

What the Science is Telling Us

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WISCONSIN
INITIATIVE ON
CLIMATE
CHANGE
IMPACTS



Record High Global Temperatures in 2014

The New York Times

2014 Breaks Heat Record, Challenging Global Warming Skeptics

Record High Global Temperatures in 20~~14~~
2015

The New York Times

2015 Was Hottest Year in Historical Record, Scientists Say

Record High Global Temperatures in 2014
~~2015~~
2016

The New York Times

Earth Sets a Temperature Record for the Third Straight Year

Record High Global Temperatures in 2014

~~2015~~

2016

The New York Times

Earth Sets a Temperature Record for the Third Straight Year

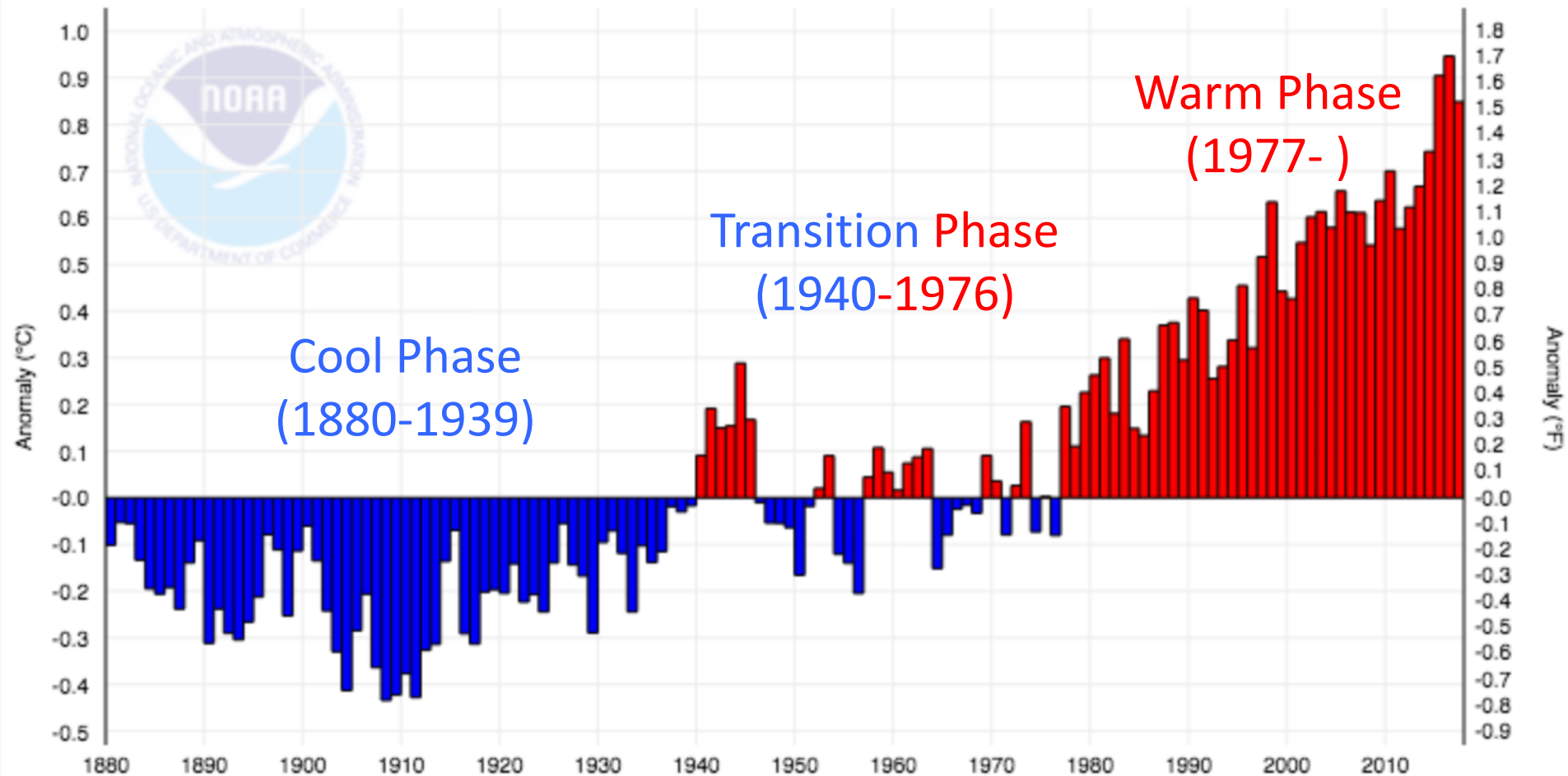
2017: Third warmest year on record

2018: Fourth warmest year on record

2019: Second warmest year on record

Global Temperatures since 1880

Global Land and Ocean Temperature Anomalies, January-December

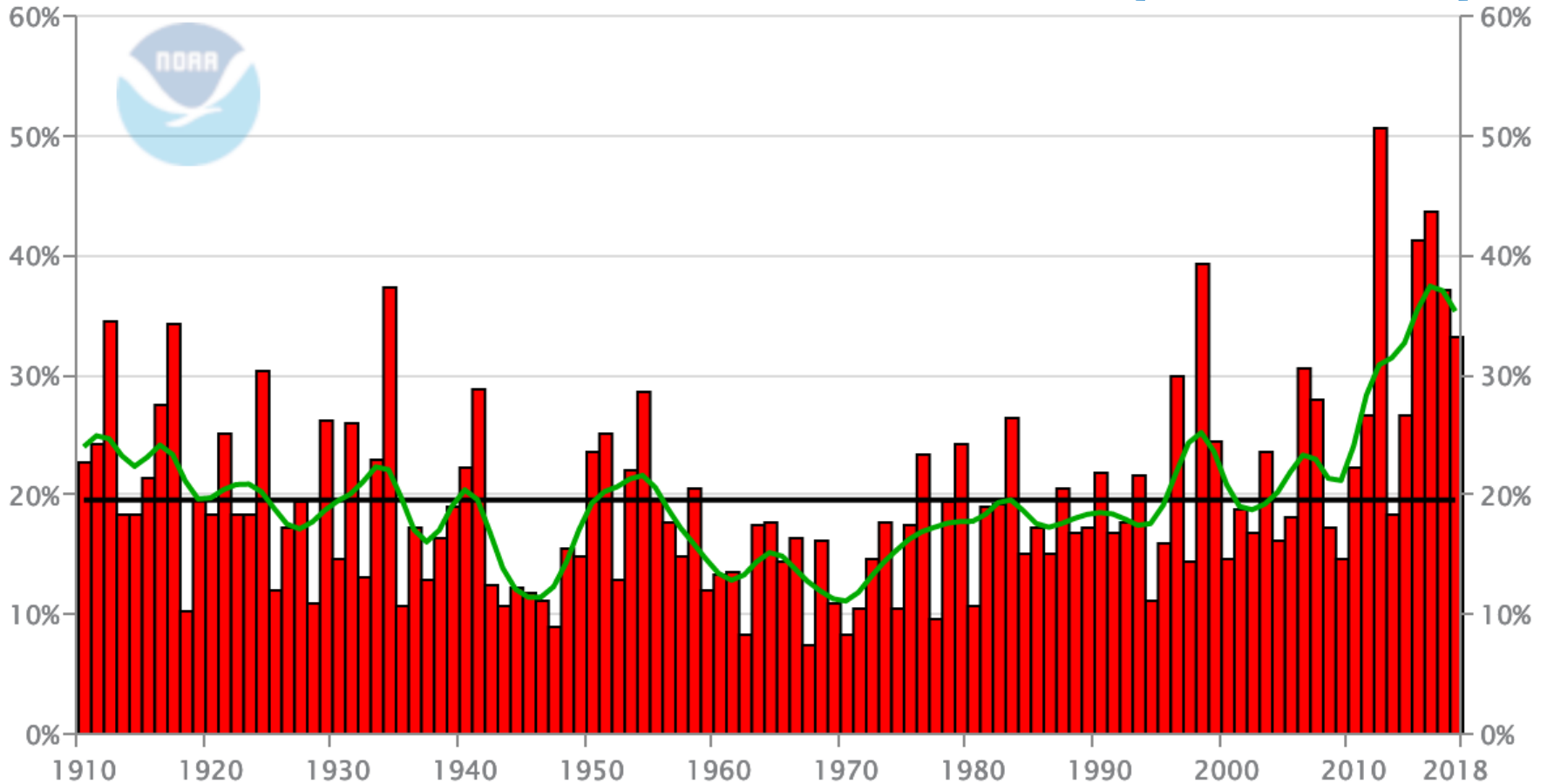


Increasing Trend of Extreme Weather

Climate Extremes Index (United States)

Contiguous U.S. Without Tropical Cyclone Indicator
Annual (January–December)

