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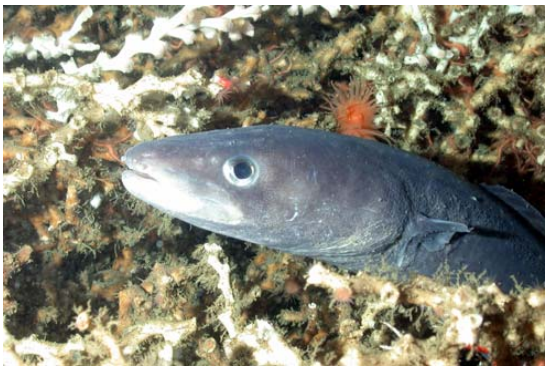
Cruise Report

August, 2004

Deployment of Coral Settlement Tiles on the Outer Continental Shelf of the Northeast Gulf of Mexico, as part of the Slope To Shelf Energetics And Exchange Dynamics project of the Naval Research Laboratory



Cruise Number: USGS-GM-2004-01
R/V Seward Johnson 29 April to 10 May 2004

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Introduction

A cooperative research project has been undertaken by the Naval Research Laboratory (NRL, Code 7300, Stennis Space Center, MS) and the United States Geological Survey, Florida Integrated Science Center, Coastal Ecology and Conservation Research Group (USGS-FISC-CEC, Gainesville, FL), for the purpose of deploying an array of in-situ, physical oceanographic sensors, and coral settlement plates, in the waters along the western shelf of the Desoto Canyon, in the Northeast Gulf of Mexico (NEGOM). The Research Vessel Seward Johnson was the platform for operations, from April 29th until May 10th, 2004, and was at port at GulfPort, MS. The physical oceanographic data collected by the NRL, will aid in the understanding of coral settlement patterns along the 500 meter isobath in the NEGOM. A total of 14 moorings were deployed, four of which, along the 500 meter isobath, had USGS coral settlement plates, and USGS acoustic relocation beacons attached. This report will first discuss the NRL's component, and then the USGS component. This coral settlement plate experiment is part of an ongoing 3-year study by the USGS CEC, to understand the Lophelia reef community structure, biotope affinities, and trophodynamics (Sulak et al, 2004).

Naval Research Laboratory (NRL)
Oceanography Division Code 7300:
Slope to Shelf Energetics and Exchange Dynamics (SEED)

NRL General Overview

This project will provide the science to understand the connections between the deep ocean dominated by baroclinic mesoscale processes and the shelf dominated by wind and buoyancy driven processes. Future naval operational systems must accurately represent the dynamics contained in both regimes as well as the interactions between the two.

NRL Goal

The goal is intended to provide the science required to expand future naval capabilities. Future ocean monitoring and predictions systems must provide a seamless representation of a variety of environments. This project provides a juncture between deep-water and continental shelf research. A continental shelf monitoring and prediction system must take into account the deep ocean influence. There are significant anomalies on the continental shelf due to deep ocean influence. Similarly, there are influences from the continental shelf on the deep ocean. The two regimes must be treated simultaneously, and to achieve this, the mechanisms through which processes transfer physical parameters must be understood.

NRL Comprehensive Sensor Systems Elements & Methods

A diversity of sensors is needed to measure the time and space scales of the relevant processes in addition to putting the processes into the context of the surrounding ocean circulation. Each measurement provides complementary information to yield a view of the processes of interest and the exchanges between shelf and deep ocean circulation.

Remote Sensors

1. *To provide the deep water eddy field, we will use altimeter data from the TOPEX/POSEIDON, ERS-2, and Geosat-Follow On satellites. These data are processed operationally daily at the Naval Oceanographic Office and at NRL. The resolution afforded by these satellites (and the incorporation of the planned JASON-1 and ENVISAT data) allows eddy features to be observed with length scales less than 50 km.*
2. *Satellite and aircraft observations of surface properties (salinity, chlorophyll, PDOM, etc…) across the shelf and slope provide high spatial resolution examination of water mass movements. The cross-frontal scales of the shelf/slope front are about 10 km, and it would be prohibitively expensive to place an in situ current array to examine these features. However, the surface imagery provides the frontal position, and the in situ array provides the vertical structure as the fronts pass the arrays.*

In-situ Sensors

1. *The in situ acoustic Doppler current profiler (ADCP) array is designed to examine the vorticity and momentum exchanges across the slope and shelf. The altimeter data provides the context of the deep circulation to understand the processes that are moving in from the deep ocean to the slope. The in situ ADCP array provides the vertical structure of deep ocean and shelf processes that the surface observations do not* (Figures 1 and 2).
2. *The Navy coastal ship capabilities are being developed at Stennis, and will be available for use in this program. A 65 foot ship will be used for CTD surveys across the continental shelf when events are observed by remote sensing to begin to develop. Through this capability we will have excellent probability of observing the temperature and salinity structure at the necessary time and space scales throughout the evolution of several events.*

Each of these components adds complementary information so that an examination of the exchange processes may be made in context of the surrounding circulation.

