Past Roger Revelle Lectures

Dr. Paul G. Falkowski

Institute of Marine and Coastal Sciences and the Department of Earth and Planetary Science, Rutgers University

The Once and Future Ocean

The ocean has been a feature of Earth's surface for at least 4 of the past 4.5 billion years and has provided the primary environment for the evolution of microbes that drive the biogeochemical cycles on Earth. Over this long period of time, the ocean has witnessed extreme changes, ranging from complete coverage with ice to extensive periods when there was no ice at all and from periods of extraordinary extinction of animal life to periods of dramatic evolutionary radiation of animals. Throughout all of Earth's history, the ocean has served as the primary backbone of life on the planet, and the core metabolic processes have been successfully transferred across vast stretches of geological time. Humans, in contrast, evolved only about 200,000 years ago and, in that short period of time, have come to outcompete and plunder many of Earth's living resources successfully. Over the past 100 years, in particular, we have increasingly altered the trophic structure of the ocean as well as its physical circulation and chemical properties. While human impacts will surely alter ecosystem functions, the core metabolism of the ocean will go on. Rather, ironically, humans are the fragile species that will lose capabilities of using the ocean as a source of food and novel molecules. Our future is intimately tied to that of the ocean. We have to begin viewing the ocean as a key component of the Earth system--one that we cannot live without.
Dr. Michael Freilich

Earth Science Division, National Aeronautics and Space Administration

Looking Down on the Seas: How Satellites are Revolutionizing our Understanding of the Ocean

Satellites have fundamentally transformed the way we observe the ocean and its properties. Global measurements of sea-surface temperature, sea level, wind forcing, ocean color, and sea ice cover are obtained by satellite-borne instruments on an almost routine basis. Satellite observations have helped illuminate the ways in which ocean currents and biology respond to changes in winds and solar energy. Dr. Freilich discussed some of the satellite measurement techniques and recent scientific findings that have advanced our knowledge of the role of the oceans in the Earth’s climate system. He explored the future of satellite oceanography and the potential to forecast ocean conditions in much the same way as we forecast weather today.

Dr. Ken Caldeira

Department of Global Ecology, Carnegie Institution of Washington, Stanford University

What Corals Are Dying to Tell Us about Carbon Dioxide and Ocean Acidification

Most of the carbon dioxide emissions from burning coal, oil, and gas are ultimately absorbed by the ocean. Carbon dioxide reacts with seawater to form carbonic acid; this acid can dissolve the shells and skeletons of marine organisms. The current trend of increasing carbon dioxide emissions threatens the extinction of many types of marine organisms, including corals, with unknown consequences for marine ecosystems globally. Dr. Caldeira discussed what is known about ocean acidification, the environmental
consequences, and actions that could be taken to avoid the risk of environmental catastrophe in our oceans.

Dr. Roger Pielke, Jr.

Director, Center for Science and Technology Policy Research, and Professor, University of Colorado

Listen to Lecture

Disasters, Death and Destruction: Accounting for Recent Calamities

The recent devastation caused by Hurricane Katrina, the Indian Ocean tsunami, and South Asian earthquake has kept natural disasters at the focus of our attention. The past decades have seen a spectacular series of catastrophes around the world with ever increasing economic losses and horrific loss of life. The recent spate of disasters has created two common perceptions among decision makers and the general public.

First, there is a sense that the economic impacts associated with extreme events have increased in recent years. Second, given that a human influence on the climate system has been well established, a perception exists that the recent increase in weather-related disasters like floods and hurricanes is in some way related to changes in climate.

These perceptions beg two questions:

• Have loss of life and damages associated with extreme weather events actually increased in recent years?
• What factors account for observed trends in the impacts of weather on society?
The answers to these questions are more than simply idle speculations—they underlie policy decisions with important social, economic, and political ramifications, such as disaster preparations, insurance, international climate change negotiations, and policies for scientific research. Because policy is based in part on the perceptions that policy makers hold about weather and climate, it is worth determining the answers to the two questions in a scientifically rigorous manner. This lecture discussed trends in loss of life and damages associated with disasters with a focus on extreme weather events. It also discussed factors which account for the observed trends and the state of our knowledge in this area. It concluded with a discussion of implications for policy and research related natural hazards and global climate change.

**Dr. Richard B. Alley**

_Evan Pugh Professor of Geosciences and Associate of the EMS Environment Institute, Pennsylvania State University_

**Abrupt Climate Change, Oceans, and Us**

Are we "rocking the boat" when it comes to climate? Explorations of the Earth's history show that when the climate system has been forced across a threshold, it can abruptly shift to a new climate, much like a tipping canoe that suddenly capsizes. These shifts have occurred within a single human generation, taking as little as a decade to move from a cooler to warmer climate or vice versa. The ocean acts as a major driver of our planet's climate machinery, in part through its capacity to store and transport heat in major ocean currents such as the Gulf Stream. Past abrupt climate changes have disrupted ocean circulation, collapsed ice sheets, and produced major shifts in regional weather patterns (e.g. droughts, floods, severe storms) that have had widespread
impacts on the environment and human communities. Because human activities affect the air, water, ice, and ecosystems that drive the earth's climate machinery, humans could increase the chance of an abrupt climate change in the foreseeable future.

