Analysis and Comparison of Geologic Features at the Miami Terrace off the Southeast Coast of Florida

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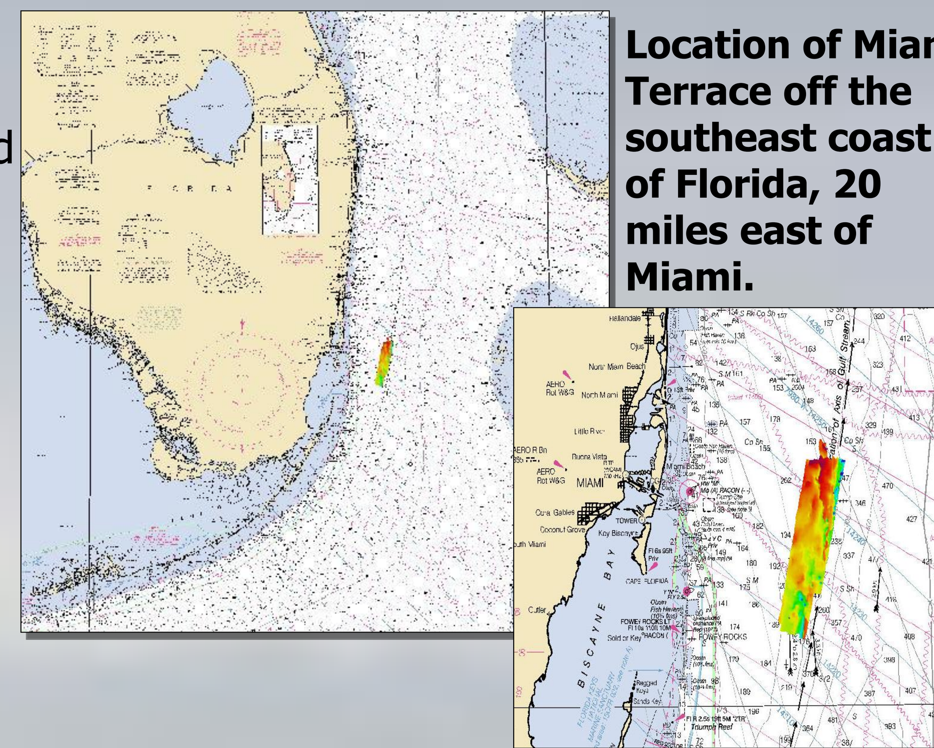
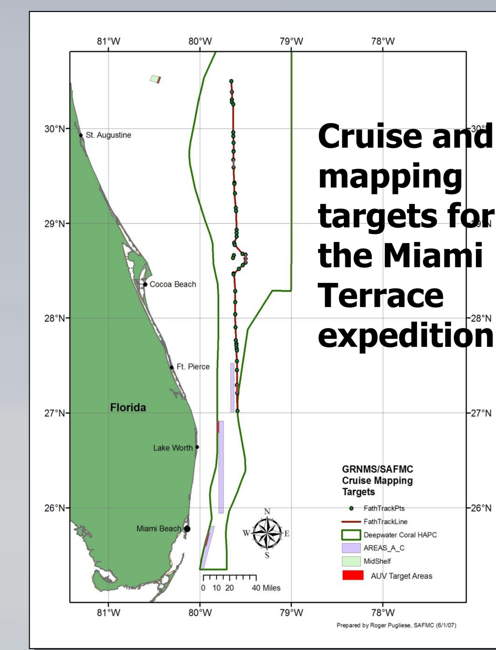
ABSTRACT

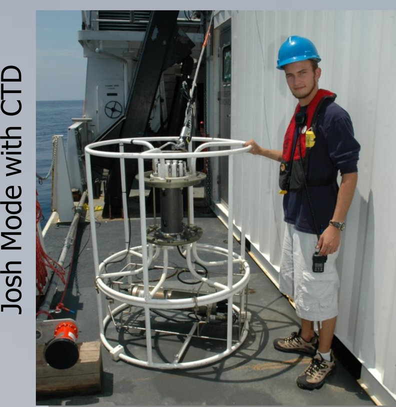
The Miami Terrace is a carbonate platform located off the Southeast coast of Florida. Throughout the Miami Terrace many geologic features exist that are conducive to marine benthic habitat. The NOAA ship *Nancy Foster* explored the features on a cruise from June 4-9, 2007. During the cruise two different Simrad multibeam mapping instruments were used to examine the ocean floor: a ship-mounted system and a system housed in an Autonomous Underwater Vehicle (AUV), the *Eagle Ray*. After the data were collected, they were processed using CARIS HIPS 6.1 to analyze the features mapped by each system. A comparison of specific features shows that the AUV produces higher quality imagery, while the ships system is able to survey a larger area in an equal amount of time with lower quality.



