

# Events

## **Thunder Bay Green Drinks**

This Wednesday, 5 – 7 pm at The Madhouse, corner of Bay and Algoma an environmentally-minded crowd, a part of the worldwide Green Drinks in over 700 cities around the world.

## **“Merchants of Doubt” - Wed. Sept. 16,**

- A documentary that lifts the curtain on a secretive group of highly charismatic, silver-tongued pundits-for-hire who present themselves in the media as scientific authorities – yet have the contrary aim of spreading maximum confusion about well-studied public threats ranging from toxic chemicals to pharmaceuticals to climate change. 7:30 pm at Maple Row (formerly Paramount Theatre) at 24 Court South. Free admission, donations appreciated.



# Asian Carp Innovative Solutions Competition

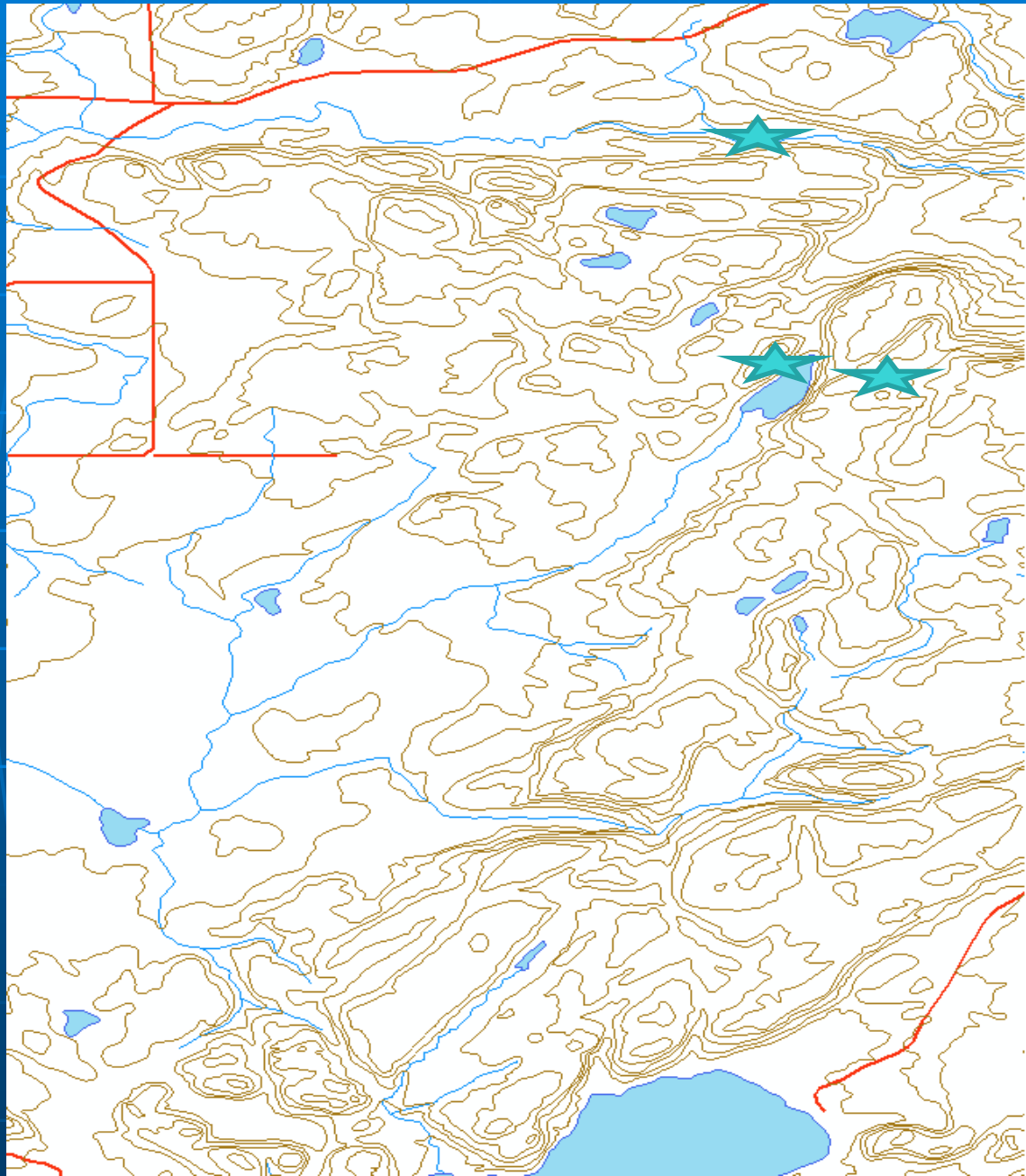
Asian Carp Canada is hosting an Innovative Solutions Competition for post-secondary students, on March 5th 2016, to develop a device, technology, equipment, chemical, or other method that could be utilized to either prevent or manage Asian carp.

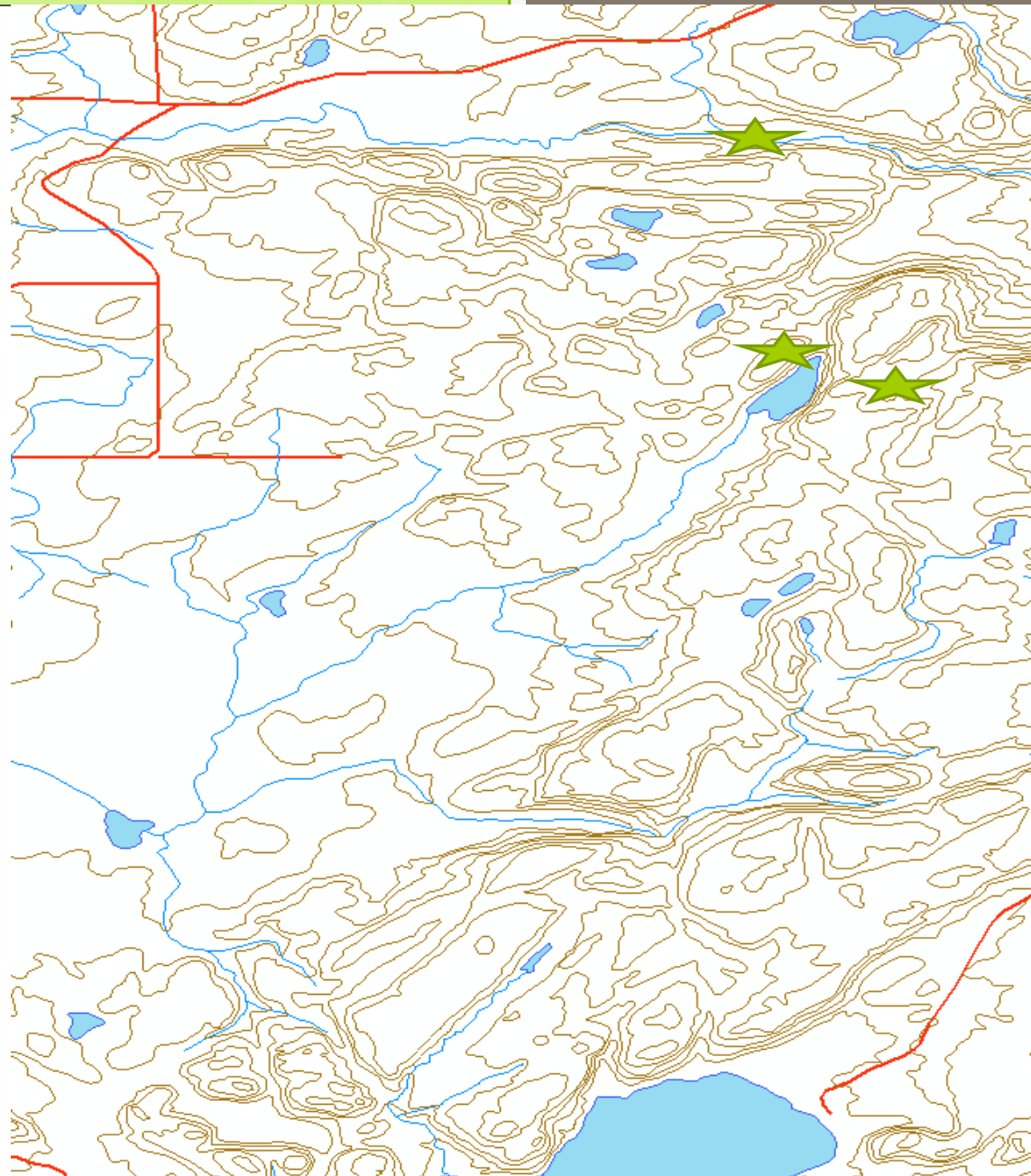
For more information and to register visit the [Innovative Solutions Competition page](#).

