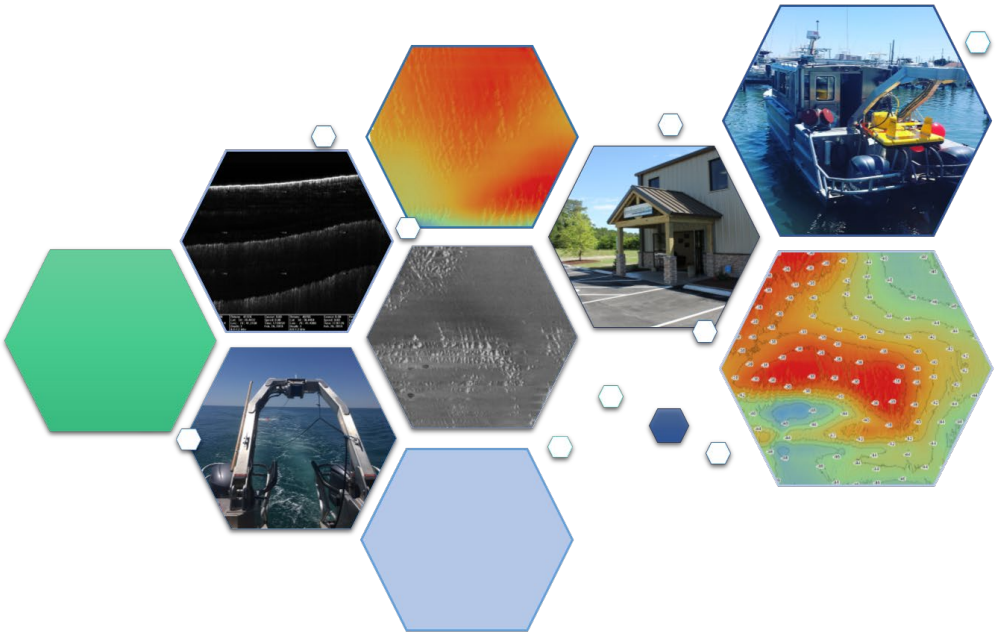
Examining Seafloor Dynamics from Hurricane Florence Offshore Bogue Banks, Ocean Dredge Material Disposal Site Carteret County, NC



Descriptive Report

April 2019
Submitted to:

Submitted by:

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1.0 INTRODUCTION

1.1 Background

Geodynamics was contracted by University of Rhode Island (URI) as part of a National Science Foundation (NSF) project to conduct hydrographic surveys offshore Bogue Banks, North Carolina at the Morehead City Ocean Dredged Material Disposal Site (ODMDS). The work included collecting multibeam echosounder (MBES) bathymetry over an area that had bathymetric data collected prior to Hurricane Florence in December, 2013 and March, 2018. The project also included sub-bottom profiler (SBP) acquisition across morphological areas of interest. Surficial sediment samples were collected at 24 sites determined by areas of varying backscatter intensities determined in post-processing.

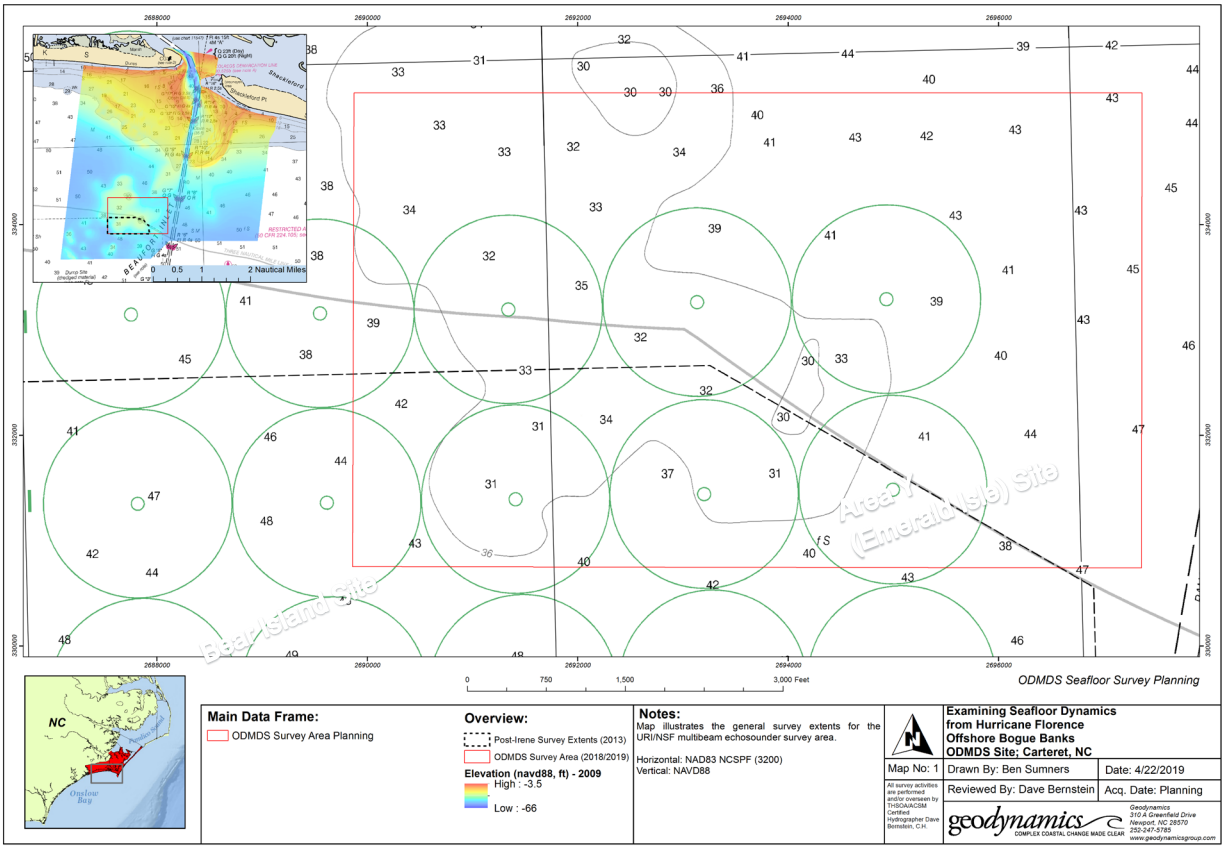

Figure 1. Survey planning map showing the survey boundaries.

1.2 Survey Objectives

The specific goals of this survey were for Geodynamics to:

1) Provide processed MBES bathymetric and backscatter (acoustic reflectance) data within the designated survey area.
    a. Data provided as XYZ, ArcGrids for survey data
2) Collect sub-bottom data across key morphological features that document changes.
    a. Provide data in raw format

3) Provide metadata, basic data analysis and generate a brief quality control and quality assurance (QA/QC) document and survey report (this report).
4) Provide existing data at the survey sites.
    a. Historical data is also provided as GeoTiffs
        i. Rasters generated to document change between surveys.

2.0 METHODOLOGY

2.1 Horizontal & Vertical Control

The project coordinate system used for this survey is NAD83 (2011) NC State Plane feet (US) and the vertical datum is NAVD88 (Geoid 12b) feet. This project is an Ellipsoidally Referenced Survey (ERS) and GPS Tides were computed in CARIS.