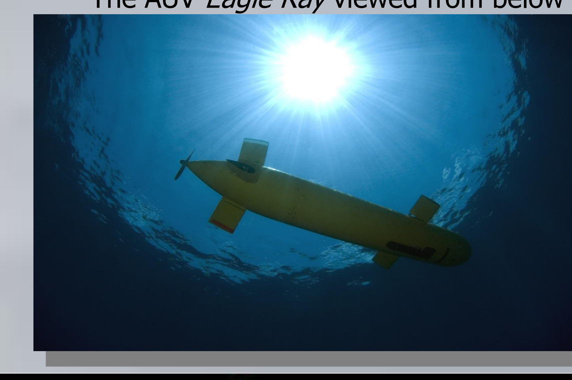
Location of Miami Terrace off the southeast coast of Florida, 20 miles east of Miami.



Cruise and mapping targets for the Miami Terrace expedition.



Josh Mode with CTD

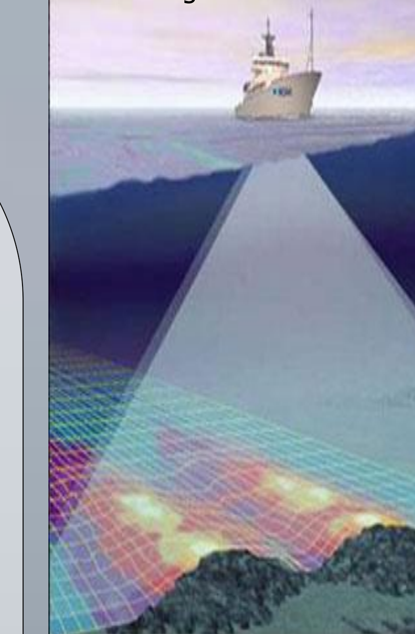


The AUV *Eagle Ray* viewed from below

Andrew Kennedy hauling the AUV *Eagle Ray*

NOAA Ship NANCY FOSTER

Scientific Team for Miami Terrace cruise



Cartoon of NOAA ship collecting multibeam data

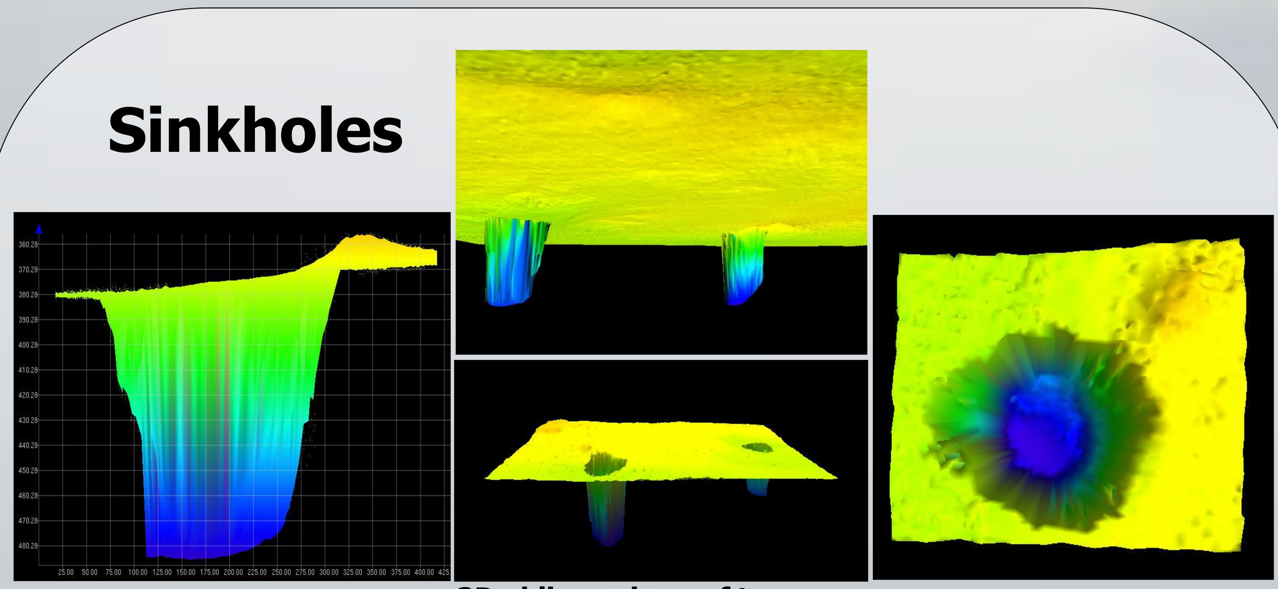
Wreck fish and barrel fish at Miami Terrace

