Leveraging Binational Collaborative Research to Advance Great Lakes Hydrological Science and Improve Operational Forecasting

Andrew Gronewold and Vincent Fortin

Great Lakes Environmental Research Laboratory
National Oceanic and Atmospheric Administration
and
Meteorological Service of Canada
Environment Canada

20th U.S. – Canadian Great Lakes
Operational Meteorology Workshop
Chicago, Illinois, USA – March 2012

Outline

1 Introduction

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1. Introduction
2. Binational collaborative research
   - Representative projects
   - Perspectives on skill assessment
   - Importance of monitoring infrastructure

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3. Conclusions and next steps

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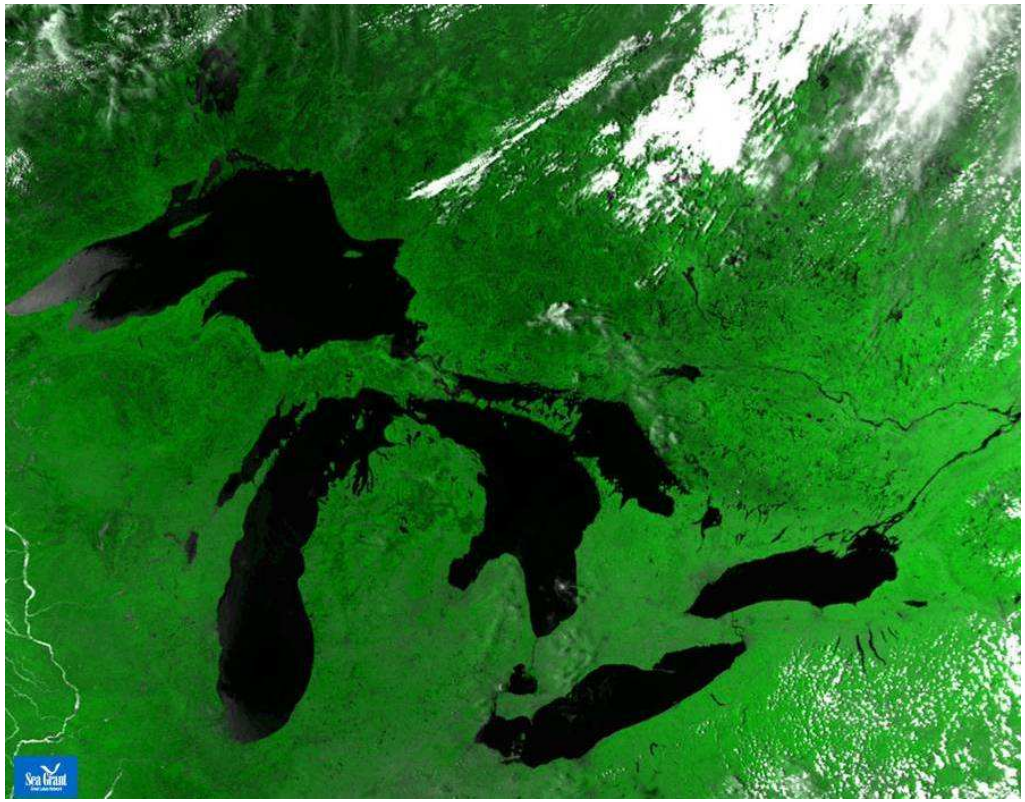

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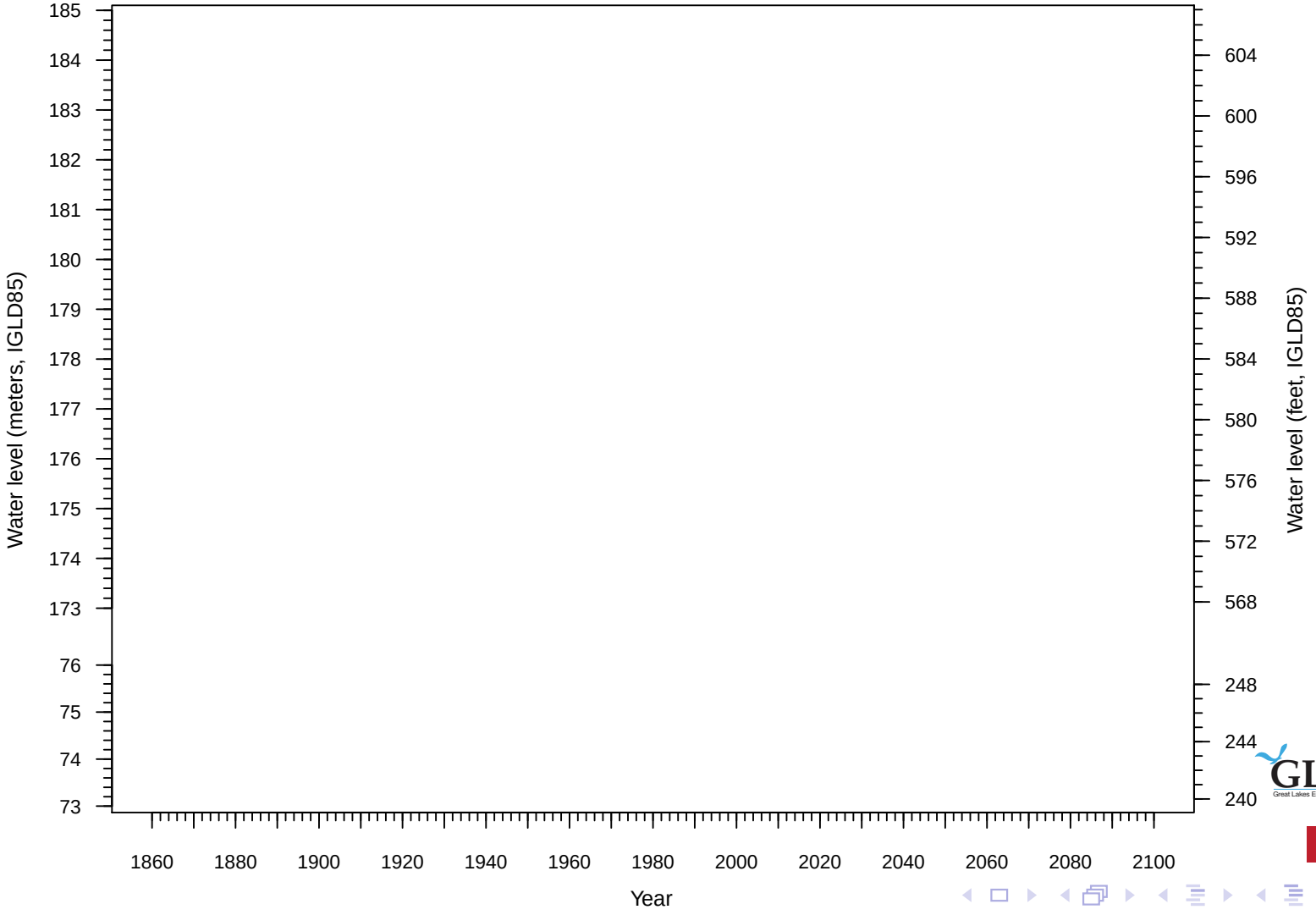
Water levels: observations (long-term)



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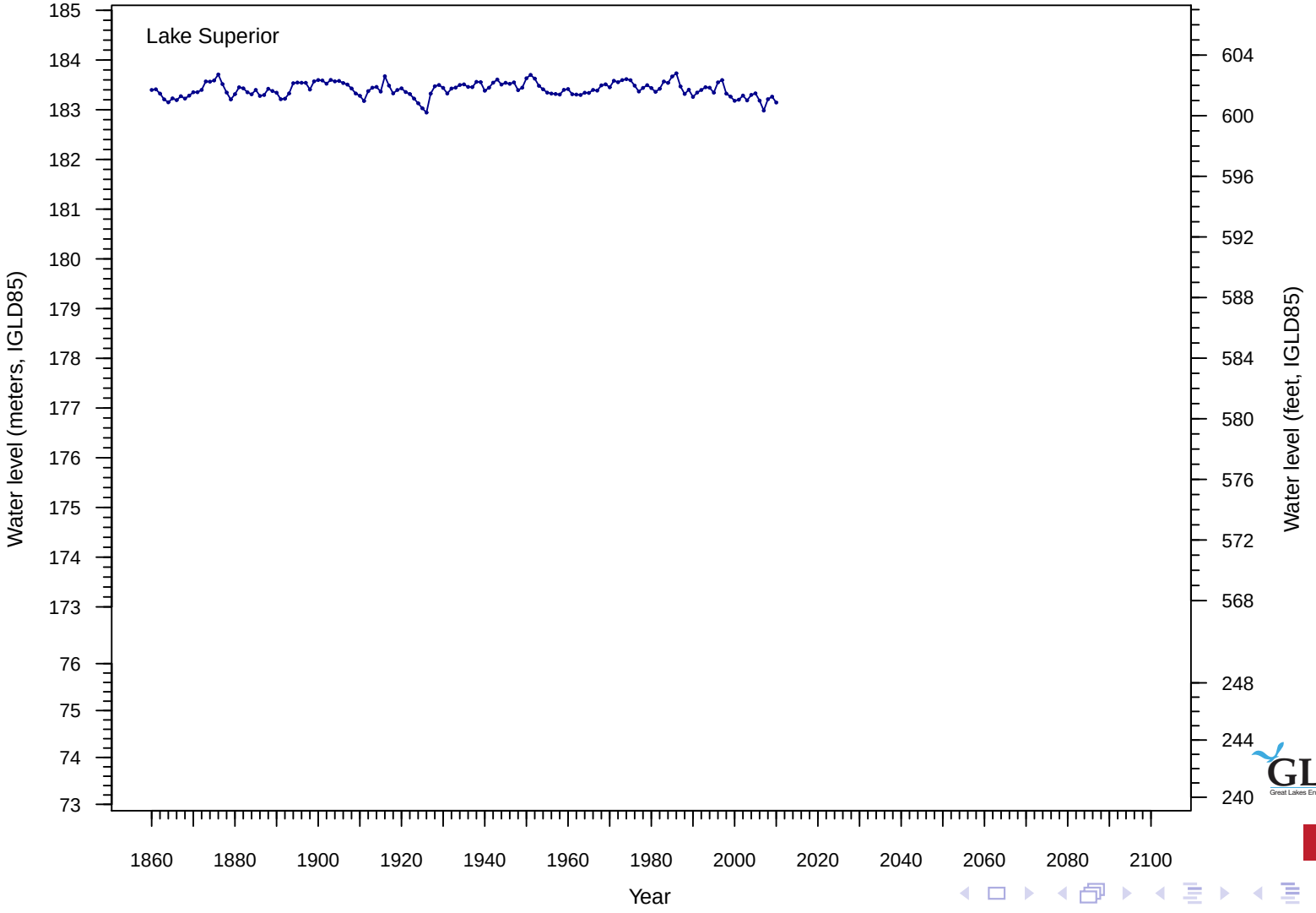

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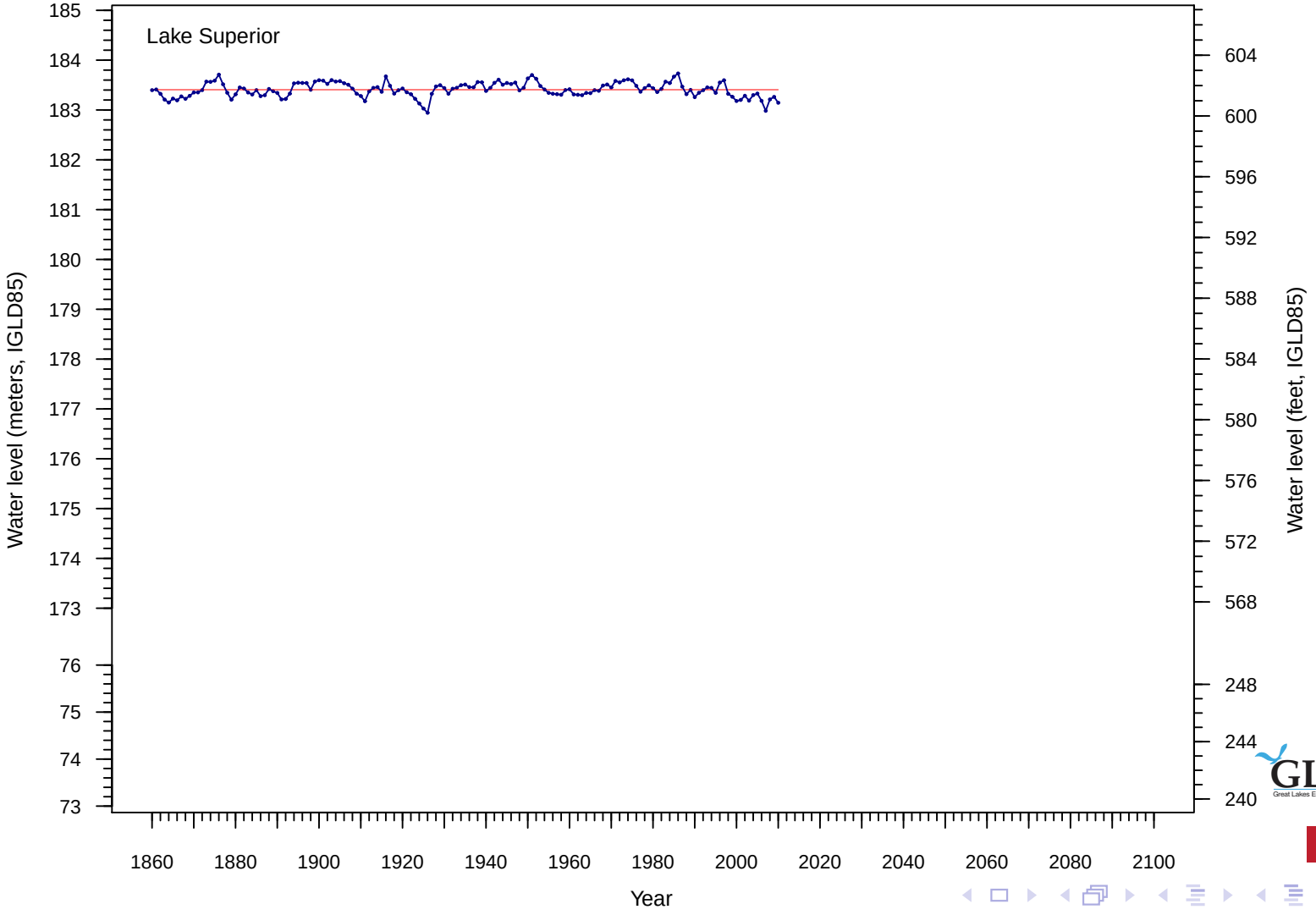

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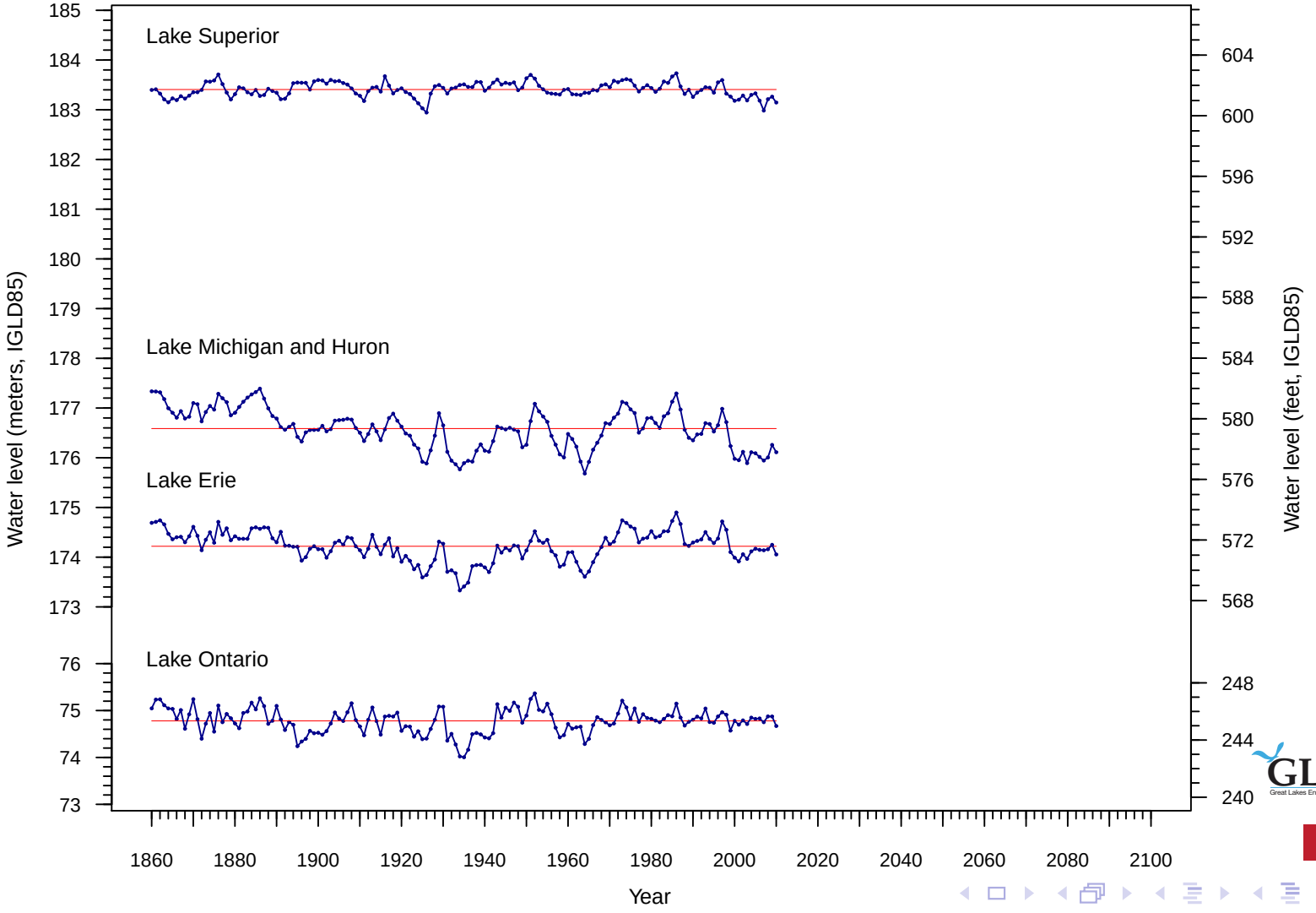

