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**REPORT TITLE:** Texas-Louisiana Shelf Circulation and Transport Processes Study: Synthesis Report, Volume I: Technical Report and Volume II: Appendices

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**BACKGROUND:** The Minerals Management Service (MMS) Gulf of Mexico Outer Continental Shelf Region sponsored a symposium on the Physical Oceanography of the Louisiana-Texas Shelf in Galveston, Texas, on 24-25 May 1998. Based on the recommendations, MMS designed the Louisiana-Texas Shelf Physical Oceanography Program (LATEX). This summary presents the main results of Study Unit A of LATEX -- the Texas-Louisiana Shelf Circulation and Transport Processes Study.

**OBJECTIVES**: (1) To identify key dynamical processes governing circulation, transport, and cross-shelf mixing on the Texas-Louisiana shelf. (2) To improve the data base available for study of the processes in objective 1, synthesize the data into a scheme of circulation, and quantify transports and mixing rates. (3) To develop conceptual models of meso- to large-scale processes and circulation features and of large-scale shelf circulation on event to seasonal scales. (4) To provide physical and chemical information needed for synthesis with biological data into a broader ecological characterization of the region.

**DESCRIPTION:** The study area is bounded by 90.5°W on the east, the 10-m isobath inshore, 26°N on the southwest, and the 1000-m isobath offshore. From April 1992 to November 1994, 18 mooring cruises and 10 hydrographic surveys with acoustic Doppler current profilers (ADCP) and drifter deployments were conducted. Historical and ancillary data, including river discharge, meteorological, tide gauge, and satellite data, were assembled.

Thirty-one current meter moorings, 8 meteorological buoys, and 2 inverted echo sounders (IES) were deployed in the study area. Current meter moorings measured current speed and direction; most measured temperature and salinity. The five innermost moorings measured directional wave spectra. Instruments were placed about 10 m below sea surface and 2 m above sea floor. For moorings in water depths of 50 m or more, a third instrument was placed at mid-depth. Meteorological buoys measured wind speed and direction at 3.6-m above sea level, air temperature at 3-m above sea surface, sea level barometric pressure, and sea surface temperature at 1-m sea surface. Four of the meteorological buoys were used to study winter cyclogenesis and so were removed during the hurricane season. IES moorings were about 1-m above bottom and measured acoustic travel time, temperature, and pressure.

Ten hydrographic/ADCP surveys were conducted in April/May (3), July/August (3), November (3), and February (1 in 1993). Hydrographic stations were made on 4-8 cross-shelf lines and on alongshelf lines on the 50-m and 200-m isobaths. The first four surveys were over the eastern shelf to 94°W; others were over the full shelf. Surveys in 1994 did not sample along the 50-m isobath. Stations included continuous vertical profiling using a Sea-Bird 911*plus* CTD system and discrete sampling using General Oceanics 12-place Rosette and 10-liter Niskin bottles. Continuous profiling was of pressure, temperature, salinity, downwelling irradiance, percent transmission, backscatterance, dissolved oxygen, and fluorescence. Discrete samples were made at every station for nutrients (nitrate, phosphate, silicate, nitrite, ammonium, and urea) and at about half the stations for salinity, dissolved oxygen, particulate material, and pigments. Secchi depth readings were taken at daytime stations. A narrow-band 150kHz ADCP was operated continuously along the track, with bottom tracking and GPS navigation for determination for ship velocity. Nineteen drifters were deployed and tracked via ARGOS satellites.

