ACCESS NUMBER: 30660-19942

STUDY TITLE: Interpretative Synthesis of LATEX Shelf and Slope Circulation Patterns from Satellite and In-situ Measurements

REPORT TITLE: Wind and Eddy-related Circulation on the LA/TX Shelf and Slope Determined from Satellite and In-Situ Measurements: October 1993-August 1994

CONTRACT NUMBER: 14-35-0001-30660-19942

SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREA: Northwestern

FISCAL YEARS OF PROJECT FUNDING: 1996; 1997; 1998; 1999; 2000

COMPLETION DATE OF REPORT: April 2001

CUMULATIVE PROJECT COST: $18,762

PROJECT MANAGER: N.D. Walker

AFFILIATION: Coastal Studies Institute, Louisiana State University

ADDRESS: Howe-Russell Geoscience Complex, Louisiana State University, Baton Rouge, LA 70803.

PRINCIPAL INVESTIGATOR: N.D. Walker

KEY WORDS: physical oceanography, currents, Louisiana/Texas shelf, Louisiana coastal current, upwelling, satellite oceanography, drifters, Loop Current eddies, NW Gulf of Mexico, shelf circulation, slope circulation.

BACKGROUND: The Louisiana-Texas Shelf Physical Oceanography Program (LATEX), sponsored by the Minerals Management Service, was funded to improve the understanding of circulation and associated causal mechanisms on the Louisiana and Texas continental shelves. Circulation in this region is complex as it is influenced by several time-varying environmental factors including wind forcing, river discharges, and the location and intensity of detached Loop Current warm-core eddies. During the LATEX field measurement program many valuable datasets were collected which individually revealed some aspects of circulation on the continental shelf and slope of Texas and Louisiana from April 1992 to December 1994. In this project, an attempt was made to further the understanding of near-surface shelf and slope circulation processes in the northwest Gulf of Mexico (GOM) by synthesizing several datasets collected during the LATEX field measurement period. The datasets included in this analysis included NOAA AVHRR sea-surface temperature (SST) imagery, TOPEX and ERS-1 sea-surface height (SSH) data, SCULP surface drifter data and LATEX-A current meter and temperature measurements.

OBJECTIVES: The goal of this research was to use selected high quality measurements obtained during the LATEX project from October 1993 through September 1994 to obtain a better understanding of synoptic-scale and seasonal-scale variations in surface and near-surface circulation on the Louisiana/Texas continental shelf and slope and the primary forcing mechanisms for the identified patterns.

DESCRIPTION: The NOAA satellite SST image data provided regional synoptic views of SST distributions over the LATEX shelf and slope when skies were relatively cloud-free. Shelf and slope circulation features such as the effluent plumes of major rivers, offshelf flow features (squirts), and Loop Current rings were identifiable and trackable in relatively clear-sky imagery. The SSH information, in the form of 10-day synthesis maps, depicted the locations and intensities of warm-core rings and cold-core eddies in the study region, information which is weather-independent. The SCULP surface drifters provided knowledge on lagrangian surface circulation patterns. The satellite datasets provided crucial information on the location and movements of shelf and slope oceanic features with which the drifter trajectories could be more accurately interpreted. The LATEX-A current meter measurements provided time-series measurements simultaneously at key locations on the LATEX shelf, enabling a more thorough investigation of the impacts of wind forcing on inner shelf circulation.

SIGNIFICANT CONCLUSIONS: Circulation on the inner and mid-shelf regions of the Louisiana/Texas continental shelf is controlled primarily by wind forcing. Down-coast flow (from Louisiana to Texas and southward along the Texas coast) prevails during much of autumn, winter and spring due to the prevalence of westward wind stress. The orientation of flow is generally along the isobaths and, therefore, changes from westward flow along the Louisiana shelf to southward flow along the Texas shelf when currents are down-coast. Velocities at the surface and down to about 10m are strongest when winds blow towards the southwest along the Louisiana coast and towards the south along the Texas coast. This wind stress situation occurs frequently with the intrusion of strong high pressure systems in the wake of cold-front passages. Down-coast current velocities are considerably stronger along the Texas coast as a result of the constriction in the continental shelf, moving from Louisiana to Texas. The summer up-coast flow regime is regionally extensive across the Louisiana/Texas shelf. There was no evidence of a surface convergence zone in summer between the up-coast flow regime along the south Texas coast and a down-coast flow regime from Louisiana. In fact, the data show that at 10 m depth up-coast flow (to north and east) occurred first along the northern Texas and central Louisiana shelf. Comparison of drifter data with sub-surface mooring data clearly demonstrate that the surface flow responds within hours to wind events whereas the sub-surface flow can exhibit lag times of days to weeks, especially along the south Texas coast. The up-coast flow regime of summer is characterized by coastal upwelling along much of the southern Texas coastline. Northward wind stress along the Texas coast results in a coastally extensive band of cool waters, 20-30 km wide, extending from Mexico to Matagorda Bay. These cool waters contrast with the warm surface waters typical of the rest of the Louisiana/Texas shelf. During June 1994, upwelling was stronger than normal and coastal upwelling

was detected along the entire Texas coast from 26ºN to Galveston.The satellite SST imagery reveals that the cool coastal waters move towards the northeast with the general up-coast shelf flow along the Texas coast. Warm core eddies on the slope typically advect the cool upwelled waters seaward into the deeper GOM. Water temperatures below 25ºC are commonly experienced along the Texas coast during June and July and sometimes August. The severity of the cooling and the longevity of upwelling are controlled primarily by the intensity and longevity of the northward wind stress. The most long-lived and pronounced up-coast flow events at both sites occurred in late June/early July and in late July.

STUDY RESULTS: The synthesis of clear sky satellite SST data and SSH data enabled a better evaluation of the circulation features that influenced the movement of SCULP drifters during autumn and winter 1993/94. The proximity of three warm core rings and several cold core eddies to the Louisiana/Texas shelf edge impacted upon circulation of the drifters. The movement of these features over time altered surface circulation processes on the shelf. Of particular interest was the identification of a narrow off-shelf flow regime southeast from Matagorda Bay. This flow regime observed primarily in November and December 1993 was termed the Matagorda squirt. Approximately 40% of the drifters released in October and November 1993 experienced off-shelf advection within this squirt feature. In the satellite SST data, the feature was revealed as a streamer of relatively cool water extending between the 30m to 200 m isobath. The feature formed between a warm core ring (Eddy V/W) to the south and a cold core eddy on the shelf to the north. Daily-averaged velocities of the drifters averaged 39 cm/s and ranged from 19 to 59 cm/s in water depths between 50 and 1000 m (Table 2). Subsequent drifter movements around the warm core ring were slightly higher, averaging 45 cm/s with maximum velocities reaching 75 cm/s. During December 1993, only 30% of the drifters were advected into this feature and by January the feature had disappeared. The SSH data demonstrated that the warm core ring moved away from the shelf, removing the main source of the forcing for this flow regime. This interesting case study reveals the large impact that warm core rings can have on shelf circulation, even away from the shelf edge.

STUDY PRODUCTS: Walker, N.D. 2001. Wind and eddy-related circulation on the Louisiana/Texas shelf and slope determined from satellite and in-situ measurements: October 1993-August 1994, OCS Study MMS 2001-025. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, 74 pp.