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STUDY TITLE: Coastal Currents in the Northern Gulf of Mexico

REPORT TITLE: Coastal Currents in the Northern Gulf of Mexico, Dixie County, Florida, to the U.S.-Mexico Border

CONTRACT NUMBER: 14-35-0001-30660-19928

SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREA(S): Gulf of Mexico

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KEY WORDS: Gulf of Mexico; coastal Currents; surface currents; alongshore currents; seasonal statistics

BACKGROUND: The Minerals Management Service (MMS) Gulf of Mexico Program (GOM) Outer Continental Shelf (OCS) office has responsibility for oil spill risk assessment within the state waters in the Gulf of Mexico. The currents responsible for the movement of contaminants (oil) on the continental shelf are predominantly alongshore on the inner shelf. MMS requires statistical knowledge of these coastal currents, especially the alongshore currents, in order to make strategic management and planning decisions.

OBJECTIVES: To statistically describe the available surface and near-surface current meter records for the inner shelf of the northern Gulf of Mexico. To describe the record mean flows and the flow variability. To describe alongshore current maximum velocities and alongshore flow persistence.

DESCRIPTION: The study area was the surface waters of the northern Gulf of Mexico inner continental shelf, from Dixie County, Florida, to the U.S.-Mexico international border, from the coastline seaward to a distance of 20 NM (36.5 km).

Historical observations from moored current meters were statistically analyzed. Data from 12 different programs, at 47 locations were used in the analysis. All data records in 10 m or less water depth were used. Only records in the upper half of the water column were used where water depth exceeded 10 m. Record lengths greater than 27 days were segmented into four seasons. Seasons were three months in duration, with December-September-November as fall.

Data were resolved into along- and cross-shore velocity components, where alongshore was determined by the local coastline. Records means, variances, standard error of means, maxima and minimum, and auto-correlation time scales were computed for each seasonal record. Statistical significance levels were determined for the record means. Total record variances were compared to those of 40-hour low-passed filtered records to estimate the relative contribution of the non-tidal flow.

Flow duration and persistence statistics were calculated for each alongshore record. These were the percent of flow in each direction, the number of flow events within selected speed ranges, the single event of maximum duration, and the single event of maximum estimated displacement.

SIGNIFICANT CONCLUSIONS: Three seasons, winter, spring and fall, exhibited predominantly westward mean flows. Spring mean flows were westward on the inner shelf west of the Mississippi Delta and eastward east of the Delta. The summer season exhibited as many occurrences of westward as eastward mean flows, with a general flow reversal to the east on the south Texas inner shelf. Maximum alongshore current magnitudes exceeded maximum cross-shore current magnitudes in all seasons. Maximum alongshore currents to the west and the alongshore variance magnitude increased to the west in all seasons.

The percentage of westward flow from individual records exceeded 50% and increase in percentage to the west in all seasons except summer, when the percentage of eastward flow from individual records was similar to westward flow.

STUDY RESULTS: Seasonal alongshore means were predominantly westward in the winter, spring and fall; summer means had no uniform flow direction. Winter, spring and fall mean velocities were lowest (>10 $cm \cdot s^{-1}$) in the east and increased with distance to the west (>10 $cm \cdot s^{-1}$). Summer mean magnitudes were mostly <>10 $cm \cdot s^{-1}$, but with as many eastward means as westward. The number of statistically significant winter and fall means was high (all to the west). Fewer spring means were statistically significant (most to the west, only eastern stations exhibited statistically significant mean flow to the east), and in summer only a few means were statistically significant (most to the east). Cross-shore means were seldom statistically significant; when they were, flow was predominantly on-shore.

Alongshore variances were consistently greater then cross-shore variances. Cross-shore variances were of similar magnitude and range across the seasons and the domain of study. Alongshore variance magnitudes and ranges increased westward and

were similar in all seasons except fall, when a lower range of values occurred. Record maximum flow speeds were computed for both, eastward and westward, alongshore directions and for both, on-shore and off-shore, cross-shore directions. Eastward alongshore maximum velocities were -50 $cm \cdot s^{-1}$ over the entire study region; westward alongshore maximum velocities increased form east to west from ~40 $cm \cdot s^{-1}$ to ~75 $cm \cdot s^{-1}$. There was little seasonal difference in patterns of alongshore maximum during all seasons; on-shore velocities increased to the east in winter and spring.

Alongshore auto-correlation time scales generally ranged form one to three days in winter, spring and fall; summer time scales were longer, some exceeding five days.

The percentage of alongshore variance in the low-frequency band increased in all seasons from <60% east of the Delta to >80% in the west. The percentage of cross-shore variance in the low-passed band was ~50% in all seasons. Low percentages of variance in the low-passed band were associated with bathymetric controls or backbarrier exchange.

The percentages of alongshore flow in a given direction were similar for the winter, spring and fall, with ~50% westward flow east of the Delta increasing to ~80% in the west. Summer flows were ~50% westward east of the Delta decreasing to ~40% westward flow to the west.

Most velocity events, regardless of season, were less than one day in duration in either alongshore direction. Longer durations were observed in summer, with a higher number of multiple day flow events. Velocity events, greater than ±25 >$cm \cdot s^{-1}$, were usually only a few hours in duration, and were more common in the western regions.

Regardless of season there were larger maximum event displacements, in both alongshore directions, in the western regions. Summer maximum event displacements and greater for eastward displacements.

STUDY PRODUCT: Dinnel, S.P., Wm, J. Wiseman, Jr., and L.J. Rouse, Jr. 1996. Coastal currents in the northern Gulf of Mexico. OCS Study MMS 97-0005. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, La. 124 pp.

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