P1.16 RECENT MONITORING OF SUSPENDED SEDIMENT PATTERNS ALONG LOUISIANA'S COASTAL ZONE USING ER-2 BASED MAS DATA AND TERRA BASED MODIS DATA.

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1. INTRODUCTION

The University of Wisconsin and Louisiana State University have teamed to study the forcing of winter season cold frontal wind systems on sediment distribution patterns and geomorphology in the Louisiana coastal zone. Wind systems associated with cold fronts have been shown to modify coastal circulation and resuspend sediments along the micro tidal Louisiana coast (Roberts et al. 1987, Moeller et al. 1993). Remote sensing data is being used to map and track sediment distribution patterns for various wind conditions. Suspended sediment is a building material for coastal progradation and wetlands renewal, but also restricts access to marine nursery environments and impacts oyster bed health. Transferring a suspended sediment concentration (SSC) algorithm to EOS MODerate resolution Imaging Spectroradiometer (MODIS; Barnes et al. 1998) observations may enable estimates of SSC globally.

MODIS is a recent (spring, 2000) advance in global monitoring capability with its 36 VNIR-LWIR spectral bands and 250m–1000m spatial resolution. MODIS has distinct improved capability over heritage instruments (e.g. AVHRR, CZCS) for coastal monitoring. It contains two 250m resolution bands at 650nm and 860nm (2300 km swath), allowing daily monitoring of coastal sediment patterns from its sun synchronous orbit on the Terra platform (1030 LT overpass). MODIS was designed for assessing global change. Careful attention was given to radiometric calibration accuracy. MODIS has reflectance and radiance onboard sources to assure consistent spatial, spectral and radiometric characterization of global data sets. The multispectral complement of MODIS allows assessment of various atmospheric (e.g. aerosol content, cloud detection, moisture) and surface properties (e,g., land cover, SST vegetation, fluorescence) from the same platform.

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In spring, 2001 a NASA high altitude (20 km) ER-2 aircraft carrying the MODIS Airborne Simulator (MAS; King et al. 1996) flew missions over coastal Louisiana to monitor suspended sediment patterns in the Atchafalaya Bay region (Figure 1). The Atchafalaya Bay is a sediment rich estuary, especially in spring when snowmelt and spring rains annually swell the Atchafalaya River discharge into the bay. Sediment is distributed by micro tidal influences and wind driven currents in the nearshore zone, accumulating on the shallow subaqueous bottom or remaining in suspension over long distances in the prevailing currents. MAS 50m resolution (38 km swath) and MODIS 250m resolution VNIR data document the sediment patterns in existing wind conditions. Additional MODIS data sets document sediment patterns on other days, providing a resource of information on the response of sediment patterns to various wind forcing conditions.

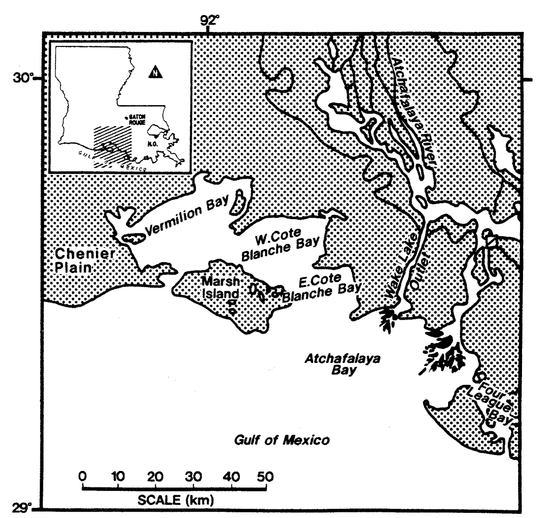

Figure 1. Louisiana coast study region. The Atchafalaya River, a distributary of the Mississippi River, flows into Atchafalaya Bay, carrying about 30% of the Mississippi River volume. New deltas are forming at the mouth of the Atchafalaya River and Wax Lake outlet.

