Water Level Variability and Extremes

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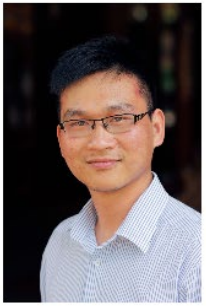
University of Michigan
School for Environment and Sustainability
Department of Civil and Environmental Engineering
Department of Earth and Environmental Sciences

Annual Great Lakes Conference, MSU-IWR
March 2022

Outline

Outline

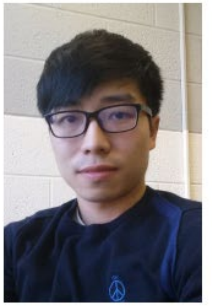


Hong Do, Ph.D. (CV)(Blog)

Post Doctorate Fellow

School for Environment and Sustainability

University of Michigan



Yiwen Mei (CV) (GitHub)

Post Doctorate Fellow

School for Environment and Sustainability

University of Michigan

Helena Garcia

School for Environment and Sustainability

Drew Pappas

School of Information

James Polidori

School for Environment and Sustainability

Princess Mutasa

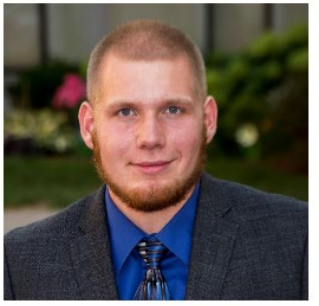
School for Environment and Sustainability

Sydney Swider

Computer Science

Jennani Jayaram

Computational Cognitive Science and Computer Science



Alexander VanDeWeghe

Environmental Engineering

Jenna Sherwin

Civil Engineering

Lisi Pei

Joe Smith

Tim Hunter

Lindsay Fitzpatrick

Lacey Mason

Anne Clites

Ayumi Manome

Brent Lofgren

Eric Anderson

Kaye LaFond

Greg Lang

Chuliang Xiao

Ron Muzzi

Steve Ruberg

Steve Constant

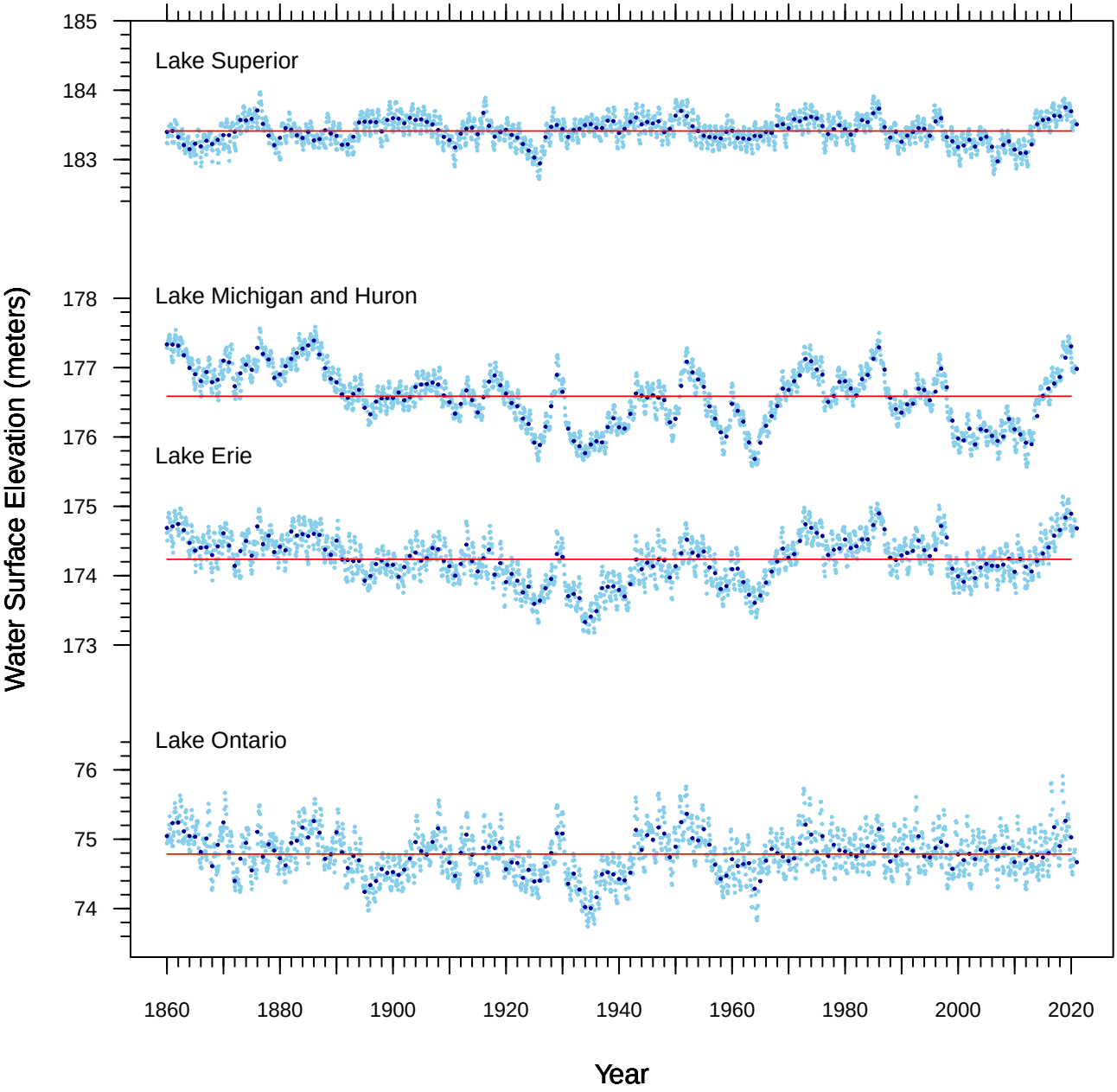
USGS

GLPF

MDOT
Michigan Department of Transportation

UNIVERSITY OF MICHIGAN

GREAT LAKES
ST. LAWRENCE
GOVERNORS
& PREMIERS


Lake Superior
Lake Michigan and Huron
Lake Erie
Lake Ontario
Water Surface Elevation (meters)
185
184
183
178
177
176
175
174
173
76
75
74
1860
1880
1900
1920
1940
1960
1980
2000
2020
Year

