Resilient Waters, Resilient Cities
Climate Change in the Great Lakes

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MICHIGAN STATE UNIVERSITY

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Outline

1. Climate Change in the Great Lakes
2. Impacts on Water and Cities
3. Acting Through Uncertainty

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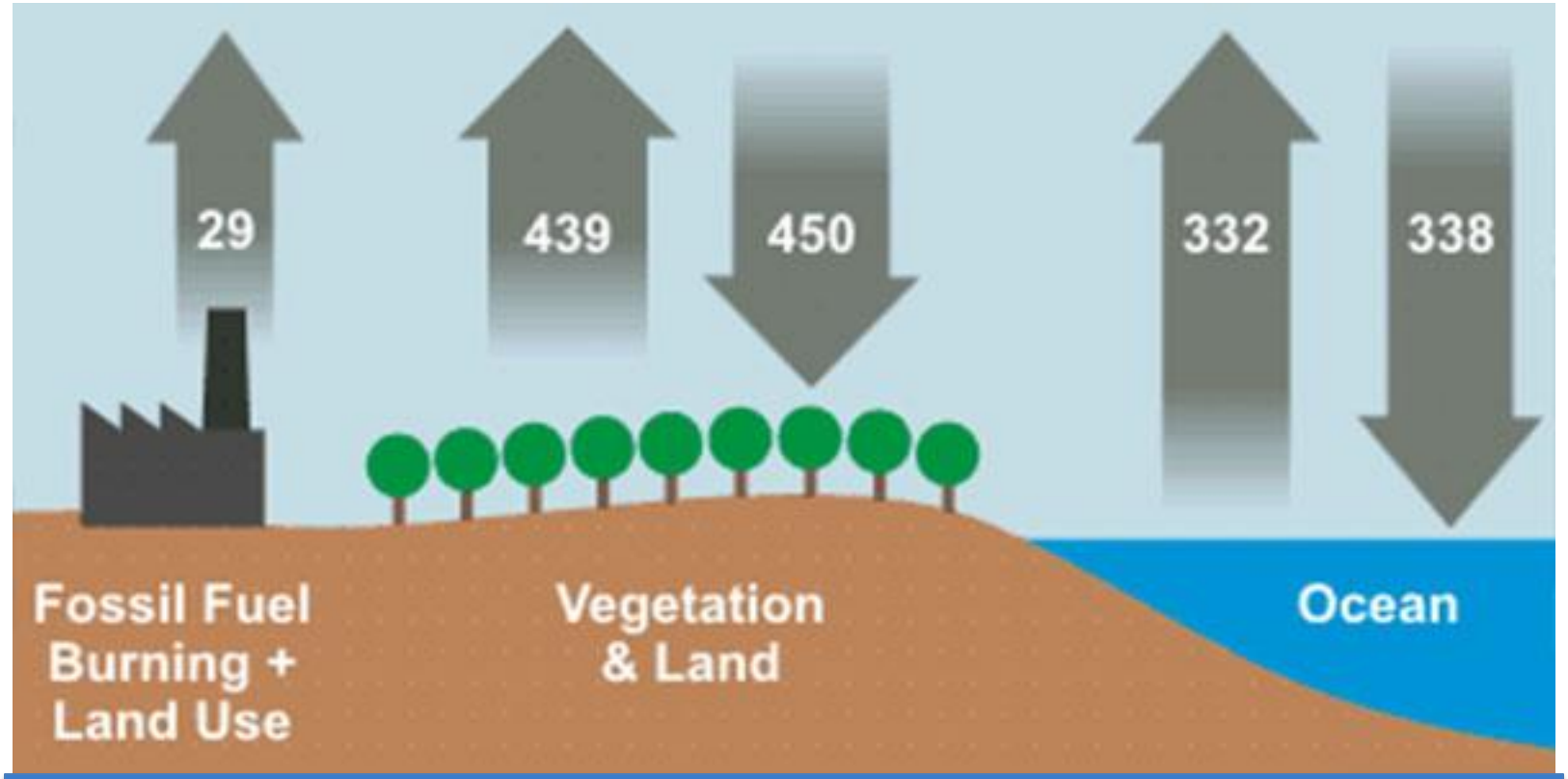
Global Carbon Cycle



The natural cycle adds and removes CO_2 to keep a balance. Humans add extra CO2 without removing any.

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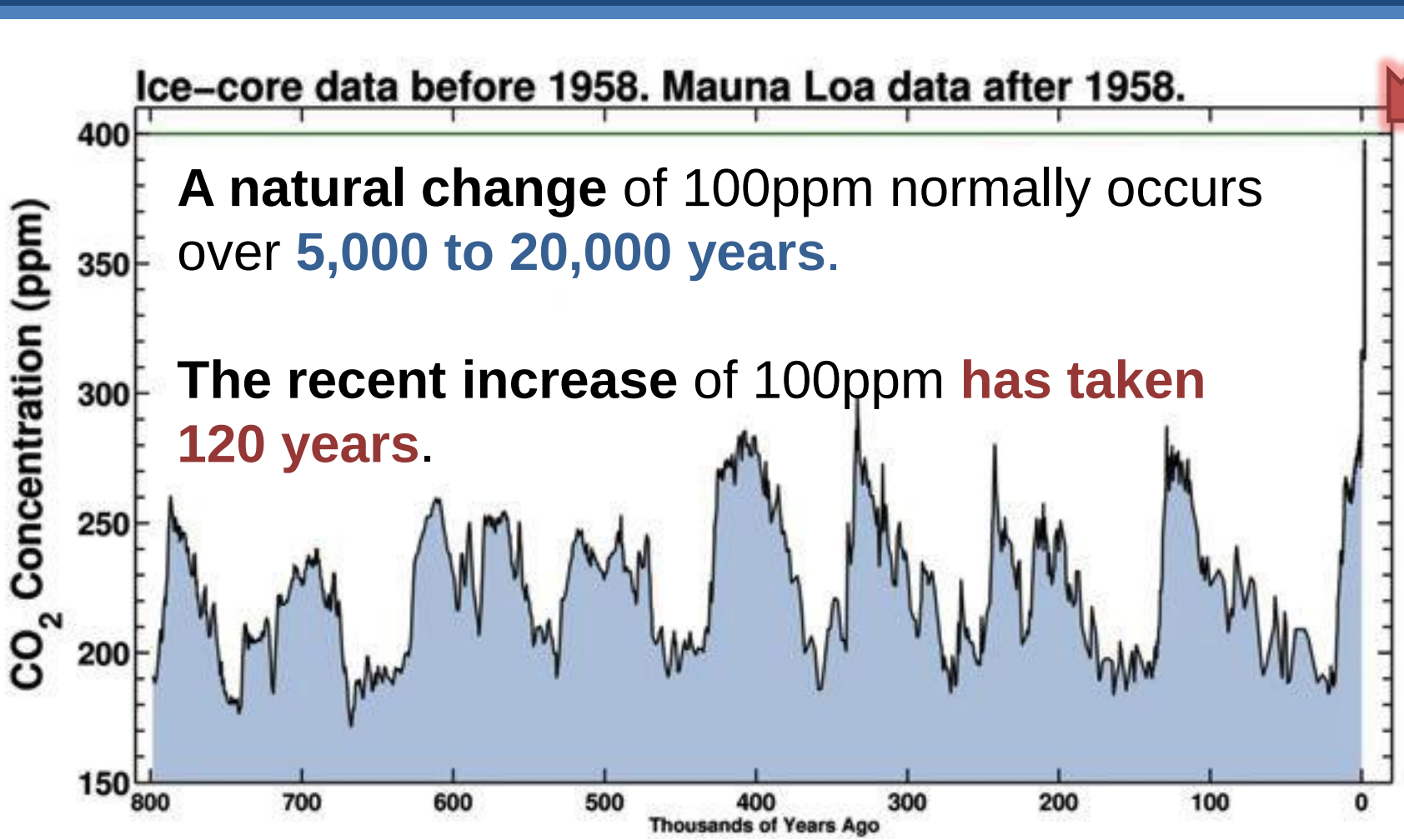
Historic Carbon Dioxide Concentration



