

# Coastal Remote Sensing: Future Applications & Collaboration

**Christopher Brown**

NOAA / NESDIS Satellite Climate Studies Branch  
University of Maryland – College Park

***Decadal Environmental Remote Sensing Science & Technology  
NESDIS & CREST Visions***

SSMC3, RM 4527, Silver Spring, Maryland, December 7-8, 2009



**NOAA-Cooperative Remote Sensing  
Science and Technology Center**

NOAA | CREST

# Presentation Outline

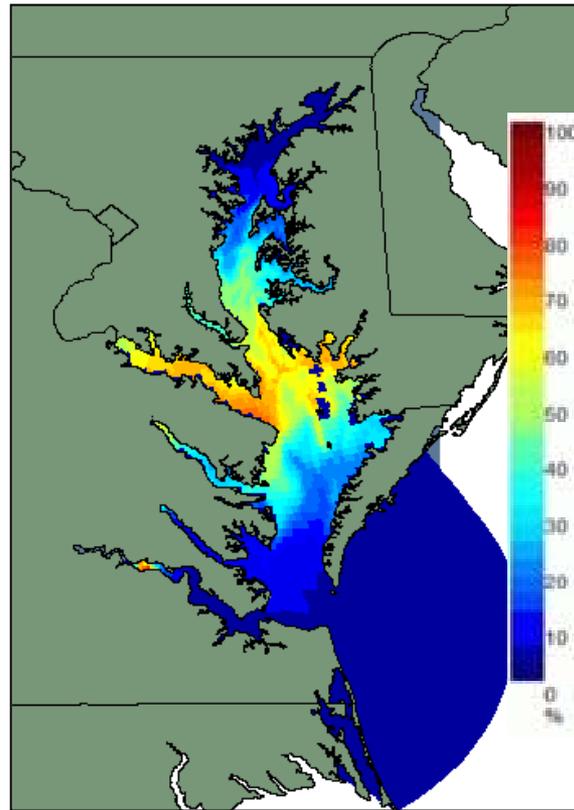
1. Envisioned Applications
  - Ecological emphasis
2. Finding common ground
  - Overlap of NESDIS / STAR and CREST interests

# Some Envisioned Applications

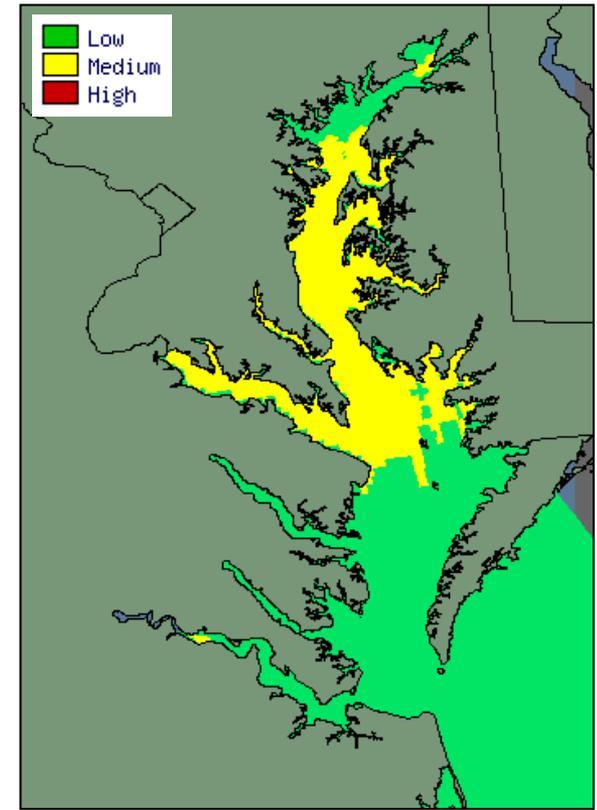
- Detect and monitor response of environment to climate change
  - Effect of sea-level rise
  - Response of coastal marine ecosystem
- Ecological Prediction & Projection
  - Short-term predictions
    - Human Health
    - Coral Reefs
    - Invasive Species
    - Fisheries
  - Longer-term projections
    - Consequences of coastal management and policies and agricultural activities

# Ecological Prediction in Chesapeake Bay: *Current Capabilities*

- Generate daily nowcasts and 3-day forecasts of jellyfish, the harmful algal bloom *Karlodinium veneficum*, and *Vibrio cholerae* in Chesapeake Bay
- Generated by identify the locations where ambient conditions coincide with the preferred environment (= habitat) of the organism



Predicted chance of encountering sea nettle, *C. quinquecirrha*, on August 17, 2007



Predicted relative abundance of *Karlodinium veneficum* on August 17, 2007

# Chesapeake Bay Forecast System

- **Objective:** Develop a fully integrated, ecological model of the Chesapeake Bay and its watershed that assimilates *in-situ* and satellite-derived data by adapting and coupling existing models
- **Purpose:**
  - Near-Real Time Applications: *Nowcasting and forecasting of marine organisms, ocean health, and coastal conditions*
  - Climate Research: *Estimating effect of climate change on the health of coastal marine ecosystems*
- **Partners:** ESSIC and other UM departemtns, UMCES\*, CoRP / SCSB, CICS

