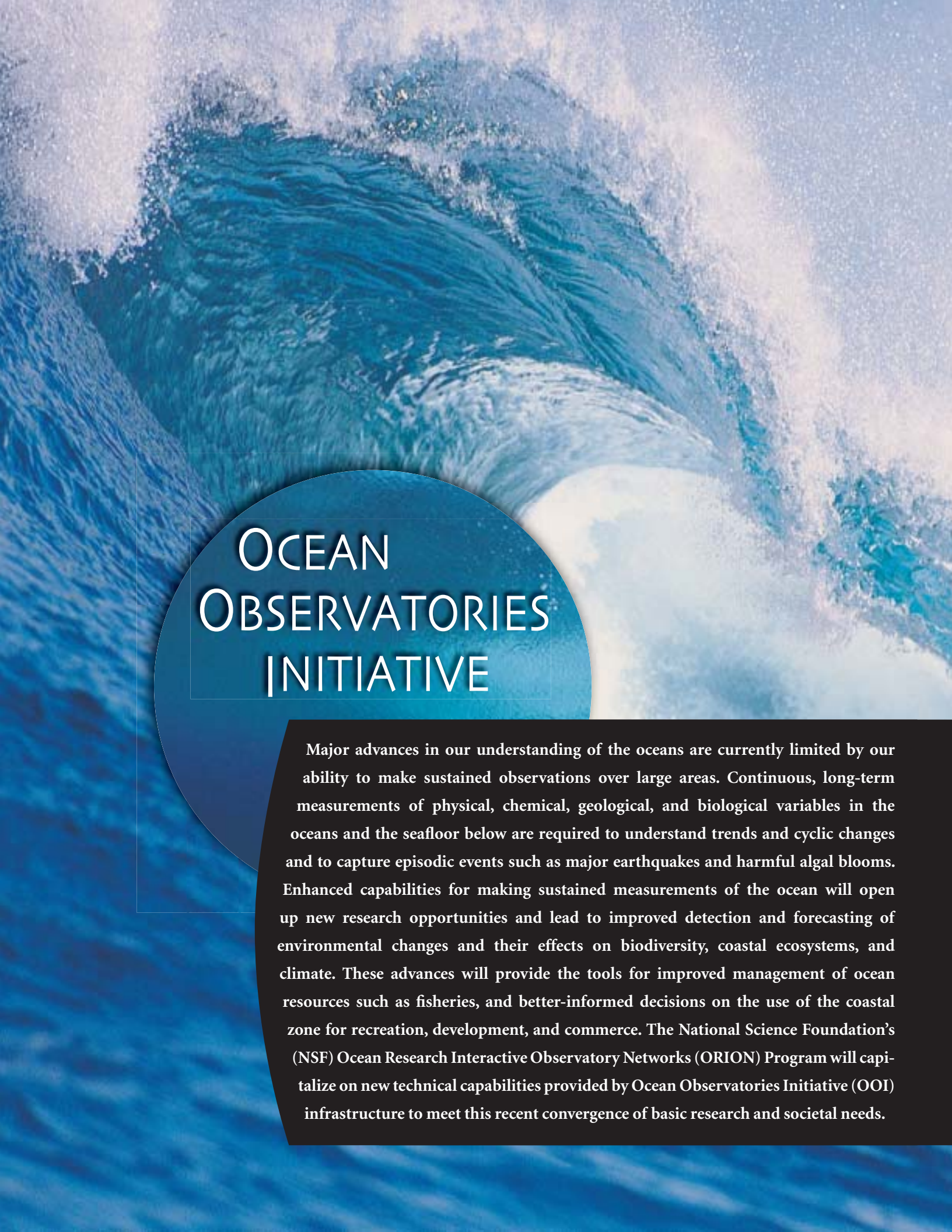
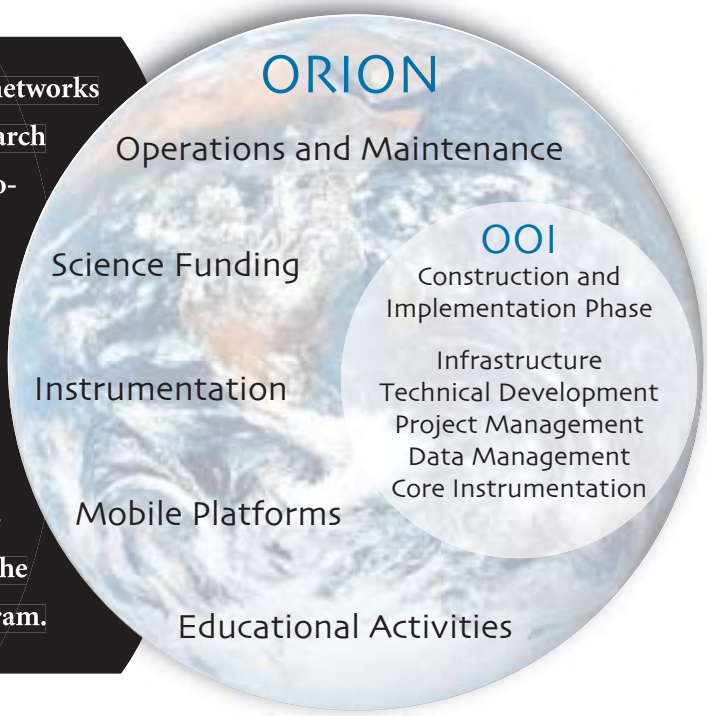


