
Flooding in Rushford, MN, Aug 2007. Courtesy MN DNR Floodplain Program

Understanding Hydroclimatic Change in Minnesota

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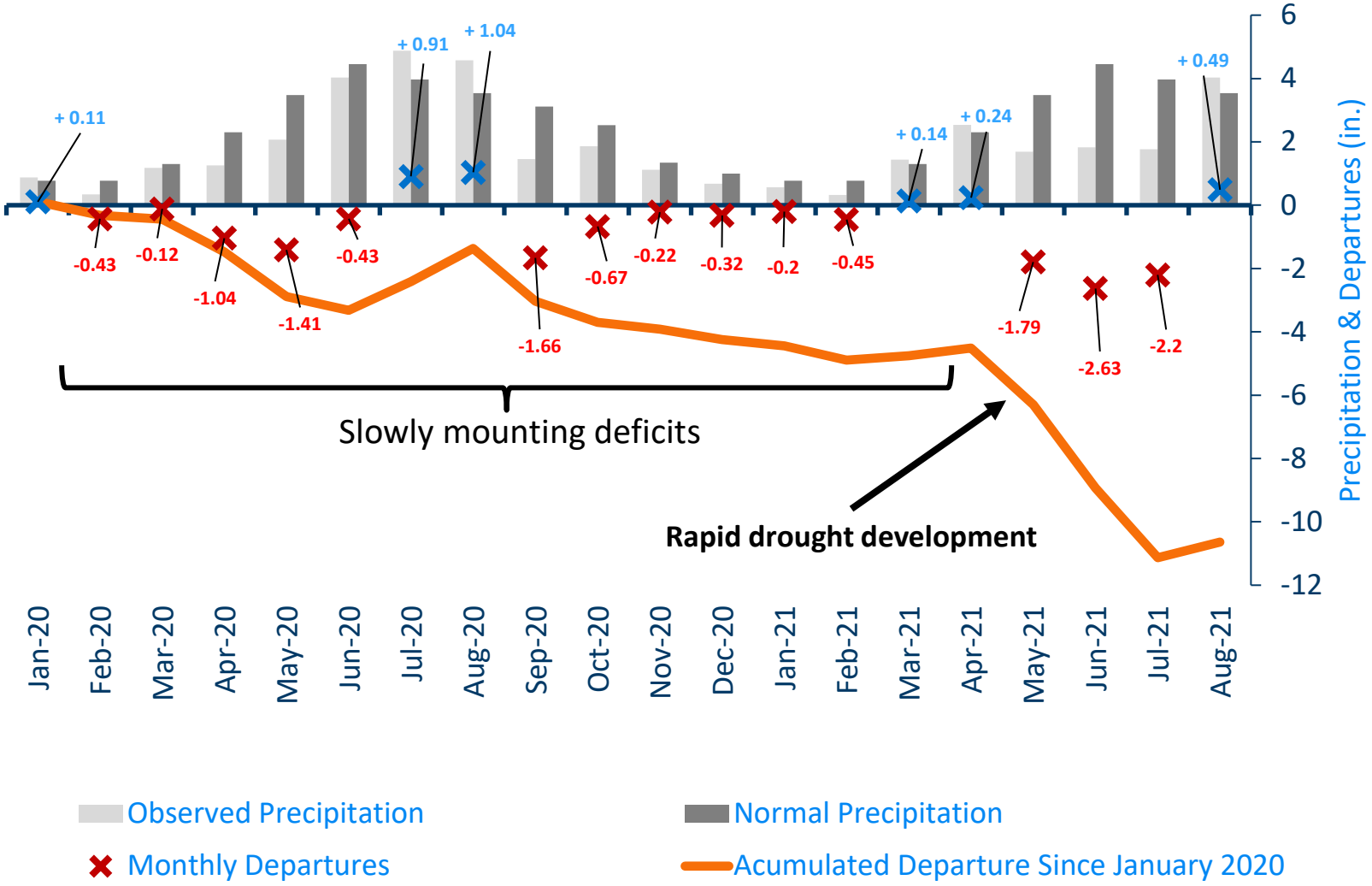
Drought of 2021

The State Climatology Office is cataloging the climatological progression of the drought for historical purposes:

https://www.dnr.state.mn.us/climate/journal/drought-2021.html

The Drought of 2021

Monthly Precipitation and Departures, Minnesota
January 2020 - August 2021



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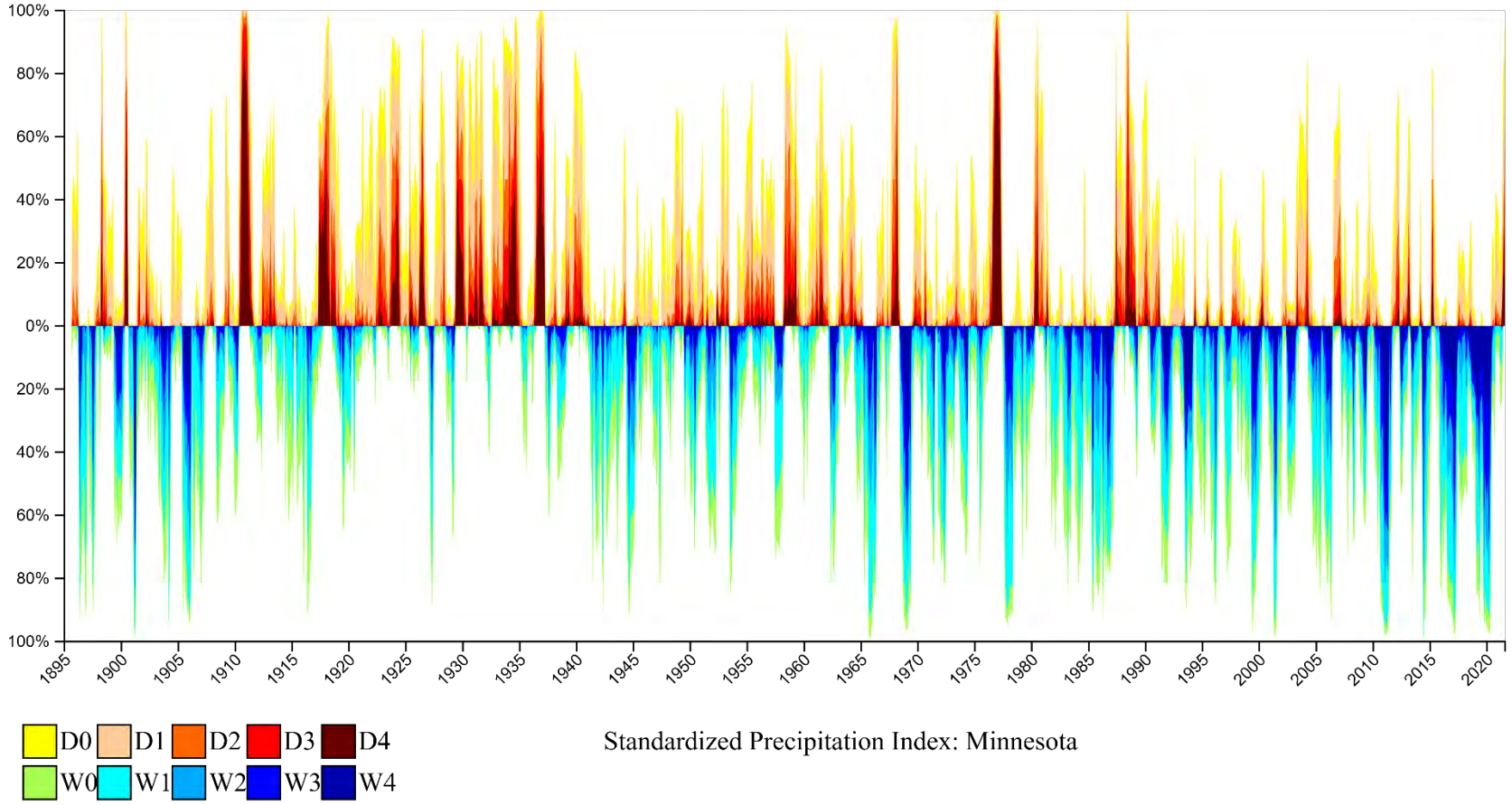
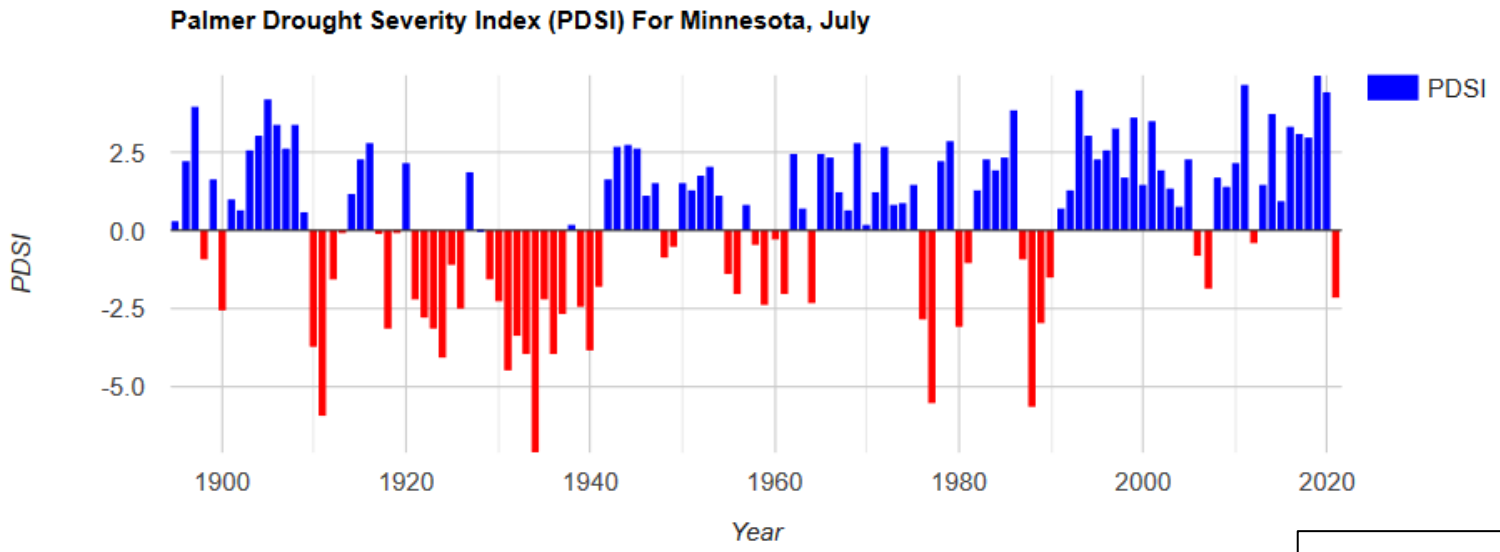
All data derived as state-averaged values by NOAA and served by Midwest Regional Climate Center via Cli-MATE retrieval tool (https://mrcc.purdue.edu/CLIMATE/welcome.jsp)

