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STUDY TITLE: Mississippi River Plume Hydrography Study (LATEX-B)

REPORT TITLE: An Observational Study of the Mississippi-Atchafalaya Coastal Plume: Final Report

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BACKGROUND: Satellite images show the presence of a longshore coherent plume-like structure that originates near the Mississippi River mouth that is augmented by the outflow of the Atchafalaya River, and then extends westward at least as far at Galveston, Texas. These plumes are highly influenced by the local winds and often are injected onto the outer shelf. The contribution of these plumes from the major passes of the modern Mississippi River delta to the extended low salinity and turbid plume that characteristically dominates the coastal waters along central and western Louisiana and the northern Texas coast appeared to be intermittent and was little understood when this study began. A total of six intensive research cruises, five in the coastal plume and one in the near field regions of the Mississippi River outflow, have provided

comprehensive information on the fundamental aspects of the velocity structure and volume and sediment flux in the Mississippi-Atchafalaya plume.

OBJECTIVES: (1) To conduct five cruises to characterize the velocity and salinity-temperature-density structure of the coastal plume, from west of the mouth of the Mississippi River to the south Texas coast. (2) To characterize the link between the dynamics of the coastal plume and its chemistry and biology, specifically nutrients, phytoplankton, zooplankton, ichthyology, pollutant chemistry, and suspended sediments. (3) To provide an historical analysis of the satellite imagery of the plume. (4) To conduct one cruise specific to the near-field plume of the Mississippi River mouth, investigating the same characteristics as the ones mentioned above.

DESCRIPTION: The study area for the five coastal plume cruises extended from 90^0 30' W off Terrebonne Bay, LA, west to 97^0, Corpus Christi, TX, to an average of 50 meter depth. The near-field plume cruise was confined to the area around the mouth of the Mississippi River. The 6 cruises, each of 6-to-7-days, made over 100 CTD observations on each cruise and utilized underway thermosalinography and ADCP data.

Biological data, including light transmissivity and nutrients, were collected from 281 stations. Surface waters were sampled for chlorophyll a concentrations. The entire size range of phytoplankton in the northern Gulf of Mexico was identified and enumerated for the first time. The zooplankton community that characterizes the mid-to-outer shelf was identified. Hypoxia studies were conducted. For the first time, a detailed examination of pollutant identification and distribution was conducted.

SIGNIFICANT CONCLUSIONS: The five coastal plume cruises show that two distinct regimes--downcoast (fall-winter-spring) and upcoast (summer) are present in the coastal plume. Results provide convincing evidence that during the downcoast regime major fluctuations of 2-to-7-day time scales and 20-to-60- cm/sec range are directly wind driven. This is not the case during the summer regime. Also, for the first time, we simultaneously observed flux and behavior of chemical pollutants, delineated the relationships between indigenous phytoplankton and zooplankton assemblages and the physical characteristics of the plume itself.

STUDY RESULTS: During the three downcoast regime cruises (spring-summer-fall), we used an integral from of the longshore momentum balance to show that a reasonably linear relationship exists between transport of the coastal plume at each section and the local wind stress. At zero wind stress the transport per unit area is not significantly different from zero, suggesting the lack of importance of buoyancy forcing the coastal plume. Similar analysis for the two summer upcoast observations indicates an entirely different result, i.e., the section transports are quite unrelated to local wind stress. In the near-field plume study, based on data from two wind regimes--northeasterly and southeasterly, it appears that a significant portion of the discharge of the Mississippi River does contribute directly to the coastal plume.

We also employed multiple and partial coherence analyses on three inshore current meters from the LATEX A array to represent the plume response in western Louisiana, central Texas, and south Texas. These analyses showed that during the fall-winter-spring downcoast regime, current fluctuations are, in all three regions, controlled by the alongshore wind stress and, secondarily, off central Texas by the longshore surface slope. During the summer upcoast flow regime the forcing of the fluctuations observed in the current in south Texas is less clear but significantly associated with the longshore surface slope and the wind stress components at various frequencies. However, variance in the currents in central Texas and central Louisiana in summer is highly coherent with sea level gradients. It appears likely that the strong southeasterly winds characteristic of south Texas in summer elevate the water level in the Texas coastal bend, which provides an eastward pressure gradient to drive fluctuations in the upcoast flow off central and east Texas and the Louisiana coast. Because these analyses identify wind forcing as a primary driving force, we simulated the observed variability in the current with a simple model of the along-plume momentum balance. Results provide convincing evidence that the major fluctuations of 2-to-7-day time scales and 20-to-60 cm/sec range are directly wind driven.

Satellite imagery shows that fronts are a major feature in temperature-salinity distribution. Imagery also shows that the size and morphology of the Atchafalaya and Mississippi River sediment plumes are controlled primarily by river discharge and wind direction and speed. Both plumes can change rapidly with major wind direction shifts.

In the biological characterization studies, several conclusions were made. Small phytoplankton, primarily cyanobacteria dominate numerically. Data suggest that the coastal plume ecosystem, with very high nutrient inputs and high production, is also highly dependent on regenerative processes typical when small phytoplankton dominate. Three types of cyanobacteria were identified for the first time, with their distribution related to variations in salinity. The hypoxia study suggests that the effects of horizontal diffusion and mixing are a less significant source of organic loading in the sampling region than vertical mixing. Spatial distribution of pollutants showed that the Atchafalaya Bay area is the most impacted by pollutants entering the system. Mass transport of pollutants was primarily in the dissolved phase; however, particulate matter and bedded sediments remain a repository for persistent pollutants, and detection indicates continued transport from riverine sources. Herbicides appear to be a major pollutant at all times and locations. It appears that the presence of a colloidal microparticulate phase may be an important contributor to the system by competing with particles for bound trace elements, thus facilitating transport rather than deposition of trace elements. Comparisons of cruise data with available satellite data reveal that the surface concentrations of chlorophyll a, phytoplankton, and herbicides are increased where Atchafalaya River waters flow onto the inner shelf.

STUDY PRODUCTS: Murray, S. P. 1998. An observational study of the Mississippi-Atchafalaya coastal plume: Final report. OCS Study MMS 98-0040. U. S. Department

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