Fact Source: EPA. Image Source, Scripps Institute of Oceanography

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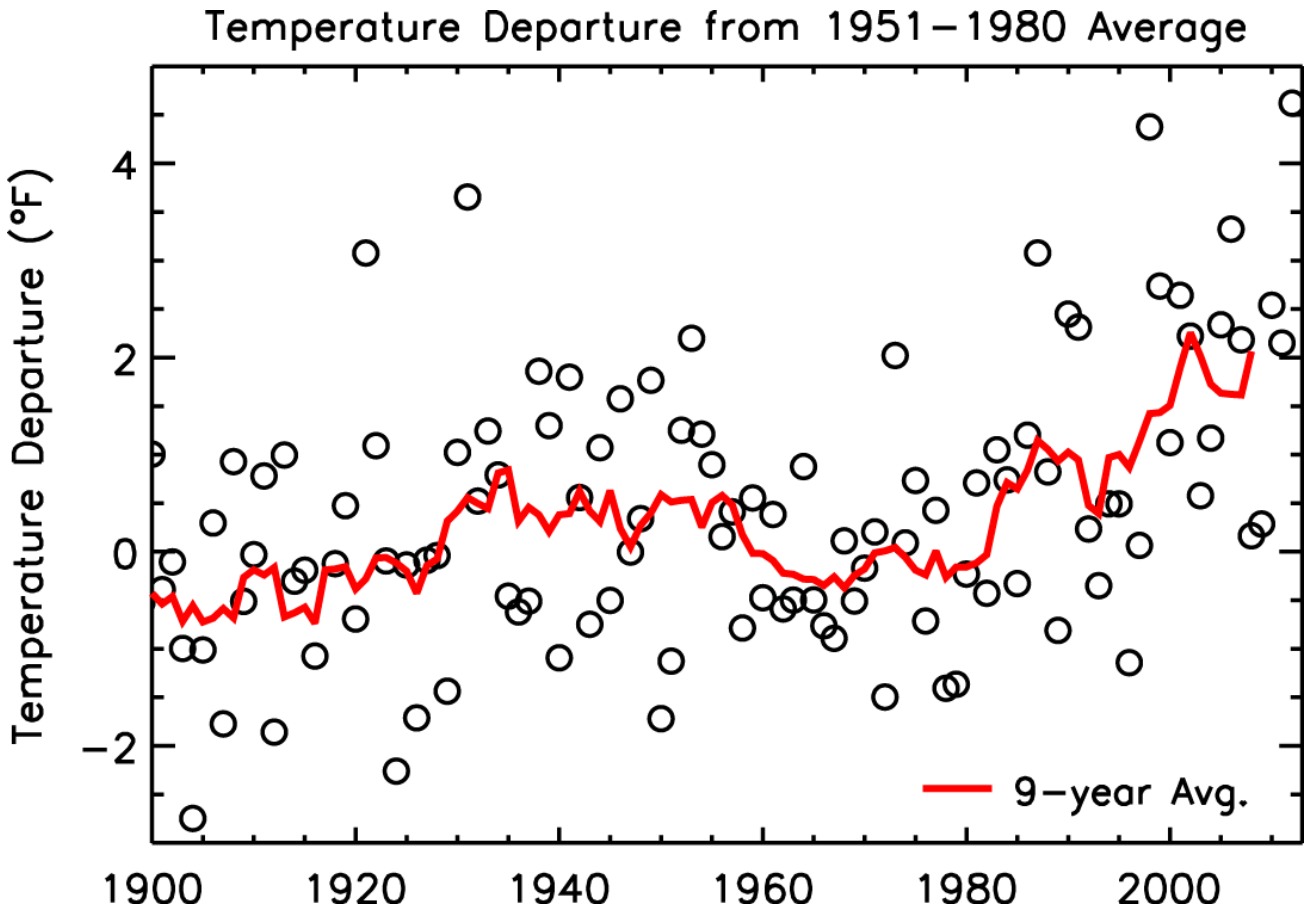
Observed Regional Temperature



2.0°F
1.1°C
1900-2012

Winter temperatures and overnight low temperatures have increased faster than annual averages.

Weighted averages of nClimDiv divisional data from 8 U.S. Great Lakes States.

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Observed Heat Waves

The number of heat waves that pose risks to human health have increased in most major Midwestern cities.

Increasing overnight, minimum temperatures have increased at a faster rate, limiting relief during hot periods.

