Climate change impacts on the Great Lakes / St. Lawrence region

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University of Nebraska-Lincoln

LimnoTech; Ann Arbor, Michigan

University of Nebraska Lincoln

Great Lakes and St. Lawrence Cities Initiative

LimnoTech Water Environment | Scientists Engineers

Climate change impacts on the Great Lakes / St. Lawrence region

Outline

- Information sources
- Global climate change: An overview
- Regional and local impacts

Adapting to Climate Change and Variability in the Great Lakes-St. Lawrence Basin

PROCEEDINGS OF A BINATIONAL SYMPOSIUM

May 13 - 15, 1997
Skydome Hotel
Toronto, Ontario, Canada

"The climate change issue is so multifaceted, so far-reaching and complex that no single discipline can answer all the questions and provide all the needed expertise."

Edited by Linda D. Mortsch, Soonya Quon, Lorraine Craig, Brian Mills, and Barbara Wrenn

Environmental Adaptation Research Group (EARG)

April 1998

Information sources

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP
Languages | IPCC web pages | Search

Assessment Reports

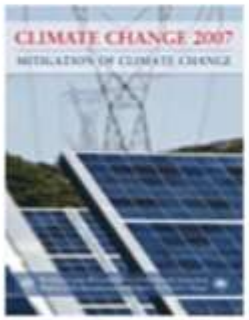
Assessment Reports

IPCC Fourth Assessment Report: Climate Change 2007 (AR4)

IPCC **statement** on the melting of Himalayan glaciers - 20 January 2010 (PDF)

Working Group I Report
"The Physical Science Basis"

Working Group II Report
"Impacts, Adaptation and Vulnerability"



Working Group III Report
"Mitigation of Climate Change"

The AR4 Synthesis Report

Information sources

globalchange.gov
U.S. Global Change Research Program

Thirteen Agencies, One Vision: Empower the Nation with Global Change Science

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National Climate Assessment: Draft Report Information

Below you will find information about the draft of the Third National Climate Assessment Report. Although the public comment period is now closed, the draft report is still available for download at http://ncadac.globalchange.gov. Click here to view/print a two-page fact sheet about the National Climate Assessment.

- What is the National Climate Assessment (NCA)?
- What are the objectives of the NCA?
- What is new about the Third NCA?
- Who is responsible for the NCA?
- How do I comment on the draft NCA report?
- What topics are covered in the Third NCA Report?
- Next steps
- Expected outcomes and benefits
- How can I get involved in the NCA?

What is the National Climate Assessment (NCA)?

Information sources

Natural Resources Canada | Ressources naturelles Canada

Canada

Natural Resources Canada

www.nrcan.gc.ca

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Home > Earth Sciences > From Impacts to Adaptation: Canada in a Changing Climate 2007

Earth Sciences

- Earth Sciences Home
- Climate Change
- Energy and Minerals
- Geography and Boundaries
- Groundwater
- Natural Hazards

Products and Services

- Maps
- Photos, Imagery and Videos

From Impacts to Adaptation: Canada in a Changing Climate 2007

From Impacts to Adaptation: Canada in a Changing Climate 2007 reflects the advances made in understanding Canada's vulnerability to climate change during the past decade.

Through a primarily regional approach, this assessment discusses current and future risks and opportunities that climate change presents to Canada, with a focus on human and managed systems. It is based on a critical analysis of existing knowledge, drawn from the published scientific and technical literature and from expert knowledge. The current state of understanding is presented, and key knowledge gaps are identified.

Advances in understanding adaptation, as well as examples of recent and ongoing adaptation initiatives, are highlighted throughout the report.

National Climate Assessment: Midwest Technical Input Report

At the request of the U.S. Global Change Research Program, GLISA and the National Laboratory for Agriculture and the Environment formed a Midwest regional team to provide technical input to the National Climate Assessment (NCA). In March 2012, the team submitted their report to the NCA Development and Advisory Committee. The following white papers comprised the chapters of the report, focusing on the potential impacts, vulnerabilities, and adaptation options to climate variability and change across many sectors. The white papers were subject to review by at least two external reviewers and revised to reflect reviewer comments.

Midwest Technical Input Report White Papers

Great Lakes Climate

National Climate Assessment: Midwest Technical Input Report
Great Lakes Climate
Great Lakes Station Climatologies
Great Lakes Climatic Divisions
2011 GLISA Symposium
2012 GLISA Symposium
Stakeholder Reports

Global climate change: An overview

“Climate is what you expect ...”

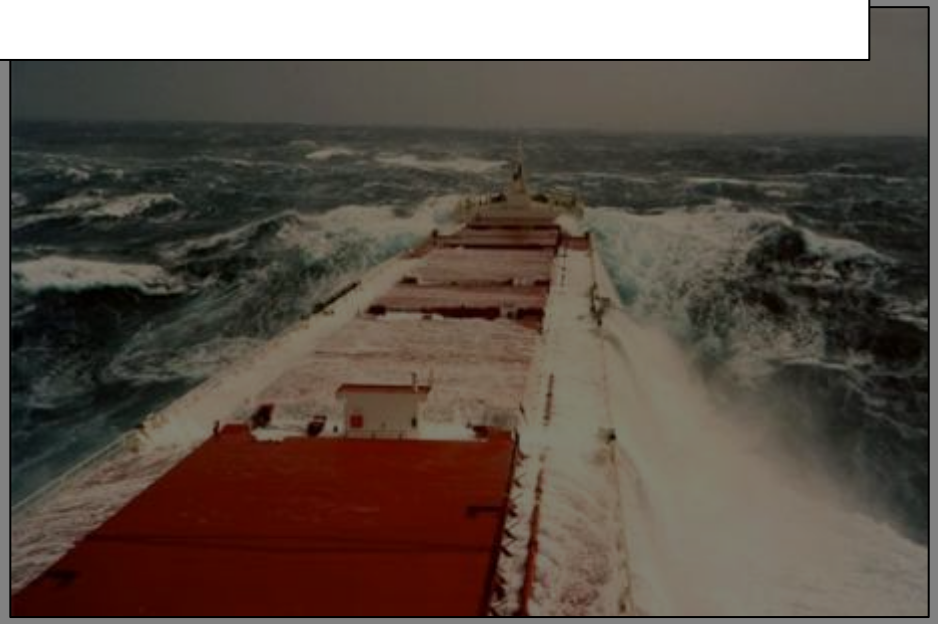
“Climate is what you expect ...”

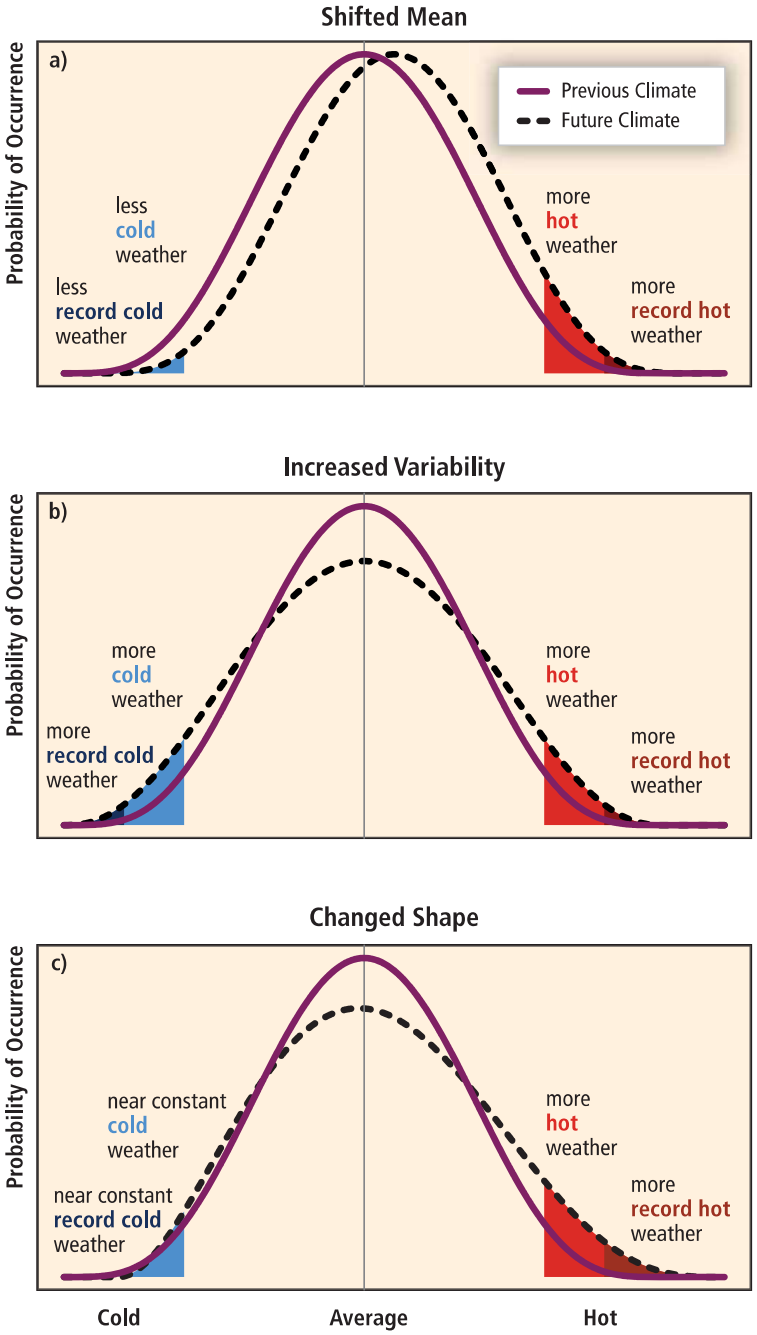
“Weather is what you get.”

“Climate is what you expect ...”

“What we expect” … is changing

“Weather is what you get.”

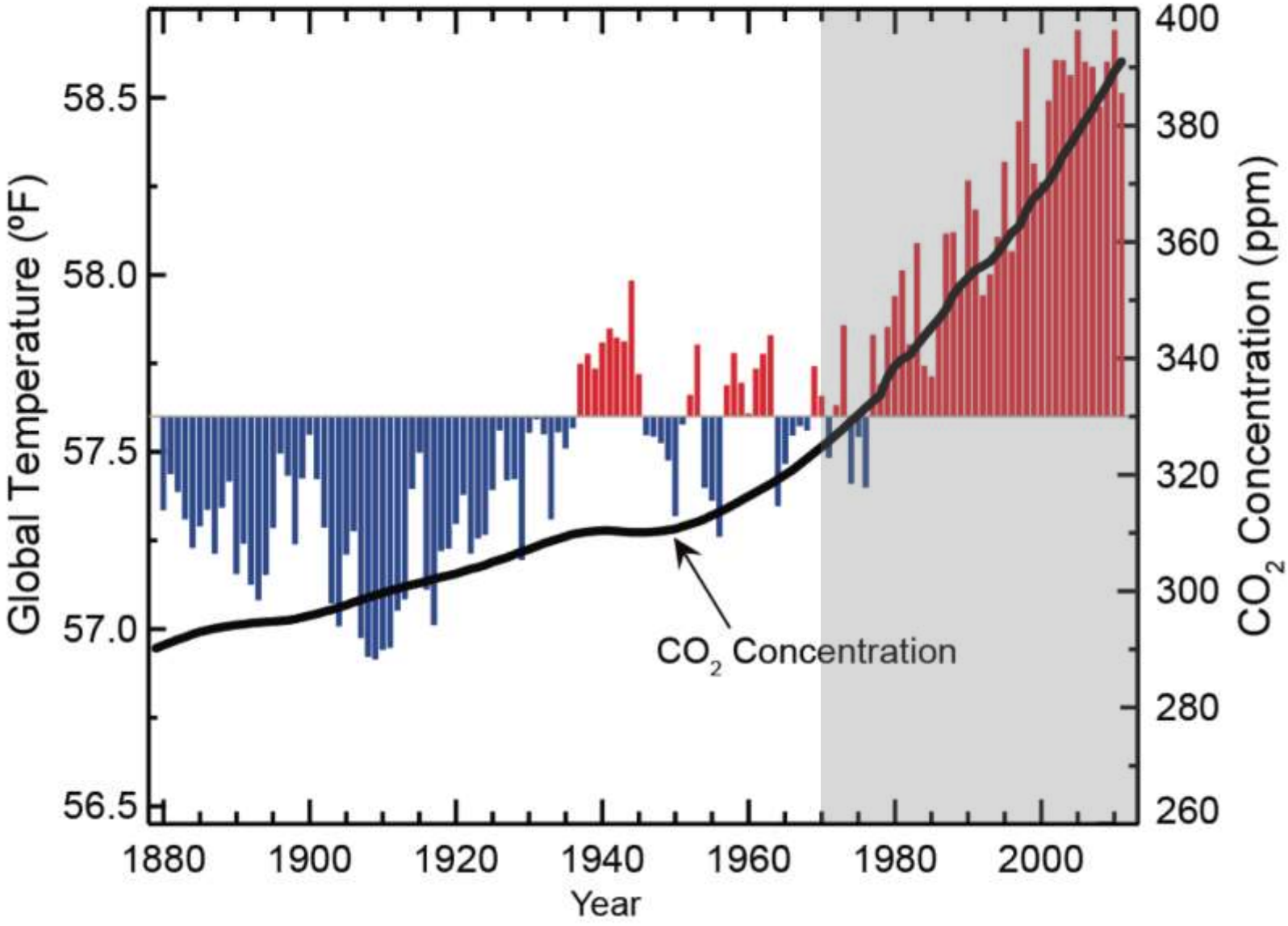




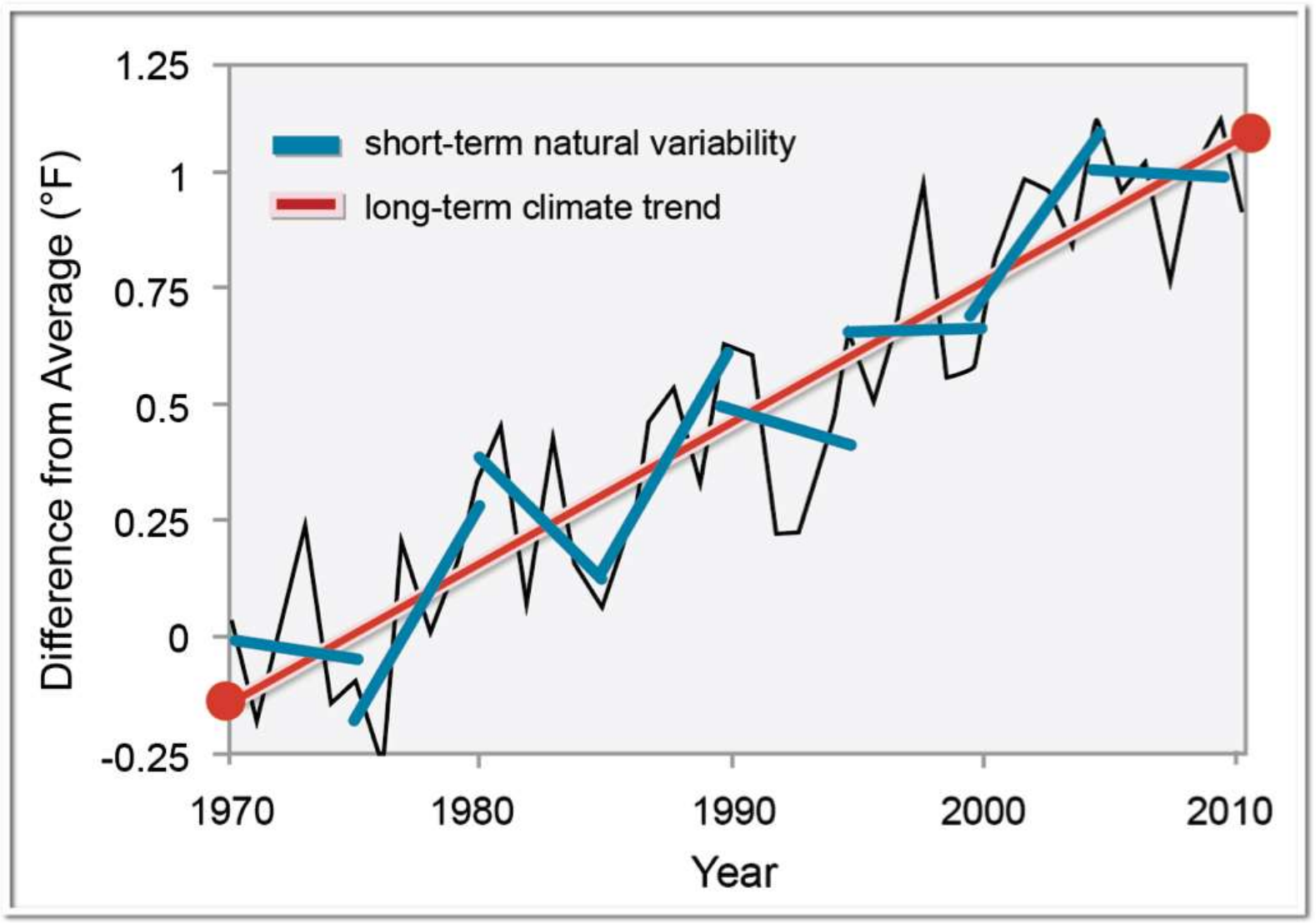
Or in other words …

- Expect the unexpected
- Likely to be warmer, wetter conditions (generally)
- But more extremes, more variability, more drought
- Expect the science to evolve and improve
- Cities should plan for long-term change; adapt / mitigate