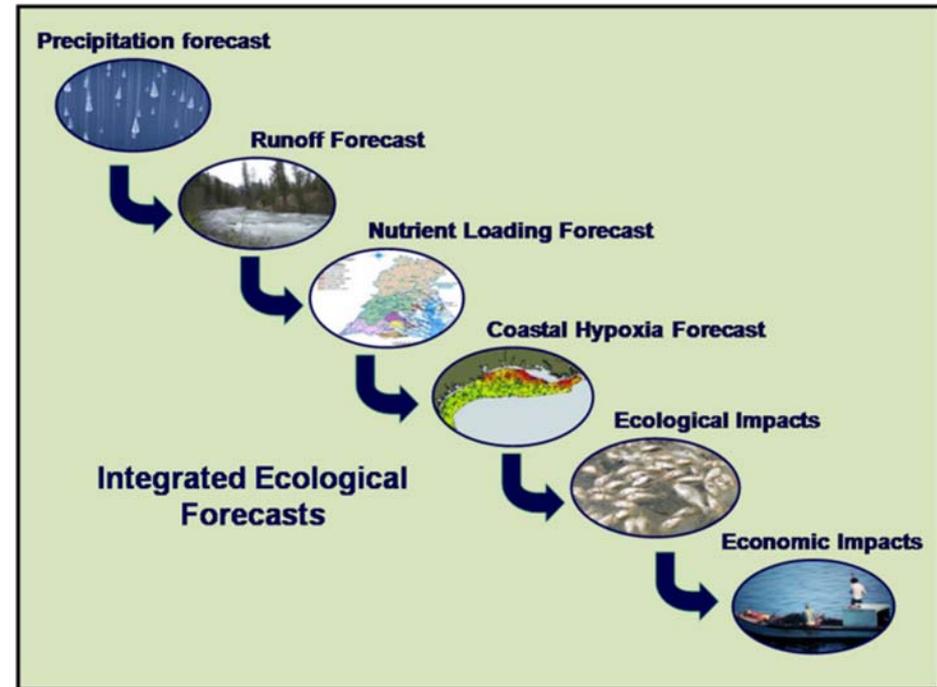


SeaWiFS true-color image of Mid-Atlantic Region from April 12, 1998.

\* University of Maryland Center of Environmental Science

# Future Application Requirements

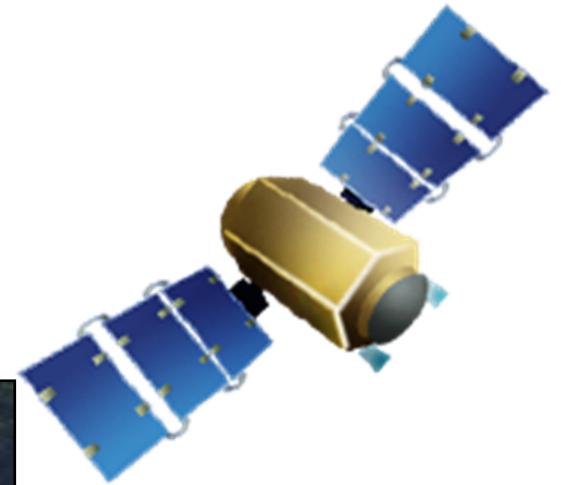
- New products;
- Multiple sources of information to estimate geo- and bio-physical characteristics;
- Enhanced data management and communication;
- Integrated forecast systems; and
- Interaction between federal agencies, NOAA LO's, cooperative Institutes, academia, and business, and users.



# Desired Ecological Variables

- Temperature
- Salinity
- Biomass estimates and taxonomic information of phyto- and zooplankton
- Primary Productivity
- Wind and current vectors
- Nutrient concentrations
- Dissolved oxygen concentration
- Spectrally-resolved optical properties

