

# The Pioneer Array



Tom Kleindinst, WHOI

The processes that shape the Earth and impact society must be investigated over the space and time scales at which they occur. New technologies are needed to provide long-term, high-resolution observations of critical environmental parameters. The National Science Foundation (NSF)-funded Ocean Observatories Initiative (OOI) will build facilities to be installed on the seafloor, in the water column and at the ocean surface. The OOI will make novel platforms available for oceanographic discovery and facilitate cutting-edge scientific investigations. The observatories will act as an interactive ocean research laboratory with a 25-30 year lifetime during which ocean measurements will be made available in near real time to the world via the Internet.

The Pioneer Array is a network of platforms and sensors operating on the continental shelf and slope south of New England that will bring a wealth of information to ocean researchers, fisheries, coastal managers, elected officials, and the general public about our shared ocean resources.

Operated by the Woods Hole Oceanographic Institution and its partner organizations (Scripps Institution of Oceanography, Oregon State University, and the Consortium for Ocean Leadership), the Pioneer Array is under construction now and is expected to be fully operational by the year 2015.

The data streams and data products of the OOI will belong to you, whether you are an ocean user, a scientist, a student, an educator, or an informed citizen.

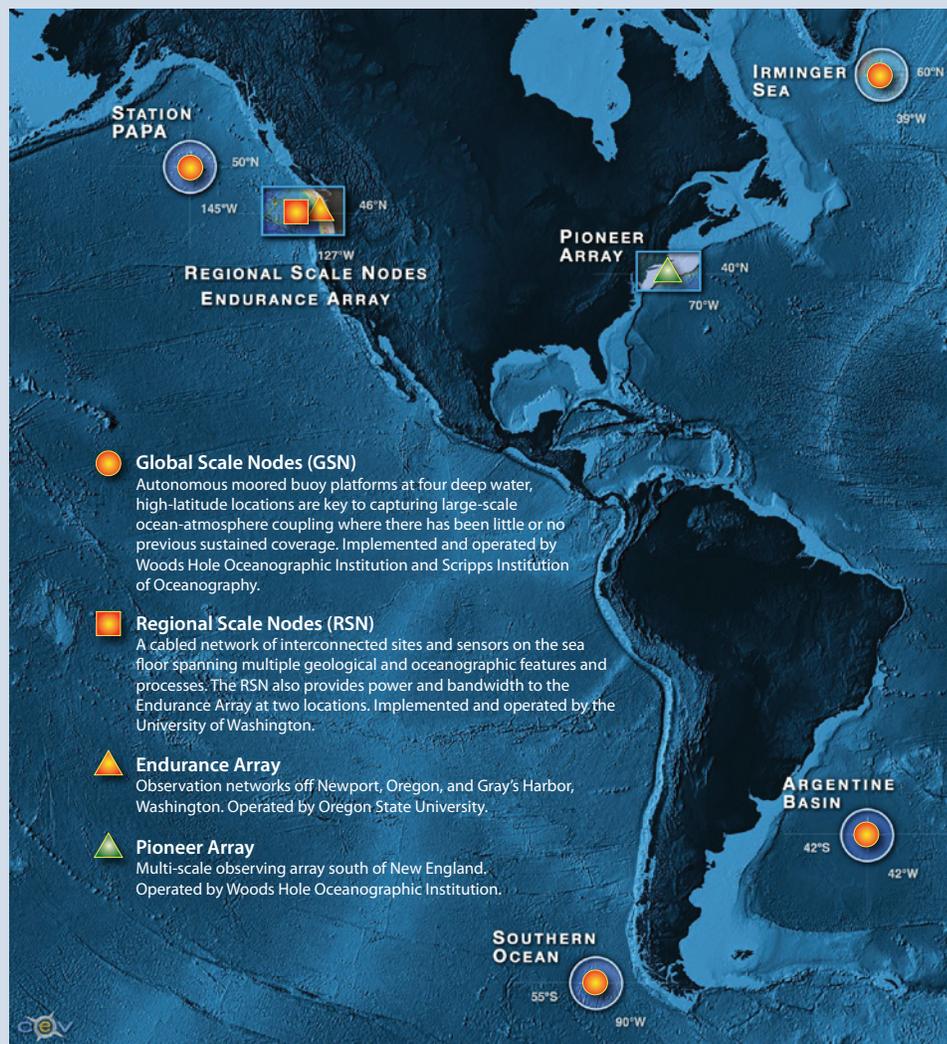
# The Ocean Observatories Initiative (OOI)

