

# Climate Change, Resilience, and Impact

Steve Vavrus

Senior Scientist

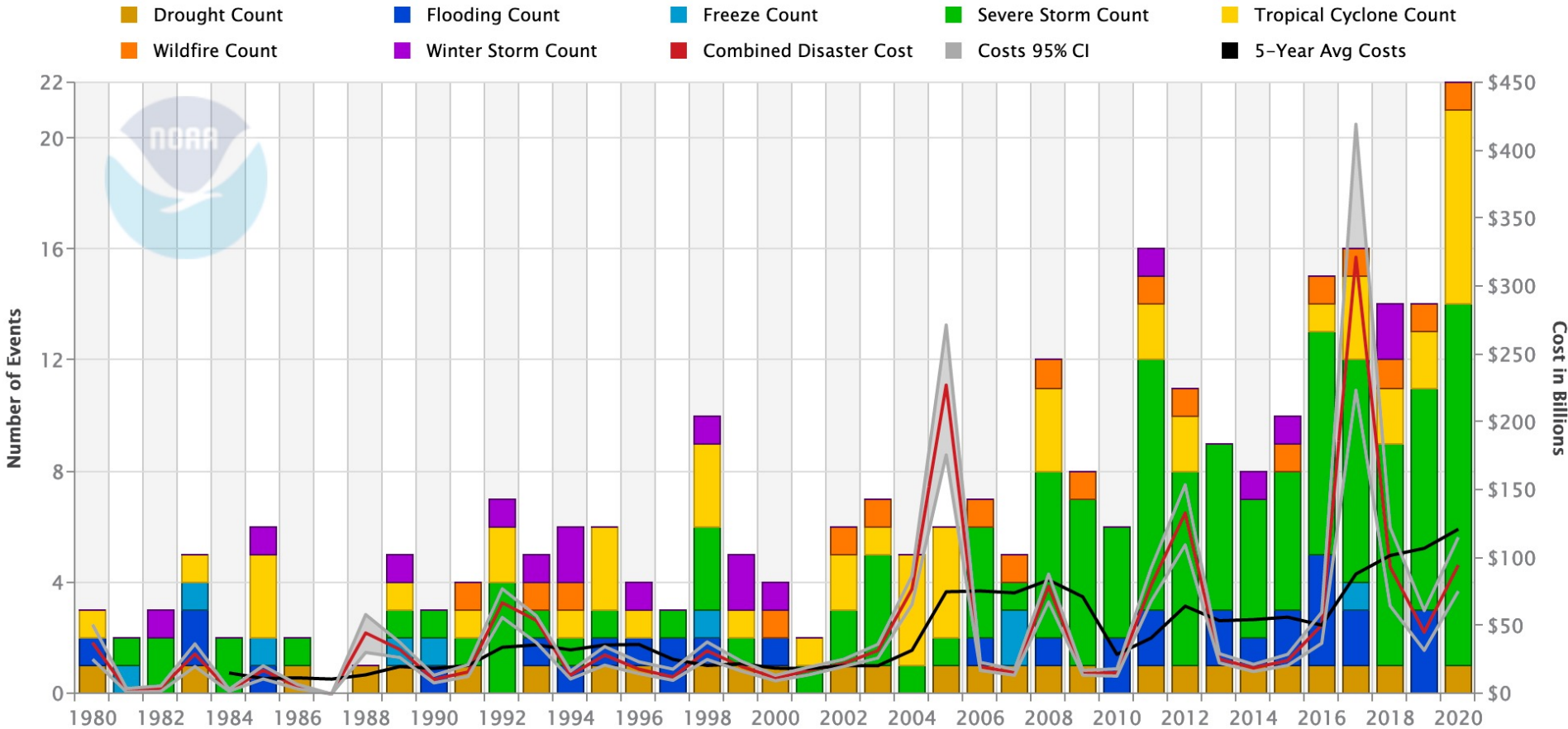
Nelson Institute Center for Climatic Research

University of Wisconsin-Madison



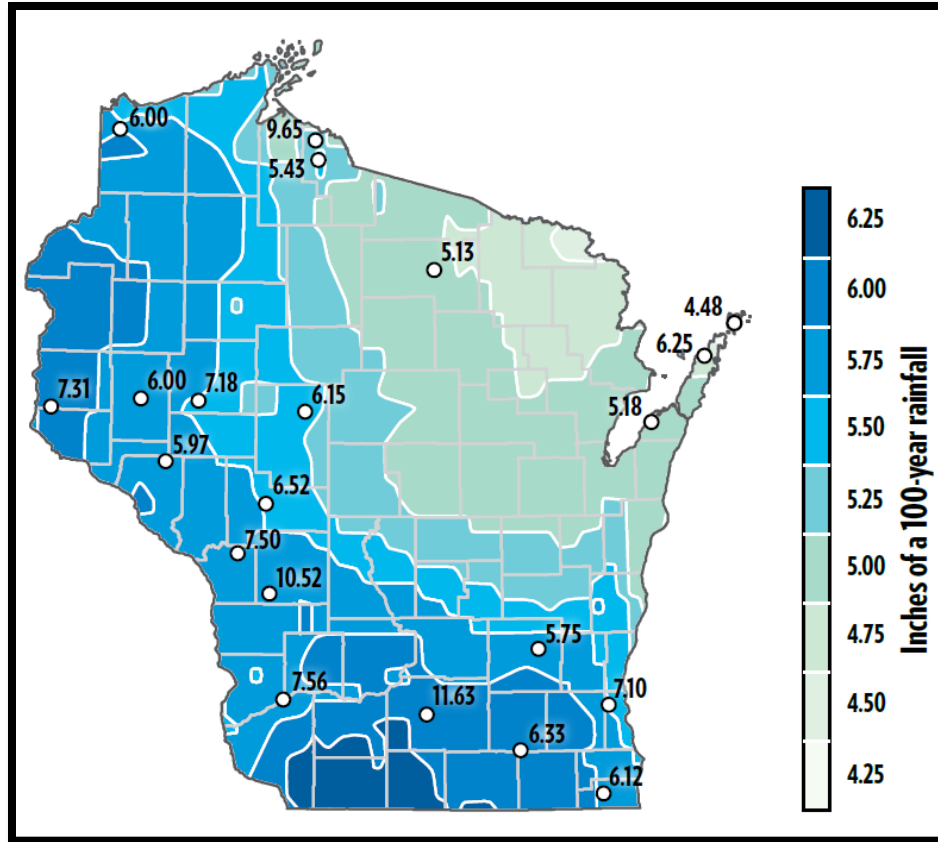
# Billion-dollar Weather Disasters in U.S. since 1980

United States Billion-Dollar Disaster Events 1980-2020 (CPI-Adjusted)



*More and more costly weather disasters. Last year set new record.*

# “100-year” Daily Rainfalls during Past Decade



*21 events affected most parts of Wisconsin*

What is **science** saying about climate change in Wisconsin?

What are expected **impacts**?

What should local governments be **preparing** for?



# Wisconsin Initiative on Climate Change Impacts (WICCI)

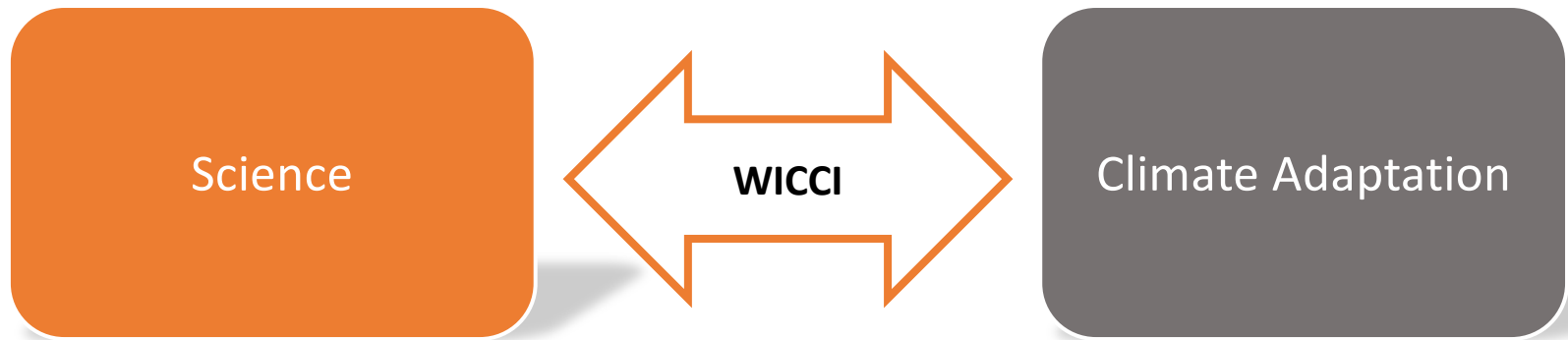
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*Established in 2007*