VOL. 96 • NO. 6 • 1 APR 2015

EOS

Earth & Space Science News

GREAT LAKES WATER LEVELS SURGE

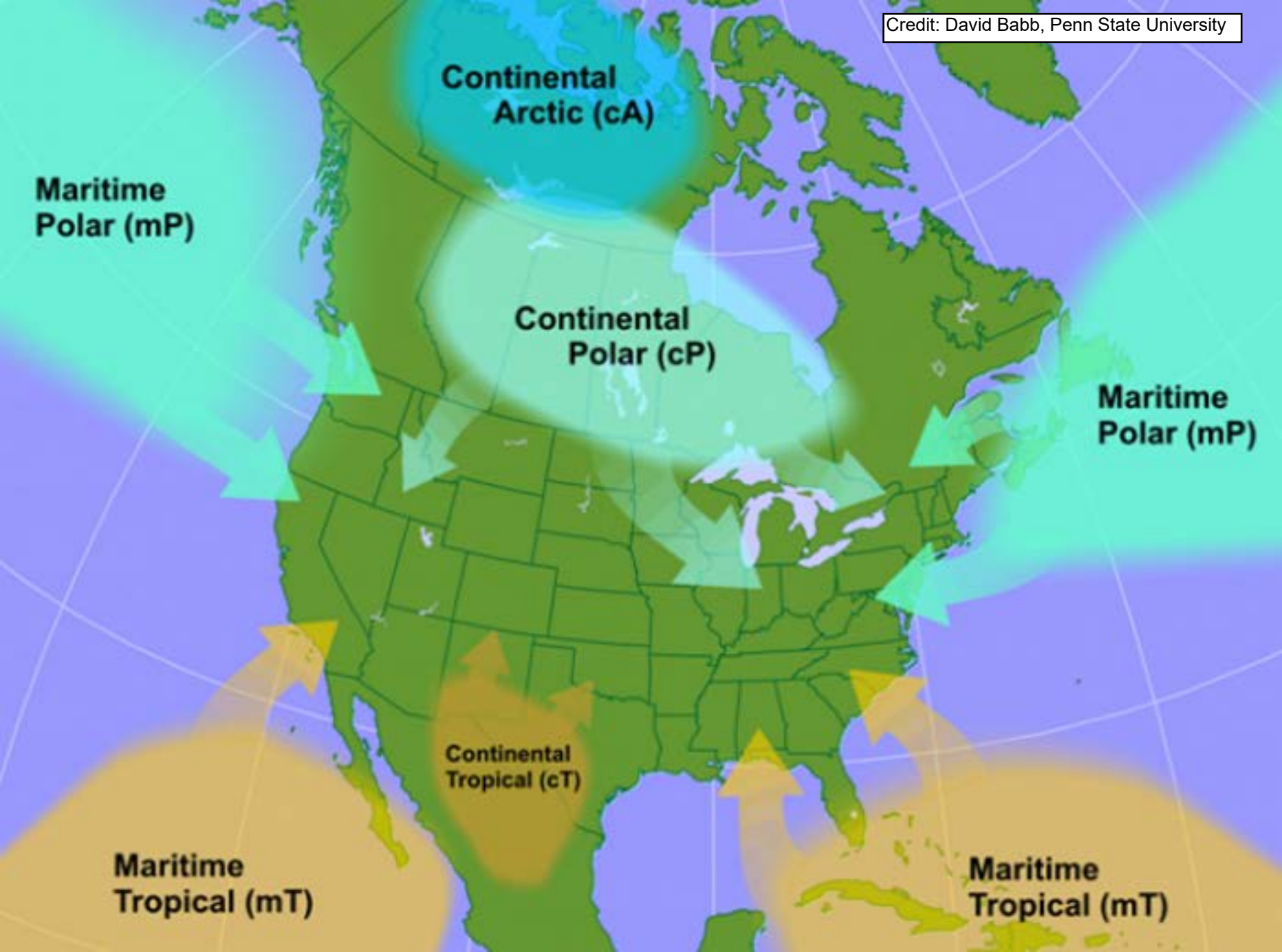
Suite of Software Analyzes Data on the Sphere

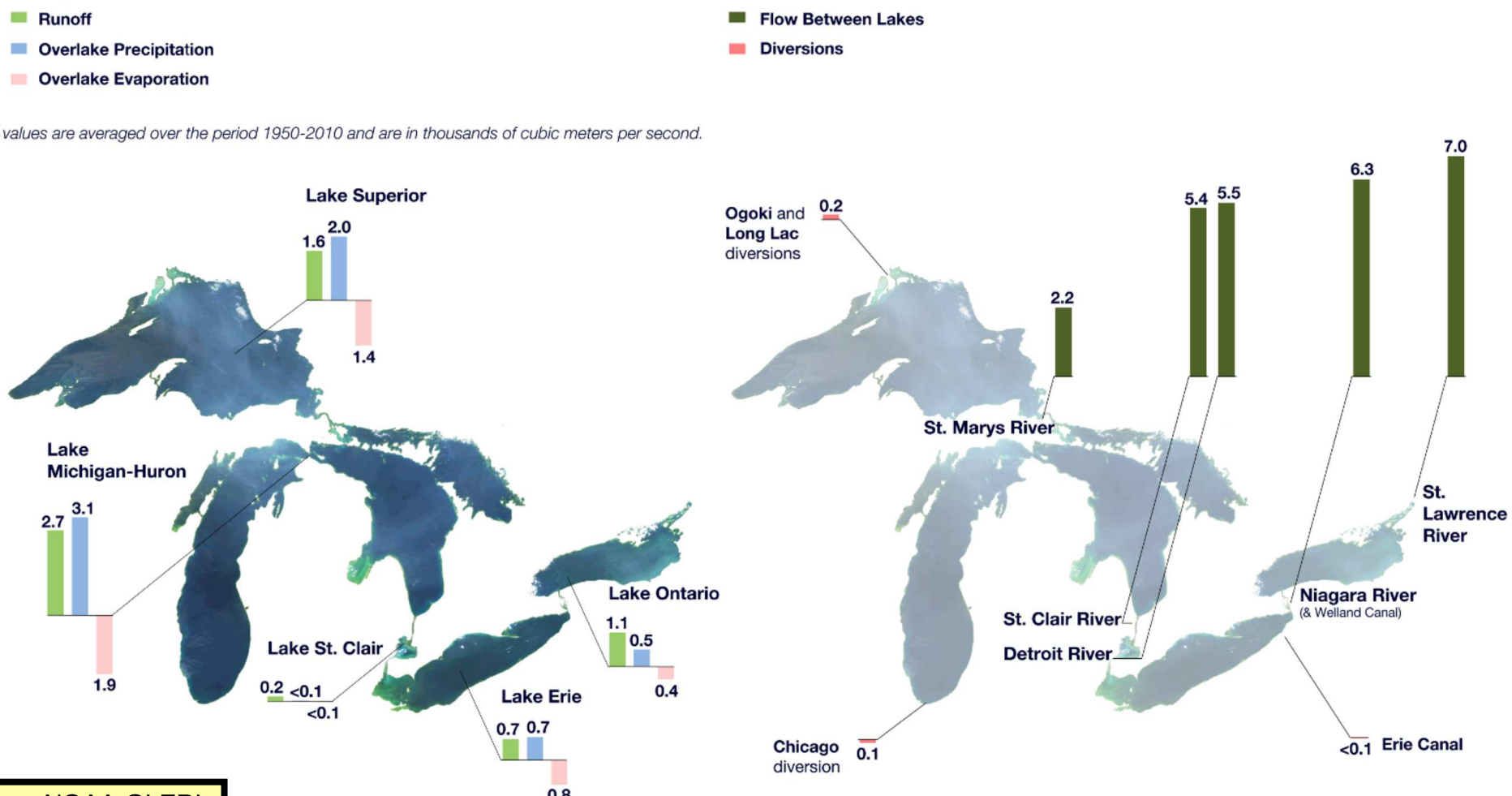
Dawn Spacecraft Orbits Dwarf Planet Ceres