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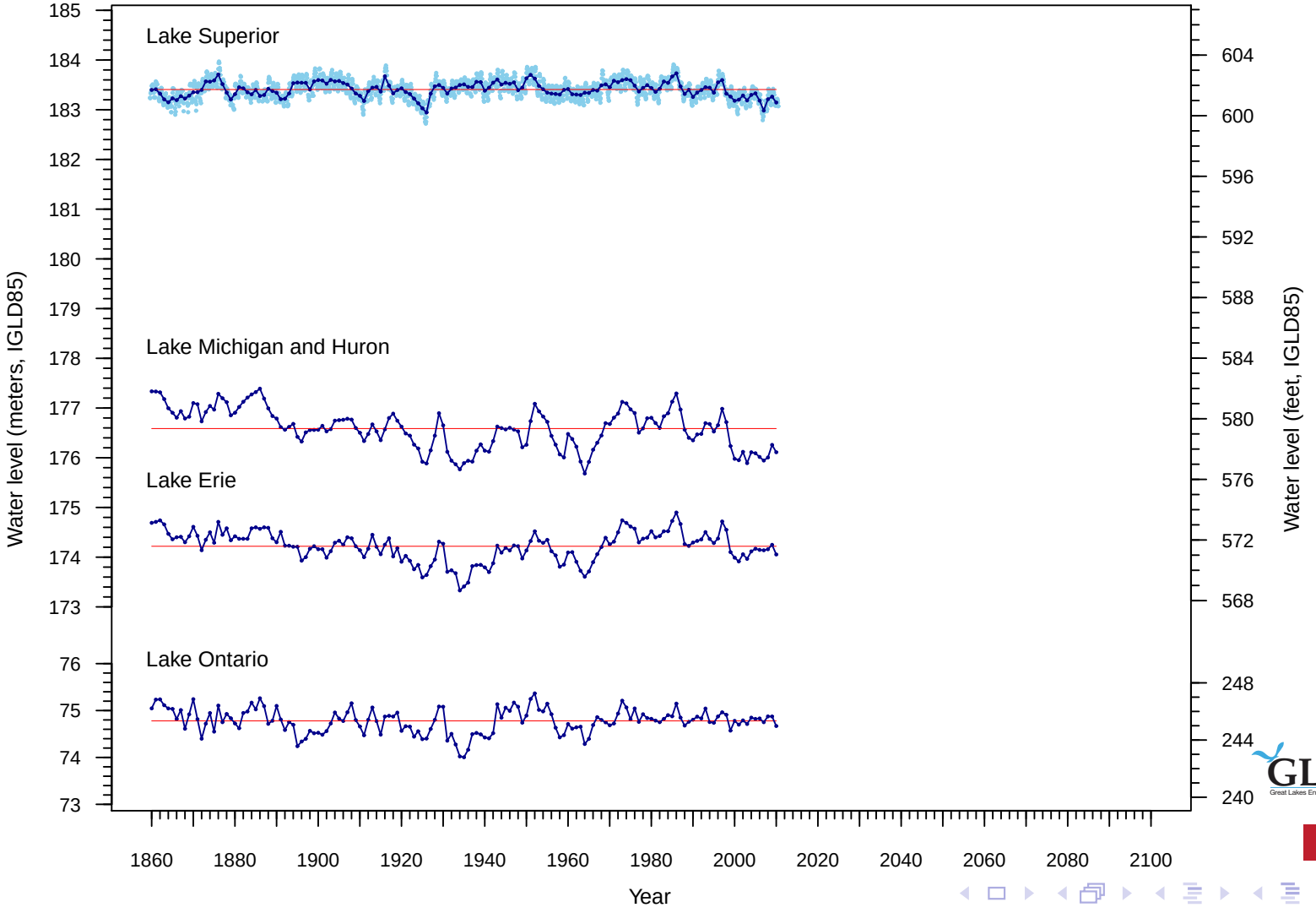

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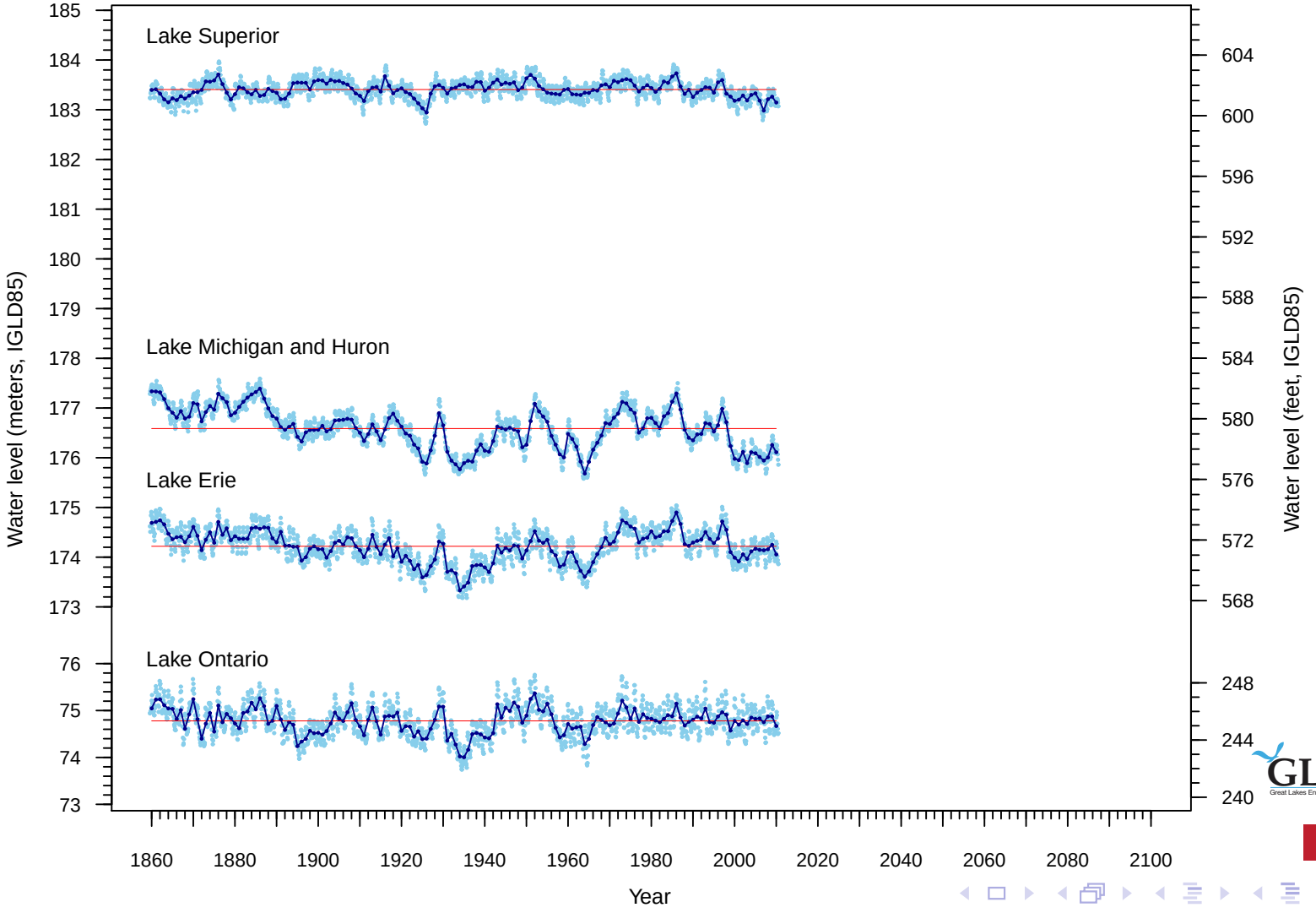

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Introduction: take home messages

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- Supporting operational forecasting

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- Improving understanding of the water balance

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- Advancing regional modeling “state of the art”

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- October 2011 EC–GLERL workshop

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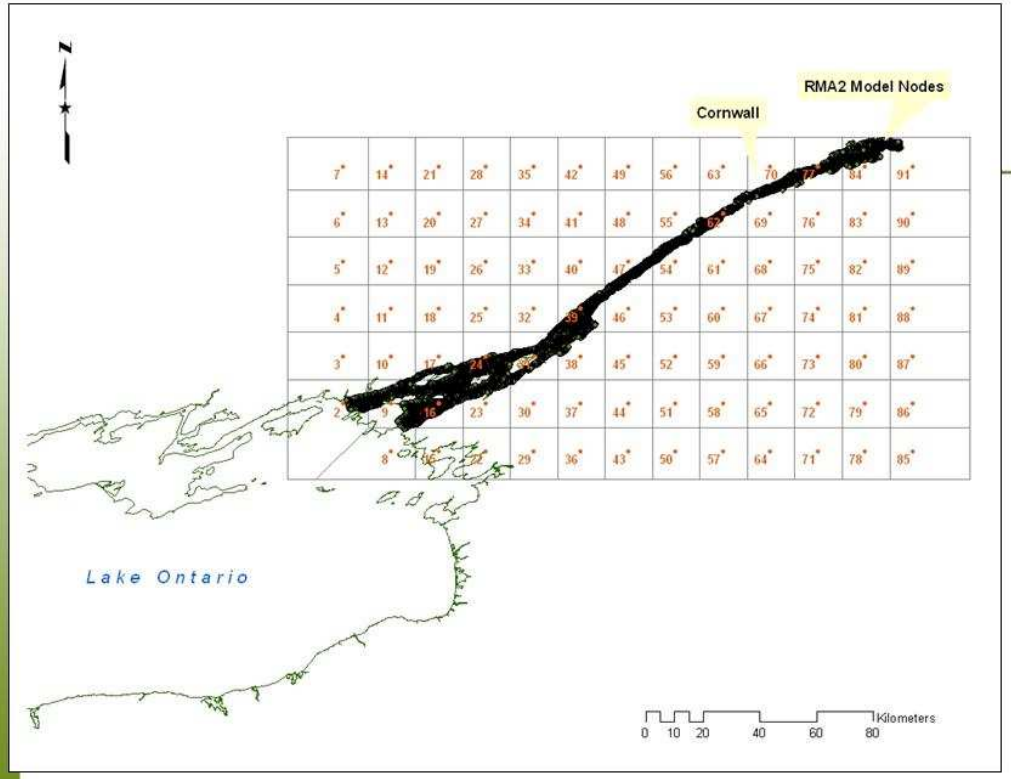
Hydrodynamic modeling:

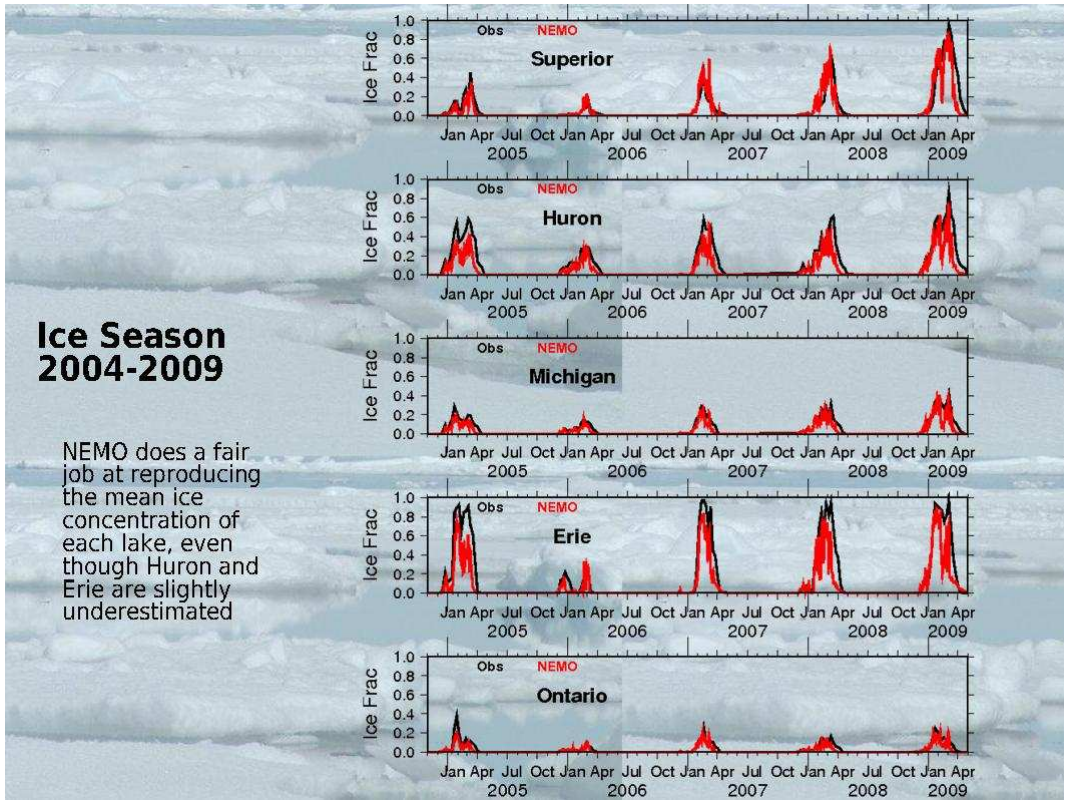
Hydrodynamic modeling: Lake Ontario outflows and Upper St. Lawrence River



E. Anderson, D. Schwab, G. Lang, *Journal of Hydraulic Engineering*, 2010.

Coupled lake models:

Coupled lake models: NEMO and GEM



F. Dupont, et al., *In Proceedings: workshop on physical processes in natural waters*, 2011.

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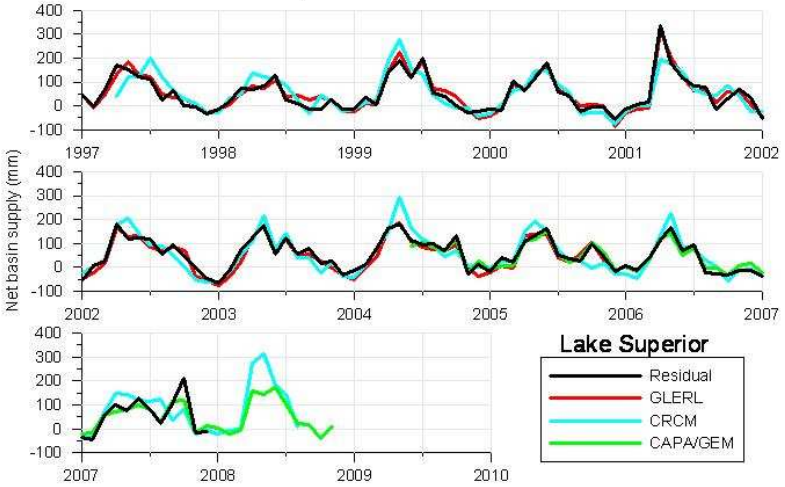
Net basin supply models:

Net basin supply models: recent advancements

Past - Hindcast

The Net Basin Supply (NBS) for each lake was then calculated using the components of the water budget:



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A. Pietroniro, V. Fortin, et al., *Hydrology and Earth System Sciences*, 2007.

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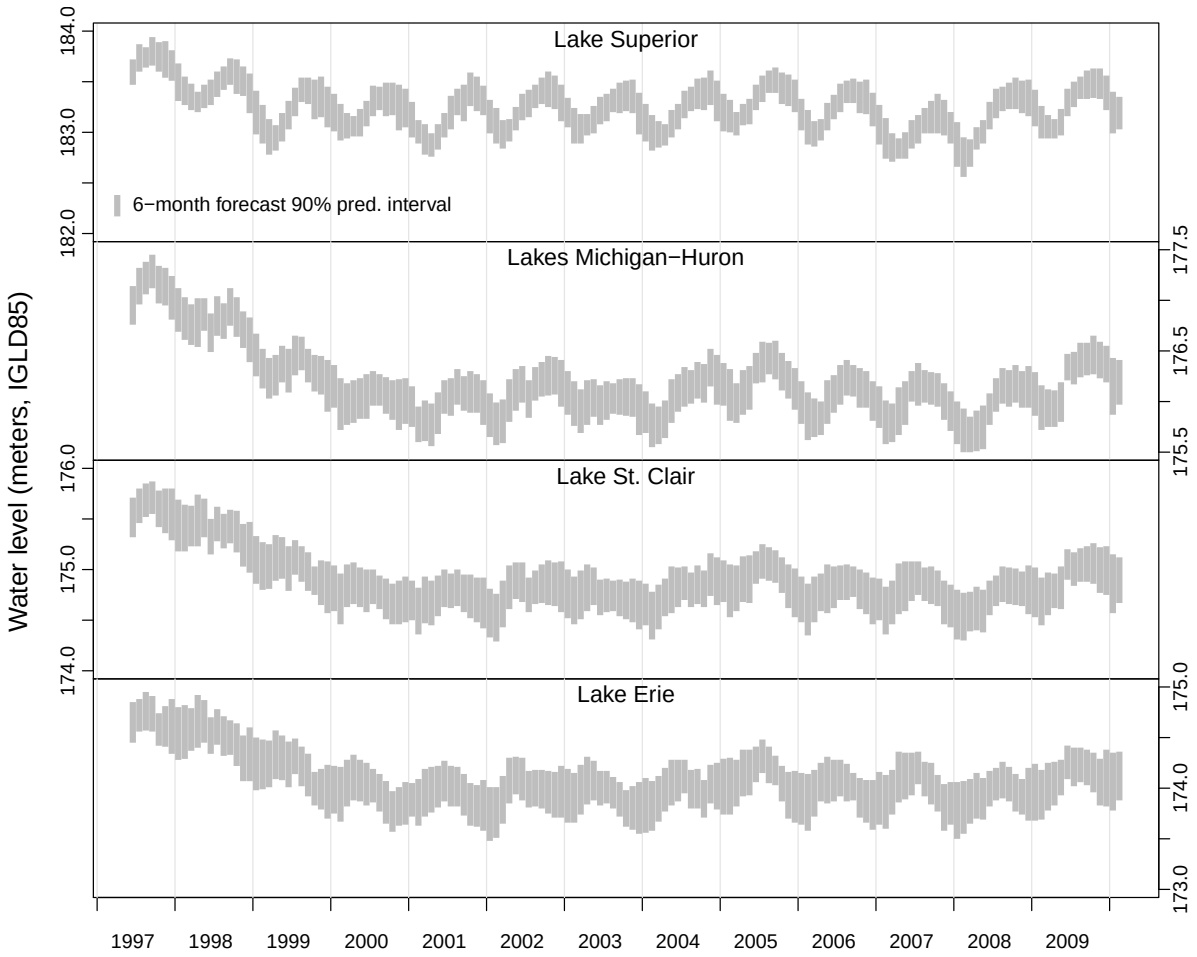
Skill assessment:

Skill assessment: seasonal water level forecasts

Gronewold, A., et al., *Journal of Great Lakes Research*, 2011.

