Argo’s “Robotic Oceanographers” Take the Ocean’s Vital Signs

Ocean observations are critical for coastal management, shipping, offshore industry and climate forecasting. NOAA researchers lead ocean observations through an innovative use of “robotic oceanographers” that measure ocean temperature, salinity, and currents. Called the Argo array, NOAA initiated its contribution to this international effort in 2000 by pledging to participate in the deployment of 3,000 free-drifting floats around the globe.

Unlike satellites which cannot “see” below the ocean surface, Argo floats spend most of their life collecting data from the surface to a depth beneath the surface of up to 2,000 meters.

Accurate climate forecasts depend on improving ocean observations within the upper layers of the ocean. Satellites relay Argo data to land-based receiving stations. From there, the data are made available within 24 hours for operational forecast centers and with more rigorous quality control within five months for scientists.

The array, which is sponsored by OAR’s Climate Program Office, is a major component of the Global Ocean Observing System (GOOS). OAR’s Atlantic Oceanographic and Meteorological Laboratory (AOML) is a U.S. Argo data center. AOML also has been active in Argo capacity building efforts for Atlantic nations, including 12 West African countries, as well as Korea and China. OAR’s Pacific Marine Environmental Laboratory in Seattle calibrates Argo floats before deployment and monitors quality control.

Impacts
A worldwide picture of ocean characteristics for industry use and climate forecasting

Scientists agree that sea levels are rising as a result of global climate change. Knowing how quickly and how high sea level will rise will help policy makers better protect coastal communities from the threat of inundation. Argo floats are collecting data that may help answer these questions.
Ocean Acidification: Climate Change Impacts on the Marine Environment

*Impact*

Understanding of climate change impacts on the ocean may lead to policies that better protect marine life.

Anyone who has had fish as pets knows that changes in pH levels can destroy life in an aquarium. The same is true in the ocean. About one-third of carbon emissions generated by human activities has been absorbed by the world’s oceans. And at a current uptake rate of 22 million tons a day, ocean absorption of carbon dioxide is lowering the pH, causing what is known as “ocean acidification.” Scientists at OAR’s Pacific Marine Environmental Laboratory (PMEL) are at work understanding this phenomenon. In field studies along the west coast of North America between Canada and Mexico, the PMEL team along with a large number of international collaborators found, for the first time, corrosive water caused by the ocean’s absorption of carbon dioxide (CO$_2$) now exists on the continental shelf of western North America.

Ocean acidification has serious implications for marine life. By the end of this century, many of the ocean’s creatures dependent on calcium to form their protective “shells” could be seriously impacted. Among them are marine algae and free-swimming zooplankton that serve as food for larger species. Fish larvae survival is also reduced, likely affecting commercial fisheries for years to come. Researchers at OAR’s Atlantic Oceanographic and Meteorological Laboratory have recently shown that coral reefs in the naturally acidic eastern tropical Pacific are becoming “unglued” as a result of the lack of cements that bind individual coral skeleton and larger reef structures. This makes reefs in high CO$_2$ waters more susceptible to erosion.

In their quest to continuously monitor and assess the impact of rising CO$_2$ on the world’s oceans, PMEL and partners have launched the first system specifically designed to monitor ocean acidification in the Gulf of Alaska. The buoy is part of a National Science Foundation project awarded to oceanographers at PMEL and the University of Washington in Seattle, in collaboration with Fisheries and Oceans Canada and the Institute of Ocean Sciences in Sidney, British Columbia.

*Images, top to bottom: Part of the largest coral reef in the continental United States along Florida’s coast; a free-swimming pteropod with a calcium carbonate shell; OAR scientist Christopher Sabine on a field study in the Southern Ocean aboard the NOAA Ship Ronald H. Brown.*

“*It’s just been an absolute time bomb that’s gone off both in the scientific community and, ultimately, in our public policymaking.*”

The Ocean as Laboratory: Undersea Vents as Models for Ocean Acidification, Carbon Capture, and the Unknown

Like champagne bubbles rising from the sea floor, liquid carbon dioxide (CO$_2$) was identified by OAR scientists and colleagues during a 2004 voyage to the Submarine Ring of Fire – volcanoes lying along the Marianas Arc in the western Pacific. Located approximately one mile below the surface, the pressure of the water column is so great that the gas forms a liquid. Researchers with OAR’s Pacific Marine Environmental Laboratory (PMEL) and Office of Ocean Exploration and Research (OER) had found a natural laboratory where the effects of carbon dioxide on marine organisms could be studied.

