The Canadian Atlas of Renewable Ocean Energy - Project Overview + Preliminary Results

Andrew Cornett, Ph.D., P.Eng.
Canadian Hydraulics Centre
National Research Council Canada

14 October, 2005

Project highlights

- ✓ Objective 1 - Quantify and map Canada's renewable ocean energy resources (winds, waves and tidal currents)
- ✓ Objective 2 - Make the results available to all Canadians through an interactive Atlas website
- ✓ High priority for the Canadian OE community (project grew from discussion at OREG symposium, Vancouver, 2005/03)
- ✓ Multi-year project, launched August 2005
- ✓ Funded by the Technology & Innovation Research Program – Natural Resources Canada (Thank you!)
- ✓ Diverse study team: NRC-CHC, EC-MSC, F&O-BIO, F&O-IOS, OREG, Powertech Labs, Triton Consultants

Who will use the OE Atlas ?

- ✓ Developers of OE projects and technologies (site identification)
- ✓ Governments and NGO's (to help shape renewable energy policy)
- ✓ Scientists and engineers (environmental assessment, technical analysis)
- ✓ Energy companies, power utilities, regulators
- ✓ Communities and municipalities
- ✓ Coastal resource managers
- ✓ Students and teachers
- ✓ Media

Workplan for year 1

- ✓ Review international resource assessment studies and methodologies
- ✓ Develop best-practice methodologies appropriate for Canadian context
- ✓ Assemble and analyse existing relevant data on winds, tidal currents and wave conditions
- ✓ Develop first-order estimates of Canadian tidal stream, wave and offshore wind energy resources
- ✓ Complete preliminary design of the digital OE Atlas
- ✓ Communicate with stakeholders
- ✓ Disseminate interim results

Workplan for year 2 and beyond

- ✓ Perform modelling studies to fill gaps and improve resource definition
- ✓ Identify promising high-energy sites
- ✓ Develop the interactive digital OE Atlas
- ✓ Launch the OE Atlas website
- ✓ Communicate with stakeholders
- ✓ Disseminate results
- ✓ Incorporate new data
- ✓ Estimate the recoverable resource

Ancillary benefits and applications

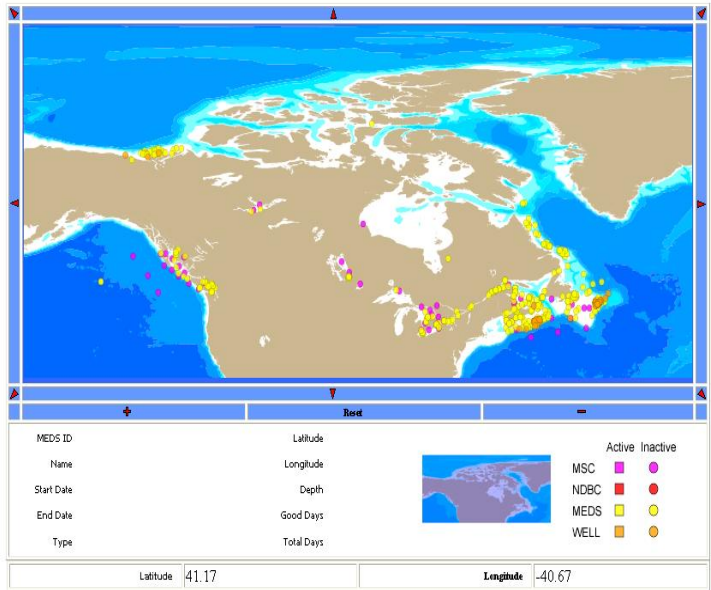
- ✓ The OE Atlas will contain a geo-referenced database with pan-Canadian information on bathymetry, wave climate, tides, tidal currents & winds
- ✓ This comprehensive database will facilitate:
  - detailed site selection studies
  - resource assessments for complex coastal areas
  - studies of potential environmental impacts for proposed OE projects
  - + other types of investigations

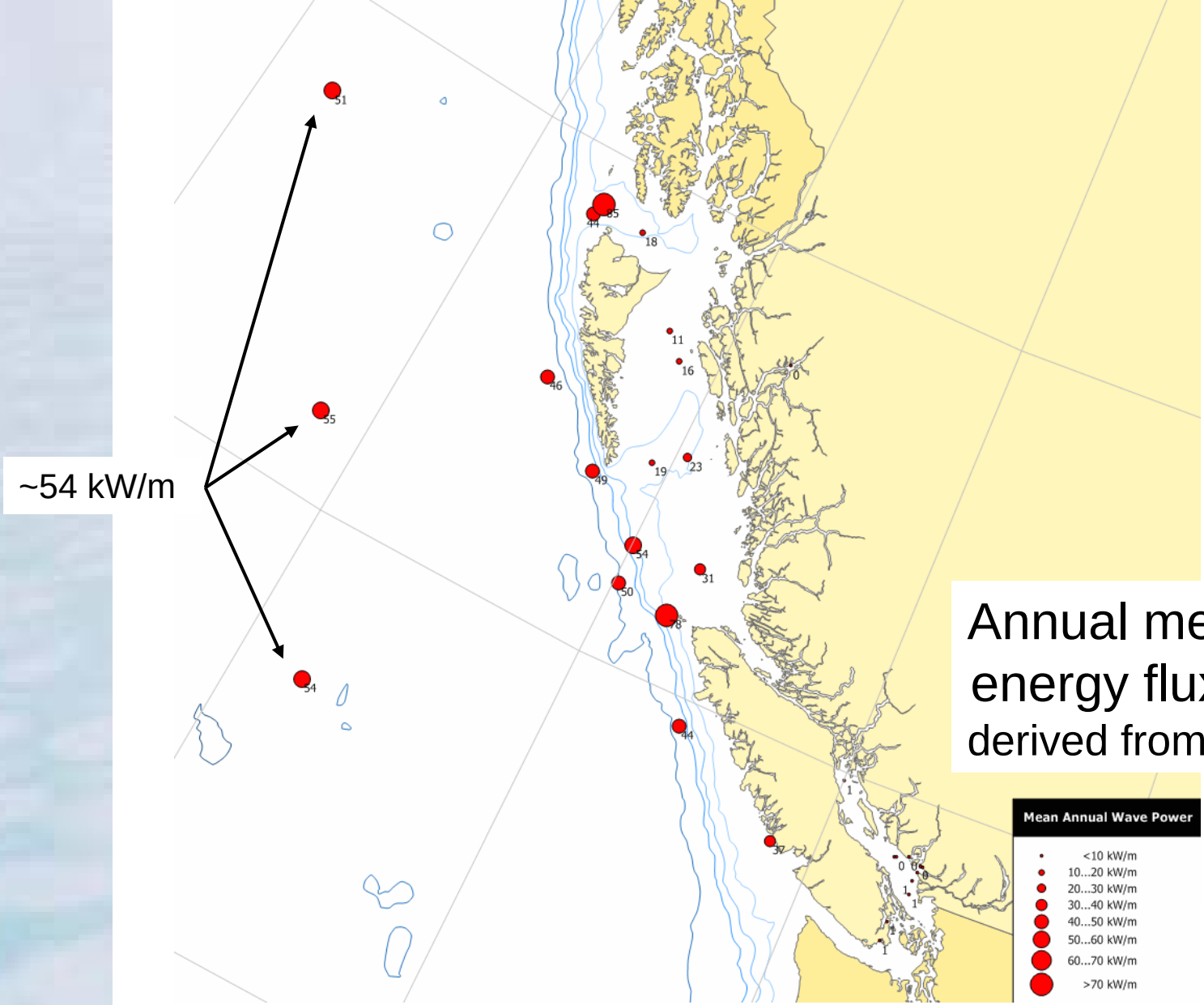
Plan to assemble and analyse many types of data

- ✓ Waves
  - Wave measurements (buoys, satellite, 2D and 3D)
  - Numerical simulations of wave conditions (hindcasts, forecasts, deep water and shallow water)
- ✓ Tides and Tidal Currents
  - Measurements of water levels and currents
  - Charts, tide tables, current tables, current atlases
  - Numerical simulations of tides and tidal currents
  - Desktop analysis of coastal inlets, narrows, channels
- ✓ Winds
  - Measurements and numerical simulations

Key data sources so far (thank you!)

- ✓ Marine Environmental Data Service (MEDS)
- ✓ Meteorological Service of Canada (MSC)
- ✓ Bedford Institute of Oceanography (BIO)
- ✓ Institute for Ocean Sciences (IOS)
- ✓ Canadian Hydrographic Service (CHS)
- ✓ Previous studies
  - EPRI (2004, 2005)
  - RSW (2004)
  - Triton (2002)
  - UBC (1994)
  - NRC (1978, 1980)
  - + others