Skill assessment: seasonal water level forecasts



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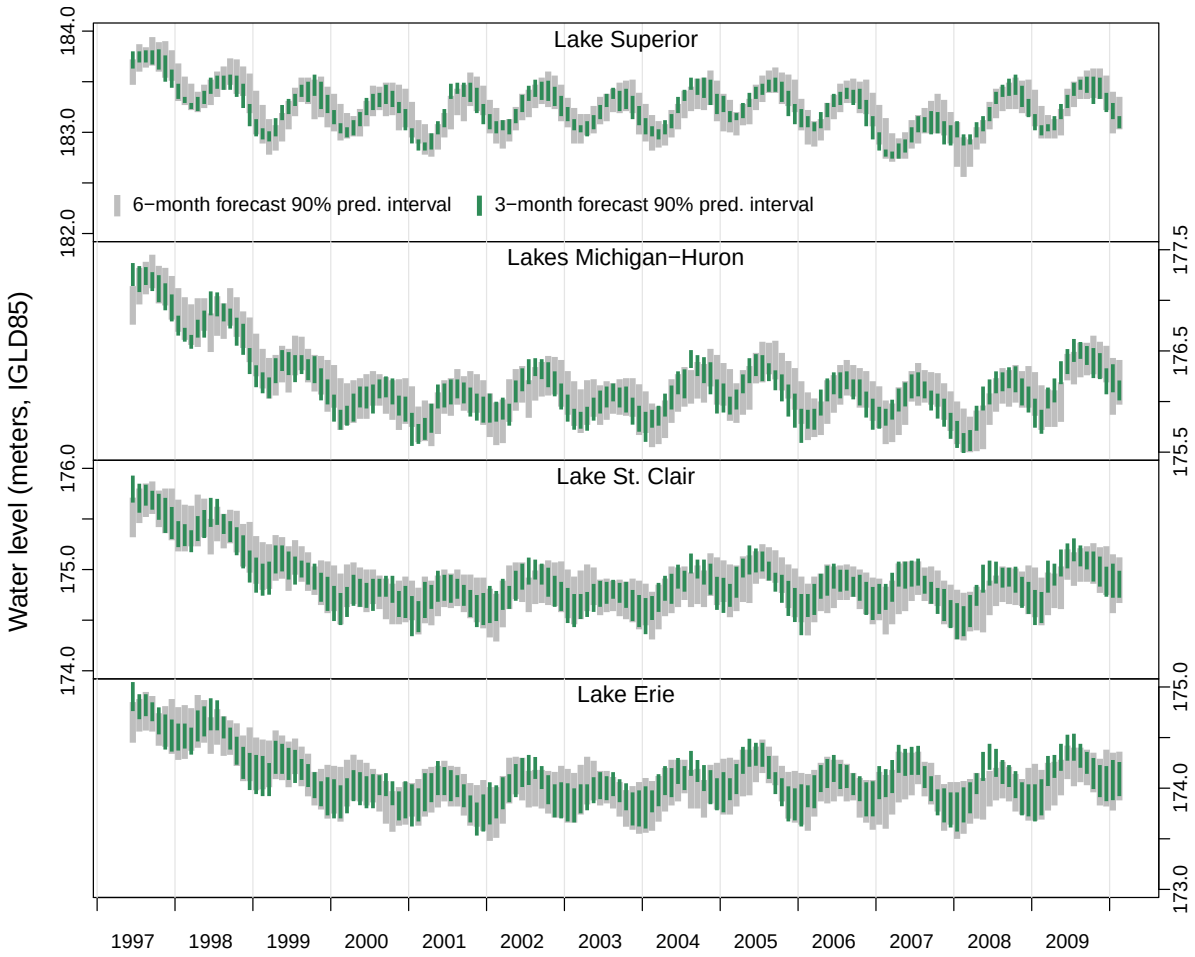
Skill assessment: seasonal water level forecasts



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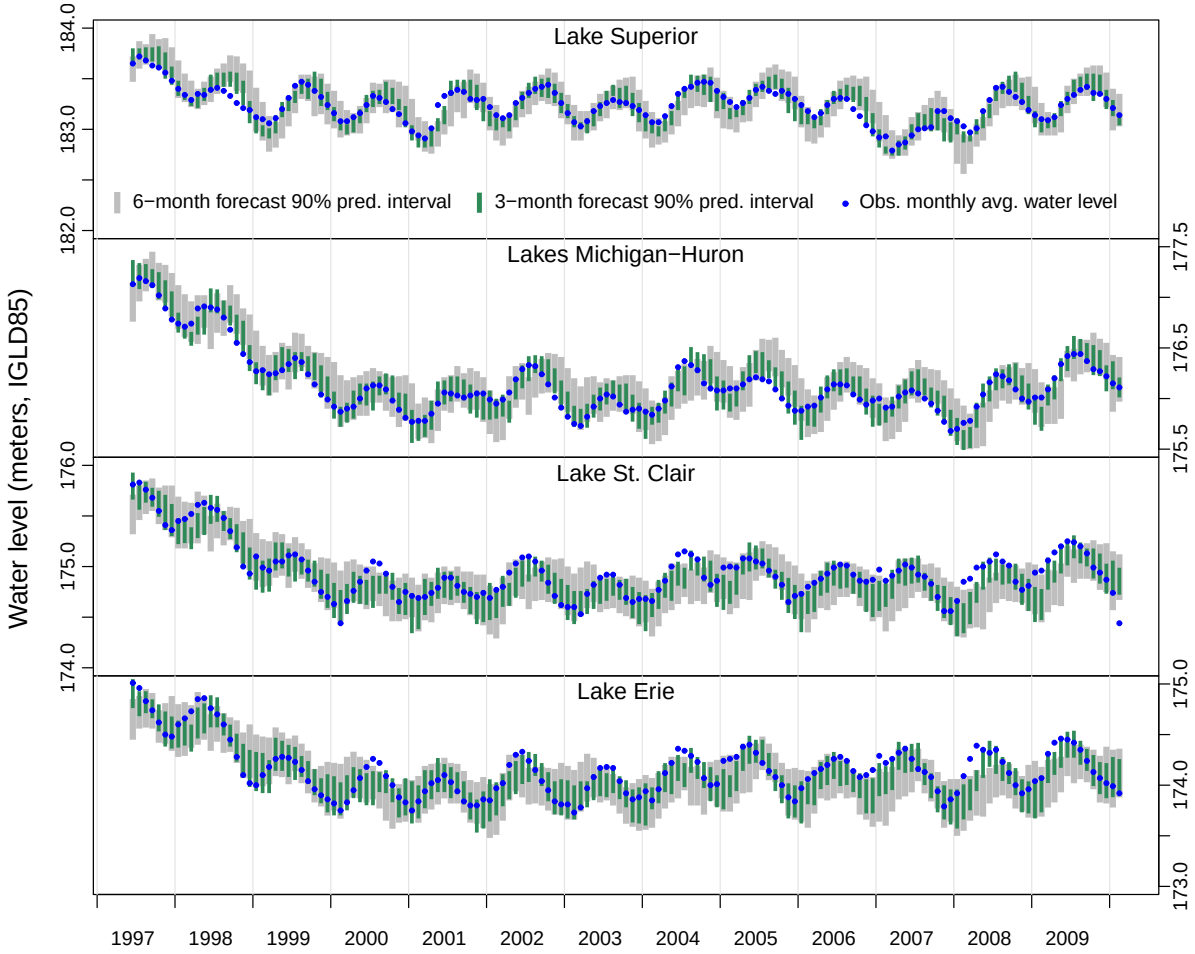
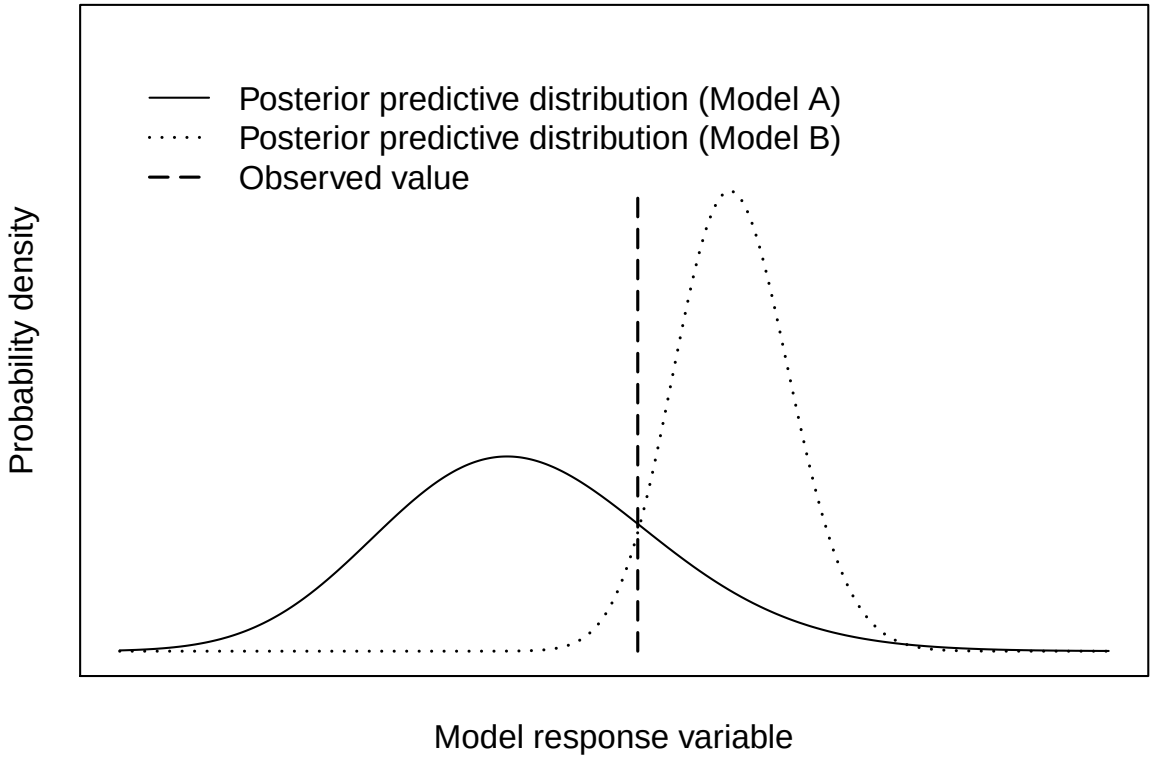


Gronewold, A., et al., *Journal of Great Lakes Research*, 2011.

Skill assessment:

Skill assessment: probabilistic models



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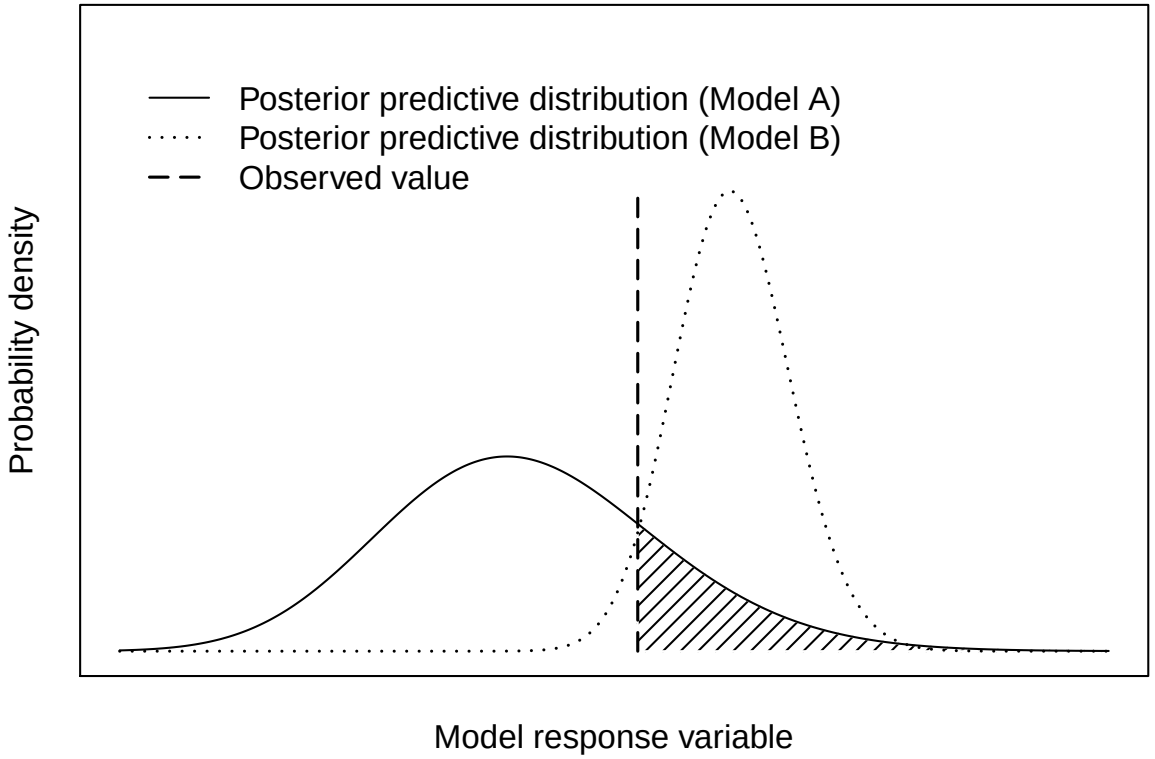

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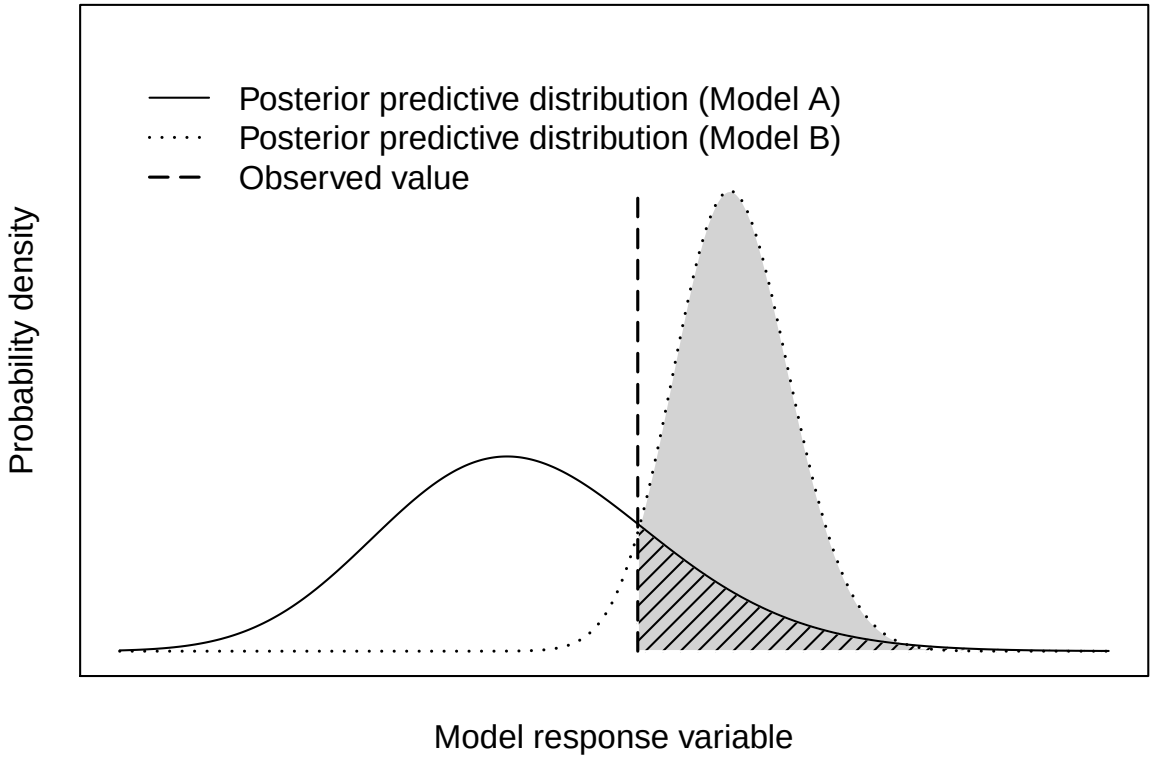
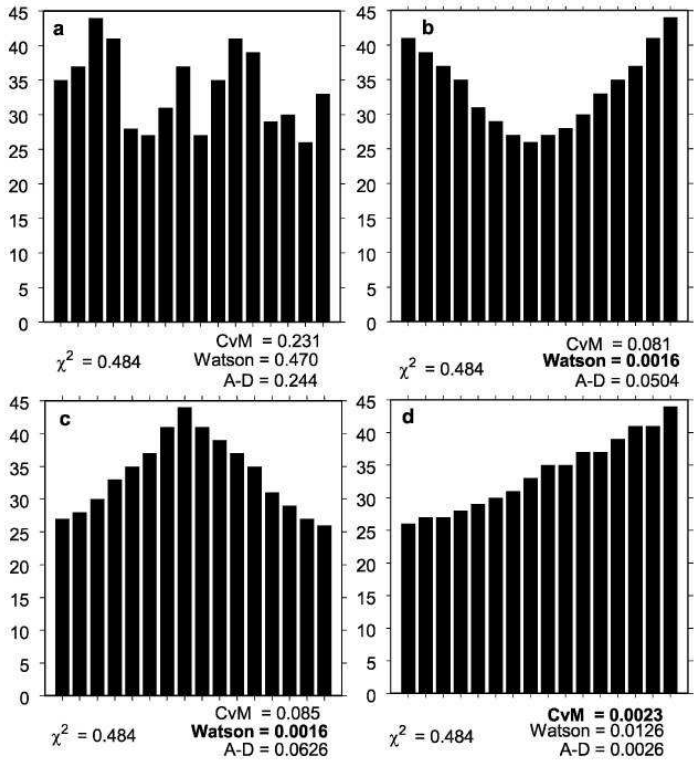


Assessing hydrological model forecasting skill



K. Elmore, *Weather and Forecasting*, 2005.

A. Gelman, J. Carlin, H. Stern, D. Rubin, *Bayesian Data Analysis*, 2004.

A. Gronewold, S. Qian, K. Reckhow, R. Wolpert, *Water Research*, 2009.

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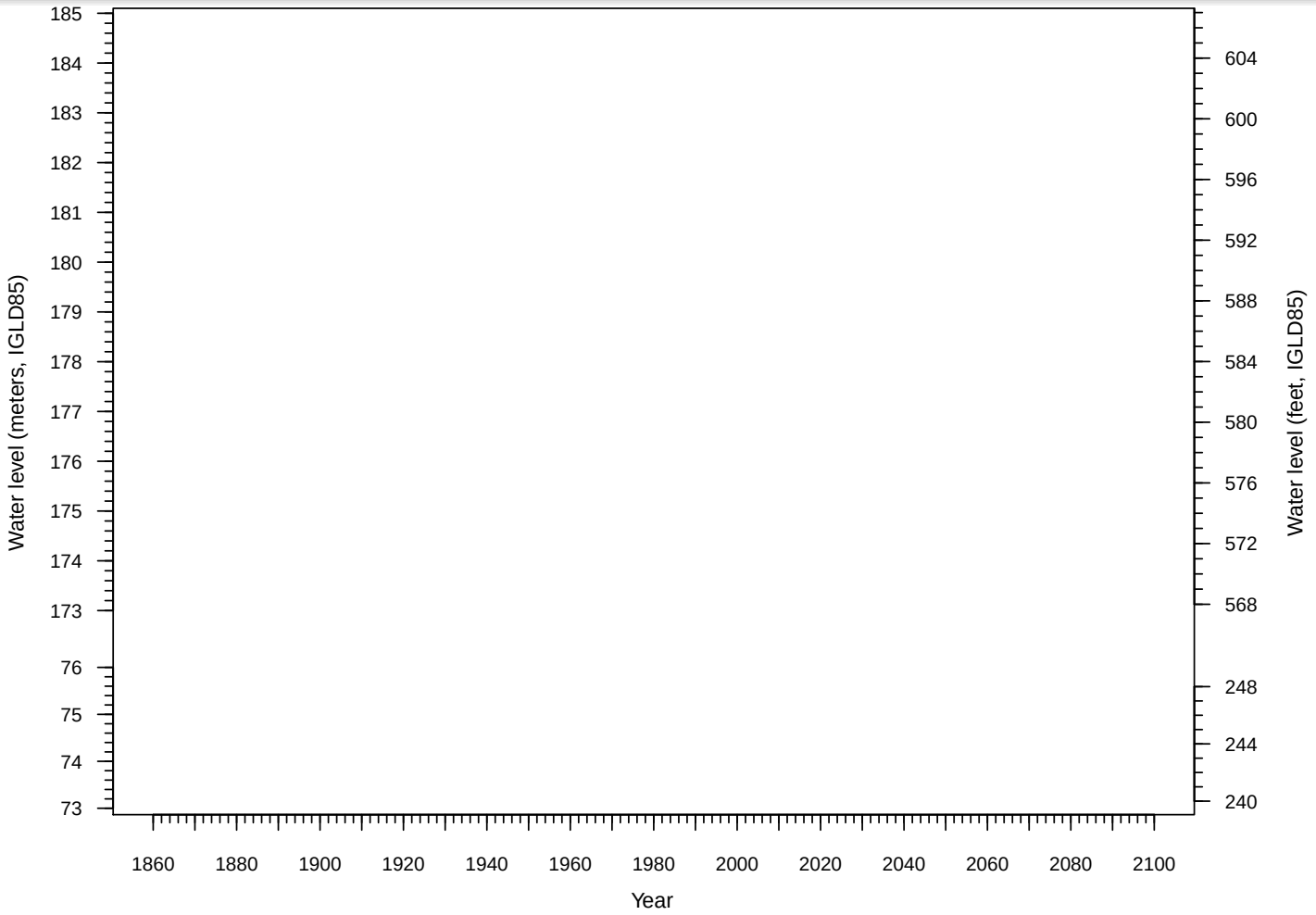
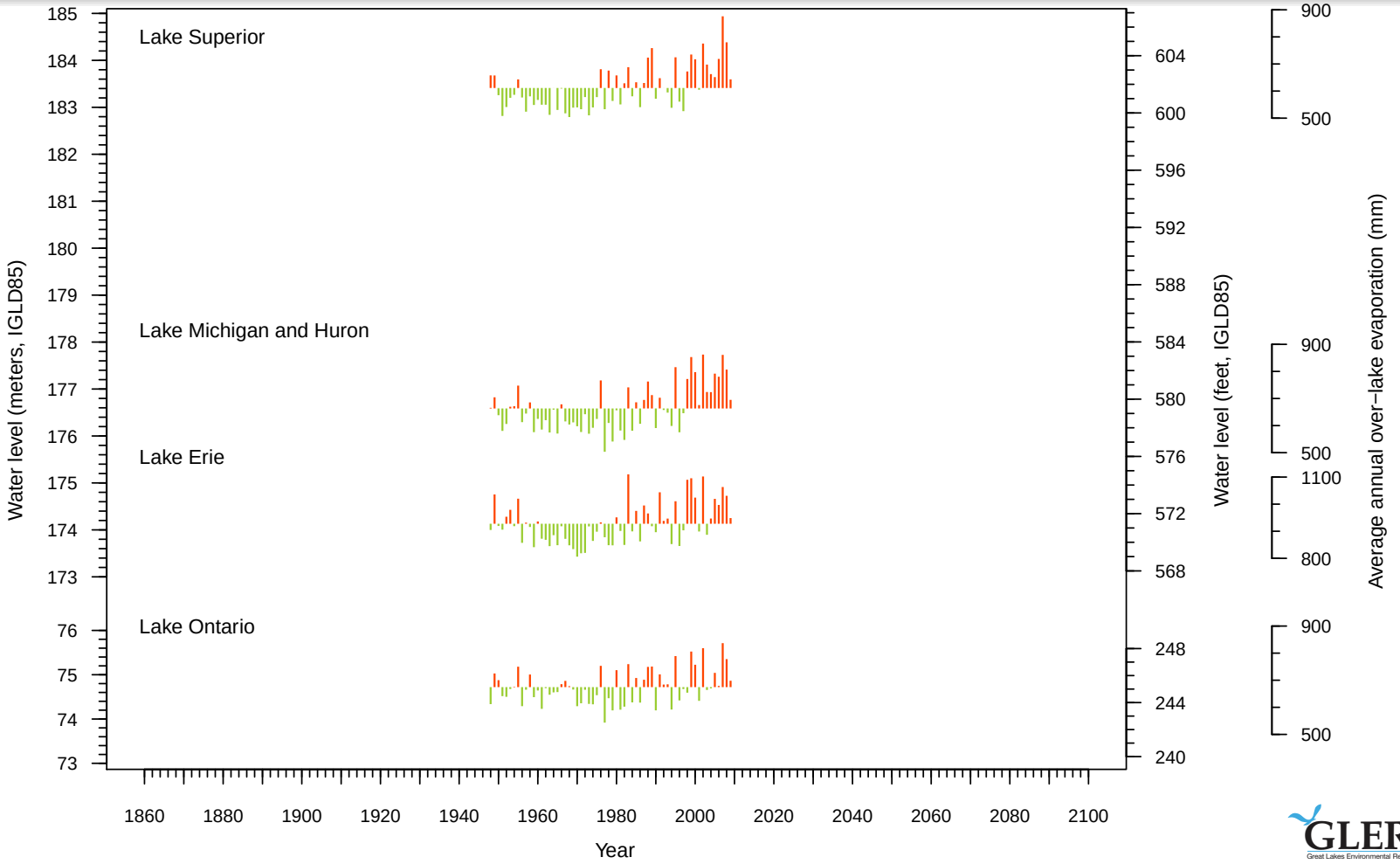
Evaporation



