

MAPPING DATA ACQUISITION AND PROCESSING SUMMARY REPORT:

EX-19-06, 2019 Southeastern U.S. Deep-Sea Exploration (Mapping)

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1. Introduction

The NOAA Office of Ocean Exploration and Research is the only federal program dedicated to exploring our deep ocean, closing the prominent gap in our basic understanding of U.S. deep waters and seafloor and delivering the ocean information needed to strengthen the economy, health, and security of our nation.

Using the latest tools and technology, OER **explores** previously unknown areas of our deep ocean, making discoveries of scientific, economic, and cultural value. Through live video streams, online coverage, training opportunities, and real-time events, OER allows scientists, resource managers, students, members of the general public, and others to actively **experience** ocean exploration, expanding available expertise, cultivating the next generation of ocean explorers, and engaging the public in exploration activities. From this exploration, OER makes the collected data needed to **understand** our ocean publicly available, so we can maintain the health of our ocean, sustainably manage our marine resources, accelerate our national economy, and build a better appreciation of the value and importance of the ocean in our everyday lives.



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2. Report Purpose

The purpose of this report is to briefly describe the acoustic seafloor and water column mapping data collection and processing methods used during exploration expedition EX-19-06, and to present a summary of the overall mapping results and mapping related cruise activities. A detailed description of the *Okeanos Explorer's* mapping capabilities is available in the 2019 NOAA Ship *Okeanos Explorer* Survey Readiness Report, available in the NOAA Central Library at the following DOI: <https://doi.org/10.25923/kkwz-5t70>.

3. Cruise Objectives

EX-19-06 was one of several NOAA Ship *Okeanos Explorer* expeditions from 2018 to 2021 planned to contribute to NOAA's Atlantic Seafloor Partnership for Integrated Research and Exploration (ASPIRE), a major multi-year, multi-national, collaborative ocean exploration program focused on raising our collective knowledge and understanding of the North Atlantic Ocean. The North Atlantic Ocean plays a pivotal role to humankind, providing biological and geological resources, ecosystem services such as seafood production and climate regulation, and a route for trade and travel between Europe and the Americas. However, we have only begun to understand the North Atlantic Ocean's ecosystems, resources and oceanography, as much about the seabed bathymetry, geology, mineralogy, and trans-Atlantic connectivity of biological communities remains unknown. With the signing of the Galway Statement on Atlantic Ocean Cooperation by The European Union, Canada and the U.S., and the Atlantic Ocean Research Alliance's deep-sea science and exploration efforts, there is significant momentum within the international community to cooperate on integrated exploration and research of the North Atlantic Ocean.

Building on previous work in the North Atlantic, including the 2011-2014 Atlantic Canyons Undersea Mapping Expeditions (ACUMEN), NOAA's ASPIRE campaign will provide data to inform research planning and management decisions in the region, by broadening both the geographic focus to include more of the U.S. Atlantic and Canada, and the scope of partnerships to include U.S. federal agencies, such as U.S. Geological Survey (USGS) and Bureau of Ocean Energy Management (BOEM), as well as international partners from Canada and Europe.

The ship started the cruise from North Kingstown, RI on October 5, 2019 and ended in Miami, Florida on October 26, 2019. EX-19-06 operations involved a transit southward along the edge of the continental shelf followed by focused ocean mapping operations mostly in deep (>200 m) U.S. federal waters off the southeast U.S. Coast on the Blake Plateau. Some limited surveying was also completed along the U.S./Bahamas maritime boundary region. The cruise conducted 24 hour/day exploratory mapping operations to provide initial characterization of the region, as well as to provide data to support more in-depth exploration with remotely operated vehicles (ROVs) planned for the follow-on EX-19-07 expedition.

The complete objectives for this cruise are detailed in the EX-19-06 Project Instructions, which are archived in the NOAA Central Library.

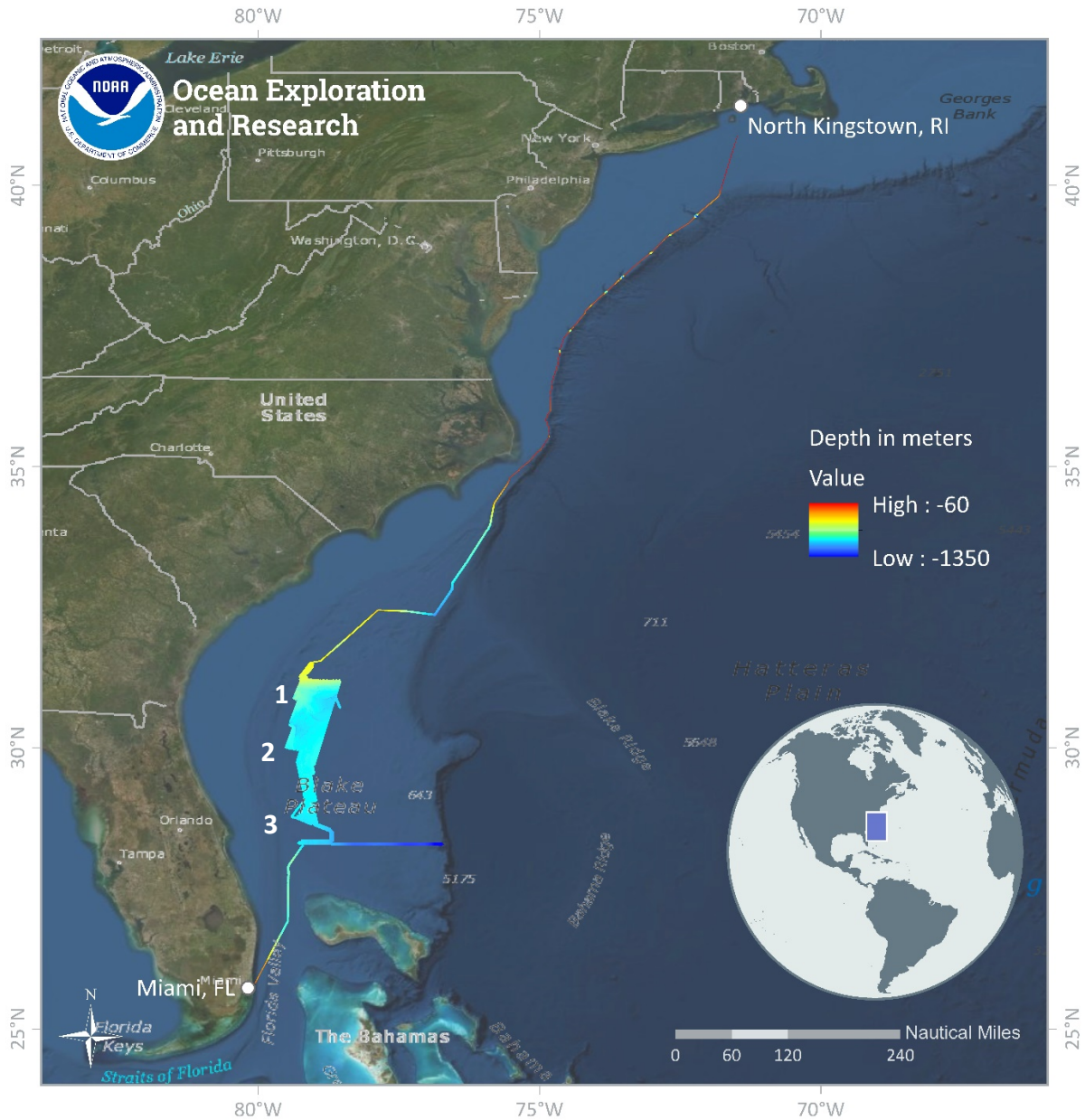
4. Summary of Mapping Results

EX-19-06 collected 20,289 square kilometers (5,915 square nautical miles) and 7,594 linear kilometers of bathymetry and associated water column data. 18,110 square kilometers of this area was mapped within the U.S. Exclusive Economic Zone in depths deeper than 200m. Multibeam bathymetry data coverage is shown in Figure 1.



