Sea Grant
Science Serving America's Coasts

The Digital Ocean: Our Oceans on a Microchip

Imagine placing the oceans on a microchip. In a fashion, the Digital Ocean Project is setting out to do this by developing methods to create extensive digital representations, or models, of ocean resources and phenomena. Such models will enable us to translate chemical, biological and physical data into tools that will help us learn how best to use and tend our marine resources. The Digital Ocean Project—identified as one of three multimillion-dollar, multi-agency undertakings under Sea Grant's Coordinated Marine Programs to Assess and Sustain the Seas (COMPASS) proposal—builds on work pioneered by Sea Grant in the areas of autonomous underwater vehicles (AUVs), modeling, mobile platforms, robots, sensors and more. Sea Grant is also participating in the National Oceanographic Partnership Program's Ocean.US to develop an integrated and sustained ocean observing system for the United States. These existing technologies—coupled with developing others to gather, analyze and make data widely available—hold much promise.

Focusing on coastal areas

Today, more than 50 percent of all Americans live in coastal counties, and the number is expected to reach 75 percent by 2025. The Digital Ocean Project offers coastal zone applications to address the increasing demands posed by this concentration of population. Current U.S. facilities are demonstrating that the technology exists to collect real-time ocean data and readily share it via the Internet. Moreover, Sea Grant's success with the Autonomous Ocean Sampling Network shows that a network of AUVs working with distributed acoustic and point sensors can achieve spatially adaptive sampling.

The first stage of the project will be to develop tools to assimilate data from distributed observatories, or even individual networked ocean sensors. These models become more powerful when they can access data collected from around the nation or the world, so the second stage will be to connect these assimilated data with various existing computer models of ocean processes.

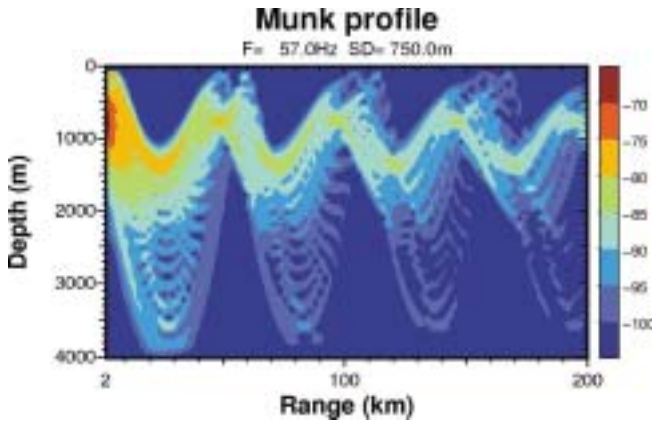
Examples of potential benefits abound. Fisheries managers will be able to quickly and easily test population models using data for Atlantic and Pacific salmon—or any other species. An almost instantaneous comparison of species trends across the country would provide a new tool for fisheries policy development. Similarly, models using assimilated water quality databases along a coastline or from neighboring watersheds would be of great value to regional authorities.

Particular topics of interest include wireless telemetry from fixed instruments, better fish stock assessment tools and intra-instrument communication so that any deployed sensor can become part of a vast network feeding data into a national database.

Preparing for hurricanes

One of the most exciting anticipated applications of the Digital Ocean Project is in the area of monitoring and models for extreme events, particularly hurricanes. U.S. financial losses due to hurricanes during the last decade were estimated at more than $53 billion. Ocean-based hurricane observation systems could greatly increase forecasting abilities and significantly decrease human fatalities and economic losses worldwide.

The coupled nature of the ocean and the atmosphere provides further rationale for increasing the ocean-based study of hurricanes. While the oceans are known to play a large part in weather processes, the atmosphere has been much more intensively studied. It is clear that studying hurricanes from an ocean perspective rather than solely an atmospheric one is of great importance.



Two Digital Ocean research areas are well-suited to investigate this area of extreme-event monitoring and modeling. The first involves the development of new *in situ* sensors capable of being used in a hurricane. AUVs, which have been used in many types of research and in hostile environments, could be modified to study the water column beneath hurricanes, or drifting sensors and rapidly deployed, robust moorings could be developed to ride through a hurricane.

The second area of investigation is the use of acoustic systems to provide greater spatial coverage of the ocean. Preliminary research indicates that hurricanes and other ocean storms may have distinctive acoustic signatures, which could be tracked over great distances. Other aspects of extreme events, such as monitoring earthquakes and underwater volcanic activity, could also prove fruitful areas of research.

Passive acoustics in fisheries

Because of their non-invasive nature, passive acoustic technologies hold special promise in helping to resolve many current fisheries issues. Over 800 species of fishes worldwide are known to be vocal, including some of the most abundant and commercially important species. Passive acoustics offers a unique tool for studying these fishes, which often live in dark and turbid waters and are difficult to observe by other means. Passive acoustic techniques can be used to locate concentrations of particular species, especially during their vulnerable spawning stage. This, in turn, allows spawning habitat to be identified, mapped and protected and fish numbers accurately assessed.

Passive acoustics can also be used to gain a better understanding of fish behavior, including migration patterns. These techniques can also be used simultaneously to monitor sources of noise pollution and evaluate the impact of human activities on marine communities. Noise generated by boating activity, seismic surveys, sonar, fish-finders, depth finders, drilling for oil and gas, and military activities all have unknown but potentially important impacts on marine fauna.

Supporting offshore oil industry

The Digital Ocean concept presents ample opportunities for supporting the offshore oil industry. The trend toward subsea wells—some 1,000 more are expected by 2005—illustrates industry expansion into deepwater and suggests the timeliness of supporting deepwater oil exploration, maintenance and safety. Recent fluctuations in oil prices make it clear that supporting our domestic oil industry is of vital national interest. Using our strong contacts with the oil industry, we can help create a new industry that contributes directly to Sea Grant's national strategic objective of economic leadership.

Two specific applications in this area include exploration and survey, and inspection and intervention. With improved AUV endurance and telemetry capabilities, researchers could deploy a small fleet of survey vehicles from one support ship and collect data more efficiently. That data could then be funneled into a comprehensive Digital Oceans database that the offshore oil industry could use to make critical decisions on pipeline routes and platform locations, providing increased safety, decreased environmental impact and substantial cost savings.

In the area of inspection and intervention, the important technologies will be sensors, telemetry and management and control software focused on the region immediately surrounding an offshore structure or pipeline. Properly equipped with quality sensors, high-bandwidth telemetry and the ability to perform highly complex tasks, AUVs could be permanently docked in these areas. This would vastly improve the efficiency and safety of intervention and inspection activities.

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Mission

The mission of the Digital Ocean Theme Team is to build on work pioneered by Sea Grant to develop methods for creating digital representations, or models, of ocean resources and phenomena. By gathering, analyzing and making data widely available, we can help provide essential tools for ensuring the health and sustainability of our marine resources and economy.

For more information:

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