

Climate Change Impacts on the Great Lakes

**Great Lakes Public Forum
October 5, 2016 – Toronto**

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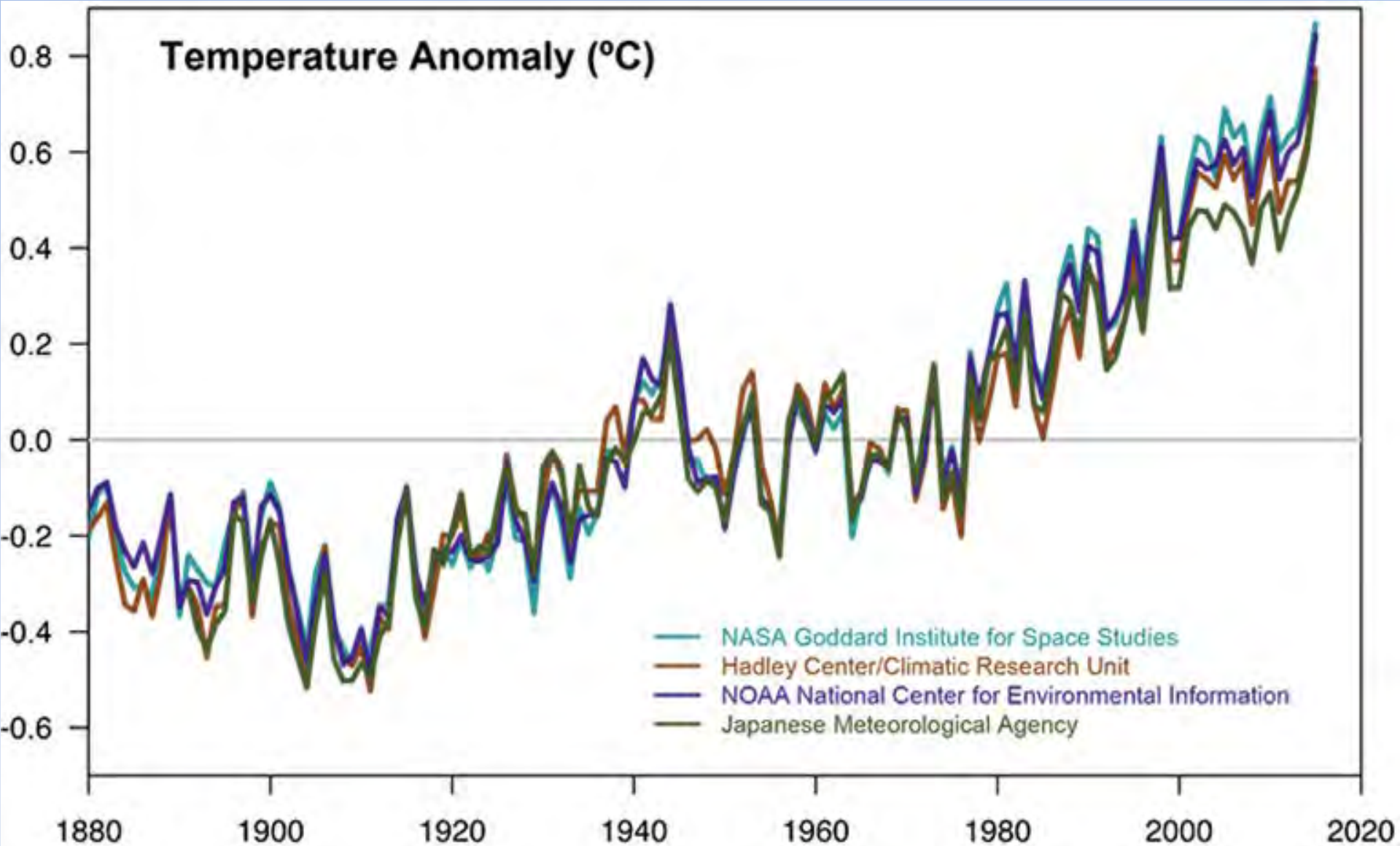
What you'll hear about today...

- Why and how climate change is impacting the Great Lakes
- Canada & U.S. commitment to address climate change
- Progress and accomplishments achieved over 2013-16
- Proposed 2017-19 science and action priorities

PURPOSE OF ANNEX 9 – CLIMATE CHANGE IMPACTS

“To enhance the long-term effectiveness of management strategies for restoring and protecting Great Lakes water quality by understanding and considering climate change impacts.”

Scientists agree that the Earth is warming



Climate change is one of the greatest risks of our time

“... the failure of climate change mitigation and adaptation has risen to the top and is perceived in 2016 as the most impactful risk for the years to come, ahead of weapons of mass Destruction...”



Canada and U.S. Recognize Importance of Fighting Climate Change

... implementing the Paris Agreement

... reducing methane emissions from the oil and gas sector; reducing use and emissions of hydrofluorocarbons; improving fuel efficiency and reducing on-road vehicle emissions...

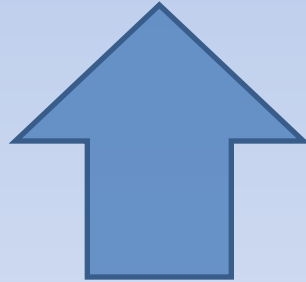
... strengthen North American energy security, phase out fossil fuel subsidies, accelerate clean energy development and foster sustainable energy development and economic growth

Climate Change is significantly impacting the Great Lakes

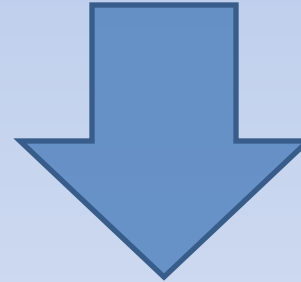
Average Temperature



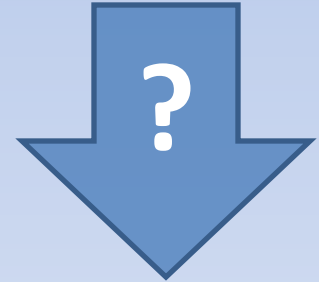
Precipitation



Ice Coverage



Water Levels



**Climate Change Impacts
Annex,
2012 Canada-U.S. Great Lakes
Water Quality Agreement**

Understanding, identifying and predicting climate change impacts.