C. Spence, et al., *Journal of Great Lakes Research, 2011.*

Evaporation



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- Maintain awareness of existing institutional frameworks

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- Continue to assess benefits of coupled models
- Maintain awareness of existing institutional frameworks
- Promote the importance of monitoring infrastructure

High priority next steps

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- Improve runoff estimates (not just tributary flows)

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Acknowledgements

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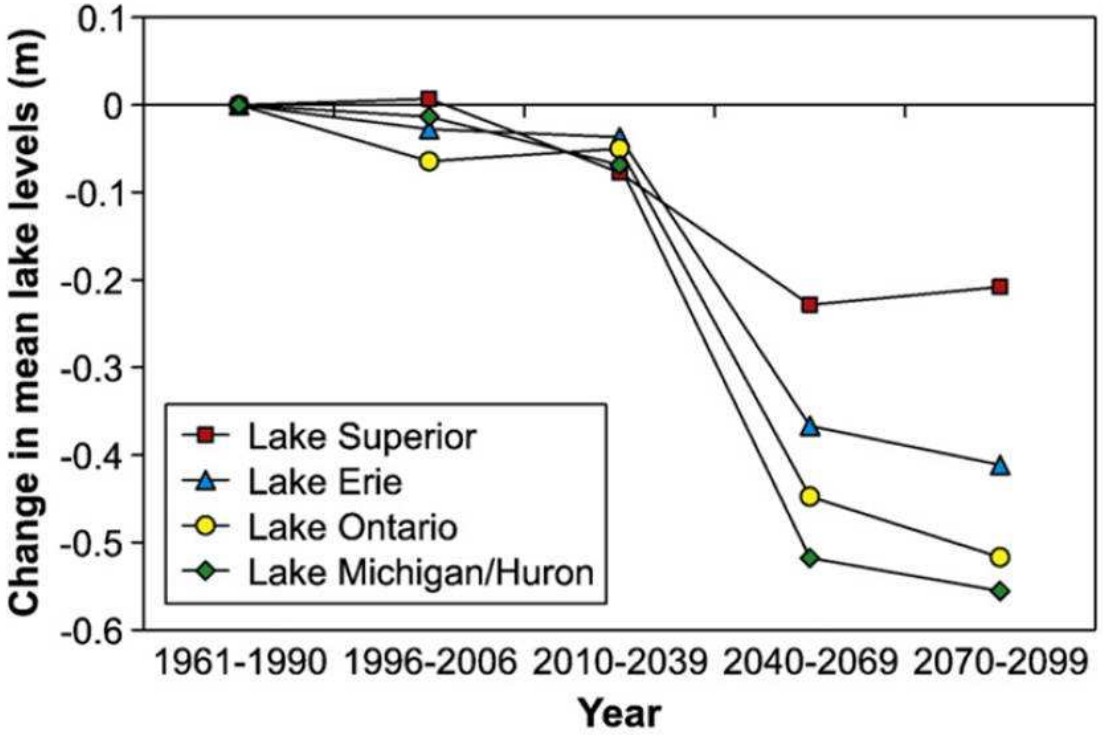
Decadal water level forecasts: Climate scenarios



Hayhoe, et al., *Journal of Great Lakes Research*, 2010.

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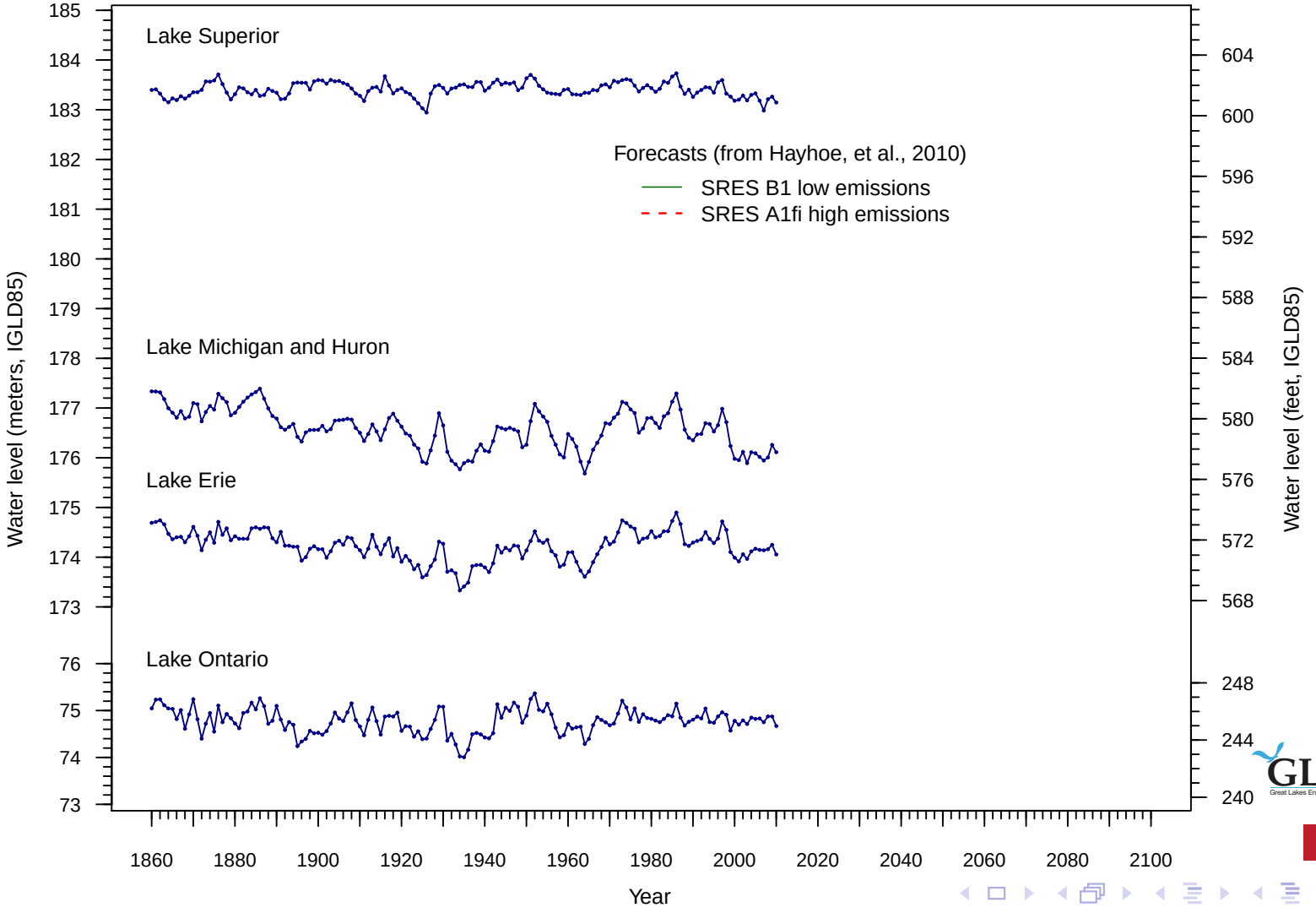

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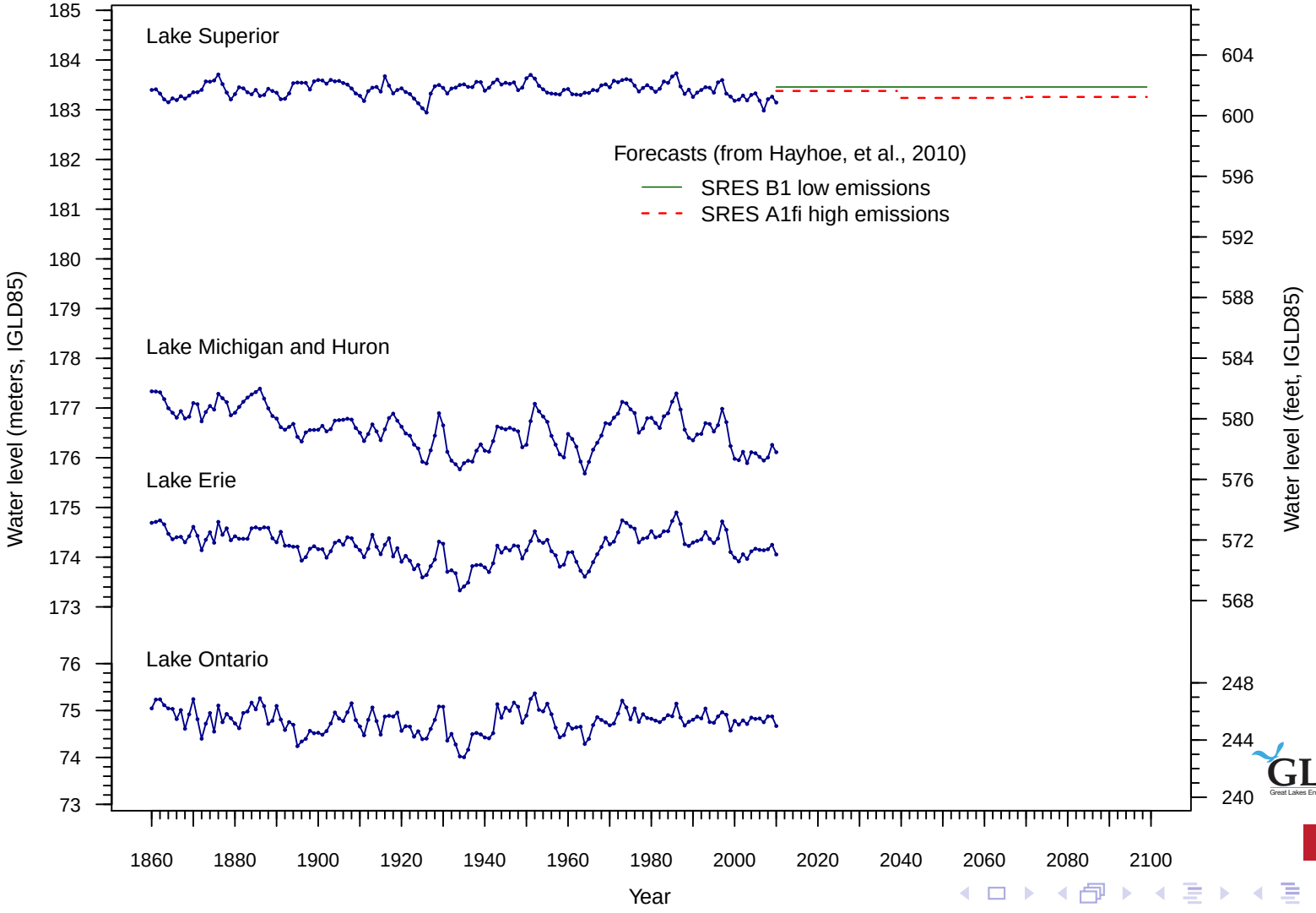

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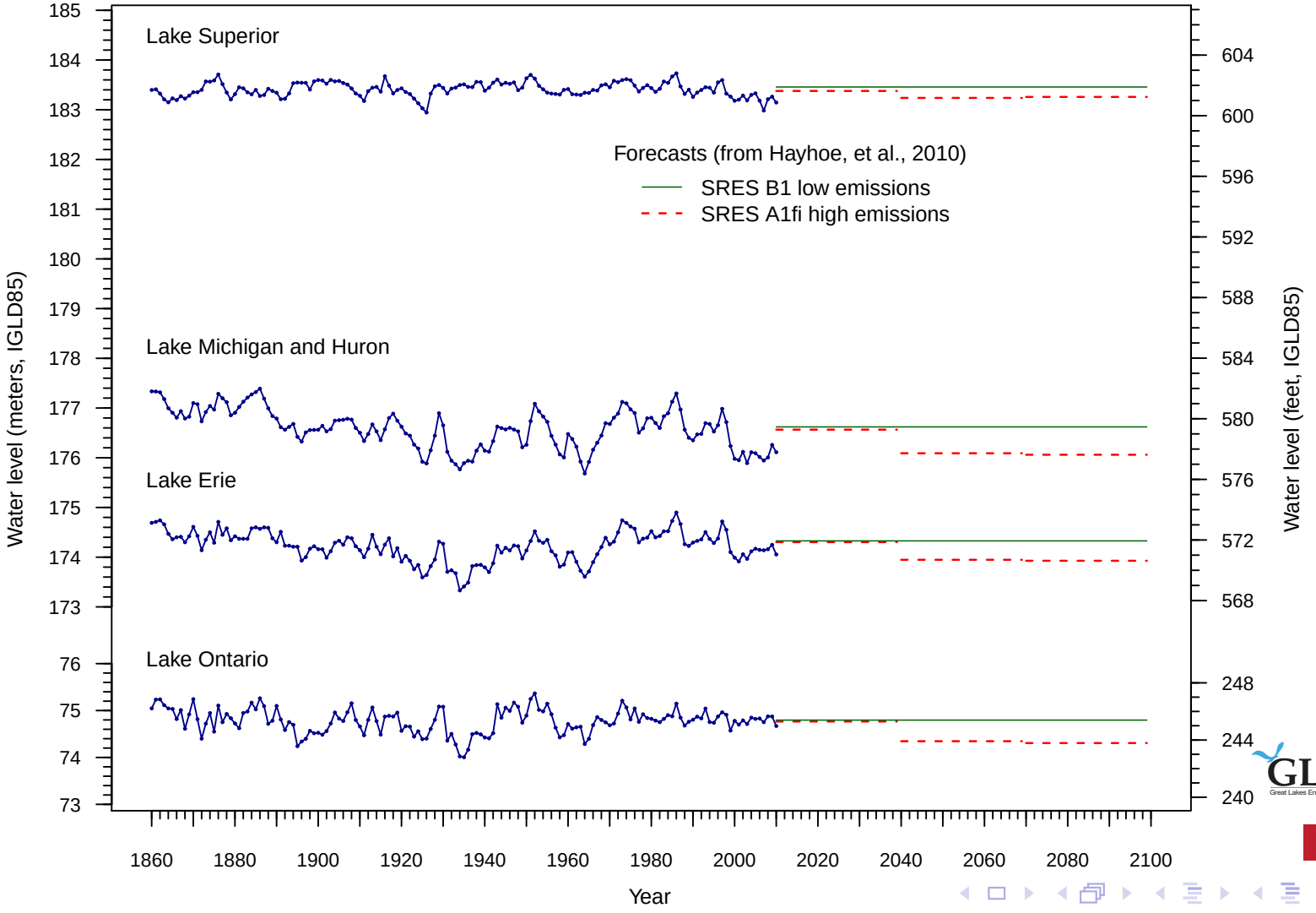

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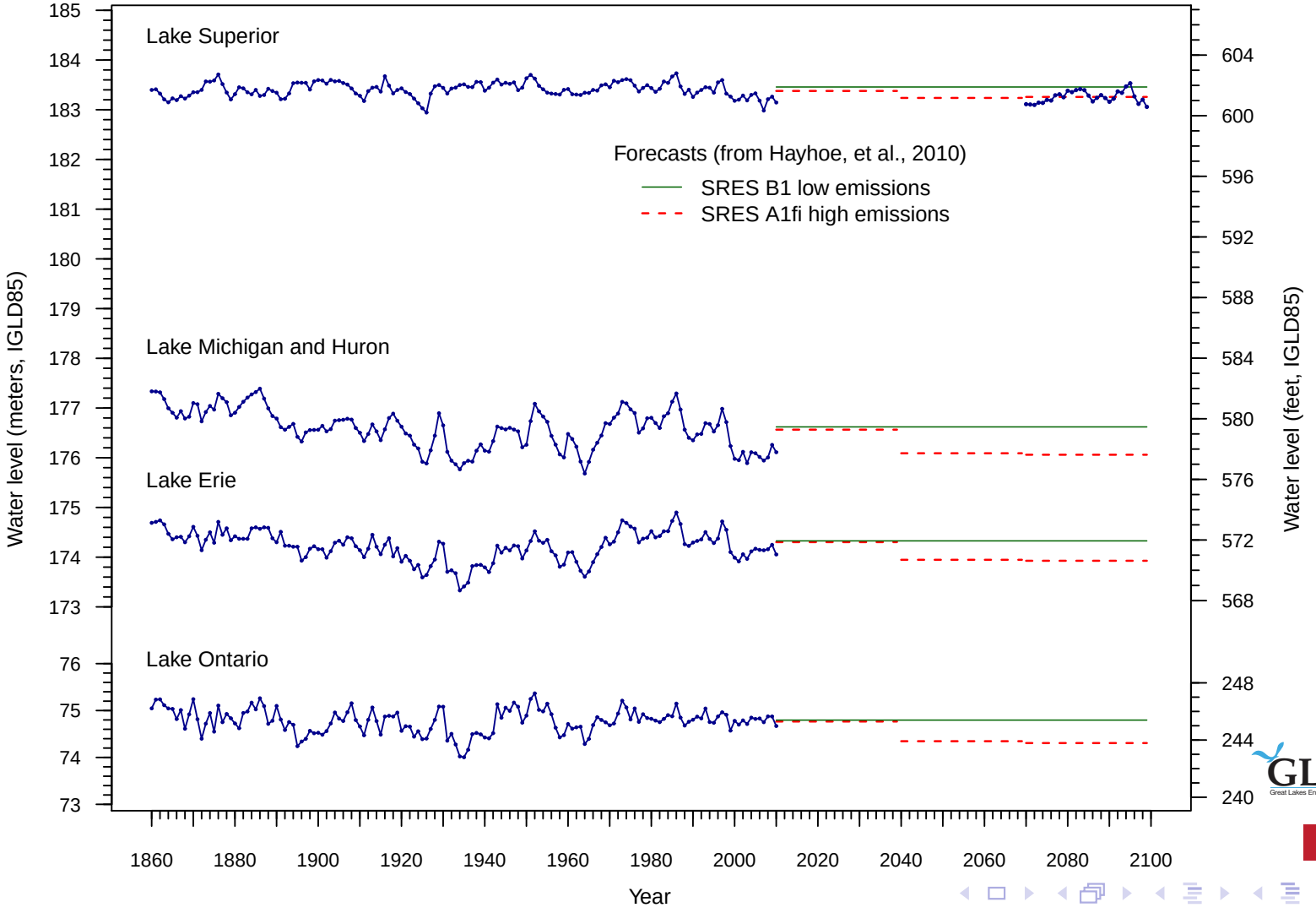

