

# Operational Wave Modelling

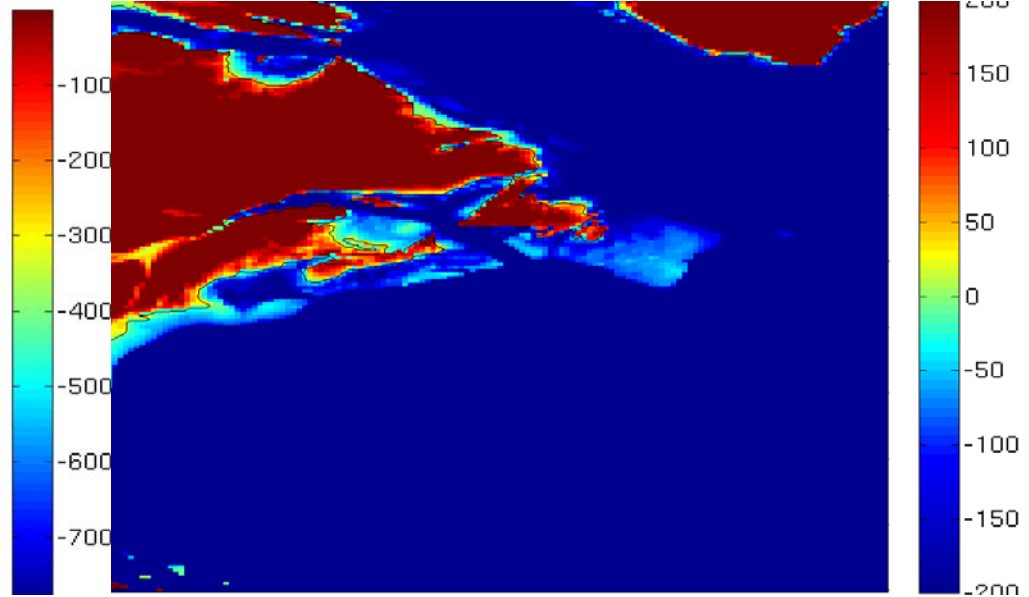
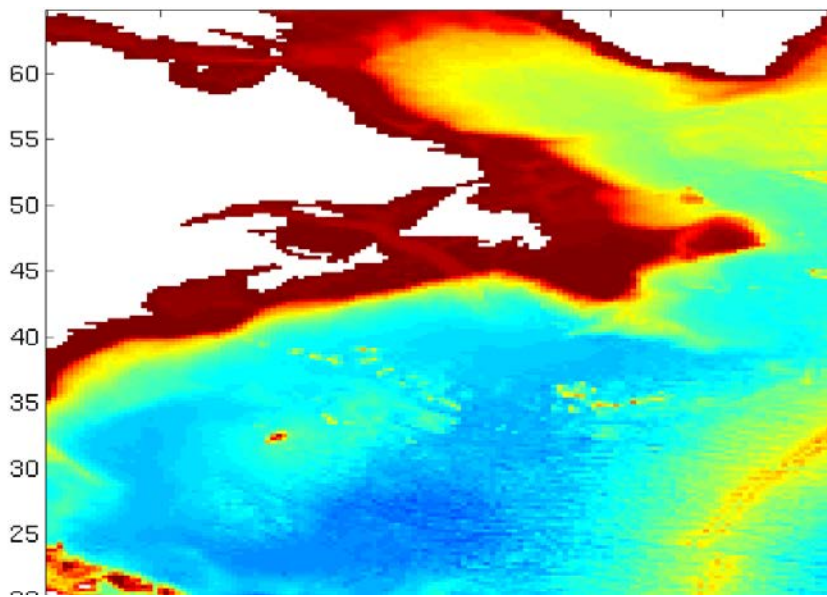
Bash Toulany, Will Perrie, Guoqiang Liu, Yajuan Sun  
(BIO/ Dalhousie)  
Jinyu Sheng (Dalhousie)

# Outline

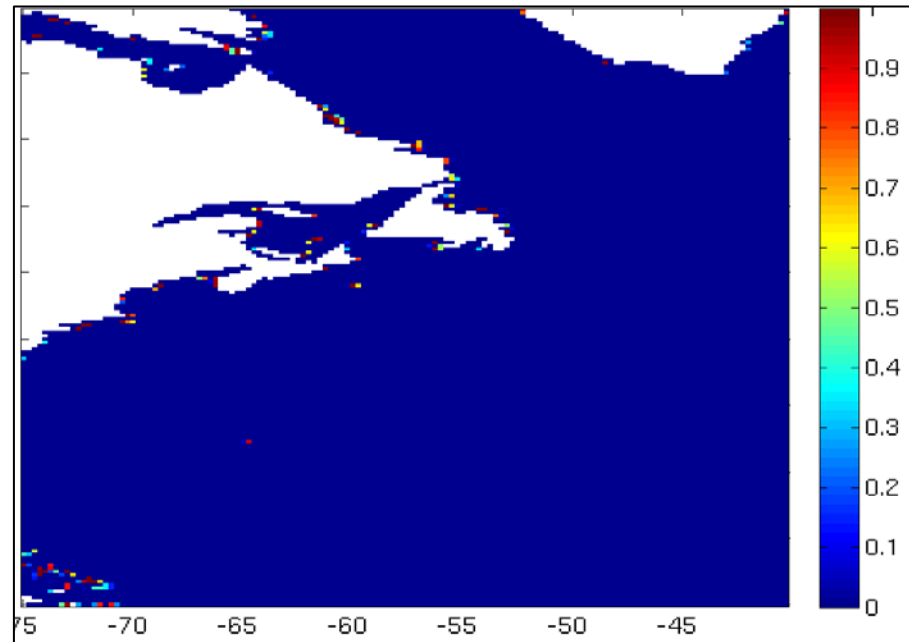
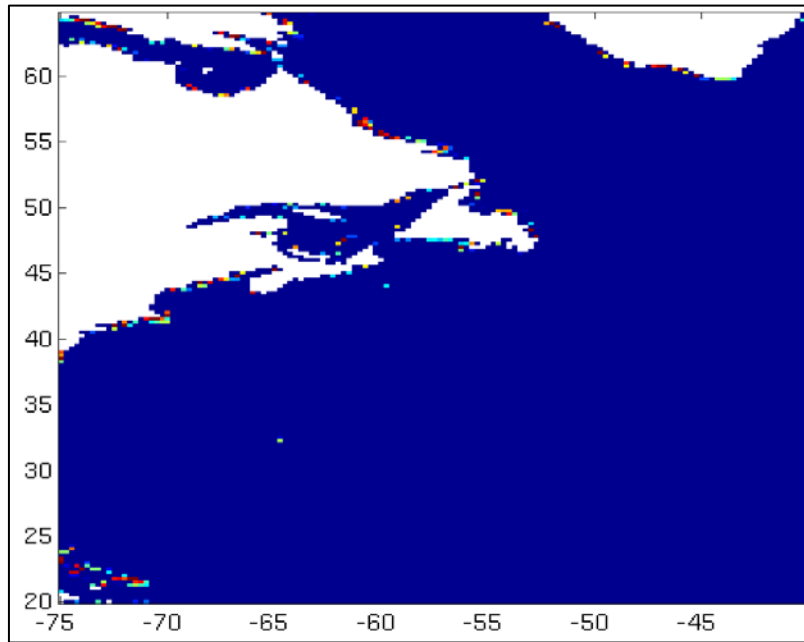
1. Grid set-up for operational forecasting
2. Running and validation in real-time
3. Tests with wave-ice interaction
4. High resolution winds
5. Tests with unstructured grid
6. Summary and future work

# Bathymetry and elevation

$\Delta x \sim 25km$



Obstructions in x and y (for sub-grid)