<http://www.invasivespeciescentre.ca/SitePages/default.aspx>

Field Trip?

T-Shirts?





# A Superior Basin Environment

A satellite-style photograph of the Superior Basin in North America. The image shows the Great Lakes (Superior, Michigan, Huron, Erie, and Ontario) and the surrounding landmasses. The lakes are dark blue-green, and the land is a mix of brown, tan, and green, indicating different geological and geomorphological features. The perspective is from space, showing the curvature of the Earth and the surrounding atmosphere.

**Geological and Geomorphological Processes  
in the Basin**

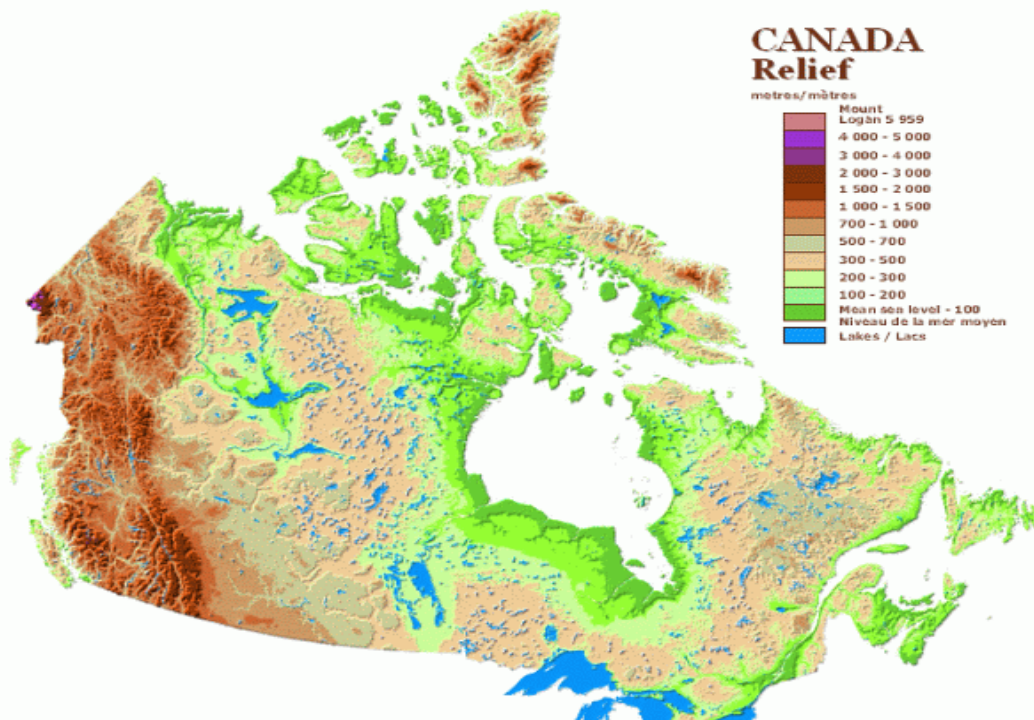


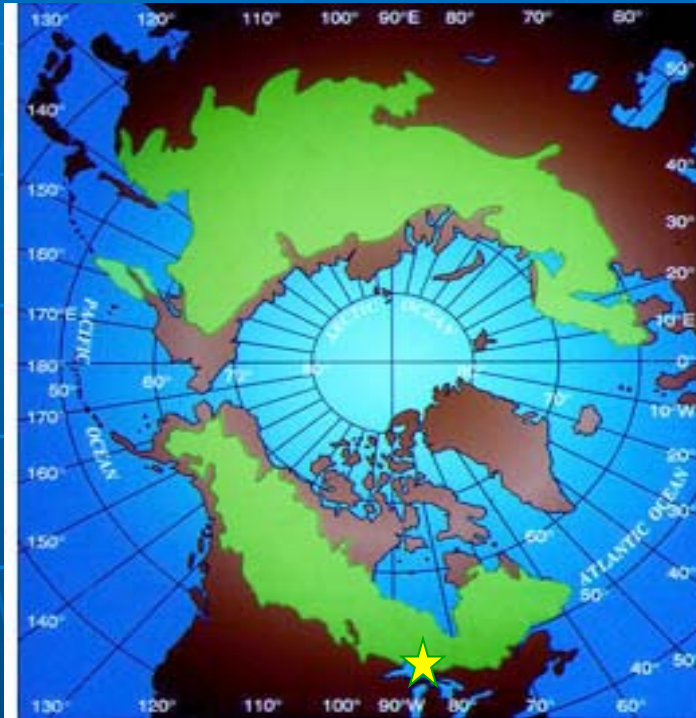
Table 2.1

**Geological Time Chart**

<b>Geological Era</b>	<b>Geological Time (millions of years ago)</b>	<b>Physiographic Region(s) Formed</b>
Precambrian	600 to 3,500	Canadian Shield
Paleozoic	250 to 600	Appalachian Uplands, Interior Plains, and Arctic Lands
Mesozoic	100 to 250	Interior Plains
Cenozoic Quaternary	0 to 100	Cordillera The Quaternary Period is divided into the Pleistocene Epoch (ice ages) and the Holocene Epoch (the post-glacial period).

