

DeSoto Canyon Eddy Intrusion Study

Annual Report: Year 3

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I. INTRODUCTION

This document describes progress by the Science Applications International Corporation (SAIC) team in accomplishing the principal objectives of the DeSoto Canyon Eddy Intrusion Study (Minerals Management Service (MMS) Contract 1435-01-96-CT-30825) during the second program year, July 1, 1998 through June 30, 1999. Briefly stated, the study objectives are to:

- document and analyze by means of *in-situ* current measurements, hydrographic data, and satellite images the Loop Current intrusions and interactions with the northeastern Gulf of Mexico (NEGM) slope. This study shall examine at a minimum the frequency and horizontal and vertical extent of these interactions and intrusions. Through the use of dynamical principles, a conceptual model shall be developed to explain how the Loop Current-slope interactions observed in the course of this study evolved;
- document and examine the dynamical processes of momentum, mass, and vertical vorticity exchanges that occur during Loop Current-slope interactions and other driving forces;
- estimate the frequency of Loop Current and secondary eddy interactions with the NEGM slope, and conduct and assessment of the vertical and horizontal current shears, exchanges of vorticity, momentum, and mass fields associated with these eddy-slope interactions; and
- elucidate the role of the DeSoto Canyon in Loop Current and eddy interactions and as a route of mass and momentum exchange between the shelf and deep water of the NEGM.

Three tasks are required to accomplish the listed objectives:

- (1) Field Work and Data Collection,
- (2) Data Reduction /Analysis and Synthesis, and
- (3) Program and Data Management.

Task 1 is being accomplished by SAIC scientists, principally Mr. James Singer, with assistance from Specialty Devices, Inc. of Plano, Texas. Task 2 will be accomplished by the Principal Investigator (PI) team consisting of Drs. Peter Hamilton (SAIC), Tony Sturges (Florida State University (FSU)), Robert Leben (University of Colorado (CU)), Tom Lee (University of Miami (UM)), and Mr. James Churchill (Woods Hole Oceanographic Institution (WHOI)). Task 3 is the responsibility of Dr. Thomas Berger (SAIC - Program Manager) and Dr. Evans Waddell (SAIC -

Data Manager). Program scientific oversight is provided by the Science Review Board consisting of Drs. Larry Atkinson (Old Dominion University (ODU)) and Gabriel Csanady (retired).

The Louisiana Universities Marine Consortium (LUMCON) research vessel (R/V) Pelican is being used for all regularly scheduled cruises to deploy or rotate instruments and acquire hydrographic data. LUMCON is also providing logistics support and storage space to the program. Additional logistics support and storage of anchors is being provided by the Port of Pensacola.

The study area, mooring locations, CMAN stations, tide stations and NDBC buoys are shown as PC ARCINFO coverages or ARCVIEW Shapefiles in Figure 1, superimposed on an AVHRR image on February 25, 1999, near the end of the field program.