Real-Time Kinematic (RTK) corrections were utilized throughout the survey using a semi-permanent base station installed on top of the University of North Carolina (UNC) Institute of Marine Science (IMS) building (Figure 2).

Figure 2. Base station on top of UNC IMS used for broadcasting RTK-GPS corrections to the survey vessel.

2.2 Multibeam Survey Data Acquisition & Processing

The Research Vessel (R/V) Benthos, owned and operated by Geodynamics, was selected to support hydrographic surveys (Figure 3). The R/V Benthos is based at Geodynamics' headquarters in Newport, NC. The specialized sensors and topside controlling systems necessary to obtain the desired hydrographic data are permanently installed on the R/V Benthos. For MBES surveys, the vessel is equipped with a custom side pole-mount, which holds the dual-head EM2040C-D multibeam system and Inertial Measurement Unit (IMU). Port and starboard transducers are mounted at approximately 35° and -35°. The multibeam system is tightly coupled with the inertial navigation system for positioning and elevation. Additionally, sound speed sensors and customized computer systems allow seamless logging of real-time beamformed bathymetric data. The R/V Benthos represents the state-of-the-art in modern multibeam hydrographic surveying.

HYPACK software suite was utilized during survey preparation to create survey line plans and evaluate the overall survey scheme line plans on-the-fly (OTF) for holiday fill and line spacing

adjustments. HYPACK Survey was used to record navigation, log targets of importance and provide the vessel captain with line tracking.

Kongsberg's SIS 4.3.2 was the data acquisition and user interface software to accompany the EM2040C-D sonar system. SIS was also used for OTF identification of holidays or gaps in the data and real-time QA-QC of the multibeam sonar data.

The POSView software by Applanix was used alongside with the POS MV positioning system software to ensure accurate positioning. The software provides the interface to view, monitor, and record tightly-coupled integration of the attitude measurements from the IMU and position and heading measurements recorded by the Global Navigation Satellite System (GNSS) in a resulting POS .000 file. The recorded POS .000 file contains all attitude, positioning, heading and error estimates of attitude and positioning. This file ensures a method of post-processing attitude and navigation data in the event of RTK-GNSS cycle slips or interruption.

Figure 3. R/V Benthos setup with survey equipment. The red box highlights the dual-head EM2040C-D sonars.

Multibeam bathymetric data were processed in CARIS HIPS and SIPS. Erroneous soundings were removed, and processed elevations were compared to previous and recent data in the areas when available (*see QA-QC Section 3.0 for more information*). For this survey, RTK-GNSS quality was excellent during hydrographic data collection and adding the post-processed POS data (POSPac SBET file) to the final data was not necessary.

Data were collected east to west as in previous surveys. In addition to operating the multibeam system under routine and current patch tests, the data was compared to previous survey data with consistent results. The final bathymetric surfaces are of 5 ft (1.52 m) resolution (Figure 4).

The backscatter intensity surfaces (1 m / 3.28 ft resolution) were generated in the Fledermaus FGMT software. The final intensity surface describes data collected real-time with no post-process flier editing. The only post-process user editing done to the backscatter data is in the selection of lines used to create the mosaic. The mosaic displays the variable textures of the ODMDS site well. The values of the arcgrids report the actual backscatter intensity values in dB (Figure 5).

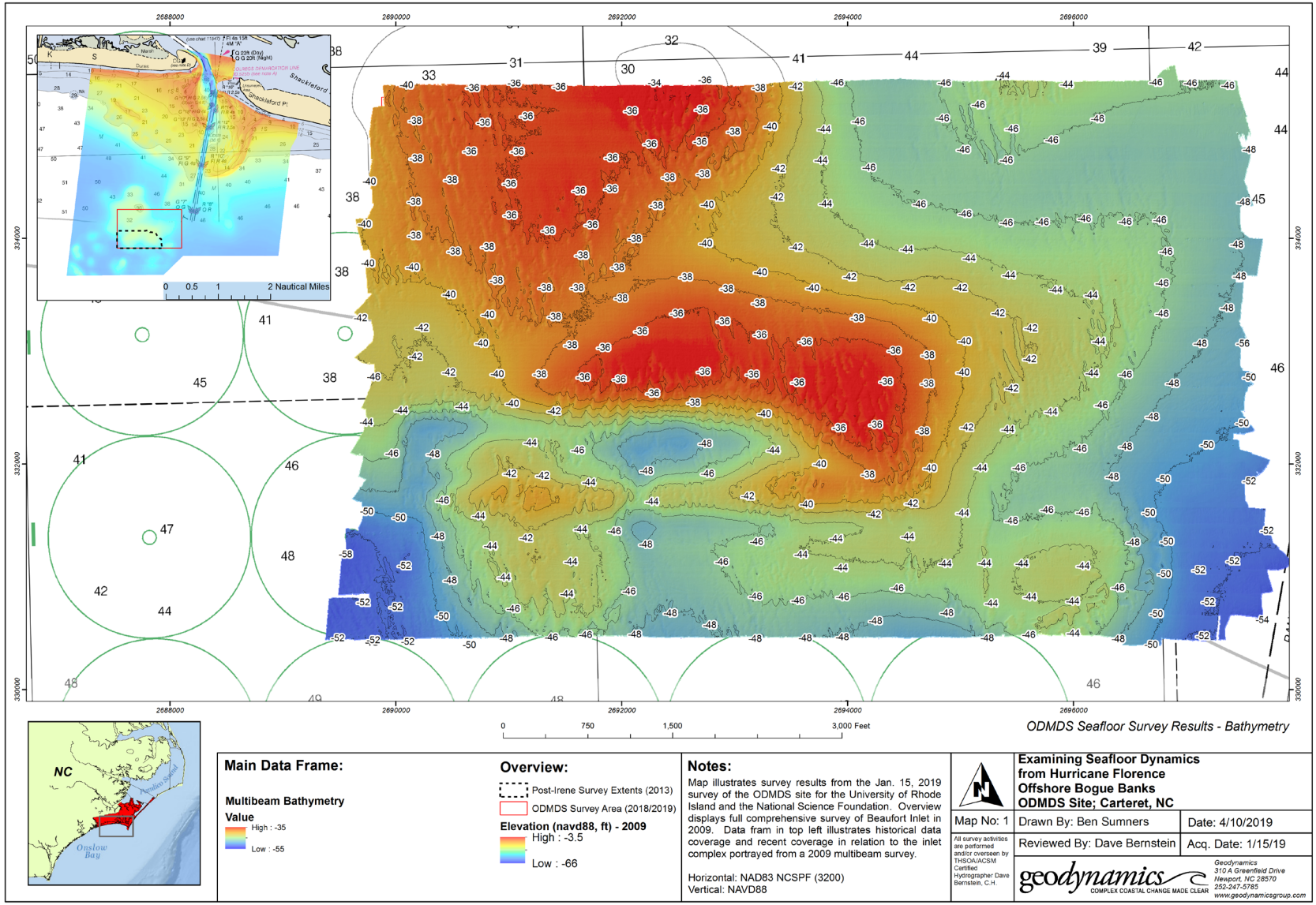

Figure 4. Overview of multibeam bathymetry collected at the ODMDS site.

