Tidal project – part of CANSSI

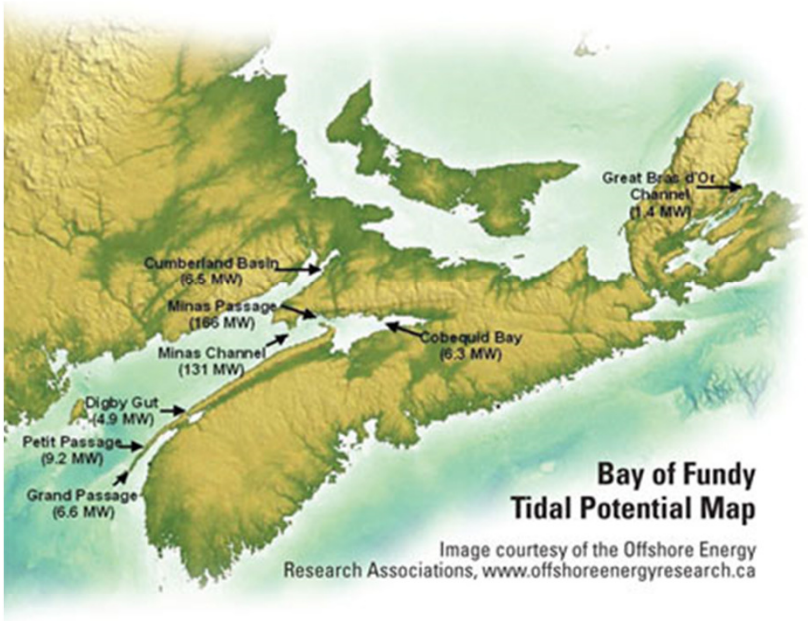
Acadia University

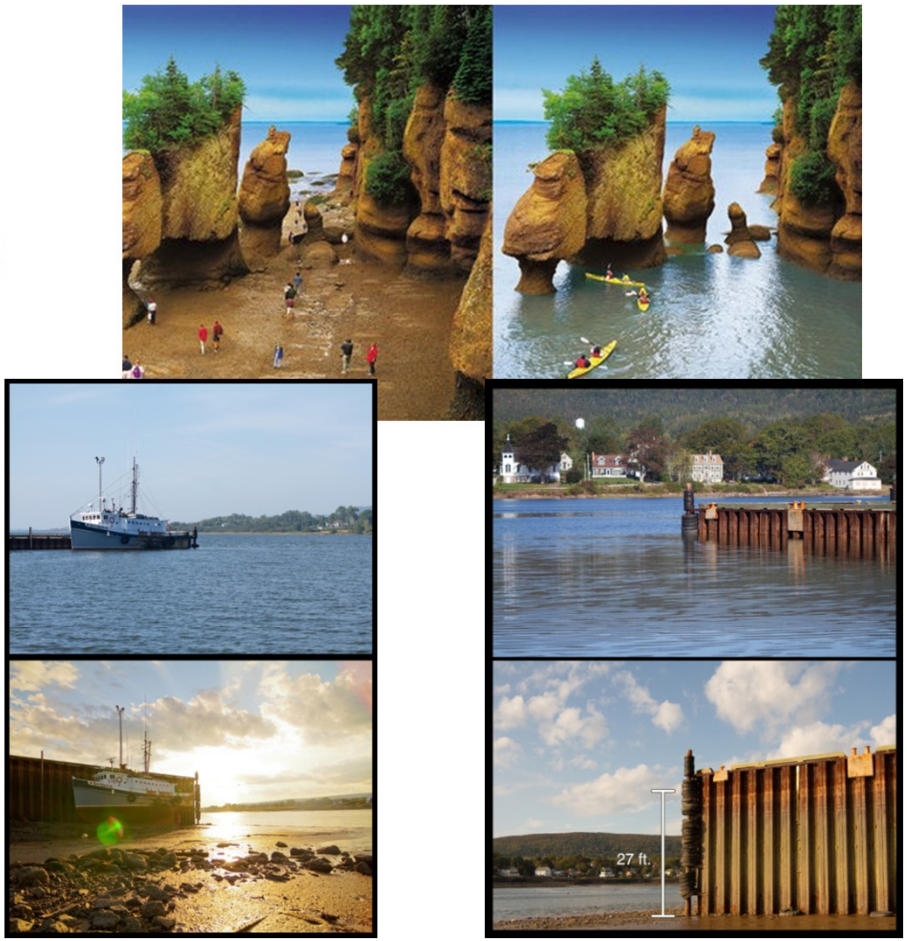
(Hugh Chipman, Pritam Ranjan and Richard Karsten)

