Data Acquisition and Processing Report

Summer Hydro 2013

Gulf of Maine survey

Between New Castle Island and Concord Point, New Hampshire
CCOM/JHC, UNH

Party Chief: Semme Dijkstra

Group Members:

Karolina Chorzewka
Htike Htike
Josh Humberston
Xinh Sy Le
Han Hu
Derek Sowers
Eunice Tetteh
Alice Qian Yin
Takafumi Hashimoto
Ashley Norton
Stanley Lim
Fang Yao

Publish date: June 2013

Contents

LIST OF FIGURES

LIST OF TABLES

A. Equipment

A.1 Survey Vessels

A.1.1 . R/V Coastal Surveyor

The Research Vessel (R/V) Coastal Surveyor was used as the acquisition platform for this multibeam survey. A Kongsberg EM2040 shallow water multibeam echosounder was mounted on the bow ram of the vessel.

Length	12.2 m
Beam	3.6 m
Maximum Draft	1.13 m
Flag	U.S.
Registry	U.S. Coastwise and Registry
Top Speed	10 knots
Roll Stabilization	Niad Active Fins
GPS	Garmin GPS17, WAAS Enabled
GNSS Antennas (GPS)	2 Trimble Zephyr Antennas
Telemetry	Trimble Trimark 3
GNSS Receiver (RTK GPS)	Applanix POSMV 320 V4 with IMU 200
Attitude	Applanix POSMV 320 V4 with IMU 200
Primary Echosounder	Kongsberg EM2040

Table 1: R/V Gulf Surveyor specifications

Figure 1: R/V Coastal Surveyor Adjustable bow ram with winch and transducer mount.

The research vessel (R/V) Cocheco was used as data acquisition platform for bottom samples and underwater video.

<table>
<tr><th colspan="2"><i>R/V Cocheco</i></th></tr>
<tr><td colspan="2"> </td></tr>
<tr><td>Length</td><td>10.4 m</td></tr>
<tr><td>Beam</td><td>3.7 m</td></tr>
<tr><td>Draft</td><td>1.7 m</td></tr>
<tr><td>Cruising Speed</td><td>16 knots</td></tr>
<tr><td>Minimum survey speed</td><td>3-4 knots</td></tr>
<tr><td>Propulsion</td><td>Luger L6140AL2 w/ ZF350IV transmission, 600HP Marine Diesel</td></tr>
<tr><td>GPS</td><td>Garmin GPS17, WAAS Enabled</td></tr>
<tr><td>GPS Antennas</td><td>Trimble 27207</td></tr>
<tr><td>Differential GPS</td><td>Trimble DSM212h</td></tr>
<tr><td>Bottom Sampler</td><td>Wildco Shipek Grab Sampler</td></tr>
<tr><td colspan="2">Additional Equipment:
- Navigation Computer
- A-frame and Hydraulic Winch
- 300-foot cable with slip ring
- Internal gigabit network</td></tr>
</table>

Figure 2 : R/V Cocheco Inventory and Specifications

A.2 Echosounding Equipment - Multibeam Sonars

A.2. A Kongsberg EM 2040 multibeam echo sounder was used for this survey. The box housing the transmit and receive transducers was mounted firmly onto a secured arm at the bow of the vessel(**Error! Reference source not found.**).

Figure 3: - EM 2040 Transducer Face (left) and how it is mounted (right).

The EM 2040 consists of a transmit transducer and a receive transducer which communicate to a processing unit via Ethernet and a workstation running SIS for data acquisition. The EM 2040 can be operated at 200, 300 or 400 kHz with roll, pitch and yaw stabilization. There are many different options for operation, including equiangular, equidistant and high density sounding patterns, and normal and single sector modes. A swath of up to 140° is achievable for the single receiver mode, and can be operated with dual swaths to increase along-track sounding density.

Function	Equipment	Manufacturer Model	Serial Number
Echo Sounding	Multibeam Echosounder	Kongsberg EM2040	TX 107/RX 108
	Hydrographic Work Station	Kongsberg HWS14	1310
	Processing Unit	Kongsberg PU	201

Table 2: Multibeam Specifications

For the majority of this survey, the EM2040 was operated at 300 kHz, with a 140 swath, in single swath mode. The operating frequency of 300 kHz was chosen because it gave the maximum resolution while still allowing the sonar to operate at maximum coverage; in order to operate at 400 kHz (and therefore higher resolution), the maximum swath angle achievable would be reduced to 120°. Additionally, the sonar was operated at high density equidistant sounding pattern, with normal bottom detection, and short CW pulse (no modulation) type. This sonar was also operated in normal mode, which gave it multisector capability.

Parameters	Setting selected	Remarks
Operating mode	Normal Mode	3 sectors were used during data acquisition to provide a more uniform data distribution within each swath.
Frequency	300 kHz	This option provided sufficient resolution and a more efficient swath width (140^0) than allowed by the 400 kHz operating mode (120^0).
Beam Spacing	High density equidistant	This option provided a uniform distribution of soundings on the seafloor within each swath.
Bottom Detection Mode	Normal	Normal bottom detection mode was used.
Pulse length	Short CW (FM disabled)	A short pulse length was used to obtain high resolution data.
Dual Swath Mode	Off	A single swath was used.

Table 3: Setting parameters in SIS

A.5 Positioning and Attitude Equipment

A.5.1 Applanix POS/MV

Figure 4. Applanix PosMV 320 V4

An Applanix POS/MV 320 Version 4 was used to determine vessel position and attitude (heave, pitch, roll, and heading). These measurements were delivered to the EM 2040 to be used for real time beam steering and sounding corrections. The position and attitude system consists of a rack mounted version 2.12 PCS, an IMU-200, and two Trimble GNSS Zephyr I antennas.

Manufacture	Applanix		
Model	POS/MV 320		
Description	The Applanix POS/MV 320 V4 provides attitude, heading, position, and timing data		
PCS	*Manufacturer*	Applanix	
	Model	320 version 4	
	Description	The POS/MV computer system consists of a processor, GPS receiver, and interface cards. These elements allow the computer to process data from both the IMU and antennas.	
	Firmware Version	2.12	
	Software Version	3.4.0.0	
	Serial Number	PCS s/n	2171
IMU	*Manufacturer*	Applanix	
	Model	IMU-200	
	Description	IMU input provides active beam steering for effective compensation of roll, pitch, and yaw vessel movements.	
	Serial Numbers	IMU s/n	179
Antennas	*Manufacturer*	Trimble	
	Model	Zephyr	
	Description	There are two GPS antennas mounted to the top of the R/V Gulf Surveyor. The port antenna is the primary antenna; the starboard antenna was utilized to improve accuracy of heading measurements.	
	Serial Numbers	Port Side:6000 4279	
		Starboard Side: 6000 8122	

Table 4: Applanix POS/MV specifications.

Figure 5. Applanix POS/MV antenna configuration.

A.6 Sound Speed Equipment

A.6.1 CTD

A.6.1.1: SBE 19 SEACAT Profiler

A SBE 19 SEACAT Profiler was used to gather periodic regular measurements of conductivity, temperature and pressure in the water column within the survey area. The data from the CTD profiles was processed with SeaTerm and SBEProcessing software to derive sound velocity profiles of the water column. The profiles were edited in SIS SVPEditor, saved in (.asvp) format and loaded into SIS for accurate operation of the multibeam sonar. Usually, 2-3 casts a day were sufficient, but on some hot days, in the shallow water, more casts were required to adequately document stratification of the water column.

Figure 6: *Seabird 19 CTD profiler*

Manufacturer	Seabird Electronics (SBE)
Model	SBE 19 SEACAT Profiler
Description	SBE 19 SEACAT Profiler was used to collect Conductivity, Temperature and Pressure (Depth) profiles of the water column during survey operations. From this, the sound velocity was calculated.

Table 5: Seabird 19 CTD specifications.

A.6.2 Surface Sound Speed

A.6.1.1: AML Smart X

An AML Smart X sound speed sensor was mounted on the bow ram of the Coastal Surveyor directly adjacent to the EM2040 transducer on the same pod. The continuous surface sound speed measurements were input into SIS on the Kongsberg workstation to ensure accurate beam steering.

Figure 7: An AML Smart X mounted at Transducer Head.

Manufacturer	AML
Model	Smart X
Description	An AML Smart X sound speed sensor was mounted on the bow ram of the Coastal Surveyor directly adjacent to the EM2040 transducers. The continuous surface sound speed measurements were input into Kongsberg’s SIS to ensure accurate beam steering.

Table 6: AML Smart specifications.

