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SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREAS: Central and Western Gulf of Mexico

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COMPLETION DATE OF REPORT: March 1996

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CUMULATIVE PROJECT COST: $2,478,722

PROGRAM MANAGER: Thomas J. Berger

AFFILIATION: Science Applications International Corporation

ADDRESS: 615 Oberlin Road, Suite 300, Raleigh, North Carolina

PRINCIPAL INVESTIGATORS*: Peter Hamilton, Robert Leben, and George Born

KEY WORDS: Physical Oceanography, Gulf of Mexico, Loop Current, Loop Current eddies, slope eddies, satellite altimetry, drifters, GEOSAT, climatology

BACKGROUND: The present study is part of a sequence of programs designed to provide MMS with a basis for evaluating the potential environmental impacts of oil and gas exploration in the Gulf of Mexico region. This sequence began with the Gulf of Mexico Physical Oceanography Program, an approximately five-year (1983-1989) field effort to study processes throughout the Gulf with different areas/processes emphasized during each program year. Subsequently the MMS funded the Louisiana-Texas Shelf Physical Oceanography Program with field work during a three-year period from spring 1992 through spring 1995. Two elements of this program focused on shelf circulation (LATEX A) and on the Mississippi River Plume//inner shelf processes (LATEX B), while the third element, this study, focused on eddy driven processed in deep water and the continental slope.

OBJECTIVES: Primary scientific objectives were to monitor and characterize three classes of mesoscale circulation patterns important in the open sea and slope waters of the northwestern Gulf of Mexico: (1) Loop Current Eddy shedding processes and eddy interactions with the slope; (2) smaller anticyclonic eddies found along the upper slope; and (3) “squirts and jets” - poorly understood shear zones usually located near the upper slope. Secondary support objectives were to provide efficient, centralized logistics support, including Service ARGOS liaison for drifting buoys, air deployed expendable bathythermograph (AXBT) and current profiler (AXCP) probes, and expendable bathythermograph (XBT) probes for a ship-of-opportunity program; and to disseminate information collected during this study to other investigators on a regular basis.

DESCRIPTION: This study encompassed three years of field work from May, 1992, through April, 1995. Monitoring Loop Current eddies and mesoscale features was accomplished in 21 aerial surveys, with AXBTs and AXCPs, to examine the instantaneous hydrographic and velocity structures of selected features. Continuous monitoring of features was done using air and ship-deployed, satellite-tracked Lagrangian drifting buoys. Satellite altimetry was used to provide a historical perspective of conditions in the Gulf of Mexico from early 1985 through 1989. Through cooperative efforts with the University of Colorado, altimetry data from the ERS-1 and TOPEX/Poseidon satellites were available in near real-time during Years 2 and 3 of the Program as an aid in locating eddies for further study using AXBT and AXCP.

SIGNIFICANT CONCLUSIONS: Satellite altimetry data, from various sources, which have been referenced to an accurate mean sea surface, such as is now available for the Gulf of Mexico, can be used to provide long term patterns and stable statistics of ocean circulation features. Statistics of eddy motions from the altimetry had good correlation with similar statistics from drifter tracks and survey data. Observations of interaction of two Loop Current eddies in the western Gulf of Mexico indicated mass conservation during merger, with energy for the merger supplied by a nearby cyclone of smaller size. Statistics of Loop Current eddy motions derived form survey data and from Lagrangian drifter tracks observed during May 1992 through April 1995 field period agrees with previous estimates, including those from the GEOSAT period. Smaller slope eddies were observed in detail for the first time as well as interactions amount these smaller features and Loop Current eddies and with the shelf circulation. The smaller features appear to play a major role in determining the circulation at the shelf break. Analyses indicate a rich variety of interactions among cyclones and anticyclones with a variety of impacts on circulation patterns and eddy persistence.

STUDY RESULTS: Five Loop Current eddies out of six detected were tracked during the GEOSAT period and compared with survey data and Lagrangian drifter data. Loop Current eddy interactions in the western Gulf of Mexico were observed. Error analyses indicate that referencing the altimeter data to an accurate mean sea surface provides a set of stable statistics which compare well with similar statistics derived from hydrographic and Lagrangian drifter data. Eddy paths and separation periods derived from these data were consistent with similar estimates made by other investigators.

Observation of the merger of two Loop Current eddies in the western Gulf of Mexico showed that, in that instance, the merger conserved mass and circulation and that the energy required likely came from an adjacent smaller cyclone. This is in contrast to various earlier theories on the merger of two anticyclones.

Five Loop Current eddies and several smaller slope cyclones and anticyclones were observed during May 1992 through April 1995 field period. Data from the three-year field program provided detailed tracks for four of the five Loop Current eddies observed and provided the first detailed data on Loop Current eddy interactions with smaller cyclones and anticyclones as well as interactions among the smaller scale features. Observations from simultaneous hydrographic surveys, drifter tracts, AXCP profiles and current meter records revealed the rich detail and complexity of the eddy field in the central and western Gulf of Mexico. These observations suggest that small scale eddy interactions on the upper slope are a prime mechanism for the movement of water onto and off the shelf, and are the cause of the lack of along shelf coherence among current meter records at even relatively short length scales.

STUDY PRODUCTS: Berger, T.J., P. Hamilton, J.J. Singer, R.R. Leben, G.H. Born, and C.A. Fox. 1996. Louisiana/Texas Shelf Physical Oceanography Eddy Circulation Study Final Synthesis Report. Vol. I: Technical Report. OCS Study MMS 96-0051. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. 319 pp.

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*P.I.'s affiliation may be different than that listed for Program Managers.