Applications of MODIS fluorescent line height measurements to monitor water quality trends and algal bloom activity.

Recent advances in satellite and airborne remote sensing, such as improvements in sensor and algorithm calibrations, processing techniques and atmospheric correction procedures have provided for increased coverage of remote-sensing, ocean-color products for coastal regions. In particular, for the Moderate Resolution Imaging Spectrometer (MODIS) sensor calibration updates, improved aerosol retrievals and new aerosol models has led to improved atmospheric correction algorithms for turbid waters and have improved the retrieval of ocean color in coastal waters. This has opened the way for studying ocean phenomena and processes at finer spatial scales, such as the interactions at the land-sea interface, trends in coastal water quality and algal blooms. Human population growth and changes in coastal management practices have brought about significant changes in the concentrations of organic and inorganic, particulate and dissolved substances entering the coastal ocean. There is increasing concern that these inputs have led to declines in water quality and have increase local concentrations of phytoplankton, which cause harmful algal blooms. In two case studies we present MODIS observations of fluorescence line height (FLH) to 1) assess trends in water quality for Tampa Bay, Florida and 2) illustrate seasonal and annual variability of algal bloom activity in Monterey Bay, California as well as document estuarine/riverine plume induced red tide events. In a comprehensive analysis of long term (2003-2011) in situ monitoring data and satellite imagery from Tampa Bay we assess the validity of the MODIS FLH product against chlorophyll-a and a suite of water quality parameters taken in a variety of conditions throughout a large optically complex estuarine system. A systematic analysis of sampling sites throughout the bay is undertaken to understand how the relationship between FLH and in situ chlorophyll-a responds to varying conditions and to develop a near decadal trend in water quality changes. In situ monitoring locations that correlated well with satellite imagery were in depths greater than seven meters and were located over five kilometers from shore. Water quality parameter of total nitrogen, phosphorous, turbidity and biological oxygen demand had high correlations with these sites, as well. Satellite FLH estimates show improving water quality from 2003-2007 with a slight decline up through 2011. Dinoflagellate blooms in Monterey Bay, California (USA) have recently increased in frequency and intensity. Nine years of MODIS FLH observations are used to describe the annual and seasonal variability of bloom activity within the Bay. Three classes of MODIS algorithms were correlated against in situ chlorophyll measurements. The FLH algorithm provided the most robust estimate of bloom activity. Elevated concentrations of phytoplankton were evident during the months of August- November, a period during which increased occurrences of dinoflagellate blooms have been observed in situ. Seasonal patterns of FLH show the on- and offshore movement of areas of high phytoplankton biomass between oceanographic seasons. Higher concentrations of phytoplankton are also evident in the vicinity of the land-based nutrient sources and outflows, and the cyclonic bay-wide circulation can transport these nutrients to the northern Bay bloom incubation region. Both of these case studies illustrate the utility MODIS FLH observations in supporting management decisions in coastal and estuarine waters.

Andrew Fischer (UTAS), Max Moreno-Mardinan (NASA) and John P. Ryan (MBARI)