The NSF-sponsored Ocean Observatories Initiative (OOI) will construct a global, networked infrastructure of science-driven sensor systems to measure the physical, chemical, geological, and biological variables in the ocean and on the seafloor. Greater knowledge of these variables is vital for improved detection and forecasting of environmental changes and their effects on biodiversity, coastal ecosystems, and climate.

The OOI is a multi-scale observatory, comprising three levels of marine observations (coastal, regional, and global) integrated by an overarching cyberinfrastructure. OOI observatories and subsystems include:

- Marine Observatories: Coastal, Regional, and Global (see figure).
- Cyberinfrastructure (CI): Systems are integrated through CI, which provides connectivity to scientists and classrooms and allows the OOI to function as a single, secure integrated network.
- Education and Public Engagement (EPE): Educational infrastructure for the OOI is developed by the EPE component through the construction of software and Web-based tools to engage a wide range of users.
- Program Management and Integration: The Consortium for Ocean Leadership in Washington, D.C., is leading the implementation of OOI.

Just as the U.S. academic research fleet is a network of ships accessible to all investigators, the OOI will be an openly accessible network of ocean observatories to facilitate the collection of long timeseries data needed to understand the dynamics of biological, chemical, geological and physical processes.



Center for Environmental Visualization, University of Washington

# The Pioneer Array

The OOI Coastal Observatories will enhance and expand upon existing coastal observing assets, providing unique research capabilities to address complex problems in the coastal environment.

The Pioneer Array, operated by the Woods Hole Oceanographic Institution, will include a network of moorings and autonomous, robotic vehicles that can be programmed to monitor waters of the continental shelf and slope. The Observatory will be located along the “continental shelf-break” south of New England – the boundary where coastal waters meet the open ocean.