The Drought of 2021: Major but expected



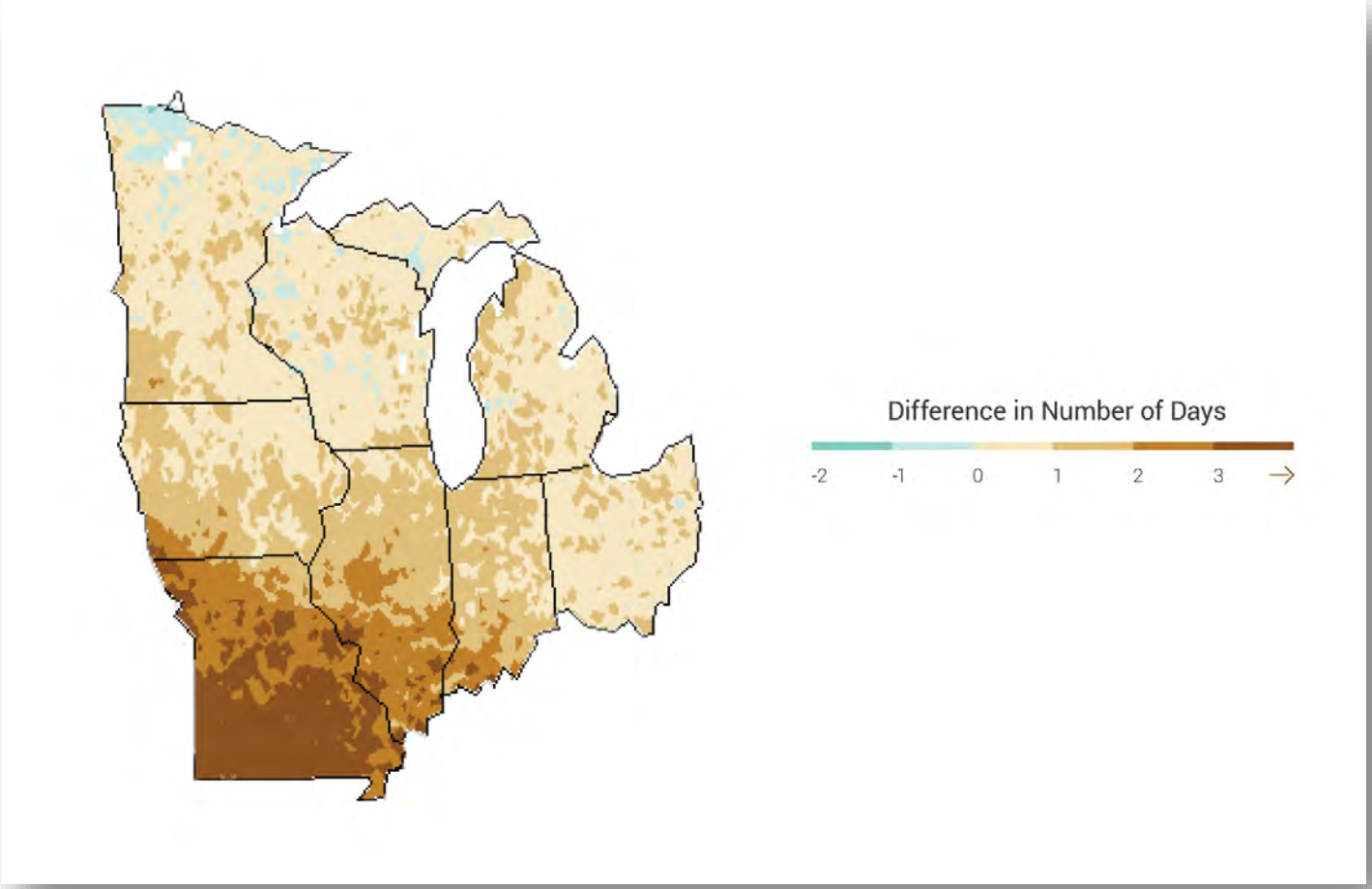
Drought has decreased over recent decades



Download:

Year	PDSI
1934	-7.09
1911	-5.93
1988	-5.62
1977	-5.49
1931	-4.44
1924	-4.07
1933	-3.94
1936	-3.93
1940	-3.84
1910	-3.71
1932	-3.36

Additional consecutive dry days projected by mid-century, though no “smoking gun”



Source: 2014 National Climate Assessment, Midwest Chapter

Minnesota's Climate

2018

2021

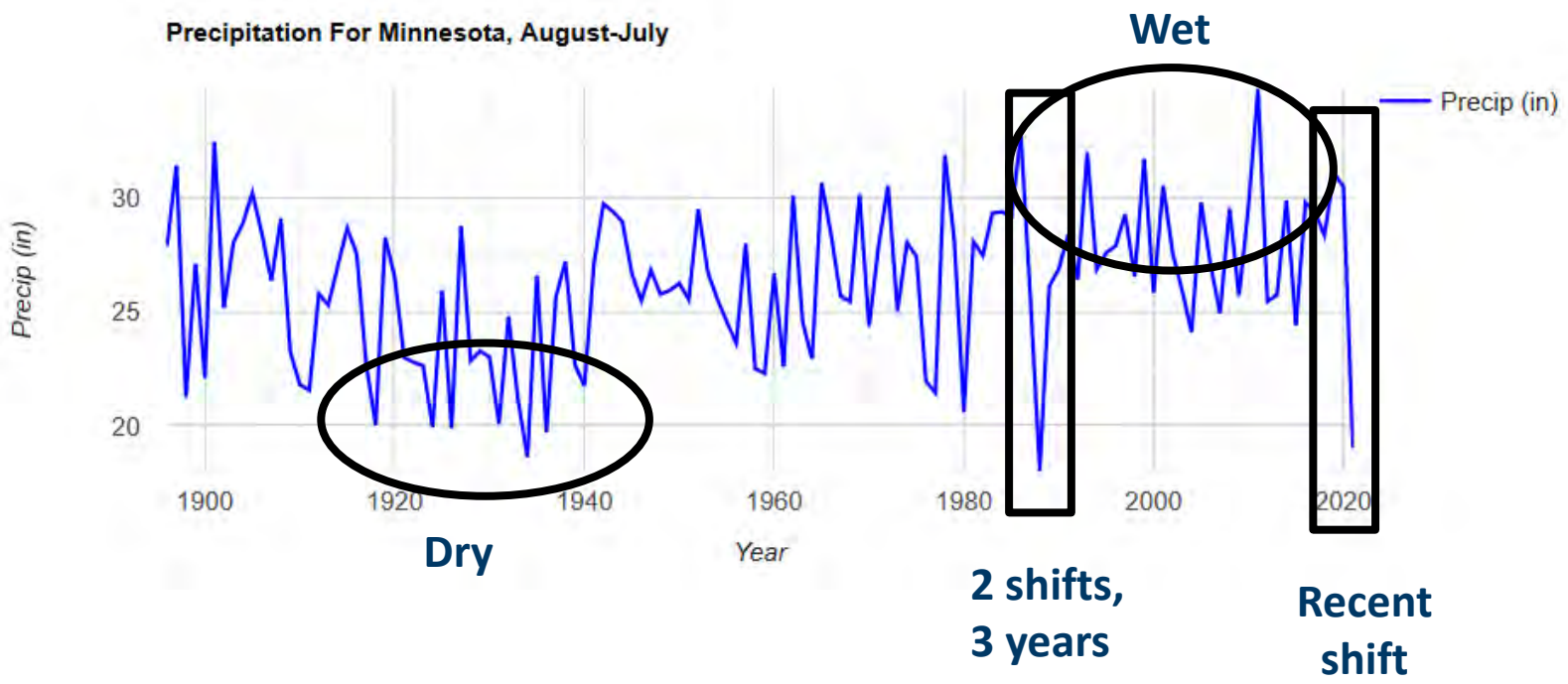
Minnesota's Climate

A. Highly variable with wide range in extremes

- High115° F (Beardsley, 1917)
- Low -60 ° F, (Tower, 1996)
- Wettest 60.21 inches (Harmony, 2018)
- Driest 6.37 inches (Ortonville, 1976)

Minnesota's Climate

B. Prone to both "regimes" and rapid shifts



Minnesota's Climate

C. Experiencing rapid change:

1. **Wetter:** more precipitation, more snow, more frequent and larger extremes

   → **Observed already, projected to continue, with wet/dry variability**

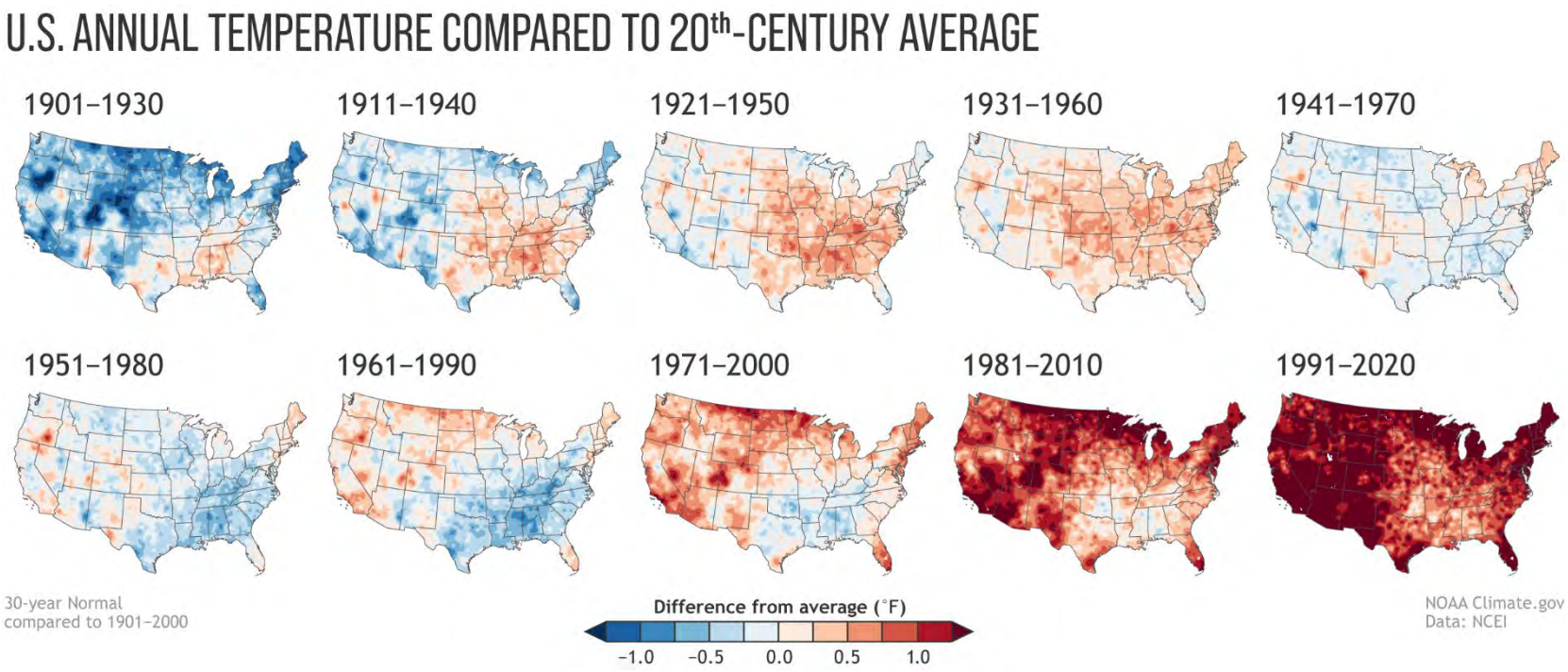
2. **Increasing temperatures:** Especially at night, during winter, and when it's cold ("Cold weather warming")

