National Report of Canada, 3rd TWLWG Meeting 5-7 April, 2011, Jeju South Korea

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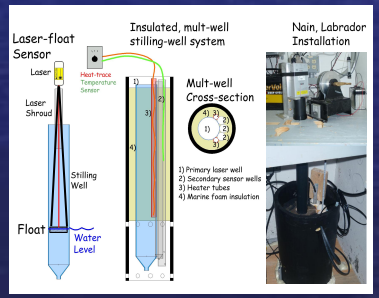
Introduction:

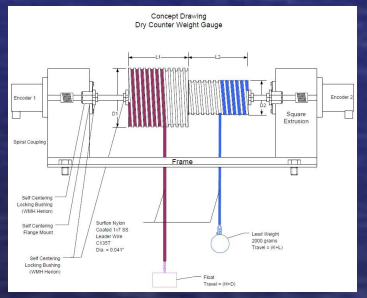
- Canada's Permanent Water Level Network (PWLN) - regional sub-networks
- Canada's water level measurement infrastructure, sensors, data collection systems and distribution

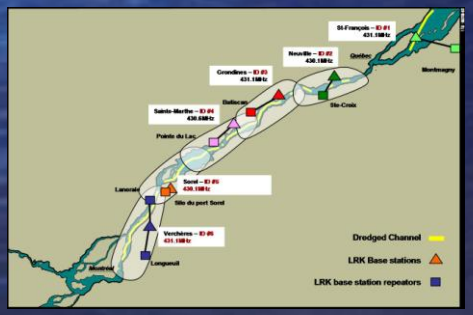
Ongoing water level related initiatives:

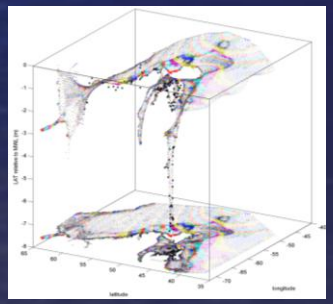
(whats new)

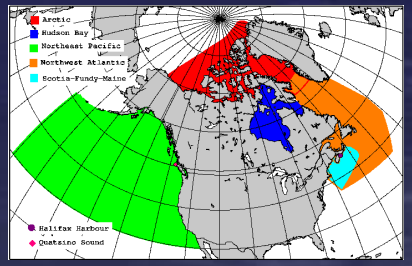
- Water level system tech developments
- Canadian Continuous Datum Project