Cruise Overview Map

2019 Southeastern U.S. Deep-Sea Exploration - Mapping Expedition Summary Map: EX-19-06 Multibeam Bathymetry



Overview map showing multibeam bathymetric data coverage completed for the expedition.
Map created by NOAA Office of Ocean Exploration and Research.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

Figure 1. Cruise map showing overall EX-19-06 bathymetry coverage. The numbers 1, 2, and 3 on the figure represent the general vicinity of the three focused bathymetric survey area priorities targeted for mapping by the expedition.

5. Mapping Statistics

Table 1. Summary statistics of ocean mapping work completed during EX-19-06.

Dates of cruise	October 5 – October 26, 2019
Ship's draft Start of cruise	Forward: 15' 3" Aft port: 13' 9.5" Aft starboard: 14' 2.5"
End of cruise	Forward: 15' 0" Aft port: 14' 1.5" Aft starboard: 14' 4.5"
Linear kilometers of survey with EM 302	7,594
Square kilometers mapped with EM 302	20,289
Square kilometers mapped with EM 302 within U.S. EEZ deeper than 200m	18,110
Number / Data Volume of EM 302 raw bathymetric / bottom backscatter multibeam files (.all)	792 files/ 70 GB
Number / Data Volume of EM 302 water column multibeam files	792 files / 140 GB
Number / Data Volume of EK 60 water column split beam files (.raw)	1,477 files / 330 GB
Number / Data Volume of sub-bottom sonar files (.segy, .kea, .keb)	756 files / 5.2 GB
Number of XBT casts	201
Number of CTD casts (including test casts)	1



6. Mapping Sonar Setup

The following sonars were operated during this cruise:

Kongsberg EM 302 Multibeam Sonar

The NOAA Ship *Okeanos Explorer* is equipped with a 30 kHz Kongsberg EM 302 multibeam sonar capable of detecting the seafloor in up to 10,000 meters of water and conducting productive mapping operations in 8,000 meters of water. The system generates a 150° beam fan containing up to 432 soundings per ping in waters deeper than 3300 meters. In waters less than 3300 meters, the system is operated in multi-ping, or dual swath mode, and obtains up to 864 soundings per ping, by detecting two swaths per ping cycle. The multibeam sonar is used to collect seafloor bathymetry, seafloor backscatter, and water column backscatter. Backscatter represents the strength of the acoustic signal reflected from a target, such as the seafloor or bubbles in the water column. The system is patch tested annually and the results are reported in the annual readiness report. The 2019 NOAA Ship *Okeanos Explorer* Mapping Systems Readiness Report is available in the NOAA Central Library at the following DOI: <https://doi.org/10.25923/kkwz-5t70>.

Simrad EK 60 / EK 80 Split-beam Sonars

The ship operated four Simrad EK 60 / EK 80 split-beam fisheries sonars: 18 kHz (EK 60), 70 kHz (EK 80), 120 kHz (EK 60), and 200 kHz (EK 60). These sonars are quantitative scientific echosounders calibrated to identify the target strength of water column acoustic reflectors - typically biological scattering layers, fish, or gas bubbles – providing additional information about water column characteristics and anomalies. These sonars were calibrated on the EX-19-02 cruise, and calibration values from that cruise were applied to the EK sonars for EX-19-06. The 2019 EK 60 & EK Calibration Report (<https://doi.org/10.25923/wzk7-6d52>) is available in the NOAA Central Library. The 70 kHz is capable of operating in narrowband or wideband mode with a frequency modulated ping. This sonar was run in narrowband mode most of EX-19-06, as the wide band mode picked up a lot of noise in the upper water column from the multibeam sonar. The ship also has a 38 kHz EK 60 transducer, but it is in need of replacement and was not operated on this cruise.

Knudsen 3260 Sub-bottom Profiler

The ship is equipped with a Knudsen 3260 sub-bottom profiler that produces a frequency-modulated chirp signal with a central frequency of 3.5 kHz. This sonar is used to provide echogram images of shallow geological layers underneath the seafloor to a maximum depth of approximately 80 meters below the seafloor. The sub-bottom profiler is operated to provide information about sub-seafloor stratigraphy and features. The data generated by this sonar is fundamental to helping geologists interpret the shallow geology of the seafloor.



7. Data Acquisition Summary

Mapping operations included EM 302 multibeam, EK 60 / EK 80 split-beam, and Knudsen sub-bottom profile data collection.

Survey lines were planned to maximize either bathymetry edge matching of existing data or data gap filling in areas with existing bathymetry coverage. In regions with no existing data, lines were planned to optimize potential exploration discoveries.

Throughout the cruise, multibeam data quality was monitored in real-time by acquisition watch standers. Ship speed was adjusted to maintain data quality as necessary and line spacing was planned to ensure one-quarter to one-third swath width overlap between lines. Cutoff angles in SIS were generally left wide open for maximum exploration data collection, and were adjusted on both the port and starboard side during focused survey operations to ensure the best data quality and coverage. Data were corrected for sound velocity in real-time using the Reson SVP-70 data at the sonar head, and profiles from Expendable Bathythermographs (XBTs) that were conducted every 2 to 4 hours, or as dictated by local oceanographic conditions. Reson sound velocity values were constantly compared against secondary derived sound speed values from the ship's onboard thermosalinograph flow-through system as a quality assurance measure.

Multibeam backscatter data quality were also closely monitored in real-time. The ping mode in SIS was held in 'Deep' mode with frequency-modulated transmit pulses disabled in SIS for most of the cruise in order to maintain consistent backscatter data. Data quality for backscatter was very good for much of the cruise, but was poor during several bad weather days.

Simrad EK 60 / EK 80 split-beam water column sonar data were collected continuously during the cruise, except for in a few limited areas with rough weather. Data were monitored in real time for quality but were not post-processed. Figure 2 shows the EK 60 / EK 80 data collected during EX-19-06.