Bamboo coral

Slit shell

Photographs courtesy of Greg McFall and NOAA

Sinkholes

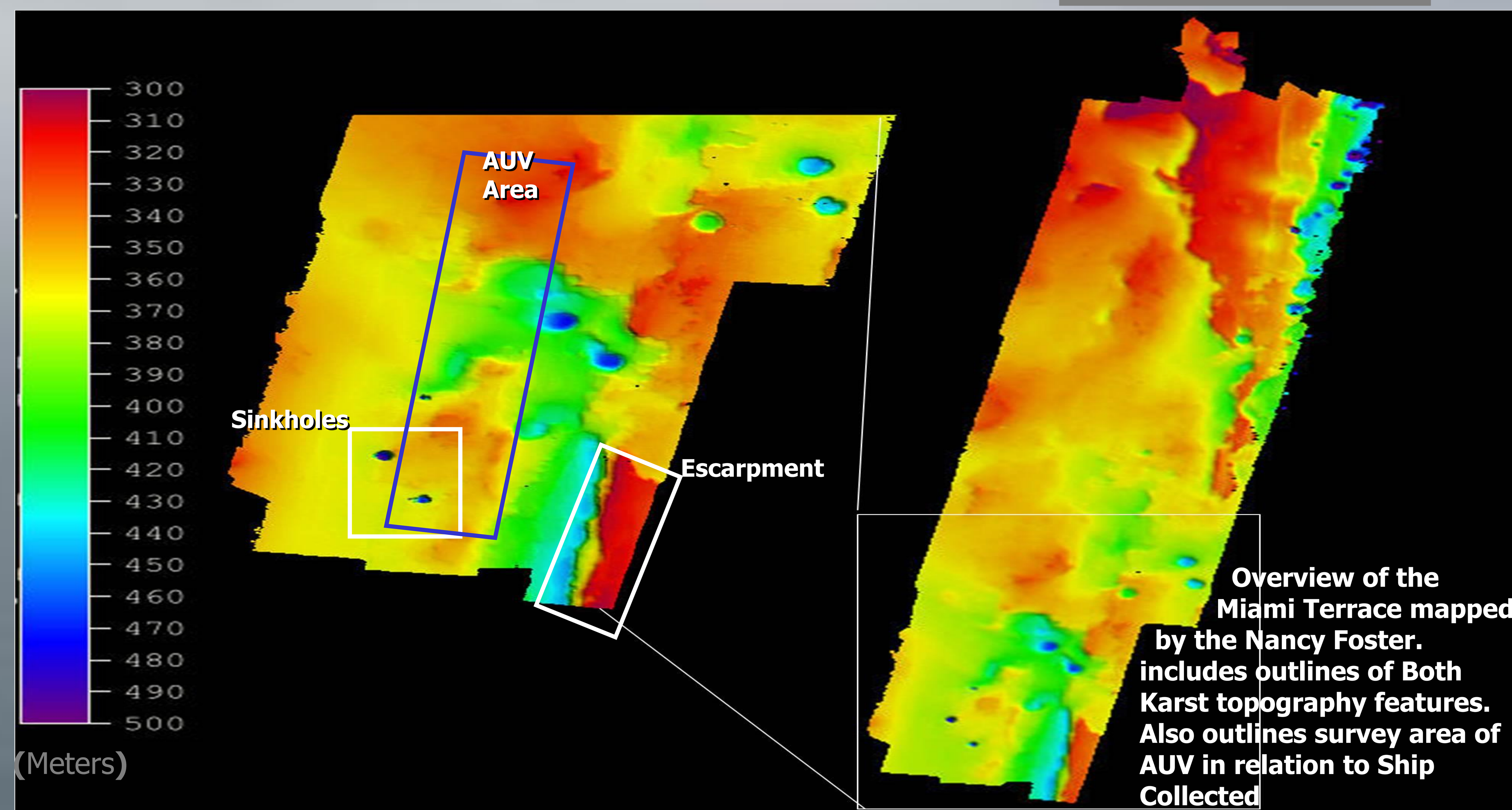


2D side profile image of sinkhole. Depth range is 100+ meters from top edge to bottom of hole.

