



Like a canary in a coal mine, marine bacteria living on Oregon's coast are sensitive to changes in their environment such as water temperature fluctuations or an influx of pollution. Scientists and engineers at the Center for Coastal Margin Observation and Prediction (CMOP) are exploring the ability to monitor changes in microbial communities to assess climate change and human influence on the Washington-Oregon coast.

MICROSCOPIC MARINE LIFE MAY HOLD CLUES TO CLIMATE CHANGE

SCIENTISTS WILL USE MICROBES, NEW SENSORS TO MONITOR THE HEALTH OF THE PACIFIC NORTHWEST COAST

BY KRIS LUDWIG

Headquartered at Oregon Health & Science University (OHSU) in Beaverton, Oregon, CMOP is one of two National Science Foundation-supported Science and Technology Centers (STCs) that focus on the ocean. It is the first STC dedicated to researching the health of the ocean and the impact of human activity in the Oregon-Washington coastal margin, where the Columbia River meets the Pacific Ocean.

With more than 40 collaborators, CMOP is embarking on a mission to fuse innovative interdisciplinary research, technology, and education to answer complicated questions about the interactions between the ocean, Earth's climate, and humans. Participants include researchers at Oregon State University (OSU) and the University of Washington (UW), computer scientists from several partner universities as well as industry partners Intel and IBM, leaders from the Institute for Tribal Government, educators from local outreach programs and high schools, and engineers from the UW Applied Physics Lab (UW-APL) and WET (Western Environmental Technology) Labs, Philomath, Ore.

Coastal margins mark the interface of rivers and oceans. Natural features such as estuaries, freshwater and sediment plumes, continental shelves, watersheds, and rivers are all part of coastal margins. These zones are found all over the world and mark unique and ever-changing environments where constant fluxes in temperature and

salinity—and human activity—affect populations at every level of the food chain.

Increasingly the focus of scientific study, the coastal margin of Oregon and Washington is a natural laboratory. The Columbia River flows more than 1,200 miles from its headwaters in British Columbia. Famous for providing Lewis and Clark with a gateway to the Pacific, the “mighty Columbia” ranks first in freshwater input to the Pacific Ocean in the Western Hemisphere. It is the lifeblood for a dense population founded on a rich economy of trade, fishing, logging, recreation, and hydroelectric power industries in the Northwest.

Because of the economic and societal importance of coastal margins, oceanographers have long studied the physical and chemical conditions within these dynamic environments. They have quantified the seasonal fluxes of sediment discharged by the river to the sea, the changes in salinity as a result of melting snow, the trends in ocean temperature as a result of El Niño events, and the impacts of these changes on seasonal salmon runs. However, the role of microorganisms living within the coastal zone remains poorly understood, and these microorganisms may hold clues to understanding and even predicting the physical and chemical changes that long have been observed in the ocean and atmosphere.

CMOP director Antônio Baptista describes the microbial world of

coastal margins as the “black box” in trying to understand the coastal margin ecosystem. With CMOP, he explains, “we really are trying to use new techniques that come from environmental genomics and open that box, and look carefully at what these microbial populations are doing.”

CMOP researchers ultimately will try to correlate microbial populations in the coastal zone with changes in climate. “Microbes are probably the first organisms to respond to environmental changes,” says postdoctoral researcher Isaac K’Owino of OHSU. “So if a human being can rely on the information that can be provided by these tiny organisms, then they’ll be more prepared for environmental changes.”

CMOP science revolves around three themes: applications of coastal margin observatories, improved understanding of coastal margin ecosystems, and creation of coastal margin observation and prediction technologies.