Ocean Observatories Initiative

Major advances in our understanding of the oceans are currently limited by our ability to make sustained observations over large areas. Continuous, long-term measurements of physical, chemical, geological, and biological variables in the oceans and the seafloor below are required to understand trends and cyclic changes and to capture episodic events such as major earthquakes and harmful algal blooms. Enhanced capabilities for making sustained measurements of the ocean will open up new research opportunities and lead to improved detection and forecasting of environmental changes and their effects on biodiversity, coastal ecosystems, and climate. These advances will provide the tools for improved management of ocean resources such as fisheries, and better-informed decisions on the use of the coastal zone for recreation, development, and commerce. The National Science Foundation's (NSF) Ocean Research Interactive Observatory Networks (ORION) Program will capitalize on new technical capabilities provided by Ocean Observatories Initiative (OOI) infrastructure to meet this recent convergence of basic research and societal needs.

The OOI, which is part of the ORION Program, will construct networks of ocean observatories using funds from NSF's Major Research Equipment and Facilities Construction account. These observatories will be linked to the Internet via seafloor cables or satellites, allowing global data access. Analysis and visualization tools developed by ORION scientists and made publicly available will permit all users to manipulate the data, thereby gaining a better appreciation of topical issues such as earthquake and tsunami mechanics, fisheries and coastal resource management, and natural and human influences on ocean and climate systems. The ORION Program will increase public awareness of the oceans through a comprehensive education and outreach program.



Major Components

Global processes that actively shape Earth and ultimately impact society must be investigated over the spatial and temporal scales at which they occur. To characterize the temporal behavior of dynamic processes occurring in the ocean, new types of infrastructure are needed that are capable of providing long-term, high-resolution observations of critical environmental parameters. These new observational capabilities will provide the means for the ocean research community to carry out fundamental research on natural and human-induced change on time scales ranging from seconds to decades. The scientific problems driving the need for an ocean observatory network are broad in scope and encompass nearly every area of ocean science.

To provide the ocean sciences research community access to a broad range of long-term measurements in the oceans and the seafloor below, the OOI will be comprised of three principal elements:

1 A **regional observatory** consisting of interconnected static observation sites located on the seafloor. These will span regional-scale (10-1000 km) geological and oceanographic features and related processes. This observatory component will use undersea telecommunications cables connected to shore to supply power, communications, data relay, and command and control capabilities to scientific instruments connected to nodes along the cabled system. These nodes will also be designed to interface with moored instruments and dynamic observing platforms, such as autonomous underwater vehicles, or floats for sampling the water column.

2 Several **relocatable deep-sea moored buoys** will contribute to studies of the ocean's role in global climate and will help support additional observations of the structure and dynamics of Earth's interior. Moored observatories consist of surface systems that provide central power generation, and data communication by a satellite or radio link to shore. The moored buoy then supports water column sensor systems for physical, biological, and chemical studies, seafloor geophysical sensors, and sophisticated flux measurements that quantify the ocean-atmosphere exchange.