3D oblique views of two sinkholes. Top image is viewed from below; bottom image is viewed from above. Both images look east.

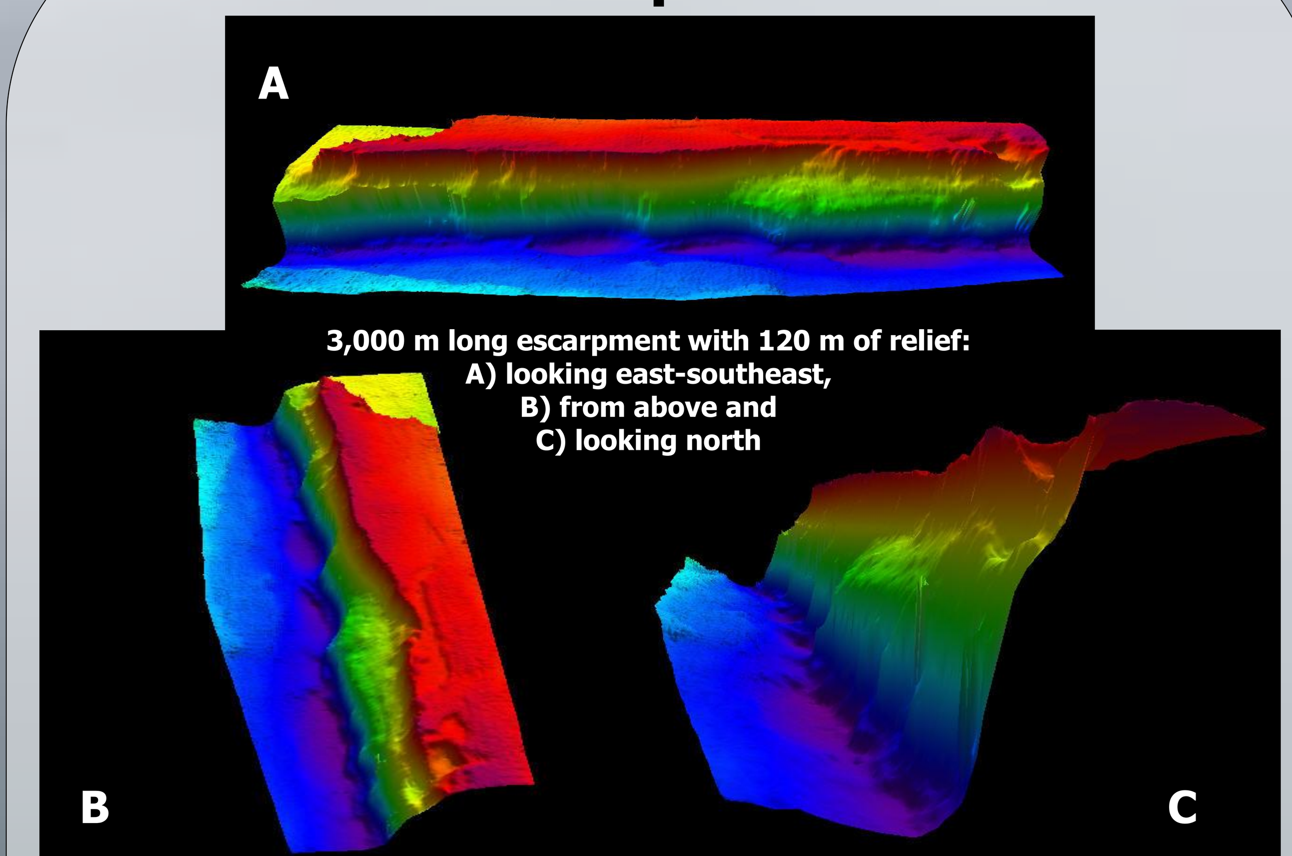
View of the sinkhole from above, looking down into the hole.