# Remote Sensing Platforms



*Courtesy of D. Wilson, NCBO*



*Courtesy of D. Fratantoni, WHOI*



*Courtesy of D. Wilson, NCBO*

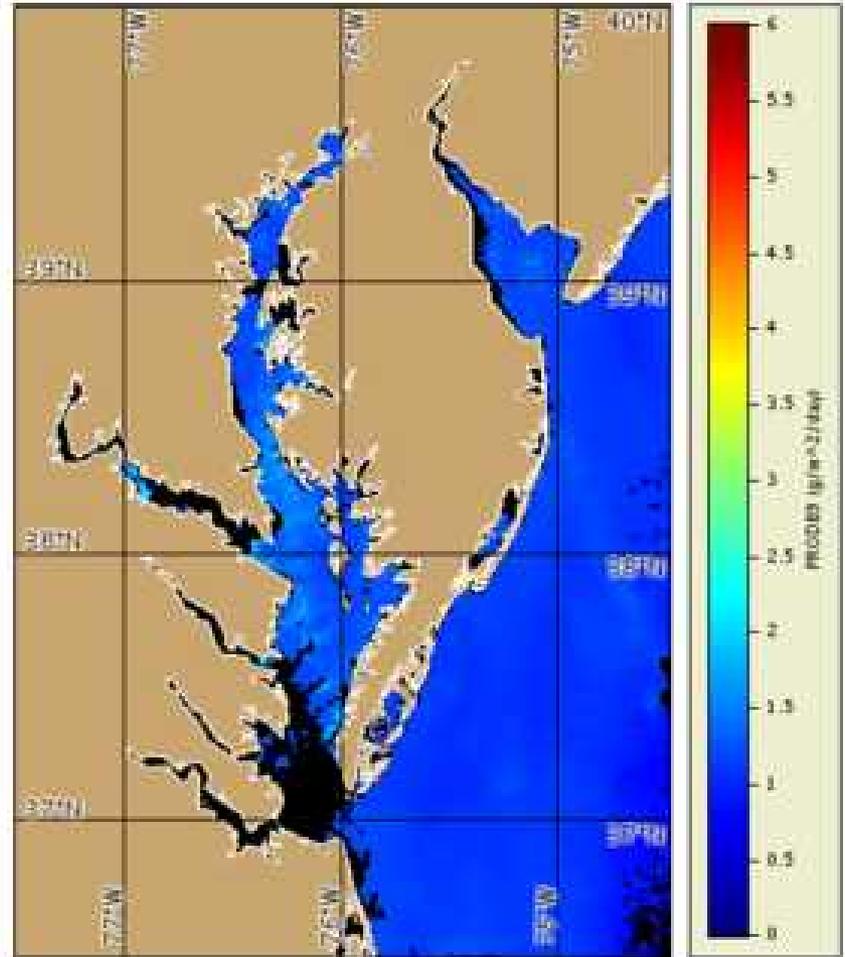
# Synopsis

- Satellites provide synoptic view, but additional remote platforms and techniques necessary to permit many of envisioned products and applications;
- Integration of products from different sources;
- Collaboration among many groups required

# **STAR – CREST Collaboration in the Coastal Ocean**

# STAR Interests

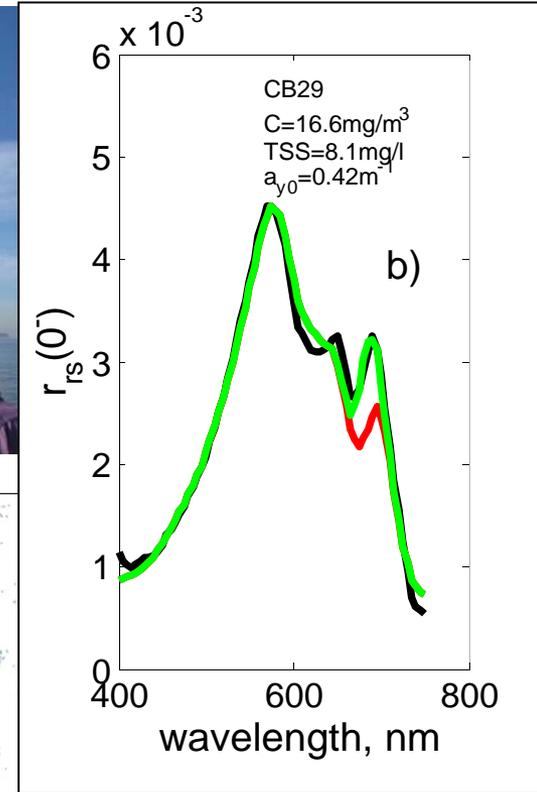
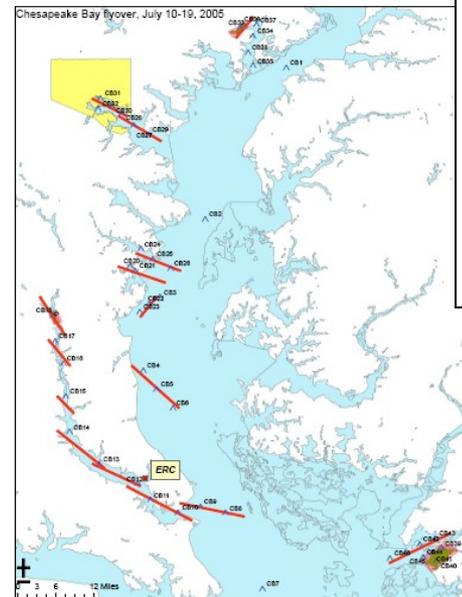
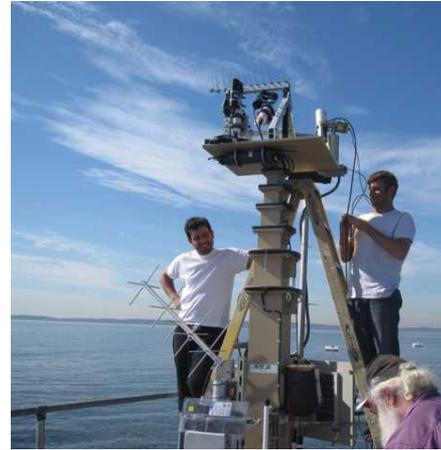
- Sensor calibration
- Atmospheric correction
- Product development and operationalization
- Data assimilation
- Application development



Estimate of primary productivity in Chesapeake Bay on 24 March 2009 using Water's nLw ratio phi max model

# CREST Activities in Coastal Oceans

- Developing and deploying optical sensor systems and packages to collect above- and in-water optical measurements in coastal waters
- Relating measured water constituent profiles to surface reflectance
- Monitoring of atmospheric trace gases
- Conducting basic research in atmospheric physics and chemistry