Co-directors: Pam Porter (DNR), Dan Vimont and Steve Vavrus (UW-Madison)

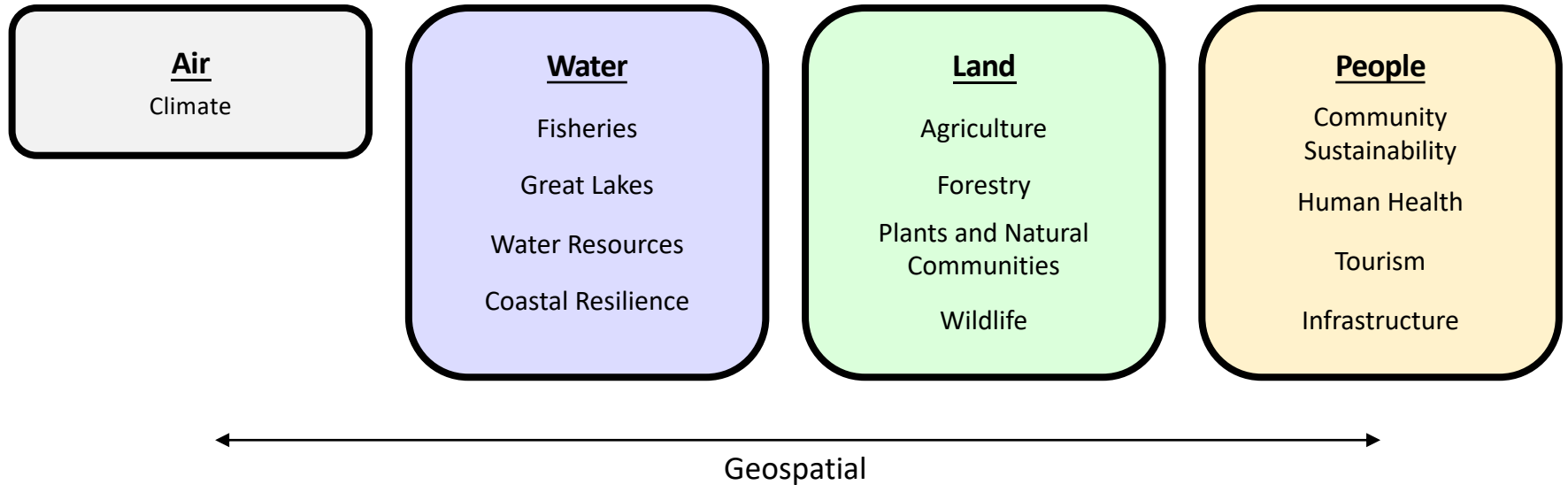


# WICCI Overview



***WICCI's mission:*** Generate and share information that can foster solutions to climate change in Wisconsin (and beyond).

