

2008 Annual Report: Center for Ocean, Seafloor, and Marine Observing Systems

In 2008 the Center for Ocean, Seafloor, and Marine Observing Systems (COSMOS), under the direction of John Trowbridge, has been active in overseeing and promoting observing systems in the coastal oceans. Ultimately, observatories will improve our ability to monitor changes in coastal systems, enable scientific advances, and promote engineering development that will increase our understanding of the oceans. The present goal of COSMOS is to establish, off the Northeast US, an ocean observing system capable of achieving WHOI's scientific objectives in the region.

Ocean observing systems

"Observing systems" are installations of multi-use instrument arrays on physical platforms ("observatories") including both moored buoys and coastal observatory towers connected to land by power and data cables. These platforms carry a variety of attached instruments measuring a range of ocean properties – primarily water current velocity, temperature, salinity, water level and chemical nutrients. Observatories also use other means of making ocean measurements: autonomous underwater vehicles (AUVs), remote sensors such as underwater gliders, satellite images, and data from shipboard surveys. Ocean observatories collect data continuously, providing a complete spatial and temporal picture of changing conditions in the coastal ocean – something that was not possible to achieve using widely-spaced shipboard measurements or isolated moorings. Researchers can now couple observing system data with computer models to produce forecasts of ocean conditions and "hindcasts" – predictions of current conditions based on past data that test the models' accuracy. In addition to furthering scientific research, ocean observatory data are available for weather forecasting, emergency management planning, policy and land-use planning in federal, state and local government agencies, and private industry.

The Massachusetts Technology Collaborative John Adams Innovation Institute

An opportunity for WHOI to promote ocean observatories through COSMOS came via a matching-fund contribution from the Massachusetts Technology Collaborative through the John Adams Innovation Institute. COSMOS will administer the funds to stimulate development of the next generation of ocean observing technology and products by promoting academic-industry partnerships and providing access to an ocean test-bed.

The first phase of this five-year project includes upgrades and enhancements of the Martha's Vineyard Coastal Observatory (see below), establishment of an Underwater Acoustic Communication Network Test-Bed at MVCO, and addition of advanced meteorological sensors to existing weather buoys off the coast of Massachusetts – enhancements that will make WHOI a showcase for coastal observing capabilities.

Martha's Vineyard Coastal Observatory

A COSMOS activity that supports the goal of achieving WHOI's scientific objectives in the Northeast is managing WHOI's ocean observatory, the [Martha's Vineyard Coastal Observatory](#) (MVCO) on Martha's Vineyard's southern shore. Through COSMOS, MVCO's chief scientist Heidi Sosik and operations manager Janet Fredericks work with Jay Sisson, Andy Girard and other WHOI engineers and technicians to operate and maintain the MVCO.

MVCO, a cabled observatory, connects an undersea power node, plus a tower carrying instruments, to an onshore "meteorological mast" monitoring weather, and an onshore laboratory. The MVCO provides laboratory-quality power and communications in a nearby ocean setting exposed to forcing from the open North Atlantic. For seven years MVCO has sent oceanographic and atmospheric data to scientists via continuous high-speed two-way communications, for dozens of projects funded by the National Science Foundation (NSF), the Office of Naval Research (ONR), the National Aeronautics and Space Administration (NASA) and private funds.

Among projects using MVCO data and facilities (its capability to provide power and bandwidth to modern instrumentation) in 2008:

- Heidi Sosik is comparing satellite data with data from instruments above and below the water at MVCO, in work sponsored by NASA, to determine the atmosphere's effect on satellite-retrieved data on ocean color (a proxy for the amount of phytoplankton present.)
- Sosik and Rob Olson use MVCO to test the "Imaging Flowcytobot," a robotic device Olson developed that measures chlorophyll and takes images of plankton cells sized between 10 and 100 micrometers (about 4 to 40 ten-thousandths of an inch) in seawater.



[Enlarge Image](#)

One of COSMOS activities is managing WHOI's ocean observatory, the Martha's Vineyard Coastal Observatory (MVCO) on Martha's Vineyard's southern shore. MVCO, a cabled observatory, connects an undersea power node, plus a tower carrying instruments, to an onshore "meteorological mast" monitoring weather, and an onshore laboratory. The MVCO provides laboratory-quality power and communications in a nearby ocean setting exposed to forcing from the open North Atlantic. (Photo by Jayne Doucette, Woods Hole Oceanographic Institution)

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It counts, measures, and identifies the organisms that bloom (have population explosions) in coastal waters and are critical parts of the marine food chain.

