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STUDY TITLE: Dynamic Height and Transport Across the Louisiana-Texas Shelf Break

REPORT TITLE: Dynamic Height and Seawater Transport Across the Louisiana-Texas Shelf Break

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BACKGROUND: The Louisiana-Texas continental shelf is a region of active oil and gas production and exploration. The U. S. Department of the Interior sponsored the Louisiana-Texas Shelf Physical Oceanography Program (LATEX) to understand the physical processes and circulation of the shelf water that influence the stability of structures, the transport of pollutants, and the ecosystem of regions that may be affected by oil and gas operations. This report contains an analysis of cross-shelf geostrophic transport at the shelf break employing LATEX data.

OBJECTIVES: To use techniques of dynamic modal analysis to estimate the time evolution of mean dynamic height and high resolution profiles of geostrophic transport across the Louisiana-Texas shelf break from LATEX-A mooring data.

DESCRIPTION: This study applies dynamic modal analysis techniques to LATEX-A mooring data to estimate time dependent, highly vertically resolved geostrophic transport across the Louisiana-Texas continental shelf break as well as dynamic height at mooring locations. Local dynamic vertical modes of pressure anomaly were

calculated with respect to smoothed, seasonally adjusted leveled state reference profiles obtained independently from LATEX hydrographic cruise data. The dynamic modes are orthogonal patterns of variability computed from the assumed dynamics of the system, providing added information based on physics to improve the resolution of estimated profiles obtained from measurements at a given time and location. These dynamic modes of pressure anomaly are rigid lid, flat bottom vertical structure functions based on the usual Sturm-Liouville boundary value problem arising from the equations of motion. Pressure anomaly profiles were computed from temperature and salinity time series using linear interpolative techniques, and were then fitted to dynamic modes of pressure anomaly. Time series of high resolution pressure profiles reconstructed from the dynamic modes and modal amplitudes are the basis for estimation of the time evolution of dynamic height and (following application of geostrophy) cross-shelf geostrophic transport at the shelf break. Geostrophic transport profiles vary smoothly with season. Offshore transport is strong in the upper 70 meters of the water column during the winter. During the summer, onshore transport develops first in deeper waters, penetrating higher in the water column until eventually the direction of transport is onshore from surface to seafloor. Mean steric water level anomaly from the shelf break moorings is consistent with the smooth annual cycle determined from cruise hydrography by Current (1996), and is notably similar to the findings of Whitaker (1971).

SIGNIFICANT CONCLUSIONS: Transport profiles are influenced less by alongshelf location on the shelf than by the time of year, with energetic offshore transport in the upper water column during winter and onshore transport during summer. A slow, smooth seasonal progression of vertical patterns of mean cross-shelf flow exists at the 200-m isobath. Mean transport over the entire shelf for the seven months studied was 0.26 Sv. The time dependent transport profiles suggest the possibility of upwelling on the outer Louisiana-Texas continental shelf, which could replenish nutrients depleted by biological demand.

STUDY RESULTS: Results of this study are consistent with the findings of the MMS-funded Texas-Louisiana Shelf Circulation and Transport Processes Study (LATEX-A), but provide high resolution vertical profiles of geostrophic transport previously unavailable to MMS. These geostrophic transport profiles vary smoothly with season. Offshore transport is strong in the upper 70 meters of the water column during the winter. During the summer, onshore transport develops first in deeper waters, penetrating higher in the water column until eventually the direction of transport is onshore from surface to seafloor.

Mean steric water level anomaly from the shelf break moorings is consistent with the smooth annual cycle determined from 1992-1994 LATEX A and C cruise hydrography by Current (1996), and is notably similar to the findings of Whitaker (1971) throughout the northern and western part of the Gulf of Mexico. The seasonal signal is characterized by a single minimum close to the time of the vernal equinox, and a single maximum near the autumnal equinox.

Circulation on the outer Louisiana-Texas shelf appears to be more complex than was thought prior to the LATEX program and this is consistent with the conclusions of the

LATEX-A scientists. Cross-shelf transport was as large as or larger than previous reports of alongshelf transport, varying greatly in time and by shelf location, confirming previous results based on other LATEX-A data.

STUDY PRODUCTS: Current, C. L., and W. J. Wiseman, Jr. 2000. Dynamic height and seawater transport across the Louisiana-Texas shelf break. A final report for the U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, Metairie, LA. Contract No. 14-12-0001-30660-19948. 58 pp. OCS Study MMS 2000-045.

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