# WICCI Working Groups

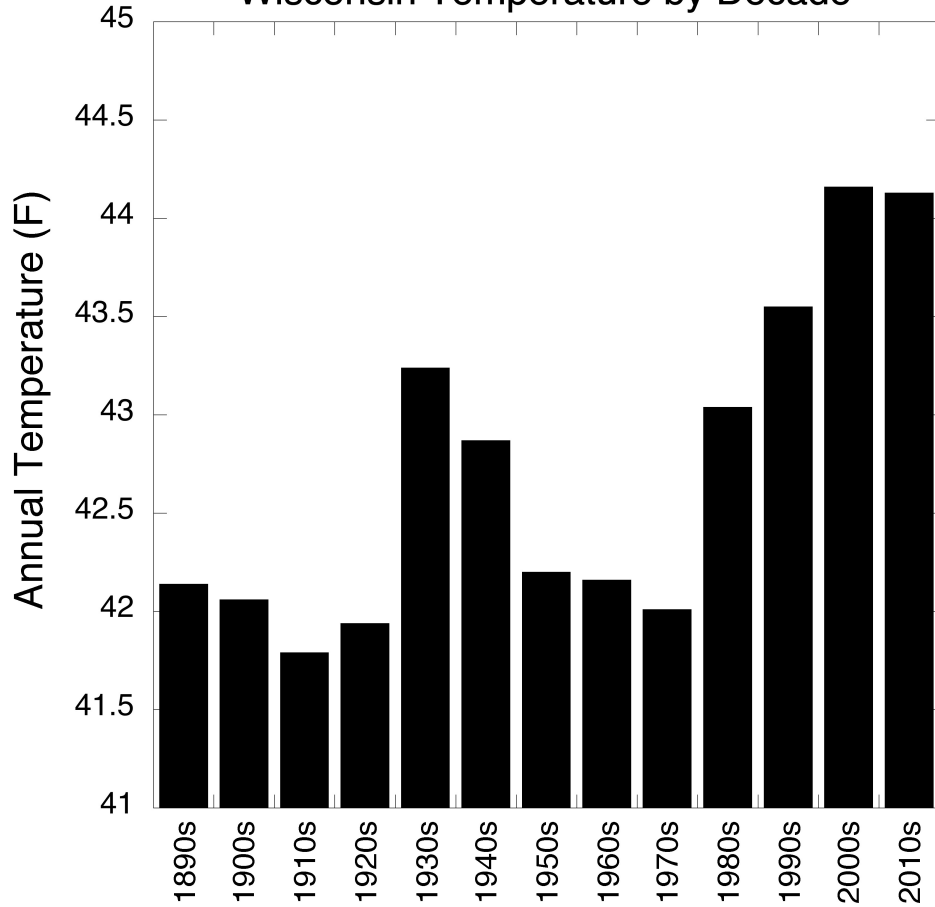


**The Science . . .**



# “Warmer and Wetter”

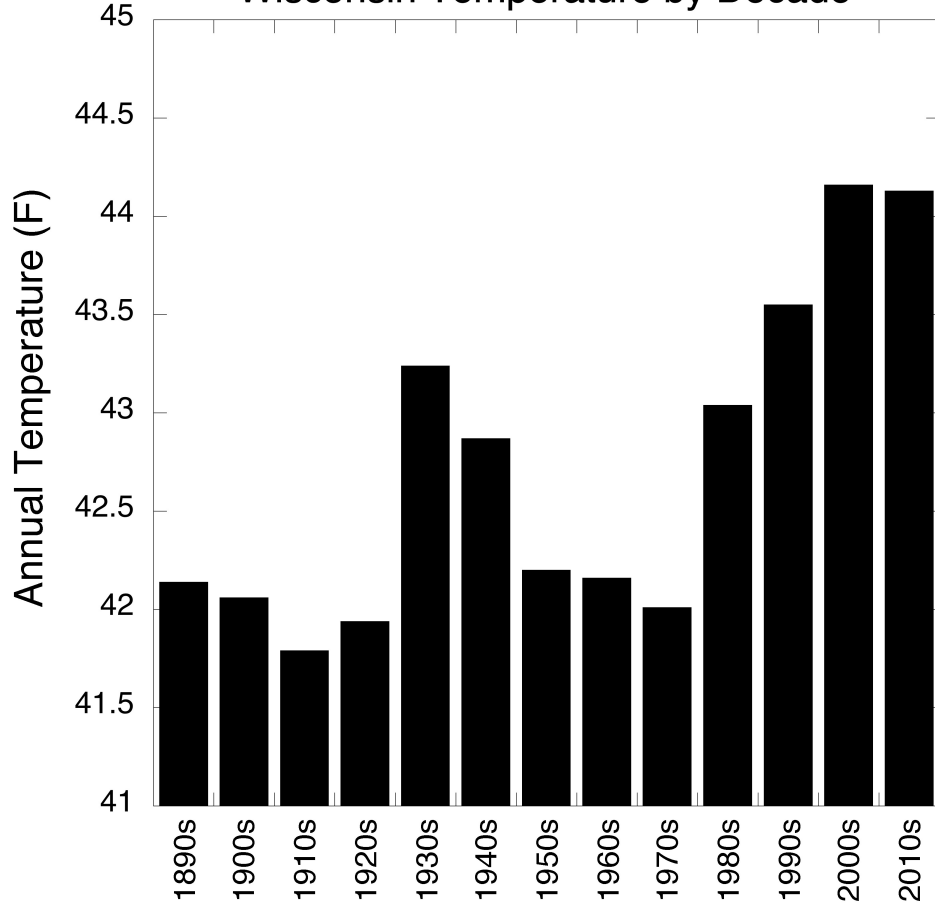
Wisconsin Temperature by Decade



*2000s and 2010s = warmest decades*

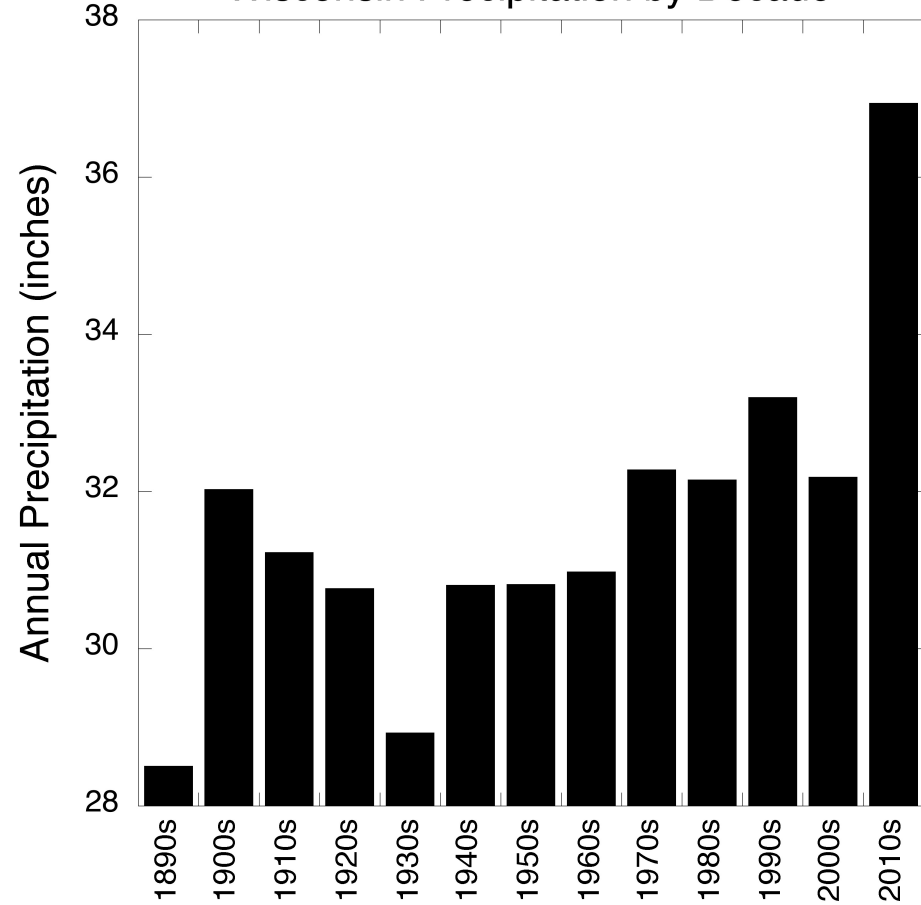
# “Warmer and Wetter”

Wisconsin Temperature by Decade



*2000s and 2010s = warmest decades*

Wisconsin Precipitation by Decade

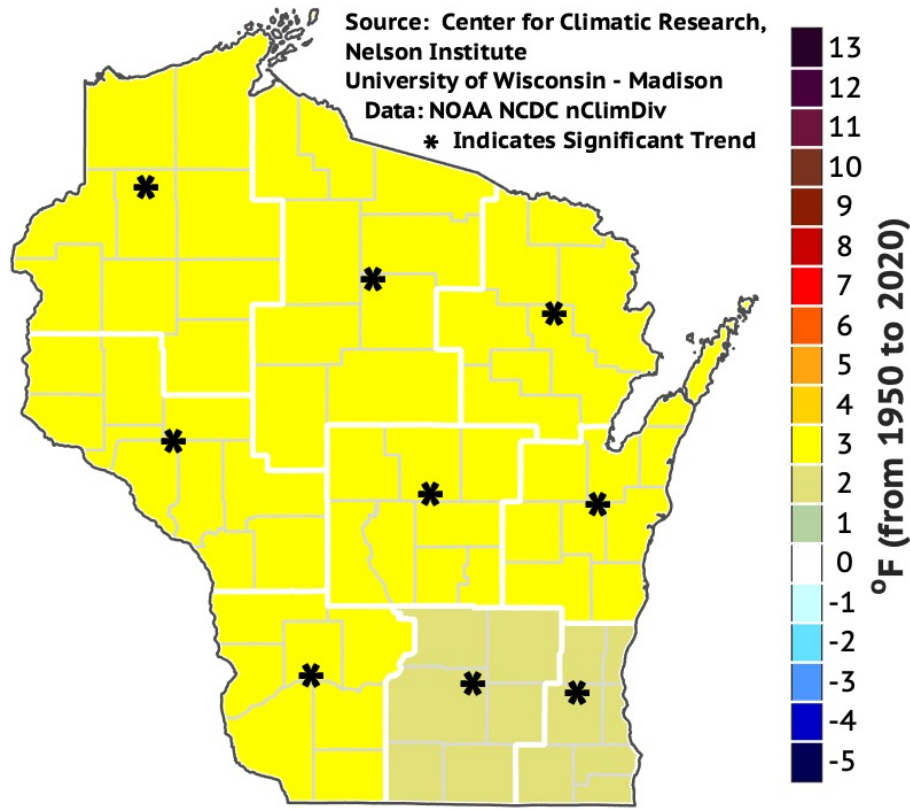


*2010s the wettest decade by far*

# “Warmer and Wetter”

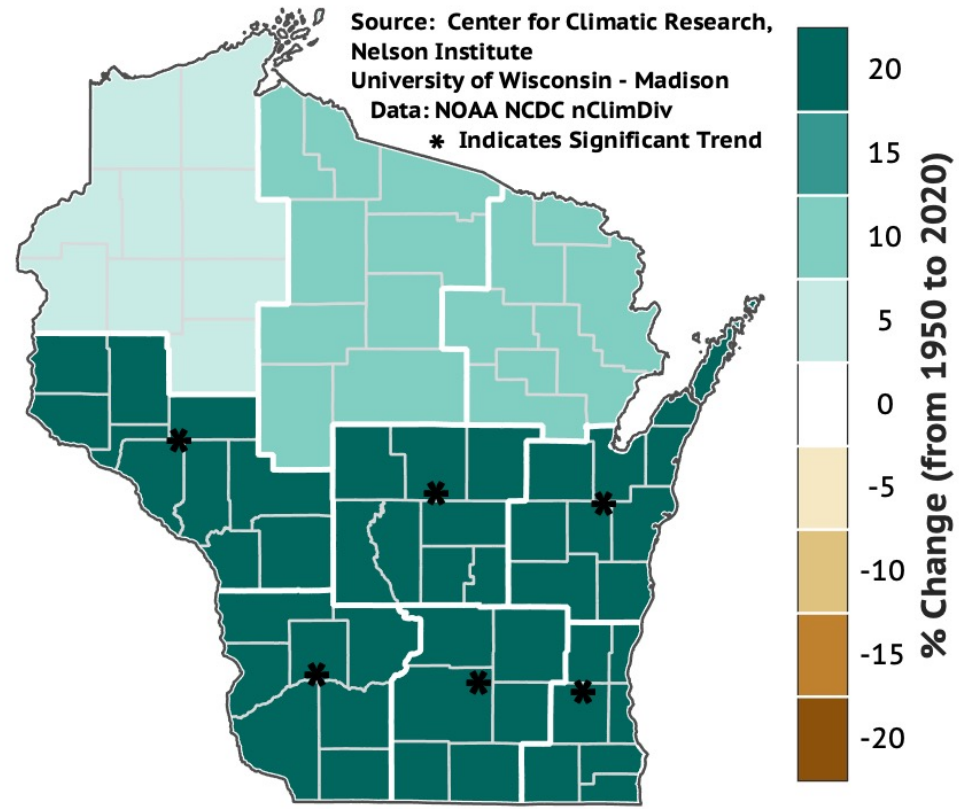
## *Climate Change since mid-20<sup>th</sup> Century*

### Annual Temperature Trend 1950-2020



*Fairly uniform warming trend since 1950*

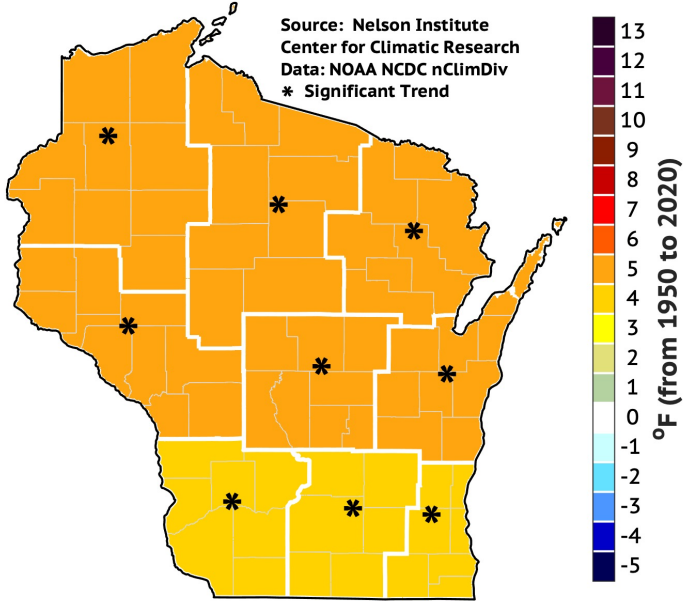
### Annual Precipitation Trend 1950-2020