Observed Change in Number of Harmful Heat Waves

Chicago, IL
1948–2011
(63 years)

Increased 1 per year

Detroit, MI
1959–2011
(52 years)

Increased 2 per year

UCS Heat in the Heartland, 2012

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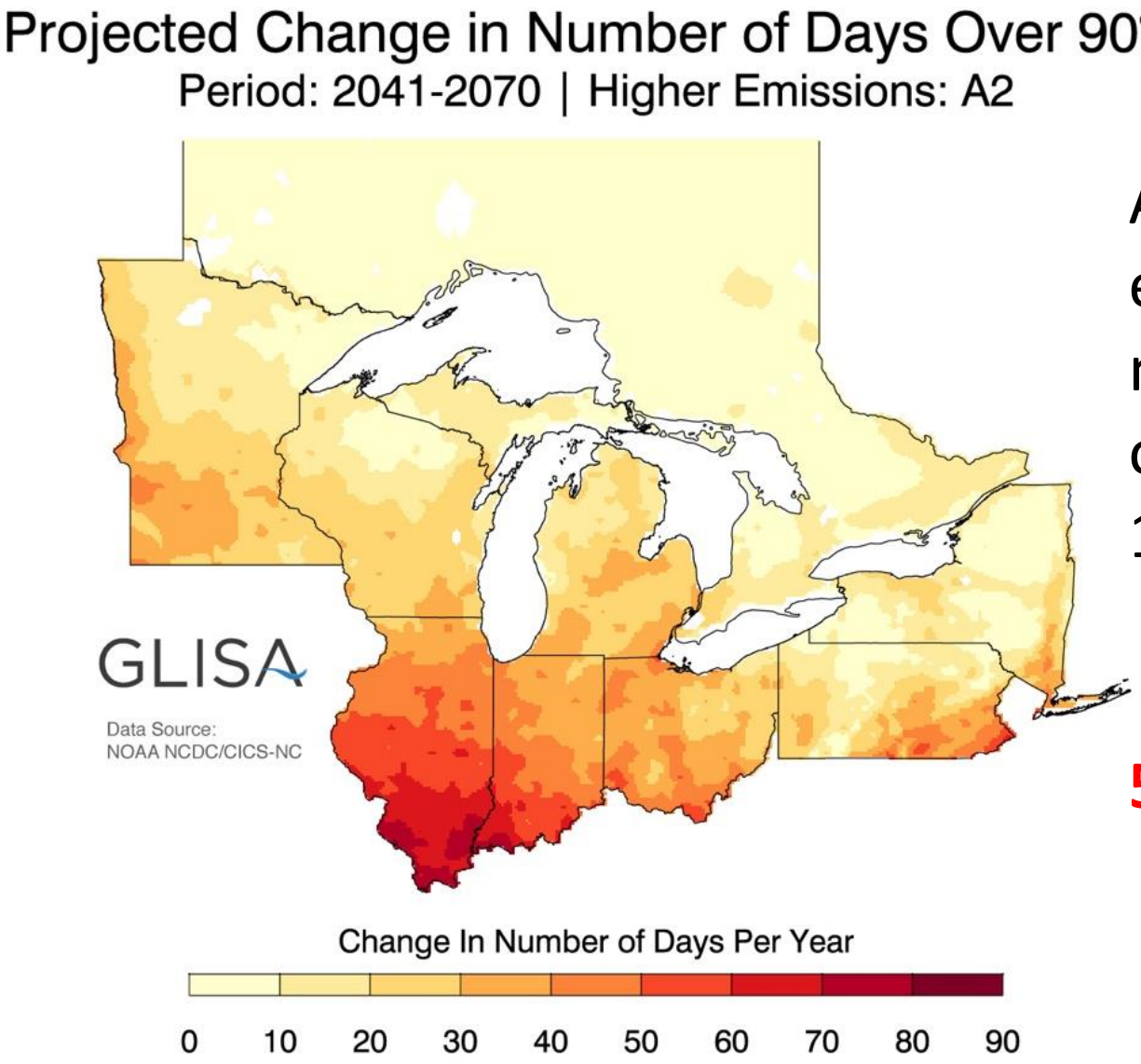
More Hot Days Anticipated



Ann Arbor, MI could experience **25-35** more days on average over 90 degrees vs. 1971-2000

5-10 more days over 95 degrees.

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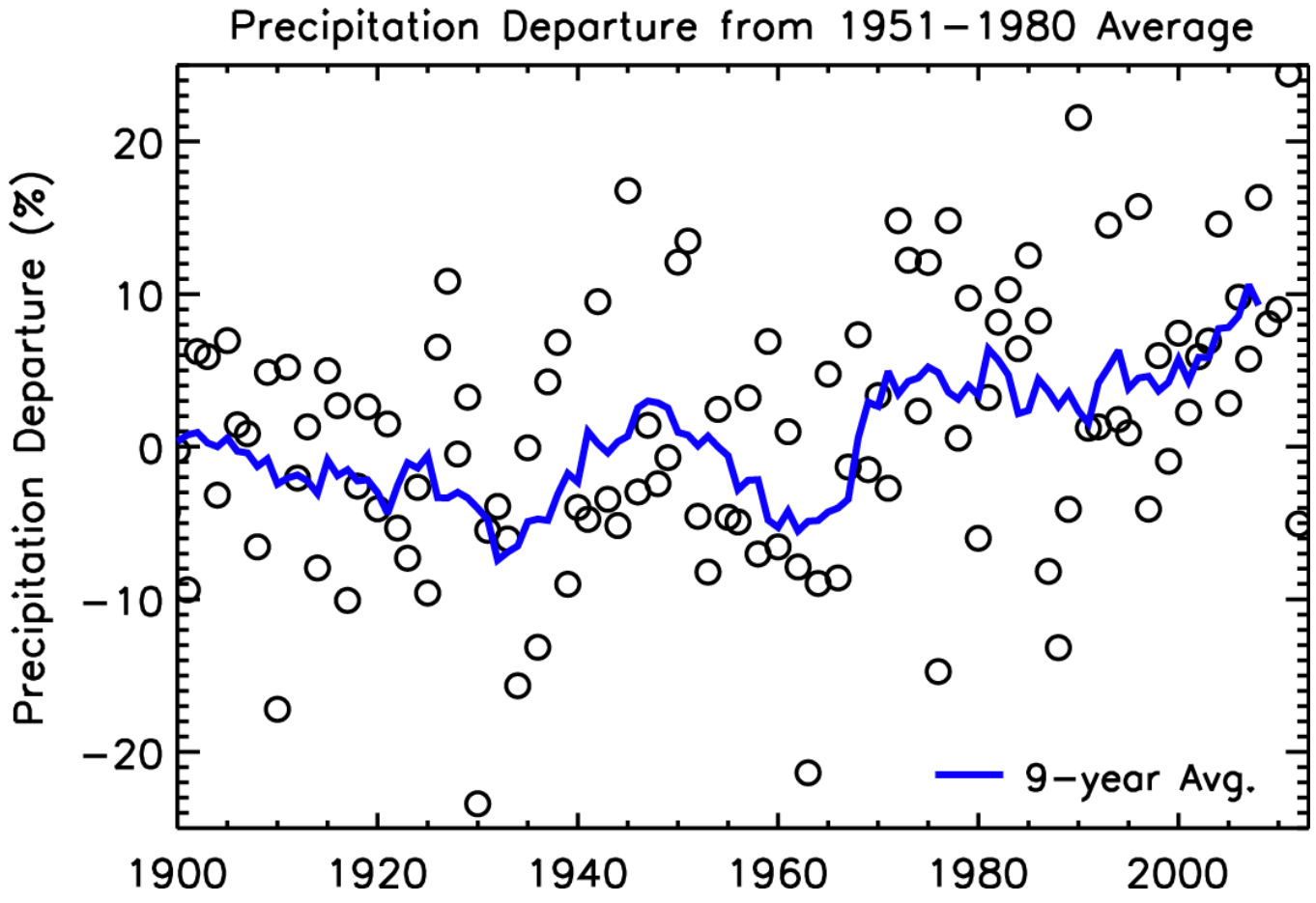
Observed Regional Precipitation



11%

1900-2012

Precipitation is variable. Some areas have seen declines while the region overall has seen an increase.