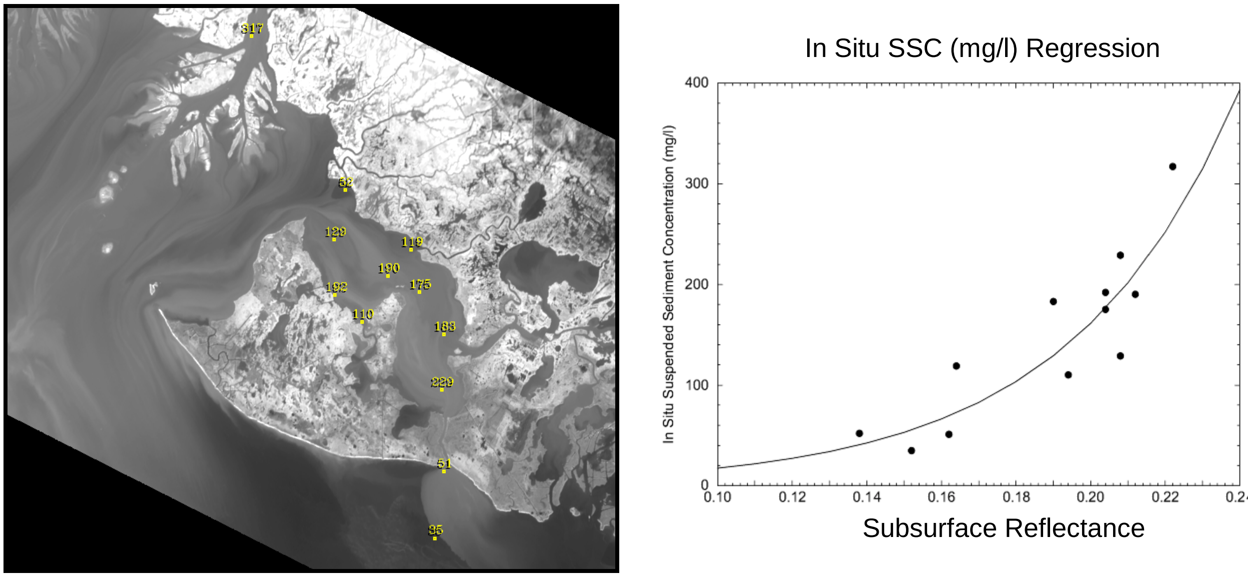

Figure 2. MAS 50m resolution near infrared (750 nm) image (left) of Atchafalaya Bay region on March 21, 2001 with in situ SSC (mg/l) data plotted at sampling locations. Atmospherically corrected MAS 660 nm reflectance is plotted against in situ SSC to define an SSC regression (right). RMS of the fit shown is 36 mg/l.

2. DATA COLLECTION

The ER-2 flew over the Atchafalaya Bay region of the Louisiana coast in spring 2001 during the Terra eXperiment – 2001 (TX-2001). On March 21, 36 hours after a cold front passage, the ER-2 flew multiple overpasses of the Atchafalaya Bay region of the central Louisiana coast while a boat team from LSU collected in situ water samples and the Terra satellite (with MODIS) passed overhead (1654 UTC). The boat team measurements included suspended sediment concentration (SSC, Figure 2), bulk temperature, salinity, secchi depth, and VNIR radiometer measurements of the upwelling reflectance out of the water column. The MAS data depicting the post-frontal conditions has been coupled with the in situ suspended sediment samples to produce an SSC estimation algorithm (Figure 2). This relationship will be transferred to co-registered MODIS 250m resolution observations for application to other days and coastal sites. The multiple MAS scenes of the Atchafalaya Bay region will be animated to derive water motion vectors, which when coupled with SSC estimates provide a sediment transport snapshot for the March 21 flight day.

Since first light (Feb, 2000), MODIS 250m resolution data has been collected on a routine basis for clear sky overpasses of the Louisiana coast. While many images are contaminated by cloud cover, clear sky cases are found throughout the annual cycle. Until the SSC estimation algorithm is transferred to MODIS data, these MODIS images can be used to provide a qualitative high-resolution (250m) snapshot of sediment patterns in response to prevailing wind conditions. Once incorporated, the SSC algorithm will benefit from the well-calibrated nature of MODIS data to extend SSC estimates to the global domain on a daily basis. This will be a valuable resource for extending analysis tools and findings to estuaries and deltas around the world.

3. SEDIMENT PATTERN OBSERVATIONS

As cold front systems approach and move downstream through the Gulf Coast of Louisiana, the coastal zone experiences pre-frontal southerly (blowing onshore) winds followed by a switch to northerlies after frontal passage. During each cycle of this wind pattern, sediment resuspension and transport results (Walker et al. 1997; Walker and Hammack, 2000). Offshore transport in the post-frontal phase exposes suspended sediment to longshore currents, resulting in downdrift transport. In the micro tidal Gulf coast, these winds have an important influence on existing water levels and circulation (Moeller et al. 1996).