This area of the Miami Terrace has unique features that we believe to be karst topography. Karst can generally be described as a geologic feature characterized by the presence of carbonate rock (for example, limestone), which formed millions of years ago through accumulation of sediments and skeletons of marine organisms. On land, this topography can form caves, sinkholes, and underground rivers. The features shown in these images are along the Miami Terrace and are approximately 100 meters across and dramatically drop vertically 100 meters. We suspect that the edges and base of this feature may provide essential fish habitat to important fishery resources.



Overview of the Miami Terrace mapped by the Nancy Foster. Includes outlines of Both Karst topography features. Also outlines survey area of AUV in relation to Ship Collected

Escarpments

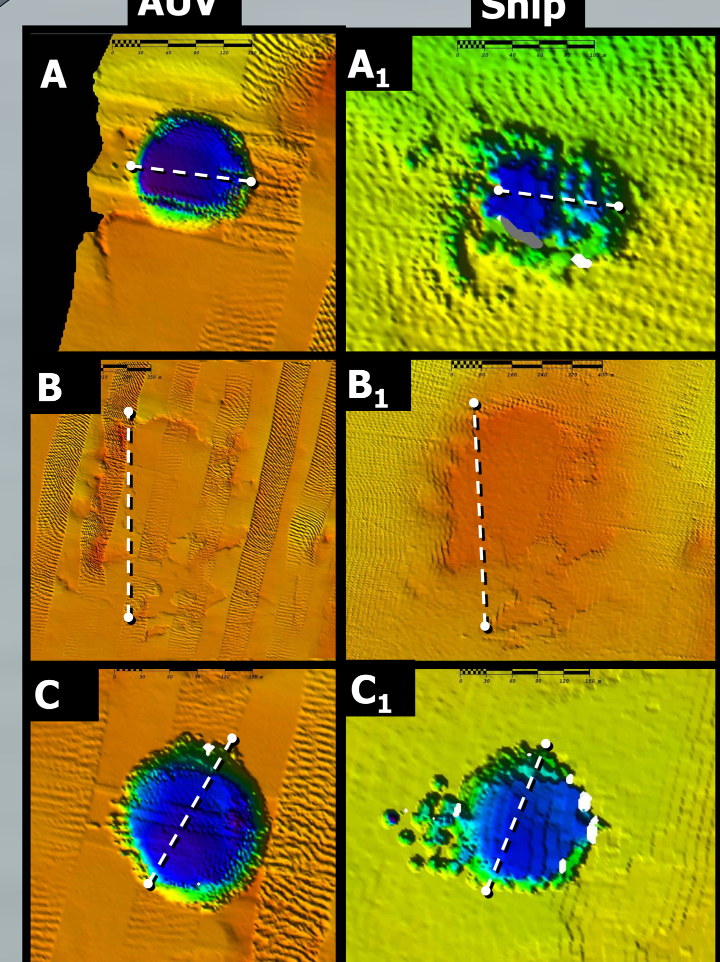


3,000 m long escarpment with 120 m of relief: A) looking east-southeast, B) from above and C) looking north