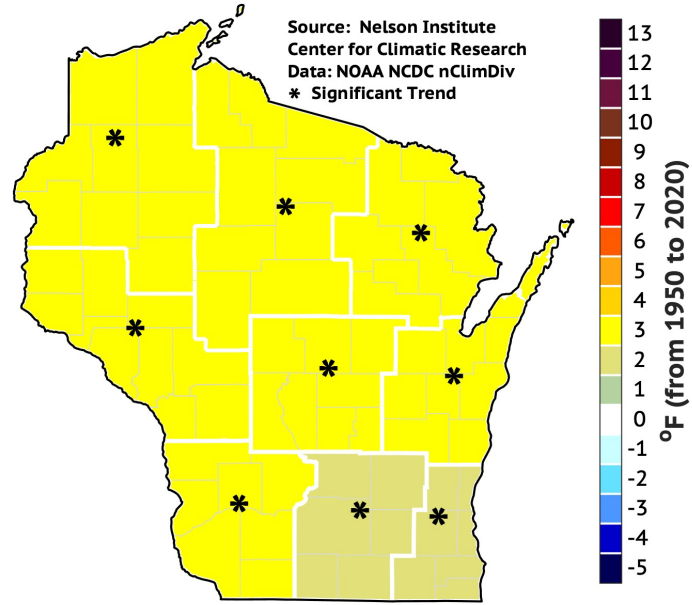
*Wetter especially in central and southern WI*