The Social Contract Between Science and Society

AGU
American Geophysical Union

Outline


Credit: David Babb, Penn State University
Continental Arctic (cA)
Maritime Polar (mP)
Continental Polar (cP)
Maritime Polar (mP)
Continental Tropical (cT)
Maritime Tropical (mT)
Maritime Tropical (mT)

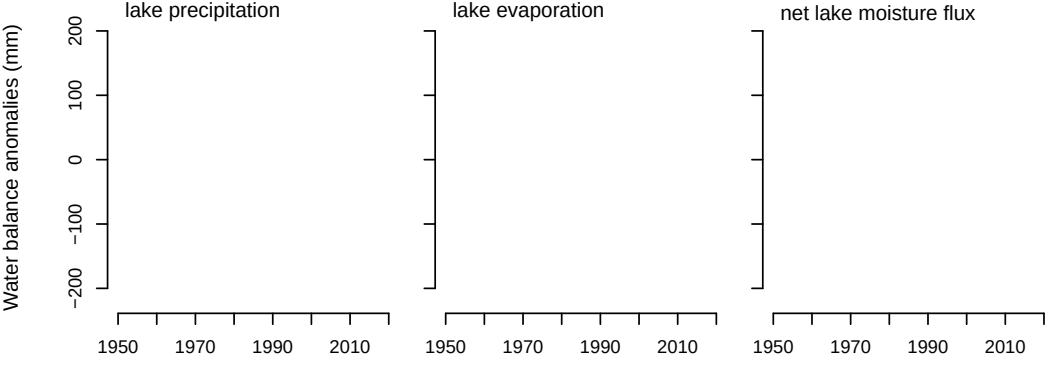


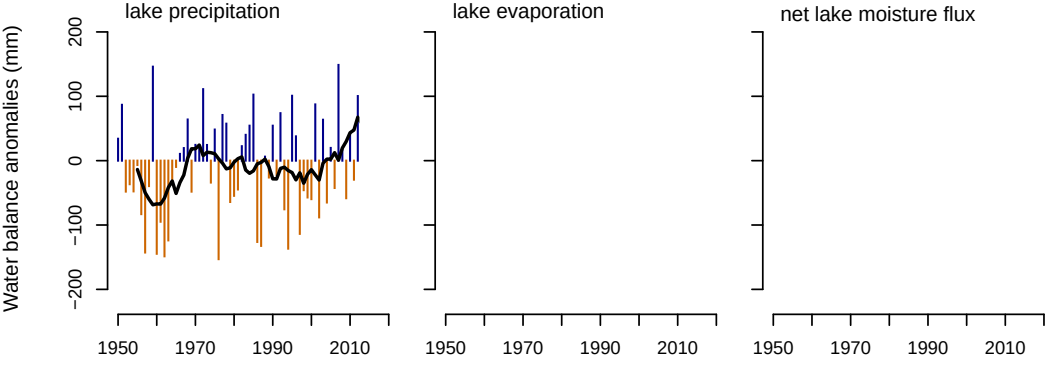
From NOAA-GLERL

Table 1

Annual Average Discharge (in Cubic Meters Per Second, cms) of North America's Eight Largest Rivers (Rounded to the Nearest Hundred)

River	Annual average discharge (cms)
Mississippi	18,400
St. Lawrence	10,800
Mackenzie	9,900
Columbia	7,500
Yukon	6,400
Fraser	3,600
Nelson	2,800
Koksoak	2,400


