



# A Snapshot of Our Changing Climatology

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# Items to bear in mind

1. Climate news elsewhere may not apply here
2. *Observations & Projections* are different
3. We can (and do have) **Variability** and **Trends** simultaneously  
– they do not disprove each other!
4. Not all hazards are changing—but they're still hazardous!
5. Seek more info and refresh frequently!

# Minnesota's pronounced **OBSERVED** trends

1. Minnesota is becoming wetter and warmer
  - **Major shift observed, projected to continue**
2. Lowest temperatures are increasing fastest
  - **Rapid loss in cold extremes, projected to continue**
3. Extreme rainfall increasing
  - **More and larger “big” events, projected to continue**

# These important hazards affect us but are not “worsening” ...YET

1. Hot days, warm nights, heat waves not yet increasing
  - But PROJECTIONS indicate future increases likely
2. Drought
  - Future increases possible
3. Tornadoes, severe convective storms
  - Future unclear; scientific uncertainty

# Confidence that climate change has already impacted Minnesota's weather and climate hazards

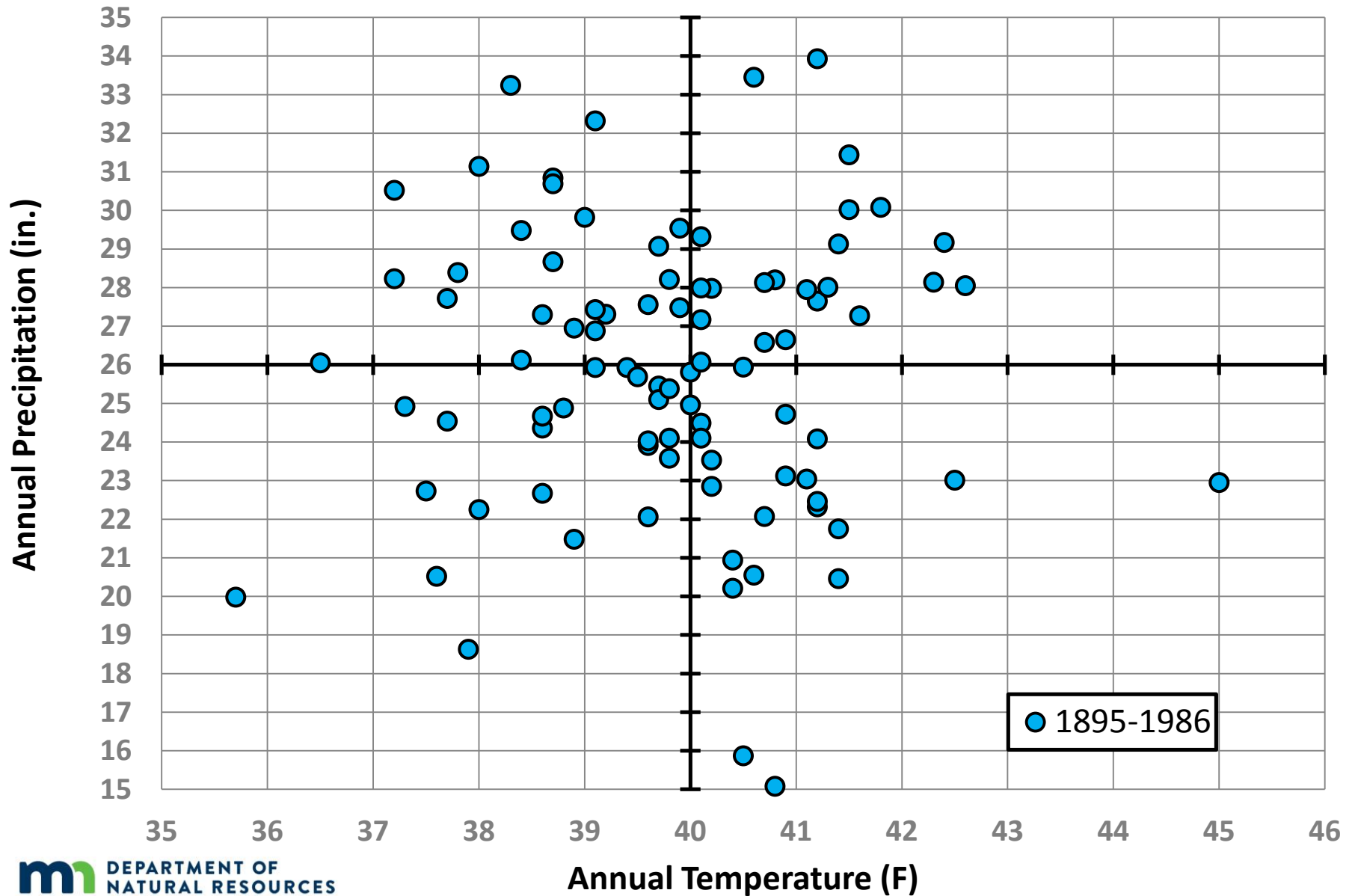
<u>Confidence</u>	<u>Attribute</u>	<u>Impacts</u>
<b>Highest</b>	<b>Winter, extreme cold</b> Becoming <u>less</u> severe	<u>Indirect</u> (expanded species ranges)
	<b>Rainfall extremes</b> Larger, more frequent	<u>Direct</u> (floods, damage, life/safety)
<b>Low</b>	<b>Severe convective storms</b> Data quality issues	<u>Direct</u> (Structural damage, power outages)
<b>Lowest</b>	<b>Heat</b> No increases or worsening	<u>Direct</u> (heat sickness, power failure)
	<b>Drought</b> No increases or worsening	<u>Indirect</u> (water shortages, crop failure)

# Confidence that climate change will impact Minnesota's weather hazards by mid-century

<u>Confidence</u>	<u>Attribute</u>	<u>Expectations by mid-century</u>
<b>Highest</b>	<b>Winter, extreme cold</b>	Continued rapid decline
	<b>Extreme rainfall</b>	<b><u>Unprecedented events expected</u></b>
<b>High</b>	<b>Heat</b>	<b>Increases in severity, coverage, and duration</b>
<b>Moderately High</b>	<b>Drought</b>	<b>Increases in severity, coverage, and duration possible</b>
<b>Moderately Low</b>	<b>Severe convective storms</b>	More “super events” possible, even if frequency decreases