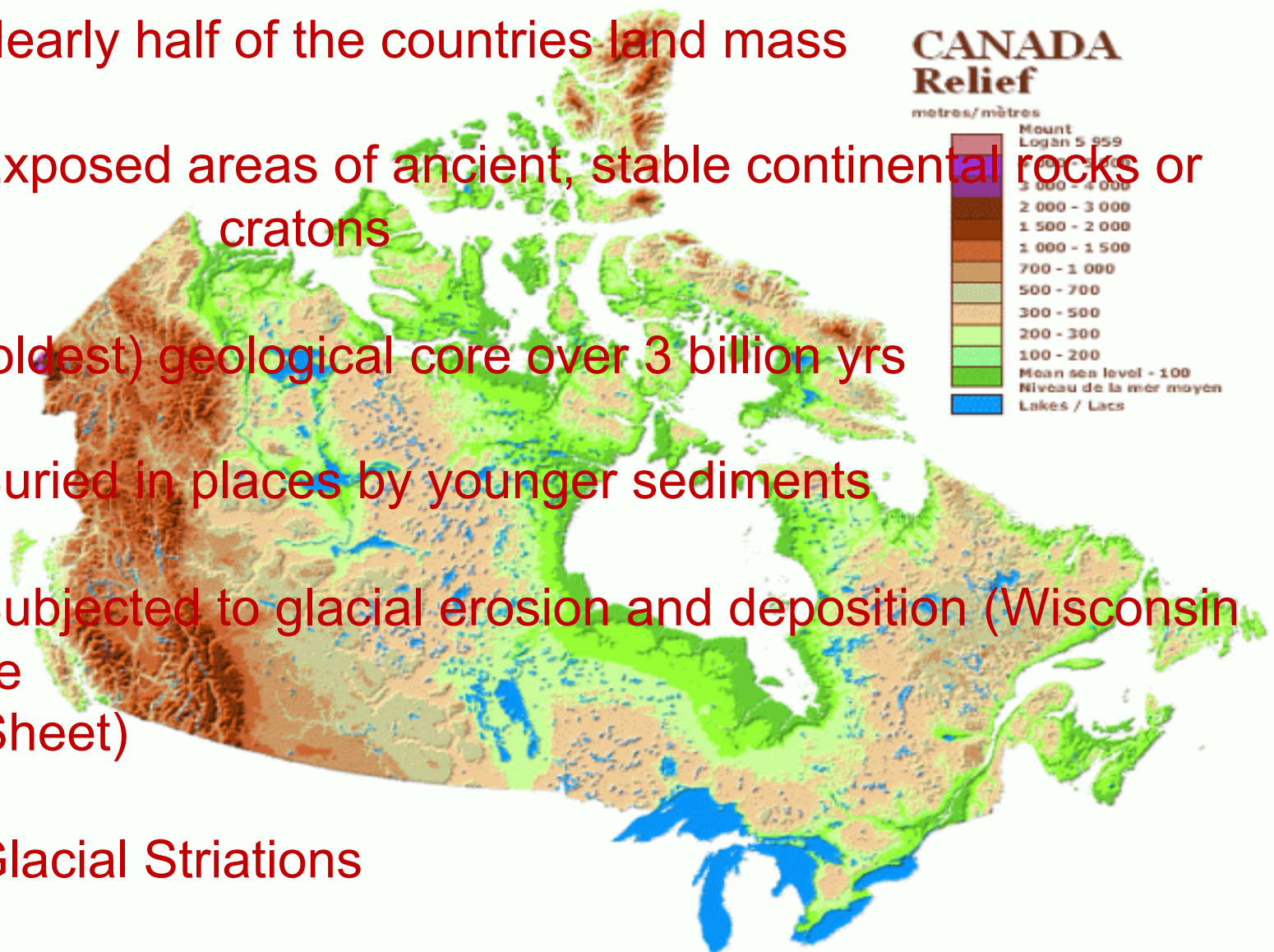


# The Global and Canadian Boreal Forest



# The Canadian Shield

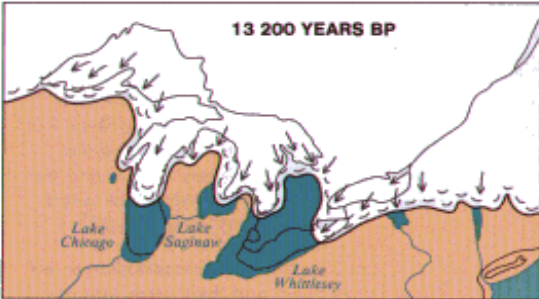
- Nearly half of the country's land mass
- Exposed areas of ancient, stable continental rocks or cratons
- (oldest) geological core over 3 billion yrs
- Buried in places by younger sediments
- Subjected to glacial erosion and deposition (Wisconsin Ice Sheet)
- Glacial Striations



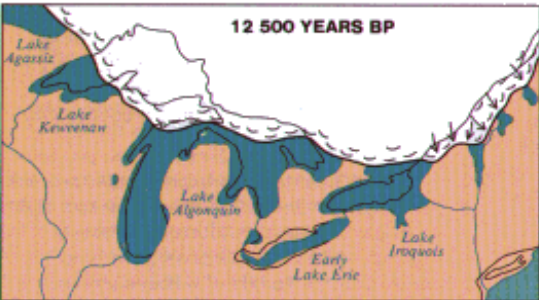
# STAGES IN THE EVOLUTION OF THE GREAT LAKES

SCALE 1: 20 000 000

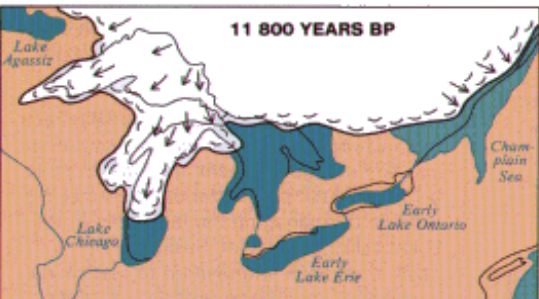
13 200 YEARS BP



12 500 YEARS BP



11 800 YEARS BP



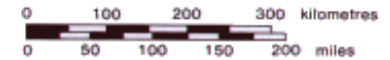
10 000 YEARS BP



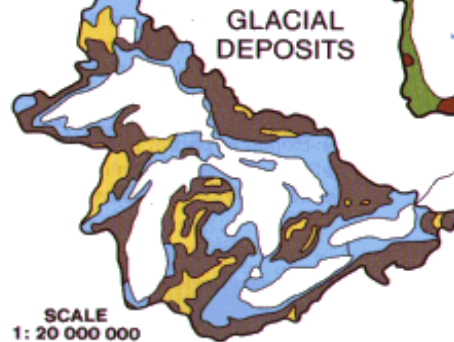
NOTE:  
The maps on left are "snapshots" of a continuously changing situation during the retreat of the Wisconsin ice sheet. They should not be viewed as a simple sequence, since many intermediate stages are omitted. The letters BP denote before present.

# GEOLOGY AND MINERAL RESOURCES

SCALE 1: 7 500 000



- Ice
- Ice Front
- Advancing Ice
- Fresh Water
- Salt Water
- Present Coastline



## GLACIAL DEPOSITS

SCALE 1: 20 000 000

### Stratified Drift

- Silt and Clay (glacial lake deposits)
- Sand and Gravel (outwash, alluvial and ice contact deposits)
- Till (ground and end moraines)

Bedrock areas where the glacial cover is absent (e.g. parts of Canadian Shield) are not distinguished.

### PRINCIPAL MINERAL AREAS

- Coal
- Gas
- Oil
- Uranium
- Copper & Zinc
- Gold & Silver
- Iron Ore
- Nickel

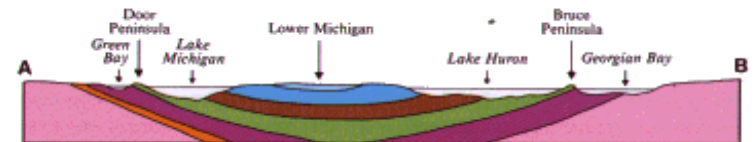
The extraction of minerals such as sand, gravel and limestone is widespread and not mappable at this scale. Other minerals, such as salt and gypsum, are omitted to preserve clarity.

### GEOLOGICAL PERIODS

- |  |               |                                 |
|--|---------------|---------------------------------|
|  | Pennsylvanian | } Carboniferous<br>345 - 290 BP |
|  | Mississippian |                                 |
|  | Devonian      | 400 - 345 BP                    |
|  | Silurian      | 440 - 400 BP                    |
|  | Ordovician    | 500 - 440 BP                    |
|  | Cambrian      | 570 - 500 BP                    |
|  | Precambrian   | 4500 - 570 BP                   |

Figures denote age in millions of years before present (BP).

