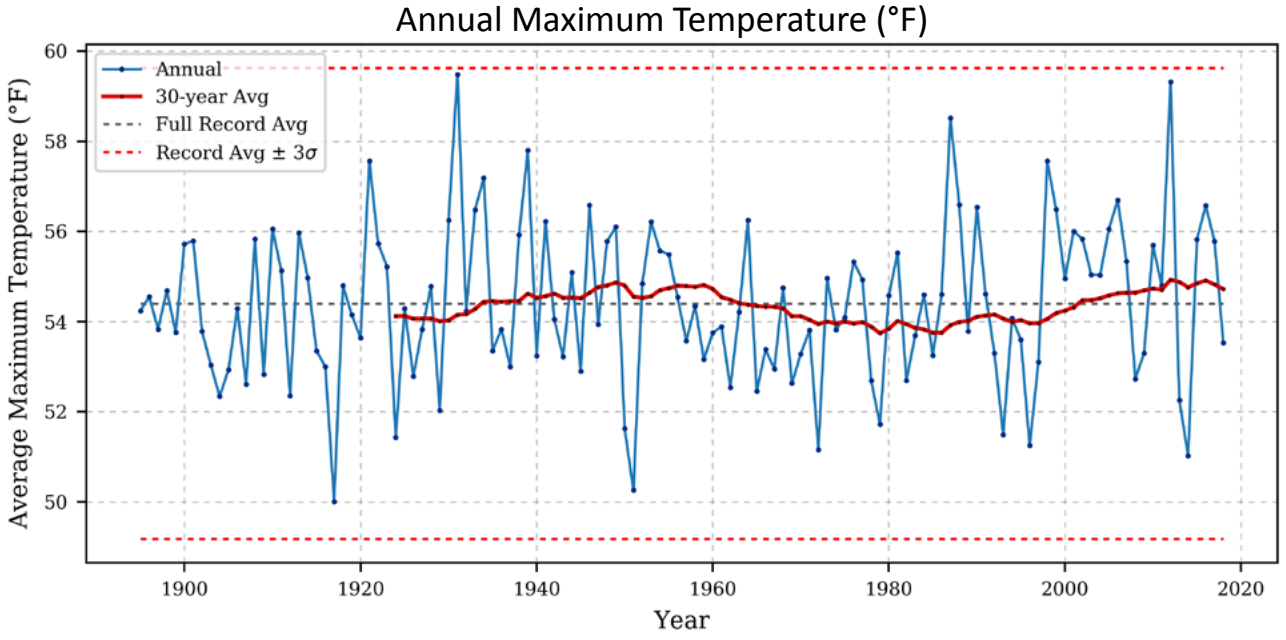
46° 50° 54° 58°

1° contour .2° contour

Watershed Average

Time period	Value
Annual	54.7°
Winter (Dec. - Feb.)	26.9°
Spring (March - May)	55.2°
Summer (June - Aug.)	79.1°
Fall (Sept. Nov.)	57.7°

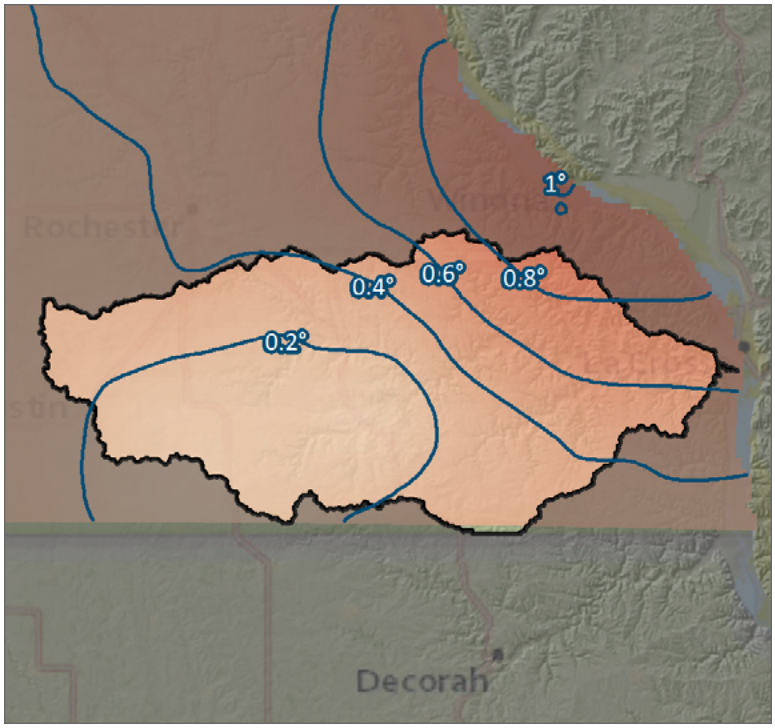
How have annual average and long-term averages changed over the climate record? This figure provides annual average values (solid blue line) alongside the 30-year running average (solid red line), and the overall record average (dashed blue line). The figure allows us to compare values across three time periods and observe how recent observations compare to long-term trends.