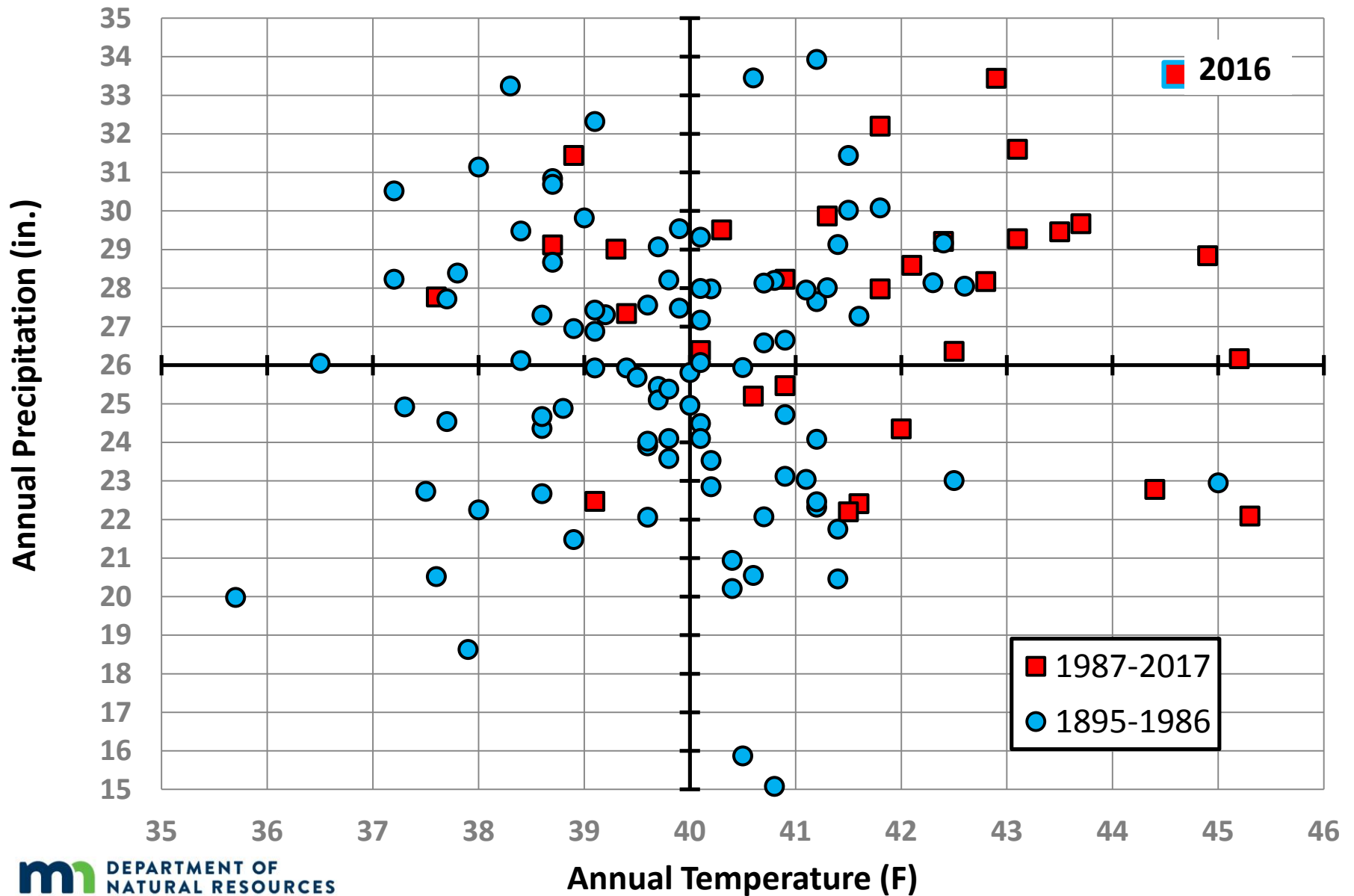
# MN Getting Warmer and Wetter

# Minnesota Average Temperature and Precipitation

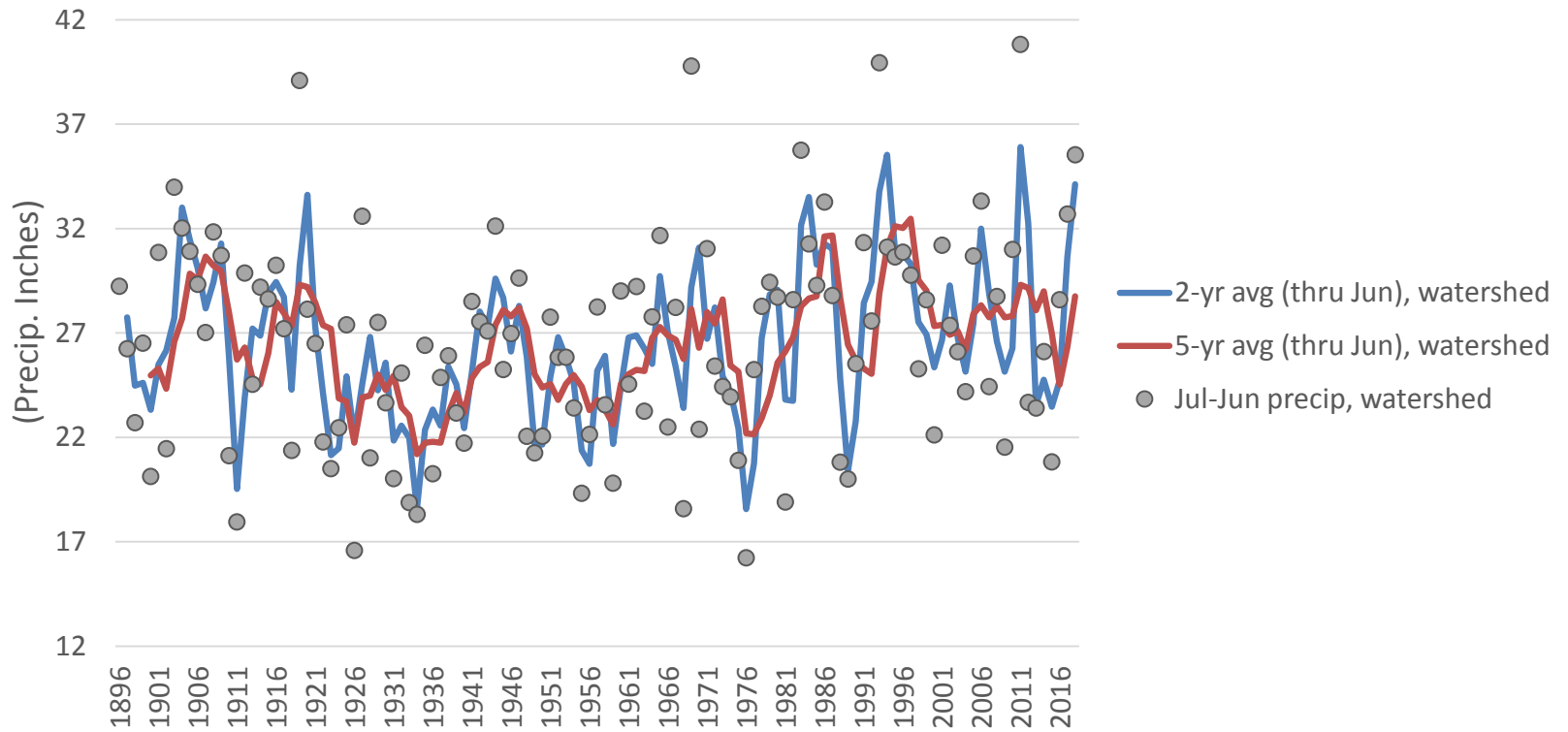




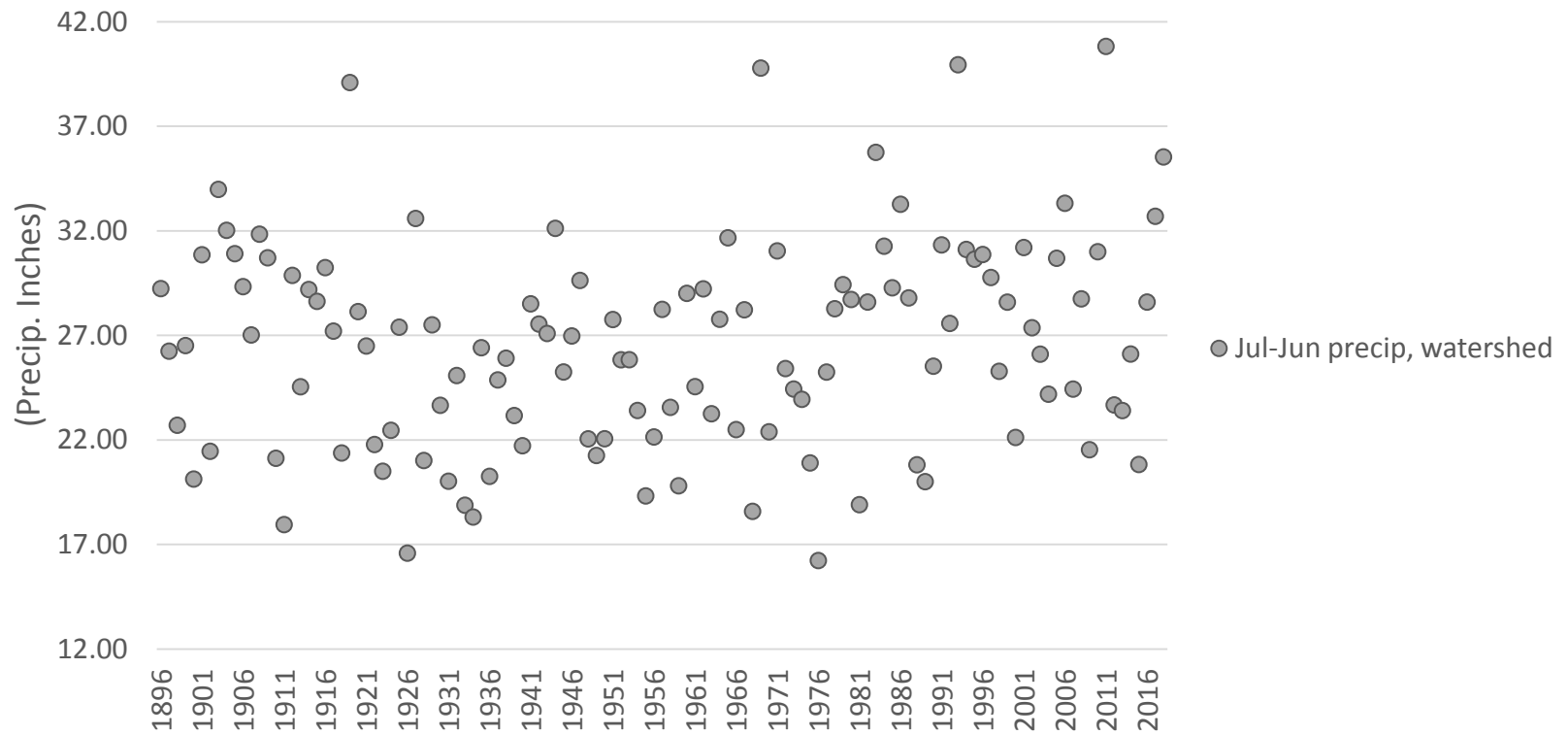