2019 Southeastern U.S. Deep-Sea Exploration - Mapping Expedition Overview Map: EK 60 / EK 80 Sonar Data Tracklines

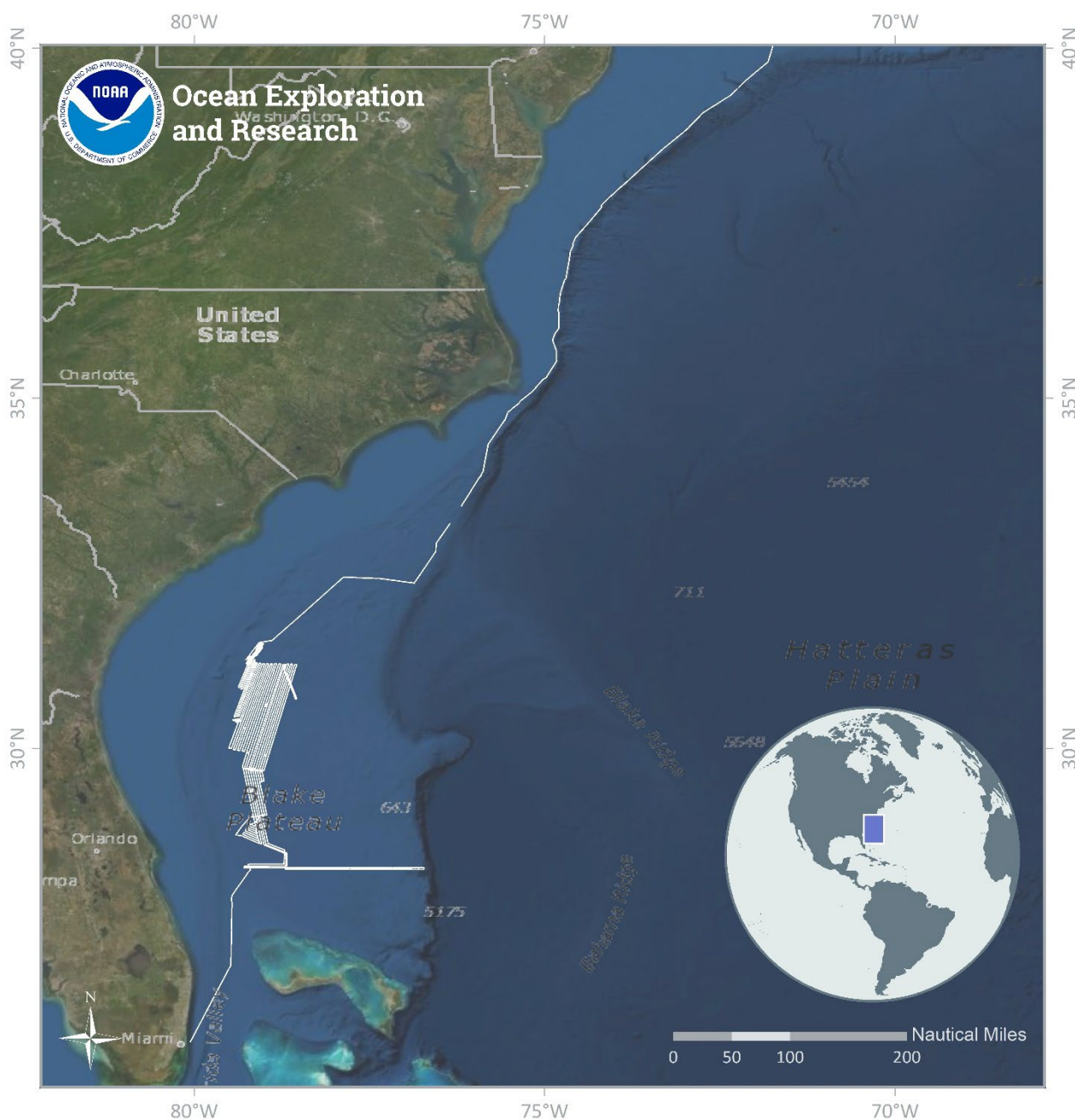


Figure 2. Map showing EK60/EK 80 split-beam sonar data tracklines (in white) collected during EX-19-06.

Knudsen 3260 sub-bottom profiler data were collected constantly throughout the cruise, except in water depths less than approximately 200m. Data were post-processed using the SEGY2JPG software during the

cruise, and the resulting jpeg and ArcGIS shapefiles are archived along with the raw data at NCEI. Figure 3 shows the Knudsen sub-bottom profiler data tracklines collected during EX-19-06.

2019 Southeastern U.S. Deep-Sea Exploration - Mapping Expedition Overview Map: Sub-bottom Profiler Sonar Data Tracklines



Figure 3. Map showing sub-bottom profiler data tracklines (in white) collected during EX-19-06.

Expendable Bathythermographs (XBTs) were conducted every 2 to 4 hours to provide temperature profiles of the water column in order to calculate sound velocity profiles. Within the largest survey area,

casts were completed every two hours due to highly dynamic temperature and salinity conditions in vicinity of the Gulf Stream current. These profiles are used while surveying with the multibeam sonar in order to properly account for sound speed changes and ensure the most accurate bathymetry data possible. The locations of the XBT casts completed during EX-19-06 are shown in Figure 4, in total there were 201 XBT casts taken as part of the mapping survey.