   → **Cold extremes already less common and less severe**

Changes in Climate Normals

Climate “normal”: an adjusted 30-year average, based on data ending in a “zero” year (e.g., 2020)

https://www.climate.gov/news-features/understanding-climate/climate-change-and-1991-2020-us-climate-normals



Changes in Climate Normals

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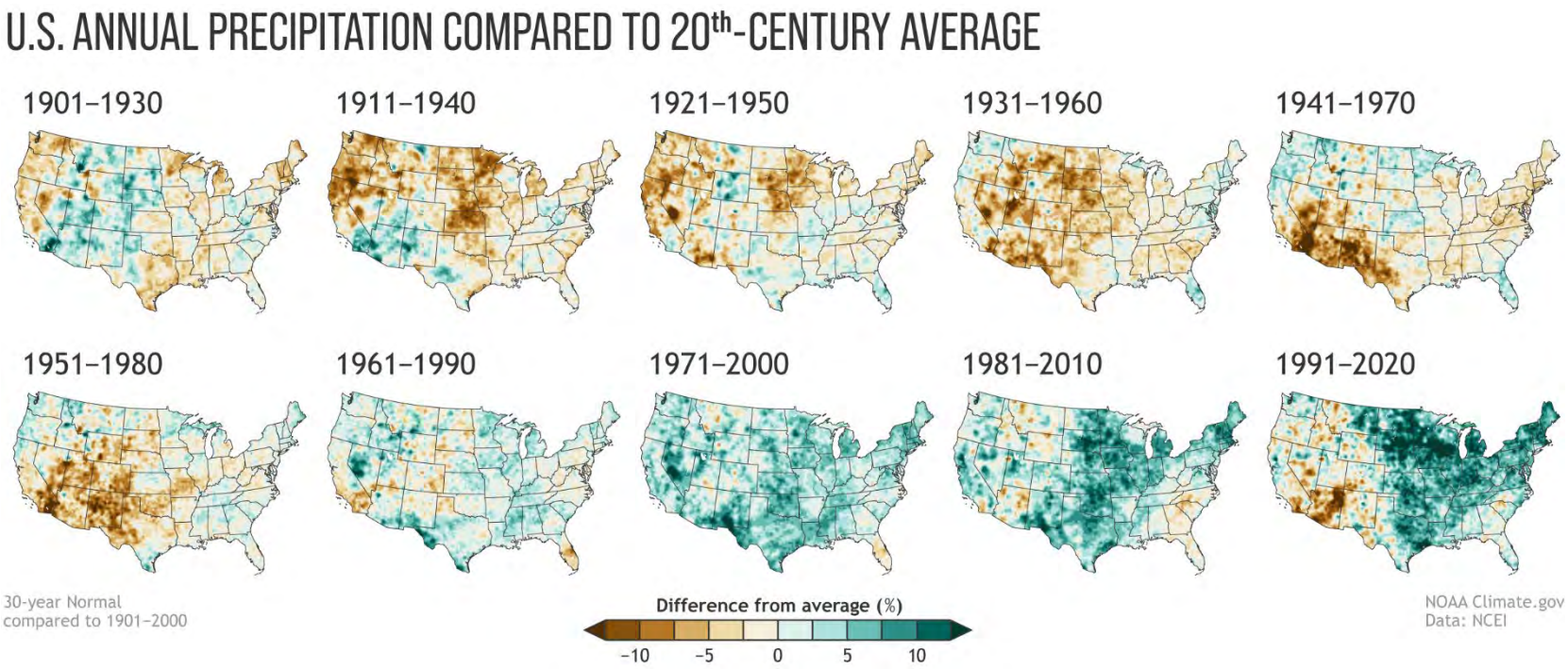
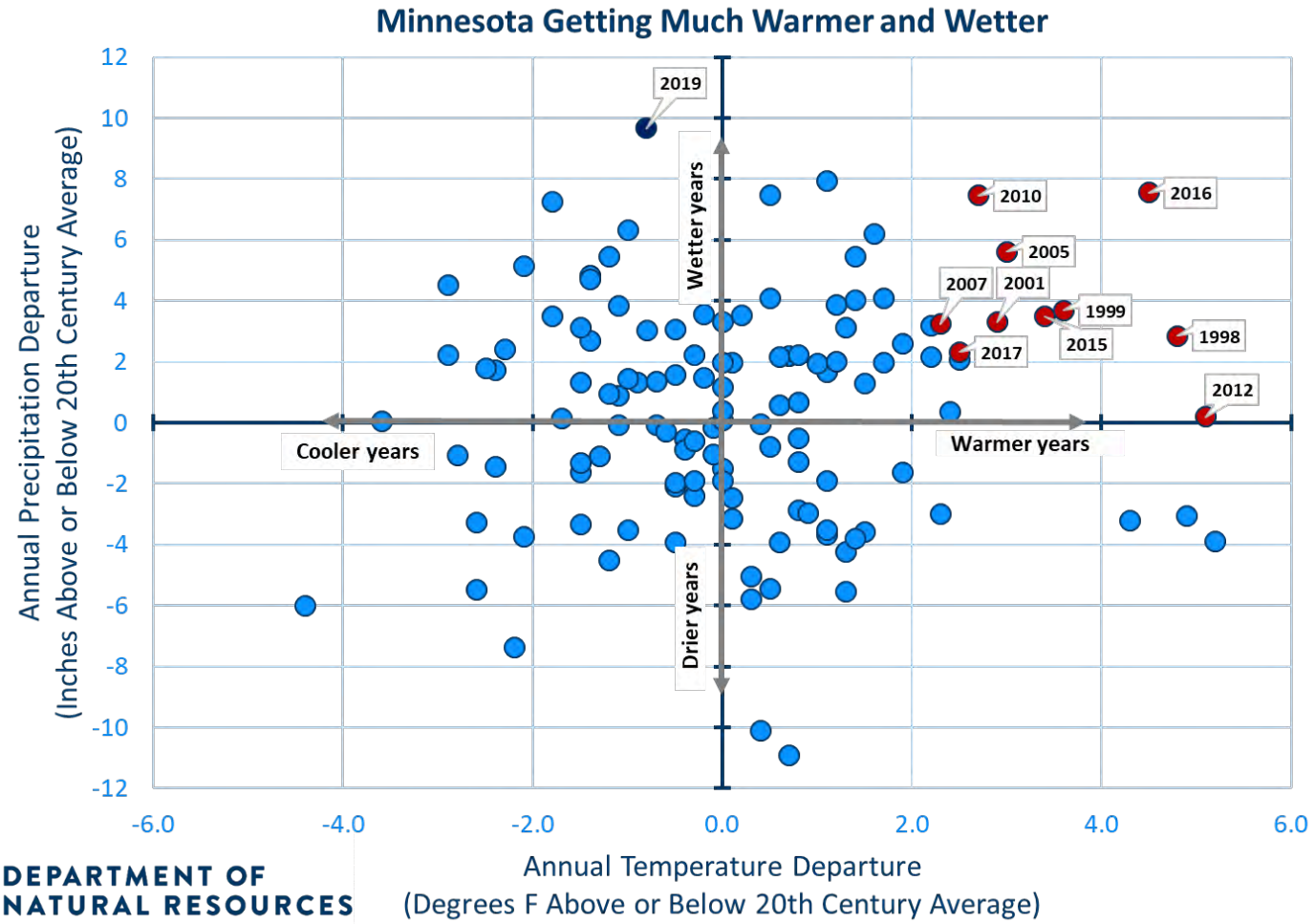


Wetter and Warmer Conditions Observed in MN



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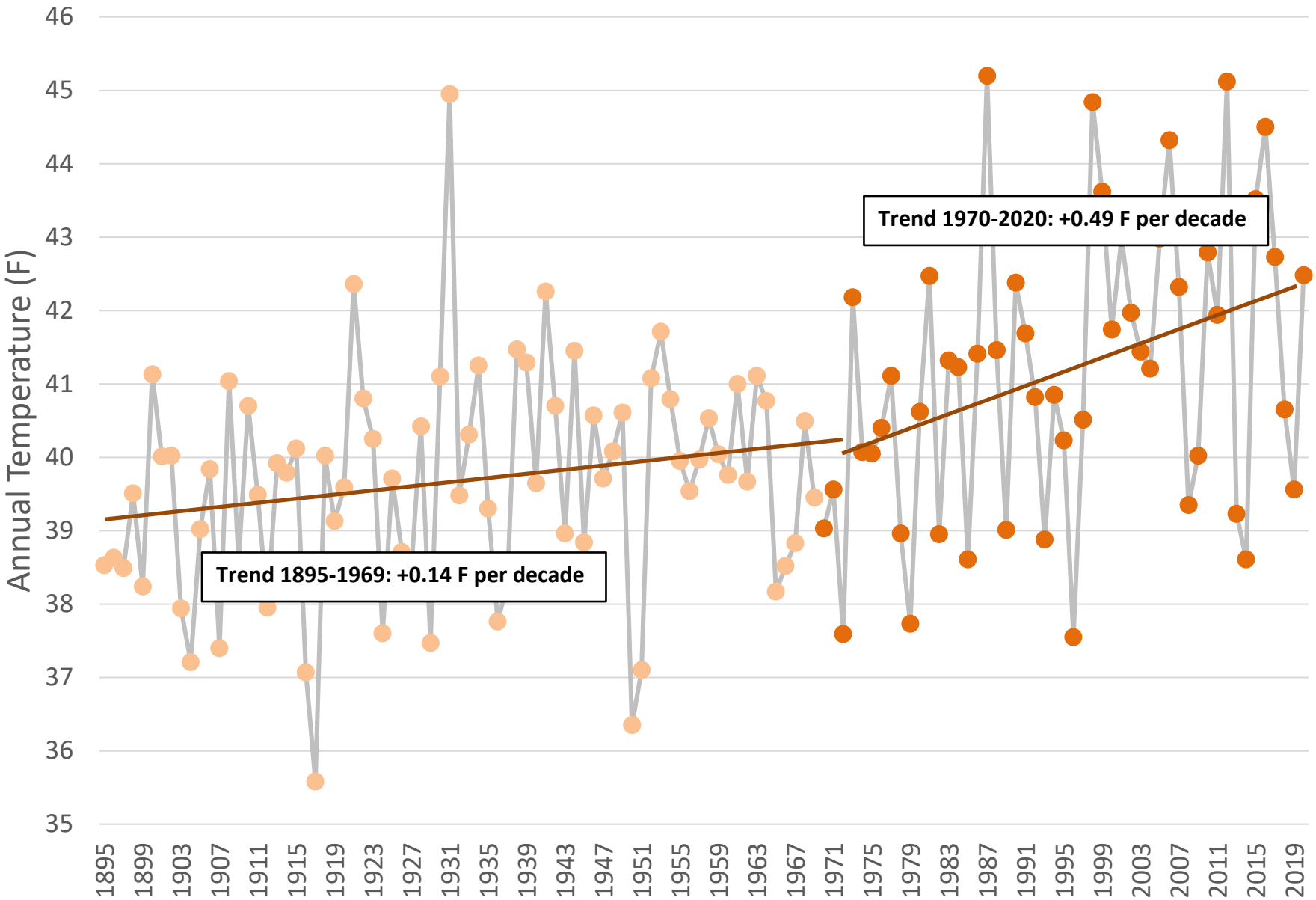
Minnesota Annual Temperature, 1895-2020