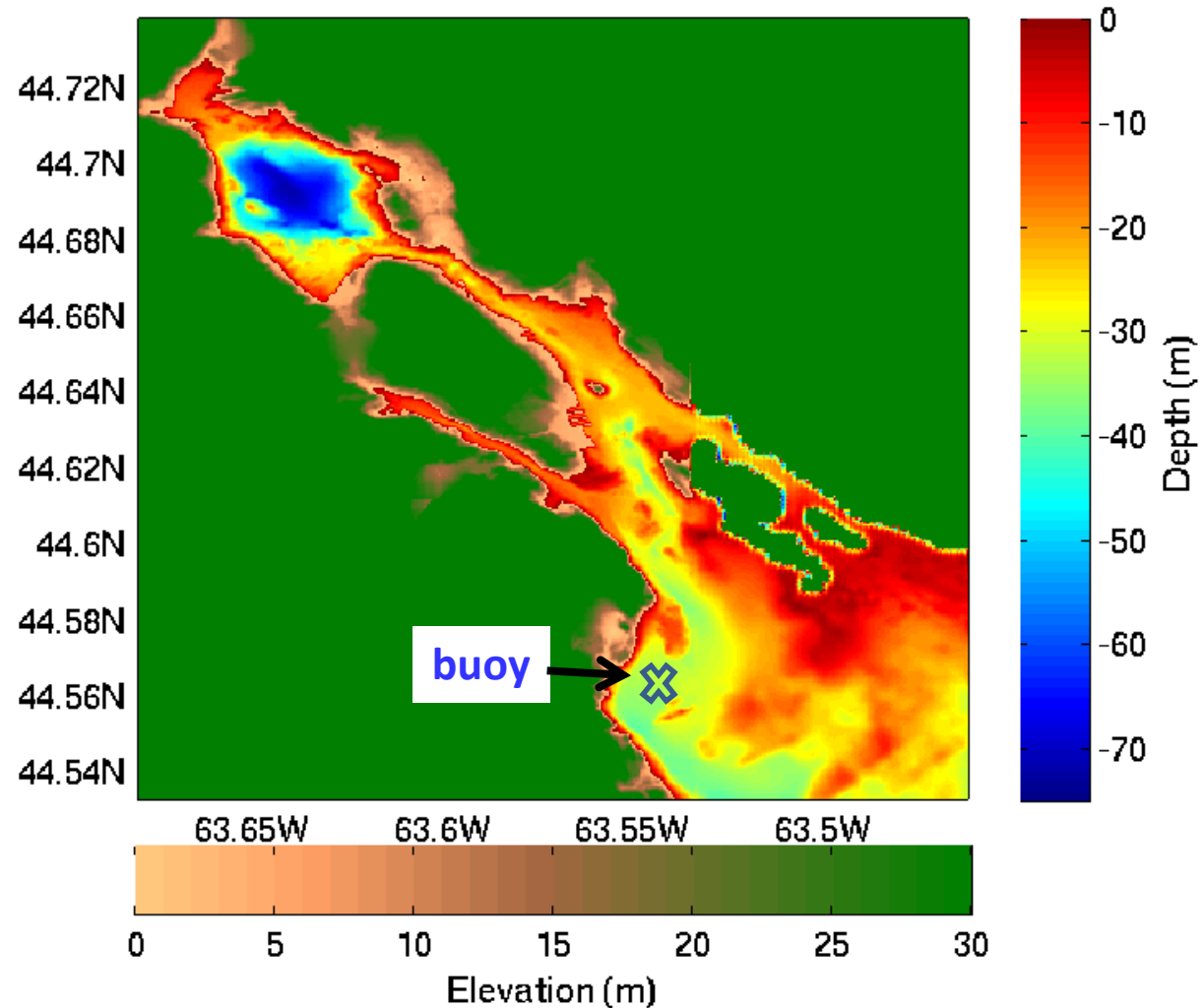


# Bathymetry and elevation

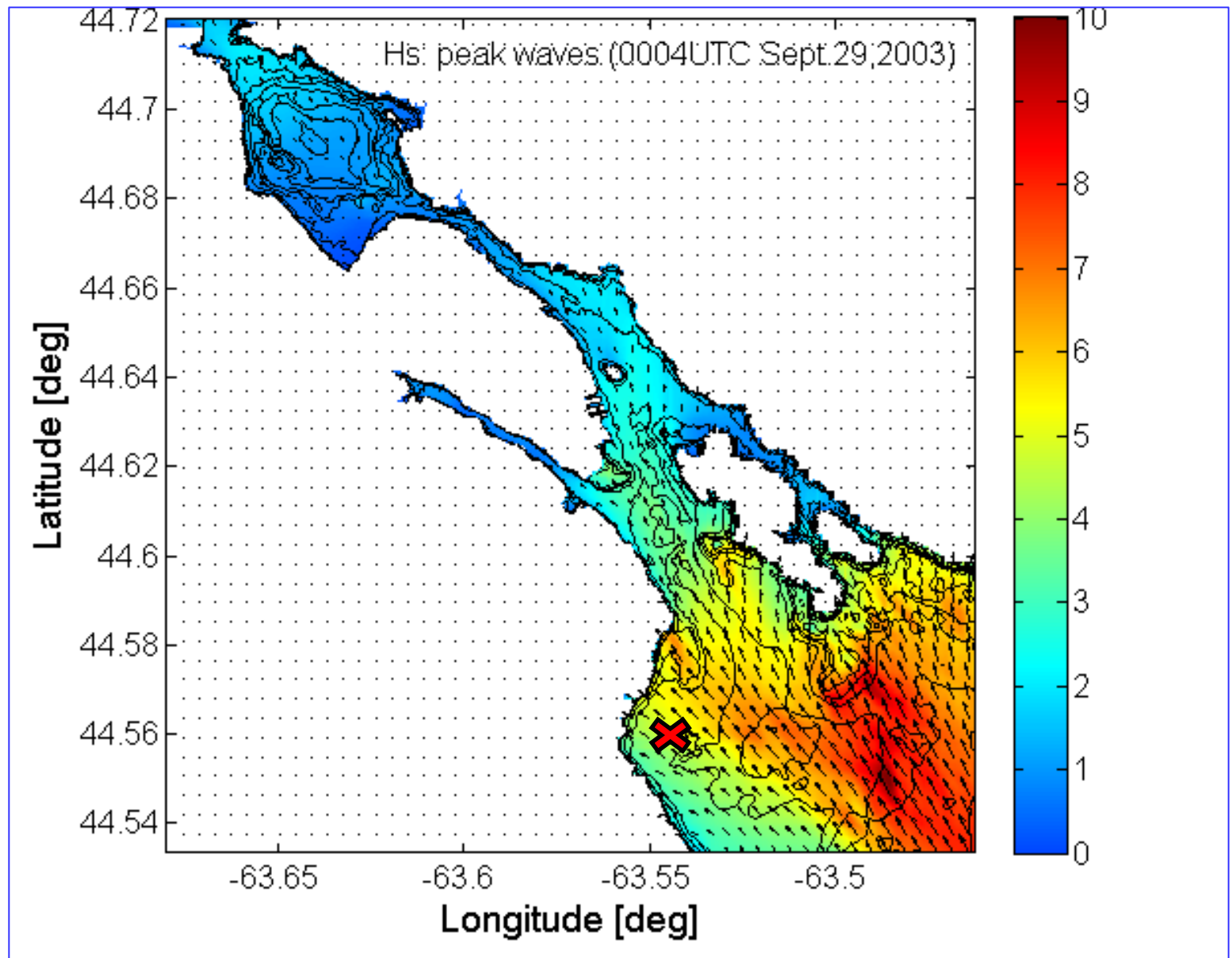
grid4 now running in ww3  
Later – to do... run in SWAN