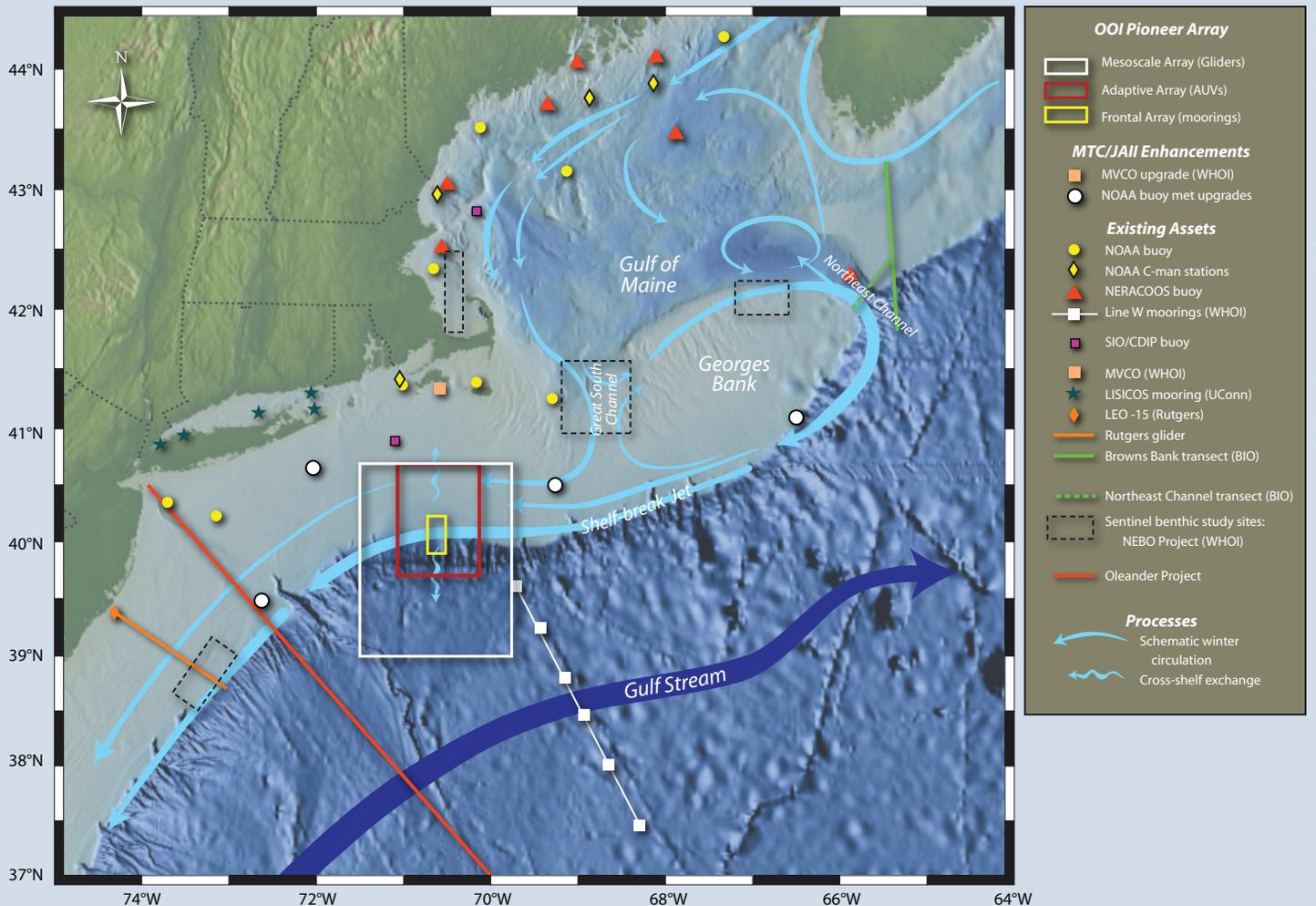
The Pioneer Array location is at a dynamic intersection where ocean currents meet in weather-like “fronts,” and where

nutrients, pollutants, and other properties are exchanged between the coast and the deep ocean. Data from the Pioneer Array will provide new insights into coastal ocean processes that are important to the New England shelf, and to continental shelf ecosystems around the world. These include:

- The structure of the shelf break front
- Nutrient exchanged between shelf and slope
- Continental shelf ecosystems
- Air-sea property exchange and climate variability
- Carbon dioxide flux and ocean acidification