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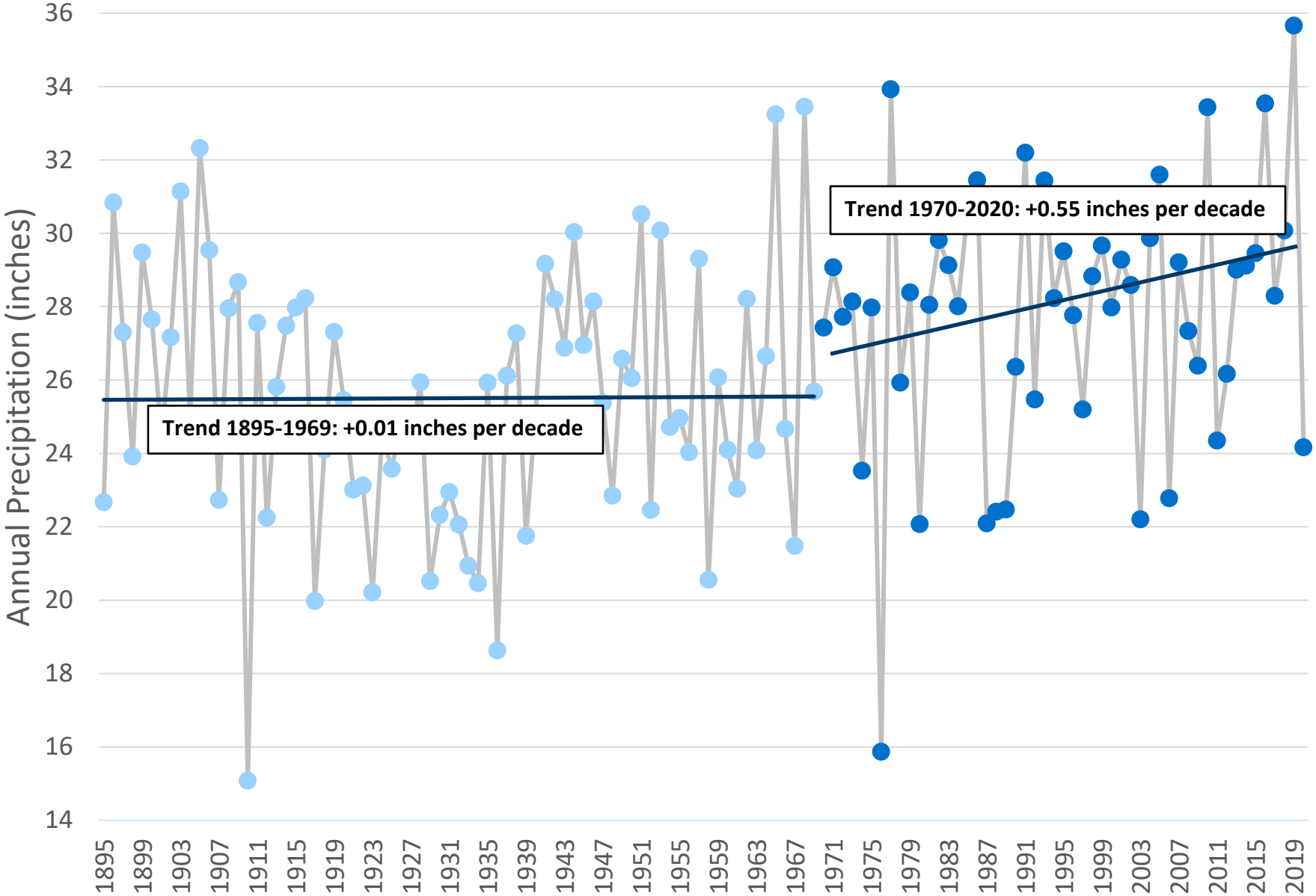
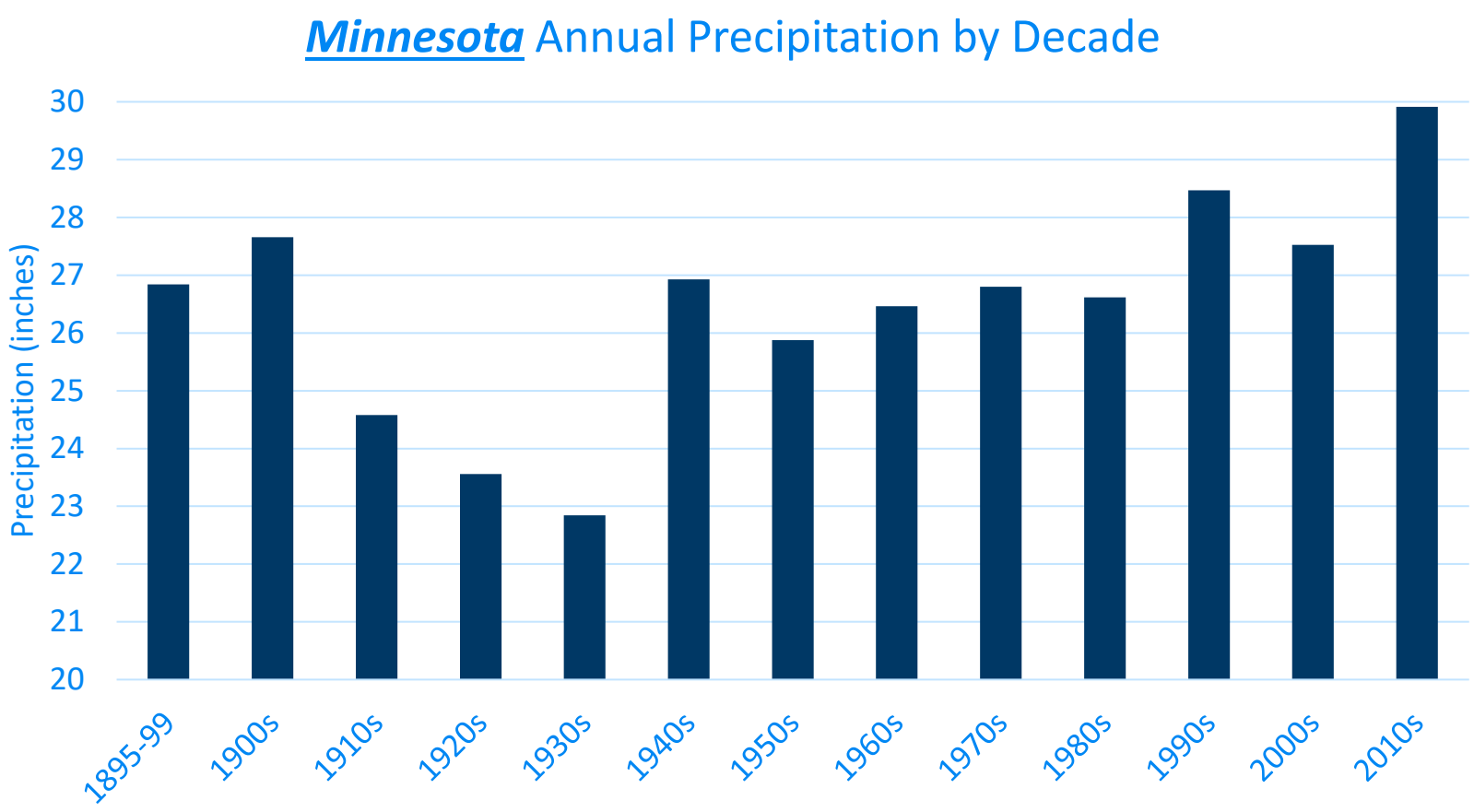
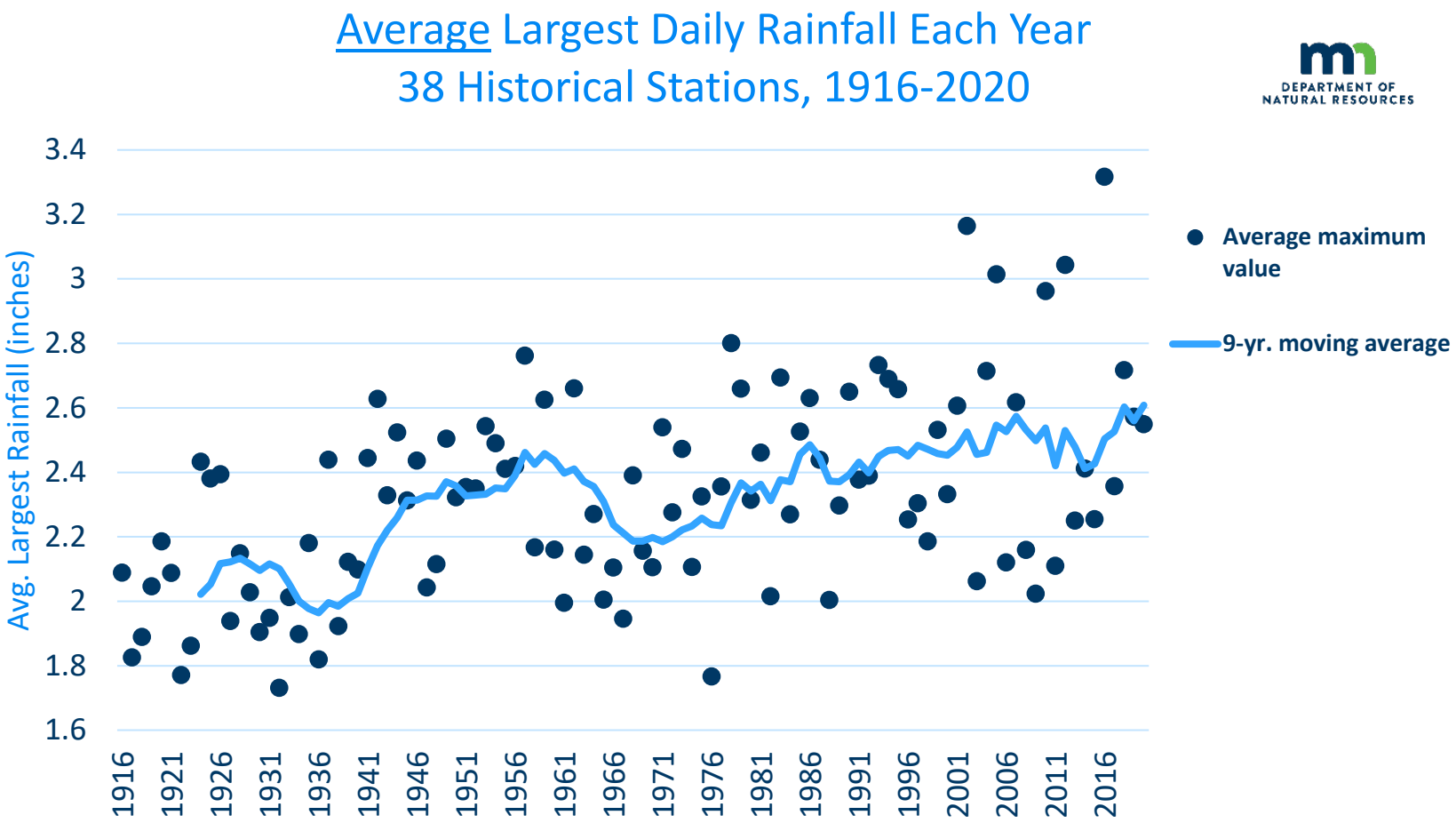
Minnesota Annual Precipitation, 1895-2020