$$\Delta x \sim 80m$$

Topography for MEOPAR grid 4 - original  
Swan



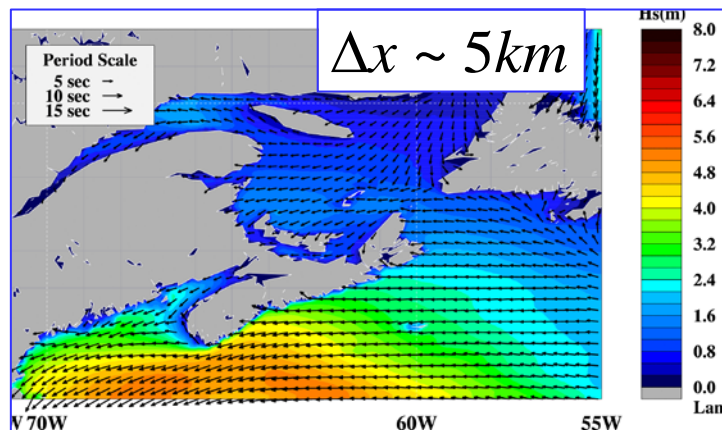
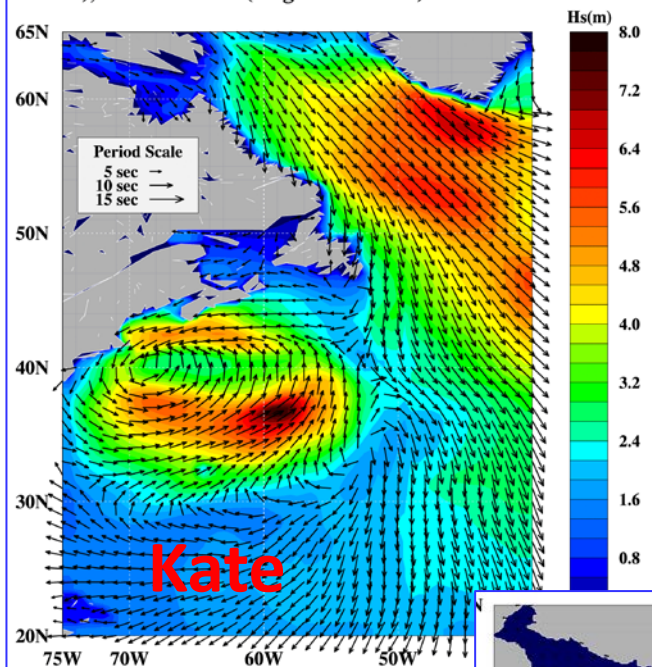
# Simulated Juan's peak intensity: Xu and Perrie 2013



# Halifax Operational Wave Forecasts (48hr)

[http://extrememarine.ocean.dal.ca/dalcoast/wave\\_forecast/wave\\_L1.php](http://extrememarine.ocean.dal.ca/dalcoast/wave_forecast/wave_L1.php)

Sig. Wave Heights (contours), Wave Directions (dir. of vectors), Wave Periods (length of vectors) At 2015111120

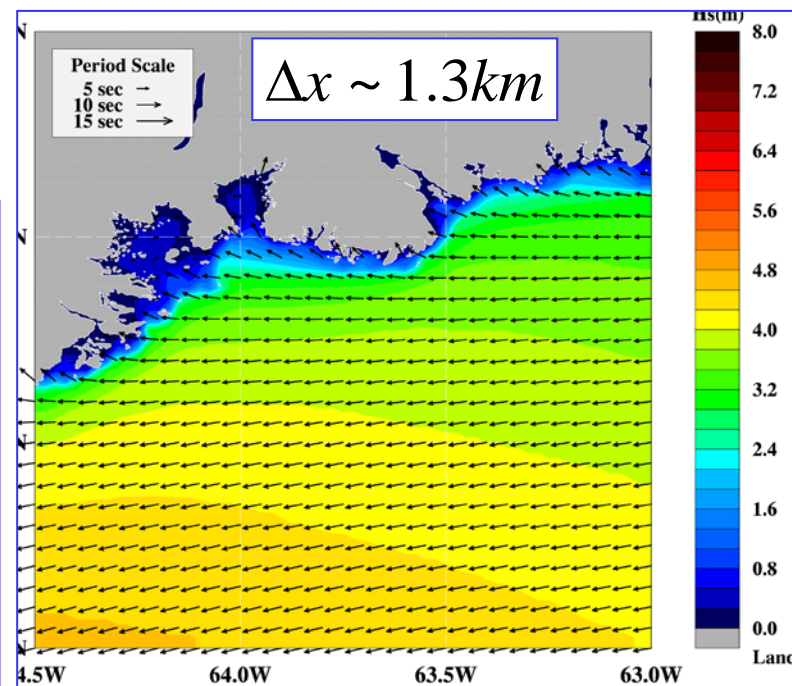
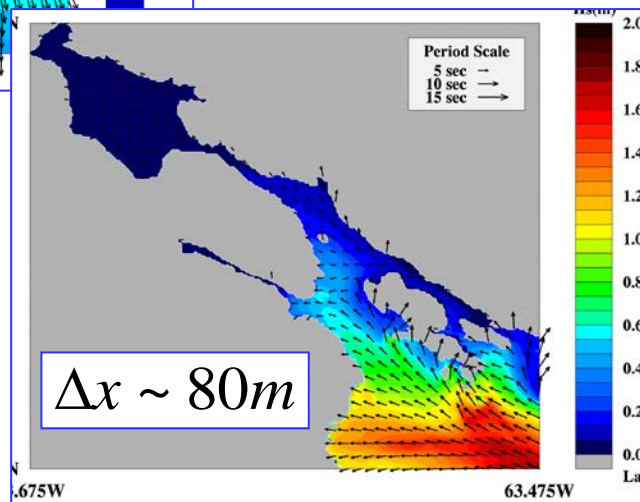


2-way nesting ...

Multi-grid runs

Run times:

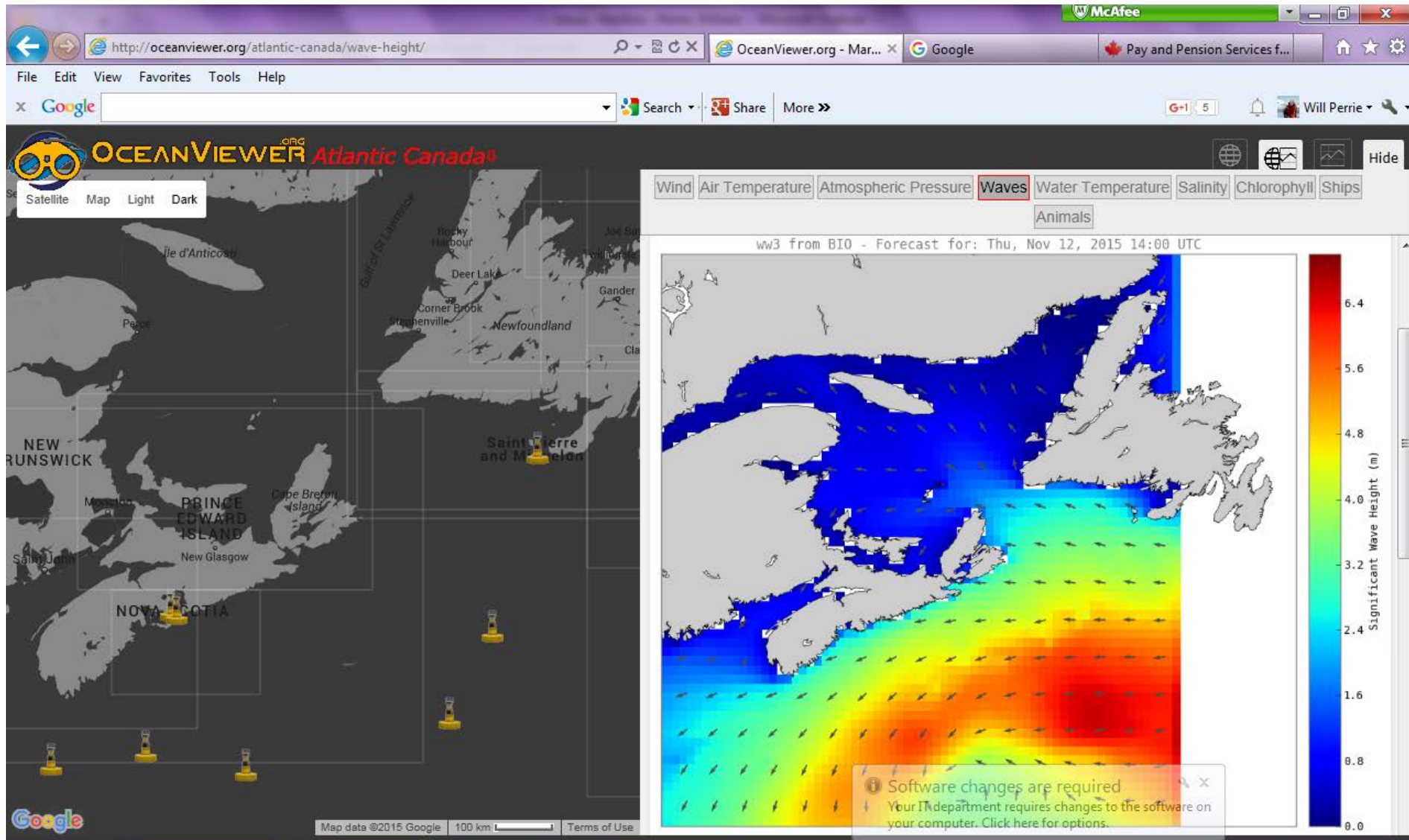
20 min with 16 CPU



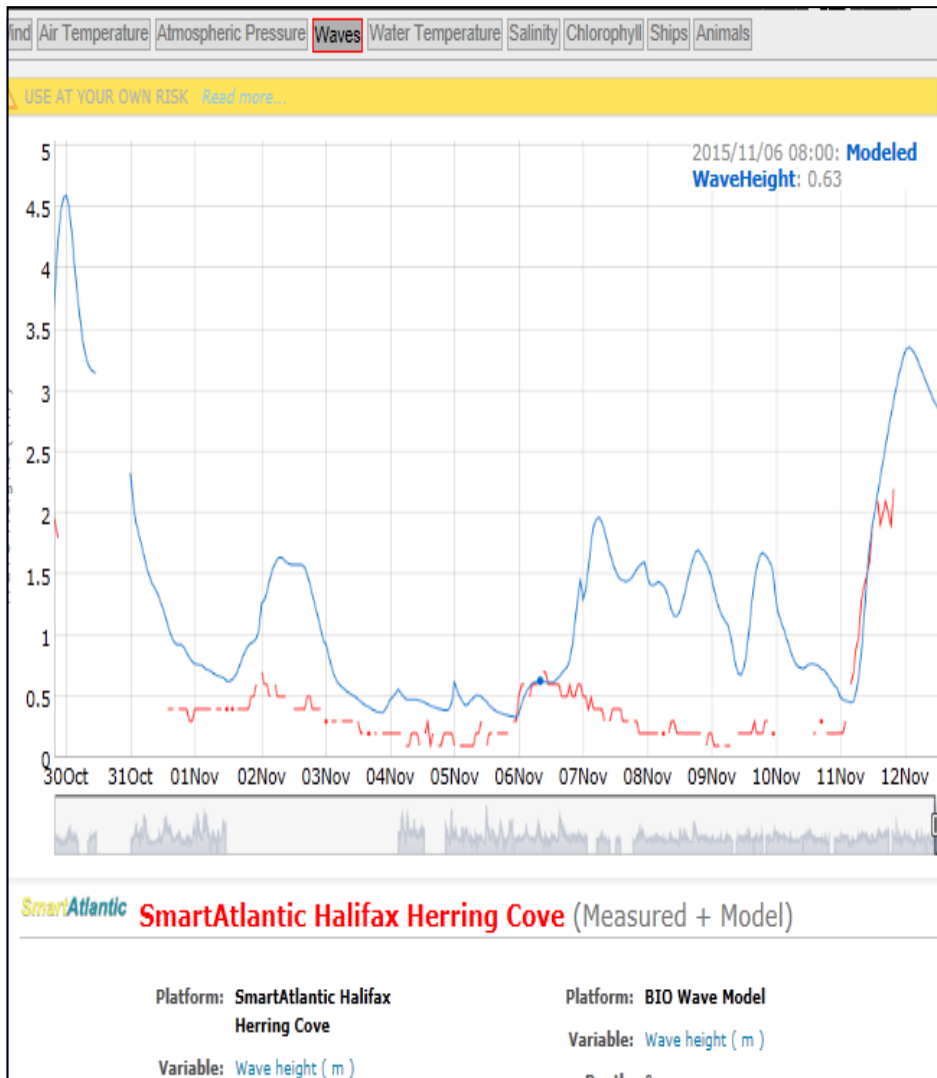


# Validation

<http://oceanviewer.org/atlantic-canada/wave-height/>

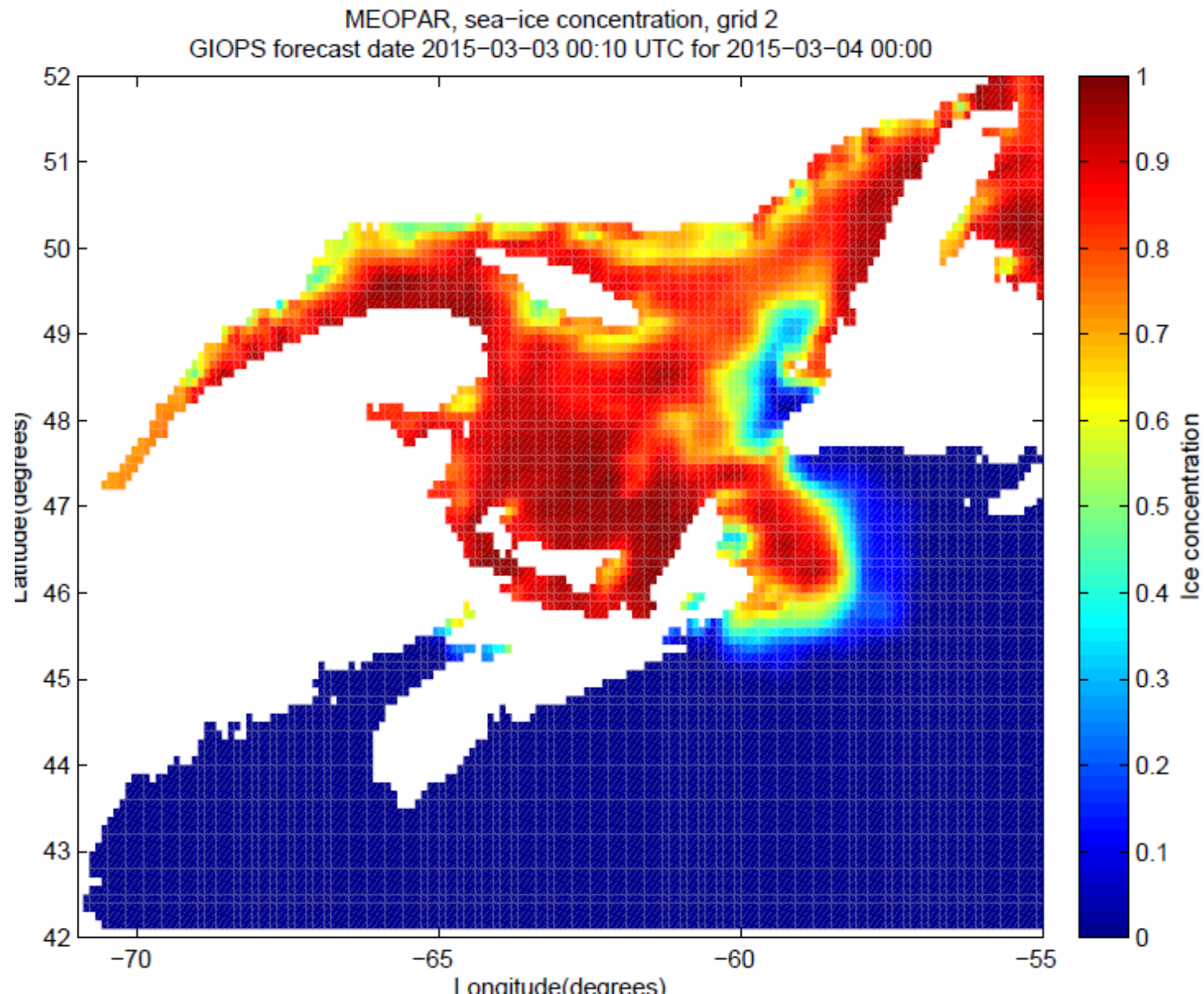


# Validation

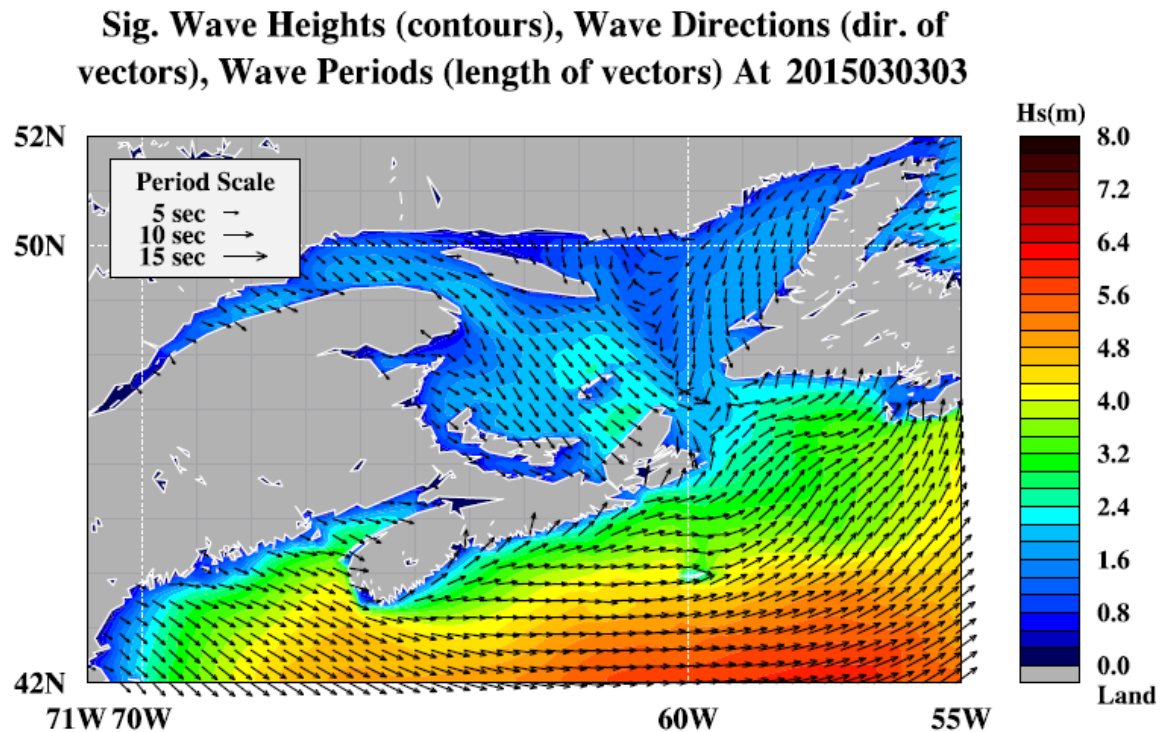