# It's Been Warming in Every Season. . .

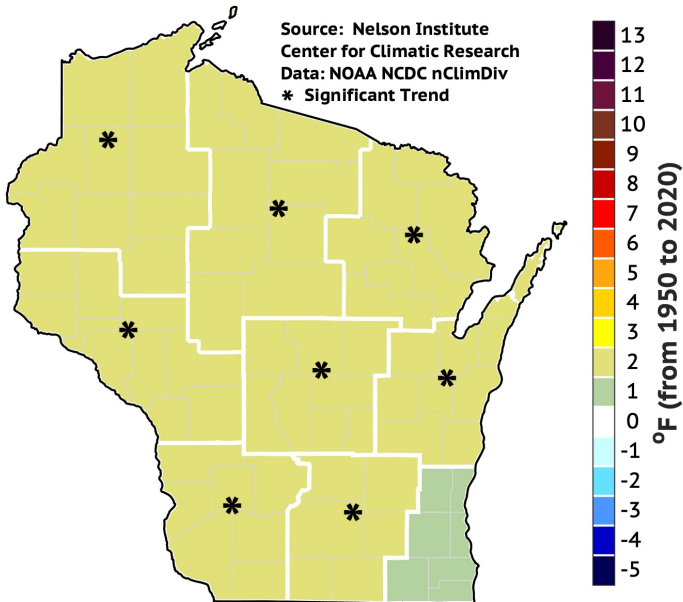
Winter



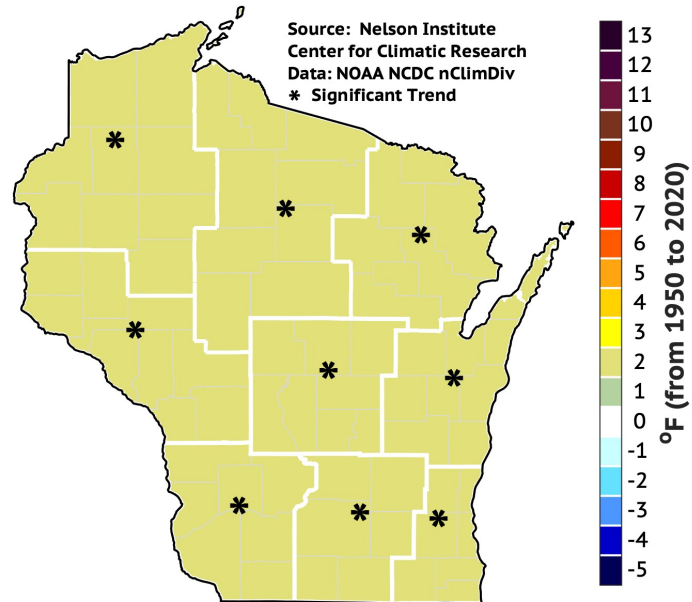
Spring



Summer

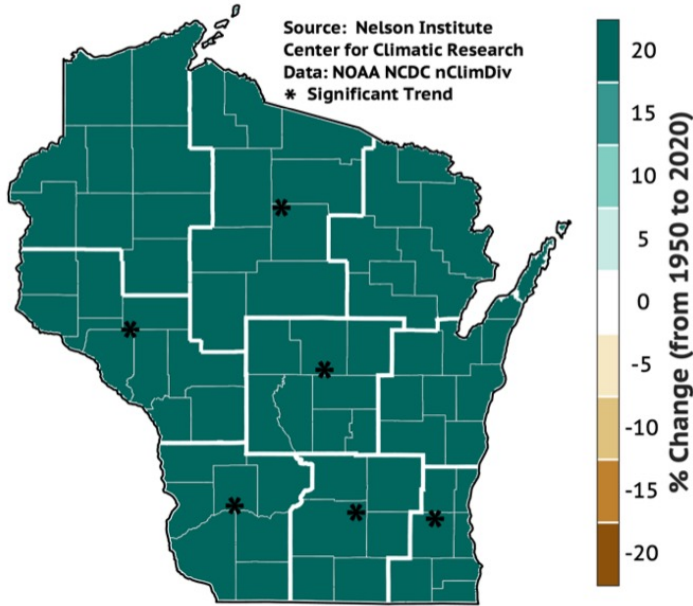


Fall

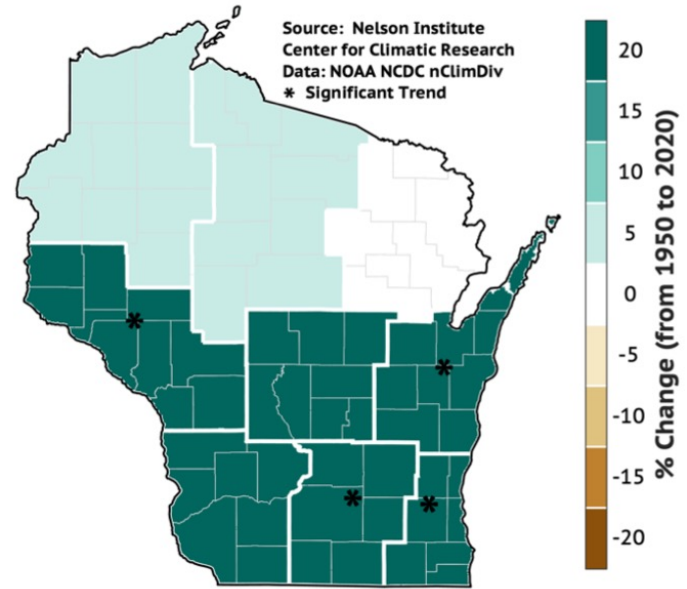


# And Wetter in Every Season. . .

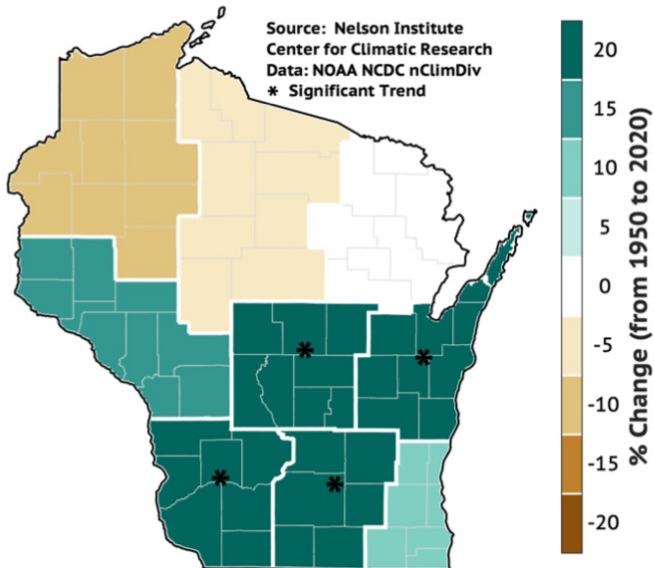
Winter



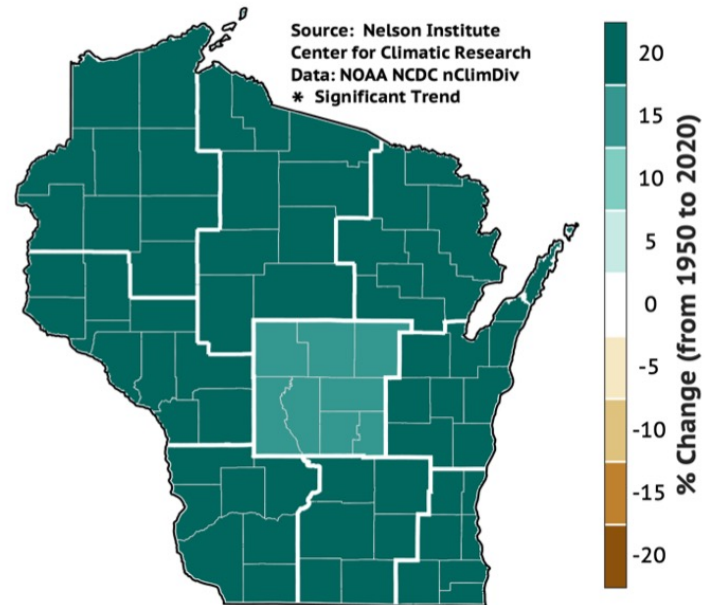
Spring



Summer

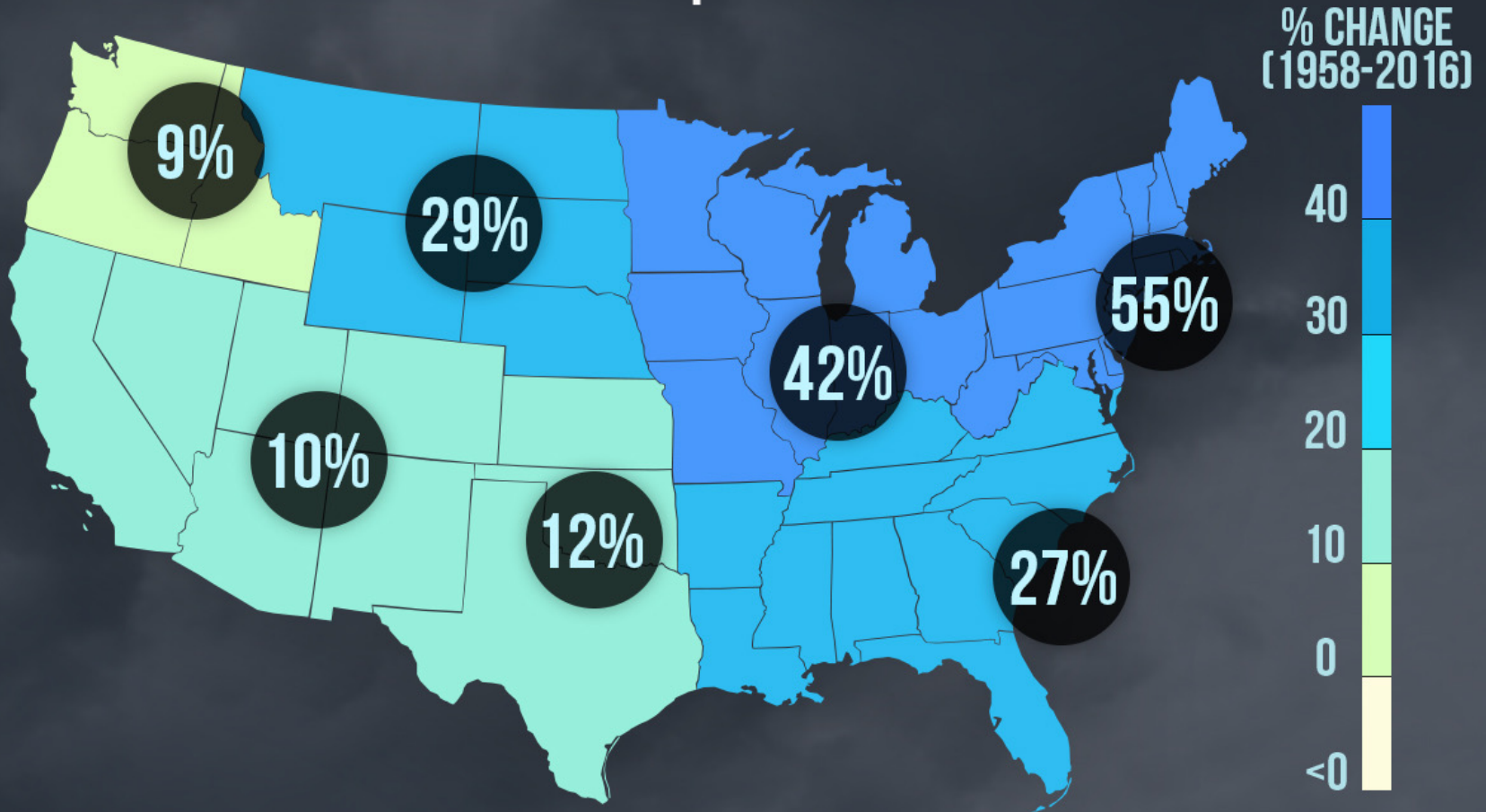


Fall



# MORE DOWNPOURS

## Increase in Heaviest Precipitation Events



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

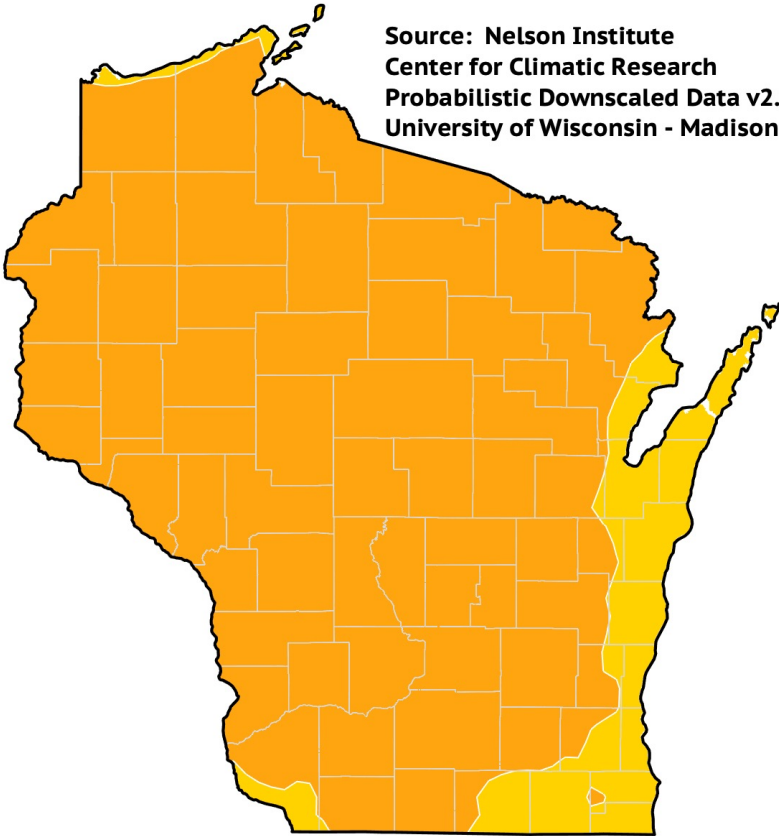
# Warmer and Wetter in the Future

Annual Temperature Change 2041-60

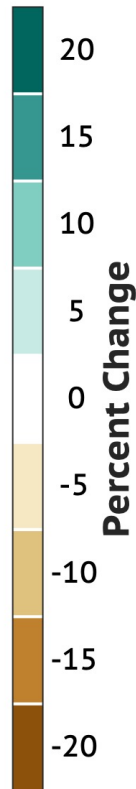
Annual Precipitation Change 2041-60

*Mid-range carbon emissions scenario*

Source: Nelson Institute  
Center for Climatic Research  
Probabilistic Downscaled Data v2.0  
University of Wisconsin - Madison



Source: Nelson Institute  
Center for Climatic Research  
Probabilistic Downscaled Data v2.0  
University of Wisconsin - Madison