### GENERALIZED CROSS-SECTION





Maximum extent of ice, 18,000 BP

# Great Lakes: 13,000 Years Ago

18



Monroe and Wikander, p. 475

# Great Lakes: 11,500 Years Ago

19



Monroe and Wikander, p. 475

# Great Lakes: 9500 Years Ago

20



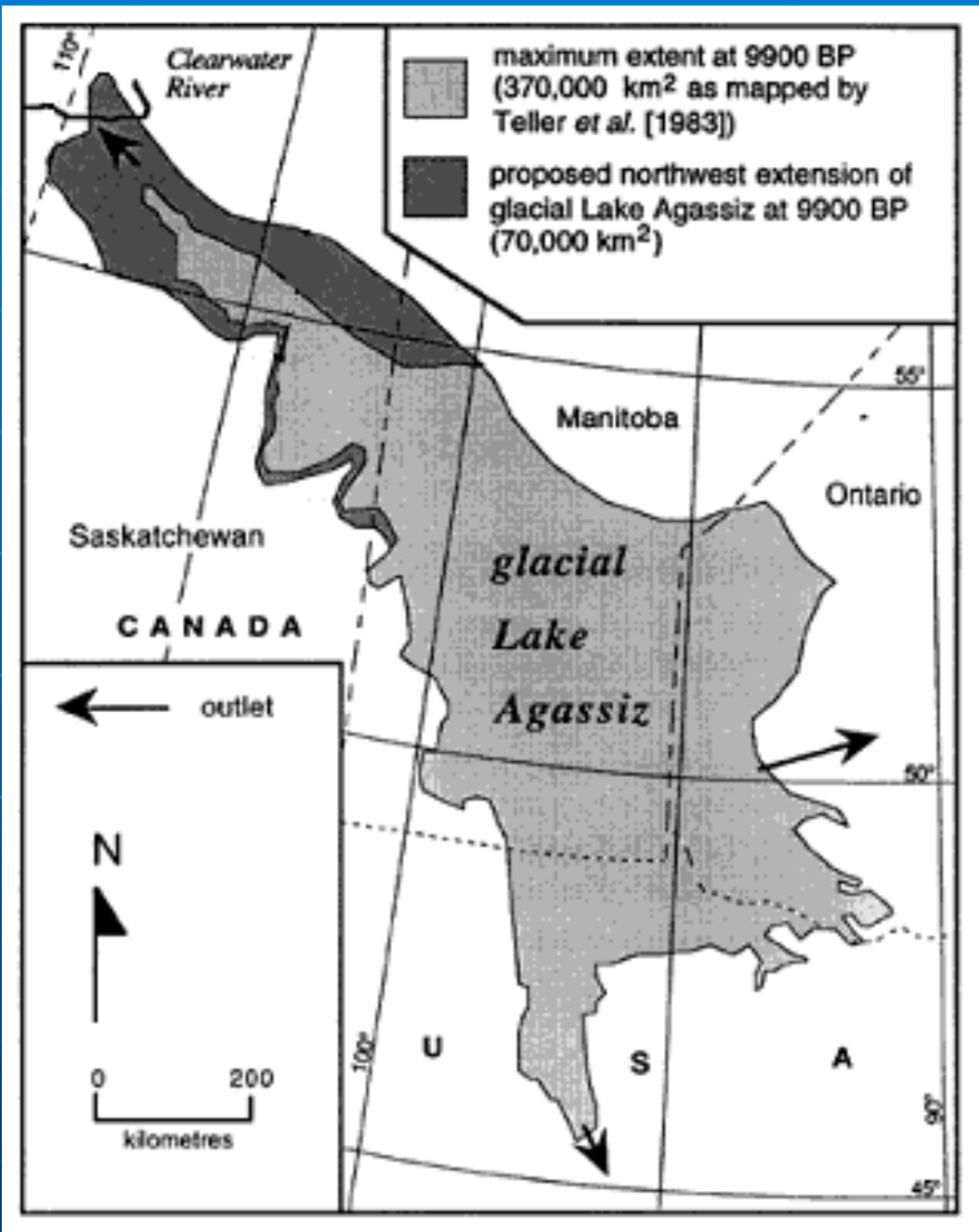
Monroe and Wikander, p. 475

# Great Lakes: 6000 Years Ago

21



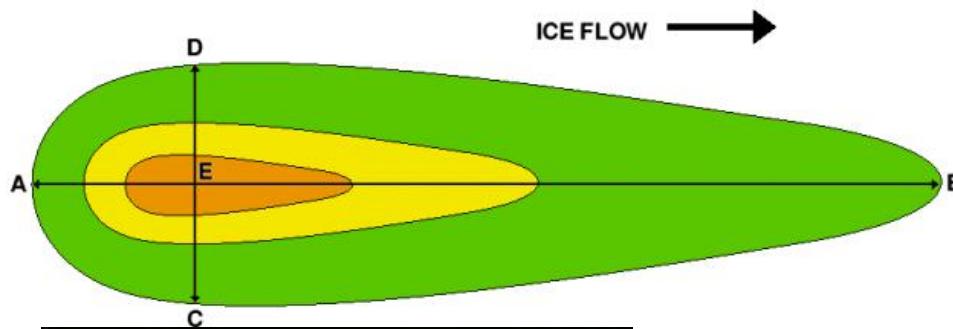
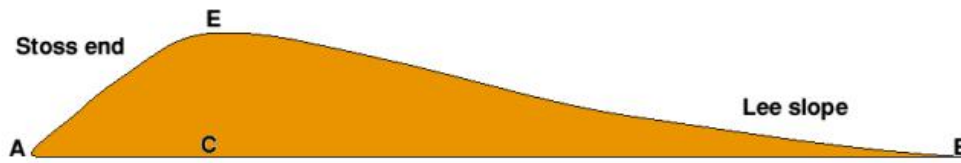
Monroe and Wikander, p. 475



## Lake Agassiz

-melting of the Laurentian about 12000 years ago

-Deposits of fossil fuels in sedimentary rock (hydrocarbons)