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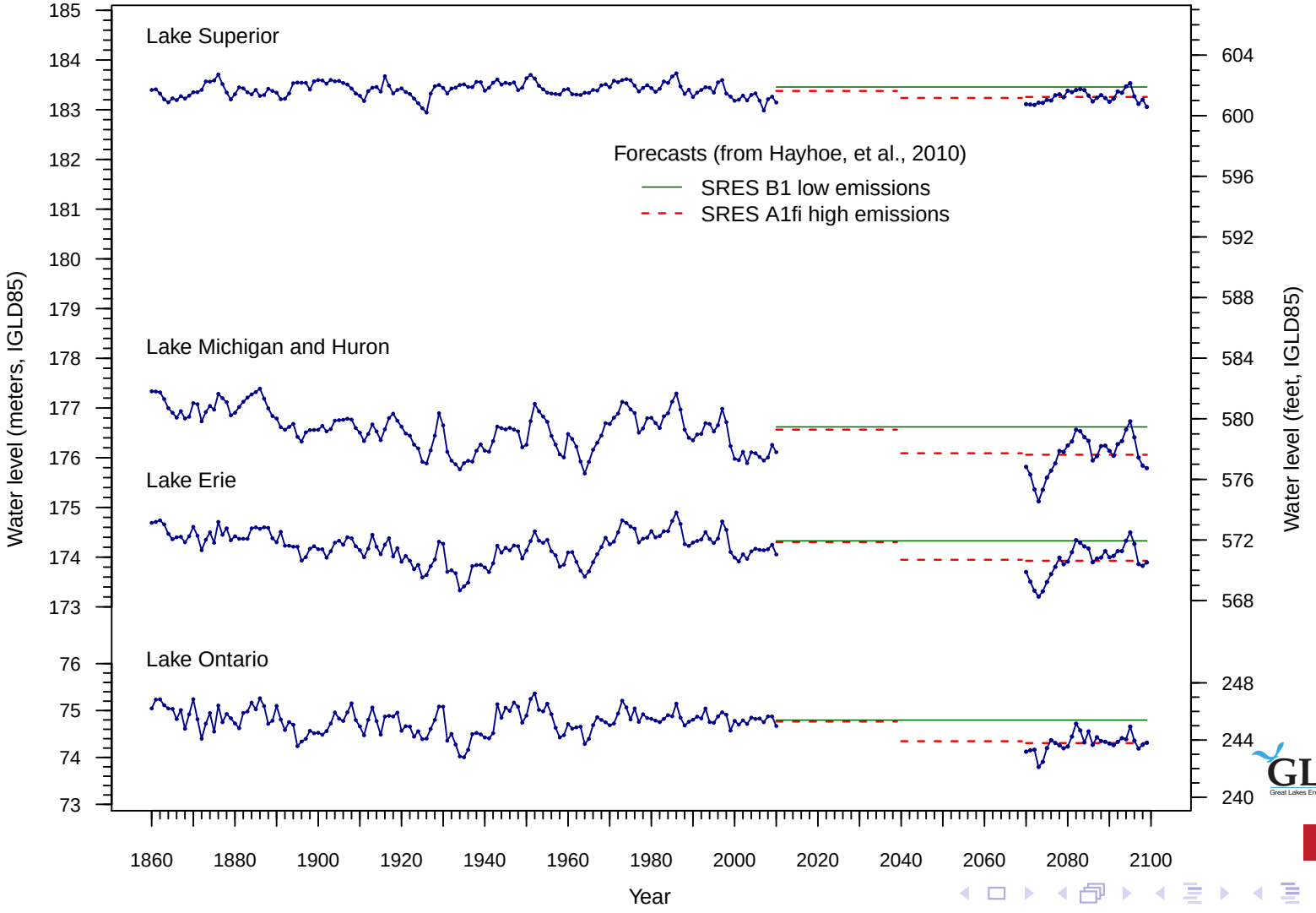

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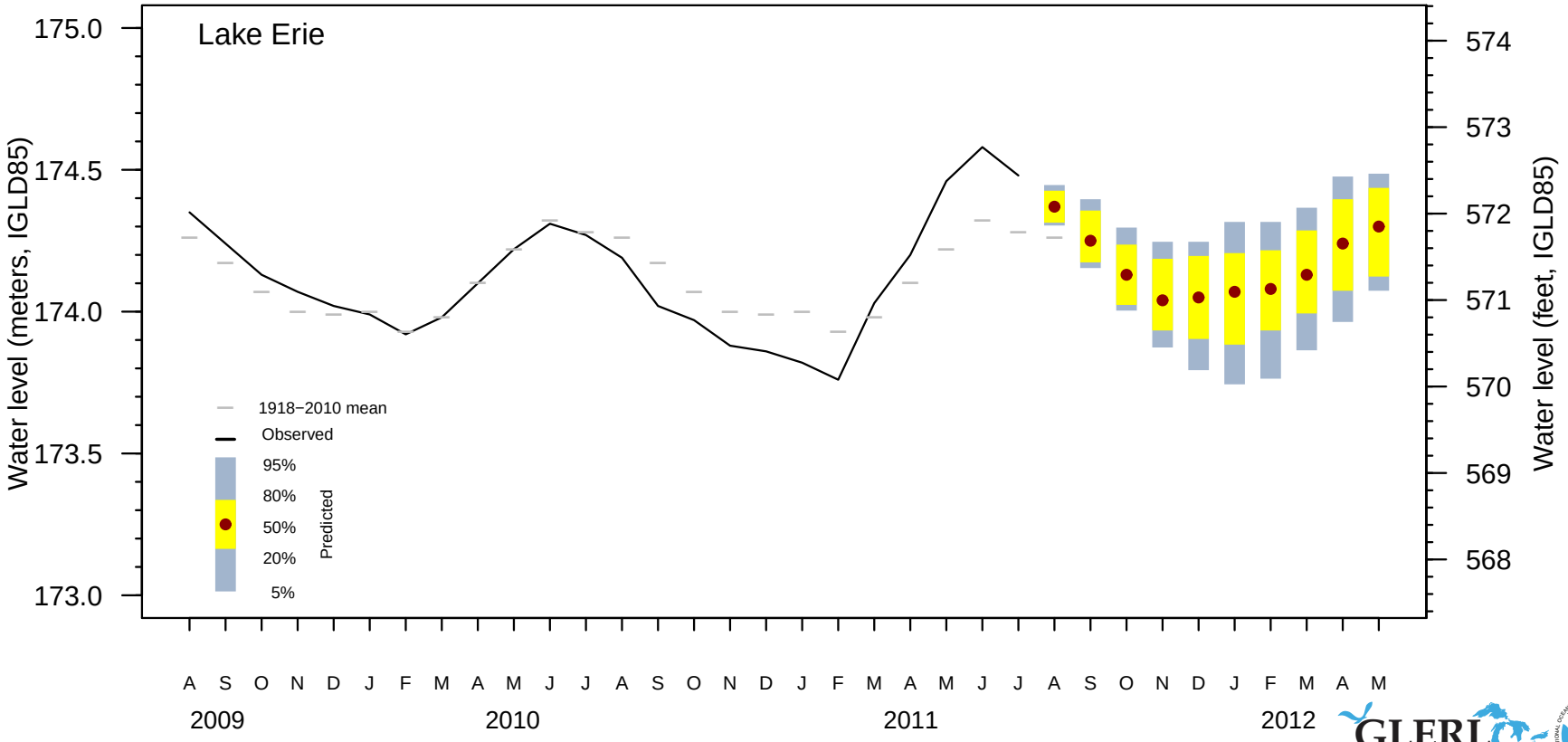

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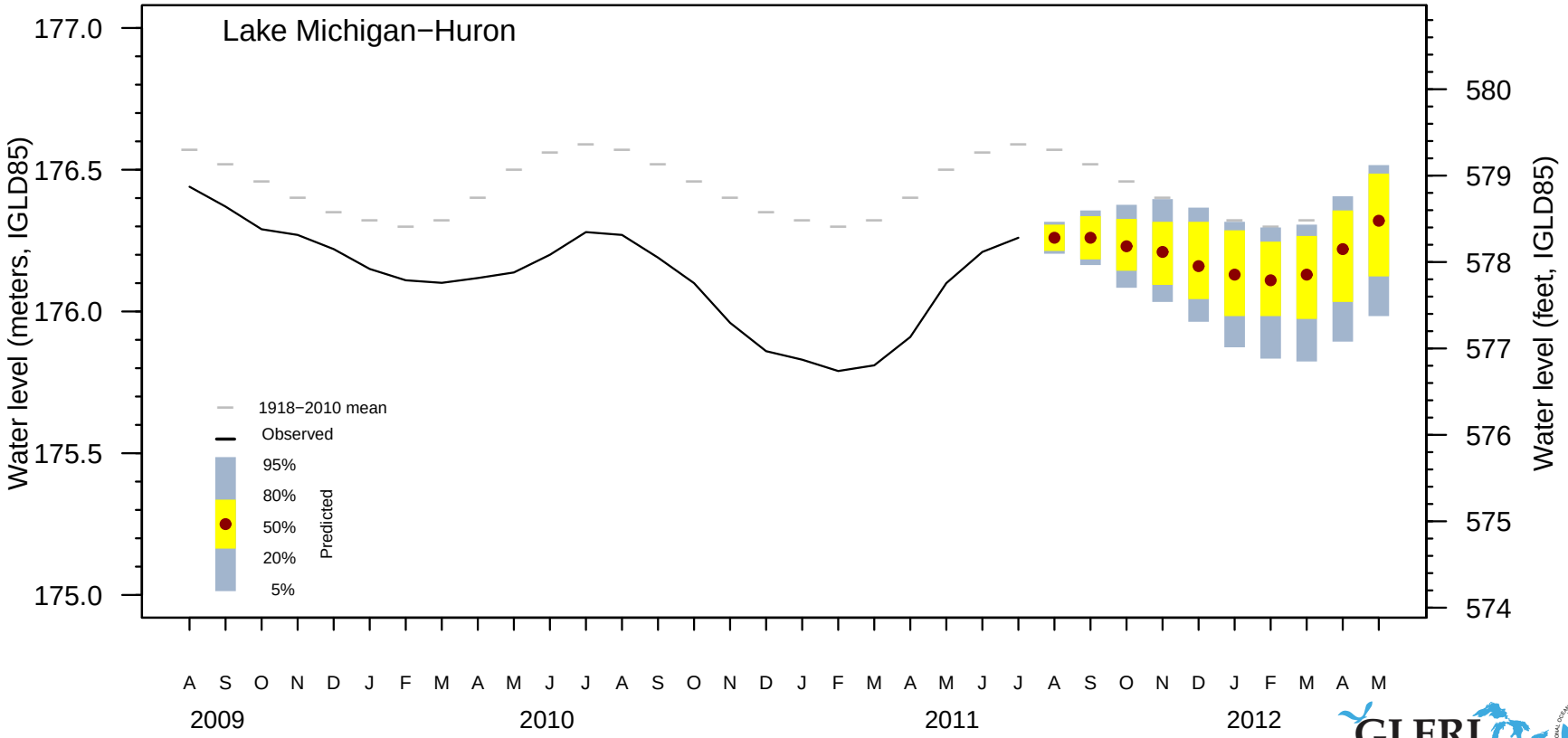

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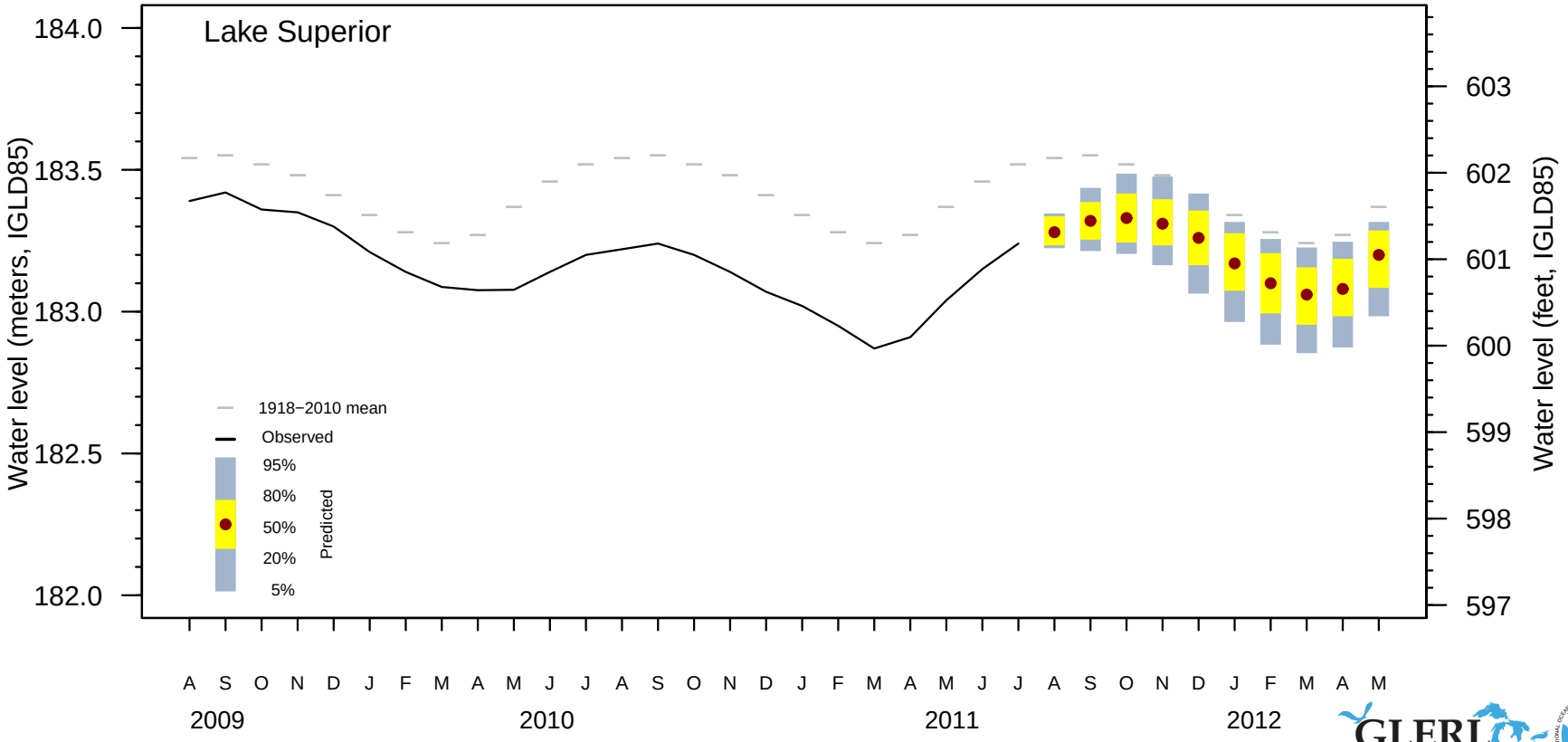

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Rank	Port	State	Total cargo volume (million tons)

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1	South Louisiana	LA	213

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1	South Louisiana	LA	213
2	Houston	TX	211
3	New York and New Jersey	NY/NJ	145
4	Long Beach	CA	73
5	Corpus Christi	TX	68
6	New Orleans	LA	68
7	Beaumont	TX	68
8	Huntington-Tristate	OH/KY/WV	59
9	Los Angeles	CA	58
10	Hampton Roads	VA	58

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⋮	⋮	⋮	⋮
25	Duluth/Superior	MN/WI	30

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10	Hampton Roads	VA	58
⋮	⋮	⋮	⋮
25	Duluth/Superior	MN/WI	30
⋮	⋮	⋮	⋮
36	Chicago	IL	19

Table: United States busiest ports ranked by gross tonnage for the calendar year 2009.

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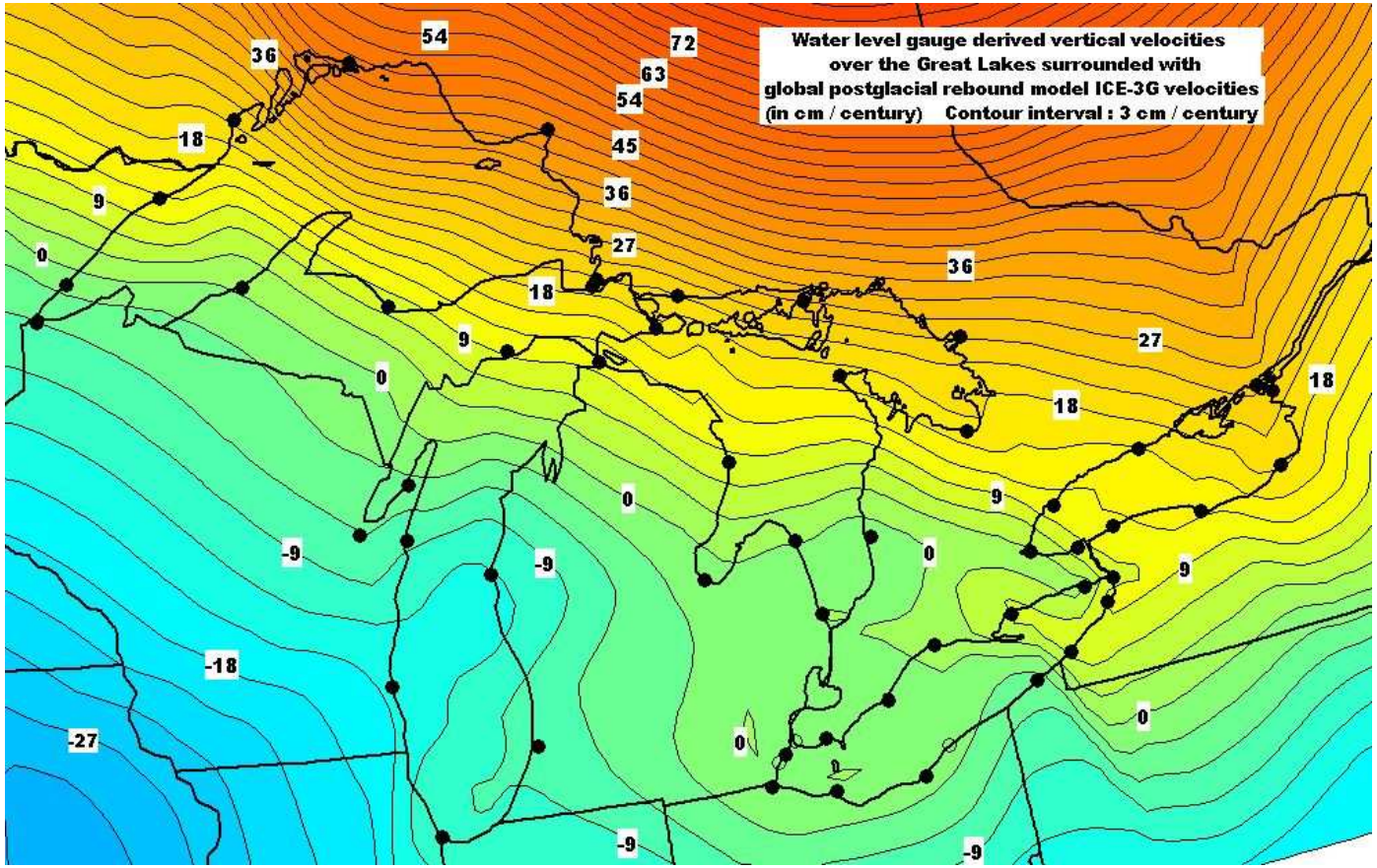