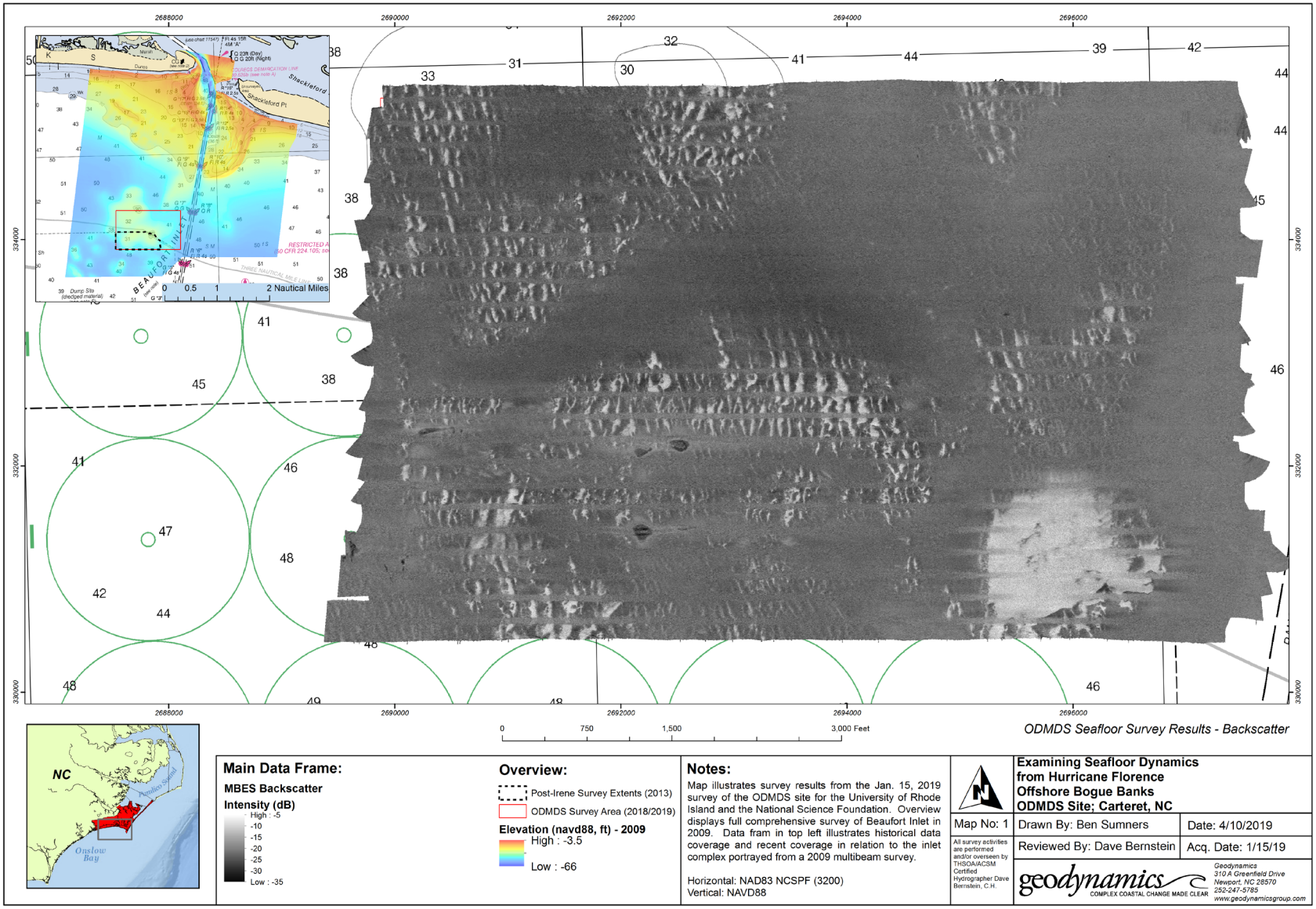

Figure 5. Overview of multibeam backscatter intensities collected at the ODMDS site.

2.3 Sub-bottom Profiler

Sub-bottom profile data was collected with an Edgetech 512i on 2/26/2019. The towfish operated at a frequency of 0.5 – 7.2 kHz @ 30 ms. To minimize the potential for ghost / multiple interference, the towfish was towed with a set of poly-balls attached to the tow point to keep maximize the distance between the transducers and the seafloor while maintaining slow survey speeds ~3.5 kts in the relatively shallow environment. This approximate towed depth was around 8 ft. Positioning was performed using a manual layback driver in Hypack Survey and exporting the corrected layback position using a serial cable and sending a NMEA GGA sentence at 9600 to the sub-bottom data logging software, Discover. This is done because Discover is the preferred platform to record Edgetech data files as it preserves specific manufacturer data in the JSF files that third-party file structures such as SGY and XTF may not. However, SGY and XTF were still recorded for data posterity and flexibility in data processing routines.

Following the survey, a QC check was performed on the data quality and layback positioning. Using two reference points of the vessel and towfish position that were recorded in the field when passing a fixed object (navigation buoy), it was determined Hypack had erroneous conversions in their towfish_simple.dll driver. This was later verified in a test setup and communication with Hypack. This driver was apparently converting the layback value in feet to meters, therefor shortening the actual layback position from the sheave (A-frame) being sent to Discover. A value of 69 ft aft should be applied in post-processing.

An additional section of multibeam bathymetry was collected in the southern portion where an additional line was collected. This data is provided as an additional dataset should the user wish to datum-align the sub-bottom in post-processing (see bottom line in Figure 6).