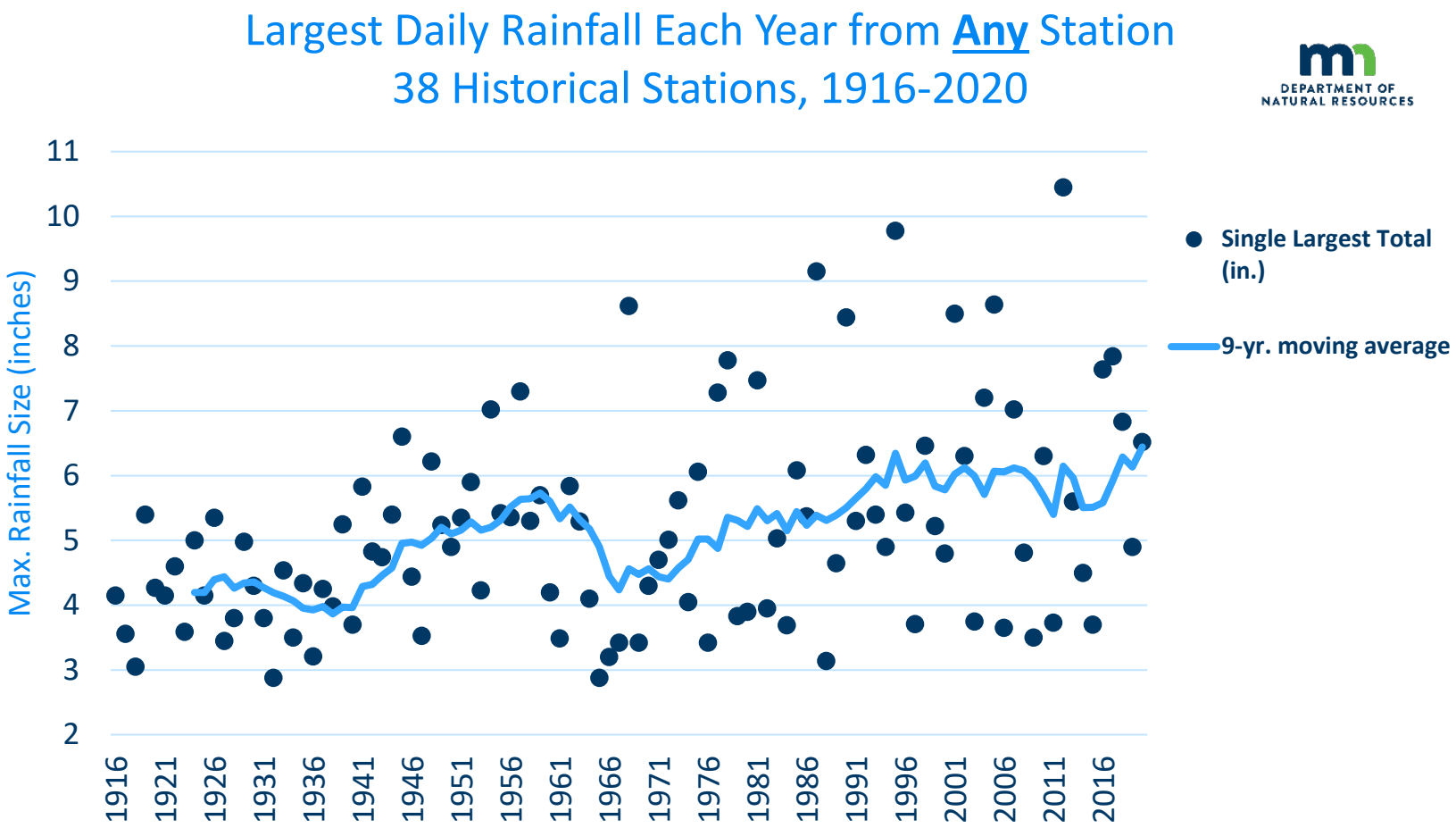
2010s: Wettest Decade on Record, Minnesota



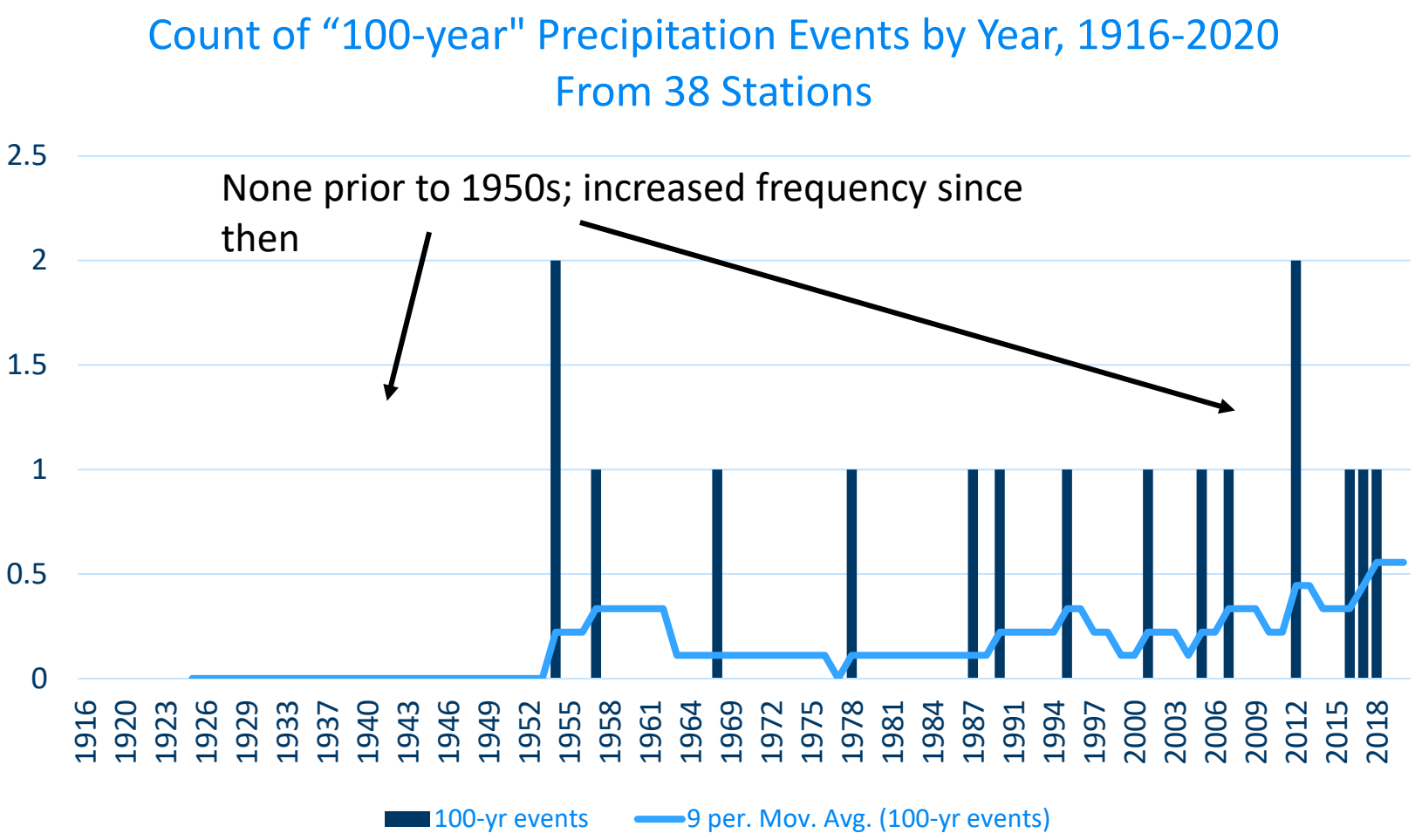
Increasing size of largest annual daily rainfall for a typical station



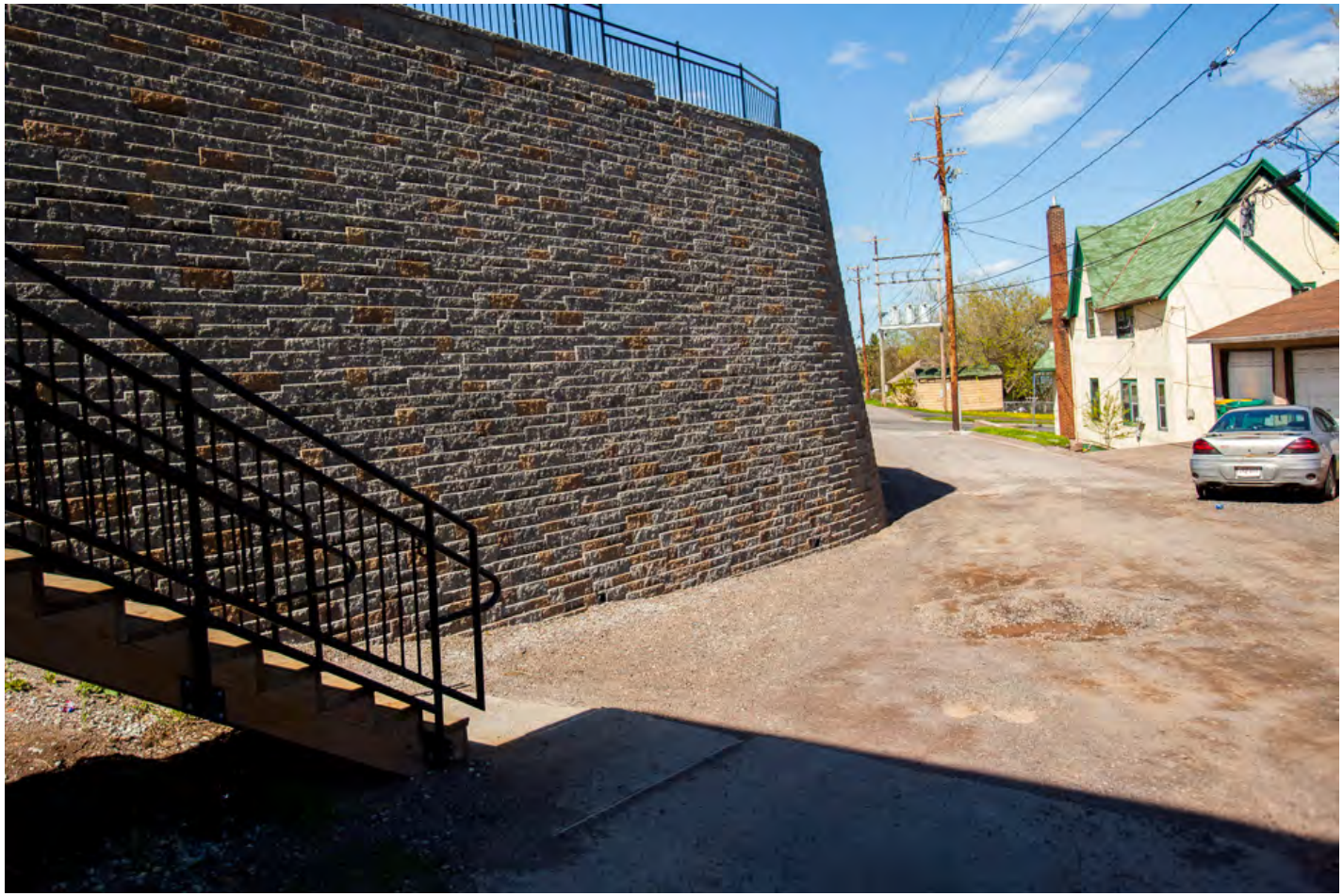
Size of largest rainfall in historical network increasing