Past 25 years



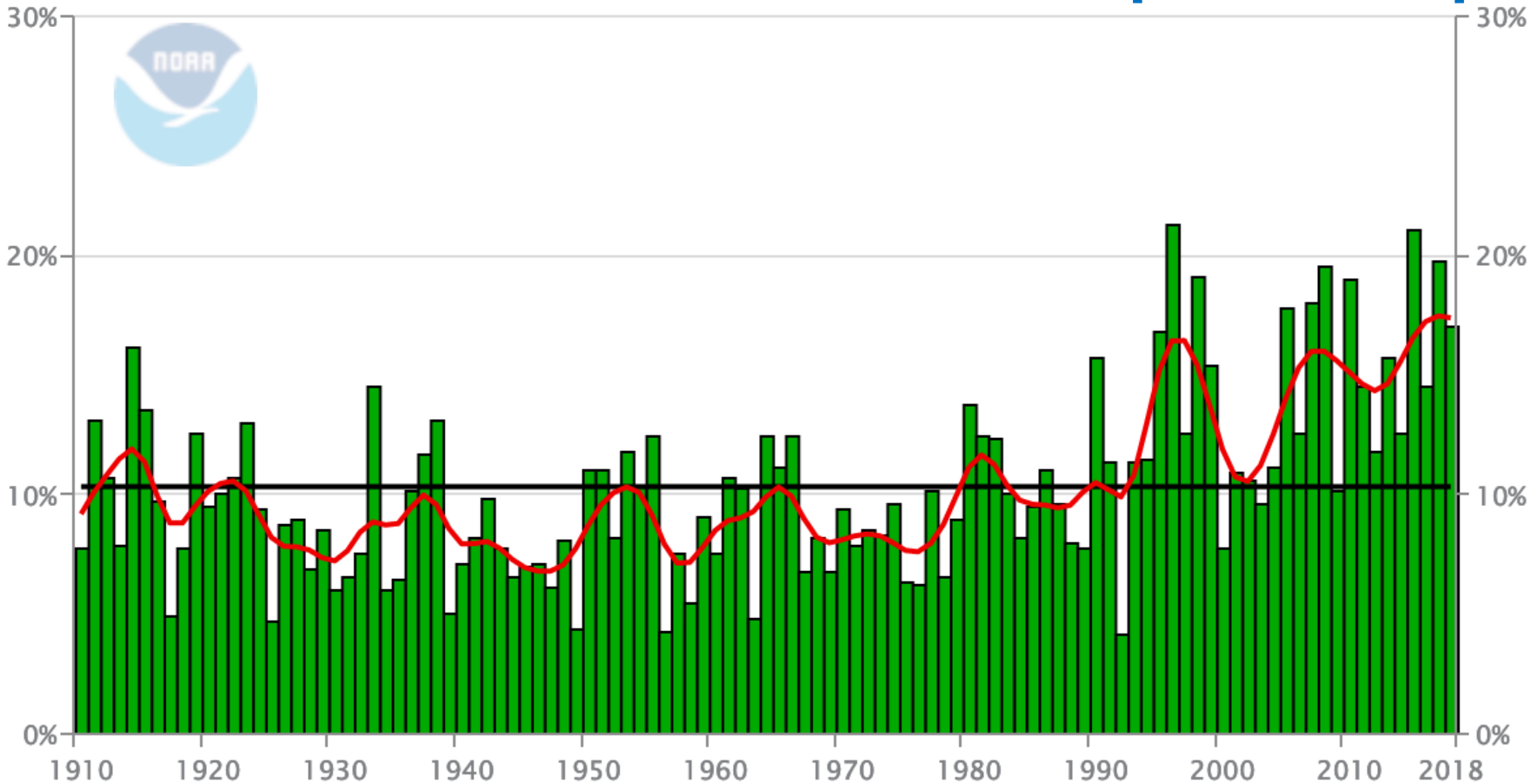
Record prevalence of extreme weather recently

Increasing Trend of Extreme Weather

Daily Precipitation Extremes (United States)

Contiguous U.S. Extremes in 1-Day Precipitation (Step 4*)
Annual (January–December)

Past 25 years

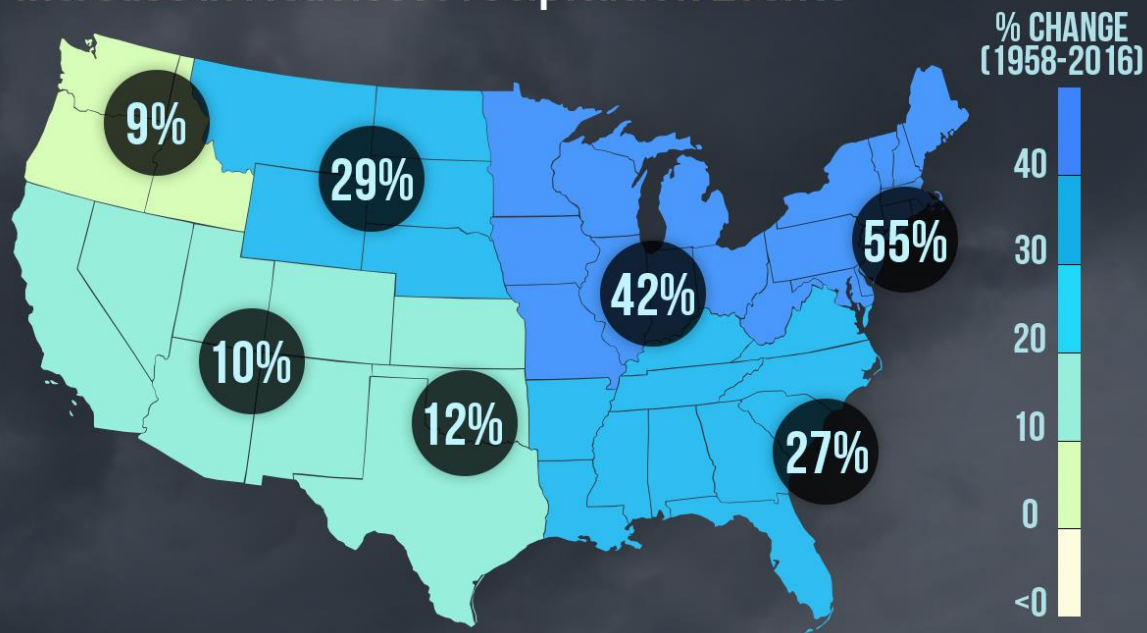


Largely due to more extreme precipitation

Trend in Heaviest Precipitation in Recent Decades

MORE DOWNPOURS

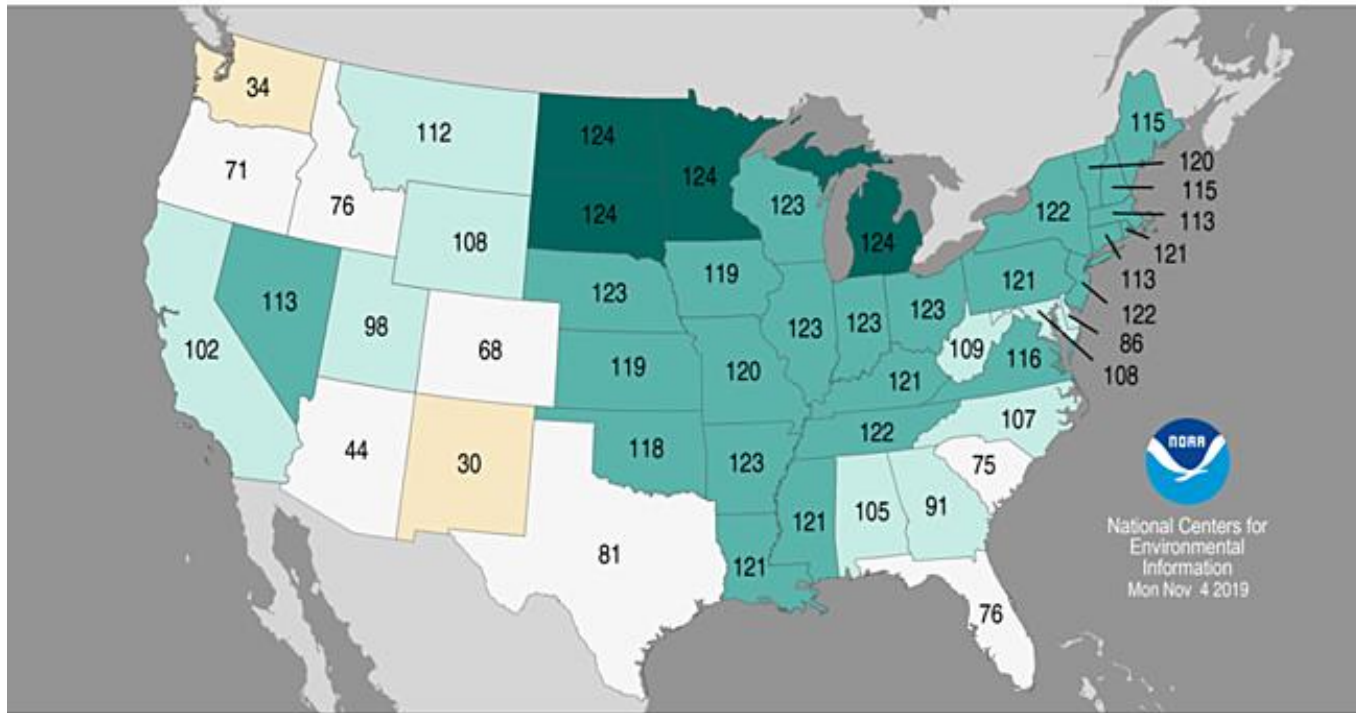
Increase in Heaviest Precipitation Events



Heaviest events defined as top 1% of events
Source: USGCRP Climate Science Special Report 2017

Past 12 Months Record Wet Nationally

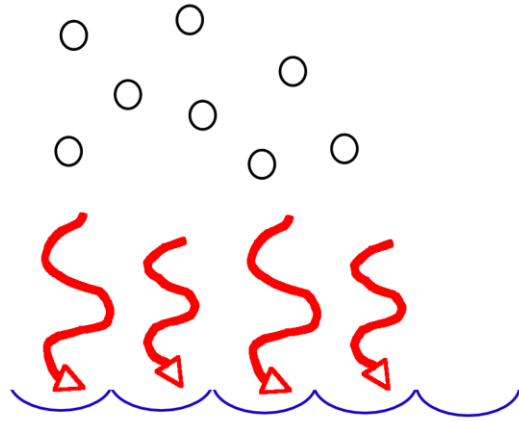
Statewide Precipitation Ranks
November 2018–October 2019
Period: 1895–2019