Canada's Coastline

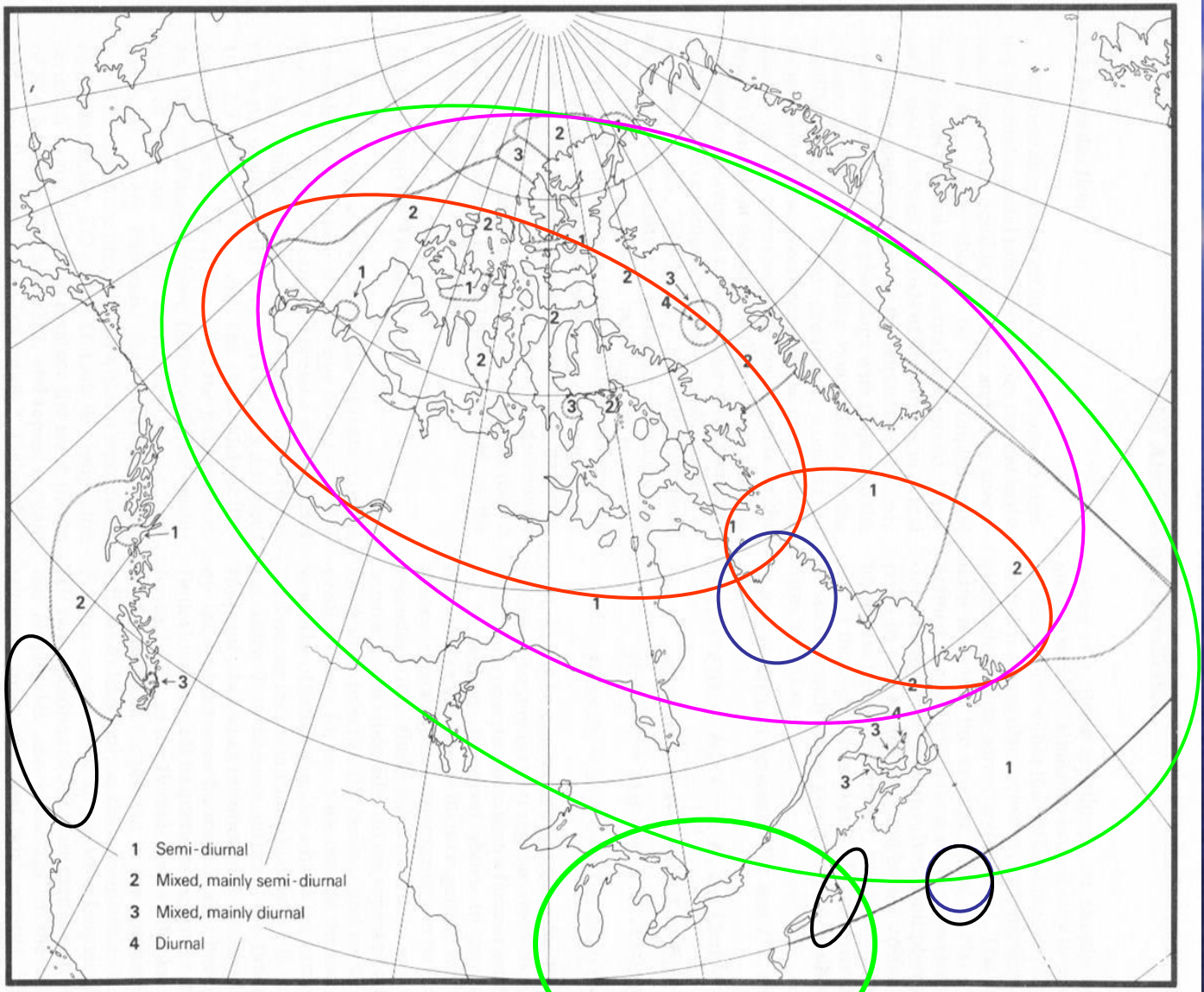
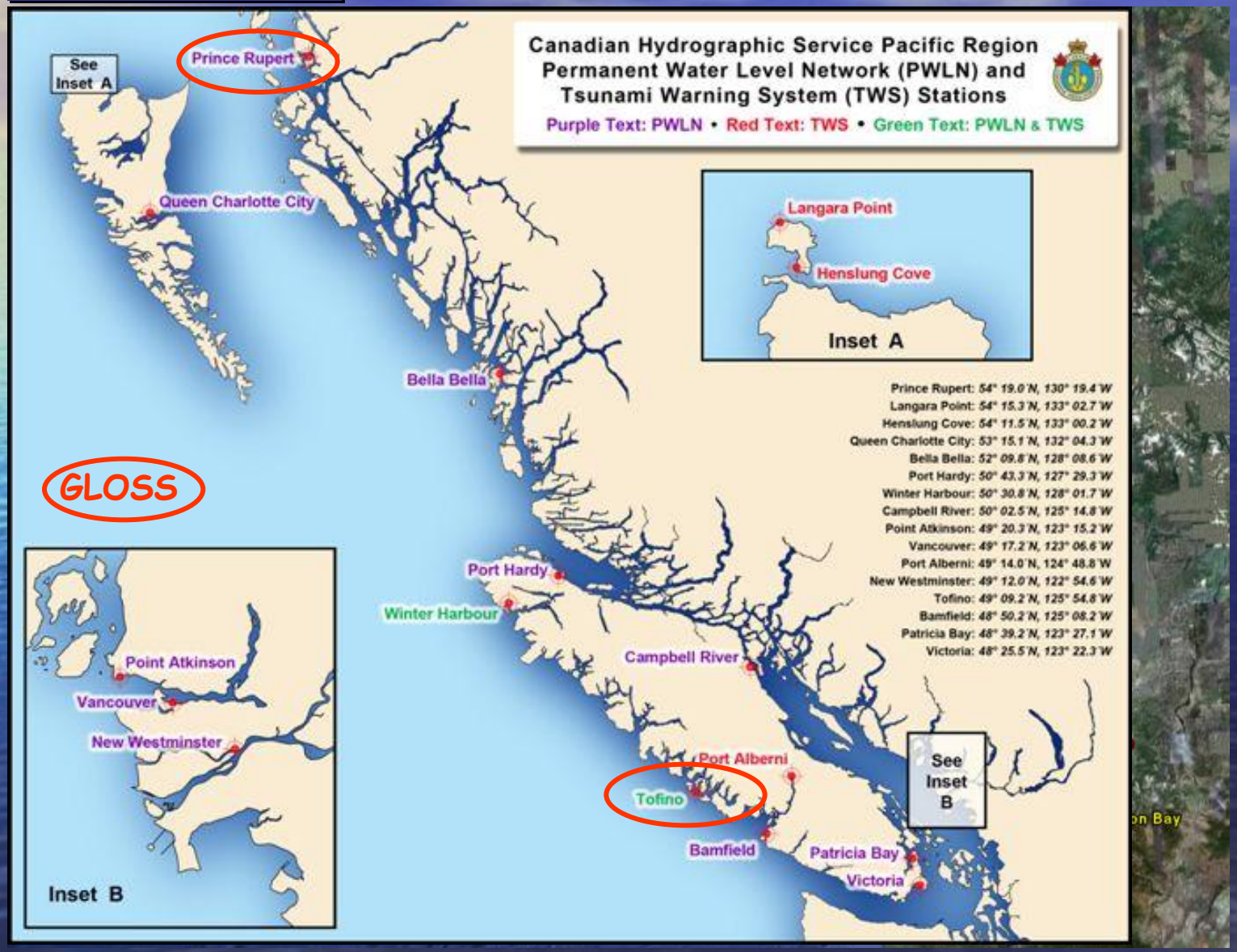


FIG. 22. Classification of tides at locations in Canadian waters.

- 10,000s of kms coastline
- Building shipping in challenging areas
- Worlds highest tides
- Severe conditions, lots of ice
- All tidal types
- Areas with large currents
- Regions with sparse water level data
- Rapidly growing information crossover requirements