Weighted averages of nClimDiv divisional data from 8 U.S. Great Lakes States.

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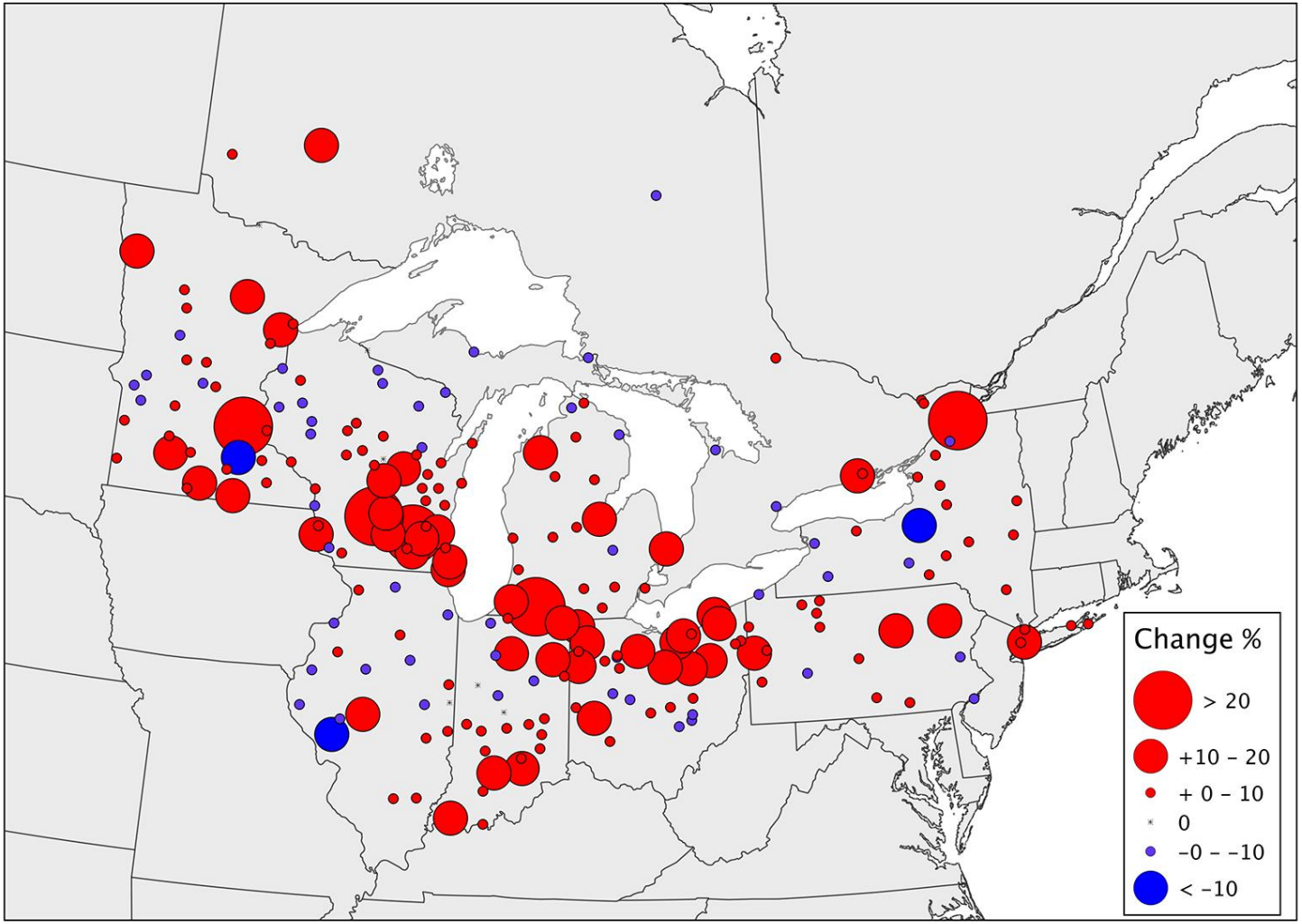
Observed Extreme Precipitation

Observed Changes (%) in the Intensity of the 1% Heaviest Precipitation Days
(1951-1980 vs. 1981-2010)



Following method

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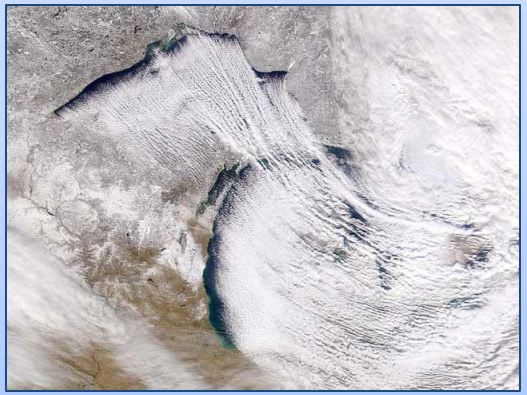
Changing Precipitation Seasonality

- Shorter winters have lead to more precipitation falling as rain instead of snow.
- Warmer surface temperatures have reduced snow accumulation.



- More lake effect precipitation events have increased snowfall in some areas.