Observed Climate Change

Maximum Temperature

How do recent observations differ from the full climate record? This map shows the difference between the recent observations (1989-2018) and the entire climate record (1895-2018). The average of the entire climate record is subtracted from the recent 30-year average, to show where the most change has been observed. Positive contour values show areas that have recently been warmer than the historic average.



Maximum Temperature Departure from Historic Average (°F)

-0.3° 0.7° 1.7°

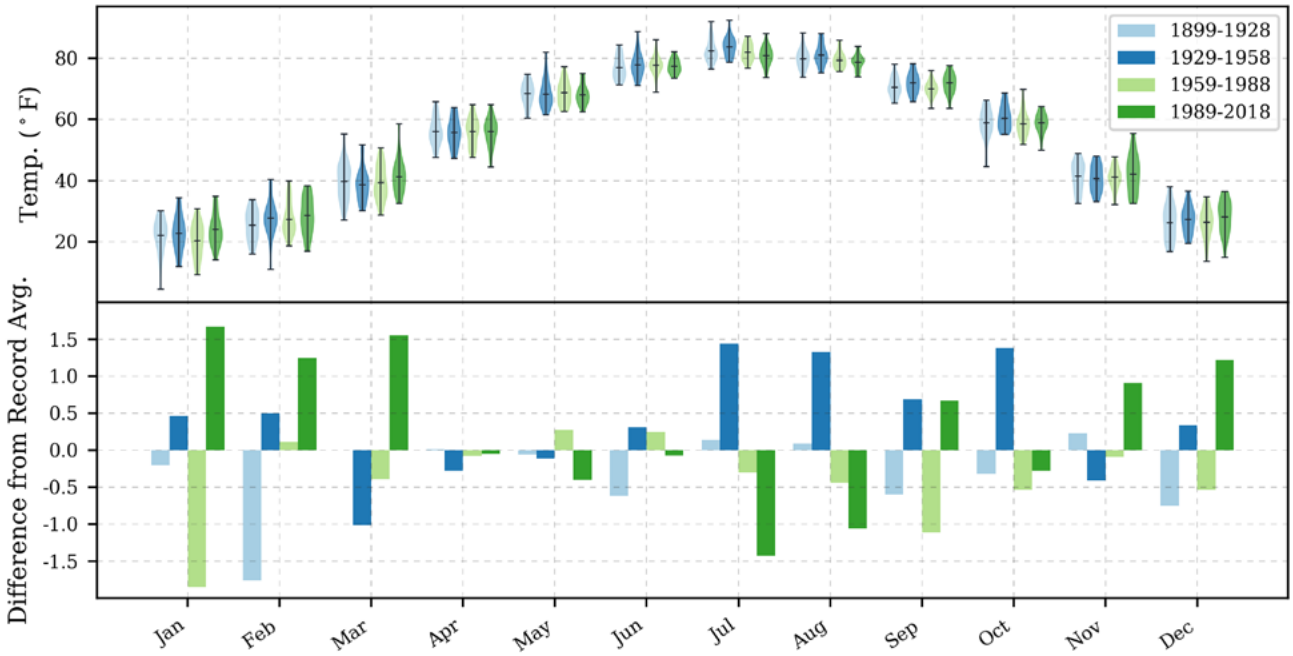
.2° contour

Watershed Average Departure

Time period	Value
Annual	0.3°
Winter (Dec. - Feb.)	1.3°
Spring (March - May)	0.4°
Summer (June - Aug.)	-0.8°
Fall (Sept. Nov.)	0.4°

