THE RELATIONSHIP BETWEEN THE INTEGRATED OCEAN OBSERVING SYSTEM AND THE OCEAN OBSERVATIORIES INITATIVE

Statement by the Interagency Working Group on Ocean Observations of the Joint Subcommittee on Ocean Science and Technology
July 2007

Overview

With the continuing development of the Integrated Ocean Observing System (IOOS), including drafting of a strategic plan, and a Final Design Review scheduled for the Ocean Observatories Initiative (OOI) in 2008, this is a particularly appropriate time for the Interagency Working Group on Ocean Observations (IWGOO) to address the relationship between the two ocean observing systems. The establishment of the IWGOO under the National Science and Technology Council (NSTC) Joint Subcommittee on Ocean Science and Technology (JSOST) reflects both the importance of ocean observing to a large number of Federal agencies, and their involvement in a wide array of related activities.

At the request of the Interagency Committee on Ocean Science and Resource Management Integration (ICOSRMI), and in response to concerns expressed by the Ocean Research and Resources Advisory Panel (ORRAP) at the December, 2006, ICOSRMI meeting, this statement was developed to address:

- The distinct but complementary nature of IOOS and OOI;
- Steps to communicate with the ocean community to clarify any confusion that may exist about their relationship; and
- Mechanisms to inform and strengthen planning to ensure that research and development necessary for IOOS is carried out, including (but not limited to) the transfer of research results from OOI to IOOS.

IOOS and OOI: Distinct but Synergistic

Both the IOOS and OOI initiatives arose from the recognition that the oceans are fundamentally under-sampled and many processes remain poorly understood, sometimes at the peril of the economy and well-being of the nation. They are complementary efforts to enhance our access to and understanding of the ocean and oceanographic processes. The IOOS will provide comprehensive, sustained and dependable observations in real time on a broad geographic basis, similar to the observations supporting the forecasts of the National Weather Service, to support information needs and forecasts for resource management, maritime transportation, and a host of other ocean and coastal activities. OOI will provide infrastructure to enable hypothesis-driven basic oceanographic and geophysical research by fostering specialized observations, instruments and activities for the purpose of answering basic research questions, with data available in as close to real-time as allowable. Whereas the IOOS will depend on established technologies capable of long-term, untended deployments in specific locations, OOI scientists will develop and use the latest technologies and sensors to push the envelope of knowledge. Just as OOI researchers will benefit from the data and access to the ocean that the unprecedented

spatial and temporal coverage of IOOS will provide, so will IOOS benefit as the techniques, sensors and knowledge gained through OOI-enabled activities migrate from research to societal applications.

IOOS

IOOS is working to "harmonize" and integrate a number of existing and planned independent, open ocean, coastal and Great Lakes observing efforts into a single "system of systems" with coordinated data management, assimilation and modeling to provide now-casting and forecasting of physical, biological, chemical, and geological ocean conditions. Both *in situ* and spaceborne observations systems are included in this effort funded by Federal, state and private sources. The emphasis is on providing information needed to produce knowledge-based solutions to management and policy related problems in seven (7) IOOS "Societal Goal" areas:

- Improve predictions of climate change and weather and their effects on coastal communities and the nation;
- Improve the safety and efficiency of maritime operations;
- More effectively mitigate the effects of natural hazards;
- Improve national and homeland security;
- Reduce public health risks;
- More effectively protect and restore healthy coastal ecosystems; and
- Enable the sustained use of ocean and coastal resources.

With an emphasis on products needed for public use, and the research needed to develop and utilize these products, IOOS is focusing on implementing a sustained base of regular observations, available in real-time, at local, regional, national, and global scales coupled to modeling and analysis capabilities that provide operational products. IOOS priorities are primarily defined by user requirements and agency missions.

IOOS has a "hierarchy" of observing system components, with 20 core variables that are priority measurements for the medium-term. At present, there are 11 regional programs covering all of the coastal areas of the U.S. as well as Alaska, the Hawaiian Islands and U.S. Pacific territories, the Caribbean, and the Great Lakes. Open ocean measurements include temperature profiles, currents, pressure, and wind vectors, which are key elements in forecast models of weather, climate and ocean circulation. In the coastal regions, priority variables include sea level, sea surface temperature, salinity (not Great Lakes), surface currents, and ocean color, giving rise to modeled operational forecast products such as harmful algal blooms forecasts, tsunami warnings and coastal inundation predictions. Regional specific issues result in additional parameters being included in certain regions, for example ice forecasts in the high latitudes for safe maritime operations. As sensors become available, measurements of biological variables will also become an important system component. Development and commercialization of biological sensors through, for example, the near-term priority on sensors outlined in *Charting the Course for Ocean Science in the United States for the Next Decade: An Ocean Research Priorities Plan and Implementation Strategy* (*Charting the Course,*

2007; http://ocean.ceq.gov/about/docs/orppfinal.pdf), may benefit the system and its users by expanding the number of operational measurements provided.