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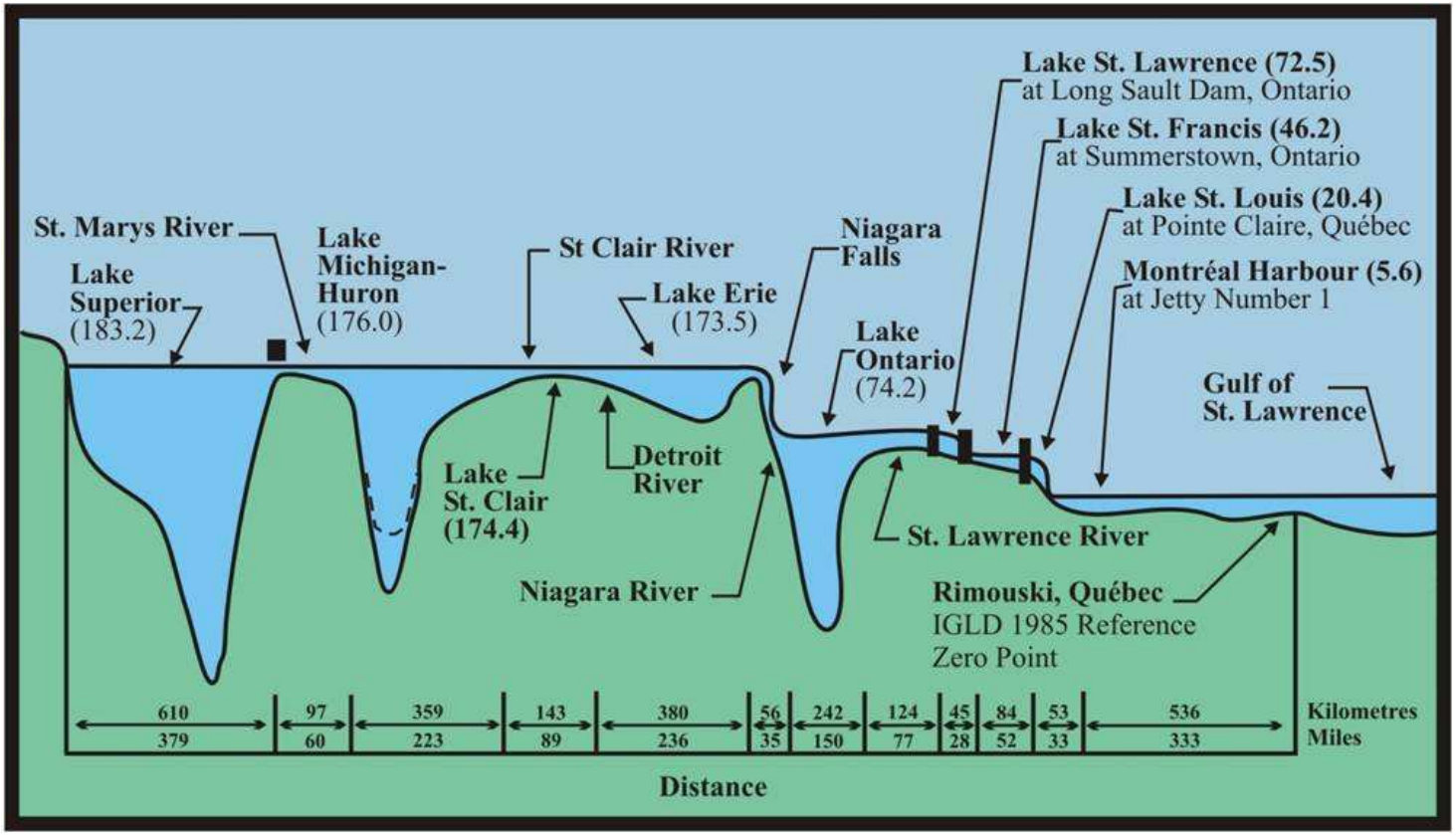
Lake St. Lawrence (72.5)
at Long Sault Dam, Ontario
Lake St. Francis (46.2)
at Summerstown, Ontario
Lake St. Louis (20.4)
at Pointe Claire, Québec
Montréal Harbour (5.6)
at Jetty Number 1
St. Marys River
Lake Superior (183.2)
Lake Michigan-Huron (176.0)
St Clair River
Lake Erie (173.5)
Niagara Falls
Lake Ontario (74.2)
Gulf of St. Lawrence
Lake St. Clair (174.4)
Detroit River
Niagara River
St. Lawrence River
Rimouski, Québec
IGLD 1985 Reference Zero Point
610 379
97 60
359 223
143 89
380 236
56 35
242 150
124 77
45 28
84 52
53 33
536 333
Kilometres
Miles
Distance

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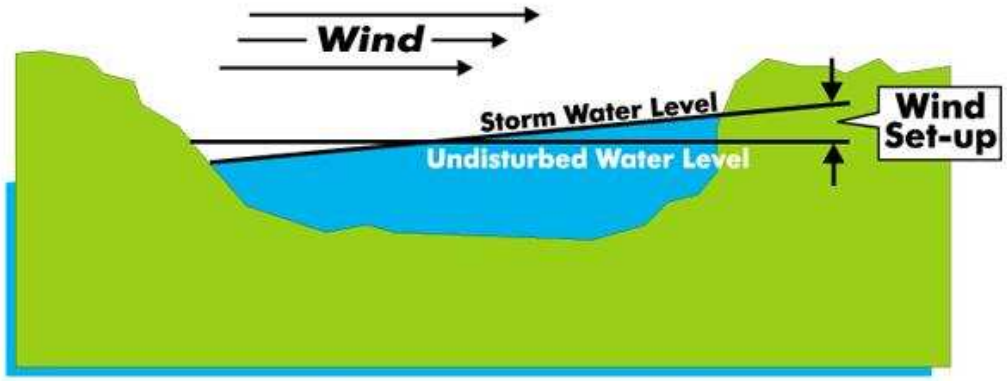

Lake profile showing wind set-up

Courtesy *Living with the Lakes*, copyright 2000
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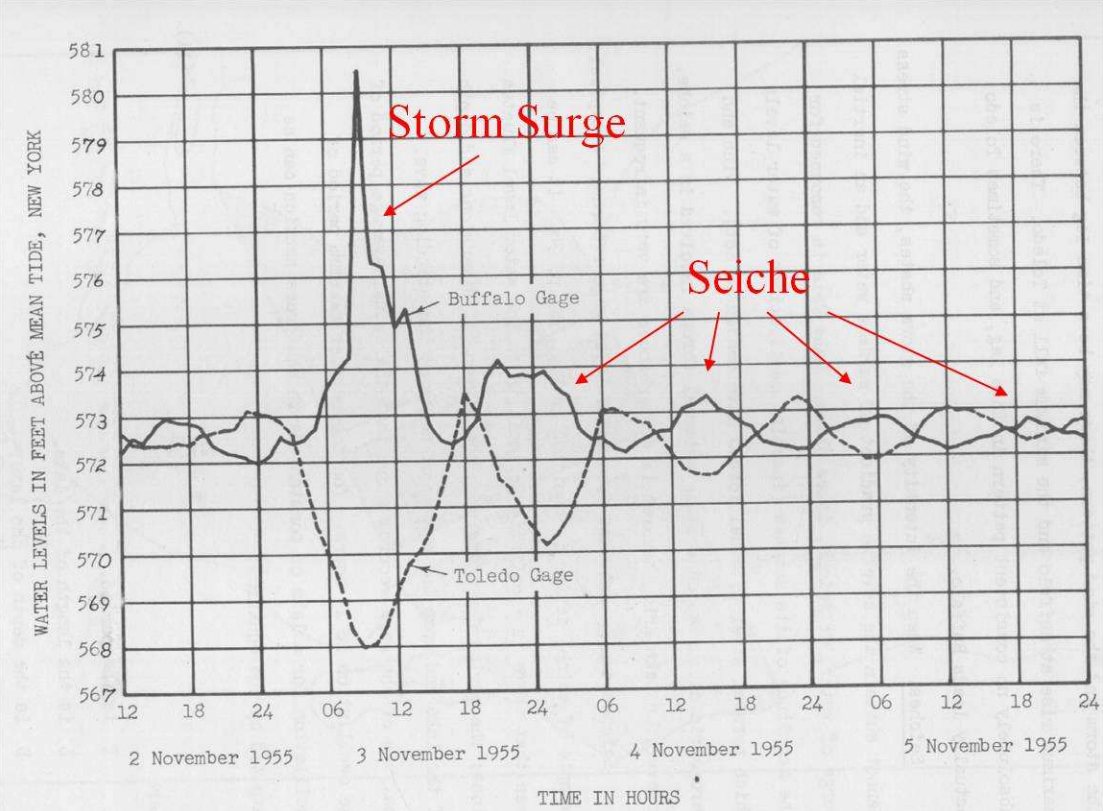

Fig. 15. General Lake Erie seiche resulting from storm of 3 November 1955.

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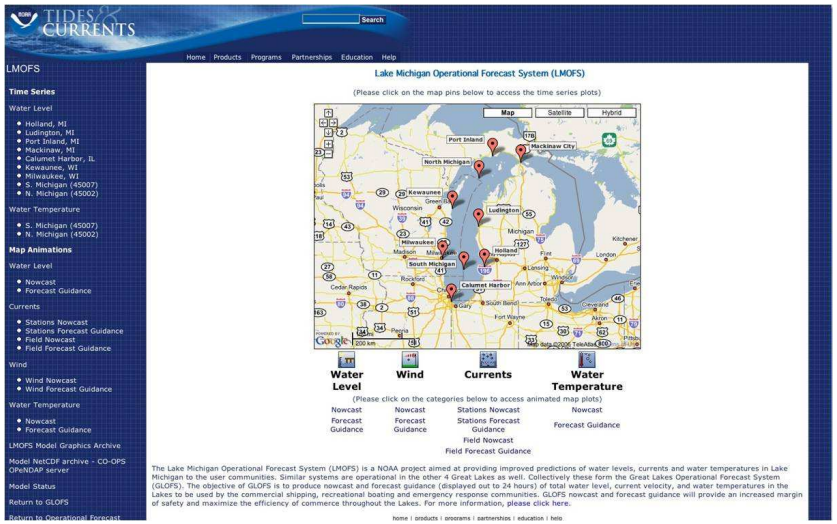

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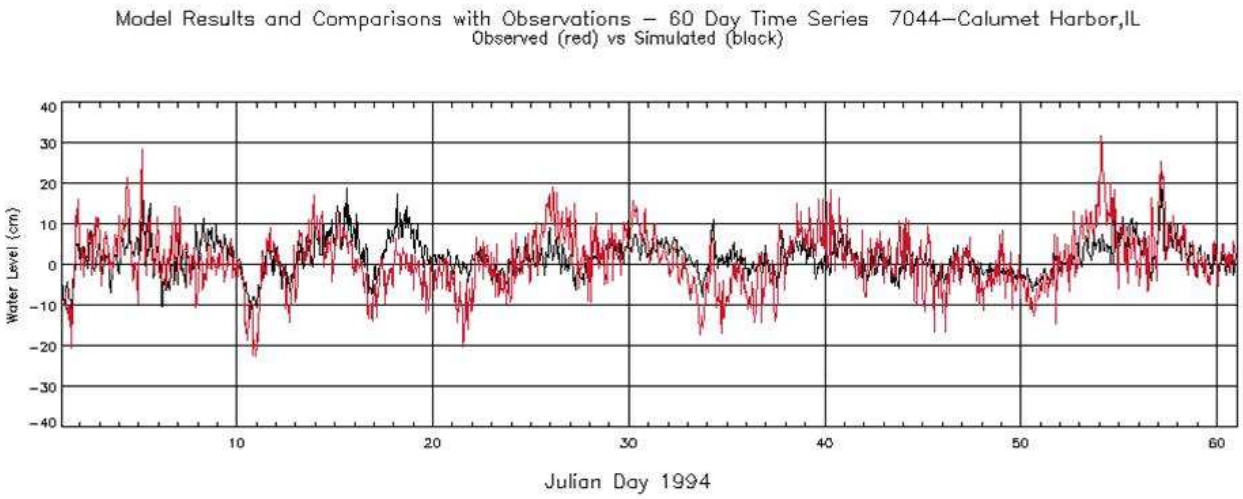

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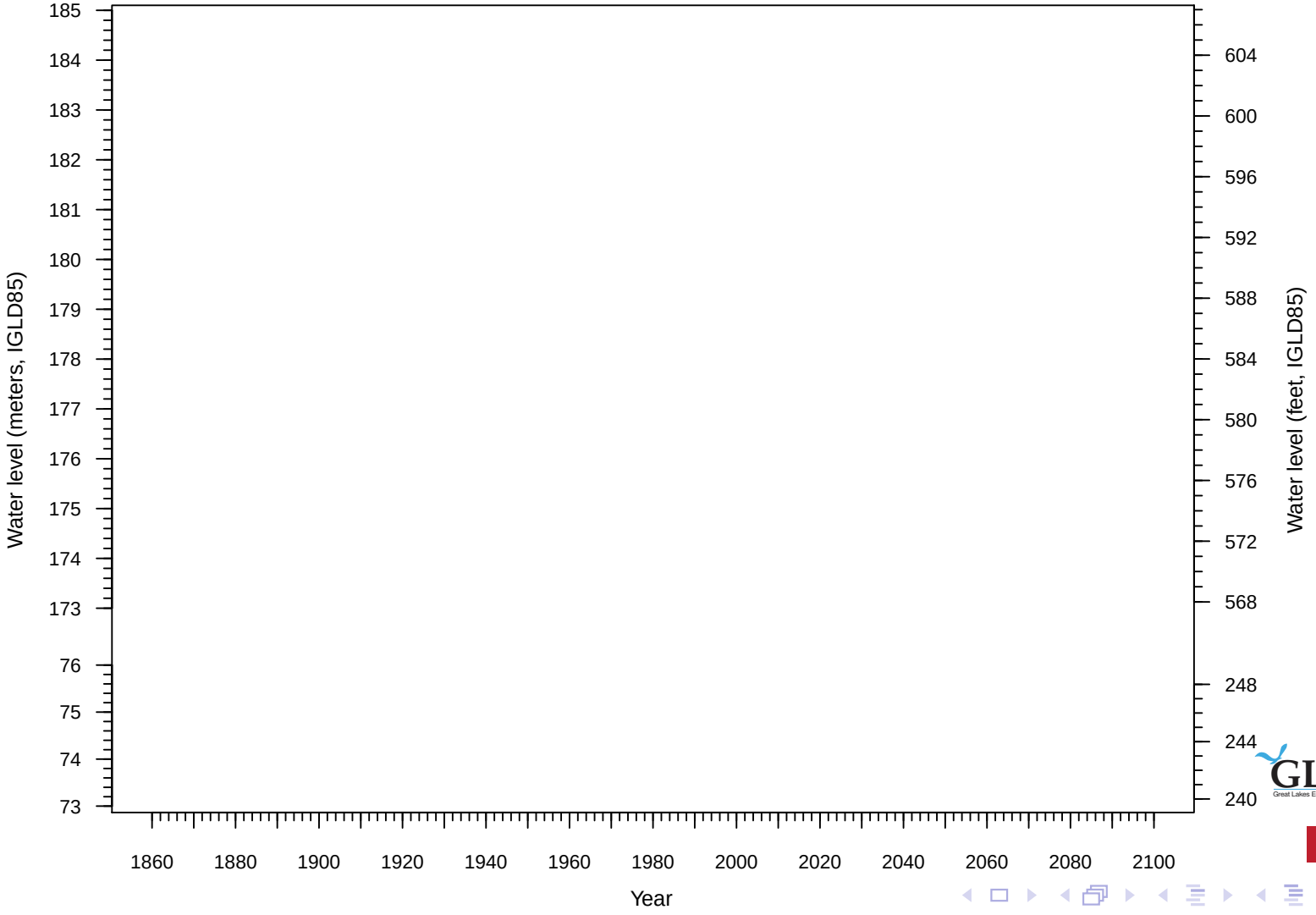
Precipitation



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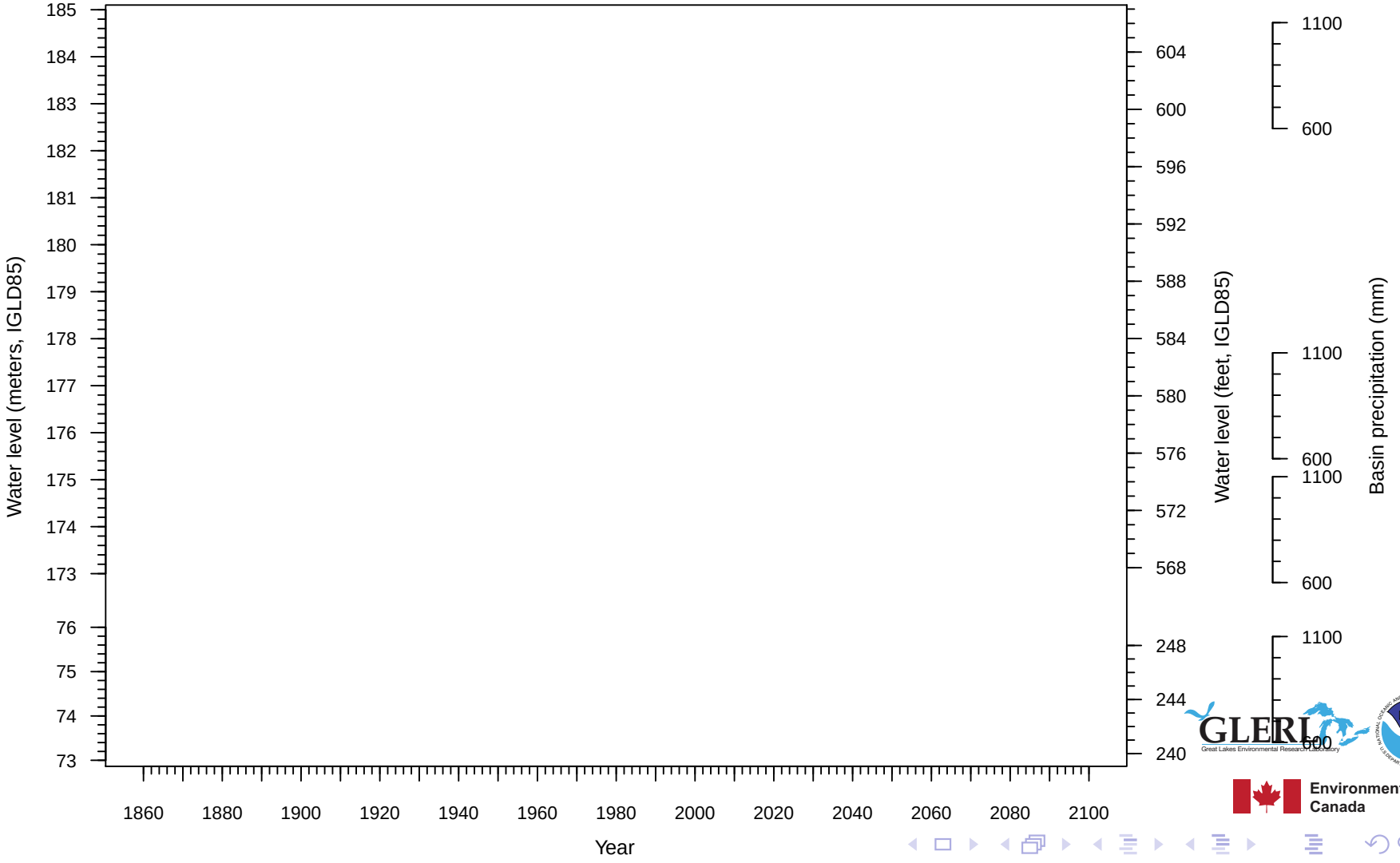