Increase in 100-year daily rainfall events



Before

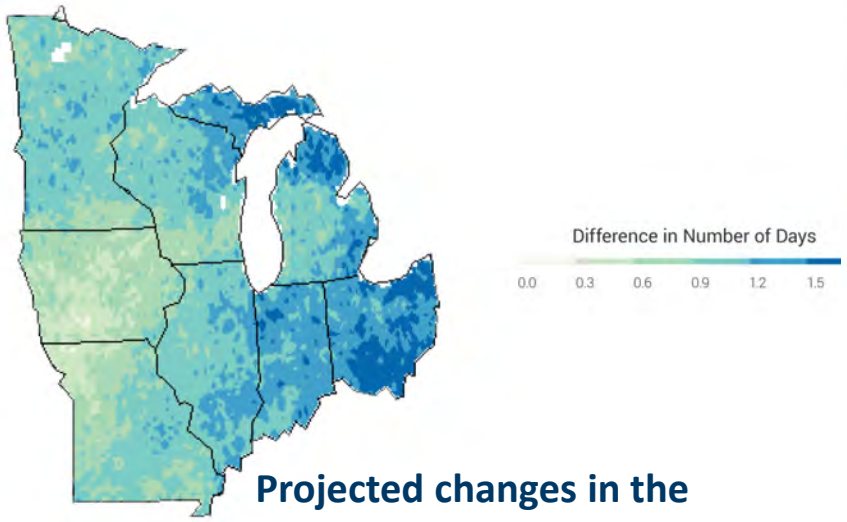


Source MPR

After

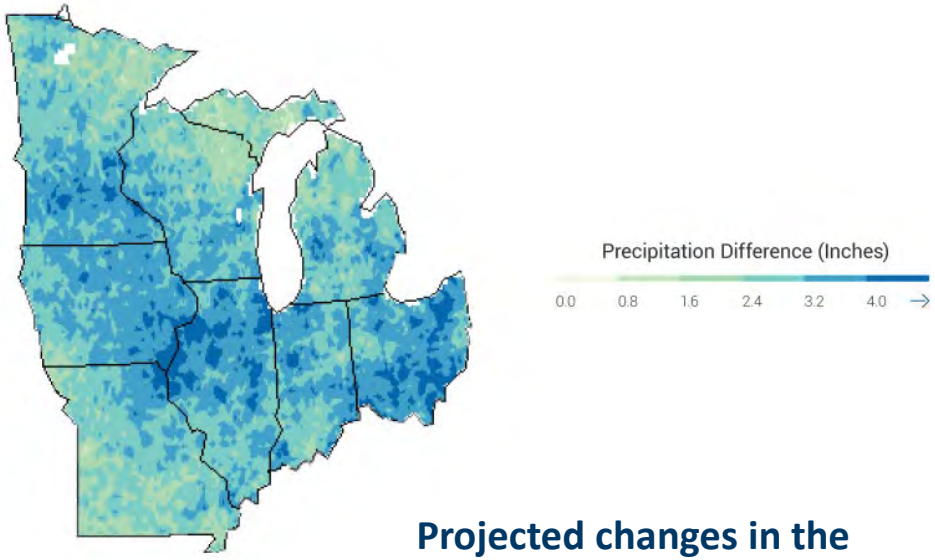
Source MPR

More precipitation projected



Projected changes in the number of days with very heavy precipitation (top 2% of all rainfalls each year) for the middle of the current century (2041-2070) relative to the end of the last century (1971-2000) under continued emissions (A2 scenario).

Source: 2014 National Climate Assessment, Midwest Chapter

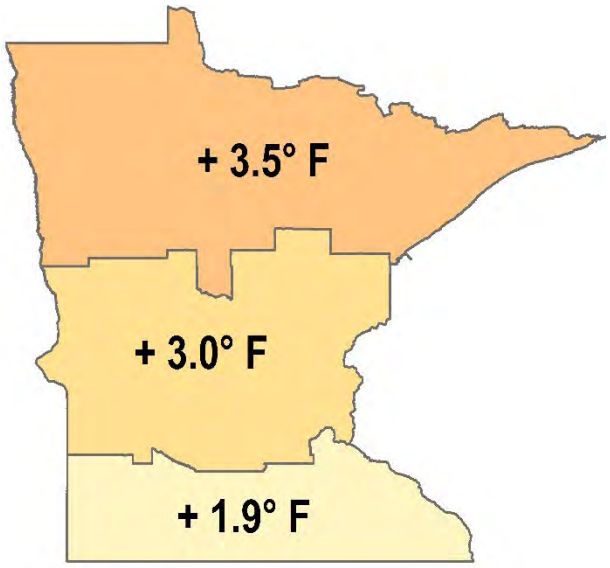


Projected changes in the average annual precipitation for the middle of the current century (2041-2070) relative to the end of the last century (1971-2000) under continued emissions (A2 scenario).

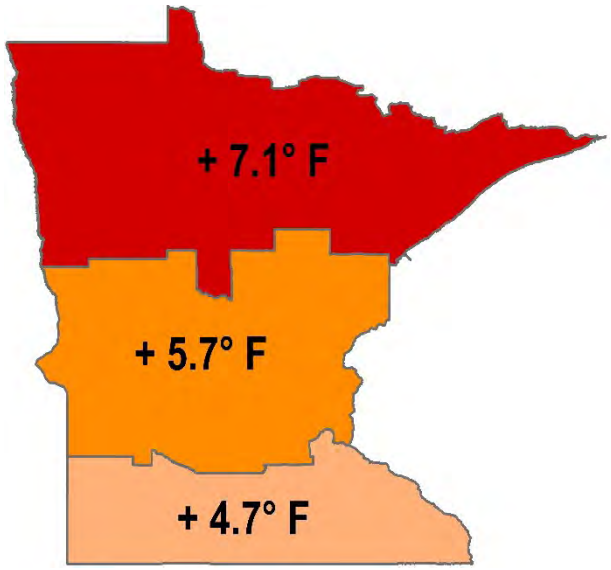
Source: 2014 National Climate Assessment, Midwest Chapter

Warmer: winter, at night, and with northward extent

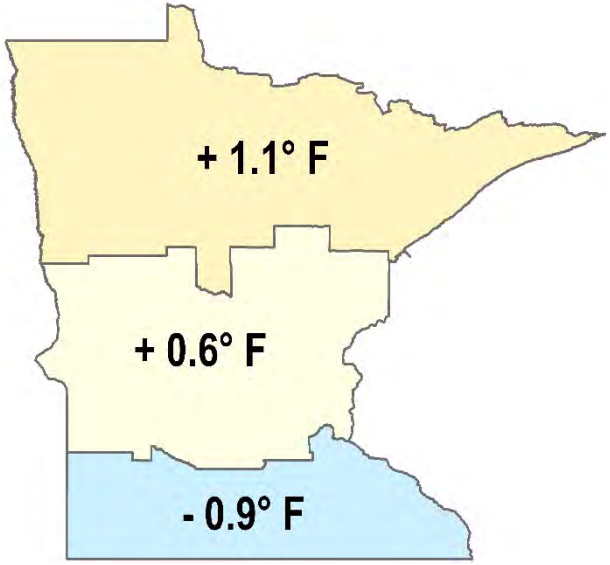
Total temperature change, 1895 – 2019



Annual Average

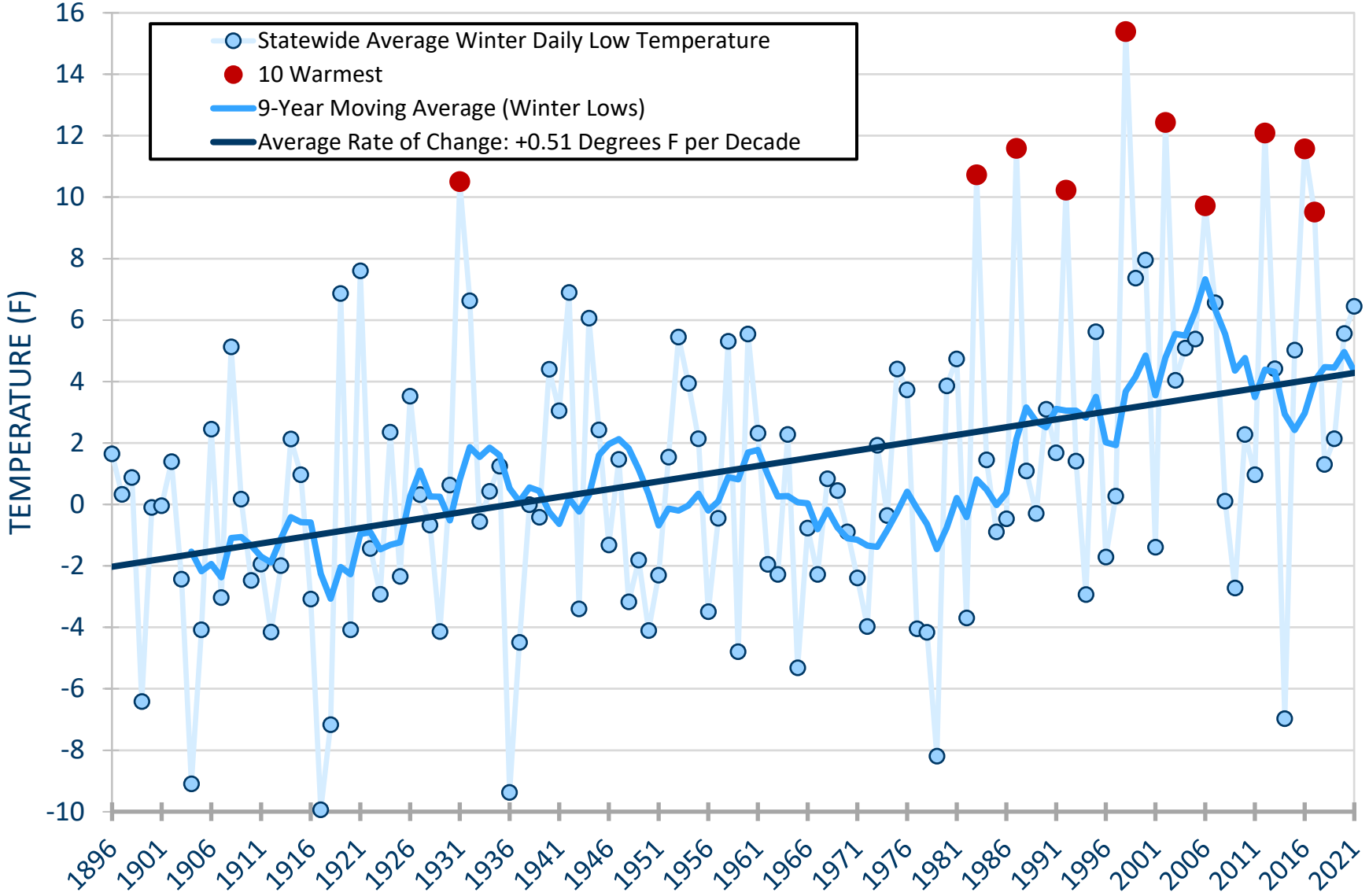


Winter Lows



Summer Highs

Minnesota Average Winter Daily Minimum Temperatures
(December through February, 1896-2021)



