ACCESS NUMBER: 30724

STUDY TITLE: Drifter Study in the Mississippi River Plume

REPORT TITLE: Velocity and Transport Characteristics of the Louisiana-Texas Coastal Current during 1994

CONTRACT NUMBER: 14-35-0001-30724

SPONSORING OCS REGION: Gulf of Mexico

APPLICATION PLANNING AREA: Western Gulf of Mexico

FISCAL YEARSS OF PROJECT FUNDING: 1993/94; 1994/95; 1995/96; 1996/97; 1997/98;1998/99

COMPLETION DATA OF REPORT: November 2001

COSTSS: FY1993; $68,335: FY1994; $34,316: FY1995; $60,535: FY 1996; $46,881: FY1997; $67,168: FY1998; $22,723: CUMMULATIVE: $299,958

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KEY WORDS: coastal current, velocity, Gulf of Mexico, drifters

BACKGROUND: The Gulf of Mexico is a semi-closed marine basin with major inflow and outflow openings in its southeastern corner. On its northern rim, it has a broad shallow shelf dominated by North American continental drainage, including the Mississippi and Atchafalaya River distributaries and an array of smaller drainages, all-discharging fresh water and sediment. The Atchafalaya–Mississippi River outflow produces buoyant, turbid plumes, which have been observed to respond to winds, impinging Loop Current rings, and high level runoff events. While a considerable but yet undetermined proportion of the Mississippi River effluent is directed offshore, studies of satellite imagery consistently show the Atchafalaya discharge is a dominant source of the major extended plume of low salinity and high turbidity that stretches from the central Louisiana coast, westward along the Texas coast and southward even at times to the U.S.-Mexican border. Initial results from the first two cruises of the Mississippi River-Atchafalaya Plume Study (sponsored by MMS, Contract No. 14-35-0001-30632) brought into sharp detail the intense temporal and spatial variability of the coastal current emanating from the Atchafalaya discharge into the shallow inner shelf off central Louisiana. It also appeared that plume water was rapidly advected by the

shifting wind field along the cruise track. Satellite images and previous drifter studies suggest the intermittent presence of a meandering, at times highly convoluted, baroclinic coastal jet.

OBJECTIVES: Objectives of this study were (1) to describe day-to-day changes in horizontal velocity components and hydrography (salinity) along four sections across and along the coastal current; (2) to estimate the average tidal currents in the region; (3) to determine whether weak to moderate summer winds can induce near inertial oscillations in the upper layer of the water column; and (4) to describe the variability of the low frequency flow and determine what mechanisms drive the low frequency current on this portion of the Louisiana-Texas shelf.

DESCRIPTION: Our understanding of the motions of various frequencies on the Louisiana-Texas shelf has improved greatly with recent studies. However, knowledge of the behavior of these motions in different locations and seasons remains decidedly lacking. This report focuses on the description of summer flow regime on the portion of the Atchafalaya River discharge into the eastward flowing Louisiana-Texas current. This description is based on a data set from the Louisiana Coastal Current Summer Flow Regime project (LOCCOSUM) that was designed to provide a more detailed characterization of the variability of currents and hydrography in the summer season. To determine the transport of the Louisiana-Texas coastal current (LTCC) and its temporal and cross-shore variability, a mooring line extending 80 km offshore was deployed on the cross-shore transect near Cameron, LA. In addition to current meter data, pressure, salinity, wind, and Atchafalaya River discharge were analyzed to better understand the variability of the LTCC. Based on availability and quality of the data, two regimes (summer upcoast flow and downcoast winter) were selected for detailed studies.

SIGNIFICANT CONCLUSIONS: Our data support the simple frictional balance model and show that a relation between the summer and winter transport fluctuations and the alongshore wind stress is reasonably linear. However, for the summer observation period, the fluctuations are not terminated when the wind stress is zero. Such behavior suggests that the remaining fluctuations are caused by other forcing mechanisms, for instance, barotropic and/or baroclinic pressure gradients. Results from the model, which assumes that currents are wind driven, confirm that the alongshore wind stress is a dominant driving force of the LTCC in the downcoast flow regime. In the upcoast flow regime, this wind stress is also an important driving force; however, other forcing mechanisms such as barotropic and/or baroclinic pressure gradients should not be neglected. Finally, the limited data from the salinity sensors deployed on the current meter moorings suggest that the cross-shore array remained in the coastal plume throughout both the summer and winter observational intervals.

STUDY RESULTS: Energy spectra of the near surface currents showed expected semidiurnal and diurnal peaks associated with tidal and inertial motions for both summer and winter flow regimes. A broad range of energetic motion was also observed in the subtidal/weather frequency band during the winter regime. Summer spectra of

the near surface currents in the subtidal band may be described as “red,” i.e., the energy increases with decreasing frequencies. For both regimes, the energy in this frequency band was also clearly polarized in the alongshore direction. In winter, cross-spectra show high coherence of the currents through the water column that do suggest their barotropic response to the driving force. In summer high coherence of currents in the vertical was not observed. Transport computations show that in the winter season, the mean transport of the LTCC is of –60,774.2 m^3/s and 19,799 m^3/s in summer. In both seasons the transport is characterized by high synoptic scale variability. Data also show that in the summer flow upcoast regime, the decorrelation time scale is greater than the downcoast flow regime with values of 80-290 hours and 40 to 80 hours, respectively. For both regimes, the decorrelation times of the cross-shore component are shorter than those of the alongshore, with values of 20-60 and 50-90 hours, respectively.

STUDY PRODUCTS: Murray, S.P., E. Jarosz and E.T. Weeks, III. 2001. Velocity and transport characteristics of the Louisiana-Texas coastal current during 1994. OCS Study MMS 2001-093. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA 106 pp.

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