A.7 Horizontal and Vertical Control Equipment

A.7.1 RTK Base Station Equipment

An RTK base station broadcasts RTK corrections, which is to be received via the Trimble TRIMMARK 3 UHF modem on board the R/V Coastal Surveyor. The base station is permanently located on the roof of the Seacoast Science Center at Odiorne State Park, NH.

Figure 8: RTK base station at Odiorne Point.

GPS Antennas	*Manufacturer*	Trimble
	Model	Zephyr Geodetic
	Description	Base station antenna at Odiorne
	Serial Numbers	60004297, 60008122
GPS Receivers	*Manufacturer*	Trimble
	Model	5700
	Description	Odiorne Point base station is powered by A/C supply from the Science Center building. It continuously broadcasts RTK corrections via UHF radio at a frequency of 461.075 MHz, in CMR+ format.
	Firmware Version	Unknown
	Serial Number	220311827
UHF Antennas	*Manufacturer*	Trimble
	Model	24253-46
	Description	The CMR+ formatted correctors broadcast on UHF antennas. The antennas are able to transmit and receive at frequencies 450-470 MHz
	Serial Number	unknown
UHF Radios	*Manufacturer*	Trimble
	Model	Trimmark 3
	Description	The modem for broadcasting corrections from the RTK base stations.

	Firmware Version	unknown
	Serial Number	unknown
Solar Panels	No solar panels were installed.	
Solar Chargers	No solar chargers were installed.	
DQA Tests	No DQA tests were performed.	

Table 7: RTK Base Station specifications.

A.7.2 Trimble Trimmark 3

To locate the vessel position, the Trimble 5700 GPS receiver and the Trimble TRIMMARK 3 radio modern were installed on the vessel (RV Coastal Surveyor) to acquire the GPS data and the corrections transmitted from the base station, respectively.

UHF Radio Modem	*Manufacturer*	Trimble	
	Model	TRIMMARK 3	
	Description	UHF radio transmits RTK corrections to the POS/MV system.	
	Serial Number	UHF Radio s/n	
	Line of Sight	15km	
	Channels	20	
	Channel Spacing	12.5khz or 25kHz	
	Transmit Power	2W, 10W, 25W	
	Frequency	410-420MHz, 430-450MHz, 450-470MHz	
	Data Output	9600 baud rate	
	Range	10-12 km (for 25W), 5-8 km (for 2W)	
UHF Antennas	*Manufacturer*	Trimble	
	Model	24253-46	
	Description	UHF antennas receive the CMR+ correctors from the RTK base station. The antennas transmit and receive at frequencies of 450-470 MHz	
	Serial Numbers	UHF Radio s/n	Unknown

Table 8: Trimble Trimmark 3 Specifications

A.8 Ground Truthing Equipment

A.8.1 Wildco Shipek grab sampler

The grab sampler is lowered to the bottom from a deck winch. When the sampler reaches the bottom, the impact force of the grab sampler triggers a trip weight that releases springs that causes the scoops of the grab sampler to clamp shut. When the sampler is recovered to the boat deck, the bottom substrate samples were analyzed for grain size, sediment color, and any notable biological specimen. Specifications for the WILDCO SHIPEK grab sampler are provided in Table 13. Details for the Grab Samples are described in the Ground Truth Report.

Figure 9: Wildco Shipek grab sampler.

Manufacturer	WILDCO®
Model	SHIPEK® grab sampler (P/N 860-A10, S/N 3710)
Description	The Shipek sampler is designed for sampling unconsolidated sediments from soft ooze to hard packed sand. The sole driving force is the Shipek's® weight, which totals over 130 pounds with the trip weight. The body itself weighs about 40 kg (85 pounds) which is augmented by the trip weight 22 kg (48 lbs), which is securely fastened by two side pins.
Model	Shipek grab sampler (P/N 860-A10)
Serial Number	3710
Material	316 Stainless Steel
Size	472 x 638 x 422 mm
Weight	60 kg
Case	546 x 762 x 1092 mm
Volume	3000 mL
Sample Area	1/24 square meter
Bite depth	102 mm
Scoop top area	198 x 198 mm
Weight	Body: 49 kg; Trip weight: 22 kg

Table 9: SHIPEK Grab Sampler Specifications

A.8.2 Drop Camera System

Visual samples of the seafloor were collected using an Underwater Video Camera, commonly referred to as a ‘drop cam’ (Figure 12). Details of the Ground Truth Survey are described in the Ground Truth Report. Specifications for the drop camera setup are provided in Table 10.

Figure 10: Drop Camera Deployment

Manufacturer	CCOM/UNH: Paul Lavoie (designed and constructed cage), Ocean Systems (camera)
Description	The drop camera system provides *in situ* information of the benthic environment being mapped. This facilitates the linking of bathymetric surface characteristics (rugosity, slope, etc.), backscatter measurements, and physical characteristics (vegetation, sediment type, etc.) of the sample site.

Table 10: Drop camera specifications

A.9 Acquisition and Processing System

A.9.1 Acquisition Software

- **SIS** version 3.8.4 was supplied by Kongsberg Maritime for real time EM 2040 MBES data monitoring and processing. All sensor interfaces, sensor offsets and angular calibration biases were applied in SIS and were logged in raw .all data files.

- **Applanix POSView** version 3.4.0.0 from the Applanix Corporation was used to monitor and log POS MV data during survey operations.

- **Hypack 2012** version 12.0.0.1 was used for pre-survey line planning and for real-time vessel navigation. A helm display of the planned lines and navigational data provided by the POS MV for vessel line steering was extended from the acquisition control area of the vessel to the helmsman steering the vessel. Data was not recorded in Hypack during this survey.

  Seacast version 1.5.7 was used to download and process sound speed profile data from the Seabird 19 CTD profiler before applying the profile to SIS

Acquisition Software	Version	Purpose
SIS (Kongsberg)	3.8.4	real time EM 2040 MBES data monitoring and processing
Applanix POSView	3.4.0.0	monitor and log POS MV data
Hypack 2012	12.0.0.1	pre-survey line planning and for real-time vessel navigation
Seacast (SBE)	1.5.7	download and process sound speed profile data

Table 11: Acquisition Software Details

A.9.2 PROCESSING Software

- **CARIS HIPS and SIPS** version 8.0 was used for all post acquisition MBES data processing, visualization, and analysis.

- **Fledermaus FMGT** version 7.3.2b was used to process and create backscatter mosaics.

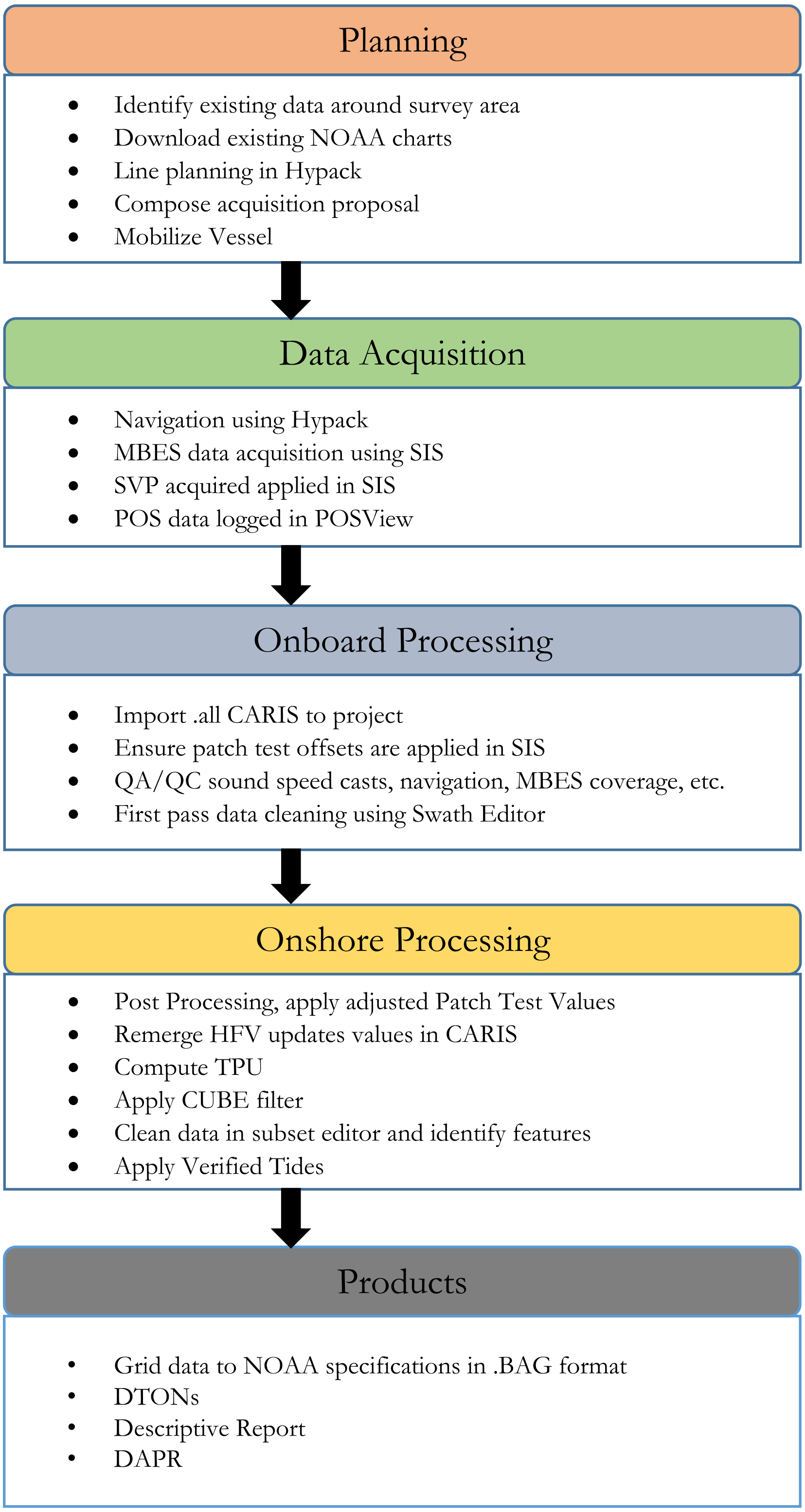
Processing Software	Version	Purpose
CARIS HIPS and SIPS	8.0	real time EM 2040 MBES data monitoring and processing
Fledermaus FMGT	7.3.2b	process and create backscatter mosaics