3 An **expanded network of coastal observatories** will provide critical measurements to better understand processes related to along- and cross-shelf transport and transformation, to assess the predictability of episodic events (e.g., harmful algal blooms, storm surge, coastal erosion), to improve the accuracy of regional coastal models and forecasts, and to assess the impact of anthropogenic inputs to and through the coastal zone. Coastal observatories will gather data using both moored buoys and cables.

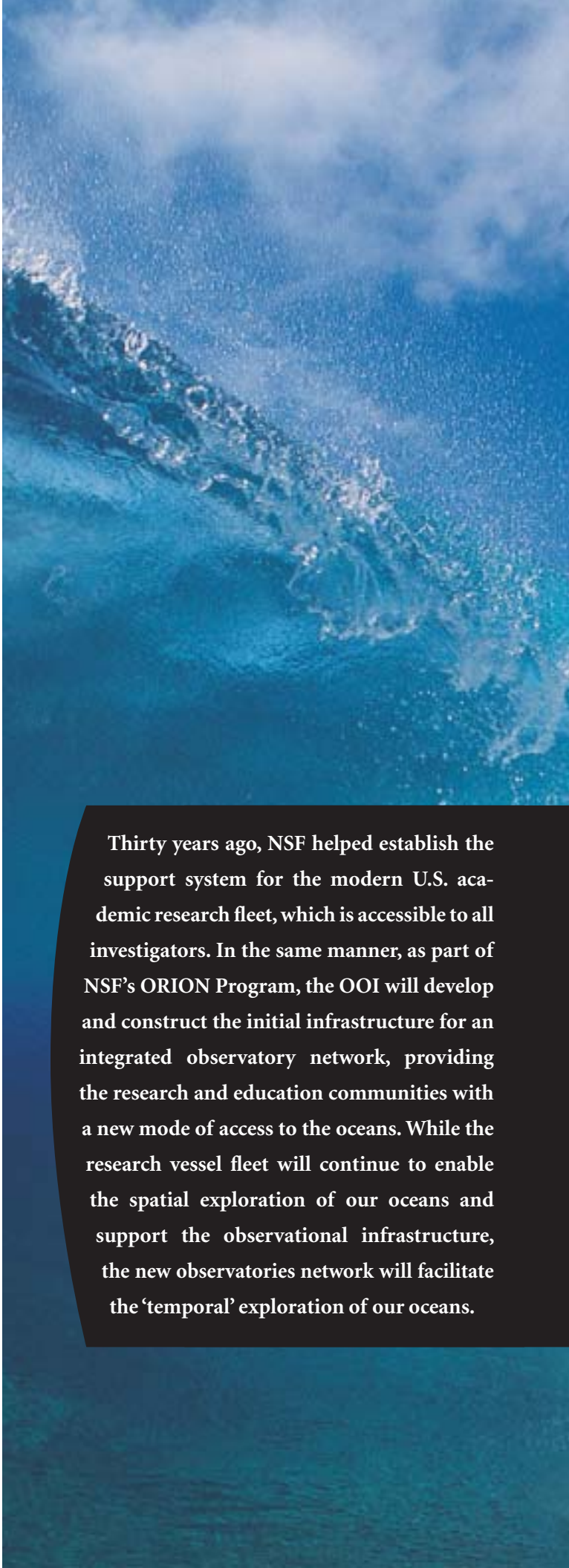
To broaden the observing extent for all three observing elements, a wide variety of methods for gathering data such as autonomous vehicles, satellites, airborne sensors, and research vessels will be used. OOI infrastructure will be deployed in phases, permitting sufficient prototyping and testing of all components of this complex network.

Scientific Challenges

Since the 1960s, important oceanic phenomena (e.g., eddies, fronts, microbial food webs, plate tectonics, and hydrothermal vents) have been discovered and measured through ship-based expeditions and limited-duration process studies. The next challenge in ocean science is to understand the initiation and evolution of these complex phenomena and unravel the interactions and feedbacks among the underlying processes. These studies require the establishment of a long-term presence in key oceanic regions to obtain detailed, multidisciplinary measurements at the appropriate time and space scales.