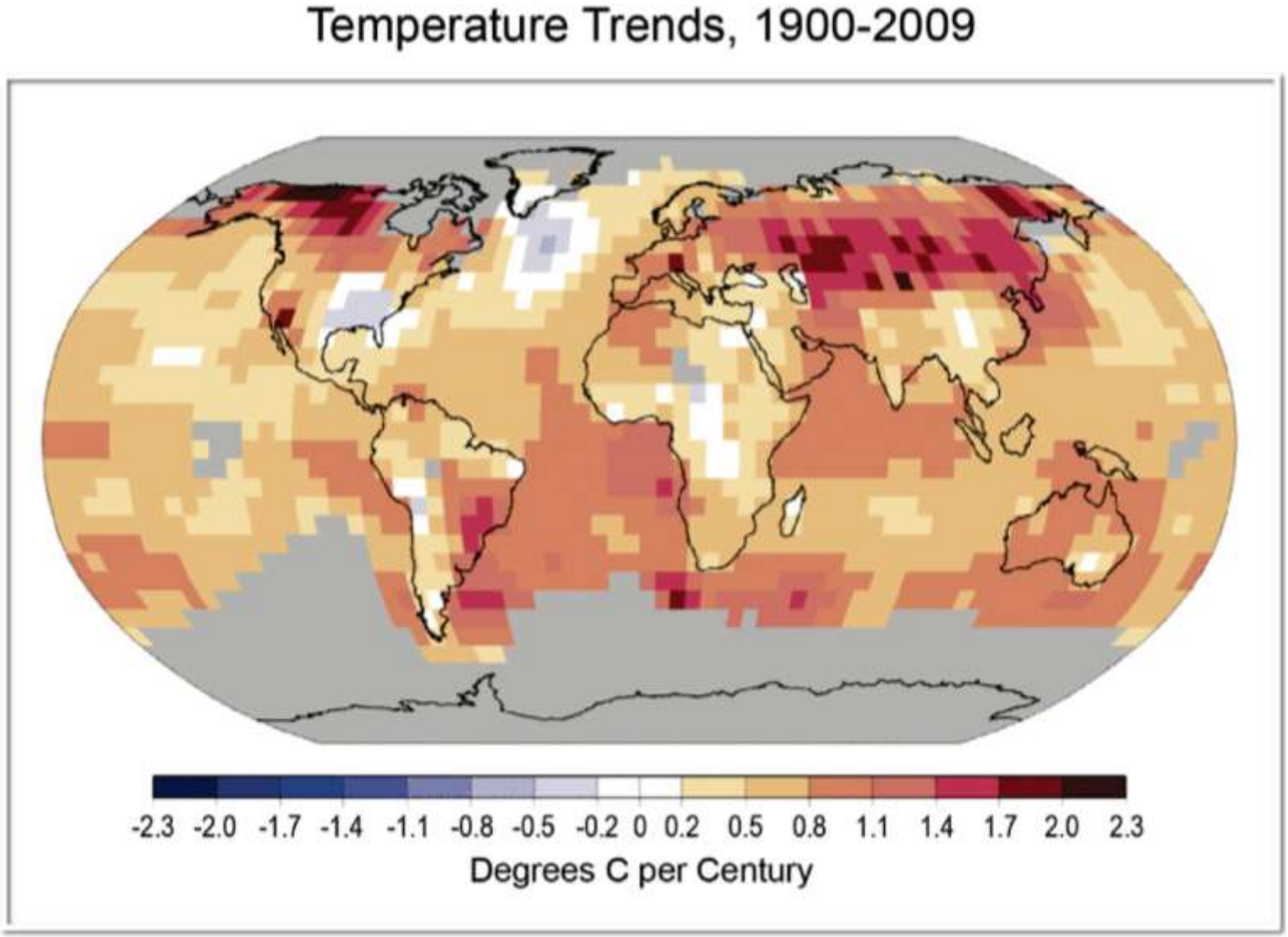
“What we expect” is changing



The changes are not uniform in time

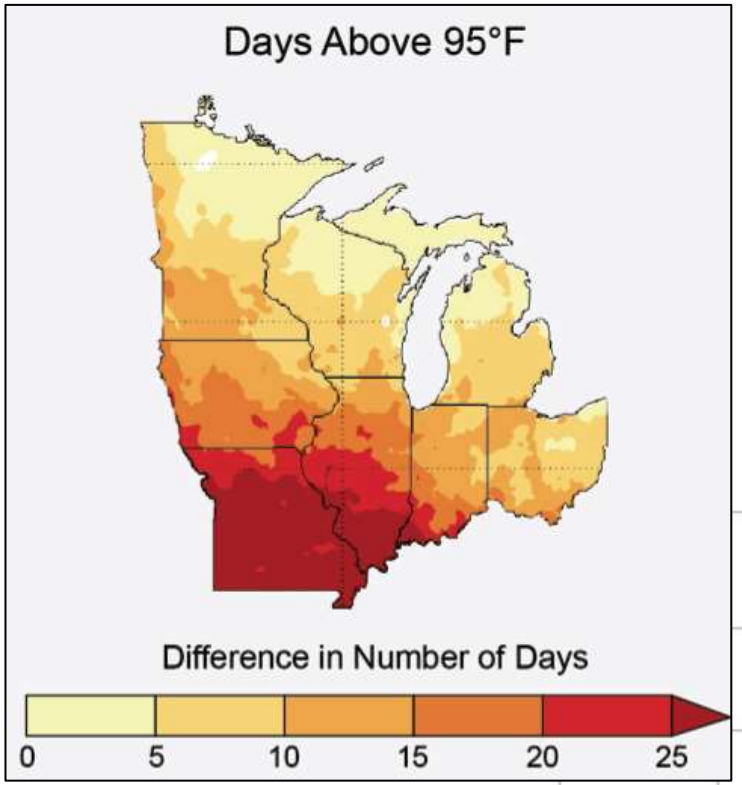


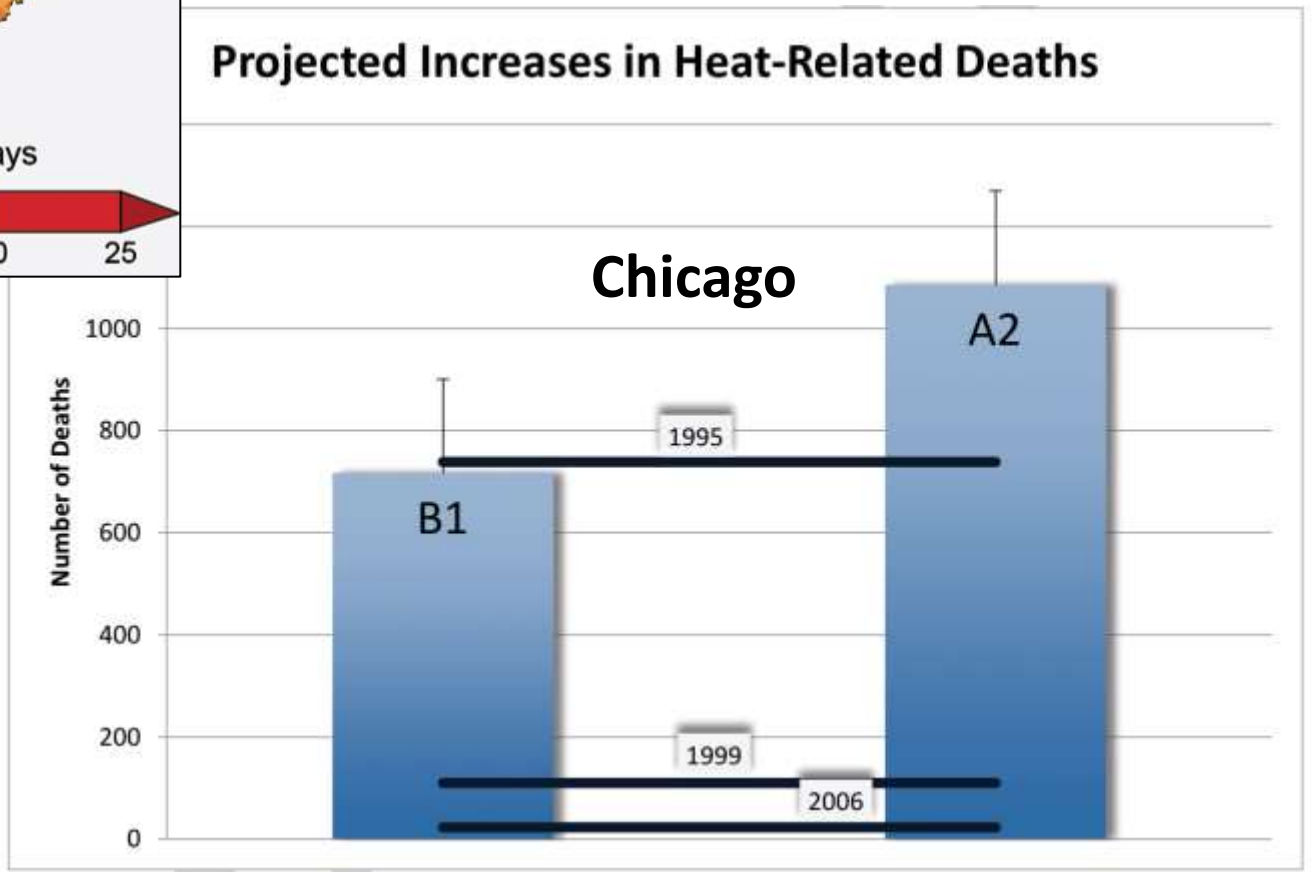
Nor are they uniform in space



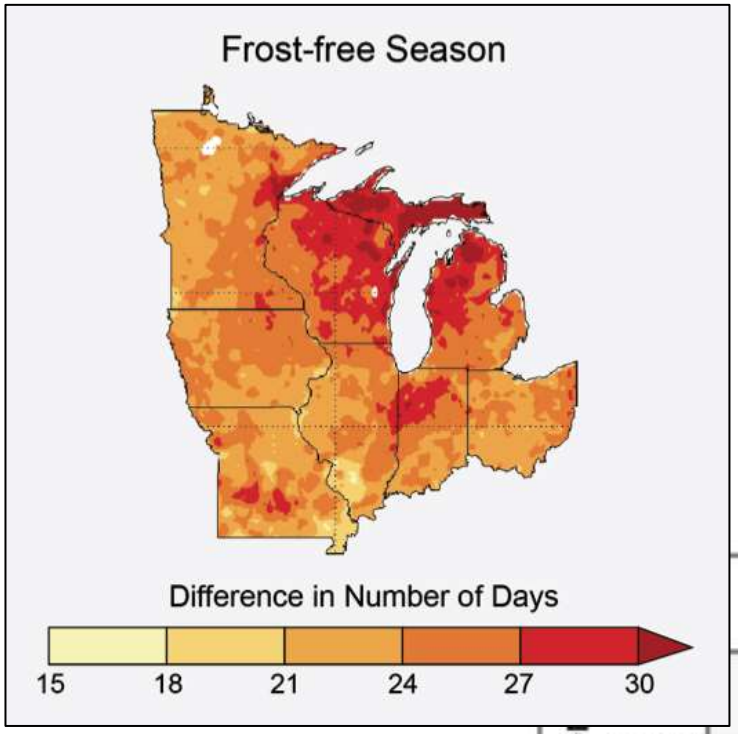
Increased heat waves

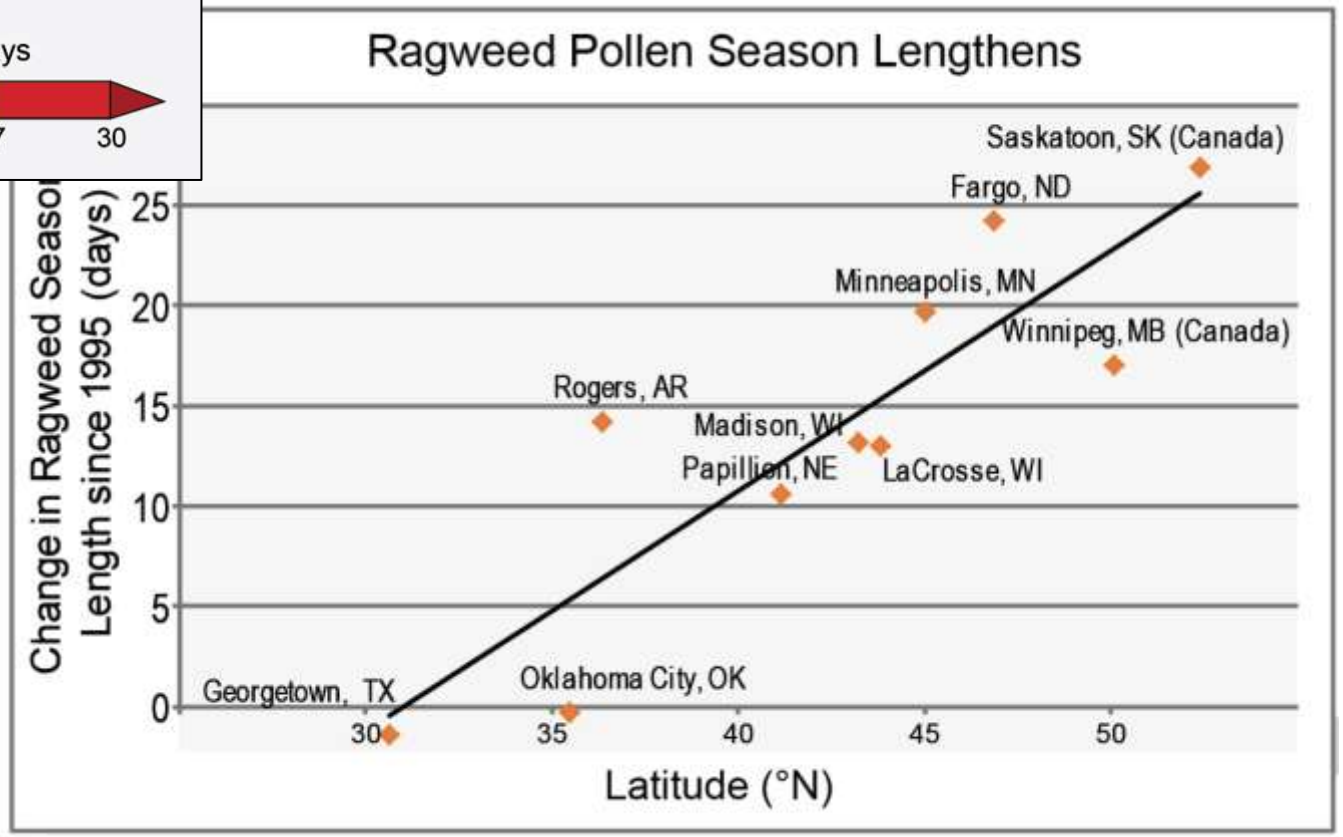
(70 years from now)



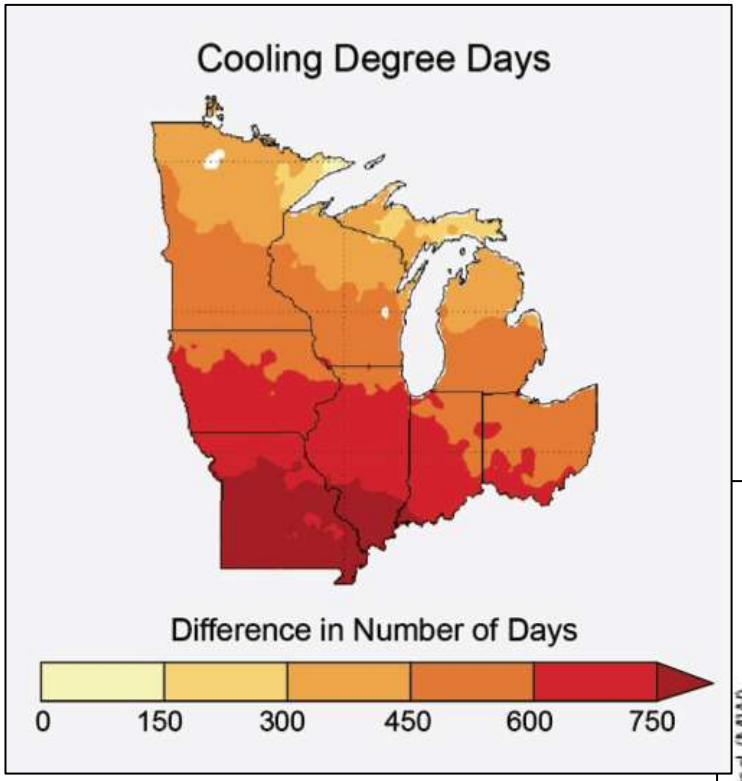


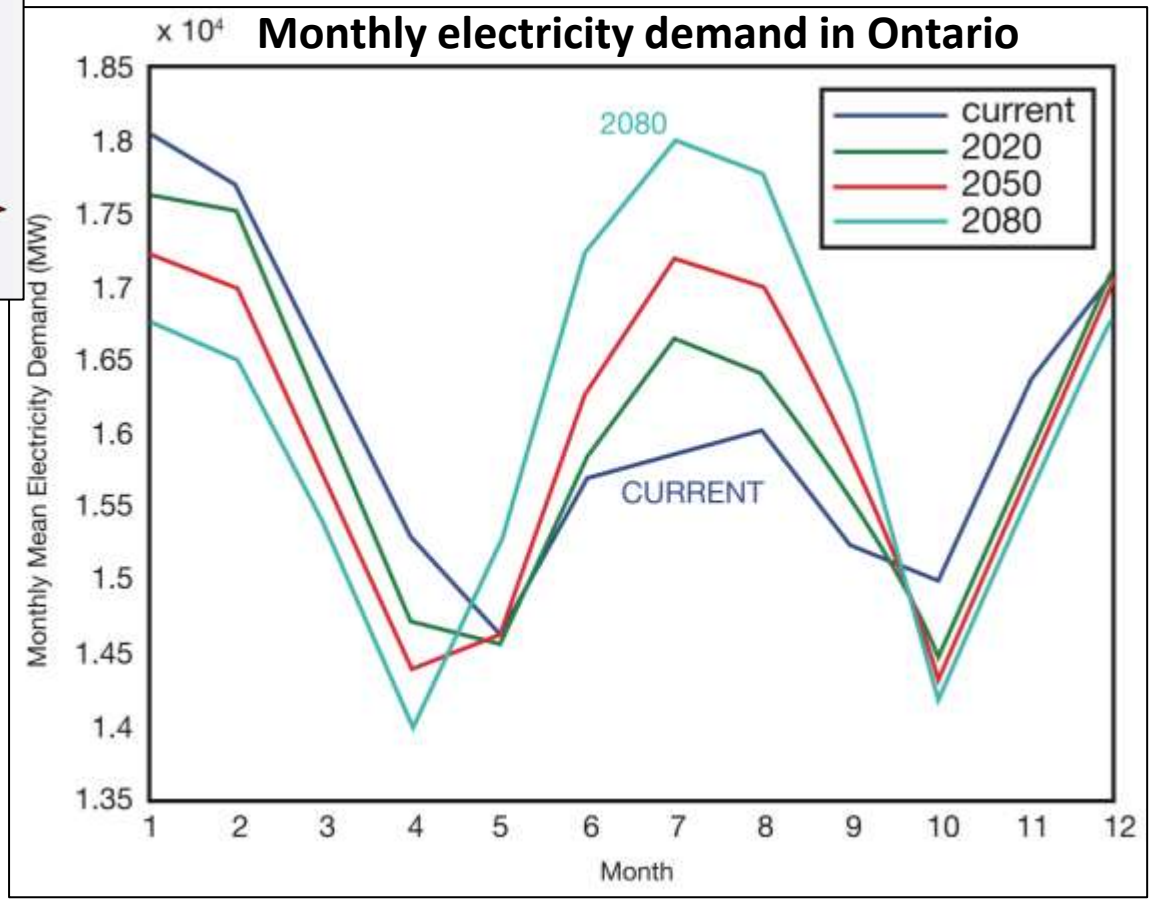
Longer growing season
(70 years from now)