Table 12: Processing Software Details

B. Quality Control

B.1 Data Acquisition

B.1.1 Multibeam Echosounder



Planning

- Identify existing data around survey area
- Download existing NOAA charts
- Line planning in Hypack
- Compose acquisition proposal
- Mobilize Vessel

Data Acquisition

- Navigation using Hypack
- MBES data acquisition using SIS
- SVP acquired applied in SIS
- POS data logged in POSView

Onboard Processing

- Import .all CARIS to project
- Ensure patch test offsets are applied in SIS
- QA/QC sound speed casts, navigation, MBES coverage, etc.
- First pass data cleaning using Swath Editor

Onshore Processing

- Post Processing, apply adjusted Patch Test Values
- Remerge HFV updates values in CARIS
- Compute TPU
- Apply CUBE filter
- Clean data in subset editor and identify features
- Apply Verified Tides

Products

- Grid data to NOAA specifications in .BAG format
- DTONs
- Descriptive Report
- DAPR

Figure 11: MBES Processing Workflow

B.1.2 Sound Speed

B.1.2.1 Sound Speed Profiles

One to four sound speed profile measurements were made each day during data acquisition. Immediately after each profile cast was taken, the .log raw sound speed measurement file was downloaded from the instrument. The raw files was converted to SIS .asvp file format using Seacast software. The file was edited for any SIS formatting errors using the SIS SV Editor tool before being loaded in to SIS. The sound speed measurement surface measurements were input into SIS from the AML profiler during real-time acquisition was used by SIS for real-time ray tracing in conjunction with the real-time surface sound speed input. The SVP was not applied in CARIS was not used during post-acquisition data processing since it has previously been applied in SIS; however, all .asvp files that were used for data acquisition were converted to CARIS .svp format for GIS display in CARIS HIPS.

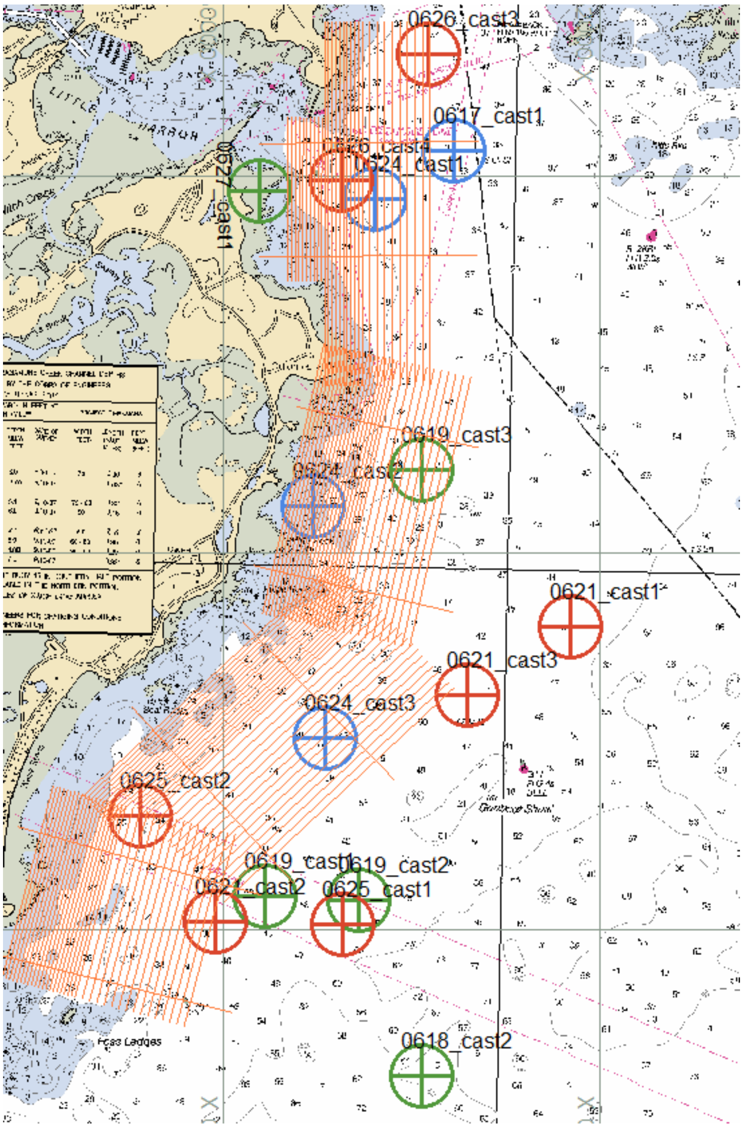


Figure 12: Example locations of sound speed profiles acquired for a survey

B.1.2.1 Surface Sound Speed

Surface sound speed at the transducer head was collected by an AML Smart X during survey operations. SIS directly used surface sound speed in its sonar operations.

B.1.3 Ground Truthing

Ground truth operations utilise an underwater camera and a SHIPEK Wildco sampler. Sample locations are pre-selected based on the bathymetry and backscatter data acquired during survey operations.

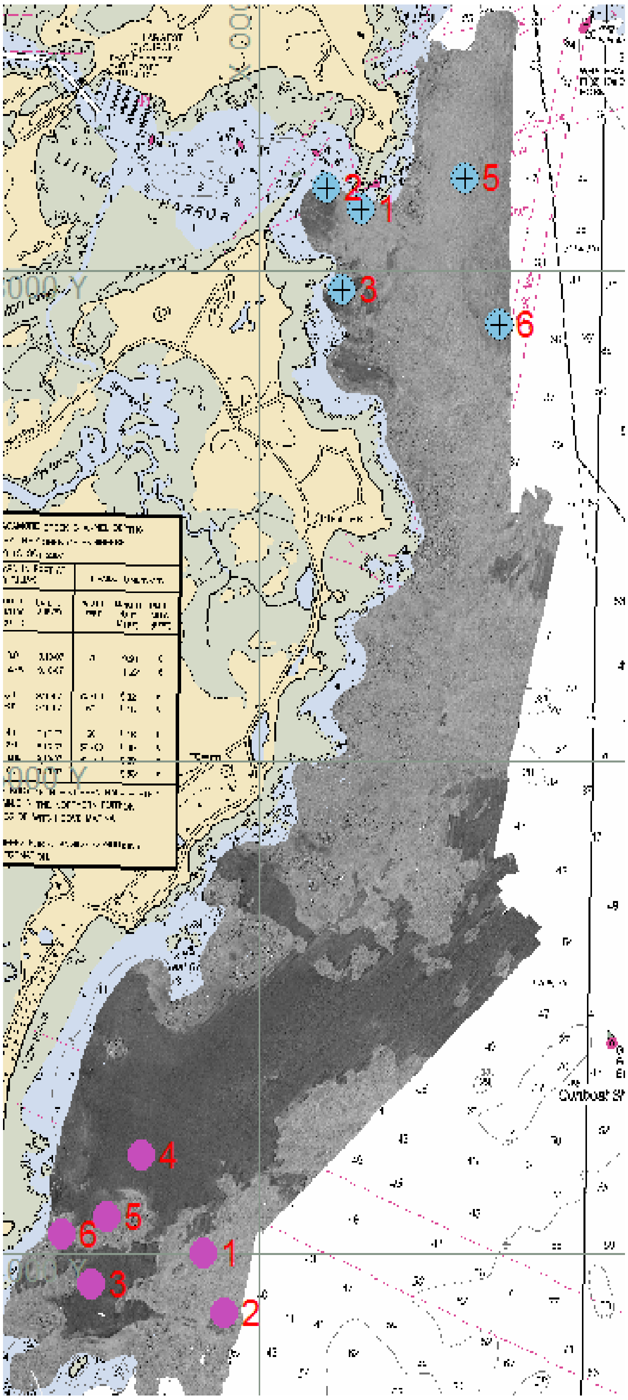


Figure 13: Example Ground Truthing Locations on Backsactter Map

B.1.4 Backscatter

Fledermaus FMGT version 7.3.2b was used to process and create backscatter mosaics.