The two 250m resolution reflectance bands (650 nm and 860 nm) are providing new

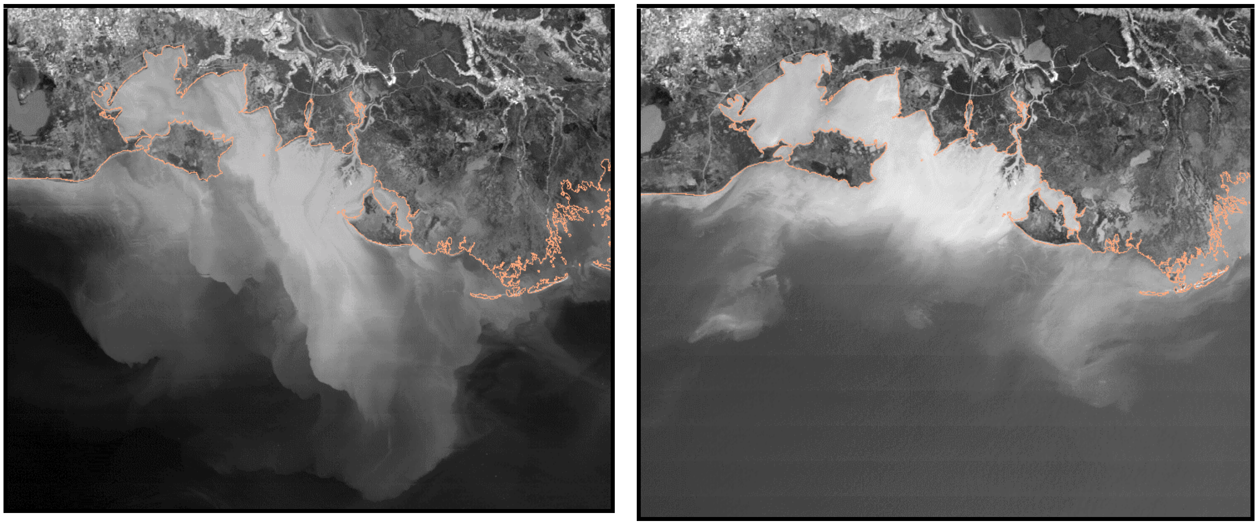

Figure 3. MODIS 250m resolution band 1 (650 nm) imagery on March 21 (left) and March 26, 2001 (right). The sediment plume from the Atchafalaya Bay (center of each image) is extended to the south and east on March 21, in keeping with the low level wind flow from the northwest. On March 26, winds had turned from the northeast pushing the sediment plume towards the southwest.

monitoring capability and insight on the spatial variability and temporal change of sediment distribution in the coastal zone. Figure 3 shows examples of sediment plume behavior on March 21 and 26, 2001. Surface wind energy (Figure 4) was primarily from the northwest on March 21, driving down water level in the Atchafalaya Bay and pushing the sediment plume out onto the inner continental shelf. This is contrasted to March 26, when wind energy was dominant from the northeast resulting in the sediment plume orienting towards the west-southwest, the prevailing direction of longshore currents off the Louisiana coast. The sediment plume areal coverage on March 21 is roughly 25–50% larger than on March 26. It is believed that sediment resuspension is an important contributing process to the sediment plume. Walker and Hammack (2000) have estimated that resuspension is contributing 75-80% of the material in the sediment plume during vigorous cold front events.

The variation of wind energy on a year to year basis, as a signature of short term climate variation, is expected to influence sediment transport from year to year. Variations of wind energy in the Louisiana coastal region may be influenced by El Nino (and La Nina) events. This is a topic of further investigation. Relationships between tropical and extra-tropical climate suggest mechanisms by which global climate change may influence sediment distribution along the Louisiana coast, and provide insight on future sediment transport behavior based on climate change predictions.

4. SUMMARY AND FUTURE WORK

Remote sensing provides an opportunity to monitor coastal zones on a regular basis. The advent of MODIS on Terra has enhanced the capability with high resolution (250m) daily coverage of the globe. Transfer of a suspended sediment concentration estimation algorithm from the ER-2 borne MAS instrument to MODIS observations would create a quantitative measure of sediment conditions, facilitating detection of short or long term change.