What is the range of values for each month, and how do they compare to the record average?
These figures display the distribution of maximum temperature values for four adjacent 30-year periods. From this figure we see the range of values that are observed in each month. The deviation charts show us which months have experienced the greatest average change when compared to the entire record average (1895-2018).

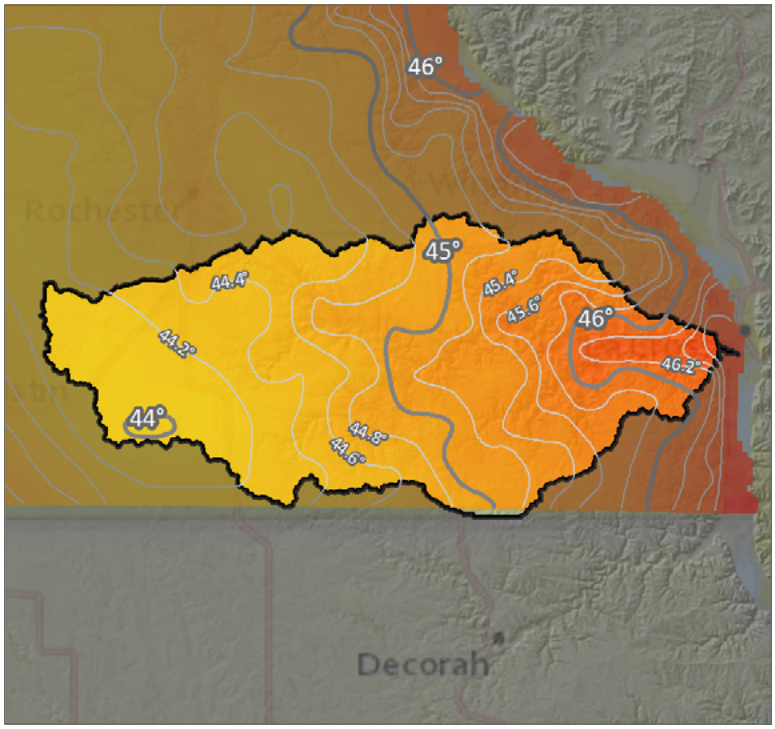
Monthly Maximum Temperature Distribution and Departure from Record Mean (°F)



Observed Climate Change

Average Temperature

What do the most recent observations tell us? This map shows the average temperature for the 1989 to 2018 period. Averages are calculated from daily measurements and interpolated to create a continuous temperature model. Contour lines help illustrate the pattern on the landscape. The summary table provides averages across all points within the watershed, as an annual value and by season.



