



Supplement of

Development and performance of a high-resolution surface wave and storm surge forecast model: application to a large lake

Laura L. Swatridge et al.

Correspondence to: Laura L. Swatridge (l.swatridge@queensu.ca)

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Supplementary Information

Table S1: Descriptions of available near-real time data that is automatically downloaded as part of the Coastlines-LO workflow, including the data type, web locations, and the method of data delivery for each location.

Data Type	Delivery Method	Data Location	Point Name
Water Levels (US)	NOAA CO-OPS data API	https://tidesandcurrents.noaa.gov/stations.html?type=Water+Levels#Great%20Lakes%20-%20Lake%20Ontario	Cape Vincent, Oswego, Rochester, Olcott Harbour
Water Levels (CAN)	Canadian Hydrographic Service Web service API	https://tides.gc.ca/en/stations	Burlington, Toronto, Cobourg, Kingston, Port Wellar
Wave/Wind	Python Web Scraping	https://www.ndbc.noaa.gov/data/realtime2	NW Lake Ontario, East Lake Ontario, Prince Edward Point, West Lake Ontario

Table S2: Approximate runtimes for model resolution configurations using a 16-cores of a XEON 2.50 GHz processor workstation with 64 GB RAM, to simulate 48 hrs of model time. Note that the simulation run times are approximation, as this value changes depending on the conditions being simulated, which impacts how long it takes for the wave model to converge on a solution to the required confidence criteria..

Configuration	Flow Resolution	Flow grid cells	Wave Resolution	Wave grid cells	Runtime
1	250m – 450m	333216	350m - 600m	169400	~4 hrs
2	250m – 450m	333216	250m – 450m	333216	~7 hrs
3	250m-450m	333216	No Waves	N/A	~0.5 hrs