# Contributions to the Partnership

- NESDIS / STAR
  - Dedicated Researchers (practitioners of the art)
  - Satellite Platforms, Sensor, and Data
  - Mechanism to transition research to operations
  - \$\$\$
- CREST
  - Students and Staff
  - Sensor Engineering and System Expertise
  - Academic Perspective



*Photo courtesy of D. Wilson*

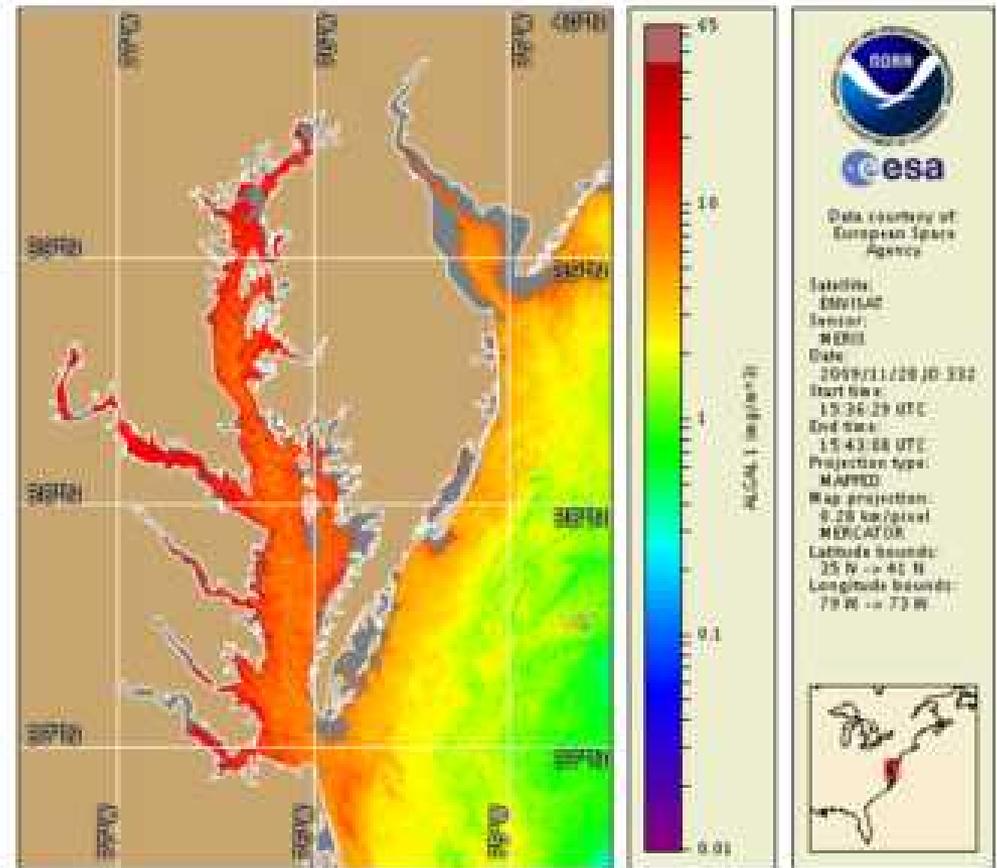
# Some Potential Areas of Collaboration

- Sensor characterization
- Product and application development
- Product validation
- Data management (IOOS) related activities
- Mentoring / Teaching



# New Sensors and Imagery

- NPP / NPOESS
- MERIS
- Ocean Color Monitor (OCM)
- Hyperspectral Imager for the Coastal Ocean (HICO)
- Geostationary Coastal and Air Pollution Events (GEO-CAPE)



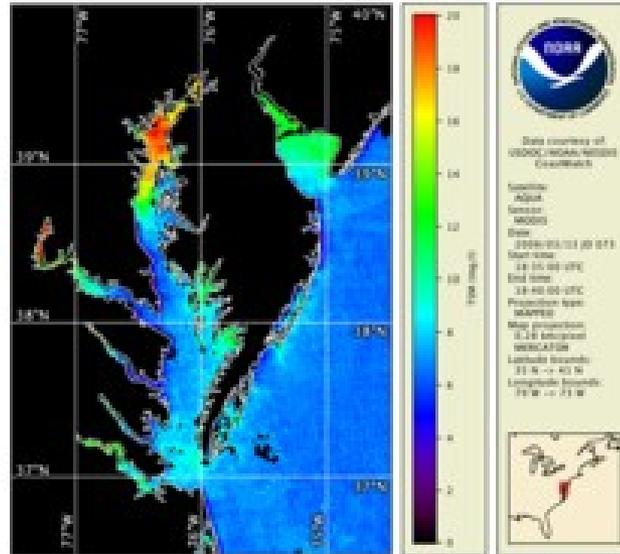
High resolution MERIS chlorophyll concentration experimental CoastWatch product for the Chesapeake Bay on 28 November 2009.