This integrated research program would not be possible without an STC, says CMOP co-director David Martin of UW-APL. In the coastal zone, “everything is interconnected—the hydrosphere, the lithosphere, the chemosphere, the biosphere, the atmosphere,” he observes. Trying to understand the entire ecosystem would be impossible through the myopic view of one discipline. □

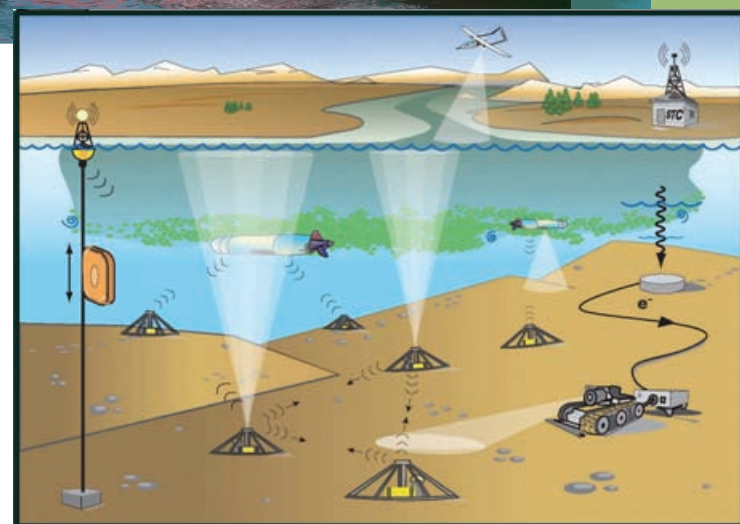
At top: The Pacific Ocean and Oregon Coast from Cape Lookout State Park. Photo: © AJ Steffani Photography

At left: Ninety feet below the surface of the Pacific, OHSU diver Michael Wilkin grasps a mooring cable that anchors an ocean observing buoy to the seafloor. Photo: Jon Graves, OHSU



Above: OHSU field staff members Michael Wilkin and Jon Graves rewire an ocean observing buoy on a calm day in the Pacific Ocean west of Seaside, Oregon. Photo: Courtesy of CMOP

At right: An artist's rendering of the CMOP sensor network. CMOP research will involve advanced observation and modeling technologies, including a range of underwater platforms. Photo: Bruce Howe, UW/APL



AN UNDERWATER SATURN

At the heart of CMOP's environmental prediction abilities is a new observatory named "SATURN" that will be installed on the seafloor of Oregon's coastal zone. Completely unoccupied by humans, SATURN will be equipped with sensors to monitor changes in everything from salinity and temperature to microbial gene expression and bacterial diversity on a 24/7 basis. Instruments will transmit data to scientists working on shore. Via the Internet, scientists working on the East Coast will be able to see the same stream of data as colleagues in Oregon or elsewhere.

At first, the SATURN observatory sounds like something lifted from science fiction. But in many ways, SATURN is representative of the future of ocean sciences, in which integrated data sets are collected remotely over sustained periods of

time. CMOP engineers are already designing the prototypes of SATURN's instruments and expect to deploy the first sensors within the next two to three years. Tom Sanford at UW-APL is devising an instrument that will exploit changes in electrical currents to estimate vertical profiles of salinity. Engineers at UW-APL and OSU are designing torpedo-shaped, unmanned underwater vehicles that will continuously monitor the continental shelf and examine freshwater plumes. Biosensors are the focus of research in Holly Simon's lab at OHSU. These gadgets will detect changes in the composition and activities of microbial communities. Researchers expect that these biosensors will ultimately help them understand the coastal margin ecosystem, and how it responds to natural variability and anthropogenic inputs.



THE NEXT WAVE IN OCEAN SENSING

On a research cruise to the Columbia River estuary and coastal zone in August 2007, CMOP scientists will identify and profile underwater microscopic residents by sampling different environments within the estuary and across the continental shelf. The effort, led by assistant professor Byron Crump of the University of Maryland Center for Environmental Science and postdoctoral researcher Lydie Herfort of OHSU, is expected to produce results not unlike a census survey: the goal is to see "who's there." Data from this expedition ultimately will be used to help design underwater sensors that will be part of a permanent seafloor observatory.

In the next two to three years, CMOP scientists will have a first crack at putting their new instruments to the test. Sensors that use chemical changes as a proxy for biological activity will help researchers understand how the coastal margin ecosystem responds to changes in the environment. CMOP plans to deploy Tom Sanford's salinity sensor and biosensors developed by Holly Simon and Isaac K'Owino in the ever-changing waters of the Columbia River coastal zone. Sensors will transmit real-time data to shore via the Internet.