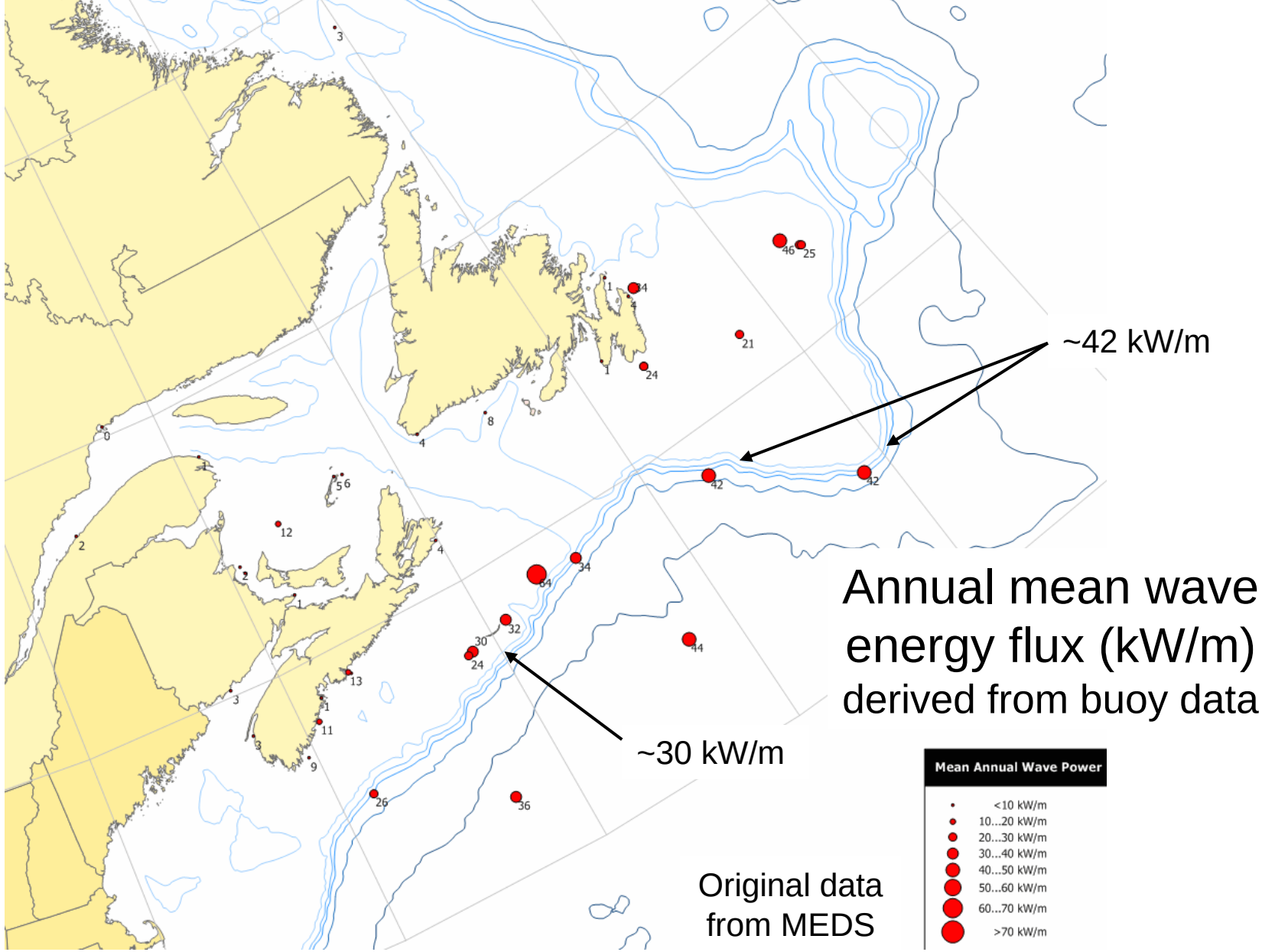




Annual mean wave energy flux (kW/m)

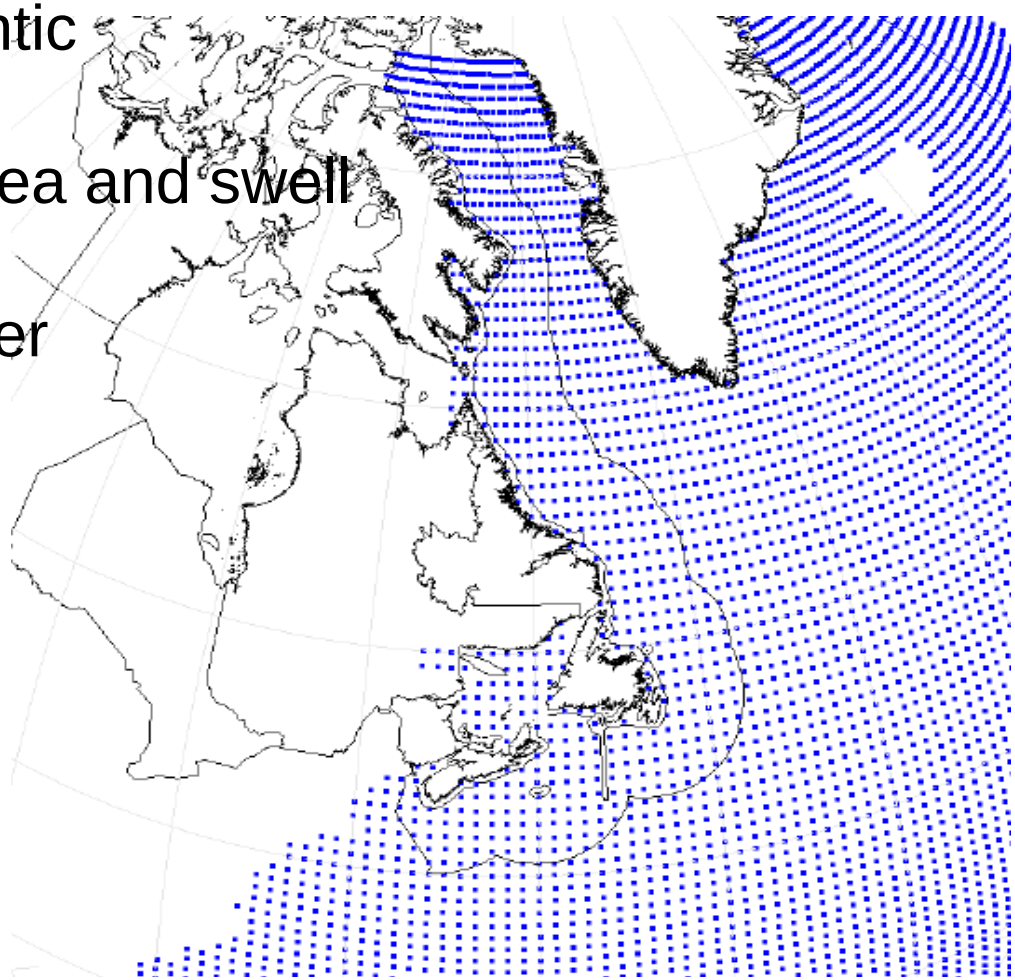
derived from buoy data

Original data from MEDS

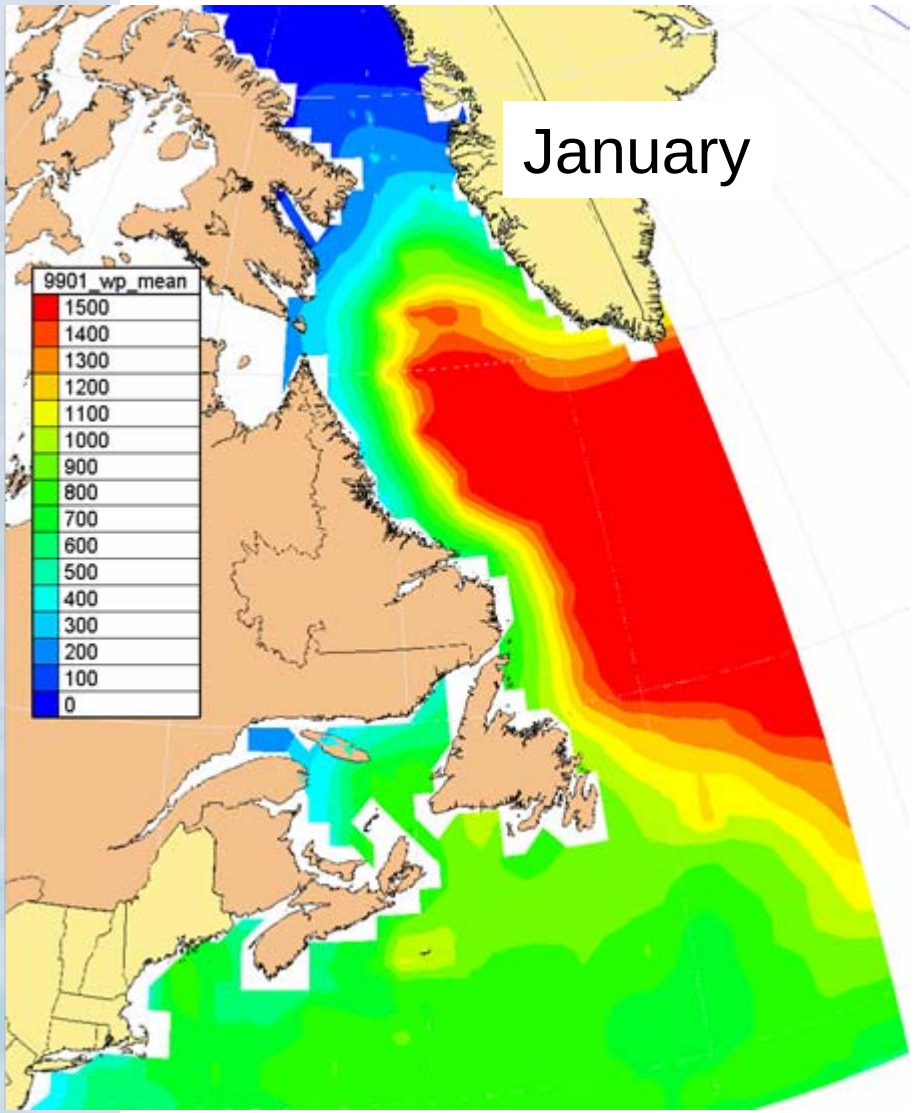

~42 kW/m
~30 kW/m
Annual mean wave energy flux (kW/m)
derived from buoy data
Original data from MEDS
Mean Annual Wave Power
<10 kW/m
10...20 kW/m
20...30 kW/m
30...40 kW/m
40...50 kW/m
50...60 kW/m
60...70 kW/m
>70 kW/m