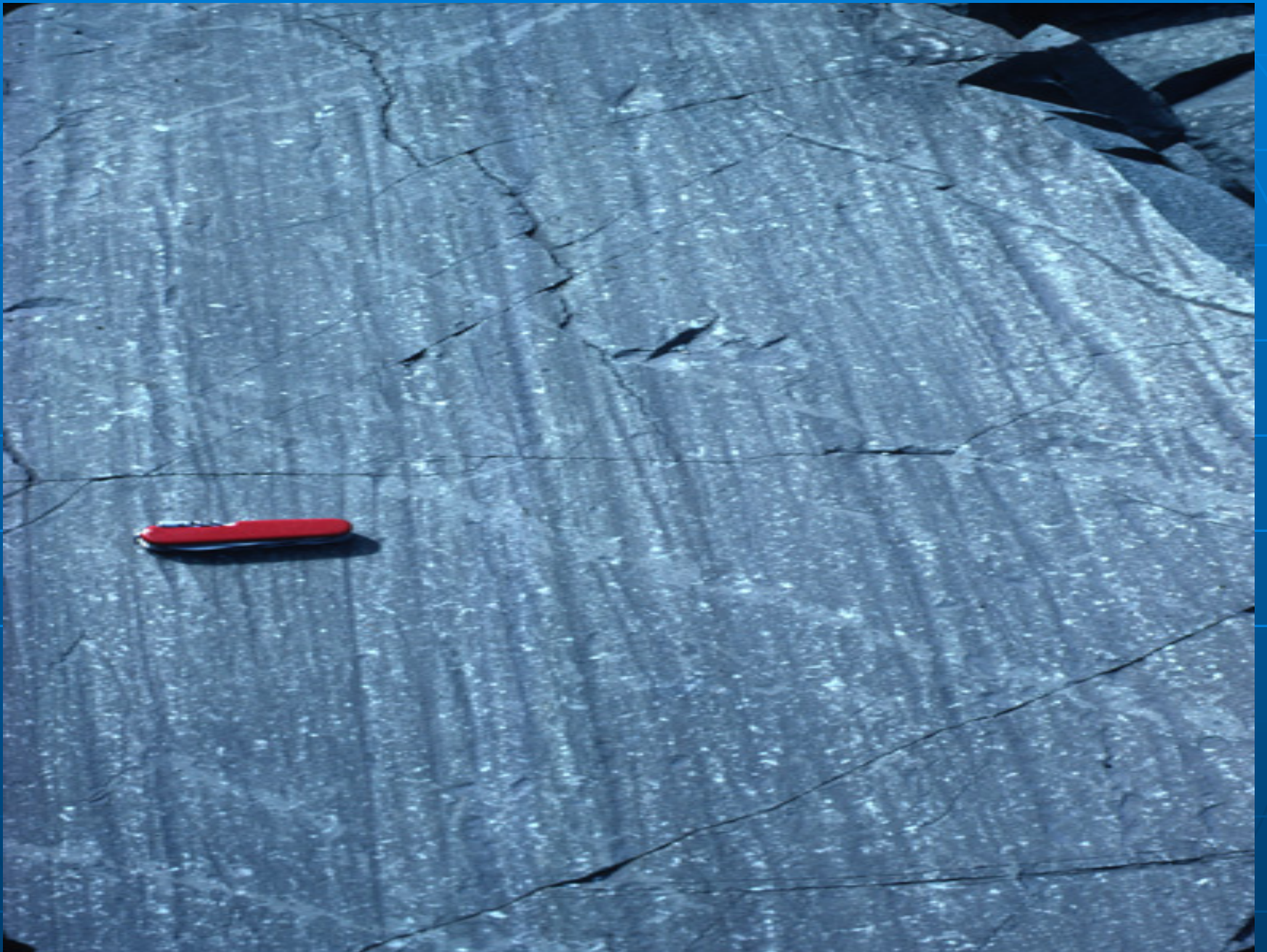


Kettle Lakes – depressions of ice sheet, filled by deposits in ice melt



Eskers: long, narrow mounds of sand and gravel deposited by melt water streams found under a glacier









# The Study of Lakes and Rivers

**Limnology** – The study of inland waters (including ponds, swamps, saline lakes, wetlands). Includes physics, chemistry, biology, geology and geography (others)  
engineering and management

**Paleolimnology** – multidisciplinary science that uses the physical, chemical, and biological information preserved in sediment profiles to reconstruct past environmental conditions in inland aquatic systems (i.e. pollution studies)

**Neolimnologist** – Scientists who work with present day aquatic systems

**Paleolimnologist** – Scientist working on a much longer time scales and primarily using sediments as their primary research material (spatial – temporal scales)

## Water and Aquatic Ecosystems

- interesting thermal and density properties of water:
  - water is less dense in its solid form and thus, floats
  - most dense at about 4°C and less dense as it gets warmer
  - freshwater becomes less dense as it gets colder until it freezes
  - water layers at different temperatures and densities
  - Density can be increased with solutes (i.e. salt water) and affects thermal and chemical stratification
  - water has a very high specific heat and heats up and cools down much slower than most naturally occurring substances (lake effect)
  - water has an extremely high surface tension (strength of surface film second only to mercury)
  - water is a universal solvent in the atmosphere, land and hydrosphere (i.e. dissolves CO<sub>2</sub> into carbonic acid)

# RIVERS AND TRIBUTARIES

Lake Superior is supplied  
by over 200 rivers:

the Nipigon River

the St. Louis River

the Pigeon River

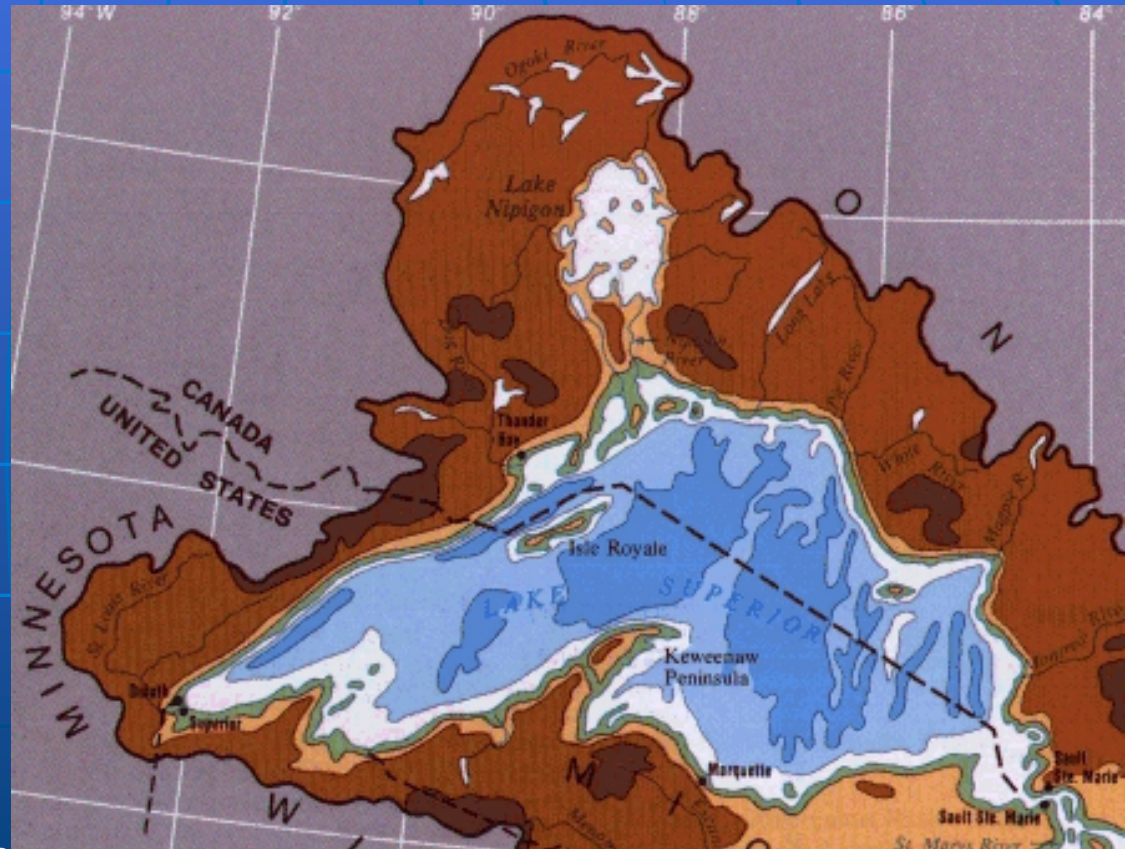
the Pic River

the White River

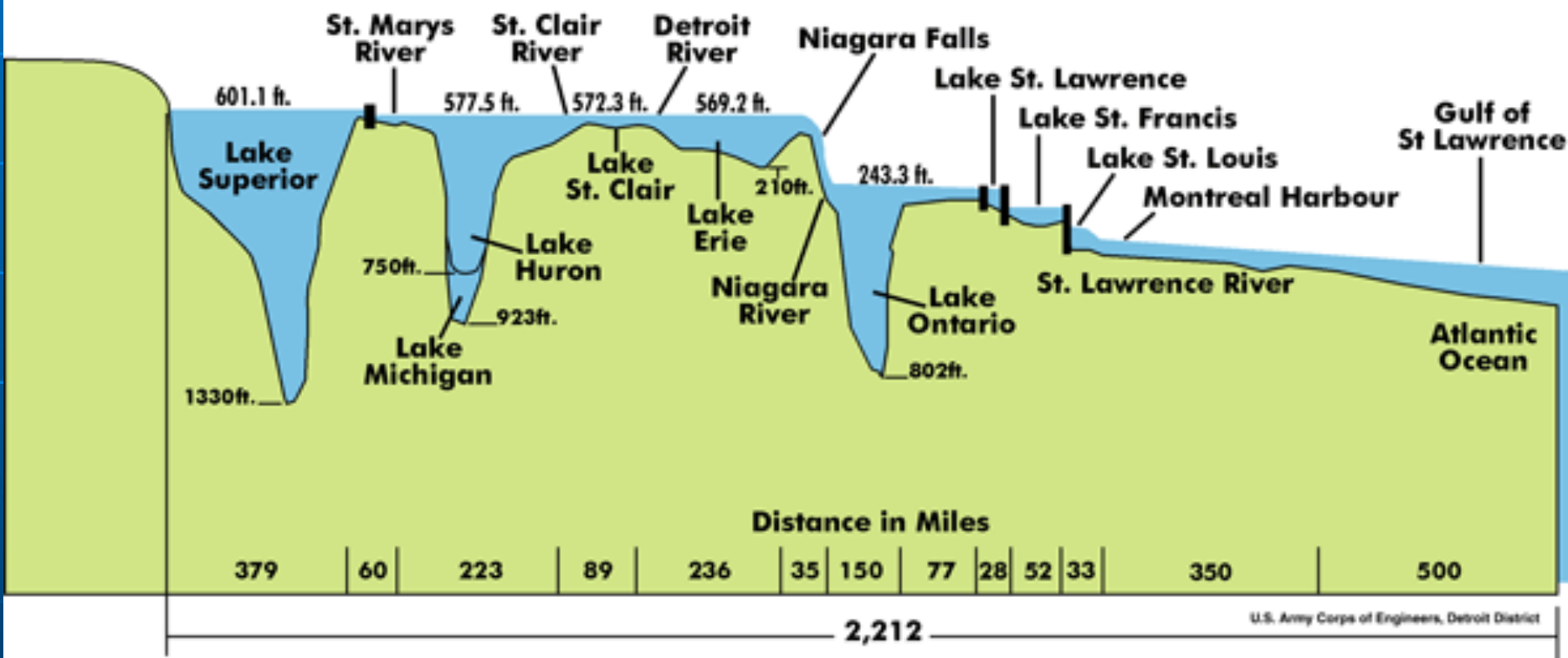
the Michipicoten River

the Brule River

the Kaministiquia River

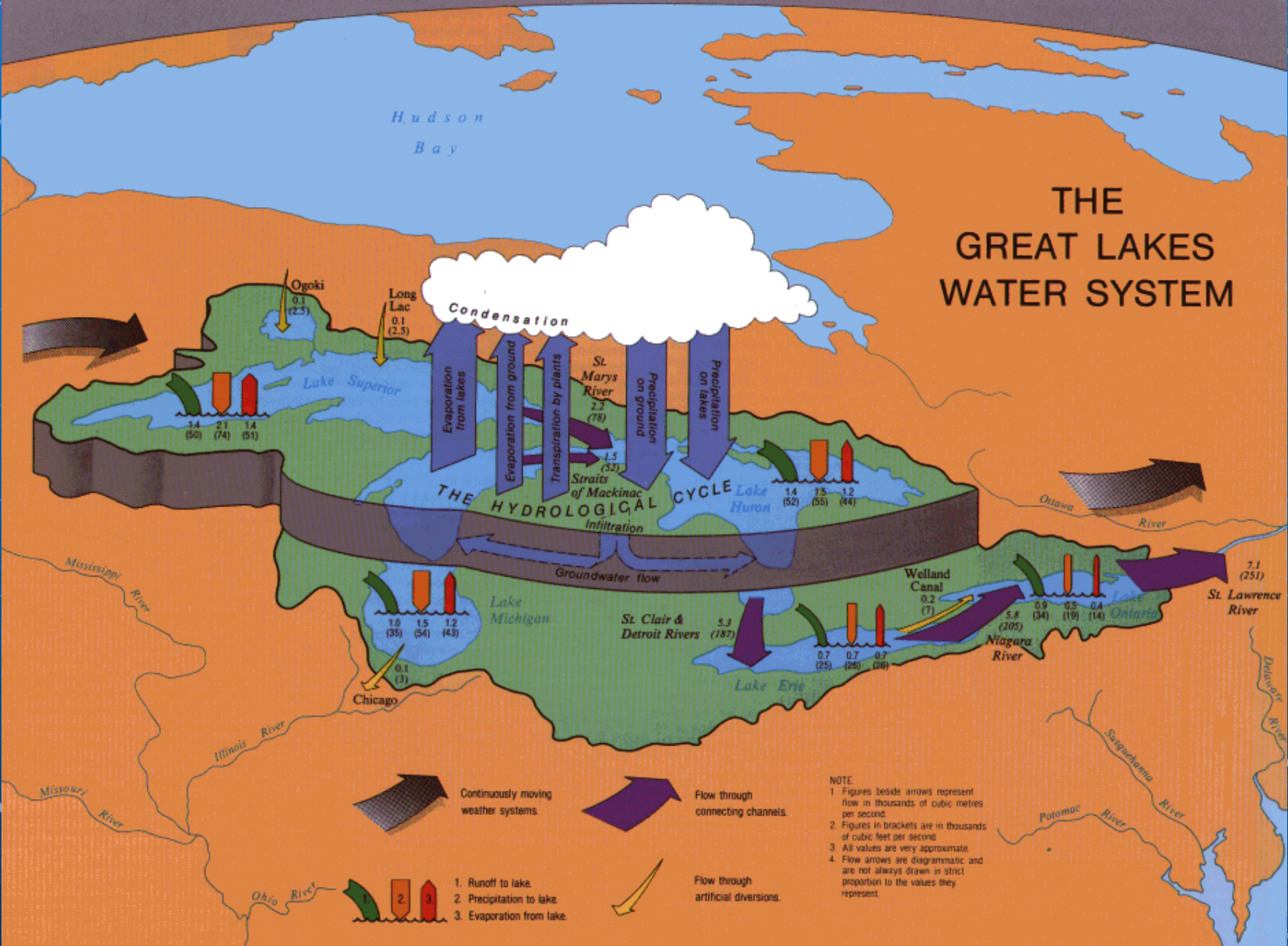


# Great Lakes System Profile



U.S. Army Corps of Engineers, Detroit District

# THE GREAT LAKES WATER SYSTEM



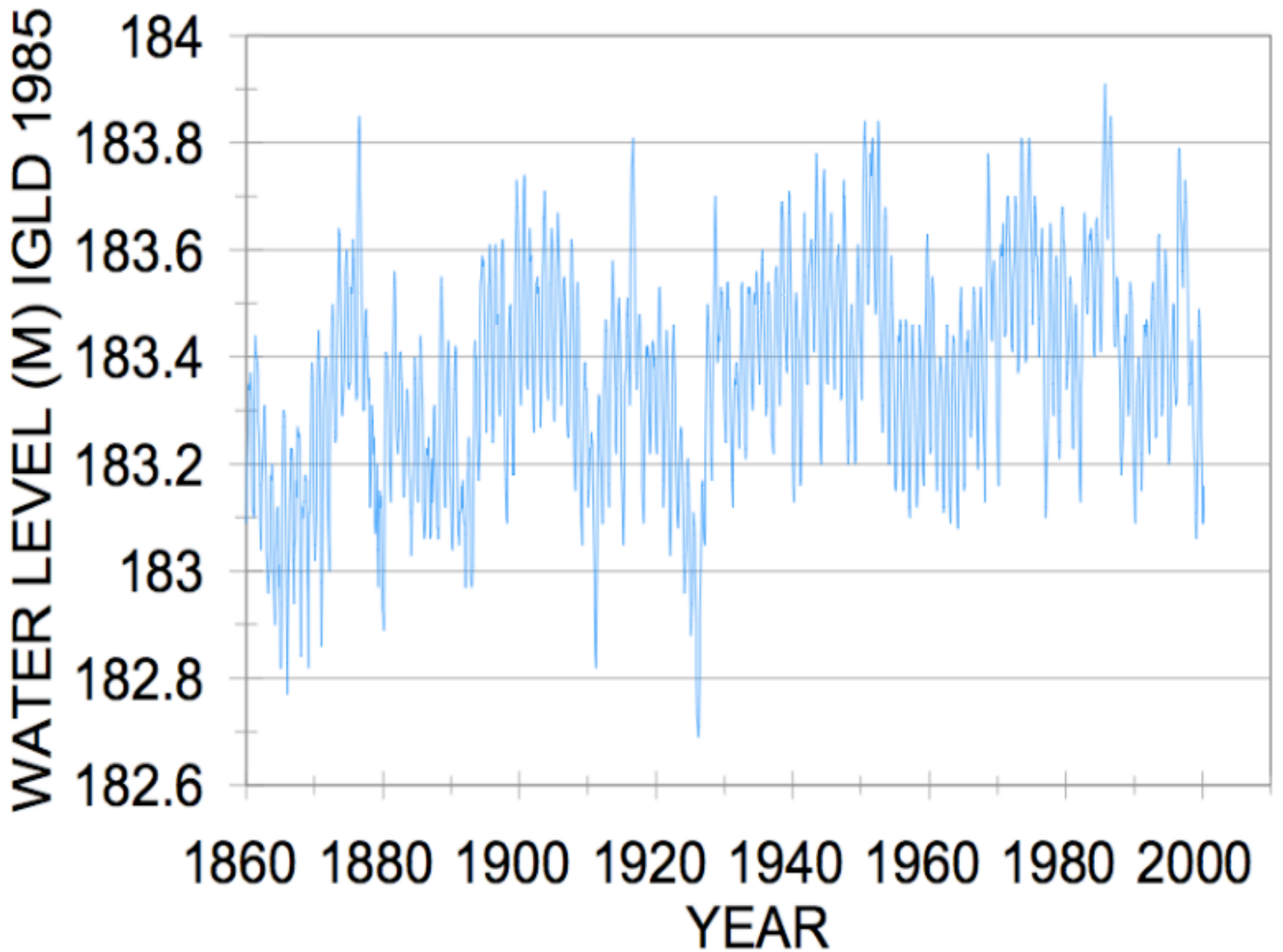
NOTE:  
 1. Figures beside arrows represent flow in thousands of cubic metres per second.  
 2. Figures in brackets are in thousands of cubic feet per second.  
 3. All values are very approximate.  
 4. Flow arrows are diagrammatic and are not always drawn in strict proportion to the values they represent.

- Continuously moving weather systems.
- Flow through connecting channels.
- Flow through artificial diversions.
- 1. Runoff to lake.
- 2. Precipitation to lake.
- 3. Evaporation from lake.

