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1 March 2005 – 31 August 2005

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Coastal Observation II – A Continuation of the OASIS Project

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Overview

Our goal is to develop a regional coastal ocean observing system along the Delmarva (Delaware/Maryland/Virginia) coast that will become a key component of the U.S. Integrated Ocean Observing System. We are developing and testing new sensors, platforms, and applications to support NOAA and NASA coastal ocean remote sensing activities and products. Our observing system will include a coastal radar system (CODAR); a fleet of solar-powered surface autonomous vehicles (OASIS); a Coastal Ocean Bio-optical Buoy (COBY); and a series of coastal ship surveys. We are making progress through the acquisition of key infrastructure, the hiring of required personnel, the development of several instrument platforms, and the creation of a data archival and access portal, which will make real-time observations available to the public. We continue to expand our observing program by establishing new collaborations.

During the past six months, we began conducting seasonal coastal ocean surveys and performing bi-weekly cross-shelf surveys. We completed several critical tasks that are necessary for providing real-time coastal ocean observation data. For example, we procured the equipment and selected and tested sites for our 3-node long-range high frequency radar system for measuring surface ocean currents. We are developing a coastal bio-optical buoy system, and we are working on the design of the hull and superstructure. A significant breakthrough occurred in our design of a surface profiling system and communications system that will provide near real-time profiles of the ocean temperature, salinity, density, nitrate, chlorophyll a and other bio-optical parameters. We are utilizing the ship support infrastructure to carry out bi-weekly surveys of the selected initial mooring location. We are nearing completion of the R&D phase of the OASIS platform. Our focus during this reporting period was on the propulsion system and its related command and control software. We have begun fabrication of OASIS platform No. 2. We are making progress on the development of several new in situ instruments to support ocean color calibration and validation efforts. Finally, we held a users' workshop in April 2005 to bring together all of the regional observing system participants, and in May we attended an organizational summit meeting of the Mid-Atlantic Coastal Ocean Observing Regional Association (MACOORA).

I. Program Management

CIT provides program management oversight and guidance to the Coastal Observation Project. In addition to NASA, our subcontractors represent leading companies and academic institutions from the region, and they provide excellent support and value to the program. For instance, Emergent Space Technologies is making substantial progress on its assigned tasks, which include the design, development, integration, and test of the Instrument Remote Control (IRC) software, and the analysis, integration and test of the navigation software. EG&G Technical Services is a major contributor in the design, fabrication and instrumentation of the OASIS platform and in the design and equipment procurement for the COBY. EG&G personnel are processing the data collected during cruises and providing analysis and interpretation of that data to NASA investigators.

We held a Program Review in March at Wallops Island. Project scientists and partners briefed their organization's roles, achievements, status and future plans. All of these briefings were uploaded to our shared website, www.Coastalobs.US. We have found that program reviews and our website, are very effective avenues for communications and collaboration.

In April, we presented a program briefing to Mr. Scott Rayder, Chief of Staff, Office of the Under Secretary of Commerce for Oceans and Atmosphere.

The remainder of this report is divided into the following sections: II. OASIS Platform; III. Sensor Suite development; IV. Software Development; V. High Frequency (HF) Radar Systems; VI. Cross-Shelf and Seasonal Field Surveys; VII. Coastal Ocean Bio-optical buoy (COBY); VIII. Data Archival Center; IX. Regional Partnerships and Outreach; and X. Project Milestones and Schedule.

II. OASIS Platform

The Ocean-Atmosphere Sensor Integration System (OASIS) platform development effort is nearing the end of its Research and Development (R&D) phase. During this reporting period, we focused on developing and testing the propulsion system and command and control system. We ran into some problems in selecting a motor/propulsion system that was capable of both propelling the platform and adapting to remote control. These problems had an impact on our schedule for testing the autonomous software. However, the final propulsion system is more efficient than our initial design. Since power is our limiting agent on the platform, the resulting system is well worth the delay. Pacific Gyre is developing a manufacturing capability on the Eastern Shore of Virginia for when the platform will become fully Commercial-Off-The-Shelf (COTS). The company is in the second year of a two-year SBIR grant to commercialize the OASIS vehicle. While the propulsion issues were being worked out, we finalized the hull design and we began fabricating a second OASIS platform. Emergent Technologies has developed and tested a complete radio-telemetered remote control system for the platform. We used this system to conduct field tests of the propulsion system. In addition to the command and control developments, the platform's solar panel system was installed and tested. The instrument and navigation mast was installed, and several in situ sensors are being installed. These include: air temperature; air velocity; relative humidity; atmospheric pressure; sea surface temperature; sea surface salinity; and chlorophyll a and Colored Dissolved Organic Matter (CDOM) fluorescence.

Our remaining milestones center around testing the remote command and control system through the Iridium satellite system and testing the fuzzy logic autonomous Guidance, Navigation and Control (GNC) software. We coded this software and tested it using an OASIS simulator and simulated ocean surface currents from the Regional Ocean Modeling System (ROMS).

III. Sensor Suite Development

We are developing several sensors to support ocean color remote sensing activities.

A. Prototype Phytoplankton Fluorescence Sensing System (PPFSS) Fluorometer: Our efforts to develop a phytoplankton fluorescence sensing system continue. Most significantly, we have modified the scope of the effort by trying to include a new tunable Optical Parametric Oscillator (OPO) laser system that will allow us to develop an adaptive spectral LIDAR (LIght Detecting and Ranging) profiling system. This system will allow the user to reconfigure the excitation wavelength being used to obtain fluorescence emission. We submitted a proposal to the NASA/GSFC Internal Research and Development (IRAD) program in July 2005 to obtain the funds ($89K) required to purchase the optical hardware. We expect a decision in mid-October. Our plan is to develop a system that can be deployed on a buoy and utilizes a fiber optic cable to sense vertically within the water column. NASA is interested in this instrument to test an adaptive sampling strategy that can be used to optimize the spectral frequencies that satellites or aircrafts use to remotely sense ocean features.

EG&G engineers proposed changing the design of the initial PPFSS to utilize a fiber optical bundle to deliver the excitation from the individual LEDs directly into the ocean and to use the center core of the bundle to deliver the fluorescence directly to the Ocean Optics USB2000 spectrometer. We are in the process of providing through-hull access to the ocean. This will be completed by November. The use of a fiber bundle design will eliminate biofouling problems related to the 2 mm chamber inlet and on the inside of the sample chamber.

B. Above-water Optical Pointer: We are creating a robotic pointing system for a 19-channel (320, 340, 380, 395, 412, 443, 465, 490, 510, 532, 555, 625, 665, 670, 683, 710, 780, 875nm and PAR) above water radiometer system called BioSRS. Biospherical Instruments fabricated this system to measure remote sensing reflectance, which is a direct satellite validation measurement for ocean color. We chose the wavelengths for the radiometer system and ordered it. We are developing a requirements document for the robotic 3 degrees-of-freedom gimbal system that will be used to mitigate the platform roll, pitch and yaw motions. While the engineering and robotic control law equations for this system are straightforward, developing a solution with the proper hardware and software controls is not. Our goal is to develop a control solution that can accommodate the range of motions observed by small sized surface platforms (3m discus buoys, OASIS, etc.). The main application for this control device is for the OASIS platforms, but it also can be installed on NOAA NDBC or COBY (see below) buoys.