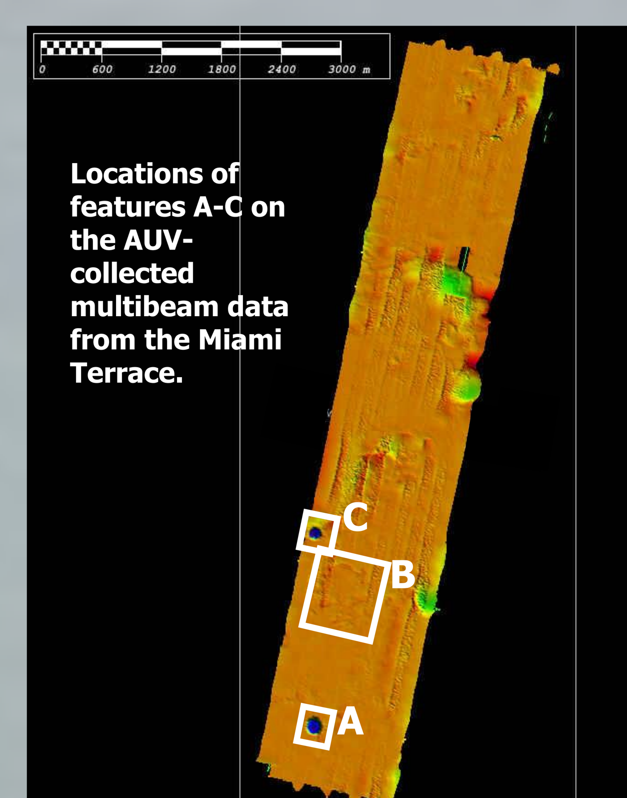
The Miami Terrace has many long and steep escarpments that provide pristine benthic habitat for many species of fish, corals and sponges. It is the steep nature of these escarpments that lures many species to live here. The high relief can provide protection and constant replenishment of nutrients and food via the currents that flow against the ledges.

Methods

Data were collected aboard the NOAA ship *Nancy Foster* on a cruise from June 4-9, 2007 led by Greg McFall of the Gray's Reef National Marine Sanctuary. Multibeam lines were planned with a HYPACK data acquisition and processing system. For ship board data collection, sound velocity profiles were acquired using a SeaBird 911 CTD mounted to a twelve bottle Niskin bottle system. Multibeam data were collected with a Simrad EM3000 system. AUV data were collected by a Simrad EM2000 system housed internally in the AUV. The ship multibeam data could be processed in real time, while the AUV data could not be processed until the AUV was on board and physically linked with the processing equipment. Data and images were processed for the ship multibeam data and the AUV multibeam data using CARIS HIPS 6.1.



Images above correspond to the data collected by the AUV (left) and from the Ship (right) shown at the same scales. Dashed lines indicate distances measured for comparisons (Table 1.)



Locations of features A-C on the AUV-collected multibeam data from the Miami Terrace.

Table 1.	Diameter of feature A	Diameter of feature B	Diameter of feature C
AUV Data	175 m	600 m	128 m
Ship Data	175.5 m	604 m	125 m

Results of Comparison

The AUV data were collected from a vehicle depth of 300 m, whereas the ship's data were collected from 0 m water depth. These differences led to a mismatch of water depths between the two instruments and varying color schemes.

A comparison of the images shows that the diameters of different features were nearly the same (+/- 2 m) (Table 1). The AUV bathymetry has a roll problem due to unknown water currents that created more of a roll in the northern section of the data. When both bathymetric maps are overlain, it is clear that the AUV bathymetry is more detailed (higher resolution) because it was closer to the seafloor, allowing for more sonar pings per square meter than the ship's data. Also, because the AUV was deeper in the water column than the ship, it had a much smaller swath and mapped less during the same period of time.

Discussion and Conclusions

- **Due to the fact that AUV data cannot be seen or processed in real time leads to a higher probability of acquiring data with problems that would usually be fixed by a ship board processor. However the results of our work show that the bathymetry data collected from the AUV is of a much higher quality and greater detail compared to the ship's bathymetric data.**
- **Although the ship is able to map a much larger area in the same amount of time as the AUV, the data resolution is poorer, as is the data quality.**
- **We conclude that if small-scale seafloor structures such as coral heads or geologic features (i.e., ledges, sinkholes, slump features, etc.) are the focus of the mapping, an AUV would be the mapping instrument of choice. If large-area initial reconnaissance work is necessary, then a ship-board multibeam system is better suited.**

It needs to be noted that the cruise using this particular AUV (the *Eagle Ray*) was a test cruise to see if the AUV multibeam system worked properly, and to fix any hardware glitches that occurred during data collection.

References:
Florida Coast Deep Corals 2005 expedition, Ocean Explorer, NOAA
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McFall, Greg, Gray's Reef National Marine Sanctuary, NOAA
Wenner, Elizabeth, South Atlantic Bight Coastal Assessment Survey, SCDNR

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