Admiral James D. Watkins

Chair, U.S. Commission on Ocean Policy

Our Oceans

Good science and good policy are inextricably intertwined. Nowhere is this more evident than in the area of ocean policy. Decisions are made every day with important economic and environmental consequences: How many fish should we catch? Where and how should we extract critical resources from the sea? How can we promote coastal tourism without damaging the very resources people come to enjoy? What kinds of climate change and fluctuations can we expect in the short and long term? None of these questions can be answered without a strong understanding of ocean and coastal processes and a robust observing system to monitor the ocean realm.

Dr. Michael K. Orbach

Director, Marine Laboratory, Duke University

Beyond the Freedom of the Seas: Ocean Policy for the Third Millennium

Up until the end of the first millenium anno Domini humans used the oceans primarily at their margins, lacking the desire or the ability to
venture further out to sea. In the second millenium humans exploded in their exploration of the seas, crossing, charting and beginning to exploit the spaces and resources of most of the world's oceans, at least to the depth of a few hundred fathoms.

In the last half of this second millenium, the formal doctrine of mare liberum, "freedom of the seas", emerged under which most uses of the world's oceans remained unregulated within any common community except for the constraints of individual nation states upon their own citizens. This "freedom of the seas" doctrine emerged for a very practical reason: No single nation or group of nations could effectively either monitor or control activities on the oceans except within fairly close proximity to land, and thus the "freedom" approach emerged as the negotiated compromise. Incursions have been made into this "freedom", notably in the 200-mile extensions of jurisdiction among coastal nations in the 1970s and 80s and in such proposals as the Common Heritage of Mankind approach to ocean resources advanced during the United Nations Law of the Sea negotiations. However, most of the world's oceans still remain in a state of "freedom" as an unregulated commons.

This "freedom" has had tragic consequences for many of the living marine resources and for water quality and habitat of the world's oceans as well as promoting unnecessary competition and conflict over ocean space and resources. We now have the technological capability to monitor and, if we wish, control human activities virtually anywhere on the world's ocean. This presentation presented alternative futures for the governance of the world's oceans and their resources, "beyond the freedom of the seas" and into the third millenium.

Dr. Marcia K. McNutt

Director, U.S. Geological Survey

Ocean Exploration
The ocean is essential to life on Earth: it is Earth's largest living space and contains most of its biomass. The ocean moderates climate to keep Earth habitable, recycles our wastes, and provides an inexpensive source of protein to feed the global population. Yet 95 percent of the ocean remains unknown and unexplored. Now, thanks to a number of technological innovations, we have the tool necessary to undertake a systematic exploration of the ocean. Autonomous vehicles can be programmed to execute precise underwater surveys lasting up to week without pause. Remotely operated vehicles equipped with physical, chemical, an biological sensors function as our eyes, ears, noses, and hands in the deep sea. New data management systems permit the systematic archiving of information, allowing subsequent generations of researchers around the world to answer questions not contemplated at the time the data were collected. Much has been learned about the oceans through traditional research programs. But research is different from exploration. While research attempts to find answers, exploration inevitably uncovers new questions. Ocean exploration brings great, but often unpredictable, rewards: cures for diseases from novel biological compounds, untapped mineral, energy, and biological resources, new insight into how the ocean functions, geological and biological vistas of unsurpassed beauty, and renewed appreciation for mankind's maritime past. The time is ripe to launch a major international program of ocean exploration with all the benefits it will bring.

Dr. Shirley A. Pomponi

President and CEO, Harbor Branch Oceanographic Institution

The Oceans and Human Health: The Discovery and Development of Marine-Derived Drugs

The oceans are a rich source of both biological and chemical diversity. During the past two decades, thousands of novel marine-derived biochemicals have been
identified. Many have the potential for development as new pharmaceuticals to treat diseases such as cancer and drug-resistant infections. The challenges facing continued discovery are both technical, such as developing new tools to explore habitats and collect and test organisms never before studied, as well as political, such as complying with regulations related to the rights of a country to its natural resources. Successful discovery and development of marine derived pharmaceuticals will depend on our ability to address a number of questions. What organism produces the bioactive compound, and why? Can we apply this knowledge to our rapidly increasing understanding of the human genome and human disease processes? Are there viable alternatives to harvesting for sustainable use of marine natural resources for drug development? And finally, what constitutes a fair and equitable sharing of revenues resulting from commercialization of marine resources, as mandated by the U.N. Convention on Biological Diversity? Addressing these questions will require the collaboration of marine and biomedical scientists and the cooperation of industry and government.

Dr. Peter Brewer

Senior Scientist, Monterey Bay Aquarium Research Institute

Contemplating Action: Storing Carbon Dioxide in the Ocean

Concerns about global climate change suggest that we should level off, or even decrease, atmospheric carbon dioxide. Recent advances in ocean science hint at the possibility of taking active steps to achieve this. Experiments have shown that it is possible to inject carbon dioxide directly into the deep ocean, where it forms a solid gas hydrate. Other options have also been explored, such as fertilizing seawater to speed up the growth of microscopic plants that consume carbon dioxide. If we want
to hold carbon dioxide levels steady, large interventions will be necessary. Is this even possible? And would there be unforeseen environmental consequences? Forty-two years after Roger Revelle's analysis of the "greenhouse" problem, society may be ready to take action through active use of the enormous buffering capacity of the ocean.