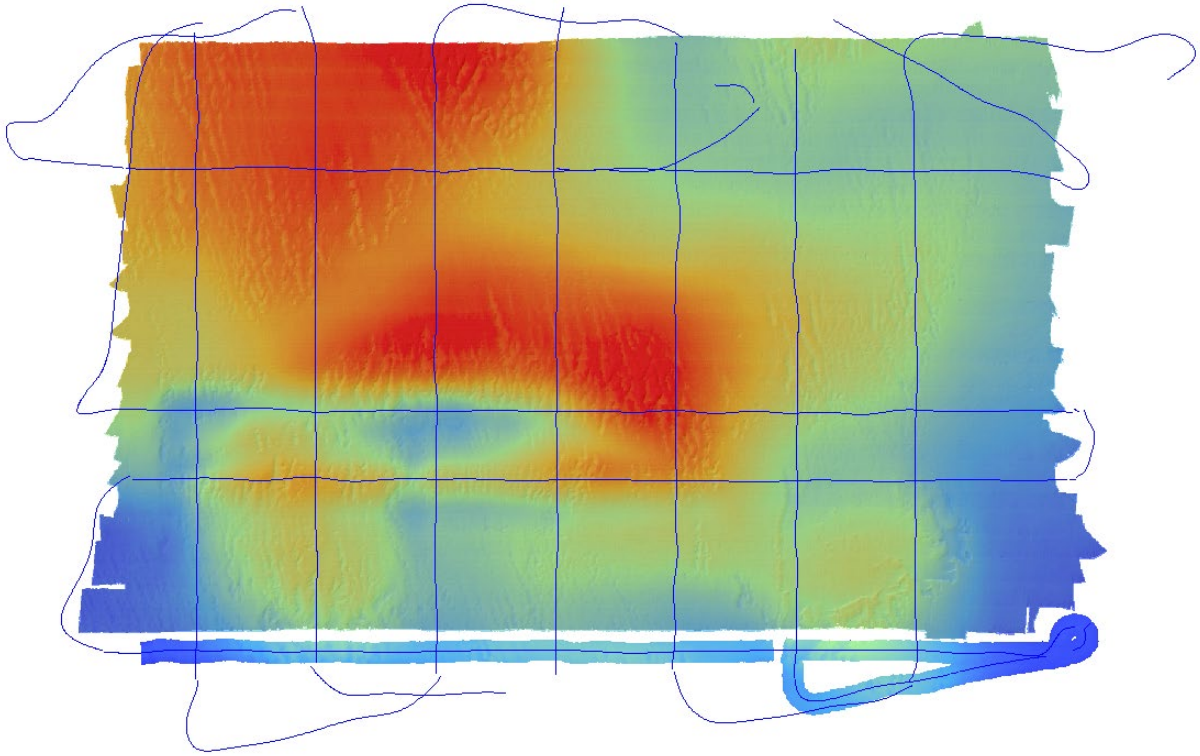

Figure 6. Sub-bottom profiler navigation data over the bathymetry dataset.

2.4 Sediment Samples

Sediment sample sites were determined by review of the backscatter intensity and morphologies and choosing sites of variable texture and location. Distribution of the samples can be seen in Figure 7 and a list of their coordinates in Table 1.

Table 1. List of surficicial grab samples and locations in NAD83 (2011) NC State Plane Feet.

Name	X_NCSPF	Y_NCSPF	Date
SS1	2695288.63	332269.45	20190227
SS2	2695253.65	334268.23	20190227
SS3	2693221.21	334224.57	20190227
SS4	2692271.74	334247.62	20190227
SS5	2690340.90	334224.35	20190227
SS6	2690354.39	331649.78	20190227
SS7	2693470.48	331610.65	20190227
SS8	2693404.79	332702.28	20190227
SS9	2692171.10	332249.14	20190227
SS10	2693532.67	333474.26	20190227
SS11	2694832.07	334118.53	20190227
SS12	2696399.82	334943.03	20190227
SS13	2696051.85	331316.61	20190227
SS14	2695639.25	330944.91	20190227
SS15	2693307.38	330860.67	20190227
SS16	2690063.03	330932.13	20190227
SS17	2692925.67	332045.04	20190227
SS18	2691732.80	333158.12	20190227
SS19	2691206.70	333812.92	20190227
SS20	2691570.37	334926.55	20190227
SS21	2692757.39	334973.66	20190227
SS22	2696490.31	334010.12	20190227
SS23	2697080.46	332622.39	20190227
SS24	2695836.98	332938.63	20190227

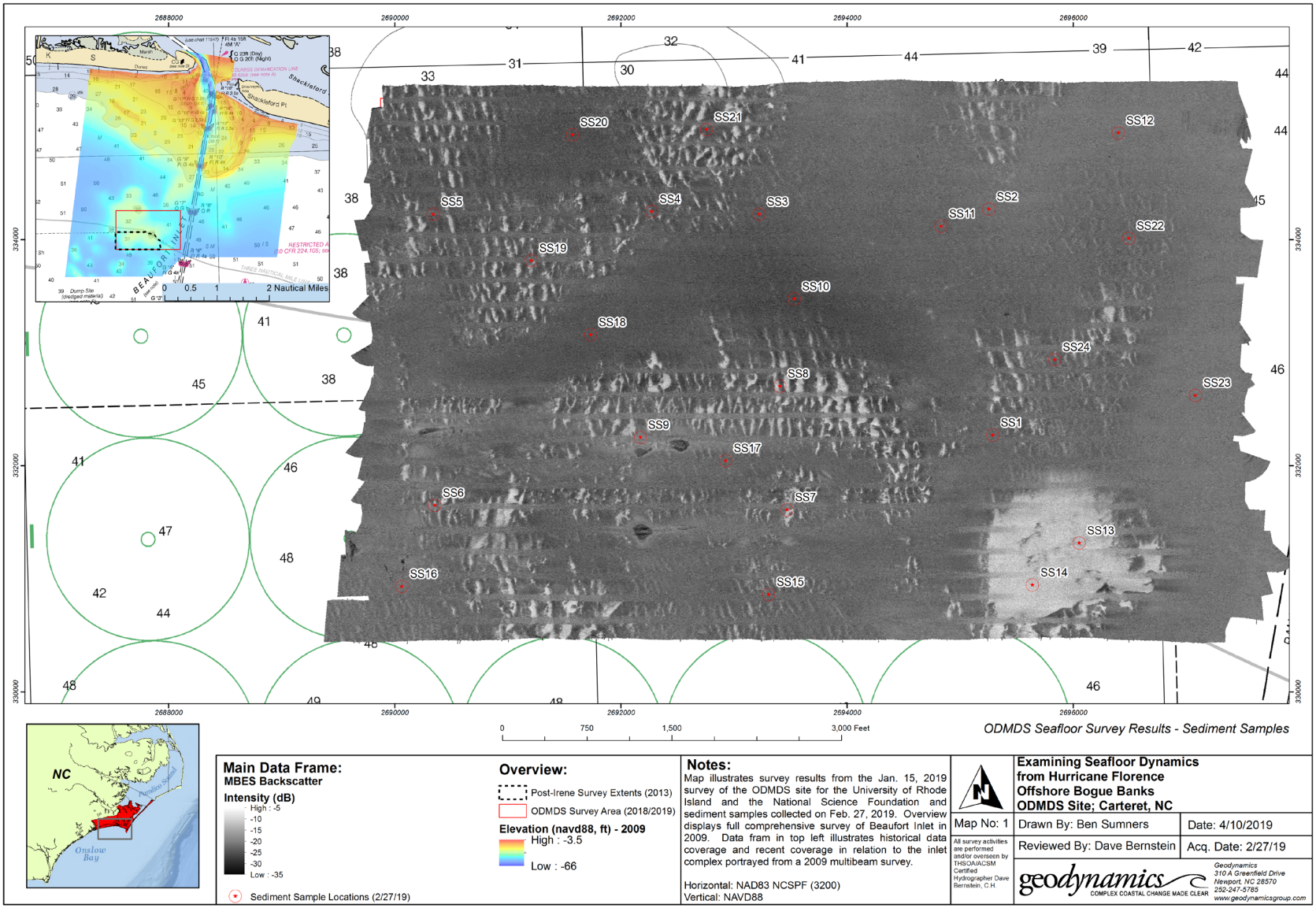

Figure 7. Distribution of sediment samples collected at the ODMDS survey site.

3.0 QA-QC

In addition to operating under patch tested configurations, horizontal and vertical data quality was assessed through data comparisons with previous and recent data in the area. The historical data provided from March 3, 2018 was subtracted from the recent survey data. Although a sound velocity artifact from the 2018 survey is imprinted on the change surface, the statistics report a -0.12 m mean difference. This skew appears to be the result from the dominant trend of the change surface revealing a net loss, meaning the recent survey is dominantly higher as a result of the artifact. This was confirmed by a cross-track profile extraction from the bathymetry of both surveys and observing the artifact in the 2018 dataset. Unfortunately, sound velocity can be a difficult survey parameter to control at the ODMDS site, as the nearby channel and mounds can create dynamic pockets of varying temperature/salinity. However, the patterns of natural change are still clearly evident.