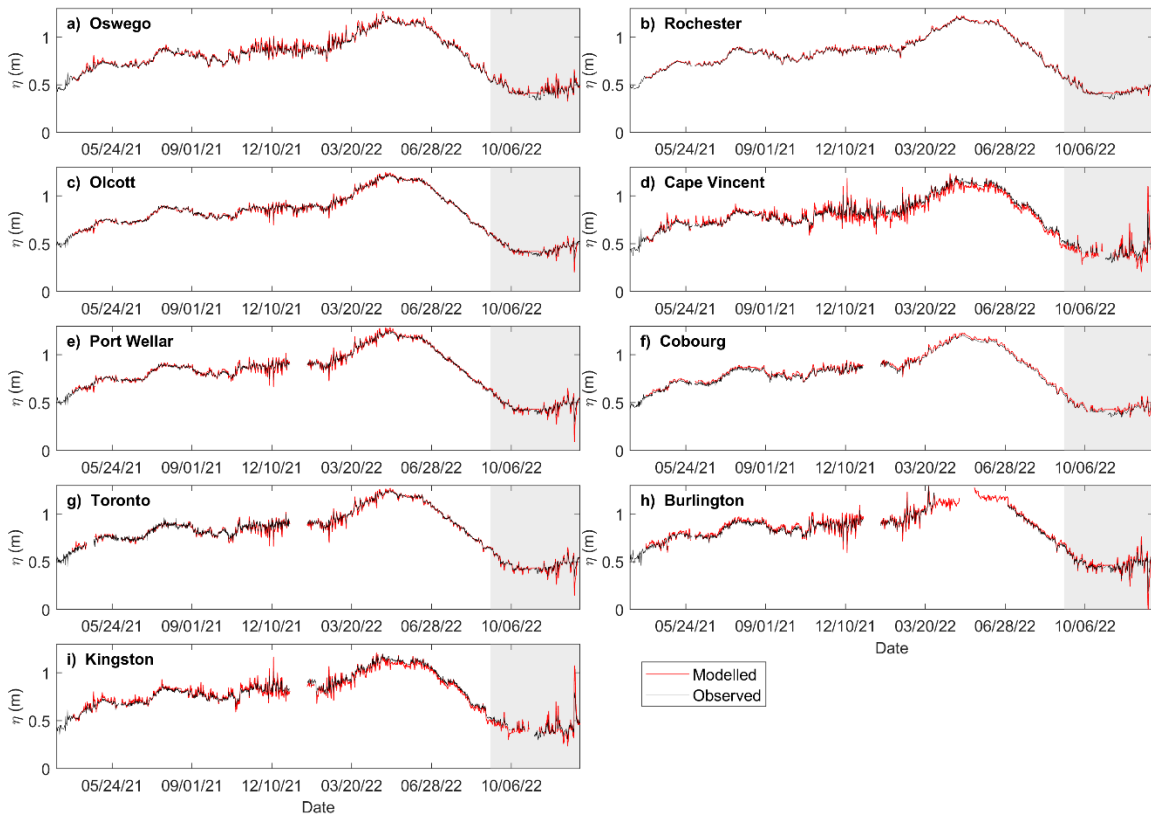


Figure S1: Time series of compiled model results (adjusted after each forecast to the correct datum) and observed total water levels at all water level observation points between May 2021 – December 2022. The highlighted area indicates the time-period examined in greater detail in Figure 3.

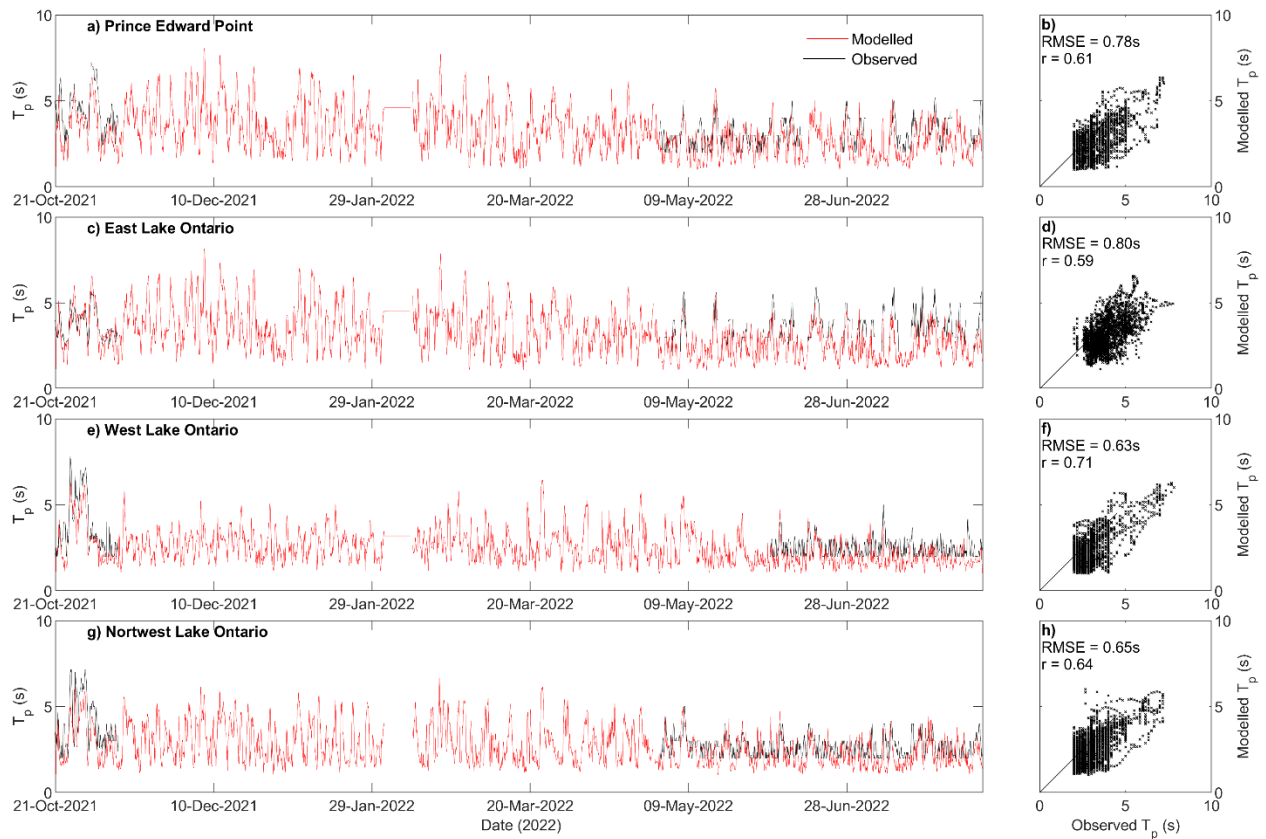


Figure S2: Time series of observed (black) and modelled (red) peak wave period over the duration that the buoys were in the lake (September -December 2022) with corresponding error scatter plots at the location of the 4 buoys. Note that the model was offline and are unavailable between February 9 – 27, 2022 due to a change of service for the meteorological inputs.

