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SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREAS: Gulfwide

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COSTS: FY 1982: $1,024,292; FY 1983: $2,688,651; FY 1984: $316,475; FY 1985: $1,432,686; FY 1986: $37,475

CUMULATIVE PROJECT COST: $5,499,579

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KEY WORDS: Eastern Gulf; Central Gulf; Western Gulf; Florida; Louisiana; Texas; physical oceanography; Loop Current; currents; satellite imagery; hydrography; survey; shipboard observations; nutrients; West Florida Shelf; slope; shelf; eddy; wind forcing; hurricane

BACKGROUND: In 1982, the U.S. Department of the Interior initiated a multi-year investigation of physical oceanographic conditions related to or resulting from deep circulation patterns in the Gulf of Mexico. During the first, second, and fourth study years, measurements and interpretation focused on the southeastern Gulf of Mexico with emphasis on the Loop Current and its interaction with the adjacent west Florida shelf and slope. The third study year focused on the western portion of the Gulf of Mexico. The present report includes field measurements from the fourth year and is considered an addendum to the first and second year report.

OBJECTIVES: (1) To develop a better understanding of conditions and processes governing Gulf of Mexico circulation; and (2) to provide a data base to be used as initial and boundary conditions in companion numerical circulation modeling studies.

DESCRIPTION: During the first two study years, data necessary to describe Loop Current behavior and associated circulation patterns were obtained from Lagrangian drifters, satellite thermal imagery, regional shipboard hydrographic surveys, moored current meters, and ships-of-opportunity. The fourth year program continued data collection using current meters, Lagrangian drifters, and ships-of-opportunity only.

Two drifting buoys equipped with position transmitting instrumentation were used to track rings. One buoy was deployed on 18 June 1985 in a newly formed warm core ring at approximately 26°N Lat and 88°W Long; on 18 July 1985, another buoy equipped with a 200-m thermistor string was deployed in another newly formed warm core ring at approximately 26°24'N Lat and 89°24'W Long. Vertical profiles of horizontal currents obtained during the previous years. Work using hull mounted acoustic doppler currents profilers were further analyzed. Current meters were used to measure temperature, subsurface currents, and pressure. In January 1985, six moorings were redeployed on the west Florida shelf and slope. The redeployment of these meters served as a continuation of field measurements that began in this region in January 1983. Five tautline moorings were deployed along a heading perpendicular to the west Florida shelf in water depths ranging from 50 to 3,275 m, while one was placed 167 km north on the 180-m isobath. The ships-of-opportunity program continued to provide information and support the field efforts.

SIGNIFICANT CONCLUSIONS: An anticyclonic feature embedded in the Loop Current was tracked. This revealed that the basic closed pattern of clockwise rotating water may exist regularly in that region interior to high speed flow regimes and can develop at least during or after Loop Current eddy separation. Inertial currents were important to the dynamics of the west Florida shelf oceanography. They were found to be energetic, with amplitudes often exceeding magnitudes of mean currents, low-frequency fluctuations, and tides. Nearshore currents on the west Florida shelf were primarily wind driven.

STUDY RESULTS: A buoy was deployed in June 1985 in what was believed to be a pinched off Loop Current eddy. Actually, separation was not complete and the drifter traveled 525 km southeast, entrained within the Loop Current, by mid-September 1985. There were three complete rotations observed before the drifter moved out of the Gulf through the Straits of Florida. The second buoy was in an actual Loop Current separated eddy. The rotation velocities decreased as the buoy neared the eddy center. Drifter velocities ranged from 30 to 90 cm sec-1 and appeared to decrease with time. In both features, the buoys indicated closed circulation. During the hydrographic cruise, 268 hydrographic stations were occupied. These data were obtained on 20 sections, 13 of which were in the vicinity of the Loop Current boundary and three were through a large cold perturbation of the Loop Current front. The general pattern had wave-like boundary features. Higher speed currents were located in a 100 to 150-km near surface band which was adjacent to the Loop Current frontal boundary. Maximum speeds near or at the surface decreased by approximately 50% or more in the upper 250 m. This zone moved laterally from the shelf break to 100 km seaward of the shelf break.

Inertial currents determined from current meter data on the west Florida shelf were energetic with peak amplitudes from 15 to 30 cm sec-1. Peak amplitudes were thought to be associated with the pycnocline. Amplitudes were intermittent in space and time and not well correlated between moorings. Mid-depth maxima of inertial amplitudes were common at moorings which sampled at the base of the mixed layer. Two hurricanes in 1985 (Elena and Kate) had similar tracks and produced sharp peaks of inertial amplitudes at all sites to a maximum of 42 cm sec-1.

Circulation patterns having periods longer than one day were Loop Current- and wind-forced. Wind signals exhibited a seasonal modulation with a summer minimum and a fall-winter-spring maximum. The primary signal was related to frontal passage. Nearshore currents were primarily wind driven. Wind forcing occurred in preferential frequency bands encompassing periods of 3 to 10 days. There was appreciable wind-current coherence which was variable with season. The Loop Current boundary moved onshore and offshore at periods of greater than two weeks.

STUDY PRODUCTS: Science Applications International Corporation. 1987. Gulf of Mexico Physical Oceanography Program Final Report, Year 4. Vol. I, Executive Summary. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, New Orleans, LA. NTIS No. PB88-170402. MMS Report 87-0006. Contract No. 14-12-0001-29158. 14 pp.

Science Applications International Corporation. 1987. Gulf of Mexico Physical Oceanography Program Final Report, Year 4. Vol. II, Technical Report. A final report for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Region, New Orleans, LA. NTIS No. PB88-170782. MMS Report 87-0007. Contract No. 14-12-0001-29158. 378 pp.

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