PORTLAND'S DOWNTOWN WATERFRONT: SITE OF FUTURE CMOP FACILITY

Portland's waterfront will become the new headquarters of CMOP team science. In five to seven years, CMOP is expected to move to a new space on the Willamette River in downtown Portland. The space will host office, lab, and classroom areas and will feature interactive displays highlighting CMOP's unique blend of science, technology, and education focused on coastal margins.

At top: OHSU diver Michael Wilkin prepares sensors for deployment at the Marsh Island station of the CORIE observation network in the Columbia River estuary. Photo: Courtesy of CMOP



CMOP IN THE CLASSROOM CONNECTING STUDENTS WITH THE SEA

To establish an "enduring pipeline" of scientists, engineers, and citizens capable of using a systems approach to addressing complex problems, CMOP is creating education and outreach programs for students and instructors at the K-12 and university levels.

Higher education and diversity director Vanessa Green is developing multidisciplinary graduate degree "tracks" at OHSU that will be accessible to CMOP graduate students attending any of the partner institutions. Students in the Environmental Information Technology track will enroll in a variety of courses ranging from aquatic chemistry and bioremediation to software design and digital signal processing. Students in the Environmental and Biomolecular Systems track will receive training to understand and solve complex environmental problems through integrative studies across multiple scales, from molecular to global. "There is a growing awareness in the U.S. of the need to focus on environmental issues in general," says Green. She sees CMOP as an educational crossroads, providing students with "many ways to intersect with a very specific mission" focused on coastal margins.

CMOP also is developing a science enrichment curriculum for middle and high school students through a partnership with The SMILE

(Science and Math Investigative Learning Experiences) Program, OSU's successful academic enrichment and college readiness program. Director of K-12 education Karen Wegner is developing CMOP's CoaCh (Coastal Challenge) series, extending SMILE's courses for high school students to address timely coastal margin themes.

CMOP will deliver CoaCh in several ways: as an after-school program, as a nine-week in-class integrated science curriculum, and as an interactive module on the CMOP education Web site. The after-school enrichment program begins during the fall of 2007, with the in-class curriculum to follow. With the Internet, Wegner envisions expanding CoaCh to include individuals and schools across the country. "We think it's one of the best ways that we can reach a national audience."

Portland-area high school students will soon have the opportunity to hone their public speaking skills while learning about marine science and policy. Wegner is developing a speech and debate program based on ocean science policy and issues. CMOP will also host regular workshops for researchers to help them understand the importance of their roles as educators beyond the university environment, and to help them learn to be more effective communicators outside of their scientific communities.

At top: OHSU divers Michael Wilkin and Jon Graves. Photo: Courtesy of CMOP

MEET THE DIRECTOR

António Baptista

CMOP director António Baptista sees Oregon's coast as the ideal laboratory for studying the impact of climate change variability in coastal margins. He is no stranger to establishing collaborative programs.

Ten years ago, he began work on CORIE, the precursor to CMOP's SATURN seafloor observatory. In 2000, he was the founding member of OHSU's Department of Environmental and Biomolecular Systems, which merged environmental science and engineering with biochemistry and molecular biology. For Baptista, creating CMOP seemed to be a logical step forward in the evolution of team science.

With CMOP, "we are going to have to understand difficult systems across scales, and we are going to have to understand the biology of these systems in an ecosystem context," says Baptista. "Because of its size and duration, the center provides a mechanism to achieve that and in the process make fundamental contributions to education, knowledge transfer, and workforce diversity."

With the responsibility of coordinating more than 40 partners in research, industry, and education, Baptista is a busy man. He is convinced "the days have shrunk" and admits, "this does not compare with anything that I have done before." Despite the seemingly shorter days, Baptista's belief in team science shines: CMOP "has to be a transformative agent for the field of ocean sciences and that's what we are trying to do."



CMOP director António Baptista. Photo: OHSU News and Publications