# Product Development

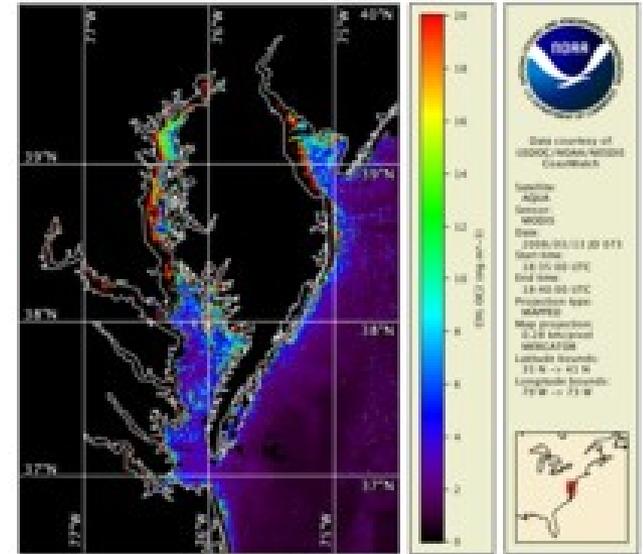
True Color Imagery



Total Suspended Matter



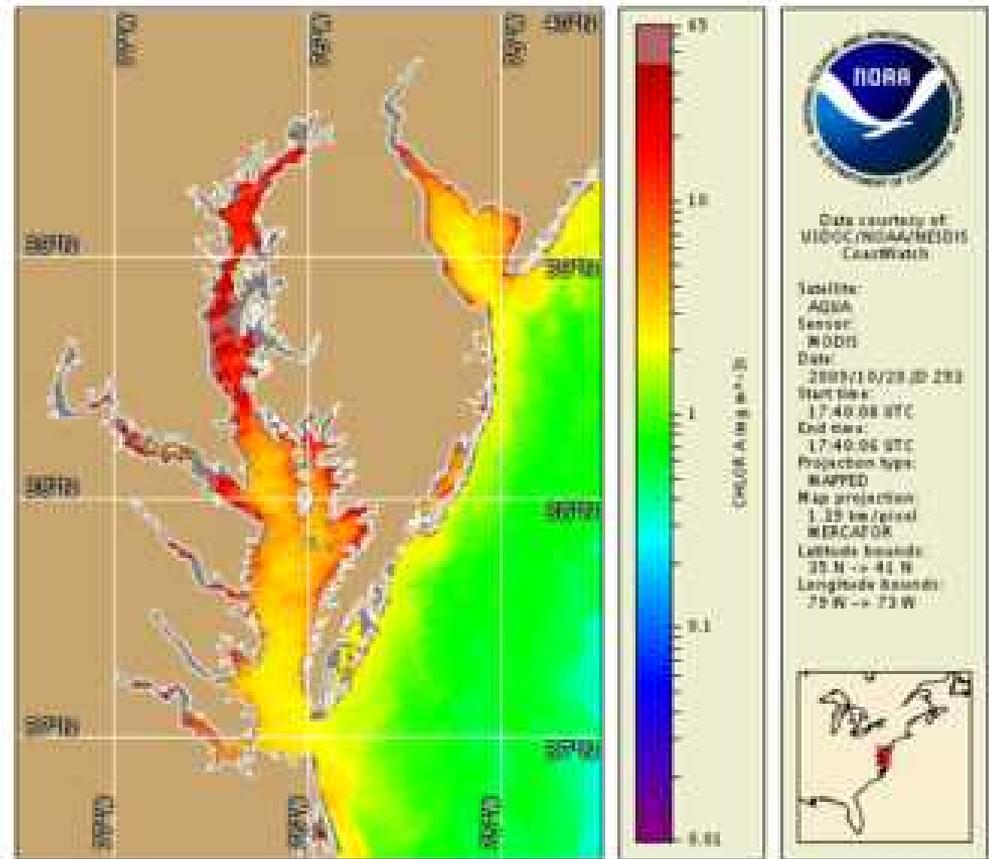
Chlorophyll Concentration



CoastWatch is developing remote sensing tools that can be utilized by resource managers and ecosystem modelers to monitor stress indicators in coastal and estuarine waters. These new high resolution products are being distributed through the CoastWatch East Coast Node for evaluation.