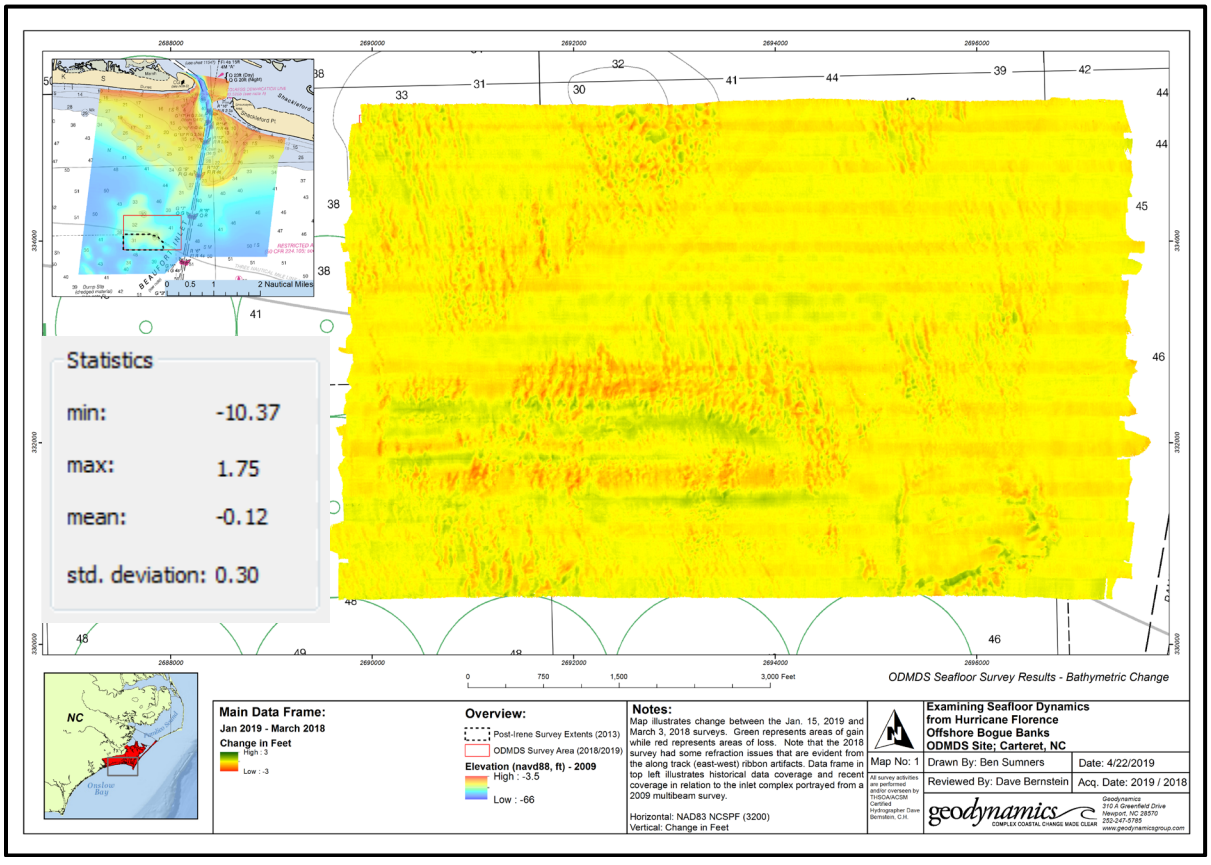

Figure 8. A change map surface between the Jan. 15, 2019 survey and the previous March 3, 2018 survey.

A comparison of the backscatter intensities between the two surveys also reveal patterns of sediment transport in a similar fashion. Since backscatter is commonly reported as negative decibel values of the return strength of the surface, theoretically this surface shows areas that have either increased their backscatter return strength (positive), decreased their return (negative), or have experienced little change (close to zero). However, even though these datasets were collected with the same sonar hardware, subtle differences in water properties, runtime parameters of the sonars themselves, and processing software can create biases between two datasets that must be normalized for proper comparisons. A mean value of 7.35 dB

from the difference surface might suggest this is this the case, however that is beyond the scope of this work. As this dataset is not empirically accurate at this time, it is provided in the following figure (Figure 9) out of research interests only and should be further investigated if such data is to be considered of interest.

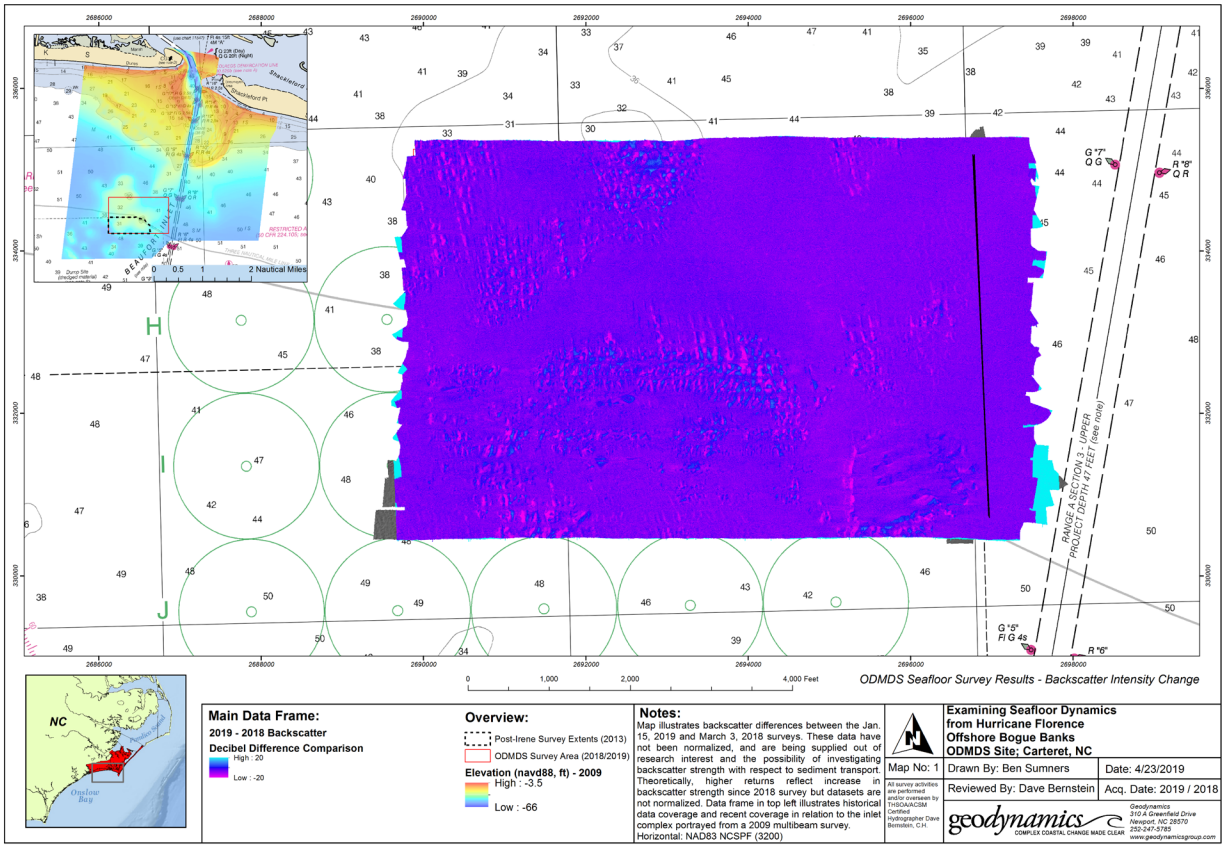

Figure 9. An investigation into backscatter time-series data shows a change in seafloor texture, but still requires additional investigation to be accurately derived. This figure is supplied out of research interests only.