**SIGNIFICANT CONCLUSIONS:** Currents over the inner shelf (inshore of about the 50-m isobath) are principally forced by alongshelf wind stress, in the pattern hypothesized by Cochrane and Kelly (1986). Currents are typically downcoast (from Mississippi to Rio Grande) during nonsummer (September through May), transition in June, and are upcoast in summer. Fresh waters from the Mississippi-Atchafalaya river system contribute to buoyancy forcing over the inner shelf. Although there is stronger baroclinic downcoast flow in spring than in fall due to river discharge, direct observations give larger downcast flow in fall; therefore, barotropic corrections must be added to geopotential anomaly patterns if the correct circulation is to be obtained. Upcoast flow in summer extends over the entire shelf width leading to a pooling of low salinity water over the Louisiana shelf in that season. Evidence indicates strong interannual variability in fluxes of mass, fresh water, and temperature and is supported by corresponding interannual variability in river discharge and surface wind fields. Kinetic energy in the weather band (2 to 10 days) is shown to dominate residual scales of motion near shore; kinetic energy in the mesoscale (10 to 100 days) is dominant over the outer shelf. Effects of severe wind events (hurricanes, cyclogenesis, and cold air outbreaks) extend into deeper water at the shelf edge as well as across the shelf. Though currents over the outer shelf respond to wind, offshore eddies dominate the circulation there; the average upcoast flow seen along the shelf edge was the integrated effect of such eddies during the LATEX period.

**STUDY RESULTS:** Low-frequency alongshelf winds are upcoast in summer and generally downcoast in other seasons. Frontal passages occur approximately every 4-7 days in nonsummer but rarely in summer. Discharge of the Mississippi-Atchafalaya river system, with typical maximum in April and minimum in September/October, is highly variable: discharge in 1993 and during late winter and spring 1994 substantially exceeded the long-term mean, while it was well below normal during the flood season in 1992. Discharge from other rivers is on order magnitude less, but occasional episodes of unusually high discharge have significant effects. Loop Current eddies seem more frequent off the lower Texas shelf, less frequent off Louisiana shelf, and infrequent off the upper Texas shelf.

Mean currents are downcoast over the inner shelf and upcoast over the outer shelf. The annual signal of inner shelf currents is of downcoast flow during nonsummer and upcoast flow during summer; over the outer shelf there is no systematic, general pattern, although currents are upcoast in summer. Kinetic energy of currents in the mesoscale band (10 to 100 day periods) is greatest at the shelf edge, particularly in regions adjacent to eddy activity, and decreases toward shore. Kinetic energy of currents in the weather band (2 to 10 day periods) is greatest near shore and decreases offshore. Currents are well correlated with wind stress in the weather band; they are most energetic in winter and spring and decrease to a minimum in summer with infrequent frontal passages. Forcing of inner shelf circulation is essentially by wind stress and buoyancy contrast. The bimodal (summer versus nonsummer) pattern of alongshelf currents is interrupted by energetic wind events that alter the direction of alongshelf wind stress for periods usually of a few days. Such current reversals follow wind stress reversals in less than 1 day. The Mississippi-Atchafalaya fresh water discharge contributes to buoyancy forcing over the inner shelf, thus increasing downcoast geostrophic shear. Eddies are major drivers of shelf edge currents and frequently affect the outer shelf through exchanges of mass, energy, and water properties. Their impact on the inner shelf circulation is episodic, but can be substantial. Because of the sporadic occurrence of eddies adjacent to the shelf, interannual variability over the outer shelf is quite large.

Distributions of particulate matter, phytoplankton pigments, and nutrients respond to Mississippi-Atchafalaya discharge and patterns of current flow. Hypoxic conditions were observed in eastern shelf bottom waters in summer 1992, spring and summer 1993, and summer 1994, with near-hypoxic conditions in spring 1992. Mississippi-Atchafalaya discharge, together with a reduction in wind stress and a seasonal thermocline in summer, contributes to the stratification over the LATEX shelf, which in turn facilitates formation of hypoxic bottom waters by restricting the resupply of oxygen from the surface.

**STUDY PRODUCT(S):** Nowlin, W.D., Jr., A.E. Jochens, R.O. Reid, S.F. DiMarco. 1998. Texas-Louisiana Shelf Circulation and Transport Processes Study - Synthesis Report. Vol. I: Technical Report. OCS Study MMS-98-0035, U.S. Dept. Of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. 502 pp.

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Peer-reviewed publications resulting from this study are available on request from the Program Manager.

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