IV. Software Development

During this reporting period, we have been preparing to test the guidance navigation and control (GNC) software of the OASIS platform. We completed developing and testing the OASIS simulator, and we simulated the GNC software capabilities within a realistic ocean environment using simulated surface circulation fields from the Rutgers Regional Ocean Modeling System (ROMS), a state-of-the-art ocean circulation model. However, progress was delayed in moving the software towards firmware until it is tested at sea. We ported the software to a Java environment, and the techniques used are being written up for publication as a master's thesis.

We are working with a NASA systems' software group to develop an application to NASA's Adaptive Sensor Fleet (ASF) software. The ASF software will create a mechanism to support management and deployment of fleets of OASIS platforms. We have submitted a proposal to NASA's Core-Capability program to develop an Observation System Simulation Experiment to demonstrate the feasibility of using a fleet of OASIS platforms to support U.S. hurricane prediction efforts.

With the completion of the OASIS simulator, we are developing dynamic mapping algorithms that will use multiple OASIS platforms to map surface ocean features in an optimized manner.

V. High Frequency Radar Systems

We purchased two separate--one long range and one standard range--HF Radar systems from CODAR Ocean Sensors. The long-range SeaSonde system is a 3-node radar system that will tie into the CODAR systems to the north at Cape May, New Jersey (operated by Rutgers University) and to the south at Duck, North Carolina (operated by the University of North Carolina). This system was shipped to the NASA/GSFC Wallops Flight Facility in late spring. An estimate of the expected coverage from this system as it relates to the Eastern Shore of Virginia, Maryland and Delaware is shown in Figure 2.

The standard range system is a 2-node radar system that will be deployed at the mouth of the Chesapeake Bay and tied into the existing 2 standard range systems operated by NOAA/NOS (Figure 3). The standard range system was shipped to Dr. Larry Atkinson of Old Dominion University. He is working with local coastal managers to determine the placement of this system.

In late spring, Dr. John Moisan (NASA) was joined by Dr. Chad Whelan (CODAR Ocean Sensors), Dr. Michael Muglia (UNC), Dr. Hugh Roarty (Rutgers University) and Dr. Bruce Lipphardt (University of Delaware) to test several potential sites to deploy the long range HF radar systems. In June, the group tested three locations. The first site was on the northern region of the Assateague Island National Park. The chosen site is situated behind large sand dunes and adjacent to a ranger station that has power and telephone access. We are putting together a proposal to the National Park Service for long-term deployment at this site. The second location was on the site of the Virginia Institute of Marine Science's Eastern Shore Laboratory, located in Wachapreque, Virginia. Unfortunately, this site was not successful and so an alternate, more remote location was tested that was closer to the ocean coastal area. The alternate site was located on the northern edge of Cedar Island, Virginia (Figures 4, and 5). This site provides good antenna coverage. We are working on a long-term deployment plan with a private corporation that owns an old Coast Guard station that will house the electronics and communication system for this CODAR site. Due to the remote location, only power is available, so we will establish communication links via a satellite uplink system. A third site that was tested using short-range HF radars is the Fort Henry military facility located on the northeastern edge of the Tidewater area of Virginia. Dr. Mark Bushnell of the Chesapeake NOAA/NOS is developing access to this facility for both the long-range and standard-range HF radar systems.

VI. Cross-Shelf and Seasonal Field Surveys

A. Seasonal Cruises

The purpose of these collaborative oceanographic cruises is to investigate the bio-physical processes in the ocean margin system. Of particular interest is the impact of the freshwater flux from the Chesapeake Bay into the Mid-Atlantic Bight, and the effects of exchanges of nutrients, suspended sediments, and other estuarine and coastal inputs on primary productivity. Researchers with a wide array of expertise will collect large amounts of data that will be used to characterize the ocean and coastal processes of the Mid-Atlantic Bight.

The BIOME I Cruise was the first of several seasonal cruises aboard the R/V Cape Henlopen, a 120 ft. research vessel out of Lewes, Delaware. The ship departed from Lewes on 30 March 2005 at approximately 0200h GMT and followed a track over the continental shelf between the Chesapeake Bay mouth and the Delaware Bay, sampling 15 stations along the route (Figure 6). Due to bad weather conditions forecasted for the final day of the planned track, the Henlopen returned to port a day early, on 02 April 2005 at approximately 0500h GMT.

Ten researchers were aboard the BIOME I Cruise, representing NASA, EG&G Technical Services, Old Dominion University, and Biospherical Instruments (Table 1). Five crew members also were aboard, including the ship's captain, first mate, engineer, technician, and cook.

Table 1. BIOME I Participants

Participant	Affiliation
Antonio Mannino, Chief Scientist	NASA Goddard Space Flight Center
Tiffany Moisan	NASA Wallops Flight Facility
Stan Hooker	NASA Goddard Space Flight Center
Mary Russ	UMBC Goddard Earth Science and Technology/ NASA GSFC
Matt Linkswiler	EG&G Technical Services
Carla Makinen	EG&G Technical Services
Jose Blanco	Old Dominion University/ NASA WFF
Katherine Filippino	Old Dominion University
Peter Bernhardt	Old Dominion University
John Morrow	Biospherical Instruments

On 25 July 2005 at approximately 0400h GMT, the R/V Cape Henlopen departed Lewes, Delaware. During the BIOME II cruise, 29 planned stations (Figure 7) were sampled (143 discreet depths sampled), and the Henlopen returned to port ahead of scheduled time on 30 July 2005. The 9 researchers on board represented NASA, EG&G Technical Services, Old Dominion University, York College of Pennsylvania, and Biospherical Instruments (Table 2).

Table 2. BIOME II Participants

Participant	Affiliation
Antonio Mannino, Chief Scientist	NASA Goddard Space Flight Center
Stan Hooker	NASA Goddard Space Flight Center
Mary Russ	UMBC Goddard Earth Science and Technology/ NASA GSFC
Carla Makinen	EG&G Technical Services
Jose Blanco	Old Dominion University/ NASA WFF
Katherine Filippino	Old Dominion University
Peter Bernhardt	Old Dominion University
John Morrow	Biospherical Instruments
Jessica Nolan	York College of Pennsylvania

Measurements taken during the BIOME I and BIOME II Cruises include inherent and apparent optical properties (IOP, AOP), particle analyses, nutrient load, community structure (phytoplankton and cyanobacteria), water chemistry (organic and inorganic carbon, nitrogen), primary productivity, and physical characteristics (Table 3).

At each station, optical instruments were utilized to measure optical properties of the water column, and water samples were collected for all other analyses. Optical instrumentation was either lowered by hand for small profiling or free-falling instruments, or by winch for large optical packages to get an optical profile of the water column along the cruise track. A CTD rosette equipped with twelve 10 L Niskin bottles was deployed to collect seawater at various depths, including the chlorophyll maximum, if one existed. From those samples, water was filtered for laboratory analyses of biological, chemical, and optical properties (Table 3). Samples were incubated on-ship for primary productivity analyses by ^{13}C uptake. The R/V Cape Henlopen is equipped with a flow-through system, allowing for the incorporation of a shipboard laser fluorometer for measurements in surface waters. Measurements compiled on BIOME I and II, as well as the associated instruments, are shown in Table 3.

Once all data from the BIOME I and II cruises are processed, analyzed, and communicated among members of the scientific party, we will gain a more thorough understanding of spring conditions of the continental shelf, and we can tie our information into physical models of the region.