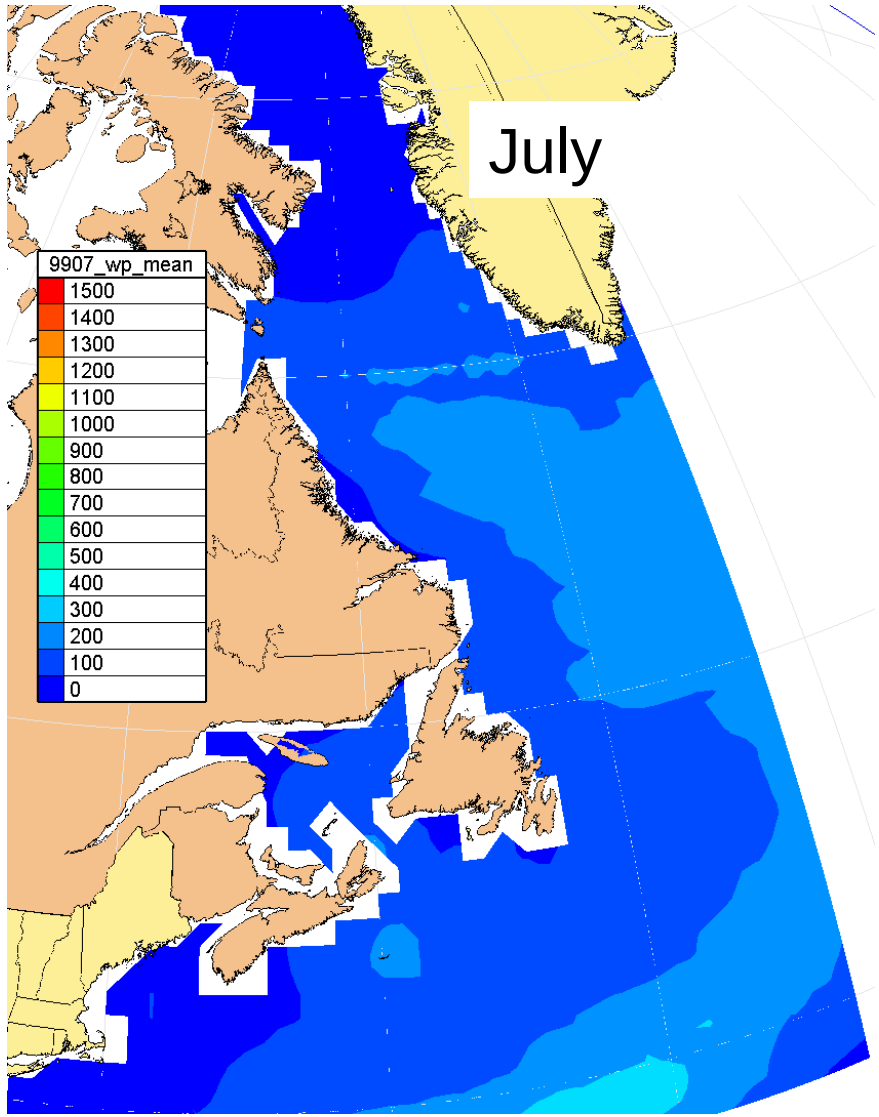
AES40 Wind-Wave Hindcast (data courtesy MSC)

- 0.625^{o} by 0.833^{o} grid (9023 points)
- covers the North Atlantic
- 50 year simulation
- considers ice cover, sea and swell
- extensive validation
- restricted to deep water

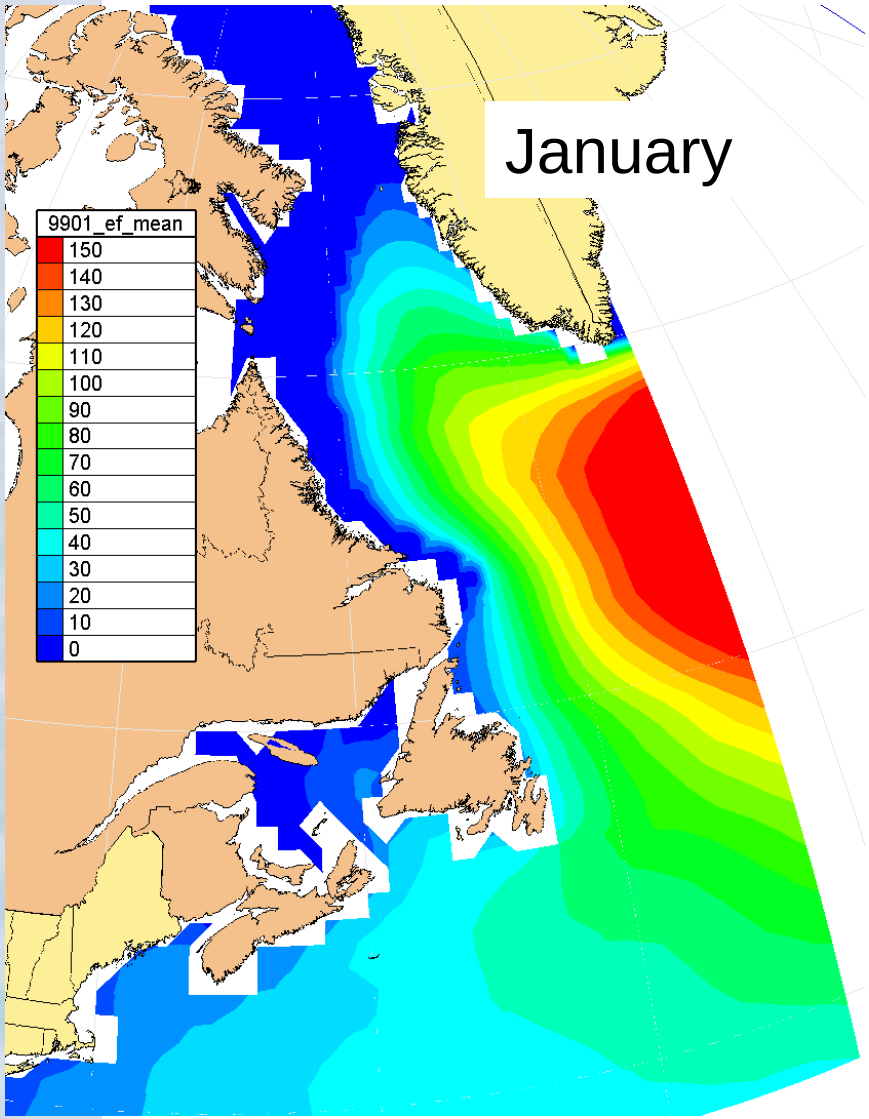


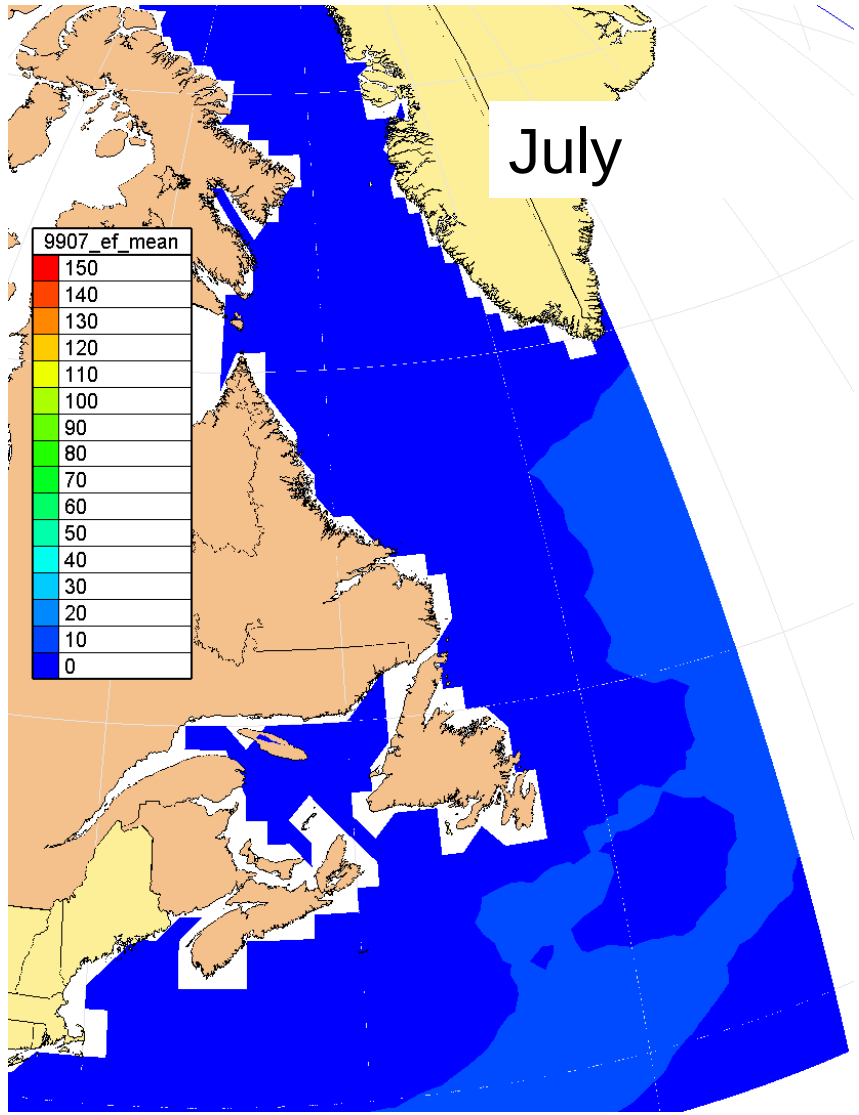
Mean WIND power density (W/m^2) derived from AES40 data