4.0 SURVEY SUMMARY

The multibeam survey of the ODMDS area provide adequate data to generate 5 ft (1.52 m) resolution bathymetric surfaces and backscatter mosaics. This resolution is also consistent with historical datasets for comparisons. The sub-bottom profiler data have been reviewed and are being supplied in their raw format as required. Sediment sample were taken at various documented sites and should have ample material for lab analysis. All datasets have been reviewed for logical consistency and accuracy using multiple methods. This dataset is of high-quality and serves its intended purpose. Additionally, all deliverables highlighted in the Scope of Work (SOW) were provided in the final deliverable package. The deliverable package also contains a readme file explaining the contents of the deliverables.

APPENDIX A – Project Scope of Work

SOW – URI / NSF – ODMDS Survey

Geodynamics - Statement of Work

Project: RAPID: Examining Seafloor Dynamics from Hurricane Florence Offshore Bogue Banks, NC

Duration of Subcontract: November 15, 2018 – November 14, 2019

Statement of Work:

1) Resurvey (with multibeam) a portion of the Morehead City Ocean Dredged Material Disposal Site.
2) Collect sub-bottom data across key morphological features to document changes.
3) Collect 8-15 surficial sediment samples to ground-truth geophysical data.
4) Complete processing of multibeam data.
5) Provide seismic reflection data in raw format.

In addition, Geodynamics will collaborate with PIs Walsh, Corbett and students to plan, process and interpret the obtained data and sand resource changes.

Time Budgeted:
2 days (16hours) Benthos & Multibeam & Sub-bottom. 3 crew

Deliverables listed:

6) MBES Data Processing
7) Basic Analysis / Mapping Deliverables
8) Basic QA-QC Reporting & Metadata
9) Basic GIS Deliverables
10) Data Management / Deliverables assembly
11) Assembling Sub-bottom Data for URI Processing

From meeting on 3/1/18

- Include the M&N ODMDS data
  - Mbes
  - Backscatter
  - SBP

APPENDIX B – Survey Equipment Documentation

AML OCEANOGRAPHIC
Xchange your old ideas

Certificate of Calibration

Asset Serial Number:	200936
Calibration Type:	Sound Velocity
Certification Date:	August 28, 2018
Calibration Range:	1414.3 to 1509 m/s
Sensor Range:	1375 to 1625 m/s
Residual (RMSE):	0.002 m/s
Standards:	Hart 1560/4067

Coefficients

Coefficient A:	0.000000E+0	Coefficient H:	1.946356E-7
Coefficient B:	0.000000E+0	Coefficient I:	0.000000E+0
Coefficient C:	9.524398E-7	Coefficient J:	0.000000E+0
Coefficient D:	1.947165E-7	Coefficient K:	0.000000E+0
Coefficient E:	-1.794826E-5	Coefficient L:	0.000000E+0
Coefficient F:	1.954237E-7	Coefficient M:	0.000000E+0
Coefficient G:	1.273567E-6	Coefficient N:	0.000000E+0

AML Oceanographic

Robert Haydock
President, AML Oceanographic

AML Oceanographic certifies that the asset described above has been calibrated or recalibrated with equipment referenced to traceable standards. If this instrument or sensor has been re-calibrated, please be sure to update your records. Please also ensure that you update the instrument's coefficient values in any post-processing software that you use, if necessary.

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AML OCEANOGRAPHIC
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Certificate of Calibration

Asset Serial Number:	300003
Calibration Type:	Pressure
Certification Date:	August 28, 2018
Calibration Range:	0 to 49 dBar
Sensor Range:	0 to 50 dBar
Residual (RMSE):	0.012 dBar
Standards:	Paros 785

Coefficients

Coefficient A:	-5.623293E+0	Coefficient H:	0.000000E+0
Coefficient B:	0.000000E+0	Coefficient I:	1.156421E-9
Coefficient C:	0.000000E+0	Coefficient J:	0.000000E+0
Coefficient D:	0.000000E+0	Coefficient K:	0.000000E+0
Coefficient E:	9.091978E-4	Coefficient L:	0.000000E+0
Coefficient F:	0.000000E+0	Coefficient M:	-8.393148E-15
Coefficient G:	0.000000E+0	Coefficient N:	0.000000E+0

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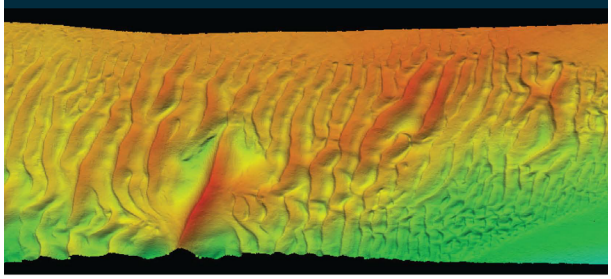
EM® 2040C

KONGSBERG



MULTIBEAM ECHO SOUNDER

The EM 2040C (C for Compact) is a shallow water multibeam echo sounder based on the EM 2040 technology, an ideal tool for any high resolution mapping and inspection application. The receiver and transmitter are integrated in a common sonar head, with the same dimensions as its predecessor EM 3002. The system fulfils and even surpasses the IHO-S44 special order and the more stringent LINZ specification.

Key facts

The operating frequency range is from 200 to 400 kHz with frequency selection in steps of 10 kHz, enabling the user to choose on the fly the best operating frequency for the application. Due to the very large operating bandwidth available, the system will have an output sample rate up to 60 kHz. The system can effectively operate with very short pulse lengths. The shortest pulse is 14 microseconds, which gives a raw range resolution (cr/2) of 10.5 mm.

By utilizing both CW and FM chirp pulses, the system can achieve a much longer range capability with a high resolution. The maximum depth range for a dual head system in cold ocean water is 520 m at 200 kHz with a swath with up to 700 m.

The angular coverage for 200 to 320 kHz is 130 degrees with one sonar head, allowing coverage of 4.3 times water depth. With two sonar heads tilted 35-40 degrees to each side, 200 degrees can be covered. This allows surveying to the water surface or up to 10 times water depth on flat bottoms. For frequencies above 320 kHz the angular coverage per head is gradually decreasing to 70 degrees at 400 kHz.

As an option, the EM 2040C can be delivered with the dual swath capability, allowing a sufficient sounding density along track at a high vessel speed.

Components

The basic EM 2040C has three units: a sonar head, a processing unit and a hydrographic workstation. For completeness, data input from a motion sensor and a positioning system is required, as is the sound speed profile of the water column between the transducers and the bottom. Sound speed at the transducer depth is an optional input and is highly recommended, especially for a dual head system.