Examples of scientific topics and themes that can be tackled using the new ocean observatory capabilities encompassed by the ORION Program and the OOI infrastructure span a wide range of studies, including:

- variability in the patterns of and controls on biological diversity and abundance in the deep sea and within the sediments and oceanic crust;
- the dynamics of organic carbon cycling in the ocean and its link to carbon sequestration in sediments and the role of the ocean in moderating atmospheric carbon dioxide buildup;
- the genesis, development, and impact of coastal episodic events such as harmful algal blooms, introduction of exotic species, cold air outbreaks, and extreme runoff from storms;
- slippage on subduction-zone thrust faults that may result in large tsunami-generating earthquakes;
- mixing in the ocean and the transfer of energy at different scales through turbulence and seafloor interactions, leading to greatly improved ocean circulation models for studies ranging from local ecosystem dynamics to the coupled ocean-atmosphere climate system;
- a direct assessment of advective chemical transport across ocean margins and interfaces to characterize and forecast change in the chemical composition of the ocean;
- seismic and geodetic monitoring leading to a more detailed understanding of deep Earth structure;
- the relationship between marine ecosystem structure and function and the timing and strength of nutrient upwelling along the coast;
- the exchange of heat, water, momentum, and gases between the atmosphere and ocean in remote ocean areas;
- cross-shelf transport that governs the health of our coastal ecosystems and the role of coastal waters in the global ocean;
- the ocean's role in the hydrologic cycle both as a recipient of coastal fresh water and a source of evaporation in the sub-tropics.



Thirty years ago, NSF helped establish the support system for the modern U.S. academic research fleet, which is accessible to all investigators. In the same manner, as part of NSF's ORION Program, the OOI will develop and construct the initial infrastructure for an integrated observatory network, providing the research and education communities with a new mode of access to the oceans. While the research vessel fleet will continue to enable the spatial exploration of our oceans and support the observational infrastructure, the new observatories network will facilitate the 'temporal' exploration of our oceans.

The ORION Program and OOI infrastructure are an outgrowth of several community-wide scientific planning efforts that build upon recent technological advances and successful pilot projects. The wide, multidisciplinary support for establishing a network of seafloor observatories for ocean research has been demonstrated through community input at numerous national and international workshops. Workshop and community reports (see below) have established the intellectual basis for the ORION Program and defined the need for the OOI infrastructure.

The outcomes of research and technology development, which are an integral part of the OOI, will provide essential support for the Integrated Ocean Observing System (IOOS). This operationally focused system is being developed and coordinated by Ocean.US under the auspices of the National Oceanographic Partnership Program. A coordinated effort will be established to ensure unified data handling and dissemination procedures that use the most advanced information and communications technologies available for both the OOI and the IOOS.

For More Information

- *Ocean Sciences at the New Millennium*: www.joss.ucar.edu/joss_psg/publications/decadal
- The NRC report, *Illuminating the Hidden Planet*: www.nap.edu/catalog/9920.html
- The NRC report, *Enabling Ocean Research in the 21st Century: Implementation of a Network of Ocean Observatories*: www.nap.edu
- *An Information Technology Infrastructure Plan to Advance Ocean Sciences*: www.geo-prose.com/oiti/report.html
- *SCOTS: Scientific Cabled Observatories for Time Series*: www.geo-prose.com/projects/scots_rpt.html
- *Coastal Ocean Processes and Observatories: Advancing Coastal Research*: www.skio.peachnet.edu/coop/materials/COS_report.pdf
- *Implementation Plan for the DEOS Global Network of Moored-Buoy Observatories*: www.coreocean.org/deos
- Ocean.US activities: www.ocean.us

This brochure is part of ORION/OOI planning activities being undertaken by the Dynamics of Earth and Ocean Systems (DEOS) Steering Committee, which was formed to advise NSF regarding ocean observatories planning. For more information on ORION and OOI activities, go to www.orionprogram.org or www.coreocean.org/deos.

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