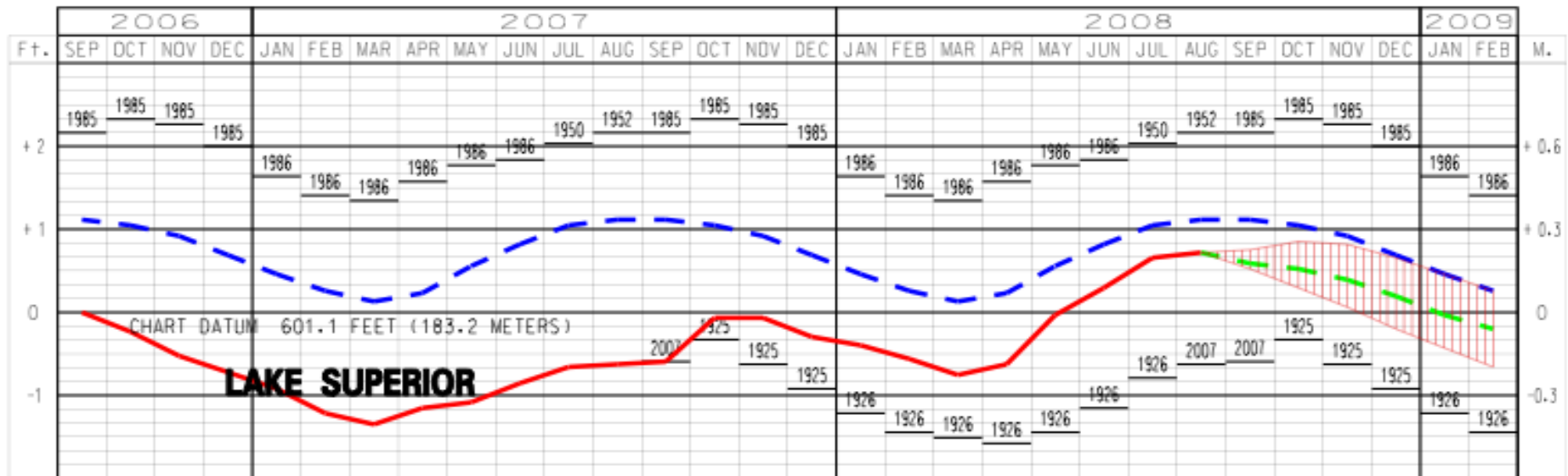








## LAKE SUPERIOR WATER LEVELS - SEPTEMBER 2008



### LEGEND LAKE LEVELS

**RECORDED**



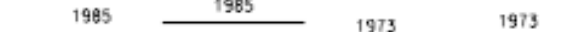
**PROJECTED**



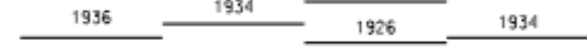
**AVERAGE \*\***



**MAXIMUM \*\***



**MINIMUM \*\***

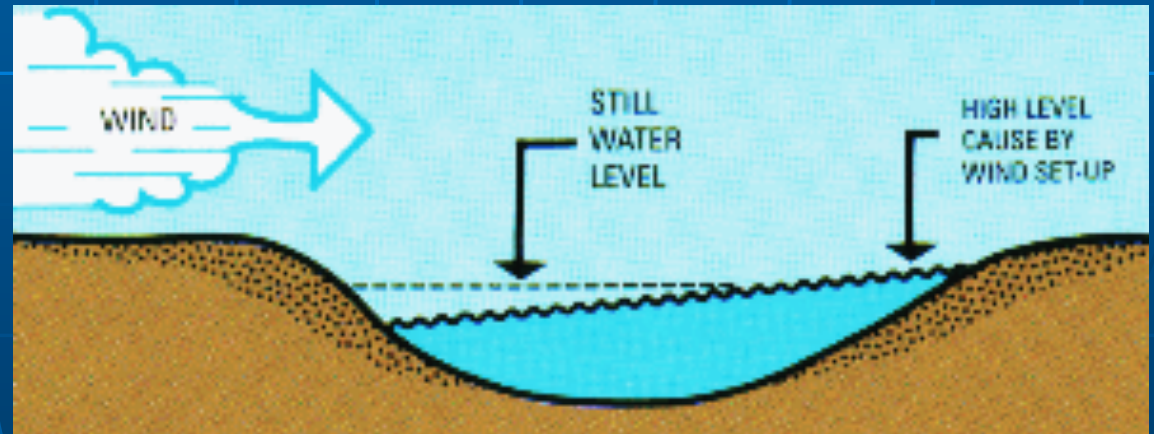


\*\* Average, Maximum and Minimum for period 1918-2007

# Lake Superior



# Wind and Waves

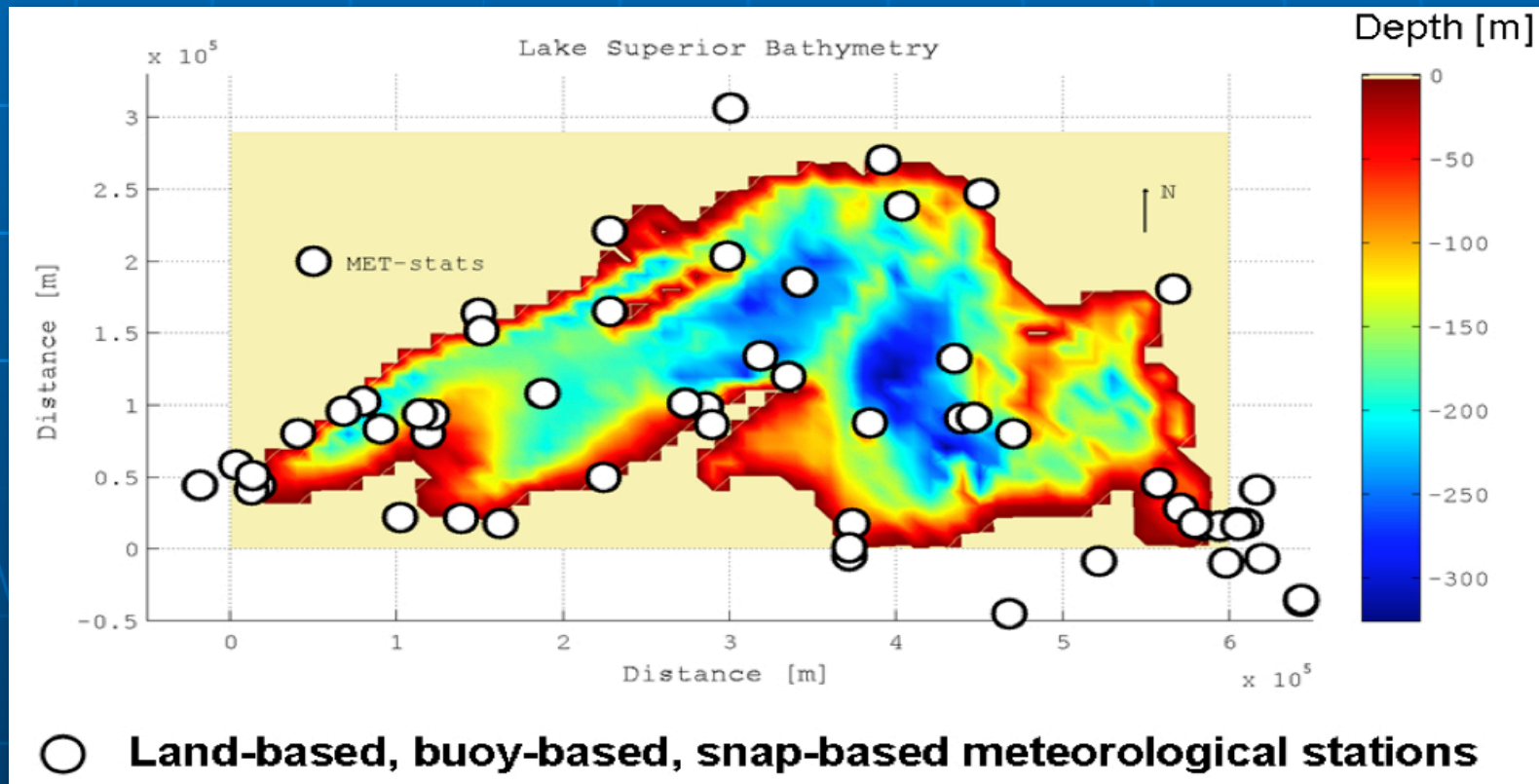


# Why Lake Superior compels our interest

- Largest freshwater lake in world by area
  - 82,400 km<sup>2</sup>
- 3<sup>rd</sup> largest freshwater lake by volume
  - Average depth 147m, max 406m
- Relatively undeveloped shoreline
  - Important shipping routes
- Large enough to create regional microclimate
  - Nearly 200 year residence time of water = buffer effect
- Mid-continent = strongly affected by cyclones and climate warming

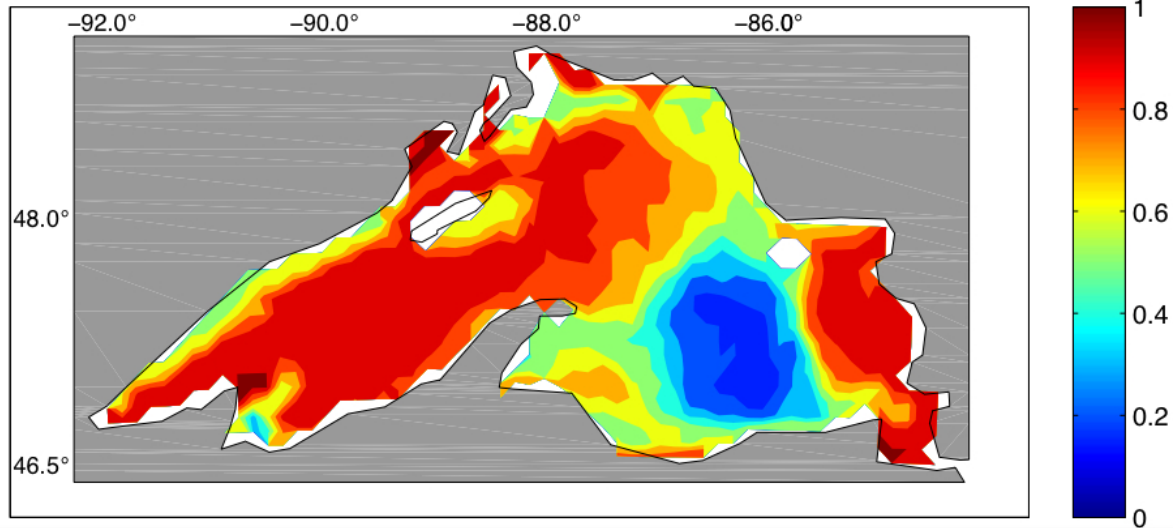
# Complex System

- But data are sparse!



# Large Variability

1997 February Ice Fraction



1998 February Ice Fraction