Average Temperature (°F), 1989-2018

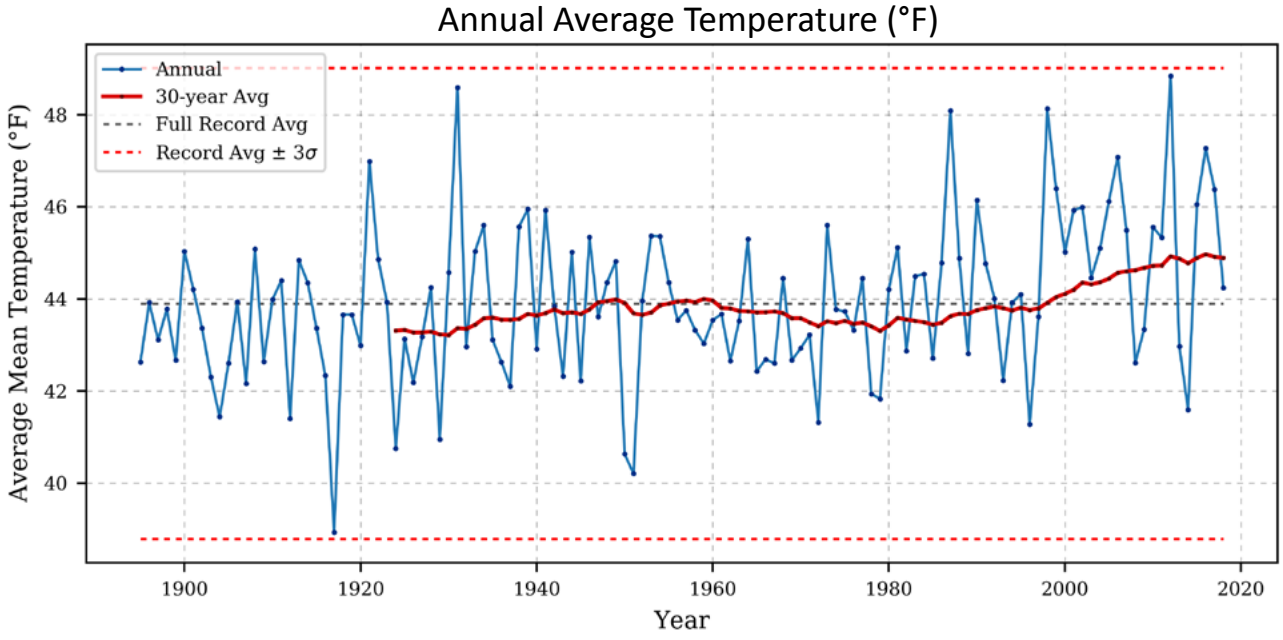
35° 39° 43° 47°

1° contour .2° contour

Watershed Average

Time period	Value
Annual	44.9°
Winter (Dec. - Feb.)	18.6°
Spring (March - May)	44.7°
Summer (June - Aug.)	68.6°
Fall (Sept. Nov.)	47.6°

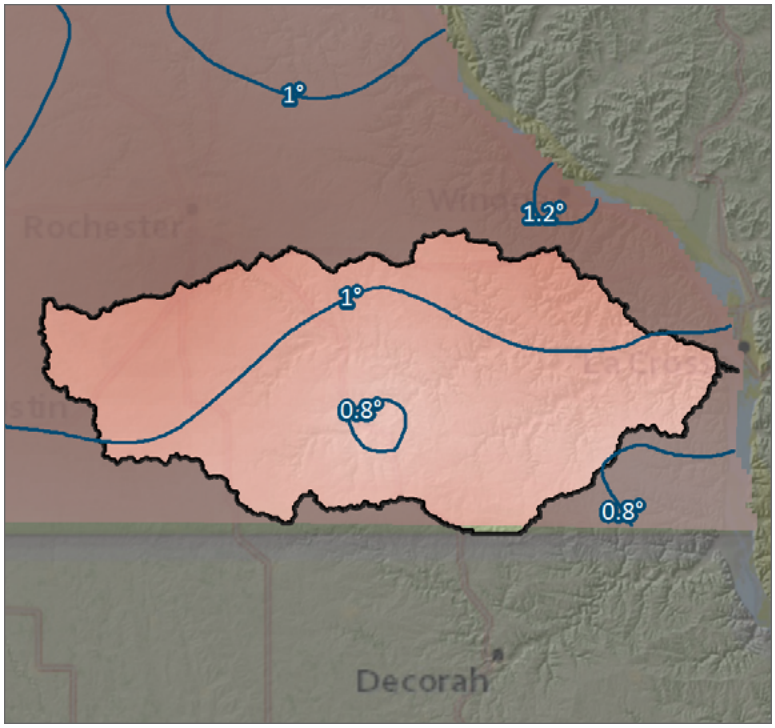
How have annual average and long-term averages changed over the climate record? This figure provides annual average values (solid blue line) alongside the 30-year running average (solid red line), and the overall record average (dashed blue line). The figure allows us to compare values across three time periods and observe how recent observations compare to long-term trends.