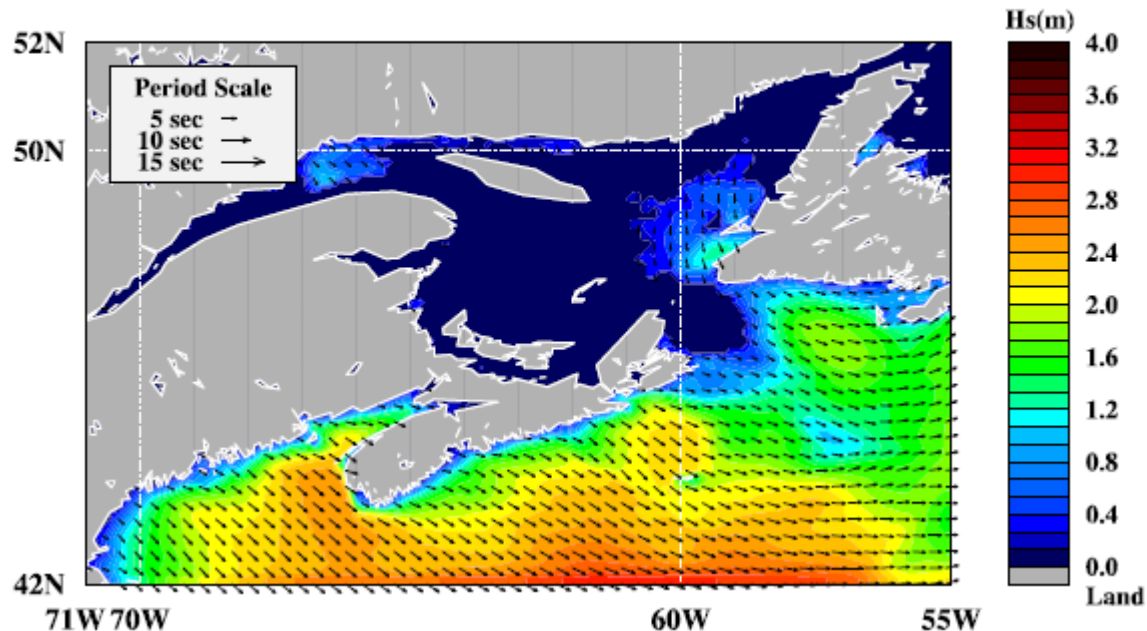
# Ice! And waves in the forecasts



Wave forecast  
no ice at 00 UTC  
on Mar 3 2015



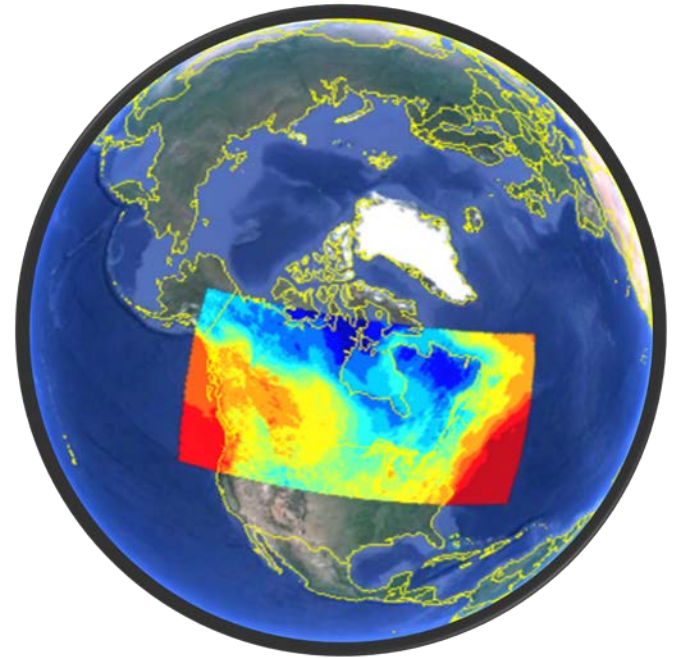
Wave forecast  
with ice at 00 UTC  
on Mar 3 2015



→ Note the change in scale!