lake precipitation
lake evaporation
net lake moisture flux
Water balance anomalies (mm)
200
100
0
−100
−200
1950
1970
1990
2010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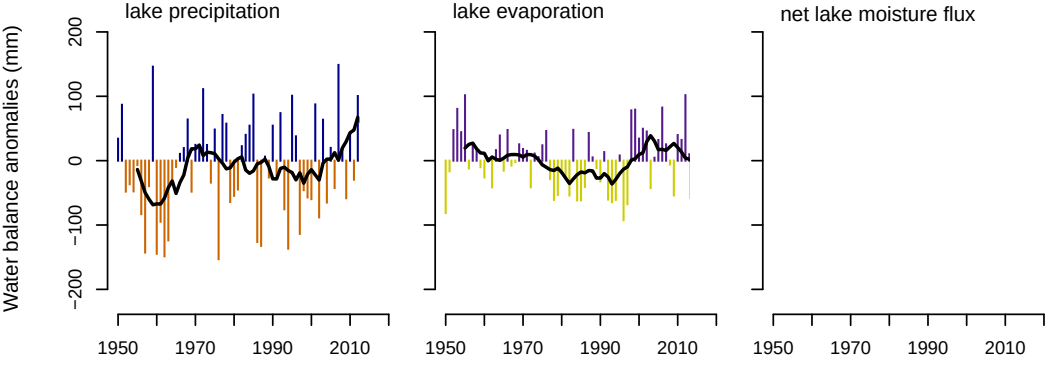
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lake evaporation
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Water balance anomalies (mm)
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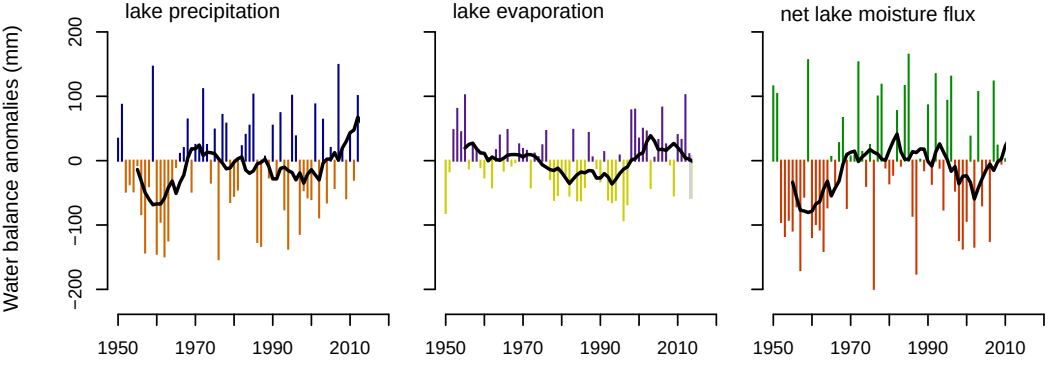
0
−100
−200
1950
1970
1990
2010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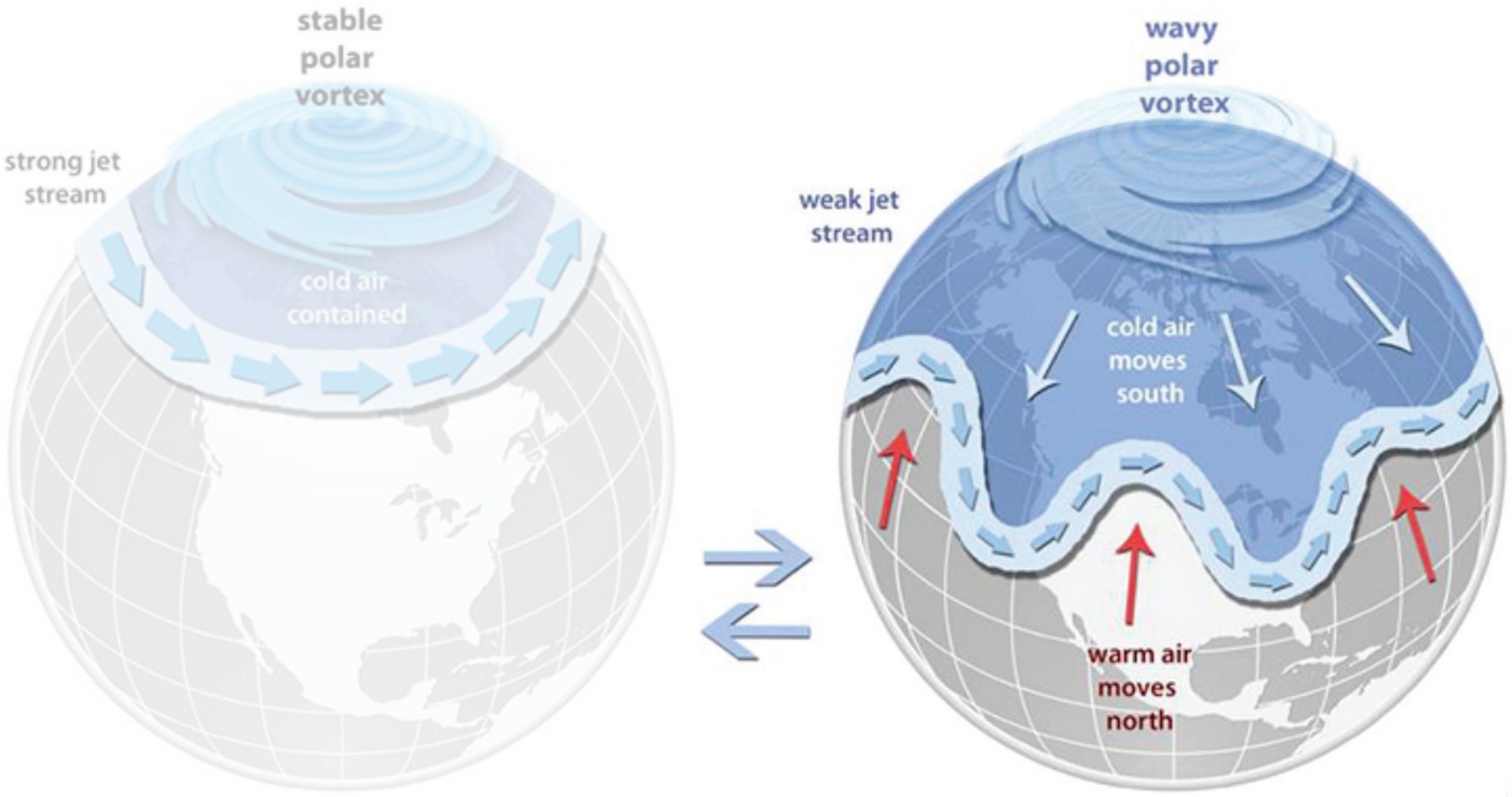
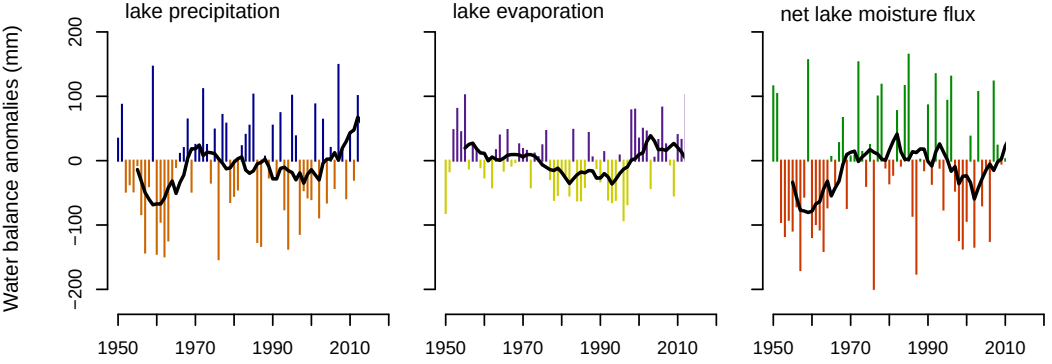