Bay of Fundy, NS

ACADIA UNIVERSITY

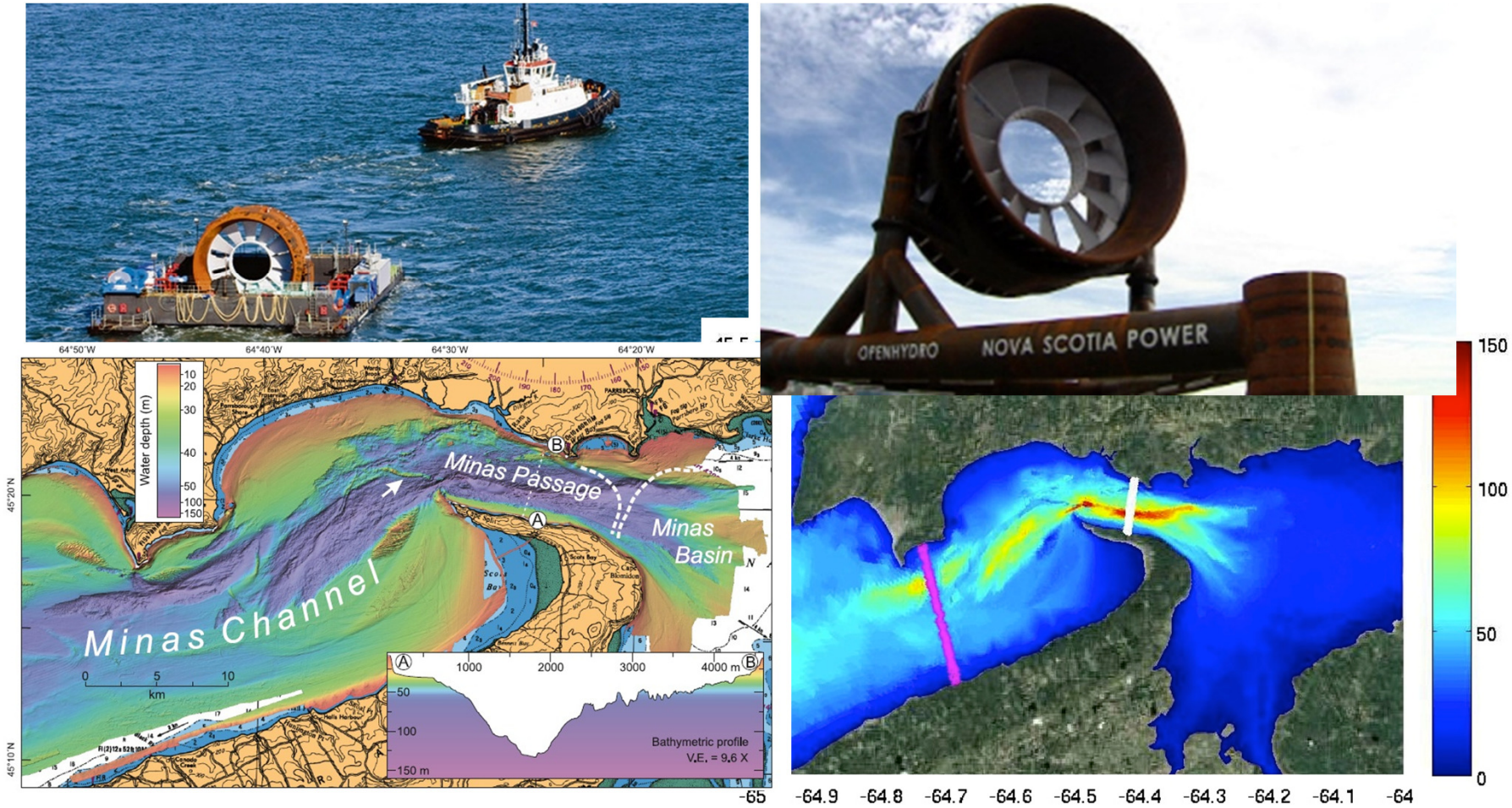
- World's highest tides (up to 17m)





Objective

- Harvest tidal energy by placing turbines in the Minas Passage



What has been done?