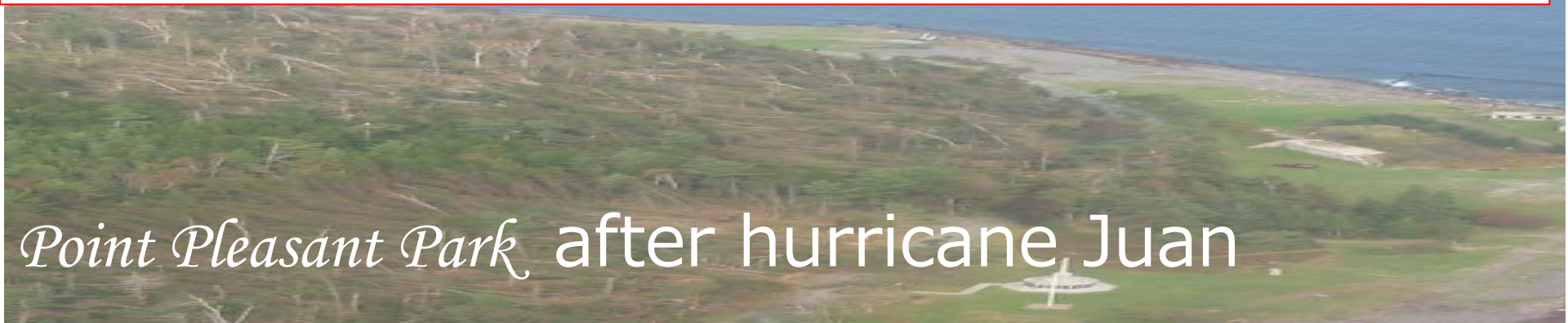
# Winds: Environment Canada High Resolution Deterministic Prediction System (HRDPS)

- Experimental Status ([coming](#))
- 2.5 km resolution
- 4 x 48-hour forecasts
- Initial surface conditions provided by CaLDAS 2.5
- Initial and boundary conditions provided by RDPS



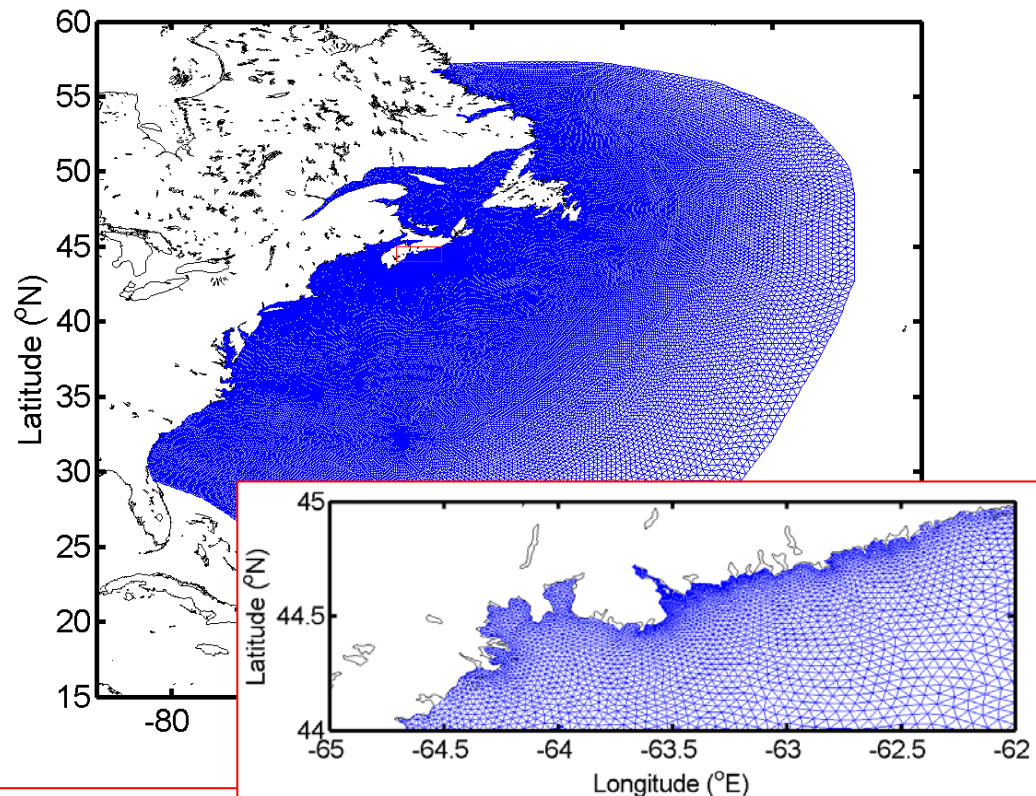


# Tests with unstructured SWAVE with FVCOM



## SWAVE model

**Grid resolution  
is 0.5km at  
coast to 80km  
in outer areas**



# Study case: Hurricane Juan (2003)

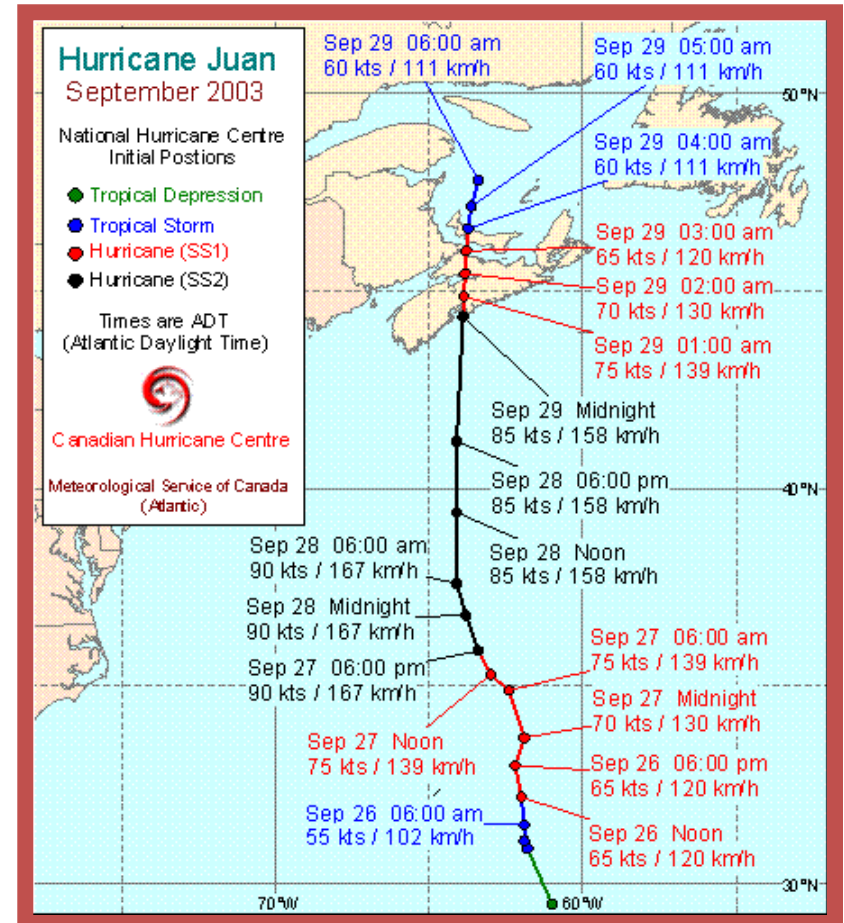
Formed: Sep 24, 2003

Dissipated: Sep 29, 2003

Maximum sustained wind speed: 105 mph  
(170km/h);