Photo credits: Umich.edu, NASA, weather.com

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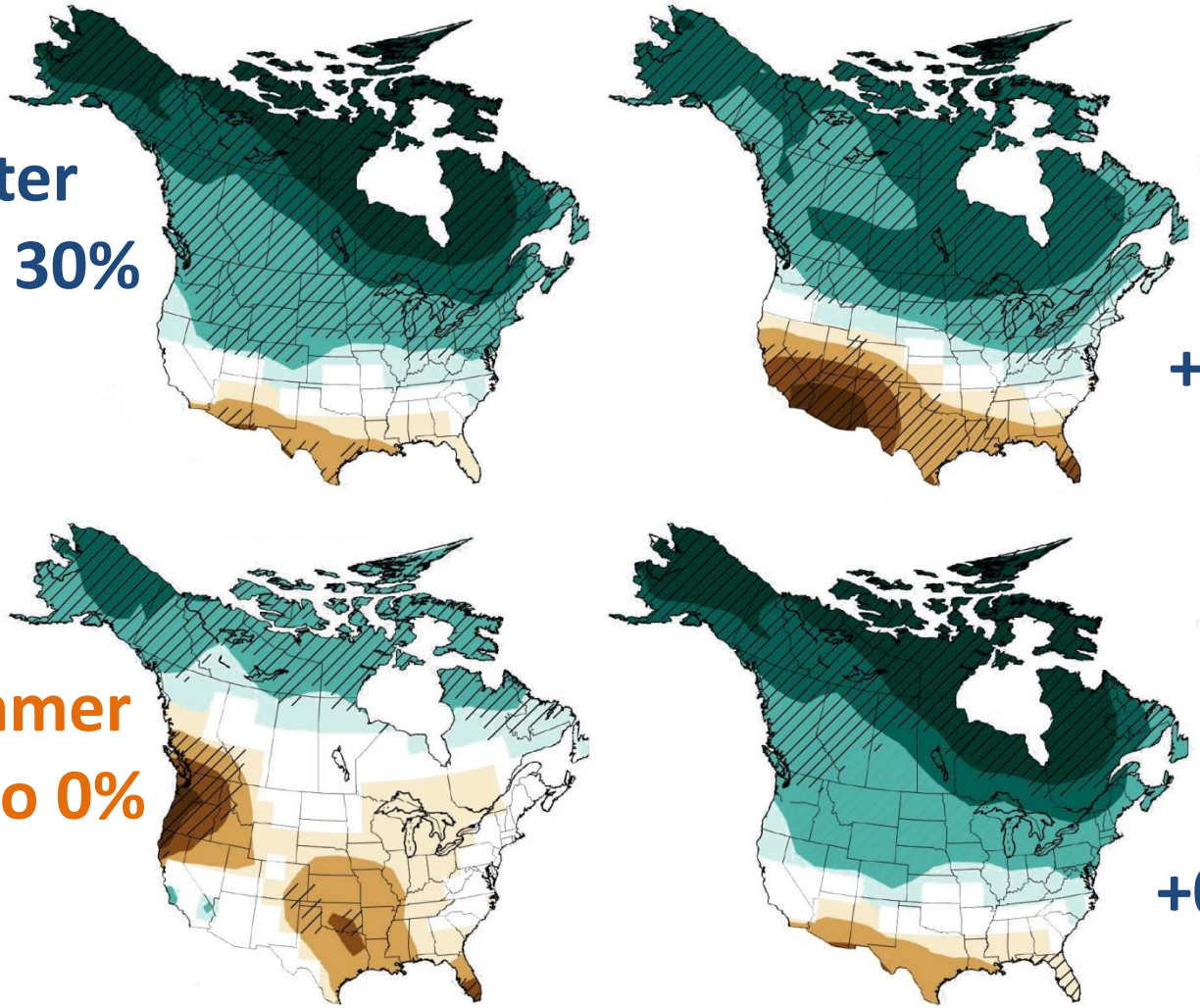
Projected Precipitation



Winter
+10 to 30%

Annual
+5 to 20%

Spring
+0 to +30%

Summer
-20 to 0%

Fall
+0 to +30%

NOAA NCDC / CICS-NC

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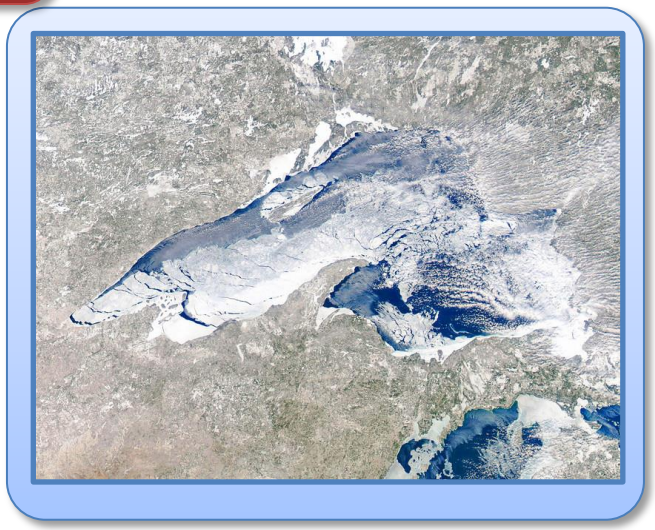
The Great Lakes are Warming

Average Great Lakes ice coverage
declined 71% percent from 1973 to 2010

Wang et al., 2012



NASA

- Lake Superior is warming twice as fast as nearby air.
- Winter ice cover is decreasing.
- Lake Superior could have little to no open-lake ice cover during a typical winter within the next 30 years.

Austin and Colman, 2007

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Impacts of Climate Change in the Great Lakes Region

Changes in temperature and precipitation throughout the region will lead to many impacts in both engineered and natural environments.










Water
Energy
Forests
Agriculture
Biodiversity
Public Health
Transportation
Fish and Wildlife
Tourism and Recreation

