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STUDY TITLE: Study of Deepwater Currents in the Northwestern Gulf of Mexico

REPORT TITLE: Study of Deepwater Currents in the Northwestern Gulf of Mexico: Volume I: Executive Summary and Volume II: Technical Report

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SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREA: Western

FISCAL YEARS OF PROJECT FUNDING: 2004: $1,583,843; 2005: $442,131; 2006: $427,823; 2007: $458,862; 2008: $417,571

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COSTS: $3,534,119

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KEY WORDS: Gulf of Mexico, currents, Loop Current, Loop Current eddies, cyclones, anticyclones, topographic Rossby waves, eddies, rings, remote sensing, PIES, inverted echo sounders, deep circulation, eddy-eddy interaction, eddy-topography interaction, inertial currents, jets

BACKGROUND: The timing and general area of investigation of this project extends the focus of a series of prior studies that as a group provide a basis for effective design and implementation of comprehensive ocean investigations having a goal of in-depth understanding and characterization of Gulf of Mexico (GOM) circulation and dynamics. These prior MMS-funded studies include the *Deepwater Physical Oceanography Reanalysis and Synthesis of Historical Data* (Nowlin, et al., 2001), the *DeSoto Canyon Eddy Intrusion Study* (Berger, et al., 2000), the *Study of Deepwater Observations in the Northern Gulf of Mexico from In-Situ Current Meters and PIES* (Hamilton, et al., 2003), and the recently completed *Exploratory Study of Deepwater Currents in the Gulf of Mexico* (Donohue, et al., 2006). Additionally, the MMS is presently funding a field measurement/data synthesis program titled: *A Study of Deepwater Currents in the Eastern Gulf of Mexico*. Clearly, this NW Gulf Study should be viewed in the context of an expanding multi-program database that is providing insights to initial characterization of dynamical aspects of the Gulf of Mexico circulation patterns that vary significantly in both time and space.

OBJECTIVES: (1) To collect current data to increase our deepwater database and knowledge of the deep circulation in the northwestern GOM; (2) To gather information to estimate oceanographic parameters needed to make experimental designs of full-scale physical oceanography studies in deepwater; and (3) To provide information to use in oil spill analyses including the emerging deep spill analysis, other ongoing studies, to help evaluate exploration plans, and contribute to the preparation of NEPA documents

DESCRIPTION: The project study area was west of 93°W. north of the EEZ and south and east of the 200-m isobath. Thirteen moored arrays, in water depths ranging from 500 to 3200 m, in conjunction with 10 PIES were used to document upper and lower-layer current, temperature and salinity fields. Moored data were begun in March 2004 and ended in June 2005. As a funded option, PIES measurement were begun in October 2004 and ended in August 2005. For the entire field measurement interval, satellite remote sensing observations (altimetry, sea-surface temperature and ocean color) were used to provide a context for the upper-layer field measurements and to characterize the associated circulation processes and patterns. Coordinated, MMS-funded moored instruments were deployed by CICESE in the Mexican Sector on the slope just south of 26°N.

SIGNIFICANT CONCLUSIONS: Using remotely sensed information, the shedding of 20 Loop Current eddy over 13.5 years was defined. The subsequent movement of each eddy was recorded as a function of time and indicates a mean path to the west southwest, however, with not preferred paths of eddy centers.

Either storms or cold front passages produced inertial current motion in the upper layers, generally above 250 m. After being initiated at the surface, energy was transmitted down into the water column. Inertial fluctuations were documented using both current measurements and time histories of thermocline fluctuations as measured with PIES Several examples of subsurface jets were documented. Such a jet is a vertically isolated high speed (>50 $cm \bullet s^{-1}$) current occurring in the upper 300 m of the water column. The available data suggested that these features occurred where a cyclonic feature was moving into an area of an anticyclone that produced diverging isotherms.

At depth, topographic Rossby waves (TRW) were well document, especially below the Sigsbee Escarpment that acted as a filter to limit the influence of TRWs over the region above the escarpment. There is some evidence that shorter period TRWs may have occurred after being initiated to the south of the study area. Modeling of TRW ray paths suggests that only TRWs have periods of approximately 60 days have a pathway that links the eastern and western portions of the Gulf of Mexico.

STUDY RESULTS: Field and remotely sensed observations produced very comprehensive and complete data sets with which to characterize upper and lower-layer current patterns and dynamics. Data returns were on the order of 98%. The measurement design showed that moored instruments in conjunction with PIES provide information that was adequate to resolve many transport processes. The Study also indicates that the vertical resolution resulting from the measurement design was

adequate to document effectively the range of conditions occurring in the area. Also, these measurements indicate that the overall duration of these measurements (on the order of 15 months) were not adequate to resolve the full spectrum of conditions occurring in the study area. Given that eddy shedding can occur with periods ranging from less than four months to 18-months and the fundamental role that Loop Current eddies have in the western Gulf and upper-layer circulation, longer measurement programs may be appropriate.

STUDY PRODUCTS: Donohue, K., P. Hamilton, R. Leben, D.R.Watts, and E. Waddell. 2008. Survey of Deepwater Currents in the Northwestern Gulf of Mexico. Volume I: Executive Summary. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2008-030. 66 pp.

Donohue, K., P. Hamilton, R. Leben, D.R.Watts, and E. Waddell. 2008. Survey of Deepwater Currents in the Northwestern Gulf of Mexico. Volume II: Technical Report. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2008-031. 364 pp.

P.I.'s affiliation may be different than that listed for Project Manager.