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STUDY TITLE: An Observational and Predictive Study of Inner Shelf Currents over the Louisiana-Texas Shelf

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PROJECT MANAGERS: William J. Wiseman, Jr., Lawrence J. Rouse

AFFILIATION: Louisiana State University

ADDRESS: Department of Oceanography& Coastal Sciences, Louisiana State University, Baton Rouge, LA 70803

PRINCIPAL INVESTIGATORS: Lawrence J. Rouse, Jr., William J. Wiseman, Jr., Leslie C. Bender, Norman L. Guinasso, Jr., F. J. Kelly, David A. Brooks, Yao-Tsi Lo, J. She, and A. Valle-Levinson

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BACKGROUND: Upon exiting the Mississippi and Atchafalaya River Deltas, the relatively fresh river waters flow westward along the coast to form the Louisiana Coastal Current (Wiseman and Kelly, 1994). The waters of this current system move downcoast (in the sense of phase propagation of Kelvin waves) most of the year and are readily identifiable along the Mexican coast of the Gulf of Mexico during the late fall, winter, and early spring. The flow is highly responsive to wind forcing, the most important synoptic wind pattern being cold air outbreaks (Huh et al., 1984), which occur on time scales of 3 to 10 days during the winter season (DiMego et al., 1976; Fernandez-Partagas and Mooers, 1975). Driven by such events, the current may reverse direction for a brief period of time and flow upcoast. During summer, when winds are weaker, the coastal waters of Louisiana are highly stratified and the surface flow may be incoherent with the near-bottom currents on sub-tidal time scales. Along the south Texas coast, the winds become upwelling favorable in late spring and the mean flow reverses direction and moves upcoast. For periods of a month or longer the direction of the mean current over the western Louisiana inner shelf may be eastward (Cochrane and Kelly, 1986).

An understanding of the currents within this coastal system is important to a number of environmentally important processes. Not the least of these is oil spills, since any spill in nearshore waters is immediately transported by the waters of this current system and any spill in Outer Continental Shelf waters must transit this current system before impacting the highly productive marshes and estuaries of coastal Louisiana and Texas. Much of this country's imported oil is lightered from super tankers offshore Louisiana and Texas. Offshore production contributes an important but significantly smaller amount than lightering. The volume of oil lightered last year from Southwest pass to Corpus Christi was about 275 million barrels; equivalent to almost 200 EXXON VALDEZ loads (Larry Smith, Calero Refining; personal communication). The volume continues to increase.

OBJECTIVES: The objective of the modeling and data analysis was to verify previous findings and to explore new features of the subtidal circulation over the Texas-Louisiana inner shelf and its response to wind forcing.

DESCRIPTIONS: TABS buoy data obtained from April 1995 to March 1998 were among the data used to study subtidal circulation over the shelf. The principal objective of the modeling effort was to investigate the basic physical mechanisms responsible for the development of the Mississippi-Atchafalaya River plume associated with surface wind forcing on the Texas-Louisiana continental shelf.

SIGNIFICANT CONCLUSIONS: Interaction between the Mississippi-Atchafalaya river plume and the Mississippi Canyon was demonstrated through circulation modeling. The results of data analyses indicate both significant spatial and temporal variability in the response of currents along the Texas-Louisiana inner shelf to wind forcing, and the fact that a local, linear relationship between the alongshore wind field and cross-shelf flow field does not explain all the observed variability in the currents. The role of upstream river discharge and local flow convergence has been suggested as important contributors to this variability. The importance of local upwelling/downwelling was confirmed.

STUDY RESULTS: Steps towards development of a fully three-dimensional model of circulation on the Louisiana-Texas shelf were presented. Data analyses have confirmed the seasonal coherence between local winds and currents. Cross-shore flow patterns were consistent with upwelling theory. Marginally significant signatures of longshore propagating flow features consistent with coastally-trapped wave theory were identified. An hypothesis was developed that there exists a seasonal geopotential high near 93o W, forced by the convergence of wind-driven flows from the southwest and riverine-driven flows from the east, which is used to explain the very low frequency patterns of flow.

STUDY PRODUCTS: Lo, Y.-T. Modeling the Buoyancy-Driven Flow Due to River Discharge On the Texas-Louisiana Continental Shelf of the Gulf of Mexico. Unpublished Ph. D. Dissertation. Department of Oceanography. Texas A&M University. College Station, TX. 154 pp.

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