NRL Study Area

The Mississippi Bight area is characterized by the DeSoto Canyon with a sharp shelf break to the West and a gradually sloping shelf (down to 1000 m) to the east. The shelf break to the West side of the Desoto Canyon is where the moorings will be deployed, along the 60, 90, 500, and 1000 meter isobaths. Figure 3 shows the isobathic-contour map of the East shelf-break of the NEGOM area, along with the proposed instrumentation deployment sites. Figure 4 is a three-dimensional perspective, looking towards the northeast, along the eastern shelf of the NEGOM study area.

Figure 1: Trawl Resistant Bottom Mounts (TRBM) – Also know as Barny's, since they resemble barnacles, have a shape that resists fishing trawls from becoming snagged.

Figure 2: Longe Range Acoustic Doppler Current Profilers (LRADCP)-Left, orientation of float while in the water column, with sensors orientated up, Right, image of the ADCP sensor package at the top of the float (White Arrow).

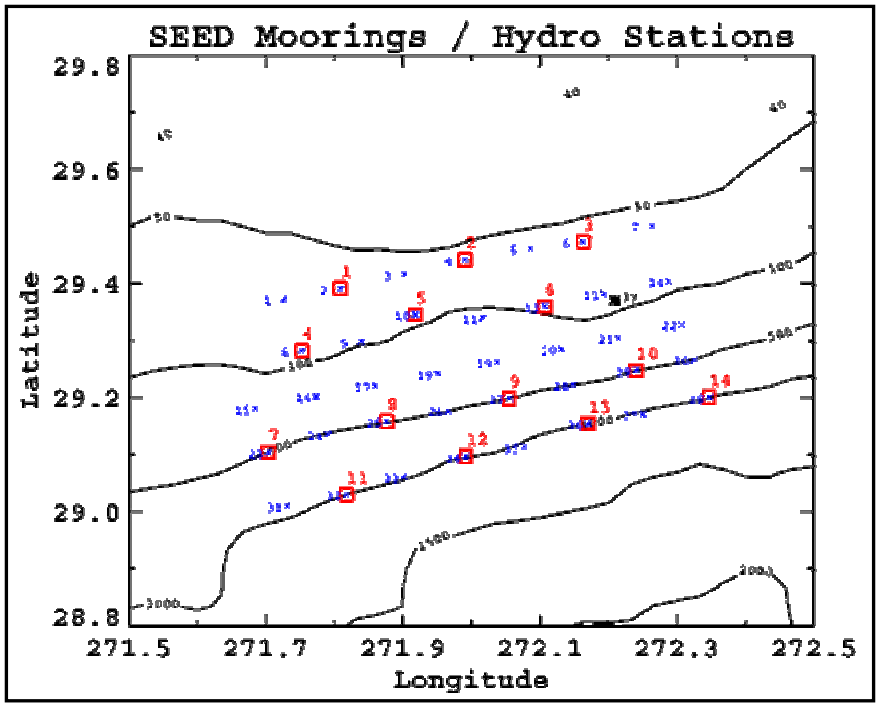

Figure 3: Moorings are red boxes, numbered 1-14. Mooring numbers 1-6 are the TRBM, and 7-14 are the LRADCP. Hydrographic (CTD, optics, and water samples) stations are blue, numbered 1-38, and a proposed time series station (4-12 hours #39 in black), and is located over a major pinnacle feature. Image courtesy of Naval Research Laboratory.