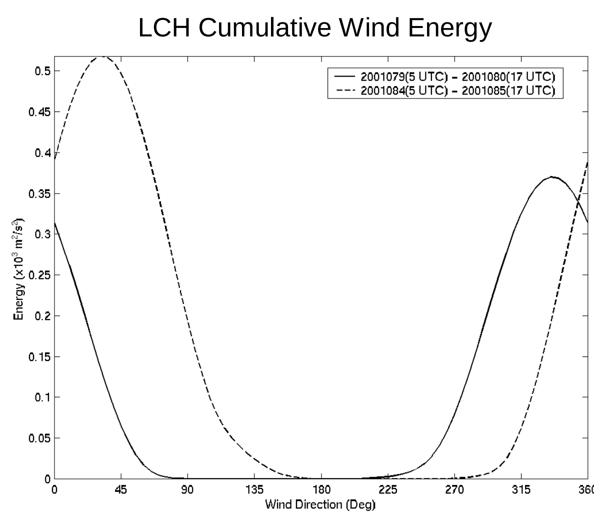

Figure 4. Lake Charles, LA cumulative surface wind energy for 36 hours leading up to MODIS imagery on March 21 (solid) and March 26 (dash), 2001 (see Figure 3 for imagery). Winds from northwest dominated on March 21, while northeast winds were prevalent on March 26.

Data collected during the spring 2001 TX-2001 field campaign show evidence of local wind influence on the sediment patterns along Louisiana's turbid central Gulf coast. In situ water sample measurements are being used to develop suspended sediment concentration estimation coefficients to quantify suspended material and transport (through animating co-registered imagery). MAS imagery will be atmospherically corrected for this procedure. The MAS SSC estimates will be co-located with MODIS data for transfer of the algorithm to MODIS. MODIS SSC estimates will be compared to new in situ measurements collected in 2002 for testing the algorithm.

The physical characteristics (particle size, shape, content) of sediments in the Atchafalaya Bay region will be used in a forward model to estimate water-leaving reflectance. This investigation will be used to gain insight on the sensitivity of water-leaving reflectance to the evolving characteristics of suspended sediment. It is expected to provide insight on the sediment characteristics of river effluents around the world, a step towards expanding the MODIS sediment estimation capability to the global domain.

MODIS data sets will continue to be collected in clear sky conditions for monitoring sediment plume behavior in the context of wind conditions along the Louisiana coast. The influence of wind will be evaluated on a seasonal basis for insight on response of sediment transport to short term climate variability.

5. REFERENCES

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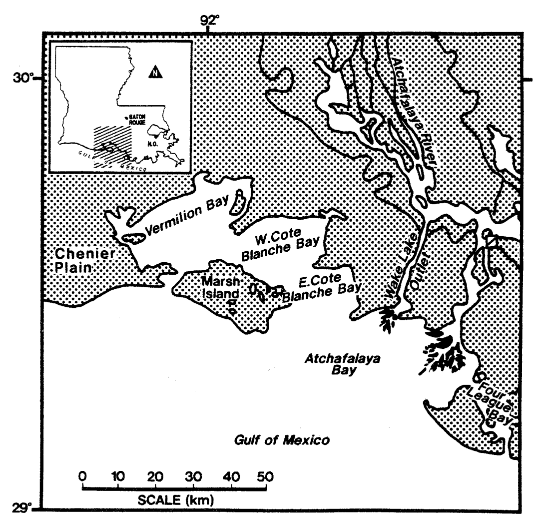