# Minnesota Average Temperature and Precipitation



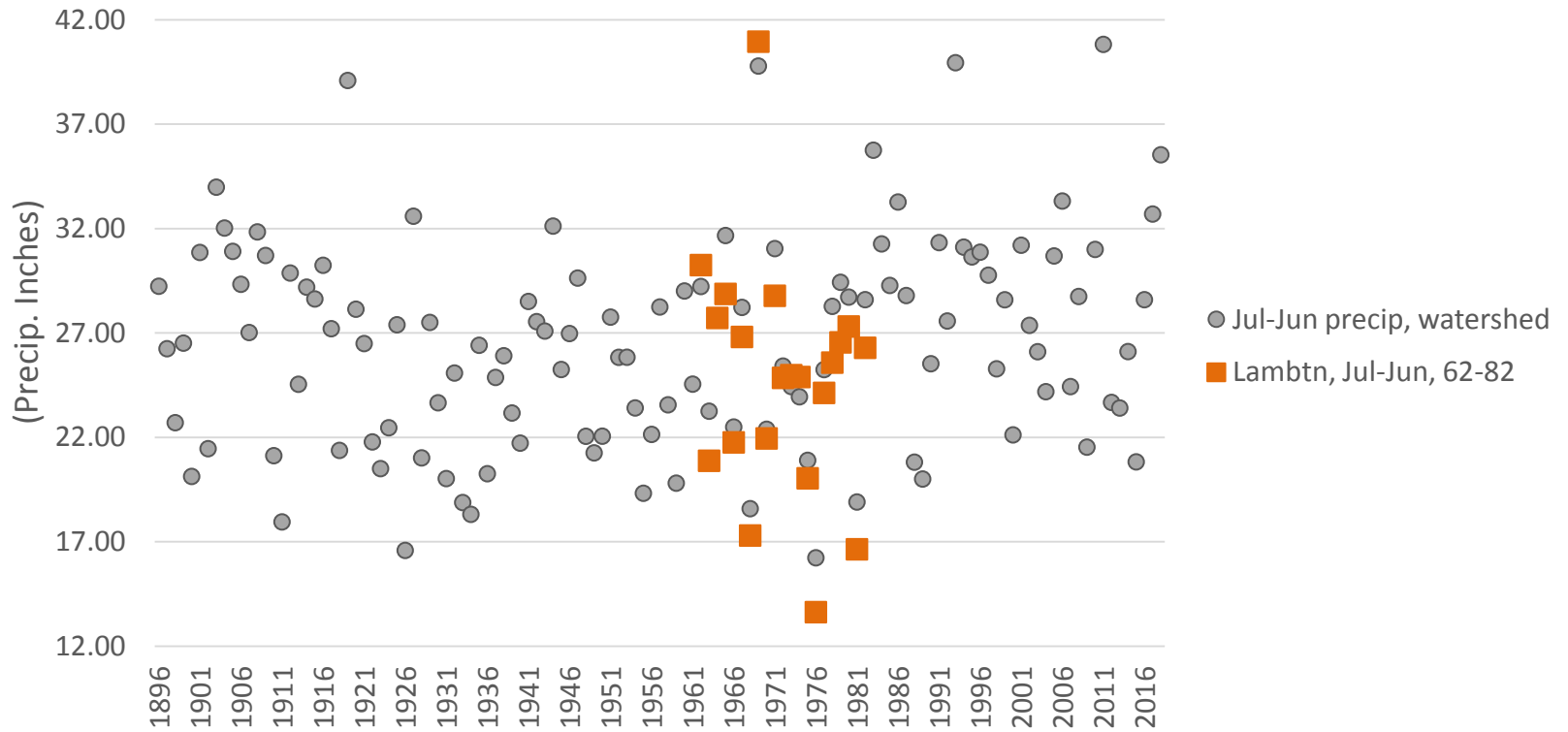
## Precipitation, Cottonwood River Watershed



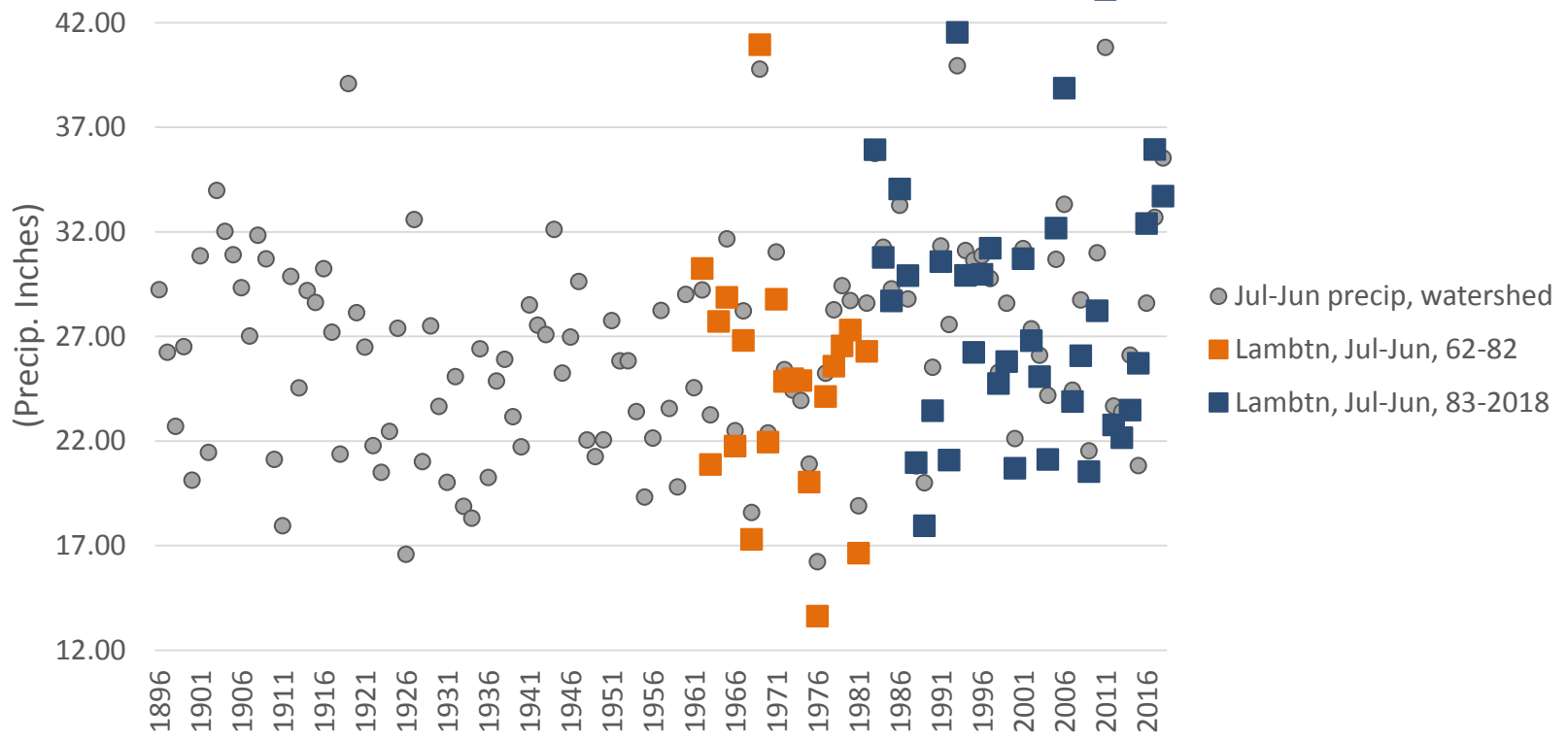
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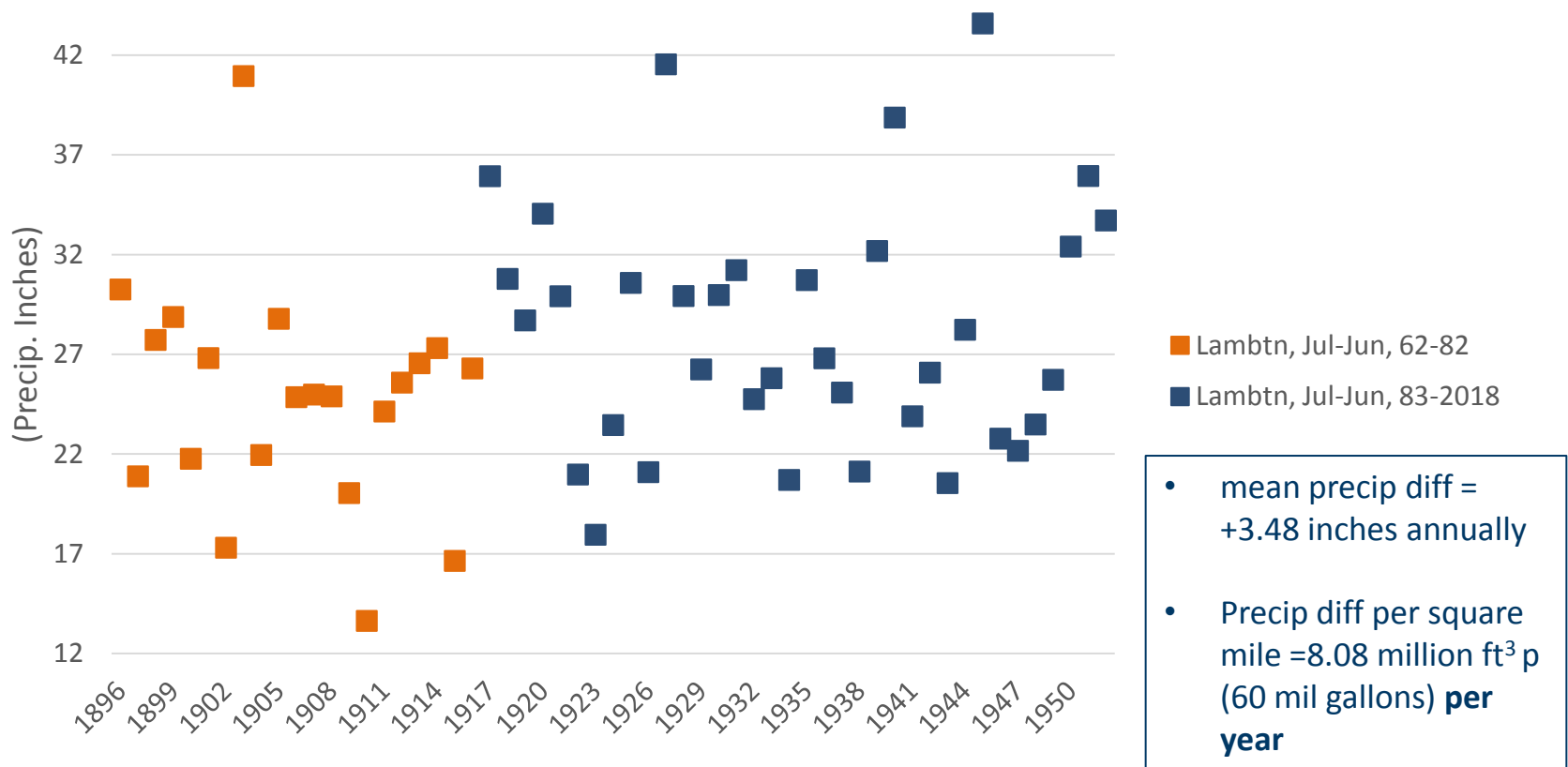