2019 Southeastern U.S. Deep-Sea Exploration - Mapping Expendable BathyThermograph (XBT) Locations Completed on EX-19-06

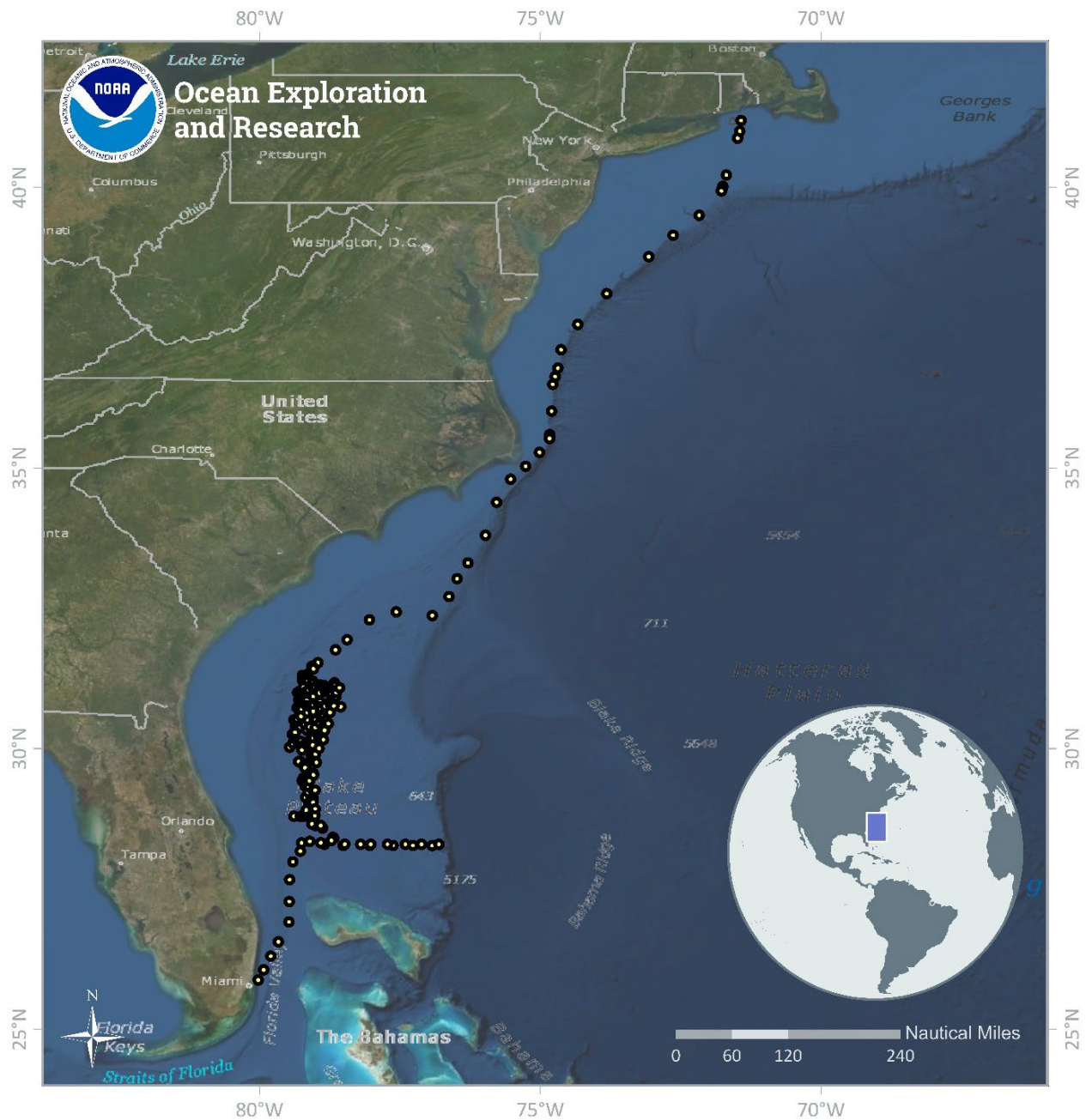


Figure 4. Map showing XBT cast locations completed during EX-19-06.

New mapping data were collected in high priority areas of shared management interest to the United States Geological Survey, the Bureau of Ocean Energy Management, and the South Atlantic Fisheries Management Council. The cruise revealed many new areas of likely deep sea coral mounds (Figure 5), and defined the easternmost extent of dense coral mound features in the southern and middle portion of the Stetson Miami Terrace Deepwater Coral Habitat Area of Particular Concern.

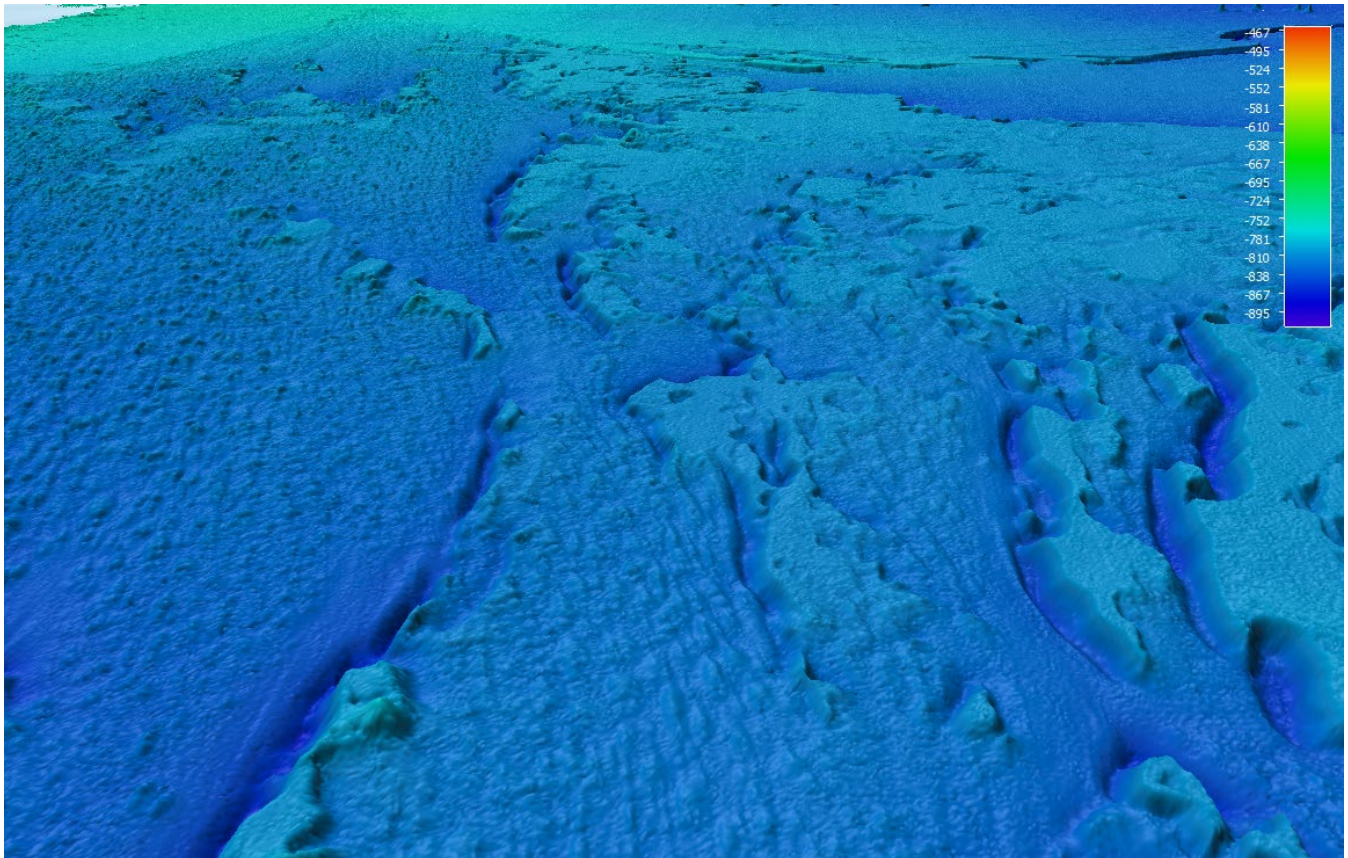


Figure 5. 3D perspective view of newly mapped mound and scarp features on the Stetson Mesa as visualized in QPS Fledermaus software with north up. Depth units on the color scale bar are in meters, the vertical exaggeration of the terrain is 6x, and the resolution of the bathymetry grid is 30 meters. Approximate location at the center bottom of the image is 79° 11.07' W, 30° 17.22' N.

The seafloor terrain on Stetson Mesa that was the main focus of this expedition exhibited many complex low-relief features. In addition to the thousands of mound features mapped, many distinct scarp features were revealed, as well as some bathymetric features with unusual textural patterns (Figure 6).