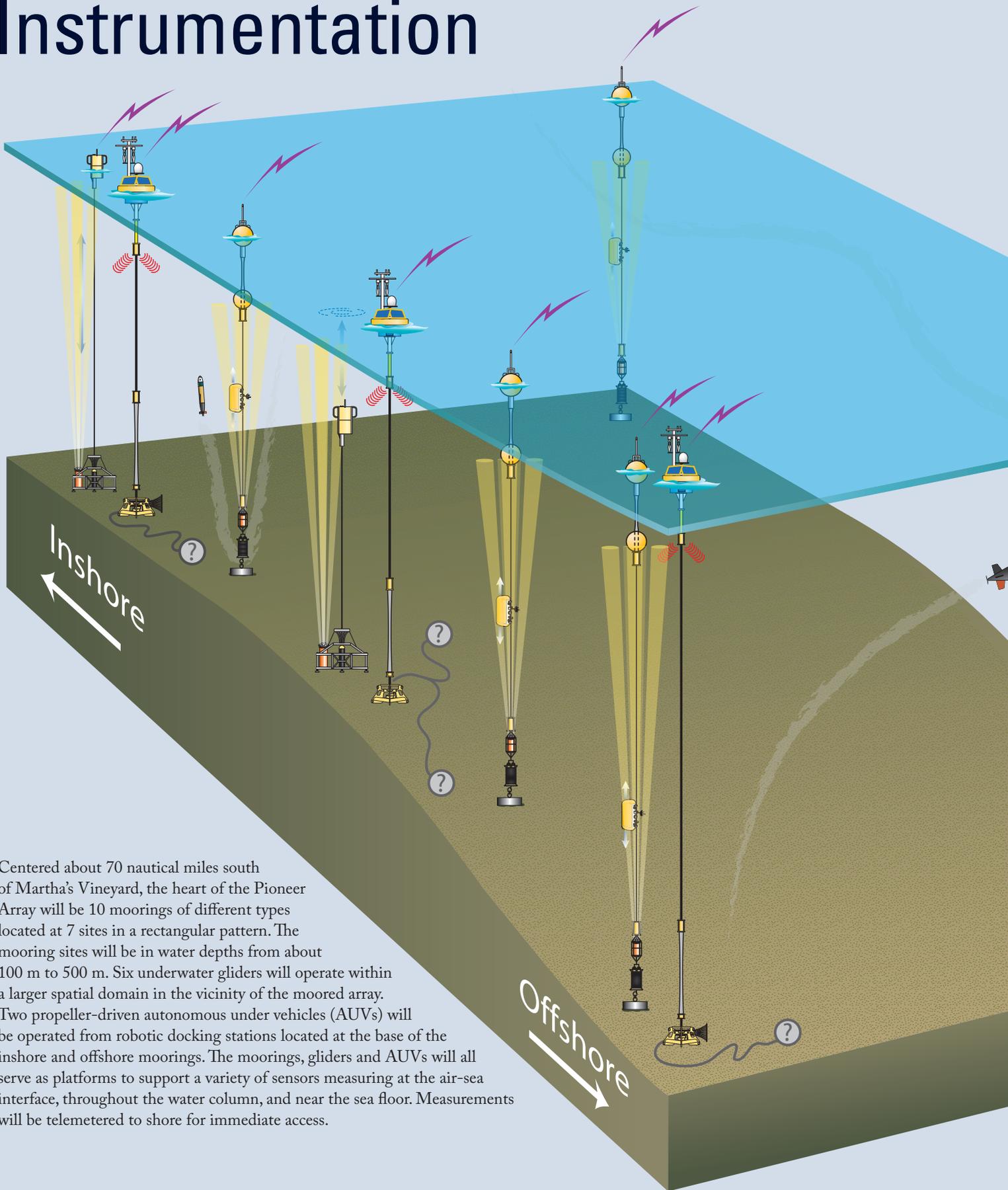


Courtesy of Hydroid, Inc.