B.2 Data Processing

B.2.1 Multibeam Echosounder

CARIS HIPS and SIPS version 8.0 was used for all post-acquisition data processing.

Project Creation and Data Import

A unified CARIS project with the additional calibration values in the vessel file was created for culminating all of the data collected during the survey. The .all files produced during data acquisition were imported into the project using CARIS's conversion wizard. Tide and true heave files were applied before computing TPU.

Data Analysis and Data Cleaning

The data was analyzed and cleaned using CARIS's swath and subset editors.

Surfaces Finalization

Once the data was cleaned and the TPU was calculated, a final 0.5 m CUBE surface was created using the NOAA cube specifications for a Special Order Survey.

Final Products

The final surface was exported from CARIS as a .bag file for viewing in other software.

B.2.2 Specific Data Processing Methods

B.2.2.1 Methods Used to Maintain Data Integrity

Acquisition and processing logs were maintained on a daily basis, and reviewed each day to ensure correct lever arms, angular offsets, and other correctors were applied during collection or in post processing. In instances of data holidays, adaptive line planning was carried out.

B.2.2.2 Methods Used to Generate Bathymetric Grids

Methods follow the specifications laid out in the NOAA NOS Hydrographic Surveys Specifications and Deliverables (2013).

B.2.2.3 Methods Used to Derive Final Depths

Final depths were derived via CUBE gridding parameters in CARIS.

B.2.3 Sound Speed

The surface sound speed probe's connection to SIS enabled real time beam forming and ray tracing. Sound speed profiles were uploaded into SIS after a quick preparation and quality control step. The SVP was not applied in CARIS was not used during post-acquisition data processing since it has previously been applied in SIS.

B.2.4 Backscatter

Data was processed in QPS FMGeocoder

B.4 Uncertainty and Error Management

B.4.1 Total Propagated Uncertainty (TPU)

According to the NOS standards for survey of special order, the maximum allowable Total Vertical Uncertainty at the 95% confidence level is determined using this formula:

$$\mp\sqrt{a^2 + (bxd)^2}$$

Where:

a is the portion of the uncertainty that does not vary with depth.

b is the coefficient that represents the portion of the uncertainty that varies with depth

d is the depth

bxd is the portion of the uncertainty that varies with depth.

Total Propagated Uncertainty values for this survey were derived from a combination of fixed values for equipment and vessel characteristics, as well as values for sound speed uncertainties. These values were included in the vessel configuration setup in CARIS.

TPU Standard	Value Entered in HVF
Motion Gyro (deg)	0.020
Heave %	5.000
Heave (m)	0.050
Roll (deg)	0.020
Pitch (deg)	0.020
Position Nav (m)	1.000
Timing Trans (s)	0.010
Nav Timing (s)	0.010
Gyro Timing (s)	0.010
Heave Timing (s)	0.010
Pitch Timing (s)	0.010
Roll Timing (s)	0.010
Offset X (m)	0.010
Offset Y (m)	0.010
Offset Z (m)	0.010
Vessel Speed (m/s)	0.300
Loading (m)	0.010
Draft (m)	0.010
Delta Draft (m)	0.010
MRU Align StdDev gyro	0.000
MRU Align StdDev R/P	0.000

Table 13: TPU used in processing MBES data

C. Corrections to Echosoundings

C.1 Vessel Offsets

C.1.1 Description of Correctors

The R/V Coastal Surveyor offsets are surveyed annually by the Ocean Mapping class students while the vessel is out of the water and are well established. The offsets available on the Coastal Surveyor website were used for sensor integration, and were verified with laser rangers and tape while the R/V Coastal Surveyor was alongside the UNH pier in New Castle, NH, prior to data acquisition. The relative offsets between the sonar head (TX and RX transducers) RPs, and the primary POS/MV GNSS antenna to the top of the POS/MV IMU were of primary interest since the top of the POS/MV IMU was used as the vessel RP, located along the centerline of the vessel near the center of motion. The RX and TX offsets were entered into SIS for correction during acquisition.

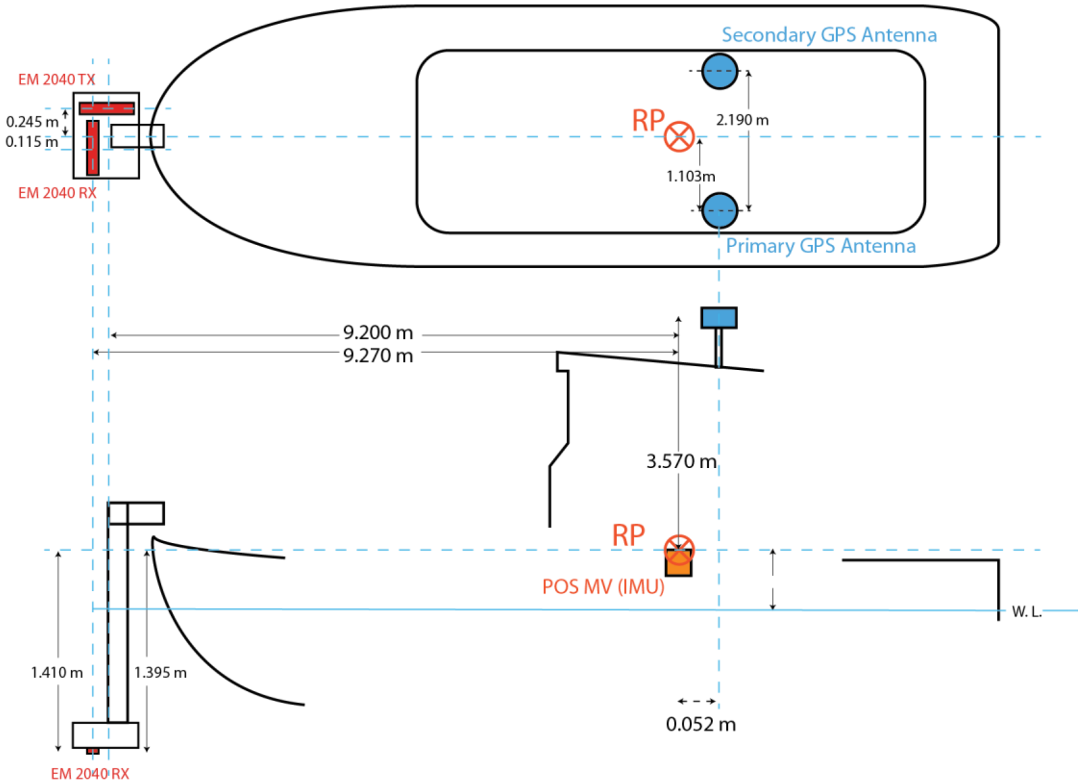


Figure 14 - R/V Coastal Surveyor Offsets

C.2 Static and Dynamic Draft

C.2.1 Static Draft

Static draft measurements were taken daily while the vessel was stationary in the survey area and noted in the daily data acquisition and processing logs which are available digitally. An inboard clear draft tube located inboard of the vessel provided visual access for measurement of the water level to the vessel reference point on the IMU. These observed values were applied in SIS as the water level before starting to survey every day. The daily variations in draft measurements were recorded for calculating the uncertainty due to static draft.

C.2.2 Dynamic Draft

Dynamic draft is derived from the settlement and squat characteristics of vessel. These characteristics of the RV Coastal Surveyor were determined by an RTK survey performed by CCOM/JHC and were documented in a 2006 report (Appendix II). They measured the height change of the vessel with changing the vessel speed. These values were input into the Caris vessel file and used in post processing for correcting the vessel dynamic draft.

