Using Globally-Corrected GPS Solutions to Assess the Viability of Hydrodynamic Modeling in the Bay of Fundy

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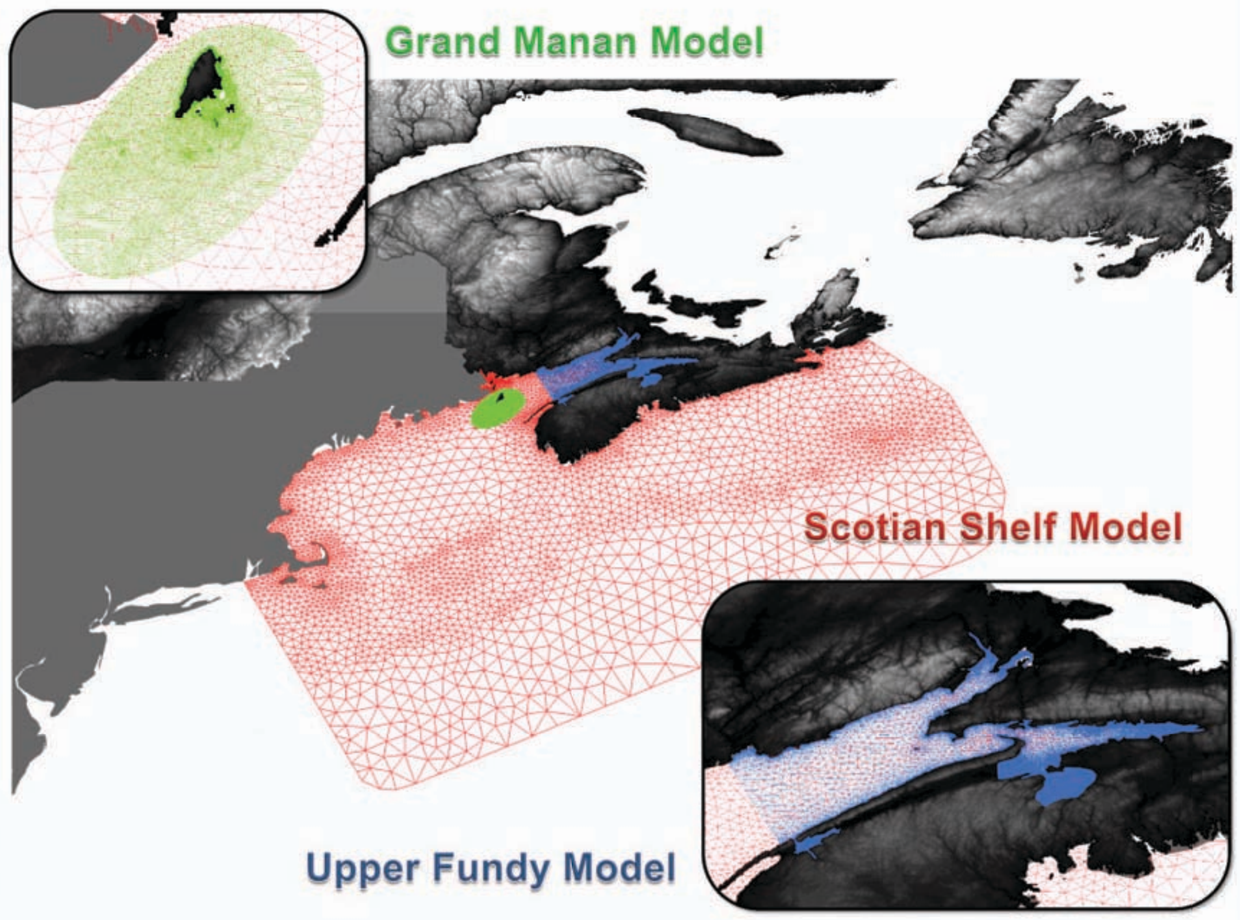
Abstract

Traditionally, hydrodynamic models are tuned to best reproduce observed tidal constituents within the model domain. Such observations are normally limited to coastlines at the edges of the model and are often in small bays cut off by constrictions that are not resolved by the model and thus may not be representative of the tides just offshore.

