

STUDY TITLE: DeSoto Canyon Eddy Intrusion Study

REPORT TITLE: DeSoto Canyon Eddy Intrusion Study, Final Report, Volume I: Executive Summary and Volume II: Technical Report

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SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREA: Eastern Gulf of Mexico

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KEY WORDS: Gulf of Mexico, DeSoto Canyon, Loop Current, eddies, rings, currents, hydrography, sea surface height, sea surface temperature, circulation, field measurements, transport, slope, shelf break.

BACKGROUND: The DeSoto Canyon region is of interest for possible development of oil and gas potential. The U.S. Department of the Interior requires an environmental characterization of potential lease areas for making appropriate management decisions. The present report presents the results of a field measurement and synthesis study for the DeSoto Canyon. The study was conducted by a team of scientists from several different institutions.

OBJECTIVES: *In-situ* current measurements, hydrographic data, and satellite images were used to document and characterize LC intrusions and interactions with the northeastern Gulf. This study used these data to examine the dynamical processes of momentum, mass and vertical vorticity exchanges occurring during LC-slope interactions. An estimate was developed of the frequency of LC, LC rings, and secondary eddies' interactions with the northeastern slope, and an assessment of the exchanges of vorticity, momentum, and mass fields associated with the eddy-slope interactions was conducted. It elucidate the role of the DeSoto Canyon in LC and eddy processes as a mechanism and as well as a route of mass and momentum exchange between the shelf and deep water of the northeastern Gulf.

DESCRIPTION: The study area is generally located in the DeSoto Canyon over the slope in the northeastern Gulf of Mexico, extending from the shelf break (100m isobath) seaward to a nominal southerly limit of 28.5°N. However, to connect processes

occurring within this area, it was necessary to examine and detail dynamics and characteristics of the Loop Current and related eddies and rings that were outside that region.

In March 1998 at the beginning of the two-year field measurement program, thirteen moorings were deployed along four transects in water depths of 100m, 500m and 1300m. An additional mooring was placed in 200m on the axis of the DeSoto Canyon. Approximately 76 hydrographic stations were occupied every four months during mooring rotation and maintenance cruises. A variety of current measuring devices were used, with Acoustic Doppler Current Profilers at the top of each mooring to provide detailed information concerning currents in the surface layer. In addition to current/temperature sensors, a number of internally recording conductivity/temperature and temperature sensors were deployed on each mooring to provide more detailed information on the vertical and horizontal water mass structure. Two special studies were conducted, involving higher spatial resolution hydrographic sampling, with a goal of helping resolve some finer scaled or ephemeral features. Satellite-derived sea surface height and sea surface temperature data was available on a daily basis to supplement the above in-situ and survey data. A very high data return was maintained to produce a comprehensive program data set.

Complete data sets (*in-situ*, hydrography and remotely sensed) were provided to the team of Principal Investigators to use in an integrated characterization of key physical oceanographic processes and patterns occurring in the study area.

SIGNIFICANT CONCLUSIONS: Eddy-like (cyclonic and anticyclonic) features and related flow patterns over the slope had a significant impact on the circulation in and adjacent to the DeSoto Canyon. Many eddies could be linked directly to the Loop Current and related features such as frontal eddies. The linkage of other eddies to the Loop Current was not well defined. The variable location, sense of rotation and strength of each eddy caused aperiodic patterns to be prevalent. Over the deeper slope regions, currents often appeared to be uncoupled from conditions nearer the surface. Wind stress on the ocean surface affected surface currents at the shelf break and over the slope, and had a substantial role in shelf break exchange. Severe storms such as hurricanes created substantial flux across the shelf break as well as establishing a strong pattern of inertial currents that varied both vertically and horizontal.

STUDY RESULTS: This study region is affected simultaneously by diverse influences of wind driven currents and circulation associated with eddy-like features, some of which are related to the Loop Current. Because eddy-like features varied in location, strength and size, their impact on observed current patterns varied with time and location. Many of the features were linked to Loop Current rings that had detached, or migrating frontal boundary eddies that could be associated with both the Loop Current and detached Loop Current rings. Depending on the structure of these features, they were affected by interaction with the bathymetry that defines the DeSoto Canyon. Several modes of eddy-bathymetry interaction were identified.

Meteorological processes had a significant role in near surface and deeper currents. Regular wind stress was strongly coherent with surface currents and contributed to shelf

break exchange as well as currents over the slope. During significant storms, such as hurricanes, meteorological forcing caused large shelf break flux as well as creating a pattern of strong inertial currents that propagated vertically and horizontally.

Wind stress and eddies combined to produce a statistical pattern of currents within DeSoto Canyon. A surface/near surface current to the east occurred near the shelf break. Down slope and at mid-depth, a counter current (with a westerly component) was evident. Offshore, and extending from the surface to 7-800m depth, circulation seems to be controlled by the presence and location of eddies, in particular cyclonic eddies, and related current patterns.

STUDY PRODUCTS: Hamilton, P., T.J. Berger, J.J. Singer, E. Waddell, J.H. Churchill, R.R. Leben, T.N. Lee, and W. Sturges. DeSoto Canyon Eddy Intrusion Study; Final Report Volume I: Executive Summary. OCS Study MMS 2000-079. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. 47 pp.

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