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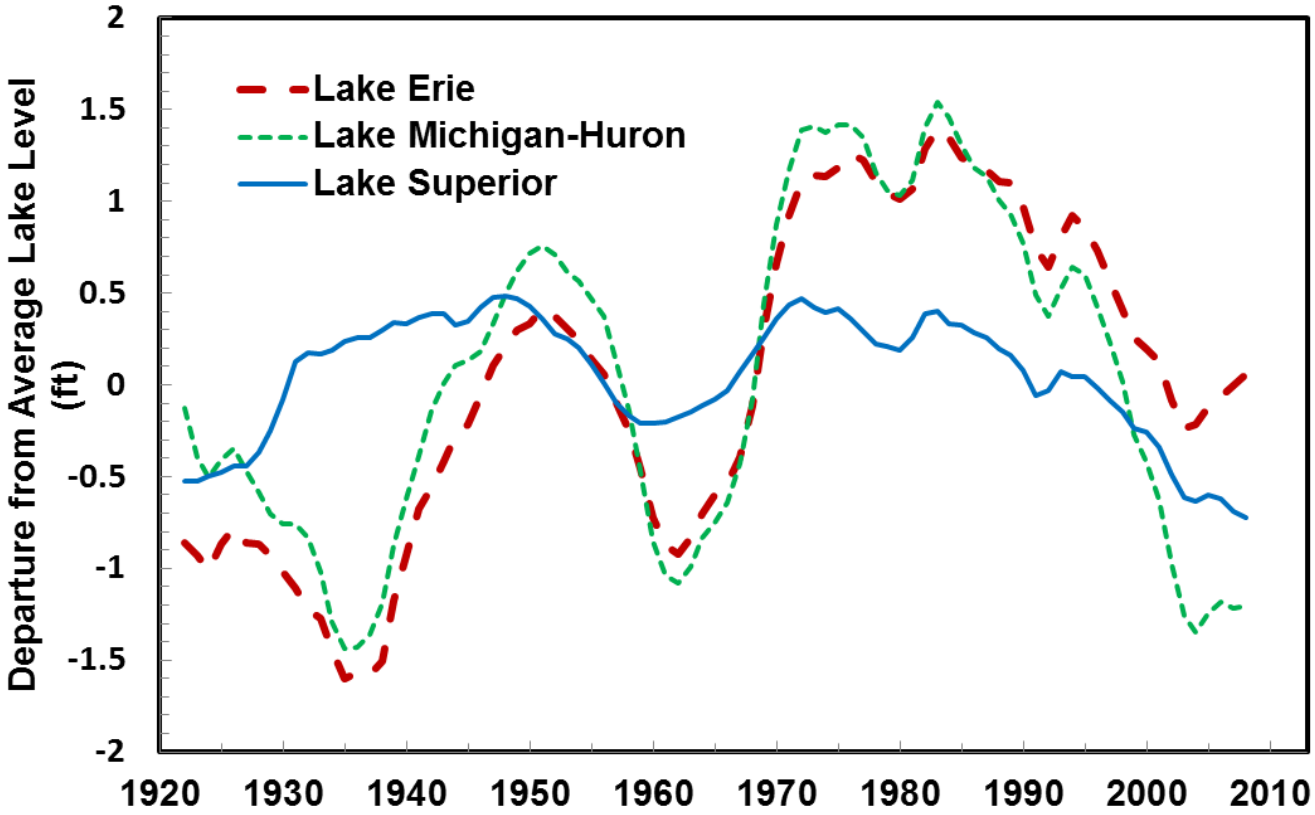
Lake Levels



Lake levels have declined since reaching record highs in the 1980s.

While most models project continued declines in long-term lake levels, there remains significant uncertainty.

Short-term variability and periods of high lake levels are still anticipated.

GLERL Great Lakes Water Level Dashboard

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Potential Impacts on Shipping

Every lost inch of water depth:

- **Reduces cargo capacity 50-270 tons**
- **Costs $10k-30k per transit.**

…but less lake ice cover allows for a longer shipping season

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Flooding and Stormwater

With increased extreme precipitation events, intense, flashy runoff amplify flooding risks.

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Water Quality

A combined sewage overflow plume in the Detroit River. Credit: Robert Burns, Detroit Riverkeeper

Lake Erie algal bloom, Oct. 20, 2011. Warmer lake surface temperatures conspire with nutrients from runoff and combined sewer overflows to exacerbate toxic algal blooms and raise public health concerns. Photo courtesy of NASA.

Rising temperatures, degrading infrastructure, and more severe precipitation may conspire to increase risks to water quality.

The impacts could be felt in many sectors, including public health, recreation and tourism, and environmental management.

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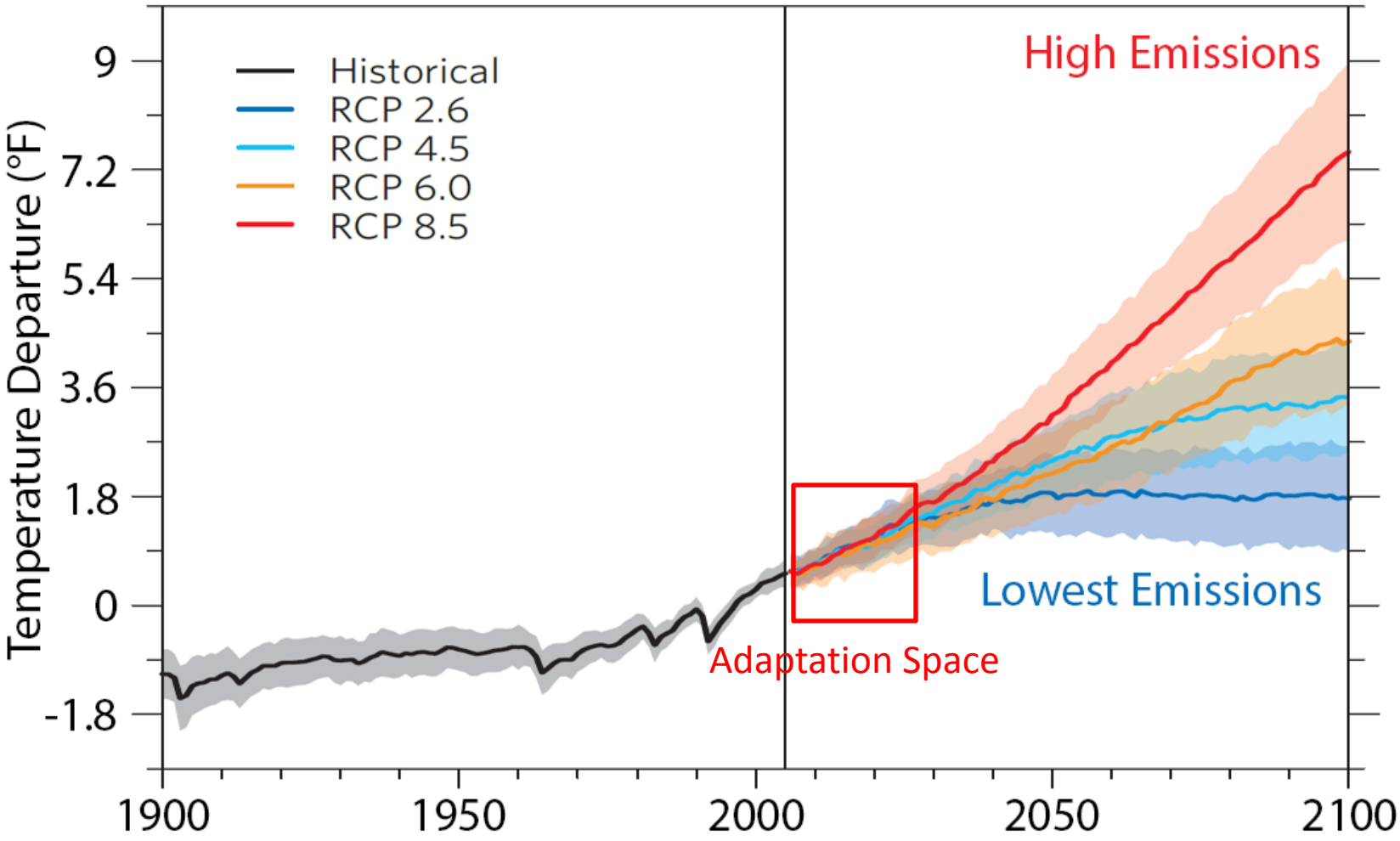
Coping with Uncertainty



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Scale Matters: Global, Regional, Local



Global trends are more certain than regional trends.