Optionally, the sonar head(s) may be delivered mounted on a frame together with the motion sensor and a sound speed sensor, factory aligned for ease of mounting.

All electronics are contained in the sonar head(s) which is interfaced to the processing unit via GBit Ethernet. The processing unit also supplies 48 VDC power via the same cable. Operator control, data quality inspection and data storage is handled by the hydrographic workstation running SIS software or by 3rd party software.

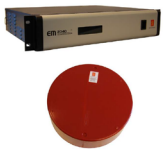
The EM 2040C is available in an EM 2040CX version where the subsea part has a depth rating of 1500 m for operation on ROV or AUV.

FEATURES

- High resolution
- Wide frequency range
- FM chirp
- Roll and pitch stabilisation
- Yaw stabilisation - for dual head
- Nearfield focusing both on transmit and receive
- Short pulse lengths, large bandwidth
- Water column display
- Seabed image
- Depth rated to 50 m
- Easy to install

Options:

- Water column logging
- Extra detections
- Dual swath
- Depth rated to 1500 m (EM 2040CX)
- Dual Head (EM 2040CD)



TECHNICAL SPECIFICATIONS

Frequency range:	200 to 400 kHz in steps of 10 kHz
Beam width:	1 * 1 degree at 400 kHz
Max ping rate:	50 Hz
Swath coverage sector:	Up to 130 degrees (single head) / 200 degrees (dual head)
Sounding patterns:	Equiangular, equidistant and high density
No. of soundings per ping:	400 (single head, single swath) 800 (single head, dual swath) 1600 (dual head, dual swath)
Roll stabilised beams:	+/-15 degrees
Pitch stabilised beams:	+/-10 degrees
Yaw stabilised beams:	+/-10 degrees (Dual head)

Coverage example for EM 2040C in cold ocean water with bottom type rock (BS = - 10 dB), NL = 45 dB, FM mode			
Operating frequency	**Max depth**	**Max coverage across**	
		Single head	**Dual head**
200 kHz	520 m	580 m	700 m
300 kHz	450 m	580 m	670 m
350 kHz	400 m	510 m	600 m
400 kHz	350 m	375 m	530 m

	200 - 400 kHz in 10 kHz step	**200 - 400 kHz in 10 kHz step**
	CW	**FM**
Pulse lengths	14, 27, 54, 135, 324 and 918 µs	3 and 12 ms

Physical dimensions (excluding connectors and mounting arrangements)			
Sonar head EM 2040C	332 x 119 (diameter x height)	18.8 kg (8.4 kg in water)	Depth rating 50 m
Sonar head EM 2040CX	332 x 122 (diameter x height)	26.1 kg (17 kg in water)	Depth rating 1500 m
Processing Unit (2U 19" rack)	482.5 x 424 x 88.6 mm (WxDxH)	10.5 kg	NA

Laptop, HWS and monitor can be delivered on request.

369468 / G August 2017

Specifications subject to change without any further notice.
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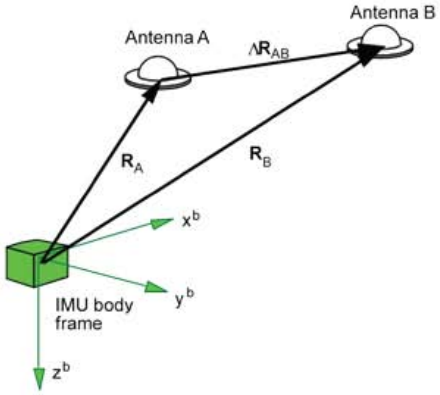
POS MV™

POS MV is a user-friendly, turnkey system designed and built to provide accurate position, heading, attitude, heave, and velocity data of your marine vessel and remote sensing equipment. With over one thousand systems deployed worldwide, POS MV is field-tested and proven in all conditions.

POS MV blends GNSS data with angular rate and acceleration data from an IMU, and heading from GPS Azimuth Measurement System (GAMS) to produce a robust and accurate full six degrees-of-freedom position and orientation solution.

GAMS provides robust heading regardless of latitude and dynamics.



Whatever your requirements, there is a POS MV system right for you.

POS MV comes in 4 models:

- POS MV SurfMaster / SurfMaster One
- POS MV WaveMaster II
- POS MV OceanMaster
- POS MV Elite

All POS MV models are designed for use with multibeam sonar systems, enabling adherence to IHO (International Hydrographic Survey) standards on sonar swath widths of greater than ±75 degrees under all dynamic conditions. At the entry-level is the POS MV SurfMaster, which delivers robust georeferencing for small platforms, both manned and unmanned. SurfMaster is available both with a remote IMU and in single-enclosure form factor. Fully supported by Applanix' industry leading post processing software, POSPac MMS, SurfMaster delivers roll and pitch accuracy to 0.03 degrees. Wavemaster II and OceanMaster are designed for increasingly difficult conditions and performance requirements. The POS MV Elite is for users seeking the very highest level of performance available to the industry.

Field-tested and proven, POS MV maximizes your ROI in multibeam technology

Benefits

- **Applanix "TrueHeave™" software improves productivity and accuracy**
  To improve the performance of real-time heave filters in long period swells, Applanix developed the TrueHeave processor. TrueHeave users reap the double benefits of significantly improved accuracy and productivity by eliminating the need for run-in time. TrueHeave also provides a unique and useful quality control tool for real-time heave during survey data collection.

- **Post-processing ensures high-quality results in difficult sea conditions**
  With the ability to log raw GNSS and inertial observables for later processing in POSPac MMS – Applanix' powerful GNSS aided inertial post processing package – an optimal positioning and orientation solution can be obtained even under the most demanding sea conditions. Post-processing benefits include:

  - *Improved Accuracy* – Post-processed kinematic processing and an advanced smoothing algorithm drastically improves position and orientation accuracy.
  - *Improved Reliability* – Setup errors can be corrected in post-processing. In addition, alternative differential GNSS sources can be found if the primary source proves unreliable.

- **Optimally aided architecture ensures a high-quality solution if GNSS outages occur.**
  POS MV uses accurate inertial data aided by observables from as few as one satellite to compute a robust navigation solution. This ensures continuity of data, including position and heading, in areas where GNSS reception is compromised. This is vital for surveying under bridges, around structures (e.g. offshore platforms), or close to mountainous terrain where GNSS shading can occur.

  In addition, due to the high quality of the inertial components used in POS MV, short-term loss of GNSS does not significantly degrade the POS MV roll, pitch or heading solution.

- **Full GNSS Support – ensures robust solution in any environment**
  POS MV uses both GPS and GLONASS observables to produce the most robust solution possible in any given environment. POS MV uses high performance GNSS components for excellent carrier phase tracking capability even in high multipath environments.

- **Decimetric positioning anywhere**
  POS MV provides support for the Fugro Marinestar™ GPS and GNSS services. With this integrated functionality there are significant benefits for the user including:

  - *Larger area of operations:* no geographical limitations
  - *Ease of use:* no additional hardware to purchase, integrate and maintain
  - *High accuracy:* position data is accurate to less than 1 decimetre
  - *Efficiency:* data is produced in real-time

  Marinestar is available via subscription from Fugro.