Canadian PWLN coastal regional sub-networks

Pacific stations ages



Canadian PWLN coastal regional sub-networks

Central + Arctic stations ıuges

Canadian PWLN coastal regional sub-networks

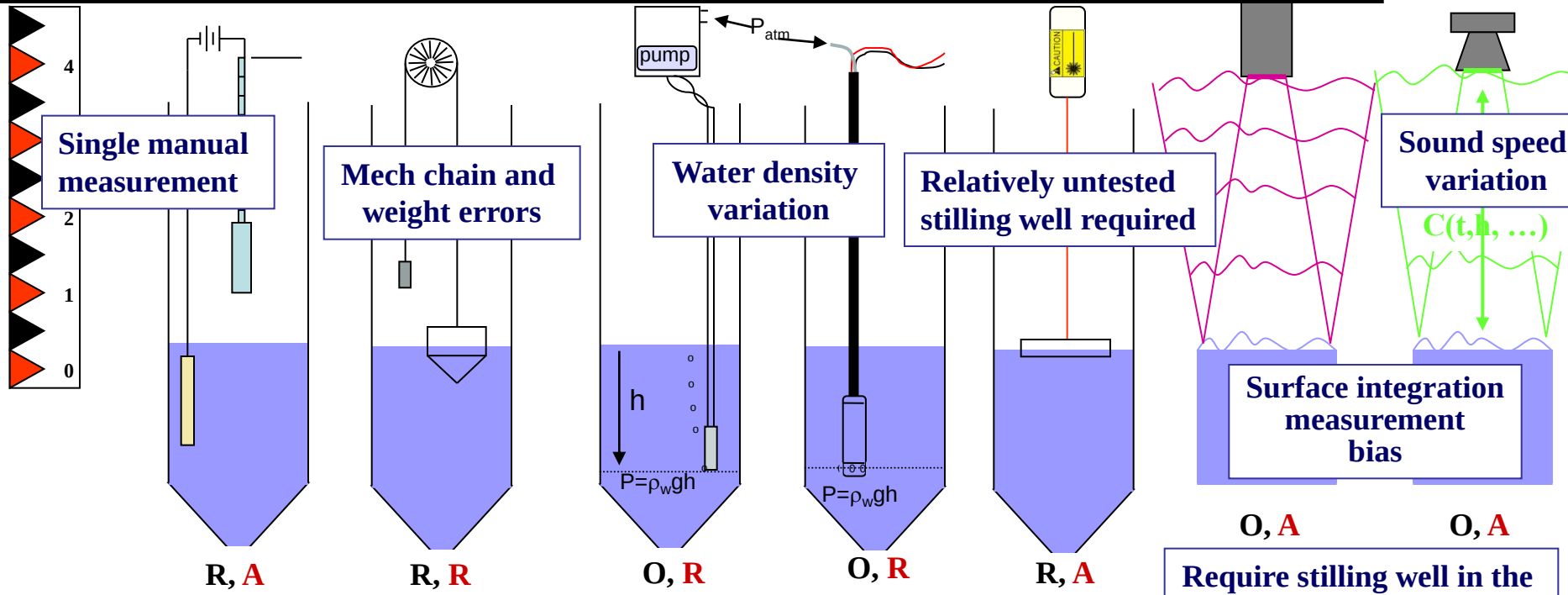
Quebec and Atlantic stations

Water level sensors (no magic solution)

Total error estimates ignoring stilling well effects
(Perspective) Wharf thermal expansion, order +/- 5 mm

CHS sensors

$.2K	$.5K	$1K	$5K	$.8K	$1.7K	$5K	$5K
+/- ~5-10 cm	+/- ~2-3 mm	+/- ~1-2 cm	+/- 1% ~2-3 cm	+/- 1% ~2-3 cm	+/- ~2-3 mm	+/- ~1-2 cm	+/- 1% ~2-3 cm
1) Tide Board	2) Tape Drop: standard device used to set relative sensors, (sensors with offsets)	3) Float and Pulley CHS Legacy sensor	4) Bubbler Sutron continuous fast response bubbler	5) Submersible pressure sensor Spectre Sensor	6) Laser sensor: Dimetix DLS-B15	7) Radar sensor:	8) Acoustic sensor:



Stilling well required – R

Stilling well Optional – O

Relative Measurement – R (must be set relative to a known)

Absolute Measurement – A (direct measurement)

Due to environmental conditions (ice) many Canadian sites require the use of stilling wells

Sensors, loggers, data sampling

- **Pacific gauges:** dual float and pulley optical encoder sensors, pressure sensor backups, radar sensors, Sutron Xpert logger, 1 minute averaged data, hourly downloads, data available next day on CHS Pacific web pages (www.bctides.ca), data fed monthly to ISDM (Integrated Science Data Management, National environmental data archive)
  - Pacific Tsunami Warning System gauges (GOES, MSAT)