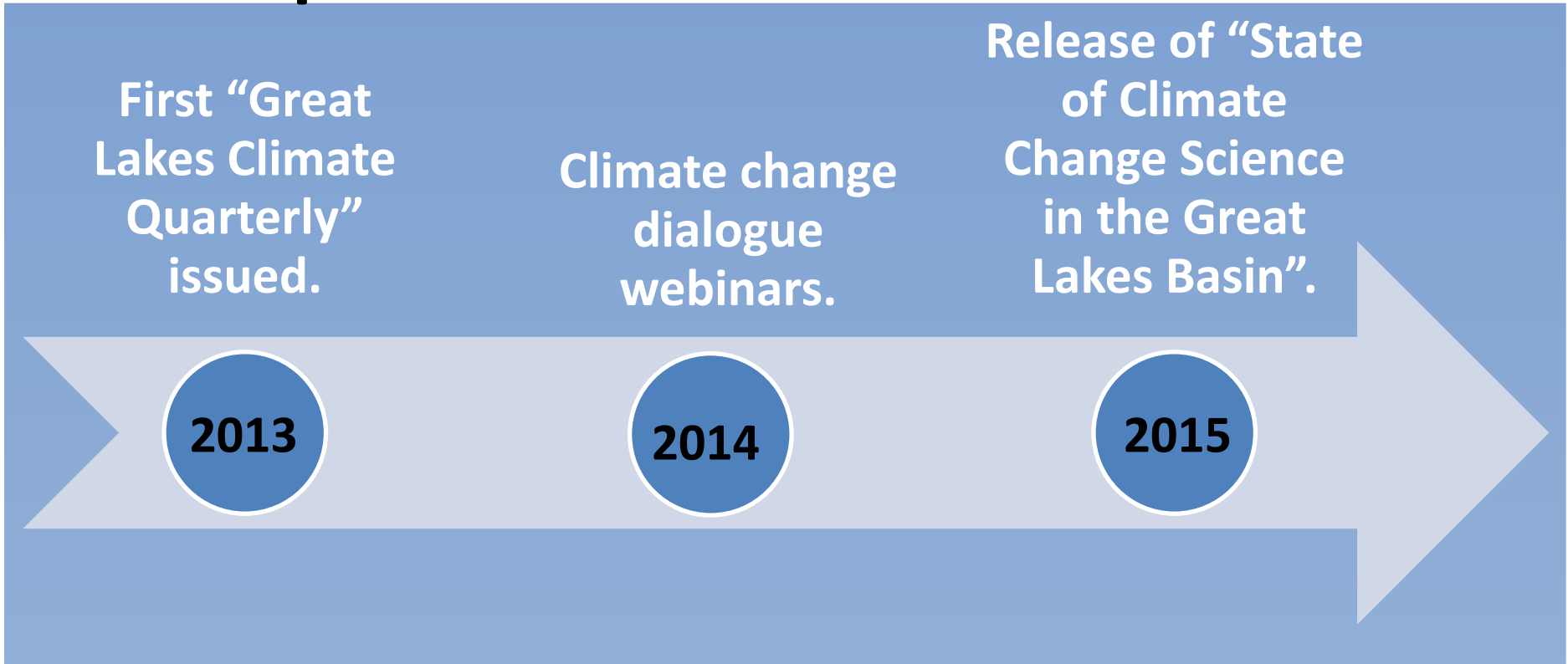
Making information related to climate change available.

Taking action through domestic programs.

Climate Change is a cross-cutting issue

Annex:	Specific references in other annexes to consider climate change:
Lakewide Management	Through the Nearshore Framework, climate change, among other factors, will be considered as a source of stress to the nearshore.
Chemicals of Mutual Concern	Recognition that climate change may affect the use, release, transport, and fate of Chemicals of Mutual Concern.
Nutrients	<p>Climate change, among other factors, will be taken into account in establishing phosphorus concentrations and loading targets.</p> <p>The influence of climate change on nutrient inputs to the Great Lakes and the formation of algae will be studied.</p>
Aquatic Invasive Species (AIS)	The potential impact of climate change on the introduction, survival, establishment, and spread of AIS will be assessed.
Habitat and Species	Science to support implementation of prevention measures to improve the resilience of native species and habitat will consider climate change impacts, among other stressors.
Groundwater	Climate change's affect on groundwater's impact on the quality of the Waters of the Great Lakes will be analyzed.

Canada and U.S. have made significant progress on assessing climate change impacts in the Great Lakes



Monitoring relevant climate and Great Lakes variables.
Analytical tools to understand and predict climate change impacts.

Great Lakes Climate Quarterly newsletters

Quarterly Climate Impacts and Outlook Great Lakes Region March 2016

Great Lakes Significant Events - for December 2015 - February 2016

Winter temperatures were much above normal for the Great Lakes basin. This resulted in late-to-normal snowfall for much of the basin as well as a delayed start and reduced extent of Great Lakes ice cover. El Niño conditions were the driver for the unseasonably warm Great Lakes weather this winter.