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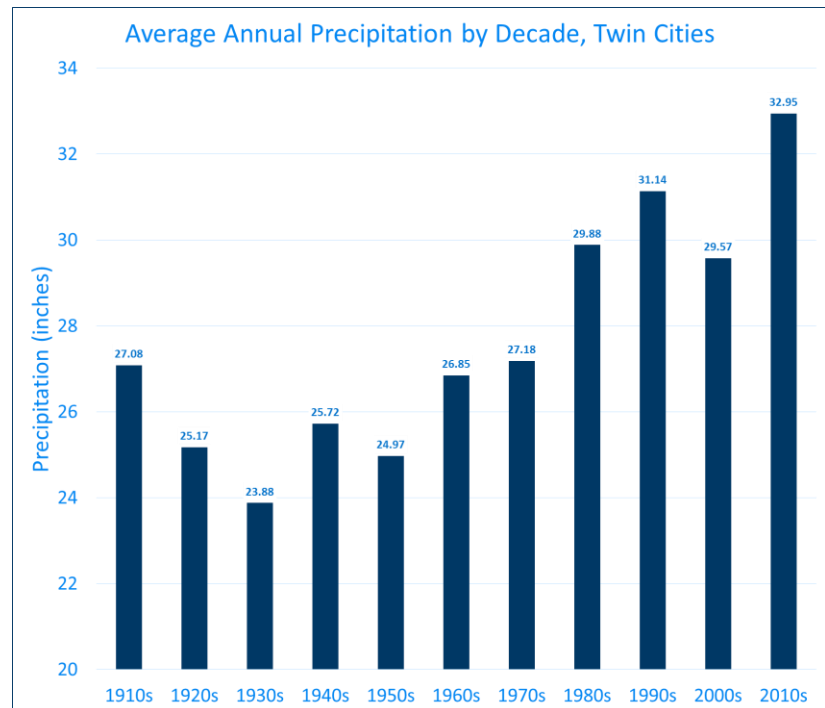
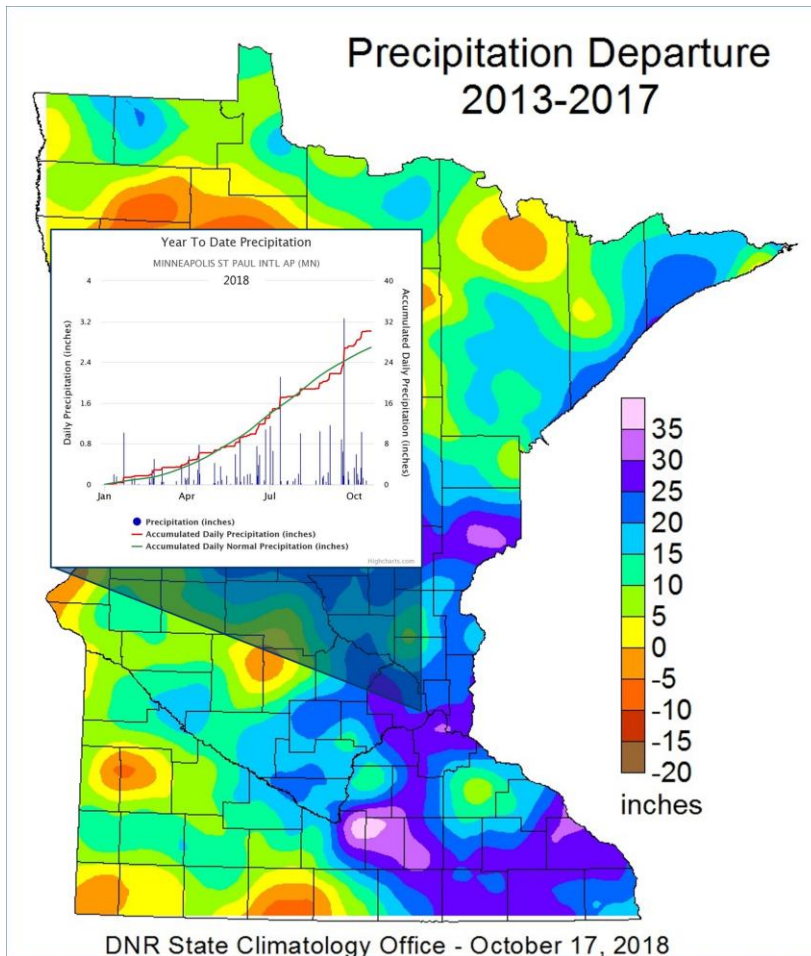


# A new precipitation regime?

## Precipitation, Cottonwood River Watershed



# 2010s wettest decade on record (almost certainly)



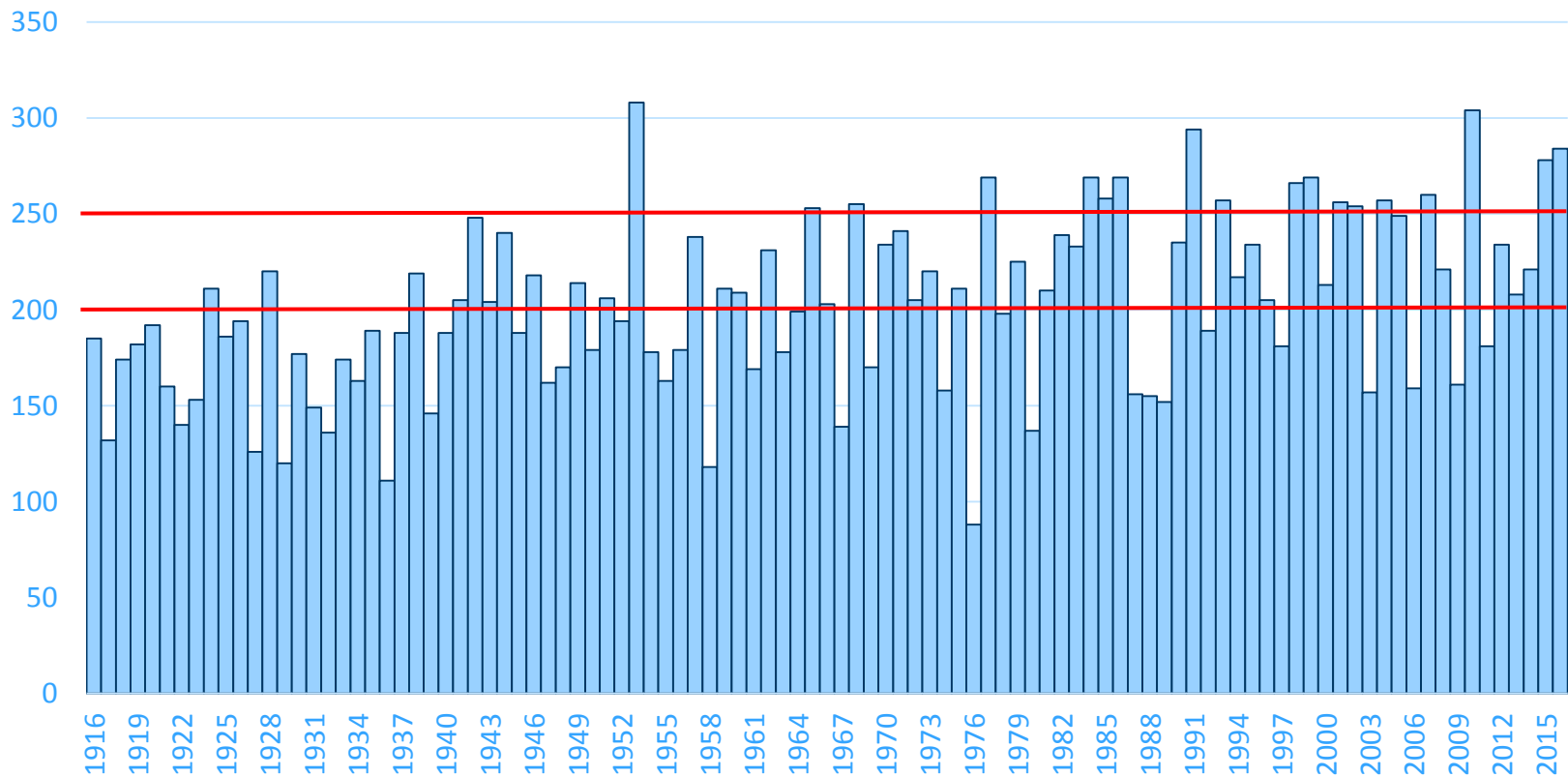
# How We're Getting Wetter and Warmer

- Increases in frequency of heavy rainfall and magnitude of heaviest rainfall
- Winter warming + loss of cold extremes
  - This warming sets us up for eventual extreme heat increases



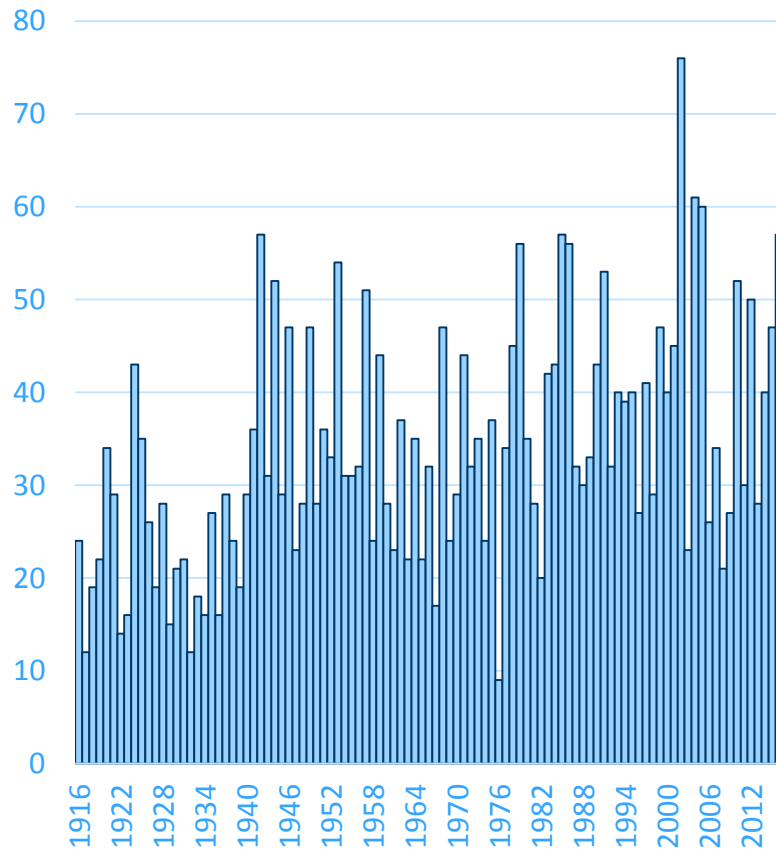
# More 1" rains, and more rainfall produced by them