# Product Validation

- For
  - Satellite-derived products
  - Model predictions

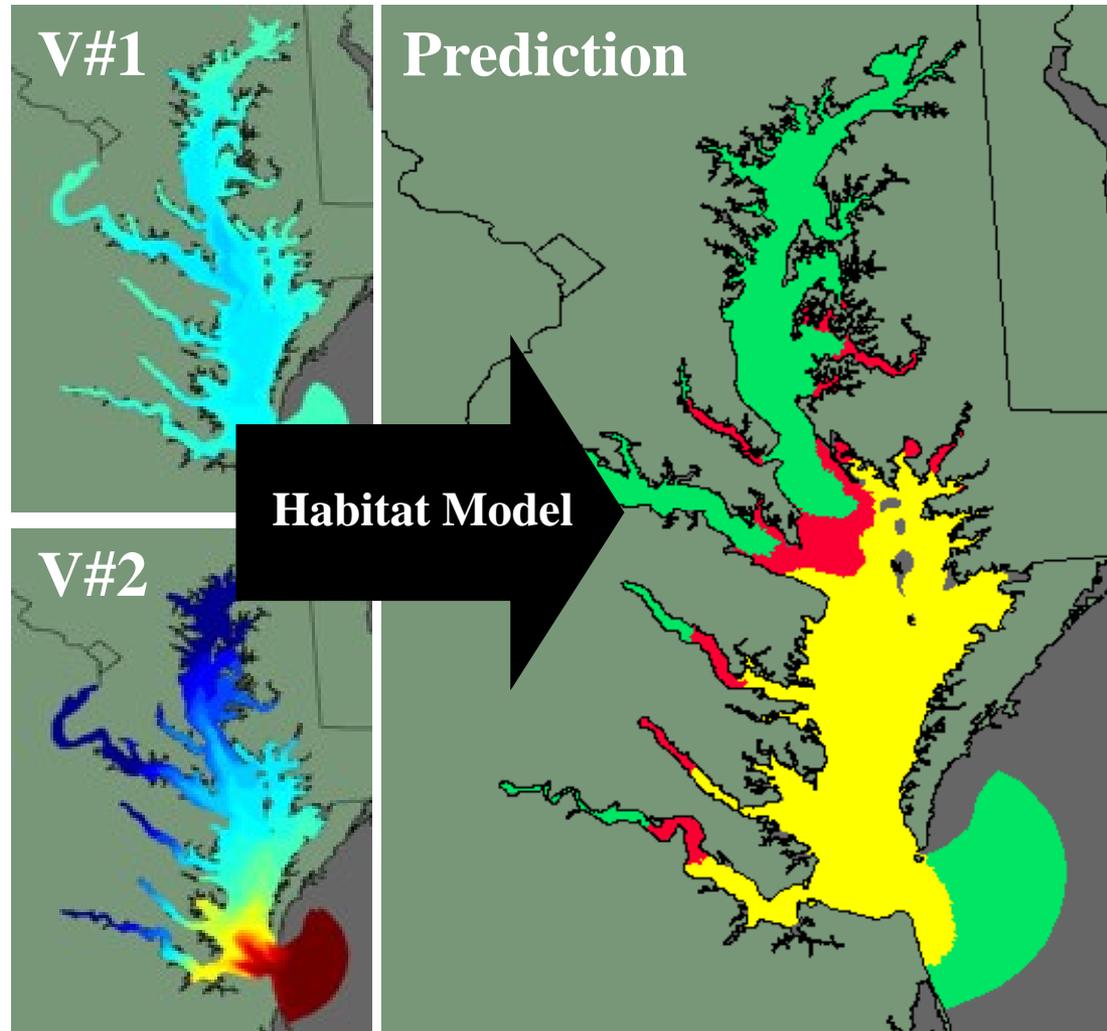


NOAA's CoastWatch MODIS / Aqua chlorophyll concentration product for Chesapeake and Delaware Bays on October 20, 2009.