Speed (m/s)	Error (m/s)	Height (m)	Error (m)
0.000	+/- 0.406	-0.000	+/- 0.0448
0.514	+/- 0.406	-0.025	+/- 0.0448
1.029	+/- 0.406	-0.040	+/- 0.0448
1.543	+/- 0.406	-0.043	+/- 0.0448
2.058	+/- 0.406	-0.035	+/- 0.0448
2.572	+/- 0.406	-0.017	+/- 0.0448
3.087	+/- 0.406	0.012	+/- 0.0448
3.601	+/- 0.406	0.053	+/- 0.0448
4.116	+/- 0.406	0.104	+/- 0.0448
4.630	+/- 0.406	0.166	+/- 0.0448
5.114	+/- 0.406	0.239	+/- 0.0448

Table 14: Dynamic Draft Values used in the hydrographic vessel file (HVF) for R/V Coastal Surveyor

C.3 System Alignment

C.3.1 Patch Test

Patch tests were conducted on June 14th, June 18th, and June 26th. The initial patch test was examined in SIS and the calibration was applied in SIS. Subsequent patch test calibrations were applied in CARIS during post processing.

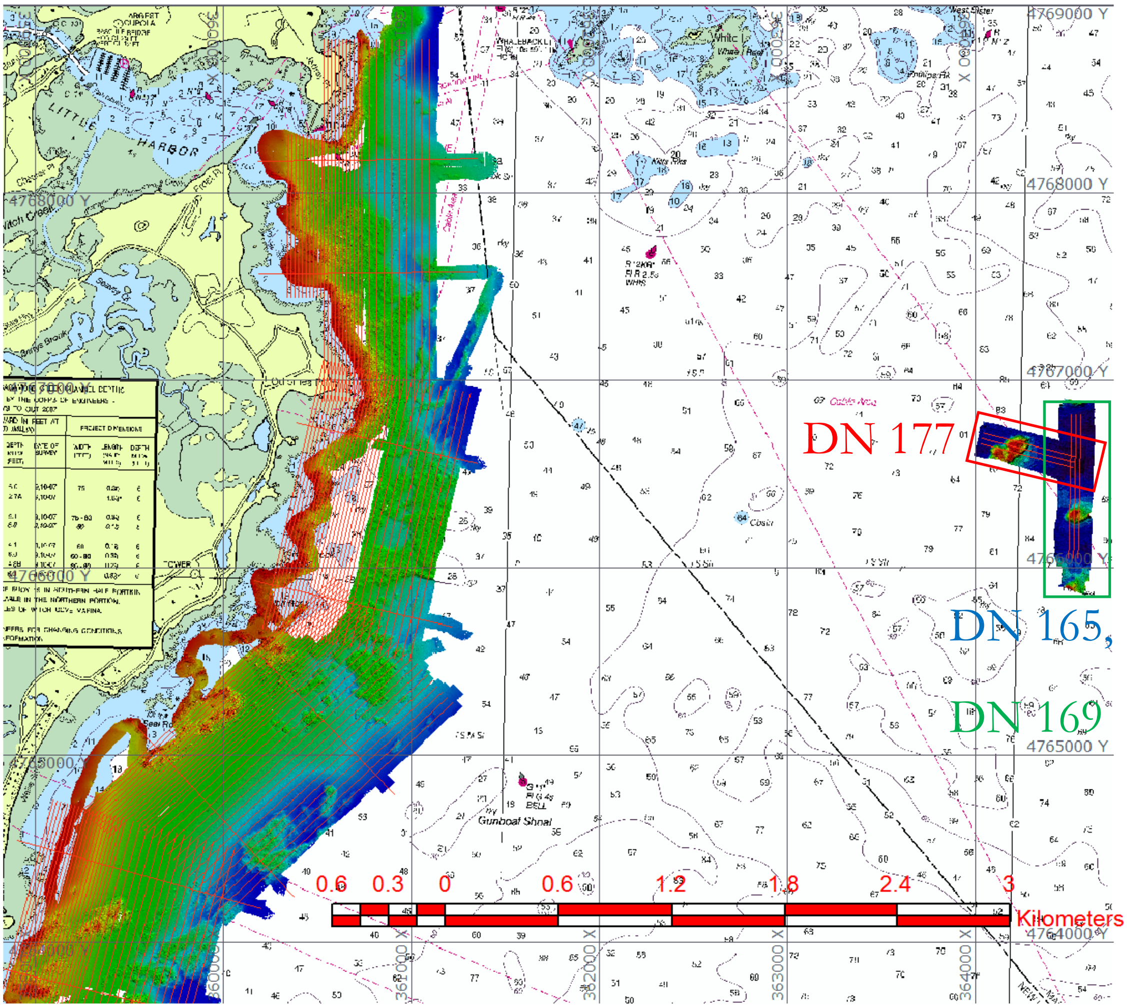


Figure 15: Overview of patch test line plan

The patch test results conducted were analyzed and the resulting surfaces compared. All data were collected using the following calibration values (Roll: -1.45, Pitch: 1.5, Heading: -1.7, Timing: 0) and further corrected in CARIS using (Roll: -1.37, Pitch: 1.5, Heading: -1.7, Timing: 0). The additional roll angular offset (+0.08 deg.) was input into the Caris vessel file.

C.3.2 Patch Test Results

Test	Timing	Roll	Pitch	Heading
1	0	-1.45	1.5	-1.7
2	0	-1.37	1.5	-1.7
3	0	-1.40	1.25	-1.58
AVERAGE	0	-1.41	1.42	-1.66
SD	0	0.04	0.14	0.07
Final	**0**	**-1.37**	**1.5**	**-1.7**

Table 15: alignment correctors from patch test input into CARIS

C.4 Positioning and Attitude

The horizontal control for the entire surveys was RTK navigation with a GPS base station and a rover station (the survey vessel). The GPS base station for all surveyed area was located at Seacoast Science Center in Odiorne Point, New Hampshire. A correction signal transmission radio antenna was set at the roof of Seacoast Science Center (43° 02’ 43.38” N, 070° 42’ 49.74” W). The GPS data was acquired by the Trimble 5700 GPS receiver on the RV Coastal Surveyor and the position of vessel was determined by combining obtained GPS data with correction information transmitted from the Seacoast Science Center using the Trimble TRIMARK 3 radio modem.

A second base station was established at the Rye Harbor State Park (43-00-4.75707 N, 070-44-39.62734W) to provide RTK corrections for any areas that would not be covered by the first base station at Seacoast Science Center, but this station did not become necessary for the area surveyed.

Position and time datagrams from the POS/MV were output to SIS and Hypack in real-time and the fixed-RTK solution was monitored during data acquisition. A single POS/MV POSPac *.000* file was logged for each day of data acquisition, and the data was used to determine true heave for post processing.

North America Datum of 1983 (NAD-83) was used for the horizontal reference and UTM 19 N was used for projecting.

C.5 Sound Speed

C.5.1 Sound Speed Profiles

A Seabird SeaCat SBE19 CTD measured sound speed profiles. Immediately after each profile cast was taken, the .log raw sound speed measurement file was downloaded from the instrument, converted to SIS .asvp file format using Seacast software, edited for any SIS formatting errors using the SIS SV Editor tool, and loaded in to SIS. The SVP was not applied in CARIS was not used during post-acquisition data processing since it has previously been applied in SIS.

C.5.2 Surface Sound Speed

The AML Smart-X sound speed sensor provided continuous sound speed measurements to SIS. The real-time surface sound speed input to SIS enabled real-time beam steering and ray tracing.

D. Acceptance Sheet

Supervision Statement:

As Chief of Party, field operations for this hydrographic survey were conducted under my direct supervision, with frequent personal checks of progress and adequacy. I have reviewed the attached survey data and reports.

Approval Statement:

All field sheets, this Descriptive Report and all accompanying records and data are approved. All records are forwarded for final review and processing to the Processing Branch

Adequacy Statement: The survey data meets or exceeds requirements as set forth in the NOS Hydrographic Surveys and Specifications Deliverables Manual, Field Procedures Manual. Standing and Letters Instructions and all HSD Technical Directives. These data are adequate to supersede charted data in their common areas. This survey is complete and no additional work is required with the exception of deficiencies noted in the Descriptive Report.