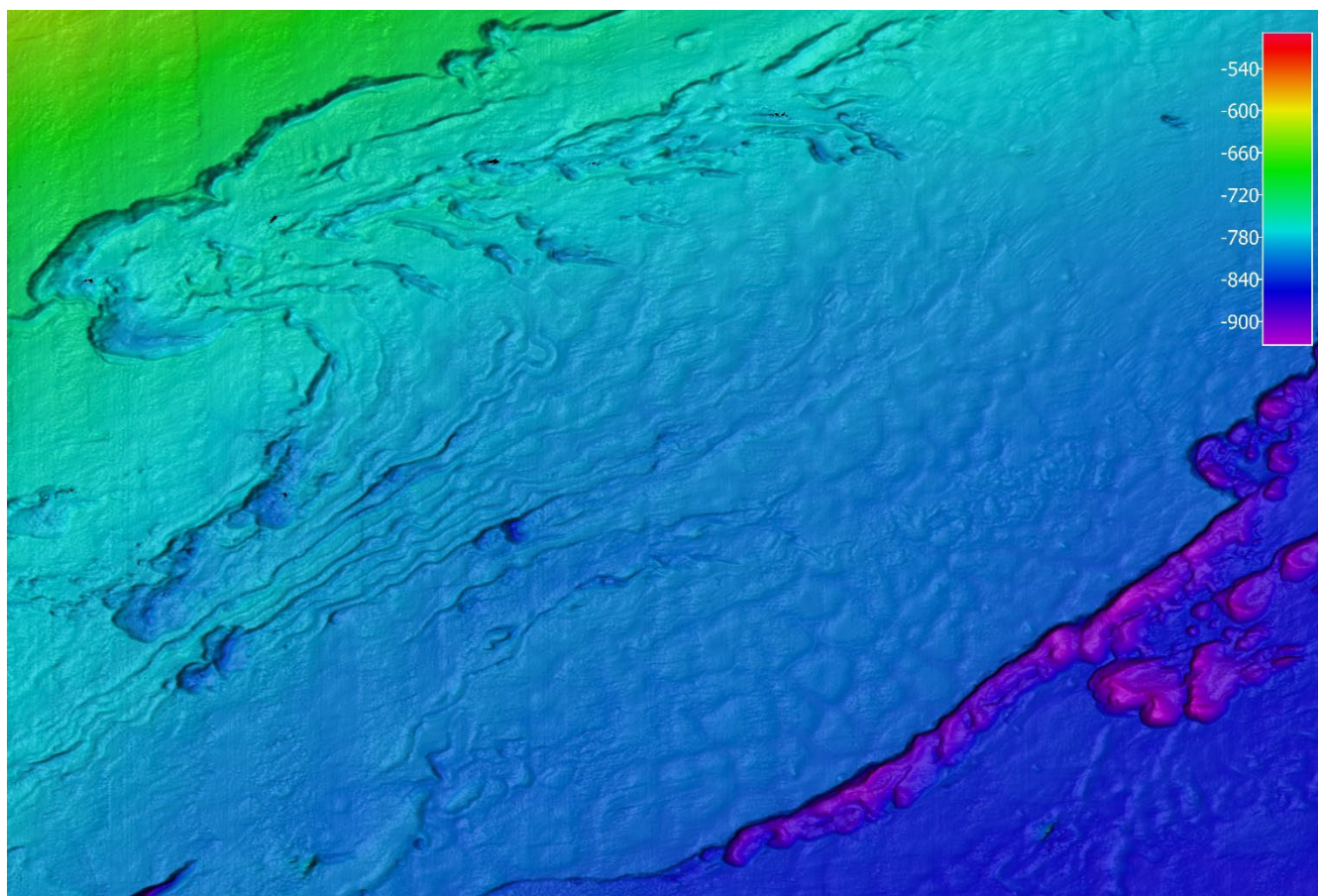


Figure 6. 3D perspective view of newly mapped features on the Stetson Mesa showing unusual patterns and textures as visualized in QPS Fledermaus software with north up. The wavy geologic features near the center of the figure and the polygon shapes on the seafloor on the right side of the figure were only observed in this region of the survey area. Depth units on the color scale bar are in meters, the vertical exaggeration of the terrain is 6x, and the resolution of the bathymetry grid is 30 meters. Approximate location at the center bottom of the image is 78° 51.96' W, 30° 52.31' N.

8. Multibeam Sonar Data Quality Assessment and Data Processing

Figure 7 shows the multibeam data processing workflow for this cruise. EM 302 Built-in Self Tests (BISTs) were run at the beginning and ending of the cruise to monitor multibeam sonar system status and are available as ancillary files in the sonar data archives. Raw multibeam bathymetry data files were acquired by SIS, then imported into QPS Qimera multibeam sonar processing data. Erroneous soundings were removed using 2-D, 3-D, and spline filtering editing tools in Qimera. Gridded digital terrain models were exported utilizing QPS Fledermaus software and posted to the ship's ftp site for daily transfer to shore. Final bathymetry QC was completed post-cruise onshore at the Center for Coastal and Ocean Mapping at the University of New Hampshire. With the vast majority of surveying completed in deep water, depth measurements were not adjusted for tides, as they are an essentially insignificant percent of the overall

water depth. Data cleaning projects were in UTM zone projections for the operations area. Final data products were exported and archived as field geographic WGS84 coordinate reference frame (i.e., un-projected).

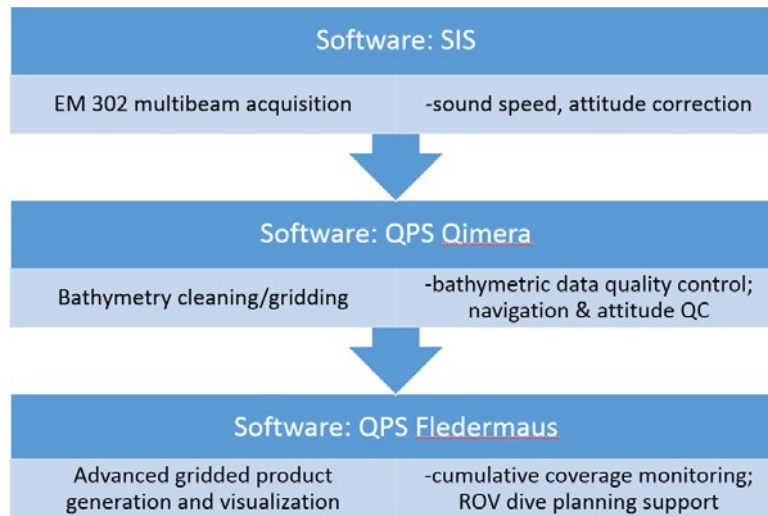


Figure 7. Shipboard multibeam data processing workflow.

Crosslines

Comparing depth values from orthogonal survey lines is a standard hydrographic quality control measure to evaluate the consistency of the multibeam sonar data collected during a cruise. A crossline was run on October 24, 2019 as shown in Figure 8. Crossline analysis was completed using the Crosscheck Tool in QPS Qimera software to evaluate if the survey meets the requirements for an International Hydrographic Order 1 survey. The results are shown below.

Crossline file:

0695_20191024_084255_EX1906_MB.all

Main scheme line files:

0476_20191018_220938_EX1906_MB.all

0485_20191019_031242_EX1906_MB.all

0486_20191019_041241_EX1906_MB.all

0496_20191019_091630_EX1906_MB.all

0571_20191021_075811_EX1906_MB.all



The results showed data quality sufficient for an International Hydrographic Organization Order 1 survey. Depths listed ("Z") are in meters.

