Guest Editorial

FOR the past century or more, oceanographers have largely operated in an exploratory mapping and sampling mode using ships as their primary observational platform. More recently, satellite observing systems have provided a quasi-synoptic, global view of the surface ocean characteristics, and extended moorings have been deployed in key places to yield more localized measurements. These observing systems have led to a growing recognition of the wide range and interrelated form of the myriad processes occurring within and beneath the ocean basins, along with a growing belief that existing observation platforms are inadequate for full understanding of these phenomena.

The ocean sciences are on the threshold of a new era in which observing systems must become part of the ocean environment and yield *in situ*, real-time, interactive observations that cross conventional disciplinary boundaries. The processes whose interrelationships must be understood include (but are certainly not limited to) weather systems, ocean currents, air–sea exchange, primary and secondary production, ocean mixing, carbon sequestration, tectonic and earthquake cycles, seafloor volcanism, chemosynthetic systems, and marine mammal migration. In each case, the relevant ocean processes are highly episodic, interlinked, and driven by poorly understood dynamic forces. Further quantification of them requires the proactive approach of maintaining a presence within the ocean so that events can be observed when and where they occur.

This issue of the IEEE Journal of Oceanic Engineering (JOE) is devoted to the topic of **Ocean Observatories**. Ocean observatories are the key enabling technology required to provide real-time high-bandwidth, two-way communication with, and substantial power for seafloor measurement systems to provide a real-time scientific presence within the ocean. The development of critical technologies in communications, power, robotics, and ocean engineering will facilitate infrastructural changes that will gradually displace ships as the main observational platform for studying the ocean. For example, most process studies and numerical model simulations require routine measurement of the ocean interior that is not provided by satellite surface imagery or research vessels at the necessary temporal resolution and scale. Ocean observatories are already providing researchers with long-term continuous measurements of the ocean interior for these investigations.

Ocean observatories also offer the ability to modify measurement systems as the scientific requirement or evolving technology dictates, and hence can evolve with time to accommodate a changing mission. This is particularly true as technologies improve to the point where autonomous underwater vehicles (AUVs) can be routinely docked at ocean observatories where they can transmit their data and recharge before heading out on another mission. In the near future, the combination of AUVs, fixed arrays, and acoustic and mechanical profilers at cabled observatories will provide four-dimensional measurements of the ocean that can be specifically adapted for each investigation.

The technological capabilities afforded by these observatories provide unprecedented access to the sea, and the only access to the sea under extreme conditions such as those encountered during severe storms and hurricanes. For example, decades of expeditionary measurements from research vessels have done little to advance our understanding of air–sea interaction under extreme winds. This is due to the difficulties and an understandable reluctance to operate research vessels in dangerous sea states. Long-term, continuous measurements of air–sea exchange from ocean observatories in regions of the world that experience high winds would vastly improve our understanding of the oceanic response to high winds without risk of life.

Ultimately, it is envisioned that most of the ocean observatories will become integrated components of the existing operational network. As with the existing array, the measurements will provide data to government agencies for weather and ocean forecasts, climate studies, and regulatory decisions about, e.g., fisheries management. Scientists and the general public will benefit from the integrated measurements because of the improved access to a wide range of data and improved operational output from the government agencies. The enhanced operational data will also better serve the fishing, shipping and other ocean related communities. It is also anticipated that the infrastructure support provided by the operational network will allow researcher to focus more on their research using the observatories and less on observatory operations.

Finally, the existence of real-time high-bandwidth communications links to the seafloor open new opportunities for educating students and the public about the ocean sciences. These opportunities will attract the next generation of marine scientists who will be able to take full advantage of these emerging technologies and ocean observatories. We look forward to the new discoveries that will result from these efforts along with an improved understanding of the world's oceans. We hope this issue of the JOE provides some insight into how this is being accomplished today along with some ideas for the future.

JAMES B.EDSON, *Guest Editor*
Woods Hole Oceanographic Institution
Dept. of Applied Ocean Physics and Engineering
Woods Hole, MA 02543

ALAN C.CHAVE, *Guest Editor*
Woods Hole Oceanographic Institution
Dept. of Applied Ocean Physics and Engineering
Woods Hole, MA 02543

MANHAR D.DHANAK, *Guest Editor*
Florida Atlantic University
Ocean Engineering Department
Boca Raton, FL 33431-0991

FRED D.DUENNEBIER, *Guest Editor*
University Of Hawaii
School of Ocean and Earth Science and Technology
Honolulu, HI 96822

Publisher Item Identifier S 0364-9059(02)05339-6.