1-inch rainfalls by year

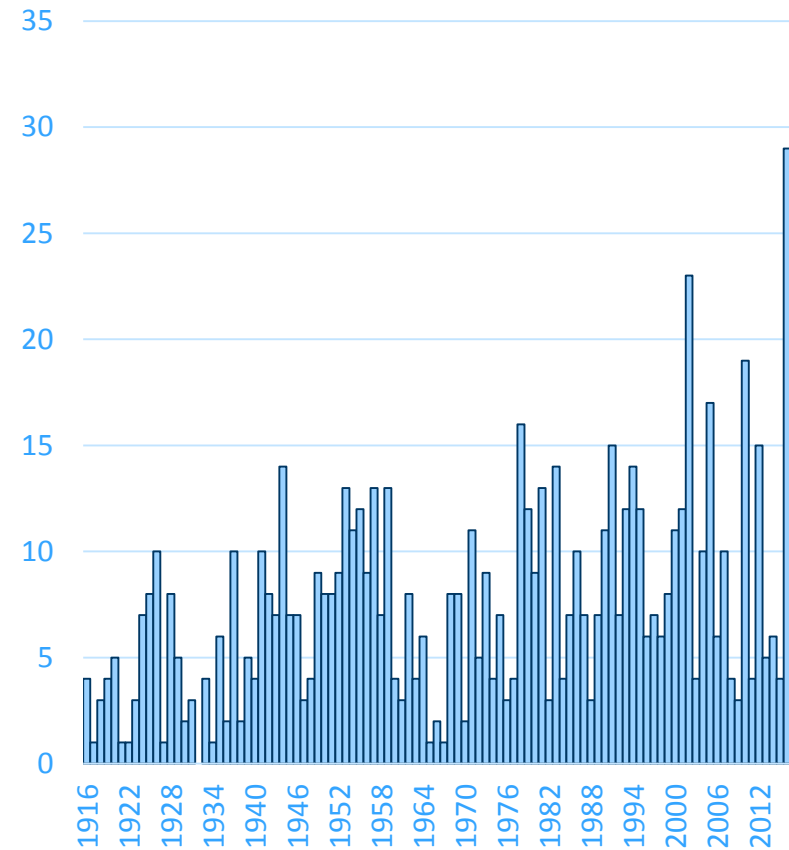


# 2" and 3" rains increasing

## 2-inch rainfalls by year

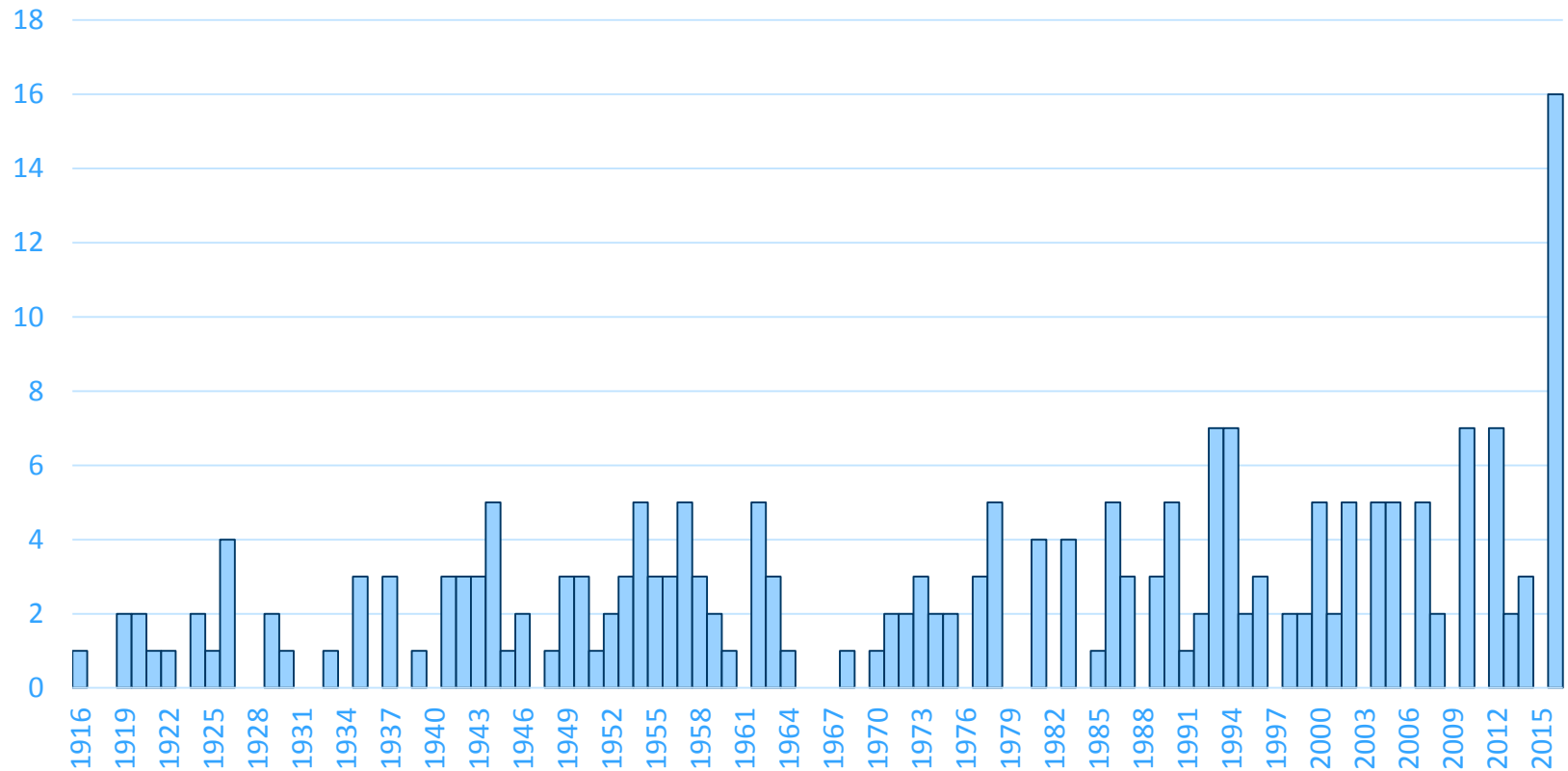


## 3-inch Rainfalls by Year



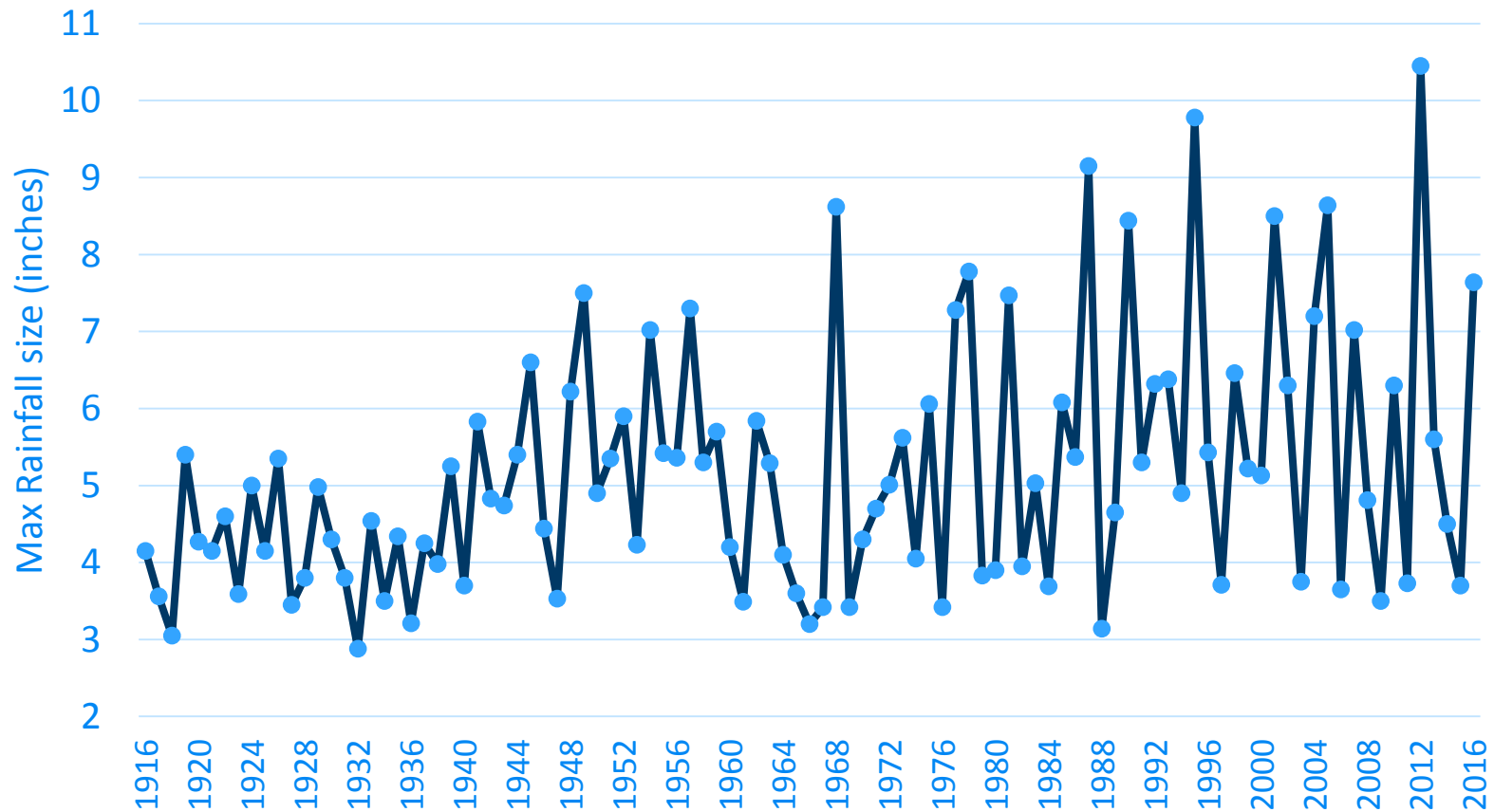
# Even 4" rains increasing

4-in rainfalls by year

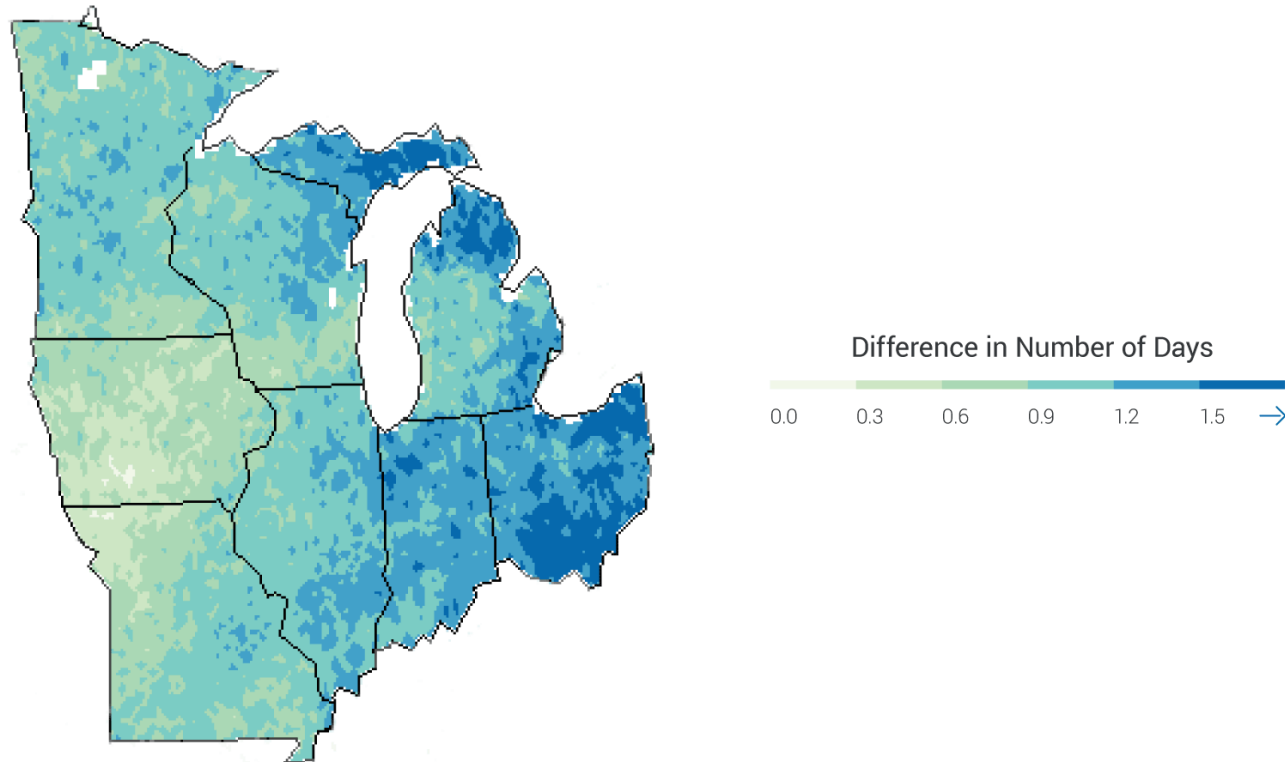


# Heaviest rain in state larger and more variable

## 40-station max rainfall by year



# Projections: Continued increase in “upper 2 percentile” rainfall

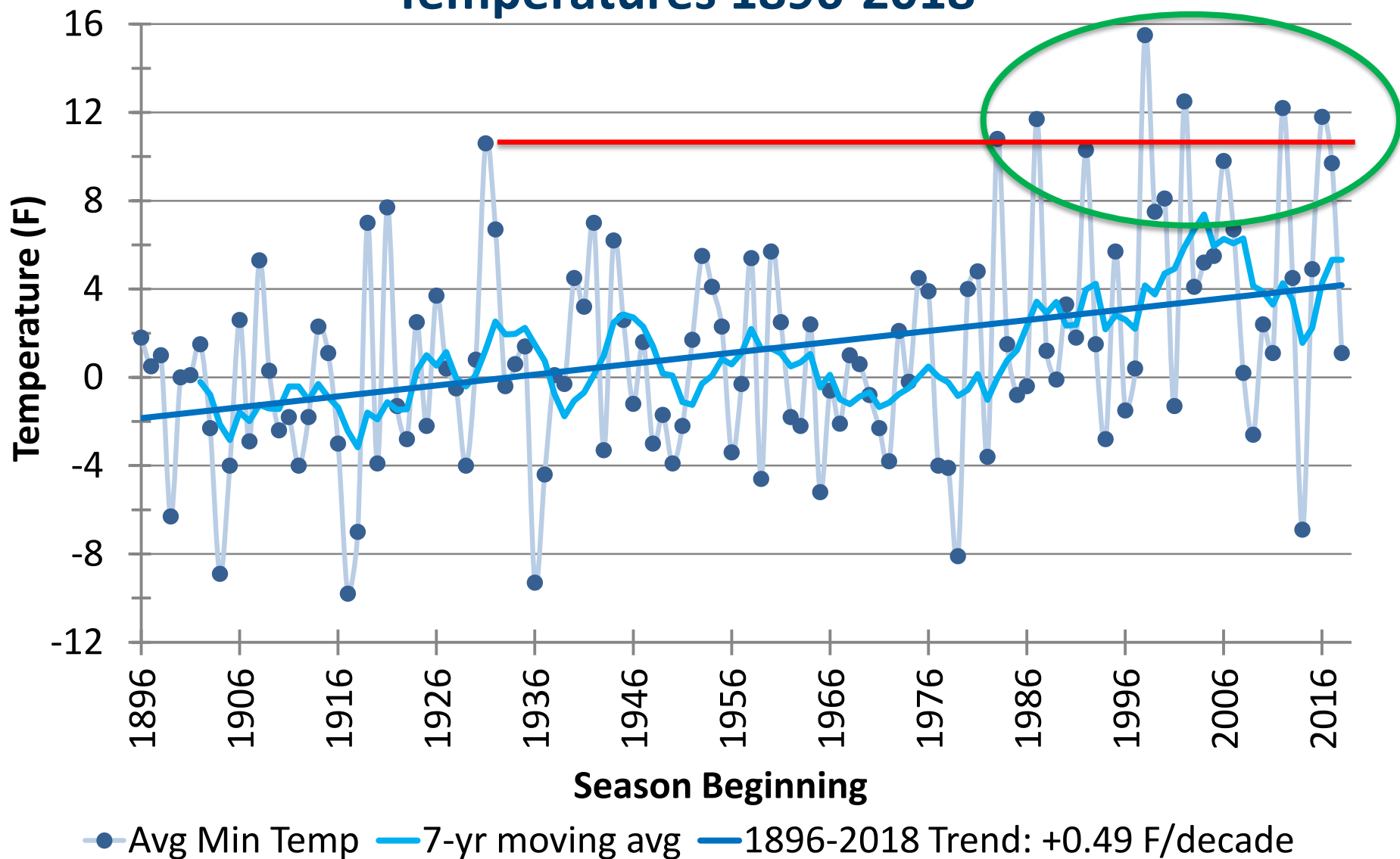


Source: 2014 National Climate Assessment, [Midwest Chapter](#)

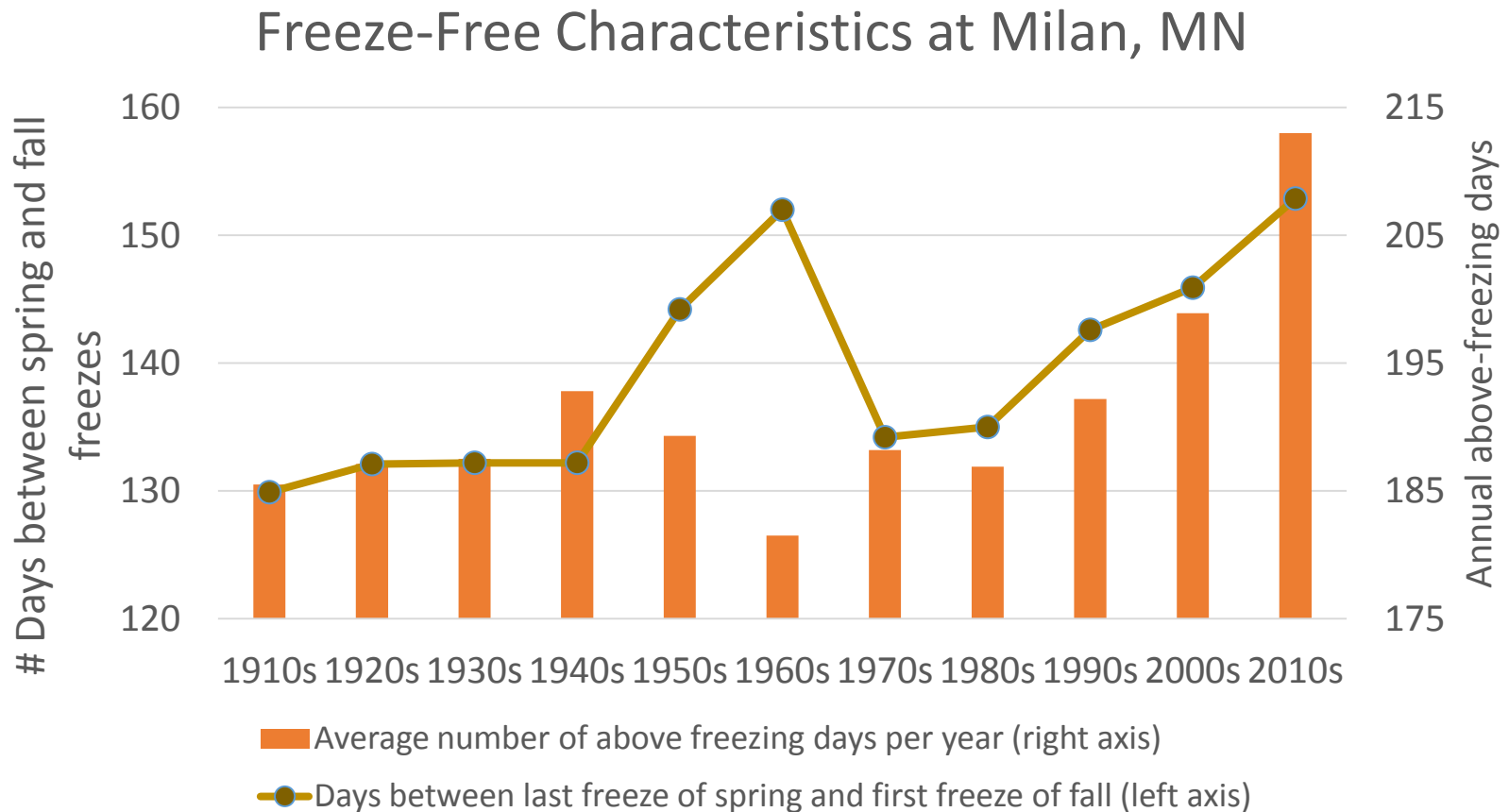
# Winter warming 13x faster than summer

Season	Temperature Metric	Avg. change <u>per decade</u> since 1895	Avg. change <u>per decade</u> since 1970
Winter (Dec - Feb)	Seasonal Avg.	+ 0.40°F	+ 1.2°F
Summer (Jun - Aug)	Seasonal Avg.	+ 0.13°F	+ 0.09°F