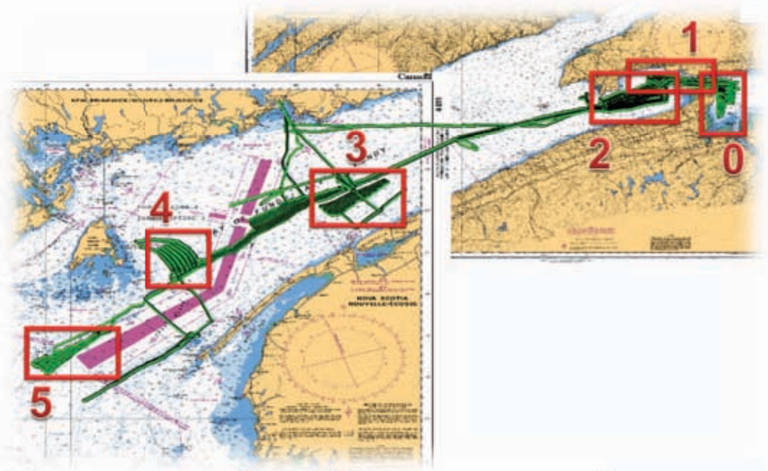
Now that Globally–corrected GPS (GcGPS) elevations are available at decimetre-level accuracy, it is possible to test the validity of hydrodynamic models in open water regions through comparison of instantaneous sea level variations from vessel transits. Rather than testing at a point location, transects can be made through critical choke point areas where phase and amplitude are predicted to change very rapidly. These observations can check on the fidelity of the model in these sensitive regions.

As part of the regional mapping operations within the Bay of Fundy under the Geoscience for Ocean Mapping program of NRCan, four different vessels have been collecting GcGPS using either Fugro Omnistar HP or C-Nav. Post Processed Kinematic (PPK) GPS was also obtained from the Princess of Acadia ferry which crosses the Bay of Fundy daily. Results of comparisons of the long period (minute+) vertical perturbations of these vessels is presented with respect to both the regional WebTide Scotian Shelf hydrodynamic model and nested higher resolution models.

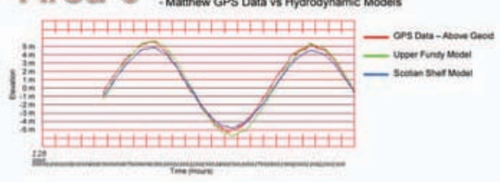


CCGS Matthew

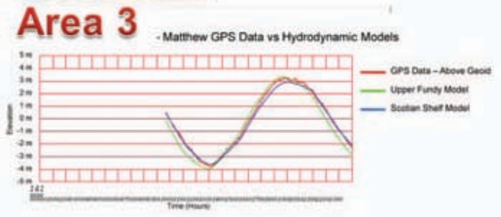
The CCGS Matthew steamed throughout the Bay of Fundy during the 2007 survey season. The orthometric heights derived from the Matthews OmniSTAR GPS data can therefore be compared to the Upper Fundy model, the Scotian Shelf model and the Grand Manan model as it stretches throughout the bay. To simplify the analysis procedure, the Matthew GPS data was divided into 6 smaller regions.



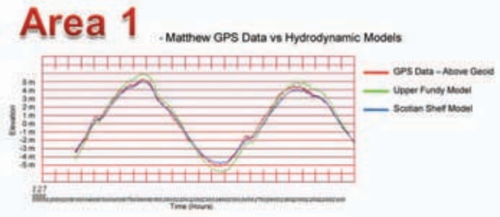
Area 0 - Matthew GPS Data vs Hydrodynamic Models



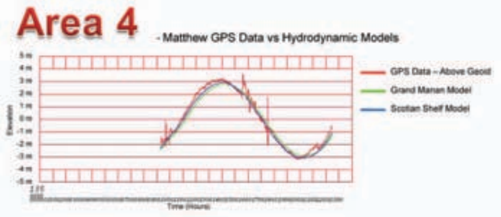
Area 3 - Matthew GPS Data vs Hydrodynamic Models



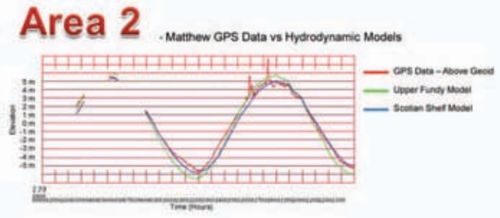
Area 1 - Matthew GPS Data vs Hydrodynamic Models



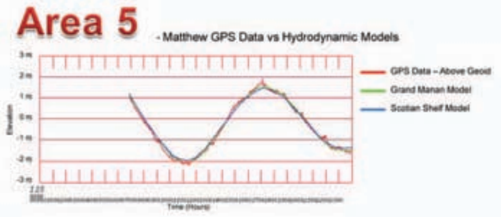
Area 4 - Matthew GPS Data vs Hydrodynamic Models



Area 2 - Matthew GPS Data vs Hydrodynamic Models

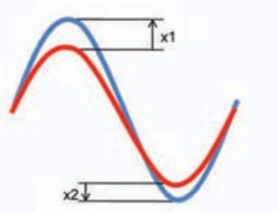


Area 5 - Matthew GPS Data vs Hydrodynamic Models



Tidal Range Difference (Model vs. GPS Data)