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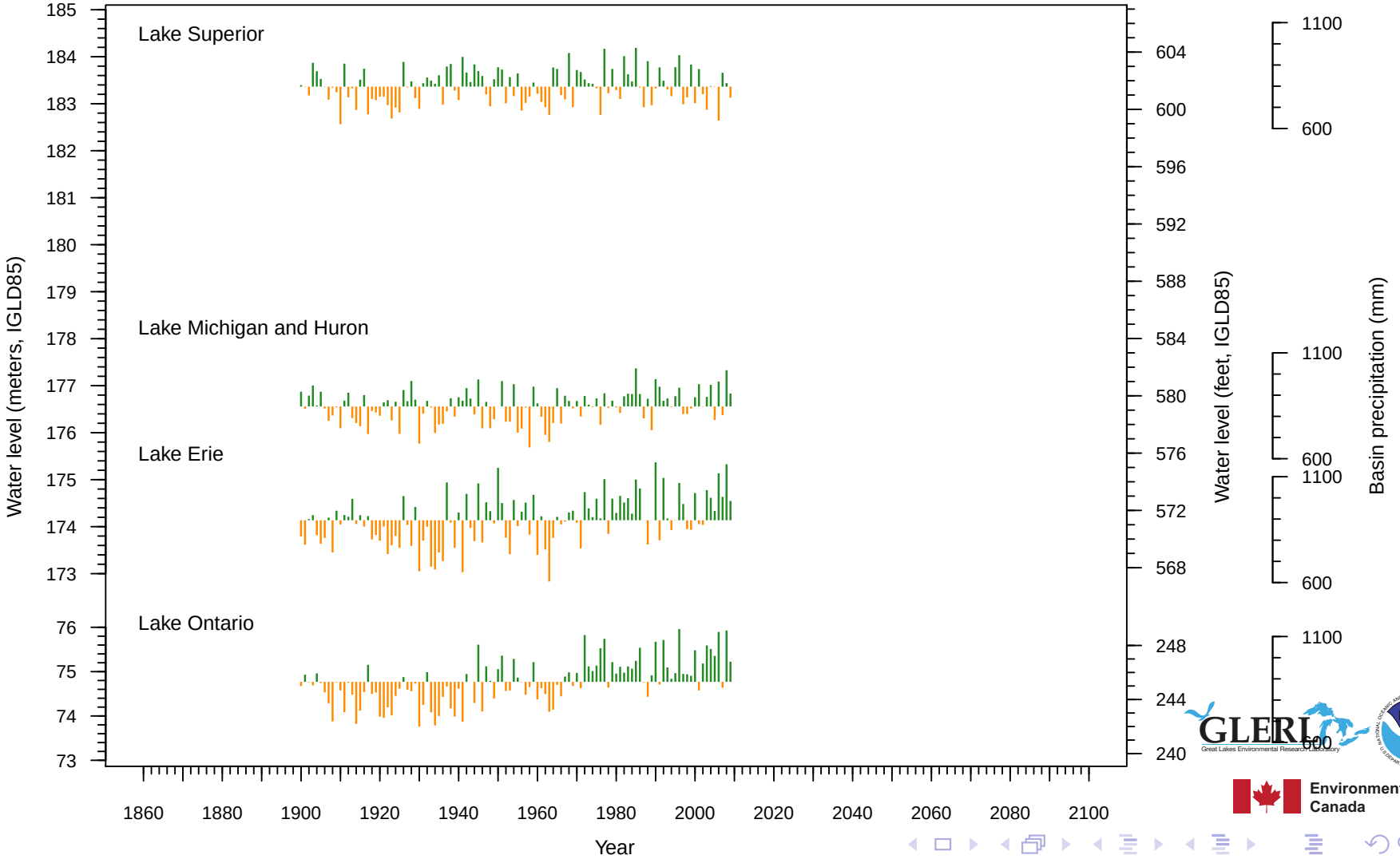

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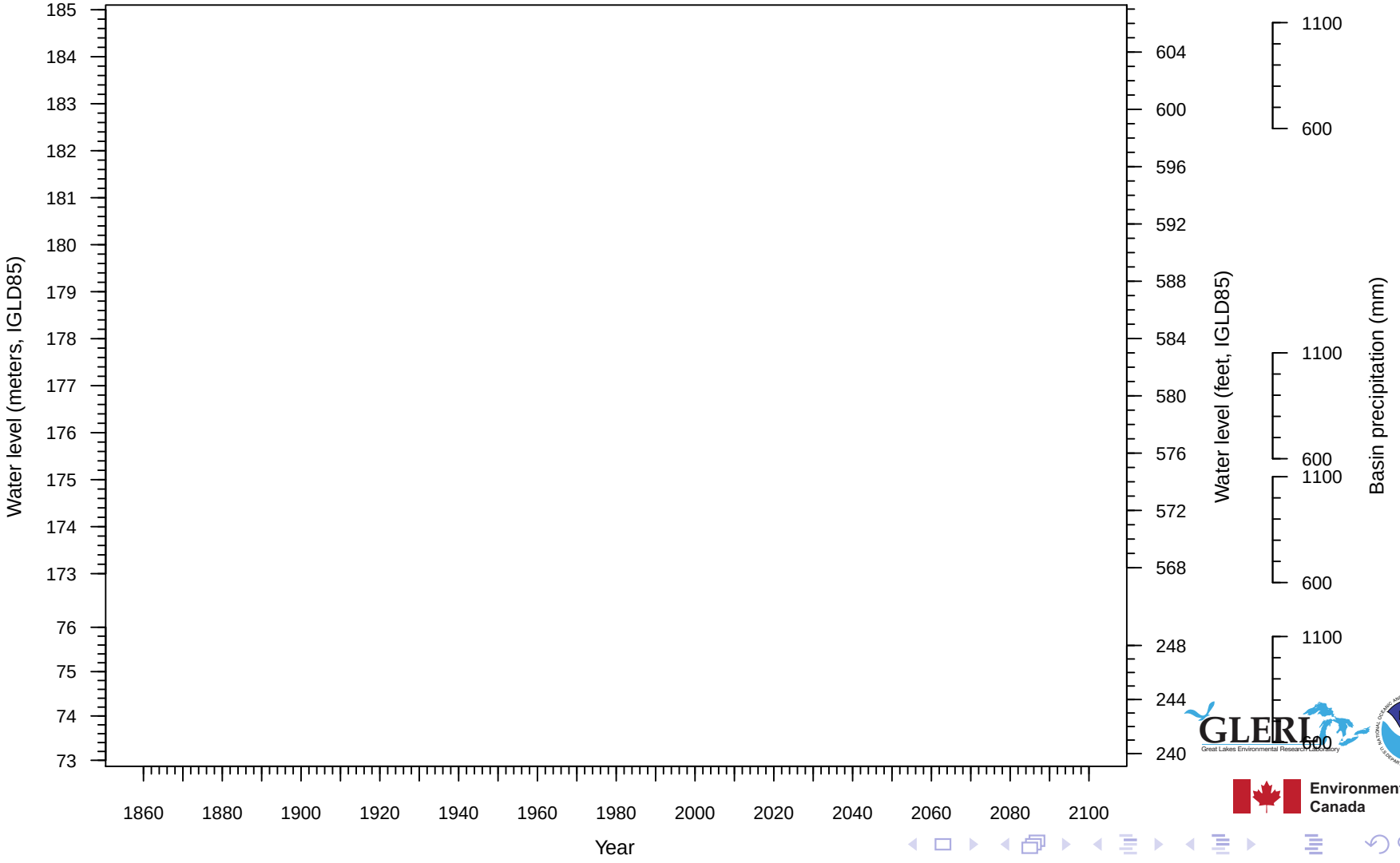
Climate forecasts



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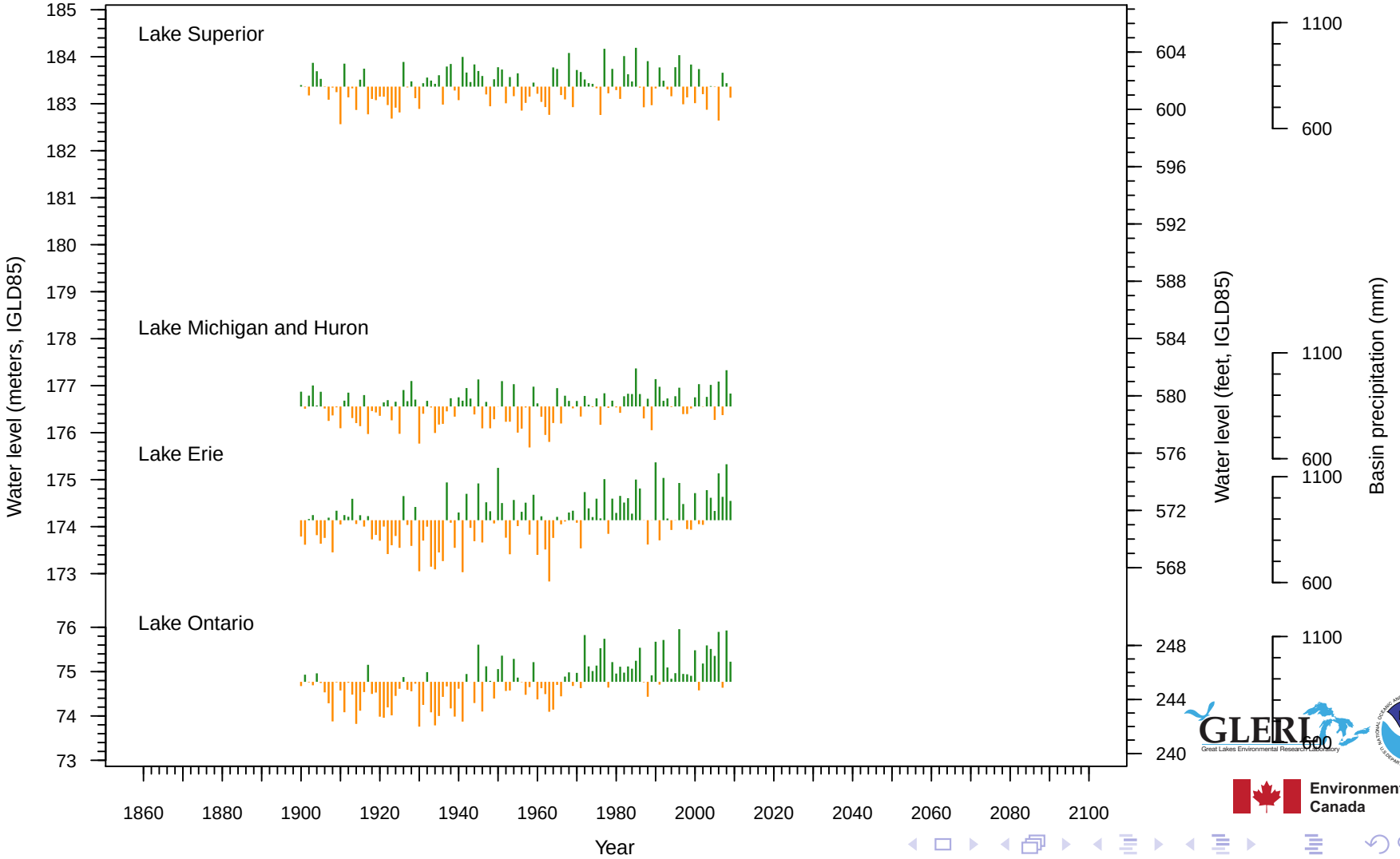

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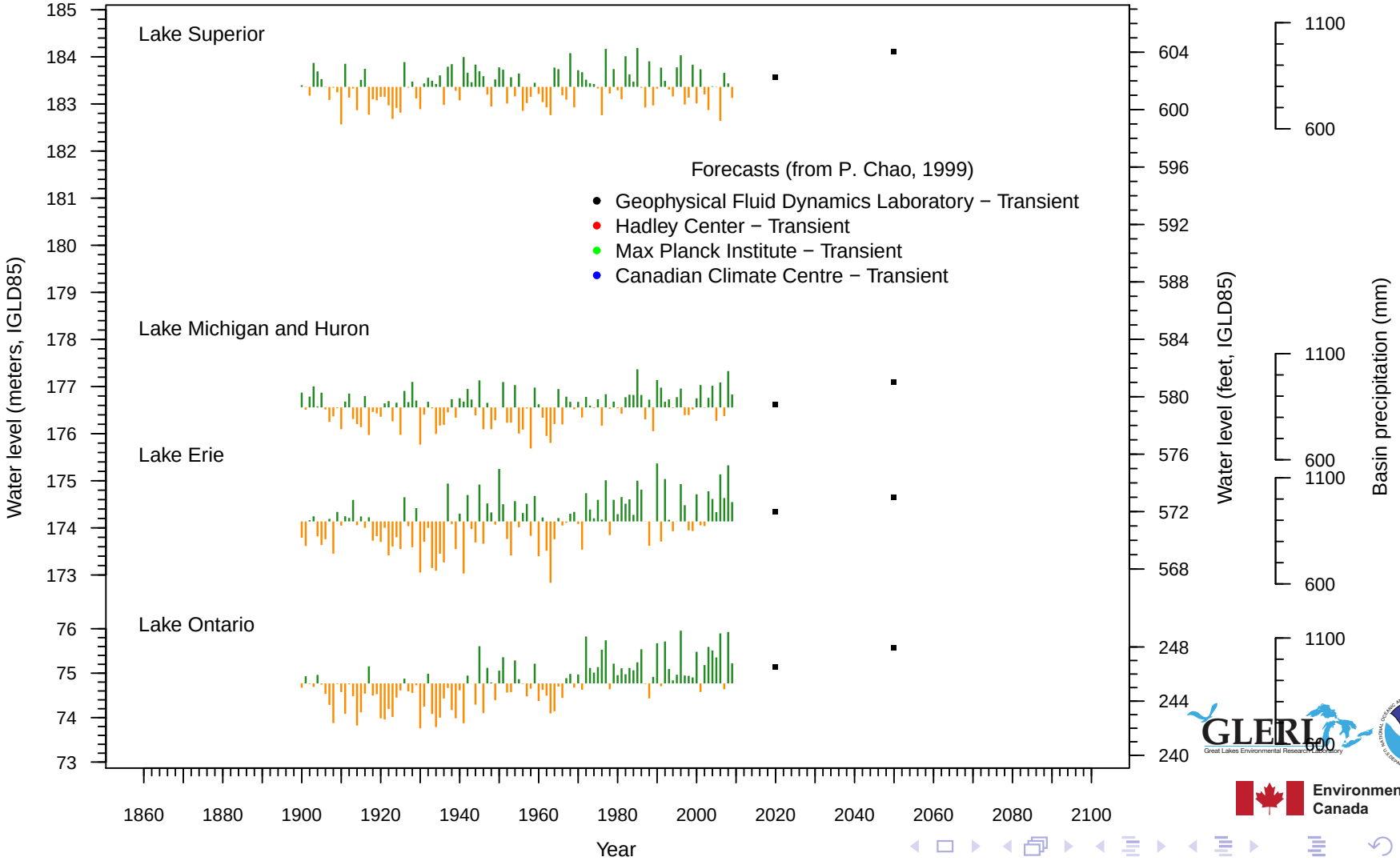

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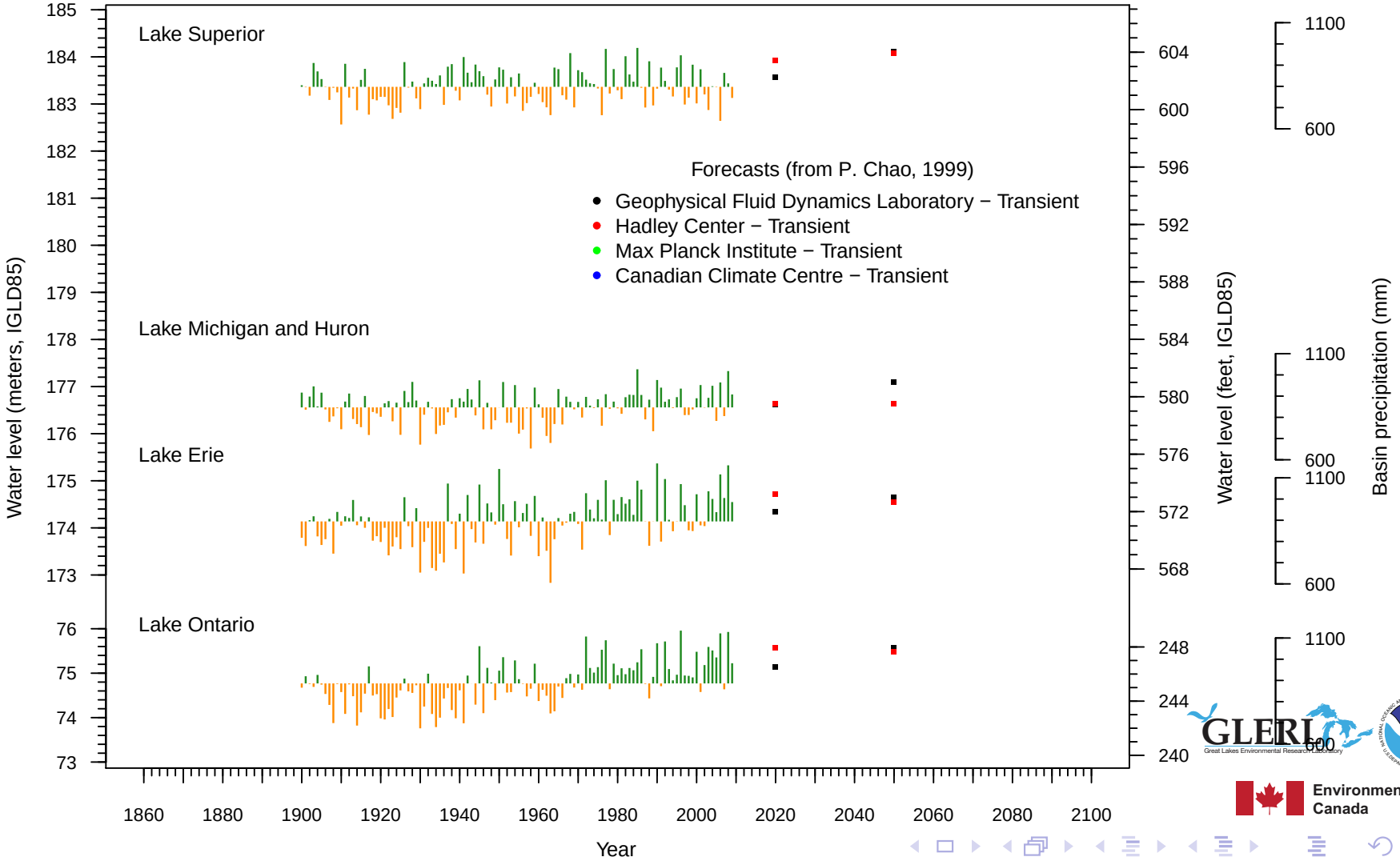