stable
polar
vortex
strong jet
stream
cold air
contained
wavy
polar
vortex
weak jet
stream
cold air
moves
south
warm air
moves
north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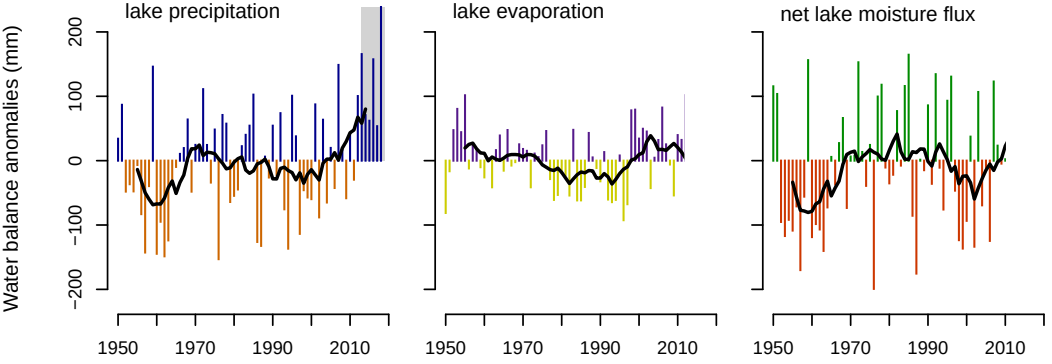
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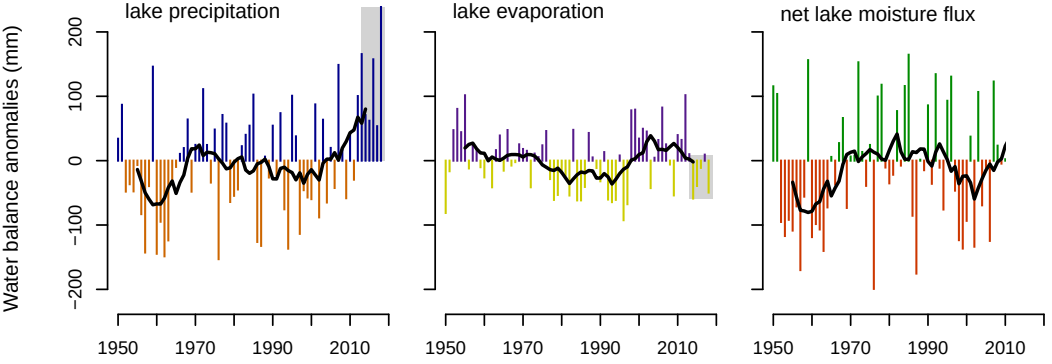
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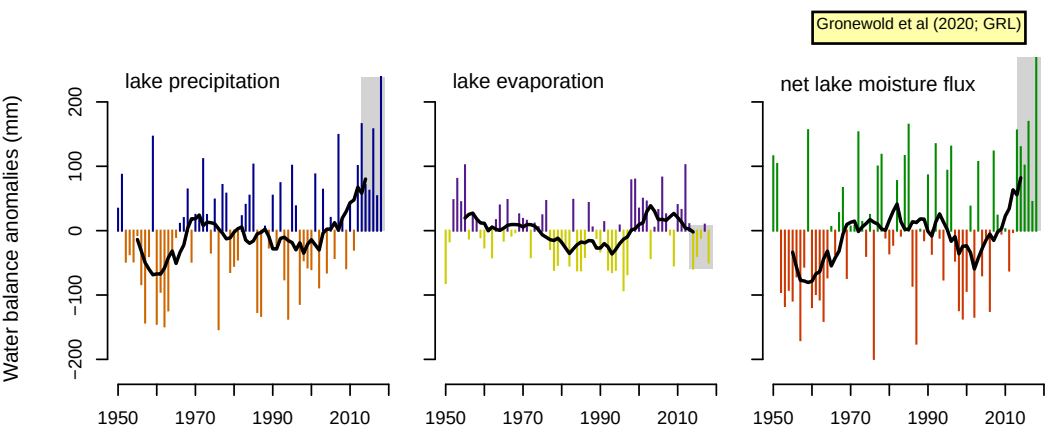
Gronewold et al (2020; GRL)
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200
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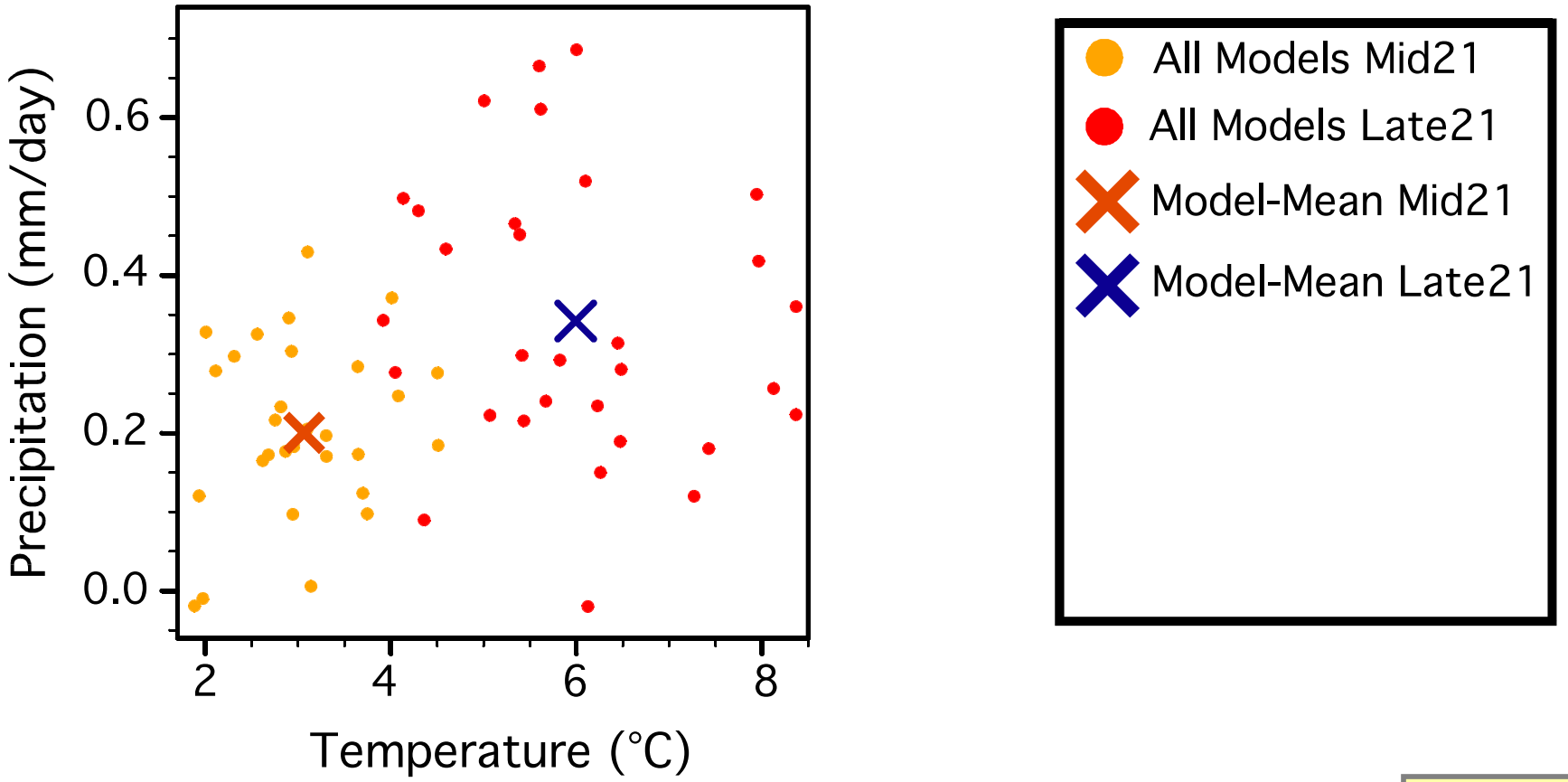
1990
2010