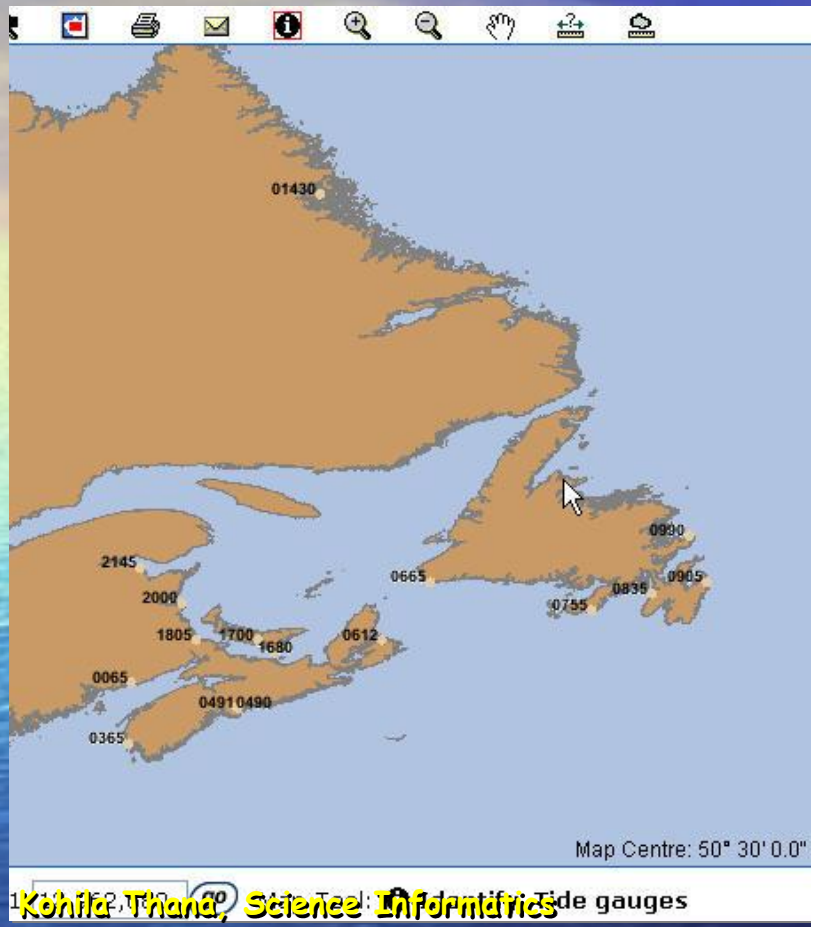
- **Central & Arctic gauges:**
  - Arctic: bubbler sensors, Sutron 8210 loggers, 3 minute sampling, daily downloads
  - Great Lakes gauges: dual float and pulley optical encoder sensors, 3 minute sampling, daily downloads,
  - Data available next day to ISDM (Integrated Science Data Management) and on CHS National water level site (http://www.waterlevels.gc.ca)

- **Quebec gauges:** tripple pressure sensors with temp + salinity, Watchman data loggers, Sineco real-time water level navigational system provides live QC data for navigation (St. Lawrence Seaway), quasi real-time data on CHS National water level site

- **Atlantic gauges:** laser-float multi-well systems, float and pulley optical encoders, bubblers, pressure sensors (3 sensors per station), 1 minute averaged data, 10 minute download, real-time data available to Atlantic storm surge and tsunami warning system on password protected web pages, quasi real-time data on CHS National water level site

- ISDM supplies 15 minute data to UHSLC and monthly mean data are submitted yearly to PSMSL

Atlantic EMO RTWL Web Pages



Kohila Thand, Science Informatics

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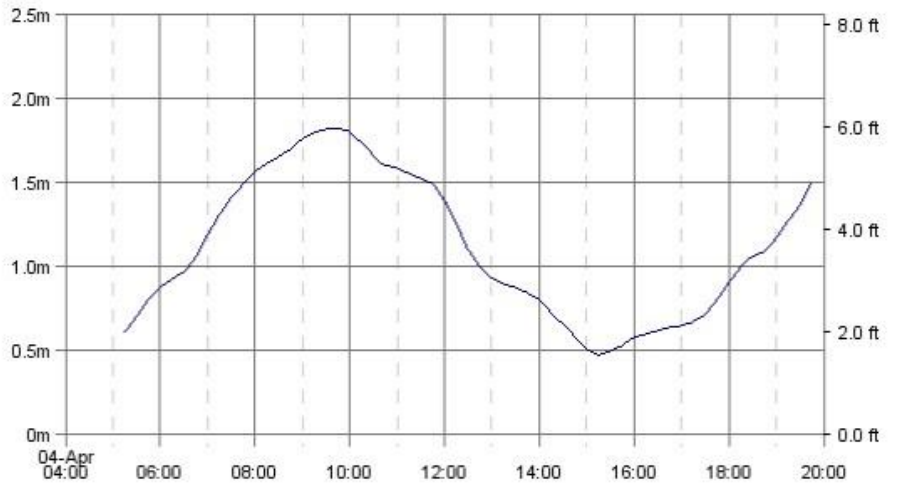
Tidal Water Level At: St Lawrence, NFLD

Bedford Institute * (Station #491)

Water Level Observations for the last 24 hours

Time Zone : ADT - Reference : Chart Datum

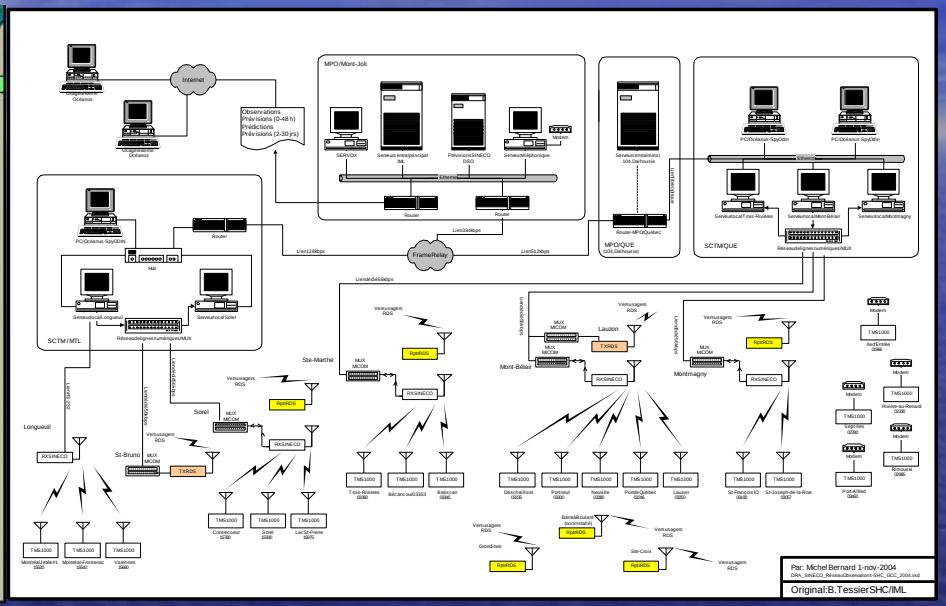


Source: http://www.tides.gc.ca/

Print

Prediction — Primary Encoder — Residual

Quebec's Sineco System (St Lawrence seaway)