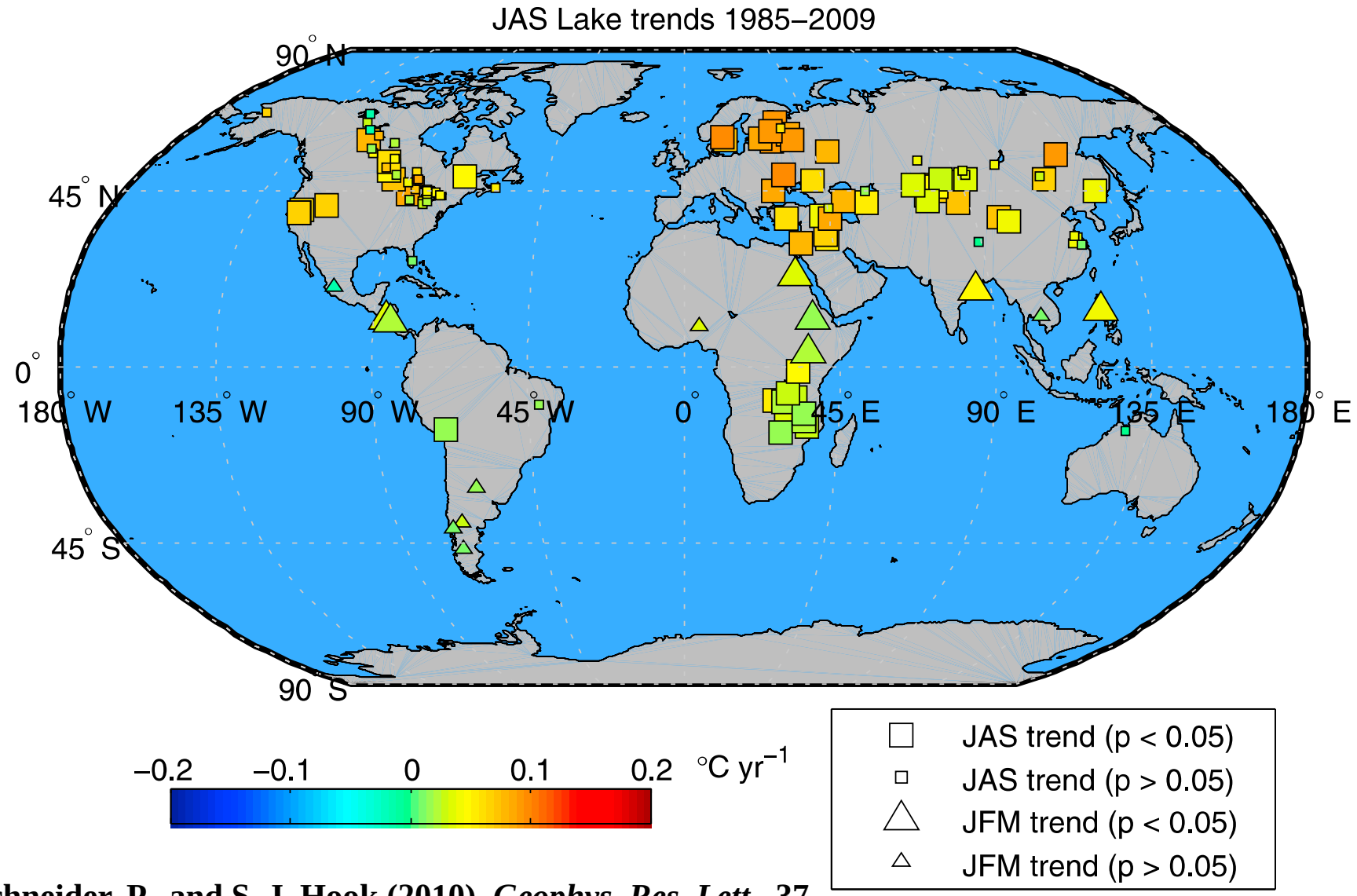


Changes in energy use
(70 years from now)



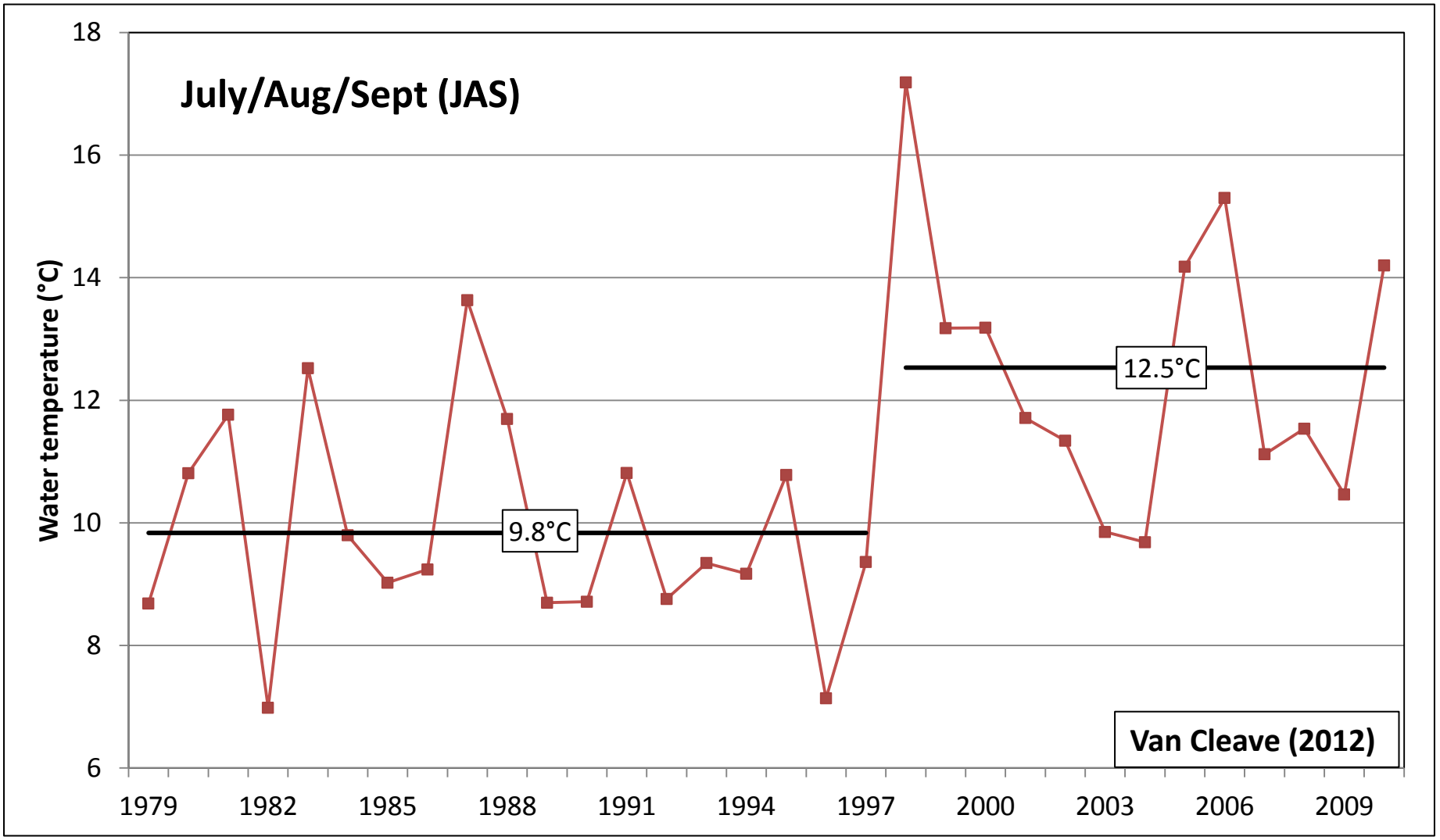


Warming of the world's lakes

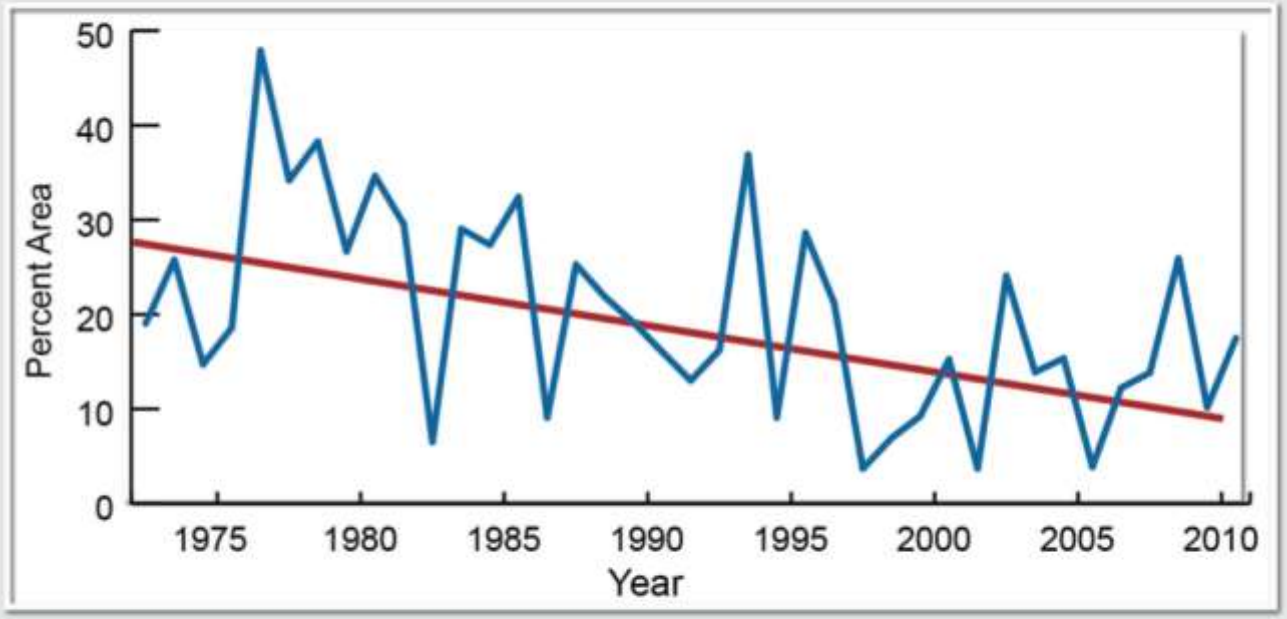


Schneider, P., and S. J. Hook (2010), *Geophys. Res. Lett.*, 37.

Rapid warming of Lake Superior



Great Lakes Ice Coverage Decline

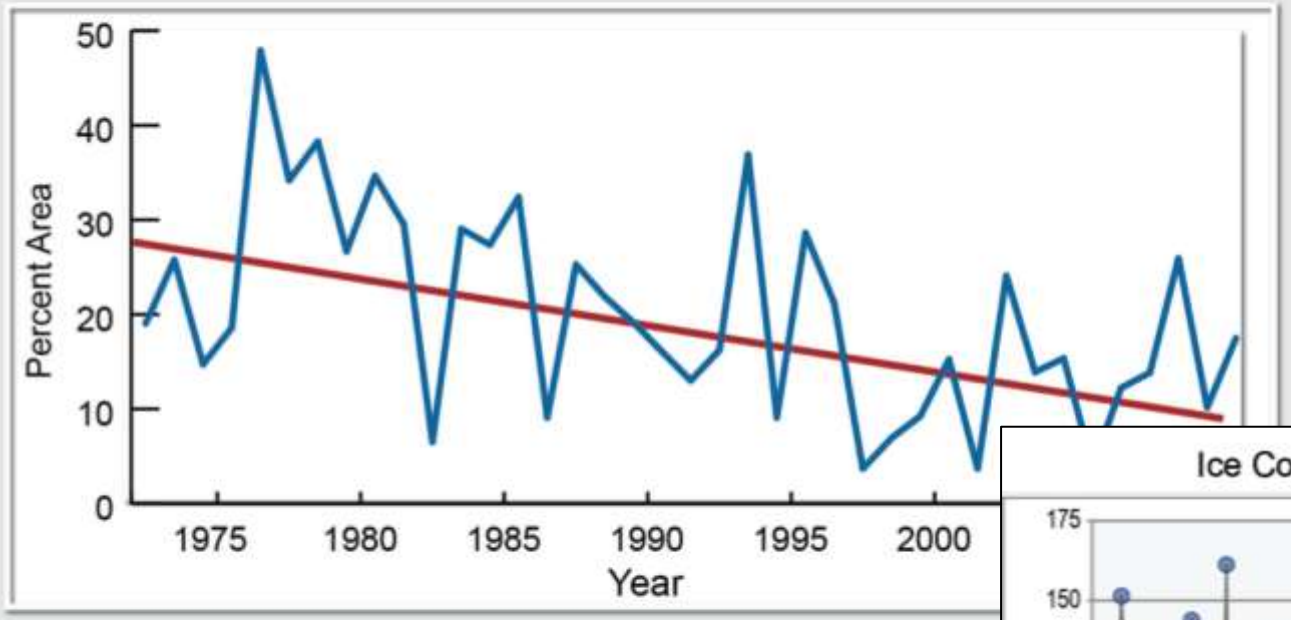


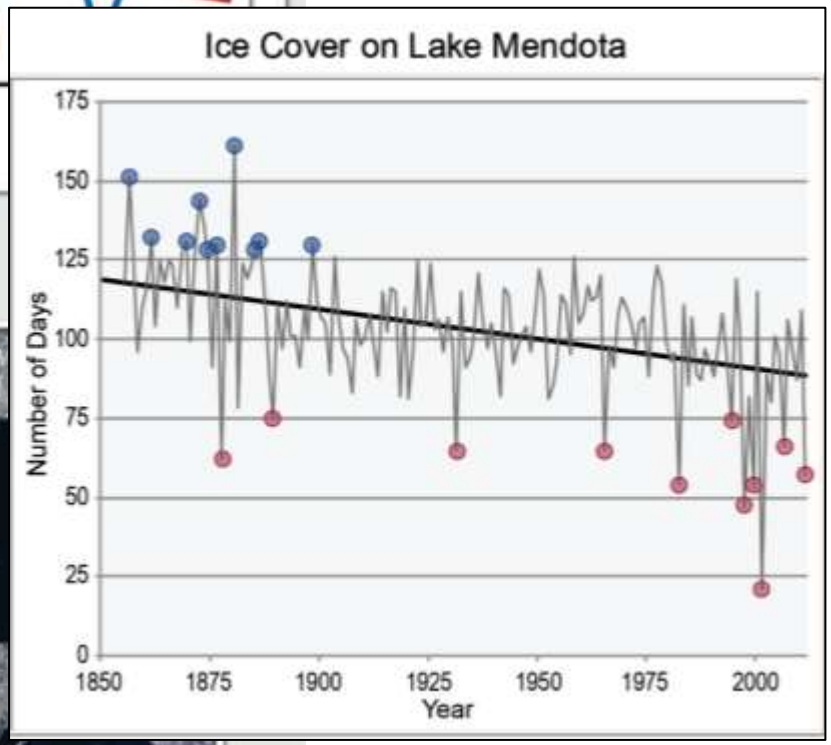
Lake Superior

March 2003

March 2012

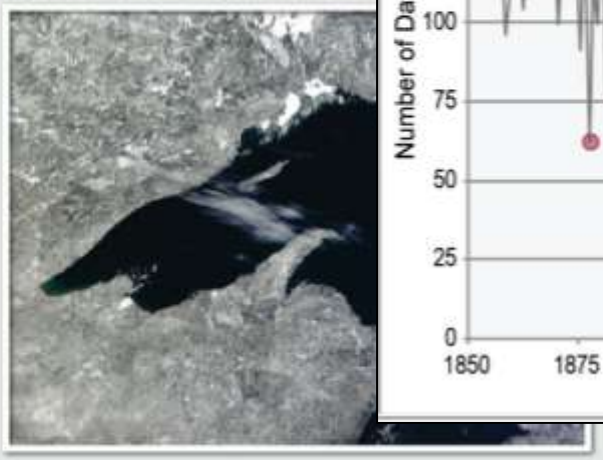
Great Lakes Ice Coverage Decline





Lake Superior

March 2003



March 2012

Lower Great Lakes water levels

The Detroit News

Metro and State

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TRENDING TOPICS AVISAIL GARCIA DETROIT MURDERS RIGHT-TO-WORK TED LINDSAY ANDY DILLON TOYOT

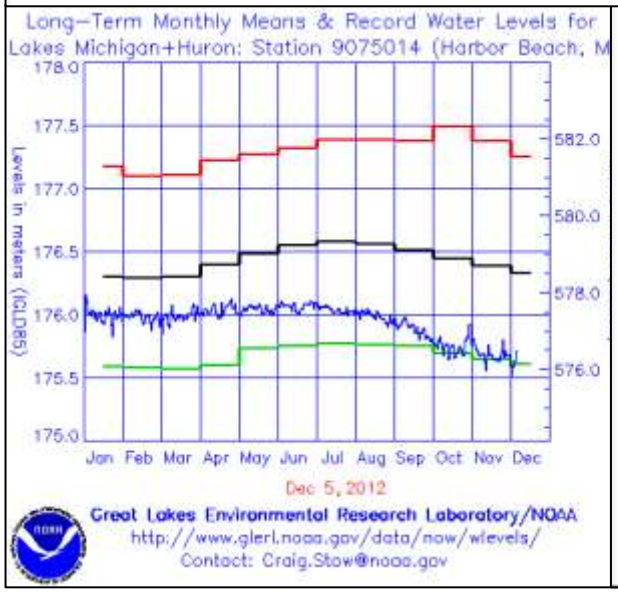
Home Metro Metro and State

DECEMBER 1, 2012 AT 2:20 PM

Water levels in Lakes Huron, Michigan head for record lows

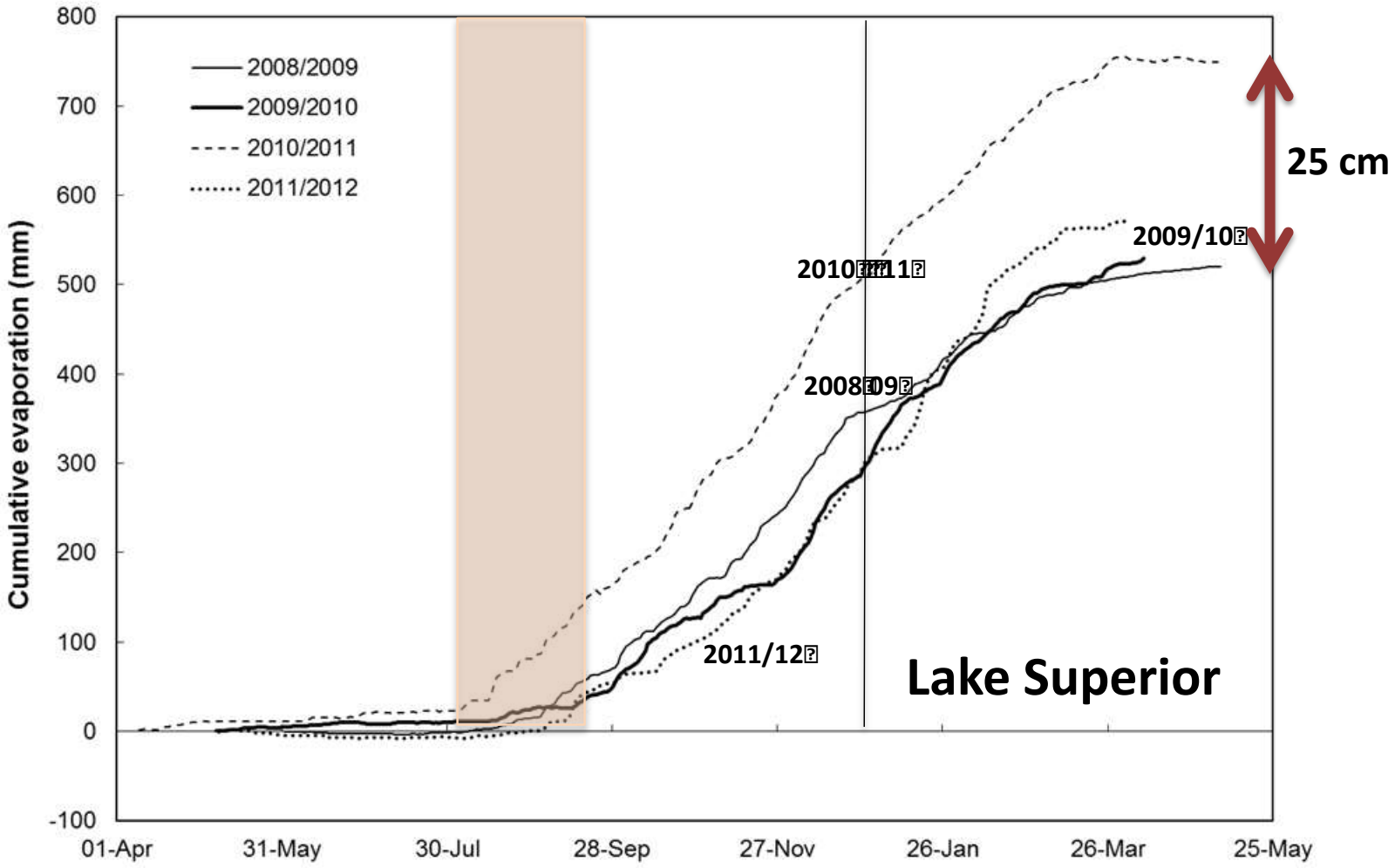
With sparse rain, they were 28" below normal average in November