December was remarkably warm across the entire Great Lakes basin, with all U.S. states and the entire province of Ontario experiencing the warmest December on record. December snowfall was significantly below-normal across the basin and the first snow of the season fell late in some places. Buffalo, NY recorded its latest date for first measurable snowfall on December 18 (breaking the previous record of December 3 set in 1899).

While still above-normal overall, January and February temperatures were more variable. For example, locations in Ontario experienced record-breaking warmth on February 3 and just one day later, many of the same locations experienced record-breaking cold (a temperature swing was 40-46°C (72-82°F) in some locations).

Great Lakes ice cover reached its maximum extent of 34% on February 14, not long after a delayed start in late December due to warmer temperatures. Ice cover fluctuated along with the temperatures in January and February (see daily graph to right). The uncovered lakes also produced significant lake-effect snow (LES) this winter. In mid-January, multiple LES events produced 0.3-1.2 m (1-4 ft) of snow eastward of Lake Ontario and 0.3-0.6 m (1-2 ft) eastward of Lake Erie.

Significant atmospheric pressure differences produced very strong winds across the basin on February 16. Peak wind gusts reached 116 km/h (72 mph), causing significant damage around Chicago, IL and producing waves of 3-6 m (10-20 ft) on lakes Michigan-Huron and Ontario.

Regional Climate Overview - for December 2015 - February 2016

Precipitation

Water precipitation across the Great Lakes basin was near to above normal. However, much fell as rain, while snowfall was mostly below normal. December: The upper lake basins were wetter than normal, while the Erie and Ontario basins were near normal. Snowfall was below normal for the entire basin. January: Precipitation was below normal in the Erie and Ontario basins, while other basins had areas ranging from below to above normal. February: Precipitation ranged from below normal in the Michigan basin to above normal in the Ontario basin. Snowfall varied from 25% to more than 200% of normal.

Air Temperature


December was record warm for the Great Lakes basin, as temperatures were more than 5°C (9°F) above normal region-wide. January temperatures ranged from near normal to 4°C (7°F) warmer than normal. February temperatures ranged from near normal to 3°C (5°F) above normal. The winter season was 2°C (4°F) to 5°C (9°F) above normal.

Great Lakes Ice Cover

Ice cover was below the long-term average on all basins this winter. The largest departures of 30% to 45% below normal ice cover were on Lake Erie. Colder temperatures in mid-January caused rapid growth, but a warm spell in late January and early-February caused quite a bit of melting before temperatures turned cold again. Ice cover peaked on February 14 at 34% but quickly began melting after warmer temperatures in late February.

Great Lakes Water Levels

After a series of generally wet weather and mild temperatures, water levels on all the Great Lakes were well above average and higher than last year. Lake Ontario ended the quarter 30 cm (11.8 in) above average and 50 cm (20 in) higher than last year. Lake Erie ended the quarter 33 cm (13 in) well above average and 38 cm (15 in) higher than last year. Lake Michigan-Huron's water level was 29 cm (11.4 in) above average and the highest end of February since 1966. Lake Superior ended the quarter 24 cm (9.4 in) above average and the highest for this time of year since 1927.



- Provides latest season's weather and water level conditions, weather and water level-related impacts, and an outlook for the upcoming quarter.

www.binational.net/category/a9/qcio-btsc

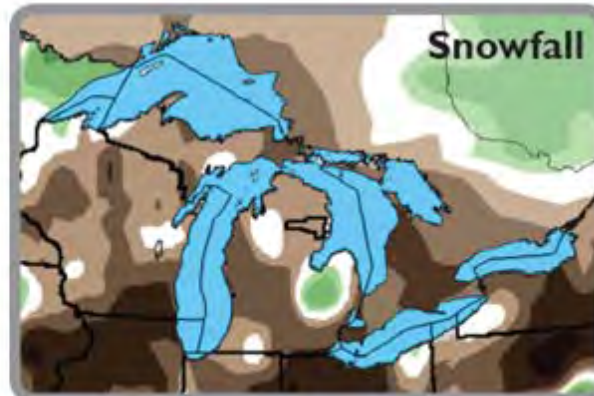
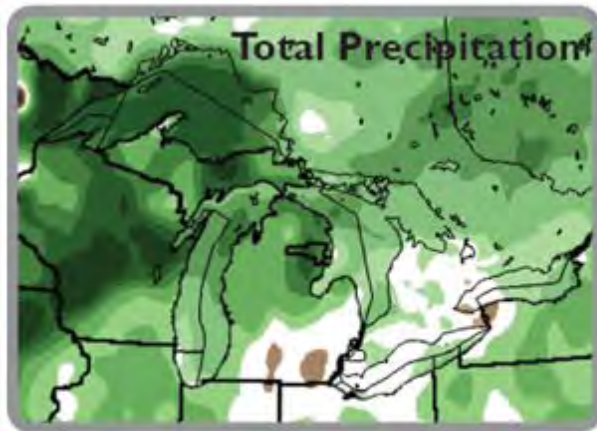
March 2016 Great Lakes Climate Quarterly

Great Lakes Significant Events - for December 2015 - February 2016

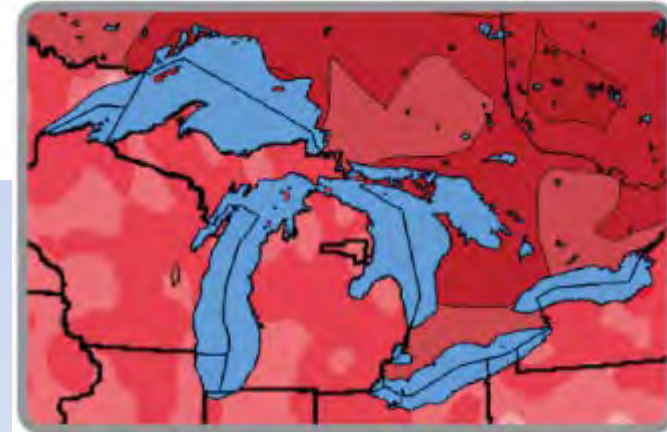
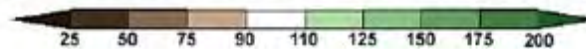