- Broadcast modeled (river stage model) predictions and real-time observed waterlevels with interpolation between stations, originally radio, now web based.
- Uses GPS positioning and a continuous datum model for offset from ellipsoid to CD

New constituent analysis methods

Versatile Harmonic Tidal Analysis: Improvements and Applications

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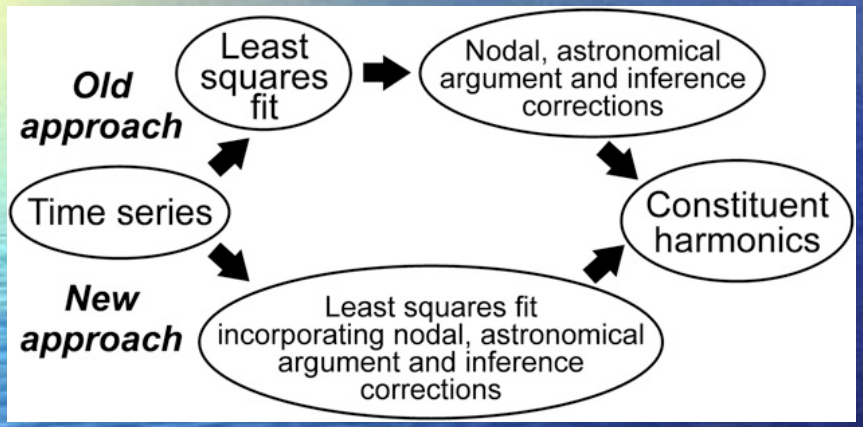
Institute of Ocean Sciences, Fisheries and Oceans Canada, Sidney, British Columbia, Canada
V. A. BALLANTYNE
Canadian Hydrographic Service, Fisheries and Oceans Canada, Sidney, British Columbia, Canada

(JOURNAL OF ATMOSPHERIC AND OCEANIC TECHNOLOGY, 2009, Vol 26)



Old Approach

$$h(t_j) = Z_0 + \sum_{k=1}^{n} f_k(t_0) A_k \cos\left[\omega_k(t_j - t_0) + V_k(t_0) + u_k(t_0) - g_k\right] + R(t_j), \quad (1)$$

