Rapid Prototyping of VIIRS Ocean Color Data for Coastal Management Applications in the Gulf of Mexico

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PROJECT OVERVIEW

Less that 25% of the land area in the United States is classified as coastal watershed. However, these areas support nearly half of U.S. jobs and generate a significant proportion of the gross domestic product. Coastal areas are very sensitive to environmental damage and their economies are coupled tightly to coastal ecological health. Coastal managers and other policy-makers use many sources of information in their short- and long-term planning. For some time now, remote-sensing data, primarily satellite weather data, have become invaluable in the management of coastal environments.

More recently, ocean color data provided by the Coastal Zone Color Scanner (CZCS), Sea-Viewing Wide Field of View Sensor (SeaWiFS) and the Moderate Resolution Imaging Spectroradiometer (MODIS) have been used to infer biogeochemical parameters in surface waters. From detection of harmful algal blooms (HABs) to hypoxia and fisheries research, and studies of the global carbon budget, the importance of ocean color measurements is well-recognized. The continuity of these measurements will be provided by a new sensor generation – the Visible Infrared Imager Radiometer Suite (VIIRS). VIIRS will be carried onboard the joint NASA-DOD-NOAA NPOESS (National Polar-orbiting Operational Environmental Satellite System) Preparatory Project. Because, in the spectral bands used to generate Ocean Color Products, the VIIRS instruments will have different spatial resolutions than the current MODIS instruments, 800 m versus 1000 m at nadir, scientists need to know how the change in resolution will affect oceanographic and coastal studies. By analyzing simulated VIIRS measurements, this question may be answered before the VIIRS instruments are deployed in orbit. Using simulated VIIRS products, NOAA, DOD and other operational agencies can then modify their decision support systems appropriately in preparation for receipt of actual VIIRS data.

This study involves simulations, modeling, sensitivity analyses and validation and verification using field and remote sensing data to evaluate the potential use of VIIRS ocean color data in coastal applications in the Northern Gulf of Mexico. The component products necessary for HABs detection and prediction will be evaluated. What are the theoretical limitations of VIIRS for remote measurements of Chl, CDOM, TSM, and salinity in coastal waters of Mississippi and Alabama? More specifically, 1) How will errors in the measurement of remotely-sensed radiance in ocean-color bands propagate in algorithm outputs? 2) What is the theoretical accuracy of the geophysical algorithms applied to VIIRS? 3) How accurate are these algorithms when they are applied to real ocean color data?

Question 1 will be answered with a series of rigorous sensitivity analyses that involve the creation of simulated VIIRS data, creation of a VIIRS analytical tool, simulations and radiative transfer modeling. Question 2 will be addressed using a combination of radiative transfer modeling and field data, and Question 3 will be addressed with a combination of field work, laboratory analyses and remote sensing imagery.

The outcomes of this study will be a quantification of the uncertainties associated with VIIRS data-products relevant to HABs detection and an established analytical tool for prototyping the application of VIIRS data for any coastal application, including hypoxia modeling, long-term studies on carbon transport by river plumes, sediment re-suspension studies and fisheries research, to name a few. Results of the study will include:

- Simulated VIIRS imagery of the Mississippi Sound
- A VIIRS analytical tool. The tool will be installed at the NASA Stennis Space Center Rapid Prototyping Laboratory.
- Sensitivity analysis documenting how errors in simulated VIIRS water-leaving radiance will propagate through regional algorithms.
- Analysis of the theoretical limitations of regional algorithms.
- Validation of algorithms using field data and satellite imagery from MODIS and SeaWiFS.
VIIRS ANALYTICAL TOOL
VIIRS simulated data will be used to develop a GUI-based analytical tool in the IDL programming environment. IDL was chosen for several practical reasons. It is one of the most powerful languages used for image analysis and is the base language of SEADAS, the software used by NASA to process imagery from SeaWiFS and MODIS ocean color sensors. Therefore, our analytical tool could be incorporated into SEADAS. Figure 1 shows hypothetical components of the VIIRS analytical tool.

The detection of HABs using ocean color remote sensing is difficult for the waters of the Northern Gulf. This is true particularly for Case II turbid waters, such as those of Mississippi Sound, where HABs typically include numerous phytoplankton species. The spectral signatures of harmful and non-harmful algae are very similar, and the spectral resolutions of current and planned sensors cannot resolve them. Moreover, the complexity of coastal environments often confounds the application of remote sensing. Therefore, approaches for HABs detection may involve multiple ocean color data products and models. The practical consequence to the rapid prototyping of VIIRS for HABs detection is that one should focus on the accuracy of data products used in various HABs detection methods, not on the actual capability to detect HABs. Therefore, we will focus on the following ocean-color data products: Chl, CDOM, TSM, and salinity. There are several algorithms for each of the products, including standard algorithms for chlorophyll and regional algorithms for Chl, CDOM, TSM, and salinity.

ANTICIPATED RESULTS
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Figure 1. Conceptual view of the functionalities of the VIIRS analytical tool.