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TEN YEARS OF NOPP ACCOMPLISHMENTS

BY ERIC J. LINDSTROM, JAMES J. KENDALL JR., AND BENJAMIN CHICOSKI

AGENCIES PARTICIPATING IN the National Oceanographic Partnership Program (NOPP) collectively invested over $295 million during the last ten years on significant collaborative activities that might not have been accomplished without the NOPP framework. The partnerships formed added efficiency to research and development, reduced duplication of effort, focused education programs, and strengthened communication of ocean issues.

The articles in this special issue of *Oceanography*, summarized below, demonstrate the range of work funded by NOPP. The program successfully brought together cutting-edge science, ocean information, and broad partnerships to better serve society generally and the ocean research community specifically.

EXCELLENCE IN PARTNERING AWARD WINNERS

The Bridge Project—2001 Award

One area emphasized heavily by NOPP is education. The Bridge project (article beginning on p. 28), whose title connotes the bridge of a ship rather than a bridge over an obstacle, is meant to be a filter for high-quality Web sites devoted to marine science education. Bridge, spearheaded by *Vicki Clark and Lee Larkin*, is a collection of highly informative online educational tools for science teachers at the K–12 level. More than 1,500 marine educators and scientists worldwide have subscribed to Scuttlebutt (Bridge's email discussion list) to help them stay abreast of the latest ocean science education news and resources.

The Argo Project—2003 Award

The Argo Project (p. 34) arose from a compelling scientific need for climate-relevant ocean data. This wide-reaching partnership created the first global array for observing the ocean's subsurface. The program began with regional float arrays in 1999, scaled up to global deployments by 2004, and remarkably achieved its target of 3,000 active instruments in 2007. The US contribution to Argo, under the leadership of *Dean Roemmich* and supported by the National Oceanic and Atmospheric Administration (NOAA) and the Navy through NOPP, provides half the floats in the international array, plus leadership in float technology, data management, data quality control, international coordination, and outreach. All Argo data are freely available without restriction, in real time and in research-quality forms.

Benefit Studies of Coastal Ocean Observing Systems—2004 Award

This NOPP-sponsored project (p. 44) led by *Hauke Kite-Powell* was a much-anticipated two-year effort by a team of researchers from around the country. The team developed and applied techniques for examining and quantifying the value of industrial and recreational activities in ten regions encompassing all US coastal waters. Their work interestingly incorporated economics and social sciences to determine the economic value of improved ocean-observing information for US waters, suggesting that aggregate values could be in the hundreds of millions of dollars per year.

Deep Wrecks Project—2006 Award

This multidisciplinary study (p. 50) focused on one basic question: do manmade structures (i.e., shipwrecks) function as artificial reefs in deepwater?

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The Deep Wrecks project, coordinated by *Rob Church*, forged a remarkable, perhaps unprecedented, partnership of scientists, historians, graduate students, filmmakers, technicians, and seamen. Encompassing a fascinating array of disciplines, the team examined six World War II era shipwrecks buried in the Gulf of Mexico seafloor at depths ranging from 87 m to 1,964 m. An additional educational component incorporated public outreach as an equal partner in every phase of expedition planning. In addition to the biological characterizations conducted at each site, the vessels were documented as historic sites for nomination to the National Register of Historic Places.

HYbrid Coordinate Ocean Model—2007 Award

Over five years, a partnership of institutions led by *Eric Chassignet* demonstrated the performance and application of real-time global- and basin-scale ocean prediction systems using the HYbrid Coordinate Ocean Model (HYCOM—p. 64). These systems couple the "best practices" of the academic and research communities with the operational missions of Navy and NOAA government labs. The systems include sophisticated, but relatively inexpensive, techniques for assimilation of satellite and in situ data. The partnership represents a broad spectrum of the oceanographic community, bringing together academia, federal agencies, and industry/commercial entities, spanning modeling, data assimilation and management, observational capabilities, and application of HYCOM prediction system outputs. The partnership itself provided the opportunity to leverage and accelerate the efforts of existing projects, producing products that should collectively serve users better than would the individual projects.

Multi-sensor Improved Sea Surface Temperature Project—2008 Award

Excellence in partnering is the one of the many outcomes of the Multi-sensor Improved Sea Surface Temperature (MISST) Project (p. 76) led by *Chelle Gentemann*. She assembled a strong, productive collaboration among National Aeronautics and Space Administration (NASA), NOAA, US Navy, academia, and private industry to study the development of improved sea surface temperature products. The team's work not only resulted in better products but also demonstrated the utility of those products in numerous operational and research applications. This project is a fine example of partnerships vastly expanding the influence and impact of basic research.