Any Additional Statements:

Signing Personnel		
Approver Name	Approver Title	Approval Date
Capt. Andrew Armstrong, Ret. NOAA	Chief of Party	
Semme Dijkstra	Chief of Party	

APPENDIX A: Survey Operations Wiring Diagram

AML Smart –X used as the surface sound speed sensor below:

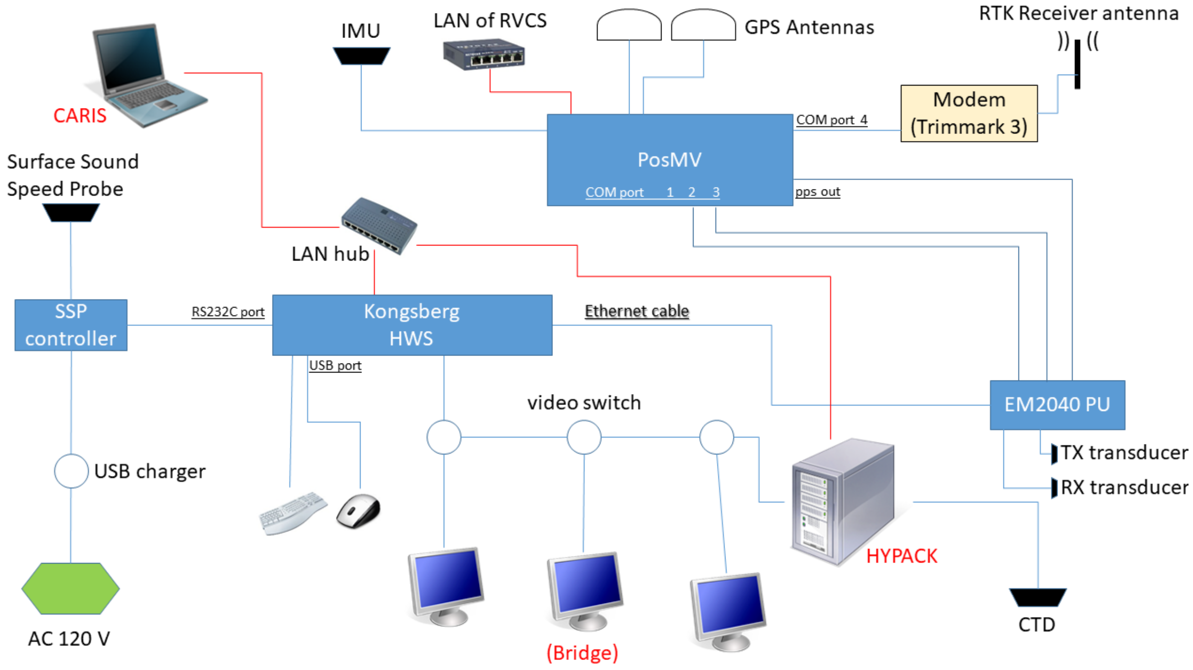


Figure 16: RVCS Survey Operations Wiring Diagram

APPENDIX B: Squat and settlement measurements for the R/V Costal Surveyor

Results from the 2006 Summer Hydrographic Field course

Version 0.1

Introduction

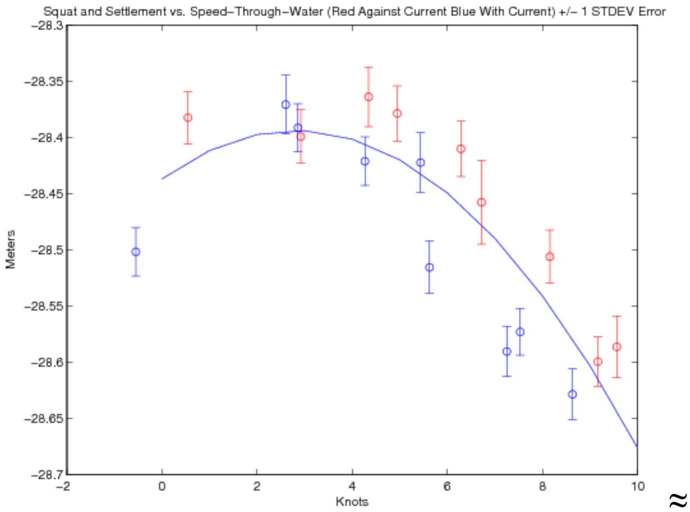
Measurements of settlement and squat were performed for the R/V Coastal Surveyor using RTK GPS. 18 measurement runs, each of 3 minutes in duration were performed at varying speeds. For each run, ellipsoidal height, pitch, speed-over-ground, speed-through-water and engine RPM were recorded at 1=second intervals. Eight measurement runs were performed into the tidal current, eight against the tidal current and 2 stationary with respect to the tidal current. Local tidal height measurements were recorded during the duration of the data taking runs which were used to correct measured ellipsoidal heights.

For each run, height of the transducer face was calculated from tidal-corrected mean ellipsoidal height reported at the IMU by the POSMV. Additional vertical translation due to vessel pitch was not included in the analysis, as this is accounted for by the EM3002 sonar.

Unfortunately, attempts at recording of speed-through-water was unsuccessful due to a computer glitch for many of the data runs. Therefore, speed-through-water was estimated by correcting mean speed-over-ground measurements recorded by the POS-MV for the mean tidal current. The mean tidal current was determined from the average of the speed-over-ground measurements obtained by the two stationary (dead-in-the-water) measurement runs.

Results

A plot of the settlement and squat characteristics of the R/V Coastal Surveyor represented as tidally corrected ellipsoidal height vs. ship-speed-through-the-water is shown in Figure 1. In this plot, red points indicate measurements against the current, while blue points indicate measurements with the current.



≈

Figure 1. Tidal corrected ellipsoidal height measurements for the R/V Coastal Surveyor. (Negative values indicate a lower riding vessel.)

The difference in measurements evident between those taken with and against the current is due to our coarse method of subtracting the mean current from each speed. However the fit of a second-degree polynomial provides a good representation of the data.

We then subtract the zero-speed height from the curve to give a relative height measurement for settlement and squat. The resulting curve is shown below.

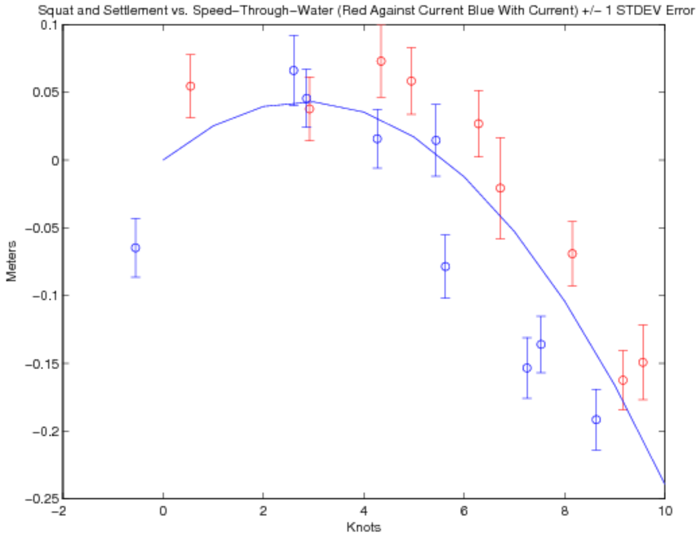


Figure 3. Squat and Settlement plot.

A table of the polynomial coefficients for this shifted plot can be found in Table 1. A table of values evaluated from the polynomial fit can be found in Table 2.

Table 1.

Polynomial Coeficients with speeds scaled [(speed-5)/10]

Term	Coefficient
x^2	-0.547
x^1	-0.239
x^0	28.197

Table 2.

Speed (kts - (m/s))	Height (m)
0.000+/-0.790 (0.000*/-0.406)	0.000+/-0.0448
1.000+/-0.790 (0.514*/-0.406)	0.025+/-0.0448
2.000+/-0.790 (1.029*/-0.406)	0.040+/-0.0448
3.000+/-0.790 (1.543*/-0.406)	0.043+/-0.0448
4.000+/-0.790 (2.058*/-0.406)	0.035+/-0.0448
5.000+/-0.790 (2.572*/-0.406)	0.017+/-0.0448
6.000+/-0.790 (3.087*/-0.406)	-0.012+/-0.0448
7.000+/-0.790 (3.601*/-0.406)	-0.053+/-0.0448
8.000+/-0.790 (4.116*/-0.406)	-0.104+/-0.0448
9.000+/-0.790 (4.630*/-0.406)	-0.166+/-0.0448
10.000+/-0.790 (5.144*/-0.406)	-0.239+/-0.0448

Theory to Practice:

In the course of the Coastal Surveyor’s patch test for the EM3002 sonar, two lines were run over the same piece of sea floor at speeds of 6 and 9 knots to assess the navigation time bias of the sonar system. A portion of these each overlapping run over flat seafloor provided an ideal real-world measurement of the squat and settlement characteristics of the vessel. The two runs were completed within 15 minutes of each other such that tidal differences may be neglected. However, lever-arm offsets between the IMU and sonar transducer were not entered into the sonar system for these lines. Therefore, the sonar could not correct for vertical translations due to pitch.