<u>Statistic</u>	<u>Value</u>
Number of points of comparison	461181
Grid Cell Size	20.000
Difference Mean	-0.331
Difference Median	-0.387
Difference Std. Dev	1.194
Difference Range	[-6.945, 8.667]
Mean + 2*Stddev	2.718
Median + 2*Stddev	2.774
Data Mean	-805.055
Reference Mean	-804.724
Data Z-Range	[-809.684, -794.703]
Reference Z-Range	[-809.413, -799.009]
Order 1 Error Limit	10.4734
Order 1 # Rejected	0
Order 1 P-Statistic	0
Order 1 Survey	ACCEPTED



A

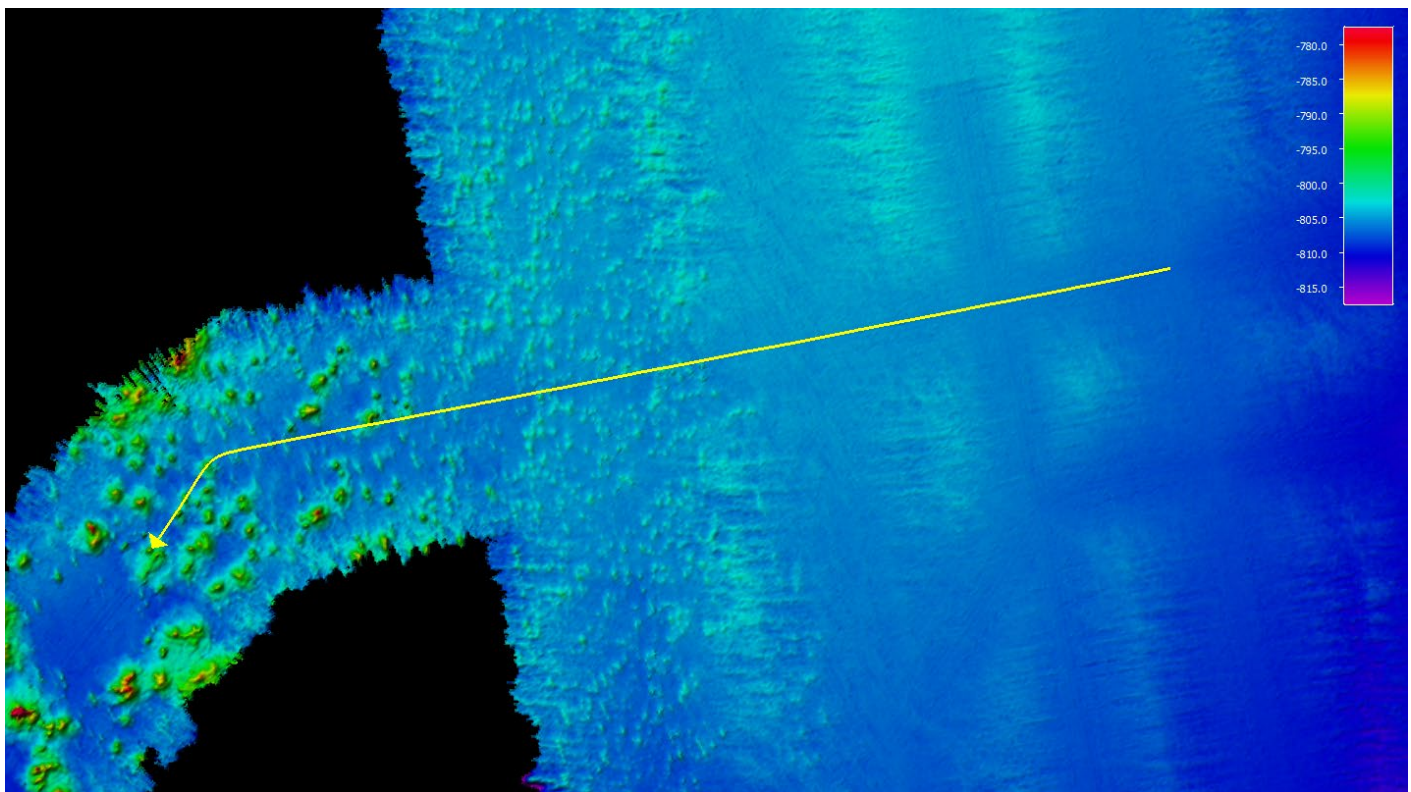


Figure 8. EX-19-06 crossline (shown in yellow) used for comparison against the bathymetric grid generated via orthogonal multibeam survey lines.

9. Data Archival Procedures

All mapping data collected by the NOAA Ship *Okeanos Explorer* are archived and publicly available within 90 days of the end of each cruise via the National Centers for Environmental Information (NCEI) online archives. The complete data management plan (which describes the raw and processed data formats produced for this cruise) is available as an appendix in the EX-19-06 project instructions available in the NOAA Central Library. Ancillary and supporting files are archived with the sonar datasets. These include:

EM 302 Multibeam bathymetry and bottom backscatter dataset:

- Mapping watch stander log
- Weather log
- Sound velocity profile log
- Multibeam acquisition and processing log

- Built-In-System-Tests (BISTs)
- Processor Unit Parameters

Simrad EK split-beam water column dataset:

- Mapping watch stander log
- Weather log
- EK data log

Knudsen 3260 Sub-bottom Profiler dataset:

- Mapping watch stander log
- Weather log
- Sub-bottom data log

EM 302 Multibeam water column dataset:

- Mapping watch stander log
- Weather log
- Sound velocity profile log
- Multibeam acquisition and processing log
- Built-In-System-Tests (BISTs)
- Processor Unit Parameters
- Multibeam water column data review log identifying files with potential seeps

All sonar data is permanently discoverable at <https://www.ngdc.noaa.gov/>

At the time of writing this report, EM 302 and EK 60 water column data, supporting data, and informational logs were available in the NCEI Water Column Sonar Archives:

https://www.ngdc.noaa.gov/maps/water_column_sonar/index.html (last accessed 1/17/2020).

Sub-bottom data, supporting data, and informational logs will be available in the NCEI Data Archives accessible at <https://www.ngdc.noaa.gov/>. For any challenges accessing SBP data, send an inquiry to ncei.info@noaa.gov requesting access to EX-19-06 Knudsen 3260 sub-bottom raw and processed data.

EM 302 bathymetry data, supporting informational logs, and ancillary files were/will be available in the

NCEI Data Archives accessible at <https://maps.ngdc.noaa.gov/viewers/bathymetry/> (last accessed 1/17/2020).

10. Cruise Calendar

All times listed are local ship time, which was -4 hours from UTC

October 2019

Sun	Mon	Tues	Wed	Thur	Fri	Sat
				3 Mobilization day. Most mission personnel arrive.	4 Mobilization day. Pre-cruise meetings and trainings.	5 First day of the cruise. Depart Rhode Island and transit south.
6 Transit south mapping along the edge of the continental shelf.	7 Transit south mapping along the edge of the continental shelf.	8 Transit south mapping along the edge of the continental shelf.	9 Focused mapping survey in priority area one on Blake Plateau offshore Georgia.	10 Focused mapping survey in priority area two on Stetson Mesa offshore Florida.	11 Focused mapping survey in priority area two on Stetson Mesa offshore Florida.	12 Focused mapping survey in priority area two on Stetson Mesa offshore Florida.
13 Focused mapping survey in priority area two on Stetson Mesa offshore Florida.	14 Focused mapping survey in priority area two on Stetson Mesa offshore Florida.	15 Focused mapping survey in priority area two on Stetson Mesa offshore Florida.	16 Focused mapping survey in priority area two on Stetson Mesa offshore Florida.	17 Focused mapping survey in priority area two on Stetson Mesa offshore Florida.	18 Focused mapping survey in priority area three on Stetson Mesa offshore Florida. Transit south to avoid storm.	19 Transit south to avoid tropical storm Nestor. Map in the region of the U.S. and Bahamas EEZ boundary.
20 Finish boundary survey and transit north surveying in priority area three.	21 Focused mapping survey in priority area two on Stetson Mesa offshore Florida.	22 Focused mapping survey in priority area two on Stetson Mesa offshore Florida.	23 Focused mapping survey in priority area three on Stetson Mesa offshore Florida.	24 Focused mapping survey in priority area three on Stetson Mesa offshore Florida. Start transit.	25 Transit mapping along EEZ border region on the way to port in Miami.	26 Arrive in port 0800 Miami, Florida. End of cruise.



