ACCESS NUMBER: 12685

STUDY TITLE: A Study of Long-Term Trends in Environmental Parameters along the LA/MS OCS Using Remote Sensing Data

REPORT TITLE: Long-Term Trends in Environmental Parameters along the Louisiana/ Mississippi Outer Continental Shelf Using Remote Sensing Data

CONTRACT NUMBER: M08AX12685 (32806-39900)

SPONSORING OCS REGION: Gulf of Mexico

APPLICABLE PLANNING AREA: Northern

FISCAL YEARS OF PROJECT FUNDING: 2007; 2008; 2009; 2010

COMPLETION DATE OF REPORT: December 2012

COSTS: FY 2007: $65,207; FY2008: $66,970; FY2009: $68,465

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KEY WORDS: Northern Gulf, Outer Continental Shelf, colored dissolved organic matter, chlorophyll, Mississippi River, remote sensing, suspended particulate matter

BACKGROUND: The Mississippi River is the primary riverine source of freshwater, nutrients, organic and inorganic particulate and dissolved matter to the Louisiana-Mississippi continental shelf and to the Gulf of Mexico. The river-influenced coastal and offshore region is also of great ecological and economic importance to the region and the country. This region has been undergoing development and resource exploitation while at the same time threats due to natural (storms, hurricanes, algal blooms) and human-made hazards (oil spills, pollutant transport) are increasing. Information related to water masses and water quality indicators is important to support strategies for response, recovery, mitigation and coastal restoration. Satellite remote sensing makes it possible to conduct surveillance on large areas of the ocean for natural conditions and changes related to human activities. Plankton biomass, chlorophyll concentrations, colored dissolved organic matter (CDOM), and other ocean color products are used in various ways to describe the water quality conditions and their positive or negative trends. In the river-dominated areas, such as coastal Louisiana, the use of satellite imagery to track water quality parameters is complicated by the variable characteristics of the river flow. In this project, standard NASA algorithms and regionally-developed

interpretations of remote sensing data will be used to improve understanding and use of NASA ocean color satellite data.

OBJECTIVES: (1) to assess standard NASA ocean color algorithms for the localized region; (2) evaluate the performance of a regional ocean color CDOM algorithm; (3) analyze long-term time series ocean color data for variability and trends; and (4) examine ocean color imagery in response to storms and hurricanes.

DESCRIPTION: The study area located in the Gulf of Mexico extends from 27-30.5° N latitude, 88.2-95.5° W longitude and includes coastal and OCS waters of the states of Louisiana, Mississippi, and part of Texas. Field data processed and analyzed as part of this study were obtained during various cruises along the Louisiana coast that include field absorption measurements of CDOM and other constituents such as phytoplankton and non-algal particles. Satellite remote sensing data used in this study include mainly ocean color data from SeaWiFS satellite sensor. SeaWiFS Level L1A data was downloaded from NASA DAAC and processed using a regional CDOM algorithm. SeaWiFS estimates of chlorophyll concentrations were obtained using the standard OC4 algorithm. Level 1A SeaWiFS data for the northern Gulf of Mexico between years 1998 to 2007 were downloaded from NASA DAAC and processed to Level 2 Chl product at 2 km resolution for the study region. NASA default coefficients and the standard atmospheric correction algorithm along with the standard OC4 algorithm were used to generate the Level 2 Chl which were then composited into 15-day, monthly or seasonal means to generate the time series data used in this study. Wavelet transform were applied to 15-day composite image data along bathymetric contour lines to examine long-term trends in their variability.

SIGNIFICANT CONCLUSIONS: In this study we examined the spatial and temporal variation of CDOM absorption properties and chlorophyll concentrations along the Louisiana coast and the northern Gulf of Mexico shelf waters. CDOM optical properties were found to be strongly influenced by riverine discharge. Additional factors, such as photobleaching and in situ biological production, also influenced the CDOM absorption properties. The application of wavelet analysis to the time series SeaWiFS data revealed different scales of variability along the Louisiana coast, a region that is strongly influenced by the discharge from the Atchafalaya and Mississippi Rivers. The seasonal river discharge appears to strongly influence the timing of the peak variance in waters that are directly influenced by the two rivers. The use of monthly QuikSCAT derived wind stress vectors superimposed on monthly Chl maps provided some insights into the Chl variance determined by wavelet analysis. Away from the river influence the interannual peaks in Chl variance were weak with strongest wavelet power peak associated with hurricane activity in 2005.

STUDY RESULTS: Optical properties of CDOM indicated strong seasonal river influences and an inverse relationship between CDOM absorption and salinity; this suggests conservative mixing in the water column between the riverine freshwater sources and the oceanic end members. Seasonal changes in CDOM absorption were also attributed to sources (algal biomass) and sinks (photo-bleaching) of CDOM. Field measurements indicated high correlations between field and satellite estimates of CDOM and salinity fields. Estimates of seasonal distribution of CDOM obtained from

SeaWiFS satellite data indicated highest levels of CDOM in the nearshore waters during the winter; these levels gradually decreased in spring, summer, and fall, potentially associated with a contraction of the nearshore region of freshwater influence. The seasonal impact of storms and hurricanes on CDOM distribution were studied using SeaWiFS CDOM imagery obtained before and after Hurricane Rita made landfall near the Texas-Louisiana border. A comparison of the CDOM imagery indicated a decrease in CDOM and an increase in salinity of the nearshore waters; this suggests an intrusion of marine waters due to Hurricane Rita.

A 10-year record of SeaWiFS Chl estimates was used to examine Chl variability occurring at different temporal scales at different locations in the study area using wavelet analysis. Wavelet analysis, in combination with QuikSCAT satellite derived monthly wind stress vectors superimposed on SeaWiFS Chl, further revealed physical linkages to the Chl variability in the nearshore and offshore waters influenced by the Mississippi and Atchafalaya Rivers. Chl variability west of the Mississippi River delta was generally related to the seasonal variability in peaks of river discharge. However, the strongest peak of wavelet power at the 20 m isobaths occurred in February 2004 and was related to a winter peak in river discharge and southerly wind stress over the region. At the 20 m isobaths off the Atchafalaya River similar seasonal peaks in wavelet power spectra were observed that appeared reduced in comparison to those off the Mississippi River. West of the Atchafalaya River delta, the impact of Hurricane Rita on the Chl variability was revealed.

STUDY PRODUCT: D'Sa, E.J. 2012. Long-term trends in environmental parameters along the Louisiana-Mississippi Outer Continental Shelf using remote sensing data. A final report for the U.S. Dept of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2012-071. 36 pp.