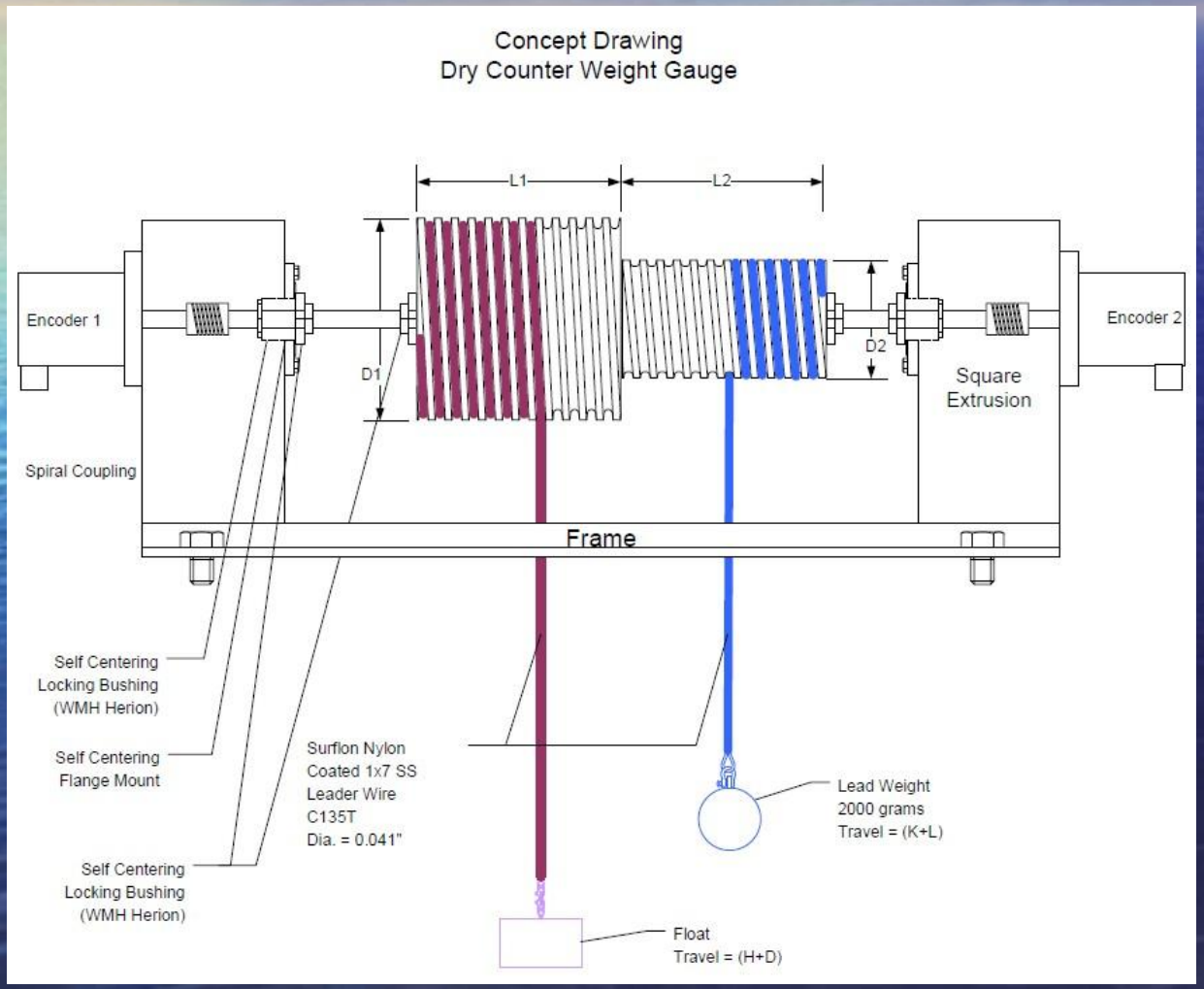
New Approach

$$h(t_j) = Z_0 + at_j + \sum_{k=1}^{n} f_k(t_j) A_k \cos\left[V_k(t_j) + u_k(t_j) - g_k\right] + R(t_j). \quad (4)$$

Permits analysis of long time-series and determination of long period constituents SA, SSA without vector averaging, new code allows direct selection of constituents for solution.

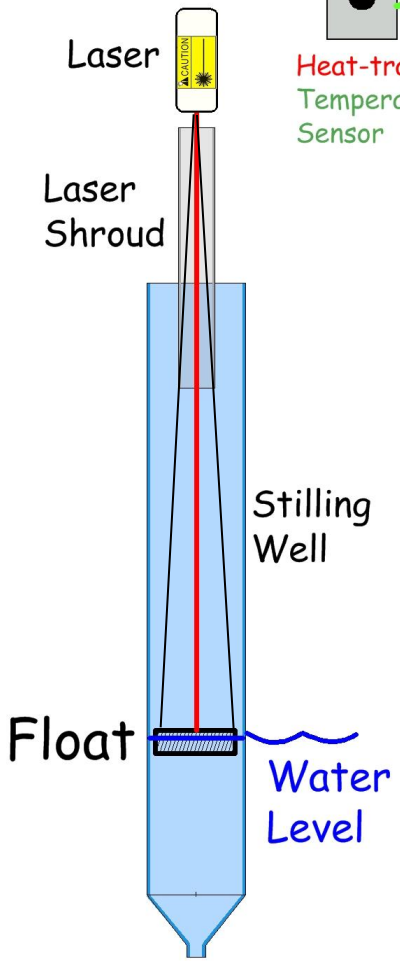
Significant Ongoing Initiatives (whats new?)

- Water level system technology developments
  - Pacific dry counter-weight system
  - Atlantic insulated, heated, laser-float multi-well system

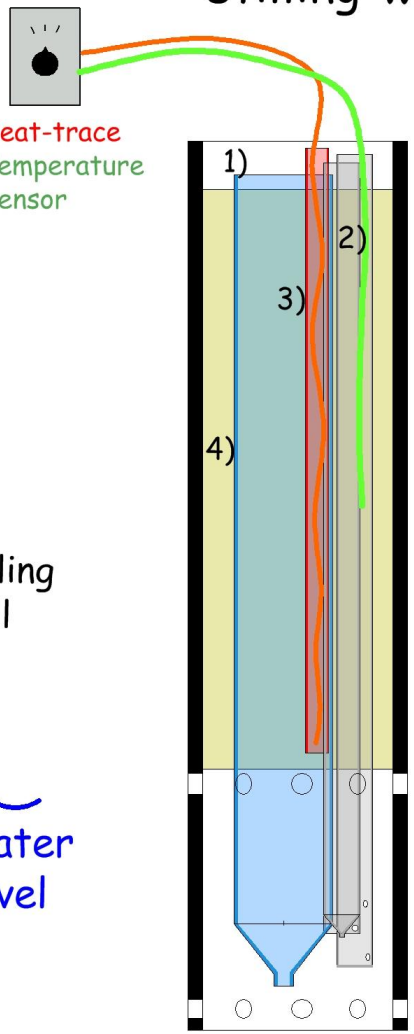


Insulated, heated multi-well and laser sensor

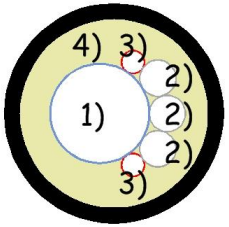
Laser-float Sensor



Insulated, mult-well stilling-well system



Mult-well Cross-section



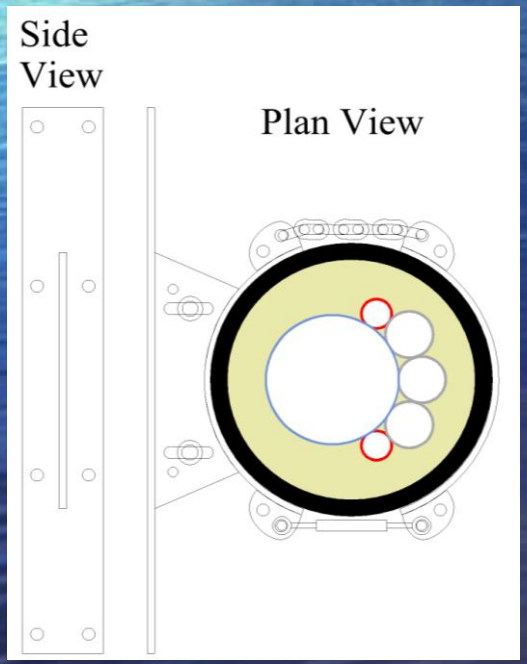
1) Primary laser well
2) Secondary sensor wells
3) Heater tubes
4) Marine foam insulation