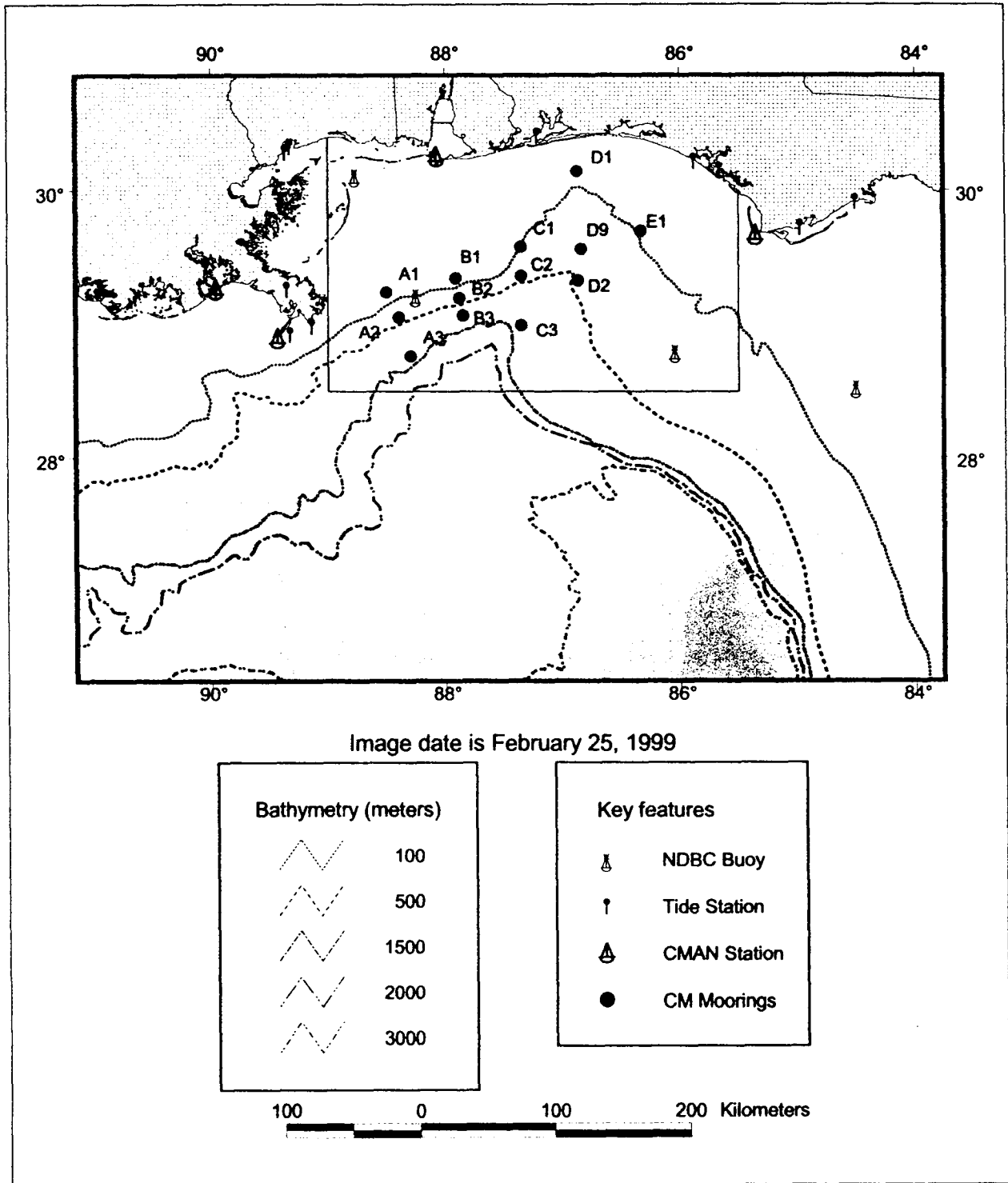


Figure 1. DeSoto Canyon Study Area.

II. OVERVIEW AND CHRONOLOGY OF EVENTS

This section briefly describes the activities completed from July 1, 1998 through June 30, 1999.

2.1 Administration

SAIC completed and submitted revisions to the original schedule to reflect actual cruise dates, based on negotiations with LUMCON.

An initial meeting among the PIs and Program Management took place in Raleigh, NC on July 7, 1998 during which all the Year 1 data were reviewed. Each PI made a brief presentation on their work to date or ideas on approaches to the data. Possible modifications in the placement of MicroCAT CTs on the 100-m moorings, such that near surface salinity measurements could be made at more locations, were discussed. These modifications were proposed to the COTR and after discussion within MMS were approved.

The second Science Review Board (SRB) teleconference was delayed for a variety of reasons. This teleconference has been rescheduled to occur during the first day of a two-day PI meeting to be held in Raleigh, NC September 21-23, 1999. This will allow the PIs and the SRB time to review the entire two-year data set and the SRB to provide guidance on the course of data analysis and synthesis to meet the program objectives.

The Program Manager, Data Manager and one PI attended the MMS Information Transfer Meeting (ITM) in December 1998.

During late spring 1999 discussions were completed with MMS to add a task to the contract to deploy a deep water mooring in the DeSoto Canyon. This mooring is to examine current profiles over the entire water column with special emphasis on near bottom currents. The task is structured as a stand alone effort to be reported on its own schedule.

2.2 Cruise 5

Cruise 5 was completed during August 4-18, 1998.

Prior to Cruise 5 the surface marker for mooring B1 was discovered adrift on the west Florida shelf and was recovered by FIO personnel and returned to SAIC (physically delivered to the Port of Pensacola). During the cruise the mooring itself could not be located and is presumed lost. An informal report on the

equipment lost was provided to the MMS. A replacement mooring using a GO MkII at 62 m and an InterOcean S4 at 94 m was deployed.

2.3 Cruise 6

Cruise 6 was completed as scheduled December 1-13, 1998. The marker buoy at mooring A1 was missing and the in-line ADCP frame was severely damaged. The ADCP data were recovered for the whole period. Examination of the data showed that the mooring experienced extreme drawdown during the passage of Hurricane GEORGES, which passed directly over the A-line moorings during September 27 - 29, 1998. The frame was subsequently examined by the manufacturer who reported that the frame had been under extreme tension and that the tension was probably not due to drawdown of the mooring.