Observed Climate Change

Average Temperature

How do recent observations differ from the full climate record? This map shows the difference between the recent observations (1989-2018) and the entire climate record (1895-2018). The average of the entire climate record is subtracted from the recent 30-year average, to show where the most change has been observed. Positive contour values show areas that have recently been warmer than the historic average.



Average Temperature Departure from Historic Average (°F)

0.6° 1.35° 2.1°

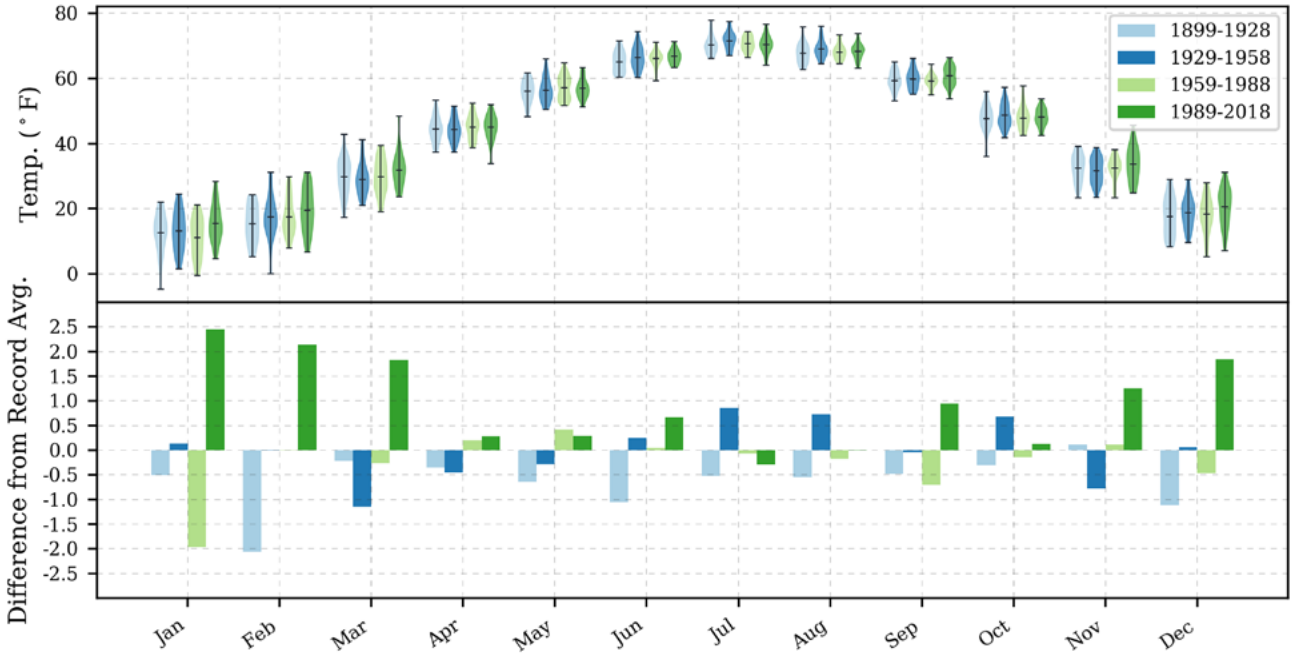
.2° contour

Watershed Average Departure

Time period	Value
Annual	1.0°
Winter (Dec. - Feb.)	2.0°
Spring (March - May)	0.8°
Summer (June - Aug.)	0.1°
Fall (Sept. Nov.)	0.8°

What is the range of values for each month, and how do they compare to the record average?
These figures display the distribution of average temperature values for four adjacent 30-year periods. From this figure we see the range of values that are observed in each month. The deviation charts show us which months have experienced the greatest average change when compared to the entire record average (1895-2018).