National Centers for
Environmental
Information
Mon Nov 4 2019



Increased Greenhouse Gases



Ocean or Land Surface

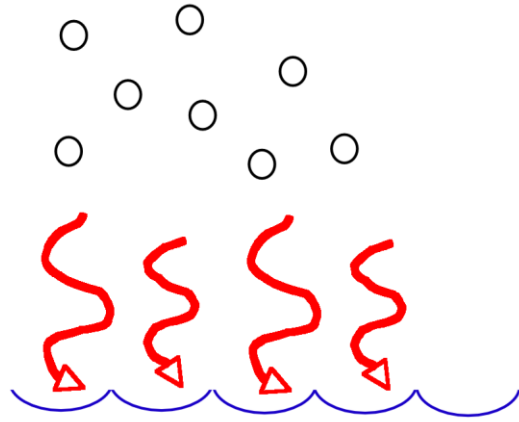


Increased Evaporation



Ocean or Land Surface

Increased Greenhouse Gases



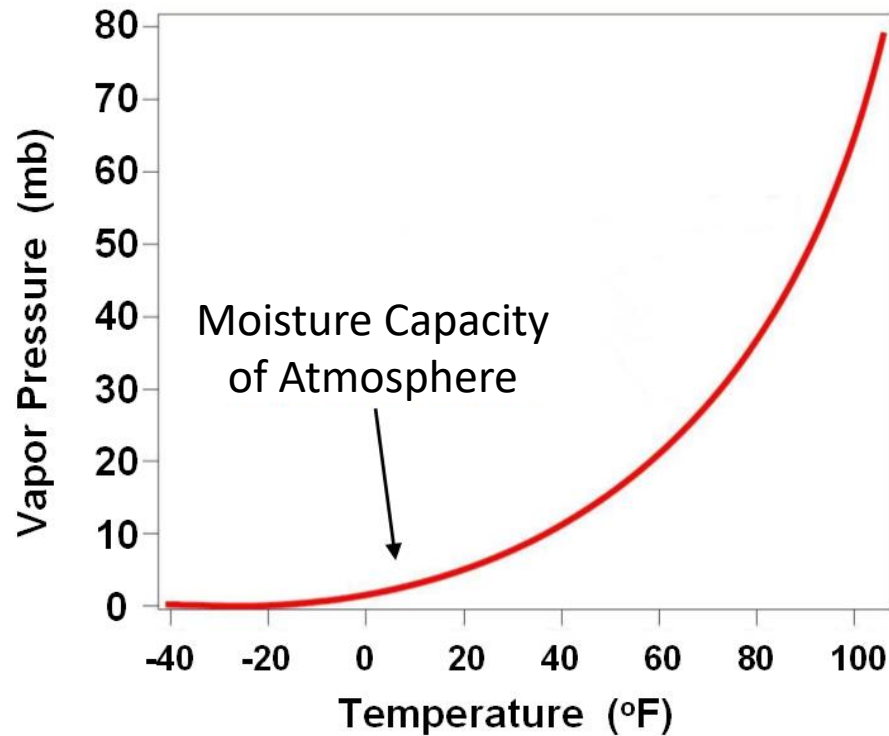
Ocean or Land Surface



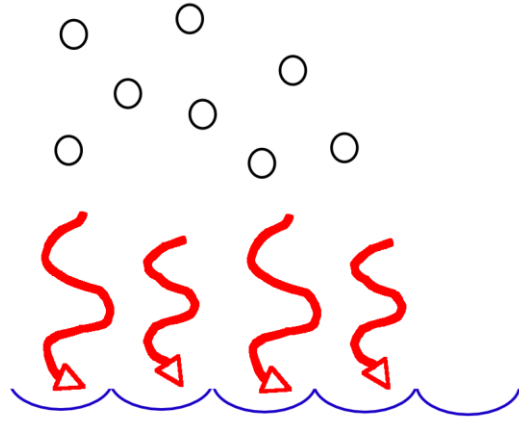
Increased Evaporation



Ocean or Land Surface



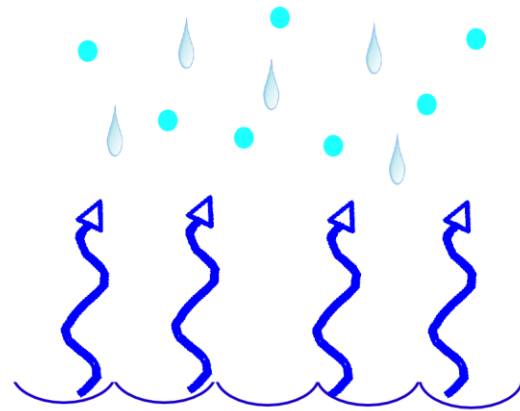
Increased Greenhouse Gases



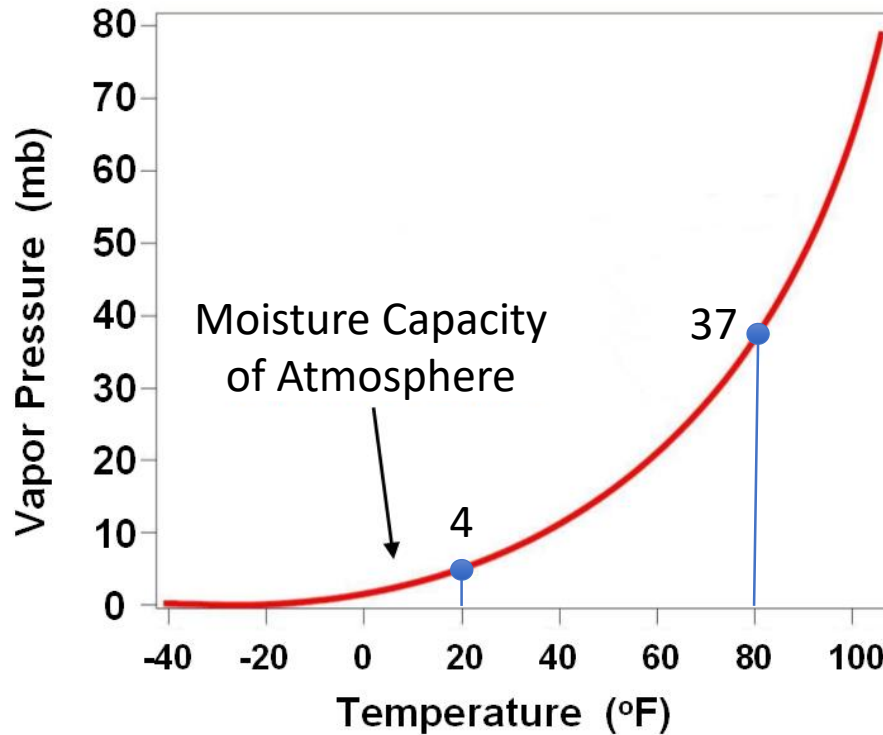
Ocean or Land Surface



Increased Evaporation

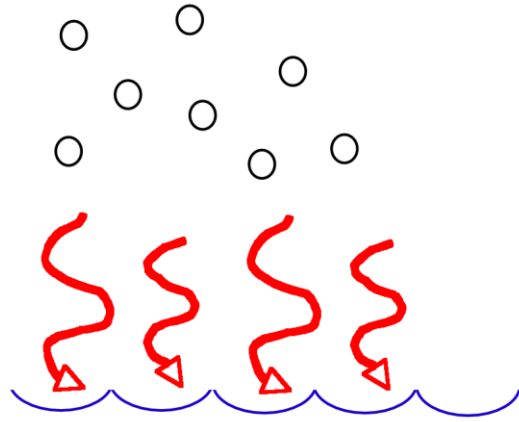


Ocean or Land Surface



Moisture capacity 9 x greater on a summer day

Increased Greenhouse Gases

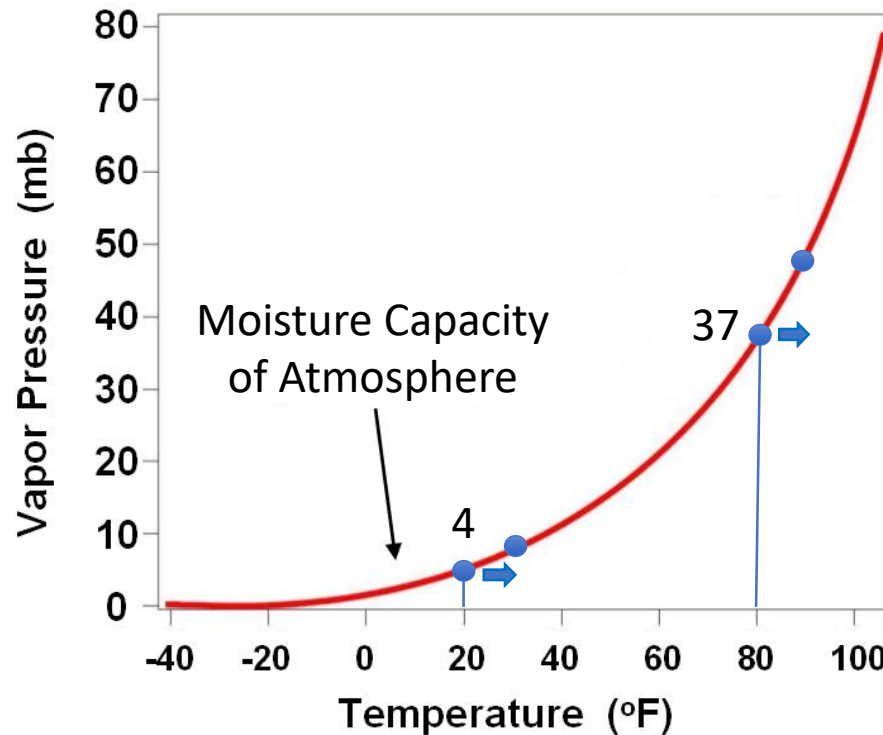


Ocean or Land Surface

Increased Evaporation



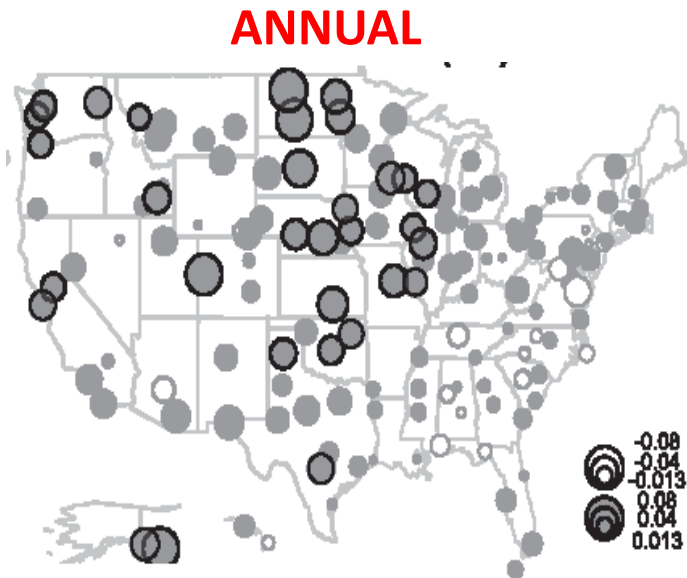
Ocean or Land Surface



Moisture capacity 9 x greater on a summer day

Warming climate = more moisture capacity

Trends in Dewpoint Temperature (1947-2010)