# Minnesota Average Winter Minimum Temperatures 1896-2018

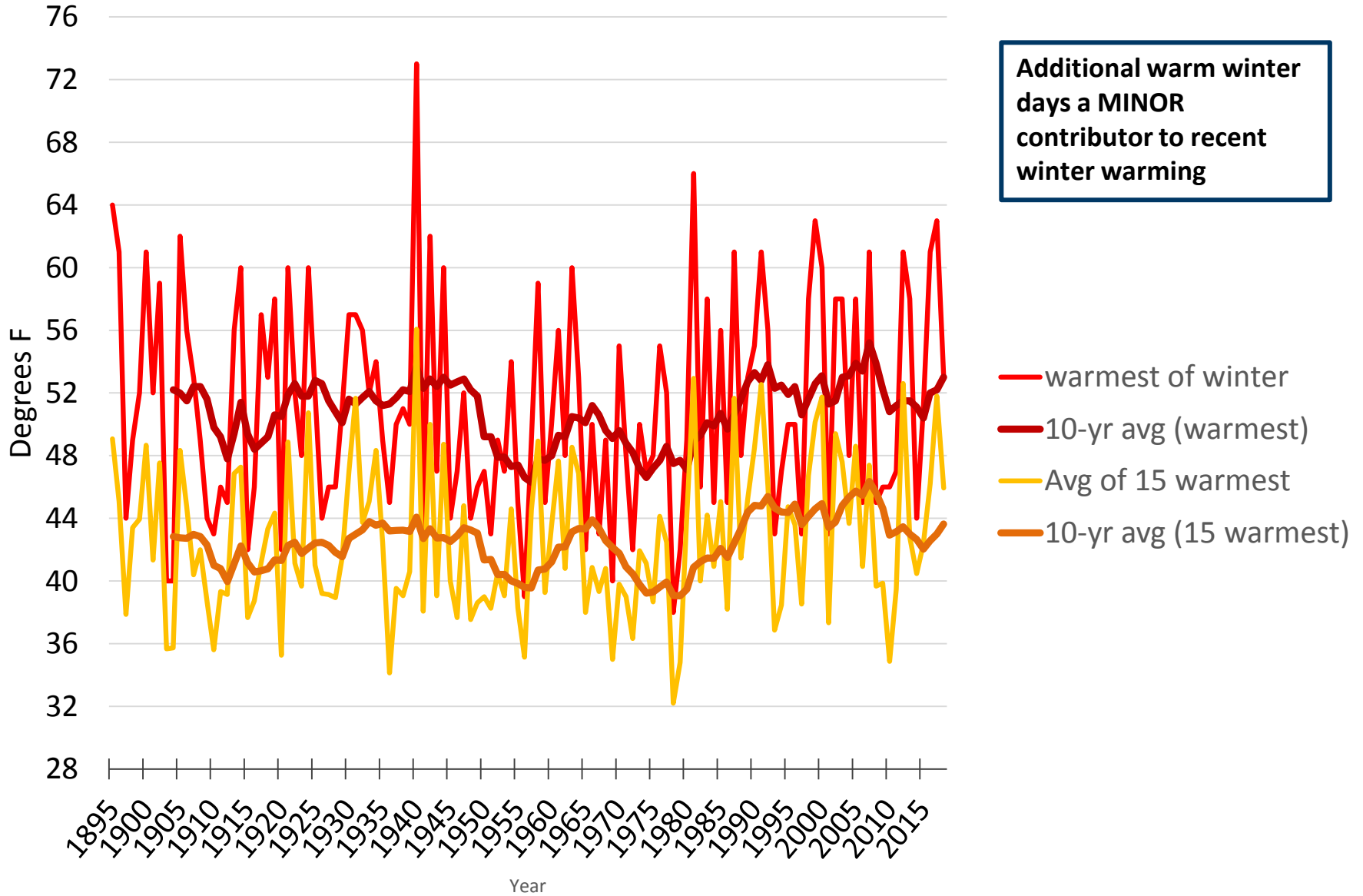


# Days entirely above freezing increasing dramatically

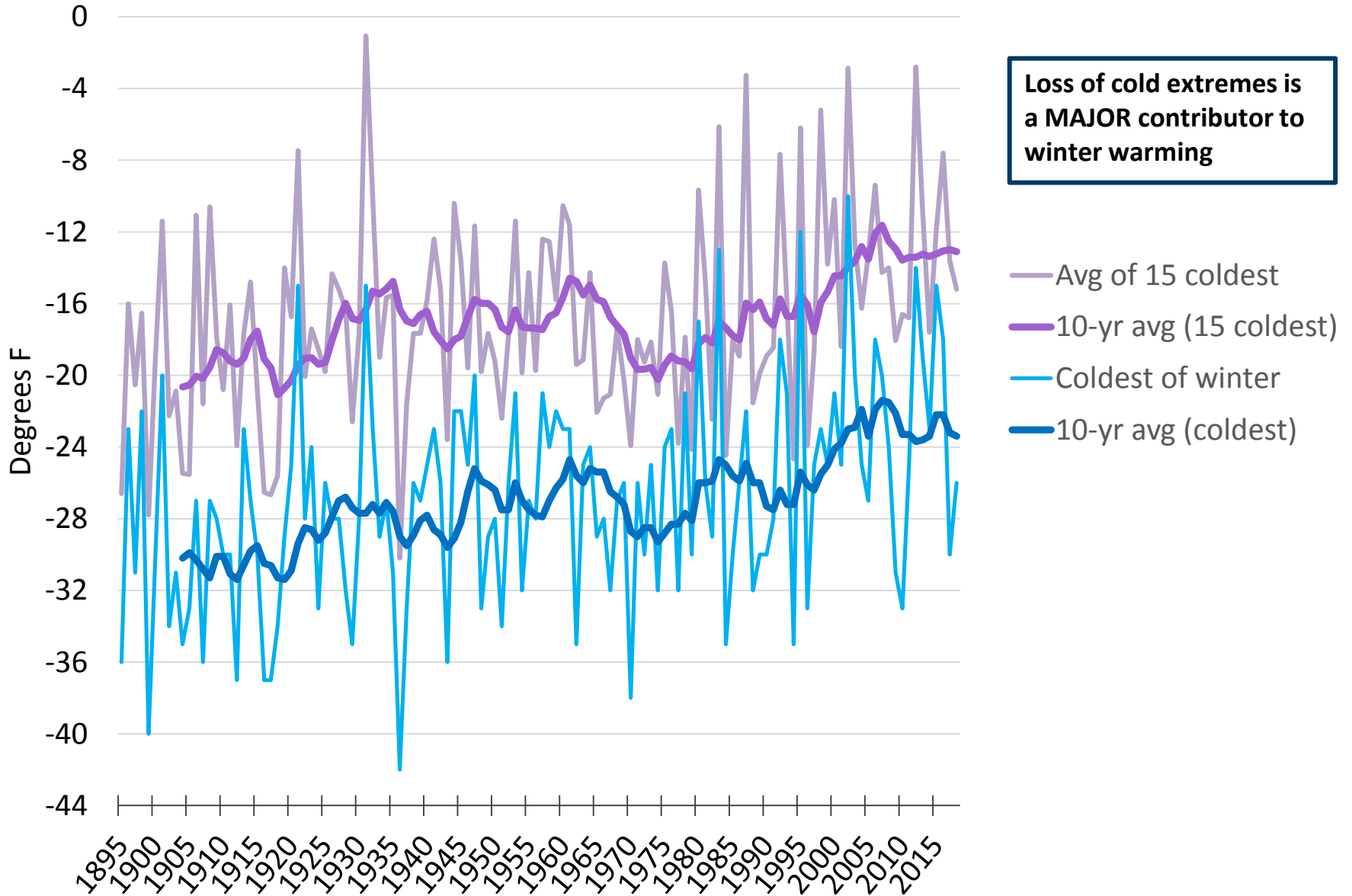




# Highest Highs of Winter, Milan (MN), 1895-2018

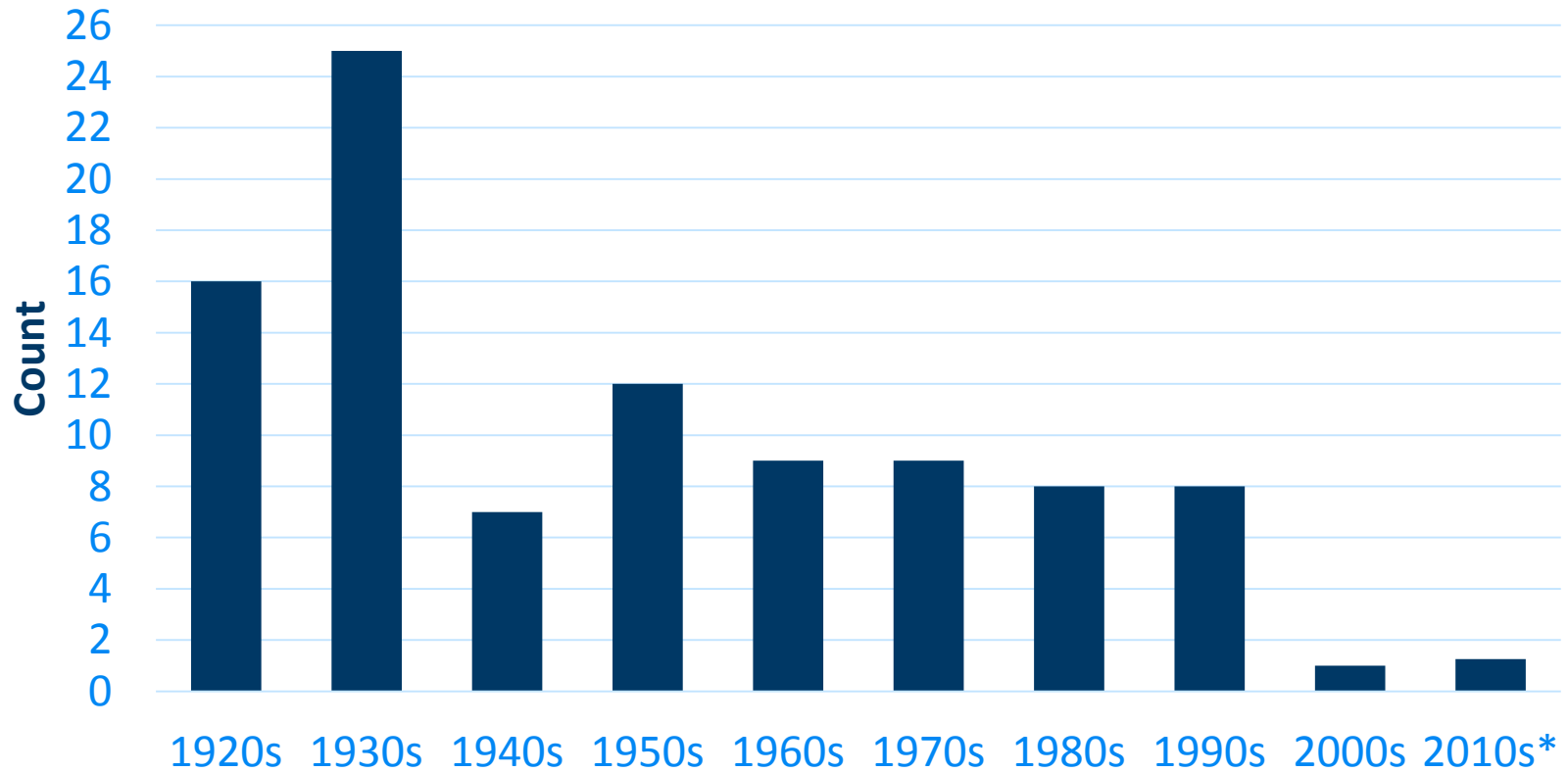


# Lowest Lows of Winter, Milan (MN), 1895-2018



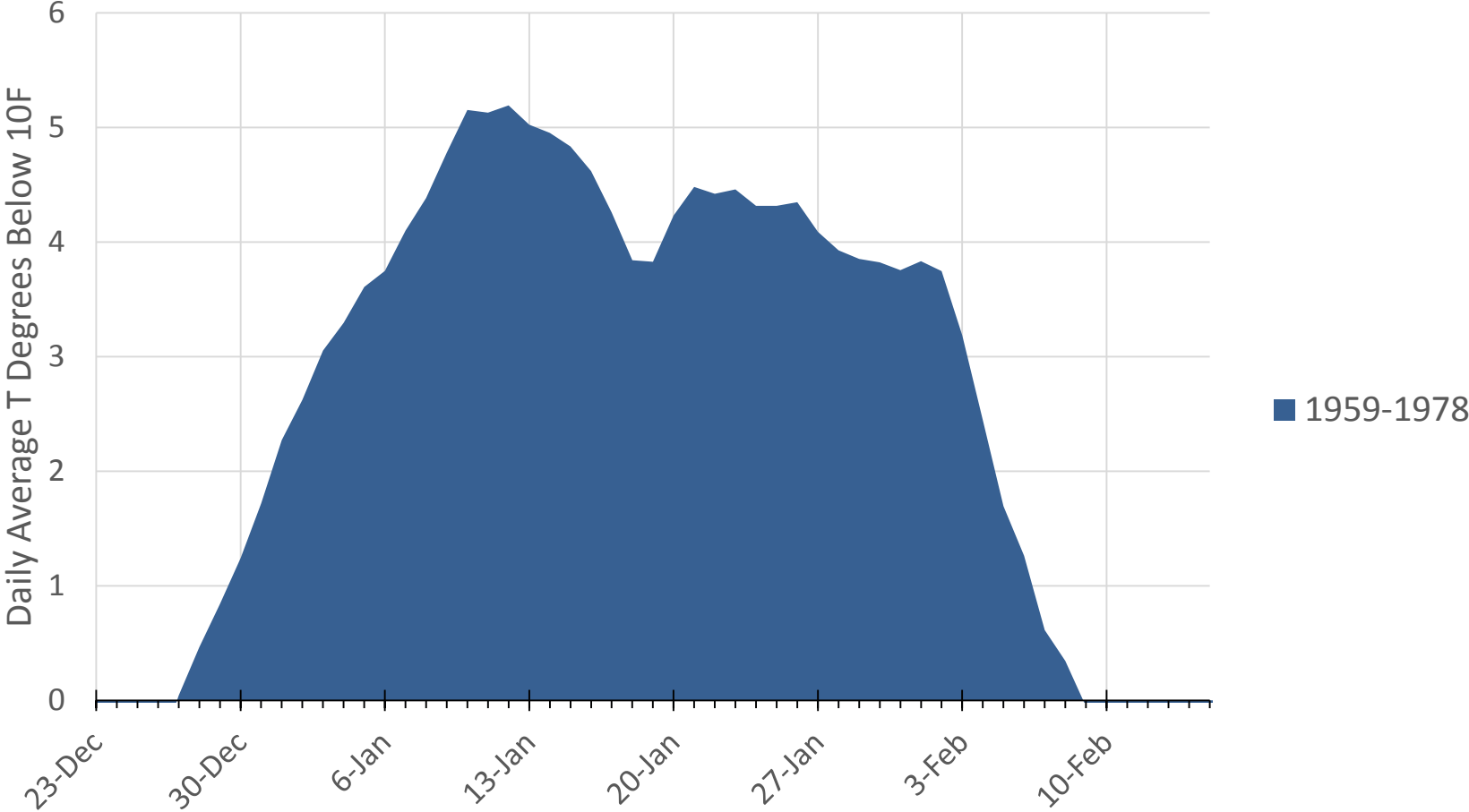
# Dramatic Loss of Cold Extremes Across MN

Count of Minimum Temps -35F or Lower, by Decade  
Grand Rapids Forest Research Station