March 2016 Great Lakes Climate Quarterly

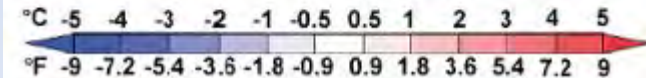
Regional Climate Overview - for December 2015 - February 2016



Dec-Feb: Percent of Normal (%)



Dec. 2015-Feb. 2016 Air Temperature:
Departure from Normal



March 2016 Great Lakes Climate Quarterly

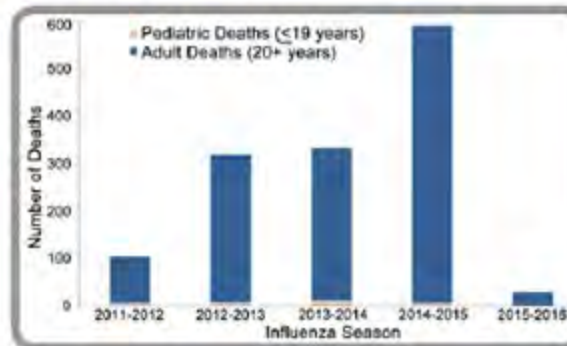
Regional Impacts - for December 2015 - February 2016

Recreation



A truck that fell through the Lake Superior Ice (Photo: J. Pillath/St. Louis County Rescue Squad)

Public Health



Reported number of deaths by influenza season in Canada (Public Health Agency of Canada)

Transportation



The multi-car accident on 2/11/16 (Photo: Lake County Sheriff's Office)