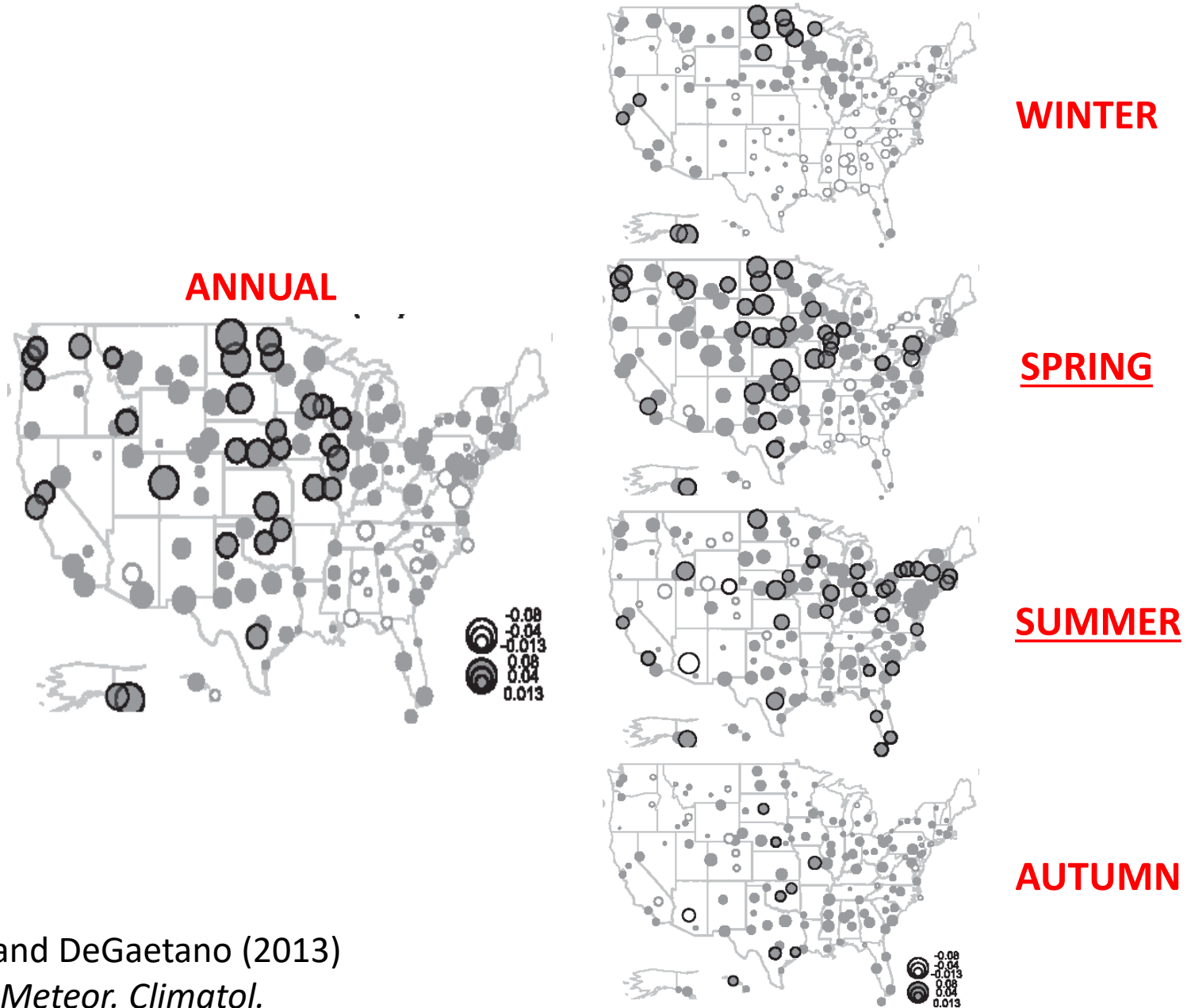


Atmospheric moisture is increasing

Brown and DeGaetano (2013)

J. Appl. Meteor. Climatol.

Trends in Dewpoint Temperature (1947-2010)



Brown and DeGaetano (2013)

J. Appl. Meteor. Climatol.

What about closer to home?



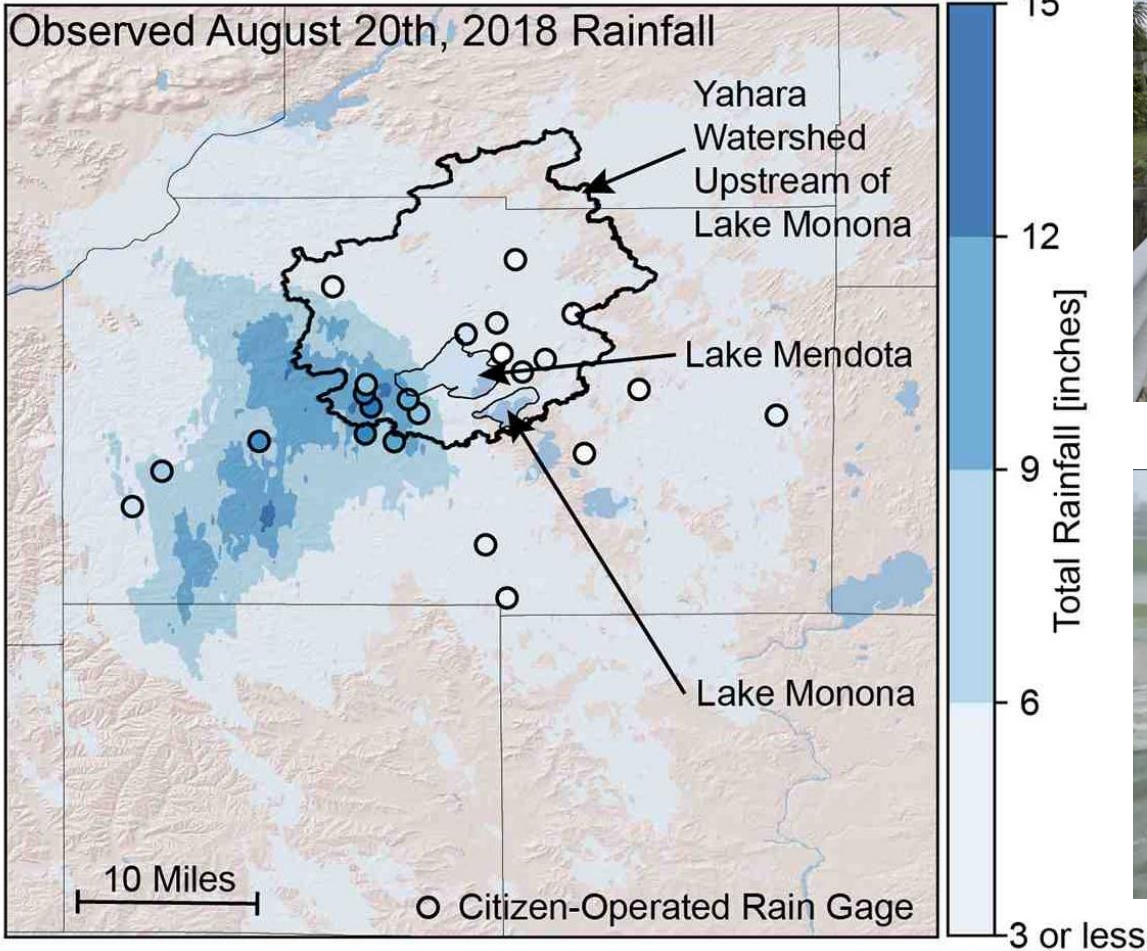
Midwest Floods March 2019

Many places are underwater, from Nebraska to Wisconsin, as major flooding engulfs the region



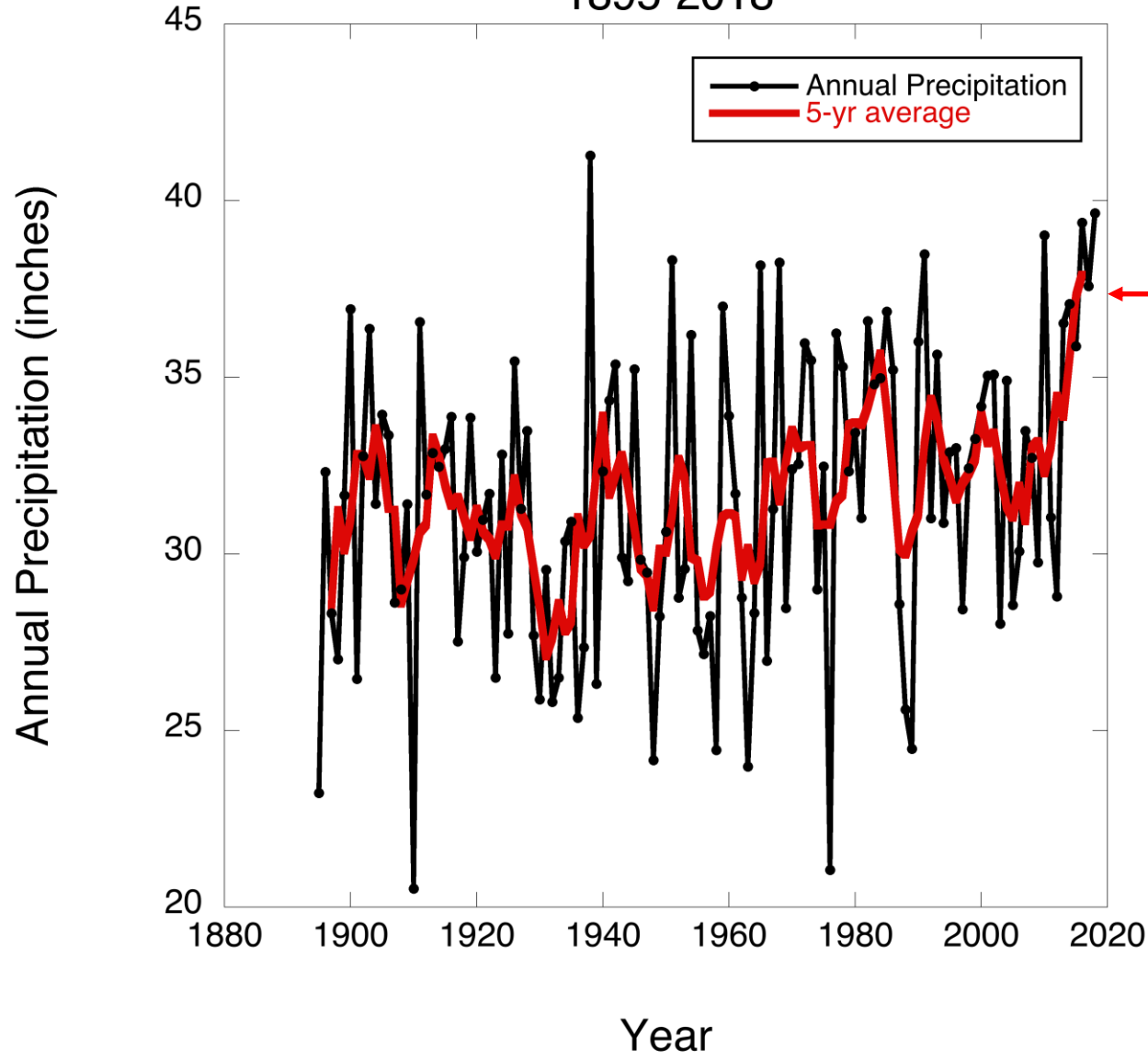
The swollen Pecatonica River spills into downtown Darlington, Wis., on March 14. (Dave Kettering/Telegraph Herald/AP)