To compare our settlement and squat measurements with data from these two lines, we must recalculate our settlement and squat curve, this time without omitting the effect of pitch on the vertical translation of the transducer. These calculations produce the following curve and table.

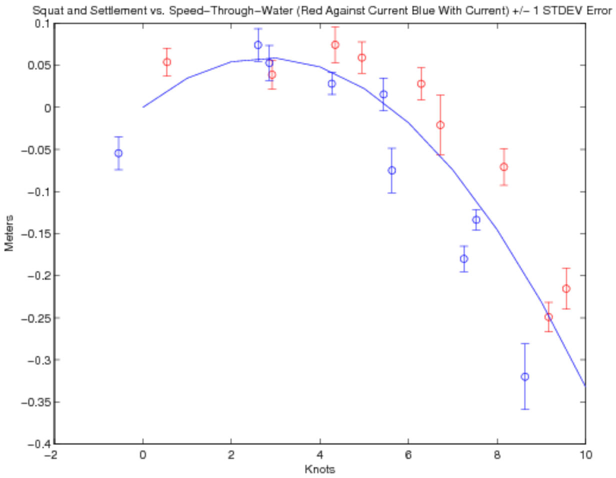


Figure 3. Settlement and Squat including vertical translation from vessel pitch.

Table 3.

Speed (kts - (m/s))	Height (m)
0.000+/-0.790 (0.000*/-0.406)	0.000+/-0.0536
1.000+/-0.790 (0.514*/-0.406)	0.035+/-0.0536
2.000+/-0.790 (1.029*/-0.406)	0.054+/-0.0536
3.000+/-0.790 (1.543*/-0.406)	0.059+/-0.0536
4.000+/-0.790 (2.058*/-0.406)	0.048+/-0.0536
5.000+/-0.790 (2.572*/-0.406)	0.022+/-0.0536
6.000+/-0.790 (3.087*/-0.406)	-0.018+/-0.0536
7.000+/-0.790 (3.601*/-0.406)	-0.074+/-0.0536
8.000+/-0.790 (4.116*/-0.406)	-0.145+/-0.0536
9.000+/-0.790 (4.630*/-0.406)	-0.231+/-0.0536
10.000+/-0.790 (5.144*/-0.406)	-0.333+/-0.0536

From each of the patch test lines, a portion of the data near nadir in the along-track direction after the patch test corrections had been applied. The area of data used for comparison and a plot of that data is illustrated in Figure 4.

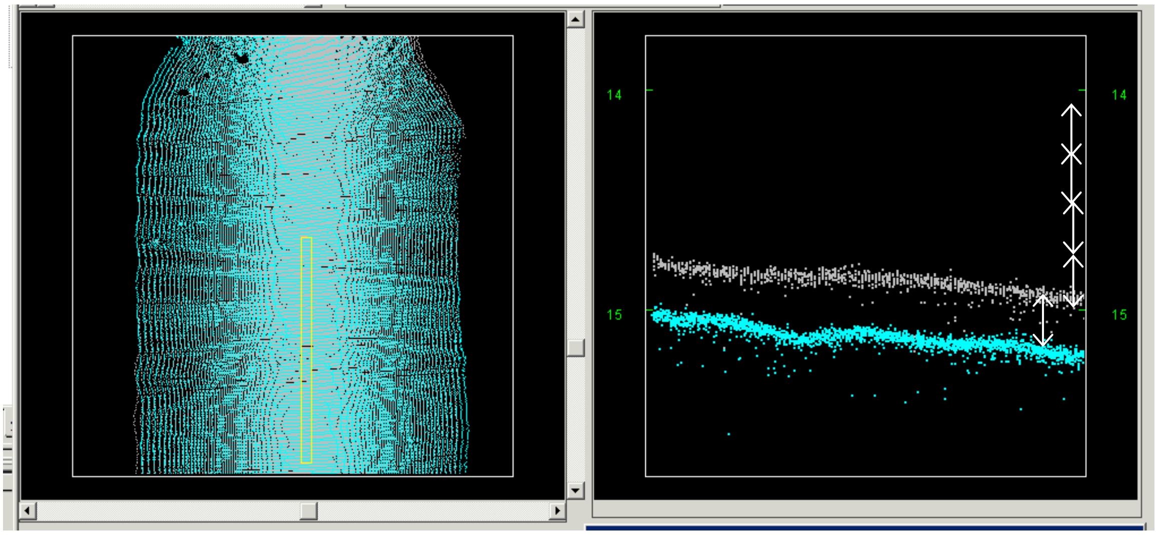


Figure 4. In this screenshot, the yellow rectangle in the left window illustrates near-nadir data that has been extracted and plotted in the right window. The right window shows the along-track trend of the two lines and the clear offset due to settlement and squat.

The offset between lines is roughly .25 meters, as measured by the double arrows in Figure 4. Using the values of the pitch-influenced squat and settlement measurements in Table 3. above, the expected offset is -.018 – (-.231) = .213m, a reasonable agreement.

APPENDIX C: E-mail correspondence regarding tidal zoning

Eunice Tetteh

From: hhtike@ccom.unh.edu
Sent: Monday, June 24, 2013 6:03 PM
To: summerhydro2013@ccom.unh.edu
Subject: [Fwd: Re: Tidal Zoning for UNH2013 Summer Hydro Survey]
Attachments: untitled-[1.2]; Portland_FortPoint.xls

Dear All,

I forwarded a replied e-mail(from "Lijuan Huang - NOAA Affiliate") concerning with tide parameters for TPU computation in CARIS.
Regards,

Htike

---------------------------- Original Message ----------------------------
Subject: Re: Tidal Zoning for UNH2013 Summer Hydro Survey
From: "Lijuan Huang - NOAA Affiliate" <lijuan.huang@noaa.gov>
Date: Mon, June 24, 2013 10:36 am
To: hhtike@ccom.unh.edu
Cc: "_NOS.CO-OPS.HPT" <nos.coops.hpt@noaa.gov>

Dear Htike,

I am not sure the tide measurement uncertainty that OCS uses as we normally only provide OCS with a 2-sigma TPE value.

The total propagated error or TPE = datum error + 1.96*(sqrt (zoning error^2 + processing error^2 + measurement error^2)). TPE is 2-sigma.

datum error = 0.02 m
processing error = 0.01 m
measurement error = 0.02 m
zoning error = sqrt (sum of differences^2/(n-1)) where the difference is the difference between the zoned 6-minute/hourly data at Fort Point and a subordinate station at survey area. Because there is no concurrent data between Fort Point and subordination stations at survey area, I attached a TPE spreadsheet using Fort Point and Portland for your reference.