11. Daily Cruise Log Entries

Generated from the daily expedition situation reports. All times listed are in local ship time which was Eastern Daylight Savings Time (EDT) (-4 hours from Coordinated Universal Time (UTC))

October 3, 2019

First mobilization day of EX-19-06. Mission personnel arrived throughout the day. The ship is in clean and ready condition for the cruise. The EM 302 multibeam was turned on and passed all BIST tests on the first try. The pallet of XBTs in the port warehouse was loaded onboard by SST and the Deck Department. New mission personnel were oriented to the ship and the team settled into their staterooms.

October 4, 2019

Today was the last in-port day prior to the start of EX-19-06. The pre-cruise meeting of EC with ship command and departments was completed. The vessel familiarization meeting was completed by OPS. EC gave the Explorer-in-Training students an orientation presentation, discussion of watchstanding duties, and tour of the control room. The EM 302 multibeam had great difficulty passing Built-in Self Tests (BIST) tests today, which was odd because it had no problem with this yesterday. After several hours of persistent troubleshooting, all tests passed and the sonar appears ready to operate normally tomorrow. The fix involved swapping in a previously used spare TX board, rebooting the TRU many times, and adjusting Ethernet cable connections. The Hypack planning project was created and transit lines delivered to the bridge.

October 5, 2019

First sea day of the cruise. The ship got underway at 1000, and began the multi-day transit southward towards the primary surveying grounds. Sea state was mild today, but we are headed towards rougher seas to the south. Much of the day was spent transiting over the broad and relatively shallow continental shelf. The thermosalinograph (TSG) was not working right and had to be fixed. The Seabird SBE38 external temperature probe was malfunctioning, causing fuse blowouts in the transmitter box. The probe was swapped with a spare to solve the problem. This work did not hinder mapping operations. Multibeam and EK data were collected over the shallow shelf after leaving Narragansett Bay, Knudsen sub-bottom data collection began in 100m water. Data quality is good given the shallow depths.

October 6, 2019

Second sea day of the cruise. Transit mapping southward along the edge of the continental shelf collecting multibeam, EK, and sub-bottom sonar data. Systems functioning normally. Sea state was mild in the morning, building somewhat in the afternoon. Weather forecasted to get worse later this week. Sonars are working normally. Drills were completed today for all mission personnel. We continued to edge-match existing multibeam coverage along the edge of the continental shelf - most of the mapping is in shallow depths between 100-1200 m. Minor deviations needed to avoid fishing gear. Clear gas seep plumes were spotted in the EK and multibeam sonars on the north side of Norfolk Canyon. These are probably known seeps, but the team will check against locations of previously noted seeps.



October 7, 2019

Third day of transiting southward towards the Blake Plateau. Shallow edge mapping continued. The sea state picked up considerably today, with the ship surveying in the trough. Several mission members impacted with seasickness. Mapping systems working normally and data quality is fairly good considering the weather. Tube 1 in the Automated XBT (AXBT) launcher is not working correctly - otherwise the AXBT is working well.

October 8, 2019

Fourth day of transiting southward towards the primary survey grounds on the Blake Plateau. Rough weather last night and part of today. Mapping data has been moderate quality with some impacts from excessive ship motion/noise and sound velocity variability. We begin focused survey work tomorrow morning mapping an area identified as a priority for searching for the *Bloody Marsh* wreck, BOEM/USGS seafloor characterization, and ASPIRE goals. Transit edge mapping continued. Overnight seas were rough, with the ship taking large rolls. The mission members impacted with seasickness yesterday recovered today and began their watchstanding training/duties. We had an extended POSMV positioning feed dropout to Hypack, EKs, SCS, and the CTD1 computer last night. This appeared to be remedied by checking and pushing in the cable connections from the POS to the buffer distribution box for the affected computers. We are mapping what appear to be small interesting mound features on our transit today (east of Charleston, South Carolina).

October 9, 2019

The day was spent surveying in our first priority mapping box, in an area that has a possible underwater cultural heritage (UCH) site (*Bloody Marsh*) and is a USGS/BOEM priority for seafloor classification. Seas were rough, with 7-11' waves. The ship secured water making all day as a precautionary measure given that apparent oil slicks (possibly from a wreck) have been reported in this area. We are moving southward overnight into the large survey area for Stetson Mesa (the main priority box for this cruise). Today's survey area has some fascinating complex bathymetry, with distinct ridges, channels, and mounds.

Multibeam data was fairly good when mapping in the SW direction along with the waves, when mapping against the waves pitching was a problem and resulted in fair/poor data. Changing line orientation was not possible given the strong Gulf Stream current in the survey area. XBTs were conducted every 2 hours. We modified the line spacing for about 100% overlap to ensure a quality bathymetric survey of the area. Backscatter data was poor all day, and thus not of much utility in searching for the *Bloody Marsh* UCH target.

We had the same issue as the day before with a long POSMV position data feed dropping out to Hypack, EK, and CTD computers. Global Foundation for Ocean Exploration engineers, mapping watch lead, and the ship's chief electronics technician worked on troubleshooting the issue. It appears that the com port out of the POS was sometimes putting out a readable NMEA string, and other times not. We secured the cabling better and made sure all connections tight. Problem resolved for now. The multibeam was unaffected by this issue, except when the attitude feed was interrupted during troubleshooting. We are filling that holiday in the survey coverage tonight.



October 10, 2019

Last night we finished a small focused survey of our first of four priority boxes for the cruise. Initial observations did not reveal any obvious wreck targets for the *Bloody Marsh* in the multibeam bathymetry or backscatter. The backscatter was mostly of low quality given the rough seas and impact of bubbles on the data. Today we began mapping the large survey area for Stetson Mesa (the main priority box for this cruise). Mapping data quality was the same as yesterday - significantly impacted by weather in one direction, with good/moderate quality on the reciprocal heading. We are doing frequent sound velocity casts with substantial overlap to make sure we are getting a good bathymetric survey grid despite the less than ideal weather. We are also surveying a little slower speed than normal to minimize bubble sweepdown under the ship and as a result of the Gulf Stream current here.

October 11, 2019

Continued working on the large survey box on Stetson Mesa. The sea state dropped a bit today and mapping data quality improved. All sonars working normally. Weather is expected to stay moderate this weekend, with Monday getting mild.