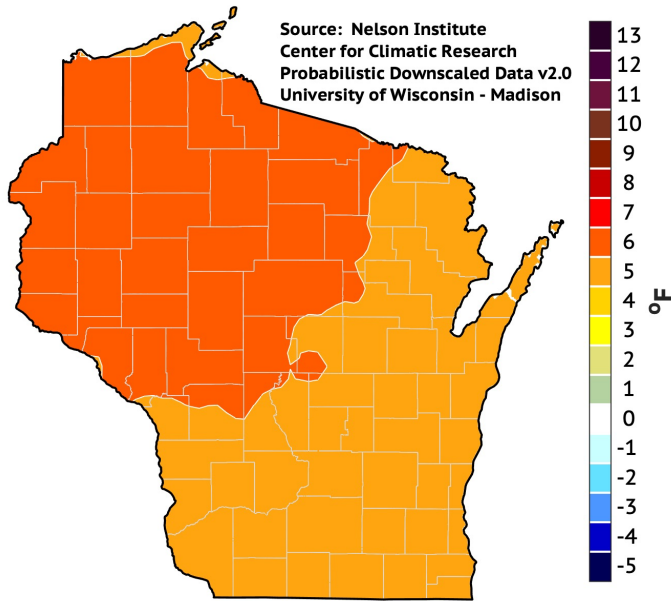
*Fairly uniform warming trend expected*

*Wetter everywhere but variations by season*

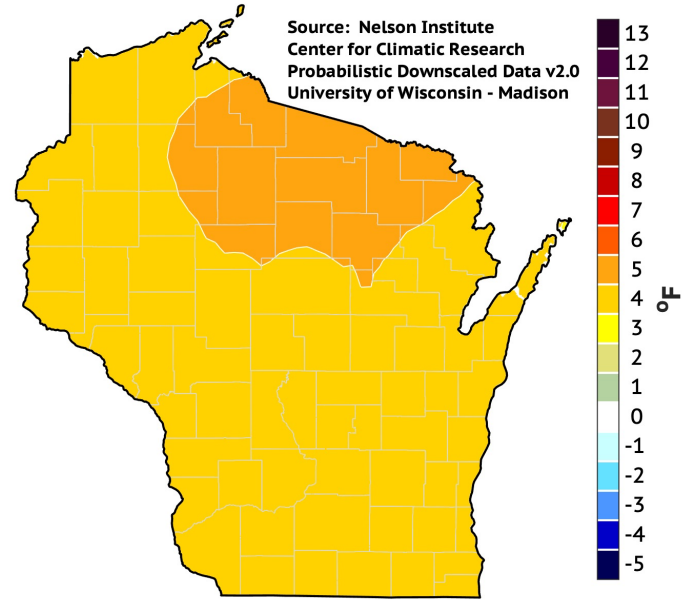
# Warming to continue in every season. . .

## Projected Temperature Change 2041-60

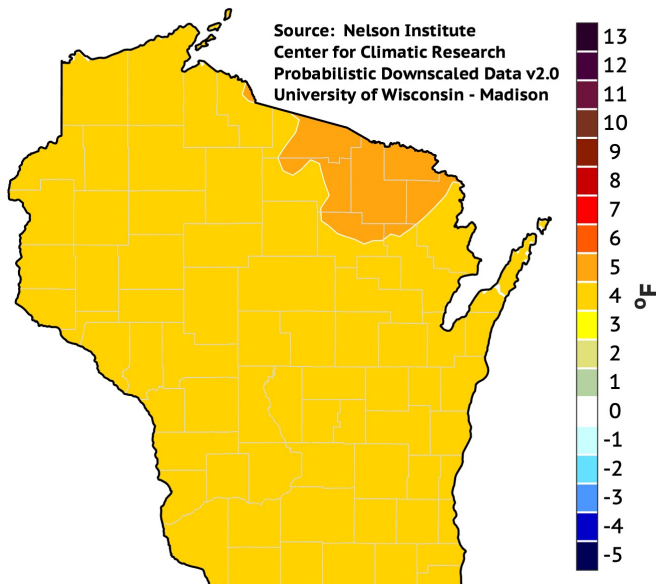
Winter



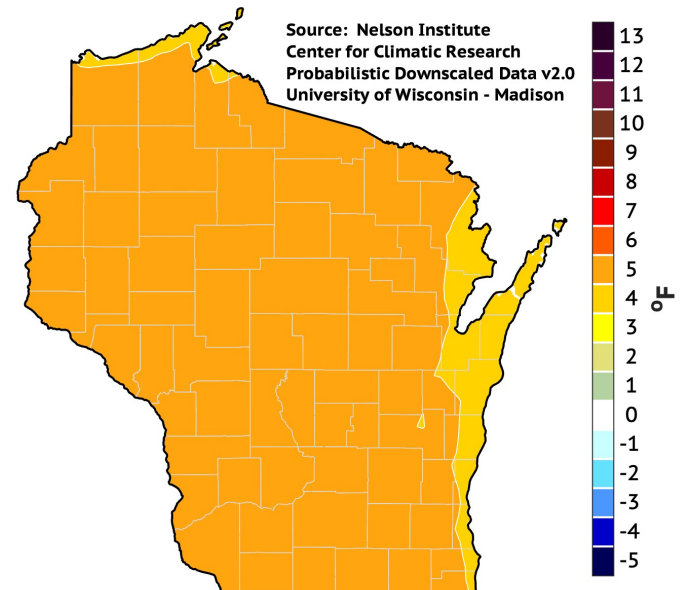
Spring



Summer



Fall

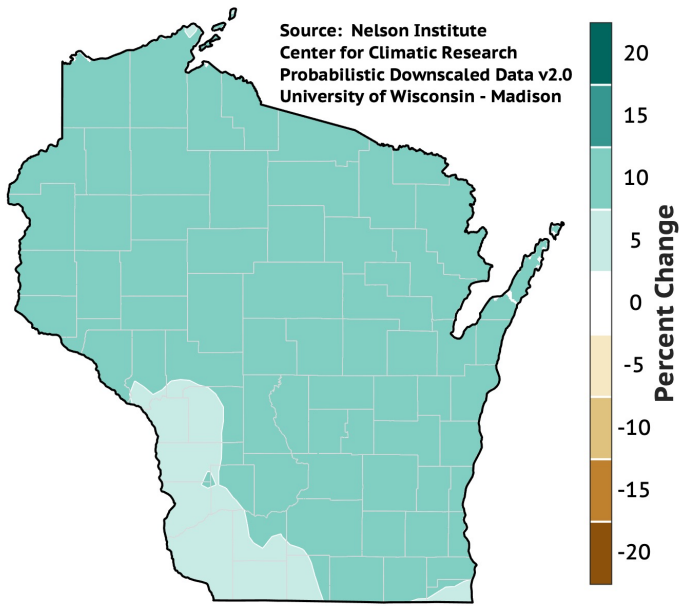




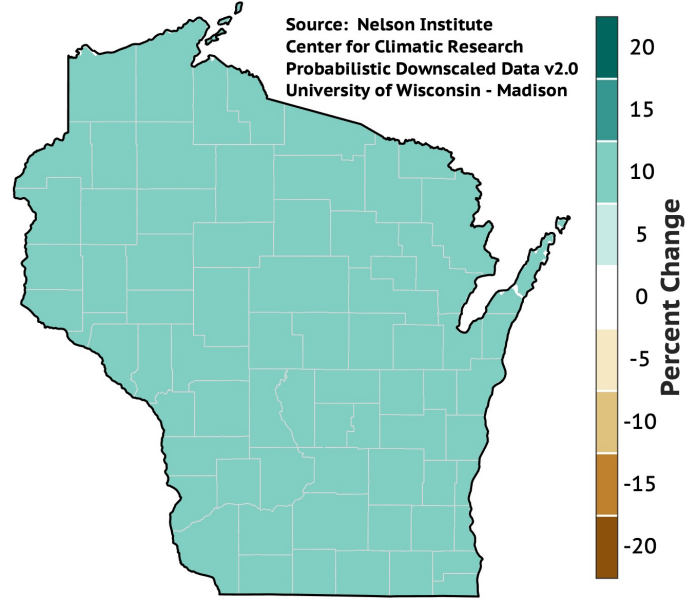
# Generally wetter throughout the year. . .