Mean WAVE energy flux (kW/m) derived from AES40 data



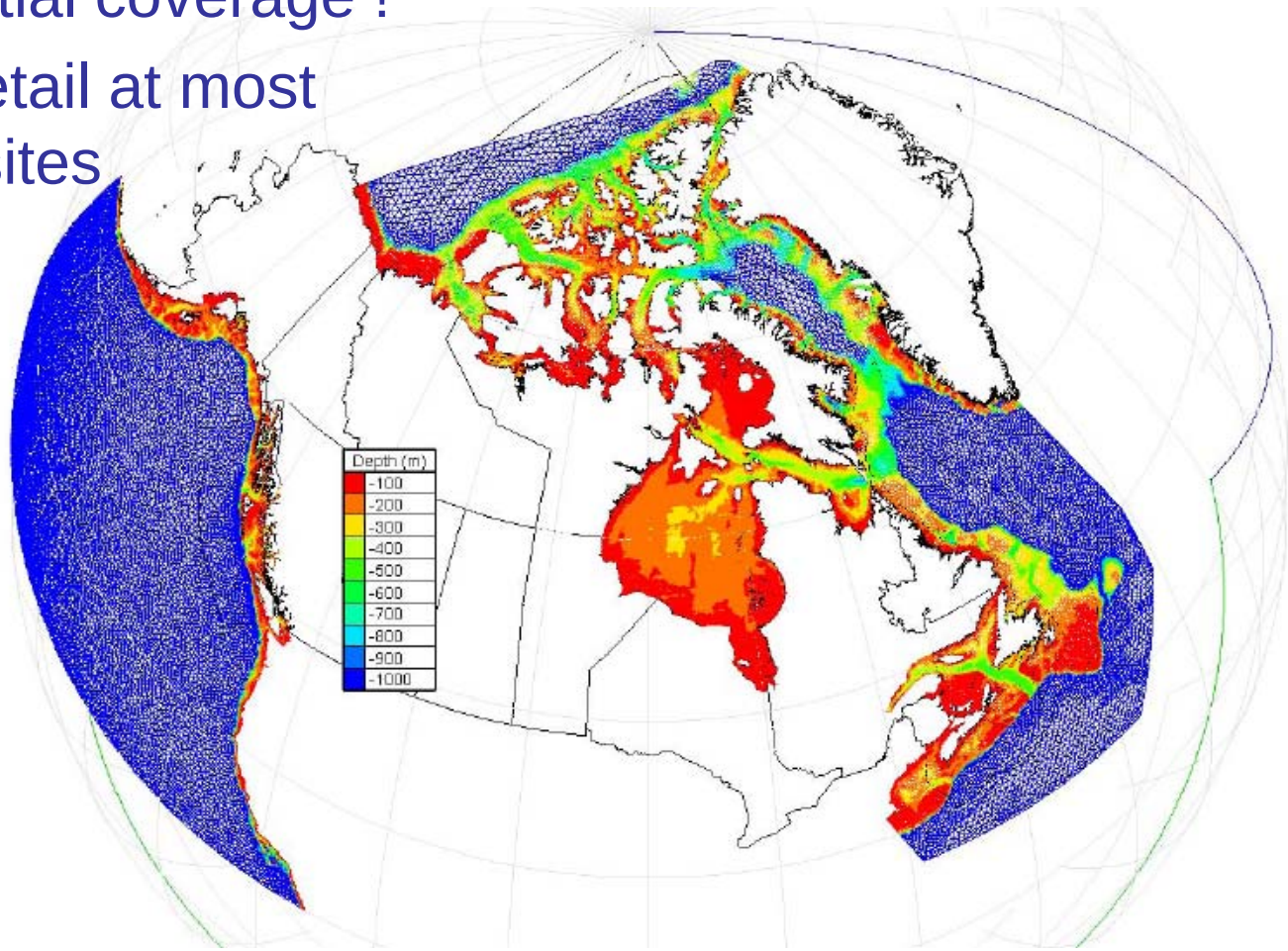


Wave Climate Modelling – general comments

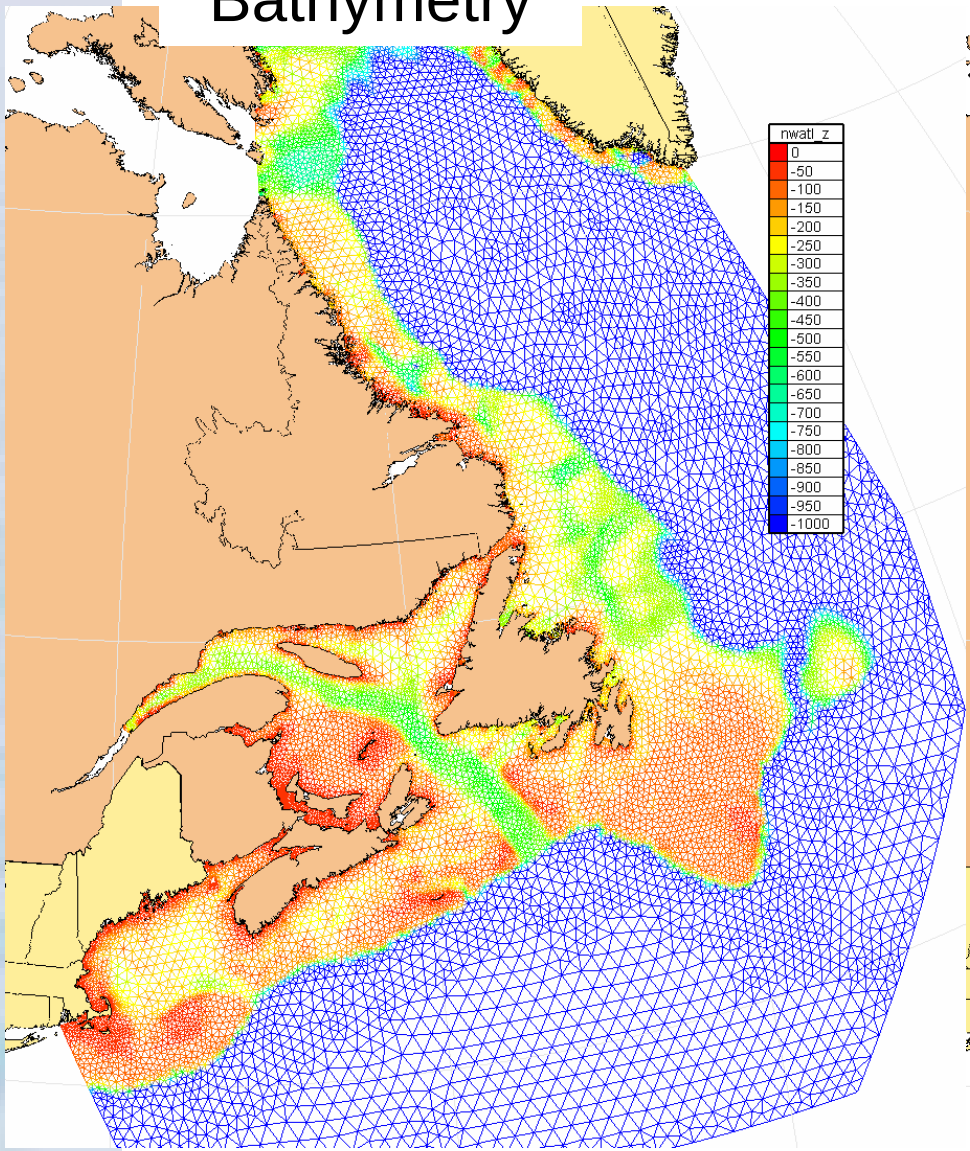
- ✓ Medium detail is generally adequate offshore
- ✓ Fine detail and sophisticated models required for good accuracy in complex coastal areas
- ✓ The challenge: Combine wide spatial coverage with good accuracy in complex coastal areas
- ✓ Our approach: Assemble and analyse existing data first, then perform new modelling to fill gaps and add detail
- ✓ Wind and wave resources are substantial but feature large seasonal variations

WebTide (courtesy F&O)

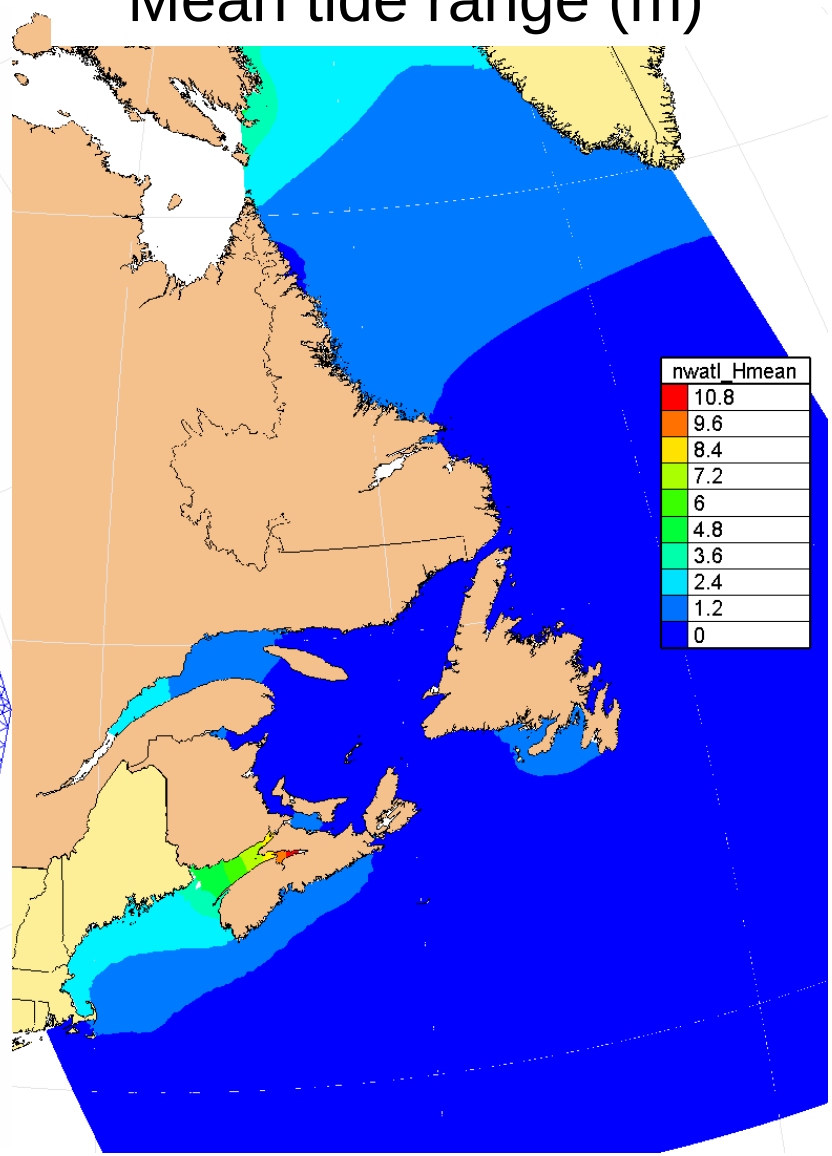
- ✓ Pan-Canadian tidal prediction program
- ✓ Excellent spatial coverage !
- ✓ Insufficient detail at most high-energy sites