October 12, 2019

Continued working on the large survey box on Stetson Mesa. Wind was very light today and the seas had minimal chop - just long period swell. Conditions for mapping were very good. With the improved seas mapping data quality improved greatly, and we are now able to go to normal line spacing and survey speed. We have found applying SVP files in Qimera is working best using "nearest in time" for a processing parameter. The frequent sound velocity casts are paying off with minimizing sound velocity problems in the data.

October 13, 2019

Continued working on the large survey box on Stetson Mesa. Data quality was excellent with favorable seas and calm breezes. We are making strong progress on our primary mapping objective. Today great progress was made in getting us back up to present with multibeam data cleaning. The data acquired during rough weather was very time intensive to clean well. New data is very high quality, and we are mapping some fascinating seafloor features in this region - many low relief but prominent scarps and interesting "microridge" features. The seafloor "texture" in some areas appears to have a unique geology and interesting backscatter response that is fairly distinct from other areas mapped in this region.

We are planning to do a CTD cast tomorrow morning. We also plan to test the new Castaway CTD hand-deployed unit. The Castaway was initialized today and we read the instruction manual and installed the device's software onto CTD1 and CTD2 computers.

We are currently keeping the multibeam in Deep1 mode to ensure consistent backscatter within this survey. Since this mode has frequency-modulated pings in the outer beams of the multibeam, we are running the EK 80 70 kHz sonar in CW mode to avoid interference in the EK's water column data. In shallower waters on this cruise we ran the EK 80 in FM (wide band) mode.



October 14, 2019

Data quality was excellent and the seas were mild. The CTD rosette was tested today to ensure proper readiness and equipment function. We also tested the new hand-deployed Castaway CTD. Both CTDs worked well. The CTD rosette worked perfectly. The Castaway CTD derived sound speed values agreed with the rosette values within 0.25 meters/second.

October 15, 2019

Another solid day of progress mapping this large continuous survey area on Stetson Mesa. Data quality has been excellent. Tomorrow seas are supposed to pick up for about 24 hours. Multibeam has been working smoothly with no errors or issues. Since we rebooted SIS a few days ago the gridding engine has been working much better and has continued to allow zooming in without the grid disappearing. We filled one holiday trouble spot where very weak backscatter in a basin feature was failing to get bottom detections in the outer beams.

October 16, 2019

The seas were building throughout the day, with rough short-period waves and high winds. We had a following sea for half the day, but were unable to get decent data on the reciprocal survey line heading. We found a heading with acceptable ride and some reasonable data quality and we will survey in this orientation until the weather subsides and we can resume our systematic survey lines. Data quality declined sharply in the afternoon and remained poor.

October 17, 2019

Wind and wave conditions subsided overnight. Data quality returned to very good today, and we resumed our systematic survey lines. The geomorphology of this region is diverse and striking and will be of great interest to our geology colleagues. There is another storm system headed to our survey area for Saturday night and Sunday with very high winds and 10'+ seas. We are thus heading south tomorrow to the most SE region of our operating area to give use the best chance of collecting data while the storm moves through. We will then return north after the storm to add more coverage to our priority survey boxes.

October 18, 2019

Very mild seas today made for excellent surveying conditions. Weather will deteriorate tomorrow and we will transit south in the morning to a more favorable location.

October 19, 2019

Weather quickly deteriorated today as tropical storm Nestor moved from the Gulf of Mexico into our operations area. The wind and waves were somewhat worse than predicted. Data quality was very poor until after lunch. At that time we settled on an almost due east heading to map along the US/Bahamas Exclusive Economic Zone (EEZ) boundary and the data gradually improved to fair. We are staying in this boundary mapping area for another 24 hours until the storm moves further north. Mapping of this boundary area was a contingency plan and still provides substantial benefit to OER's objectives for this region. The TSG pump was somehow turned off in the early morning hours and data provided through the flow through system was thus out from about 10 - 12:30 UTC. It could not be turned back on from the push switch in the Wet Lab. This provides a QC comparison of sound speed against which to compare our primary mapping sound speed sensor (the Reson SVP70), but does not impact data quality.

October 20, 2019

Sea state calmed down a bit overnight, but was still unsettled all day today. Data quality was fair, and gradually improving later in the day. We continued surveying in the US/Bahamas EEZ boundary region, and completed the entire east/west portion of it. Weather should be favorable tomorrow and we are heading back north to continue priority mapping work on the eastern edge of our survey. Late last night the TSG stopped working again. Engineering is working to resolve the issue, but it was not operational all day today. This does not affect surveying data directly. The problem is with the pump/pump circuit in the bow thruster room that pushes the seawater through the system. Parts are onboard to fix the issue.

October 21, 2019

An excellent day of good weather and high quality mapping data. The TSG remains down for the time being as the Engineering Department is necessarily focused on working on top priority maintenance/repair on a generator and the water making reverse osmosis unit. We have moved back north and are mapping long straight lines again.

October 22, 2019

Another productive day of mapping in the northern priority area of Stetson Mesa. Work in this area will be completed overnight, at which time we move south to add further coverage to the eastern edge of the coral region unofficially dubbed "Million Mounds." Seas were mild and data quality was excellent.

October 23, 2019

Sea state was a little rougher today up to 6' but data quality remained very good. We expect similar conditions for the remainder of the cruise. All systems working normally. All EX data in the region was compiled last night for presentation to the South Atlantic Fisheries Management Council.

October 24, 2019

Today we found and confirmed the easternmost extent of dense mound features in the "Million Mounds" region below 30 degrees N latitude. We also completed a major gap filling survey of dense corals that connected three different EX surveys for complete coverage of a high priority area. This evening we began the transit south edge-matching our "boundary survey" area, then beginning our transit to Miami at approximately 0400 10/25.

October 25, 2019

Last full sea day of the cruise. Today was spent transit mapping on our way to port in Miami. Winds were blowing steady 20 knots from the east with seas 5-8'. Data quality was mostly good despite the conditions since we are in the trough and not pitching too much. The whole transit is against the Gulf Stream so speeds are slow. We have had to come off our planned trackline along the N-S EEZ boundary to find more favorable currents and to move more directly towards the sea buoy in order to get there on time tomorrow. The transit data is interesting with many apparent mound features revealed. Some of the transit data was within the Bahamian EEZ (as allowed by our Marine Scientific Research MSR permit). The ship's passage to the Coast Guard base must be timed with the tide to clear a shoal hazard. We are scheduled to arrive at the base at approximately 0800 Saturday.



October 26, 2019

Last day of the cruise. Arrived in port at 0800 as planned. Multibeam mapping concluded near the sea buoy.

12. References

The 2019 NOAA Ship *Okeanos Explorer* Survey Readiness Report can be obtained in the NOAA Central Library or by contacting the NOAA OER mapping team at oar.oer.exmappingteam@noaa.gov.

The EX-19-06 Project Instructions can be obtained from the NOAA Central Library. The EX-19-06 Data Management Plan is an appendix of the project instructions.

The following data were used as background data throughout the expedition:

- Sandwell, D.T., and W.H.F Smith, Global marine gravity from retracked Geosat and ERS-1 altimetry: Ridge Segmentation versus spreading rate, *J. Geophys. Res.*, 114, B01411, doi:10.1029/2008JB006008, 2009.
- NOAA Nautical Charts
- Various datasets downloaded from the NCEI archives via NOAA AutoChart.