Preliminary data from BIOME I show several interesting trends. A definite plume can be seen emanating from the mouth of the Chesapeake Bay in the figures of CDOM, chlorophyll a, and phycoerythrin (Figure 8), temperature, and salinity (Figure 9). This is the type of observation we need to monitor the influence of the Chesapeake Bay on the adjacent coastal ocean margin ecosystem.

Preliminary results of fluorescence yield from the pulse amplitude modulation (PAM) fluorometer indicate significantly lower ($P<0.001$) fluorescence yields at Stations 4, 7, 9, and 11 than most other stations during the BIOME I cruise. Station 11 showed significantly lower yield than all other stations. Stations 4, 7, and 9 were significantly lower than all other stations except for Station 6, where the difference was not significant (Figure 10).

A lack of PAM data from the Chesapeake Bay mouth region will make any conclusions about the role of the Bay plume in this pattern difficult to ascertain. However, we anticipate that fluorometric chlorophyll and absorption data, once analyzed, will give insight to the underlying causes of the distribution of low yields outside the Chesapeake Bay mouth.

B. Bi-weekly Cruises

We are conducting bi-weekly cross-shelf cruises in conjunction with the Virginia Marine Science Consortium. To date, we have completed five bi-weekly transect cruises, typically covering six stations between the Chincoteague Inlet and Washington Canyon (Figure 11). One of the field instruments that was very useful for these surveys is the WetLabs Dolphin bio-optical profiling system (Figure 12). This system allows us to continuously monitor the entire water column while underway, saving considerable amount of time and allowing us to extend our ship surveying capability. In addition, the Nature Conservancy has approached us with their plans to acquire a new coastal vessel to survey the region around the Watchapreague Island area. We are working with them to develop plans for instrumenting and manning these surveys.

Researchers collaborating on these cruises include scientists and students from NASA Wallops Flight Facility, EG&G Technical Services, Old Dominion University, York College of Pennsylvania, Goucher College, and Millersville University (Table 3).

Table 3. Participants on the biweekly COBY transect cruises.

Participant	Institution
Tiffany Moisan	NASA Wallops Flight Facility
Carla Makinen	EG&G Technical Services
Jose Blanco	Old Dominion University
Jessica Nolan	York College
Julie Ambler	Millersville University
Stephanie Kopala	Millersville University
Melissa Day	Millersville University
Bill Johnson	Goucher College

Measurements taken by NASA, EG&G, and ODU scientists include optical profiles (Tables 4 & 5), fluorometric chlorophyll, particulate organic carbon, particulate nitrogen, absorption, and nutrient concentration. Other collaborators sample pelagic zooplankton (vertical and horizontal tows), size fractionated chlorophylls, and epibenthic zooplankton (benthic sled).

Data from optical instrumentation are downloaded and archived after each cruise, and we are plotting and analyzing this data.

We conducted several seasonal BIOME field surveys. The data sets are being analyzed, and the samples are being processed. In addition, we are developing a web site that will present all of the data sets collected. An OPenDAP server will provide archival/access.

Table 4. List of measurements for the BIOME cruises.

Measurements	Data Product	Instrument
	Optics	
AOPs - Vertical profiles	Lwn, Reflectance	Biospherical Radiometers
IOPs-bio-optics pkg.	Backscatter	HOBI Hydroscat & a-Beta
IOPs – ship flow through	CDOM, chl a, PE/PC fluorescence	Shipboard Laser Fluorometer
IOPs – Lab anal. CDOM	a(CDOM), S	Cary 100
IOPs – Lab anal. Filter	a(particle), a(ph), a(d), S(d)	Perkin-Elmer Lamda 800
IOPs – Lab anal. Filter	Chl a (by fluorescence), Pigments	Turner Fluorometer HPLC
IOPs – Lab anal. Filter	Chl a (by fluorescence)	Turner Fluorometer
IOPs – Lab anal. Filter	HPLC pigments	Shimadzu HPLC
Ship's flow through	Nitrate	Satlantic ISUS
Lab anal. particles	Fluorescence excitation	Perkin-Elmer Spectrofluorometer
Lab anal. particles	PAM fluorometer	Walz PAM Fluorometer
	Biology / Chemistry	
Phytoplankton	Abundance, Taxa	Olympus BX51 Microscope
Cyanobacteria	Abundance, Taxa	Olympus BX51 Microscope
Satellite ocean color	Chlorophyll a, Temperature, etc	Satellite Ocean Color
Bulk DOM chemistry	DOC, TDN, DON	Shimadzu TOC-V + NM1
Terrigenous DOM-surf.	Lignin Phenols	Agilent GC-MS
Anthropogenic DOM-surf.	Black Carbon	Elemental Anal., Leco CHNS
DOC biological lability	Decay rates, Labile, Semi-Labile, Refractory DOC	Shimadzu TOC-V + NM1, Cary 100
DOC photooxidation	Decay rates, Photo-labile DOC, CDOM	Shimadzu TOC-V + NM1, Cary 100
Bulk POM	Total Suspended Particles	Mettler-Toledo AX-26DR
Bulk POM chemistry	POC, PN	Elemental Analyzer Leco CHNS, Europa EA
Nutrients	NH4, NO3, NO2, PO4, SiO4	Old Dominion University
DIC	DIC	
Microbial Activity	Uptake of NO3, NO2, NH4, urea, DFAA	Europa IRMS
Primary Productivity	Primary productivity (C-13 uptake)	Europa IRMS
	Physics	
Current profiles	Vertical current profiles	ADCP
CTD Profiles & SAIL	Temp., Salinity, Dens., O_2, Fluorescence	CTD
Meteorogical Obs.	Wind Speed & Dir., Bar. Pressure, etc.	
GPS Log Book	Lat, Lon, Depth, Date, GMT, SAIL CTD	

Table 5. Optical instrumentation on the profiling rack and DOLPHIN.

Instrument	Manufacturer	Measurement
AC-Spectra	Wet Labs, Inc.	Absorption (multi-spectral)
AC-9	Wet Labs, Inc.	Absorption (9 wavelengths)
ECO VSF	Wet Labs, Inc.	Volume Scattering Function
Hydroscat-2	Hobi Labs, Inc.	Backscatter (2 wavelengths)
a-Beta	Hobi Labs, Inc.	Absorption/Backscatter
ISUS Nitrate	Satlantic	Nitrate concentration
PRR-800	Biospherical Instruments	Radiance/Irradiance

VII. Coastal Ocean Bio-optical buoy (COBY)

Developing the COBY has proven to be our most difficult task. Dr. John Moisan and Dr. Jose Blanco researched deployed buoys systems across the globe. Initially, we wanted to deploy a simple surface instrumented system. However, we know that the offshore regions of the Virginia coastal ocean have strong seasonal stratification effects, and we wanted to observe this occur. As a result, we worked to develop a profiling capability. In the end, we settled upon one that will use a 3 m discus hull, similar to those used by NOAA/NDBC, and a surface-mounted profiling system designed by researchers at the University of Washington (see Dunne, et al., J. Atmos. Oceanic Tech., 19, 1709-1721, 2002.). We are working with The Gilman Corp. to assist us in designing the system and to fabricate the flotation hull. The superstructure will be fabricated locally to maximize cost savings. These changes to the COBY design were significant but necessary for adequately observing this coastal ocean region. Our schedules for design, fabrication, instrumentation and deployment of COBY slipped to accommodate these changes.