BY TOM GREENWOOD THE DETROIT NEWS 18 COMMENTS



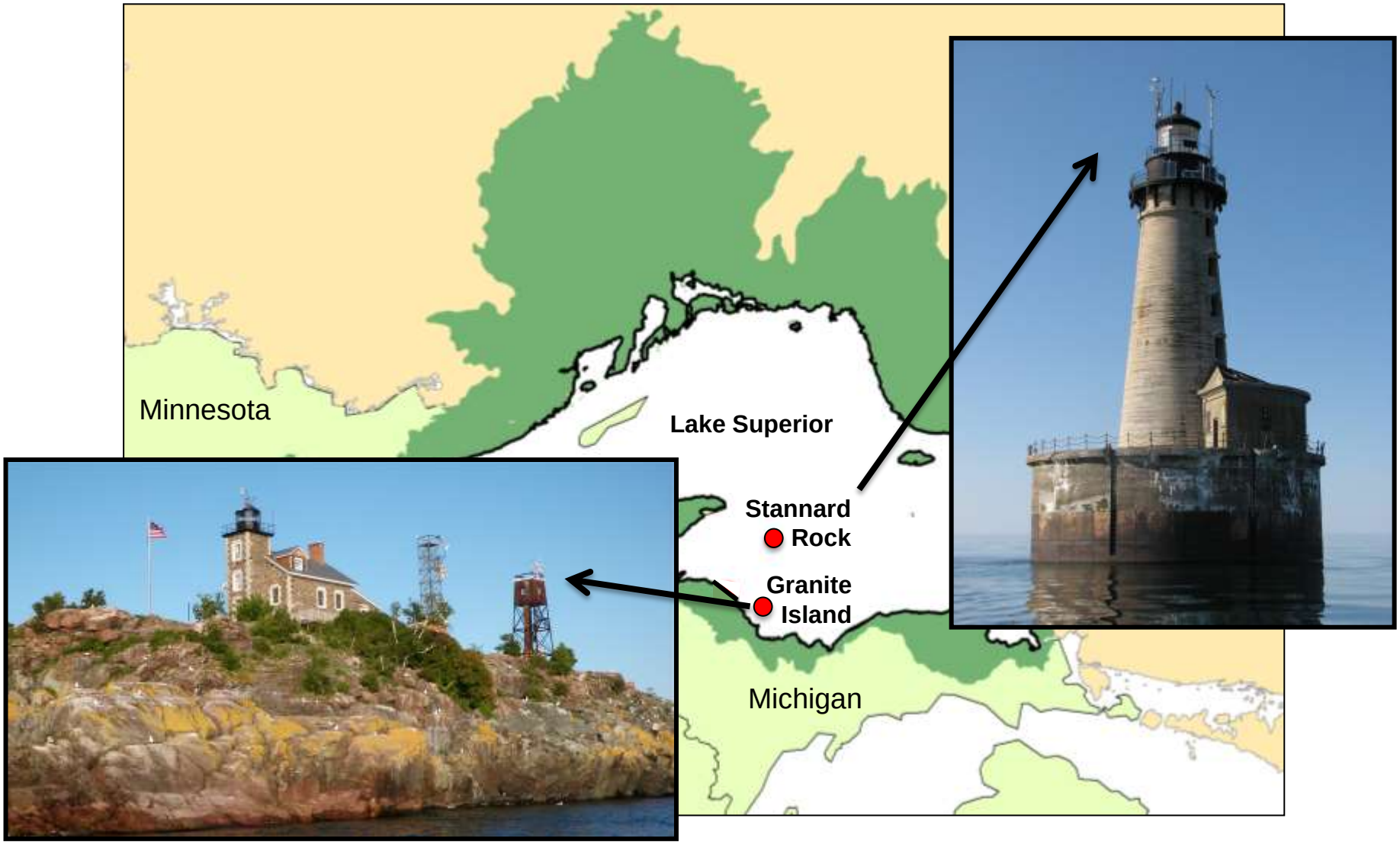
The dipping water levels in Lake Michigan have left docks out of the water and beaches extending hundreds of feet into West Grand Traverse Bay northwest of Traverse City. (John L. Russell / Great Lakes Images)

Higher rates of evaporation

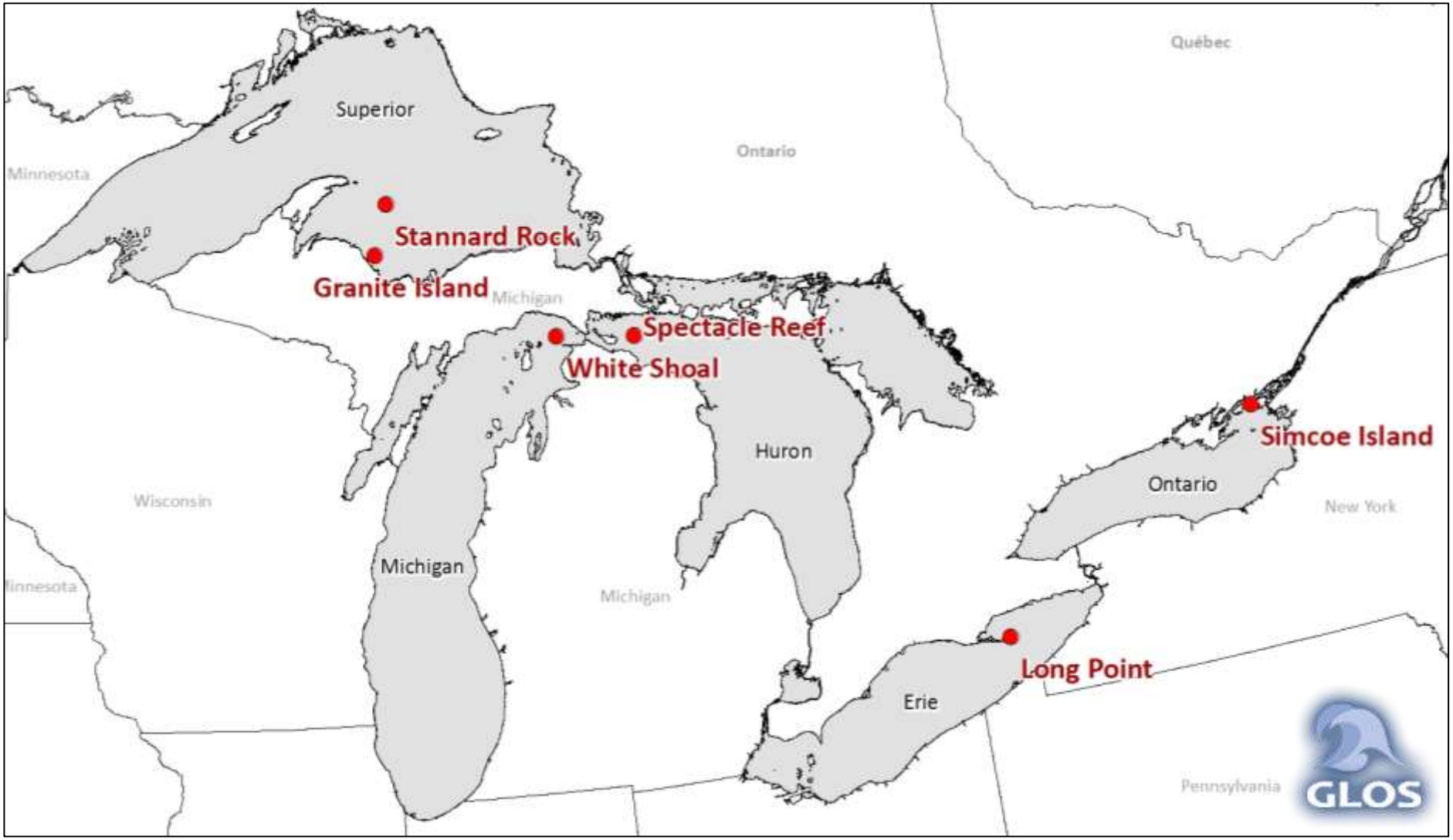


Spence et al. (2013) *Journal of Hydrometeorology (in press)*

Lake Superior monitoring sites

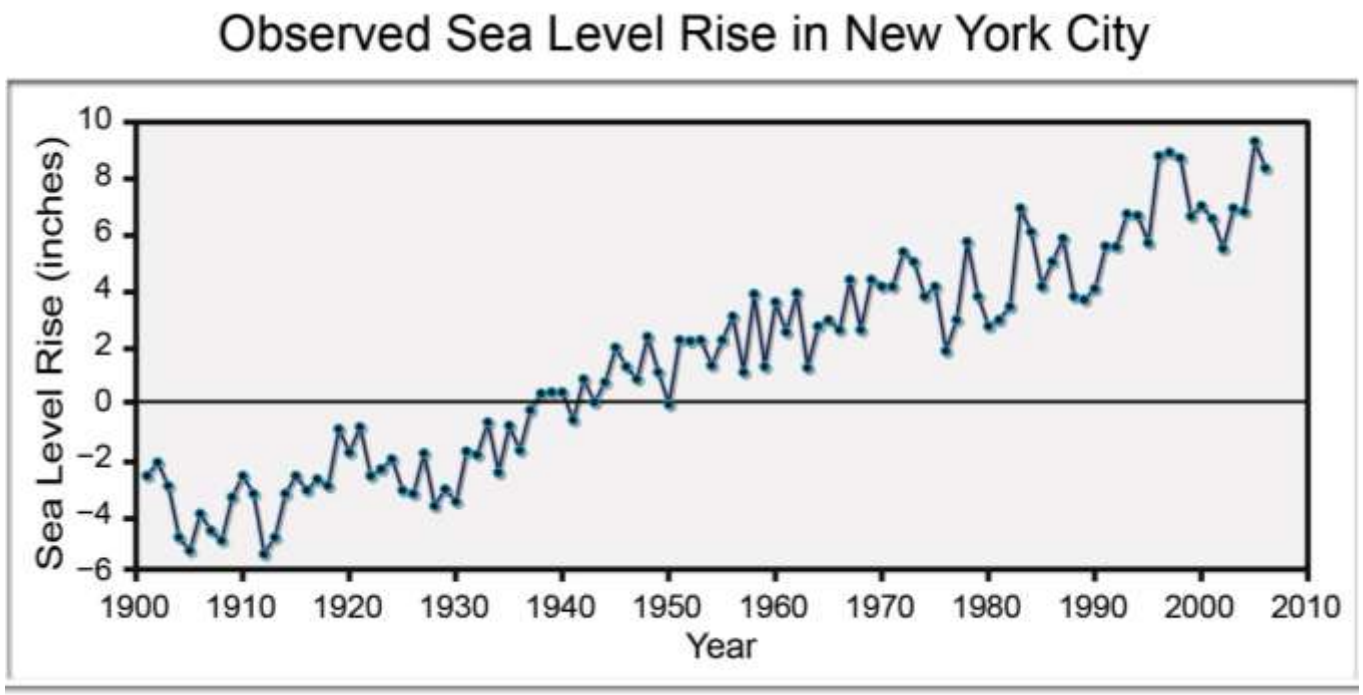


Great Lakes evaporation network

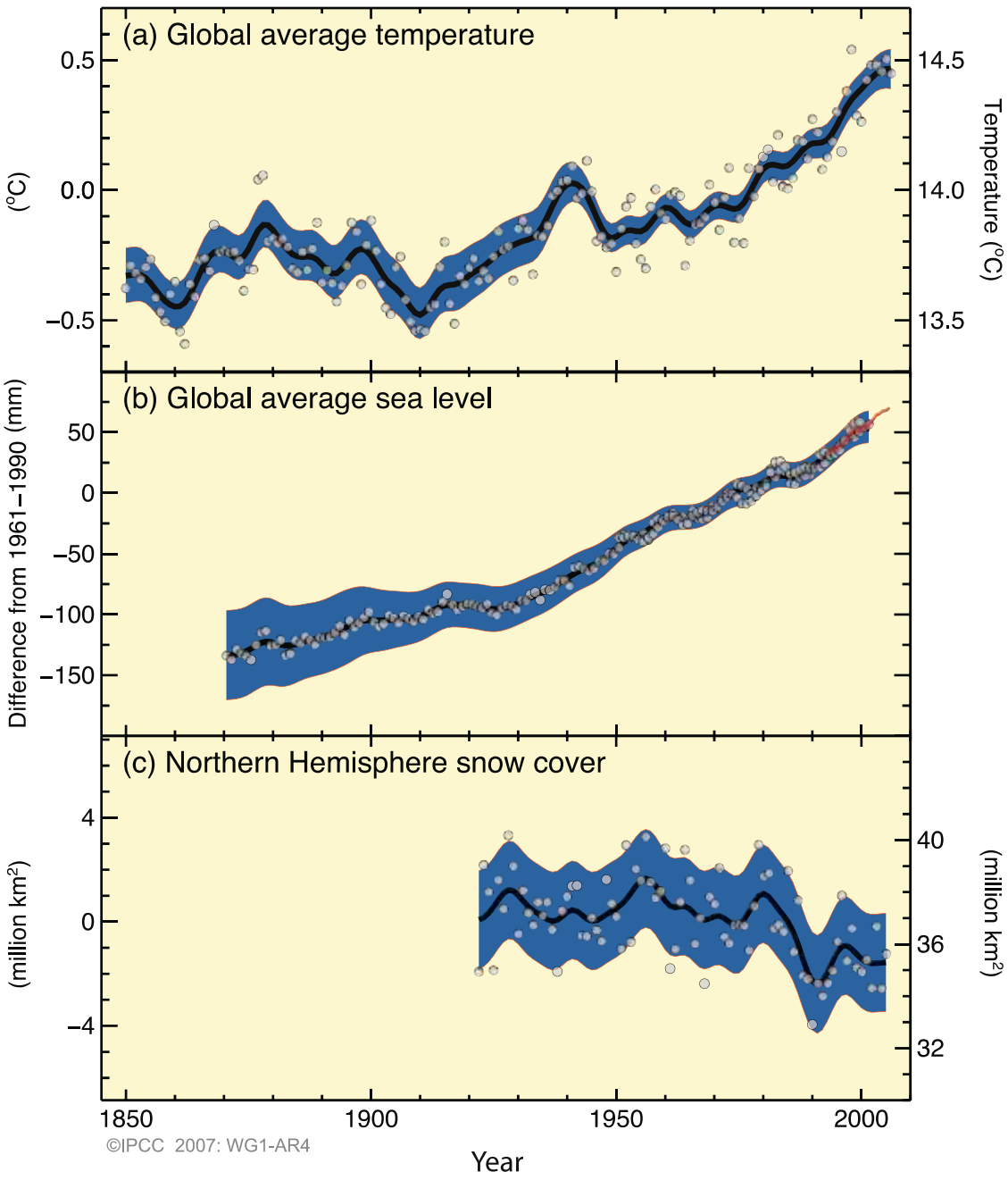


Global warming?

Global warming?
or
Global “weirding?”