Projected Precipitation Change 2041-60

Winter

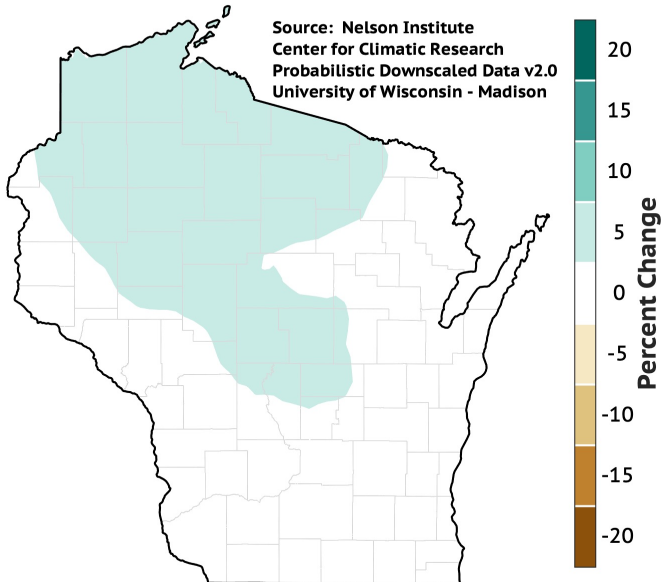


Spring

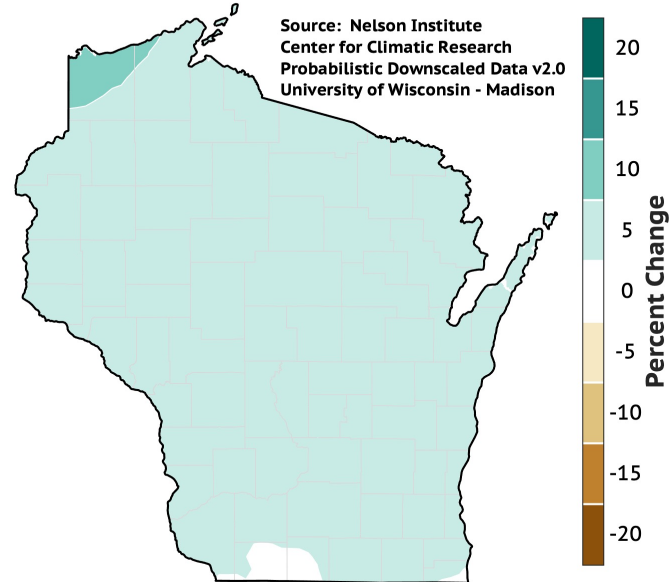


Summer

?



Fall

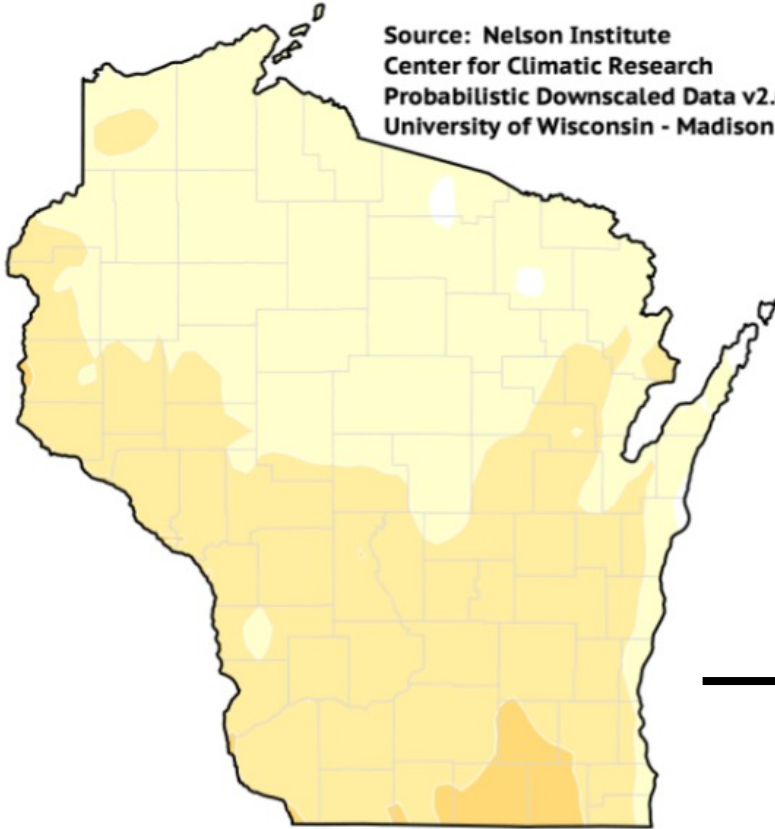


# Wisconsin's Future Climate by Mid Century?: Extremes

## Extreme Heat (90 degree days)

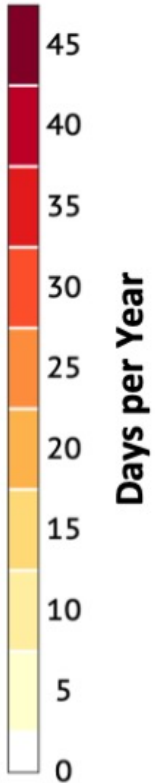
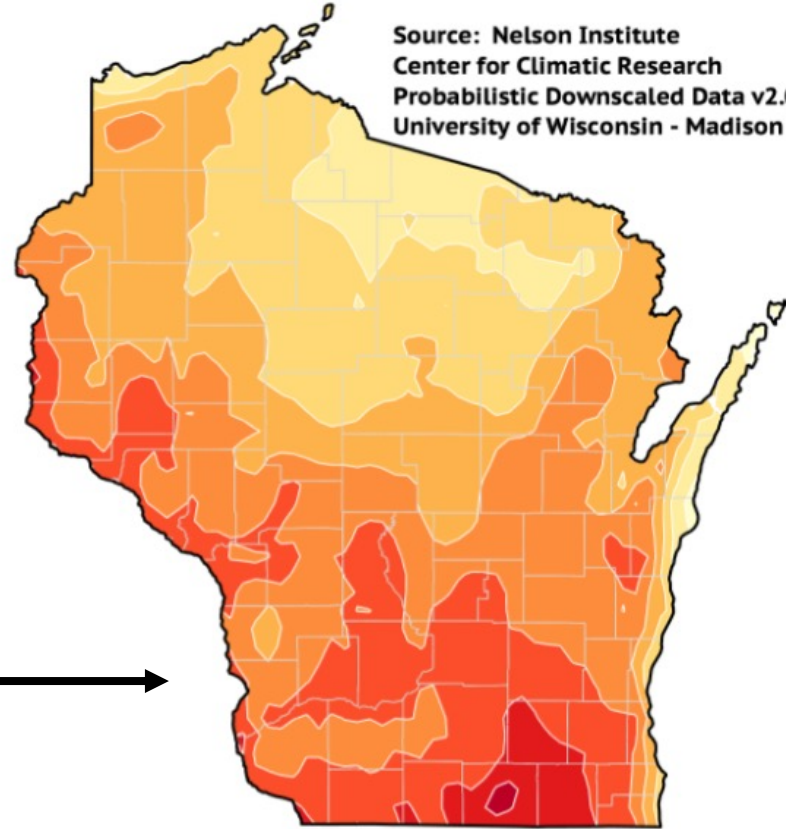
PAST: 1981-2010 average

Source: Nelson Institute  
Center for Climatic Research  
Probabilistic Downscaled Data v2.0  
University of Wisconsin - Madison



FUTURE: 2040-2060 average

Source: Nelson Institute  
Center for Climatic Research  
Probabilistic Downscaled Data v2.0  
University of Wisconsin - Madison



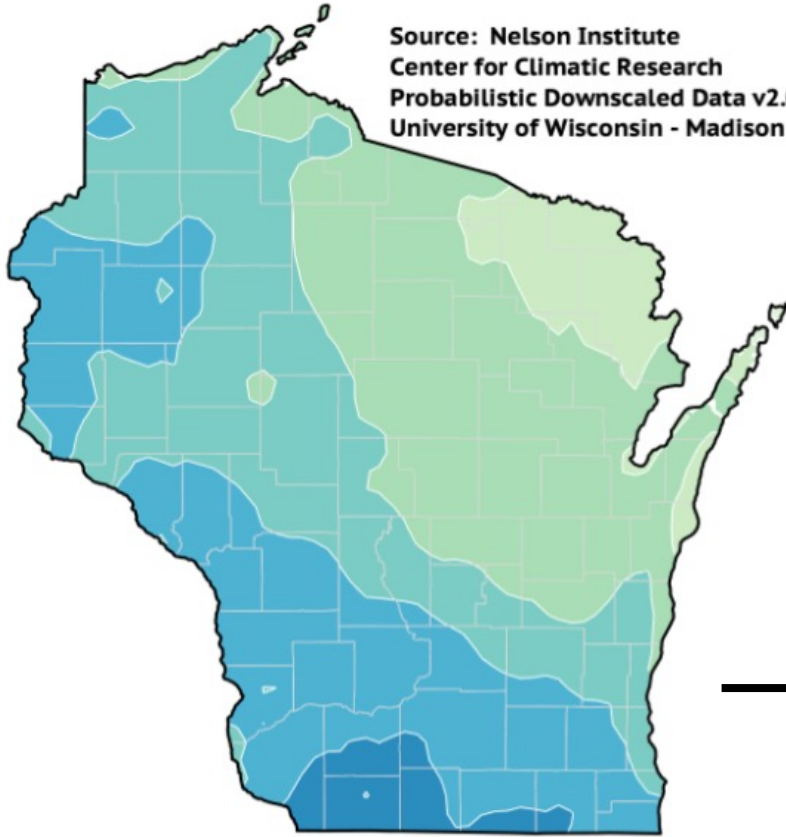
*90-degree days likely to triple in frequency state-wide in the next few decades*