VIII. Data Archival Center

We installed a DODS server in our computer room and are developing the archive data sets. We will make the coastal data time series available on the OPeNDAP (previously known as DODS) FreeForm server. We installed FreeForm software, and we wrote the format file that OPeNDAP uses to access the data. Our next step is to link the data to the FreeForm server. Our first data set will be the archived fresh water flux and nutrient load data set developed using USGC data. It will be used to study boundary conditions to coastal ocean coupled physical/biogeochemical models. Next, we plan to add the HF Radar and cross-shelf survey data.

We are working with Rutgers University to act as a second archival site to the MACOORA HF Radar data set. Rutgers will process the CODAR data along with the entire northeastern US CODAR data sets to create a regional product. Our data archival system will serve as the applications storage system and will act as the back-up for the Rutgers CODAR archive.

IX. Regional Partnerships and Outreach

Our goal of developing a sustainable regional node to the U.S. National Ocean Observing System requires collaboration with regional partners in the academic, governmental, and commercial sectors who have a stake in such an ocean observing system. We are working to bring in additional necessary manpower to support this effort by expanding ties with local academic institutions such as Old Dominion University, Hampton University and the Virginia Institute of Marine Science. Investigators from most of these institutions are helping us obtain key observations of the coastal ocean. In addition, we are working with the National Park Service and the U.S. Coast Guard to help provide the necessary logistical support for maintaining the HF Radar arrays and the offshore bio-optical buoy (COBY). As our ocean color data sets begin to mature into a useful archive, we will coordinate with the NOAA NESDIS ocean color effort, which provides coastal managers with satellite-derived ocean color products, for additional distribution of the new data sets. We will continue to develop and foster additional regional partnerships as we expand the suite of observations that are collected, archived and made available through an open access archive.

We have developed several partnerships, and we are developing others. We are collaborating with Drs. Antonio Mannino and Stan Hooker, both of NASA/GSFC. Dr. Mannino's focus is on the cycling of dissolved organic matter in the coastal ocean, and Dr. Hooker works exclusively on ocean bio-optics. They are collaborating with Dr. Tiffany Moisan by participating on the seasonal field surveys and by assisting in the development of the coastal ocean bio-optical buoy. Dr. Hooker also is working with Dr. John Moisan to develop the optical pointing system for the BioSRS system. We are collaborating with the NOAA/NOS facility (Dr. Mark Bushnell) and Old Dominion University (Dr. Larry Atkinson) to manage and maintain the two standard-range HF radar systems. Funds from FY2005 will support this effort. In addition, Dr. Tiffany Moisan is collaborating with Drs. Larry Atkinson and Margaret Mulholland (Old Dominion University) to characterize the links between the physics, chemistry and bio-optics. Dr. Atkinson will work with Dr. Blanco to analyze the physical oceanography observations acquired during the seasonal field surveys. Dr. Mulholland also will participate on the field surveys but will focus more on productivity and nutrient dynamics.

We are collaborating with Rutgers University (Dr. Josh Kohut) to develop a region-wide HF Radar surface current product using all of the long-range seasondes located between Duck, NC and Cape Cod, MA. NASA asked us to resubmit a proposal with colleagues from the University of Colorado, the University of Rhode Island, Rutgers University, the University of Connecticut, and the U.S. Coast Guard to utilize the HF radar and satellite-derived surface current estimates to support USCG search and rescue applications. When we first submitted the proposal, sufficient funds were not available.

During the winter and early spring, Drs. Tiffany and John Moisan met with several researchers affiliated with the Virginia Marine Science Consortium. This effort resulted in several new collaborators joining in the COBY cross-shelf surveys. These individuals include: Dr. William Scott Johnson (Goucher College, VA) who will participate in zooplankton studies; Drs. Julie Ambler (Millersville University, PA) and Nancy Butler (Kutztown University) who will also work on zooplankton studies; Dr. Yin Soong (Millersville University, PA) who will work on the along-shelf circulation patterns; and, Dr. Jessica Nolan (York University, PA) who will collaborate with Dr. Tiffany Moisan to study coastal bio-optics and phytoplankton photophysiology.

An air-sea heat, momentum and gas flux effort continues to progress through support of Drs. Jeff Hare and Chris Fairall (NOAA/ETL) and Wade McGillis (Lamont-Doherty). Their goal is to develop a complete air-sea flux system that can be incorporated onto the OASIS platforms. We will test the initial system in October after the completion of the OASIS GNC tests. Then we will continue with the system integration into the OASIS platform.

Dr. Tiffany Moisan continues to collaborate with Dr. Pat Tester (NOAA) to utilize the OASIS platform to identify, track and monitor Harmful Algal Blooms.

Educational Component to BIOME

Figure 1. Students from Wilson High School embark on the R/V Parker for and oceanographic cruise. (NASA Wallops Flight Facility).

One goal of our project is to introduce high school students to coastal oceanography. We have developed ties with several local high schools. We arranged for students from Wilson High School in Reading, PA, to embark on an oceanographic cruise off of the coast of Virginia. Students were able to "plan" their own cruise utilizing various types of oceanographic instrumentation such as physical, optical, and biology sensors. We analyzed and presented the data they collected to them at a later date. They also visited the NASA Photophysiology Laboratory for a hands-on demonstration on phytoplankton microscopy and physiology.

Additionally, we are developing an education magazine for high school teachers and students. The co-investigators from our project are writing articles about their research. (Table 6). We are assembling an editorial staff to conduct reviews of the journal. It will be a peer-reviewed journal consisting of papers written to a high school audience. We also have hired two teachers to develop teaching curriculum at the high school level. This curriculum will be available in October.

We are supporting the research of several postdoctoral candidates who are working on understanding nitrogen fluxes and primary productivity in the coastal zone, studying colored dissolved organic matter in the area, and working on the physical oceanography of the region in conjunction with an understanding of optics and biology.

Brian Campbell, education lead specialist for the NASA Hydrospheric Sciences Division, has created several websites, including http://phytoplankton.gsfc.nasa.gov and http://ocean.wff.nasa.gov/biome1/ , which are specific to the Coastal Observation project. All of the educational material will be posted on the Coastal Observation website at www.Coastalobs.US.

Table 6. Co-Investigator topics for the Educational Journal

Julie Ambler	Ecosystems
Arnoldo Valle-Levinson	Circulation in coastal waters
Madhumi Mitra	Marine algae in the rivers
John Moisan	OASIS
Oscar Schofield	The Cool ROOM at Rutgers University
Stan Hooker	Calibration and Validation of Ocean Color Satellites
Antonio Mannino	Dissolved Organic Matter in the Coastal Ocean
Bill Boicourt	Chesapeake Bay Observing System in the Chesapeake Bay
Margaret Mullholland	Dissolved Organic Nitrogen in the Coastal Ocean
Tiffany Moisan	Ocean Color and Primary Productivity
Pat Tester	Harmful Algal Blooms
Jessica Nolan	Picophytoplankton in the ocean

X. Project Milestones and Schedule

Task	Milestone Date
HF Radar System Design	Completed
HF Radar System Delivery and Testing	Completed
HF Radar System Deployment	Completed
HF Radar Archival System	Completed
HF Radar System Operational	30 October 2005
OASIS Simulator Software Completion	Completed
OASIS Platform Sea Trials	Ongoing
OASIS Remote Radio-Control	Completed
OASIS GNC Test	30 September 2005
OASIS Open Ocean Field Trials	Ongoing
Begin Additional OASIS Platform Fabrications	15 August, 2005
OASIS HAB Inst. Field Tests	October 2005
Design of COBY	30 September 2005
Fabrication of COBY	31 October, 2005
Instrumentation of COBY	31 October, 2005
Deployment of COBY	November 2005
Develop COBY line instrument system	Completed
Bi-weekly COBY lines	Ongoing
Complete Data Archival System Design for CODAR	Ongoing
Carry out seasonal field surveys	Ongoing
Deploy ADCPs for CODAR validations	October 2005