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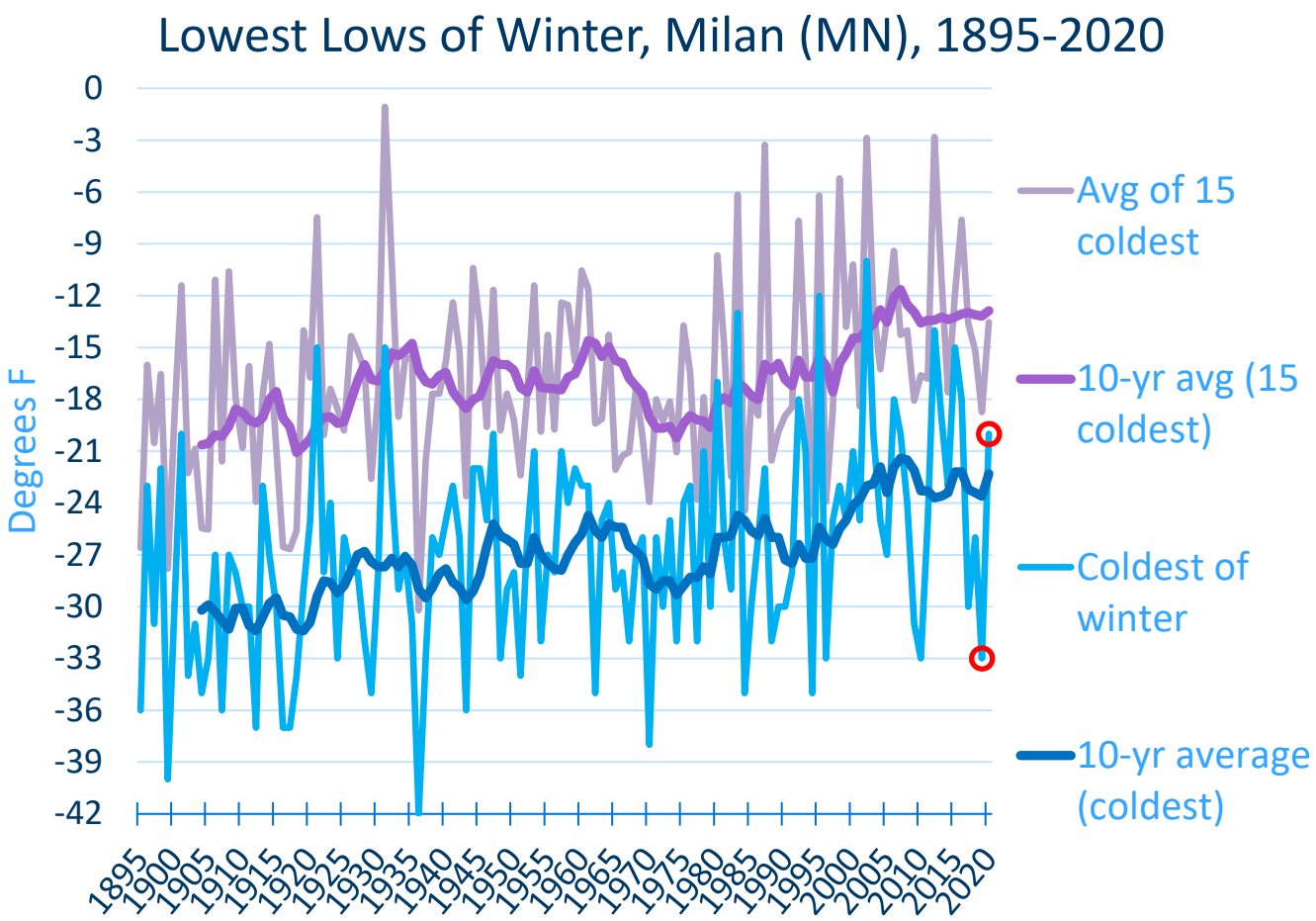
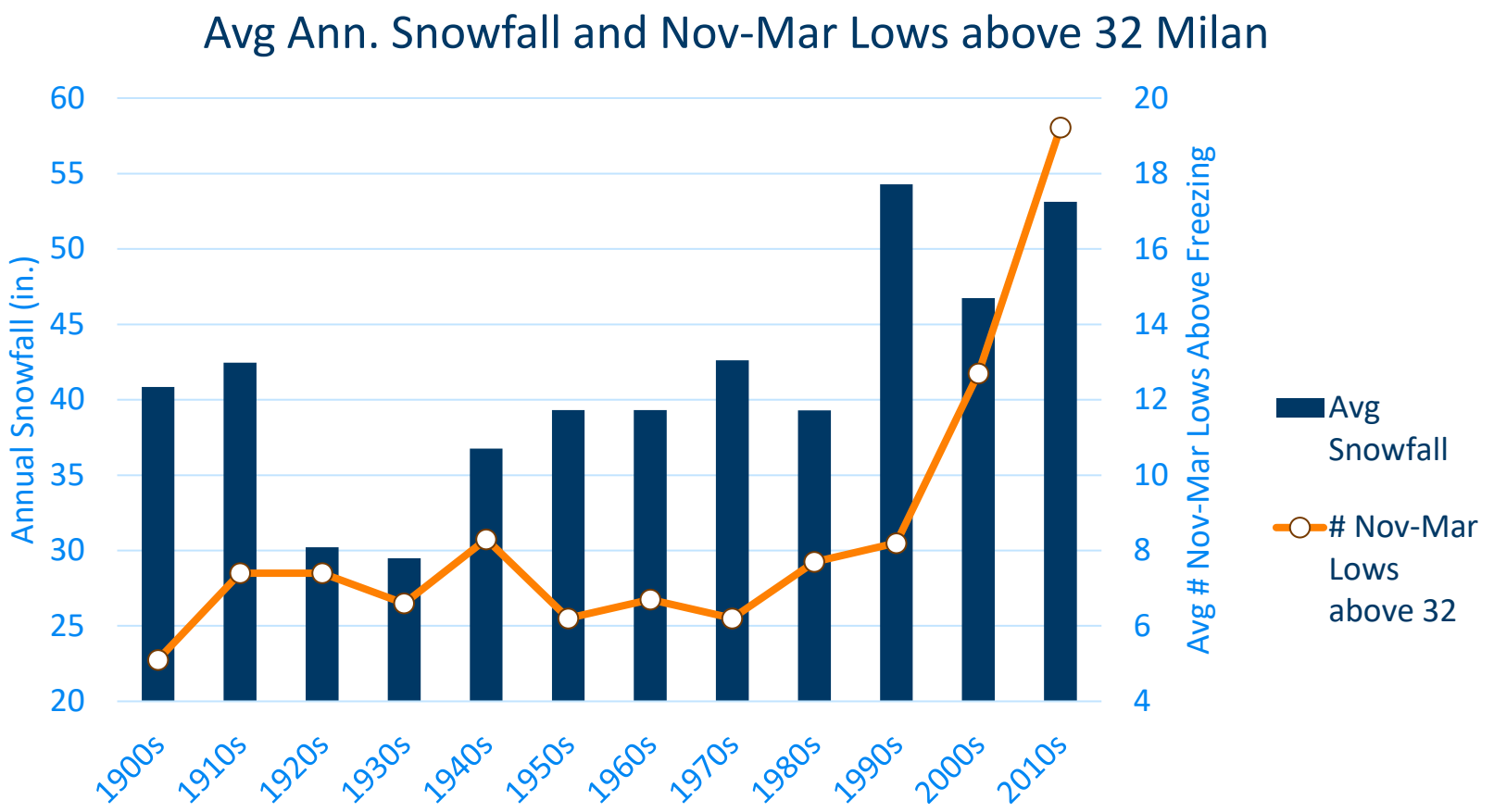
All data from NOAA and accessed as state-averaged values via Minnesota Climate Explorer (https://arcgis.dnr.state.mn.us/ewr/climateexplorer/main/historical)

Fewer/lesser cold extremes

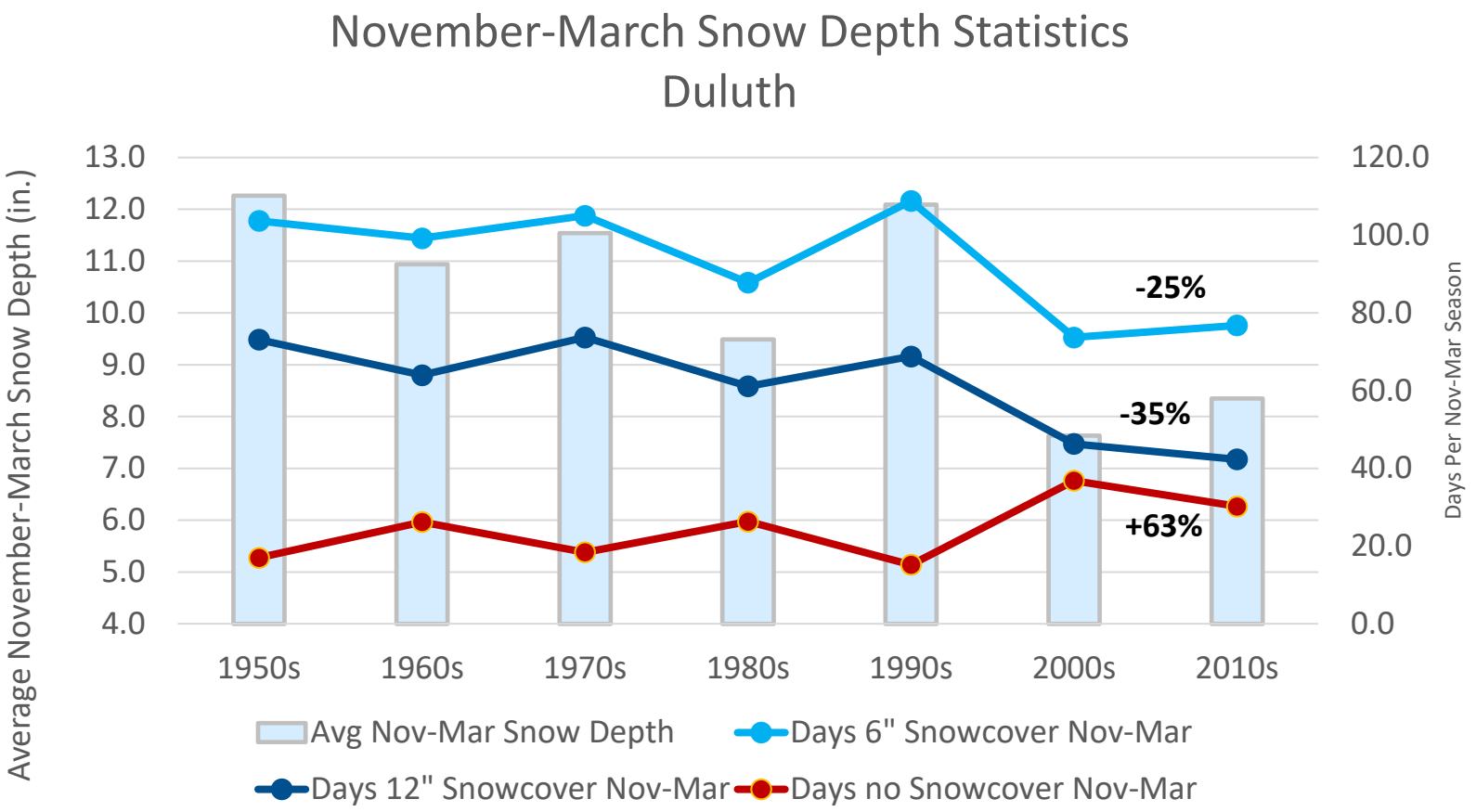
- Lowest and average of 15 lowest temperatures of year increasing
- Current “cold extremes” used to be more common
- What used to be “extremely cold” no longer occurs