Municipal Services

Shipping

March 2016 Great Lakes Climate Quarterly

Regional Outlook - for April - June 2016

Temperature &

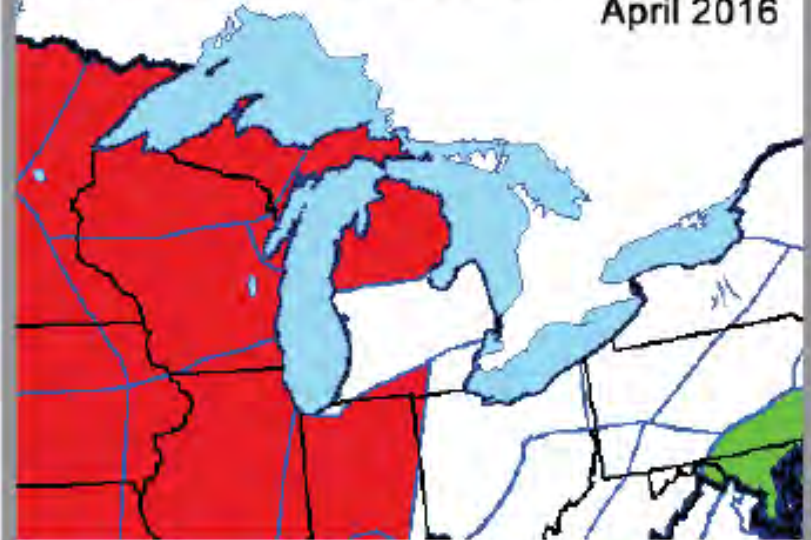
Above-normal

Precipitation Outlook

Below-normal

Wildfire Potential

Significant Wildland Fire Potential Outlook
April 2016

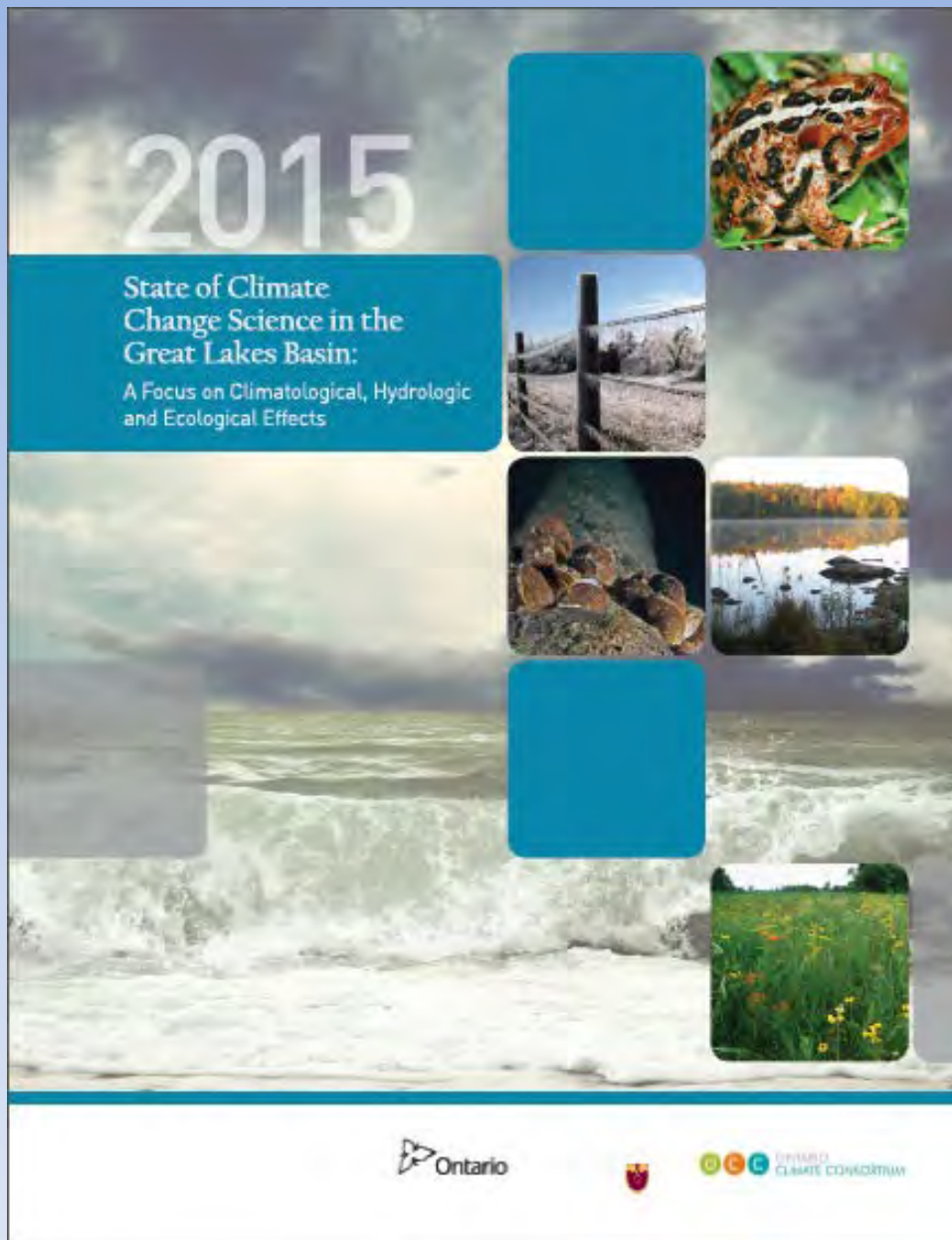


Significant Wildland Fire Potential

 Above Normal	 Increasing to Above Normal
 Below Normal	 Decreasing to Below Normal
 Normal	 Returning to Normal
 Geographic Area Boundary	 Predictive Services Area Boundary



Map produced by
Predictive Services,
National Interagency Fire Center
Boise, Idaho
Issued March 1, 2016
Next issuance April 1, 2016



Sections of Report

1. Climate Information in the Great Lakes Basin
2. Assessment of Great Lakes Climate Change Science
3. Climate Change Impacts and Vulnerabilities in the Great Lakes Basin
4. Knowledge Gaps

A MAIN SEARCH FORM ✕

WELCOME TO THE 2015 GREAT LAKES CLIMATE CHANGE SCIENCE KNOWLEDGE DATABASE!

This tool will allow you to query a database various reports and scientific studies that have been analysed in the report "2015 State of Great Lakes Climate Change Science".

SEARCH TYPE 1: You have the option of selecting from three ways of searching (see buttons below). The next screen will ask you to select the type of synthesis you would like to see (Study meta-information or study result synthesis). You will then be able to view and print summaries from the database.

Browse By Great Lakes Location	e.g., search for a list of all studies in Wisconsin or Lake Huron Drainage Basin
Browse By Research Theme	e.g., search for a list of all studies covering the "water level" research theme
Browse By Process Model / Analysis Method Type	e.g., search for a list of all studies using hydrologic models

SEARCH TYPE 2: View full records for individual studies (including text search and browsing)

View full records for individual studies (including text search and

CLOSE DATABASE

This database interface is in 'beta' testing. Please contact efausto@trca.on.ca should you have any questions.

Study Information By Geographic Location

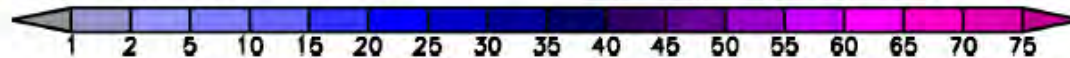
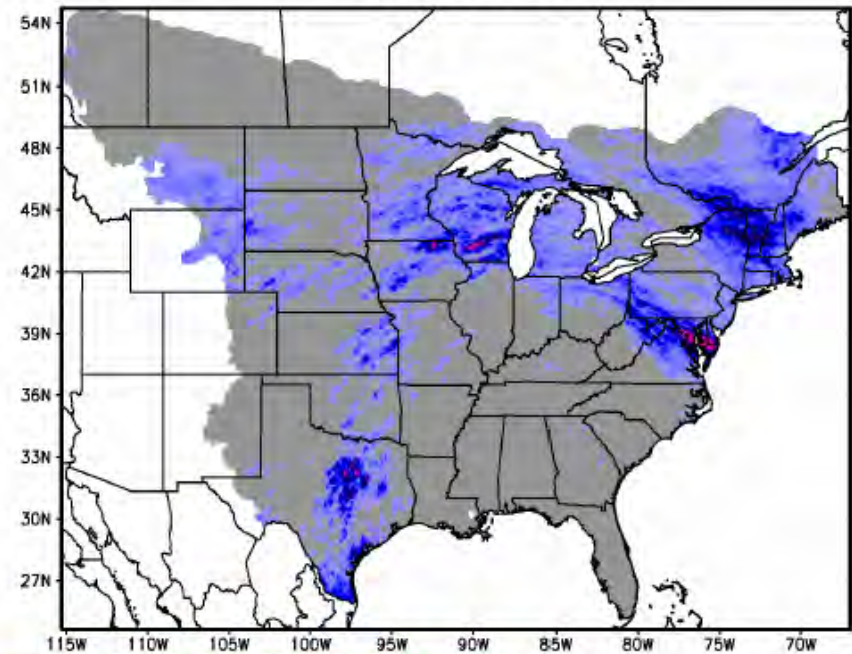
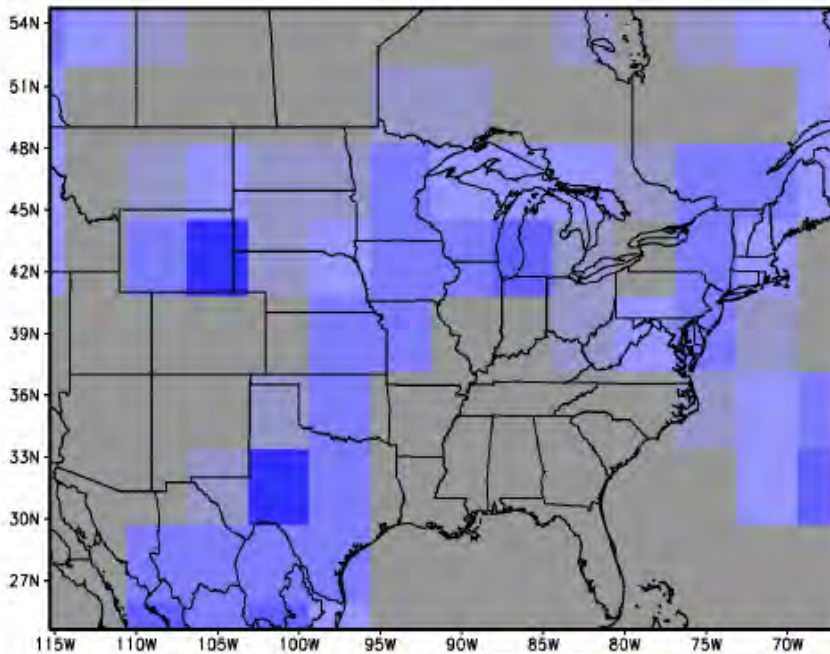
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Print Preview