Bathymetry



Mean tide range (m)

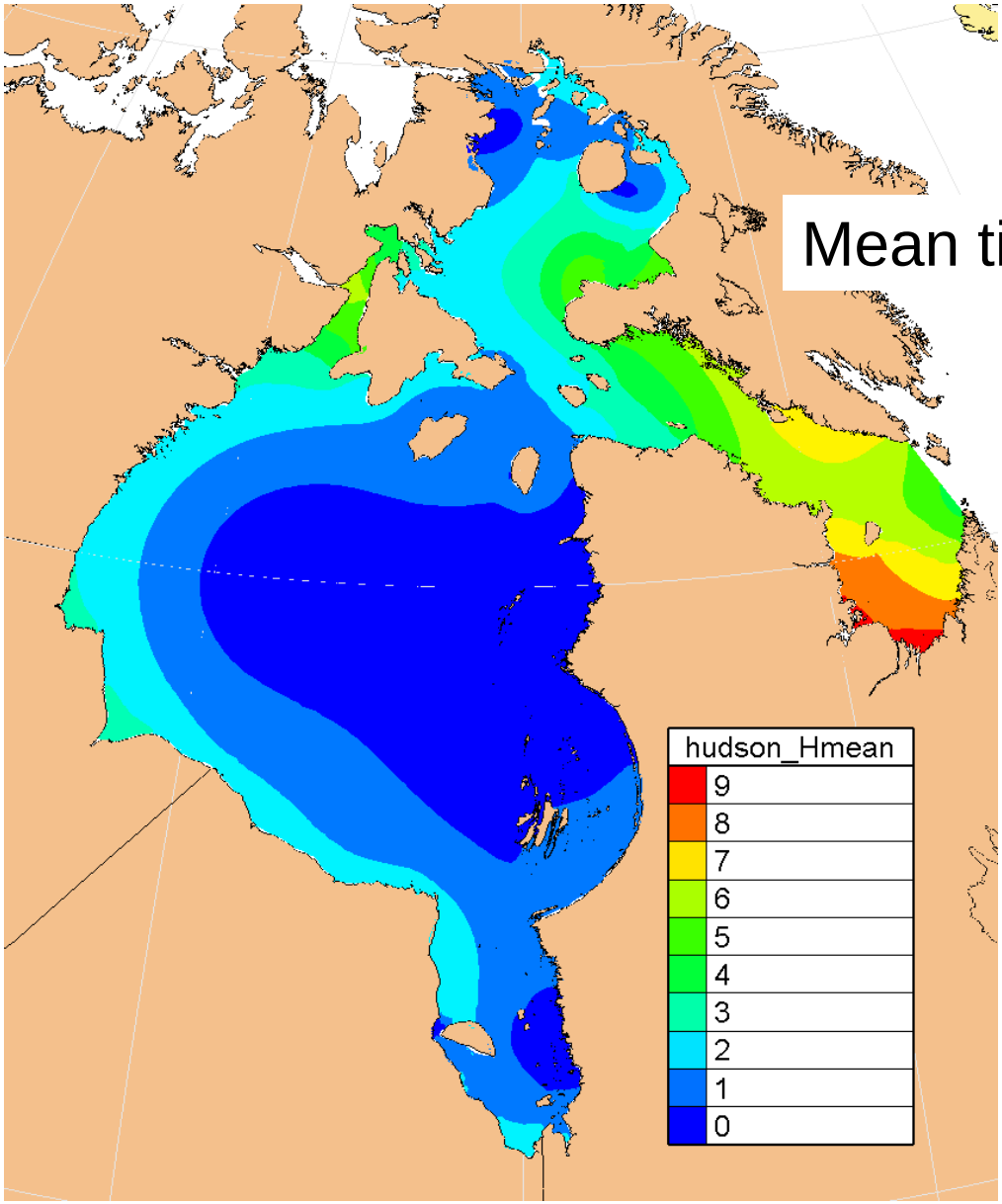


CHC CANADIAN HYDRAULICS CENTRE
CENTRE D'HYDRAULIQUE CANADIEN

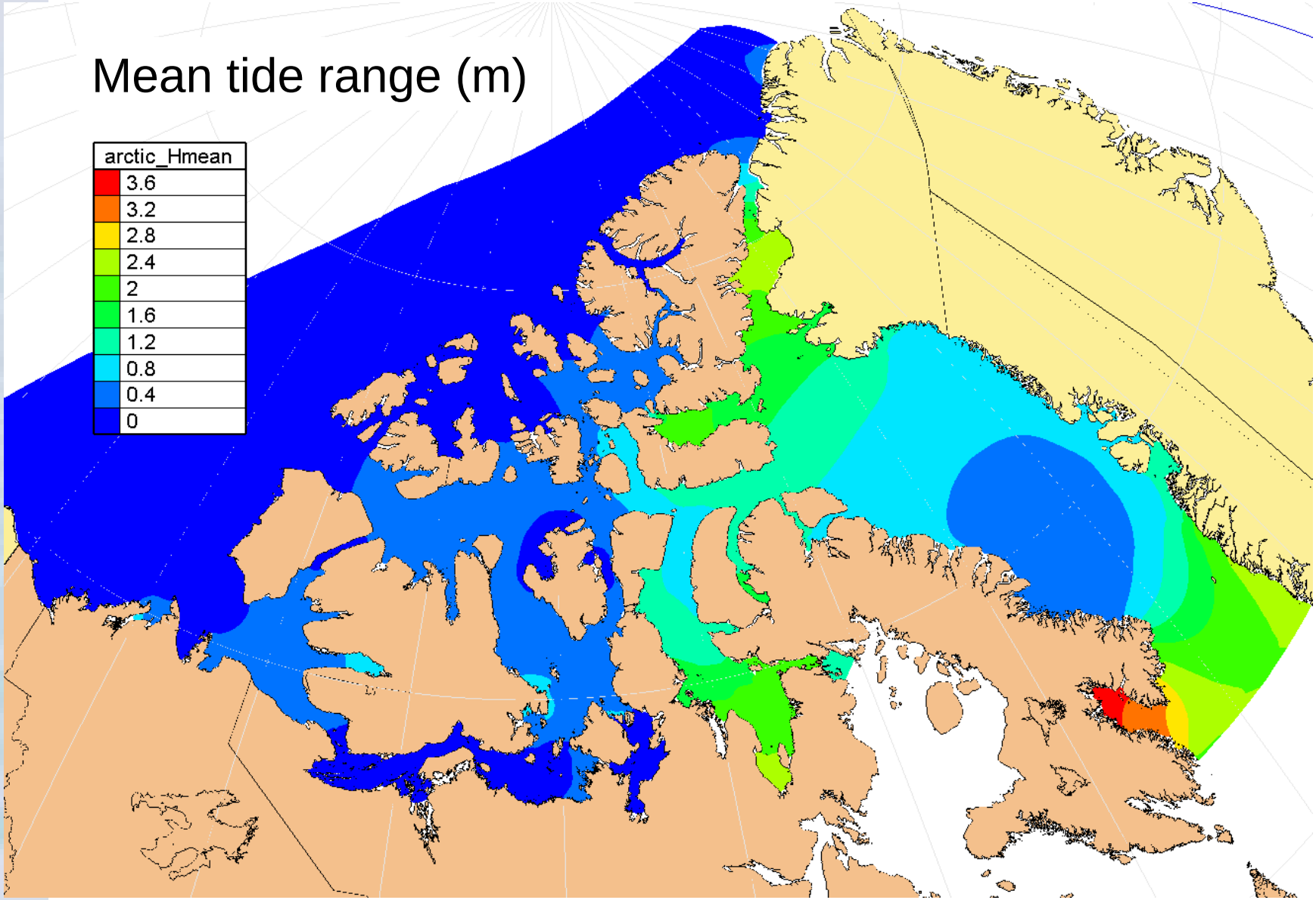
National Research Council Canada
Conseil national de recherches Canada

Canada

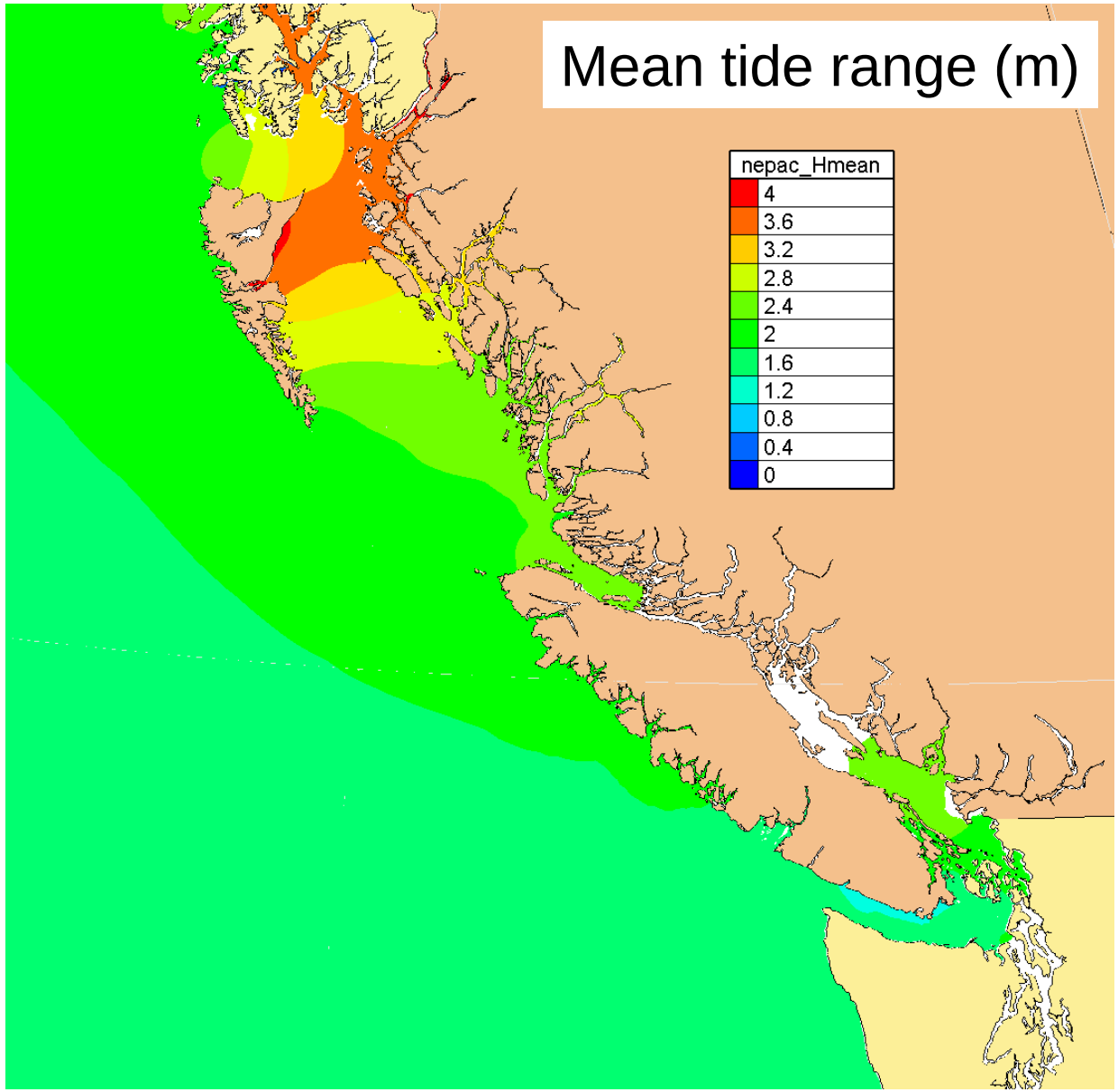
Mean tide range (m)