Sosik and Plueddemann, WHOI; Illustration by Jack Cook, WHOI

# Instrumentation

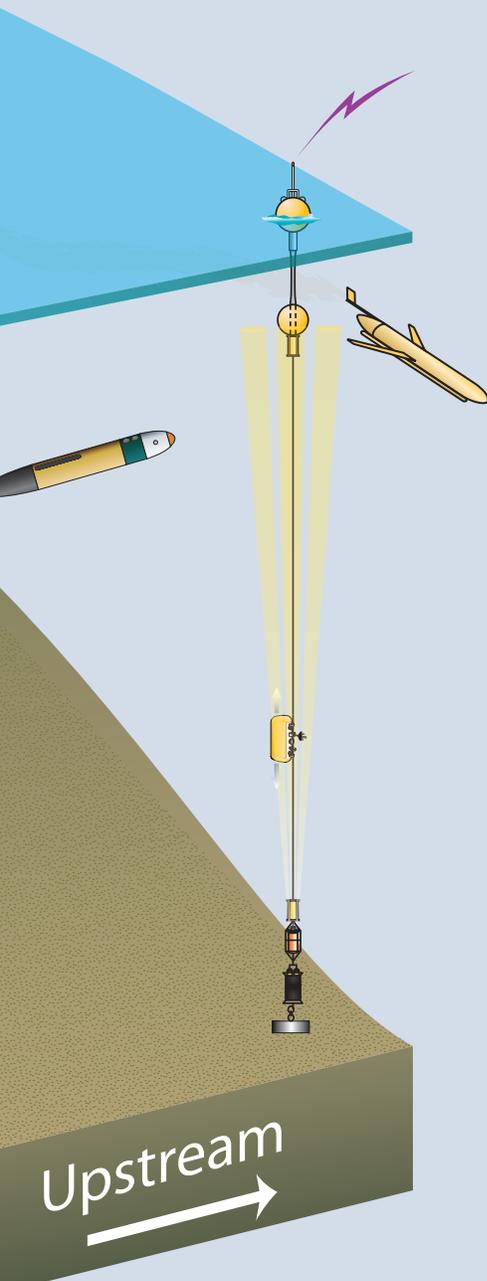


Centered about 70 nautical miles south of Martha's Vineyard, the heart of the Pioneer Array will be 10 moorings of different types located at 7 sites in a rectangular pattern. The mooring sites will be in water depths from about 100 m to 500 m. Six underwater gliders will operate within a larger spatial domain in the vicinity of the moored array. Two propeller-driven autonomous under vehicles (AUVs) will be operated from robotic docking stations located at the base of the inshore and offshore moorings. The moorings, gliders and AUVs will all serve as platforms to support a variety of sensors measuring at the air-sea interface, throughout the water column, and near the sea floor. Measurements will be telemetered to shore for immediate access.

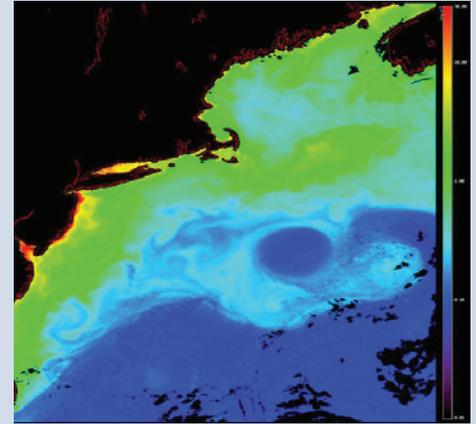
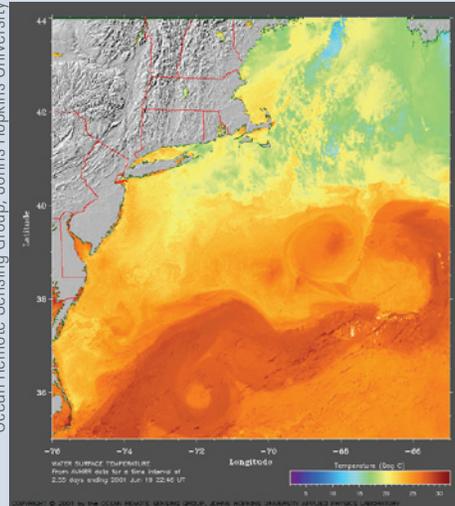
Al Plueddemann, WHOI; Illustration by Jack Cook, WHOI

# DATA COLLECTION NETWORK

The OOI networked sensor grid will collect ocean and seafloor data at high sampling rates over years to decades. Researchers will make simultaneous, interdisciplinary measurements to investigate a spectrum of phenomena including episodic, short-lived events (tectonic, volcanic, biological, and meteorological), and more subtle, longer-term changes and emergent phenomena in ocean systems (circulation patterns, climate change, ocean acidity, and ecosystem trends).