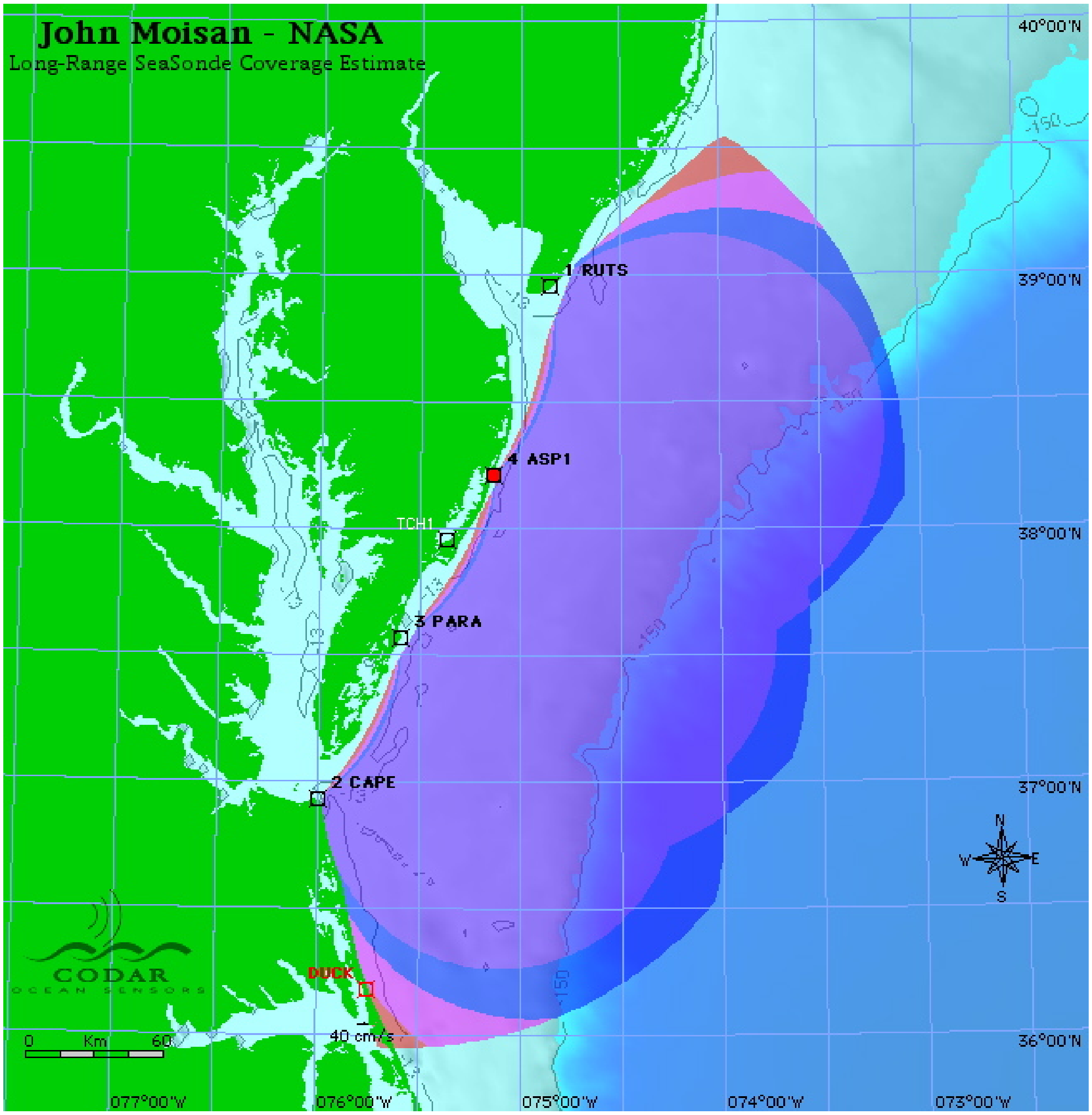


Figure 2. Anticipated coverage area for 3-node long-range HF radar system.

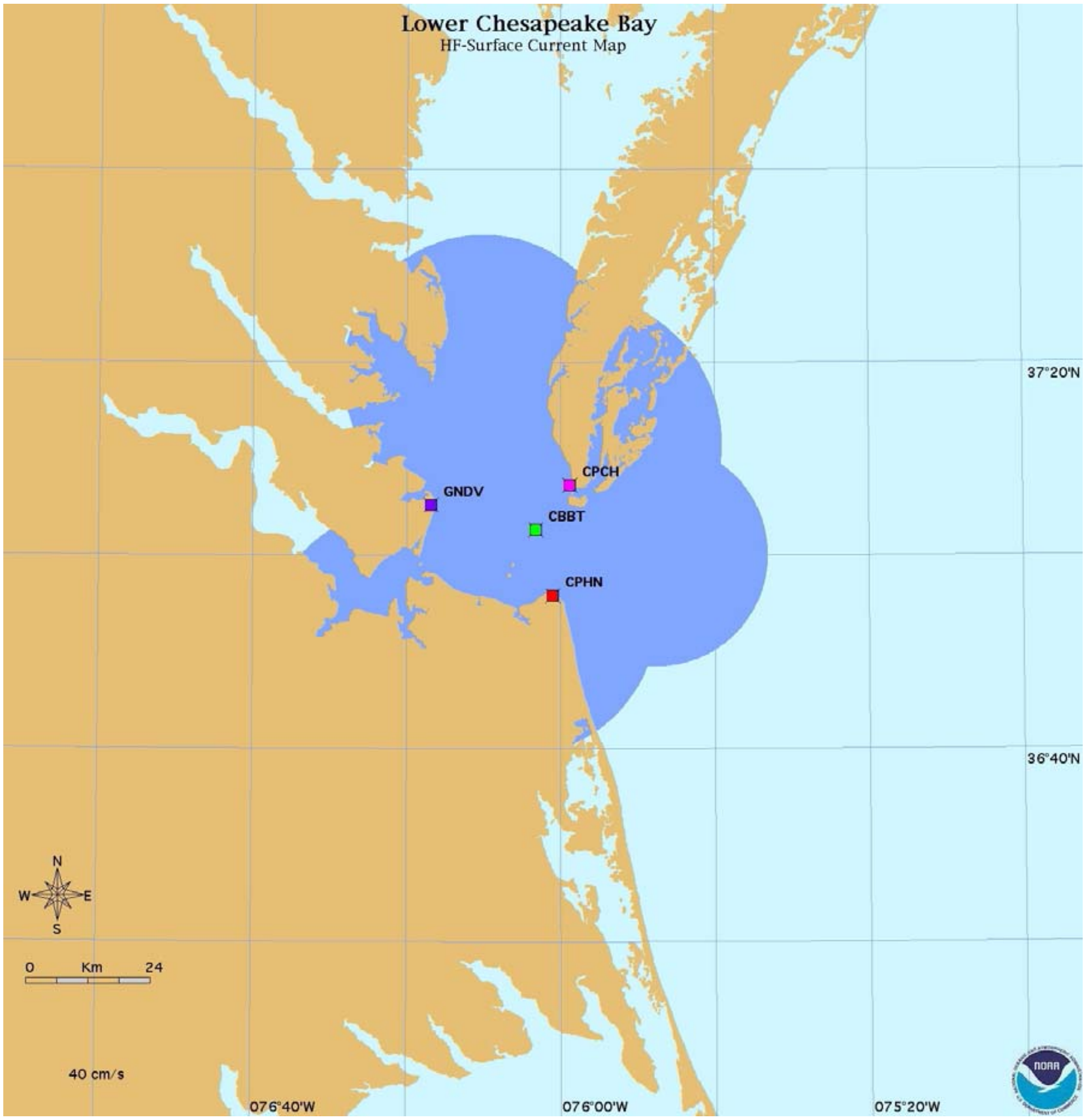


Figure 3. Anticipated coverage area for 3-node long-range HF radar system.