Dane County Floods August 2018



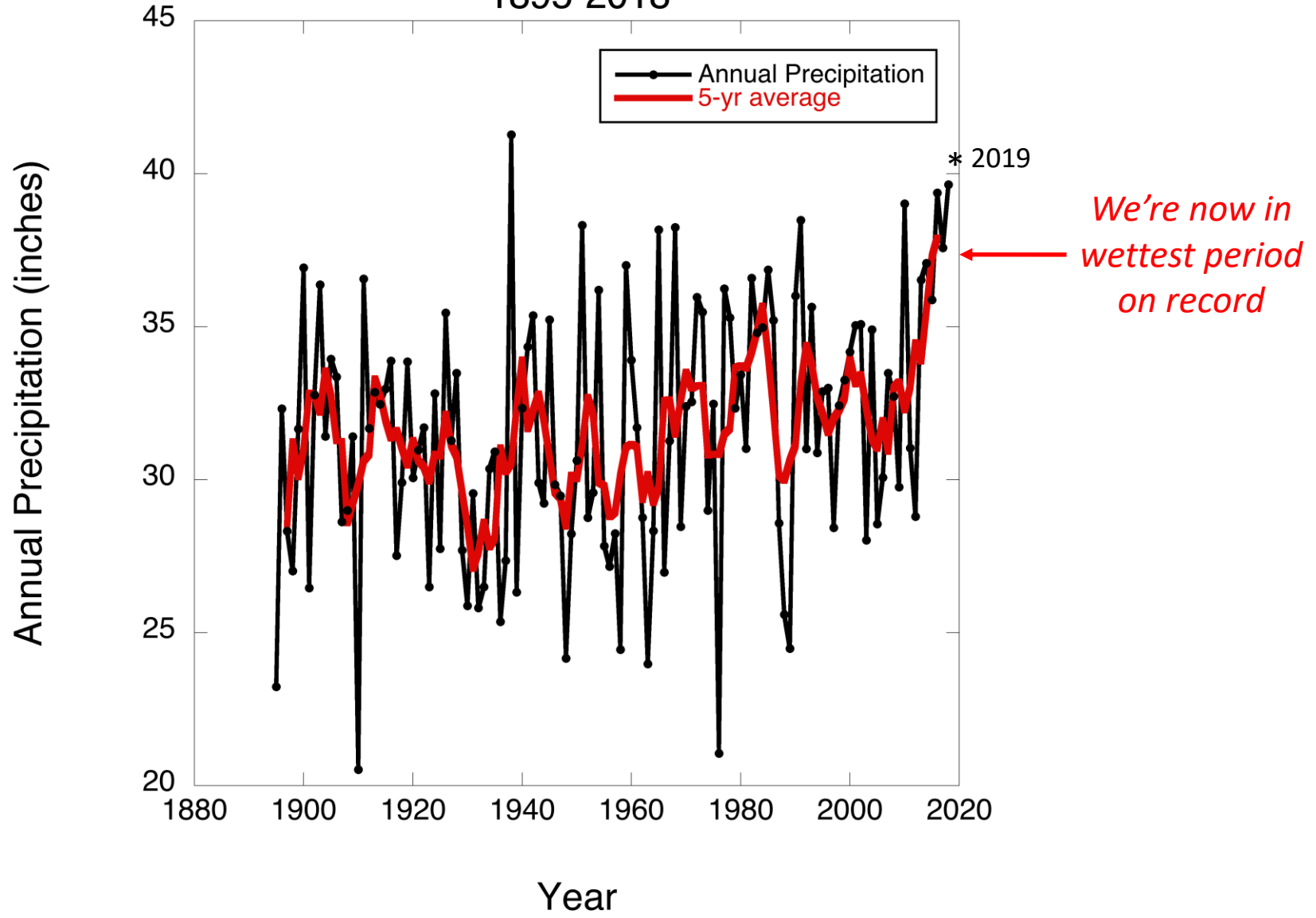
Unofficial Wisconsin record for heaviest 24-hour rainfall

Total Annual Precipitation in Wisconsin 1895-2018



*We're now in
wettest period
on record*

Total Annual Precipitation in Wisconsin 1895-2018

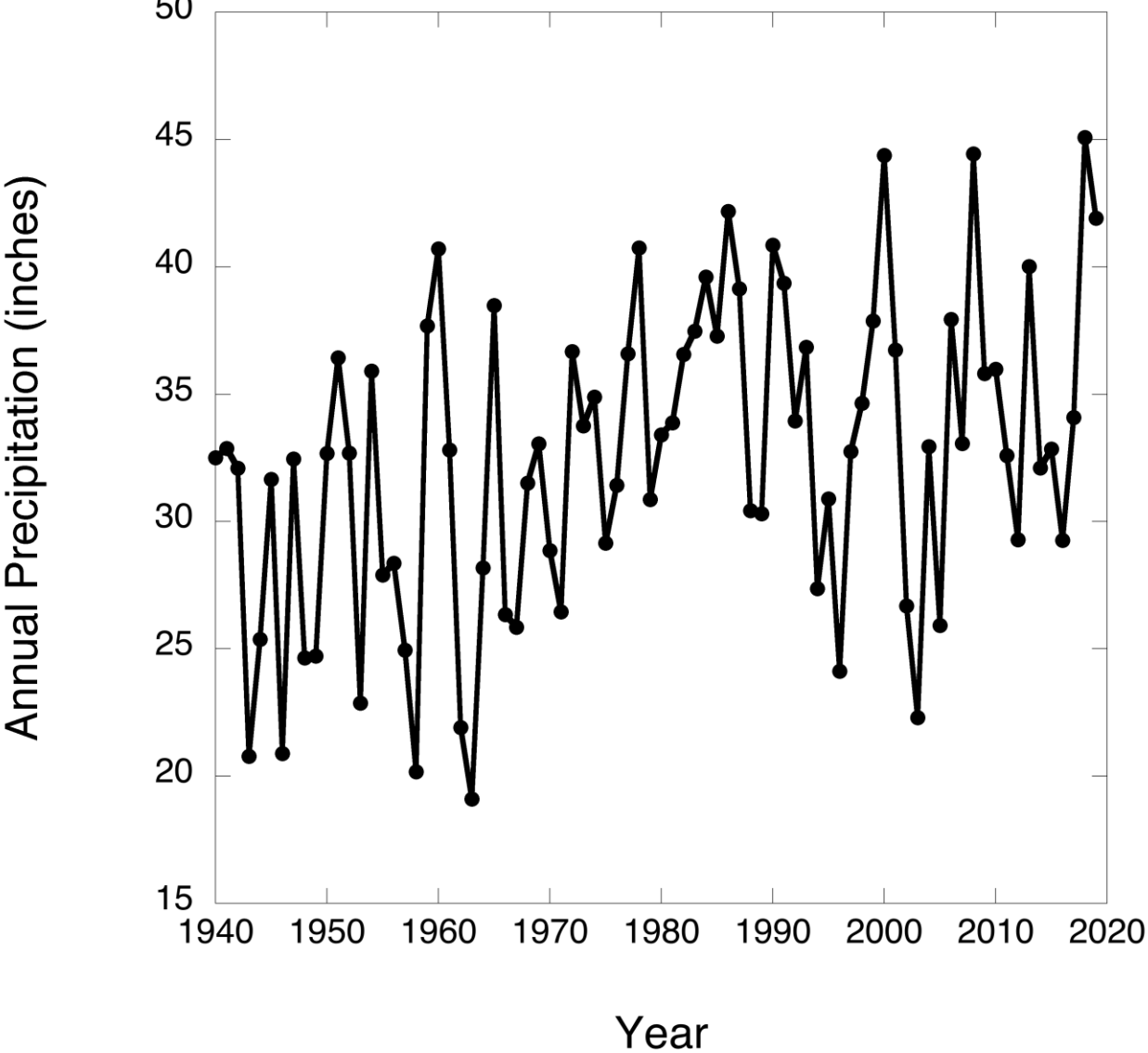


Long-Term Seasonal Trends in Wisconsin (1895-2018)