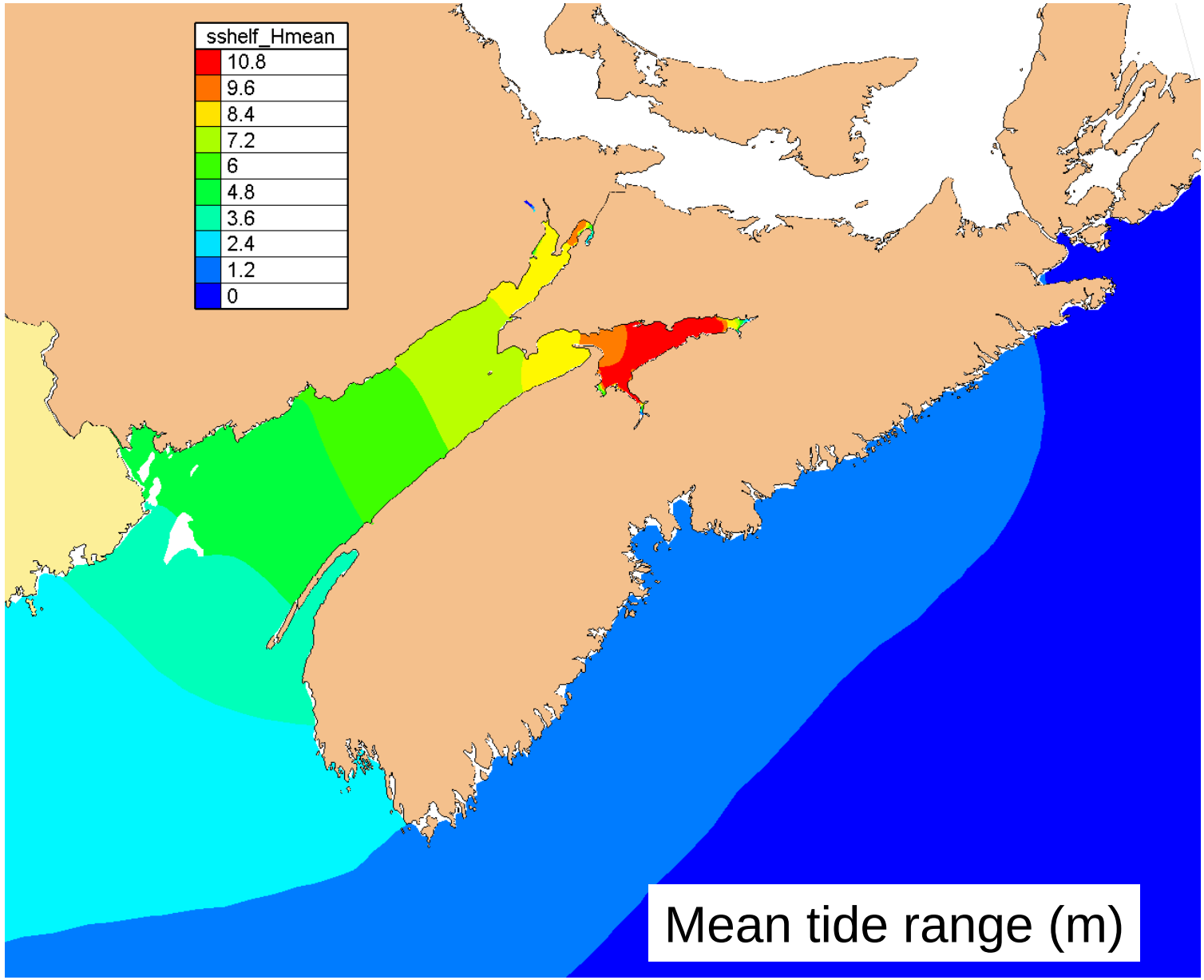


Mean tide range (m)

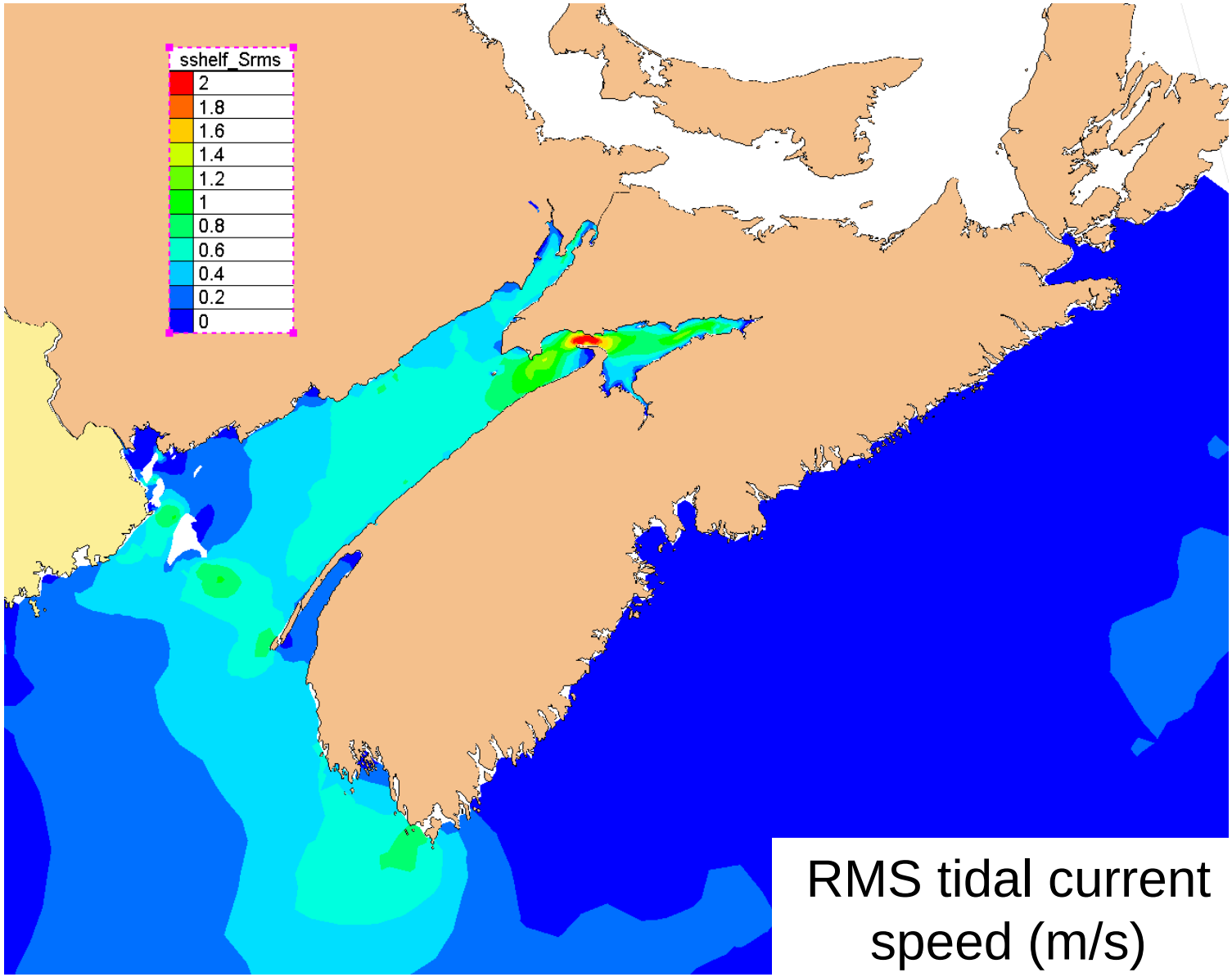


Mean tide range (m)