Figure 4. Long range HF Radar Transmission Antenna located on Cedar Island, Virginia during field testing activities held in June 2005.

Figure 5. Long range HF Radar Receive Antenna (located to right of picture) located on Cedar Island, Virginia during field testing activities held in June 2005.

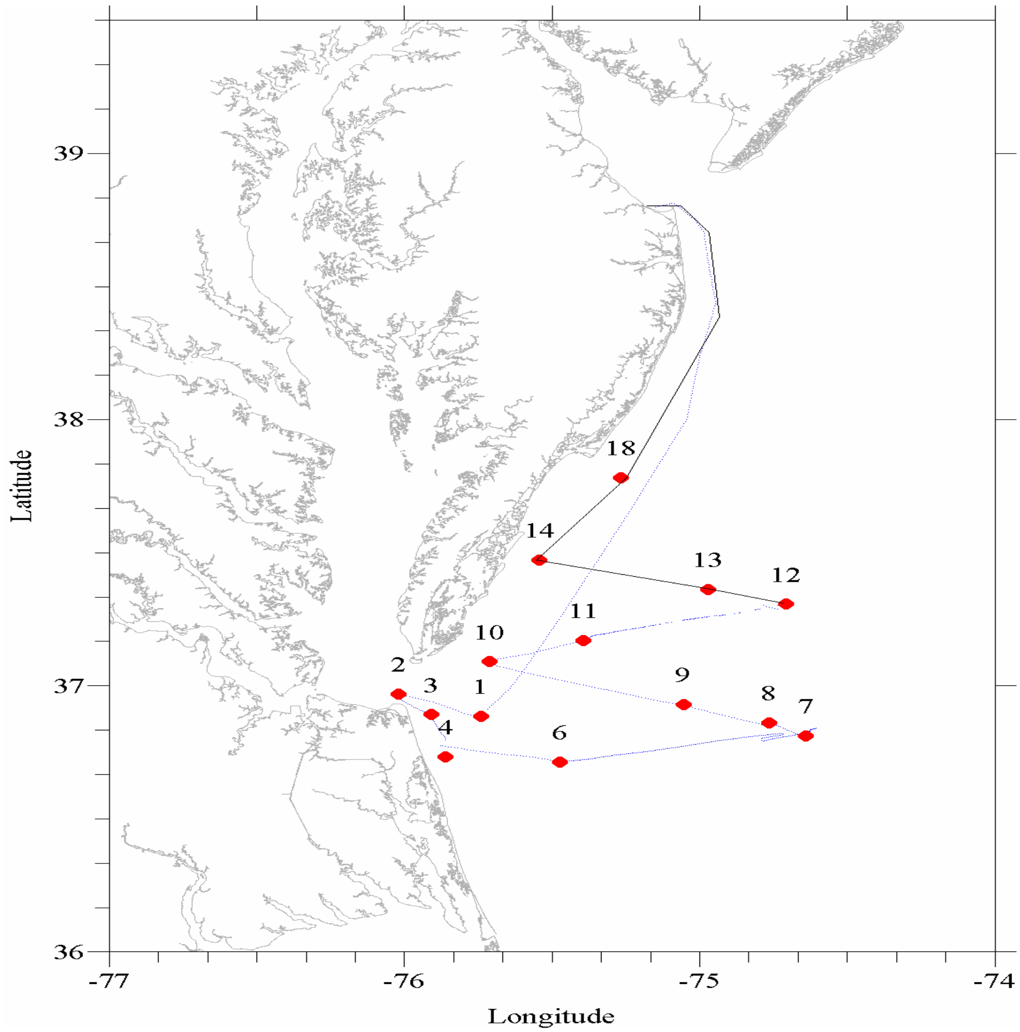


Figure 6. Cruise track from BIOME I cruise

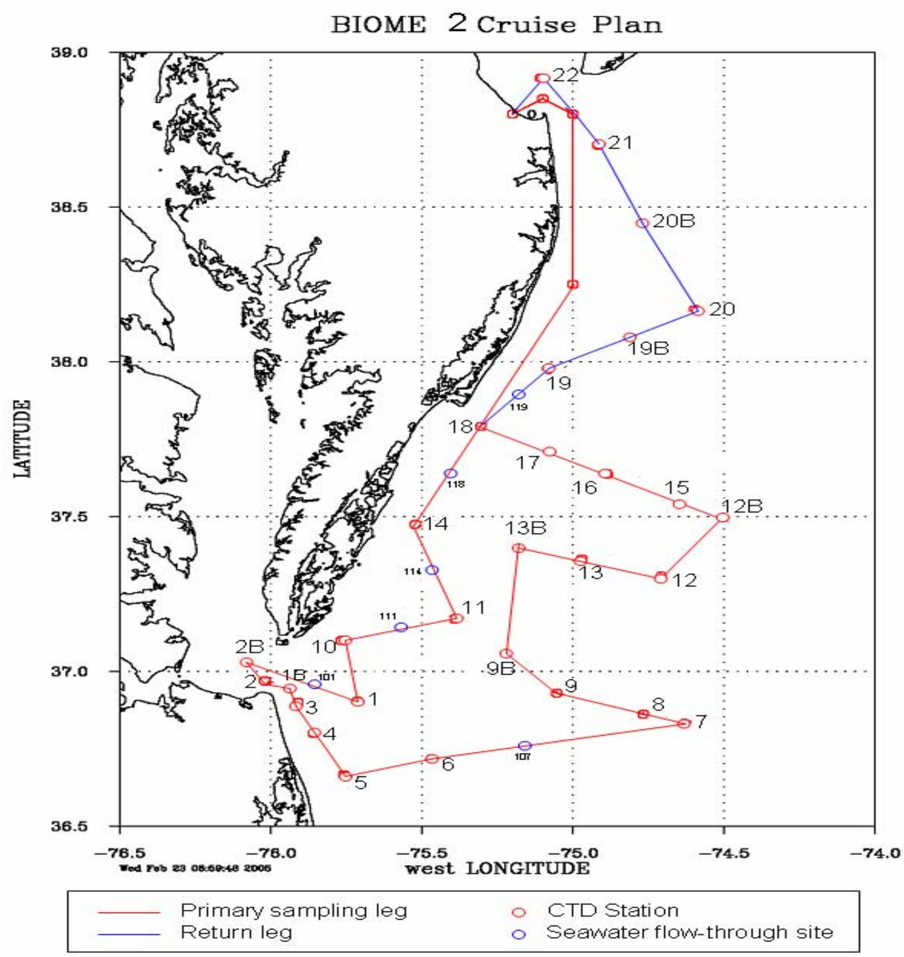
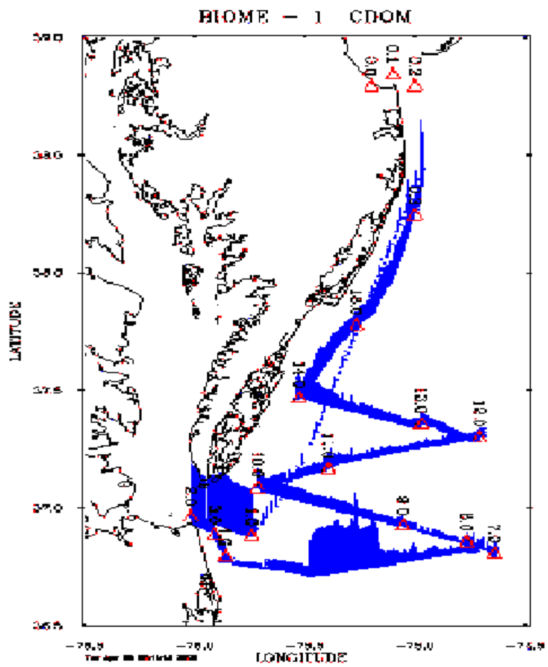
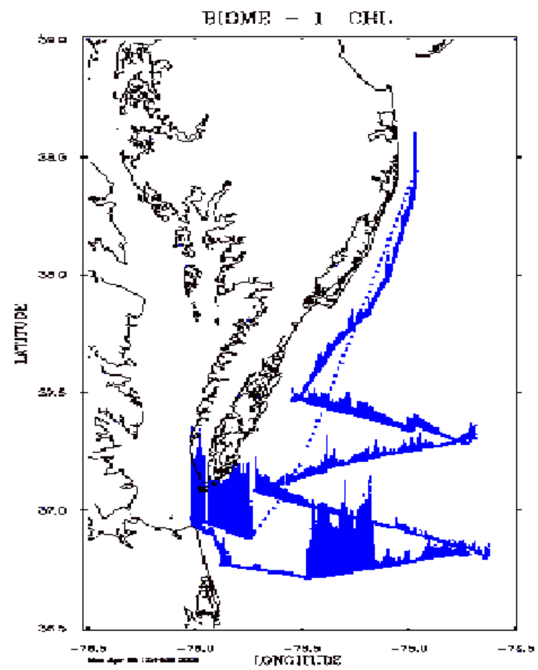