The S4 on mooring A1 suffered a battery failure, unrelated to the hurricane, and recorded only five days of data. All other moorings were rotated without incident. The surface marker at A1 was replaced with the previously recovered marker from B1. The original B1 mooring was not found and is presumed lost.

2.4 Cruise 7

Cruise 7, the final mooring recovery and hydrography cruise, was completed March 30 - April 7, 1999.

About three weeks prior to Cruise 7, we were notified that Mooring B1 had been dragged and recovered intact by shrimping vessel. Equipment from Mooring B1 were retrieved from Caribbean Shipping Co. in Bayou la Batre, Alabama and delivered to LUMCON as Cruise 7 ended. Data from the instruments were also recovered intact.

III. DETAILS OF DATA COLLECTION AND ANALYSIS

3.1 Time Series Data

This data set includes current meter data, CTD data from six moored SEACAT/MicroCAT instruments, and thermistor data. The time series data acquired and processed thus far comprises a full two years of data. Table 1 shows the number of good records, number of possible records, number of instruments deployed, and data return for the current meters, moored CTs (Sea-Bird) and thermistors (Hugrun).

Table 1. Instrument Performance.

Deployment	S4	Hugrun	Sea-Bird	ADCP*	RCM-7/8	GO MkII
1	7977	64038	49905	146571	223565	74452
	7977	64038	49905	146571	246355	75359
	(1)	(12)	(6)	(13)	(13)	(10)
2	24532	72120	58932	148537	209215	73778
	24532	72120	60944	148537	216395	83631
	(3)	(12)	(5)	(13)	(11)	(9)
3	49692	80267	80317	173190	256274	63484
	49692	80267	80317	173190	274213	63484
	(5)	(12)	(6)	(13)	(12)	(6)
4	27495	72117	48181	143576	213975	63045
	44628	72117	72181	155576	228239	66049
	(5)	(12)	(6)	(13)	(11)	(7)
5	34515	68389	52993	135942	209905	66097
	42366	68389	52993	135942	216469	74206
	(5)	(12)	(5)	(12)	(11)	(8)
6	44458	67206	44927	134780	214273	50594
	48168	67206	44927	134780	214273	61821
	(6)	(12)	(4)	(12)	(12)	(7)
TOTALS	188669	424137	335255	882596	1327207	391450
	217363	424137	361267	894596	1395944	424550
	(25)	(72)	(32)	(76)	(70)	(47)
Percent Good	86.80%	100%	92.80%	98.66%	95.08%	92.20%

Grand TOTAL: 3,549,314/3,717,857 = 95.47%

*All ADCP levels for each instrument counted as one

3.2 Hydrographic Data

This data set consists of the hydrographic station data acquired during each of seven cruises. Data from the Chemical Oceanography and Hydrography Program will be used as well since

these cruises, which began in November 1997, occur at roughly the same schedule as this program.

CTD data were collected using a SeaBird 911+ CTD system with an SBE 11 deck unit. The system was calibrated by the manufacturer in March 1997 and again in February 1998 prior to the beginning of each years' field measurements. At the time of recalibration, after the first three cruises, only minor adjustments in the calibrations were required. In addition, during each cruise bottle salinities were collected from mixed layers (one for each cast when possible). These provided a preliminary indication that the calibration of the instrument was holding steady (well within the expected accuracy of the instrument). Table 2 shows the Cruise IDs, dates, number of stations planned and completed and data return.

Table 2. CTD Data Return.

Cruise No Cruise ID	Dates	CTD Stations Planned	CTD Stations Completed	Data Return (%)
1. PE9722	3/18/97-3/28/97	75	75	100
2. PE9803	7/8/97-7/19/97	75	68	90.7*
3. PE9820	11/10/97-11/22/97	80	79	98.8
4. PE9830	3/31/98-4/10/98	80	80	100
5. PE9908	8/3/98-8/14/98	80	80	100
6. PE9923	12/1/98-12/13/98	87	87	50**
7. PE9932	3/29/99-4/6/99	80	79	98.8
Totals		557	548	90.6

* - Tropical Storm DANNY prevented completion of seven shelf break stations.

** - Problem with CTD plumbing resulted in no useful salinity data, but temperature data were valid.

Salinity time series data from various current meters and SeaBird SeaCAT or MicroCAT CTs were adjusted by comparing with calibrated CTD casts made near each instrument at the beginning and end of a deployment period. The CTD measurements determined whether an offset (common occurrence with GO MkII current meters) or instrument drift had occurred, and the time series salinity data were adjusted accordingly.