Natural variability plays a larger role at the regional scale.

Local changes in land use can alter the severity of climate change impacts.

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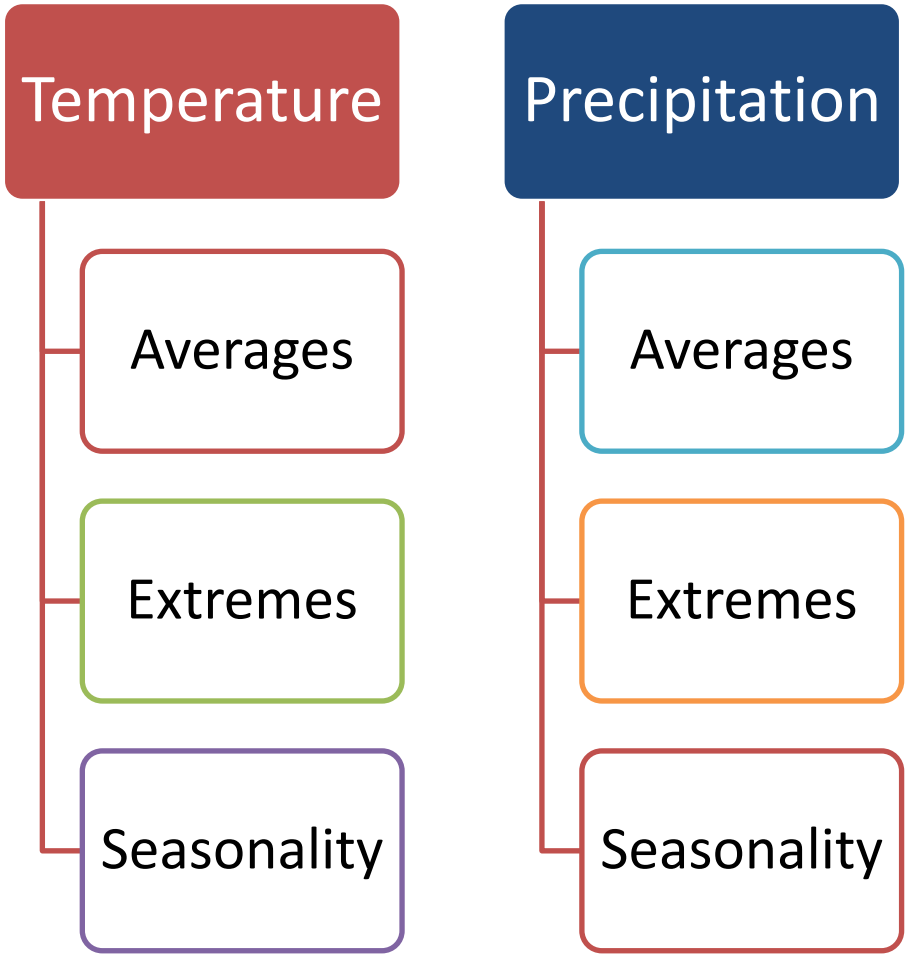
What has Changed?



Scientists often discuss changes in terms of averages, but *our environments are managed in terms of timing and extremes.*

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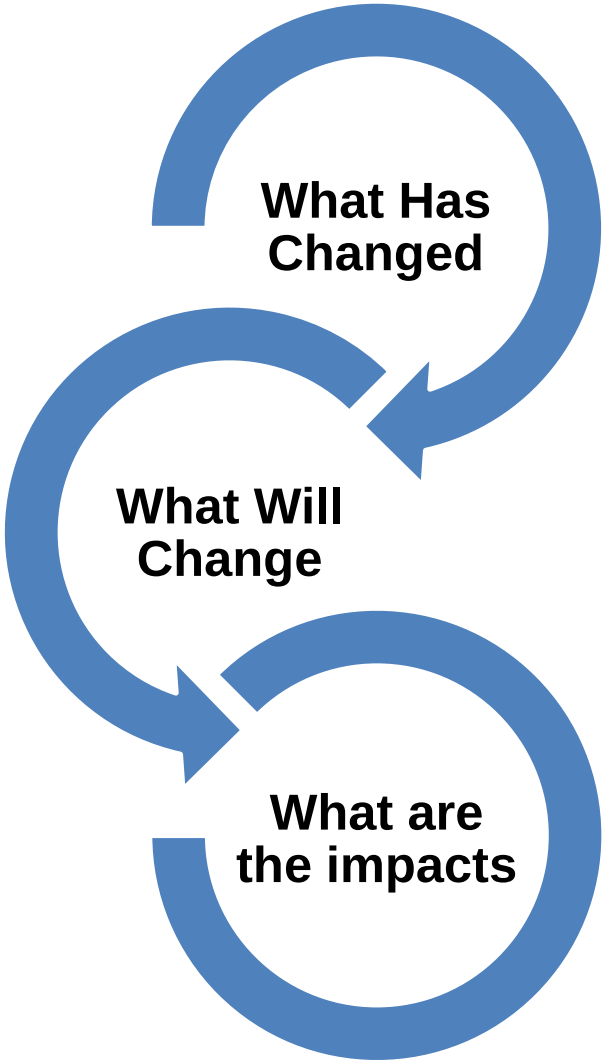
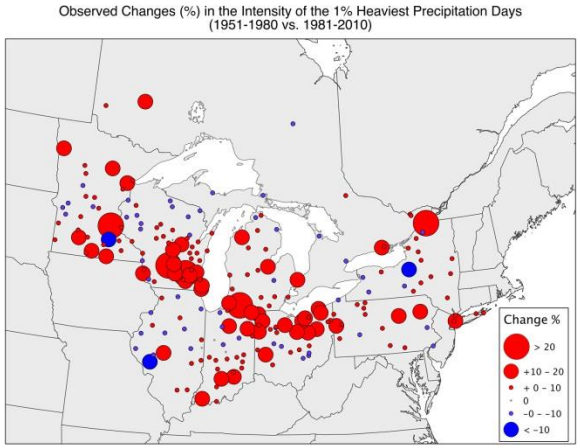
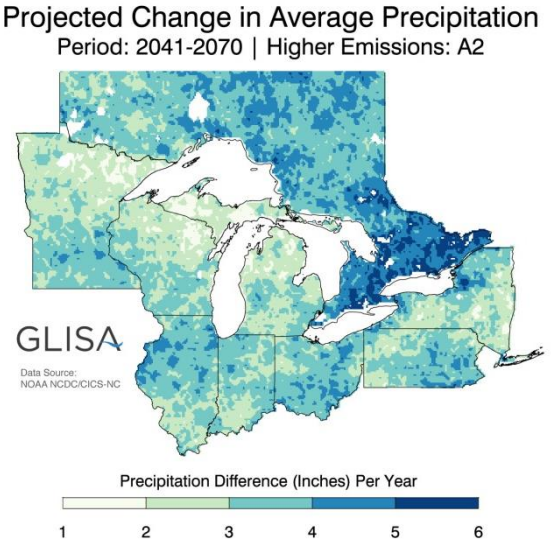
Decision Rubric