Figure 7. BIOME II cruise track.





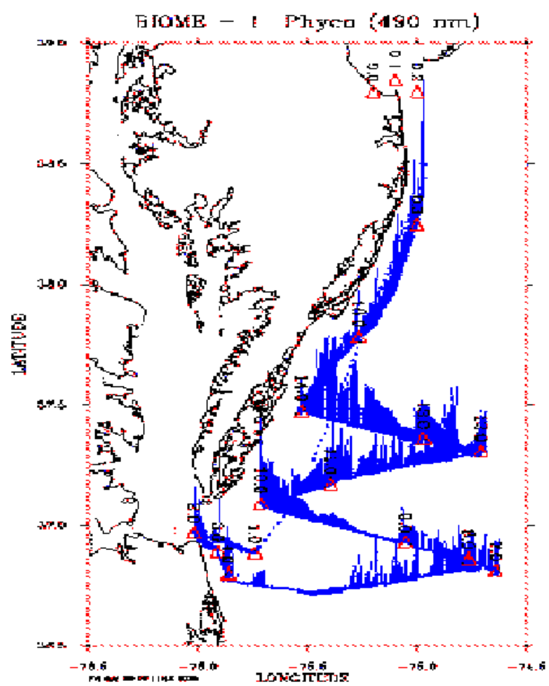


Figure 8. Values for CDOM (upper left panel), chlorophyll a (upper right panel) and phycoerythrin (lower left panel) measured by the shipboard laser fluorometer during the BIOME I cruise.

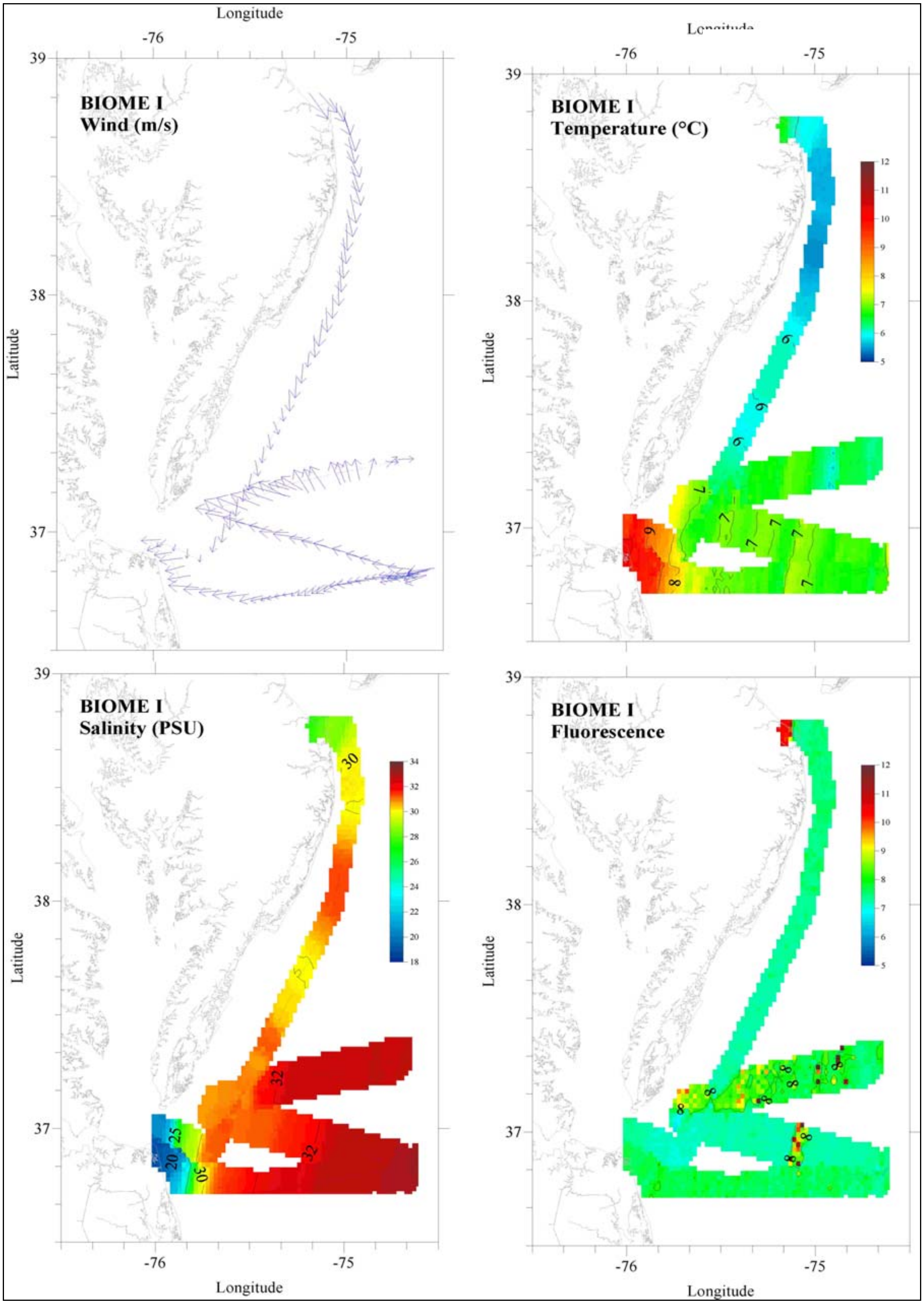


Figure 9. Wind speed, temperature, salinity, and fluorescence during Biome I.