Ocean Remote Sensing Group, Johns Hopkins University



Heidi Sosik, WHOI

## COASTAL DYNAMICS

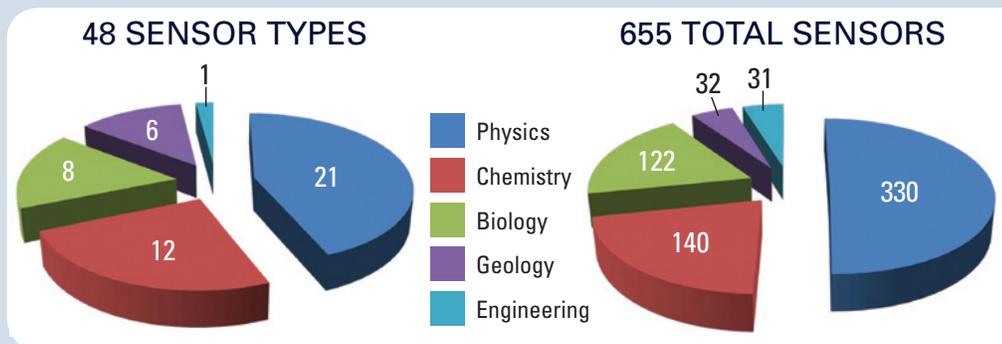
The mechanisms responsible for the distribution and exchange of properties between the continental shelf and slope are complex and not completely understood. The image above shows sea surface temperature measured by satellite, with relatively cold water on the shelf (yellow colors) and warm water over the slope (red colors).

## ECOSYSTEM DYNAMICS

The ecosystem is strongly influenced by the distribution and exchange of water properties. The image above shows chlorophyll concentration (a measure of plant growth at the ocean surface) for the same time period as the sea surface temperature distribution at the left. The cold shelf water shows relatively high growth compared to the warmer slope water.

## OOI SENSOR DISTRIBUTION BY DISCIPLINE

The charts below show sensor distribution by primary disciplines of biology, chemistry, physics, chemistry, geology, physics, and engineering. Below-left: how an estimated 48 sensor types will be distributed across disciplines. Below-right: how an estimated 655 individual sensors will be distributed.



# Benefits

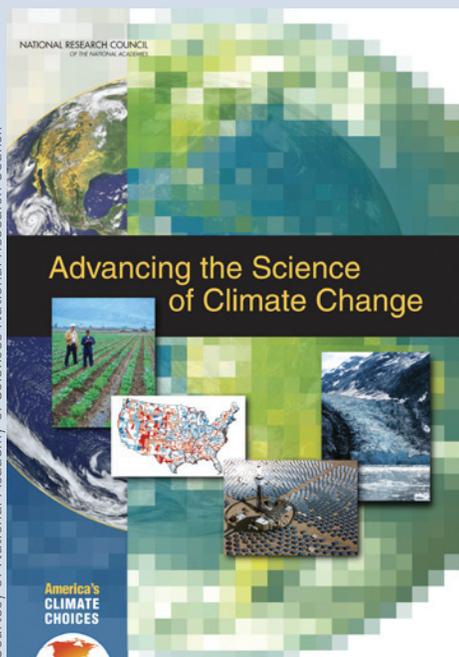
The goal of the OOI is to install transformational technology in ocean observatories to provide information to ocean users, researchers, policymakers and the public.



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Courtesy of National Academy of Sciences National Research Council