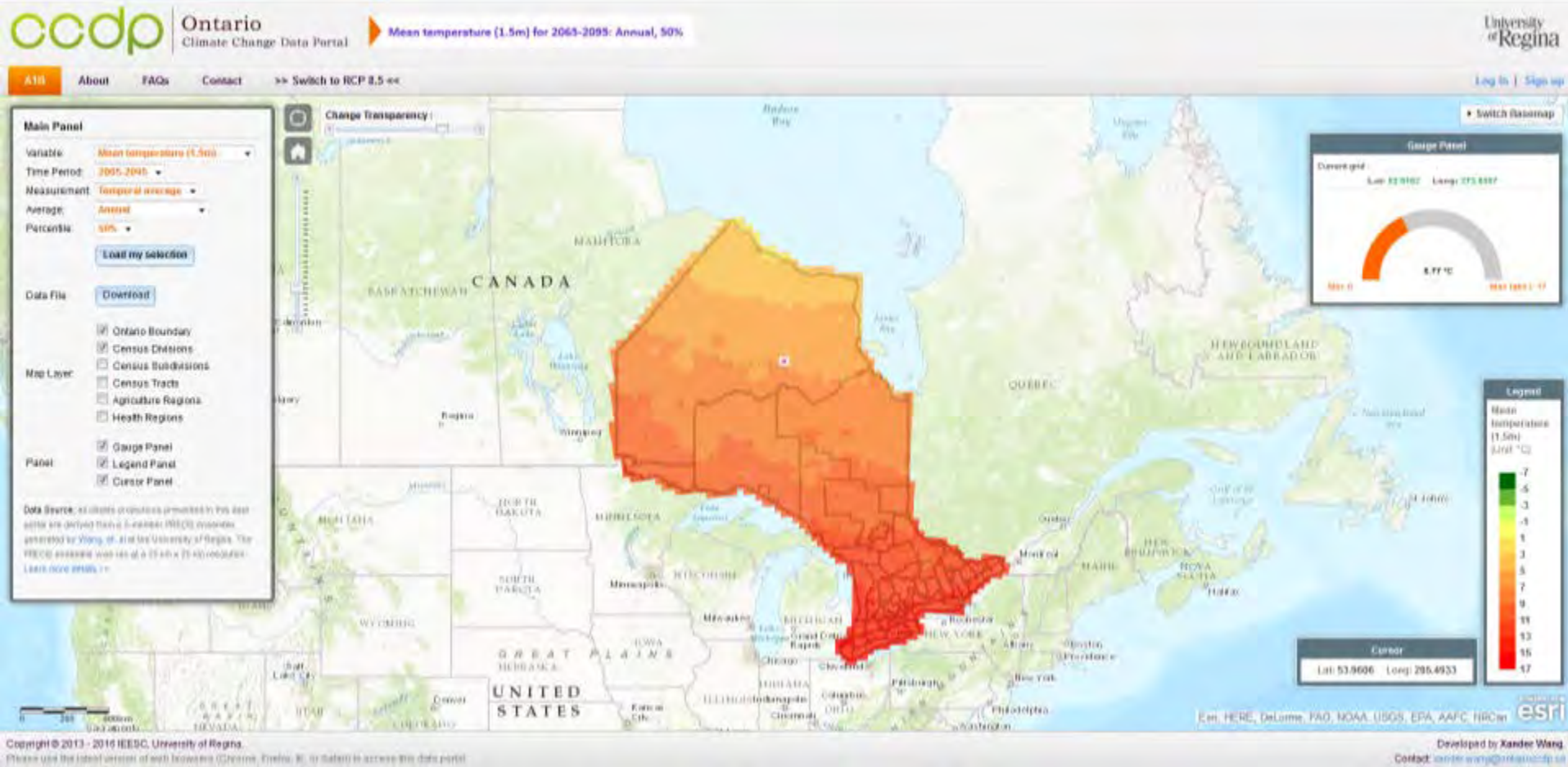
Location	Author Name	Date	ID	Study Name	Objectives	Methods Summary	Key Results
Lake Erie	Abdullah BaMasoud and Mary-Louise Byrne	2011	1008	Analysis of Shoreline Changes (1959–2004) in Point Pelee National Park, Canada	To estimate shoreline change rates of Point Pelee National Park, Ontario for the period 1959–2004 using orthoair photos.	Shorelines, traced and digitized on a screen using ArcGIS, were detected using the wet/dry boundary mark method. EPRs (m/y) were obtained by averaging the net shoreline displacement between the 1959 and the 2004 shorelines.	Recession and accretion was observed in the eastern an western shores respectively. Longer duration of ice coverage during winter, favourable topography, and sedimentary conditions led to the observed difference in shoreline response.
	Hebb, Andrea J., Linda D. Mortsch, Peter J. Deadman, and A. Raymond Cabrera	2013	1062	Modeling Wetland Vegetation Community Response to Water-Level Change at Long Point, Ontario	To develop and evaluate the accuracy of ththree spatially-explicit wetland models	Three spatially-explicit wetland models were developed in a geographic information system (GIS) to simulate wetland vegetation response to water-level fluctuations	The rule-based model replicated the spatial distribution of vegetation communities more accurately and may be more broadly applicable. Accuracy was over over 80% for Rule Based and Vegetation Transition Probability models, and 55% for the VSP model.