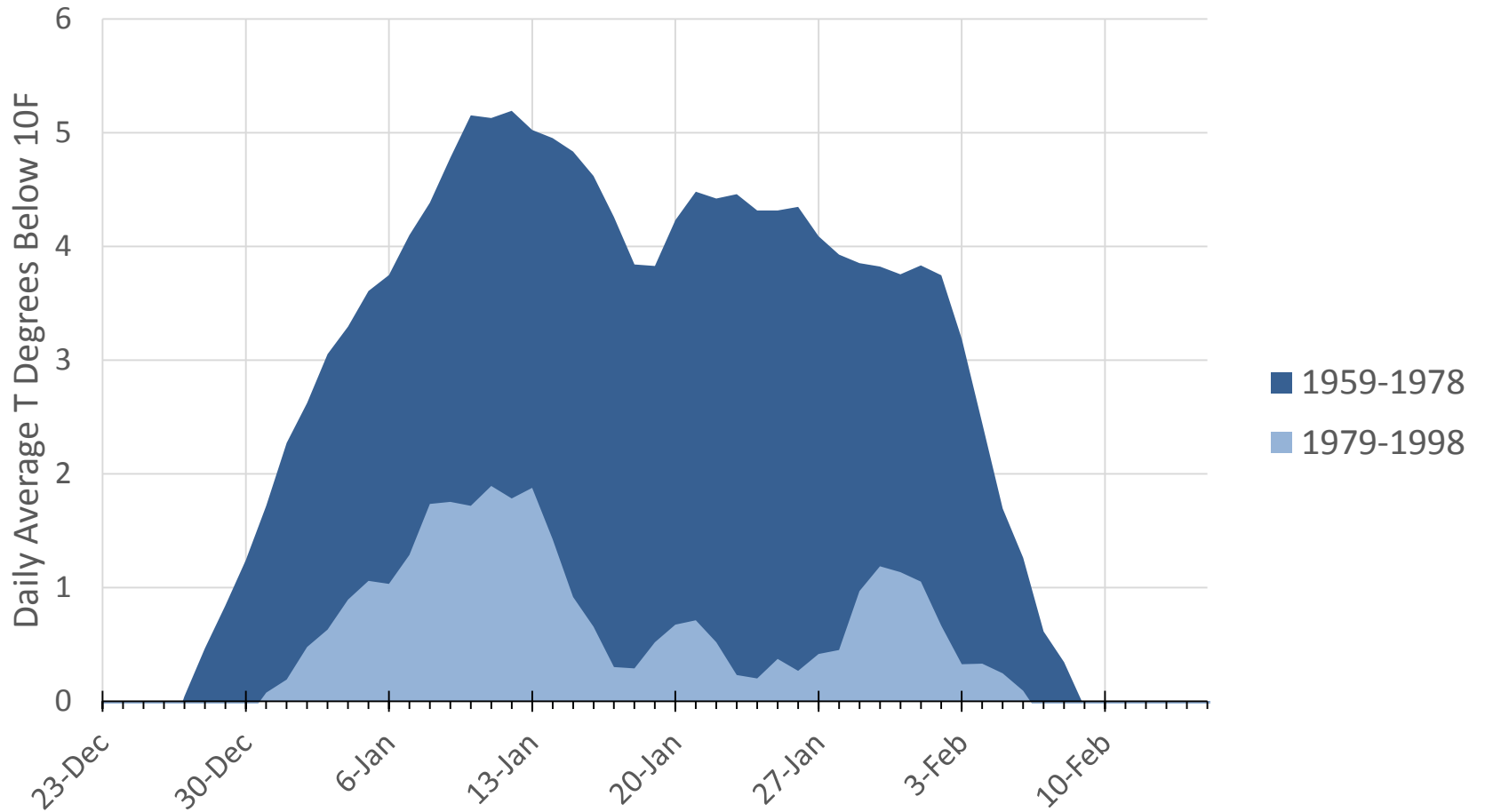


\* Prorated

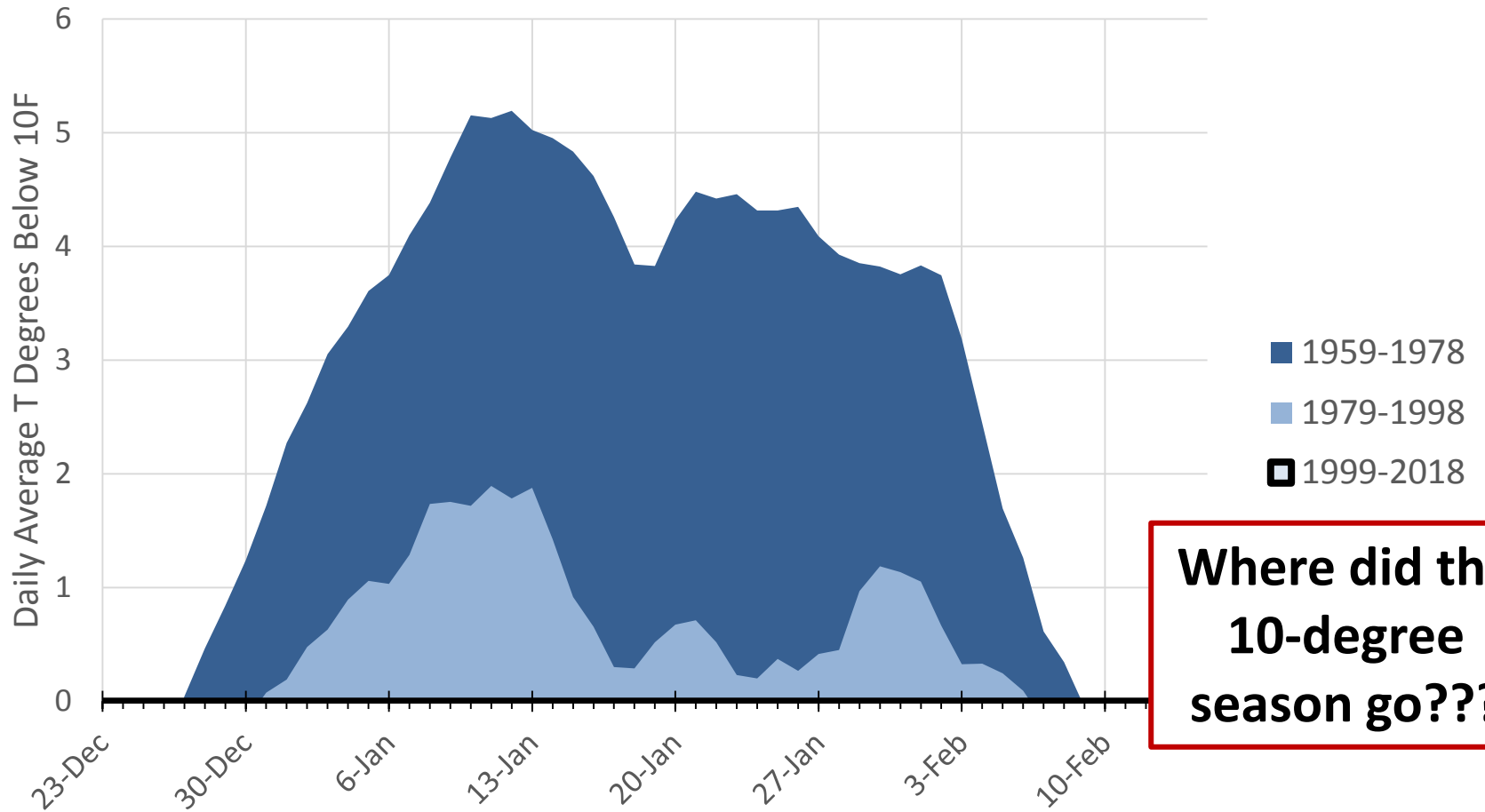
# Length and Magnitude of 10 F Temperature Season, Duluth MN



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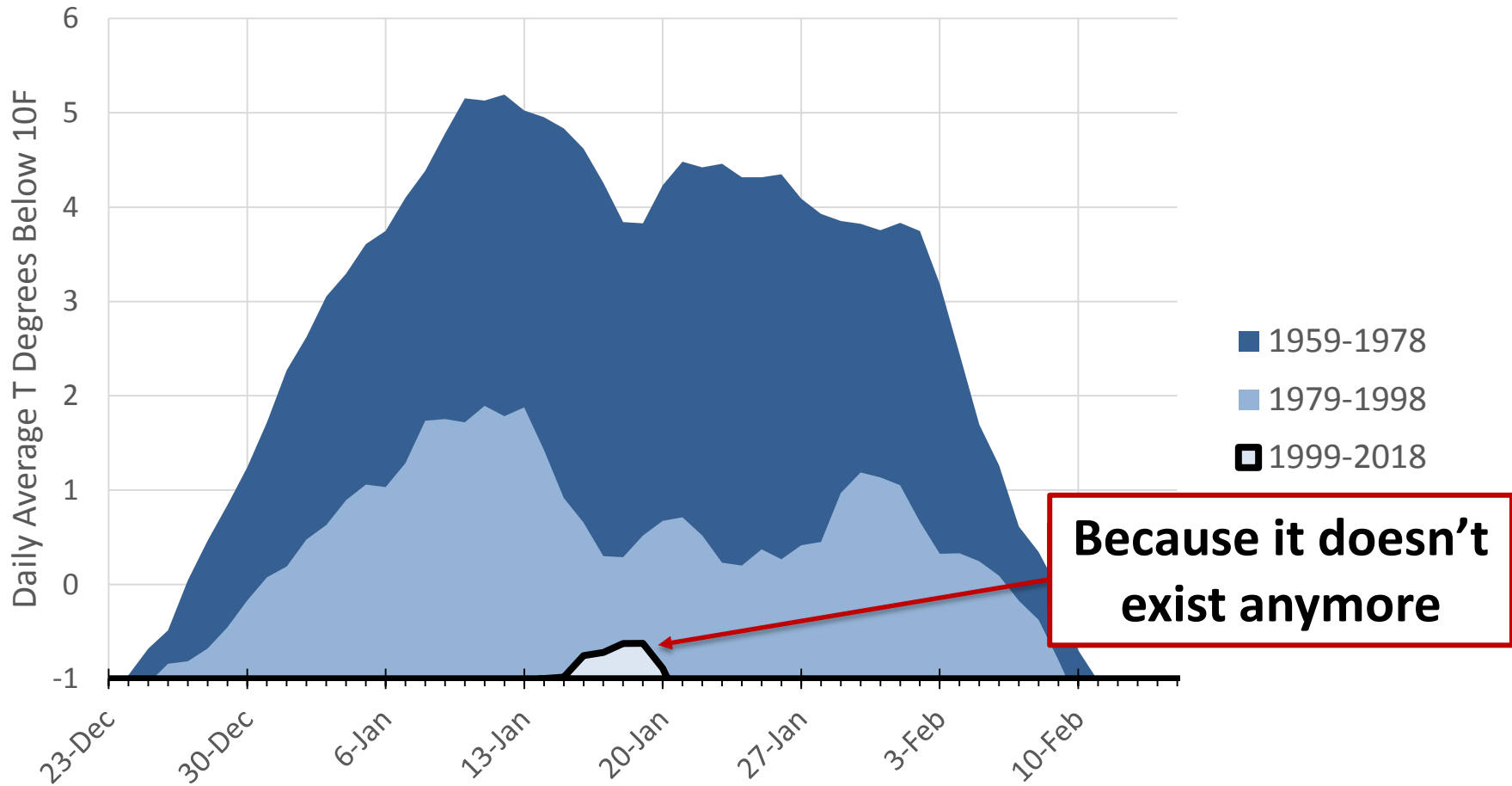