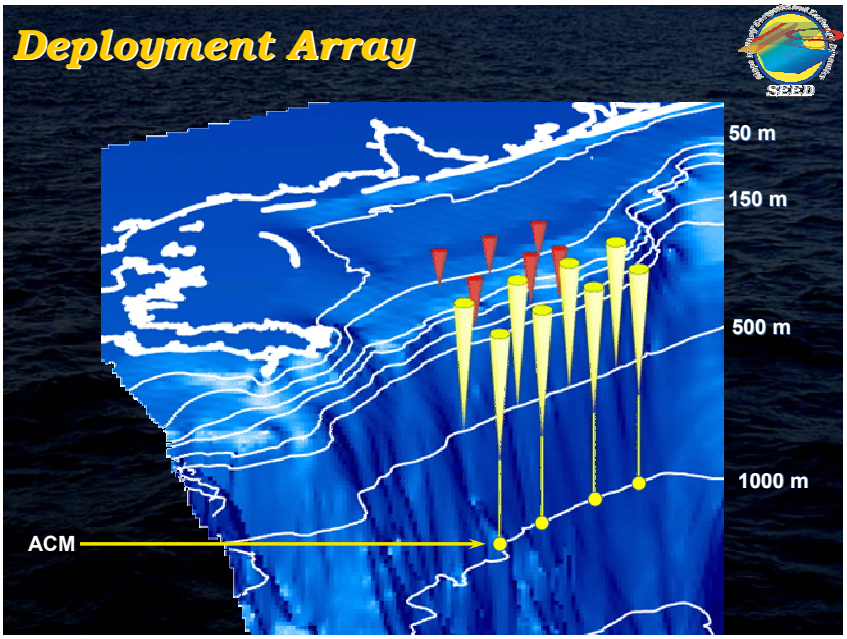

Figure 4: Oblique 3D view of the study sites with the TRBM positions (Red) and LRADCP positions (Yellow) with acoustic bottom current meters (ACM) installed towards the bottom of the mooring line. Image courtesy of Naval Research Laboratory.

NRL Timeline

FY04: *First deployment (May 04), aircraft salinity flights, incremental model dynamic examination using idealized eddy/shelf interactions and Shelf/Slope Current flows, examination of non-linear surface tracer measurement assimilation*

FY05: *Recover, maintenance, and redeploy moorings (November 04), recover moorings (August 05), aircraft salinity flights, incremental model dynamic examination of eddy and Shelf/Slope Current interactions, examination of measurement type influence (surface tracer, velocity, etc…)*

FY06: *Process studies based on measurements and incremental model experiments to examine vorticity dynamics, eddy effects, buoyancy effects, and shelf/slope currents, realistic model experiments with boundary conditions from Intra-Americas Seas assimilation, examination of boundary condition, measurement, and dynamical covariance weights*

FY07: *Continuation of process studies, examination of wind effects in realistic model experiments, assimilation of ADCP and surface observations*

FY08: *Understanding HYCOM (*HYBRID COORDINATE OCEAN MODEL*) dynamical accuracy on the shelf, determine times and places at which HYCOM dynamics do not agree with measurements, determine methods to improve the HYCOM dynamics*

NRL Results

All mooring were deployed as planned, during 4 days from May 2 to May 6, 2004 (Table 1). The position of the Moorings locations were taken from GPS (WGS 84 datum). Hydrographic stations were conducted during the night, and for the remainder of the cruise, until May 09, 2004. Over 100 CTD and Optical casts were conducting within the mooring area, including a time series CTD station that lasted 6 hours.

Table 1: Mooring locations for TRBM and LRADCP Instruments.

Mooring # and Type	Latitude (N)	Longitude (W)	Depth (m)
1 TRBM	29° 23.475'	88° 11.460'	58
2 TRBM	29° 26.017'	88° 00.386'	60
3 TRBM	29° 28.420'	87° 50.233'	60
4 TRBM	29° 16.617'	88° 14.836'	88
5 TRBM	29° 20.618'	88° 04.896'	89
6 TRBM	29° 21.146'	87° 53.638'	87
7 LRADCP	29° 05.320'	88° 17.058'	515
8 LRADCP	29° 08.660'	88° 06.88°4'	518
9 LRADCP	29° 11.307'	87° 56.564'	518
10 LRADCP	29° 14.322'	87° 45.341'	518
11 LRADCP	29° 02.220'	88° 11.249'	1016
12 LRADCP	29° 05.376'	88° 00.273'	1038
13 LRADCP	29° 09.362'	87° 49.835'	1025
14 LRADCP	29° 11.848'	87° 39.183'	1029

United States Geological Survey
Florida Integrated Science Center
Coastal Ecology and Conservation Group

USGS General Overview

The Coastal Ecology and Conservation Research Group (CEC) of the United States Geological Survey, at the Florida Integrated Science Center, assisted in the deployment of the in-situ devices on the first NRL SEED cruise, in May 2004. The cooperative component, overseen by CEC staff, attached ceramic, coral-settlement plates, and acoustic relocation beacons on the four anchors that will be deployed at the 500 meter isobath contour (LRADCP 7-10, Table 1). These settlement plates will be at the same depth range of previously observed *Lophelia* reefs (Moore and Bullis, 1960, Newton et al., 1987).

USGS Goals

To determine recruitment patterns of deepwater coral species, over a three to four year period, on horizontally orientated settlement plates, giving special attention to observations of *Lophelia settlement*. To further understand how the Northeast Gulf of Mexico's NEGOM shelf-edge currents, temperatures, and baroclinic water-layers may be possible forcing functions for species selection of coral recruitment on settlement plates (Rapp and Sneli 1999, Squires 1959).