The significance of this liquid CO$_2$ discovery relates to changes in ocean chemistry resulting from climate change. About one-third of the world’s carbon dioxide is absorbed by the ocean, which has led to ocean acidification. PMEL researchers and colleagues asked how their underwater liquid CO$_2$ discovery could help them understand and possibly predict the effects of ocean acidification.

Using special technology deployed from a robotic submersible, the scientists collected samples. The Champagne Vent field, where the liquid CO$_2$ was found, also spews out hot gas-rich fluid. Back in the lab, the scientists found that the vent was a high carbon flux system, rich in CO$_2$. Not only is this finding important for studying ocean acidification in a natural state and the ocean’s role in carbon cycling, but it also may be an important model for studying carbon sequestration, a method for taking excess carbon from the air and storing it in the ocean’s depths.

The expedition has been called “path finding” by many in the ocean community, and underscores the fact that there is so much to learn about one of the Earth’s most important features – the ocean.

**Impact**

Tapping the potential of previously unknown ocean resources

Ocean exploration is discovering the unknown. The ocean is a vast resource full of unidentified organisms, which might produce a cure for cancer or a biotechnology that can be harnessed for alternative fuel production.

“We were just going from one incredible event to the next, seeing things we had never witnessed before.”

Bill Chadwick, volcanologist, OAR’s Cooperative Institute for Marine Resources Studies at Oregon State University.

Learn More:
http://oceanexplorer.noaa.gov/explorations/04fire/welcome.html

*Images, top to bottom: A champagne vent, where bubbles of liquid CO$_2$ escape from the white chimneys and surrounding seafloor; bathymetry of Eifuku in the Marianas Arc where liquid CO$_2$ vents were found.*
The ocean covers more than 70 percent of the Earth’s surface, driving weather, regulating temperature, and supporting life on this planet. The ocean remains 95 percent unexplored, unknown, and unseen by human eyes.

**“America’s Ship for Ocean Exploration”: New Technologies Bring the Excitement of Real-time Discovery Ashore**

Stay dry, and explore the ocean from the comfort of your living room! Through technologies aboard the NOAA Ship *Okeanos Explorer* – the only vessel in the world dedicated to ocean exploration – OAR’s Office of Ocean Exploration and Research has launched a new paradigm for exploration, giving shore-based explorers of all ages access to the excitement of real-time discovery.

Commissioned in August 2008, the *Okeanos Explorer* is outfitted with a deep-water mapping system, remotely-operated vehicles (ROVs), and unique “telepresence” technology. This newest member of the NOAA fleet will explore our largely unknown ocean for the purpose of discovery and advancing knowledge.

The deep-diving ROV system – capable of operating at depths of 6,000 meters – consists of a maneuverable vehicle fully equipped to collect high-definition video and take samples of its surroundings and a non-maneuverable “camera sled,” positioned to film as it investigates interesting features and habitats.

Telepresence, is the key technology that promises to change ocean exploration fundamentally. Traditionally, scientists explore the ocean from the ship. In contrast, telepresence uses real-time broadband satellite communications and high-speed Internet to bring the ship and its discoveries to scientists. When situated at any of five Command Centers, scientists also can interact directly with the *Okeanos Explorer* and remotely participate remotely in each mission.

Also, anyone with a computer and web access can watch and listen in on operations aboard ship, bringing real-time exploration into living rooms, offices, schools, and businesses around the globe. Our goals are to advance knowledge and, at the same time, excite and engage people so they are able to make informed decisions about environmental issues that relate to the ocean, climate, and life on our planet. We also hope to inspire a new generation of oceanographers, scientists, and engineers.

Images, top to bottom: NOAA Ship Okeanos Explorer; NOAA research diver; high school students investigating water quality as part of the NOAA Emerging Scientist Program.