Additionally, IOOS plays a role in the public education arena as a tool to enhance development of a science, technology and operations workforce, and to improve the user community's ability to make informed decisions regarding the oceans, coasts and Great Lakes. Goals of IOOS education efforts include developing and sustaining a community of educators in informal, formal and postsecondary education that uses IOOS information to achieve their education objectives, and creating the workforce needed to develop and sustain IOOS and produce allied information products, services and tools.

OOI

OOI and its associated science programs at the National Science Foundation (NSF) will be operated by and for researchers and driven by basic research questions related to how the earth-ocean-atmosphere system works. Key scientific themes include:

- Climate variability and its impact on the global oceans;
- Coastal ocean dynamics linking land and sea;
- Plate tectonics, associated natural hazards and deep Earth structure;
- Role of turbulent ocean mixing in air-sea exchange, redistribution of ocean heat, carbon and nutrients, global climate and severe weather; and
- Biology, hydrology and geology beneath the seafloor.

Within each theme, basic research will lead to observations and models that improve predictability of ocean processes in areas of societal need, such as the IOOS Societal Goals.

OOI has four components: coastal observatories, a regional cabled observatory, a global system of relocateable moorings for open ocean settings at high and low latitudes, and a cyberinfrastructure that links the three for research and education. Each component will be configured to address specific science questions. OOI will emphasize flexibility in relocating observatories as science evolves, in sensor development, and in real-time interaction with experiments and observations at sea. The OOI deployments will be geographically targeted, but will sample with high spatial and temporal resolution. Data streams from OOI will be available in near-real to real-time (with possible delays for quality assurance/quality control procedures and any national security requirements) to all for use in basic and applied science. OOI research will be aimed at optimizing the observing system and utilizing it for basic scientific research that addresses topics of national concern. For example, the coastal component will provide information essential for ecosystem-based management, among other issues. In many cases it will further the needs of IOOS, but is not explicitly designed to do so.

Education will be an integral part of OOI, including the development of educational materials based on real-time access to experiments at sea for use in both formal and informal programs. The high-speed, interactive communication capabilities of OOI will open entirely new avenues for student and public audiences to interact with and

understand the ocean. To exploit these opportunities, ocean scientists and educators are working together to ensure that educational and public outreach needs are factored into planning from the beginning. An important element of this strategy is developing working partnerships with a number of existing education programs in the marine sciences. For example, NSF is planning for a new Center for Ocean Science Excellence in Education (COSEE) utilizing OOI science and technology.

Distinctions

While the systems share a similar fundamental ocean observing objective, there are critical distinctions.

	IOOS	**OOI**
Data	Driven by societal goals and must **routinely and continuously deliver data and data products** of known quality **in real time** to decision makers.	Governed by the needs of the research community, with **experimental data delivery in near-real time** ultimately leading to improved predictability of ocean processes in areas of societal need.
Sensors	Will depend on **highly reliable sensors** and data telemetry to ensure that critical data streams are not interrupted, as well as on operational models for making predictions with known levels of uncertainty.	Will provide the motivation and capability to try out **new, experimental sensors** and to develop new observing strategies that may eventually be adopted by the IOOS system once their reliability for routine operation is established.
Design	**Primarily stationary operational system**, designed to provide reliable operational data streams.	**Highly adaptive**, allowing scientists to respond to ocean events and control and adapt observatory assets and data streams to address new events.

Synergies

Although the primary motivation behind these two efforts differs (basic research applications for OOI and societal applications for IOOS), there are critical areas where the two efforts can and should work together to create powerful synergies:

- OOI, including both cabled and moored testbeds already in operation, will provide IOOS with fundamental advances in ocean access technologies. These include more robust and capable power and communication systems, tools for more effective data management and data access, higher capability observatory platforms, and advanced sensor technology that will enable IOOS to meet its longer-term operational goals;
- IOOS will provide a larger framework of observations and background data necessary for interpreting the process-oriented experiments that are the centerpiece of basic research by OOI researchers;

- The IOOS framework will provide enhanced access to atmospheric forcing functions essential to the OOI user community for numerical models linking the physical and biogeochemical processes in the upper ocean;
- IOOS will provide a potential pathway for enhanced and more timely impact of OOI research on societal needs;
- IOOS and OOI are new developments in ocean observing and are two components of a larger array of ocean observing elements.
- IOOS, OOI and their academic users will advance scientific knowledge necessary to achieve the longer term goals of IOOS and to develop next generation science questions that will drive OOI re-deployments;
- IOOS and OOI will be strong foci for ocean education, reaching potential workforce participants, students in K-12, college and post-graduate programs and the general public; and
- Both OOI and IOOS are next-steps in the ocean sciences and their application. Either would be diminished if the other did not exist.