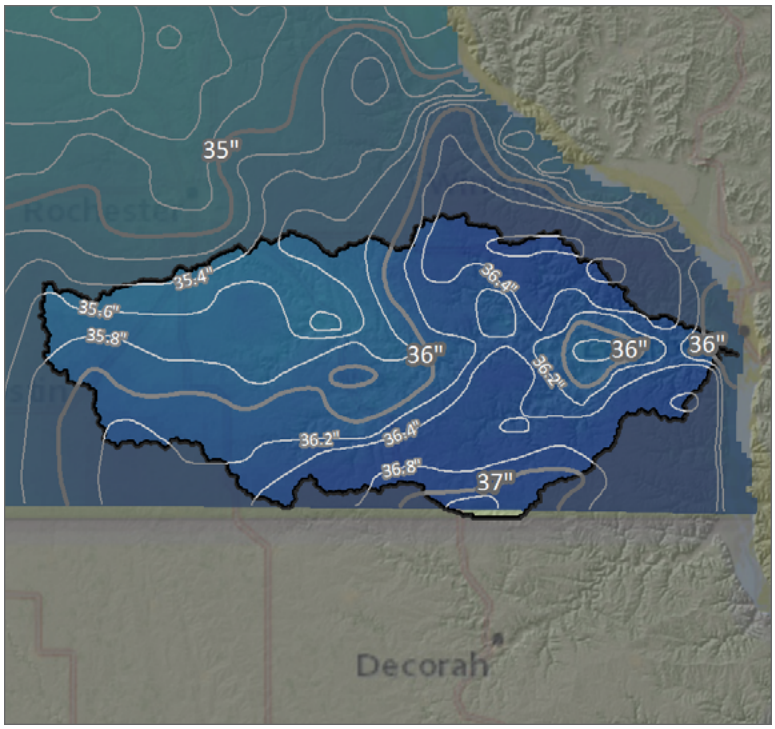
Monthly Average Temperature Distribution and Departure from Record Mean (°F)



Observed Climate Change

Precipitation

What do the most recent observations tell us? This map shows the average annual precipitation for the 1989 to 2018 period. Averages are calculated from daily measurements and interpolated to create a continuous temperature model. Contour lines help illustrate the pattern on the landscape. The summary table provides averages across all points within the watershed, as an annual value and by season.



Average Annual Precipitation (inches), 1989-2018

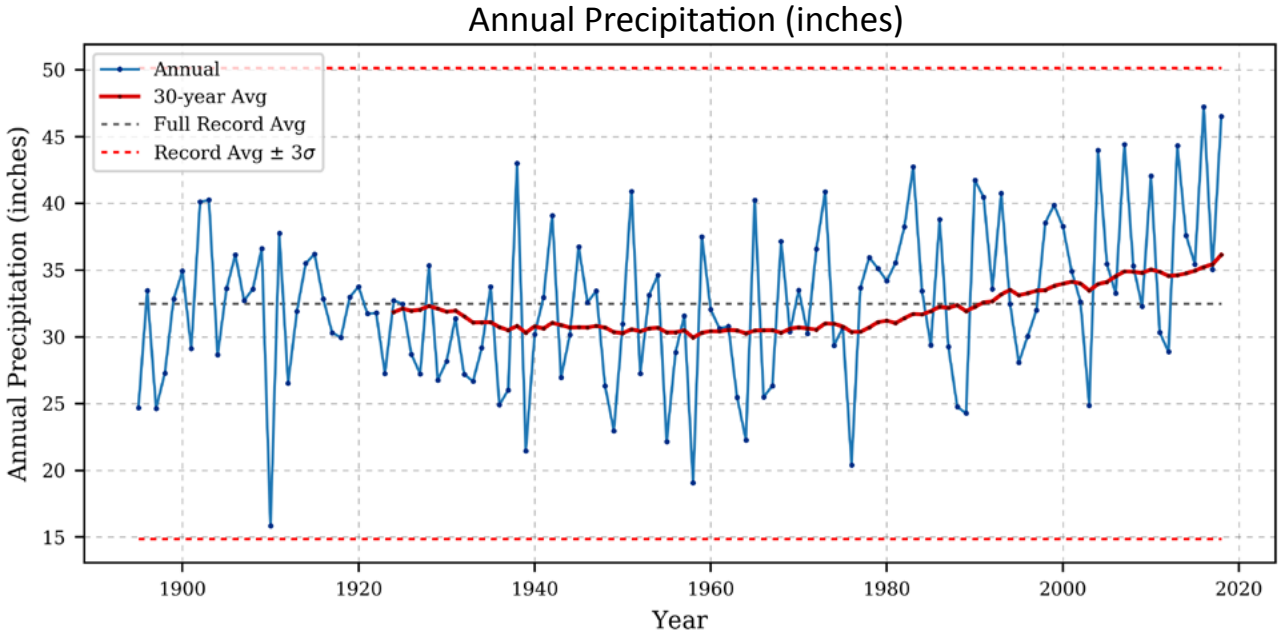
20” 26” 32” 38”

