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**STUDY TITLE:** Deepwater Program: Deepwater Current Measurements at 25° N; 90° W in Mexican Territory

**REPORT TITLE:** Full-Water Column Current Observations in the Central Gulf of Mexico

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**BACKGROUND:** Large-scale and intensive oceanographic observations, focused on the proper determination and description of the circulation in the Gulf of Mexico have been made in U.S. waters by various agencies and research institutions under the auspices of the U.S. Department of the Interior, Minerals Management Service. The present study provides an extension into Mexican waters of the intensive surveys made at about the same time over the Texas-Louisiana shelf and slope, and provides new, detailed, full-water column observations of the currents in the deep region that connects the eastern and western basins of the Gulf.

**OBJECTIVES:** To deploy a deep-ocean mooring and retrieve ocean current, temperature, and pressure data conducive to the adequate description of the circulation in the central Gulf of Mexico.

**DESCRIPTION:** A full-water column mooring, instrumented with acoustic current profilers, current meters, and temperature and pressure sensors, was installed at 25º

5'N; 90º 30'W, in the central Gulf of Mexico. It successfully monitored current and temperature fluctuations from the near surface to the bottom, from May 2003 to August 2004 (16 months). The velocity spectral density shows peaks at tidal and inertial bands with over 90% of the variance in subinertial motions. Bursts of inertial wave activity occur throughout the period of observations, possibly related to the passage of eddy-related fronts and wind events. A considerable portion of the subinertial current fluctuations are surface intensified, very coherent throughout the water column, and geostrophically related to the sea surface slopes, as determined from satellite altimetry. The projection of the data onto modal structures shows that the barotropic and first baroclinic dynamical modes contribute 46% and 45% of the total variance. An EOF decomposition shows 49% and 24% of the variance in the first and second modes, both confirming the surface intensification. A second intensification detected within the bottom boundary layer probably arises as an effect of bottom-trapped topographic waves. Most of the fluctuations appear driven by eddies propagating to the west, away from their generation off the Loop Current. The temperature measurements combined with the measured vertical excursions of some instruments and the dynamical modes allow estimates of the full temperature and vertical displacement profiles; temperature fluctuations are also consistent with the passage of warm/cold, anticyclonic/cyclonic eddies.

**SIGNIFICANT CONCLUSIONS:** Perhaps the most remarkable finding of this study is that the data suggest highly coherent motions throughout the water column, which largely decompose into a barotropic and first baroclinic mode structures. Progressive vector diagrams and vector plots suggest an upper layer from the surface down to 800-900 meters depth, a transition layer between 900-1200 meters, more in tune with the upper layer, and a deep coherent layer below 1200 meters. This partition is consistent with the thermodynamic studies of Rivas et al., [2005; 2006] and the analysis of the deep circulation in the Caribbean and Gulf of Mexico of Sturges, [2005, *Jour. Geophys. Res.*]. The highly coherent motions below 1000 m, their bottom intensification, and their spectral characteristics are definitely reminiscent of topographic Rossby wave motions, as reported by Hamilton [year. *Ref.*].

**STUDY RESULTS:** A highly instrumented deep mooring in the central Gulf of Mexico was successfully deployed. Most of the instruments performed adequately and data recovery was close to 100 percent. There were nonetheless some slight problems with a couple of instruments. For example, the mid-water LR-ADCP (75 kHz) had a few problematic first bins close to the head's instrument. Although all the data passed RDI's data quality tests easily, the data in question showed poor correlations with those of higher bins, and relatively low velocity variance. They were therefore discarded and we are still investigating the cause of this malfunction. The 300 kHz ADCP located close to the bottom provided good data only for the first five bins due to the lack of sufficient reflectors farther away from the bottom in such deep water.

The analysis of the velocity data shows that tides (diurnal components) and inertial oscillations have a relatively small contribution to the variability. Energy spectra are red, and most of the energy is in the subinertial motions. The 20-100 days period band is

highly energetic. Especially interesting is that energy in the peak centered at periods around 30 days is larger near the bottom than in the rest of the water column, except near the surface. Mean velocity values are smaller than their standard deviations throughout the whole water column; that is, energy is dominated by fluctuations rather than by the mean currents. These fluctuations appear related to the passage of eddies generated from Loop Current processes. Decomposition in dynamical modes and empirical orthogonal functions shows that 90% of the variability is explained by the barotropic and first baroclinic modes with nearly equipartitioned energy. Four EOFs are required to explain the same amount of velocity variance, with their configuration depending on the way they are computed, which indicates that they should be interpreted with caution and highlights the need of performing both statistical and dynamical decompositions of the data to better interpret the results.

During the analysis of the data, a new method developed to correct mooring motion and determine temperature values at nominal instrument depths or any other depths, using the mooring measurements and a reference profile determined from nearby CTD casts or climatology. The method assumes adiabatic displacements of the reference profile and uses potential temperature as a Lagrangian Label. The method appears to give results similar to other techniques available in the literature, but its implementation is somewhat easier. Comparisons of mooring measurements with altimetry data shows that most energetic events are associated with eddies passing close or over the mooring. The high correlation between both sources of data permits the identification of the vertical penetration and time evolution of the anomalies identified by the altimeter data and gives confidence on the quality of our measurements. It is remarkable that eddies might generate coherent, detectable signals in velocity and isotherm displacements to a depth of 1500m. Finally, the northeastward mean velocity and its variance measured in the mooring below 1000m depth is consistent with the deep flow characteristics reported from nearby regions by other researchers using PALACE floats.

**STUDY PRODUCTS:** Sheinbaum J., A. Badan, J. Ochoa, J. Candela, D. Rivas, and J.I. González. 2007. Full-water column current observations in the central Gulf of Mexico. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2007-022. 68 pp.

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