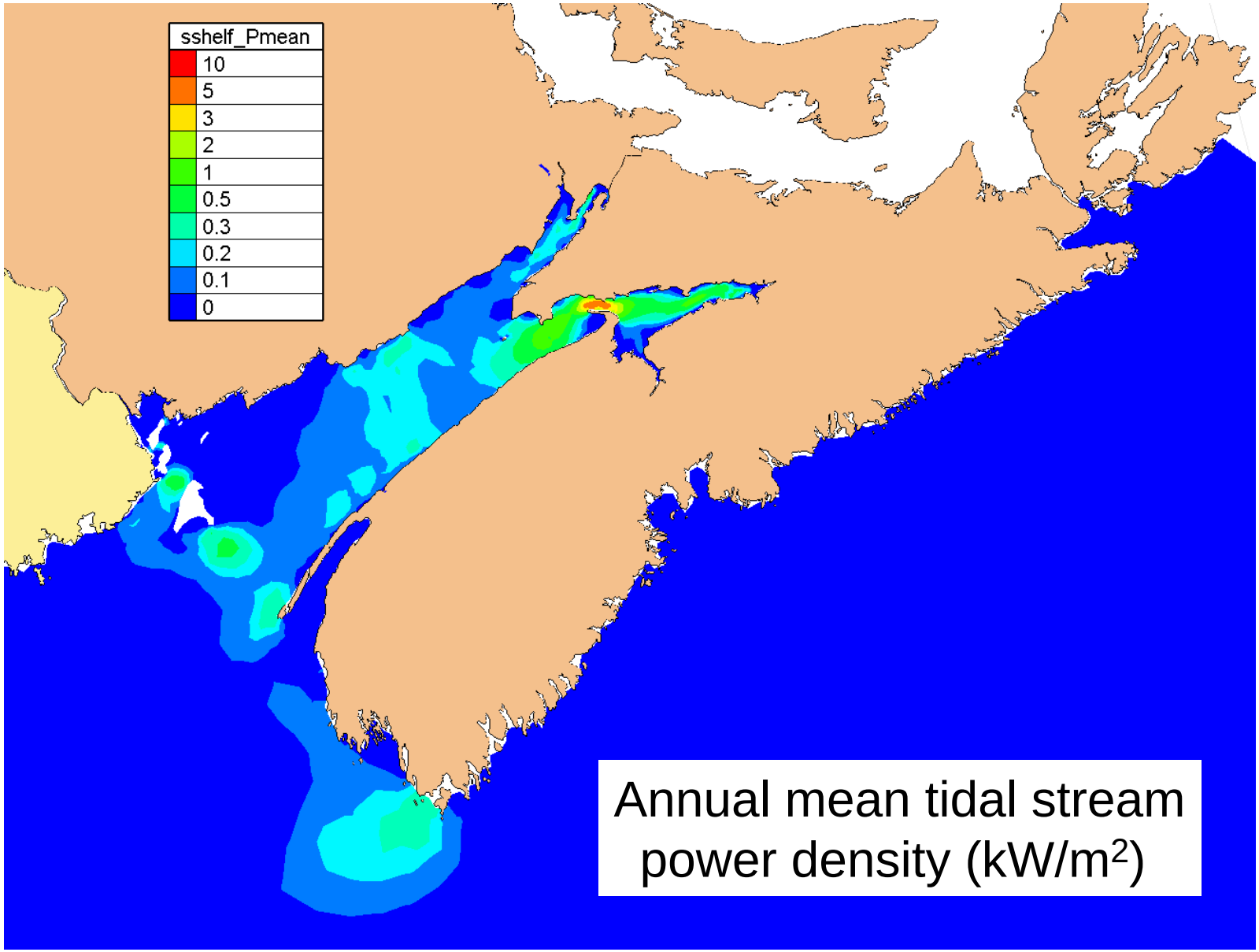




Mean tide range (m)



RMS tidal current speed (m/s)

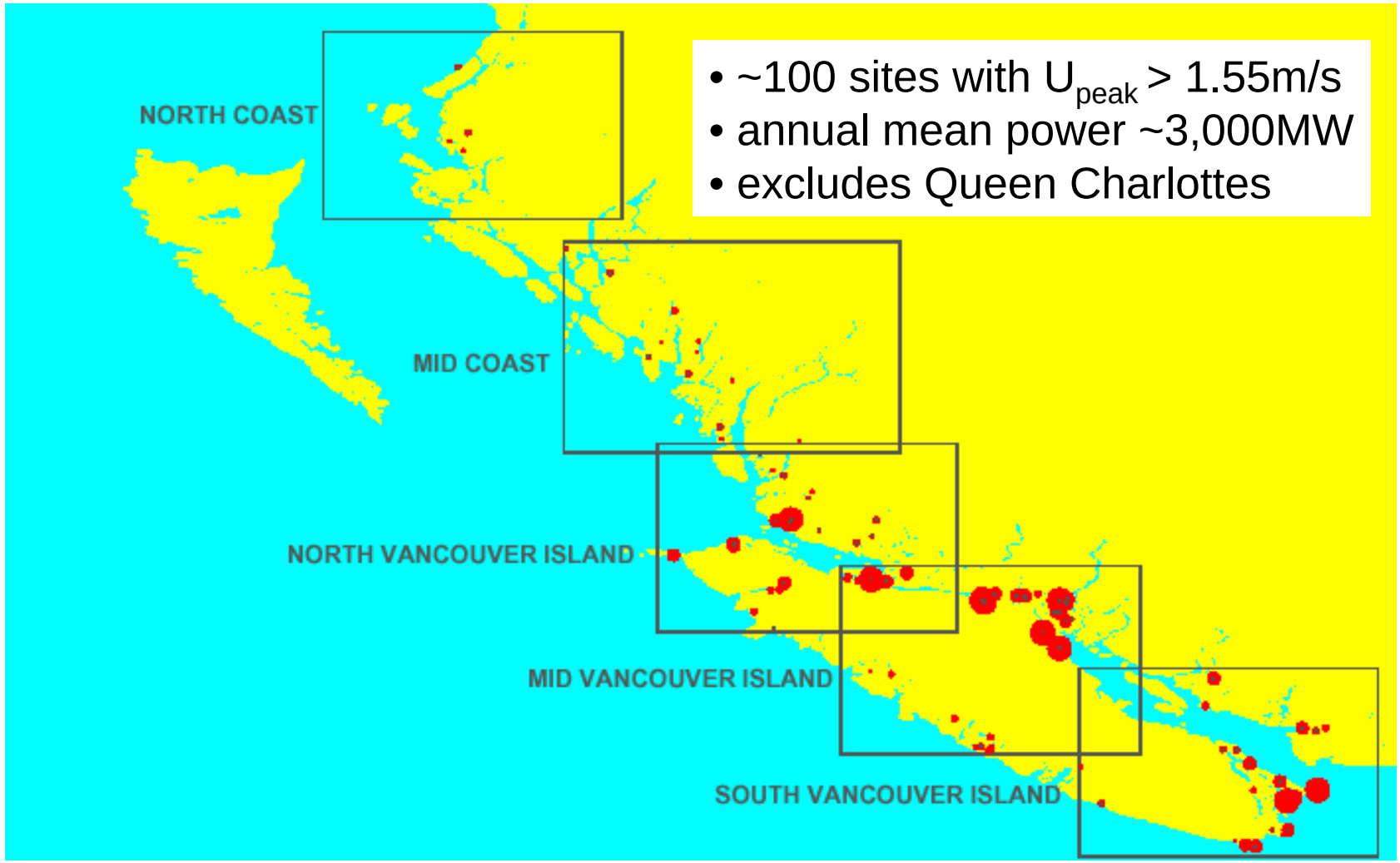


Annual mean tidal stream power density (kW/m^2)

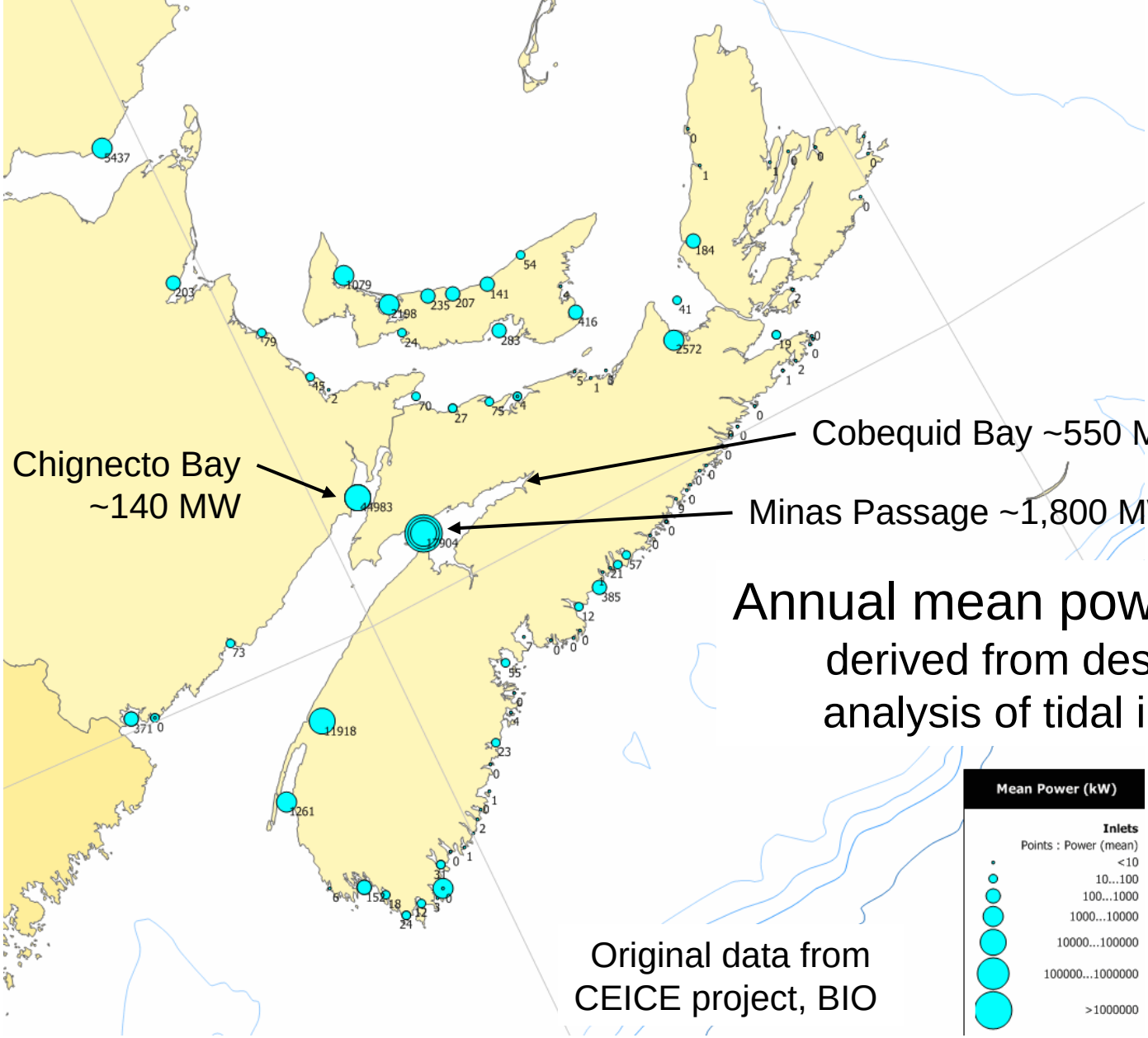
Tidal Flow Modelling - general comments

- ✓ Many existing solvers, grids & simulations
- ✓ Very fine detail required for good accuracy at high-energy sites
- ✓ The challenge: Combine wide spatial coverage together with fine detail at high-energy sites
- ✓ Our approach: Assemble and analyse existing data first, then conduct new modelling to fill gaps and add detail