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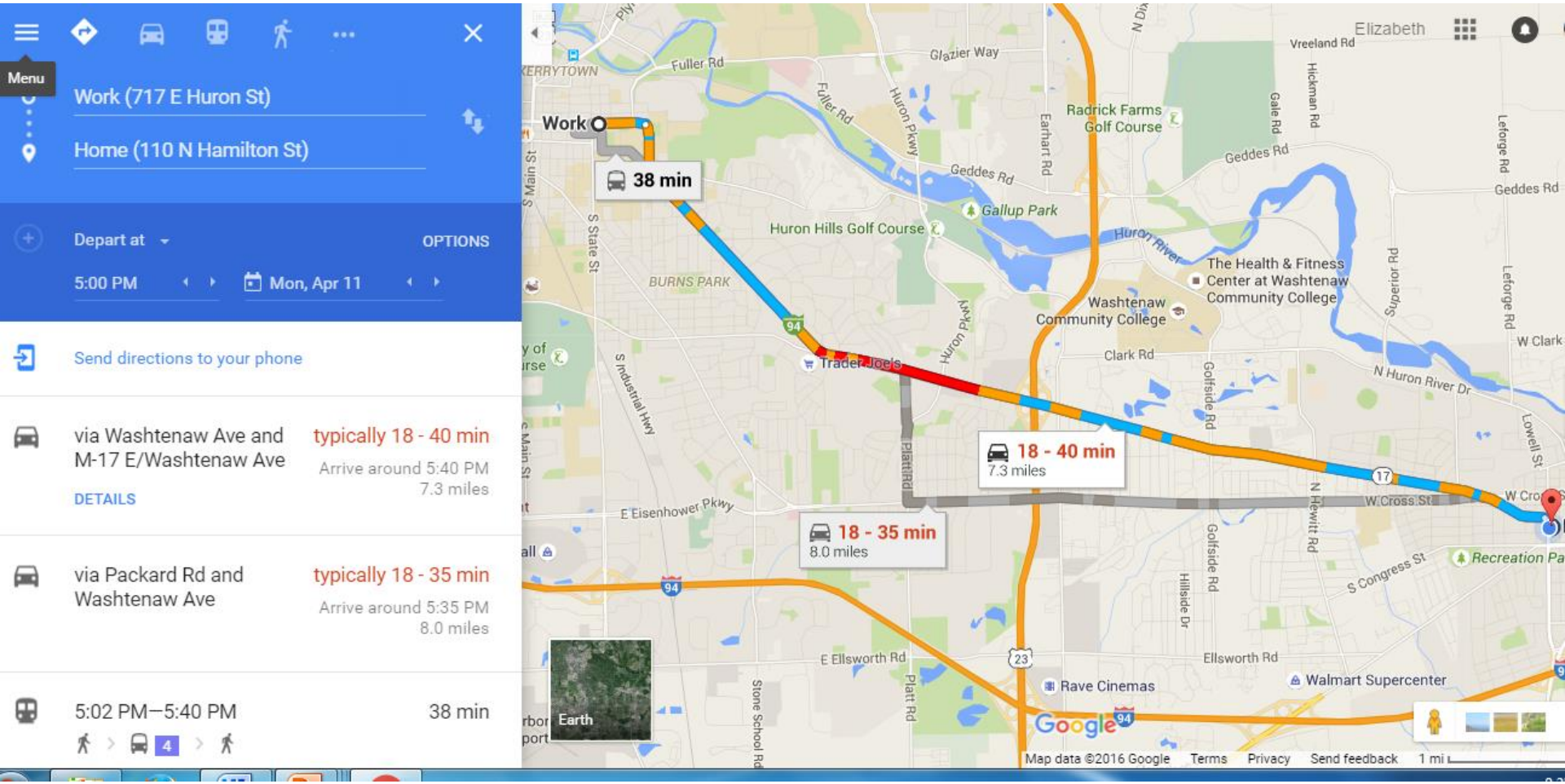
Recognizing Uncertainty



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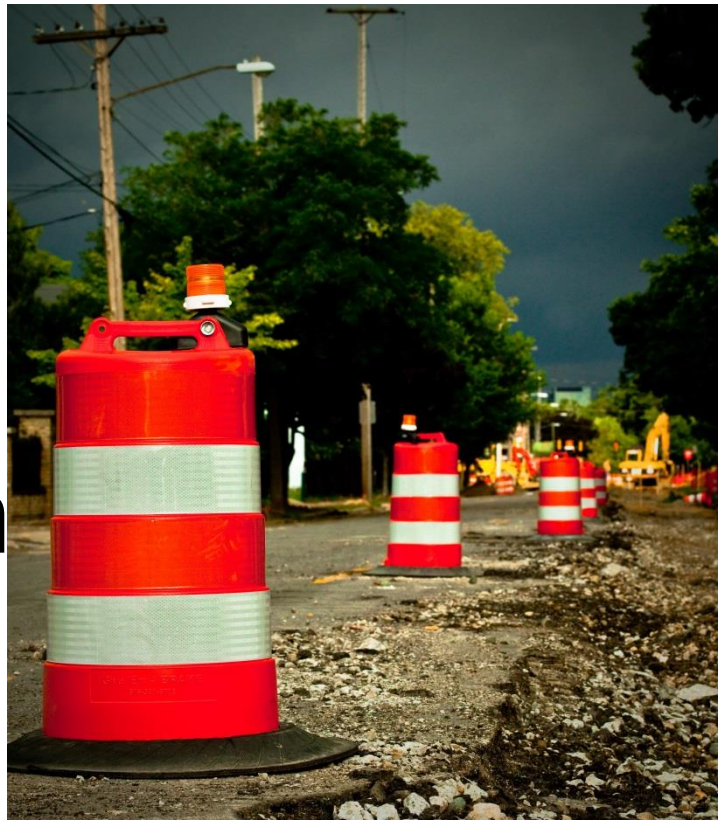
Moving to Action

- Gather the facts
- Find a community
- Develop adaptive management solution
- **Act!**



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Research

Service

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www.graham.umich.edu/climate

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