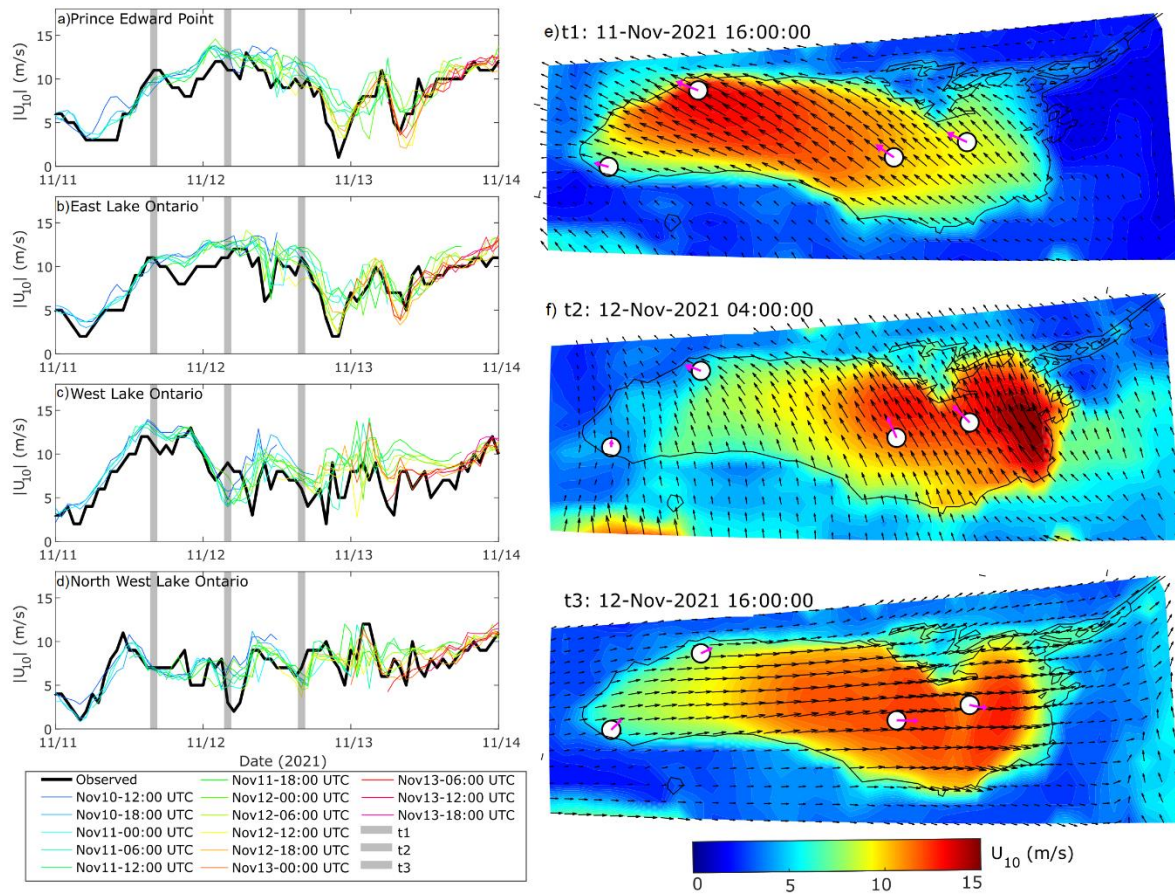


Figure S3: Time series of observed wind speeds compared to HRDPS forecasts at wave buoy locations between November 11-14, 2021 (left) and maps of HRDPS wind forecasts shown at select times with every 5th vector plotted for clarity (right). Vectors of observed data are plotted in magenta at the location of the buoys.