Canada and U.S. continue to improve tools to predict impacts of climate change in Great Lakes

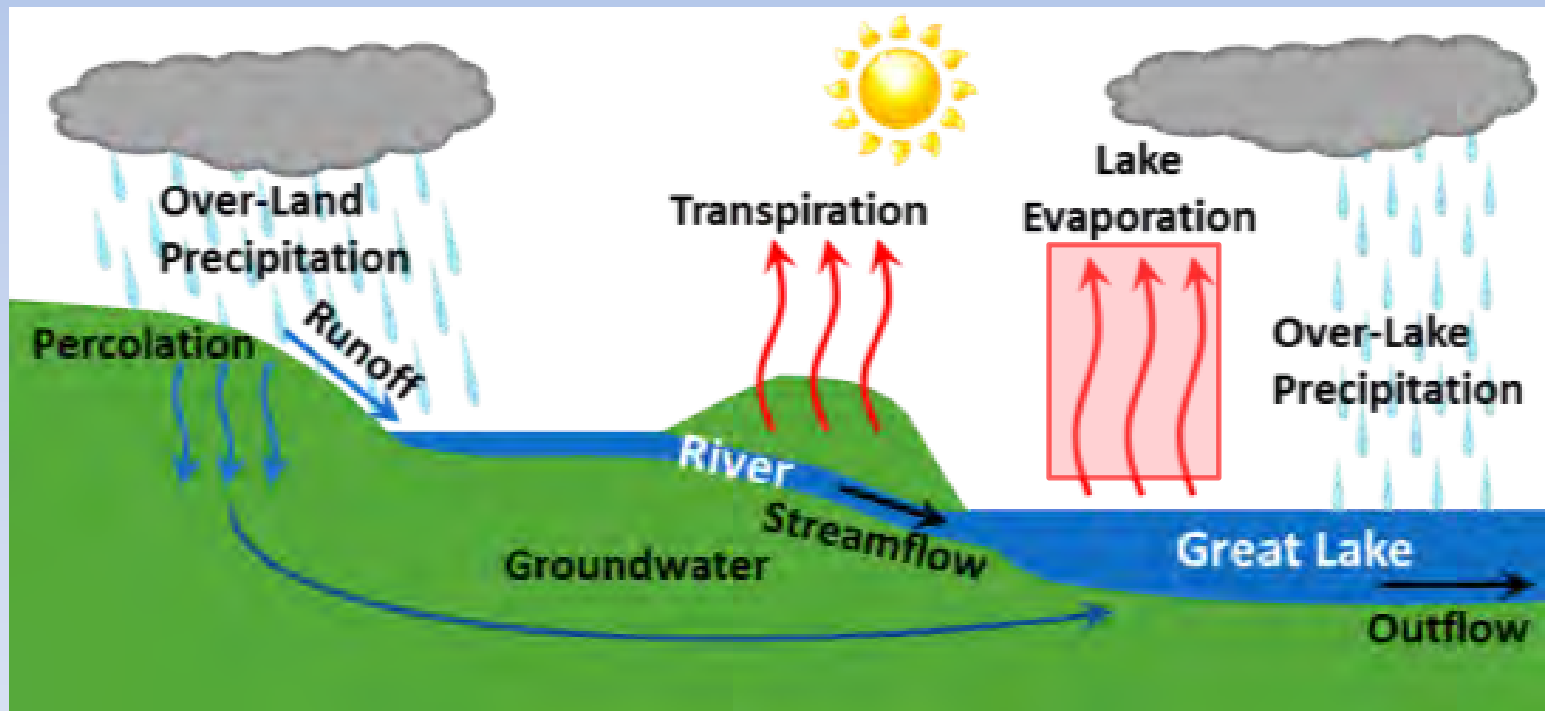
Precipitation (mm) on Jun 14, 2000 for model cccma_cgcm3_1
model downscaled