Nain, Labrador Installation

Well Construction

Transport + Install

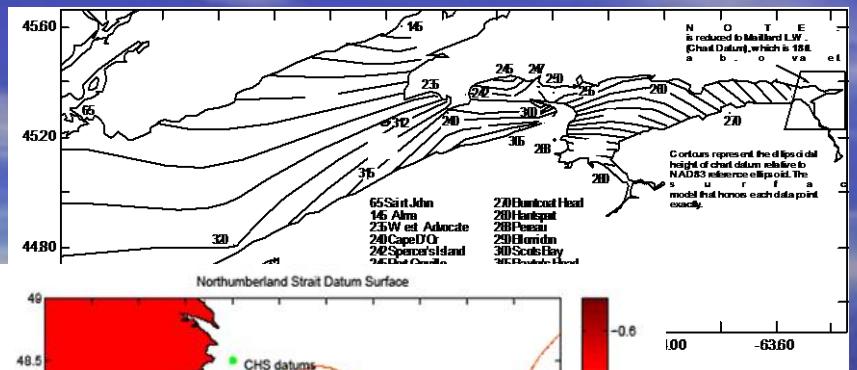
St John's Installation (wharf mount) 2008

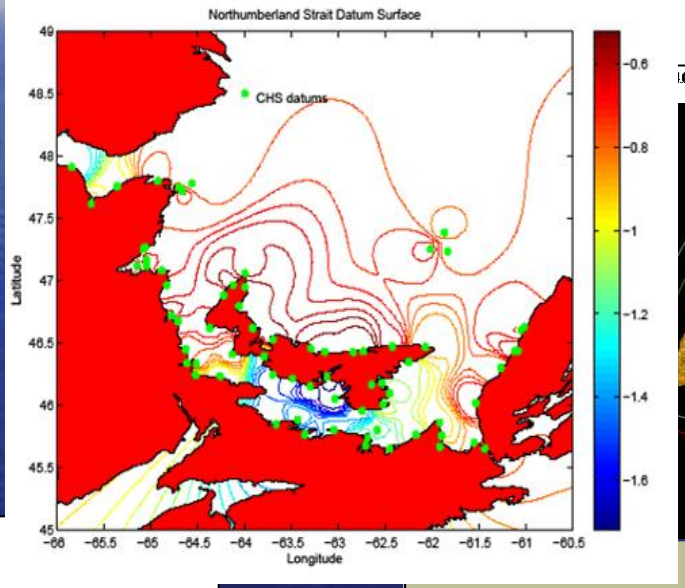


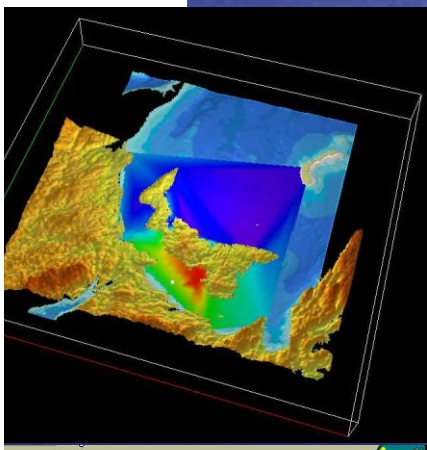
St Lawrence and Bonavista 2010

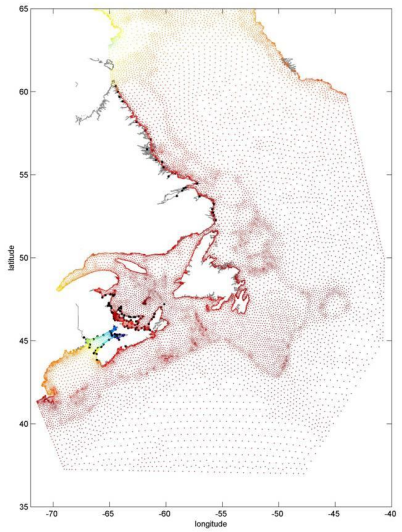
Examples of earlier Canadian continuous vertical datums

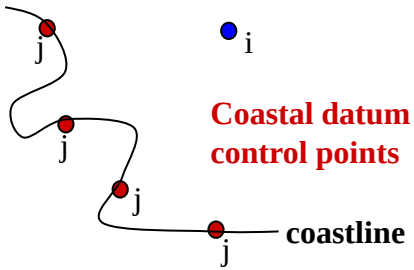
- Bay of Fundy survey datum (CD_NAD83)
- Northumberland Strait survey datum CD_NAD83)
- Sineco
- Webtide (MWL_CD)