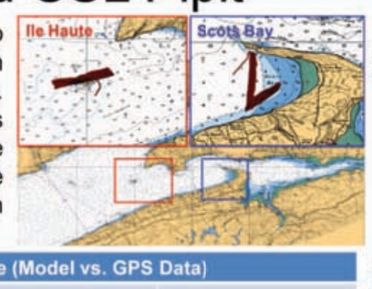
Difference = Model Tide Range– GPS Tide Range	Area 0	Area 1	Area 2	Area 3		Area 4	Area 5
Scotian Shelf	-0.9 m	-0.4 m	0.2 m	-0.4 m	**Scotian Shelf**	-0.1 m	-0.2 m
Upper Fundy	0.7 m	1.2 m	1.7 m	0.4 m	**Grand Manan**	-0.2 m	0.1 m



Range Difference = x1 + x2

CSL Plover and CSL Pipit

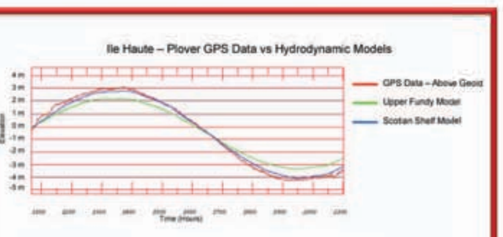
The CCGS Matthew has two survey launches which run in tandem with the Matthew. OmniSTAR GPS data was collected on both vessels for the survey season of 2007. One survey area was chosen for each vessel for analysis.



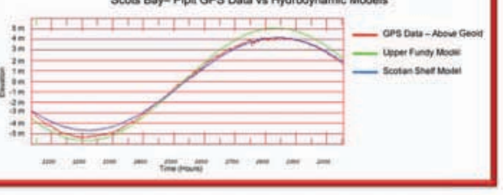
Tidal Range Difference (Model vs. GPS Data)

Difference = Model Tide Range– GPS Tide Range	Ile Haute	Scots Bay
Scotian Shelf	-0.4 m	-0.6 m
Upper Fundy	-1.7 m	1.3 m

Ile Haute – Plover GPS Data vs Hydrodynamic Models

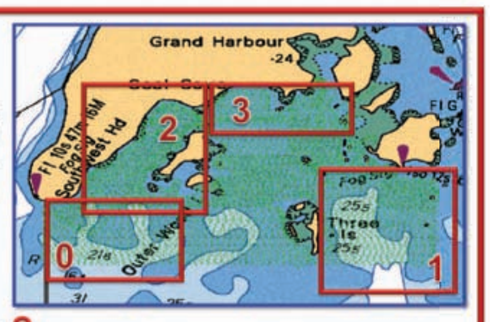


Scots Bay– Pipit GPS Data vs Hydrodynamic Models

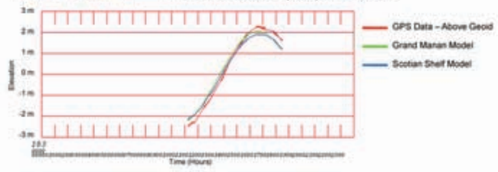


CSL Heron

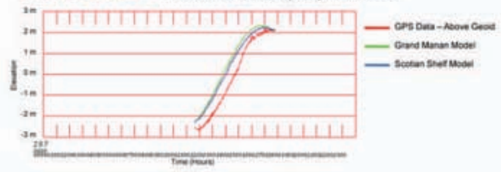
The CSL Heron spent the summer of 2007 performing hydrographic surveys at the southern tip of Grand Manan Island, within the Bay of Fundy. CNav Globally Corrected GPS was logged for the survey season. To simplify the analysis procedure, the Heron GPS data was divided into 4 smaller regions.



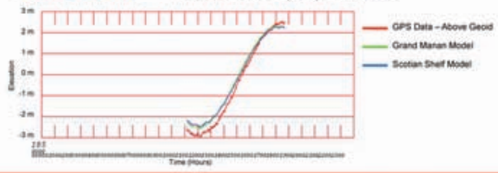
Area 0 – Heron GPS Data vs Hydrodynamic Models