Changes in Temperature, Sea Level and Northern Hemisphere Snow Cover



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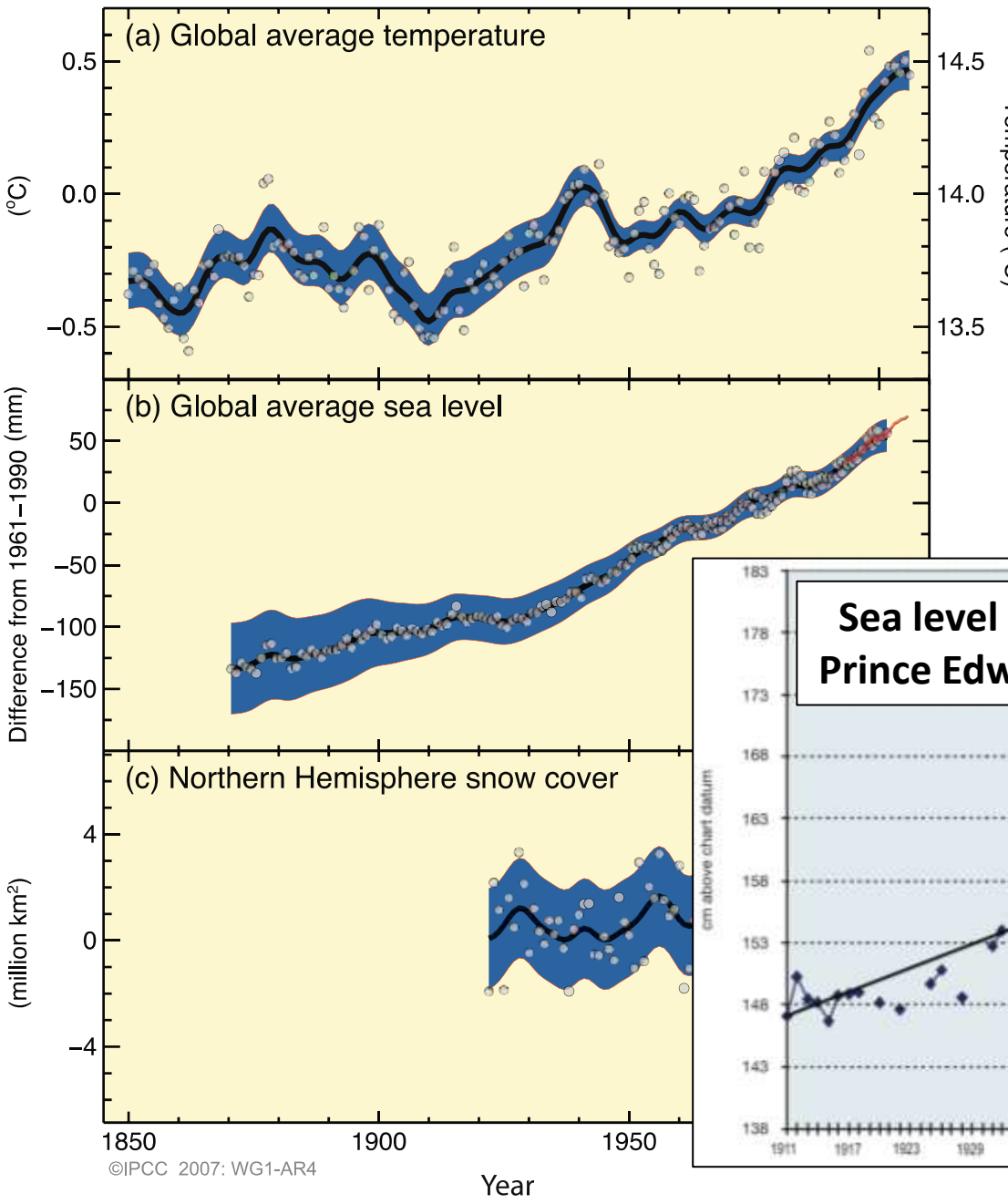
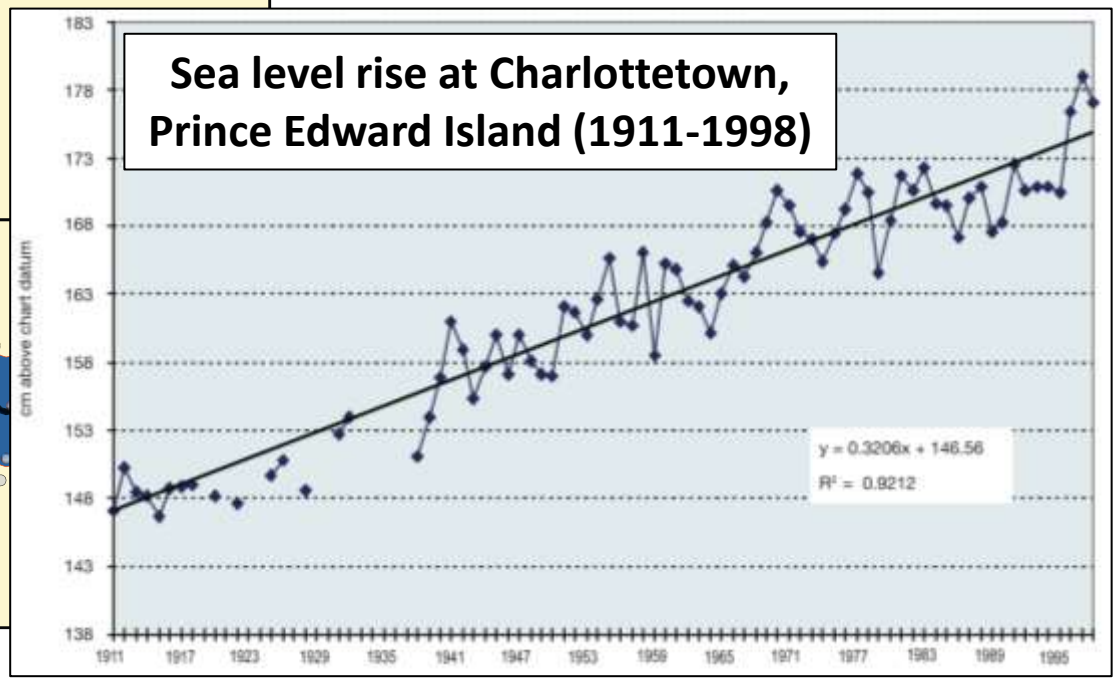
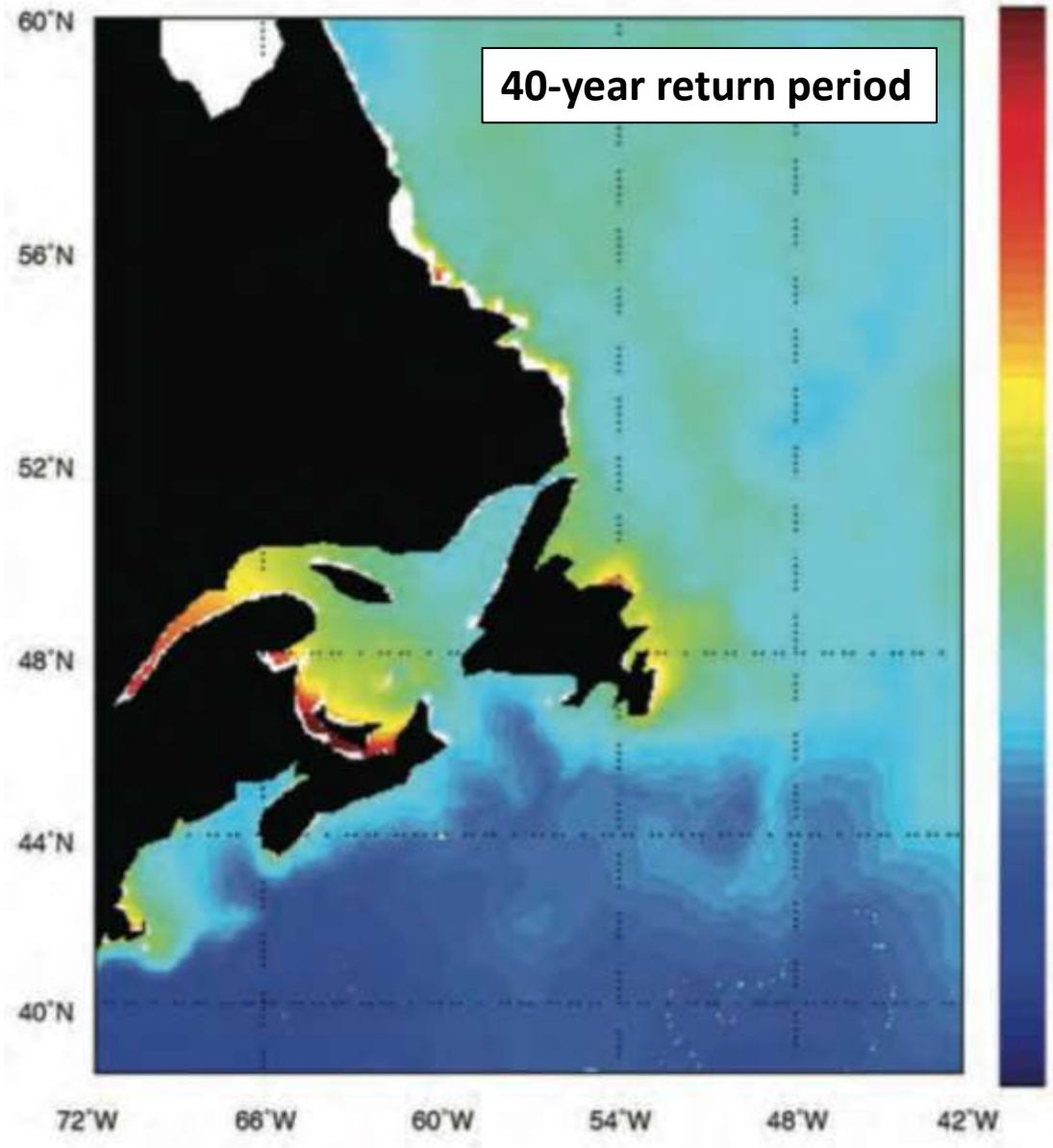
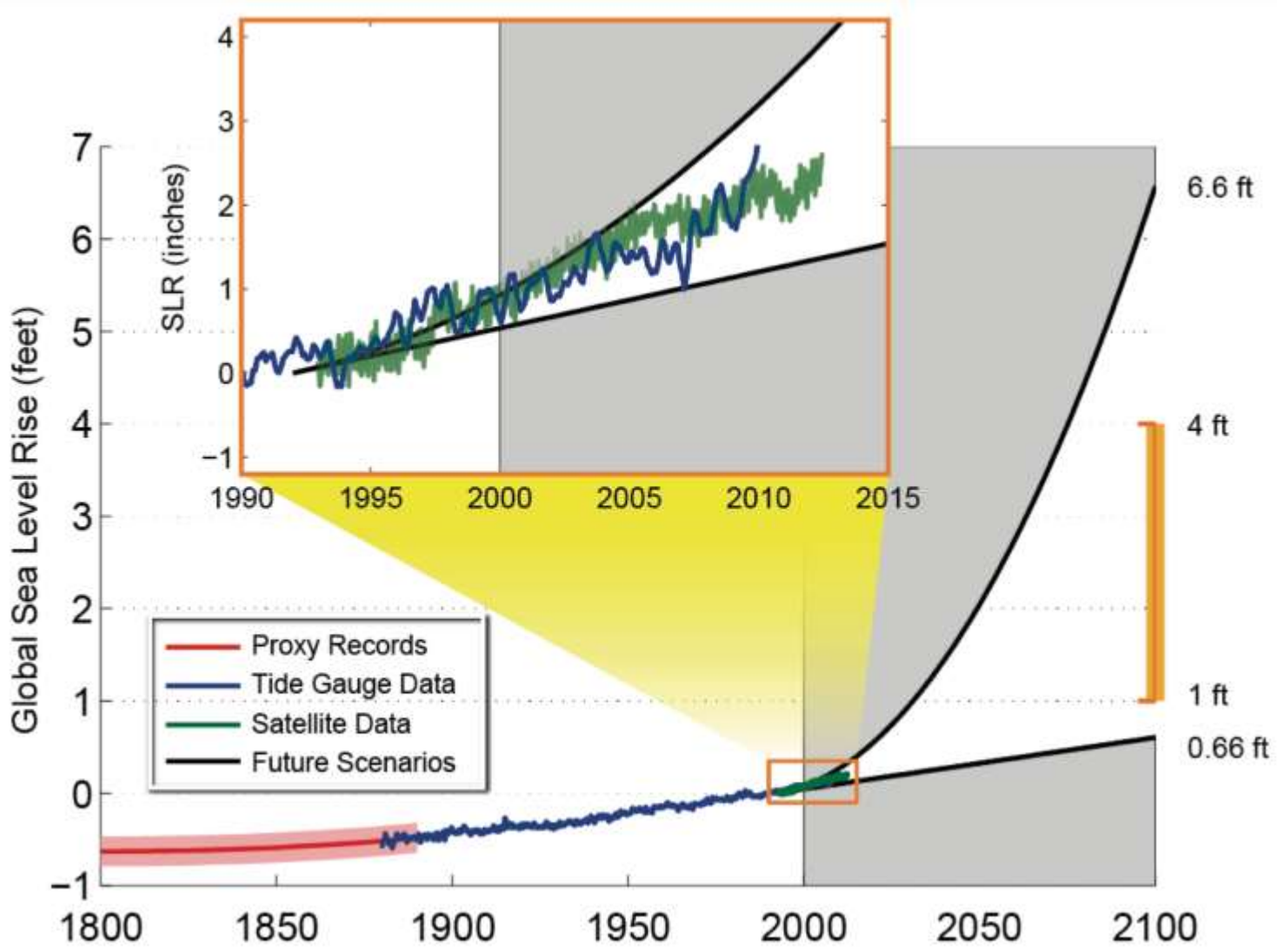