Combined trends: more snow AND more thaws

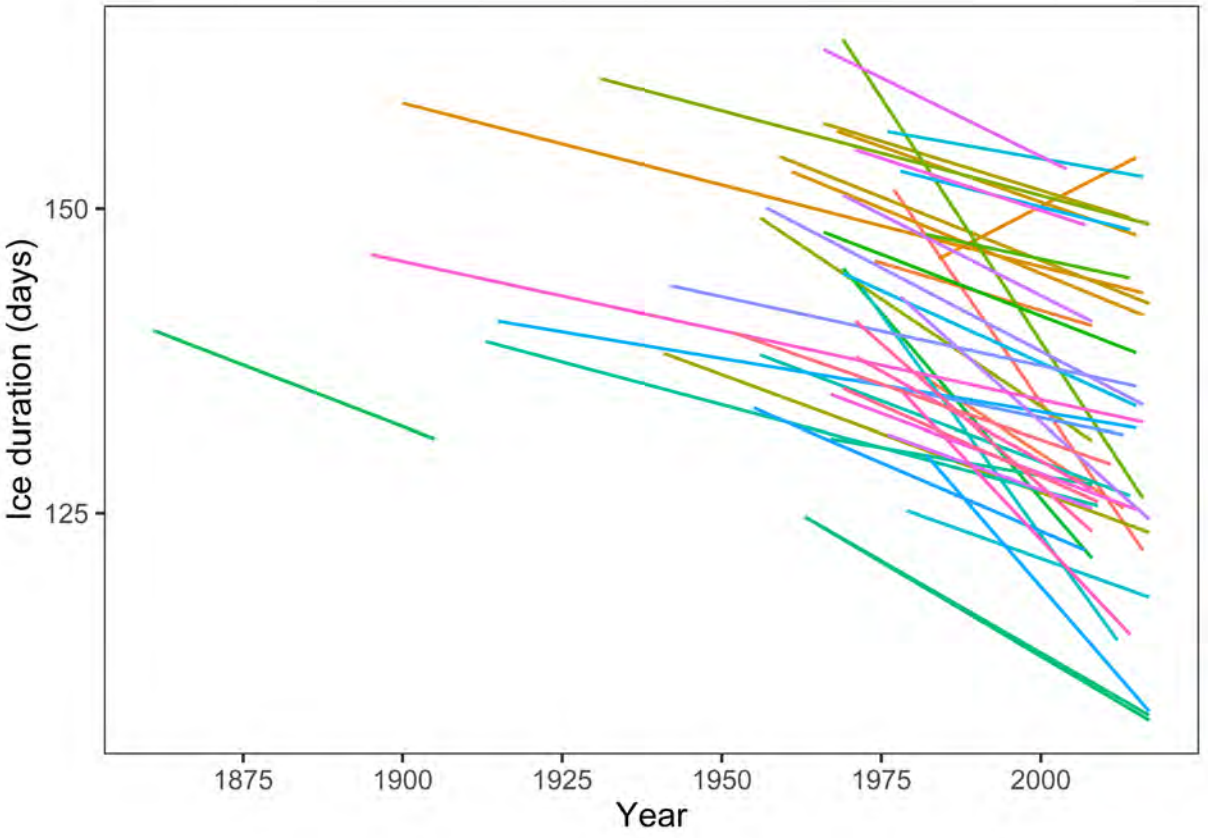


Snow Depth Declining



Lake ice season decreasing

- Long-term state-avg decline is 1.8 days per decade
- Decline from 1987-2017 is ***-4.2*** days per
- (Source DNR internal analyses)



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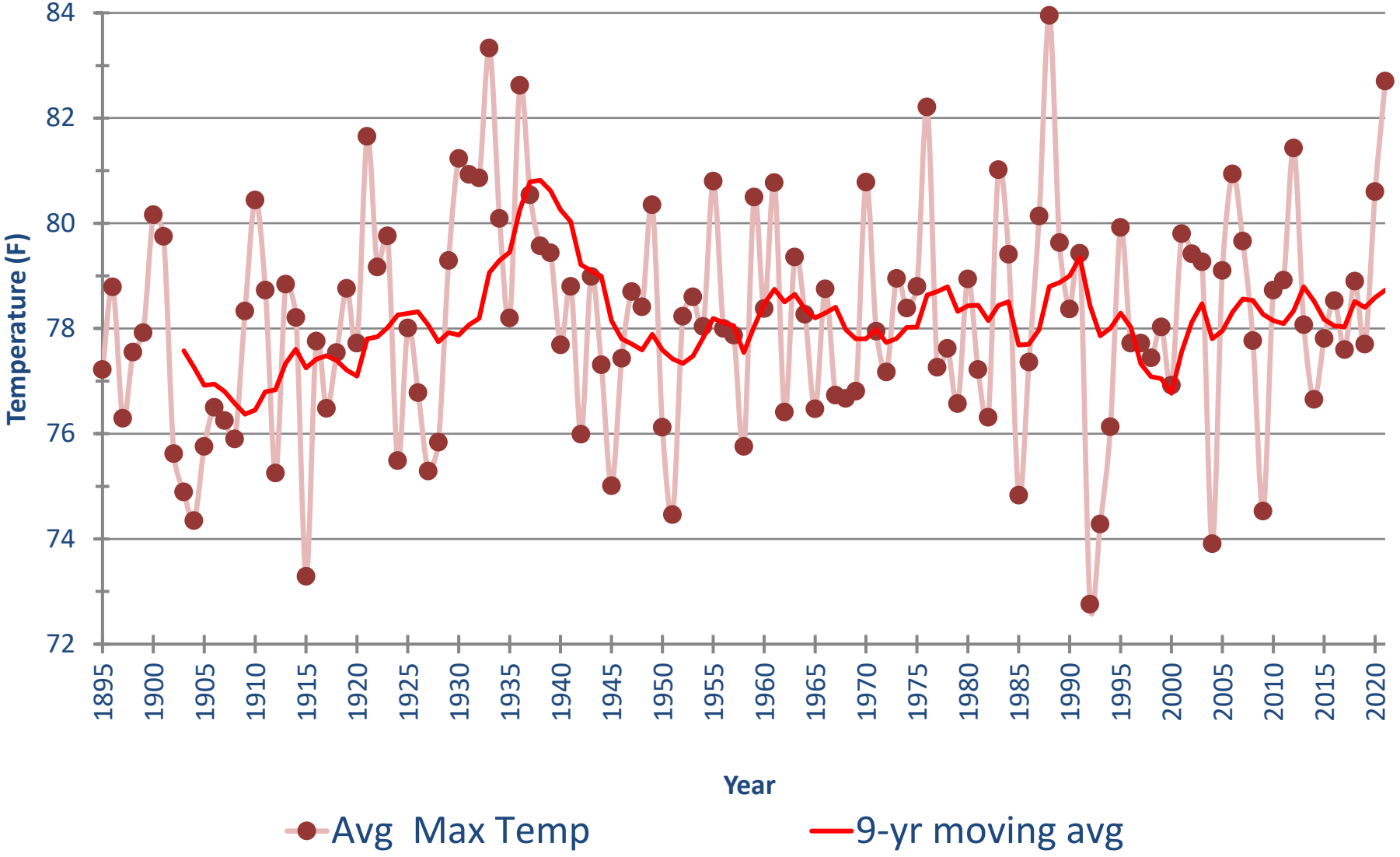
Minnesota Average Summer Maximum Temperatures
1895–2021: No obvious trend yet



More warming on the way

Projections indicate:

- Shorter frost seasons
- Warmer winters
- More summer heat (shown)

→For all future scenarios

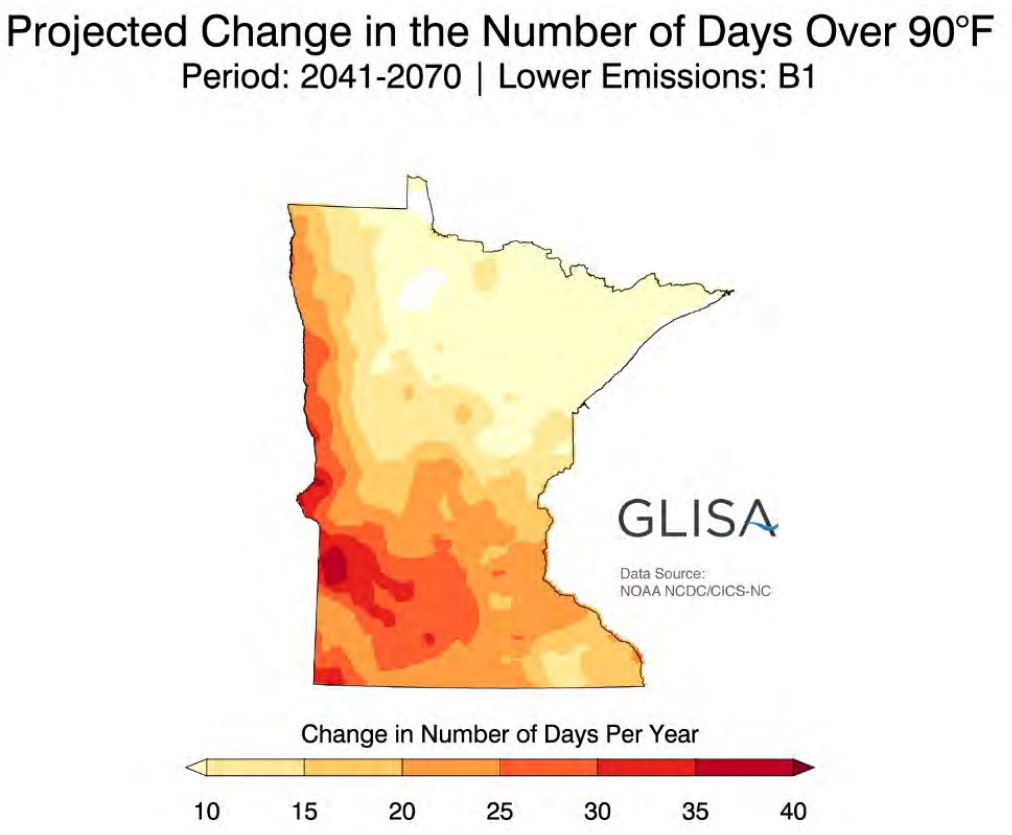


Image produced from NOAA projections by GLISA (Great Lakes Integrated Science + Assessments)

Recent lessons

- IPCC: We're behind on all goals
- Texas: Extraordinary cold still possible
- Portland/PAC-NW: Extreme heat may eclipse all experiences
- NYC: Unprecedented rainfall beyond comprehension possible
  - Lead-time on extreme, record events general 3-5 days, at best

In Summary

1. Minnesota already wetter and warmer, with more precipitation extremes, warmer winters, and warmer nights

2. Projections for mid-century indicate more precipitation, further warming, and hotter summers too

3. Variations, including extreme ones, will remain part of our climate

   → Dry periods, drought, cold spells all likely, even as we trend wetter and warmer

   → Expect “surprises” that interrupt dominant climate regime

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Thank You!

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