# Wisconsin's Future Climate by Late Century?: Extremes

## Extreme Rain: 2-inch daily rainfalls

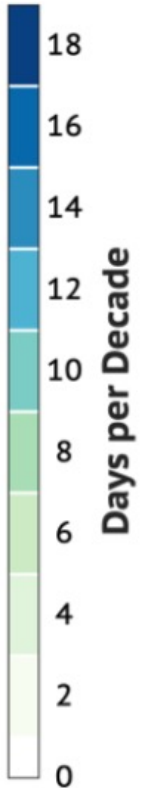
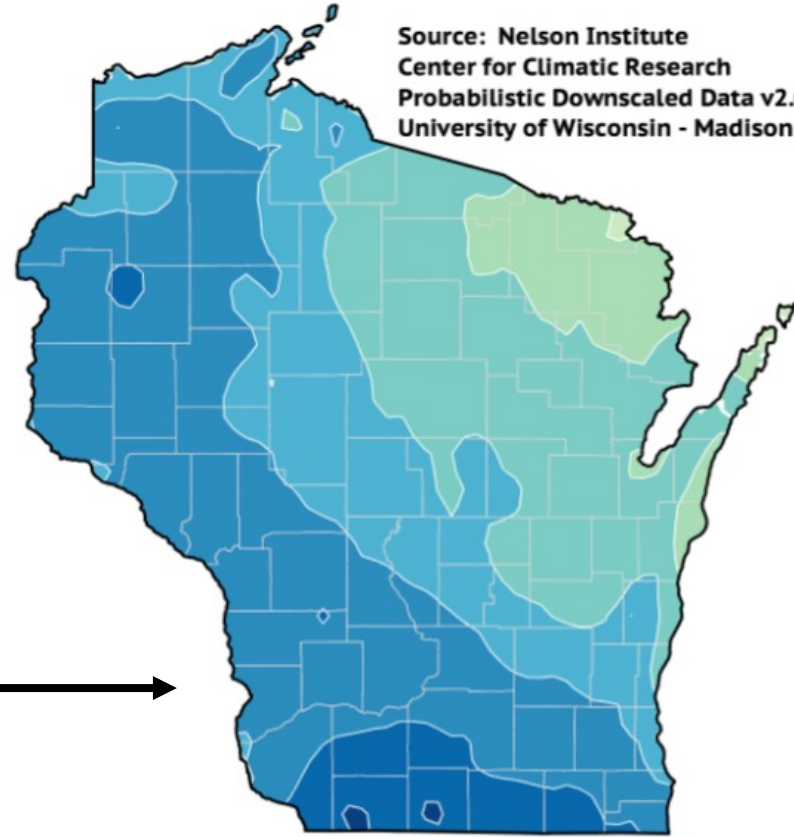
**PAST:** 1981-2010 average

Source: Nelson Institute  
Center for Climatic Research  
Probabilistic Downscaled Data v2.0  
University of Wisconsin - Madison



**FUTURE:** 2040-2060 average

Source: Nelson Institute  
Center for Climatic Research  
Probabilistic Downscaled Data v2.0  
University of Wisconsin - Madison



*Extreme rainfall to increase in the future throughout Wisconsin*

# **The Impacts and Preparations . . .**



# FEMA

## Multiple Mitigation Measures Give Darlington An Elevating Experience

**Darlington, WI** - Located in the southwestern corner of Wisconsin, this rural city was founded beside the Pecatonica River and officially given the name of Darlington in 1869. It has a well-run city government headed by a mayor and a population of 2,398. A police and fire department along with a supporting emergency medical treatment (EMT) unit serves the city. Darlington has its own 34-bed hospital complete with a heli-pad (it's an 18 minute flight to Madison). A modern nursing home with capability to care for 120 seniors is just two blocks down the street from the hospital.



*A Darlington business with flood shields installed shown during a 1998 flood.  
Photo: Phil Riseeuw, Darlington*

Darlington is also the county seat and home to the Lafayette County Fair.

### Long History of Flooding

During the past 172 years, this beautiful community has been at odds with the Pecatonica River, a medium-sized body of water that nearly encircles it with coils of brownish water at flood time. Normally, the river gently flows southward, then bends east until it bends abruptly north, east, south and east again, forming a tight horseshoe. It is at this horseshoe bend where trouble bubbles over and swamps Darlington when the river rises.

A sturdy concrete and steel bridge crossing the river connects Darlington's business district to the south side of town. It is in this low-lying area on the north bank of the river between the bridge and the horseshoe bend that waters from the Pecatonica most frequently invade downtown. Most of the buildings here date back to the mid-1800s and are of considerable historic importance. Across the bridge, the street continues up hill, away from the river, and passes through a residential area on its way to a rapidly-developing industrial park.



*Aerial view of Darlington showing flood-prone area between bridge over east-flowing portion of Pecatonica River and horseshoe bend.  
Photo courtesy of USGS*

## Darlington's Flood Hazard Mitigation Plan

- First in WI to get FEMA approval
- Businesses, homeowners, City
- elevate and relocate buildings
- install "flood shields" downtown
- alter access ramps to buildings
- Successful in floods of '07, '08, '19

# 2020: WICCI report to the Governor's Task Force on Climate Change



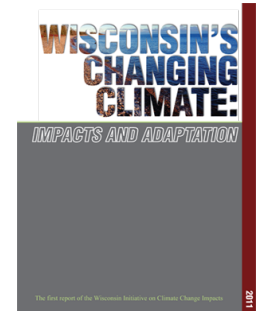
*Issues, Impacts, and Strategies*

# 2020: WICCI report to the Governor's Task Force on Climate Change



## 2021: New WICCI Assessment Report

- *First update since 2011*
- *Electronic format for rapid dissemination and easy updating*
- *Utilizes narratives to improve science communication*
- *Greater emphasis on climate justice*
- *Target audience is decision-makers (government, conservation, etc.)*
- *Includes climate change adaptation and mitigation strategies*
- *To be released this fall-winter*



# WICCI is partnering with Wisconsin communities



Monroe County Climate Change Task Force

Sauk County Emergency Management

Dane County Emergency Management Hazard Mitigation Plan

City of Madison Climate Resilience Planning



# Climate Vulnerability Assessment Summary

## City of Madison Operations

Type of Event	Current Impacts	Future Changes
Length of growing season	Landscaping, mowing, pest prevalence, suitability of plant species	Very likely to increase
Heavy precipitation	Infrastructure, erosion, disease, transportation, beach closures	Wetter, especially in winter-spring; more heavy rainfalls in all seasons
Snowfall	Road plowing and salting, traffic accidents, absenteeism	Less snow overall but possibly in heavier snowfall events
Ice	Road salting, traffic and pedestrian accidents	Possibly more ice storms as winter precip shifts to liquid
Winter melt events	Potholes, road salting, polluted runoff into lakes and streams	Very likely to increase
Hot weather	Buckled roads, AC costs, cooling centers, air quality, outside work time	More heat waves and humid conditions with muggy nights
Cold weather	Water mains/pipes, heating costs, ice jams, lake ice, health risks	Fewer cold waves eventually but uncertainty in near-term
Drought	Streamflow, lake levels, tree mortality, water usage, food supply	Uncertain but probably more likely during summer
Severe storms (hail, tornadoes)	Public safety, infrastructure, property damage	Uncertain

# Selected Weather/Climate Impacts from Survey

## City of Madison Operations

### Likely climate change impacts:

- Strained cooling capacity in CDA housing
- Increased staff demands for weather crises (storms, heat waves, floods)
- Road damage in high heat (more crashes, new pavement designs needed)
- Greater stormwater retention needs
- Different tree species needed
- Parking garage flooding
- Degraded water quality from additional runoff (and heat) → beach closures
- Ruined paper recycling and more waterlogged trash to landfill during floods

### Possible climate change impacts:

- Pothole changes?
- More salt use on streets and walkways or less?
- More water main breaks with less snow cover?
- Greater tree damage (rainstorms and glazing) → more lawsuits?

### Expected climate change benefits:

- Lower maintenance costs for equipment
- More time to work on maintenance
- Lower heating bills (but higher cooling costs)
- Less need for public warming centers but more need for cooling centers

# Conclusions

- The Science: warmer and wetter in Wisconsin, now and in the future
  - Climate change is becoming increasingly costly
  - More extreme rainfalls are expected
- The Impacts: flooding, extreme heat, more winter melt events, longer growing seasons
- The Preparation: community vulnerability assessments are needed
  - Each community has unique vulnerabilities and opportunities
  - Recent climate change and extreme weather have provided “stress tests”
  - Seek “win-win” strategies that improve resilience and offer other benefits