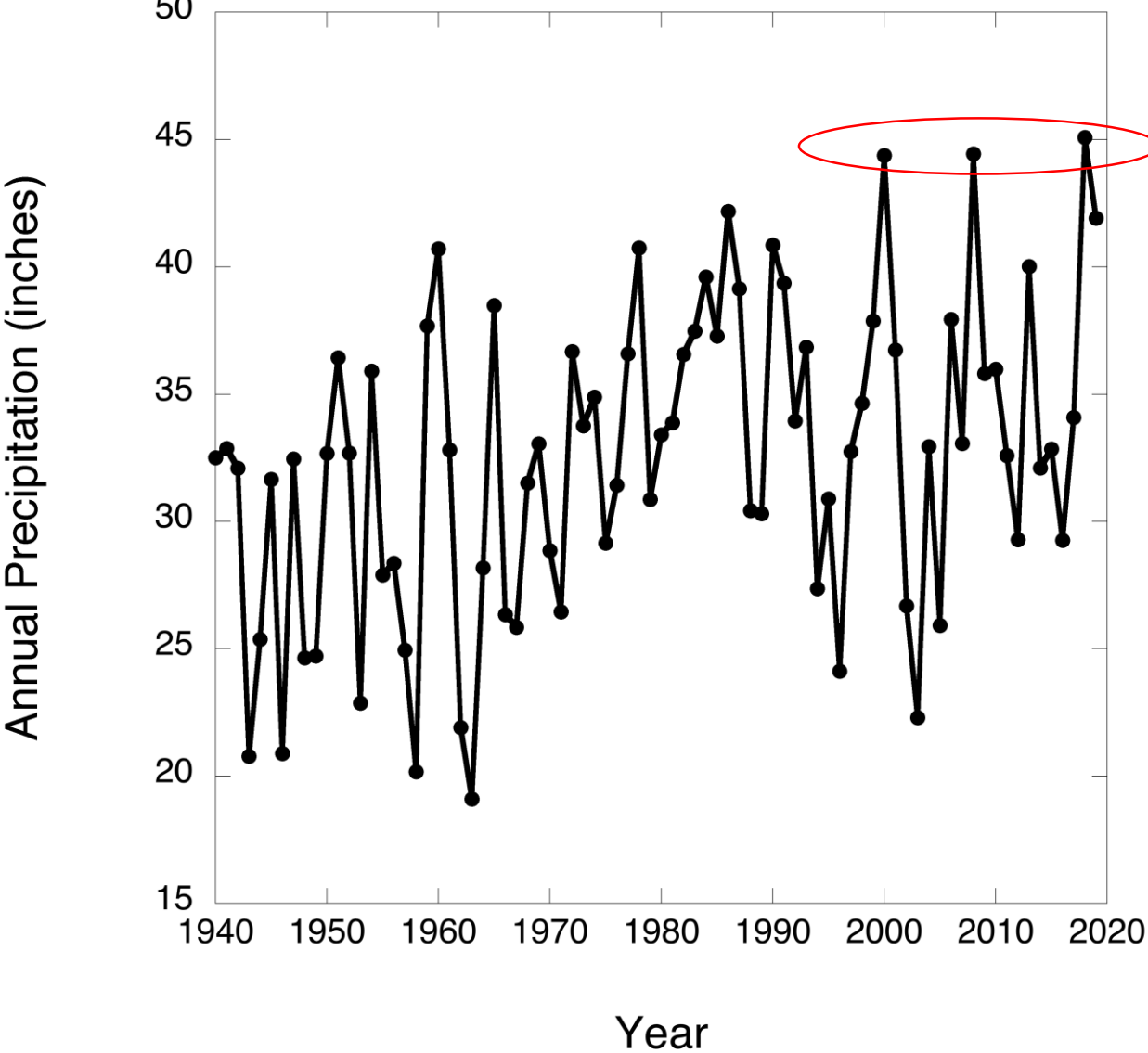
Statewide Precipitation Trends (1895-2018) inches (%)	
Annual	3.97 (13.4%)
Winter	0.40 (12.0%)
Spring *	1.19 (15.8%)
Summer *	1.70 (15.6%)
Autumn	0.67 (8.5%)

Wisconsin becoming wetter in all seasons, especially spring and summer

Annual Precipitation in Milwaukee (airport)
1940-2019

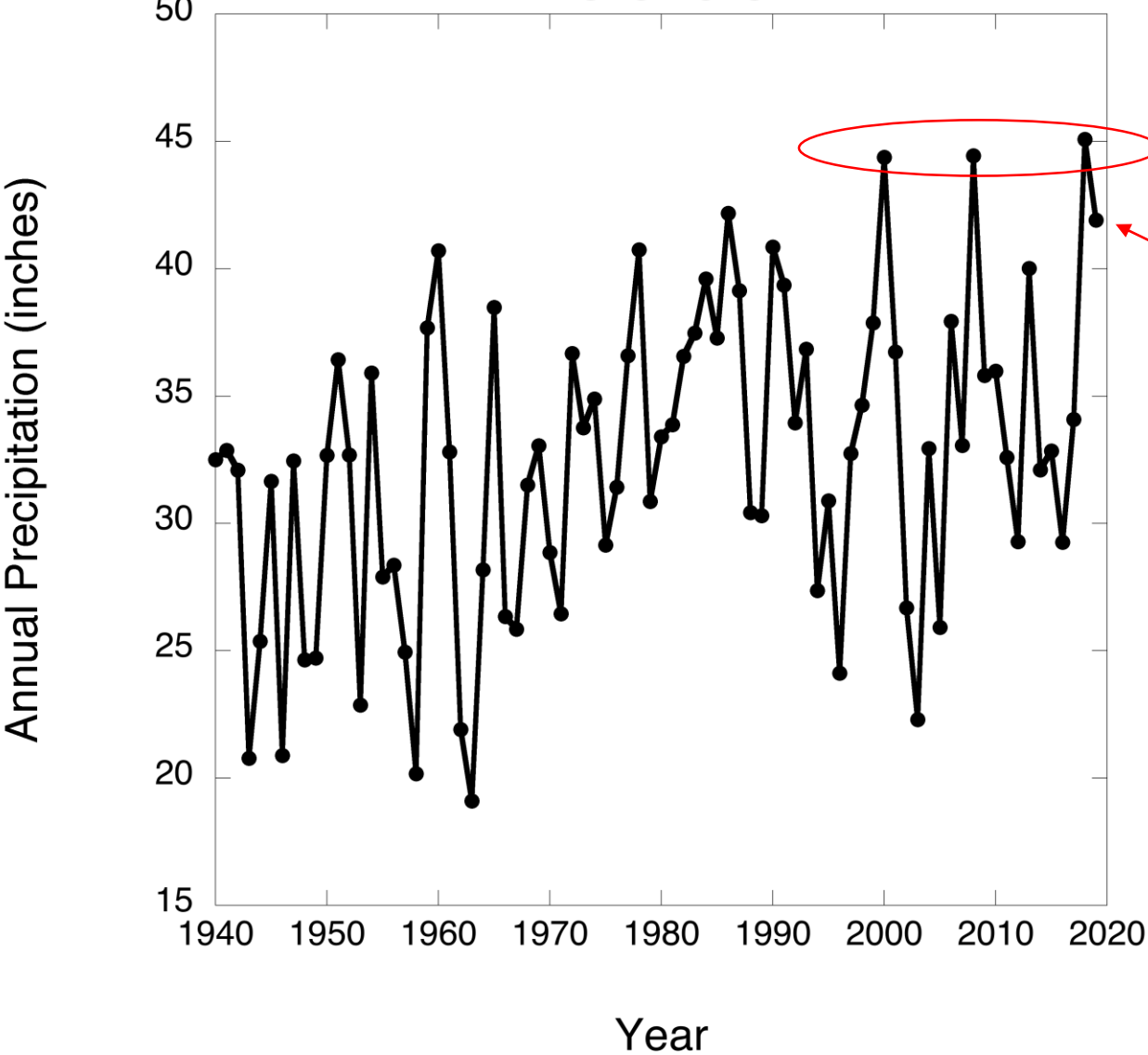


Annual Precipitation in Milwaukee (airport)
1940-2019



3 wettest years
since 2000

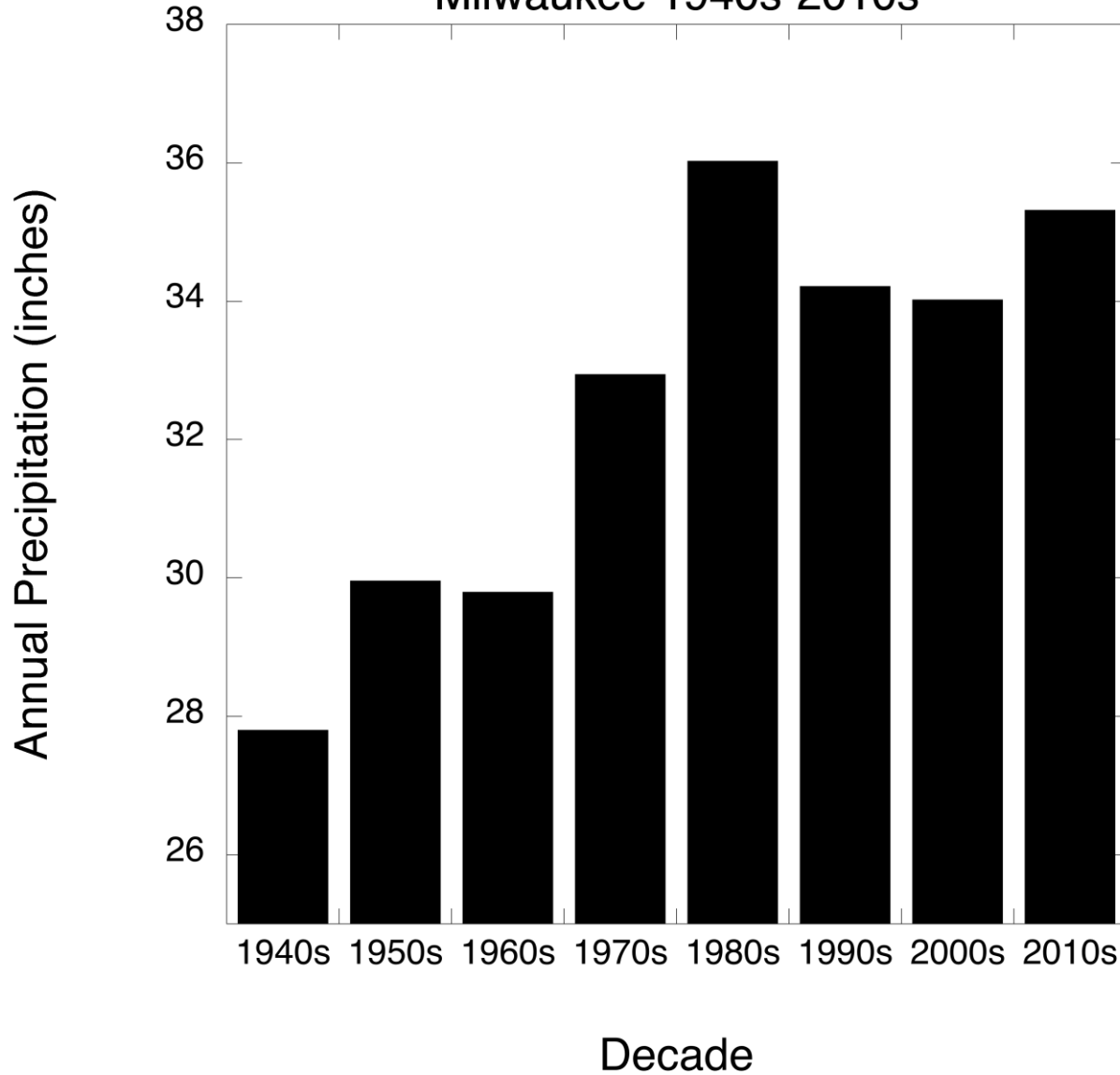
Annual Precipitation in Milwaukee (airport)
1940-2019