# Length and Magnitude of 10 F Temperature Season, Duluth MN

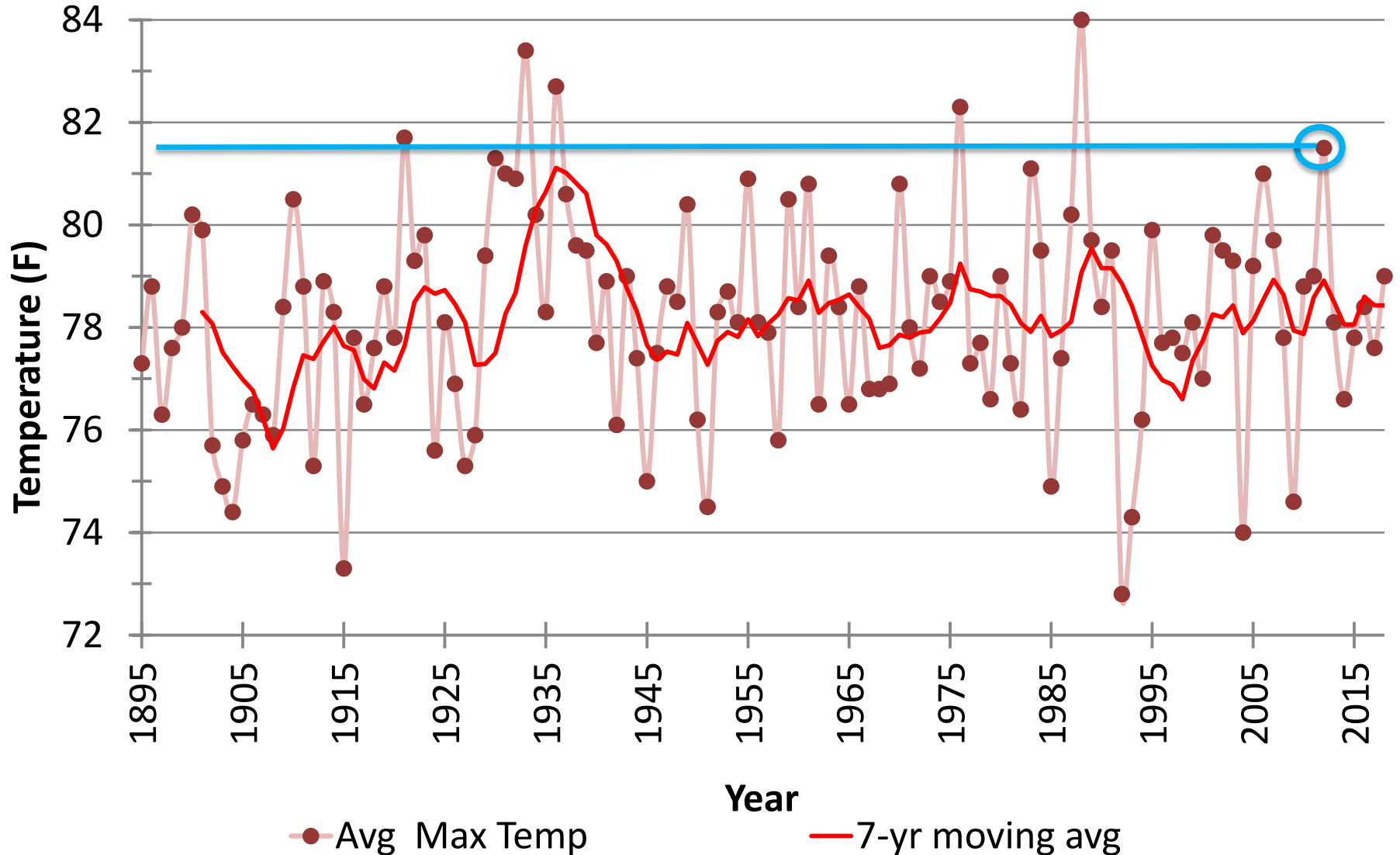


**Where did the  
10-degree  
season go???**

# Length and Magnitude of 10 F Temperature Season, Duluth MN



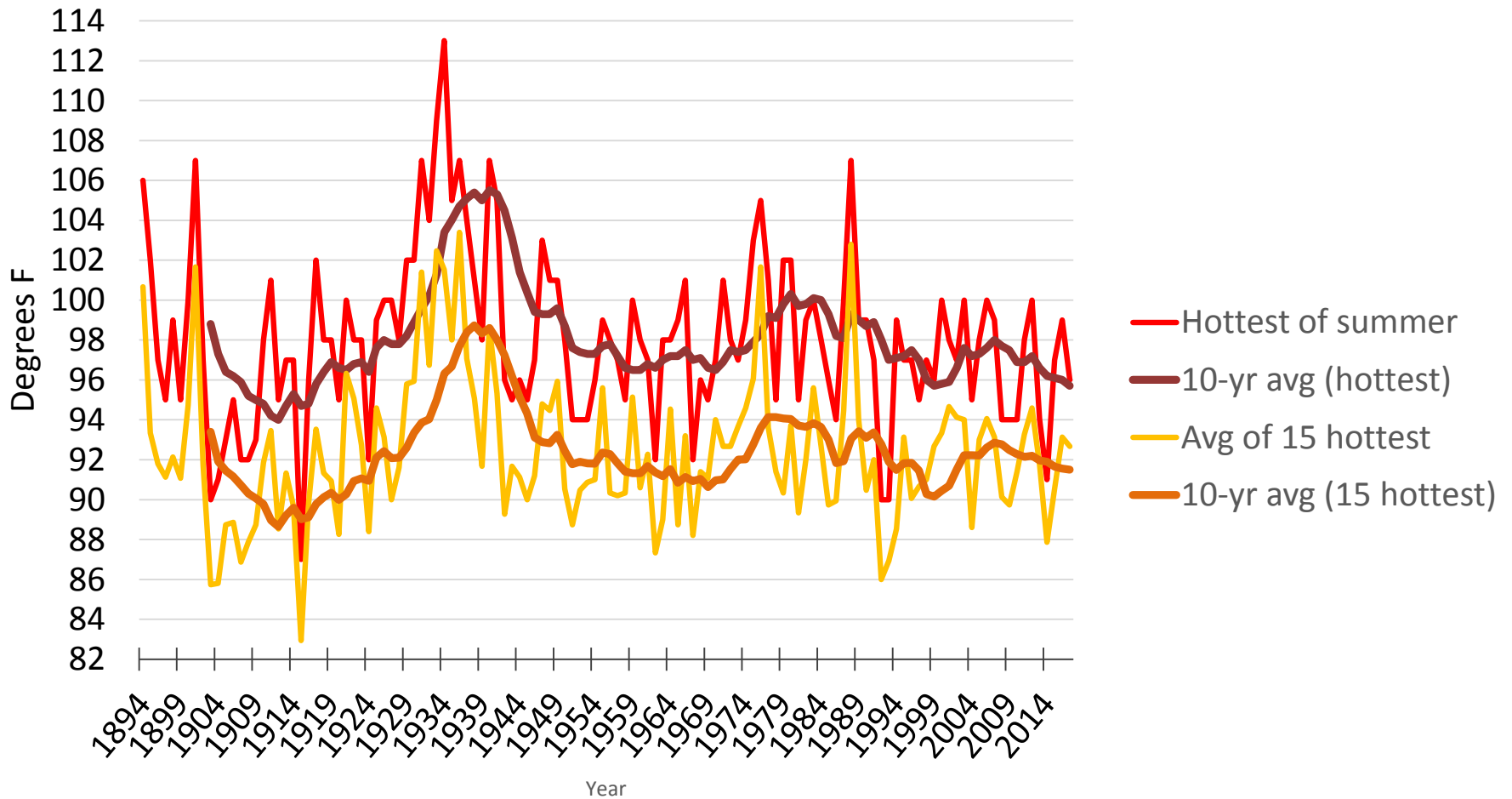
# Minnesota Average Summer Maximum Temperatures 1895–2018





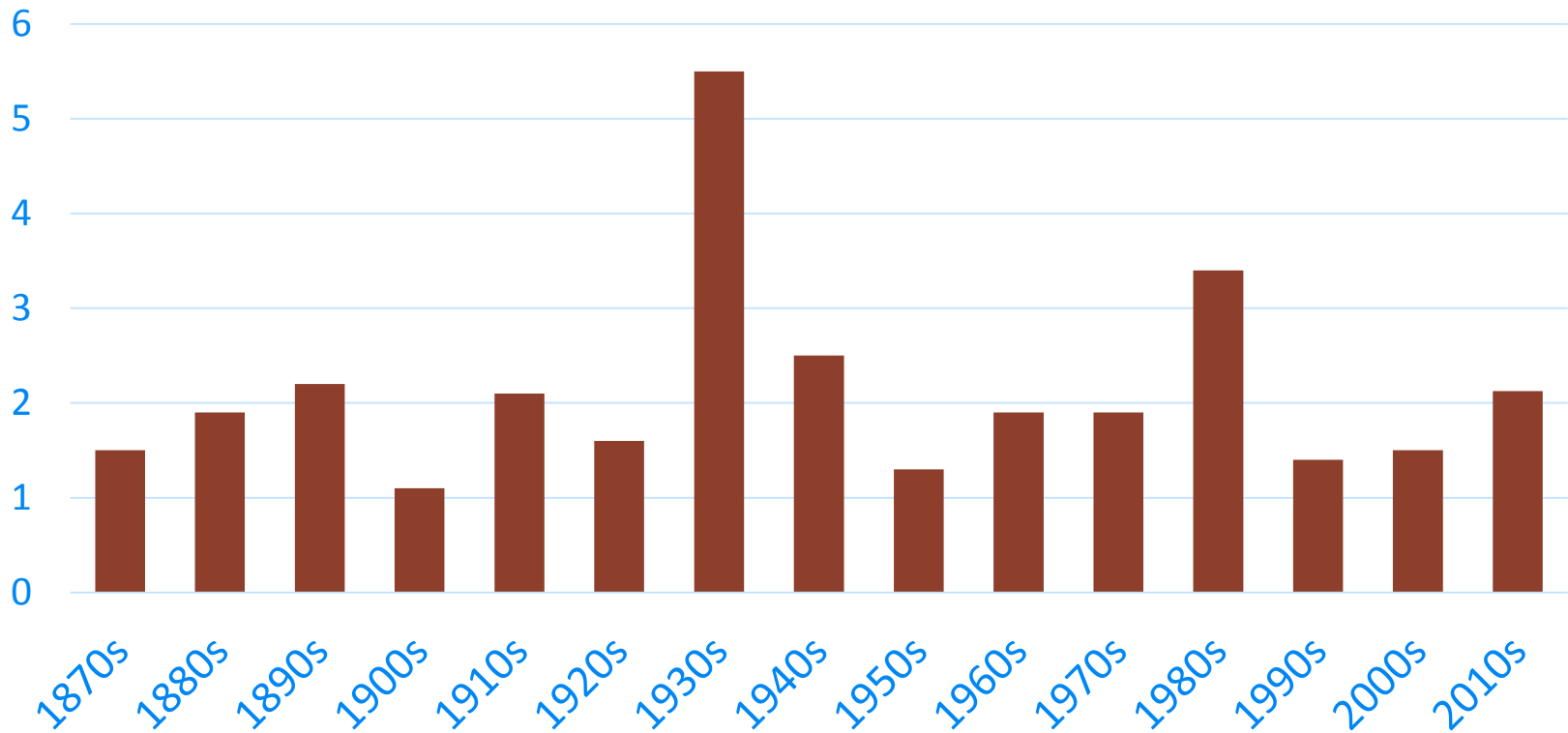
# Extreme heat not increasing--yet

## Highest Highs of Summer Milan (MN), 1894-2017

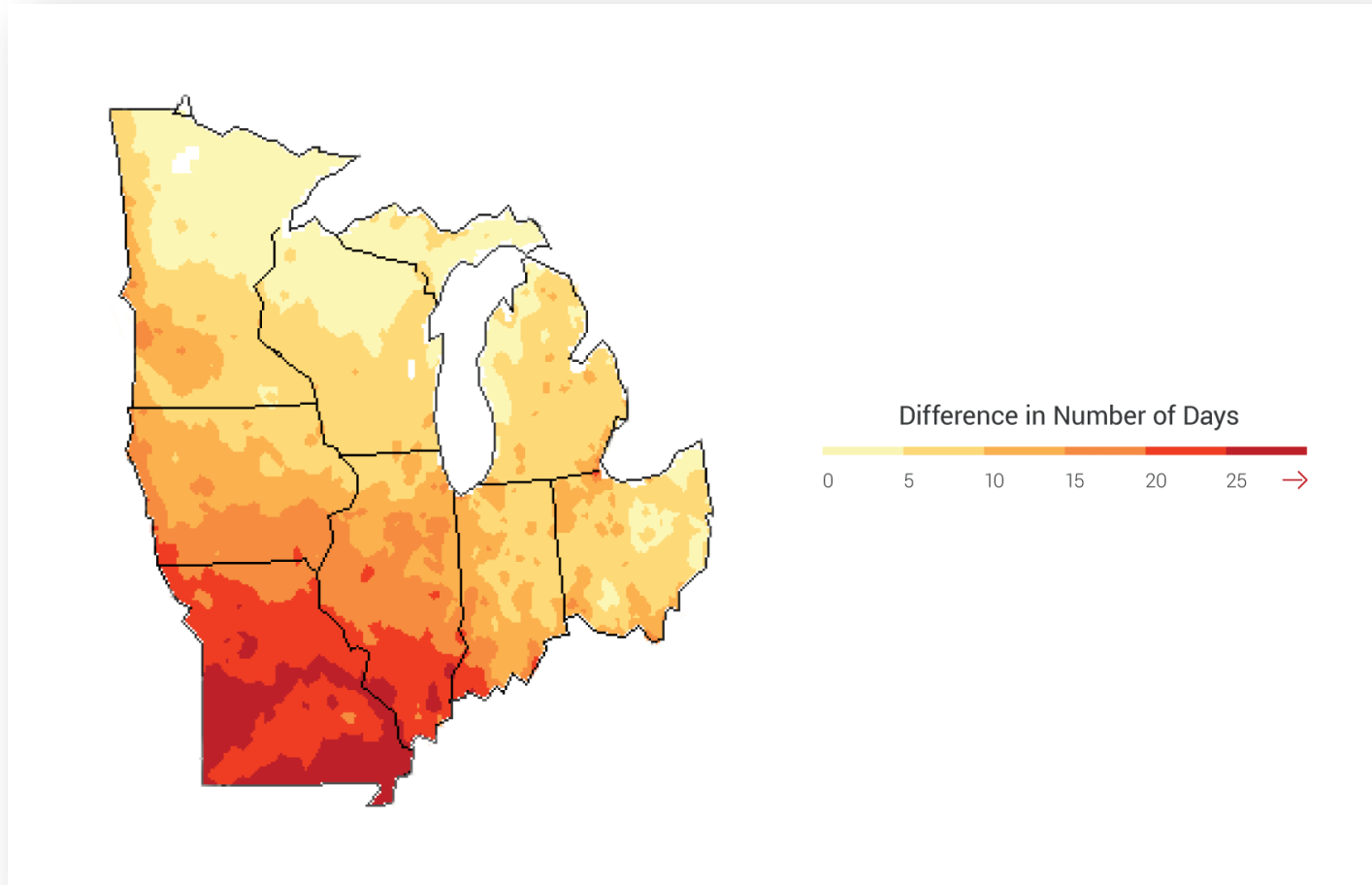


# Extreme heat not increasing--yet

Average # 90-degree days per year, Duluth



# However, additional days above 95 F projected by mid-century



Source: 2014 National Climate Assessment, [Midwest Chapter](#)

# In Summary

1. Minnesota has gotten much wetter and warmer, and is projected to continue doing so.
2. Increased wetness has been driven in part by more frequent and larger heavy rains, with further increases expected.
3. The coldest conditions have eroded the fastest.
4. Hot weather has not “worsened,” but erosion of winter cold will set us up for hotter summers in years/decades ahead  
→Remember, we don’t know exactly when this will begin (2040?)

# Thank You!

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