Figure 1 provides a graphical overview of the distinctions and synergies between OOI and IOOS.

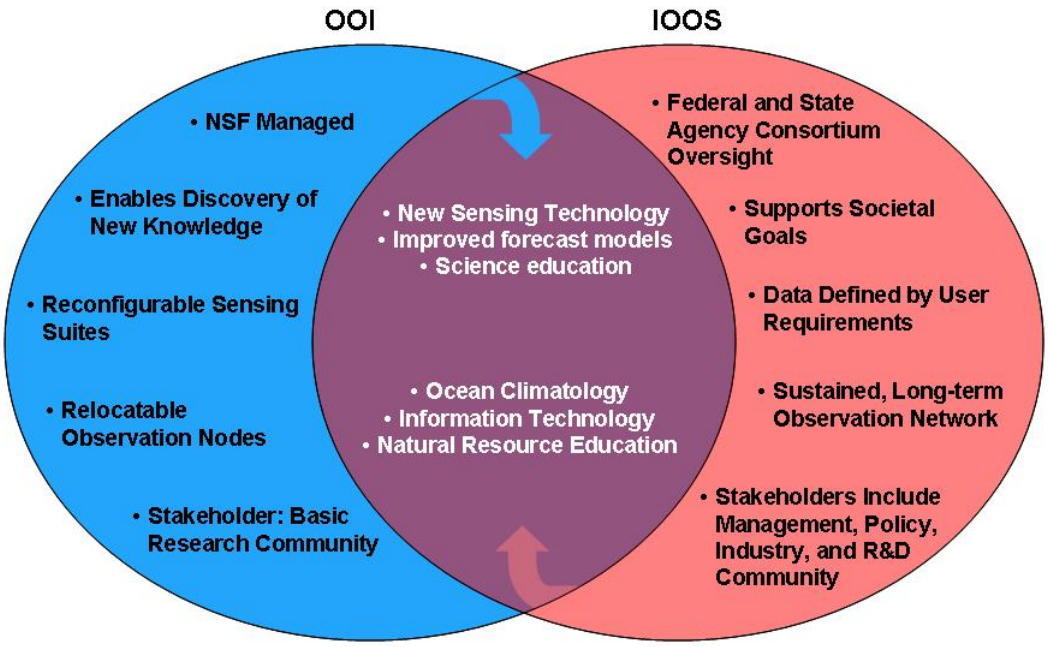

Figure 1: Distinctions and Synergies between OOI and IOOS.

Communicating with the Ocean Community

This statement, together with the IOOS Strategic Plan, will be used as the basis for a series of briefings for different segments of the community: Congress; the media; stakeholders in IOOS and/or OOI at the national, state and regional level; and the science community. Standard briefings on ocean observing would be in the larger context of

observations at sea via ships, satellites and shore-based facilities and the science they are meant to address, including priorities in *Charting the Course*. These briefings could be adapted to suit specific agency or audience needs, will be made available to member agencies, their principals and employees for use in activities such as budget hearings, town hall meetings, workshops and panels on ocean observing, and discussions with stakeholders.

Ensuring Coordinated Planning for IOOS and OOI

Currently, a limited amount of coordinated planning has occurred between IOOS and OOI on an ad hoc basis via a mix of formal and informal mechanisms. While these efforts have benefited both systems, a more institutionalized approach to coordination across a wider spectrum of issues and groups is needed. Liaisons between the IOOS Data Management and Communications Committee and the OOI Cyberinfrastructure Committee have provided valuable cross-fertilization in data management, one of the most essential enabling components of both programs. Formal interagency activities through the National Oceanographic Partnership Program Broad Agency Announcements on sensor development are also starting to contribute to specific areas of need for both OOI and IOOS. Informal communication occurs between program officers leading the development efforts, via interagency participation at workshops and other planning meetings, and through participation of the scientists and engineers involved in both planning efforts.

Looking forward, areas that will need substantive and sustained coordination include commercialization of sensor and access technology, transfer of research and development (R&D) products between systems, development of partnerships with the private sector, and optimization of data security and data integrity from the observing networks. As the observing systems are commissioned, topics such as methods for inter-calibration of in situ and satellite measurements and advancing modeling capability to utilize new types of data will also become important. The IWGOO will work with IOOS agency program offices and the OOI program office to develop strategies for coordinating planning and ensuring that interagency interests are represented and incorporated.

Additional Information on the status of these observing systems is available at:

1. U.S. IOOS (http://www.ocean.us/)
2. ORION (http://www.orionprogram.org/)
3. OOI (http://www.orionprogram.org/OOI/default.html)