- One 1MW OpenHydro turbine was installed by *Fundy Ocean Research Center for Energy* (FORCE) in the Minas Passage during Nov 2009 – Dec 2010
  - Unfortunately, no access to the data

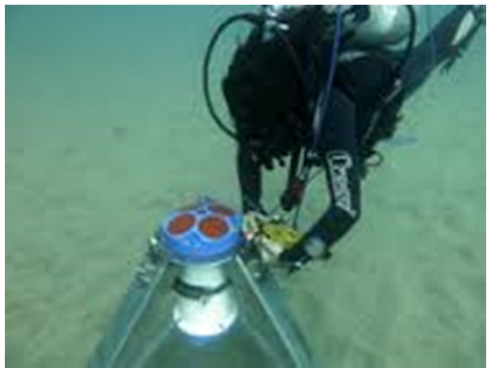
- FORCE and OpenHydro intend to deploy a 4MW tidal array by 2015
- $10-million turbine was destroyed due to strong current

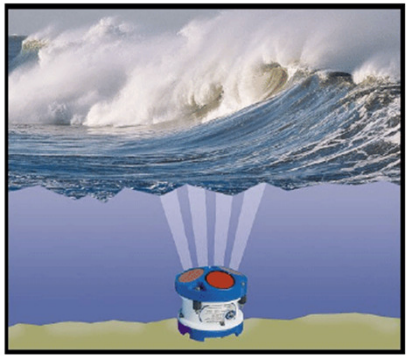
Turbine construction

- Successful development of turbines to generate electricity from tidal currents requires more knowledge of the inflow conditions.

- The key parameters (turbulence intensity and turbulence spectra) are estimated by collecting real data using *acoustic Doppler current profiler* (ADCP) and *acoustic Doppler velocimeter* (ADV) devices.

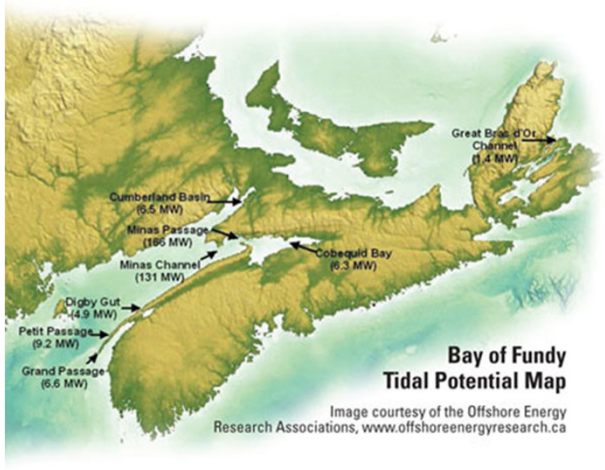
- .

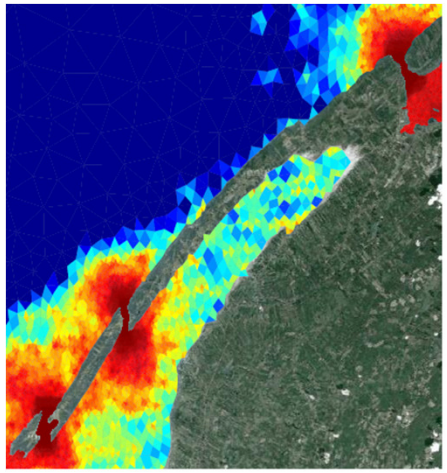




Industry partner

- Fundy Tidal Inc. – have rights to deploy arrays of small turbines (100 – 250 KW) in the Digby Neck region.