Potential sites – BC coast (Triton, 2002)



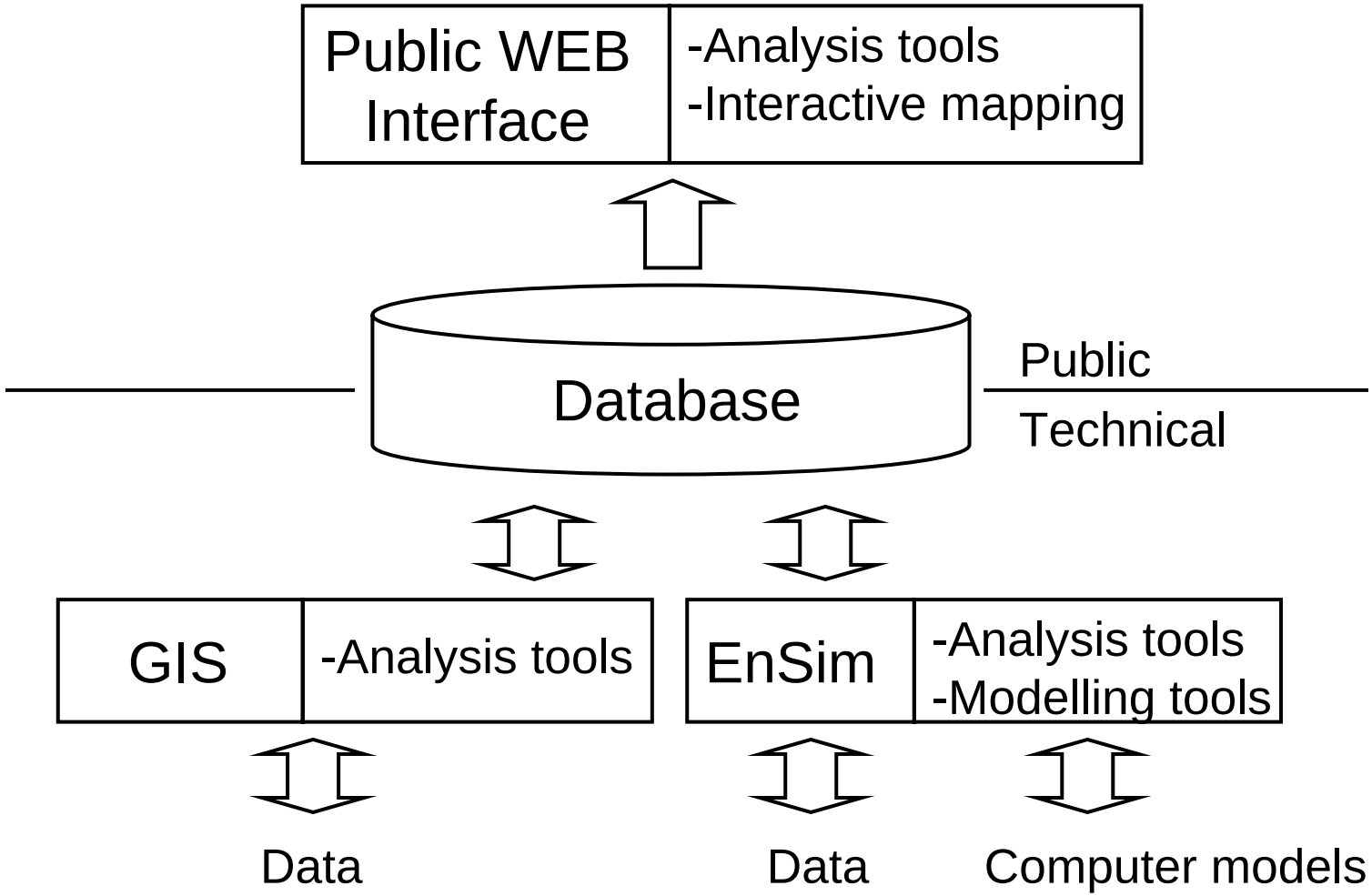
- ~100 sites with U_{peak} > 1.55m/s
- annual mean power ~3,000MW
- excludes Queen Charlottes

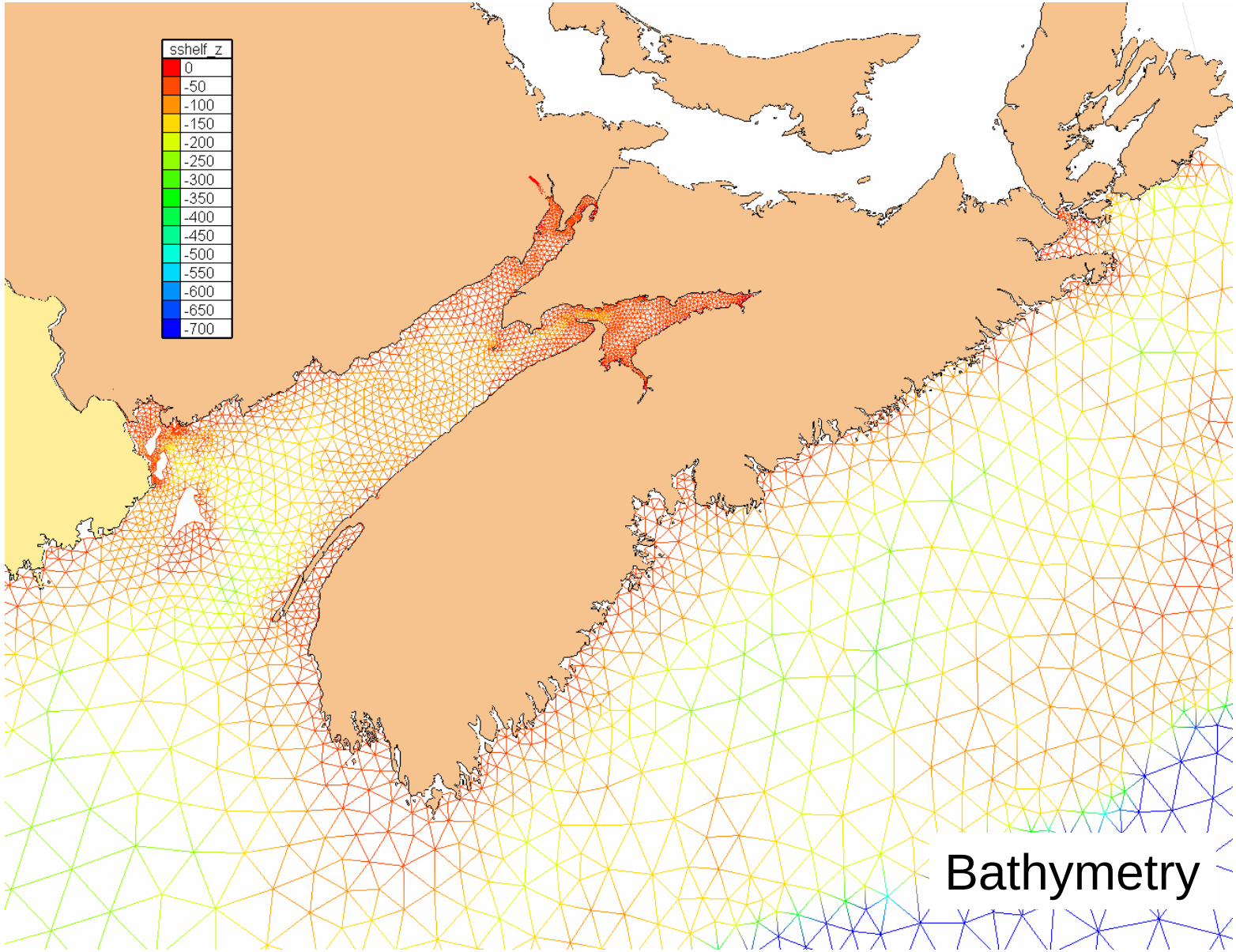

Chignecto Bay
~140 MW
Cobequid Bay ~550 MW
Minas Passage ~1,800 MW
Annual mean power (kW)
derived from desktop
analysis of tidal inlets
Original data from
CEICE project, BIO
Mean Power (kW)
Inlets
Points : Power (mean)
<10
10...100
100...1000
1000...10000
10000...100000
100000...1000000
>1000000

Thank you !

Andrew Cornett
(613) 993 6690
Andrew.Cornett@nrc.ca

Preliminary OE Atlas Architecture




sshelf_z
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
-550
-600
-650
-700
Bathymetry

Analysis of tidal model output

- ✓ Amplitudes and phases for main constituents
- ✓ Ellipse parameters for main constituents
- ✓ Construct time series for:
  - Surface elevation
  - Flow speed (depth averaged)
  - Energy density (depth averaged)
- ✓ Statistical analysis of time series to compute key parameters for database