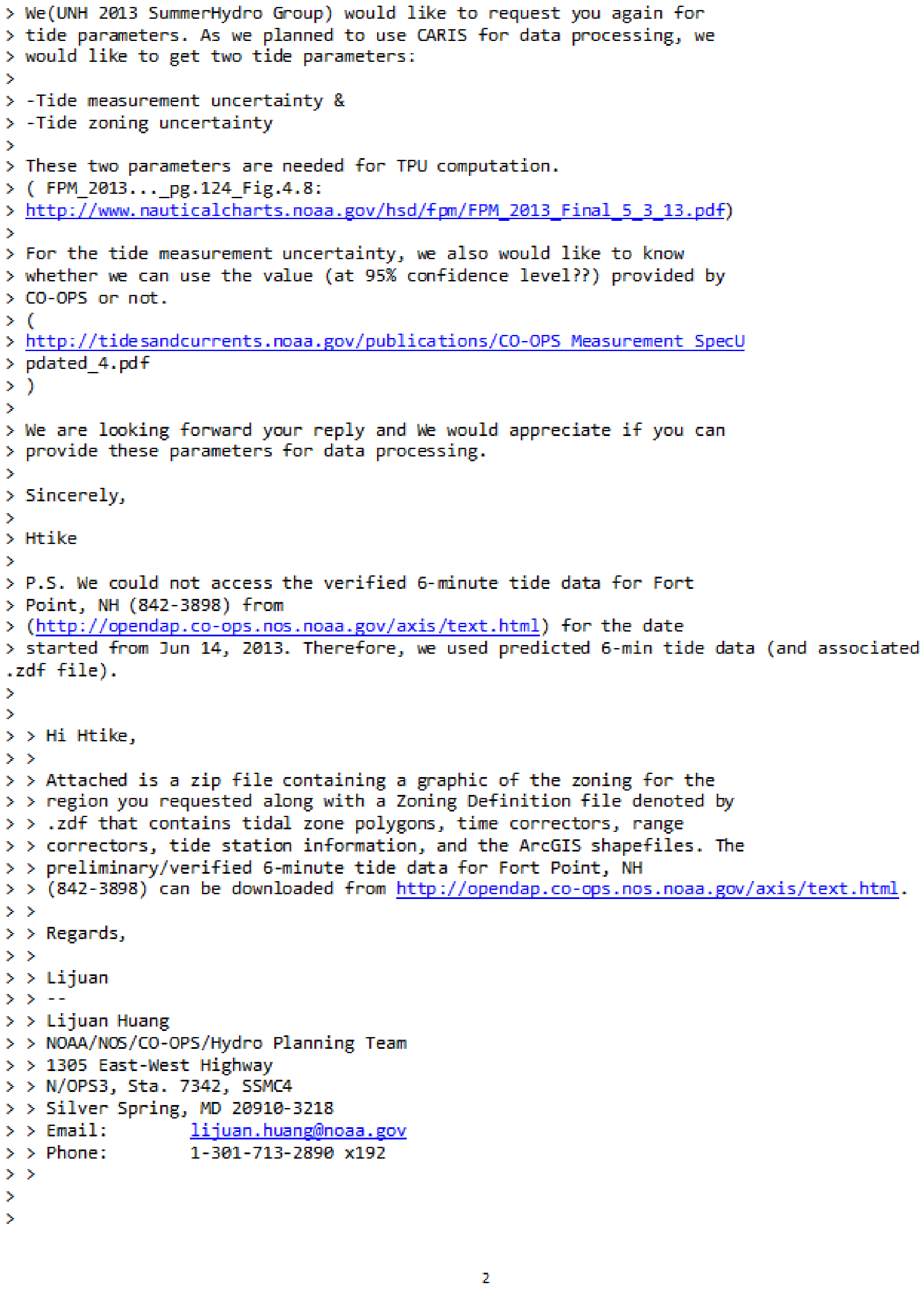
Hope this is helpful.

Thanks,
Lijuan

On Fri, Jun 21, 2013 at 8:35 PM, <hhtike@ccom.unh.edu> wrote:

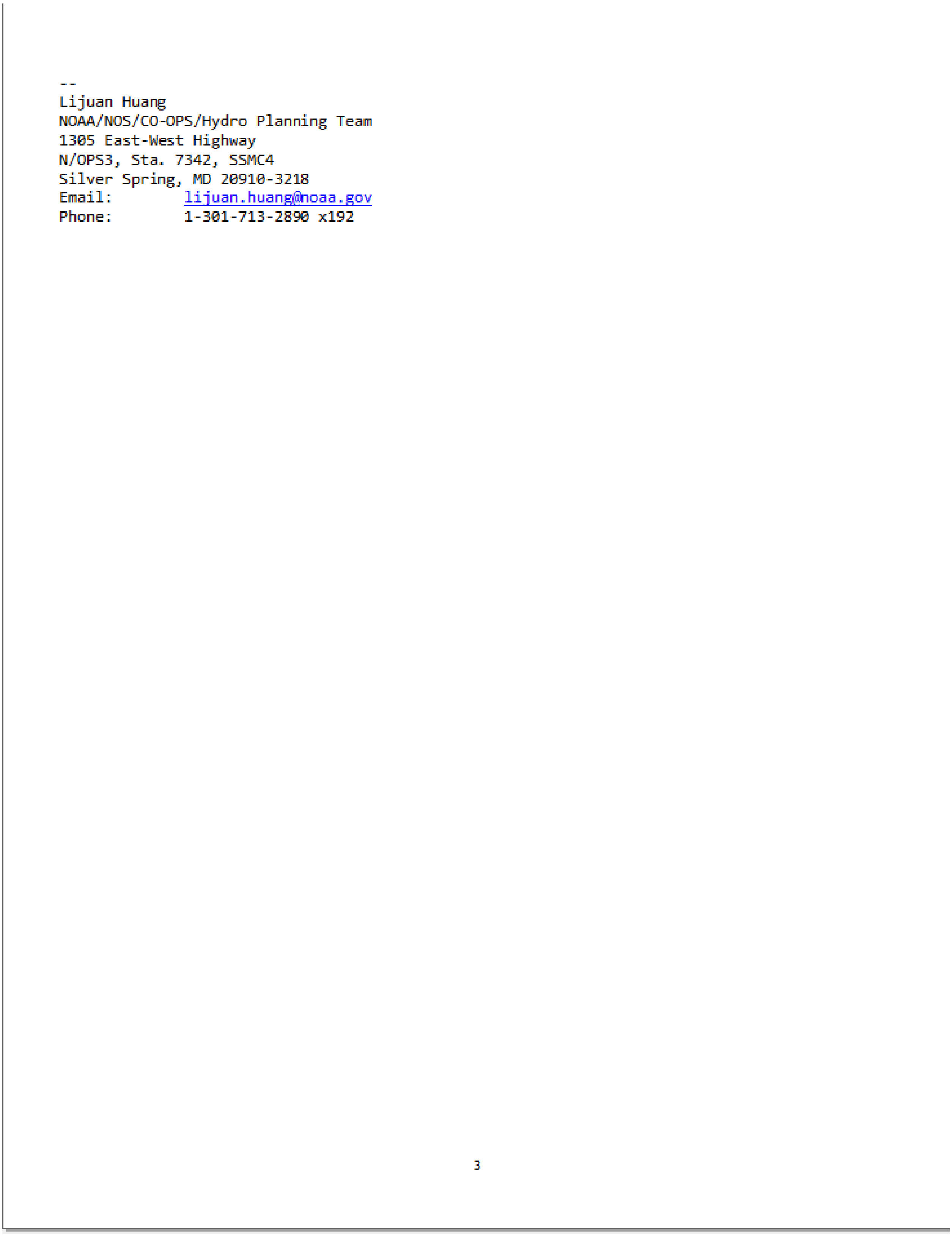
> Dear Lijuan,
>
> Thank you so much for your information related to tide zoning.
>

1



> We(UNH 2013 SummerHydro Group) would like to request you again for
> tide parameters. As we planned to use CARIS for data processing, we
> would like to get two tide parameters:
>
> -Tide measurement uncertainty &
> -Tide zoning uncertainty
>
> These two parameters are needed for TPU computation.
> (FPM_2013..._pg.124_Fig.4.8:
> http://www.nauticalcharts.noaa.gov/hsd/fpm/FPM_2013_Final_5_3_13.pdf)
>
> For the tide measurement uncertainty, we also would like to know
> whether we can use the value (at 95% confidence level??) provided by
> CO-OPS or not.
> (
> http://tidesandcurrents.noaa.gov/publications/CO-OPS_Measurement_SpecU
> pdated_4.pdf
>)
>
> We are looking forward your reply and We would appreciate if you can
> provide these parameters for data processing.
>
> Sincerely,
>
> Htike
>
> P.S. We could not access the verified 6-minute tide data for Fort
> Point, NH (842-3898) from
> (http://opendap.co-ops.nos.noaa.gov/axis/text.html) for the date
> started from Jun 14, 2013. Therefore, we used predicted 6-min tide data (and associated
.zdf file).
>
>
> > Hi Htike,
> >
> > Attached is a zip file containing a graphic of the zoning for the
> > region you requested along with a Zoning Definition file denoted by
> > .zdf that contains tidal zone polygons, time correctors, range
> > correctors, tide station information, and the ArcGIS shapefiles. The
> > preliminary/verified 6-minute tide data for Fort Point, NH
> > (842-3898) can be downloaded from http://opendap.co-ops.nos.noaa.gov/axis/text.html.
> >
> > Regards,
> >
> > Lijuan
> > --
> > Lijuan Huang
> > NOAA/NOS/CO-OPS/Hydro Planning Team
> > 1305 East-West Highway
> > N/OPS3, Sta. 7342, SSMC4
> > Silver Spring, MD 20910-3218
> > Email: lijuan.huang@noaa.gov
> > Phone: 1-301-713-2890 x192
> >
>
>

2



--
Lijuan Huang
NOAA/NOS/CO-OPS/Hydro Planning Team
1305 East-West Highway
N/OPS3, Sta. 7342, SSMC4
Silver Spring, MD 20910-3218
Email: lijuan.huang@noaa.gov
Phone: 1-301-713-2890 x192