USGS Methods

Five settlement plates (ceramic saltillo tiles), with 28.9 cm by 28.9 cm dimensions, were attached in a near horizontal orientation, spaced equally around the top of the 91.4cm diameter train wheel, yielding a total tile-surface area of 4176 cm^2. The plates were attached to the steel train wheel with underwater epoxy glue (Denapox Aquagel ®). Acoustic beacons (customized EMT-01-3, by Sonotronics Inc.) were attached to the moorings, so that acoustic tracking systems could aid in relocation. The beacons have a frequency of 30 kHz, a pulse width of 16 milliseconds, a pulse interval of 16-18 seconds, produce 168 dB, and are powered to last 3 years. Figure 5 shows the arrangement of settlement plates and acoustic beacons on the mooring anchors. The acoustic beacons were attached by using zip ties, a stainless steel wire wrap, and underwater glue (Marine Goop ®) to avoid damage during deployment.

The NRL LRADCP instrument package was housed in a buoyancy float, and was tethered to an acoustic release, which was connected to the mooring anchor. During deployment, a tag line was used to keep NRL equipment from damaging settlement plates and acoustic beacon (Figure 6).

As funding becomes available, or if other investigations are close to the area, observations will be made, to note the type and quantity of any epiboints that have settled onto the plates. The use of remotely operated vehicles, or manned submersible will be the platform for the video or digital image recording devices. Individual colonizers will be recorded to the lowest possible taxonomic resolution.

Figure 5: (Left) An above view of the settlement plates with a yard stick (91.44cm) for scale. The chain was used by the NRL to attach the LRADCP equipment to the anchor. (Right) An oblique view of the acoustic beacon attached to the mooring anchor

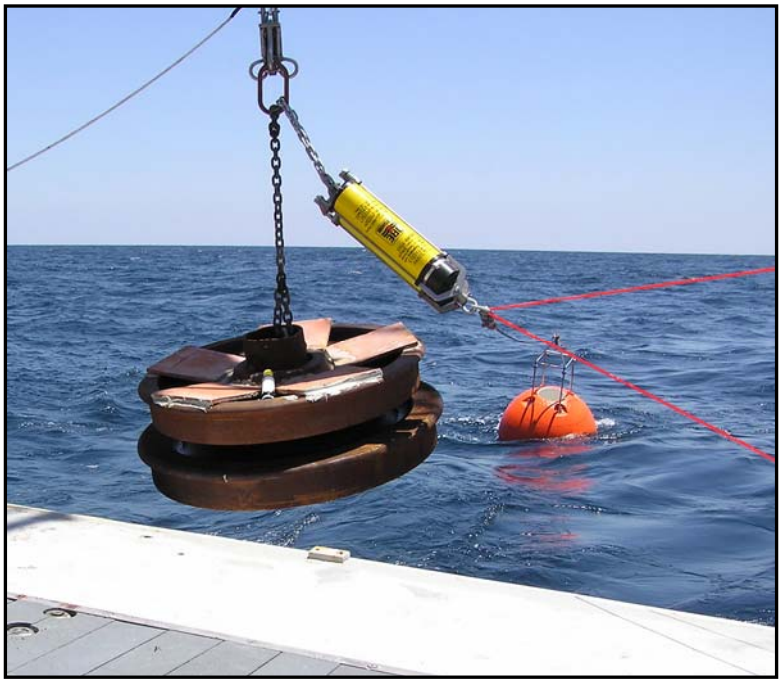

Figure 6: Deployment of LRADCP mooring with settlement plates attached. The orange float in the background (containing the LRADCP instrument package) is tethered to the acoustic release (yellow), which is being kept clear of the settlement plates and acoustic beacon by the red tag line. The mooring was released by the quick release, shown at the top of the photo. Image courtesy of Bill Kerstetter, JO1 Naval Reserve Journalist.

USGS Time Line

FY04 April 2004 -Attachment of settlement plates to moorings at Stennis Space Center.
May 2004- Deployment of NRL moorings with settlement plates attached.

FY04 continued

July-Aug 2004- Relocation of mooring # 9 using depth sounder on Seward Johnson II, during cruise # USGS-GM-2004-03. Use of Trackpoint II to try and hear the acoustic beacon on mooring #9.

FY05 NOV 2004-Attachment of 5 settlement plates to each of 4 mooring anchors (20 total).

TBA Secondary observations of settlement plates.

USGS Results

With settlement plates attached four moorings were deployed successfully. The moorings were deployed along the 500 meter isobath, with locations and depths listed in table 1 (Moorings 7-10, see page 7). Only three of the acoustic relocation beacons were deployed, on moorings 7-9 (Table 1, page 7). The moorings were deployed on May 5th and 6th, 2004. Mooring anchor # 9 was relocated using the depthsounder on the Seward Johnson II, during the cruise USGS-GM-2004-03. Using the ORE Trackpoint II system on the ship, the acoustic relocation beacon could not be heard.

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