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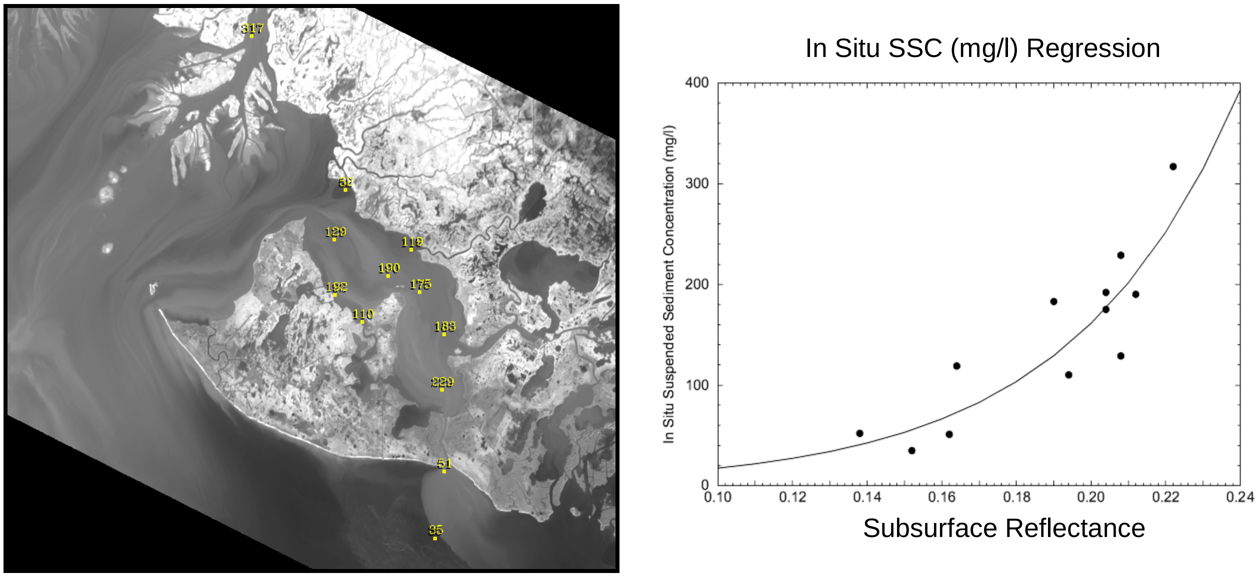

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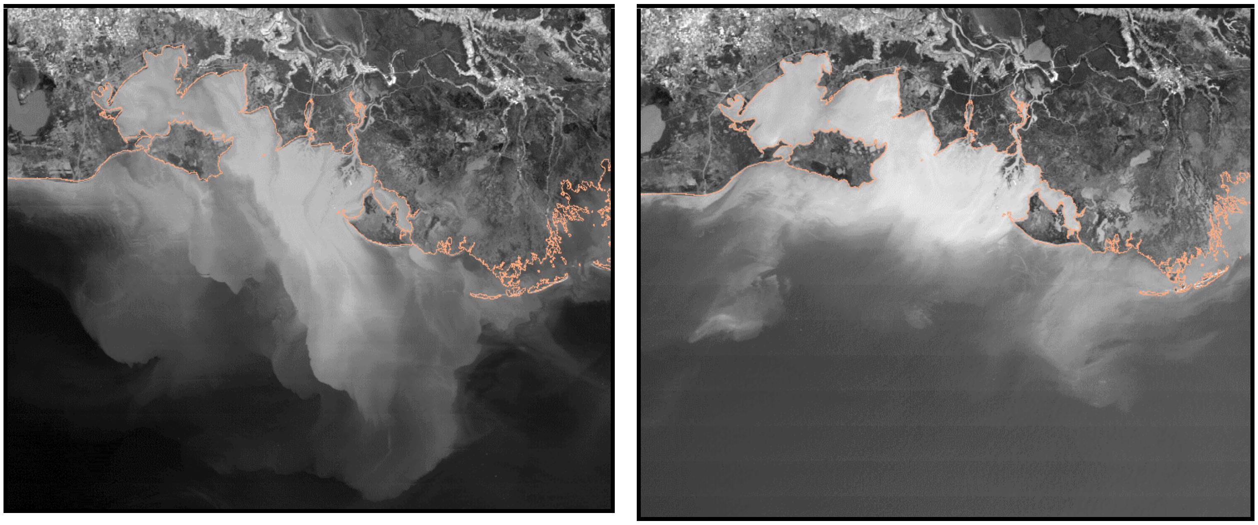

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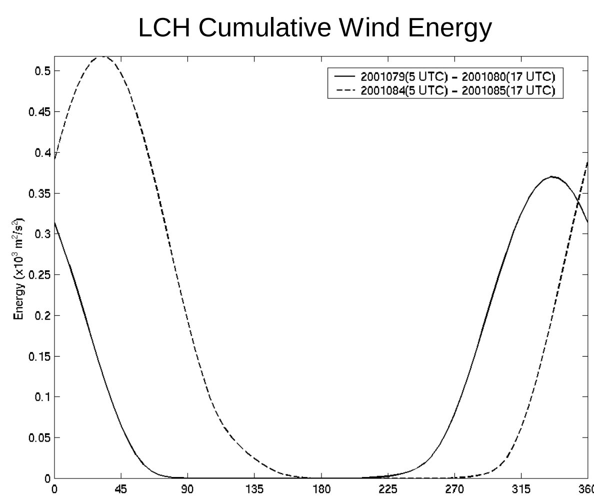

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