Outline



Adapted from Notaro et al (2015)

(Antonio Perez / Chicago Tribune)

Groundwater running out in northeastern Illinois

FEB 25, 2021

The New York Times

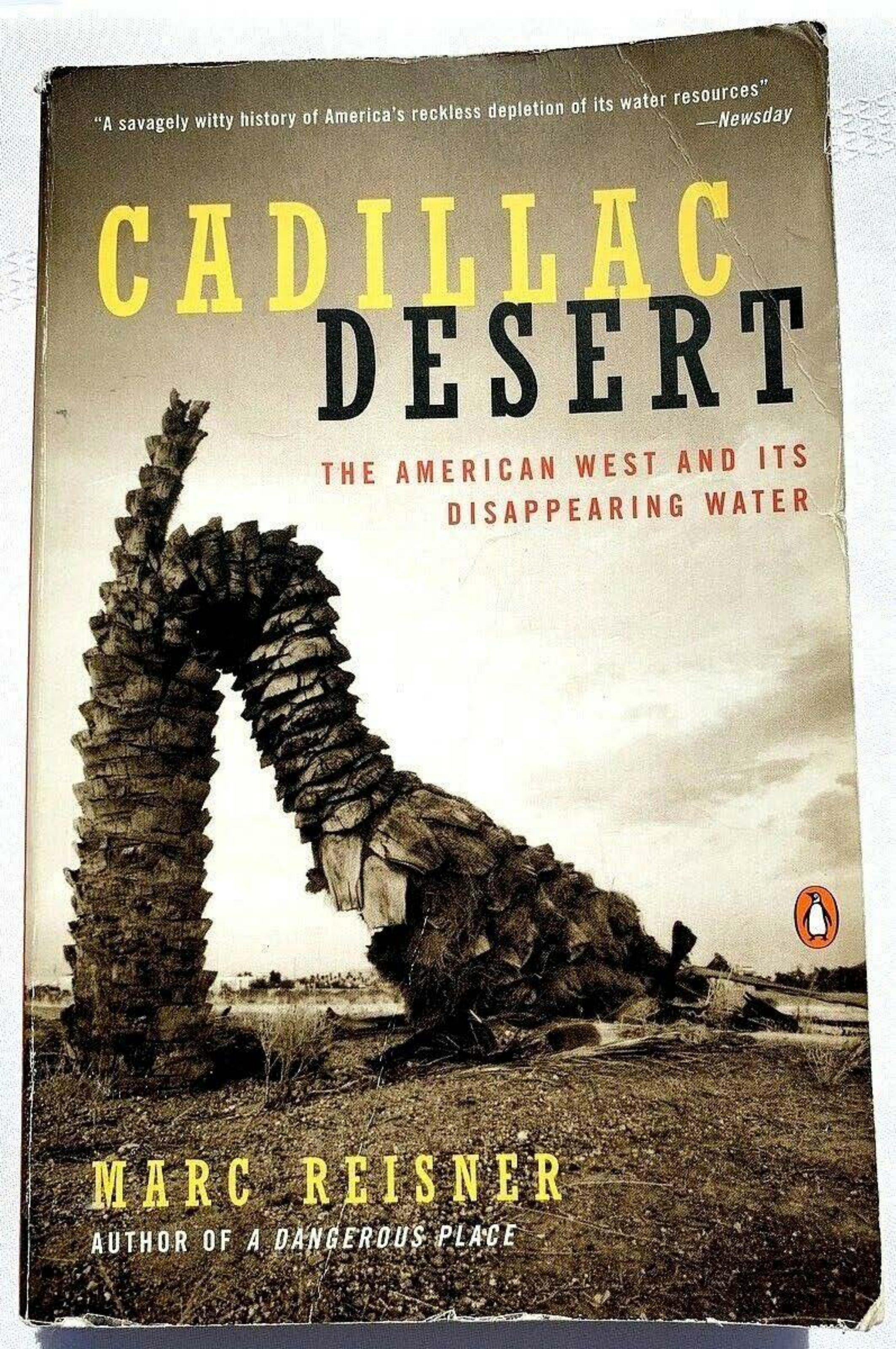
CANADA

Montreal Flooding Displaces Thousands

"A savagely witty history of America's reckless depletion of its water resources"
—*Newsday*