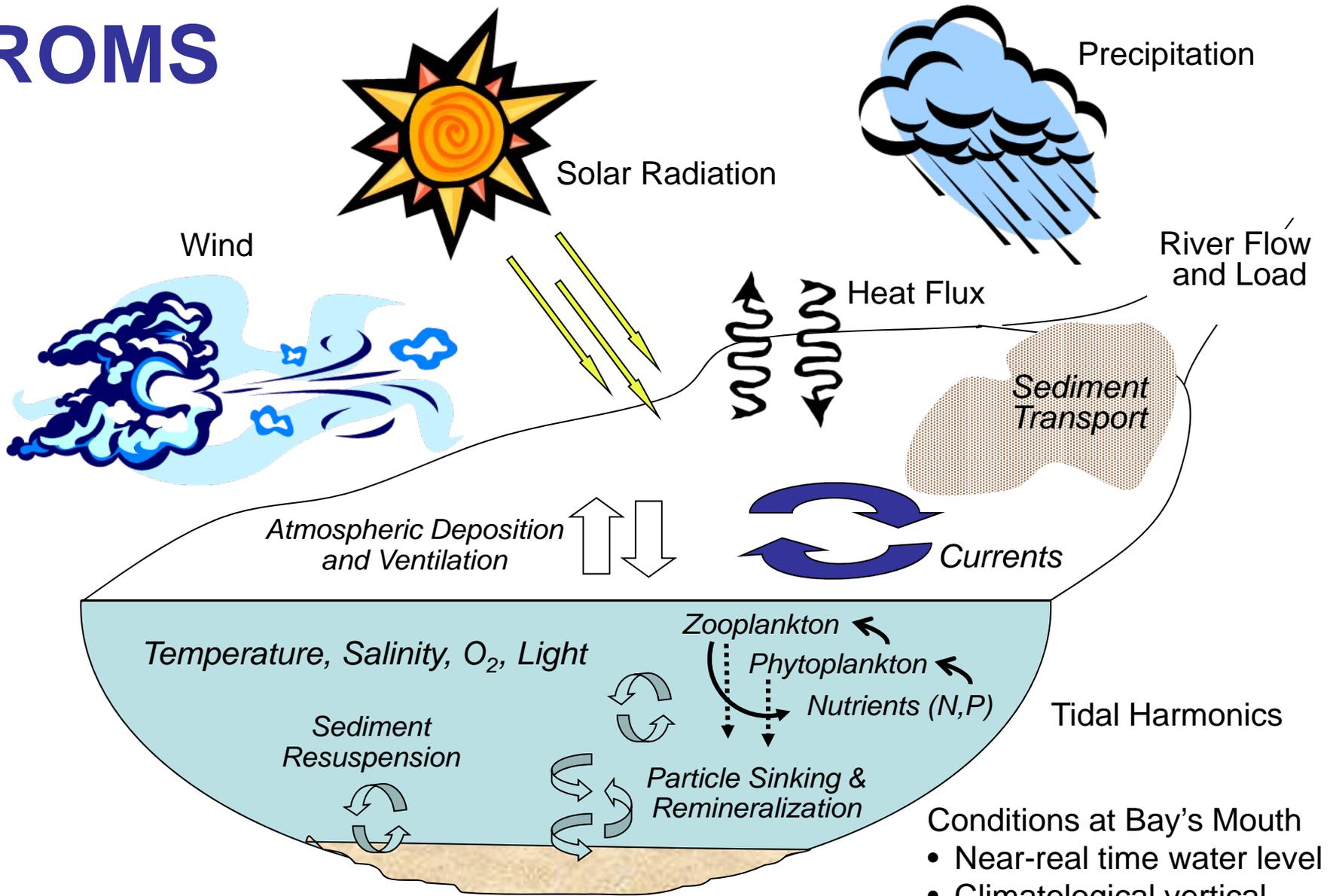
# Extra Slides

# Statistical – Mechanistic Approach

Using **real-time and forecast data** acquired and derived from a variety of sources and techniques to **drive multi-variate empirical habitat models** that predict the probability of the target species.



# ROMS



- Conditions at Bay's Mouth
- Near-real time water level
  - Climatological vertical profiles of temperature, salinity, and  $\text{NO}_3$ ,  $\text{PO}_4$ ,  $\text{O}_2$  concentrations

Oct. 20 Granule

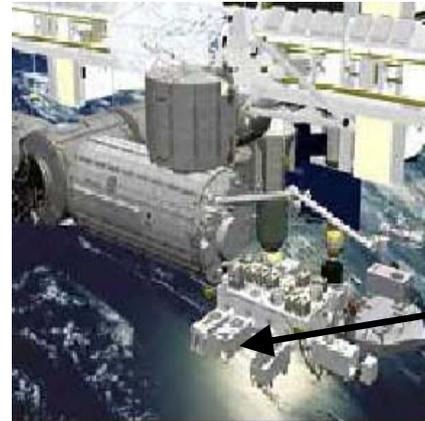


# HICO: NRL Hyperspectral Imager for the Coastal Ocean

Successfully launched 9/10/09

5 nm spectral resolution from 380-1000nm

100m spatial resolution with 50 x 200 km scene size



HICO is mounted on the Japanese Experiment Module – Exposed Facility (JEM-EF) on the International Space Station

Coastal Optical Characterization Experiment (COCE) – Optical characterization of biogeochemical processes and validation of ocean color sensors. Initialization experiment Conducted 10/20/09. Below are in-water spectra that will be used to validate HICO data collected during overpass.