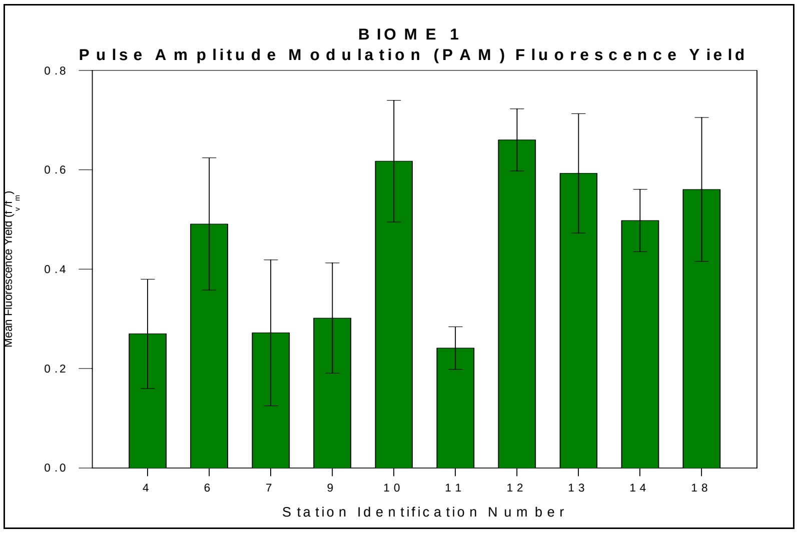
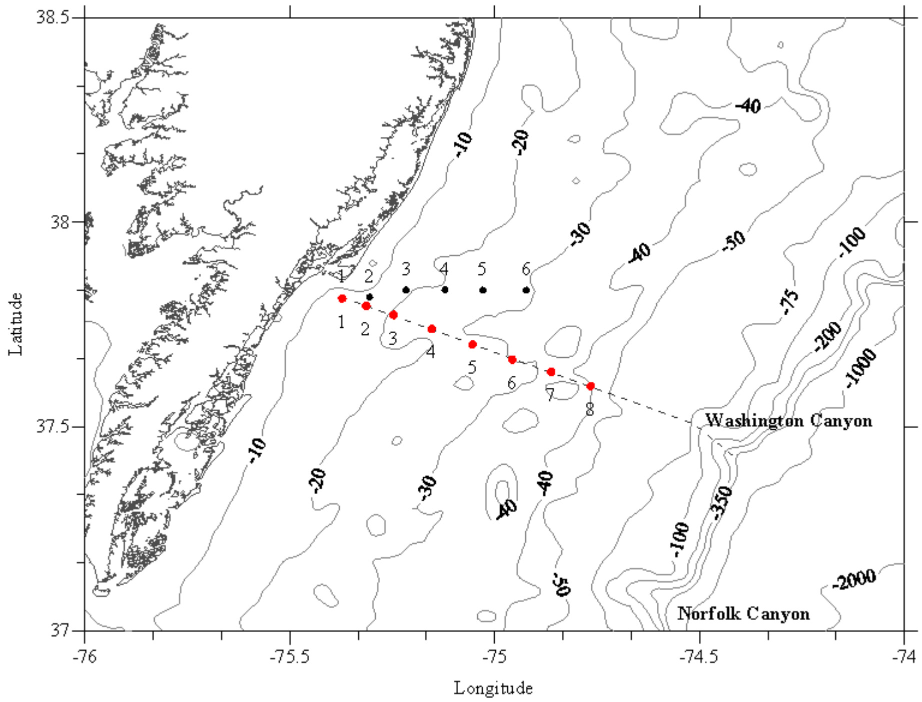


Figure 10: Mean fluorescence yield, as determined by pulse amplitude modulation fluorometry for each station of the BIOME 1 cruise. Samples were from surface waters only. Error bars indicate standard deviation.



Station	Longitude		Latitude		Distance (nm)	
Number	deg	min	deg	Min		sum
1	-75	22.328	37	48.809		0.0
2	-75	18.809	37	47.717	3.0	3.0
3	-75	14.805	37	46.382	3.4	6.4
4	-75	9.223	37	44.319	4.9	11.3
5	-75	3.276	37	42.013	5.2	16.5
6	-74	57.452	37	39.829	5.1	21.6
7	-74	51.748	37	38.009	4.9	26.5

Figure 11. Biweekly COBY transect cruise track and station coordinates.

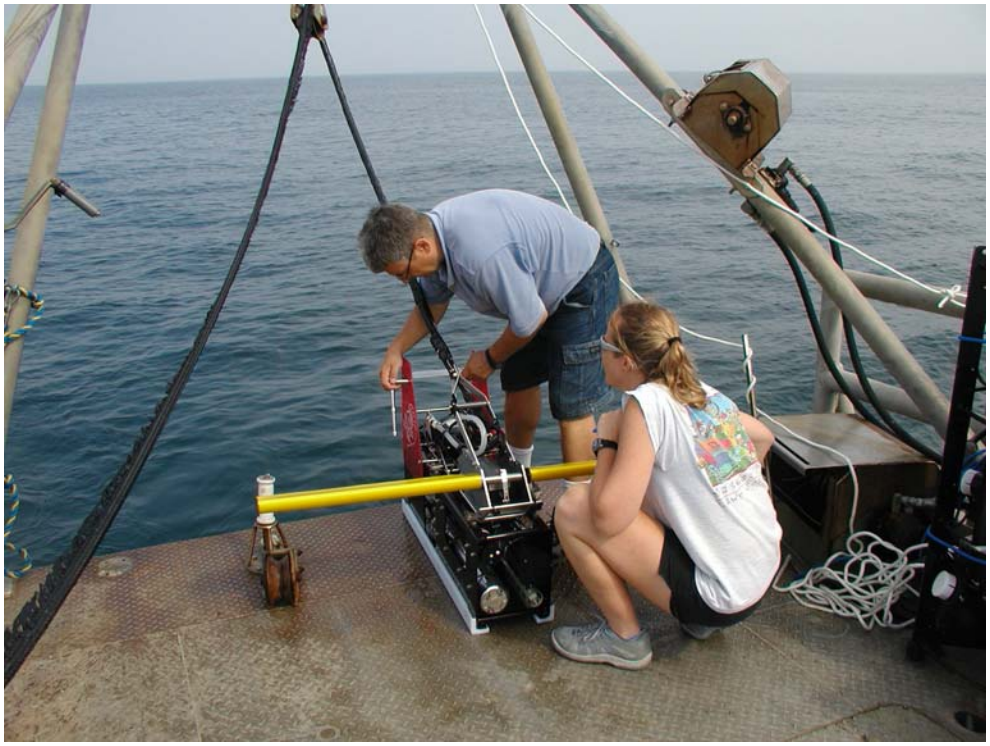


Figure 12. Pre-flight check during one of the bi-weekly cross shelf field surveys of newly acquired Dolphin bio-optical profiling system from Wet Labs.