3 wettest years
since 2000

This year is
fourth place

Average Annual Precipitation by Decade Milwaukee 1940s-2010s



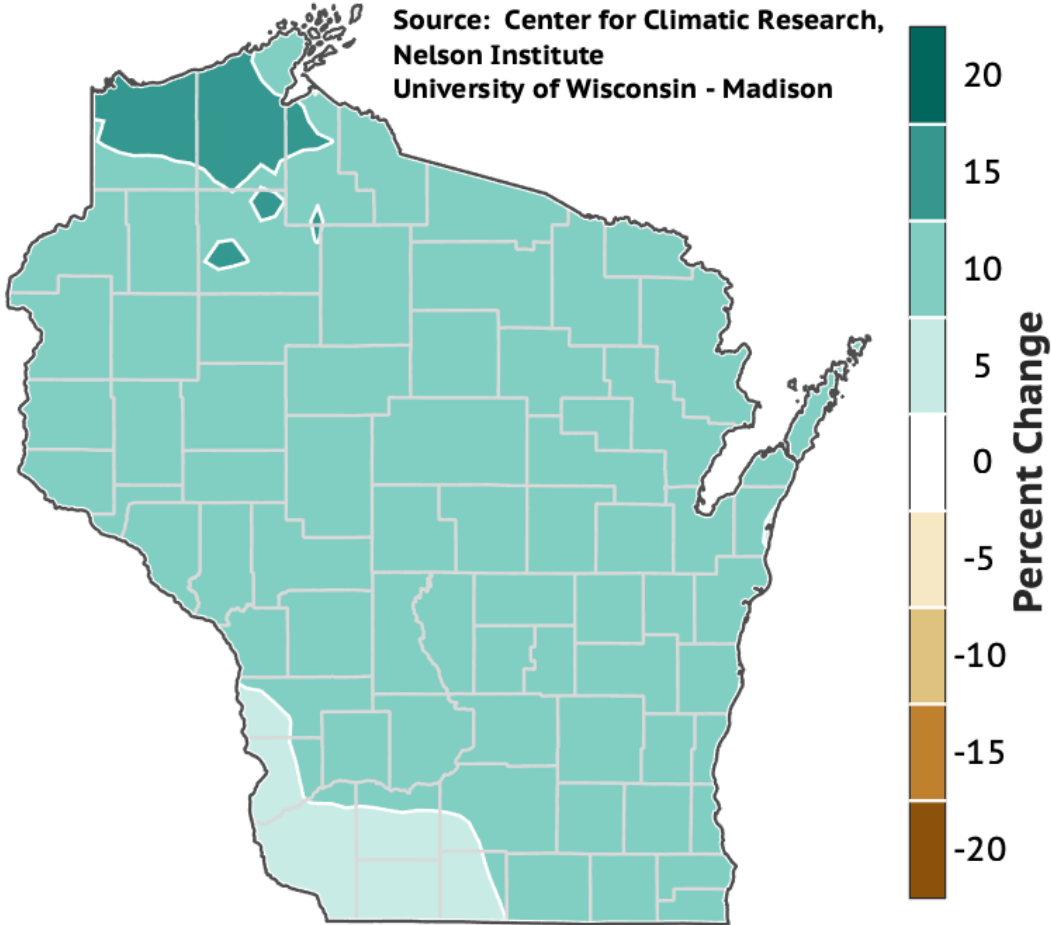
*This decade is almost
8 inches/year wetter
than 1940s (+25-30%)*

Projected Change in Annual **Mean Precipitation** in Wisconsin

Statistical downscaling, RCP8.5

Late 21st Century

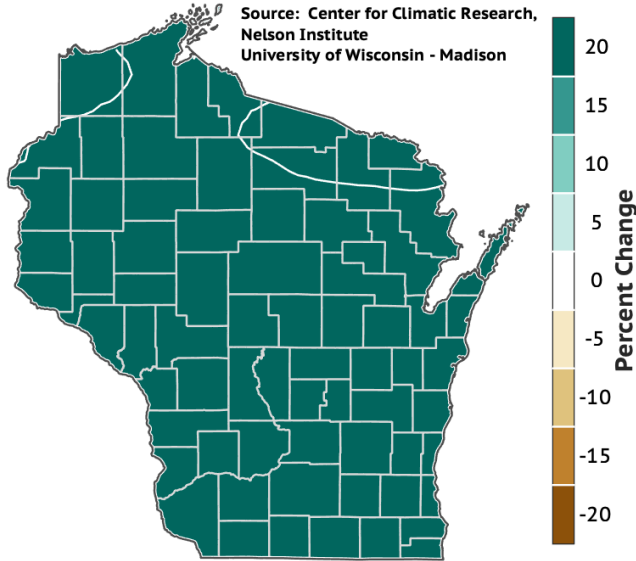
**Change in Annual PRCP (%), RCP85:
2071-2090 minus 1981-2010**



Projected Change in Mean Precipitation in Wisconsin

Change in DJF PRCP (%), RCP85:
2071-2090 minus 1981-2010

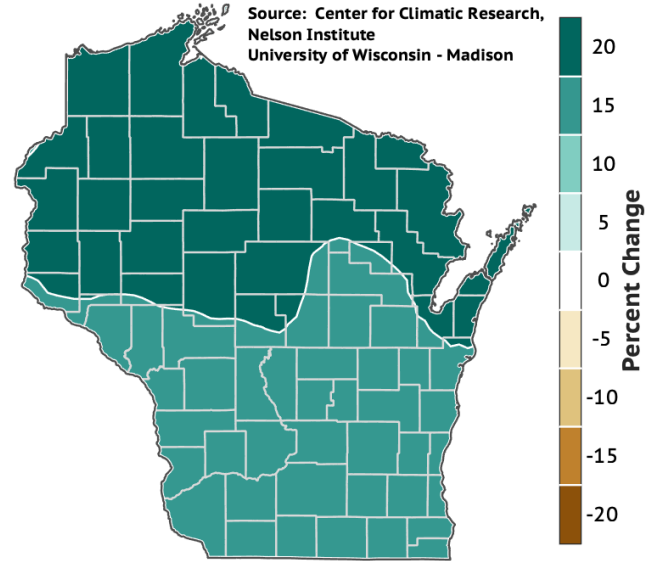
Source: Center for Climatic Research,
Nelson Institute
University of Wisconsin - Madison



Winter

Change in MAM PRCP (%), RCP85:
2071-2090 minus 1981-2010

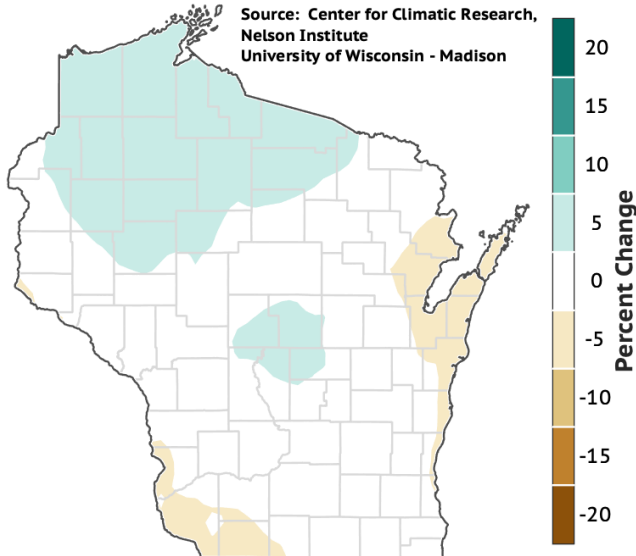
Source: Center for Climatic Research,
Nelson Institute
University of Wisconsin - Madison



Spring

Change in JJA PRCP (%), RCP85:
2071-2090 minus 1981-2010

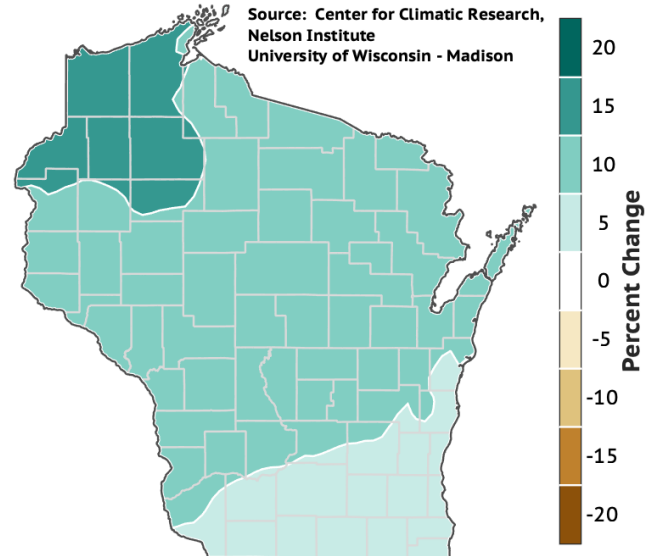
Source: Center for Climatic Research,
Nelson Institute
University of Wisconsin - Madison



Summer

Change in SON PRCP (%), RCP85:
2071-2090 minus 1981-2010

Source: Center for Climatic Research,
Nelson Institute
University of Wisconsin - Madison



Autumn

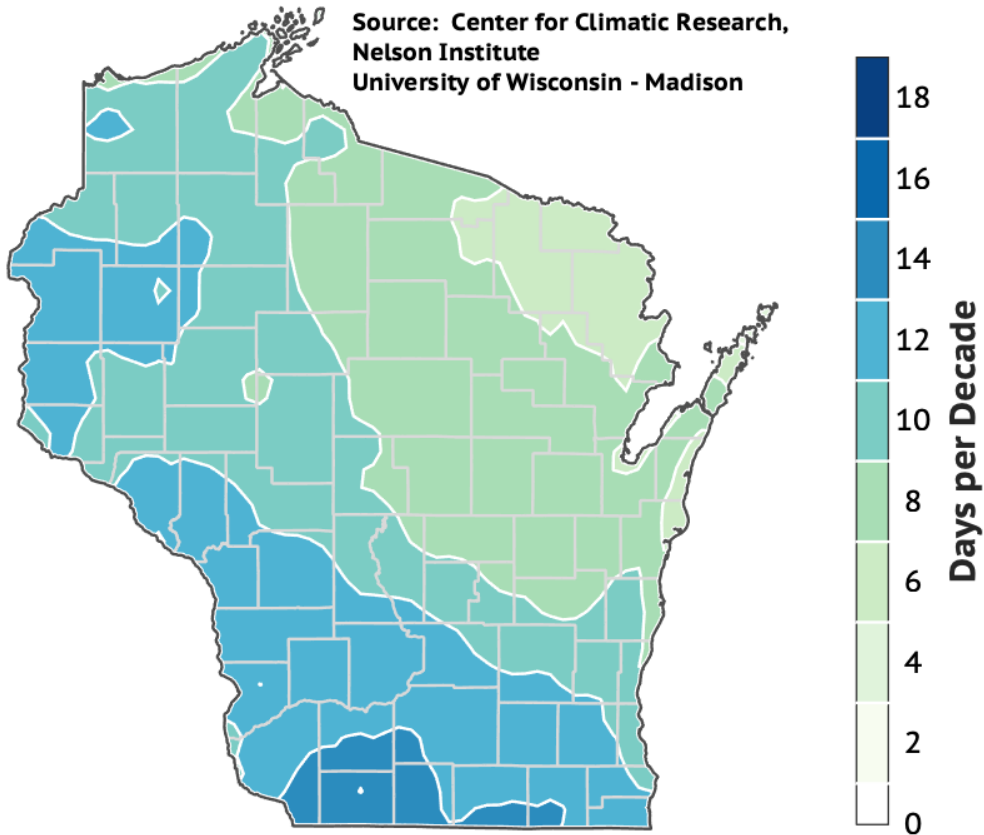
Statistical
Downscaling

Projected Change in **Extreme Precipitation** in Wisconsin

Statistical downscaling, RCP8.5

**Days per Decade with PRCPDays > 2in
1981-2010 Conditions (HISTORICAL)**

Source: Center for Climatic Research,
Nelson Institute
University of Wisconsin - Madison