- **Applanix' Inertially Aided RTK ensures more robust solution than standalone RTK.**
  Standalone RTK suffers from dropouts of both the GNSS signal and the telemetry from the base station. These dropouts can be caused by other vessels, bridges, topography, buildings or other obstructions. Re-acquisition of a centimetric level accuracy solution can and does take several minutes following a dropout. Applanix proprietary Inertially Aided RTK (IARTK) algorithms enable the rapid re-acquisition of fixed integer RTK positioning. Difficult GNSS environments are often encountered where accuracy requirements are at their most stringent (e.g. port areas). In these conditions POS MV with IARTK affords a significantly more robust and accurate position solution than can be achieved with standalone RTK.

- **Upgradeability – your investment is protected!**
  POS MV uses the latest Trimble 220 channel GNSS receivers with the best available GNSS antenna technology. POS MV affords a low cost upgrade path to the latest technology ensuring your investment is protected.

POS MV is designed and built specifically for marine applications

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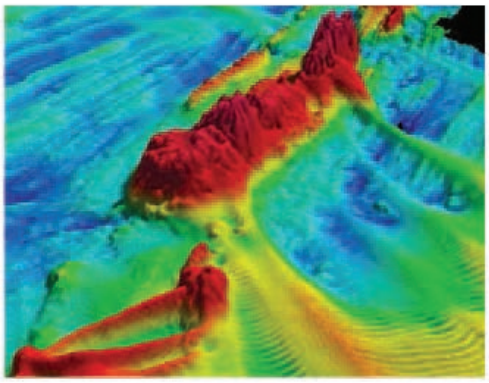
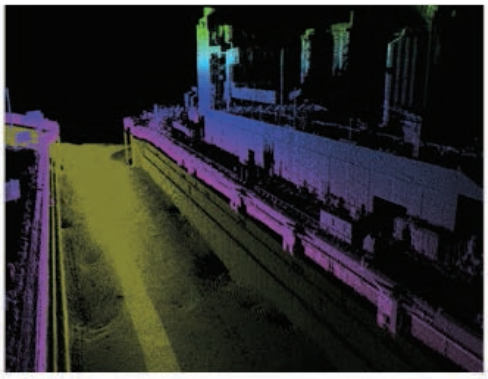
Applications

Seafloor Mapping:
Producing maps of the seafloor has always been a unique challenge. Today, multibeam sonar is the marine technology typically used by hydrographers to generate precise seafloor mapping data. Georeferencing this data using POS MV produces the most advanced and accurate solution for mapping the seafloor.



Coastline Mapping Above and Below the Waterline:
Mapping the geography, seabed and man-made structures in coastal waters means conducting highly detailed mapping exercises onboard a dynamic marine vessel, frequently in areas where bridges and other shoreline structures – the items to be surveyed – make the GPS environment extremely difficult.



Harbour Mapping:
Mapping the seabed and geography in harbour waters means conducting detailed, highly accurate mapping exercises onboard moving marine vessels in shallow, narrow, and frequently rough waters. Applanix offers proven technology for doing this. No matter what the goal - port and harbour asset inventory, coastal zone management, marine hazard mapping, or management projects to satisfy government regulations – our mobile mapping solutions on marine vessels are highly cost-effective ways of acquiring quality marine infrastructure GIS data.

Performance you can rely on:

- Accurate under all dynamic conditions
- Heading accuracy maintained in high multipath environments and in areas of poor GNSS availability
- Continuous sensor monitoring to ensure optimum performance
- Almost instantaneous reacquisition of RTK following any GNSS signal loss
- Automatic initialization upon power-up following a one-time calibration
- Very low noise L1 and L2 carrier phase measurements
- Superior low-elevation tracking performance regardless of latitude

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POSPac™ MMS

POSPac™ MMS for marine applications is your key to powerful, consistent, reliable, and accurate data...every time.

POSPac MMS for marine is powerful post-mission software for processing sensor data from your POS MV for highly accurate and robust direct georeferencing.

Optimised for the marine environment and compatible with a wide variety of hydrographic processing packages, this software solution achieves both maximum accuracy and maximum efficiency for direct georeferencing survey data.

The complete post-processing toolbox delivers a streamlined field-to-office workflow for best results possible.

POSPac MMS Improves Your Accuracy and Reliability

Accuracy – Post-processed kinematic processing and an advanced smoothing algorithm drastically improves position and orientation accuracy.

Reliability – Setup errors can be corrected in post-processing. In addition, alternative differential GNSS sources can be found if primary source proves unreliable.

It contains all the tools required to:

- Produce highly accurate position and orientation solutions from the GNSS and Inertial data logged by your POS MV system
- Obtain maximum immunity to GNSS outages in difficult environments – under bridges, cranes and other structures
- Achieve stable, reliable, repeatable, and more accurate results
- Import, manage and assess the data from your POS MV system and GNSS reference stations
- Automate data output in a wide variety of industry standard formats or define your own
- Built-in database of GNSS reference stations enables POSPac MMS to find the most suitable reference stations

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POSPac MMS is industry-leading software for Direct Georeferencing.

Only POSPac MMS features Applanix SmartBase™ and IN-Fusion™ Technology

POSPac MMS for Marine includes the Applanix SmartBase™ software module with Applanix IN-Fusion™ technology. These tools are designed to significantly increase the efficiency, accuracy, and robustness of mapping and surveying using GNSS on marine platforms. GNSS network and inertial post-processing methods work in direct cooperation, reducing and in some cases eliminating the restrictions associated with high accuracy GNSS positioning in a marine-based environment. Reliable centimetric accuracy can be obtained from existing reference station networks, even if the nearest reference station is 70 km or more away. In many scenarios, this completely eliminates the expense and logistical headaches associated with deploying a dedicated station close to the project area.

The Applanix SmartBase™ module uses the data logged from a network of GNSS reference stations to create a model of the atmospheric and other geometric errors across the survey area, and thus generate a set of GNSS observables at a "virtual" location close to the vessel. These and the remote receiver observables are then post-processed along with data from the Inertial Measurement Unit using the Applanix IN-Fusion technology, to simultaneously solve for the GNSS ambiguities and position and orientation of the vessel. The Applanix SmartBase approach ensures errors due to atmospheric delays are accurately modelled anywhere within the network of receivers, meaning the correct integer ambiguities are quickly and reliably computed. Tight integration with inertial data improves accuracy and robustness through cycle slips or full outages.

Applanix SmartBase™ and IN-Fusion™ Technology Deliver High Accuracy, Productivity

The combination of the Applanix SmartBase and the Applanix IN-Fusion technologies provides important new benefits over standard GNSS Kinematic Ambiguity Resolution (KAR). Because there is no need to set up dedicated stations close to the project area, and because the time spent in the office post-processing results is less, the overall expenditure associated with high-accuracy surveying is significantly reduced. The robustness of the solution however is increased, ensuring the data is captured first time, every time.

Rigorous Quality Assurance and Control

Included in SmartBase is the ability to perform a quality check on the reference station data. Using rigorous GNSS surveying adjustment algorithms, 18 to 24 hours of reference station data is processed to check the quality of both the network coordinates and the raw observations against a control you specify. Bad reference station data, antenna heights, or reference station coordinates, are detected and corrected with the SmartBase module before the remote GNSS data from the vessel is touched.

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