Multivariate analysis of the influences of oceanic and meteorological processes on suspended particulate matter distributions in Mississippi coastal water

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Abstract

The Mississippi Sound is influenced by a high volume of sediment discharge from the Biloxi River, Mobile Bay via Pass a l'Heron, Pass a l'Heron, Pearl River, Wolf River, and Lake Pontchartrain through the Rigolets. The river discharge, variable wind, wave direction and tide have a significant impact on the turbidity and transport of sediments in the Sound. Level 1 Moderate Resolution Imaging Spectroradiometer (MODIS) data is processed to extract the remote sensing reflectance at the wavelength of 645 nm and binned into an 8-day composite at a resolution of 500 m. The study uses a regional ocean color algorithm to compute suspended particulate matter (SPM) concentration based on these 8-day composite images. Multivariate analysis is applied between the SPM and time-series of tides, wind, turbidity and river discharge measured at federal and academic institutions’ stations and moorings. The multivariate analysis also includes in situ measurements of suspended sediment concentration and advective exchanges through the Mississippi Sound’s tidal inlets between the coastal shelf and the nearshore estuarine waters. Mechanisms underlying the observed spatiotemporal distribution of SPM, including material exchange between the Sound and adjacent shelf waters, will be explored. The results of this study will contribute to current understanding of exchange mechanisms and pathways with the Mississippi Bight via the Mississippi Sound’s tidal inlets.

Data Sources

Data was collected during summer and fall 2015 at Ship Island, Mississippi and Dauphin Island, Alabama. Particle size distribution was measured with a LISST particle size analyzer. This sensor measures light diffracted by particles to determine the size distribution of particles in the water column. Suspended particulate matter concentration was measured at some stations by filtering water samples into pre-combusted and preshrunk 1.3 cm Whatman GF/F filters. Filters were dried at 105 °C to a constant mass and weighed to estimate the concentration of SPM. Filters were flushed with nanopore water after filtering to prevent the accumulation of salt in the filter’s pore spaces (Zhao, 2011).

Figure 1. a) Location map of study region highlighted in red.

Figure 2. a) Water level at Dauphin Island for the period August to November 2015.

Figure 3. b) Concentration of SPM was estimated for the period corresponding to the sampling at Main Pass (10/24/2015 - 10/12/2015) using an algorithm developed by Zhao et al. (2011). Increased SPM concentrations observed at Main Pass and the tidal passes indicates an increase in estuarine outflow associated with increased precipitation between 10/25 - 10/27/2015. The SPM distribution is strongly affected by Hurricane Patricia’s weather system. The scenario is that waters were driven downshore (Figure 2a), then floodwater with particulate loads emptied out of estuaries onto the MS Bight. This is evident in the plans that appear in the SPM distribution.

Figure 4. a) Location of USGS (river discharge), NOAA PORTS (current speed), Mobile Bay National Estuary Program (turbidity), National Data Buoy Center (wind) and NOAA NOS (water level) sensors. b) and c) 2012 time series of the sensors listed above.

Figure 5. a) The correlation between SPM and the Alabama River discharge was not significant. It takes approximately 5 to 10 days for Alabama/Tombigbee River water to exit through Pass a l’Herons.

Figure 6. a) The correlation between SPM and the Rahmelitic Bay discharge was similar to SPM/ Alabama River correlation.

Figure 7. a) Wind was expected to have a more significant effect on SPM. The depth of Pass a l’Herons is less than 3 m. As a specific threshold wind speed the sediments will be suspended due to the shallow bathymetry. An increase in wind speed beyond this threshold will not result in an increase in the concentration of suspended sediments.

Conclusion

Initial results suggest the following:

• Changes in the grain size distribution with depth are associated with the salinity gradient.
• Cold fronts and tropical systems can flush fresher estuarine waters onto the MS Bight, leading to pronounced patchiness in SPM.
• The high SPM and water level correlation may be the result of the 7 day spring/ neap tidal cycle. The difference between high and low water is maximized at spring tide. The convoluted nature of Pass a l’Herons results in the velocity of the water exiting Mobile Bay during okh tide via Pass a l’Herons to increase. The concentration of SPM is directly proportional to the velocity of the exiting water mass.

Future Work

In situ data (LISST and water samples) will be collected in MS Sound in spring and summer.

• Mid depth water samples will be collected to measure grain size distribution and suspended sediment concentration.
• Calculate the cross-correlation for a region located in central Mobile Bay. Analyze higher frequency data (i.e. turbidity) instead of 8-day binned SPM.
• Compute cross-correlation at different lag times.
• Compute a multiple linear regression for turbidity / SPM using a longer time series.

References


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