Area 2 – Heron GPS Data vs Hydrodynamic Models



Area 1 – Heron GPS Data vs Hydrodynamic Models

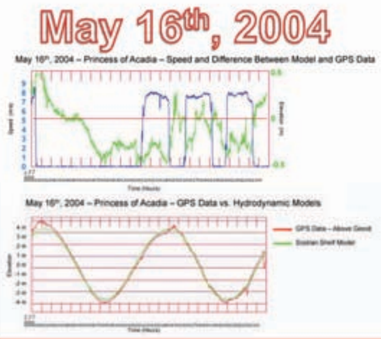


Area 3 – Heron GPS Data vs Hydrodynamic Models

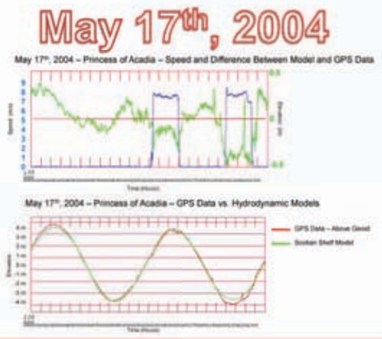
Princess of Acadia

In 2004 a project was established to collect GPS data on the Princess of Acadia ferry, operated by Bay Ferries, during its transit between Saint John, New Brunswick, and Digby, Nova Scotia for one year. The data was post processed using additional data from base stations at Saint John and Digby to achieve centimetre level precision. One week of data was examined for analysis, May 16th, 2004 to May 21st, 2004, three days of which are shown here.

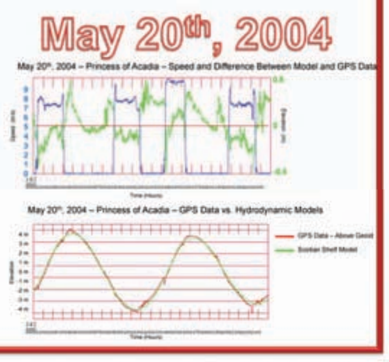
May 16th, 2004



May 17th, 2004

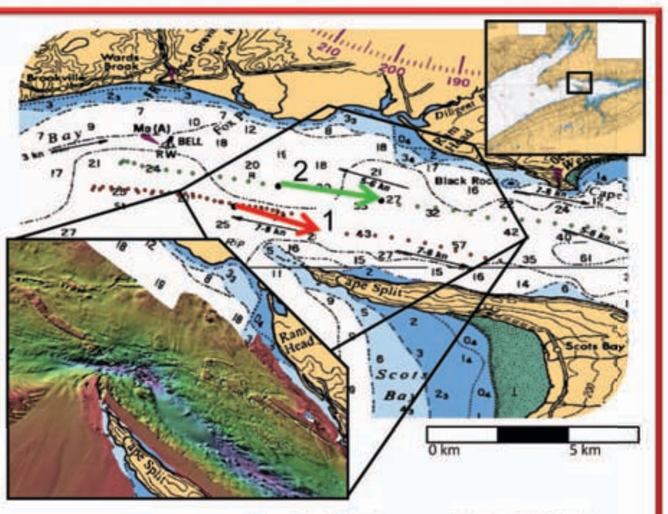


May 20th, 2004

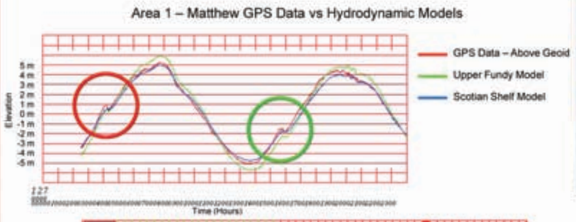


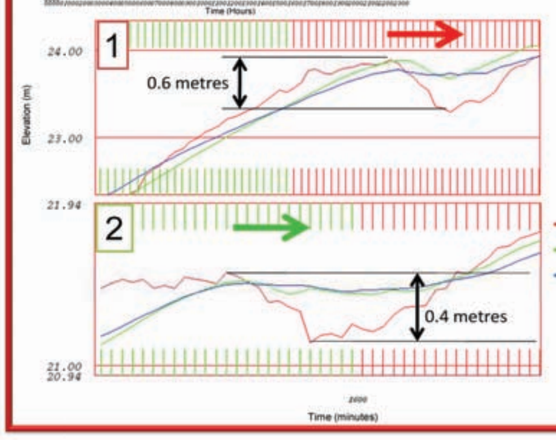
Minas Passage

While the Matthew steamed through Area 1, an anomaly was observed in the GPS data as the vessel travelled from west to east in the Minas Passage. The vessel fell approximately half a metre in seven minutes over three kilometres during the flood tide.



Area 1 – Matthew GPS Data vs Hydrodynamic Models





The Upper Fundy model does a better job of resolving the step like anomaly, presumably because the higher resolution grid better defines the area bathymetry, yet the model does not resolve it to the extent described by the GPS data.

Ian Church is from Fredericton, New Brunswick, Canada. He graduated from the University of New Brunswick with a Bachelors degree in Geodesy and Geomatics Engineering in 2006 and is currently pursuing his Master of Science in Engineering with the Ocean Mapping Group under the supervision of Dr. John Hughes Clarke.

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