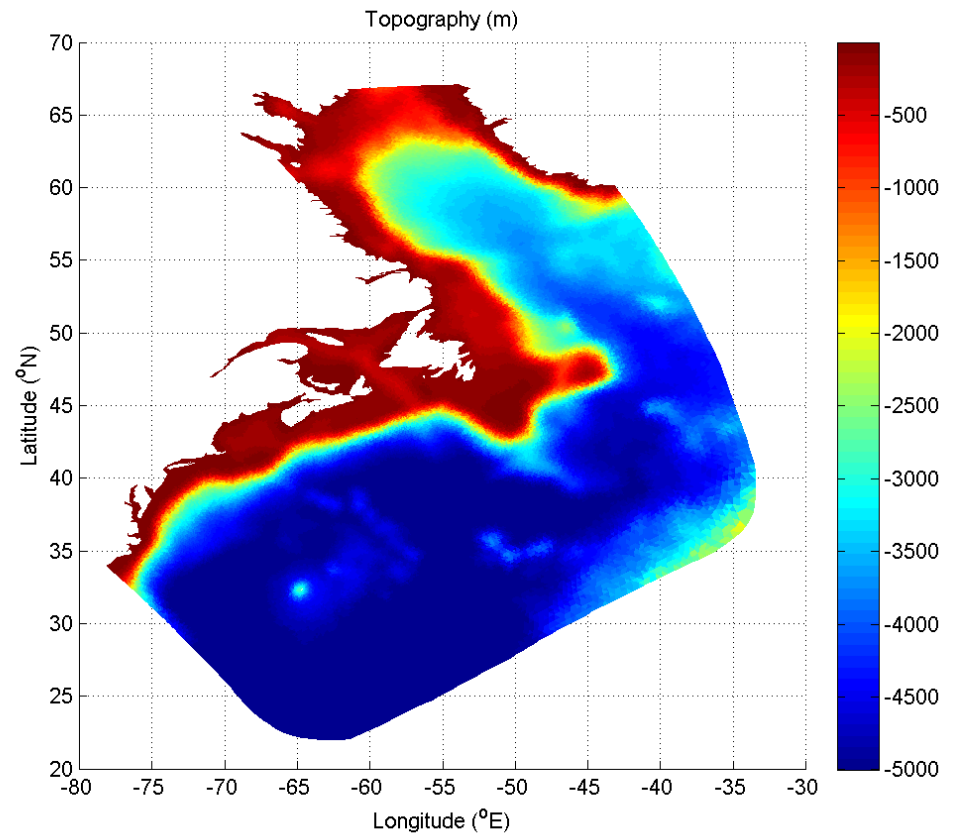
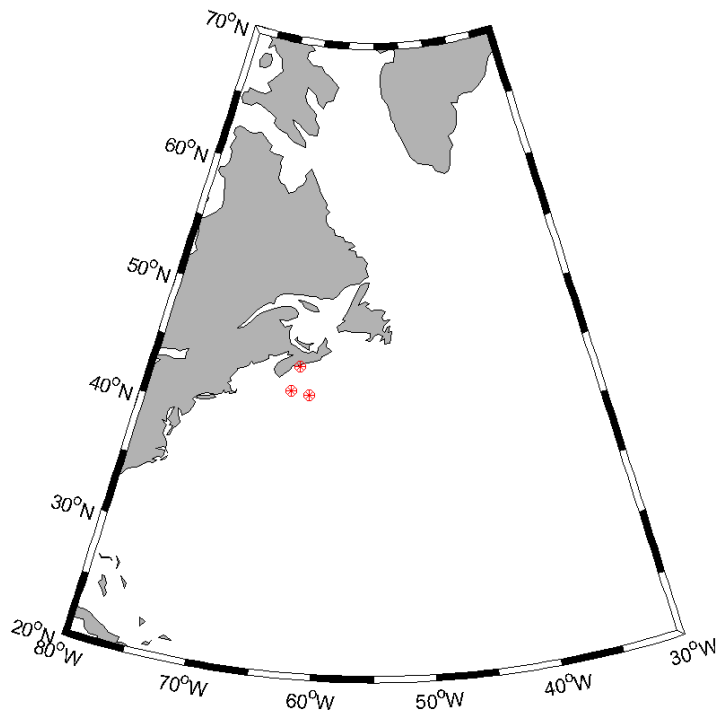
Maximum sustained wind speed at  
landfall: 100 mph (160km/h);

Saffir-Simpson Hurricane Scale: category 2.



## Set-up and data:

- ☐ ETOPO5;
- ☐ hourly CFSR wind forcing;
- ☐ HYCOM + NCODA Global 1/12° Reanalysis;
- ☐ Buoy stations 44137, 44258, 44142;
- ☐ Satellite altimeter Jason-1.