3.3 Special ADCP Survey of DeSoto Canyon

During Cruise 6 a special survey was conducted of the head of DeSoto Canyon using the 150 kHz and 600 kHz ADCPs on the R/V Pelican. Three triangular survey legs (20, 20, and 29 nm), with the apex at the head of the canyon, were completed while running at constant speed. The circuit was run four times during December 10-11, 1998. A series of expendable bathythermographs (XBTs) were deployed along the long leg of the circuit however none produced reliable data. The probes used were subsequently determined to have been from a bad lot. Likewise, the 600 kHz ADCP provided no reliable data. The data set from this special survey is being processed.

3.4 Ancillary Data

The principal ancillary data types include satellite imagery provided by US Geological Survey, satellite altimetry data being processed by University of Colorado, and appropriate meteorological data.

Satellite images of the northeastern Gulf of Mexico (area from 22.0°N to 31.6°N and 79.0°W to 92.7°W) are available from the USGS web page

http://coastal.er.usgs.gov/east_gulf/html/sst.html.

Thumbnail images are reviewed online and the images with cloud free coverage of the study area (and vicinity) are then downloaded. Navigation data are contained in the GeoTIFF image header, thus, these images can be used directly in ARCVIEW and in IMAGINE without conversion. A total of 302 clear sky images are available for the fall-spring months of the study. In general, thermal imagery of the sea surface in the Gulf of Mexico is not useful during the summer months because of uniformly high temperatures. Table 1 shows the monthly distribution of clear sky images during the study period. These clear sky images have been provided to the PIs on CD-ROM.

Table 3. Monthly Distribution of Clear Sky AVHRR Images.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1997	na	na	4	8	15	0	0	0	0	4	21	23
1998	30	21	65	51	7	0	0	0	0	0	0	5
1999	10	17	16	5	na	na	na	na	na	na	na	na

Satellite altimetry data are archived at the University of Colorado and will be used in data analysis and synthesis. These data may be seen at the Colorado Center for Astrodynamics Research (CCAR) web site at

http://shaman.colorado.edu/~leben/gom_rgdr.html.

Appropriate National Weather Service meteorological data are being acquired as needed during the project. Water level, C-MAN, and river flow data for Year 1 have been acquired and processed. Data through February 1999 have been acquired but not processed. Data for March and April 1999 will be acquired and the entire set will be processed.

An ARCVIEW project for display of pertinent data, including imagery, mooring sites, hydrographic stations, locations of the water level stations, river flow gauges, and C-MAN stations has been completed.

Data from a series of Lagrangian drifters deployed for MMS by SAIC and TAMU have been provided but not yet processed.

3.5 Data Sharing

Data sharing agreements were reached by all NEGOM program participants at a coordination meeting at University of South Florida, St. Petersburg, Florida in late April 1998. Most program data, other than imagery, is being hosted on a TAMU web site. Due to the volume of time series data collected by the DeSoto Canyon Eddy Intrusion Study, these data were placed on CD-ROM (approximately 450 MB for Year 1) and distributed in early July 1998 to all participating institutions in the coordination meeting. A similar CD-ROM was prepared for Deployment 5 data (August 4 - December 13, 1998) since this period included the passage of Hurricanes Earl and Georges through the study area. This CD was distributed to a small group of investigators who were interested primarily in the passage of Hurricane Georges. These data were provided in standard NODC formats.

3.6 Data Products

Data products books have been compiled after each cruise and distributed to the PIs and related programs. A typical list of contents included:

- a brief narrative on study events since the last report;
- plots showing mooring locations and hydrographic stations;
- a table showing instrument types and depths at each mooring;
- timelines for the moorings and timelines for each instrument

- variable on each mooring for the entire study period;
- time series plots for each instrument variable (velocity components, sticks, and temperature separately) plus contoured temperature plots for the upper 62-300 m of the 500 m moorings for both deployment periods;
- time series plots of salinity with dots indicating nearby CTD measurements during Cruise 6 (beginning) and Cruise 7 (end);
- selected spectra and phase and coherence plots (u,v same instrument or temperature at adjacent instruments) - generally one per mooring;
- tables giving basic statistics for each mooring;
- maps of temperature and salinity surfaces, dynamic height and geostrophic velocities;
- vertical plots of temperature sections; and
- a T-S diagram for Cruise 7 data.

Two additional sets of data products covering the entire field year 1 data have been provided; Time Series Data Products: Year 1 March 1997 - April 1998 and Statistical Data Products: Year 1 March 1997 - April 1998.

A data report which describes calibration procedures, data return, instrument performance and other issues is being prepared.



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Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The **MMS Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.