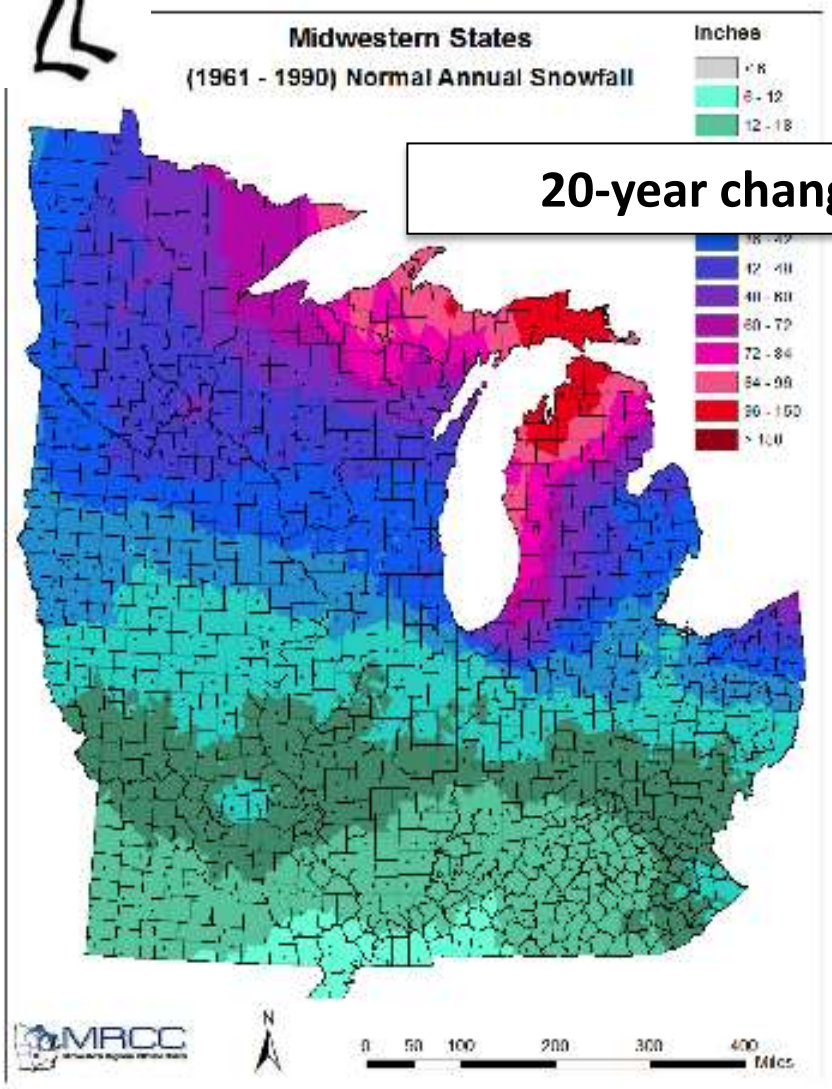
Storm surge vulnerability



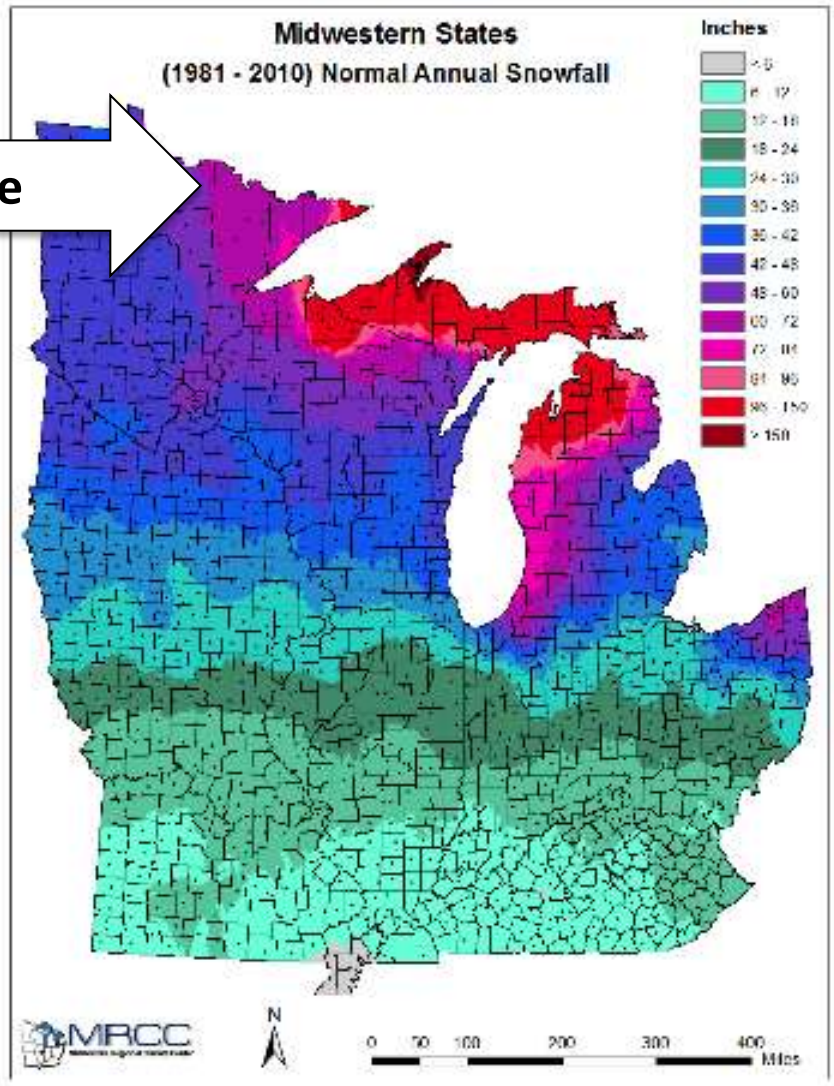
Future sea level rise



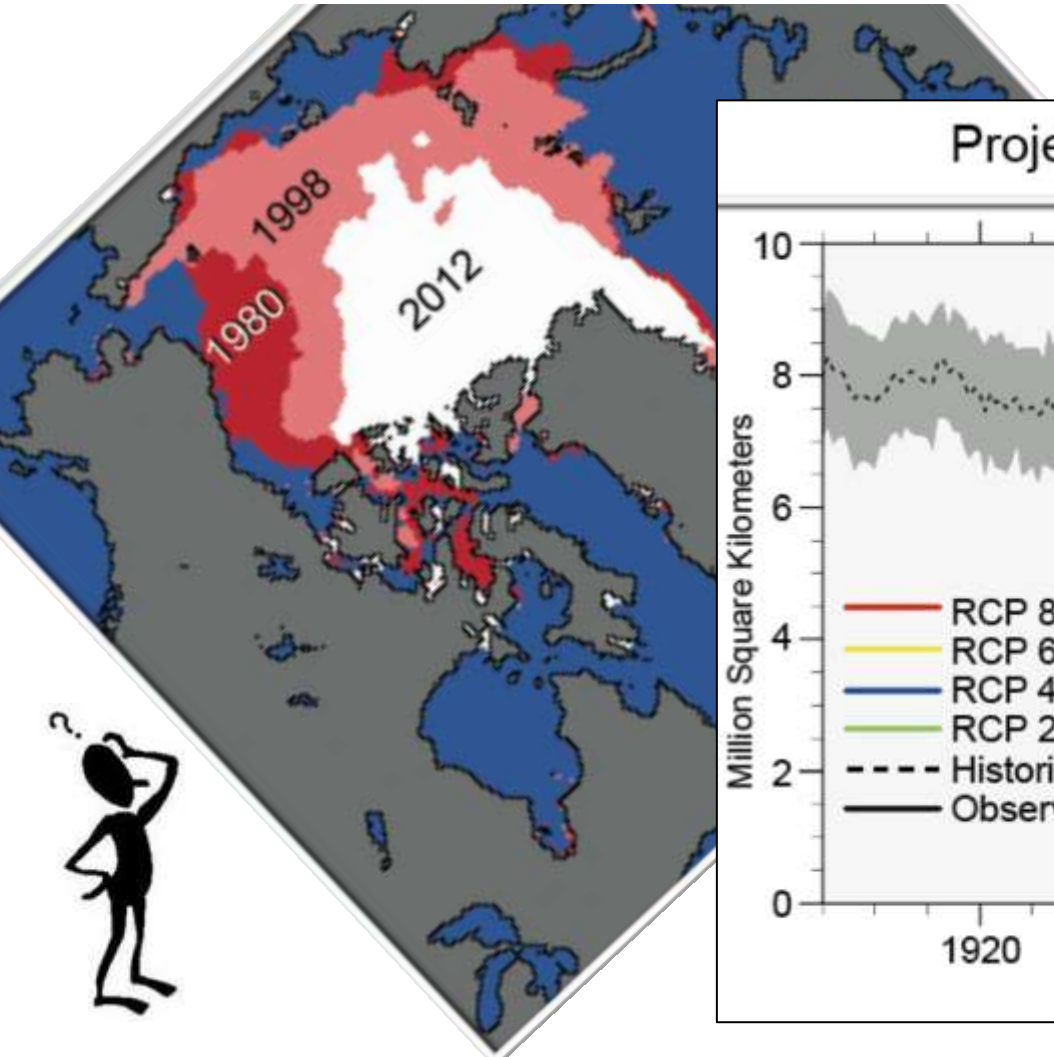
Less snow? Not necessarily

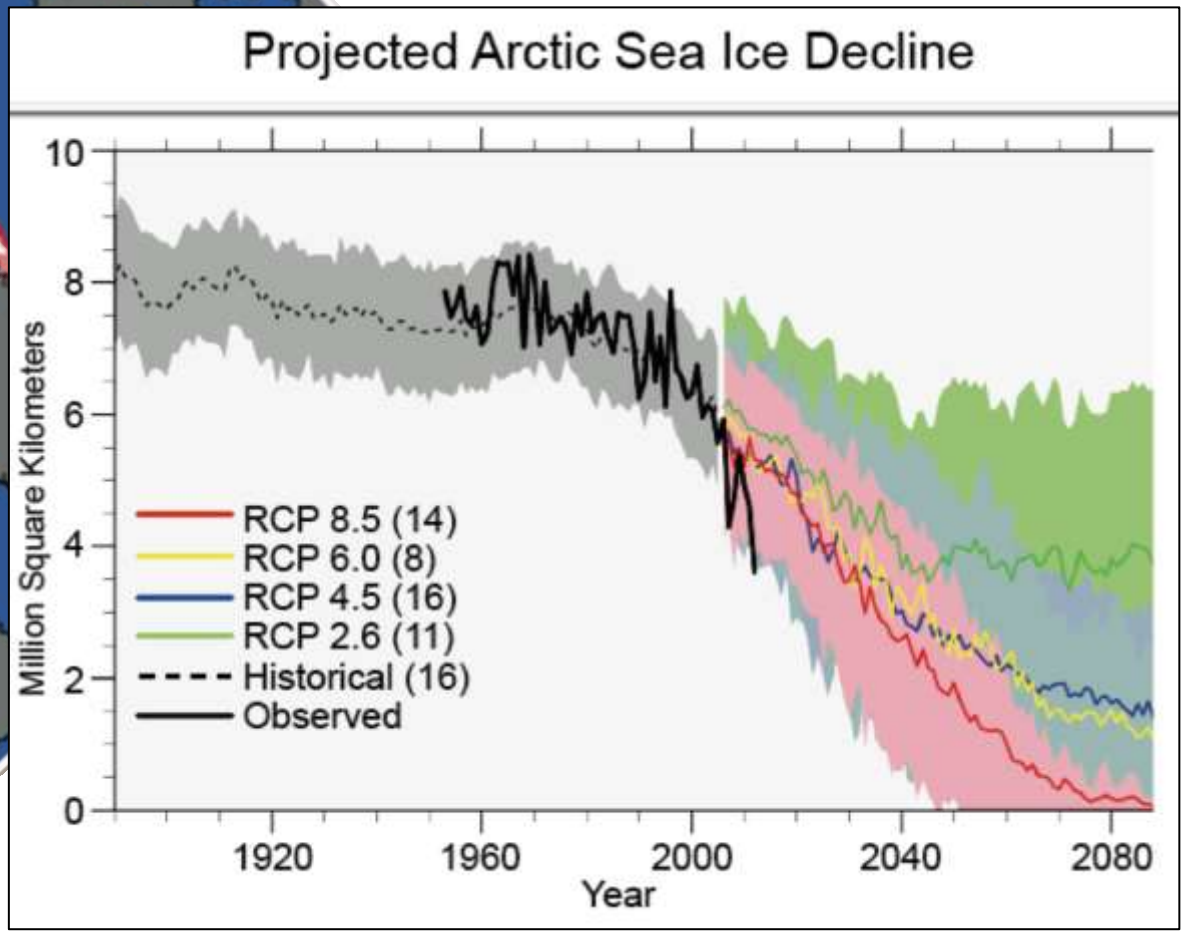


20-year change

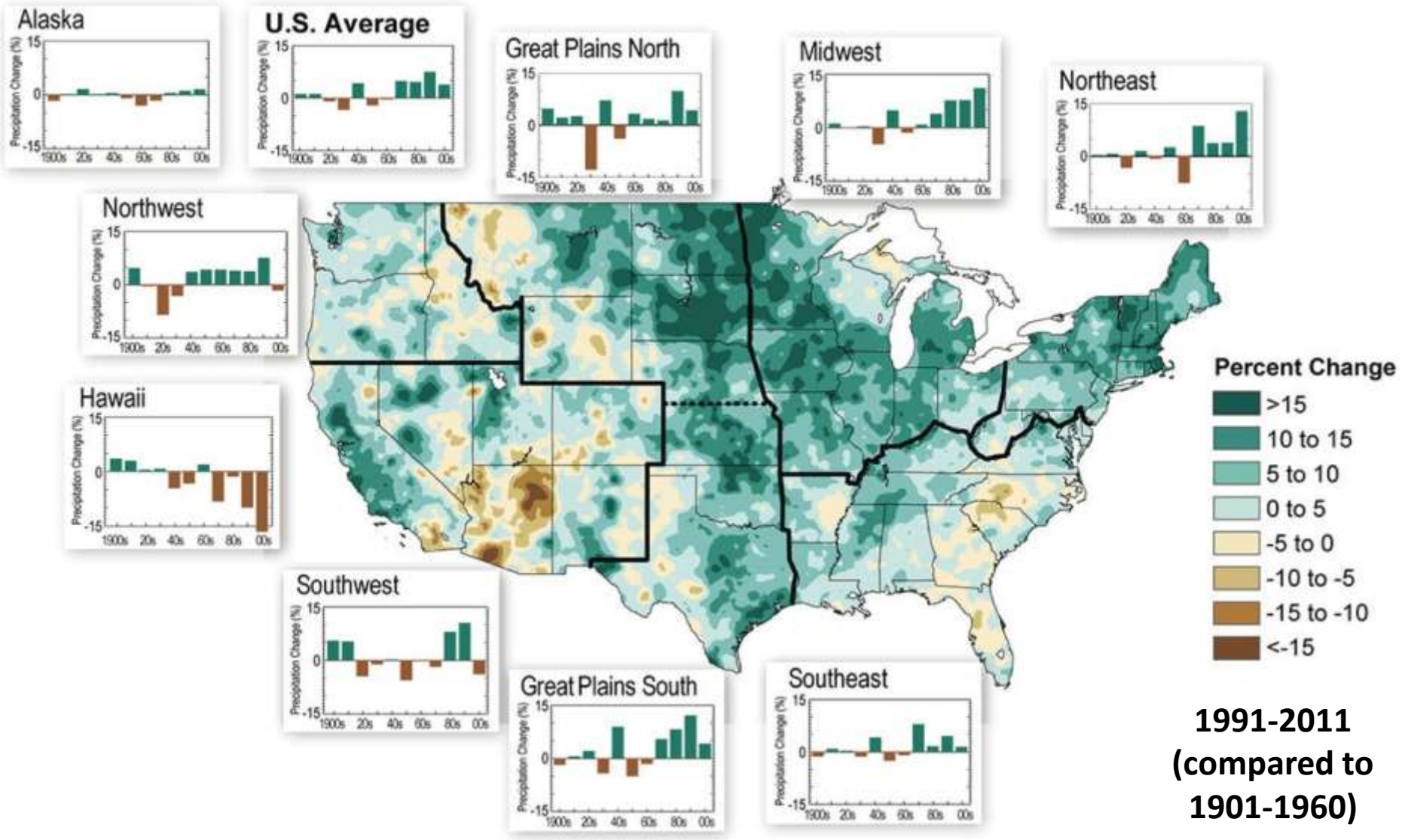


Seemingly “remote” problems …
Are <u>not</u> remote





Generally wetter conditions



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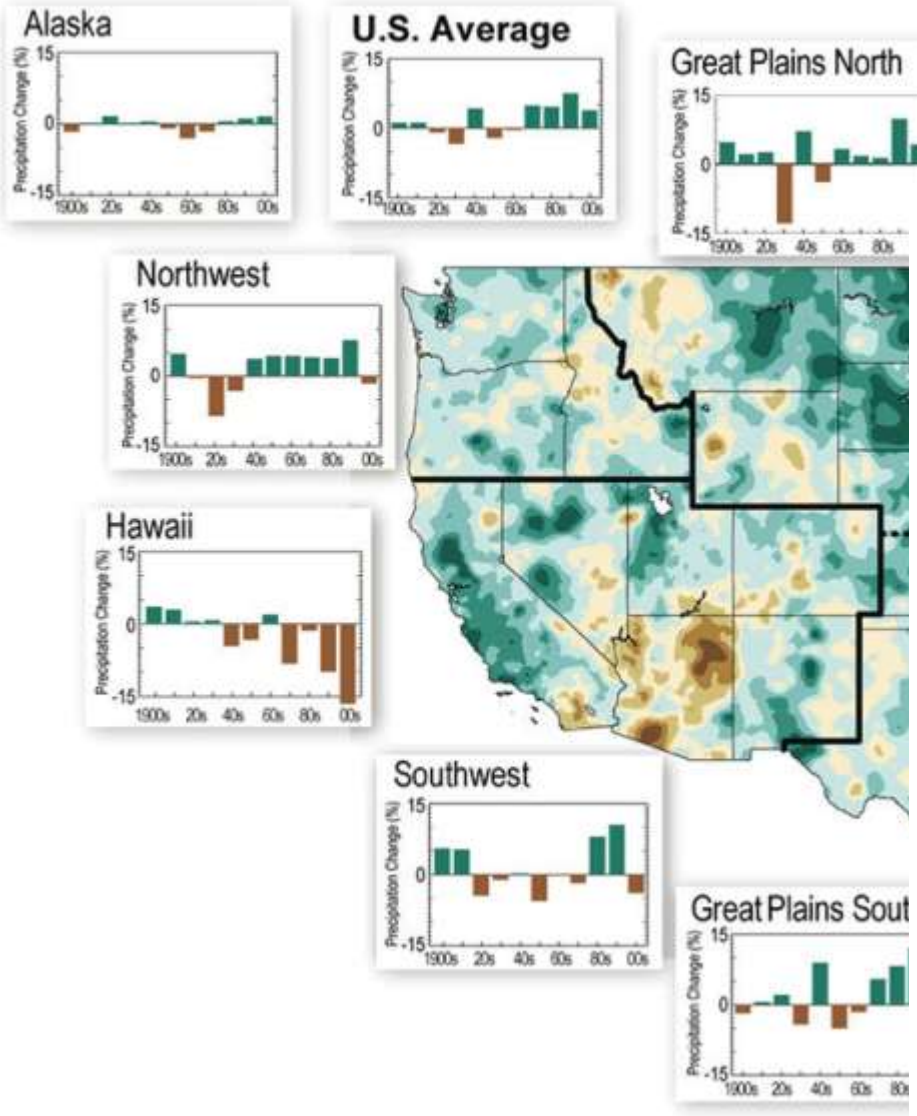
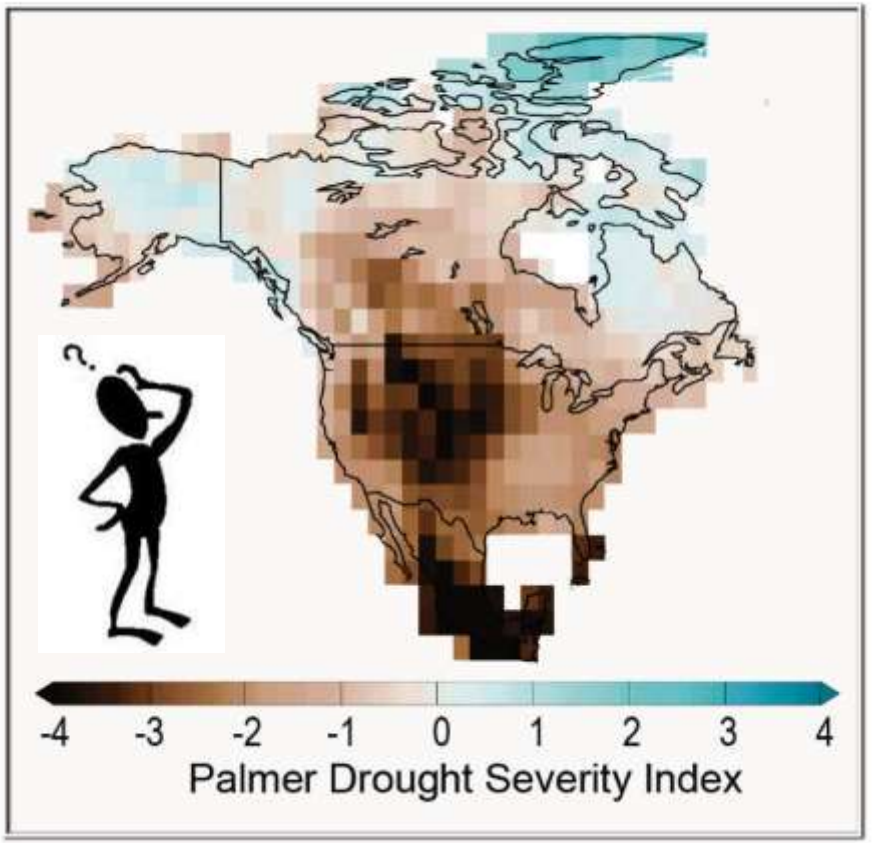
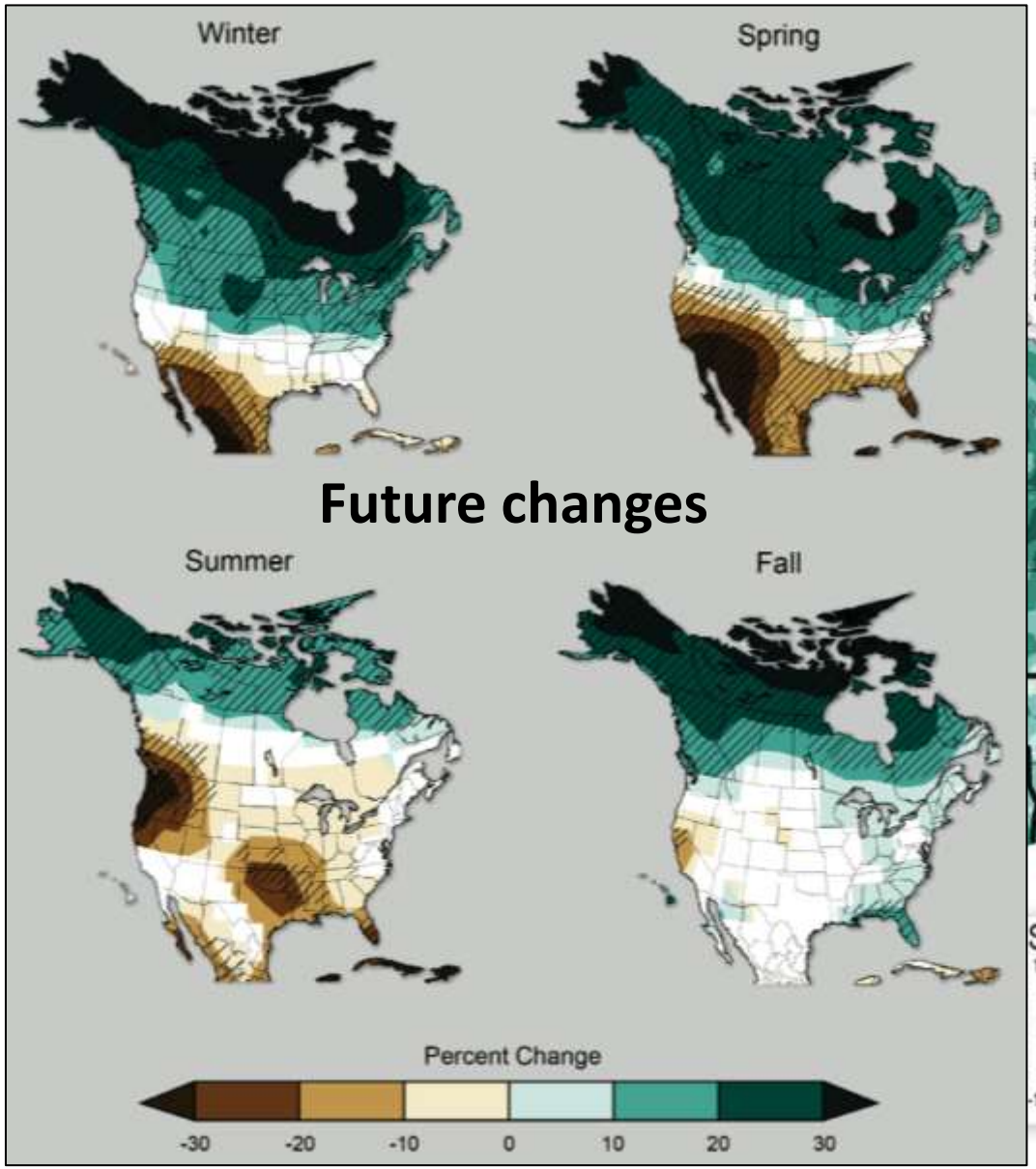
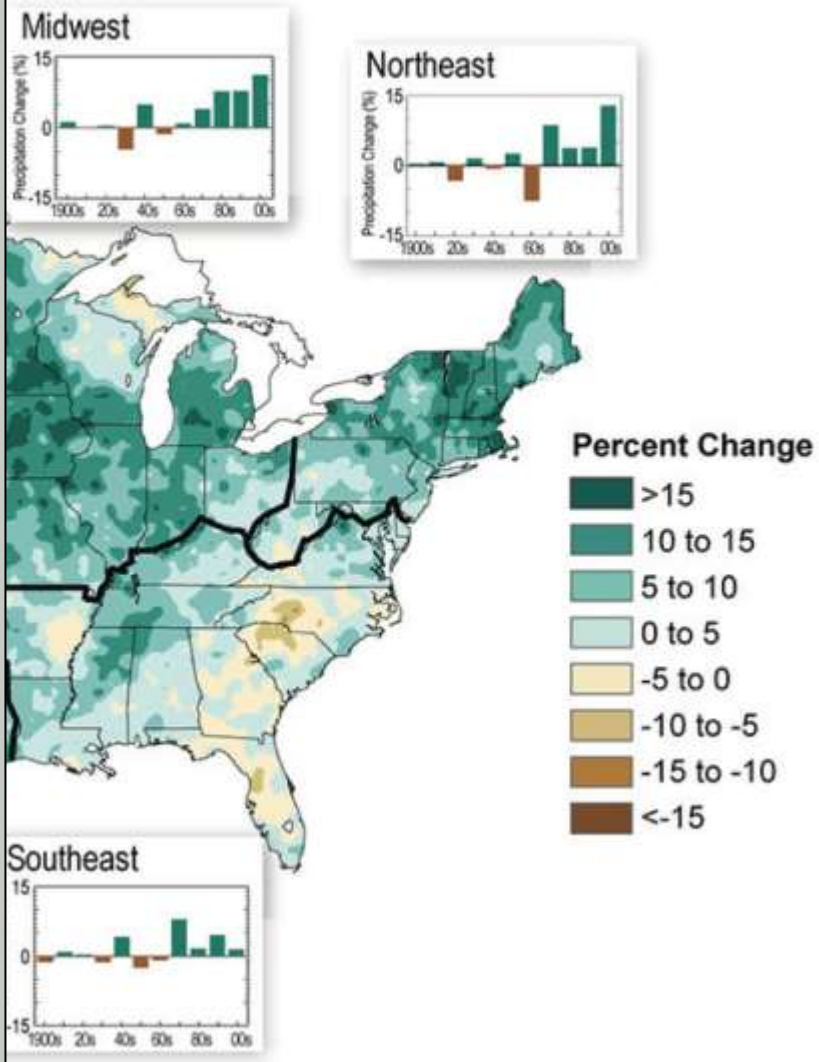