Coastal datum control points

$$T_i = \sum t_j w_j, \quad \sum w_j = 1$$

$$w_j = \frac{(far - dist_j)^p}{\sum_j (far - dist_j)^p}$$

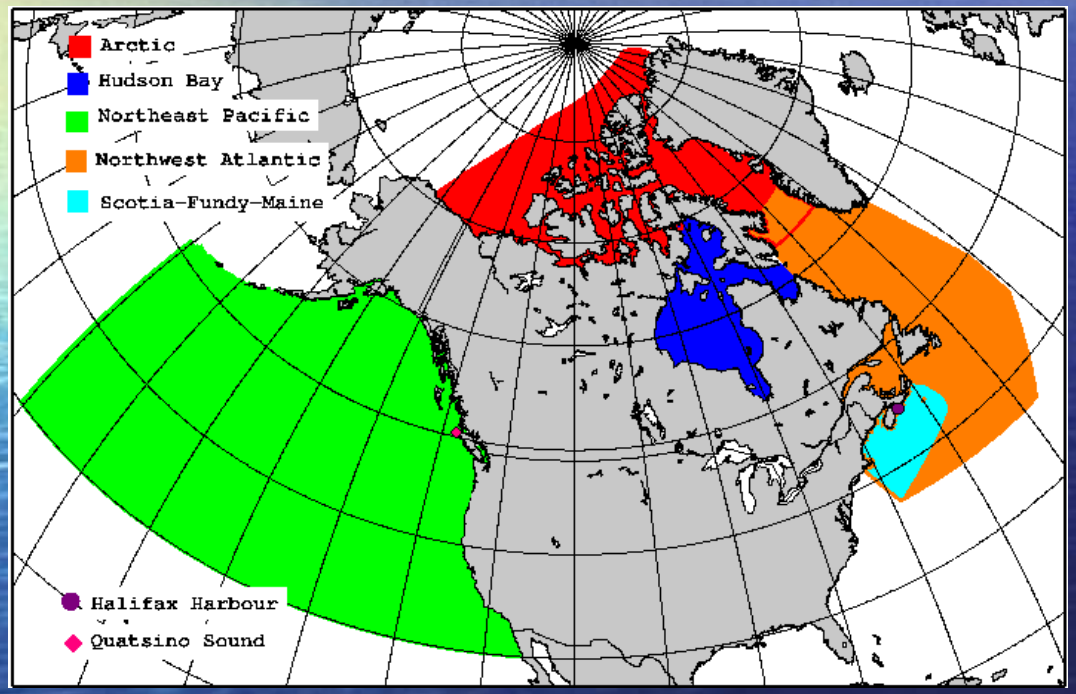
Canadian Continuous Vertical Datum Project

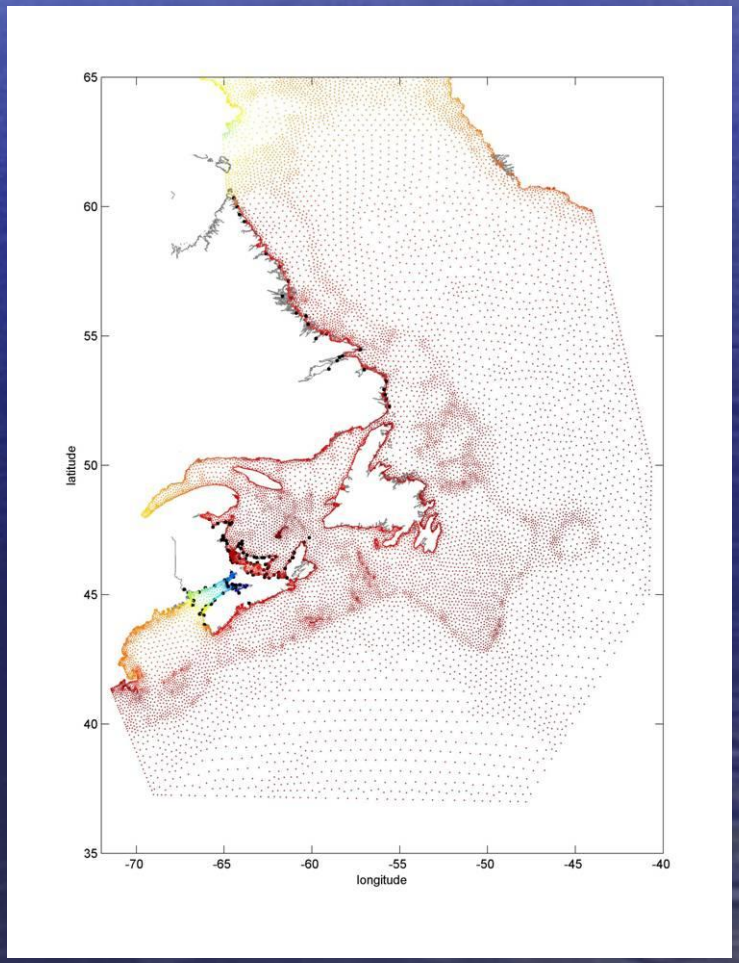
- National in scope: develop common strategies for all CHS regions (Pacific, Central and Arctic, Quebec and Atlantic)
- Present Status:
  - Planning methods
  - Collecting, collating and improving shore based data and control
  - Obtaining funding (this will ultimately determine timescale)
- Strategy:
  - Clean up shore based datum and target holdings and establish solid links to reference systems, NAD83(CSRS)xxxx, CGVD28
    - In Progress, 24 hr occupations, NRCan PPP processed, references to NAD83(CSRS)2006 and CGVD28 (modeled HTv2.0)
  - Mean water level in open ocean or far from land from satellite altimetry
  - Open ocean and far from land transformations MLW_CDxxxx and to LATxxxx, HHWLTxxxx … (Ocean Modeling)
  - Link offshore to shore based data (methods still under discussion May 2010, combination of VDATUM and VORF methods)

Starting with Webtide (really just an interpolation engine), Canadian version of the US VDatum tool including constituent based water level prediction

(test version completed)

Pred_CD, NAD83(CSRS)_CD, any gridded reference_CD





Constituents derived from a Hydrodynamic Barotropic Ocean Model Assimilating Topex Posieden Altimeter data

Dupont, F., C.G. Hannah, D.A. Greenberg, J.Y. Cherniawsky and C.E. Naimie. 2002. Modelling system for tides for the North-west Atlantic coastal ocean. [online]. [Accessed 21 April, 2008]. Available from World Wide Web: http://www.dfo-mpo.gc.ca/Library/265855.pdf

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