Past

Projected Change in **Extreme Precipitation** in Wisconsin

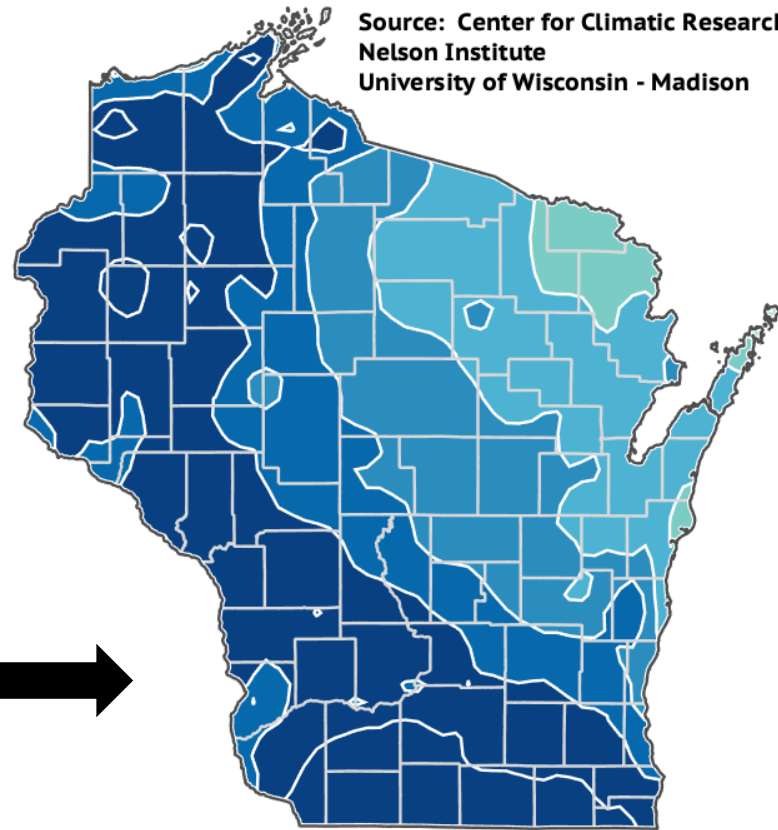
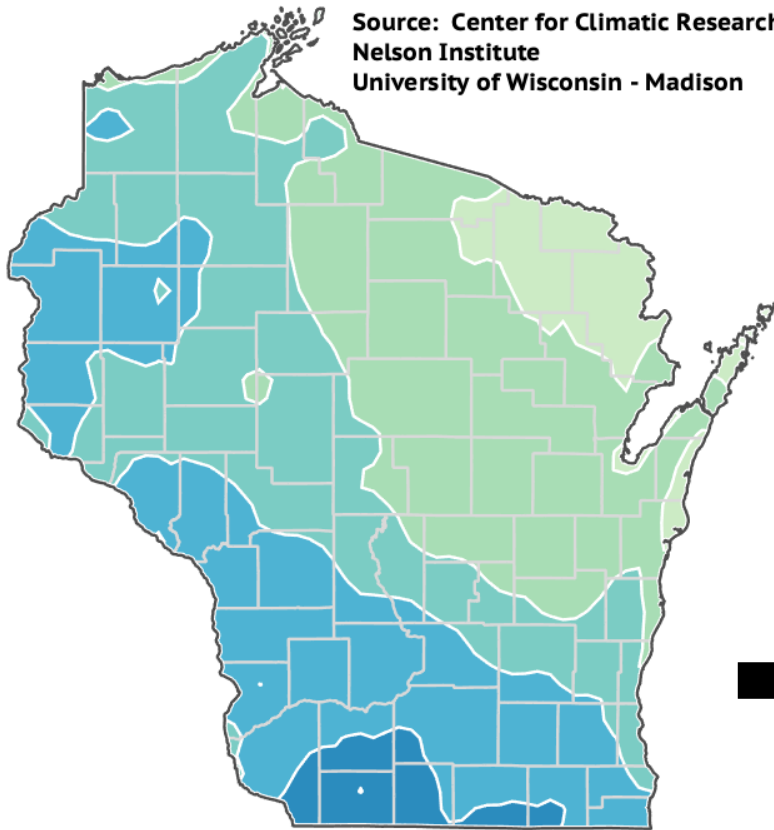
Statistical downscaling, RCP8.5

**Days per Decade with PRCPDays > 2in
1981-2010 Conditions (HISTORICAL)**

**Days per Decade with PRCPDays > 2in
2071-2090 Conditions (RCP85)**

Source: Center for Climatic Research,
Nelson Institute
University of Wisconsin - Madison

Source: Center for Climatic Research,
Nelson Institute
University of Wisconsin - Madison



Days per Decade

Past

Future

Conclusions

- Climate continues to warm and become moister
- Extreme weather increasing overall, *especially heavy precipitation*
- Currently record-high precipitation statewide
- Wisconsin becoming wetter in all seasons, especially spring and summer
- A warmer and wetter future expected, especially winter and spring
- More extreme rainfalls likely in the future throughout Wisconsin

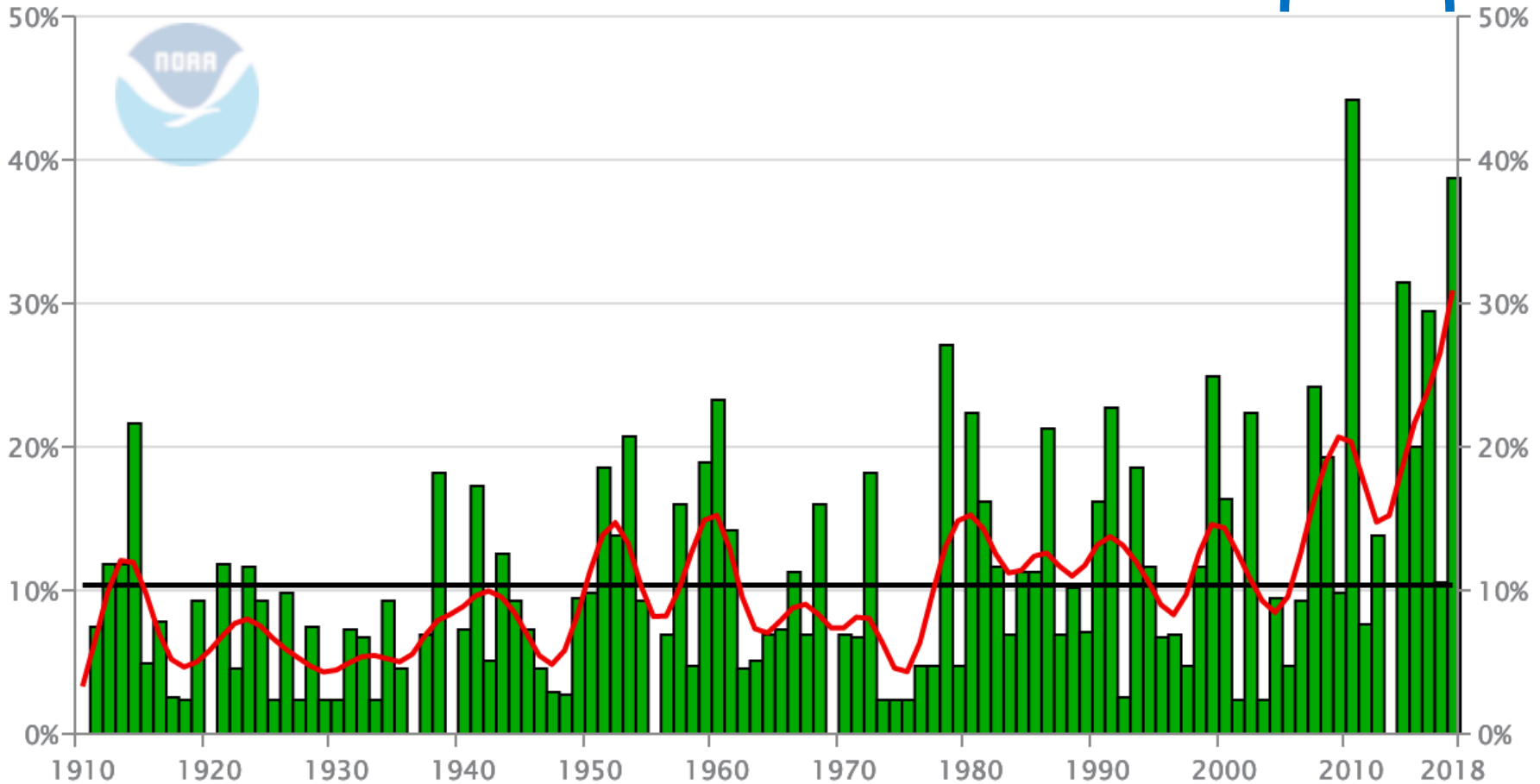
Regional Climate Extremes Index Annual 2018



More favorable conditions for flooding

Daily Precipitation Extremes (Upper Midwest)

Upper Midwest Extremes in 1-Day Precipitation (Step 4*)
Annual (January–December)



Recent increase in heavy precipitation, especially past 10-15 years