	Coastlines - LO	GLCFS
Model	Delft3D-SWAN	FVCOM
Wind Input	HRDPS (2.5 km)	HRRR (2km)
Layers	1 (depth averaged)	30 layers
Grid Resolution	350-750 m	30 m – 2km
Wave Coupling	Yes	Not yet.
Inflows/ outflows	No	Yes
Forecast Length	48 hrs	120 hrs
Time Step	120 seconds	10 seconds
Processes	Circulation, waves	Ice, temperature, circulation,
Cores	16	High performance computer

Table S3: Overview of modelling approach differences between Coastlines-LO and the GLCFS. Details for the setup of the GLCFS are sourced from the NOAA’s GLERL webpage (<https://www.glerl.noaa.gov/res/glcfs/>), and various model validation studies (Kelley et al., 2018; Peng et al., 2019).

Location	Coastlines-LO RMSE	GLCFS RMSE (m)	Coastlines-LO r	GLCFS r
Oswego	0.02	0.03	0.63	0.71
Cape Vincent	0.02	0.02	0.60	0.65
Cobourg	0.04	0.04	0.65	0.61
Burlington	0.02	0.02	0.84	0.83
Olcott	0.01	0.01	0.71	0.85
Port Wellar	0.03	0.02	0.72	0.73
Toronto	0.03	0.02	0.82	0.84
Kingston	0.02	0.03	0.83	0.80

Table S4: Error statistics comparing Coastlines-LO and GLCFS results between November 30 – December 5, 2022.

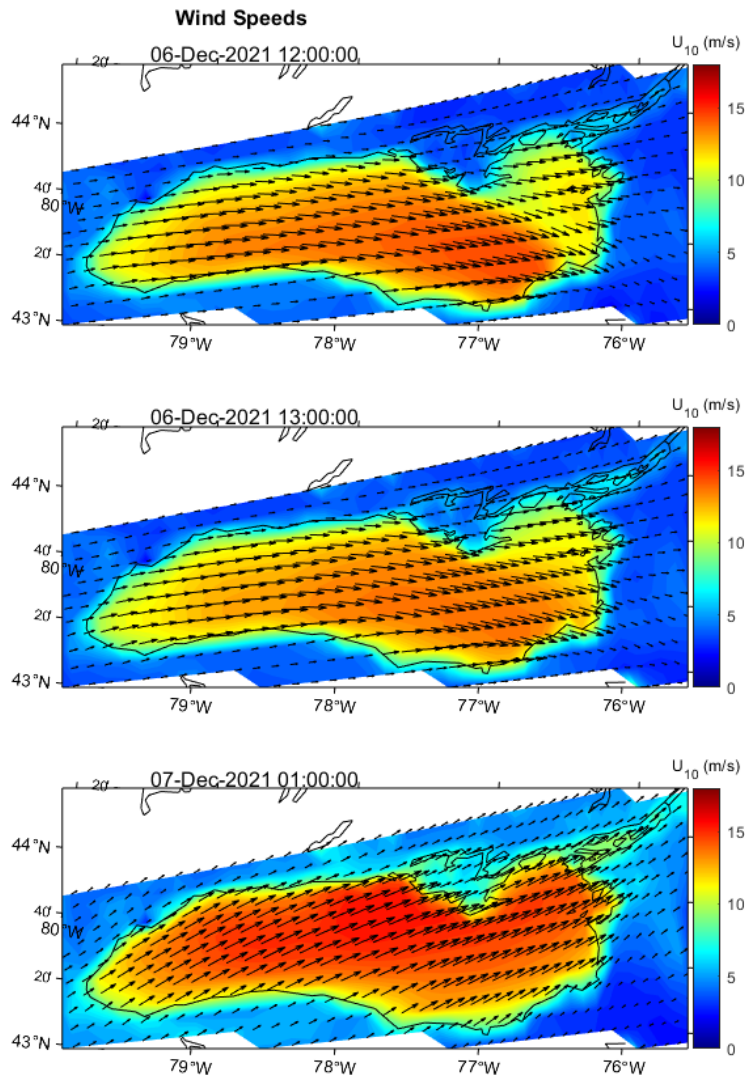


Figure S4: Maps of HRDPS wind forecasts shown at select times with every 5th vector plotted for clarity.