Projected Changes in Drought Severity

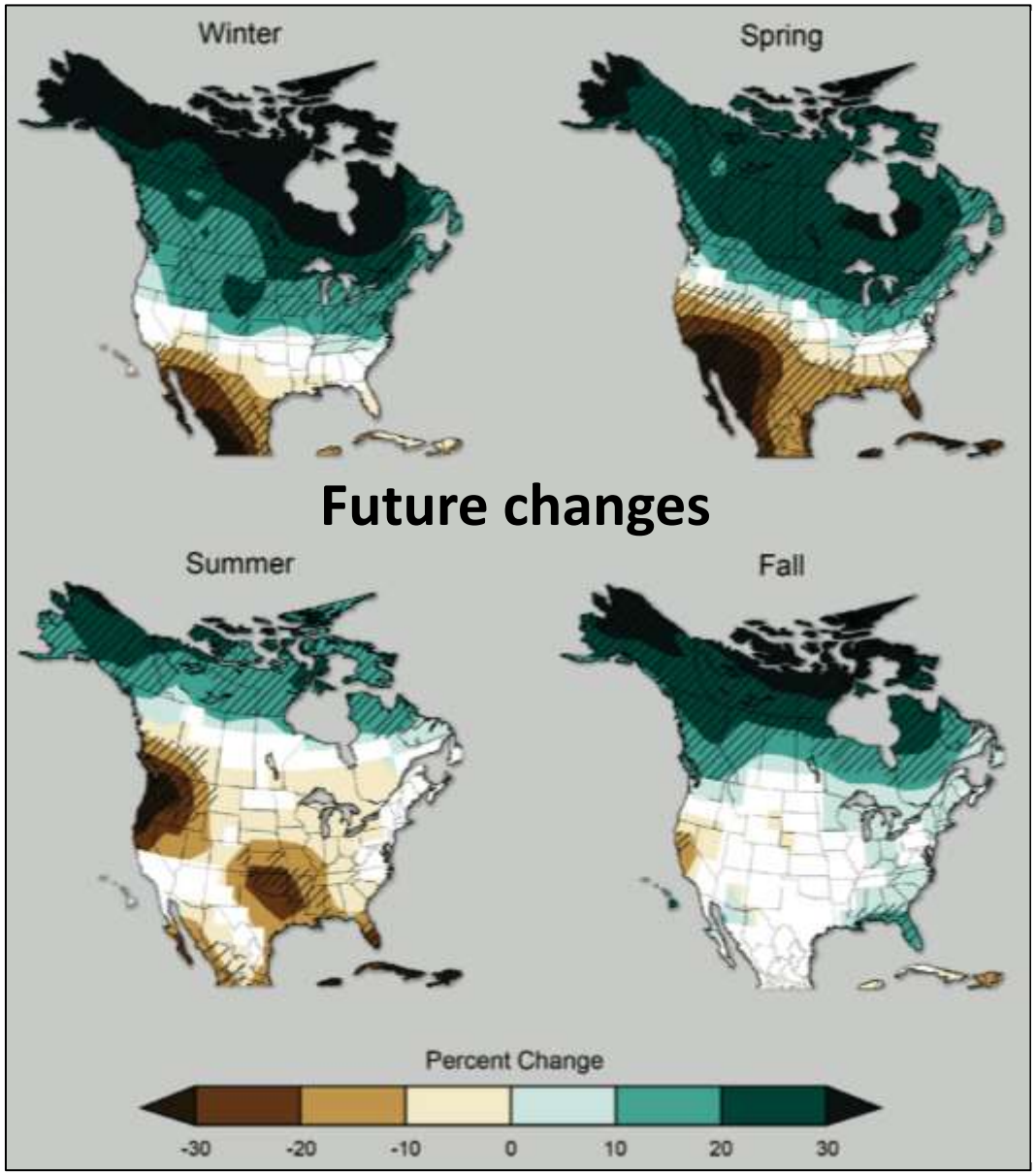


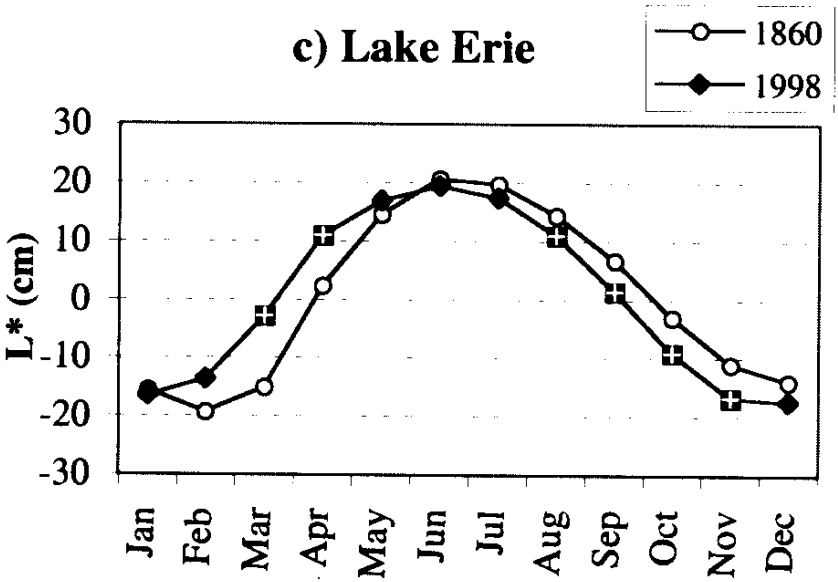
Shifting seasons

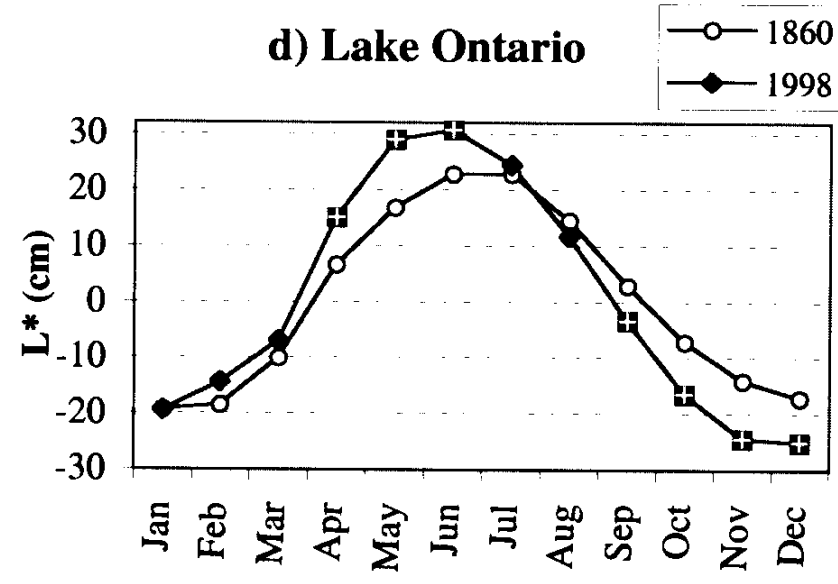


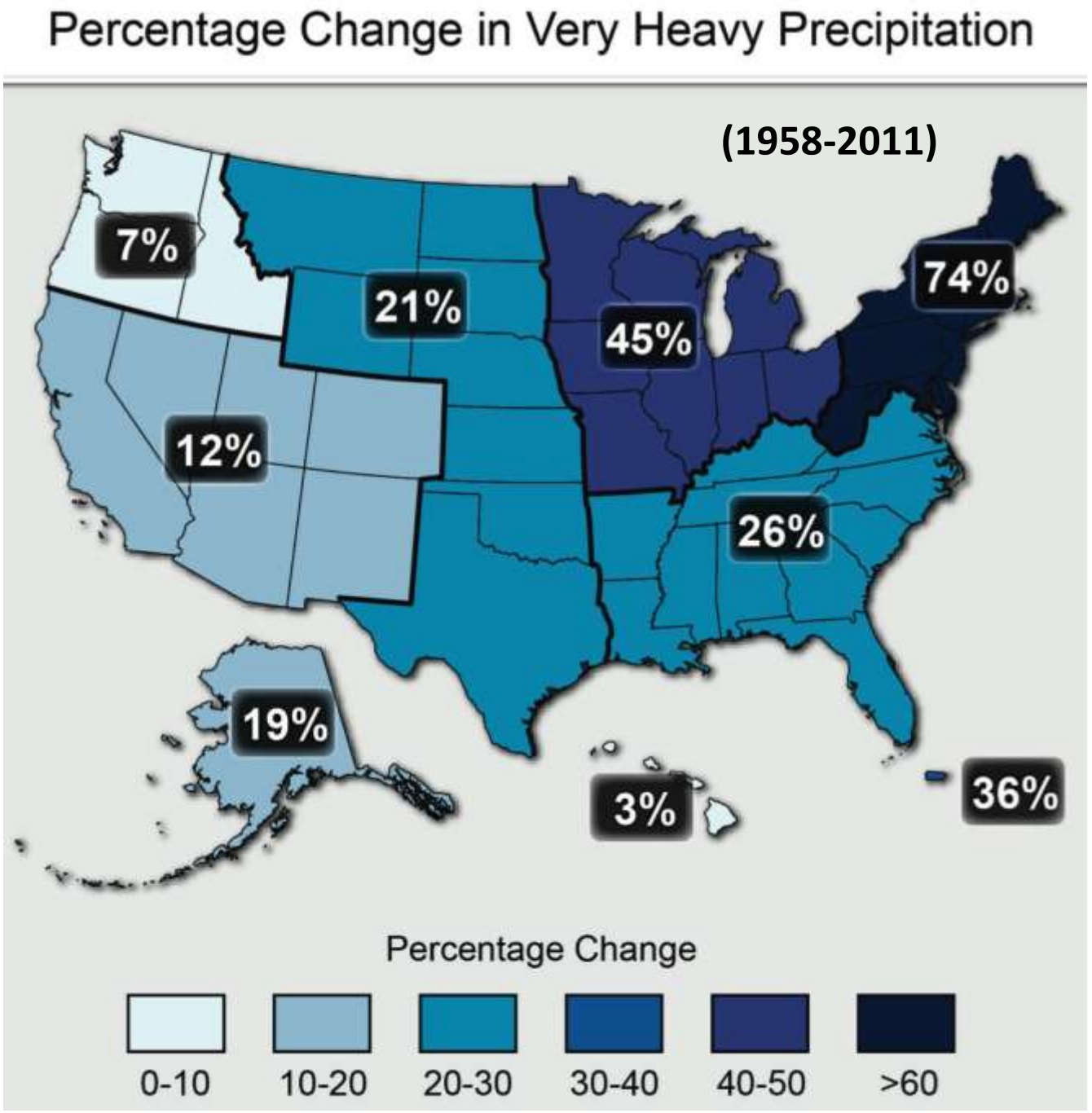


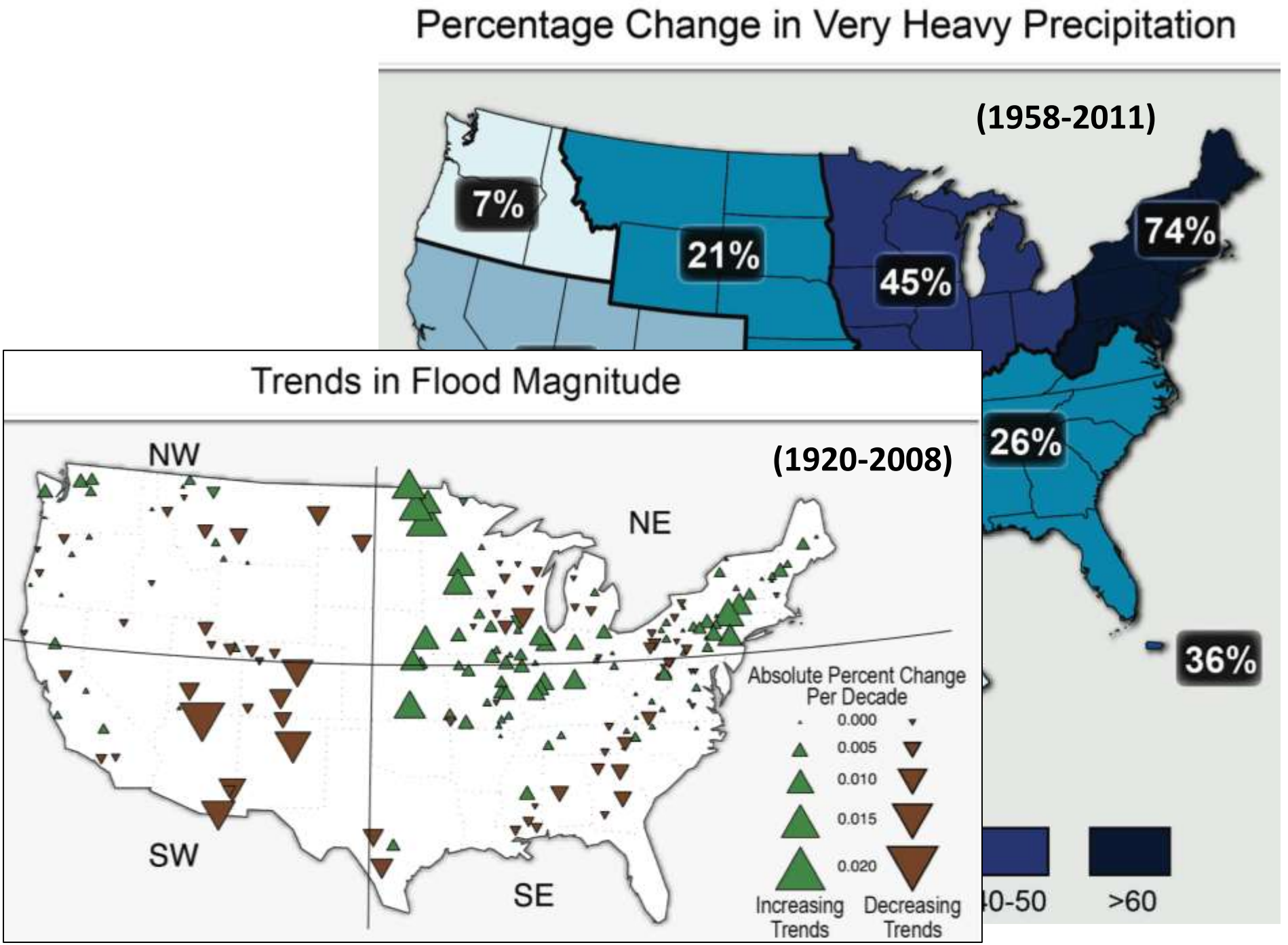
Shifting seasons

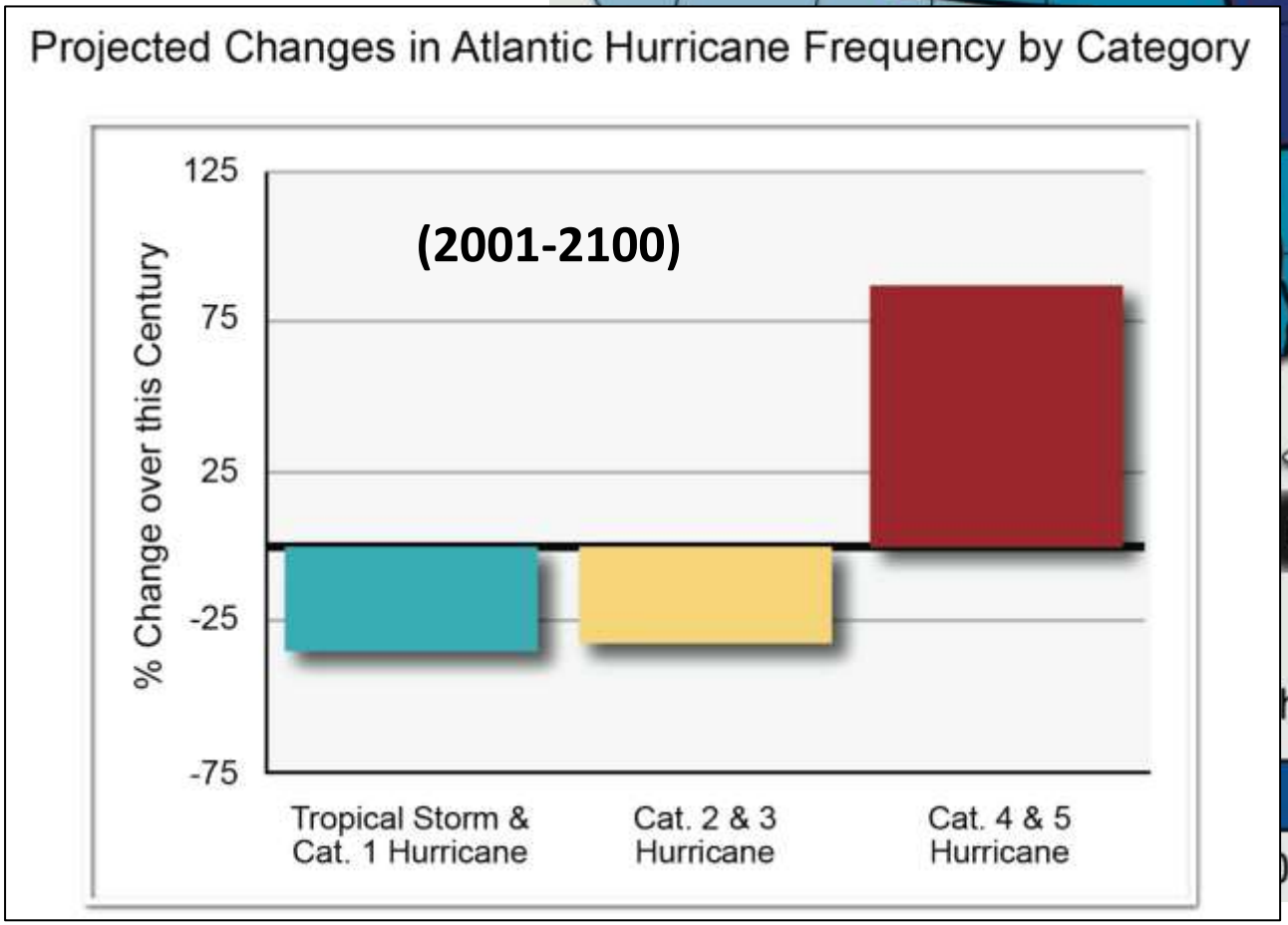







Percentage Change in Very Heavy Precipitation
(1958-2011)
7%
21%
45%
74%
12%
26%
19%
3%
36%
Percentage Change
0-10
10-20
20-30
30-40
40-50
>60


Percentage Change in Very Heavy Precipitation
(1958-2011)
7%
21%
45%
74%
26%
36%
40-50
>60
Trends in Flood Magnitude
(1920-2008)
NW
NE
SW
SE
Absolute Percent Change Per Decade
0.000
0.005
0.010
0.015
0.020
Increasing Trends
Decreasing Trends


Projected Changes in Atlantic Hurricane Frequency by Category
(2001-2100)
% Change over this Century
125
75
25
-25
-75
Tropical Storm & Cat. 1 Hurricane
Cat. 2 & 3 Hurricane
Cat. 4 & 5 Hurricane

Percentage Change in Very Heavy Precipitation
(1958-2011)
7%
21%
45%
74%
26%
3%
36%
hange
-40
40-50
>60

Hurricane Central

Sandy Brings High Waves, Floods to Great Lakes

Associated Press & weather.com | Published: Nov 1, 2012, 9:07 AM EDT | weather.com

Onlookers take photos as strong waves created by superstorm Sandy crash against the Lake Michigan waterfront, Tuesday, Oct. 30, 2012, on the south side of Chicago. Strong winds from the outer edge of superstorm Sandy are ripping up near-record high waves on Lake Michigan.