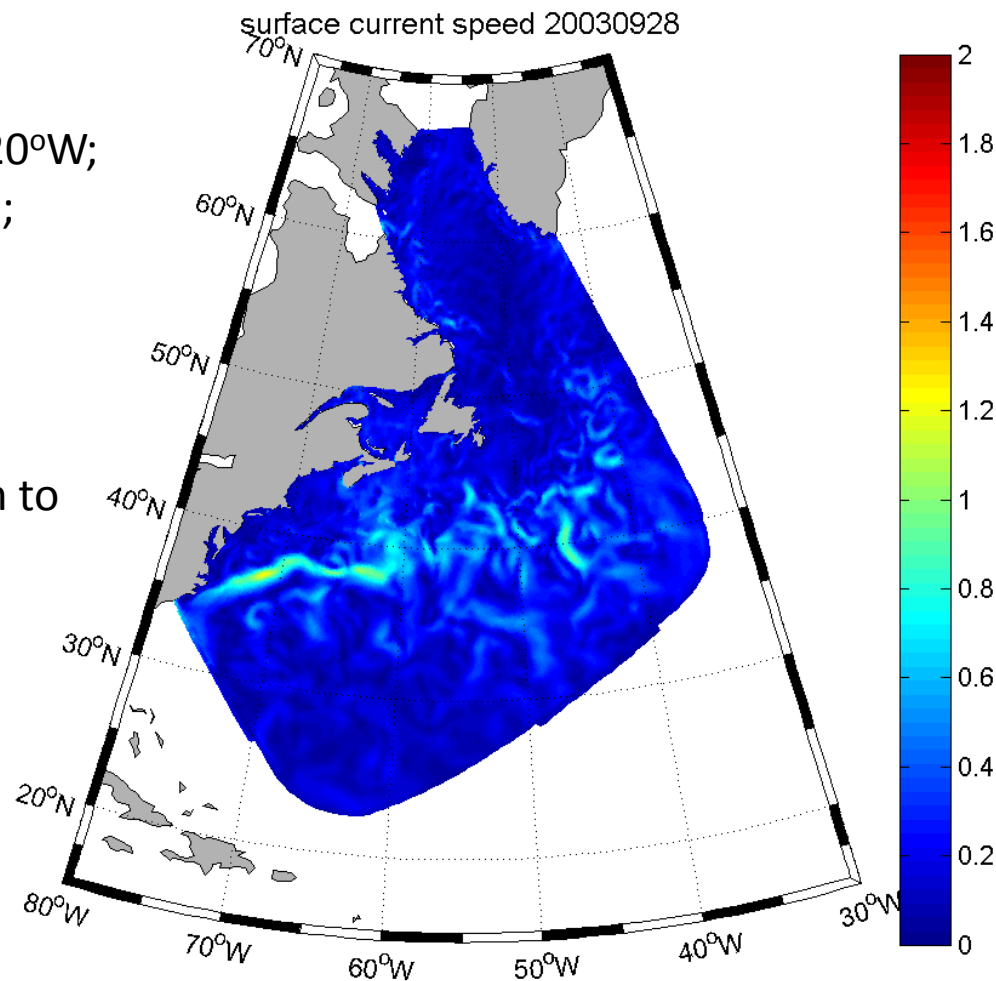




# Methods and Model Settings

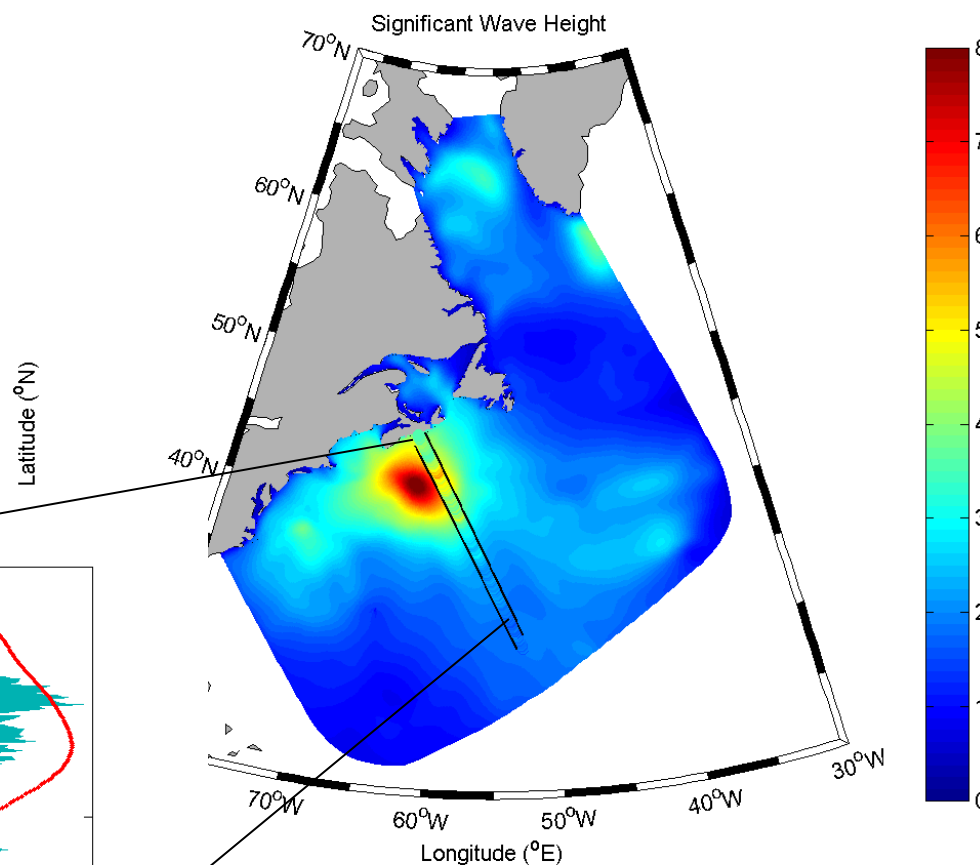
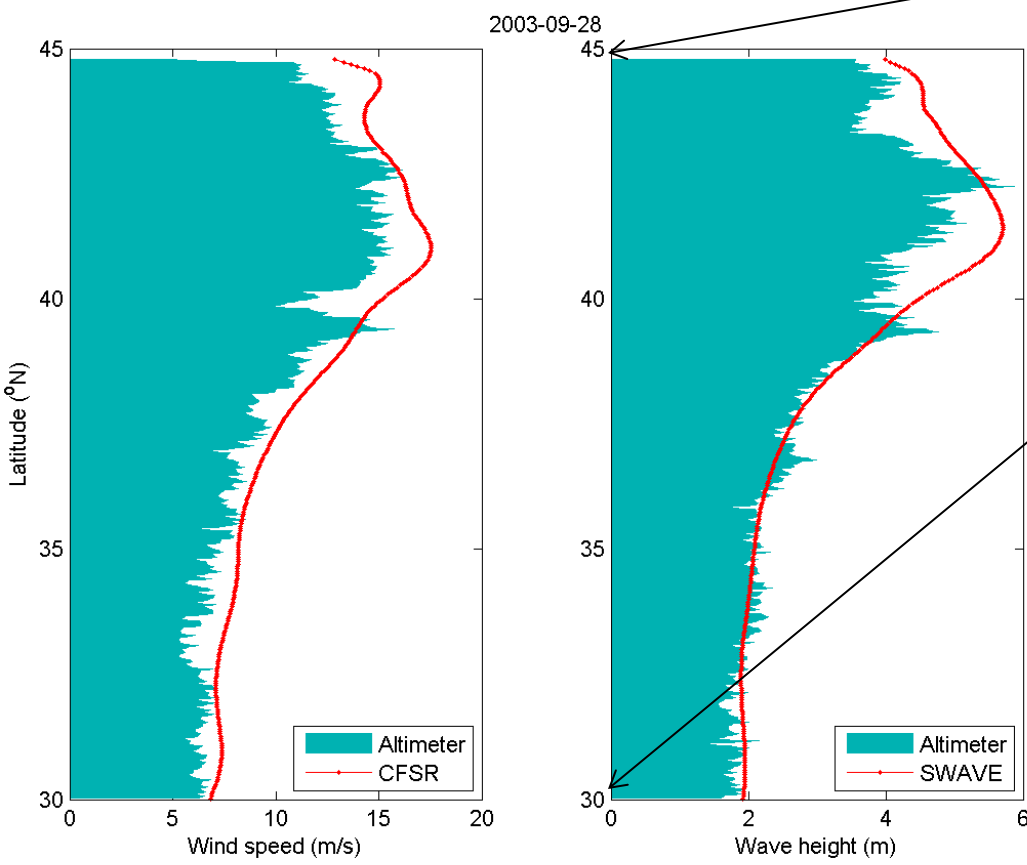
Coupled ocean- wave model:  
FVCOM 3.2 and SWAVE

- ❖ Simulation domain: 20°N-70°N, 80°W-20°W;
- ❖ Simulation period: Sep25 to Oct1, 2003;
- ❖ Total nodes: 35,788;
- ❖ Total cells: 69,764;
- ❖ Topography: 10 - 5000m;
- ❖ Vertical 41 levels;
- ❖ Horizontal resolution varies from 0.5km to 80km;



# Wave only model results validation with Jason-1

Sep 28, 2003, 19:49 – 19:55



	SWH (m)	wind (m/s)
RMS	0.50	1.76
Corr. Coe.	0.96	0.96

# Summary ...

- 1) For waves in Halifax Harbour, we can use multi-nested grids and 2 wave models (WW3, SWAN)
- 2) Unstructured grid SWAN wave model (SWAVE) has potential
- 3) 2-way wave model coupling between fine- and coarse grids is operational
- 4) We show wave-ice interactions is important and we want to make it operational/routine...
- 5) Water level and currents – need to synchronize with ocean model from Dalhousie University
- 6) Two-way coupled wave-current interactions under developed
- 7) Demonstrated ‘oceanviewer’ works for validation – need to add statistical metrics
- 8) Still to come: wave run-up estimates
- 9) Need more storm test cases like hurricanes Juan and Sandy