CADILLAC DESERT

THE AMERICAN WEST AND ITS DISAPPEARING WATER



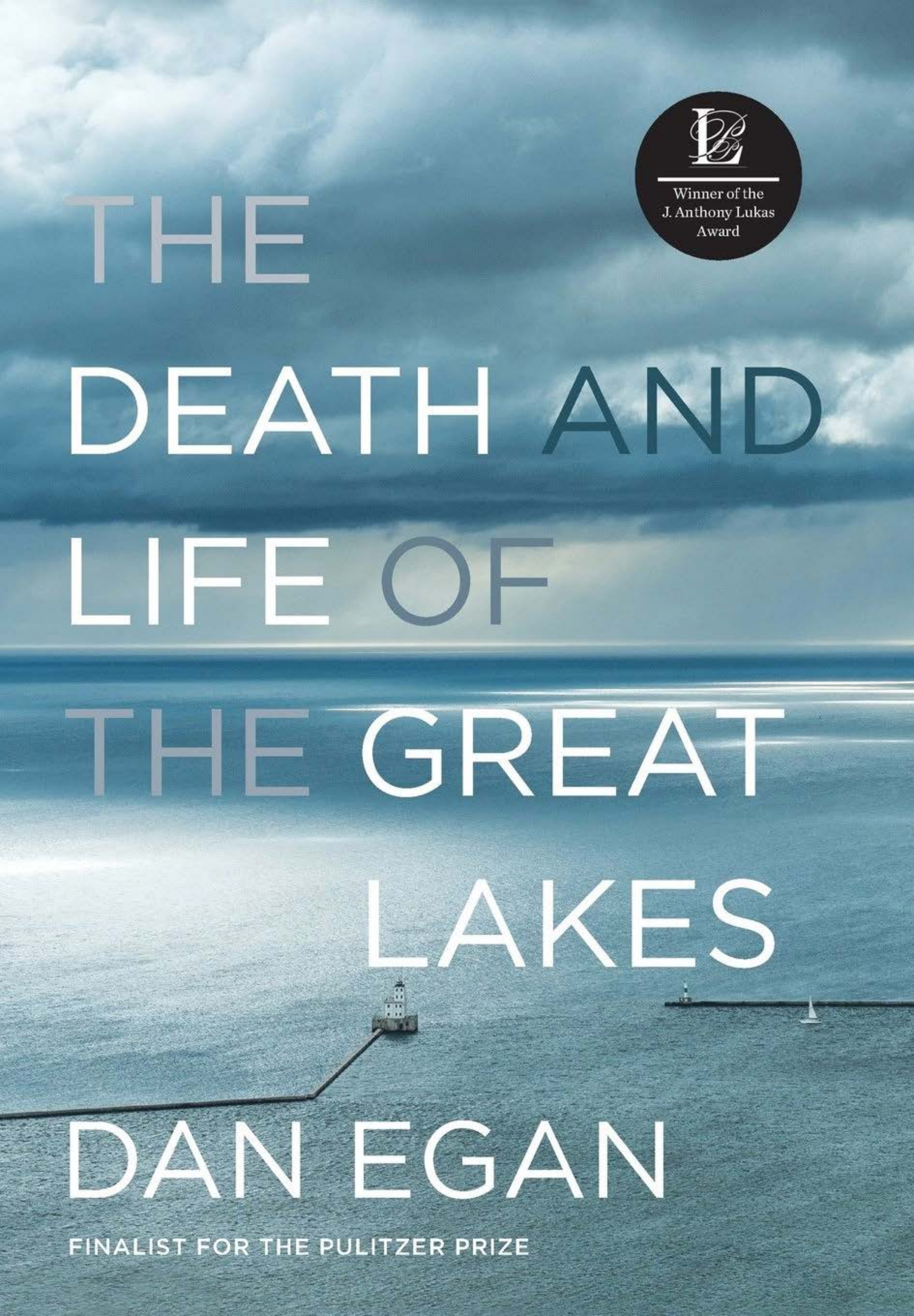
MARC REISNER

AUTHOR OF *A DANGEROUS PLACE*

THE SOURCE

HOW RIVERS MADE AMERICA AND AMERICA REMADE ITS RIVERS

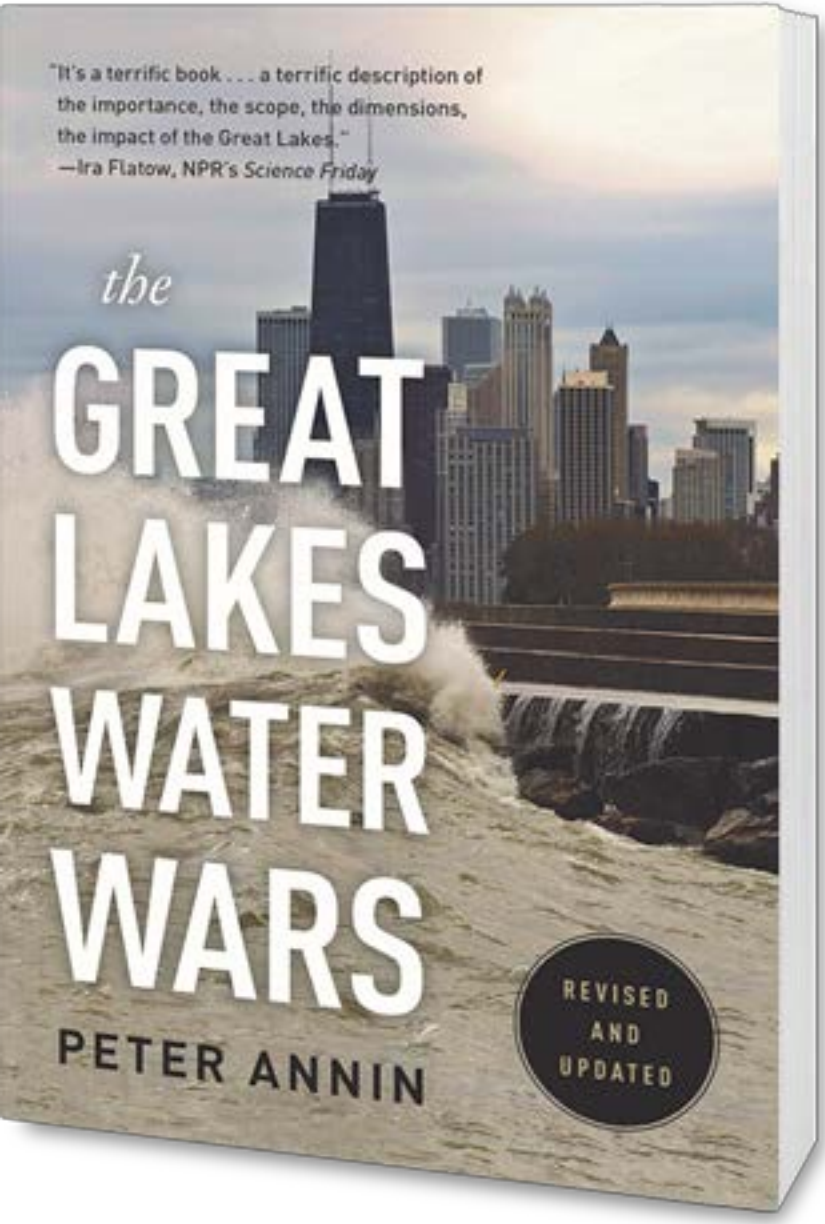
MARTIN DOYLE



THE DEATH AND LIFE OF THE GREAT LAKES

DAN EGAN

FINALIST FOR THE PULITZER PRIZE


"It's a terrific book . . . a terrific description of the importance, the scope, the dimensions, the impact of the Great Lakes."
—Ira Flatow, NPR's Science Friday
the
GREAT LAKES WATER WARS
PETER ANNIN
REVISED AND UPDATED

Outline

- Great Lakes are a massive and complex hydrologic system

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- Continental-scale movement of air masses

- Great Lakes are a massive and complex hydrologic system
- Continental-scale movement of air masses
- Long-term water level forecasting is a major challenge