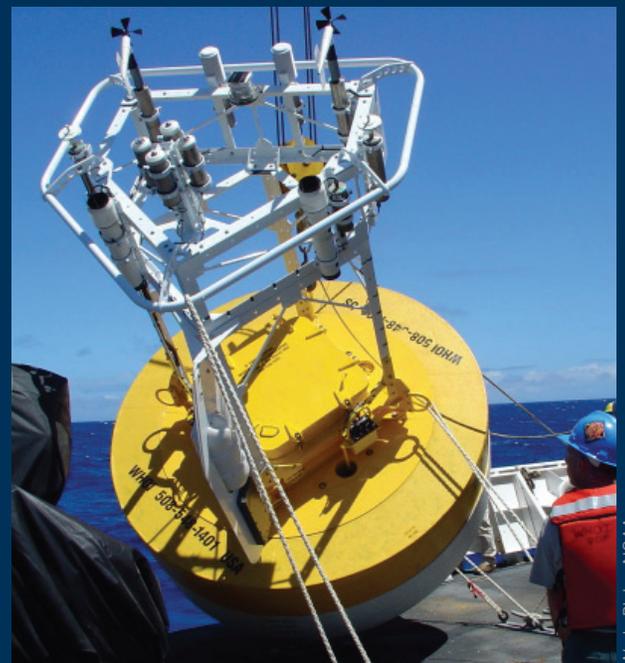
*WHOI researchers describe equipment, techniques, and research goals during a variety of outreach activities. Below, a visiting group of journalists learns about ship-based operations. Left, top: visiting scientists examine a moored profiler in the WHOI high-bay; left, middle: visitors to the MIT Museum see examples of observing technologies; left, bottom: data from the observatories is a valuable tool for policymakers.*



Jayne Doucette, WHOI

## Test Mooring Milestone

In mid-September 2011, the Ocean Observatories Initiative (OOI) program will conduct at-sea tests of moorings off the New England Coast, marking the first comprehensive test of an OOI system on the East Coast. Two of the test moorings are for the Pioneer Array component of the OOI and will be deployed in approximately 520 meters depth (1710 ft) on the continental slope south of Cape Cod; another test mooring, designed for use in the deep ocean global array part of the program, will be deployed in approx. 2480 meters (8136 ft).



Wade Blake, NOAA

# Facilities

The Woods Hole Oceanographic Institution is a private, independent organization in Falmouth, Mass., dedicated to marine research, engineering, and higher education. Established in 1930 on a recommendation from the National Academy of Sciences, its primary mission is to understand the ocean and its interaction with the Earth as a whole, and to communicate a basic understanding of the ocean's role in the changing global environment.

*Left, top: The WHOI-owned coastal research vessel, Tioga; Left, middle: An artist's conception of the Lab for Ocean Sensors and Observing Systems (LOSOS), currently under construction; Left, bottom: WHOI's Iselin marine facility. Right, top: WHOI operates the Navy-owned global class R/V Knorr; Right, bottom: Aerial view of WHOI research fleet in port.*



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Courtesy of WHOI



Jayne Doucette, WHOI



Courtesy of WHOI Archives

# The Pioneer Array



## Implementing Organizations

The Consortium for Ocean Leadership has selected “implementing organizations” to lead the development, installation, and initial operation of the individual OOI network components.

### Coastal and Global Scale Nodes

Woods Hole Oceanographic Institution (lead)

Oregon State University’s College of Earth, Ocean, and Atmospheric Sciences

Scripps Institution of Oceanography at University of California, San Diego

### Regional Scale Nodes

University of Washington, School of Oceanography and Applied Physics Laboratory

### Cyberinfrastructure Component

The University of California, San Diego, division of the California Institute for Telecommunications and Information Technology (CalIT2)

### Education and Public Engagement

Rutgers, The State University of New Jersey

University of Maine

Raytheon Mission Operations and Services

## Funding and Management

### National Science Foundation

The Ocean Observatories Initiative is funded by the National Science Foundation.

### Consortium for Ocean Leadership

The Consortium for ocean Leadership is a Washington, D.C.-based nonprofit organization that represents 99 of the leading public and private ocean research education institutions, aquaria, and industry with the mission to advance research, education, and sound ocean policy.

## FOR FURTHER INFORMATION

### Woods Hole Oceanographic Institution

General: [www.whoi.edu](http://www.whoi.edu)

Ocean Observing:  
[www.whoi.edu/observingsystems](http://www.whoi.edu/observingsystems)

### Ocean Observatories Initiative

[www.oceanobservatories.org](http://www.oceanobservatories.org)

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