Extreme rainfall and stormwater infrastructure

FIGURE 17: Damage at Finch Avenue and Black Creek, north Toronto flood, August 2005 (courtesy of City of Toronto).

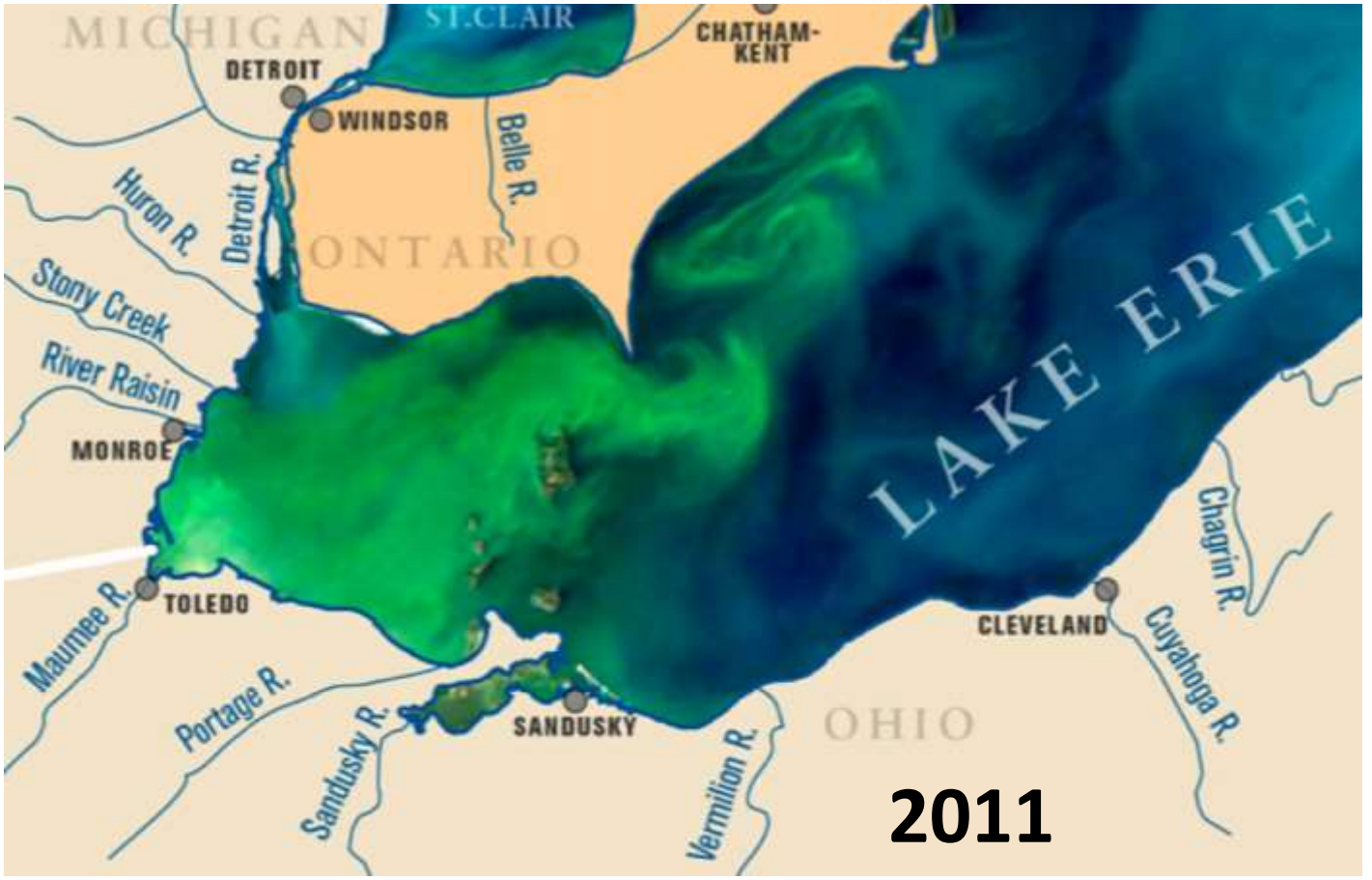
FIGURE 18: July 2004 flood, Peterborough, Ontario (courtesy of City of Peterborough Emergency Management Division).

FIGURE 19: June 2002 storm, northwestern Ontario (Groeneveld, 2006).

PNAS

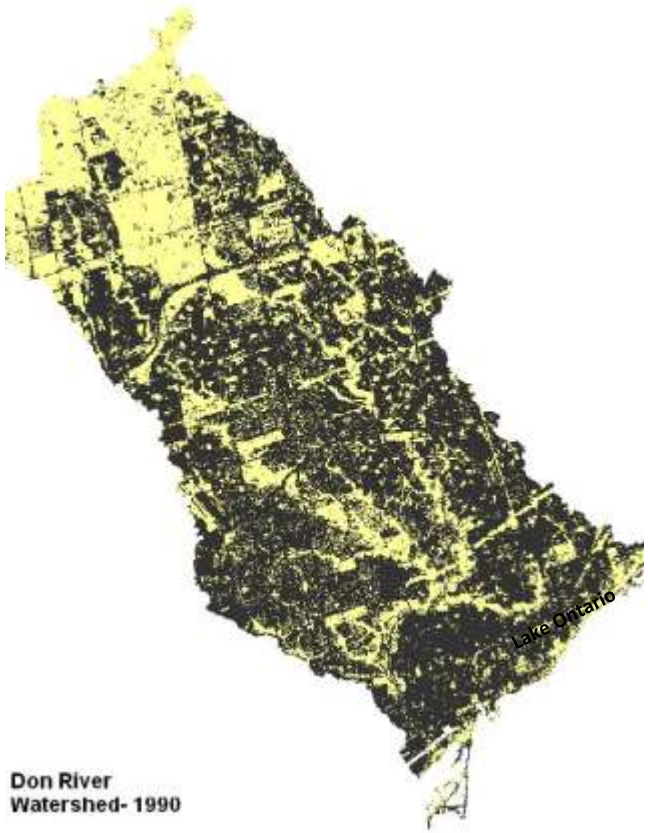
Record-setting algal bloom in Lake Erie caused by agricultural and meteorological trends consistent with expected future conditions

Anna M. Michalak[a,1], Eric J. Anderson[b], Dmitry Beletsky[c], Steven Boland[d], Nathan S. Bosch[e], Thomas B. Bridgeman[f], Justin D. Chaffin[f], Kyunghwa Cho[g,2], Rem Confesor[h], Irem Daloğlu[g], Joseph V. DePinto[i], Mary Anne Evans[g,3], Gary L. Fahnenstiel[j], Lingli He[k], Jeff C. Ho[l], Liza Jenkins[g,j], Thomas H. Johengen[c], Kevin C. Kuo[d,m], Elizabeth LaPorte[n], Xiaojian Liu[d], Michael R. McWilliams[o], Michael R. Moore[g], Derek J. Posselt[d], R. Peter Richards[h], Donald Scavia[g], Allison L. Steiner[d], Ed Verhamme[i], David M. Wright[d], and Melissa A. Zagorski[d]

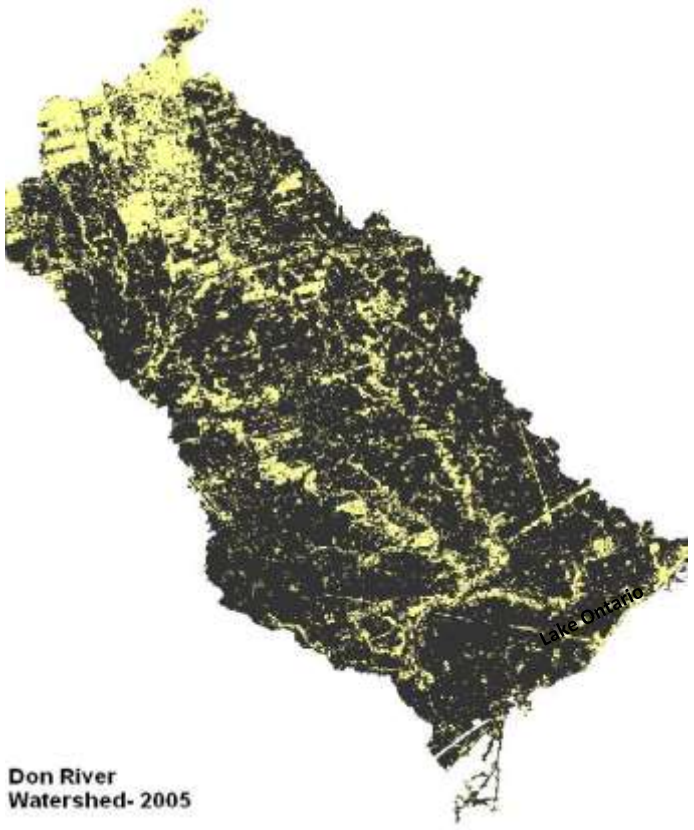


Don River Watershed (Toronto): Changing Land Use with Time

1990 – 70% Impervious



2005 – 84% Impervious

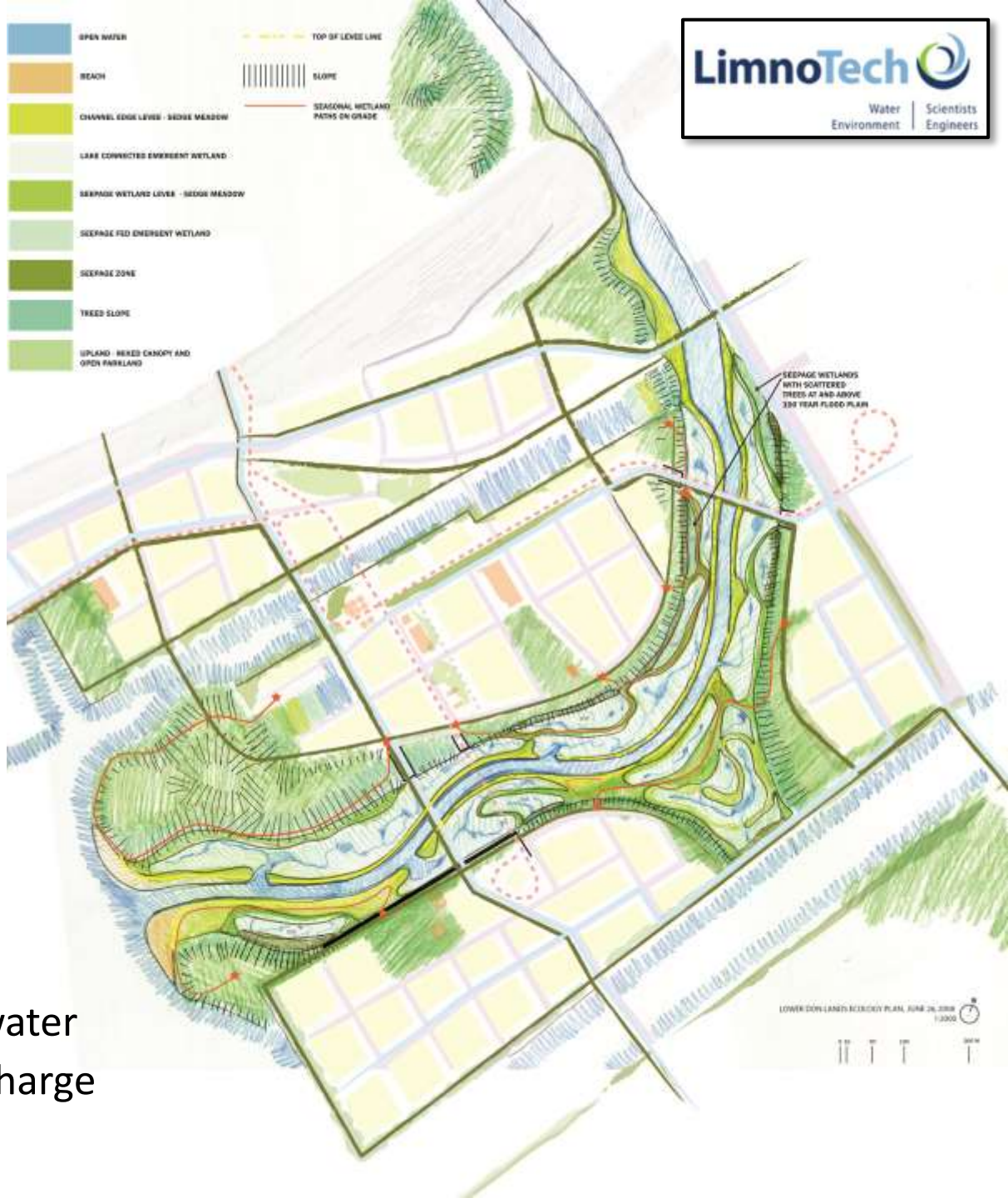


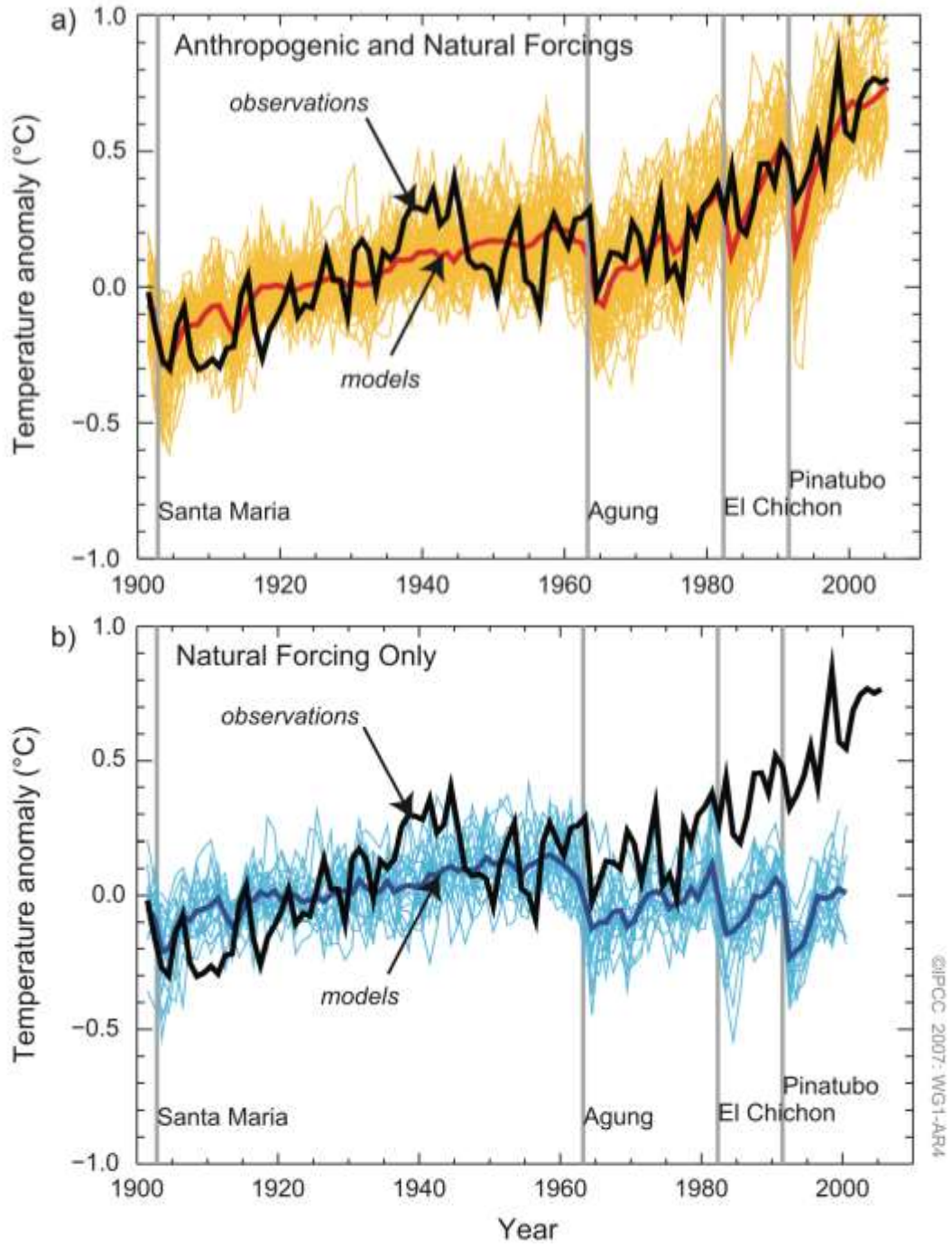
From Amirsalari, 2007, Masters Thesis University of Waterloo, Dept. of Geography

River / Wetland Restoration Plan

- **The challenges**
  - Urbanized watershed
  - Changing lake levels
  - Competing uses
  - Climate impacts

- **Adaptation strategy**
  - <u>Design for</u>:
  - Low baseflow
  - Range of lake levels
  - Flashy hydrology, floodwater
  - Improved sediment discharge





Final thought

We are the cause …

We can be part of the solution

Let’s chart a new future for the Great Lakes …

Thank you!