- Turbine builders – Clean Current and Tocardo

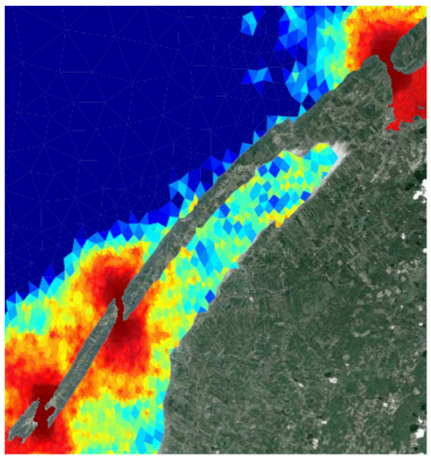
- Aiming to install several turbines in Digby Neck region by 2015

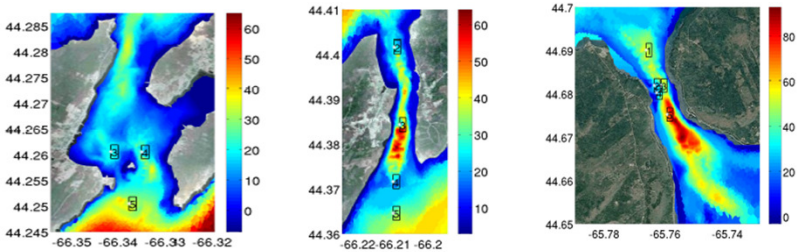
Data - ADCP

- We have real ADCP data for 13 sites in Digby Neck region
- We also have simulator (DNgrid) data for these sites and more

  - Time-series response (velocity) at several heights
  - At each location the data was recorded for 1 month

    actual time lag 1sec - 2min (working with 10min avg lag)
  - Data collection started in 2012
  - Number of sites is increasing





(a) Grand Passage (b) Petit Passage (c) Digby Gut

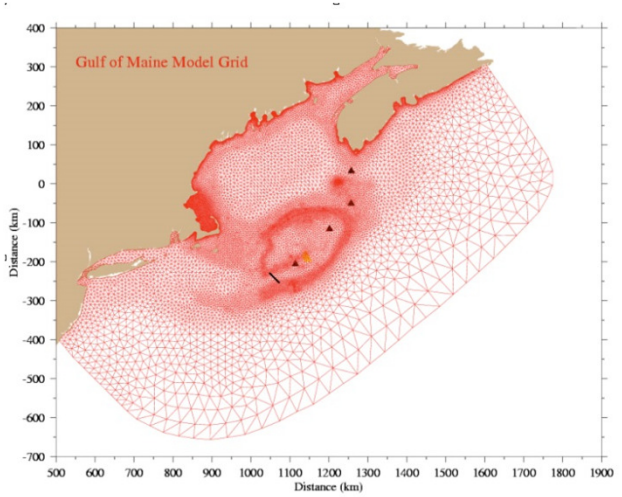
More real data

- Tide gauge data measured by *pressure gauge*
  - Time series data averaged over 2-5 min time lag
  - Two devices are cabled to the shore (in DG and GP)
  - Collecting data for a year now
  - Measures height of the water

- Tomography data across Grand Passage (started collecting very recently – last week, still at the experimental stage)

FVCOM data

- FVCOM – measures velocity, water height for entire Bay of Fundy
  - roughly 200,000 locations (15 m resolution)
  - Multi-fidelity model, resolution: 15 m – 500 m
  - 10 vertical locations
  - Can generate 10 sec – 10 min interval data
  - coarse time res (1 month) yield 200 GB data



  - **Computer simulator is expensive**
  - 3d runs (all 10 layers) for the full grid on 128 CPUs takes roughly 40 hours for a week of data
  - 2d runs (averaged over 3d layers) on 128 CPUs takes roughly 20 hours for one month of data

Research Problems

ACADIA UNIVERSITY

1. Finding optimal locations for installing a farm of tidal turbines in Minas Passage using multi-resolution simulator model runs.

2. Uncertainty quantification and sensitivity analysis in tidal current annual energy production (AEP) estimates.

3. Calibration of a time-series valued computer simulator that matches the field ADCP data in the Digby Neck region.

4. Modeling reliability of turbines at different locations (currently we don't have any real data, working on building simulators).