1” contour .2” contour

Watershed Average

Time period	Value
Annual	36.2"
Winter (Dec. - Feb.)	3.3"
Spring (March - May)	10.5"
Summer (June - Aug.)	14.5"
Fall (Sept. Nov.)	7.8"

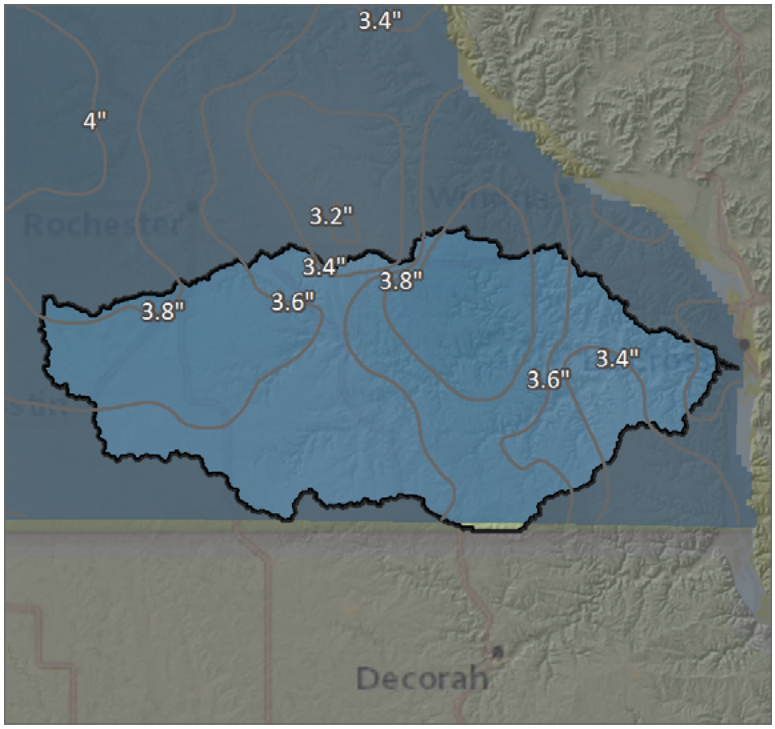
How have annual average and long-term averages changed over the climate record? This figure provides annual average values (solid blue line) alongside the 30-year running average (solid red line) and the overall record average (dashed blue line). The figure allows us to compare values across three time periods and observe how recent observations compare to long-term trends.



Observed Climate Change

Precipitation

How do recent observations differ from the full climate record? This map shows the difference between the recent observations (1989-2018) and the entire climate record (1895-2018). The average of the entire climate record is subtracted from the recent 30-year average, to show where the most change has been observed. Positive contour values show areas that have recently been wetter than the historic average.



Precipitation Departure from Historic Average (inches)

-0.7” 1.8” 4.3”

.2° contour

Watershed Average Departure

Time period	Value
Annual	3.6"
Winter (Dec. - Feb.)	0.2"
Spring (March - May)	1.5"
Summer (June - Aug.)	1.8"
Fall (Sept. Nov.)	0.1"

What is the range of values for each month, and how do they compare to the record average?
These figures display the distribution of precipitation values for four adjacent 30-year periods. From this figure we see the range of values that are observed in each month. The deviation charts show us which months have experienced the greatest average change when compared to the entire record average (1895-2018).