Water Abundance Across the Great Lakes

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Lake Superior
Apostle Islands
Superior
Bayfield
Ashland
Brule
Hurley
MICHIGAN
Gogebic Range
St Croix River
Hayward
Lake Chippewa
Park Falls
Eagle River
Spooner
Ojibwa
Menominee R
Rhinelander
Pembine
Rice Lake
Crandon
St Croix Falls
Timms Hill 1951
Tomahawk
Wolf River
Merrill
Antigo
Marinette
Chippewa River
Wausau
Oconto
Menomonie
Chippewa Falls
Green Bay
Door Pen
Sturgeon Bay
Eau Claire
Shawano
Mississippi River
Marshfield
Osseo
Stevens Point
Green Bay
Black River
De Pere
Kewaunee
Wisconsin Rapids
Black River Falls
Appleton
Kaukauna
Pentenwell Lake
Two Rivers
Lake Winnebago
Manitowoc
MINNESOTA
Sparta
Tomah
Oshkosh
The Dells
La Crosse
Fond du Lac
Sheboygan
Plymouth
Wisconsin Dells
Waupun
Viroqua
Portage
Beaver Dam
Michigan
Lake
West Bend
Richland Center
Wisconsin
Menomonee Falls
Watertown
Wauwatosa
Prairie du Chien
Madison
Waukesha
Milwaukee
IOWA
Dodgeville
Fort Atkinson
West Allis
Platteville
Janesville
Racine
Monroe
Kenosha
Beloit
94
43
39
90


Ogoki Diversion
Nipigon River
Long Lac Diversion
Statute Miles
50 0 50 100 150 200
Kilometers
100 0 100 200 300
MINNESOTA
LAKE SUPERIOR
ONTARIO
Duluth
St. Marys River
MICHIGAN
Sault Ste. Marie
Ottawa River
St. Lawrence River
QUEBEC
Cornwall
Massena
GEORGIAN BAY
LAKE HURON
Straits of Mackinac
WISCONSIN
Green Bay
LAKE MICHIGAN
Toronto
LAKE ONTARIO
Milwaukee
MICHIGAN
Welland Canal
Buffalo
NEW YORK
St. Clair River
Niagara River
Detroit
Detroit River
LAKE ERIE
Chicago
ILLINOIS
Chicago Sanitary and Ship Canal
INDIANA
Cleveland
PENNSYLVANIA
OHIO

Name	Country	Surface area		Volume	
		(km^2)	(mi^2)	(km^3)	(mi^3)
Michigan–Huron	U.S. and Canada	117,702	45,445	8,458	2,029
Superior	U.S. and Canada	82,414	31,820	12,100	2,900
Victoria	Multiple	69,485	26,828	2,750	660
Tanganyika	Multiple	32,893	12,700	18,900	4,500
Baikal	Russia	31,500	12,200	23,600	5,700
Great Bear Lake	Canada	31,080	12,000	2,236	536
Malawi	Multiple	30,044	11,600	8,400	2,000
Great Slave Lake	Canada	28,930	11,170	2,090	500
Erie	U.S. and Canada	25,719	9,930	489	117
Winnipeg	Canada	23,553	9,094	283	68
Ontario	U.S. and Canada	19,477	7,520	1,639	393

Table: Water volume and surface area of Earth's largest (ranked by surface area) fresh surface waters.

From: Gronewold, Fortin, Lofgren, Clites, Stow, and Quinn (2013). *Climatic Change*.

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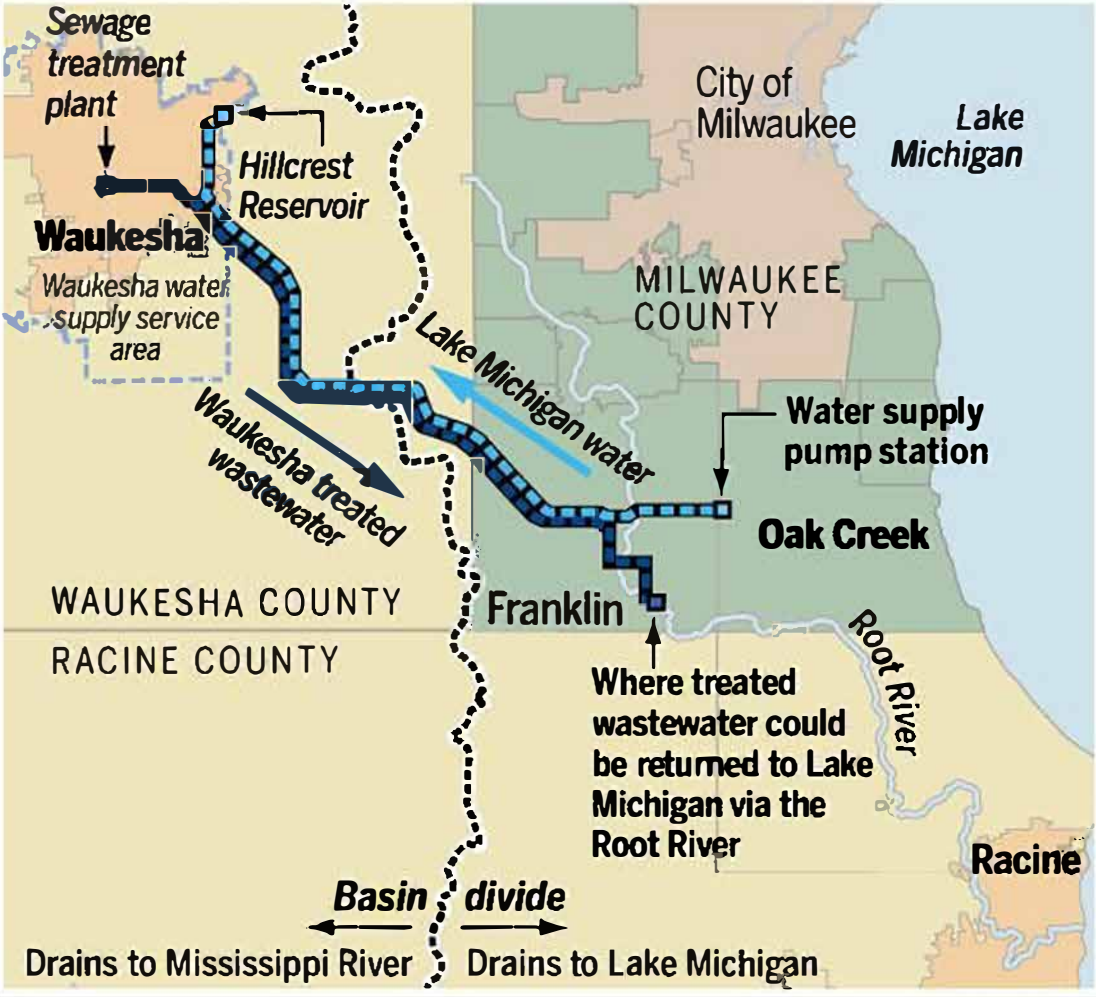
DNR approves water plan

The Wisconsin Department of Natural Resources said Tuesday it will forward the City of Waukesha's request for Lake Michigan water to the Conference of Great Lakes Governors. Waukesha's application to purchase lake water from Oak Creek needs the unanimous approval of the Great Lakes governors.



Source: City of Waukesha water utility

Journal Sentinel

Calculated Soil Moisture Ranking Percentile
AUG 24, 2021