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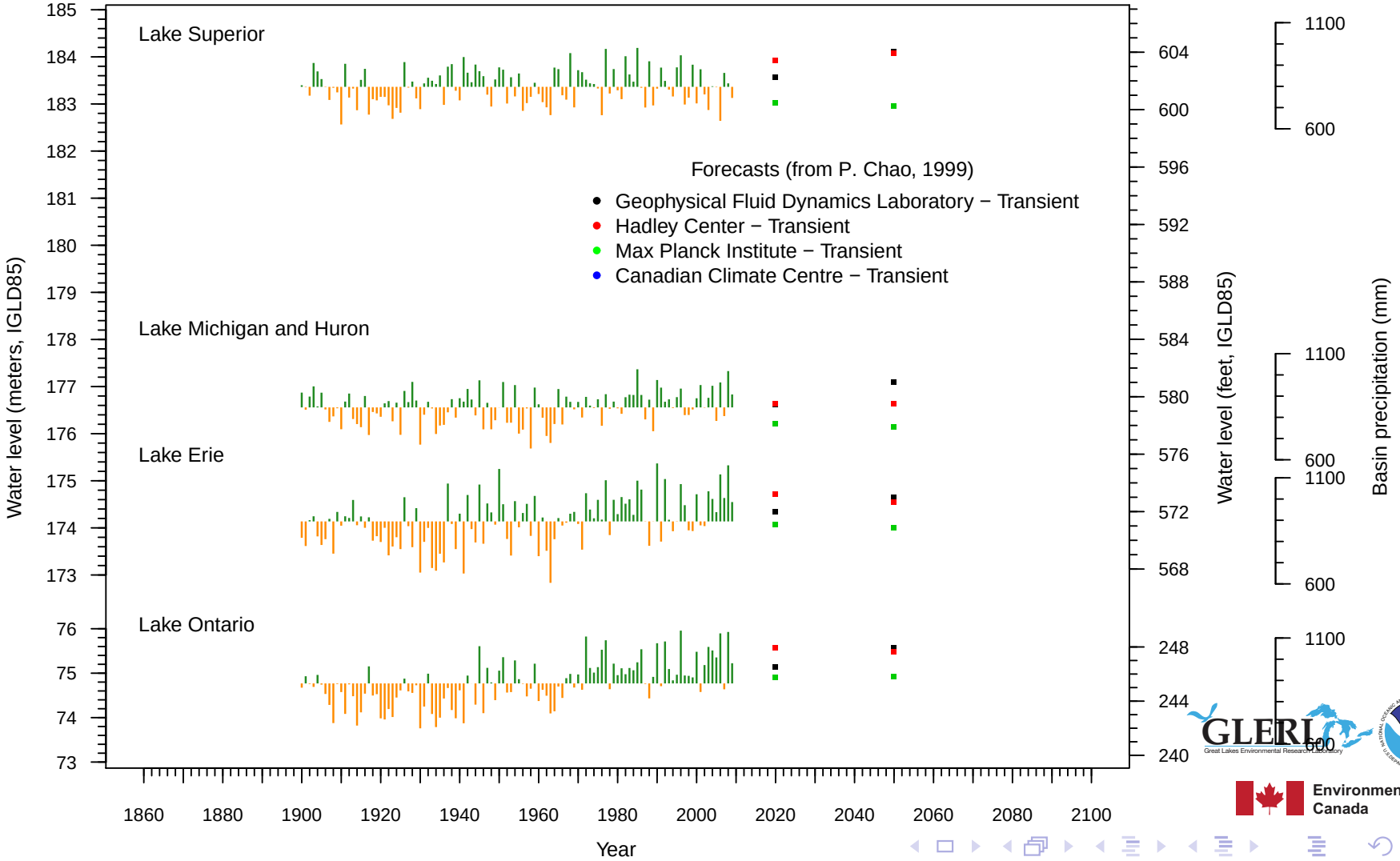

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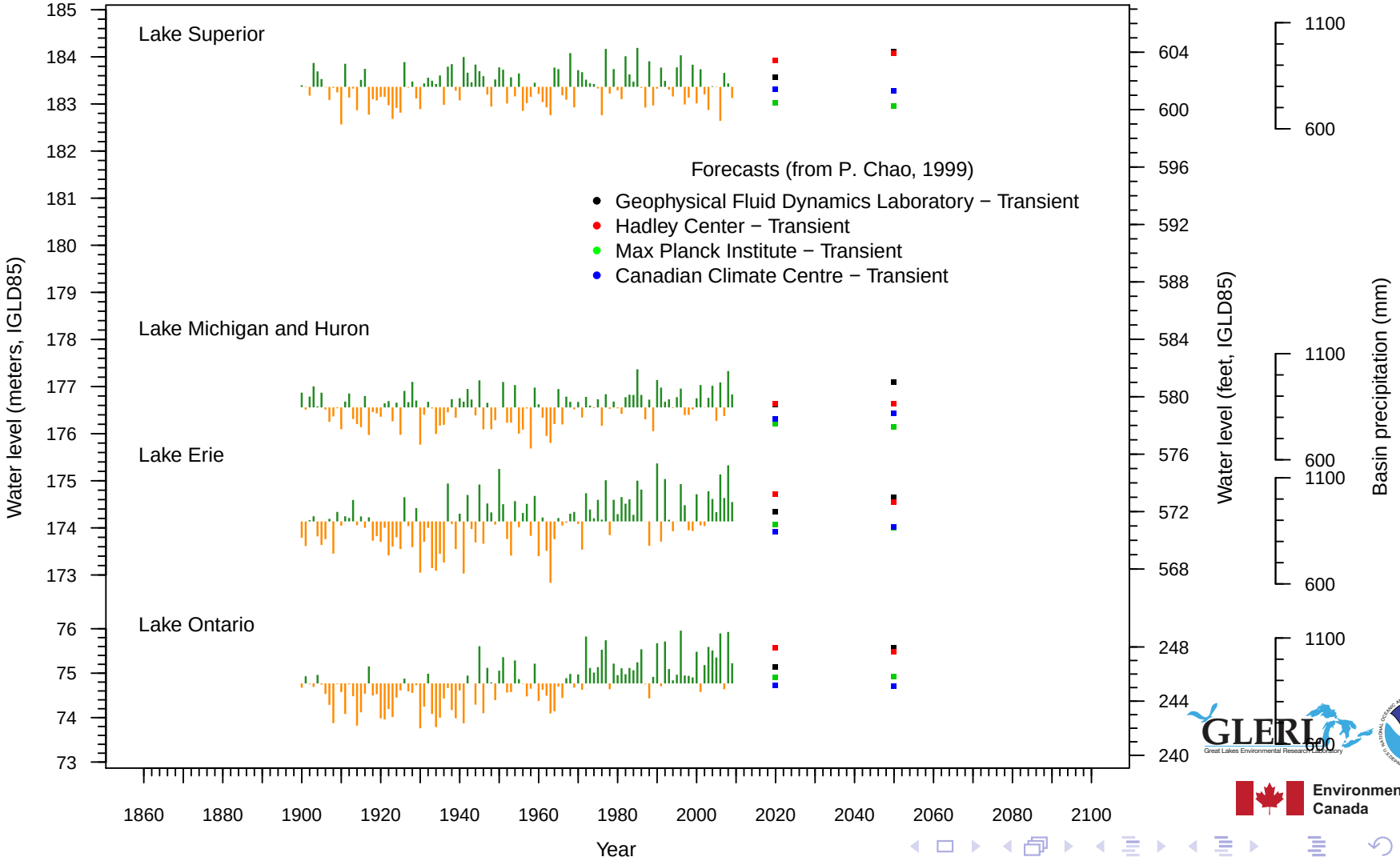

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Motivating regulatory frameworks

- 1909 Boundary Waters Treaty

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Existing Great Lakes collaborative efforts

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Context: take home message

- Recognize and utilize these ongoing efforts

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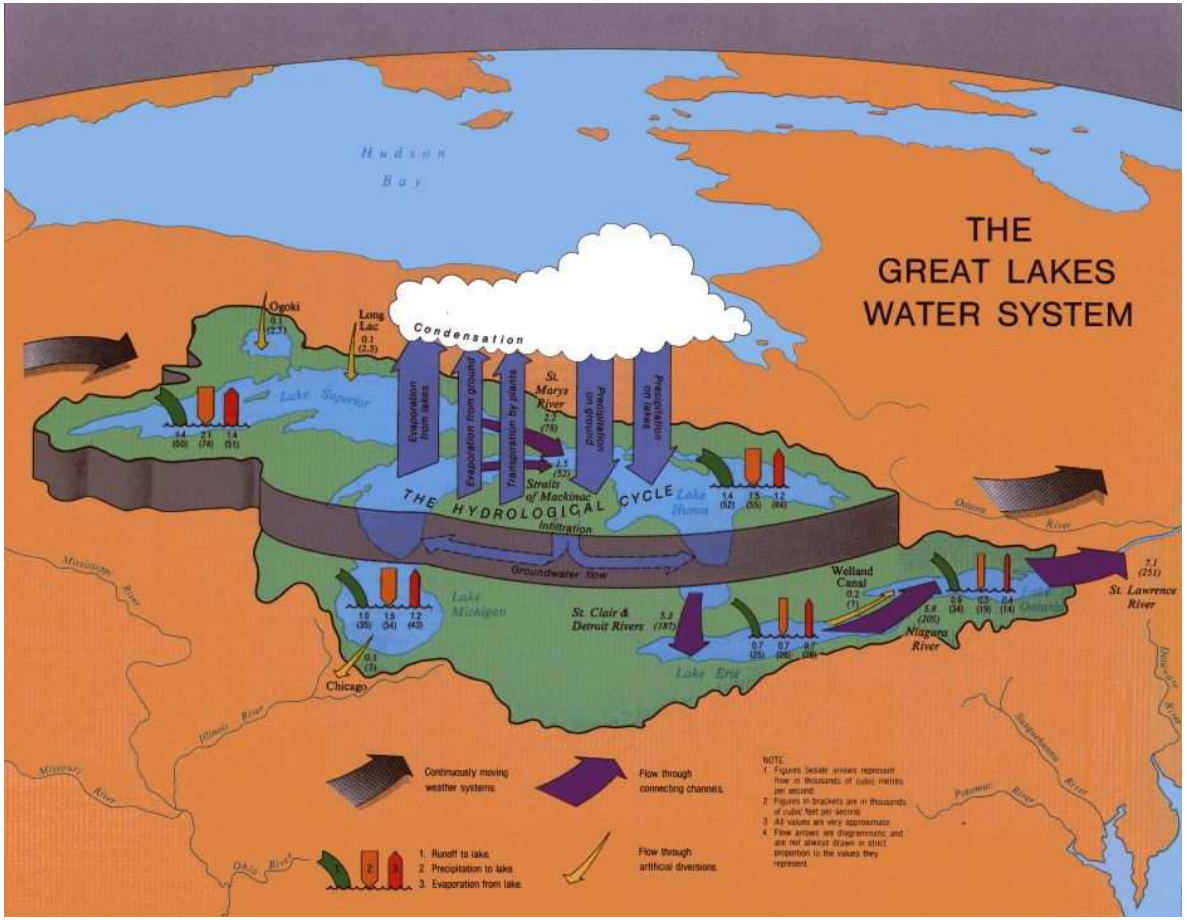
- Notice when they're lead by groups outside of Basin



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Name	Country	Surface area		Volume	
		(km^2)	(mi^2)	(km^3)	(mi^3)
Caspian Sea	Multiple	371,000	143,000	78,200	18,800
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 areas of the earth's twelve highest surface area continental water bodies.

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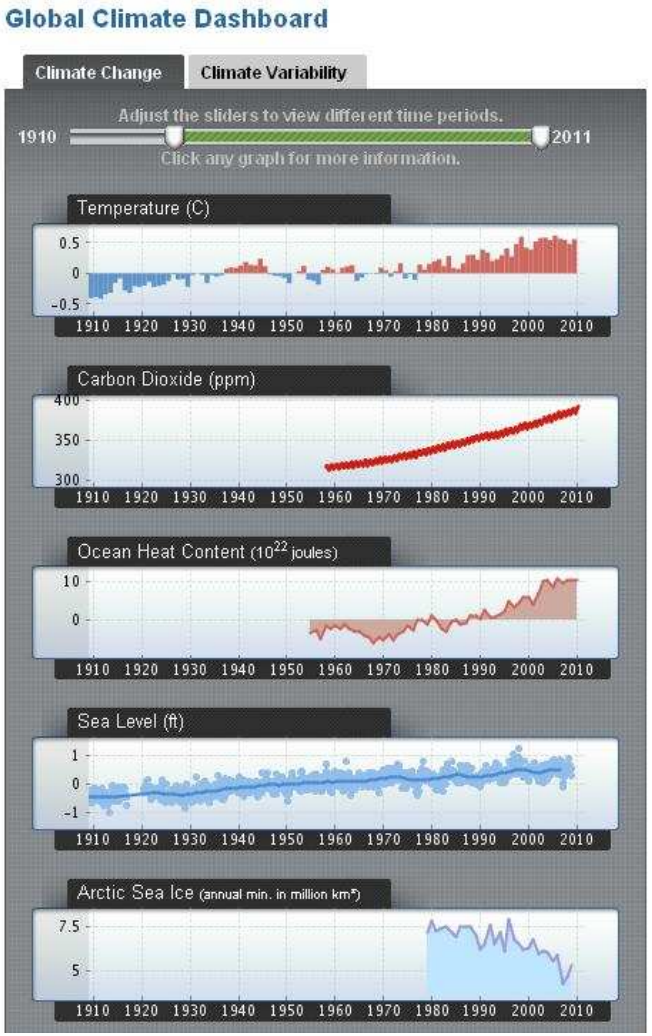

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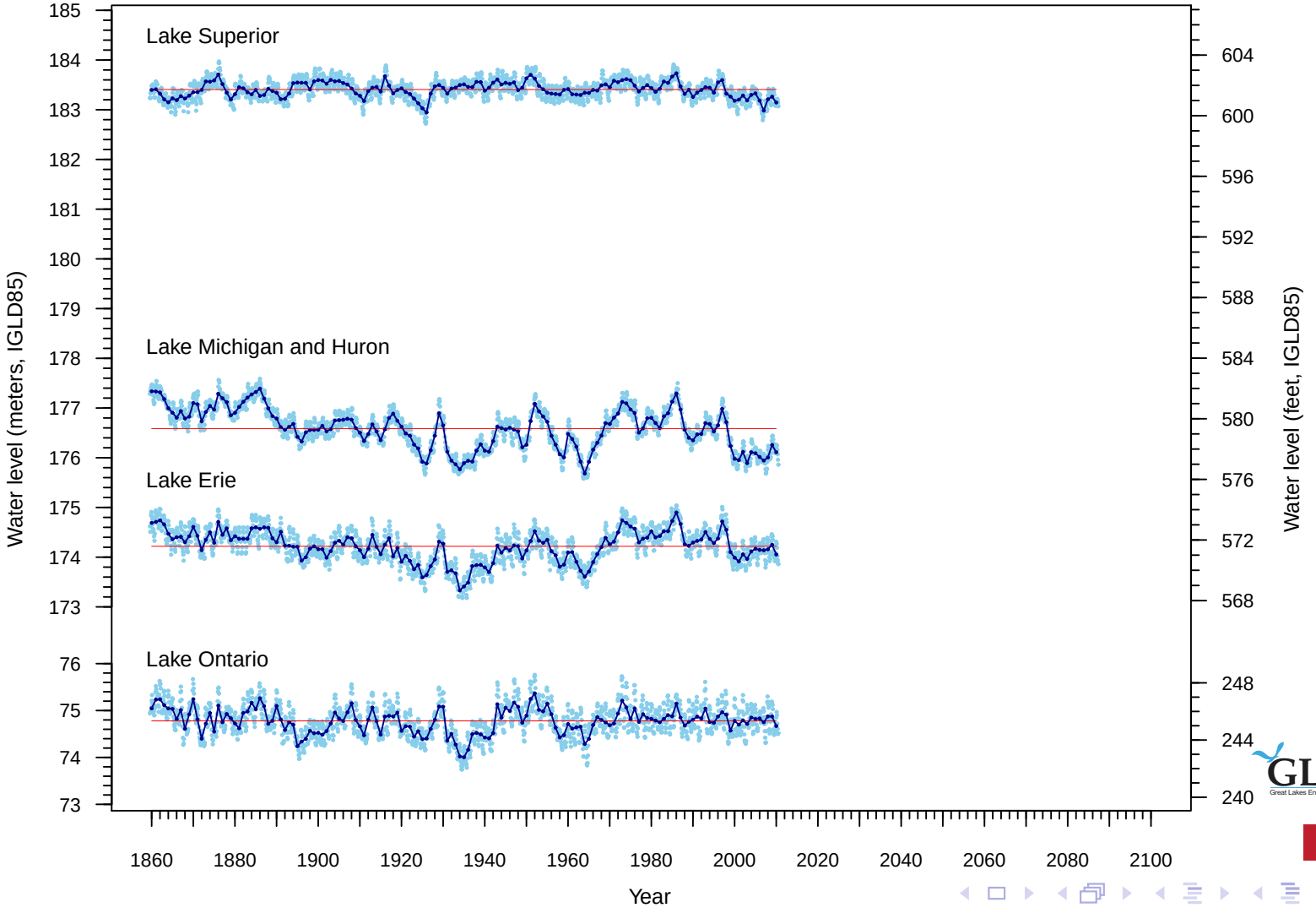

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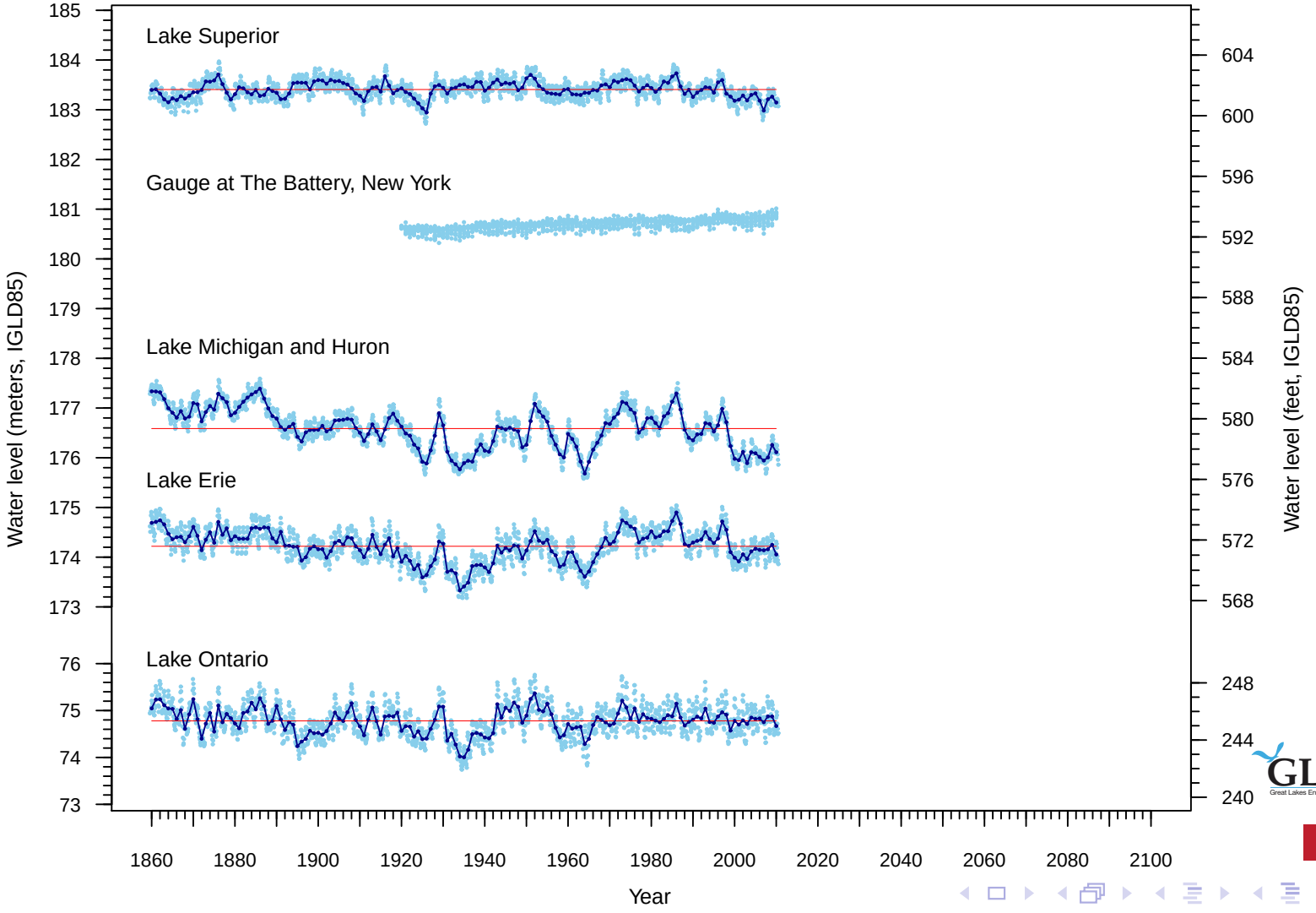

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