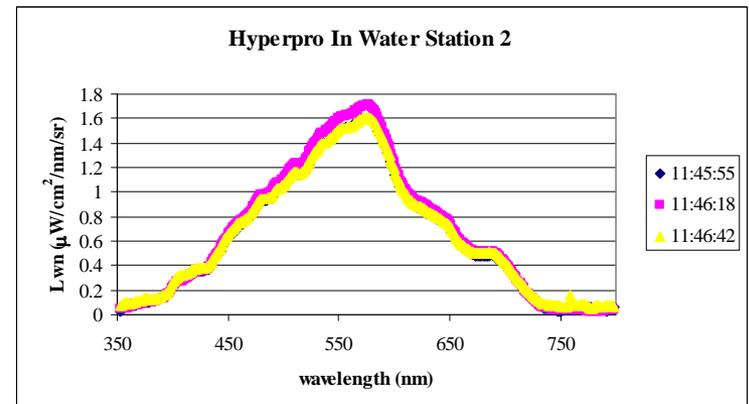
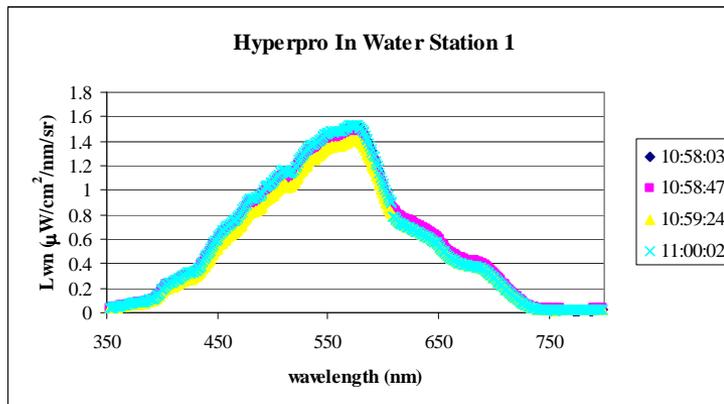
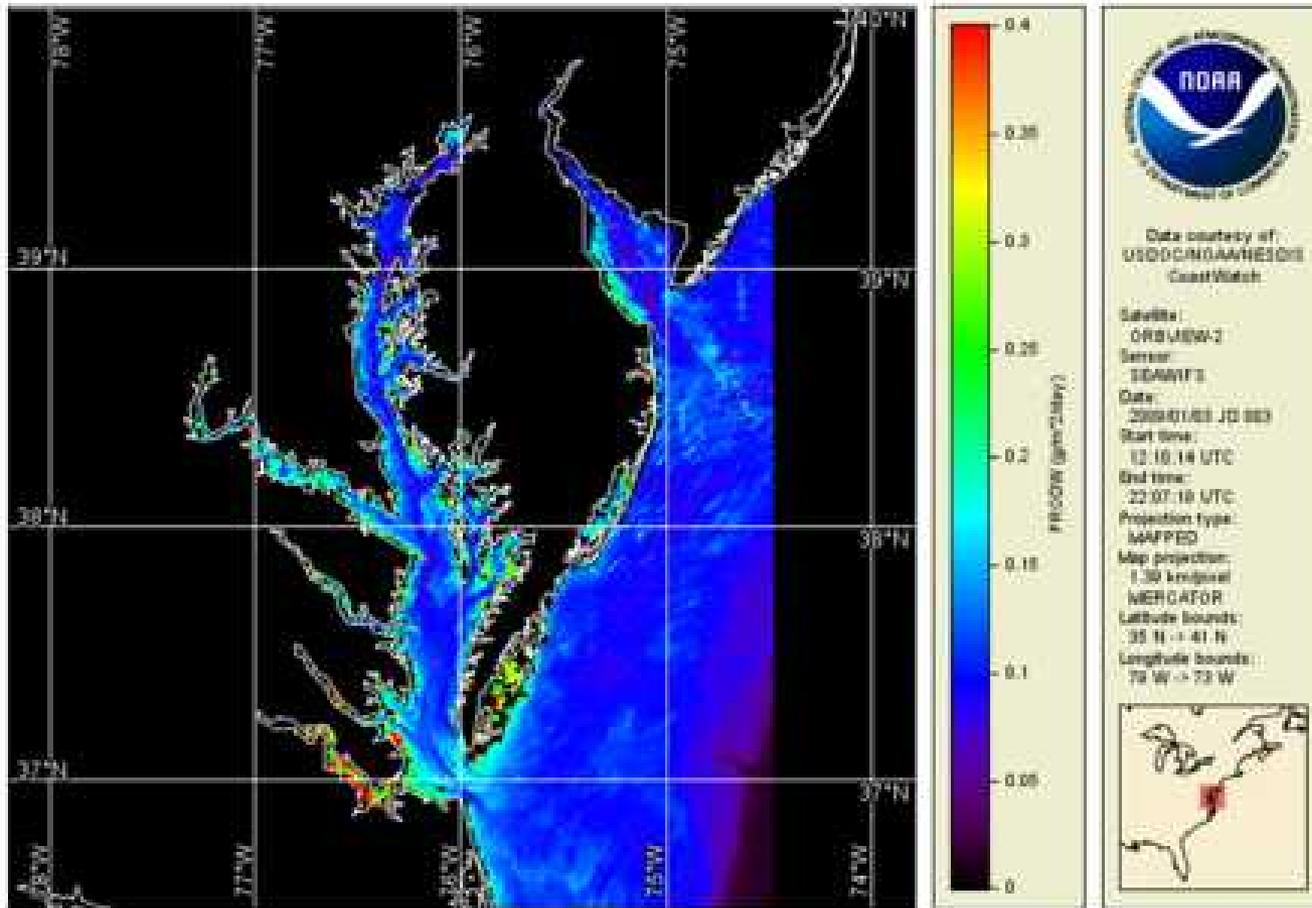


Image courtesy of William Synder (NRL)

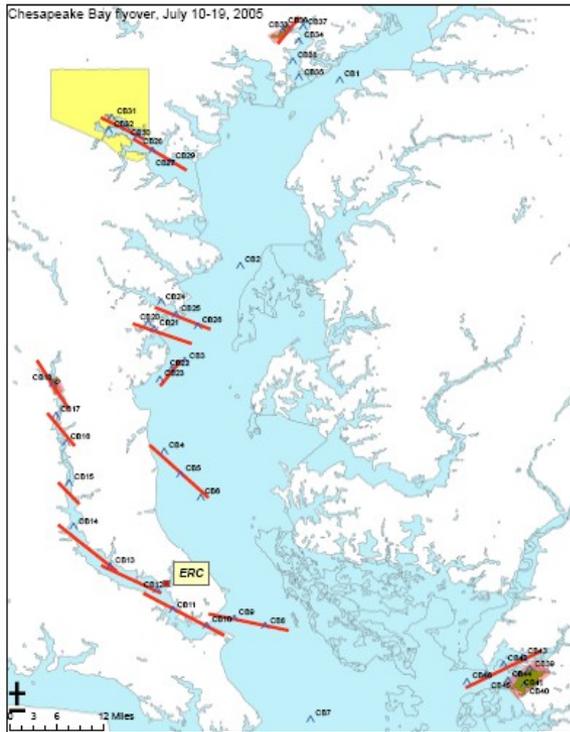
Michael Ondrusek (michael.ondrusek@noaa.gov)

Harding et al., 2002, CBPM productivity with Zeu from NASA K490  
January 03, 2009



<http://www.orbit.nesdis.noaa.gov/sod/mecb/coastwatch/prod/L4/indicatrix.html>

# Areas of field campaigns



## Areas of study:

Chesapeake Bay (2005), Georgia waters near Sapelo Island (2006), Long Island Sound, Peconic Bay NY Harbor, Hudson River (2007), Sandy Hook, NJ (2008)