DATA/INFORMATION/PRODUCT DEVELOPMENT

An area that NOPP has emphasized is development of more sophisticated data products and ocean state estimation. Bringing ocean data of all kinds to the desktop in a useful and practical way is a hallmark of several NOPP projects. During the last decade, *Carl Wunsch and Ichiro Fukumori* led a team that examined the ocean's general circulation (p. 88). The aim has been to make the best possible estimates of ocean circulation and its role in climate by combining state-of-the-art models with the nearly complete global ocean data sets. Solutions are now easily available that adequately fit almost all of the observations and simultaneously are consistent with the models. They are being applied to understanding ocean variability, biological cycles, coastal physics, geodesy, and many other areas.

Pat Halpin led a team in developing a world center for marine mammal, sea bird, and sea turtle distributions (p. 104). The science needed to understand highly migratory marine mammal, sea bird, and sea turtle species has not adequately been addressed by individual data collections developed for a single region or single time period. These data must be brought together into a common, global map based on a coherent, interoperable, and openly accessible information system. To date, this information system, called OBIS-SEAMAP, includes more than 2.2 million observational records from over 230 data sets, spanning 73 years (1935–2008), and growth of this data archive is accelerating.

Peter Cornillon has long been recognized as a leader in data-sharing technology in the oceanographic community. NOPP was fortunate to gain his expertise and a strong team to develop the foundation for a National Virtual Ocean Data System (NVODS—p. 116). This effort has resulted in a robust data-access framework for oceanographic data and a broad community of ocean data providers that remains vigorous and growing many years after NOPP funding ended. The project produced a number of "lessons learned" related to the design and implementation of distributed data systems that can and do inform other related efforts.

OBSERVING SYSTEM PLATFORMS AND SENSORS

The Rutgers University Coastal Ocean Observing Lab (COOL—p. 128) headed by *Oscar Schofield and Scott Glenn* has provided the community with a unique perspective on partner-based regional observing systems. Promoting as a core value "the philosophy of partnership between diverse groups as fundamental," COOL is an enduring product of NOPP partnerships that has expanded to international collaboration. COOL provides a regional perspective that supports interdisciplinary process studies and provides a test bed, allowing rapid development of sensors and platforms, and it has anchored new science programs in which hundreds of scientists come together for intensive multi-institutional experiments.

Working toward better observation and sensing capabilities, NOPP-supported projects have facilitated a series of partnerships fostering the development of technologies and techniques that have allowed us to better describe the ocean environment and its processes. *Charles Eriksen and Mary Jane Perry* used NOPP support to demonstrate the versatility of Seagliders as well as their capability as "serious" autonomous vehicles (p. 146). The integration of chemical and biological sensors, efforts to improve the efficiency of power supplies, and upgrading software have served well in increasing their value and role in our ocean toolbox.

Working to develop a capability that goes beyond detecting and identifying physiochemical parameters, *Christopher Scholin* assembled a team to detect marine microbes, small invertebrates, harmful algae, and biotoxins. Their development of an Environmental Sample Processor (p. 158) moves our community from just observing, monitoring, and describing the environment to being on the verge of providing near-real-time information suitable for management and environmental response capabilities. This project presents an excellent opportunity for additional and stronger partnerships as commercial interests work to refine the procedures and their applications.

Looking toward the goal of providing more rapid feedback and predictions concerning the state and health of the ocean environment, *Tommy Dickey* led a team striving to improve our capability to measure biological, chemical, and optical parameters in the ocean. The consecutively sponsored O-SCOPE and MOSEAN projects (p. 168) led not only to the development and sustained operations of new sensors and systems, but also to new technologies for near-real-time telemetry and mitigating biofouling. The strong collaborations between the varied participants and the growing need for sustained observations on the ocean environment will surely substantiate the importance of this multiyear effort.

James Bishop led the NOPP-supported effort to develop a fully autonomous, real-time capability to observe carbon biomass and sedimentation of the world ocean (p. 182). Such a capability is fundamental to understanding the ocean carbon sink and the implications of rapidly changing conditions (e.g., acidification). Merging these technologies with well-proven platforms supporting other sensor suites moves us further toward a more complete understanding of the ocean carbon system. This project has demonstrated that year-round real-time observations of carbon concentration and sedimentation can be achieved in the world ocean.

An interdisciplinary team representing government, academia, and private sector scientists focused on maximizing the use of satellite ocean surface vector wind data (p. 194). Led by *Paul Chang*, the team's work helped build a foundation for more efficient use of their data in developing better operational weather forecasting and warning capabilities with potential for a sustained system serving users (customers) around the world. The utilization and acceptance of such products by the private sector is a solid example of the transitioning of research to operations.

THE OCEAN RESEARCH AND RESOURCES ADVISORY PANEL

NOPP is much more than the projects described in this article and detailed in the special issue section. Its external advisory body, the Ocean Research and Resources Advisory Panel (ORRAP) has, over the past 10 years, provided critical advice to the US federal government on ocean research, resource management, education, and priorities. Its most recent activity was to produce a strategic transition document for the Obama Administration. This report, and others, plus presentations and more information on ORRAP's accomplishments can be accessed at http://www.nopp.org/Dev2Go.web?id=207773.