# Temporal and Spatial Variations of Sea Surface Temperature and *Chlorophyll a* in Coastal Waters of North Carolina

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ABSTRACT

Environmental changes in marine ecosystem are difficult to detect with field based methods due to ubiquitous temporal and spatial variations. Satellite remote sensing has improved both temporal coverage and spatial resolution of a suite of sea surface properties including temperature and *chlorophyll a*. We have applied remote sensing data of two satellite sensors: Sea-viewing Wide Field-of-view Sensor (SeaWiFS) and Moderate Resolution Imaging Spectroradiometer (MODIS), for the study of the coastal waters of North Carolina and Virginia. Our study revealed some important temporal and spatial patterns that need further investigation and environmental management attention.

Temperature and *chlorophyll a* are two fundamental seawater properties that reflect environmental change. The distribution of temperature and *chlorophyll a* in seawater reflect both ocean circulation and environmental change. High *chlorophyll a* are indicative of polluted rivers and excessive nutrient input to the marine environment. There are four sources of nutrients; fluvial flux, atmospheric deposition, deepwater upwelling, and ground water input. In addition to nutrients, deepwater upwelling also alters surface temperature. Traditionally, both temperature and *chlorophyll a* are determined by shipboard sensors that can only provide limited temporal and spatial coverage.

Satellite remote sensing improved the temporal coverage and spatial resolution of both temperature and *chlorophyll a* determinations. After the launch and operation of environmental satellites sensors like SeaWiFS and MODIS, the spatial resolution of approximately 1 km and temporal coverage of daily frequency became available for temperature and *chlorophyll a* in most part of the world. Data from two satellite sensors: SeaWiFS and MODIS were used to study temporal and spatial variations of sea surface properties of coastal waters of North Carolina and Virginia. SeaWiFS sensor, which has been in operation for twelve years, yields sea surface *chlorophyll a* data. Aqua-MODIS, which has been in operation for seven years, yields both sea surface *chlorophyll a* and temperature. Both climatology maps and area-averaged time series data are derived for the coastal regions. Climatology maps are based on the mean of several years of satellite data, while time series are based on monthly area averages. The region of the study (34°N, 40°N, 78°W, 74°W) included Chesapeake Bay, Albemarle Sound, and part of Northeast North Atlantic Ocean. Monthly sea surface *chlorophyll a* concentration based on 12 years SeaWiFS data and sea surface temperature data based on 7 years of Aqua-MODIS data was obtained from NASA website (GIOVANNI) for this study.

Both climatology maps and time series of sea surface properties were used to evaluate environmental changes of the coastal waters of North Carolina and Virginia. Specifically,

following three patterns were derived: (1) The monthly climatology of sea surface *chlorophyll a* was calculated from monthly remote sensing data; (2) Temporal variation of area averaged *chlorophyll a* and sea surface temperature for selected regions (i.e. Albemarle Sound, Chesapeake Bay) was calculated; (3) Temporal variations of both *chlorophyll a* and sea surface temperature distribution animation were also created. Seasonal cycles of both *chlorophyll a* and sea surface temperature were observed in our study region. *Chlorophyll a* concentrations are higher along the coast than in the open ocean. Particularly interesting was a jump in the area-averaged *chlorophyll a* of Chesapeake Bay in 2003. Before 2003, *chlorophyll a* concentrations in the Chesapeake Bay were significantly lower than after 2003. These observations indicate that there were some significant environmental changes in the Chesapeake Bay before and after 2003.