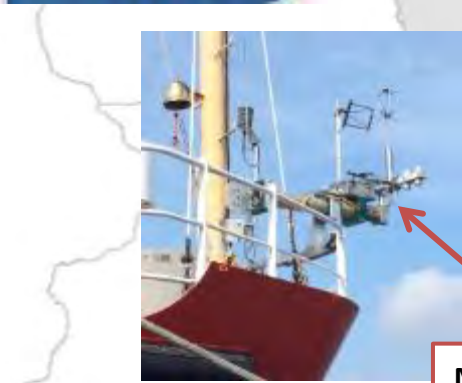
Canada and U.S. continue to improve tools to predict impacts of climate change in Great Lakes



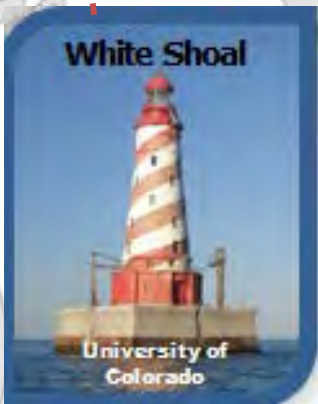
Enhanced Monitoring Great Lakes Evaporation Network



Evaporation Stations on the Great Lakes



Mobile station



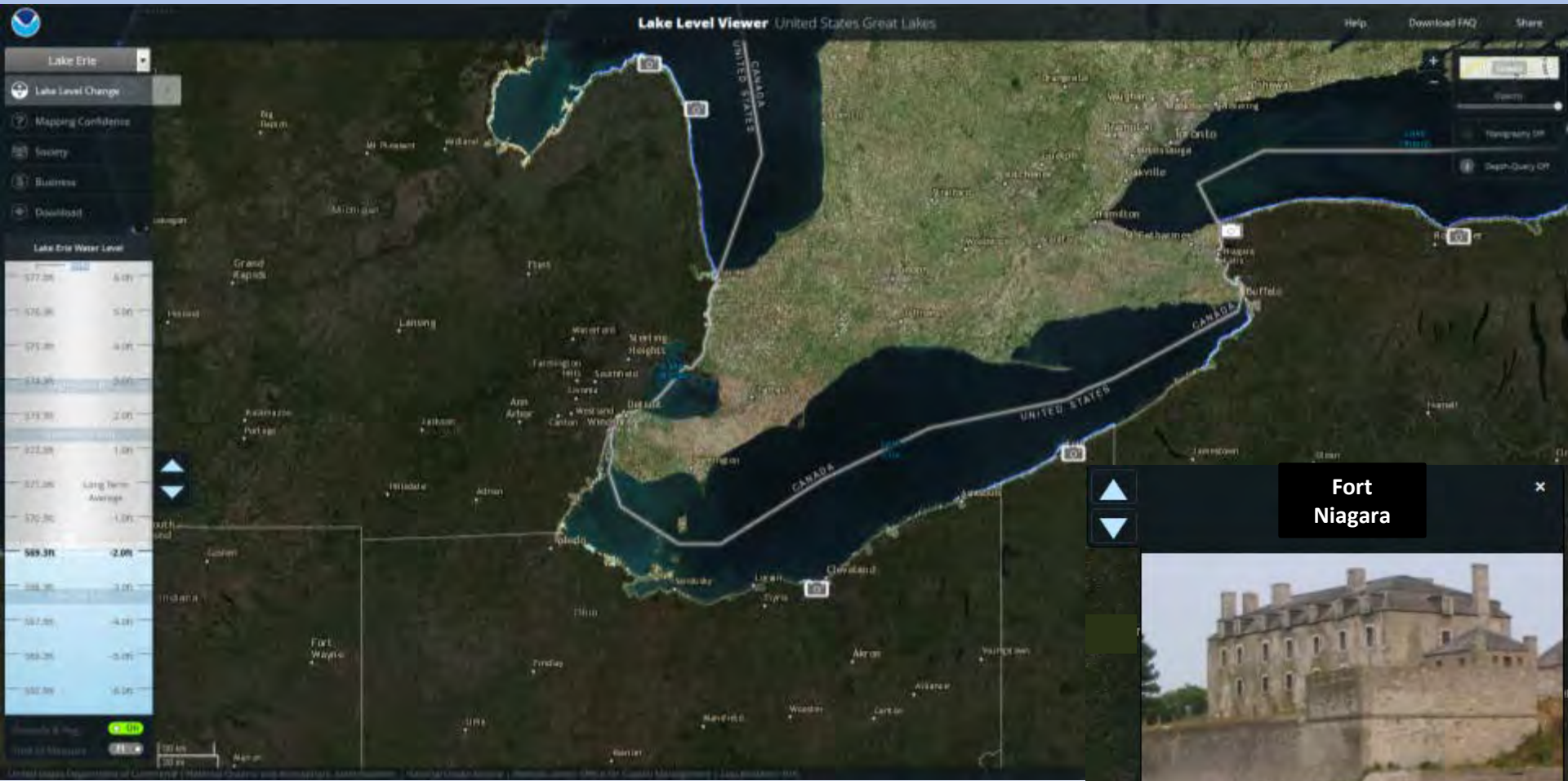
Legend

- Existing Evaporation Network
- Evaporation Station – Test Site

0 50 100 200 300 Kilometers

Lake Level Viewer

<https://coast.noaa.gov/llv/>



Use the water level arrows to view a simulation of lake level change at this location.

Proposed 2017-19 Work for the Climate Change Impacts Annex

Priorities for Science

- Refine and implement State of the Great Lakes indicators for assessing and reporting on the impacts of climate change

Priorities for Action

- Identify key areas across the issues of the GLWQA where climate change needs to be considered and integrated
- Review knowledge gaps identified in State of Climate Change Science report with Annex Co-Leads to identify the priority areas for future action
- Continue to regularly deliver climate information through issuance of the “Great Lakes Climate Summaries and Outlooks”²⁴

Questions?

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