- MVCO's continuous record of ocean conditions and data from the Imaging FlowCytobot have made it possible to test ecological hypotheses about seasonal blooms of specific organisms. For instance, with NASA funding, Sosik, Steve Lentz and John Trowbridge, are using measurements from MVCO and models to characterize processes of water mixing, to study winter and autumn phytoplankton blooms.
- Instruments (seafloor and profiling sensors) at MVCO have determined the distribution of particles and optical and acoustical properties near the seabed. In a collaborative project funded by ONR, John Trowbridge and researchers from University of Maine, Dalhousie University and Bedford Institute of Oceanography, using advanced sensors that use the MVCO power and communications infrastructure, are collecting data and using those data to evaluate and improve computer models of the links between water physics, particle concentration and size, and optical and acoustical properties near the seabed.
- NSF supported Steve Lentz in a project to develop computer models of wave-driven water circulation over the inner continental shelf, using new data from a cross-inner shelf array of instruments at MVCO, plus past measurements from other coastal observatories and MVCO. The MVCO measurements were a central element of MIT-WHOI Joint Program student Melanie Fewings' doctoral thesis.
- ONR funded Jim Preisig to study the performance of underwater acoustics at MVCO to determine how to transmit data underwater, reliably and efficiently.
- ONR also supported the "Ripples DRI" project at MVCO: Peter Traykovski with colleagues from Dalhousie University, the US Geological Survey (USGS) and Naval Post-Graduate School deployed an array of high resolution, sidescan (side-looking) sonars for months, to measure changes in sea-bottom fine and coarse sand formations with wave and current conditions.
- The US Geological Survey conducted large-scale surveys with advanced sonar equipment to produce accurate measurements of the ocean bottom –and several very high- resolution surveys using an autonomous (robotic) vehicle, the REMUS-100 AUV.

The NOAA Integrated Ocean Observing System

NERACOOS's region, from Nova Scotia to New York City, includes bays, estuaries, and the coastal ocean to the western continental shelf. Issues of concern here include harmful algal blooms, nearshore and estuarine water quality, ecosystem and fishery sustainability, safety and efficiency of marine operations, and coastal flooding and inundation. Ocean observatories will help us address all these.

IOOS-supported projects within NERACOOS include:

- A grant led by WHOI that supports infrastructure throughout the entire NERACOOS region, including in particular buoys in the Gulf of Maine and Long Island Sound, data management and communications activities, development and test deployment of advanced sensors to obtain continuous time-series measurements of nutrient concentrations, and development and demonstration of advanced capabilities for simulation of storm surge and inundation.
- A grant led by WHOI that supports long-range planning for NERACOOS.
- The Northeast Benthic Observing System, which takes images of the sea floor with "HABCAM", a towed optical imaging system developed by Scott Gallagher and others. The system automatically processes images of the seafloor so researchers can characterize the habitat of sea scallops and measure scallop abundance and sizes on George's Bank, a historically rich fishing area. This information will help regulators of the scallop fishing industry.
- Hauke Kite-Powell is developing economic models to maximize the economic impact of NERACOOS.
- Funding went to Janet Fredericks to work on the "Open-Geospatial Consortium Sensor Web Enablement" program and to participate in the Global Earth Observations System of Systems (GEOSS) sensor web project to develop standards to allow "interoperability" between sensor data and data consumers. The important goal of this work is to create a standard framework for describing the capabilities of *in-situ* observatory instruments, how they take measurements, how data are processed, and how to implement data quality control. Such a framework will allow future users to better understand the observatory data they request and process.

Other national and international programs

COSMOS is also involved with international observatory systems. Jian Lin is working with scientists at Tongji University in Shanghai, China to define scientific objectives and plan a deep-sea cabled observatory in the South China Sea. Scott Gallagher and Janet Fredericks were invited guests at the International Workshop on SeaFloor Observatories in Shanghai.

Finally, COSMOS has been working in parallel with the ongoing development of the "Pioneer Array," a new observatory system to be installed south of Martha's Vineyard – part of a major program at NSF, the Ocean Observatory Initiative. WHOI is the implementing organization for the coastal- and global-scale components of this program: Principal investigator Bob Weller, project manager Libby Signell, project scientist Al Plueddemann and their colleagues at Scripps Institution of Oceanography, Oregon State University and Raytheon's Integrated Defense Systems Division were granted infrastructure funds over five years and additional operating funds for the first 10 years.

~~[John Trowbridge](#)~~, Center Director

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Mail: Woods Hole Oceanographic Institution, 266 Woods Hole Road, Woods Hole, MA 02543, USA.

E-Contact: info@whoi.edu; press relations: media@whoi.edu, tel. (508) 457-2000

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